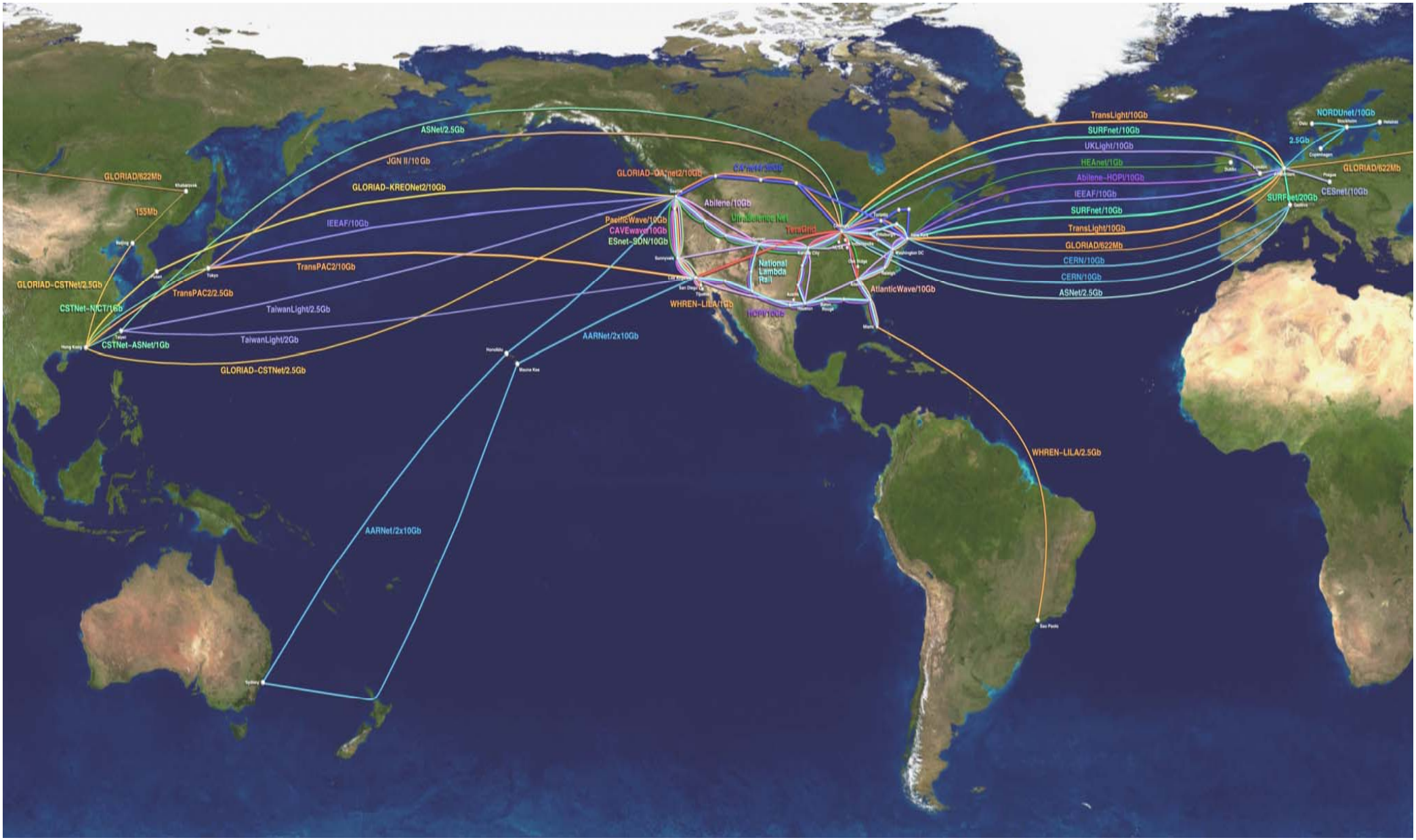
Revolutions in Networks and Grids for HEP and Global Science

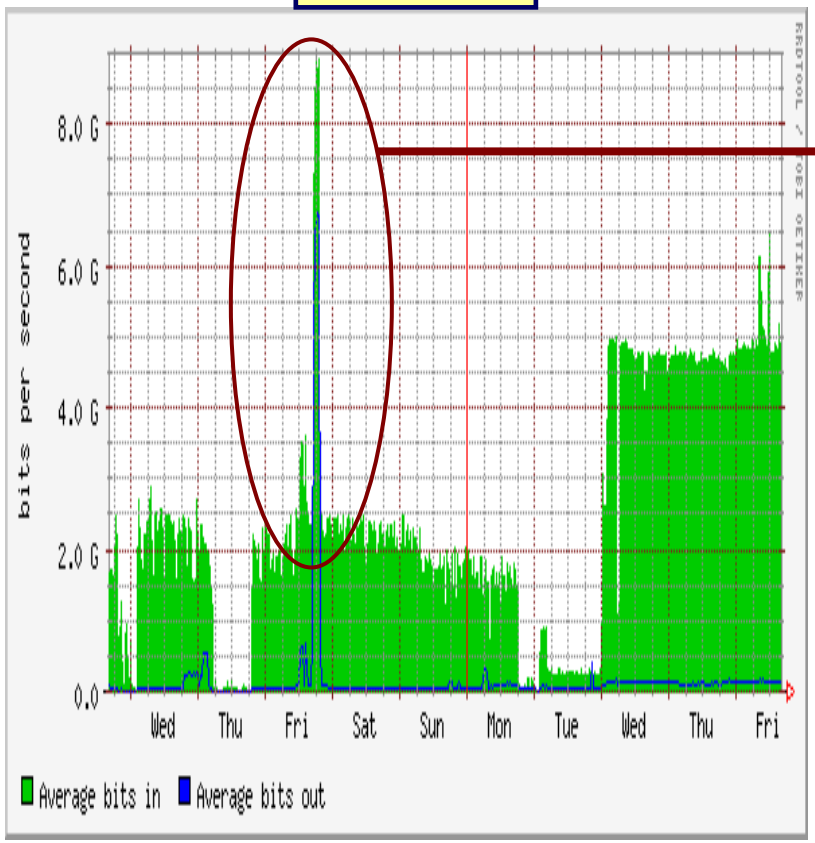
- An Era of unprecedented opportunity for Global eScience
  - Spread of the "Grid Imprint"; moving towards a common foundation
    - Including running experiments: Run2, MINOS, BaBar
    - Many fields of Data Intensive Science (e.g. Biomedicine)
  - A new generation of real-time Grid systems is emerging, to support worldwide data analysis by the physics community
  - Leading role of HEP in developing new systems and paradigms for Data Intensive Grids
- Rapid and Profound Progress in Networks
  - Transformed view and theoretical understanding of TCP as an efficient, scalable protocol with a wide field of use
  - Efficient standalone and shared use of 10 Gbps paths of virtually unlimited length; progress towards 100 Gbps networking
  - Emergence of a new generation of "hybrid" packet- and circuit- switched networks

The Global Lambda Integrated Facility for Research and Education (GLIF)



