Improving Regional Connectivity
with the
Asian Information Superhighway

Michael Ruddy
Director of International Research
Terabit Consulting

TERABIT Consulting

Part 1: Background and Methodology

Project Scope

Since 2012, Terabit Consulting has completed **detailed analyses of broadband infrastructure and markets** on behalf of UN ESCAP, covering a total of 27 countries:

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

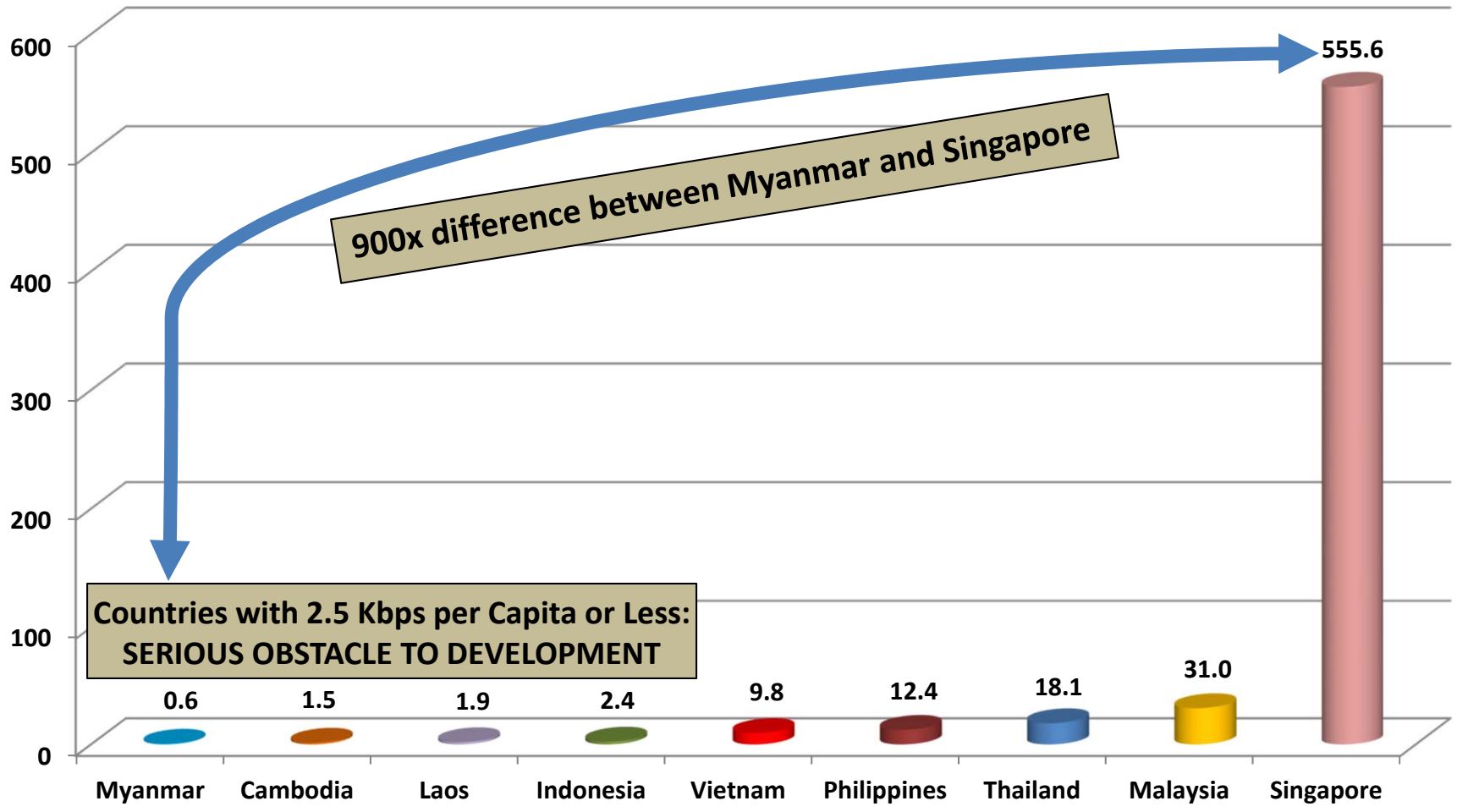
Sources of Data

- **Terabit Consulting has completed dozens of demand studies for submarine and terrestrial fiber networks worldwide**
  - Constant contact with operators, ISPs, and other stakeholders
- **Terabit Consulting's published reports include:**
  - *The Undersea Cable Report* (1,500+ pages)
  - *International Telecommunications Infrastructure Analysis* (1,000+ pages)
- **Terabit Consulting's core data and intelligence covers infrastructure, demand, traffic flows, pricing, and market share**

TERABIT Consulting

Part 2: The Bandwidth Divide

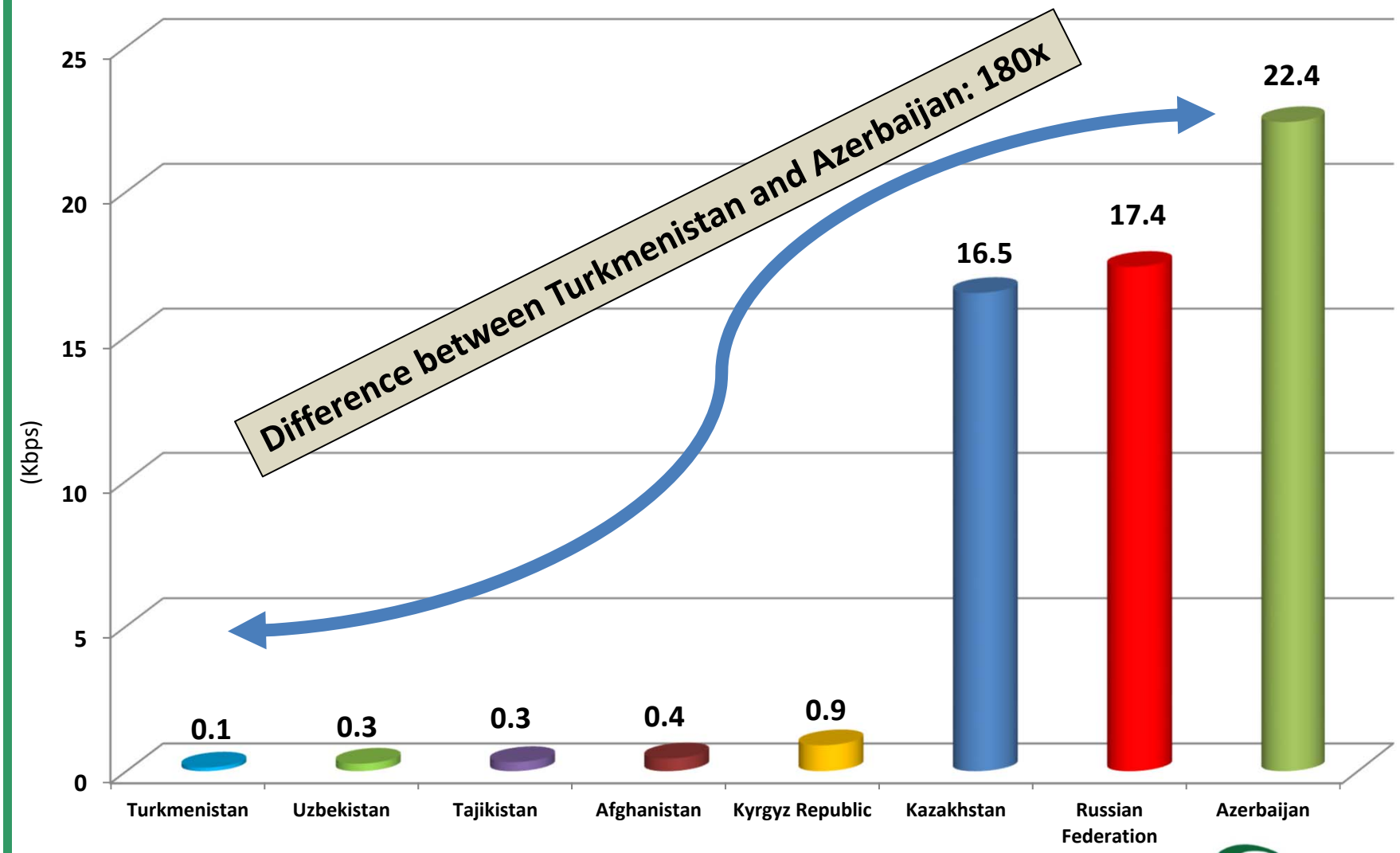
ASEAN Int'l. Internet B/Width per Capita (Kbps)



