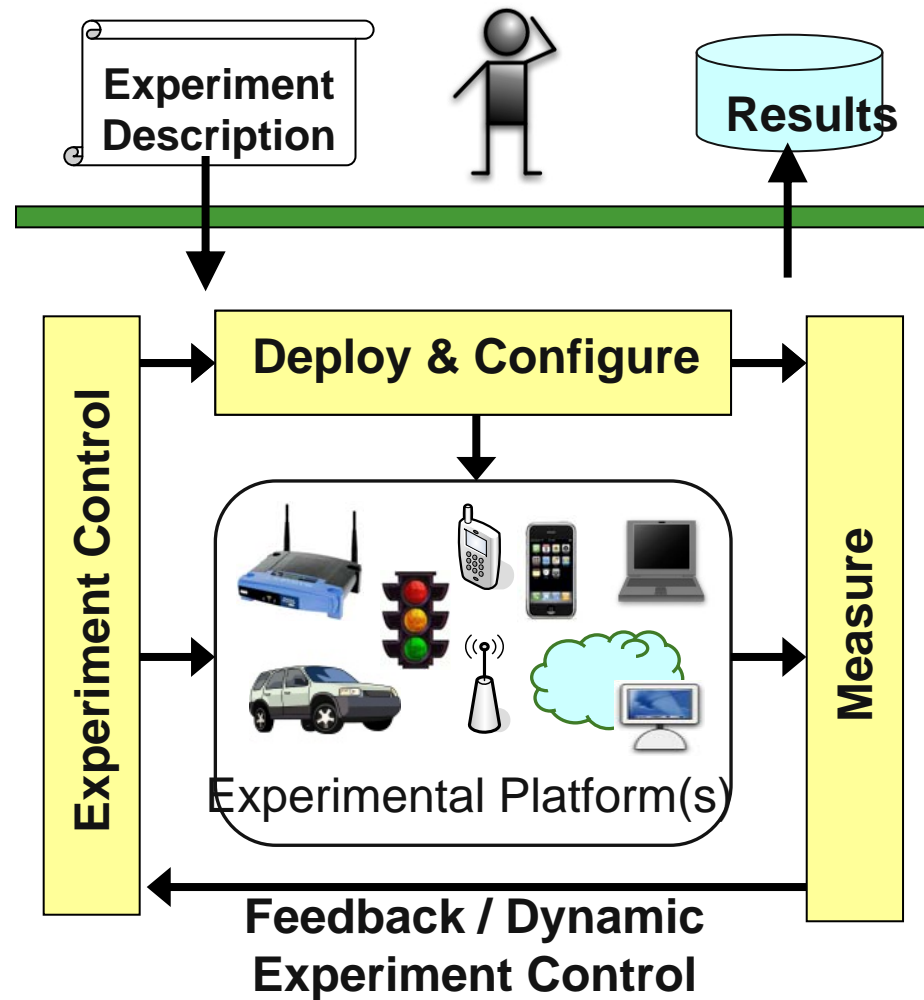


OMF Project Review & Future Work Plans

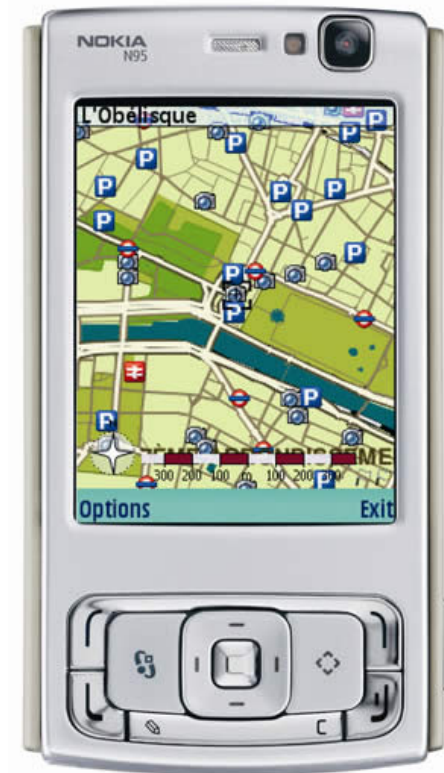
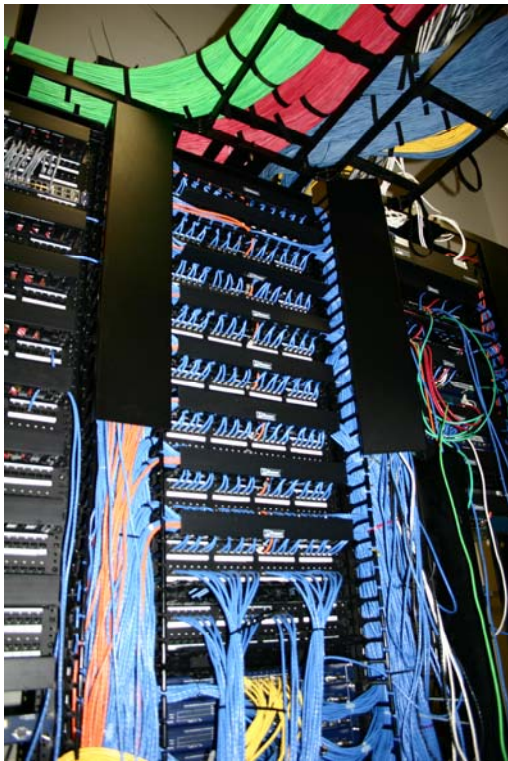
Marco Gruteser, Max Ott & Ivan Seskar



