Results of the 2016 PCH/CIRA Study on Canadian Network Interconnection

November 8, 2016
Canadian ISP Summit

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Methodology

This is a five-year follow-on to the study we performed in 2011.

In addition to surveys, direct observation of, and participation in Canada's IXPs, we analyzed a total of 2,207,228 traceroutes in compiling our statistics. Of those, we performed 296,836 in the months of September and October 2016, while the remaining 1,910,392 were performed by other users of the RIPE Atlas and M-Lab measurement platforms between 2013 and the present.

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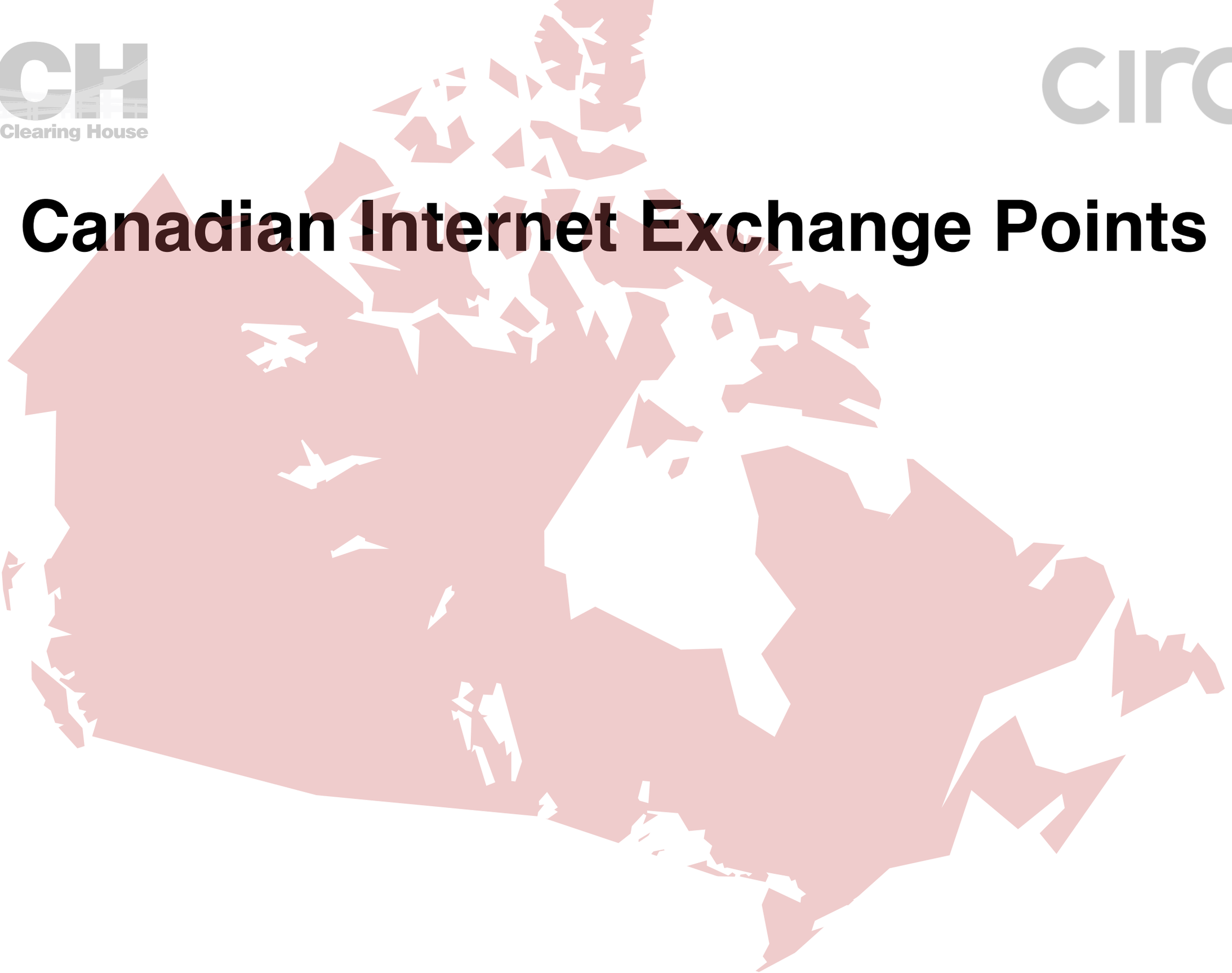
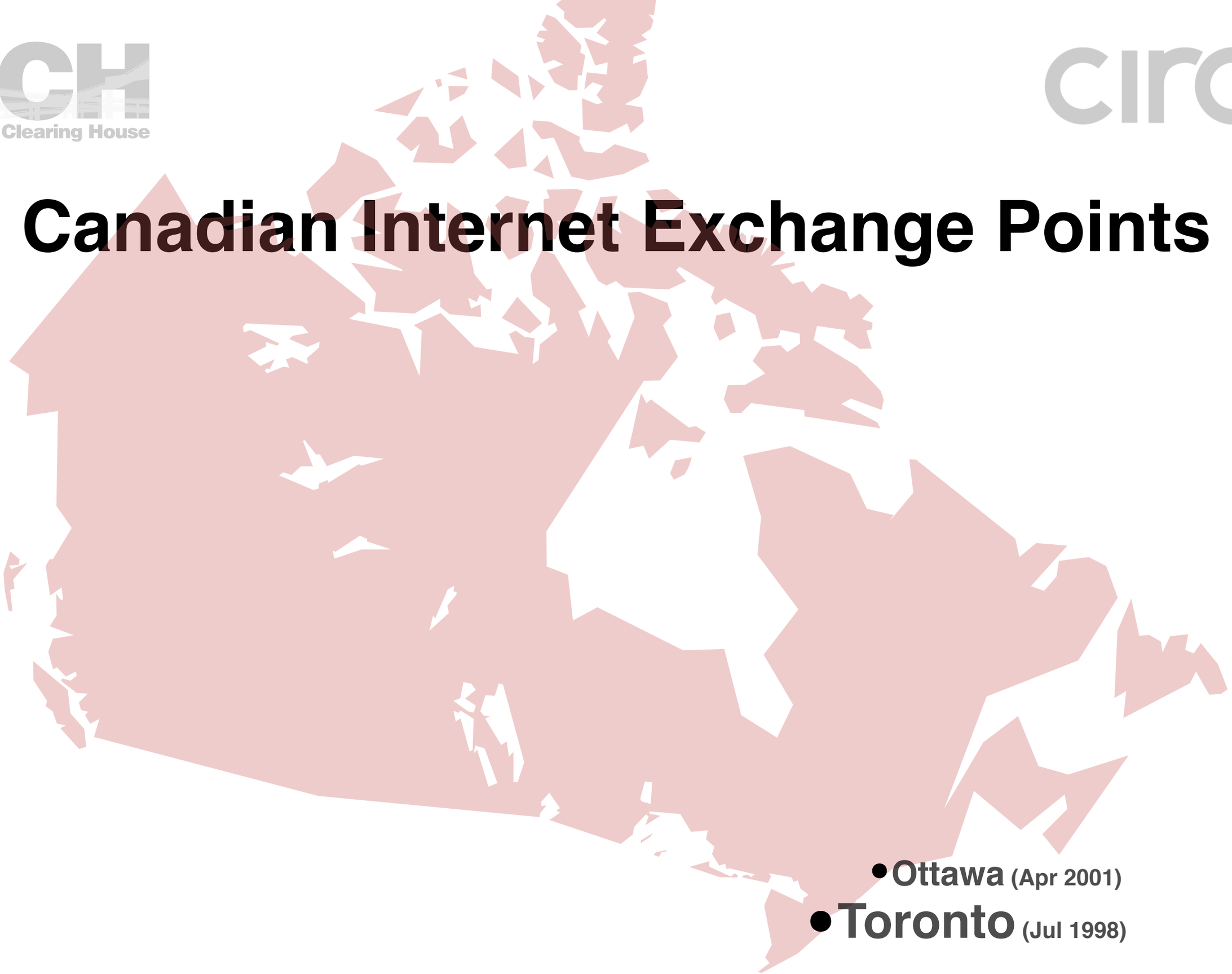
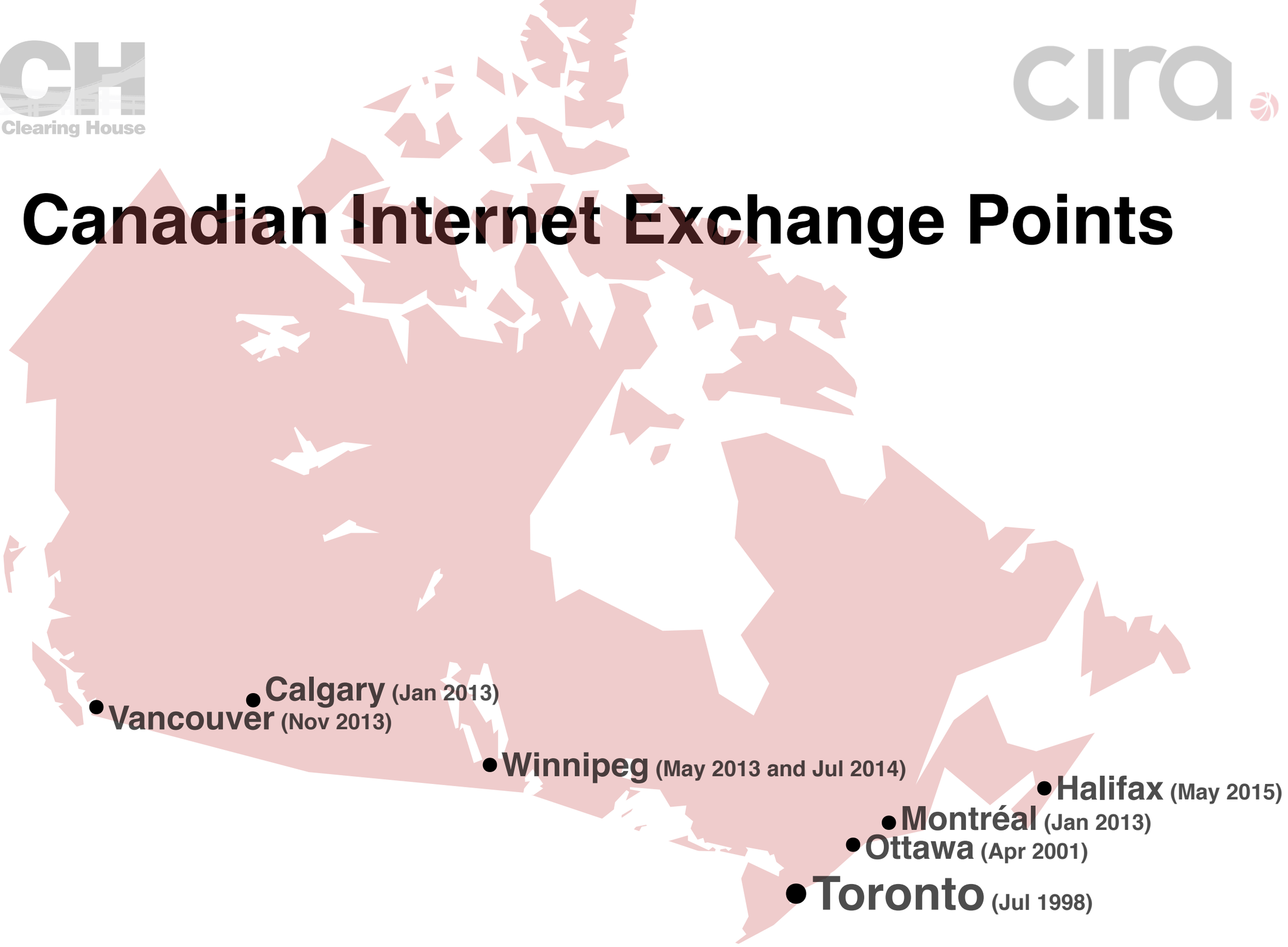
Canadian Internet Exchange Points



