Mapping The Digital Silk Road

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ENOG 8

Baku, Azerbaijan

Before the Internet...

Sanskrit, Persian inscriptions in Baku's Fire Temple

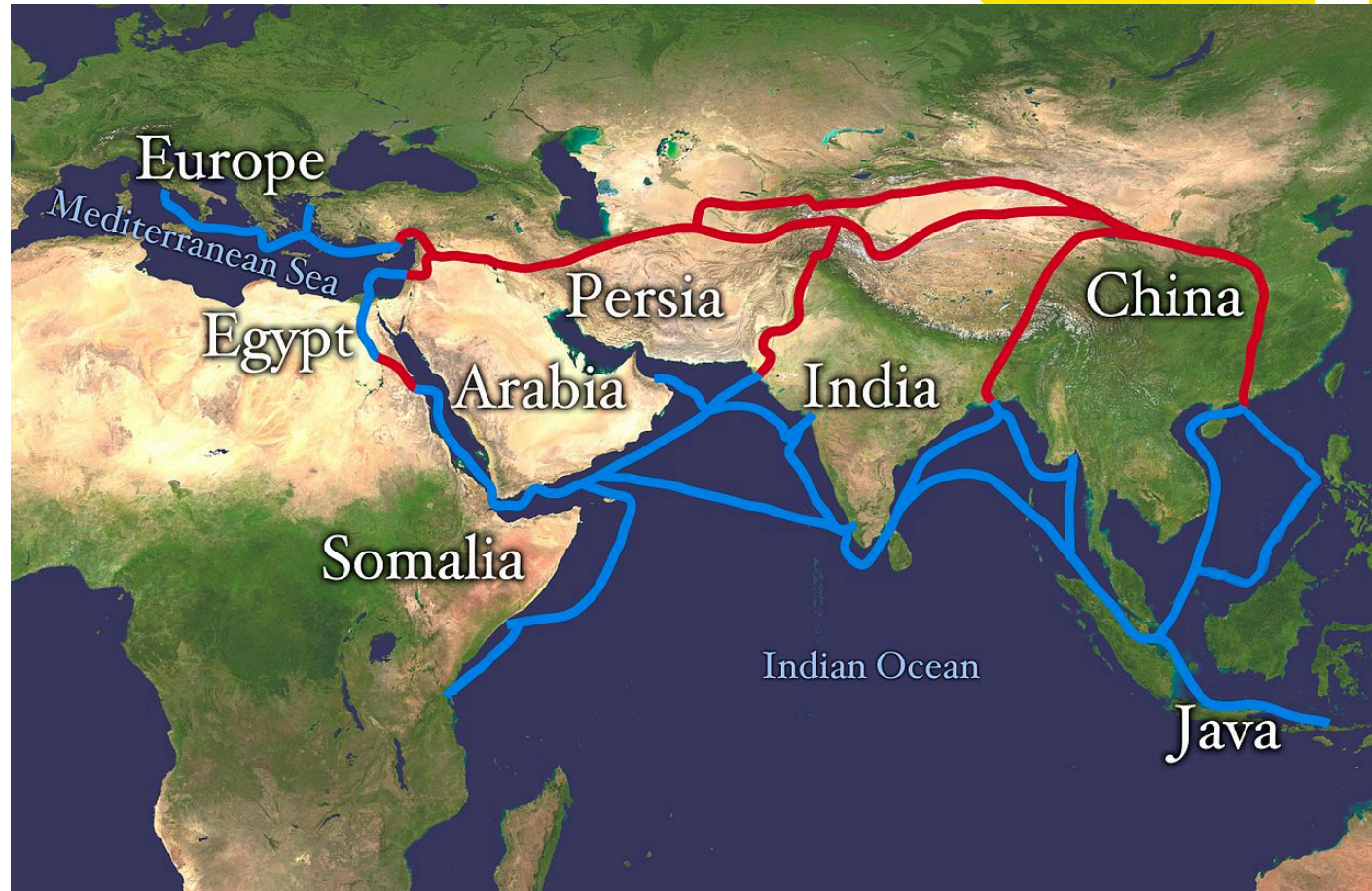БЫВШІЙ ХРАМЪ ОГНЕПОКЛОННИКОВЪ (Въ Сураханахъ близъ Баку).

Silk Road: The Original "Network of Networks"

- **Common paths for cultural transmission and economic trade, from China to Europe**

- **Established based on local need, by merchants and traders in search of profit**

- **Long-distance relationships that were alternately fragile and resilient**

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Not One, But
2 Silk Roads

Terrestrial

Sea Lanes

Europe

Mediterranean Sea

Egypt

Persia

China

Arabia

India

Somalia

Indian Ocean

Java

Decline (14th c.)

- **Decay of Byzantium, End of Mongol Empire, Black Death**

- **Rise of Maritime Europe → End-to-End Carriers Replaced Local Handoffs**

Europe
Mediterranean Sea
Egypt
Persia
Arabia
China
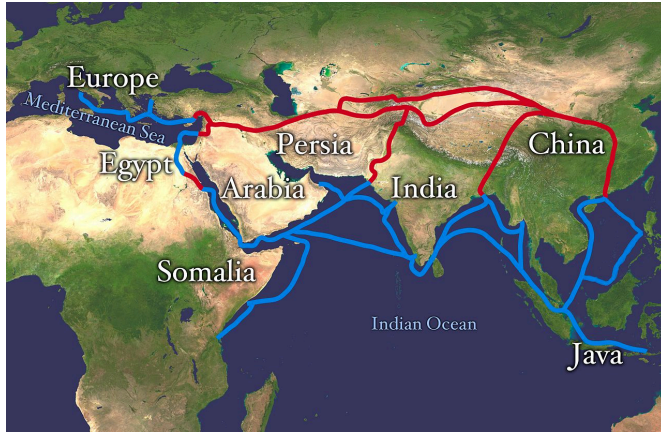India
Somalia
Indian Ocean
Java

Dyn
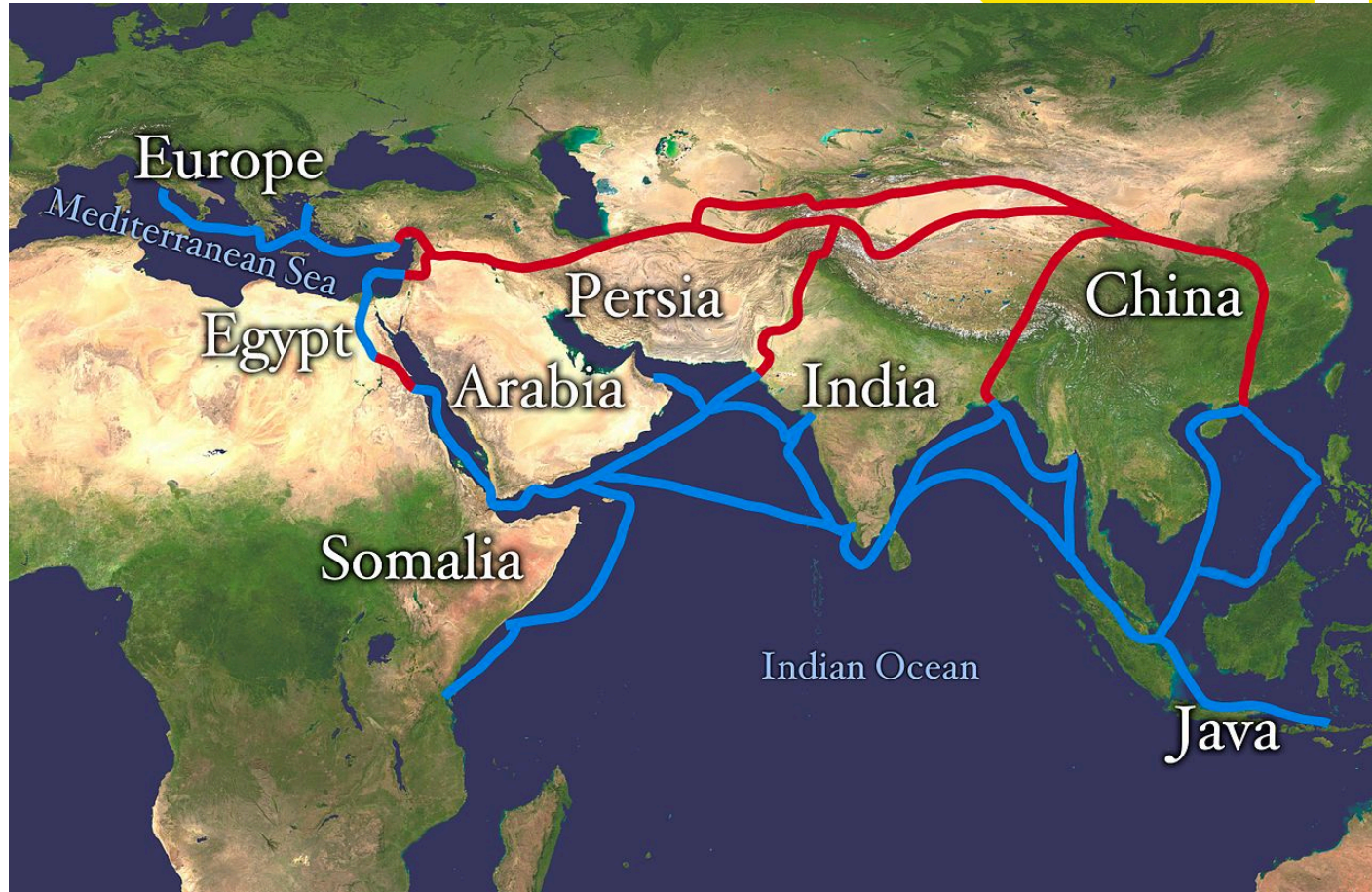
Decline (14ᵗʰ c.)

