



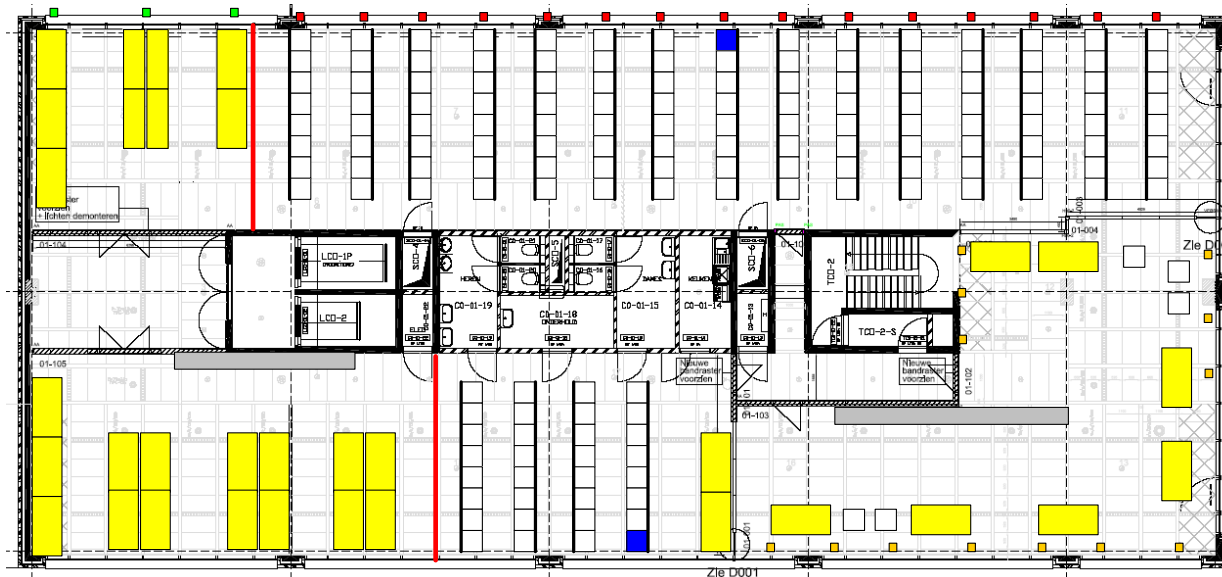
iMinds w-iLab.t

Hands-on: running
experiments on
w-iLab.t Zwijnaarde

Pieter Becue
Vincent Sercu
Bart Jooris
Stefan Bouckaert

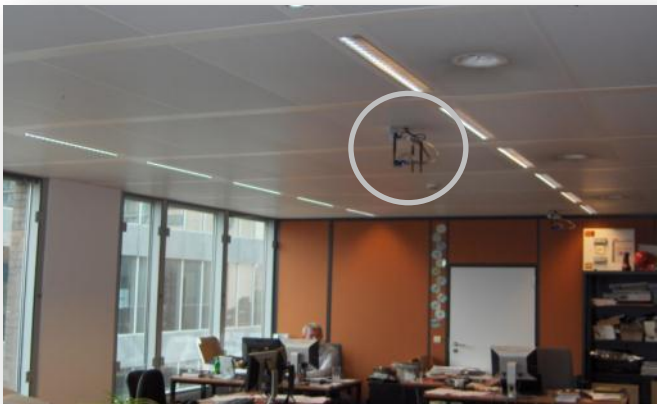
About the iMinds iLab.t

- The iLab.t research centre is located in Ghent



w-iLab.t : Facts and figures

- heterogeneous, generic testbed for wireless networks
 - Sensor networks
 - Wi-Fi based wireless ad-hoc/mesh/vehicular
- 2 testbed locations
 - Office: three office floors of 90m x 18m [200 nodes]
 - “Pseudo-shielded”, Zwijnaarde, 60m x 20m [60 nodes]



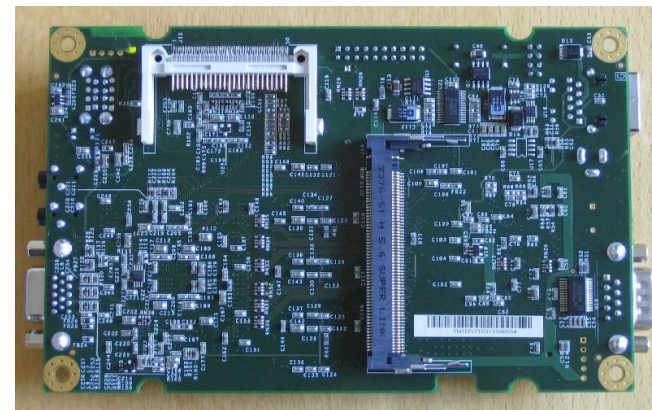
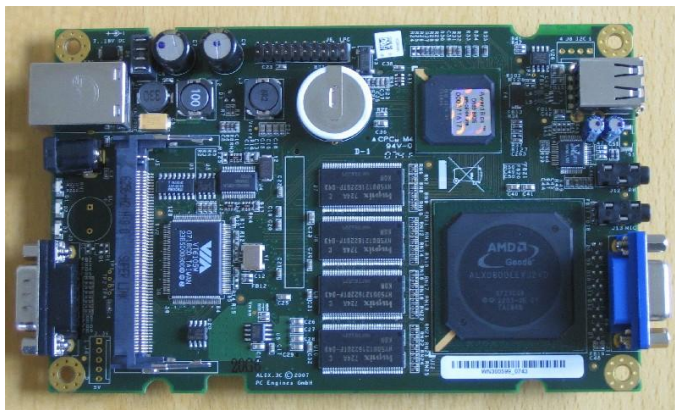
w-iLab.t

Hardware overview

Hardware – Embedded PC

- w-iLab.t Office

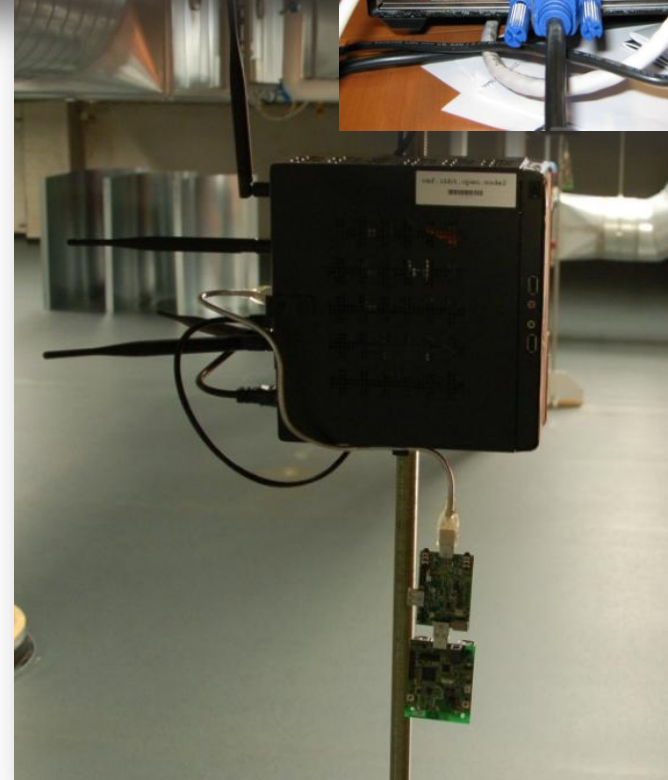
- Alix 3c3 (500 MHz AMD, 256 MB Ram)
 - Ethernet NIC (100Mbit) / Serial port
 - VGA, onboard audio
 - compact flash storage (2 Gb)
 - 2 x mini PCI slot
 - USB



Picture source: www.pceingines.ch

Hardware – Embedded PC

- w-iLab.t Zwijnaarde
 - Zotac
 - 4Gb RAM
 - 160 Gb Hard Drive
 - Intel Atom D510 1.66GHz Dual core
 - Wireless interfaces :
 - 802.11a/b/g/n (x2)
 - **Bluetooth**
 - **iMinds Rmoni sensor node** (802.15.4)
 - Environment Emulator
 - **Webcam** (20%)

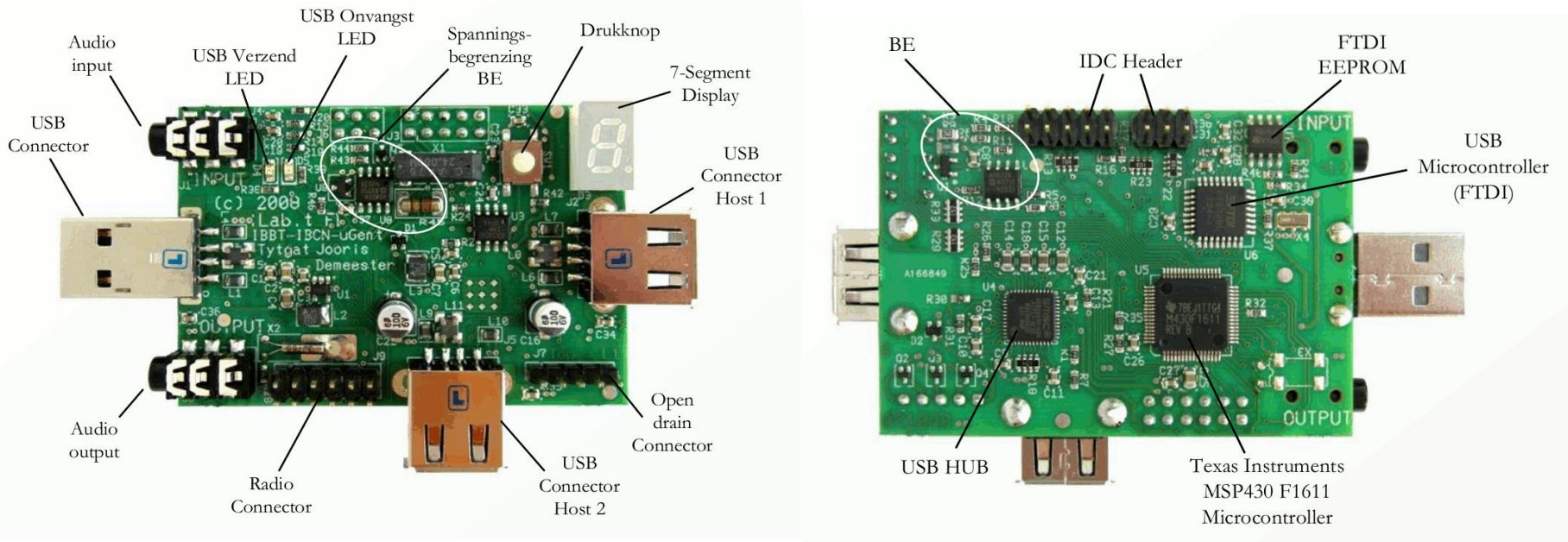


Hardware – sensor devices

- Tmote Sky (office) & iMinds Rmoni (Zwijnaarde)
 - TI msp430
 - CC2420 or CC2520
 - Sensors for **temperature** and **humidity**
- Specifications available on www.crew-project.eu/portal



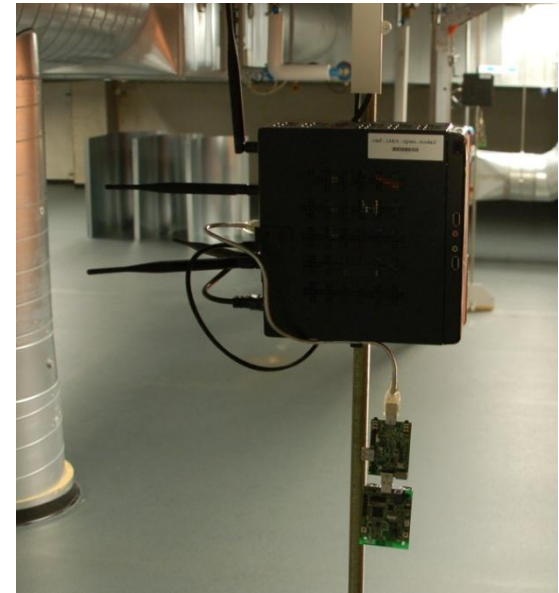
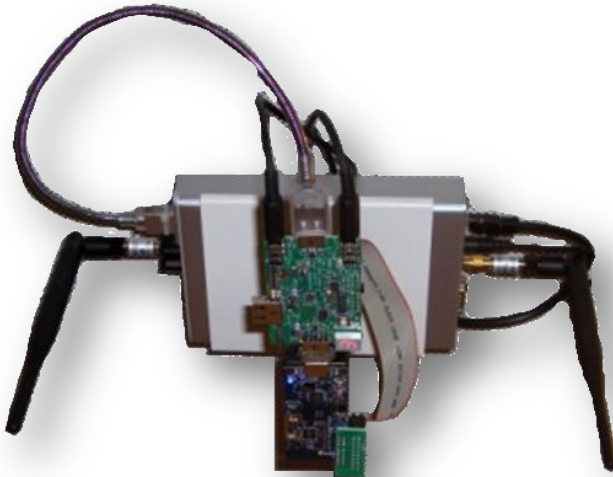
Hardware: environment emulator



