

Internet eXchange/ Internet eXchange Point

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ACKNOWLEDGEMENT

This presentation material is based loosely on a ITU no. 153-2009 Project entitled:
Establishment of National Internet Exchange of Afghanistan that was conducted between July-October 2009.

The project consisted of several activities:

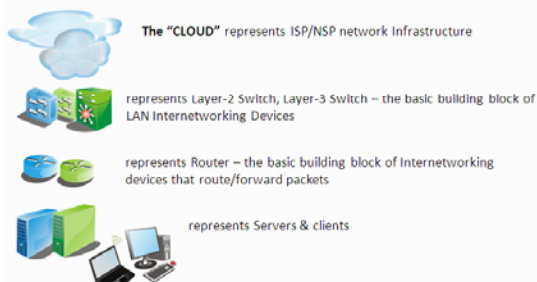
- Field Survey , Data Gathering, & Discussions @ Kabul, Afghanistan
- Study, Preparation of Techno-commercial design plan
- Field Study & Workshop (technical – 2 days) conducted in Jakarta, Indonesia, including site visits to:
 - *Indonesian IX - APJII*
 - *Indonesian Open IX - IDC*
 - *ID-SIRTII* (Indonesian Gov. sponsored Internet Security task force)

Special thanks to Mr. Sameer Sharma – ITU Senior Advisor for guidance & assistance during the project



IX / IXP BASIC

HOUSEKEEPING – ICON NOTATION



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INTERNET

- 1969 – the **ARPANET**

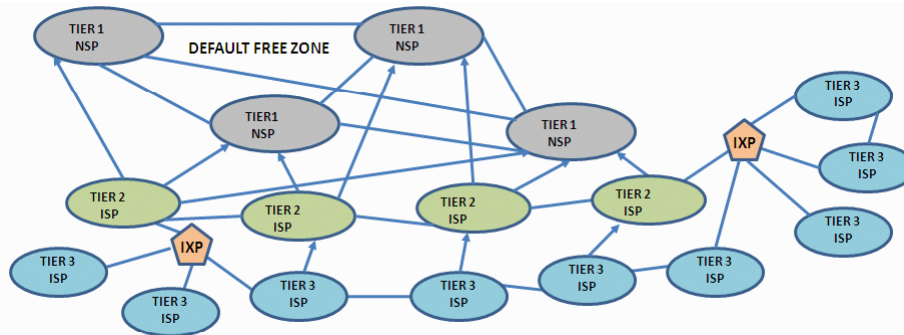


- 1970s – The development of TCP/IP Protocol suite – the underlying INTERNET glues
- 1980s – more players developed their own packet-networks using TCP/IP & other protocols & operated the infrastructure. To name few: The US National Science Foundation (NSF-NET); AT&T Bell Laboratories (the UNIX o/s, led to USENET); NASA (SPAN); Various United States Universities (BITNET)
- More networks; new private Service Providers...



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THE INTERNET

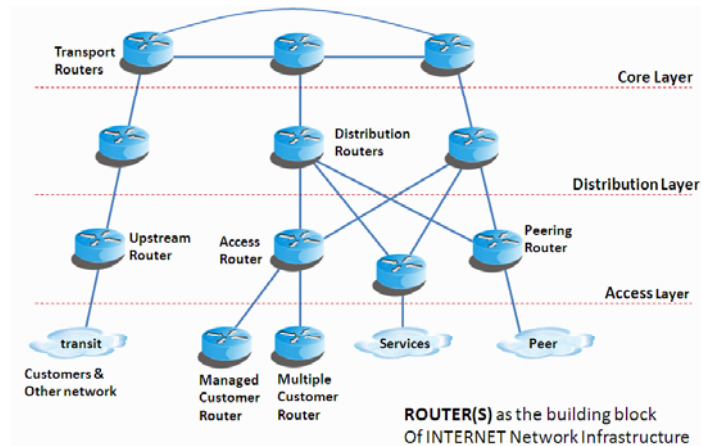


The **INTERNET** is a global system of interconnected computer networks that use the standardized Internet Protocol Suite (TCP/IP) to serve billions of users worldwide. It is a *network of networks* that consists of millions of private and public, academic, business, and government networks of local to global scope that are linked by copper wires, fiber-optic cables, wireless connections, and other technologies. (... *Wikipedia*)

