EUROPEAN COMMISSION
Communications Networks, Content and Technology
Cloud & Software

ANNEX 1 (part A)

Research and Innovation action

NUMBER — 731529 — STAMP

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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 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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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
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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

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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

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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

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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

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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

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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) Updated table "Main dissemination and communication goals" to include relation to KPIs that substantiate the dissemination objectives (p. 38) Updated effort and cost break-down (p. 47) 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

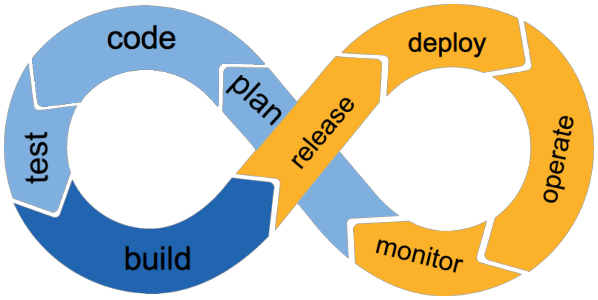


Figure 1a - The DevOps continuous delivery cycle

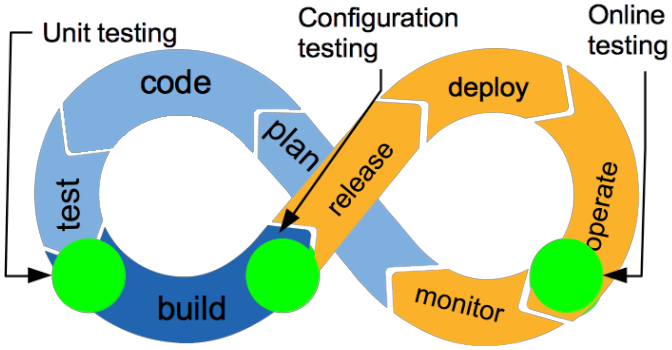


Figure 1b - The integration of STAMP's test amplification in DevOps

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**. 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.

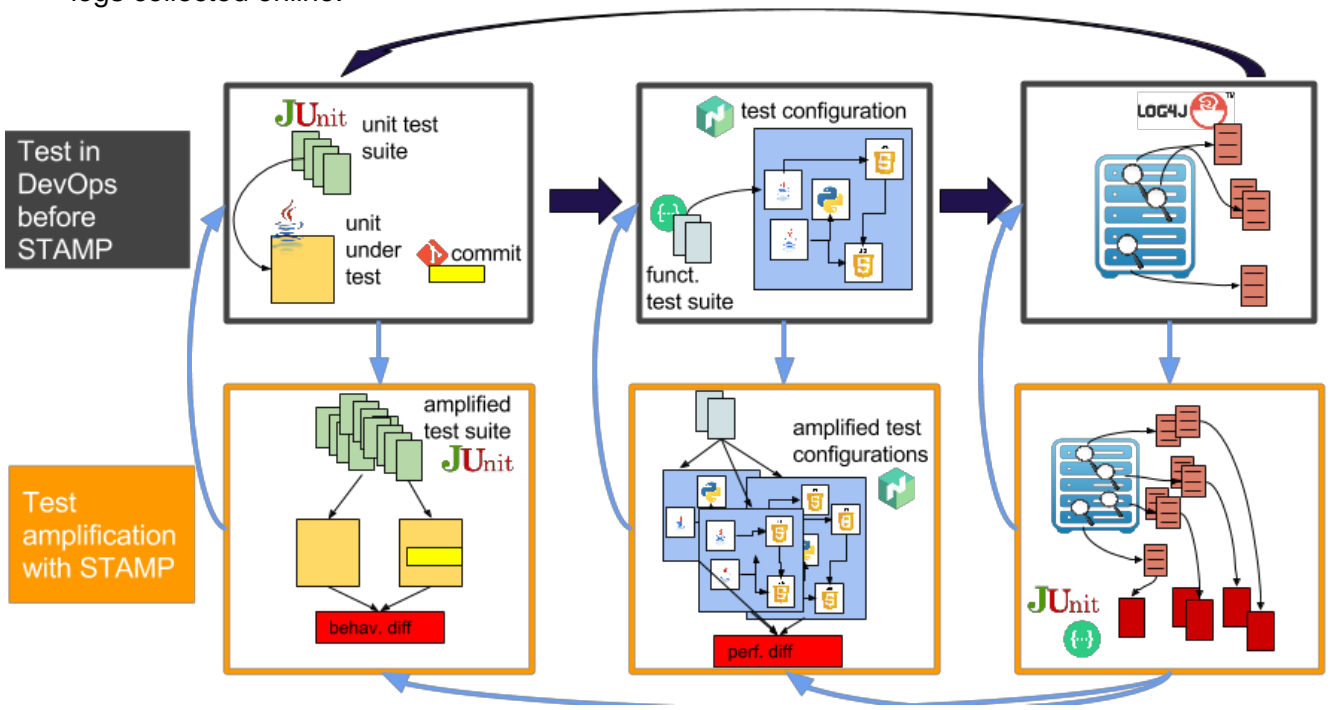
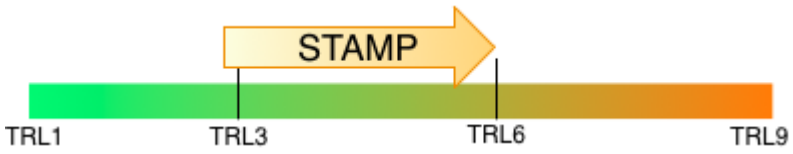