- Average in Western Europe: 100 Kbps

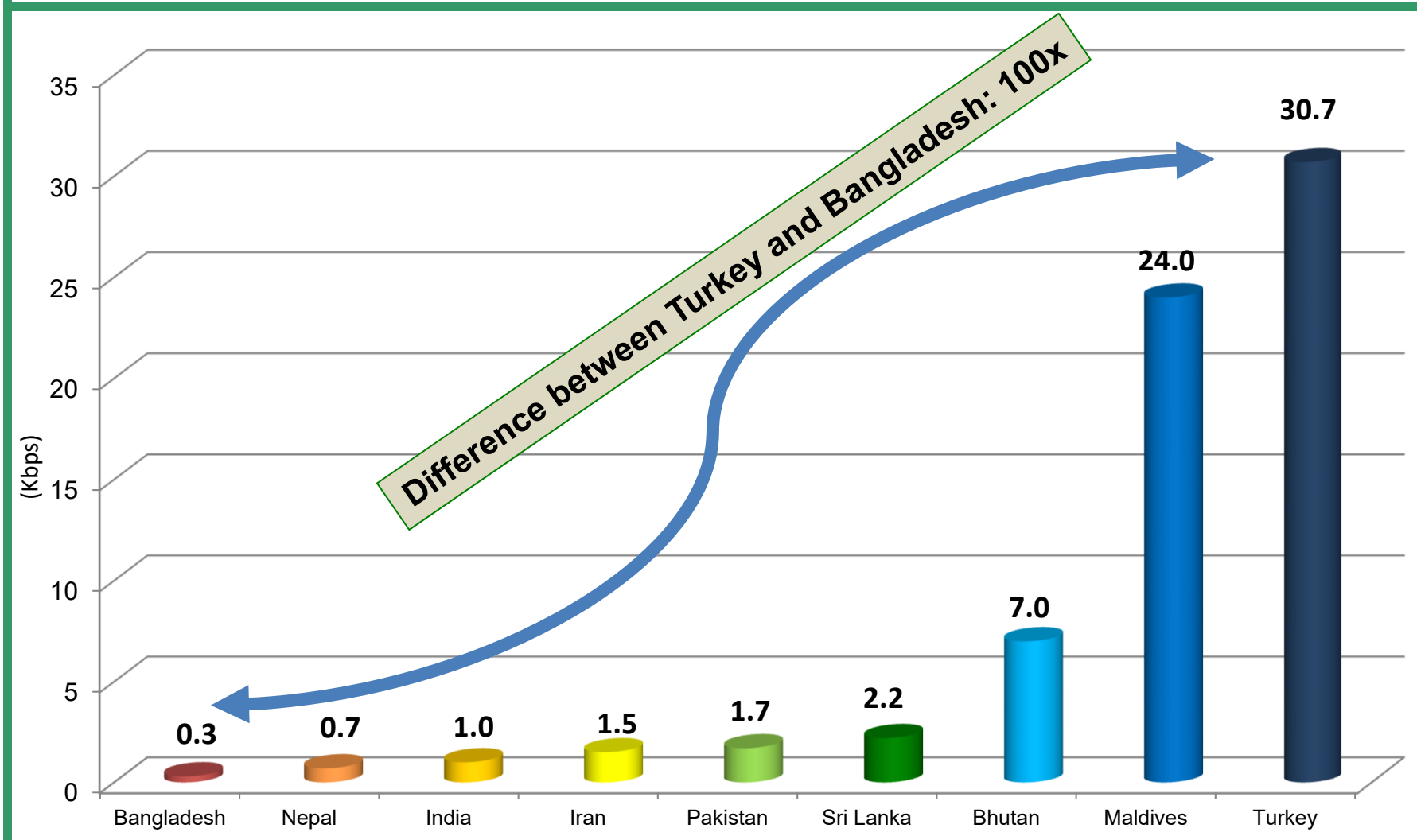
TERABIT Consulting

No. & Cent. Asia Int'l. Internet B/width per Capita



TERABIT Consulting

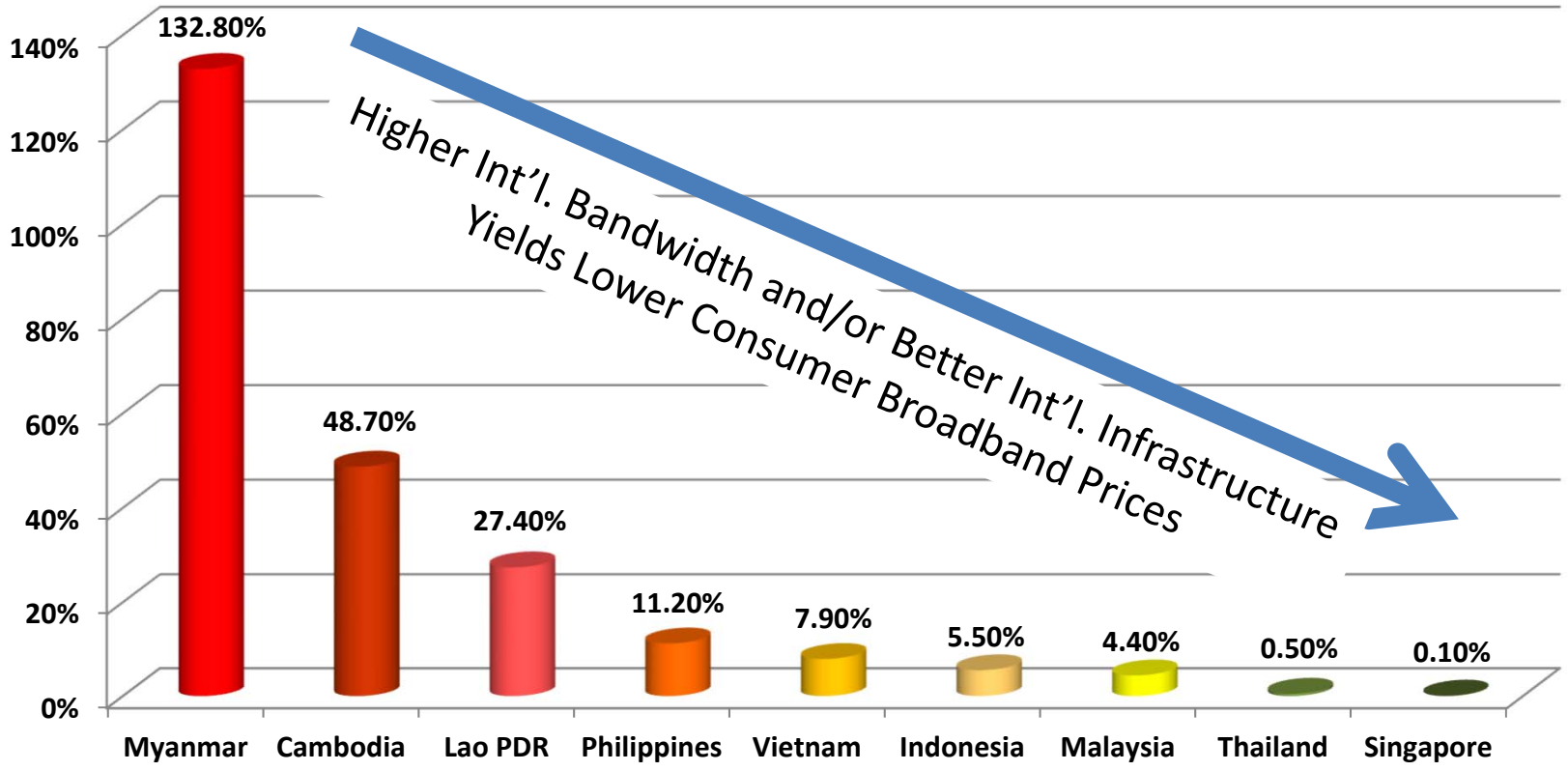
W. and So. Asia Int'l. Internet Bandwidth per Capita



TERABIT Consulting

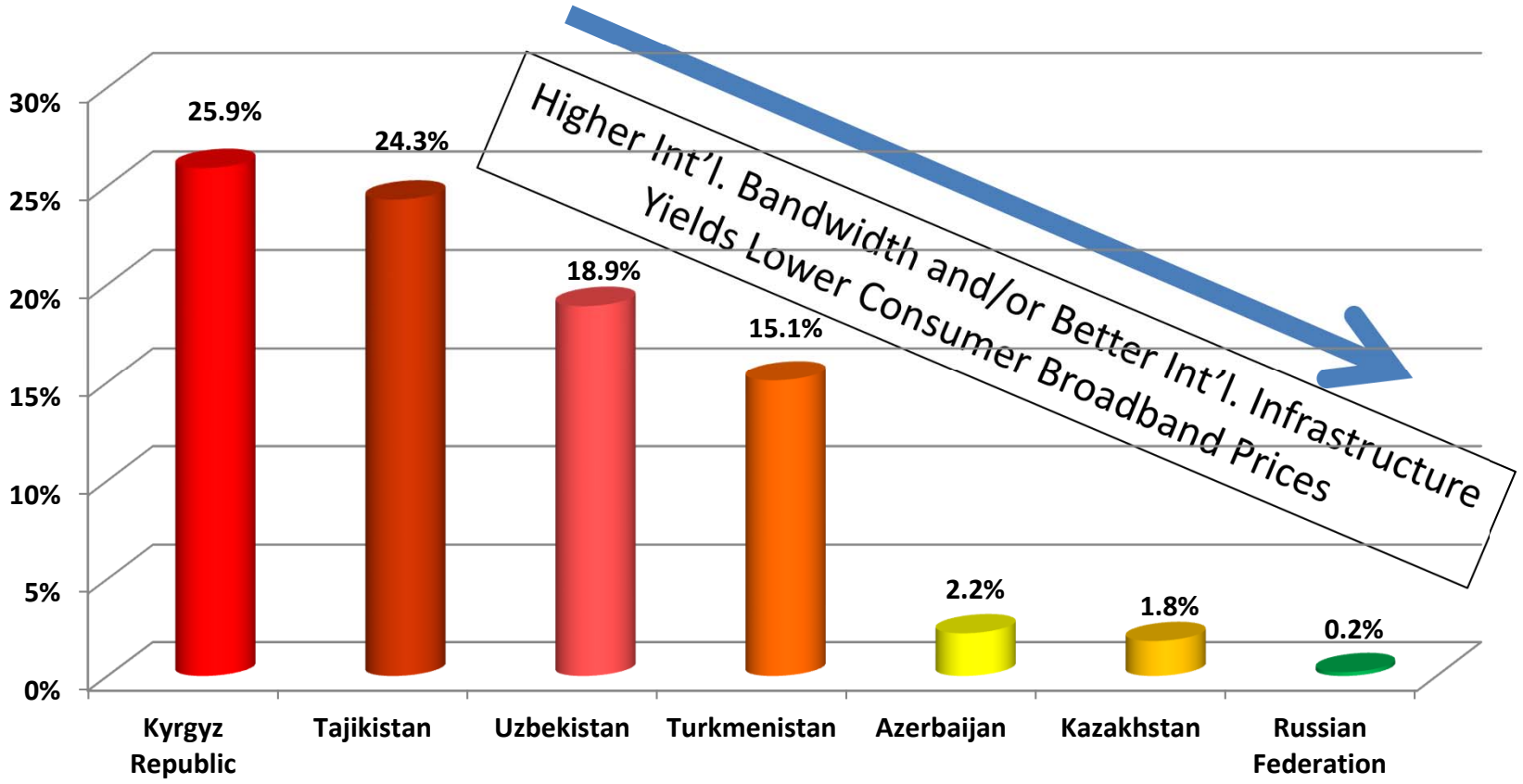
Weak Int'l. Bandwidth Impacts Consumer Pricing

1 Mbps Broadband Connection: Annual Subscription + Installation as a % of Per-Capita GDP (2013)



Consumer Pricing Disparities in No. & Cent. Asia

1 Mbps Broadband Connection: Annual Subscription + Installation as a % of Per-Capita GDP (2013)



TERABIT Consulting

Conclusion of Bandwidth Analysis

- A clear divide between Asia's bandwidth "haves" and its bandwidth "have-nots."
- The first step in addressing the inequality is the construction of international fiber infrastructure that puts the entire continent on an equal footing.