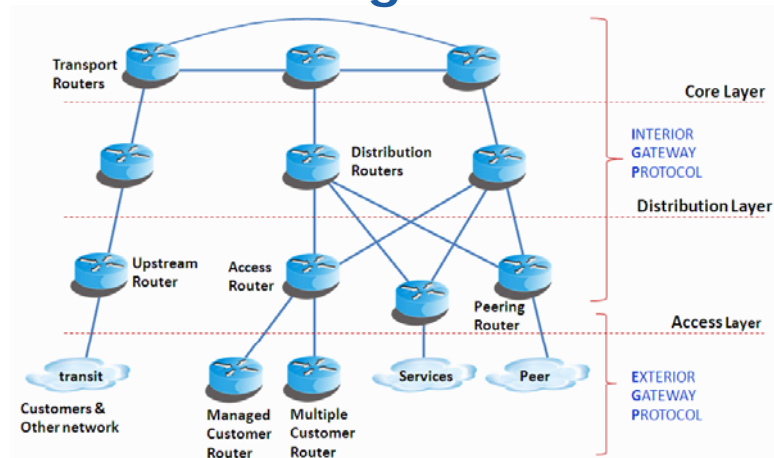
IXP – Natural Growth

- History: **Network Access Point (NAP)s** established at the end of *NSF-NET*. This is the original 'exchange points'
- Major Providers (Tier1 – Tier2 etc) connect their networks and Exchange traffic
- It is a high speed network – nowadays: mostly Ethernet based Network
- Nowadays - It is ANY place, where ISPs come together to exchange traffic
- In essence, IXPs are one of the most important critical part of INTERNET's infrastructure. ISP must interconnect with other networks to successfully provide Internet Services.

INTERNET – ISPs



Routing Protocols



Routing Protocols

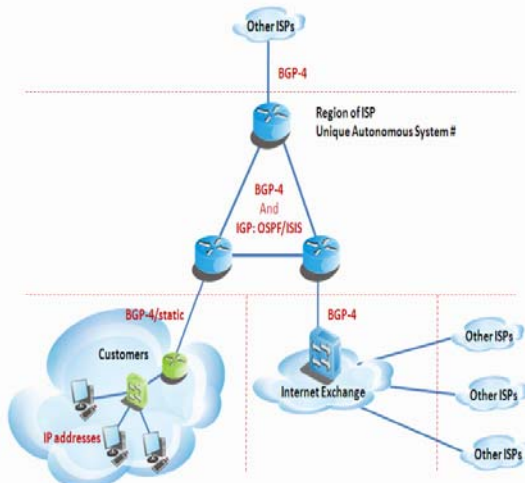
- Interior
 - Automatic neighbor discovery
 - Generally trust your IGP routers
 - Binds routers in one **Autonomous Systems (AS)** together
 - Carries ISP infrastructure address ONLY
 - Keep IGP small for efficiency & scalability
 - Ex> **OSPF**
- Exterior
 - Specifically Configured PEERS
 - Connecting with outside Networks
 - Binds **Autonomous Systems** together
 - Carries Customer prefixes
 - Carries Internet Prefixes
 - EGP are independent of ISP network Topology
 - Ex> **BGP**



A collection of networks with same Routing policy. Usually under single ownership, trust & Administrative control

