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Presentation for ITU

Overview of recent changes in the International IP interconnection ecosystem

23 January 2012 • Michael Kende

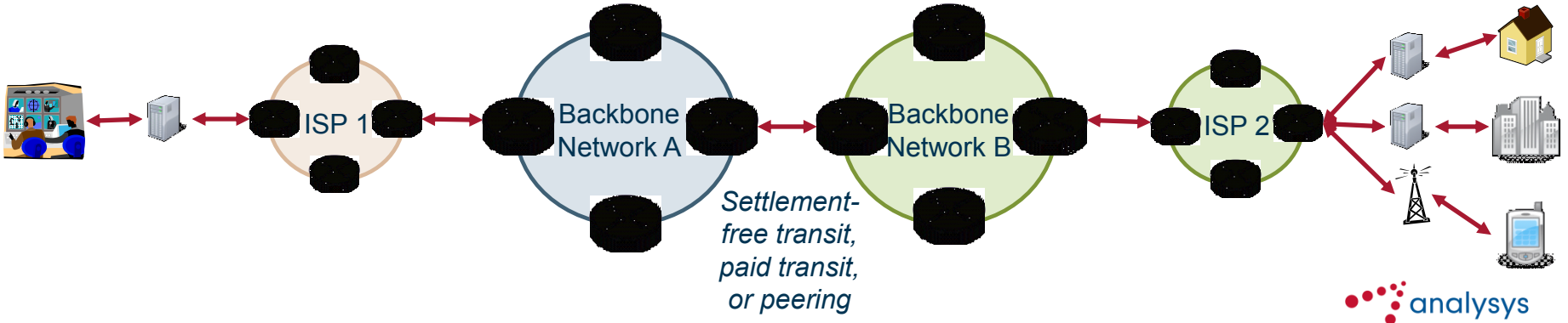
Introduction

- The Internet is characterized by two underlying trends in last fifteen years:
  - The Internet has globalized
  - Internet traffic has increased by many orders of magnitude
- Interconnection has evolved in response to these trends
  - Internet Exchange Points (IXPs) have helped to localize traffic and increase the efficiency of the Internet
  - Countries with successful IXPs have become regional hubs for traffic

We highlight successful case studies and policies that countries can adopt to become a hub, and the impact for countries without those policies

The commercial Internet is relatively young

- The National Science Foundation Network (NSFNET) Backbone Service was decommissioned in favor of the commercial Internet on April 15, 1995
  - The NSFNET was used by regional networks to exchange traffic
  - In its place, four Network Access Points (NAPs) were designated for traffic exchange
  - Interconnection was not regulated – in its place were commercial arrangements (*peering* and *transit)*



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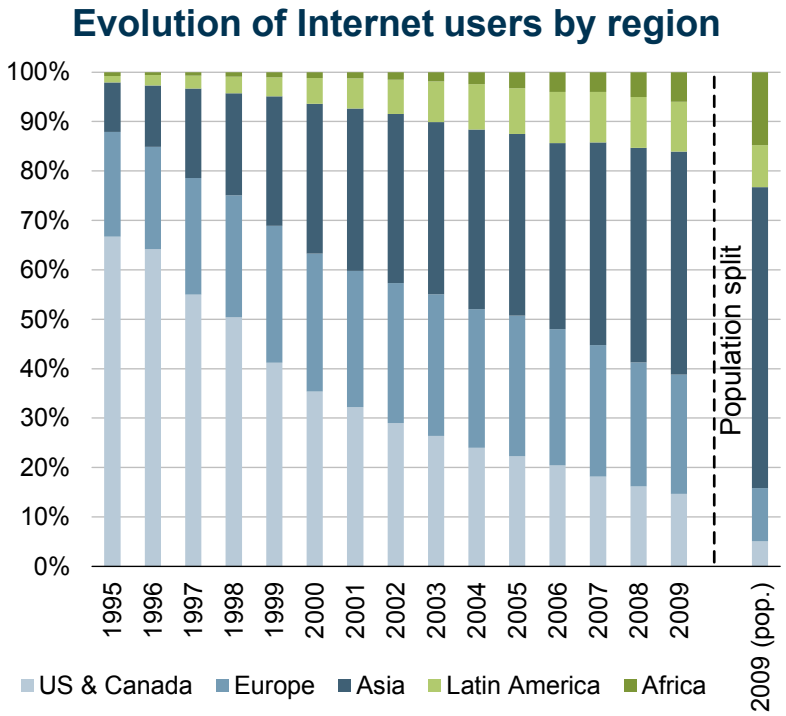
In 1995 the Internet was very US-centric for a number of reasons