Part 3:
Regional Terrestrial Infrastructure

Existing Terrestrial Deployment in Asia

- **Asian terrestrial deployment falls into six categories:**
  - ✓ **Asia-to-Europe and China-Russia transit networks**
  - ✓ **Subregional initiatives**
  - ✓ **Southeast Asian multi-national networks**
  - ✓ **New West Asia/Middle East Networks**
  - ✓ **China-India cables**
  - ✓ **Other transborder (bilateral) links**

Asia-Europe & China-Russia Transit Networks

- **Trans Asia Europe (TAE)**
  - Conceived in 1990s; very low capacity; missing trans-Caspian links
- **China-Russia Networks**
  - Trans Europe Asia (TEA) (Rostelecom)
  - Europe-Russia-Asia (ERA) / China-Russia-2 / Eurasia Highway (TransTeleCom)
  - Europe-Russia-Mongolia-China (ERMC) via Mongolia Railway (2004)
  - MegaFon Diverse Route for European & Asian Markets (DREAM) (2013)
  - Europe-Kazakhstan-Asia (EKA) / Information Silk Road
- **Trans Eurasian Information Superhighway (TASIM)**
  - Frankfurt-Hong Kong
  - China, Kazakhstan, Azerbaijan, Georgia, Turkey (Including trans-Caspian link)

Subregional Initiatives

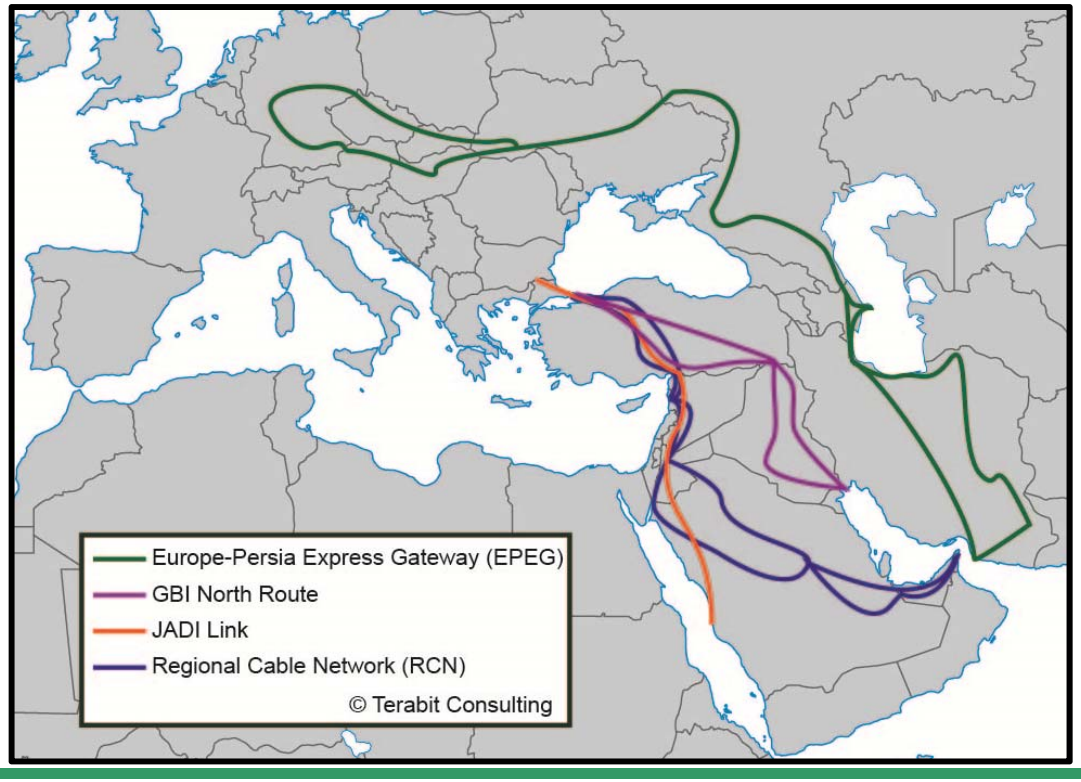
- **Greater Mekong Subregion (GMS) Information Superhighway**
  - Cambodia, China, Laos, Myanmar, Thailand, Vietnam
  - Supported by Asian Development Bank
- **South Asian Subregion Economic Cooperation (SASEC) Information Superhighway**
  - Bangladesh, Bhutan, India, Nepal
  - Supported by Asian Development Bank

Southeast Asian Multi-National Networks

- **China-Southeast Asia Cable (CSC) (2001)**
  - China, Vietnam, Laos, Thailand, Malaysia, Singapore
- **Thailand-Cambodia-Vietnam-Hong Kong (2012-2013)**
  - TCC (Thailand), VTI/VNPT (Vietnam), NTC (Cambodia), DHT (Hong Kong)

New W. Asia/Middle East Networks

- 2010:2013, four new interregional terrestrial networks were constructed between the Middle East and Europe.
- 2010: **JADI Link** & **Regional Cable Network (RCN)**: as of 2015, out-of-service (Syrian Civil War)
- 2012: **Europe-Persia Express Gateway (EPEG)**, conceived as a terrestrial backup route for the Europe-India Gateway (EIG) submarine cable, which had been prevented from landing in Egypt.
- 2013: Gulf Bridge International (GBI) activated its terrestrial **GBI North Route** through Iraq and Turkey in 2013 in order to provide redundancy for its Egyptian terrestrial crossing via the TE Transit Corridor.



China-India & Other Bilateral Cables

- The region is also connected by trans-border links, typically developed by two operators (one in each country).
- These systems are typically designed for the use of the two investing operators, and do not offer a practical or cost-effective solution for bandwidth purchasers.