More information: L. Tytgat, B. Jooris, P. De Mil, B. Latré, I. Moerman, P. Demeester, "**Demo abstract: WiLab, a real-life wireless sensor testbed with environment emulation**", published in European conference on Wireless Sensor Networks, EWSN adjunct poster proceedings (EWSN), Cork, Ireland, 11-13 February 2009

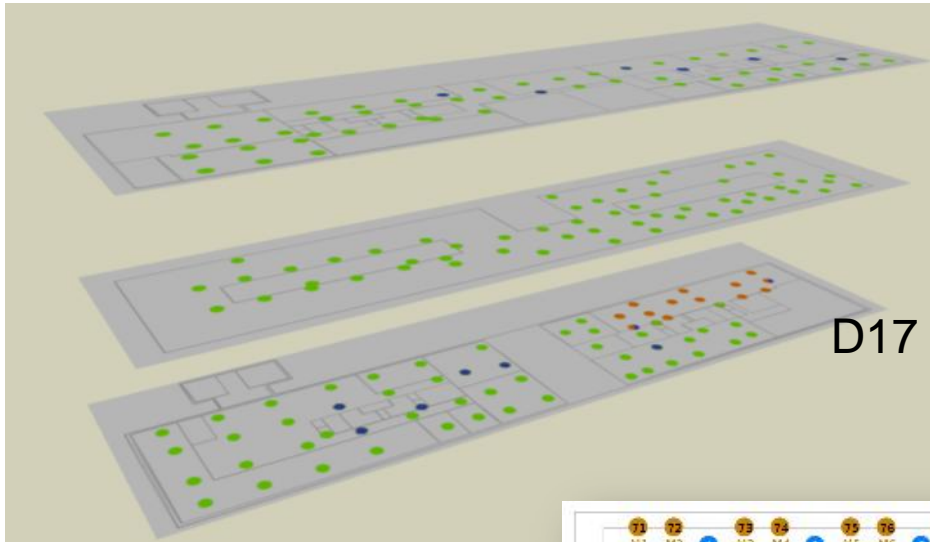
Node locations

- w-iLab.t Office (x200)
 - Node = Embedded PC + EE + Tmote Sky
- w-iLab.t Zwijnaarde (x60)
 - Node = Embedded PC + EE + RM090



Topology

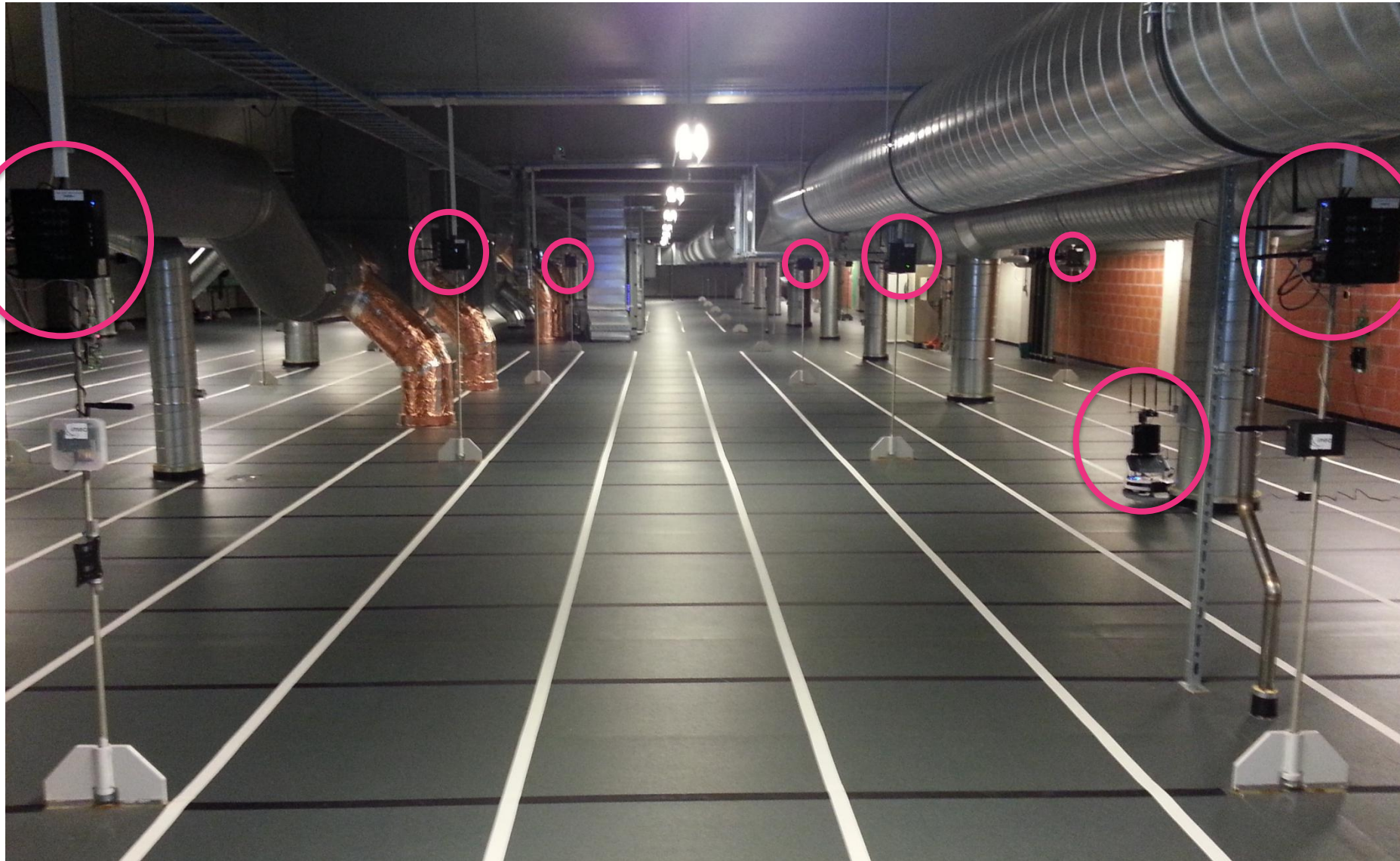
- w-iLab.t Office



- w-iLab.t Zwijnaarde



The w-iLab.t Zwijnaarde testbed

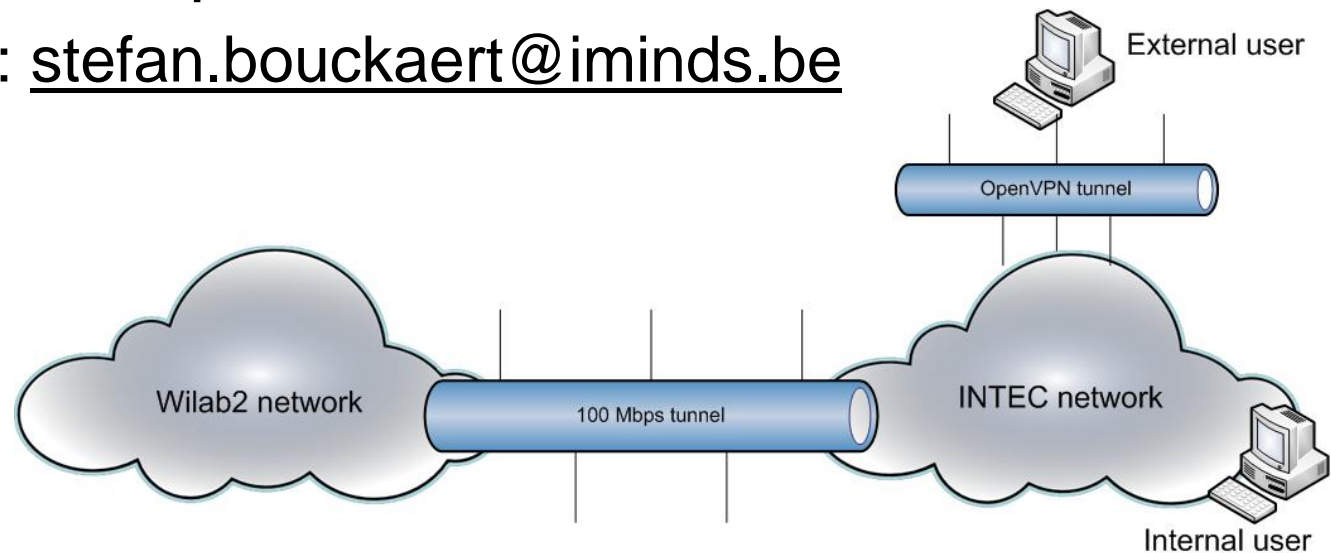


w-iLab.t

Testbed Architecture & Management

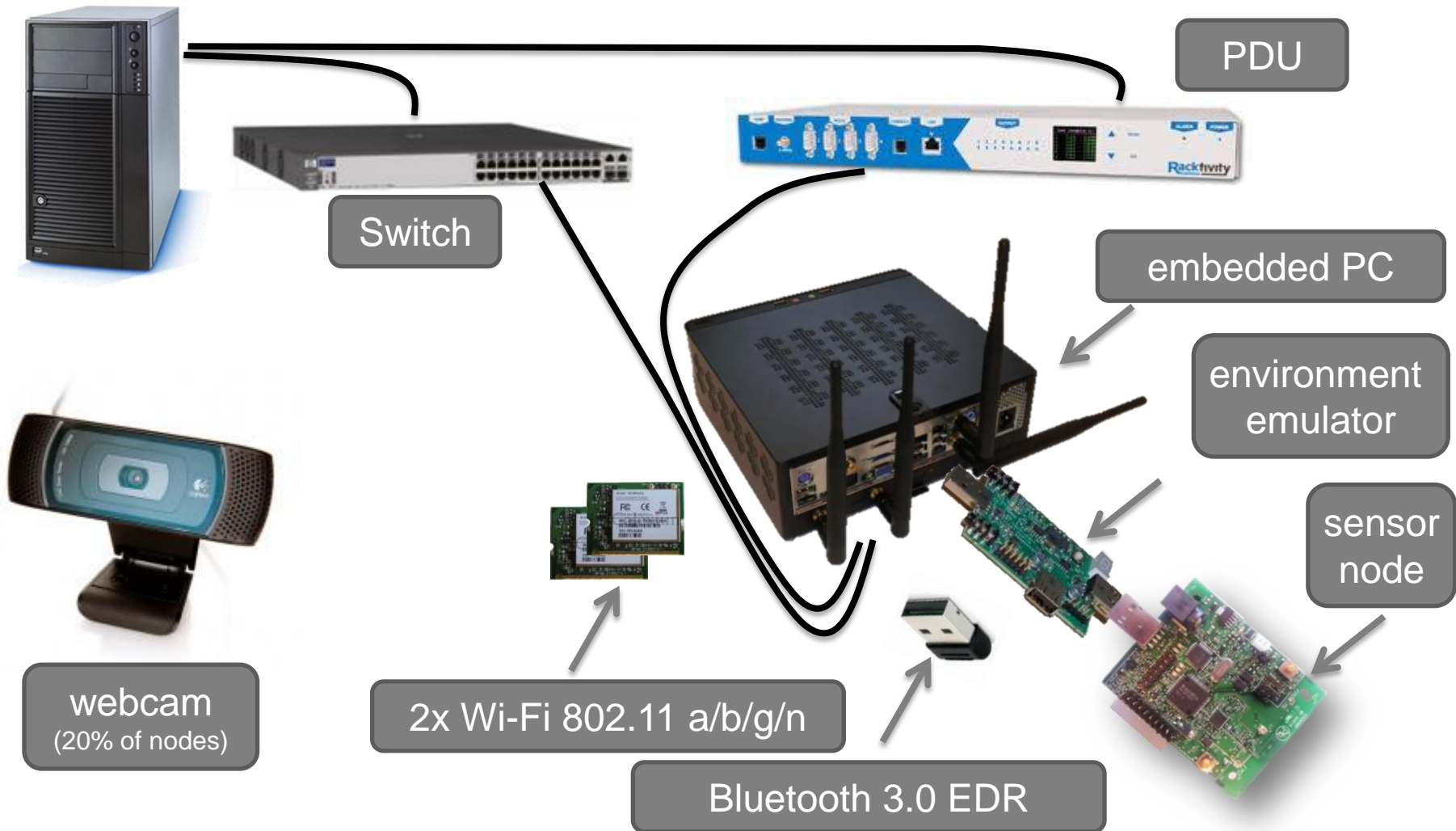
Network

- .wilab2.ilabt.iminds.be (10.11.16.0/20)
- OpenVPN required
 - mailto: stefan.bouckaert@iminds.be



