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# FELIX

**FE**derated Test-beds for **L**arge-scale **I**nfrastructure e**X**periments

# Federation

## FELIX Project

FEderated Test-beds for Large-scale Infrastructure eXperiments

***A federation is a union comprising a number of partially self-governing regions united by a central ("federal") government under a common set of objectives*** *

- Interconnection of EU and JP testbeds
  - To **increase mutual benefits** of European and Japanese researchers by **creating more complex environments** for specialized research and experiments
  - To **create new opportunities** for experiments due to **geographical dispersion** of testbeds

**Resources of the global EU-JP Federation will become available for users of individual testbeds**

* *Thierry Parmentelat, INRIA („OneLab2 & Federation")*

# Project Objectives

## FELIX Project

FEderated Test-beds for Large-scale Infrastructure eXperiments

***Colaboration project between EU and Japan***

***- Create a common framework***

***for Future Internet experimental research -***

- Create **an integrated Europe-Japan SDN test-bed**
  - Utilize functionality of OpenFlow and NSI for creation of Federated SDN Services
  - Introduce new APIs and logic for globally distributed heterogeneous SDN and IT islands
  - Enable interchange of resources information, share overall resource pools
  - Provide dynamic network interconnectivity between and within islands
- Exploit i**nter-domain dynamic connection provisioning standard, NSI**, which is being deployed in many R&E networks
- Facilitate **Europe-Japan collaboration on new standards** for infrastructure management (both IT and network resources)

# State of the Art

## Examples of Experimental Facilities in Europe and Japan

- **OFELIA** (OpenFlow in Europe – Linking Infrastructure and Applications)
  - FP7 FIRE project
  - An OpenFlow testbed (incl. IT and L1/L2 network resources) for researchers and other projects in Europe. The concept is based on the federation of resources *„islands"* in BE, DE, ES, CH, IT & UK

- **RISE** (Research Infrastructure for large-Scale network Experiments)
  - OpenFlow testbed over JGN-X (the largest testbed network in Japan), with wide-area coverage from US West coast to Southeast Asia. Users can experiment and validate their own SDN, cloud, and OF controller solution in the RISE sandbox

# State of the Art
## SDN, OpenFlow and NSI

- **SDN (Software Defined Network) and OpenFlow**
  - SDN network testbeds (islands) based on OpenFlow have been constructed and in operation in Europe and Japan (OFELIA/RISE)
  - By federating SDN islands, an integrated infrastructure can be constructed over globally distributed resources

- **NSI (Network Services Interface)**
  - An interface to request a multi-domain dynamic network
  - Being standardized in Open Grid Forum and will be deployed by R&E networks in Europe, Asia and US
  - Can provide inter-island connectivity to SDN

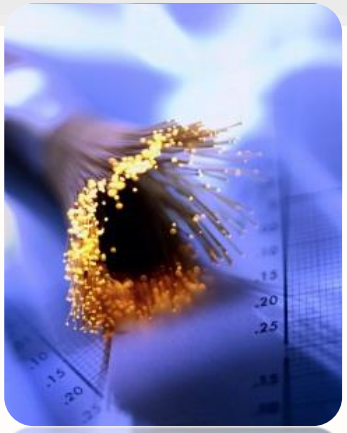
OpenGridForum

# Project Use Cases

## High Quality Media Transmission over long-distance networks [1]

The experiment will help to determine the behaviour of transmission mechanisms in streaming of the high resolution media content at a **very long distance**

- Investigate **negative effects in a network** (e.g. jitter)
- Investigate possible problems with **synchronization of the 3D streams** (i.e. left eye, right eye)

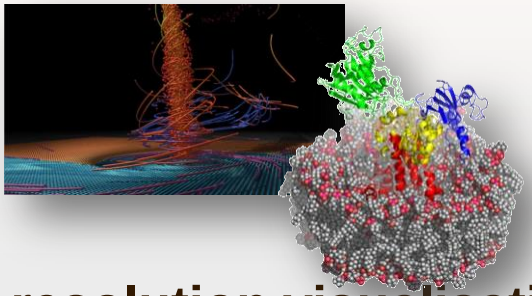


Federation of SDN testbeds interconnected through NSI-enabled domains enables opportunities for testing of media streaming over **existing network technologies** in backbone networks (DWDM, MPLS, etc.) **in conjunction with OpenFlow** deployed in the testbeds.

