DIONASYS

Declarative and Interoperable Overlay Networks,
Applications to Systems of Systems

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DIONASYS project overview year 2

chist-era meeting

May 21st 2017

Brussels

Introduction

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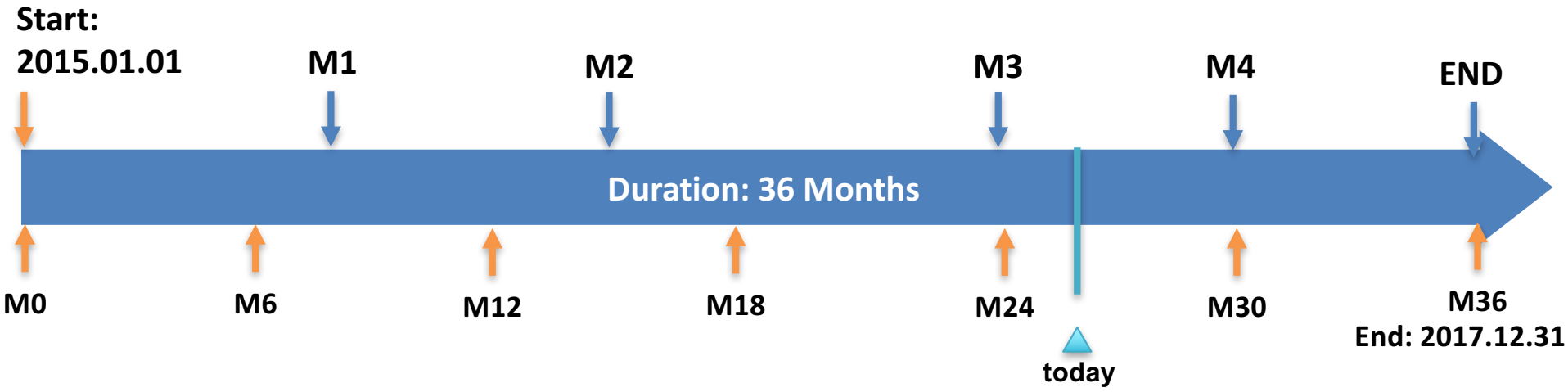
- Declarative and Interoperable Overlay Networks, and Applications to Systems of Systems
- Call 2013 – topic Heterogeneous Distributed Computing
- 3 years: January 2015 – December 2017



Context

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- Proliferation of heterogeneous and isolated systems
  - Many forms of Cloud systems deployment
  - Wireless and sensor networks
  - Internet of Things
- Composition in systems-of-systems leading to advanced services
  - Geo-distributed Cloud systems
  - IoT-Cloud and smart environments
  - Edge and fog computing

Motivation

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- 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 and performance
  - ☹ Interoperability among systems
  - ☹ Composition of existing and future systems
  - Abstraction mismatch

The DIONASYS objectives

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- 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

Target contributions

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- Conceptual framework
  - Principled systems of systems composition
- Declarative approaches for overlay structures and composition
  - Domain-Specific Languages and compilers
- Self-organization using gossip-based overlay construction
- Adaptation and interoperability
- Integration of programmable networking support and overlay management

