DIONASYS project overview
phase 1

chist-era meeting
April 27th 2016
Bern
Introduction

- Declarative and Interoperable Overlay Networks, and Applications to Systems of Systems

- Call 2013 – topic Heterogeneous Distributed Computing

- 3 years: January 2015 – December 2017

Start: 2015.01.01
Duration: 36 Months
End: 2017.12.31
Context

1. Proliferation of heterogeneous and isolated systems
   - Cloud systems
   - Wireless and sensor networks
   - Smart environments

2. Composition in systems-of-systems leads to advanced services
   - Multi-cloud
   - Cloud-assisted IoT, e.g. environmental surveillance
   - Edge and fog computing
Motivation

Programming complex, heterogeneous large-scale systems

- Requires thinking “global”
  - What are the services, the guarantees, the structure
- But to act “local”
  - Implementing complex interactions at the level of individual nodes

Problems

- 🙁 Maintainability over time
- 🙁 Adaptation and evolution of functionalities
- 🙁 Interoperability among systems
- 🙁 Composition of existing and future systems
- 🕵️‍♂️ Abstraction mismatch
The DIONASYS objectives

- Raise the level of abstraction for specifying and operating complex systems and system of systems

- Think global, act global
  - Declare the function and structure of the system ...

- Leverage generative programming for overlay networks with gossip-based self-organization and software-defined networks
  - ... and let DIONASYS generate, augment, evolve, and bridge the corresponding implementation
Overlays as first class entities

- Virtual graph connecting system nodes, implementing services
- Well-principled guarantees, structures, APIs
- System of systems through overlay composition
Generative programming approach

Overlay designer

Overlay principles, structures, functionalities, adaptation and composition requirements.

DIONASYS Compiler

DIONASYS runtime

Deployer

DIONASYS code

Generated Code

overlays high-level specs. in DSL
Integrate new systems, bridge with already existing ones
Automate reasoning on overlays structures and functionalities
Target contributions

- Conceptual framework
  - Principled systems composition

- Declarative approaches for overlay structures and composition
  - Domain-Specific Languages and compilers

- Self-organization using gossip-based overlay construction

- Adaptation and interoperability
  - Formalization and runtime support

- Integration of advanced networking support
Potential impact

- Principled techniques for systems-of-systems programming
  - Potential for use in IoT and IoT-Cloud environments

- Better understanding of inter-overlay adaptation and interoperation
  - Including functional and non-functional aspects

- Open the way for the composition and interoperation of future and already deployed systems
Realizations
Conceptual contributions

- Tectons: principled opportunistic composition [AOC 2015]

- First version of the holon framework [ARM 2015]
  - Framework for principled systems composition
  - Discussion of challenges and definition of use cases
  - Roadmap for project objectives

- Intent-driven networking [Arxiv, under submission]
  - Framework for applications to declare *intent* on use of network
  - Optimization and adaptation framework
Holon framework

Developer

Service specification library

Holon specifications

Holon compiler

Deployer

Service implementation library

Leaf holons

Runtime
Overlay based systems

- **Declarative programming support for self-organizing overlays**
  - Under submission and reviewed for open source release
  - Systematic classification of overlay structures and self-organizing construction complexity (ongoing)
  - Application: study of self-organizing DHT robustness under churn [DAIS16]

- **Adaptation of overlays in heterogeneous contexts**
  - Application to WSN overlay-based broadcast
  - Use of formalized representation based on timed automata
  - Principles and techniques for automatic and safe protocol switch
  - Work in progress, open sourced
Integration of a multi-site testbed based on OpenStack and SDN [ATN 2016]

- Nodes in Cluj, Neuchâtel and Bordeaux
- Allows inter-overlay SDN-driven interoperation
- Control using Splay [COMM 2016]

grape cluster

- Custom design 4U rack
- 48 RaspberryPI (~200 cores)
- Includes networking, power management, optimized power supply
Consortium
Consortium

- **4 partners**
  - Université de Neuchâtel (CH) – coordinator
  - LaBRI, Bordeaux (FR)
  - Lancaster University (UK)
  - Technical university of Cluj-Napoca (RO)

- **~1 M Euros funding from chist-era**

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<tr>
<th>Expertise domain</th>
<th>Partner</th>
<th>1. UniNE</th>
<th>2. LaBRI</th>
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Key personnel: *Etienne Rivière (coordinator)*

Computer Science dept. @ UniNE

Key competencies
- Large-Scale Distributed Systems
- Experimental support for Dist. Systems
- Overlay networks and Gossip-based protocols
Key personnel: Floréal Morandat, Laurent Réveillère
Associate member: David Bromberg (U. Rennes 1)

Competences

- Languages and compilation
- Middleware adaptation
- Large-scale distributed systems
Lancaster University, UK

Key personnel: *Gordon Blair, Geoff Coulson, Yehia El Khatib*

Competencies:

- adaptive and reflective middleware,
- component-based systems,
- cloud computing,
- network programming
Key personnel: Virgil Dobrota

Competencies
- SDN (Software Defined Networking), OpenFlow
- Cross-Layer QoS
- Active/passive measurements in Internet
- Networking
THANK YOU!

http://www.dionasys.eu