OPENAIR-CN Deployment

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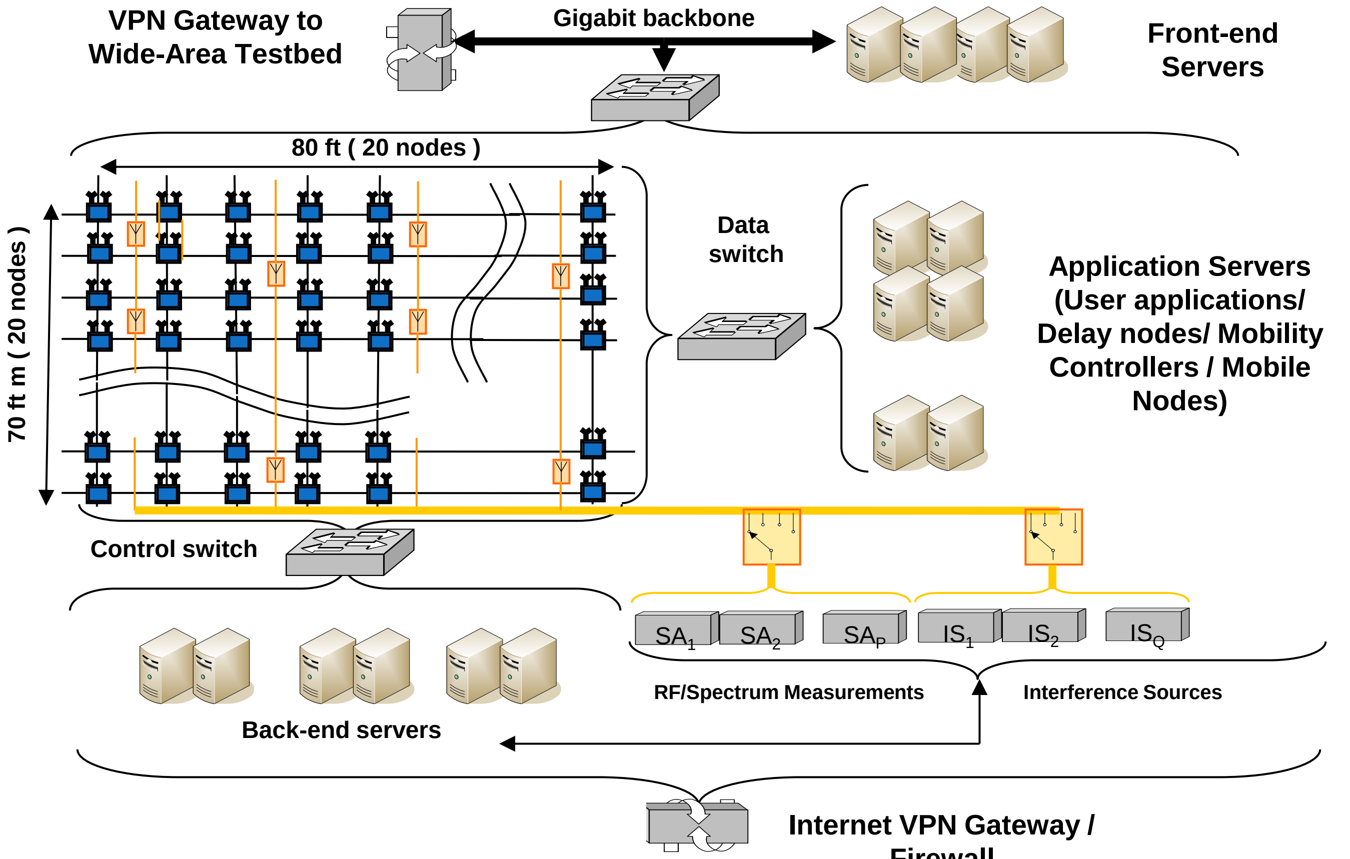
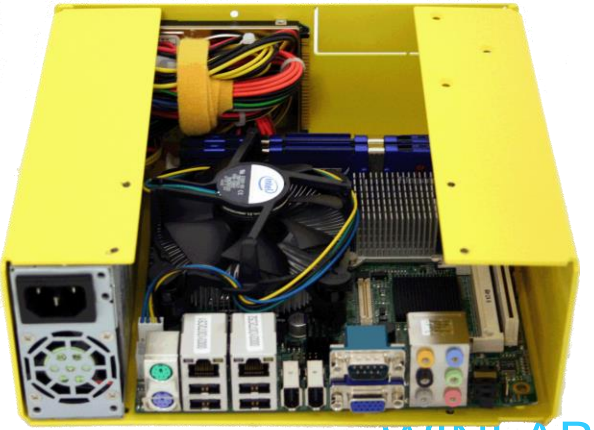
Orbit Testbed



Radio Node (Version 4)

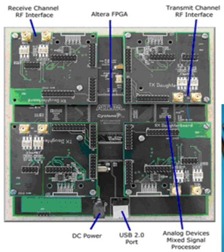
- I7-4770 3.4 GHz Q87T Express chipset
- 16 GB DDR3
- 2 x Gigabit Ethernet ports
- PCI-Express 2.0 X16
- 2 x Mini-PCIexpress socket
- 8 x USB 3.0
- OOB Mgmgt.

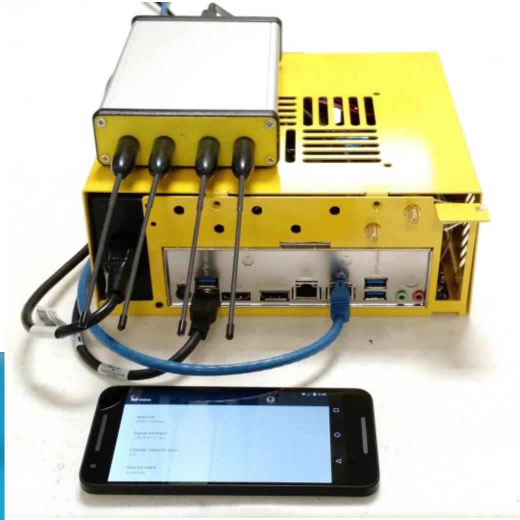
- Xeon E5-2600v3 with 18 cores
- 64 GB DDR4
- 2 x 10G Ethernet ports
- 2 x Gigabit Ethernet ports
- PCI-Express 3.0 X16
- 8 x USB 3.0
- OOB Mgmgt.

