EUROPEAN COMMISSION
Communications Networks, Content and Technology

Future Networks
**Cloud & Software**


# GRANT AGREEMENT

## NUMBER — 731529 — STAMP

This **Agreement** ('the Agreement') is **between** the following parties:

**on the one part,**

the **European Union** ('the EU'), represented by the European Commission ('the Commission'),

represented for the purposes of signature of this Agreement by Head of Unit, Communications Networks, Contents & technology, Digital Society, Trust & Cyber Security, Administration and Finance, Griet VAN CAENEGEM,

**and**

**on the other part,**

1. 'the coordinator':

**INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE (INRIA)**, 180089047, established in DOMAINE DE VOLUCEAU ROCQUENCOURT, LE CHESNAY CEDEX 78153, France, VAT number FR45180089047, represented for the purposes of signing the Agreement by CEO, Antoine PETIT

and the following other beneficiaries, if they sign their 'Accession Form' (see Annex 3 and Article 56):

2. **STIFTELSEN SINTEF (SINTEF)** NO1, 948007029, established in STRINDVEIEN 4, TRONDHEIM 7034, Norway, VAT number NO948007029MVA,

3. **TECHNISCHE UNIVERSITEIT DELFT (TUD)**, 27364265, established in STEVINWEG 1, DELFT 2628 CN, Netherlands, VAT number NL001569569B01,

4. **OW2 CONSORTIUM ASSOCIATION (OW2)** FR3, 499409712, established in AV JEAN JAURES 7, LES CLAYES SOUS BOIS 78340, France,

5. **ENGINEERING - INGEGNERIA INFORMATICA SPA (ENG)** SPA, 531128/ CF00967720285, established in Via San Martino Della Battaglia 56, ROMA 00185, Italy, VAT number IT05724831002,

6. **TELLU AS (TellU)** AS, 989743295, established in LENSMANNSLIA 4, ASKER 1386, Norway, VAT number NO989743295MVA,

7. **XWIKI SAS (XWiki)** SAS, 477865281, established in RUE DUBAN 15, PARIS 75016, France, VAT number FR69477865281,

8. **ATOS SPAIN SA (ATOS)** SA, M64516, established in CALLE DE ALBARRACIN 25, MADRID 28037, Spain, VAT number ESA28240752,

9. **ACTIVEEON (AEon)** SAS, 500 807 284, established in ROUTE DES LUCIOLES LES ALGORITHMES BAT PYTHAGORE B SOPHIA ANTIPOLIS 2000, VALBONNE 06560, France, VAT number FR19500807284,

Unless otherwise specified, references to 'beneficiary' or 'beneficiaries' include the coordinator.

The parties referred to above have agreed to enter into the Agreement under the terms and conditions below.

By signing the Agreement or the Accession Form, the beneficiaries accept the grant and agree to implement it under their own responsibility and in accordance with the Agreement, with all the obligations and conditions it sets out.

The Agreement is composed of:

Terms and Conditions

Annex 1 Description of the action

Annex 2 Estimated budget for the action

2a Additional information on the estimated budget

Annex 3 Accession Forms

Annex 4 Model for the financial statements

Annex 5 Model for the certificate on the financial statements

Annex 6 Model for the certificate on the methodology

# TERMS AND CONDITIONS

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# CHAPTER 1 GENERAL

## ARTICLE 1 — SUBJECT OF THE AGREEMENT

This Agreement sets out the rights and obligations and the terms and conditions applicable to the grant awarded to the beneficiaries for implementing the action set out in Chapter 2.

# CHAPTER 2 ACTION

## ARTICLE 2 — ACTION TO BE IMPLEMENTED

The grant is awarded for the action entitled '**Software Testing AMPlification — STAMP**' **('action')**, as described in Annex 1.

## ARTICLE 3 — DURATION AND STARTING DATE OF THE ACTION

The duration of the action will be **36 months** as of 1 December 2016 ('**starting date of the action**').

## ARTICLE 4 — ESTIMATED BUDGET AND BUDGET TRANSFERS

### 4.1 Estimated budget

The '**estimated budget**' for the action is set out in Annex 2.

It contains the estimated eligible costs and the forms of costs, broken down by beneficiary (and linked third party) and budget category (see Articles 5, 6, and 14).

### 4.2 Budget transfers

The estimated budget breakdown indicated in Annex 2 may be adjusted — without an amendment (see Article 55) — by transfers of amounts between beneficiaries, budget categories and/or forms of costs set out in Annex 2, if the action is implemented as described in Annex 1.

However, the beneficiaries may not add costs relating to subcontracts not provided for in Annex 1, unless such additional subcontracts are approved by an amendment or in accordance with Article 13.

# CHAPTER 3 GRANT

## ARTICLE 5 — GRANT AMOUNT, FORM OF GRANT, REIMBURSEMENT RATES AND FORMS OF COSTS

### 5.1 Maximum grant amount

The '**maximum grant amount**' is **EUR 4,307,070.00** (four million three hundred and seven thousand seventy EURO).

### 5.2 Form of grant, reimbursement rates and forms of costs

The grant reimburses **100% of the action's eligible costs** (see Article 6) ('**reimbursement of eligible costs grant**') (see Annex 2).

The estimated eligible costs of the action are EUR **4,307,070.00** (four million three hundred and seven thousand seventy EURO).

Eligible costs (see Article 6) must be declared under the following forms ('**forms of costs**'):

(a) for **direct personnel costs**:

- as actually incurred costs (‘**actual costs**’) or
- on the basis of an amount per unit calculated by the beneficiary in accordance with its usual cost accounting practices (‘**unit costs**’).

Personnel **costs for SME owners** or **beneficiaries that are natural persons** not receiving a salary (see Article 6.2, Points A.4 and A.5) must be declared on the basis of the amount per unit set out in Annex 2a (**unit costs**);

(b) for **direct costs for subcontracting**: as actually incurred costs (**actual costs**);

(c) for **direct costs of providing financial support to third parties**: not applicable;

(d) for **other direct costs**: as actually incurred costs (**actual costs**);

(e) for **indirect costs**: on the basis of a flat-rate applied as set out in Article 6.2, Point E (‘**flat-rate costs**’);

(f) **specific cost category(ies):** not applicable.

### 5.3 Final grant amount — Calculation

The ‘**final grant amount**’ depends on the actual extent to which the action is implemented in accordance with the Agreement’s terms and conditions.

This amount is calculated by the Commission — when the payment of the balance is made (see Article 21.4) — in the following steps:

Step 1 – Application of the reimbursement rates to the eligible costs

Step 2 – Limit to the maximum grant amount

Step 3 – Reduction due to the no-profit rule

Step 4 – Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

#### 5.3.1 Step 1 — Application of the reimbursement rates to the eligible costs

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiaries and linked third parties (see Article 20) and approved by the Commission (see Article 21).

#### 5.3.2 Step 2 — Limit to the maximum grant amount

If the amount obtained following Step 1 is higher than the maximum grant amount set out in Article 5.1, it will be limited to the latter.

#### 5.3.3 Step 3 — Reduction due to the no-profit rule

The grant must not produce a profit.

'**Profit**' means the surplus of the amount obtained following Steps 1 and 2 plus the action's total receipts, over the action's total eligible costs.

The '**action's total eligible costs**' are the consolidated total eligible costs approved by the Commission.

The '**action's total receipts**' are the consolidated total receipts generated during its duration (see Article 3).

The following are considered **receipts**:

(a) income generated by the action; if the income is generated from selling equipment or other assets purchased under the Agreement, the receipt is up to the amount declared as eligible under the Agreement;

(b) financial contributions given by third parties to the beneficiary or to a linked third party specifically to be used for the action, and

(c) in-kind contributions provided by third parties free of charge and specifically to be used for the action, if they have been declared as eligible costs.

The following are however not considered receipts:

(a) income generated by exploiting the action's results (see Article 28);

(b) financial contributions by third parties, if they may be used to cover costs other than the eligible costs (see Article 6);

(c) financial contributions by third parties with no obligation to repay any amount unused at the end of the period set out in Article 3.

If there is a profit, it will be deducted from the amount obtained following Steps 1 and 2.

### 5.3.4 Step 4 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations — Reduced grant amount — Calculation

If the grant is reduced (see Article 43), the Commission will calculate the reduced grant amount by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the maximum grant amount set out in Article 5.1.

The final grant amount will be the lower of the following two:

- the amount obtained following Steps 1 to 3 or
- the reduced grant amount following Step 4.

### 5.4 Revised final grant amount — Calculation

If — after the payment of the balance (in particular, after checks, reviews, audits or investigations; see Article 22) — the Commission rejects costs (see Article 42) or reduces the grant (see Article 43), it will calculate the '**revised final grant amount**' for the beneficiary concerned by the findings.

This amount is calculated by the Commission on the basis of the findings, as follows:

- in case of **rejection of costs**: by applying the reimbursement rate to the revised eligible costs approved by the Commission for the beneficiary concerned;

- in case of **reduction of the grant**: by calculating the concerned beneficiary's share in the grant amount reduced in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations (see Article 43.2).

In case of **rejection of costs and reduction of the grant**, the revised final grant amount for the beneficiary concerned will be the lower of the two amounts above.

## ARTICLE 6 — ELIGIBLE AND INELIGIBLE COSTS

### 6.1 General conditions for costs to be eligible

'**Eligible costs**' are costs that meet the following criteria:

(a) for **actual costs**:

(i) they must be actually incurred by the beneficiary;

(ii) they must be incurred in the period set out in Article 3, with the exception of costs relating to the submission of the periodic report for the last reporting period and the final report (see Article 20);

(iii) they must be indicated in the estimated budget set out in Annex 2;

(iv) they must be incurred in connection with the action as described in Annex 1 and necessary for its implementation;

(v) they must be identifiable and verifiable, in particular recorded in the beneficiary's accounts in accordance with the accounting standards applicable in the country where the beneficiary is established and with the beneficiary's usual cost accounting practices;

(vi) they must comply with the applicable national law on taxes, labour and social security, and

(vii) they must be reasonable, justified and must comply with the principle of sound financial management, in particular regarding economy and efficiency;

(b) for **unit costs**:

(i) they must be calculated as follows:

{amounts per unit set out in Annex 2a or calculated by the beneficiary in accordance with its usual cost accounting practices (see Article 6.2, Point A)

multiplied by

the number of actual units};

(ii) the number of actual units must comply with the following conditions:

- the units must be actually used or produced in the period set out in Article 3;

- the units must be necessary for implementing the action or produced by it, and

- the number of units must be identifiable and verifiable, in particular supported by records and documentation (see Article 18);

(c) for **flat-rate costs**:

(i) they must be calculated by applying the flat-rate set out in Annex 2, and

(ii) the costs (actual costs or unit costs) to which the flat-rate is applied must comply with the conditions for eligibility set out in this Article.

**6.2 Specific conditions for costs to be eligible**

Costs are eligible if they comply with the general conditions (see above) and the specific conditions set out below for each of the following budget categories:

A. direct personnel costs;
B. direct costs of subcontracting;
C. not applicable;
D. other direct costs;
E. indirect costs;
F. not applicable.

'Direct costs' are costs that are directly linked to the action implementation and can therefore be attributed to it directly. They must not include any indirect costs (see Point E below).

'Indirect costs' are costs that are not directly linked to the action implementation and therefore cannot be attributed directly to it.

**A. Direct personnel costs**

**Types of eligible personnel costs**

A.1 Personnel costs are eligible, if they are related to personnel working for the beneficiary under an employment contract (or equivalent appointing act) and assigned to the action ('**costs for employees (or equivalent)**'). They must be limited to salaries (including during parental leave), social security contributions, taxes and other costs included in the **remuneration**, if they arise from national law or the employment contract (or equivalent appointing act).

Beneficiaries that are non-profit legal entities[1] may also declare as personnel costs **additional remuneration** for personnel assigned to the action (including payments on the basis of supplementary contracts regardless of their nature), if:

(a) it is part of the beneficiary's usual remuneration practices and is paid in a consistent manner whenever the same kind of work or expertise is required;

(b) the criteria used to calculate the supplementary payments are objective and generally applied by the beneficiary, regardless of the source of funding used.

[1] For the definition, see Article 2.1(14) of the Rules for Participation Regulation No 1290/2013: '**non-profit legal entity**' means a legal entity which by its legal form is non-profit-making or which has a legal or statutory obligation not to distribute profits to its shareholders or individual members.

Additional remuneration for personnel assigned to the action is eligible up to the following amount:

(a) if the person works full time and exclusively on the action during the full year: up to EUR 8 000;

(b) if the person works exclusively on the action but not full-time or not for the full year: up to the corresponding pro-rata amount of EUR 8 000, or

(c) if the person does not work exclusively on the action: up to a pro-rata amount calculated as follows:

{{EUR 8 000

divided by

the number of annual productive hours (see below)},

multiplied by

the number of hours that the person has worked on the action during the year}.

A.2 The **costs for natural persons working under a direct contract** with the beneficiary other than an employment contract are eligible personnel costs, if:

(a) the person works under the beneficiary's instructions and, unless otherwise agreed with the beneficiary, on the beneficiary's premises;

(b) the result of the work carried out belongs to the beneficiary, and

(c) the costs are not significantly different from those for personnel performing similar tasks under an employment contract with the beneficiary.

A.3 The **costs of personnel seconded by a third party against payment** are eligible personnel costs, if the conditions in Article 11.1 are met.

A.4 **Costs of owners** of beneficiaries that are small and medium-sized enterprises ('**SME owners**') who are working on the action and who do not receive a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2a multiplied by the number of actual hours worked on the action.

A.5 **Costs of 'beneficiaries that are natural persons'** not receiving a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2a multiplied by the number of actual hours worked on the action.

**Calculation**

Personnel costs must be calculated by the beneficiaries as follows:

{{hourly rate

multiplied by

the number of actual hours worked on the action},

plus

for non-profit legal entities: additional remuneration to personnel assigned to the action under the conditions set out above (Point A.1)}.

The number of actual hours declared for a person must be identifiable and verifiable (see Article 18).

The total number of hours declared in EU or Euratom grants, for a person for a year, cannot be higher than the annual productive hours used for the calculations of the hourly rate. Therefore, the maximum number of hours that can be declared for the grant is:

{the number of annual productive hours for the year (see below)

minus

total number of hours declared by the beneficiary for that person in that year for other EU or Euratom grants}.

The '**hourly rate**' is one of the following:

(a) for personnel costs declared as **actual costs:** the hourly rate is calculated *per full financial year*, as follows:

{actual annual personnel costs (excluding additional remuneration) for the person

divided by

number of annual productive hours}.

using the personnel costs and the number of productive hours for each full financial year covered by the reporting period concerned. If a financial year is not closed at the end of the reporting period, the beneficiaries must use the hourly rate of the last closed financial year available.

For the 'number of annual productive hours', the beneficiaries may choose one of the following:

(i) 'fixed number of hours': 1 720 hours for persons working full time (or corresponding pro-rata for persons not working full time);

(ii) 'individual annual productive hours': the total number of hours worked by the person in the year for the beneficiary, calculated as follows:

{annual workable hours of the person (according to the employment contract, applicable collective labour agreement or national law)

plus

overtime worked

minus

absences (such as sick leave and special leave)}.

'Annual workable hours' means the period during which the personnel must be working, at the employer's disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.

If the contract (or applicable collective labour agreement or national working time legislation) does not allow to determine the annual workable hours, this option cannot be used;

(iii) 'standard annual productive hours': the 'standard number of annual hours' generally applied by the beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the 'standard annual workable hours'.

If there is no applicable reference for the standard annual workable hours, this option cannot be used.

For all options, the actual time spent on **parental leave** by a person assigned to the action may be deducted from the number of annual productive hours.

As an alternative, beneficiaries may calculate the hourly rate *per month*, as follows:

{actual monthly personnel cost (excluding additional remuneration) for the person

divided by

{number of annual productive hours / 12}}

using the personnel costs for each month and (one twelfth of) the annual productive hours calculated according to either option (i) or (iii) above, i.e.:

- fixed number of hours or
- standard annual productive hours.

Time spent on **parental leave** may not be deducted when calculating the hourly rate per month. However, beneficiaries may declare personnel costs incurred in periods of parental leave in proportion to the time the person worked on the action in that financial year.

If parts of a basic remuneration are generated over a period longer than a month, the beneficiaries may include only the share which is generated in the month (irrespective of the amount actually paid for that month).

Each beneficiary must use only one option (per full financial year or per month) for each full financial year;

(b) for personnel costs declared on the basis of **unit costs**: the hourly rate is one of the following:

(i) for SME owners or beneficiaries that are natural persons: the hourly rate set out in Annex 2a (see Points A.4 and A.5 above), or

(ii) for personnel costs declared on the basis of the beneficiary's usual cost accounting practices: the hourly rate calculated by the beneficiary in accordance with its usual cost accounting practices, if:

- the cost accounting practices used are applied in a consistent manner, based on objective criteria, regardless of the source of funding;

- the hourly rate is calculated using the actual personnel costs recorded in the beneficiary's accounts, excluding any ineligible cost or costs included in other budget categories.

  The actual personnel costs may be adjusted by the beneficiary on the basis of budgeted or estimated elements. Those elements must be relevant for calculating the personnel costs, reasonable and correspond to objective and verifiable information;

and

- the hourly rate is calculated using the number of annual productive hours (see above).

**B. Direct costs of subcontracting** (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if the conditions in Article 13.1.1 are met.

**C. Direct costs of providing financial support to third parties**

Not applicable

**D. Other direct costs**

D.1 **Travel costs and related subsistence allowances** (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if they are in line with the beneficiary's usual practices on travel.

D.2 The **depreciation costs of equipment, infrastructure or other assets** (new or second-hand) as recorded in the beneficiary's accounts are eligible, if they were purchased in accordance with Article 10.1.1 and written off in accordance with international accounting standards and the beneficiary's usual accounting practices.

The **costs of renting or leasing** equipment, infrastructure or other assets (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are also eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets and do not include any financing fees.

The costs of equipment, infrastructure or other assets **contributed in-kind against payment** are eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets, do not include any financing fees and if the conditions in Article 11.1 are met.

The only portion of the costs that will be taken into account is that which corresponds to the duration of the action and rate of actual use for the purposes of the action.

D.3 **Costs of other goods and services** (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible, if they are:

(a) purchased specifically for the action and in accordance with Article 10.1.1 or

(b) contributed in kind against payment and in accordance with Article 11.1.

Such goods and services include, for instance, consumables and supplies, dissemination (including open access), protection of results, certificates on the financial statements (if they are required by the Agreement), certificates on the methodology, translations and publications.

D.4 **Capitalised and operating costs of 'large research infrastructure'**[2] directly used for the action are eligible, if:

(a) the value of the large research infrastructure represents at least 75% of the total fixed assets (at historical value in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure[3]);

(b) the beneficiary's methodology for declaring the costs for large research infrastructure has been positively assessed by the Commission ('**ex-ante assessment**');

(c) the beneficiary declares as direct eligible costs only the portion which corresponds to the duration of the action and the rate of actual use for the purposes of the action, and

(d) they comply with the conditions as further detailed in the annotations to the H2020 grant agreements.

**E. Indirect costs**

**Indirect costs** are eligible if they are declared on the basis of the flat-rate of 25% of the eligible direct costs (see Article 5.2 and Points A to D above), from which are excluded:

(a) costs of subcontracting and

(b) costs of in-kind contributions provided by third parties which are not used on the beneficiary's premises;

(c) not applicable;

(d) not applicable.

Beneficiaries receiving an operating grant[4] financed by the EU or Euratom budget cannot declare indirect costs for the period covered by the operating grant.

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[2] '**Large research infrastructure**' means research infrastructure of a total value of at least EUR 20 million, for a beneficiary, calculated as the sum of historical asset values of each individual research infrastructure of that beneficiary, as they appear in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure.

[3] For the definition, see Article 2(6) of the H2020 Framework Programme Regulation No 1291/2013: '**Research infrastructure**' are facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields. Where relevant, they may be used beyond research, e.g. for education or public services. They include: major scientific equipment (or sets of instruments); knowledge-based resources such as collections, archives or scientific data; e-infrastructures such as data and computing systems and communication networks; and any other infrastructure of a unique nature essential to achieve excellence in research and innovation. Such infrastructures may be 'single-sited', 'virtual' or 'distributed'.

[4] For the definition, see Article 121(1)(b) of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 ('**Financial Regulation No 966/2012**')(OJ L 218, 26.10.2012, p.1): '**operating grant**' means direct financial contribution, by way of donation, from the budget in order to finance the

**F. Specific cost category(ies)**

Not applicable

**6.3 Conditions for costs of linked third parties to be eligible**

**Costs incurred by linked third parties** are eligible if they fulfil — mutatis mutandis — the general and specific conditions for eligibility set out in this Article (Article 6.1 and 6.2) and Article 14.1.1.

**6.4 Conditions for in-kind contributions provided by third parties free of charge to be eligible**

**In-kind contributions provided free of charge** are eligible direct costs (for the beneficiary or linked third party), if the costs incurred by the third party fulfil — *mutatis mutandis* — the general and specific conditions for eligibility set out in this Article (Article 6.1 and 6.2) and Article 12.1.

**6.5 Ineligible costs**

'**Ineligible costs**' are:

(a) costs that do not comply with the conditions set out above (Article 6.1 to 6.4), in particular:

(i) costs related to return on capital;

(ii) debt and debt service charges;

(iii) provisions for future losses or debts;

(iv) interest owed;

(v) doubtful debts;

(vi) currency exchange losses;

(vii) bank costs charged by the beneficiary's bank for transfers from the Commission;

(viii) excessive or reckless expenditure;

(ix) deductible VAT;

(x) costs incurred during suspension of the implementation of the action (see Article 49);

(b) costs declared under another EU or Euratom grant (including grants awarded by a Member State and financed by the EU or Euratom budget and grants awarded by bodies other than the Commission for the purpose of implementing the EU or Euratom budget); in particular, indirect costs if the beneficiary is already receiving an operating grant financed by the EU or Euratom budget in the same period.

**6.6 Consequences of declaration of ineligible costs**

Declared costs that are ineligible will be rejected (see Article 42).

This may also lead to any of the other measures described in Chapter 6.

functioning of a body which pursues an aim of general EU interest or has an objective forming part of and supporting an EU policy.

# CHAPTER 4 RIGHTS AND OBLIGATIONS OF THE PARTIES

## SECTION 1 RIGHTS AND OBLIGATIONS RELATED TO IMPLEMENTING THE ACTION

### ARTICLE 7 — GENERAL OBLIGATION TO PROPERLY IMPLEMENT THE ACTION

#### 7.1 General obligation to properly implement the action

The beneficiaries must implement the action as described in Annex 1 and in compliance with the provisions of the Agreement and all legal obligations under applicable EU, international and national law.

#### 7.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

### ARTICLE 8 — RESOURCES TO IMPLEMENT THE ACTION — THIRD PARTIES INVOLVED IN THE ACTION

The beneficiaries must have the appropriate resources to implement the action.

If it is necessary to implement the action, the beneficiaries may:

- purchase goods, works and services (see Article 10);
- use in-kind contributions provided by third parties against payment (see Article 11);
- use in-kind contributions provided by third parties free of charge (see Article 12);
- call upon subcontractors to implement action tasks described in Annex 1 (see Article 13);
- call upon linked third parties to implement action tasks described in Annex 1 (see Article 14).

In these cases, the beneficiaries retain sole responsibility towards the Commission and the other beneficiaries for implementing the action.

### ARTICLE 9 — IMPLEMENTATION OF ACTION TASKS BY BENEFICIARIES NOT RECEIVING EU FUNDING

Not applicable

### ARTICLE 10 — PURCHASE OF GOODS, WORKS OR SERVICES

#### 10.1 Rules for purchasing goods, works or services

10.1.1 If necessary to implement the action, the beneficiaries may purchase goods, works or services.

The beneficiaries must make such purchases ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their contractors.

10.1.2 Beneficiaries that are 'contracting authorities' within the meaning of Directives 2004/18/EC[5] (or 2014/24/EC[6]) or 'contracting entities' within the meaning of Directive 2004/17/EC[7] (or 2014/25/EC[8]) must comply with the applicable national law on public procurement.

**10.2 Consequences of non-compliance**

If a beneficiary breaches any of its obligations under Article 10.1.1, the costs related to the contract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Article 10.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 11 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES AGAINST PAYMENT

**11.1 Rules for the use of in-kind contributions against payment**

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties against payment.

The beneficiaries may declare costs related to the payment of in-kind contributions as eligible (see Article 6.1 and 6.2), up to the third parties' costs for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services.

The third parties and their contributions must be set out in Annex 1. The Commission may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and

- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

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[5] Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public work contracts, public supply contracts and public service contracts (OJ L 134, 30.04.2004, p. 114).

[6] Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC. (OJ L 94, 28.03.2014, p. 65).

[7] Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors (OJ L 134, 30.04.2004, p. 1)

[8] Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC (OJ L 94, 28.03.2014, p. 243).

### 11.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the costs related to the payment of the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 12 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES FREE OF CHARGE

### 12.1 Rules for the use of in-kind contributions free of charge

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties free of charge.

The beneficiaries may declare costs incurred by the third parties for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services as eligible in accordance with Article 6.4.

The third parties and their contributions must be set out in Annex 1. The Commission may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and
- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

### 12.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the costs incurred by the third parties related to the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 13 — IMPLEMENTATION OF ACTION TASKS BY SUBCONTRACTORS

### 13.1 Rules for subcontracting action tasks

13.1.1 If necessary to implement the action, the beneficiaries may award subcontracts covering the implementation of certain action tasks described in Annex 1.

Subcontracting may cover only a limited part of the action.

The beneficiaries must award the subcontracts ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The tasks to be implemented and the estimated cost for each subcontract must be set out in Annex 1 and the total estimated costs of subcontracting per beneficiary must be set out in Annex 2. The Commission

may however approve subcontracts not set out in Annex 1 and 2 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and

- they do not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their subcontractors.

13.1.2 The beneficiaries must ensure that their obligations under Articles 35, 36, 38 and 46 also apply to the subcontractors.

Beneficiaries that are 'contracting authorities' within the meaning of Directive 2004/18/EC (or 2014/24/EU) or 'contracting entities' within the meaning of Directive 2004/17/EC (or 2014/25/EU) must comply with the applicable national law on public procurement.

### 13.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 13.1.1, the costs related to the subcontract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Article 13.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 14 — IMPLEMENTATION OF ACTION TASKS BY LINKED THIRD PARTIES

### 14.1 Rules for calling upon linked third parties to implement part of the action

14.1.1 The following **affiliated entities**[10] and **third parties with a legal link to a beneficiary**[11] ('**linked third parties**') may implement the action tasks attributed to them in Annex 1:

[10] For the definition, see Article 2.1(2) of the Rules for Participation Regulation No 1290/2013: '**affiliated entity**' means any legal entity that is:
- under the direct or indirect control of a participant, or
- under the same direct or indirect control as the participant, or
- directly or indirectly controlling a participant.

'Control' may take any of the following forms:
(a) the direct or indirect holding of more than 50% of the nominal value of the issued share capital in the legal entity concerned, or of a majority of the voting rights of the shareholders or associates of that entity;
(b) the direct or indirect holding, in fact or in law, of decision-making powers in the legal entity concerned.

However the following relationships between legal entities shall not in themselves be deemed to constitute controlling relationships:
(a) the same public investment corporation, institutional investor or venture-capital company has a direct or indirect holding of more than 50% of the nominal value of the issued share capital or a majority of voting rights of the shareholders or associates;
(b) the legal entities concerned are owned or supervised by the same public body.

[11] '**Third party with a legal link to a beneficiary**' is any legal entity which has a legal link to the beneficiary implying collaboration that is not limited to the action.

- UNIVERSITE DES SCIENCES ET TECHNOLOGIES DE LILLE - LILLE I (USTL), affiliated or linked to INRIA
- UNIVERSITE DE RENNES I (UR1), affiliated or linked to INRIA
- XWIKI SOFTWARE SRL (XWiki Romania), affiliated or linked to XWiki
- ATOS ORIGIN BILISIM DANISMANLIK VEMUSTERI HIZMETLERI SANAYI VE TICARET AS (ATOS TURKEY), affiliated or linked to ATOS

The linked third parties may declare as eligible the costs they incur for implementing the action tasks in accordance with Article 6.3.

The beneficiaries must ensure that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their linked third parties.

14.1.2 The beneficiaries must ensure that their obligations under Articles 18, 20, 35, 36 and 38 also apply to their linked third parties.

### 14.2 Consequences of non-compliance

If any obligation under Article 14.1.1 is breached, the costs of the linked third party will be ineligible (see Article 6) and will be rejected (see Article 42).

If any obligation under Article 14.1.2 is breached, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 15 — FINANCIAL SUPPORT TO THIRD PARTIES

### 15.1 Rules for providing financial support to third parties

Not applicable

### 15.2 Financial support in the form of prizes

Not applicable

### 15.3 Consequences of non-compliance

Not applicable

## ARTICLE 16 — PROVISION OF TRANS-NATIONAL OR VIRTUAL ACCESS TO RESEARCH INFRASTRUCTURE

### 16.1 Rules for providing trans-national access to research infrastructure

Not applicable

### 16.2 Rules for providing virtual access to research infrastructure

Not applicable

### 16.3 Consequences of non-compliance

Not applicable

## SECTION 2 RIGHTS AND OBLIGATIONS RELATED TO THE GRANT ADMINISTRATION

## ARTICLE 17 — GENERAL OBLIGATION TO INFORM

### 17.1 General obligation to provide information upon request

The beneficiaries must provide — during implementation of the action or afterwards and in accordance with Article 41.2 — any information requested in order to verify eligibility of the costs, proper implementation of the action and compliance with any other obligation under the Agreement.

### 17.2 Obligation to keep information up to date and to inform about events and circumstances likely to affect the Agreement

Each beneficiary must keep information stored in the Participant Portal Beneficiary Register (via the electronic exchange system; see Article 52) up to date, in particular, its name, address, legal representatives, legal form and organisation type.

Each beneficiary must immediately inform the coordinator — which must immediately inform the Commission and the other beneficiaries — of any of the following:

(a) **events** which are likely to affect significantly or delay the implementation of the action or the EU's financial interests, in particular:

(i) changes in its legal, financial, technical, organisational or ownership situation or those of its linked third parties and

(ii) changes in the name, address, legal form, organisation type of its linked third parties;

(b) **circumstances** affecting:

(i) the decision to award the grant or

(ii) compliance with requirements under the Agreement.

### 17.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 18 — KEEPING RECORDS — SUPPORTING DOCUMENTATION

### 18.1 Obligation to keep records and other supporting documentation

The beneficiaries must — for a period of five years after the payment of the balance — keep records and other supporting documentation in order to prove the proper implementation of the action and the costs they declare as eligible.

They must make them available upon request (see Article 17) or in the context of checks, reviews, audits or investigations (see Article 22).

If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Articles 22), the beneficiaries must keep the records and other supporting documentation until the end of these procedures.

The beneficiaries must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The Commission may accept non-original documents if it considers that they offer a comparable level of assurance.

### 18.1.1 Records and other supporting documentation on the scientific and technical implementation

The beneficiaries must keep records and other supporting documentation on scientific and technical implementation of the action in line with the accepted standards in the respective field.

### 18.1.2 Records and other documentation to support the costs declared

The beneficiaries must keep the records and documentation supporting the costs declared, in particular the following:

(a) for **actual costs**: adequate records and other supporting documentation to prove the costs declared, such as contracts, subcontracts, invoices and accounting records. In addition, the beneficiaries' usual cost accounting practices and internal control procedures must enable direct reconciliation between the amounts declared, the amounts recorded in their accounts and the amounts stated in the supporting documentation;

(b) for **unit costs**: adequate records and other supporting documentation to prove the number of units declared. Beneficiaries do not need to identify the actual eligible costs covered or to keep or provide supporting documentation (such as accounting statements) to prove the amount per unit.

In addition, **for direct personnel costs declared as unit costs calculated in accordance with the beneficiary's usual cost accounting practices**, the beneficiaries must keep adequate records and documentation to prove that the cost accounting practices used comply with the conditions set out in Article 6.2, Point A.

The beneficiaries and linked third parties may submit to the Commission, for approval, a certificate (drawn up in accordance with Annex 6) stating that their usual cost accounting practices comply with these conditions ('**certificate on the methodology**'). If the certificate is approved, costs declared in line with this methodology will not be challenged subsequently, unless the beneficiaries have concealed information for the purpose of the approval.

(c) for **flat-rate costs**: adequate records and other supporting documentation to prove the eligibility of the costs to which the flat-rate is applied. The beneficiaries do not need to identify the costs covered or provide supporting documentation (such as accounting statements) to prove the amount declared at a flat-rate.

In addition, for **personnel costs** (declared as actual costs or on the basis of unit costs), the beneficiaries must keep **time records** for the number of hours declared. The time records must be in writing and approved by the persons working on the action and their supervisors, at least monthly. In the absence

of reliable time records of the hours worked on the action, the Commission may accept alternative evidence supporting the number of hours declared, if it considers that it offers an adequate level of assurance.

As an exception, for **persons working exclusively on the action**, there is no need to keep time records, if the beneficiary signs a **declaration** confirming that the persons concerned have worked exclusively on the action.

For costs declared by linked third parties (see Article 14), it is the beneficiary that must keep the originals of the financial statements and the certificates on the financial statements of the linked third parties.

### 18.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, costs insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 42), and the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 19 — SUBMISSION OF DELIVERABLES

### 19.1 Obligation to submit deliverables

The coordinator must submit the '**deliverables**' identified in Annex 1, in accordance with the timing and conditions set out in it.

### 19.2 Consequences of non-compliance

If the coordinator breaches any of its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

## ARTICLE 20 — REPORTING — PAYMENT REQUESTS

### 20.1 Obligation to submit reports

The coordinator must submit to the Commission (see Article 52) the technical and financial reports set out in this Article. These reports include requests for payment and must be drawn up using the forms and templates provided in the electronic exchange system (see Article 52).

### 20.2 Reporting periods

The action is divided into the following '**reporting periods**':

- RP1: from month 1 to month 18
- RP2: from month 19 to month 36

### 20.3 Periodic reports — Requests for interim payments

The coordinator must submit a periodic report within 60 days following the end of each reporting period.

The **periodic report** must include the following:

(a) a '**periodic technical report**' containing:

(i) an **explanation of the work carried out** by the beneficiaries;

(ii) an **overview of the progress** towards the objectives of the action, including milestones and deliverables identified in Annex 1.

This report must include explanations justifying the differences between work expected to be carried out in accordance with Annex 1 and that actually carried out.

The report must detail the exploitation and dissemination of the results and — if required in Annex 1 — an updated '**plan for the exploitation and dissemination of the results**'.

The report must indicate the communication activities;

(iii) a **summary** for publication by the Commission;

(iv) the answers to the '**questionnaire**', covering issues related to the action implementation and the economic and societal impact, notably in the context of the Horizon 2020 key performance indicators and the Horizon 2020 monitoring requirements;

(b) a '**periodic financial report**' containing:

(i) an '**individual financial statement**' (see Annex 4) from each beneficiary and from each linked third party, for the reporting period concerned.

The individual financial statement must detail the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) for each budget category (see Annex 2).

The beneficiaries and linked third parties must declare all eligible costs, even if — for actual costs, unit costs and flat-rate costs — they exceed the amounts indicated in the estimated budget (see Annex 2). Amounts which are not declared in the individual financial statement will not be taken into account by the Commission.

If an individual financial statement is not submitted for a reporting period, it may be included in the periodic financial report for the next reporting period.

The individual financial statements of the last reporting period must also detail the **receipts of the action** (see Article 5.3.3).

Each beneficiary and each linked third party must **certify** that:

- the information provided is full, reliable and true;
- the costs declared are eligible (see Article 6);
- the costs can be substantiated by adequate records and supporting documentation (see Article 18) that will be produced upon request (see Article 17) or in the context of checks, reviews, audits and investigations (see Article 22), and
- for the last reporting period: that all the receipts have been declared (see Article 5.3.3);

(ii) an **explanation of the use of resources** and the information on subcontracting (see Article 13) and in-kind contributions provided by third parties (see Articles 11 and 12) from each beneficiary and from each linked third party, for the reporting period concerned;

(iii) not applicable;

(iv) a '**periodic summary financial statement**', created automatically by the electronic exchange system, consolidating the individual financial statements for the reporting period concerned and including — except for the last reporting period — the **request for interim payment**.

**20.4 Final report — Request for payment of the balance**

In addition to the periodic report for the last reporting period, the coordinator must submit the final report within 60 days following the end of the last reporting period.

The **final report** must include the following:

(a) a '**final technical report**' with a **summary** for publication containing:

(i) an overview of the results and their exploitation and dissemination;

(ii) the conclusions on the action, and

(iii) the socio-economic impact of the action;

(b) a '**final financial report**' containing:

(i) a '**final summary financial statement**', created automatically by the electronic exchange system, consolidating the individual financial statements for all reporting periods and including the **request for payment of the balance** and

(ii) a '**certificate on the financial statements**' (drawn up in accordance with Annex 5) for each beneficiary and for each linked third party, if it requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 5.2 and Article 6.2, Point A).

**20.5 Information on cumulative expenditure incurred**

Not applicable

**20.6 Currency for financial statements and conversion into euro**

Financial statements must be drafted in euro.

Beneficiaries and linked third parties with accounting established in a currency other than the euro must convert the costs recorded in their accounts into euro, at the average of the daily exchange rates published in the C series of the *Official Journal of the European Union*, calculated over the corresponding reporting period.

If no daily euro exchange rate is published in the *Official Journal of the European Union* for the currency in question, they must be converted at the average of the monthly accounting rates published on the Commission's website, calculated over the corresponding reporting period.

Beneficiaries and linked third parties with accounting established in euro must convert costs incurred in another currency into euro according to their usual accounting practices.

**20.7 Language of reports**

All reports (technical and financial reports, including financial statements) must be submitted in the language of the Agreement.

**20.8 Consequences of non-compliance**

If the reports submitted do not comply with this Article, the Commission may suspend the payment deadline (see Article 47) and apply any of the other measures described in Chapter 6.

If the coordinator breaches its obligation to submit the reports and if it fails to comply with this obligation within 30 days following a written reminder, the Commission may terminate the Agreement (see Article 50) or apply any of the other measures described in Chapter 6.

**ARTICLE 21 — PAYMENTS AND PAYMENT ARRANGEMENTS**

**21.1 Payments to be made**

The following payments will be made to the coordinator:

- one **pre-financing payment**;
- one or more **interim payments**, on the basis of the request(s) for interim payment (see Article 20), and
- one **payment of the balance**, on the basis of the request for payment of the balance (see Article 20).

**21.2 Pre-financing payment — Amount — Amount retained for the Guarantee Fund**

The aim of the pre-financing is to provide the beneficiaries with a float.

It remains the property of the EU until the payment of the balance.

The amount of the pre-financing payment will be EUR **3,445,656.00** (three million four hundred and forty five thousand six hundred and fifty six EURO).

The Commission will — except if Article 48 applies — make the pre-financing payment to the coordinator within 30 days, either from the entry into force of the Agreement (see Article 58) or from 10 days before the starting date of the action (see Article 3), whichever is the latest.

An amount of EUR **215,353.50** (two hundred and fifteen thousand three hundred and fifty three EURO and fifty eurocents), corresponding to 5% of the maximum grant amount (see Article 5.1), is retained by the Commission from the pre-financing payment and transferred into the '**Guarantee Fund**'.

**21.3 Interim payments — Amount — Calculation**

Interim payments reimburse the eligible costs incurred for the implementation of the action during the corresponding reporting periods.

The Commission will pay to the coordinator the amount due as interim payment within 90 days from receiving the periodic report (see Article 20.3), except if Articles 47 or 48 apply.

Payment is subject to the approval of the periodic report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as interim payment** is calculated by the Commission in the following steps:

Step 1 – Application of the reimbursement rates

Step 2 – Limit to 90% of the maximum grant amount

### 21.3.1 Step 1 — Application of the reimbursement rates

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs ; see Article 6) declared by the beneficiaries and the linked third parties (see Article 20) and approved by the Commission (see above) for the concerned reporting period.

### 21.3.2 Step 2 — Limit to 90% of the maximum grant amount

The total amount of pre-financing and interim payments must not exceed 90% of the maximum grant amount set out in Article 5.1. The maximum amount for the interim payment will be calculated as follows:

{90% of the maximum grant amount (see Article 5.1)

minus

{pre-financing and previous interim payments}}.

## 21.4 Payment of the balance — Amount — Calculation — Release of the amount retained for the Guarantee Fund

The payment of the balance reimburses the remaining part of the eligible costs incurred by the beneficiaries for the implementation of the action.

If the total amount of earlier payments is greater than the final grant amount (see Article 5.3), the payment of the balance takes the form of a recovery (see Article 44).

If the total amount of earlier payments is lower than the final grant amount, the Commission will pay the balance within 90 days from receiving the final report (see Article 20.4), except if Articles 47 or 48 apply.

Payment is subject to the approval of the final report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as the balance** is calculated by the Commission by deducting the total amount of pre-financing and interim payments (if any) already made, from the final grant amount determined in accordance with Article 5.3:

{final grant amount (see Article 5.3)

minus

{pre-financing and interim payments (if any) made}}.

At the payment of the balance, the amount retained for the Guarantee Fund (see above) will be released and:

- if the balance is positive: the amount released will be paid in full to the coordinator together with the amount due as the balance;

- if the balance is negative (payment of the balance taking the form of recovery): it will be deducted from the amount released (see Article 44.1.2). If the resulting amount:

    - is positive, it will be paid to the coordinator

    - is negative, it will be recovered.

The amount to be paid may however be offset — without the beneficiaries' consent — against any other amount owed by a beneficiary to the Commission or an executive agency (under the EU or Euratom budget), up to the maximum EU contribution indicated, for that beneficiary, in the estimated budget (see Annex 2).

**21.5 Notification of amounts due**

When making payments, the Commission will formally notify to the coordinator the amount due, specifying whether it concerns an interim payment or the payment of the balance.

For the payment of the balance, the notification will also specify the final grant amount.

In the case of reduction of the grant or recovery of undue amounts, the notification will be preceded by the contradictory procedure set out in Articles 43 and 44.

**21.6 Currency for payments**

The Commission will make all payments in euro.

**21.7 Payments to the coordinator — Distribution to the beneficiaries**

Payments will be made to the coordinator.

Payments to the coordinator will discharge the Commission from its payment obligation.

The coordinator must distribute the payments between the beneficiaries without unjustified delay.

Pre-financing may however be distributed only:

(a) if the minimum number of beneficiaries set out in the call for proposals has acceded to the Agreement (see Article 56) and

(b) to beneficiaries that have acceded to the Agreement (see Article 56).

**21.8 Bank account for payments**

All payments will be made to the following bank account:

Name of bank: TRESOR PUBLIC
Full name of the account holder: INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET AUTOMATIQUE INRIA
Full account number (including bank codes): ()
IBAN code: FR7610071780000000100634856

**21.9 Costs of payment transfers**

The cost of the payment transfers is borne as follows:

- the Commission bears the cost of transfers charged by its bank;
- the beneficiary bears the cost of transfers charged by its bank;
- the party causing a repetition of a transfer bears all costs of the repeated transfer.

**21.10 Date of payment**

Payments by the Commission are considered to have been carried out on the date when they are debited to its account.

**21.11 Consequences of non-compliance**

21.11.1 If the Commission does not pay within the payment deadlines (see above), the beneficiaries are entitled to **late-payment interest** at the rate applied by the European Central Bank (ECB) for its main refinancing operations in euros ('reference rate'), plus three and a half points. The reference rate is the rate in force on the first day of the month in which the payment deadline expires, as published in the C series of the *Official Journal of the European Union*.

If the late-payment interest is lower than or equal to EUR 200, it will be paid to the coordinator only upon request submitted within two months of receiving the late payment.

Late-payment interest is not due if all beneficiaries are EU Member States (including regional and local government authorities or other public bodies acting on behalf of a Member State for the purpose of this Agreement).

Suspension of the payment deadline or payments (see Articles 47 and 48) will not be considered as late payment.

Late-payment interest covers the period running from the day following the due date for payment (see above), up to and including the date of payment.

Late-payment interest is not considered for the purposes of calculating the final grant amount.

21.11.2 If the coordinator breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or the participation of the coordinator may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 22 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS

### 22.1 Checks, reviews and audits by the Commission

#### 22.1.1 Right to carry out checks

The Commission will — during the implementation of the action or afterwards — check the proper implementation of the action and compliance with the obligations under the Agreement, including assessing deliverables and reports.

For this purpose the Commission may be assisted by external persons or bodies.

The Commission may also request additional information in accordance with Article 17. The Commission may request beneficiaries to provide such information to it directly.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

#### 22.1.2 Right to carry out reviews

The Commission may — during the implementation of the action or afterwards — carry out reviews on the proper implementation of the action (including assessment of deliverables and reports), compliance with the obligations under the Agreement and continued scientific or technological relevance of the action.

Reviews may be started **up to two years after the payment of the balance**. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the review is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Commission may carry out reviews directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information and data in addition to deliverables and reports already submitted (including information on the use of resources). The Commission may request beneficiaries to provide such information to it directly.

The coordinator or beneficiary concerned may be requested to participate in meetings, including with external experts.

For **on-the-spot** reviews, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the review findings, a '**review report**' will be drawn up.

The Commission will formally notify the review report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations ('**contradictory review procedure**').

Reviews (including review reports) are in the language of the Agreement.

### 22.1.3 Right to carry out audits

The Commission may — during the implementation of the action or afterwards — carry out audits on the proper implementation of the action and compliance with the obligations under the Agreement.

Audits may be started **up to two years after the payment of the balance**. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the audit is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Commission may carry out audits directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information (including complete accounts, individual salary statements or other personal data) to verify compliance with the Agreement. The Commission may request beneficiaries to provide such information to it directly.

For **on-the-spot** audits, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the audit findings, a '**draft audit report**' will be drawn up.

The Commission will formally notify the draft audit report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations ('**contradictory audit procedure**'). This period may be extended by the Commission in justified cases.

The '**final audit report**' will take into account observations by the coordinator or beneficiary concerned. The report will be formally notified to it.

Audits (including audit reports) are in the language of the Agreement.

The Commission may also access the beneficiaries' statutory records for the periodical assessment of unit costs or flat-rate amounts.

### 22.2 Investigations by the European Anti-Fraud Office (OLAF)

Under Regulations No 883/2013[14] and No 2185/96[15] (and in accordance with their provisions and procedures), the European Anti-Fraud Office (OLAF) may — at any moment during implementation

of the action or afterwards — carry out investigations, including on-the-spot checks and inspections, to establish whether there has been fraud, corruption or any other illegal activity affecting the financial interests of the EU.

### 22.3 Checks and audits by the European Court of Auditors (ECA)

Under Article 287 of the Treaty on the Functioning of the European Union (TFEU) and Article 161 of the Financial Regulation No 966/2012[16], the European Court of Auditors (ECA) may — at any moment during implementation of the action or afterwards — carry out audits.

The ECA has the right of access for the purpose of checks and audits.

### 22.4 Checks, reviews, audits and investigations for international organisations

Not applicable

### 22.5 Consequences of findings in checks, reviews, audits and investigations — Extension of findings

#### 22.5.1 Findings in this grant

Findings in checks, reviews, audits or investigations carried out in the context of this grant may lead to the rejection of ineligible costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44) or to any of the other measures described in Chapter 6.

Rejection of costs or reduction of the grant after the payment of the balance will lead to a revised final grant amount (see Article 5.4).

Findings in checks, reviews, audits or investigations may lead to a request for amendment for the modification of Annex 1 (see Article 55).

Checks, reviews, audits or investigations that find systemic or recurrent errors, irregularities, fraud or breach of obligations may also lead to consequences in other EU or Euratom grants awarded under similar conditions (‘**extension of findings from this grant to other grants**’).

Moreover, findings arising from an OLAF investigation may lead to criminal prosecution under national law.

#### 22.5.2 Findings in other grants

The Commission may extend findings from other grants to this grant (‘**extension of findings from other grants to this grant**’), if:

[14] Regulation (EU, Euratom) No 883/2013 of the European Parliament and of the Council of 11 September 2013 concerning investigations conducted by the European Anti-Fraud Office (OLAF) and repealing Regulation (EC) No 1073/1999 of the European Parliament and of the Council and Council Regulation (Euratom) No 1074/1999 (OJ L 248, 18.09.2013, p. 1).

[15] Council Regulation (Euratom, EC) No 2185/1996 of 11 November 1996 concerning on-the-spot checks and inspections carried out by the Commission in order to protect the European Communities' financial interests against fraud and other irregularities (OJ L 292, 15.11.1996, p. 2).

[16] Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 (OJ L 298, 26.10.2012, p. 1).

(a) the beneficiary concerned is found, in other EU or Euratom grants awarded under similar conditions, to have committed systemic or recurrent errors, irregularities, fraud or breach of obligations that have a material impact on this grant and

(b) those findings are formally notified to the beneficiary concerned — together with the list of grants affected by the findings — no later than two years after the payment of the balance of this grant.

The extension of findings may lead to the rejection of costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44), suspension of payments (see Article 48), suspension of the action implementation (see Article 49) or termination (see Article 50).

**22.5.3 Procedure**

The Commission will formally notify the beneficiary concerned the systemic or recurrent errors and its intention to extend these audit findings, together with the list of grants affected.

22.5.3.1 If the findings concern **eligibility of costs**: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings;

(b) the request to submit **revised financial statements** for all grants affected;

(c) the **correction rate for extrapolation** established by the Commission on the basis of the systemic or recurrent errors, to calculate the amounts to be rejected if the beneficiary concerned:

(i) considers that the submission of revised financial statements is not possible or practicable or

(ii) does not submit revised financial statements.

The beneficiary concerned has 90 days from receiving notification to submit observations, revised financial statements or to propose a duly substantiated **alternative correction method**. This period may be extended by the Commission in justified cases.

The Commission may then start a rejection procedure in accordance with Article 42, on the basis of:

- the revised financial statements, if approved;

- the proposed alternative correction method, if accepted

or

- the initially notified correction rate for extrapolation, if it does not receive any observations or revised financial statements, does not accept the observations or the proposed alternative correction method or does not approve the revised financial statements.

22.5.3.2 If the findings concern **substantial errors**, **irregularities or fraud** or **serious breach of obligations**: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings and

(b) the flat-rate the Commission intends to apply according to the principle of proportionality.

The beneficiary concerned has 90 days from receiving notification to submit observations or to propose a duly substantiated alternative flat-rate.

The Commission may then start a reduction procedure in accordance with Article 43, on the basis of:

- the proposed alternative flat-rate, if accepted

or

- the initially notified flat-rate, if it does not receive any observations or does not accept the observations or the proposed alternative flat-rate.

**22.6 Consequences of non-compliance**

If a beneficiary breaches any of its obligations under this Article, any insufficiently substantiated costs will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

**ARTICLE 23 — EVALUATION OF THE IMPACT OF THE ACTION**

**23.1 Right to evaluate the impact of the action**

The Commission may carry out interim and final evaluations of the impact of the action measured against the objective of the EU programme.

Evaluations may be started during implementation of the action and up to five years after the payment of the balance. The evaluation is considered to start on the date of the formal notification to the coordinator or beneficiaries.

The Commission may make these evaluations directly (using its own staff) or indirectly (using external bodies or persons it has authorised to do so).

The coordinator or beneficiaries must provide any information relevant to evaluate the impact of the action, including information in electronic format.

**23.2 Consequences of non-compliance**

If a beneficiary breaches any of its obligations under this Article, the Commission may apply the measures described in Chapter 6.

## SECTION 3 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND AND RESULTS

### SUBSECTION 1 GENERAL

[17] Commission Recommendation C(2008) 1329 of 10.4.2008 on the management of intellectual property in knowledge transfer activities and the Code of Practice for universities and other public research institutions attached to this recommendation.

## ARTICLE 23a — MANAGEMENT OF INTELLECTUAL PROPERTY

### 23a.1 Obligation to take measures to implement the Commission Recommendation on the management of intellectual property in knowledge transfer activities

Beneficiaries that are universities or other public research organisations must take measures to implement the principles set out in Points 1 and 2 of the Code of Practice annexed to the Commission Recommendation on the management of intellectual property in knowledge transfer activities[17].

This does not change the obligations set out in Subsections 2 and 3 of this Section.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

### 23a.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

## SUBSECTION 2 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND

## ARTICLE 24 — AGREEMENT ON BACKGROUND

### 24.1 Agreement on background

The beneficiaries must identify and agree (in writing) on the background for the action ('**agreement on background**').

'**Background**' means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that:

(a) is held by the beneficiaries before they acceded to the Agreement, and

(b) is needed to implement the action or exploit the results.

### 24.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 25 — ACCESS RIGHTS TO BACKGROUND

### 25.1 Exercise of access rights — Waiving of access rights — No sub-licensing

To exercise access rights, this must first be requested in writing ('**request for access**').

'**Access rights**' means rights to use results or background under the terms and conditions laid down in this Agreement.

Waivers of access rights are not valid unless in writing.

Unless agreed otherwise, access rights do not include the right to sub-license.

**25.2 Access rights for other beneficiaries, for implementing their own tasks under the action**

The beneficiaries must give each other access — on a royalty-free basis — to background needed to implement their own tasks under the action, unless the beneficiary that holds the background has — before acceding to the Agreement —:

(a) informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel), or

(b) agreed with the other beneficiaries that access would not be on a royalty-free basis.

**25.3 Access rights for other beneficiaries, for exploiting their own results**

The beneficiaries must give each other access — under fair and reasonable conditions — to background needed for exploiting their own results, unless the beneficiary that holds the background has — before acceding to the Agreement — informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel).

'**Fair and reasonable conditions**' means appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the results or background to which access is requested and/or the scope, duration or other characteristics of the exploitation envisaged.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

**25.4 Access rights for affiliated entities**

Unless otherwise agreed in the consortium agreement, access to background must also be given — under fair and reasonable conditions (see above; Article 25.3) and unless it is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel) — to affiliated entities[18] established in an EU Member State or '**associated country**'[19], if this is needed to exploit the results generated by the beneficiaries to which they are affiliated.

Unless agreed otherwise (see above; Article 25.1), the affiliated entity concerned must make the request directly to the beneficiary that holds the background.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

**25.5 Access rights for third parties**

Not applicable

[18] For the definition, see 'affiliated entity' footnote (Article 14.1).

[19] For the definition, see Article 2.1(3) of the Rules for Participation Regulation No 1290/2013: '**associated country**' means a third country which is party to an international agreement with the Union, as identified in Article 7 of Horizon 2020 Framework Programme Regulation No 1291/2013. Article 7 sets out the conditions for association of non-EU countries to Horizon 2020.

### 25.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## SUBSECTION 3 RIGHTS AND OBLIGATIONS RELATED TO RESULTS

## ARTICLE 26 — OWNERSHIP OF RESULTS

### 26.1 Ownership by the beneficiary that generates the results

Results are owned by the beneficiary that generates them.

'**Results**' means any (tangible or intangible) output of the action such as data, knowledge or information — whatever its form or nature, whether it can be protected or not — that is generated in the action, as well as any rights attached to it, including intellectual property rights.

### 26.2 Joint ownership by several beneficiaries

Two or more beneficiaries own results jointly if:

(a) they have jointly generated them and

(b) it is not possible to:

(i) establish the respective contribution of each beneficiary, or

(ii) separate them for the purpose of applying for, obtaining or maintaining their protection (see Article 27).

The joint owners must agree (in writing) on the allocation and terms of exercise of their joint ownership ('**joint ownership agreement**'), to ensure compliance with their obligations under this Agreement.

Unless otherwise agreed in the joint ownership agreement, each joint owner may grant non-exclusive licences to third parties to exploit jointly-owned results (without any right to sub-license), if the other joint owners are given:

(a) at least 45 days advance notice and

(b) fair and reasonable compensation.

Once the results have been generated, joint owners may agree (in writing) to apply another regime than joint ownership (such as, for instance, transfer to a single owner (see Article 30) with access rights for the others).

### 26.3 Rights of third parties (including personnel)

If third parties (including personnel) may claim rights to the results, the beneficiary concerned must ensure that it complies with its obligations under the Agreement.

If a third party generates results, the beneficiary concerned must obtain all necessary rights (transfer, licences or other) from the third party, in order to be able to respect its obligations as if those results were generated by the beneficiary itself.

If obtaining the rights is impossible, the beneficiary must refrain from using the third party to generate the results.

**26.4 EU ownership, to protect results**

26.4.1 The EU may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to disseminate its results without protecting them, except in any of the following cases:

(a) the lack of protection is because protecting the results is not possible, reasonable or justified (given the circumstances);

(b) the lack of protection is because there is a lack of potential for commercial or industrial exploitation, or

(c) the beneficiary intends to transfer the results to another beneficiary or third party established in an EU Member State or associated country, which will protect them.

Before the results are disseminated and unless any of the cases above under Points (a), (b) or (c) applies, the beneficiary must formally notify the Commission and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Commission decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

No dissemination relating to these results may take place before the end of this period or, if the Commission takes a positive decision, until it has taken the necessary steps to protect the results.

26.4.2 The EU may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to stop protecting them or not to seek an extension of protection, except in any of the following cases:

(a) the protection is stopped because of a lack of potential for commercial or industrial exploitation;

(b) an extension would not be justified given the circumstances.

A beneficiary that intends to stop protecting results or not seek an extension must — unless any of the cases above under Points (a) or (b) applies — formally notify the Commission at least 60 days before the protection lapses or its extension is no longer possible and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Commission decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

### 26.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to the any of the other measures described in Chapter 6.

## ARTICLE 27 — PROTECTION OF RESULTS — VISIBILITY OF EU FUNDING

### 27.1 Obligation to protect the results

Each beneficiary must examine the possibility of protecting its results and must adequately protect them — for an appropriate period and with appropriate territorial coverage — if:

(a) the results can reasonably be expected to be commercially or industrially exploited and

(b) protecting them is possible, reasonable and justified (given the circumstances).

When deciding on protection, the beneficiary must consider its own legitimate interests and the legitimate interests (especially commercial) of the other beneficiaries.

### 27.2 EU ownership, to protect the results

If a beneficiary intends not to protect its results, to stop protecting them or not seek an extension of protection, the EU may — under certain conditions (see Article 26.4) — assume ownership to ensure their (continued) protection.

### 27.3 Information on EU funding

Applications for protection of results (including patent applications) filed by or on behalf of a beneficiary must — unless the Commission requests or agrees otherwise or unless it is impossible — include the following:

> *"The project leading to this application has received funding from the* European Union's Horizon 2020 research and innovation programme *under grant agreement No 731529".*

### 27.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

## ARTICLE 28 — EXPLOITATION OF RESULTS

### 28.1 Obligation to exploit the results

Each beneficiary must — up to four years after the period set out in Article 3 — take measures aiming to ensure '**exploitation**' of its results (either directly or indirectly, in particular through transfer or licensing; see Article 30) by:

(a) using them in further research activities (outside the action);

(b) developing, creating or marketing a product or process;

(c) creating and providing a service, or

(d) using them in standardisation activities.

This does not change the security obligations in Article 37, which still apply.

### 28.2 Results that could contribute to European or international standards — Information on EU funding

If results are incorporated in a standard, the beneficiary concerned must — unless the Commission requests or agrees otherwise or unless it is impossible — ask the standardisation body to include the following statement in (information related to) the standard:

> *"Results incorporated in this standard received funding from the* European Union's Horizon 2020 research and innovation programme *under grant agreement No 731529".*

### 28.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced in accordance with Article 43.

Such a breach may also lead to any of the other measures described in Chapter 6.

## ARTICLE 29 — DISSEMINATION OF RESULTS — OPEN ACCESS — VISIBILITY OF EU FUNDING

### 29.1 Obligation to disseminate results

Unless it goes against their legitimate interests, each beneficiary must — as soon as possible — '**disseminate**' its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

A beneficiary that intends to disseminate its results must give advance notice to the other beneficiaries of — unless agreed otherwise — at least 45 days, together with sufficient information on the results it will disseminate.

Any other beneficiary may object within — unless agreed otherwise — 30 days of receiving notification, if it can show that its legitimate interests in relation to the results or background would be significantly harmed. In such cases, the dissemination may not take place unless appropriate steps are taken to safeguard these legitimate interests.

If a beneficiary intends not to protect its results, it may — under certain conditions (see Article 26.4.1) — need to formally notify the Commission before dissemination takes place.

### 29.2 Open access to scientific publications

Each beneficiary must ensure open access (free of charge online access for any user) to all peer-reviewed scientific publications relating to its results.

In particular, it must:

(a) as soon as possible and at the latest on publication, deposit a machine-readable electronic copy of the published version or final peer-reviewed manuscript accepted for publication in a repository for scientific publications;

Moreover, the beneficiary must aim to deposit at the same time the research data needed to validate the results presented in the deposited scientific publications.

(b) ensure open access to the deposited publication — via the repository — at the latest:

(i) on publication, if an electronic version is available for free via the publisher, or

(ii) within six months of publication (twelve months for publications in the social sciences and humanities) in any other case.

(c) ensure open access — via the repository — to the bibliographic metadata that identify the deposited publication.

The bibliographic metadata must be in a standard format and must include all of the following:

- the terms “European Union (EU)” and “Horizon 2020”;
- the name of the action, acronym and grant number;
- the publication date, and length of embargo period if applicable, and
- a persistent identifier.

**29.3 Open access to research data**

Not applicable

**29.4 Information on EU funding — Obligation and right to use the EU emblem**

Unless the Commission requests or agrees otherwise or unless it is impossible, any dissemination of results (in any form, including electronic) must:

(a) display the EU emblem and

(b) include the following text:

*“This project has received funding from the* European Union’s Horizon 2020 research and innovation programme *under grant agreement No 731529”.*

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Commission.

This does not however give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

### 29.5 Disclaimer excluding Commission responsibility

Any dissemination of results must indicate that it reflects only the author's view and that the Commission is not responsible for any use that may be made of the information it contains.

### 29.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

## ARTICLE 30 — TRANSFER AND LICENSING OF RESULTS

### 30.1 Transfer of ownership

Each beneficiary may transfer ownership of its results.

It must however ensure that its obligations under Articles 26.2, 26.4, 27, 28, 29, 30 and 31 also apply to the new owner and that this owner has the obligation to pass them on in any subsequent transfer.

This does not change the security obligations in Article 37, which still apply.

Unless agreed otherwise (in writing) for specifically-identified third parties or unless impossible under applicable EU and national laws on mergers and acquisitions, a beneficiary that intends to transfer ownership of results must give at least 45 days advance notice (or less if agreed in writing) to the other beneficiaries that still have (or still may request) access rights to the results. This notification must include sufficient information on the new owner to enable any beneficiary concerned to assess the effects on its access rights.

Unless agreed otherwise (in writing) for specifically-identified third parties, any other beneficiary may object within 30 days of receiving notification (or less if agreed in writing), if it can show that the transfer would adversely affect its access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned.