- **Decay of Byzantium, End of Mongol Empire, Black Death**

- **Rise of Maritime Europe → End-to-End Carriers Replaced Local Handoffs**

"The MPLS Tunnel of the Late 14ᵗʰ Century"

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Today's Submarine Cable Map

A careful replication of the ancient trade routes

Credit: http://www.cablemap.info/

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What About Terrestrial Networks?

PIC COURTESY OF BP AND PARTNERS
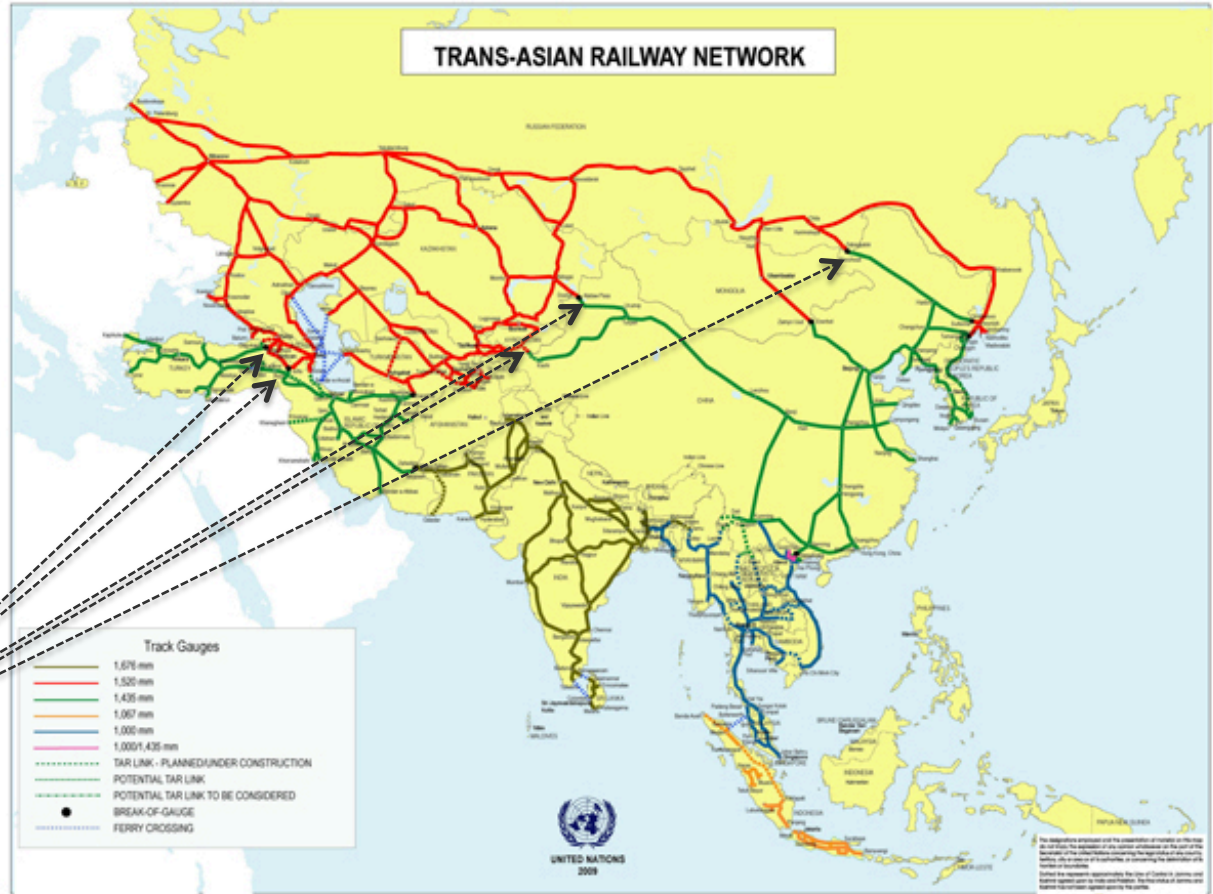
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Fiber Routes Follow Railway Networks

Northern Route
- **Russia/CIS**

Southern Route
- **Turkey, Caucasus, Iran** via Pakistan, India

Breaks of Gauge along Russian imperial frontier

TRANS-ASIAN RAILWAY NETWORK

Track Gauges

- 1,676 mm
- 1,520 mm
- 1,435 mm
- 1,067 mm
- 1,000 mm
- 1,000/1,435 mm
- TAR LINK - PLANNED/UNDER CONSTRUCTION
- POTENTIAL TAR LINK
- POTENTIAL TAR LINK TO BE CONSIDERED
- BREAK-OF-GAUGE
- FERRY CROSSING

UNITED NATIONS
2009

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Fiber Routes Also Follow Energy Pipelines

- **Baku-Novorossiysk**

- **Baku-Supsa**

- **Baku-Tbilisi-Erzurum**

- **Baku-Turkmenbasy** *(Some day?)*

A Complex Game

- **Geopolitics of Caspian and Black Sea pipelines**

- **Every project creates potential new fiber routes**

Credit: Le Monde Diplomatique
*http://mondediplo.com/blogs/
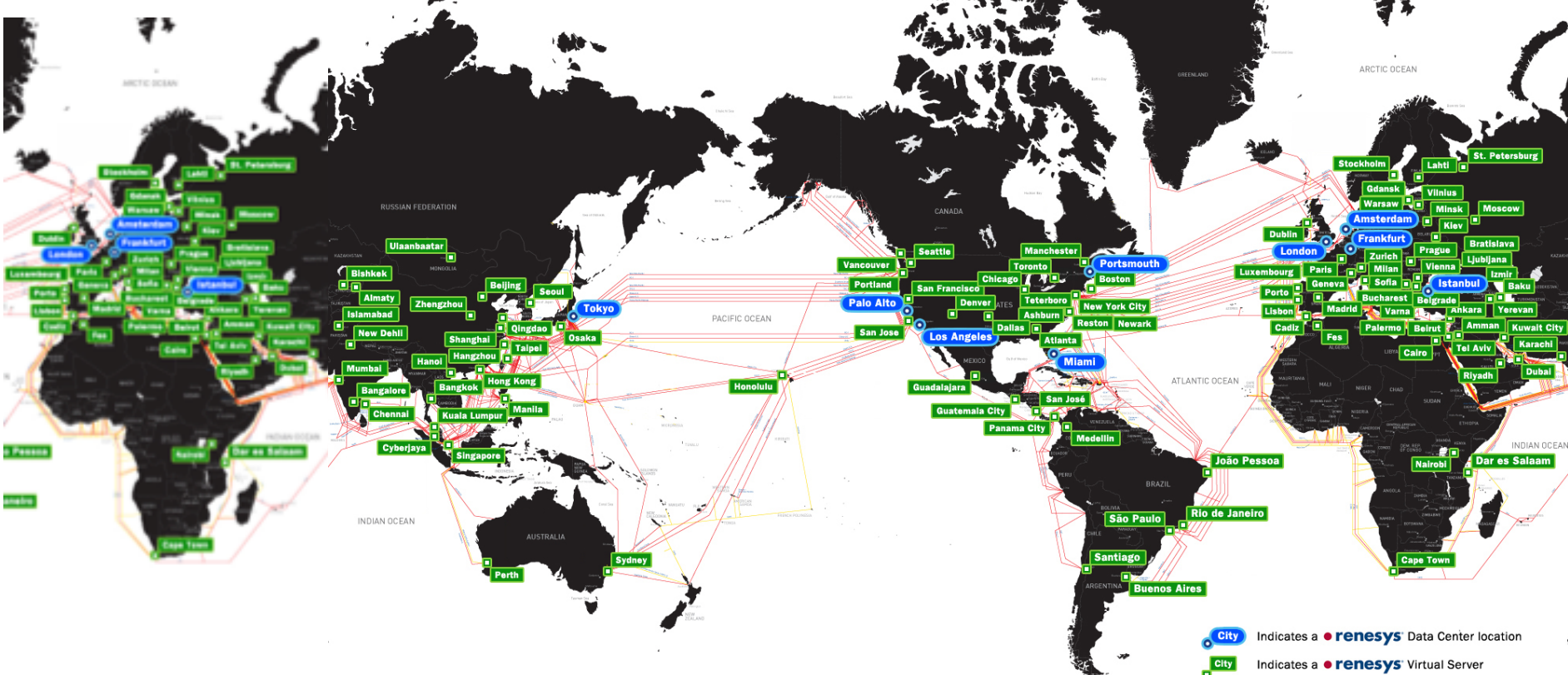pipeline-chess-across-the-black-sea3*
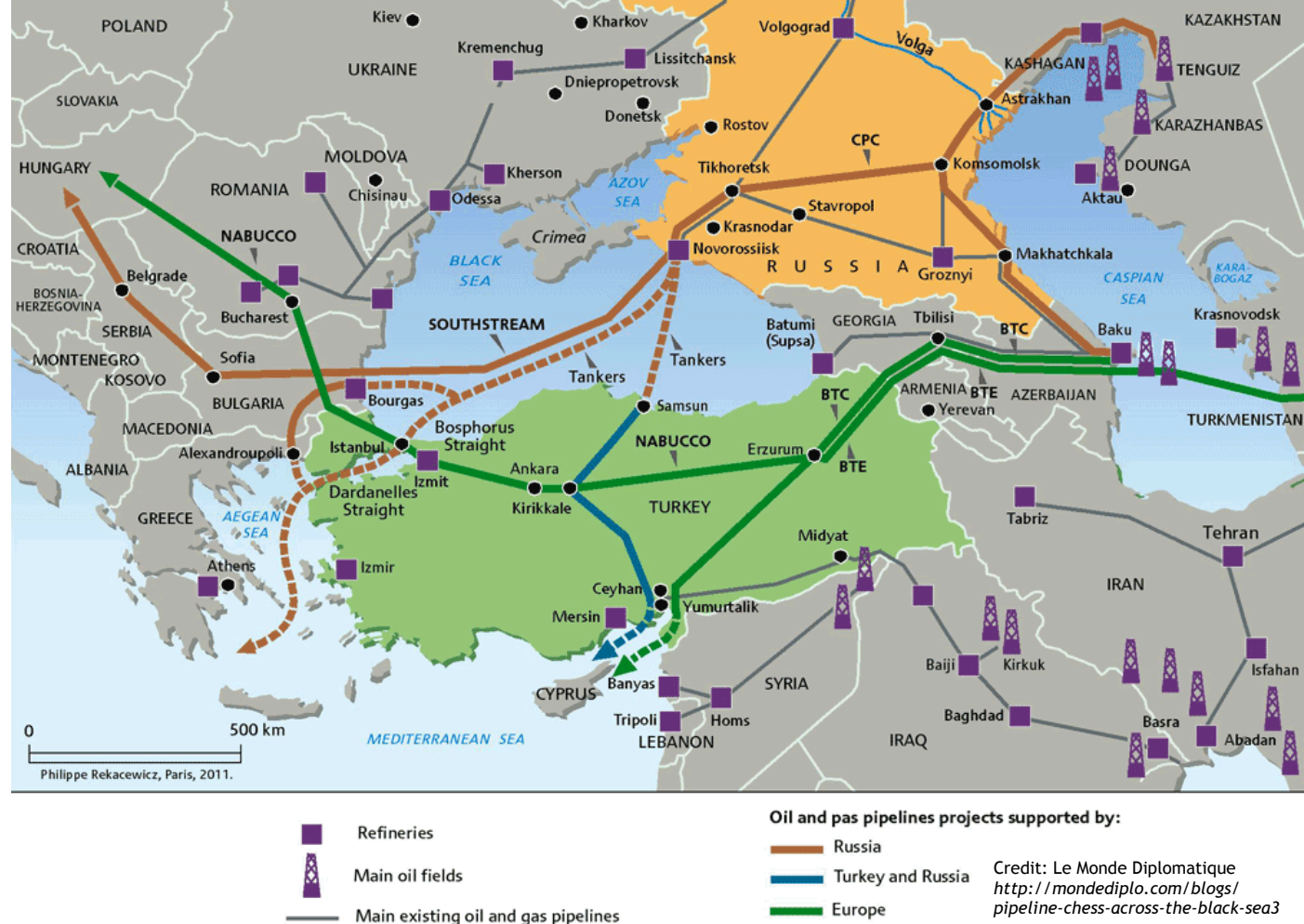
Spheres of Influence: Terrestrial Internet