Support the **entire** investigative life-cycle



Support **reproducible** experiments across wired, wireless, and mobile testbeds



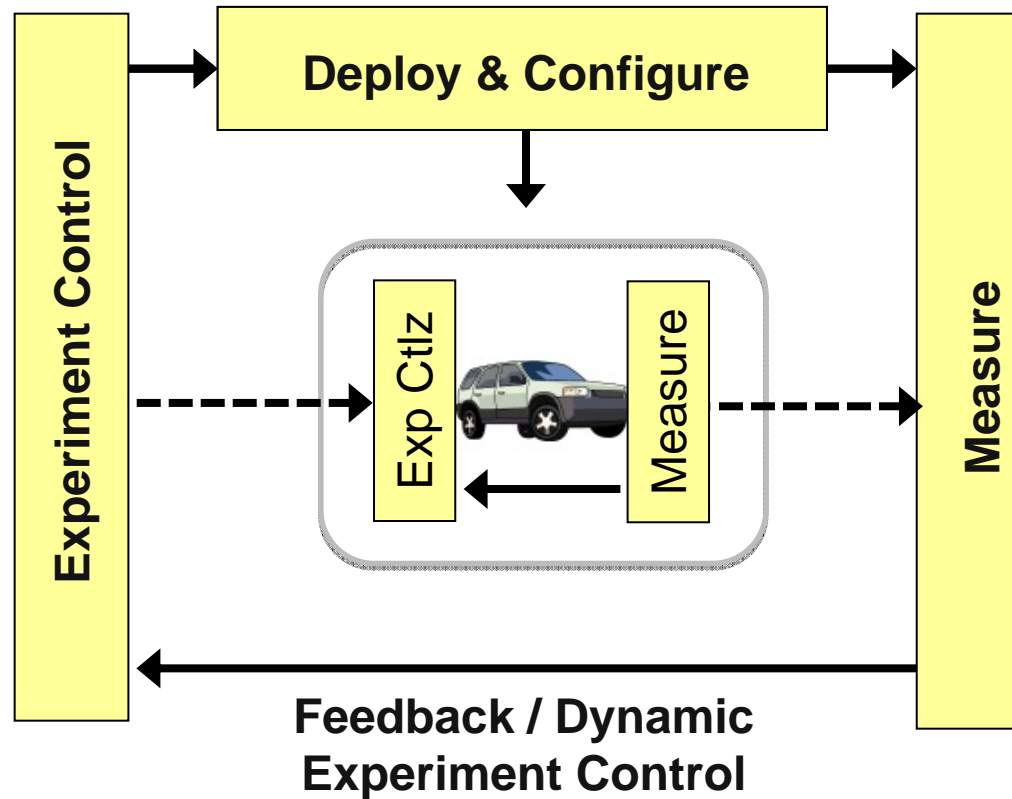
SOW

- Extend OMF to support multiple heterogeneous testbeds, anticipating GENI control framework structures where possible and integrate into your testbeds
 - OMF is deployed on the following beyond Orbit
 - Thomson Research: Proprietary embedded access point
 - CUNY/CERTH/NICTA: Low cost platform. Node mgmt. via PoE
 - T-labs: Access points based on ARM with 64-bit OML server
 - WINLAB/NICTA: Increasing support for motes incl. OML integration
 - Refactoring of components and aligning names with GENI terminology (more than a renaming exercise)
 - Increasingly simplified installation due to feedback from OMF adopters
 - Mature code based due to continuous operation on various testbeds
 - Cleaner, better documented architecture due to increasing developer community.