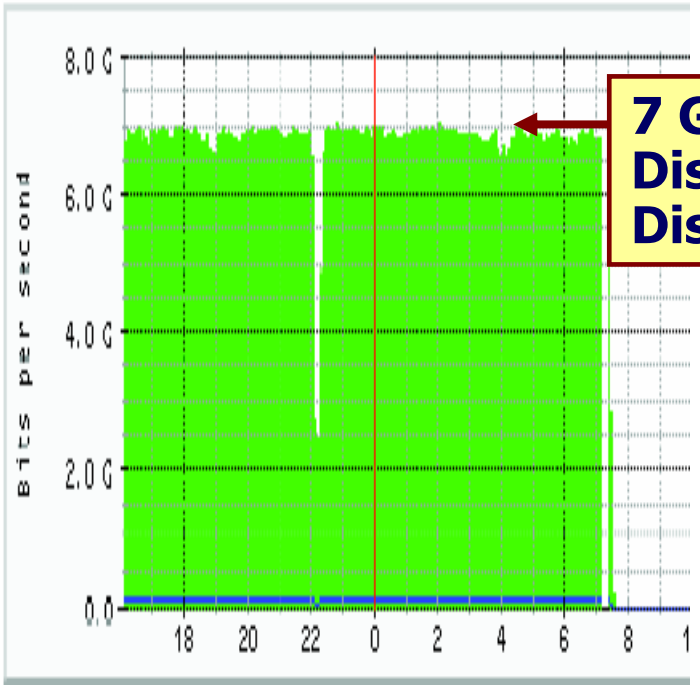
FNAL-CERN Service Challenges Traffic Over LHCNet (Starlight-CERN)

SC1: 11/2004



Caltech: FAST TCP Flows don't affect production traffic; Not the case with std. TCP, to 9 Gbps

SC2 4/5/2005



7 Gbps Disk to Disk

Data Analysis in the LHC Era, as a Global Collaboration, Will Be a New Experience

The Scale of Grids and Networks: Outlook for 2005-2008

- Fermilab Demonstrated 7 Gbps on LHCNet from CERN Disk to DIsk; Using 150 Nodes the capability was ~60 Gbps (in 2005)
- Cluster I/O and WAN Capabilities Advancing Rapidly
  - ➔ Each 1U Node: 50-100 Mbytes/s Now; ~Match 1 Gbps disk to disk by 2006-7 (to 30 Gbps Per Rack)
  - ➔ Data Servers at > 0.5 GBytes/s now; to 1 GByte/sec by 2006-7 (also ~30 Gbps Per Rack)
- >200 Gbps in US: 7 US Tier2s ~60 G to Starlight; FNAL 20-60 G; Michigan: 30 G; Korea 10 G Now; Facility in NYC: BNL 20 Gbps, Buffalo 20 Gbps, Canada 10 Gbps, Amsterdam. 20 Gbps + ATLAS T2s…
- HENP Roadmap of 1000X Per Decade is Realistic: 40 Gbps US-CERN by 2007, 80 Gbps by 2009

Long Range Intercontinental Data Transport at N X 10G is a Reality. Grid

Progress in Closing the Digital Divide

- ***We Must Work to Close to Digital Divide, from Several Perspectives***
  - ***To Allow Scientists in All World Regions to Take Part in Discoveries; to Foster Research and Education***
  - **Removing Regional, Last Mile, Local Bottlenecks and Compromises in Network Quality are *On the Critical Path***
- **"Dark Fiber" and community owned/operated networks emerging as the means to rapid progress in a growing list of nations:**

  us, ca, nl, jp, kr; *pl, cz, br, sk, cn, pt, ie, gr, …; Also GEANT2*
- ***Important Examples*** **on the Road to Closing the Digital Divide**
  - **GLORIAD (US-Russia-China-Korea) Global Optical Ring**
  - **IEEAF "Global Quilt"; NSF: IRNC and *New Initiative on Africa***
  - **CHEPREO, WHREN and the Brazil HEPGrid in Latin America**
  - ***Leadership & Outreach: HEP Groups in US, EU, Japan, Korea***

GLORIAD Network

Date: 3/1/2007

Closing the Digital Divide: R&E Networks in/to Latin America

RNP2 and the GIGA Project (ANSP)

***AmPath*: 45 Mbps Links to US (2002-5)**

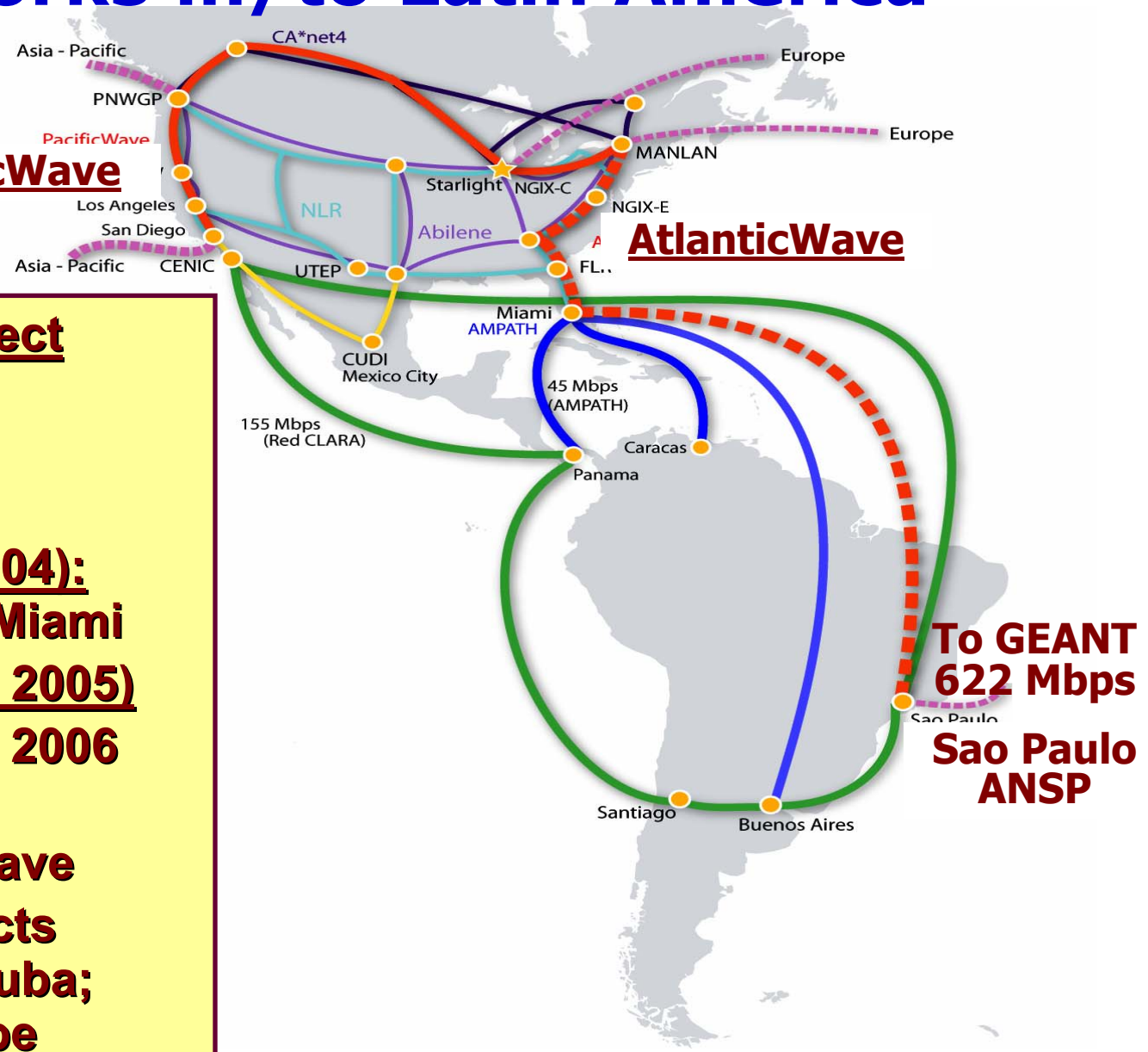
CHEPREO (NSF, from 2004):
622 Mbps Sao Paulo – Miami