Figure 2 - The STAMP concept: test amplification through the whole lifecycle of software products and services (unit, configuration and online testing, from left to right).

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.

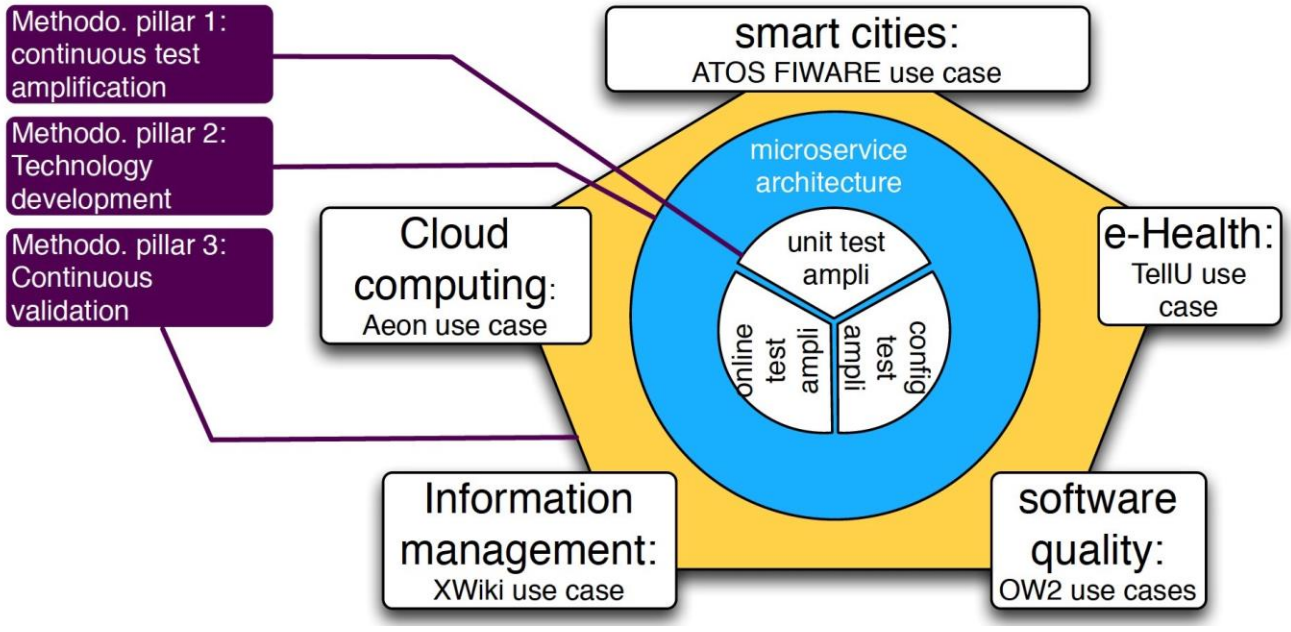


Figure 3a - the STAMP methodology is founded on three pillars: the development of innovative amplification technology (white, at the center of the figure), the development of these technologies following a microservice architecture model (blue circle) and continuous feedback from use cases coming from 5 application domains