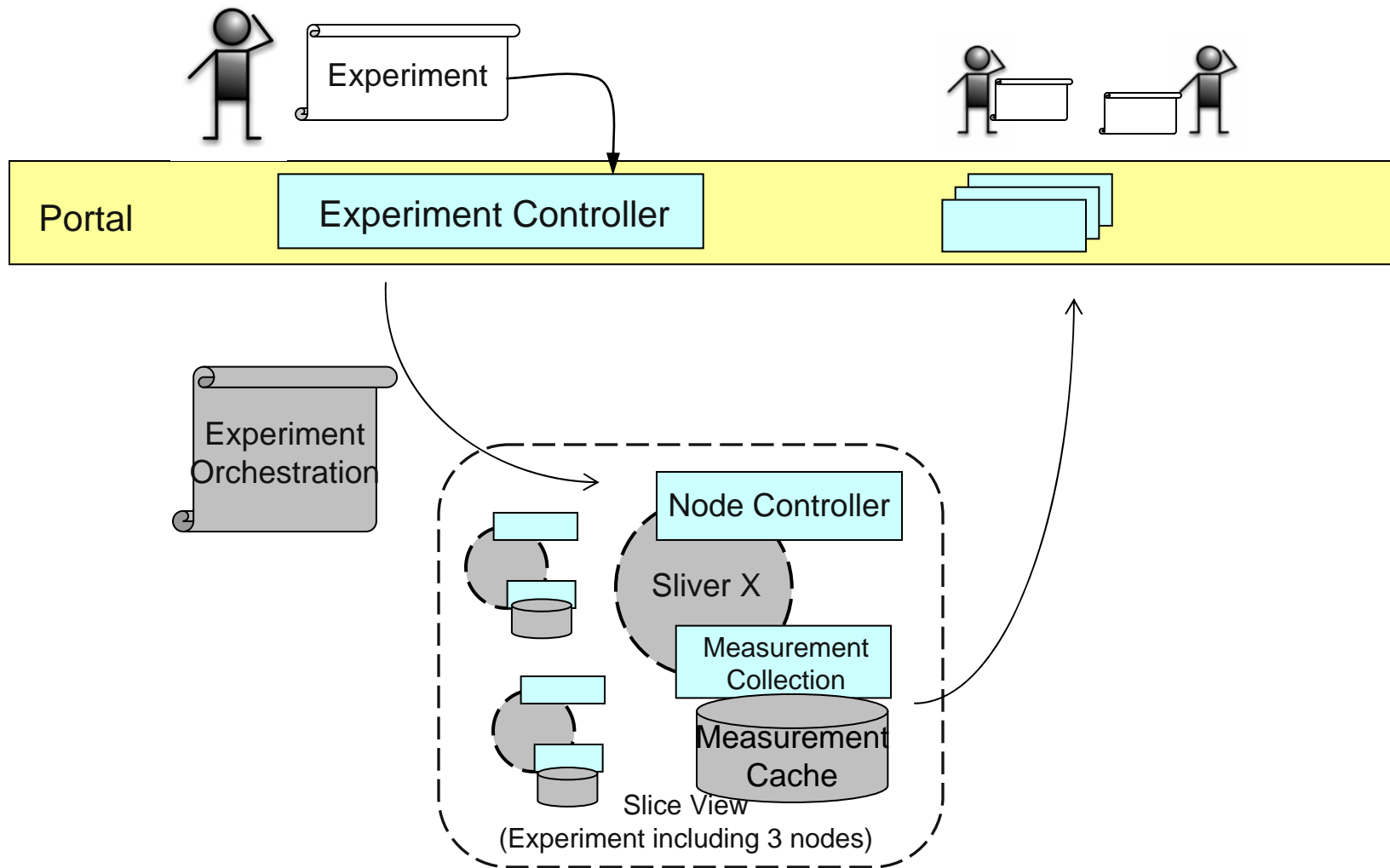
SOW ...

- Extend OMF interfaces and software to support mobile testbeds by: distributing experiment scripts to mobile nodes; providing local caching of experiment results during disconnection; and by executing experiment actions at predefined points in time
 - Demonstrated at GEC4
 - Operational and usable today
 - V2 with cleaner integration planned after putting XMPP communication framework into operation
 - Primary issue currently is the clean detection of disconnection
 - Feedback indicates that experimenters want to have more control over cache operation
 - Local caching of measurements has wider applications
 - Some testbeds do not have separate control network