Potential for impact

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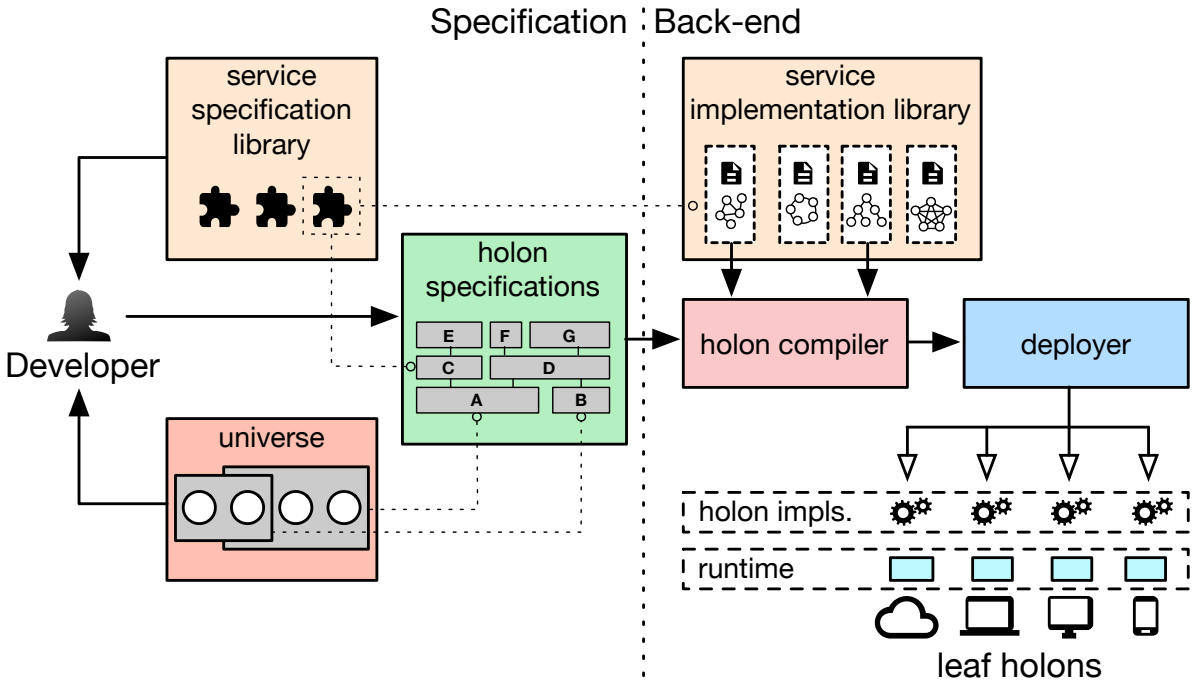
- Principled techniques for systems-of-systems programming
  - Potential for use in IoT and IoT-Cloud environments
- Better understanding of inter-overlay adaptation and interoperation
  - Including functional and non-functional aspects
- Open the way for the composition and interoperation of future and already deployed systems

Realizations (years 1 and 2)

Conceptual contributions

- Holon framework [ARM 2015]
  - Principled systems composition and roadmap for project objectives
  - Y2: definition of ontologies for automated systems-of-systems composition
- Intent-driven networking
  - Framework for applications to declare *intent* on use of network
  - Optimization and adaptation framework



Self-organizing and composed overlays

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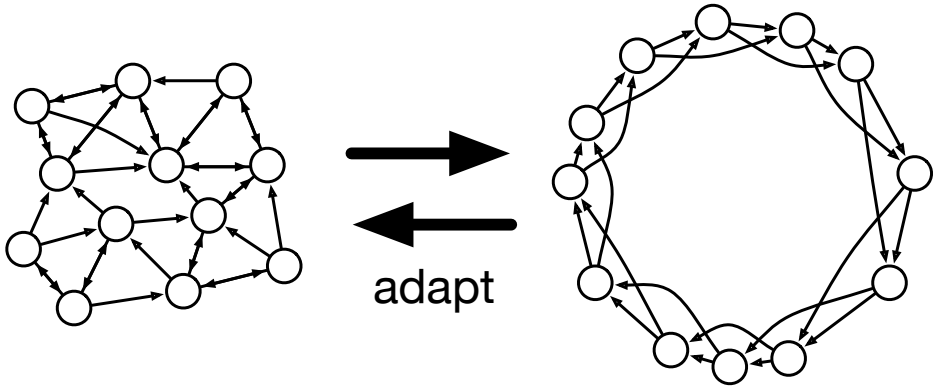
- Declarative programming support for self-organizing overlays
  - libdio library (open source) [DAIS16]
  - Implements self-organizing construction based on *gossip* principles
  - Live adaptation of overlay structure
  - 1st demonstration (tomorrow morning)