### 30.2 Granting licenses

Each beneficiary may grant licences to its results (or otherwise give the right to exploit them), if:

(a) this does not impede the rights under Article 31 and

(b) not applicable.

In addition to Points (a) and (b), exclusive licences for results may be granted only if all the other beneficiaries concerned have waived their access rights (see Article 31.1).

This does not change the dissemination obligations in Article 29 or security obligations in Article 37, which still apply.

### 30.3 Commission right to object to transfers or licensing

Not applicable

### 30.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

## ARTICLE 31 — ACCESS RIGHTS TO RESULTS

### 31.1 Exercise of access rights — Waiving of access rights — No sub-licensing

The conditions set out in Article 25.1 apply.

The obligations set out in this Article do not change the security obligations in Article 37, which still apply.

### 31.2 Access rights for other beneficiaries, for implementing their own tasks under the action

The beneficiaries must give each other access — on a royalty-free basis — to results needed for implementing their own tasks under the action.

### 31.3 Access rights for other beneficiaries, for exploiting their own results

The beneficiaries must give each other — under fair and reasonable conditions (see Article 25.3) — access to results needed for exploiting their own results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

### 31.4 Access rights of affiliated entities

Unless agreed otherwise in the consortium agreement, access to results must also be given — under fair and reasonable conditions (Article 25.3) — to affiliated entities established in an EU Member State or associated country, if this is needed for those entities to exploit the results generated by the beneficiaries to which they are affiliated.

Unless agreed otherwise (see above; Article 31.1), the affiliated entity concerned must make any such request directly to the beneficiary that owns the results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

### 31.5 Access rights for the EU institutions, bodies, offices or agencies and EU Member States

The beneficiaries must give access to their results — on a royalty-free basis — to EU institutions, bodies, offices or agencies, for developing, implementing or monitoring EU policies or programmes.

Such access rights are limited to non-commercial and non-competitive use.

This does not change the right to use any material, document or information received from the beneficiaries for communication and publicising activities (see Article 38.2).

### 31.6 Access rights for third parties

Not applicable

### 31.7 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## SECTION 4 OTHER RIGHTS AND OBLIGATIONS

## ARTICLE 32 — RECRUITMENT AND WORKING CONDITIONS FOR RESEARCHERS

### 32.1 Obligation to take measures to implement the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers

The beneficiaries must take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[21], in particular regarding:

- working conditions;
- transparent recruitment processes based on merit, and
- career development.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

### 32.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

## ARTICLE 33 — GENDER EQUALITY

### 33.1 Obligation to aim for gender equality

The beneficiaries must take all measures to promote equal opportunities between men and women in the implementation of the action. They must aim, to the extent possible, for a gender balance at all levels of personnel assigned to the action, including at supervisory and managerial level.

### 33.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Commission may apply any of the measures described in Chapter 6.

[21] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

## ARTICLE 34 — ETHICS AND RESEARCH INTEGRITY

### 34.1 Obligation to comply with ethical principles and research integrity

The beneficiaries must carry out the action in compliance with:

(a) ethical principles (including the highest standards of research integrity)

and

(b) applicable international, EU and national law.

Funding will not be granted for activities carried out outside the EU if they are prohibited in all Member States or for activities which destroy human embryos (for example, for obtaining stem cells).

The beneficiaries must ensure that the activities under the action have an exclusive focus on civil applications.

The beneficiaries must ensure that the activities under the action do not:

(a) aim at human cloning for reproductive purposes;

(b) intend to modify the genetic heritage of human beings which could make such changes heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed), or

(c) intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer.

The beneficiaries must respect the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity[22].

This implies notably compliance with the following essential principles:

- honesty;
- reliability;
- objectivity;
- impartiality;
- open communication;
- duty of care;
- fairness and
- responsibility for future science generations.

[22] European Code of Conduct for Research Integrity of ALLEA (All European Academies) and ESF (European Science Foundation) of March 2011.
http://www.esf.org/fileadmin/Public_documents/Publications/Code_Conduct_ResearchIntegrity.pdf

This means that beneficiaries must ensure that persons carrying out research tasks:

- present their research goals and intentions in an honest and transparent manner;
- design their research carefully and conduct it in a reliable fashion, taking its impact on society into account;
- use techniques and methodologies (including for data collection and management) that are appropriate for the field(s) concerned;
- exercise due care for the subjects of research — be they human beings, animals, the environment or cultural objects;
- ensure objectivity, accuracy and impartiality when disseminating the results;
- allow — as much as possible and taking into account the legitimate interest of the beneficiaries — access to research data, in order to enable research to be reproduced;
- make the necessary references to their work and that of other researchers;
- refrain from practicing any form of plagiarism, data falsification or fabrication;
- avoid double funding, conflicts of interest and misrepresentation of credentials or other research misconduct.

**34.2 Activities raising ethical issues**

Activities raising ethical issues must comply with the '**ethics requirements**' set out as deliverables in Annex 1.

Before the beginning of an activity raising an ethical issue, each beneficiary must have obtained:

(a) any ethics committee opinion required under national law and

(b) any notification or authorisation for activities raising ethical issues required under national and/or European law

needed for implementing the action tasks in question.

The documents must be kept on file and be submitted upon request by the coordinator to the Commission (see Article 52). If they are not in English, they must be submitted together with an English summary, which shows that the action tasks in question are covered and includes the conclusions of the committee or authority concerned (if available).

**34.3 Activities involving human embryos or human embryonic stem cells**

Activities involving research on human embryos or human embryonic stem cells may be carried out, in addition to Article 34.1, only if:

- they are set out in Annex 1 or
- the coordinator has obtained explicit approval (in writing) from the Commission (see Article 52).

### 34.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 35 — CONFLICT OF INTERESTS

### 35.1 Obligation to avoid a conflict of interests

The beneficiaries must take all measures to prevent any situation where the impartial and objective implementation of the action is compromised for reasons involving economic interest, political or national affinity, family or emotional ties or any other shared interest (‘**conflict of interests**’).

They must formally notify to the Commission without delay any situation constituting or likely to lead to a conflict of interests and immediately take all the necessary steps to rectify this situation.

The Commission may verify that the measures taken are appropriate and may require additional measures to be taken by a specified deadline.

### 35.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 36 — CONFIDENTIALITY

### 36.1 General obligation to maintain confidentiality

During implementation of the action and for four years after the period set out in Article 3, the parties must keep confidential any data, documents or other material (in any form) that is identified as confidential at the time it is disclosed (‘**confidential information**’).

If a beneficiary requests, the Commission may agree to keep such information confidential for an additional period beyond the initial four years.

If information has been identified as confidential only orally, it will be considered to be confidential only if this is confirmed in writing within 15 days of the oral disclosure.

Unless otherwise agreed between the parties, they may use confidential information only to implement the Agreement.

The beneficiaries may disclose confidential information to their personnel or third parties involved in the action only if they:

(a) need to know to implement the Agreement and

(b) are bound by an obligation of confidentiality.

This does not change the security obligations in Article 37, which still apply.

The Commission may disclose confidential information to its staff, other EU institutions and bodies. It may disclose confidential information to third parties, if:

(a) this is necessary to implement the Agreement or safeguard the EU's financial interests and

(b) the recipients of the information are bound by an obligation of confidentiality.

Under the conditions set out in Article 4 of the Rules for Participation Regulation No 1290/2013[23], the Commission must moreover make available information on the results to other EU institutions, bodies, offices or agencies as well as Member States or associated countries.

The confidentiality obligations no longer apply if:

(a) the disclosing party agrees to release the other party;

(b) the information was already known by the recipient or is given to him without obligation of confidentiality by a third party that was not bound by any obligation of confidentiality;

(c) the recipient proves that the information was developed without the use of confidential information;

(d) the information becomes generally and publicly available, without breaching any confidentiality obligation, or

(e) the disclosure of the information is required by EU or national law.

### 36.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 37 — SECURITY-RELATED OBLIGATIONS

### 37.1 Results with a security recommendation

Not applicable

### 37.2 Classified information

Not applicable

### 37.3 Activities involving dual-use goods or dangerous materials and substances

Not applicable

### 37.4 Consequences of non-compliance

Not applicable

[23] Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" (OJ L 347, 20.12.2013 p.81).

## ARTICLE 38 — PROMOTING THE ACTION — VISIBILITY OF EU FUNDING

### 38.1 Communication activities by beneficiaries

#### 38.1.1 Obligation to promote the action and its results

The beneficiaries must promote the action and its results, by providing targeted information to multiple audiences (including the media and the public) in a strategic and effective manner.

This does not change the dissemination obligations in Article 29, the confidentiality obligations in Article 36 or the security obligations in Article 37, all of which still apply.

Before engaging in a communication activity expected to have a major media impact, the beneficiaries must inform the Commission (see Article 52).

#### 38.1.2 Information on EU funding — Obligation and right to use the EU emblem

Unless the Commission requests or agrees otherwise or unless it is impossible, any communication activity related to the action (including in electronic form, via social media, etc.) and any infrastructure, equipment and major results funded by the grant must:

(a) display the EU emblem and

(b) include the following text:

> For communication activities: *"This project has received funding from the* European Union's Horizon 2020 research and innovation programme *under grant agreement No 731529".*
>
> For infrastructure, equipment and major results: *"This [infrastructure][equipment][insert type of result] is part of a project that has received funding from the* European Union's Horizon 2020 research and innovation programme *under grant agreement No 731529".*

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Commission.

This does not, however, give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

#### 38.1.3 Disclaimer excluding Commission responsibility

Any communication activity related to the action must indicate that it reflects only the author's view and that the Commission is not responsible for any use that may be made of the information it contains.

### 38.2 Communication activities by the Commission

#### 38.2.1 Right to use beneficiaries' materials, documents or information

The Commission may use, for its communication and publicising activities, information relating to the action, documents notably summaries for publication and public deliverables as well as any other material, such as pictures or audio-visual material received from any beneficiary (including in electronic form).

This does not change the confidentiality obligations in Article 36 and the security obligations in Article 37, all of which still apply.

If the Commission's use of these materials, documents or information would risk compromising legitimate interests, the beneficiary concerned may request the Commission not to use it (see Article 52).

The right to use a beneficiary's materials, documents and information includes:

(a) **use for its own purposes** (in particular, making them available to persons working for the Commission or any other EU institution, body, office or agency or body or institutions in EU Member States; and copying or reproducing them in whole or in part, in unlimited numbers);

(b) **distribution to the public** (in particular, publication as hard copies and in electronic or digital format, publication on the internet, as a downloadable or non-downloadable file, broadcasting by any channel, public display or presentation, communicating through press information services, or inclusion in widely accessible databases or indexes);

(c) **editing or redrafting** for communication and publicising activities (including shortening, summarising, inserting other elements (such as meta-data, legends, other graphic, visual, audio or text elements), extracting parts (e.g. audio or video files), dividing into parts, use in a compilation);

(d) **translation**;

(e) giving **access in response to individual requests** under Regulation No 1049/2001[25], without the right to reproduce or exploit;

(f) **storage** in paper, electronic or other form;

(g) **archiving**, in line with applicable document-management rules, and

(h) the right to authorise third parties to act on its behalf or sub-license the modes of use set out in Points (b), (c), (d) and (f) to third parties if needed for the communication and publicising activities of the Commission.

If the right of use is subject to rights of a third party (including personnel of the beneficiary), the beneficiary must ensure that it complies with its obligations under this Agreement (in particular, by obtaining the necessary approval from the third parties concerned).

Where applicable (and if provided by the beneficiaries), the Commission will insert the following information:

> "© – [year] – [name of the copyright owner]. All rights reserved. Licensed to the European Union (EU) under conditions."

### 38.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

[25] Regulation (EC) No 1049/2001 of the European Parliament and of the Council of 30 May 2001 regarding public access to European Parliament, Council and Commission documents, OJ L 145, 31.5.2001, p. 43.

Such breaches may also lead to any of the other measures described in Chapter 6.

## ARTICLE 39 — PROCESSING OF PERSONAL DATA

### 39.1 Processing of personal data by the Commission

Any personal data under the Agreement will be processed by the Commission under Regulation No 45/2001[26] and according to the 'notifications of the processing operations' to the Data Protection Officer (DPO) of the Commission (publicly accessible in the DPO register).

Such data will be processed by the '**data controller**' of the Commission for the purposes of implementing, managing and monitoring the Agreement or protecting the financial interests of the EU or Euratom (including checks, reviews, audits and investigations; see Article 22).

The persons whose personal data are processed have the right to access and correct their own personal data. For this purpose, they must send any queries about the processing of their personal data to the data controller, via the contact point indicated in the privacy statement(s) that are published on the Commission websites.

They also have the right to have recourse at any time to the European Data Protection Supervisor (EDPS).

### 39.2 Processing of personal data by the beneficiaries

The beneficiaries must process personal data under the Agreement in compliance with applicable EU and national law on data protection (including authorisations or notification requirements).

The beneficiaries may grant their personnel access only to data that is strictly necessary for implementing, managing and monitoring the Agreement.

The beneficiaries must inform the personnel whose personal data are collected and processed by the Commission. For this purpose, they must provide them with the privacy statement(s) (see above), before transmitting their data to the Commission.

### 39.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 39.2, the Commission may apply any of the measures described in Chapter 6.

## ARTICLE 40 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE COMMISSION

The beneficiaries may not assign any of their claims for payment against the Commission to any third party, except if approved by the Commission on the basis of a reasoned, written request by the coordinator (on behalf of the beneficiary concerned).

If the Commission has not accepted the assignment or the terms of it are not observed, the assignment will have no effect on it.

[26] Regulation (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data (OJ L 8, 12.01.2001, p. 1).

In no circumstances will an assignment release the beneficiaries from their obligations towards the Commission.

## CHAPTER 5 DIVISION OF BENEFICIARIES' ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION

### ARTICLE 41 — DIVISION OF BENEFICIARIES' ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION

#### 41.1 Roles and responsibilities towards the Commission

The beneficiaries have full responsibility for implementing the action and complying with the Agreement.

The beneficiaries are jointly and severally liable for the **technical implementation** of the action as described in Annex 1. If a beneficiary fails to implement its part of the action, the other beneficiaries become responsible for implementing this part (without being entitled to any additional EU funding for doing so), unless the Commission expressly relieves them of this obligation.

The **financial responsibility** of each beneficiary is governed by Articles 44, 45 and 46.

#### 41.2 Internal division of roles and responsibilities

The internal roles and responsibilities of the beneficiaries are divided as follows:

(a) Each **beneficiary** must:

(i) keep information stored in the Participant Portal Beneficiary Register (via the electronic exchange system) up to date (see Article 17);

(ii) inform the coordinator immediately of any events or circumstances likely to affect significantly or delay the implementation of the action (see Article 17);

(iii) submit to the coordinator in good time:

- individual financial statements for itself and its linked third parties and, if required, certificates on the financial statements (see Article 20);
- the data needed to draw up the technical reports (see Article 20);
- ethics committee opinions and notifications or authorisations for activities raising ethical issues (see Article 34);
- any other documents or information required by the Commission under the Agreement, unless the Agreement requires the beneficiary to submit this information directly to the Commission.

(b) The **coordinator** must:

(i) monitor that the action is implemented properly (see Article 7);

(ii) act as the intermediary for all communications between the beneficiaries and the Commission (in particular, providing the Commission with the information described in Article 17), unless the Agreement specifies otherwise;

(iii) request and review any documents or information required by the Commission and verify their completeness and correctness before passing them on to the Commission;

(iv) submit the deliverables and reports to the Commission (see Articles 19 and 20);

(v) ensure that all payments are made to the other beneficiaries without unjustified delay (see Article 21);

(vi) inform the Commission of the amounts paid to each beneficiary, when required under the Agreement (see Articles 44 and 50) or requested by the Commission.

The coordinator may not delegate or subcontract the above-mentioned tasks to any other beneficiary or third party (including linked third parties).

**41.3 Internal arrangements between beneficiaries — Consortium agreement**

The beneficiaries must have internal arrangements regarding their operation and co-ordination to ensure that the action is implemented properly. These internal arrangements must be set out in a written '**consortium agreement**' between the beneficiaries, which may cover:

- internal organisation of the consortium;
- management of access to the electronic exchange system;
- distribution of EU funding;
- additional rules on rights and obligations related to background and results (including whether access rights remain or not, if a beneficiary is in breach of its obligations) (see Section 3 of Chapter 4);
- settlement of internal disputes;
- liability, indemnification and confidentiality arrangements between the beneficiaries.

The consortium agreement must not contain any provision contrary to the Agreement.

**41.4 Relationship with complementary beneficiaries — Collaboration agreement**

Not applicable

**41.5 Relationship with partners of a joint action — Coordination agreement**

Not applicable

# CHAPTER 6 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS — DAMAGES — SUSPENSION — TERMINATION — FORCE MAJEURE

## SECTION 1 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS

### ARTICLE 42 — REJECTION OF INELIGIBLE COSTS

#### 42.1 Conditions

The Commission will — at the time of an **interim payment**, after **termination of the participation of a beneficiary**, at the time of an **interim payment**, **at the payment of the balance** or **afterwards** — reject any costs which are ineligible (see Article 6), in particular following checks, reviews, audits or investigations (see Article 22).

The rejection may also be based on the **extension of findings from other grants to this grant** (see Article 22.5.2).

#### 42.2 Ineligible costs to be rejected — Calculation — Procedure

Ineligible costs will be rejected in full.

If the rejection of costs does not lead to a recovery (see Article 44), the Commission will formally notify the coordinator or beneficiary concerned of the rejection of costs, the amounts and the reasons why (if applicable, together with the notification of amounts due; see Article 21.5). The coordinator or beneficiary concerned may — within 30 days of receiving notification — formally notify the Commission of its disagreement and the reasons why.

If the rejection of costs leads to a recovery, the Commission will follow the contradictory procedure with pre-information letter set out in Article 44.

#### 42.3 Effects

If the Commission rejects costs at the time of an **interim payment** or **the payment of the balance**, it will deduct them from the total eligible costs declared, for the action, in the periodic or final summary financial statement (see Articles 20.3 and 20.4). It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the Commission rejects costs **after termination of the participation of a beneficiary**, it will deduct them from the costs declared by the beneficiary in the termination report and include the rejection in the calculation after termination (see Article 50.2 and 50.3).

If the Commission — **after an interim payment but before the payment of the balance** — rejects costs declared in a periodic summary financial statement, it will deduct them from the total eligible costs declared, for the action, in the next periodic summary financial statement or in the final summary financial statement. It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the Commission rejects costs **after the payment of the balance**, it will deduct the amount rejected from the total eligible costs declared, by the beneficiary, in the final summary financial statement. It will then calculate the revised final grant amount as set out in Article 5.4.

## ARTICLE 43 — REDUCTION OF THE GRANT

### 43.1 Conditions

The Commission may — **after termination of the participation of a beneficiary**, **at the payment of the balance** or **afterwards** — reduce the grant amount (see Article 5.1), if :

(a) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or

(b) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

### 43.2 Amount to be reduced — Calculation — Procedure

The amount of the reduction will be proportionate to the seriousness of the errors, irregularities or fraud or breach of obligations.

Before reduction of the grant, the Commission will formally notify a '**pre-information letter**' to the coordinator or beneficiary concerned:

- informing it of its intention to reduce the grant, the amount it intends to reduce and the reasons why and

- inviting it to submit observations within 30 days of receiving notification

If the Commission does not receive any observations or decides to pursue reduction despite the observations it has received, it will formally notify **confirmation** of the reduction (if applicable, together with the notification of amounts due; see Article 21).

### 43.3 Effects

If the Commission reduces the grant **after termination of the participation of a beneficiary**, it will calculate the reduced grant amount for that beneficiary and then determine the amount due to that beneficiary (see Article 50.2 and 50.3).

If the Commission reduces the grant **at the payment of the balance**, it will calculate the reduced grant amount for the action and then determine the amount due as payment of the balance (see Articles 5.3.4 and 21.4).

If the Commission reduces the grant **after the payment of the balance**, it will calculate the revised final grant amount for the beneficiary concerned (see Article 5.4). If the revised final grant amount for the beneficiary concerned is lower than its share of the final grant amount, the Commission will recover the difference (see Article 44).

## ARTICLE 44 — RECOVERY OF UNDUE AMOUNTS

### 44.1 Amount to be recovered — Calculation — Procedure

The Commission will — after **termination of the participation of a beneficiary, at the payment of the balance** or **afterwards** — claim back any amount that was paid but is not due under the Agreement.

Each beneficiary's financial responsibility in case of recovery is limited to its own debt (including undue amounts paid by the Commission for costs declared by its linked third parties), except for the amount retained for the Guarantee Fund (see Article 21.4).

#### 44.1.1 Recovery after termination of a beneficiary's participation

If recovery takes place after termination of a beneficiary's participation (including the coordinator), the Commission will claim back the undue amount from the beneficiary concerned, by formally notifying it a debit note (see Article 50.2 and 50.3). This note will specify the amount to be recovered, the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Commission will **recover** the amount:

(a) by '**offsetting**' it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Commission may offset before the payment date specified in the debit note;

(b) not applicable;

(c) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial regulation No 966/2012.

If payment is not made by the date specified in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC[27] applies.

#### 44.1.2 Recovery at payment of the balance

If the payment of the balance takes the form of a recovery (see Article 21.4), the Commission will formally notify a '**pre-information letter**' to the coordinator:

[27] Directive 2007/64/EC of the European Parliament and of the Council of 13 November 2007 on payment services in the internal market amending Directives 97/7/EC, 2002/65/EC, 2005/60/EC and 2006/48/EC and repealing Directive 97/5/EC (OJ L 319, 05.12.2007, p. 1).

- informing it of its intention to recover, the amount due as the balance and the reasons why;

- specifying that it intends to deduct the amount to be recovered from the amount retained for the Guarantee Fund;

- requesting the coordinator to submit a report on the distribution of payments to the beneficiaries within 30 days of receiving notification, and

- inviting the coordinator to submit observations within 30 days of receiving notification.

If no observations are submitted or the Commission decides to pursue recovery despite the observations it has received, it will **confirm recovery** (together with the notification of amounts due; see Article 21.5) and:

- pay the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is positive** or

- formally notify to the coordinator a **debit note** for the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is negative**. This note will also specify the terms and the date for payment.

If the coordinator does not repay the Commission by the date in the debit note and has not submitted the report on the distribution of payments: the Commission will **recover** the amount set out in the debit note from the coordinator (see below).

If the coordinator does not repay the Commission by the date in the debit note, but has submitted the report on the distribution of payments: the Commission will:

(a) identify the beneficiaries for which the amount calculated as follows is negative:

{{{{beneficiary's costs declared in the final summary financial statement and approved by the Commission multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned

plus

its linked third parties' costs declared in the final summary financial statement and approved by the Commission multiplied by the reimbursement rate set out in Article 5.2 for each linked third party concerned}

divided by

the EU contribution for the action calculated according to Article 5.3.1}

multiplied by

the final grant amount (see Article 5.3)},

minus

{pre-financing and interim payments received by the beneficiary}}.

(b) formally notify to each beneficiary identified according to point (a) a **debit note** specifying the terms and date for payment. The amount of the debit note is calculated as follows:

{{amount calculated according to point (a) for the beneficiary concerned

divided by

the sum of the amounts calculated according to point (a) for all the beneficiaries identified according to point (a)}

multiplied by

the amount set out in the debit note formally notified to the coordinator}.

If payment is not made by the date specified in the debit note, the Commission will **recover** the amount:

(a) by '**offsetting**' it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Commission may offset before the payment date specified in the debit note;

(b) by **drawing on the Guarantee Fund**. The Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable;

(ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

### 44.1.3 Recovery of amounts after payment of the balance

If, for a beneficiary, the revised final grant amount (see Article 5.4) is lower than its share of the final grant amount, it must repay the difference to the Commission.

The beneficiary's share of the final grant amount is calculated as follows:

{{{beneficiary's costs declared in the final summary financial statement and approved by the Commission multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned

plus

its linked third parties' costs declared in the final summary financial statement and approved by the Commission multiplied by the reimbursement rate set out in Article 5.2 for each linked third party concerned}

divided by

the EU contribution for the action calculated according to Article 5.3.1}

multiplied by

the final grant amount (see Article 5.3)}.

If the coordinator has not distributed amounts received (see Article 21.7), the Commission will also recover these amounts.

The Commission will formally notify a **pre-information letter** to the beneficiary concerned:

- informing it of its intention to recover, the due amount and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If no observations are submitted or the Commission decides to pursue recovery despite the observations it has received, it will **confirm** the amount to be recovered and formally notify to the beneficiary concerned a **debit note**. This note will also specify the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Commission will **recover** the amount:

(a) by '**offsetting**' it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Commission or an executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Commission may offset before the payment date specified in the debit note;

(b) by **drawing on the Guarantee Fund**. The Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable;

(ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the date for payment in the debit note, up to and including the date the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

## ARTICLE 45 — ADMINISTRATIVE SANCTIONS

In addition to contractual measures, the Commission may also adopt administrative sanctions under Articles 106 and 131(4) of the Financial Regulation No 966/2012 (i.e. exclusion from future procurement contracts, grants and expert contracts and/or financial penalties).

## SECTION 2 LIABILITY FOR DAMAGES

## ARTICLE 46 — LIABILITY FOR DAMAGES

### 46.1 Liability of the Commission

The Commission cannot be held liable for any damage caused to the beneficiaries or to third parties as a consequence of implementing the Agreement, including for gross negligence.

The Commission cannot be held liable for any damage caused by any of the beneficiaries or third parties involved in the action, as a consequence of implementing the Agreement.

### 46.2 Liability of the beneficiaries

Except in case of force majeure (see Article 51), the beneficiaries must compensate the Commission for any damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement.

## SECTION 3 SUSPENSION AND TERMINATION

## ARTICLE 47 — SUSPENSION OF PAYMENT DEADLINE

### 47.1 Conditions

The Commission may — at any moment — suspend the payment deadline (see Article 21.2 to 21.4) if a request for payment (see Article 20) cannot be approved because:

(a) it does not comply with the provisions of the Agreement (see Article 20);

(b) the technical or financial reports have not been submitted or are not complete or additional information is needed, or

(c) there is doubt about the eligibility of the costs declared in the financial statements and additional checks, reviews, audits or investigations are necessary.

### 47.2 Procedure

The Commission will formally notify the coordinator of the suspension and the reasons why.

The suspension will **take effect** the day notification is sent by the Commission (see Article 52).

If the conditions for suspending the payment deadline are no longer met, the suspension will be **lifted** — and the remaining period will resume.

If the suspension exceeds two months, the coordinator may request the Commission if the suspension will continue.

If the payment deadline has been suspended due to the non-compliance of the technical or financial reports (see Article 20) and the revised report or statement is not submitted or was submitted but is also rejected, the Commission may also terminate the Agreement or the participation of the beneficiary (see Article 50.3.1(l)).

## ARTICLE 48 — SUSPENSION OF PAYMENTS

### 48.1 Conditions

The Commission may — at any moment — suspend payments, in whole or in part and interim payments or the payment of the balance for one or more beneficiaries, if:

(a) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed or is suspected of having committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or

(b) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

If payments are suspended for one or more beneficiaries, the Commission will make partial payment(s) for the part(s) not suspended. If suspension concerns the payment of the balance, — once suspension is lifted — the payment or the recovery of the amount(s) concerned will be considered the payment of the balance that closes the action.

### 48.2 Procedure

Before suspending payments, the Commission will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to suspend payments and the reasons why and

- inviting it to submit observations within 30 days of receiving notification.

If the Commission does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the suspension procedure is not continued.

The suspension will **take effect** the day the confirmation notification is sent by the Commission.

If the conditions for resuming payments are met, the suspension will be **lifted**. The Commission will formally notify the coordinator or beneficiary concerned.

During the suspension, the periodic report(s) for all reporting periods except the last one (see Article 20.3), must not contain any individual financial statements from the beneficiary concerned

and its linked third parties. The coordinator must include them in the next periodic report after the suspension is lifted or — if suspension is not lifted before the end of the action — in the last periodic report.

The beneficiaries may suspend implementation of the action (see Article 49.1) or terminate the Agreement or the participation of the beneficiary concerned (see Article 50.1 and 50.2).

## ARTICLE 49 — SUSPENSION OF THE ACTION IMPLEMENTATION

### 49.1 Suspension of the action implementation, by the beneficiaries

#### 49.1.1 Conditions

The beneficiaries may suspend implementation of the action or any part of it, if exceptional circumstances — in particular *force majeure* (see Article 51) — make implementation impossible or excessively difficult.

#### 49.1.2 Procedure

The coordinator must immediately formally notify to the Commission the suspension (see Article 52), stating:

- the reasons why and
- the expected date of resumption.

The suspension will **take effect** the day this notification is received by the Commission.

Once circumstances allow for implementation to resume, the coordinator must immediately formally notify the Commission and request an **amendment** of the Agreement to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement or the participation of a beneficiary has been terminated (see Article 50).

The suspension will be **lifted** with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension of the action implementation are not eligible (see Article 6).

### 49.2 Suspension of the action implementation, by the Commission

#### 49.2.1 Conditions

The Commission may suspend implementation of the action or any part of it, if:

(a) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed or is suspected of having committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false declaration, failure to provide required information, breach of ethical principles);

(b) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2), or

(c) the action is suspected of having lost its scientific or technological relevance.

**49.2.2 Procedure**

Before suspending implementation of the action, the Commission will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to suspend the implementation and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Commission does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the procedure is not continued.

The suspension will **take effect** five days after confirmation notification is received (or on a later date specified in the notification).

It will be **lifted** if the conditions for resuming implementation of the action are met.

The coordinator or beneficiary concerned will be formally notified of the lifting and the Agreement will be **amended** to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement has already been terminated (see Article 50).

The suspension will be lifted with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension are not eligible (see Article 6).

The beneficiaries may not claim damages due to suspension by the Commission (see Article 46).

Suspension of the action implementation does not affect the Commission's right to terminate the Agreement or participation of a beneficiary (see Article 50), reduce the grant or recover amounts unduly paid (see Articles 43 and 44).

## ARTICLE 50 — TERMINATION OF THE AGREEMENT OR OF THE PARTICIPATION OF ONE OR MORE BENEFICIARIES

### 50.1 Termination of the Agreement, by the beneficiaries

**50.1.1 Conditions and procedure**

The beneficiaries may terminate the Agreement.

The coordinator must formally notify termination to the Commission (see Article 52), stating:

- the reasons why and

- the date the termination will take effect. This date must be after the notification.

If no reasons are given or if the Commission considers the reasons do not justify termination, the Agreement will be considered to have been '**terminated improperly**'.

The termination will **take effect** on the day specified in the notification.

**50.1.2 Effects**

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a periodic report (for the open reporting period until termination; see Article 20.3) and

(ii) the final report (see Article 20.4).

If the Commission does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Commission will **calculate** the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the reports submitted. Only costs incurred until termination are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Improper termination may lead to a reduction of the grant (see Article 43).

After termination, the beneficiaries' obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

**50.2 Termination of the participation of one or more beneficiaries, by the beneficiaries**

**50.2.1 Conditions and procedure**

The participation of one or more beneficiaries may be terminated by the coordinator, on request of the beneficiary concerned or on behalf of the other beneficiaries.

The coordinator must formally notify termination to the Commission (see Article 52) and inform the beneficiary concerned.

If the coordinator's participation is terminated without its agreement, the formal notification must be done by another beneficiary (acting on behalf of the other beneficiaries).

The notification must include:

- the reasons why;

- the opinion of the beneficiary concerned (or proof that this opinion has been requested in writing);

- the date the termination takes effect. This date must be after the notification, and

- a request for amendment (see Article 55), with a proposal for reallocation of the tasks and the estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination takes effect after the

period set out in Article 3, no request for amendment must be included unless the beneficiary concerned is the coordinator. In this case, the request for amendment must propose a new coordinator.

If this information is not given or if the Commission considers that the reasons do not justify termination, the participation will be considered to have been **terminated improperly**.

The termination will **take effect** on the day specified in the notification.

**50.2.2 Effects**

The coordinator must — within 30 days from when termination takes effect — submit:

(i) a report on the distribution of payments to the beneficiary concerned and

(ii) if termination takes effect during the period set out in Article 3, a '**termination report**' from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources, the individual financial statement and, if applicable, the certificate on the financial statement (see Articles 20.3 and 20.4).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Commission, (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Commission, the Agreement is **amended** to introduce the necessary changes (see Article 55).

The Commission will — on the basis of the periodic reports, the termination report and the report on the distribution of payments — **calculate** the amount which is due to the beneficiary and if the (pre-financing and interim) payments received by the beneficiary exceed this amount.

The **amount which is due** is calculated in the following steps:

Step 1 — Application of the reimbursement rate to the eligible costs

The grant amount for the beneficiary is calculated by applying the reimbursement rate(s) to the total eligible costs declared by the beneficiary and its linked third parties in the termination report and approved by the Commission.

Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Step 2 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

In case of a reduction (see Article 43), the Commission will calculate the reduced grant amount for the beneficiary by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or

breach of obligations, in accordance with Article 43.2) from the grant amount for the beneficiary.

If the payments received **exceed the amounts due**:

- if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Commission will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Commission will draw upon the Guarantee Fund to pay the coordinator and then notify a **debit note** on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- in all other cases, in particular if termination takes effect after the period set out in Article 3, the Commission will formally notify a **debit note** to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Commission the amount due and the Commission will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- if the beneficiary concerned is the former coordinator, it must repay the new coordinator according to the procedure above, unless:

  - termination takes effect after an interim payment and

  - the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7).

  In this case, the Commission will formally notify a **debit note** to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Commission the amount due. The Commission will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

If the payments received **do not exceed the amounts due**: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the Commission does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the Commission does not receive the report on the distribution of payments within the deadline (see above), it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that

- the beneficiary concerned must not repay any amount to the coordinator.

Improper termination may lead to a reduction of the grant (see Article 43) or termination of the Agreement (see Article 50).

After termination, the concerned beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

### 50.3 Termination of the Agreement or the participation of one or more beneficiaries, by the Commission

#### 50.3.1 Conditions

The Commission may terminate the Agreement or the participation of one or more beneficiaries, if:

(a) one or more beneficiaries do not accede to the Agreement (see Article 56);

(b) a change to their legal, financial, technical, organisational or ownership situation (or those of its linked third parties) is likely to substantially affect or delay the implementation of the action or calls into question the decision to award the grant;

(c) following termination of participation for one or more beneficiaries (see above), the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants (see Article 55);

(d) implementation of the action is prevented by force majeure (see Article 51) or suspended by the coordinator (see Article 49.1) and either:

(i) resumption is impossible, or

(ii) the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants;

(e) a beneficiary is declared bankrupt, being wound up, having its affairs administered by the courts, has entered into an arrangement with creditors, has suspended business activities, or is subject to any other similar proceedings or procedures under national law;

(f) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has been found guilty of professional misconduct, proven by any means;

(g) a beneficiary does not comply with the applicable national law on taxes and social security;

(h) the action has lost scientific or technological relevance;

(i) not applicable;

(j) not applicable;

(k) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed fraud, corruption, or is involved in a criminal organisation, money laundering or any other illegal activity;

(l) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles);

(m) a beneficiary has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

(n) despite a specific request by the Commission, a beneficiary does not request — through the coordinator — an amendment to the Agreement to end the participation of one of its linked third parties that is in one of the situations under points (e), (f), (g), (k), (l) or (m) and to reallocate its tasks.

**50.3.2 Procedure**

Before terminating the Agreement or participation of one or more beneficiaries, the Commission will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to terminate and the reasons why and

- inviting it, within 30 days of receiving notification, to submit observations and — in case of Point (l.ii) above — to inform the Commission of the measures to ensure compliance with the obligations under the Agreement.

If the Commission does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify to the coordinator or beneficiary concerned **confirmation** of the termination and the date it will take effect. Otherwise, it will formally notify that the procedure is not continued.

The termination will **take effect**:

- for terminations under Points (b), (c), (e), (g), (h), (j), (l.ii) and (n) above: on the day specified in the notification of the confirmation (see above);

- for terminations under Points (a), (d), (f), (i), (k), (l.i) and (m) above: on the day after the notification of the confirmation is received.

**50.3.3 Effects**

(a) for **termination of the Agreement**:

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a periodic report (for the last open reporting period until termination; see Article 20.3) and

(ii) a final report (see Article 20.4).

If the Agreement is terminated for breach of the obligation to submit reports (see Articles 20.8 and 50.3.1(l)), the coordinator may not submit any reports after termination.

If the Commission does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Commission will **calculate** the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the reports submitted. Only costs incurred until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

This does not affect the Commission's right to reduce the grant (see Article 43) or to impose administrative sanctions (Article 45).

The beneficiaries may not claim damages due to termination by the Commission (see Article 46).

After termination, the beneficiaries' obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

(b) for **termination of the participation of one or more beneficiaries**:

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a report on the distribution of payments to the beneficiary concerned;

(ii) a request for amendment (see Article 55), with a proposal for reallocation of the tasks and estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination is notified after the period set out in Article 3, no request for amendment must be submitted unless the beneficiary concerned is the coordinator. In this case the request for amendment must propose a new coordinator, and

(iii) if termination takes effect during the period set out in Article 3, a **termination report** from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources, the individual financial statement and, if applicable, the certificate on the financial statement (see Article 20).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Commission, (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Commission, the Agreement is **amended** to introduce the necessary changes (see Article 55).

The Commission will — on the basis of the periodic reports, the termination report and the report on the distribution of payments — **calculate** the amount which is due to the beneficiary and if the (pre-financing and interim) payments received by the beneficiary exceed this amount.

The **amount which is due** is calculated in the following steps:

Step 1 — Application of the reimbursement rate to the eligible costs

The grant amount for the beneficiary is calculated by applying the reimbursement rate(s) to the total eligible costs declared by the beneficiary and its linked third parties in the termination report and approved by the Commission.

Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Step 2 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

In case of a reduction (see Article 43), the Commission will calculate the reduced grant amount for the beneficiary by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the grant amount for the beneficiary.

If the payments received **exceed the amounts due**:

- if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Commission will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Commission will draw upon the Guarantee Fund to pay the coordinator and then notify a **debit note** on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- in all other cases, in particular if termination takes effect after the period set out in Article 3, the Commission will formally notify a **debit note** to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Commission the amount due and the Commission will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- if the beneficiary concerned is the former coordinator, it must repay the new coordinator according to the procedure above, unless:

  - termination takes effect after an interim payment and

  - the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7).

  In this case, the Commission will formally notify a **debit note** to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Commission the amount due. The Commission will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

If the payments received **do not exceed the amounts due**: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the Commission does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the Commission does not receive the report on the distribution of payments within the deadline (see above), it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

After termination, the concerned beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

## SECTION 4 FORCE MAJEURE

### ARTICLE 51 — FORCE MAJEURE

'Force majeure' means any situation or event that:

- prevents either party from fulfilling their obligations under the Agreement,
- was unforeseeable, exceptional situation and beyond the parties' control,
- was not due to error or negligence on their part (or on the part of third parties involved in the action), and
- proves to be inevitable in spite of exercising all due diligence.

The following cannot be invoked as force majeure:

- any default of a service, defect in equipment or material or delays in making them available, unless they stem directly from a relevant case of force majeure,
- labour disputes or strikes, or
- financial difficulties.

Any situation constituting force majeure must be formally notified to the other party without delay, stating the nature, likely duration and foreseeable effects.

The parties must immediately take all the necessary steps to limit any damage due to force majeure and do their best to resume implementation of the action as soon as possible.

The party prevented by force majeure from fulfilling its obligations under the Agreement cannot be considered in breach of them.

## CHAPTER 7 FINAL PROVISIONS

### ARTICLE 52 — COMMUNICATION BETWEEN THE PARTIES

#### 52.1 Form and means of communication

Communication under the Agreement (information, requests, submissions, 'formal notifications', etc.) must:

- be made in writing and
- bear the number of the Agreement.

**Until the payment of the balance**: all communication must be made through the electronic exchange system and using the forms and templates provided there.

**After the payment of the balance**: formal notifications must be made by registered post with proof of delivery (‘formal notification on paper’).

Communications in the electronic exchange system must be made by persons authorised according to the Participant Portal Terms & Conditions. For naming the authorised persons, each beneficiary must have designated — before the signature of this Agreement — a ‘legal entity appointed representative (LEAR)’. The role and tasks of the LEAR are stipulated in his/her appointment letter (see Participant Portal Terms & Conditions).

If the electronic exchange system is temporarily unavailable, instructions will be given on the Commission websites.

### 52.2 Date of communication

**Communications** are considered to have been made when they are sent by the sending party (i.e. on the date and time they are sent through the electronic exchange system).

**Formal notifications** through the **electronic** exchange system are considered to have been made when they are received by the receiving party (i.e. on the date and time of acceptance by the receiving party, as indicated by the time stamp). A formal notification that has not been accepted within 10 days after sending is considered to have been accepted.

Formal notifications **on paper** sent by **registered post** with proof of delivery (only after the payment of the balance) are considered to have been made on either:

- the delivery date registered by the postal service or
- the deadline for collection at the post office.

If the electronic exchange system is temporarily unavailable, the sending party cannot be considered in breach of its obligation to send a communication within a specified deadline.

### 52.3 Addresses for communication

The **electronic** exchange system must be accessed via the following URL:

https://ec.europa.eu/research/participants/portal/desktop/en/projects/

The Commission will formally notify the coordinator and beneficiaries in advance any changes to this URL.

**Formal notifications on paper** (only after the payment of the balance) addressed **to the Commission** must be sent to the following address:

European Commission
Communications Networks, Content and Technology
Cloud & Software
BU 25 3/178
B-1049 Brussels Belgium

Formal notifications on paper (only after the payment of the balance) addressed **to the beneficiaries** must be sent to their legal address as specified in the Participant Portal Beneficiary Register.

## ARTICLE 53 — INTERPRETATION OF THE AGREEMENT

### 53.1 Precedence of the Terms and Conditions over the Annexes

The provisions in the Terms and Conditions of the Agreement take precedence over its Annexes.

Annex 2 takes precedence over Annex 1.

### 53.2 Privileges and immunities

Not applicable

## ARTICLE 54 — CALCULATION OF PERIODS, DATES AND DEADLINES

In accordance with Regulation No 1182/71[28], periods expressed in days, months or years are calculated from the moment the triggering event occurs.

The day during which that event occurs is not considered as falling within the period.

## ARTICLE 55 — AMENDMENTS TO THE AGREEMENT

### 55.1 Conditions

The Agreement may be amended, unless the amendment entails changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

Amendments may be requested by any of the parties.

### 55.2 Procedure

The party requesting an amendment must submit a request for amendment signed in the electronic exchange system (see Article 52).

The coordinator submits and receives requests for amendment on behalf of the beneficiaries (see Annex 3).

If a change of coordinator is requested without its agreement, the submission must be done by another beneficiary (acting on behalf of the other beneficiaries).

The request for amendment must include:

- the reasons why;
- the appropriate supporting documents;

[28] Regulation (EEC, Euratom) No 1182/71 of the Council of 3 June 1971 determining the rules applicable to periods, dates and time-limits (OJ L 124, 8.6.1971, p. 1).

- for a change of coordinator without its agreement: the opinion of the coordinator (or proof that this opinion has been requested in writing).

The Commission may request additional information.

If the party receiving the request agrees, it must sign the amendment in the electronic exchange system within 45 days of receiving notification (or any additional information the Commission has requested). If it does not agree, it must formally notify its disagreement within the same deadline. The deadline may be extended, if necessary for the assessment of the request. If no notification is received within the deadline, the request is considered to have been rejected

An amendment **enters into force** on the day of the signature of the receiving party.

An amendment **takes effect** on the date agreed by the parties or, in the absence of such an agreement, on the date on which the amendment enters into force.

## ARTICLE 56 — ACCESSION TO THE AGREEMENT

### 56.1 Accession of the beneficiaries mentioned in the Preamble

The other beneficiaries must accede to the Agreement by signing the Accession Form (see Annex 3) in the electronic exchange system (see Article 52) within 30 days after its entry into force (see Article 58).

They will assume the rights and obligations under the Agreement with effect from the date of its entry into force (see Article 58).

If a beneficiary does not accede to the Agreement within the above deadline, the coordinator must — within 30 days — request an amendment to make any changes necessary to ensure proper implementation of the action. This does not affect the Commission's right to terminate the Agreement (see Article 50).

### 56.2 Addition of new beneficiaries

In justified cases, the beneficiaries may request the addition of a new beneficiary.

For this purpose, the coordinator must submit a request for amendment in accordance with Article 55. It must include an Accession Form (see Annex 3) signed by the new beneficiary in the electronic exchange system (see Article 52).

New beneficiaries must assume the rights and obligations under the Agreement with effect from the date of their accession specified in the Accession Form (see Annex 3).

## ARTICLE 57 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES

### 57.1 Applicable law

The Agreement is governed by the applicable EU law, supplemented if necessary by the law of Belgium.

### 57.2 Dispute settlement

If a dispute concerning the interpretation, application or validity of the Agreement cannot be settled amicably, the General Court — or, on appeal, the Court of Justice of the European Union — has sole

jurisdiction. Such actions must be brought under Article 272 of the Treaty on the Functioning of the EU (TFEU).

As an exception, if such a dispute is between the Commission and STIFTELSEN SINTEF, TELLU AS, the competent Belgian courts have sole jurisdiction.

If a dispute concerns administrative sanctions, offsetting or an enforceable decision under Article 299 TFEU (see Articles 44, 45 and 46), the beneficiaries must bring action before the General Court — or, on appeal, the Court of Justice of the European Union — under Article 263 TFEU.

## ARTICLE 58 — ENTRY INTO FORCE OF THE AGREEMENT

The Agreement will enter into force on the day of signature by the Commission or the coordinator, depending on which is later.

SIGNATURES

For the coordinator

Antoine PETIT with ECAS id npetiato signed in the Participant Portal on 03/10/2016 at 07:37:18 (transaction id SigId-239606-APglGM8WhNwmCQAA0jk6Jmwb5Aj4ZZ6PK2y5h3zKzttazJMdAFZ8Gv7zlgTgECkW5JFuf2w2TTwkg0DJ36Mnm1C-Jj71zxYb8yrYiyGUQlxsv0-caVkmfVfoGahlWzZuZvxlA4D1gAIDgb8lq5kzSFvzQR0). Timestamp by third party at
Mon Oct 03 08:37:28 CEST 2016

For the Commission

Signed by Griet VAN CAENEGEM with ECAS id caenegr as an authorised representative on 26-10-2016 19:10:12 (transaction id SigId-65689-s6J4MihAVezKcj0Dvkno54hBBCL6edxoFE7NmgG3C6bPcbuEe4fFvLcU2s0c9aEU4wngP5h6ICJ9c9cwdUza7f-Jj71zxYb8yrkmoAceBIUCa-PdOjzaPgE3ehbzaklA3TJuGWq7jqzshtYCRIamYKBuRG)
Wed Oct 26 19:10:18 CEST 2016

EUROPEAN COMMISSION
Communications Networks, Content and Technology
Cloud & Software


# ANNEX 1 (part A)

## Research and Innovation action

## NUMBER — 731529 — STAMP

# Table of Contents

# 1.1. The project summary

| Project Number [1] | 731529 | Project Acronym [2] | STAMP |
|---|---|---|---|

One form per project

| General information | |
|---|---|
| Project title [3] | Software Testing AMPlification |
| Starting date [4] | 01/12/2016 |
| Duration in months [5] | 36 |
| Call (part) identifier [6] | H2020-ICT-2016-1 |
| Topic | ICT-10-2016<br>Software Technologies |
| Fixed EC Keywords | Software quality Management, Cloud computing, Software engineering, operating systems, computer languages |
| Free keywords | Software testing, Program analysis, Microservice architecture, Open source development, |


Abstract [7]

Release early, release often. Such is the mantra of IT giants like Twitter or Netflix. Pioneers in the engineering of applications that run in the cloud now routinely perform hundreds of code updates per day in what has become a thrust of continuous delivery around the clock. This stunning agility is a decisive competitive edge. It cuts time-to-market and hikes revenue. Behind the feat lies DevOps. This powerful development methodology brings high degrees of automation at all steps of construction and deployment.
DevOps has gained more traction in the USA than in Europe and concern is raised that European companies may be “missing the train”. Their disinclination is thought to reflect a different cultural attitude toward risk. Indeed, a hasty deployment may propagate a regression bug into production due to lack of sufficient testing. Fear of breaking things is all the more justified as testing in DevOps mostly relies on manual effort.
Leveraging advanced research in automatic test generation, STAMP aims at pushing automation in DevOps one step further through innovative methods of test amplification. It will reuse existing assets (test cases, API descriptions, dependency models), in order to generate more test cases and test configurations each time the application is updated. Acting at all steps of development cycle, it will bring amplification services at unit level, configuration level and production stage.
STAMP will raise confidence and foster adoption of DevOps by the European IT industry. The project gathers 3 academic partners with strong software testing expertise, 5 software companies (in: e-Health, Content Management, Smart Cities and Public Administration), and an open source consortium. This industry-near research addresses concrete, business-oriented objectives. All solutions are open source and developed as microservices to facilitate exploitation, with a target at TRL 6.

# 1.2. List of Beneficiaries

| Project Number [1] | 731529 | Project Acronym [2] | STAMP |
|---|---|---|---|

List of Beneficiaries

| No | Name | Short name | Country | Project entry month[8] | Project exit month |
|---|---|---|---|---|---|
| 1 | INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE | INRIA | France | 1 | 36 |
| 2 | STIFTELSEN SINTEF | SINTEF | Norway | 1 | 36 |
| 3 | TECHNISCHE UNIVERSITEIT DELFT | TUD | Netherlands | 1 | 36 |
| 4 | OW2 CONSORTIUM ASSOCIATION | OW2 | France | 1 | 36 |
| 5 | ENGINEERING - INGEGNERIA INFORMATICA SPA | ENG | Italy | 1 | 36 |
| 6 | TELLU AS | TellU | Norway | 1 | 36 |
| 7 | XWIKI SAS | XWiki | France | 1 | 36 |
| 8 | ATOS SPAIN SA | ATOS | Spain | 1 | 36 |
| 9 | ACTIVEEON | AEon | France | 1 | 36 |

# 1.3. Workplan Tables - Detailed implementation

## *1.3.1. WT1 List of work packages*

| WP Number[9] | WP Title | Lead beneficiary[10] | Person-months[11] | Start month[12] | End month[13] |
|---|---|---|---|---|---|
| WP1 | Unit Test Amplification | 1 - INRIA | 87.00 | 1 | 36 |
| WP2 | Configurability test amplification | 2 - SINTEF | 82.00 | 1 | 36 |
| WP3 | Runtime test amplification | 3 - TUD | 65.00 | 1 | 36 |
| WP4 | Development and Integration | 5 - ENG | 84.00 | 1 | 36 |
| WP5 | Use cases and validation | 8 - ATOS | 117.00 | 1 | 36 |
| WP6 | Dissemination, exploitation and communication | 4 - OW2 | 63.00 | 1 | 36 |
| WP7 | Management and coordination | 1 - INRIA | 18.00 | 1 | 36 |
| | | **Total** | 516.00 | | |

### 1.3.2. WT2 list of deliverables

| Deliverable Number[14] | Deliverable Title | WP number[9] | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|---|
| D1.1 | Report on the state of practice for unit testing and test assessment | WP1 | 1 - INRIA | Report | Public | 6 |
| D1.2 | Initial prototype of the unit test amplification tool | WP1 | 1 - INRIA | Demonstrator | Public | 12 |
| D1.3 | Enhanced prototype of the unit test amplification tool and report on the performance | WP1 | 1 - INRIA | Demonstrator | Public | 20 |
| D1.4 | Consolidated tool for the unit test amplification, selection and execution | WP1 | 1 - INRIA | Demonstrator | Public | 34 |
| D1.5 | Final report about the amplification process for unit test suites | WP1 | 1 - INRIA | Report | Public | 36 |
| D2.1 | Report on the state of practices for configuration testing | WP2 | 2 - SINTEF | Report | Public | 6 |
| D2.2 | Initial prototype on configuration test amplification | WP2 | 2 - SINTEF | Report | Public | 12 |
| D2.3 | Enhanced prototype of the configuration amplification and report on the performance | WP2 | 2 - SINTEF | Demonstrator | Public | 20 |
| D2.4 | Consolidated tool for the configuration amplification, selection and execution | WP2 | 2 - SINTEF | Demonstrator | Public | 34 |
| D2.5 | Final report on configuration testing amplification | WP2 | 2 - SINTEF | Report | Public | 36 |
| D3.1 | Survey on logging practices and tools | WP3 | 3 - TUD | Report | Public | 6 |
| D3.2 | Initial prototype of log optimization tool | WP3 | 3 - TUD | Demonstrator | Public | 12 |
| D3.3 | Prototype of amplification tool for common and anomaly behaviors | WP3 | 3 - TUD | Demonstrator | Public | 20 |

| Deliverable Number[14] | Deliverable Title | WP number[9] | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|---|
| D3.4 | Consolidated services for online-test amplification | WP3 | 3 - TUD | Demonstrator | Public | 34 |
| D3.5 | Final report for online-test amplification | WP3 | 3 - TUD | Report | Public | 36 |
| D4.1 | STAMP Collaborative Software Engineering Platform | WP4 | 4 - OW2 | Other | Public | 6 |
| D4.2 | First public version of the API and initial implementation of services and courseware | WP4 | 5 - ENG | Other | Public | 14 |
| D4.3 | Second public version of the API and implementation of services and courseware | WP4 | 5 - ENG | Other | Public | 24 |
| D4.4 | Final public version of the API and implementation of services and courseware | WP4 | 5 - ENG | Other | Public | 36 |
| D5.1 | Industrial requirements and metrics V1 | WP5 | 7 - XWiki | Report | Confidential, only for members of the consortium (including the Commission Services) | 6 |
| D5.2 | Validation Roadmap and framework V1 | WP5 | 8 - ATOS | Report | Confidential, only for members of the consortium (including the Commission Services) | 9 |
| D5.3 | Industrial requirements and metrics V2 | WP5 | 7 - XWiki | Report | Public | 20 |
| D5.4 | Validation Roadmap and framework V2 | WP5 | 8 - ATOS | Report | Public | 20 |
| D5.5 | UC validation report V1 | WP5 | 9 - AEon | Report | Confidential, only for members of the consortium (including the Commission Services) | 18 |
| D5.6 | UC validation report V2 | WP5 | 4 - OW2 | Report | Confidential, only for members of the consortium (including the Commission Services) | 30 |

| Deliverable Number[14] | Deliverable Title | WP number[9] | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|---|
| D5.7 | UC validation report final | WP5 | 8 - ATOS | Report | Public | 36 |
| D6.1 | Dissemination and Communication Plan | WP6 | 4 - OW2 | Report | Public | 3 |
| D6.2 | Communication Material | WP6 | 4 - OW2 | Report | Public | 4 |
| D6.3 | Market Analysis | WP6 | 9 - AEon | Report | Public | 18 |
| D6.4 | Exploitation Plan | WP6 | 9 - AEon | Report | Public | 30 |
| D6.5 | Business Plan | WP6 | 9 - AEon | Report | Public | 36 |
| D7.1 | Project Quality Plan & Private web platform | WP7 | 1 - INRIA | Report | Confidential, only for members of the consortium (including the Commission Services) | 2 |

## 1.3.3. WT3 Work package descriptions

| | | | |
|---|---|---|---|
| **Work package number** [9] | WP1 | **Lead beneficiary** [10] | 1 - INRIA |
| **Work package title** | Unit Test Amplification | | |
| **Start month** | 1 | **End month** | 36 |

**Objectives**

This WP aims at developing algorithms for the selection, amplification and efficient execution of unit test cases, when a change is introduced in an individual service. The inputs for all algorithms developed in this WP are as follow: one version of the service under test, an updated version (or the commit) and a test suite that passes on the reference version. The detailed method for this WP is in Part 1 - methodological pillar 1 (unit test amplification)

**Description of work and role of partners**

**WP1 - Unit Test Amplification** [Months: 1-36]
**INRIA**, SINTEF, TUD, OW2, ENG, XWiki, ATOS, AEon
Task 1.1 State of the art and empirical analysis of practices (leader: INRIA) months 1 to 6
This first task aims at establishing a survey of the different program analysis, metrics and tools used for unit testing and for assessing the quality of unit test suites. This survey will also collect information about the performance of unit test and the frequency of execution of these test suites. We will gather empirical observations among use cases, as well as in other OW2 open source projects
Output: a survey of tools and metrics used to assess unit test suites.
Partner Contributions :
# INRIA : Coordinate all activities related to literature gathering and analysis of practices
# SINTEF : Participate in the evaluation of state of the art solutions
# TUD : Participate in the evaluation of state of the art solutions
# AEon : Survey existing tools and provide metrics about their testing practices
# ATOS : Survey techniques tools for code monitoring
# XWiki : Survey test metrics and existing tools
# OW2 : Survey test metrics and practices among the consortium's project

T1.1 : Inria 6PM ; Sintef 2PM ; TUD : 3PM ; OW2 : 3PM ; XWiki : 1PM ; XWiki SRL : 2PM ; Atos : 3 PM ; AEon : 4 PM

**********

Task 1.2 Measurement tool to analyze the interplay between test suites and program
This task aims at building a tool to precisely monitor the interplay between test suites and the unit under test. Metrics capture different aspects of this interplay: coverage metrics, scope of the test cases, API interactions, historical data about test cases, types of bugs detected by existing test cases. They are then used in the amplification process and in the evaluation of the impact of amplification.
Output: a set of metrics definitions to measure the interplay between a test suite and a program under test, as well as a tool that instruments the code to automatically collect these metrics.
Partner Contributions :
# INRIA: Participate in the definition of the metrics and the design of the tool
# TUD: Participate in the definition of metrics to analyze the effect of test cases generated in WP3
# XWiki: Lead the definition of metrics, the design and implementation of the tool and the exploitation of the tool to evaluate the impact of amplification

T1.2 : Inria 6PM ; TUD : 3PM ; XWiki : 3PM ; XWiki SRL : 6PM

**********

Task 1.3 Automatic generation of test cases variants (leader: INRIA) months 1 to 20
This task focuses on the definition of effective code transformations, which can produce new test cases as variants of existing ones. This task is articulated around four main subtasks:
# selection of test cases that are prone to amplification
# transformations of test cases to generate test variants
# definition and evaluation of fitness functions to steer the amplification
# generation of oracle and insertion of significant observations points in the new test cases

Output: Systematic metrics and methodology to select the set of test cases that are prone to amplification and algorithms for the automatic transformation of these test cases
Partner Contributions :
# INRIA: Lead the development of algorithms, tools and methodology for automatic generation of test cases variants
# TUD: Contribute to the selection and implementation of search-based algorithms for amplification
# SINTEF: Participate in the definition of selection criteria that can steer the amplification towards test cases useful for WP2
# XWiki: Participate in the definition of sound and relevant techniques for the selection of test cases prone to amplification, in the identification of relevant observation points and in the definition of criteria for the selection of amplified test cases

T1.3 : Inria 10PM ; Sintef 3PM ; TUD : 3PM ; XWiki : 1PM ; XWiki SRL : 3PM

**********

Task 1.4 Test execution (leader: ATOS) months 18 to 36
This task focuses on the development of a specific test runner, which exploits the commonalities between test cases. For example since several test cases in the amplified test suite share a common preamble, time can be saved by running this common part only once and sharing this state for all test case variants. The automatic identification of common states as well as state sharing mechanisms form the code contribution of this task.
Output: a test runner that speeds up the execution of amplified test suites, exploiting knowledge about the commonalities between test cases
Partner Contributions :
# INRIA: Coordinate the development efforts for this specific test runner
# SINTEF: Contribute their expertise in resource management to evaluate performance savings of the runner
# ATOS: Contribute expertise in JVM and optimization

T1.4 : Inria 6PM ; Sintef 3PM ; Atos : 7 PM

**********

Task 1.5 Industrialization (leader: ENG) months 12 to 36
This task focuses strengthening the software prototypes of WP1 in order to deliver clearly packaged services, well-documented and tested.
Output: a set of microservices that can be assembled to provide full-fledged amplification of unit test suites.
Partner Contributions:
# INRIA: Participate in the industrialization of services developed in other tasks
# ENG: Lead the definition of APIs and packaging of micro-services

T1.5 : Inria 4PM ; ENG 5PM

**********

Participation per Partner

| Partner number and short name | WP1 effort |
|---|---|
| 1 - INRIA | 32.00 |
| 2 - SINTEF | 8.00 |
| 3 - TUD | 9.00 |
| 4 - OW2 | 3.00 |
| 5 - ENG | 5.00 |
| 7 - XWiki | 5.00 |
| XWiki Romania | 11.00 |
| 8 - ATOS | 10.00 |
| 9 - AEon | 4.00 |
| **Total** | 87.00 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| D1.1 | Report on the state of practice for unit testing and test assessment | 1 - INRIA | Report | Public | 6 |
| D1.2 | Initial prototype of the unit test amplification tool | 1 - INRIA | Demonstrator | Public | 12 |
| D1.3 | Enhanced prototype of the unit test amplification tool and report on the performance | 1 - INRIA | Demonstrator | Public | 20 |
| D1.4 | Consolidated tool for the unit test amplification, selection and execution | 1 - INRIA | Demonstrator | Public | 34 |
| D1.5 | Final report about the amplification process for unit test suites | 1 - INRIA | Report | Public | 36 |

## Description of deliverables

D11 Report on the state of practice for unit testing and test assessment (M6, INRIA)
D12 Report on the amplification process for unit test suites (M12, INRIA)
D13 Initial prototype of the unit test amplification tool (M12, INRIA)
D14 Report on the performance of the amplification process for unit test suites (M24, INRIA)
D15 Consolidated services of the unit test amplification tool (M24, INRIA)
D16 Final report about the amplification process for unit test suites (M36, INRIA)

D1.1 : Report on the state of practice for unit testing and test assessment [6]

Report on the state of practice for unit testing and test assessment

D1.2 : Initial prototype of the unit test amplification tool [12]

Initial prototype of the unit test amplification tool

D1.3 : Enhanced prototype of the unit test amplification tool and report on the performance [20]

Enhanced prototype of the unit test amplification tool and report on the performance

D1.4 : Consolidated tool for the unit test amplification, selection and execution [34]

Consolidated tool for the unit test amplification, selection and execution

D1.5 : Final report about the amplification process for unit test suites [36]

Final report about the amplification process for unit test suites

## Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS3 | Initial pilot on selected use case | 3 - TUD | 4 | Test amplification techniques run on one use case |

Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS7 | First prototypes of test amplification workflows | 1 - INRIA | 10 | Complete chain of selection and transformation runs and conforms to the API |
| MS8 | First prototypes of the amplification tool | 1 - INRIA | 12 | Complete chain of selection and transformation runs and conforms to the API. D12, D22, D32 available |
| MS10 | Enhanced prototypes of test amplification workflows | 1 - INRIA | 18 | Complete chain of selection and transformation runs, conforms to the API, includes feedback from WP4 and WP5 |
| MS12 | Enhanced prototypes of the amplification tool | 1 - INRIA | 20 | Complete chain of selection and transformation runs and conforms to the API. D13, D23, D33 available |
| MS14 | Consolidated test amplification workflows | 1 - INRIA | 30 | Complete chain of unit test amplification is efficient and effective at detecting new bugs |
| MS15 | International scientific workshop | 1 - INRIA | 33 | In conjunction with a major academic event in the area of software testing |
| MS16 | Consolidated prototypes of the amplification tool | 1 - INRIA | 34 | Complete chain of selection and transformation runs and conforms to the API. D14, D24, D34 available |

| Work package number [9] | WP2 | Lead beneficiary [10] | 2 - SINTEF |
|---|---|---|---|
| Work package title | Configurability test amplification | | |
| Start month | 1 | End month | 36 |

## Objectives

This WP aims at developing algorithms and tools for the amplification and efficient execution of configuration tests. From the input of a set of test cases (either provided by developers or generated from WP1) and a small number of test configurations (manually designed by developers, specified in mainstream scripting languages), the algorithms and tools developed under this work package will automatically generate a set of new configurations in order to increase coverage of the space of system configurations. The tools will also analyze these amplified configurations to select the ones that best fit the provided test cases, deploy the services on simulated or real cloud environments according to the selected configurations, and execute the test cases in a managed and efficient way against the services.
The detailed method for this WP is in Part 1 - methodological pillar 1 (configuration test amplification)

## Description of work and role of partners

**WP2 - Configurability test amplification** [Months: 1-36]
**SINTEF**, INRIA, TUD, OW2, ENG, TellU, XWiki, ATOS, AEon
Task 2.1 Survey state of practice for configuration specification and automatic configuration planning (leader: SINTEF) months 1 to 6
This task will survey the tools and languages used to specify and deploy test configurations. It will also survey the metrics that are collected to assess this specific testing activity among partners and other open source projects in the area of cloud computing. The survey will be collaborated with Task 1.1.
Partner Contributions
# SINTEF: Coordinate the survey, with a focus on automatic configuration generation
# INRIA: Survey on the configuration testing approaches
# OW2: Survey on configuration testing for scalability on open source projects
# TellU: Survey based on the state of the practice in the company
# ATOS: Survey based on the state of the practice of scripting languages

T2.1 : Inria 1PM ; Sintef 3PM ; OW2 : 3PM ; TellU : 1PM ; Atos : 1 PM

**********

Task 2.2 Abstract configuration model (leader: SINTEF) months 6 to 12
This task aims at abstracting the common concepts from mainstream configuration scripts to define a common model for micro-service configuration. The model will not be provided to developers, but be a basis for the subsequent tasks on configuration amplification and selection. This task will also develop the text comprehension and mining techniques to transform scripts to the common model, and the incremental code generation to transform the new model back to executable scripts.
This task will be based on the result from T2.1
Partner Contributions
- SINTEF: Language definition and transformation development
- XWiki: Language definition and transformation development
- ATOS: Transformation between common model and mainstream languages
- Aeon: Transformation between common model and mainstream languages

T2.2 : Sintef 6PM ; XWiki : 2PM ; XWiki SRL : 3PM ; Atos : 7PM ; AEon : 2PM

**********

Task 2.3 Automatic configuration generation (leader: SINTEF) months 9 to 30
This task will design and implement the algorithms to automatically generate new configurations from provided ones. We will define a set of primitive mutation operators on the common configuration model, as well as the crossover strategies on multiple configurations. We will also work on a constraint solving-based technique to automatically complete the required calibrations after mutation and crossover, in order to produce valid configurations for testing.
This task will be based on the result from T2.1
Partner Contributions :

-SINTEF: Investigate on generation and constraint solving algorithms
-XWiki: Participate in the mutation and crossover design on configurations
-INRIA: Participate in the mutation and crossover design
-TellU Participate in the mutation and crossover design

T2.3 : Inria 1PM ; Sintef 12PM ; TellU : 1PM ; XWiki : 1PM ; XWiki SRL : 3PM

**********

Task 2.4 Configuration assessment and selection (leader: Tellu) months 12 to 30
This task aims at providing methods and tools to assess the relevance, diversity and space coverage of the automatically generated configurations, in order to select the effective set of configurations for a given set of test cases and the latest changes. This task will be conducted together with the measurement of test cases in T1.2
Partner Contributions:
- SINTEF: Design and develop the configuration assessment methods and tools
- INRIA: Participate in the analysis of the relevance between configurations and test cases
- XWiki: Assessment with a relation to test case analysis
- TellU: Lead the task, define configuration assessment methods and criteria with industrial experience

T2.4 : Inria 2PM ; Sintef 5PM ; TellU : 6PM ; XWiki : 1PM ; XWiki SRL : 1PM

**********

Task 2.5 Configuration execution and instrumentation (leader: AEon) months18 to 36
The objective of Task 2.5 is to efficiently deploy the services according to the selected configurations and to execute the test cases on these services. The research will be focus on the optimisation of deployment and execution scheduling, as well as the managed execution of test cases. This task will produce a library of ready-to-deploy packages that wrap up the instrumentation mechanisms from T1.5. The execution will be performed on a cloud-based testing laboratory.
Partner Contributions:
-SINTEF: Participate in the scheduling and execution, and provide part of the testing laboratory.
-TUD: Participate in the execution and instrumentation, with a connection to WP3
-Aeon: Lead the task, with the focus on the scheduling of test execution
-ENG: Package and document the amplification service

T2.5 : Sintef 6PM ; TUD : 3PM ; ENG 5PM ; AEon : 6PM

Participation per Partner

| Partner number and short name | WP2 effort |
|---|---|
| 1 - INRIA | 4.00 |
| 2 - SINTEF | 32.00 |
| 3 - TUD | 3.00 |
| 4 - OW2 | 3.00 |
| 5 - ENG | 5.00 |
| 6 - TellU | 8.00 |
| 7 - XWiki | 4.00 |
| XWiki Romania | 7.00 |
| 8 - ATOS | 8.00 |
| 9 - AEon | 8.00 |
| **Total** | 82.00 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| D2.1 | Report on the state of practices for configuration testing | 2 - SINTEF | Report | Public | 6 |
| D2.2 | Initial prototype on configuration test amplification | 2 - SINTEF | Report | Public | 12 |
| D2.3 | Enhanced prototype of the configuration amplification and report on the performance | 2 - SINTEF | Demonstrator | Public | 20 |
| D2.4 | Consolidated tool for the configuration amplification, selection and execution | 2 - SINTEF | Demonstrator | Public | 34 |
| D2.5 | Final report on configuration testing amplification | 2 - SINTEF | Report | Public | 36 |

## Description of deliverables

D21 Report on the state of practices for configuration testing (M6, SINTEF)
D22 Report of internal configuration modelling language (M12, SINTEF)
D23 Initial prototype of the configuration amplification, selection and execution tool (M24, SINTEF)
D24 Consolidated tool for the configuration amplification, selection and execution (M36, SINTEF)
D25 Final report on configuration testing amplification (M36, SINTEF)

D2.1 : Report on the state of practices for configuration testing [6]

Report on the state of practices for configuration testing

D2.2 : Initial prototype on configuration test amplification [12]

Initial prototype on configuration test amplification

D2.3 : Enhanced prototype of the configuration amplification and report on the performance [20]

Enhanced prototype of the configuration amplification and report on the performance

D2.4 : Consolidated tool for the configuration amplification, selection and execution [34]

Consolidated tool for the configuration amplification, selection and execution

D2.5 : Final report on configuration testing amplification [36]

Final report on configuration testing amplification

## Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|

| Work package number [9] | WP3 | Lead beneficiary [10] | 3 - TUD |
|---|---|---|---|
| Work package title | Runtime test amplification | | |
| Start month | 1 | End month | 36 |

## Objectives

The goal of this WP is to monitor running software and its log data and to use the observed behaviors for amplifying existing tests. Therefore, this WP will be devoted to (i) defining monitoring techniques and log data analytics to collect run-time information; (ii) detecting interesting behaviors with respect to existing tests; (iii) creating new tests for testing the behaviors of interest; (iv) adding new probes and new log messages into the production code to improve its testability. The detailed method for this WP is in Part 1 - methodological pillar 1 (online test amplification)

## Description of work and role of partners

**WP3 - Runtime test amplification** [Months: 1-36]
**TUD**, INRIA, SINTEF, OW2, ENG, TellU, AEon
Task 3.1 Modern logging practices (leader: TUD) months 1 to 6
The goal of this first task is to establish how developers use log data collected from running software for debugging or resilience purposes. To achieve these goals, we will conduct interviews with developers from the industrial partners involved in this project, as well as with developers from other institutions. Furthermore, we plan to survey existing approaches to analyze and manage log files in the related research literature and how these approaches match developers' needs.
Output: Qualitative analysis of log file usage from the developer's perspective and a literature survey on existing approaches to support debugging starting from log data.
Partner Contributions:
-TUD: Coordinate all activities related to interviews and the literature survey
-INRIA: Participate in the evaluation of state of the art solutions
-SINTEF: Participate in the evaluation of state of the art solutions
-TellU: Participate in the interview providing feedback on modern logging practices
-AEon: Participate in the interview providing feedback on modern logging practices and survey logging tools
-OW2: Survey practices and tools for logging among OW2 projects

T3.1: Inria 1PM ; USTL (Inria 3rd party) 1PM ; Sintef 1PM ; TUD : 6PM ; OW2 : 1PM ; TellU 1PM ; AEon : 2PM

**********

Task 3.2 - Log Data optimization for debugging (leader TUD) months 7 to 18
This task focuses on the definition of effective techniques for log file optimization, which means reducing the amount of log data throughout redundancy removal and machine learning techniques. This task consists of: (i) defining strategies to detect redundancy in log files; (ii) using machine learning algorithms to derive behavioral patterns as state machine models; (iii) adding dynamic probes and log messages into the production code in order to improve its testability.
Output: Metrics and methodologies for the selection of the minimal set of log data that is relevant for debugging and that can be exploited for test amplification.
Partner Contributions:
-TUD: Lead the development of algorithms and tools for log file optimization
-INRIA: Participate in the definition optimization strategies for log file

T3.2: Inria 1PM ; TUD : 6PM

**********

Task 3.3 - Test amplification for anomalies replication (leader TUD) months 14 to 23
This task focuses on the automatic generation of test cases that can replicate failures, crashes, anomalies and outlier events. Therefore, we will use search-based techniques and mutation analysis to automatically generate tests that can trigger the target anomalies by exploiting crash data from collected stack traces. Output: New algorithms and methodologies for generating new tests that can replicate software anomalies reported in optimized log data
Partner Contributions:
-TUD: Lead the design and evaluation of test case generation algorithms for anomalies replication.
-INRIA: Contribute to the design of algorithms for test amplification.

-SINTEF: Contribute to the design of algorithms for test amplification.
-ENG: Development of a reliable, efficient & fully documented (industry ready) implementation of the developed algorithms
-TellU: Participate in the empirical evaluation of algorithms and generated tests
-OW2: Participate in the empirical evaluation of algorithms and generated tests
-AEon: Participate in the empirical evaluation of algorithms and generated tests

T3.3: Inria 1PM ; USTL 1PM ; Sintef 1PM ; TUD : 8PM ; OW2 : 1PM ; ENG 2PM ; TellU 2PM ; AEon : 3PM

**********

Task 3.4 Test amplification for common behaviors (leader: TUD) months 24 to 32
This task focuses on amplifying an existing suite by generating new tests that exercise common behaviors observed during software execution. To this aim, we will use search-based algorithms to generate test that replicate/exercise detected uncovered behaviors mined from optimized log data. It also includes the definition of proper assertions generation strategies.
Output: Systematic metrics and methodologies for identifying uncovered behaviors and generating corresponding test cases.
Partner Contributions:
-TUD: Lead the design and evaluation of test case generation algorithms for testing uncovered common software behaviors
-INRIA: Contribute to the identification of uncovered behaviors with respect to WP1
-SINTEF: Contribute to the identification of uncovered behaviors with respect to WP2
-ENG: Development of a reliable, efficient & fully documented (i.e. industry ready)implementation of the developed algorithms
-OW2: Participate in the empirical evaluation of algorithms and generated tests
-TellU: Participate in the empirical evaluation of algorithms and generated tests
-Aeon: Participate in the empirical evaluation of algorithms and generated tests

T3.4: Inria 2PM ; USTL 1PM ; Sintef 1PM ; TUD : 8PM ; OW2 : 1PM ; ENG 1PM ; TellU 2PM ; AEon : 2PM

**********

Task 3.5 Strategies for speeding-up runtime amplification (leader: ENG) months 12 to 36
The main goal of this task is to determine strategies for speeding-up runtime amplification and detecting potential inefficiencies by experimenting the tools developed in previous tasks with industrial software projects and in industrial development environment.
Partner Contributions:
-TUD: Coordinate the validation of run-time amplification tools in industrial environment and identify speeding up strategies
-ENG: Investigate the use of parallelization to reduce times for both the generation & execution of test suites - and in particular, the use of distributed genetic algorithms

T3.5: TUD : 6PM ; ENG 2PM

Participation per Partner

| Partner number and short name | WP3 effort |
|---|---|
| 1 - INRIA | 5.00 |
| USTL | 3.00 |
| 2 - SINTEF | 3.00 |
| 3 - TUD | 34.00 |
| 4 - OW2 | 3.00 |
| 5 - ENG | 5.00 |
| 6 - TellU | 5.00 |
| 9 - AEon | 7.00 |

| Partner number and short name | WP3 effort |
|---|---|
| **Total** | 65.00 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| D3.1 | Survey on logging practices and tools | 3 - TUD | Report | Public | 6 |
| D3.2 | Initial prototype of log optimization tool | 3 - TUD | Demonstrator | Public | 12 |
| D3.3 | Prototype of amplification tool for common and anomaly behaviors | 3 - TUD | Demonstrator | Public | 20 |
| D3.4 | Consolidated services for online-test amplification | 3 - TUD | Demonstrator | Public | 34 |
| D3.5 | Final report for online-test amplification | 3 - TUD | Report | Public | 36 |

## Description of deliverables

D31 Survey on logging practices and tools (M6, TUD)
D32 Initial prototype of log optimization tool (M10, TUD)
D33 Initial prototype of amplification tool for anomalies reproduction (M16, TUD)
D34 Initial prototype of amplification tool for common behaviors (M22, TUD)
D35 Consolidated services for online-test amplification (M28, TUD)
D36 Final report for online-test amplification (M36, TUD)

D3.1 : Survey on logging practices and tools [6]

Survey on logging practices and tools

D3.2 : Initial prototype of log optimization tool [12]

Initial prototype of log optimization tool

D3.3 : Prototype of amplification tool for common and anomaly behaviors [20]

Prototype of amplification tool for common and anomaly behaviors

D3.4 : Consolidated services for online-test amplification [34]

Consolidated services for online-test amplification

D3.5 : Final report for online-test amplification [36]

Final report for online-test amplification

## Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS3 | Initial pilot on selected use case | 3 - TUD | 4 | Test amplification techniques run on one use case |

Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS10 | Enhanced prototypes of test amplification workflows | 1 - INRIA | 18 | Complete chain of selection and transformation runs, conforms to the API, includes feedback from WP4 and WP5 |
| MS14 | Consolidated test amplification workflows | 1 - INRIA | 30 | Complete chain of unit test amplification is efficient and effective at detecting new bugs |

| Work package number [9] | WP4 | Lead beneficiary [10] | 5 - ENG |
|---|---|---|---|
| Work package title | Development and Integration | | |
| Start month | 1 | End month | 36 |

## Objectives

The main goal of this work package is to develop the three amplification services in such a way that they can be integrated in different tool chains (maven build, Jenkins, or as an online service). For this there are several important development tasks. The goal is to be at TRL 6 for all the software assets that will go out for this WP.
The detailed method for this WP is in Part 1 - methodological pillar 2

## Description of work and role of partners

**WP4 - Development and Integration** [Months: 1-36]
**ENG**, INRIA, TUD, OW2, XWiki, ATOS, AEon
Task 4.1 Collaborative Software Engineering Platform setup and management (leader: OW2) months 1 - 12
This task will set up a collaborative software engineering platform that will support the development, the build and the testing of the STAMP assets. In particular, the following tools will be made available to the project members, and hosted by OW2: Git repositories, issue tracker, CI server, OW2 Oscar platform (quality assurance tools), mirroring capabilities to GitHub.
Output: a survey and classification of the literature and available open source tools in the area of systematic analysis and transformation of unit test suites.
Partner Contributions:
-AEon, ATOS, XWiki: Test and provide feedback about the collaborative platform
-INRIA: Architecture design and test
-ENG: Infrastructure configuration
-OW2: Lead developer and host of the platform

T4.1: Inria 3PM ; OW2 : 8PM ; ENG 5PM ; XWiki 1PM ; ATOS 1PM ; AEon : 1PM

**********

Task 4.2 Stamp product architecture definition and implementation (leader: ENG) months 1 to 30
Precisely define the different micro-services and their dependencies resulting from the STAMP Project Integration. Those services will serve as a foundation for the integration of the STAMP artefacts in different software factories used by developers (IDE, building tools, CI tools, ...). This task will also provide extension points to adapt STAMP assets to different technical environments.
Output: API specifications and implementations for each micro-service, test cases to ensure alignment between implementation and API, a Docker container for each STAMP asset a workflow showing how those assets can be used together or separately, extension points for STAMP assets.
Partner Contributions:
-AEon: Unified Cloud API for the STAMP platform in order to offer STAMP as a Service, expertise about the micro-services development and integration
-ENG: Definition, implementation and testing of the API; package each asset as a configurable Docker container
-INRIA: Participate in the definition of the API and tests.

T4.2: Inria 3PM ; UR1 (Inria 3rd party) 3PM ; ENG 12PM ; AEon : 9PM

**********

Task 4.3 STAMP assets integration in various software factory (leader: ENG) months 1 to 36
This task integrates the amplification services in several software factories
IDE Client for Amplification: a set visual plugins, seamlessly integrated within Eclipse. These plugins will extend existing Eclipse support for testing, configuration and run-time instrumentation.
Building environment for Amplification: a set of Maven/Gradle plugins to easily integrate some stamp services in a common building process.
Amplification aware continuous integration: a Jenkins plugin that can integrate all services in a global workflow. This work is based on the workflow definition of task 4.2.
Output: integration of test amplification in common toolchains.

Partner Contributions:
-ATOS: Eclipse integration
-ENG: Integration in Maven and Jenkins
-AEon: Advise and expertise in Docker
-XWiki: Advise and expertise in Maven

T4.3: ENG 12PM ; XWiki SRL 2PM ; ATOS 7PM ; AEon : 2PM

**********

Task 4.4 Stamp assets documentation (leader: ENG) months 12 to 36
Build and maintain documentation, courseware, tutorials to disseminate STAMP amplification services. The goal is to explain how to integrate the amplification tooling in the Continuous Deployment tool chain. This task will also show, through simple example how the stamp tool chain can be extended for a new technical environment.
Output: courseware material to be used for dissemination
Partner Contributions:
-ENG: Lead the definition and evolution of courseware
-INRIA: Support the definition and production of courseware
-TUD: Develop training material on test generation

T4.4: Inria 4PM ; TUD : 2PM ; ENG 9PM

## Participation per Partner

| Partner number and short name | WP4 effort |
|---|---|
| 1 - INRIA | 10.00 |
| UR1 | 3.00 |
| 3 - TUD | 2.00 |
| 4 - OW2 | 8.00 |
| 5 - ENG | 38.00 |
| 7 - XWiki | 1.00 |
| XWiki Romania | 2.00 |
| 8 - ATOS | 8.00 |
| 9 - AEon | 12.00 |
| **Total** | 84.00 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| D4.1 | STAMP Collaborative Software Engineering Platform | 4 - OW2 | Other | Public | 6 |
| D4.2 | First public version of the API and initial implementation of services and courseware | 5 - ENG | Other | Public | 14 |
| D4.3 | Second public version of the API and | 5 - ENG | Other | Public | 24 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| | implementation of services and courseware | | | | |
| D4.4 | Final public version of the API and implementation of services and courseware | 5 - ENG | Other | Public | 36 |

## Description of deliverables

D4.1: STAMP Collaborative Software Engineering Platform (M6, OW2)
D4.2: First public version of the API and initial implementation of services based on the initial results of WP1, 2, 3. First public release of the documentation, tutorials, courseware (M14, ENG)
D4.3: Second public version of the API and consolidated implementation of services. The implementation is packaged with Docker and Maven, an initial STAMP as a service is provided. Second public release of the documentation, tutorials, courseware (M24, ENG)
D4.4: Presentation of extension points to extend the STAMP assets for new technical environments. Final public version of the API and consolidated implementation of services. Final release of the documentation, tutorials, courseware (M36, ENG)

D4.1 : STAMP Collaborative Software Engineering Platform [6]

STAMP Collaborative Software Engineering Platform

D4.2 : First public version of the API and initial implementation of services and courseware [14]

First public version of the API and initial implementation of services and courseware

D4.3 : Second public version of the API and implementation of services and courseware [24]

Second public version of the API and implementation of services and courseware

D4.4 : Final public version of the API and implementation of services and courseware [36]

Final public version of the API and implementation of services and courseware

## Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS1 | Feedback from partners collected through the issue tracker | 1 - INRIA | 3 | Presence of feedback on the issue tracker |
| MS4 | Initial API Specification | 5 - ENG | 6 | Availability of API drafts for amplification services |
| MS6 | Second API Specification + Tests | 5 - ENG | 9 | Availability of test cases for the API |
| MS8 | First prototypes of the amplification tool | 1 - INRIA | 12 | Complete chain of selection and transformation runs and conforms to the API. D12, D22, D32 available |

Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS11 | Initial workflow definition showing STAMP services used together or separately | 5 - ENG | 18 | Initial workflow runs on use cases |
| MS12 | Enhanced prototypes of the amplification tool | 1 - INRIA | 20 | Complete chain of selection and transformation runs and conforms to the API. D13, D23, D33 available |
| MS16 | Consolidated prototypes of the amplification tool | 1 - INRIA | 34 | Complete chain of selection and transformation runs and conforms to the API. D14, D24, D34 available |

| Work package number [9] | WP5 | Lead beneficiary [10] | 8 - ATOS |
|---|---|---|---|
| Work package title | Use cases and validation | | |
| Start month | 1 | End month | 36 |

## Objectives

STAMP project is driven by industrial needs. The main objective of this WP is to assess that the project outcomes fulfill these needs and fit for the purpose expressed by the industrial stakeholders, providing this feedback to WP1-WP4. Other objectives are: evaluate the maturity of the STAMP project results for potential industrial exploitation; define the metrics that measure the fulfilment of stakeholder's requirements; setup the validation process and coordinate the validation activities, such as measuring and analyzing the metrics, and reporting results; to report feedback to technical developers. The detailed method for this WP is in Part 1 - methodological pillar 3

## Description of work and role of partners

**WP5 - Use cases and validation** [Months: 1-36]
**ATOS**, INRIA, SINTEF, TUD, OW2, TellU, XWiki, AEon
Task 5.1 Industrial requirements and metrics for validation (leader: XWiki) months 1 to 20
This task coordinates the elicitation of the industrial requirements for test amplification from the use case stakeholders, aiming at influencing the scientific and technical development of WP1-WP4 and the selection of results for industrial exploitation in WP6. This task also defines the metrics that will assess the fulfillment of these requirements. Hence, elicited requirements will be formalized using these metrics to express the constraints required to be considered satisfied.
Partner Contributions:
-XWiki: Task leadership, Definition of metrics and collection methodologies
-AEon: Contribute to definition of requirements and metrics for test amplification
-ATOS: Contribute to definition of requirements and metrics for test amplification
-TellU: Contribute to definition of requirements and metrics for test amplification
-OW2: Contribute to definition of requirements and metrics for test amplification
-INRIA: Contribution to definition of metrics and collection methodologies for unit test amplification
-SINTEF: Contribution to definition of metrics and collection methodologies for configurability test amplification
-TUD: Contribution to definition of metrics and collection methodologies for runtime test amplification

T5.1: Inria 1PM ; Sintef 1PM ; TUD : 1PM ; OW2 : 3PM ; TellU 3PM ; XWiki : 3PM ; XWiki SRL : 7PM ; Atos : 3 PM ; AEon : 3 PM

**********

Task 5.2 Validation Roadmap and Framework (leader: ATOS) months 3 to 20
This task coordinates the validation activities conducted in the different case studies. It defines the common validation means, including the in-lab controlled evaluation setup, the selection of testing target groups, the organization of workshops, the definition of common reporting criteria, the means to provide feedback to the activities in WP1-WP4, and WP6. It also organizes the roadmap of activities in iterations aligned to the main milestones, and the timely schedule of reporting.
Partner Contributions:
-XWiki: Contribute Open Source Process knowledge for development of validation framework
-AEon: Contribute to the development of the validation framework
-ATOS: Task leadership. Definition and implementation of validation roadmap and framework
-TellU: Contribute to the development of the validation framework
-OW2: Contribute to the development of the validation framework

T5.2: OW2 : 3PM ; TellU 2PM ; XWiki : 1PM ; XWiki SRL : 1PM ; Atos : 10 PM ; AEon : 2 PM

**********

Task 5.3 ProActive Scheduling and Workflows (ActiveEon) case validation (leader: AEon) months 6 to 36
This task will use ProActive Workflow and Scheduling from ActiveEon to evaluate the test amplification developed by the STAMP project in term of unit test, configurability and run-time test amplifications. The ProActive Scheduler actually lacks a set of automated distributed and configuration tests. The needs in the ProActive Product test can be summarized as Multi-sites deployment and configuration tests, Better test categorization and enforcement (e.g. small,

medium, large), to better prioritize the testing effort and control the quality of the product, installation testing with multiple configurations, performance and scalability tests and specific REST API test amplifications. The requirements of the ProActive software regarding test amplification will be provided for the task 5.1.
Partner Contributions:
-AEon: Evaluation of test amplification in ProActive Workflow and Scheduling
-SINTEF: Feedback collection on configurability test amplification
-TUD: Feedback collection on runtime test amplification

T5.3: Inria 2PM ; Sintef 1PM ; TUD : 2PM ; AEon : 10 PM

**********

Task 5.4 FIWARE Ecosystem (ATOS) case validation (leader: ATOS) months 6 to 36
This task conducts the evaluation of the unit, configurability and runtime test amplification techniques and tools, applied on the different IoT Smart City pilots developed by Atos using the FIWARE Ecosystem. This UC intends to assess the benefits of the STAMP results on improving the reliability and robustness of the client applications that access FIWARE GEs' APIs and integrate them into correct choreographies and orchestrations.
Partner Contributions:
-ATOS: Evaluation of test amplification in IoT Smart City FIWARE pilots.
-INRIA: Feedback collection on test amplification in IoT

T5.4: Inria 2PM ; ATOS Turkey 15PM

**********

Task 5.5 TellU case validation (leader: TellU) months 6 to 36
This task evaluates the unit test amplification (WP1), configurability test amplification (WP2) and runtime test amplification (WP3) methods and tools on TellU's existing tests suites and running services. The evaluation will be carried out with different teams, both developer and operational.
Partner Contributions:
-TellU: Evaluation of test amplification on Tellu's existing tests suites and running services
-INRIA: Feedback collection on unit test amplification
-SINTEF: Feedback collection on configurability test amplification
-TUD: Feedback collection on runtime test amplification

T5.5: Inria 1PM ; Sintef 2PM ; TUD : 1PM ; Tellu : 10 PM

**********

Task 5.6 xWiki case validation (leader: XWIKI) months 6 to 36
This task will concentrate on evaluation of the unit test amplification (WP1) in the context of XWiki's automated build / Continuous Integration based system using Maven. It will also partially validate runtime test amplification (WP3) for creating measurable test improvement from runtime data. It will provide cursory validation of configurability test amplification for reduction of "flakey tests" caused by race conditions in interacting processes.
Partner Contributions:
-XWiki: Evaluation of test amplification in XWiki Platform development process
-INRIA: Feedback collection on unit test amplification
-TUD: Feedback collection on runtime test amplification

T5.6: Inria 1PM ; TUD : 1PM ; XWiki : 4PM ; XWiki SRL : 9PM

**********

Task 5.7 OW2 case validation (leader: OW2) months 6 to 36
OW2 hosts approximately 50 open-source projects in the domains of the Open Cloud, Big Data, Security and the Future Internet. The OW2 use case will focus on the integration of STAMP outcomes into the OW2 quality platform, on their application to a subset of four OW2 projects (Joram, Sat4J, Asm and Lutec), and on the evaluation of this integration by the project leaders.
Partner Contributions:
- OW2: Evaluation of test amplification on the OW2 quality platform

T5.7: OW2 : 12PM

| Partner number and short name | WP5 effort |
|---|---|
| 1 - INRIA | 7.00 |
| 2 - SINTEF | 4.00 |
| 3 - TUD | 5.00 |
| 4 - OW2 | 18.00 |
| 6 - TellU | 15.00 |
| 7 - XWiki | 8.00 |
| XWiki Romania | 17.00 |
| 8 - ATOS | 13.00 |
| ATOS TURKEY | 15.00 |
| 9 - AEon | 15.00 |
| **Total** | 117.00 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| D5.1 | Industrial requirements and metrics V1 | 7 - XWiki | Report | Confidential, only for members of the consortium (including the Commission Services) | 6 |
| D5.2 | Validation Roadmap and framework V1 | 8 - ATOS | Report | Confidential, only for members of the consortium (including the Commission Services) | 9 |
| D5.3 | Industrial requirements and metrics V2 | 7 - XWiki | Report | Public | 20 |
| D5.4 | Validation Roadmap and framework V2 | 8 - ATOS | Report | Public | 20 |
| D5.5 | UC validation report V1 | 9 - AEon | Report | Confidential, only for members of the consortium (including the Commission Services) | 18 |
| D5.6 | UC validation report V2 | 4 - OW2 | Report | Confidential, only for members of the consortium (including the Commission Services) | 30 |
| D5.7 | UC validation report final | 8 - ATOS | Report | Public | 36 |

## Description of deliverables

D5.1 Industrial requirements and metrics for validation. V1 (M6, XWiki)
D5.2 Industrial requirements and metrics for validation. V2 (M20, XWiki)
These deliverables will report the industrial requirements elicited from use cases for test amplification techniques and tools, as well as the measurable metrics that will assess their achievement.
D5.3 Validation Roadmap and framework (M9, ATOS)
D5.4 Validation Roadmap and framework (M20, ATOS)
These deliverables will report the project validation roadmap and activities planned, as well as all the means (e.g. the framework) adopted to conduct the evaluation and report the findings.
D5.5 UC validation report V1 (M18, AEon)
D5.6 UC validation report. V2 (M30, OW2)
D5.7 UC validation report. Final (M36, ATOS)
These deliverables reports the validation activities conducted in the different use cases and their main validation findings and recommendations.

D5.1 : Industrial requirements and metrics V1 [6]

Industrial requirements and metrics V1

D5.2 : Validation Roadmap and framework V1 [9]

Validation Roadmap and framework V1

D5.3 : Industrial requirements and metrics V2 [20]

Industrial requirements and metrics V2

D5.4 : Validation Roadmap and framework V2 [20]

Validation Roadmap and framework V2

D5.5 : UC validation report V1 [18]

UC validation report V1

D5.6 : UC validation report V2 [30]

UC validation report V2

D5.7 : UC validation report final [36]

UC validation report final

## Schedule of relevant Milestones

| **Milestone number**[18] | **Milestone title** | **Lead beneficiary** | **Due Date (in months)** | **Means of verification** |
|---|---|---|---|---|

| Work package number [9] | WP6 | Lead beneficiary [10] | 4 - OW2 |
|---|---|---|---|
| Work package title | Dissemination, exploitation and communication | | |
| Start month | 1 | End month | 36 |

## Objectives

This workpackage has the following objectives: generate awareness by developing appropriate communication messages, material and initiatives targeting our key audiences: IT industry, Research communities, EU-projects and developers; ensure the sustainability of the project's results beyond the actual duration of the project through pragmatic exploitation plans and commercialization strategies; grow a community of early adopters around the project's concepts and tools by positioning STAMP as a recognized solution for software quality and testing in relevant industry media including websites, events and conferences.

## Description of work and role of partners

**WP6 - Dissemination, exploitation and communication** [Months: 1-36]
**OW2**, INRIA, SINTEF, TUD, ENG, TellU, XWiki, ATOS, AEon
Task 6.1 Communication (leader: OW2) months 1 to 36
This task delivers the Communication infrastructure and material for STAMP. This includes: design and continuously update of the communication material required to support the dissemination of STAMP; design the project's visual identity and develop the content and graphic design of communication collateral ranging from logos and factsheet to brochure, posters, goodies; set up and curate the online communication resources: Website design, social network curation on LinkedIn, Twitter and Youtube.
Partner Contributions :
-INRIA: contribute to the edition and coordination of all content available on the public and private website; coordinate the scientific dissemination efforts, participate in the organization of workshops to disseminate STAMP results; contribute with scientific publications.
-OW2: will lead this task: Development and curation of the communication material

T6.1: Inria 2PM ; OW2 : 5PM

**********

Task 6.2 Dissemination (leader: OW2) months 1 to 36
This task covers the activities required to develop awareness about STAMP in direction of the different target audiences as described in Section 2.2. We will ensure STAMP's visibility in specialized industry media and relevant IT industry events on software engineering, testing and cloud computing (e.g. Cloud Expo Europe, OpenStack Summit, or CeBit. This task also covers scientific dissemination at conferences and scientific journals. On the standard side, this also includes identifying and approaching relevant working group on software testing (e.g. ISTQB).
Partner Contributions :
-INRIA: coordinate the scientific dissemination efforts, participate in the organization of workshops, contribute with scientific publications and approach the ISTQB.
-SINTEF: will participate in the organization of workshops to disseminate STAMP results. Will contribute to scientific dissemination with scientific publications.
-TUD: will participate in the organization of workshops to disseminate STAMP results. Will contribute to scientific dissemination with scientific publications.
-OW2: will lead this task and organize STAMP's presence in industry events
-TellU: will contribute to the dissemination in industry forums
-AEon: will contribute to the industrial dissemination activities

T6.2: Inria 3PM ; Sintef 3PM ; TUD : 3PM ; OW2 : 7PM ; TellU 1PM ; AEon : 2 PM

**********

Task 6.3 Exploitation (leader: AEon) months 1 to 36
This task will be the implementation of the Exploitation Plan that is described in the section 2.2 where AEon will act as the exploitation manager. It aims at facilitating the market take-up of STAMP by developing pragmatic exploitation plan and strategies targeting relevant stakeholders and market segments. It will hinge on the following activities: setting up of the End-User Advisory Board, a group of industry practitioners whoe will help improve STAMP's alignment

with market expectations; organize hands-on workshops each year with the End-User Advisory Board and invited third parties to check progress, provide critical feedback and support market outreach; advise and support the consortium for IPR management issues and protection when required (patent, copyright, etc.) and for handling the open source code, the long-term governance of the open source project and the implementation of recognized open source project management best practices.
Write and follow-up the detailed exploitation plan and foster the development of individual exploitation plans by each partner during the project as the results mature.
Partner Contributions :
-OW2: contribute to the setting-up of the end-user group and verify STAMP value proposition(s), internal and in value chain of OW2 projects
-TellU: verify STAMP value proposition(s), internal and in value chain. Provide (value chain) input to product wanted position.
-XWiki: verify STAMP value proposition(s), internal and in value chain. Provide (value chain) input to product wanted position.
-ENG: verify STAMP value proposition(s), internal and in value chain. Provide (value chain) input to product wanted position.
-ATOS: will support the exploitation of STAMP within FIWARE
-AEon: will lead the exploitation and the market take up activities, AEON will be the Exploitation Manager

T6.3: OW2 : 2PM ; ENG 2PM ; TellU 1PM ; XWiki : 1PM ; XWiki SRL : 1PM ; Atos : 5 PM ; AEon : 4 PM

**********

Task 6.4 Market analysis and business modeling (leader: AEon) months 18 to 36
This task will conduct a market study with support from local partners. The methodology for this study will combine desk research and interviews with the project partners and members of the End-User Advisory Board. We will proceed, taking into consideration previous deliverables, in cooperation with the project partners on following tasks: provide guidelines to improve adoption of the STAMP technologies; organise internal workshops with the project partners to adapt and evolve the exploitation and business plans; solicit the End-User Advisory Board as mirror group to provide feedback on the draft exploitation and business strategies.
Partner Contributions :
-INRIA: contributes to the organization of workshops and the validation of business models
-OW2: will contribute to this task by collating information from its community and organize workshops to validate the business models with its community
-XWiki: will takepart in this task with some interviews with third party and desk research and contribute to workshops to validate the business models with its community
-ATOS: will takepart in this task with some interviews with third party and desk research and contribute to workshops to validate the business models with its community
-ENG: will validate the business models in the perspective of its own business practice
-AEon: will lead this task, will define the guidelines of the analysis and compile the results of the interviews. It will also validate the business models adding in the perspective of its own business practice

T6.4: Inria 1PM ; OW2 : 4PM ; ENG 4PM ; XWiki : 3PM ; XWiki SRL : 1PM ; Atos : 4 PM

Participation per Partner

| Partner number and short name | WP6 effort |
|---|---|
| 1 - INRIA | 6.00 |
| 2 - SINTEF | 3.00 |
| 3 - TUD | 3.00 |
| 4 - OW2 | 18.00 |
| 5 - ENG | 6.00 |
| 6 - TellU | 2.00 |
| 7 - XWiki | 4.00 |

| Partner number and short name | WP6 effort |
|---|---|
| XWiki Romania | 2.00 |
| 8 - ATOS | 9.00 |
| 9 - AEon | 10.00 |
| **Total** | 63.00 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| D6.1 | Dissemination and Communication Plan | 4 - OW2 | Report | Public | 3 |
| D6.2 | Communication Material | 4 - OW2 | Report | Public | 4 |
| D6.3 | Market Analysis | 9 - AEon | Report | Public | 18 |
| D6.4 | Exploitation Plan | 9 - AEon | Report | Public | 30 |
| D6.5 | Business Plan | 9 - AEon | Report | Public | 36 |

## Description of deliverables

D6.1: Dissemination and Communication Plan (M3, OW2) This report will detail the communication activities envisioned to implement the dissemination plan outlined in Section 2.2. It will cover the communication initiatives, the scientific dissemination and the communication infrastructure. The report will also provide KPIs for these activities.
D6.2: Communication Material (M4, OW2) This report compiles the initial communication material developed to support the communication and dissemination activities – updated at each project review.
D6.3: Exploitation Plan (M18, AEon) This deliverable is the Exploitaion Plan describing the exploitation strategy. It will be issued on M18, another iteration for the update will be at M36.
D6.4: Market Analysis (M30, AEon). This deliverable is a report describing STAMP's market environment and recommendations for enhancing the adoption of STAMP's results. An updated version of this plan will be delivered at M36.
D6.5: Business Plan (M36, AEon) This deliverable will outline the overall project's value chain and potential business models for future exploitation of the project's results.

D6.1 : Dissemination and Communication Plan [3]

Dissemination and Communication Plan

D6.2 : Communication Material [4]

Communication Material

D6.3 : Market Analysis [18]

Market Analysis

D6.4 : Exploitation Plan [30]

Exploitation Plan

D6.5 : Business Plan [36]

Business Plan

Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS2 | Presence of feedback on the issue tracker | 2 - SINTEF | 3 | Website, mailing lists, private wiki operational, social accounts created, domain name registered |
| MS5 | User Advisory Board created | 4 - OW2 | 6 | Members of UAB published on website and mailing list setup |
| MS9 | Public presentation of the project | 4 - OW2 | 12 | Project has been formally presented at an industry or an academic event |
| MS13 | Market readiness | 4 - OW2 | 24 | Code is published on a public repository, well documented and accessible to third party contributors |
| MS15 | International scientific workshop | 1 - INRIA | 33 | In conjunction with a major academic event in the area of software testing |

| Work package number [9] | WP7 | Lead beneficiary [10] | 1 - INRIA |
|---|---|---|---|
| Work package title | Management and coordination | | |
| Start month | 1 | End month | 36 |

## Objectives

This WP ensures the achievement of the project's objectives, in terms of scientific quality, timely delivery, and contribution to the expected impact of the project. WP7 aims at achieving: efficient progress monitoring; timely and detailed reporting to the EC; constitution and organisation of the WP management teams; proper scientific quality of the deliverables.
In terms of consortium management, WP7 objectives are to guarantee sound management of contractual and financial issues, setting-up and maintaining project management tools, good communication in the consortium, proper quality assurance in the delivered reports, financial and contractual management, reporting to the EC. Consortium management and scientific coordination are placed under the responsibility of the coordinator

## Description of work and role of partners

**WP7 - Management and coordination** [Months: 1-36]
**INRIA**
Task 7.1 Project coordination (leader: INRIA - 8pm) months 1 to 36
This task groups the coordinator's activity of organization and monitoring of the work progress:
• Elaboration of the detailed work plan, established at the beginning of the project, defining with precision the activities of each Partner within each task and identifying the involved persons.
• Supervision of project deliverables, progress milestones, and planning;
• Risk analysis and management plan throughout the project;
• Performance indicators identification and follow up;
• Continuous monitoring of Partners' scientific achievements;
• Scientific review of the work and deliverables performed by the Partners;

**********

Task 7.2 Quality management (leader: INRIA - 3pm) months 1 to 36
This includes the following:
• Elaboration and application of a Project Quality Plan, internal guideline detailing project procedures (quality assurance, document management, document templates, etc.), in accordance with the project management and organisation defined in the Contract;
• Set-up and maintenance of a web-based document management tool for publishing and exchanging documents within the consortium;
• Monitoring of workflow and information management, ensuring good communication within the consortium.
• Maintenance of Partners' contact information, including emailing lists;

**********

Task 7.3 Project secretariat and meetings organization (leader: INRIA - 3pm) months 1 to 36
This includes the following:
• Preparation, organization and minutes of the kick-off meeting with all Partners at the beginning of the project;
• Preparation, organization and minutes of project meetings every 4 months.
• Preparation, organization and minutes of ExCom meetings; physical meetings jointly with each project meetings and possible additional phone meetings;
• Preparation, organization and minutes of the yearly External user advisory board meetings (jointly with the project meetings);
• Preparation, organization and minutes of the yearly GB meetings (jointly with the yearly project meetings);
• Handling of the project correspondence;
• Acting as entry point for the project for external bodies;
• Support to project Partners upon request;
• More generally, ensuring that all Partners share the same level of information on general issues concerning the project, i.e. contract and project management, work progress, dissemination, etc.

**********

Task 7.4 Contractual & Financial Management (Leader: INRIA - 4 pm) months 1 to 36
This task comprises the management of the administrative and financial issues:
• Maintenance of the Grant and Consortium Agreements;
• Management of funds and maintenance of budget files;
Coordination of the periodic (M18 and M36) and final (M36) reporting to the EC; advice on contractual / financial matters to project Partners upon request.

## Participation per Partner

| Partner number and short name | WP7 effort |
|---|---|
| 1 - INRIA | 18.00 |
| **Total** | 18.00 |

## List of deliverables

| Deliverable Number[14] | Deliverable Title | Lead beneficiary | Type[15] | Dissemination level[16] | Due Date (in months)[17] |
|---|---|---|---|---|---|
| D7.1 | Project Quality Plan & Private web platform | 1 - INRIA | Report | Confidential, only for members of the consortium (including the Commission Services) | 2 |

## Description of deliverables

D7.1 Project Quality Plan & Private web platform (M2, INRIA)

D7.1 : Project Quality Plan & Private web platform [2]

Project Quality Plan & Private web platform

## Schedule of relevant Milestones

| Milestone number[18] | Milestone title | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|

### 1.3.4. WT4 List of milestones

| Milestone number[18] | Milestone title | WP number[9] | Lead beneficiary | Due Date (in months)[17] | Means of verification |
|---|---|---|---|---|---|
| MS1 | Feedback from partners collected through the issue tracker | WP4 | 1 - INRIA | 3 | Presence of feedback on the issue tracker |
| MS2 | Presence of feedback on the issue tracker | WP6 | 2 - SINTEF | 3 | Website, mailing lists, private wiki operational, social accounts created, domain name registered |
| MS3 | Initial pilot on selected use case | WP1, WP3 | 3 - TUD | 4 | Test amplification techniques run on one use case |
| MS4 | Initial API Specification | WP4 | 5 - ENG | 6 | Availability of API drafts for amplification services |
| MS5 | User Advisory Board created | WP6 | 4 - OW2 | 6 | Members of UAB published on website and mailing list setup |
| MS6 | Second API Specification + Tests | WP4 | 5 - ENG | 9 | Availability of test cases for the API |
| MS7 | First prototypes of test amplification workflows | WP1 | 1 - INRIA | 10 | Complete chain of selection and transformation runs and conforms to the API |
| MS8 | First prototypes of the amplification tool | WP1, WP4 | 1 - INRIA | 12 | Complete chain of selection and transformation runs and conforms to the API. D12, D22, D32 available |
| MS9 | Public presentation of the project | WP6 | 4 - OW2 | 12 | Project has been formally presented at an industry or an academic event |
| MS10 | Enhanced prototypes of test amplification workflows | WP1, WP3 | 1 - INRIA | 18 | Complete chain of selection and transformation runs, conforms to the API, includes feedback from WP4 and WP5 |
| MS11 | Initial workflow definition showing STAMP services used together or separately | WP4 | 5 - ENG | 18 | Initial workflow runs on use cases |
| MS12 | Enhanced prototypes of the amplification tool | WP1, WP4 | 1 - INRIA | 20 | Complete chain of selection and transformation runs and conforms to the API. D13, D23, D33 available |
| MS13 | Market readiness | WP6 | 4 - OW2 | 24 | Code is published on a public repository, well documented and accessible to third party contributors |
| MS14 | Consolidated test amplification workflows | WP1, WP3 | 1 - INRIA | 30 | Complete chain of unit test amplification is efficient and |

| Milestone number[18] | Milestone title | WP number[9] | Lead beneficiary | Due Date (in months)[17] | Means of verification |
|---|---|---|---|---|---|
| | | | | | effective at detecting new bugs |
| MS15 | International scientific workshop | WP1, WP6 | 1 - INRIA | 33 | In conjunction with a major academic event in the area of software testing |
| MS16 | Consolidated prototypes of the amplification tool | WP1, WP4 | 1 - INRIA | 34 | Complete chain of selection and transformation runs and conforms to the API. D14, D24, D34 available |

### 1.3.5. WT5 Critical Implementation risks and mitigation actions

| Risk number | Description of risk | WP Number | Proposed risk-mitigation measures |
|---|---|---|---|
| 1 | Amplification does not improve regression testing Impact: This risk is inherent to the highly ambitious objectives of the WP | WP1 | All partners in WP1 will investigate in details the interactions between bugs, amplified tests and the code to identify the cause of the problem. Probability: 3 - Impact: 3 |
| 2 | Amplification cannot be applied on use cases Impact: More effort is needed to adapt the techniques to the use cases | WP1 | The consortium will adjust the efforts in order to dedicate time to adapt the techniques. We will focus the requirements and dedicate efforts to adapt amplification to these requirements. Probability: 1 - Impact: 3 |
| 3 | Overhead of amplification Impact: Time for amplification and amplified test execution exceeds the benefits | WP1 | The consortium will adjust the efforts and development tasks to dedicate more time to execution optimization. We will narrow down the scope of amplification, focus the tooling context and dedicate efforts to optimize amplification in this setting. Probability: 3 - Impact: 3 |
| 4 | Technological ground not in line with market, partner expectations Impact: The HW/SW solution is at the very basic of the overall solution | WP1, WP5 | Involve external user advisory board very early and continuously survey technological evolutions in the area of DevOps and software engineering for the cloud in order to adjust technical choices as soon as possible. Probability: 2 - Impact: 5 |
| 5 | Architectural design not adequate to define the overall STAMP system Impact: A poor architectural design could result in a complex, expensive, system integration as well as in a system not corresponding to expectations. | WP1, WP5 | The whole consortium from integrators, research groups to use case providers and external users will be involved in early pilot studies to design a suitable architecture. Probability: 1 - Impact: 5 |
| 6 | Amplification cannot automatically generate meaningful configurations from existing configurations Impact: The main objective of enlarging testing configuration coverage will not be achieved | WP2 | The consortium will adjust the efforts to work on interactive generation of configurations, in order to utilize more input from developers to improve the generation result. (C) Probability: 2 - Impact: 4 |
| 7 | Selected configuration languages and tools are out of date Impact: The technique cannot be used by mainstream development teams | WP2 | The partners will keep watching the evolution of configuration techniques, and in the same time design the tools with the capability of easy adaptation to new techniques. (P) Probability: 3 - Impact: 3 |
| 8 | State machine models derived from log data are not accurate Impact: More effort | WP3 | All partners in WP3 will investigate in details which information to consider when deriving state machine models to reduce the “noise” in the learning process. Probability: 3 - Impact: 3 |

| Risk number | Description of risk | WP Number | Proposed risk-mitigation measures |
|---|---|---|---|
| | is required to define ad-hoc machine learning algorithms | | |
| 9 | Test case generated from state machine are too long Impact: Test cases are too complex to understand and too difficult to manage by developers | WP3 | We will use refactoring techniques to split long tests in sub-tests. Probability: 3 - Impact: 1 |
| 10 | Test amplification algorithms not ready for packaging Impact: Delays the development of microservices | WP4 | We will re-balance effort and work between WP 1-3 and WP4 in order to refine the requirements for packaging and consolidate the amplification algorithms. Probability: 2 - Impact: 3 |
| 11 | Integration in Jenkins workflow longer than planned Impact: Hampers the development of Maven and Gradle plugins | WP4 | Focus efforts on the Jenkins workflow and document Maven as a possible extension point. Probability: 3 - Impact: 2 |
| 12 | Features to planned to be evaluated in UC are not available by time scheduled for evaluation Impact: The evaluation of these features will need to be postponed | WP1, WP5 | (C) Evaluation of these features will be postponed to next evaluation iteration. Probability: 2 - Impact: 3 |
| 13 | No metrics were found to evaluate a concrete feature/ requirement, or there are not available means to measure them providing quantitative measures. Impact: The evaluation will not be able to provide quantitative figures | WP1, WP5 | (P) Metrics will be defined together with technical WPs. (C) Alternative qualitative metrics will be considered. Probability: 3 - Impact: 3 |
| 14 | Very limited interest in STAMP Impact: Failure to achieve dissemination and exploitation indicators. | WP6 | Involve all partners in the refinement of requirements, demos and tutorials, in order to re'align amplification features with the needs. Probability: 2 - Impact: 3 |
| 15 | Poor performance of the resulting platform Impact: Exploitation of project results becomes uncertain. | WP5, WP6 | Work with partners to re-align use case to optimize results. Probability: 3 - Impact: 3 |
| 16 | Competition appears with same value proposal Impact: Exploitation of project results becomes uncertain. | WP6 | All partners to define a differentiation strategy and adapt use-case accordingly. Probability: 1 - Impact: 4 |
| 17 | Partner underperforms or leaves the consortium | WP7 | Such situations will be foreseen by the Consortium Agreement, which will describe measures to be taken to prevent non-compliance to project activities. Probability: 2 - Impact: 3 |

| Risk number | Description of risk | WP Number | Proposed risk-mitigation measures |
|---|---|---|---|
| 18 | The quality of the project results are lower than expected. | WP7 | The internal reviewing process for all project deliverables and reports, plus the contribution of the Advisory Board, will ensure high quality project results. Probability: 2 - Impact: 3 |
| 19 | Difficulties to hire people with specialized skills | WP7 | The partners that compose the consortium are attractive. Nevertheless, in case of difficulties to hire on time people with skills that fit to the project needs, the corresponding work will be temporarily handled by the key contributors of the project participants until the definitive recruitment. Probability: 3 - Impact: 3 |
| 20 | Communication activities raise little interest outside of the project | WP7 | The coordinator will take support on the competences and expertise of the Communication Department of his institution. The communication plan will be revised and updated every year according to the needs of the project. In case of low interest outside of the project, additional, more targeted communication channels will be used. The communication strategy will also take support on the well-known ecosystem of each partner. Probability: 3 - Impact: 2 |
| 21 | Diversion might occur between the member of the consortium Impact: Research programs might suffers some delays and in the worst case one partner could be terminated | WP7 | The consortium agreement foresees this case and gives rules to follow. Probability: 1 - Impact: 3 |

## *1.3.6. WT6 Summary of project effort in person-months*

| | WP1 | WP2 | WP3 | WP4 | WP5 | WP6 | WP7 | Total Person/Months per Participant |
|---|---|---|---|---|---|---|---|---|
| 1 - INRIA | 32 | 4 | 5 | 10 | 7 | 6 | 18 | 82 |
| · USTL | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| · UR1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| 2 - SINTEF | 8 | 32 | 3 | 0 | 4 | 3 | 0 | 50 |
| 3 - TUD | 9 | 3 | 34 | 2 | 5 | 3 | 0 | 56 |
| 4 - OW2 | 3 | 3 | 3 | 8 | 18 | 18 | 0 | 53 |
| 5 - ENG | 5 | 5 | 5 | 38 | 0 | 6 | 0 | 59 |
| 6 - TellU | 0 | 8 | 5 | 0 | 15 | 2 | 0 | 30 |
| 7 - XWiki | 5 | 4 | 0 | 1 | 8 | 4 | 0 | 22 |
| · XWiki Romania | 11 | 7 | 0 | 2 | 17 | 2 | 0 | 39 |
| 8 - ATOS | 10 | 8 | 0 | 8 | 13 | 9 | 0 | 48 |
| · ATOS TURKEY | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 15 |
| 9 - AEon | 4 | 8 | 7 | 12 | 15 | 10 | 0 | 56 |
| **Total Person/Months** | 87 | 82 | 65 | 84 | 117 | 63 | 18 | 516 |

### *1.3.7. WT7 Tentative schedule of project reviews*

| Review number [19] | Tentative timing | Planned venue of review | Comments, if any |
|---|---|---|---|
| RV1 | 18 | Brussels | 1st interim Review |
| RV2 | 36 | Brussels | Final Review |

**1. Project number**

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

**2. Project acronym**

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

**3. Project title**

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

**4. Starting date**

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a written justification.

**5. Duration**

Insert the duration of the project in full months.

**6. Call (part) identifier**

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

**7. Abstract**

**8. Project Entry Month**

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

**9. Work Package number**

Work package number: WP1, WP2, WP3, ..., WPn

**10. Lead beneficiary**

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

**11. Person-months per work package**

The total number of person-months allocated to each work package.

**12. Start month**

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

**13. End month**

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

**14. Deliverable number**

Deliverable numbers: D1 - Dn

**15. Type**

Please indicate the type of the deliverable using one of the following codes:

| | |
|---|---|
| R | Document, report |
| DEM | Demonstrator, pilot, prototype |
| DEC | Websites, patent fillings, videos, etc. |
| OTHER | |
| ETHICS | Ethics requirement |

**16. Dissemination level**

Please indicate the dissemination level using one of the following codes:

| | |
|---|---|
| PU | Public |
| CO | Confidential, only for members of the consortium (including the Commission Services) |
| EU-RES | Classified Information: RESTREINT UE (Commission Decision 2005/444/EC) |
| EU-CON | Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC) |
| EU-SEC | Classified Information: SECRET UE (Commission Decision 2005/444/EC) |

**17. Delivery date for Deliverable**

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

**18. Milestone number**

Milestone number:MS1, MS2, ..., MSn

**19. Review number**

Review number: RV1, RV2, ..., RVn

**20. Installation Number**

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

**21. Installation country**

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

**22. Type of access**

| | |
|---|---|
| VA | if virtual access, |
| TA-uc | if trans-national access with access costs declared on the basis of unit cost, |
| TA-ac | if trans-national access with access costs declared as actual costs, and |
| TA-cb | if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost. |

**23. Access costs**

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.


**H2020-ICT-2016-2017**

**Annex 1 to the Grant Agreement**
**(Description of the Action)**
**Part B**

**Action Acronym: STAMP**
**Action number: 731529**
**Action Title: Software Testing AMPlification**

| History of changes of the Description of the Action | |
|---|---|
| The option for open research pilot ("Article 29.3) has not been selected since the project had opted out given that it will not generate data | 19/08/2016 |
| Remove tables 3.1-a, 3.1-b, 3.1-c, 3.2-a, 3.2-b et 3.4-a | 22/08/2016 |
| Justify dissemination KPIs | 02/09/2016 |
| Beneficiary 5 (Engineering) is involved in WP6 | 07/09/2016 |
| Updated "Contribution to impacts set out in the work program" with relation to KPIs (p. 26)<br>Updated table "Main dissemination and communication goals" to include relation to KPIs that substantiate the dissemination objectives (p. 38)<br>Updated effort and cost break-down (p. 47)<br>Added letters of intent to contribute to the end users group (p. 77-80) | 21/09/2016 |
| | |
| | |
| | |

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# 1. Excellence

## 1.1 Objectives

Software-driven enterprise is disrupting industries in all sectors, "from movies to agriculture to national defense" as put by Marc Andreesen in his article "Why Software Is Eating The World" [1]. This makes software quality a major concern of today's and future economy. The ability to increase the quality and the user experience of software systems while keeping the agility for constant evolutions is key to the viability and the sustainability of all industries.

DevOps has emerged, as a major cultural movement to handle this need for increased agility. This movement is essentially about bridging the gap between the developers (Dev) and the teams that ship and deploy the software systems (Ops), as illustrated by the continuous cycle of Figure 1a. While this movement is loosely bound to development methods, a number of practices have emerged to operationalize this extreme agility: loosely coupled software architectures meant to support incremental updates and build (services or micro services with clear APIs); a very high degree of automation at multiple stages of the development lifecycle.

Whereas DevOps has gained huge traction in the US, there is concern that the more conservative European enterprises may be “missing the train”. For instance, a survey by Rackspace LCC[2] has found that only 40% of UK organizations have adopted this methodology, compared to 66% of their American counterparts. The discrepancy is thought to result primarily from a different cultural attitude toward risk-taking. Indeed, a hasty deployment entails the hazard of propagating a regression bug into production due to lack of sufficient testing. With traditional software development models, long development cycles afford plenty of time for manual software testing but with DevOps methodologies, especially Continuous Delivery, there is no time for manual testing and the full responsibility of bug detection is placed upon the automated test suites. **STAMP aims to bolster these test suites through the automatic transformation of test assets.**

Rapid feedback about code quality is crucial in order to minimize regression bugs in production. However, the production and maintenance of large test suites to detect these regressions would immensely slow down delivery. According to a survey by Cambridge University Judge Business School, it was estimated that 50% of all time spent developing software is spent finding and fixing bugs[3]. The **key technical challenge that STAMP aims at overcoming is to reduce the cost due to regression bugs** that propagate to production.

STAMP aims at overcoming this key technical challenge through **advanced research in automatic test generation**. The key novelty of our research agenda is to leverage existing assets (such as test cases or execution logs) in order to increase test effectiveness. This innovative research is at the crossroads of program analysis and transformation, software testing, automatic deployment and search-based software engineering. STAMP enhances automatic testing at three different stages in a DevOps process (illustrated in Figure 1 b)

- Unit testing: developers manually write test cases, which cover a very small portion of possible behaviors. STAMP aims at automatically analyzing manually written test cases in order to generate new ones and reduce the time necessary to detect regression bugs
- Configuration testing: Building and deploying complex multi-component systems for testing purposes is tedious and time consuming. STAMP aims to generate large quantities of configuration variants and resource conditions and automatically deploy all of them to test the scalability of a system.
- Online testing: The feedback from operations to development provides rich data about the system’s behavior, which is otherwise costly to exploit. STAMP automates the analysis of production logs to re-inject production-level test cases in the continuous testing process.

[1] http://www.aberdeeninvestment.com/wp-content/uploads/2009/11/Why-Software-Is-Eating-The-World-8-20-111.pdf
[2] https://www.rackspace.co.uk/sites/default/files/devops-automation-report.pdf
[3] http://markets.financialcontent.com/stocks/news/read/23147130/Cambridge_University_Study_States_Software_Bugs_Cost_Economy_$312_Billion_Per_Year

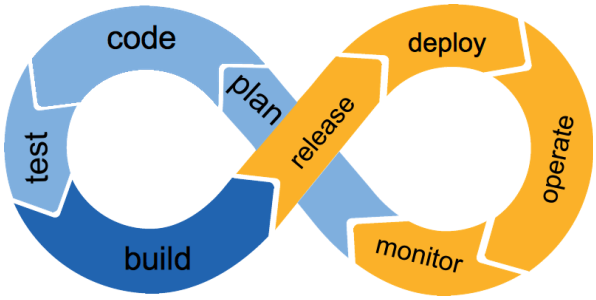



**Figure 1a - The DevOps continuous delivery cycle**

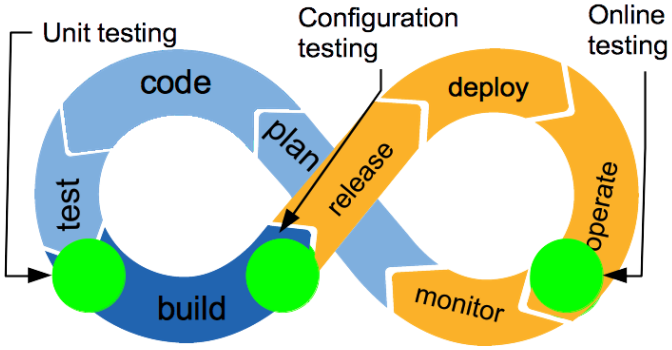



**Figure 1b - The integration of STAMP's test amplification in DevOps**

## Objectives

The main objective of STAMP is to **automatically transform existing test assets** in order to **detect regression bugs before production** and **drive down the cost of software testing**.

We address this ambitious objective through increased test automation and research and development activities articulated around the objectives presented below: innovative software testing amplification techniques, which increases automation at critical steps of DevOps continuous delivery processes; the development of a micro service architecture to integrate these amplification techniques in various DevOps toolchains; continuous improvement of our solutions through constant interactions and validation with use cases; dissemination and exploitation of our open source amplification technologies in the consortium and towards a wider community of European software companies.

**Objective 1. Provide an approach to automatically amplify unit test cases when a change is introduced in a program**

The automatic generation of variant test cases aims at triggering a larger variety of behaviors and at observing a larger variety of program states in order to increase the number of regression bugs detected before going in production. This technical objective directly targets the reduction of software defects in production. While, this can be re-stated as a simple increase in software quality, the reduction of bugs in production has the secondary effect of decreasing need for changes to code, interfaces and specifications, thus stabilizing APIs and promoting code reuse. This objective also participates in the reduction of time to detect bugs, which is expected to increase developer productivity, leading to windfalls in time-to-market and quality.

**Objective 2. Provide an approach to automatically generate, deploy and test large numbers of system configurations.**

The specification and deployment of system configurations (assembly of unit components to form a complete configuration of the system under test) is currently a task that relies on huge manual effort. Technical objective 2 addresses this serious limitation and directly aims at reducing the costs of manual testing. Reliance upon manual testing is seen as an impediment to adoption of Continuous Delivery and other agile and lean methodologies so decrease of the need for manual testing is expected to pave the way toward adoption of DevOps, decreasing both time-to-market and software development productivity.

