CYCLONE in a Nutshell

CYCLONE is a Horizon 2020 innovation action funded by the European Commission which aims at integrating existing cloud management software to allow a unified management of federated clouds. Application service providers (ASPs) develop, deploy, and maintain complex computing platforms within multiple cloud infrastructures to improve resilience, responsiveness and elasticity of their applications.

The CYCLONE project targets the ASPs, providing them with software and tools that

- Facilitate the deployment, management, and use of their complex, multi-cloud applications, and
- Enhance the end-to-end security and network management of those applications.

The CYCLONE project integrates and improves existing, production-quality tools to achieve this aim.

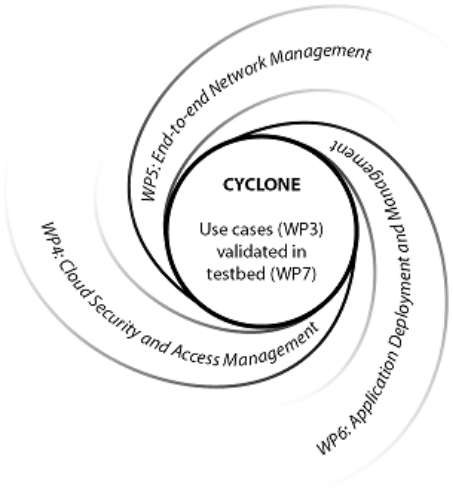
The project partners have identified two flagship domains: academic use cases for bioinformatics research and use cases for a commercial platform for future energy management. These will guide the initial development of the tools. Additional use cases, selected during the course of the project, will highlight missing, critical features and guide the evolution of the software.

The project adopts *agile software processes*, notably SCRUM, to ensure that:

- The project delivers production quality code that is thoroughly and systematically tested.
- The needs of the real-world use cases are well covered by the CYCLONE features.
- Features for deploying and maintaining running cloud applications are provided.
- The project can respond to new opportunities by rapidly re-focusing development effort.
- Constantly maintains a working version of the CYCLONE tools and platform.

The CYCLONE distributed testbed will play a critical role, enabling the full, continuous validation of the software before the foreseen production deployments on a federated bioinformatics cloud.

This process will also allow CYCLONE to measure the technical progress of the project through tickets attached to work items for particular development iteration ("sprint") along with progress summaries of each sprint.

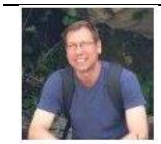


CYCLONE focus areas and relevant work packages

The main ***objectives*** of the CYCLONE project are:

- *Improve* cloud services in the Infrastructure-as-a-Service (IaaS) layer by integrating network services into the cloud offering, allowing direct control over virtual machine (VM) network accessibility, intra-site data access, and inter-site data transfers.
- *Develop* tools that provide enhanced functionality for cloud providers that agree to federate their resources, such as dynamic allocation of bandwidth between cloud providers and common authentication mechanisms.
- *Provide* tools that allow application developers to take advantage of features like VM coordination within deployments, automated placement of service components, and scaling of service components, essentially providing them with the means to develop a Platform-as-a-Service (PaaS) offering.
- *Provide* software that allows developers to ensure the end-to-end, secure use of data within their application as well as secured access to remote data sources.
- *Demonstrate* that the CYCLONE software meets the needs of concrete academic and commercial use cases, while providing frequent, production-quality releases of that software.

Manage Your Cloud Application Resources



Charles Loomis
Chief Technical Officer (SixSq)
CYCLONE Technical Coordinator and
WP6 Leader

As an **application service provider**, you must optimize the performance/cost ratio for your application by wisely allocating cloud resources. Long-running services make this challenge more daunting because the application must be re-optimized frequently to respond to the inevitable peaks and troughs in demand.

SlipStream, a core component of the CYCLONE platform developed by SixSq, already allows you to perform rather sophisticated resource management for your cloud applications. Based on your application definition, SlipStream can:

- *Automatically provision* all resources necessary to deploy the application,
- *Coordinate the configuration* of the deployed application components, and
- *Scale an application* based on your explicit requests.

