



Modeling World Trade: Land & Sea

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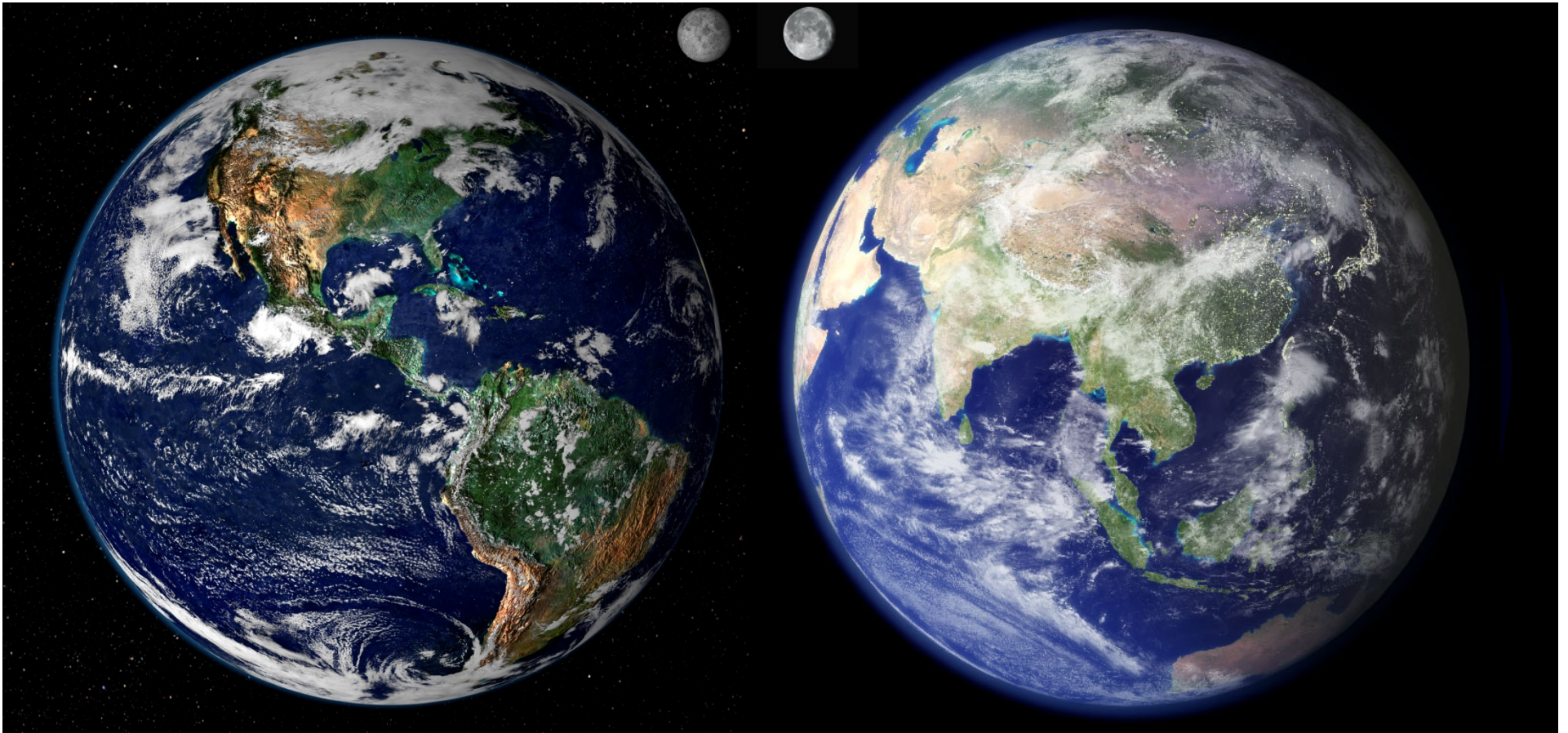


Outline

- 1. Modeling Global Health (prosperity & harmony) by measuring the World's Trade networks**
 - Transportation network evolution (global trade) as a proxy
- 2. Flow of goods over intercontinental transport networks**
 - On land, revitalization of Old Silk Roads (OSR) through trade routes -- Northern Distribution Network (NDN) or New Silk Road (NSR).
 - Effectiveness & impact of trade networks. Trade moves goods, cultures, technology, knowledge, disease (Marco Polo's day).
 - At sea, effects as canals & port channels get deeper and wider & companies are larger & fewer.
 - Global Supply Chain: Network measurements guide policies for producing better trade flow.
- 3. How to use social networks to measure global prosperity and harmony?**

Earth: How healthy is it? Is it getting healthier or sicker?

A Proxy: Measure the changing health of its transportation-trade networks



Announcement: Interdisciplinary Contest in Modeling (ICM)

--- help your students compete

2012

- 1337 three-undergraduate teams worked 4 days in Feb 2012 to solve a criminal conspiracy problem
- 83 people in the company (8 known conspirators, 7 known non-conspirators)
- 600 messages

2014

- 1028 teams
- Erdos collaboration network (510 coauthors, 1400 papers)
- Which papers are the most influential in network science?
- Which individual network researcher is most influential?

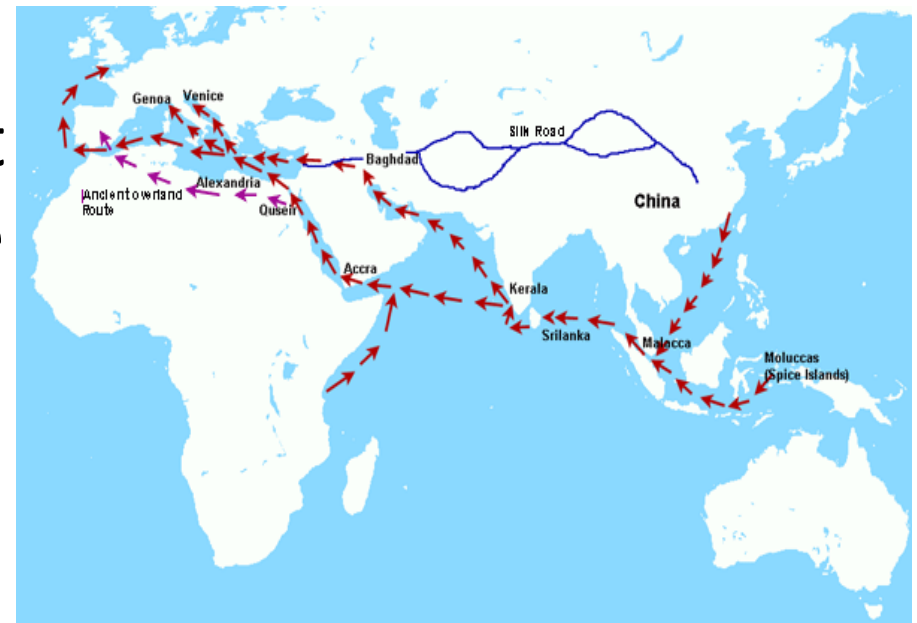
2015

- 1496 teams confronted a challenge to measure sustainability for low development countries
- 641 teams took on Measuring churn and other human capital properties in an organization
- ICM is in conjunction with 3 problems in the mathematical contest in modeling

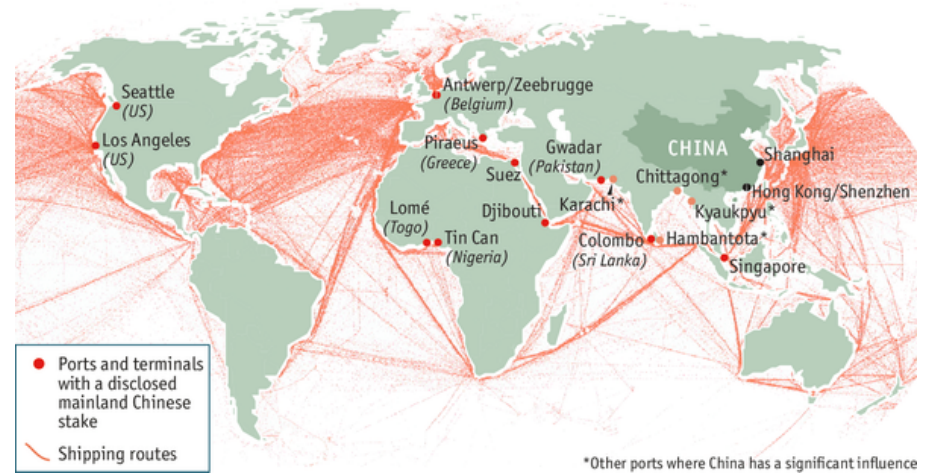
• See Comap.com and sign up a team or two from your school for 2016's contest (in February) involving interdisciplinary problems in network, environmental, and policy issues.

