

Next Generation Campus Network

Affan Basalamah
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Outline

- Business Requirements
- Technical Requirements
- Implementation
- Get Results
- Closing

Cerita Awal

- Waktunya core network upgrade setelah 10 tahun lebih
- Saatnya teknologi baru untuk requirements baru
- Saatnya berpikir kembali



Institut Teknologi Bandung

Aula Barat ITB



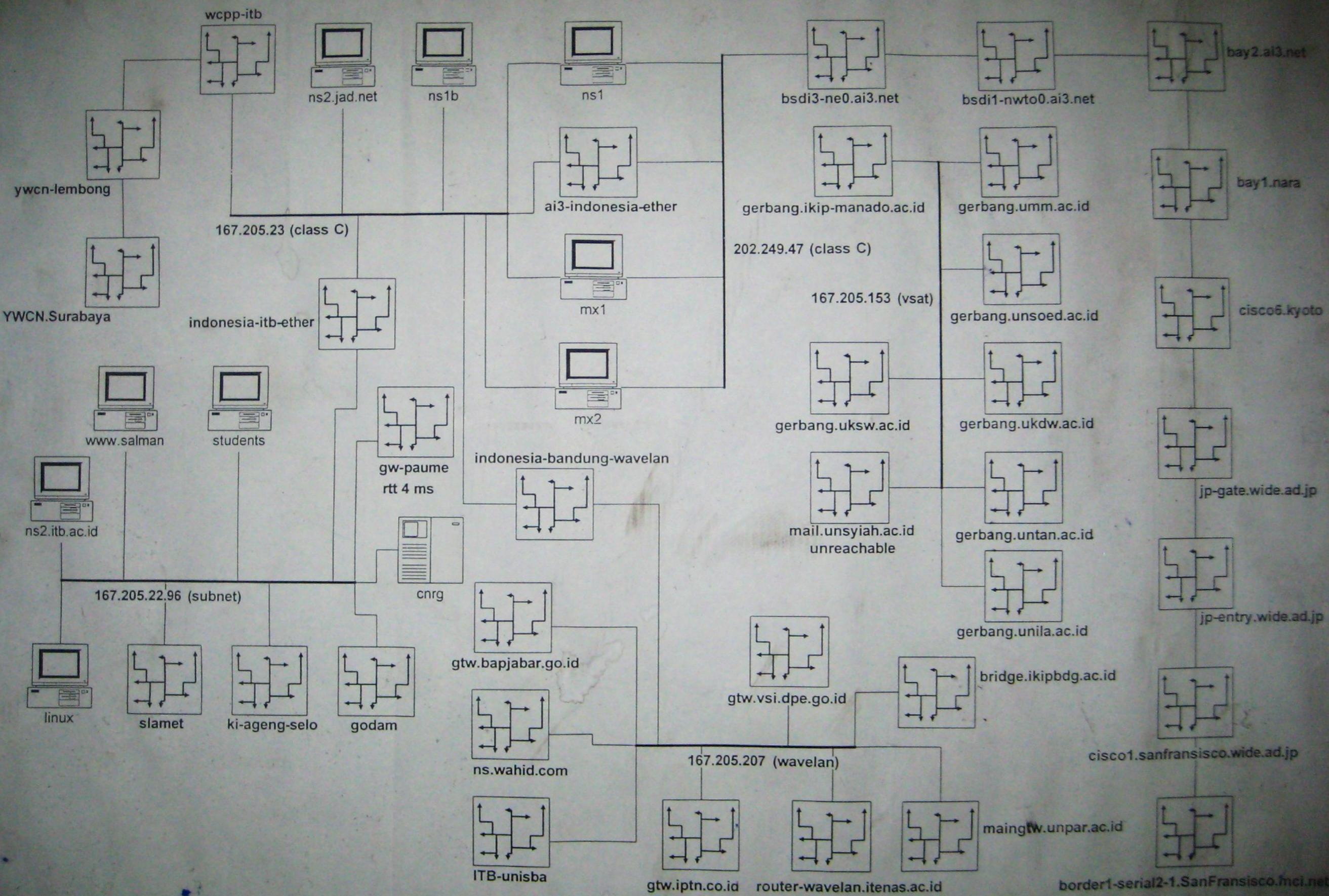
Observatorium Bosscha



Gedung PAU ITB

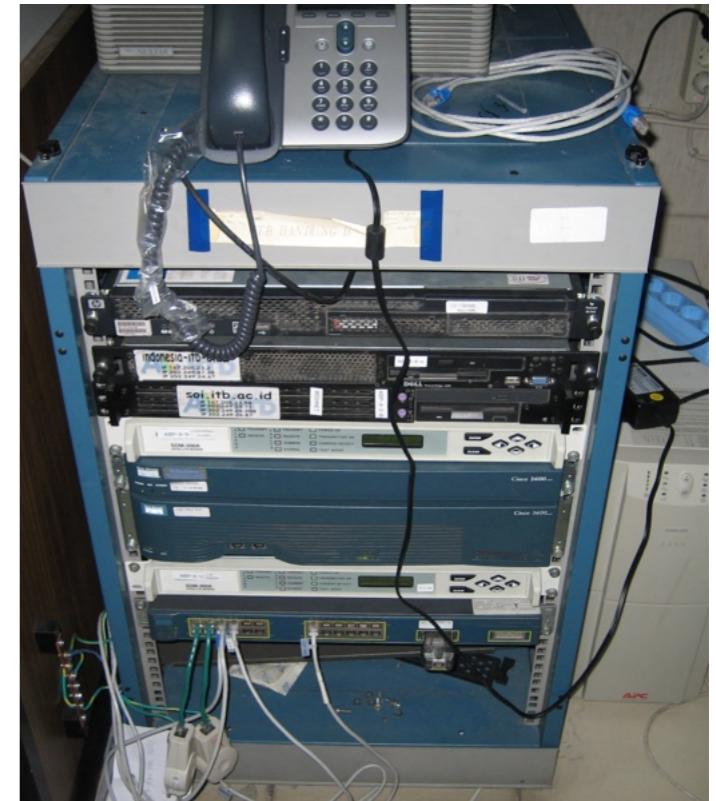
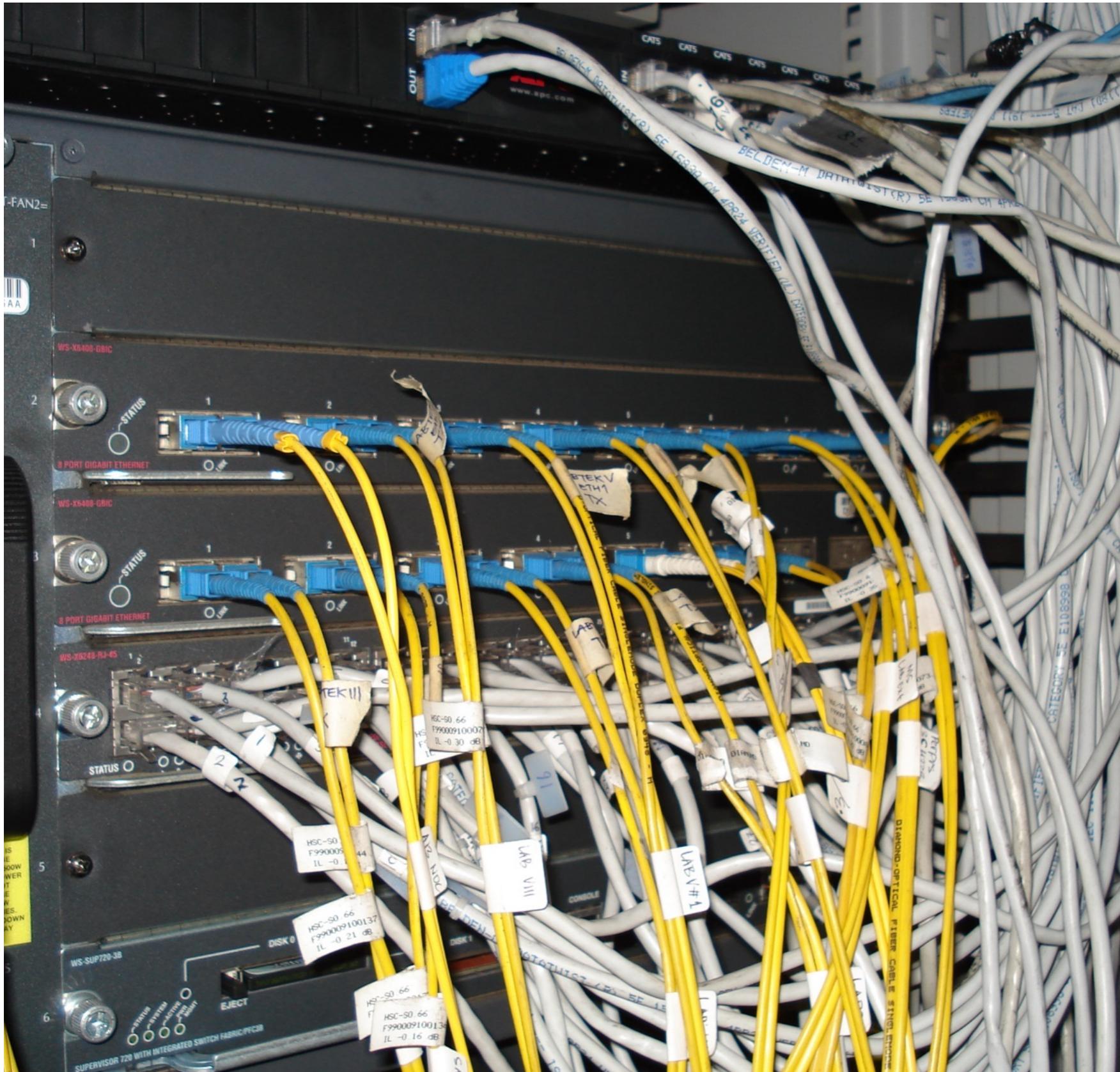


TOPOLOGI JARINGAN INTERNET AI3 - ITB





Era Kabel Kuning dan WaveLAN



Era Cisco Catalyst 6500, Fiber Optic dan PC Router

What's Next?

”خَيْرُ النَّاسِ أَنْفَعُهُمْ لِلنَّاسِ“

“Sebaik-baik manusia adalah yang paling bermanfaat bagi orang lain”

(HR. Ahmad, Thabranī)

“The value of a network grows
as the square number of its
users: $V \sim N^2$ ”

-Bob Metcalfe

Tantangan

- Meningkatkan value dari network
- Menambah jumlah connectivity
 - Menambah jumlah pihak yang tersambung
- Infrastruktur tidak mendukung
 - Hanya didesain untuk enterprise network

Arah masa depan

- Value dari university meningkat karena memiliki connectivity dengan berbagai institusi
- University memberikan manfaat lebih bagi sekelilingnya, diakselerasi dengan IT

Era baru (1)

- End user bukan lagi berwujud komputer (desktop/laptop)
 - Smartphone, tablets
 - Printers, IP Phone, IP camera
 - Smartwatch, (Google) Glass, health accessories
 - Sensor-sensor

Era baru (2)

- Universitas harus mampu berkolaborasi dengan pihak lain
 - Universitas dan lembaga pendidikan lainnya
 - ISP, Mobile broadband, Content Providers
 - Enterprise - Bank, Payment gateway, dsb.
 - Instansi Pemerintah
- Output: Kerjasama baru menggunakan layanan baru
Bisnis

Era baru (3)

- Universitas sebagai area live labs dan PoC teknologi
 - Software Defined Networking (SDN)
 - High Performance Computing (HPC), BigData
 - Internet of Things (IoT)
 - Teknologi Service Provider skala kecil
- Output: SDM yang sudah familiar dengan teknologi terkini sebelum meninggalkan kampus sebagai orang dengan skill yang relevan dengan industri

