

Internet eXchange/ Internet eXchange Point

Presented @ NTC ITU ASP COE Training
Workshop on Infrastructure Sharing 31 August
– 3 September 2010 Bangkok, Thailand

Garin Ganis
CTO – PrawedaNET Aliansi Teknologi- Indonesia
Based on ITU Project#153-2009



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:

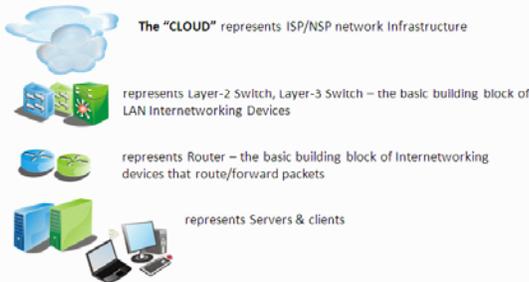
- Field Survey , Data Gathering, & Discussions @ Kabul, Afghanistan
- Study, Preparation of Techno-commercial design plan
- Field Study & Workshop (technical – 2 days) conducted in Jakarta, Indonesia, including site visits to:
 - *Indonesian IX - APJII*
 - *Indonesian Open IX - IDC*
 - *ID-SIRTII* (Indonesian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

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



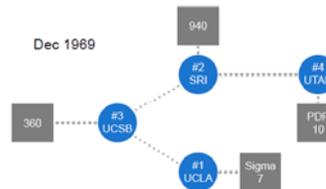
IX / IXP BASIC

HOUSEKEEPING – ICON NOTATION



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...

THE INTERNET

The diagram illustrates the Internet's hierarchical structure. At the top level, there are four TIER 1 NSP (National Service Provider) nodes. These are interconnected with each other and with TIER 2 ISP (Internet Service Provider) nodes. A 'DEFAULT FREE ZONE' is indicated between the top two TIER 1 NSP nodes. Below the TIER 2 ISPs, there are several TIER 3 ISP nodes. Two IXP (Internet Exchange Point) nodes are shown, one connecting TIER 2 ISPs to TIER 3 ISPs, and another connecting TIER 3 ISPs to each other.

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*)