Canadian Internet Exchange Points



Canadian Internet Exchange Points



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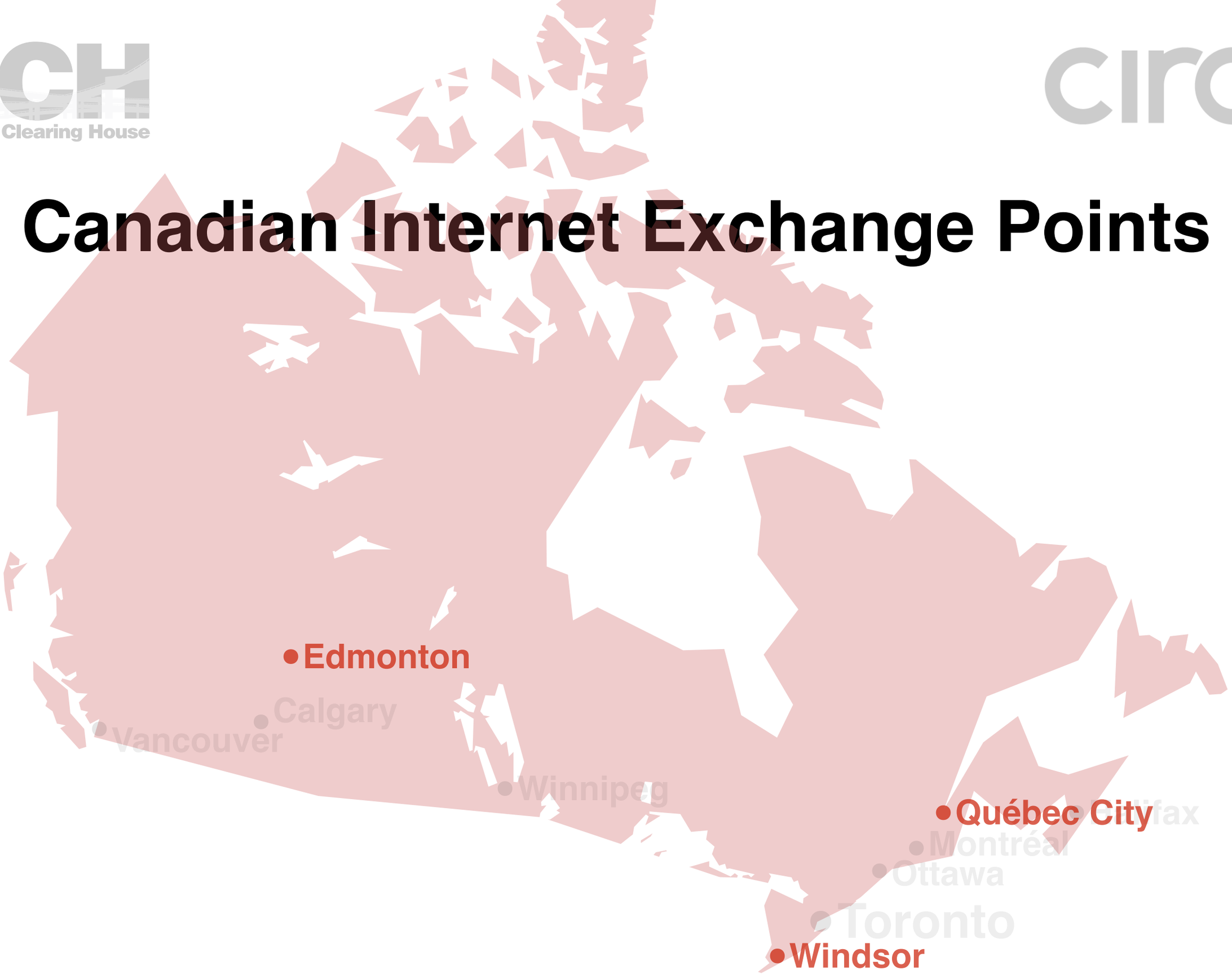
Canadian Internet Exchange Points