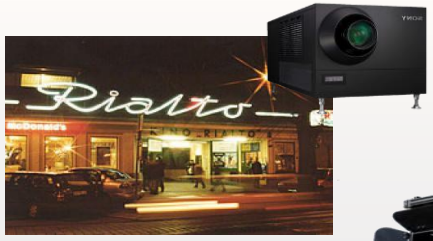
# Project Use Cases

## High Quality Media Transmission over long-distance networks [2]

## Applications



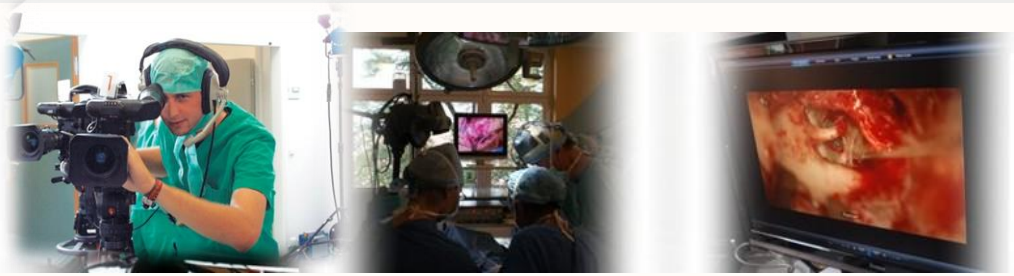
**High resolution visualisation of scientific processes**





**Digital Cinema**

Live transmissions
from cultural or sport events



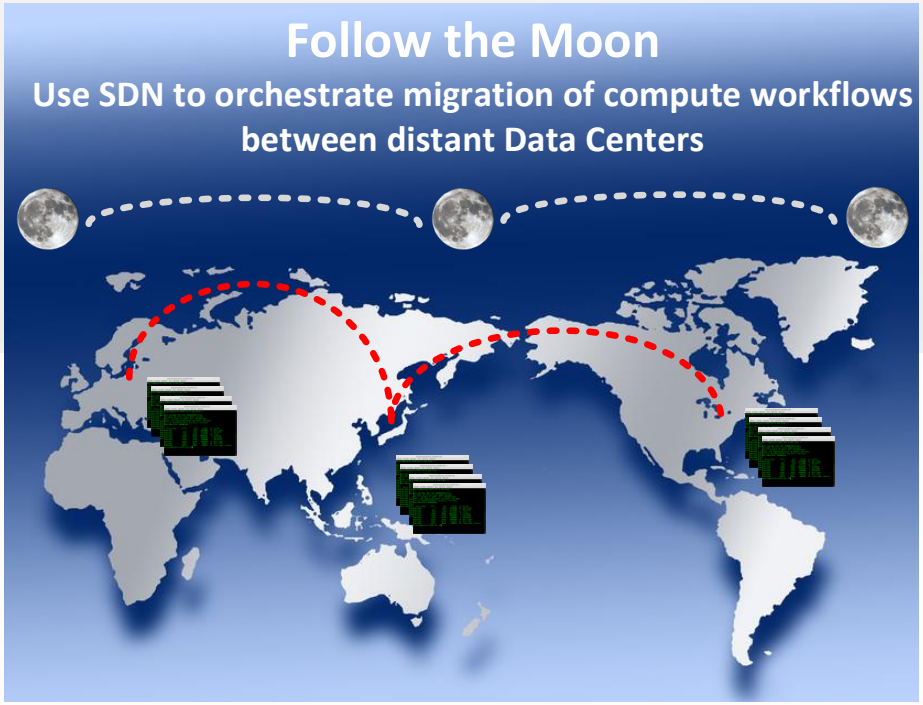
**Telemedicine**

live video transmissions of complex surgeries
to remote teams of supporting experts

