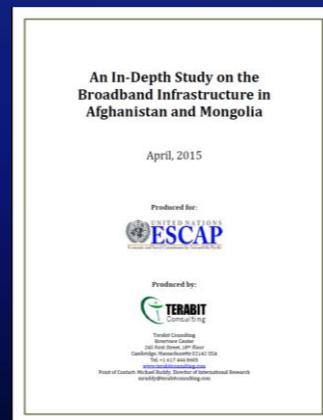
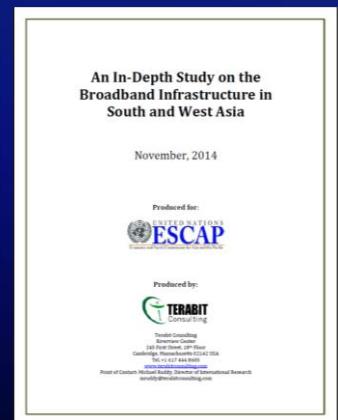
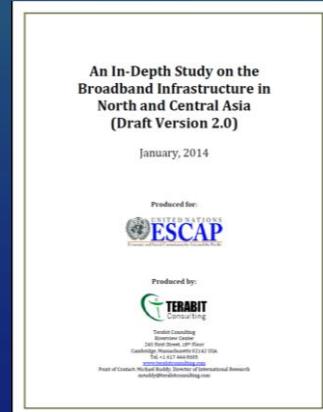
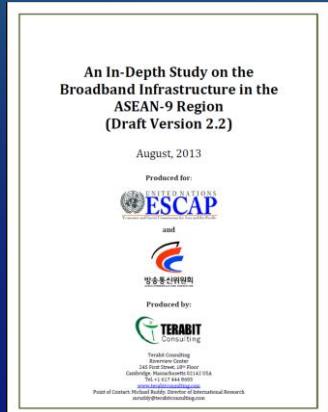


Pan-Asian Connectivity: Leveraging Linear Infrastructure for Improved International Bandwidth



Michael Ruddy
Director of International Research
Terabit Consulting

Terabit Consulting's Role in AP-IS Development



Since 2012, Terabit Consulting has completed **detailed analyses of broadband infrastructure and markets** on behalf of UN ESCAP, covering a total of 29 countries:

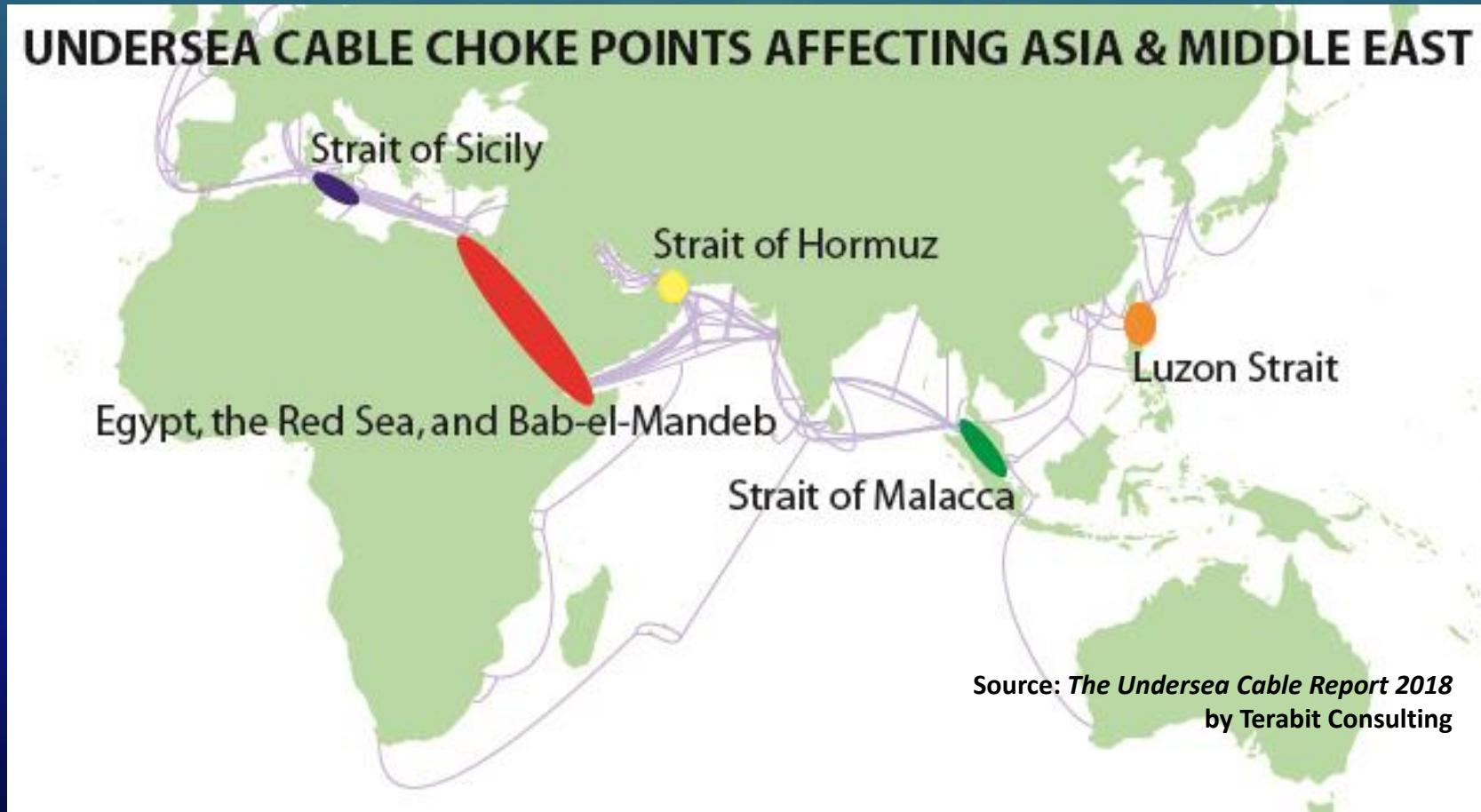
- **ASEAN-9** (study delivered August, 2013)
- **North and Central Asia** (November, 2013)
- **South and West Asia** (November, 2014)
- **Afghanistan and Mongolia** (April, 2015)

