

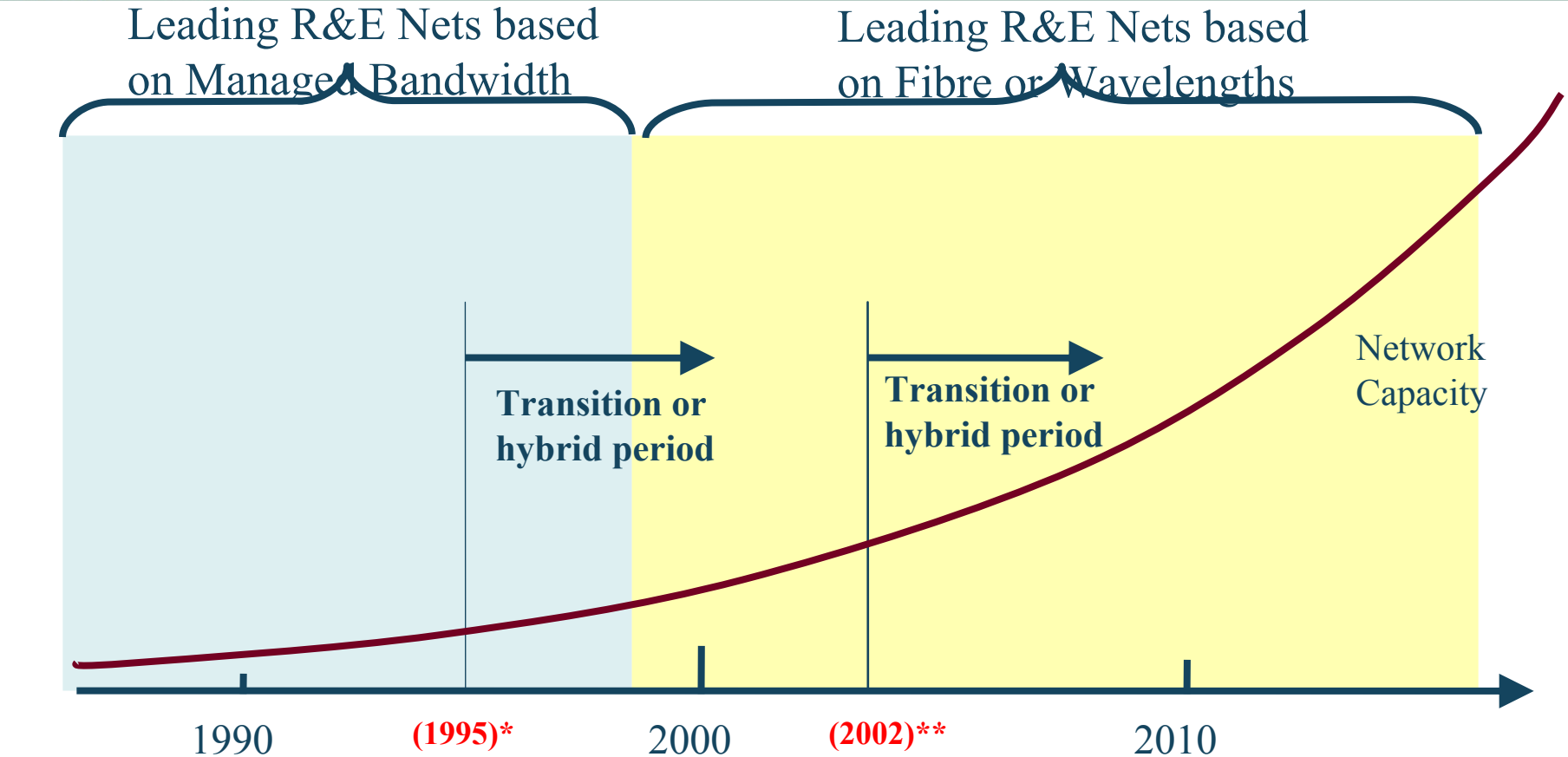
# CANARIE

## CA\*net 4 update and lightpath discussion points (cont'd)

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# Research and Education Networking Transitions



**Classic Internet Era** → **Intranet Era** → **Lightpath Era**

**\* Decommissioning of NSFnet**

**\*\* Commissioning of CA\*net 4**



# What has changed?

In the classical and Internet eras, R&E institutions and NRENs would purchase circuits from carriers and provision connectionless Internet services.