Tridharma Perguruan Tinggi

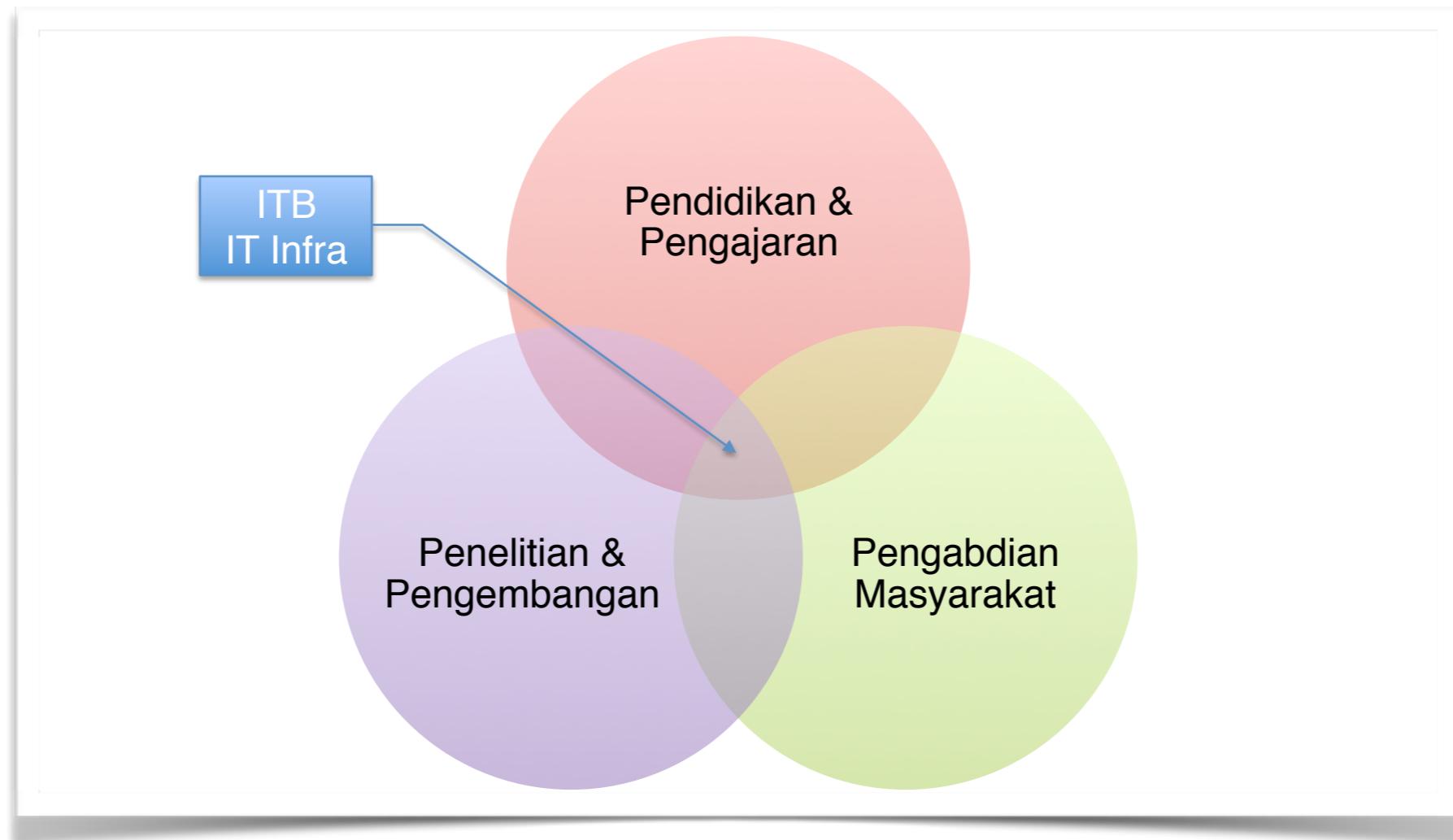
- Pendidikan dan Pengajaran
 - Pembelajaran adalah proses interaksi mahasiswa dengan dosen dan sumber belajar pada suatu lingkungan belajar
- Penelitian dan Pengembangan
 - kegiatan yang dilakukan menurut kaidah dan metode ilmiah secara sistematis untuk memperoleh informasi, data, dan keterangan yang berkaitan dengan pemahaman dan/atau pengujian suatu cabang ilmu pengetahuan dan teknologi.
- Pengabdian kepada Masyarakat
 - kegiatan sivitas akademika yang memanfaatkan Ilmu Pengetahuan dan Teknologi untuk memajukan kesejahteraan masyarakat dan mencerdaskan kehidupan bangsa.

Tridharma Perguruan Tinggi

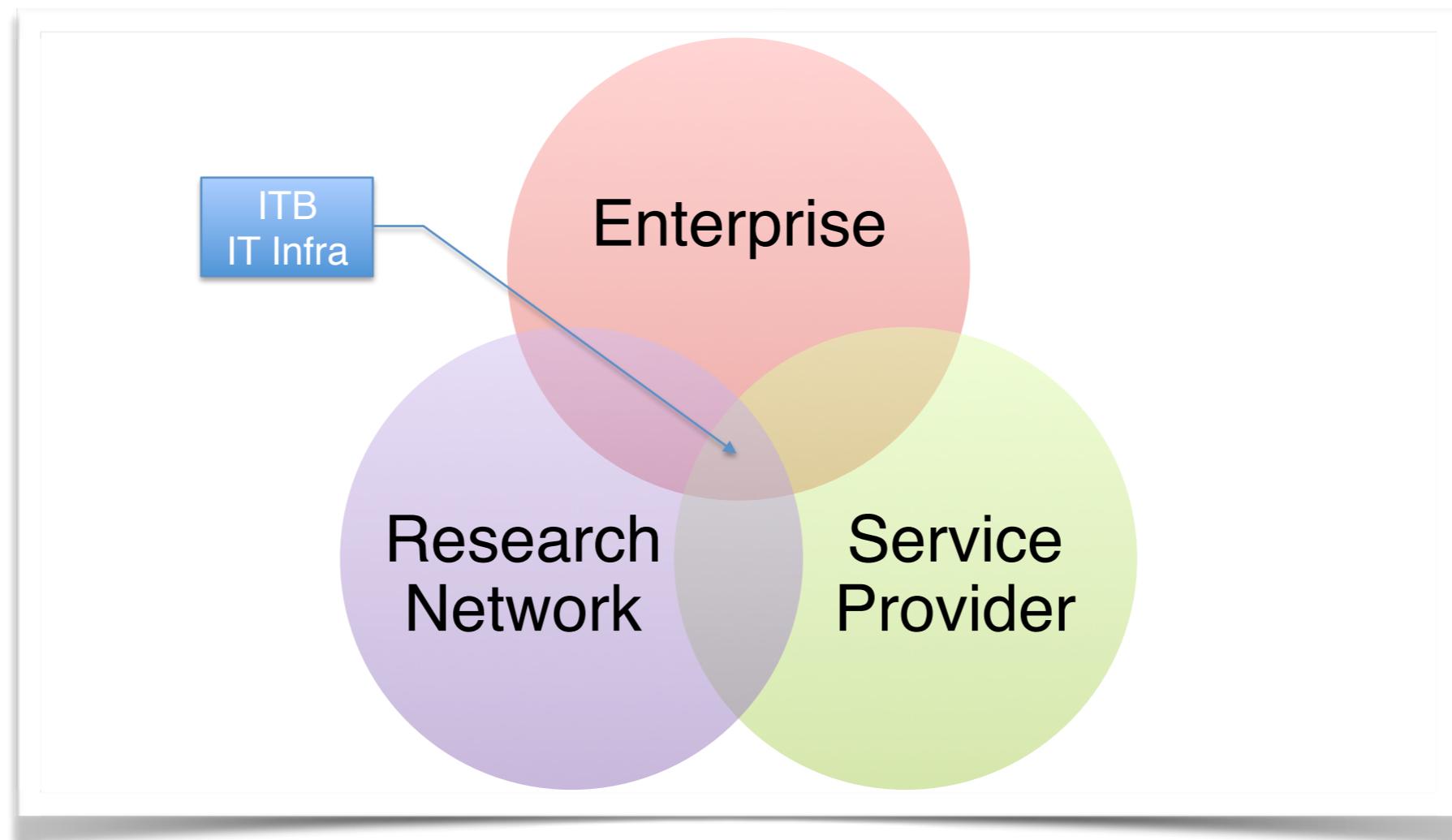
UU no. 12/2012

1. Pendidikan dan Pengajaran
2. Penelitian dan Pengembangan
3. Pengabdian kepada Masyarakat

Tridharma Perguruan Tinggi



Implementasi Infrastruktur



Technical Requirements

- Running legacy apps on IPv4 and IPv6
- Multi-tenancy SP technology
 - Networking with MPLS VPN
 - Datacenter with open cloud technology
- Research network with SDN OpenFlow support

Enterprise Network

- Keep business network running as usual
 - Layer 2: switching - VLAN, STP
 - Layer 3: routing - static, OSPF, BGP
 - Layer 4: policy-based routing (PBR), ACL, Firewall
 - Layer 7: conventional application on datacenter

Research Education Network

- Research lab on live campus network
 - High Performance Computing (HPC) & BigData
 - Software Defined Network (SDN)
 - Internet of Things (IoT)
- Specific network for specific research purposes
 - Astronomy
 - Weather Simulation

Service Provider Technology

- Create new opportunities with new services
 - Layer 2: L2VPN, VPLS, GRE tunnel
 - Layer 3: VRF and L3VPN
 - Layer 7: Datacenter virtualization: VMware, KVM



**ITB
Enterprise**

ITB Next Generation Campus Network



ITB Enterprise Network



Core Network

- 1 GbE optical & 1GbE copper
- 10 GbE optical, Ready for 40/100 GbE
- Enterprise features: STP, VLAN, OSPF, BGP, IPv6
- Service Provider: MPLS, L3VPN, L2VPN, VPLS
- Software Defined Network (SDN): OpenFlow v1.0/1.3
- ITB choose Brocade MLXe-8 Router



Enterprise Network Technology

- L2 Switching
- L3 Routing: OSPF
- IPv6 Routing (OSPFv3, BGP)
- IPv6 Multicast Routing
- Policy Based Routing (PBR) and Access Control List (ACL)
- Existing network working as usual

High Availability Features

- Redundant Management Module
- Redundant Power Supply with new UPS
- Link Aggregation Groups (LAG)
- BiDirectional Forwarding Detection (BFD)

Network Security Features

- Management network CPU protection
- L2 ACL, IPv4 & IPv6 ACL
- SSH & SCP authentication via TACACS+ & RADIUS
- DDoS Rate Limit Protection

Management Network

- Dedicated ethernet management port
- SNMP
- TACACS+ & RADIUS
- Support RANCID
- NTP
- Syslog
- SFlow
- NETCONF

Datacenter Network

- 10 GbE & 40 GbE interfaces
- Supporting Server technology:
 - HPC Blade
 - Cloud computing
 - iSCSI Storage Area Networking

Ethernet Fabric

- L2 for virtualization & cloud
- Inter datacenter with VPLS from Core Network
- VMware vCenter management & OpenStack plugins
- Fabric Ethernet technology with TRILL
- Brocade VDX6740 Fabric Ethernet Switch



Edge Gateway Network

- Juniper MX80 for Gateway Router
- Juniper SRX650 for Firewall
- Sophos UTM650 for DPI
- Brocade ADX1000 for Application Delivery Switch
- Cisco ASR1002 for NREN Gateway Router

Access Network

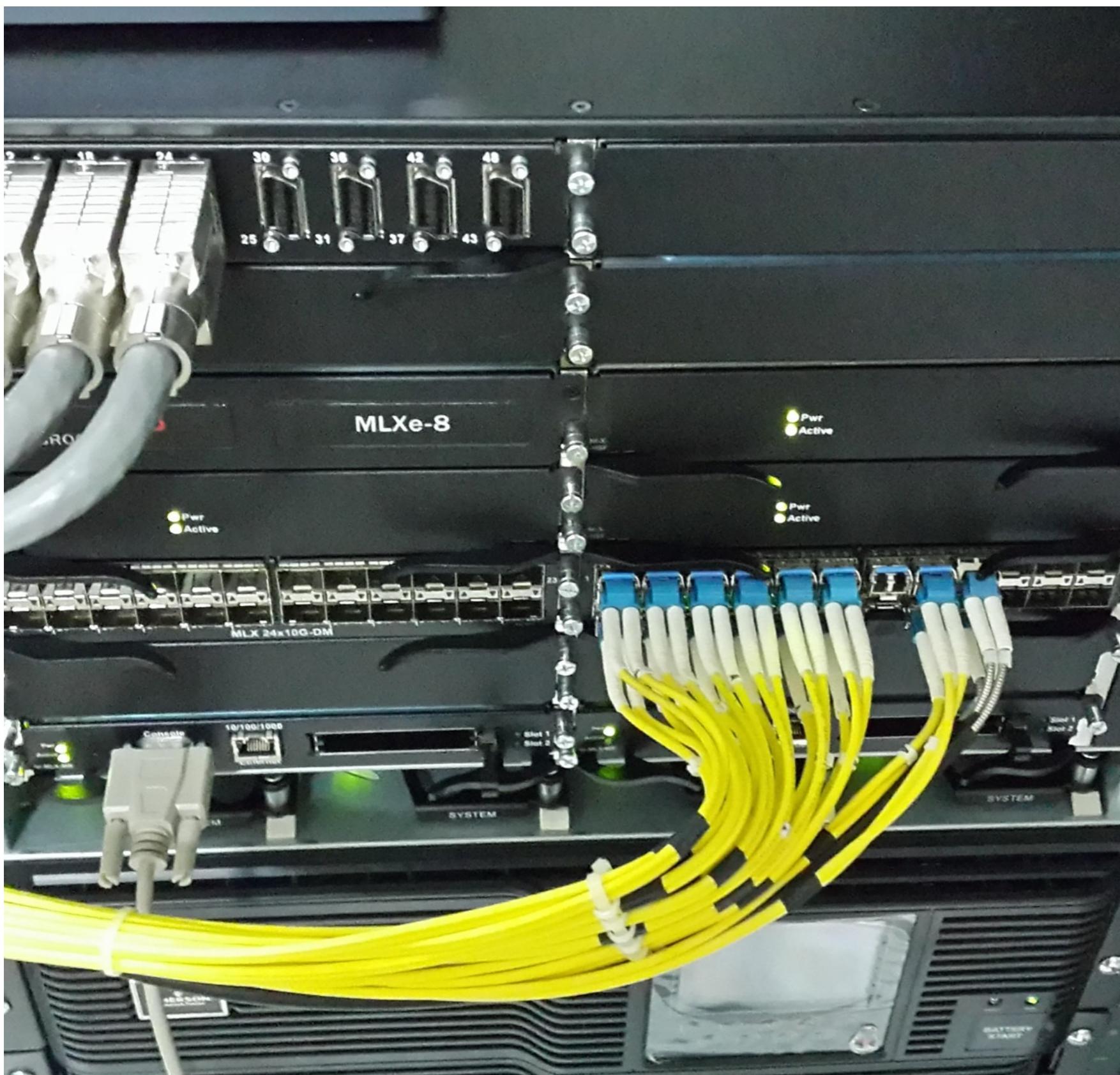
- L2 switches, mixed of:
 - Brocade ICX6430/6450
 - Juniper EX2200
 - Cisco Catalyst 3560
- VLAN & Spanning-Tree
- Security features: DHCP snooping, 802.1x

