

TWAREN Current Status and Future Development

Dr. Te-Lung Liu

Researcher

***Manager, Network Technology Division
National Center for High-Performance Computing***

tliu@nchc.org.tw



Outline

- TWAREN Network Overview
- Development and Research Technologies
- TAIWANLight and International Collaborations

- **TWAREN Network Overview**
- Development and Research Technologies
- TAIWANLight and International Collaborations

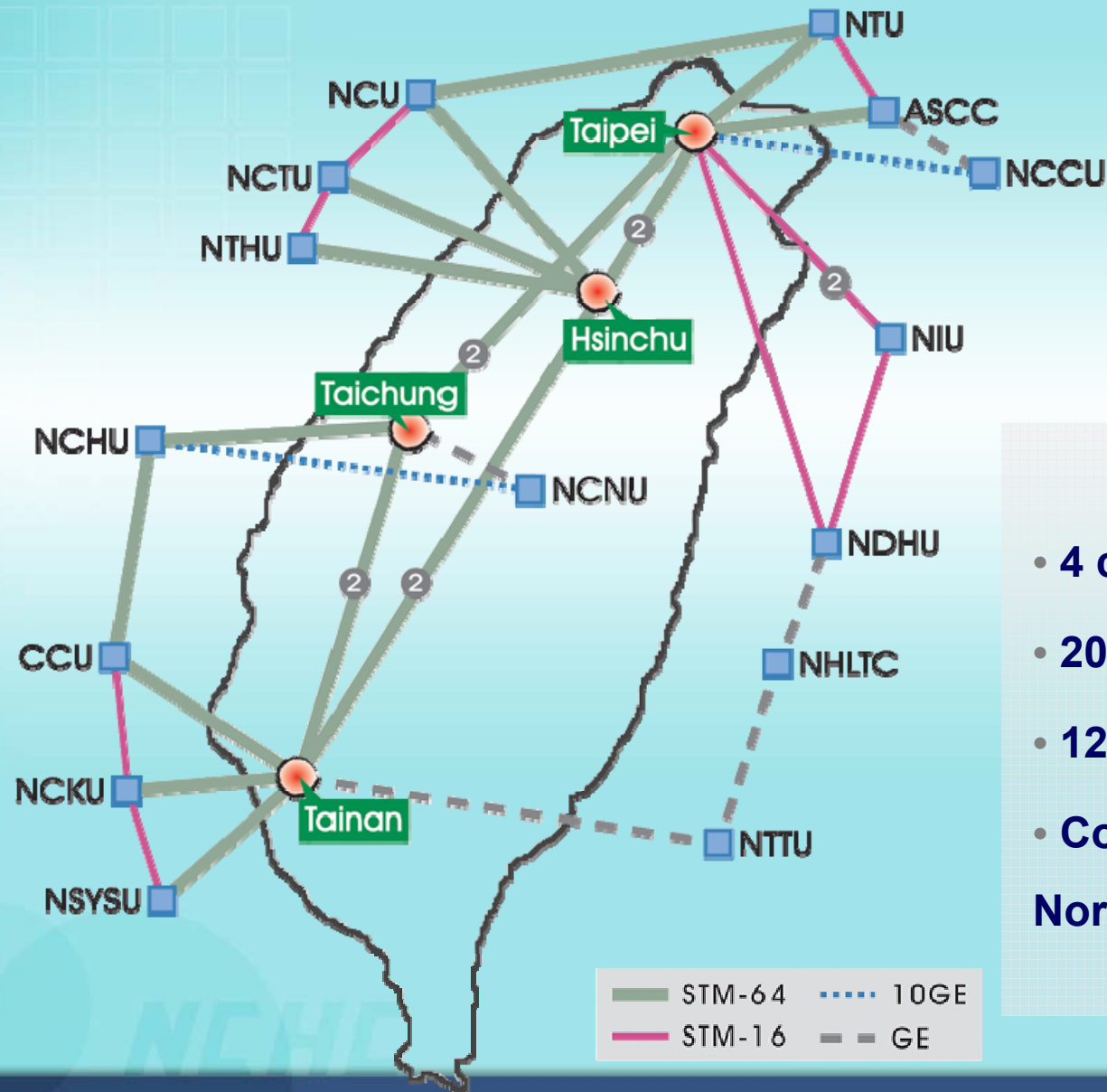
TWAREN

TaiWan
Advanced
Research and
Education
Network

What is TWAREN

- **A physical network serves multiple purposes and logical networks**
 - TANet, connects to commodity Internet
 - TWAREN research network
 - experiment, testbed, special research
- **Provisioning services on multiple layers**
 - L1 lightpaths
 - L2 VLAN
 - L3 IP
- **has been successfully migrated from old backbone in Oct 2006**
- **Migration to All-optical DWDM backbone is scheduled in mid 2010**

TWAREN Architecture

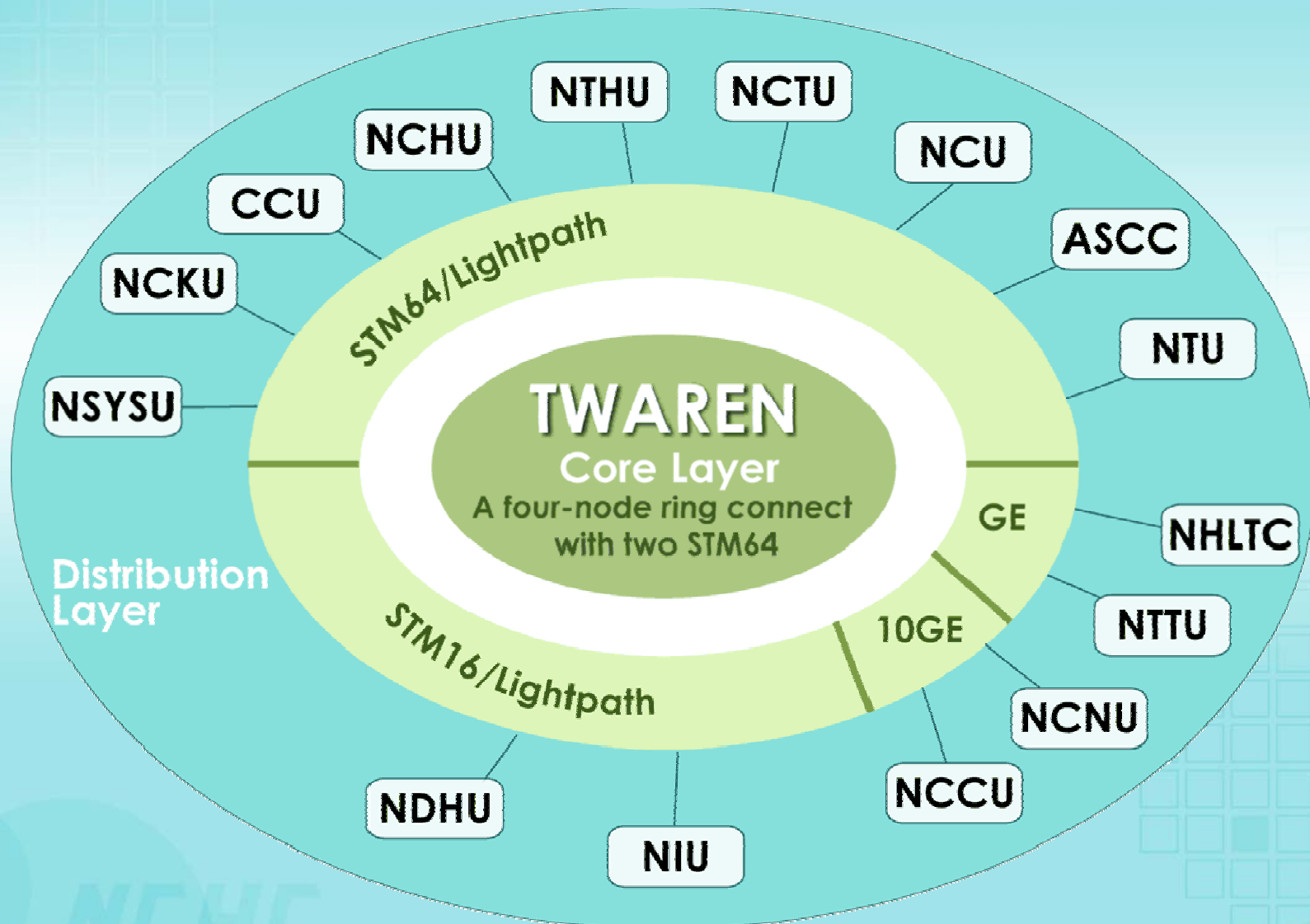


- 4 core nodes
- 20G backbone
- 12 GigaPops
- Connects HPC resources in North and South Taiwan

Goals of TWAREN

- **TWAREN is part of “Challenge 2008”, a comprehensive six-year national development plan formulated by the government**
- **Build a highly reliable, stable and flexible R&E network for academic and research community in TW**
- **Provide advanced network services to satisfy the needs of academia field in TW.**
- **Increase the International and domestic collaboration**
- **Future infrastructure drives today’s research agenda**

TWAREN GigaPoPs



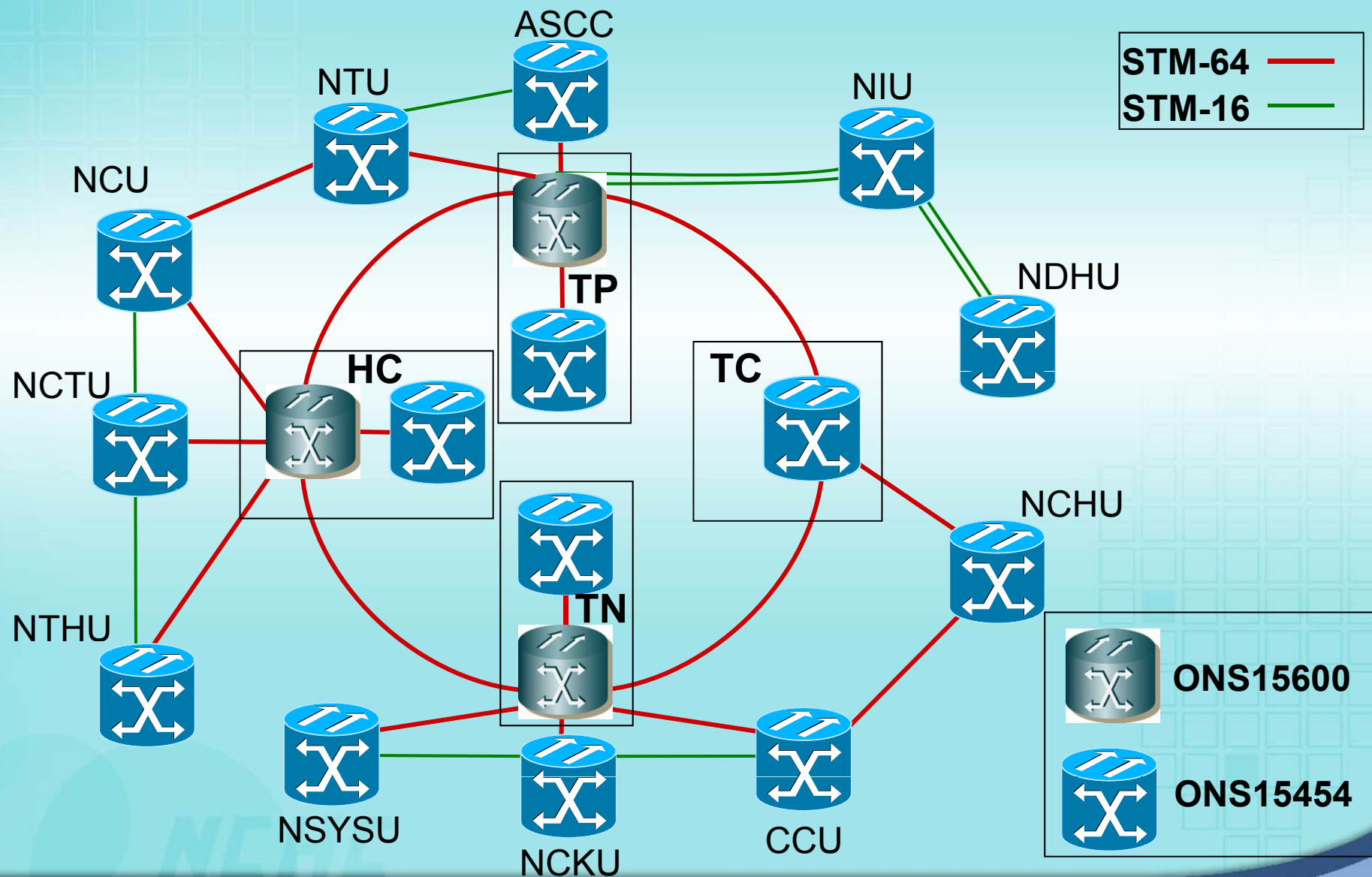
TWAREN Services

- 
- **Broadband Connection Service**
 - **International Research Network Transit (Internet2)**
 - **Measurement / Network Management**
 - **Multimedia / Multicast**
 - **Lightpath provisioning**
 - **Virtual Private Network(VPN)**
 - **Native IPv6 Service**
 - **Internet access**
 - **MCU**
 - **Proxy Server**
 - **SourceForge**
 - **File Download Center**
 - **Consultation**
 - **Applications support**

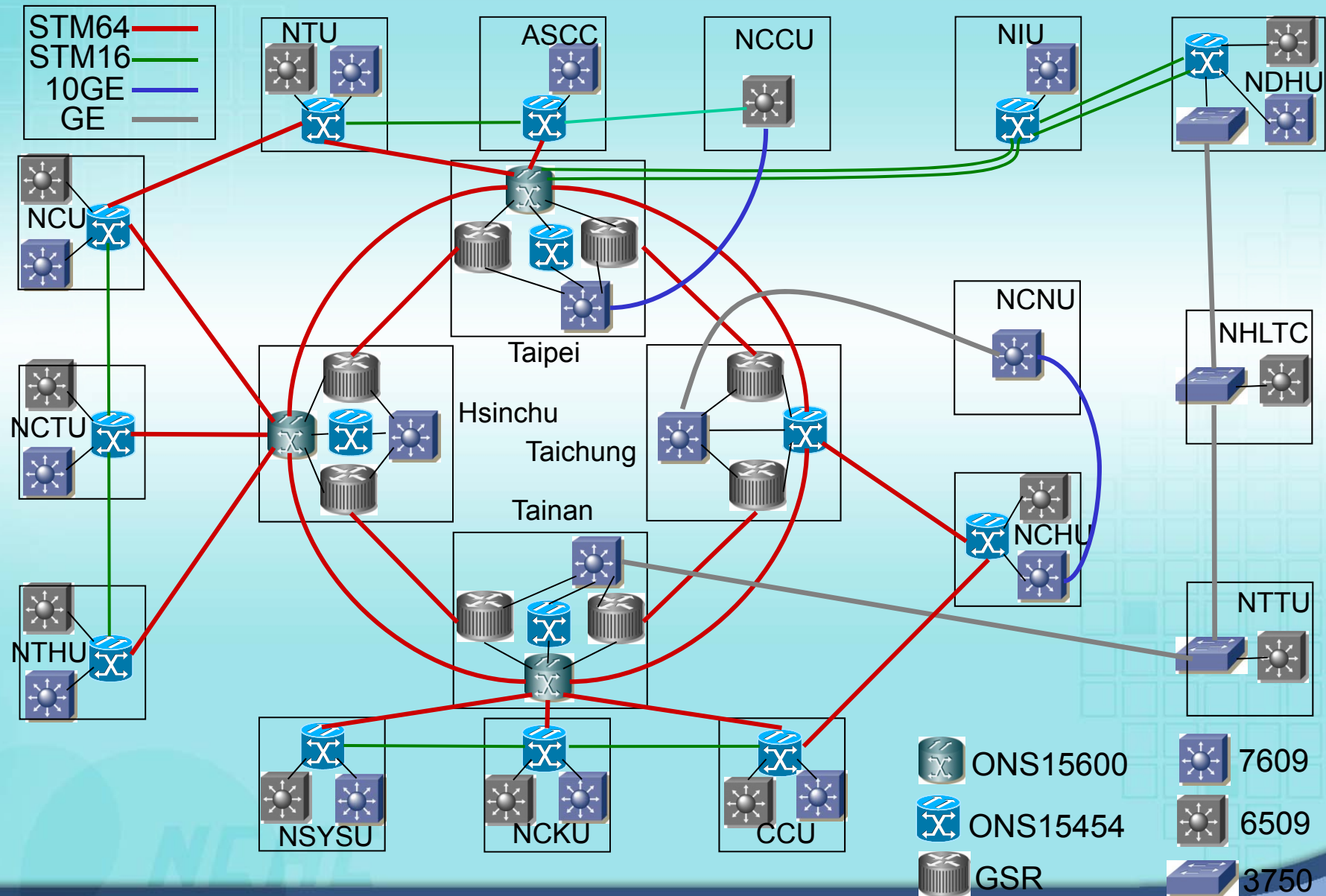
TWAREN Achievements

- **High reliability & availability**
(99.9% → 99.99%)
 - fault tolerance
 - automatic protection if possible
 - automatic failure detection and locating
- **Better performance**: minimum number of routers between GigaPoPs
- **Flexible**: can be easily and quickly to set up a logical network per user's request
- **People skills**: Optical network OAM

Optical Backbone



Interconnecting with L2/L3 devices



Protection Mechanism

■ Circuit break:

2 levels of protection

- **By carriers:** SDH protected

- **By architecture:**

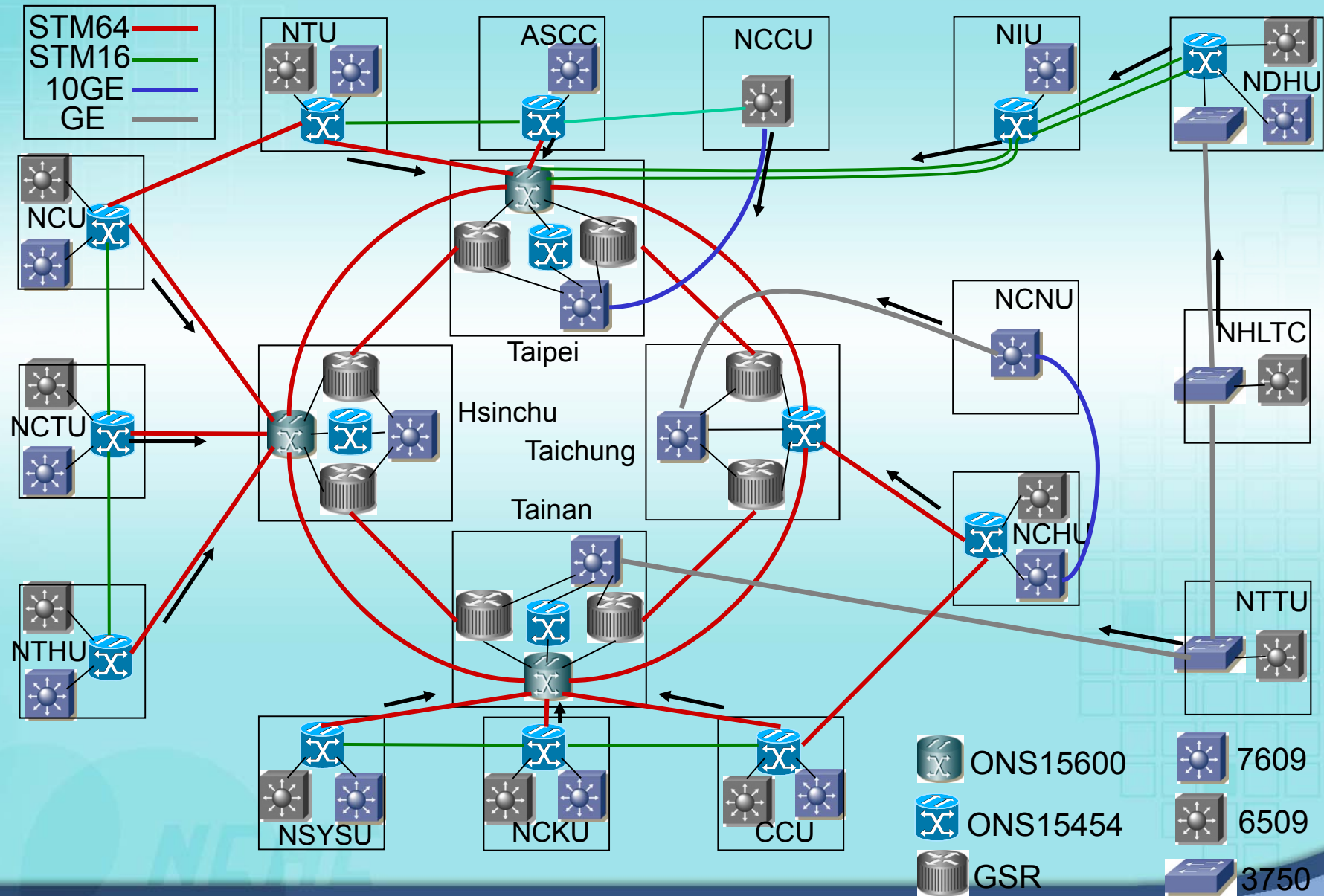
- **Link b/w core nodes:** VLAN are reconfigured with rapid spanning-tree protocol. (5s)
- **Link b/w GigaPOP and core node:** the backup SNCP lightpaths are configured for automatic fail-over. (50ms)