WHREN/LILA (NSF, from 2005)

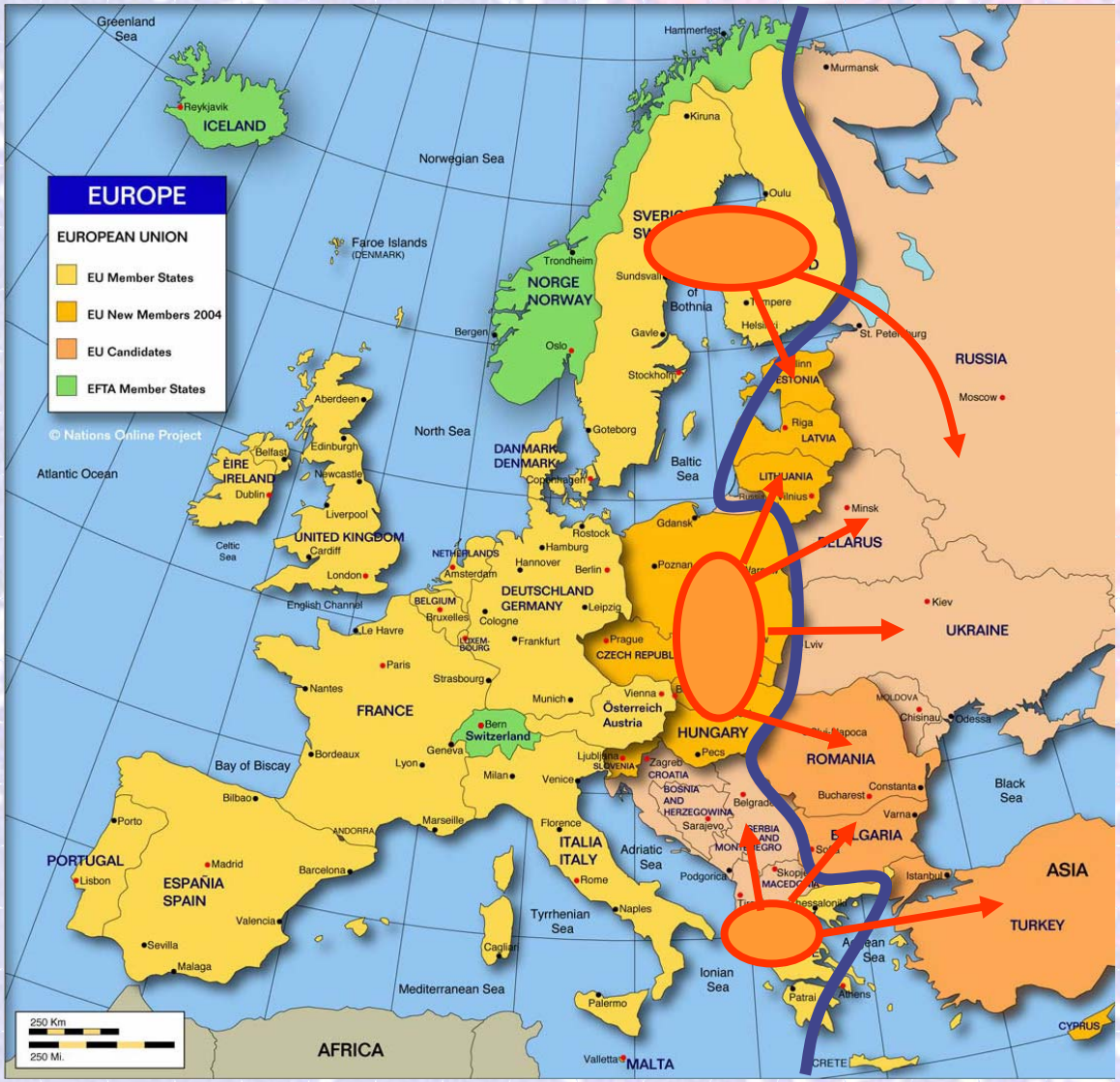
➔ 0.6 to 2.5 G Ring by 2006

➔ Connections to Pacific & Atlantic Wave

RedCLARA (EU): Connects 18 Latin Am. NRENs, Cuba; 622 Mbps Link to Europe



„Porta Optica – a coordinated task to Heal the Digital Divide to the East ...



- CE countries – CBDF links to EE neighbours:
  - Poland: DF connectivity to every eastern neighbour
  - Scandinavia: the northern route
  - GRNET: activity in the Balkan region (SEEREN/ SEEFIRE) + the south route
- GEANT/TERENA: political & organisational support
- all: influencing the EE countries wrt. DF acq., importance of DF infrastructure & business models

TEIN2 Project

Managed by DANTE

An initiative of the European Commission with the stated objective of improving connectivity in certain developing countries of the Asia Pacific region