- The US was the historic home of the Internet
  - 70% of Internet users were in the US in 1995, along with much of the content
  - Up to 60% of European traffic routed through the US
- Much of the European traffic was *tromboning* through the US back to Europe
  - All European ISPs had to connect to the US to access users and content anyway
  - The lack of liberalization in Europe made national and inter-European links very expensive: in 1998 leased lines prices for a 2 Mbit/s link were:
    - London – Paris: $38,000 / month
    - London – Virginia: $30,000 / month

The US-centric architecture was not sustainable

- Usage began to change significantly
  - Globalization of users (*see right*)
  - Content increased in bandwidth
  - Applications became more latency-sensitive, such as VoIP
- Tromboning was less sustainable
  - the cost of connectivity fell
  - latency was more notable
- There were three responses to the US-centric nature of the Internet
  - Interconnection moved from NAPs to IXPs
  - The IXPs began to develop outside the US
  - Some countries sought a policy response to pricing (e.g. ICAIS)



Source: ITU

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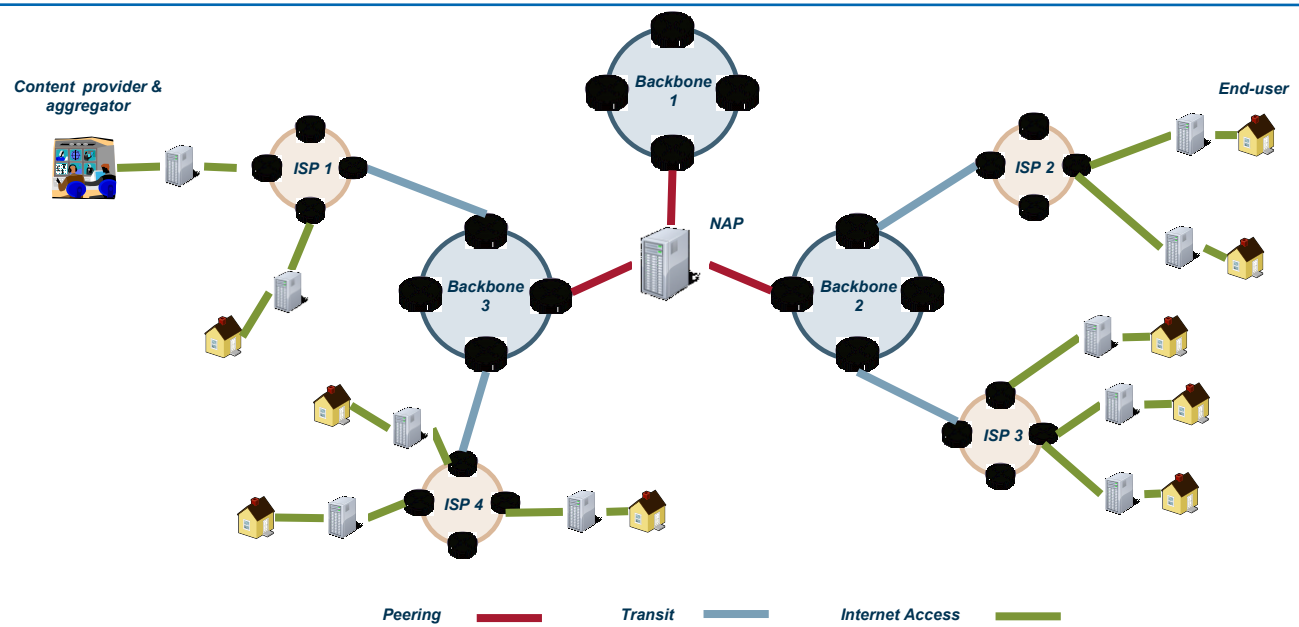
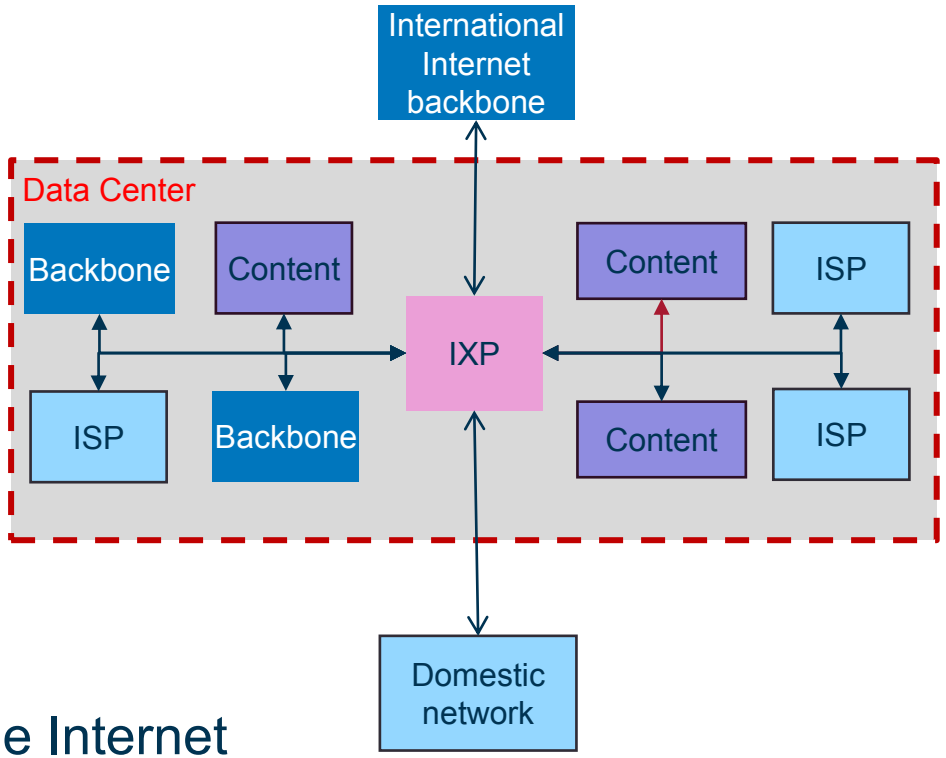
The Internet quickly outgrew the Network Access Points