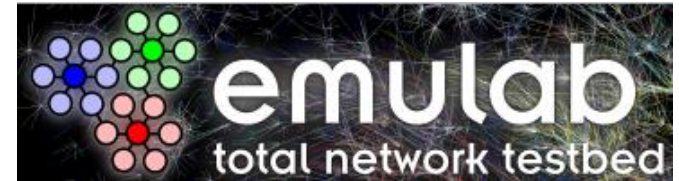
- Outgoing connections only over HTTP_PROXY
 - <http://proxy2.intec.ugent.be:8080>
- **IPv6 enabled** (no VPN needed)

Testbed Architecture



Management Framework & Tools

- Emulab (<http://emulab.net>)



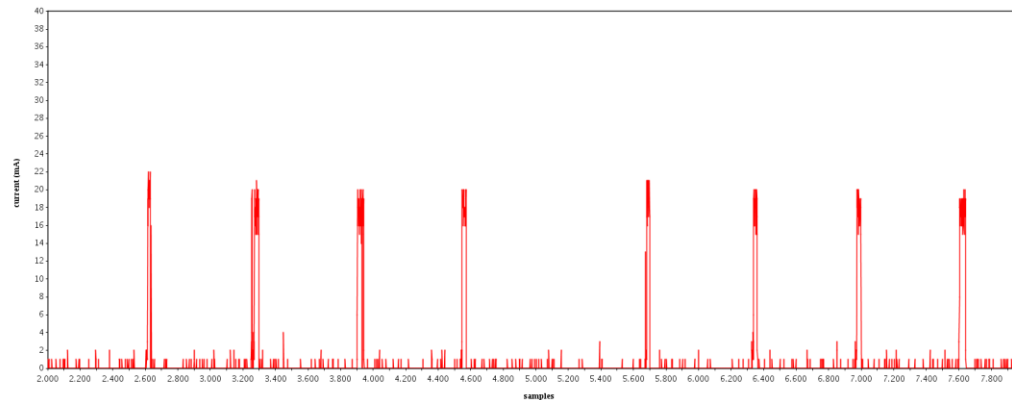
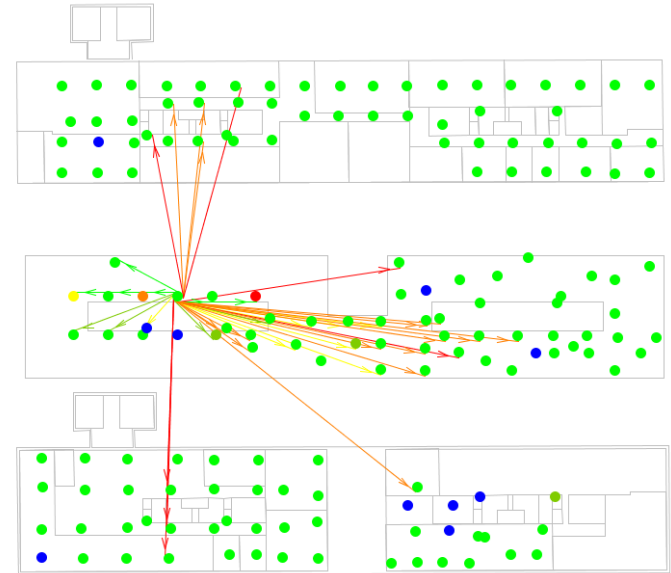
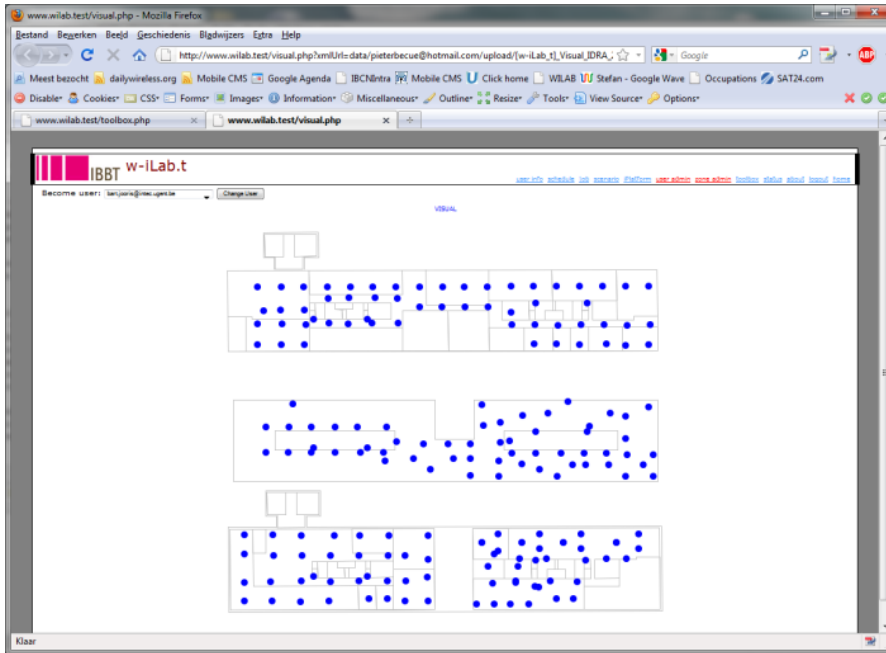
- OMF (<http://omf.mytestbed.net>)



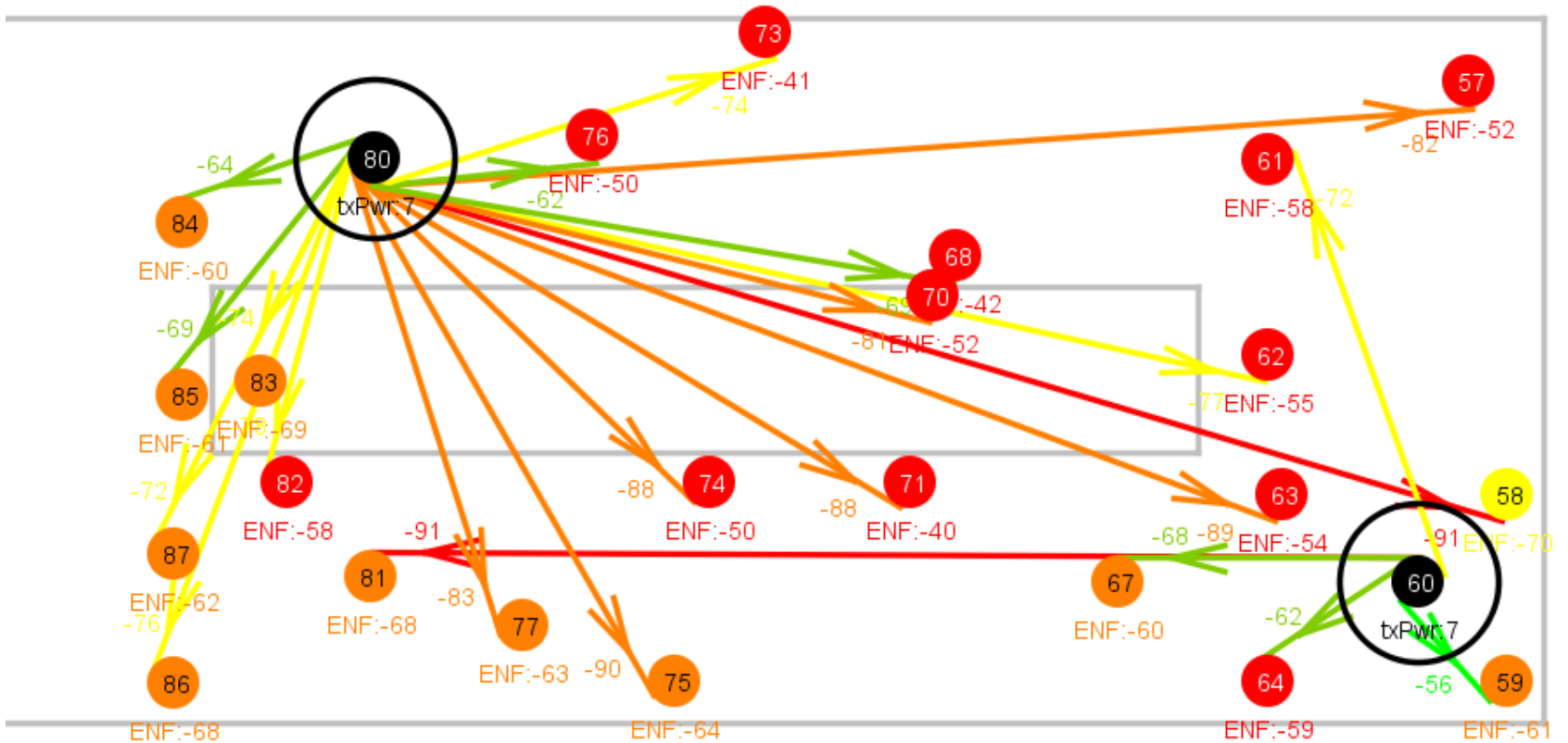
- OML for collecting measurements (<http://oml.mytestbed.net>)



Visualization toolbox



Tx power – RSSI - ENF



w-iLab.t

Testbed Hardware Extensions

Shielded testing environment

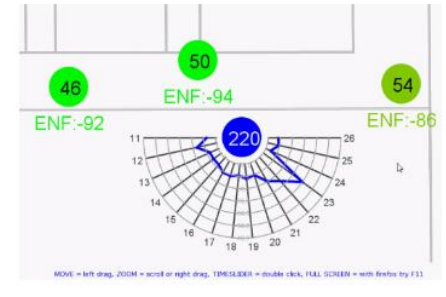


- shielded from outside interference
- coax connected
- variable attenuators
- emulate mobility



Cognitive components

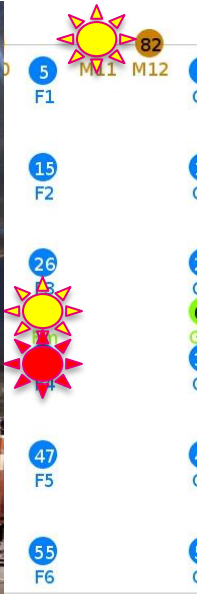
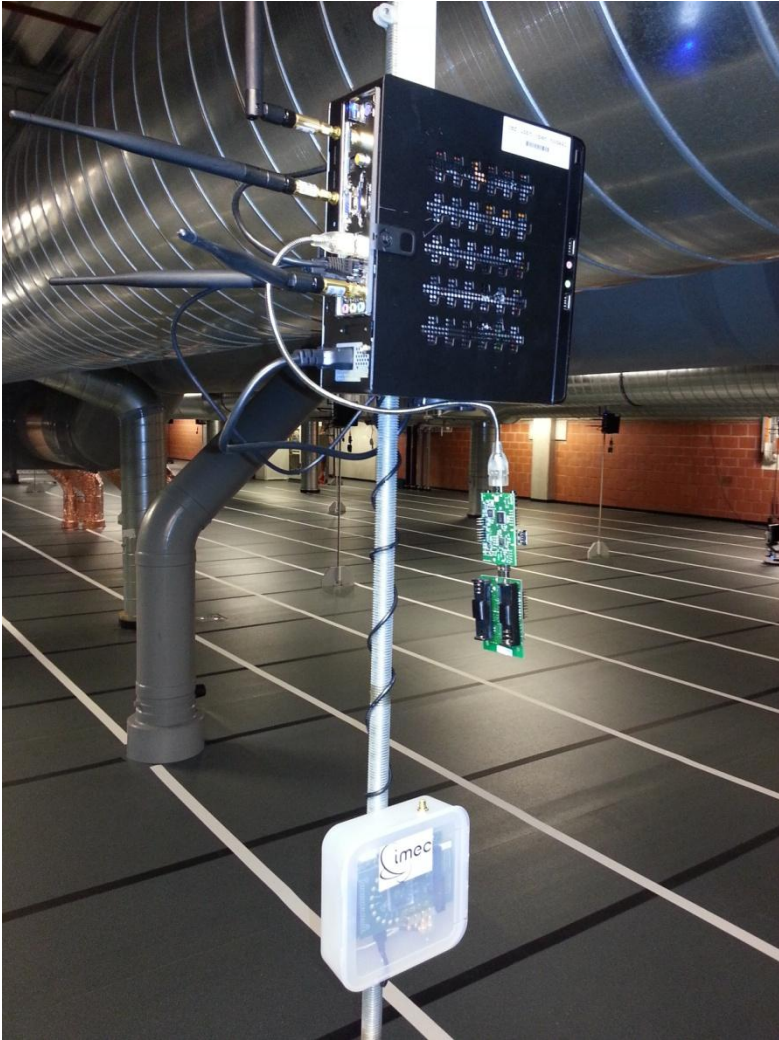
- imec sensing engine
- USRP2 (SDR radios)
- Rice WARP