Wireless Network

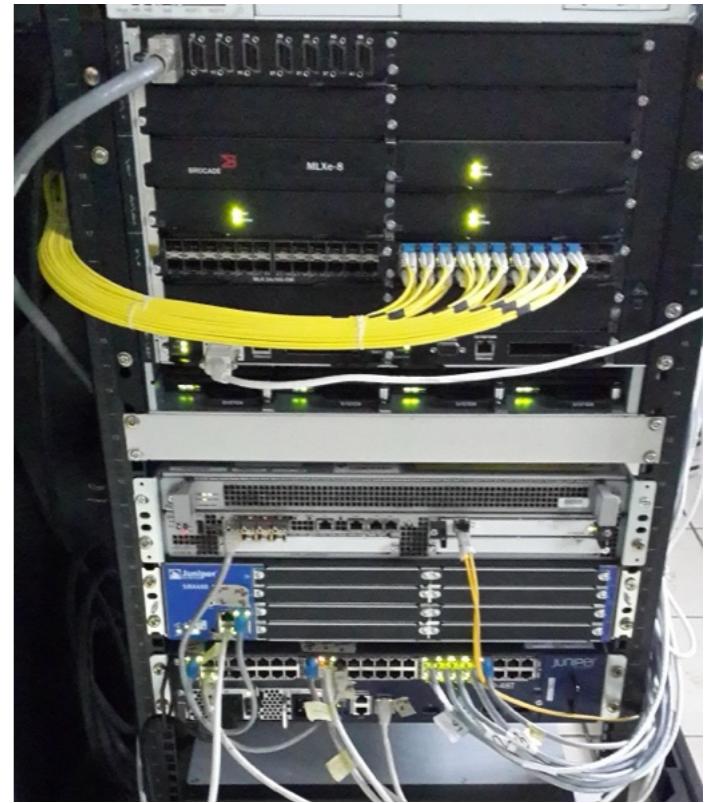
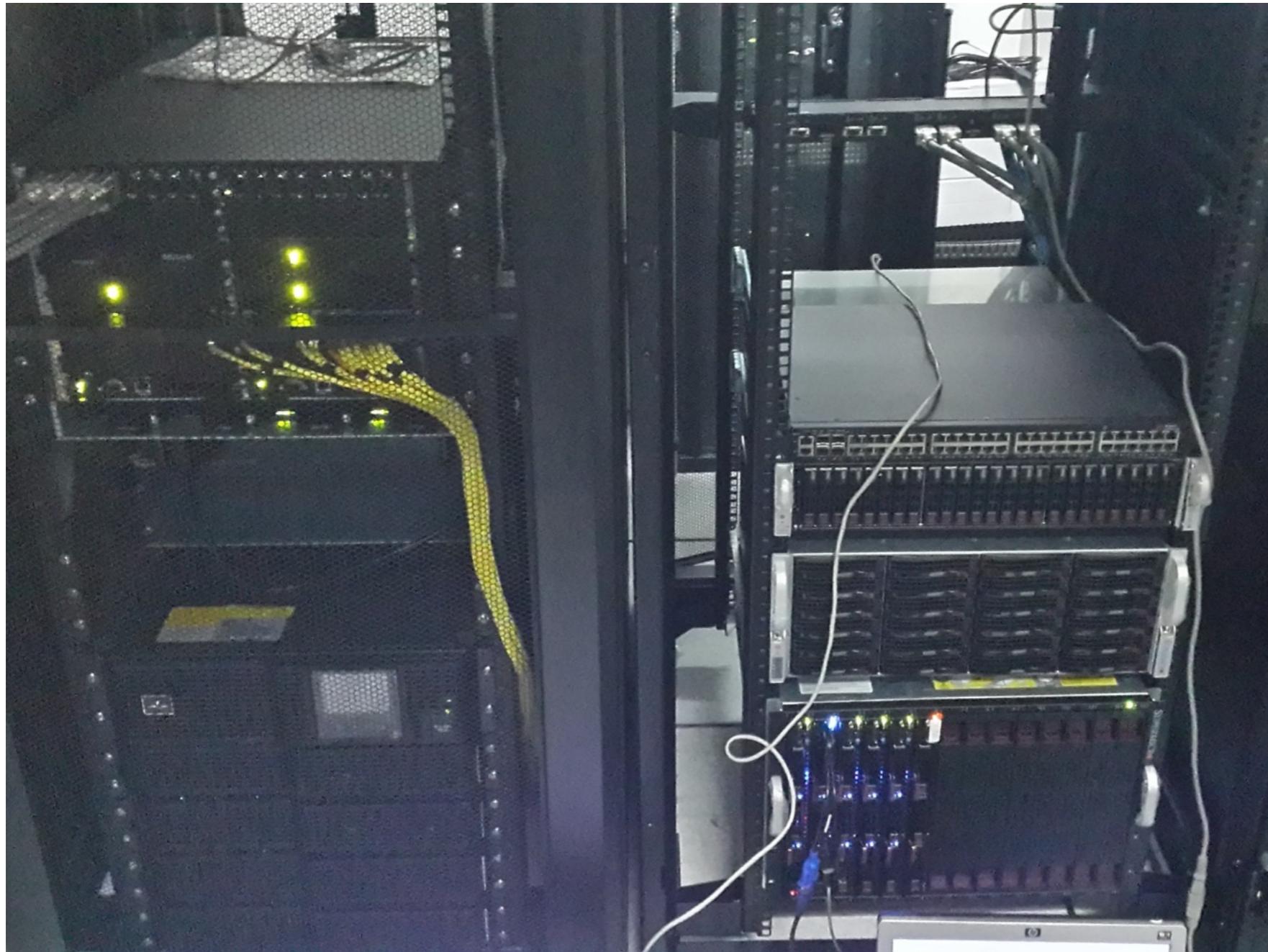
- Ruckus Wireless
 - Wifi Controller
 - Wifi Access Point Indoor
- Ready for 3G Offload in Campus
 - Wifi Access Point Outdoor

Management Network

- Support for existing: SNMP, CLI, feeding Cacti & Nagios
- Management VRF
- SFlow for data collection & telemetry
 - New apps with SFlow-RT with OpenFlow
- NETCONF & YANG
 - Support new application

