OFERTIE

OpenFlow Experiments in Real-Time Interactive Edutainment

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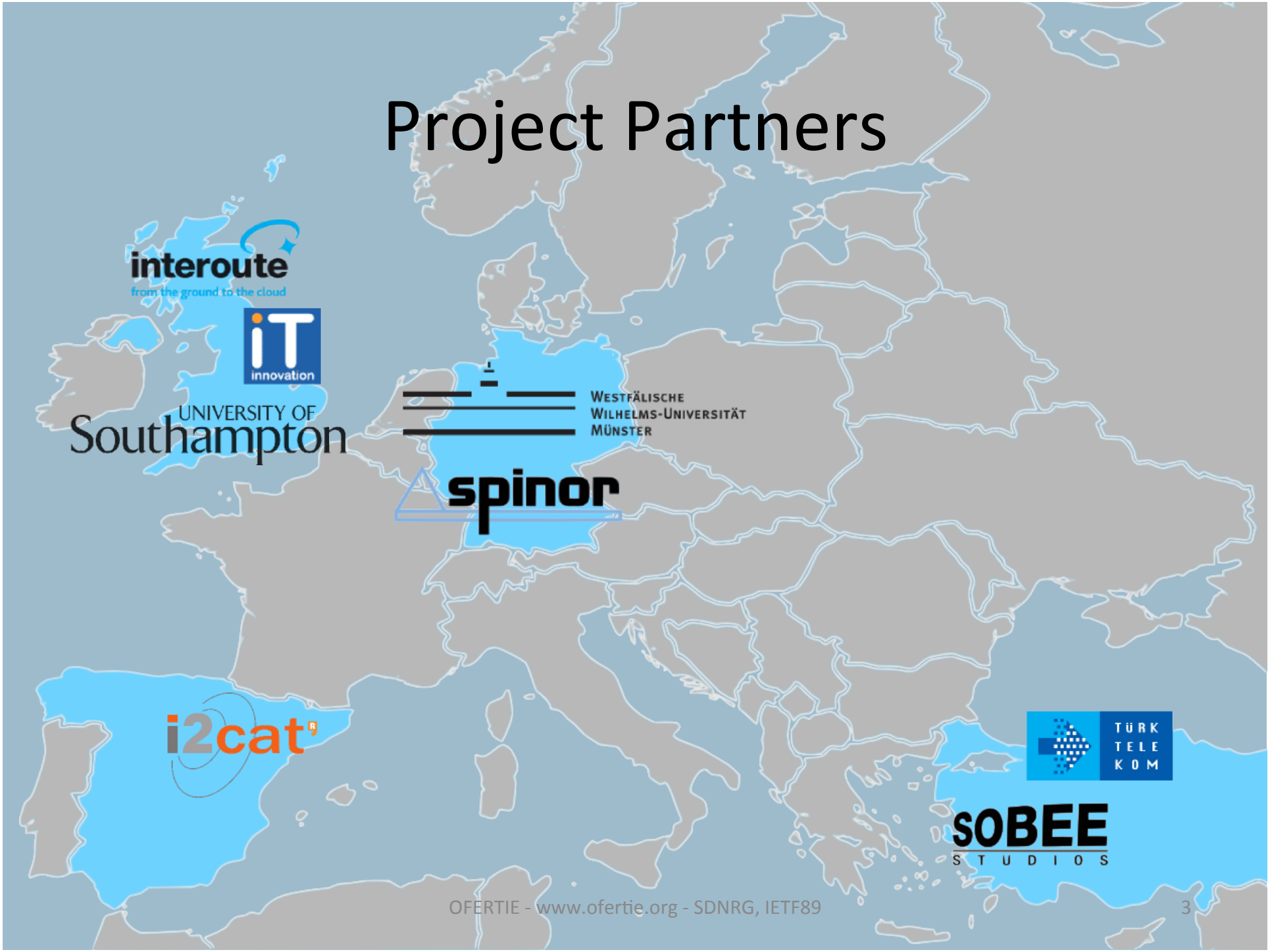
About OFERTIE

- OFERTIE is a research project funded within the European Commission's FIRE area (Future Internet Research and Experimentation)
  - http://cordis.europa.eu/fp7/ict/fire/
  - Just entering new Horizon 2020 programme now, first calls for funding due in April 2014

- OFERTIE includes research organisations, ISPs, universities and application developers
  - Seven European partners

Project Partners

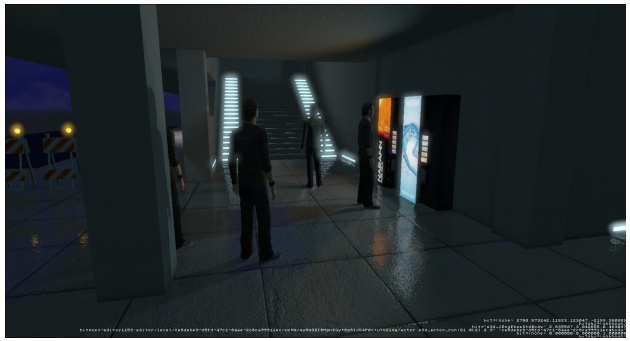


Real-Time Online Interactive Applications (ROIA)

- OFERTIE's target application domain is *Real-Time Online Interactive Applications (ROIAs)* and their challenging network demands

- Example Application Scenarios:
  - *Collaborative real-time world editor*
  - *Large-scale multiplayer online games*

- Characteristics include:
  - High level of interactivity and update rates
  - Dynamically changing game situations
  - Network requirements change dynamically
  - Variable player loads over time
  - Impact of packet loss and latency on QoE will depend on what player is doing



Content (assets and artwork) by courtesy of PrävEM research group of the University of Applied Sciences Mittweida.