**Objective 3. Provide an approach to automatically amplify, optimize and analyze production logs in order to retrieve test cases that verify code changes against real world conditions.**

While the collection of information from production is an intrinsic and key feature of DevOps, the connection between this log data (collected in Ops) and the testing activity (on the Dev side) remains weak. Technical objective 3 aims at reducing the time cost invested in development of automated tests. By observing the behavior of the application at runtime, we aim to reduce the time that developers spend in re-creating test cases that can trigger production crashes in a controlled environment and which are essential to detect future regressions. This will reduce the cost of test development while maintaining or improving the level of assurance provided by those tests.

**Objective 4. Develop three test amplification microservices that can be integrated in different toolchains.**

This objective aims at developing a flexible architecture for test amplification services, leveraging a microservice approach. A critical aspect when addressing this objective will be to design the amplification services in a way that supports the integration of test amplification in different toolchains. In particular, we

target popular build technologies in a DevOps context: Maven, Gradle and the Jenkins continuous integration engine.

**Objective 5. Validate the relevance and effectiveness of amplification on 5 use cases.**

This objective has a dual dimension: validate the effectiveness of test amplification techniques; and validate the relevance of amplification beyond software production within specific application domain. The first aspect aims at demonstrating that test amplification can be applied on the use cases, which are industry-strength code bases, representative of the type of application targeted by STAMP: applications that run continuously in the cloud. The second aspect aims at demonstrating that test amplification addresses a significant problem that occurs in multiple domains. This is done by selecting case studies that span several industrial sectors where software plays a key role: e-Health, smart cities, content management, cloud computing and software development itself.

**Objective 6. Disseminate and exploit the open source STAMP test amplification services.**

STAMP's test amplification techniques are developed as open source software. This last objective of the project aims at disseminating, showcasing and further exploiting these testing services. The project benefits from the long experience of the OW2 open source consortium to build and sustain open source projects. In addition, ActiveEon, in collaboration with all industry partners, will establish business plans for the commercial exploitation of STAMP's open source solutions. This objective also covers the need to disseminate results through industrial and academic publications.

## Key Performance Indicators

In the table below, we provide key performance indicators for each objective. The KPIs we use for objective 6, related to dissemination, are in line with usual practices to evaluate the impact of software innovations within communities of software developers.

| Objective | | | | | | | KPIs |
|---|---|---|---|---|---|---|---|
| ID | 1 | 2 | 3 | 4 | 5 | 6 | |
| KPI1 | X | | | | | | Increase the diversity of execution paths covered by 40% |
| KPI2 | X | | | | | | Decrease by 20% the number of tests which fail once but not again if run several times |
| KPI3 | X | | | | | | Increase by 20% the number of lines of product code, which are executed for each second of time spent running tests. |
| KPI4 | | X | | | | | Increase by 40% the number of unique invocation traces between services in a global perspective |
| KPI5 | | X | | | | | Increase by 30% the number of valid bugs detected during testing which are specific to the generated configurations |
| KPI6 | | X | | | | | Reduce by 30% the time on configuring and deploying products for testing purpose |
| KPI7 | | | X | | | | Reduce the size of log files by an order of magnitude, keeping all essential information |
| KPI8 | | | X | | | | Increase by 70% the number of crash replicating test cases |
| KPI9 | | | X | | | | Enhance existing test suites with 10% of production-level test cases |
| KPI10 | | | | X | | | 3 test amplification services integrated in 2 different toolchains |
| KPI11 | | | | | X | | Validation of each test amplification service by at least 3 use cases. |
| KPI12 | | | | | X | | Validation by UC industrial focus groups in at least 2 dedicated in-lab controlled workshops, conducting concrete comparative studies. |
| KPI13 | | | | | | X | Adoption of STAMP technologies: number of external contributions (bug report or feature request) or pull requests > 15 by at least 3 different third-party organizations |
| KPI14 | | | | | | X | Tweeter: 200 followers outside the project consortium at the end of the project |
| KPI15 | | | | | | X | Unique visitors on the website (except consortium members) : 500 on year 1, 750 year 2 and 1000 year 3 |
| KPI16 | X | X | X | X | X | X | 5 presentations of the STAMP technologies in the most important international open source forums |
| KPI17 | X | X | X | X | X | X | 10 papers accepted to conferences and journals in software engineering research, adhering to the EU open access publication guidelines. |

## *1.2 Relation to the work program*

STAMP addresses both themes a and b expressed in the call. The exact topics addressed by STAMP are highlighted below and loosely quantified in the following table.

**Aspects of the ICT-10-2016 call addressed by STAMP**

| **Specific Challenge** | |
|---|---|
| Need for programming and modelling methods, platforms and **software reuse** that facilitate the development of more interconnected, flexible, **reliable**, secure and efficient software | **Reuse of software assets is at the core of the STAMP concept**: reuse test cases, test configurations, API descriptions or probes and logs produced along the development in order to automatically amplify the values of these assets towards increased quality. |
| Holistic approach in the software development that goes **beyond software production within specific application domains** | STAMP's approach is anchored in DevOps to increase the impact and exploitation opportunities of the new testing techniques. Yet, it is independent of a specific application domain, as revealed by the **large spectrum of application domains found among our use cases**.<br>STAMP also has a holistic vision of software testing in the context of DevOps. This is reflected by three technical objectives that target test amplification at three stages of the development lifecycle, which cover both Dev and Ops quality assurance. |
| **a. Advanced software development approaches and methodologies** | |
| Novel development approaches which would drastically **increase development productivity** | The main objective of STAMP is to **increase test automation** for the development of software applications that run in the cloud. This directly increases development productivity since time spent on detecting bugs is reduced. In particular, our objectives 1, 2 and 3 are tightly connected to productivity: the reduction of manual effort for testing and the reduction of debugging time immediately saves efforts to deliver products faster or to develop new features in the meantime; technical debt is also a major impediment to innovation and the automated techniques that rapidly detect regressions can limit the risks of migration, and hence reduce the technical debt and improve productivity. |
| and various dimensions of software quality such as security, **reliability**, **performance**, **scalability** and adaptability | Test automation immediately relates to the reliability dimension of software quality: all three amplification technologies developed in STAMP aim at reducing the number of functional and performance bugs that go in production and hence increase the reliability of applications. Yet, STAMP also addresses performance and scalability aspects, through the development of automatic techniques to amplify the generation and deployment of multiple, diverse configurations (objective 2). |
| Aspects that can be covered include: novel requirement engineering approaches; **tools and mechanisms for managing software quality**, including big data analytics on user feedback and runtime software performance monitoring; | STAMP's core technological innovations aim at providing tools for increasing software quality through the systematic amplification of test cases, including the generation of oracles that can capture bugs that are not detected by existing test cases. The scientific foundations of these mechanisms are in the area of software testing, trace analysis, software architecture and program transformation. |

| | |
|---|---|
| **tools for automated deployment and dynamic configuration**; | One key aspect of test amplification of STAMP is related to the amplification of service configurations in order to test the scalability of the system. This amplification phase relies on two main mechanisms: amplification of existing test configurations and the automatic deployment of these configurations to run back-to-back tests on all of them. This amplification step will hence rely on a new architecture to emulate dynamic configurations and automatically deploy them for testing purposes. |
| **b. Seamless software architectures** | |
| Innovative architectures, **frameworks** and platforms addressing the need for evolvable, secure, context-aware and **self-adaptive** software in highly connected and **interoperable** systems. | STAMP's amplification techniques are developed as innovative frameworks for the automatic generation and execution of test cases at different phases of a DevOps process. In particular the amplification of configurations addresses a testing issue that is specific to self-adaptive systems, namely software systems that run in the cloud and that autonomously scale up or down according to their incoming load. This amplification phase also addresses interoperability by testing that services can be deployed and execute correctly on different platforms (with different CPU, memory or bandwidth resources). |
| Support for the **development and testing of software for distributed systems in heterogeneous environments**, | STAMP targets software testing for software systems that run in the cloud. A particular aspect of these systems is that, even though they run in a single logical location, software services are physically distributed on a network of machines that can be in different physical data centers. These distributed networks are heterogeneous since physical or virtual machines can have very different resources and run various operating systems and libraries. |
| addressing issues such as data consistency, **reliability**, **scalability** and the efficient use of underlying resources. | As mentioned in previous points STAMP's main objective is to increase the levels of automation in software testing in order to find bugs earlier. In particular we focus on functional bugs and performance bugs in the presence of automatic scaling. The shorter time and the increased chances of detecting these bugs have direct positive impact on the reliability and scalability of the applications under test. |

In addition to addressing the ICT-10-2016 call, STAMP is fully aligned with the European Commission's ambition towards open source software: all STAMP technologies are developed as open source projects supported by the OW2 open source consortium; the STAMP technologies are validated and exploited within FIWARE through ATOS and Engineering, two strong industrial members of the FIWARE community.

## *1.3 Concept and methodology*

### *(a) Concept: Novel techniques for the automatic amplification of test cases*

**The concept of STAMP is to automatically transform testing assets that are manually written by human developers in order to improve testing effectiveness. We aim at adding value to human labor and eventually reducing the number of bugs in production while limiting the risks associated with code updates.**

The key research question of STAMP is as follows: can the automatic transformation of testing assets, a.k.a. test amplification, increase test effectiveness (e.g. fault detection)? This question raises a number of challenges that form the core of STAMP's scientific investigations: select a relevant subset of testing assets for amplification; define effective transformations for amplification; handle the combinatorial explosion of test cases produced through automated transformations; keep test execution times reasonable.

Test amplification aims to provide software developers with a tool that increases the levels of automation in software testing. The concept of test amplification is generic and can be investigated in multiple application domains. However, **STAMP focuses on test amplification in the context of DevOps and targets the early detection of regression bugs.** The key particularity of DevOps is to focus 100% on testing in order to achieve 100% automation of production release and deployment of **software products which run in the cloud or require very fast time-to-market**. In that sense, STAMP directly addresses one of the essential challenges for software engineering for the cloud: *Challenge Cloud-7:* Methods and tools for agile life cycle support of cloud applications including the development, testing, deployment and management of cloud applications[4].

**Goals of amplification**

The amplification of testing assets increases test effectiveness. In particular, the goals are:

- To detect more regression bugs on continuous integration servers, before functional testing.
- To detect more scalability bugs, before going to production and experiencing bad behavior (trashing, freezing) with high user load.
- To reproduce more production bugs in edge cases thanks to semantic logging.

**Foundations of amplification**

The STAMP concept of automatic test amplification builds on solid scientific foundations and is integrated into a dynamic technological landscape that forms the current toolset in DevOps.

- **Scientific foundations**: STAMP builds on two major threads in the field of software testing. The first one is **test case generation** [McM04]. The major difference between test case generation and test amplification as done in STAMP is that test generation starts from scratch, with no tests. On the contrary, test amplification starts with existing testing assets such as a test case. This makes a major difference: test amplification can scale to larger and more complex programs because it starts from an initial point that is already elaborated (a fortiori by human intelligence). Second, test amplification builds on the literature on **test oracle analysis** and improvement [BHM15]. This is key in the context of STAMP, since the number of regression bugs is one of the test adequacy criteria that we target, and this criterion is very much correlated to oracle effectiveness.
  The development of STAMP's scientific contribution leverages core theoretical and technical foundations of software engineering. First, the amplification technologies developed in STAMP will exploit **program and model transformation technologies**, in order to automatically and systematically generate new testing assets as variants of existing ones. Second, we leverage **search-based and optimization techniques** to address the combinatorial explosion of possible variants of existing tests cases. Third, we exploit **static and dynamic analysis** in order to identify an effective scope for amplification and to speed-up the execution of amplified test suites.
- **Technological Foundations**: STAMP builds on testing infrastructure that is mature and widely used in the context of DevOps. The testing framework JUnit[5] is used by millions of software projects, both in commercial proprietary products and open-source applications. Other major frameworks that the project will consider include the web testing framework Selenium[6] and oracle libraries such as Hamcrest[7]. Second, continuous integration technology, such as Jenkins[8], is mature and industry standard. The DevOps thread of engineering heavily relies on this testing infrastructure. Consequently, STAMP engineering will rely and contribute to these software components that already exist, in order to increase adoption. It must also be noted that these popular software testing tools are all open source. Hence, STAMP's choice to deliver all resulting amplification technologies under open source license matches standard practices in DevOps.
- **Experimental Foundations**: The scientific advances of STAMP will be made with an empirical research standpoint. This empirical perspective has two aspects. First, the consortium will perform systematic and large scale empirical studies to understand the strengths and weaknesses of software testing in practice. Second, all tools developed in the context of the project will be evaluated on large benchmarks composed of open-source applications and their tests. This provides the STAMP project with excellent experimental foundations.

[4] NESSI white paper: http://www.nessi-europe.eu/Files/Private/NESSI_SE_WhitePaper-FINAL.pdf
[5] http://junit.org/junit4/
[6] http://docs.seleniumhq.org/
[7] http://hamcrest.org/
[8] https://jenkins.io/

Figure 2 illustrates the concept of STAMP. The top part of figure 2 illustrates three current software testing practices in the context of DevOps: unit testing focuses on the production of test cases for the early detection of regression bugs inside isolated code units (classes or services); configuration testing consists in assembling and deploying complete service configurations in order to detect scalability bugs; online testing focuses on the insertion of probes in production code in order to log execution and detect issues at runtime. The **bottom part of the figure illustrates how STAMP amplifies the software assets already developed in order to increase test effectiveness**:

- generate variants of existing unit test cases to speed up the detection of regression bugs when changes are introduced in code units;
- generate variants of test configurations in order to speed up the detection of scalability bugs;
- generate new test cases that can replay production execution conditions through the analysis of logs collected online.

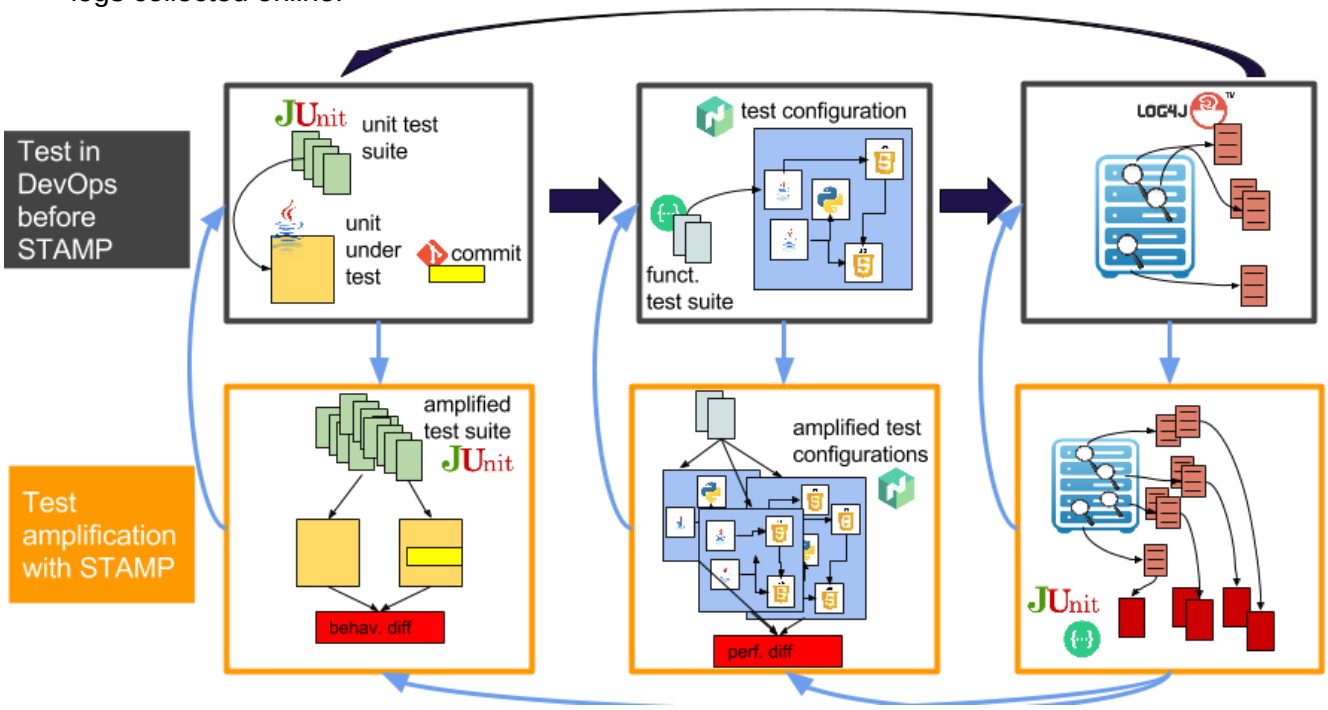
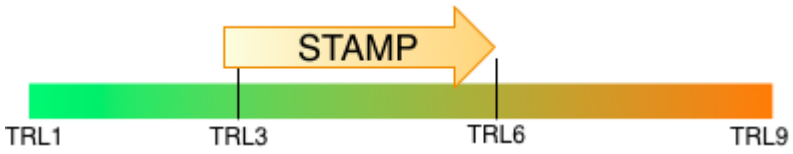



**Figure 2 - The STAMP concept: test amplification through the whole lifecycle of software products and services (unit, configuration and online testing, from left to right).**

**Technological Realization**. We target Java as the main languages for application code, the popular associated testing tools (JUnit, log4j, Selenium), Gradle and Maven for build automation, Swagger for the description of REST APIs, Nomad and Docker for the description of service assemblies and automatic deployment.

**STAMP relies on solid scientific foundations with timely challenges as well as mature and well-accepted testing technologies.**

## Positioning of the project




STAMP targets the development of test amplification software services, which have TRL6 at the end of the project. The figure above illustrates that the project foresees this maturity level thanks to software components that are available at the beginning of the project and that have proven the feasibility of the amplification concept (they are at TRL 2 or 3): INRIA provides the DSpot tool, which can already transform

unit test cases and run them on two different versions [9]; SINTEF provides the Consolas prototype at TRL2, which implements initial prototypes to amplify test configurations [10]; TUD has already demonstrated the feasibility of generating test cases from production logs[11].

The initial results exploited to bootstrap the STAMP research are outcomes of the following previous projects.

DIVERSIFY[12] (FP7, 2013 - 2016): this FET project investigated the automatic production of source code diversity in order to produce variants of programs that are functionally similar, yet exhibit different computations. In order to compare the functional behavior of variants, the DIVERSIFY project contributed initial solutions for unit test amplification that will feed the STAMP project. The DIVERSIFY project was coordinated by Benoit Baudry (INRIA, coord. of STAMP)

HEADS[13] (FP7, 2013 - 2017): this project develops model-based solutions to design and deploy software applications on heterogeneous execution infrastructures (from sensors to the cloud). In particular, the project has specified a formal language to specify configuration topologies, which serves as a seed for the abstract configuration model required for configuration testing amplification. The HEADS project is coordinated by Franck Fleurey (SINTEF, PI on STAMP).

RISCOSS[14] (FP7, 2012 – 2015): the RISCOSS Project developed a methodology and a software solution for evaluating risks related to adoption of Open Source software components for industrial and business use cases and identifying possible risk mitigation strategies. The RISCOSS methodology clearly identified lack of testing as a Risk Driver for software defect related risks and STAMP project aims to further the collection of testing related metrics and develop a methodology to reduce bug related risks. OW2 and xWiki were partners in RISCOSS.

The open source test amplification services developed within STAMP will also contribute to the extremely vibrant ecosystem of testing and build tools in the context of DevOps:

- JUnit is a framework to structure test cases and to automate their execution against Java programs. This tool is popular among Java developers and is used by all use case providers in STAMP. This tool is considered mature and serves as the technical foundation of unit test amplification and online test amplification. This choice increases the chances of adoption of STAMP solutions, as well as the opportunities to contribute to a flagship software testing tool.

- Jenkins is a leading *Continuous Integration* tool, a software product for automating the compilation, assembly and testing of software. This is also used by all STAMP use case providers. STAMP targets integration of amplification services within the automatic test execution processes of Jenkins. STAMP's contribution to the large Jenkins open source community will increase the visibility of STAMP results.

**Related research and innovation initiatives**

SENECA[15] (H2020 – ITN, 2015 - 2019): SENECA is a European Industrial Doctorate project, which research program is organized around 3 axis: Product quality in cloud-related software development projects; Process quality in cloud-related software development; Operations' quality in cloud systems. The first axis is completely aligned with the ambitions of STAMP, and TUD, who is involved in both projects can contribute to the good articulation between the research findings.

Cirrus (2016 – 2020): an Industry-driven Norwegian project in which SINTEF collaborates with VISMA and SuperOffice, two companies that develop web services. Over the years, the companies have developed multiple variants of their services to fit each customer. A major issue these companies face when migrating services into the cloud is to understand the dependencies or incompatibilities between all versions. SINTEF will contribute a solution to retrieve these constraints. This technology will be an important asset to automatically amplify valid test configurations.

[9] https://github.com/DIVERSIFY-project/dspot
[10] http://ceur-ws.org/Vol-1554/PD_MoDELS_2015_paper_3.pdf
[11] repository.tudelft.nl/assets/uuid:6bc5d560-6563-4203-ad3d-80b86b51e591/TUD-SERG-2015-008.pdf
[12] http://diversify-project.eu/
[13] http://heads-project.eu/
[14] http://www.riscoss.eu
[15] http://senecaproject.github.io/

FIWARE [16] is a middleware platform, driven by the European Union, for the development and global deployment of applications for Future Internet. The API specification of FIWARE is open and royalty-free, where the involvement of users and developers is critical for this platform to become a standard and reusable solution. STAMP will interact closely with the FIWARE community through two of its contributors (ATOS and Engineering), both for validation and exploitation.

"Big Software on the Run" (2015-2018) involves the three Dutch Technical Universities (3TU): Delft, Eindhoven, and Twente. The project aims at using process mining techniques on execution logs to support the evolution of big software systems. STAMP will directly benefit from the results of this project for online test amplification.

STAMP's objectives have been defined being aware of projects previously and currently funded by the European Commission in the areas of software and services (FP7 calls 1, 5, 8, 10 and H2020 call 1). In particular, we are aware of the results of FITTEST and MIDAS, which investigated software testing and RISCOSS, which investigated software quality metrics. The main novelty in STAMP is to generate test cases by reusing testing assets (instead of starting from scratch as in FITTEST) and to be anchored in the area of DevOps and continuous testing (a more agile context than MIDAS').

### *(b) Methodology*

Figures 3a and 3b illustrate the three essential pillars of the STAMP methodology:

**METHODOLOGICAL PILLAR 1:** The development of innovative test amplification techniques for unit test suites, configuration tests and for the exploitation of runtime logs. This first pillar focuses on the design and development of amplification algorithms in accordance with the software architecture defined jointly with the consortium partners. The expected TRL at this stage is around 2 or 3.

**METHODOLOGICAL PILLAR 2:** The software prototypes are further developed and packaged according to a global microservice architecture. The development activities performed as part of this pillar aim at providing amplification services that can be inserted in different build toolchains. The objective in this case is to bring the TRL to level 4.

**METHODOLOGICAL PILLAR 3:** The continuous validation of test amplification techniques against the needs of use case providers coming 5 different sectors of the software market: e-Health, smart cities, cloud computing, information management and software quality.

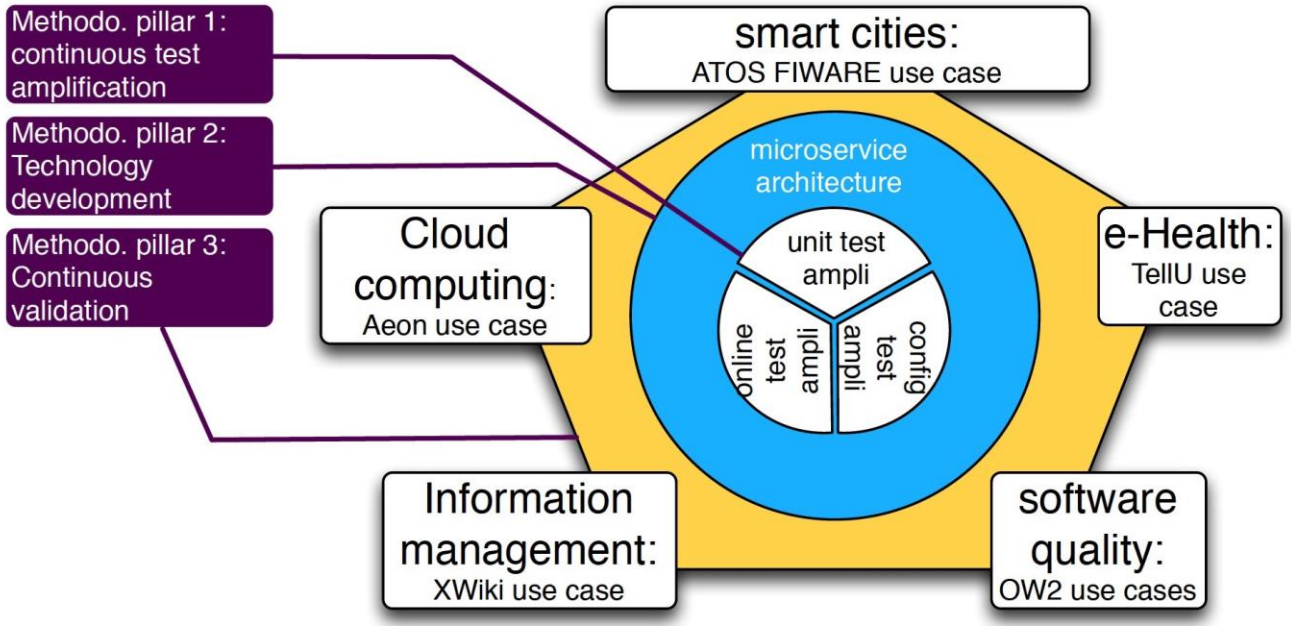



**Figure 3a - the STAMP methodology is founded on three pillars: the development of innovative amplification technology (white, at the center of the figure), the development of these technologies following a microservice architecture model (blue circle) and continuous feedback from use cases coming from 5 application domains**

[16] https://www.fiware.org/

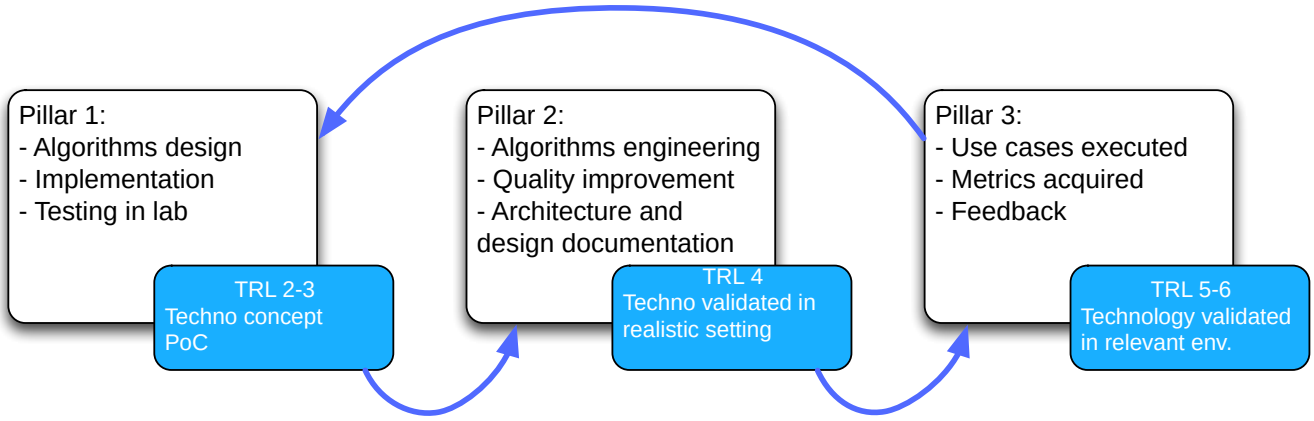



**Figure 3b - the three methodological pillars of the STAMP methodology support the technological ambition of the project: porting the research ideas and prototypes to industry-strength tools at TRL 6**

## METHODOLOGICAL PILLAR 1: continuous test amplification

### Unit test amplification

In the context of micro services, unit testing refers either to testing one service as a stand alone executable, with API testing, or testing specific classes that form a part of the service. **Unit test amplification consists in amplifying the set of existing test cases, manually written by the developers, to generate variants that cover more inputs, behaviors and observation points**. This aims at **speeding up the detection of behavioral regressions**.

As a preamble to unit test amplification, we build a **tool to monitor the interplay between test suites and the unit under test**. It collects metrics about coverage, the scope of the test cases (e.g., trigger long or short execution traces, trigger exceptional cases), API interactions (e.g., frequency of method calls, protocol of method calls), historical data about test cases (e.g., when the test case failed for the last time, frequency of pass and failure). We also characterize the types of regression bugs usually introduced and that can be detected with unit test cases. These metrics provide essential insights for several stages of test amplification: before we start the development, to quantify the weaknesses of existing test cases; for the amplification process itself to steer the search towards test cases that have different characteristics than the initial ones; for the evaluation of the amplification technology, to quantify its effect on KPIs.

The **automatic generation of variants of unit test cases**, a.k.a amplification, forms the core of this technique. Inputs are: the original unit under test before the change, the commit(s) or the updated unit and the test suite that passes on the original version. Amplification iteratively proceeds as follows:

**1. pre-amplification - determine candidate test cases for amplification:** use the metrics to select test cases for amplification. For example, we select test cases that cover the part that has changed and its dependencies (because regression bugs are likely to happen in these parts), or we select test cases that cover complex behavior.

**2. amplification – iteratively search for good test case variants:** automatically transform test cases in order to produce new ones (e.g., modify literal values, add/remove invocations in existing test cases); evaluate a fitness function on the new test cases (e.g., new paths covered, increased ratio of lines covered by test case, increased observation space); select the good ones and transform again

**3. post-amplification - add regression oracles in the new test cases:** amplify the set of observations on the program's behavior by adding assertions in the new test cases. These assertions are called regression assertions, because they aim at determining if the updated version behaves differently than the original one.

The last activity of unit test suite amplification consists in **running the amplified test suite against both the original and updated code** unit in order to detect the behavioral differences. We provide a specific test runner that optimizes the parallel execution of test cases inside the same Java Virtual Machine.

The example below illustrates a possible result of amplification. We amplify `testOrigin` and generate `testAmpli` through the following transformations: add two method invocations (lines 3 and 7), remove an assertion of the original test case (line 3 of `testOrigin`), extract the method invocation from that assertion and insert it in the amplified test (line 8), add three new assertions in `testAmpli` (lines 4, 5, 7).

**Listing 1 - Example of unit test amplification. Left side: the `testOrigin` (extracted from the test suite of Apache `commons.collection`). Right side: `testAmpli` is an example of amplified variant of `testOrigin`**

```
testOrigin() {
1.  stack.push(((E)("First Item")));
    stack.push(((E)("Second Item")));
3.  assertEquals("Top item is \'Second Item\'", 1,
stack.search("Second Item"));
    assertEquals("Cannot find \'Missing Item\'", -1,
stack.search("Missing Item"));}
```

```
testAmpli() {
1.  stack.push(((E)("First Item")));
    stack.push(((E)("Second Item")));
3.  E o5 = stack.peek();
    assertFalse(((java.lang.String)o5).isEmpty());
5.  assertEquals(((java.lang.String)o5), "Second Item");
    E o6 = stack.pop();
7.  assertEquals(((java.lang.String)o6), "Second Item");
    Object o7 = stack.search("Second Item");
9.  assertEquals("Cannot find \'Missing Item\'", -1,
stack.search("Missing Item"));}
```

**The main outcome of unit test amplification** is a set of behavioural differences between the original and updated versions, and the test cases that reveal these differences. The generated test cases and the metrics form secondary outcomes.

## Configuration test amplification

As illustrated in Figure 2, configuration testing is the activity of assembling different services in a complete system, to deploy and test it. The assembly of services is done manually, as well as the design of test scenarios, while the deployment and test execution are automated. Running well-defined configurations provides both a real environment for executing the test cases against the services, and an opportunity to reveal bugs that only expose in particular system assemblies. **Configuration test amplification consists in automatically transforming the configurations designed manually in order to run the test cases in more situations and decrease the time needed to detect scalability and performance regressions.**

In Listing 2, we first use a simple example to illustrate the expected effect of configuration amplification. The left part shows an excerpt of a configuration file in Docker, which sets up a FIWARE Orion Context Broker (a FIWARE Generic Enablers). The configuration has two parts: 1) a Dockerfile which clones the latest source code, builds it, and wraps it up; and 2) a Docker-compose file that instantiates an Orion service together with a dependent MongoDB database service.

The right half of the Listing shows one of the amplified configurations which illustrates the following four types of configuration amplifications for different testing purposes. **Resource limitation**. In lines L3 and L4, we add new attributes to limit the CPU and memory for the running Orion service, in order to validate the *vulnerability of Orion on scarce resources*, and compute the impact of resource on Orion's performance. **Horizontal scaling**. We duplicate the Orion service instance (L5), together with a load balancer (L7), to validate the *scalability* of Orion, and to inspect how scaling improve the performance. Similar amplifications can be applied to the MongoDB service as well. **Dependency twisting**. In L2, we substitute clang for gcc. Even if end users will not use an Orion compiled by Clang, abnormal behaviors observed under this twisted configuration will still imply potential bugs. **Instrumentation**. In L1, we replace the base image by a predefined docker image that contains generic probes that monitor logs, resource usage, etc. Such instrumentation will help the monitoring and analysis of the services themselves when running the test cases. STAMP investigates the following technical approaches to achieve such automatic amplifications on test configurations.

We first define a **common configuration model**, along with the **bidirectional transformations** between the mainstream configuration scripts (such as dockerfile, chef recipes, etc.) and the common model, so that the amplifications can be performed in a platform-independent way. It involves the text and program comprehension techniques to extract the abstract information, and a three-way transformation that complete the details that are contained in the original scripts but does not present in the common model, so that the generated scripts are still executable.

We perform **automatic amplification of configurations** on the common model, in the forms of mutation and crossover. **Mutation** modifies a configuration by applying primitive operators from changing an attribute value (as is illustrated in Listing 2) to duplicating a whole elements (L5), etc. **Crossover** combines two or more configurations to generate new ones. For example, by combining the configuration in Listing 2 with a sample scaled-up MongoDB configuration, we can test how the scaling of MongoDB improves the performance of Orion. Mutation and crossover will most likely lead to invalid configurations. For example, a naive duplication of an Orion service in Listing 2 is invalid, because the two services will compete on the

same port in the hosting virtual machine, and without a load balancer the original test cases will not be able to invoke the two services in the same time. We exploit **constraint solving** techniques after each round of mutation or crossover to calibrate the generated configuration, e.g., assigning a new port number (L6) and introducing a load balancer (L7).

In the next step, we will **analyze** the generated configurations and **select** the appropriate ones to feed the testing execution. **Evaluation of relevance** will be performed on each individual configuration to assess to what extent it fits the selected test cases and the latest changes. **The diversity analysis** will quantify the distance between each pair of configurations and compute the global diversity and space coverage of all the selected configurations. Finally, an **interactive selection** step may be performed with the developers, to elicit new constraints and patterns.

The final step is the **execution of amplified and selected configurations**. The executor will **optimize the global testing schedules** to maximize the reuse of common steps between the executions of different configurations, in order to reduce testing time. The reuse will be based on the image-container mechanisms in deployment tools such as Docker. During the execution of these configurations, we will keep **monitoring the performance of individual services and the communication** between them, to provide a reference for the running of these services, and also for later testing activities. Finally, we will set up and maintain a **testing laboratory** with an internal cloud environment and relevant hardware and devices, to simulate the real execution environment.

An important side-effect of configuration amplification is to provide service users a rich set of sample configurations. Users can pick a sample and deploy it into their own environment, with simple or even no modifications. More importantly, these configurations are already validated through testing.

**Listing 2 - Example of configuration amplification. Left: the original configuration of FIWARE Orion Context Broker, extracted from its official GitHub repository[17]. Right: a sample amplified configuration**

```
# 1) Dockerfile orion
FROM centos:centos6.6
RUN \
  yum -y install gcc
  git clone https://…/fiware-orion && make &&…
ENTRYPOINT ["/usr/bin/contextBroker", ...]
---
# 2) Docker-compose.yml
mongo:
 image: mongo:2.6
 command: --smallfiles --nojournal
orion:
 image: orion
 links: [ mongo ]
 ports: ["1026:1026"]
 command: -dbhost mongo
```

```
     # 3) Dockerfile orion
L1   FROM stamp/centos-instrument
L2   RUN  yum –y install clang...
     ---
     # 4) Docker-compose-2.yml
     orion:
       image: orion
L3     mem-limit: 1000000000
L4     cpu-quota: 50000
       ports: ["1026:1026"]
     orion2:…
L5     ports: ["1027:1026"]
L6   haproxy:
L7     image: tutum/haproxy
       links: [orion, orion2]
       ports: ["80:80"]
```

## Online test amplification

Once the configuration of services is deployed in production, the operational deploy probes in order to log issues at runtime (e.g. through Logstash or the ELK stack). **Online test amplification automatically extracts information from logs collected in production in order to generate new tests that can replicate failures, crashes, anomalies and outlier events**. As illustrated in Figure 2, the input of online test amplification is a set of log files. These files include data related to important events such as intermediate progress data, errors, crashes and warning messages. Developers usually analyze log files/messages manually for debugging purposes. Online test amplification is aimed at reducing the time spent by developers on this analysis by automatically re-generating tests to replicate the behavior of interest, e.g., crash failures.

This amplification technique starts from existing probes and logs and proceeds as follows:

**1. Log data analysis**. we collect log data from software execution by mining the available log files. However, industrial projects have megabyte or gigabyte of log data per day with an implicit redundancy due to multiple executions of the same paths. Therefore, the main challenge is to reduce the amount of

[17] https://github.com/telefonicaid/fiware-orion/tree/develop/docker

log data by extracting only information that can be relevant for software developers. For example, we extract crash stack traces that are useful for understanding the root cause of a crash, or we extract common patterns in log messages which reflect common software behaviors.

**2. Learning state machine models**. Learning algorithms are used in order to derive common patterns in log messages, which mirror common software behaviors. For example, we use machine learning algorithms in order to derive a state models for software behaviors detectable from log data. The state models can be exploited to identify both common behaviors and anomalies.

**3. Test Case Generation**. The state models are used to generate new tests that either (i) cover **common behaviors**, or (ii) **replicate crashes** and anomalies. For the former testing, we use state models as guidance to generate new test cases with the aim at maximizing model based coverage criteria, e.g., path or transition coverage. For the latter, we exploit information available in crash stack traces and we use a novel fitness function guide test case generation algorithms toward the generation of tests directly usable by developers to find the cause of the crash and fix the bugs.

The new amplified tests are also good candidates to add into existing test suites to verify whether crashes/bugs revive in future releases or whether new changes have introduced errors into unchanged parts of the software, endangering its common behavior. This step also uses as input the result of the unit test amplification in order to derive which transitions or paths in the state models are already covered by existing (manually written or amplified) tests.

**4. Runtime log enhancement**. Log messages and probes manually written by developers may be not sufficient for generating meaningful state machine models or to allow crash replication. We dynamically add probes and log messages into the production code in order to improve its testability. For example, we add probes in code components devoid of log messages, or we enrich log messages with further details (such as OS version, etc.) in existing log messages in case of crashes.

The example below illustrates a possible result of the online amplification from crash detectable from log file. This is an example of crash stack trace obtained for the bug ACC-70 affecting the Apache commons Collection library (version 3.1). The right side of Listing 3 illustrates an example of automatically generated test that can be obtained during the online amplification and can be directly used by developers for debugging. Indeed, according to our test, the crash is caused by a call to `previous()` when a `TreeListIterator` is instantiated with the first parameter (parent of the tree) set to `null`. Since inside the method `previous()` there is no check condition on such a parameter, a null pointer exception is generated. A simple fixing would consist of adding a check condition to verify that the parent of the tree is not `null`.

**Listing 3 - Example of online amplification for crash reproduction. Left side: the original crash stack trace for the bug ACC-70 from the Apache Commons Collections library (version 3.1); Right side: example of test case generated during the online amplification.**

```
// Crash Stack Trace
Exception in thread "main" java.lang.NullPointerException at
org.apache.commons.collections.list.TreeList$TreeListIterator
    .previous (TreeList.java:841)
at java.util.Collections.get(Unknown Source)
at java.util.Collections.iteratorBinarySearch(Unknown Source)
at java.util.Collections.binarySearch(Unknown Source)
at utils.queue.QueueSorted.put(QueueSorted.java:51)
at framework.search.GraphSearch.solve(GraphSearch.java:53)
at search.informed.BestFirstSearch.solve(BestFirstSearch.java:20)
at Hlavni.main(Hlavni.java:66)
```

```
// Amplified/generated  test
public void testAmpli () throws Throwable {
  TreeList treeList0 = new TreeList();
  treeList0.add (( Object ) null );

  TreeList.TreeListIteratorl = new
      TreeList.TreeListIterator(treeList0
          , 73);
  // Undeclared exception !
 treeList_TreeListIterator0.previous ();}
```

**The first pillar of STAMP's methodology gathers the project's research contribution to form the foundations of automatic test amplification throughout a development lifecycle**

## METHODOLOGICAL PILLAR 2: Technology development

The second pillar of STAMP's methodology focuses on the development of test amplification services that can be integrated in different software production tool chains. Considering the STAMP ambition to offer enterprise level testing services, the first objective is to enhance the software quality in the context of the DevOps. We will deliver well-documented, working test software services at TRL 6 at the end of the project. We will leverage open source development and the expertise of OW2 to ensure sustainability of (pre-industrial) tools to make the project outcomes attractive to industry. The quality of the microservices

will be assessed through rigorous software testing and the exploitation of the project's automatic test amplification.

**The STAMP test amplification microservices**

We choose to follow an approach based on a micro-service architecture in which all STAMP assets (presented in the figure 4 below) are loosely coupled. Each of the amplification technique presented in the methodological pillar 1 is packaged as a stand-alone service (the three large boxes in the figure 4). Each service is also decomposed in a flow of microservices. For example, the unit test amplifier uses a tool to compute metrics in order to select a subset of test cases, which are then amplified and executed: each of the four actions is developed as an independent service that produces results which can be used independently of the larger service.

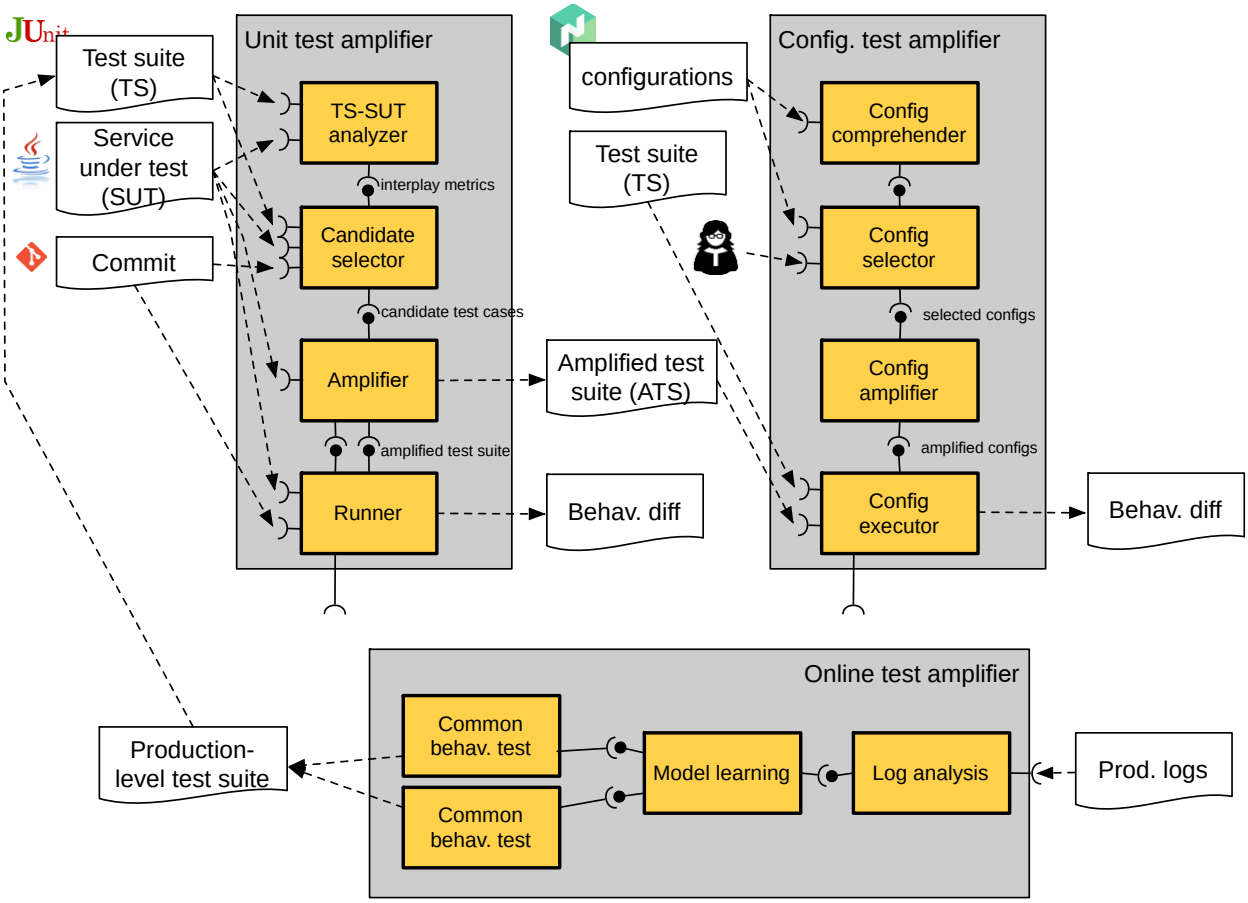



**Figure 4 - STAMP micro-service architecture**

The choice of a micro service architecture is motivated by the following reasons: we target DevOps teams, which already intensively deploy micro services for continuous improvement and delivery, hence this type of architecture increases chances for adoption; a micro service architecture facilitates language independence to implement the technical solutions, leaves open a large choice of implementation frameworks, while still supporting integration with other tools used in different development contexts; this choice is prone to different exploitation and business models, as will be discussed in Part 2. A micro service architecture also supports our two essential goals:

- Empowering STAMP case studies (end users) through the provision of expressive data flow definition APIs, an expressive data flow designer, flexible Input-Processor-Output runtime model, data type agnostic function definitions (json, xml, messagepack, protobuf), simplified deployment
- Execution Performance through optimal resource management, plan reconfiguration at runtime, dynamic physical data flow decisions

In the STAMP vision, each case study will design a specific data flow, using the provided micro-services for its needs, and select a set of particular technical components for managing the deployment (such as docker for heterogeneous system or maven/OSGi in pure Java environment). STAMP shall provide connectors for the integration with continuous development environment such as Appveyor or Jenkins.

The first major technical challenge to pursue this vision in methodological pillar 3 is to specify precise and complete API for each test amplification service. APIs have grown dramatically in the last five years[18] and form an essential part of the solution to ensure interoperability between applications and services[19]. Indeed, each service needs to precisely define what function it provides, what are the input and output data, what is the format for these data. Yet, there is a lack of uniquely adopted formal specifications for APIs and data formats. STAMP will investigate the following formalisms for describing the micro-services: OpenAPI (https://openapis.org/) for describing APIs, OCCI (OGF specifications) or, at least, JSON schemas for data formats and models. Swagger framework (http://swagger.io/) will be used to represent RESTFul API. The adoption of Swagger is suggested by the fact that it is supported by several widely adopted programming languages and deploy environments. Leveraging Swagger eases the production of the documentation (Swagger UI) as well as client code generation and supports services discoverability (Swagger tools). It is widely adopted by major software companies such Microsoft, Paypal, and others.

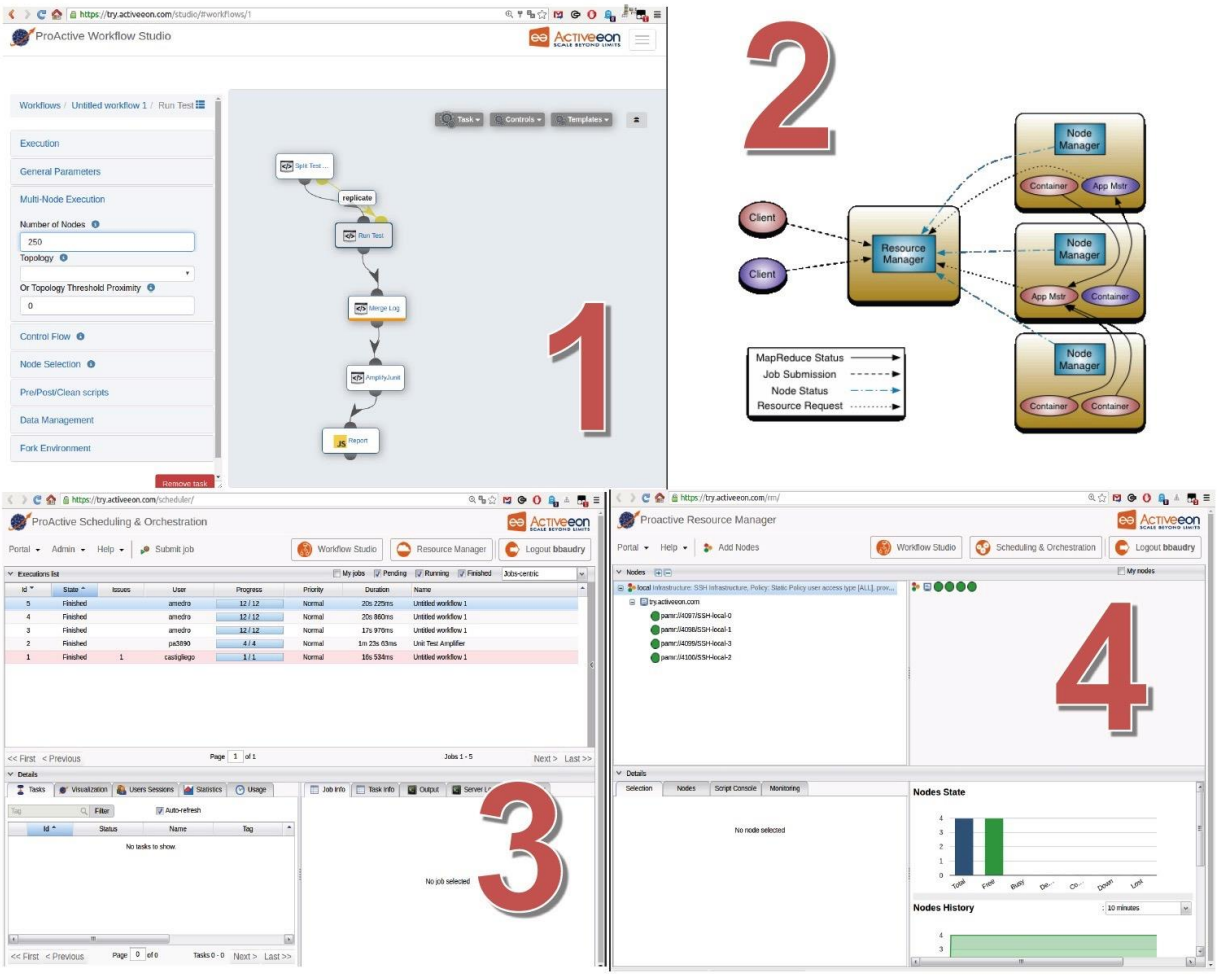



**Figure 5 – Controlling the distribution of amplification computation**

The second challenge for the industrial development of STAMP assets is to support the scalability of amplification. Here we rely on a framework that splits the functionalities of resource management and job scheduling/monitoring into separate daemons. STAMP's infrastructure will provide a support for the automatic parallelization of micro-services execution on top of a set of distributed computing resources, which will be hosted by OW2 for the lifetime of the project. As a result, a STAMP application will be either a single job (eg: running amplified test) or a DAG of jobs (for running the unit test amplifier, running the unit tests, running the configuration amplifier, ... ). A distributed workflow and resource manager will schedule resources among all the services that run in the system. This architecture style provides a high level configuration of the STAMP platform using flow-based programming and a clear separation between job scheduling, job deployment and job monitoring in order to provide efficient job execution on top of a distributed infrastructure. The concrete implementation of STAMP infrastructure as a micro-services

[18] Comm. of the ACM, Feb 2016, **59(2)**. Economic and business dimensions column: Revealing the API Ecosystem and Enterprise Strategy via Visual Analytics

[19] Comm of the ACM, March 2016, **59(3)**. Riding and Thriving on the API Hype Cycle.

application will leverage container platforms and related technologies. It will in particular reuse the ActiveEon Studio (https://try.activeeon.com/studio) to describe the workflow, distribute the workflow and manage resource allocation for each task. We will also consider the use of apache tez (https://tez.apache.org/) and Apache Hadoop YARN for running this workflow. Figure 5 shows an example of dashboard that can be provided to a developer using ActiveEon studio to run a specific STAMP service workflow on top of a private cloud infrastructure. Part 1 shows the editor that can be used by a developer to specify her own STAMP service. Part 2 illustrates the logical architecture we will follow for distributing the task on top of a cloud infrastructure. Part 3 and 4 show the dashboard that can be used by a STAMP user to follow a STAMP service execution.

**Integration scenarios**

Individuals as well as larger organization will leverage the STAMP test amplification services thanks to the integration within well known and widely adopted tools in software development.

For individual developers, STAMP services will be available through plugins. We envision a Maven plugin for unit test amplification within the usual build process enforced by Maven, as a specific goal (i.e.: mvn amplify-unit-tests), and an Eclipse plugin to make the same services available within the developer IDE. We focus on Maven and Eclipse since they are among the most used development tools within organization that develop software applications for the cloud. This choice exposes the STAMP techniques to a wider adoption.

Jenkins integration will be used to leverage all the three services, making them available within automated processes orchestrated by Jenkins: unit test amplification, test configuration amplification and runtime test amplification. The three main scenarios will be:

1. Unit test case amplification: the Jenkins workflow will orchestrate the following steps a) original tests execution -> b) original tests amplification -> c) amplified tests execution. The process will output possible behavioral differences between the committed version and the previous one and the developer will have the possibility to store new test cases in the code repository;
2. Automation of the deployment of newly generated (amplified) test environment in the form of Docker Images: there are several well-known experiences of the usage of Docker and Jenkins to automate delivery process. We further enhance automation of the delivery leveraging Ansible and Kubernetes. The integration with STAMP leads to an automated process of amplifying existing test environments, delivering in it applications and services under test, and execute current test cases in the amplified test configuration;
3. Automation of runtime tests: this case will be a variant of the point 1, where the amplification will be fed by runtime logs. Again, the Maven integration will be leveraged to automate this process in Jenkins.

**The second pillar of STAMP's methodology gathers the project's development and integration contributions to deliver high quality micro services that handle amplification workflows.**

## METHODOLOGICAL PILLAR 3: Continuous validation of amplification technologies

The development of the amplification technologies described above is performed in tight collaboration with the use cases in order to ensure the development of industry-relevant solutions that fit for the purpose and fulfill the expectations expressed by their stakeholders. Regular interactions with the 5 use cases coming from different domains (from e-Health to cloud management) are essential to ensure the applicability of our techniques.

Continuous feedback gathering will drive this development from use case stakeholders, namely software developers and integrators who will assess the feasibility and scalability of the proposed solutions. The project adopts an iterative validation roadmap that includes the following phases:

- Phase 1: early empirical study and pilot studies for each amplification technology within 1 or 2 use cases
- Phase 2: extension of the pilot experimentation on additional use cases
- Phase 3: opening the validation to external communities of developers

Validation activities will be conducted according to a validation plan and framework that defines the:

- Validation target groups: identifying concrete end-user roles and expertise required to assess concrete test amplification techniques and tools;
- Validation environments, including:

- An in lab assessment environment, targeting the evaluation of each use case pilot, within a controlled environment and validators target group;
- An open field assessment environment, targeting the evaluation by open-communities of developers.

- Iterative assessment process, aligned to the agile STAMP development life-cycle;
- Feedback gathering and reporting mechanism, seamlessly integrated within the STAMP development management framework.

These validation phases start as early as month 3, and involve all STAMP use cases that cover different industrial application domains. Yet, it must also be noted that all use cases share common technological tasks that ensure short development cycles to adapt the techniques to each use case

| XWiki SAS hybrid Open Source business/project use case |
|---|
| **Application domain and main features**<br>The XWiki Platform is an Open Source extensible Collaboration and Knowledge Management Software Platform aimed at improving productivity in enterprise, not-for-profit and public body settings. The main features of the XWiki Platform are Application Within Minutes which allows ordinary users to become developers by using the platform to structure their data in the context of an application. |
| **Testing needs and amplifiable assets**<br>The XWiki Platform is composed of 902 000 lines of code in predominantly Java, Javascript and Velocity template language and has over 3328 tests written using Junit, Mockito and (for integration tests) Selenium/WebDriver. XWiki SAS also contributes a 3 person QA team toward manual testing of the product before each release. However, 123 “regression” issues were reported in the year 2015, proving that there is still work to be done. XWiki would like to make use of test amplification in fully automated scenarios such as on a Continuous Integration server to increase the assurance made possible by automated testing of XWiki. |
| **Relation to the three amplification service**<br>XWiki means to make use of the amplification developments<br>• at unit level to provide incremental improvements to the existing test suite. XWiki already makes use of informal test amplification to build many tests from a common “template” but would like to move toward an amplification methodology, which leverages a wider range of pre-existing tests.<br>• at configuration and multi-process testing level, primarily for hardening the Selenium based functional and integration tests which make use of multiple system processes working together.<br>• through runtime monitoring for measuring and improving the quality (reducing the presence of errors in production) of the XWiki software and specifically the XWiki SAS cloud offering. |

| ATOS FIWARE Smart City Ecosystem |
|---|
| **Application domain and main features**<br>ATOS brings as a use case a set of software services in the area of smart cities. These services are developed in the context of the FIWARE ecosystem (https://www.fiware.org/), that make intensive usage of the FIWARE Generic Enablers (GEs, http://catalogue.fiware.org/). The ATOS solution for Madrid city offers environmental datasets collected from outdoor sensors, which are published as open data in the FIWARE Lab Open Data Portal. A second solution for Malaga city, in the context of the SMART-FI project, offers a city hall SPARQL endpoint hub that exposes public data sets about different city aspects, including energy, traffic or security in house infrastructures. In these solutions, Atos develops applications and services that exploit some of the existing FIWARE GEs such as Identity Manager, Cygnus Context-Broker, IDAS IoT-Backend Device Management or CKAN Open Data Portal. |
| **Testing needs and amplifiable assets**<br>A significant number of development situations, which hampered the development of the Atos Smart City services and applications, have been caused by deficient (i.e. incomplete or inaccurate) testing support for GEs. Available test cases neither provide enough coverage of the entire API exposed by the required GE, nor on the acceptable input sets this API supports. Tests do not provide enough coverage |

for API choreography as to precisely determine the correct other of API invocations (i.e.. REST-like) in complex client-service conversations. These circumstances were particularly problematic when integrating different compositions of GEs and there was the need to identify the sources causing unexpected behaviours in these compositions. Available test suites did not provide suitable support for runtime configuration testing, helping to determine adequate configuration setups for specific execution circumstances, including adequate stress-tests for non-functional properties such as performance.

**Relation to the three amplification service**

These reported issues and others related could be significantly managed:

- at design time, by amplifying existing unit API test suites to increase coverage of the API and retrieve interactions among methods declared in the API
- at deployment time, by exploring extreme cases to configure the FIWARE GEs

## ProActive Workflows and Scheduling (AEon use case)

**Workflows Scheduling and Cloud Resource Management**

Proactive Workflows and Scheduling is a software suite based on the ProActive microservice architecture, which includes 3 main layers. The *workflows studio* is a user interface to create workflows, i.e., sets of tasks with dependencies that perform any kind of computation, such as Big Data and High performance computing or Cloud application deployment. The *scheduler* is the engine that executes the workflow. The scheduler optimizes the execution of the workflow in the right order of the execution of its tasks according to the dependencies that were defined during the workflow design. The *Resource Manager*: is the layer where resources are managed and provisioned for the execution of tasks of the workflow. The manager can deal with multiple types of resources, on-premise or in the Cloud. A Cloud service manager is responsible of getting resources from different cloud providers.

**Testing needs and amplifiable assets**

Software testing of ProActive is performed in 3 stages: (1) The local tests include unit and integration tests along with the development process locally on the dev machine. Here, we use Jacoco, Nightwatch, Selenium, Hamcrest, JUnit, Mockito. All these assets can be passed for unit test amplification. (2) Trydev.activeeon.com: is a cloud on which the ProACtive release candidate is delployed to perform last feature assessment and tests before release. For this platform, the tests are: unit, integration, deployment and system tests. Here, we develop test assets with AngularJS, Docker, RestAssure, all of them can be passed for configuration test amplification. (3) Try.activeeon.com is a cloud, which proposes the current release deployment for the ProActive users to try the product in SaaS mode. We run deployment and UAT (manual) tests before the release deployment.

**Relation to the three amplification service**

Activeon will experiment with the following amplification services with this use case:

- Unit test amplification to increase the number of lines covered;
- configuration amplification test to strengthen the verification of the ProActive Scheduler in multiple configurations;
- runtime tests amplification on the try.activeeon.com and the trydev.activeeon.com platforms

## OW2 Software Quality Platform

**OW2 Software Quality Platform**

The OW2 use case will consist in experimenting the STAMP components in the context of the OW2 quality program. The experimentation will focus on 4 OW2 projects selected for their maturity level in particular in the area of quality assurance, the size of their customer base, their complexity, and the compatibility level of their underlying technologies with the ones supported by STAMP. The initially targeted projects are: Joram, Lutece, Sat4j, Asm. This selection covers 3 application domains, namely: machine-to-machine (Joram), content management (Lutece) and software engineering (Sat4j and Asm). The interest of STAMP and of its integration into the OW2 platform will be evaluated by the project leaders in collaboration with the OW2 Management Office, i.e. the team running the Consortium on a

daily basis. Once tested against STAMP WP1, WP2 and WP3 will combine with the existing OW2 quality platform for providing OW2 projects with enhanced testing tools at the code, configuration and runtime levels.

**Testing needs and amplifiable assets**

The selected OW2 projects have amplifiable assets in the three axis targeted by STAMP: unit testing, configuration testing and runtime testing.

**Relation to the three amplification service**

OW2 will put into practice the STAMP amplification methods and tools at three levels:

- Unit test amplification will be experimented with all the selected projects. A special focus will be brought to Sat4j for its large base of unit tests that is particularly suitable for amplification.
- Configuration test amplification: since Joram is meant to be deployed in a large variety of environments with dedicated configurations, the service relating to configuration test amplification will focus specifically on Joram, while being also experimented with the other targeted projects.
- Runtime tests amplifications: the capabilities of STAMP with respect to runtime test amplification will be experimented in particular against the Lutece and the Asm projects.