[16] https://www.fiware.org/

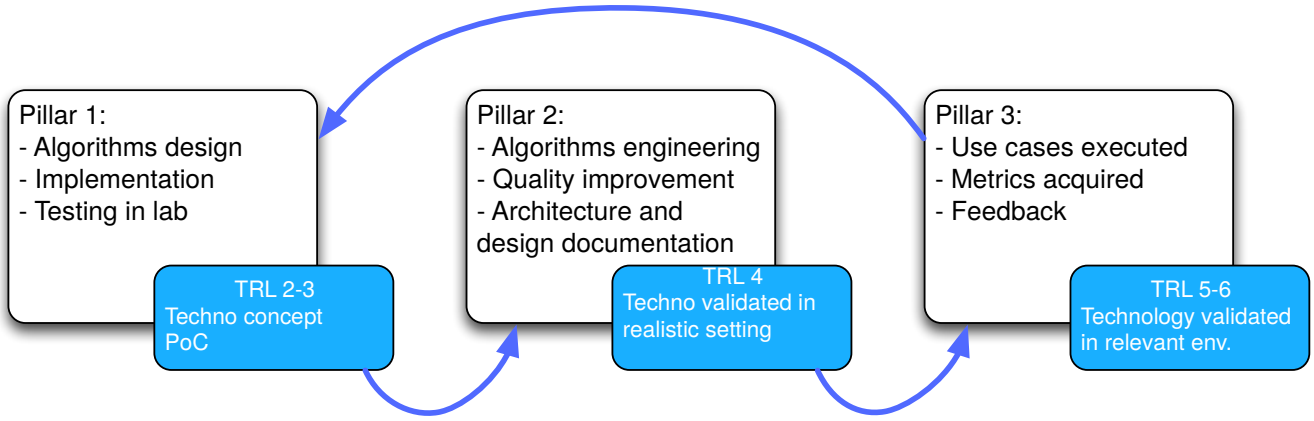


Figure 3b - the three methodological pillars of the STAMP methodology support the technological ambition of the project: porting the research ideas and prototypes to industry-strength tools at TRL 6

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.