- Opportunistic composition & automatic *bridging* of overlays
  - Application: autonomous repair of routing overlay in emergency situations

Adaptive overlays for MANET broadcast

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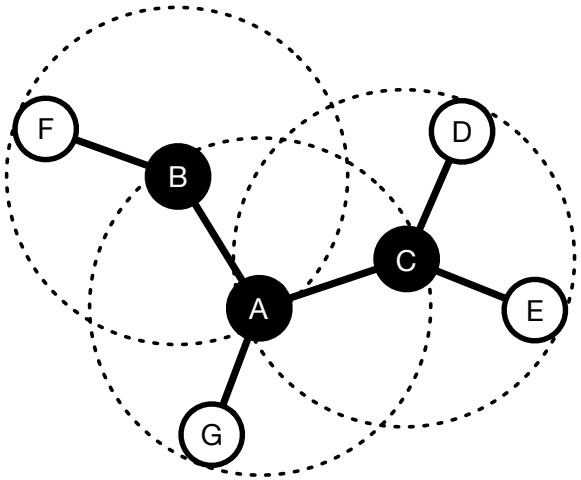
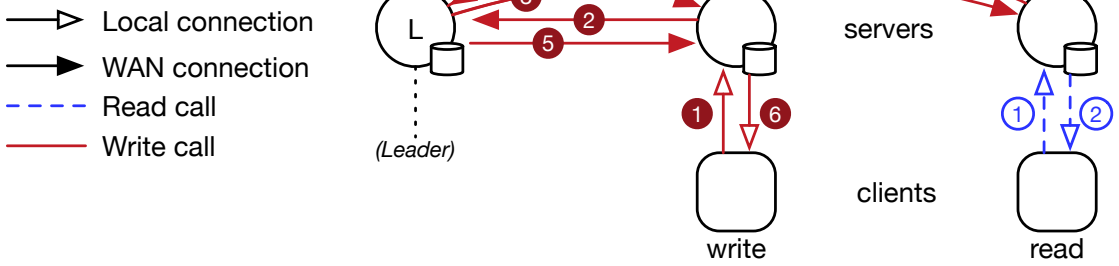
- Broadcast in mobile ad-hoc networks
  - Collisions, energy constraints, heterogeneity
  - Reactive vs. multiple variants of overlay-based approaches
  - Not one size fits all
    - Depending primarily on density and mobility [ICDCS 17]

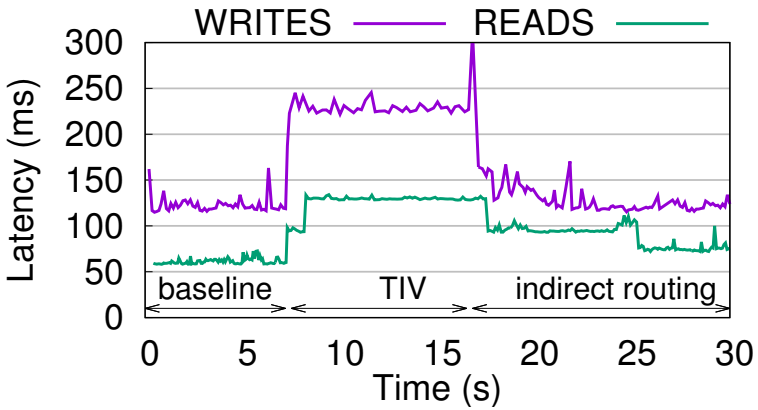
- Emergent and adaptive overlays
  - Observation of deployment conditions
  - Autonomous shift between protocols
  - Safety guarantees for dissemination
  - Declarative definitions based on time automata



