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Our Platform:
- ▸ scalable,
- ▸ multi-tenant,
- ▸ carrier-grade,
- ▸ high call quality,
- ▸ distributed load,
- ▸ geo-optimized,
- ▸ fault-tolerant,
- ▸ *enterprise* VoIP
- ▸ for **Canadians.**

VAN1
Upgraded:
- ▸ **2016**

Location:
- ▸ **1050 W. Pender**

Transit:
- ▸ **Telus, Bell…**

Local IX / Peering:
- ▸ **VANIX** April '17
- ▸ **AS395152**

TOR1
Upgraded:
- ▸ **2016**

Location:
- ▸ **151 Front St. W.**

Transit:
- ▸ **Telus, Bell…**

Local IX / Peering:
- ▸ **TorIX** May '17
- ▸ **AS393755**

MTL1
Upgraded:
- ▸ **2017**

Location:
- ▸ **D2-3445 du Parc**

Transit:
- ▸ **Bell** Peering…

Local IX / Peering:
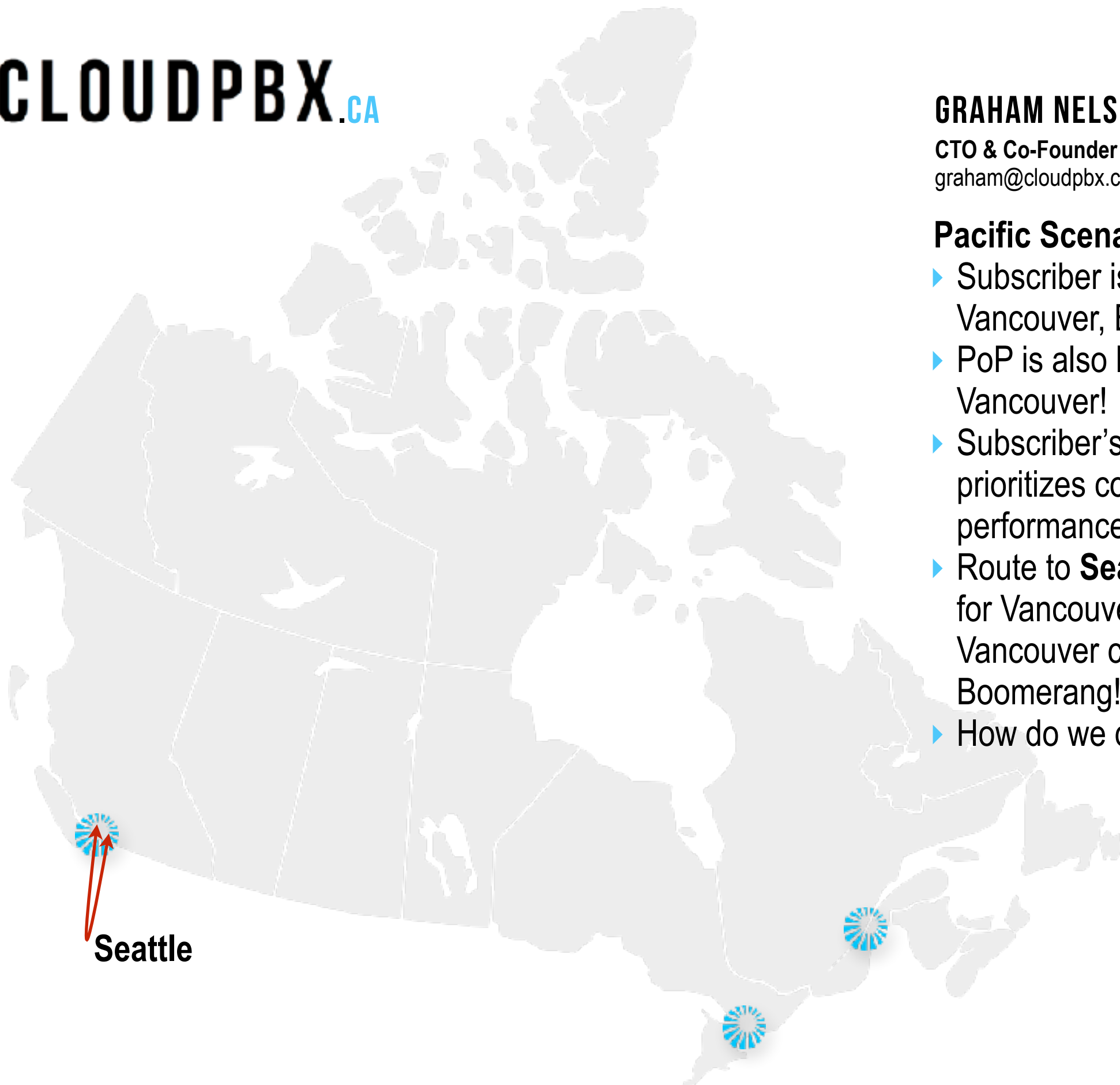- ▸ **QIX** July '17
- ▸ **AS395152**