Weak Regional Infrastructure Divides and Constrains the Region

- The continent's long-haul terrestrial fiber infrastructure is **low-capacity, geographically-limited, high-cost, and unreliable**
- There are **no coherent, cost-effective, pan-regional fiber optic networks:**
 - international connectivity consists almost entirely of **bilateral, point-to-point, closed-access trans-border links**
- **Landlocked countries** are at the mercy of **bandwidth-rich coastal neighbors**
- **Coastal countries also suffer** because bandwidth is concentrated on **vulnerable submarine cable routes** including those that cross Egypt



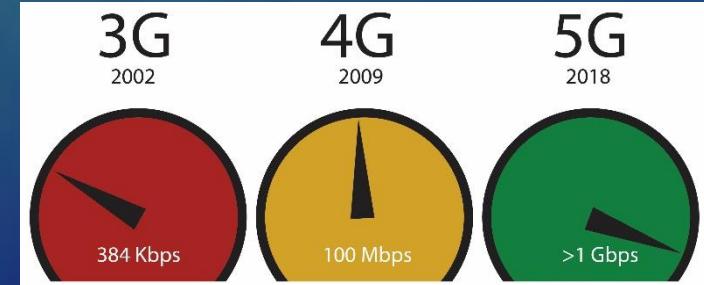
Terrestrial as a Solution for Submarine



The global telecommunications industry is desperate for a cost-effective solution that would avoid undersea choke points.

Key Drivers of Bandwidth Demand

1. Mobile data, especially in developing markets, where:
 - A. Volume growth is typically 75% to 100% per year; potential step change on horizon with 5G
 - B. Operators' data revenues are growing at >50% per year and compensating for falling ARPUs
 - C. Rapid rollout of LTE has been facilitated by infrastructure sharing and towercos
2. Successful FTTH deployments
 - A. NBNs
 - B. Operator buildouts
 - C. Utilities leveraging linear infrastructure
3. Content: insatiable OTT and private network demand



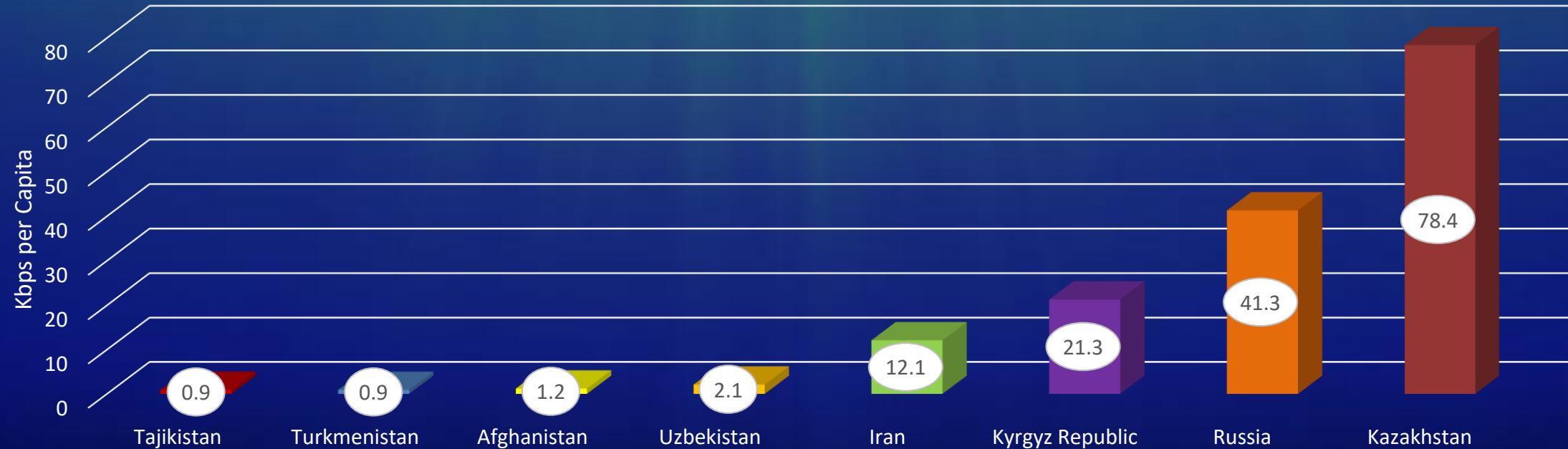
Content Providers' Demand



- Azure (Microsoft's WAN): As of 2017, “Over the last three years, we've grown our long-haul WAN capacity by 700 percent”: 91% CAGR
- B4 (Google's SDN WAN): most recent published traffic figures indicated 10x increase in 3.5-year period leading up to 2015: 93% CAGR