Challenges

- Project challenges/questions include
  - How can SDN optimise network utilisation whilst keeping QoS levels to agreed SLAs?
  - What can SDN do to enable novel business models for game/ application developers, network providers / data centres?
  - How can application developers specify effective network requirements in an abstract way?

- Methodology
  - Design and development of components
  - Phased experiments
  - Seek to (re)use other projects' experimental facilities/testbeds
    - OFELIA, XIFI, Fed4FIRE, BonFIRE, etc.

Technology Stack

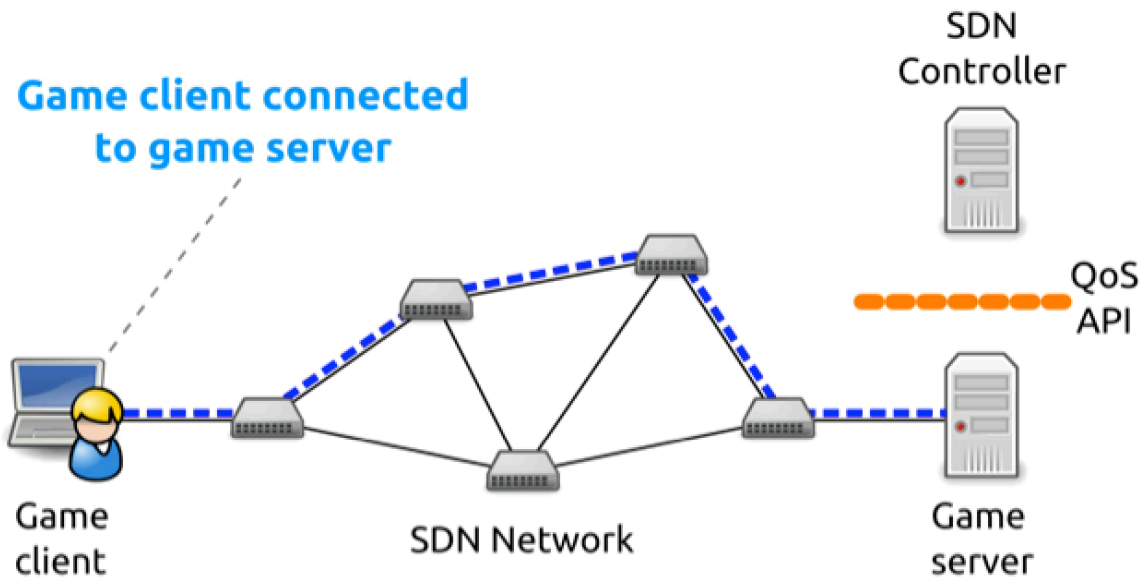
Management Layer	Service Level Agreement Monitor SLA violation Audit
Application Layer	ROIA Northbound API Real-Time Framework Application metrics
Network Control Layer	OpenNaaS OpenFlow controller Packet logging
Network Infrastructure Layer	 OpenFlow-enabled switches

- Open source network virtualisation platform
  - Provides Networks as a Service (NaaS), e.g. virtualised CPE
  - http://opennaas.org/

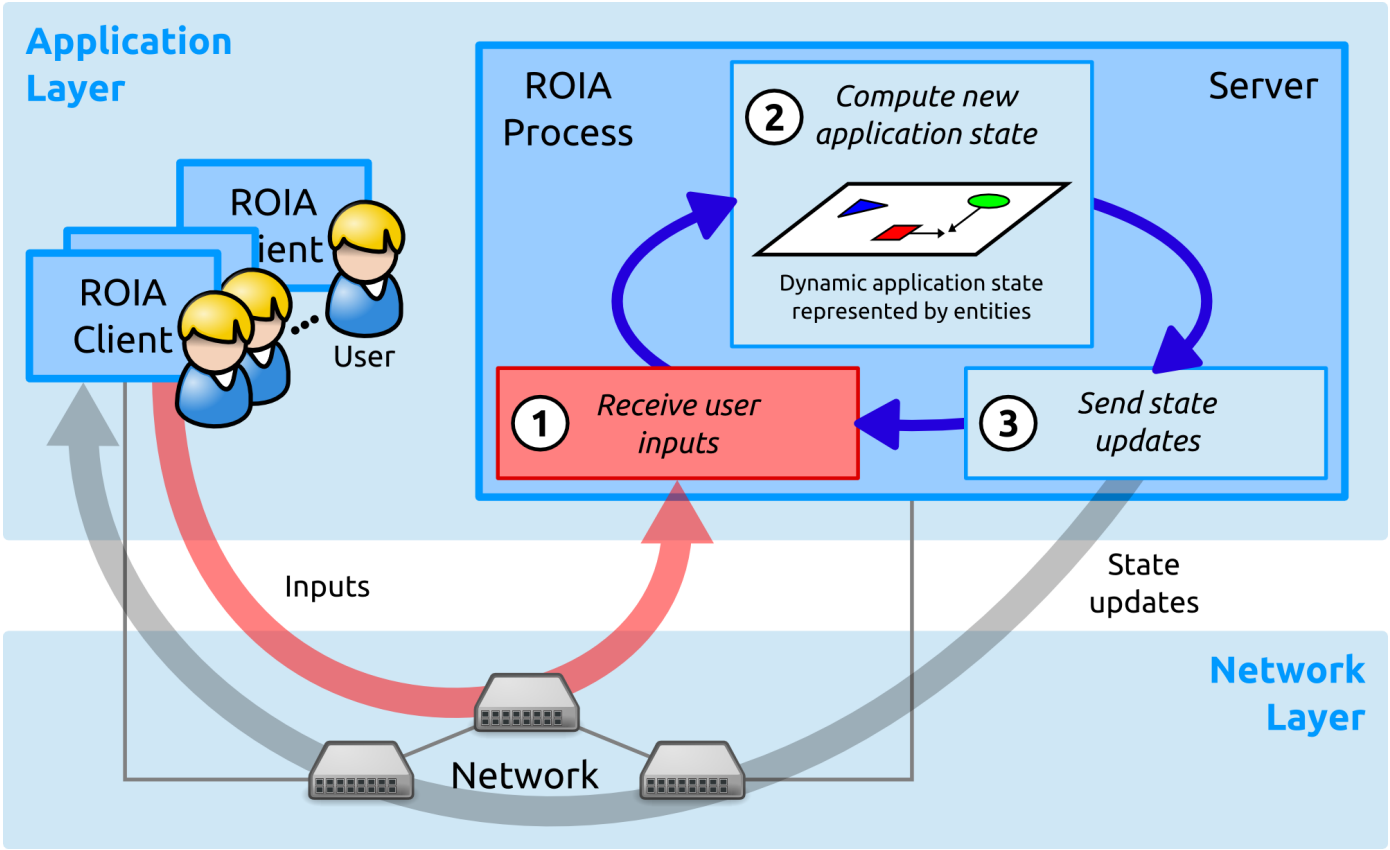
- OFERTIE is developing additional components for OpenNaaS to allow it to deliver SLA-based monitoring and control for OpenFlow networks
  - http://opennaas.org/2013/10/29/opennaas-0-24-released/
  - e.g. reading or deleting flows on an OpenFlow switch
  - Will come back to the Network Control Layer (NCL) later