- **EU and APAC drive demand**

- **Must mitigate risks of submarine pinchpoints**

- **Russia, Kazakhstan, Turkey, Iran: key terrestrial transmission routes**
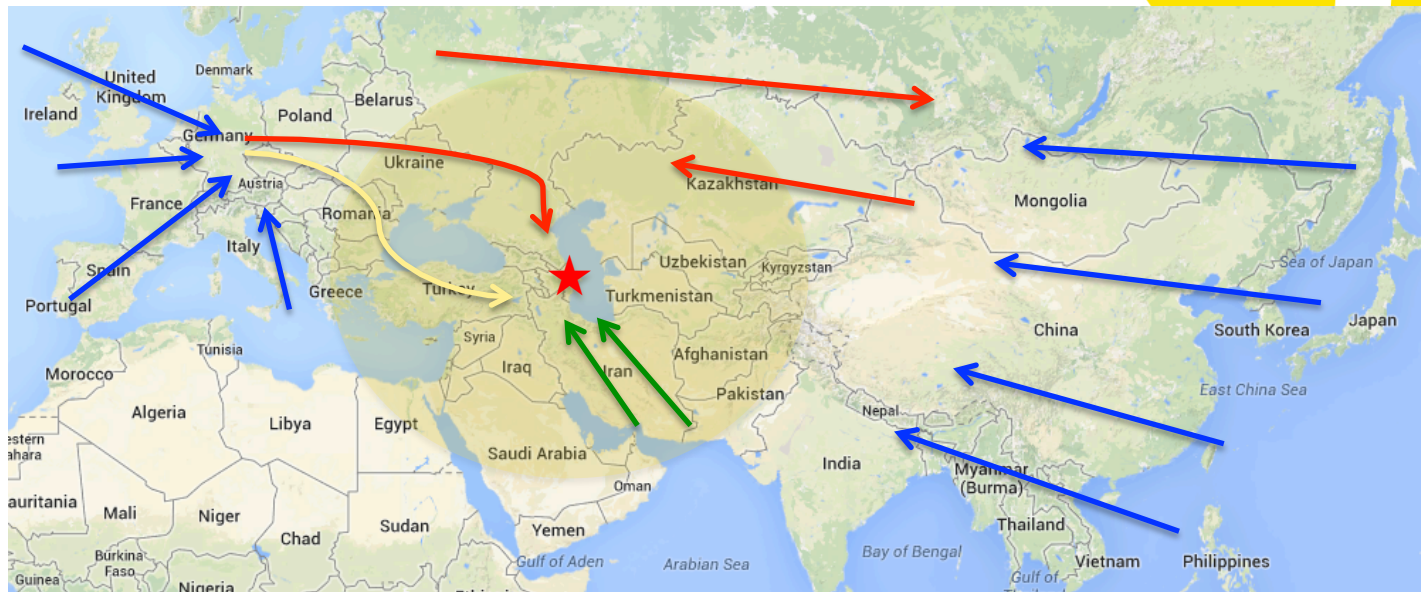
Caucasus and Caspian nations are (literally) pivotal.

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renesys | **Active Measurement Infrastructure** - May 2014 (plus Global Submarine Cable Map)

City — Indicates a **renesys** Data Center location
City — Indicates a **renesys** Virtual Server

Note: Some cities host multiple collectors. Cable map credit: Telegeography

Dyn measures the Digital Silk Road from:

- Baku
- Tashkent
- Izmir
- Istanbul
- Ankara
- Yerevan
- Tehran
- Amman
- Karachi
- Islamabad
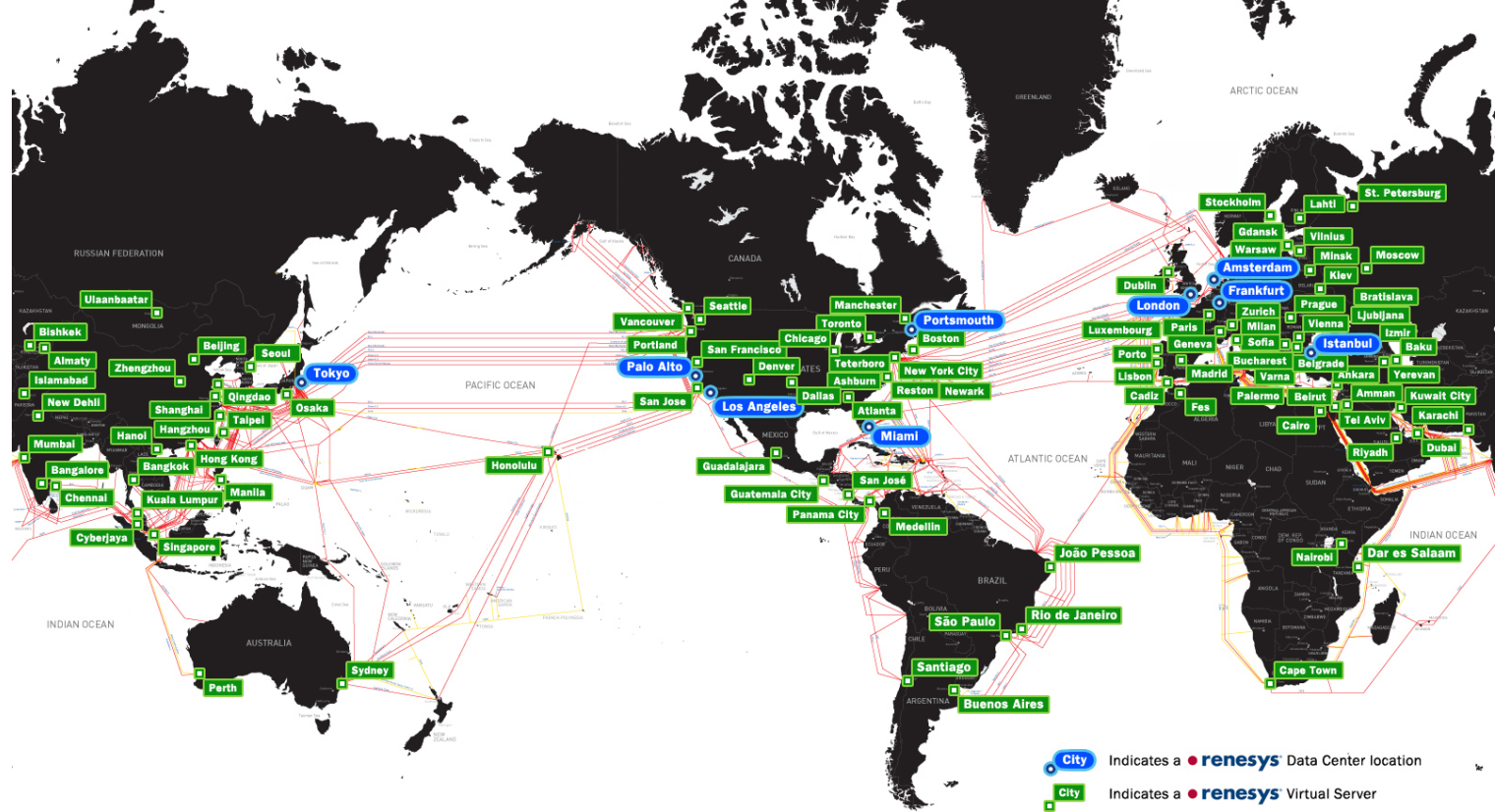- Bishkek
- Almaty
- ....