Lay of the Land & Sea Transport & Trade Networks

- Goal: Understand effects of new trade networks & how they affect society
- Build the networks (geographic constraints, structure, attributes, process -- flow)
- Compare to existing networks
- Determine flow mechanisms & usage rates - size, shapes, speeds, hubs, interoperability
- Infrastructure costs
- Maintenance & movement
- Trade volume and revenue
- Effect on Society

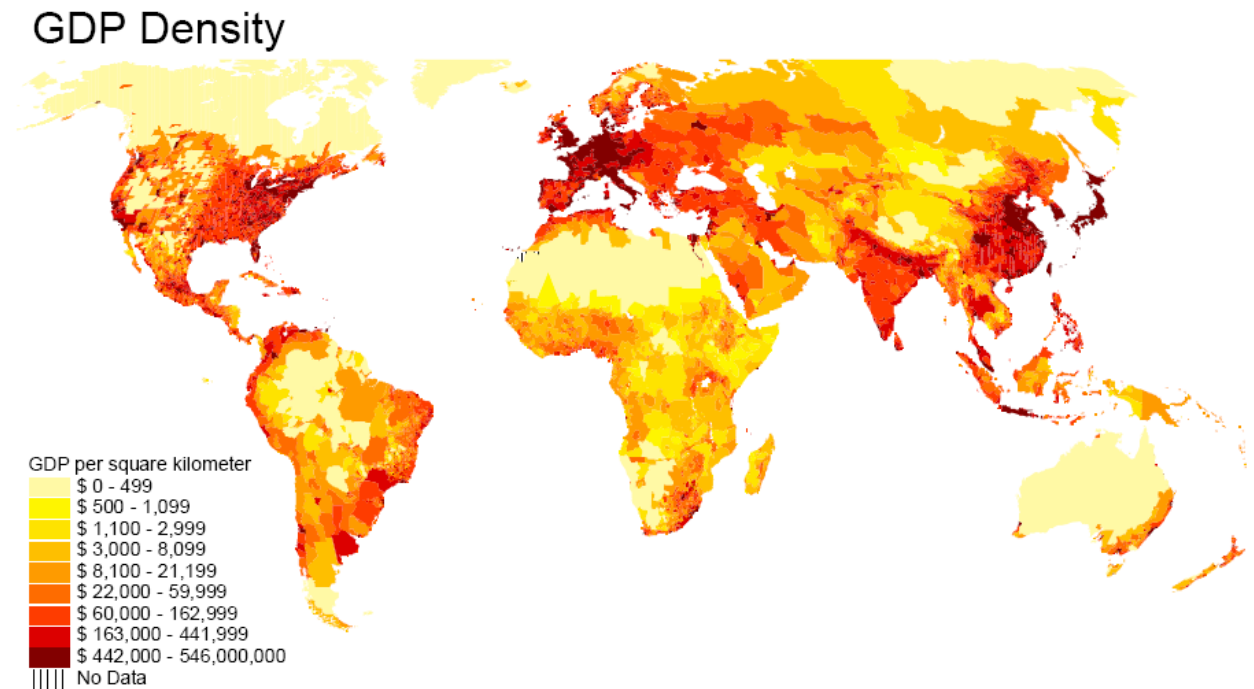


The Social Aspects & Impacts



- Spatial Cohesion & Social Contagion
- Vulnerability & Security factors
- Human elements -- political, diplomatic, gov't
- National Measures, Regional Measures, Global Measures
- Goals: Economic (prosperity) vs Social (Human Rights)
- Policy Decisions (questions: to participate, to develop systems, which modes, where, tipping points)

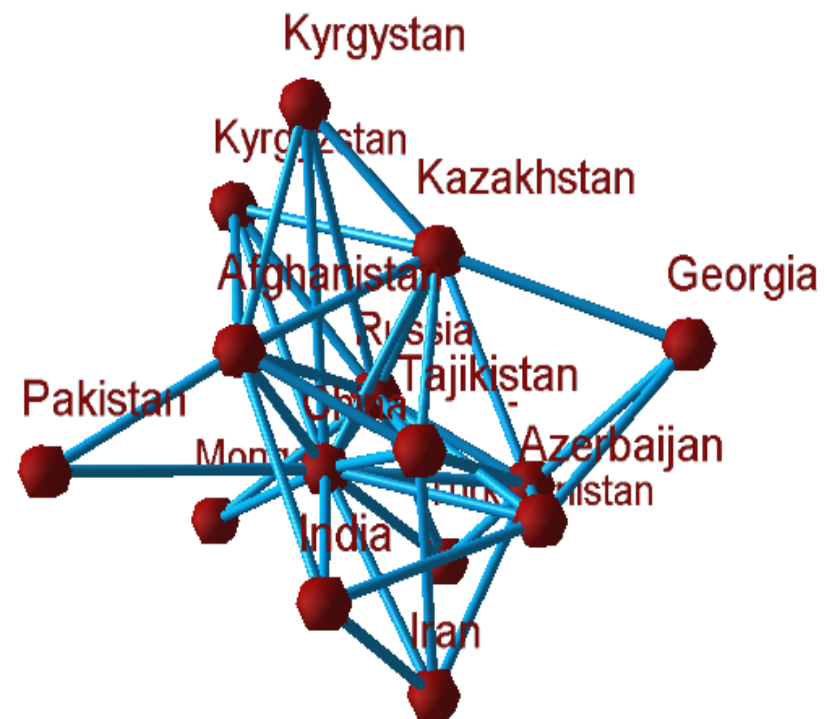
Philosophy of the Health Model



- Health comes from prosperity (network functionality & harmony) and its equality.
- Isolation or low trade adversely affects a nation's prosperity.
- Extreme inequality undermines world harmony -- unequal opportunity and access to global influence.
- In Network Science terms: Measures of global health are **high density** and **low centralization** in the world trade network -- less variance in centrality and data.

Land Transportation & Trade --- The Asia-Europe (and now Africa) Corridor

- Old Silk Road (OSR) (100BC-1400) (5,000 miles)
- No Road --- Central Asia Land-bridge closed (1450-1960)
- Northern Distribution Network --- NDN (1980-2015)
- New Silk Road
- Speed factors:
Time vs distance
(road, rail, sea)



