



# Blurring Boundaries: Global and Regional IP Interconnection

Dennis Weller  
ITU Consultant

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# *Development of the Internet Market for Connectivity*

- Internet traffic 1,200,000 times greater in 2010 than in 1994 (140% CAGR)
- Last five years: eightfold growth (50%)
- Next five years: fourfold growth (30%, Cisco est.)
- Asia Pacific growing faster than North America and Europe
- Other regions making up ground with faster growth



# *Performance of the Market*

- The market for IP connectivity has performed well
  - Low prices, investment to keep up with demand growth, efficient direction of resources
- Transit prices have fallen every year, by an average of 38% per year. Now two USD, some as low as USD 0.50, at major hubs.
- In voice terms an equivalent rate for global transport and termination would be about USD 0.0000008
- **BUT** Not all regions have experienced the same benefits

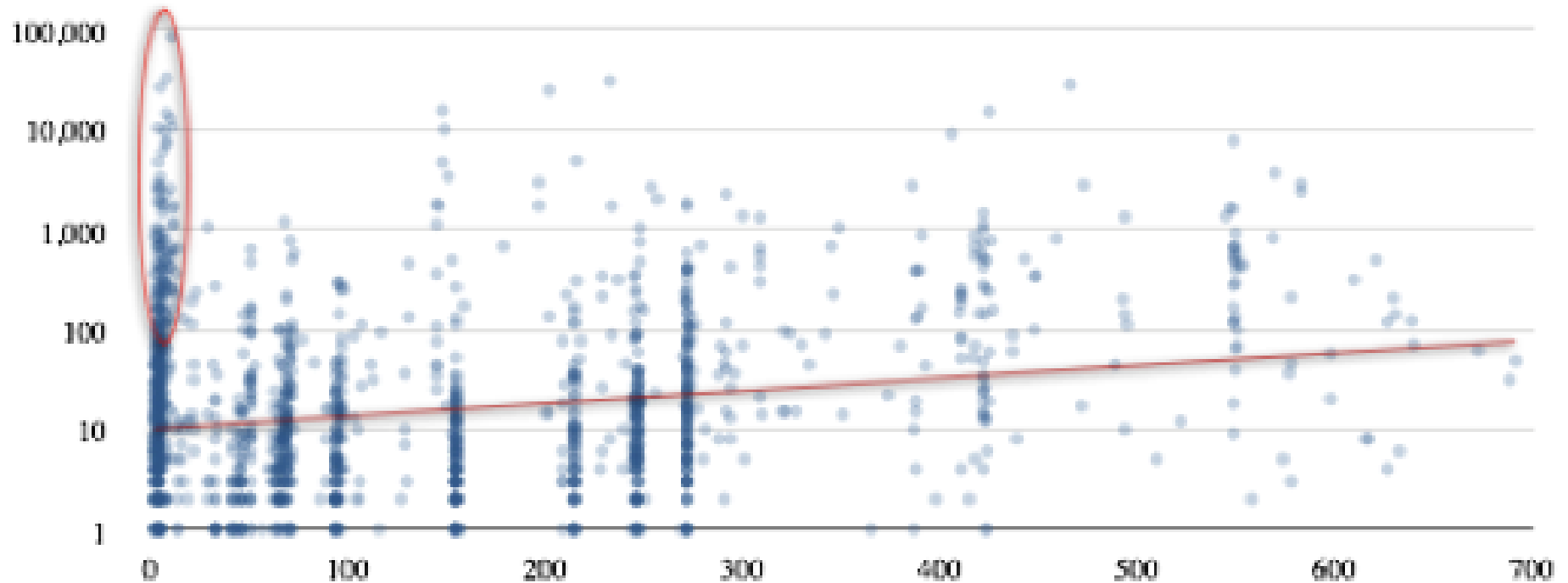


# Structural Change in the Market: Peering

- Internet networks have expanded their use of peering to reduce costs, disintermediate transit providers, and deliver traffic more directly
  - Most traffic does not touch major backbones
- A recent survey of peering agreements shows that 99.51% were “handshake” agreements with no written document.
- 99.73 percent symmetric (settlement-free)
- Importance of multilateral agreements
- Strong preferences for country of relevant law



# Different Interconnection Strategies



Number of advertised prefixes (Y-Axis) over number of interconnection partners (X-Axis) per carrier