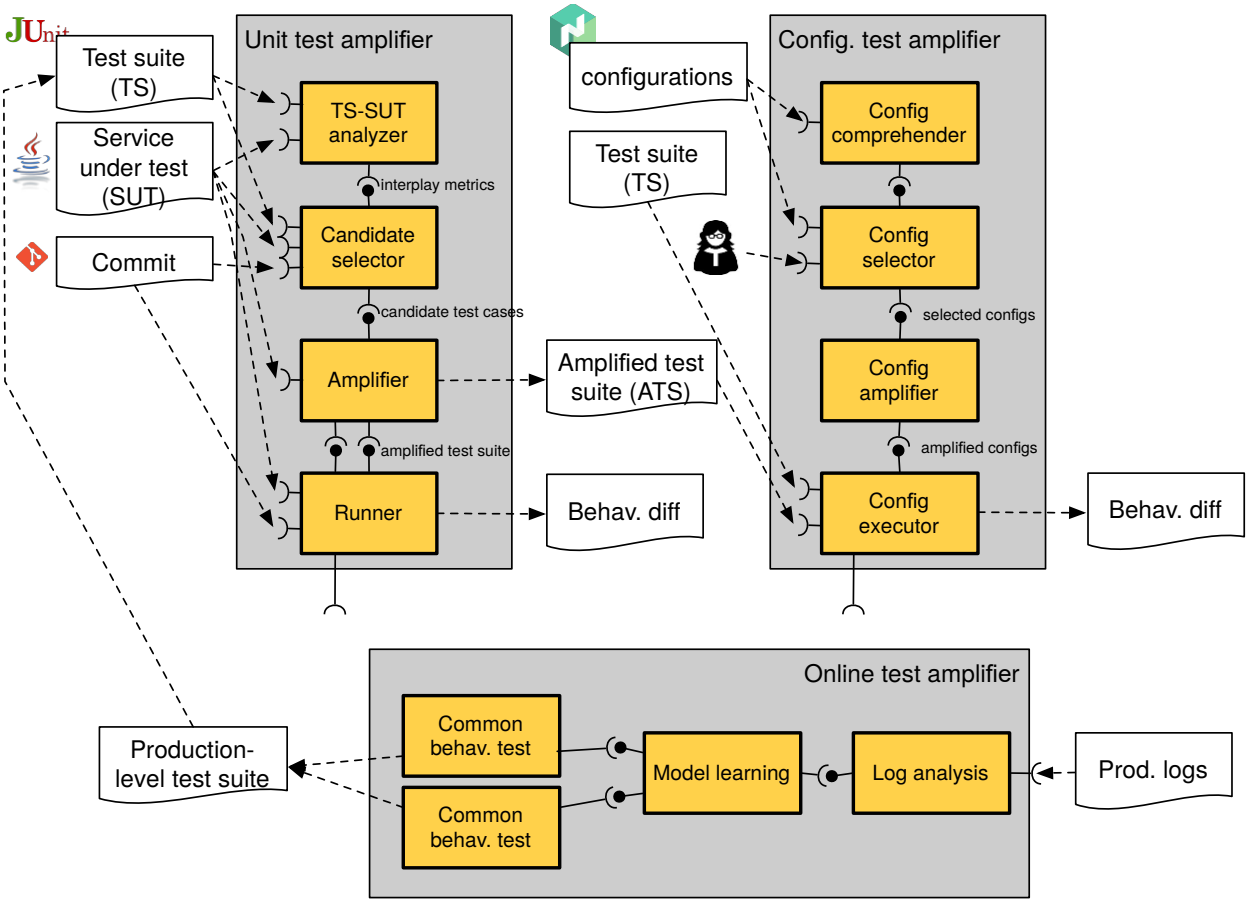


Figure 4 - STAMP micro-service architecture

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.

