EXPRESS: Implementing an SDN infrastructure over a federation of testbeds

(experiment within the OpenLab project)

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CNIT / University of Rome «Tor Vergata»

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EXPRESS objectives

- Design an innovative, *resilient* SDN system to extend the SDN applicability domain from fixed networks to intermittently connected network, like wireless mesh networks.

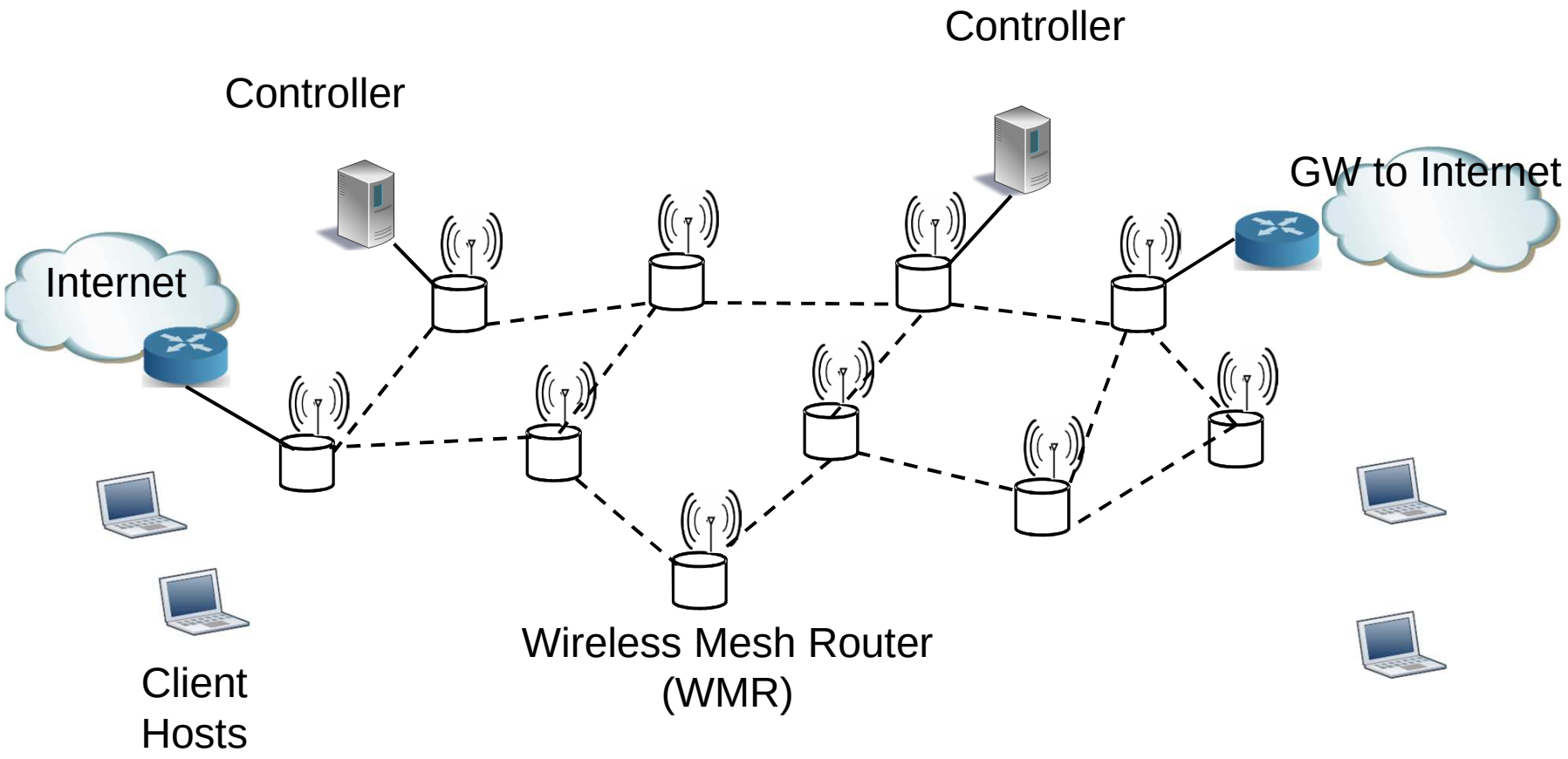
- Evaluate our solutions over a federation of **three OpenLab testbeds (PlanetLab, NITOS and W-iLab.t)**, where PlanetLab plays the role of the core fixed network and NITOS and W-iLab.t play the role of the wireless mesh networks

Outline

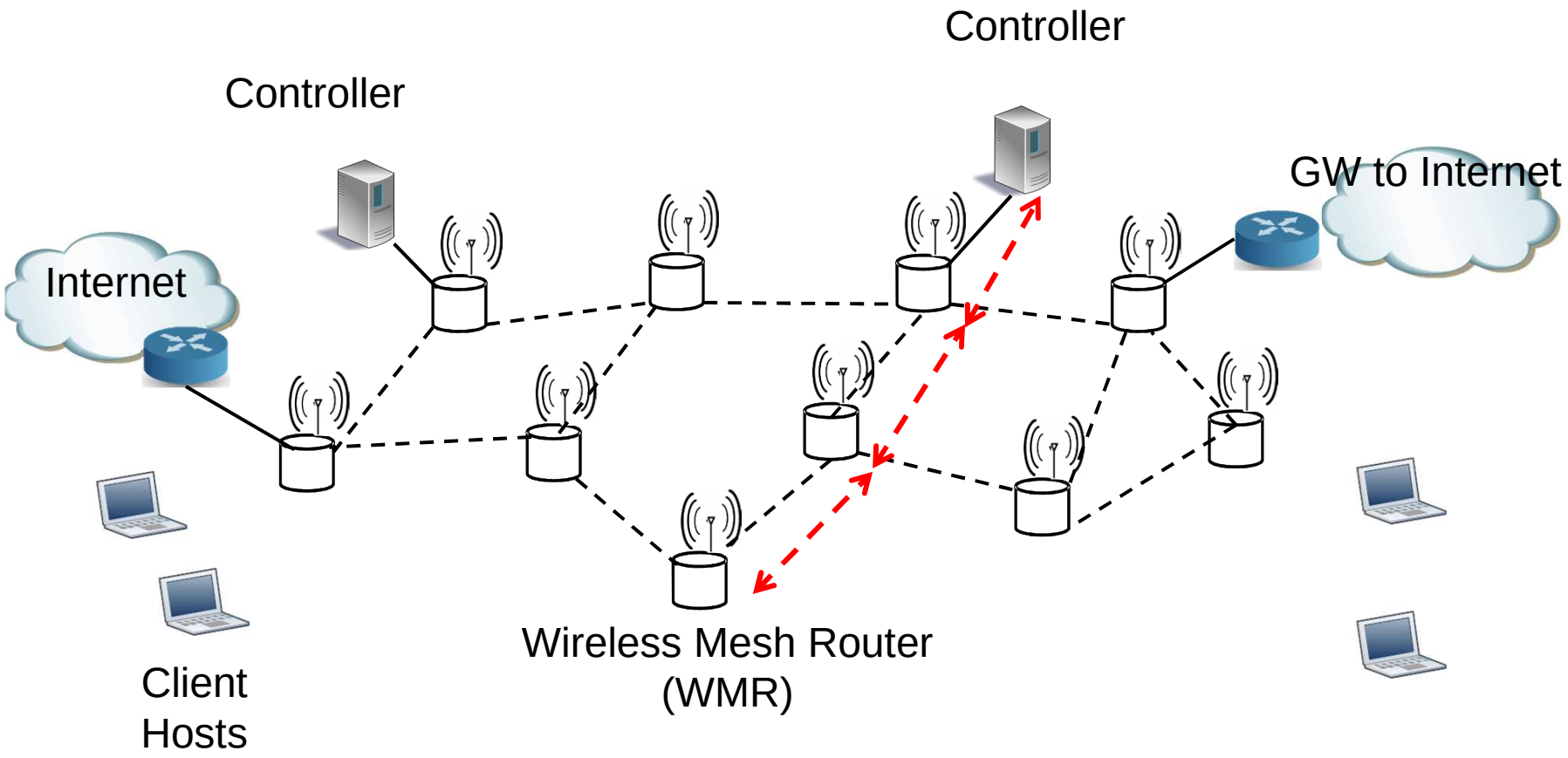
- wmSDN : wireless mesh Software Defined Network
  - SDN in a highly dynamic networking environment with network partitions /merging
  - Wireless Mesh Router (WMR) architecture
  - Controller selection aspects