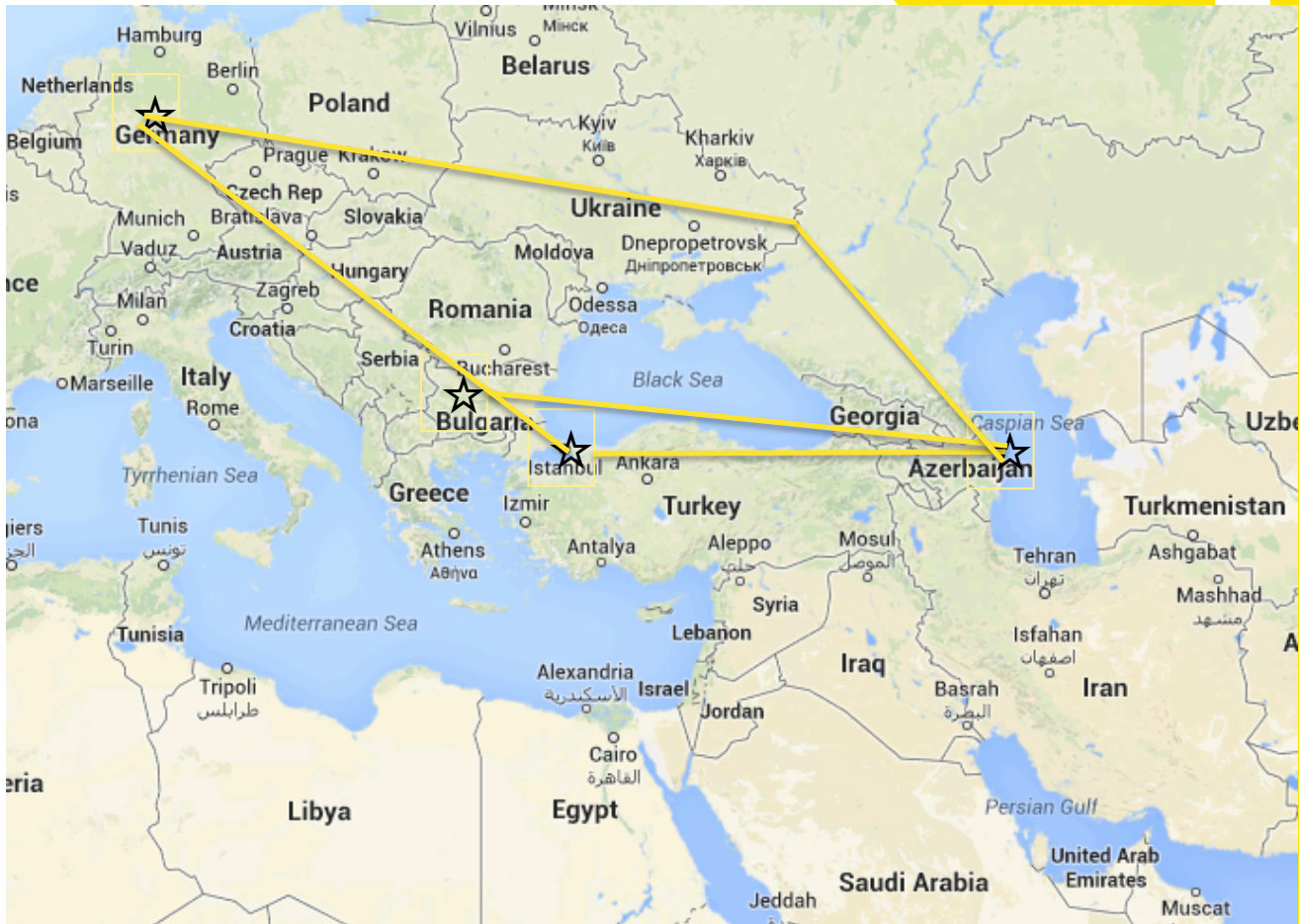**Active Measurement Infrastructure** - May 2014 (plus Global Submarine Cable Map)

Note: Some cities host multiple collectors. Cable map credit: Telegeography

Distances Are Deceiving

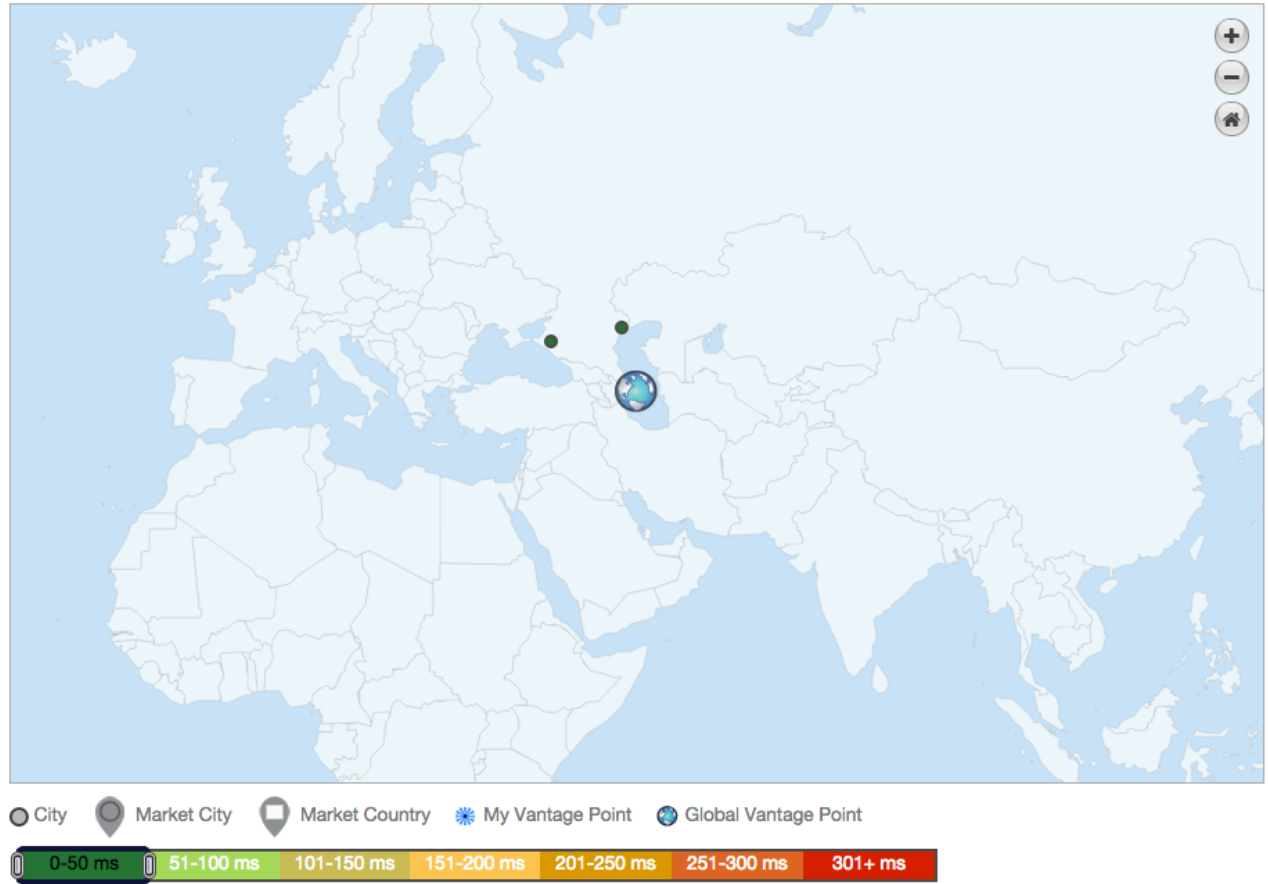Packets can travel great distances from end to end

Who peers with whom, and where, helps determine customer experience

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Baku's Local Neighborhood

<=50ms RTT

- **Baku**

- **Krasnodar**

- **Astrakhan**

- Direct connection between Delta and Rostelecom 44467

○ City   ◉ Market City   ▢ Market Country   ✳ My Vantage Point   ◉ Global Vantage Point

| 0-50 ms | 51-100 ms | 101-150 ms | 151-200 ms | 201-250 ms | 251-300 ms | 301+ ms |

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"Two hops" from Baku

50-100ms RTT

- **Dublin**

- **Tunis**

- **Astana**

- **Novosibirsk**

- **Tashkent**

City | Market City | Market Country | My Vantage Point | Global Vantage Point

0-50 ms | 51-100 ms | 101-150 ms | 151-200 ms | 201-250 ms | 251-300 ms | 301+ ms