Improving network QoS in ROIA

- Analysis of ROIA requirements on the underlying network
- Specification of a novel API that allows ROIA applications to specify their dynamic network requirements and to meet them using SDN technology**)**
- The API frees ROIA developers from specifying detailed, low-level network metrics

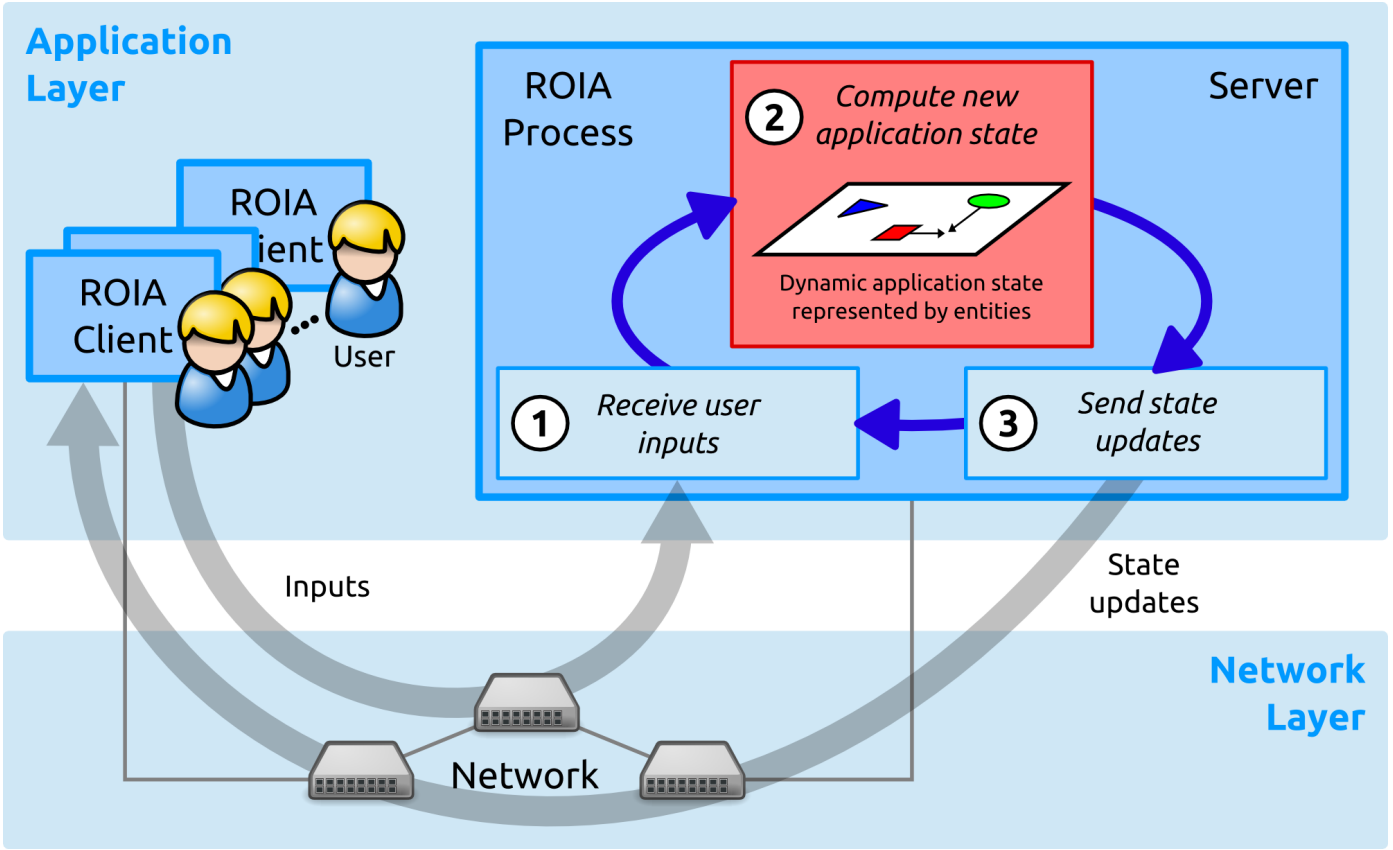