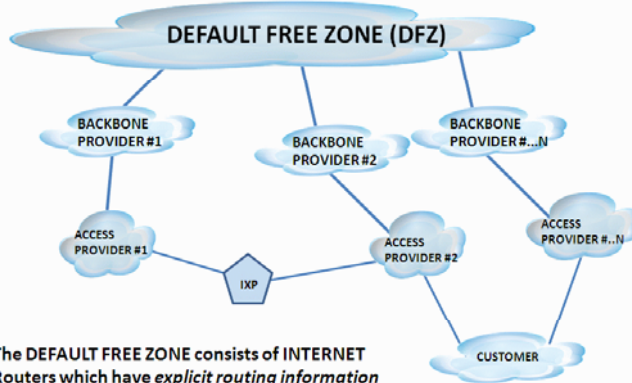
Routing Protocol: **BGP-4**

*The “Magic Ingredient” that glues
INTERNET together*



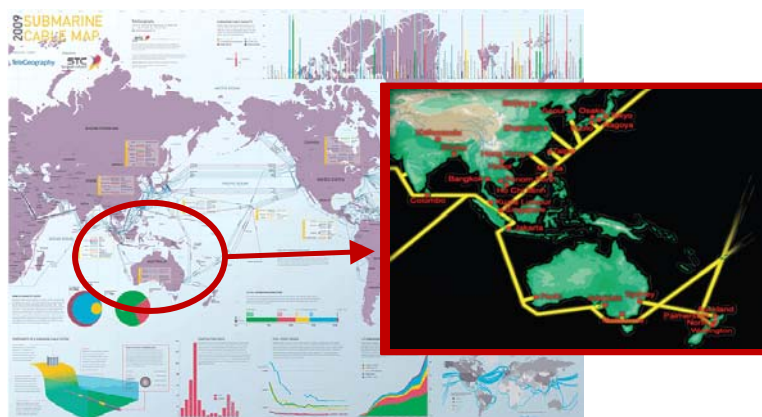
- BGP = Border Gateway Protocol
- protocol to connect ISP routers – a way to exchange *routing information* and define *routing policy*
- very scalable routing protocol

Global INTERNET – Logical View



The DEFAULT FREE ZONE consists of INTERNET Routers which have *explicit routing information* About the rest of the INTERNET, and do not Need to use a *default route*

Global INTERNET – Physical (sample)



- 93 of the world's major submarine cable systems¹
Connecting APAC region to Tier-1-NSP (AT&T, Sprint, NTT, etc.)

Source: submarine map courtesy of www.TeleGeography.com; cable landing courtesy of www.pch.net

Regulatory – who controls THE Internet?

- NO single country owns it
- But, Engineers keeps “talking” & working together:
ex.
 - North America: NANOG (North American Network Operators Group) – meetings & mailing list
 - Asia Pacific:
 - **APRICOT** (Asia Pacific Internet Conference on Operational technologies) – annual Conference
 - **APNIC** – by-yearly meeting
 - **SANOG** (South Asia Network Operators Group) – a yearly meeting
 - Europe:
 - RIPE Meetings, working groups and mailing lists
 - IETF (Internet Engineering Task Force) meetings & mailing lists



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Other INTERNET “Glue”

- The INTERNET would not exist without **agreements** between ISP/NSP to exchange (*internet*) traffic!
- Internet Service Provider (ISP) must cooperate with each other to support the exchange of IP packets & serve their clients
- Two major forms of ISP Traffic Exchange Scenario:
 - **Peering**
 - **Transit**



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General I SP Goal

- **Minimize** the **cost** of operating the ISP business!
- ISP is always facing these scenarios:
 - ❑ **TRANSIT** – not so ☺
 - ❑ ISP has to pay for circuit (International or domestic)
 - ❑ ISP has to pay for data (Mbps)
 - ❑ **PEERING** – A Joy ☺
 - ❑ No Need to pay for data
 - ❑ if one can reduce TRANSIT data volume, one will reduce COST
 - ❑ how? ISP Could either share circuit cost with peer (private) or runs circuit to a public peering point