Disconnection Tolerant Framework



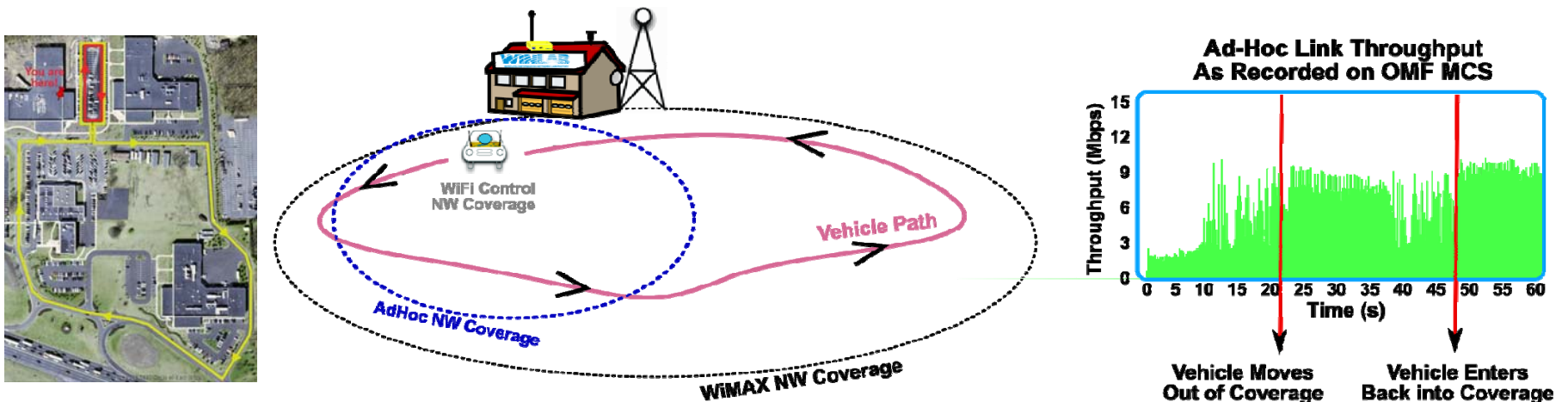
Disconnection Tolerant Framework



* OMF entities are in light-blue

GEC4 Demo: Disconnected Operation

- Measures ad hoc network capacity between a fixed-node and a mobile vehicle
- Experiment flow and measurement results preserved beyond WiFi control network coverage, and sync'ed when coverage returns
- Vehicle mobility and experiment flow is monitored via WiMAX network real-time



SOW ...

WiMAX Base Station Integration

- Separate Presentation!

SOW ...

- Provide VLAN connectivity from your testbeds to the GENI backbone network on NLR (via MAPGPI East)
 - L2 connectivity to MAGPI East established, waiting for connectivity to I2
 - NICTA connected to I2 via AARNET (contributes lambda to LA for one year)
- Establish OMF operating environment for your stationary and mobile testbeds, verify with experiments, and demo at GEC
 - Testbeds used constantly
 - Shown demo at GEC4
 - Demo for GEC5 in preparation (also expected as SIGCOMM demo)

SOW ...

- Support experimentation on your stationary testbed by other GENI users outside of related projects.
 - We have been doing this for a long time
- Collaborate with O&M team on methods to share ORBIT O&M data with other GENI groups for Spiral 1
 - Provided Jon-Paul Herron (gMOC) with information
- Collaborate with Security team on security design for Spiral 1
 - Meeting with Stephen Schwab to explain ORBIT's security arch.
- Contribute to GENI outreach plan, by including undergraduate students from under-represented groups in the design and development activities
 - Summer program that includes 9 undergraduate students including 4 women working on various OMF related projects

Future Work Plans

Towards a Common Framework

- Federation is key
 - I want to maintain control over what I build, pay for, ...
- Resource Description
 - So we know what we are requesting, using, measuring
 - Formal model so we can reason about it & tie it to policies & extend it
 - Support different abstraction levels with formal mapping between
- Everything needs to be observable
 - Measurements crucial and need to be tightly integrated
 - Can't hide behind service abstractions
 - ... while minimizing privacy concerns
- Policy & Authorization Framework
 - In federation everything is relative
 - Based on formal model so we can tie policies & authorization together