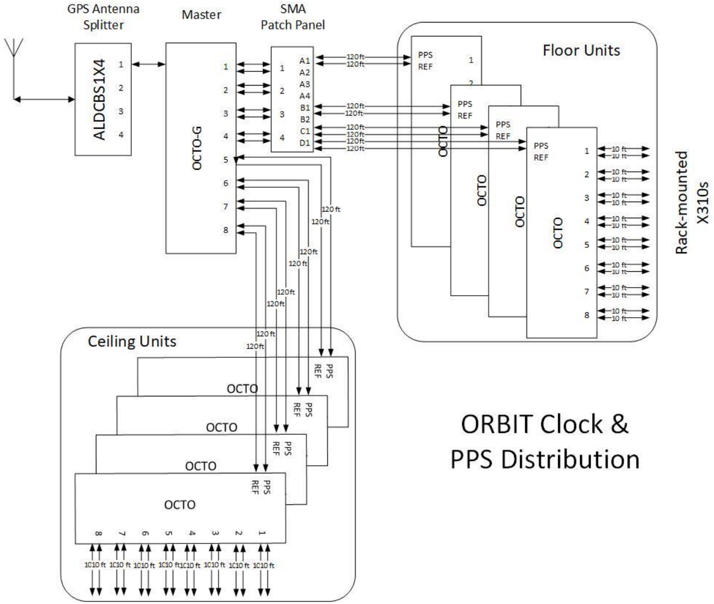


ORBIT Grid SDRs

- Currently: ~10 USRP and ~30 USRP2, 36 USRP X310s, 16 B210s, 16 RTL-SDR, 4 Nutaq, WARP, Zync and GENI CR-Kit platforms
- 64 units are PPS/10 MHz ref. synchronized







ORBIT Grid

Massive-MIMO

- 32 USRP X310s
  - Available FPGA resources:

Resource Type	Number
DSP48 Blocks	58K
Block Rams (18 kB)	14K
Logic Cells	7.2M
Slices (LUTs)	1.5M

  - 2 x UBX-160 (10 MHz - 6 GHz RF, 160 MHz BB BW)
  - 2 x 10G Ethernet for fronthaul/interconnect
  - Four corner movable mini-racks (4 x 16 x 16 -> 1 x 64 x 64)
- > CloudLab Rack: 500+ GPP Cores with 24+ GPUs (TESLA P100) and100G SDN aggregation switch

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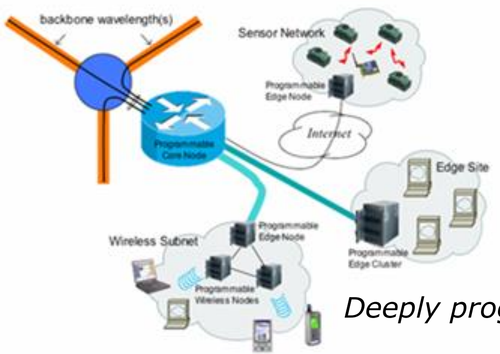
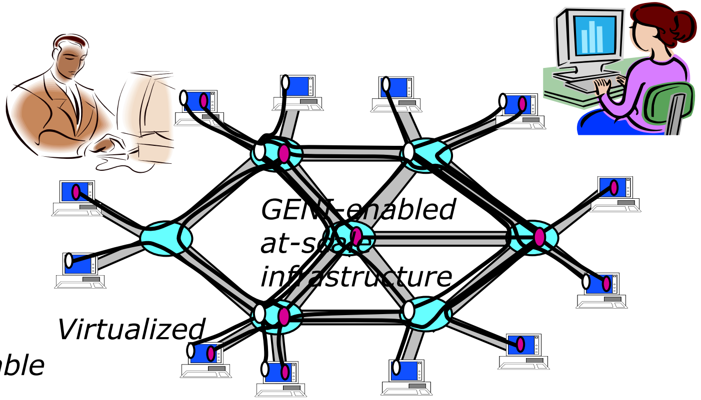
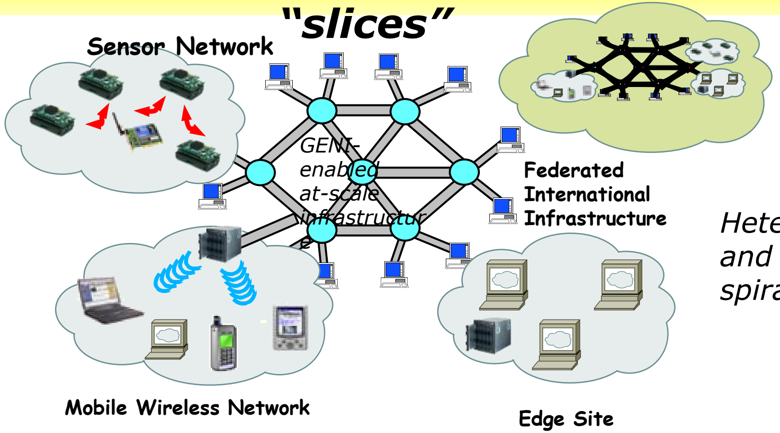
GENI: Infrastructure For At-Scale Experimentation



Deeply programmable



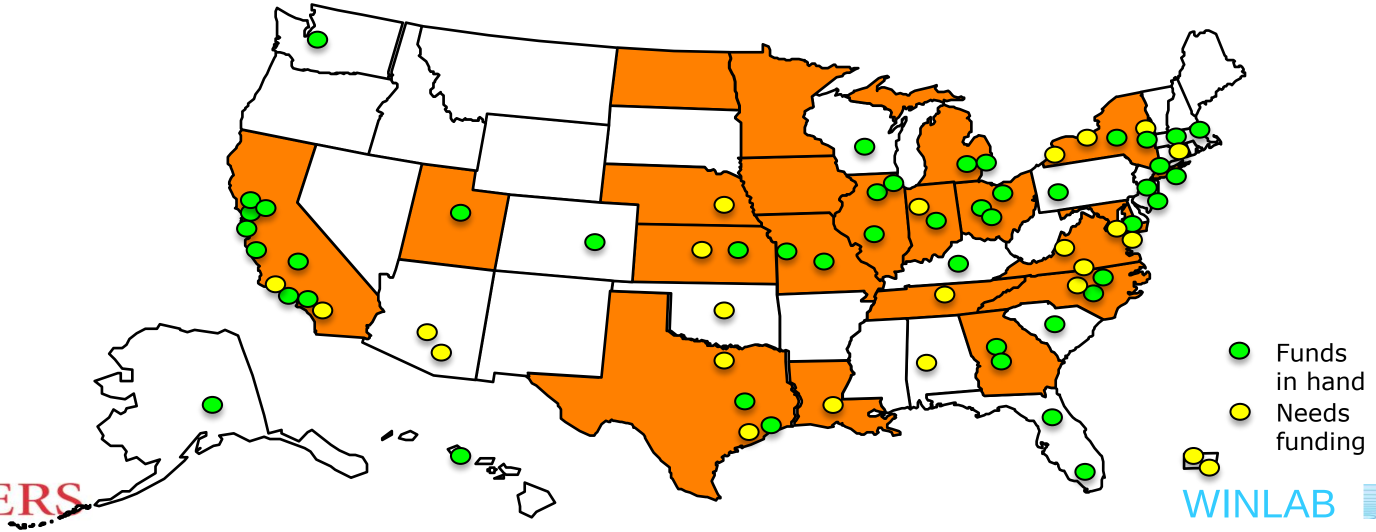
Programmable & federated, with end-to-end virtualized "slices"