Protection Mechanism

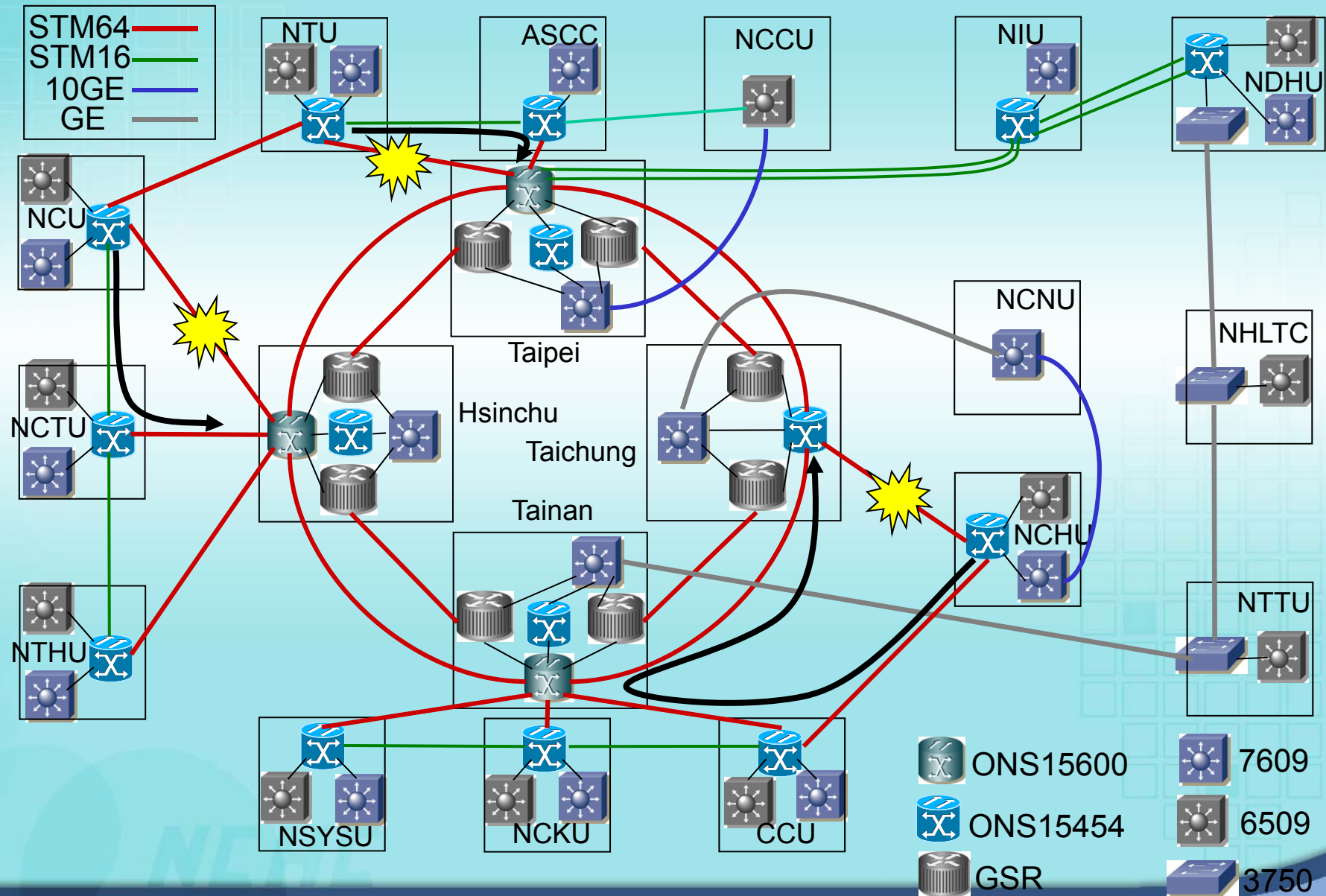
■ Equipment protection

- **Core node failure:** Manually configure emergency lightpaths to re-route traffic from affected GigaPoPs to another core node. Emergency lightpaths need to be designed and documented.
- **GigaPoP failure:** Spare line cards

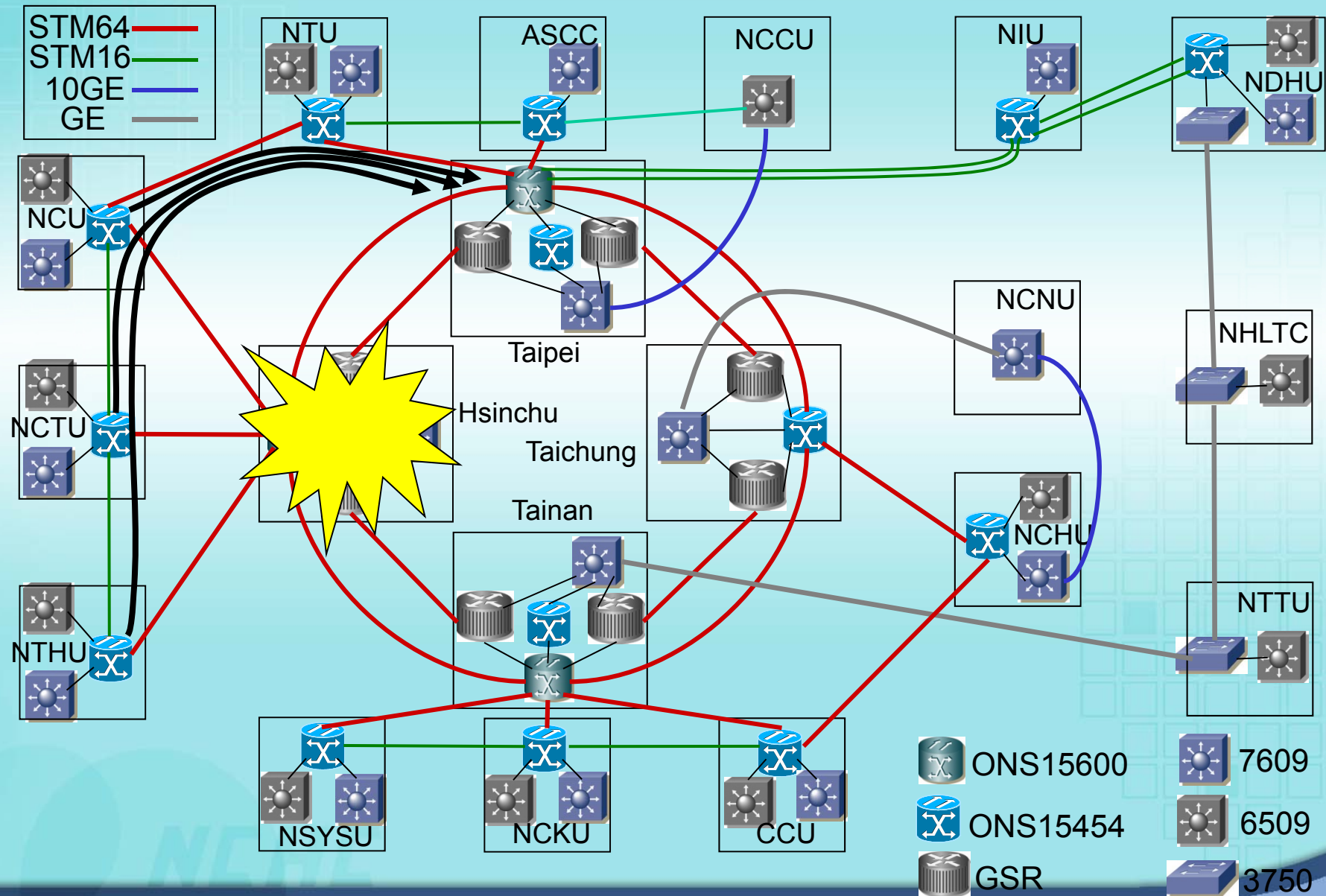
Normal Traffic Flows



In case of circuit break...



In case of core node failure...



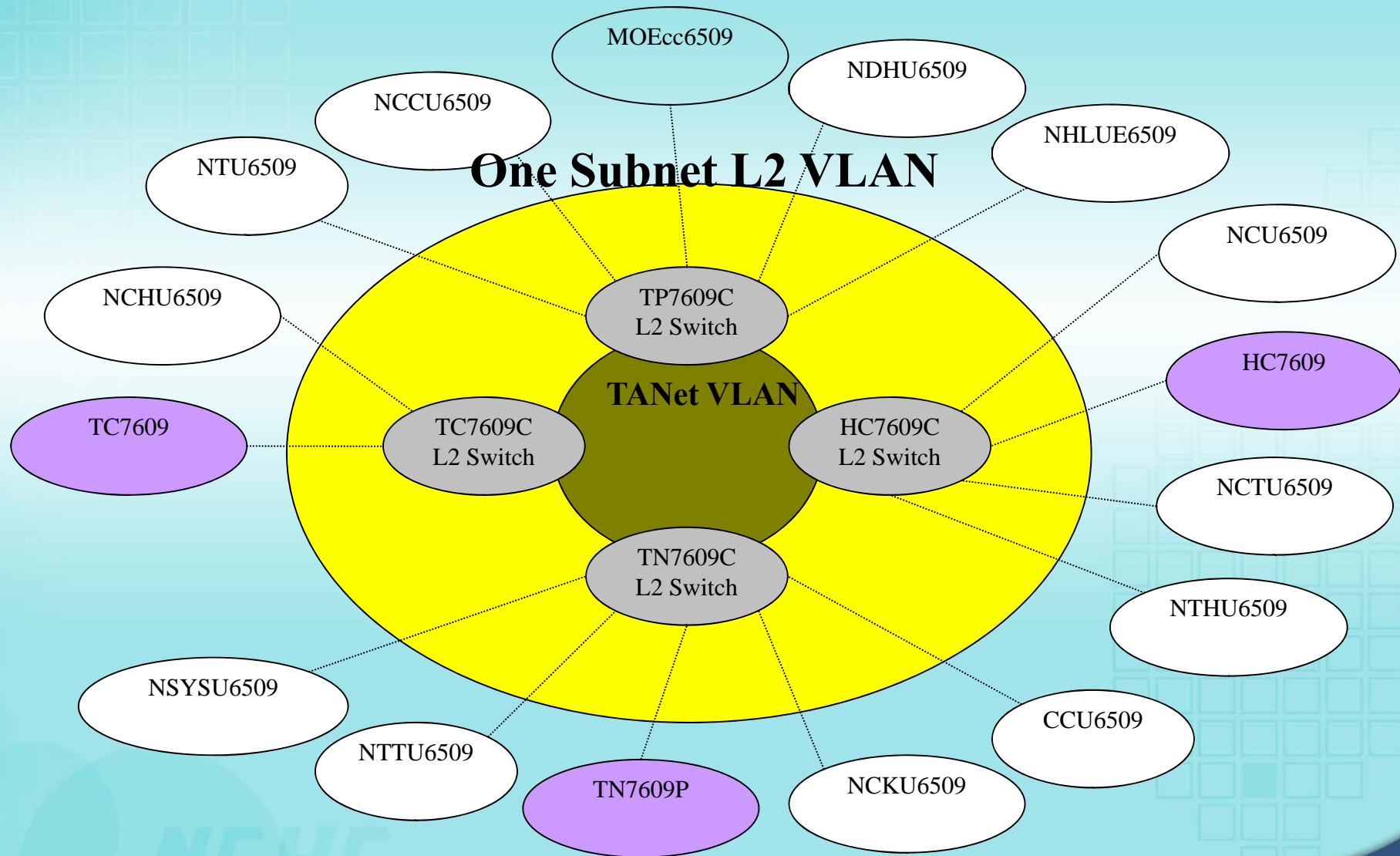
TWAREN NOC

- **NOC (Network Operation Center)**
- **Located at NCHC southern business unit in Tainan Science Park**
- **Goals: To ensure the 7x24 network operation**
- **Major works:**
 - Providing 7x24 network maintenance and operation
 - Enhance the security capacity
 - Provide network service
 - Peering
 - Light path provision
 - Network architecture design

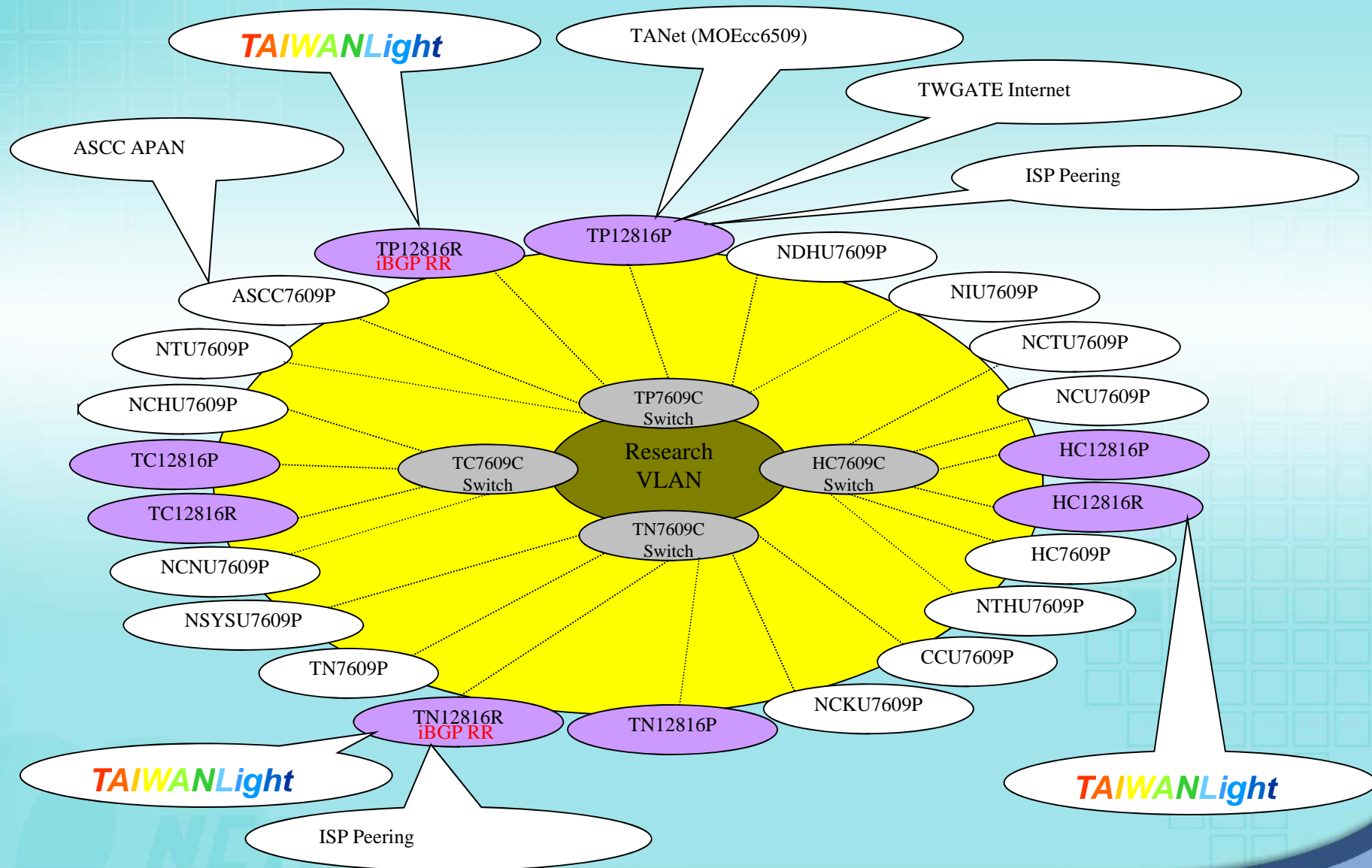


TWAREN NOC

TANet VPN



TWAREN Research VPN



VPN Services

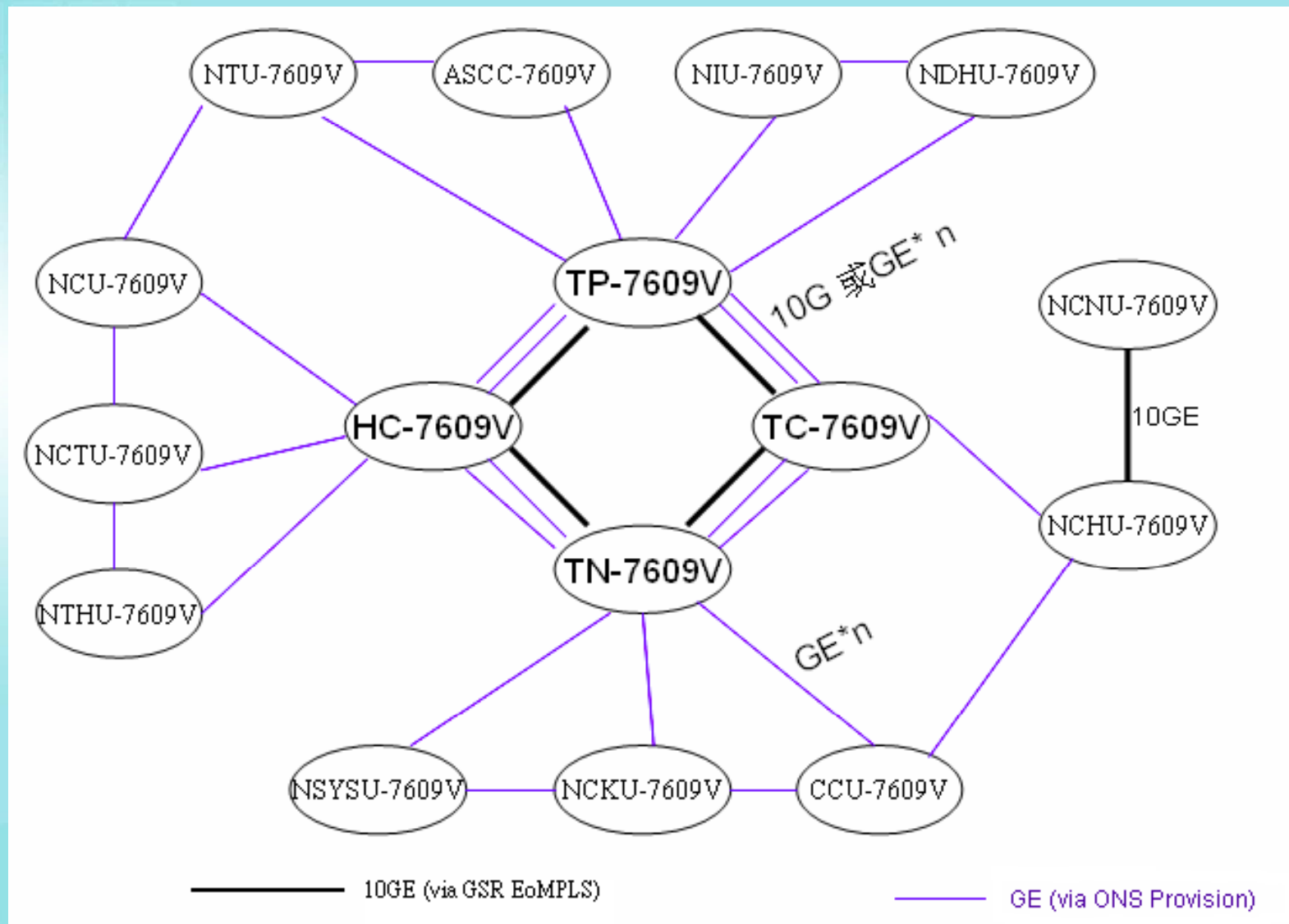
■ Multipoint-to-Multipoint Layer2 VPN

- Multiple VPNs over single architecture
- Cross-area campuses and offices can be connected within single administrative domain
- Provide dynamic creation of VPNs for National-wide integrated projects

