

DIONASYS

Declarative and Interoperable Overlay Networks,
Applications to Systems of Systems



chist-era

DIONASYS project overview year 2

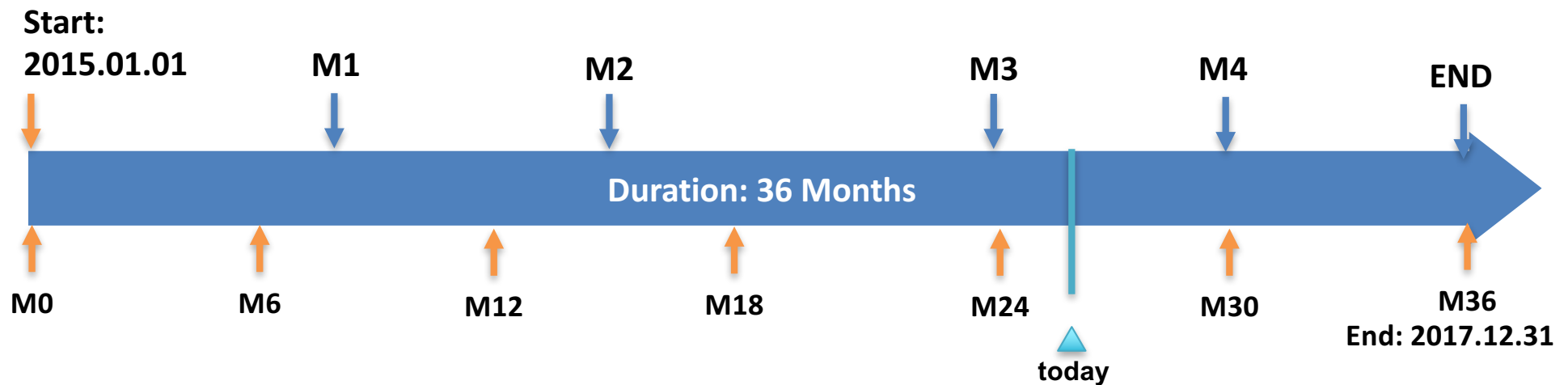
chist-era meeting

May 21st 2017

Brussels

Introduction

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



- 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

■ 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

- 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

- 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

- 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)

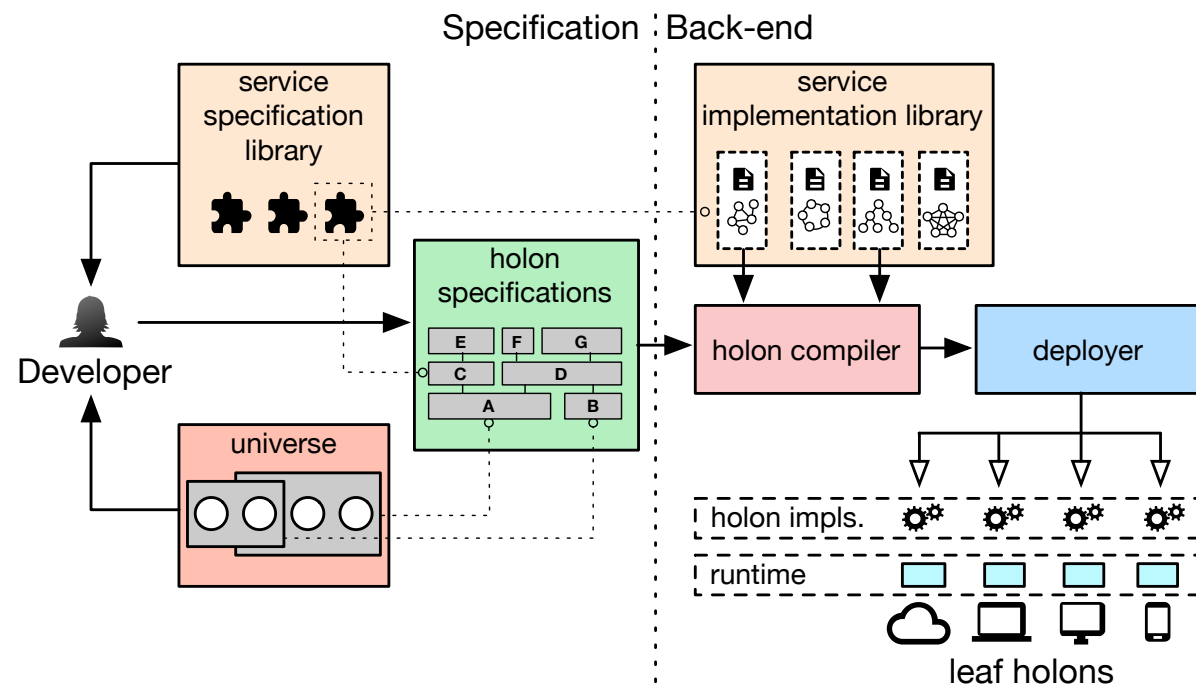
Conceptual contributions

Holon framework [ARM 2015]

