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End to end lightpaths

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Background

- Today's centrally managed hierarchical networks have many limitations
- User controlled and managed networks are increasingly common
  - metro dark fiber networks
  - long-haul wavelength networks
- Most Canadian universities and many schools connected with dark fiber
- Many network organizations building their own private optical networks
  - Boeing, NLR, Lougheed-Martin
  - NLR, Pacific Light Rail etc

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What are E2E lightpaths?

- **Customer controlled E2E lightpaths are not about optical networking**
  - E2E lightpaths do not use GMPLS or ASON
- **The power of the Internet was that an overlay packet network controlled by end user and ISPs could be built on top of telco switched network**
  - CA*net 4 is an optical overlay network on top of telco optical network where switching is controlled by end users
- **More akin to MAE-E "peermaker" but at a finer granularity**
  - "Do you have an e2e lightpath for file transfer terminating at a given IX? Are you interested in peering with my e2e lightpath to enable big file transfer?"
  - Lightpath may be only from border router to border router
- **With OBGP can establish new BGP path that bypasses most (if not all) routers**
  - Allows lower cost remote peering and transit
  - Allows e2e lightpaths for big file transfer

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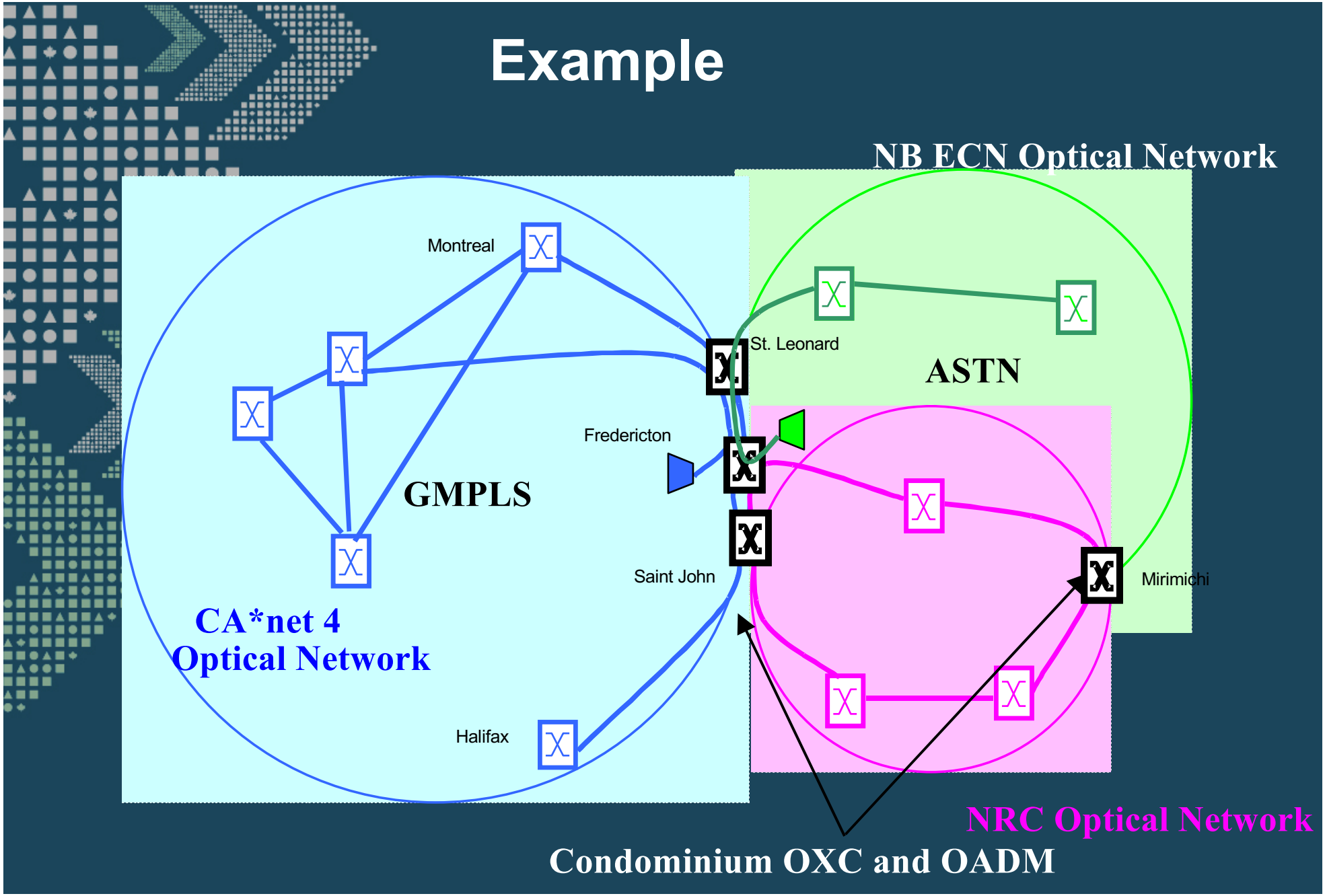
Drivers

- reduce the cost of bandwidth
  - a capital cost, rather than a monthly service charge
- directly peer with each other
- set up lightpaths to no cost peering exchanges
- eliminate expensive high end routers and replace them with optical switches
- technical advantages in support of E2E lightpaths and QoS for demanding services
  - large file transfer, storage area networks and Grid services

Technical Challenges

- Resource heterogeneity
  - combined resources from different sources
- Only customers have total visibility
  - no single carrier has total visibility of a customer's network
- Centrally managed hierarchical networking technologies do NOT work.
- Customers want to manage their own restoral and protection schemes
- Customers want to independently provide optical VPN services and manage subletting.