- NAPs were used by large backbones to exchange traffic, reinforcing a hierarchy topped by these backbones
- Traffic was exchanged via *public peering*, involving a shared switch that soon congested
- The owners of the NAPs included operators who were not perceived as neutral in selling access

Interconnection migrated from Network Access Points to Internet Exchange Points

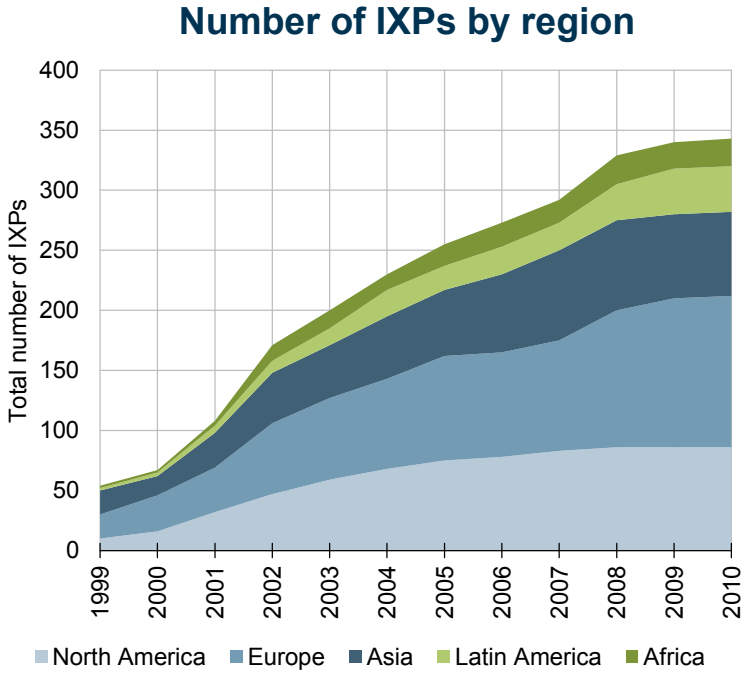
- IXPs address the issues raised by NAPs
  - IXPs are neutral
  - many are non-profit associations
  - often they are housed within commercial data centers
  - within the data center, large providers can engage in *private peering*