# Project Use Cases

## A Follow the Moon Model – green energy in Data Centers

**Move the compute workflow to the nearest greenest power available in a federation**




**Moving data vs. moving compute loads!**

# FELIX contribution:

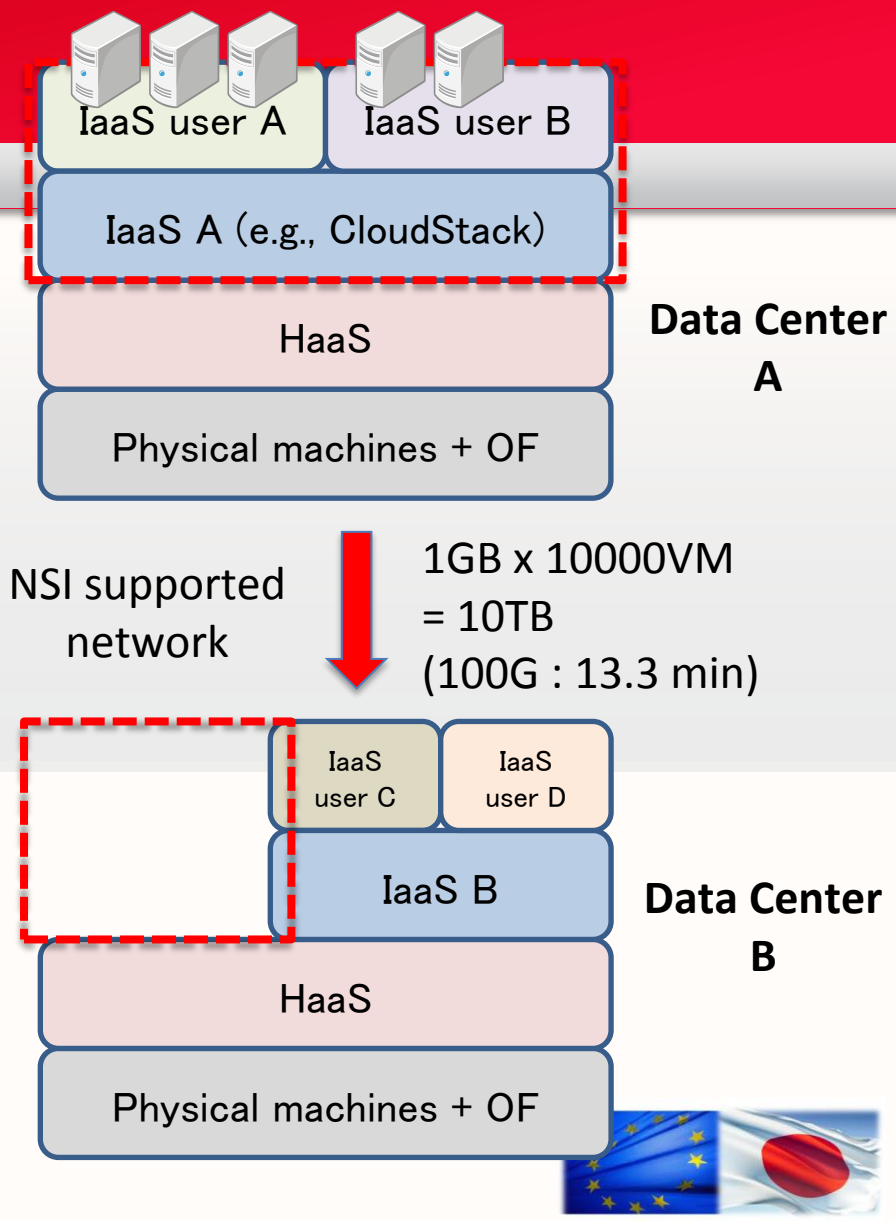
Investigate technical possibilities for use of SDN in implementation of the Follow the Moon concept in Data Centers

Validate technical viability for relocating computing loads to less energy consuming Data Centers in a federation using FELIX Control Framework

