OMF: Control, Measurement and Resource Management Framework for Heterogeneous, Mobile & Wireless Testbeds

Maximilian Ott

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http://omf.mytestbed.net

http://www.nicta.com.au/tempo

Australian Government

Department of Communications, Information Technology and the Arts

Australian Research Council

NICTA Members

ANU — THE AUSTRALIAN NATIONAL UNIVERSITY

UNSW — THE UNIVERSITY OF NEW SOUTH WALES

Department of State and Regional Development

Victoria — The Place To Be

THE UNIVERSITY OF MELBOURNE

The University of Sydney

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QUT — Queensland University of Technology

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

NICTA Partners

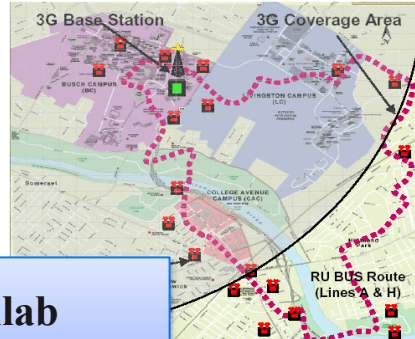**from imagination to impact**

OMF

- OMF is a framework to use and manage experimental platforms (testbeds)

- Use
  - support "experiment cycles" & scientific rigor
  - validation, accuracy & reproducibility

- Manage
  - ease operation and maintenance tasks
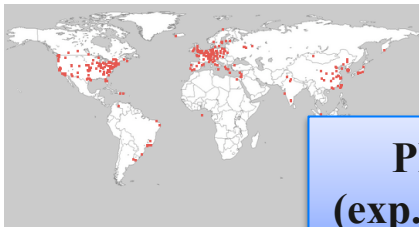 - optimize resource utilization inside / across testbeds

Where is OMF currently used ?