The Road Ahead

- Federation
- Maturity
- Experiment Tools
- Year 2 Plan

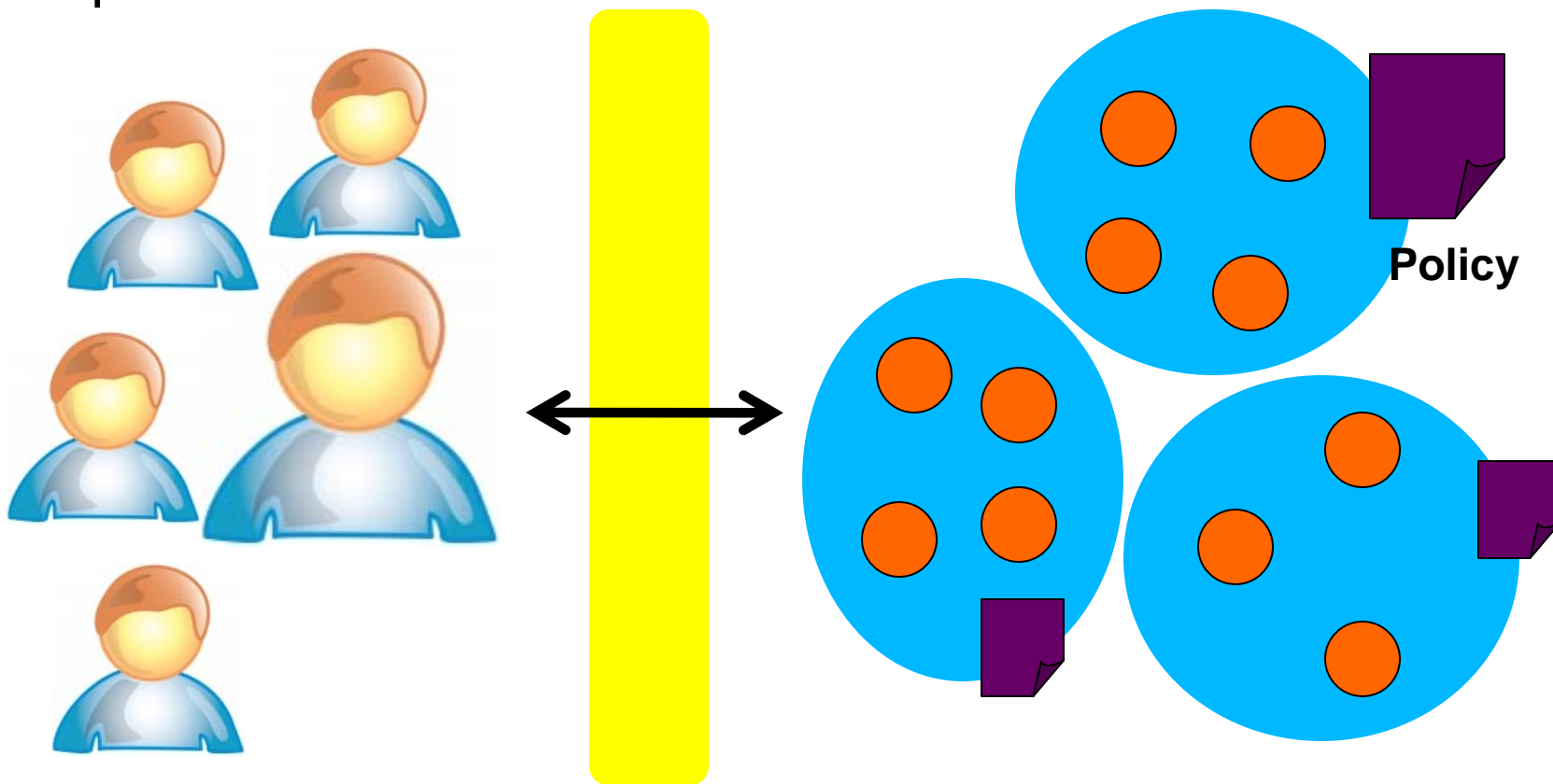
Disclosure

We are also involved in the following testbed activities:

- Onelab2 (EU 7th FW, major FIRE project)
 - OMF used in wireless work package
 - CERTH: Testbed kit
 - ALCATEL: WiMax integration
 - CINI: PlanetLab interface
- 4WARD (EU 7th FW)
 - WiMAX Virtualization work package
- NaDa (EU 7th FW, FIRE)
 - Managed P2P
 - Main partners: Telefonica (ISP), Thomson (STB)
 - Virtualizing STB (OpenVZ) and emulating DSLAM
- Continuous Bridge Monitoring, RTA Australia
 - Deploying monitoring testbed on bridges (Motes, UMTS)