By concentrating on applications, rather than virtual machines, SlipStream already significantly lightens your management burden. CYCLONE will further lighten this burden by enhancing SlipStream with advanced brokering, monitoring, and matchmaking features.

Currently with SlipStream, you choose the placement of your application components explicitly; each application deployment requires human intervention. For most applications however, the placement constraints for an application can be expressed as a static "policy", opening up the possibility of automated placement. To do this, two interconnected CYCLONE components will be developed:

- A **brokering database** that contains characteristics of cloud service offers. The database will include a wide variety of information, such as pricing from Cloud Service Providers like Exoscale, security certifications from organizations like the Cloud Security Alliance, benchmarks from sites like CloudHarmony and metrics from the application itself. Having an open schema will allow all of these types of information to be included, allowing you to create rich deployment policies. The implementations will use JSON-LD as an interchange format.
- A **matchmaker** that compares an application deployment policy vs. available cloud service offers. The implementations will take an application description and the application deployment policy to find acceptable cloud service offers from the brokering database. The policy can also reference a ranking algorithm (e.g. minimum price) to prioritize the acceptable offers. The resulting prioritized list of offers can be used for automated placement as well as refined manual placement. The policies will initially be based on DMTF's CIMI filtering syntax and will evolve to meet the needs of the CYCLONE use cases.

To achieve true "1-click" deployments, CYCLONE will extend SlipStream to use these components. You will be able to specify the deployment policy for each component of the cloud application. With this and the application definition, SlipStream will use the Matchmaker to find acceptable placement options and use the results for fully-automated deployment.

Going a step further, application monitoring will be coupled with the automated provisioning to provide fully-automated scaling for applications using the CYCLONE platform. With this you can define self-managing cloud applications, eliminating much of the tedious work involved with cloud application management.

You can already use SlipStream and other components of the CYCLONE platform. If the advanced features interest you, we'd like to talk with you about your use case. Get in touch!