# Project Use Cases

## Disaster Recovery

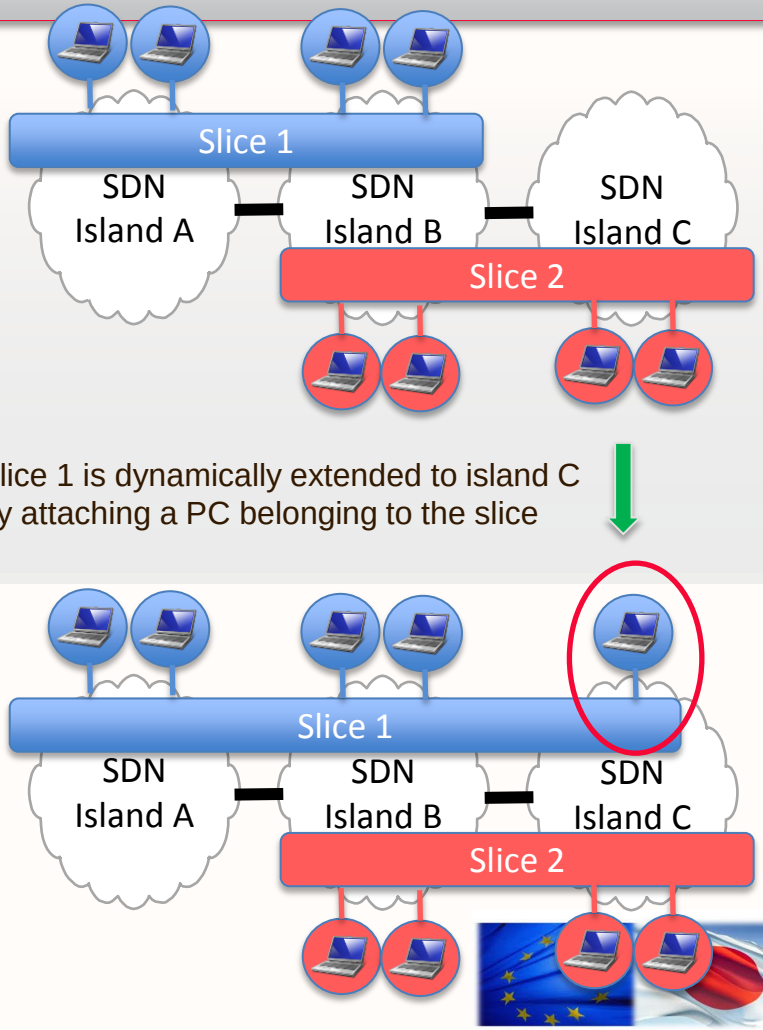
- **Migrate "IaaS" to remote data center** to continue business
  - IaaS = a cluster of VMs, including IaaS management nodes
  - Each IaaS is constructed by IaaS software (e.g., CloudStack, OpenStack)
- By introducing "HaaS (Hardware as a Service)" layer, abstraction of physical resources is realized
  - IaaS can be migrated to a differently configured data center
  - Abstraction is supported by OpenFlow and nested VM