Dyn
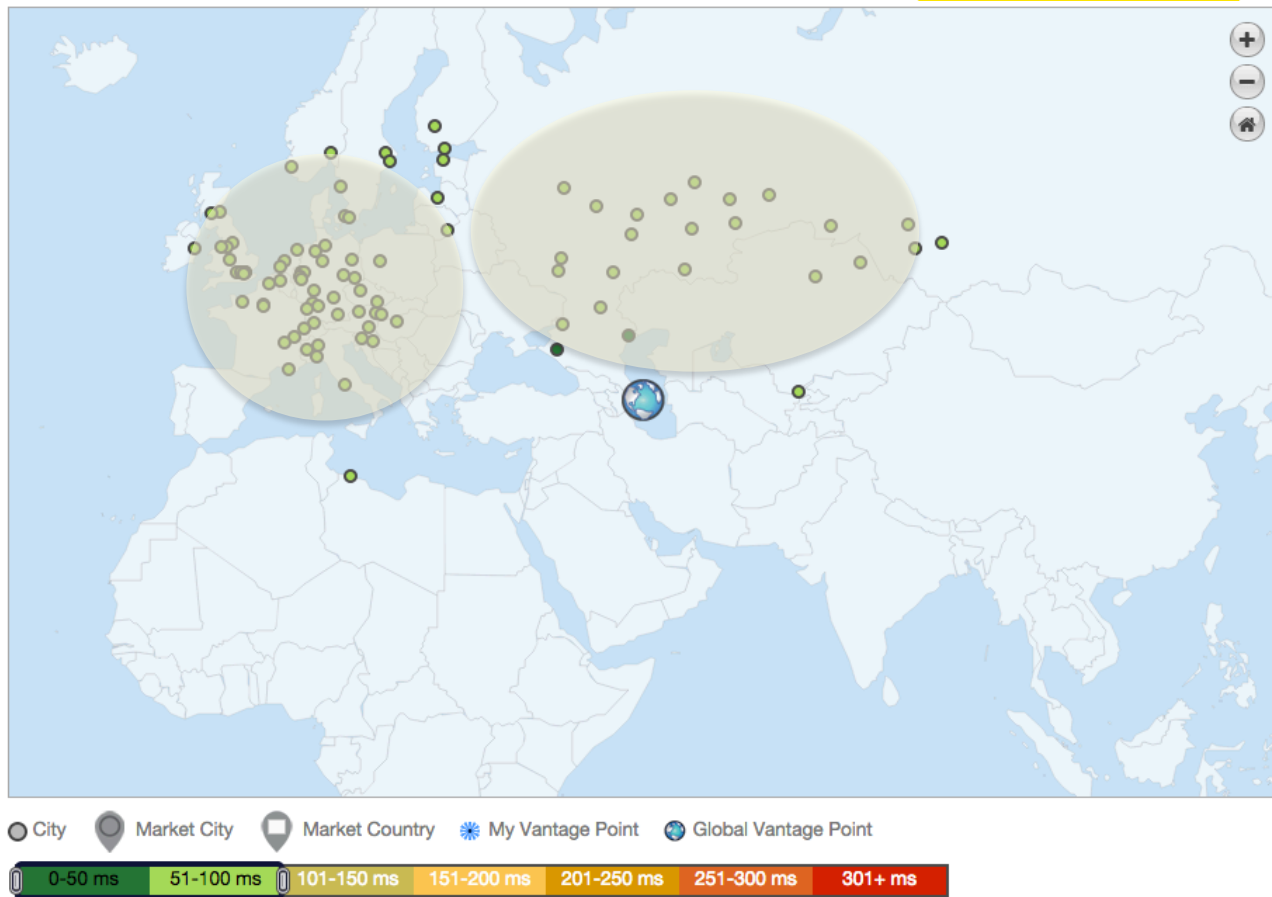
Two Long Hops…

100-150ms RTT

- **Reykjavik**

- **Djibouti**

- **Almaty, Bishkek**

- **Khabarovsk**

- **Tbilisi, Yerevan (!)**

○ City ◉ Market City ▢ Market Country ✳ My Vantage Point 🌐 Global Vantage Point

0-50 ms	51-100 ms	101-150 ms	151-200 ms	201-250 ms	251-300 ms	301+ ms
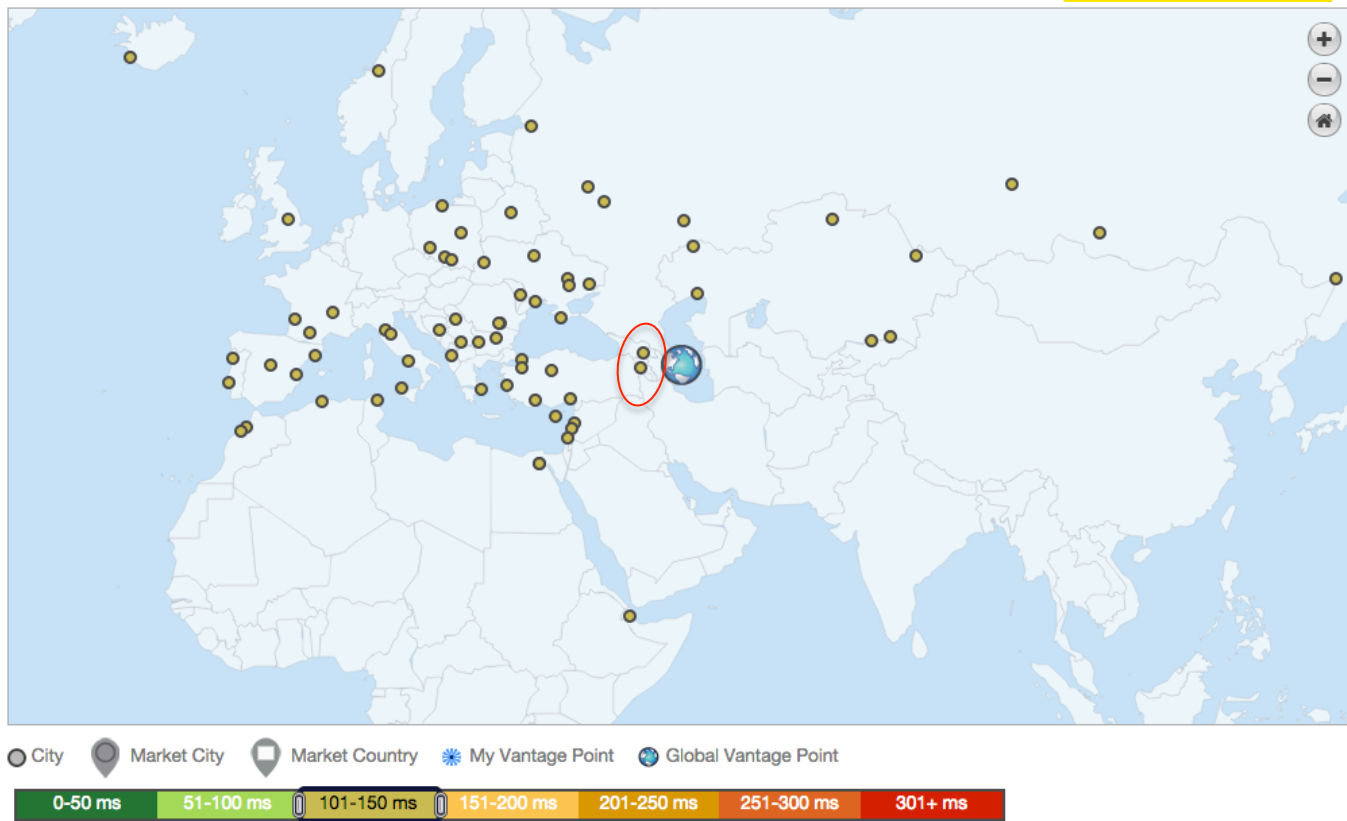
Baku-Yerevan

100-150ms RTT

- **Traffic traverses roundtrip path to Sofia, Bulgaria**

- **Delta, Armentel both buying transit from L3**
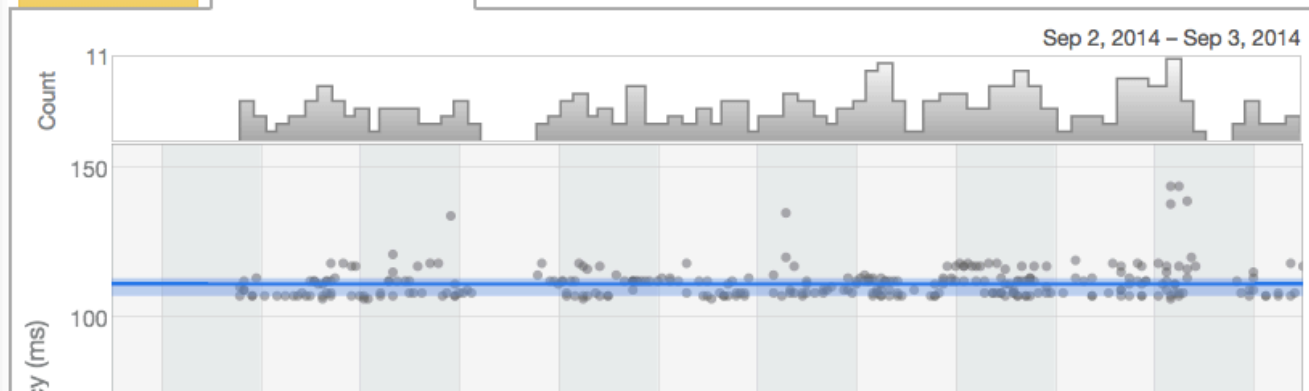
Baku-Tbilisi:
"Only" 560km

100-150ms RTT *median via longhaul transit*

10ms *optimal via direct local transit*

Selected Providers (5 max)

	Var	Path
Caucasus Online (AS 20771)	☐	→
Caucasus Online (AS 28751)	☐	→
Caucasus Online (AS 16010)	☐	→
Silknet (AS 35805)	☐	→
Egrisi (AS 34797)	☐	→

The graph compares the performance histories of selected providers in this market. You can select other providers using the table below.

Egrisi maintains backup transit relationship with Delta

Long Range Performance: **Baku, Azerbaijan** 🇦🇿 ➡ **Tbilisi, Georgia** 🇬🇪

Jul 21, 2014 – Sep 2, 2014

Median Latency (ms)