Generic ROIA Processing: The Real-Time Loop



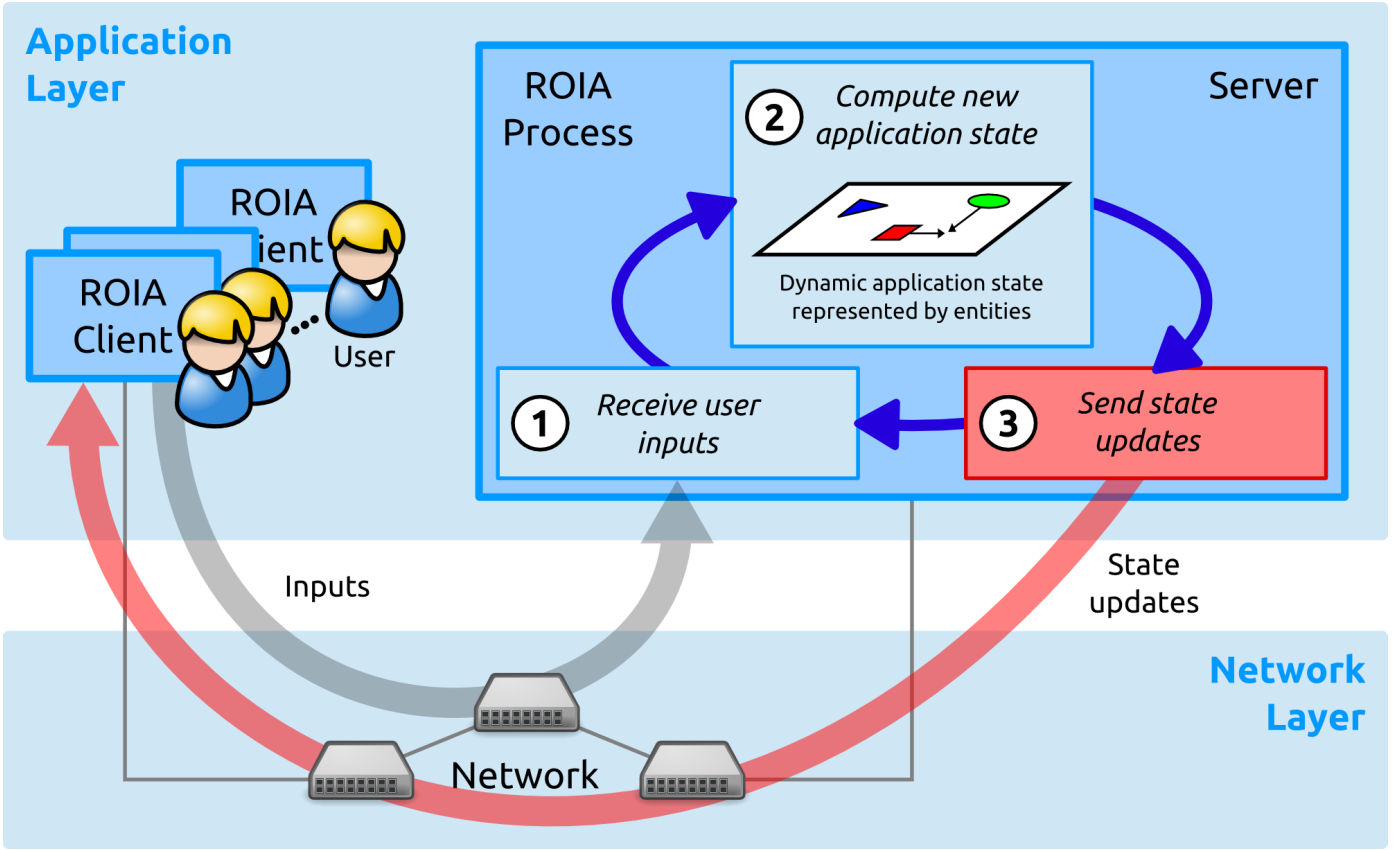
- The server receives inputs (e.g., movement commands) from connected clients

Generic ROIA Processing: The Real-Time Loop



- The server computes a new application state according to the application logic

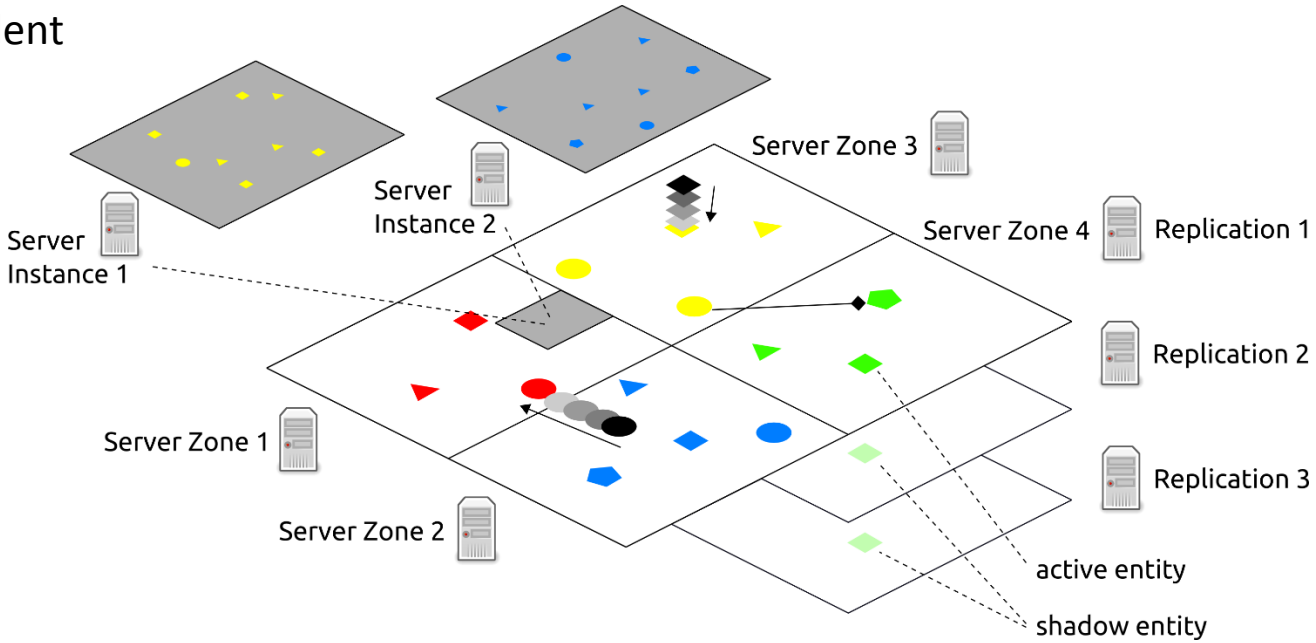
Generic ROIA Processing: The Real-Time Loop