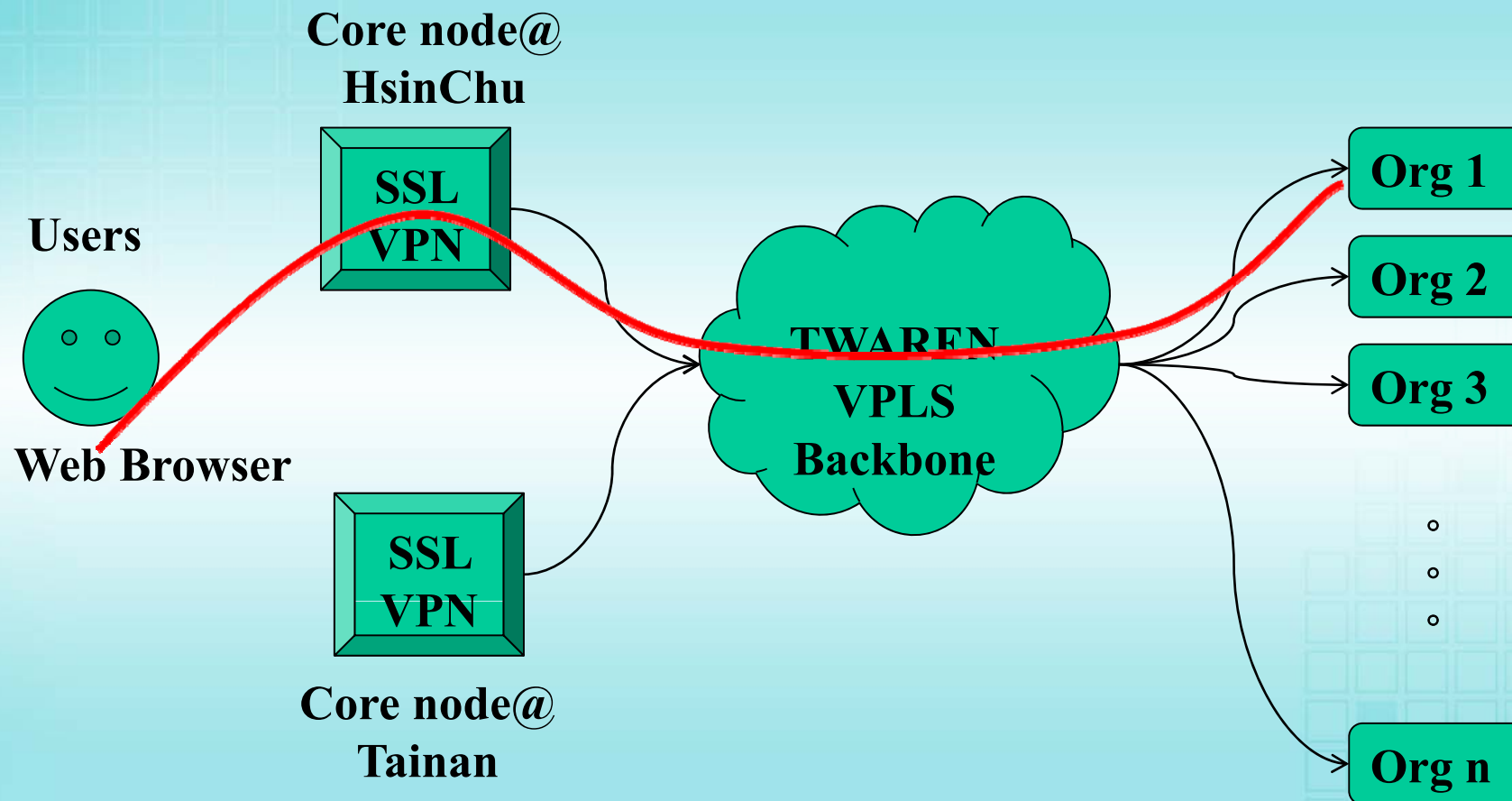
■ User-based SSL VPN Access

- Access to different VPN according to login name and password authentication
- Researchers and Professors could access their own research resources from home or outside

VPLS Architecture



User-Based SSL VPN Access

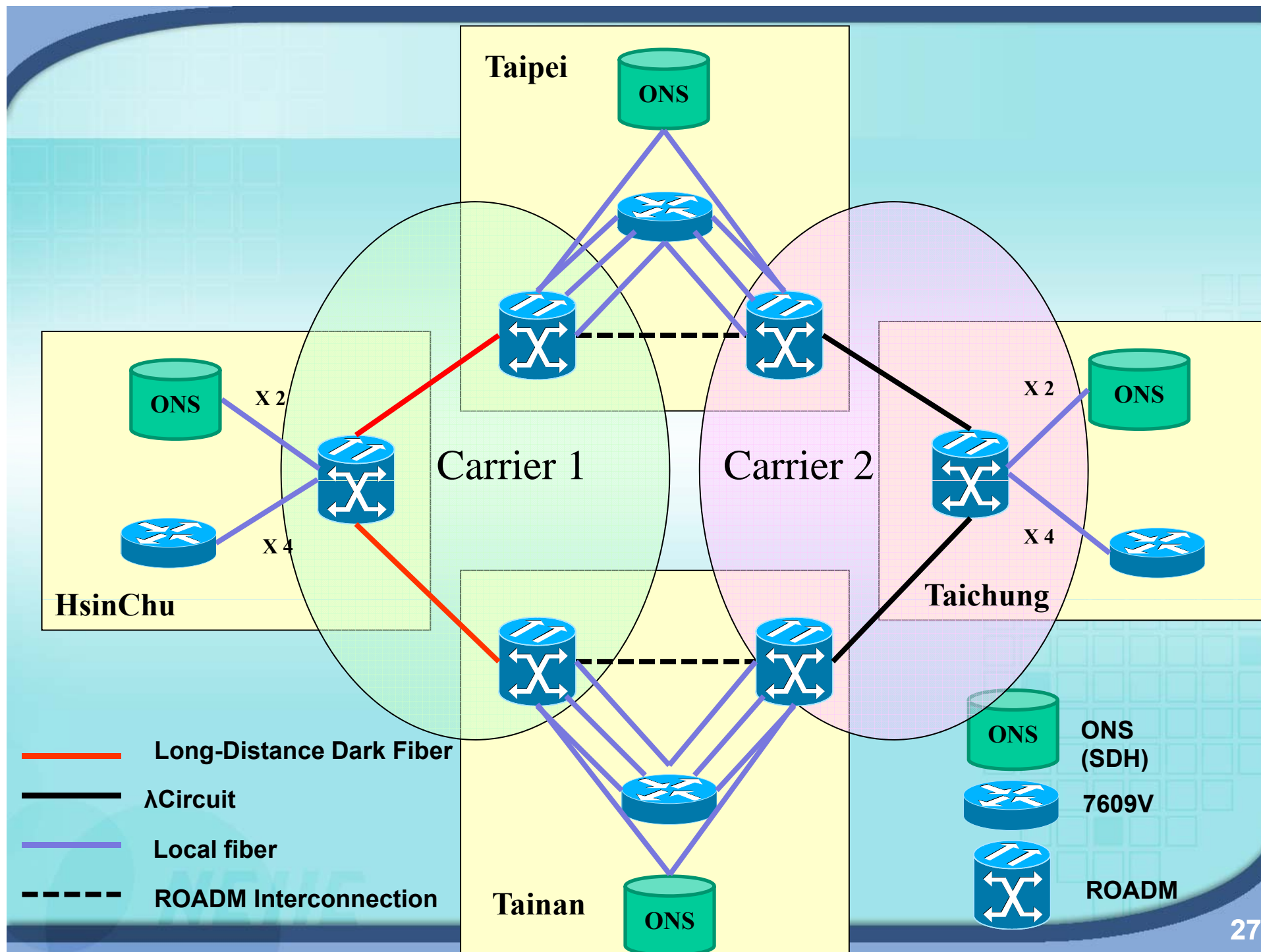


- TWAREN Network Overview
- **Development and Research Technologies**
- TAIWANLight and International Collaborations

DWDM/ROADM All- Optical Design for Next-Generation TWAREN

Design Concept

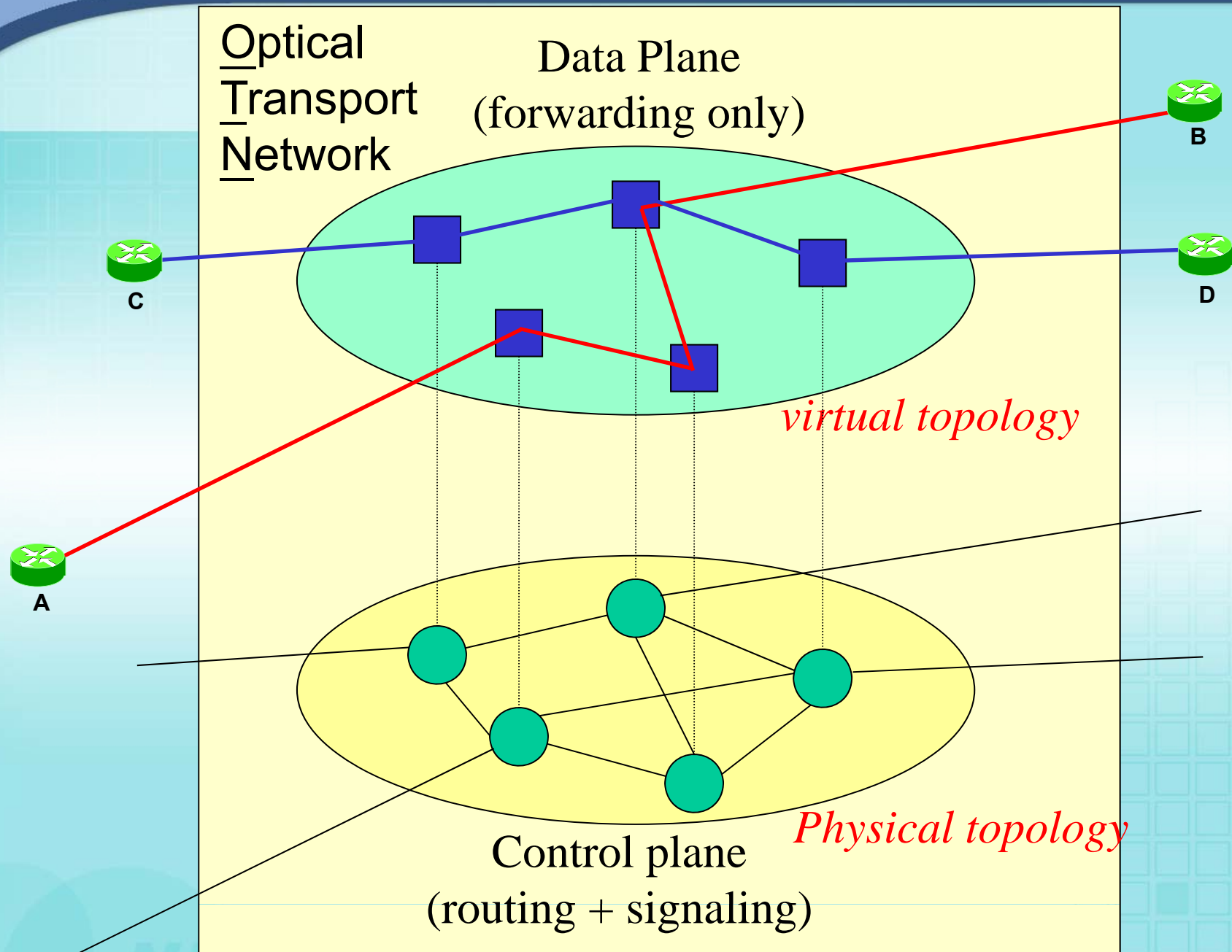
- Migrate four core nodes to ROADM in the first stage
 - scheduled in the mid 2010
- Circuits and ROADM devices in a single bid
 - Divided into two parts for two carriers
 - Challenges for ROADM interconnection

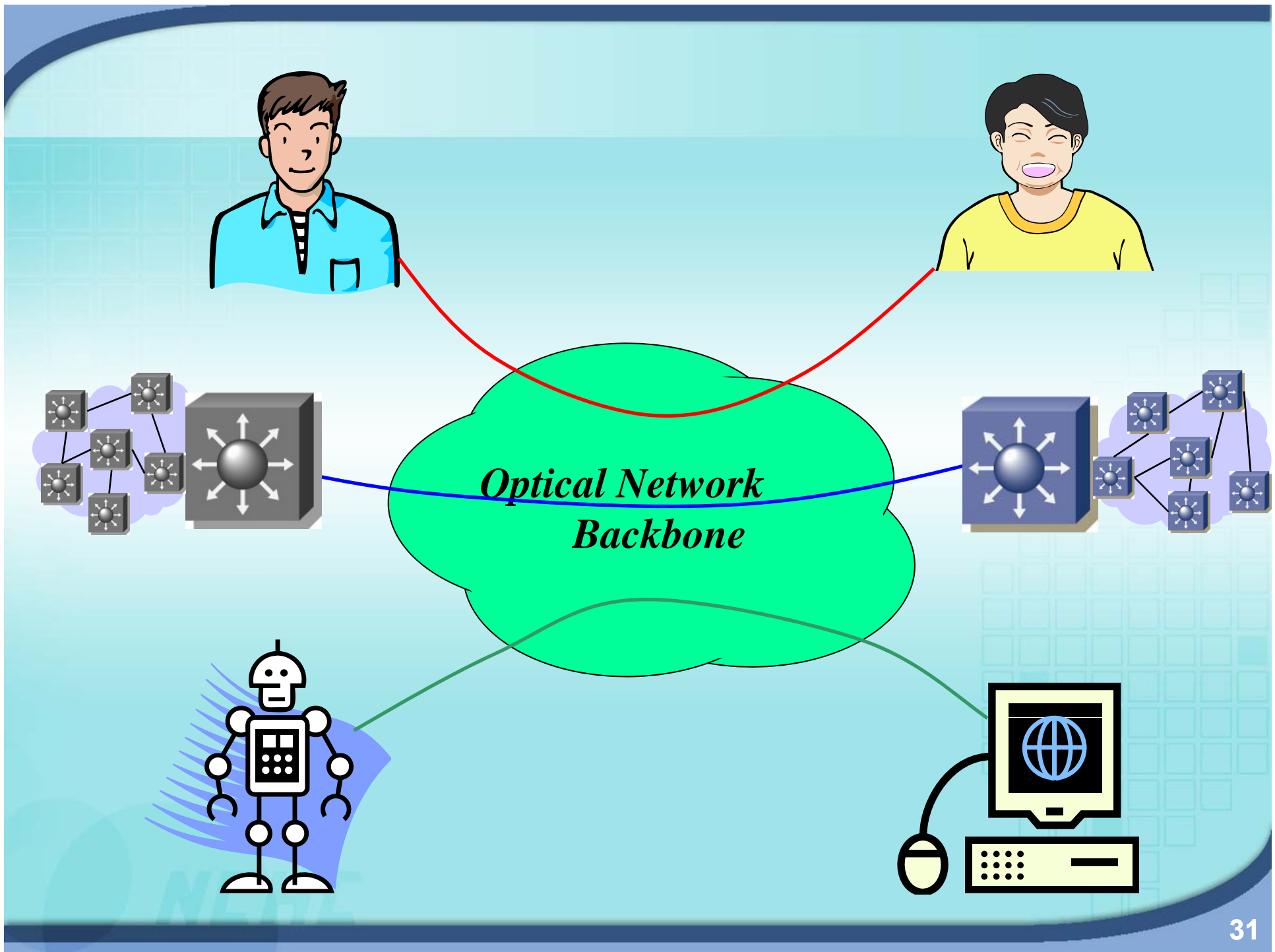


Dynamic Optical Lightpath Control

Control Plane and Data Plane

- **Control plane** chooses and reserves a deterministic, bandwidth-guaranteed path for a given connection request.
 - routing + signaling
 - messages are passed through "control channel" over physical topology
- **Data plane** is separated from control plane in order to speed up forwarding.
 - network is now viewed as a collection of "lightpaths"
 - Virtual topology is depicted by connecting lightpaths and routers in between