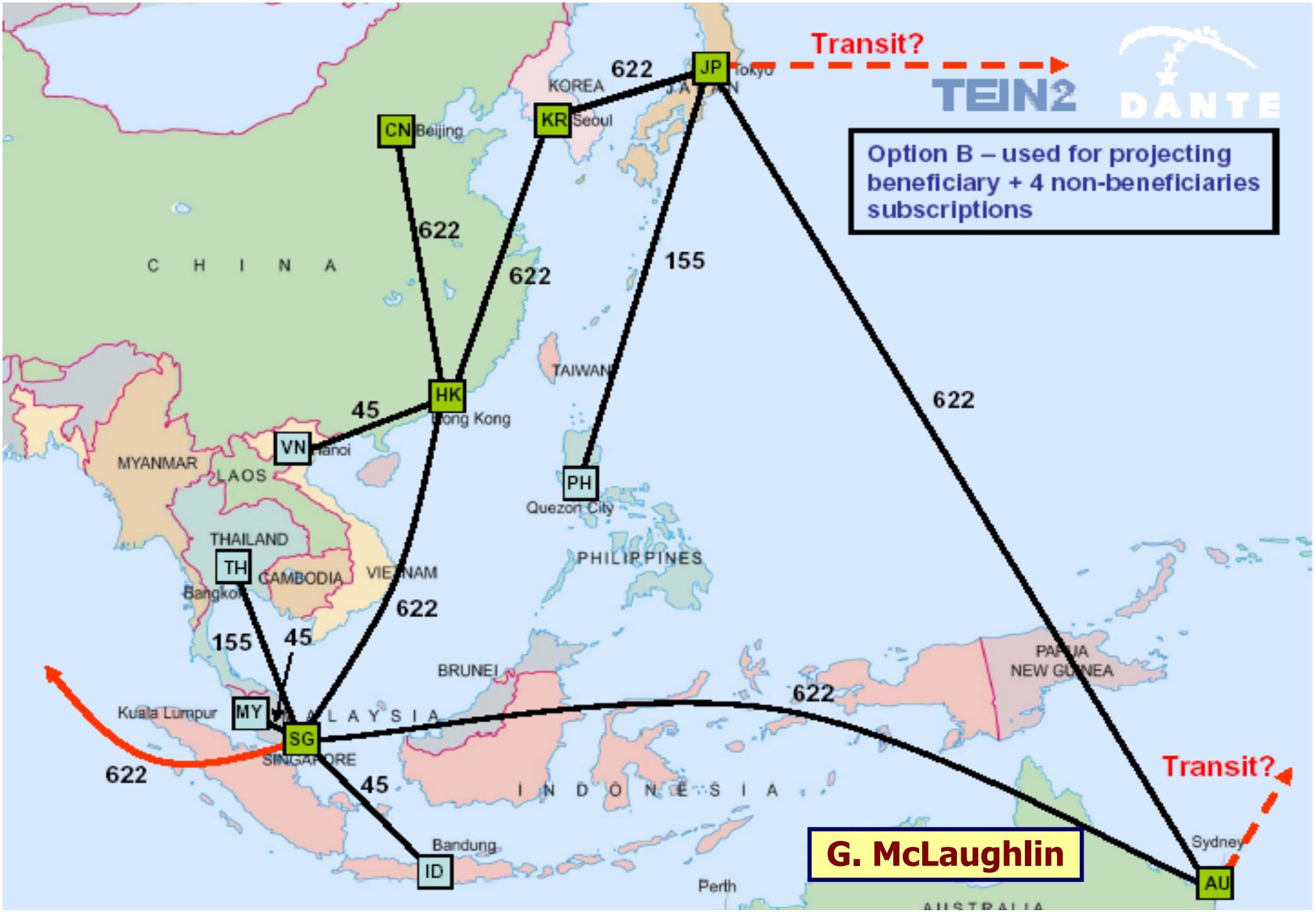
Partners:

- China (CERNET)
- Indonesia (ITB)
- Malaysia (MDC)
- Philippines (ASTI)
- Thailand (ThaiREN)
- Vietnam (MOST)
- Korea (KISDI)
- Singapore (SingAREN)
- Australia (AARNet)
- France (RENATER)
- Netherlands (SURFnet)
- UK (UKERNA)

- Contracts Q2/3, operational Q4 2005 (to end 2007)
- Exploring collaborations with existing and planned initiatives