Many Asian Markets Are Getting Left Behind by the Region's Weak and Expensive Connectivity

International Bandwidth per Capita in Central Asia, YE16 (Kbps); Source: Terabit Consulting



- By comparison: 104.3 Kbps in USA, 796.2 Kbps in Singapore
- Less than 10 Kbps per capita is virtually unusable and is a serious obstacle to growth
- IP Transit costs >\$50 Mbps in many Central Asian markets, compared to >\$1 in USA & Europe

Low International Bandwidth & Weak Intl. Infrastructure Has a High Cost Across the Economy

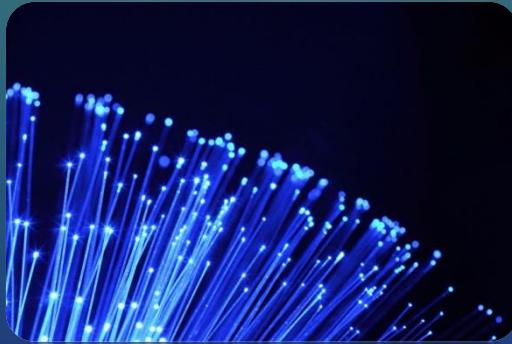
- At the macro level: a major obstacle to economic and human development
 - Detachment from digital economy
 - Continued economic inefficiencies and restrained growth
 - Lack of access to critical social development tools including telemedicine, distance learning, scientific/research networks
- More specifically within the telecom environment: higher wholesale and consumer prices, and lower broadband adoption rates



Conclusions of Terabit Consulting's Broadband Analysis for ESCAP

- There is a clear divide between Asia's bandwidth “haves” and its bandwidth “have-nots”
 - Among the 29 Asian countries analyzed by Terabit Consulting for ESCAP, 16 had unacceptably low levels of per-capita bandwidth, and unacceptably high bandwidth prices
- The first step in addressing the inequality is the construction of international fiber infrastructure that puts the entire continent on an equal footing.
- The most efficient way to do this is by leveraging existing linear infrastructure for the construction of fiber networks.

Strategies to Ensure Successful Network Development



1. Leveraging existing linear infrastructure

- Right-of-way procurement and uniform construction techniques would be enabled through the use of linear infrastructure such as the Asian Highway, railways, or energy networks.

2. Functioning and monitored as single, uniform network

- Existing multi-national terrestrial networks cannot offer uniform quality-of-service guarantees between endpoints (as good as “weakest link” or “weakest operator”).

3. Fully integrated and coherent

- Redundant ring or mesh architecture would allow for in-network healing in the event of physical cable outages or instability affecting connectivity in specific countries.

Strategies to Ensure Successful Network Development

(Continued)



4. Cost-effective

- With suitable transmission capacity and fiber count, a pan-regional terrestrial fiber network could compete effectively with submarine cable on both a regional and intercontinental basis.

5. Open access and non-discriminatory pricing

- In order to achieve development and policy goals, as well as to serve the region's consumers, all purchasers of capacity must be able to access the network on an equal, non-discriminatory basis.

6. Developed and managed by a Special Purpose Vehicle (SPV)

- SPV shareholding would ensure the neutrality and efficiency of the network
- Allows participation by all stakeholders while still maintaining arm's-length terms over all capacity sales and leases.

Improved Regional Fiber Connectivity: Immediate Benefits & Opportunities for Operators

1. Would bring lower-cost, higher-volume bandwidth

- Via improved regional access to Russia, Europe, and China

2. Would increase the reliability of int'l. connectivity

- Additional fiber connectivity decreases the likelihood of network outages

3. Would increase value of operators' existing infrastructure

- improved regional fiber connectivity would greatly increase the utility and value of domestic networks

4. Would present a stronger opportunity for the sale of transit capacity to neighbors & share of Europe-Asia

- Improved regional connectivity would allow countries to export to their neighboring markets, and also to capture a share of the lucrative Europe-to-Asia transit market (currently in excess of 20 Tbps)

Deployment of Multinational Fiber Networks along Linear Infrastructure is Imperative for Asia's Growth

1. The “bandwidth have-nots” are falling farther behind, and this will limit growth across the entire continent
2. FTTH, LTE, and 5G networks cannot function without reliable and abundant international connectivity
3. No other region has such vast unleveraged linear infrastructure
4. Key stakeholders, public and private, are convinced of the need for urgent improvement of the continent’s connectivity



**Intelligence, Analysis, and Forecasting
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