

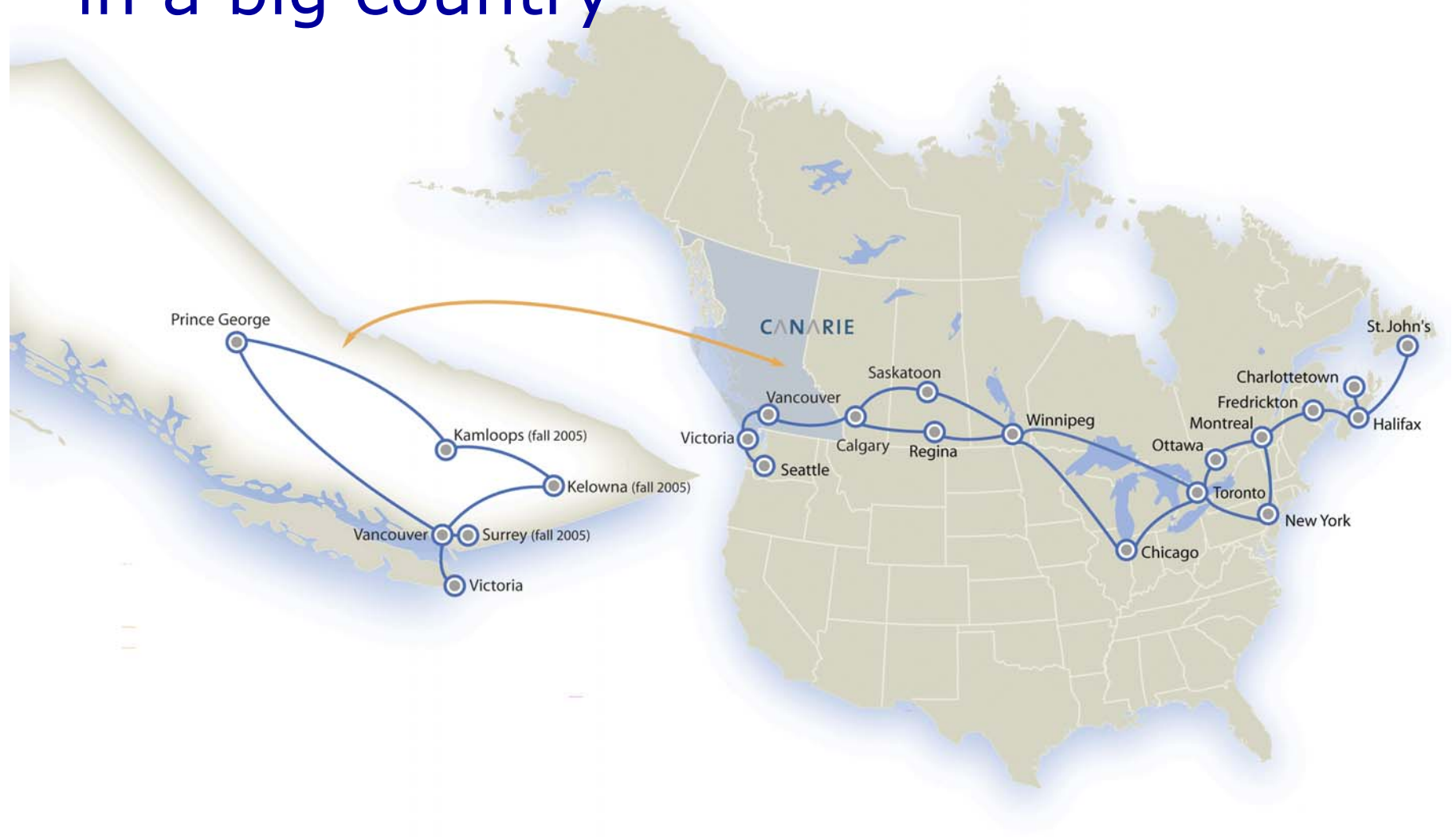


BC.NET

Developing
BC's Advanced Networks

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BCNET – small regional, big province, in a big country



Transit Exchanges – A Simple Scheme for Big Broadband

- What is a TX and why bother?
- How has BCNET constructed a network using TXs?
- What has worked, and what hasn't

Connecting communities: The Transit Exchange

- Transit exchanges allow communities to provide FACILITIES without providing SERVICES.
- A community network consists of providers + fibre facilities.
- Transit links (not a **bus** 😊) connect this network to the outside world.
 - An exchange allows the local community **easily** and **economically** to support many transit links.
- The transit exchange is the new central office
- Supplier networks interconnect exchanges.
 - These suppliers have variability in their connection fabrics.
- The equivalent to free local calling (*peering*) occurs within exchanges.
- Transit exchanges are the building blocks of new networks.
 - Paul Vixie: there should be an exchange in every community size 50k, maybe in the basement of a bank building.