Specifications available on
www.crew-project.eu/portal



Cognitive radio extions in w-iLab.t Zwijnaarde testbed



sensing er

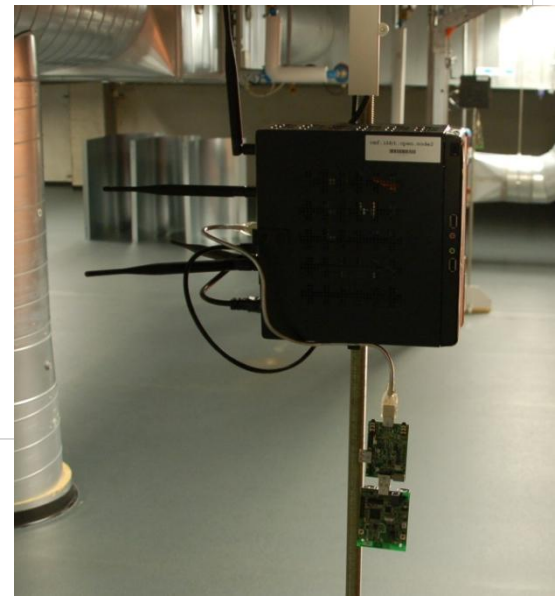
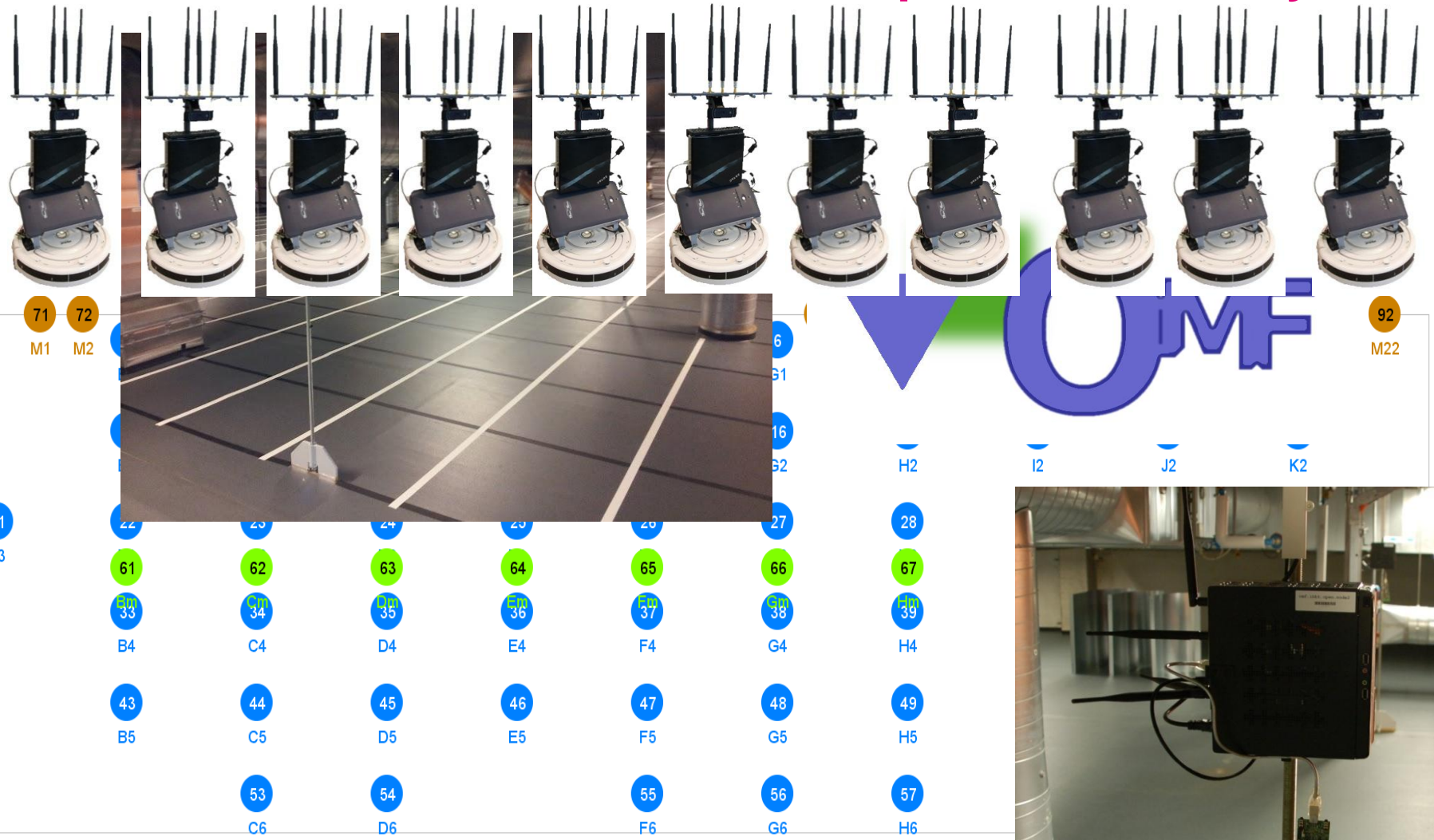
sensing er



32
L3

Mobility @ w-iLab.t

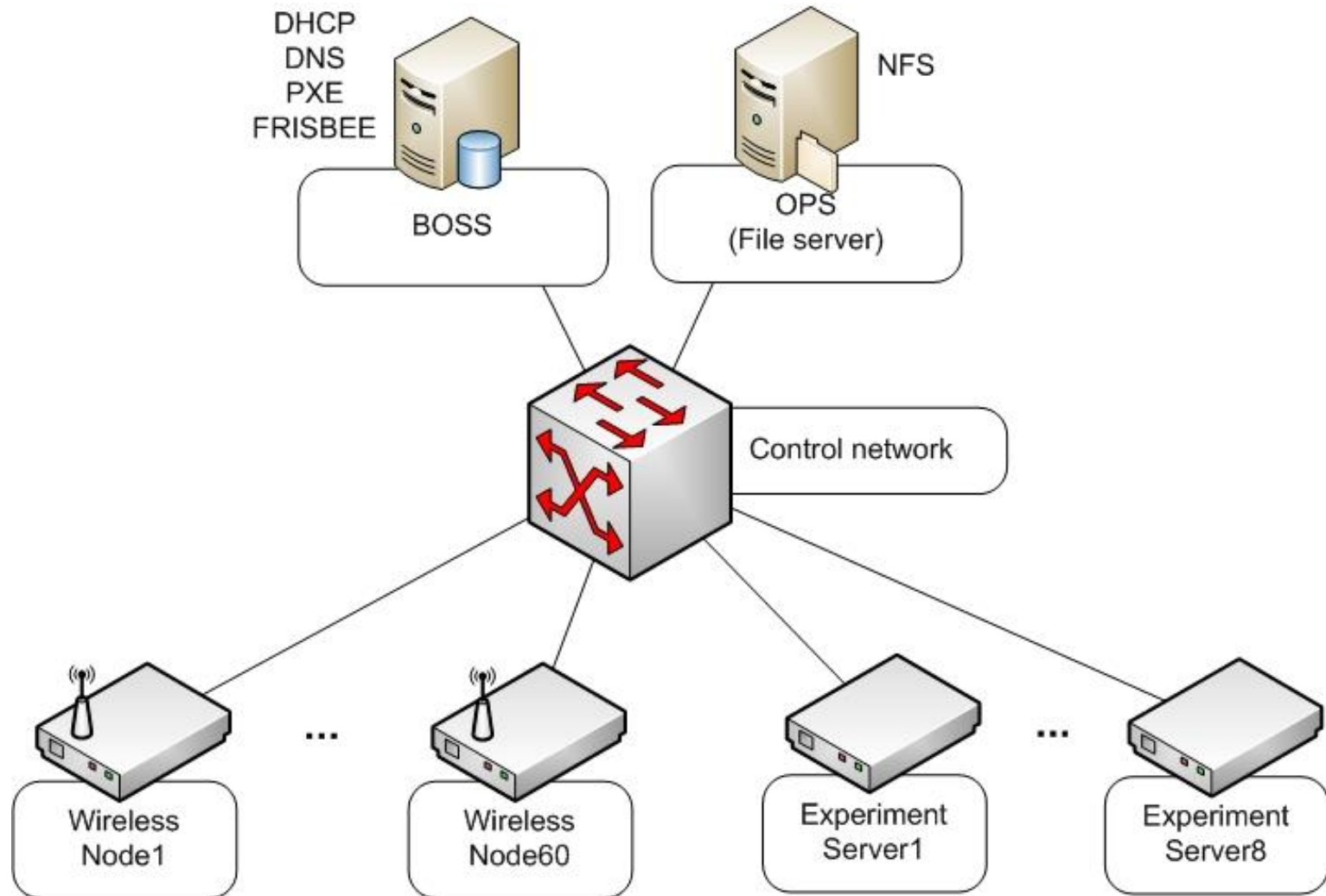
Easy-to-use
Repeatable mobility!



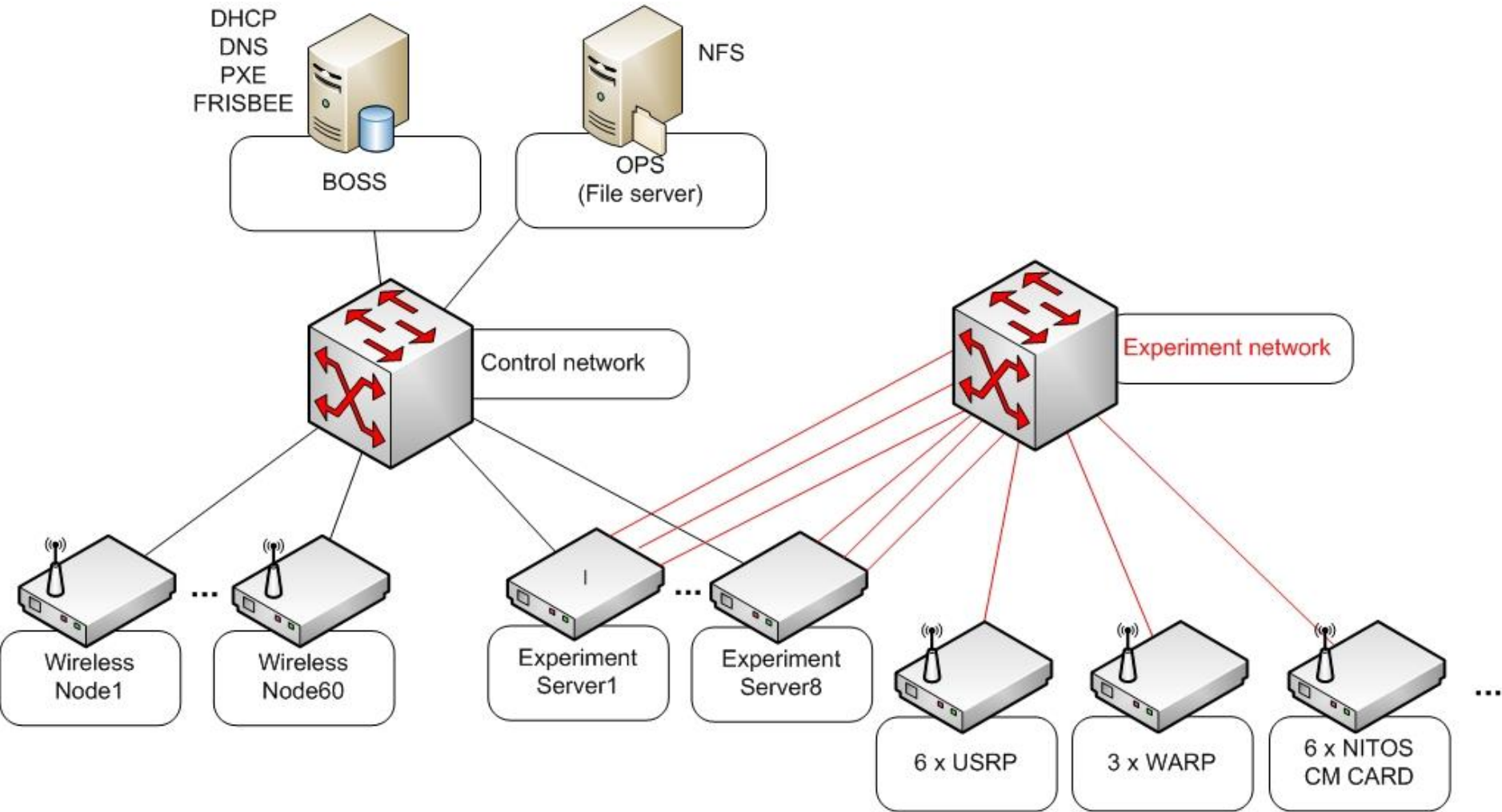
w-iLab.t

Emulab Introduction

Emulab install



Experiment Network



Emulab user-server (OPS)