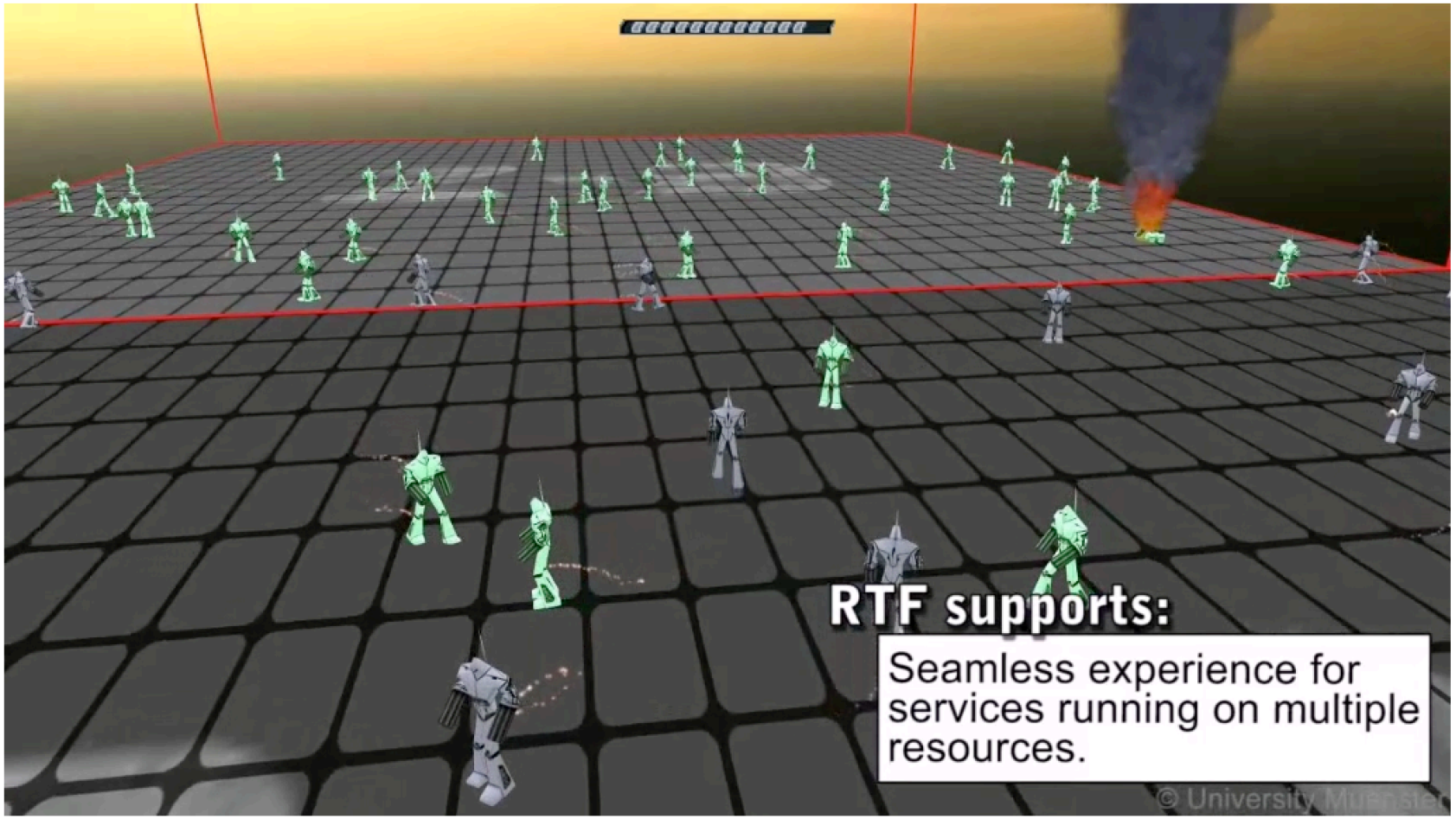
- The server sends the newly computed state to the users and other servers

Real-Time Framework

- The **Real-Time Framework (RTF)** of the Univ. Münster is a C++ library for development and runtime support of ROIAs
- RTF supports several concepts for distributing ROIA processing on multiple servers:
  - *Zoning:* disjoint areas are processed by distinct servers
  - *Replication:* same area is processed cooperatively by distinct servers, each server responsible for a disjoint set of entities
  - *Instancing:* independent copies of the same area are processed by distinct servers
- RTF offers access to high-level application metrics, e.g.:
  - Response time
  - Entity count
  - Entity positions