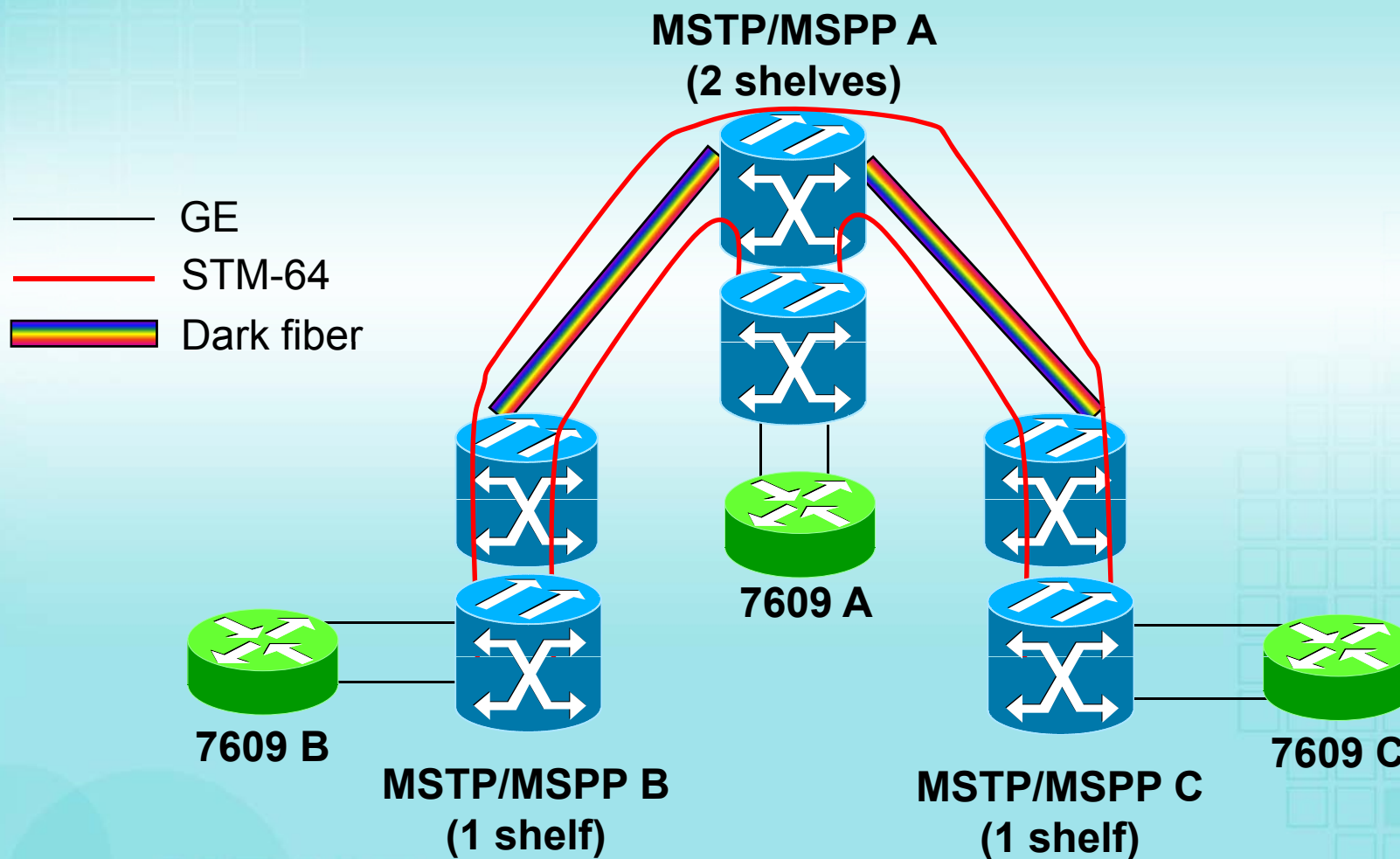




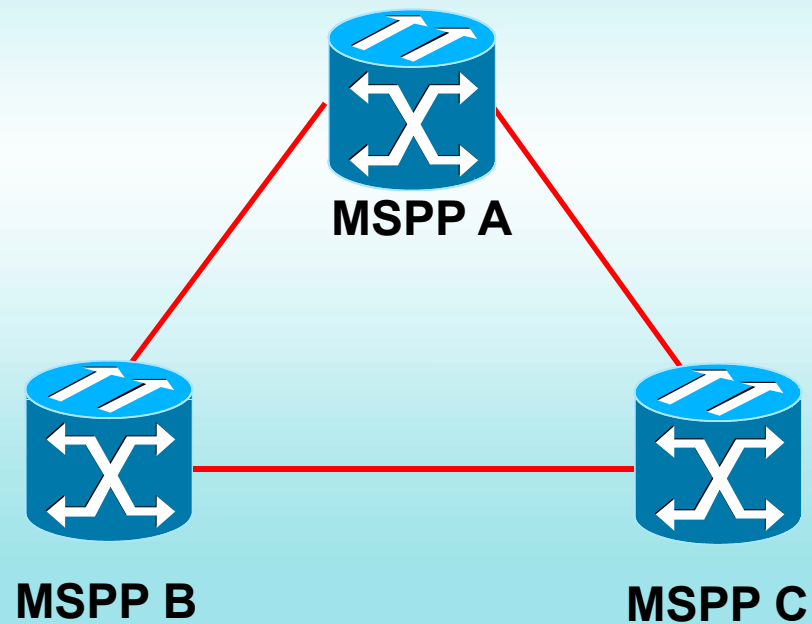
TWAREN Optical Labs



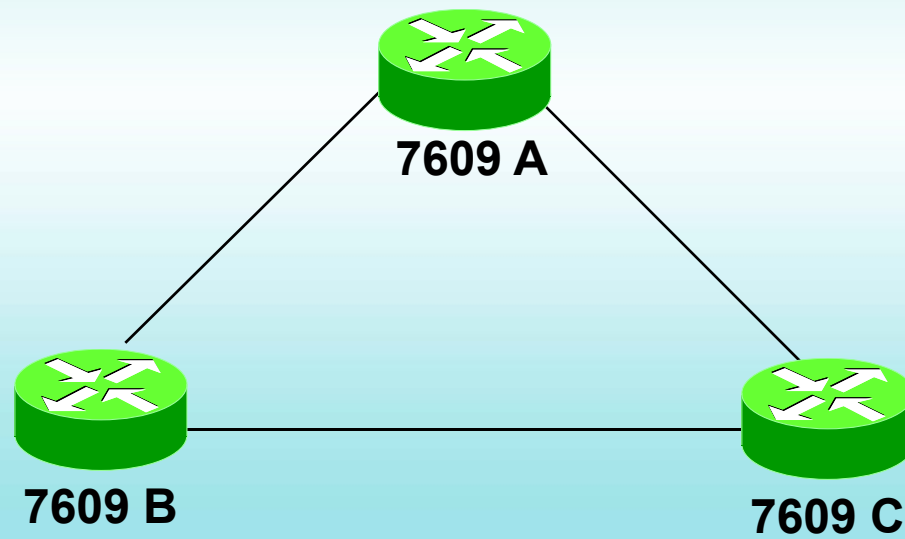
Lab Network Topology



SDH Topology



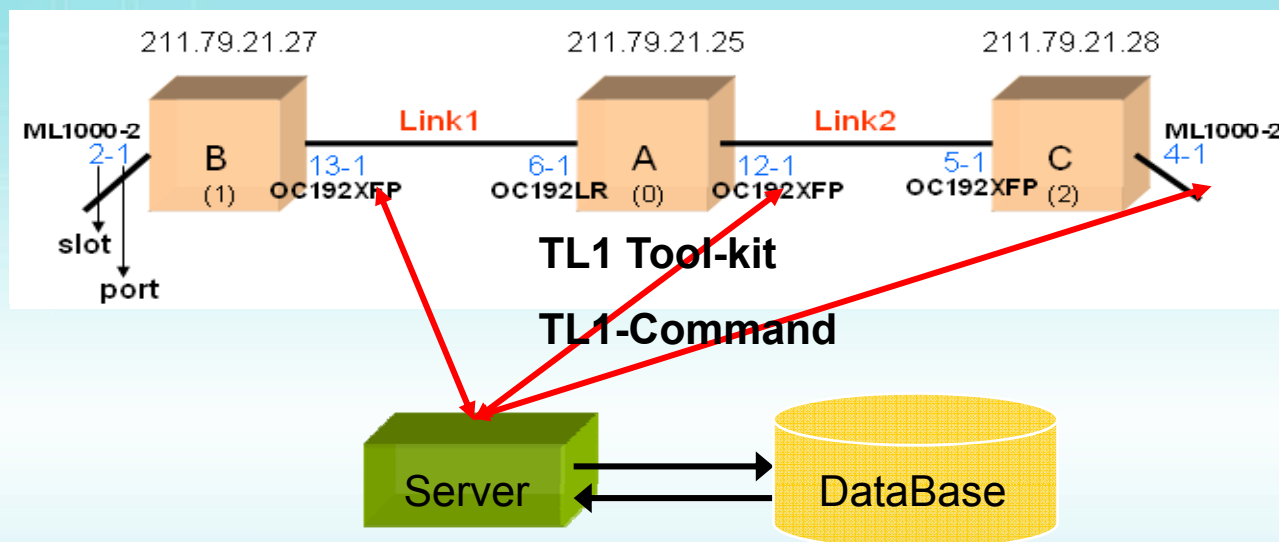
IP Topology



TWAREN LightPath Control System

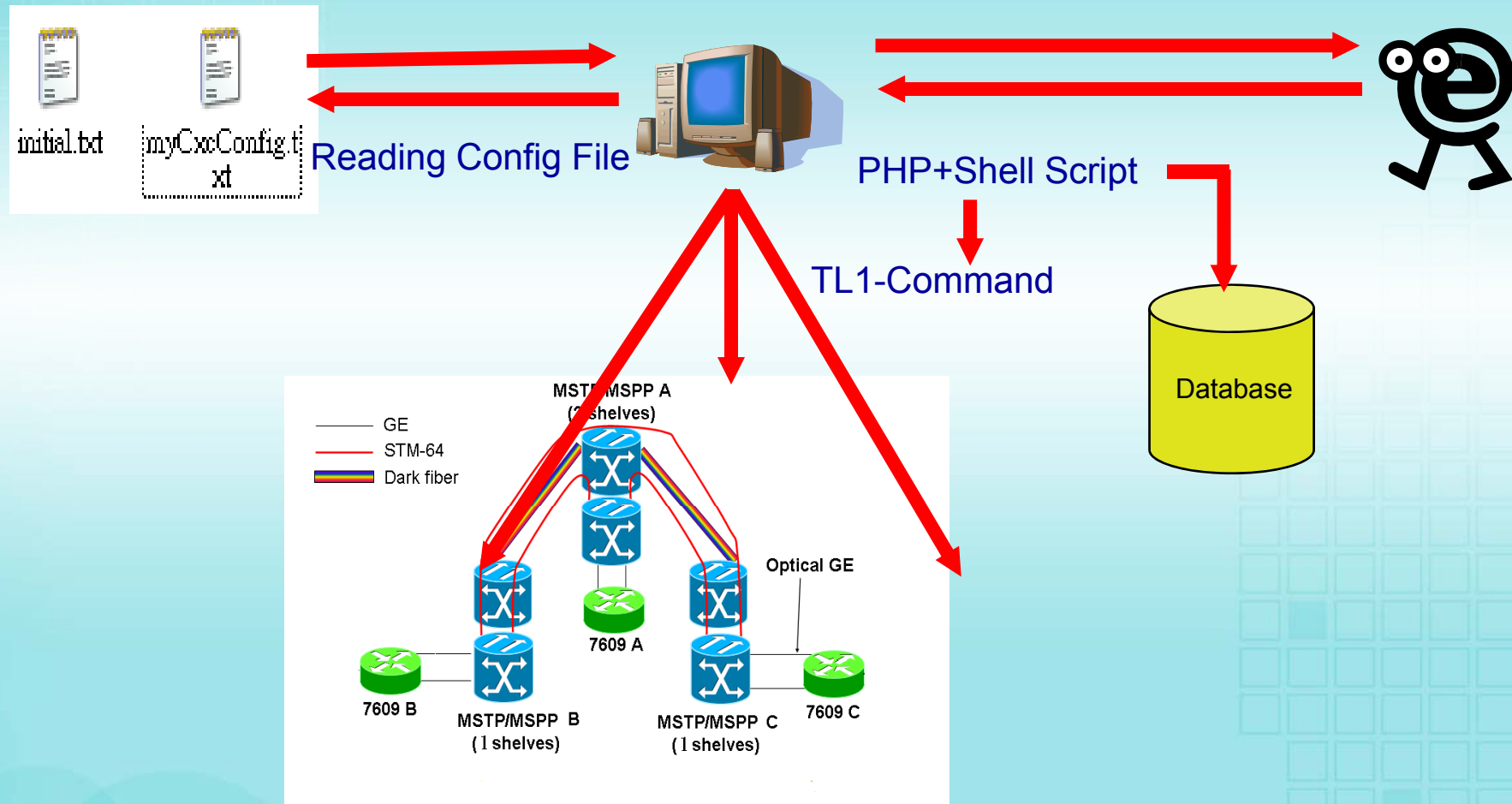
- A web-based control and resource management system
- Platform : Linux
- Tools : PHP+ Shell script+TL1 Toolkit
- Test environment : TWAREN optical network lab

Steps to Create a LightPath

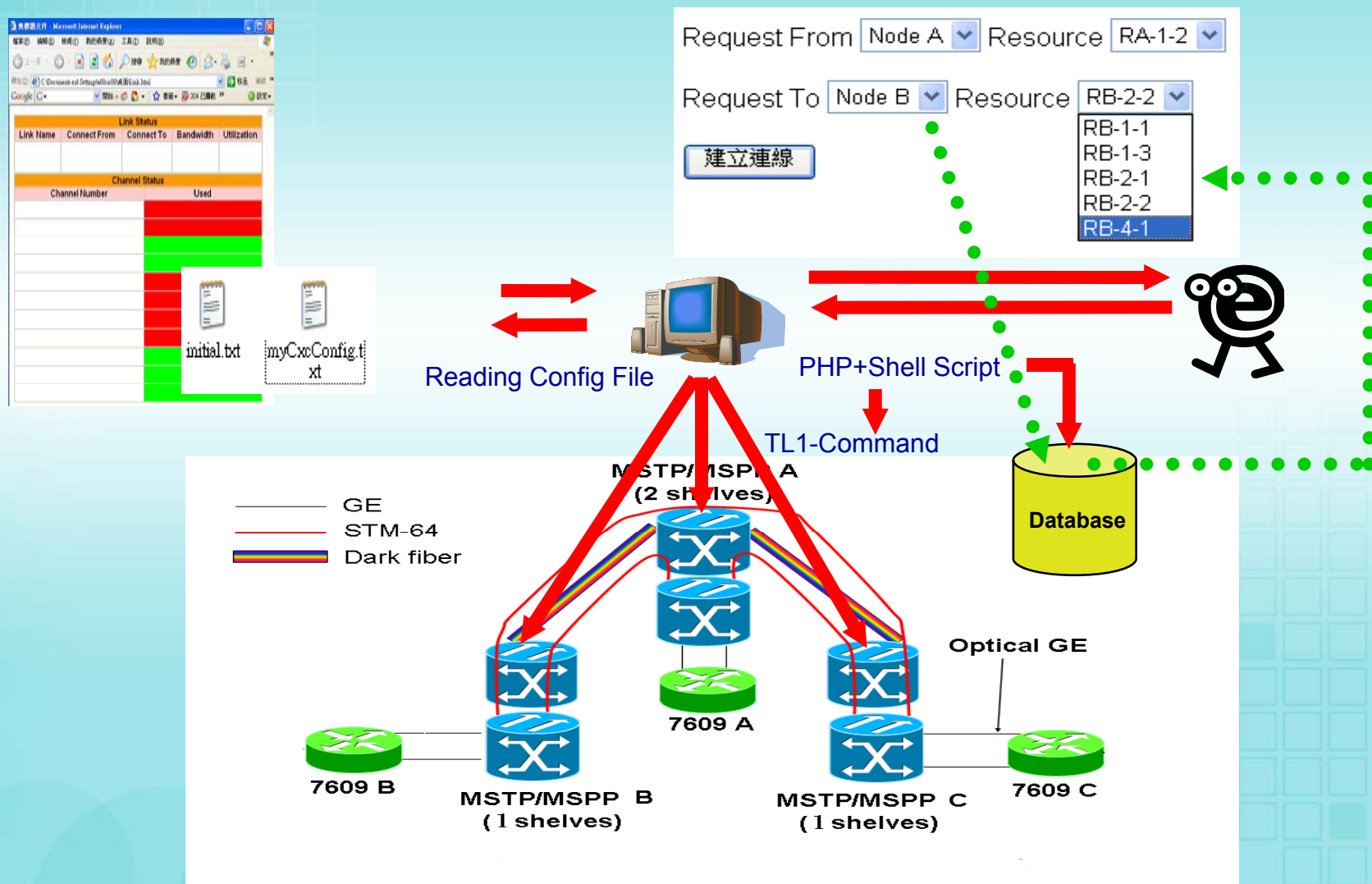


1. Use TL1-toolkit to query real-time status
2. Check if path is supported
3. Check if bandwidth is supported
4. Execute the SPF algorithm to find the best path
5. Setup the connection between devices
6. Synchronize the database