G. McLaughlin

aarnet

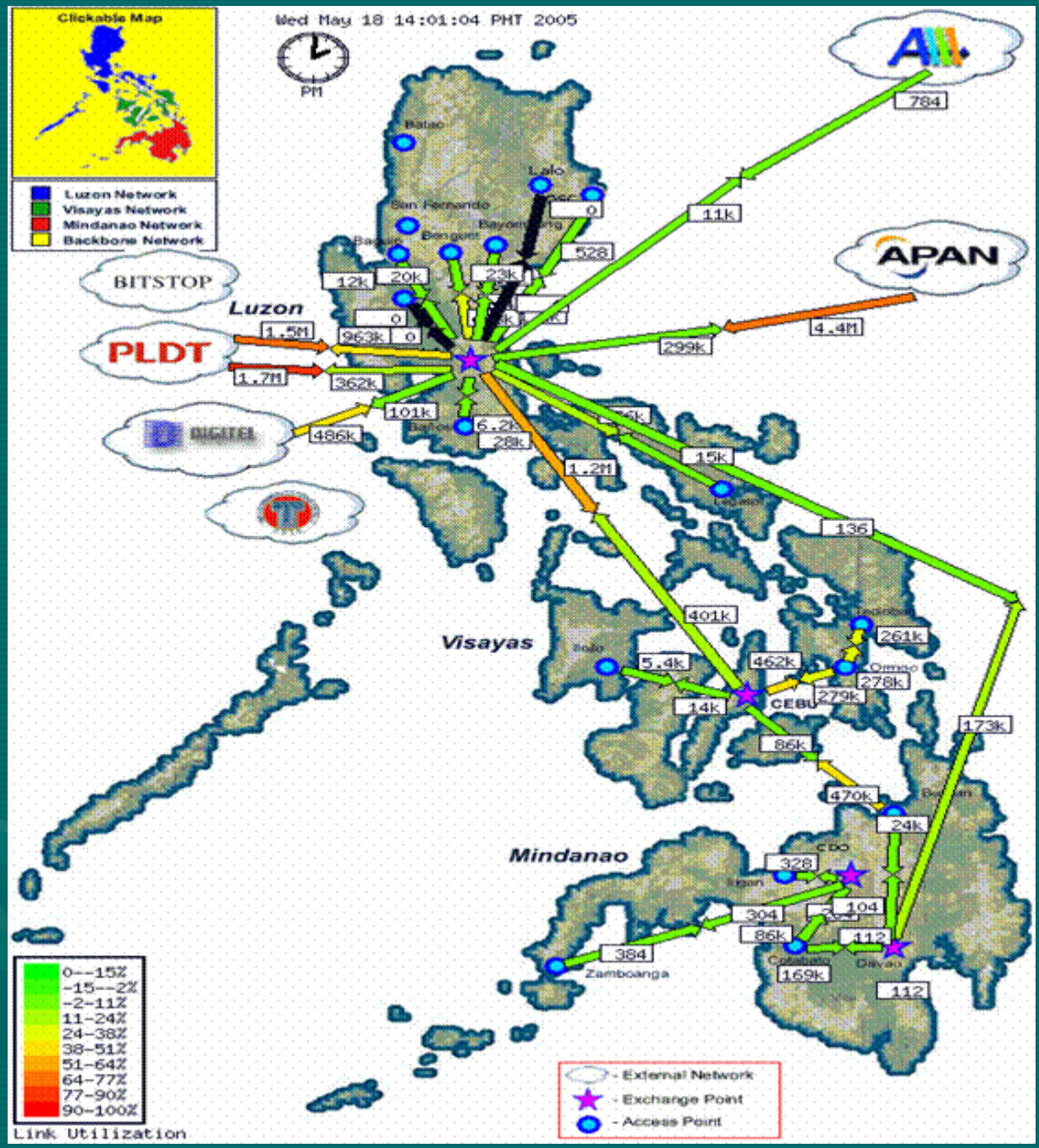

Transit?
TEIN2
DANTE
Option B – used for projecting beneficiary + 4 non-beneficiaries subscriptions
622
JP
Tokyo
KOREA
KR
Seoul
CN
Beijing
622
622
155
C H I N A
TAIWAN
HK
Hong Kong
45
622
VN
Hanoi
MYANMAR
LAOS
PH
Quezon City
THAILAND
TH
CAMBODIA
VIETNAM
PHILIPPINES
622
155
45
BRUNEI
PAPUA NEW GUINEA
622
Kuala Lumpur
MY
M A L A Y S I A
SG
SINGAPORE
622
45
I N D O N E S I A
Transit?
Bandung
ID
Sydney
AU
Perth
AUSTRALIA
G. McLaughlin

Philippines: PREGINet Network Map

No. of Partner Institutions as of March 31, 2005:

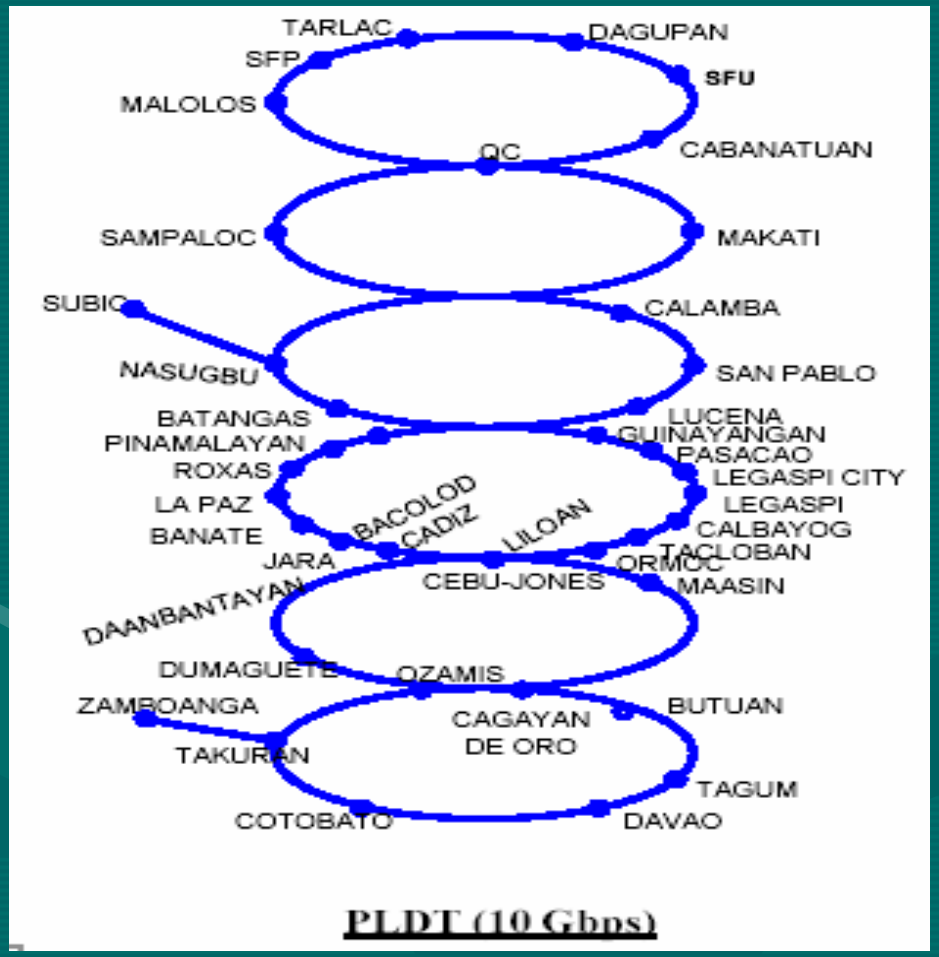
Academe	=	34
Government	=	33
Research	=	27
TOTAL		96