TelluCloud e-health

**Application domain and main features**

Tellu develops and operates the TelluCloud platform that provides IoT services within the domains of welfare technology and e-health. By nature the services are security critical and it is very crucial that they are operational at all times. The device integration layer establishes the connectivity towards the various devices. This layer is in control of bidirectional device communication, that is terminating standard and proprietary device protocols. Examples of devices connected to TelluCloud are blood pressure meters and tele-safety alarms. The core component of TelluCloud consists of the Business Rule Engine. Services are implemented with rules that inspect events and configuration data and issue actions when logic predicates are satisfied. The API layer serves all REST APIs towards applications and third party systems.

**Testing needs and amplifiable assets**

There have been several situations in the operation of the TelluCloud service where software bugs have caused the service to malfunction or provide poor performance. Tracing down these bugs are often both tedious and costly, as well as the service may not be performing according to SLA during times when bugs are in effect. As a consequence of this Tellu has started to build test suites that are executed at design time (unit and API tests) and runtime (runtime test of rules). However, these tests suites do not cover enough of the TelluCloud API calls, code base or business rules. TelluCloud test suites are also lacking support for performance testing in combination with different configurations.

**Relation to the three amplification service**

In order to improve the software quality and thus TelluCloud service quality we will exploit STAMP tools and methodologies to amplify existing test suites and create new test suites based on collected execution traces. The main objectives for STAMP application to TelluCloud are:

- By tools and methodologies amplify existing and new set of JUnit test suites to improve code coverage and number of bugs that are detected at development time.
- By tools and methodologies test service configurations to a.) ensure that the response times and throughput latencies are within specified limits. Configurations may both imply horizontal scaling (more instances) or vertical scaling (more resources, e.g. CPU), b.) ensure that the connected service interfaces are compatible, c.) test service vulnerability in terms of avoiding any single point of failure.
- By tools and methodologies that test the services produced at runtime are behaving according to specifications. New sets of devices and business rules will be dynamically added/removed during runtime and it is important that both existing and new services are behaving consistently.

**The third pillar of STAMP's methodology gathers experimental insights about automatic test amplification on 5 use case from 5 different industrial sectors.**

### Sex and gender

The STAMP consortium is committed to fair and non-discriminatory employment policy. All scientists participating in STAMP research activities have been and shall be chosen based solely on their expertise. All the academic partners, Inria, SINTEF, TU Delft signed "The European Charter for Researchers", set of general principles and requirements which specifies the roles, responsibilities and entitlements of researchers as well as of employers of researchers. In this respect, all actions and activities of STAMP project will pay a great attention to the non-discrimination principle: "Employers and/or funders of researchers will not discriminate against researchers in any way on the basis of gender, age, ethnic, national or social origin, religion or belief, sexual orientation, language, disability, political opinion, social or economic condition." As a consequence, recruitment of new staff members involved in STAMP project will be achieved on the basis of an equal opportunity policy.

## *1.4 Ambition*

### *(a) Progress beyond state of the art*

In this section we summarize the state of the art in the three areas of software testing that STAMP addresses (unit, configuration and online testing), as well as advances that we foresee in this state of the art.

### Innovation in unit test amplification

#### State of the art

While the generation of unit test cases has been investigated for many years [McM04], unit test amplification, as described in this proposal, has been very little explored. The work by Yoo and Harman [YH12] refers to "test regeneration", however it perfectly fits our definition of amplification. Their technique augments the input space coverage. It is based on four transformations on numerical values in test cases, and a hill-climbing algorithm where a fitness is the computation of the euclidean distance between two input points in a numerical space. Xu et al.'s work on "test augmentation" [XR09; Xu+10] refers to targeted test generation for code elements that have just been changed. They show that test case amplification is statistically significant.

In [PRW13], Pezze et al. "generate integration test cases that leverages existing unit test cases". They use the information provided in unit test cases about object creation and initialization to build composite test cases that generate unexpected exceptions when testing the interactions between objects. The idea of finding exceptions has also been explored by Fraser and Arcuri [FA15]. In both cases, they do not use domain-specific oracles of the form of assertions, hence they only find very generic faults. Zhang and Elbaum [ZE12] identify environmental resources that can trigger exceptions, then, they mock the calls to these resources in order to control whether they throw an exception or not. The authors can generate environments that trigger more or less exceptions, to stress the exception handling code. Joshi et al. [JSS07] use concolic execution to predict violations of generic assertions such as buffer overflows. The key idea is to look for executions that are "nearby" the original ones of existing tests, hence being realistic: this is what they consider as amplification.

Milani et al. [MMM14] target testing of web applications that use rich Javascript client code. They perform two steps: extract knowledge from the human-written oracles; and reuse this oracle knowledge in a fuzz-testing loop in a client-side crawler. The evaluation results show that the fault detection rate and the coverage are improved with the amplified tests. Perfblower is a system for finding memory performance problems [FDX15]. The developer specifies the kind of problem she looks for with two primitives "amplify" and "deamplify", which simulate worst case scenarios. The amplification triggers the apparition of the memory problem under consideration.

In preliminary work of co-PIs, Baudry et al. [BFL06] have proposed a test case selection approach based on the novel concept of dynamic basic block, which abstracts over code based on the test case coverage. The selected tests allow for a better localization diagnosis. Santelices et al [San+08] is not a test amplification technique according to our definition, it is rather a test generation technique to create a test case that shows a difference in the output. The work by Staats et al. [SGH12] can be seen as a kind of oracle amplification. They propose a technique that allows for suggesting very strong assertions. This is a very important piece of work with respect to STAMP, which will indeed devise novel techniques for the automatic amplification and suggestion of new oracles.

**Progress beyond state of the art**

STAMP will advance the state-of-the-art of automatic generation of unit test cases, by focusing on a novel approach that directly exploits existing test cases. **We focus on three research challenges**: 1) the definition of **systematic criteria** to select test cases to be amplified 2) **managing the complexity of oracles** that can be amplified and 3) the **performance of test amplification**. First, STAMP will devise a set of algorithms to assess the information quantity of each test case and the expected value of amplifying it. Second, STAMP will consider complex oracles that go beyond primitive type values returned by getter methods, STAMP will amplify complex assertions esp. those dealing with spurious randomness due to concurrency, runtime environments and application non-determinism. Third, STAMP will improve the performance of amplification, because test amplification does require a large amount of resources. However, to remain valuable, it has to run in classical DevOps integration servers, within a timeframe a couple of hours (for instance overnight). STAMP will improve the performance of amplification by exploiting the fact that many amplification tasks can be parallelized and that some information learned from one amplification can be reused in a subsequent amplification task.

**Innovation in configuration testing amplification**

**State of the art**

Early approaches on the testing of component-based systems rely on a small number of fixed compositions of components (configurations). Rosenblum [Ros97] uses UML component diagram and the sequence diagram to analyze the coverage of test cases in terms of the components in a particular composition. Gosh et al. [GM99] propose an interface and exception coverage-based approach to design the test cases for distributed component-based systems. Briand et al. [BLH08] apply similar coverage analysis into regression testing of component-based systems, in order to select the test cases and compositions that have maximal effects on the recent changes. All these approaches require additional specification besides the actual configuration, usually the interaction of components. Some software architecture-based testing approaches utilizes the difference between configurations for regression testing. Muccini et al. [MR05] uses software architecture as an oracle to run test cases. When the changes in some components may have global impact, the approach require testers or developers to modify the software architecture in order to increase the possibility to expose bugs related to the changes. Wu et al. [WC00] requires a Component Interaction Graph (CIG) to select potential configurations of components which are relevant to the changes. The approaches revealed the significance of configurations as an independent input for testing, however, the reliance on testers to provide configurations still limit the coverage of potential configuration space.

For performance testing on service-oriented systems, Tsai et al.'s approach [THS11] performs testing on a set of different configurations, each with changes only on a particular feature, such as CPU, memory, etc., in order to isolate their impact on scalability. Similar to architecture-based testing, the different configurations are also defined manually by developers. Bai et al. [BLC+11] listed a number of testing approaches for cloud-based systems, and some approaches, including LISA [ITKO], Cloud Testing [CT], use a set of predefined configurations to automatically test the performance of cloud applications. However, the focus is more on the variety of configurations that are common to different systems, such as the browser set up, the computation resource..

In the hardware discipline, the automatic generation of test configurations is well-researched for the testing of Field Programmable Gate Arrays (FPGA). As the core technique of their application-independent testing approach for FPGA, Tahoori et al. [TM03, Ta06] propose an approach to automatically generating a set of different configurations with different connections between FPGA cells, based on the enumeration on a switch matrix graph built on the cells. Renovell and Zorian [RZ00] experimented a number of other generation algorithms. An FPGA cell has a much smaller state space comparing to software components, and therefore even though the algorithms are inspiring to the generation of software testing configurations, they cannot be used directly.

In the practice of software engineering, some development environments support automatic configuration testing through executable specifications of multiple configurations. An example is the configuration testing support of Visual Studio 2015 [VS15]. Similar effect can be achieved with automatic build and development tools, such as Docker [Fin15]. However, by using these tools, developers still need to define candidate configurations manually.

Outside the testing scope, some tools are becoming popular for automatic deployment, such as Chef (chef.io), Puppet (puppetlabs.com), as well as Docker-compose (docker.com), all of which provide scripts that can be deployed automatically. As for automatic configuration, the research approaches are mainly around software product line (SPL) and feature models. For example, Batory [Bat05] and Mannion

[Man02], among others, propose one-step automatic configurations. White et al. [WGS+14] and Xiong et al. [XHS+12] talked about the automatic evolution of feature models interactively in multiple steps. All these approaches involves the application of formal constraint solving. The main problem so far is that the automatic deployment of feature model to running products is still ad hoc.

**Progress beyond the state of the art**

STAMP will advance the state of the art of system testing through the **systematic transformation of existing test configurations** in order to generate variants that stress the scalability of the system under test. The research will be based on the existing achievements on how to make effective multiple configurations, and how to record and automatically deploy these configurations. In the same time, it will go beyond the state of the art by automatically generating such configurations for testing. As part of the effort towards automatic configuration generation, it will also come up with **novel ways of analyzing and selecting a large number of configurations**, as well as novel ways to execute test cases on these configurations. From a more general point of view, the outcome of STAMP will be a significant step forward towards automated software engineering, with fully automatic approach to transform software from source code to multiple forms of running applications.

**Innovation in online testing amplification**

**State of the art**

Traditional testing is usually performed by manually writing test cases before software is released to verify whether it behaves as intended. Even if tests do not fail, running software of the field can lead to unexpected behaviors, malfunctions or also performance problems. Therefore, monitoring a system's behavior in real life operations can overcome the limits of traditional testing [BER07]. Previous work on online testing fall into two main categories, namely *passive* or *active*, depending on whether they simply observe software behaviors (passive) or interact with the system stimulating specific behaviors (active). For example, Bayes et al. [BAY05] developed a tool to support passive testing that compares the execution trace of the implementation with the specification provided by software designers in the form of Finite State Machines (FSMs). Transitions on these FSMs represents software invariants that can be executed in a prefixed order (obligation) or not (simple). Ernst et al. [ERN01] proposed a three-step technique to dynamically discover invariants: (i) instrumenting the source code to trace the variables of interest, (ii) running the instrumented program over a set of test cases, and (iii) inferring invariants over both the instrumented variables and over derived variables that are not manifest in the original program. Online testing can also be applied to web applications as reported by Mesbah et al. [MES011]. They have proposed CRAWLJAX, a tool aimed at automatically deriving a model of the user interface (UI) states of an AJAX application. The model is built by "crawling" an AJAX application exercising the client-side UI functionality, i.e., automatically clicking buttons and other UI-elements. They use invariants to identify failures in these executions, where invariants are properties of either the client-side DOM-tree or the derived state machine that should hold for any execution. Aart et al. [AAR14] used active learning to discover the logical structure underlying sequences of events (e.g., function calls) in execution traces as state machine model. Intuitively, their techniques can be seen as a grammatical inference problem in which the events are modeled as the symbols of a language, and the goal is to find a model for this language.

Other approaches related to online testing try stimulating the application after deployment when some events happen, for instance software crashes. To this aim, several automated techniques have been proposed for replicating crashes, including the use of core dumps to generate crash reproducible test cases [LEI09, ROS13] record-replay approaches [ART08], post-failure approaches [JIN12], and approaches based on crash stack traces [CHE15, XUA15]. However, the techniques mentioned above present some limitations which may adversely impact their capabilities in generating crash reproducible test cases. For example, core dumps are not always generated by software applications at the crash time, which may reduce the applicability of approaches which are merely based on using core dumps [LEI09, ROS13]. Record-replay approaches apply dynamic mechanisms to monitor software executions, thus, leading to higher performance overhead [ART08]. To overcome these limitations, Chen and Kim [CHE15] proposed STAR, an approach to produce test cases that can crash at the same position and can generate stack traces as similar to target stack traces as possible. STAR combines backward symbolic execution with a novel method sequence technique to create test cases that can produce test inputs to satisfy the identified crash triggering preconditions. The results of their empirical study involving real crashes from open source projects revealed that STAR can successfully replicate 42% of crashes due to real bugs [CHE15]. Xuan et al. [XUA15] proposed an alternative technique, namely MuCrash, that mutates existing test cases that can reproduce crashes, rather than generating new test cases which is the general strategy used in STAR [CHE15]. Each selected test case produces a set of test case mutants, which are executed on the program under test. Tests reproducing crashes are delivered to developers for debugging. The

results of an empirical evaluation based on open source projects demonstrate that MuCrash can replicate some crashes not replicable with symbolic execution (STAR).

The main limitations of existing approaches in online testing is that they need already defined FSMs [BAY05] or to derive such model upon execution of existing test cases [ERN01] limiting the observation for expected behaviors only. Moreover, existing works on crash reproduction uses single isolated stack traces collected only at the time of the crash failure and do not capture execution history information which is frequently critical for diagnosis. In addition, multiple crashes can be caused by the same root cause, thus, focusing on single (perhaps duplicated) crash stack traces is not particularly efficient.

**Progress beyond state of the art**

STAMP aims at extending existing online testing techniques leveraging on log files that are commonly used in both commercial or open source projects to log important events such as error or warning messages, as well as some *historic* information generated during normal execution. First, **log data will be used for deriving common patterns** in log and automatically learning FSM mirror invariants and anomalies (e.g., crashes). Second, online test amplification will be applied by generating test cases to cover transitions in the derived FSM as well as to **replicated anomalies** and software crashes reported in log data (e.g., using crash stack traces). Finally, the quality of log data strongly impacts online testing effectiveness: too detailed log messages could degrade system performance while too general log data may prevent event replication (such as crash failure). Therefore, STAMP will go beyond traditional online testing techniques by dynamically add/remove/change probes and assertions into the production code to improve its testability by deciding which are the good places and the right timing for probing the system.

### *(b) Innovation potential*

**STAMP's novel contribution to automatic software testing will increase trust in continuous delivery processes and have the potential to increase DevOps adoption in European software companies**. The current state of practice for testing in DevOps relies in extensive manual effort to produce test cases that hardly cover all the code. STAMP's automatic amplification solutions will increase code coverage and the diversity of tested behavior by 40%. This will reduce the number of regression bugs in production, the cost of updates and enhance trust continuous delivery. We believe these are key ingredient to trigger a break through of DevOps on the European software industry.

This potential for radical innovations in DevOps relies on one key concept: **deliver test amplification software services, which can increase test automation at multiple development steps that span from early development to operations in production and which can be integrated in various DevOps toolchains**. STAMP addresses test automation at unit level, configuration level and production stage, leveraging the human knowledge and the manual effort invested in the production of test assets (unit tests, APIs, manually defined test configurations, etc.) to increase their value through automatic amplification. The STAMP amplification services are validated on use cases that span a wide variety of application domains (e-Health, smart cities, information management, cloud computing and software production) and that exploit different, representative DevOps toolchains (with Maven, Jenkins, Docker, etc.).

The innovation potential of STAMP techniques also relies on strategic choices for the development and distribution of the test amplification services:

- The tools developed within STAMP **build upon the most popular technologies** for software development and testing in a Devops context: JUnit, log4j, Selenium for testing and logging, gradle and maven for build automation, openapi and swagger for the description of REST APIs, Nomad and Docker for the description of service assemblies and automatic deployment.
- The **tools are developed as open source services**. All technical solutions cited above are massively used in software companies and are all open source. The development of STAMP techniques in open source is hence essential to increase the potential adoption of our solutions. The involvement of OW2 as a core partner of the consortium ensures a constant feedback from a large open source community.

We target **TRL 6 for the maturity of the test amplification services at the end of STAMP**. We expect that each of the three test amplification services developed in the methodological pillar 1 will be developed as TRL 2-3 prototypes. The STAMP project will provide the framework for partners from academia and industry to transform these prototypes into industry-strength component through collaborative industry-near research and development efforts.

In order to maximise the innovation potential, the consortium will implement the following activities: the delivery of three test amplification technologies, as open source services; the demonstration of test amplification impact in 5 different sectors; bring the key enabling technologies from TRL 3 to TRL 6 in the course of the project.

# 2. IMPACT

## 2.1 Expected impacts

**Contribution to impacts set out in the work program**

| Call text | How STAMP addresses it | Relation to KPIs |
|---|---|---|
| Reduction of the time to market of the new generations of software enabled products and services; | According to a survey by Cambridge University Judge Business School, it was estimated that 49.9% of all time spent developing software is spent finding and fixing bugs. Increased test automation through STAMP's amplification techniques will reduce the time to detect regression bugs and thus increase developer productivity, leading to windfalls in time-to-market and quality.<br>STAMP will improve the targeting of tests toward bug-prone units of code. This will reduce the time invested in development of automated tests while maintaining or improving the level of assurance provided by those tests.<br>Automatic test amplification is expected to increase the adoption of DevOps, decreasing time-to-market and improving software development productivity. | KPI2, KPI3, KPI6: decreasing the number of undederministic test cases and configuration effort, while increasing the test per second rate saves testing time and reduces time to market |
| A significant and substantiated productivity increase in all aspects of software life-cycle especially for distributed systems; | The automatic test amplification will reduce the time invested in development of tests while maintaining or improving the level of assurance provided by those tests. Improved targeting of tests toward bug-prone units of code and reduction of debugging time will improve productivity. A reduction in the cost of dependency upgrade will reduce costs through increased code reuse and reduction of risk of software dependencies.<br>STAMP test amplification techniques aim to reduce the accumulation of technical debt due to prohibitive refactoring costs, by significantly lowering the risk of opportunistic refactoring. The impact will be a decrease in associated long term maintenance costs. | KPI1 KPÏ5, KPI9, KPI10: automatic code generation and test generation will increase the productivity of developers, letting them focus on business value, with automatic algorithms taking care of the repetitive and error-prone exploration of large data spaces |
| Ability to meet software quality levels required by a fast growing number of software-enabled products and services; | Reduction of software defects has, in addition to a simple increase in software quality, a significant impact of decreasing need for changes to code, interfaces and specifications.<br>STAMP test amplification at configuration level will improve the detection of software dependencies at upgrades. Reduction in the cost of dependency upgrade will have widespread impact on costs in the software development process; ranging from increased code reuse through reduction of risk of software dependencies leading to higher quality. | KPI1, KPI5, KPI9 all contribute to the automatic enhancement of test suites and their ability to detect bugs faster, ultimately increase code quality. |
| Increased reuse of code, design or functional requirements in the development of new software. | Reuse of testing artefacts (test cases, test configurations, log files) is at the core of the STAMP concept. The essential innovation of test amplification is to reuse existing assets in order to increase their value through systematic and automatic analyses and transformations. | KPI1, KPI4, KPI8 all leverage the reuse and exploitation of existing test assets (test cases, test configuration |

| | | |
|---|---|---|
| | Improved code quality and the improved test amplification tools at configuration and run time will encourage code reuse and reduce costs of upgrading dependencies of software products.<br>Improved quality through test amplification will contribute to stabilizing APIs and promoting code reuse and therefore to reduce business costs due to bugs that are not detected before being experienced in production. | descriptions and log traces). |

## Impact on the software industry

"Industrial value creation is progressively shifting upwards the technology stack since the effort invested in software development and engineering is continuously increasing. This leads to an increased need for efficient and effective software engineering methods, techniques and tools."[20]

The STAMP project focuses on software testing and increased automation of test generation in the context of DevOps. DevOps can be a key enabler to reduce time to market and increase innovations capacities. Yet, its adoption needs to be accompanied by high level of automation and sound techniques to ensure the quality of continuous deliveries. STAMP's advanced research and development of robust tools in the domain of software testing will increase trust in DevOps.

**On a short term, STAMP's results will increase the quality of products delivered by the use case providers** of the project. We foresee a 40% increase in the diversity of behaviors covered by amplified test suites and 30% in the number of valid bugs detected during testing, which reduces the risks of letting regression bugs leak in production code and hence increases trust in the delivered service.

**On the longer term, the technologies of STAMP will support a safe transition towards software-driven industry**. A 2015 Oxford Economics' study shows that 80% of senior business and technology executives, coming from a wide variety of economic sectors, consider « the shift to a software-driven enterprise is a critical driver of competitive advantage ». This movement has a considerable impact on companies in all sectors, and 50% of the respondents are bringing more software development back in-house. In this context, there is a critical need for an adaptation to the « application economy at a rapid and accelerating pace». This study concludes that, among the 5 key steps to keep "a software-driven enterprise moving in the right direction", development and operations staffs must embrace DevOps[21]. The open source strategy and the microservice architecture of test amplification technologies will foster the integration of STAMP's results in various toolchains that will be implemented in different sectors.

## Impact on science and education

STAMP will have an impact on the science of software. Until now, most approaches for the construction and verification of software establish a clear dichotomy between the parts of a software product that result from intensive manual labor (e.g., the functional code) and the parts that are automated (e.g., the deployment of the code on specific hardware). STAMP aims at reconciling these two fundamental facets of software engineering: amplify the value of assets produced by humans through systematic transformation and analyses. Following this path, STAMP will deepen the scientific community's understanding of the key features of test cases that are essential to detect bugs. We will also contribute to the body of knowledge and tools around test oracles, which is still very limited.

The results of STAMP will have an immediate impact on education. The extensive knowledge that the consortium will further acquire and produce about the engineering of robust, large open source industrial products, and about test automation will serve as extremely valuable input for the preparation of educational material with illustrations of real challenges and solutions. The development of new tools and associated courseware will also be integrated by INRIA and TUD who are involved in teaching advanced classes in software engineering.

The novel algorithms and results of STAMP will be directly transferred into our classes. The educational impact of STAMP will be pushed further through the participation of TUD in the SENECA ITN, which started in 2015. This European network will be an excellent forum to disseminate the latest STAMP results in doctoral-level training

## Impact on society

The adoption of tools for enhancing quality of software by public and private organizations will lead to immediate benefits for the society as a whole. Considering the fact that software is everywhere, simplify software development processes will have relevant impacts on many (probably all) complex value chains required to support human life and development. For example, high quality software and the adoption of cloud computing solutions will cause a drastic decrease of the time to market for many products (e.g.

[20] NESSI white paper: http://www.nessi-europe.eu/Files/Private/NESSI_SE_WhitePaper-FINAL.pdf

[21] *« The battle for competitive advantage in the app economy », Oxford Economics, June 5, 2015*

lifesaving drugs). Many economists (e.g. Federico Etro[22]) have demonstrated that the reduction of ICT fixed costs will reduce the cost for creating new jobs. The key economical ingredients here is that the software cost reduction move capital expenditure into operative costs (jobs). In other words, as the costs of computing and telecom infrastructure required to build and run a business are reduced, the costs of creating new jobs are also reduced.

Gartner predicted that Citizen developed applications would be 25% of new applications developed by 2014. The percentage today is lower than predicted, but the reasons for expecting a growth of citizen application in the next future are still there[23]. Among that reasons it is for sure the difficulties in producing working and maintainable software. Citizen developed applications must be enabled by new technologies (like the one that STAMP will introduce) and deployed on SaaS or PaaS platforms. That is why STAMP will cover an important role in the near future: software quality assurance is a key activity to ensure that software will not lead to unwanted side-effects or exhibit dangerous bugs. In particular in the case of citizen software, quality assurance needs to be performed seamlessly, trying to avoid to interfere or putting barrier to the user's creativity. Current quality assurance techniques are though and designed for software engineers and require explicit knowledge of them. STAMP represents an advance in this direction: online testing provides novel opportunities for automating the quality assurance process, thus making it transparent to the software developers.

**Barriers/obstacles and activities required to achieve the expected impacts**

As emphasized by Dries Buytaert[24], founder and lead developer of the Drupal CMS, and others, the process at hand in today's open-source software adoption is darwinian[25]. Only the fittest methodologies and tools manage to get a community large enough to have an impact and to keep their innovation pace fast enough to survive until it becomes, ideally, a de-facto industry standard.

The industrial impact of STAMP will depend on its capacity to overcome the following hindrances successfully:

- The complexity obstacle at the architecture and at the engineering levels, in relation to the scientific challenges at hand and to the significantly high number of stakeholders.
- The difficulty to turn innovative methods early enough into easy-to-install software distributed together with the appropriate courseware material and technical documentation for easy appropriation by technical managers and by developers.
- The difficulty to grow a community of adopters while progressing on an innovative hence uncertain path, and to update the software continuously by taking into account community feedback so as to enter a virtuous cycle.

The consortium intends to overcome these obstacles by leveraging the following assets and strategy:

- Usage of a best of breed collaborative infrastructure for knowledge sharing and software engineering as a catalyst for collective innovation.
- Adoption of a technical strategy based on micro-services for enabling decoupled innovation on several fronts.
- Implementation of short iteration cycles and continuous quality assessment of the engineering process by using state-of the art agile methods.
- An emphasis on the integration and delivery activities through a dedicated work package, drawing lessons from previous projects.
- A "eat your own dog food" approach by applying STAMP on STAMP.
- A focus brought to the use cases requirements and to the evaluation provided by the use case partners.
- The set up of a core group of STAMP tech within the consortium who will reach out to developer communities.

## *2.2 Measures to maximise impact*

The driving force behind our dissemination and exploitation activities is that we will position STAMP more like a product than like a research project. Therefore the "plan for the dissemination and exploitation

[22] "The Economic Consequences of the Diffusion of Cloud Computing," 2010 World Economic Forum, The Global Information Technology Report 2009–2010.

[23] http://blogs.starcio.com/2015/06/4-reasons-why-citizen-developers-next-appdev.html#sthash.vyJF27qi.dpuf

[24] https://en.wikipedia.org/wiki/Dries_Buytaert

[25] http://buytaert.net/the-business-behind-open-source

of the project's results" is a plan that will converge towards the launch of STAMP like a product at a main industry event.

While being in the full interest of both academic and industrial partners, launching STAMP like a product is also an efficient way to maximize the market impact of the project. The structure of the dissemination and exploitation plan will reflect this approach. We will aim at developing all the components of a product launch: an already evangelized group of early adopters, executable code that can be downloaded and installed, source code that can be forked, partners that endorse the platform, and marketing collateral like a start-up.

### *(a) Dissemination and exploitation of results*

**Joint Communication and Dissemination Plan**

We set-up an efficient communication and collaboration infrastructure, we identify and approach stakeholders, we build a community around the open source assets and we unfold a launch plan supported by industry-class marketing collaterals.

In order to facilitate early access to STAMP, and hence its early dissemination, we will implement the best practices of leading open source projects such as Ubuntu and OpenStack. This includes organizing open workshops, a release plan with short iterations, and state of the art documentation (special attention will be paid to documentation and it will be made available at each release, not at the end of the project).

For maximum impact we will concentrate the STAMP message on the delivery of a beta version of the platform. Moreover the dissemination and exploitation plan will be tailored accordingly to maximize the attractiveness of the project: open roadmap, carefully drafted documentation, early and frequent releases, tutorials, access to the team, etc.

STAMP's communication and dissemination will be carried out through the following activities:

**1. Communication material and resources**. Design and on-going update of the communication material required to support the dissemination of STAMP. This includes designing the project's visual identity and developing the content and graphic design of communication collateral ranging from logos and factsheet to brochure, posters, video (project presentation, interviews and testimonials, online demonstrations and screencasts), goodies, etc. It also includes setting up and curating the online communication resources: Website design, Website and social network curation on LinkedIn, Twitter, SlideShare and Youtube.

**2. Industry communication initiatives.** We will ensure STAMP's visibility in specialized industry media including social media and press writing and circulating press releases. We will arrange STAMP's visibility through booth, presentations and/or dedicated sessions at relevant IT industry events on software engineering, testing and cloud computing such as Cloud Expo Europe, Cloud Computing World Expo, OpenStack Summit, DockerCon, etc.

**3. Scientific dissemination.** Efforts will be carried out to raise awareness for STAMP within the scientific community and standardization bodies by submitting presentations and papers at relevant scientific and academic events, conferences and scientific journals. On the standard side, this also includes identifying and approaching relevant working group on software testing. Additionally, we will organize an international scientific workshop in the last year of the project, in conjunction with a major academic event in the area of software testing (e.g. ISSTA or ICST).

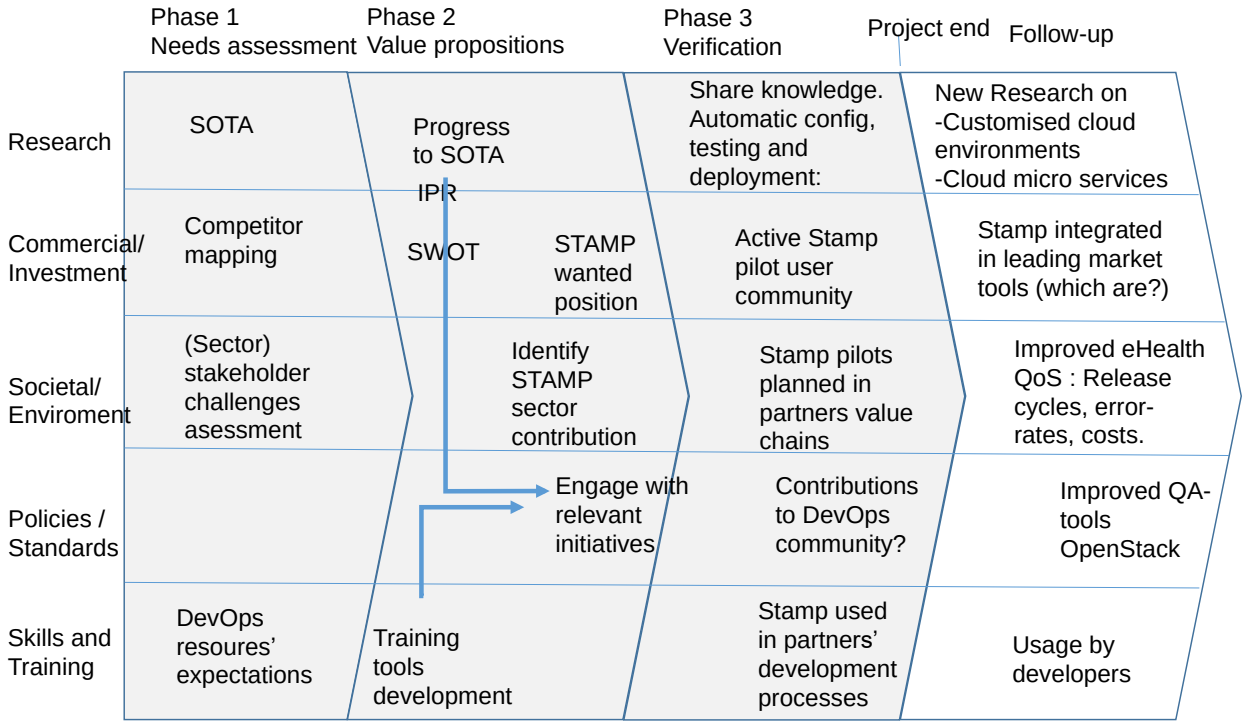
STAMP dissemination and exploitation plan will be narrowly targeted at specific market category called the innovators and early adopters, i.e. those that can take immediate advantage of the platform in the state it is delivered. They include different audiences such as the Commercial users, the Academic and Research communities,, the other EU-funded projects, and the professional developers, including the open source communities The table below details what are the different audiences, what are the issues for each audience, what is STAMP value for each audience and how do we reach each audience.

| Audience | Needs and issues addressed by STAMP | STAMP value | How we reach them |
|---|---|---|---|
| **Commercial Users (Software Industry)** | | | Participation in industry-oriented and cloud-oriented events such as Cloud Expo Europe, Cloud Computing World Expo, OpenStack Summit, DockerCon.<br><br>Press releases and interviews to leading industry magazines such as: The Server Side, InfoQ, Cloud Pro, Business Cloud News, GigaOM, Computerworld, TechTarget, ZDNet, Information Week, Linuxmag, Innovation Review |
| Software vendors | They need to reduce time to market of quality products | STAMP helps accelerate production of new release. | |
| SaaS vendors and Cloud Service Providers | | STAMP helps enhance their value proposal by assessing the quality of the services | |
| Cloud Service Providers | They want to maximise revenue from services offered to customers | STAMP helps demonstrate service quality and implement yield management strategies. | |
| Solution integrators | They need to assess the integration of different technologies into a unique solution for a specific usage | STAMP helps accelerate and automate the integration of different technologies in business specific solutions | |
| **Research Communities** | The scientific state of the art for automatic test generation is very much focused on two main trends: generate from abstract models or generate from source code without considering the existence of test assets produced by the developers. | STAMP will support the development of novel scientific contributions, which consider The scientific | Publications in international journals (TSE, TOSEM, EMSE, IST, JSS, STVR) and participation in software engineering academic conferences (ICSE, ASE, FSE, ISSTA, ICST, ICSME, SCAM).<br>conference).<br>Presentation of the STAMP project and outcomes in the context of the SENECA ITN in order to target Early Stage Researcher |
| **Other EU-Funded projects** | Create synergies between EU-funded projects | STAMP supports innovation by assessing and demonstrating the quality of EU-funded projects software outcome. | EU-driven events such as Net-Futures, CloudScape, etc.<br>CSAs such as AppHub<br>Hands-on sessions. |
| **Open Source communities** | They need to build trust with mainstream users by demonstrating the quality of the software. | STAMP is an open source project freely available to help demonstrate quality of other open source projects. | Open source-oriented events such as OSCON, OpenStack Summit, Paris Open Source Summit, EclipseCon, OW2con, FOSDEM. |

## Joint Exploitation Plan

The exploitation of the STAMP results will follow a specific methodology developed by the STAMP partners. The first step is to define an Exploitation Manager of STAMP (AEon) to coordinate all the exploitation efforts in order to establish a solid basis for the development and use of the project results at the end of the project. For the preparation of the project activities targeted to commercial exploitation, we provide a preliminary business plan taking into account the market of the Test Management Tools. This business plan is an insight about what can be the overall business plan during the project life. This will enable us to have a software product vision from the beginning of the project which is based on the preliminary value proposition derived from the use case partners. The product definition and the value propositions will be developed, strengthened and verified during the project lifetime, providing a sound basis for developing a (product) business strategy.

The joint exploitation plan coordinates the exploitation and dissemination activities. The objective is to maximise the effect of the exploitation activities during project lifetime, and to prepare a set of follow-up activities which will enable the partners to deliver the identified project values to the targeted users after project end. The plan is organised along two dimensions. The first dimension is the targeted users and uses of the project results. The targeted users and uses are defined in the joint dissemination plan. The plan identifies follow-up measures which will help the project partners to prepare to maximize the impact of the project after project end. The second dimension is the elaboration of a process based on 3 phases: Needs Assessment, Value Propositions and Verification and Business Plan.



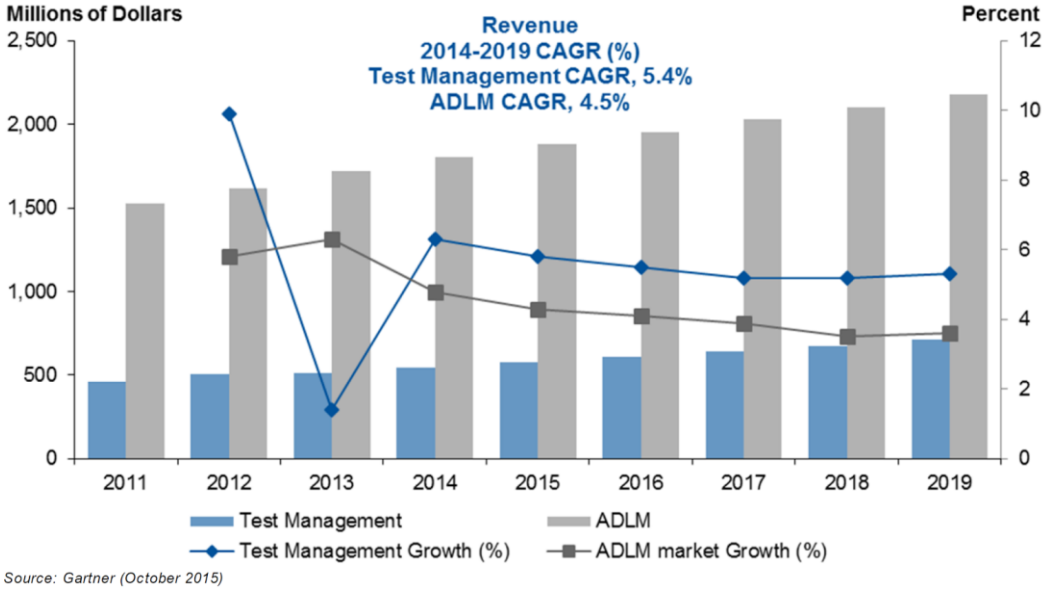

The exploitation plan phases are:

- Needs assessment: This phase starts with a market analysis that identifies the key enabling technologies described in the proposal, and extends it with in-depth technology evaluations including alternative technologies, future markets, competitors, IPRs and related information. The academic component of the consortium will be the main contributor.
- Value propositions: This phase defines the market segments targeted by the technologies listed at the previous stage. Therefore, it must explore the applications and potential uses, meeting the needs of a particular customer segment. This approach requires structured seminars/workshops where cross-domain expertise is required. It also includes interactions (focus groups, one-to-one meetings, tradeshows, etc.) with target customers and industry experts. The research component of the consortium and OW2 will be the main contributors.
- Verification and Business Plan: This phase start with generating a business model draft, a visual chart with elements describing the value proposition, infrastructure, customers and financial elements of each value prospection identified at the previous stage. The phase also identifies the best exploitation form based on the nature of the results and its ownership structure (creation of

spin-offs, products producing and selling, licensing of products/services, patenting, etc.). Once the best business model draft has been selected, a Preliminary Business Plan is developed, with the industry component of the consortium as the main contributor.

**Preliminary Business Plan and market orientation**

The preliminary business plan has been established based on the current understanding of the market and the industrial partners in the project. The results of the project can be categorized as a new sub-market of the test management tools market. According to an analysis done by Gartner the growth of the test management tool market is expected to be steady (forecast CAGR of 5.4% by 2019 and the forecast for Application Development Lifecycle Management (ADLM) CAGR will be around 4.5%) as more players enter the market and established vendors expand their portfolio. This study recommends that before implementing a new tool, it is better to ensure well managed testing process is in place. The tool developed by the STAMP project is coping with this recommendation in the sense that it will be based on existing solutions and to enhance their capability to amplify tests. Another recommendation in the study is the recognition that not all projects have the same needs of testing. This later is one of the STAMP objectives in developing a tools based on microservice architecture to better separate test services according to the domain and the use case.




*Source: Gartner (October 2015)*

A first-cut value proposition is defined, based on the expectations of users among project partners:

| | |
|---|---|
| **For** (target customer)<br>**who** (statement of the need or opportunity)<br>**the** (product/service name)<br>**is a** (product/service category)<br>**that** (statement of benefit) | For TellU, who develops and operates a 24/7 cloud IoT-platform for eHealth services the STAMP test amplification suite is a test tool that<br>-quickly and accurately<br>Identifies bugs and inconsistencies at unit test stage so that the quality and reliability of the code is greatly improved.<br>-at configuration and release upgrade verifies that the new release maintains the consistencies and service level with interconnected systems, that all dependencies are correctly maintained, that all functional upgrades are verified to not introduce new errors.<br>- At run time monitors continuously to identify any abnormal behaviour or change of states with or system and our system's interconnection with other systems, devices and sensors. |
| **Unlike** (primary competitive alternative),<br>**our product** (statement of primary differentiation). | Unlike (existing test products used) STAMP<br>Provides a far finer grained and targeted test cases that are relevant for our solutions and extends our manual inputs. A test tools that amplifies our expertise, is easy to set up and provides an intuitive reporting tool that quickly guides us to identify and prioritise the most relevant errors and bugs. |

The preliminary business plan involves the following tasks:

- **Product differentiation** : the project will create a new category of test tool and thus a new market taking into account enhance existing testing tools rather than developing new one. Then the test

amplification as new service combined with test tools will have a new impact on the test management tools.

- **Market perception**: The STAMP product will define its market among the test management tools market. This market consists of independent vendors, as well as traditional quality or application development life cycle management tools. In reexamining all testing activities, Gartner has found that the manual testing process is still the largest portion of time spent on a typical project. We continue to see organizations using traditional word processors and spreadsheets to manage their testing efforts, large or small. Organizations are struggling to keep up with the rapid changes, varying complexity, and diversification of business and technology. Driven by demands to improve productivity, users who rely on traditional tools, need an improved function to manage such complexities in testing. Users also recognize the benefit from tools that work together, as well as from integrated solutions that bridge the silos with workflows and reporting. Therefore, STAMP as one of the test management vendors will add more capabilities and specific integration options to supplement fundamental test management elements.
- **Product positioning**: The STAMP product will be provided as on-premise or as a service in the Cloud. According to Gartner, the test management tools via SaaS models have quickly become an attractive alternative to on premises solutions that require dedicated hardware and higher licensing costs. The SaaS model, in general, is expected to grow strongly in application development. This will alter test management tools to manage not just the tests, but also the environment and data. This direction will create new entrants to the market, as well as merger and acquisition activity to move from point solutions to whole product solutions. The product will be follow the open source business model to create value and can
    - Enterprise license version with specific support license
    - Community license version based on the community of users (FREE)
    - Consultancy and support
    - Training service
- **Market segmentation**: the segmentation of the market will be depending on the users of STAMP. In the test tool management tools market we can have big software providers in addition to SME software editors. More specifically software editors and integrators are the main market segment for STAMP. The test management solution market is segmented into the following three categories:
    - Full-suite vendors
    - Independent pure-play vendors
    - Open-source tools
- **Distribution channel**: The OW2 partner in his role as an open source consortium, has identified a distribution channel and a supply chain network based on the knowledge of the sales of the open source projects. Different software modules can be independently commercialized in order to offer the possibility of combining only the modules of interest for a specific end-user.
- **Cost**: the implementation of the STAMP software will bring new costs. However the specified architecture based on microservices will guarantee that software teams that use STAMP for test amplification will be able to exploit the techniques to reduce costs due to regressions.
- **Pricing**: The target price of the complete enterprise license version will be 40,000 Euros, this will include development of specific features, installation deployment and full lifetime support. A table of prices will be established according to the service given. Support service can be sold as tokens on different levels silver, gold, platinum. A token is managed by time of intervention for the support. For example a silver support token for one hour is about 200€.
- **Promotion**: STAMP will communicate with customers to foster product awareness and likelihood of purchasing both complete enterprise license, support and training services. This will be done in the different dissemination activities according to the dissemination plans presented in this proposal.

**Knowledge Management and IPR**

Dissemination and use of knowledge generated in the project is governed by the terms of the Grant Agreement (GA) and the terms of the Consortium Agreement (CA).

Knowledge and IP rules are described in section 3.2.1 (“Project organization”, sub-section “Consortium Agreement”) and can be summarized in:

- Ownership: the owning partners of a result or knowledge will provide adequate and effective protection of the result or knowledge before its dissemination, publication and exploitation.

- Access rights to background and results: the CA will address provisions concerning the Access Rights to Background and results both for a good the execution of the project by the partners and in order to ensure a wide exploitation of the results.
- Publication and communication: partners will be allowed to publish information on knowledge arising from the project according to the provisions of the GA, and provided this does not affect the protection of that knowledge. In that respect before any knowledge dissemination, publication or communication takes place, the matter must be agreed with the Executive Committee.
- Open Source software: as the main objective of the STAMP project is to provide test amplification tools as open source services, the consortium agreement will include « Specific Software Provisions », particularly concerning Open Source licenses of the background and of the results. It will strongly recommend the use of open source licenses which are already widely used by the software engineering industry companies, such as Eclipse, Apache, LGPL or, in some particular cases, BSD or MIT. This will ensure a licensing policy of the background and results of the STAMP project consistent with its dissemination strategy

In order to make sure that these terms are followed, to avoid disputes and to facilitate business planning, the project manager will maintain an IPR Directory throughout the lifetime of the project. This document will list all items of knowledge relating to the work of the project (both background know-how and results developed in the project), and make explicit for each item its owner, nature, status and dissemination and protection measures. The directory will be regularly updated and distributed to all partners. It will form a key tool to enable knowledge management.

An initial version of the IPR directory will be created at the start of the project. However, at the stage of producing the proposal, the consortium has already considered what kind of strategy should be followed concerning IPR issues for the main results of the project, and reached preliminary agreement on this. The basic principle on which we agree is that research and development results must be available to a large audience to facilitate wide adoption of project results, while in the meantime having options in place for rewarding those that invested.

The consortium is committed to the innovation model and to the business models allowed by open-source software licenses and by open access to scientific work. The table below summarizes the principles that all the partners commit to and that will be at the core of the consortium's agreement.

| | |
|---|---|
| Methods and Models | Open Access |
| Algorithms | Open Access |
| Software | Eclipse, Apache, LGPL or, in some particular cases, BSD or MIT licences |
| APIs | Open Access to documentation |

**Open Access Strategy:**

STAMP will fully embrace the open access policy of Horizon 2020 by providing online access to scientific information that is free of charge to end-users and that is re-usable. In the context of this project, scientific information refers to peer-reviewed scientific research articles (published in journals) and metrics to quantify the impact of test amplification on regression bugs and the cost of enhanced quality. STAMP does not generate data and hence STAMP will not be part of the Pilot on Open Research Data. Yet, as described in the previous items of this section (specifically « Joint Dissemination Plan » and « Knowledge Management and IPR »), the IPR open source and dissemination strategies have been chosen to optimize a large use of the results of the STAMP projects in all the addressed communities (software industry, research, other EU projects, open source communities).

Concerning publications, we choose self-archiving ‘green’ open access for all the STAMP partners. INRIA already routinely uses it via the HAL repository (https://hal.archives-ouvertes.fr/). It is free and allows us to publish STAMP work simultaneously in the best conferences and journals. TU Delft regulations require all publications to be (green) open access and has repository.tudelft.nl.

**Individual Dissemination and exploitation activities**

**Academic partners**

*Dissemination during the Project*

INRIA, SINTEF and TU Delft will use academic publication as the essential vector for the dissemination of the project's result. We will target general software engineering conferences (ICSE, ASE) and journals (TSE, TOSEM, IST, JSS), as well as venues specifically dedicated to software testing (ISSTA, ICST, ICSME, STVR). Researchers in software engineering and practitioners represent the typical audience for all journals and conferences listed above.

*Exploitation of the STAMP results*

Academic partners will exploit the STAMP results through several channels. They will initiate standardization activities to sustain the STAMP results in open source communities. They will exploit software tools developed within STAMP in other projects, in collaboration with other software companies. In particular, they will strengthen collaborations with their regular partners who deliver software through a DevOps approach (IBM, ING Banking, April Insurance).

**Industry partners**

*Dissemination during the Project*

ActiveEon, ATOS, Engineering and TellU will present STAMP and its advances as an integral part of a modern vision of the ICT industry. They will engage stakeholders through the participation in national and European market fairs. ATOS and Engineering, as core partners animating the FIWARE community, will actively promote the STAMP results in the FIWARE development processes. They will publish news and key findings in online social media channels and on international journals, trade bulletins and books. They will also disseminate in their internal communication channels (e.g., the Atos Ascentblog or ENGZine).

*Exploitation of the STAMP results*

All industry partners will exploit the STAMP results in their software production chains. Engineering will introduce test amplification in its software development factory. The project results are all exploitable by ATOS as testing activities will improve the software quality and result in a productivity increase in the entire software development cycle. ActiveEon will exploit the results in its own development process and to use test amplification in the ProActive software. TellU will incorporate the project results in integration projects with customers and partners, to share tools and knowledge with partners and customers technical teams. XWiki will integrate the STAMP assets to measure and report on the effectiveness of the automated testing and to improve XWiki's test suites through amplification.

**OW2**

*Dissemination during the Project*

As dissemination partner, OW2 will develop an on-going dissemination activity through the public website, social networks, industry events, EU-driven events and the press. OW2 will showcase STAMP at different global industry events such as OSCON, OpenStack Summit, Cloud Expo Europe, Cloud Computing World Expo, etc. and EU-driven events such as Net Futures. OW2 will promote the project to other EU R&D projects through hands-on sessions during EU events such as CloudScape and Net Futures. OW2 will disseminate STAMP and the enhancements it brings to the OW2 quality program in IT magazines such as The Server Side, InfoQ, Innovation Review, eWeek.

*Exploitation of the STAMP results*

OW2 intends to integrate STAMP as a standard service into the next-generation of its quality program. Quality is a strategic commitment of OW2 and the addition of STAMP will add value to the quality-checking support OW2 can offer to its 100 projects. OW2 will leverage STAMP to extend its quality program at two levels: (i) the testing section of the OW2 quality model will be refined and completed with new items covering testing amplification at development / runtime / configuration stages, (ii) the OW2 quality platform will integrate the STAMP components as new value-added services offered to the OW2 community of developers.

### *(b) Communication activities:*

A number of specific communication activities will be developed to implement the dissemination plan and to pave the way for future exploitation of the project outcome.

Communication activities will start at the onset of the project. They comprise a) setting up and administrating the technical infrastructure, b) creating appropriate communication material, c) engaging in outreach initiatives toward the industry, the scientific community and standards organizations, d) developing business plans, market research and market take-up material.

Website and Collaborative Infrastructure set-up and Administration

- Website design: the website will be the main information portal and the basis for communicating over social networks. Developed by OW2, the project's public website will run on an XWiki platform hosted and administered by OW2. As a complement to the website, we will create and run a LinkedIn Group and a Twitter account to be used by the project consortium's members;
- Project mailing lists: there will be lists to support the project's internal communications and public lists for outward communications. The mailing list platform will be made available as soon as the project is launched.
- Project wiki: a back-end collaborative environment for the partners, provided by OW2, the private wiki will be made available as soon as the project is launched, it will help manage deliverables, meeting minutes, reference documents, etc.
- Development tools: the OW2 technical infrastructure will be made accessible to the STAMP development team, this includes tools such as Gforge, SVN, Maven, Bamboo, Jira and the ow2stack cloud infrastructure for integration, cloud deployment testing and fine tuning by Engineering in WP4.

Market Outreach and Promotion

- Communication strategy: we will draft a communication plan including an event and announcement plan correlated with STAMP's releases and its main milestones;
- Industry events: STAMP will be represented through a booth and presentations in IT trade shows selected for their relevance with regard to software engineering, testing and cloud computing such as Cloud Expo Europe, Cloud Computing World Expo, OpenStack Summit, DockerCon, etc.
- Hands-on workshops: we will organize hands-on sessions providing demonstrations, training material and live testing of participants projects; among others we will leverage EU-supported events, projects and support actions such as Net Futures, Cloudscape and Cloudwatch to create opportunities for STAMP use by other H2020 projects.
- Press releases: we will write and distribute press releases to be issued by individual partners at each release and important news and achievement of STAMP.

Scientific dissemination and standardization

- Scientific communication: the research partners will have plenty of opportunities submission of STAMP results to leading academic conferences and scientific journals.
- Standardization working groups: we will identify relevant working group and arrange contribution to software quality standards and models.
- International scientific workshop: we will organize an international scientific workshop during the last year of STAMP in conjunction with a major academic event in the area of software engineering (e.g. ISSTA or ICST).

Industrialization, Exploitation and Market Take-up

- End-user advisory board: an advisory board comprising practitioners (i.e. non-academic members) will be set up in order to, in combination with partners' knowledge, desk research, and community feedback. help produce a market analysis, and identify business opportunities.
- Courseware: documentation and training material will be made available to facilitate the take up of STAMP's concepts, methodology and technology components. Educational materials and tutorial will be made available on the project website as open teaching material under a Creative Commons license.
- Market Readiness: beyond the communication collateral and initiatives, we will ensure STAMP follows best practices in open source project management including such basics as publicly available source code, documentation on how to build from source, tutorials, developers' mailing list and appropriate open source licensing.
- Exploitation plan: each industrial partner will devise an exploitation plan covering Technology assessment, Innovation opportunities and the Business Plan. Turning the main STAMP components into a commercial SaaS offering will be considered, for which a business plan will be drafted.

**Main dissemination and communication goals**

| Activity | Remark | Objectives | Relation to KPIs |
|---|---|---|---|
| Website | Set up at M1, maintained and curated throughout the project duration | Visits: 1000 (year 1), 2000 (year 2), 3000 (year 3). Total: 6000 | KPI15 |
| Collateral | Delivered at M4: factsheet, generic presentation, roll-up poster, screen cast, | Updated in year 2 or 3 | |
| Industry Events | | 3-4 events per year (e.g., CeBit, DockerCon, OpenStack conference) | KPI16 |
| Scientific Events | Including organizing an international scientific workshop | 3-4 events per year<br>One workshop toward end of project. | KPI17 |
| Project Workshop | Hands-on session at third-party events | One in year 2<br>Two in year 3 | KPI13 |
| Press releases | One press release at each major announcement. | 1-2 press releases per year | |

# 3. Implementation

## 3.1 Work plan — Work packages, deliverables

**Brief presentation of the overall structure of the work plan**

STAMP's workplan is organized around 7 workpackages, as described in the PERT chart below. Workpackages 1, 2 and 3 focus on research in the area of automated software test amplification. WP1 aims at amplifying existing unit test cases in order to reduce the cost of regression testing. This amplified test suite can be reused as input for techniques of WP2 and WP3, and the test cases retrieved from runtime logs in WP3 can be integrated here. WP2 aims at amplifying the test configurations provided by developers, in order to automate testing against configuration-related properties, such as performance and scalability. The test cases generated by WP1 and the runtime logs from WP3 will be inputs for WP2 on configuration amplification. WP3 aims at generating test cases that are representative of production conditions. These new test cases can be passed as input for further amplification in WP1.

Workpackages 4 and 5 focus on the development and the assessment of industry-ready software services. WP4 takes as input the software components provided by WP 1, 2 and 3 and strengthens their development through the definition of clearly defined and tested APIs, packaging in various technologies and updated documentation. STAMP project is driven by industrial needs. WP5 assesses that the project outcomes fulfill these industrial needs and fit for the purpose expressed by industrial stakeholders. The evaluation is conducted in a coordinated manner in the real life scenarios proposed within the different use cases. This workpackage delivers feedback and metrics that will be used to improve contributions of WP1, 2 and 3 in an iterative manner. This iterative process of research and development will be based on very frequent interactions between the use case providers and the research teams, and will be marked by three main deliveries at months 12, 20 and 34 (as illustrated on the Gantt chart).

Workpackage 6 gathers all tasks related to dissemination and exploitation. It will (i) grow a community of users and of developers around the project's concepts and tools, (ii) promote and disseminate STAMP in industrial and scientific communities, and (iii) support the business exploitation of STAMP results by each industrial partner, including via the potential launch of STAMP as a commercial SaaS offering.

The WP7, 'Consortium and project management' deals with the project coordination, as well as the contractual, financial and quality management

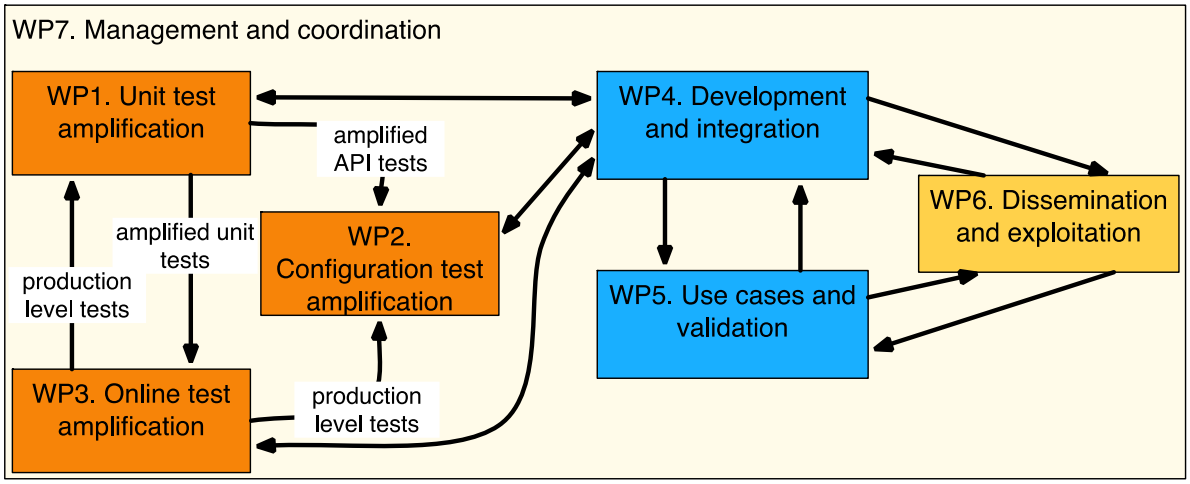
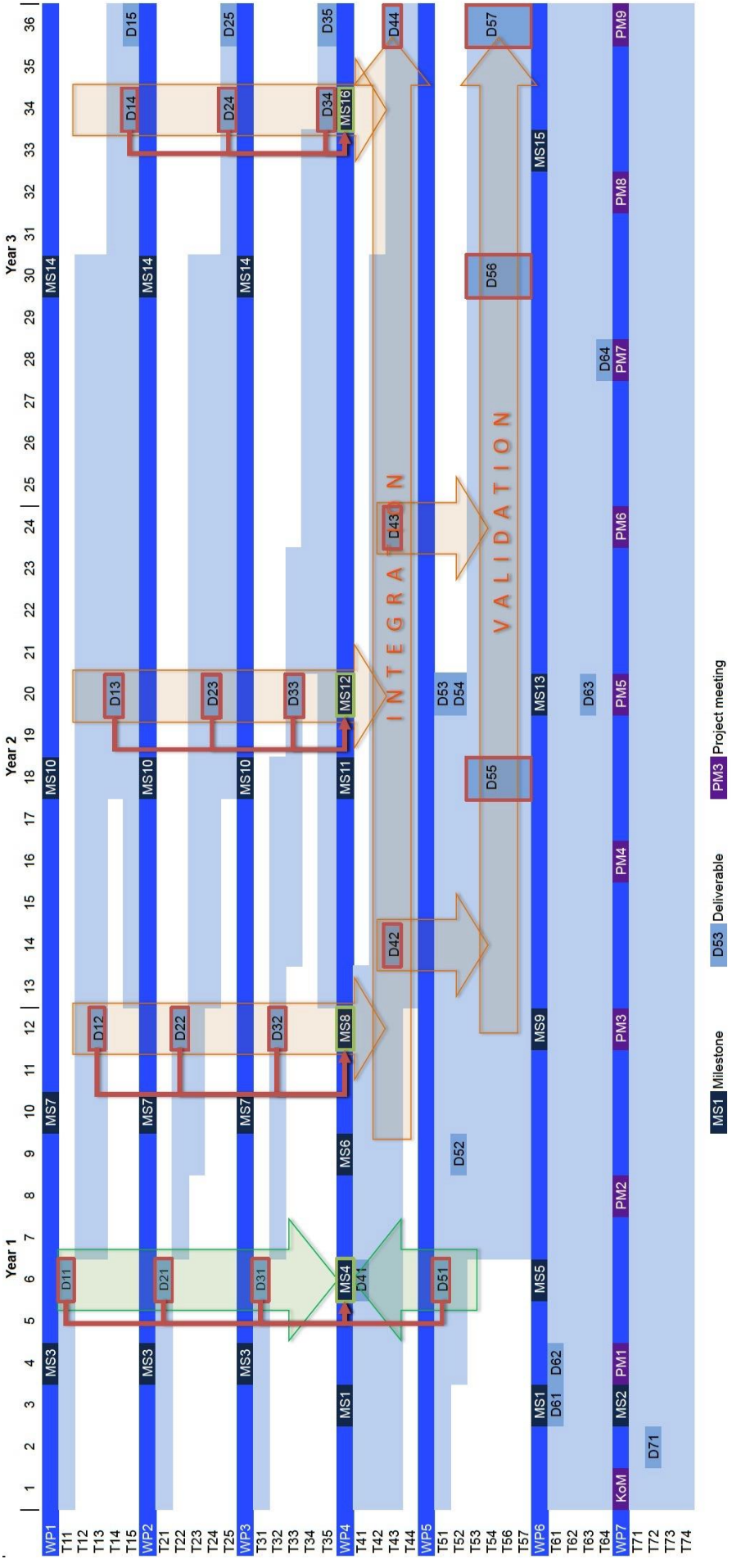



*Figure 6: PERT diagram*

Figure 7 : GANTT Chart



## 3.2 Management structure, milestones and procedures

### Project organisation

The main governing structure of the STAMP project is the Governing Board (GB), which will be responsible for all strategic decision-making. Each partner will be equally represented. Moreover, in order to ensure the day-to-day management of the project, an operational management structure gathering all the WP leaders around the Coordinator and the Project Management Officer (PMO) is proposed: the executive committee (ExCom).

The seven WPs are thoroughly described in paragraph §3.1 above. The intended structure of the project is shown in the figure below. A leader is appointed for every WP. The leaders are responsible for ensuring that the work in their WP proceeds consistently with the project description of work. The roles and responsibilities of the project management bodies and actors are described below.

