King Abdullah University of Science and Technology

KAUST

KAUST IT UPDATE
Internet2 SIG Session
Muscat, OMAN
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Network & Communications / IT
30 Nov 2010

Talk roadmap

- Background/history
- Key research labs with ICT flavor
- Network statistics/monitoring
- What's our network
- International perspective
- Lessons learned/what remains

Welcome to KAUST!

What are we?

- Established by Royal Decree late 2006
- Graduate-only research science & engineering focus
- Opened 05 Sep 09 with < 400 students
- 700 students from 60+ countries, co-educational
- 80 + faculty
- Over 1000 researchers, support staff & admin functions
- Maturity 1800-2000 students by 2020

Where are we?

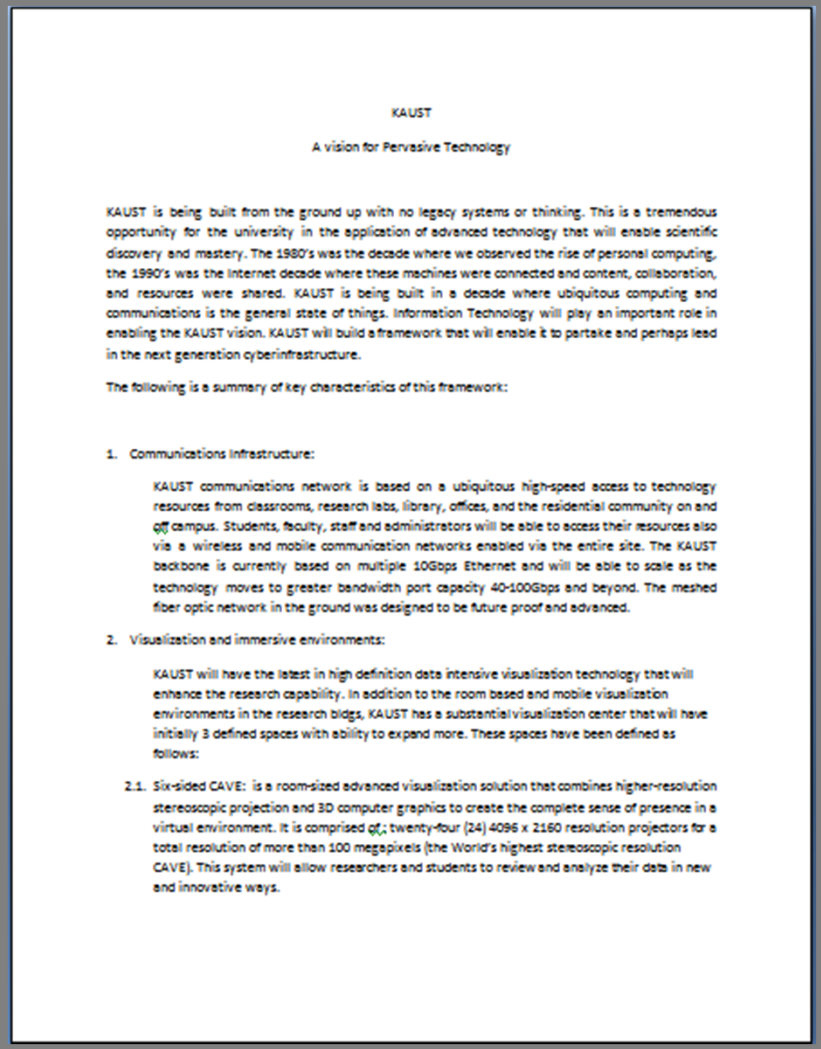

KAUST
Index of Major Services & Utilities
Index of Roads & Streets
Safaa Harbor
LEGEND

Driving forces for WORLD CLASS IT

- Generation Y & Z
- 21st Century University
- Multidisciplinary nature of KAUST
- Geographic remoteness
- No legacy systems and no legacy thinking
- IT as Showcase
- University operational efficiency
- Productivity, risk mitigation, governance

KAUST: A vision for Pervasive Technology

1. Communications Infrastructure
2. Visualization & immersive environments
3. R&E Network Connectivity
4. Supercomputing



KAUST

A vision for Pervasive Technology

KAUST is being built from the ground up with no legacy systems or thinking. This is a tremendous opportunity for the university in the application of advanced technology that will enable scientific discovery and mastery. The 1980's was the decade where we observed the rise of personal computing, the 1990's was the Internet decade where these machines were connected and content, collaboration, and resources were shared. KAUST is being built in a decade where ubiquitous computing and communications is the general state of things. Information Technology will play an important role in enabling the KAUST vision. KAUST will build a framework that will enable it to partake and perhaps lead in the next generation cyberinfrastructure.

The following is a summary of key characteristics of this framework:

1. Communications Infrastructure:

   KAUST communications network is based on a ubiquitous high-speed access to technology resources from classrooms, research labs, library, offices, and the residential community on and off campus. Students, faculty, staff and administrators will be able to access their resources also via a wireless and mobile communication networks enabled via the entire site. The KAUST backbone is currently based on multiple 10Gbps Ethernet and will be able to scale as the technology moves to greater bandwidth port capacity 40-100Gbps and beyond. The meshed fiber optic network in the ground was designed to be future proof and advanced.

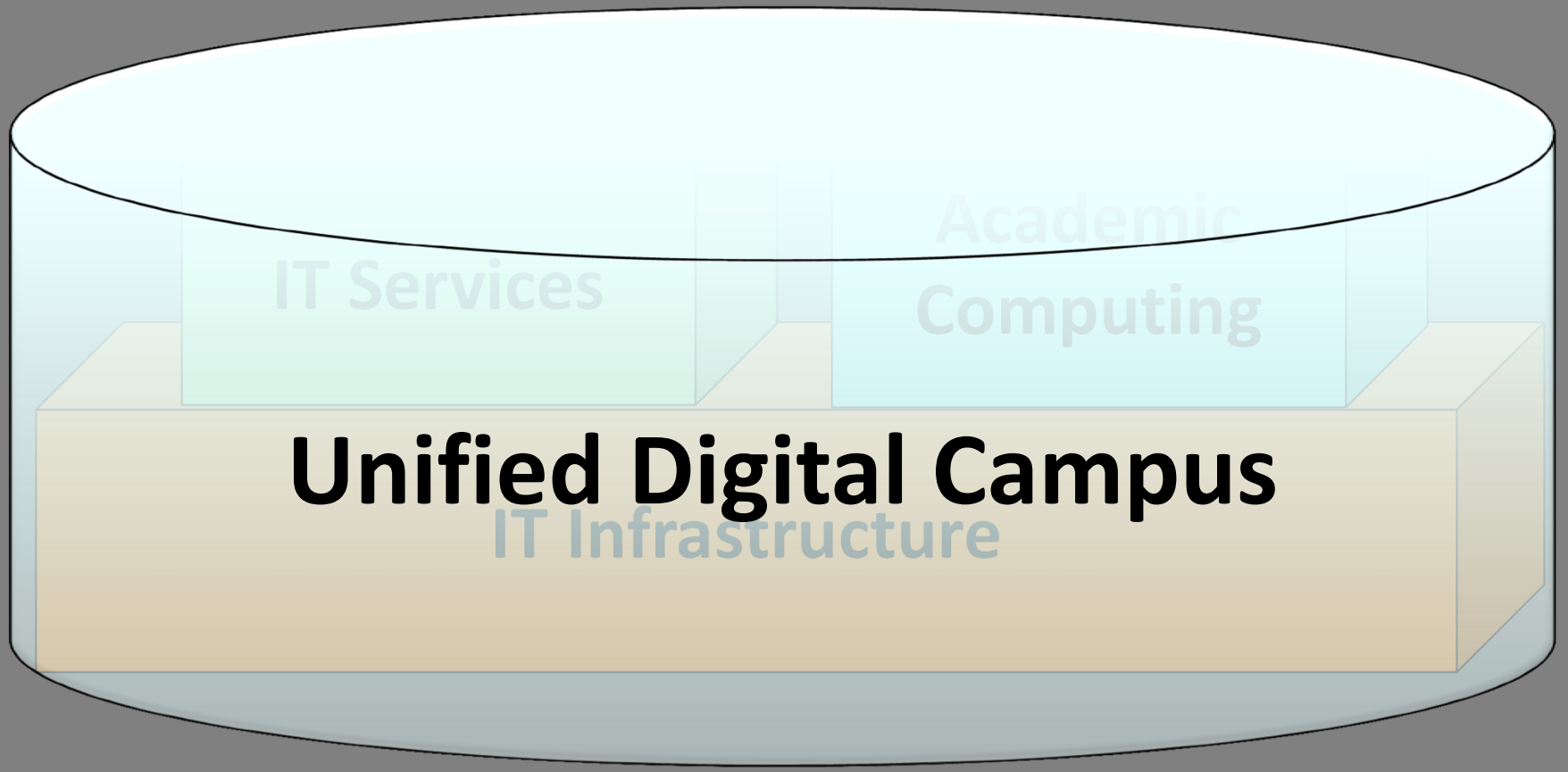
2. Visualization and immersive environments:

   KAUST will have the latest in high definition data intensive visualization technology that will enhance the research capability. In addition to the room based and mobile visualization environments in the research bldgs, KAUST has a substantial visualization center that will have initially 3 defined spaces with ability to expand more. These spaces have been defined as follows:

   2.1. Six-sided CAVE: is a room-sized advanced visualization solution that combines higher-resolution stereoscopic projection and 3D computer graphics to create the complete sense of presence in a virtual environment. It is comprised of: twenty-four (24) 4096 x 2160 resolution projectors for a total resolution of more than 100 megapixels (the World's highest stereoscopic resolution CAVE). This system will allow researchers and students to review and analyze their data in new and innovative ways.