# Project Use Cases

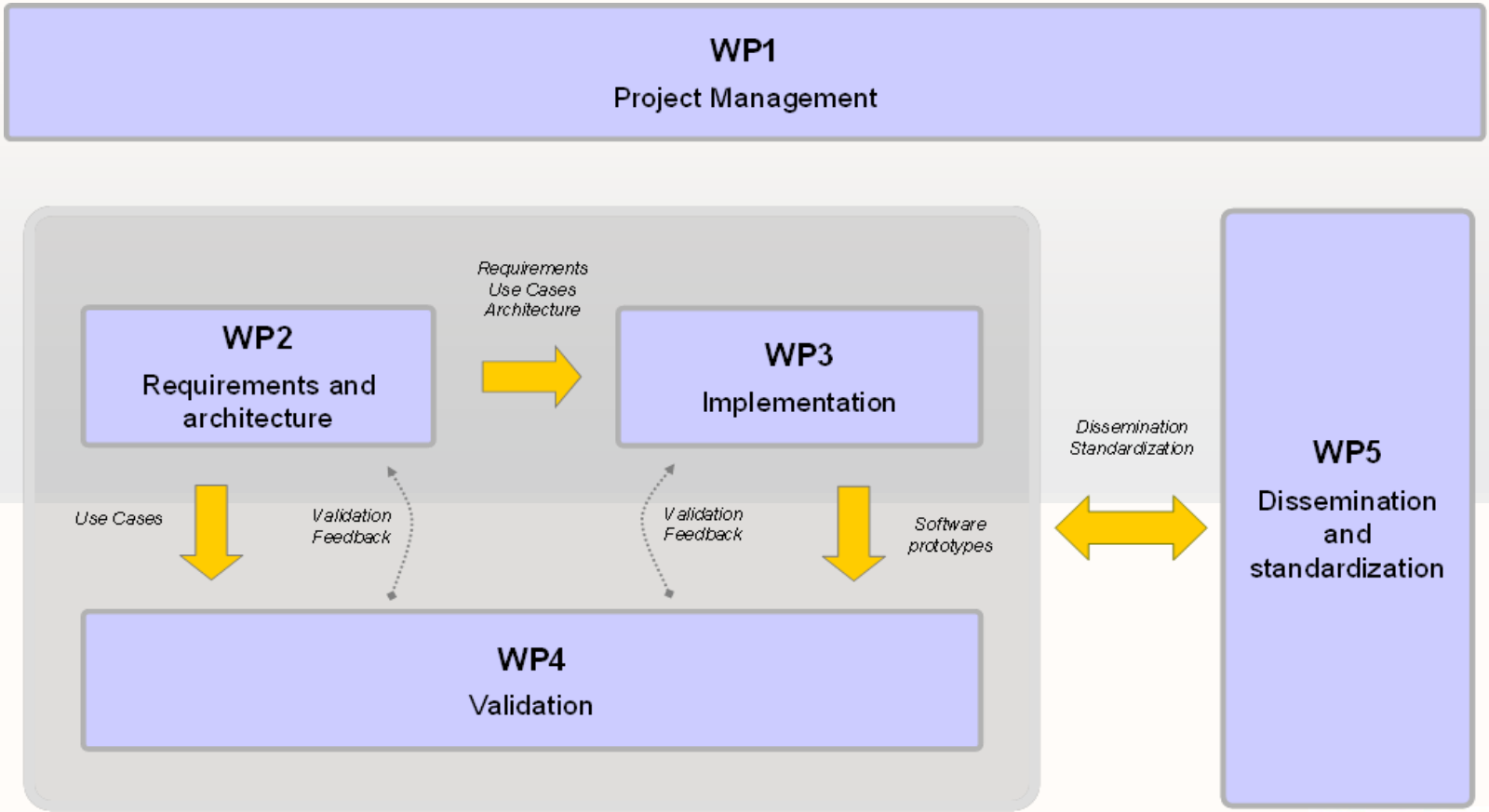
## Reactive inter-domain slice reconfiguration

- **Reconfigure an inter-domain slice** by attachment/detachment of network equipment
- Integration of management of **OpenFlow reactive** behavior and **NSI proactive** behavior



# Project Structure

## Work Packages & Inter-dependencies



# Key milestones in the project workplan

(M29: AUG 2015) **Experiments report**

(M20: NOV 2014) **First implementation ready**

**Testbed environment ready**

(M12: MAR 2014) **General architecture and functional blocks**

(M6: SEP 2013) **Use cases and requirements**

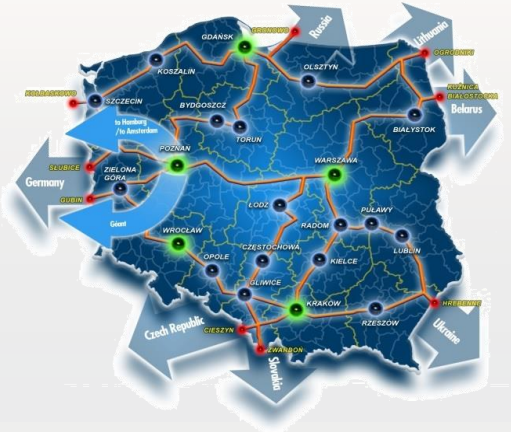
**Project start APR 2013**

**Project end MAR 2016**

# EU partners – role in the project

## Poznan Supercomputing and Networking Center

PIONIER
Polish Optical Internet




### FELIX-EU Project Coordinator

Represents European NRENs in the consortium – operator of Polish NREN

### Technical responsibilities in FELIX

- Leader of WP1 (Project Management) & WP2 (Requirements and architecture)
- Design and implementation of OGF NSI extensions to support multi-domain SDN technologies
- Contribution to the project with an OpenFlow island (as part of ALIEN/OFELIA)
- Contribution to standardization activities:
  - OGF NSI-WG (NSI extensions)
  - IRTF SDN-RG (convergence of NSI-SDN and SDNi)