Overlay adaptation for geo-replicated storage

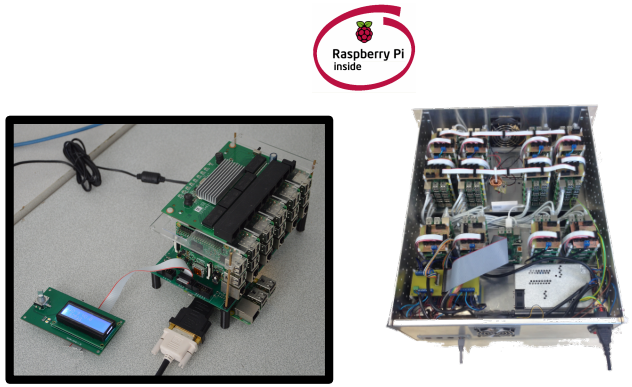
- NoSQL storage (ZooKeeper) deployed over multi-site cloud
  - Geo-replication: disaster tolerance and local *reads*
  - Coherence protocol requires several WAN interactions for ordering *writes*
- Edge control of network traffic and application of *indirect routing*
  - Open vSwitch at 4 sites, SDN controller
  - Traffic injection and monitoring to detect Triangle Inequality Violation (TIV)
  - Indirect routing mitigates performance impact on coherence protocol
- 2nd demonstration (tomorrow morning)

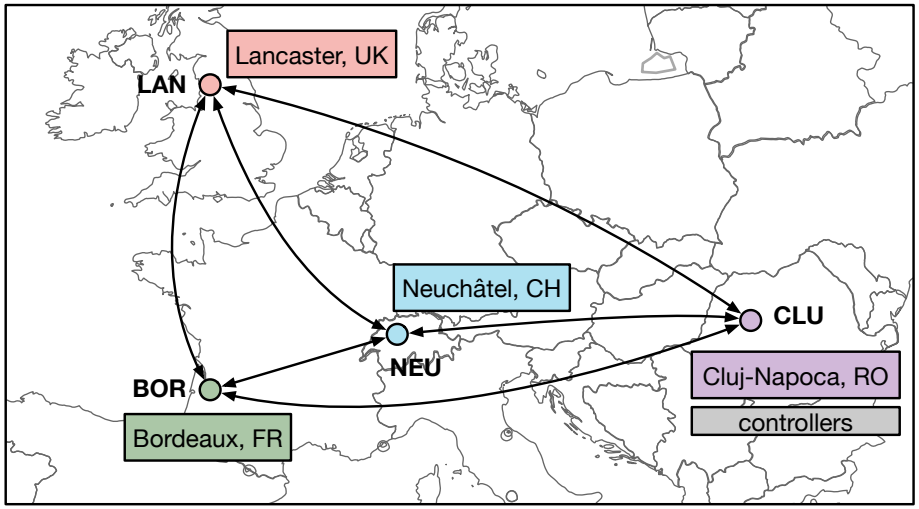




Testbed infrastructure

- 4-site testbed with SDN support [ATN 2016]
  - Inter-overlay SDN-driven interoperation
  - Control using Splay [COMM 2016]
- Heterogeneous compute nodes
  - Regular servers
  - *PiRack* cluster
    - 4U rack, 48 RaspberryPI (~200 cores)
  - Grape mini-cluster
    - 6 RPI (+1)
    - Representative of edge Cloud devices [IEEE IC 17]
    - See our 1st demonstration