Orbit, Winlab Rutgers University, USA

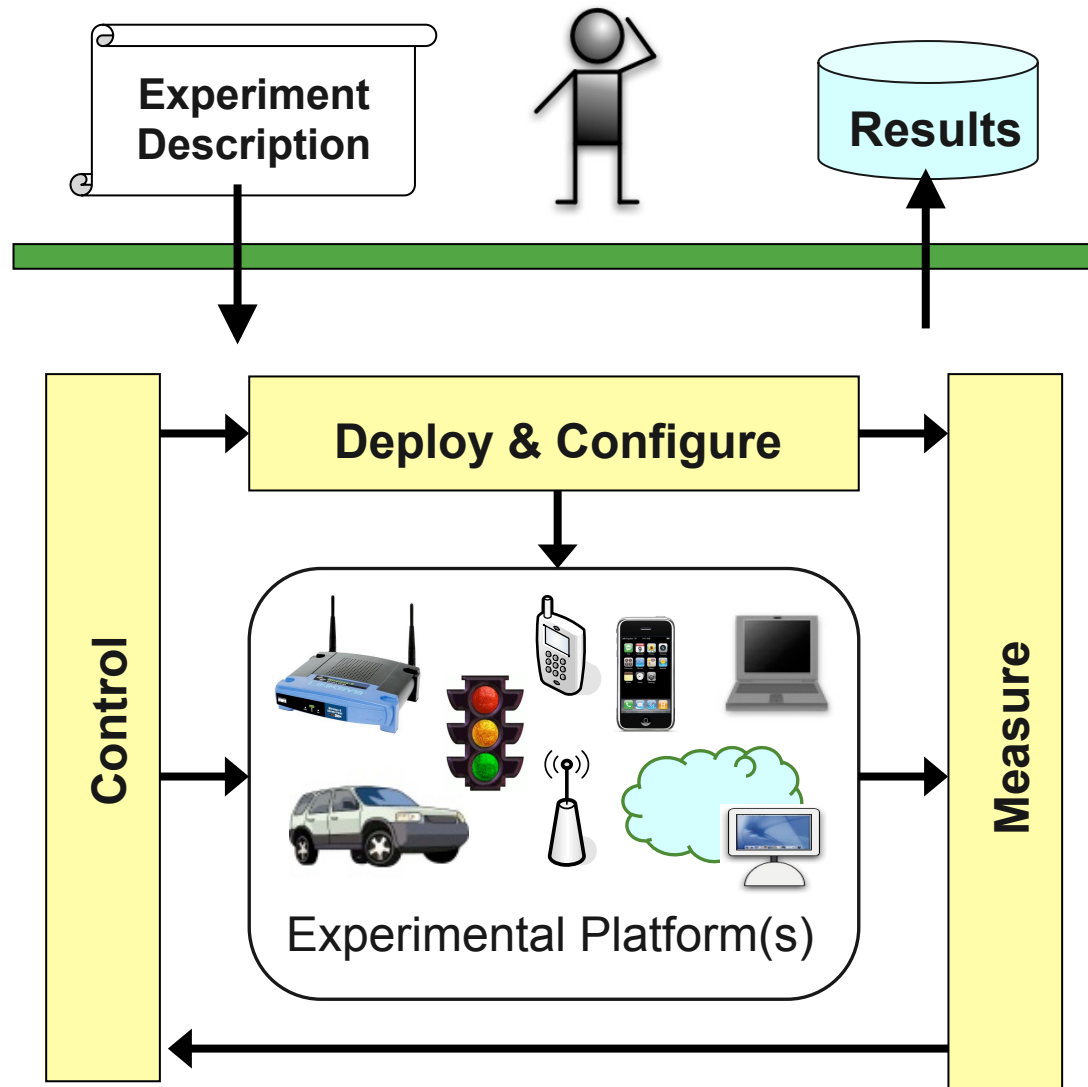**Thomson Lab, Paris, France**

PlanetLab, (exp.deployment)

NICTA Sydney, Australia

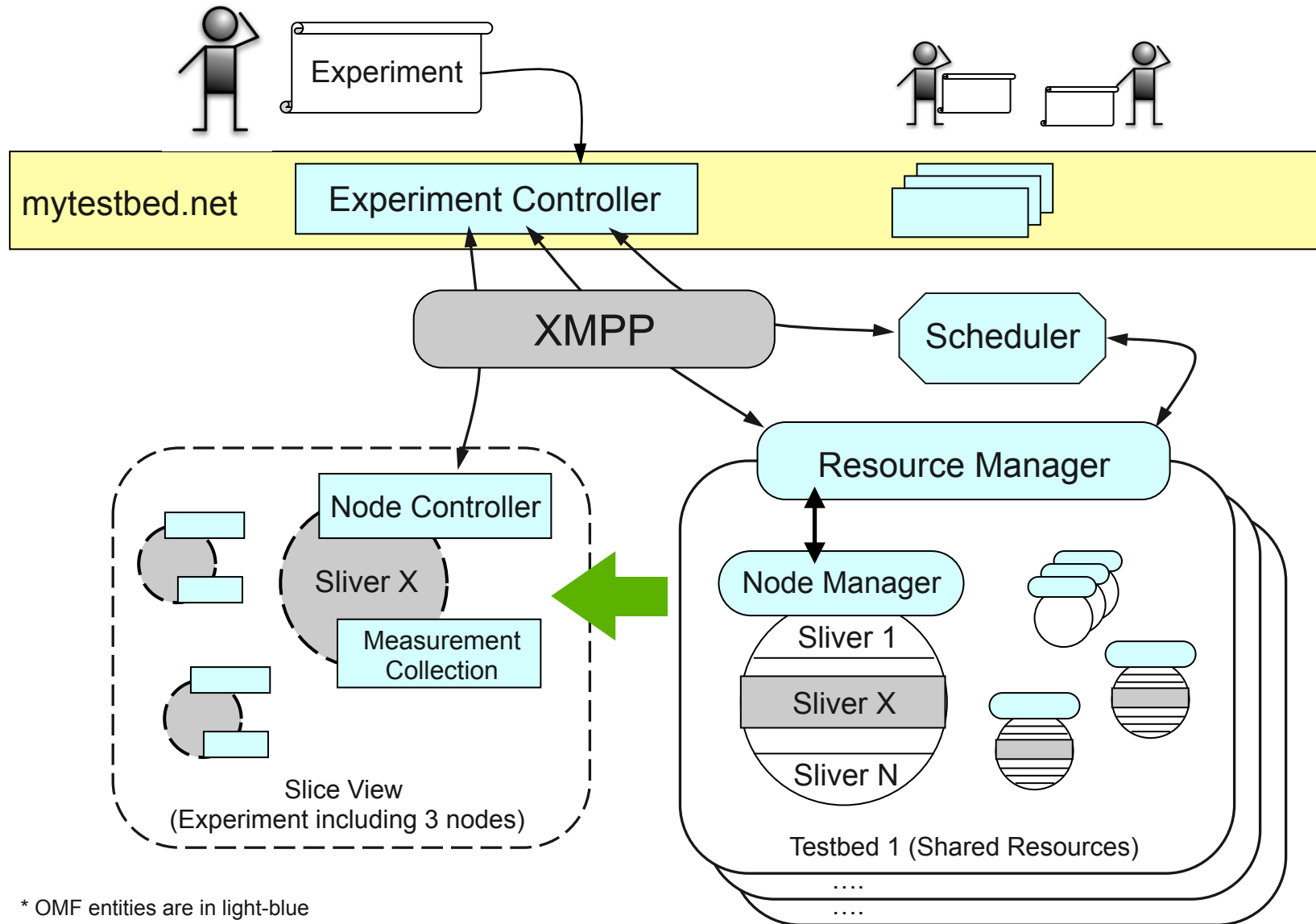**Center for Research and Technology, Greece, (under deployment)**