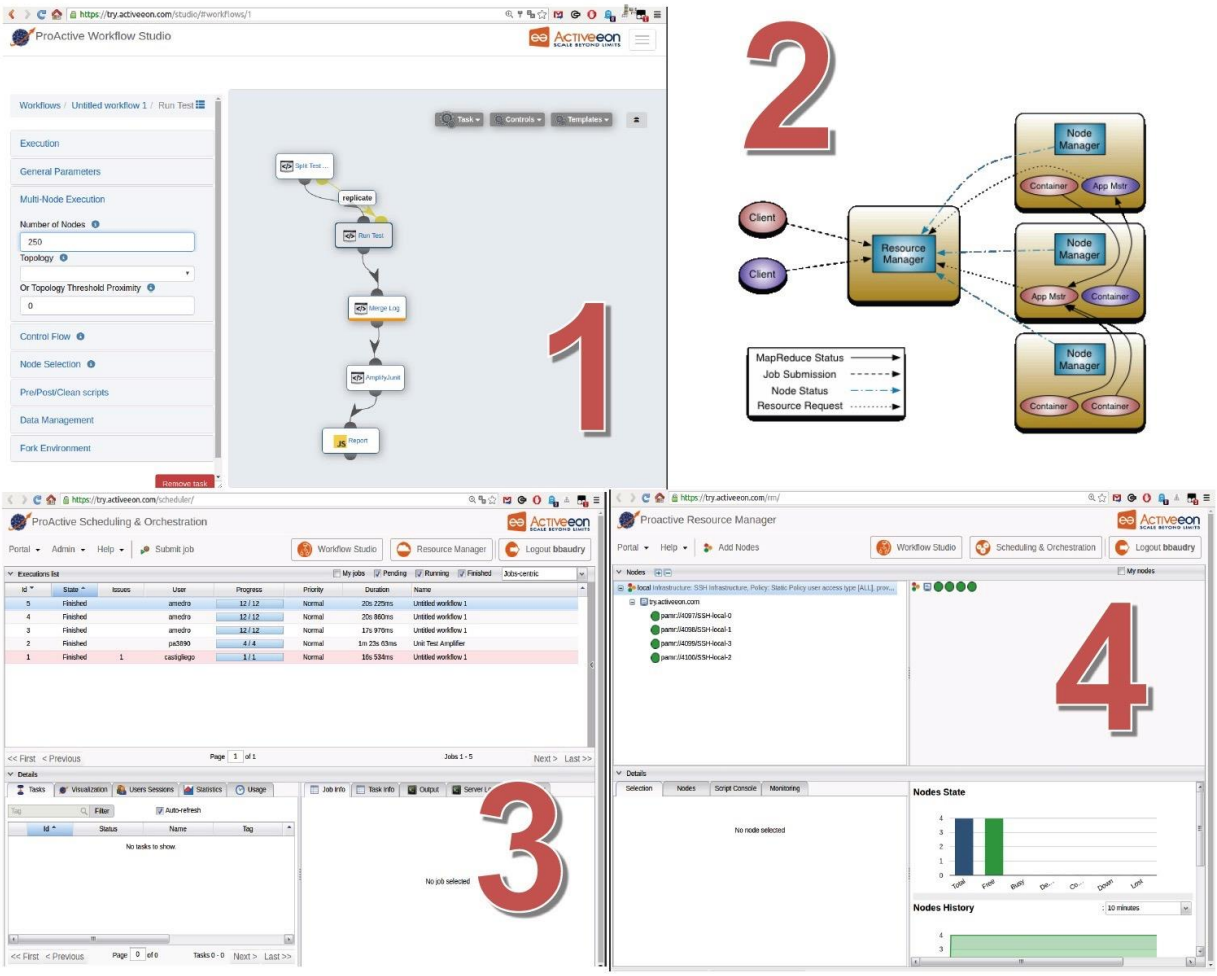


Figure 5 – Controlling the distribution of amplification computation

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 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 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 XWiki means to make use of the amplification developments • 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. • 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. • 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 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 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. 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. 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. 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. 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. 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).

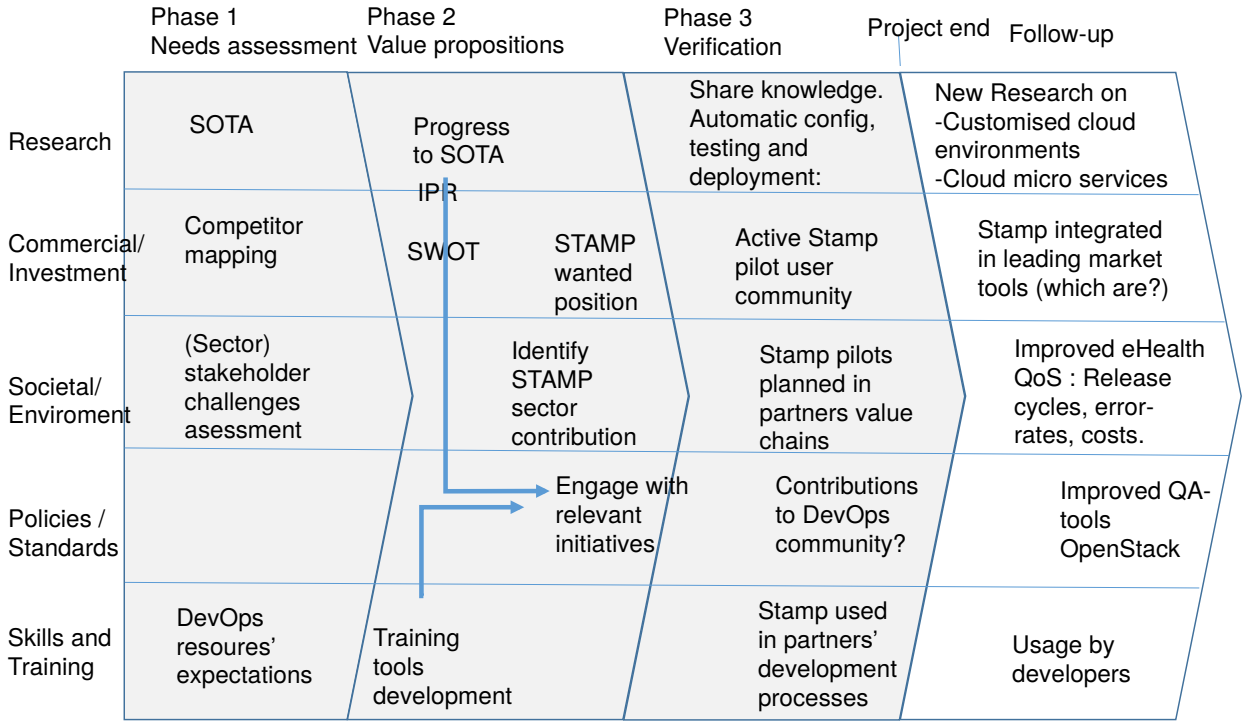
STAMP dissemination and exploitation plan will be narrowly targeted at specific market category called the innovators and early adopters, i.e. those that can take immediate advantage of the platform in the state it is delivered. They include different audiences such as the Commercial users, the Academic 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. 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). conference). 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. CSAs such as AppHub 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.