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Peering & Transit

PEERING

Exchanging traffic & Routing Information between 2 ISPs (with roughly same characteristics, traffic volumes etc) with no charge/fee

Ex. Regional provider connects to regional provider; Tier1-to-Tier-1 provider; Small ISPs connecting to each other for the purposes of exchanging traffics

TRANSIT

Carrying traffic across a network , usually for a **fee**

Ex. ISP connect to Tier-1 ISP – which provides access to the rest of the world



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Peering – How it works

- If two (2) ISPs are of equivalent sizes, i.e.:
 - Equivalent customer size
 - About the same network infrastructure coverage
 - Similar content volumes to be shared with the Internet
- Then, these two (2) ISPs make a good **peering** partners
- For those refuse to peer, then:
 - Both ISPs have to pay an upstream provider for interconnectivity among their customers
 - The two ISPs have to fund the **transit costs** via the upstream provider ☹



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Transit – How it works

- A small ISP is giving services to customers such as:
 - Internet Café
 - Corporate INTERNET access
 - Mix of dial-up users, fixed link etc
- So, these ISP customers need to get access to the rest of the INTERNET
- The only thing this ISP can do is buying access from its upstream larger ISPs who already have visibility of the rest of INTERNET



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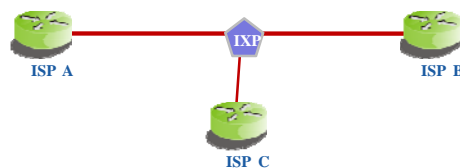
Private Interconnect

- Two (2) ISPs connect their networks over a private link
 - Can be in a PEERING Agreement
 - No Charge for traffic
 - Share cost of Link
 - Can be in a TRANSIT Agreement
 - Example: One ISP charges the other ISP for traffic
 - Example: One ISP (corporate client) pays for the link



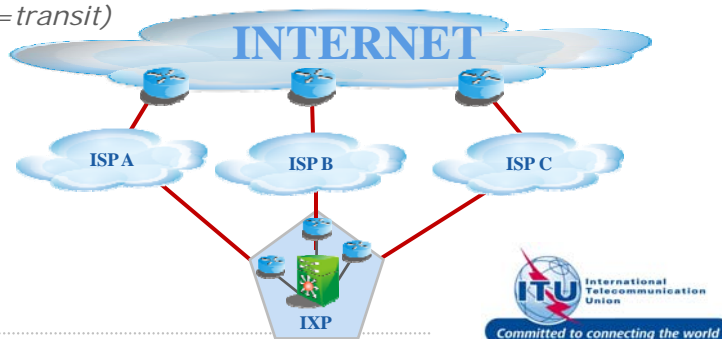
Public Interconnect

- Several ISPs meeting in a common neutral location and interconnect their networks
 - Usually it is a peering arrangement



IXP – How it works?

- **More than two** (2) ISPs mutually agree to connect their networks to a “neutral location” – local IXP
- In essence, ISPs operate by exchanging traffics at their borders using a router at the exchange
- This exchange can be *settlement free* (=peering) or *paid* (=transit)

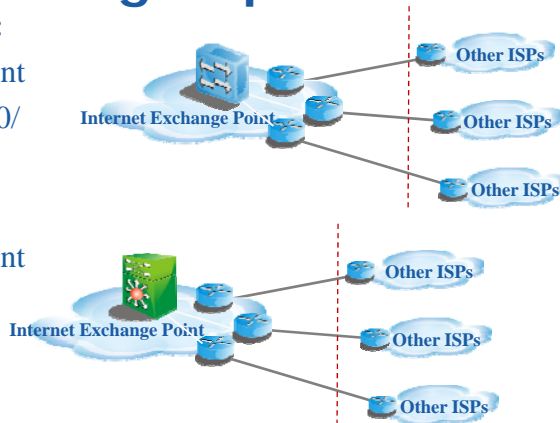


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IXP Design Option

IXP Core fabric option:

- Layer-2 Exchange Point
 - Ethernet (100/1000/10,000 Mbps)
- Layer-3 Exchange Point
 - Router- IXP



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INTERNET EXCHANGE – CASE STUDIES



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IX – Global Current Status

Based on latest August 20th, 2010 data¹, There are currently **89 countries** with **Internet Exchange/ Internet Exchange Point(s)**, with the remaining **158 Countries** under U.N. that has no Internet Exchange

- Countries with more than one IXP operation:
 - **The United States – 84 IXPs** ; Japan – 17; France – 15; Brazil – 16; Germany – 14; Sweden – 12; United Kingdom – 11; Australia – 10; Russia – 11; India – 7; Spain – 6; Indonesia – 6; New Zealand – 6; Netherlands – 5; Poland – 5; etc.
- IXP with highest aggregated bandwidth: **794 G @ Deutscher Commercial IX** – Frankfurt, Germany
- IXP with highest participants: **336 @ Amsterdam IX** – Amsterdam, Netherlands
- **Newest ITU-sponsored IXP: NIXA @ Kabul, Afghanistan** (commissioned: 2010)

Countries with IXPs: 89		Countries without IXPs: 158	
United States	84	Afghanistan	
Japan	17	Albania	
Brazil	16	Angola	
France	15	American Samoa	
Germany	14	Andorra	
Sweden	12	Anguilla	
United Kingdom	11	Antigua and Barbuda	

Source: ¹<https://prefix.pch.net/applications/ixpdix/summary/>



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IXP - local

- Business driven: Two ISPs peer point-to-point directly to exchange customer traffic
- More than two (2) ISPs:
 - They could all peer to each other by commissioning WAN link to every ISPs
 - Or They could peer at a “neutral location”: an **Exchange Point**
- Some results:
 - Point to point , Closer = @ business value it translates to Cheaper cost
 - Low Latency, Faster connection – better network performance
 - More efficient



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Case Study#01 – The London Internet Exchange (LINX)

- LINX is among the largest & oldest internet exchanges; it has over 280 members from 40 countries
- Although most members are from Europe, around 25% are from The United States, Africa, the Middle East, & Asia.
- Before 2000, members were only “traditional” ISPs
- After the restriction was lifted, nowadays a wide variety of networks connect at LINK, including:
 - Google, Yahoo, Akamai, the BBC
 - Diversity of service providers, including: Gaming, gambling specialists, media streaming providers, Security specialists, advertising networks, software-as-service (ASP) providers etc.
- Some offering include bi-lateral agreement as well as other specific arrangement



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Case Study#02 – The KENYA IXP (KIXP) - 1

- ☺ An idea of IXP in Nairobi came after one local internet engineer from Kenya attended *ISOC network workshop* in 1999
- ☺ KIXP was launched in 2000
- ☹ Almost immediately. **Telcom Kenya** filed a complaint with the national regulator, the Communication Commission of Kenya (CCK), arguing that KIXP violated Telcom Kenya's exclusive monopoly on the carriage of international traffic
- ☹ Within 2 weeks – the CCK concluded that the KIXP required a license & ordered it to be shut down, as it was a legal Telecommunication Facility
- ☺ **KIXP** is in Nairobi, operated by **TESPOK** (Telecommunication Services Providers Association of Kenya) – a professional non profit association representing ISP/Telco interests in Kenya



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Case Study#02 – The KENYA IXP (KIXP) - 2

- ☺ KIXP appealed to The Communications Appeals Tribunal with technical argument:
 - ☺ KIXP is a standard off-the-shelf Ethernet L2 Switch
 - ☹ If KIXP were to be then CCK would need to shut down every computer network using Ethernet L2 in the country – since technical architecture & components were equivalent
- ☹ Telkom Kenya's counter argued, of fearing losing significant portion of its international leased line revenues
- ☺ KIXP's rebuttal, by presenting the facts:
 - ☺ KIXP was a closed-user group – legal under Kenyan Telecommunication Acts
 - ☺ KIXP is for *domestic* Internet traffic, as such, it did not contravene Telkom Kenya's International monopoly, since all international traffic would continue to flow over its international links
- ☺ Finally the solution in this face-saving situation:
 - ☺ The Establishment of a company called *KIXP Limited*, which then applied for an IXP license that quickly approved by CCK, and made Kenya the first country in the world to have an IXP license.