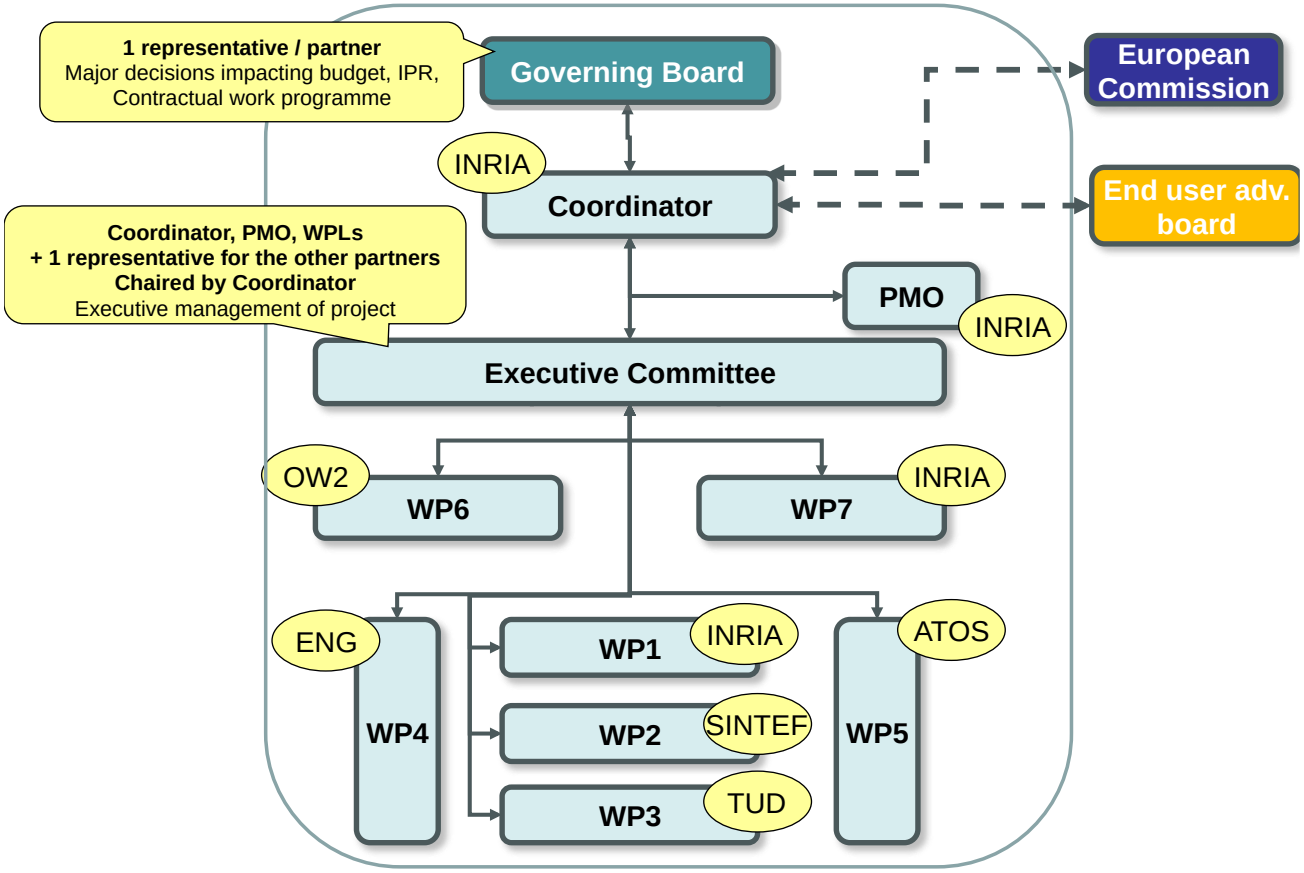



*Figure 8: Management structure of the project*

### Roles and responsibilities of project bodies and actors

Governing Board

*Casting*

Each Partner shall appoint one representative to the GB. The chairman will be elected at the first meeting for a 3 year period.

*Mission*

The GB is the highest authority of the STAMP project. The GB is the only one authorized to amend in any way the Consortium Agreement (CA) as well as validate any request to the EC for Grant Agreement (GA) amendment. The GB shall convene upon request from the ExCom for specific and/or unsolved issues. Here are some examples of the GB's decisions:

- Any major change to the CA;
- Validation of GA amendment request;

- Definition of strategic orientations of the work program. In particular, every decision concerning budget and allocations must be approved by the GB.
- The Termination of a partner's participation.

*Voting procedure*

Decisions of the GB shall require a vote (2/3 majority; Quorum: 2/3) by the partners present or represented. Only decisions in the agenda can be voted. Decision making procedures will be further detailed in the CA.

Executive Committee

*Casting*

The members of the ExCom are 1 representative for each partner, including the WP leaders, the Coordinator and the PMO. The Coordinator is the chairman of the ExCom.

*Mission*

The ExCom is the body in charge of the day-to-day management of the STAMP project, including decisions, follow-up and adaptations of technical roadmaps for such project. The responsibilities of the ExCom are the following:

- Day-to-day project management, follow-up and adaptations of technical roadmaps;
- Assessment of the results obtained and of the relevance of the future work with regards to these results, with the possible organization of technical and management reviews for such assessments;
- Preparation of the periodic scientific and management reports;
- Discussion and proposal of technical orientations for the work program;
- Discussion of the funding issues and in particular of the possible funding re-allocations;
- Discussion of the harmonization issues of the detailed work plans.

*Voting procedure*

Decisions of the Executive Committee shall be taken upon a majority of 2/3 of the votes of the parties present or represented. Decision making procedures will be further detailed in the Consortium Agreement.

Coordinator

The Coordinator manages the relationships between the partners of the consortium and the EC. The Coordinator is not entitled to act or to make legally binding declarations on behalf of any other Partner or to enlarge his own role. His responsibilities are the following:

- Ensure the scientific and technical coordination of the STAMP project;
- Chair the ExCom;
- Report to the GB on strategy and activities (project management, funding, scientific and technical work);
- Organize annual project meetings and initiate technical meetings within WP;
- Undertake all necessary legal and ethical responsibilities and obligations;
- Have the overall responsibility on financial management, including budgeting, resource allocation and distribution, the legal and financial contracting of potential sub-contractors and all expenditure, financial controls and audits;
- Validate and submit reports and deliverables to the EC, in particular periodic report;
- Issue the detailed project work plans;
- Organize external interactions;
- Control the information and document flow between the partners of the consortium;
- Ensure the internal and external communication, information and dissemination of knowledge.

Project Management Officer (PMO)

The PMO is in charge of the project management support tasks described below, in collaboration with the Coordinator:

- Follow-up of the GB and ExCom decisions;
- Monitoring of work progress, planning and issuing of deliverables and list of publication
- Quality & workflow management;
- Risk management;
- Propose amendment to the CA and to the GA whenever necessary;
- Financial reporting;
- Consolidation and edition of periodic reports;

- Various project management tasks such as preparation of meetings, writing and distribution of minutes, management organization, etc.

These activities are part of WP7.

WP Leaders

STAMP project is divided into seven WPs led by WP leaders (WPLs). Each WP covers an area of the work program and is divided into tasks.

The WPLs are in charge of:

- Implementing in their WP decisions taken by the GB and the ExCom in their WP;
- Reporting to the Coordinator the work progress, the use of resources and the management issues in their WP;
- Coordinating the work within their WP and monitoring the achievements of the tasks of their WPs;
- Ensuring a proper and timely execution and submission of the deliverables;
- Organizing WP progress meetings, including distribution of minutes;
- Contributing to the periodic scientific and management reports;
- Organizing the quality control of the results obtained in their WP, including cross-checking deliverable data sets and reports;
- Participating to the ExCom meetings and reporting within the ExCom;
- Writing executive summaries for their WP;
- Issuing the deliverables of their WP.

Exploitation manager

Relevant exploitation issues will be coordinated by the Exploitation Manager (EM). ActiveEon takes this role. Exploitation issues will be addressed as an agenda item during the meetings of the Executive Committee and technical meetings if necessary. The EM will have fluid communication with the Coordinator and WP leaders to assure good visibility on scientific and technical questions linked to exploitation. The role of the EM will be:

- Watch the follow-up of provisions in the CA;
- Draft partner agreements (IPR, software licensing, etc.) in the project for post project joint or individual implementation;
- Contribute to the overall plan for further commercialization (identification of exploitable results, market analysis and business modeling);
- Review and monitor the progress of exploitation activities and report updates to the Executive Committee and Coordinator.

All Partners

Each Partner will appoint:

- A representative to the GB;
- Technical Partners, who will (i) carry out the tasks the Partners have committed themselves to perform, as well (ii) as participate to the technical progress meetings and plenary meetings. The technical Partners include the WPL and the Coordinator.
- A main contact, in charge of scientific and technical/technological aspects in the STAMP project;
- An authorized representative, who can make legally binding commitments for his/her organization in the STAMP project;
- A financial representative in charge of budget, funding process, cost statements and certificates on financial statement;
- A legal correspondent: in charge of the grant agreement and CA issues, IP rights, etc.), usually a legal adviser from such partner’s organization;

End User Advisory Board (EUAB)

The EUAB consists of content providers, archivists, video solution providers and media services representatives that have an overview on the latest trends in the audio-visual sector. The establishment of the EUAB takes place under the WP6. The mission of the EUAB is to monitor the outcomes of the project work packages and ensure that STAMP solution will reach the expected level of maturity to be introduced to the market after the end of the project.

Four organizations already sent intent letters to become members of the EUAB (see appendix of the proposal): IBM, Huawei, Nokia & Tieto.

**Management procedures**

In order for the management to be efficient in coordinating the STAMP project, several underlying activities will have to be carried out during the entire STAMP project duration. Ranking from "Quality Control" to "Reporting" and "Risk Assessment", the scope of managerial activities is described in the following sections.

Quality Control

Quality Control will be part of the STAMP Project Quality Plan, which will be a deliverable of the STAMP project (D7.1). This document will be used internally by the Consortium to describe the guidelines adopted by the STAMP project on documentation of project activities, periodic reporting, preparation of financial statements, approval and submission of deliverables, and risk management. The implementation of the quality management will include the following phases:

- Identification of the procedures needed;
- Planning, design and development of the procedures and the forms to be implemented;
- Development of an implementation guide for all the partners.

Project's internal meetings

The following project meetings are planned:

- 1 kick-off meeting at the beginning of the project;
- 1 ExCom meeting by phone/video conference every month;
- 1 physical ExCom meeting every 4 months (reporting on work progress), which will be hosted by each partner.
- Optional WP meetings whenever needed;
- 1 plenary meeting each year, jointly with a governing board, an ExCom and a EUAB meeting.

The kick-off meeting will serve to launch the project, familiarize all project partners with each other, create a trustful and encouraging atmosphere and adjust expectations. It will serve also to elect the chairman of the Governing Board.

Management Tools

An online collaborative workspace will be set up and used to support efficient collaboration between the Partners. The shared workspace will benefit all of them and will act as an internal document repository. Key project information, such as the contractual documents, GANTT charts, meeting minutes, templates for producing project deliverables and presentations, will be available on the workspace.

Information Flow

A key success factor in project management is to ensure that information circulates rapidly and efficiently to all Partners. To this end, the management will rely on a wide array of communication support tools. First, dedicated mailing lists will be created and archived (one for each WP, for the entire project and one for every managerial body of the project). Besides, the STAMP project will rely extensively on video-conferencing for addressing technical or managerial issues. Periodic technical and management meetings will also be organized to support exchanges and discussions within the STAMP project. Each meeting will result in the production of meeting minutes, which will be made available to all partners of the consortium involved. The workspace will also support the collaboration among the teams. Ultimately, all efforts will be made by the management to support fluid information flow and avoid information bottlenecks.

Consortium Agreement

Before the STAMP project starts, the consortium partners will sign a Consortium Agreement (CA, based on DESCA 2020) wherein roles, responsibilities and mutual rights and obligations will be defined. These will in particular include the sensitive questions of Intellectual Property (IP) rights, as well as the structure and organization of the STAMP project. It will be in complete accordance with the rules of the Grant Agreement (GA) and will adopt the recommended guidelines laid down by the EC and will include, among others:

- General and specific arrangements concerning IP rights to be applied among the Partners and their affiliates, and/or third parties;

- Management of knowledge and results generated by the STAMP project, and rules for knowledge and results transfer, dissemination and communication;
- Internal organization of the Consortium, its governance structure, responsibilities and authority of each partner, decision-making processes, reporting mechanisms, controls, penalties and management arrangements;
- Arrangements for the distribution of the European Commission financial contribution among Partners and among activities;
- Rules for partners joining or leaving the Consortium;
- Provisions for the settlement of disputes within the Consortium and applicable law.

The Consortium Agreement will document in detail the treatment of IP rights:

- **IP Ownership :**

Results shall be owned by the project partner carrying out the work generating such results. Results jointly created by at least two project partners will be jointly owned by the contributing project partners, in proportion to the effort leading to the generation of such knowledge or results. In case of debate, the Governing Board will have the final say, and any conflicts will be resolved using specific voting mechanisms defined in the CA. The owning partners of a result or knowledge will provide adequate and effective protection of the result or knowledge before its dissemination, publication and exploitation.

- **Access Rights to background and exploitation of results**

In order to ensure a good execution of the project, the project partners agree to grant each other royalty-free Access Rights to their Background and Results for the execution of the project. For a fair exploitation of its results, the CA will also address provisions concerning the Access Rights to background and results in order to ensure exploitation of the results.

- **Open Source software**

As the main objective of the STAMP project is to provide test amplification tools as open source services, the consortium agreement will include « Specific Software Provisions », particularly concerning Open Source licenses of the background and of the results. It will strongly recommend the use of open source licenses that are already widely used by the software engineering industry companies, such as Eclipse, Apache, LGPL or, in some particular cases, BSD or MIT. This will ensure a licensing policy of the background and results of the STAMP project consistent with its dissemination strategy which objective is to maximize its impact in the European software engineering industry.

- **Publications and communication**

The STAMP Consortium partners may publish information on knowledge arising from the project according to the provisions of the GA, and provided this does not affect the protection of that knowledge. In that respect before any knowledge dissemination, publication or communication takes place, the matter must be agreed with the Executive Committee

Conflict Resolution and Relationship Breakdown

The Consortium decision-making process is aimed at building consensus throughout the STAMP project with the activities of one Partner not having adverse effects on the activities of another partner. In the event that disputes or differences arise that cannot be resolved, the following process shall be followed.

Disputes within a WP that cannot be resolved internally by the WPL should be referred to the Coordinator who will attempt to reconcile differences. If this does not resolve the dispute, the Coordinator will table the issue for discussion with the ExCom. In case the dispute remains after discussion with the ExCom, the conflict will be presented to the GB.

Consultation with the Project Officer of the EC will also be sought.

If no other solution is possible, a partner(s) may be excluded by the GB, following appropriate procedure.

The final settlement of outstanding disputes will be managed through arbitration in Brussels under the rules of arbitration of the International Chamber of Commerce by an arbitration panel appointed under those rules. The award of the arbitration panel will be final and binding upon the Partners concerned.

Where the dispute concerns IP, the dispute can be raised to the ExCom that can request the assistance of the EC IP rights helpdesk or require the creation of an IP rights External Advisory Panel to provide counsel and advice. The decisions of an IP rights Strategic Task Force in such matters are binding for all partners.

Interaction with other European Projects

Interaction with other European projects is foreseen, as it contributes to the overall integration of the research & technological development activities of the EC. After decision of the GB, the Coordinator will establish a formal contact; a permanent correspondent in the STAMP project for each other project will

then possibly be appointed. All the information circulation between projects shall respect the provisions of the GA and the CAs relating to both projects.

**Management risk**

The risks of the STAMP project will be managed in WP7. At the beginning of the STAMP project and during each meeting, the ExCom will assess the level of the identified risks and work on reducing this level identifying and implementing preventive actions.

## *3.3 Consortium as a whole*


**Figure 9 - Map of the consortium**

The STAMP Consortium is composed of 2 large companies (ATOS, Engineering), 3 SMEs (XWIKI, ActiveEon, TellU), 1 open source consortium (OW2), 2 research organizations (INRIA, SINTEF) and 1 university (TU Delft).

A multi-disciplinary consortium, which can achieve cross cutting objectives for successful delivery of the project goals, is required to complete the objectives of the STAMP project. In light of this, the STAMP Consortium has been set up to cover all the required competences.

The table hereafter summarizes the expertise of the partners of the consortium as far as relevant for the tasks in this STAMP project. It also reveals the diversity of relevant experience of partners, and how their combination of know-how and previous work is a key for the STAMP project success.

| Expertise | INRIA | SINTEF | TUD | OW2 | ENG | TellU | XWiki | ATOS | AEon |
|---|---|---|---|---|---|---|---|---|---|
| Software testing | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ |
| Automatic deployment | ++ | +++ | | | | +++ | ++ | ++ | +++ |
| Program analysis | +++ | +++ | +++ | ++ | | | +++ | | |
| Software development | ++ | ++ | ++ | +++ | +++ | +++ | +++ | +++ | +++ |
| Software metrics | ++ | | ++ | +++ | + | | +++ | | |
| Open source dissemination | | | | +++ | ++ | | ++ | | ++ |
| Open source exploitation | | | | | ++ | | +++ | | +++ |

## *3.4 Resources to be committed*

In order for the Consortium to succeed in achieving its objectives, and taking into account the implication between the WPs and the use cases to perform, the STAMP project duration will be **36 months**. The estimated total budget needed to carry out all the tasks presented in Section 3 is 4 307 K€ with an equal total requested grant.

As described in the table below, the STAMP project rallies 516 PM, among which 234 pm are dedicated to research activities. This represent 45 % of the total effort, allocated to research activities from WP1 to WP3, and is thus coherent with the goals established in this project and the level of the targeted progress. Moreover, the core research and engineering activities (WP1-WP4) dealing with the design of the tools and its implementation, account for 62 % of the effort. Furthermore, WP5, which refers to the validation and the demonstration through use cases, represents approximately 23 % of the total person-months.

We can also mention that Dissemination, Communication and Exploitation activities (WP6) gather 12 % of the total personnel effort. These will be used for the business models analysis and market study, as well as the set-up of the STAMP project website, the organization of dissemination events, and will also serve to reach out stakeholders and demonstrate the STAMP project benefits and achievements.

Last but not least, the administrative and scientific coordination receives 3,5 % of the total PM to ensure a solid and consistent management for the Consortium and across the WP.

Cost breakdown per activity

- Total personnel costs for research, integration and validation activities (WP1-5): 2 647 K€ (86,5% of personnel costs)
- Total personnel costs for dissemination, communication and exploitation activities (WP6): 342 k€ (11,2 % of personnel costs)
- Total personnel costs for management activities (WP7): 70 k€ (2,3 % of personnel costs)

Cost breakdown per type

- Personnel: with a direct cost of 3 060 K€, personnel is the main direct cost item (71 % of the total eligible costs).
- Travel costs: 265 k€ :
  - 171 K€ for project meetings, based on 3 meetings per year, 2 participants per meeting (except for Inria: 3 participants, including the Project Management Officer)
  - 94 K€ for conferences, EU Events & trade shows
- Equipment: no purchase, only hiring of the needed technical infrastructure via OW2 : 48 K€
- Other goods and services: 57 k€
  - Audit costs: 3 k€ for each partner requesting more than 325k€ EC funding (except for Inria because of financial audits by the French public administration) : 21 K€
  - Communication material and booth preparation in trade shows: OW2 (23 k€)
  - Provision for End-User Advisory Board members travel expenses: INRIA (13 k€)

- Total for other direct costs : 370 K€ i.e. 12% of the personnel costs
- Indirect costs account for 858 K€, following financial rules of H2020.
- Finally, 19 K€ are provisioned for subcontracting of a few communication tasks of the SME software company TellU, in WP6

**Detailed of the Other Direct Costs items** for OW2, the only participant whose sum of costs for 'travel', 'equipment', and 'goods and services' exceeds 15% of personnel costs

| OW2 | Cost (K€) | Justification |
|---|---|---|
| Travel | 25 K€ | Standard amount : 18 K€ for project meetings and 7 K€ for trade shows and EU events |
| Other goods and services | 23 K€ | Communication material and booth preparation in trade shows (such as Cloud Expo Europe, Cloud Computing World Expo, OpenStack Summit, DockerCon ) |
| | 48 K€ | STAMP project infrastructure hosting |
| | 3 K€ | Financial audit |
| **Total** | 99 K€ | |

Table 3.4b : Other Direct Cost

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# 4. Members of the consortium

## 4.1. Participants (applicants)

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| No.1 | INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE | Inria | FRANCE |  |

**Brief Description**:

Established in 1967, Inria is the only French public research body fully dedicated to computational sciences. It is a national operator in research in digital sciences and is a primary contact point for the French Government on digital matters. Under its founding decree as a public science and technology institution, jointly supervised by the French ministries for research and industry, Inria's missions are to produce outstanding research in the computing and mathematical fields of digital sciences and to ensure the impact of this research on the economy and society in particular. Inria covers the entire spectrum of research at the heart of these activity fields and works on digitally-related issues raised by other sciences and by actors in the economy and society at large. Beyond its structures, Inria's identity and strength are forged by its ability to develop a culture of scientific innovation, to stimulate creativity in digital research.

Throughout its 8 research centres and its 172 project teams, Inria has a workforce of 3 400 scientists with an annual budget of 233 million euros, 37% of which coming from its own resources.

Inria's mission is to pursue excellent research in computer science and applied mathematics in order to play a major role in resolving scientific, societal and industrial challenges. Therefore, Inria actively collaborates with public and private bodies including strategic partnerships with large firms, sme's technology platforms and industrial clusters. Technology transfer is further enhanced by helping to launch new companies (since 1984, 120 companies have stemmed from Inria) and by forming partnerships with innovative SMEs.

Inria has been very active in the previous European framework programmes (in FP7: 231 projects, including 124 in the ICT theme of the Cooperation Programme and 33 ERC grants). Notably, the institute has been strongly involved in programmes aimed at fostering scientific excellence, such as the European Research Council, Future and Emerging Technologies (in particular the FET flagship initiative), and in the ICT Theme of the Cooperation programme. .

Inria makes a firm commitment to Horizon 2020, with which the institute's strategic plan is aligned. The objective is to combine scientific excellence with a more focused consideration of major European and global societal challenges to which Inria can bring a key contribution. Inria is currently involved in 27 H2020 funded projects

Website: www.inria.fr/en/

**Role in Project**: The STAMP project involves more particularly Inria's DiverSE research team. Research in DiverSE is anchored in the field of software engineering and is articulated around four main axis: language engineering, software product lines, adaptive software architecture, software diversity. In STAMP, DiverSE will act as the project coordinator, scientific leader and will lead workpackages 1 and 7

**Key Staff**

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| Dr. Benoit Baudry | **Benoit Baudry** (Male) is a research scientist at INRIA, where he leads the DiverSE team. He received his PhD from the Université of Rennes 1 in 2003, spent one year at CEA (French Nuclear Agency) in 2004 and one year at Colorado State University in 2008. His research interests include software testing, program analysis and transformations and software diversity. He is in the program committee of the main software engineering conferences (ICSE, ASE, ISSTA, |

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| | FSE) and is on the editorial board of the Journal for Software and Systems Modeling.<br>Since 2012 he leads the DiverSE research team, which includes 10 researchers and 30 PhD students and engineers. From 2013 to 2016 he has been leading the FP7-FET DIVERSIFY project, which gathered researchers in ecology and software engineering to investigate novel mechanisms to emerge software diversity at the application level. As key outcome of this project, he has developed new techniques to diversify source code and to exploit software diversity for privacy, against browser fingerprinting.<br>http://people.rennes.inria.fr/Benoit.Baudry/ |
| Dr. Olivier Barais | **Olivier Barais** (male) is a Full Professor at the University of Rennes 1, member of the DiverSE INRIA research team. He passes a PhD in computer science from the University of Lille 1, France in 2005. His research interests include Component Based Software Design, Model-Driven Engineering and Aspect Oriented Modeling. Olivier Barais has co-authored 12 journals, 55 international conference papers, 2 book chapters and 35 workshop papers in conferences and journals such as SoSyM, IEEE Computer, ICSE, ASE, MoDELS, SPLC and CBSE.<br>http://olivier.barais.fr |
| Dr. Johann Bourcier | **Johann Bourcier** (male) is an associate Professor at University of Rennes 1, member of the DiverSE INRIA research team. He received his Ph.D. degree in 2008 from the University of Grenoble 1. He is a former member of the LIG Adele research group (Grenoble) and later the Distributed Software Engineering Section in the Department of Computing of Imperial College London. His research interests include the use of software engineering to simplify the development of highly dynamic applications. Johann Bourcier has co-authored 21 international peer-reviewed conference, journal and book chapters in venue such as TAAS, JSS, GECCO, SEAMS. He is or has been involved in FP7 projects: ITN RELATE, FET DIVERSIFY, HEADS, DiVA, and ANR INFRA-JVM.<br>https://sites.google.com/site/johannbourcier/ |
| Dr. Martin Monperrus | **Martin Monperrus** (male) has been an associate professor at the University of Lille, France, since 2011. Member of the SPIRALS INRIA research team, in Lille. He was previously with the Darmstadt University of Technology, Germany, as a research associate. He received a Ph.D. from the University of Rennes in 2008, and a Master's degree from the Compiègne University of Technology (UTC). His research lies in the field of software engineering with a current focus on automatic software repair.<br>http://www.monperrus.net/martin/ |

**Publications**:

- ScapeGoat: Spotting Abnormal Resource Usage in Component-based Reconfigurable Software Systems . I Gonzalez-Herrera, J Bourcier, E Daubert, W Rudametkin, O Barais, F Fouquet, JM Jézéquel, B Baudry. *Journal of Systems and Software*, 2016
- The Multiple Facets of Software Diversity: Recent Developments in Year 2000 and Beyond. (Benoit Baudry, Martin Monperrus), In *ACM Computing Survey*, volume 48, 2015.
- Crash Reproduction via Test Case Mutation: Let Existing Test Cases Help (Jifeng Xuan, Xiaoyuan Xie, Martin Monperrus), In *Proc. of ESEC/FSE, NIER track*, 2015.
- Tailored source code transformations to synthesize computationally diverse program variants. (Benoit Baudry, Simon Allier, Martin Monperrus), In *Proc. of the Int. Symp. on Software Testing and Analysis (ISSTA)*, 2014.
- Test Case Purification for Improving Fault Localization (Jifeng Xuan, Martin Monperrus), In *Proc. of the Int. Symp. on the Foundations of Software Engineering* (FSE), 2014.

**References**:

- DIVERSIFY (FP7, 2013 – 2016) was a project which targeted the increase of spontaneous emergence of diversity in software systems. It resulted in novel mechanisms to automatically diversify source code and software architectures. The diversification transformations and

automatic architecture reconfiguration techniques developed by the DiverSE team can be reused in PROJECT_NAME.

- HEADS (FP7, 2013 – 2016) is about the development of distributed systems. In particular, DiverSE develops a novel testing infrastructure, in which it is possible to deploy multiple versions of an application (e.g. generated with multiple compiler options) and test them to look for behavioral and performance differences.
- amiunique (https://amiunique.org/) is an initiative to investigate software diversity in web browsers. Along with these observations, the DiverSE team develops a counter-measure against browser fingerprinting based on the software diversity and automatic assembly of software components in a web browser.
- Occiware aims to establish a formal and equipped framework for the management of all cloud resource based on the OCCI standard.

**Infrastructure/technical equipment** :

Each INRIA Research Centre has a Technology Transfer and Partnerships Department (STIP - Service Transfert pour l'Innovation et Partenariats) whose vocation is to orient and accompany the researchers. The Department's role is to promote and organise research partnerships for the research project teams, either through bilateral collaboration with businesses or through national or European collaborative programmes, and also to implement the transfer of the project teams' technology results to industry. This particularly involves providing information on the project teams, mapping and promoting the offer to industry, identifying opportunities for technology transfer, help in negotiating and drawing up contracts, protecting and capitalising on research results and assisting in the establishment of innovative start-ups.

**Other relevant information:**

Participation on previous European projects:

**ITEA MERGE (2012 – 2015)** develop and demonstrate innovative concepts and design tools addressing in combination the "Safety" and "Security" concerns. The DiverSE team developed an approach for modular language construction.

**FP7 NoE – NESSoS (2010 – 2014)** Software engineering for secured future internet. In this project I specifically investigate architecture and design of future internet applications. The DiverSE team explored models@runtime to secure distributed systems.

**FP7 Marie-Curie Relate (2010 – 2014)** The RELATE Initial Training Network aims to establish a network of international academic and industrial partners for a joint research training effort in the area of engineering and provisioning service-based cloud applications. The DiverSE team trained three PhD students in the area of language engineering for cloud computing.

**FP7 STREP – DIVA (2008 – 2011).** Dynamic variability in complex, adaptive systems. In this project I specifically investigated the verification of adaptation rules and of AOP as an adaptation mechanism. The DiverSE team developed a prototype for models@runtime.

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| No.2 | STIFTELSEN SINTEF | SINTEF | NORWAY | SINTEF |

**Brief Description**:

SINTEF is Scandinavia's largest independent research organisation, and is a non-profit research foundation. We employ 2100 people most of whom are located in Trondheim and Oslo (Norway). More than 90% of our annual turnover derives from contract research for industry and the public sector in Norway and internationally, and we receive minimal state funding (around 6%). SINTEF is multidisciplinary, with international top-level expertise in a wide range of technological and scientific disciplines, medicine and the social sciences. Our company vision is "technology for a better society", and it is an important aspect of our societal role to contribute to the creation of more jobs. We also act as an incubator, commercialising technologies through the establishment of new companies. SINTEF is represented in this consortium by SINTEF ICT, and more precisely the department for Networked Systems and Services (NSS) located in Oslo.

Website: www.sintef.no

**Role in Project**:

NSS in SINTEF provides research-based expertise in model-driven development, quality and security technology, and user-centred development. SINTEF will lead Work Package 2 in STAMP, and will bring into it the cloud configuration modelling and automatic deployment tool CloudML, as well as the research approaches developed on top of CloudML, such as automatic cloud configuration, static configuration assessment, etc. SINTEF will participate in the other two technical work packages, bringing their research expertise on code generation and model at runtime into Work Package 1 and 3, respectively.

**Key Staff**

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| Dr. Franck Fleurey (male) | Dr Franck Fleurey is a senior research scientist at SINTEF ICT. He received a Ph.D. degree in Computer Science from the University of Rennes 1, France in 2006, for a dissertation on model-driven development techniques. He is the authors of over 50 peer-reviewed scientific publications on software engineering. He joined SINTEF in 2008 and works on practically applying model-based software engineering technique to embedded systems, product lines and adaptive systems. He has experience from working in a number of EU research project and has been a work package leader in the DiVA FP7 STREP project. He is currently technical manager of FP7 HEADS project. |
| Dr. Hui Song (male) | Dr. Hui Song is a research scientist at SINTEF ICT. He received his PhD in 2012 from Peking University in China, and worked as post-doc from 2012 to 2013 in Trinity College Dublin, Ireland. His research interest is in model-driven engineering, models@runtime, and their application on cloud computing. He has authored 30 papers on journals and conferences in these areas, and has contributed to the EU FP7 projects MODAClouds, DIVERSIFY, and Broker@Cloud, and a national project Cirrus. |
| Dr. Arnor Solberg (male) | Dr. Arnor Solberg is a senior research scientist at SINTEF ICT and the research manager of the Model-Driven Software Development group. He is an expert on software architectures and software engineering practices. He received his PhD from the University of Oslo. His research interests include model-driven software engineering, aspect oriented modelling and adaptive systems. He has a long track record as a project manager and technical manager for several national and international/EU research projects, in particular he was the technical manager of DiVA, the scientific director of the MODAClouds, and the project coordinator of HEADS, which are all EU FP7 research projects. He is member of program committees of relevant international conferences and workshops such as the MODELS conference. |

**Publications**:

- **CloudML** is a modelling language for specifying deployment architectures and resource provisioning on multicloud infrastructures. CloudML is supported by tools for design time

editing as well as run time adaptation of the deployment architecture and resource provisioning. The CloudML is aligned with the OASIS standard on Topology and Orchestration Specification for Cloud Applications (TOSCA) where SINTEF is a member of the Technical Committee.

- Ferry, N., Song, H., Rossini, A., Chauvel, F. and Solberg, A., 2014, December. **CloudMF: Applying MDE to Tame the Complexity of Managing Multi-cloud Applications.** In Proceedings of the 2014 IEEE/ACM 7th International Conference on Utility and Cloud Computing (pp. 269-277). IEEE Computer Society.
- Song, H., Elgammal, A., Nallur, V., Chauvel, F., Fleurey, F. and Clarke, S., 2015, May. **On architectural diversity of dynamic adaptive systems.** In Proceedings of the 37th International Conference on Software Engineering-Volume 2 (pp. 595-598). IEEE Press.
- Morin, B., Barais, O., Jezequel, J.M., Fleurey, F. and Solberg, A., 2009. **Models@ run. time to support dynamic adaptation**. Computer, 42(10), pp.44-51.
- Fleurey, F., Morin, B., Solberg, A. and Barais, O., 2011. **MDE to manage communications with and between resource-constrained systems**. In Model Driven Engineering Languages and Systems (pp. 349-363). Springer Berlin Heidelberg.

**References**:

- FP7 **MODAClouds**. The main goal of MODAClouds is to provide methods, a decision support system, an open source IDE and run-time environment for the high-level design, early prototyping, semi-automatic code generation, and automatic deployment of applications on multi-Clouds with guaranteed QoS. Model-driven development combined with novel model-driven configuration analysis and quality prediction will enable developers to specify Cloud-provider independent models enriched with quality parameters. SINTEF was the scientific manager of MODAClouds, and the main developer of the CloudML language and framework. STAMP will utilize CloudML as the basis configuration modelling language behind automatic configuration amplification, and will also utilise the cloud architecture (configuration) analysis approaches developed in MODAClouds.
- FP7 **DIVERSIFY** explores diversity as the foundation for a novel software design principle and increased adaptive capacities in collaborative adaptive systems. Increased diversity in the system provides a pool of software solutions that can eventually be used to adapt to unforeseen situations at design time. The scientific development of DIVERSIFY is based on a strong analogy with ecological systems, biodiversity, and evolutionary ecology. SINTEF is the leader of Work Package 3: exploitation of software diversity, and more precisely working on the diversification of cloud architectures. In DIVERSIFY, SINTEF has developed an automatic architecture planning approach based on constraint solving, to automatically diversify a cloud configuration into many different configurations, and guarantee that each of the generated configurations are valid and meaningful. The initial results in this research will be the starting point of automatic configuration amplification in STAMP.
- H2020 **ARCADIA** project aims to design and validate a Novel Reconfigurable-By-Design Highly Distributed Applications Development Paradigm over Programmable Infrastructure. The proposed framework will rely on the development of an extensible Context Model which will be used by developers directly at the source-code level. SINTEF is working in ARCADIA on the architecture configuration for micro-services in cloud. The research experience and results in this topic will be used in STAMP.
- FP7 **HEADS** aims at providing service developers with languages and code generation frameworks, together with an operational methodology to specify and deploy services whose business logic is deployed across a continuum of devices ranging from cloud down to smart devices. HEADS will provide STAMP the experience and approaches on code generation in different programming and configuration languages, and the deployment and management of services in heterogeneous environments.
- **Cirrus** is a “User-Driven Research” project funded by the Research Council of Norway, starting from 2016. It aims at the software engineering research and innovation to support the development and delivery of customisations on multi-tenant cloud services. As the sole academic partner in the project, SINTEF is in charge of the novel mechanism and modelling for cloud product customisation. SINTEF will bring into STAMP the research on how to host and manage thousands of customer-configured service instances, and feed back into Cirrus with the advanced way of automatic testing for customisation code.

**Infrastructure/technical equipment** :

- **CloudML** is an open source language and framework owned by SINTEF for the modelling of cloud configuration and the automatic deployment according to the configurations. STAMP will use CloudML as the common configuration modelling language between different scripts from different deployment tools, and develop the amplification, selection and execution of the test configuration in a model-based way.
- SINTEF has invested in a "mini-cloud", composed of 6 quad-core 64-bits machines equipped with 16GB RAM and 256GB SSD each (3 machines also having 2TB disks). This mini-cloud currently supports SINTEF's research in cloud computing. SINTEF will rely on and extend this infrastructure as part of STAMP, in order to provide an experimental framework to actually deploy and execute the amplified configurations.

**Other relevant information:**

Participation on previous European projects:

•FP7 call 1 : Diva

•FP7 call 5 : Remics

•FP7 call 8 : MODAcloud

•H2020 call 1 : Arcadia

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| No.3 | Delft University of Technology | TUD | The Netherlands | TU Delft |

**Brief Description**:

Delft University of Technology is the largest and oldest technical public university in Netherlands. It hosts over 19,000 students (undergraduate and postgraduate), more than 2,600 scientists and more than 2,100 people in the support and management staff. TU Delft cooperates with many other educational and research institutions, both in the Netherlands and abroad. It has numerous contacts with governments, trade associations, consultancies, industry and small and medium-sized companies.

The research group involved in the project is the Software Engineering Group (SERG), which is part of the department of Software Technology, faculty of Electrical Engineering, Mathematics, and Computer Science, and a member of the research school IPA. The group employs approximately 25 people (depending on the completion or initiation of projects), comprising full, associate, and assistant professors, lecturers, postdocs, and PhD students. The main research areas for the groups include but are not limited to software testing, software quality and maintenance, software evolution, search-based software engineering.

Websites:

http://tudelft.nl

http://swerl.tudelft.nl/bin/view/Main/WebHome

**Role in Project**:

TU-Delft will contribute to the project by developing new research strategies for amplifying existing tests and/or generating new tests leveraging on run-time information of running software. Therefore, expertise in software testing (i.e., regression testing, search based software testing, web testing, test case optimization), mining software repository (e.g., for analysing log files, software behaviour within IDE or build server), and machine learning (e.g., for model learners) are particularly profitable for WP3, which is focused on runtime-testing.

**Key Staff**

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| Dr. Prof. Arie van Deursen (male) | He is a full professor in Software Engineering, the head of Department of Software technology, the head of the Software Engineering Research Group (SERG) at Delft University of Technology, the Netherlands.<br>His research interests include software testing, software architecture, web 2.0 (and Ajax in particular), reverse engineering, repository mining, program comprehension, and model-driven engineering. He also serves on the editorial boards of the ACM Transactions on Software Engineering and Methodology, Empirical Software Engineering, and the Journal of Software: Process and Evolution, and Journal of Computing.<br>He serves and has served in the organizing and program committees of several conferences, such as ICSE, ESE/FSE, FSE, and OOPLSA. He is the chair for ESEC/FSE 2017. |
| Dr. Annibale Panichella (male) | He received the PhD in Software Engineering from the Department of Information Technology of the University of Salerno in 2014. From March 2014 to December 2014 he was a collaborator of the Security & Trust research unit at the Center for Information Technologies of Fondazione Bruno Kessler in Trento (Italy. Currently, he is a post-doctoral researcher on the TestRoots and the Big Software on Run projects in the Software Engineering Research Group (SERG) at Delft University of Technology (TU Delft) in Netherlands. His main research interests include search-based software engineering, test case/suite optimization, evolutionary testing, security testing, and empirical software engineering. He serves in the program committee of ICST, ICSME, ICPC, SCAM and PROMISE. He is also member of the review board for Empirical Software Engineering. |

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| Dr. Prof. Andy Zaidman (male) | Andy Zaidman is an associate professor at the Delft University of Technology, The Netherlands. He obtained his M.Sc. (2002) and Ph.D. degree (2006) in Computer Science from the University of Antwerp, Belgium. His main research interests are software evolution, program comprehension, mining software repositories and software testing. He was the general chair of the 15th Working Conference on Reverse Engineering (WCRE 2008) held in Antwerp, Belgium, program co- chair of WCRE 2009 held in Lille, France and program co-chair of VISSOFT 2014 held in Victoria, BC, Canada. In 2013 Andy Zaidman was the laureate of a NWO Vidi career grant. |

**Publications**:

- A. Mesbah, A. van Deursen, D. Roest. Invariant-Based Automatic Testing of Modern Web Applications. IEEE Transactions on Software Engineering, Volume 38, Issue 1, pages 35-53, Year 2012. DOI : 10.1109/TSE.2011.28
- Arie van Deursen. 2015. Testing web applications with state objects. Communications of the ACM, Volume 58, Issue 8, 36-43, Year 2015. DOI=10.1145/2755501
- D. Athanasiou, A. Nugroho, J. Visser, A. Zaidman: Test Code Quality and Its Relation to Issue Handling Performance. IEEE Transactions on Software Engineering. Volume 40, Issue 11, pages 1100-1125, Year 2014. DOI: 10.1109/TSE.2014.2342227
- A. Panichella, O. Oliveto, M. Di Penta, A. De Lucia. Improving Multi-Objective Test Case Selection by Injecting Diversity in Genetic Algorithms. IEEE Transactions on Software Engineering. Volume 41, issue 4, pages 358-383, Year 2015. DOI: 10.1109/TSE.2014.2364175
- A. Panichella, F. M Kifetew, P. Tonella. Reformulating Branch Coverage as a Many-Objective Optimization Problem. In: Proceedings of the 8th IEEE International Conference on Software Testing, Verification and Validation (ICST 2015). Graz, Austria. DOI: 10.1109/ICST.2015.7102604

**References**:

- Big Software on Run. The goal of the project is to provide a solid scientific basis for in vivo software analytics while exploiting the world-renowned competences of computer science groups from the three technical University (3TU) in Netherlands. The research topics include: working on process mining, visualization, software engineering, formal methods, security analysis, and distributed/large-scale computing. Website: http://www.3tu-bsr.nl/doku.php?id=start
- TestRoots. As software applications become ever more important in our lives, we rely on the assumption that this software is itself reliable. However, a 2002 study reports that software failures cost the US economy $59.5 billion annually. Because testing is arguably the most important means to ensure software reliability, the number indicates a fundamental lack of testing. Based on this insight, TestRoots aims at analyzing and improving the state of the art of Software Testing. Website: http://www.testroots.org

**Infrastructure/technical equipment**:

In the context of this project, TUD will use the DAS-5 (The Distributed ASCI Supercomputer) for speeding up compute-intensive operations, including automated generation of tests and run-time analysis of software behavior. DAS-5 is a six-cluster wide-area distributed system designed by the Advanced School for Computing and Imaging (ASCI). DAS-5 is funded by NWO/NCF (the Netherlands Organization for Scientific Research).

**Other relevant information:**

Participation on previous European projects:

•FP7 call 10: SENECA

| No.4 | OW2 CONSORTIUM ASSOCIATION | OW2 | France |  |
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**Brief Description**:

OW2 is a global open source software community organization. OW2's global community membership involves some 25 paying members in 2015, including commercial, public and academic organizations, and over 2000 individual members. An open source non-profit organization, its mission is to develop open source code infrastructure software and to grow a community of open source code developers. The organization is dedicated to the creation of new technology: original code development is one of its fundamental characteristics. As the organization becomes part of the open source marketplace, it also stresses the quality and market usability of its software.

- OW2 manages a code base of open source projects that will provide a good sample for the STAMP use cases. Infrastructure software related to its Open Source Cloudware initiative will be good candidates
- OW2 is an organization designed to facilitate inter-relationships, first, between the community members themselves and, second, between the community and the market. It runs a portfolio of communication collaborative resources that will support the production and dissemination efforts of the project.
- OW2 provides its projects a quality program supported by its own technical infrastructure. It will provide an adequate neutral environment to deploy and exploit the results of the project.
- OW2 provides the technical infrastructure required by projects and contributes to their dissemination efforts: development and curation of the website, social media presence, events organization, collateral development.

The expertise OW2 is bringing to the project derives directly from the three types of services it provides to its community.

- First, OW2 operates a technical infrastructure delivering tools and collaborative services to project teams: the core of the platform is a forge, the application which technically supports the projects through a number of tools for the management of code contributions, versions, debugging, licenses, contributors, downloads, etc. And an operational dedicated open cloud platform, ow2stack, opened to all OW2 projects.
- Second it provides community services, organizing activities and the decision-making process; OW2 is a catalyst for social and business interaction in the framework of a well proven governance system that includes a unique software quality program (Software Quality Assurance and Trustworthiness – SQuAT).
- Third, it provides marketing services by helping build the community identity and brand and the projects visibility essentially in three ways for which it has extensive experience: creating collateral, organizing the community's presence at professional IT and open source events and driving outbound communication. Market outreach is supported by three community initiatives that are properly aligned with key market trends: the Open Source Cloudware initiative, OSCi, the Future Internet Software and Services initiative, FISSi, and the Big Data initiative.

Website: www.ow2.org

**Role in Project**:

OW2 will lead the dissemination, exploitation and communication work package (WP6), implement a dedicated use case (in WP5) and will provide and maintain an infrastructure that will support the collaborative development of the STAMP software and will be used for deploying and executing amplified tests in several environments including OpenStack and Docker (in WP4).

**Key Staff**

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| Cedric Thomas (male) | Cedric Thomas is OW2's CEO. Over the past five years, he has developed OW2 into a global community spanning four continents. He is an IT industry veteran with twenty-five years of experience in strategic and marketing consulting for IT vendors and systems integrators, he actively took part in three IPOs, contributed to the launch of several technology start-ups, and helped set up technology firms |

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| | in Boston and San Francisco. His role will be to lead the market outreach and community building efforts in the project. |
| Stéphane Laurière (male) | Stéphane Laurière joined OW2 as CTO in 2015. His work at OW2 focuses on the development of the OW2 Quality program, the evolution of the OW2 engineering platform and the growth of the OW2 community. Prior to OW2, Stéphane took part in collaborative research projects at Inria, XWiki, and Mandriva, mainly in the fields of open-source software engineering, Cloud Computing and semantic technologies. His role will be to lead the OW2 use case and to provide the technology competence for the dissemination efforts. |
| Catherine Nuel (female) | Catherine Nuel is marketing coordinator for the OW2 Consortium. She is in charge of the organization of events and conferences, as well as the coordination of the participation of consortium members in international conferences and trade shows. She also leads the development of communication material and organizes communication and marketing actions to ensure visibility of the consortium and its projects. Her role will be to manage the project's event and collateral plans and to organize conference and exhibition participation. |
| Olivier Bouzereau (male) | Olivier Bouzereau is OW2's Community Coordinator and, as such, oversees OW2 participant in collaborative projects and its dissemination activities. He has already participated in several collaborative projects including FP7 projects RISCOSS and OCEAN. Olivier was a journalist and communication consultant specialized in the IT industry for over ten years, before joining OW2. His role will be to create content for the project website and social media. |
| Martin Hamant (male) | Martin Hamant is OW2's IT specialist. He runs and maintains the OW2 technical infrastructure. This includes monitoring and fine-tuning applications, managing the hardware platform in terms of response time and use of available resources, implementing new services such as ow2stack, the OW2 cloud platform. He is also responsible for handling the platform users' specific requests (project managers and developers) and for. His role will be to set up and maintain the infrastructure needed for the STAMP testing environment and for collaborative code development. He will also provide "back-end" support to the project. |
| Olivier Lizounat (male) | Olivier Lizounat is OW2's webmaster. He develops and manages the main OW2 website as well as websites dedicated to collaborative projects. He is in charge of graphic design and has developed many different collateral including banners, posters, logos, etc. He is also responsible for managing and publishing the video content developed through OW2 events. His role will be to provide the "front-end" technical support to the project. |

**Publications**:

- No publications: OW2 is not a research or academic organization
- OW2 has developed project dashboards reflecting quality metrics associated with each OW2 mature project. These metrics include some metrics about testing, which coming primarily from SonarQube. STAMP will allow to develop significantly the number of test related metrics for each project.

**References:**

- OW2 Collaborative Engineering Platform: this platform provides services needed by developers to design, develop, build, test software collaboratively. It can be seen as a competitor to GitHub, Google Cloud Source Repositories or Amazon CodeDeploy, CodeCommit, CodePipeline.
- OSCAR: Oscar is the name of the OW2 quality program. It stands for Open-source Software Capability Assessment Radar. It is both a methodology supporting open-source software quality and an open-source integration platform that instruments the methodology. OSCAR has a dedicated chapter on testing which is currently limited to the self-evaluation of testing strategies and to continuous integration. STAMP will enhance the OSCAR quality model.
- OW2 was successfully engaged in several collaborative projects that all are or have been delivering open source cloud computing software. All projects but one are cloud computing oriented. OW2 has sucessfully carried out dissemination tasks. They include:

- CHOReOS (FP7 257178): development of a software engineering approach and execution platform for ultra-large-scale applications for the Future Internet (http://www.choreos.eu, project completed).
- OCEAN (FP7 318294): provision of services to help disseminate European open cloud projects and to foster cooperation with Japan and French (http://www.ocean-project.eu, , project completed).
- CompatibleOne (France): development of an open source cloud service broker platform (http://www.compatibleone.org, project completed).
- OpenCloudware (France): this project aims at building an open software engineering platform for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures (http://www.opencloudware.org, project completed).
- AppHub: this project builds upon the OCEAN project to develop a marketplace for the open source outcome of European Project
- Xlcloud (France): this project aims at defining and demonstrating the principles of HPC as a Service (High Performance Computing) for all those applications that involve highly intensive calculations (http://www.xlcloud.org, project completed).

**Infrastructure/technical equipment :**

OW2 will host an infrastructure for supporting the following activities:

- Collaborative engineering of STAMP software
- Deployment and execution of STAMP in an OpenStack environment
- Deployment and execution of STAMP in containers environments such as Docker or Rocket

4 servers will be dedicated to the project: 2 for OpenStack deployment, 2 for using STAMP within containers. In addition, OW2 will allocate services hosted on shared servers to support the collaborative development of STAMP software.

**Other relevant information:**

Participation on previous European projects:

•FP7 call 5 : Choreos

•FP7 call 8 : Riscoss

•H2020 call 1 : Chorevolution

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| No.5 | Engineering - Ingegneria Informatica S.p.A. | ENG | Italy | ENGINEERING |

**Brief Description**:

The Engineering group is the largest Software and Information Technology services group in Italy. The key to this success, 30 years from its foundation, is based on business and technological excellence and continuous innovation of market offer, due to a collaborative enterprise environment in which operate four market divisions (Public Administration, Industry & Utilities, Finance, Telecommunications & Media), three main business lines (System Integration & Consultancy, Software, Outsourcing), six competence centres (Managed Operations, ERP, ECM, IT Security, Plant Management Systems, Broadband & Media), and a Research & Innovation Division. In 2011 ENG has achieved operating revenues of Euro 775.7 million with approx. 6.500 employees located across 38 offices in Italy and 5 foreign subsidiaries in USA (Delaware), Brazil, Argentina, Belgium, and Lebanon. The Group mission to design, develop and deliver innovative information systems and solutions for medium to large scale clients, involves over 1.000 clients in Europe and worldwide, with increasing overseas market activities. Since 1994, the Quality Management System of ENG is ISO 9000 certified, currently updated to ISO 9001:2008. In 2005, ENG obtained the Maturity certification SW-CMM v1.1, now holding Level 3 of the CMM v.1.2. In addition, ENG has NATO AQAP 2110 and NATO AQAP 160 certifications.

Engineering uses different technologies in its own development and develops open source products and solutions in collaboration with the main global communities. More than 100 resources, with international experience in open source project development and coordination, work at the Engineering's competence center that provides a complete, integrated offer of services, projects and certified professional skills in the entire software stack: basic infrastructures, middleware and applications. The main competences are: development of solutions in the most varied application areas, including information management, service-based systems, process modeling, creation of digital libraries, product quality, process and service, grid and cloud computing, big data and business intelligence, mobile applications certified professional competences in leading market open source solutions in the infrastructural and application area open source solution and component selection services support services for the introduction of open source solutions and components into a company integration services of open source components in software projects and products technical and professional support services for own and third-party solutions migration of existing infrastructures to open source solutions using assessment methods, tests and benchmarks, risk management and the start up of pilot projects. The products developed and managed by the communities led by Engineering are available with free, open source software licenses and are made available by the main communities in this sector: OW2 Consortium and Eclipse Foundation. This guarantees all the users for independence of solutions, quality of development and their availability over time. Engineering provides professional services of assistance and support, according to the "pure open source" model that does not impose any lock-ins on clients.

Website: www.eng.it

**Role in Project**:

Engineering believes in research and in the need to transform the potential of information technology into growth opportunities for its own clients through innovation, in a continuous alignment with the evolution of technologies, processes and business models. In STAMP, Leading the WP4, Engineering will be at the interface between the researchers and the industrial partners to industrialize the test amplification techniques as industry-ready software services.

**Key Staff**

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| Domenico Presenza (male) | **Domenico Presenza** leads the Software Engineering Unit at the Engineering R&D Lab. He got his University Degree in Computer Science in 1989 at University of Pisa. His main competencies concern conceptual modeling, Distributed Computing, Multi-Agent Systems, Interaction Design, and algorithms for automatic layouting. During his professional life, Domenico Presenza has been author of different scientific publications presented at international conferences. He has |

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| | been Project Director of the EU SERENITY integrated project from January 2006 to June 2009. |
| Keven Kearney (male) | **Keven Kearney** received a BA degree in Psychology (cognitive science - specialising in AI) in 1998, and in 2000, an MSc degree in Intelligent Systems (complex adaptive systems & autonomous robotics) - both from the School of Computation and Cognitive Sciences at the University of Sussex, UK. In 2001 he joined ENG's R&D department as researcher, and has worked on AI related issues in various IST projects (I-MASS, BRICKS, SLA@SOI, FI-WARE). He is currently involved with the FP7-ICT project ENVISAGE (Engineering Virtualised Services), working on the utility-based prioritisation & scheduling of computational tasks under resource constraints. |

**Publications**:

- Gagnon, L., Peretz, I., Fulop, T. (2009). Musical structural determinants of emotional judgments in dementia of the Alzheimer type. Neuropsychology, 23(1), 90-97. doi: 10.1037/a0013790

**Other relevant information:**

Participation on previous European projects:

•FP7 call 8 : Artist, Markos

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| No.6 | Tellu AS | TellU | Norway |  |

**Brief Description**:

Tellu is a SME software company founded in 2006 as a spin-off from Ericsson. Tellu operates the TelluCloud service, which is a state-of-the-art sensor integration platform with focus on tracking personnel and assets, both indoor and outdoors. The platform is deployed in the health sector, the security sector and in a range of enterprise applications. The service is used in several European countries by companies such as Telenor, Tieto, X-Guard, G4S, SMC and Trigion, and in China.

Tellu has competencies on integrating different sensor systems and handling large amount of collected data. This includes rule definition and rule engine execution on collected sensor data and UI programming to configure and retrieve sensor data. Tellu possesses in-depth knowledge of smartphone application development utilising a maximum of the smartphone built-in sensors.

Cloud based service operation is another competence of Tellu. The TelluCloud service is run within virtual server clusters in hosting centres. Performance and high-availability are important properties of a security intensive service. TelluCloud will be offered on amazon Cloud service during H1 2016.

Website: www.tellucloud.com

**Role in Project**:

TellU is a use case partner, then largely involved in WP5 but also in WP2, WP3 and WP6. TellU will provide the TelluCloud service as a test-bed for methods and technologies developed in the project. Tellu will apply the technologies developed in STAMP in TelluCloud SW development and run-time monitoring to improve development efficiency and product quality.

**Key Staff**

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| Mr. Knut Eilif Husa, CTO (male) | Mr. Knut Eilif Husa has solid experience within mobile and information technology. He holds an M.Sc. degree in computer science from NTNU and has several patents within internet technology and information security. Prior to working in Tellu, he was working in Ericsson with telecom service platforms and mobile e-commerce systems. Mr. Husa has deep knowledge in information, mobile and communication technologies. He has worked on several national and international research projects. |
| Mr. Geir Melby (male) | Mr. Geir Melby has specialist competence within information, mobile and communication technology. He was one of the founders of Tellu. Before joining Telluhe was research manager at Ericsson in Norway. He has solid experience with research and development projects, project management and execution of research projects. He holds an MSc degree in communication technology. |
| Mr. Lars Thomas Boye (male) | Mr. Lars Thomas has experience in system development and object-oriented design and modeling. He has worked on mobile platforms, especially Android. Have particular experience of design and customization of solutions for people with special needs. He has worked on several national and international research projects. He holds an MSc degree in communication technology. |

**Publications**:


- Haugen, O., K.E. Husa, R.K. Runde, and K. Stølen. *Why Timed Sequence Diagrams Require Three-Event Semantics*. in *Scenarios: Models, Transformations and Tools*. 2005. Dagstuhl: Springer LNCS 3466 p 1-25 ISBN: 3-540-26189-3.
- Haugen, O., K.E. Husa, R.K. Runde, and K. Stølen, *STAIRS towards formal design with sequence diagrams*. Software and System Modeling (SoSyM), 2005


**References:**

- HEADS, EU FP7 STREP – Heterogenous And Distributed Services
- OffPAD, Eurostars -Offline Personal Authentication Device
- Poseidon FP7 STREP -Inclusion of People with Down Syndrome in Society

**Other relevant information:**

Participation on previous European projects:

- Mylife -Multimedia technology to support independence for and participation by people with dementia. EU Active Ambient Living (AAL) Joint Programme
- PIA -Personal IADL Assistant. ) EU AAL Joint Programme (2013-2015).
- T&Tnet -Travel and Transportation solutions through emotional-social NETworking. ) EU AAL Joint Programme (2012-2014).

| No.7 | XWiki SAS | *XWiki* | France | |
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**Brief Description**:

XWiki SAS is an OpenSource SME created in 2004 that is specialized in the development of collaborative solutions for the enterprise. Its main product is named after the company and provides an open source platform that focuses on the development of collaborative applications for editing and sharing information in the context of the enterprise.

The XWiki platform has been used to address different types of markets and needs, such as collaborative watch, project management and the implementation of advanced intranets and extranets. The platform is also corroborated by a wide OpenSource community that contributes to its development and its uses in different domain.

XWiki SAS' solutions have also been used for deploying large scale solutions in the context of the Curriki Project[1] (a non profit organization that distributes educational OpenSource material in order to improve education worldwide), and EMC, worldwide leader in storage solutions.

Website: http://xwiki.com/

**Role in Project**:

XWiki will provide a use case in improving the software development process used in developing the XWiki Open Source Collaborative Software Product. All of the specified objectives are important to XWiki's use case and XWiki will be paying attention to all of the specified measurables. Furthermore XWiki will invest effort in the measurement of testing KPIs and integration of tools resulting from the project into build tool and/or Continuous Integration server plugins which are reusable in both the XWiki development process and in other Open Source projects. XWiki is mainly involved in the WP5 but also in WP1, WP2 and WP6.

**Key Staff**

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| Vincent Massol (*male*) | After receiving his Engineering degree from Télécom Bretagne (a French Engineer school) in 1995 (Bachelor + 5 years, equivalent M.Sc.), Vincent Massol worked 4 years at OCTO Technology as a senior Technical Architect for large scale Information Systems.<br>He created and managed OCTO's London office in 2001, co-founded Pivolis (an Agile offshore software development company) 2 years after.<br>In 2006, Vincent joined XWiki, an open source wiki product company, as CTO and co-founder.<br>In parallel, he is has founded and participated in a number of Open Source projects including Cactus, Maven, Mock Objects and Cargo.<br>Vincent is the best-seller author of "JUnit in Action" (Manning), "Maven: A Developer's Notebook" (O'Reilly) and "Better Builds with Maven" (Mergere) and has spoken at numerous conferences including Solutions Linux 2014, LesCastCodeurs 2014, HumanCoders 2014, Codeurs en Seine 2013, CodeCamp Iasi 2013, Devoxx France 2013, FOSDEM 2013, Devoxx BE 2012. |
| Caleb James DeLisle (*male*) | Originally from Massachusetts USA, Caleb James DeLisle graduated from the Franklin County Technical School Machine Technology program and after two years of University, left the Mechanical Engineering field to work in Open Source. In 2011 he founded the cjdns Open Source project for cryptographically assured IP packet routing, he then went on to co-develop the ncry.pt encrypted pastebin, pioneering a secure key sharing technique which would later find it's way into ZeroBin, Mega.co.nz and others. After joining XWiki SAS fulltime, he authored the first realtime collaborative editor to make use of Nakamoto Blockchains for state synchronisation, removing the complex logic from the server. |

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| | His Open Source work has been featured in Wired Magazine (USA), NewScientist (USA), Neue Zurcher Zeitung (Switzerland), Kommersant (Russia) |
| Dr. Paul Libbrecht (male) | Having done his masters in Mathematics at University of Lausanne, Switzerland, Paul went on to obtain his PhD, Magna cum Laude from University of Saarland.<br>Paul joined the Omega research team of the University of Saarland (specialised in automated provers) in 2000. There he co-designed the ActiveMath learning environment combining intelligent tutoring systems, user-modelling, and semantic knowledge representations.<br>After 2013, Paul became a lecturer in computer science (Vertretungspro-fessor). Teaching of informatics to teachers' and media-management students. Research in learning analytics (visualizations, web-architecture, storage) and open educational resources (search, re-use); search multilingualization of Open Discovery Space (an OER platform). Ac-quisition of EU projects. Direction and advice for masters' (6) and doctoral theses (1).<br>Paul has published over 98 times with a total of 1,070 citations for an H-index of 15. |

**Publications**:

- XWiki Platform - An Open Source enterprise collaboration and knowledge management platform with over 3,240 automated tests.
- XWiki Testing Infrastructure - A test framework for the XWiki Platform which executes the hand-written tests under a set of different circumstances totaling in 14,000 test-executions.

**References:**

- XWiki participated in the CompatibleONE French research project for developing an Open Source solution for cloud hosting, including adaptation of software to support containerization for repeatability.

**Infrastructure/technical equipment :**

XWiki will provide a VMWare virtual machine cluster hosted on OVH for the purposes of running normal and amplified tests to validate the results of the project and to collect pre-results data sets for before-after validation.

**Other relevant information:**

Participation on previous European projects:

•FP7 call 8 : Riscoss

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| No.8 | Atos Spain | Atos | Spain | Atos |

**Brief Description**:

**Atos SE** (Societas Europaea) is a leader in digital services with 2014 pro forma annual revenue of circa €11 billion and 93,000 employees in 72 countries. Serving a global client base, the Group provides Consulting & Systems Integration services, Managed Services & BPO, Cloud operations, Big Data & Cyber-security solutions, as well as transactional services through Worldline, the European leader in the payments and transactional services industry. With its deep technology expertise and industry knowledge, the Group works with clients across different business sectors: Defence, Financial Services, Health, Manufacturing, Media, Utilities, Public Sector, Retail, Telecommunications and Transportation.

Atos is focused on business technology that powers progress and helps organizations to create their firm of the future. The Group is the Worldwide Information Technology Partner for the Olympic & Paralympic Games and is listed on the Euronext Paris market. Atos operates under the brands Atos, Atos Consulting, Atos Worldgrid, Bull, Canopy, Unify and Worldline.

**Atos Research & Innovation** (ARI) is the R&D hub for emerging technologies and a key reference for the whole Atos group. With almost 30 years of experience in running Research, Development and Innovation projects, we have become a well-known player in the EU context. Our multidisciplinary and multicultural team has the skills to cover all the activities needed to run projects successfully, from scientific leadership to partnership coordination, from development of emerging technologies to the exploitation of project outcomes, with a strong focus on dissemination, innovation adoption and commercialization.

Atos is a founding member of the European Technology Platform NESSI (Networked European Software and Services Initiative). Our company is a major partner in Future Internet-related initiatives being member of the FI PPP Steering Board and Industrial Advisory Board. Since 2014, Atos is a founding member of the Big Data Value Association (BDVA), assuming the roles of Vice-presidency and Deputy Secretary-general. We are also member of the 5G PPP Steering Board. Additionally, Atos is a member of NetWorld2020, NEM, Nanomedicine, ERTICO, CELTIC, NIS, EOS, LSEC, ETSI, OW2, OASIS, Cloud Security Alliance, Eurocities, etc. Finally Atos is a core member of the KIC EIT HEALTH and an official member of the KIC EIT DIGITAL associated node Madrid. At national level, Atos is currently holding the Presidency and Secretary of PLANETIC for ICT, as well as the Vice-presidency of es.Internet for Future Internet technologies, and is member of several others, such as PESI, Logistop, eVIA for Health and Independent Living, NanoMed or the Spanish Railways Technology Platforms (PTFE).