Heterogeneous,
and evolving over time via spiral development

GENI - a virtual lab for networking and distributed systems research and education

- GENI started with exploratory, rapid prototyping 8 years ago
- GENI design assumes federation of *autonomously owned and operated* systems
- Yearly prototyping cycle for an idea: develop, integrate and *operate*
- Experimenters use the testbed *while we are building it out*
- Even prototypes have "activist" users, and must evolve to satisfy those users or fade away. Two of five original design frameworks predominate now.
- "Horizontal" dataplane slicing as a service (or sometimes just engineered)
- "Vertical" control plane APIs to negotiate and allocate resources



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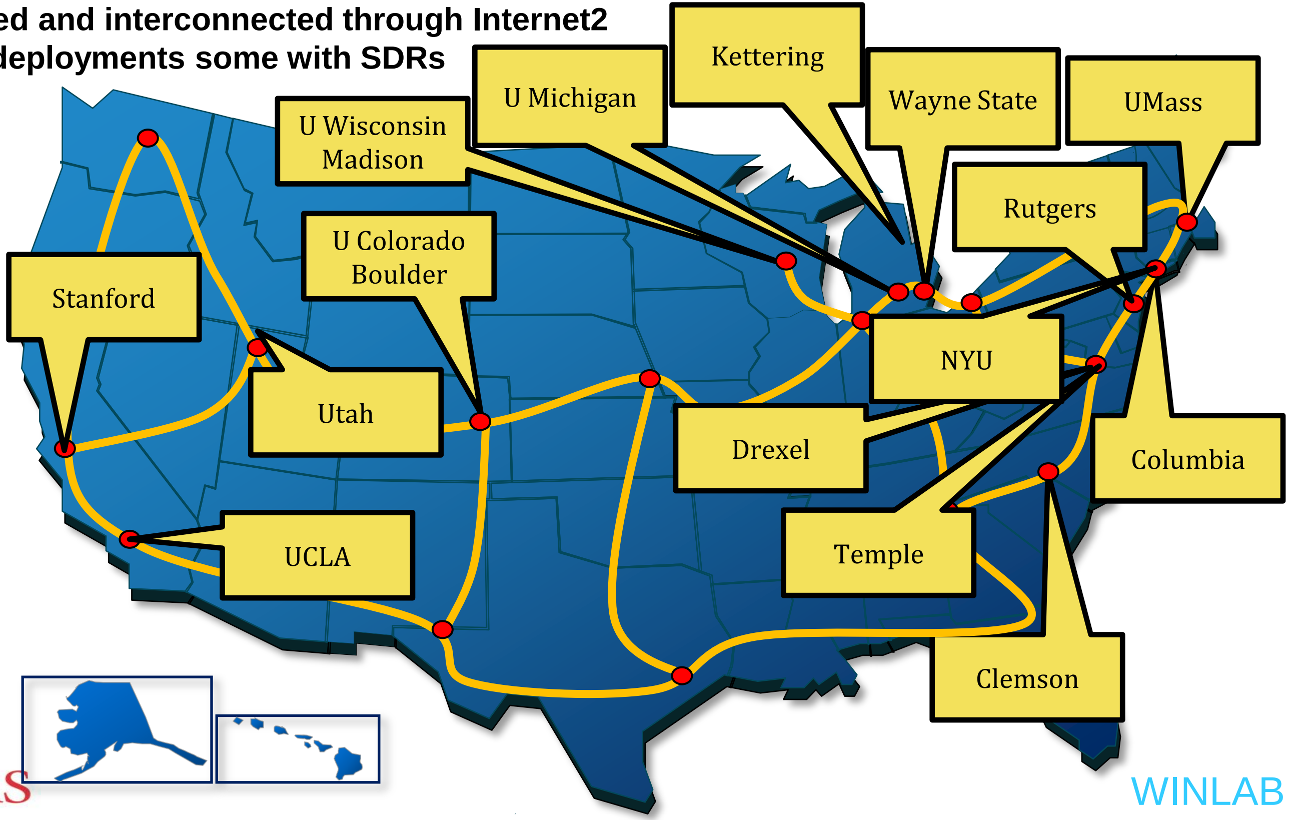
GENI Wireless Deployment

