What will Optical Networking for the Americas look like?
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What do we mean by Optical Networking?

- End to end optical routing?
  - Not yet visible on our horizon

- High capacity national and international pipes?
  - Already available, permitting support for arbitrarily large and complex applications

- User control of networking infra-structure?
  - Alters the user dependence on costly telco services
  - New paradigm for future of networking

Traditional networking model

- Involves setting up IP infrastructure based on leased telco services

- Telcos were state monopolies until recently in many Latin American countries, and still are in some:
  - no competition $\rightarrow$
    - arbitrary (high) pricing
    - unavailability of some (advanced) services
      This can be an opportunity to influence the telco offerings through collaborative innovation!

Replacing copper by optical fibre

- Technical advantages:
  - (much) greater transmission capacity
  - (much) greater distances between equipment
  - (much) lighter and cheaper

→ **simplifies the infrastructure for networking**

→ **makes feasible user ownership or provision**

- This can be be put to use at many levels:
  - 3 examples from Brazil

1. A distributed university – UFF (1998)

- UFF (Universidade Federal Fluminense, Niterói, RJ)
  - large (23,000 students), urban, federal gov't maintained
  - main campus spread around 16 sites in the city
  - until 1997, all internal communications services (data and voice) provided by local monopoly telco
  - in 1998 installed its own optical fibre infrastructure to 50 buildings over 12 sites, with interconnections between them (24 km, 12km between sites)
    - ATM 622 Mbps (soon GE) backbone; FE to building
    - integrated telephony (with inter-site VoIP trunking)
    - interconnects with local cable TV network for transmission of university channel content for distribution, and potential staff and student access

UFF's optical fibre infrastructure in Niterói

2. Curitiba Metropolitan Area Network (1999)

- Curitiba is the capital of the state of Paraná, with a population of more than 1 million.

- MAN connects 3 universities (CEFET-PR, PUC-PR and UFPR) and local software development company (CITS)

  - one of 14 such networks launched 1999 - 2000

- Fibre infrastructure built by the MAN partnership starting in 1999 (40 to 50 km)

  - initially ATM 155 Mbps

  - in 2002 migrated to GE
    (they just had to change the switches)

ReMAVs: High-speed Metropolitan Networks (1999 -)

ReMAVs

1000 km

- 2 year funding (starting 1998) - joint initiative RNP/CNPq
- Based on dark fibre and originally ATM em 155 Mbps
- Several now migrating to GE

