Network Topology

Computer Networks

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Websites & Network Diversity

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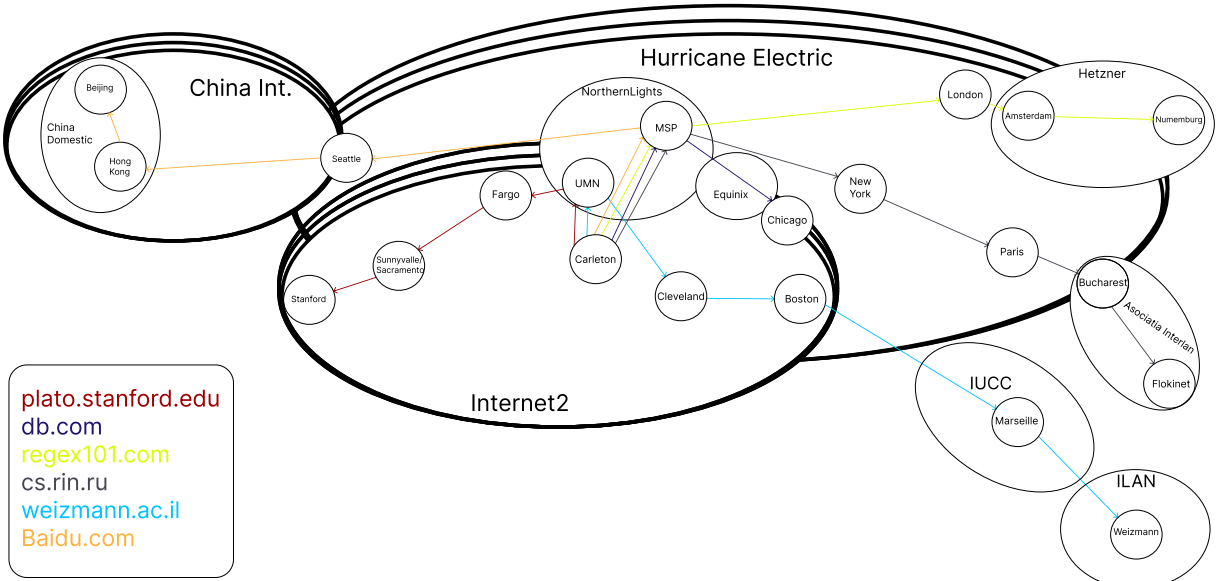
traceroute to regex101.com (78.47.220.195), 30 hops max, 60 byte packets
 1  _gateway (10.133.0.254)  3.695 ms  3.664 ms  3.647 ms
 2  137.22.198.4 (137.22.198.4)  8.509 ms  10.827 ms  10.816 ms
 3  e0-21.switch3.msp1.he.net (184.105.39.113)  8.748 ms * *
 4  * port-channel22.core3.chi1.he.net (184.104.199.201)  17.846 ms *
 5  * * *
 6  * * port-channel11.core3.lon2.he.net (72.52.92.165)  125.445 ms
 7  100ge0-76.core1.lon3.he.net (184.104.198.245)  98.019 ms  98.738 ms  98.696 ms
 8  port-channel16.core1.ams2.he.net (184.105.65.17)  102.645 ms  103.687 ms  102.619 ms
 9  hetzner.interxionfra11.nl-ix.net (193.239.117.110)  109.045 ms  110.391 ms  110.211 ms
10  core11.nbg1.hetzner.com (213.239.224.233)  113.879 ms  113.753 ms  113.309 ms
11  * * *
12  * * *
13  27878.your-cloud.host (128.140.21.123)  113.139 ms  113.927 ms  112.905 ms
14  static.195.220.47.78.clients.your-server.de (78.47.220.195)  113.974 ms  112.978 ms  113.033 ms
```

Figure 1: Above is the traceroute to regex101.com, the TRs included:

- Small Websites: cs.rin.ru (Russia), regex101.com (Germany)
- Universities: Weizmann Institute (Israel) , Stanford (US)
- Large Corporations: Deutsche Bank (International), baidu.com (China)

Network Map


China Int.
Beijing
China Domestic
Hong Kong
Seattle
Hurricane Electric
NorthernLights