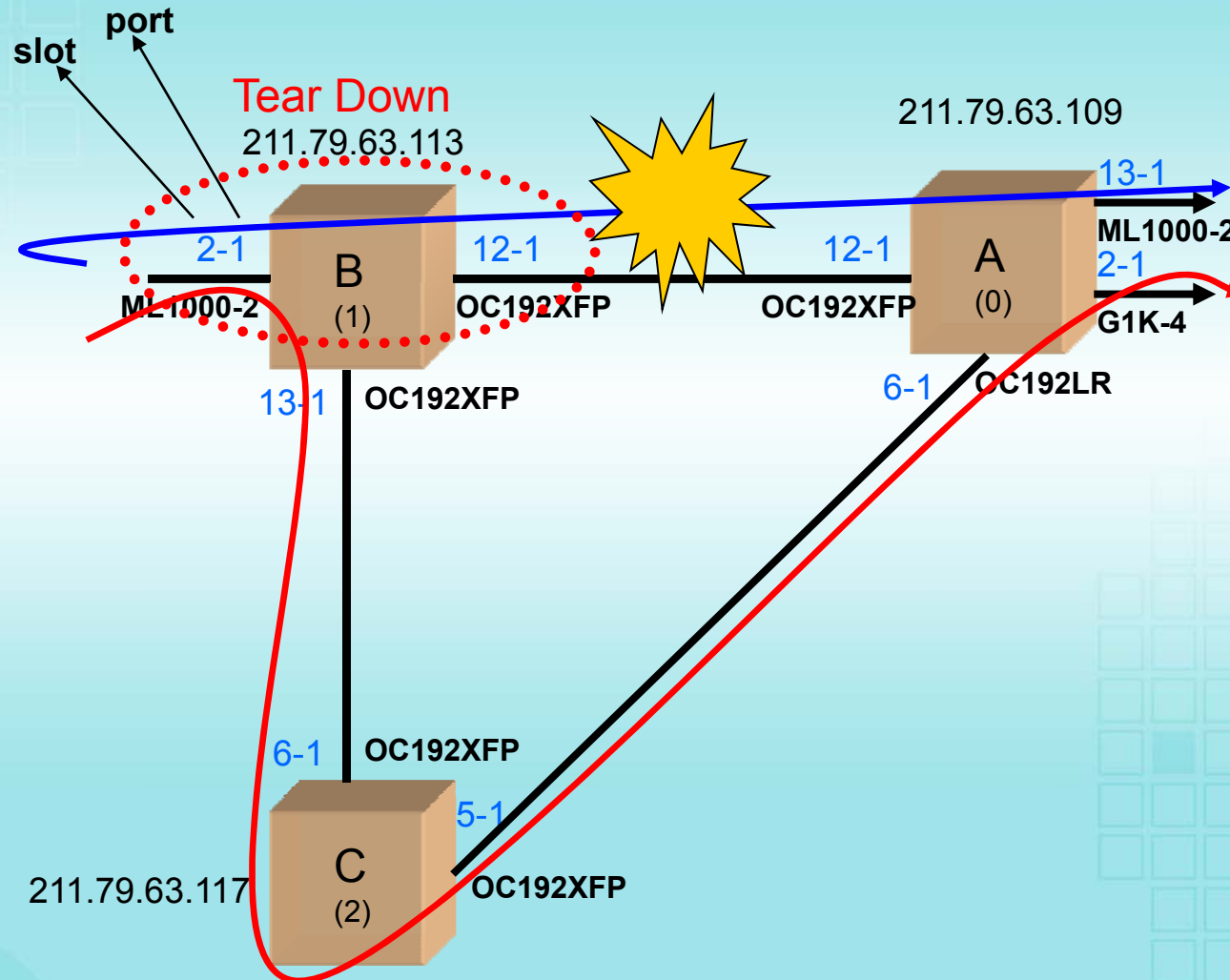
Resource Management Architecture



Request Testing

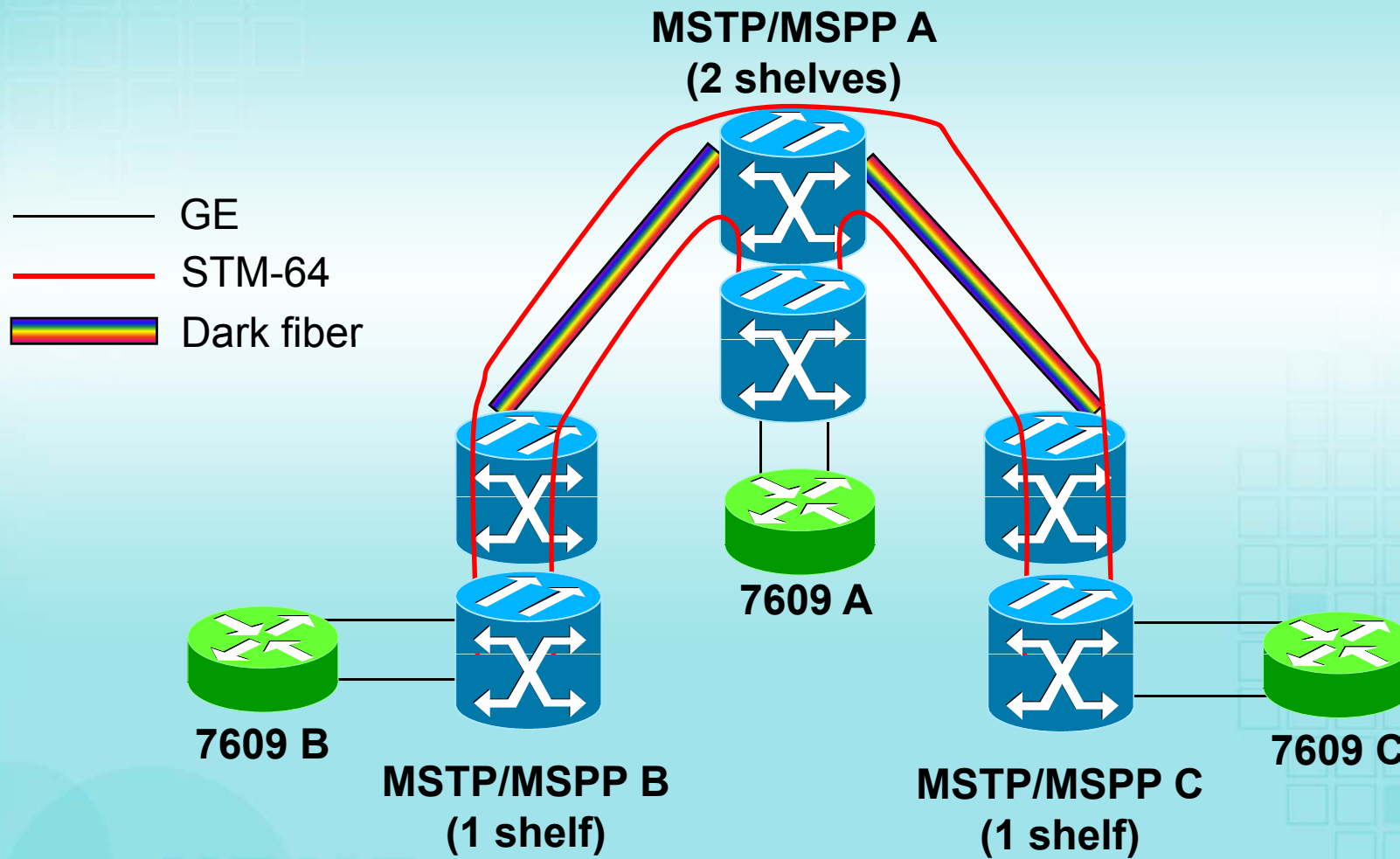


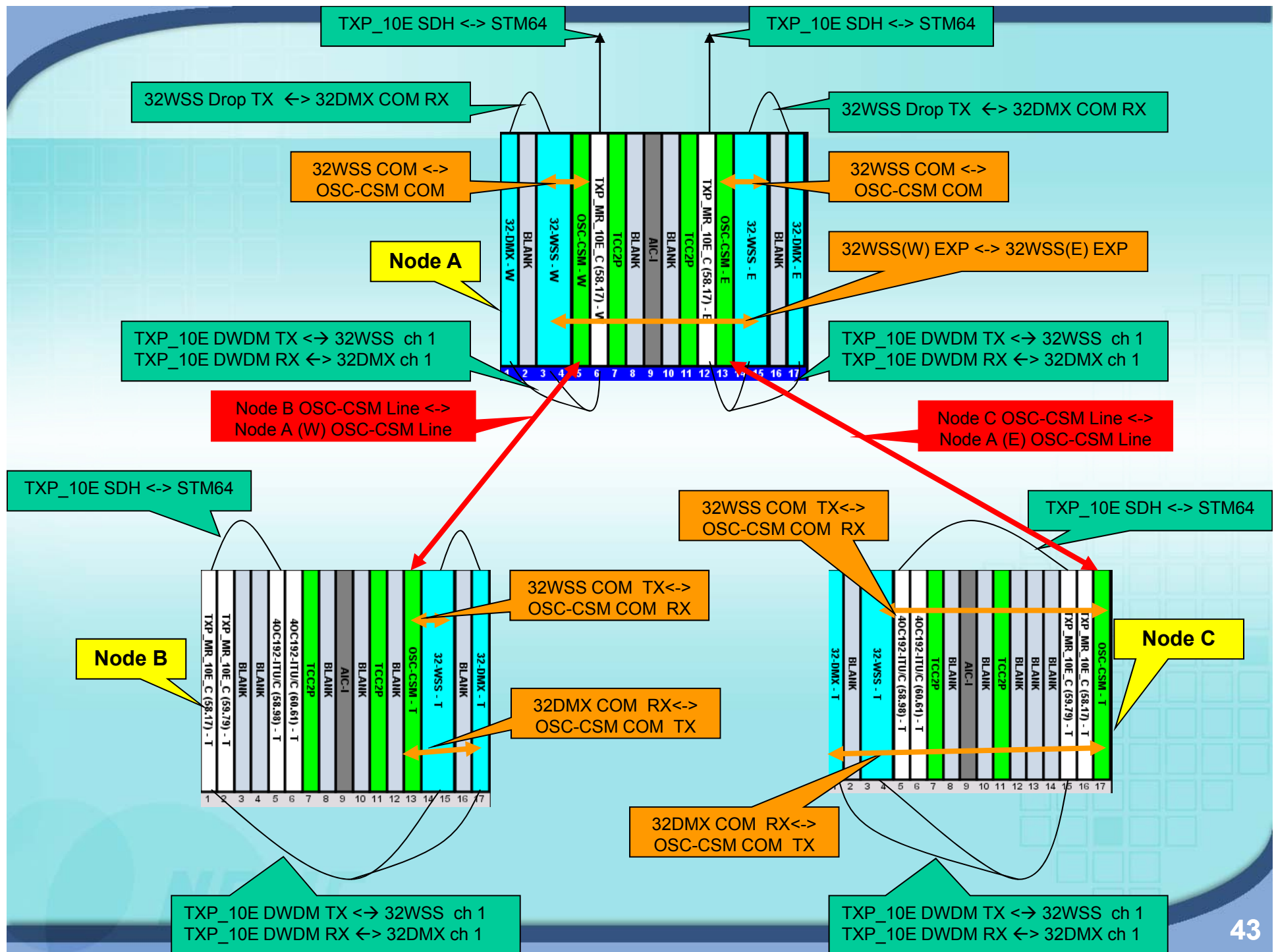
Lightpath Restoration



Alarm Correlation in Hybrid IP/Optical Network

Lab Network Topology





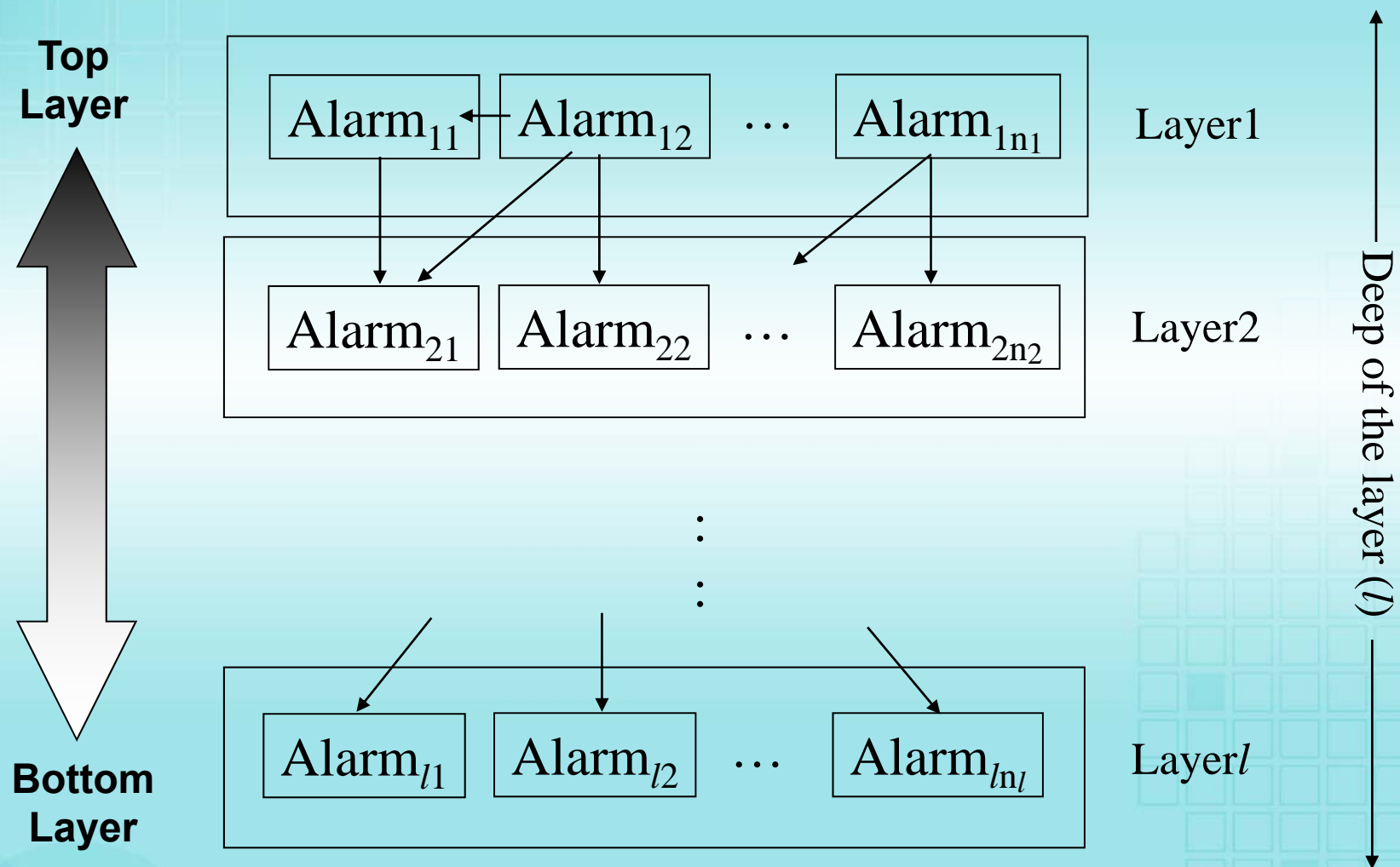
Hybrid IP/Optical Networks

- Hybrid networks contain Layer3 IP / Layer2 Switching networks with underlying optical infrastructure as its backbone.
- Optical infrastructure may consist of DWDM/ROADM wavelength-division technology and SONET/SDH time-division technology.

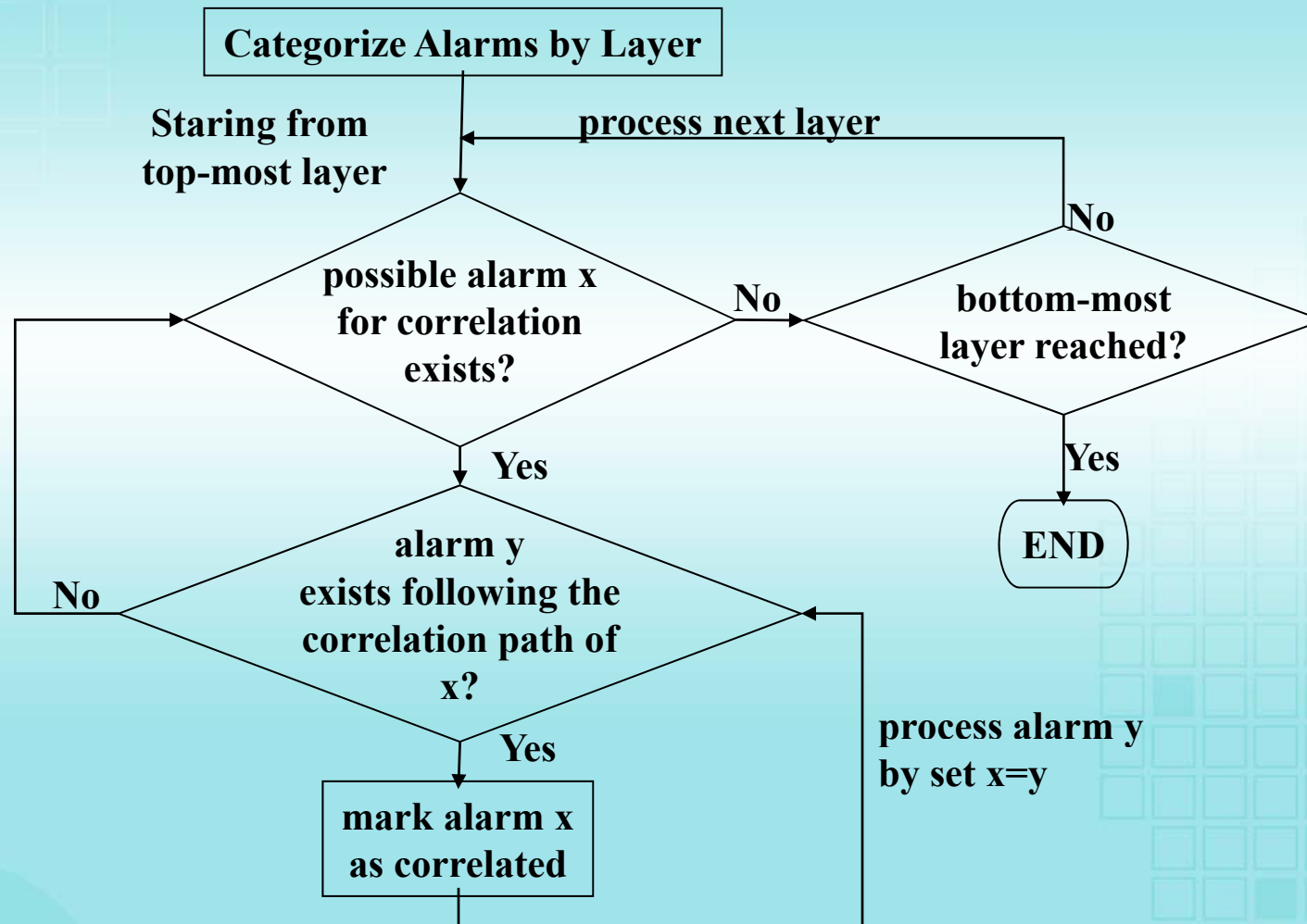
Alarm Management in Hybrid Networks

- If any disruption occurs in lower layer, it will cause upper layer alarms.
- Tens of alarms will show up in burst, which confuse network operators and engineers.
 - Fault location identification is possible with proper alarm analysis/correlation

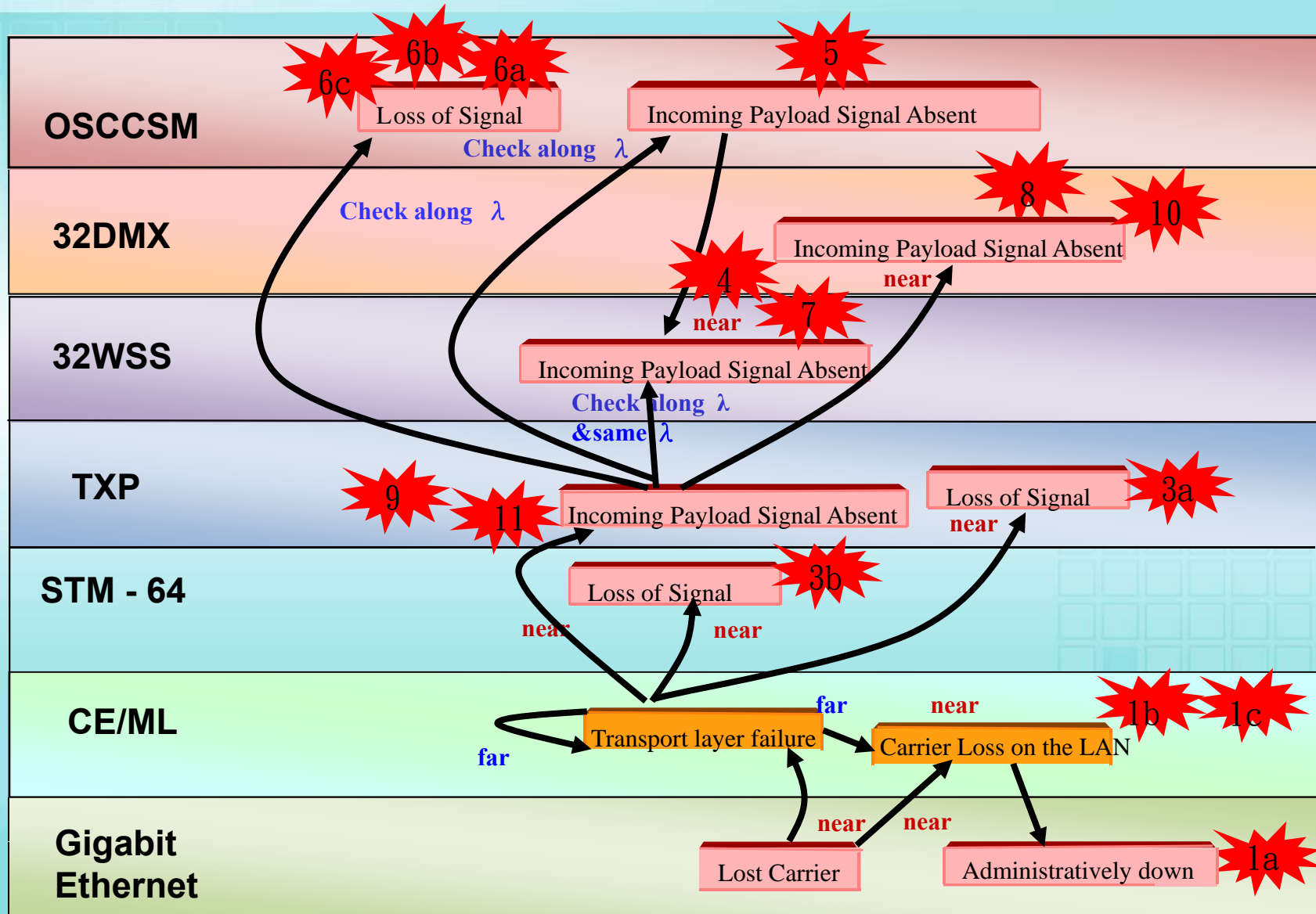
Correlation Diagram

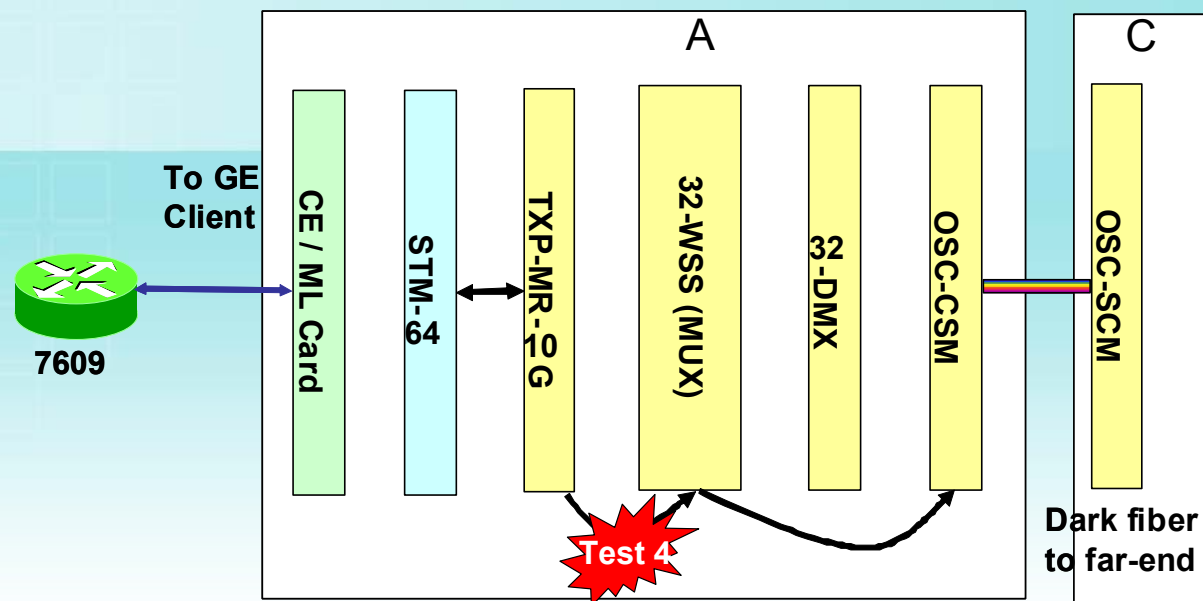


Alarm Correlation Algorithm



Alarm Correlation Diagram

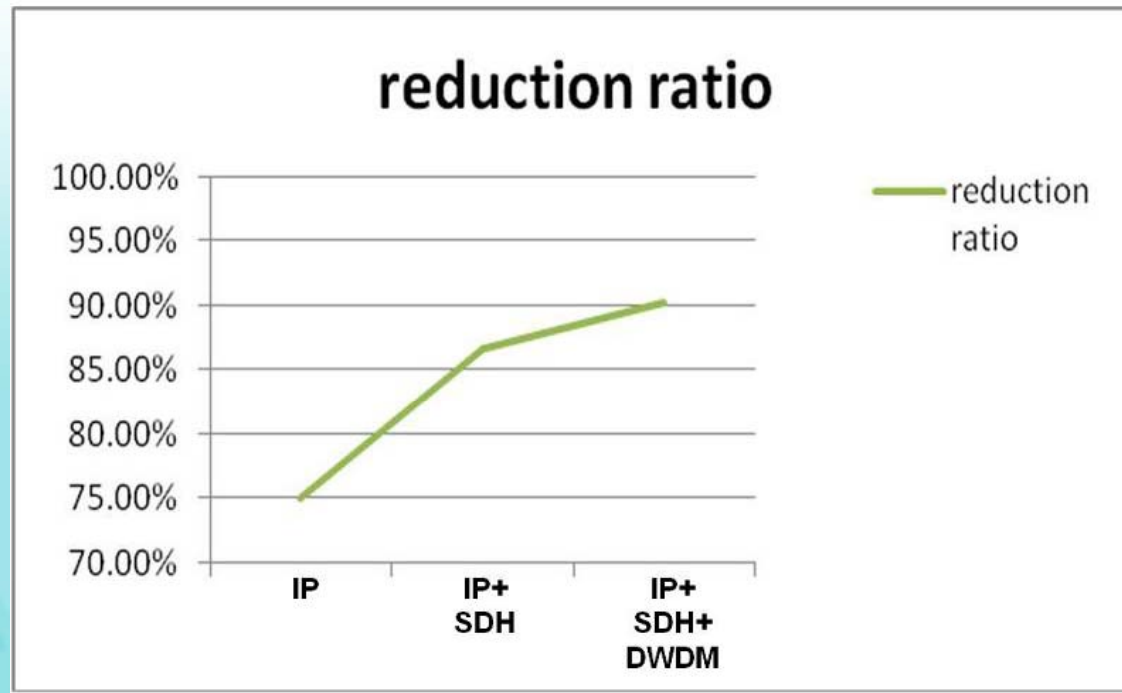




	Layer	Alarm Descriptions	Alarm source (near-end or far-end)	Affected card/module
Test 4	IP	Lost Carrier	Router A Router C	GigabitEthernet
	IP	Transport layer failure	Node A Node C	CE/ML
	Wavelength	Incoming Payload Signal Absent	Node C	TXP-MR-10G
	Wavelength	Incoming Payload Signal Absent	Node A	32-WSS
	Fiber	Incoming Payload Signal Absent	Node A	OSC-CSM

Results

- 75%, 87%, and 91% alarms are correlated in average when network disruption in IP Layer, SDH Layer, and DWDM layer respectively.



Implementation on perfSONAR

PerfsonarUI-v0.15

File Interfaces Circuits BWCTL Looking Glass FlowSA Link Status Links Playground Correlation Help

Interfaces Circuits BWCTL Looking Glass FlowSA Link Status Links Playground Correlation

perfSONAR

Query options ⌵
 Service addresses
 Options

Execute query ⌵
 One Alarms
 Snmp Alarms
Correlation
 Clear

<http://211.73.95.8:8080/nl-mp/services/TL1Service>

Use	ONSdevice	IP	Port	Username	Password	Prompt
<input checked="" type="checkbox"/>	A2	211.79.63.108	3083	training	*****	>
<input checked="" type="checkbox"/>	A	211.79.63.109	3083	training	*****	>
<input checked="" type="checkbox"/>	B	211.79.63.113	3083	training	*****	>
<input checked="" type="checkbox"/>	C	211.79.63.117	3083	training	*****	>

<http://211.73.95.8:8080/snmp-lite-mp/services/SNMP LiteService>

Use	Name	IP	port	ifIndex	version	community
<input checked="" type="checkbox"/>	7609A2	211.79.63.110	161.3		2	public
<input checked="" type="checkbox"/>	7609A2	211.79.63.110	161.4		2	public
<input checked="" type="checkbox"/>	7609A2	211.79.63.110	161.5		2	public
<input checked="" type="checkbox"/>	7609B	211.79.63.114	161.3		2	public
<input checked="" type="checkbox"/>	7609B	211.79.63.114	161.4		2	public
<input checked="" type="checkbox"/>	7609C	211.79.63.118	161.3		2	public
<input checked="" type="checkbox"/>	7609C	211.79.63.118	161.4		2	public

<http://211.73.95.8:8080/correlation-mp/services/CorrelationService>

Alarms

Date	Node	Card	Slot	Port	Severity	Message	WaveLe...
08/15/08	A2	STM64	12	1-1	CR	Loss Of St...	1550
08/15/08	A2				MN	Secondary...	x
08/15/08	A2	STM64	12	1-1	MN	Regenerat...	1550
08/15/08	A2	CEML	14	1	MJ	Transport L...	x
08/15/08	A2	STM64	6	1-1	MN	Regenerat...	1550
08/15/08	C	CEML	13	1	MJ	Transport L...	x

[Open Test Case](#)

Results

Date	Node	Card	Slot	Port	Severity	Message	WaveLe...
08/15/08	A2	STM64	12	1-1	CR	Loss Of St...	1550

```

graph TD
    A[A] ---|DWDM-2| C[C]
    A ---|DWDM-1| B[B]
    C ---|SDH-2| R1((R1 7609A2))
    B ---|SDH-1| R1
    C ---|SDH-3| B
    R1 ---|SDH-2| C
    R1 ---|SDH-1| B
  
```

Completed.