Have networks really changed?

- Our networks are overlaid on monopoly telco facilities for the first mile
 - ... well, now it's a duopoly, and there is a bit of a market in inter-LATA services
- Functions have changed, but the basic structure remains the same
 - Even *broadband* is a telco term!
- Thesis: next gen networks need next gen structure

My needs for any new network

- Solid
- Innovative
- Scope and choice
- Fast
- Cheap
- Simple

What is the proper structure?

- Structure as (infra)structure
 - Arrangements of nodes and links
- Lots of thought about function
 - End2end, p2p, layers
 - Routing is a function assuming a generalized structure of nodes and links
- But what about structure?
 - Is there a structuralist argument for networks rather than black box?
 - Is there a philosophy of networks?
- Let function not triumph over structure
 - There is a delicate interplay

What is the infrastructure to support internet function?

- Function – endtoend, applications at the edges have primacy
 - Triumph of function over structure
 - IP over everything
 - Black box vs structure/function
- Structural problems exist, have existed since dawn of MAEs
- What should the structure of networks encompass?

Can we create a network marketplace?

- Airports and airlines
- Buses and depots
- Stock and commodity exchanges
- Malls
- What is the equivalent in networks?

My Network World

- Ubiquitous fibre cabling
- FROM: At least 2 independent paths from EVERY location
- TO: independent exchange/interconnect points
- Network exchange points as marketplaces

How do universities fit?

- Mission
 - Community – local connections
 - Research – unique connections, worldwide
 - Teaching – encourage worldwide learning across common networks
- Do this cheaply! Reliably! With quality!
- Needs
 - Transit
 - Private networks
 - Community connections
- Can this be done over a common structure?
 - Yes, using local fibre and community TXs

How did current university networks miss the point?

- National, maybe regional at best
- Private
- Poorly interconnected/integrated into community
- Emphasis on bringing the network to campus, rather than the campus to the network
- No first mile emphasis
 - Rather, long haul networks seem to get the \$\$\$\$

Build the first mile FIRST

- Everything else falls into place easily
- Break free of the duopoly
- Glass is freedom!

First mile fibre – then what?

- Has to connect *somewhere* and to *something*
 - An exchange point and a place to get service
 - A network marketplace
- Let's call these **transit exchanges**
 - Different from IXs/MAEs
 - End-user oriented rather than supplier
 - MAEs/IXs as a solution to the balkanization problem
- Alternative – fibre provider (muni??) as monopoly ISPs

What is a TX?

- It's SIMPLE – here are the parts
 - Patch panel (L1)
 - Allow all possible cross-connects
 - Switch (L2)
 - An optimization of the patch panel, use of virtual cross connects
 - Router (L3)
 - An optimization for packet networks, uses peering for virtual cross connects
- Can be done in one rack for a small town
- Connects end nodes to each other and to upstream suppliers
- Allows many-to-many connections

Location, location, location

- Optimal spot for both inter-TX service providers and local fibre infrastructure
- Adjacent to cheap colo facilities
 - Need for expandable real estate
 - Do we need zoning for these things?
- We've had bad experiences with putting them in city hall

How does a TX function?