- Testebed interoperability aspects

wmSDN
wireless mesh Software Defined Network



wmSDN
control plane connections with controllers



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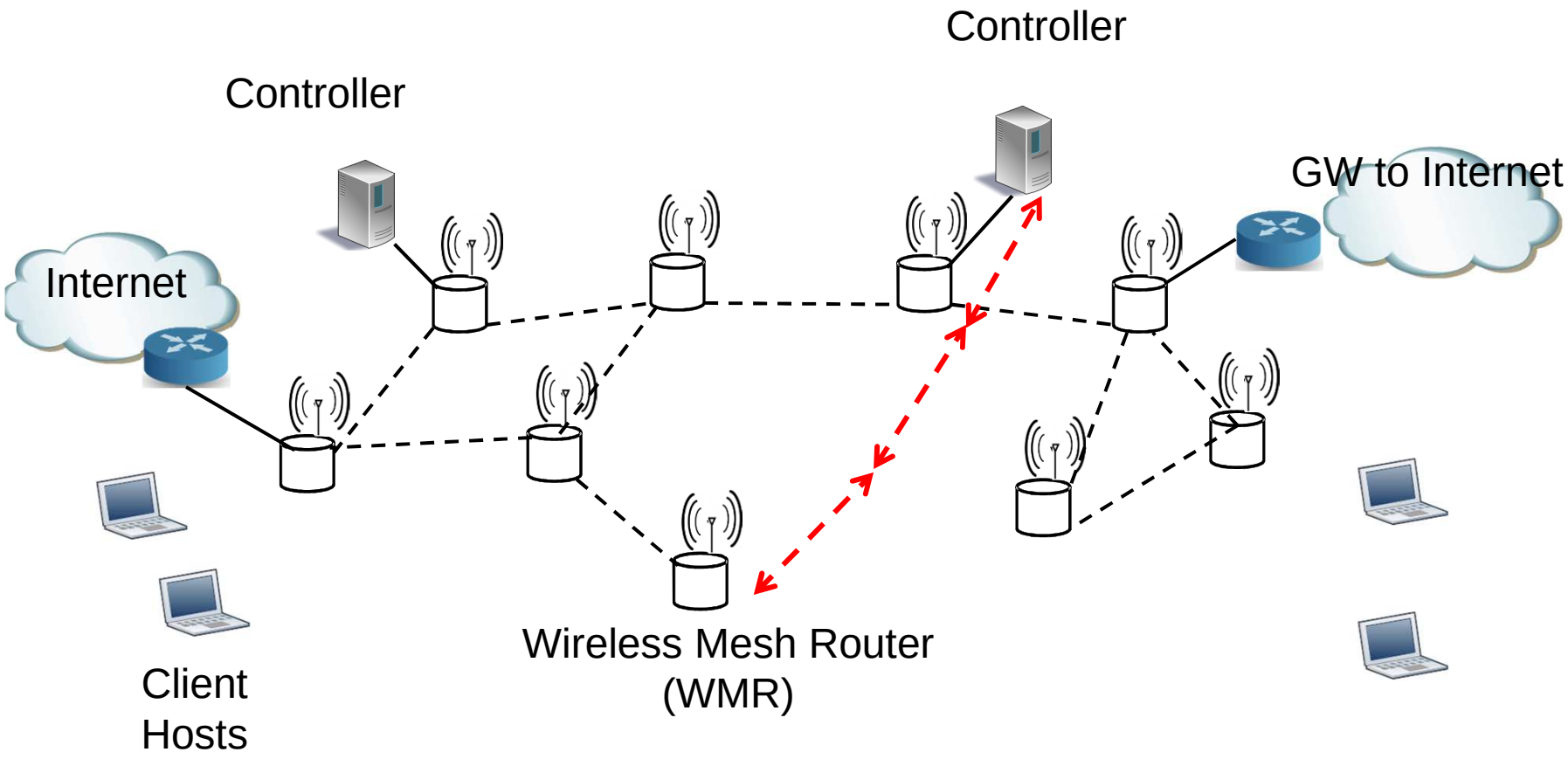
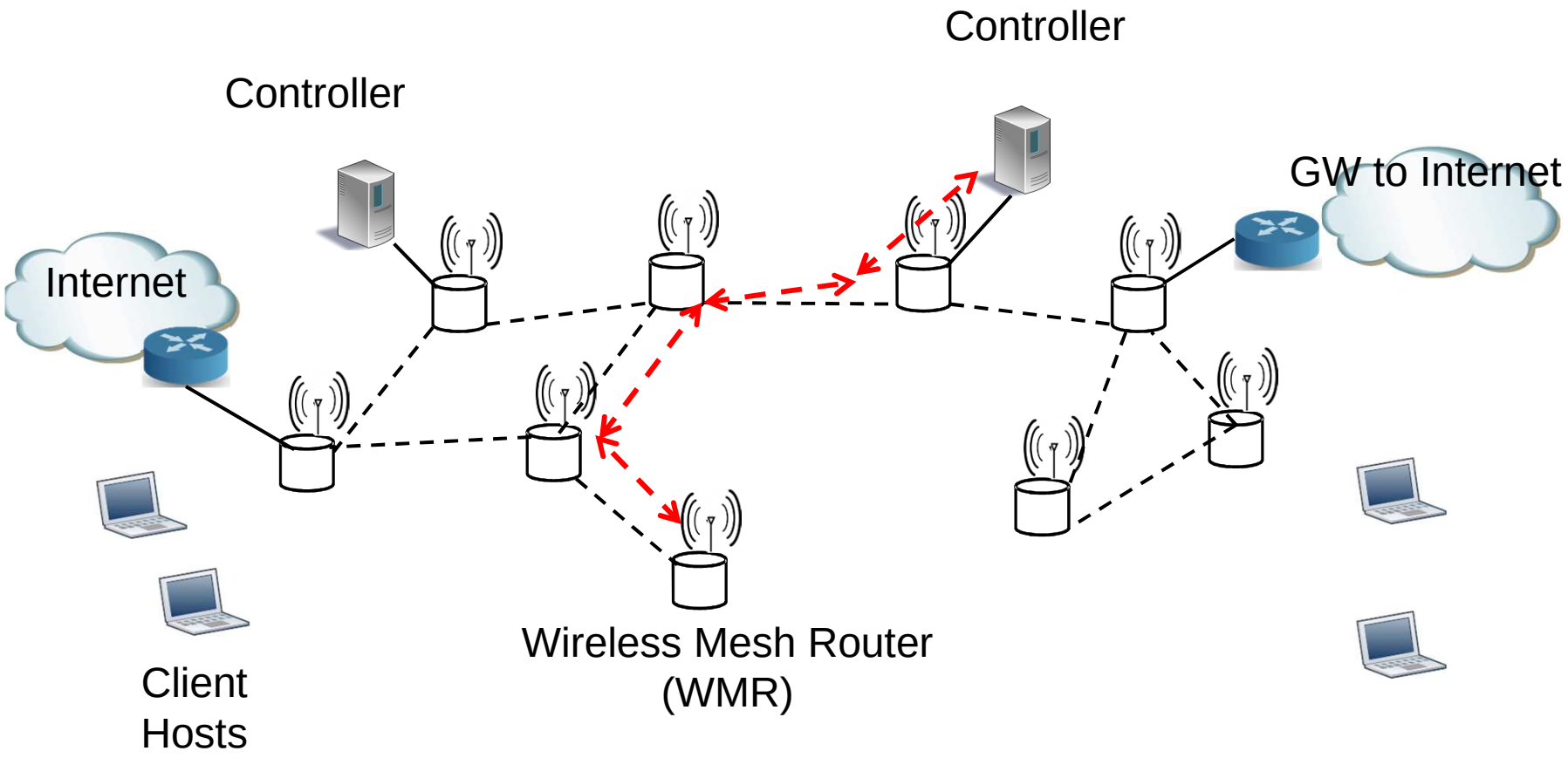
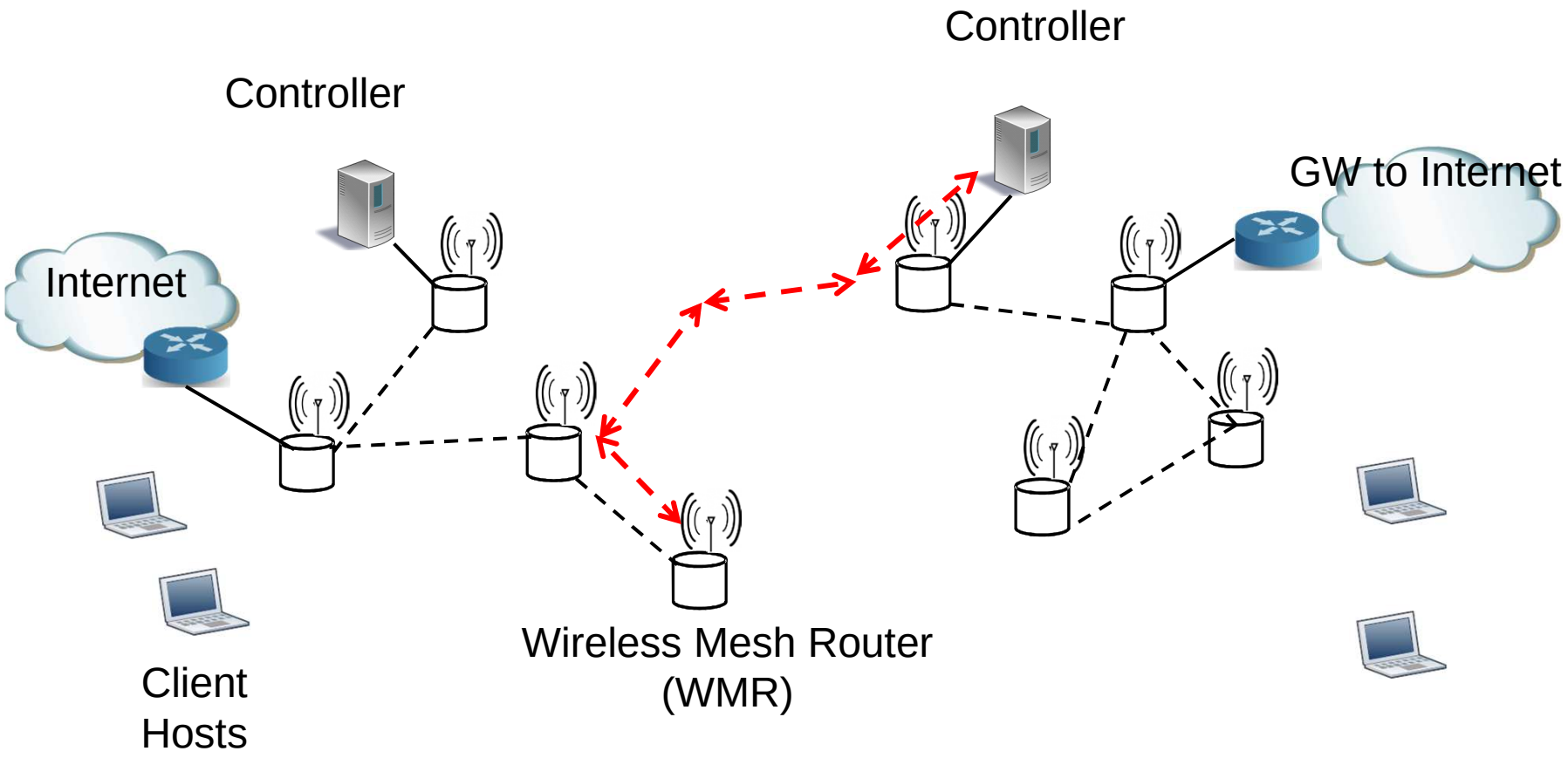