請按這裡開始操作

Wireless Roaming – eduroam

Cross-Campus WLAN Roaming

- ◆ **Taiwan**: 104 schools and institutions participated.
- ◆ **International**: eduroam (Education Roaming)
 - eduroam Europe**: UK, France, Netherland, and more
 - eduroam APAN**: Taiwan, Japan, Australia, China and Hong Kong

<http://wlanrc.nchc.org.tw>



Roaming Platform Participants

- | | |
|---|--|
| 1) National Taiwan University | 26) Tamkang University |
| 2) National Cheng-chi University | 27) Feng Chia University |
| 3) National Chiao-Tung University | 28) I-Shou University |
| 4) National Tsing-Hua University | 29) Soochou University |
| 5) National Central University | 30) Wufeng Institute of Technology |
| 6) National Cheng-Kung University | 31) Vanung University |
| 7) National Chi-Nan University | 32) Huaan University |
| 8) National Chung-Hsing University | 33) Kaohsiung Medical University |
| 9) National Dong Hwa University | 34) Ming Chuan University |
| 10) National Taipei University | 35) Providence University |
| 11) National Yang-Ming University | 36) Da-Yeh University |
| 12) National Taiwan Normal University | 37) Shih Hsin University |
| 13) National Chung-Cheng University | 38) Yuan Ze University |
| 14) National Taiwan Ocean University | 39) Chung Hua University |
| 15) National United University | 40) Chinese Culture University |
| 16) National Hsinchu University of Education | 41) Hsiuping Institute of Technology |
| 17) National University of Tainan | 42) Ling Tung University |
| 18) National University of Kaohsiung | 43) Lunghwa University of Science and Technology |
| 19) National Ilan University | 44) Takming College |
| 20) National Taitung University | 45) Jin Wen Institute of Technology |
| 21) National Taiwan University of Science and Technology | 46) Fooyin University |
| 22) National Yunlin University of Science and Technology | 47) Tatung University |
| 23) National Kaohsiung First University of Science and Technology | 48) Mingdao University |
| 24) Northern Taiwan Institute of Science and Technology | 49) St. John's University |
| | 50) Yuanpei Institute of Science and Technology |

Can roaming between 110+ universities
in Taiwan.

And over 900,000 user accounts
are being served.

Project Brief

■ Objectives

- Provide the WLAN roaming environment in campus.
- Promote WLAN applications.
- Cross-Campus WLAN Roaming Security Enhancement

■ Tasks

- Construct the roaming platform and the operation and maintenance manual.
- Build the Web-based and 802.1x Authentication environments to test the roaming platform.
- Promote and provide the technical support to build the WLAN roaming environment.
- Evaluate campuses' WLAN environment and support them to join the WLAN roaming platform.
- Construct the web site to provide WLAN cross-campus roaming information and service consultation.
- International WLAN Roaming Cooperation

Services

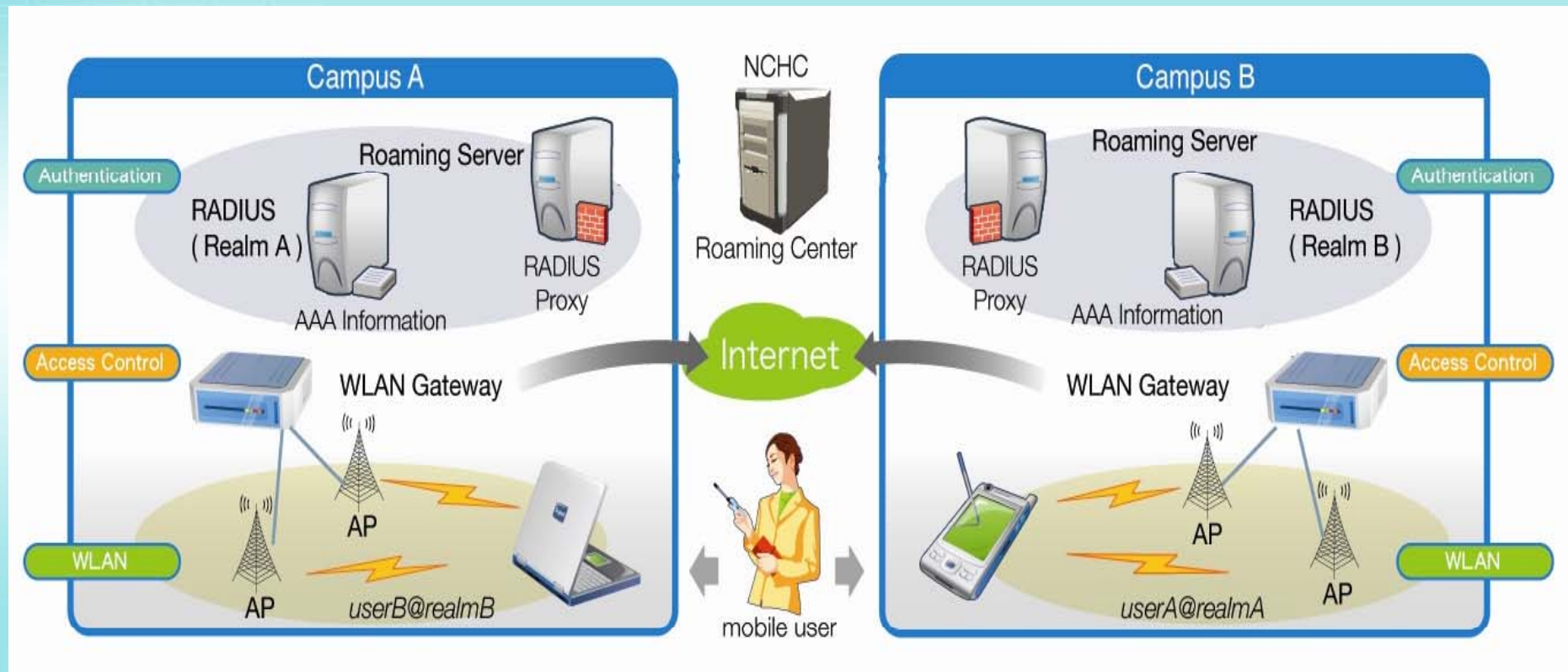
■ Current Services

- Mobile users can use their own accounts and passwords to pass through the authentication mechanism in other campuses through the WLAN Roaming Center.

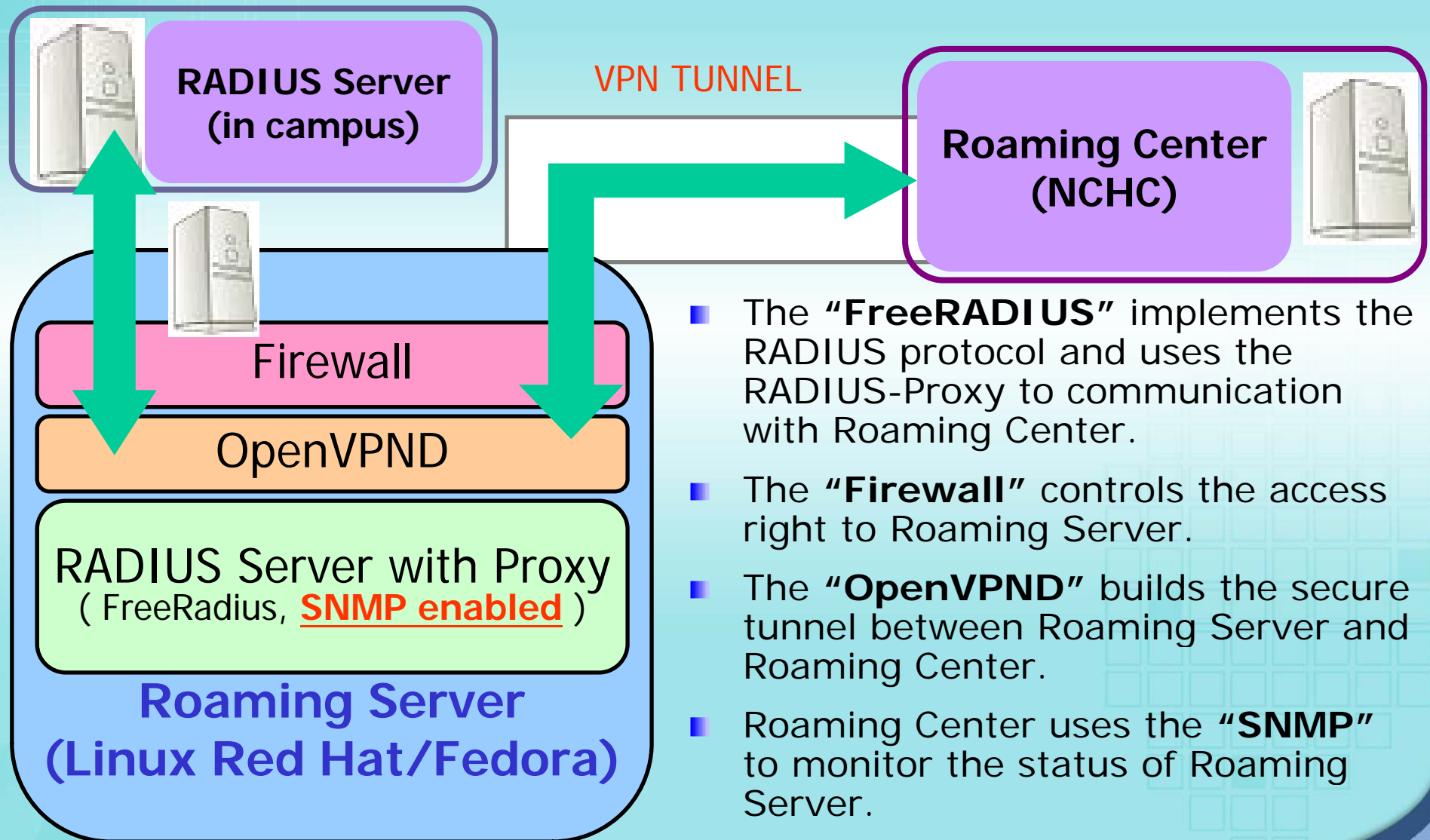
■ Future Services

- Establish a standard cross-campus authentication architecture
 - Tele-courses
 - VoIP/Viedo Phone Applications

WLAN Roaming Architecture



Roaming Server – Software Architecture



- The **"FreeRADIUS"** implements the RADIUS protocol and uses the RADIUS-Proxy to communication with Roaming Center.
- The **"Firewall"** controls the access right to Roaming Server.
- The **"OpenVPND"** builds the secure tunnel between Roaming Server and Roaming Center.
- Roaming Center uses the **"SNMP"** to monitor the status of Roaming Server.

Current Authentication in Taiwan's Campus WLAN

- Web-based UAM (Universal Access Method)- 92%
 - PRO
 - Easy implementation/ Easy installation
 - Supporting multiple OS. UNIX 、LDAP 、SQL Server ...etc
 - CON
 - Phishing is possible.
- 802.1x EAP (Extensible Authentication Protocol)- 5%
 - PRO
 - Standardized Authentication with many option
 - Better security level
 - If EAP-TTLS is used, multiple account authentication systems can be supported
 - CON
 - Access Point and client need to support 802.1x
 - Higher installation cost
- Others- 3%
 - MAC address
 - Open

International WLAN Roaming

- collaboration with the eduroam project for international WLAN roaming services.
- Authentication mechanism : 802.1x EAP-TTLS
- Eduroam project website : <http://www.eduroam.org/>

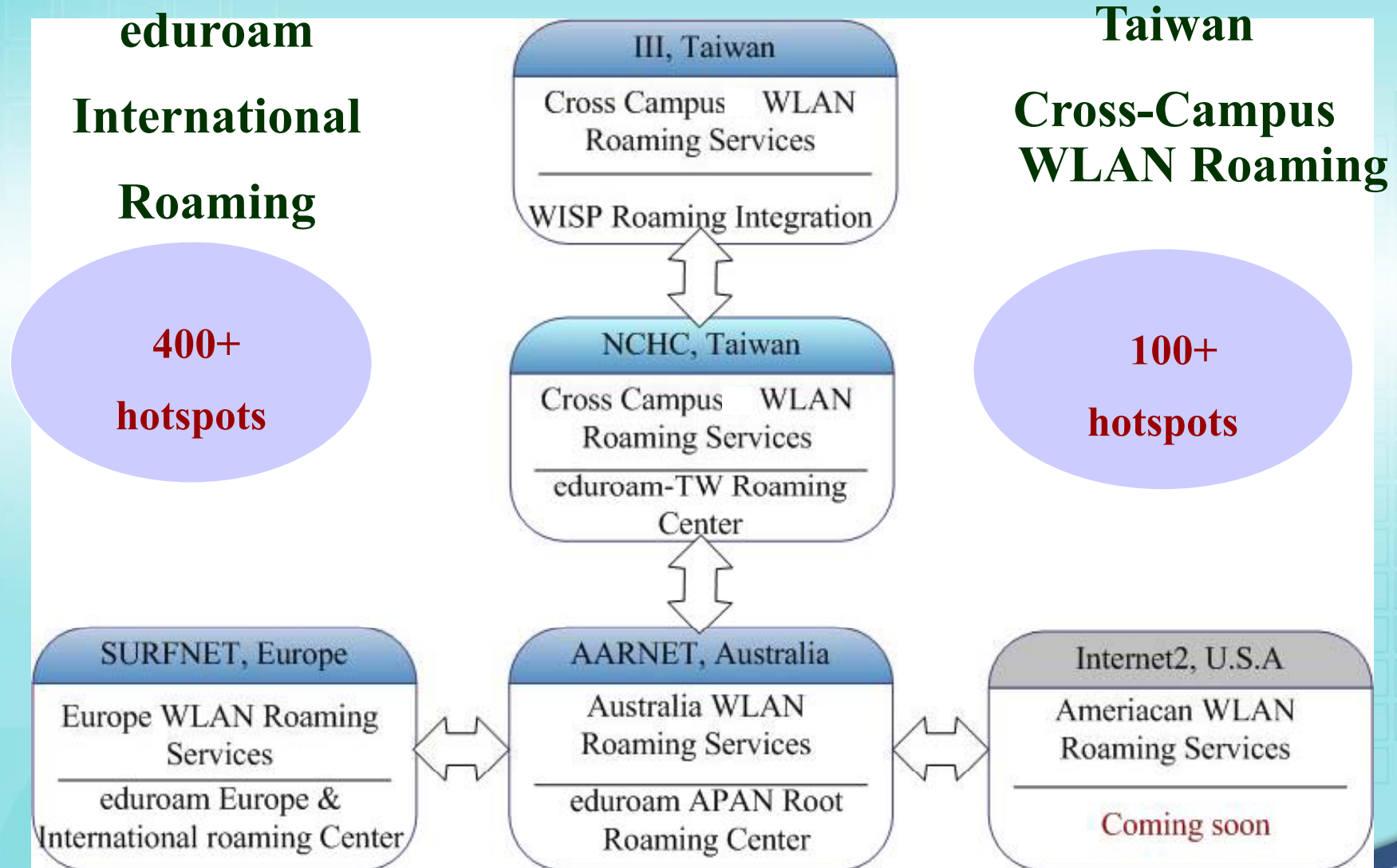


Eduroam
Asia-Pacific



Eduroam
Europe

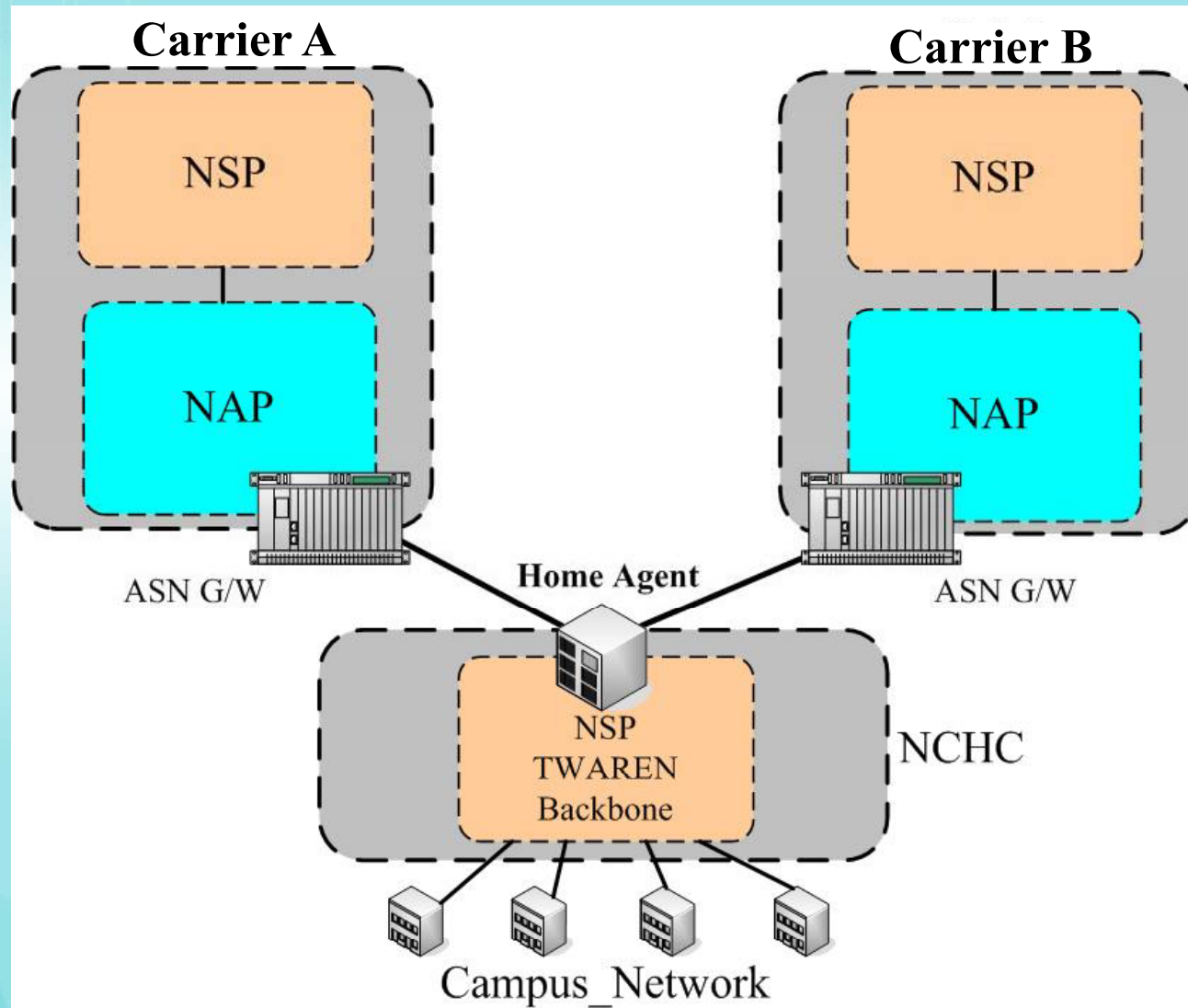
International WLAN Roaming Map



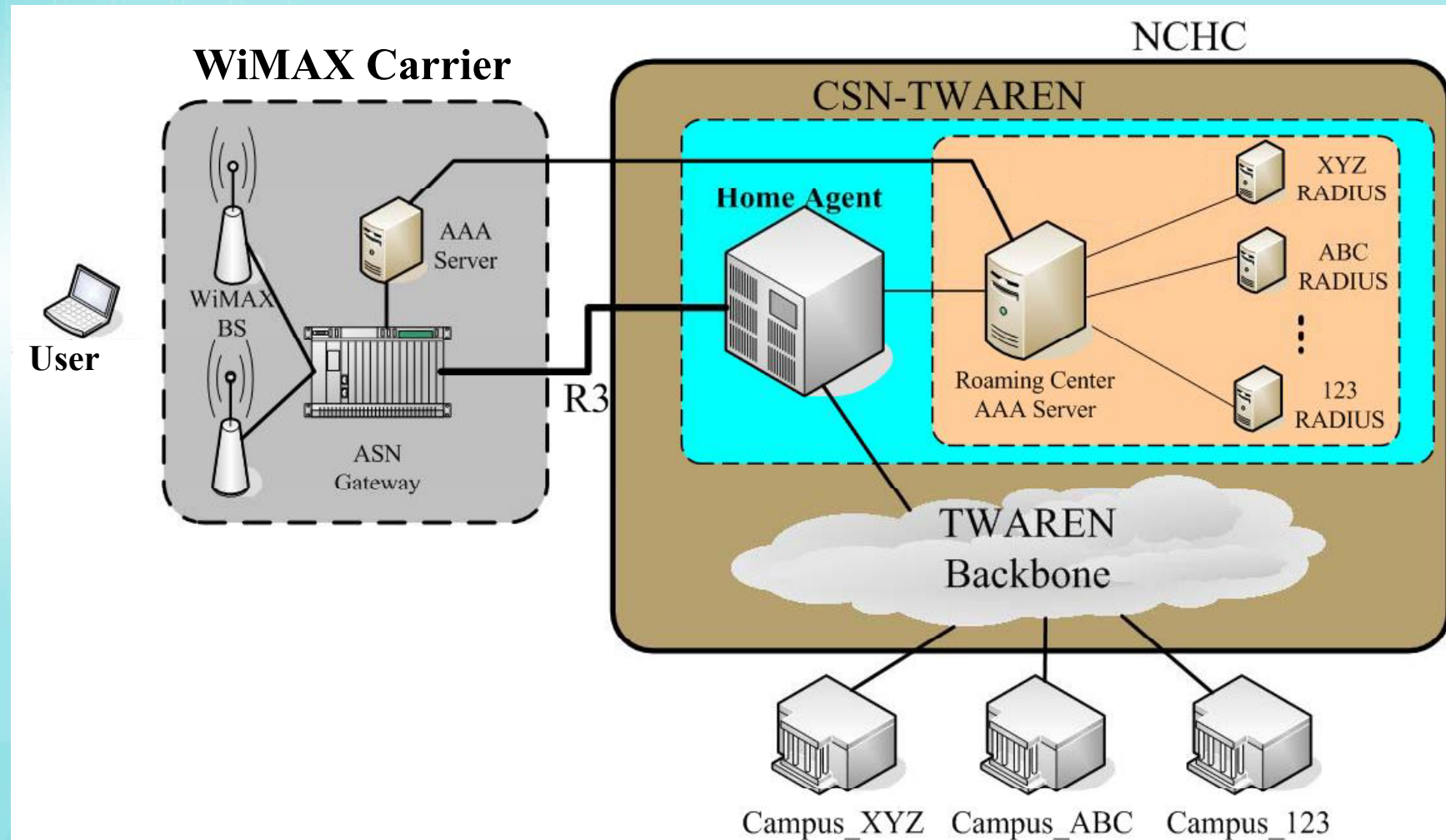
WLAN Roaming and WiMAX Integration

- To co-operate with WiMAX service providers, we try to integrate them with WLAN Roaming service
- Campus users can sign-in WiMAX service with their own account
 - no extra connection fee
 - Stimulate the active users of WiMAX Service