- Users have fibre to the TX
- Suppliers have fibre to the TX
- TX operator enables cross connects from users to suppliers using L(i)
- Peering router used as a commons
 - All users connected in a mesh is not scalable, so reduces to $O(n)$
 - But could be used in other ways
 - Users (as opposed to suppliers) LIKE to peer with each other – this has VALUE

Uses of TXs

- Ability to multi-home
 - Maybe even test multi-path routing techniques
 - Robustness
 - Especially if fibre network is constructed with every node having 2+ independent paths to different TXs
 - Building reliable networks out of a set of unreliable providers
- Ability to construct specialized private networks
 - Use of packet or circuit switching to do so
 - Users can buy inter-TX links that optimize throughput over reliability (eg, R&E nets)
- ISPs with NO facilities! Pure brokers
 - Blended schemes, market makers, IHN
 - Co-ops or buying clubs can form
- Measurement
- Multi-TX VPNs

Benefits of TXs

- TXs in communities
 - Encourages competition, driving down prices
 - Builds technological centre
 - Can provide a hub to attract hi-tech business
 - Allows a platform for application service providers
- TXs as regional hubs
 - Keep local traffic as regional as possible
 - Allow remote community ISP (and maybe end users) larger choice of providers at TX, rather than only the ones who can get to the community.
- Provide incentive for muni fibre networks
 - Allows city to provide cabling only and staying out of the service business
- Drive cost of transit down
 - Transit costs decreased by 30%, capacity quadrupled

A word about net neutrality

- This is a market condition not a technical one
- Or, it is a regulatory condition, not a technical one
- Protocols/techniques can and will discriminate
- Net neutrality shows that structure has been ignored
 - Bandaid of regulation

Questions

- What is the right number of TXs in an area?
- Should TXs be aggregated? At what level?
 - Regional L2 TXs vs close-to-home TXs
 - mix and match?
- Who should operate a TX?
 - Could be privately owned and operated
 - InvisibleHand Networks
 - Could be independent non-profit (airport authority)
- Should there be competing sets of TXs?
- How can these ideas be tested?