KAUST IT Components

KAUST IT development can be divided into three major components serving Academic, Town Center, and the residential community :

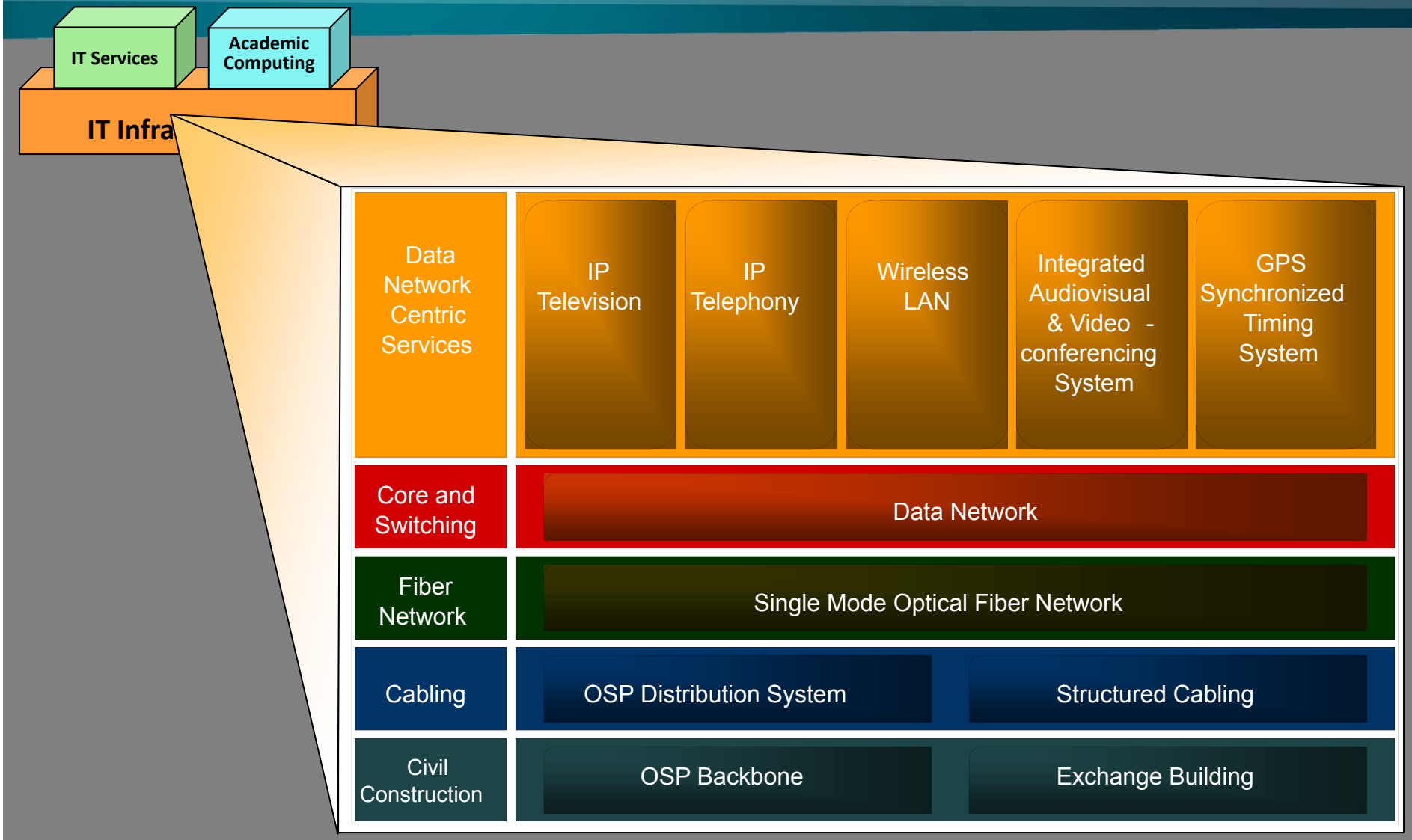


Technology Partnerships

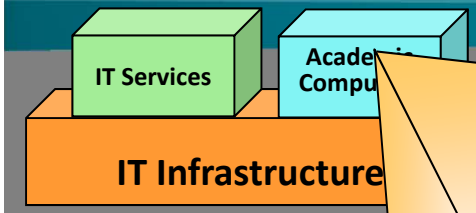
To achieve the highest level of innovation and excellence, we are partnering with

- Cisco
- IBM
- Google
- Apple
- Microsoft
- SAP
- SUN
- and many world leading technology companies.

KAUST IT Components – Communication Infrastructure



KAUST IT Components – Research & Academic Computing



- Visualization Core Lab & Center
- Petascale Computational Science Center
- HPC clusters
- IT-enabled and integrated Academic Library
- Campus wide academic facilities including Smart Classroom, distance education & conferencing
- Building Behavior Sensors
- Research Network Connectivity

KAUST Digital Library

KAUST Library will be :

- Fully Automated
- Fully Digital Library
- Hybrid SCI-Tech

The Home of SHAHEEN and CORNEA

- Much more than a traditional research lab, this building will host both the Scientific Computing Center and the Geometric Modelling & Scientific Visualization Research Center.

- Both are designed by leading architects, engineers and scientists to be a showcase of advanced technology – most important they will provide tools for the finest scientific and technological minds in the world to make breakthroughs that will propel knowledge and achievement forward into the 21st Century.

CORNEA

SHAHEEN

SHAHEEN

- Partnering with IBM, KAUST is one of the only universities to house one of the top supercomputer in the world which will be one of its kind academically.
- Initially based on the 16-rack Blue gene/P system with 65,536 individual processor cores, Shaheen is capable of providing up to 222 teraflops. System storage peaks at 1.9 Petabytes, enough to hold about 25 years of High-Definition (HD) video
- We will reach petascale processing level and investigate future exascale computing as it becomes available.
- Ranked as #14 in world (2nd fastest outside of Europe and the fastest in Asia) in fall 2009 (eclipsed by China recently??)
- KAUST will serve as the hub of SAREN - giving research institutions all over the Kingdom access to Shaheen and the ability to connect and share information with one another.

Anatomy of SHAHEEN

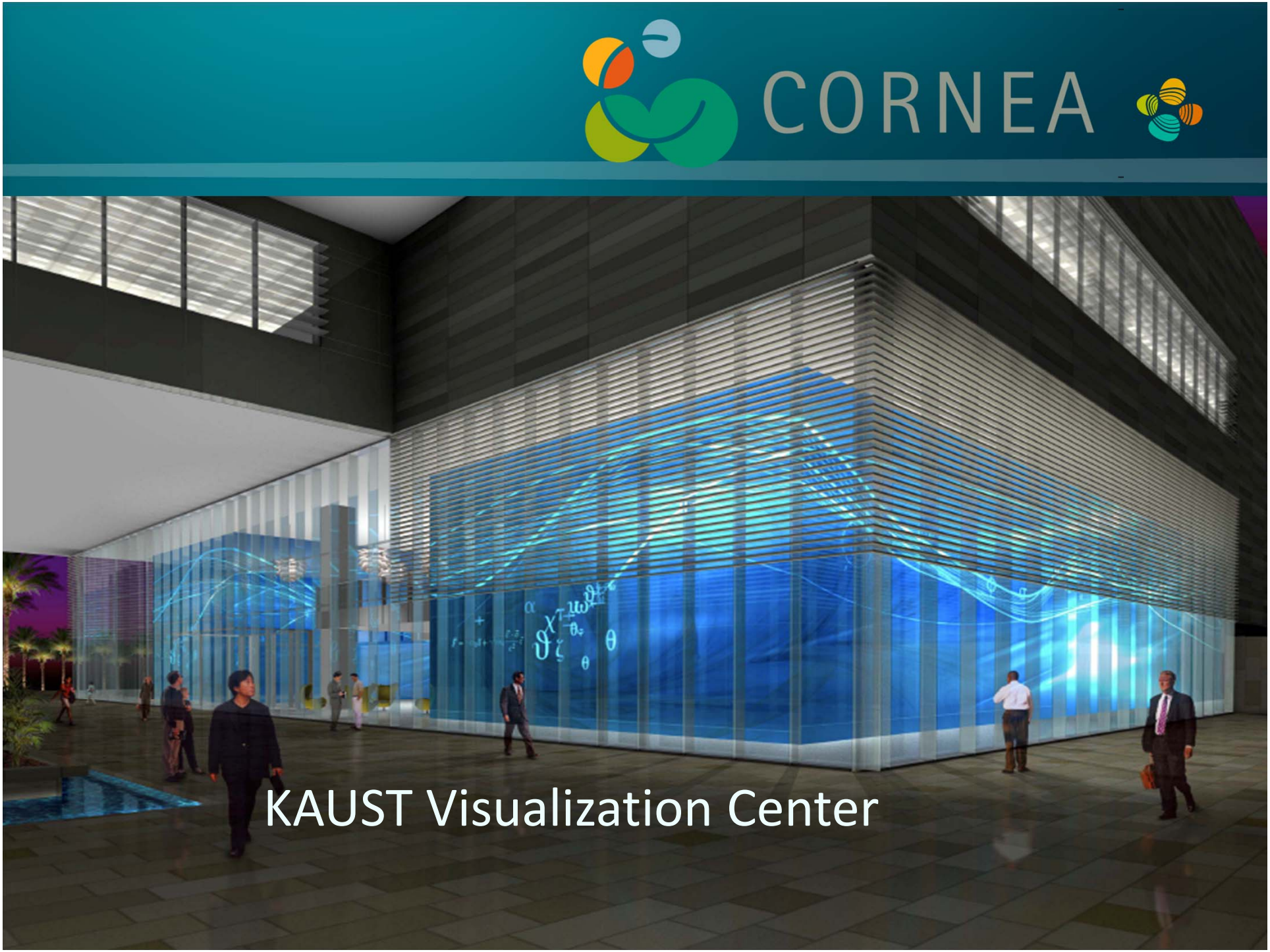
KAUST Supercomputing Ecosystem

- Immediate access & establishment of compute cycles and knowhow

Knowhow

- establishing world class SCC
- enabling the research thrusts
- creating knowledge, IPs, and registering patents
- collaborate with other institutes and centers
- placing KAUST and Saudi on “the map”