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Case Study#02 – The KENYA IXP (KIXP) - 3

- ☺ Some good lessons learned:
 - ☺ Before KIXP, all internet traffic was exchanged internationally
 - ☺ 30% of upstream traffic via international link was actually to a domestic/local destination
 - ☺ Original satellite latency: 1,200-2,000 msec. After KIXP, it was around 60-80 msec.
 - ☺ A rise in local content facilitated the government initiative to digitize some government services
 - ☺ The arrival of international content companies, such as Goggle to locally hosting their services. All Google traffic such as searches, mail, maps, applications, documents now goes through KIXP; Google pays for the capacity from Kenya to their network in the United States
 - ☺ KIXP has implemented local instances of F and J root servers. In addition to local .com and .net resolution services. As a result, locally originated lookup requets for these services no longer need to transit international links for a response



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Case Study#03 – Indonesian IX (1)

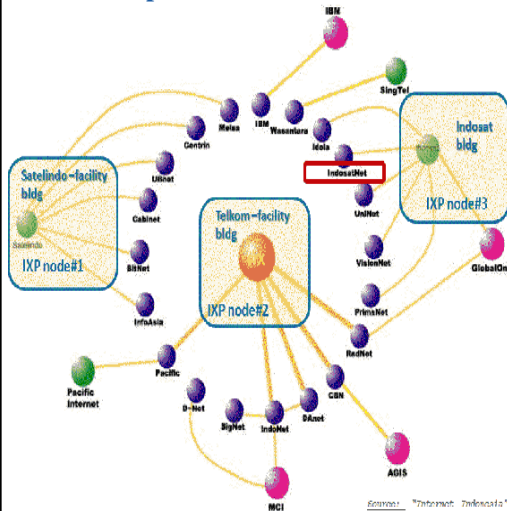
- First Operational ISP in 1994: **INDONET**
- **RadNET** was the first licensed ISP (1995)
- by end of 1995: 27 ISP Licenses were issued
- APJII (Asosiasi Penyelenggara Jasa Internet Indonesia) – Indonesian association of ISPs founded in March 1996
- Indonesia Internet Exchange (IIX) was initiated by APJII on June 1997; in Operational by August 2007; equipments were donated
- During 2000s more licenses were granted. For example, 90 New ISP licenses in 2000, 60 more new ISP licenses in 2001
- By 2009, the are at least 200+ popular portals
- The Phenomenal growth of *Internet Cafes*



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Case Study#03 – Indonesian IX (2)

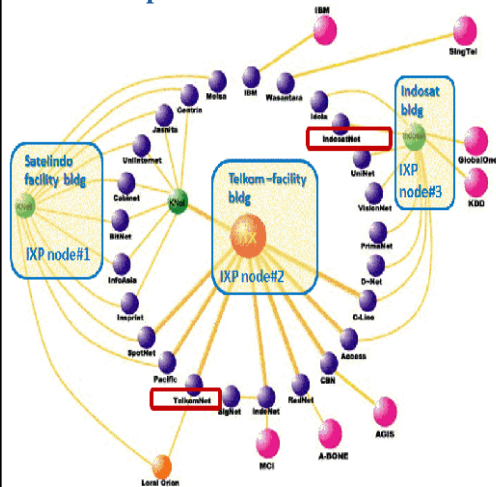
IXP Development – Circa 1997



- Umbrella agreement Telecommunication Law #36 that deals with ISP value-added operation
- Earlier only few ISPs “got it” & got serious in collaborating & setting the IXP.
- The IXP facility was rented from PT. Telkom Indonesia, one of Indonesian government’s owned Telco