- IXPs also flatten the hierarchy of the Internet
  - content providers and ISPs who can use the IXP to peer directly with one another
  - the members of the IXP can also purchase transit services within the data center

There have been three phases of globalization

- *US-Centric* phase, for historical reasons starting with the commercialization of the Internet
- *OECD-Centric*, focused on developed countries in Europe and Asia
- *Rest of World (ROW) Centric*, focused on emerging markets
  - In Africa only two countries had IXPs before 2002, which has risen to 20 by the end of 2010



Source: Packet Clearing House, Analysys Mason

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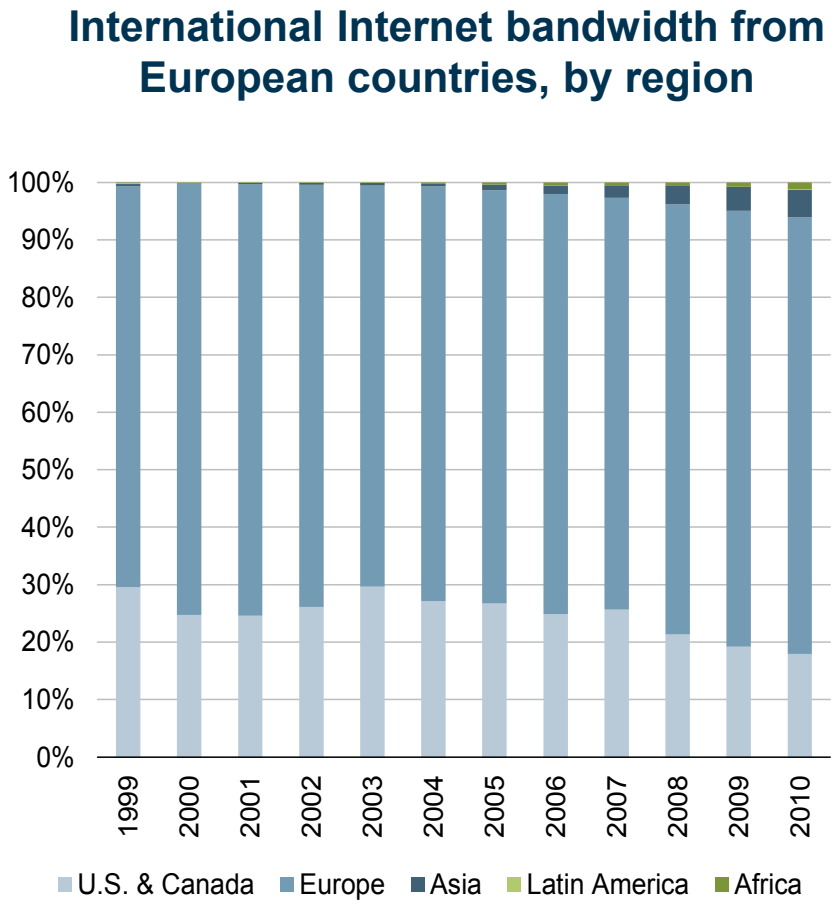
The OECD-Centric phase has drastically reduced Europe's reliance on the US

- The early IXPs in Europe were setup before 1999, significantly reducing tromboning before this dataset starts
- Nonetheless, the reliance on the US has now fallen to less than 20% of bandwidth, while Asia is increasingly a destination