# EU partners – role in the project

## Nextworks

**Research performing SME**

- Strong focus on Control Plane technologies and architectures (GMPLS/PCE, BoD, SDN/OF)
- Specialized in integrated systems engineering and consultancy
- Long experience in planning and execution of co-financed R&D projects, both in national and European contexts

**Technical responsibilities in FELIX**

- Leader of Software Governance activity, selecting the most appropriate existing tools to be the baseline of FELIX developments
- Contribution to the design of FELIX architecture with Flow-aware PCE in multiple federated OF domains
- Liaisoning with other research projects
  - e.g. ICT FP7-FIBRE, EU-Brazil cooperation

# EU partners – role in the project

## i2CAT Foundation

**Renowned research center**

Project Coordinator of FIBRE (joint EU-Brazil project)

Leader of OFELIA's control framework development

**Technical responsibilities in FELIX**

- Leader of WP3 (Implementation)
- Contribution to the project with an OpenFlow island – EXPERIMENTA testbed
- Design and implementation of FELIX's federated control framework
- Design the extensible User Interface to support the lifecycle of federated slices

# EU partners – role in the project

## EICT

**Public-Private Partnership** of scientific institutions, institutes of applied research and leading industrial companies

- founding members: Deutsche Telekom, Daimler AG, Fraunhofer Society and the Technical University of Berlin

Project coordinator of OFELIA, EU-funded project

**Technical responsibilities in FELIX**

- EICT will contribute to the EU-JP federation representing the OFELIA project
- EICT will also contribute to the project with inter-connectivity set up for needs of federating OFELIA islands with JGN-X open flow islands

# EU partners – role in the project

## iMinds

**Research institute founded by the Flemish government**

Project Coordinator of Fed4FIRE

FED4FIRE

**Technical responsibilities in FELIX**

- Contribution to FELIX use case definition and architectural design
- Design and implementation of FELIX integrated monitoring framework

# EU partners – role in the project

## SURFnet

**Represents European NRENs** in the consortium – operator of Dutch NREN

**Technical responsibilities in FELIX**

- SURFnet joins the project as a non-funded partner, working on tasks concerning the NSI-SDN interoperation
- In FELIX, SURFnet provides international connectivity via NetherLight, over existing cross border fibre and leased services

**Network topology SURFnet7**


# JP partners – role in the project
## AIST

**FELIX-JP project coordinator**

The largest national research laboratory in Japan

AIST's goal in FELIX

- Establishment of an inter-domain resource management technology and its standardization

**Technical responsibilities in FELIX**

- Establish and implement FELIX framework from the Cloud view
- Operate a small data-center (SDN island) to be used for the experiments
- Disseminate the outcome of FELIX Project to Cloud community in Japan
- Leader of WP5
  - Lead standardization in OGF NSI-WG.

# JP partners – role in the project
## KDDI

**One of the major telecom operators in Japan**

KDDI's goal in FELIX

- Establishment of a network control technology to realize inter-domain SDN

**Technical responsibilities in FELIX**

- Establish and implement FELIX framework from the network operator's point of view
- Build the FELIX-JP island on RISE, an SDN testbed of JGN-X
- Verify the federated SDN testbed by running real application between Japan and EU
- Disseminate the outcome of FELIX Project to academic and industry partners in Asian region and US
- Leader of WP4 (Validation)
  - Responsible for the operation of the federated FELIX facility
  - Contribute in deployment o FELIX technology on the RISE environment.
  - Bring up global connectivity between Japan and EU in cooperate with SURFnet

# FELIX in a nutshell

***FE**derated Test-beds for **L**arge-scale **I**nfrastructure e**X**periments*

| | |
|---|---|
| **Total costs requested to EC:** | 1 499K € |
| **Total costs requested to NICT:** | 150M ¥ |
| **Duration (36 months):** | 01.04.2013 – 31.03.2016 |
| **Project resources:** | 302 PM (person months) |

**European Partners:**

PSNC (coord.)

NXW

i2CAT

EICT

iMinds

SURFNet

**Japanese Partners:**

AIST (coord.)

KDDI