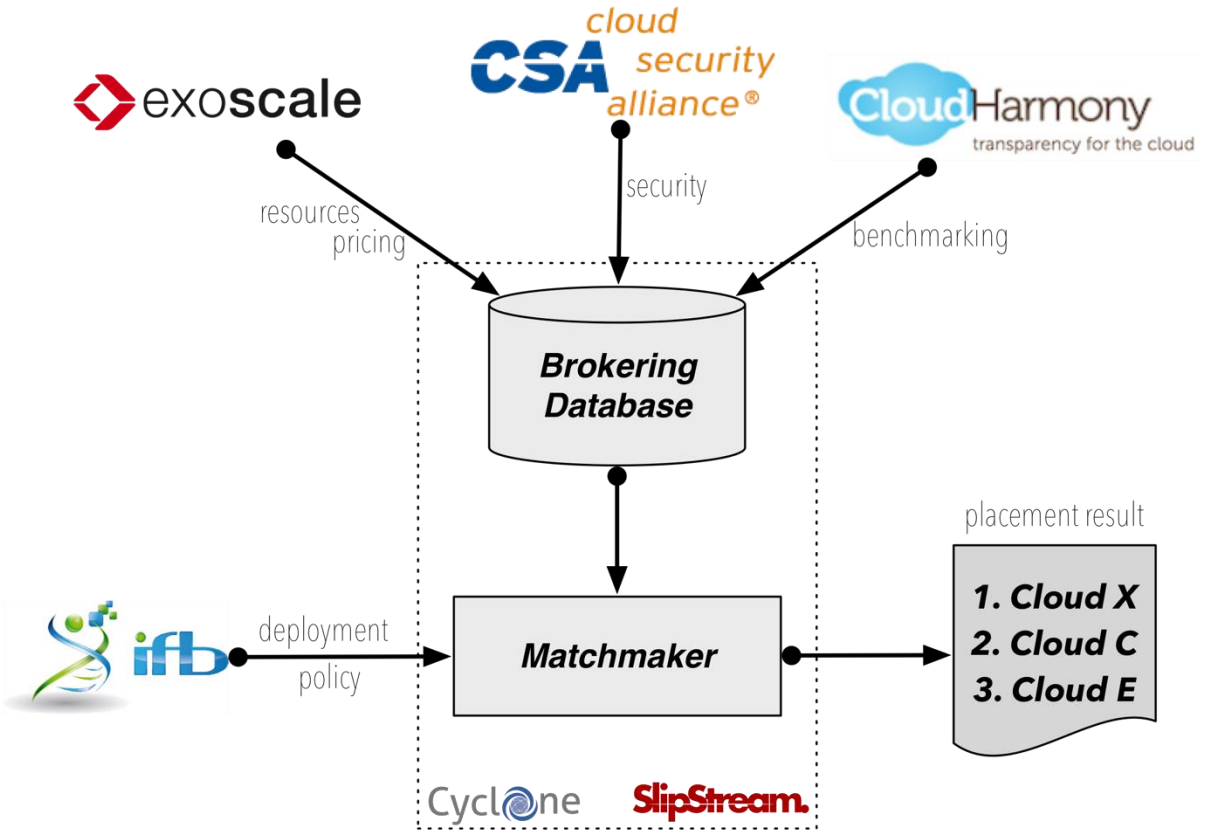


Figure 1: CYCLONE components that automate cloud resource provisioning through SlipStream.

CYCLONE Bioinformatics Use Case Scenarios

Christophe Blanchet
Chief Technical Officer (CNRS IFB)
CYCLONE WP3 Leader

Bioinformatics deals with the collection and efficient analysis of biological data, particularly genomic information from DNA sequencers. The capability of modern sequencers to produce terabytes of information coupled with low pricing (less than US$ 1000 for a human genome), and causes a "data deluge" that is being experienced by researchers in this field.

To analyse these data, the scientific and industrial community daily use bioinformatics software that is characterized by a high degree of fragmentation: literally hundreds of different software packages are regularly used for scientific analyses with an incompatible variety of dependencies and a broad range of resource requirements. For this reason, the bioinformatics community has strongly embraced cloud computing with its ability to provide customized execution environments and dynamic resource allocation.

The French Institute of Bioinformatics - IFB consists of a national hub, the IFB-core, and 34 bioinformatics platforms (PF) grouped into 6 regional centres spanning the entire French territory. The IFB currently deployed two cloud facilities on its own premises, one in IFB-core (Orsay, France) and another one in the platform IFB-GenOuest (Rennes, France), and two others in collaborations with the local computing centres in Lille and Strasbourg. In the

next years, the IFB aims to deploy a federated cloud infrastructure over the regional PFs. This cloud infrastructure is devoted to the French life science community, research and industry, with services for the management and analysis of life science data.

Thus, the CYCLONE consortium has identified several concrete bioinformatics use cases that aim to address some specific well-identified limitations. For example, regarding the key technical areas of the CYCLONE project, Cloud Access Management through cloud proxies and Matchmaking, Brokering, and Mediation of Cloud Resources will provide the IFB with features to access other cloud infrastructures than the current national IFB's, to integrate the future cloud infrastructures that will be deployed by the regional IFB's platform, and also to access external cloud infrastructures from academic or commercial providers. Naturally, the infrastructure users, for example biomedical staff analysing human biomedical data or researchers analysing genome sequences, will benefit from these features while accessing the system and carrying out their analyses. Two bioinformatics use cases are already deployed on the CYCLONE infrastructure.

The first CYCLONE bioinformatics use case scenario – Securing Human Biomedical Data

This use case is a single virtual machine (VM) application requiring enhanced security features such as a trusted federated authentication mode and a deployment done only on certified (by the French Health Ministry) cloud infrastructure. The use case workflow to ensure data security is illustrated in Figure 2. The cloud appliance NGS-Unicancer is developed by the bioinformatics platform of the Centre Léon Bérard, Lyon, France in the context of the project NGS-Clinique (INCA - Institut National du Cancer). It provides a simple web interface to launch the biomedical genomic analysis pipeline. The appliance was enhanced by the Federation Provider developed by Technische Universität Berlin and is ready for on-demand deployment on the IFB's core cloud infrastructure. The user deploys the appliance NGS-Unicancer through the IFB's web interface in "1-click" and uses the CYCLONE federation provider to get access to the VM web interface based on its identity in the federation. The user then easily uploads relevant data, runs the analysis and gets the results.

