Network Topology

Computer Networks

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Websites & Network Diversity

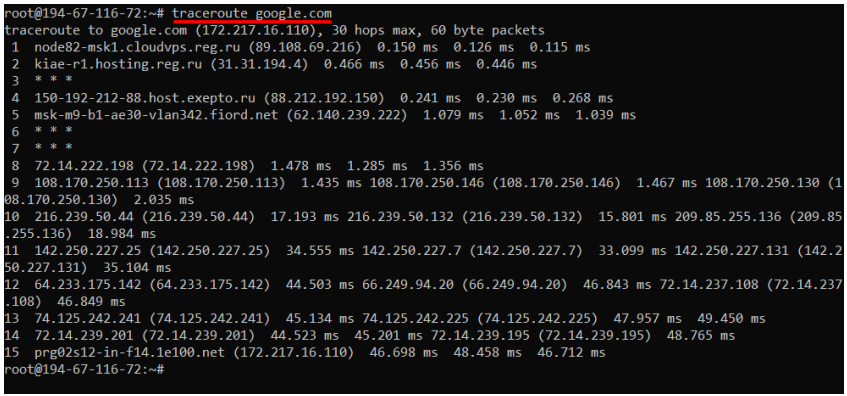
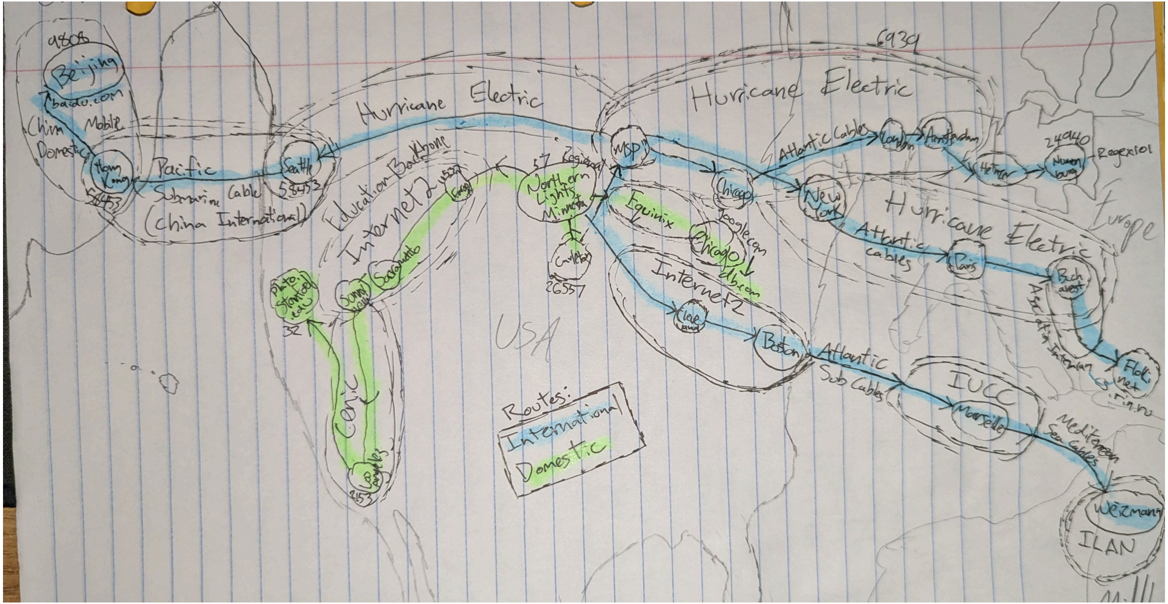


Figure 1: Traceroutes were from

- Small Websites: cs.rin.ru, regex101.com
- Universities: Weizmann Institute , Stanford
- Large Corporations: Deutsche Bank, baidu.com

Network Map



9808
Beijing
baidu.com
China Mobile
Domestic
Hong Kong
58453
Pacific
Submarine Cable
(China International)
Seattle
Hurricane Electric
Education Backbone
Internet2
Sacramento
CENIC
Los Angeles
Northern Lights Minnesota
Regional
26557
MSP
6939
Hurricane Electric
Equinix
Chicago
google.com
Chicago
Atlantic Cables
London
Amsterdam
24940
Regex101
New York
Hurricane Electric
Atlantic cables
Paris
Europe
Internet2
Boston
Atlantic
Sub Cables
IUCC
Marseille
Mediterranean Sea Cables
ILAN
USA
Routes:
International
Domestic