The New Era in Central Asia

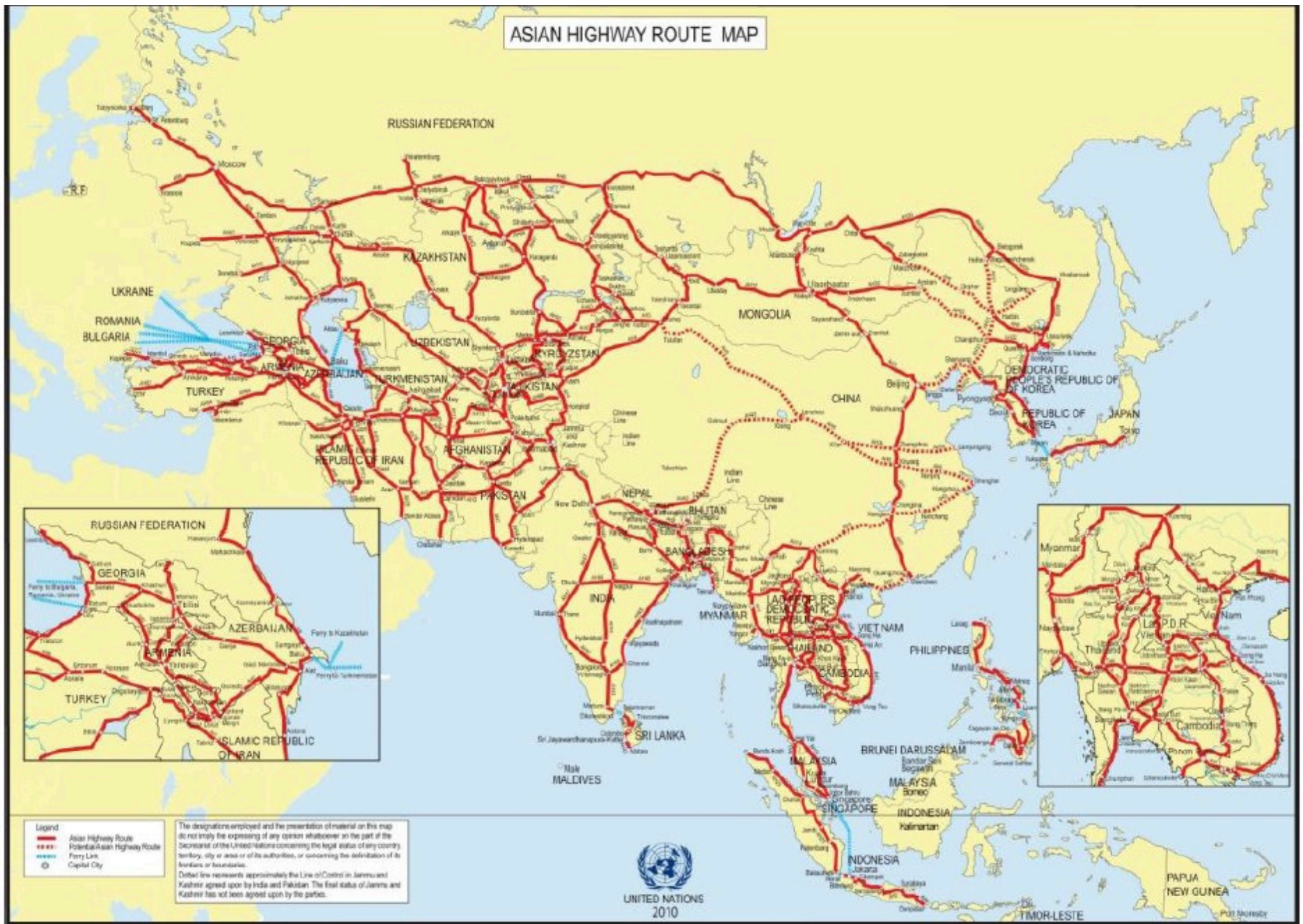
- Kazakhstan (16.6 m), Kyrgyzstan (5.5 m), Tajikistan (7.6 m), Turkmenistan (5.1 m), & Uzbekistan (29.5 m), the region's potential is finally realized by other nations.
- US resupply in Afghanistan developed the NDN.
- China, Russia, Iran, and US have strong competing and cooperative reasons for developing the NSR (roadways, railways, pipelines)
- Ultimate Multi-modal transport network



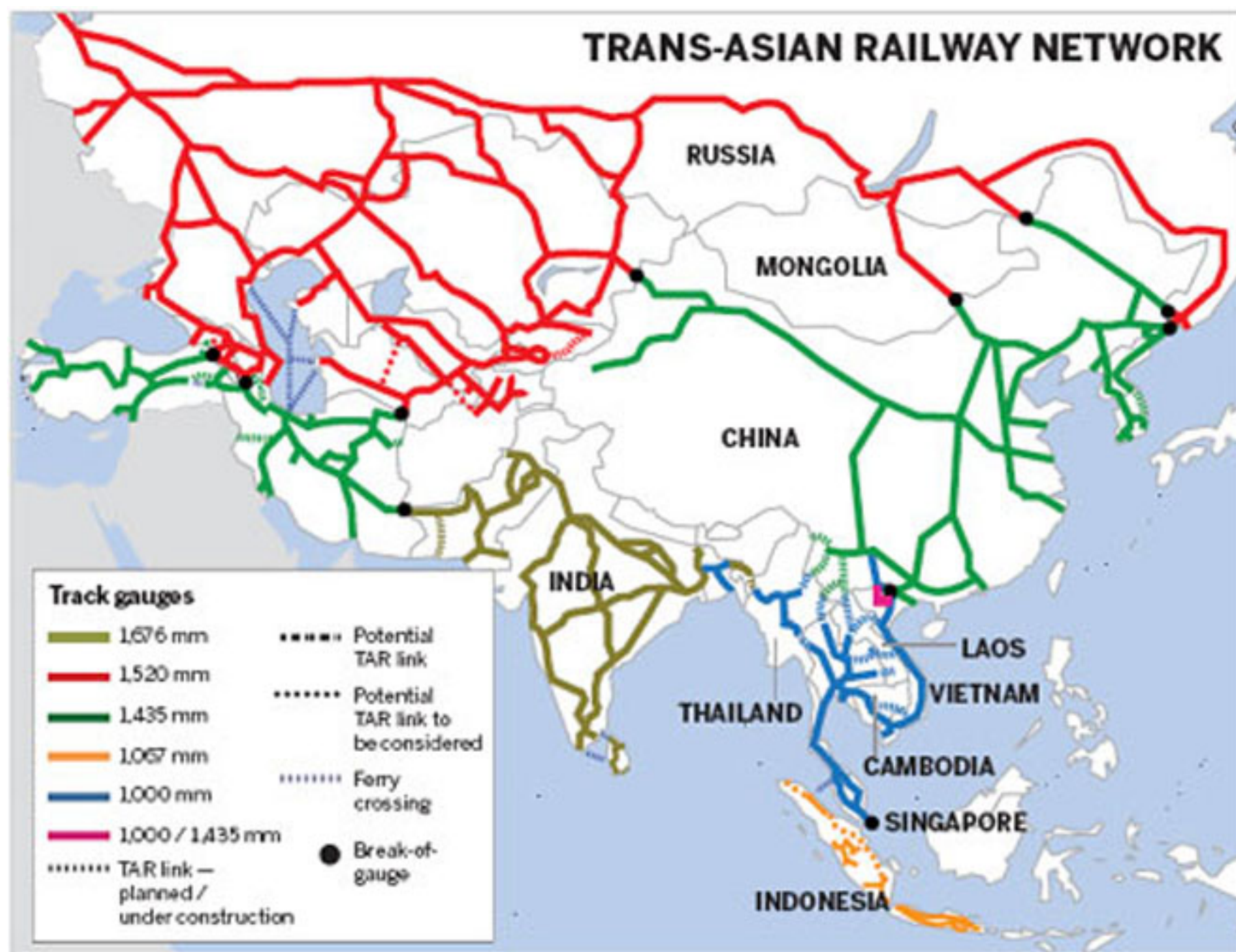
One View: A Giant (8,000 mile) Land Bridge through Central Asia