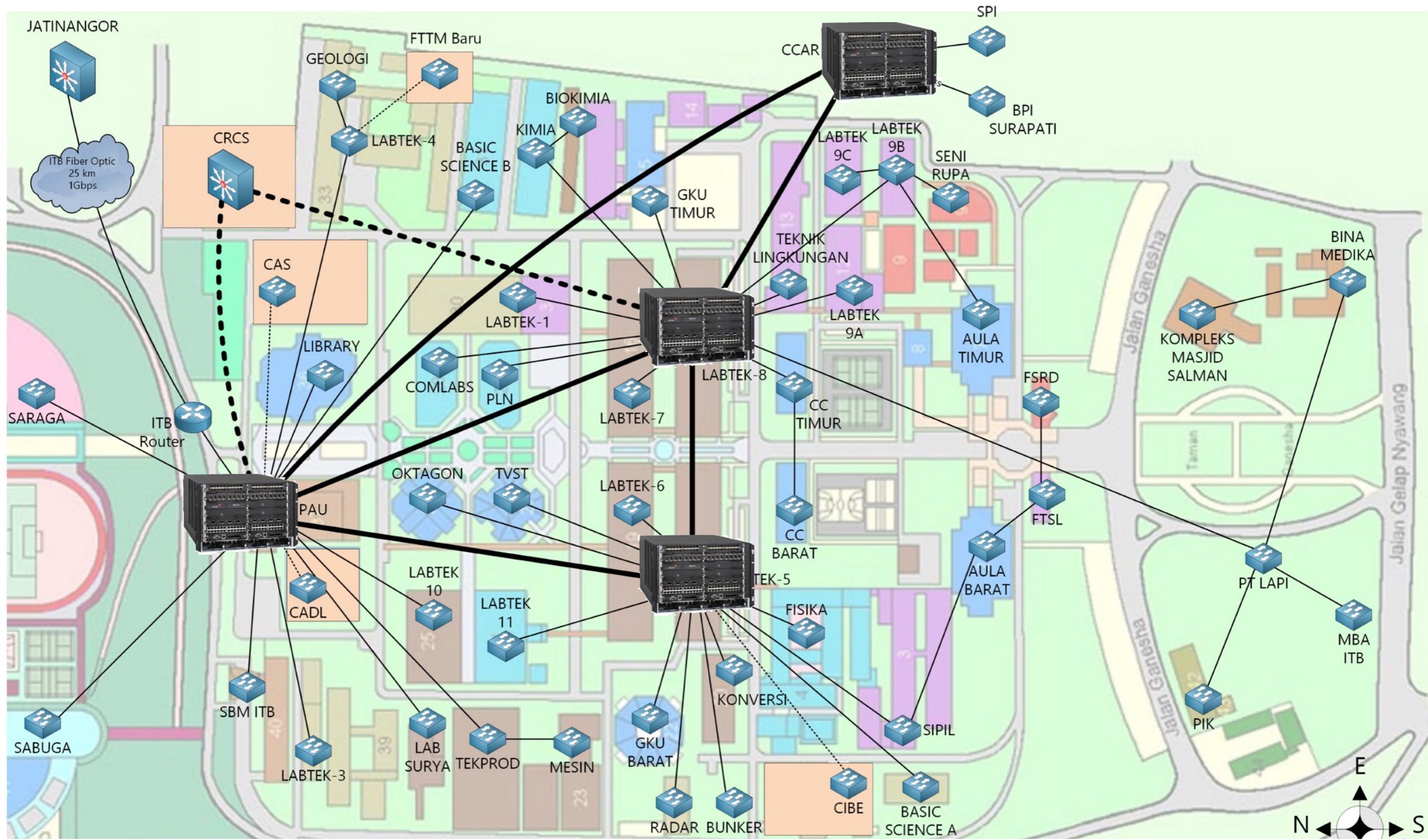


Brocade MLXe-8 Core Network

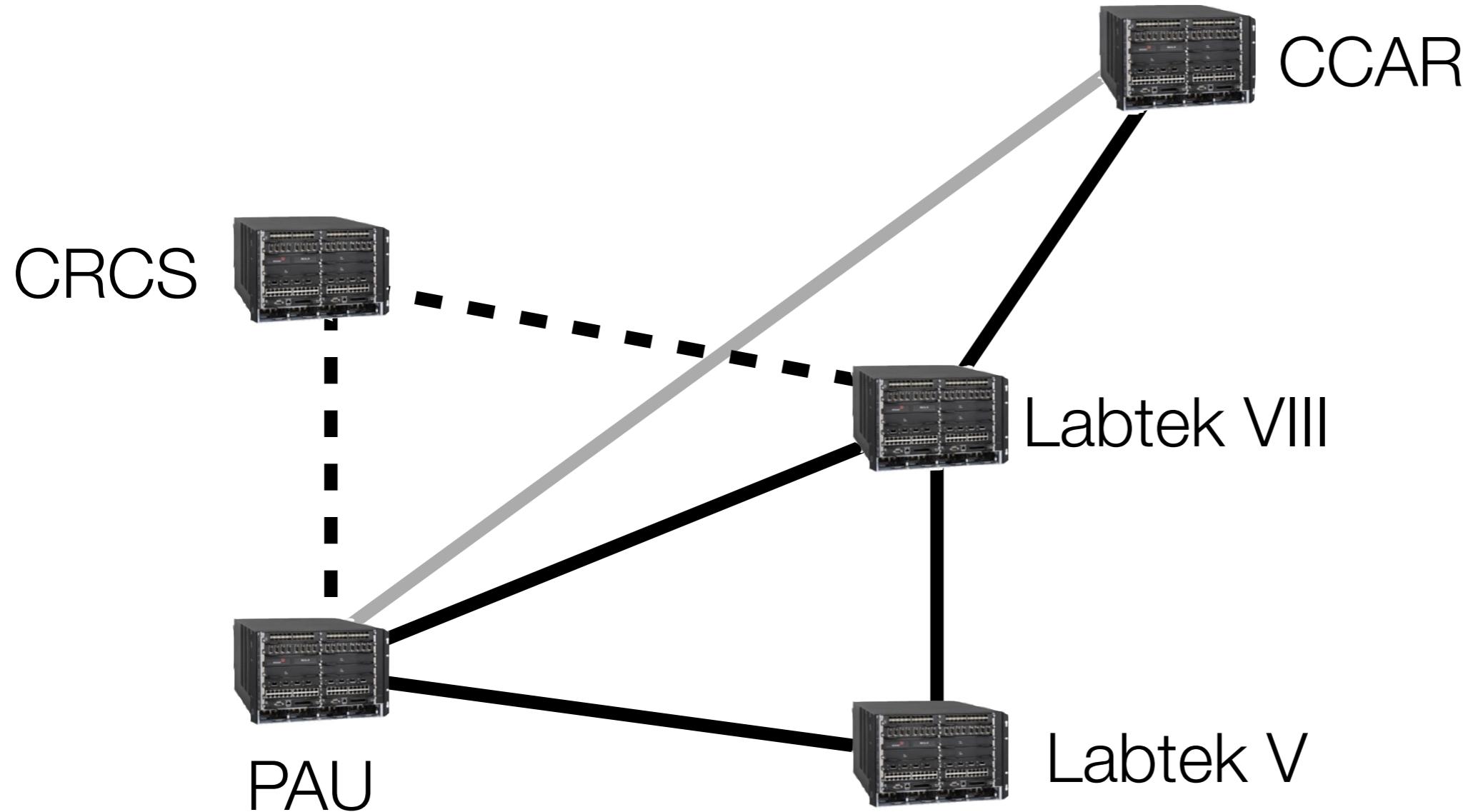


Brocade MLXe-8 Core Network

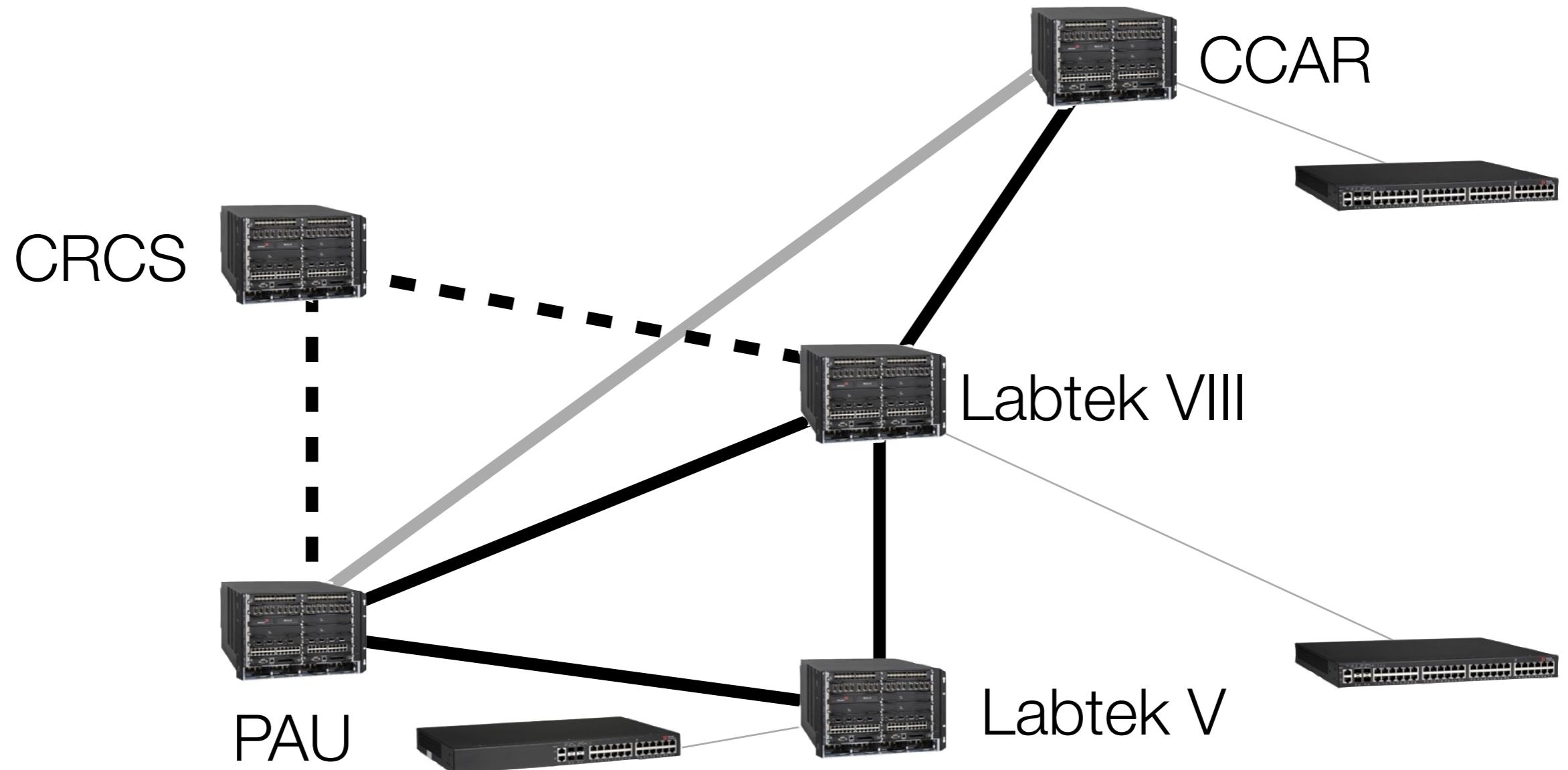
Campus Core Network



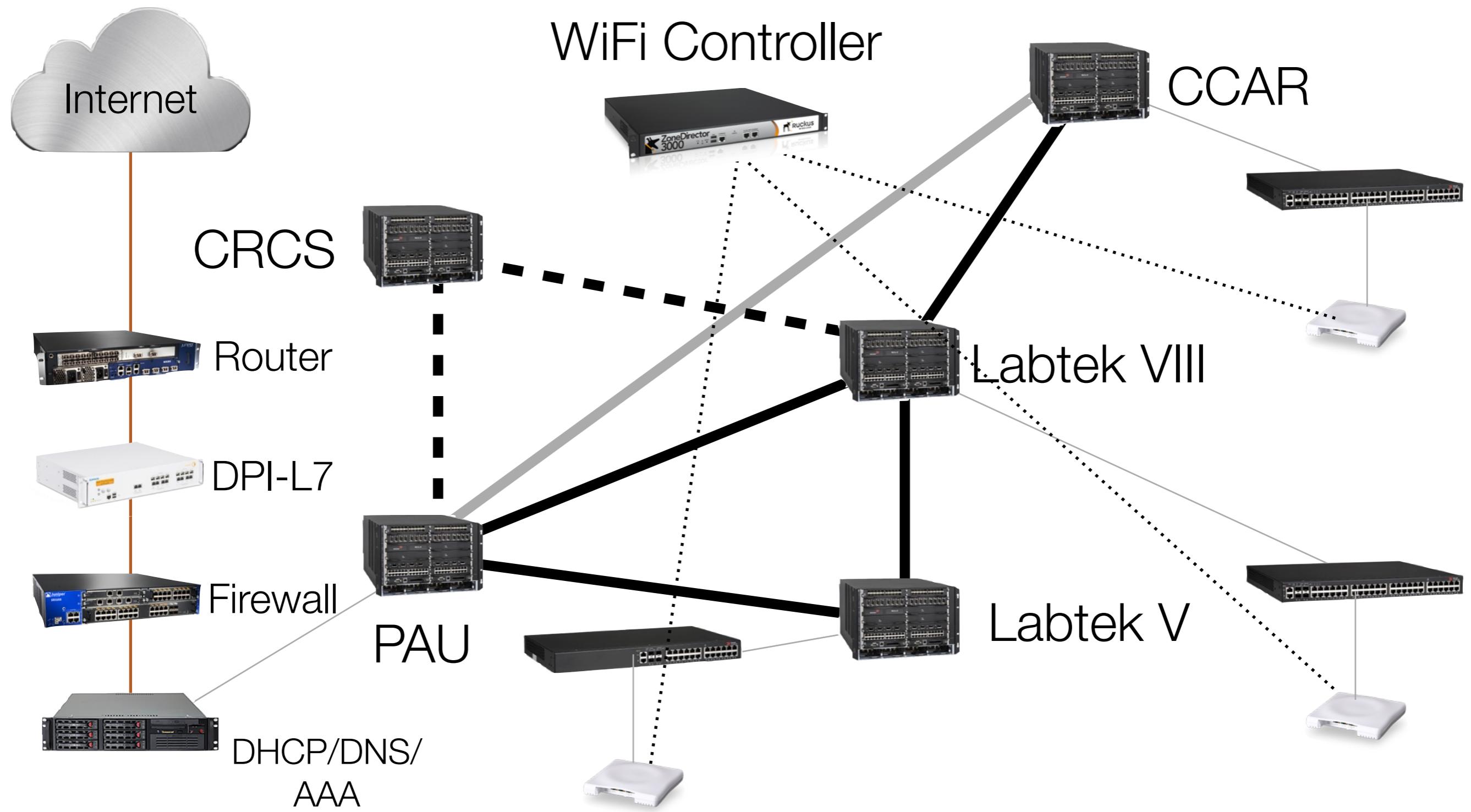
Campus Core Network



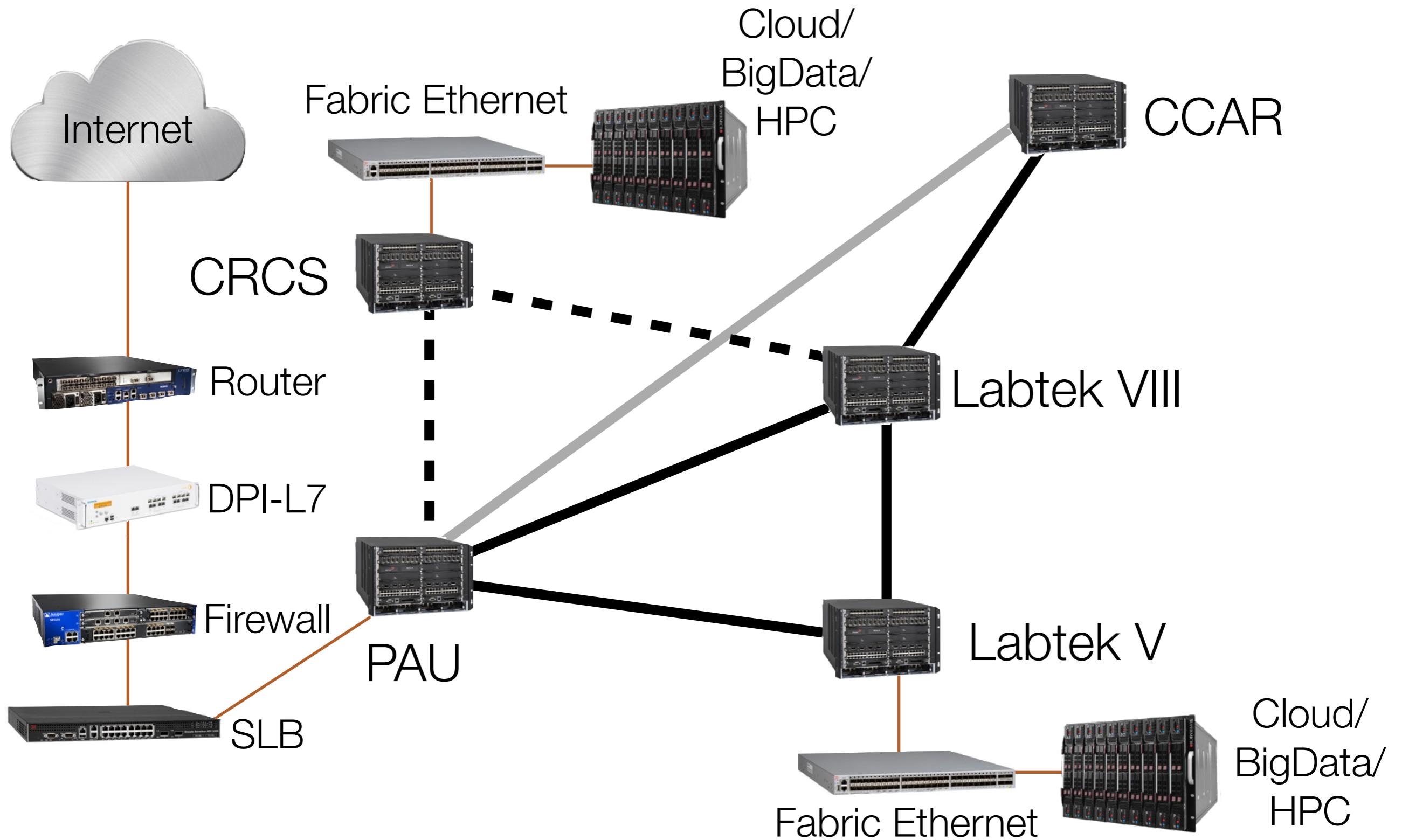
Core & Access Network



Campus Wifi Network



Datacenter Network