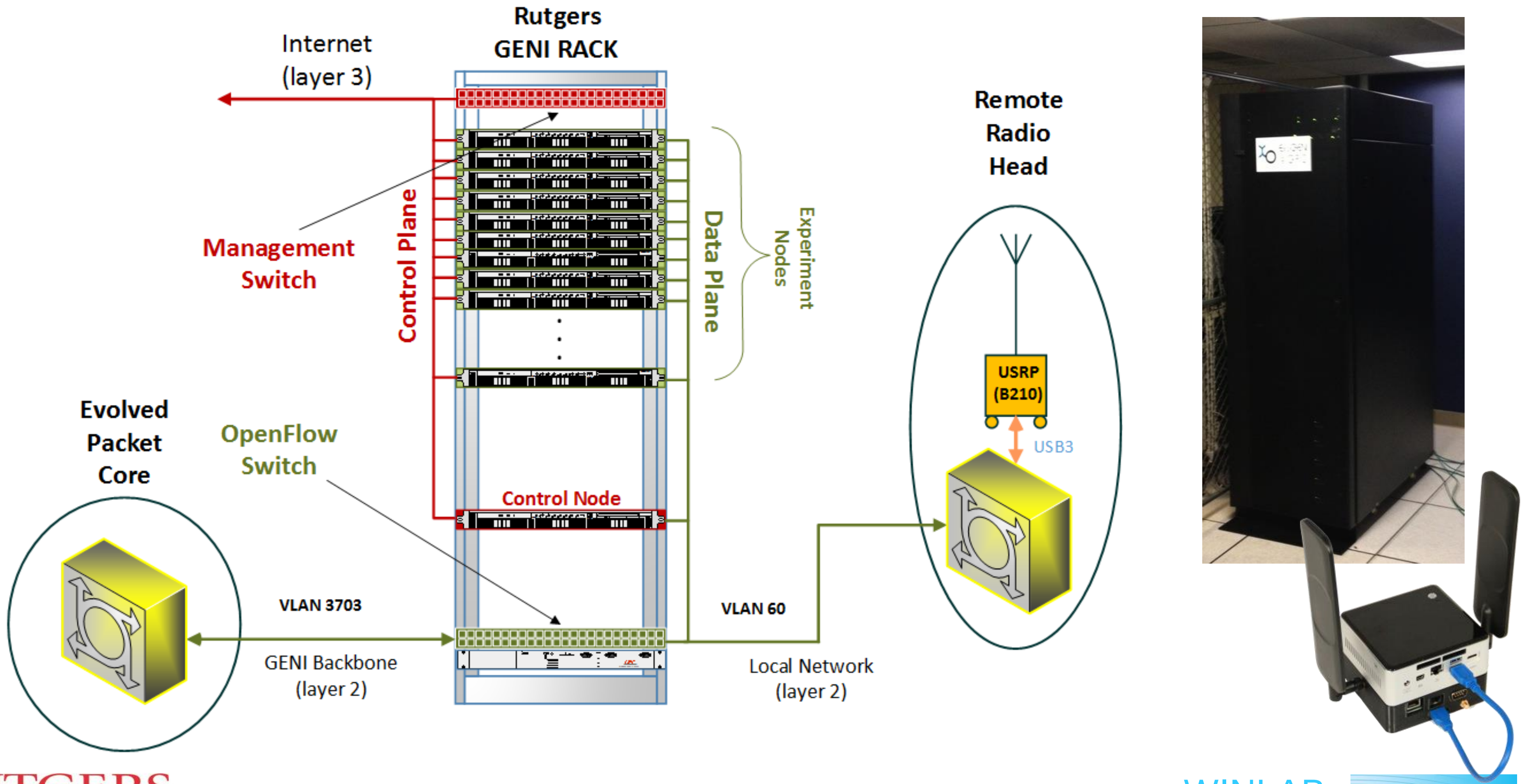
- **32 LTE and WiMAX BS on 14 campuses**
- **SDN (Click and OVS based) datapath/backbone**
- **Sliced, virtualized and interconnected through Internet2**
- **10 mini-ORBIT deployments some with SDRs**



GENI LTE eNodeB Platforms

Ip.access	Amarisoft (USRP)	OAI (USRP)	Airspan
			
FDD	FDD/TDD	FDD/TDD	TDD/(FDD)
10MHz	20 MHz	10 MHz	20 MHz
2 x 10 dBm	20 dBm	20 dBm	2 x 37 dBm (2 x 40 dBm)
13 Mbps	BW limited	30 Mbps	70-300 Mbps
4 (max idle 64)	BW limited	5 (25)	> 100 (256)

OAI ePC in GENI Rack



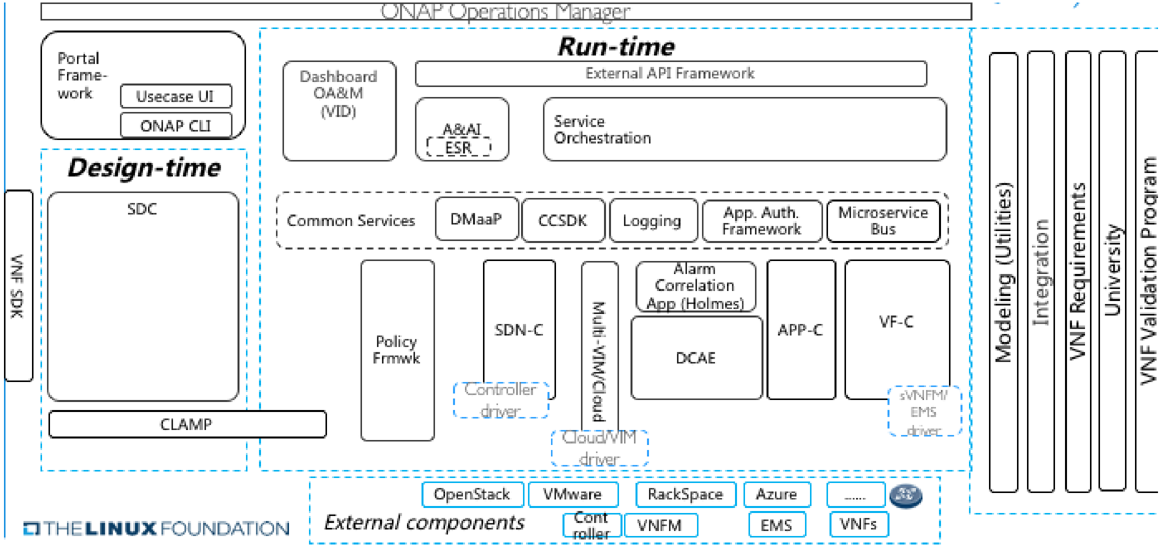
ONF Wireless & Mobile Working Group (WMWG)

- Mission and Goals
  - Examine the unique requirements of SDN in wireless and mobile networks
  - Simplify the interaction between wireless physical networks and packet networks with centralized control and management.
  - Develop reference architectural descriptions that encompass different elements of ONF based technologies in wireless and mobile network domains
  - Identify enhancements to ONF technologies to improve operation of mobile and wireless networks.
    - *ONF technologies include OpenFlow Switch, OF-Config Protocols, Northbound interfaces and associated architectures.*

Open Network Automation Platform (ONAP)

"Open source software platform that delivers capabilities for the design, creation, orchestration, monitoring, and life cycle management of:

- Virtual Network Functions (VNFs)
- The carrier-scale Software Defined Networks (SDNs) that contain them
- Higher-level services that combine the above"



Design-Time Environment

- Design, define and program the platform

Execution-time environment

- Execute the logic programmed in the design phase.

ONAP
OPEN NETWORK AUTOMATION PLATFORM

ONAP Open Labs

Provide an End to End testing on real environment, focusing on:

- Help promote the industry adoption through demonstrating ONAP capabilities
- Interoperability testing with multi-vendor's hardware and software in "real" environment (without IT constraint).
- Continuous Integration and Conscious distribution testing with all components (i.e. OpenStack, etc.)