The Role of Terrestrial Fiber Infrastructure

- Up to 50% of Asian countries' international traffic is intraregional and should logically be routed via terrestrial cables.
- However, the region's terrestrial connectivity consists mostly of bilateral links, or multinational networks that fail to operate on a coherent basis
- In its current state, most of the region's terrestrial international bandwidth is high-price, closed-access, low-capacity, and low-reliability: it is not competitive.
- Consequently, most international traffic continues to be routed via submarine cables, while landlocked countries suffer from weak, overpriced, unreliable connectivity

TERABIT Consulting

Part 4:
Why a Coherent, Open-Access, Cost-Effective Pan-Asian Fiber Infrastructure Would Benefit the Region

Reason #1

Telecommunications and Internet development in the *"bandwidth have-not"* countries, as well as each country's overall economic development, has been greatly restrained as a result of weak international infrastructure.

TERABIT Consulting

The Impact of Low International Bandwidth & Weak International Infrastructure

- **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**
  - IP transit in the region's less developed markets can be more than $50 per Mbps
    - *Compared to HK: $5 per Mbps*
    - *Compared to Turkey: $2.60 per Mbps*
    - *Compared to USA: $1 per Mbps*

Reason #2

Despite their developed international connectivity, the markets with strong, low-cost bandwidth (the *"bandwidth haves"*) would greatly benefit from improved pan-regional terrestrial fiber.

Pan-Regional Fiber Benefits Markets with Strong Connectivity

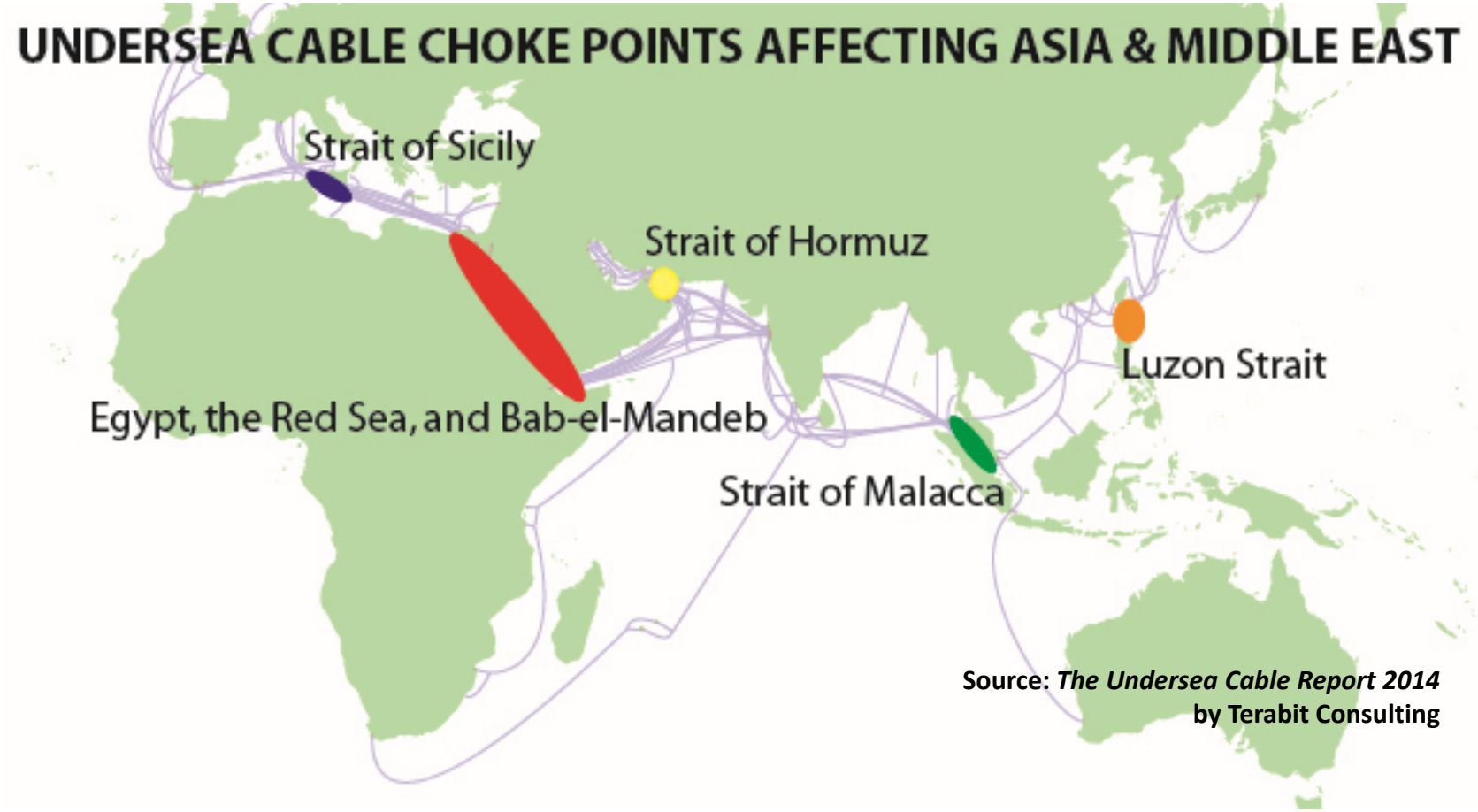
- Mesh connectivity throughout the region would increase all countries' network reliability and provide critical outlets of connectivity
  - Allowing Singapore to have a stronger alternative to the Strait of Malacca and the Egyptian bottleneck, for instance
- Stimulating the region's overall demand presents a greater market opportunity for transit providers and submarine cable operators in wealthier countries.

Reason #3

In financial terms, the viability of constructing coherent pan-Asian terrestrial fiber optic connectivity can be guaranteed by capturing even a small portion of bandwidth demand between Asia and Western Europe.