wmSDN
“in-band” control plane



wmSDN
network partitions



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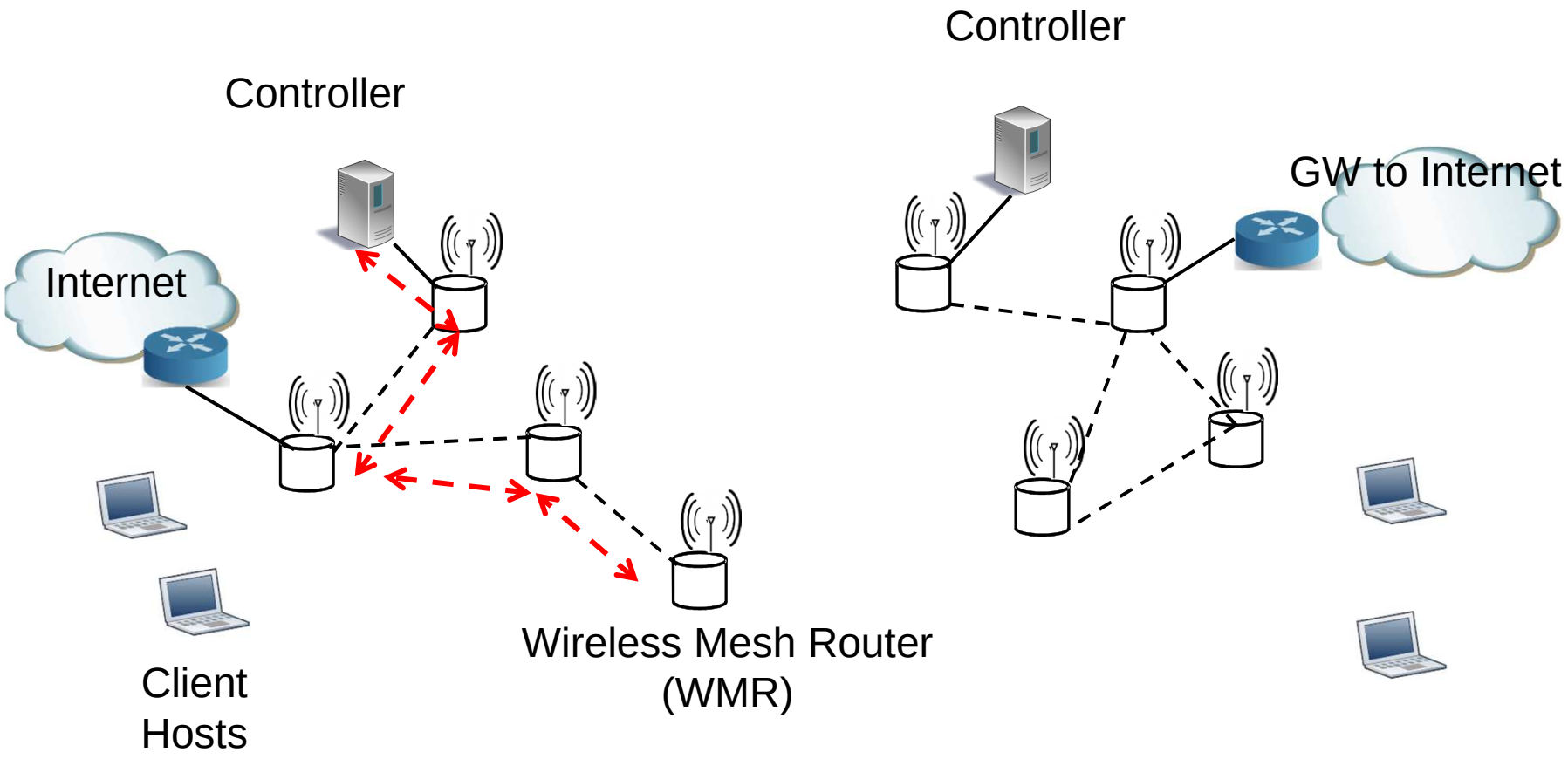
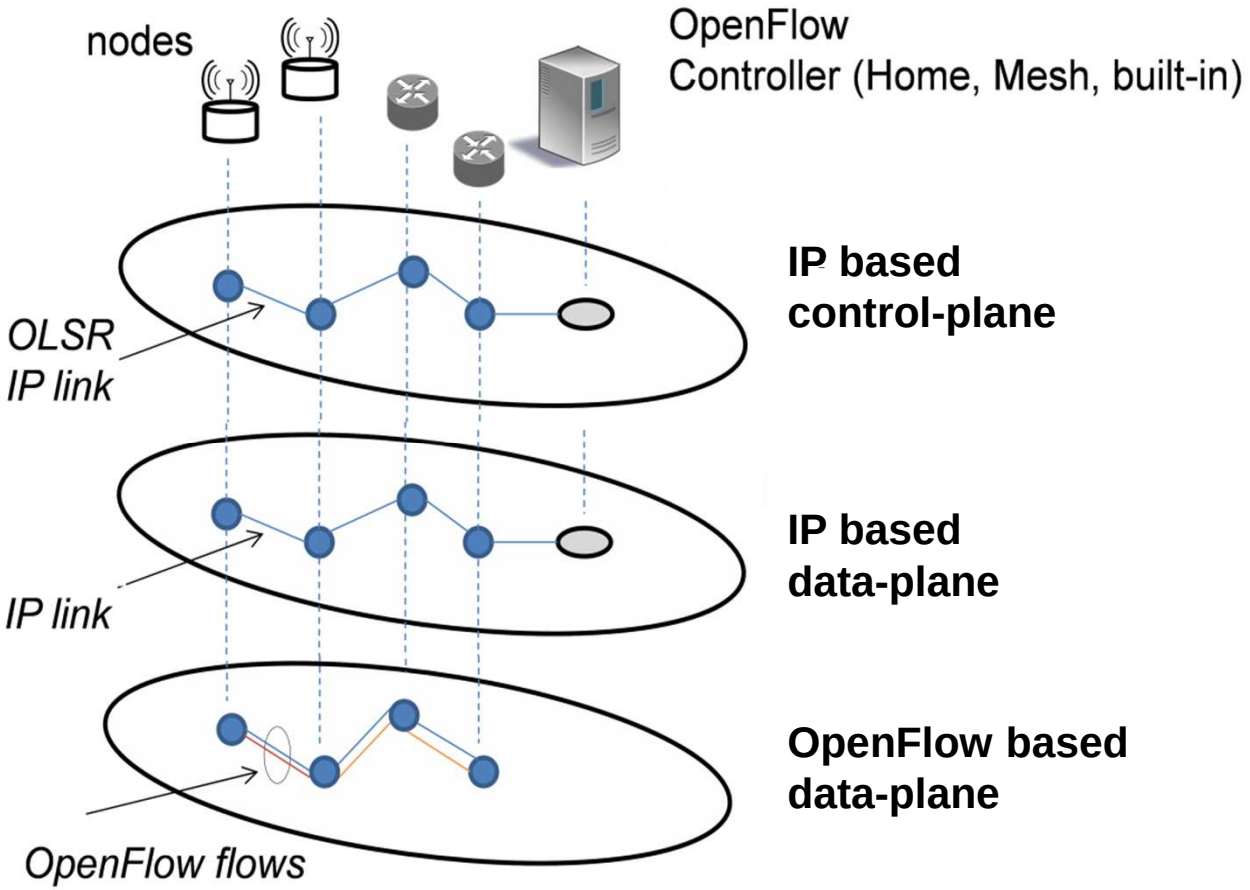