- ops.wilab2.ilabt.iminds.be
 - Login with web-credentials
 - Or upload SSH pub key to your profile
 - NFS directories
 - /users/username (home-dir)
 - /proj/projectname (project home-dir)
 - **Accessible on all your nodes** during your experiment
 - Emulab projects are like UNIX groups
 - Everybody in same project can modify /proj/ directory

Swap in some Zotacs with the Emulab framework

First Emulab experiment

https://wilab2.ilabt.iminds.be

emulab
total network testbed

Information
Home
Utah Emulab
News
Documentation
Forums **New!**
Projects on Emulab

Search Documentation

or

Request a New Emulab Account

If you already have an Emulab account, **please log on first!**

[Join an Existing Project.](#)
or
[Start a New Project.](#)

If you are a **student (undergrad or graduate)**, please do not try to start a project!
Your advisor must do it.

[Flux Research Group] [School of Computing] [University of Utah]
Copyright © 2000-2013 The University of Utah

Built With
Emulab

■ Request Account

- Start your own project or
- Join Existing project :
 - cognitiveradio
 - GreenWeCan
 - QoCON
 - Wings

Log in

- User : crew
- Pass : training@wilab2

Create experiment

- iperf_group**X**
- X : 1 .. 10

Create a new Experiment (New GUI editor)

The screenshot shows the top navigation bar of the Emulab website. It includes links for 'My Emulab', 'Logout', 'News', and 'Contact Us'. A search bar for 'Documentation' is present with a 'Go' button. A 'Current Experiments' summary box shows 3 Active, 2 Idle, and 16 Swapped experiments. A dropdown menu is open under 'Experimentation', listing options like 'My Emulab', 'Begin an Experiment', 'Experiment List', 'Node Status', 'List ImageIDs', 'Start New Project', and 'Join Existing Project'. Below the menu are tabs for 'Experiments', 'Projects', and 'Profile'. A user profile section displays the following information:

Username:	pbecue (10002)
Full Name:	Pieter Becue
Email Address:	pieter.becue@intel.com

The screenshot shows the 'Begin a Testbed Experiment' page. The header includes the Emulab logo ('total network testbed') and the same navigation bar as the previous screenshot. The main content area contains the following instructions:

- **If you have an NS file:**
You may want to [syntax check it first](#)
- **If you do not have an NS file:**
[New GUI editor](#) - An enhanced Java applet for editing topologies. ([ProtoGeni Version - What's ProtoGeni?](#))
The older [NetBuild GUI](#) can be used to graphically create topologies. ([Additional information](#)).

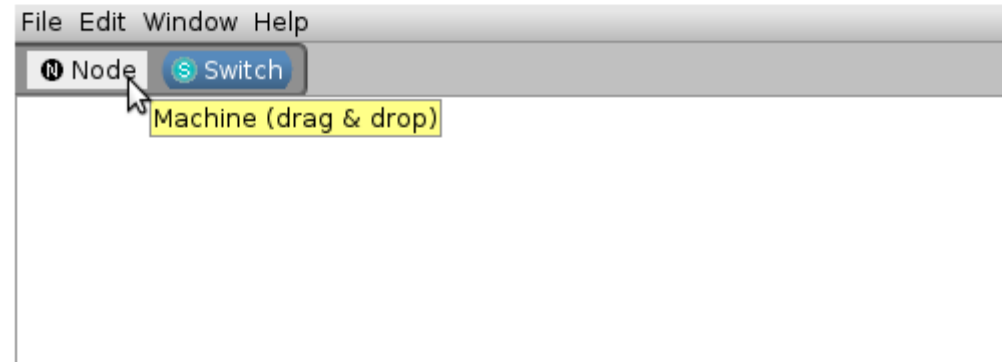
At the bottom of the page, there are two form fields:

Select Project:	Please Select ▾
Group:	Default Group ▾ (Must be default or correspond to selected project)

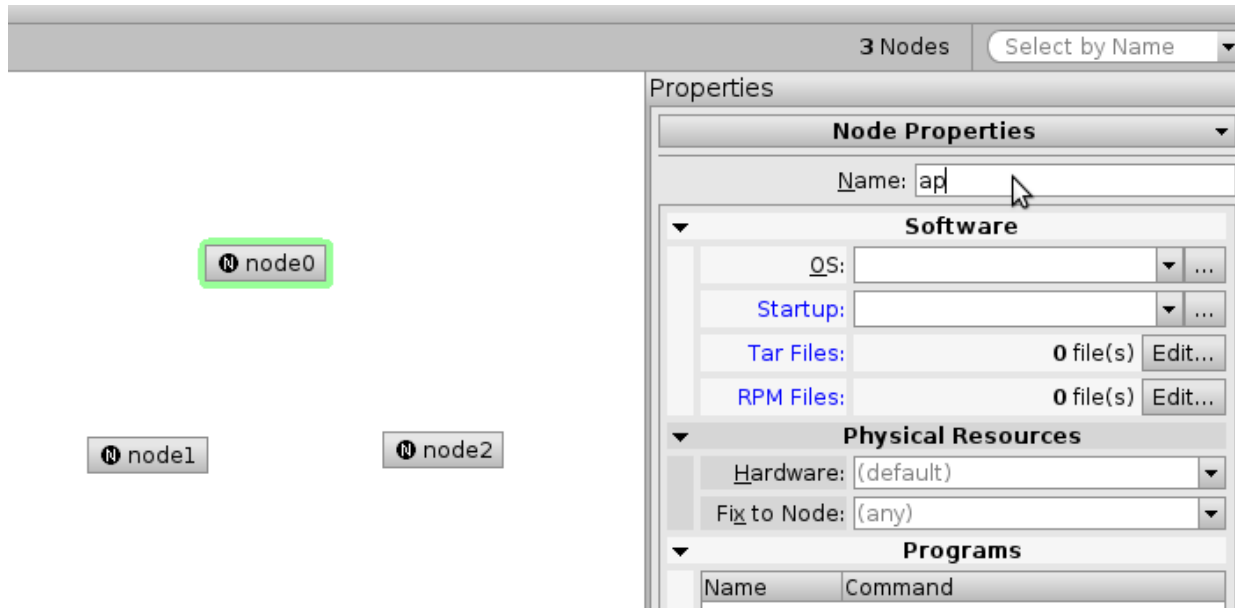
Click & drag some nodes into the white field

Experiment Creation GUI

Note: See the Help menu for quickstart and tips

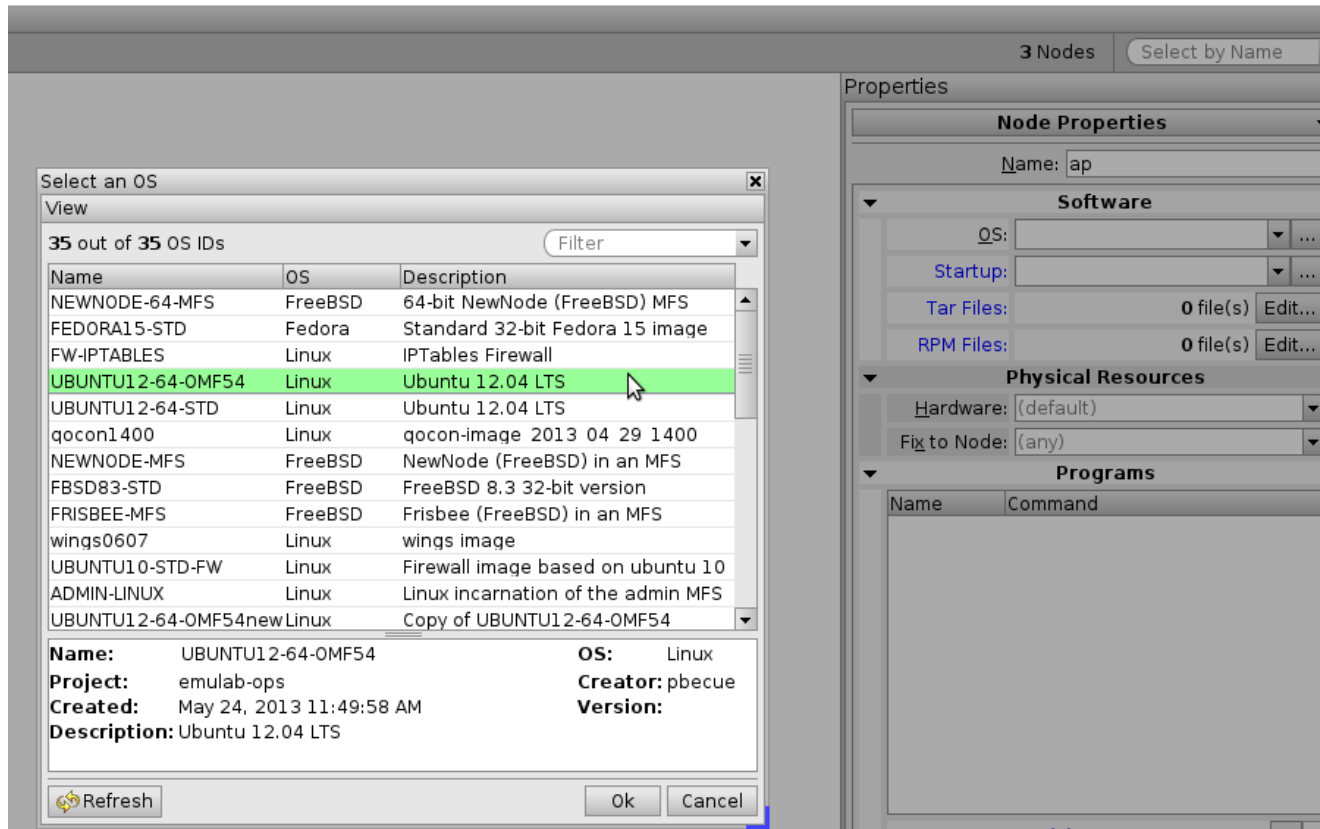


Select a node and give it a name



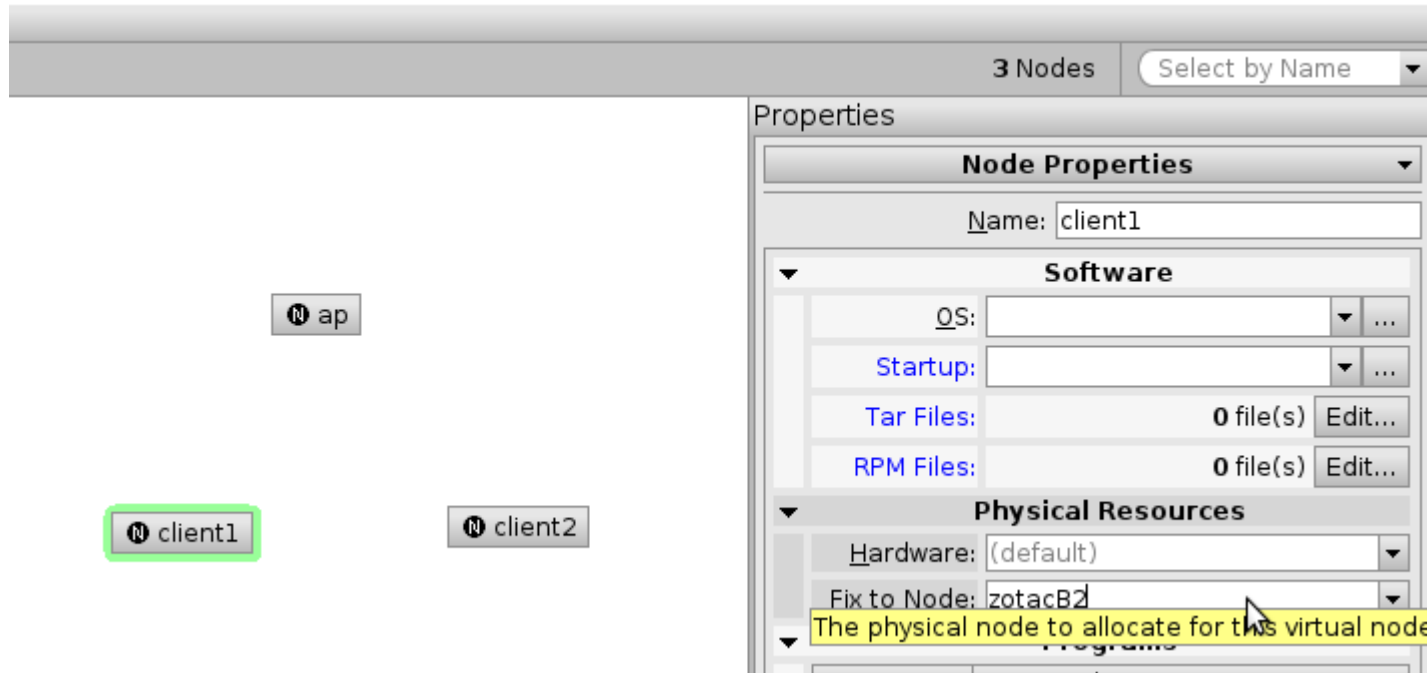
- This will be the DNS name of your node :
 - nodeName.experiment.project.wilab2.ilabt.iminds.be
- Name should be **different** from physical node ID (like zotacB2)
- **Do NOT** draw any link between the nodes