China Mobile ONAP Lab	China Mobile	Beijing, China
Reliance Jio R&D Labs	Reliance Jio Infocomm	Maharashtra, India
China Telecom ONAP Lab	China Telecom	Beijing, China
WIP	Intel	USA

China Mobile ONAP Lab	China Mobile	Beijing, China
Orange Integration Center	Orange	France
TLAB	AT&T Advanced Technologies	USA
ORBIT/WINLAB	Rutgers University/AT&T	USA

ONAP OPEN NETWORK AUTOMATION PLATFORM

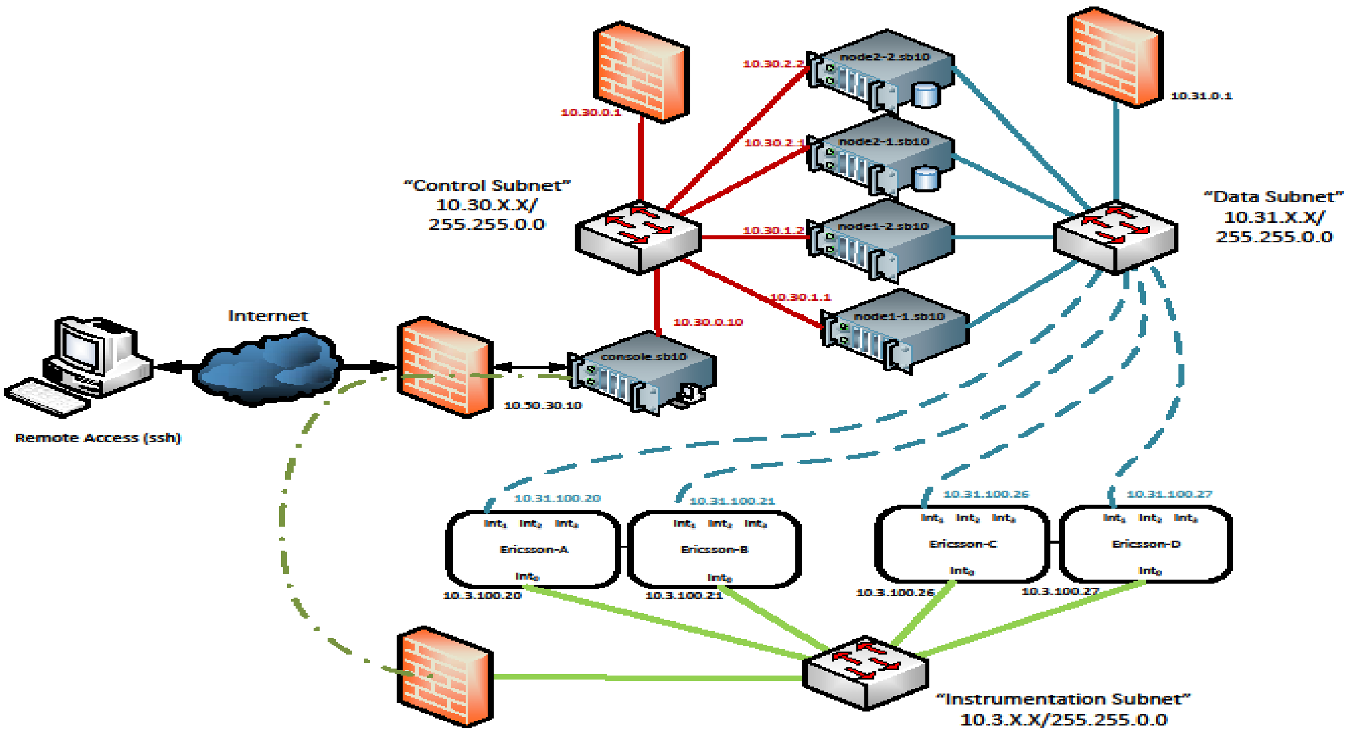
ONF Wireless Transport 3rd Proof Of Concept (PoC)

Scope of the PoC:

- Extend the standardized µWave/mmWave model in a multivendor microwave network to cover all parameters modeled by TR-532
- Verify/validate the extensibility of the model to mmWave equipment (both indoor and outdoor)
- Demonstrate new use cases: ‘closed Loop automation’, ‘frequency spectrum management’, ‘Test Automation’.

Hosted by AT&T in WINLAB, 24-28 October 2016

Permanent ONAP Testbed



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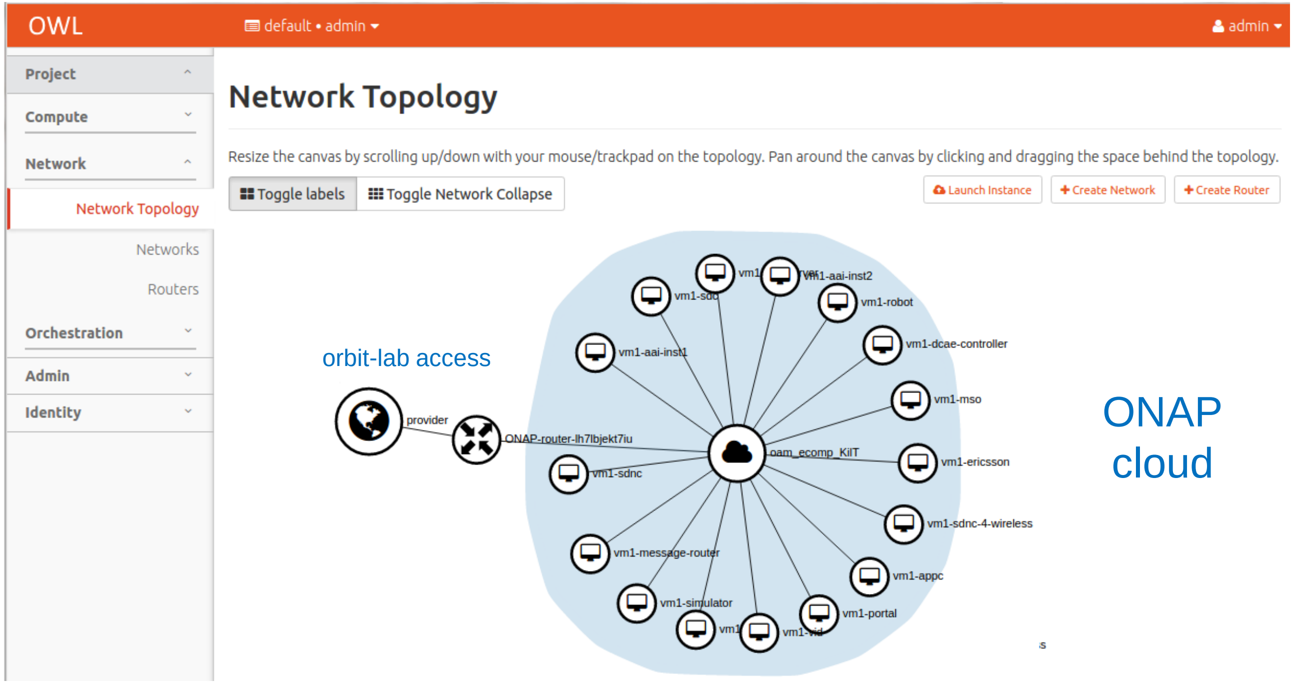
OWL (ONAP Wireless Lab) secure access