Control and data plane

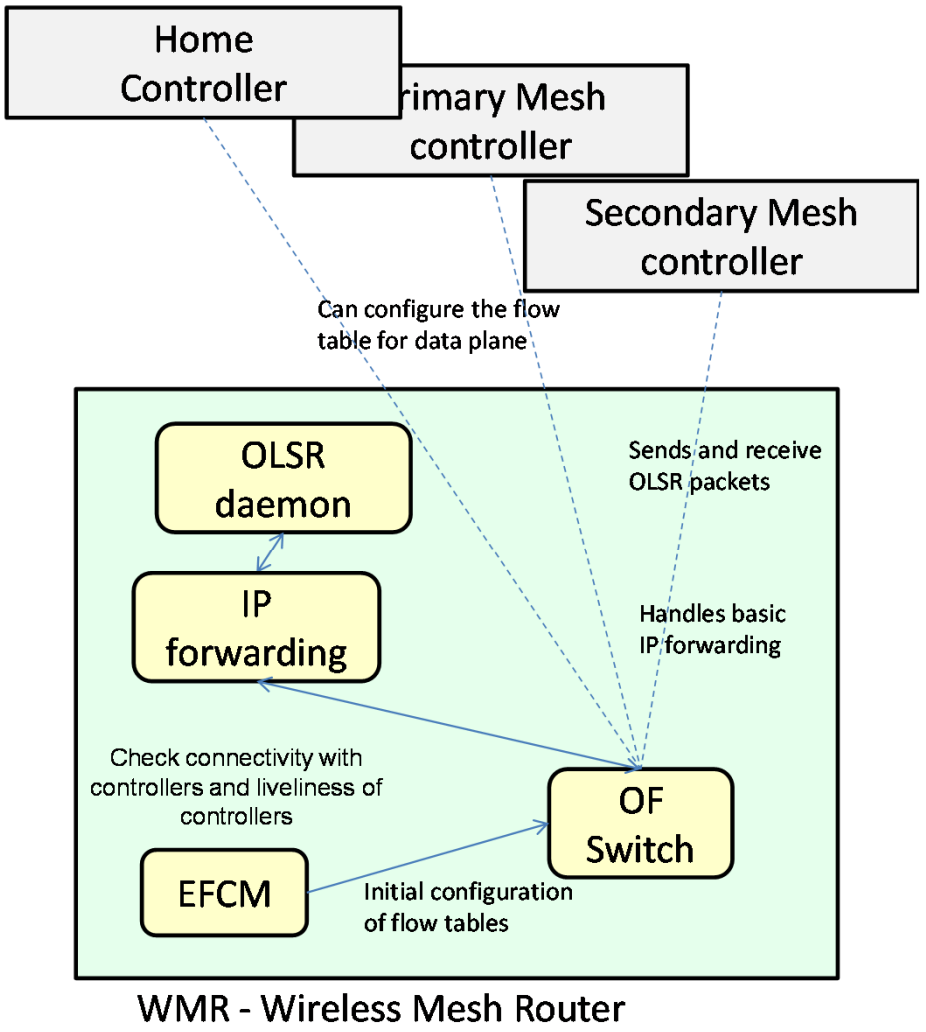
- The OLSR routing protocol for Mobile Adhoc Networks is used to establish a basic IP connectivity in the Wireless Mesh Net
- The OpenFlow/SDN control plane (switch-to-controller communication) goes **“in-band”** over the basic IP connectivity
- Data plane uses the IP connectivity or an “SDN based connectivity” in a flexible way
- When using SDN based connectivity, the routing of packet flows is decided by the SDN controller

Control and data plane



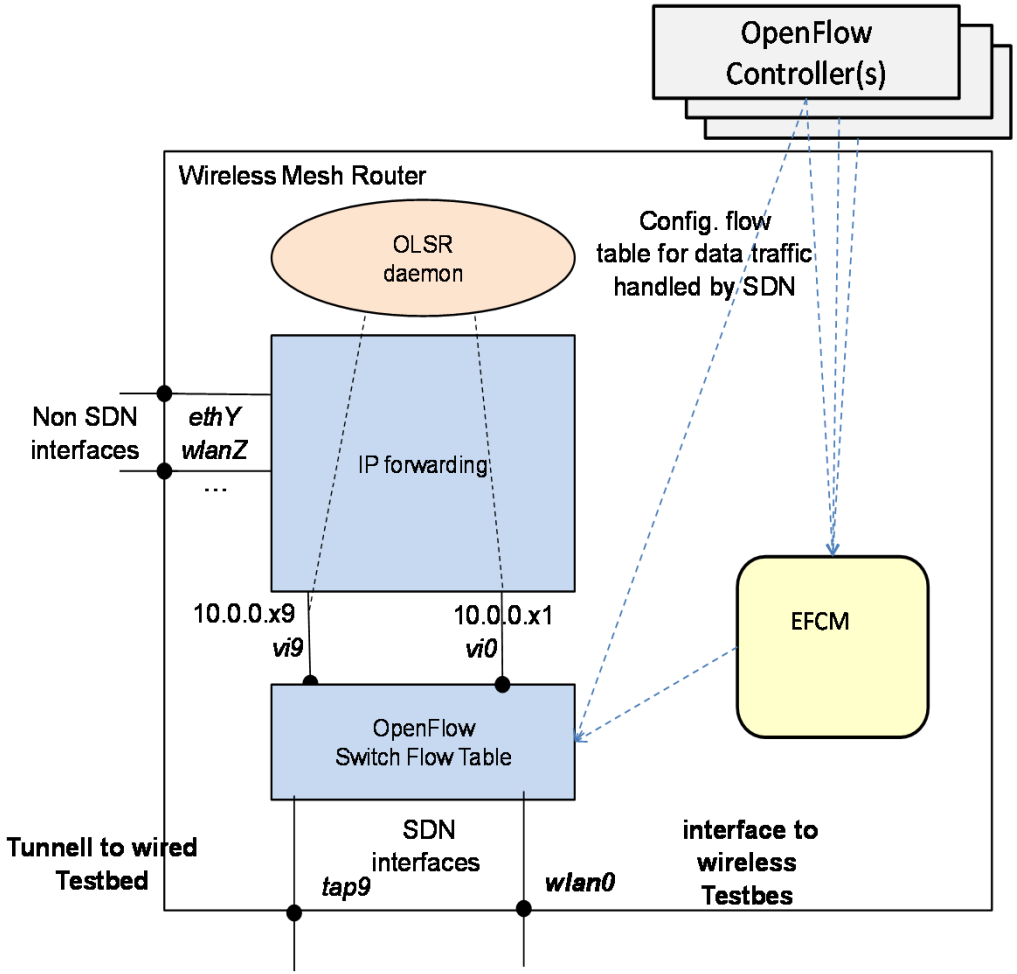
wmSDN: architecture

- OpenFlow controllers
- OLSR Daemon
- OpenFlow switch (Open vSwitch)
- EFCM - External Flow table and Controller Manager



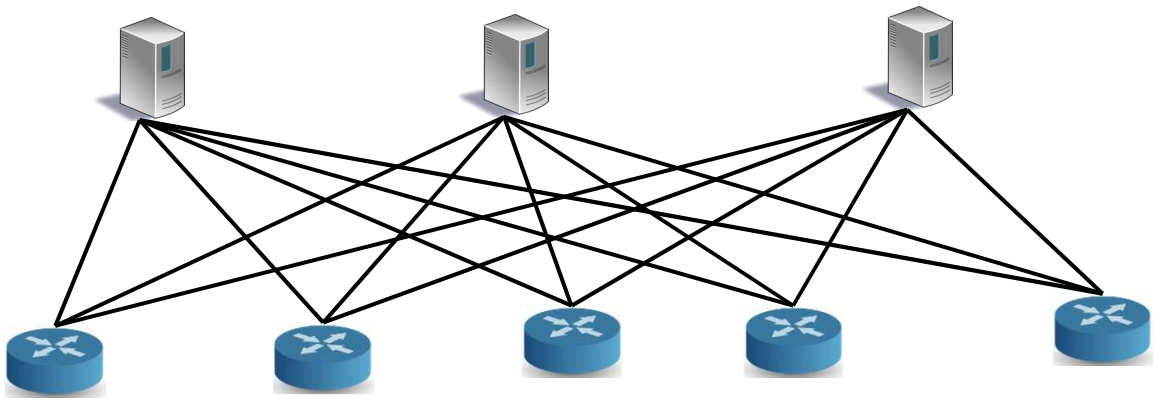
Details of WMR node architecture

- Each physical interface is associated with a virtual interface
- Traffic can forwarded in two ways
  - IP forwarding which operates on the virtual interfaces (routing is set by OLSR)
  - with SDN rules in the OF switch



Master controller election in SDN fixed nets

- Communications among controllers are relatively reliable -> the controllers can run a master election procedure to take control of each switch
- (Implementation issue) Open vSwitch can only connect to a preconfigured set of controllers