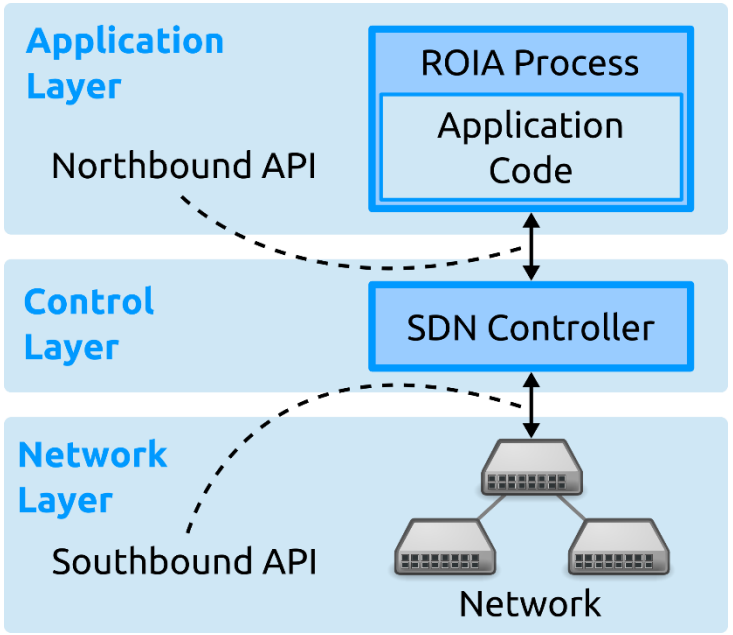


RTFdemo


RTF supports:
Seamless experience for services running on multiple resources.

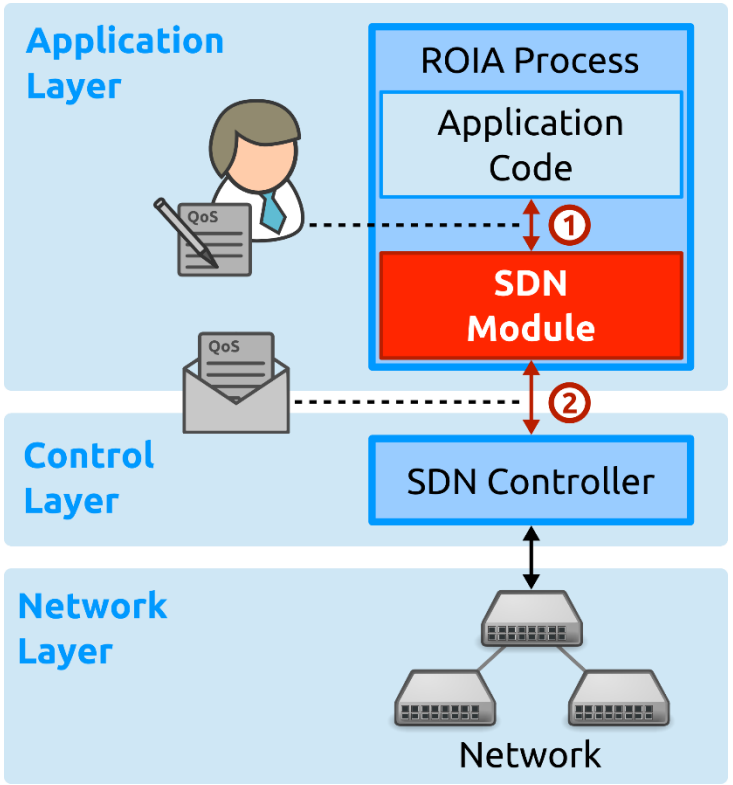
SDN Northbound API

- **SDN** decouples the control logic from the individual network components; centralised SDN Controller configures the forwarding behaviour
- **Problem:** No standardised Northbound API for SDN (only southbound, e.g., OpenFlow)
- **Our goal:** Provide an easy-to-use and well-defined SDN Northbound API for ROIA
- **Challenges:**
  - Develop a Northbound API for specifying application's QoS by the developer
  - Implement the API by translating: application QoS ⇔ network QoS metrics
  - Organise QoS monitoring and dynamic network reconfiguration to meet the QoS



SDN Northbound API

- **Design decision:** Separate the Northbound API in two parts:
  1. *Application-level API*
     ROIA developer specifies runtime network QoS requirements and is notified about changes in QoS
  2. *Network-level API*
     SDN Module requests network QoS and receives QoS status notifications from the SDN Controller
- The two APIs are implemented by the SDN Module integrated in RTF
- The SDN Module is the basis for developing applications that can use the benefits of SDN and OpenFlow-enabled networks