ASIAN HIGHWAY ROUTE MAP



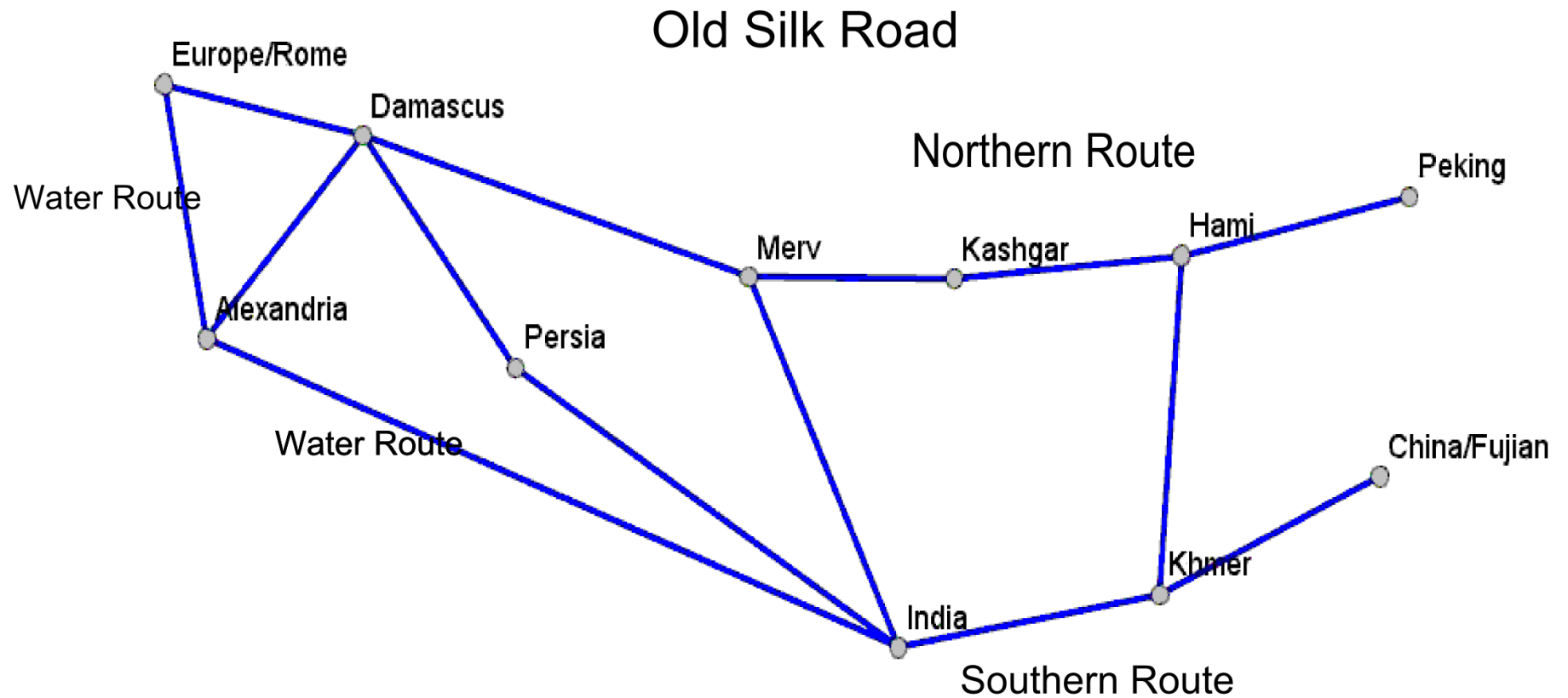
TRANS-ASIAN RAILWAY NETWORK



(U) China's Import Transit Routes/Critical Chokepoints and Proposed/Under Construction SLOC Bypass Routes