SHAHEEN
SHAHEEN
CAUTION

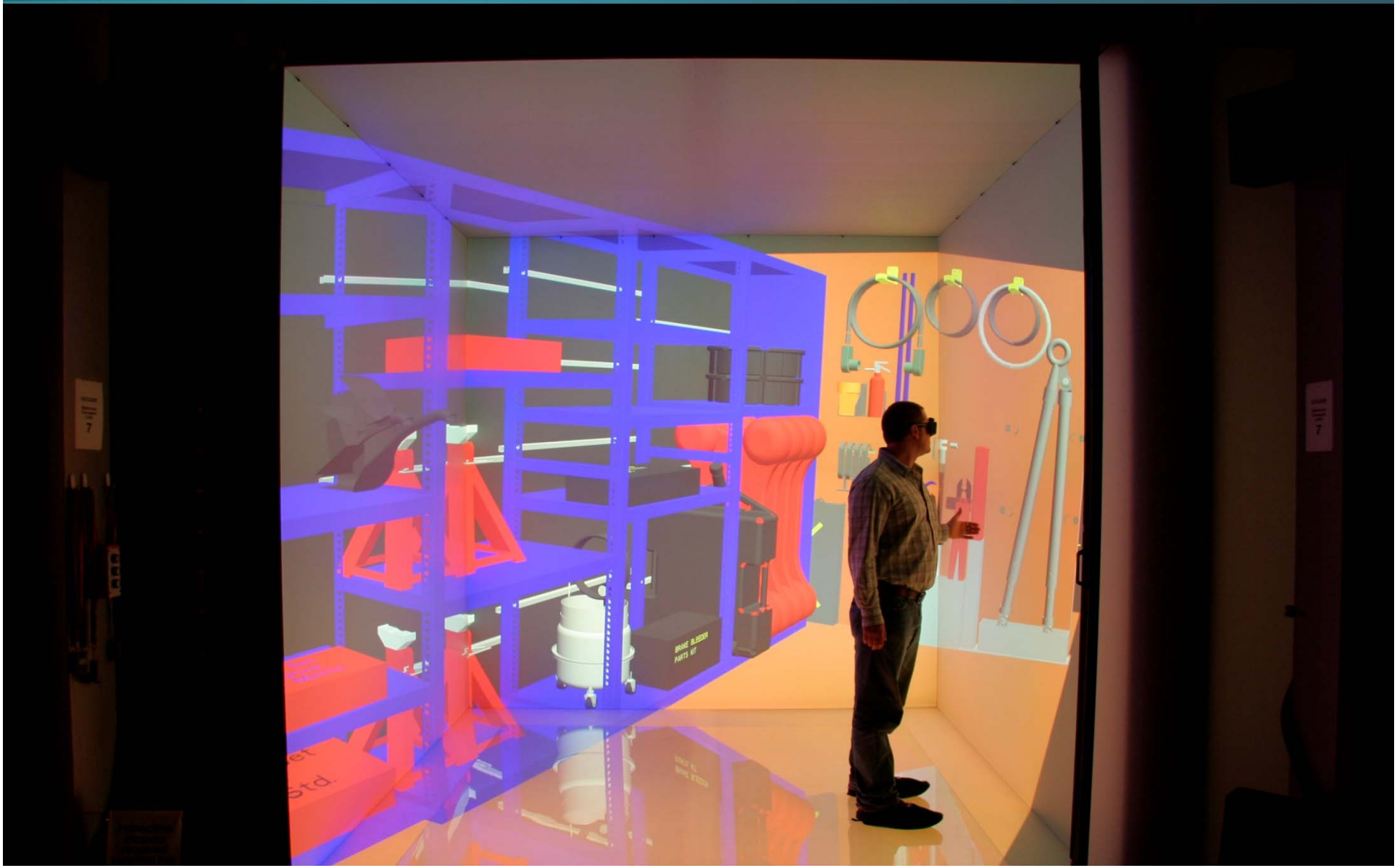

CORNEA
KAUST Visualization Center

KAUST's Advanced Visualization Facility

- One of world's most advanced visual computing, visualization, and virtual reality facility IS available to KAUST researchers
- This specialized facility features highest resolution commercially-available screens and finest audio
- The KAUST Advanced Visualization Facility enables researchers to:
  - See and hear data in full-surround
  - Record and transmit it too
  - audio is a new area of vis research

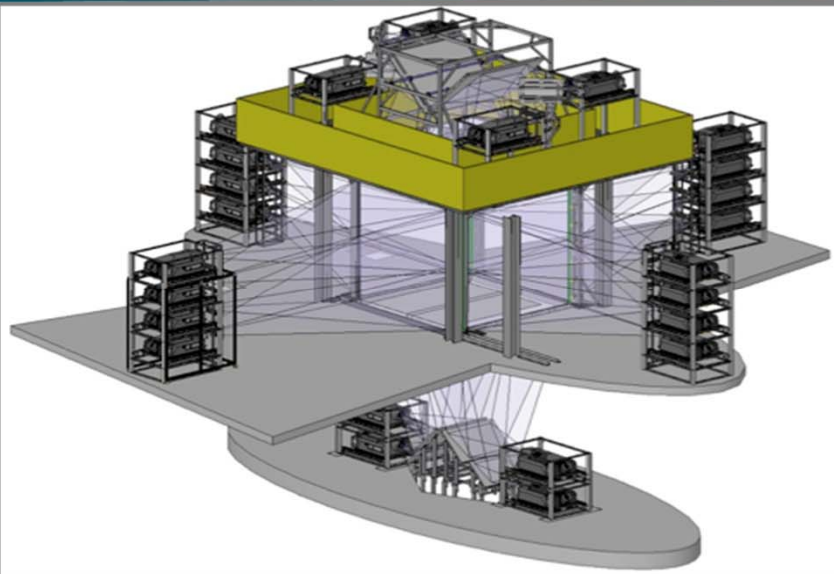
KAUST's Advanced Visualization Facility

CORNEA



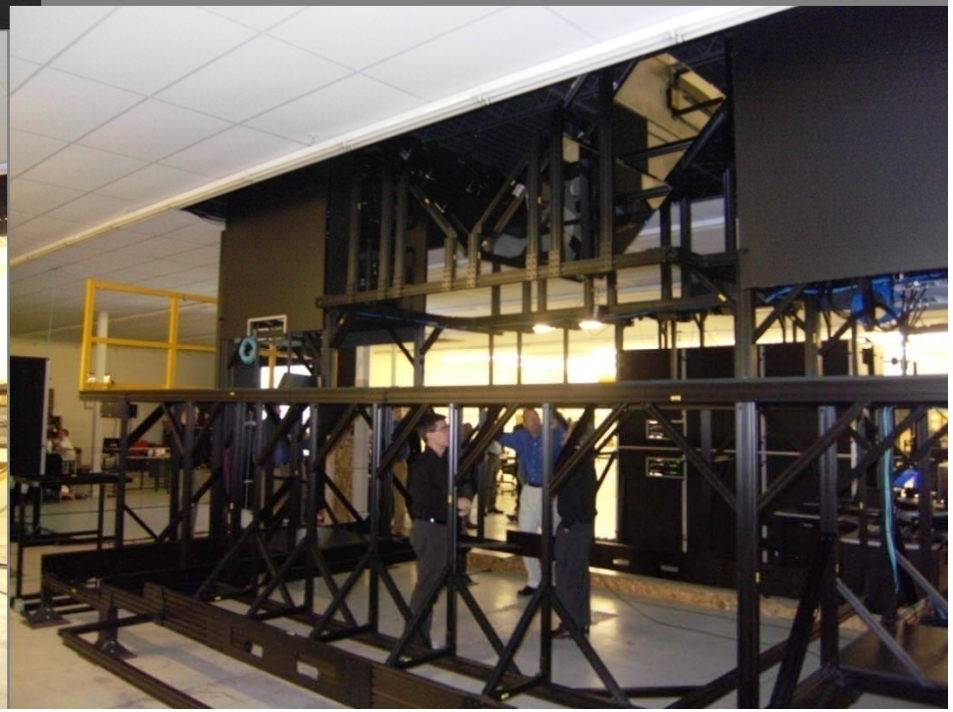
The Immersive Cube
Visualization Laboratory VL6

- 24 of the world's highest native resolution projectors (4096 x 2160 pixels each)
- Fully immersive stereoscopic visual environment
- 100 Million Pixels
- Allows up to 8 viewers in the environment



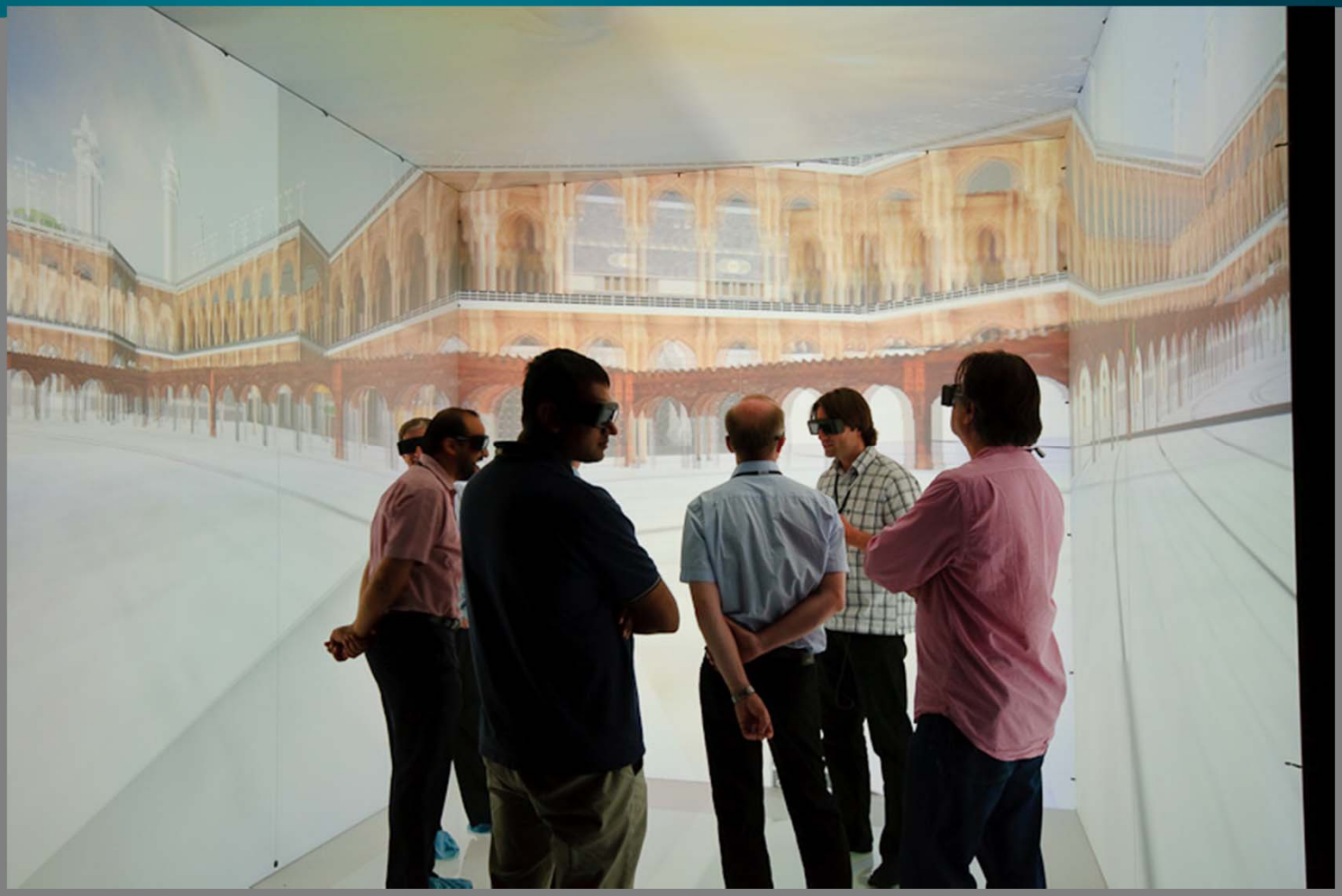
CORNEA


COVER



10 x 4 Tiled Display (46” Monitors)