3. Project GIGA
– networking testbed in SE Brazil (2003)

- Partnership between RNP and CPqD (former telco monopoly's R&D centre in Campinas, SP)
- Explore user control of long-distance optical fibre infrastructure
  - interconnect 20 academic R&D centres along the corridor Campinas - Rio de Janeiro (~600 km)
  - use of IP/DWDM with Ethernet framing
- Develop R&D projects in optical and IP networking technology and advanced applications and services
- Industry participation (telcos provide the fibres; technology transfer of products and services required)
- Government funding for 3 years - started December 2002
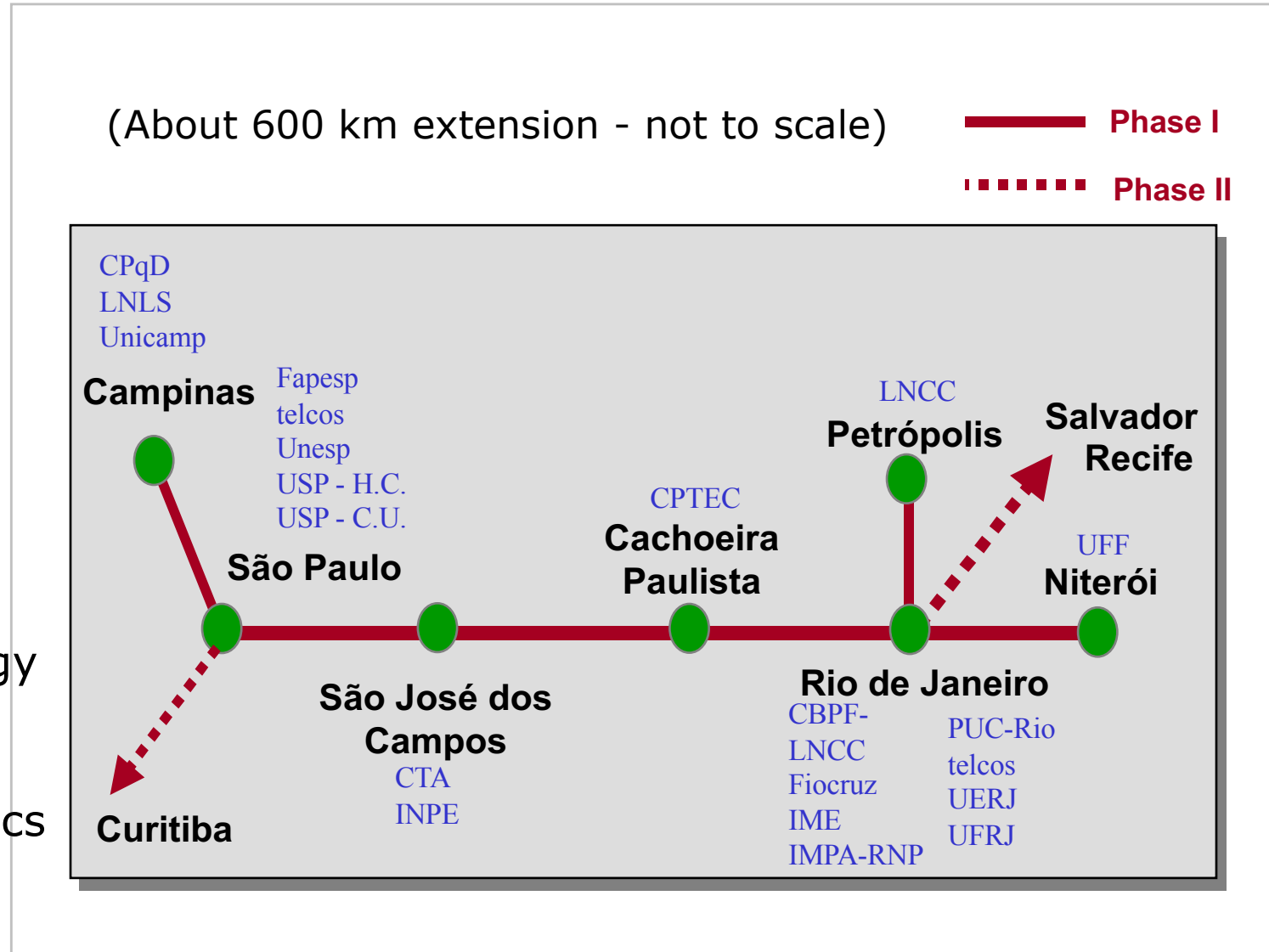
Geographic localisation of GIGA network

Universities
IME
PUC-Rio
UERJ
UFF
UFRJ
Unesp
Unicamp
USP

R&D Centres
CBPF   - physics
CPqD   - telecom
CPTEC - meteorology
CTA   - aerospace
Fiocruz - health
IMPA   - mathematics
INPE   - space
LNCC   - HPC
LNLS   - physics

(About 600 km extension - not to scale)

— **Phase I**

····· **Phase II**

CPqD
LNLS
Unicamp

Campinas

Fapesp
telcos
Unesp
USP - H.C.
USP - C.U.

São Paulo

LNCC
Petrópolis

Salvador
Recife

CPTEC
Cachoeira Paulista

UFF
Niterói

São José dos Campos
CTA
INPE

Rio de Janeiro
CBPF-
LNCC
Fiocruz
IME
IMPA-RNP

PUC-Rio
telcos
UERJ
UFRJ

Curitiba

Conclusion

- The most important consequence of optical networking is empowerment of the users

- Academic networking projects serve as proof of concept for wider application
  - "Information Society" projects for access to schools, hospitals and other public facilities

- Main impact will be through condominium fibre networks à la Bill St Arnaud (CANARIE)

More information about RNP available at

www.rnp.br/index_en.html

Questions to the panel

- Q-1: Which e-Science projects do you consider most important for North and South American competitiveness?

- Q-2: For our Latin American participants on the panel, what have your North American colleagues done in the past that's been helpful and what do you believe they should do in the future