Experimentation in Heterogeneous European Testbeds through the Openlab Facility: The case of PlanetLab federation with the wireless NITOS Testbed

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Introduction

➢ The Need:
the existence of experimental network facilities featuring heterogeneous resources is required for testing implemented schemes under real world settings.

➢ The Key idea:
Federation of existing network testbeds.

➢ Our Solution:
through Openlab project, we develop a federated environment that utilizes both wireless and wired infrastructure.
Outline

- Testbed Federation
- Research Scenario
- Federation Framework
- Experimental Setup
- Experimental Evaluation
- Insights and Future work
Testbed Federation

Federation between heterogeneous testbeds introduces several issues that arise due to:

- the difference in the nature of experimental resources,
- the use of different software frameworks for resources management and controlling.

In this work, the federation between two inherently heterogeneous testbeds has been made possible, due to:

- The utilization of a common experiment control framework OMF (cOntrol and Management Framework)
- and the adoption of the slice abstraction.
Testbed Federation

- Through the resulting setup, a researcher can utilize the Openlab facilities to run experiments, using resources of:
  - NITOS Wireless Testbed to reserve wireless nodes
  - Planetlab Europe Testbed to reserve wired nodes
NITOS Testbed

- NITOS is a large-scale outdoor deployed wireless testbed that currently consists of 50 wireless nodes and several other platforms:
  - USRP nodes
  - MIMO enabled nodes
  - Sensor nodes
  - Openflow switches

- NITOS has adopted OMF as its testbed control and management framework.
Planetlab Europe Testbed

- PlanetLab Europe is the European portion of the publicly available PlanetLab testbed, offering a total of 1000+ nodes worldwide.
- Did not support OMF!
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In IEEE 802.11 WLANs, each station (STA) has to first associate with an access point (AP), before it can start transmitting data to other nodes in the network.

IEEE 802.11 standard defines **RSSI – based Association Policy**

A STA simply selects the AP from which it has received the strongest signal during the scanning process.
We decided to implement the following research scenario:

- The wireless STA decides about its association based on the end-to-end delay on both the wired and the wireless part.
The Solution

- We developed the following experimental setup to fulfill the researcher’s needs:

- The experimental scenario is implemented in the federated NITOS - Planetlab Europe testbeds
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Federation Framework

The basic components that enabled the federation between NITOS and PLE consist of:

- **Single Sign Up** procedure
- Deployment of **OMF/OML** at **PLE** resources
- **XMPP** Communication using slices
Deployment of OMF/OML at PLE

The team of Max Ott, Thierry Rakotoarivelolo and Thierry Parmentelat worked on enabling the PLE resources to run OMF.

- As a result, Planetlab users are able to run OMF on PLE resources, by simply enabling the OMF-friendly tag for their slice.
In order for all the resources to be able to communicate with the EC, they must be registered in the same XMPP server...
XMPP Communication (2/2)

- ... or to a set of XMPP servers that are peered with each other
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Experimental Setup

- **RTT\textsubscript{WIRED}**: estimated through probe packets that are transmitted from the APs and are destined to the PLE node

- **RTT\textsubscript{WIRELESS}**: estimations are based on consideration of channel contention generated by neighboring nodes
Experimental Setup

- **Driver level** modifications, so that APs are able to broadcast RTT\textsubscript{WIRED} estimations in their Beacon frames and also at the STA mode, so that the STA detects channel contention on each channel.

- Packet Forwarding through **Iptables (NAT)** settings at both the:
  - APs
  - NITOS Server
Packet Discrimination at the PLE based on port numbers (**NMAP**)

Based on the incoming flows port number we inject artificial Delay for packets received at the PLE node (**Dummynet**).
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Even small variation of delay in the wired part significantly affects TCP throughput.

The wireless access link acts as the performance bottleneck that significantly limits yielded performance.

Higher deviation values when conducted in the combined topology, for the cases of 200, 300 and 500 msecs of delay.
Even a low increase in RTT values of 20 ms increases file transmission duration up to 5.5s (15%).

UDP experiments were conducted as well.

However, UDP performance in terms of throughput, packet loss and jitter is not affected by the artificial RTT delay.
Even contending flows of low traffic rate highly impact performance in both cases.

In the TCP case, we observe lower throughput performance yielded in the combined network. (TCP limits the rate of injected traffic, as it is adaptive to RTT variations.)
2nd set of Experiments (2/2)

- UDP performance is directly related to loss of packets.

- As the STA injects packets with higher traffic rate, the wireless network capacity is exceeded due to the simultaneous transmissions of contending flows.

- UDP does not restrict the rate of data entering the network within the network capacity region.
OMF Visualization
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Insights and Future Work

- **Experimental Insights:**
  - UDP performance in terms of throughput, packet loss and jitter is not affected by the artificially injected RTT delay.
  - High variation of RTT delays also impacts performance and has to be further investigated.

- **Future Work:**
  - Test UDP performance in setups of multiple PLE destination nodes, located across different locations and thus featuring diverse RTT values.
  - Test video performance in terms of successfully delivered frames ratio and delivered PSNR.
  - Test performance of more specific metrics.
Thank You!