Case Study#03 – Indonesian IX (3)

IXP Development – Circa 1998

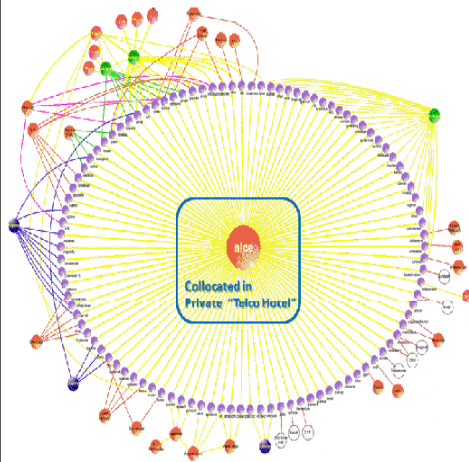


- More ISPs big & small joined in
- The big telcos took notice!

Case Study#03 – Indonesian IX (4)

IXP Development - > 2005

-All ISPs joined !



Latest Statistics (Aug 2010) :

- Peak @40+ Gigabit/sec traffic
- 240 BGP Peering sessions

Source: "Internet Indonesia" IDC Indonesia



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Case Study#04 – Afghanistan IX (1)

Current Issue

- All ISPs in Afghanistan use VSAT solution to connect to the ISP upstream providers
- The same in many part of the world, International bandwidth prices are biggest contributor to high costs
- Except for recent inauguration completion (march 2009) of Afghanistan National Fiber Optic Ring, there is currently no significant terrestrial infrastructure available in Major Cities, such as Kabul

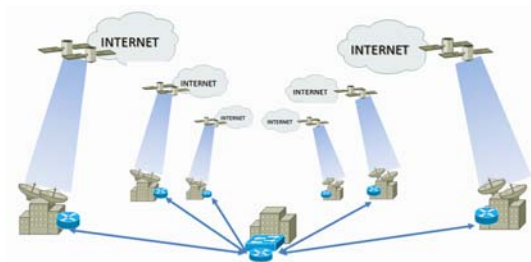


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Case Study#04 – Afghanistan IX (2)

Stake holders:

- MCIT – Ministry of Communication & Information Technology
- NDA – Afghanistan's National Data Center
- ATRA – Afghanistan Telecommunication Regulatory Authority
- **Afghan Telecom**
- NISPAA – National Internet Service Provider Association of Afghanistan



- 20 listed ISPs licenses
- NISPAA membership: 10 ISPs



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Case Study#04 – Afghanistan IX (3)