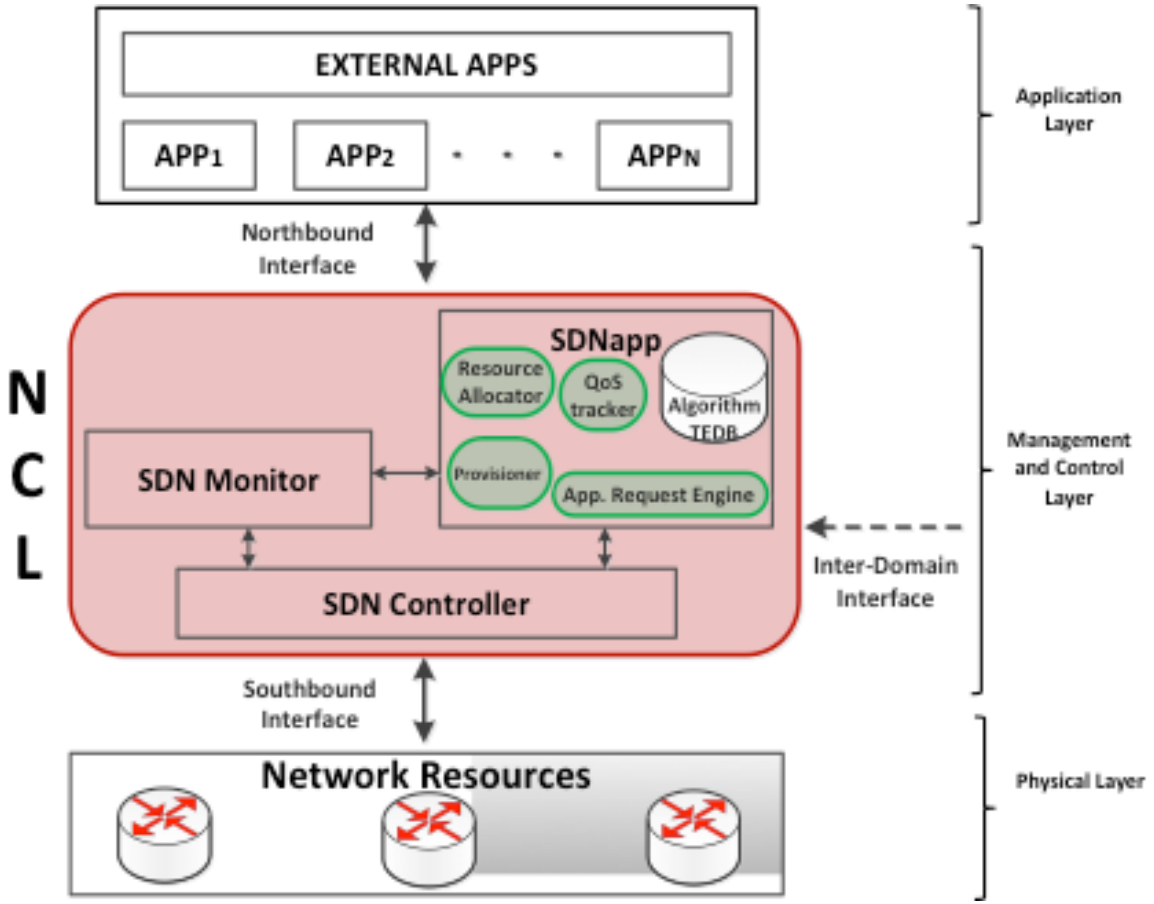
Network Control layer

- **Design:**

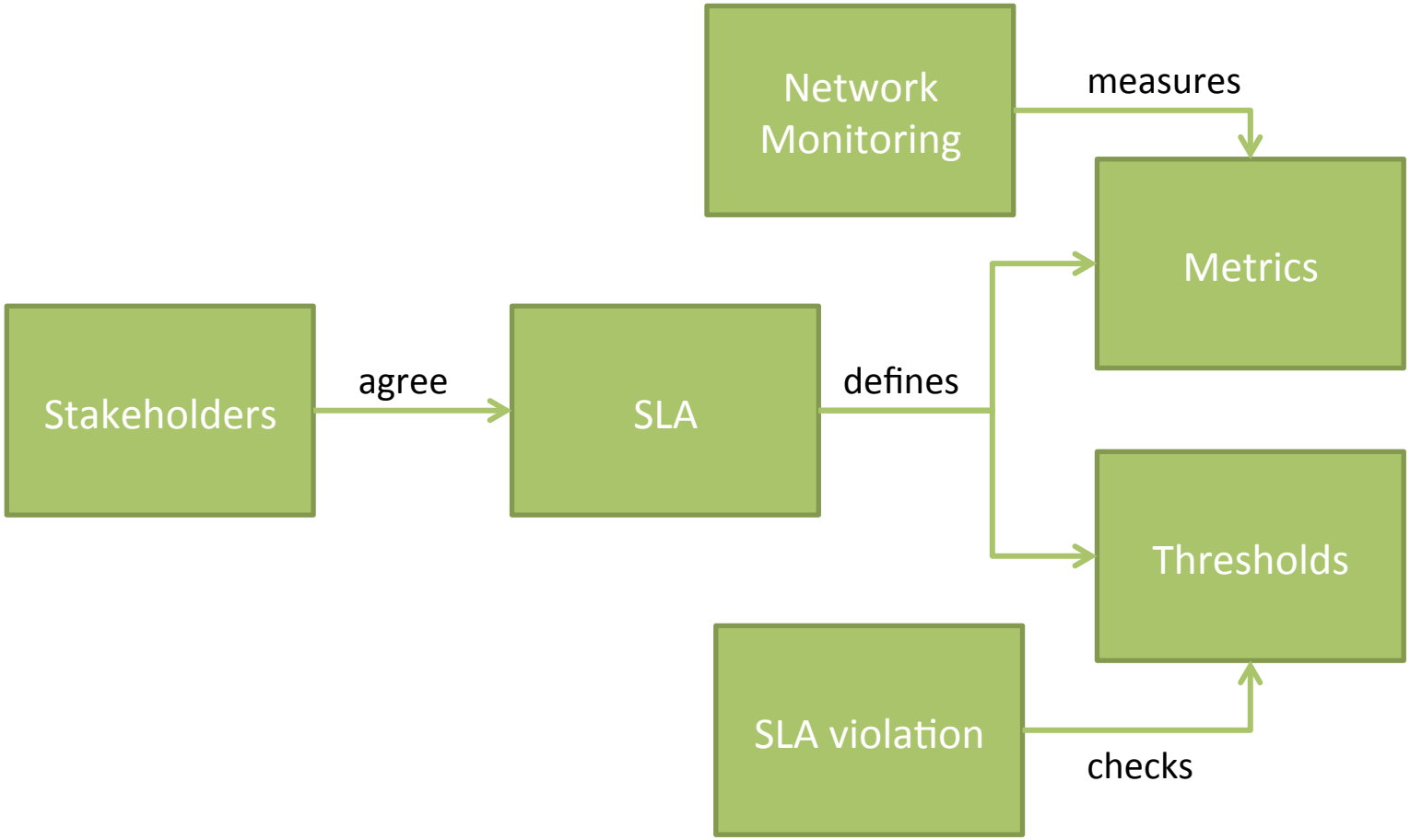
  NCL that integrates three modules:
  - SDN App (QoS algorithms, QoS tracker, resource allocation, provisioning)
  - SDN Monitoring tools
  - SDN Controller