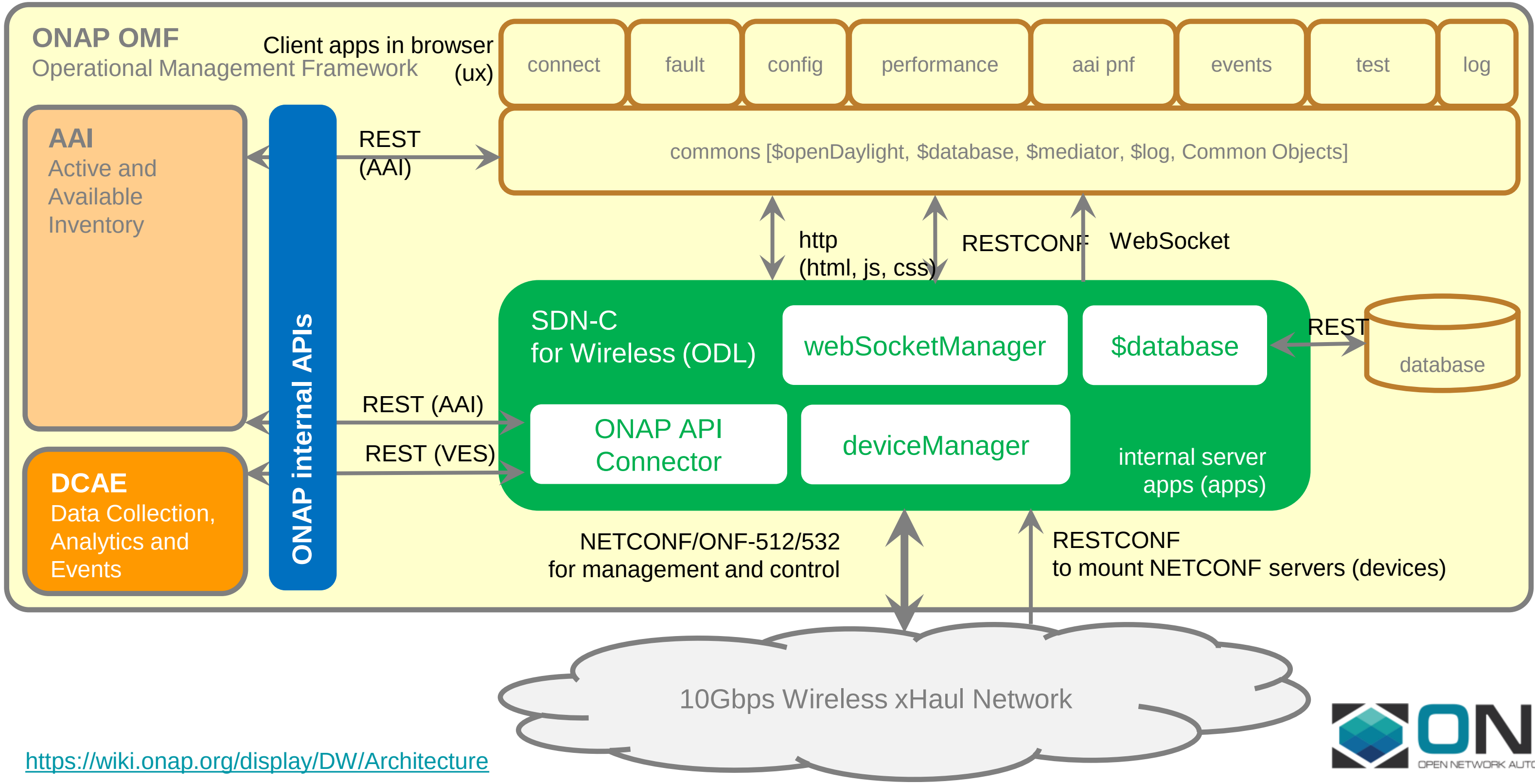


Screen shot: OWL OpenStack Network Topology 2017-09-06

3 step security:

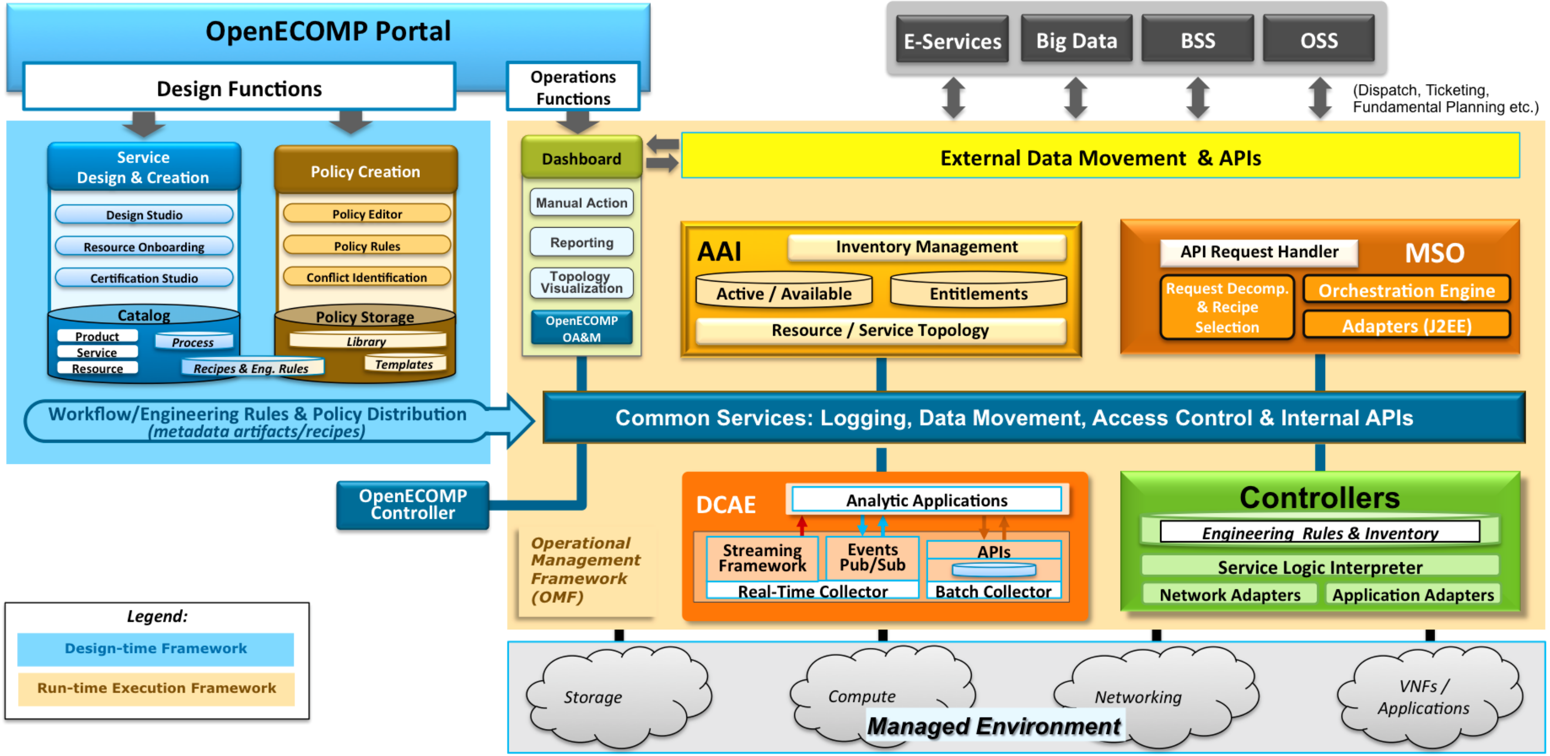
1. Registered access from the internet to orbit-lab
2. Limited access for selected members from ORBIT community to ONAP cloud, (controlled by ONAP).
3. VM/application specific access mechanisms (SSH, Basic-auth, certificates, etc.).