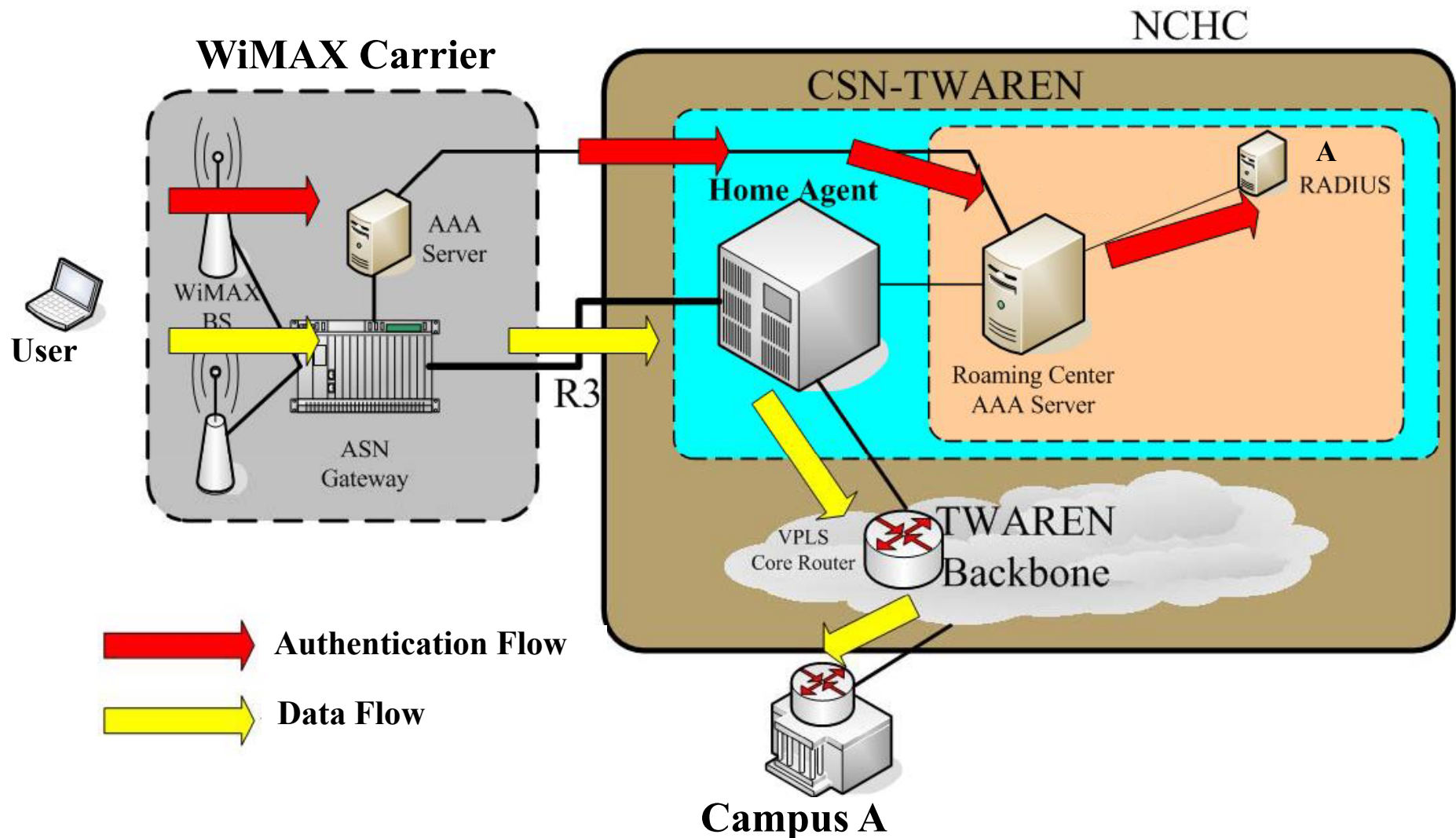
NAP Sharing Architecture



Roaming Architecture



Authentication and Data Flows



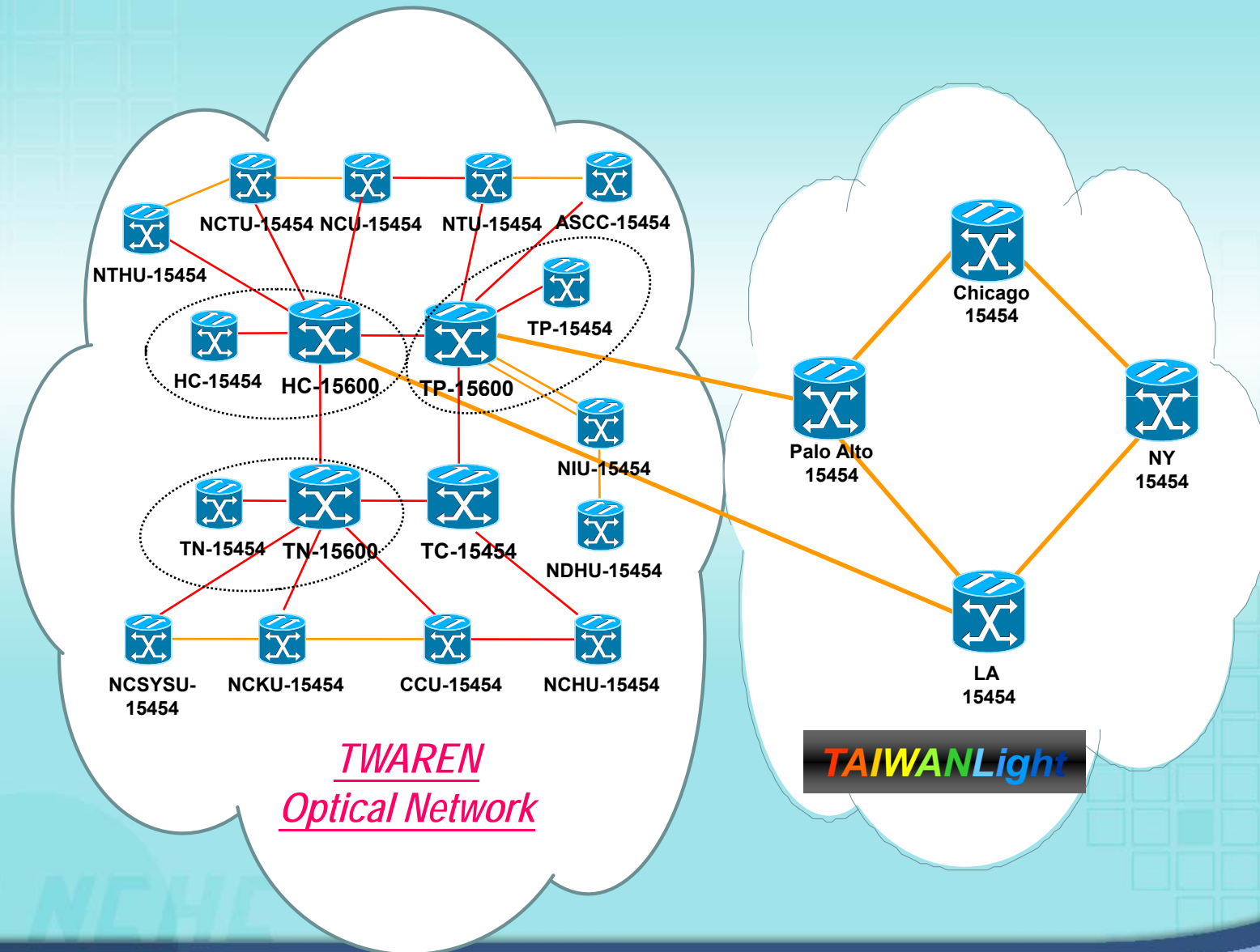
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TWAREN's International Connections

- Pacific Crossing to USA's west coast upgraded to 5 Gb/s
- Connections between LA, Palo Alto, Chicago, and New York are 2.5 Gb/s
- Connects to the rest of the world via the U.S.'s Abilene Network
- Connection expanded to Europe in 2006 (IEEAF donated 622 Mbps of bandwidth/fiber optic cable)

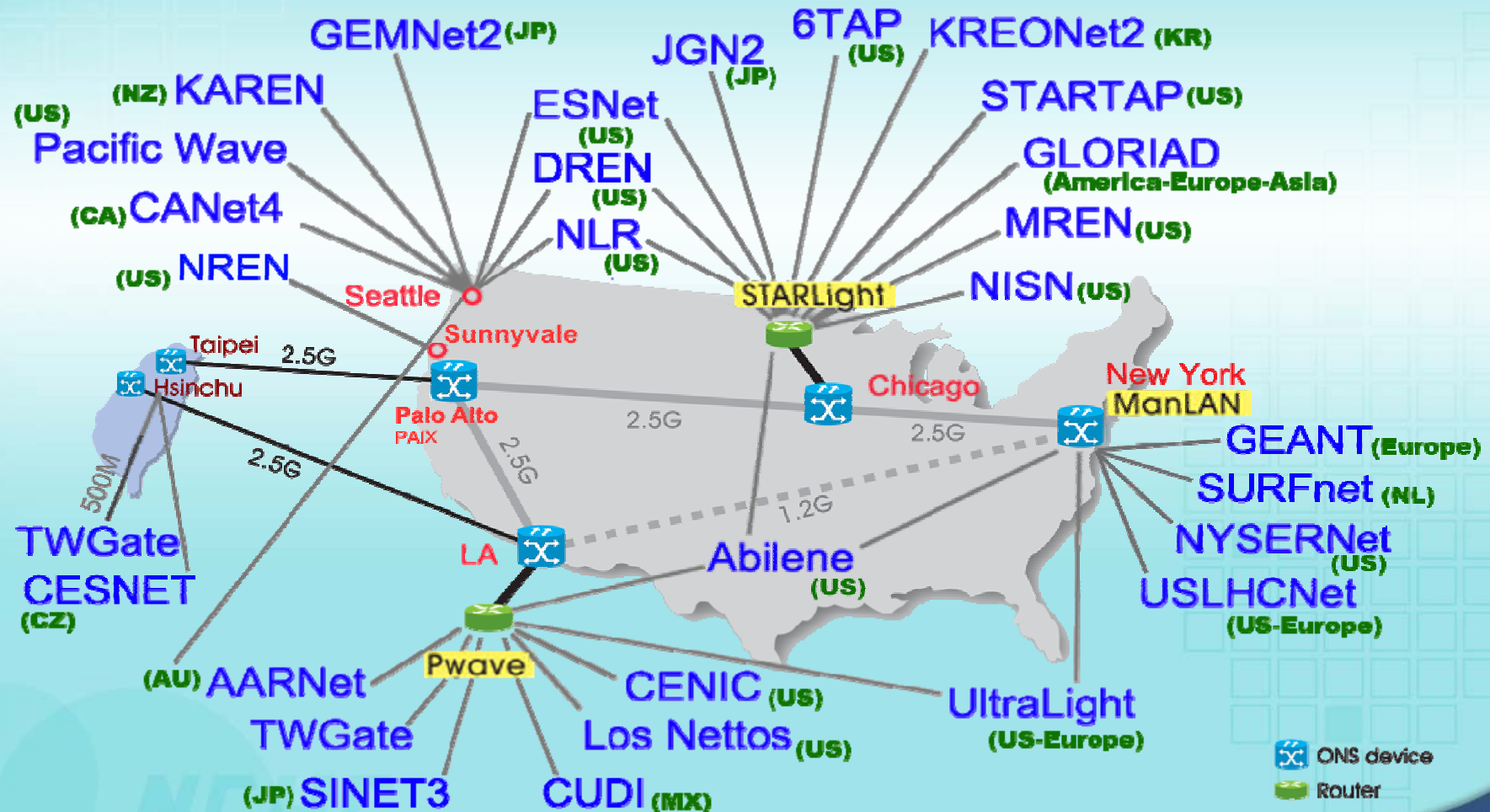


Combined **TWAREN/TAIWANLight** Lambda Testbed



TWAREN's International Peerings

- TWAREN made peerings with international NRENs at Los Angeles, Chicago, New York and Seattle (through Pacific Wave).



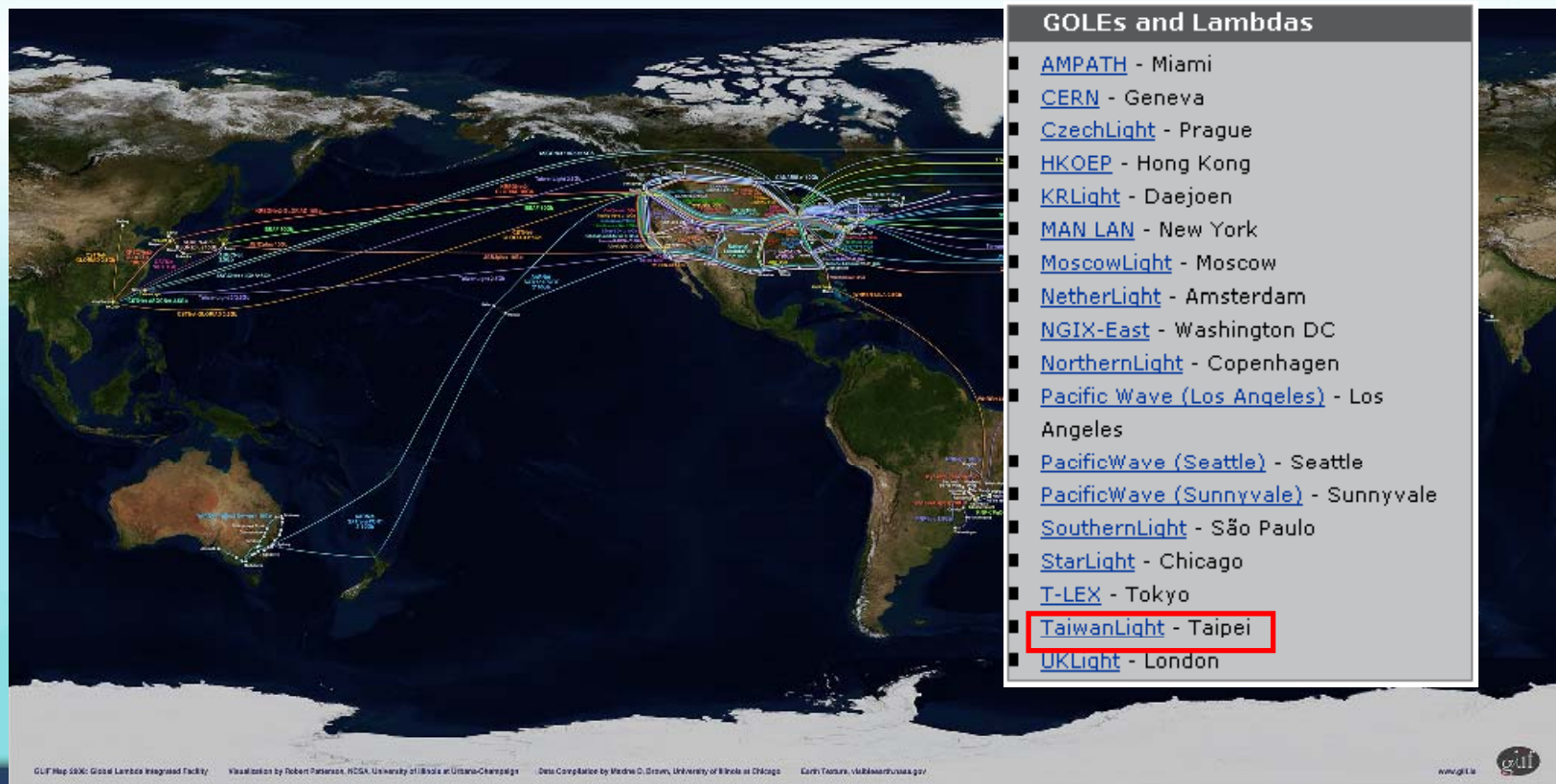
TWAREN's Direct Peerings Coverage

- TWAREN's direct peering covers most area in America, Asia, Australia and New Zealand, and will soon be expanded to Europe.



TWAREN/**TAIWAN**Light and GLIF

- TWAREN is a member of GLIF (Global Lambda Integrated Facility)
- **TAIWAN**Light is an official optical exchange - GOLE (GLIF Open Lightpath Exchange)



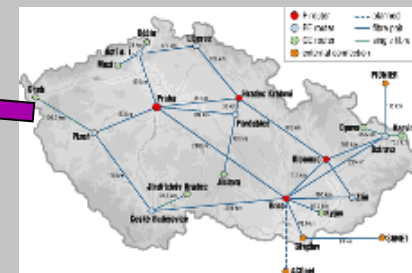
TWAREN-CESNET connection

- A direct lightpath that connects TW and CZ is provisioned through Pacific and Atlantic oceans in 2008/2.
 - Joint work among TWAREN, CA*net, MANLAN, NetherLight and CESNET
- **IPv6** and **Multicast** are enabled and several video streams are exchanged between TWAREN and CESNET.
- Further collaborations on **live medical streaming** and **HPC computing** are going on.