140
120
100
80
60
40
20
0

Jul 26   Aug 2   Aug 9   Aug 16   Aug 23   Aug 30

12 Aug: Caucasus Online shifts Delta relationship from Frankfurt to Sofia
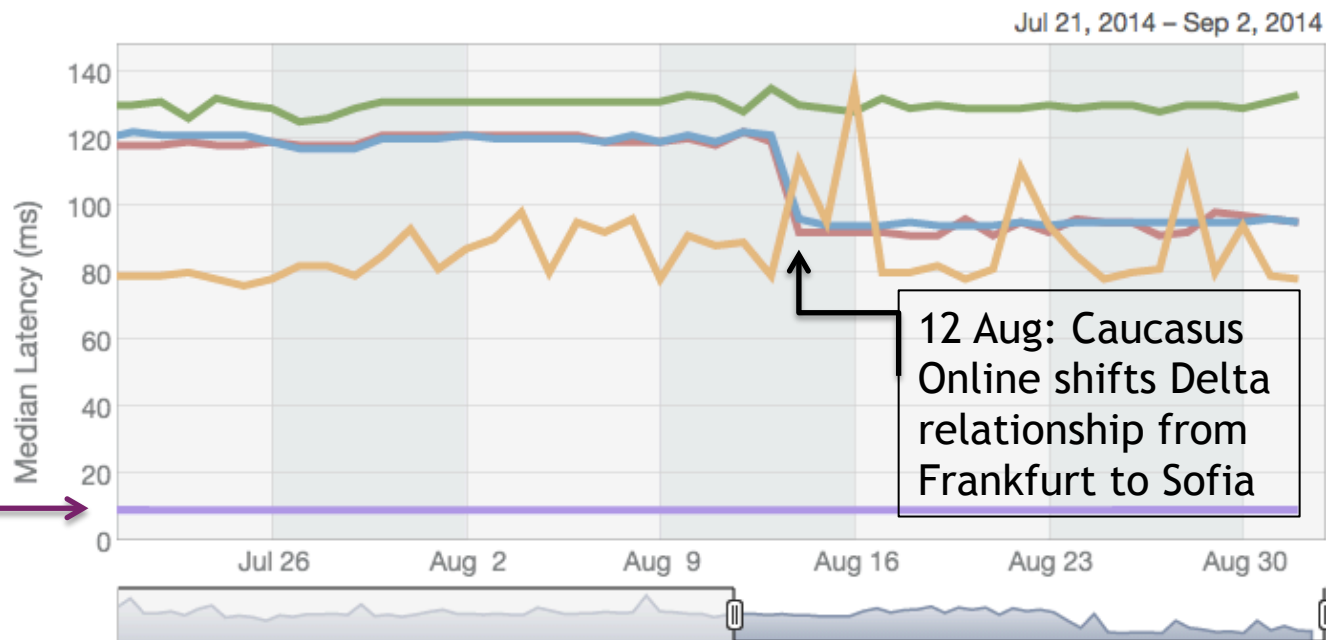
Baku-Tbilisi: Where Do *You* Want To Hand Off?

Path 1
USE **16%** LATENCY **92 ms**

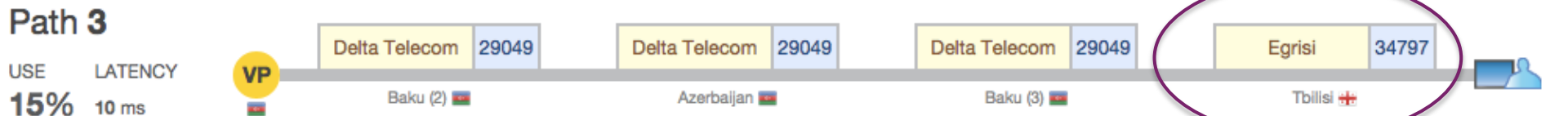| Delta Telecom | 29049 | | Delta Telecom | 29049 | | Level 3 | 3356 | | Level 3 | 3356 | | Level 3 | 3356 | | Caucasus O... | 16010 |
Baku — Azerbaijan — Sofia — Sofia show all hops (1) — Sofia (3) — Tbilisi (3)

Path 2
USE **16%** LATENCY **135 ms**

| Delta Telecom | 29049 | | Delta Telecom | 29049 | | TeliaSonera | 1299 | | TeliaSonera | 1299 | | TeliaSonera | 1299 | | Caucasus O... | 16010 |
Baku — Azerbaijan — Frankfurt am Main (2) — Vienna — Sofia (2) — Tbilisi

92ms (Baku – Sofia – Tbilisi via Level3)

136ms (Baku – Frankfurt – Tbilisi via TeliaSonera)

Path 3
USE **15%** LATENCY **10 ms**

| Delta Telecom | 29049 | | Delta Telecom | 29049 | | Delta Telecom | 29049 | | Egrisi | 34797 |
Baku (2) — Azerbaijan — Baku (3) — Tbilisi

10ms (Baku –Tbilisi direct interconnect)

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Direct Connection = Faster Service
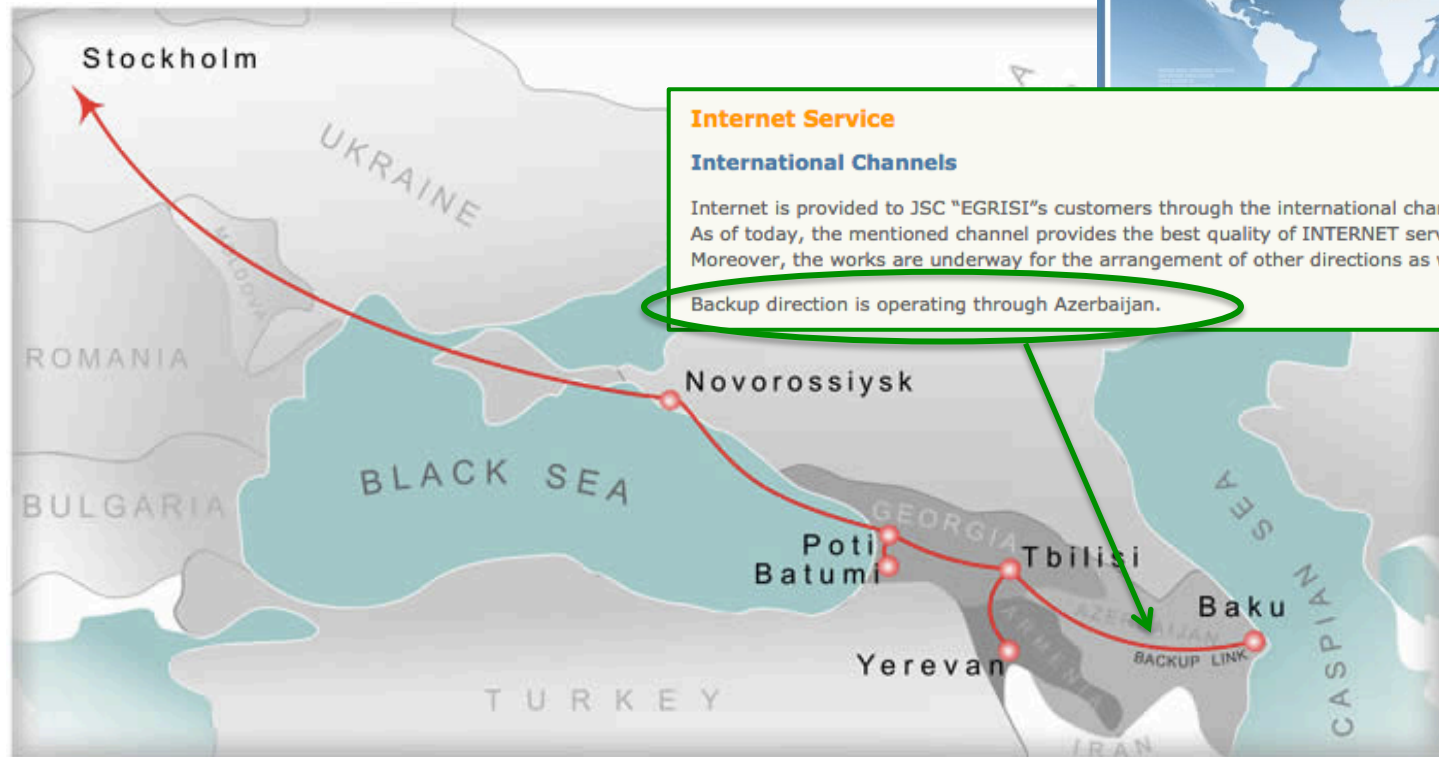
Even Farther From Baku

150-250ms RTT

- **Vladivostok**

- **Dakar**

- **Persian Gulf**

- **Nairobi**

- **North America**

City | Market City | Market Country | My Vantage Point | Global Vantage Point

| 0-50 ms | 51-100 ms | 101-150 ms | 151-200 ms | 201-250 ms | 251-300 ms | 301+ |

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dyn.com
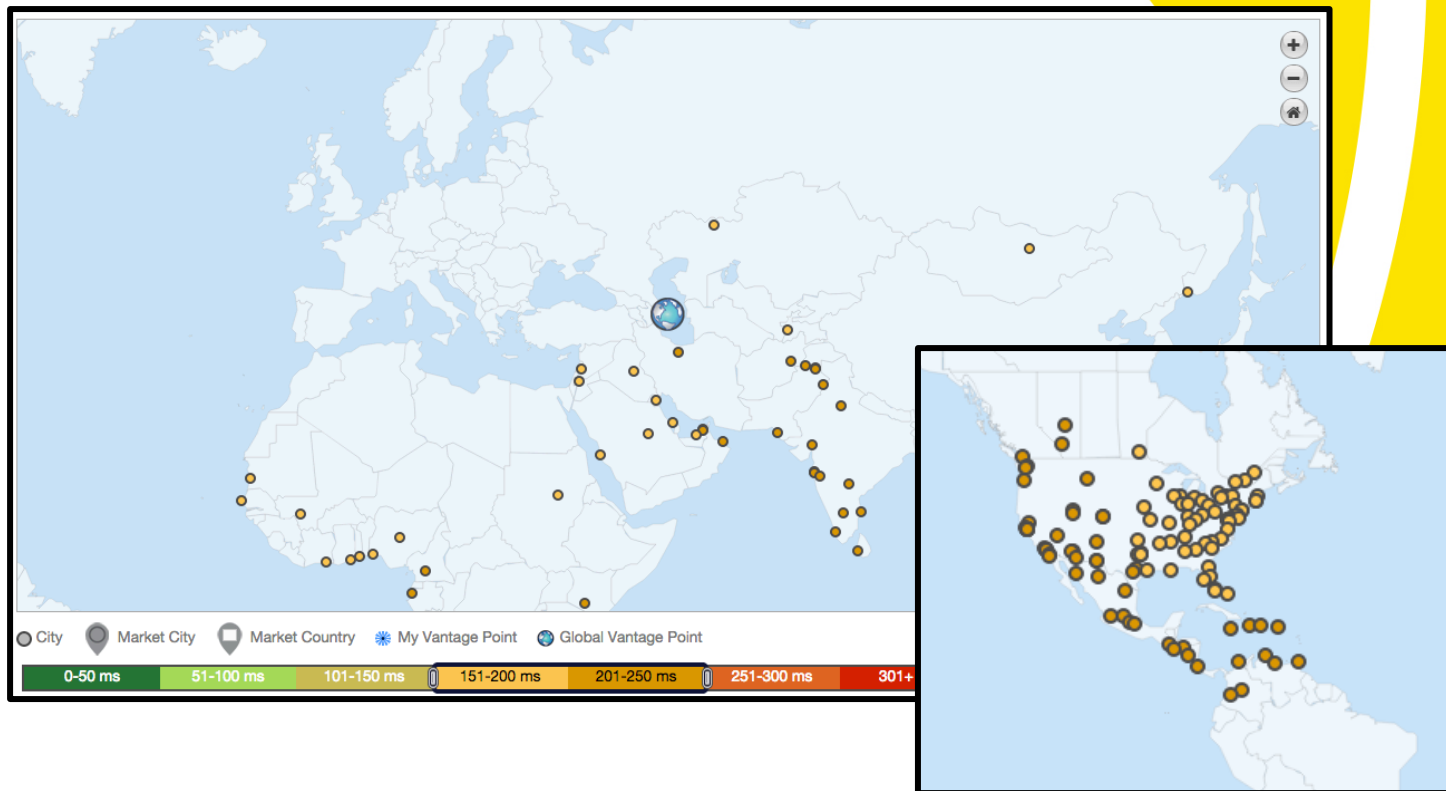
Farthest from Baku