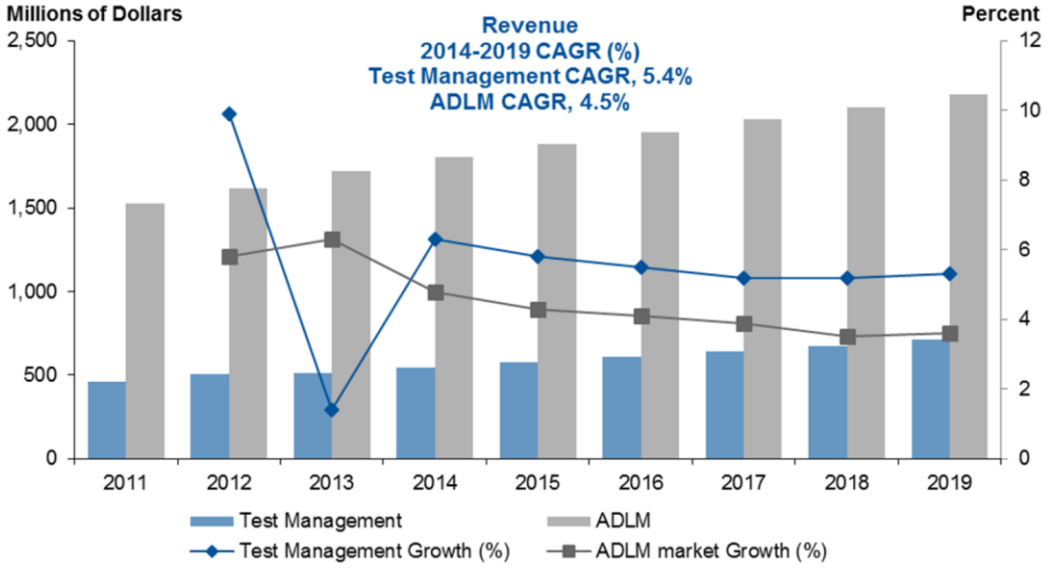
The exploitation plan phases are:

- 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) **who** (statement of the need or opportunity) **the** (product/service name) **is a** (product/service category) **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 -quickly and accurately Identifies bugs and inconsistencies at unit test stage so that the quality and reliability of the code is greatly improved. -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. - 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), **our product** (statement of primary differentiation).	Unlike (existing test products used) STAMP 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 One workshop toward end of project.	KPI17
Project Workshop	Hands-on session at third-party events	One in year 2 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