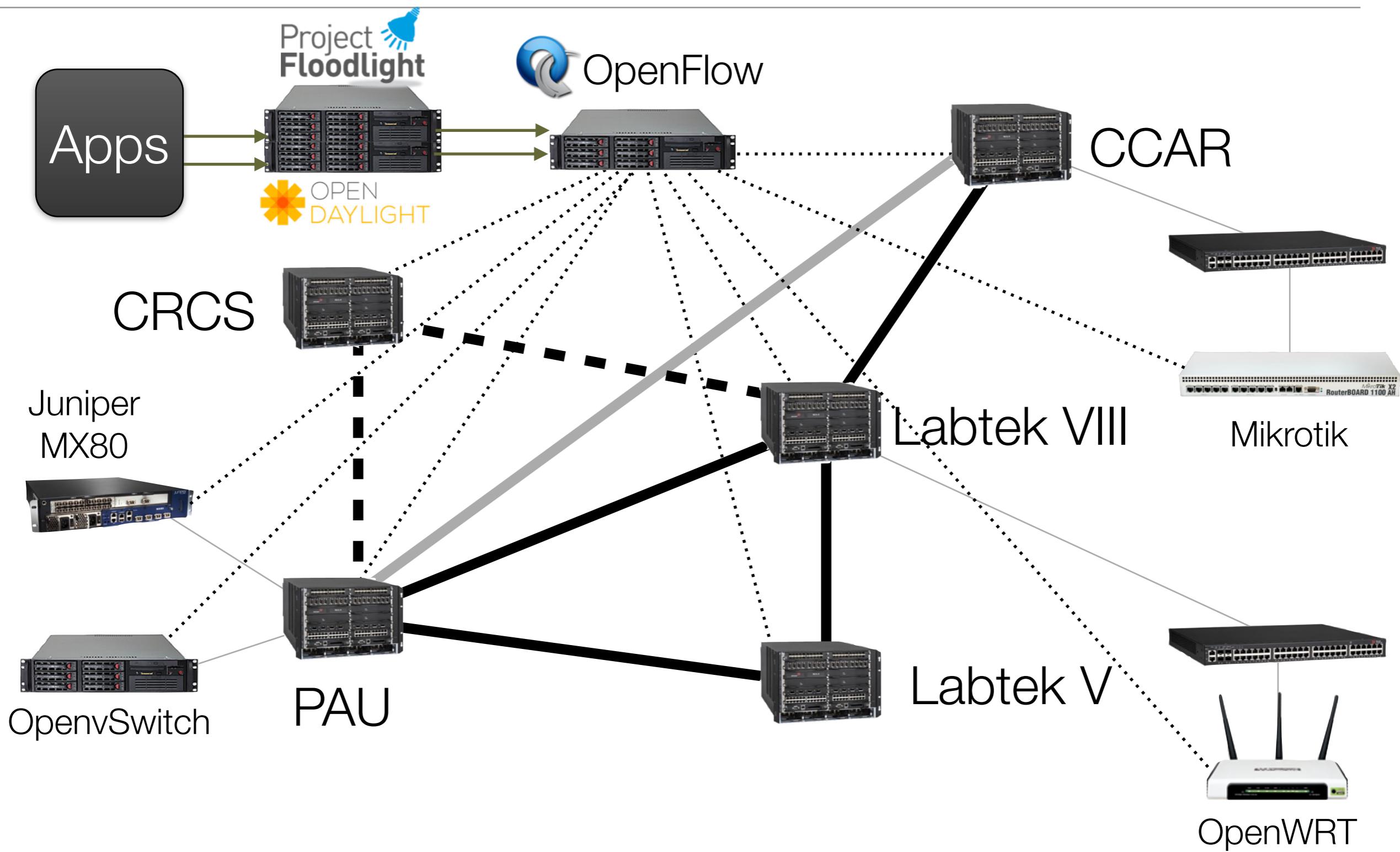
Research & Education Network



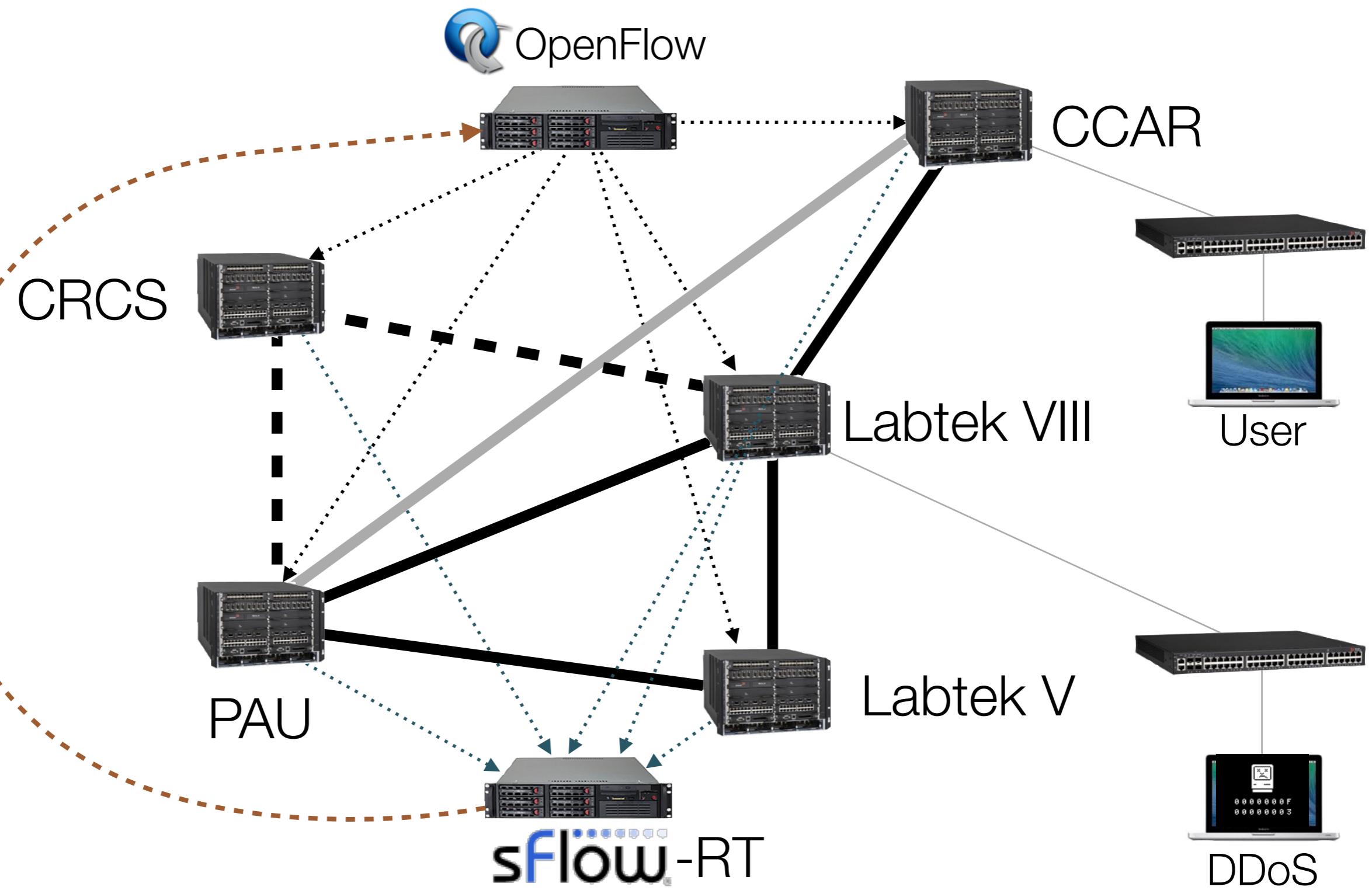
OpenFlow SDN

- Core network support OpenFlow v1.0
- Hybrid Port Mode with Protected & Unprotected VLANs
 - Protected VLANs is not subject to defined OpenFlow flows
 - Regular network can coexist with OpenFlow
 - VPLS support on VLAN on OpenFlow Hybrid Mode
- L2 mode & L3 mode
- OpenFlow actions & counters