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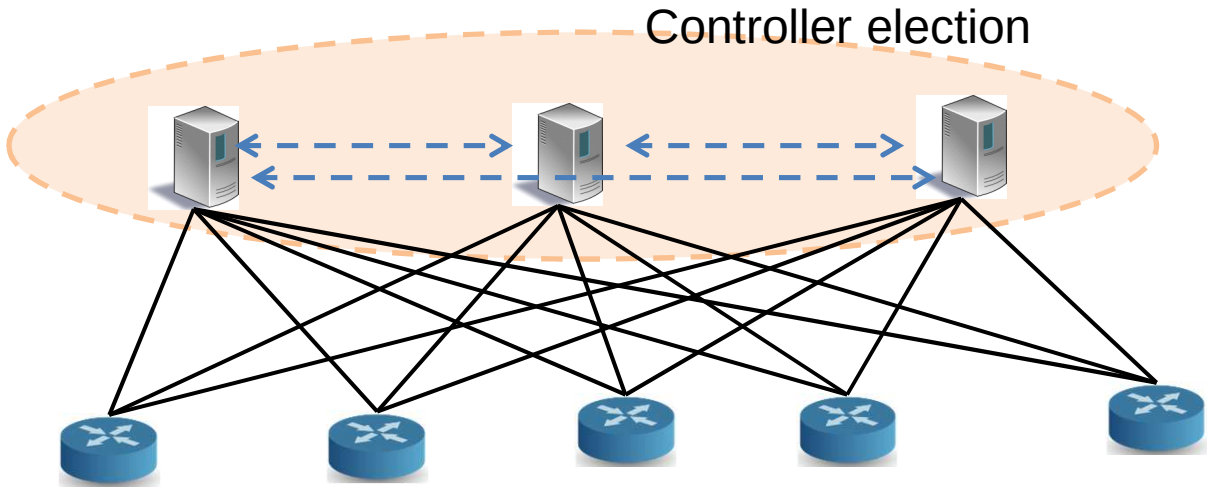

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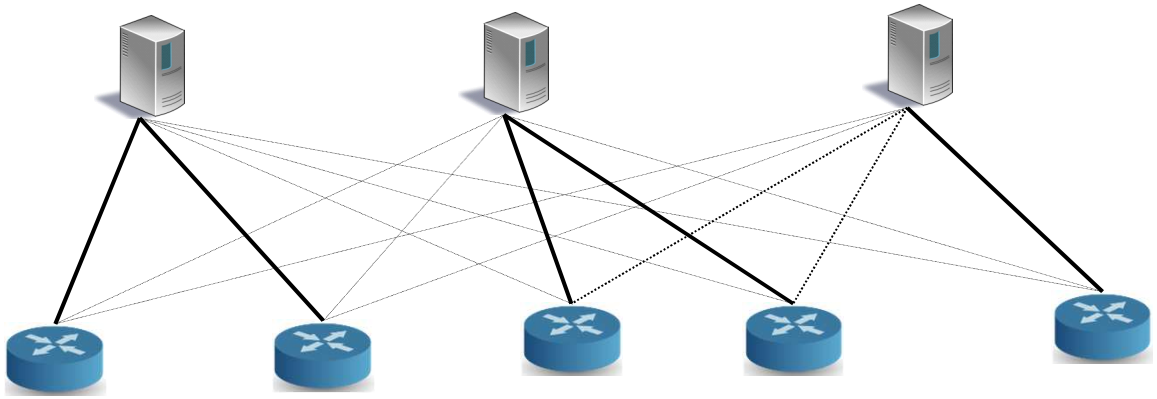


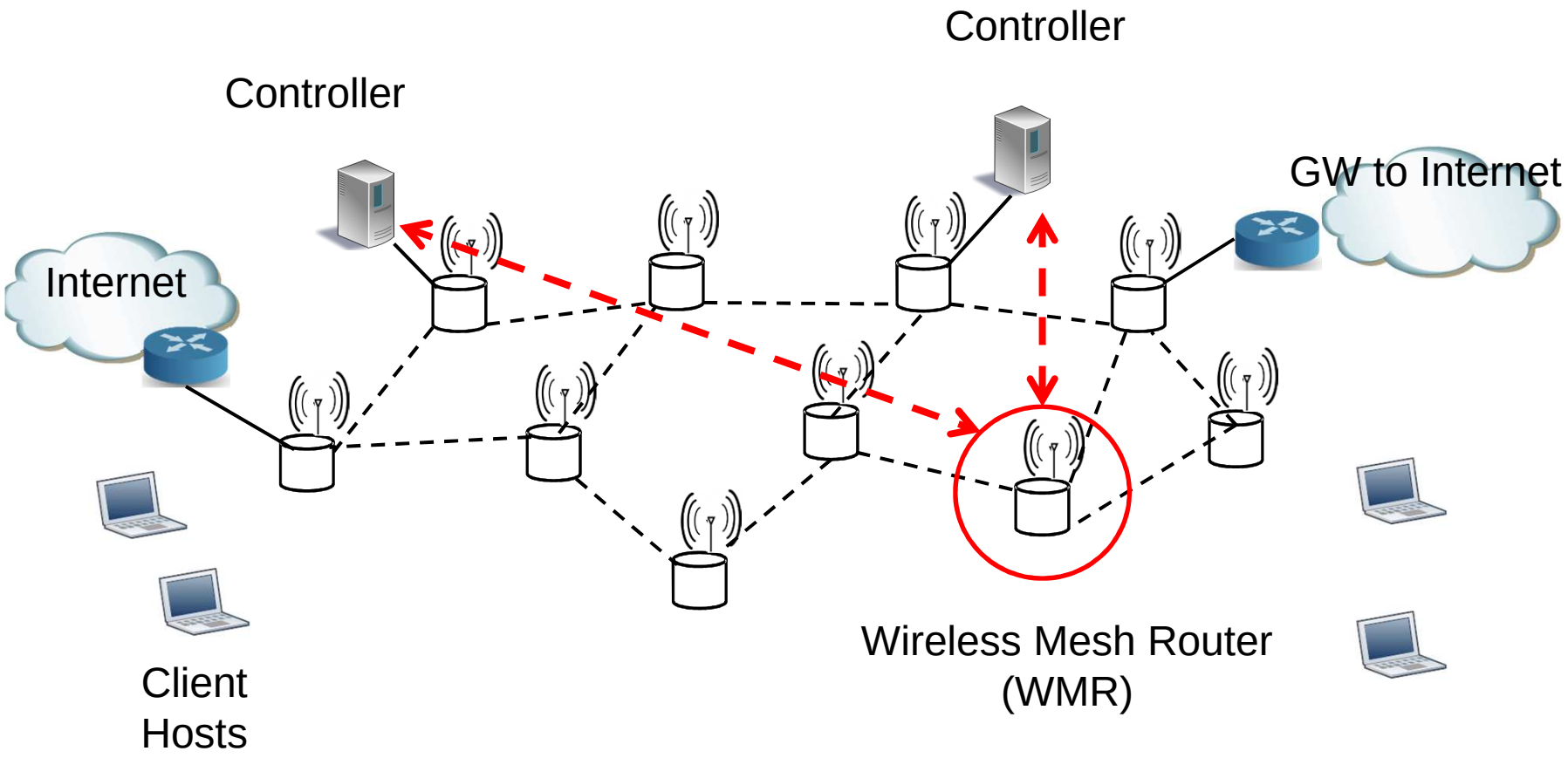
From Master Election to Controller Selection

- WMRs select the more appropriate controller given the connectivity status of the network (Controller Selection)

- The Controller Selection procedure is performed by the EFCM

- Simple strategy, based on a “Hierarchy of Controllers”: select the connected controller with the highest level in the hierarchy