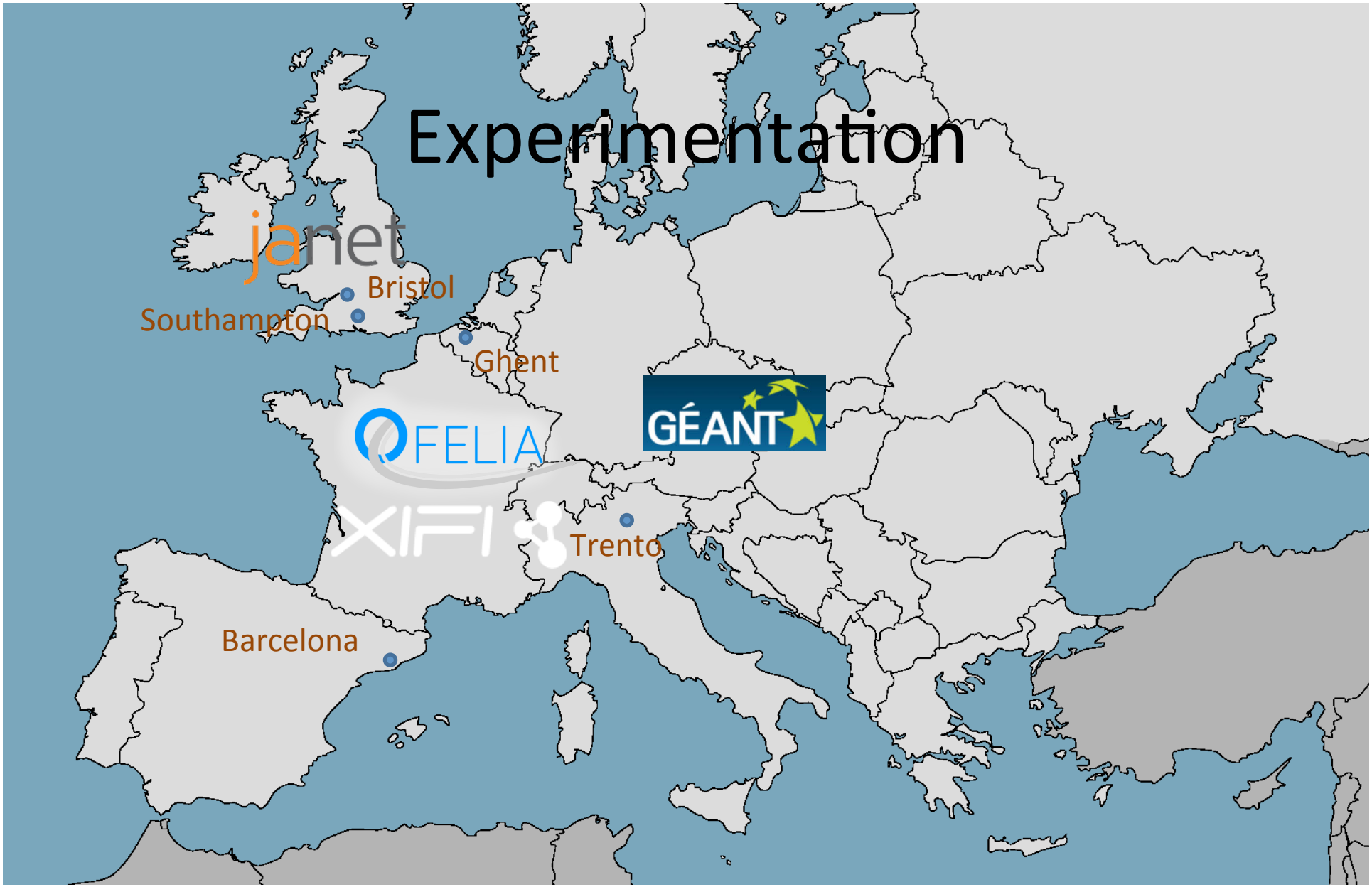
- **Solution based on:**
  - OpenFlow:
    - SDN communication protocol used between the control and data planes
  - OpenNaaS:
    - A framework that enables the NCL to supply applications with on-demand self-service, resource manipulation rights, resource pooling, flexibility, elasticity and dynamic service management.

Network Control Layer



Management Layer




Experimentation
janet
Bristol
Southampton
Ghent
OFELIA
GÉANT
XIFI
Trento
Barcelona

OFELIA

- An OpenFlow-based testbed
  - Built through a previous project
  - Uses OFELIA Control Framework
  - Currently being extended to Brazil (FIBRE) and Japan
  - Plans for sustainability through OFELIA Foundation
  - http://www.fp7-ofelia.eu/
  - Using OFELIA islands to test OFERTIE outputs

OFELIA Facility and Islands

Experiments

Phase 1

- Dynamic QoS for MMO
- Dynamic QoS for Shark3D ROIA prototype
- Network monitoring and SLA violation reporting
- On-the-fly asset download for Shark3D
- Multi-island extension
- IPv6+Multicast tests to validate OF1.3

Phase 2

- SDN-managed VOIP
- Multi-domain QoS management for VOD
- Enhanced collaborative visual production application (innovative Shark3D + RTF integration)
- Inter-site IPv6 experiment on JANET, using OF1.3+
- Inter-testbed experiment (XIFI)

FIRE SDN workshop

- We held an SDN workshop for FIRE projects in Brussels on 30th January this year
  - http://www.ofertie.org/2014/02/18/ofertiecityflow-sdn-concertation-workshop/
  - Includes information on OFELIA and GEANT Testbed as a Service (TaaS)
  - Commonalities, e.g. architectures, APIs
  - Workshop report should be published soon

- Planning a second workshop late in 2014

http://www.ofertie.org/

- Public reports
- Project video
- News
- Events

- Questions?