Federation is Key

- Many users, many facilities, many objectives, many policies



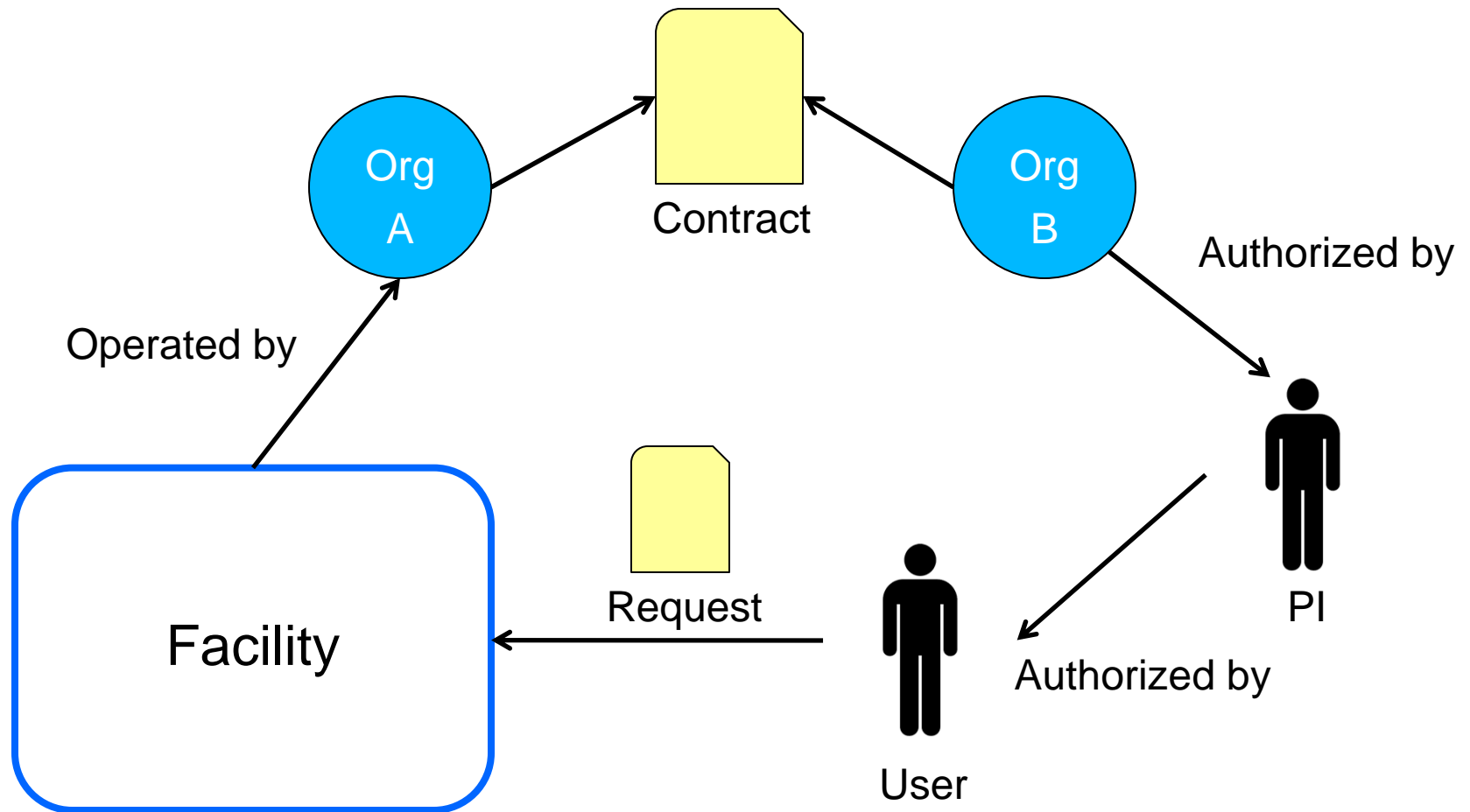
Federation through Messaging

- Message-oriented architecture
 - Need for asynchronicity
 - Scalability – same command to many
 - Responsiveness – certain things take a while
 - Observability - Things break!
- Bi-directional communication among actors based on XMPP
 - Standards-based (IETF)
 - Various open-source, high performance implementations available
 - Domain discovery through DNS
 - Using Pub/Sub extension
 - We require multi-cast like communication patterns (set-based)

Authorization, Allocation & Authentication

- User A requests resource B
 - CAN user A request B
 - SHOULD resource B be given to A
- Can => LEGAL
- Should => POLICY (legal)

In Federation, everything is Relative



Federation requires distributed decisions

- Distributed policies
 - Need to allow each facility to control usage & allocation policies
 - Need to be separated
 - Policies change
 - Not everyone wants to process it
- Looking at SAML (& XACL)
 - Want to use formal & standards-based solution
 - Assertions & SAML seem to provide that
 - Identity is less important - controversial 😊
 - Policy decision is kept separate
 - Not too eager to get into policies