The **Information Technologies (IT) market** addresses software developers and companies, solutions integrators and software consultants. The market objective is to foster the adoption and transfer of emerging technologies and assets surrounding Cloud, Software and Service Engineering to Atos business units and other potential customers in IT domain and other vertical sectors. This goal allows further alignment of the research activity in these technologies with customers' needs, providing added value solutions to be included in the company's portfolio. In order to support this goal, the market participates or leads high level initiatives to establish roadmaps and guidelines for the Spanish and European IT market. A multidisciplinary and multi-geographical team, industry-oriented and highly experienced both in business and technology allows the ARI IT market to develop research IT solutions to facilitate the taking up of emerging technologies by the industry.

Website: http://es.atos.net/

**Role in Project**:

For the **business and sustainability** related tasks in the project, Atos provides also a proven methodology to elaborate business scenarios, exploring the full value chain for the developed solution environment, and sustainable exploitation plans beyond the project life. The methodology depicts how to obtain different approaches for the ownership and governance of post-project exploitation

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| based on previous experience across different projects. ATOS is involved in WP1, WP2, WP4, WP5 and WP6, mainly on WP5 for a FIWARE use case. | |
| **Key Staff** | |
| **Clara Pezuela** (female) | She has a degree in Computer Science from the Universidad Politécnica of Madrid. She has 17 years' experience in R&D projects development and management. Currently, she is the Head of IT Market at Research and Innovation Group in Atos. Her main responsibilities now are the management of research projects and teams, the preparation of new research proposals and the commercialization of research assets in Atos business units. She is skilled in open business models and innovation processes, collaborative development environments, service and software engineering. She has coordinated an integrated project in FP7-ICT-ARTIST about migration of applications to the cloud. Currently she is coordinating a H2020-ICT-TANGO about a reference architecture for software in heterogeneous devices and leading an activity project (MCloudDaaS) in EIT Digital Future Cloud action about usage of multi cloud in Big Data analytics as a service. She is also the President of PLANETIC, the Spanish technology platform for the adoption and promotion of ICT in Spain. Her current interest areas are innovation management, the improvement of software development processes and methods and the adoption of innovation assets by the industry. |
| **Ilknur Chulani** (female) | She joined Atos as a Software Architect and Technical Coordinator in 2011. Ilknur graduated as a Computer Engineer in 1999 from Ege University in Izmir, Turkey, and gained about ten years of research and development experience with IBM in the USA and Canada. She worked on the development of WebSphere Studio Device Developer, the first commercial Java IDE based on the Eclipse platform, and on the implementation of Java Class libraries and IBM's J9 Java Virtual Machine. She took on roles like Senior Developer, Development Lead and Coordinator, and collaborated with international and cross-functional teams at IBM. In Turkey, she gained knowledge on SOA, ESB and BPEL at BEA Systems eSolutions. At Atos, Ilknur has been working on Cloud Computing Infrastructures, Cloud Application Governance and Service Level Agreement Management, Open source collaboration tools and Future Internet technologies. She has been involved in several FP7 projects including OPTIMIS, Cloud4SOA, MARKOS, ARTIST and FI-CORE. In FI-CORE, she is acting as a FIWARE coach to the accelerator project teams, providing training and mentoring services; and leading the Atos team in the coaching, development and operation of FIWARE technologies and nodes. She is also supporting the commercial team in FIWARE related offers. |
| **Omer Ozdemir** (male) | He has a BSc degree in Computer Science and Engineering from Marmara University/Istanbul - Turkey in 2009. Since then he has worked for Ericsson and Sony in various telecom projects as a Senior Software/Integration Engineer. He joined Atos Research and Innovation/Software Engineering Lab in December 2013 and been involved in the development of several European projects such as Xifi, IoT-est, Cloudwave and now RAPID. He is actively participating in the FIWARE coaching team and helping SMEs to integrate their applications into the FIWARE platform. He is one of the responsibles for building and maintaining the OpenStack / FIWARE Lab test instance of ARI. His interests are SaaS/PaaS and Openstack environment. |
| **Publications**:<br>• "API as a Service I: How the FIWARE Platform Drives Innovation" Malena Donato, (Ascent ATOS Blog, May 2015) https://ascent.atos.net/api-service-fiware-platform-drives-innovation<br>• Smart Cities and Beyond: How FIWARE is shaping the Smart Society Malena Donato, (Ascent ATOS, Blog May 2015) https://ascent.atos.net/smart-cities-beyond-fiware-shaping-smart-society/ | |

**Other relevant information:**

Participation on previous European projects:

**FI-WARE** - FUTURE INTERNET CORE PLATFORM (FI PPP; 2011- 2014 and 2015-2017) [www.fi-ware.eu].

FI-WARE is a core platform that eases the creation of innovative applications by lowering the costs and complexity of serving large numbers of users globally and handling data at a large scale. Atos participates in the Apps Ecosystem and FI-CODE tools chapters on the first phase of the project, developing a light-weighted semantic-enabled service composition engine and some FIWARE development tools. In the second phase, Atos is

leading the development of FIWARE PoCs and participating in the coaching activities, aiming to provide support to the FIWARE accelerator projects.

**IoTest:** Internet of Things Environment for Service Creation and Testing (FP7 2011-2014) [www.iotest.eu/iotest]. IoTest establishes and eases the creation and provision of IoT enabled business services by bringing together the three disciplines Internet of Things, Service Engineering and Testing. Atos led the development of the Service Composition Environment, one of the main results of the project, while also developing the means for automatic adaptation at runtime. Atos also participates in the scenario identification, reference architecture definition, implementation of reusable components and led the integration of all developed components.

**XIFI**: eXperimental Infrastructures for the Future Internet (FI PPP 2013- 2015) [www.fi-xifi.eu]. The XIFI project facilitates the uptake, deployment and federation of several instances of a common platform to pave the way for a unified European marketplace that is crucial for enabling commercial exploitation of FI resources. This is achieved via FIWARE Ops (http://www.fiware.org/fiware-operations/), a collection of tools that ease the deployment, set-up and operation of FIWARE instances on infrastructures. It is designed to help expanding the infrastructure associated to a given FIWARE instance by means of federating additional nodes (datacenters) over time and allowing cooperation of multiple Platform Providers. ATOS is involved mainly on leading the WP4 Services & Tools, where it is responsible to design and implement the Resource Catalogue, the SLA Manager and the Security Dashboard. Further, ATOS is responsible to manage the integration with the Federation Layer and collaborate in the definition of the Architecture. It is also involved in some of the show case that demonstrates the use of these components.

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| No.9 | ActiveEon | AEon | France | |

**Brief Description**:

ActiveEon is an open source solution provider of parallel computing technologies and services. Thanks to the Research and Industry synergy and to its recognized expertise by the largest IT vendors, commercial partnerships sprang quickly and thus bringing industrial end users across varied domains.

ActiveEon provides a uniform parallel computing interface with distributed and parallel Workflows, and a uniform resource management, independent from the underlying virtualized infrastructure, for better utilization of existing resources from desktop, multi-cores, servers, clusters to Grids and Clouds.

Website: http://www.activeeon.com

**Role in Project**: ActiveEon is use case provider, and technology provider for the STAMP as a service platform. ActiveEon will use the STAMP project to enhance its software test process. ActiveEon will provide the integration of the platform to be run as a Service using its automatic cloud deployment solution (ProActive Cloud Automation)

**Key Staff**

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| Dr. Iyad Alshabani (Male) R&D Manager | Hold a PhD in Computer Science from the University of Science and Technologies of Lille (Lille1) and his PhD thesis work was mainly on the distributed and parallel software components and composition frameworks. He is specialized in component based software engineering, SOA, EDA, Big Data, business and scientific workflows and scientific research environments. He has a solid experience in R&D on multiple fields and he participated on many collaborative projects among them we can cite: H2020 MC-SUITE, EU FP7 PLAY, ANR SocEDA, ICTLab Multimodal Mobility Activity, ANR SONGS, ANR USS-SimGrid, ANR PERSO. |
| Dr. Brian Amedro, (Male) CTO | Chief Technical Officer at Activeeon and manages a 10 developers team. He has a PhD in Computer Science dedicated to parallel computing “A programming model for numerical applications: from multicore to clouds “and his speciality fields of competence are the Cloud architectures (IaaS, Paas, Saas), parallel and distributed systems, high performance applications. |
| Dr. Denis Caromel, (Male) CEO | Initially professor at University of Nice-Sophia Antipolis-CNRS and INRIA Sophia. He has himself coordonate EU projects. He is also founder and president at ActiveEon. His research interests include distributed, and Cloud computing. Denis Caromel gave many invited talks on Object, Parallel and Distributed Computing around the world (Jet Propulsion Laboratory, Berkeley, Stanford, ISI, USC, Electrotechnical Laboratory Tsukuba, Sydney, Oracle-BEA EMEA, Digital System Research Center in Palo Alto, NASA Langley, IBM Tom Watson and Zurich). He acted as key-note speaker at several major conferences keynote (MDM, DAPSYS 2008, CGW’08, Shanghai CCGrid 2009, IEEE ICCP’09, ICPADS 2009 in Hong Kong). Recently, he gave many invited talks, e.g., at Devoxx (gathering about 3500 persons), an invited conference on Cloud at Expo Universal 2010, Oct. 18, Shanghai, China, and at 2011 Open Stack Summit in Santa Clara. |
| Dr. Codé Diop (Male) R&D Engineer | Codé Diop is a Network and Telecommunications engineer and he has a PhD in Computer Science and Systems Architecture. His main research interests concern cloud computing, service-oriented architecture, microservices architecture, autonomic manage of QoS. |

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| | Author of the book Smart SOA Platforms in Cloud Computing Architectures, Codé is working as an R&D Engineer, Cloud and Distributed System Architect |

**Publications**:

- S. Malik, F. Huet, D. Caromel: Latency based group discovery algorithm for network aware cloud scheduling. Future Generation Comp. Syst. 31: 28-39 (2014)
- Denis Caromel, Cédric Dalmasso, Christian Delbé, Fabrice Fontenoy, Oleg Smirnov: OW2 ProActive Parallel Suite: Building Flexible Enterprise CLOUDs. ERCIM News 2010(83): 38-39 (2010)
- Denis Caromel, Ludovic Henrio, Bernard P. Serpette: Asynchronous and deterministic objects. POPL 2004: 123-134
- Ernesto Exposito, Codé Diop, "Smart SOA platforms in cloud computing architectures", Wiley-ISTE, ISBN: 978-1-84821-584-9, June 2014, pp.224.
- http://www.iste.co.uk/index.php?f=x&ACTION=View&id=668
- Codé Diop, Ernesto Exposito, Christophe Chassot. "QoS and scalability management in an autonomic cloud-based networked service bus", 20th International Conference on Telecommunications, Casablanca, Morocco, 6-8 May 2013, 5p.
-

**References:**

- **TEFIS** is a large-scale integrating project that addresses the EU- FP7 work program objective ICT-2009.1.6: Experimental Facilities. ActiveEon is use-case provider and contributes to the integration and deployment of the TEFIS platform (the ProActive Scheduler is a core service of the platform) http://www.tefisproject.eu/
- **CompatibleOne** is an open source project with the aim of providing interoperable middleware for the description and federation of heterogeneous clouds comprising resources provisioned by different cloud providers. Interoperability is addressed through the Open Cloud Computing Interface (OCCI). http://www.compatibleone.com/community/
- **UnivCloud** is a French project for building an dedicated cloud, including a large set of services from infrastructure to software, for Universities. http://univcloud.fr/
- **DataScale** project main mission is to develop synergies between Big Data and HPC, and more specifically to develop Big Data technological building blocks that will enrich the HPC ecosystem. http://datascale.org/
- **OpenCloudware** aims at building an open software engineering platform, for the collaborative development of distributed applications to be deployed on multiple Cloud infrastructures. http://www.opencloudware.org/
- **OCCIware**: The OCCIware project aims at developing a formal framework as well as tools for modelization, design, deployment and execution of every computing resource as a service. It will leverage the Open Cloud Computing Interface (OCCI) recommendation from Open Grid Forum (OGF), http://www.occiware.org/

**Infrastructure/technical equipment :**

Activeeon will ask a budget to get resources in the Cloud in order to be able to provide the "STAMP as a Service" integrated platform

**Other relevant information:**

Participation on previous European projects:

- **TEFIS** is a large-scale integrating project that addresses the EU- FP7 work program objective ICT-2009.1.6: Experimental Facilities. ActiveEon is use-case provider and contributes to the integration and deployment of the TEFIS platform (the ProActive Scheduler is a core service of the platform) http://www.tefisproject.eu/
- **SHIWA** : The Shiwa is working on large-scale interoperable workflows for scientific simulations. Objectives of the project are to free workflow communities from lock-in to their selected workflow system and its supported distributed computing infrastructure. Activeeon's role is a technology provider for its workflow system, http://www.shiwa-workflow.eu/project
- **MC-Suite** : The MC-SUITE project proposes a new generation of ICT enabled process simulation and optimization tools enhanced by physical measurements and monitoring that can increase the competence of the European manufacturing industry, reducing the gap between the programmed process and the real part http://www.mc-suite.eu/

## *4.2. Third parties involved in the project (including use of third party resources)*

### 4.2.1. ***Inria***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | Y |
| • ***University of Rennes 1****, linked to Inria by a general agreement addressing all the common Inria-University of Rennes 1 common research activities via joint research teams of the « Rennes Bretagne Atlantique » Inria Research Centre, including the "DiverSE" research team. University of Rennes 1 will be involved in WP1.*<br>• ***Universite des Sciences et Techniques de Lille-Lille 1****, linked to Inria by a general agreement addressing all the common Inria-Lille 1 common research activities via joint research teams of the « Lille Nord Europe » Inria Research Centre, including the "SPIRALS" research team. Universite des Sciences et Techniques de Lille-Lille 1, will be involved in WP1.* | |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

### 4.2.2. ***SINTE***F

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | N |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

### 4.2.3. ***TUD***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | N |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

### 4.2.4. ***OW2***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | N |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

4.2.5. ***ENG***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | N |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

4.2.6. ***TellU***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | Y |
| *TellU plans to subcontract a part of its participation in WP6 exploitation, tasks 6.2 and 6.5, limited up to 19 K€. The tasks will include contributing to the definition of communication strategy and dissemination material and facilitating the engagement of Stamp to stakeholders in Tellu's value chains and markets. This engagement will differ from Tellu's existing business engagements with these stakeholders and it will be beneficial for Tellu's contribution to WP6 to combine own resources with external competence for this activity.*<br>*The rules for choosing the subcontractor will follow the EC requirements and TellU will ensure that the "best price for quality" subcontractor will be selected* | |
| Does the participant envisage that part of its work is performed by linked third parties | N |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

4.2.7. ***XWiki***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | Y |

| | |
|---|---|
| *XWiki SAS will involve a linked Third Party XWiki Software SRL, established in Iasi, Romania. XWiki Software SRL is a subsidiary at 95% of XWiki SAS and is fully integrated in the XWiki SAS organization, including development of the XWiki Software and providing services using the XWiki Software.*<br>*XWiki SAS and XWiki Software SRL will collaborate on the STAMP project by providing unique types of expertise. XWiki SAS specializes in the development of the Open Source XWiki Platform upon which all XWiki SAS offerings sit and XWiki Software SRL specializes in testing and projects around that platform. It is expected that XWiki Software SRL will use their Project Management and Testing skills to organize the project around the needs of the XWiki Software SRL Testing Team and the XWiki SAS Research and Development Team. The XWiki SAS Research and Development Team will provide their technical expertise around the XWiki Platform and it's build and automated test infrastructure and continuous integration platform while the XWiki Software SRL Testing Team will provide their expertise in defining the testing and KPI collection procedures and evaluation of the success of the XWiki Use Case integration*. | |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

### 4.2.8. ***ATOS***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | Y |
| *Atos Spain has introduced in the consortium a third party Atos Turkey. Atos Turkey is one of the companies of Atos group, an International Information Technology Services company based in Istambul. Serving a global client base, it delivers hi-tech transactional services, consulting and technology services, systems integration and managed services. Atos focuses on business technology that powers progress and helps organizations to create their firm of the future. It is the Worldwide Information Technology Partner for the Olympic Games. Over ten years of local presence in the country,* ***Atos Turkey has been serving its clients turning their visions into results with a large team of experts. Atos Turkey is a Telecommunciations Competence Center since the year 2000.***<br><br>*In STAMP,* ***Atos Turkey work is mainly focused on WP5, Mrs. Ilknur Chulani will be the T5.4 leader. The team provides high expertise to operate FIWARE platform and accesing GEs' APIs. They will perform all required activities such as running the IoT Smart City pilots*** *and configuring all and applying test amplification techniques and tools on the platform.* | |
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

### 4.2.9. ***AEon***

| | |
|---|---|
| Does the participant plan to subcontract certain tasks | N |
| Does the participant envisage that part of its work is performed by linked third parties | N |

| | |
|---|---|
| Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement) | N |

# 5. Ethics and security

## 5.1 Ethics

STAMP will involve ethics issues: NO

## 5.2 Security

STAMP will involve:

- activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

## ***Appendix: letters of intent (members of the End-User Advisory Board)***

The hereafter letters of intent confirm the contribution of the members of the End-User Advisory Board (EUAB), IBM, Huawei, Nokia & Tieto.

IBM

Compagnie IBM France
1 bis, avenue du Gulfstream
33380 – Pornichet

**Without Prejudice and Subject to Contract**

Philippe Bauquel
Program director Rational R&D, IBM France Lab
IBM France
1 bis, avenue du Gulfstream
33380 – Pornichet
France

Email : bauquel.p@fr.ibm.com
Tel : +33-2-5116-4010

4 avril 2016

Dear Dr. Baudry,

I confirm you that my organization, France Lab z Systems Software, is very interested in the STAMP project proposal that you will submit to the Horizon 2020 Programme, under the topic ICT-10-2016.

France Lab z Systems Software develops products in order to facilitate the DevOps adoption in large organization developing SOR on mainframe. Our developers are mainly Java developers, collaborating with other laboratories in a continuous Integration and deployment context. We are searching to continuously optimise our development process through tests and deployment automation in order to ship more often new releases without impacting the robustness of our product. We believe that STAMP could be a solution to address this need.

Therefore, we strongly support the STAMP proposal and we confirm our intention to contribute to the End Users Group, to provide our experience, discuss our needs, have favoured access to the project results and share ideas with the project partners and the other members of this group about the potential markets for the developed technology.

We understand that our efforts cannot be directly funded via this project, but for our participation in project meetings and workshops, travel and accommodation expenses are reimbursed by the project to some extent (according to the EU rule).

Yours sincerely

P. O.

IBM France
9 rue de Verdun
94253 Gentilly Cedex
France

*Philippe Bauquel*
*Program director Rational R&D, IBM France Lab*

Compagnie IBM France
Société par Actions Simplifiée au capital de 611 451 766,20 Euros
Siège Social : 17 avenue de l'Europe
92275 Bois-Colombes Cedex
552 118 465 RCS Nanterre
Siret 552 118 465 03644 - Code NAF 6202A

**Without Prejudice and Subject to Contract**

HUAWEI TECHNOLOGIES IRELAND LIMITED
3rd Floor
No.4 Custom House Plaza
Harbourmaster Place
IFSC
Dublin 1

Email : michael.christopher.woods@huawei.com
Tel : +353 86 74 86 742

Ireland, April 4th 2016

Dear Sirs,

I confirm you that my organization, Huawei is very interested in the STAMP project proposal that you will submit to the Horizon 2020 Programme, under the topic ICT-10-2016.

Huawei is a leading global information and communications technology (ICT) solutions provider. Driven by responsible operations, ongoing innovation, and open collaboration, we have established a competitive ICT portfolio of end-to-end solutions in telecom and enterprise networks, devices, and cloud computing. Our ICT solutions, products, and services are used in more than 170 countries and regions, serving over one-third of the world's population. With more than 170,000 employees, Huawei is committed to enabling the future information society, and building a Better Connected World.

Therefore, we strongly support the STAMP proposal and we confirm our intention to contribute to the End Users Group, to provide our experience, discuss our needs, and have favoured access to the project results and share ideas with the project partners and the other members of this group about the potential markets for the developed technology.

We understand that our efforts cannot be directly funded via this project, but for our participation in project meetings and workshops, travel and accommodation expenses are reimbursed by the project to some extent (according to the EU rule).

Yours sincerely

Chris Woods

Huawei Ireland H2020 Research Lead

NOKIA

26 February 2016

Project Consortium STAMP

Josef Urban

Head of Technology Vision

Nokia Bell Labs

Direct mobile: +491754331720

Josef.Urban@nokia.com

Nokia

Nokia Solutions and Networks GmbH & Co. KG

Office Address:

St. Martin Str. 76

81541 Munich

Germany

To whom it may concern

I confirm that Nokia Bell Labs is very interested in the STAMP project proposal that you will submit to the Horizon 2020 Programme, under the topic ICT-10-2016.
Software development and testing practices in particular in the context of continuous integration and DevOps is a focus of our research activities with the goal to increase productivity and quality in developing software systems. Therefore, we are interested in the ideas and results of the STAMP project and we would support the project by providing feedback.
Therefore, we strongly support the STAMP proposal and we confirm our intention to contribute to the End Users Group, to provide our experience, discuss our needs, and share ideas with the project partners and the other members of this group about the potential markets for the developed technology. By doing so we will get favored access to the project results.
We understand that our efforts cannot be directly funded via this project, but for our participation in project meetings and workshops, travel and accommodation expenses are reimbursed by the project to some extent (according to the EU rule).

Best regards

**Tieto**

**Without Prejudice and Subject to Contract**

Christian Westli
Solution architect
Tieto
Vestveien 18
1400 Ski
Email: christian.westli@tieto.com
Tel: +47 415 52 340

Mars 30, 2016

To whom it concerns

I confirm you that my organization, Tieto, is very interested in the STAMP project proposal that you will submit to the Horizon 2020 Programme, under the topic ICT-10-2016.

Tieto develops and maintains software solutions for the Healthcare and Welfare area. Tieto focuses on high quality software development and acknowledges comprehensive testing as part of this. Tieto possess skilled professionals within both software development and the healthcare area.

Therefore, we strongly support the STAMP proposal and we confirm our intention to contribute to the End Users Group, to provide our experience, discuss our needs, have favoured access to the project results and share ideas with the project partners and the other members of this group about the potential markets for the developed technology.

We understand that our efforts cannot be directly funded via this project, but for our participation in project meetings and workshops, travel and accommodation expenses are reimbursed by the project to some extent (according to the EU rule).

Yours sincerely

Christian Westli, Solution architect

# ESTIMATED BUDGET FOR THE ACTION (page 1 of 2)

| | Estimated eligible[1] costs (per budget category) | | | | | | | | | EU contribution | | | Additional information | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A. Direct personnel costs | | | | B. Direct costs of subcontracting | C. Direct costs of fin. support | D. Other direct costs | E. Indirect costs[2] | Total costs | Reimbursement rate % | Maximum EU contribution[3] | Maximum grant amount[4] | Information for indirect costs | Information for auditors | Other information: |
| | A.1 Employees (or equivalent)<br>A.2 Natural persons under direct contract<br>A.3 Seconded persons<br>[A.6 Personnel for providing access to research infrastructure] | | A.4 SME owners without salary<br>A.5 Beneficiaries that are natural persons without salary | | | | D.1 Travel<br>D.2 Equipment<br>D.3 Other goods and services<br>D.4 Costs of large research infrastructure | | | | | | Estimated costs of in-kind contributions not used on premises | Declaration of costs under Point D.4 | Estimated costs of beneficiaries/ linked third parties not receiving EU funding |
| Form of costs[6] | Actual | Unit[7] | Unit[8] | | Actual | Actual | Actual | Flat-rate[9] 25% | | | | | | | |
| | (a) | Total (b) | No hours | Total (c) | (d) | (e) | (f) | (g)=0,25x ((a)+(b)+ (c)+(f) +[(h1)+(h2)]- (m)) | (i)= (a)+(b)+(c)+ (d)+(e)+(f)+ (g)+(h1)+(h2)+(h3) | (j) | (k) | (l) | (m) | Yes/No | |
| 1. INRIA | 378040.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 55000.00 | 108260.00 | 541300.00 | 100.00 | 541300.00 | 541300.00 | 0.00 | No | |
| - USTL[14] | 18900.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 4725.00 | 23625.00 | 100.00 | 23625.00 | 23625.00 | 0.00 | No | |
| - UR1[14] | 21000.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 5250.00 | 26250.00 | 100.00 | 26250.00 | 26250.00 | 0.00 | No | |
| Total beneficiary 1 | 417940.00 | 0.00 | | | 0.00 | 0.00 | 55000.00 | 118235.00 | 591175.00 | | 591175.00 | 591175.00 | 0.00 | | |
| 2. SINTEF | 511200.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 33000.00 | 136050.00 | 680250.00 | 100.00 | 680250.00 | 680250.00 | 0.00 | No | |
| 3. TUD | 452984.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 41000.00 | 123496.00 | 617480.00 | 100.00 | 617480.00 | 617480.00 | 0.00 | No | |
| 4. OW2 | 291712.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 99000.00 | 97678.00 | 488390.00 | 100.00 | 488390.00 | 488390.00 | 0.00 | No | |
| 5. ENG | 295000.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 28000.00 | 80750.00 | 403750.00 | 100.00 | 403750.00 | 403750.00 | 0.00 | No | |
| 6. TellU | 263504.00 | 0.00 | 0 | 0.00 | 18770.00 | 0.00 | 28000.00 | 72876.00 | 383150.00 | 100.00 | 383150.00 | 383150.00 | 0.00 | No | |
| 7. XWiki | 138600.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 25500.00 | 41025.00 | 205125.00 | 100.00 | 205125.00 | 205125.00 | 0.00 | No | |
| - XWiki Romania[14] | 89700.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 5000.00 | 23675.00 | 118375.00 | 100.00 | 118375.00 | 118375.00 | 0.00 | No | |
| Total beneficiary 7 | 228300.00 | 0.00 | | | 0.00 | 0.00 | 30500.00 | 64700.00 | 323500.00 | | 323500.00 | 323500.00 | 0.00 | | |
| 8. ATOS | 197925.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 18000.00 | 53981.25 | 269906.25 | 100.00 | 269906.25 | 269906.25 | 0.00 | No | |
| - ATOS TURKEY[14] | 85575.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 10000.00 | 23893.75 | 119468.75 | 100.00 | 119468.75 | 119468.75 | 0.00 | No | |
| Total beneficiary 8 | 283500.00 | 0.00 | | | 0.00 | 0.00 | 28000.00 | 77875.00 | 389375.00 | | 389375.00 | 389375.00 | 0.00 | | |
| 9. AEon | 316000.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 28000.00 | 86000.00 | 430000.00 | 100.00 | 430000.00 | 430000.00 | 0.00 | No | |
| Total consortium | 3060140.00 | 0.00 | | 0.00 | 18770.00 | 0.00 | 370500.00 | 857660.00 | 4307070.00 | | 4307070.00 | 4307070.00 | 0.00 | | 0.00 |

# ESTIMATED BUDGET FOR THE ACTION (page 2 of 2)

(1) See Article 6 for the eligibility conditions
(2) The indirect costs covered by the operating grant (received under any EU or Euratom funding programme; see Article 6.5.(b)) are ineligible under the GA. Therefore, a beneficiary that receives an operating grant during the action's duration cannot declare indirect costs for the year(s)/reporting period(s) covered by the operating grant (see Article 6.2.E).
(3) This is the theoretical amount of EU contribution that the system calculates automatically (by multiplying all the budgeted costs by the reimbursement rate). This theoretical amount is capped by the 'maximum grant amount' (that the Commission/Agency decided to grant for the action) (see Article 5.1).
(4) The 'maximum grant amount' is the maximum grant amount decided by the Commission/Agency. It normally corresponds to the requested grant, but may be lower.
(5) Depending on its type, this specific cost category will or will not cover indirect costs. Specific unit costs that include indirect costs are: costs for energy efficiency measures in buildings, access costs for providing trans-national access to research infrastructure and costs for clinical studies.
(6) See Article 5 for the forms of costs
(7) Unit : hours worked on the action; costs per unit (hourly rate) : calculated according to beneficiary's usual accounting practice
(8) See Annex 2a 'Additional information on the estimated budget' for the details (costs per hour (hourly rate)).
(9) Flat rate : 25% of eligible direct costs, from which are excluded: direct costs of subcontracting, costs of in-kind contributions not used on premises, direct costs of financial support, and unit costs declared under budget category F if they include indirect costs
(10) See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit).
(11) See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit, estimated number of units, etc)
(12) Only specific unit costs that do not include indirect costs
(13) See Article 9 for beneficiaries not receiving EU funding
(14) Only for linked third parties that receive EU funding

**ANNEX 2a**

# ADDITIONAL INFORMATION ON THE ESTIMATED BUDGET

## Unit cost for SME owners/natural beneficiaries without salary

### 1. Costs for a *[*SME owner*]/[*beneficiary that is a natural person*]* not receiving a salary

Units: hours worked on the action

Amount per unit ('hourly rate'): calculated according to the following formula:

{{ EUR 4,650 / 143 hours}
multiplied by
{country-specific correction coefficient of the country where the beneficiary is established}

Country-specific correction coefficient (in force at the time of the call):

**EU Member States**

| country | coefficient | country | coefficient | country | coefficient | country | coefficient | country | coefficient |
|---|---|---|---|---|---|---|---|---|---|
| AT | 104.8% | DK | 135.3% | HR | 97.5% | LV | 75.9% | SE | 111.7% |
| BE | 100.0% | EE | 78.3% | HU | 76.2% | MT | 89.6% | SI | 86.1% |
| BG | 71.5% | EL | 92.7% | IE | 113.5% | NL | 104.3% | SK | 82.6% |
| CY | 91.8% | ES | 97.6% | IT | 106.7% | PL | 76.4% | UK | 120.3% |
| CZ | 83.8% | FI | 116.6% | LT | 73.1% | PT | 89.1% | | |
| DE | 98.8% | FR | 111.0% | LU | 100.0% | RO | 68.3% | | |

**H2020 associated countries**

| country | coefficient | country | coefficient | country | coefficient | country | coefficient | country | coefficient |
|---|---|---|---|---|---|---|---|---|---|
| AL | 76.1% | FO | 134.1% | LI | 110.0% | MK | 68.4% | TR | 86.6% |
| BA | 73.6% | IL | 108.7% | MD | 61.1% | NO | 131.9% | | |
| CH | 113.1% | IS | 116.6% | ME | 66.9% | RS | 67.1% | | |

**Other countries**

| country | coefficient | country | coefficient | country | coefficient | country | coefficient | country | coefficient |
|---|---|---|---|---|---|---|---|---|---|
| AM | 89.9% | CU | 83.8% | JP | 115.9% | NI | 57.3% | TJ | 64.9% |
| AO | 114.6% | CV | 76.4% | KE | 78.1% | NP | 73.5% | TL | 78.3% |
| AR | 58.5% | DJ | 93.4% | KG | 83.1% | NZ | 94.1% | TN | 70.5% |
| AU | 105.0% | DO | 66.9% | KH | 70.5% | PA | 57.0% | TO | 85.0% |
| AZ | 93.0% | DZ | 81.7% | KR | 105.2% | PE | 75.5% | TT | 74.1% |
| BB | 116.6% | EC | 68.8% | KZ | 100.2% | PG | 83.0% | TW | 83.6% |
| BD | 47.2% | EG | 48.6% | LA | 77.7% | PH | 65.8% | TZ | 65.2% |
| BF | 93.8% | ER | 61.2% | LB | 86.4% | PK | 49.4% | UA | 92.3% |
| BJ | 92.6% | ET | 85.2% | LK | 61.6% | PS | 100.4% | UG | 65.7% |
| BM | 151.5% | FJ | 68.1% | LR | 100.1% | PY | 71.9% | US | 99.4% |
| BO | 51.3% | GA | 113.1% | LS | 56.7% | RU | 115.5% | UY | 75.3% |
| BR | 92.0% | GE | 89.5% | LY | 60.0% | RW | 87.3% | UZ | 51.4% |
| BW | 55.3% | GH | 68.2% | MA | 83.5% | SA | 84.8% | VE | 70.0% |
| BY | 65.0% | GM | 67.7% | MG | 80.0% | SB | 93.3% | VN | 51.1% |
| BZ | 75.3% | GN | 60.4% | ML | 90.4% | SD | 65.1% | VU | 112.6% |
| CA | 86.4% | GT | 78.8% | MR | 64.5% | SG | 102.5% | WS | 75.8% |
| CD | 127.6% | GW | 102.7% | MU | 72.7% | SL | 85.2% | XK | 58.6% |
| CF | 114.3% | GY | 58.9% | MW | 76.0% | SN | 86.2% | YE | 68.1% |
| CG | 124.9% | HK | 93.8% | MX | 70.4% | SR | 50.6% | ZA | 55.8% |
| CI | 102.0% | HN | 69.0% | MY | 71.6% | SV | 74.3% | ZM | 66.4% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CL | 67.1% | HT | 108.7% | MZ | 71.6% | SY | 74.8% | ZW | 47.2% |
| CM | 103.3% | ID | 75.3% | NA | 68.3% | SZ | 56.8% | | |
| CN | 85.0% | IN | 52.8% | NC | 128.9% | TD | 125.3% | | |
| CO | 76.6% | JM | 94.9% | NE | 87.9% | TG | 88.7% | | |
| CR | 76.7% | JO | 75.5% | NG | 92.4% | TH | 65.0% | | |

***[additional OPTION for beneficiaries/linked third parties that have opted to use the unit cost (in the proposal/with an amendment):*** For the following beneficiaries/linked third parties, the amounts per unit (hourly rate) are fixed as follows:

- Beneficiary/linked third party [short name]: EUR [insert amount]
- Beneficiary/linked third party [short name]: EUR [insert amount]

[same for other beneficiaries/linked third parties, if necessary] *]*

Estimated number of units: see Annex 2

## Energy efficiency measures unit cost

### *[OPTION if specific unit cost applicable to the grant:* 2. Costs for energy efficiency measures in buildings

Unit: $m^2$ of eligible 'conditioned' (i.e. built or refurbished) floor area

Amount per unit*: see (for each beneficiary/linked third party and BEST table) the 'unit cost table' attached

* Amount calculated as follows:
{EUR 0.1 x estimated total kWh saved per m² per year x 10}

Estimated number of units: see (for each beneficiary/linked third party and BEST table) the 'unit cost table' attached

Unit cost table (energy efficiency measures unit cost)[1]

| Short name beneficiary/linked third party | BEST No | Cost Amount per unit | Estimated No of units | Total unit cost (cost per unit x estimated no of units) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

*]*

## Research infrastructure unit cost

### *[OPTION if specific unit cost applicable to the grant:* 3. Access costs for providing trans-national access to research infrastructure

Units[2]: see (for each access provider and installation) the 'unit cost table' attached

[1] Data from the 'building energy specification table (BEST)' that is part of the proposal and Annex 1.

Amount per unit*: see (for each access provider and installation) the 'unit cost table' attached

* Amount calculated as follows:

$$\frac{\text{average annual total access cost to the installation (over past two years}^{3}\text{)}}{\text{average annual total quantity of access to the installation (over past two years}^{4}\text{)}}$$

Estimated number of units: see (for each access provider and installation) the 'unit cost table' attached

Unit cost table (access to research infrastructure unit cost)[5]

| Short name access provider | Short name infrastructure | Installation | | Unit of access | Amount per unit | Estimated No of units | Total unit cost (cost per unit x estimated no of units) |
|---|---|---|---|---|---|---|---|
| | | No | Short name | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

*]*

## Clinical studies unit cost

### *[OPTION if specific unit cost is applicable to the grant: 4.* Costs for clinical studies

Units: patients/subjects that participate in the clinical study

Amount per unit*: see (for each clinical study and beneficiary/linked third party) the 'unit cost table' attached

Estimated number of units: see (for each clinical study and beneficiary/linked third party) the 'unit cost table' attached

* Amount calculated, for each task described in the protocol, as follows:

{Task 1
{unit cost component 'personnel costs'
+ unit cost component 'costs of consumables'
+ unit cost component 'costs of medical equipment'
+ unit cost component 'costs of other specific services'
+ unit cost component 'indirect costs'}
+ Task 2
{unit cost component 'personnel costs'
+ unit cost component 'costs of consumables'
+ unit cost component 'costs of medical equipment'
+ unit cost component 'costs of other specific services'

---

2 Unit of access (e.g. beam hours, weeks of access, sample analysis) fixed by the access provider in proposal.

3 In exceptional and duly justified cases, the Commission/Agency may agree to a different reference period.

4 In exceptional and duly justified cases, the Commission/Agency may agree to a different reference period.

5 Data from the 'table on estimated costs/quantity of access to be provided' that is part of the proposal and Annex 1.

+ unit cost component 'indirect costs'}
[same for all other tasks]**}**

Unit cost components calculated as follows:

Unit cost component '**personnel costs**' (i.e. 'personnel costs of doctors' + 'personnel costs of other medical personnel' + 'personnel costs of technical personnel')

For unit cost component 'personnel costs of doctors':

**{**'average hourly cost for doctors', i.e.:
certified or auditable total personnel costs for doctors for year N-1
{1720 * number of full-time equivalent for the personnel category doctors for year N-1}
multiplied by
estimated number of hours worked by doctors for the task (per patient/subject)**}**

For unit cost component 'personnel costs of other medical personnel':

**{'**average hourly cost for other medical personnel', i.e.:
certified or auditable total personnel costs for other medical personnel for year N-1
{1720 * number of full-time equivalent for the personnel category other medical personnel for year N-1}
multiplied by
estimated number of hours worked by other medical personnel for the task (per patient/subject)**}**

For unit cost component 'personnel costs of technical personnel':

**{**average hourly cost for technical personnel, i.e.:
certified or auditable total personnel costs for technical personnel for year N-1
{1720 * number of full-time equivalent for the personnel category technical personnel for year N-1}
multiplied by
estimated number of hours worked by technical personnel for the task (per patient/subject)**}**

'total personnel costs' means actual salaries + actual social security contributions + actual taxes and other costs included in the remuneration, provided they arise from national law or the employment contract or equivalent appointing act

Unit cost component '**costs of consumables**' (i.e. 'costs of consumables category 1 + 'costs of consumables category 2' + 'costs of consumables category 3', etc)

For each category of consumables:

**{**'average price per item', i.e.:
{certified or auditable total costs of purchase of the consumables in year N-1 for the category of consumables concerned
total number of items purchased in year N-1 for the category of consumables concerned}
multiplied by
estimated number of items used for the task (per patient/subject)**}**

'total costs of purchase of the consumables' means total value of the supply contracts (including related duties, taxes and charges such as non-deductible VAT) concluded by the beneficiary for consumables delivered in year N-1, provided the contracts were awarded according to the principle of best value-for-money and without any conflict of interests

Unit cost component '**costs of medical equipment**' (i.e. 'costs of medical equipment category 1' + 'costs of medical equipment category 2' + 'costs of medical equipment category 3', etc.)

For each category of medical equipment:

**{**'average cost of depreciation and directly related services per unit of use', i.e.:

{certified or auditable total depreciation costs in year N-1 for the category of equipment concerned + certified or auditable total costs of purchase of services in year N-1 for the category of equipment concerned}
/
total capacity in year N-1
multiplied by
estimated number of units of use of the equipment for the task (per patient/subject)**}**

'total depreciation costs' means total depreciation allowances as recorded in the beneficiary's accounts of year N-1 for the category of equipment concerned, provided the equipment was purchased according to the principle of best value-for-money and without any conflict of interests + total costs of renting or leasing contracts (including related duties, taxes and charges such as non-deductible VAT) in year N-1 for the category of equipment concerned, provided they do not exceed the depreciation costs of similar equipment and do not include finance fees

Unit cost component '**costs of other specific services**' (i.e. 'costs of contracts for specific service 1' + 'costs of contracts for specific service 2' + 'costs of contracts for specific service 3', etc.)

For each category of specific service:

'average cost of a specific service per patient or subject', i.e.:
certified or auditable total costs of purchase of a service in year N-1 for the category of specific services necessary for the conduct of clinical studies
/
total number of patients or subjects included in the clinical studies for which the specific service was delivered in year N-1

'total costs of purchase of a service' means total value of the contracts concluded by the beneficiary (including related duties, taxes and charges such as non-deductible VAT) for the specific service delivered in year N-1 for the conduct of clinical studies, provided the contracts were awarded according to the principle of best value-for-money and without any conflict of interests

Unit cost component '**indirect costs**'

**{**25%
multiplied by
{unit cost component 'personnel costs' + unit cost component 'costs of consumables' + unit cost component 'costs of medical equipment'}**}**

The following must be excluded:

- costs of in-kind contributions provided by third parties which are not used on the beneficiary's premises and
- costs of providing financial support to third parties (if any).

Unit cost table: clinical studies unit cost[6]

| **[Insert name of clinical study]** | | | | | |
|---|---|---|---|---|---|
| **Tasks and unit cost components** | **Resources per patient** | **Amount per unit**<br><br>**for beneficiary /linked third party** | **Amount per unit**<br><br>**for beneficiary /linked third party** | **Amount per unit**<br><br>**for beneficiary/linked third party 3 [insert short name]** | **…** |

[6] Same table as in proposal and Annex 1.

| | | | 1 [insert short name] | 2 [insert short name] | | in-kind contributions by third party* | |
|---|---|---|---|---|---|---|---|
| **Task No. 1** Blood sample | | | | | | | |
| **Personnel costs** | doctors | ---- | 0 | 0 | 0 | 0 | |
| | other medical personnel | Phlebotomy (nurse), 10 minutes | 8,33 EUR | 11,59 EUR | 10,55 EUR | 9,76 EUR | |
| | technical personnel | Sample Processing (lab technician), 15 minutes | 9,51 EUR | 15,68 EUR | 13,77 EUR | 12,35 EUR | |
| **Costs of consumables** | Category 1 | Syringe, 1 | XX EUR | XX EUR | XX EUR | XX EUR | |
| | Category 2 | Cannula, 1 | XX EUR | XX EUR | XX EUR | XX EUR | |
| | Category 2 | Blood container, 1 | XX EUR | XX EUR | XX EUR | XX EUR | |
| | … | | | | | | |
| **Costs of medical equipment** | Category 1 | Use of -80° deep freezer, 60 days | XX EUR | XX EUR | XX EUR | XX EUR | |
| | Category 2 | Use of centrifuge, 15 minutes | XX EUR | XX EUR | XX EUR | XX EUR | |
| | …. | | | | | | |
| **Costs of other specific services** | Category 1 | | | | | | |
| | Category 2 | | | | | | |
| | … | | | | | | |
| **Indirect costs** | | | | | | | |
| **Task No. 2** | | | | | | | |
| … | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| **Total amount per unit** | | | **XX EUR** | **XX EUR** | **XX EUR** | **XX EUR**** | |
| **Estimated No of units** (patients/subjects participating in the study) | | | **XX** | **XX** | **XX** | **XX** | |
| **Total unit cost for beneficiary/linked third party** (total cost per unit x estimated no of units) | | | **XX EUR** | **XX EUR** | **XX EUR** | | |

* Use costs of third party making in-kind contribution.

** Capped at payment to third party, if any.

**ANNEX 3**

# ACCESSION FORM FOR BENEFICIARIES

**STIFTELSEN SINTEF (SINTEF)** NO1, 948007029, established in STRINDVEIEN 4, TRONDHEIM 7034, Norway, VAT number NO948007029MVA, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('2')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Morten DALSMO with ECAS id ndalsmmo signed in the Participant Portal on 09/11/2016 at 16:35:58 (transaction id SigId-28882-kzSNEjA5tVMGc6CyhmOZMVSjZVhrunPHHGJiMVlTmvuJrSiMy16rOwoJLJUcV8fAMjqzc7EJUcmmwsfLFbKn63-PHslUMVSXYCEbaUOEcOk1C-wXjtZTvOmzQbPS6g8MKiHk209Da55eLMjhWIw1U9U7U). Timestamp by third party at
Wed Nov 09 16:36:08 CET 2016

**ANNEX 3**

# ACCESSION FORM FOR BENEFICIARIES

**TECHNISCHE UNIVERSITEIT DELFT (TUD)**, 27364265, established in STEVINWEG 1, DELFT 2628 CN, Netherlands, VAT number NL001569569B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('3')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Rob FASTENAU with ECAS id nfastero signed in the Participant Portal on 10/11/2016 at 07:39:13 (transaction id SigId-916-pywrJInbzJQg8vS2IpOH6mcRXbrhXsWqjE0n9PmwB3zSgyDzyMrG5ayzYTGiw9UpNTN7Nzr0fM78sFg0fLIZhFA-Jj71zxYb8yrLDSH1hfLDmK-NUjm0M897mufgMV267Zzo9ftzUtTEo9N19TI91I5GlLW). Timestamp by third party at Thu Nov 10 07:39:20 CET 2016

**ANNEX 3**

# ACCESSION FORM FOR BENEFICIARIES

**OW2 CONSORTIUM ASSOCIATION (OW2)** FR3, 499409712, established in AV JEAN JAURES 7, LES CLAYES SOUS BOIS 78340, France, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('4')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

CEDRIC THOMAS with ECAS id nthomace signed in the Participant Portal on 28/10/2016 at 18:57:21 (transaction id SigId-139-3QLsMlzZMyFh2kvkMQdZxLQZNgd7hL1AY9oJrd3AdDH7BrzaVRTzM1dq50mA9rIquTY6AynVOnaSwmD2M9Q4vMW-Jj71zxYb8yrI8GmV4asVNa-gTygYSS57IpEOhON0zKSb960K3PP4BFWwVSV1LwNycI). Timestamp by third party at
Fri Oct 28 19:57:28 CEST 2016

**ANNEX 3**

## ACCESSION FORM FOR BENEFICIARIES

**ENGINEERING - INGEGNERIA INFORMATICA SPA (ENG)** SPA, 531128/CF00967720285, established in Via San Martino Della Battaglia 56, ROMA 00185, Italy, VAT number IT05724831002, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('5')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Michele CINAGLIA with ECAS id ncinagmi signed in the Participant Portal on 28/10/2016 at 14:27:07 (transaction id SigId-10707-zaW3qbPLKrSt9zrIONH7MjW8jiJUrLRLWAS8ziJXazy6LrV22UPtfFGqMdljLcLJoNZ9mx5SMY6DnXxYr2dRx0m-PHslUMVSXYCSODP6fhoRgS-9GYlOfZUFRTdTEh2U8uy0LYuzSidE8btdkjdIPu49YP). Timestamp by third party at Fri Oct 28 15:27:15 CEST 2016

**ANNEX 3**

## ACCESSION FORM FOR BENEFICIARIES

**TELLU AS (TellU)** AS, 989743295, established in LENSMANNSLIA 4, ASKER 1386, Norway, VAT number NO989743295MVA, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('6')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Geir MELBY with ECAS id nmelbyge signed in the Participant Portal on 27/10/2016 at 09:29:59 (transaction id SigId-69312-w4ayVc5HMzODmZI9QvM3Wh7a6YsgkXIvlmbLpH4oqR853qJGxezYoof8Zs3UdDmoxNVd68V4xxVEebzQuufvol0-Jj71zxYb8yrkmoAceBIUCa-gLO4WHWugzicjEvNCKztjPbm9X2pYHKw4zOUjzfqXWsU). Timestamp by third party at Thu Oct 27 10:30:12 CEST 2016

**ANNEX 3**

# ACCESSION FORM FOR BENEFICIARIES

**XWIKI SAS (XWiki)** SAS, 477865281, established in RUE DUBAN 15, PARIS 75016, France, VAT number FR69477865281, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('7')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Ludovic DUBOST with ECAS id nduboslu signed in the Participant Portal on 31/10/2016 at 16:47:06 (transaction id SigId-8022-mZ6E9jmeSsUXEBQJH1RGzulp4LTNzRDQr7lO3zIwA794AcaDFQAwuqve7RAARlmVxX5aeI8EEZYlRk02zx0xL4y-Jj71zxYb8yrI8GmV4asVNa-TKWH2Iat0vlWUozmLaG4yZ41QzqBEzQAkSlzykAzLeYLm).
Timestamp by third party at
Mon Oct 31 16:47:14 CET 2016

**ANNEX 3**

## ACCESSION FORM FOR BENEFICIARIES

**ATOS SPAIN SA (ATOS)** SA, M64516, established in CALLE DE ALBARRACIN 25, MADRID 28037, Spain, VAT number ESA28240752, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('8')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Alicia GARCÍA with ECAS id ngarcbyd signed in the Participant Portal on 27/10/2016 at 14:27:14 (transaction id SigId-76883-YbqpnpiQh8aGmWEEFBOGImoQ4ybwzrDzrgsx1kaUp1wX0qnbzXD2KVXvsFC6h1Elj0QbnTuXhTGMtU5rXVjFbLG-Jj71zxYb8yrkmoAceBIUCa-ys6NuArpc9AzVzZoX7XyzU7zo8za7swu9Vzhx0px3pALS). Timestamp by third party at Thu Oct 27 15:27:23 CEST 2016

**ANNEX 3**

## ACCESSION FORM FOR BENEFICIARIES

**ACTIVEEON (AEon)** SAS, 500 807 284, established in ROUTE DES LUCIOLES LES ALGORITHMES BAT PYTHAGORE B SOPHIA ANTIPOLIS 2000, VALBONNE 06560, France, VAT number FR19500807284, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

**hereby agrees**

**to become beneficiary** No ('9')

**in Grant Agreement No** 731529 ('the Agreement')

**between** INSTITUT NATIONAL DE RECHERCHE ENINFORMATIQUE ET AUTOMATIQUE **and** the European Union ('the EU'), represented by the European Commission ('the Commission'),

**for the action entitled** 'Software Testing AMPlification (STAMP)'.

**and mandates**

**the coordinator** to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

Denis CAROMEL with ECAS id ncaroden signed in the Participant Portal on 28/10/2016 at 09:58:06 (transaction id SigId-4033-eoghzfIGeyNt2zwP2s6eawI5kcrB24mBze6kzzVUbaZH2rhDrJB2hFclk1d0a7V78vQIjyv0q6BY5BcEUhWVCCx-PHslUMVSXYCSODP6fhoRgS-5FNprJfSrhvrtlY4s5HZq5NdFTay8ajrV6TeoxzcY7L). Timestamp by third party at Fri Oct 28 10:58:16 CEST 2016

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## MODEL ANNEX 4 FOR H2020 GENERAL MGA — MULTI

### FINANCIAL STATEMENT FOR *[BENEFICIARY [name]/ LINKED THIRD PARTY [name]]* FOR REPORTING PERIOD [reporting period]

| | Eligible[1] costs (per budget category) | | | | | | | | | | | | Receipts | EU contribution | | | Additional information |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A. Direct personnel costs | | | | B. Direct costs of subcontracting | *[C. Direct costs of fin. support]* | D. Other direct costs | | E. Indirect costs[2] | *[F. Costs of … ]* | | Total costs | Receipts | Reimbursement rate % | Maximum EU contribution[3] | Requested EU contribution | Information for indirect costs : |
| | A.1 Employees (or equivalent)<br>A.2 Natural persons under direct contract<br>A.3 Seconded persons<br>*[A.6 Personnel for providing access* | | A.4 SME owners without salary<br>A.5 Beneficiaries that are natural persons without salary | | | *[C.1 Financial support]*<br>*[C.2 Prizes]* | D.1 Travel<br>D.2 Equipment<br>D.3 Other goods and | *[D.4 Costs of large research infrastructure]* | | *[F.1 Costs of …]* | *[F.1 Costs of …]* | | Receipts of the action, to be reported in the last reporting period, according to Article 5.3.3 | | | | Costs of in-kind contributions not used on premises |
| **Form of costs[4]** | Actual | Unit | Unit | | Actual | Actual | Actual | Actual | Flat-rate[5] 25% | *[Unit][Lump sum]* | Unit | | | | | | |
| | a | Total b | No hours | Total c | d | *[e]* | f | *[g]* | h=0,25 x (a+b+c+f+[g]+ | No units | Total *[i1]* | Total *[i2]* | j = a+b+c+d+[e]+f+[g]+ | k | l | m | n | o |
| **[short name beneficiary /linked third party]** | | | | | | | | | | | | | | | | | |

**The beneficiary/linked third party hereby confirms that:**
The information provided is complete, reliable and true.
The costs declared are eligible (see Article 6).
The costs can be substantiated by adequate records and supporting documentation that will be produced upon request or in the context of checks, reviews, audits and investigations (see Articles 17, 18 and 22).
For the last reporting period: that all the receipts have been declared (see Article 5.3.3).

ⓘ Please declare all eligible costs, even if they exceed the amounts indicated in the estimated budget (see Annex 2). Only amounts that were declared in your individual financial statements can be taken into account lateron, in order to replace other costs that are found to be ineligible.

[1] See Article 6 for the eligibility conditions

[2] The indirect costs claimed must be free of any amounts covered by an operating grant (received under any EU or Euratom funding programme; see Article 6.2.E). If you have received an operating grant during this reporting period, you cannot claim any indirect costs.

[3] This is the *theoretical* amount of EU contribution that the system calculates automatically (by multiplying the reimbursement rate by the total costs declared). The amount you request (in the column 'requested EU contribution') may be less

[4] See Article 5 for the form of costs

[5] Flat rate : 25% of eligible direct costs, from which are excluded: direct costs of subcontracting, costs of in-kind contributions not used on premises, direct costs of financial support, and unit costs declared under budget category F if they include indirect costs (see Article 6.2.E)

[6] Only specific unit costs that do not include indirect costs

**ANNEX 5**

# MODEL FOR THE CERTIFICATE ON THE FINANCIAL STATEMENTS

- **For options [*in italics in square brackets*]: choose the applicable option. Options not chosen should be deleted.**
- **For fields in [grey in square brackets]: enter the appropriate data**

**TABLE OF CONTENTS**

**Terms of Reference for an Independent Report of Factual Findings on costs declared under a Grant Agreement financed under the Horizon 2020 Research and Innovation Framework Programme**

This document sets out the '**Terms of Reference (ToR)**' under which

*[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')]*

agrees to engage

[**insert legal name of the auditor**] ('the Auditor')

to produce an independent report of factual findings ('the Report') concerning the Financial Statement(s)[1] drawn up by the *[Beneficiary] [Linked Third Party]* for the Horizon 2020 grant agreement [insert number of the grant agreement, title of the action, acronym and duration from/to] ('the Agreement'), and

to issue a Certificate on the Financial Statements' ('CFS') referred to in Article 20.4 of the Agreement based on the compulsory reporting template stipulated by the Commission.

The Agreement has been concluded under the Horizon 2020 Research and Innovation Framework Programme (H2020) between the Beneficiary and *[OPTION 1: the European Union, represented by the European Commission ('the Commission')][ OPTION 2: the European Atomic Energy Community (Euratom,) represented by the European Commission ('the Commission')][OPTION 3: the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)] ('the Agency'), under the powers delegated by the European Commission ('the Commission').]*

The *[Commission] [Agency]* is mentioned as a signatory of the Agreement with the Beneficiary only. The *[European Union][Euratom][Agency]* is not a party to this engagement.

### 1.1 Subject of the engagement

The coordinator must submit to the *[Commission][Agency]* the final report within 60 days following the end of the last reporting period which should include, amongst other documents, a CFS for each beneficiary and for each linked third party that requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 20.4 of the Agreement). The CFS must cover all reporting periods of the beneficiary or linked third party indicated above.

The Beneficiary must submit to the coordinator the CFS for itself and for its linked third party(ies), if the CFS must be included in the final report according to Article 20.4 of the Agreement..

The CFS is composed of two separate documents:

- The Terms of Reference ('the ToR') to be signed by the *[Beneficiary] [Linked Third Party]* and the Auditor;

[1] By which costs under the Agreement are declared (see template 'Model Financial Statements' in Annex 4 to the Grant Agreement).

- The Auditor's Independent Report of Factual Findings ('the Report') to be issued on the Auditor's letterhead, dated, stamped and signed by the Auditor (or the competent public officer) which includes the agreed-upon procedures ('the Procedures') to be performed by the Auditor, and the standard factual findings ('the Findings') to be confirmed by the Auditor.

If the CFS must be included in the final report according to Article 20.4 of the Agreement, the request for payment of the balance relating to the Agreement cannot be made without the CFS. However, the payment for reimbursement of costs covered by the CFS does not preclude the *[Commission,][ Agency,]* the European Anti-Fraud Office and the European Court of Auditors from carrying out checks, reviews, audits and investigations in accordance with Article 22 of the Agreement.

### 1.2 Responsibilities

The *[Beneficiary] [Linked Third Party]:*

- must draw up the Financial Statement(s) for the action financed by the Agreement in compliance with the obligations under the Agreement. The Financial Statement(s) must be drawn up according to the *[Beneficiary's] [Linked Third Party's]* accounting and book-keeping system and the underlying accounts and records;
- must send the Financial Statement(s) to the Auditor;
- is responsible and liable for the accuracy of the Financial Statement(s);
- is responsible for the completeness and accuracy of the information provided to enable the Auditor to carry out the Procedures. It must provide the Auditor with a written representation letter supporting these statements. The written representation letter must state the period covered by the statements and must be dated;
- accepts that the Auditor cannot carry out the Procedures unless it is given full access to the *[Beneficiary's] [Linked Third Party's]* staff and accounting as well as any other relevant records and documentation.

The Auditor:

- *[Option 1 by default:* is qualified to carry out statutory audits of accounting documents in accordance with Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts, amending Council Directives 78/660/EEC and 83/349/EEC and repealing Council Directive 84/253/EEC or similar national regulations*]*.
- *[Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer:* is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary*]*.
- *[Option 3 if the Beneficiary or Linked Third Party is an international organisation:* is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation*]*.

The Auditor:

- must be independent from the Beneficiary *[and the Linked Third Party]*, in particular, it must not have been involved in preparing the *[Beneficiary's] [Linked Third Party's]* Financial Statement(s);
- must plan work so that the Procedures may be carried out and the Findings may be assessed;
- must adhere to the Procedures laid down and the compulsory report format;
- must carry out the engagement in accordance with this ToR;
- must document matters which are important to support the Report;
- must base its Report on the evidence gathered;
- must submit the Report to the *[Beneficiary] [Linked Third Party]*.

The Commission sets out the Procedures to be carried out by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement, the Auditor does not provide an audit opinion or a statement of assurance.

### 1.3 Applicable Standards

The Auditor must comply with these Terms of Reference and with[2]:

- the International Standard on Related Services ('ISRS') 4400 *Engagements to perform Agreed-upon Procedures regarding Financial Information* as issued by the International Auditing and Assurance Standards Board (IAASB);
- the *Code of Ethics for Professional Accountants* issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the *[Commission][Agency]* requires that the Auditor also complies with the Code's independence requirements.

The Auditor's Report must state that there is no conflict of interests in establishing this Report between the Auditor and the Beneficiary *[and the Linked Third Party]*, and must specify - if the service is invoiced - the total fee paid to the Auditor for providing the Report.

### 1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7).

Under Article 22 of the Agreement, the Commission*[, the Agency]*, the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are declared from [*the European Union*] [*Euratom*] budget. This includes work related to this engagement. The Auditor must provide access to all working papers (e.g. recalculation of hourly rates, verification of the time declared for the action) related to this assignment if the Commission *[, the Agency]*, the European Anti-Fraud Office or the European Court of Auditors requests them.

### 1.5 Timing

The Report must be provided by *[*dd Month yyyy*]*.

### 1.6 Other terms

[*The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor's fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.*]

| | |
|---|---|
| [legal name of the Auditor] | [legal name of the *[Beneficiary][Linked Third Party]*] |
| [name & function of authorised representative] | [name & function of authorised representative] |
| [dd Month yyyy] | [dd Month yyyy] |
| Signature of the Auditor | Signature of the *[Beneficiary][Linked Third Party]* |

[2] Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services ('ISRS') 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.

**Independent Report of Factual Findings on costs declared under Horizon 2020 Research and Innovation Framework Programme**

*(To be printed on the Auditor's letterhead)*

To
[ name of contact person(s)], [Position]
[ [*Beneficiary's*] [*Linked Third Party's*] name ]
[ Address]
[ dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with *[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')],*

we

[name of the auditor ] ('the Auditor'),

established at

[full address/city/state/province/country],

represented by

[name and function of an authorised representative],

have carried out the procedures agreed with you regarding the costs declared in the Financial Statement(s)[3] of the *[Beneficiary] [Linked Third Party]* concerning the grant agreement [insert grant agreement reference: number, title of the action and acronym] ('the Agreement'),

with a total cost declared of
[total amount] EUR,

and a total of actual costs and 'direct personnel costs declared as unit costs calculated in accordance with the [*Beneficiary's*] [*Linked Third Party's*] usual cost accounting practices' declared of

[sum of total actual costs and total direct personnel costs declared as unit costs calculated in accordance with the *[Beneficiary's] [Linked Third Party's]* usual cost accounting practices] EUR

and **hereby provide our Independent Report of Factual Findings ('the Report')** using the compulsory report format agreed with you.

**The Report**

Our engagement was carried out in accordance with the terms of reference ('the ToR') appended to this Report. The Report includes the agreed-upon procedures ('the Procedures') carried out and the standard factual findings ('the Findings') examined.

[3] By which the Beneficiary declares costs under the Agreement (see template 'Model Financial Statement' in Annex 4 to the Agreement).

The Procedures were carried out solely to assist the [*Commission*] [*Agency*] in evaluating whether the [*Beneficiary's*] [*Linked Third Party's*] costs in the accompanying Financial Statement(s) were declared in accordance with the Agreement. The *[Commission] [Agency]* draws its own conclusions from the Report and any additional information it may require.

The scope of the Procedures was defined by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence. Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, the Auditor does not give a statement of assurance on the Financial Statements.

Had the Auditor carried out additional procedures or an audit of the *[Beneficiary's] [Linked Third Party's]* Financial Statements in accordance with International Standards on Auditing or International Standards on Review Engagements, other matters might have come to its attention and would have been included in the Report.

**Not applicable Findings**

We examined the Financial Statement(s) stated above and considered the following Findings not applicable:

*Explanation (to be removed from the Report):*

*If a Finding was not applicable, it must be marked as '**N.A**.' ('Not applicable') in the corresponding row on the right-hand column of the table and means that the Finding did not have to be corroborated by the Auditor and the related Procedure(s) did not have to be carried out.*

*The reasons of the non-application of a certain Finding must be obvious i.e.*

*i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable;*

*ii) if the condition set to apply certain Procedure(s) are not met the related Finding(s) and those Procedure(s) are not applicable. For instance, for 'beneficiaries with accounts established in a currency other than euro' the Procedure and Finding related to 'beneficiaries with accounts established in euro' are not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.*

**List here all Findings considered not applicable for the present engagement and explain the reasons of the non-applicability.**

**….**

**Exceptions**

Apart from the exceptions listed below, the *[Beneficiary] [Linked Third Party]* provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and evaluate the Findings.