- ▶ Principled systems composition and roadmap for project objectives
- ▶ Y2: definition of ontologies for automated systems-of-systems composition

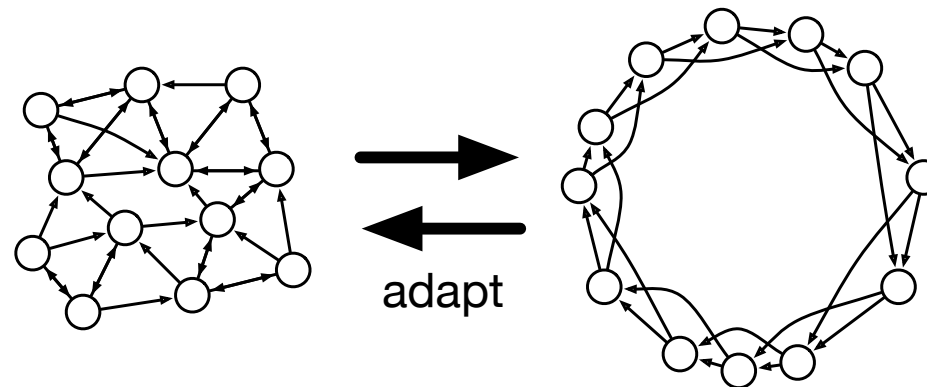
Intent-driven networking

- ▶ Framework for applications to declare *intent* on use of network
- ▶ Optimization and adaptation framework



■ 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

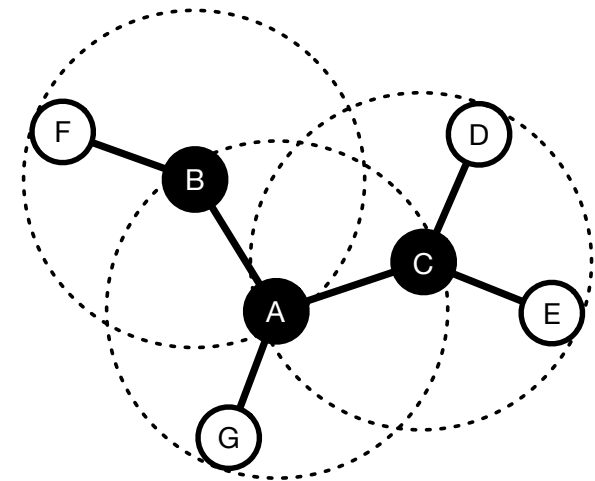
- ▶ Application: autonomous repair of routing overlay in emergency situations

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]

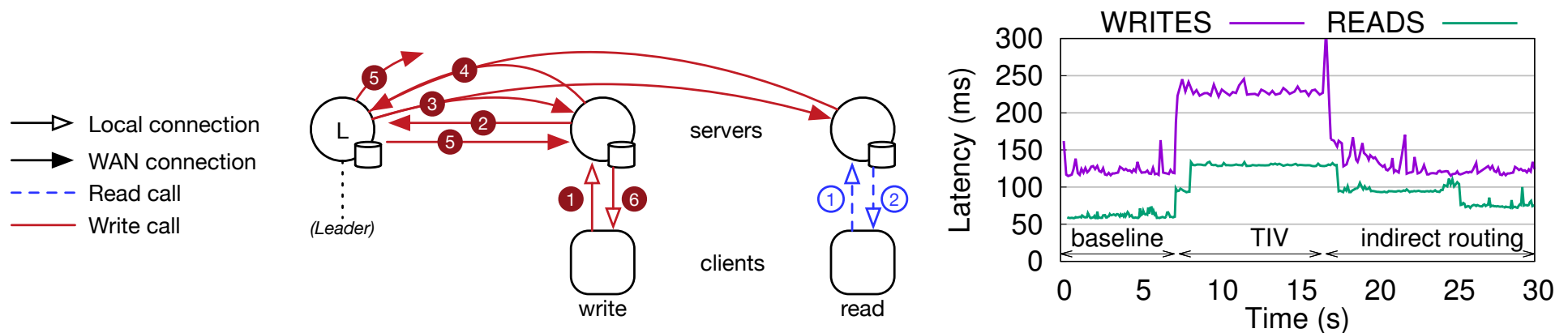
Emergent and adaptive overlays

- ▶ 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)