Submarine Cables

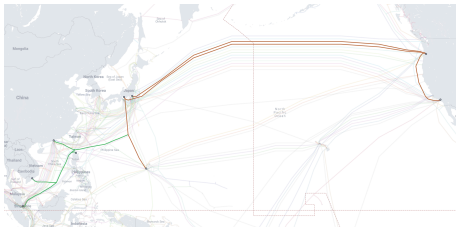


Figure 3: Pacific cables to Hong Kong

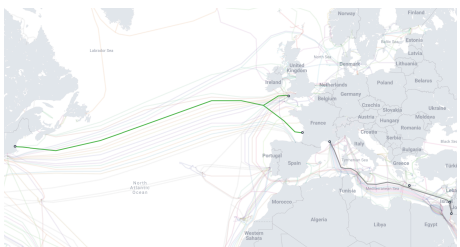


Figure 4: Atlantic Cables to Israel

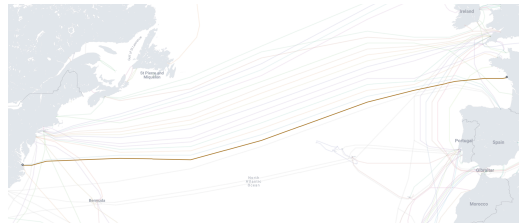


Figure 5: Atlantic Cables to cs.rin.ru

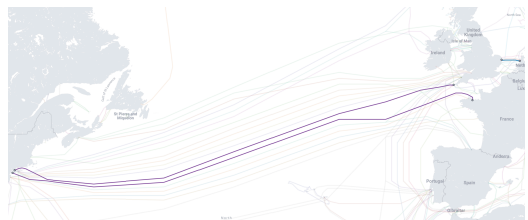


Figure 6: Atlantic Cables to Amsterdam

Map Analysis

Carleton connects directly to at least 2 networks:

- **Northern Lights GigaPoP**: mainly for US academic/research traffic
- **Hurricane Electric**: big commercial ISP, often for global/commercial sites
- First hop is always Carleton's gateway, second is Carleton's public IP.
- Third hop changes based on destination: either NLG/gigapop.net or he.net.
- Pattern: US/edu sites stick with NLG as long as possible (fast, direct); international/commercial sites (like China or Russia) shift over to HE.net early to get better global peering.

US & Western Europe:

- Much better connected (e.g. Stanford 60ms, regex101.com/Germany 113ms, Google/cloud even lower)
- Fewer hops, low consistent latency
- Academic and carrier networks are well-peered, with direct/fast routes

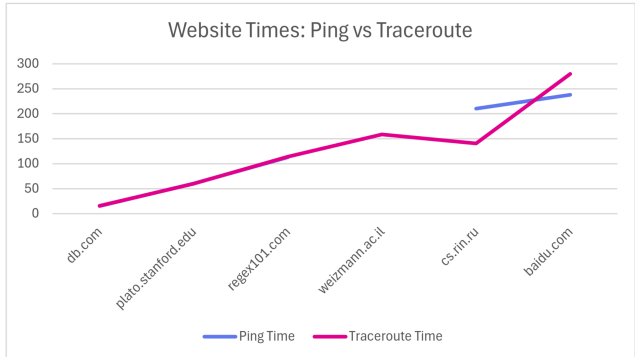
China & Russia:

- Higher ping, more hops, lots of (baidu.com 238ms, cs.rin.ru 210ms)
- More filters/firewalls, less peering, more missing data

Patterns: After leaving the US core, latency and inconsistency jump, showing weaker links to some regions.)

Times & Analysis

- For the first three sites on the graph ping and traceroute are identical
- ▸ **cs.rin.ru**: ping avg 210ms, traceroute 140ms
  baidu.com: ping avg 238ms, traceroute 279.8ms
- Differences might be because ping and traceroute don't always hit the exact same IPs (sometimes ping a different server or interface), or maybe traceroute gets blocked/throttled on last hops. Also, heavy filtering/firewalls can skew traceroute times.
- RTTs mostly confirm the topology graph, but if the final traceroute hop's RTT is much less than the ping RTT, it probably means the traceroute gets filtered at the end



- A barrier, when collecting this data, was finding a website hosted in the middle east that didn't firewall the traceroute once it arrived in the country.