In the lightpath era, R&E institutions and NRENs purchase dark fibre or wavelengths and provision their own circuits.

SONET and SDH based optical networks have been deployed extensively. Just never before by non-traditional carriers.



# What is a lightpath again ? ;-)

>it is an optical circuit

> **by circuit, mean absence of statistical multiplexing**

> **by circuit, necessarily mean pt-pt**

> **by optical, mean high capacity**

> **by optical, necessarily mean using optical technology (fibres, lasers, etc.)**

>a lambda is a coarse optical circuit



# What is a lightpath again ? ;-)

- >CA\*net 4 research program aims to extend idea of condo fibre to the wide area: condo-wavelengths
- >without fibre and own DWDM, decided to emulate “GbE DWDM” using TDM to implement condo-wavelengths
- >is TDM optical?
  - > **SONET: Synchronous Optical Network**
  - > **optical switches:**
    - > **opaque (OEO) a.k.a. optical cross-connects, digital cross connects, add/drop multiplexers**
    - > **transparent (OOO) a.k.a. photonic cross-connect**
- >but TDM is clearly not a lambda



# What is a lightpath again ? ;-)

> want a word that captures condo-wavelength idea including lambda and lambda emulation through 1<sup>st</sup> generation of optical networks (TDM)

> “circuit” isn't sexy -> harder to generate excitement, i.e funding

> hence

> **“lightpath” in English**

> **“route optique” in French**

> simple definition:

> **analog wavelength or other unidirectional layer 1 channel that is fixed in Bw capacity and cannot be statistically multiplexed, merged, or otherwise modified between any two points in a network**