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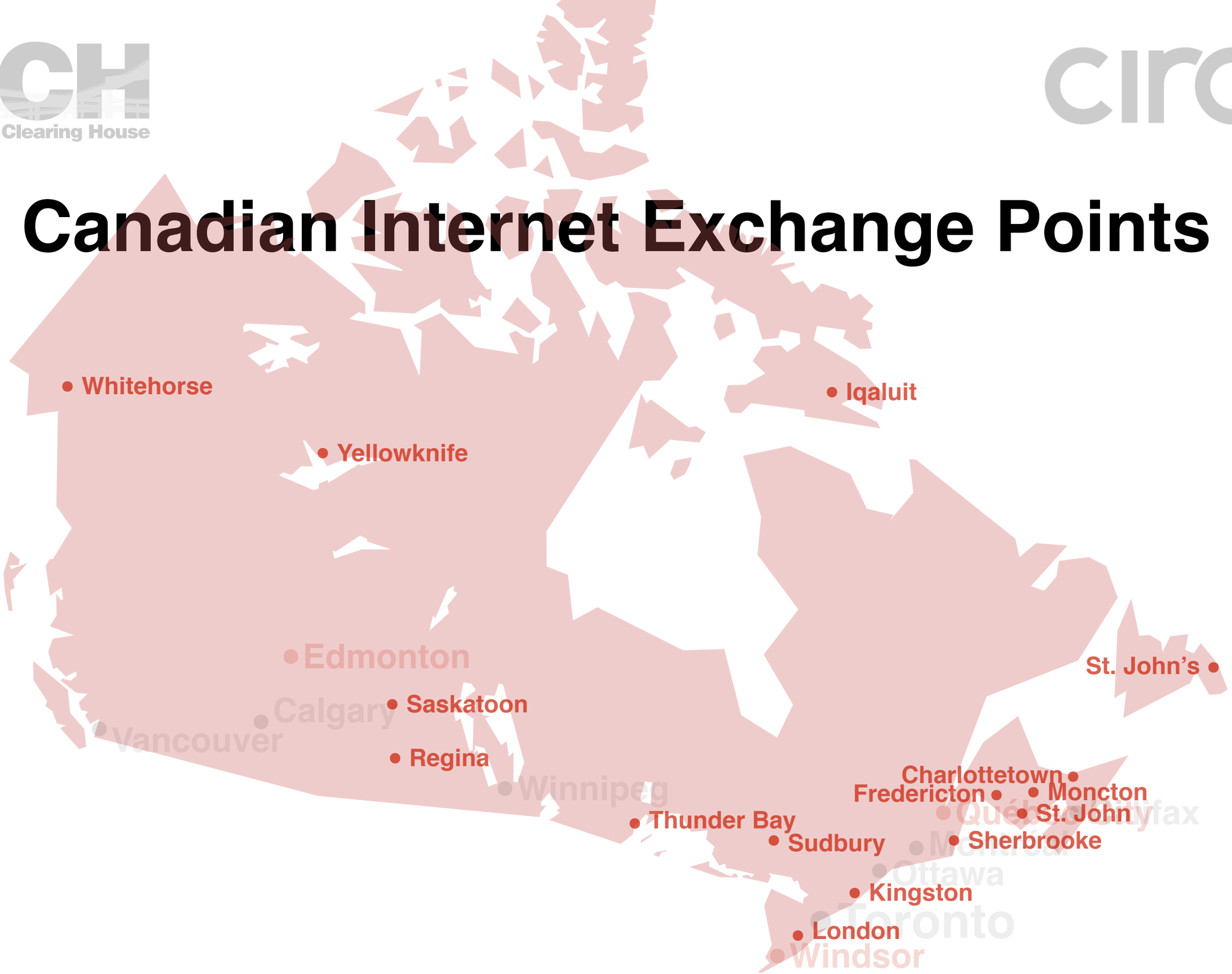