Cornea



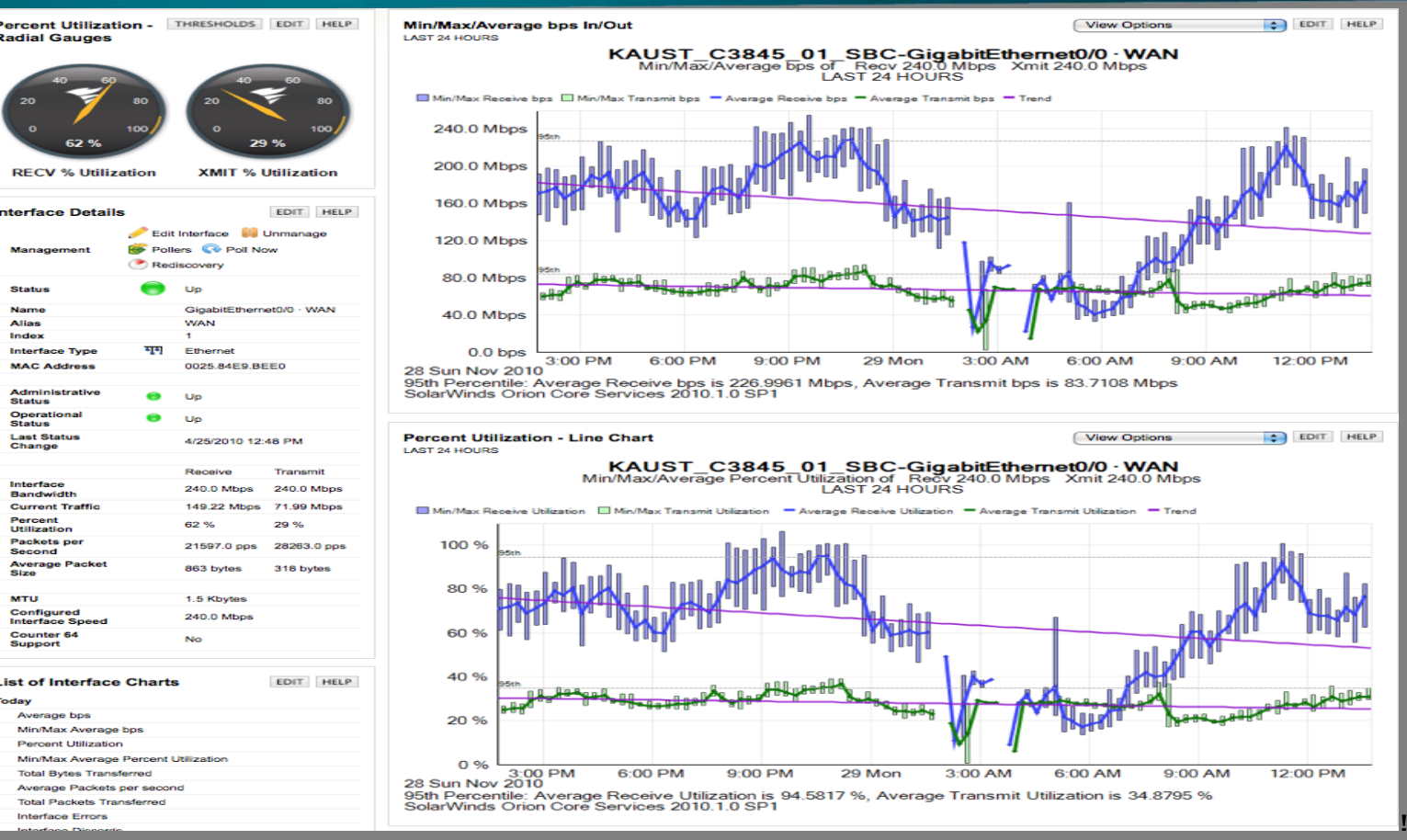
ollaboration – 20 Oct 09

exCave – 7 x 3 Array of Stereoscopic Monitors

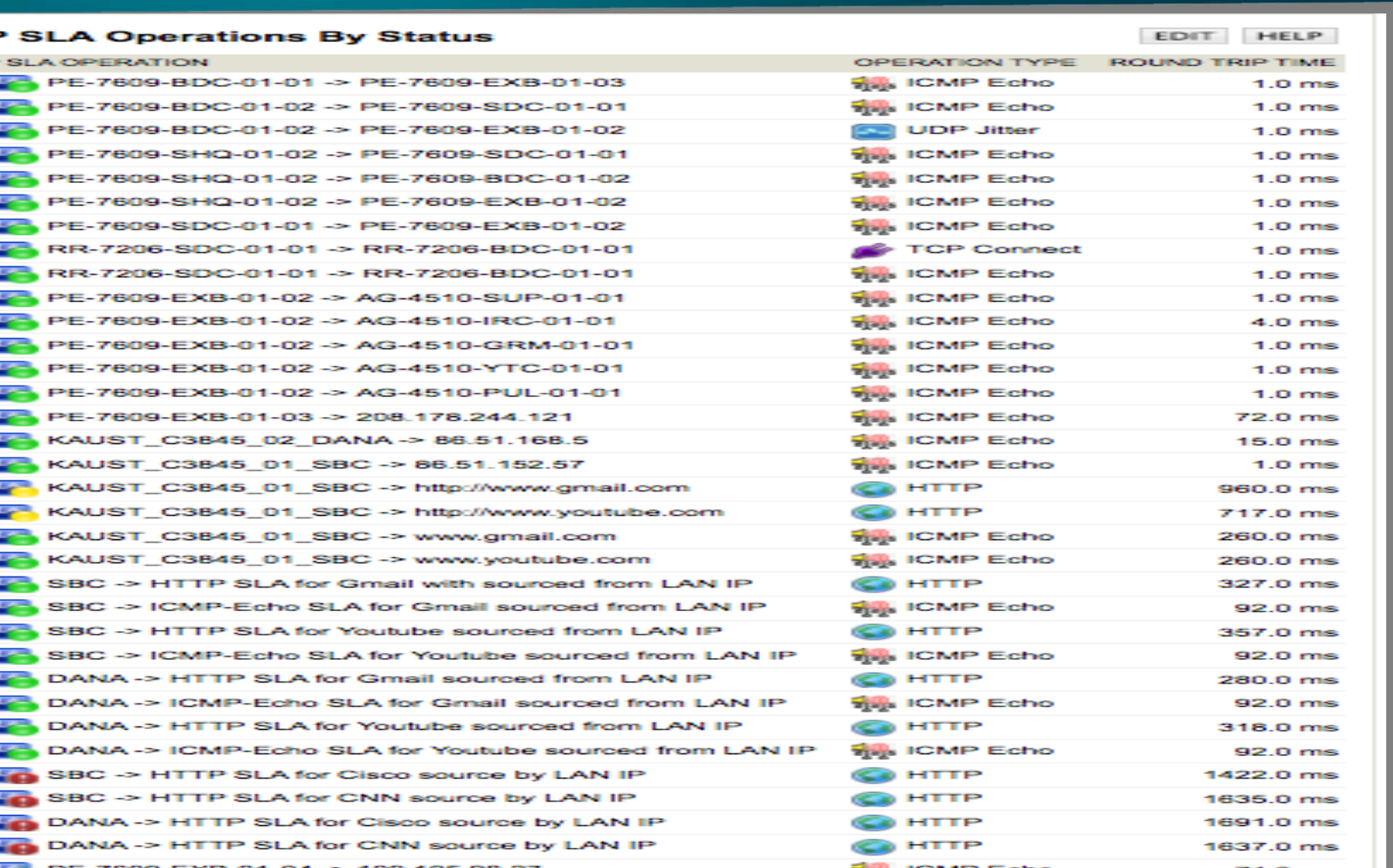
y The Numbers

- On 36 million m^2 on Red Sea 90 km north of Jeddah
- 1 core academic/admin/research bldgs in ‘horseshoe’,
- h ~ 50 support buildings/facilities
- ~ 3200 residences (flats, townhomes, standalone homes)
- ll-IP network all over campus
- 100,000 Ethernet ports
- 3,000 IP phones
- 400 WAPs (700 indoor, 700 outdoor)
- 190 TV channels distributed
- 00 Mbps FTTH
- 400 km of FOC
- and yes, there is some (30 km) copper…