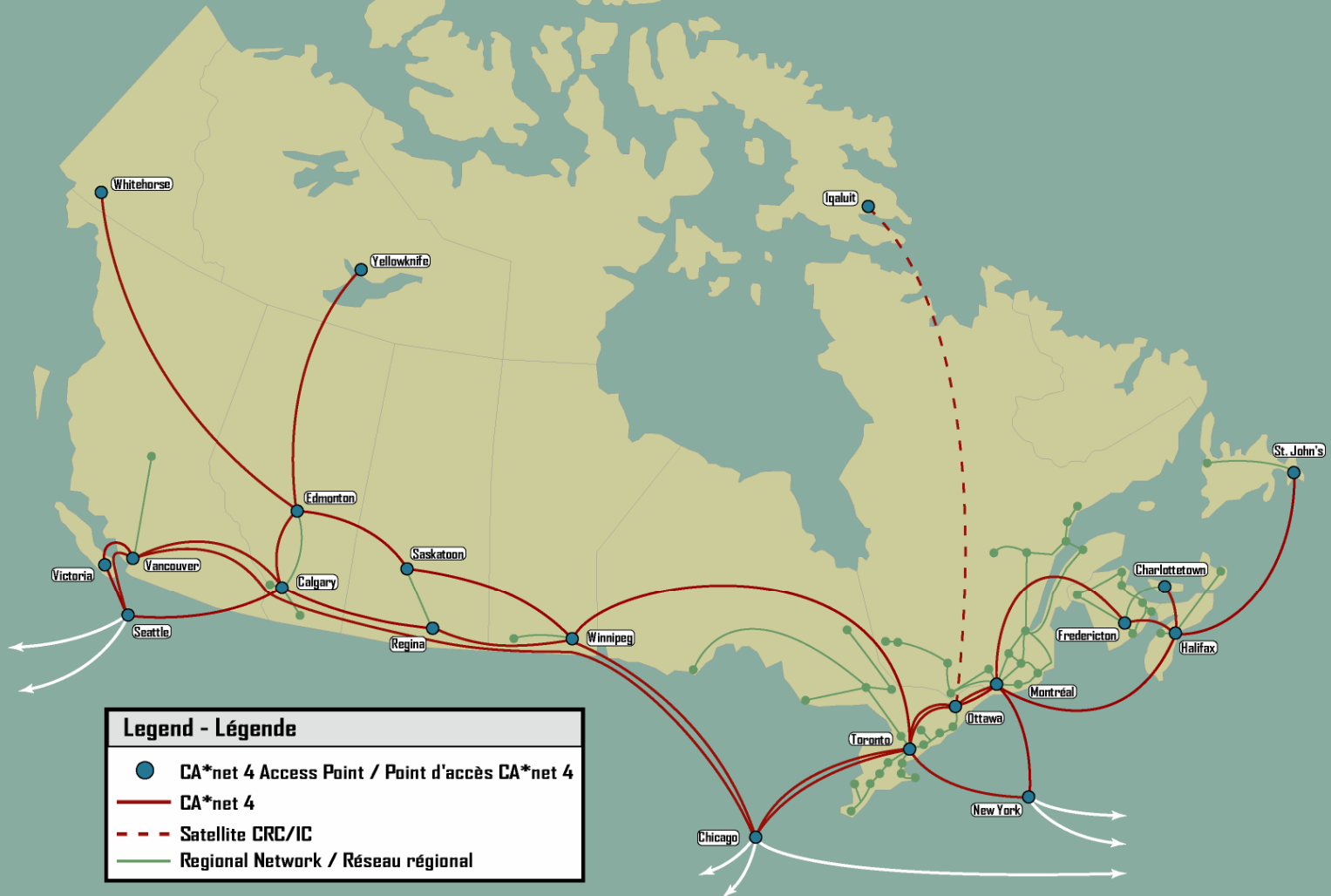


# additional element to CA\*net 4 definition

- > CA\*net 4 is made up of a multitude of pt-pt lightpaths and optical cross connects from a number of different carriers and fiber suppliers
- > lightpaths + optical cross connects = lightpath objects
- > lightpath objects owned and controlled by an end user = user-controlled lightpaths (UCLP)

# CA\*net<sup>4</sup>

Canada's Research and Innovation Network  
Réseau canadien pour la recherche et l'innovation





# CA\*net 4 architecture

3 OC-192/STM-64 wavelengths from 3 different DWDM carriers

- **Group Telecom (Bell Canada)**
- **Shaw / Big Pipe**
- **TELUS**

wavelengths framed SONET/SDH with line layer / multiplex section layer transparency