250ms++ RTT

- **South America**

- **South Africa**

- **Australia**

- **South/East Asia**

- **This is not a good replacement for the Silk Road!**

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| City | Market City | Market Country | My Vantage Point | Global Vantage Point |

| 0-50 ms | 51-100 ms | 101-150 ms | 151-200 ms | 201-250 ms | 251-300 ms | 301+ ms |

SET LATENCY RANGE
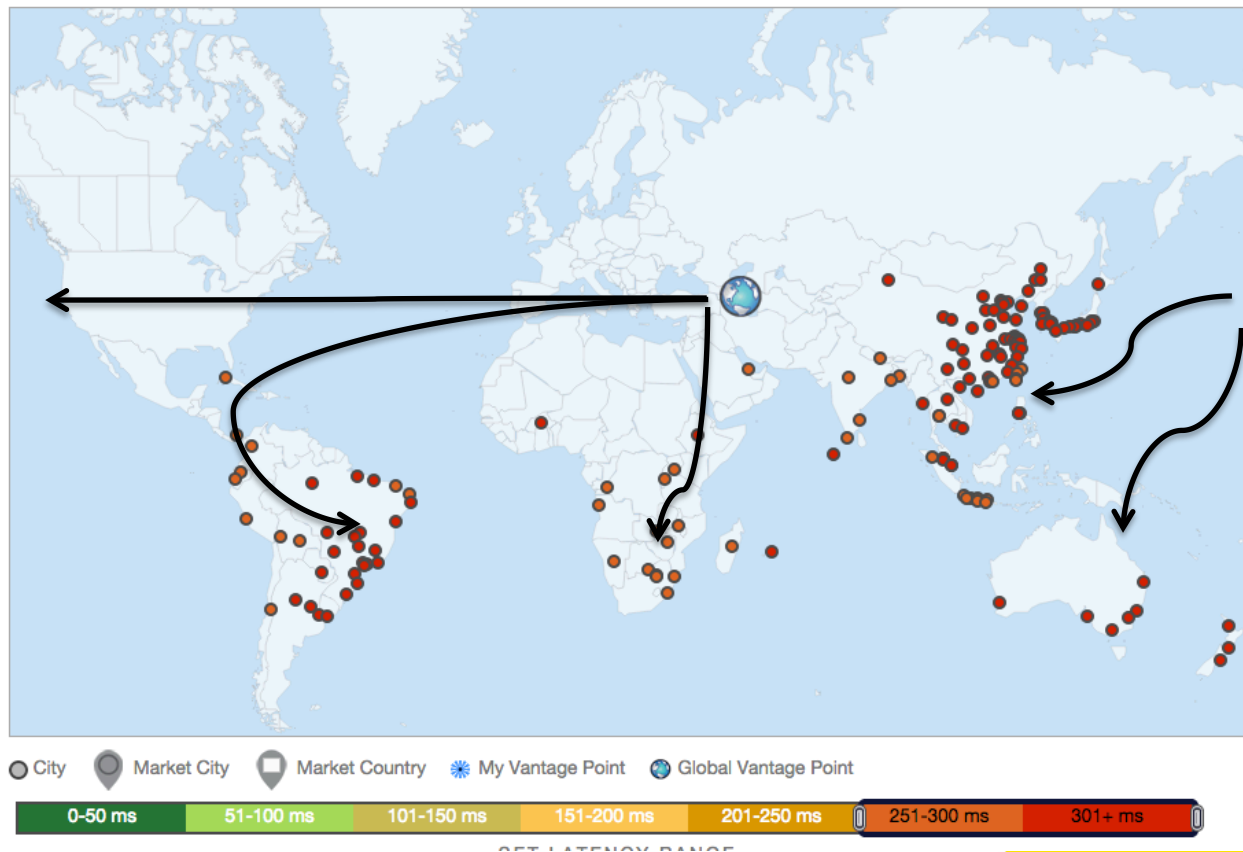
2. By The Numbers:

Inferring Diversity and Competition Among Regional Providers
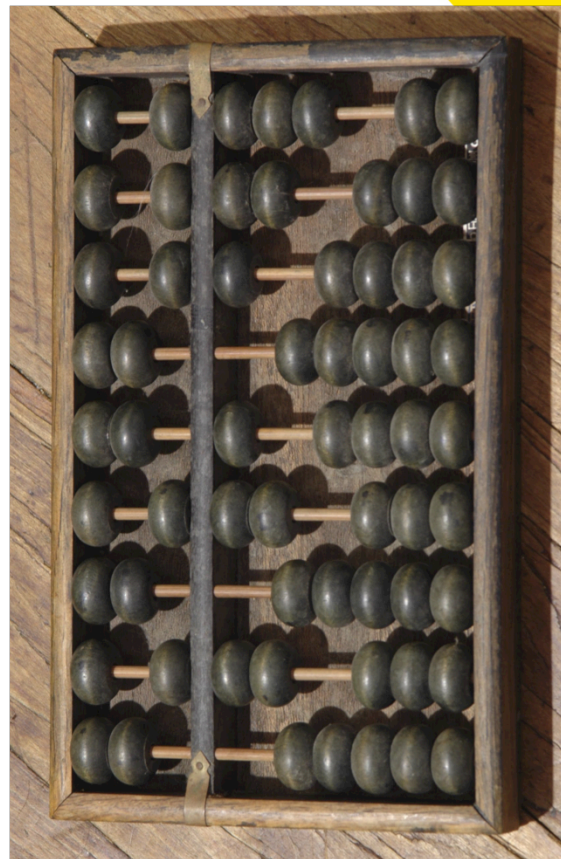
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Basic ASN Counts, September 2014

Russia	4,450
Ukraine	1,640
Bulgaria	475
Turkey	325
Iran	305
Kazakhstan	199
Moldova	78
Armenia	57
Georgia	51
Iraq	44
Azerbaijan	33

Basic ASN Counts, September 2014

Russia	**4,450**
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THE CAUCASUS REGION

ASNs per Million People

Bulgaria	66.0
Ukraine	38.1
Russia	30.5
Moldova	22.3
Armenia	19.0
Kazakhstan	11.7
Georgia	11.3
Turkey	**4.2**
Iran	**3.9**
Azerbaijan	**3.5**
Iraq	**1.2**

USA	47.7
Netherlands	34.6
Germany	16.5

"ASNs per capita" varies widely.

Countries with fewer ASNs per capita may simply be at an earlier stage of development….

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ASNs per Million People		y/y incr	Largest Domestic, percent on-net	
Bulgaria	66.0	4.03	BTC	33%
Ukraine	38.1	(1.19)	Datagroup	26%
Russia	30.5	1.36	Rostelecom	50%
Moldova	22.3	2.86	Moldtelecom	58%
Armenia	19.0	0.67	GNC-Alfa	34%
Kazakhstan	11.7	6.00	KazakhTelecom	86%
Georgia	11.3	1.33	Caucasus Online	39%
Turkey	4.2	0.34	Turk Telecom	82%
Iran	3.9	0.49	TIC (AS12880)	75%
Azerbaijan	3.5	0.21	Delta	90%
Iraq	1.2	0.11	Earthlink	69%
USA	47.7	0.90	CenturyLink	17%
Netherlands	34.6	2.94	KPN	20%
Germany	16.5	1.84	euNetworks	9%

*However, countries with fewer ASNs per person also tend to have **domestic providers with dominant shares** of the national market: a possible indicator of reduced competition and higher prices.*

They also grow more slowly.

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Single-homed ASNs, %pct	2 transits	3+ transits
Germany	34	45	21
Netherlands	36	36	28
USA	38	38	24
Bulgaria	40	39	21
Russia	43	39	18
Iraq	48	30	22
Moldova	49	31	20
Iran	51	35	14
Armenia	52	24	24
Ukraine	53	33	14
Georgia	58	28	14
Kazakhstan	59	27	14
Turkey	64	27	9
Azerbaijan	65	20	15

Countries served by a higher than average proportion of single-homed ASNs are at higher risk of widespread Internet failure due to reliance on single large providers.

Global average:
- *42% singlehomed*
- *39% dualhomed*
(Sep 2014)

Percentage ASNs with Cross Border Transit

September 2014

Georgia	49%
Moldova	35%
Bulgaria	34%
Iraq	25%
Armenia	18%
Ukraine	12%
Azerbaijan	9%
Russia	9%
Turkey	9%
Kazakhstan	7%
Iran	2%

Germany	65%
Netherlands	60%
USA	59%

Smaller numbers suggest that a small number of **large domestic providers** *mediate most international transit for smaller providers*

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3.
Navigating the Shifting Sands

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Can Istanbul Serve the Region?