From Master Election to Controller Selection

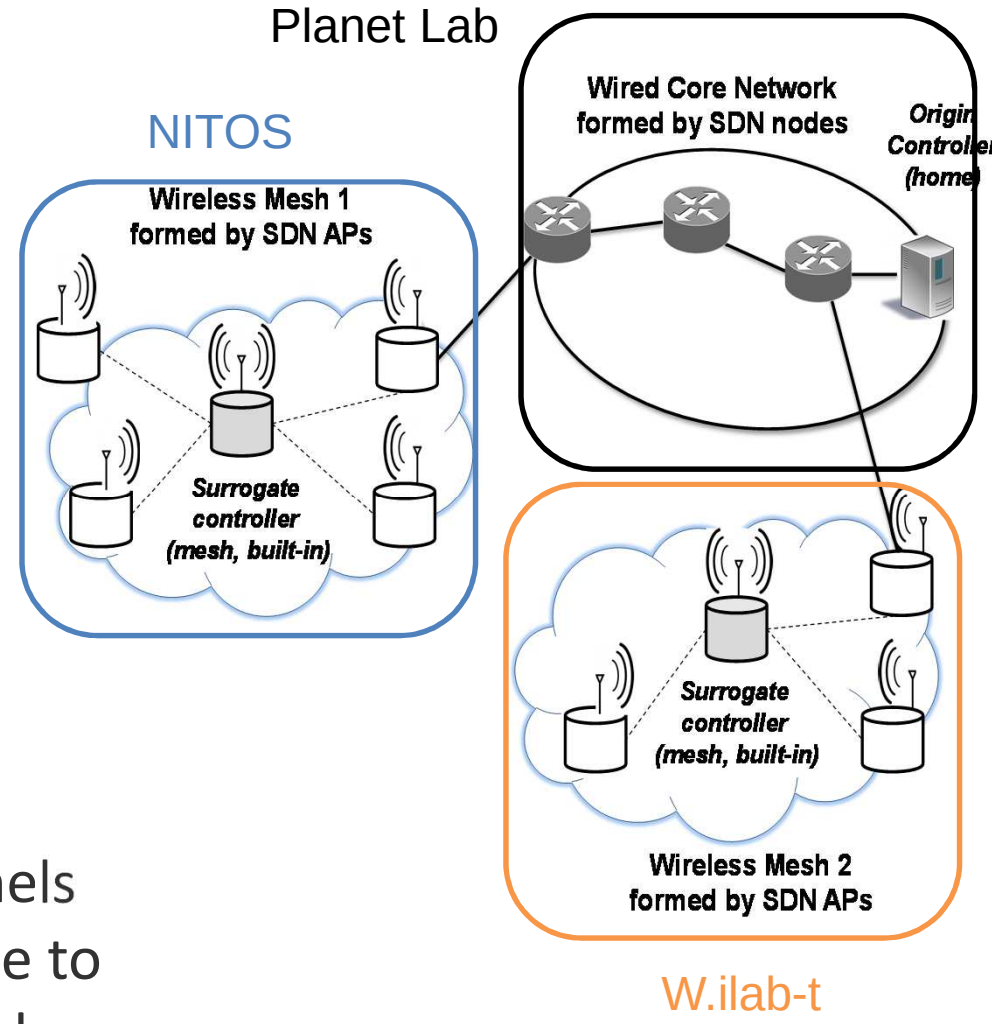


Experimenting in OpenLab testbeds

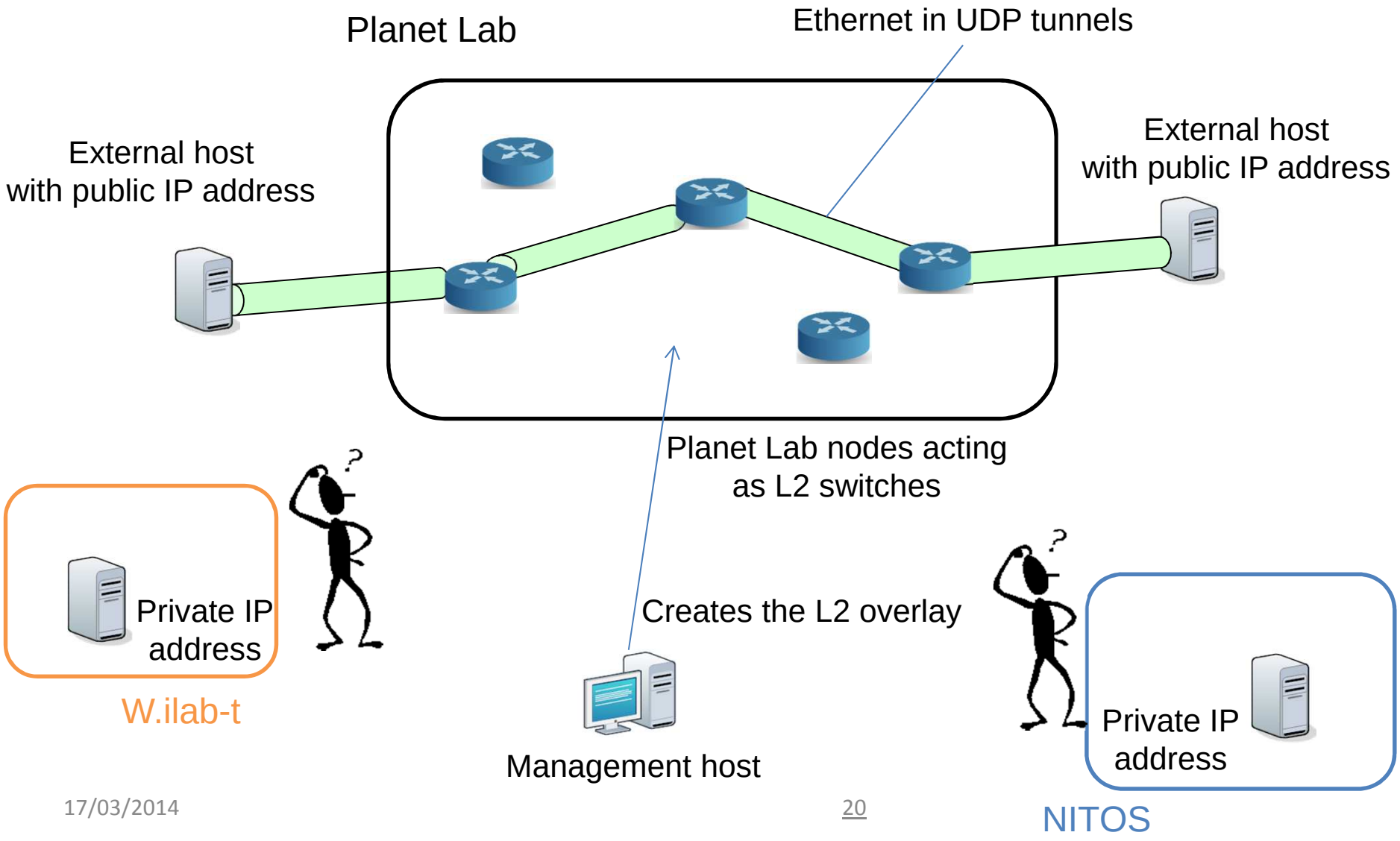
- Wireless testbeds:
  - W.iLab-T
  - NITOS
- Fixed testbed
  - PlanetLab

- Interconnection of Wireless testbeds with fixed “backbone”

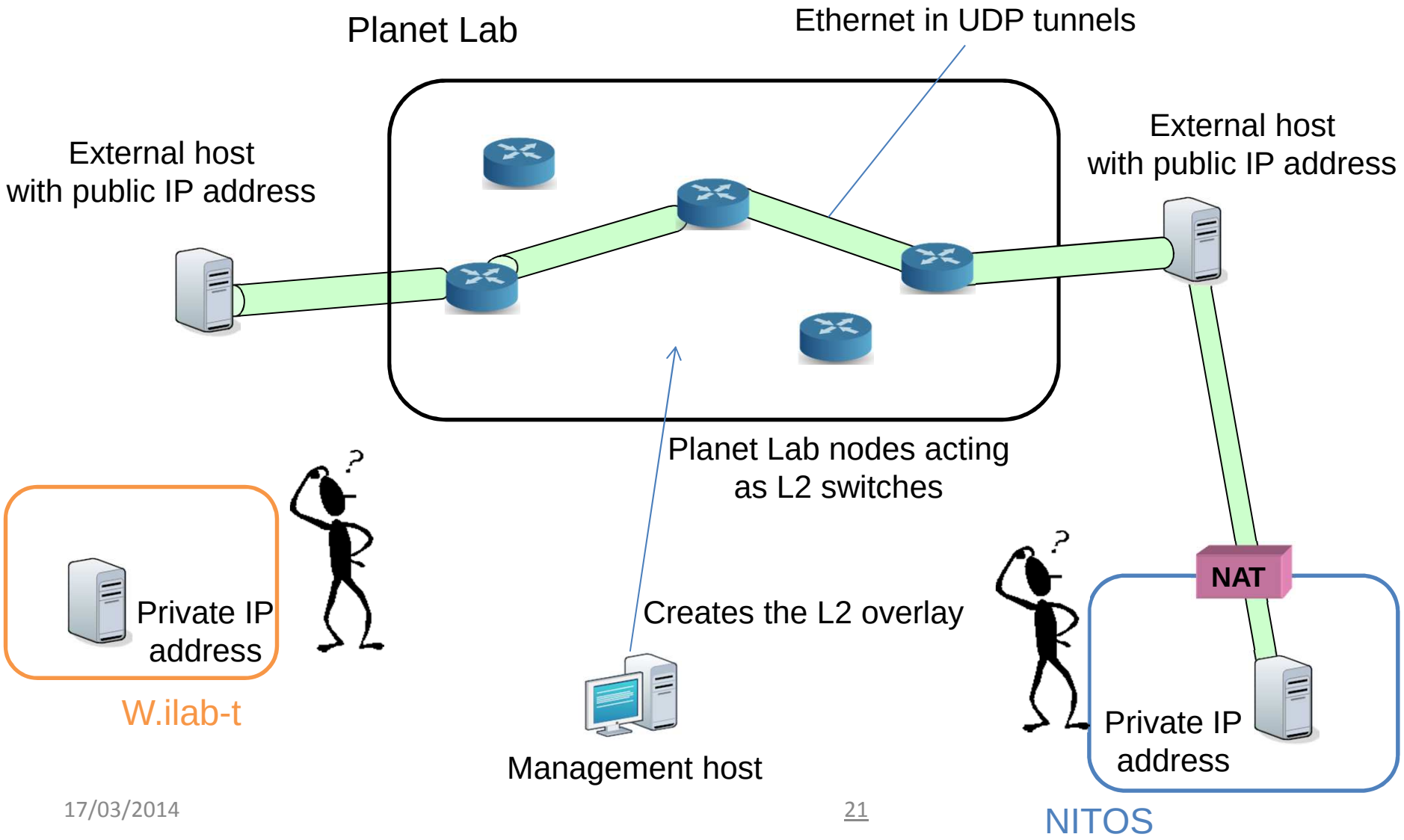
- Ethernet over UDP tunnels across Planet Lab Europe to interconnect the testbeds