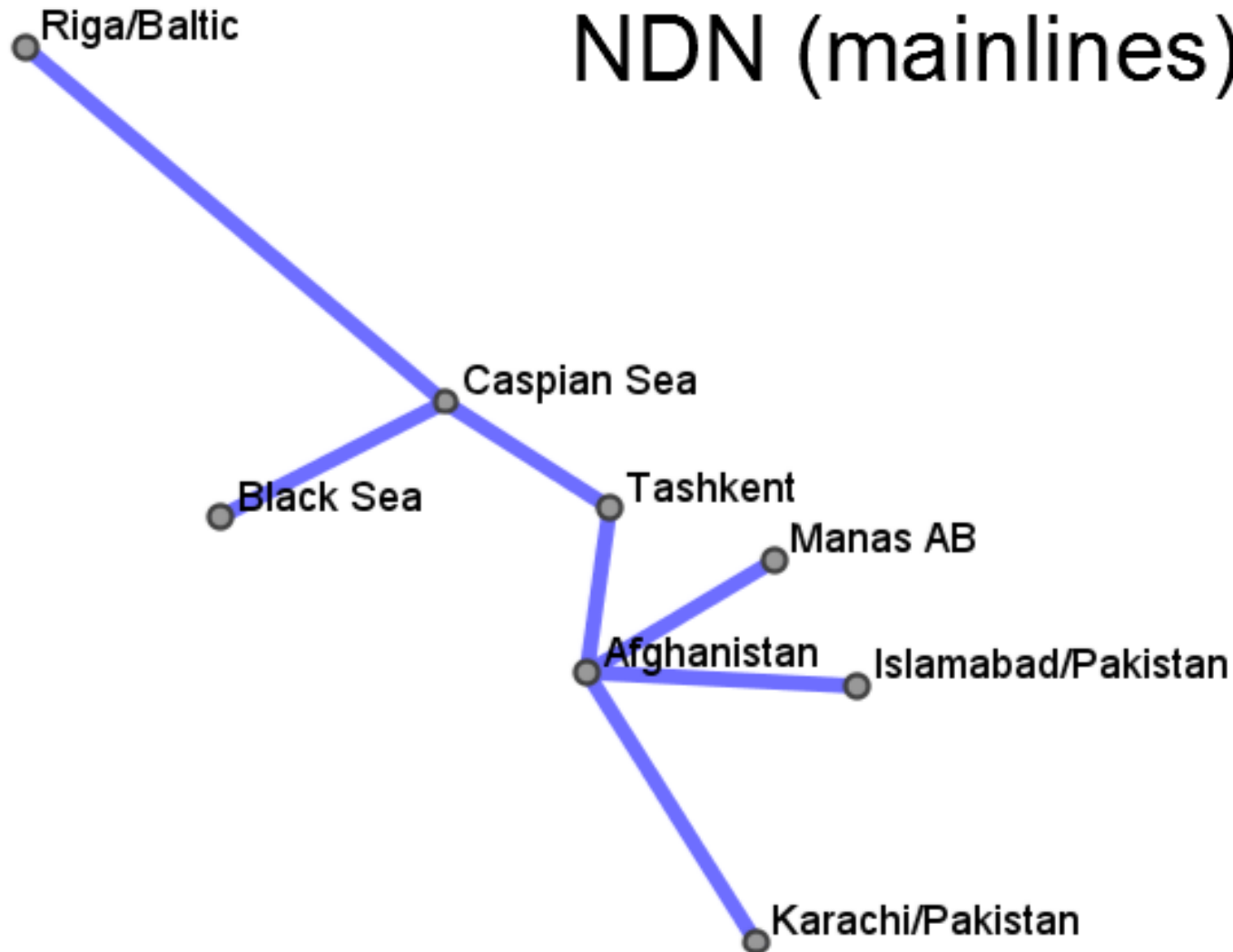


Another view: The Transit Map of OSR



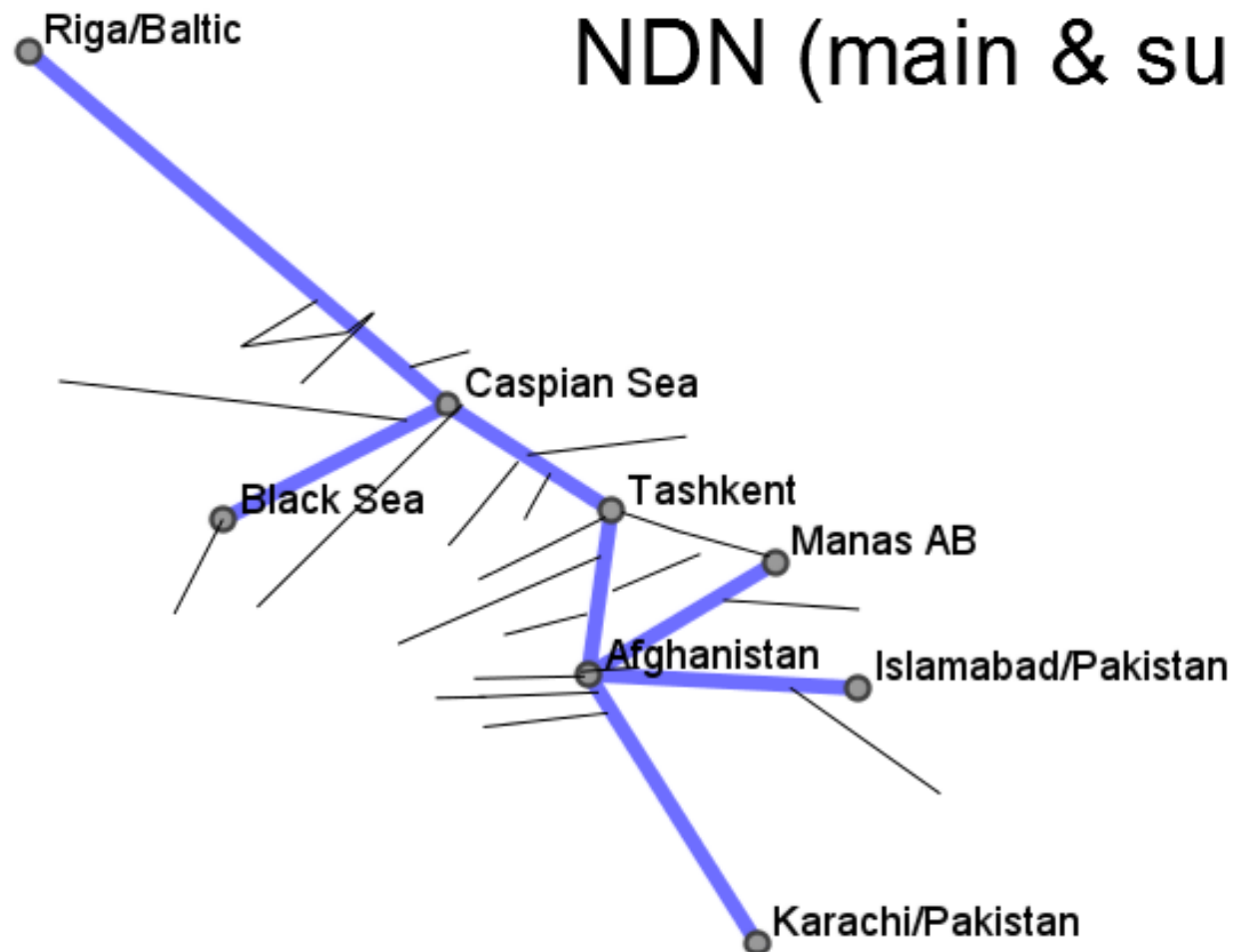
The Transit Map of NDN

NDN (mainlines)