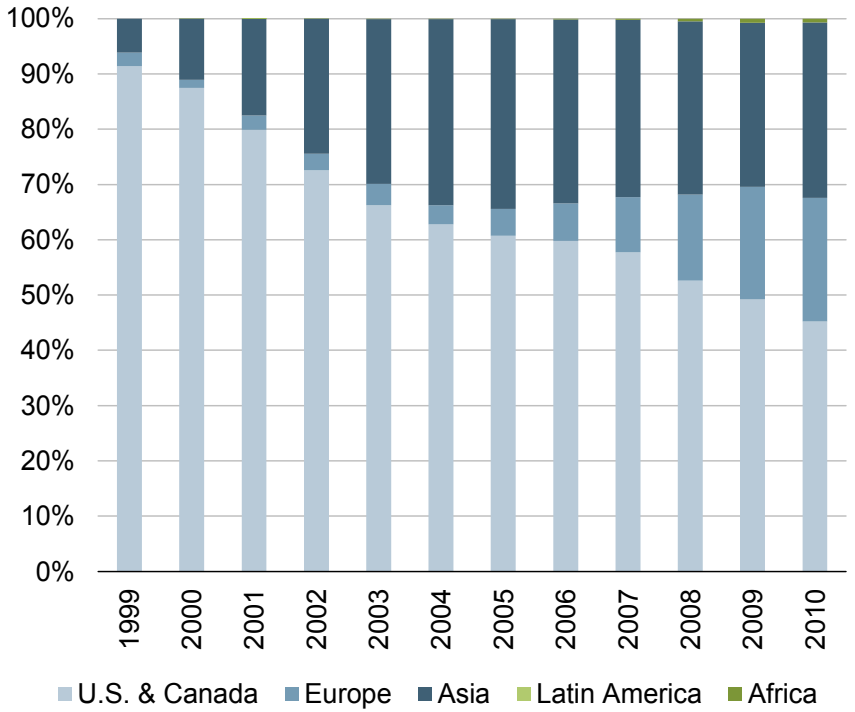


Source: Telegeography Global Internet Bandwidth

The OECD-Centric phase has also reduced Asia's reliance on the US

- Asia had a later start in localizing traffic, but has now reduced reliance on the US for Internet bandwidth by half
- Intra-Asian traffic has increased as more traffic localizes, while Europe is increasingly a destination for traffic exchange

International Internet bandwidth from Asian countries, by region

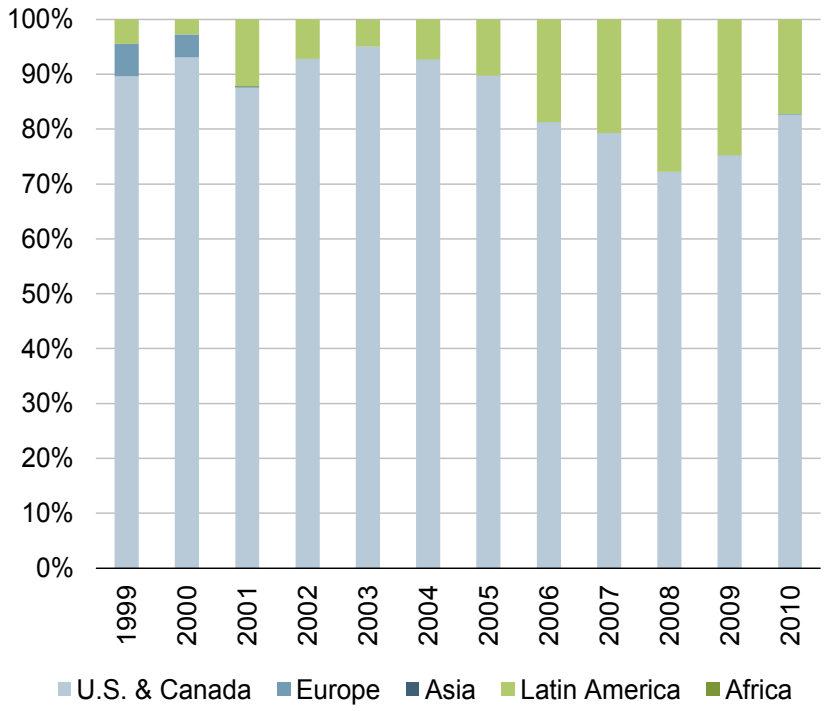


Source: Telegeography Global Internet Bandwidth

The ROW-phase has not had as great an impact on Latin America

- Latin American reliance on the US has begun to fall, but is still above 80%
- Unlike the African situation, intra-regional traffic is growing, but still demonstrates the need for continued localization