Select an OS (click on ...)



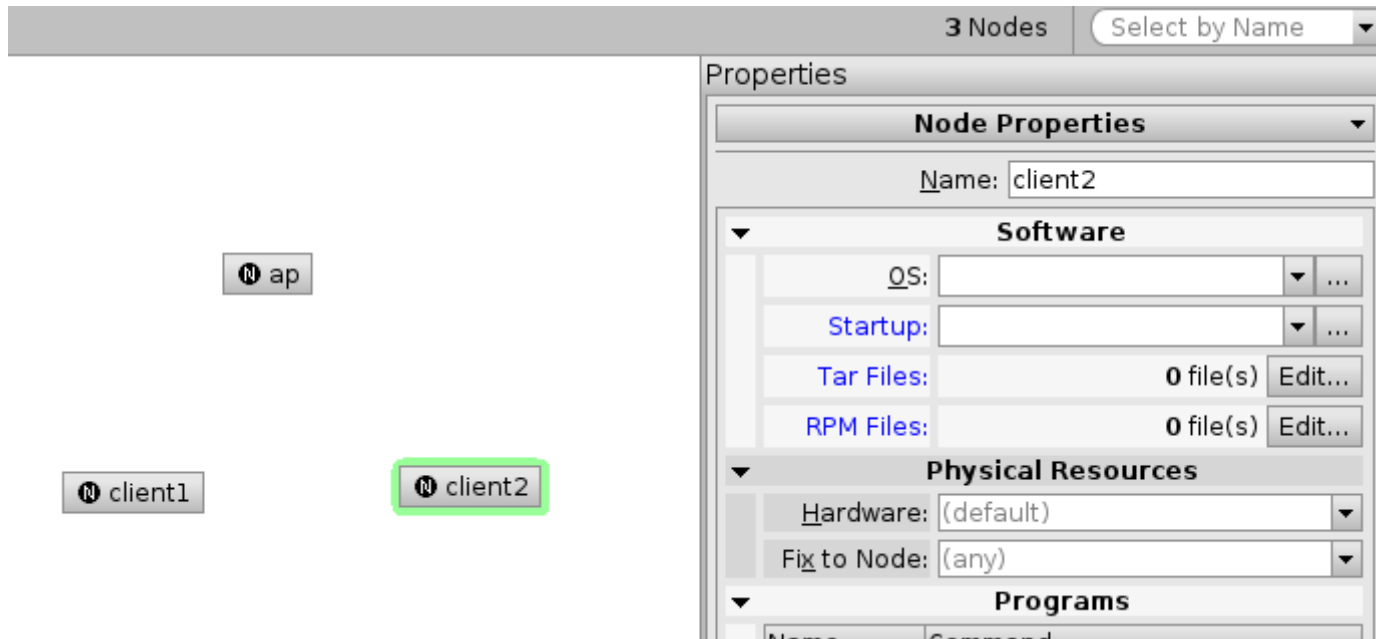
- UBUNTU12-64-OMF54 is the **default** image
- Leave the OS field **blank** if you want to use this default image, else choose one from the list.

Fill in the Fix to Node field if you want to use a specific node



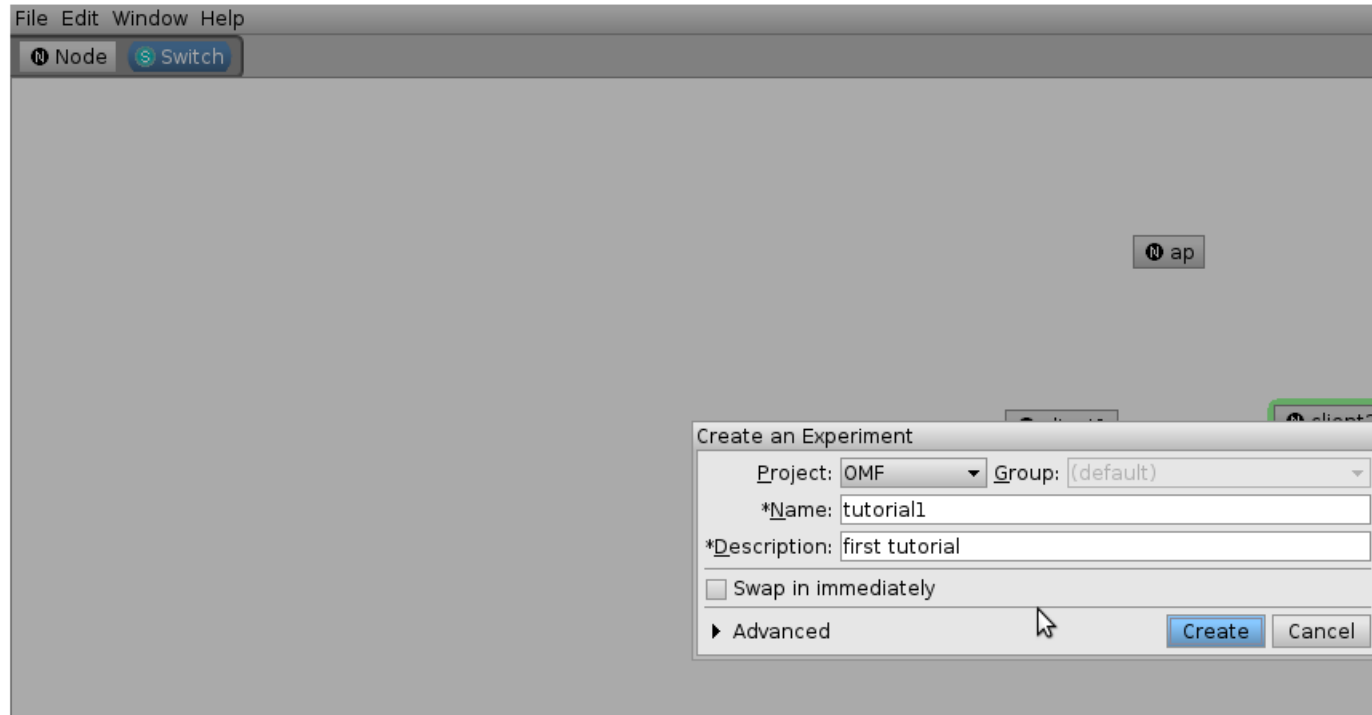
- If this field is left **blank**, Emulab will choose a **random** node for you
- See the w-iLab.t 2 map for the node ID's (e.g. zotacH4)

Leave everything blank if you want :



- Default OS will be loaded (UBUNTU12-64-OMF54)
- Emulab will choose random node

Click File > Create New Experiment



- Choose project , Name and description
- Click **Create**

Experimentation > Experiment List

total network testbed Information Experimentation 17 Swapped

Experiment (OMF/tutorial1)

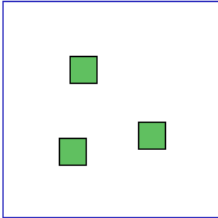
Settings Visualization NS File Details

Experiment Options

- [View Activity Logfile](#)
- [Swap Experiment In](#)
- [Terminate Experiment](#)
- [Modify Experiment](#)
- [Modify Settings](#)
- [Show History](#)
- [Duplicate Experiment](#)

52 Free PCs, 0 reloading

ZOTAC	48	SERVER5P	3
SERVER1P	1	USRP	6
WARP	0	ALIX	0



Name:	tutorial1
Description:	first tutorial
Project:	OMF
Group:	OMF
Creator:	pbecue
Created:	2013-06-12 10:30:41
Last Swap/Modify:	2013-06-12 10:30:49 (pbecue)
Idle-Swap:	Yes (after 4 hours)
Max. Duration:	Yes (after 16 hours)
Save State:	No
Path:	/proj/OMF/exp/tutorial1
Status:	swapped
Linktest Level:	0
Min/Max Nodes:	3/3 (estimates)
Virtual Nodes:	Unknown
Mem Usage Est:	0
CPU Usage Est:	3
Locked Down:	No (Toggle)
Skip Vlans:	No (Toggle)
Sync Server:	ap
Index:	71

- Select your experiment
- Click **Swap Experiment in**

Experiment List

Experiment Information Listing

Show: Active, [Batch](#), [All](#)

View: List, [Detailed Thumbnails](#), [Brief Thumbnails](#)

Active Experiments

PID	EID	PCs [1]	Hours Idle [2]	Description	Creator/ Swapper
OMF	tutorial1	3	0?	first tutorial	pbecue (iMinds)

1. **Red** indicates nodes other than PCs. A * mark by the node count indicates that the experiment is currently considered idle. The number of local pcs is indicated in the parens.
2. A ? indicates that the data is stale, and at least one node in the experiment has not reported on its proper schedule.

Node Totals

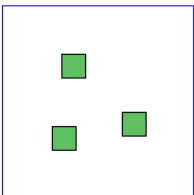
pc:	3
	-
Total:	3

Experiment (OMF/tutorial1)

Experiment Options

[View Activity Logfile](#)
[Cancel Experiment Swapin](#)
[Terminate Experiment](#)
[Modify Settings](#)
[Run LinkTest](#)
[Show History](#)
[Duplicate Experiment](#)

49 Free PCs, 0 reloading
ZOTAC/45 SERVER5P/3
SERVER1P/1 USRP/6
WARP/0 ALIX/0



- **View Activity Logfile** to check swap-in/out progress
- <http://www.wilab2.ilabt.iminds.be/reservation>

If everything goes well : Swap Success

Experiment Activity Log

Experiment **OMF/tutorial1**

Done!

```
reboot (zotacI5): Successful!
reboot: Done. There were 0 failures.
reboot (zotacC2): child returned 0 status.
reboot (zotacB2): child returned 0 status.
reboot (zotacI5): child returned 0 status.
Waiting for nodes ...
zotacB2 has reported state ISUP
Checking for feature OsloadFailNonfatal.
zotacB2 is alive and well
*** os_setup: Still waiting for zotacC2 (TBSETUP) - it's been 1 minute(s).
zotacC2 has reported state ISUP
Checking for feature OsloadFailNonfatal.
zotacC2 is alive and well
zotacI5 has reported state ISUP
Checking for feature OsloadFailNonfatal.
zotacI5 is alive and well
Asking [pc] for volunteers
TIMESTAMP: 10:32:53:810170 os_setup finished
Starting the event system.
TIMESTAMP: 10:32:53:820062 eventsys_control started
Checking for feature NewEventScheduler.
TIMESTAMP: 10:32:56:434046 eventsys_control finished
Establishing proxy TCP ports...
TIMESTAMP: 10:32:56:641935 Starting event time
Successfully finished swap-in for OMF/tutorial1. 10:32:56:650141
TIMESTAMP: 10:32:56:650827 tbswap in finished (succeeded)
Running 'tbreport -b OMF tutorial1'
Doing a savepoint on the experiment archive ...
Swap Success!
```