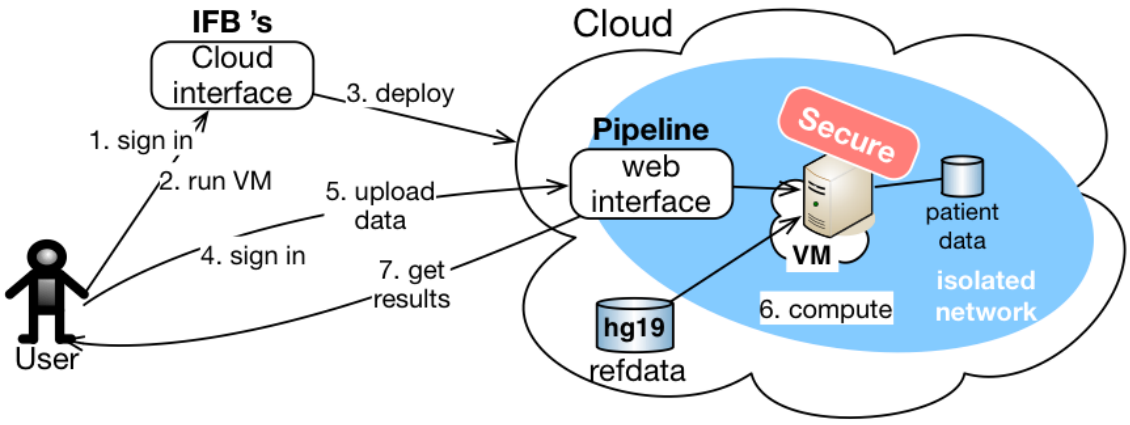


Figure 2. Functional schema of the use case "Securing human biomedical data".

The second CYCLONE bioinformatics use case - Cloud Virtual Pipeline for Microbial Genomes Analysis

This use case (which workflow is illustrated in Figure 3) is developed by the platform IFB-MIGALE, Jouy-en-Josas, France. The application requires several components: a user web interface, a relational postgreSQL database, and a complete computing cluster with a master and several nodes to perform the data-intensive analyses. This infrastructure already running in a classical static way on bare-metal servers in IFB-MIGALE premises was ported to the cloud and extended with a "1-click" deployment feature by using SlipStream recipes. The image was exported

from the IFB's cloud and registered in the StratusLab Marketplace. Afterwards, IFB-core wrote a deployment recipe based on SlipStream that instantiates the complete application with all the required VMs on the CYCLONE infrastructure.