MSP
UMN
Fargo
Sunnyvale/ Sacramento
Stanford
Carleton
Cleveland
Equinix
Chicago
Boston
New York
London
Hetzner
Amsterdam
Numemburg
Paris
Bucharest
Asociatia Interlan
Flokinet
IUCC
Marseille
ILAN
Weizmann
Internet2
plato.stanford.edu
db.com
regex101.com
cs.rin.ru
weizmann.ac.il
Baidu.com

Submarine Cables

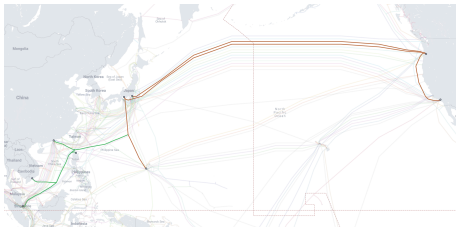


Figure 3: Pacific cables to Hong Kong

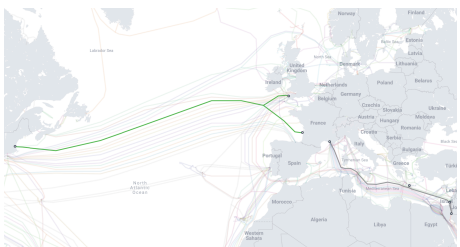


Figure 4: Atlantic Cables to Israel

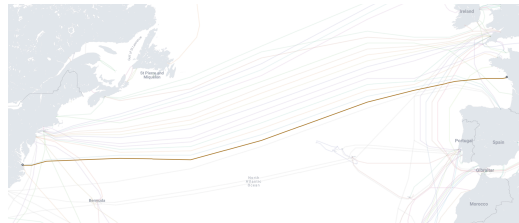


Figure 5: Atlantic Cables to cs.rin.ru

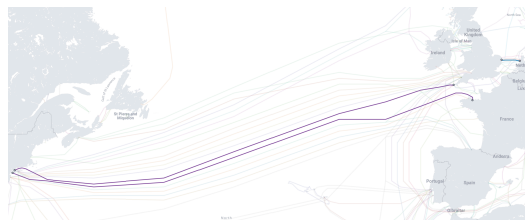


Figure 6: Atlantic Cables to Amsterdam

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 Northern Lights or Hurricane Electric.
- Domestic sites stick with Northern Lights as long as possible (fast, direct), while international sites shift over to Hurricane Electric to get better global peering.

US & Western Europe:

- Much better connected (e.g. Stanford 60ms, regex101.com/Germany 113ms)
- Fewer hops, low consistent latency
- Academic and carrier networks are well-peered, with direct and 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
- Baidu's path had a large amount of hops inside of China most likely due to traffic engineering

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 or firewalls can inflate 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

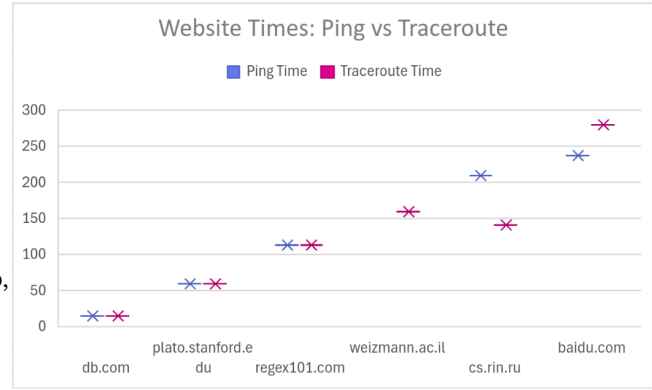


Figure 7: Weizmann didn't respond to the Ping

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