OMF - User View

Experiment Description

Results

Control

Deploy & Configure

Experimental Platform(s)

Measure

Wireless Testbeds

- ## Large investment by single entity
  - Need for strong autonomy

- ## Strong locality
  - Doesn't easily scale though federation

- ## Emphasis on "low-level" experiments
  - Challenge for virtualization

- ## Emphasis on short experiments

Resource sharing does NOT require virtualization

OMF: Next Generation

Experiment

mytestbed.net

Experiment Controller

XMPP

Scheduler

Resource Manager

Slice View
Node Controller
Sliver X
Measurement Collection
Slice View
(Experiment including 3 nodes)

Node Manager
Sliver 1
Sliver X
Sliver N
Testbed 1 (Shared Resources)
….
….

* OMF entities are in light-blue

Challenges

- ## Describing Resources
  - Entities, relationships & constraints

- ## Describing Experiments
  - Configuration, execution, recovery

- ## Measurements
  - What & how, steering

- ## Methodology
  - Ensuring scientific rigor

- ## Teaching
  - Experimental based curriculum

GENI/FIRE Collaboration

- We have our feet in both camps already
  - Orbit cluster in GENI Spiral 1
  - Onelab (WP6) & NADA
  - Maintain common code base and experiment portability
  - WiMax use case
    - Onelab/Alcatel
    - Orbit/NEC
- Resource allocation & usage policies
  - Wireless testbeds are local and "intrusive"
  - Projects are often "multi-institutional"
  - Usage, as well as funding is around projects

Other collaborations

- GRID/HPC community
    - Many similar issues

Summary

- ## OMF

  - Control & Management framework for wireless & mobile testbeds

  - Easily adaptable to new use cases & technologies

  - Mature: 5+ years of development

  - Secure base funding

- ## Challenge for this gathering:

  - Resource description & allocation

  - Usage policies

<u>http://omf.mytestbed.net</u>
(migration in progress)