Consortium

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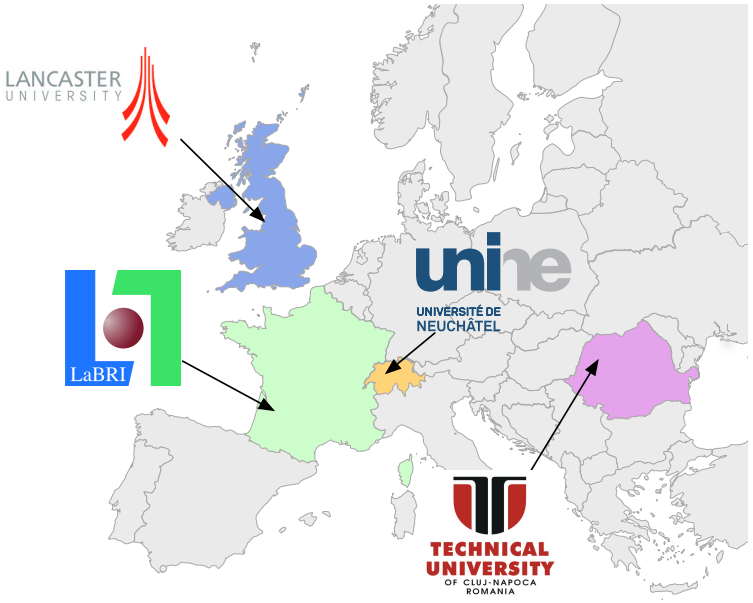
- 4 partners
  - Université de Neuchâtel (CH) – coordinator
  - LaBRI, Bordeaux (FR)
  - Lancaster University (UK)
  - Technical university of Cluj-Napoca (RO)
- ~1 M Euros funding from chist-era



Expertise domain / Partner	1. UniNE	2. LaBRI	3. Lancaster	4. TUCN
(domain-specific) Languages and compilation	+	+ + +	+ +	+
Large-scale networked systems	+ + +	+ +	+ +	+++
Wireless networked systems, sensor networks	+ +	+	+ + +	++
Gossip-based and self-organizing systems	+ + +	+	+	++
Middleware adaptation	+	+ + +	+ + +	+
Interoperability, complex systems composition	+	+ +	+ + +	++
QoS-oriented routing and composition	+	++	+	+++
Distributed execution frameworks	+ + +	+	+ +	+
Distributed systems evaluation	+ + +	+ +	+ +	+

University of Neuchâtel, Switzerland

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- *Etienne Rivière (coordinator), Raziel Carvajal Gomez*
- Computer Science dept. @ UniNE
- Key competencies
  - Large-Scale Distributed Systems
  - Experimental support for Dist. Systems
  - Overlay networks and Gossip-based protocols




UNIVERSITÉ DE NEUCHÂTEL

LaBRI - Bordeaux

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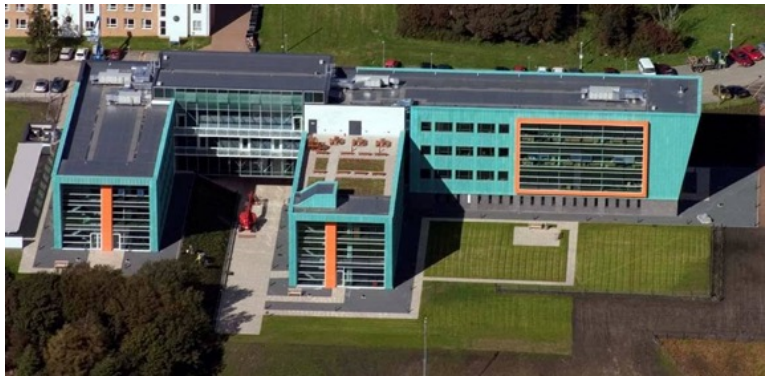
- *Inti Gonzalez-Herrera, Floréal Morandat, Laurent Réveillère (PI)*
- Associate member: *David Bromberg* (U. Rennes 1)
- Competences
  - Languages and compilation
  - Middleware adaptation
  - Large-scale distributed systems

LaBRI

Lancaster University, UK

- *Gordon Blair (PI), Yehia El Khatib, Vicent Sanz Marzo*
- Competencies:
  - adaptive and reflective middleware,
  - component-based systems,
  - cloud computing,
  - network programming

Lancaster University



Technical University of Cluj-Napoca, Romania

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- *Virgil Dobrota (PI), Iustin Ivanciu, Eduard Luchian, Adrian Taut*

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

THE TECHNICAL UNIVERSITY of CLUJ-NAPOCA

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THANK YOU!

http://www.dionasys.eu

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