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Pacific Scenario
▸ Subscriber is located in Vancouver, BC.
▸ PoP is also located in Vancouver!
▸ Subscriber's ISP prioritizes cost over performance.
▸ Route to **Seattle** is used for Vancouver-to-Vancouver calls… Boomerang!
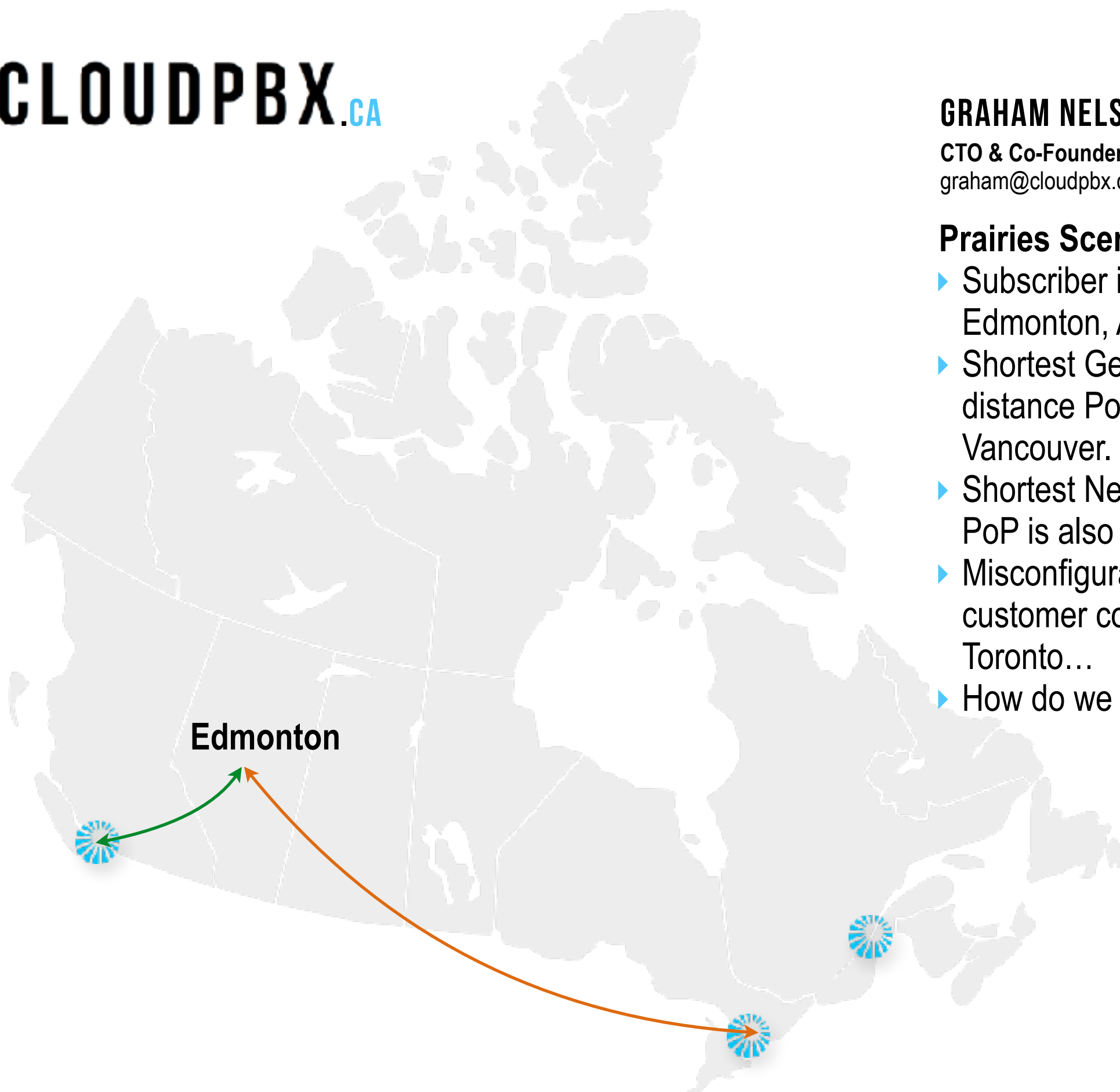▸ How do we detect?