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from imagination to impact

OMF

Topology

Properties

Test code

Measurements

Application

App 1

Sys

Prototype

Mapping Strategy

P1

Pi

Dynamic

- Mapping
    nodes to prototype
- Binding
    free properties

Static
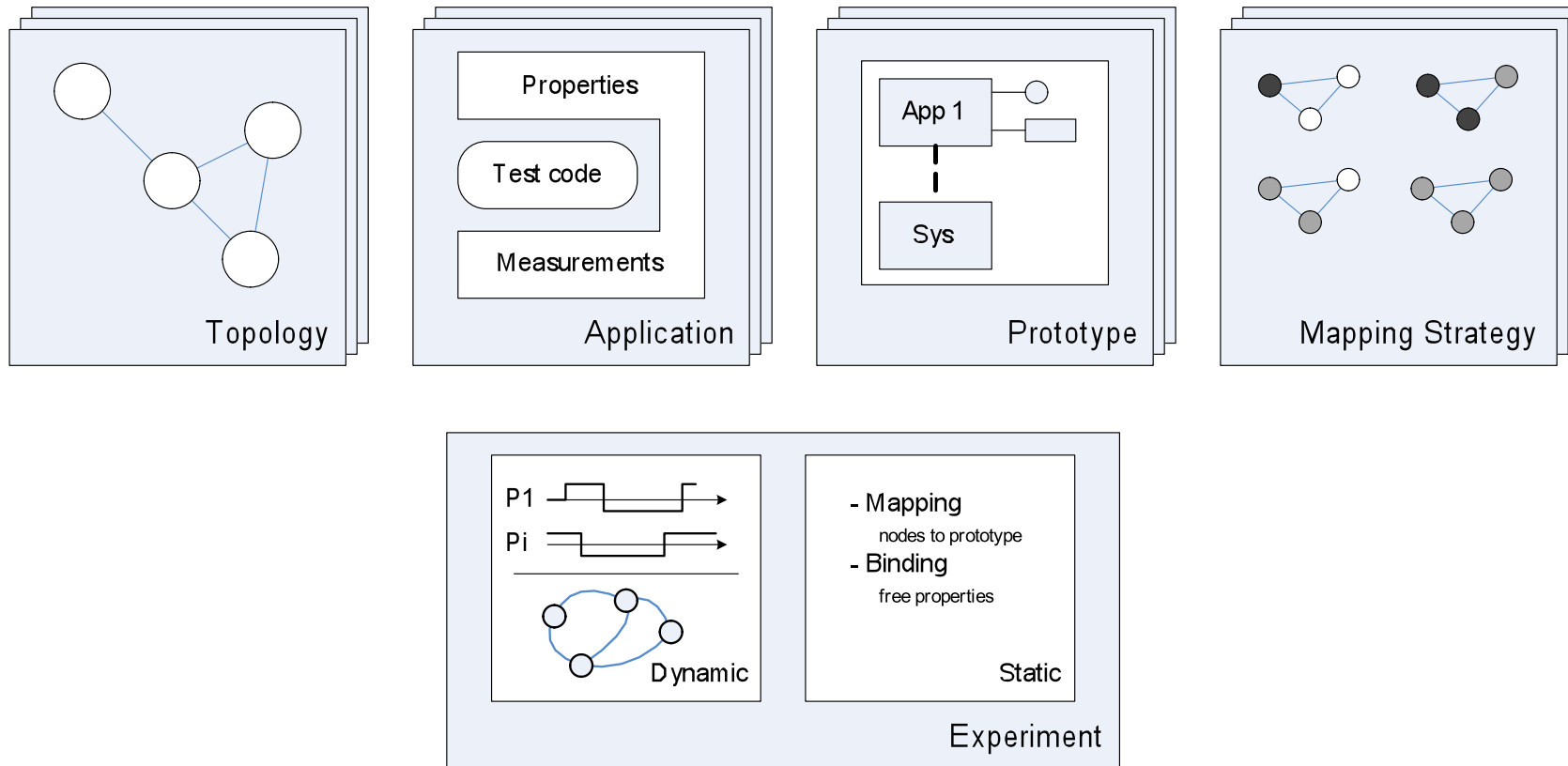
Experiment

Status and 12mo Milestones

- **Currently deployed on 4 testbeds:**
  - Australia, USA, Europe

- **Currently partner in two EU 7thFP projects:**
  - OneLab and NADA

- **Federation Support**
  - Support experiments across multiple heterogeneous testbeds

- **Mobility Support**
  - Disconnection-tolerant experiment installation and measurement retrieval
  - Time- and Location-based experiment orchestration tools

OMF

- Open-source (MIT license)
- 5+ years of development
  - Funding for next 3 years is assured
- Deployed in various wireless testbeds around the world
  - Runs on Planetlab as well
- Very interested to collaborate:
  - Porting it to other testbeds
  - Expanding the framework
    - Resource allocation
    - Security, authentication
    - Analysis
- http://omf.mytestbed.net

Glimpse of Future Features

- Federation:
  - Experimentation **on / across** multiple testbeds

- A unique description → many instances
  - How to describe an experiment & required resources ?
  - How to discover/schedule resources & map descriptions ?
  - How to federate multiple organizations ?

- An experiment across testbeds → enhanced capabilities
  - Further description, discovery, scheduling, mapping issues
  - How to coordinate resource usage across locations ?

Glimpse of Future Features

- Resource Sharing: System & Communication abstraction
  - at which level and layer to virtualize?