International
Telecommunication
Union

Committed to connecting the world

5

IXP – Natural Growth

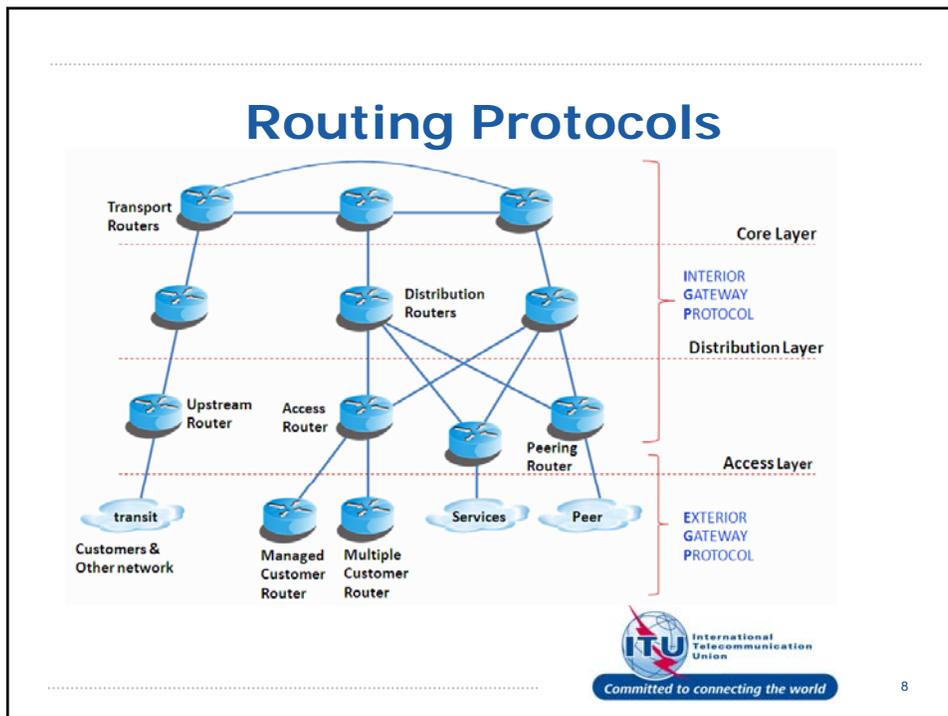
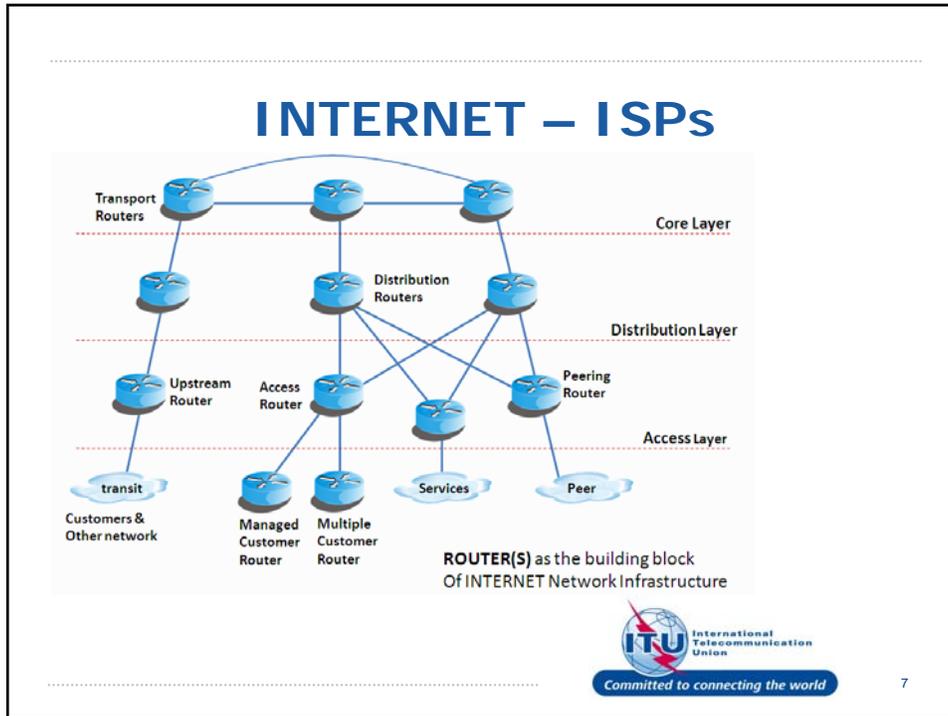
- History: **Network Access Point (NAP)s** established at the end of *NSF-NET*. This is the original 'exchange points'
- Major Providers (Tier1 – Tier2 etc) connect their networks and Exchange traffic
- It is a high speed network – nowadays: mostly Ethernet based Network
- Nowadays - It is ANY place, 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.



International
Telecommunication
Union

Committed to connecting the world

6



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**

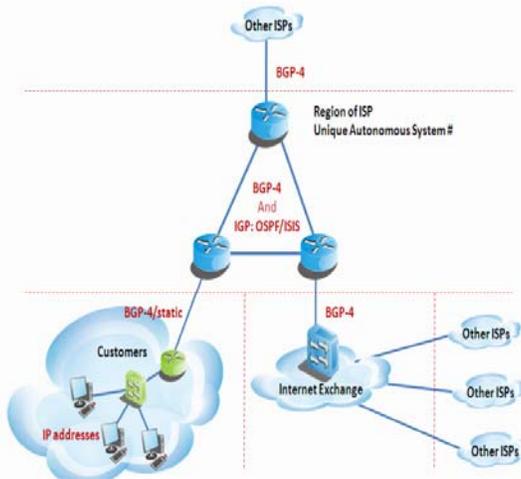
- Exterior
 - Specifically Configured PEERS
 - Connecting with outside Networks
 - Binds **Autonomous Systems** together
 - Carries Customer prefixes
 - Carries Internet Prefixes
 - EGPs are independent of ISP network Topology
 - Ex> **BGP**