Testbeds interconnection issues



Solutions for testbeds interconnection



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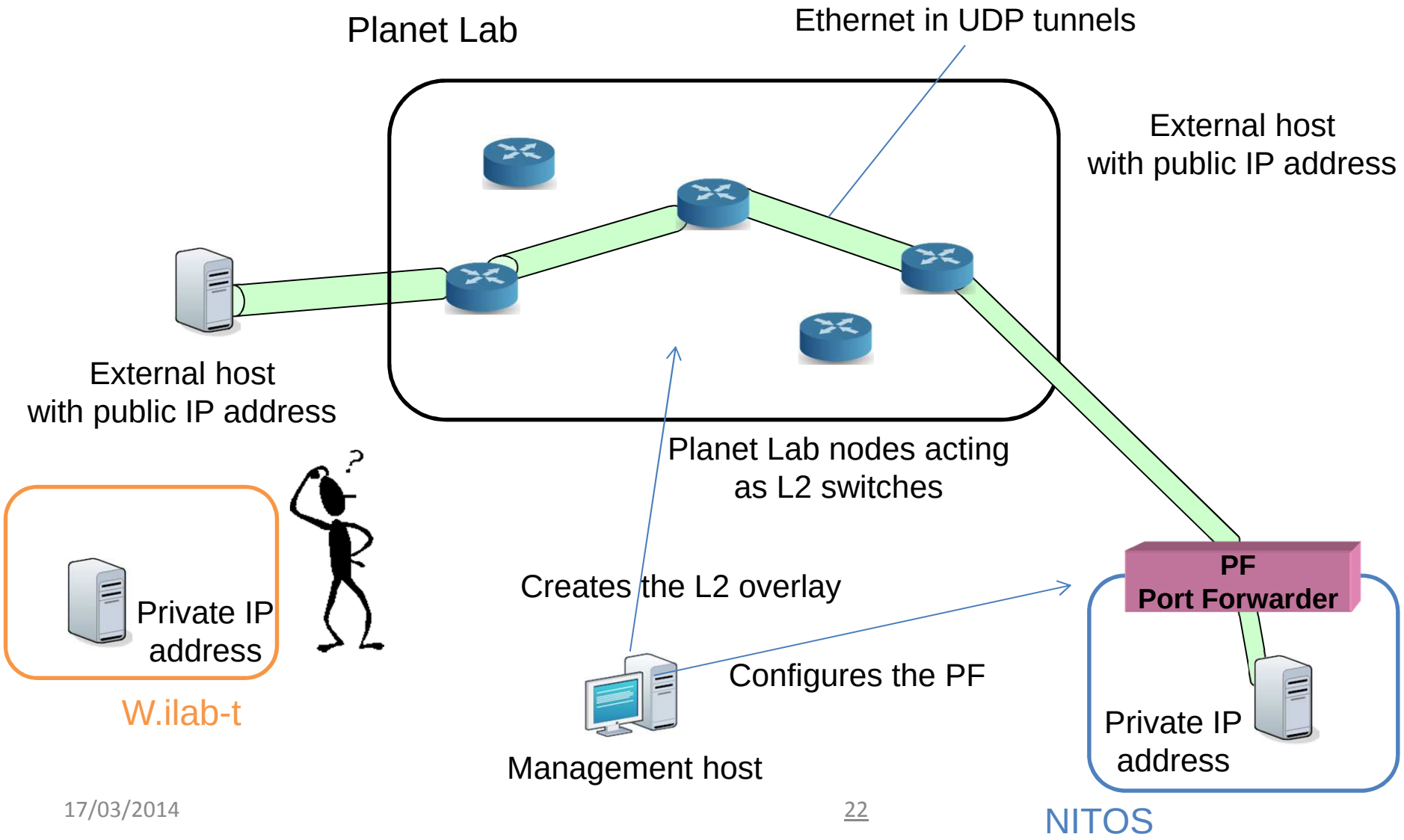

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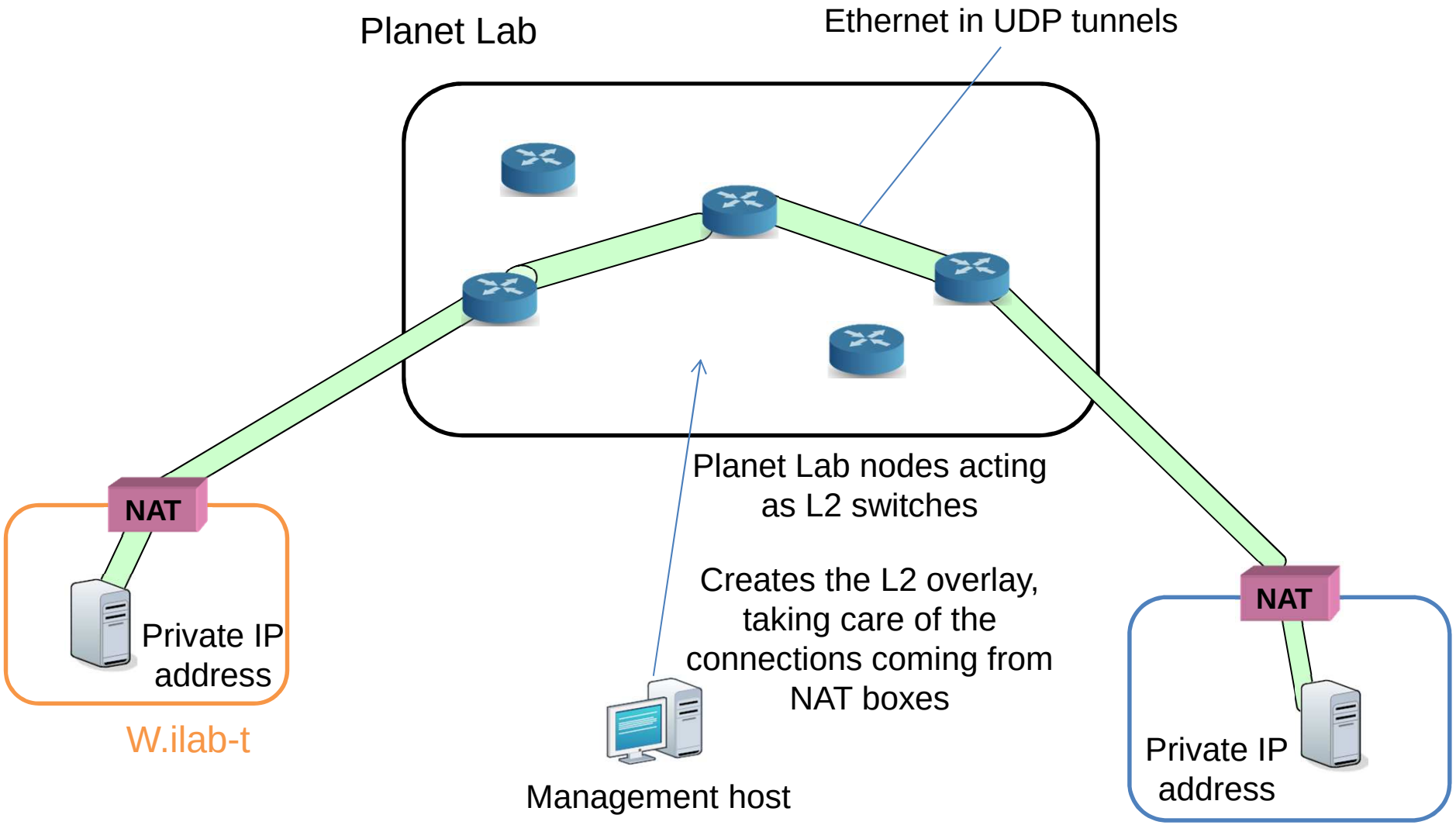