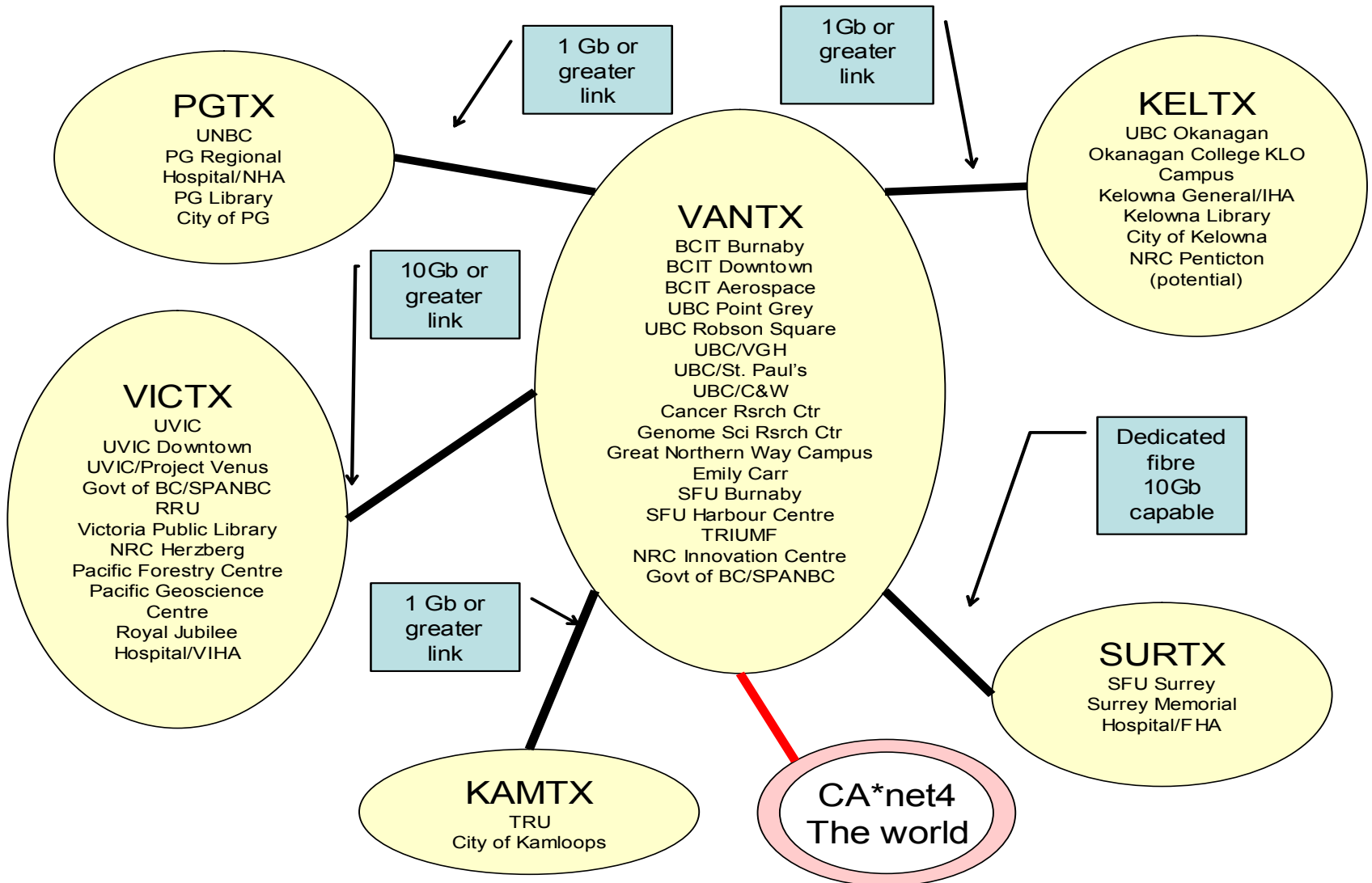
BCNET principles

- Building blocks
 - Use of community dark fibre in local metro networks
 - Create transit exchanges in local communities where BCNET member institutions (universities) exist
 - Connect exchanges with lightpaths
 - Purchase transit for institutions at each local TX
- Features
 - Allow ANYTHING – L1, L2, L3
 - Emphasis on easy local peering and multihoming
 - Exchanges are open to ALL
 - R&E networks are simply private networks using community fibre infrastructure and interexchange wavelengths.
 - Creates a marketplace per metro area, driving down costs, making interconnects easy