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

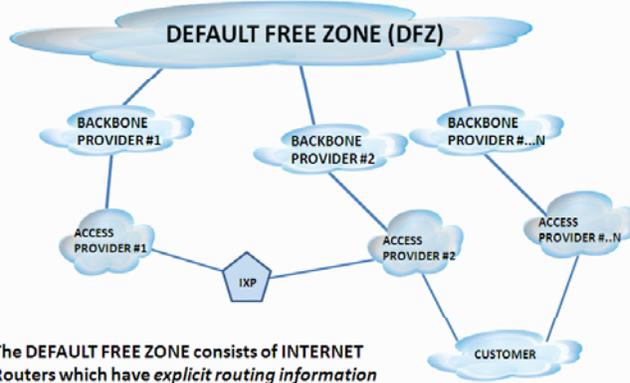
Routing Protocol: **BGP-4**

The “Magic Ingredient” that glues INTERNET together



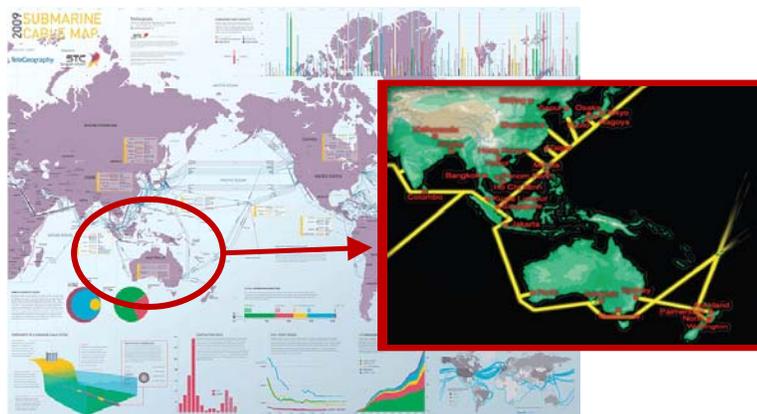
- BGP = Border Gateway Protocol
- protocol to connect ISP routers – a way to exchange *routing information* and define *routing policy*
- very scalable routing protocol

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



13

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**



14

General ISP 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



15

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



16

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 ☹



17

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



18

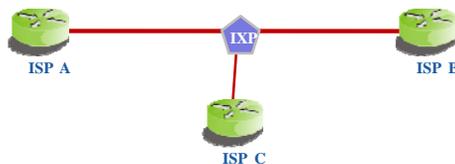
Private Interconnect

- 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



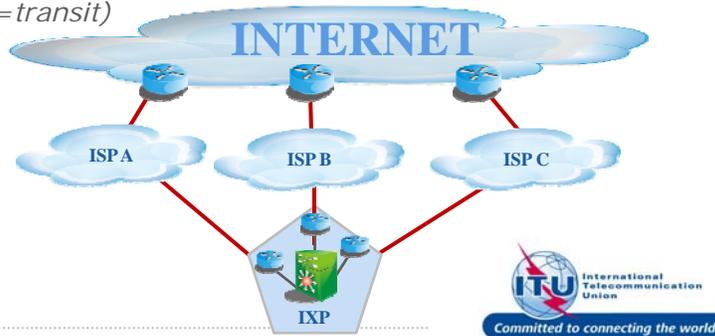
Public Interconnect

- 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)