Seattle

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Prairies Scenario
- ▸ Subscriber is located in Edmonton, AB.
- ▸ Shortest Geographical distance PoP is Vancouver.
- ▸ Shortest Network latency PoP is also Vancouver.
- ▸ Misconfiguration has customer connected to Toronto…
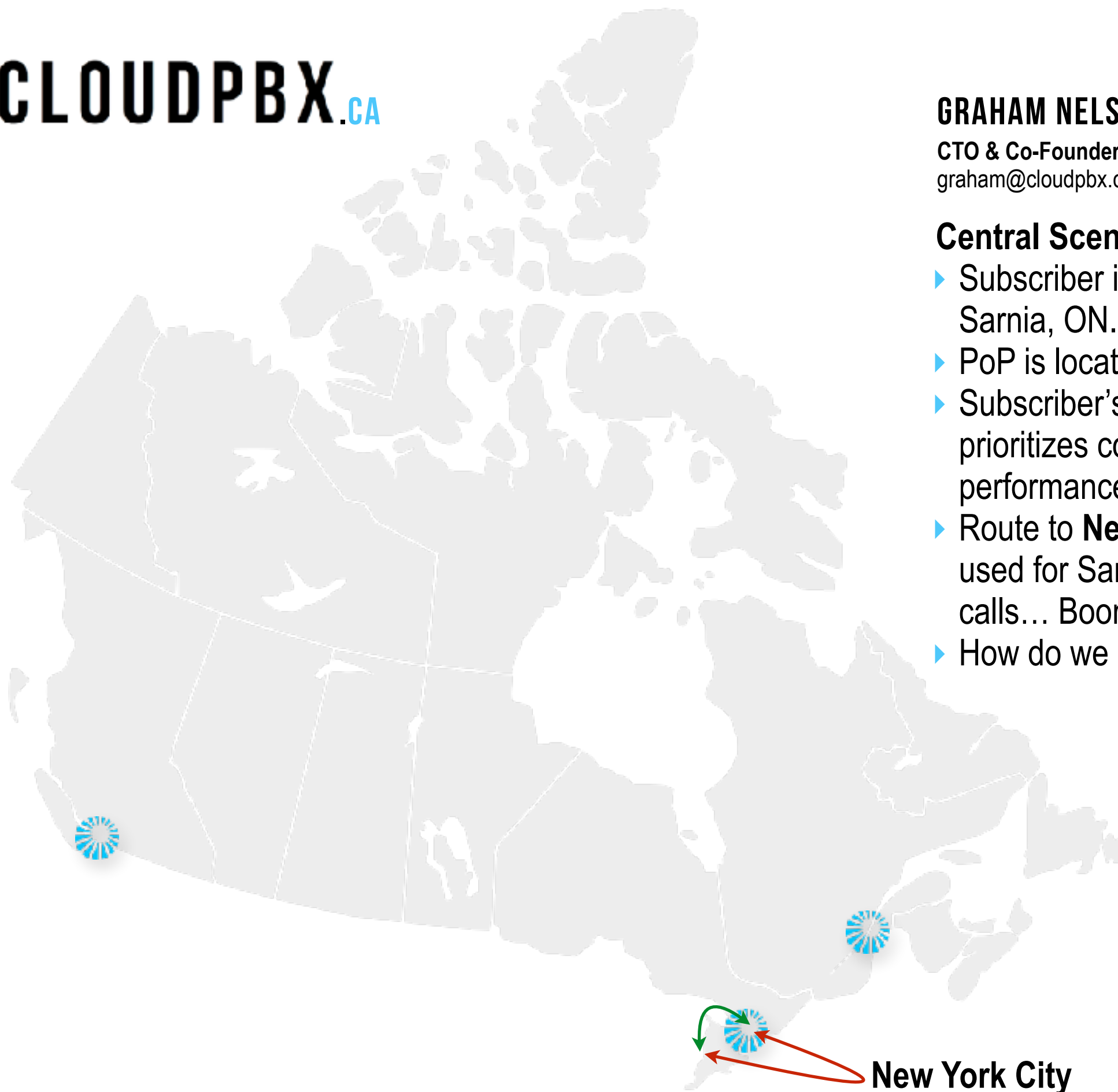- ▸ How do we detect?