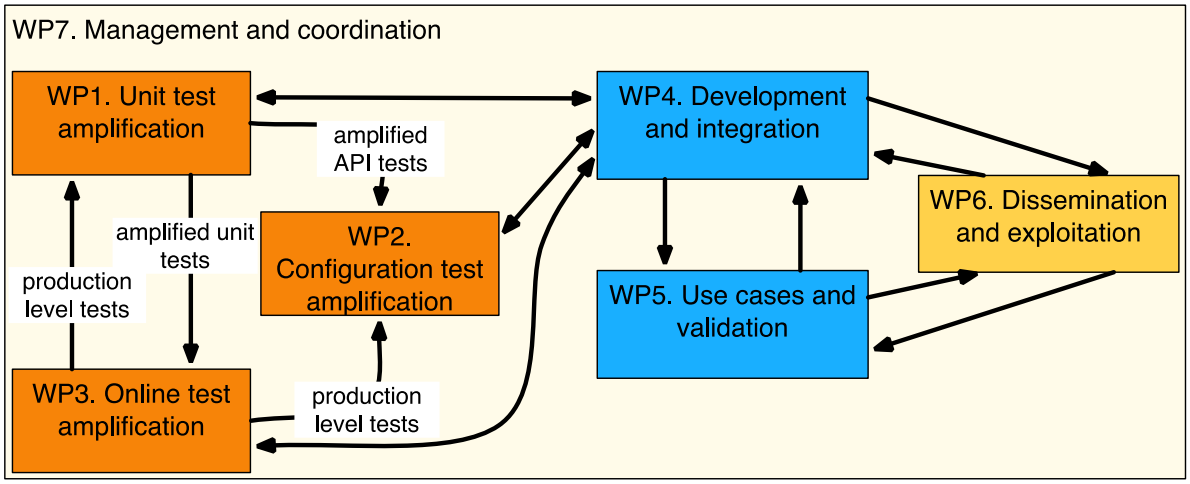
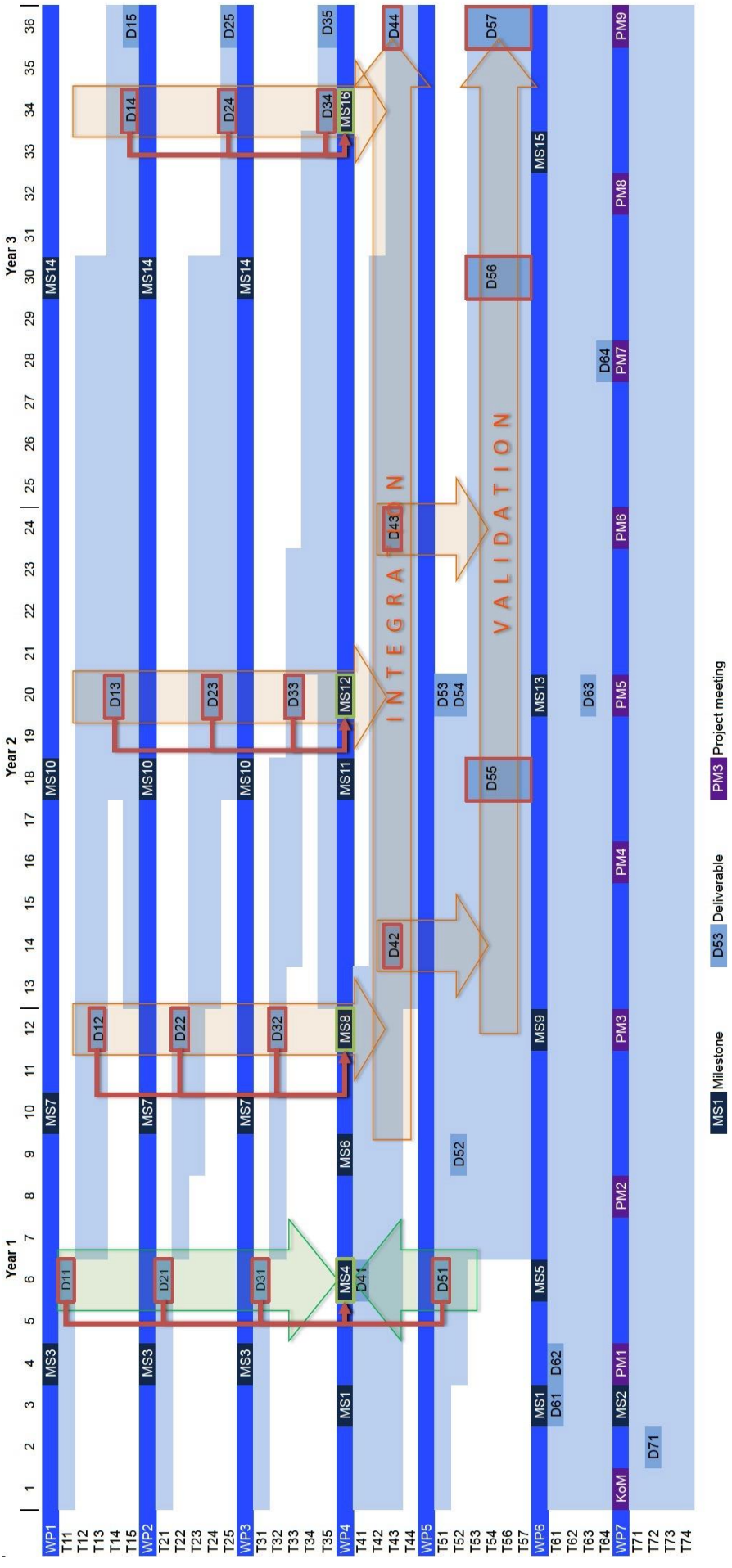


Figure 6: PERT diagram

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.