TERABIT Consulting

Terrestrial as a Solution for Submarine



Source: *The Undersea Cable Report 2014* by Terabit Consulting

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

TERABIT Consulting

The Need for a Terrestrial Alternative to Egypt

- The global bandwidth industry's most urgent requirement is for a **reliable, cost-effective, low-latency route between Europe and Asia that avoids the Egyptian "bottleneck"**
- **More than 95 percent** of activated Europe-to-Asia bandwidth (including key systems such as FLAG Europe-Asia, Sea-Me-We-3, Sea-Me-We-4, and I-Me-We) **passes through Egypt's Gulf of Suez and metro Alexandria**
- For the past 20 years, concerns have been expressed by global operators regarding the vulnerability of this network traffic, with sources identifying Egypt, and specifically the Suez corridor and adjacent coastal areas, as the **"Achilles Heel" of global networks**

Egyptian Submarine Cable Catastrophes

- The **arrest of three scuba divers** allegedly cutting submarine cables in March 2013
- **Anchor damage** caused to EIG & TE-North in 2013 by a tanker
- **Three simultaneous cable cuts** off Egyptian Red Sea coast (2012)
- **FLAG Europe-Asia and SMW-3** cable cut in 2008

- **Continuing political risk & surveillance issues**

TERABIT Consulting

Strong Growth in Europe-to-Asia Bandwidth Demand

	2007	2008	2009	2010	2011	2012	2013	2014
FLAG Europe-Asia (FEA) (formerly FLAG)	20	50	50	50	110	140	240	240
Sea-Me-We-3 (SMW3)	150	150	200	200	200	200	410	480
Sea-Me-We-4 (SMW4)	640	640	1,500	1,500	1,700	2,000	3,590	3,590
Falcon	200	200	200	200	300	390	390	520
Seacom / TGN Eurasia			80	100	110	240	240	480
India-Middle East-Western Europe (I-ME-WE)				260	640	2,560	3,660	3,660
Europe-India Gateway (EIG)					240	240	700	700
Gulf Bridge International Cable System (GBI) /MENA						480	1,180	1,980
TOTAL ACTIVATED EUROPE-TO-ASIA SUBMARINE CAPACITY (Gbps)	**1,010**	**1,040**	**2,030**	**2,310**	**3,300**	**6,250**	**10,410**	**11,650**
CAGR (2007-2014)	**41.2%**							

Plus two new Europe-to-Asia projects: Sea-Me-We-5 and AAE-1

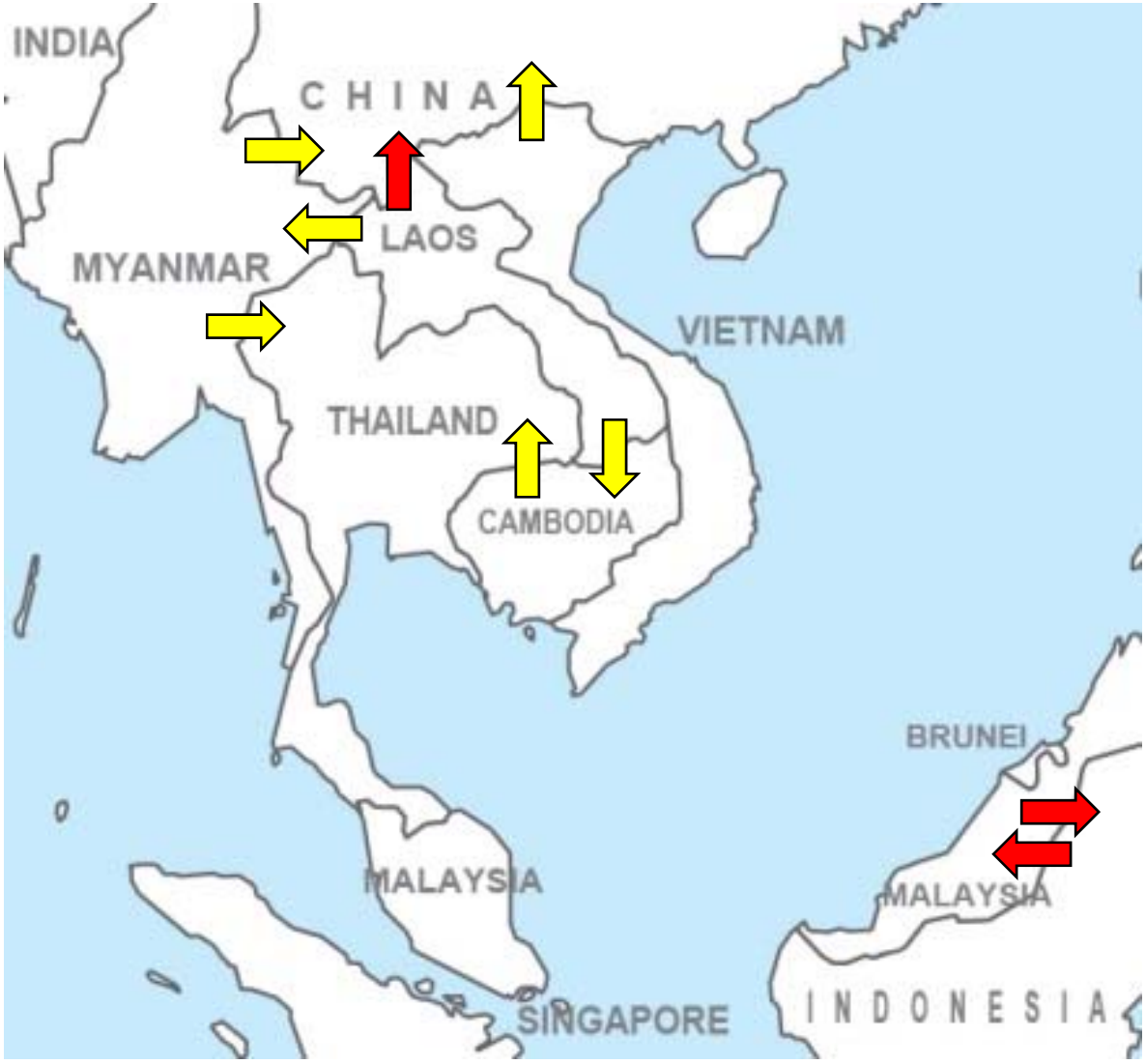
A Pan-Asian Terrestrial Network Would Be More Competitive than Europe-Asia Submarine

	Submarine	Terrestrial
Connectivity	Cable station to cable station, with expensive backhaul	POP-to-POP
Repair	Faults take weeks to repair; ships running costs $50,000+ per day	Networks accessible by highway can be quickly repaired at low cost
Capacity and Upgrades	Long-haul limited to 8 fiber pairs; submerged electronics poses limitation	Unlimited capacity with proper duct installation and maintenance
Costs	Unrepeatered 3-fiber pair cable: $12,500 per km, marine services $20k-$40k / km	$1,250 per km with marginal fiber costs of as low as $60 per km
Risk and Reliability	No viable alternative to Egyptian bottleneck	Mesh configuration could offer “five nines” if properly designed