- OS / Hardware virtualization

- Network / Link Layer virtualization

  - e.g. how to share wireless medium?

- Current trials:

  - Xen virtual machines on NICTA's testbed

  - Space and Frequency sharing

- Issues:

  - adapt to user needs & to new technologies

Glimpse of Future Features

- Other features under development
  - Additional access methods (e.g. web interface)
  - Generic processing & visualization tools
  - Default context measurements (e.g. system stats)
  - "Disconnected" mode (e.g. mobile testbeds)
  - "Batch" mode
  - ...

How do we know what we need?

- Testbed design and specifications need to be highly influenced by user community

- We need to develop proper methodologies

  - Repeatability

  - Representational

  - Trustable

- Experimental validation is only one part of a scientific investigation

  - Testbeds are still not the reality

- We need realistic benchmarks

  - To compare approaches

  - To be relevant

To overcome the Dilemma we need:

- Input and guidance from user community
- Make the testbed design & methodology a research problem
- Free funding for engineering

Challenge: Describing Resources

- To accurately describe experiment to peers
  - When I say 'apple' you know what I mean

- To allow others to repeat experiments
  - Requires certain level of detail – 'Granny Smith'

- To request resources unambiguously

- ??

What do we want to describe?

- **Things we have**
  - Boxes, CPU, disk, network interfaces
  - Cables, networks
  - Space, spectrum
  - <u>**People, end users**</u>

- **Things we want to control (or at least capture)**
  - Mobility
  - Interference, noise
  - Weather

… What do we want to describe?

- Things we can measure
  - Performance: bits/sec, load, temperature
  - Events: Start/stop of applications, shutdown, handover, nearby
  - Satisfaction: quality, happiness
  - **Accuracy:** required, achievable, impact

- Intent
  - What do we actually want to achieve
    - Not: Node A1, B3 & C7; router D2; channel 56
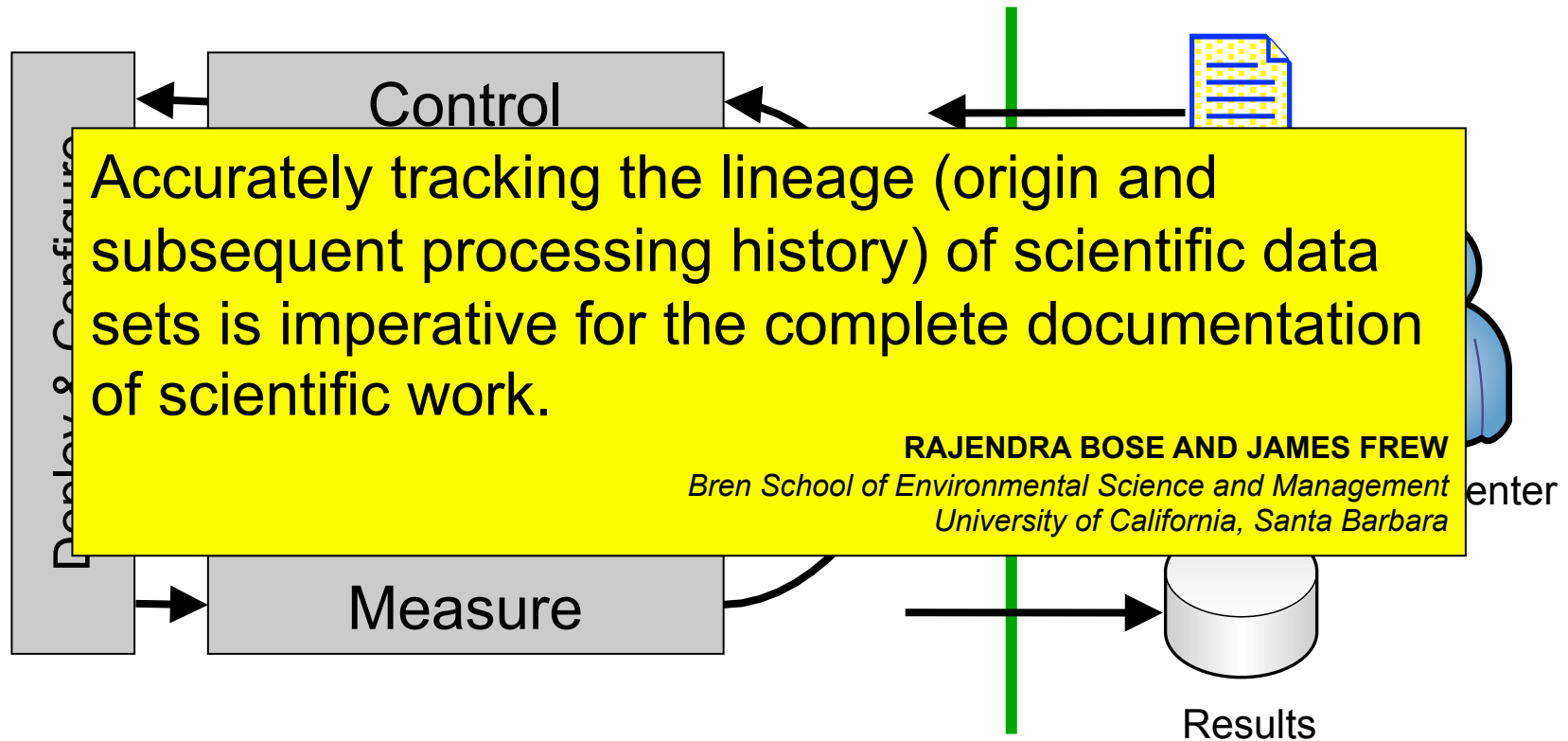   - **BUT:** A topology with characteristics A, scale S, fidelity F
  - Benchmarks?