Network Management



IP SLA probe view

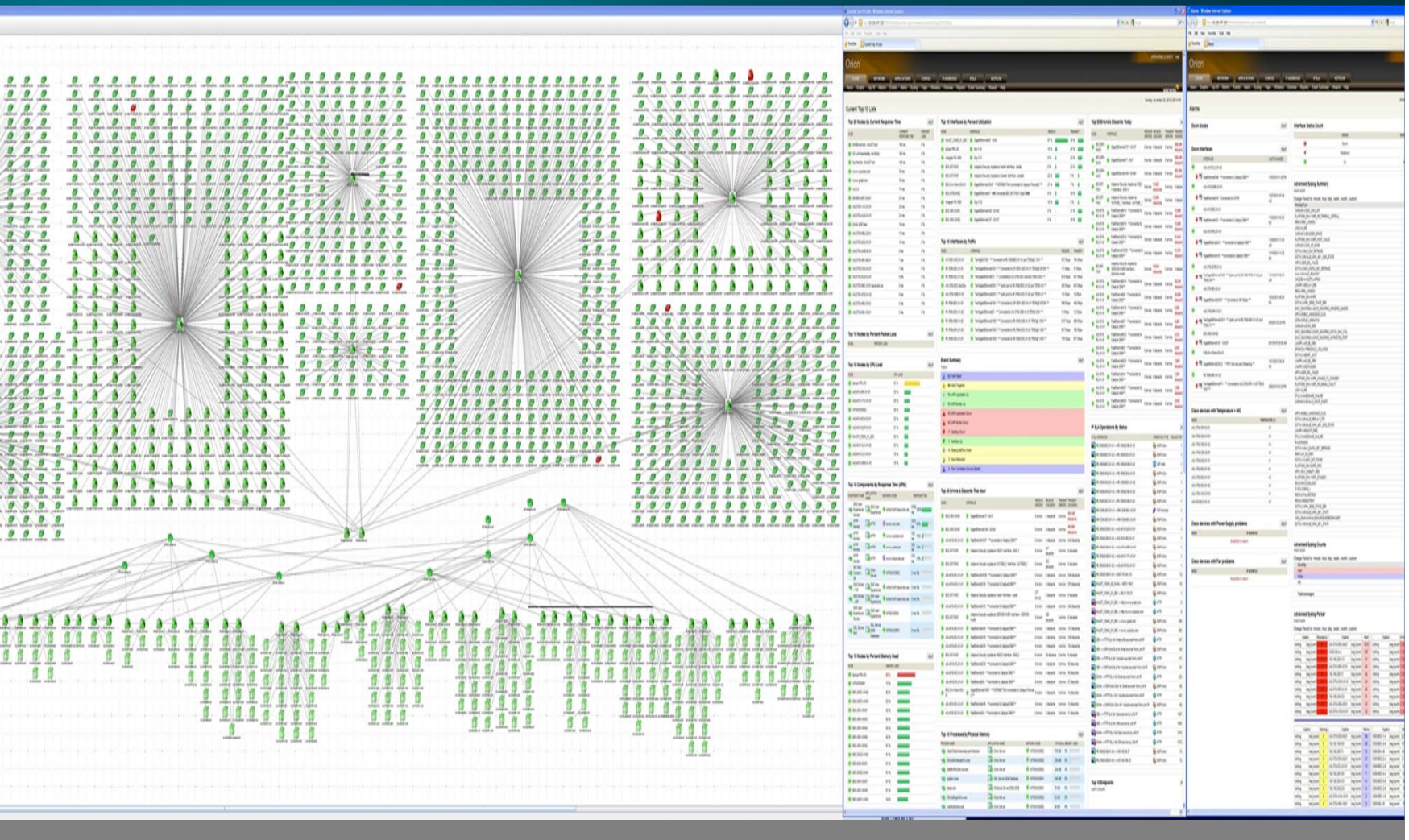


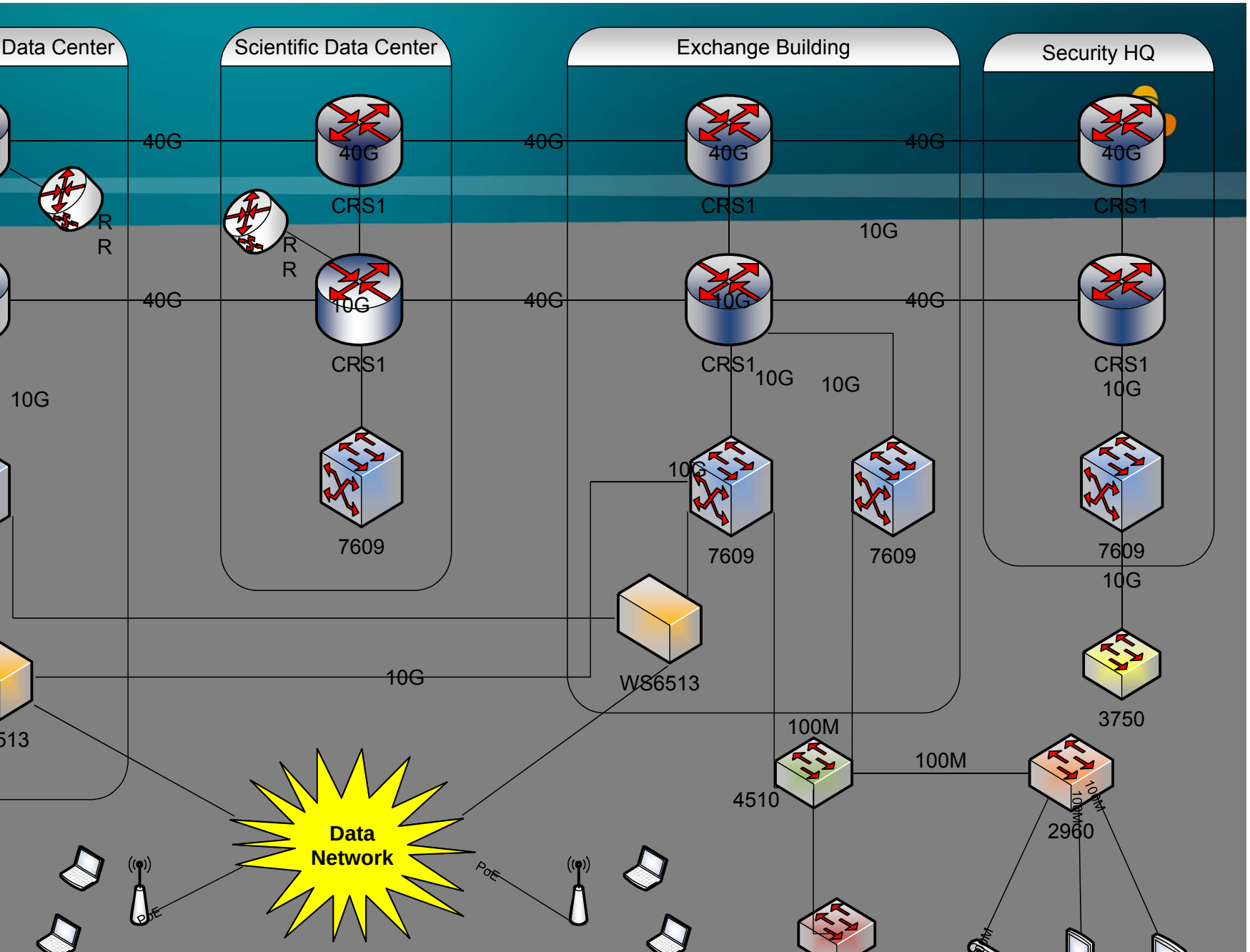
P SLA Operations By Status

EDIT HELP

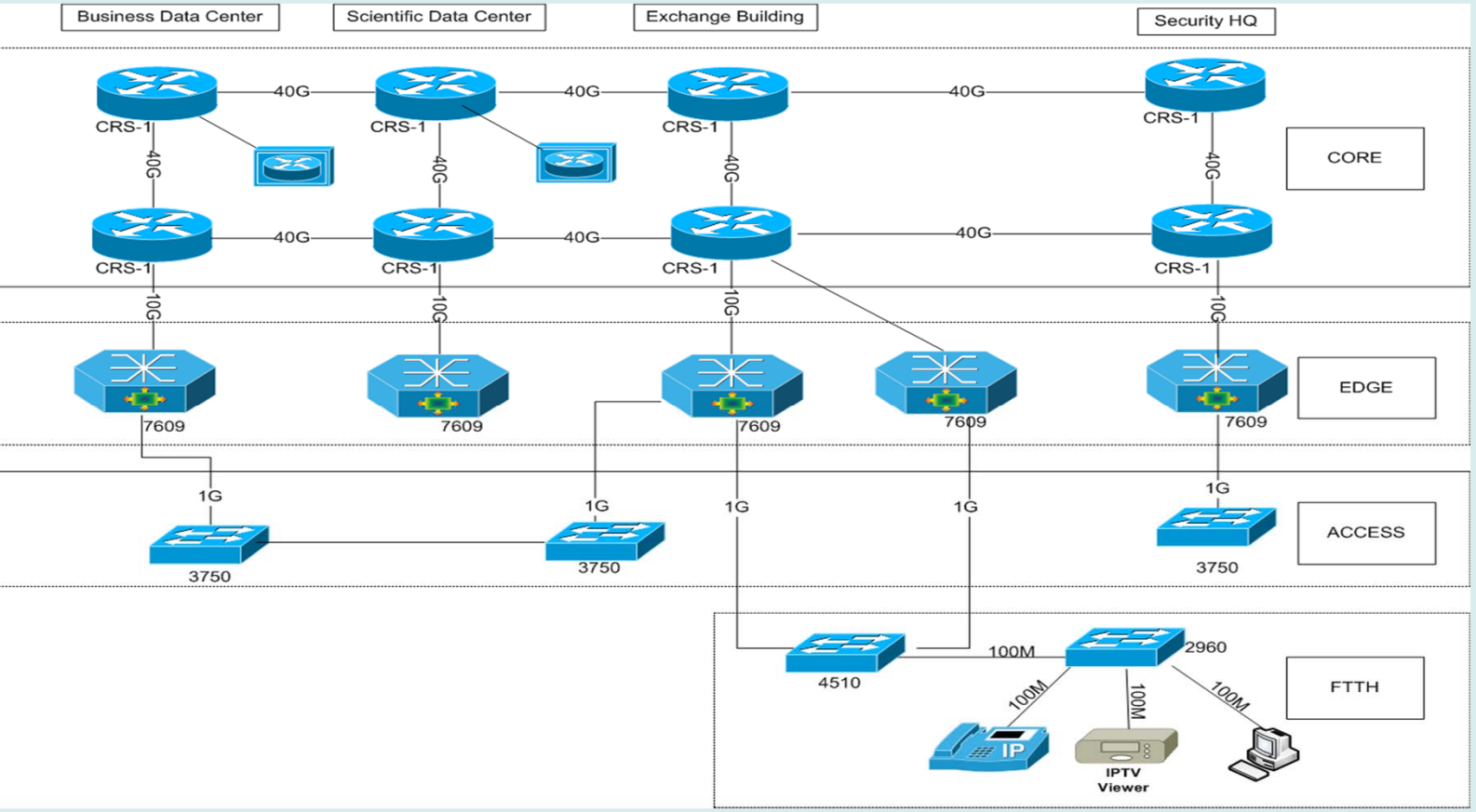
SLA OPERATION	OPERATION TYPE	ROUND TRIP TIME
PE-7609-BDC-01-01 -> PE-7609-EXB-01-03	ICMP Echo	1.0 ms
PE-7609-BDC-01-02 -> PE-7609-SDC-01-01	ICMP Echo	1.0 ms
PE-7609-BDC-01-02 -> PE-7609-EXB-01-02	UDP Jitter	1.0 ms
PE-7609-SHQ-01-02 -> PE-7609-SDC-01-01	ICMP Echo	1.0 ms
PE-7609-SHQ-01-02 -> PE-7609-BDC-01-02	ICMP Echo	1.0 ms
PE-7609-SHQ-01-02 -> PE-7609-EXB-01-02	ICMP Echo	1.0 ms
PE-7609-SDC-01-01 -> PE-7609-EXB-01-02	ICMP Echo	1.0 ms
RR-7206-SDC-01-01 -> RR-7206-BDC-01-01	TCP Connect	1.0 ms
RR-7206-SDC-01-01 -> RR-7206-BDC-01-01	ICMP Echo	1.0 ms
PE-7609-EXB-01-02 -> AG-4510-SUP-01-01	ICMP Echo	1.0 ms
PE-7609-EXB-01-02 -> AG-4510-IRC-01-01	ICMP Echo	4.0 ms
PE-7609-EXB-01-02 -> AG-4510-GRM-01-01	ICMP Echo	1.0 ms
PE-7609-EXB-01-02 -> AG-4510-YTC-01-01	ICMP Echo	1.0 ms
PE-7609-EXB-01-02 -> AG-4510-PUL-01-01	ICMP Echo	1.0 ms
PE-7609-EXB-01-03 -> 208.178.244.121	ICMP Echo	72.0 ms
KAUST_C3845_02_DANA -> 86.51.168.5	ICMP Echo	15.0 ms
KAUST_C3845_01_SBC -> 86.51.152.57	ICMP Echo	1.0 ms
KAUST_C3845_01_SBC -> http://www.gmail.com	HTTP	960.0 ms
KAUST_C3845_01_SBC -> http://www.youtube.com	HTTP	717.0 ms
KAUST_C3845_01_SBC -> www.gmail.com	ICMP Echo	260.0 ms
KAUST_C3845_01_SBC -> www.youtube.com	ICMP Echo	260.0 ms
SBC -> HTTP SLA for Gmail with sourced from LAN IP	HTTP	327.0 ms
SBC -> ICMP-Echo SLA for Gmail sourced from LAN IP	ICMP Echo	92.0 ms
SBC -> HTTP SLA for Youtube sourced from LAN IP	HTTP	357.0 ms
SBC -> ICMP-Echo SLA for Youtube sourced from LAN IP	ICMP Echo	92.0 ms
DANA -> HTTP SLA for Gmail sourced from LAN IP	HTTP	280.0 ms
DANA -> ICMP-Echo SLA for Gmail sourced from LAN IP	ICMP Echo	92.0 ms
DANA -> HTTP SLA for Youtube sourced from LAN IP	HTTP	318.0 ms
DANA -> ICMP-Echo SLA for Youtube sourced from LAN IP	ICMP Echo	92.0 ms
SBC -> HTTP SLA for Cisco source by LAN IP	HTTP	1422.0 ms
SBC -> HTTP SLA for CNN source by LAN IP	HTTP	1635.0 ms
DANA -> HTTP SLA for Cisco source by LAN IP	HTTP	1691.0 ms
DANA -> HTTP SLA for CNN source by LAN IP	HTTP	1637.0 ms