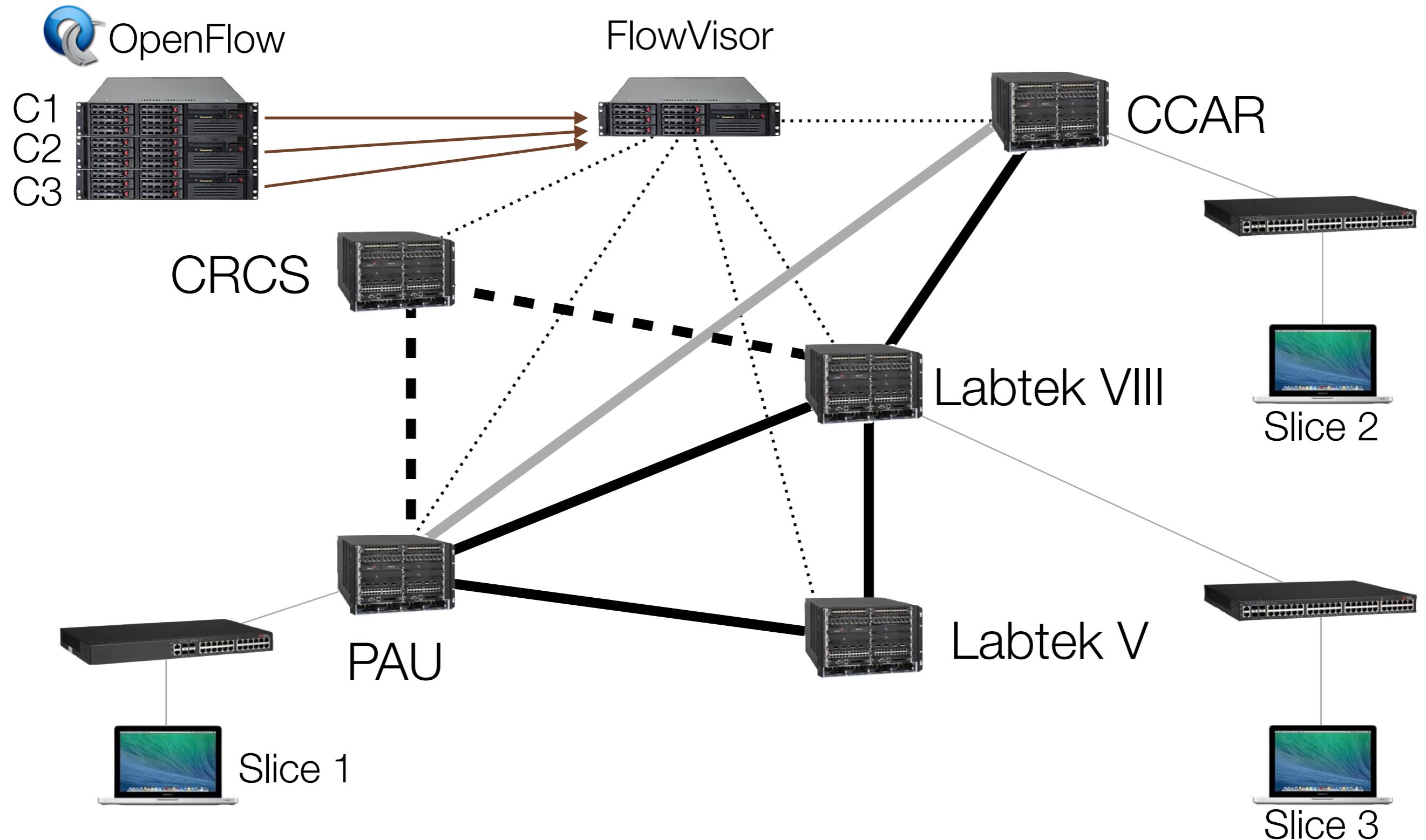
Software Defined Network



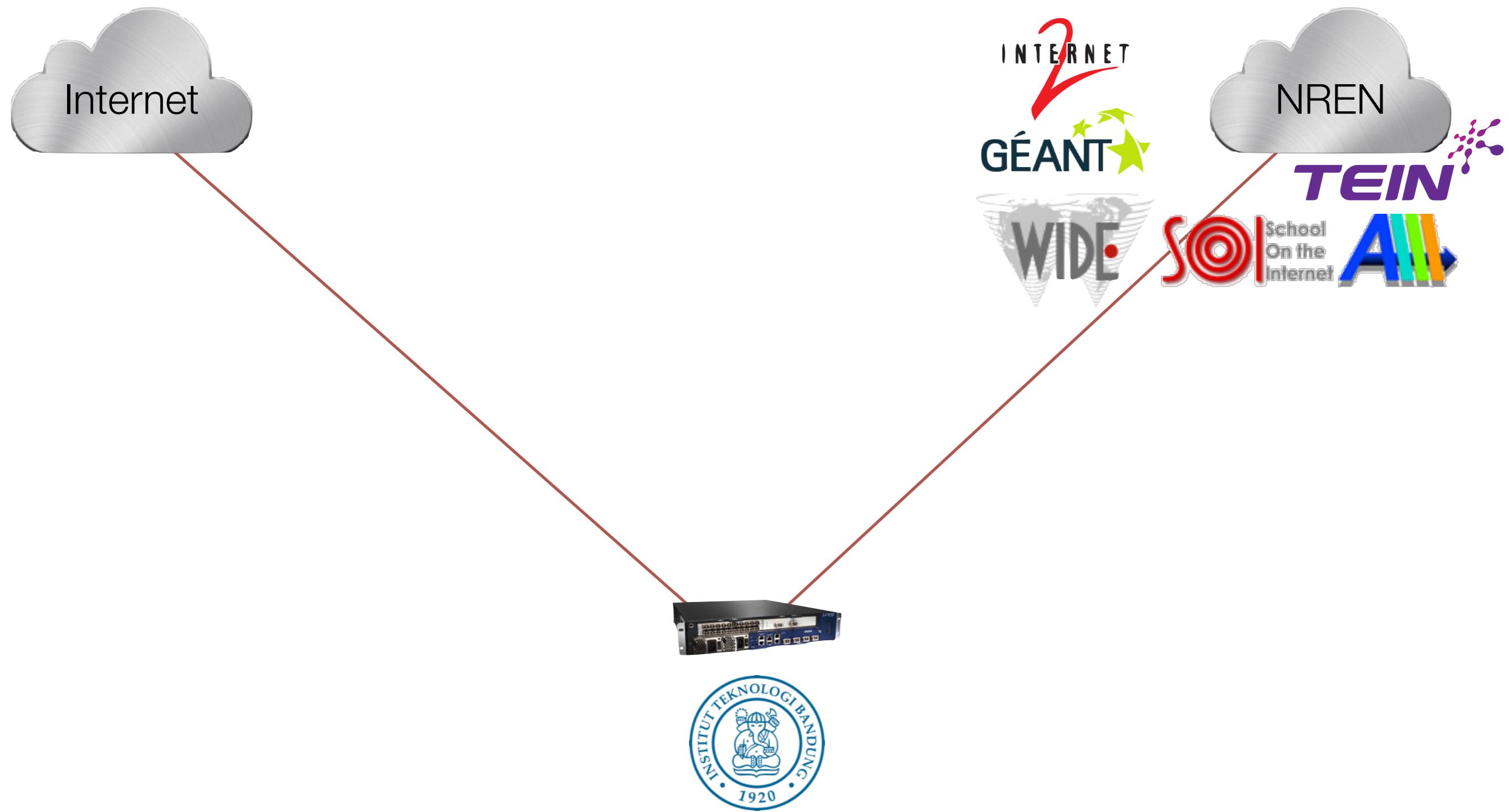
SDN for DDoS Protection



Network Slicing with OpenFlow



Research Education Network



Research Application

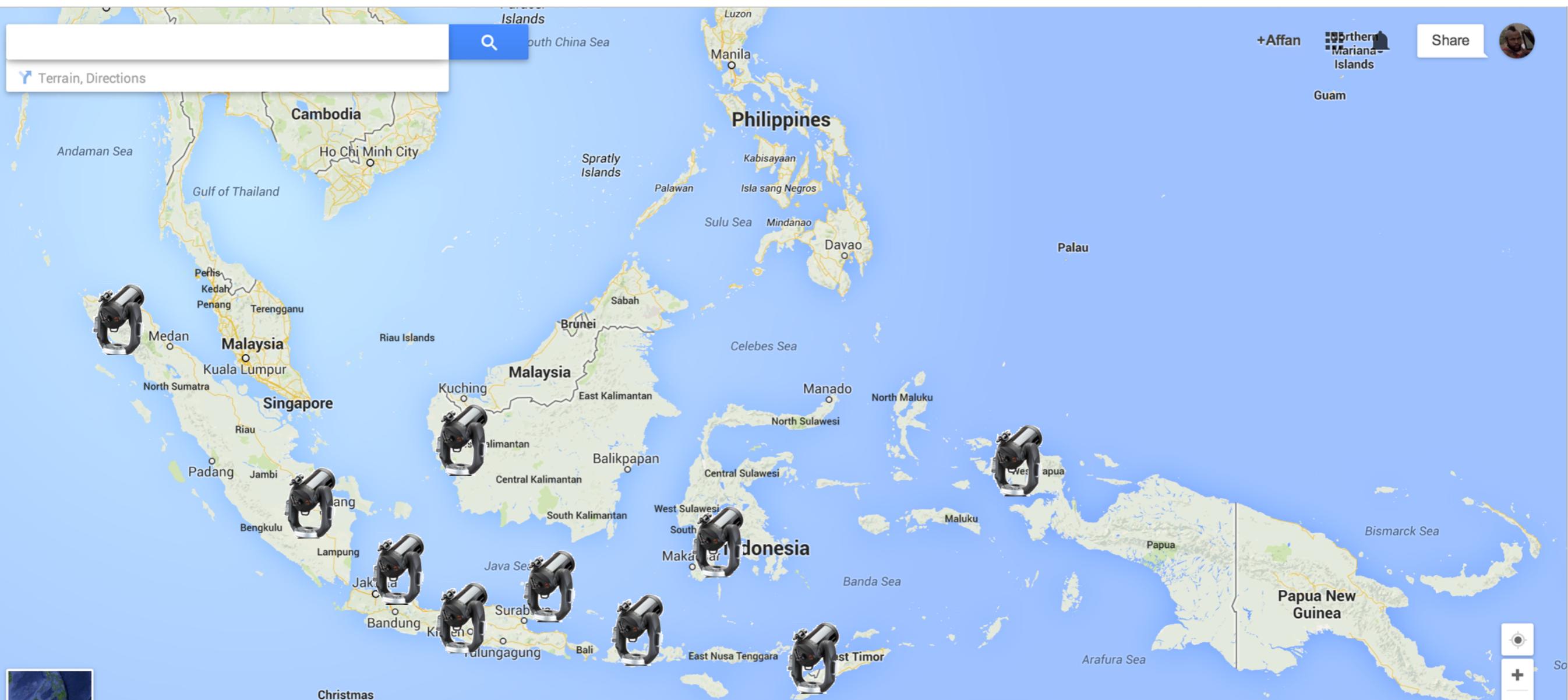
- HPC
 - Weather simulation
 - Nanotechnology
 - BigData
- Astronomy
 - Remote Robotic Telescope
 - Radio Astronomy,
preparing for eVLBI
 - Prepare for National Observatory in Kupang

Next Generation Astronomy Research

- Radio Astronomy - Detecting Radio waves from astronomical object far far away
- Interferometry - Radio astronomy conducted by “clustering” radio antenna array to detect farther
- eVLBI - “clustering” number of radio telescope and correlate all of the data exported from the telescope
- Remote Telescope - Controlled Telescope on remote site over TCP/IP
 - Observator can “lease” other observator telescope
 - Eg. Northern hemisphere observator can observe southern hemisphere sky via other observator telescope
 - Peneropongan Hilal

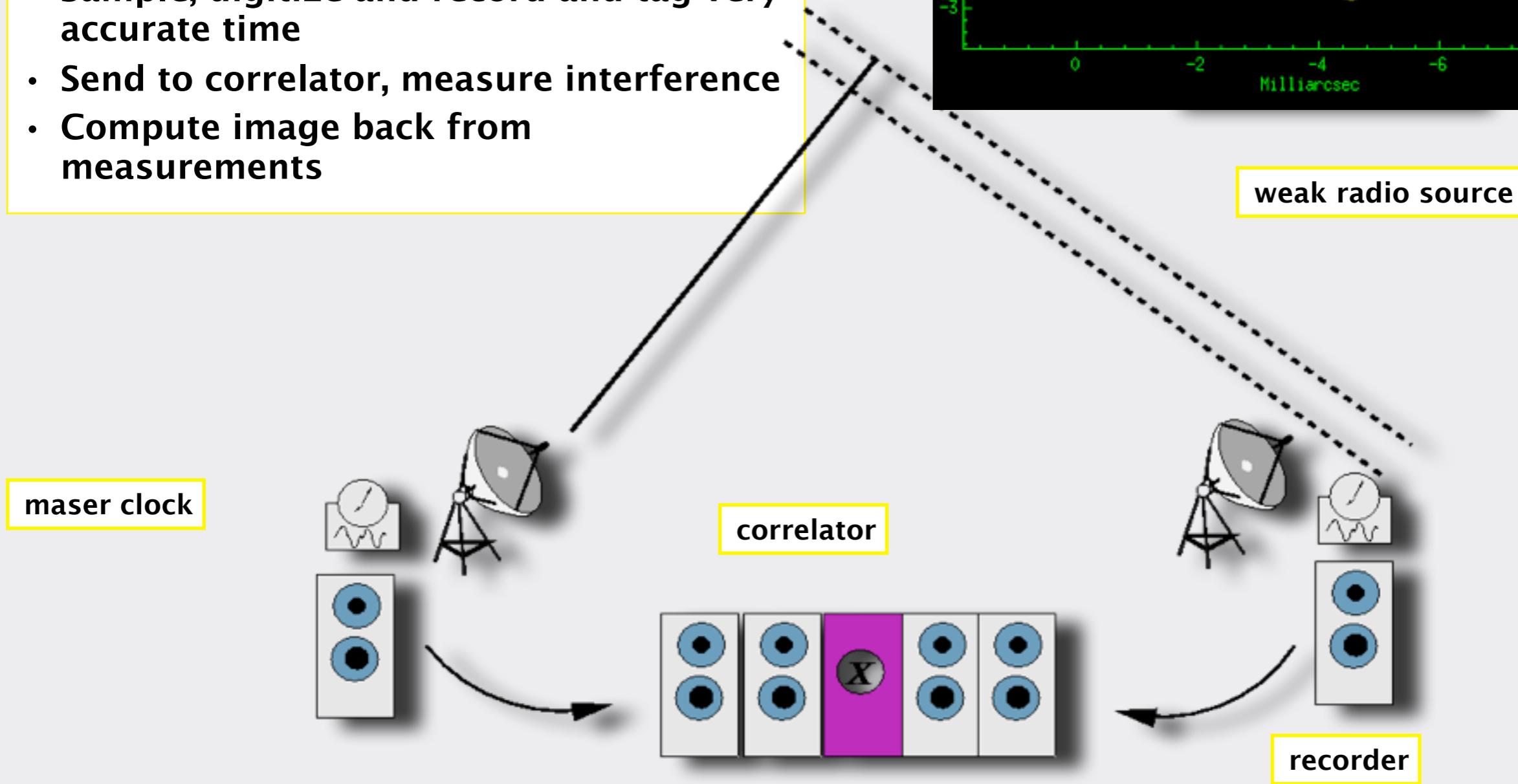
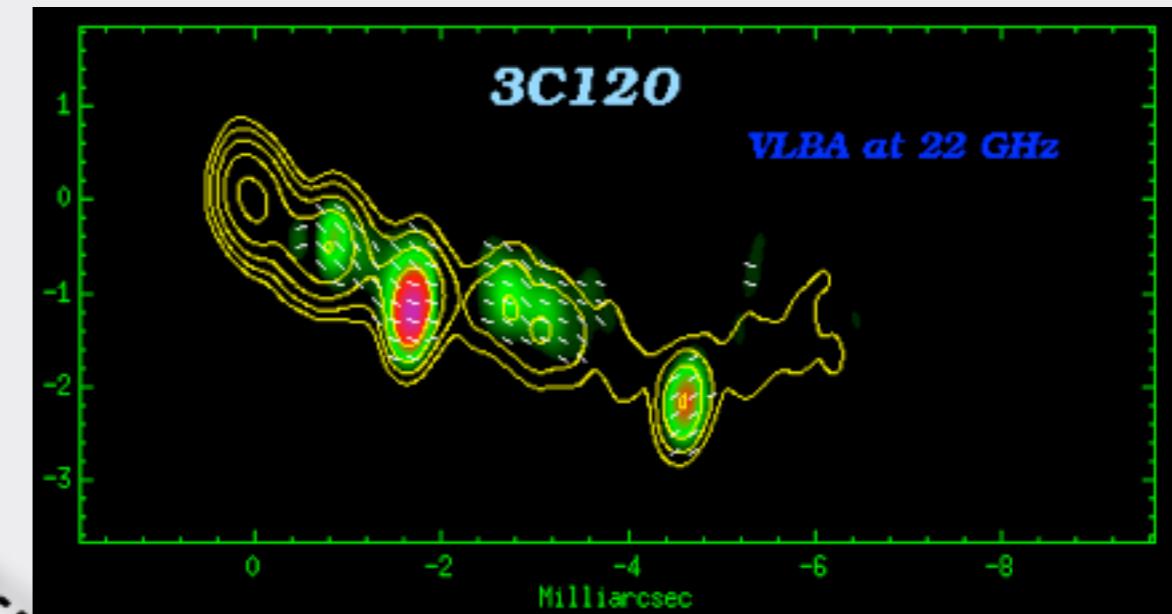
Peneropongan Hilal Kominfo

- Bosscha mempopulerkan peneropongan hilal sejak 2007
- Saat ini dipusatkan di <http://hilal.kominfo.go.id>



VLBI: make a giant telescope

- Radio interferometry measures Fourier components of sky
- Atmosphere transparent for radio emission 100M - 100GHz
- Big telescopes more sensitive, long baselines high resolution
- Sample, digitize and record and tag very accurate time
- Send to correlator, measure interference
- Compute image back from measurements