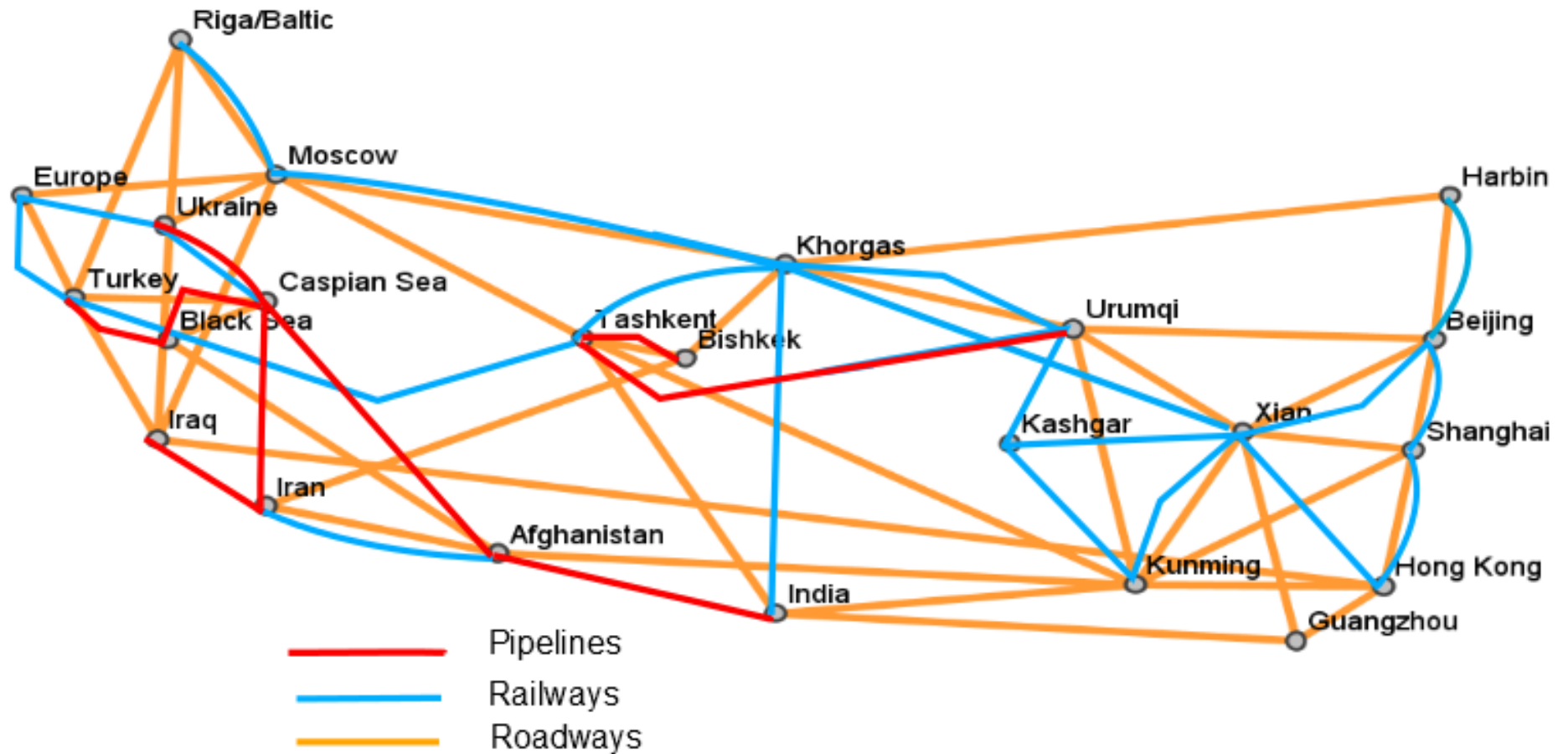


There is more, much more

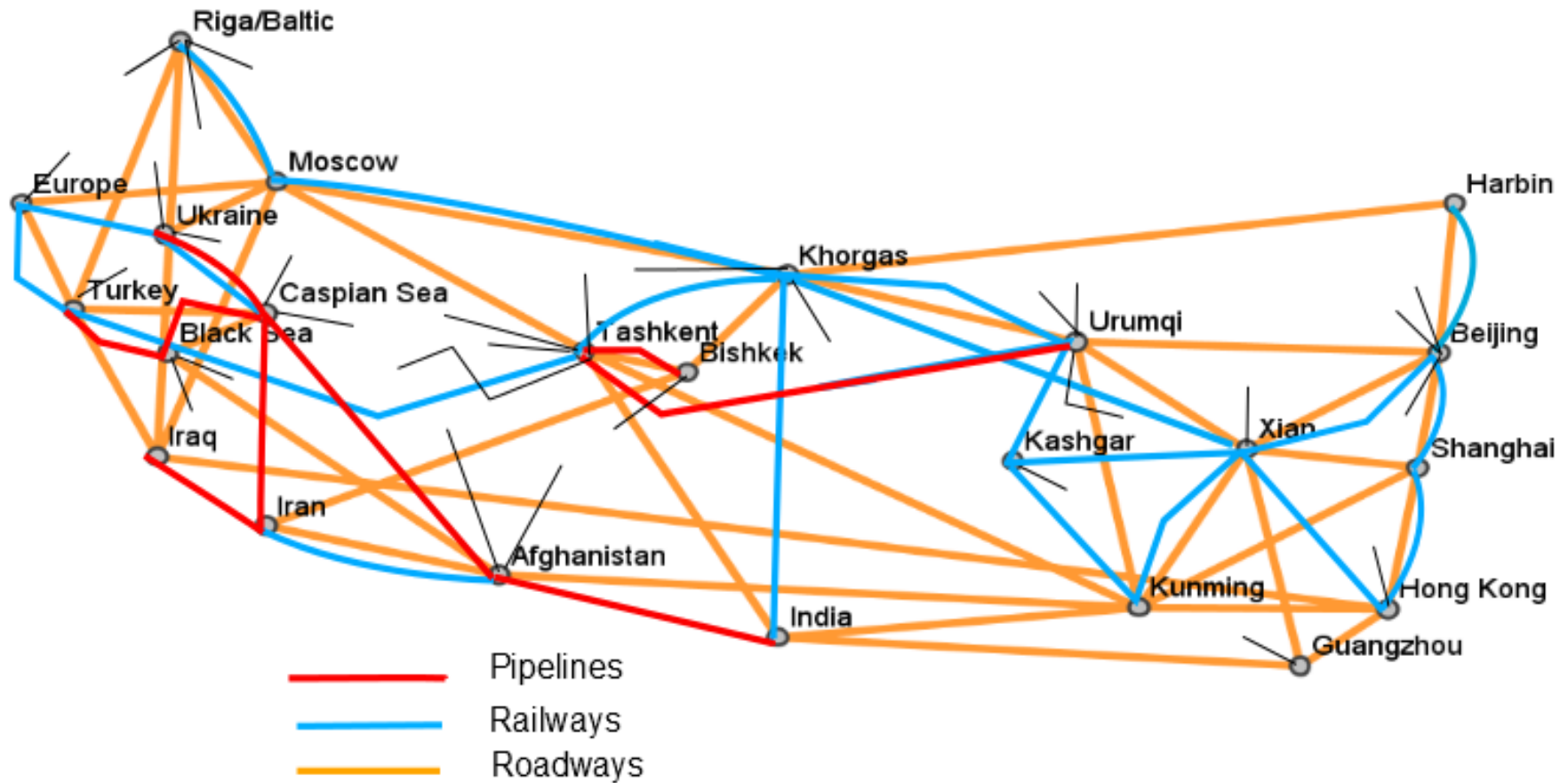
NDN (main & subs)



Transit Map of NSR



Much More to do



Flow & Usage rates and costs

Cooperation drives down prices & builds efficiencies

Rail Link or Sea Lane --- 36 day container ship trip reduced to several 13 day freight train (China-Europe)

Multimodal (diversity always helps)

Rail link Problems (differing rail gauges)

Border Crossing Issues (tariffs, fees)

Social and Political issues abound

Status Report

NSR produces a large central trader --- China gaining more centralization along with US domination (not good for global health)

Social factors are unsettled and unresolved – potential for advances in societal health as the islets become more central

Multi-modal trade is good for economy & control & influence (less centralization --- more places for the smaller nations)

New players (like Iran) can emerge and gain stature in the network (less centralization)

Sea Lane Evolution/Revolution

Before Canals

- No containers
- Suez --- 1870
- Panama -- 1914

Modern Shipping

- 5,000 container ships
- Efficient-designed ports
- Suez (26 ft depth, 16 hrs for 120 miles)
- Panama (40 ft depth, 20 hrs for 48 miles)

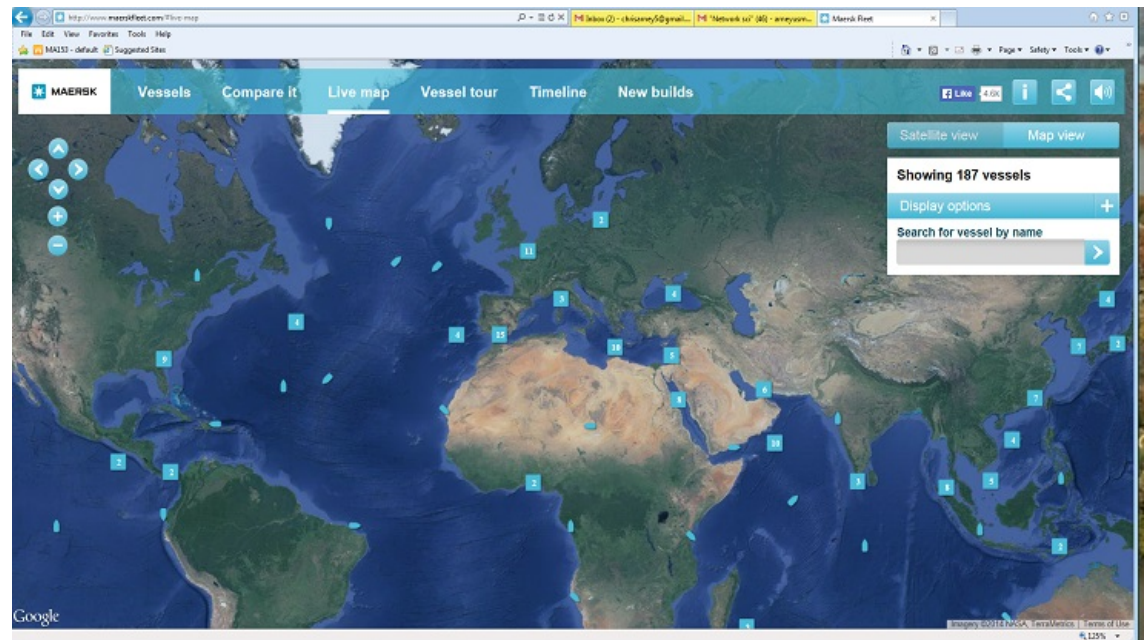
Mega Shipping

- 18,000 container ships
- 600-ship companies
- New Panama Canal (25% longer, 50% wider, 25% deeper)
- Net Suez facilities (79 ft depth)
- North Passage studies



- International Maritime Organization -- UN agency responsible for shipping and prevention of marine pollution.
- Value of TEU container lies in how it is used.
- **Container** -- basic entity of flow networks for moving goods from anywhere to anywhere.
- 30 million containers in the world. Each of them with 60,000 pounds of something. Doesn't matter what you're shipping – the price is the same.