Framework Maturity

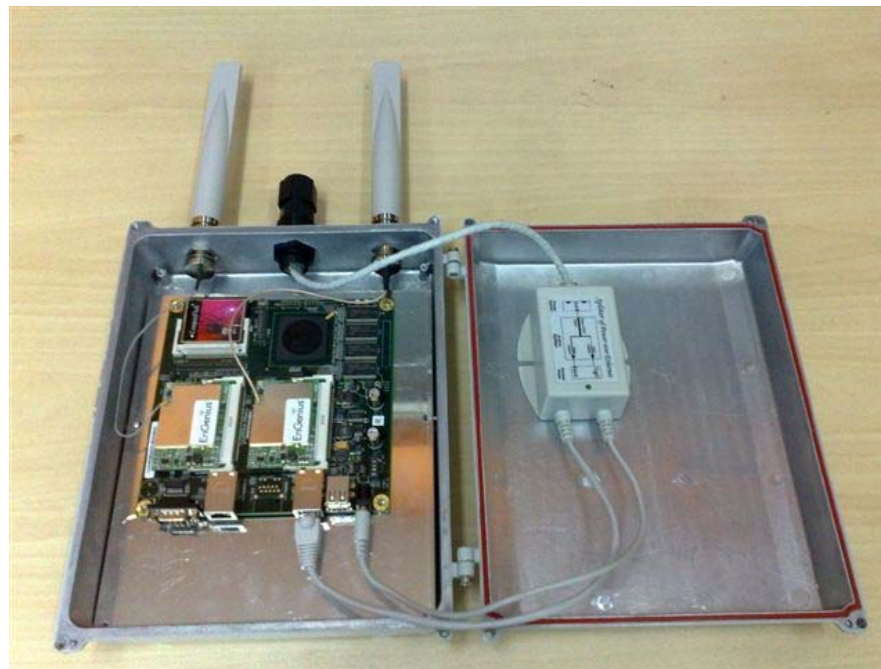
- Portal: omf.mytestbed.net
 - All code freely available
- Greatly improved documentation
- Installation on new testbeds
 - Shrinking installation guide (means we are making it simpler)
 - Well defined debian packages (with dependencies)
- Supporting interesting testbeds at various stages
 - Virtualized set-top boxes & DSLAM access
 - Lab for teaching networking (IREEL)
 - Continuous monitoring of bridges (hierarchical networks)
 - Wireless campus network where experiments carry real user traffic
 - Motes & cognitive radios
 - Underwater

Maturity ...

- Inventory
 - Keeping track of things
 - Where is what installed
 - Resource discovery
 - All nodes with a bluetooth radio
 - Linked to measurement framework (consisting naming)
 - Physical location of nodes; MAC address of interfaces
 - Operational support
 - How many disks did we replace last month

Maturity ...

- Testbed Kit (supporting an eco system of testbeds)
 - CERTH/NICTA: Develop a low-cost WiFi testbed kit
 - Based on ALIX boards and PoE power/mgmt



User tools

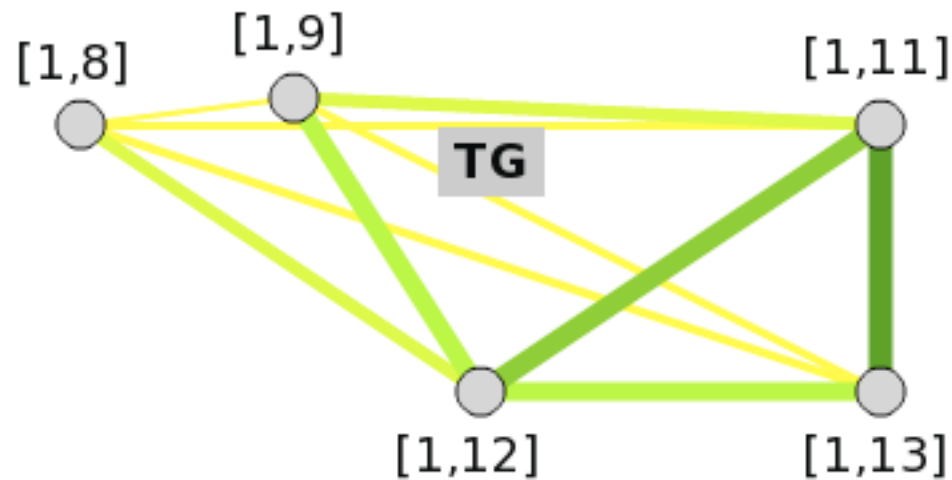
- More efficient use of resources
 - Rewritten scheduler with automated allocation policies
 - Experimenting with Spectrum as reservable resource
 - CERTH/CUNY
 - Modified Linux's CRDA (Central Regulatory Domain Agent)
 - Unattended experiments in batch mode
 - INRIA: Using grid scheduler
 - Mapping from user requests to available resources
 - High-level description of resources needed
 - Efficient algorithms which consider policies

Measurements

- OML
 - Support for caching
 - Simplified client-side filter architecture
 - Interest for sophisticated in-network processing
 - Wrapped around various libraries:
 - Libsigar: Node monitoring (CPU, memory, network stats, ...)
 - Libtrace: Packet monitoring and tracing (including radiotab)
 - GPS
 - Renewed effort to integrate spectrum analyzers (KC/Clemson)
 - Support for 64-bit architectures (on collection side)
 - Interest to integrate OML into ‘thing under investigation’

Web 2.0 interface

- Because everyone needs to have one 😊
- Embedded web server in experiment controller
 - Status, logs, scripts, measurements
 - Currently for single experiment only
 - Need to get integrated into portal to support investigation life-cycle
- Visualization
 - Based on Berkeley's Flare library