Source: Woodcock and Adhikari

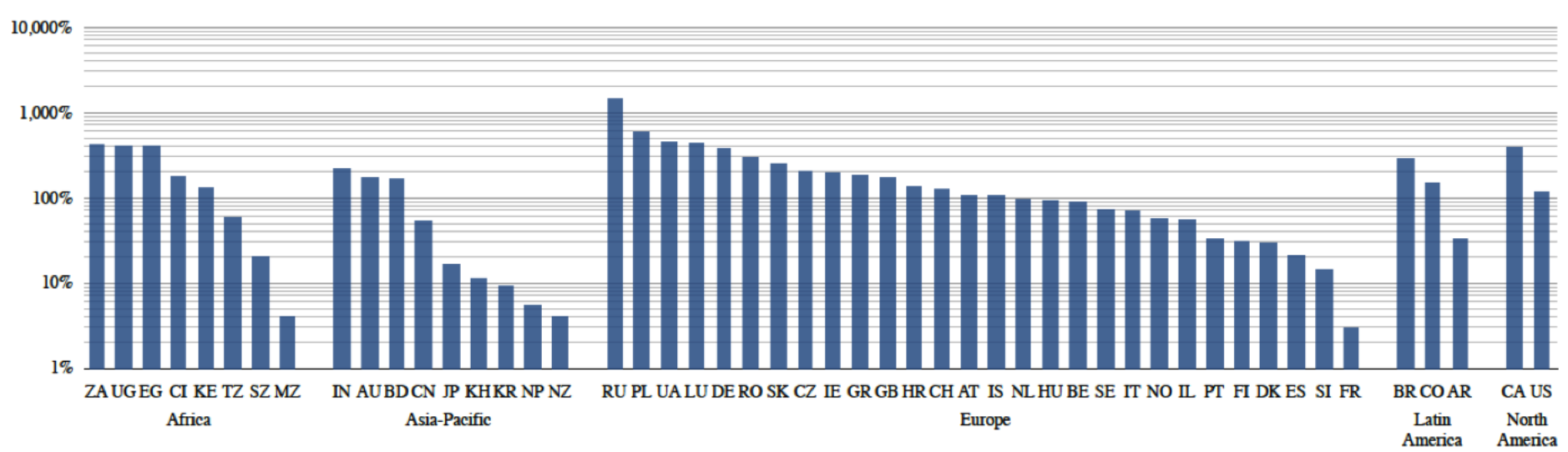


# *Structural Change in the Market: Internet Exchange Points*

- Internet exchange points (IXPs) provide local hubs where traffic can be exchanged
- Avoid the need to send traffic to a distant exchange point (“tromboning”)
  - Reduces transit cost, improves quality, frees capacity on long haul routes
- Provides focal point for investment in Internet assets
  - Caches, DNS servers, web sites
- Combined with other elements, can contribute to “virtuous circle” of development



# Growth in number and Capacity of IXPs



Annualized percentage growth in domestic Internet bandwidth production, grouped by region, 2005-2010

Source: Weller and Woodcock (2012), based on data from Packet Clearing House



# *Structural Change in the Market: Content Delivery Networks*

- Content Delivery Networks (CDNs) improve quality
  - Direct transport of content to terminating network
  - Caching of content close to recipient
- Now represent 35-45% of Internet traffic
- Support changing patterns of demand
  - Decline in voice, peer-to-peer
  - Increasing role of streaming, cloud
- Negotiations to set terms of trade with others
  - Market answers to net neutrality questions?
- Possible constructive role in developing countries.....