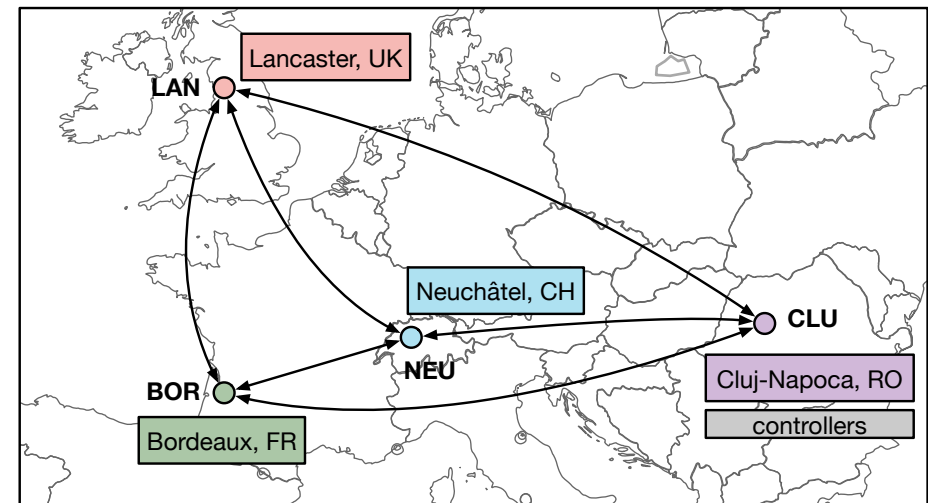
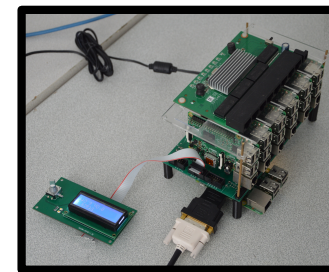
Testbed infrastructure

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



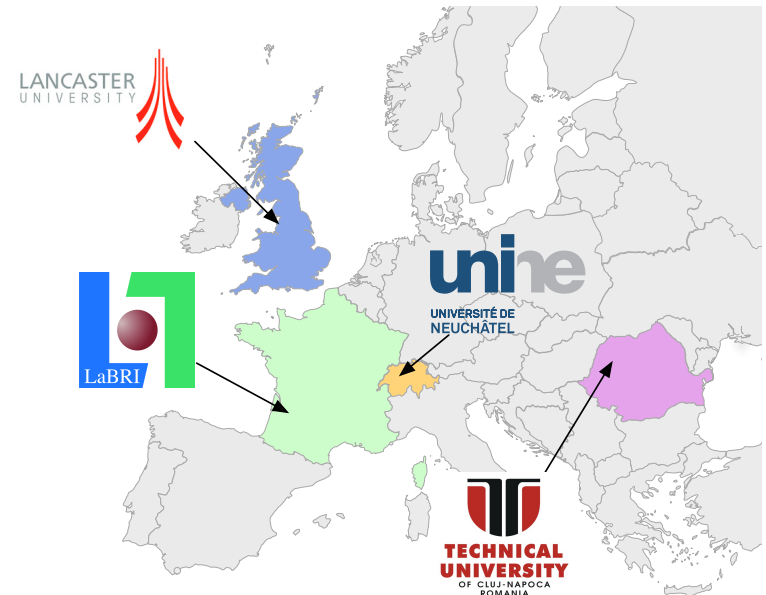
Consortium

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



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

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



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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



Gordon Blair (PI), Yehia El Khatib, Vicent Sanz Marzo

Competencies:

- ▶ adaptive and reflective middleware,
- ▶ component-based systems,
- ▶ cloud computing,
- ▶ network programming



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

■ Competencies

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



THANK YOU!

<http://www.dionasys.eu>



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