NMC videowall

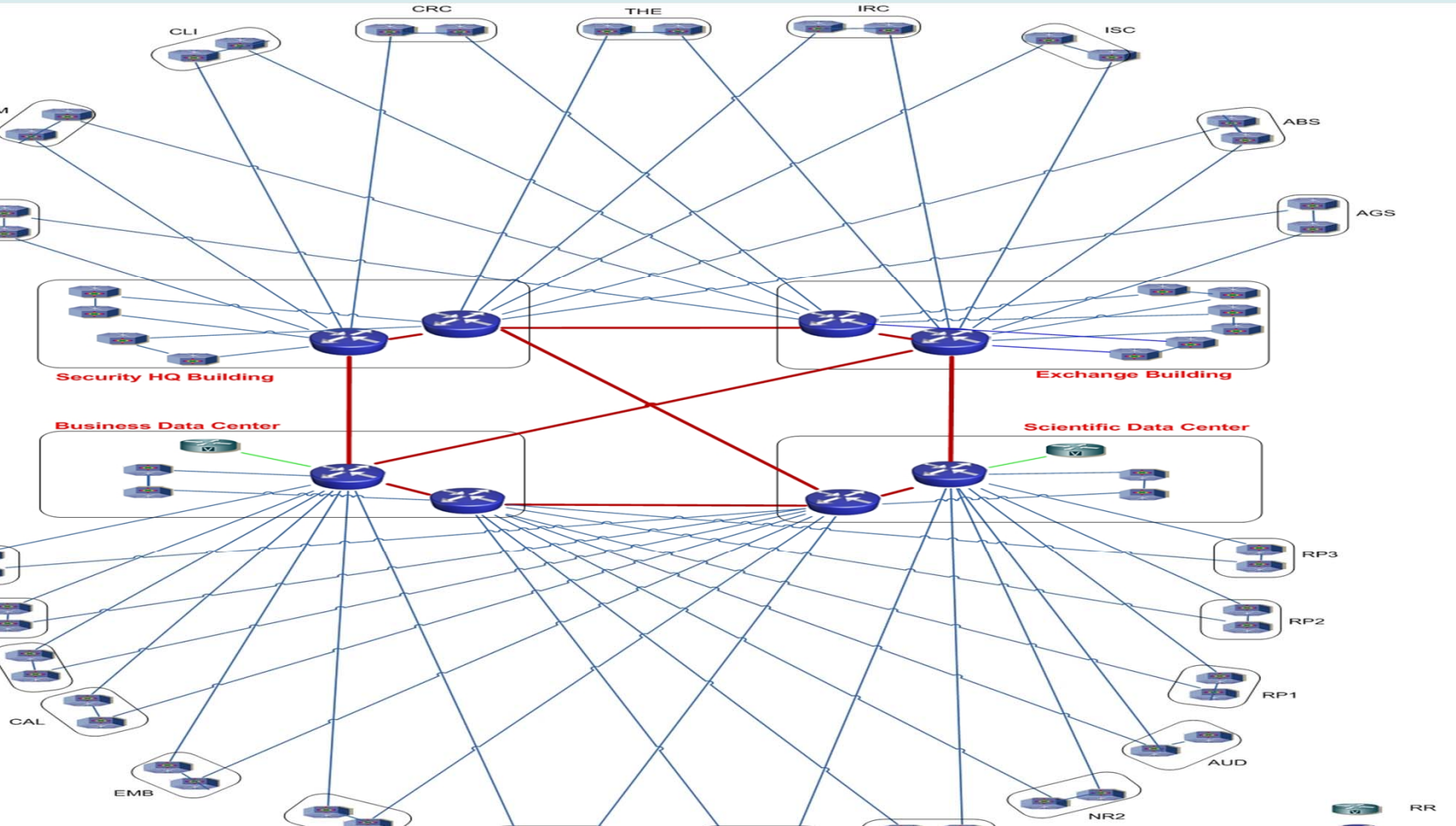



Data Center
Scientific Data Center
Exchange Building
Security HQ
40G
CRS1
10G
7609
W86513
3750
100M
4510
2960
Data Network
PoE