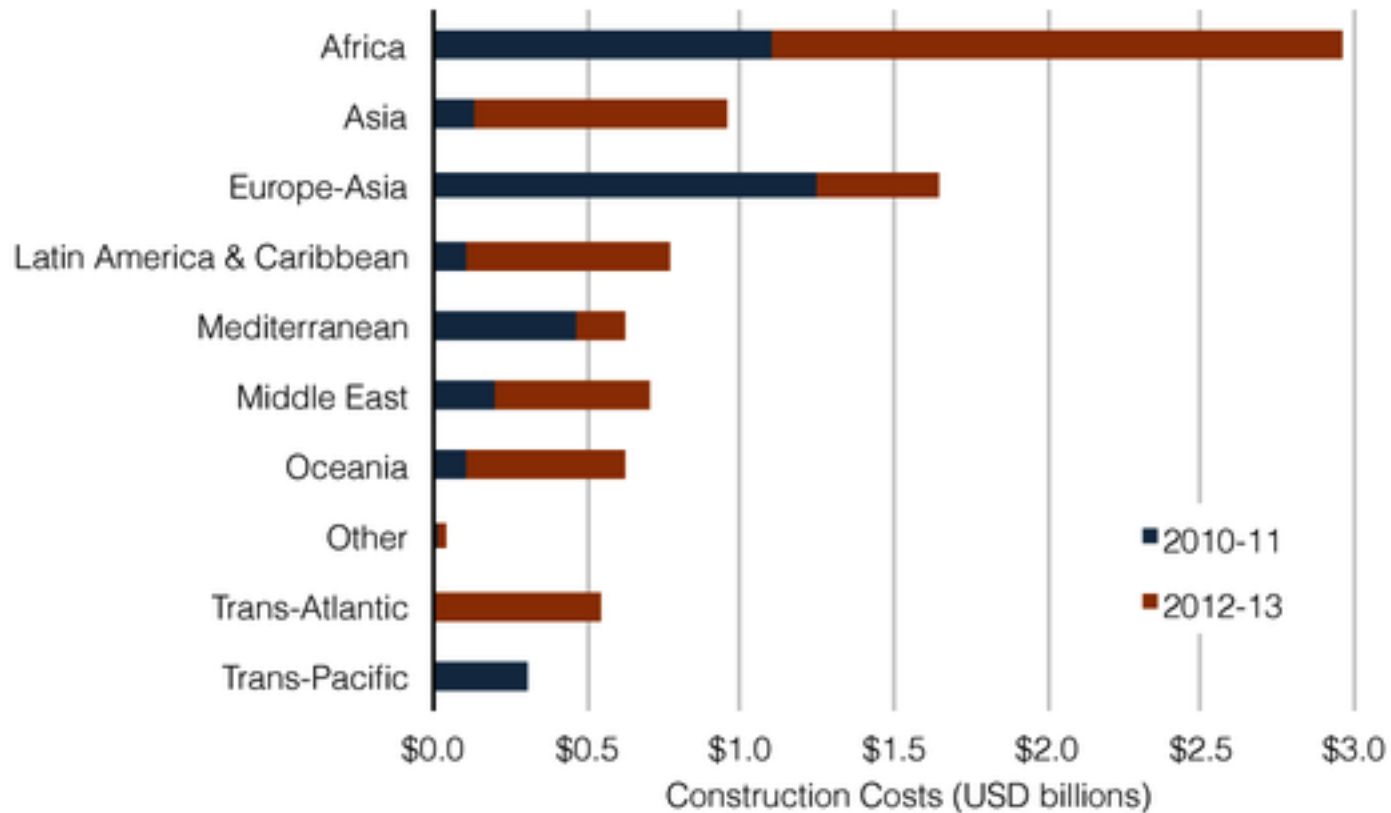
# *Structural Change in the Market: Investment in Internet Facilities*

- Market has called forth investment to support rapid demand growth
- Undersea cables
  - Capacity glut on some routes after 2000
  - Other regions underserved, with limited competition
- New wave of investment in undersea cables
  - 19 new systems in 2010-2011
  - 33 more systems in 2012-2013
- Investment also in terrestrial routes
  - Total capacity of terrestrial cross-border routes in sub-Saharan Africa grew from 33 mb/sec in 2005 to 30,860 mb/sec in 2011