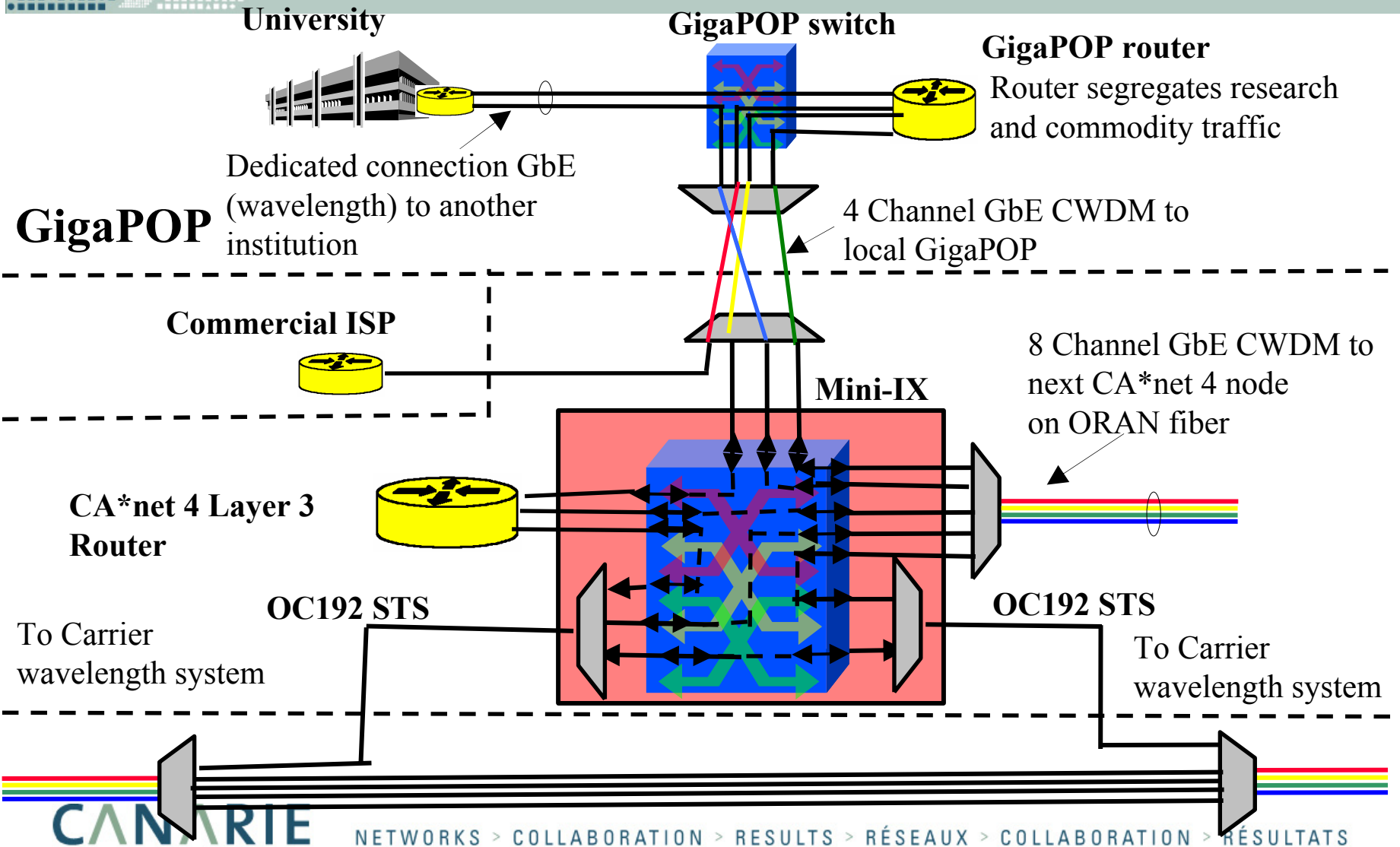
2 different OXC equipment vendors to do grooming and line / multiplex section termination

- **Cisco ONS 15454 MSPP**
- **Nortel OME 6500**

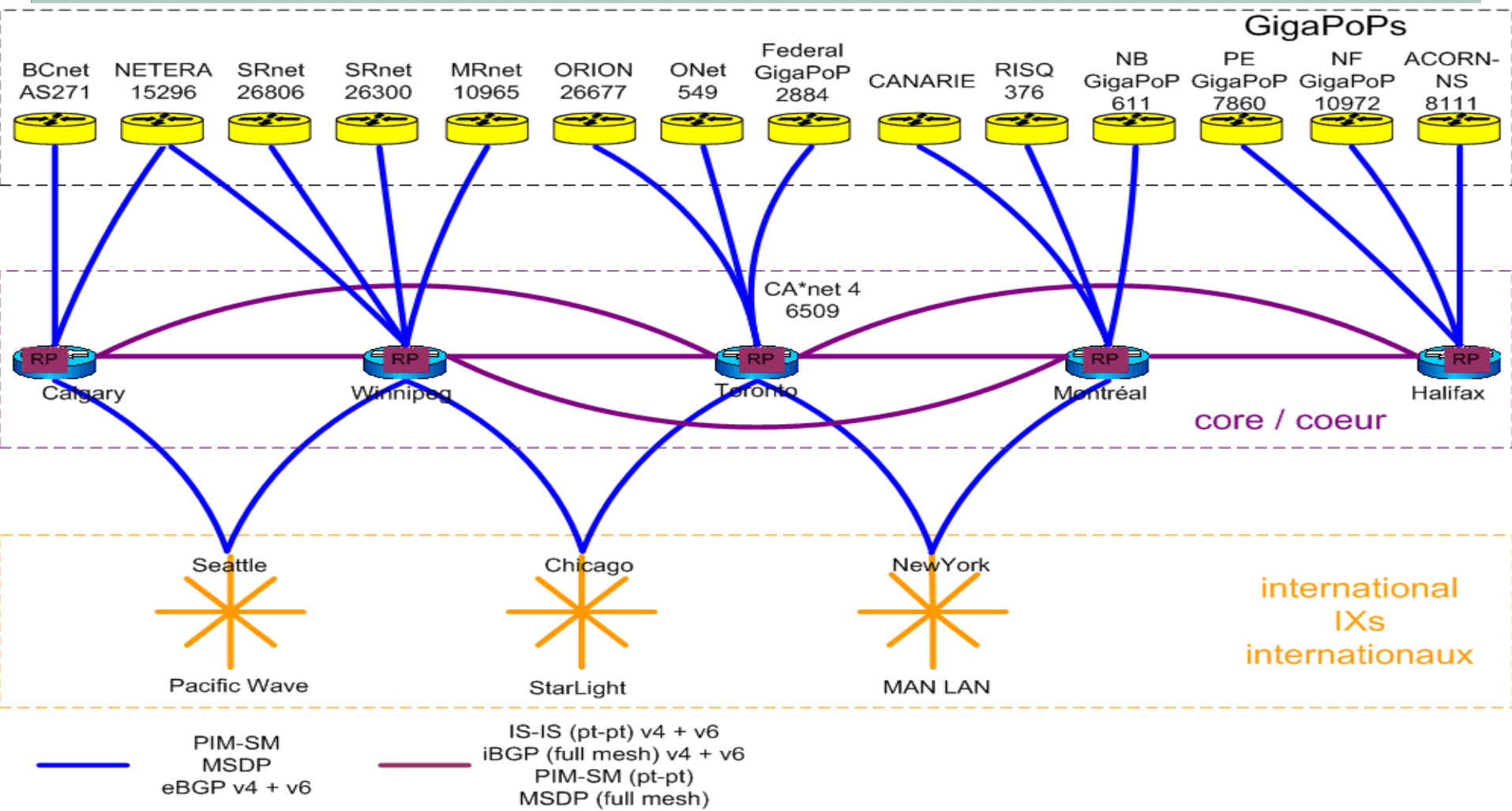
local loops -> 3 scenarios:

- **CA\*net 4 PoP in major R&E institution, no local loop required**
- **CA\*net 4 PoP in carrier neutral hotel with dark fibre to ORAN**
- **CA\*net 4 PoP in carrier neutral hotel with dark fibre to major R&E institution**

# GigaPOP – CA\*net 4 node



# CA\*net 4 IP backbone, RANs, and int'l exchange points





# Why are we having difficulty defining a lightpath?

>are we trying to define layer 1 functionality through layer 3 concepts?

**> basic function of SONET/SDH is to do TDM:**

**> provide base TDM frame structure (also used for synchronization and 3R)**

**> define a limited variety of payload envelopes or virtual containers (independent of concept of packet; just interested in bits)**

**> provide for a flexible byte interleaving synchronous multiplexing method for placing payload envelopes into base signal**



# Performance measurement

- >it is a circuit
- >Remember: SONET and SDH based optical circuits have been deployed extensively
- > How do carriers measure the performance of a circuit? This is not new. Done independently of hosts which will be attached to circuit.
- > 3 main things one can measure:
  - > **continuity (detection of transitions)**
  - > **connectivity (between pair of peers, e.g. at SONET section, line, or path layers)**
  - > **quality (BER)**



## more definition discussion

- > Sort of funny to see layer 3 routing engineers trying to define a lightpath (circuit) in terms of layer 3 parameters
- > e.g. a lightpath does not have to be 9k byte MTU, this is a layer 2/3 concept. The Lucent Lambda Unite GbE card does not support jumbo frames. Interface cards do not have to be GbE, can be SAN interface (e.g. FICON ...)
- > but maybe we should qualify lightpaths based on encapsulation, capacity, etc.
  - **GbE GFP-F STS-24c lightpath**
  - **GbE LEX STS-12c lightpath**
  - ...



# what is a lightpath good for?

- >Metcalf's law still valid
- >not an either/or proposition
- >flexible circuit provisioning
- >a simple way to support few high-end users/applications
- >a simple way to provision wide area VPNs (i.e. RPNs)
- >a simple way to do traffic engineering
- >a flexible way to support special requirements (get around a firewall, do jumbo frames, do QoS)
- >a flexible way to support experimentation