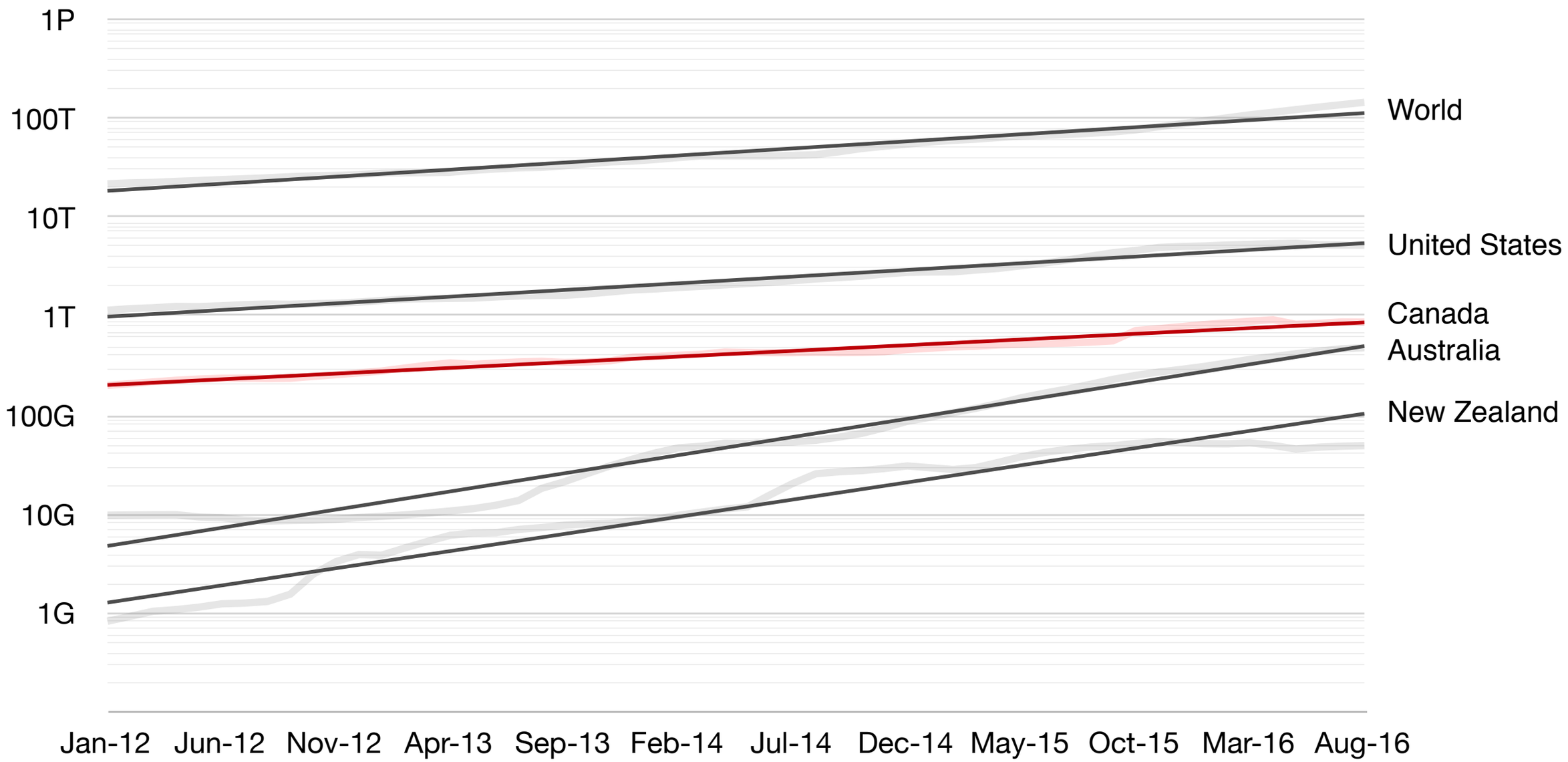
Canadian Internet Exchange Points