Edmonton

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Central Scenario
- Subscriber is located in Sarnia, ON.
- PoP is located in Toronto!
- Subscriber's ISP prioritizes cost over performance.
- Route to **New York City** is used for Sarnia-to-Toronto calls… Boomerang!
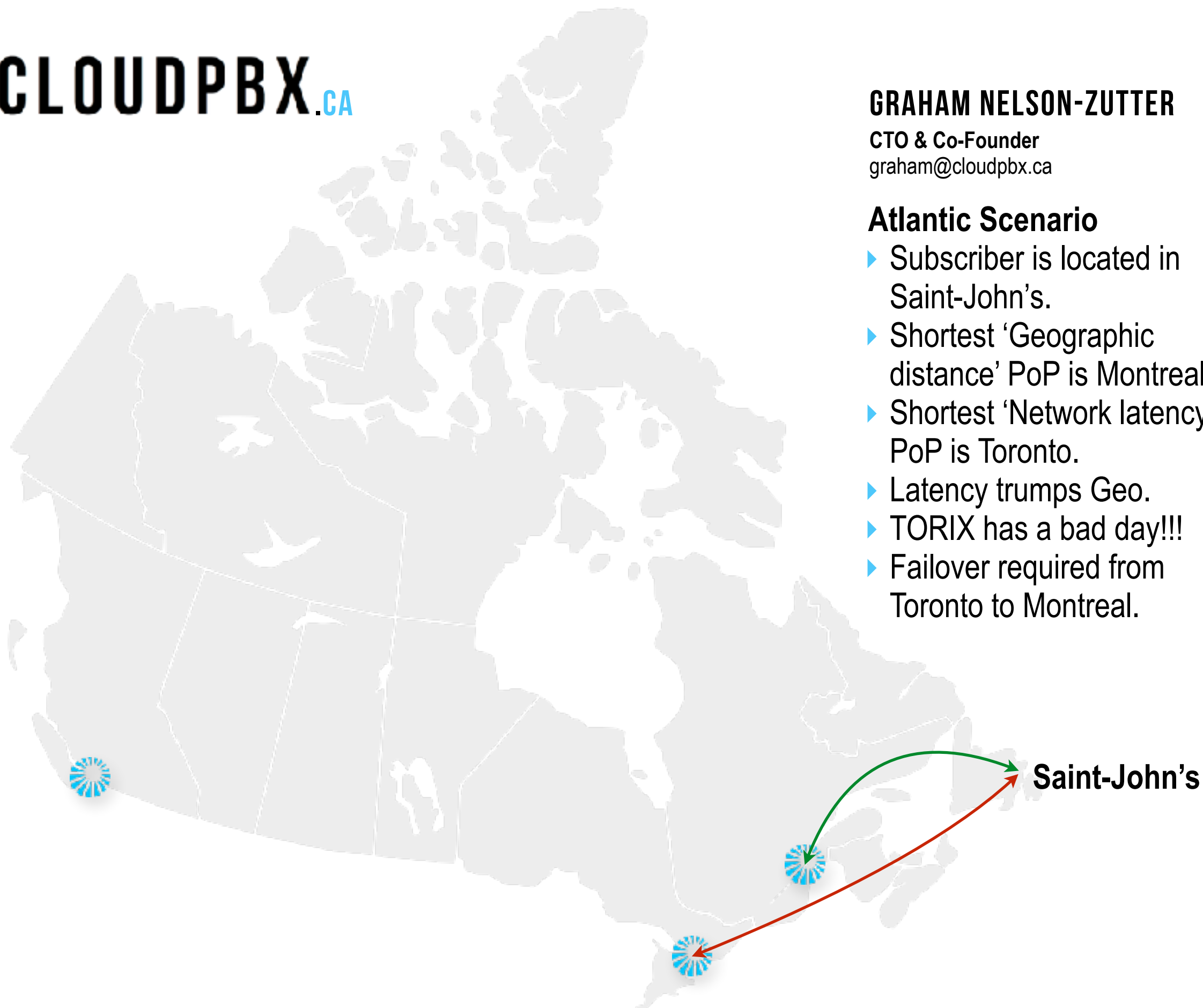- How do we detect?