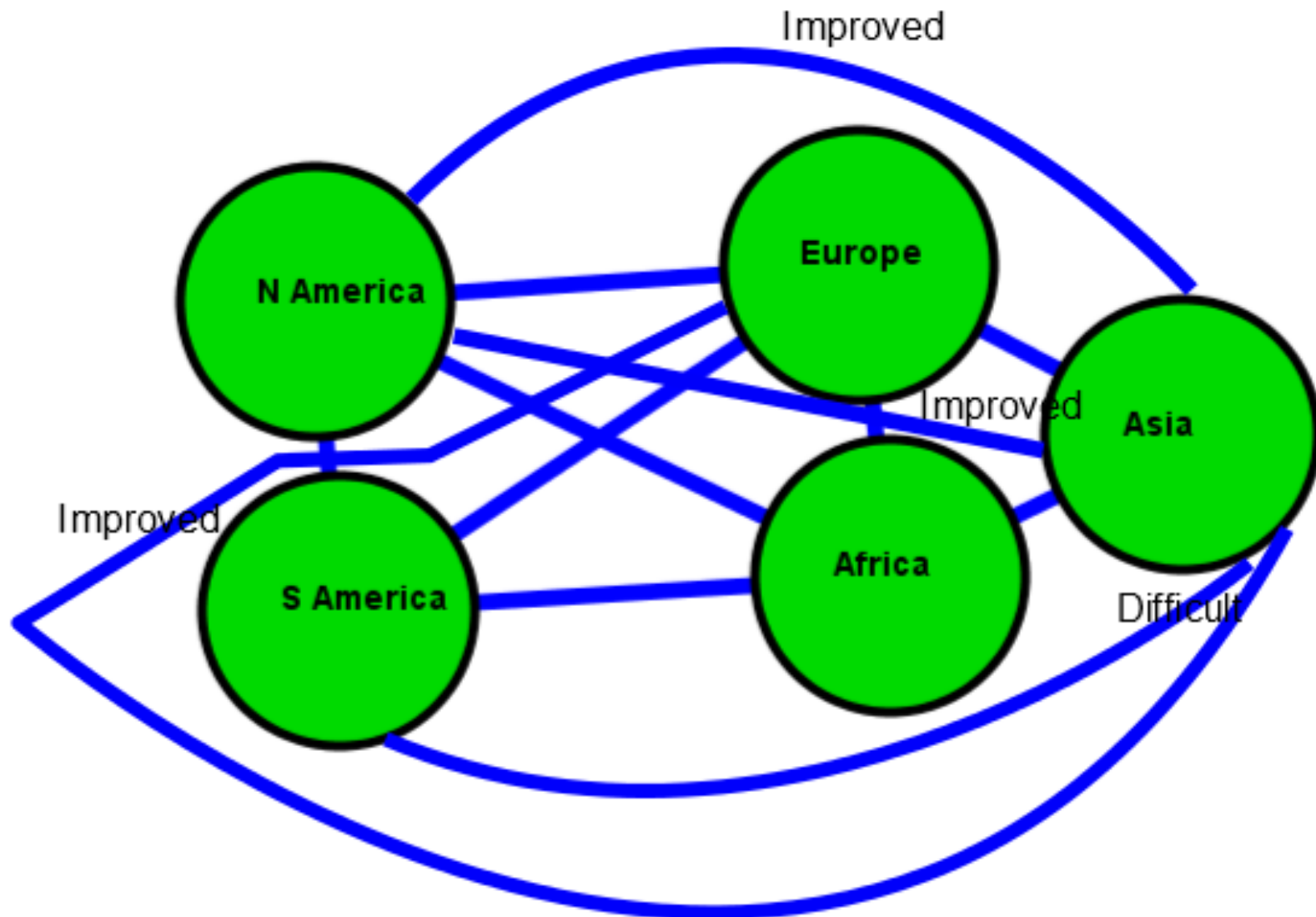
“The Box, How the Shipping Container Made the World Smaller and the World Economy Bigger,” by Marc Levinson.



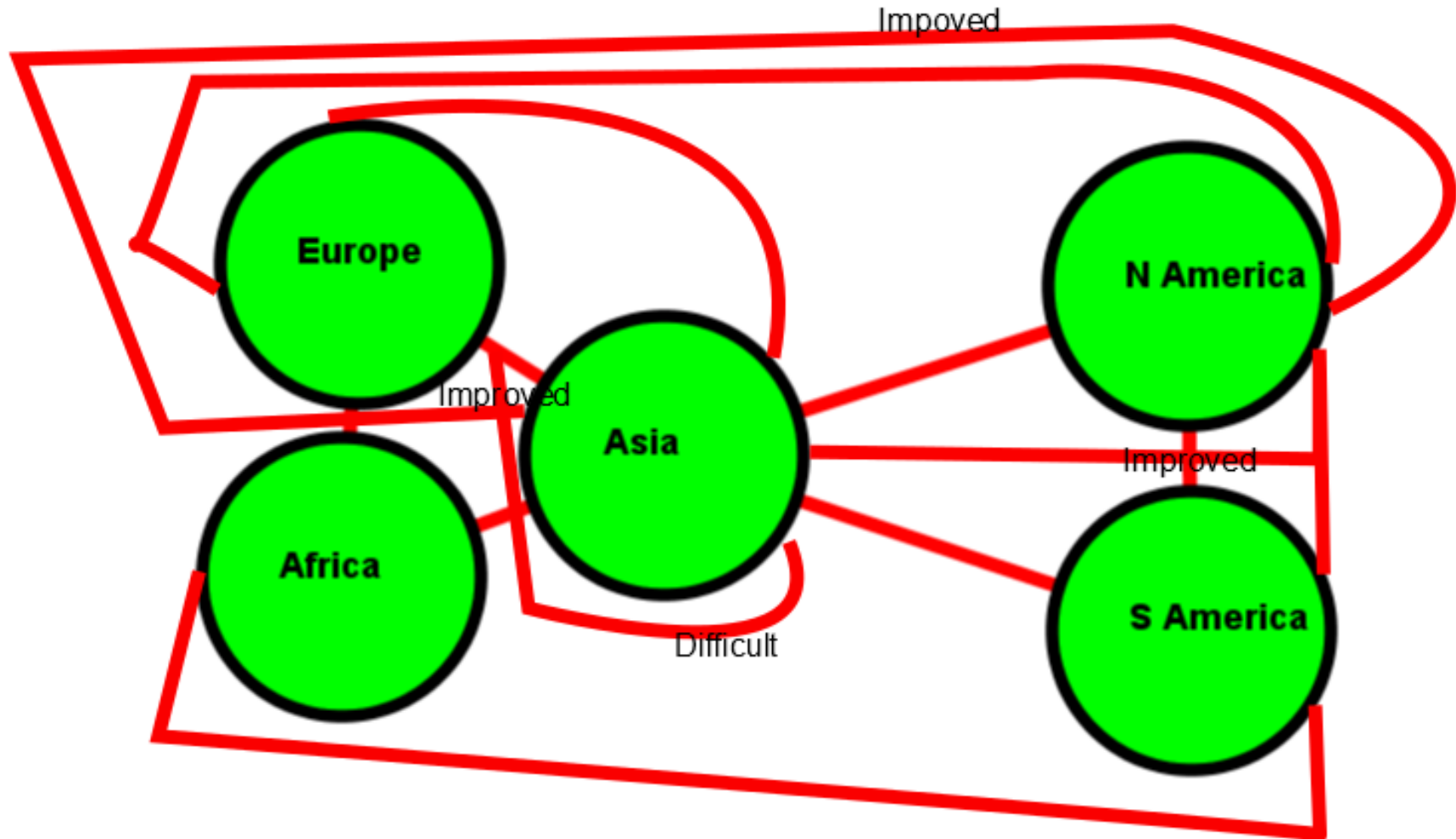
The Good, Bad, and Cold (the north is open for business)