Bandwidth Production Growth Rates



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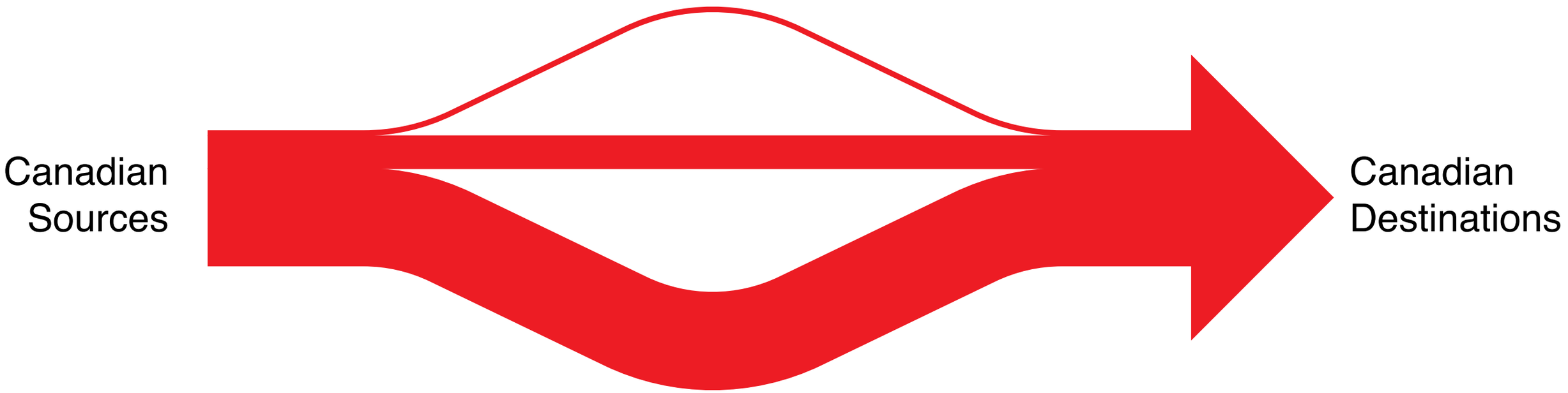
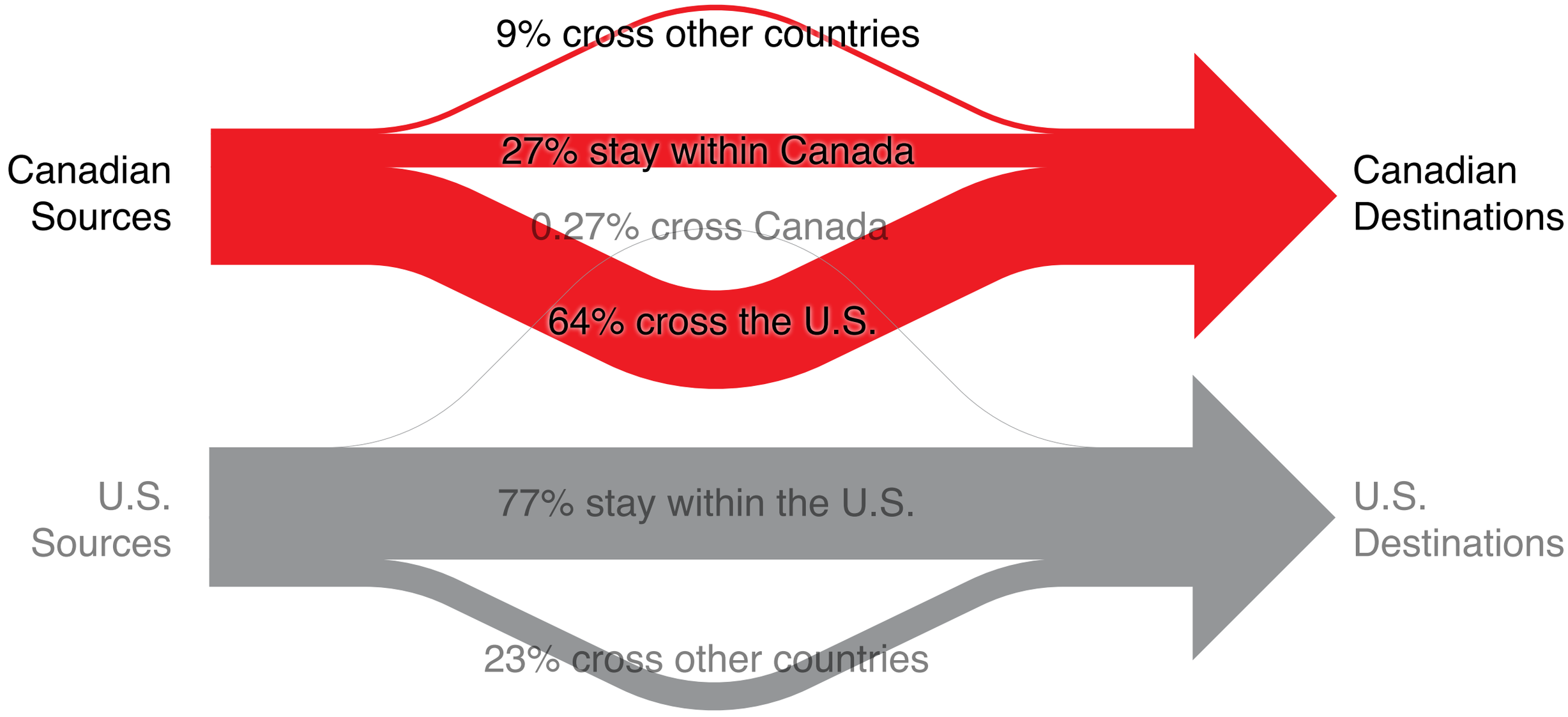



9% cross other countries
Canadian Sources
27% stay within Canada
Canadian Destinations
64% cross the U.S.


9% cross other countries
Canadian Sources
27% stay within Canada
0.27% cross Canada
64% cross the U.S.
Canadian Destinations
U.S. Sources
77% stay within the U.S.
23% cross other countries
U.S. Destinations

Intra-Canadian Traffic

1,275,742 traceroutes with sources and destinations inside Canada:
- 26.95% stayed within Canada
- 63.8% crossed the border into the United States
- 9.25% crossed other countries

On a hop-by-hop basis, packets spent:
- 72% of their time in Canada
- 27% of their time in the United States
- 1% in twenty other countries, mostly in Western Europe

10.8% traversed three other countries before reentering Canada
3.4% traversed four or more other countries

Comparison to Intra-US Traffic

703,170 traceroutes with sources and destinations inside the US:

- 77.11% stayed within the US
- 0.27% crossed the border into Canada
- 22.62% crossed other countries

On a hop-by-hop basis, packets spent:

- 98.16% of their time in the United States
- 0.0022% of their time in Canada
- 1.84% in 43 other countries in Western Europe and East Asia

3.1% traversed three other countries before reentering the US

0.4% traversed four or more other countries

Canadian Governmental Web Sites

961 Canadian governmental web sites
- 28.82% of them had instances hosted in Canada
- 66.91% were hosted only in the United States
- 4.27% were in the Netherlands, UK, and France

45,291 traceroutes from Canadian sources to those web sites
- Among the subset of Canadian governmental web sites which were actually hosted within Canada:
  - 52.86% of the traceroutes crossed the United States
  - 35.03% stayed entirely within Canada
  - 12.11% crossed other countries

6.5% traversed three other countries
1.6% traversed four or more other countries

Canadian Governmental Web Sites

Of the 643 which were hosted in the United States 54 (8.4%) had IPv6 addresses as well as IPv4.