10Gbps Wireless xHaul (ONAP architecture + ONF apps)



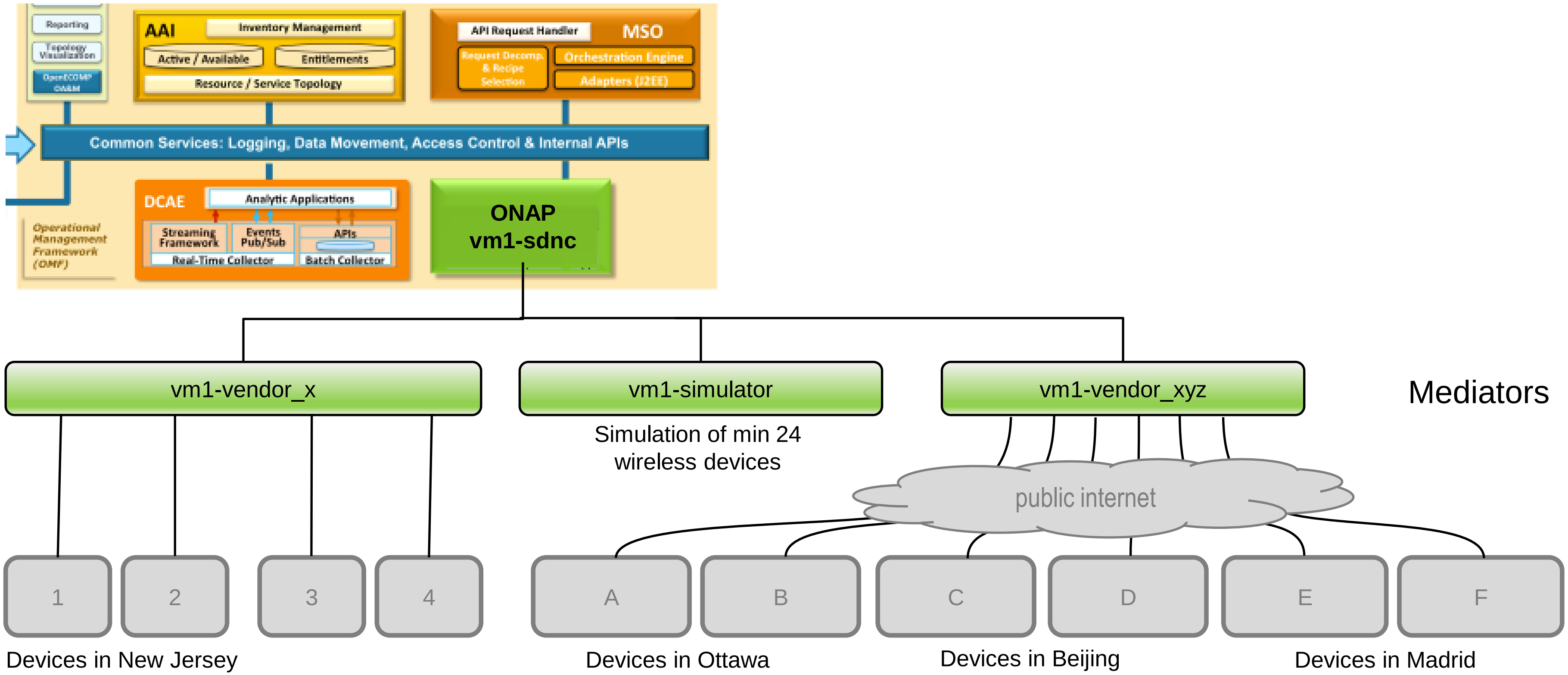
https://wiki.onap.org/display/DW/Architecture