Jodrell Bank
Cambridge

Irbene LV

3 telescopes in Russia

Sardinia 64m



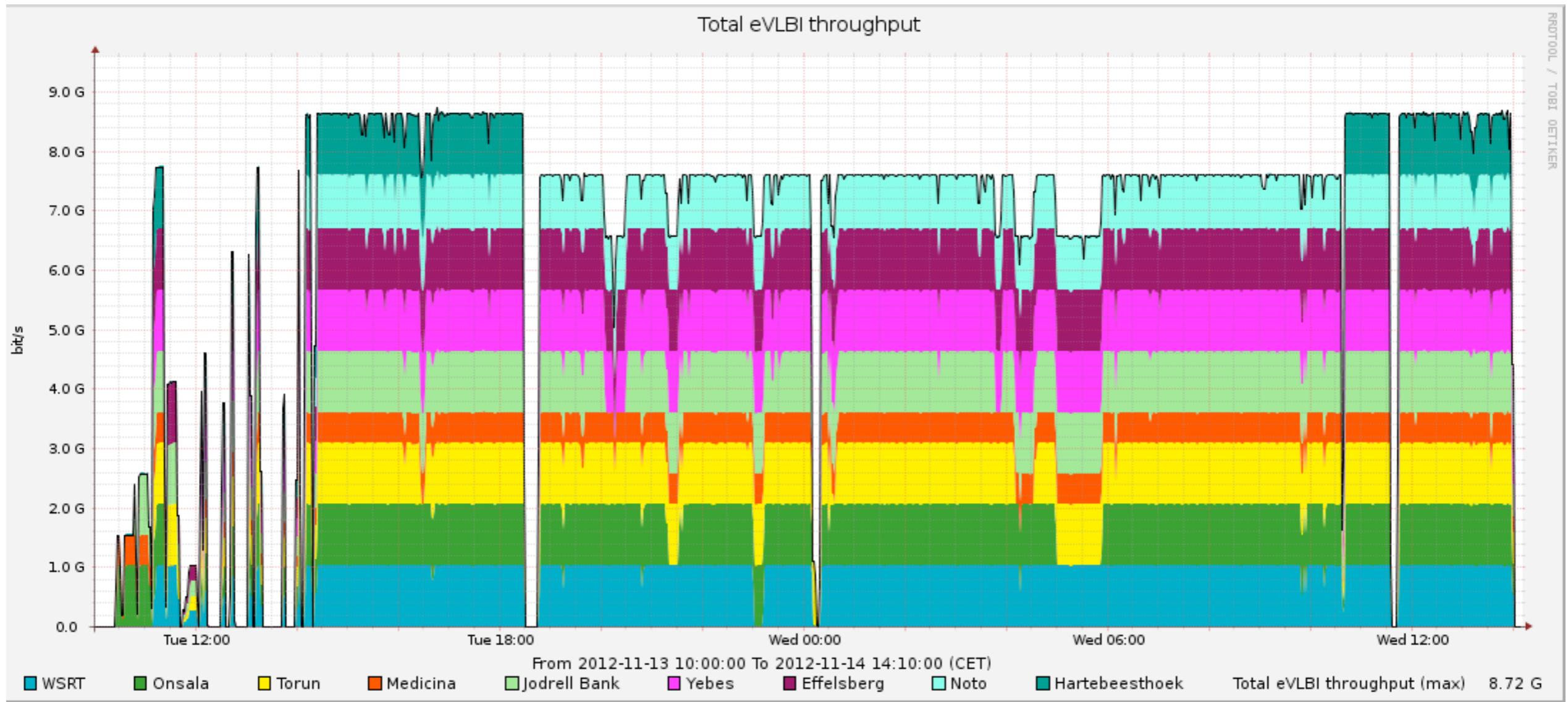
Arecibo, Puerto Rico



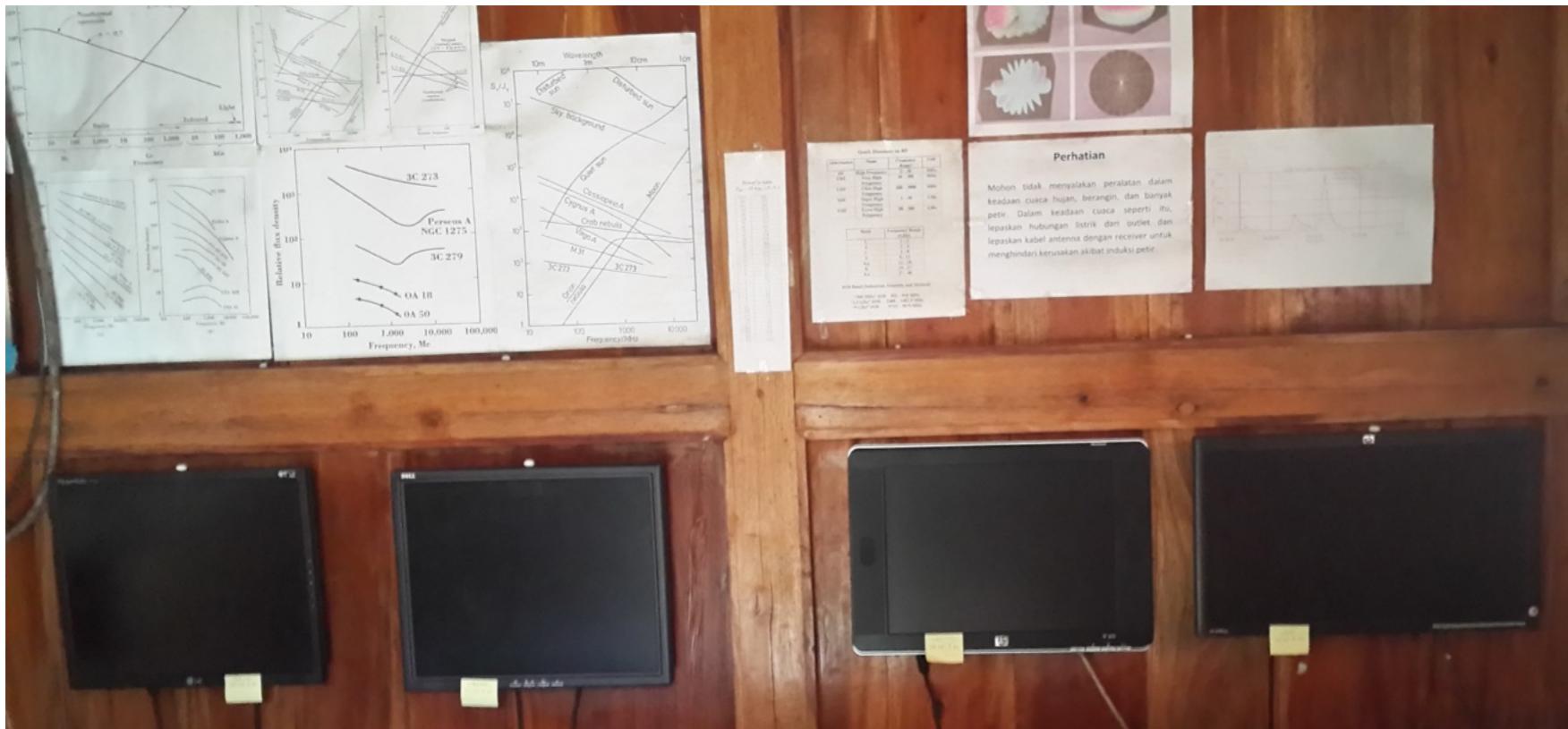
Hartebeesthoek, South Africa

4 telescopes in China

A typical e-VLBI run



- 8 - 12 telescopes
- 1024 Mb/s per telescope (Near future: 4Gb/s)
- 8 - 12 hours
- 30 - 65 TB



Rintisan Radio Astronomy dan Remote Telescope di Bosscha

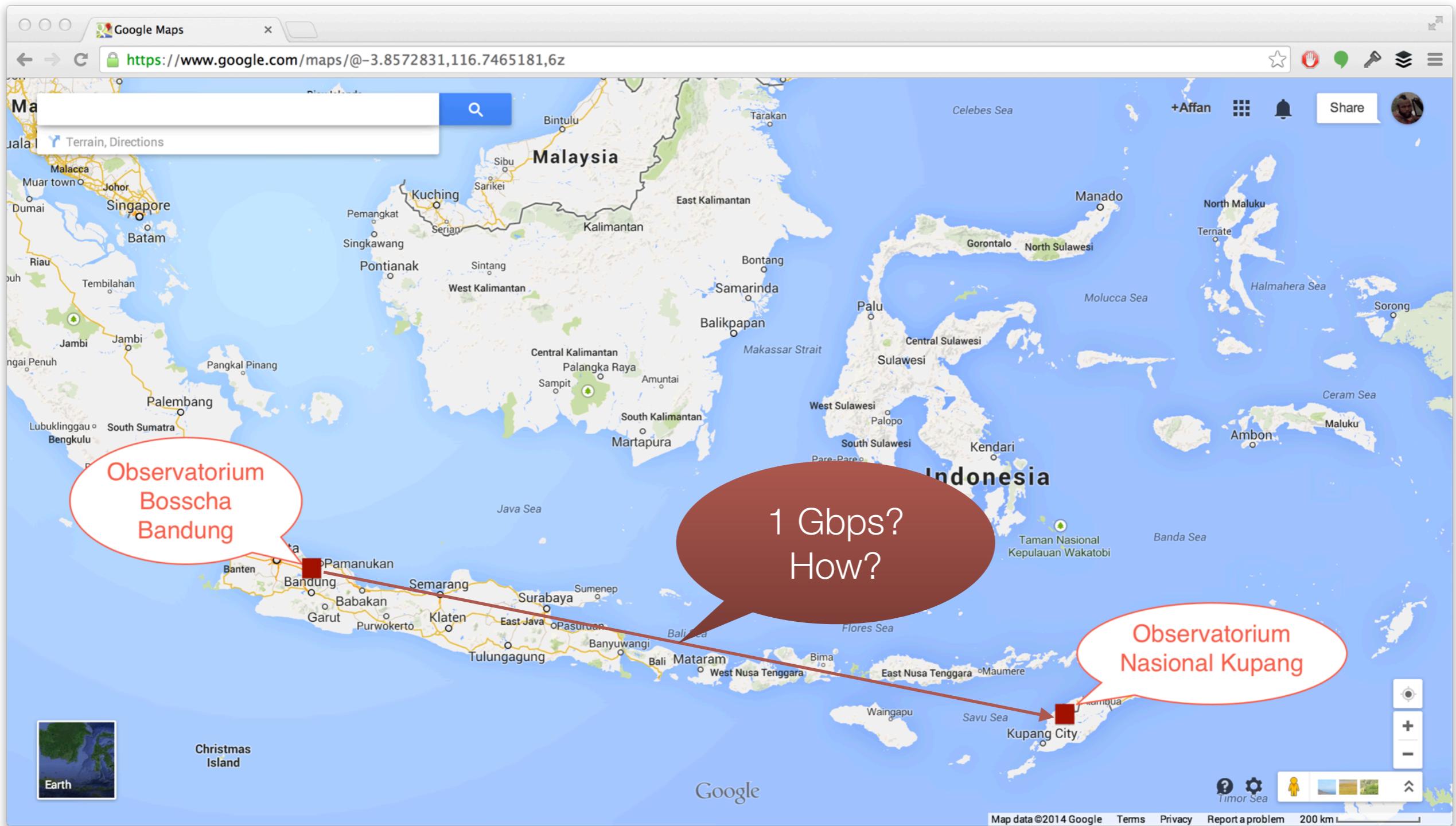
Observatorium Nasional Kupang

- Kompleks Observatorium optik dan radio
- 150 km timur laut kota Kupang, NTT
- Direncanakan selesai tahun 2018
- Menggantikan Bosscha yang berumur 89 tahun



Observatorium Nasional Kupang

- Ada yang bisa membantu?



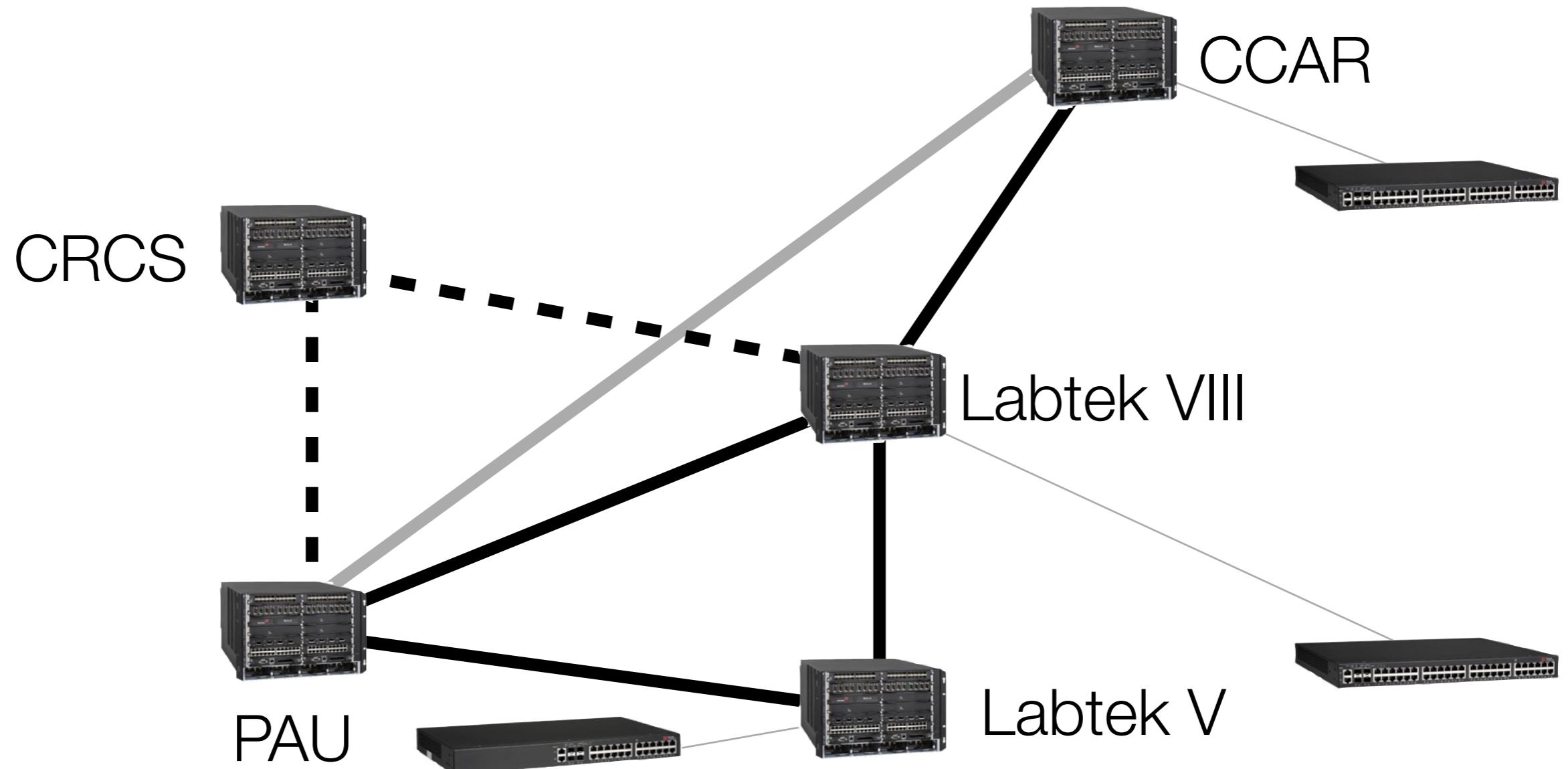
Service Provider Network



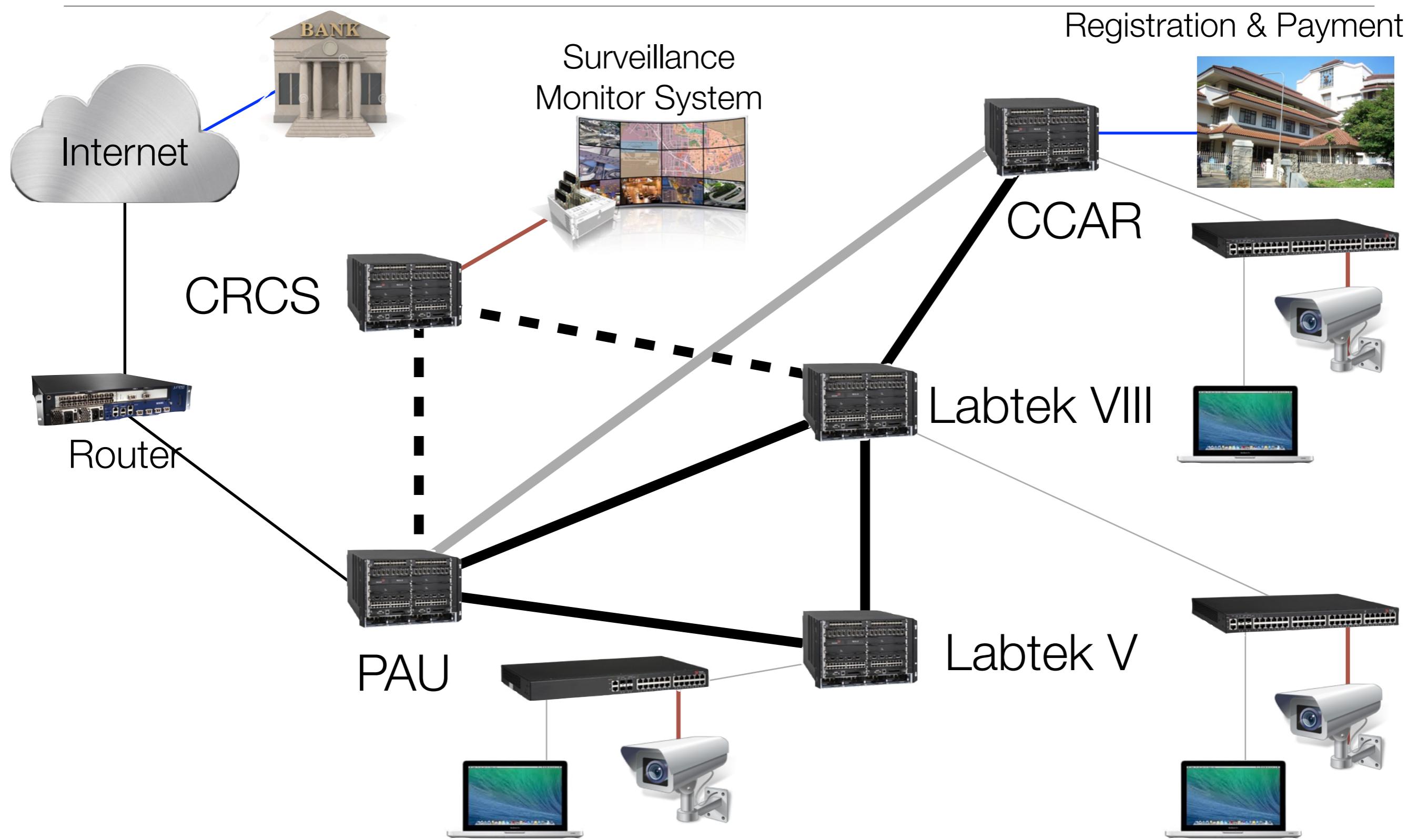
MPLS Network

- MPLS forwarding
- LDP or RSVP or BGP signalling
- L3VPN for new services
- L2VPN for new services
- VPLS for new services