1 of the 25 hosted in the Netherlands had an IPv6 address.

None of the 277 Canadian-hosted ones advertised a AAAA IPv6 address at the time of this study.

DNS Root-Server Use

981 traceroutes between Canadian sources and the eight root-servers with Canadian anycast instances:

- 100% of these packets should have stayed within Canada
- 53.35% ultimately reached servers in Canada
- 42.88% reached servers in the United States
- 3.77% were served from Western Europe

Of the subset that ultimately reached servers located within Canada

- 61.45% crossed the border with the United States
- 36.95% stayed within Canada
- 1.6% crossed other countries

3.5% traversed three other countries before reentering Canada

1% traversed four or more other countries

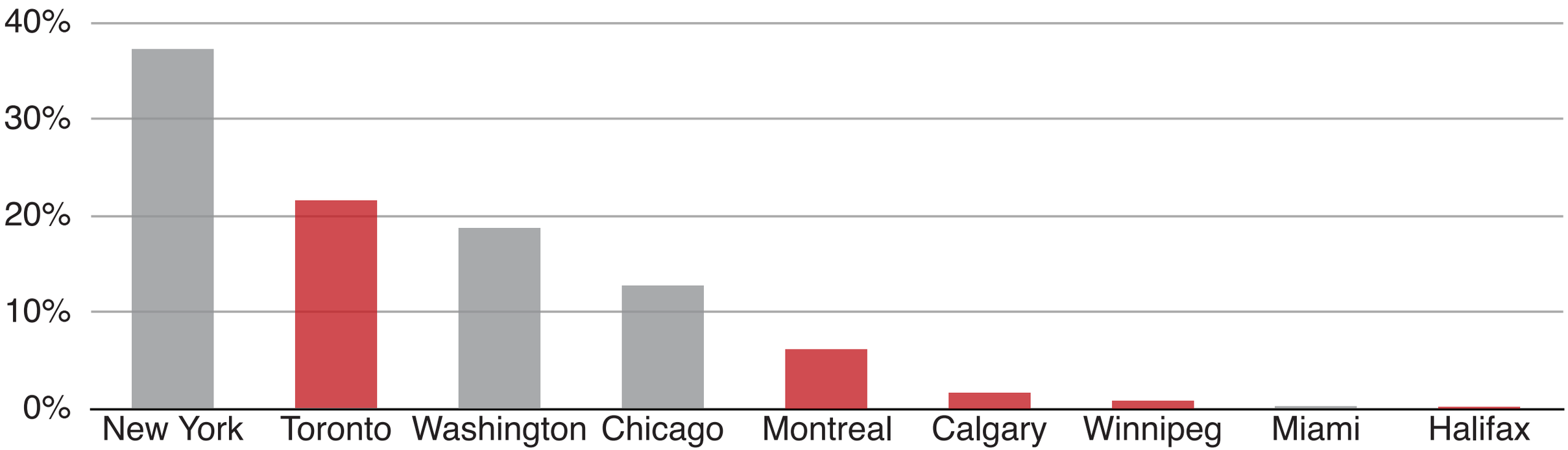
Queries to .CA DNS Servers

915 traceroutes between Canadian sources and the .CA DNS servers
- 100% of these packets should have stayed within Canada
- 52.5% ultimately reached servers in the United States
- 44.92% reached servers in Canada
- 1.67% reached a server in South Africa
- 0.6% reached a server in England

Of the subset that ultimately reached servers located within Canada
- 63.43% crossed the border with the United States
- 32.63% stayed within Canada
- 3.94% crossed other countries

4.6% traversed three countries before reaching their destination
1.7% traversed four or more countries.

Canadian queries to .CA Servers



This distribution shows where the subset of .CA queries that originate from users in Canada are served.

Alexa Canadian Top 250

47,906 traceroutes between Canadian sources and the 250 web sites most popular in Canada

- 69.12% of those sites were hosted in the United States
- 20.21% were hosted in Canada
- 2.31% were hosted in the Netherlands
- 1.3% were hosted in each of the U.K. and Russia
- 5.76% were hosted in other countries

Of the subset that ultimately reached servers located within Canada

- 45.54% stayed within Canada
- 41.84% crossed the border with the United States
- 12.62% crossed other countries

	Stay	Go	Ratio
WorldLinx	14,770	2	7385
Neutral Data Centers	19,547	5	3909
Voyageur	15,911	10	1591
SSI Micro	16,059	13	1235
Merlin	12,372	30	412
Server North	13,966	623	22.4
EGate	24,674	1,345	18.3
Accelerated Connections	14,398	1,076	13.4
Storm	17,008	1,505	11.3
Bell Canada	111,524	10,141	11.0
Cogeco	12,058	1,138	10.6
Bell Aliant	39,291	4,204	9.35
BCNET	12,383	1,834	6.75
Eastlink	52,080	7,752	6.7
Telus	85,088	12,733	6.68
Shaw	73,833	12,976	5.69
Pathway	12,777	3,447	3.71
Distributel	11,613	3,247	3.58
Rogers Cable	434,659	131,983	3.29
MTS Allstream	19,154	5,894	3.25
Les.net	11,514	3,694	3.12
Electronic Box	10,784	4,134	2.61
Cogeco	94,979	37,254	2.55
TekSavvy	50,364	23,318	2.16
iWeb	33,261	16,024	2.08
Hurricane Electric	1,191,045	1,137,657	1.05
Videotron	22,664	36,486	0.621
Start Communications	5,553	9,153	0.607
Cogent	624	48,232	0.01294
Tata/Teleglobe	38	67,759	0.00056

Reasons Traffic Leaves Canada

Performance: When Canadian network operators upgrade international links in preference to domestic ones, international routes consequentially perform better and are more desirable to both users and operators.