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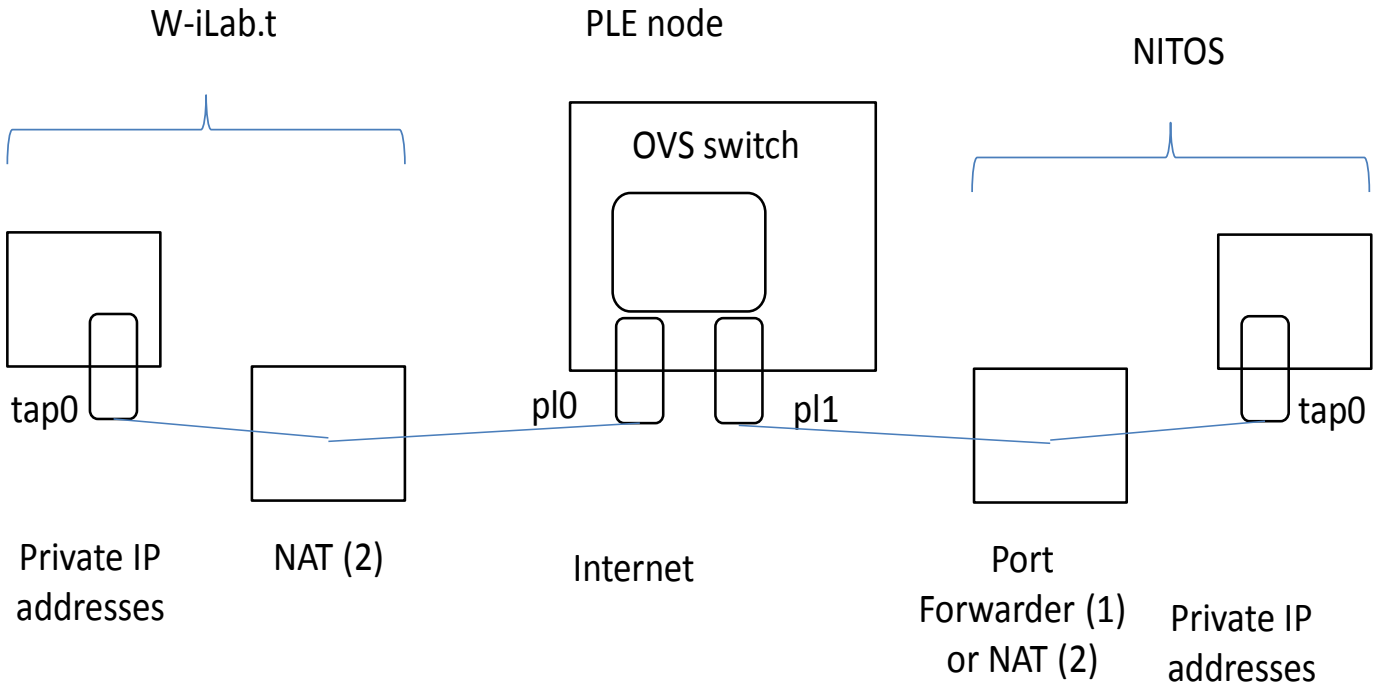
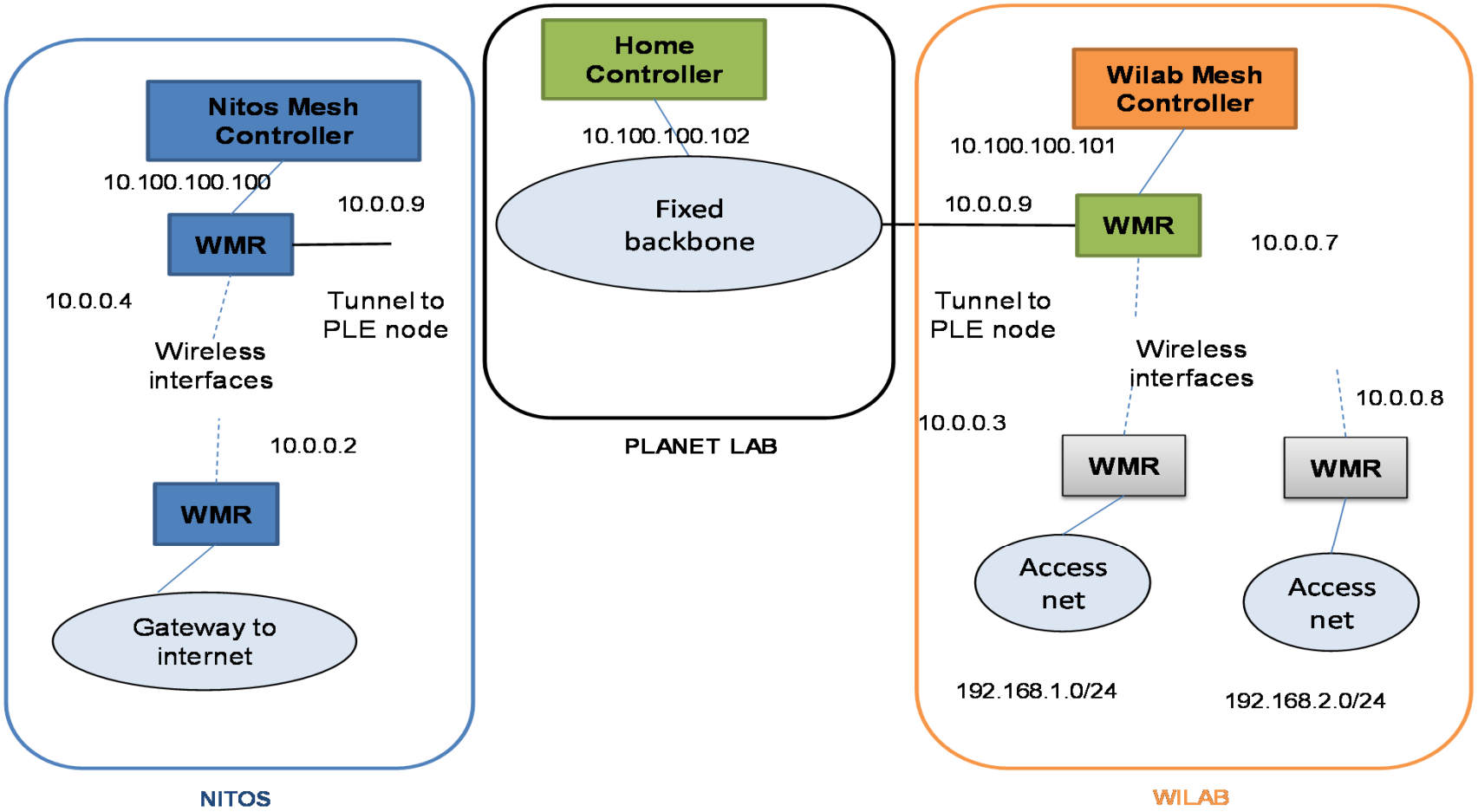


- (1) “Port Forwarder” running in the node that interconnects a testbed with the Internet, it can run at kernel level or application level

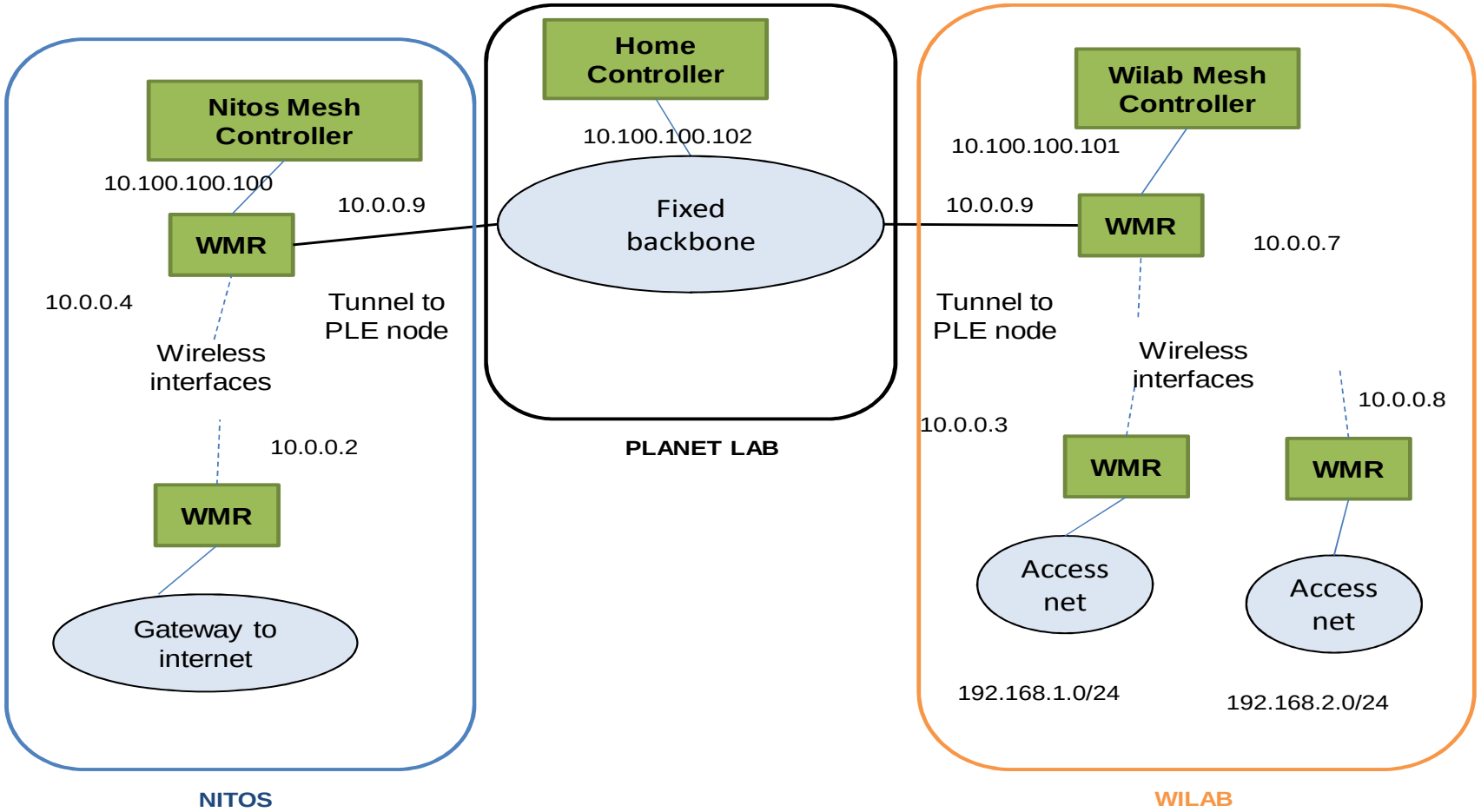
- (2) Regular NAT translation of an outgoing UDP flow from a node in the testbed and terminating in the tunnel endpiont node in Planet Lab

Controller selection over federated testbeds



- The Network is divided in 3 partitions: blue, green and gray
- WMRs in different partition are connected to the best available controller (or using only IP routing if no controller is available)

Controller selection over federated testbeds



- Network partition are joined together
- WMRs are connected to the “best” available controller

http://netgroup.uniroma2.it/wmSDN/

Thank you for your attention
Questions?

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