Click **Details** to see DNS names and physical node mapping

[Settings](#)
[Visualization](#)
[NS File](#)
[Details](#)

```

Experiment: OMF/tutorial1
State: active



Virtual Node Info:
ID          Type      OS          Qualified Name
-----
ap          pc        UBUNTU12-64-OMF54  ap.tutorial1.OMF.wilab2.ilabt.iminds.be
client1 (zotacB2) ZOTAC    UBUNTU12-64-OMF54  client1.tutorial1.OMF.wilab2.ilabt.iminds.be
client2    pc        UBUNTU12-64-OMF54  client2.tutorial1.OMF.wilab2.ilabt.iminds.be

Physical Node Mapping:
ID          Type      OS          Physical
-----
ap          ZOTAC    UBUNTU12-64-OMF54  zotacI5
client1    ZOTAC    UBUNTU12-64-OMF54  zotacB2
client2    ZOTAC    UBUNTU12-64-OMF54  zotacC2
    
```

Show Events




Save to File

Reserved Nodes

Node ID	Name	Type	Default OSID	Node Status	Hours Idle[1]	Startup Status[2]	SSH	Console	Log
zotacB2	client1	ZOTAC	UBUNTU12-64-OMF54	up	0	none			
zotacC2	client2	ZOTAC	UBUNTU12-64-OMF54	up	0	none			

Click on a node you want to check

Reserved Nodes

Node ID	Name	Type	Default OSID	Node Status	Hours Idle[1]	Startup Status[2]	SSH	Console	Log
zotacB2	client1	ZOTAC	UBUNTU12-64-OMF54	up	0	none			
zotacC2	client2	ZOTAC	UBUNTU12-64-OMF54	up	0	none			
zotacI5	ap	ZOTAC	UBUNTU12-64-OMF54	up	0	none			

- Show boot log, create disk image, Reboot node

Node zotacI5

Node Options

- [SSH to node \(howto\)](#)
- [Edit Node Info](#)
- [Update Node](#)
- [Reboot Node](#)
- [Show Boot Log](#)
- [Create a Disk Image](#)
- [Show Node Log](#)
- [Show Node History](#)
- [Set Node Location](#)
- [Update Power State](#)
- [Modify Node Attributes](#)

Node ID:	zotacI5
Virtual Name:	ap
Project:	OMF
Experiment:	tutorial1
Node Type:	ZOTAC
Def Boot OS:	UBUNTU12-64-OMF54
EventState:	ISUP (2013-06-12 10:32:44)
Operating Mode:	NORMALv2 (2013-06-12 10:31:42)
AllocState:	RES_READY (2013-06-12 10:32:48)
Last Activity:	2013-06-12 10:32:34

List image ID's to see all images you can use in your project

total network testbed Information Experimentation 2 idle 16 Swapped

Image Search

More Options
[Create an Image Descriptor](#)
[More info on Images](#)

Find images th
 Find images w
 Search name a

My Emulab
 Begin an Experiment
 Experiment List
 Node Status
List ImageIDs
 Start New Project
 Join Existing Project

Search Comma sep
 Search Comma sep
 Search Plain text, c

There are 16 matching images.

Image	PID	Description
DEB60-STD	emulab-ops	Debian Squeeze 32bit
DEB60_64-STD	emulab-ops	Debian Squeeze 64bit
FBSD83-64-STD	emulab-ops	FreeBSD 8.3 64-bit version
FBSD83-STD	emulab-ops	FreeBSD 8.3 32-bit version
FEDORA15-64-STD	emulab-ops	Standard 64-bit Fedora 15 image
FEDORA15-OPENVZ-STD	emulab-ops	Fedora15 with OpenVZ
FEDORA15-STD	emulab-ops	Standard 32-bit Fedora 15 image
openWRT	testbed	openWRT transfered from old setup
qocon1400	testbed	qocon-image_2013_04_29_1400
UBUNTU10-STD-FW	emulab-ops	Firewall image based on ubuntu 10
UBUNTU12-64-OMF54	emulab-ops	Ubuntu 12.04 LTS with OMF5.4 support
UBUNTU12-64-OMF54new	testbed	Copy of UBUNTU12-64-OMF54
UBUNTU12-64-STD	emulab-ops	Ubuntu 12.04 LTS
UBUNTU12-OMF54-USRP	emulab-ops	UBUNTU12-64-OMF54 with USRP software
WIN7SP1-STD	emulab-ops	Windows 7 SP1 - 32bit (no activation, 30days)
wings0607	testbed	wings image

w-iLab.t

OMF Introduction



OMF Tutorial

Thierry Rakotoarivelo

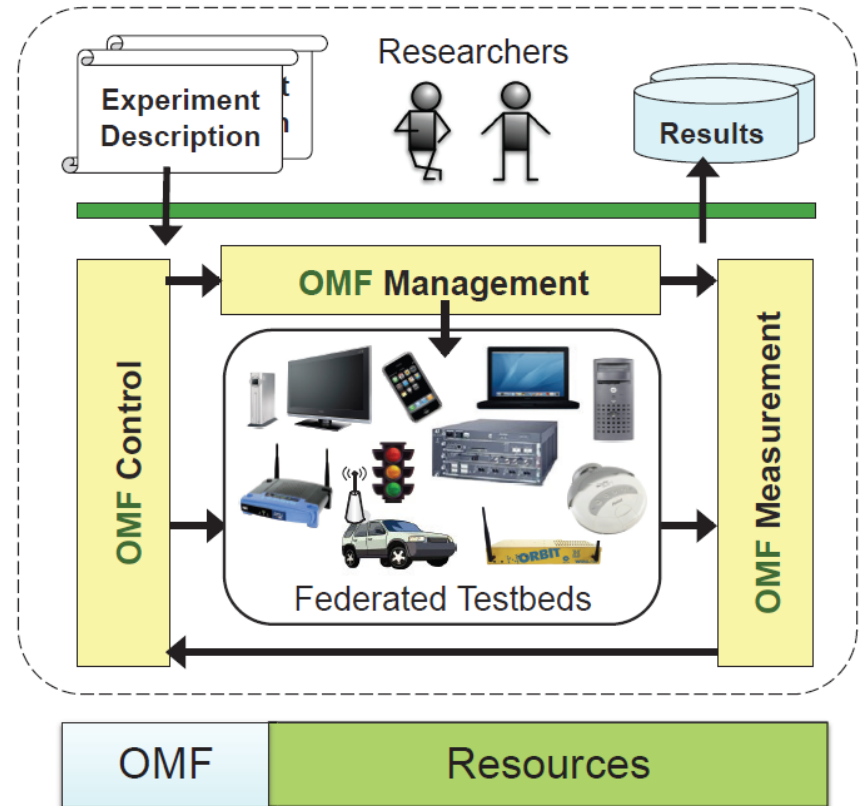
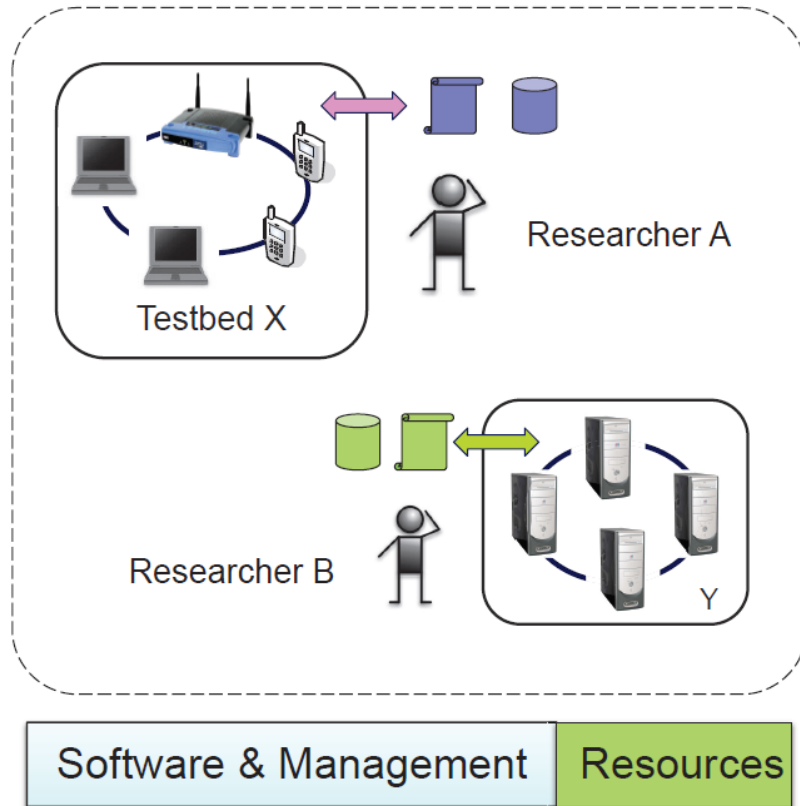


Australian Government
Department of Broadband, Communications
and the Digital Economy
Australian Research Council