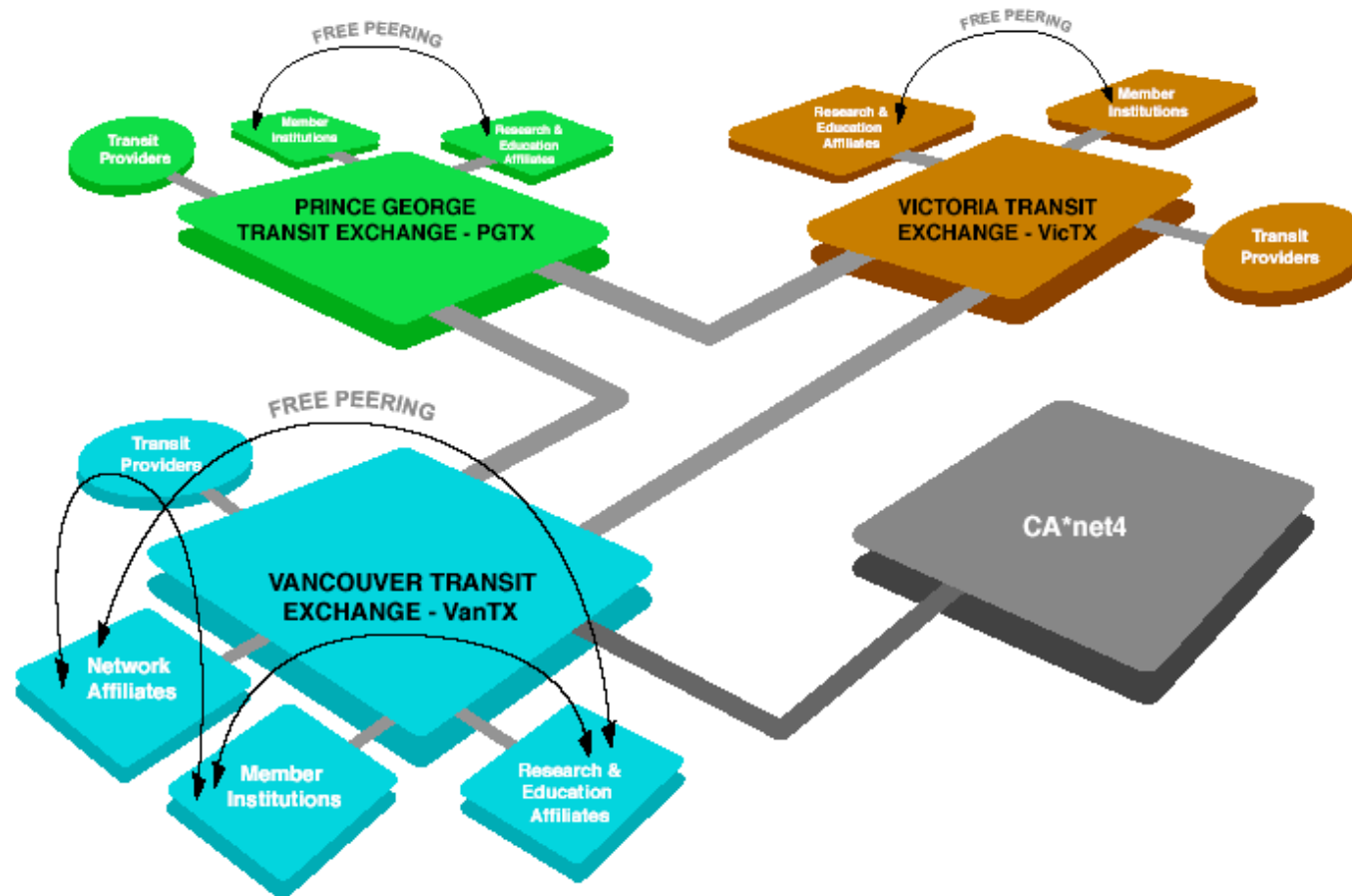
BCNET – how to build a network

- Acquire local fibre for end nodes
 - City fibre build issues
 - Trend towards city facilities
 - RAV line in Vancouver
 - Local fibre is expensive unless muni steps in
- Create a TX
 - Location, location, location
- Attract suppliers
 - Includes high speed R&E network facilities
- Integrate