- **The 50ms footprint only covers Anatolia and Eastern Europe**

- **Caucasus, Levant, Gulf Regions are 100ms+ or even 150ms+**

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# Istanbul Losing Ground to Sofia as Regional Hub

Turkish Routes, Bulgarian Routes, Russian Routes

Sofia increasingly dominates the regional peering picture, thanks to the Black Sea cable from Georgia to Bulgaria, where content is welcome and regulation is light. Level3 is a key beneficiary of this shift.

Istanbul increasingly serves only Turkish traffic bound for Western Europe and the USA.

Istanbul's dream of becoming a regional Internet hub city seems to be fading due to neighbor politics, lack of domestic IX capacity, regional competition.
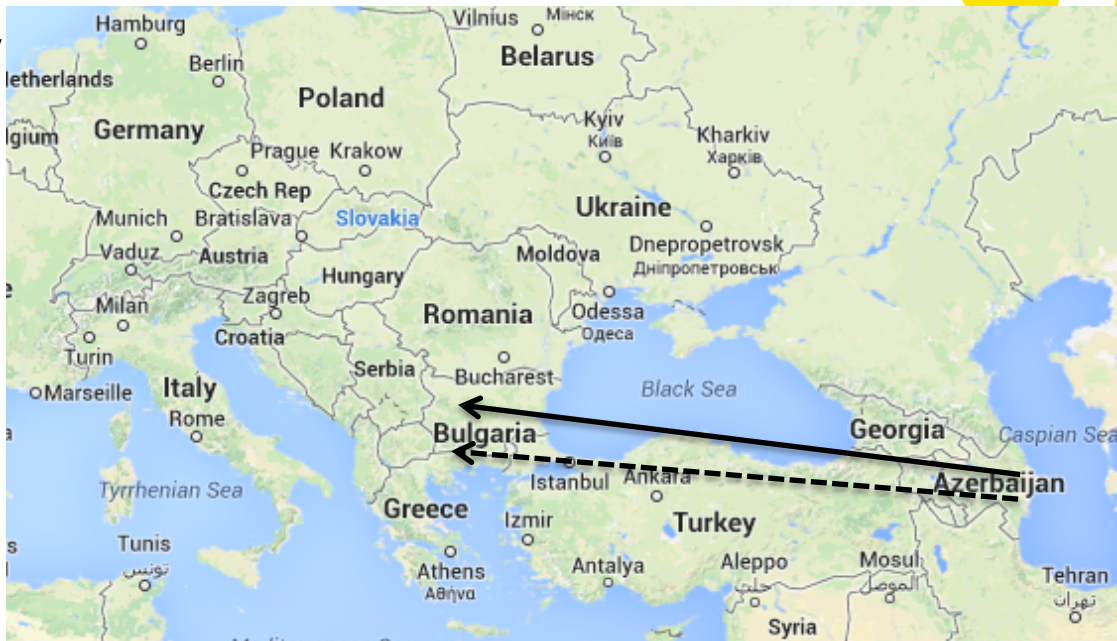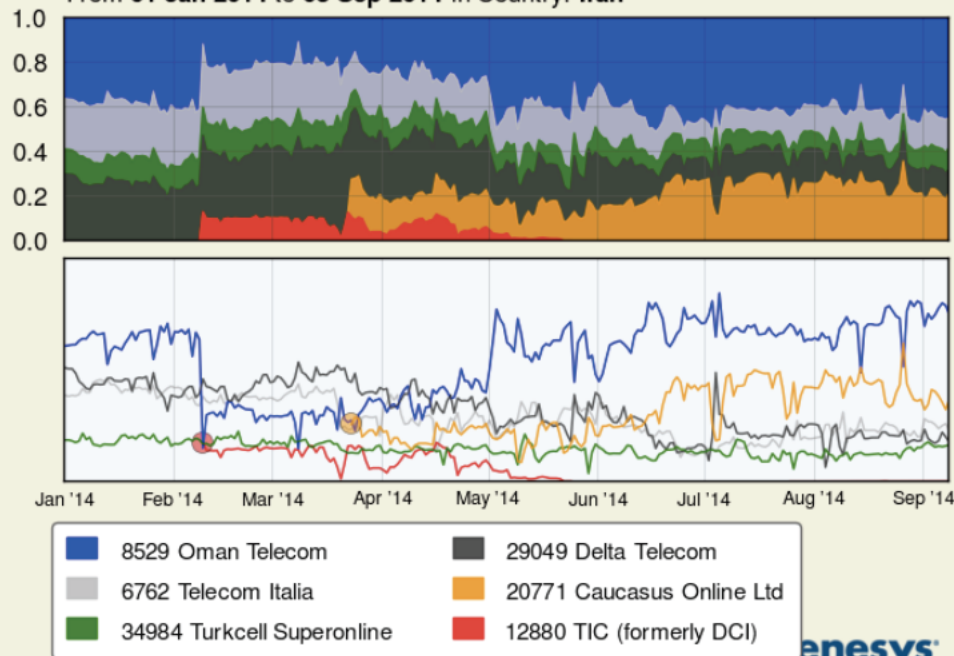
Iran's Internet Transit is Smart, Adaptive

Iran takes advantage of all regional transit opportunities without getting pinned down to a single supplier.

- **OmanTel,** Telecom Italia
- **Turkcell/Superonline**
- **Delta Telecom**
- **Caucasus Online (**)**

*** Since March 2014*

Transit for **TIC (formerly DCI) (AS48159)**
From **01 Jan 2014** to **08 Sep 2014** in Country: **Iran**

Legend:
- 8529 Oman Telecom
- 6762 Telecom Italia
- 34984 Turkcell Superonline
- 29049 Delta Telecom
- 20771 Caucasus Online Ltd
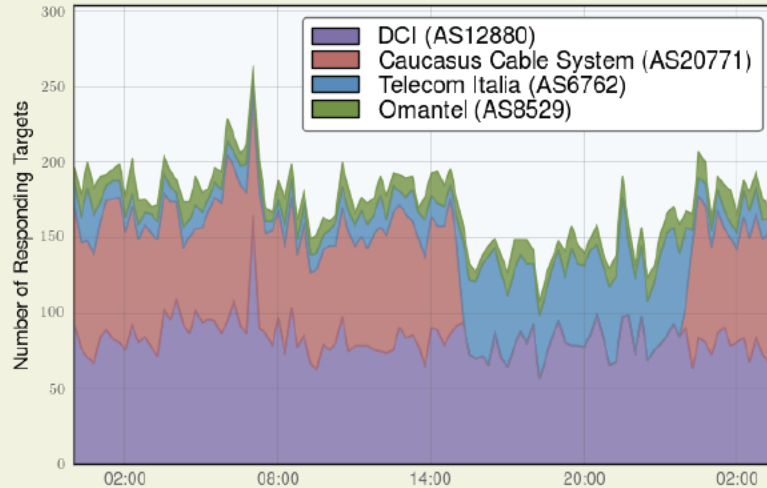- 12880 TIC (formerly DCI)

Genesys
DELIVERED BY Dyn

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Iran's Connection to Sofia Routes Via *Armenia*

Upstreams of TIC (AS48159) (Iran)
23 Jul 2014 through 24 Jul 2014

Legend:
- DCI (AS12880)
- Caucasus Cable System (AS20771)
- Telecom Italia (AS6762)
- Omantel (AS8529)

Y-axis: Number of Responding Targets (0–300)
X-axis: 02:00, 08:00, 14:00, 20:00, 02:00

Source: Traceroute Data

Upstreams of Ucom LLC (AS44395) (Armenia)
23 Jul 2014 through 24 Jul 2014

Legend:
- Level 3 (AS3356)
- Sofia Connect (AS47872)
- GNC-ALFA CJSC (AS49800)

Y-axis: Number of Responding Targets (0–400)
X-axis: 02:00, 08:00, 14:00, 20:00, 02:00

Source: Traceroute Data

TIC Transit Shift, 24 July 2014
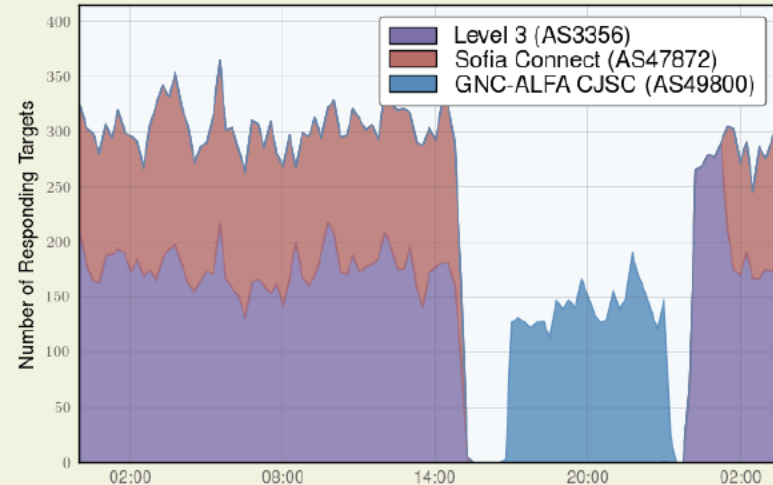
Ucom Armenia Transit Shift, 24 July 2014

dyn.com

Azerbaijan's Important Role

As **Sofia** increases in importance, **Azerbaijan** becomes a natural crossing point for traffic across Russian or Black Sea/Caucasus routes to Western Europe.

Iran subsequently becomes the leading candidate for a Middle Eastern terrestrial backbone linking Southeast Asia and the Gulf with Europe through Azerbaijan.

Could this be the rebirth of a New Silk Road?

TASIM: An Alternative Future?

"Trans-Eurasian Information Super Highway" now in the planning stages

Plans call for "proprietary IP/MPLS network" as a wholesale offering for telecom providers

All-incumbent partners from China, Kazakhstan, Azerbaijan, Russia, Turkey

We'll see what happens!

http://tasim.net

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Thank you!

Təşəkkür edirəm!

Mapping The Digital Silk Road
ENOG 8, Baku

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