International Internet bandwidth from Latin American countries, by region

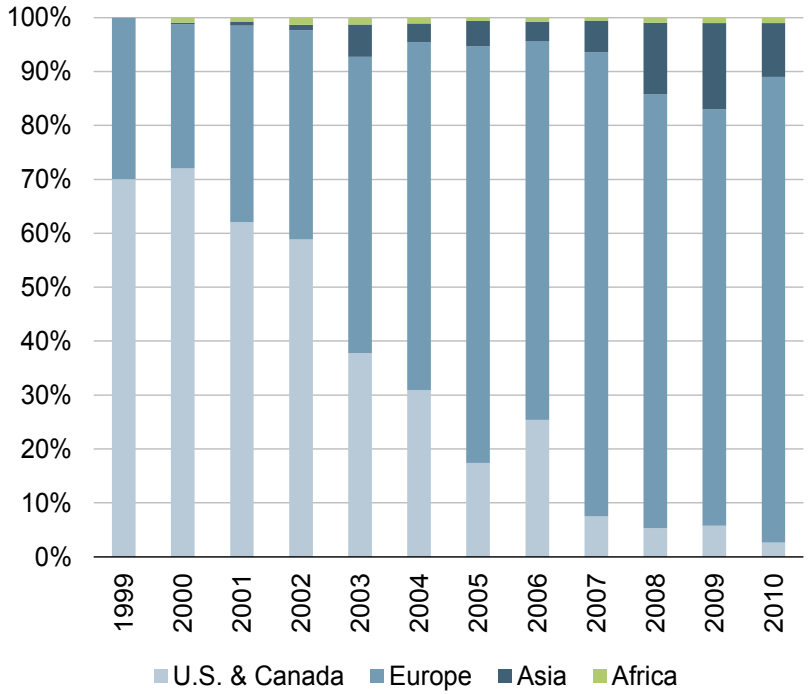


Source: Telegeography Global Internet Bandwidth

Africa has shifted it's reliance from the US to Europe

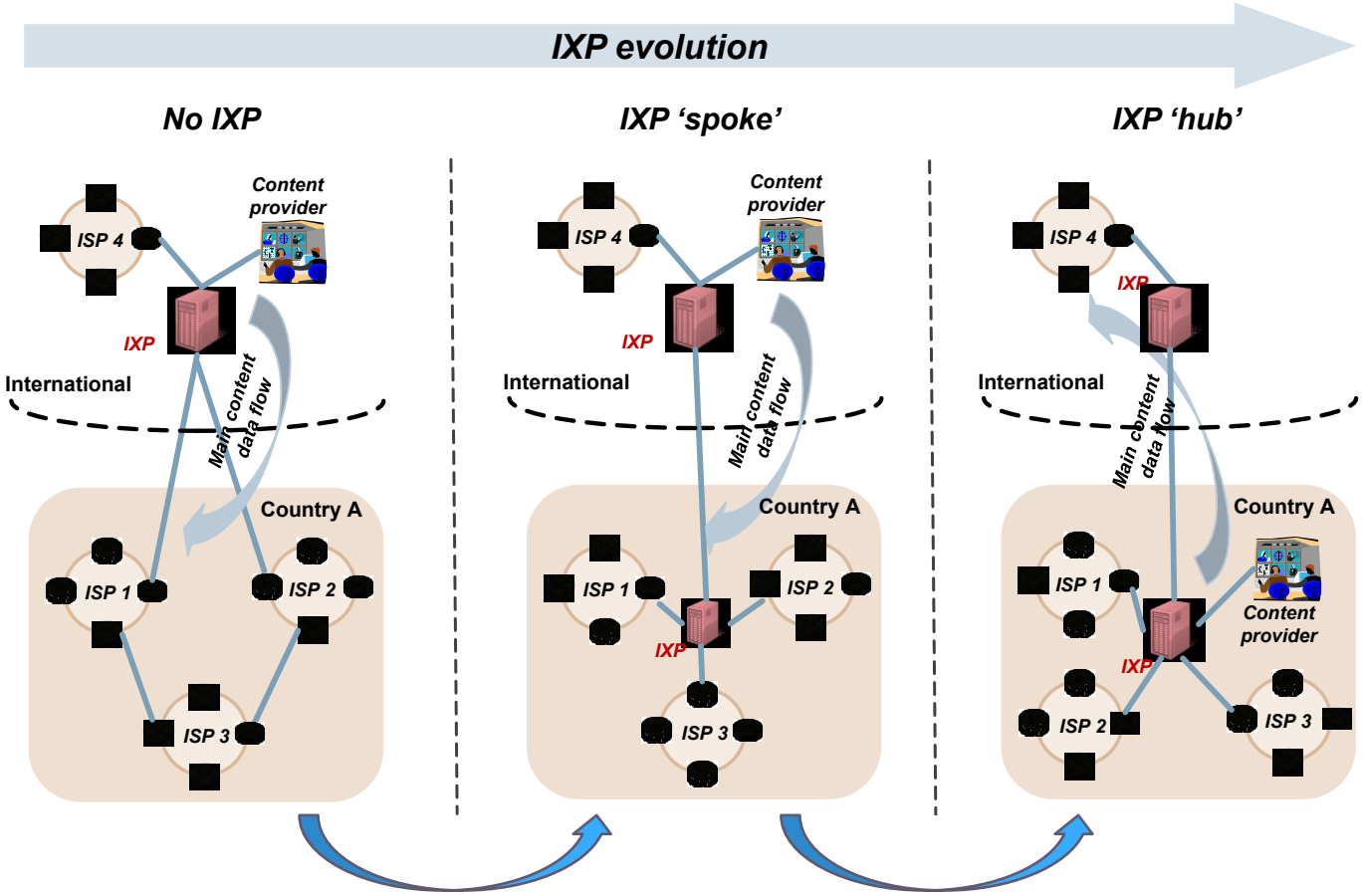
- African reliance on the US for Internet bandwidth has reduced drastically
- However, the reliance has shifted to Europe, which demonstrates both the adaptability of the Internet structure but also the need for continued localization in Africa