2 Mbps Backbone

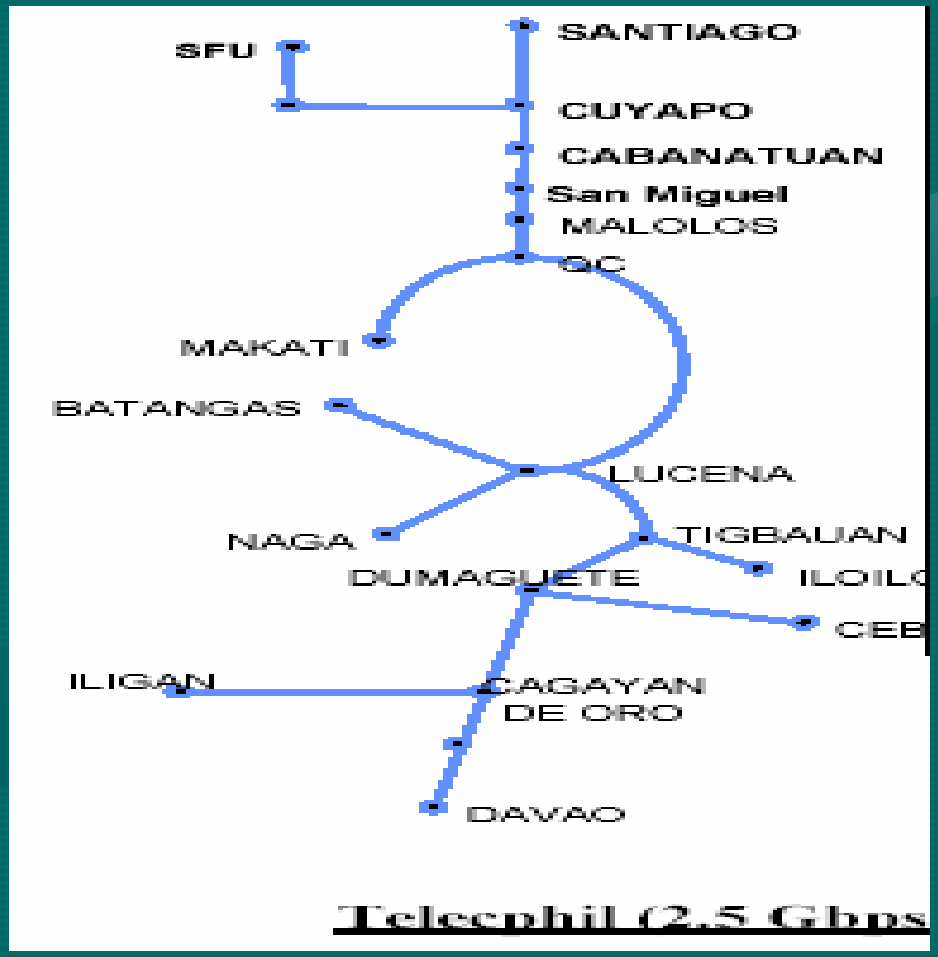


DOMESTIC FIBER OPTIC SYSTEMS

1



2

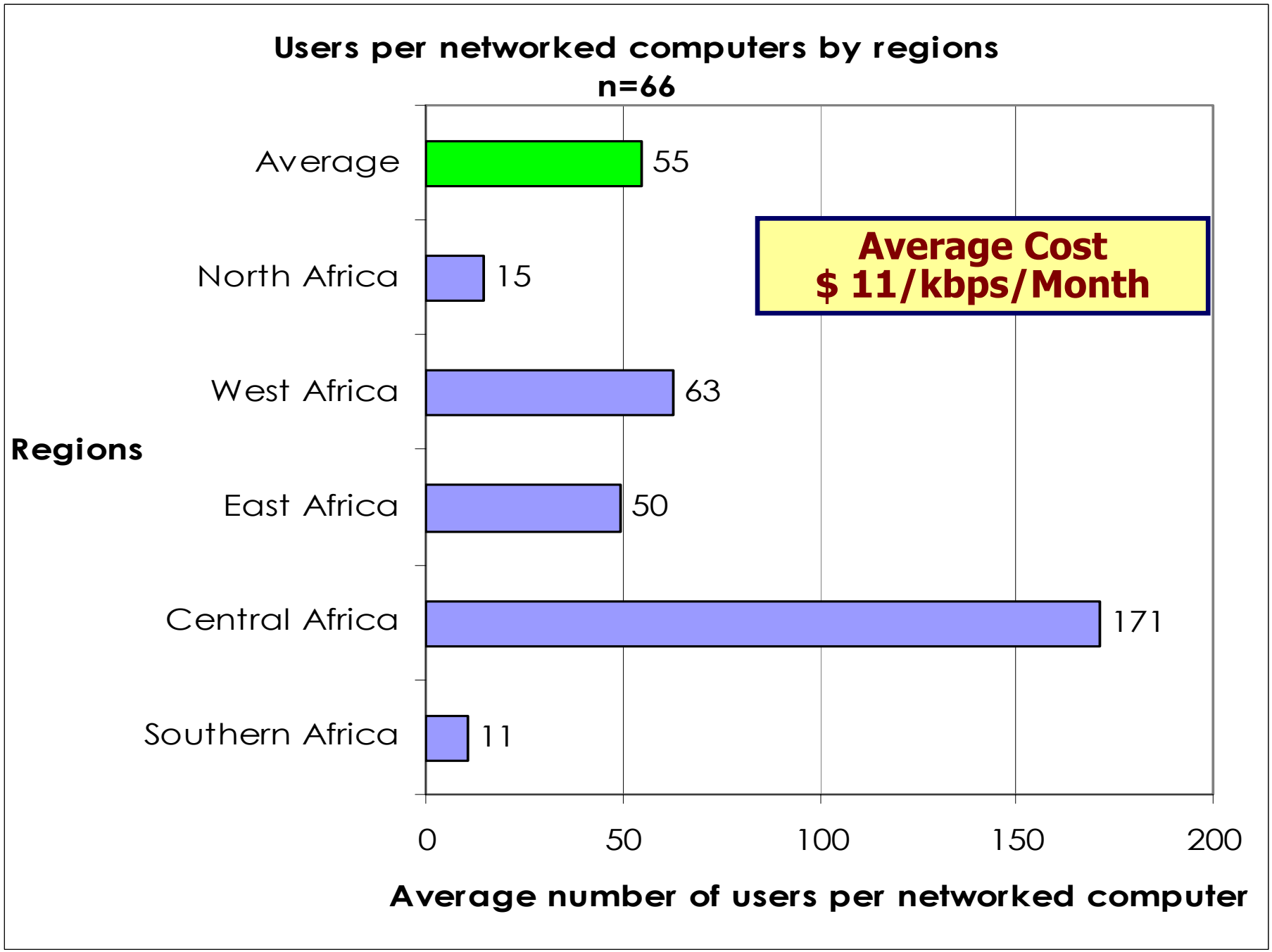


Commercial Backbone Now 10 Gbps

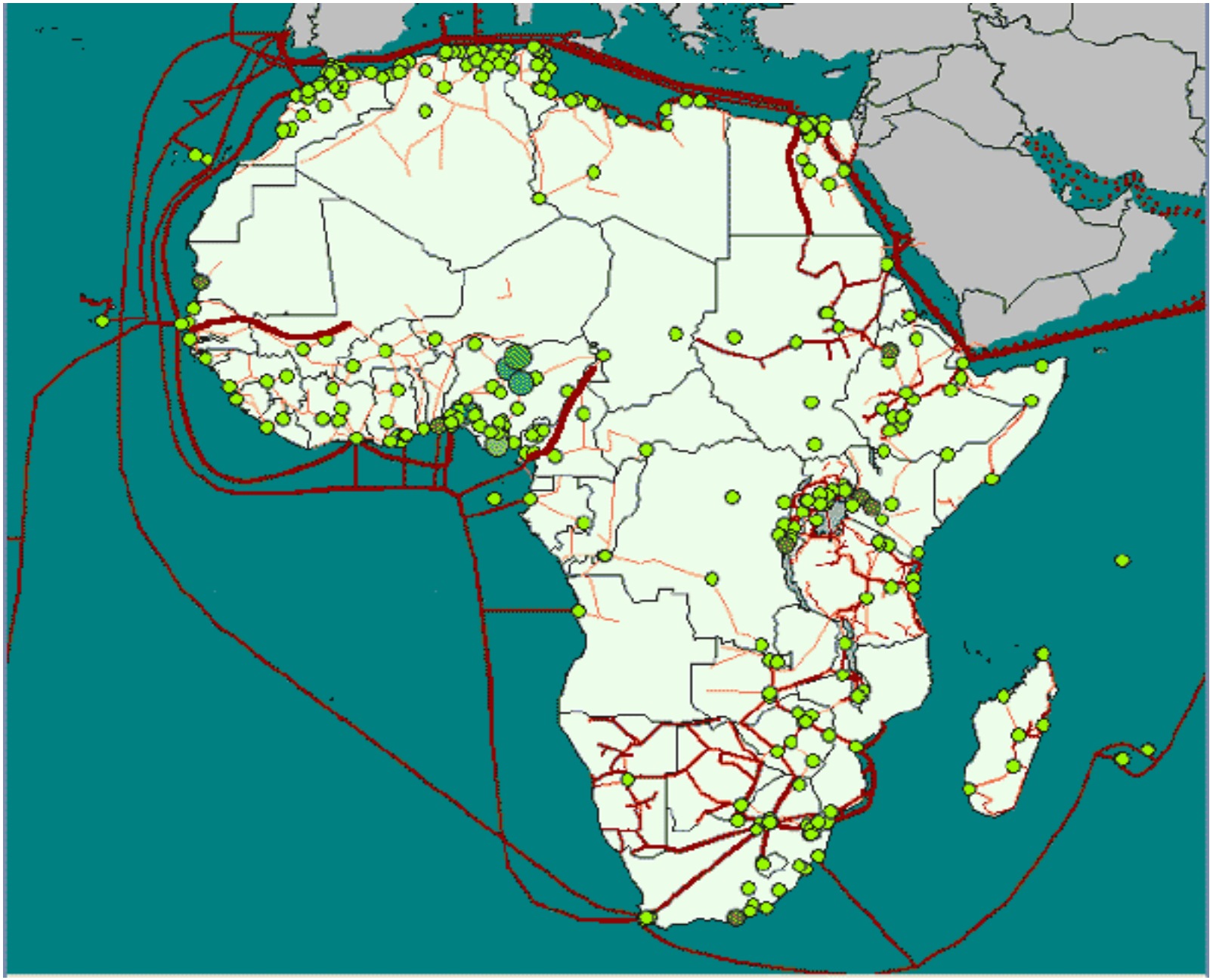
Many systemic factors:

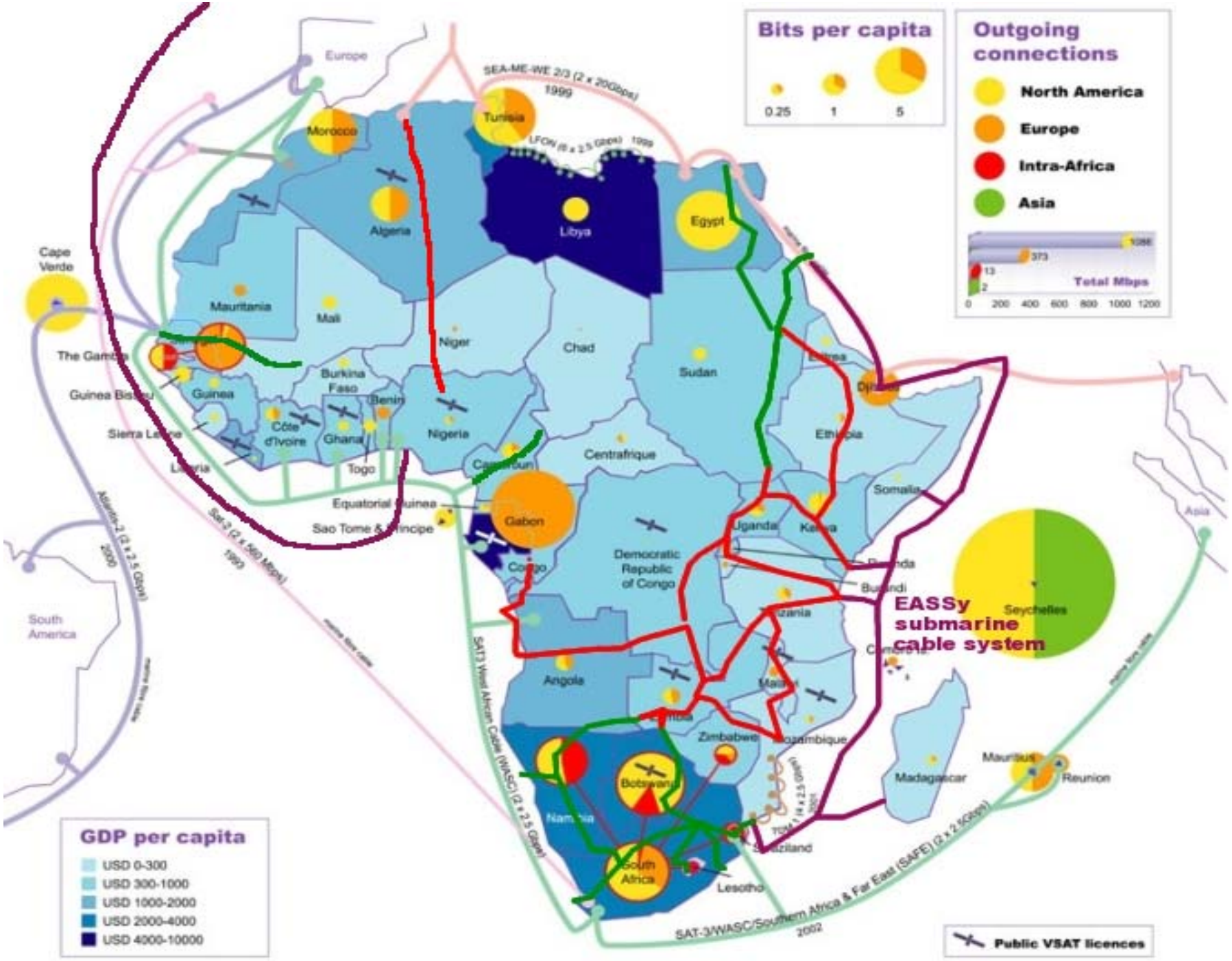
Electricity,
Import duties,
Skills

M. Jensen


Users per networked computers by regions
n=66
Average
North Africa
West Africa
East Africa
Central Africa
Southern Africa
55
15
63
50
171
11
Average Cost
$ 11/kbps/Month
Regions
0
50
100
150
200
Average number of users per networked computer

International & National Backbones

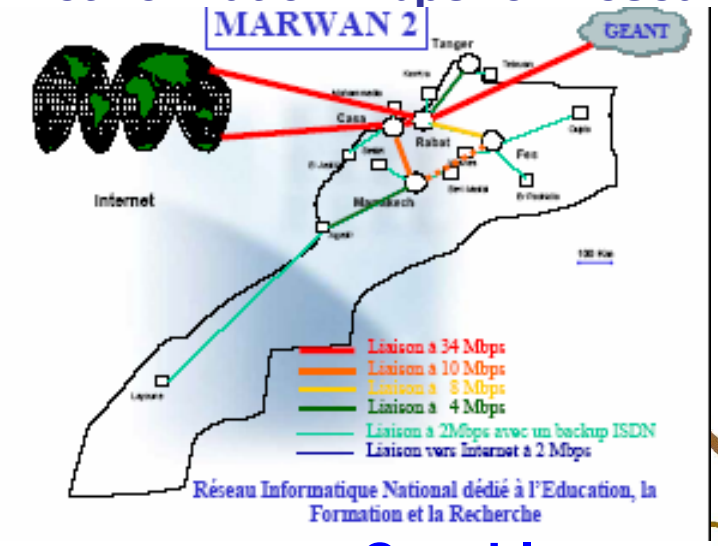



Bits per capita
0.25
1
5
Outgoing connections
North America
Europe
Intra-Africa
Asia
1088
373
13
2
Total Mbps
0
200
400
600
800
1000
1200
Europe
SEA-ME-WE 2/3 (2 x 20Gbps)
1999
Tunisia
Morocco
Algeria
Libya
Egypt
Cape Verde
Mauritania
Mali
Niger
Chad
Sudan
The Gambia
Guinea Bissau
Guinea
Burkina Faso
Benin
Sierra Leone
Côte d'Ivoire
Ghana
Nigeria
Liberia
Togo
Cameroun
Centrafrique
Equatorial Guinea
Sao Tome & Principe
Gabon
Congo
Democratic Republic of Congo
Uganda
Somalia
Rwanda
Burundi
Tanzania
Angola
Malawi
Zambia
Zimbabwe
Mozambique
Madagascar
Mauritius
Reunion
Seychelles
Botswana
Namibia
South Africa
Lesotho
Swaziland
EASSy submarine cable system
South America
Asia
Atlantis-2 (2 x 2.5 Gbps)
2000
SAT-3 (2 x 560 Mbps)
1993
SAT3 West African Cable (WASC) (2 x 2.5 Gbps)
SAT-3/WASC/Southern Africa & Far East (SAFE) (2 x 2.5Gbps)
2002
GDP per capita
USD 0-300
USD 300-1000
USD 1000-2000
USD 2000-4000
USD 4000-10000
Public VSAT licences