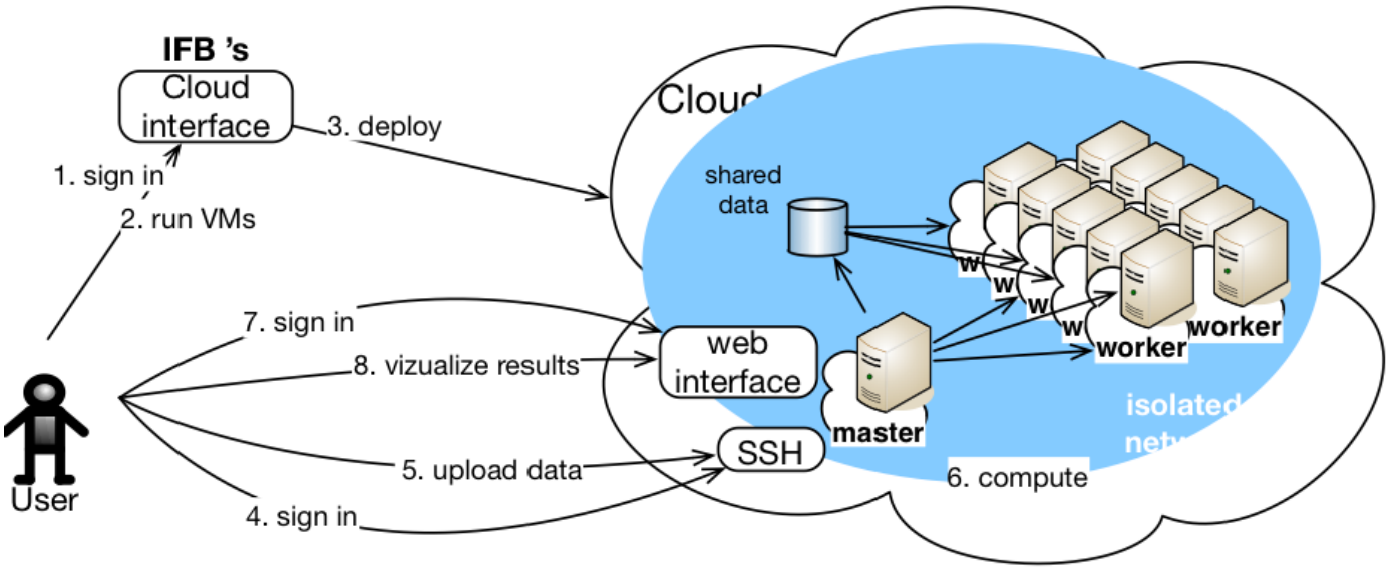


Figure 3 Functional schema of the use case "Cloud virtual pipeline for microbial genomes analysis".

CYCLONE Energy Use Case Scenario

Doris Hacker

Head of Trustful Cloud Solutions (QSC AG)

CYCLONE WP7 Leader

In order to comply with the "20/20/20" climate change mitigation goals of the EU, the energy supply has to be changed from fossil energy generation to the increasing usage of renewable energy sources. The integration of CO_2 free, volatile and decentralized, renewable energy resources, into the energy system leads to a new approach for energy management systems. To efficiently incorporate the huge number of future participants to the energy system, the integration with new cloud-based ICT technologies is essential.

The first described use case coming from the energy sector (see Figure 4) has the focus on the geographically widely distributed, volatile energy production combined to a Virtual Power Plant. The main idea of a Virtual Power Plant is to integrate the small, distributed energy resources for the generation of renewable energy and to combine them to one reliable power plant to bring the produced energy into the existing power system. The decentralized energy production leads to the necessity to collect and aggregate measurement data of energy production in real time all over the grid. Concerning the different energy components coming with their own smart metering technologies, the data management has to deal with heterogeneous data.

Given the sensitivity of the energy system the ICT platform has to fulfill high standards in security, availability and scalability. All these requirements for the data management platform lead to a distributed ICT environment with a trustable and heterogeneous multi-cloud base.