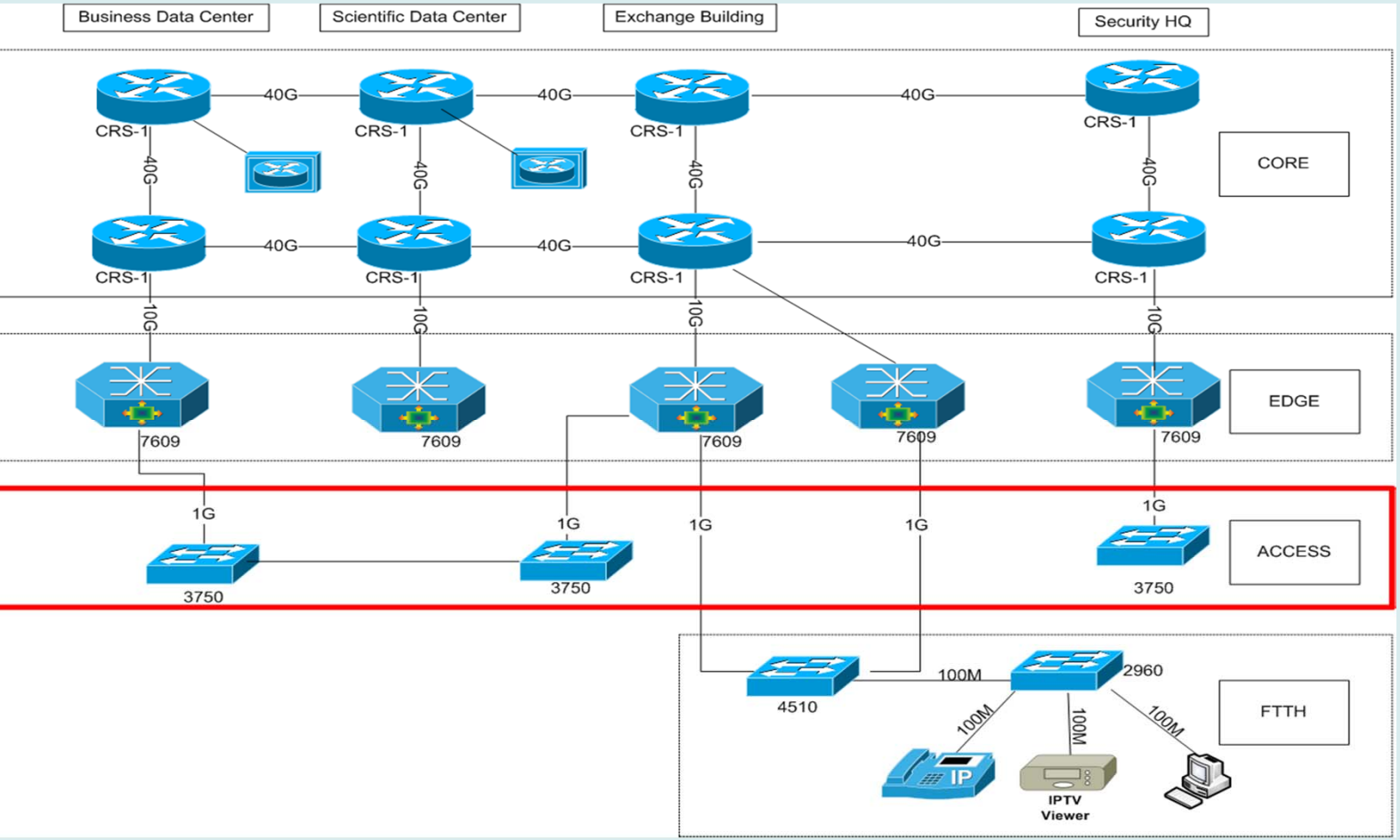
ETWORK LOGICAL LAYOUT



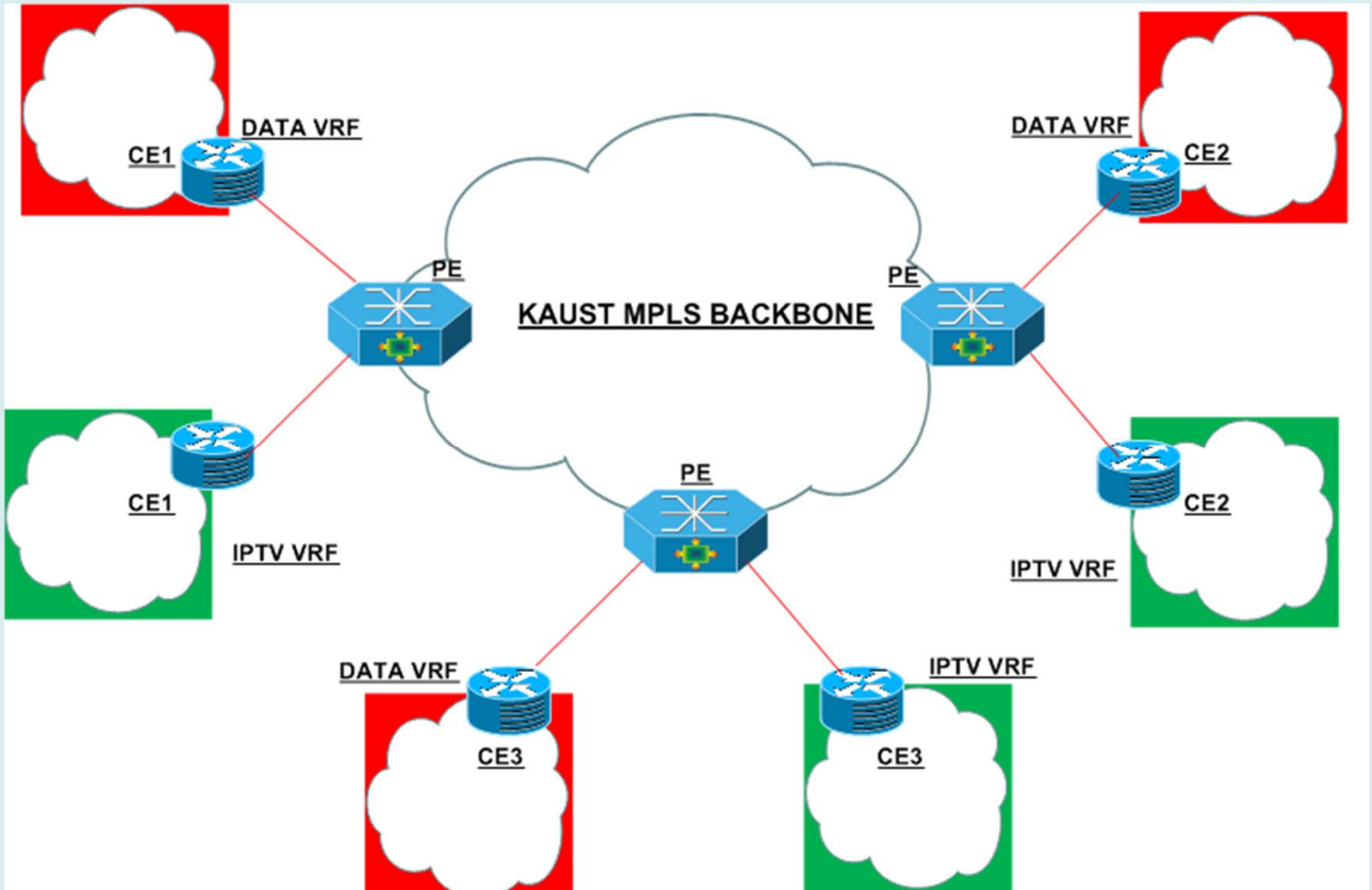
OMPLETE MPLS CORE



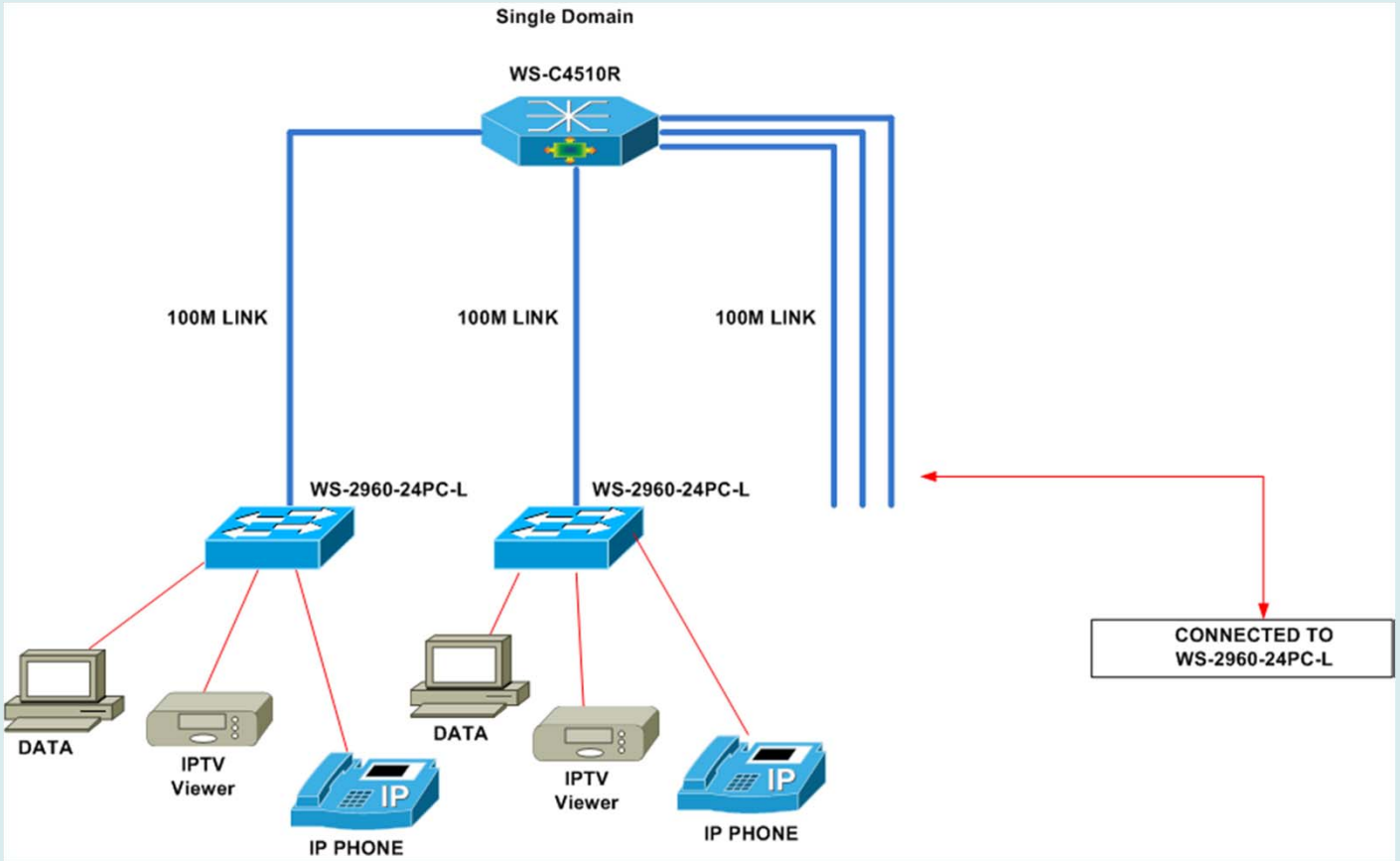
CCESS LAYER (HIGHLIGHTED).