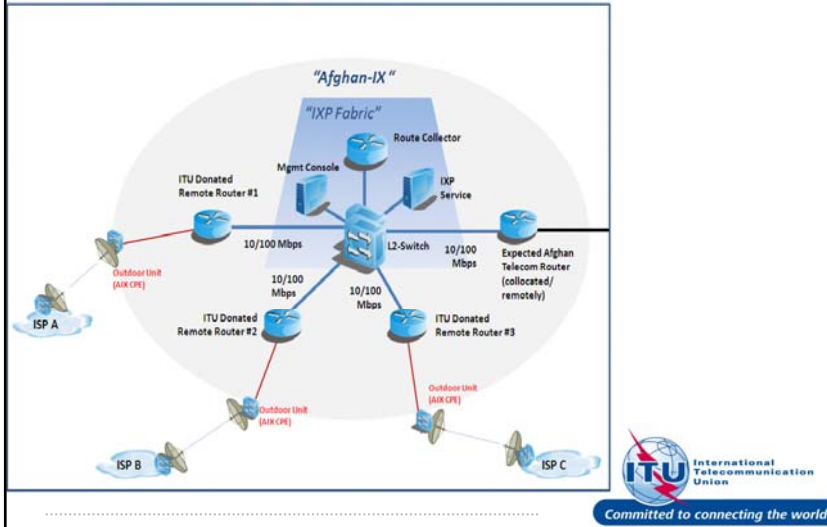
- From an IXP field survey sponsored by ITU which was conducted on July 2009 @ Kabul, Afghanistan, it was clear that IXP concept was different thing for different people. Some overheard comments:
 - 💡 "... We don't want any pornographic materials in the exchange..."
 - 💡 "... some of my customers are XYZs, we don't want any filtering at the Internet Exchange..."
 - 💡 "... we just purchased big core routers.. Just tell me what you need for the exchange, and we will get..."
 - 💡 "... I doubt if the AIX is useful..my customers mostly have email @ Yahoo.com, gmail.com etc..."
 - 💡 "... We will support, although we will expect to loose customers to competitors..."
- OBSERVATION: other technical misconception – just because one connects to another physically – the IP packet would automatically pass through ! It depends on BGP Configuration!
ISP A is a "friend" of ISP B, but "arc-enemy" of ISP C. After finding out that an IXP equipment is mostly just Layer-2 Switch, A will not join if ISP C join and plug into the IXP equipment. The fact that ISP A brings its link to the IXP collocation and plug into the switch does not automatically connect in "traffic exchange sense" with ISP C. (The "magic" is on BGP-4 Protocol was revealed during technical workshop session)



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Case Study#04 – Afghanistan IX (4)

Design



Case Study#04 – Afghanistan IX (5)

Training, Site visit & Workshop



Case Study#05 – Afghanistan IX (5)

Policy Perspectives

- From a public policy perspective, ensuring the presence of IXP in Kabul help encourages:
 - Local content development specific to Afghanistan
 - Creation of local content providers, hosting services etc
 - Development of local IT knowledge workers & job creation
 - Local ISPs to connect local institution, companies, schools, and in the process nurturing local social networking, peer-to-peer effective local communication, and other incentives

NOTE: when natural resources within countries are exhausted, and the world Globalization is at the front door of every nation, human resource with talents are of at most importance. Please read: **Thomas L. Friedman's** *The World Is Flat 3.0: A Brief History of the Twenty-first Century* .

Internet Exchange set up may give incentives to local **IT related business** opportunities to proliferate and in turns spearheading creation of local IT talents that fuels local business.



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INTERNET EXCHANGE – DISCUSSION



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Reason(s) to Set Local IXP

- To be efficient & economical: Keep domestic/ Local Traffic, Local! If there is no domestic/local Internet Exchange facility, your local ISPs must purchase **transit** from their foreign upstream ISPs
 - Remember Tier1/Tier 2 from slide on “DFZ”, most of this **transit providers** (AT&T, Sprint, NTT etc) are providers from the United States, England & Japan
 - There is NO incentive for these providers to peer with small ISPs from developing countries (or what not) with no significant contents (added service, customers) to counter-offer
 - Yes, these local ISPs have to pay the expensive transit service (with associated WAN expensive link etc) sold by the Upstream providers
- Nurture the development & creation of Local Content and the supporting Internet-based businesses (ISP, Network & System Integrators, programmers etc)



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Factors that inhibit IXP Establishment

A list of some general symptoms that inhibits IXP establishment in many countries that don't have IXP:

- A lack of mutual appreciation of IXP benefits among all stakeholders
- Resistance from those providers with market dominance (ie. refusal to peer)
- In many developing countries, such as Indonesia, the government owns the Big Telco /Service Provider. While the government has the position to nurture the growth of particular Internet Industry locally, this fact would be perceived as conflict of interest among smaller ISPs

NOTE: From Indonesian IXPs experience – the government remain neutral to APJII and nurtures the development of IX based on community-driven

- A chicken or egg situation: if there is enough local traffic to be exchanged



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Thank you

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