New York City

COMMON ISSUES

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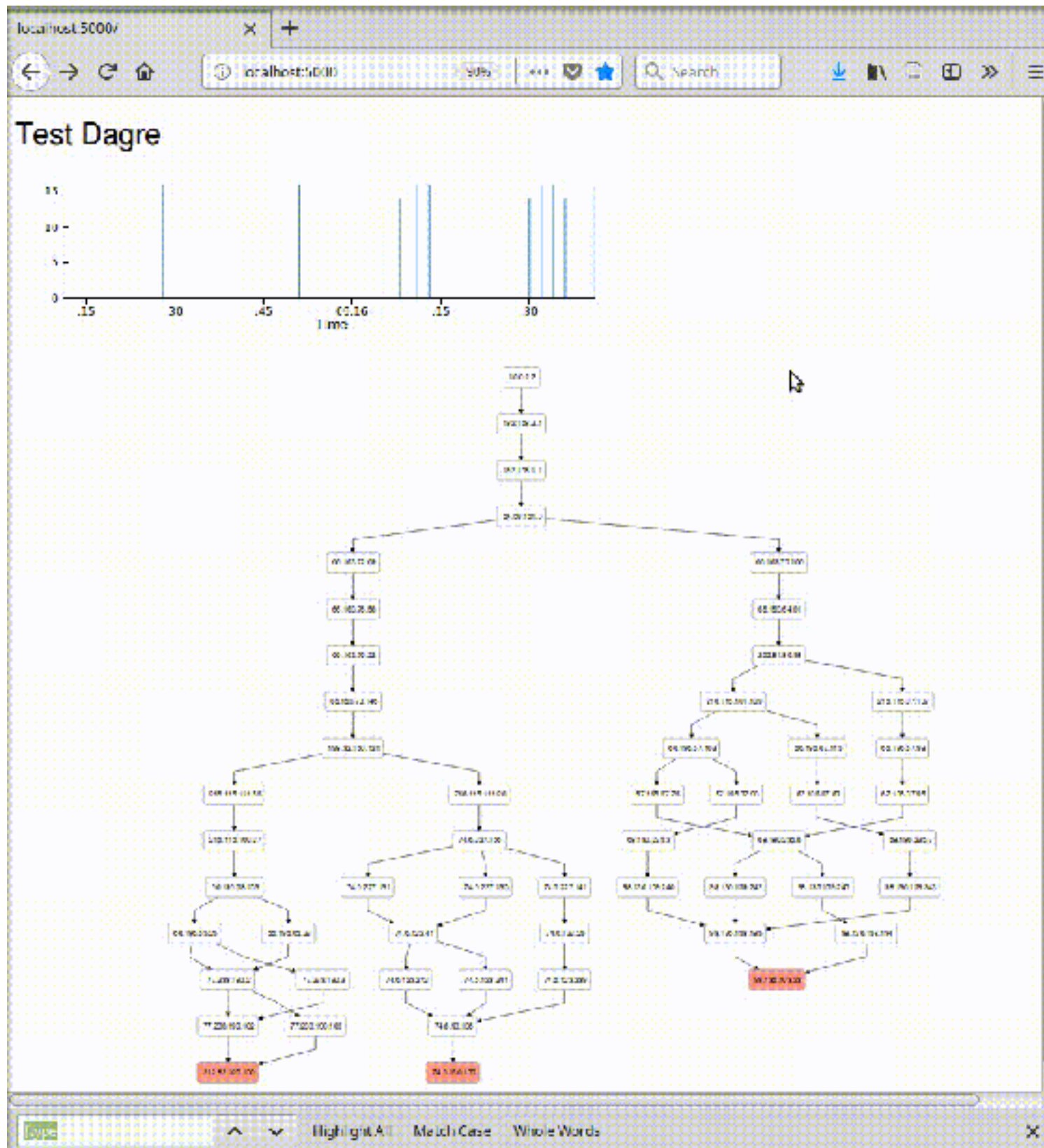| Problem	How?	Location	Remedies	Ideas?
Upsteam Saturation	Subscriber's upstream (Tx) internet link is used beyond the available bandwidth.	**Subscriber Last-Mile**	Traffic Shaping (QoS) rules Dedicated or segregated VoIP-LAN/VLAN and connection.	Is there a pattern to when this happens? Can QoS rules adjust dynamically?
Downsteam Saturation	Subscriber's downstream (Rx) internet link is used beyond the available bandwidth.	**Subscriber Last-Mile**	Traffic Shaping (QoS) rules Dedicated or segregated VoIP-LAN/VLAN and connection.	Is there a pattern to when this happens? Can QoS rules adjust dynamically?
ISP Internal Saturation	ISP is over-subscribed is a specific region. Their internal equipment can't handle load.	ISP Core	Detect ISP who may have this problem consistently. Request for repair or use higher quality ISP.	
ISP Handoff Saturation	ISP port to other ISPs is saturated. Unequal port speeds on regional IXs can overload.	Peering & Regional IX	Attempt to isolation geography and reroute traffic is possible to region not affected	Is there a pattern to when this happens? Can rerouting change dynamically?
Transit Saturation	Transit providers with global links may have too much traffic to match demand.	IP Transit	Attempt to isolation geography and reroute traffic is possible to region not affected	
Route Change	Planned and unplanned changes in routing can happen internal and external of ISPs.	ISP Core, Peering	Attempt to isolation how the route geography or network was changed and reroute.	
Circuit Noise or Failure	Copper and wireless last-mile connectivity is subject to external noise can impact UDP packets.	Subscriber Last-Mile	Failover to backup ISP link. Forward calls to PSTN mobile numbers for each subscriber.	Is there a pattern to when this happens? Are there environmental factors?