BCNET Regional Network and TXs



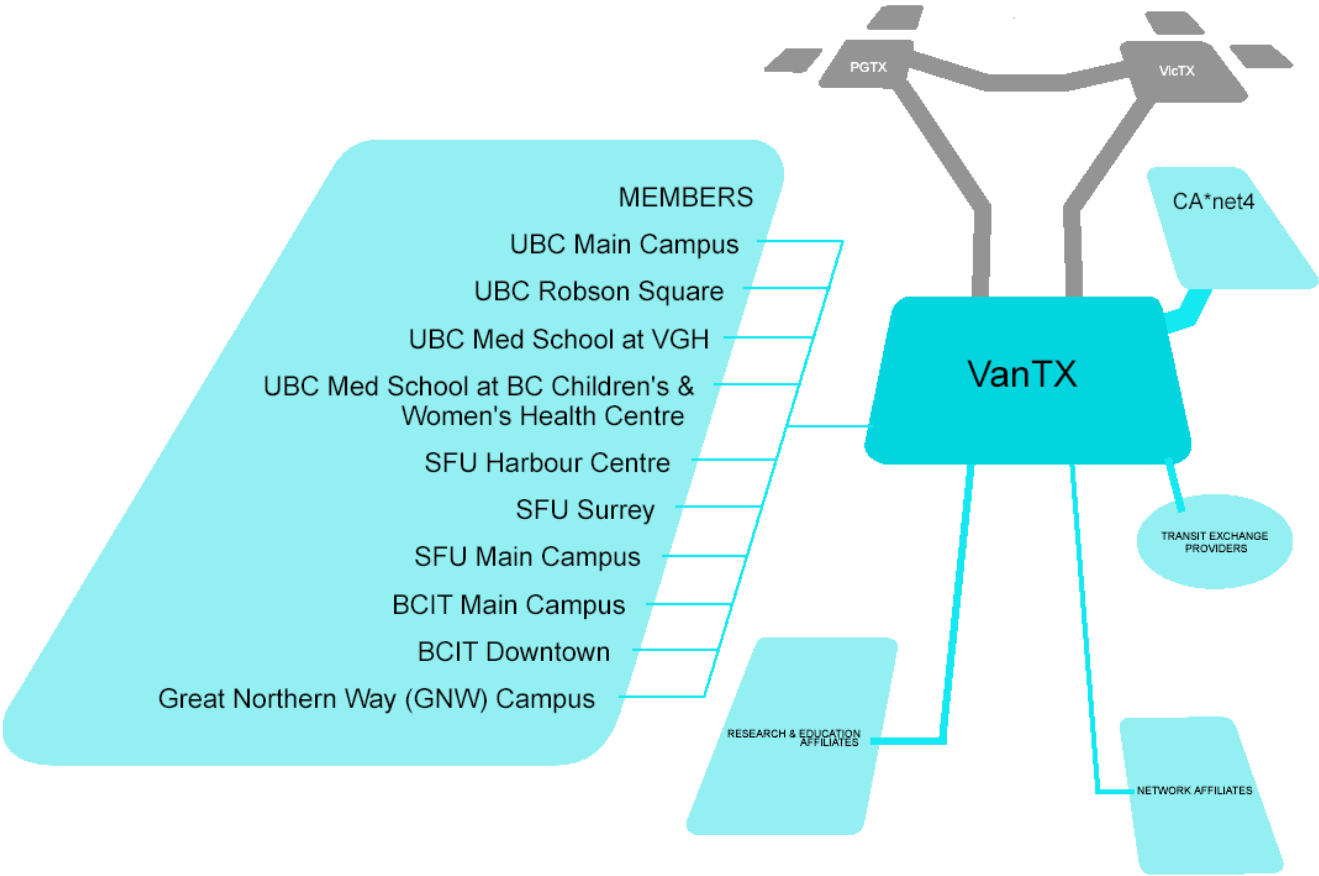
BCNET TXs



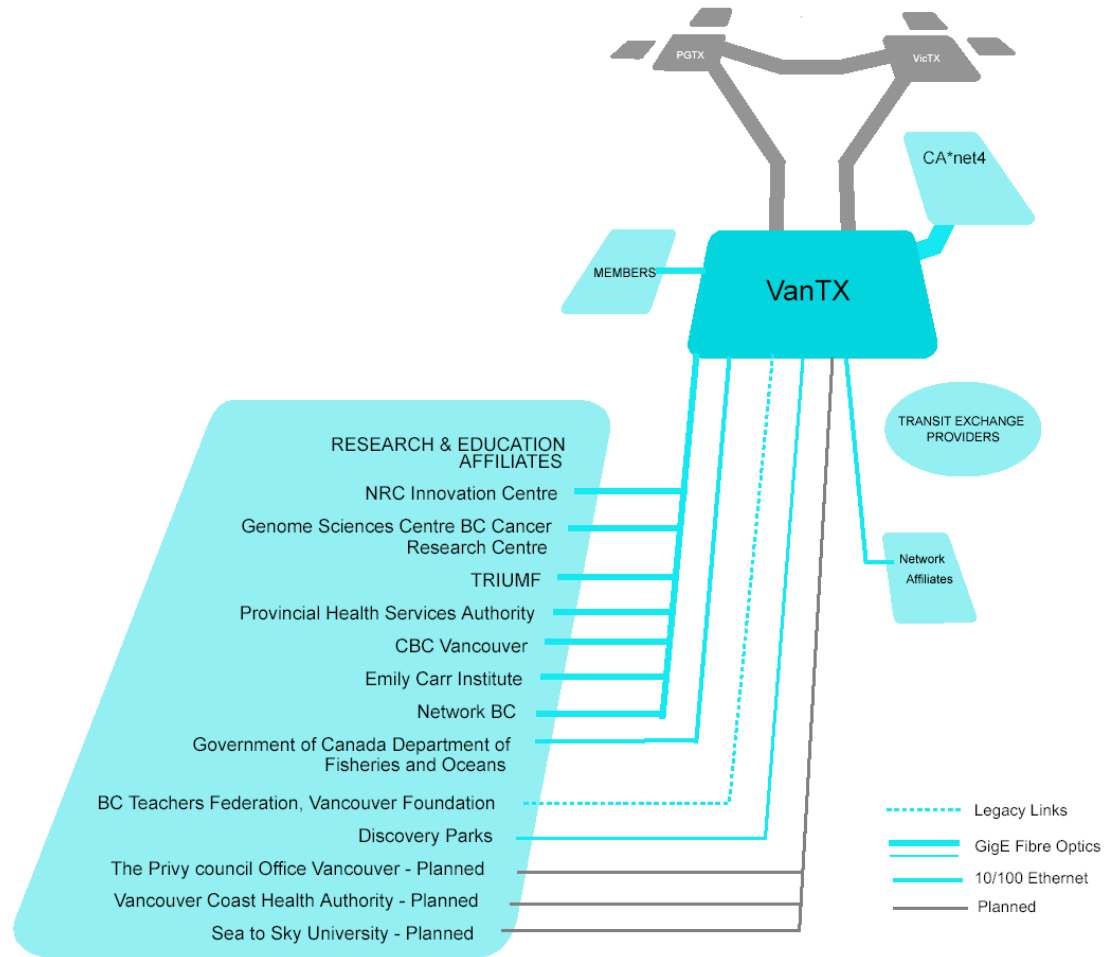
BC TXs – where we are

- PGTX – floundering; no marketing; poor demand
- KELTX – growth, location, location, location
- KAMTX – city fibre, growth
- VICTX – city fibre coming, growth
- VANTX – lots of fibre supply, growth