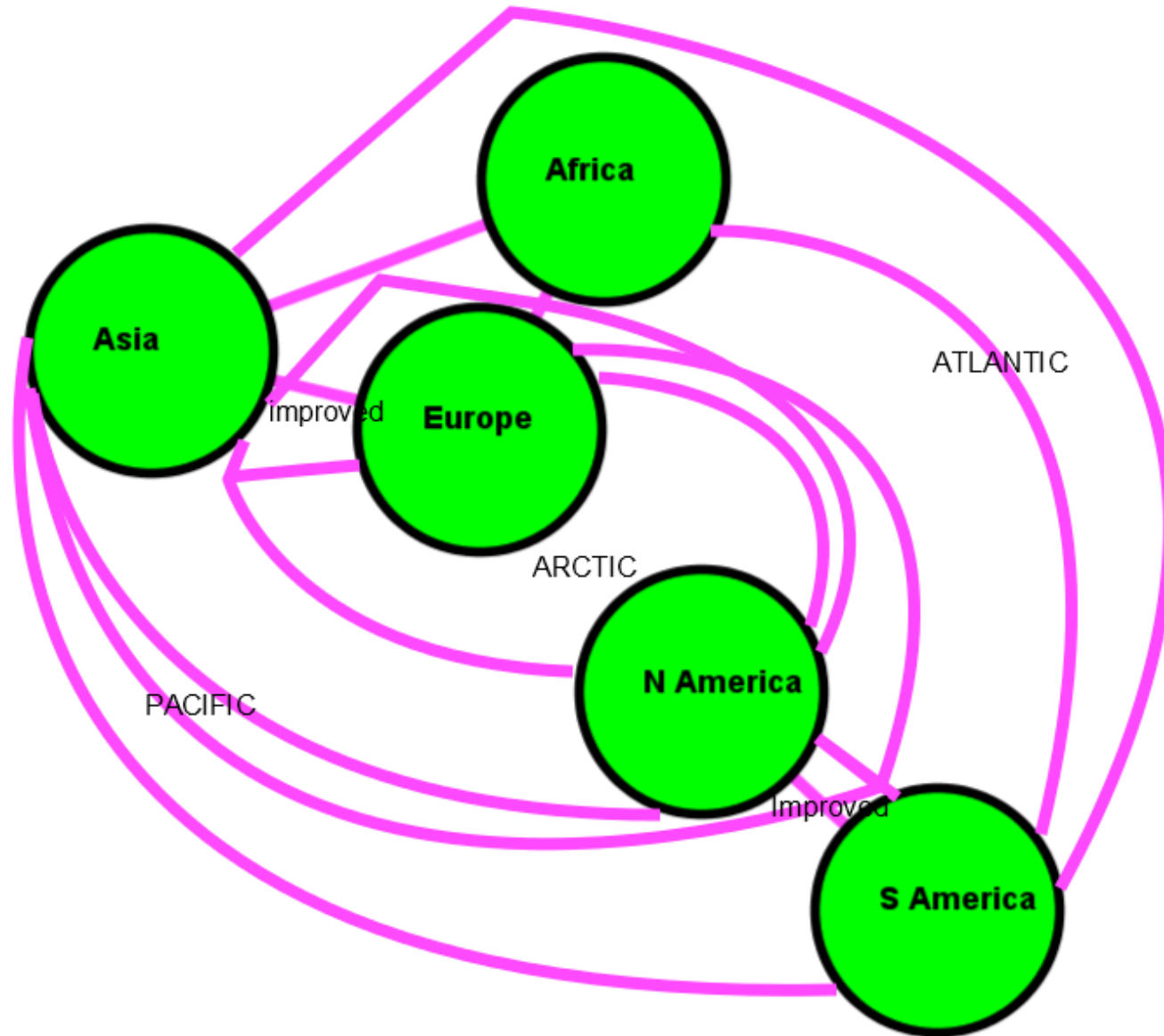
The Transit Map of Sea-lanes (Atlantic-centered)



The Transit Map of Sea-lanes (Pacific Centered)



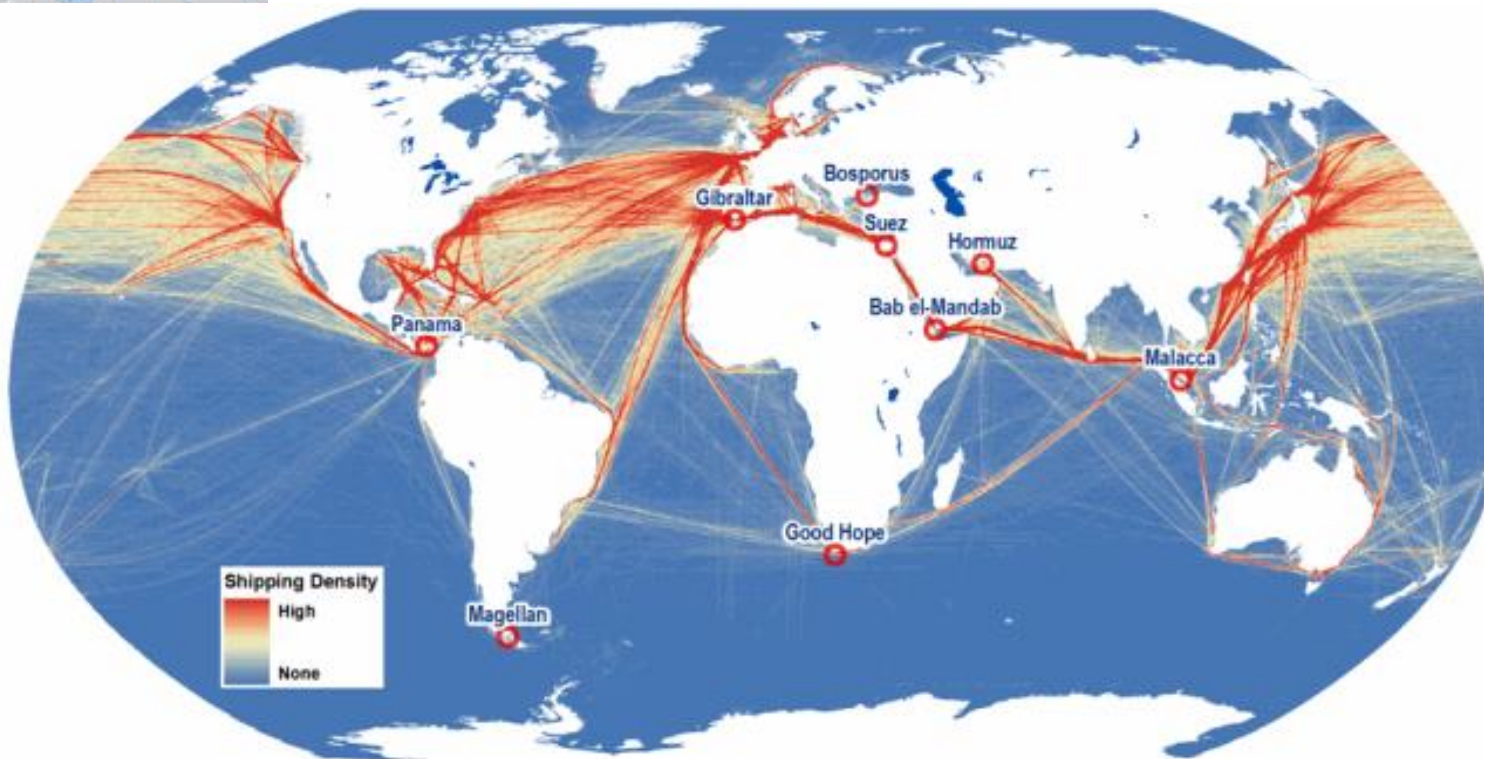
A Transit Map of Sea-lanes (Arctic-Centered)





Sea-Lane Flow Summary

- US gains from Panama Improvement (more centrality)
- China gains from Suez Improvement (more centrality)
- Russia gains from Northern Passage opening (more centrality)
- Rest of the world loses if big companies/nations (the Big 3) get bigger (more centralization), or gains if everyone gains from these changes (less centralization).



Still much to do

- Human-based measures for prosperity and harmony from multi-modal trade/diplomacy networks.
- What is the impact of greater trade density. Everyone can't be central but can be equal (less centralization in trade). The Silk Road's Bigger, Stronger, Fewer, does not help.
- Probability for 50% increase in trade in less than 10 years?

Africa Megacity Vulnerability Network

Rapidly **evolving social, economic, and physical structures** throughout the world suggest that future operations will involve **complex systems, unexpected scenarios, and nonlinear processes**. These systems have been described as having four components: **volatility, uncertainty, complexity, and ambiguity** (VUCA) (Kail, 2010).

The following questions will guide our research:

- Who are the key actors and what are the main supply-chains and core processes? How do these develop and change?
- Who is vulnerable? Why are they vulnerable? How do we mitigate risk and vulnerability?
- How are Infrastructure/Resource/Logistic networks sustained when growth outpaces capacity?
- How does environmental stress, to include resource demand and pollution, exacerbate vulnerability and strain networks?

This research will use our vulnerability framework and social network models to reveal the dynamics in urban and peri-urban spaces to expose critical elements and vulnerable populations.