International Internet bandwidth from African countries, by region



Source: Telegeography Global Internet Bandwidth

A successful IXP can evolve from acting as a ‘spoke’ to a ‘hub’



An IXP ‘spoke’ can quickly eliminate tromboning, but still accesses content and international transit abroad

An IXP ‘hub’ acts as a magnet for content and international backbones to sell services in the country and greater region

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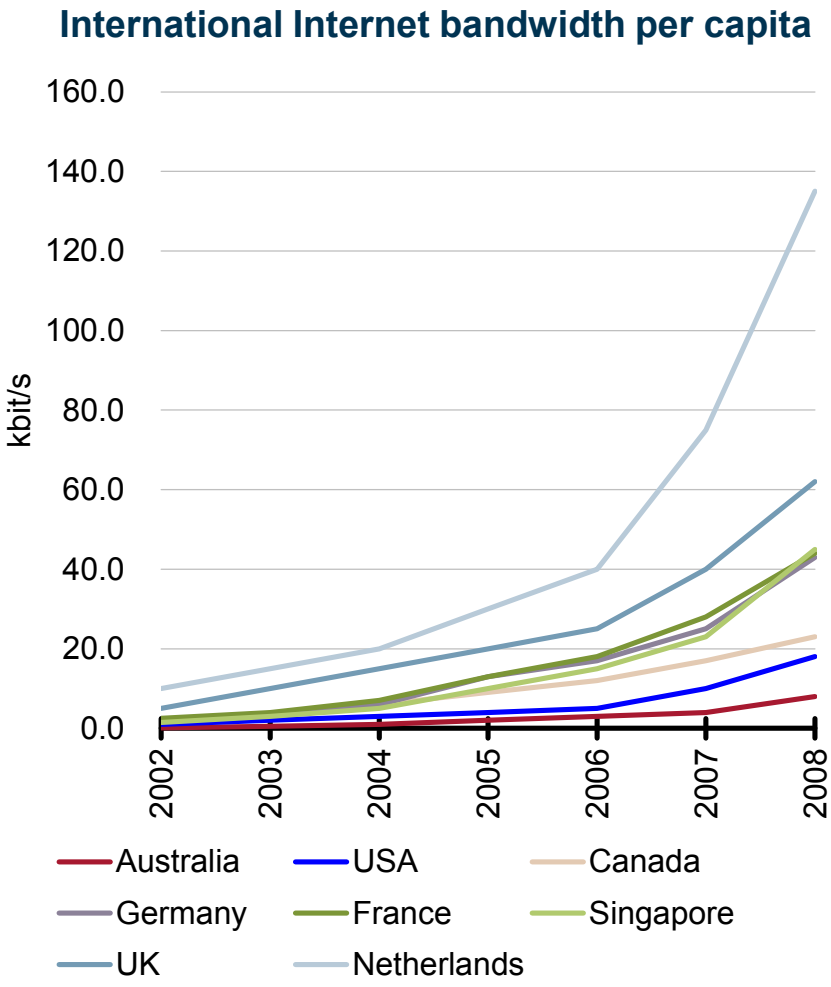
The evolution to IXP 'hub' may require broad policy changes, with corresponding benefits