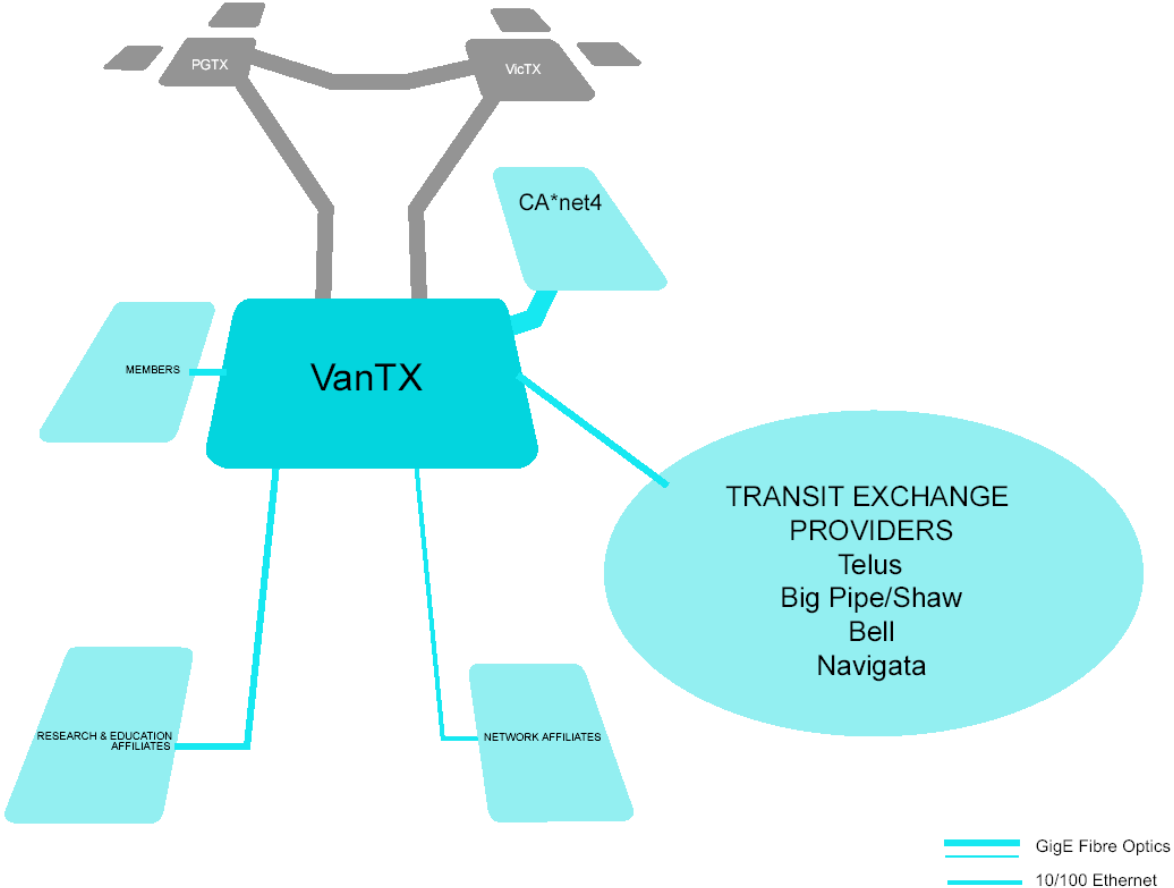
VANTX – Universities/Institutes



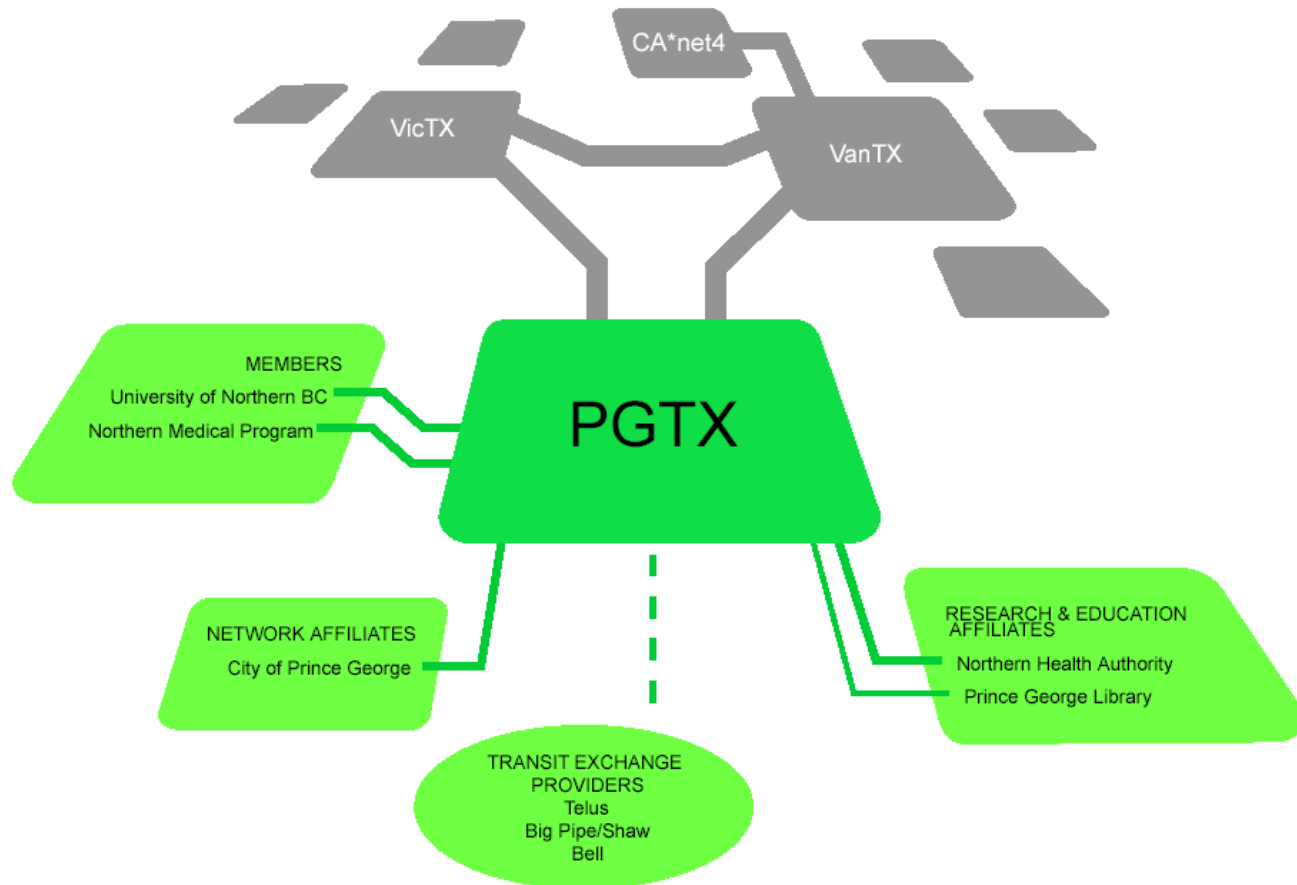
VANTX – R&E Affiliates



VANTX – Providers



PGTX



Lessons Learned

- Municipal fibre is important
- Pricing sensitivity
- TX location is important
- Use of local focus groups and a marketing campaign is necessary
- Anchor user tenants (government, university) needed
- Anchor supplier tenants willing to think outside the box needed
- Colo partner can be helpful, but watch out
- Long, slow process