PLS VPN BACKBONE

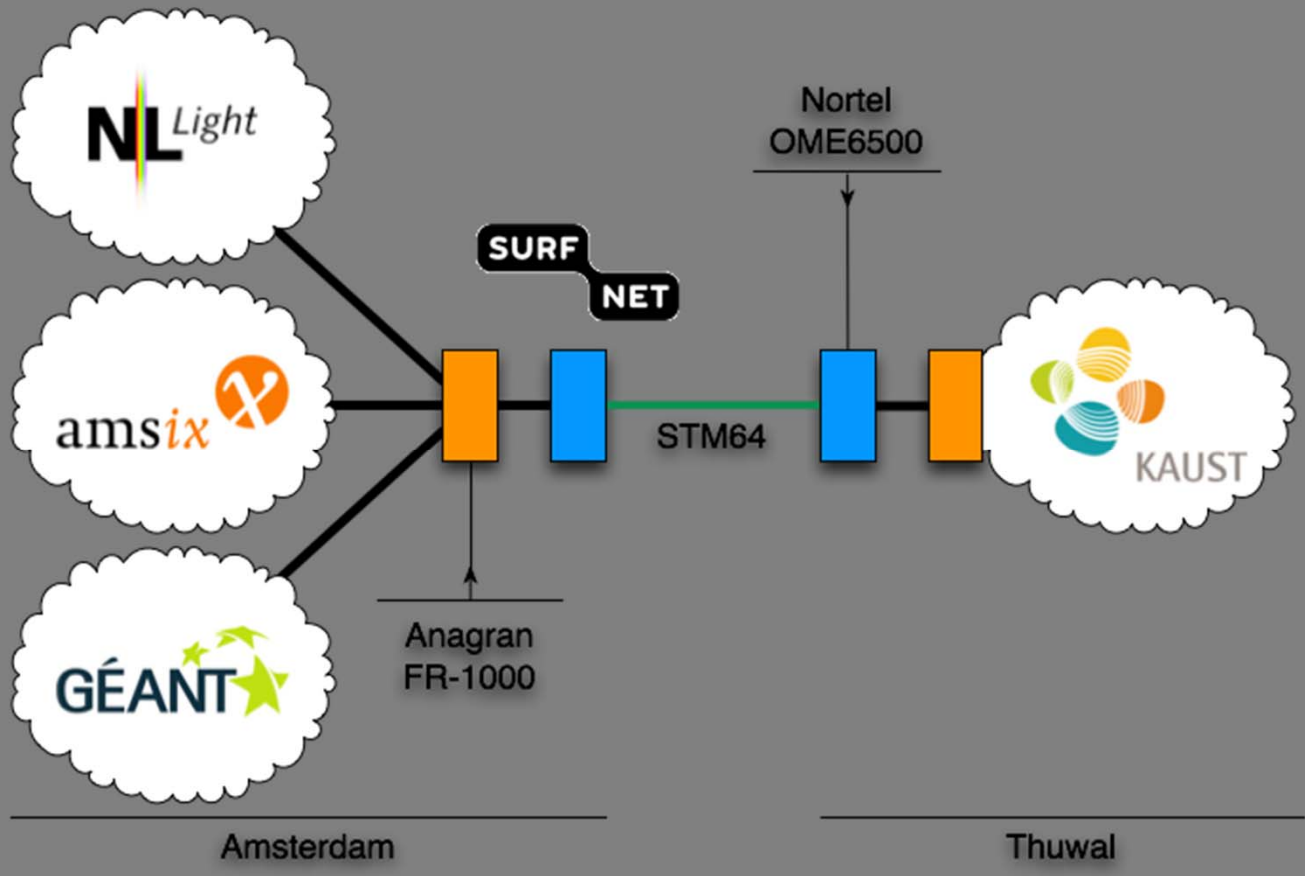


TTH LAYER 2 TOPOLOGY

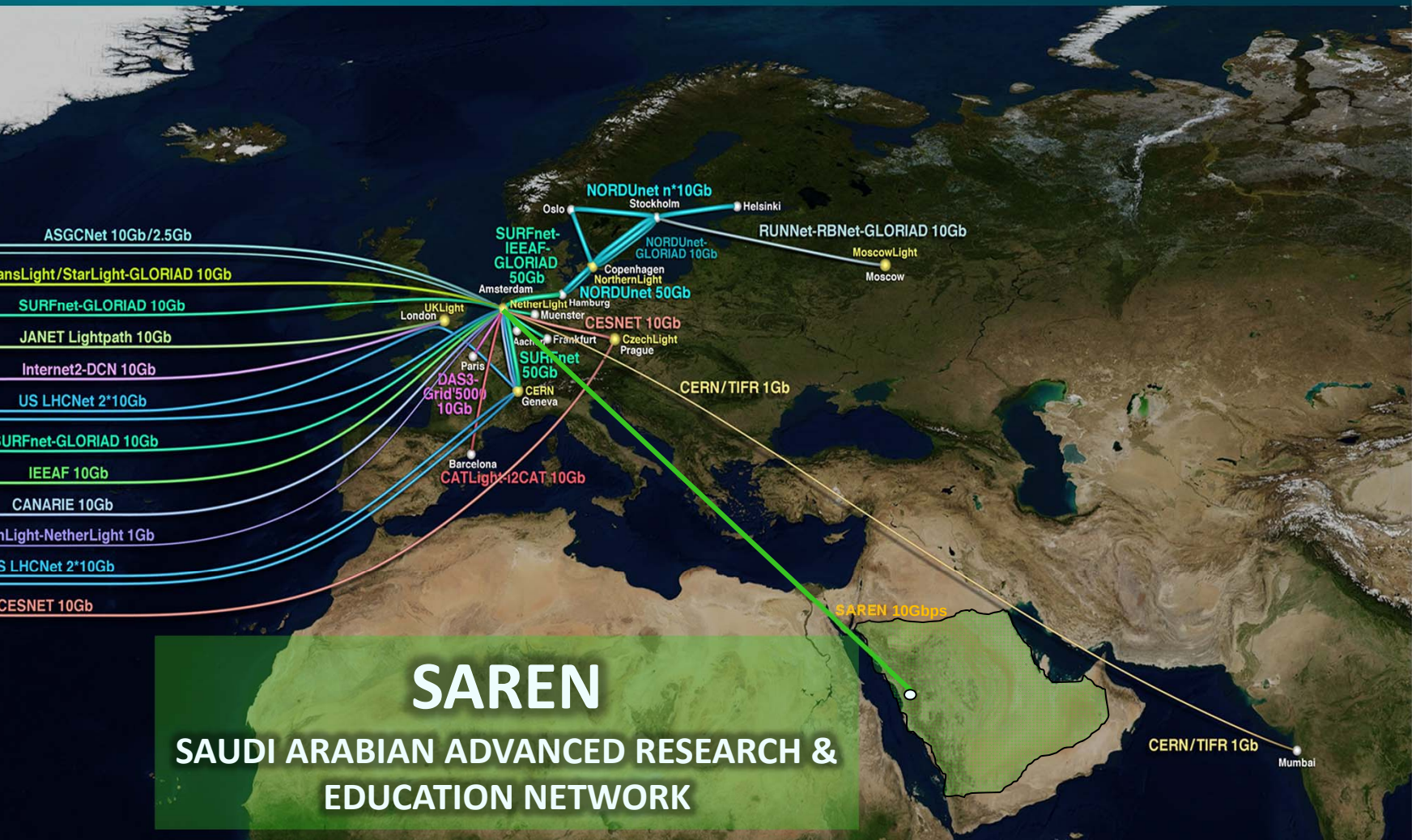


ur External view of the world

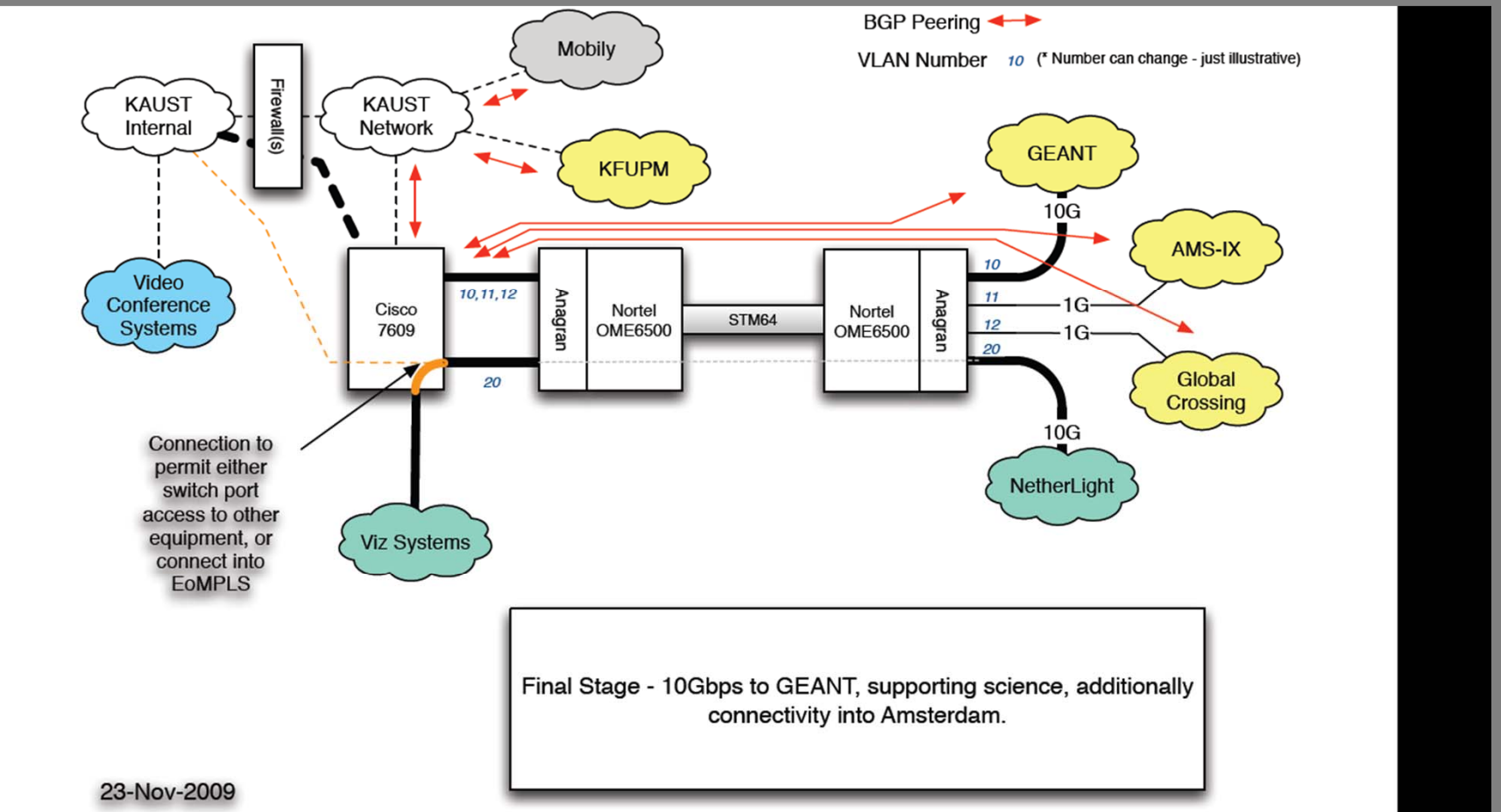
ternational Connectivity



AUST Global Connectivity (10Gbps)



LOBAL CROSSING LINK



Lessons Learned 1

- cus on proactive fault management & performance ysis.
- bandwidth restriction = decentralized access to mation **but** allows network abuse.
- Rs located inside apartments serve more than one nt – **bad idea**
- ow based traffic control - adaptive policing (prior ually detect and block bandwidth-abusers).
- PI to police bandwidth intensive apps (e.g., P2P DDL)

Lessons Learned 2

cceptable network use policy to raise awareness

abling/labeling is not as expected due to startup

deadline => rearrange

esign didn't consider some services

=> budget, design, and implement.

ecognize = ISP @ enterprise level,

=> implement cache farm & filtering

onfiguration/change control to be improved

Lessons Learned 3

- nplement single sign-on system (Shibboleth xtension?)
- duroam for collaboration
- esearch is unpredictable
  - IT organization adaptability & agility key
  - ‘survival/performance’ characteristic
- AREN uptake slow – why?
- utomate processes to free up human capital

A view of Campus library from the plaza

Thank you!

طارق العاص و
باسم قطان

uscat I2 notes

Oman = 40 years. KAUST opening 05Sep09 = 1.1 years…

40G backbone with 1Gpbs user connections

2 R&E orgs connected locally

10 G Amsterdam