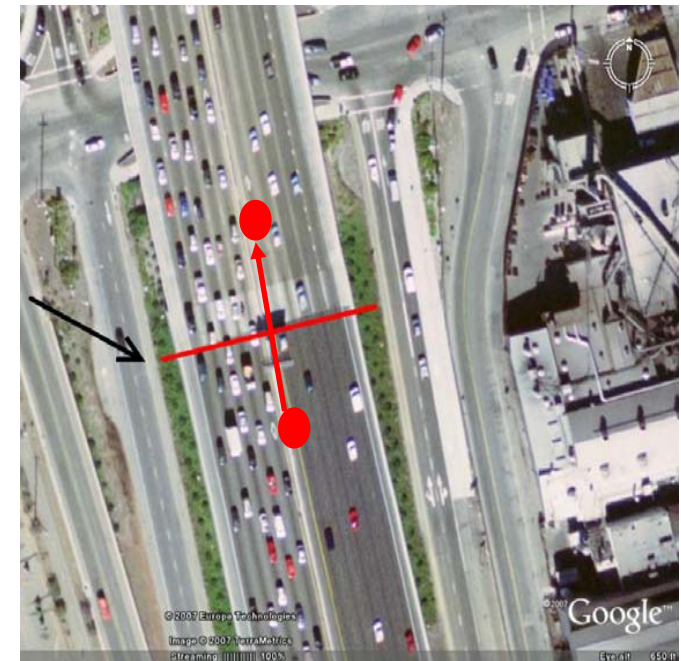


Year 2 Plans

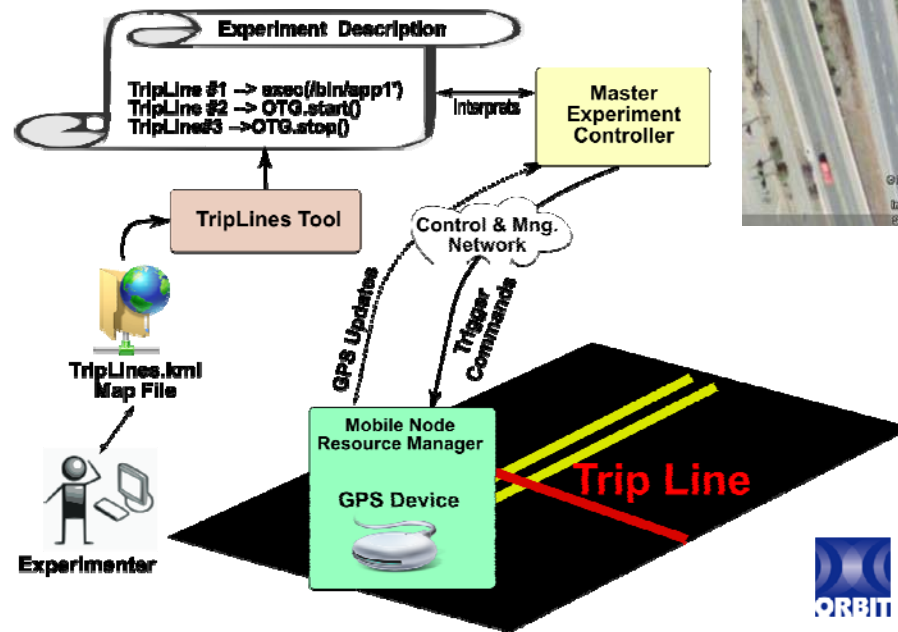
- Extend OMF to support experiments across multiple testbeds.
 - Integrate with PlanetLab. Shared user identities
 - Use case: PL nodes with wireless interfaces connected to a mesh network controlled by OMF
- Extend to OMF to support experiments driven by context, such as location information
 - Trip wire
- Continue working with WiMAX basestation project
 - Clean interfaces and resource model
 - OML integration
- Develop a resource description model for our resources
 - Collaborate with ORCA team on common model
 - Based on NDL/OWL & ITU-T G.800 standards family

Controlling Mobile Experiments with Spatial and Temporal Triggers

Executed command when
 Node passes spatial trigger
 15s after experiment start
 5 nodes are within 1/2 mile radius
 Implemented through events



Spatial Trigger



Year 2 Stretch Goals (depends on resource availability)

- Experimenting with user mobility
 - Extend to experiments with services
 - Virtualize mobile phone (Android)
 - Good experience with hacking Android & virtualizing embedded systems
- Better integrating OpenFlow to:
 - Connect testbeds via L2
 - Demo: Control WiMax BS from Australia through R6
 - Enable testbed framework experiments
 - Support ‘flow processing’ – cloud processing inside the network
- Support teaching labs based on testbed experiments
 - Workbook like interface (see ireel.npc.nicta.com.au)
 - OEDL meets Wiki markup