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INVESTIGATIONS

Layer	Challenge	Tools	Theory	Questions
Call Quality	**What is the relationship between latency, distance and call quality? How best to identify quality?**	**PCAP & RTCP MOS**	**Using predictive jitter buffer algorithms is a good enough representation of quality to predict MOS and true opinion.**	**Is there a relationship between network router and latency changes that could be predictive?**
Jitter	**Latency changes negatively impact call quality. Imagine shaking a tight-wire line.**	**PING, PCAP, Simulation**	**Network jitter which occurs outside of calls can be used to predict call quality.**	**Is ICMP similar enough to UDP RTP packets to accurately predict this?**
Latency	How do we detect the lowest possible latency route to achieve best response times?	ICMP Ping, Traceroute	If we can collect user latency data, we will be able to choose the best network routes.	Is network latency correlated to quality? Which route has the highest MOS?
Distance	How can we compare geographical and network distance to predict latency?	GeoLite	Geographical distance is a useful general measurement to predict the best network route.	Is there a predictive relationship between distance / latency / quality?
Network Sovereignty	Can we detect when routes outside Canada are used? How might we investigate this?	GeoLite, Probes	Collecting the network route data using traceroute can accurately show route location and country.	When 2 or more possible routes have similar latency, how can we detect country?
Carrier Leg	Each off-net call is connected to the PSTN via a carrier. Is this carrier using the best route?	A/B Leg Sessions	Combining the A-leg and B-leg of calls connected with the PSTN will provide helpful relative MOS.	When there are 2 legs bridged, how can we detect which leg was problematic?
PSTN	From which region and to which region are calls passing? Is the best handoff location used?	NPANXXXXXX Geo Prefixes	Comparing source and destination regions, we can see the relative IP location distance.	Could selecting different network routes decrease latency hidden in the PSTN?