Describing Relationships – The Power of the Link

Why XML won't
be enough

eth0: 10.1.1.3

?

eth0: 10.1.1.2
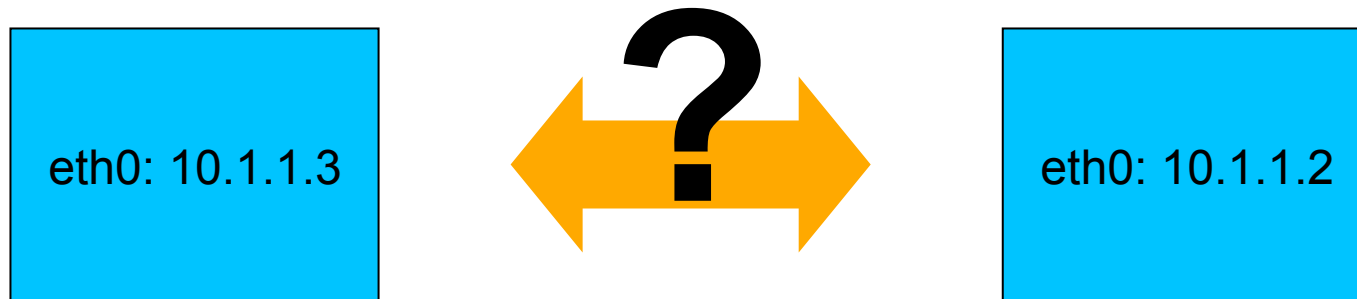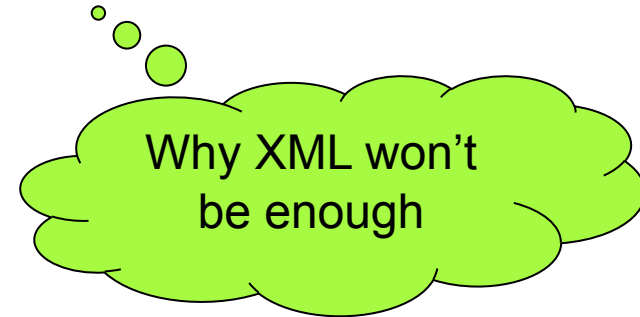
Challenge: How to describe an Experiment?

- Need to capture entire experiment for repeatability
- Need to describe all involved resources
  - Instance, driver version, motherboard rev., …
- Need to request resources at a higher abstraction
  - "20 nodes within 50 meter of access point"
- Need to deal with imperfect resources
  - "when 80% nodes are available …"
  - "when below X request Y more resources"

Challenge: Reproducible Results!

Accurately tracking the lineage (origin and subsequent processing history) of scientific data sets is imperative for the complete documentation of scientific work.