TERABIT Consulting

Part 5:
Identification of Priority Cross-Border Terrestrial Links

Priority Trans-border Projects in ASEAN



High Priority

Lao PDR to Yunnan

Indonesia to/from Malaysia

Medium Priority

Cambodia to Thailand

Lao PDR to Cambodia

Lao PDR to Myanmar

Myanmar to Thailand

Myanmar to Yunnan

Vietnam to Yunnan

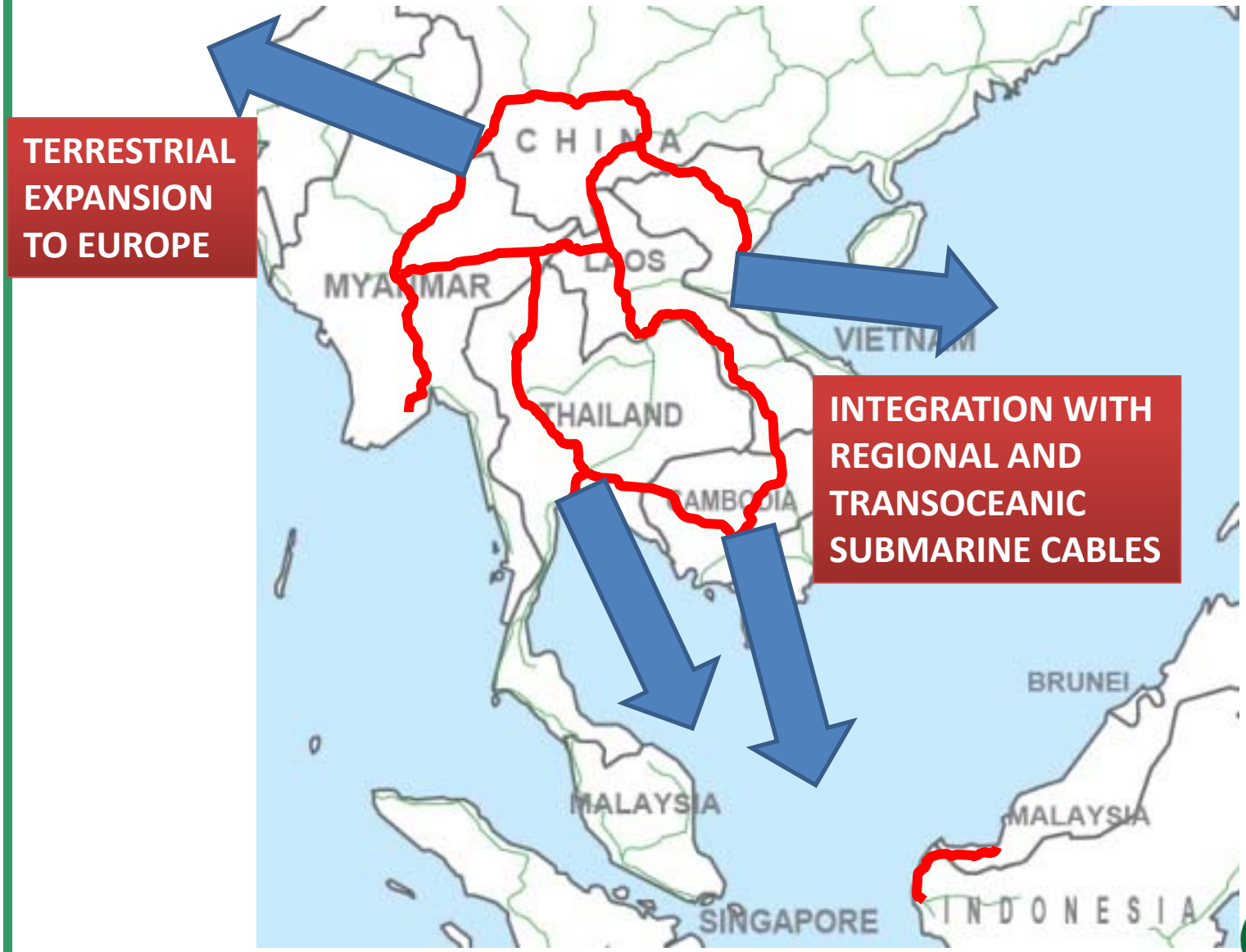
TERABIT Consulting

Envisioned ASEAN Fiber Network Based on Priority Trans-Border Links

LEVERAGING LINEAR INFRASTRUCTURE

TERABIT Consulting

Metcalfe's Law: The Value of a Network is Proportional to the Square of the Number of Nodes



TERABIT Consulting

North & Central Asia: Int'l. Bandwidth Infrastructure

TERABIT Consulting

Priority Projects in North & Central Asia

High Priority Trans-Border Projects

- Turkmenistan ↔ Kazakhstan
- Kyrgyz Republic ↔ Uzbekistan
- Tajikistan ↔ Uzbekistan
- Turkmenistan ↔ Uzbekistan

Medium Priority Trans-Border Projects

- Kyrgyz Republic ↔ Kazakhstan
- Uzbekistan ↔ Kazakhstan
- Kyrgyz Republic ↔ Tajikistan

South & West Asia Priority Projects

High Priority Trans-Border Projects

- Bangladesh ↔ Myanmar
- Bhutan ↔ India
- India ↔ Myanmar
- India ↔ Pakistan
- Nepal ↔ China
- Pakistan ↔ China
- Turkey ↔ Armenia

Medium Priority Trans-Border Projects

- India ↔ China
- India ↔ Nepal
- Iran ↔ Pakistan

Afghanistan & Mongolia Priority Projects

High Priority Trans-Border Projects

- Mongolia ↔ China
- Mongolia ↔ Russia

Medium Priority Trans-Border Projects

- Afghanistan ↔ China
- Afghanistan ↔ Iran
- Afghanistan ↔ Tajikistan
- Afghanistan ↔ Uzbekistan

TERABIT Consulting

Part 6:
The Case for Installing a Terrestrial Pan-Asian Fiber Optic Network Along Highway Rights-of-Way

International Highway Infrastructure

- In the near-term, many of the countries in the region will be upgrading existing highway infrastructure and installing new links
- Simultaneous installation of high-capacity fiber and ducts would be a negligible marginal cost in most projects

TERABIT Consulting

Installing Fiber within a Road Project

- In the US (high labor-cost market), conduit+fiber installation during open road construction costs between USD$6,000 and USD$18,000 per kilometer
- Road installation costs at least USD$1.8 million per lane, per kilometer
- Cost of fiber network installation during open road construction: much less than 1% of project total