- Creation of an IXP
  - ISPs can act together to create an IXP
  - The ability of an IXP to become a hub lies outside of the control of the IXP
- Two sets of factors impact the evolution of the IXP into a hub
  - general business environment
  - sector policies including international liberalization, and licensing requirements and obligations
- The impact of AMS-IX is noticeable in terms of bandwidth per capita (*see right*)



Source: Telegeography Global Internet Bandwidth

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The Kenya IXP (KIXP) represents a successful case study

- An association of ISPs in Kenya (TESPOK) setup KIXP in Nairobi in early 2000
  - The immediate benefit was to eliminate reliance on satellite for tromboning, reducing latency and cost significantly
  - Telkom Kenya challenged the IXP but was denied

- The growth in the IXP has been significant
  - There are now 28 members peering at KIXP, including all major operators, a government network, and several DNS servers
  - KIXP is one of the fastest growing IXPs in the world, peaking at up to 1Gbps traffic recently

KIXP has generated a virtuous cycle of growth

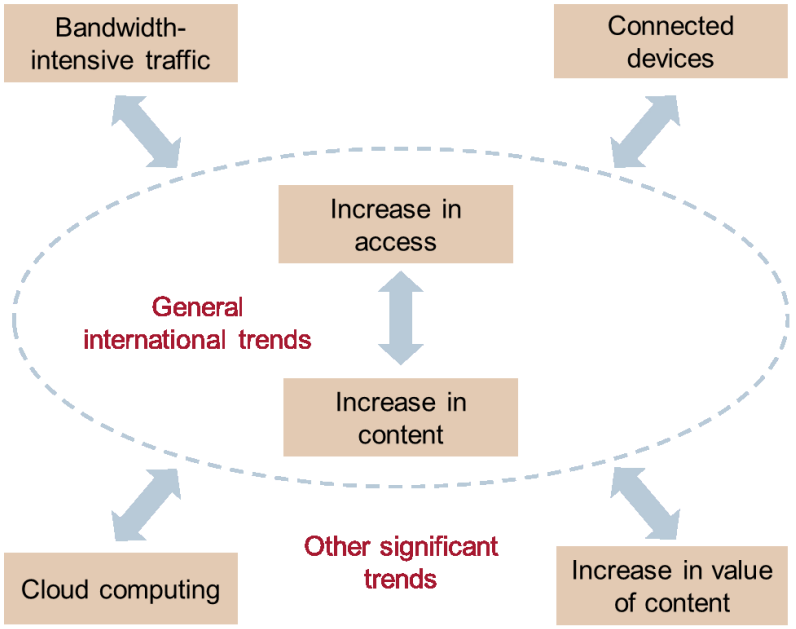
- Google put a cache in Nairobi available to all members of the IXP, increasing usage (and data revenues) while lowering international bandwidth costs
- The .ke ccTLD (KENIC) has seen significant growth in domains, at the expense of gTLDs such as .com
- The tax authority (KRA) sees the exchange as vital to its ability to tax imports and raise income taxes
- A second IXP has opened in Mombasa to benefit from proximity to the new cables that have landed recently
- The IXP is increasingly serving regional routes to countries as far away as Nigeria

Analysys Mason has been engaged by the Internet Society to conduct a study of the benefits of KIXP – the paper should be released in February

The impact of Internet trends only highlights the need for Internet hubs in emerging markets

- The reliance on Internet access and content is increasing
  - Cloud-based computing
  - Accessed by smart-devices
- Policy solutions should focus on creating local hubs, rather than simply lowering the cost of acting as a spoke
  - As demand increases, international access costs will continue to rise
  - In addition, access to local or regional IXPs will reduce latency and improve resiliency

Summary of Internet trends



Source: Analysys Mason

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