Maroc Wide Area Network

MARWAN 2

Network at 34 Mbps for Research and high education



Réseau GEANT

Connexion vers les ré-seaux de la Recherche, Europe, Amérique...

45 Mbps

Algeria & tunisia connected to Geant - 45 Mbs

Rabat

Casablanca

Université

Université

Université

Institut

Université

Université

Université

Institut

Institut

Université

34 Mbps

2 Mbps

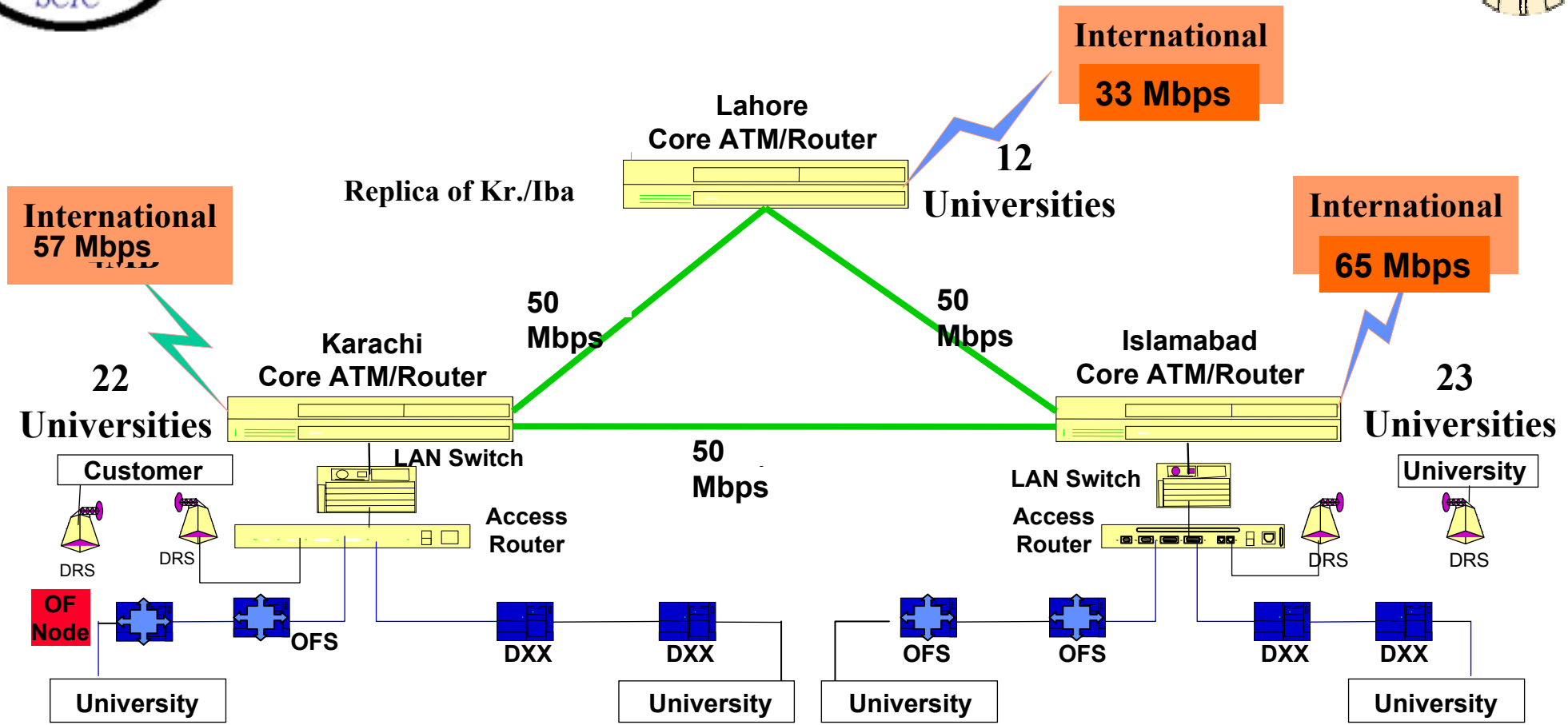
45 Mbit/s

34 Mbit/s

2 Mbit/s

Abdeslam Hoummada

PERN: Network Architecture



- HEC will invest $ 4M in Backbone
- 3 To 9 Points-of-Presence (Core Nodes)
- $ 2.4M from HEC to Public Universities for Last Mile Costs
- Possible Dark Fiber Initiative

We Need to Work on the Digital Divide from Several Perspectives

- Workshops and Tutorials/Training Sessions
  - For Example: ICFA DD Workshops: Rio 2/04, *Daegu May 2005,* HONET (Pakistan) 12/04
- Share Information: *Monitoring, BW Progress*; Dark Fiber Projects & Pricing
  - Model Cases: Poland, Slovakia, Czech Rep., China, Brazil,…
- Encourage, and Work on Inter-Regional Projects
  - *GLORIAD, Russia-China-Korea US Optical Ring*
  - Latin America: CHEPREO/WHREN (US-Brazil); RedCLARA
  - Asia Pacific: TEIN2
- Help with Modernizing the Infrastructure
  - Design, Commissioning, Development
  - Provide Tools for Effective Use: Monitoring, Collaboration Systems; Advanced TCP Stacks, Grid System Software
- Work on Policies and/or Pricing: pk, br, cn, SE Europe, in, …
  - Encourage Access to Dark Fiber
- *Raise World Awareness of Problems, & Opportunities for Solutions*
  - *Increased Engagement with Government Representatives and Agencies*

ICFA SCIC Digital Divide Workshops

- Now a Tradition
  - *Daegu May 2005: Excellent occasion to focus on the Asia Pacific*
- A View of Progress and Remaining Issues
- Bring target areas where progress can be made next into focus
  - E.g. Russia, Pakistan, India, North-South Connections in the Asia Pacific
- Next Meeting
  - Choice of a Key Location: Russia, Poland, Romania have been discussed; expressions of interest welcome.
  - Greater participation from government representatives