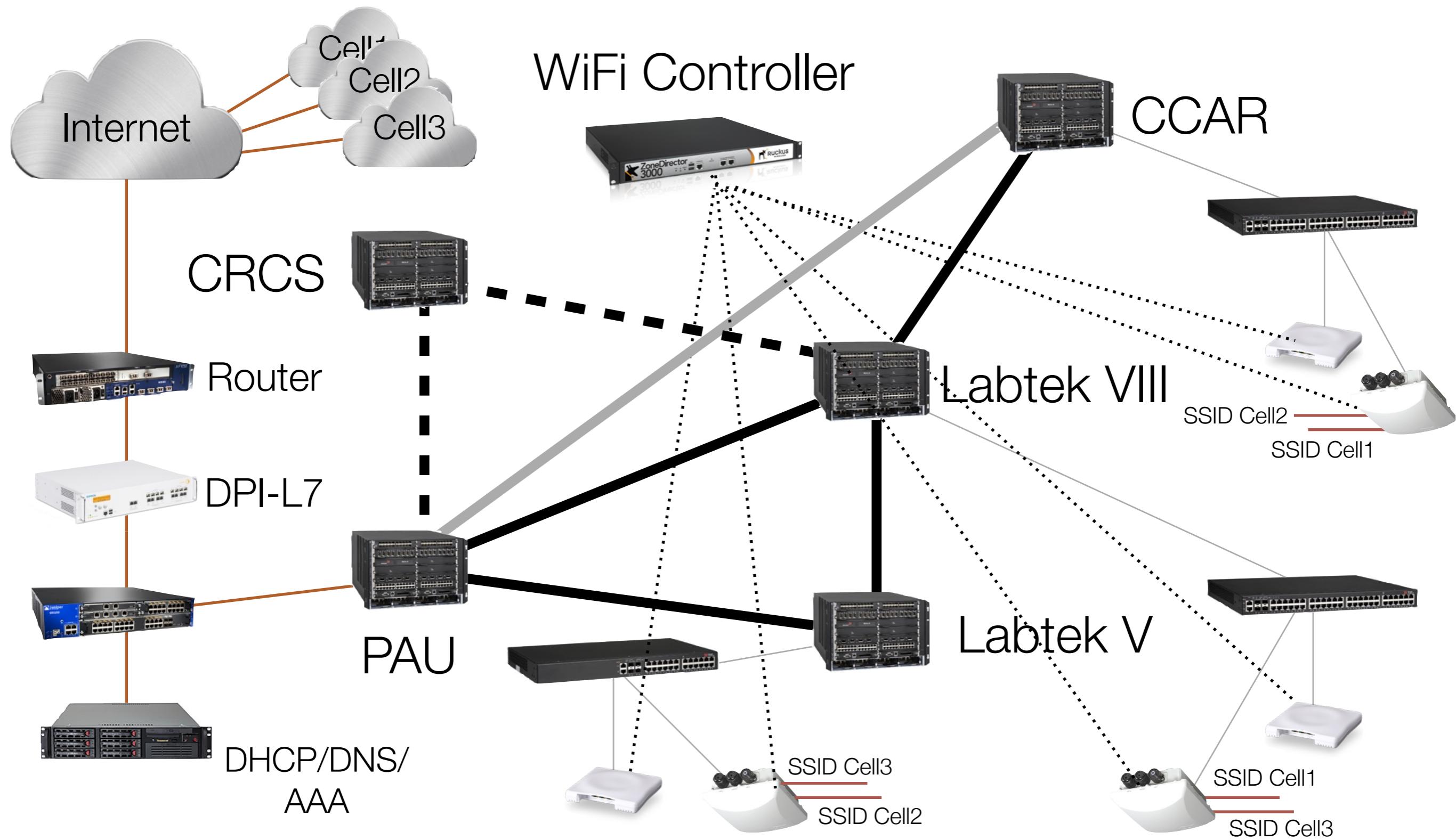
Core & Access Network



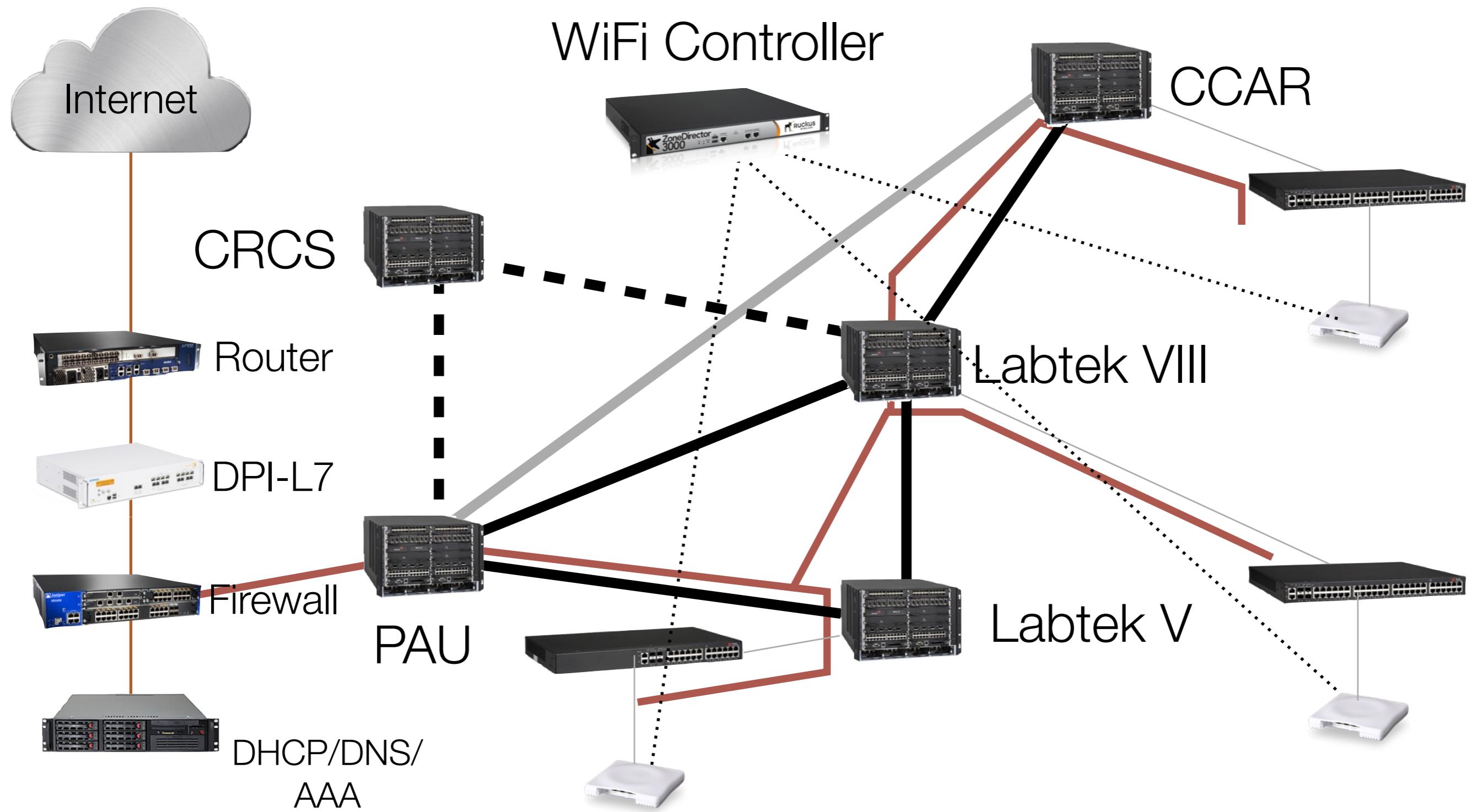
MPLS Service Network - L3VPN



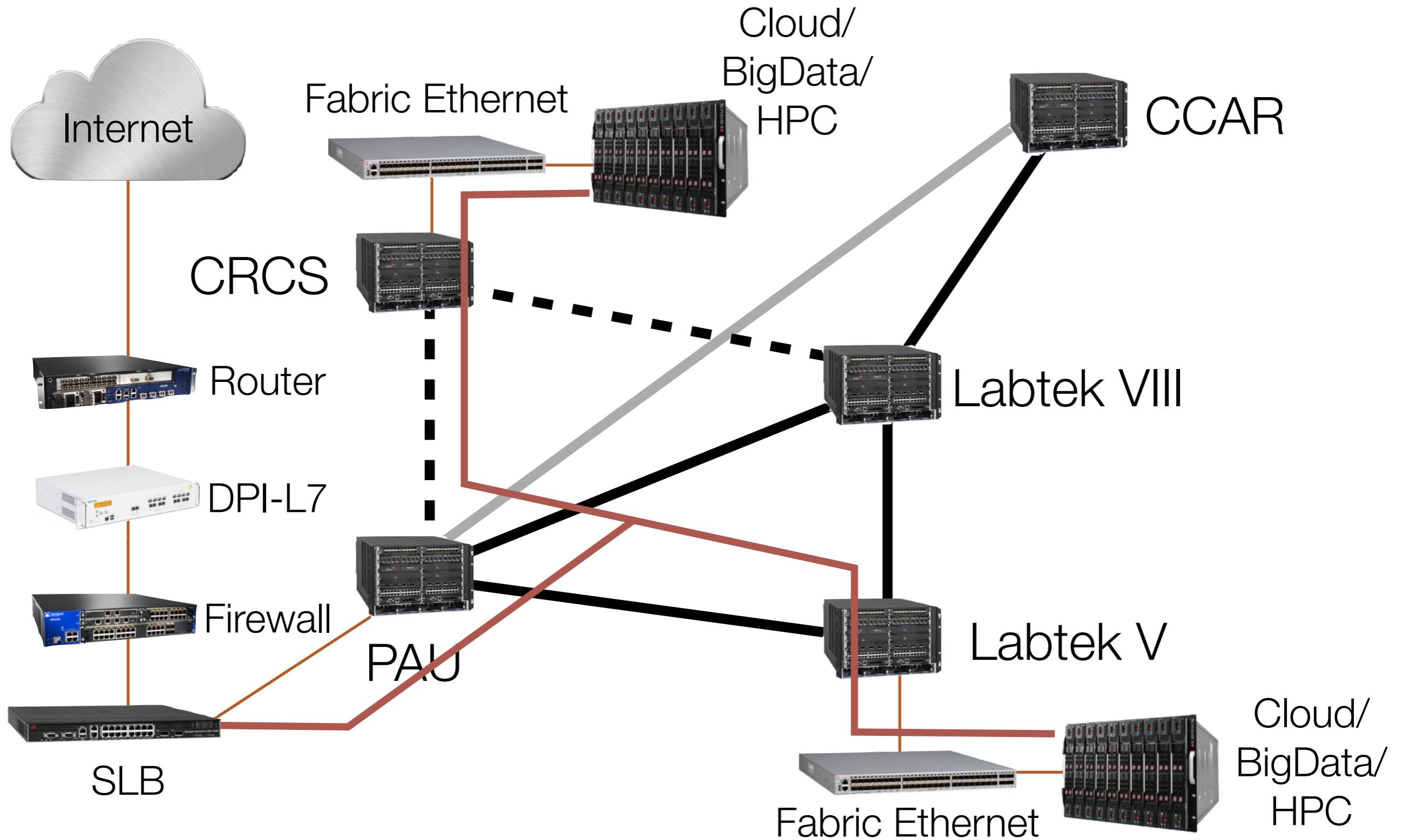
3G Offload Wifi Network



Wifi Network with VPLS



Datacenter Network with VPLS



Penutup



Tantangan ke depan

- Adopsi teknologi baru bagi operator lama
- Adopsi sosial dengan layanan dan kemungkinan baru

Pencapaian Akhir

- Value dari university meningkat karena memiliki connectivity dengan berbagai institusi
- University memberikan manfaat lebih bagi sekelilingnya, diakselerasi dengan IT

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“Sebaik-baik manusia adalah yang paling bermanfaat bagi orang lain”

(HR. Ahmad, Thabrani)

Terima kasih!

Ada Pertanyaan?