RAJENDRA BOSE AND JAMES FREW
Bren School of Environmental Science and Management
University of California, Santa Barbara

Summary

- Exciting times for experimental researchers
- Lots of activities, but also lots of hype
- Need for a clear value proposition
  - Researcher: Is the extra effort valued?
  - Industry: Is very interested but we lack clear business models
  - Teaching: Need proper curriculum (and tools) – but very compelling
- Building testbeds is hard & expensive
  - We need to share & aggregate (federate)
  - We want rich and diverse resources and environments
  - We should minimize diversity in control & management
- If you want to build a testbed – contact me
  - Max.ott@nicta.com.au

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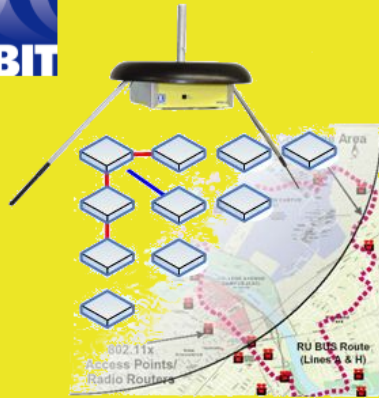
RUTGERS UNIVERSITY BUSCH CAMPUS
ORBIT TESTBED OUTDOOR DEPLOYMENT
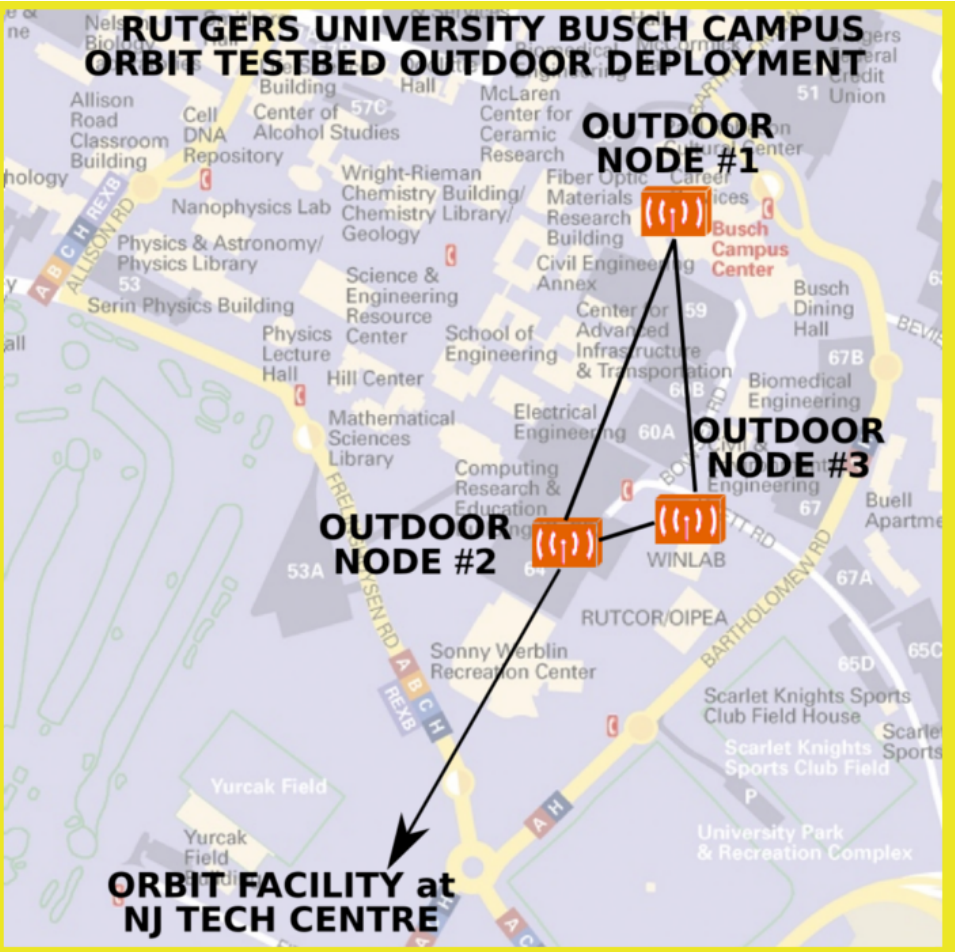
OUTDOOR NODE #1

OUTDOOR NODE #2

OUTDOOR NODE #3

WINLAB

ORBIT FACILITY at NJ TECH CENTRE