Habit: When traffic arrives on a foreign network, their routing topology may resemble a hub-and-spoke, and route Canadian traffic to a hub outside Canada before sending it onward to its destination.

Anti-Competition: By wasting the expense of international transport, a network operator can force its competitors to waste a similar or greater amount of money, and if its competitors exist on the thinner margins that result from more competitive pricing, they may be driven out of business.

Performance

Disturbingly, there's a superficially-sound performance rationale for passing traffic across the United States border.

In our measurements, traceroutes that stayed within Canada required an average of 9 hops and 116ms to reach their destinations.

Ones that traversed the United States took 11 hops but only 84ms to reach their destinations within Canada.

Traffic that crosses the border and comes back again arrives, on average, 28% sooner than traffic that goes direct.

But these are observations of the current state of the network, not unavoidable conditions.

The remedy is to build domestic routes with cheaper, faster, less-congested circuits than international ones. Right now they're just shorter but more expensive.

Habit

There’s a clear correlation between the country of incorporation of a network and where that network prefers to route traffic.

Canadian networks are at a natural advantage in keeping Canadian domestic traffic inside Canadian borders, because any hub-and-spoke routing topology they use will favor Canadian routing hubs, and they’re economically advantaged by using bandwidth produced in Canadian IXPs.

These observations are, however, mostly relevant to small networks, which also buy transit from other Canadian networks inside Canada. Once a network is big enough to not be primarily dependent on transit, the third reason becomes the dominant one...

Anti-Competition

In countries with lax regulation, market-dominant incumbents often abuse their power by refusing to interconnect with other networks inside their home country. This forces their competitors to make a choice between unwillingly and unnecessarily becoming their customer, or unnecessarily transporting domestic traffic outside the country to deliver it to the incumbent at a foreign IXP.

The incumbent is trying to achieve three possible goals:

1) Force a competitor to become a transit customer in order to receive domestic routes

2) Force a competitor that operates on thinner margins to expensively and unnecessarily transport domestic traffic across the border, thereby losing money

3) Force a competitor to become a customer for transport services across the border in order to accomplish (2)

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	Toronto	Montreal	Vancouver	Calgary	Ottawa	Halifax	Winnipeg	Edmonton	New York	Chicago	Seattle	Ashburn	New York	London	Palo Alto	Paris	Milan	Buffalo	Dallas	Amsterdam	Frankfurt	Hong Kong	Atlanta	San Jose	Singapore	
MTS Allstream	●	●	●						●	●	●	●	●		●											3/9
Nexicom	●								●	●	●	●		●	●				●				●			1/9
BlackBerry/RIM										●				●		●			●	●	●	●			●	0/8
Primus	●		●		●				●	●	●		●													3/7
Shaw	●		●						●	●	●	●												●		2/7
CANARIE	●		●	●		●			●		●															4/6
Continent 8	●								●				●	●		●	●									1/6
TekSavvy	●	●							●	●			●													2/5
Rogers	●								●	●	●	●														1/5
Bell Canada									●	●	●	●			●											0/5
Zerofail	●	●							●				●													2/4
TeraGo	●		●								●							●								2/4
Fibrenoire	●	●							●			●														2/4
Beanfield	●	●							●				●													2/4
Videotron	●								●	●		●														1/4
Zip Telecom	●	●	●																							3/3
Server North	●				●												●									2/3
SaskTel	●		●								●															2/3
Manitoba NetSet	●						●			●																2/3
Eastlink	●	●							●																	2/3
Axia Connect	●			●							●															2/3
Frontier Networks	●								●		●															1/3
Fiber Networx	●									●								●								1/3
Xplornet	●									●	●															1/3
Telus										●	●		●													0/3
Bell Aliant									●	●		●														0/3
	22	7	6	2	1	1	1	0	16	14	13	8	7	3	3	2	2	2	2	1	1	1	1	1	1	

Government: Lead by Example

Repatriate web sites.

Multi-home on Canadian networks that peer within Canada.

Don’t do business with, and regulate if necessary, abusive market-dominant networks that force Canadian traffic over the border at everyone else’s expense.

Make information and services available on IPv6.

ISPs: Solve Your Own Problems

Build more IXPs, and more connectivity to them. Peer everywhere you can, with everyone you can.

Seek the lowest APBDC by upgrading your short domestic circuits, rather than your long international ones.

Don’t let yourself be forced into buying transit from networks that refuse to peer with you... choose any other transit provider instead.

Thanks, and Questions?

Copies of this presentation are available in PDF format.

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