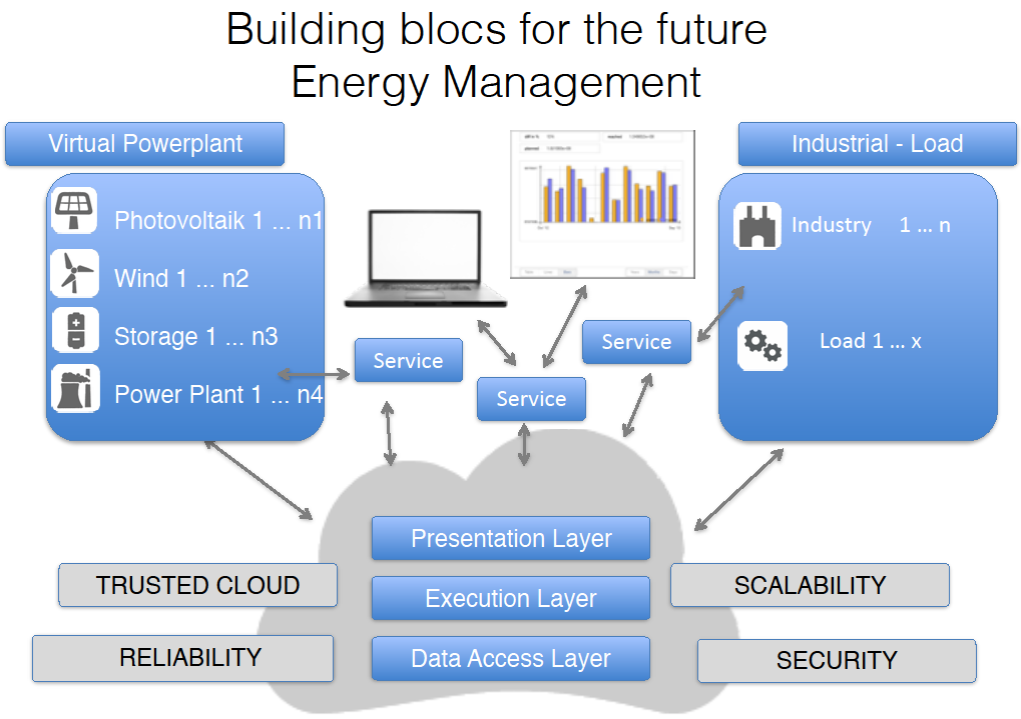


Figure 4. CYCLONE Energy Use Case.

RECENT CYCLONE PUBLICATIONS*

1. M. Slawik, Y. Demchenko, J. I. Aznar Baranda, R. Branchat, C. Loomis, O. Lodygensky, C. Blanchet. CYCLONE Unified Deployment and Management of Federated, Multi-Cloud Applications. Proceedings of the 5th workshop on Network Infrastructure Services as part of Cloud Computing (NetCloud 2015). December, 2015.

2. Y. Demchenko, C. Dumitru, R. Koning, C. de Laat, T. Matselyukh, S. Filiposka, M. de Vos, D. Arbel, D. Regvart, T. Karaliotas, K. Baumann. Open Cloud eXchange (OCX): A Pivot for Intercloud Services Federation in Multi-provider Cloud Market Environment. Proceedings of the 4th IEEE International Workshop on Cloud Computing Interclouds, Multiclouds, Federations, and Interoperability (Intercloud 2015), pp. 472-479.

3. M. Slawik, B. I. Zilci, F. Knaack, A. Küpper. The Open Service Compendium: Business-pertinent Cloud Service Discovery, Assessment, and Selection. Proceedings of the 12th International Conference on Economics of Grids, Clouds, Systems and Services (GECON 2015). Springer. View online

4. B. I. Zilci, M. Slawik, A. Küpper. Cloud Service Matchmaking using Constraint Programming. Proceedings of the 24th IEEE International Conference on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE 2015), pp. 63-68, 2015.

5. J. I. Aznar Baranda. Contribution to the position paper of Inter-cloud Challenges, Expectations and Issues Cluster within the EUCloudClusters initiative.

6. Y. Demchenko, C. Loomis, E. Escalona, J. I. Aznar Baranda, M. Slawick, O. Lodygensky. CYCLONE: Multi-cloud applications deployment and management platform and ecosystem. Poster, EGI2015 Conference, May 2015.

7. Y. Demchenko. CYCLONE: Multi-cloud applications deployment and management platform for research and academic community. Poster, TNC15 Conference, 14-18 June 2015. Download poster

*Please refer to the CYCLONE website for updated information on publications and dissemination/demonstration activities for forthcoming events

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CYCLONE at a glance

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Project coordinator
Matteo Biancani, Interoute S.p.A.
Tel: +39 (0)6 61 52 40 33
Fax: +39 (0)6 61 52 40 99
Contact

Technical coordinator
Eduard Escalona, i2CAT
Contact

The CYCLONE consortium

Interoute S.p.A. Italy

Fundacio Privada I2CAT, Internet I Innovació Digital a Catalunya Spain

Centre National de la Recherche Scientifique France

QSC AG Germany

SixSq Sàrl, Switzerland

Technische Universität Berlin, Germany

Universiteit van Amsterdam, The Netherlands