ONAP Architecture

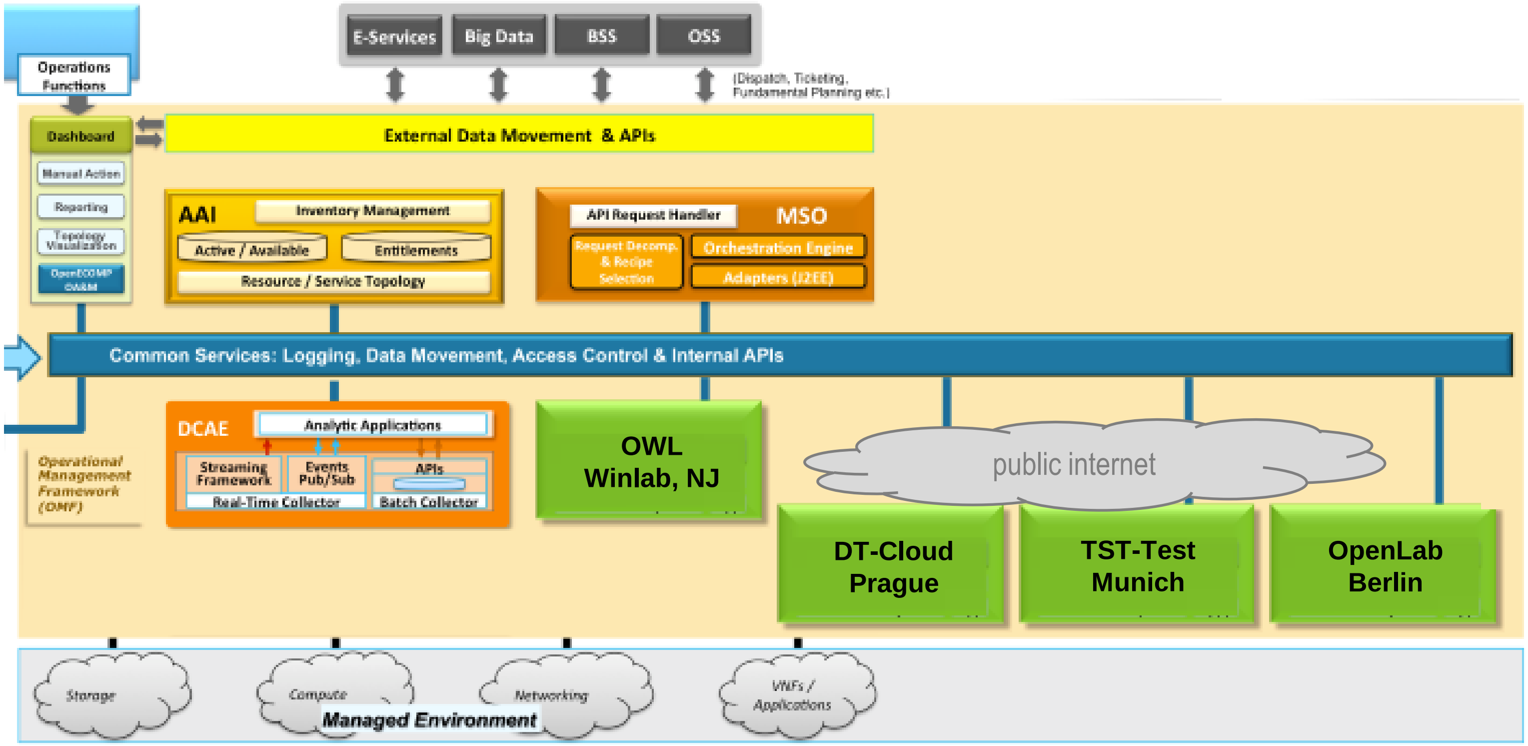


ONAP
OPEN NETWORK AUTOMATION PLATFORM

Example → Network Adapters (mediators) @ OWL (ORBIT)



Multi-vendor/operator 4.1th PoC (Nov. 27th)



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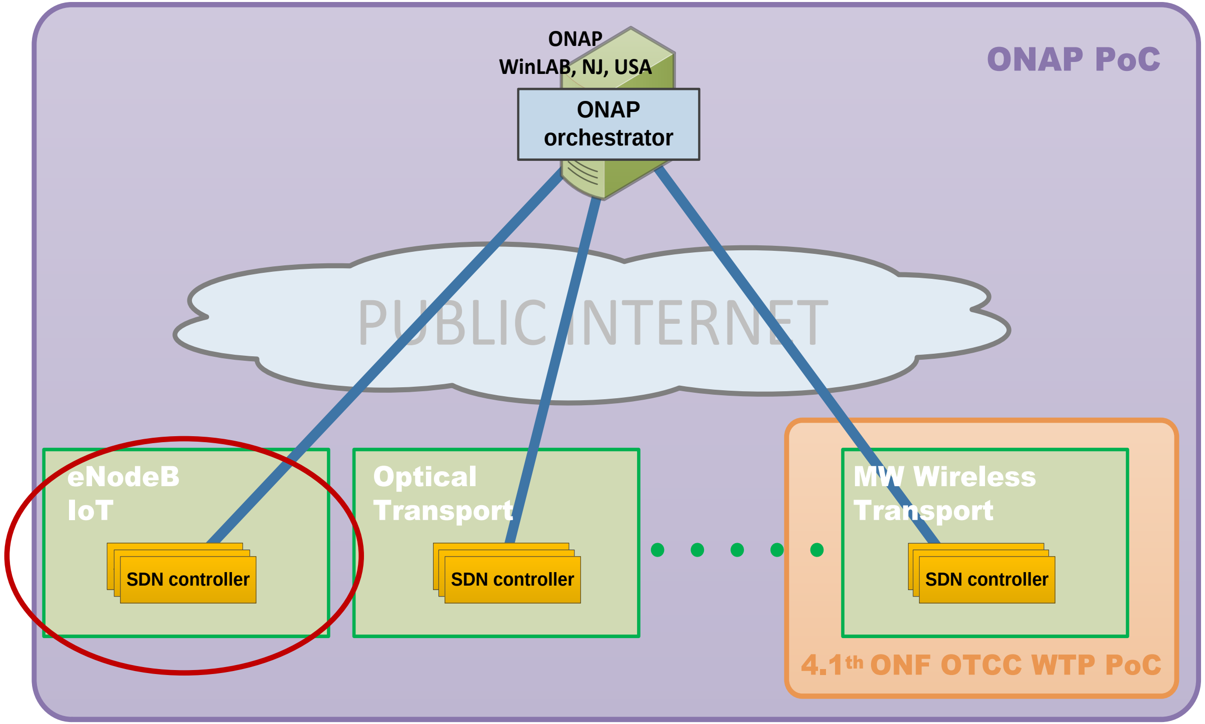
OPEN NETWORK AUTOMATION PLATFORM

4.1 PoC: Multi-domain multi-technology ONAP



- Expand ONAP support to other wireless devices
- NETCONF with YANG model for eNodeBs
- Can we do it for OAI

Platforms for Advanced Wireless Research

DRIVING FUTURE ADVANCED WIRELESS TECHNOLOGIES

Silently, invisibly, all around us, wireless signals sail through the air, transmitting information: emanating from our smartphones, pacemakers, pollution sensors, and even satellites millions of miles away in space.

Over the last decade, there has been widespread growth in the emergence and use of mobile, connected devices that use wireless transmissions.

But experts believe this is just the tip of the iceberg. In the future, as wireless communications technologies get cheaper and smaller, more and more devices will connect wirelessly to global networks – receiving and broadcasting their status, and acting on this information – giving rise to the internet of things and a smarter, more connected world

The Administration's Advanced Wireless Research Initiative, led by the National Science Foundation, seeks to spur the development of new wireless technologies as well as the research infrastructure necessary to test innovations at large scales.

Millimeter-Wave (mmWave): ultra-high-frequency millimeter-waves have been shown to transmit data at ultra-high speeds across networks that cover a few city blocks, making it possible to download the equivalent of a high-definition movie within a few seconds.

Dynamic spectrum sharing: devising technologically, economically and legally feasible ways to share limited radio spectrum bandwidth would allow wireless providers to serve an exponentially growing number of devices – expected to exceed one trillion devices over the next decade.

Network virtualization: software-defined networking (SDN) and software-defined infrastructure (SDI) are enabling improved security, performance and resilience in both the wired and wireless communications.