*Explanation (to be removed from the Report):*

- *If the Auditor was not able to successfully complete a procedure requested, it must be marked as '**E**' ('Exception') in the corresponding row on the right-hand column of the table. The reason such as the inability to reconcile key information or the unavailability of data that prevents the Auditor from carrying out the Procedure must be indicated below.*
- *If the Auditor cannot corroborate a standard finding after having carried out the corresponding procedure, it must also be marked as '**E**' ('Exception') and, where possible, the reasons why the Finding was not fulfilled and its possible impact must be explained here below.*

**List here any exceptions and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, include the corresponding amount.**

**….**

*Example (to be removed from the Report):*

1. *The Beneficiary was unable to substantiate the Finding number 1 on … because ….*
2. *Finding number 30 was not fulfilled because the methodology used by the Beneficiary to calculate unit costs was different from the one approved by the Commission. The differences were as follows: …*
3. *After carrying out the agreed procedures to confirm the Finding number 31, the Auditor found a difference of _____ EUR. The difference can be explained by …*

**Further Remarks**

In addition to reporting on the results of the specific procedures carried out, the Auditor would like to make the following general remarks:

*Example (to be removed from the Report):*

1. *Regarding Finding number 8 the conditions for additional remuneration were considered as fulfilled because …*
2. *In order to be able to confirm the Finding number 15 we carried out the following additional procedures: ….*

**Use of this Report**

This Report may be used only for the purpose described in the above objective. It was prepared solely for the confidential use of the *[Beneficiary] [Linked Third Party]* and the [*Commission*] [*Agency*], and only to be submitted to the [*Commission*] [*Agency*] in connection with the requirements set out in Article 20.4 of the Agreement. The Report may not be used by the *[Beneficiary] [Linked Third Party]* or by the [*Commission*] [*Agency*] for any other purpose, nor may it be distributed to any other parties. The [*Commission*] [*Agency*] may only disclose the Report to authorised parties, in particular to the European Anti-Fraud Office (OLAF) and the European Court of Auditors.

This Report relates only to the Financial Statement(s) submitted to the *[Commission] [Agency]* by the *[Beneficiary] [Linked Third Party]* for the Agreement. Therefore, it does not extend to any other of the [*Beneficiary's*] [*Linked Third Party's*] Financial Statement(s).

There was no conflict of interest[4] between the Auditor and the Beneficiary *[and Linked Third Party]* in establishing this Report. The total fee paid to the Auditor for providing the Report was EUR _____ (including EUR_____ of deductible VAT).

We look forward to discussing our Report with you and would be pleased to provide any further information or assistance.

[legal name of the Auditor]
[name and function of an authorised representative]
[dd Month yyyy]
Signature of the Auditor

[4] A conflict of interest arises when the Auditor's objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:
- was involved in the preparation of the Financial Statements;
- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.

## Agreed-upon procedures to be performed and standard factual findings to be confirmed by the Auditor

The European Commission reserves the right to i) provide the auditor with additional guidance regarding the procedures to be followed or the facts to be ascertained and the way in which to present them (this may include sample coverage and findings) or to ii) change the procedures, by notifying the Beneficiary in writing. The procedures carried out by the auditor to confirm the standard factual finding are listed in the table below.

If this certificate relates to a Linked Third Party, any reference here below to 'the Beneficiary' is to be considered as a reference to 'the Linked Third Party'.

The 'result' column has three different options: 'C', 'E' and 'N.A.':

- 'C' stands for 'confirmed' and means that the auditor can confirm the 'standard factual finding' and, therefore, there is no exception to be reported.
- 'E' stands for 'exception' and means that the Auditor carried out the procedures but cannot confirm the 'standard factual finding', or that the Auditor was not able to carry out a specific procedure (e.g. because it was impossible to reconcile key information or data were unavailable),
- 'N.A.' stands for 'not applicable' and means that the Finding did not have to be examined by the Auditor and the related Procedure(s) did not have to be carried out. The reasons of the non-application of a certain Finding must be obvious i.e. i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable; ii) if the condition set to apply certain Procedure(s) are not met then the related Finding(s) and Procedure(s) are not applicable. For instance, for 'beneficiaries with accounts established in a currency other than the euro' the Procedure related to 'beneficiaries with accounts established in euro' is not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| **A** | **ACTUAL PERSONNEL COSTS AND UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICE** | | |
| | The Auditor draws a sample of persons whose costs were declared in the Financial Statement(s) to carry out the procedures indicated in the consecutive points of this section A.<br>(*The sample should be selected randomly so that it is representative. Full coverage is required if there are fewer than 10 people (including employees, natural persons working under a direct contract and personnel seconded by a third party), otherwise the sample should have a minimum of 10 people, or 10% of the total, whichever number is the highest)*<br>The Auditor sampled _____ people out of the total of _____ people. | | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| **A.1** | **PERSONNEL COSTS**<br><br>For the persons included in the sample and working under an employment contract or equivalent act (general procedures for individual actual personnel costs and personnel costs declared as unit costs)<br><br>To confirm standard factual findings 1-5 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary:<br>o a list of the persons included in the sample indicating the period(s) during which they worked for the action, their position (classification or category) and type of contract;<br>o the payslips of the employees included in the sample;<br>o reconciliation of the personnel costs declared in the Financial Statement(s) with the accounting system (project accounting and general ledger) and payroll system;<br>o information concerning the employment status and employment conditions of personnel included in the sample, in particular their employment contracts or equivalent;<br>o the Beneficiary's usual policy regarding payroll matters (e.g. salary policy, overtime policy, variable pay);<br>o applicable national law on taxes, labour and social security and<br>o any other document that supports the personnel costs declared.<br><br>The Auditor also verified the eligibility of all components of the retribution (see Article 6 GA) and recalculated the personnel costs for employees included in the sample. | 1) The employees were i) directly hired by the Beneficiary in accordance with its national legislation, ii) under the Beneficiary's sole technical supervision and responsibility and iii) remunerated in accordance with the Beneficiary's usual practices. | |
| | | 2) Personnel costs were recorded in the Beneficiary's accounts/payroll system. | |
| | | 3) Costs were adequately supported and reconciled with the accounts and payroll records. | |
| | | 4) Personnel costs did not contain any ineligible elements. | |
| | | 5) There were no discrepancies between the personnel costs charged to the action and the costs recalculated by the Auditor. | |
| | *Further procedures if 'additional remuneration' is paid*<br><br>To confirm standard factual findings 6-9 listed in the next column, the Auditor:<br>o reviewed relevant documents provided by the Beneficiary (legal form, legal/statutory | 6) The Beneficiary paying "additional remuneration" was a non-profit legal entity. | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | obligations, the Beneficiary's usual policy on additional remuneration, criteria used for its calculation…);<br>o recalculated the amount of additional remuneration eligible for the action based on the supporting documents received (full-time or part-time work, exclusive or non-exclusive dedication to the action, etc.) to arrive at the applicable FTE/year and pro-rata rate (see data collected in the course of carrying out the procedures under A.2 'Productive hours' and A.4 'Time recording system'). | 7) The amount of additional remuneration paid corresponded to the Beneficiary's usual remuneration practices and was consistently paid whenever the same kind of work or expertise was required. | |
| | *IF ANY PART OF THE REMUNERATION PAID TO THE EMPLOYEE IS NOT MANDATORY ACCORDING TO THE NATIONAL LAW OR THE EMPLOYMENT CONTRACT ("ADDITIONAL REMUNERATION") AND IS ELIGIBLE UNDER THE PROVISIONS OF ARTICLE 6.2.A.1, THIS CAN BE CHARGED AS ELIGIBLE COST TO THE ACTION UP TO THE FOLLOWING AMOUNT:* | 8) The criteria used to calculate the additional remuneration were objective and generally applied by the Beneficiary regardless of the source of funding used. | |
| | *(A) IF THE PERSON WORKS FULL TIME AND EXCLUSIVELY ON THE ACTION DURING THE FULL YEAR: UP TO EUR 8 000/YEAR;*<br>*(B) IF THE PERSON WORKS EXCLUSIVELY ON THE ACTION BUT NOT FULL-TIME OR NOT FOR THE FULL YEAR: UP TO THE CORRESPONDING PRO-RATA AMOUNT OF EUR 8 000, OR*<br>*(C) IF THE PERSON DOES NOT WORK EXCLUSIVELY ON THE ACTION: UP TO A PRO-RATA AMOUNT CALCULATED IN ACCORDANCE TO ARTICLE 6.2.A.1.* | 9) The amount of additional remuneration included in the personnel costs charged to the action was capped at EUR 8,000 per FTE/year (up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action). | |
| | *Additional procedures in case "unit costs calculated by the Beneficiary in accordance with its usual cost accounting practices" is applied:*<br>Apart from carrying out the procedures indicated above to confirm standard factual findings 1-5 and, if applicable, also 6-9, the Auditor carried out following procedures to confirm standard | 10) The personnel costs included in the Financial Statement were calculated in accordance with the Beneficiary's usual cost accounting practice. This methodology was consistently | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | factual findings 10-13 listed in the next column:<br>o obtained a description of the Beneficiary's usual cost accounting practice to calculate unit costs;.<br>o reviewed whether the Beneficiary's usual cost accounting practice was applied for the Financial Statements subject of the present CFS;<br>o verified the employees included in the sample were charged under the correct category (in accordance with the criteria used by the Beneficiary to establish personnel categories) by reviewing the contract/HR-record or analytical accounting records;<br>o verified that there is no difference between the total amount of personnel costs used in calculating the cost per unit and the total amount of personnel costs recorded in the statutory accounts;<br>o verified whether actual personnel costs were adjusted on the basis of budgeted or estimated elements and, if so, verified whether those elements used are actually relevant for the calculation, objective and supported by documents. | used in all H2020 actions.<br>11) The employees were charged under the correct category.<br>12) Total personnel costs used in calculating the unit costs were consistent with the expenses recorded in the statutory accounts.<br>13) Any estimated or budgeted element used by the Beneficiary in its unit-cost calculation were relevant for calculating personnel costs and corresponded to objective and verifiable information. | |
| | <u>For natural persons included in the sample and working with the Beneficiary under a direct contract other than an employment contract, such as consultants (no subcontractors).</u><br>To confirm standard factual findings 14-18 listed in the next column the Auditor reviewed following information/documents provided by the Beneficiary:<br>o the contracts, especially the cost, contract duration, work description, place of work, ownership of the results and reporting obligations to the Beneficiary;<br>o the employment conditions of staff in the same category to compare costs and;<br>o any other document that supports the costs declared and its registration (e.g. invoices, | 14) The natural persons reported to the Beneficiary (worked under the Beneficiary's instructions).<br>15) They worked on the Beneficiary's premises (unless otherwise agreed with the Beneficiary).<br>16) The results of work carried out belong to the Beneficiary. | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | accounting records, etc.). | 17) Their costs were not significantly different from those for staff who performed similar tasks under an employment contract with the Beneficiary. | |
| | | 18) The costs were supported by audit evidence and registered in the accounts. | |
| | <u>For personnel seconded by a third party and included in the sample (not subcontractors)</u><br>To confirm standard factual findings 19-22 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary:<br>o their secondment contract(s) notably regarding costs, duration, work description, place of work and ownership of the results;<br>o if there is reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution against payment): any documentation that supports the costs declared (e.g. contract, invoice, bank payment, and proof of registration in its accounting/payroll, etc.) and reconciliation of the Financial Statement(s) with the accounting system (project accounting and general ledger) as well as any proof that the amount invoiced by the third party did not include any profit;<br>o if there is no reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution free of charge): a proof of the actual cost borne by the Third Party for the resource made available free of charge to the Beneficiary such as a statement of costs incurred by the Third Party and proof of the registration in the Third Party's accounting/payroll;<br>o any other document that supports the costs declared (e.g. invoices, etc.). | 19) Seconded personnel reported to the Beneficiary and worked on the Beneficiary's premises (unless otherwise agreed with the Beneficiary). | |
| | | 20) The results of work carried out belong to the Beneficiary. | |
| | | *If personnel is seconded against payment:*<br>21) The costs declared were supported with documentation and recorded in the Beneficiary's accounts. The third party did not include any profit. | |
| | | *If personnel is seconded free of charge:*<br>22) The costs declared did not exceed the third party's cost as | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | | recorded in the accounts of the third party and were supported with documentation. | |
| **A.2** | **PRODUCTIVE HOURS**<br><br>To confirm standard factual findings 23-28 listed in the next column, the Auditor reviewed relevant documents, especially national legislation, labour agreements and contracts and time records of the persons included in the sample, to verify that:<br>o the annual productive hours applied were calculated in accordance with one of the methods described below,<br>o the full-time equivalent (FTEs) ratios for employees not working full-time were correctly calculated.<br><br>If the Beneficiary applied method B, the auditor verified that the correctness in which the total number of hours worked was calculated and that the contracts specified the annual workable hours.<br><br>If the Beneficiary applied method C, the auditor verified that the 'annual productive hours' applied when calculating the hourly rate were equivalent to at least 90 % of the 'standard annual workable hours'. The Auditor can only do this if the calculation of the standard annual workable hours can be supported by records, such as national legislation, labour agreements, and contracts.<br><br>*BENEFICIARY'S PRODUCTIVE HOURS' FOR PERSONS WORKING FULL TIME SHALL BE ONE OF THE FOLLOWING METHODS:*<br>***A.*** *1720 ANNUAL PRODUCTIVE HOURS (PRO-RATA FOR PERSONS NOT WORKING FULL-TIME)*<br>***B.*** *THE TOTAL NUMBER OF HOURS WORKED BY THE PERSON FOR THE BENEFICIARY IN THE YEAR (THIS METHOD IS ALSO REFERRED TO AS 'TOTAL NUMBER OF HOURS WORKED' IN THE NEXT COLUMN). THE CALCULATION OF THE TOTAL NUMBER OF HOURS WORKED WAS DONE AS FOLLOWS: ANNUAL WORKABLE HOURS OF THE PERSON ACCORDING TO THE EMPLOYMENT* | 23) The Beneficiary applied method [*choose one option and delete the others*]<br><br>[**A**: 1720 hours]<br><br>[**B**: the 'total number of hours worked']<br><br>[**C**: 'standard annual productive hours' used correspond to usual accounting practices] | |
| | | 24) Productive hours were calculated annually. | |
| | | 25) For employees not working full-time the full-time equivalent (FTE) ratio was correctly applied. | |
| | | *If the Beneficiary applied method B.*<br><br>26) The calculation of the number of 'annual workable hours', overtime and absences was verifiable based on the documents provided by the Beneficiary. | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | *CONTRACT, APPLICABLE LABOUR AGREEMENT OR NATIONAL LAW PLUS OVERTIME WORKED MINUS ABSENCES (SUCH AS SICK LEAVE OR SPECIAL LEAVE).*<br><br>***C.** THE STANDARD NUMBER OF ANNUAL HOURS GENERALLY APPLIED BY THE BENEFICIARY FOR ITS PERSONNEL IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICES (THIS METHOD IS ALSO REFERRED TO AS 'STANDARD ANNUAL PRODUCTIVE HOURS' IN THE NEXT COLUMN). THIS NUMBER MUST BE AT LEAST 90% OF THE STANDARD ANNUAL WORKABLE HOURS.*<br><br>*'ANNUAL WORKABLE HOURS' MEANS THE PERIOD DURING WHICH THE PERSONNEL MUST BE WORKING, AT THE EMPLOYER'S DISPOSAL AND CARRYING OUT HIS/HER ACTIVITY OR DUTIES UNDER THE EMPLOYMENT CONTRACT, APPLICABLE COLLECTIVE LABOUR AGREEMENT OR NATIONAL WORKING TIME LEGISLATION.* | 26.1) The Beneficiary calculates the hourly rates per full financial year following procedure A.3 (method B is not allowed for beneficiaries calculating hourly rates per month). | |
| | | *If the Beneficiary applied method C.*<br><br>27) The calculation of the number of 'standard annual workable hours' was verifiable based on the documents provided by the Beneficiary. | |
| | | 28) The 'annual productive hours' used for calculating the hourly rate were consistent with the usual cost accounting practices of the Beneficiary and were equivalent to at least 90 % of the 'annual workable hours'. | |
| **A.3** | **HOURLY PERSONNEL RATES**<br><br><u>I) For unit costs calculated in accordance to the Beneficiary's usual cost accounting practice (unit costs):</u><br><br>If the Beneficiary has a "Certificate on Methodology to calculate unit costs " (CoMUC) approved by the Commission, the Beneficiary provides the Auditor with a description of the approved methodology and the Commission's letter of acceptance. The Auditor verified that the | 29) The Beneficiary applied [*choose one option and delete the other*]:<br><br>[Option I: "Unit costs (hourly rates) were calculated in accordance with the Beneficiary's usual cost | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | Beneficiary has indeed used the methodology approved. If so, no further verification is necessary.<br><br>If the Beneficiary does not have a "Certificate on Methodology" (CoMUC) approved by the Commission, or if the methodology approved was not applied, then the Auditor:<br><br>o reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates;<br><br>o recalculated the unit costs (hourly rates) of staff included in the sample following the results of the procedures carried out in A.1 and A.2.<br><br><u>II) For individual hourly rates:</u><br><br>The Auditor:<br><br>o reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates;<br><br>o recalculated the hourly rates of staff included in the sample (recalculation of all hourly rates if the Beneficiary uses annual rates, recalculation of three months selected randomly for every year and person if the Beneficiary uses monthly rates) following the results of the procedures carried out in A.1 and A.2;<br><br>o (only in case of monthly rates) confirmed that the time spent on parental leave is not deducted, and that, if parts of the basic remuneration are generated over a period longer than a month, the Beneficiary has included only the share which is generated in the month.<br><br>*"UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICES":*<br>*IT IS CALCULATED BY DIVIDING THE TOTAL AMOUNT OF PERSONNEL COSTS OF THE CATEGORY TO WHICH THE EMPLOYEE BELONGS VERIFIED IN LINE WITH PROCEDURE A.1 BY THE NUMBER OF FTE AND THE ANNUAL TOTAL PRODUCTIVE HOURS OF THE SAME CATEGORY CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH PROCEDURE A.2.* | accounting practices"]<br><br>[Option II: Individual hourly rates were applied] | |
| | | *For option I concerning unit costs and if the Beneficiary applies the methodology approved by the Commission (CoMUC):*<br><br>30) The Beneficiary used the Commission-approved methodology to calculate hourly rates. It corresponded to the organisation's usual cost accounting practices and was applied consistently for all activities irrespective of the source of funding. | |
| | | *For option I concerning unit costs and if the Beneficiary applies a methodology not approved by the Commission:*<br><br>31) The unit costs re-calculated by the Auditor were the same as the rates applied by the Beneficiary. | |
| | | *For option II concerning individual hourly rates:*<br><br>32) The individual rates re- | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | *HOURLY RATE FOR INDIVIDUAL ACTUAL PERSONAL COSTS:*<br>*IT IS CALCULATED FOLLOWING ONE OF THE TWO OPTIONS BELOW:*<br><br>*A) [OPTION BY DEFAULT] BY DIVIDING THE ACTUAL ANNUAL AMOUNT OF PERSONNEL COSTS OF AN EMPLOYEE VERIFIED IN LINE WITH PROCEDURE A.1 BY THE NUMBER OF ANNUAL PRODUCTIVE HOURS VERIFIED IN LINE WITH PROCEDURE A.2 (FULL FINANCIAL YEAR HOURLY RATE);*<br><br>*B) BY DIVIDING THE ACTUAL MONTHLY AMOUNT OF PERSONNEL COSTS OF AN EMPLOYEE VERIFIED IN LINE WITH PROCEDURE A.1 BY 1/12 OF THE NUMBER OF ANNUAL PRODUCTIVE HOURS VERIFIED IN LINE WITH PROCEDURE A.2.(MONTHLY HOURLY RATE).* | calculated by the Auditor were the same as the rates applied by the Beneficiary.<br>32.1) The Beneficiary used only one option (per full financial year or per month) throughout each financial year examined. | |
| **A.4** | **TIME RECORDING SYSTEM**<br>To verify that the time recording system ensures the fulfilment of all minimum requirements and that the hours declared for the action were correct, accurate and properly authorised and supported by documentation, the Auditor made the following checks for the persons included in the sample that declare time as worked for the action on the basis of time records:<br>o description of the time recording system provided by the Beneficiary (registration, authorisation, processing in the HR-system);<br>o its actual implementation;<br>o time records were signed at least monthly by the employees (on paper or electronically) and authorised by the project manager or another manager;<br>o the hours declared were worked within the project period;<br>o there were no hours declared as worked for the action if HR-records showed absence due to holidays or sickness (further cross-checks with travels are carried out in B.1 below) ;<br>o the hours charged to the action matched those in the time recording system. | 33) All persons recorded their time dedicated to the action on a **daily/ weekly/ monthly** basis using a **paper**/**computer-based** system. (*delete the answers that are not applicable)* | |
| | | 34) Their time-records were authorised at least monthly by the project manager or other superior. | |
| | | 35) Hours declared were worked within the project period and were consistent with the presences/absences recorded in HR-records. | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | *ONLY THE HOURS WORKED ON THE ACTION CAN BE CHARGED. ALL WORKING TIME TO BE CHARGED SHOULD BE RECORDED THROUGHOUT THE DURATION OF THE PROJECT, ADEQUATELY SUPPORTED BY EVIDENCE OF THEIR REALITY AND RELIABILITY (SEE SPECIFIC PROVISIONS BELOW FOR PERSONS WORKING EXCLUSIVELY FOR THE ACTION WITHOUT TIME RECORDS).* | 36) There were no discrepancies between the number of hours charged to the action and the number of hours recorded. | |
| | <u>If the persons are working exclusively for the action and without time records</u><br>For the persons selected that worked exclusively for the action without time records, the Auditor verified evidence available demonstrating that they were in reality exclusively dedicated to the action and that the Beneficiary signed a declaration confirming that they have worked exclusively for the action. | 37) The exclusive dedication is supported by a declaration signed by the Beneficiary's and by any other evidence gathered. | |
| **B** | **COSTS OF SUBCONTRACTING** | | |
| **B.1** | **The Auditor obtained the detail/breakdown of subcontracting costs and sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest*).<br>To confirm standard factual findings 38-42 listed in the next column, the Auditor reviewed the following for the items included in the sample:<br>o the use of subcontractors was foreseen in Annex 1;<br>o subcontracting costs were declared in the subcontracting category of the Financial Statement;<br>o supporting documents on the selection and award procedure were followed;<br>o the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the subcontract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment). | 38) The use of claimed subcontracting costs was foreseen in Annex 1 and costs were declared in the Financial Statements under the subcontracting category. | |
| | | 39) There were documents of requests to different providers, different offers and assessment of the offers before selection of the provider in line with internal procedures and procurement rules. Subcontracts were awarded in accordance with the principle of best value for money.<br>*(When different offers were not collected the Auditor explains* | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | In particular,<br>i. if the Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC (or 2014/24/EU) or of Directive 2004/17/EC (or 2014/25/EU), the Auditor verified that the applicable national law on public procurement was followed and that the subcontracting complied with the Terms and Conditions of the Agreement.<br>ii. if the Beneficiary did not fall under the above-mentioned category the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement..<br><br>For the items included in the sample the Auditor also verified that:<br>o the subcontracts were not awarded to other Beneficiaries in the consortium;<br>o there were signed agreements between the Beneficiary and the subcontractor;<br>o there was evidence that the services were provided by subcontractor; | *the reasons provided by the Beneficiary under the caption "Exceptions" of the Report. The Commission will analyse this information to evaluate whether these costs might be accepted as eligible)* | |
| | | 40) The subcontracts were not awarded to other Beneficiaries of the consortium. | |
| | | 41) All subcontracts were supported by signed agreements between the Beneficiary and the subcontractor. | |
| | | 42) There was evidence that the services were provided by the subcontractors. | |
| **C** | **COSTS OF PROVIDING FINANCIAL SUPPORT TO THIRD PARTIES** | | |
| **C.1** | **The Auditor obtained the detail/breakdown of the costs of providing financial support to third parties and sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest*).<br><br>The Auditor verified that the following minimum conditions were met:<br>a) the maximum amount of financial support for each third party did not exceed EUR 60 000, unless explicitly mentioned in Annex 1; | 43) All minimum conditions were met | |

| Ref | Procedures | Standard factual finding | Result (C / E / N.A.) |
|---|---|---|---|
| | b) the financial support to third parties was agreed in Annex 1 of the Agreement and the other provisions on financial support to third parties included in Annex 1 were respected. | | |

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| **D** | **OTHER ACTUAL DIRECT COSTS** | | |
| **D.1** | **COSTS OF TRAVEL AND RELATED SUBSISTENCE ALLOWANCES**<br><br>**The Auditor sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest*).<br><br>The Auditor inspected the sample and verified that:<br><br>o travel and subsistence costs were consistent with the Beneficiary's usual policy for travel. In this context, the Beneficiary provided evidence of its normal policy for travel costs (e.g. use of first class tickets, reimbursement by the Beneficiary on the basis of actual costs, a lump sum or per diem) to enable the Auditor to compare the travel costs charged with this policy;<br><br>o travel costs are correctly identified and allocated to the action (e.g. trips are directly linked to the action) by reviewing relevant supporting documents such as minutes of meetings, workshops or conferences, their registration in the correct project account, their consistency with time records or with the dates/duration of the workshop/conference;<br><br>o no ineligible costs or excessive or reckless expenditure was declared. | 44) Costs were incurred, approved and reimbursed in line with the Beneficiary's usual policy for travels. | |
| | | 45) There was a link between the trip and the action. | |
| | | 46) The supporting documents were consistent with each other regarding subject of the trip, dates, duration and reconciled with time records and accounting. | |
| | | 47) No ineligible costs or excessive or reckless expenditure was declared. | |
| **D.2** | **DEPRECIATION COSTS FOR EQUIPMENT, INFRASTRUCTURE OR OTHER ASSETS**<br><br>**The Auditor sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest*).<br><br>For "equipment, infrastructure or other assets" [from now on called "asset(s)"] selected in the sample the Auditor verified that:<br><br>o the assets were acquired in conformity with the Beneficiary's internal guidelines and procedures;<br><br>o they were correctly allocated to the action (with supporting documents such as delivery | 48) Procurement rules, principles and guides were followed. | |
| | | 49) There was a link between the grant agreement and the asset charged to the action. | |
| | | 50) The asset charged to the action was traceable to the accounting records and the underlying documents. | |

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| | note invoice or any other proof demonstrating the link to the action)<br>o they were entered in the accounting system;<br>o the extent to which the assets were used for the action (as a percentage) was supported by reliable documentation (e.g. usage overview table);<br><br>The Auditor recalculated the depreciation costs and verified that they were in line with the applicable rules in the Beneficiary's country and with the Beneficiary's usual accounting policy (e.g. depreciation calculated on the acquisition value).<br><br>The Auditor verified that no ineligible costs such as deductible VAT, exchange rate losses, excessive or reckless expenditure were declared (see Article 6.5 GA). | 51) The depreciation method used to charge the asset to the action was in line with the applicable rules of the Beneficiary's country and the Beneficiary's usual accounting policy.<br><br>52) The amount charged corresponded to the actual usage for the action.<br><br>53) No ineligible costs or excessive or reckless expenditure were declared. | |
| **D.3** | **COSTS OF OTHER GOODS AND SERVICES**<br><br>**The Auditor sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest*).<br><br>For the purchase of goods, works or services included in the sample the Auditor verified that:<br>o the contracts did not cover tasks described in Annex 1;<br>o they were correctly identified, allocated to the proper action, entered in the accounting system (traceable to underlying documents such as purchase orders, invoices and accounting);<br>o the goods were not placed in the inventory of durable equipment;<br>o the costs charged to the action were accounted in line with the Beneficiary's usual accounting practices;<br>o no ineligible costs or excessive or reckless expenditure were declared (see Article 6 GA).<br><br>In addition, the Auditor verified that these goods and services were acquired in conformity with the Beneficiary's internal guidelines and procedures, in particular:<br>o if Beneficiary acted as a contracting authority within the meaning of Directive | 54) Contracts for works or services did not cover tasks described in Annex 1.<br><br>55) Costs were allocated to the correct action and the goods were not placed in the inventory of durable equipment.<br><br>56) The costs were charged in line with the Beneficiary's accounting policy and were adequately supported.<br><br>57) No ineligible costs or excessive or reckless expenditure were declared. For internal invoices/charges only the cost element was charged, without any mark-ups. | |

| | | | |
|---|---|---|---|
| | 2004/18/EC (or 2014/24/EU) or of Directive 2004/17/EC (or 2014/25/EU), the Auditor verified that the applicable national law on public procurement was followed and that the procurement contract complied with the Terms and Conditions of the Agreement.<br>o if the Beneficiary did not fall into the category above, the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement.<br>For the items included in the sample the Auditor also verified that:<br>o the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the contract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Auditor also verified that the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment);<br>*SUCH GOODS AND SERVICES INCLUDE, FOR INSTANCE, CONSUMABLES AND SUPPLIES, DISSEMINATION (INCLUDING OPEN ACCESS), PROTECTION OF RESULTS, SPECIFIC EVALUATION OF THE ACTION IF IT IS REQUIRED BY THE AGREEMENT, CERTIFICATES ON THE FINANCIAL STATEMENTS IF THEY ARE REQUIRED BY THE AGREEMENT AND CERTIFICATES ON THE METHODOLOGY, TRANSLATIONS, REPRODUCTION.* | 58) Procurement rules, principles and guides were followed. There were documents of requests to different providers, different offers and assessment of the offers before selection of the provider in line with internal procedures and procurement rules. The purchases were made in accordance with the principle of best value for money.<br>*(When different offers were not collected the Auditor explains the reasons provided by the Beneficiary under the caption "Exceptions" of the Report. The Commission will analyse this information to evaluate whether these costs might be accepted as eligible)* | |
| **D.4** | **AGGREGATED CAPITALISED AND OPERATING COSTS OF RESEARCH INFRASTRUCTURE**<br>The Auditor ensured the existence of a positive ex-ante assessment (issued by the EC Services) of the cost accounting methodology of the Beneficiary allowing it to apply the guidelines on direct costing for large research infrastructures in Horizon 2020.<br>***In the cases that a positive ex-ante assessment has been issued*** *(see the standard factual findings 59-60 on the next column)**,*** | 59) The costs declared as direct costs for Large Research Infrastructures (in the appropriate line of the Financial Statement) comply with the methodology described in the positive ex-ante assessment report. | |

| | | | |
|---|---|---|---|
| | The Auditor ensured that the beneficiary has applied consistently the methodology that is explained and approved in the positive ex ante assessment;<br><br>***In the cases that a positive ex-ante assessment has NOT been issued*** *(see the standard factual findings 61 on the next column),*<br>The Auditor verified that no costs of Large Research Infrastructure have been charged as direct costs in any costs category;<br><br>***In the cases that a draft ex-ante assessment report has been issued with recommendation for further changes*** *(see the standard factual findings 61 on the next column),*<br>• The Auditor followed the same procedure as above (when a positive ex-ante assessment has NOT yet been issued) and paid particular attention (testing reinforced) to the cost items for which the draft ex-ante assessment either rejected the inclusion as direct costs for Large Research Infrastructures or issued recommendations. | 60) Any difference between the methodology applied and the one positively assessed was extensively described and adjusted accordingly.<br><br>61) The direct costs declared were free from any indirect costs items related to the Large Research Infrastructure. | |
| **E** | **USE OF EXCHANGE RATES** | | |
| **E.1** | a) For Beneficiaries with accounts established in a currency other than euros<br><br>**The Auditor sampled _____ cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement** ( *full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest)*:<br><br>*COSTS RECORDED IN THE ACCOUNTS IN A CURRENCY OTHER THAN EURO SHALL BE CONVERTED INTO EURO AT THE AVERAGE OF THE DAILY EXCHANGE RATES PUBLISHED IN THE C SERIES OF OFFICIAL JOURNAL OF THE EUROPEAN UNION (https://www.ecb.int/stats/exchange/eurofxref/html/index.en.html ), DETERMINED OVER THE CORRESPONDING REPORTING PERIOD.*<br><br>*IF NO DAILY EURO EXCHANGE RATE IS PUBLISHED IN THE OFFICIAL JOURNAL OF THE EUROPEAN UNION FOR THE CURRENCY IN QUESTION, CONVERSION SHALL BE MADE AT THE AVERAGE OF THE MONTHLY ACCOUNTING RATES ESTABLISHED BY THE COMMISSION AND PUBLISHED ON ITS WEBSITE (http://ec.europa.eu/budget/contracts_grants/info_contracts/inforeuro/inforeuro_en.cfm ), DETERMINED OVER THE CORRESPONDING REPORTING PERIOD.* | 62) The exchange rates used to convert other currencies into Euros were in accordance with the rules established of the Grant Agreement and there was no difference in the final figures. | |

| | | | |
|---|---|---|---|
| | b) For Beneficiaries with accounts established in euros<br><br>**The Auditor sampled _____ cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement** ( *full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest)*:<br><br>*COSTS INCURRED IN ANOTHER CURRENCY SHALL BE CONVERTED INTO EURO BY APPLYING THE BENEFICIARY'S USUAL ACCOUNTING PRACTICES.* | 63) The Beneficiary applied its usual accounting practices. | |

***[legal name of the audit firm]***
***[name and function of an authorised representative]***
***[dd Month yyyy]***
***<Signature of the Auditor>***

**ANNEX 6**

# MODEL FOR THE CERTIFICATE ON THE METHODOLOGY

- **For options [*in italics in square brackets*]: choose the applicable option. Options not chosen should be deleted.**
- **For fields in [grey in square brackets]: enter the appropriate data.**

**TABLE OF CONTENTS**

**Terms of reference for an audit engagement for a methodology certificate in connection with one or more grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme**

This document sets out the '**Terms of Reference (ToR)**' under which

*[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')]*

agrees to engage

[**insert legal name of the auditor**] ('the Auditor')

to produce an independent report of factual findings ('the Report') concerning the *[Beneficiary's] [Linked Third Party's]* usual accounting practices for calculating and claiming direct personnel costs declared as unit costs ('the Methodology') in connection with grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme.

The procedures to be carried out for the assessment of the methodology will be based on the grant agreement(s) detailed below:

[title and number of the grant agreement(s)] ('the Agreement(s)')

The Agreement(s) has(have) been concluded between the Beneficiary and *[OPTION 1: the European Union, represented by the European Commission ('the Commission')][ OPTION 2: the European Atomic Energy Community (Euratom,) represented by the European Commission ('the Commission')][OPTION 3: the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)] ('the Agency'), under the powers delegated by the European Commission ('the Commission').]*.

The *[Commission] [Agency]* is mentioned as a signatory of the Agreement with the Beneficiary only. The *[European Union] [Euratom] [Agency]* is not a party to this engagement.

### 1.1 Subject of the engagement

According to Article 18.1.2 of the Agreement, beneficiaries *[and linked third parties]* that declare direct personnel costs as unit costs calculated in accordance with their usual cost accounting practices may submit to the *[Commission] [Agency]*, for approval, a certificate on the methodology ('CoMUC') stating that there are adequate records and documentation to prove that their cost accounting practices used comply with the conditions set out in Point A of Article 6.2.

The subject of this engagement is the CoMUC which is composed of two separate documents:

- the Terms of Reference ('the ToR') to be signed by the *[Beneficiary] [Linked Third Party]* and the Auditor;

- the Auditor's Independent Report of Factual Findings ('the Report') issued on the Auditor's letterhead, dated, stamped and signed by the Auditor which includes; the standard statements ('the Statements') evaluated and signed by the *[Beneficiary] [Linked Third Party]*, the agreed-upon procedures ('the Procedures') performed by the Auditor and the standard factual findings

('the Findings') assessed by the Auditor. The Statements, Procedures and Findings are summarised in the table that forms part of the Report.

The information provided through the Statements, the Procedures and the Findings will enable the Commission to draw conclusions regarding the existence of the *[Beneficiary's] [Linked Third Party's]* usual cost accounting practice and its suitability to ensure that direct personnel costs claimed on that basis comply with the provisions of the Agreement. The Commission draws its own conclusions from the Report and any additional information it may require.

### 1.2 Responsibilities

The parties to this agreement are the *[Beneficiary] [Linked Third Party]* and the Auditor.

The *[Beneficiary] [Linked Third Party]:*

- is responsible for preparing financial statements for the Agreement(s) ('the Financial Statements') in compliance with those Agreements;
- is responsible for providing the Financial Statement(s) to the Auditor and enabling the Auditor to reconcile them with the *[Beneficiary's] [Linked Third Party's]* accounting and bookkeeping system and the underlying accounts and records. The Financial Statement(s) will be used as a basis for the procedures which the Auditor will carry out under this ToR;
- is responsible for its Methodology and liable for the accuracy of the Financial Statement(s);
- is responsible for endorsing or refuting the Statements indicated under the heading 'Statements to be made by the Beneficiary/ Linked Third Party' in the first column of the table that forms part of the Report;
- must provide the Auditor with a signed and dated representation letter;
- accepts that the ability of the Auditor to carry out the Procedures effectively depends upon the *[Beneficiary] [Linked Third Party]* providing full and free access to the *[Beneficiary's] [Linked Third Party's]* staff and to its accounting and other relevant records.

The Auditor:

- *[Option 1 by default: is qualified to carry out statutory audits of accounting documents in accordance with Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts, amending Council Directives 78/660/EEC and 83/349/EEC and repealing Council Directive 84/253/EEC or similar national regulations]*.
- *[Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer: is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary]*.
- *[Option 3 if the Beneficiary or Linked Third Party is an international organisation: is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation]*.

The Auditor:

- must be independent from the Beneficiary *[and the Linked Third Party]*, in particular, it must not have been involved in preparing the Beneficiary's *[and Linked Third Party's]* Financial Statement(s);
- must plan work so that the Procedures may be carried out and the Findings may be assessed;
- must adhere to the Procedures laid down and the compulsory report format;
- must carry out the engagement in accordance with these ToR;
- must document matters which are important to support the Report;
- must base its Report on the evidence gathered;
- must submit the Report to the *[Beneficiary] [Linked Third Party]*.

The Commission sets out the Procedures to be carried out and the Findings to be endorsed by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement the Auditor does not provide an audit opinion or a statement of assurance.

### 1.3 Applicable Standards

The Auditor must comply with these Terms of Reference and with[1]:

- the International Standard on Related Services ('ISRS') 4400 *Engagements to perform Agreed-upon Procedures regarding Financial Information* as issued by the International Auditing and Assurance Standards Board (IAASB);
- the *Code of Ethics for Professional Accountants* issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the Commission requires that the Auditor also complies with the Code's independence requirements.

The Auditor's Report must state that there was no conflict of interests in establishing this Report between the Auditor and the Beneficiary *[and the Linked Third Party]* that could have a bearing on the Report, and must specify – if the service is invoiced - the total fee paid to the Auditor for providing the Report.

### 1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7 of the Agreement).

Under Article 22 of the Agreement, the Commission, *[the Agency]*, the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are declared from *[the European Union] [Euratom]* budget. This includes work related to this engagement. The Auditor must provide access to all working papers related to this assignment if the Commission*[, the Agency]*, the European Anti-Fraud Office or the European Court of Auditors requests them.

### 1.5 Timing

The Report must be provided by [dd Month yyyy].

### 1.6 Other Terms

*[The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor's fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.]*

| | |
|---|---|
| [legal name of the Auditor] | [legal name of the [Beneficiary] [Linked Third Party]] |
| [name & title of authorised representative] | [name & title of authorised representative] |
| [dd Month yyyy] | [dd Month yyyy] |
| Signature of the Auditor Signature | Signature of the *[Beneficiary] [Linked Third Party]* |

[1] Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services ('ISRS') 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.

**Independent report of factual findings on the methodology concerning grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme**

*(To be printed on letterhead paper of the auditor)*

To
[ name of contact person(s)], [Position]
[[Beneficiary's] [Linked Third Party's] name]
[ Address]
[ dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with *[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')]*,

we

[ name of the auditor] ('the Auditor'),

established at

[full address/city/state/province/country],

represented by

[name and function of an authorised representative],

have carried out the agreed-upon procedures ('the Procedures') and provide hereby our Independent Report of Factual Findings ('the Report'), concerning the *[Beneficiary's] [Linked Third Party's]* usual accounting practices for calculating and declaring direct personnel costs declared as unit costs ('the Methodology').

You requested certain procedures to be carried out in connection with the grant(s)

[title and number of the grant agreement(s)] ('the Agreement(s)').

**The Report**

Our engagement was carried out in accordance with the terms of reference ('the ToR') appended to this Report. The Report includes: the standard statements ('the Statements') made by the *[Beneficiary] [Linked Third Party]*, the agreed-upon procedures ('the Procedures') carried out and the standard factual findings ('the Findings') confirmed by us.

The engagement involved carrying out the Procedures and assessing the Findings and the documentation requested appended to this Report, the results of which the Commission uses to draw conclusions regarding the acceptability of the Methodology applied by the *[Beneficiary] [Linked Third Party]*.

The Report covers the methodology used from [dd Month yyyy]. In the event that the *[Beneficiary] [Linked Third Party]* changes this methodology, the Report will not be applicable to any Financial Statement[1] submitted thereafter.

The scope of the Procedures and the definition of the standard statements and findings were determined solely by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence.

Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, we do not give a statement of assurance on the costs declared on the basis of the *[Beneficiary's] [Linked Third Party's]* Methodology. Had we carried out additional procedures or had we performed an audit or review in accordance with these standards, other matters might have come to its attention and would have been included in the Report.

**Exceptions**

Apart from the exceptions listed below, the *[Beneficiary] [Linked Third Party]* agreed with the standard Statements and provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and corroborate the standard Findings.

**List here any exception and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, also indicate the corresponding amount.**

**…..**

*Explanation of possible exceptions in the form of examples (to be removed from the Report):*

*i. the [Beneficiary] [Linked Third Party] did not agree with the standard Statement number … because…;*

*ii. the Auditor could not carry out the procedure … established because …. (e.g. due to the inability to reconcile key information or the unavailability or inconsistency of data);*

*iii. the Auditor could not confirm or corroborate the standard Finding number … because ….*

**Remarks**

We would like to add the following remarks relevant for the proper understanding of the Methodology applied by the [Beneficiary] [Linked Third Party] or the results reported:

*Example (to be removed from the Report):*

*Regarding the methodology applied to calculate hourly rates …*

*Regarding standard Finding 15 it has to be noted that …*

*The [Beneficiary] [Linked Third Party] explained the deviation from the benchmark statement XXIV concerning time recording for personnel with no exclusive dedication to the action in the following manner: …*

**Annexes**

Please provide the following documents to the auditor and annex them to the report when submitting this CoMUC to the Commission:

[1] Financial Statement in this context refers solely to Annex 4 of the Agreement by which the Beneficiary declares costs under the Agreement.

1. Brief description of the methodology for calculating personnel costs, productive hours and hourly rates;
2. Brief description of the time recording system in place;
3. An example of the time records used by the [*Beneficiary] [Linked Third Party*];
4. Description of any budgeted or estimated elements applied, together with an explanation as to why they are relevant for calculating the personnel costs and how they are based on objective and verifiable information;
5. A summary sheet with the hourly rate for direct personnel declared by the [*Beneficiary*] [*Linked Third Party*] and recalculated by the Auditor for each staff member included in the sample (the names do not need to be reported);
6. A comparative table summarising for each person selected in the sample a) the time claimed by the [*Beneficiary*] [*Linked Third Party*] in the Financial Statement(s) and b) the time according to the time record verified by the Auditor;
7. A copy of the letter of representation provided to the Auditor.

**Use of this Report**

This Report has been drawn up solely for the purpose given under Point 1.1 Reasons for the engagement.

The Report:

- is confidential and is intended to be submitted to the Commission by the [*Beneficiary*] [*Linked Third Party*] in connection with Article 18.1.2 of the Agreement;
- may not be used by the [*Beneficiary*] [*Linked Third Party*] or by the Commission for any other purpose, nor distributed to any other parties;
- may be disclosed by the Commission only to authorised parties, in particular the European Anti-Fraud Office (OLAF) and the European Court of Auditors.
- relates only to the usual cost accounting practices specified above and does not constitute a report on the Financial Statements of the [*Beneficiary*] [*Linked Third Party*].

No conflict of interest[2] exists between the Auditor and the Beneficiary *[and the Linked Third Party*] that could have a bearing on the Report. The total fee paid to the Auditor for producing the Report was EUR _____ (including EUR _____ of deductible VAT).

We look forward to discussing our Report with you and would be pleased to provide any further information or assistance which may be required.

Yours sincerely

[legal name of the Auditor]
[name and title of the authorised representative]
[dd Month yyyy]
Signature of the Auditor

[2] A conflict of interest arises when the Auditor's objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:
- was involved in the preparation of the Financial Statements;
- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.

## Statements to be made by the Beneficiary/Linked Third Party ('the Statements') and Procedures to be carried out by the Auditor ('the Procedures') and standard factual findings ('the Findings') to be confirmed by the Auditor

The Commission reserves the right to provide the auditor with guidance regarding the Statements to be made, the Procedures to be carried out or the Findings to be ascertained and the way in which to present them. The Commission reserves the right to vary the Statements, Procedures or Findings by written notification to the Beneficiary/Linked Third Party to adapt the procedures to changes in the grant agreement(s) or to any other circumstances.

If this methodology certificate relates to the Linked Third Party's usual accounting practices for calculating and claiming direct personnel costs declared as unit costs any reference here below to 'the Beneficiary' is to be considered as a reference to 'the Linked Third Party'.

| ***Please explain any discrepancies in the body of the Report.*** | |
|---|---|
| **Statements to be made by Beneficiary** | **Procedures to be carried out and Findings to be confirmed by the Auditor** |
| **A. Use of the Methodology**<br>I. The cost accounting practice described below has been in use since *[*dd Month yyyy*]*.<br>II. The next planned alteration to the methodology used by the Beneficiary will be from [dd Month yyyy*]*. | **Procedure:**<br>✓ The Auditor checked these dates against the documentation the Beneficiary has provided.<br>**Factual finding:**<br>1. The dates provided by the Beneficiary were consistent with the documentation. |
| **B. Description of the Methodology**<br>III. The methodology to calculate unit costs is being used in a consistent manner and is reflected in the relevant procedures.<br>*[Please describe the methodology your entity uses to calculate <u>personnel</u> costs, productive hours and hourly rates, present your description to the Auditor and annex it to this certificate]*<br>*[If the statement of section "B. Description of the methodology" cannot be endorsed by the Beneficiary or there is no written methodology to calculate unit costs it should be listed here below and reported as exception by the Auditor in the main Report of Factual Findings:*<br>- *...]* | **Procedure:**<br>✓ The Auditor reviewed the description, the relevant manuals and/or internal guidance documents describing the methodology.<br>**Factual finding:**<br>2. The brief description was consistent with the relevant manuals, internal guidance and/or other documentary evidence the Auditor has reviewed.<br>3. The methodology was generally applied by the Beneficiary as part of its usual costs accounting practices. |
| C. **Personnel costs**<br><u>General</u> | **Procedure:**<br>*The Auditor draws a sample of employees to carry out the procedures indicated in* |

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| IV. The unit costs (hourly rates) are limited to salaries including during parental leave, social security contributions, taxes and other costs included in the remuneration required under national law and the employment contract or equivalent appointing act;<br>V. Employees are hired directly by the Beneficiary in accordance with national law, and work under its sole supervision and responsibility;<br>VI. The Beneficiary remunerates its employees in accordance with its usual practices. This means that personnel costs are charged in line with the Beneficiary's usual payroll policy (e.g. salary policy, overtime policy, variable pay) and no special conditions exist for employees assigned to tasks relating to the European Union or Euratom, unless explicitly provided for in the grant agreement(s);<br>VII. The Beneficiary allocates its employees to the relevant group/category/cost centre for the purpose of the unit cost calculation in line with the usual cost accounting practice;<br>VIII. Personnel costs are based on the payroll system and accounting system.<br>IX. Any exceptional adjustments of actual personnel costs resulted from relevant budgeted or estimated elements and were based on objective and verifiable information. *[Please describe the 'budgeted or estimated elements' and their relevance to personnel costs, and explain how they were reasonable and based on objective and verifiable information, present your explanation to the Auditor and annex it to this certificate]*.<br>X. Personnel costs claimed do not contain any of the following ineligible costs: costs related to return on capital; debt and debt service charges; provisions for future losses or debts; interest owed; doubtful debts; currency exchange losses; bank costs charged by the Beneficiary's bank for transfers from the Commission/Agency; excessive or reckless expenditure; deductible VAT or costs incurred during suspension of the implementation of the action.<br>XI. Personnel costs were not declared under another EU or Euratom grant (including grants awarded by a Member State and financed by the EU budget and grants awarded by bodies other than the Commission/Agency for the purpose of implementing the EU budget). | *this section C and the following sections D to F.*<br>*[The Auditor has drawn a random sample of 10 full-time equivalents made up of employees assigned to the action(s). If fewer than 10 full-time equivalents are assigned to the action(s), the Auditor has selected a sample of 10 full-time equivalents consisting of all employees assigned to the action(s), complemented by other employees irrespective of their assignments.]*. For this sample:<br>✓ the Auditor reviewed all documents relating to personnel costs such as employment contracts, payslips, payroll policy (e.g. salary policy, overtime policy, variable pay policy), accounting and payroll records, applicable national tax , labour and social security law and any other documents corroborating the personnel costs claimed;<br>✓ in particular, the Auditor reviewed the employment contracts of the employees in the sample to verify that:<br>i. they were employed directly by the Beneficiary in accordance with applicable national legislation;<br>ii. they were working under the sole technical supervision and responsibility of the latter;<br>iii. they were remunerated in accordance with the Beneficiary's usual practices;<br>iv. they were allocated to the correct group/category/cost centre for the purposes of calculating the unit cost in line with the Beneficiary's usual cost accounting practices;<br>✓ the Auditor verified that any ineligible items or any costs claimed under other costs categories or costs covered by other types of grant or by other grants financed from the European Union budget have not been taken into account when calculating the personnel costs;<br>✓ the Auditor numerically reconciled the total amount of personnel costs used to calculate the unit cost with the total amount of personnel costs recorded in the statutory accounts and the payroll system.<br>✓ to the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, the Auditor carefully examined those elements and checked the information source to confirm that they correspond to objective and verifiable information; |

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| <u>If additional remuneration as referred to in the grant agreement(s) is paid</u><br><br>XII. The Beneficiary is a non-profit legal entity;<br><br>XIII. The additional remuneration is part of the beneficiary's usual remuneration practices and paid consistently whenever the relevant work or expertise is required;<br><br>XIV. The criteria used to calculate the additional remuneration are objective and generally applied regardless of the source of funding;<br><br>XV. The additional remuneration included in the personnel costs used to calculate the hourly rates for the grant agreement(s) is capped at EUR 8 000 per full-time equivalent (reduced proportionately if the employee is not assigned exclusively to the action).<br><br>*[If certain statement(s) of section "C. Personnel costs" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor in the main Report of Factual Findings:*<br>*- ...]* | ✓ if additional remuneration has been claimed, the Auditor verified that the Beneficiary was a non-profit legal entity, that the amount was capped at EUR 8 000 per full-time equivalent and that it was reduced proportionately for employees not assigned exclusively to the action(s).<br><br>✓ the Auditor recalculated the personnel costs for the employees in the sample.<br><br>**Factual finding:**<br><br>4. All the components of the remuneration that have been claimed as personnel costs are supported by underlying documentation.<br><br>5. The employees in the sample were employed directly by the Beneficiary in accordance with applicable national law and were working under its sole supervision and responsibility.<br><br>6. Their employment contracts were in line with the Beneficiary's usual policy;<br><br>7. Personnel costs were duly documented and consisted solely of salaries, social security contributions (pension contributions, health insurance, unemployment fund contributions, etc.), taxes and other statutory costs included in the remuneration (holiday pay, thirteenth month's pay, etc.);<br><br>8. The totals used to calculate the personnel unit costs are consistent with those registered in the payroll and accounting records;<br><br>9. To the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, those elements were relevant for calculating the personnel costs and correspond to objective and verifiable information. The budgeted or estimated elements used are: — (indicate the elements and their values).<br><br>10. Personnel costs contained no ineligible elements;<br><br>11. Specific conditions for eligibility were fulfilled when additional remuneration was paid: a) the Beneficiary is registered in the grant agreements as a non-profit legal entity; b) it was paid according to objective criteria generally applied regardless of the source of funding used and c) remuneration was capped at EUR 8 000 per full-time equivalent (or up to up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action). |

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| **Statements to be made by Beneficiary** | **Procedures to be carried out and Findings to be confirmed by the Auditor** |
| **D. Productive hours**<br><br>XVI. The number of productive hours per full-time employee applied is *[delete as appropriate]*:<br>A. 1720 productive hours per year for a person working full-time (corresponding pro-rata for persons not working full time).<br>B. the total number of hours worked in the year by a person for the Beneficiary<br>C. the standard number of annual hours generally applied by the beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the standard annual workable hours.<br><br><u>If method B is applied</u><br><br>XVII. The calculation of the total number of hours worked was done as follows: annual workable hours of the person according to the employment contract, applicable labour agreement or national law plus overtime worked minus absences (such as sick leave and special leave).<br>XVIII. 'Annual workable hours' are hours during which the personnel must be working, at the employer's disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.<br>XIX. The contract (applicable collective labour agreement or national working time legislation) do specify the working time enabling to calculate the annual workable hours.<br><br><u>If method C is applied</u><br><br>XX. The standard number of productive hours per year is that of a full-time equivalent.<br>XXI. The number of productive hours per year on which the hourly rate is based i) corresponds to the Beneficiary's usual accounting practices; ii) is at least 90% of the standard number of workable (working) hours per year.<br>XXII. Standard workable (working) hours are hours during which personnel are at | **Procedure (same sample basis as for Section C: Personnel costs):**<br><br>✓ The Auditor verified that the number of productive hours applied is in accordance with method A, B or C.<br>✓ The Auditor checked that the number of productive hours per full-time employee is correct.<br>✓ If method B is applied the Auditor verified i) the manner in which the total number of hours worked was done and ii) that the contract specified the annual workable hours by inspecting all the relevant documents, national legislation, labour agreements and contracts.<br>✓ If method C is applied the Auditor reviewed the manner in which the standard number of working hours per year has been calculated by inspecting all the relevant documents, national legislation, labour agreements and contracts and verified that the number of productive hours per year used for these calculations was at least 90% of the standard number of working hours per year.<br><br>**Factual finding:**<br><br><u>General</u><br><br>12. The Beneficiary applied a number of productive hours consistent with method A, B or C detailed in the left-hand column.<br>13. The number of productive hours per year per full-time employee was accurate.<br><br><u>If method B is applied</u><br><br>14. The number of 'annual workable hours', overtime and absences was verifiable based on the documents provided by the Beneficiary and the calculation of the total number of hours worked was accurate.<br>15. The contract specified the working time enabling to calculate the annual workable hours.<br><br><u>If method C is applied</u><br><br>16. The calculation of the number of productive hours per year corresponded to the usual costs accounting practice of the Beneficiary. |

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| **Statements to be made by Beneficiary** | **Procedures to be carried out and Findings to be confirmed by the Auditor** |
| the Beneficiary's disposal preforming the duties described in the relevant employment contract, collective labour agreement or national labour legislation. The number of standard annual workable (working) hours that the Beneficiary claims is supported by labour contracts, national legislation and other documentary evidence.<br>*[If certain statement(s) of section "D. Productive hours" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:*<br>- *...]* | 17. The calculation of the standard number of workable (working) hours per year was corroborated by the documents presented by the Beneficiary.<br>18. The number of productive hours per year used for the calculation of the hourly rate was at least 90 % of the number of workable (working) hours per year. |
| **E. Hourly rates**<br>The hourly rates are correct because:<br>XXIII. Hourly rates are correctly calculated since they result from dividing annual personnel costs by the productive hours of a given year and group (e.g. staff category or department or cost centre depending on the methodology applied) and they are in line with the statements made in section C. and D. above.<br>*[If the statement of section 'E. Hourly rates' cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:*<br>- *...]* | **Procedure**<br>✓ The Auditor has obtained a list of all personnel rates calculated by the Beneficiary in accordance with the methodology used.<br>✓ The Auditor has obtained a list of all the relevant employees, based on which the personnel rate(s) are calculated.<br>For 10 full-time equivalent employees selected at random (same sample basis as Section C: Personnel costs):<br>✓ The Auditor recalculated the hourly rates.<br>✓ The Auditor verified that the methodology applied corresponds to the usual accounting practices of the organisation and is applied consistently for all activities of the organisation on the basis of objective criteria irrespective of the source of funding.<br>**Factual finding:**<br>19. No differences arose from the recalculation of the hourly rate for the employees included in the sample. |
| **F. Time recording**<br>XXIV. Time recording is in place for all persons with no exclusive dedication to one Horizon 2020 action. At least all hours worked in connection with the grant agreement(s) are registered on a **daily/weekly/monthly** basis *[delete as appropriate]* using a **paper/computer-based system** *[delete as appropriate]*;<br>XXV. For persons exclusively assigned to one Horizon 2020 activity the | **Procedure**<br>✓ The Auditor reviewed the brief description, all relevant manuals and/or internal guidance describing the methodology used to record time.<br>The Auditor reviewed the time records of the random sample of 10 full-time equivalents referred to under Section C: Personnel costs, and verified in particular: |

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| Beneficiary has either signed a declaration to that effect or has put arrangements in place to record their working time;<br>XXVI. Records of time worked have been signed by the person concerned (on paper or electronically) and approved by the action manager or line manager at least monthly;<br>XXVII. Measures are in place to prevent staff from:<br>i. recording the same hours twice,<br>ii. recording working hours during absence periods (e.g. holidays, sick leave),<br>iii. recording more than the number of productive hours per year used to calculate the hourly rates, and<br>iv. recording hours worked outside the action period.<br>XXVIII. No working time was recorded outside the action period;<br>XXIX. No more hours were claimed than the productive hours used to calculate the hourly personnel rates.<br><br>*[Please provide a brief description of the time recording system in place together with the measures applied to ensure its reliability to the Auditor and annex it to the present certificate[1]].*<br><br>*[If certain statement(s) of section "F. Time recording" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the* | ✓ that time records were available for all persons with not exclusive assignment to the action;<br>✓ that time records were available for persons working exclusively for a Horizon 2020 action, or, alternatively, that a declaration signed by the Beneficiary was available for them certifying that they were working exclusively for a Horizon 2020 action;<br>✓ that time records were signed and approved in due time and that all minimum requirements were fulfilled;<br>✓ that the persons worked for the action in the periods claimed;<br>✓ that no more hours were claimed than the productive hours used to calculate the hourly personnel rates;<br>✓ that internal controls were in place to prevent that time is recorded twice, during absences for holidays or sick leave; that more hours are claimed per person per year for Horizon 2020 actions than the number of productive hours per year used to calculate the hourly rates; that working time is recorded outside the action period;<br>✓ the Auditor cross-checked the information with human-resources records to verify consistency and to ensure that the internal controls have been effective. In addition, the Auditor has verified that no more hours were charged to Horizon 2020 actions per person per year than the number of productive hours per year used to calculate the hourly rates, and verified that no time worked outside the action period was charged to the action.<br><br>**Factual finding:**<br>20. The brief description, manuals and/or internal guidance on time recording provided by the Beneficiary were consistent with management |

[1] The description of the time recording system must state among others information on the content of the time records, its coverage (full or action time-recording, for all personnel or only for personnel involved in H2020 actions), its degree of detail (whether there is a reference to the particular tasks accomplished), its form, periodicity of the time registration and authorisation (paper or a computer-based system; on a daily, weekly or monthly basis; signed and countersigned by whom), controls applied to prevent double-charging of time or ensure consistency with HR-records such as absences and travels as well as it information flow up to its use for the preparation of the Financial Statements.

| ***Please explain any discrepancies in the body of the Report.*** | |
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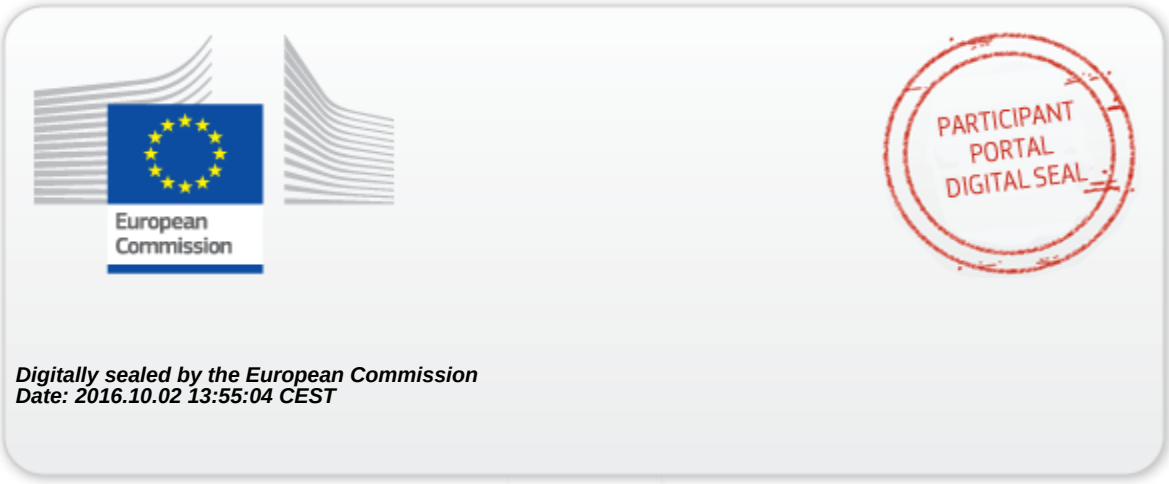
| *Auditor:*<br>- *...]* | reports/records and other documents reviewed and were generally applied by the Beneficiary to produce the financial statements.<br>21. For the random sample time was recorded or, in the case of employees working exclusively for the action, either a signed declaration or time records were available;<br>22. For the random sample the time records were signed by the employee and the action manager/line manager, at least monthly.<br>23. Working time claimed for the action occurred in the periods claimed;<br>24. No more hours were claimed than the number productive hours used to calculate the hourly personnel rates;<br>25. There is proof that the Beneficiary has checked that working time has not been claimed twice, that it is consistent with absence records and the number of productive hours per year, and that no working time has been claimed outside the action period.<br>26. Working time claimed is consistent with that on record at the human-resources department. |

***[official name of the** [Beneficiary] [Linked Third Party]**]***
***[name and title of authorised representative]***
***[dd Month yyyy]***
*<**Signature of the** [Beneficiary] [Linked Third Party]>*

***[official name of the Auditor]***
***[name and title of authorised representative]***
***[dd Month yyyy]***
*<**Signature** of the Auditor>*

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