Photos: Terabit Consulting

TERABIT Consulting

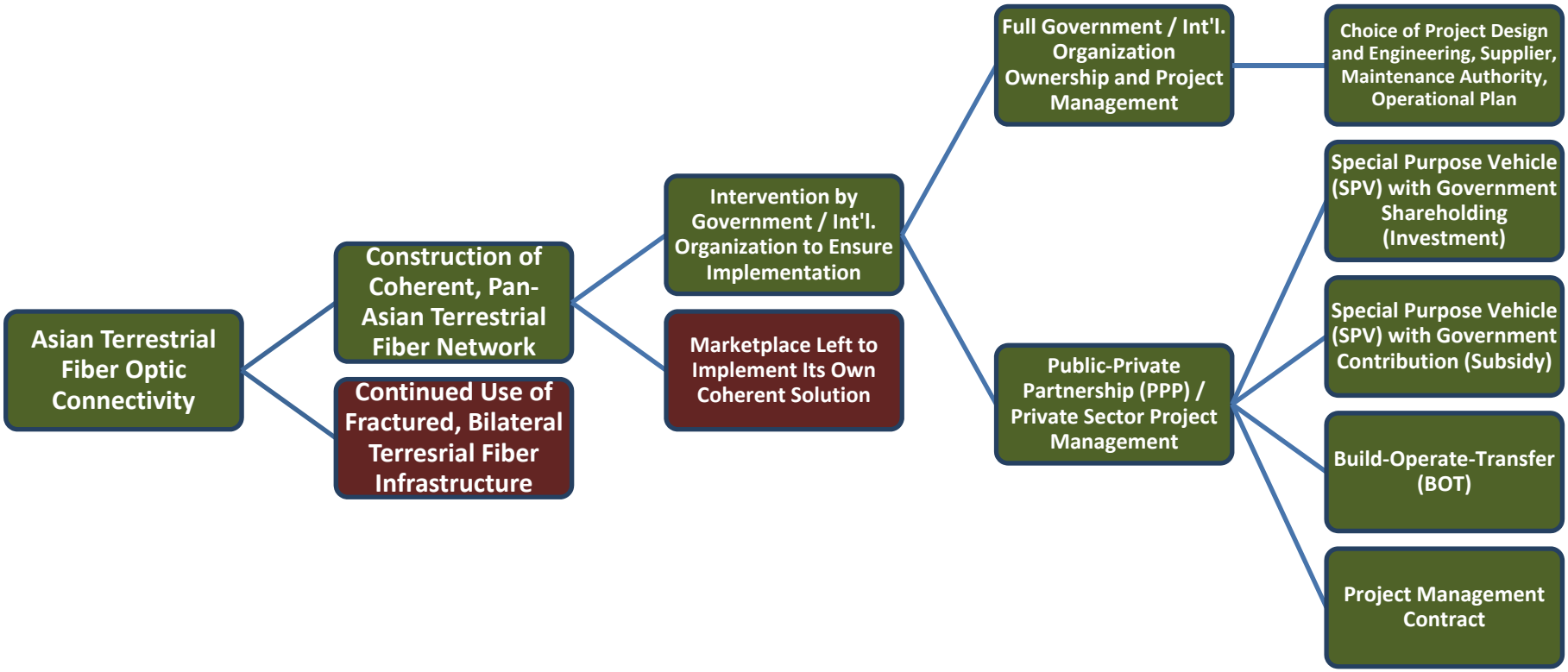
Part 7: The Case for Intervention to Ensure Network Development

The Need for Intervention

Intervention (by government or int'l. organizations) is required to ensure the implementation of a pan-Asian terrestrial fiber optic network for 5 reasons:

1. To overcome the region's vast broadband inequality.
2. To ensure that the region receives broadband services on a par with more developed markets.
3. To finance or assist in financing a major capital project that is unlikely to be fully financed by the private sector.
4. To pool and leverage private-sector resources which are disparately insufficient.
5. To stimulate and facilitate future private investment through market development and maturation.

Options for Government/UN Participation



Part 8: Principles to Guide Network Development

Principles to Guide Future Network Development

1. **Fully integrated and coherent**
   - Mesh configuration to allow for in-network healing in the event of physical cable outages or political instability affecting connectivity in specific countries.
2. **Functioning and monitored as single, uniform network**
   - Most existing multi-national terrestrial networks cannot offer uniform quality-of-service guarantees between endpoints (as good as “weakest link” or “weakest operator”).
3. **Leveraging existing infrastructure**
   - Right-of-way procurement and uniform construction techniques would be enabled through the use of the Asian Highway network, Pan-Asian Railway project, or power transmission networks.

Principles to Guide Future 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.

Part 9:
Gaining Support for the Project

Stakeholder Participation is Key

- The study by Terabit Consulting identified 95 potential stakeholders in ASEAN-9 that should be involved in the project, including:
  - National Regulatory Authorities
  - Incumbent Operators and Major International Gateway Operators
  - Competitive Telecommunications Operators and ISPs
  - Road and Railway Authorities/Operators
- Suppliers and contractors must also be consulted in the preliminary development stage.

Convincing Governments of the Project's Advantages

1. Benefits to consumers

- Broadband Internet remains unaffordable to consumers in a large number of the region's countries.
- Better, more cost-effective connectivity in the region will greatly reduce consumer prices in less developed markets and improve broadband reliability throughout the region.

2. Economic growth

- Improvement in ICT infrastructure yields:
  - Increased demand for the output of other industries (demand multiplier)
  - New opportunities for production in other industries (supply multiplier)
  - New goods and services for consumers (final demand)
- It also increases firms' innovation capabilities and increases the probability of new products, innovations, and organizations

Convincing Governments of the Project's Advantages

(Continued)

3. Increased government revenue

- Growth in economic output from ICT investment results in greater tax revenue
- Increased employment in the telecommunications sector
- Greater collections from telecom licenses and excise

4. Regional stability through better international and intercultural relations

- More efficient routing of trans-border traffic would encourage trans-border initiatives in the education, healthcare, and research sectors that would not otherwise be possible.

Convincing the Private Sector of the Project's Advantages

1. The network would offer the private sector reliable, high-capacity international fiber paths across all borders
   - Compared to low-capacity, less-reliable links currently in service
2. The network would finally provide a cost-effective alternative to undersea cable "choke points"
   - Of interest not only to operators, but communications-critical industries (e.g. finance)
3. Commercial arguments can be made on a case-by-case basis to win support of incumbent operators wary of competition.
4. Opportunities for private or PPP investment

TERABIT Consulting

Road Map / Next Steps

- Critical international connectivity weaknesses throughout Asia are being identified by Terabit Consulting: Next step would be an integrated study
- As more market analyses are completed, the viability of a coherent pan-Asian network is becoming clearer
- Continuation to Detailed Feasibility Study (DFS) to determine traffic, revenue, and preliminary costs
- Rough Order of Magnitude (ROM) costing exploration should be initiated via suppliers
- Conduct outreach to stakeholders; determine support
- Financing options should be identified

Thank you!

TERABIT Consulting

Intelligence, Analysis, and Forecasting for the International Telecommunications Infrastructure Community

Michael Ruddy

Director of International Research

Cambridge Riverview Center
245 First Street, 18th Floor
Cambridge, Massachusetts 02142 USA

Tel.: +1 617 444 8605
Fax: +1 617 444 8405
mruddy@terabitconsulting.com

www.terabitconsulting.com