NICTA Funding and Supporting Members and Partners



The Problem and Our approach



Support & share different resources
Federation of different testbeds

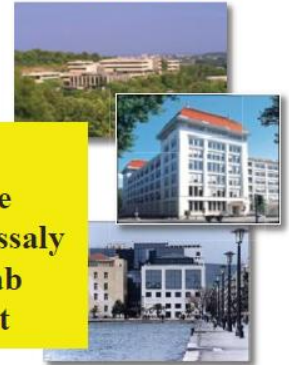
OMF deployment worldwide



**Rutgers University,
New Jersey**



**Europe
INRIA, France
University of Thessaly
Technicolor Lab
el-Lucent**



PlanetLab

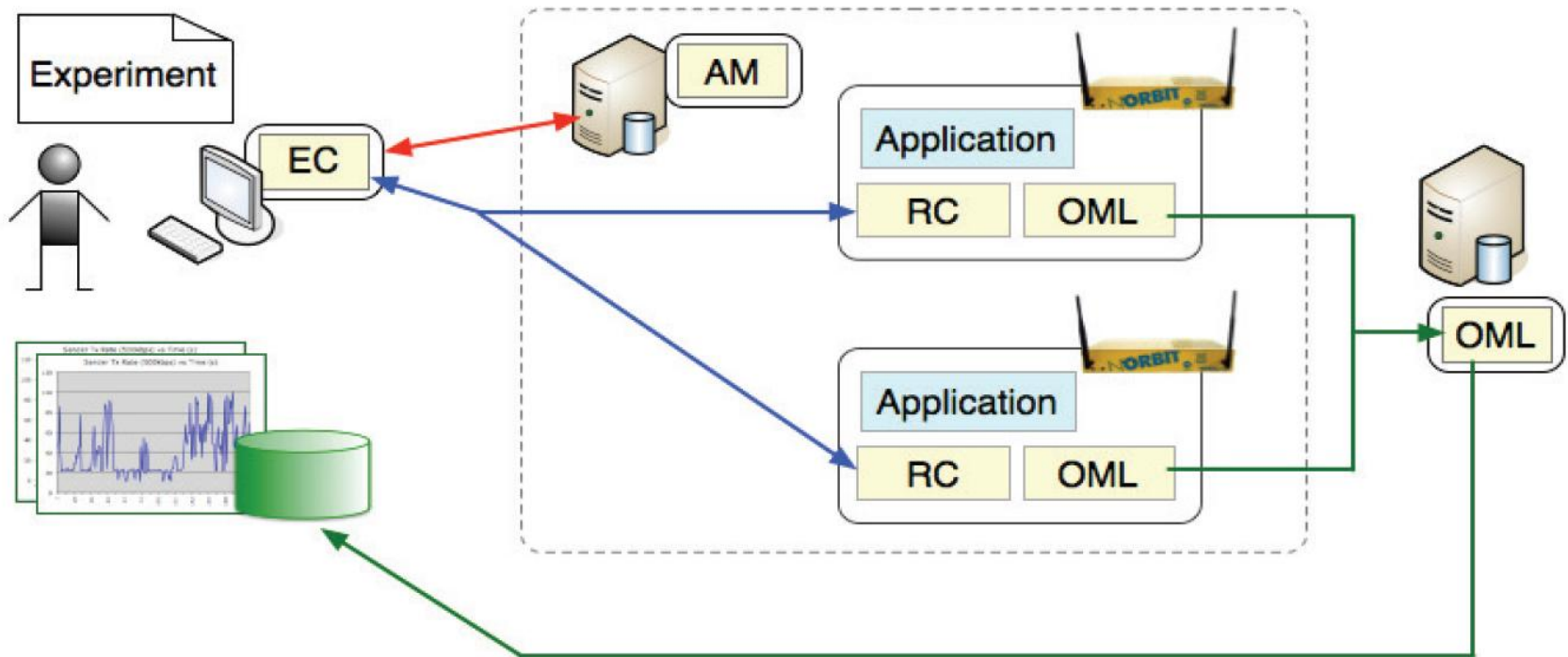
erry Rakotoarivelo



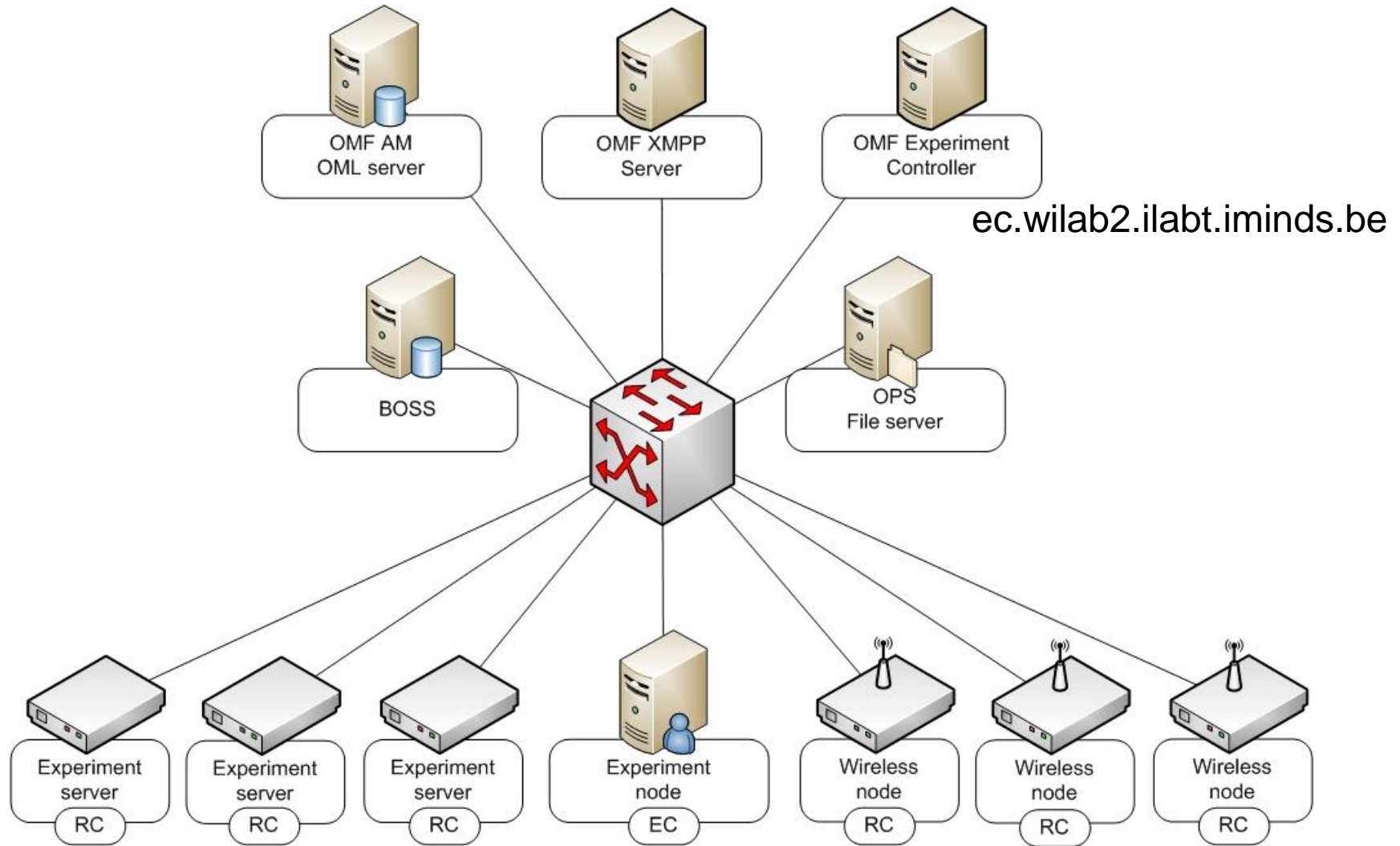
**iMinds
ILAB.T**

**NICTA, Sydney
Bridge Deployment**

How it works from a user's perspective?



OMF Setup @ w-iLab.t Zwijnaarde

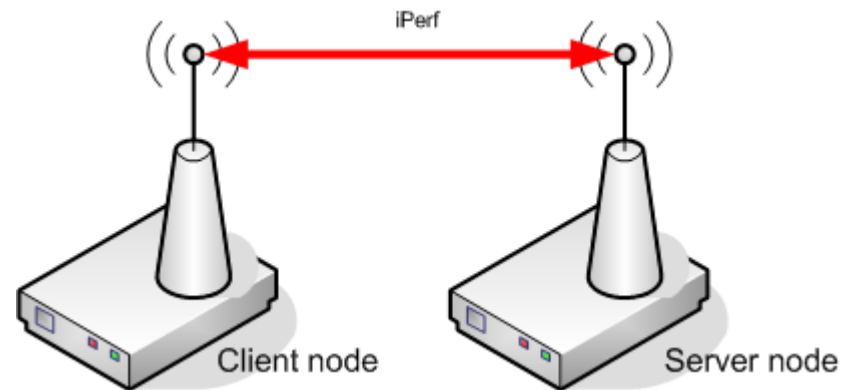


w-iLab.t

OMF Tutorial – Step by step

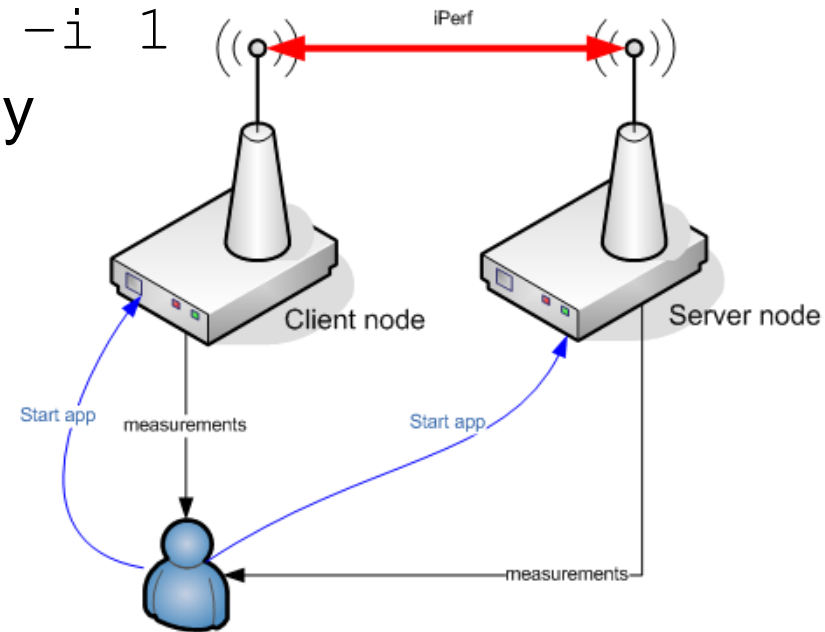
Running basic OMF Experiments: demo case

Goal: Test throughput of Wi-Fi using iPerf



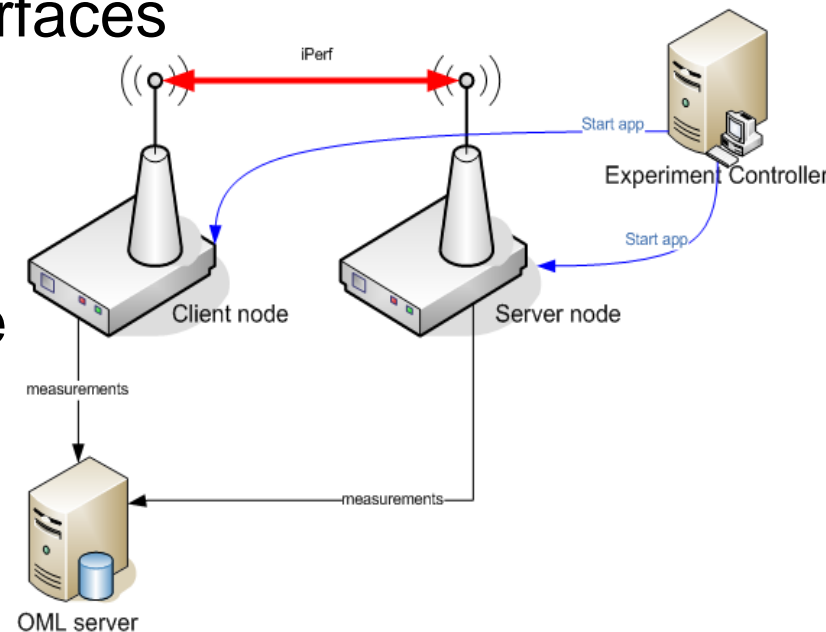
Running basic OMF Experiments: manual approach

1. ssh to the server
2. set up wireless interface
3. start serverside application with `iperf -s -u`
4. ssh to the client
5. set up wireless interface and connect it to the server
6. start clientside application with: `iperf -c [serverip] -u -b 1000M -i 1`
7. collect measurements manually



Running basic OMF Experiments: the OMF way

1. ssh to the experiment controller
2. write an **application definition**
 - where can OMF find iPerf?
 - what are valid commandline arguments?
 - what is the output of iPerf? (wrapper/native)
3. write an **experiment description**
 - configuration of wireless interfaces
 - which nodes?
 - timeline of the experiment
4. execute the experiment
5. read measurements in database



Running basic OMF Experiments



Experiment Definition



Application Definition



Application

`/usr/bin/iperf`

Using a wrapper



Experiment Definition



Application Definition

On the resource



Wrapper script
(parses output of iPerf for measurements)



Application

`/usr/bin/iperf`

Running basic OMF Experiments



Experiment Definition

```
defGroup("ap", "ap.exp1.crew.wilab2.ilabt.iminds.be")  
  <config wireless interface>  
  <add application(s)>  
defGroup("client", "client.exp1.crew.wilab2...")  
  <config wireless interface>  
  <add applications(s)>
```

```
defApplication('iperfwrap', 'iperfwrap')
```

```
onEvent(:ALL_UP_AND_INSTALLED) do |event|  
  info "iPerf experiment - wait for interfaces to come  
  up"  
  wait 5  
  group("ap").startApplications  
  info "Starting stream 1 server..."  
  wait 2  
  info "Starting stream 1 client..."  
  group("client").startApplications  
  wait 60  
  group("client").stopApplications  
  group("ap").stopApplications  
  Experiment.done  
end
```



Application Definition



Wrapper script
(parses output of iPerf for measurements)



Application

/usr/bin/iperf

Running basic OMF Experiments



Experiment Definition



Application Definition

```
defApplication('iperfwrap', 'iperfwrap') do |app|
  app.path = File.join(File.dirname(__FILE__), 'iperfwrap.rb')
  app.appPackage = "iperfwrap.tar"

  app.shortDescription = "iPerf wrapper"
  app.description = "Simple iPerf wrapper with OML logging"

  app.defProperty('server', 'Act as server (true/false)', 's', ...)
<more properties>

  # the measurement definition
  app.defMeasurement('iperfmp') do |mp|
  <metrics: i.e. the fields in every record in the database>
  end
end
```



Wrapper script
(parses output of iPerf for measurements)



Application

/usr/bin/iperf

Running basic OMF Experiments



Experiment Definition



Application Definition



Wrapper script

(parses output of iPerf for measurements)

```
require "/usr/share/liboml2-dev/oml4r.rb"  
APPPATH = "/usr/bin/iperf"  
  
class MPStat < OML4R::MPBase  
  name :iperfmp  
  param :hostname  
  param :interval_begin, :type => :double #sec  
  param :interval_end, :type => :double #sec  
  <other metric definitions>  
  
end  
  
<logic to pass commandline args to iperf>  
<logic to parse output and generate OML>
```



Application

/usr/bin/iperf

Run it!

- ssh to ec.wilab2.ilabt.iminds.be (login on sheets)
- `cd/users/crew/`
- `mkdir groupX`
- `cp iperf/* groupX/`
- modify resource names !
- modify mode, channel and essid (see sheets)
- run the experiment using
`omf exec iperfED.rb`
- See measurements on
<http://am.wilab2.ilabt.iminds.be/phppgadmin>

The w-iLab.t testbed

details:
<http://ilabt.iminds.be/>

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