# Undersea Cable Investment

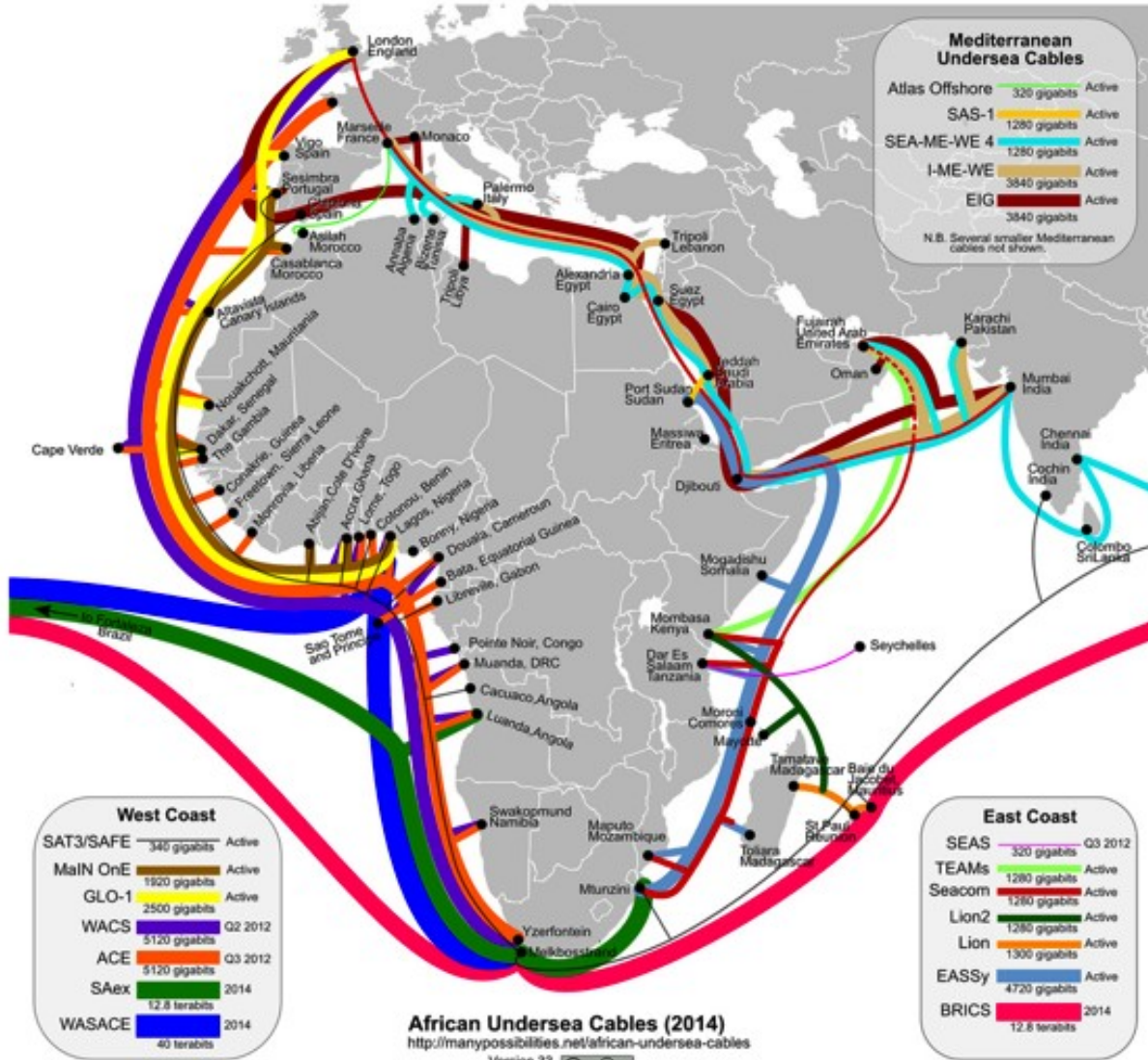
## Submarine Cable Construction Costs by Region, 2010-2013



Improved geographic coverage and ownership diversity



# New Cable Routes Around Africa





# *Virtuous Circles in Developing Markets*

- Three examples illustrate possibilities created by liberalized policies, increased investment in undersea cables and development of IXPs
- IXPs in Kenya (Nairobi), Ghana (Accra), and Nigeria (Lagos) have similar patterns of success
- New undersea cables have increased capacity and competition, and sharply reduced rates
- IXPs have localized traffic, reduced cost and latency
- All three IXPs have seen dramatic increases in traffic
- High levels of growth, opportunities for business, education, government services



## *Challenges in Policy*

- For National Regulatory Authorities (NRAs) in developed markets
- For International policy frameworks
- For NRAs in developing markets



## *Best Practices to Promote a Virtuous Circle of Development*

- Liberalized framework with separate regulator, open entry, access to rights of way, low barriers such as license fees
- Enabling policies for mobile development in licensing, spectrum, tower siting
- Low barriers for deployment of long-haul capacity: access to international gateways, low licensing fees, public investment where appropriate
- Support for the development of IXPs
- Constraints on anticompetitive behavior by incumbent



# *Best Practices to Promote a Virtuous Circle of Development*

- Openness to foreign direct investment
- Promotion of demand for broadband services. These include e-government, investment in national education and research networks (NRENs)
  - Minimizing taxes or certification policies that drive up the prices of either customer equipment (laptops, handsets), or network equipment
  - Markets open to attractive applications, such as VoIP, that increase the usefulness of broadband