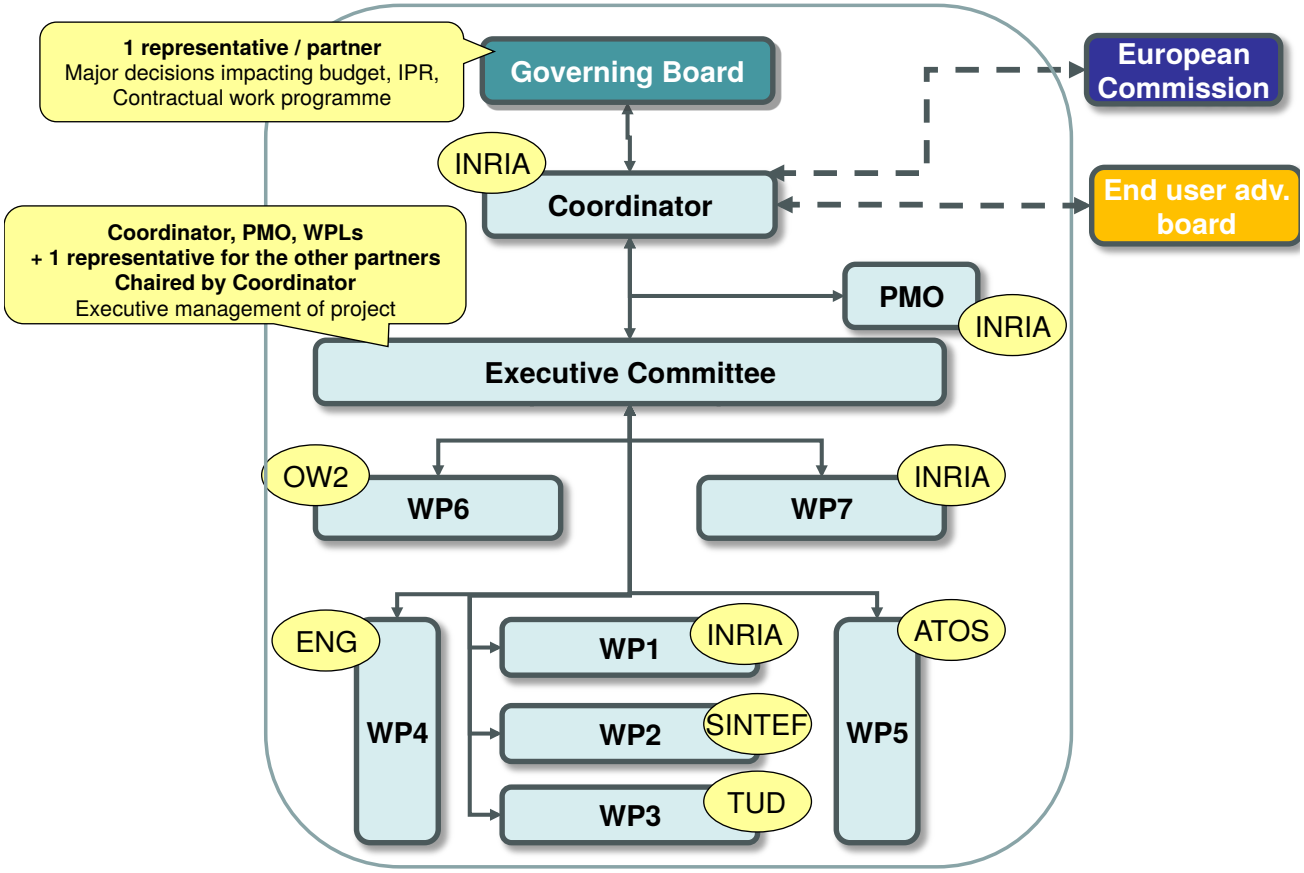


Figure 8: Management structure of the project

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)

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

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,

	FSE) and is on the editorial board of the Journal for Software and Systems Modeling. 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. 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. 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. 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. 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.

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

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

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

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. 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. 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.

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	

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

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

	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

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

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

	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

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

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	

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

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. He created and managed OCTO's London office in 2001, co-founded Pivolis (an Agile offshore software development company) 2 years after. In 2006, Vincent joined XWiki, an open source wiki product company, as CTO and co-founder. In parallel, he is has founded and participated in a number of Open Source projects including Cactus, Maven, Mock Objects and Cargo. 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.

	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. 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. 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). 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

No.8	Atos Spain	Atos	Spain	

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

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: • "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 • 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.

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

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.

	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.* • ***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. *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. *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.*** *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) A.2 Natural persons under direct contract A.3 Seconded persons [A.6 Personnel for providing access to research infrastructure]		A.4 SME owners without salary A.5 Beneficiaries that are natural persons without salary				D.1 Travel D.2 Equipment D.3 Other goods and services 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