TWAREN

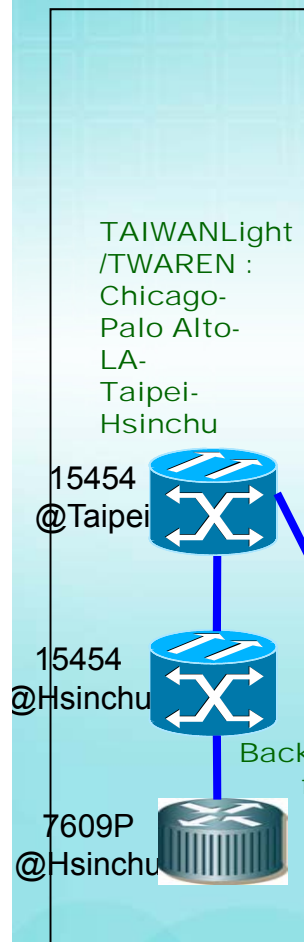
TW-CZ Lightpath
Single hop
RTT : 310ms
Bandwidth : 576Mbps



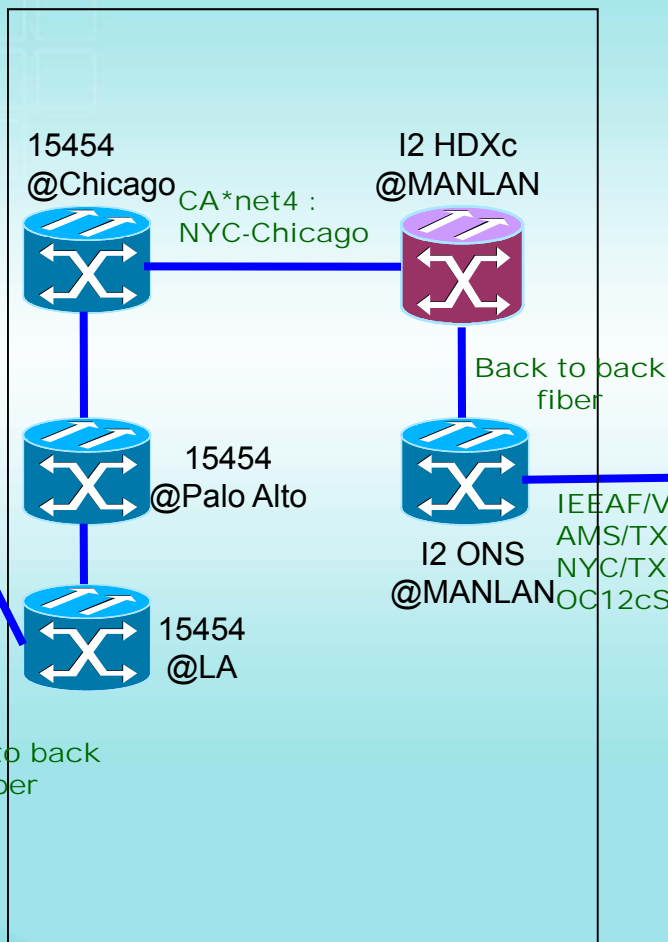
CESNET

TWAREN-CESNET Optical Topology

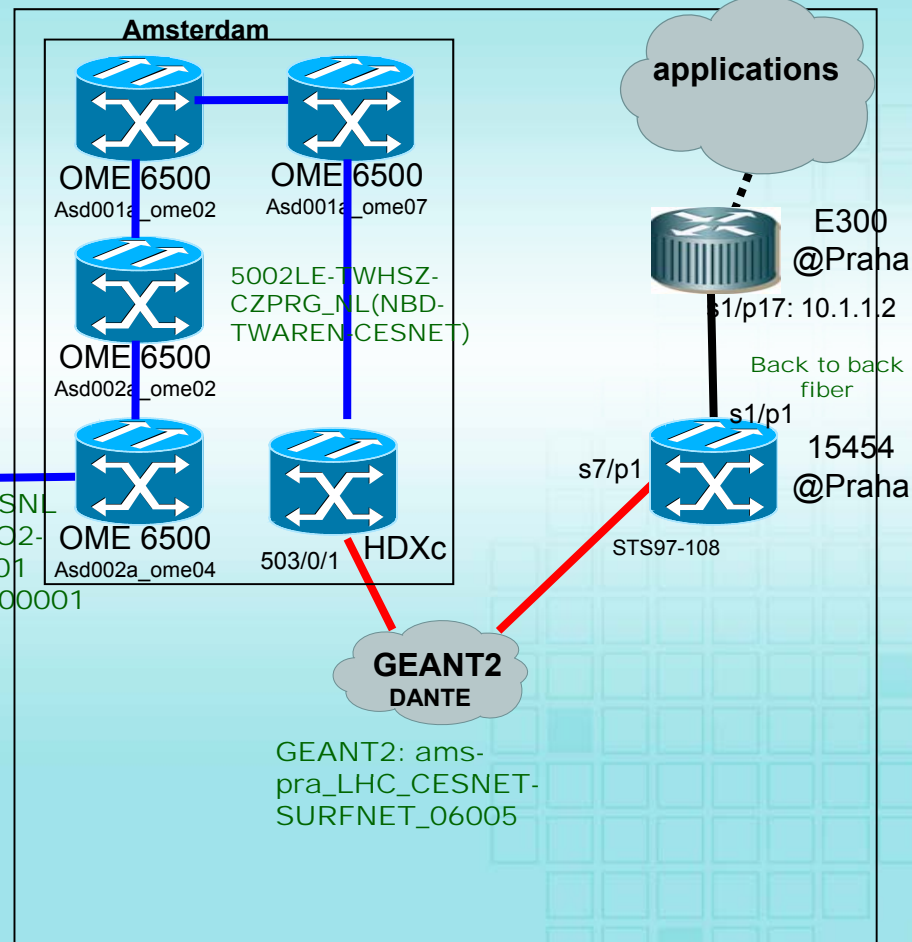
Taiwan



U.S.A



Europe



622M/s

1 GE

OC-192c

Live Medical Streaming 1

High-quality video streaming of live surgery with CESNet:

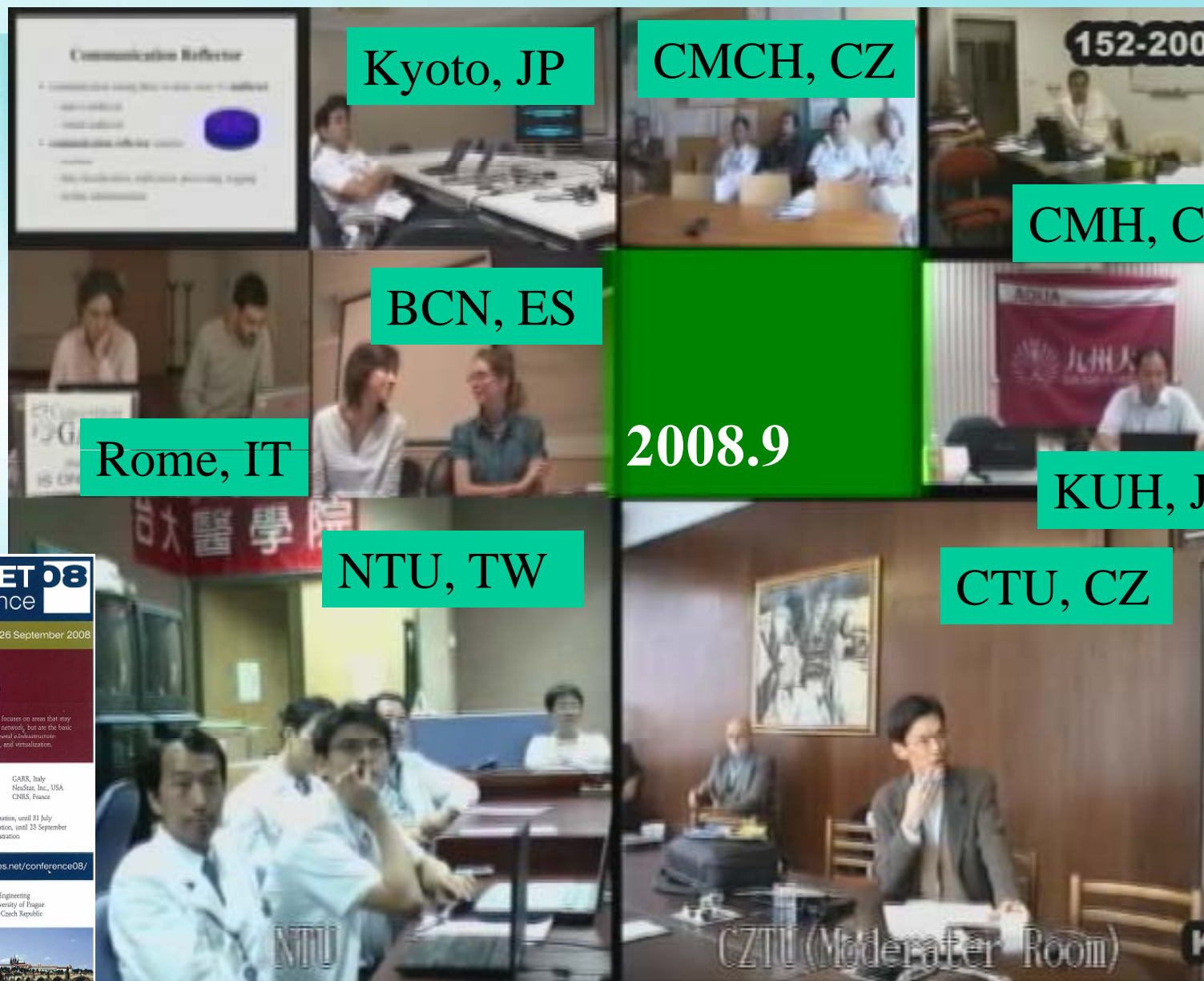
- 2007/10: Ophthalmology surgery (NCKU College of Medicine in Taiwan and Central Military Hospital in Czech).



Live Medical Streaming 2

- 2008/9: Demo of gastrointestinal endoscopy in CESNET08 conference (8 sites in Japan, Taiwan, Italy, Spain and Czech).





CESNET 08
conference

Prague, 25-26 September 2008

security
middleware
virtualization

Topics: This year conference focuses on areas that may be the building blocks of general infrastructure: security, middleware, and virtualization.

Keynote speakers: Mauro Campanella (GARR, Italy), Jeff Hodges (NetStar, Inc., USA), Johan Montagnat (CNRS, France)

Registration fees and deadlines: 180 Euro early registration, until 31 July; 220 Euro late registration, until 25 September; 240 Euro on-site registration.

<http://www.ces.net/conference08/>

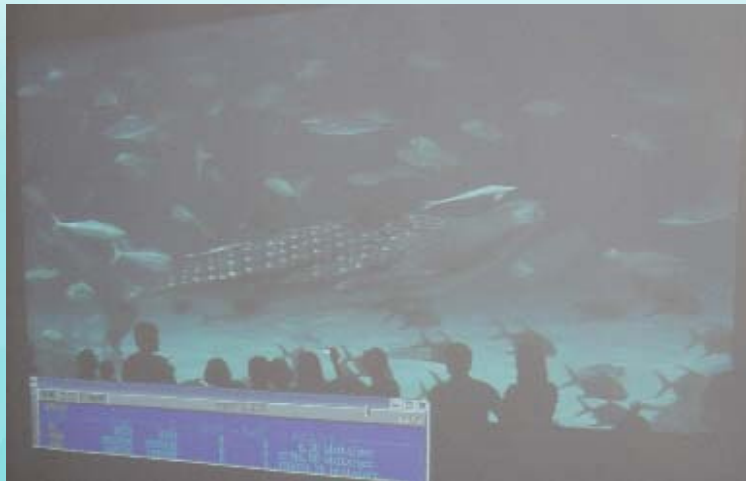
Venue: Faculty of Electrical Engineering, Czech Technical University of Prague, Technická 2, Prague, Czech Republic

we you in Prague

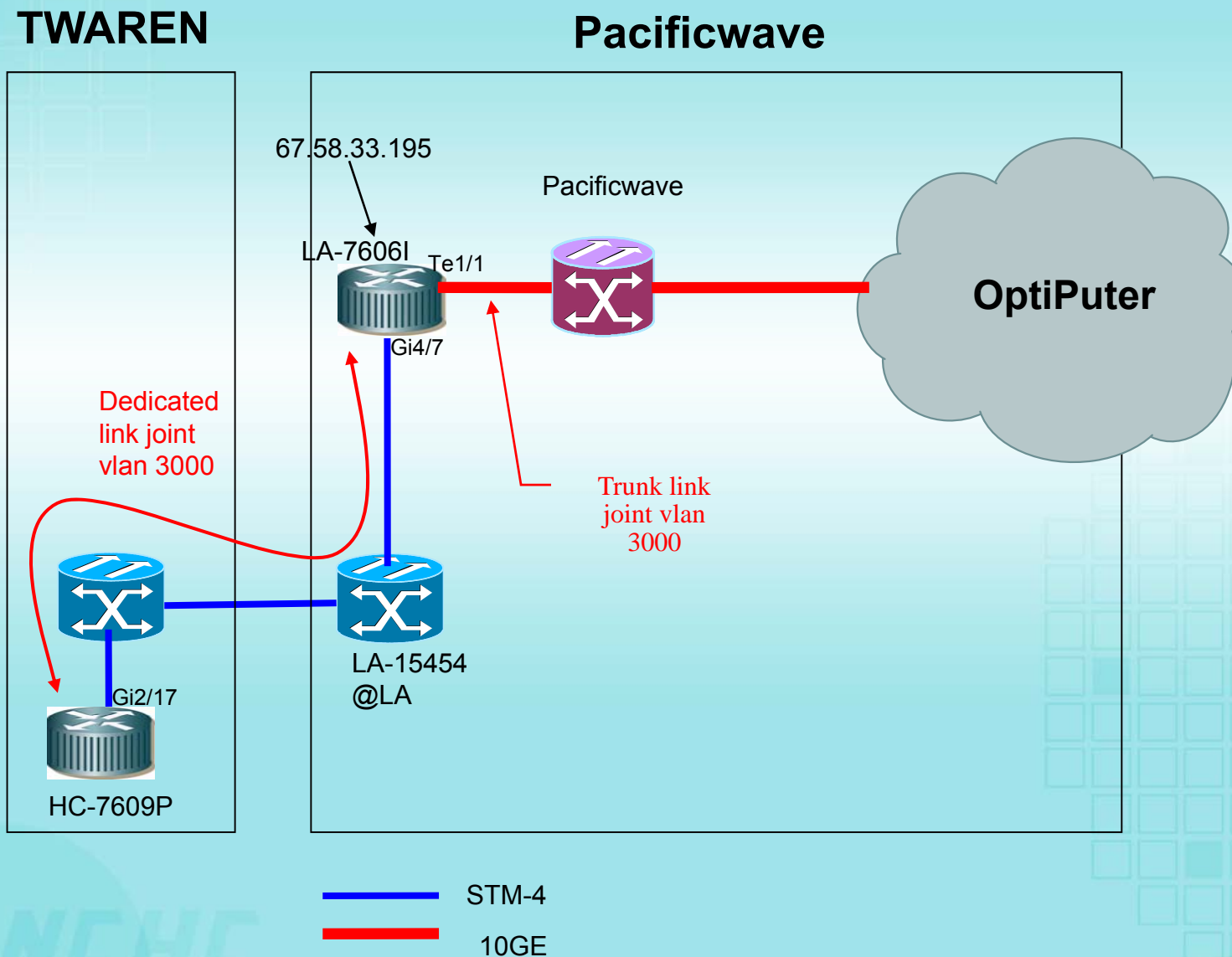
CESNET

OptIPuter Participation

- NCHC is an *OptIPuter* participant
 - An experimental lighpath is connected to OptIPuter for testing performance and video transmission.
- NCHC Taichung site serves as “OptIPuter-ready” video streaming and education center (PRAGMA), grand opening in 2009/03.
 - We demonstrated in SC conferences.
- *OptIPlanet* Collaboratory with Calit2, UCSD



TWAREN-OptIPuter Optical Topology

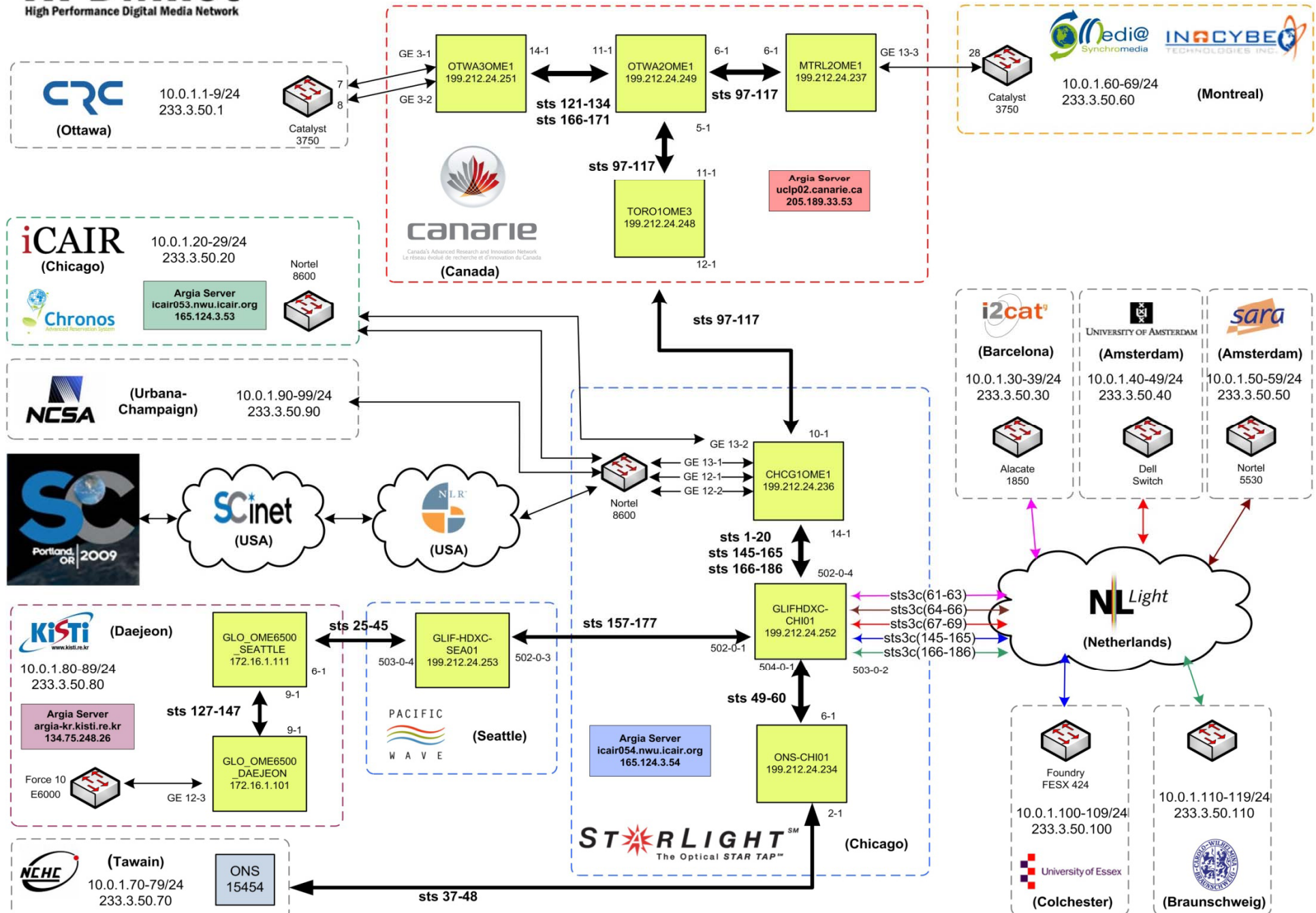


HPDMnet Demos

- We participate the HPDMnet project and provide demos.
 - GLIF
 - SC09
- HPDMnet is a collaboration platform providing dynamically provisioned network resources and high-quality digital contents.

HPDMnet

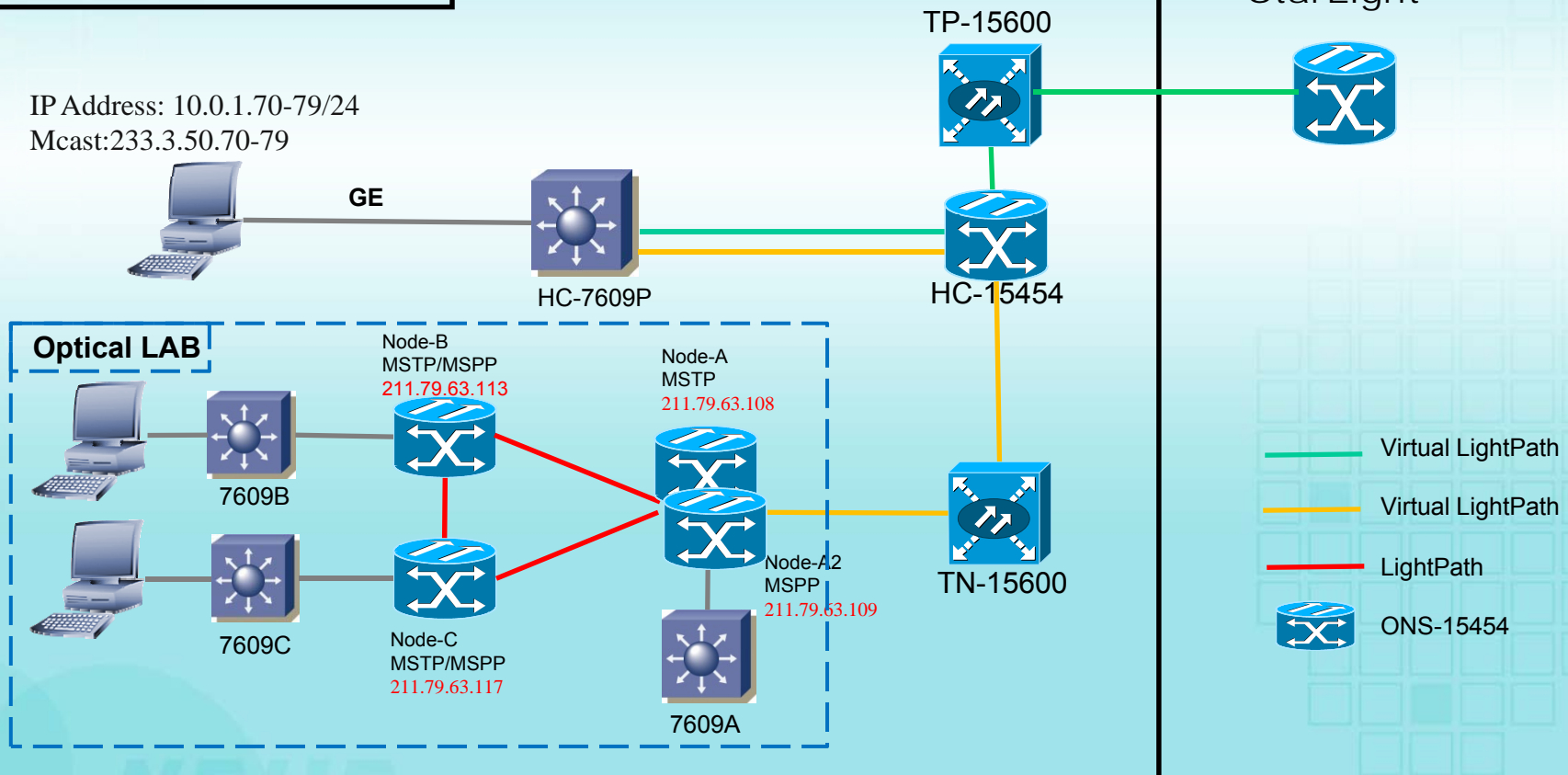
High Performance Digital Media Network



NCHC-HPDMnet Architecture

NCHC, TW

IP Address: 10.0.1.70-79/24
Mcast:233.3.50.70-79



HPDMnet Demos

- Live streams sending from Taiwan to the venue



Thank You !

For more information, please see :

www.twaren.net

- 2009 -