Example



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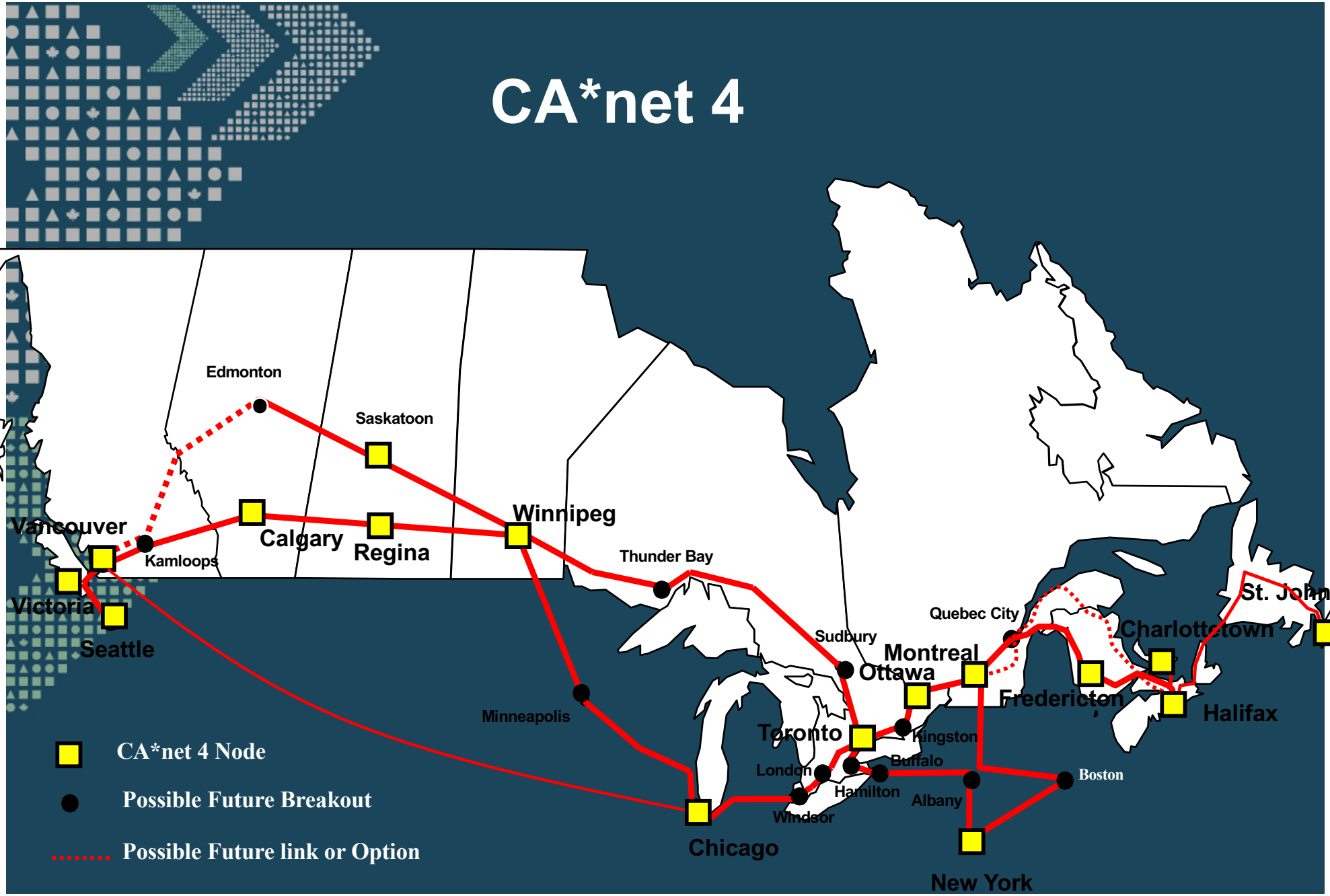
CA*net 4
Edmonton
Saskatoon
Vancouver
Kamloops
Calgary
Regina
Winnipeg
Thunder Bay
Victoria
Seattle
Sudbury
Quebec City
Montreal
Ottawa
Charlottetown
St. John's
Fredericton
Halifax
Minneapolis
Toronto
Kingston
Buffalo
London
Hamilton
Albany
Boston
Windsor
Chicago
New York
CA*net 4 Node
Possible Future Breakout
Possible Future link or Option

CA*net 4 Architecture Principles

- A network of point to point condominium wavelengths
  - **Do not confuse with traditional optical solutions like GMPLS or ASON**
- Grid service architecture for user control and management of e2e lightpaths
  - Uses OGSA and Jini/JavaSpaces for end to end customer control
- Owners of wavelengths determine topology and routing of their particular light paths
- All wavelengths terminate at mini-IXs where owner can
  - add/drop STS channel or wavelength
  - cross connect to another condominium owner's STS channels or wavelengths
  - Web serviced enabled "peermaker"
- Condominium owner can recursively sub partition their wavelengths and give ownership to other entities
- Wavelengths become objects complete with polymorphism, inheritance, classes, etc

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