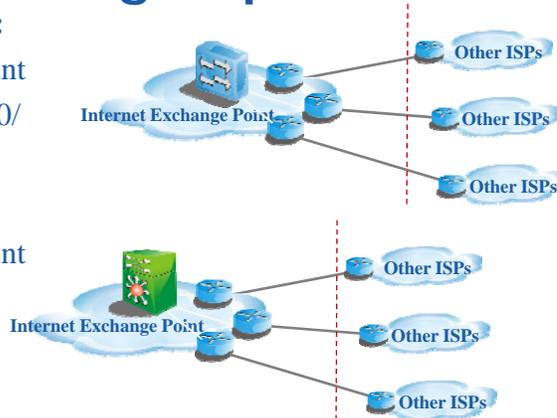


21

IXP Design Option

IXP Core fabric option:

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



22

INTERNET EXCHANGE – CASE STUDIES



23

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	Australia	



24

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

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



25

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



26

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



27

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.



28

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



29

Case Study#03 – Indonesian IX (1)

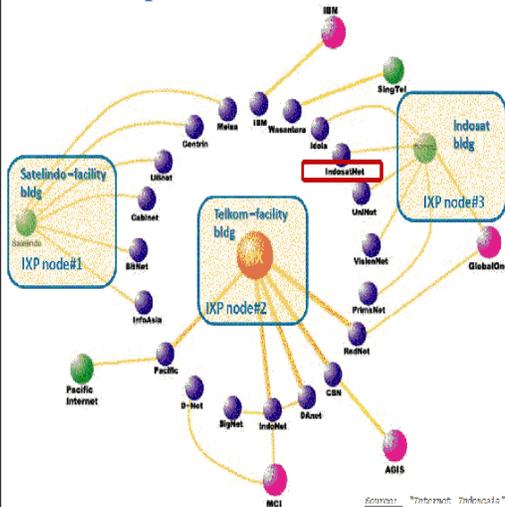
- First Operational ISP in 1994: **INDONET**
- **RadNET** was the first licensed ISP (1995)
- by end of 1995: 27 ISP Licenses were issued
- APJII (Asosiasi Penyelenggara Jasa Internet Indonesia) – Indonesian association of ISPs founded in March 1996
- Indonesia Internet Exchange (IIX) was initiated by 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*



30

Case Study#03 – Indonesian IX (2)

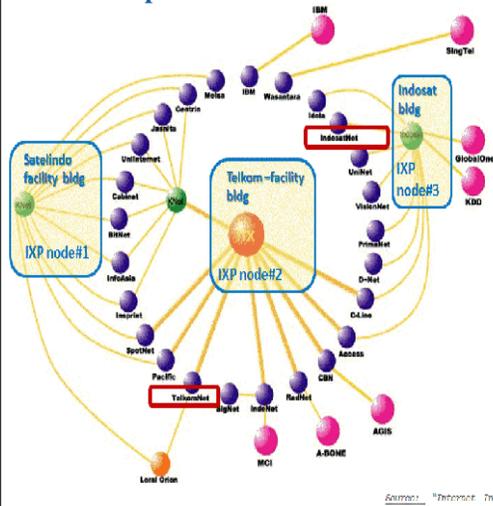
IXP Development – Circa 1997



- 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

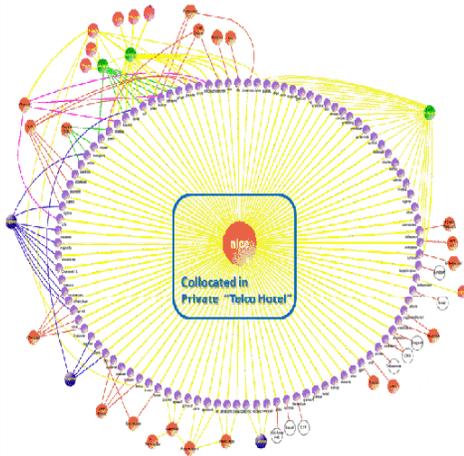


- More ISPs big & small joined in
- The big telcos took notice!

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



33

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

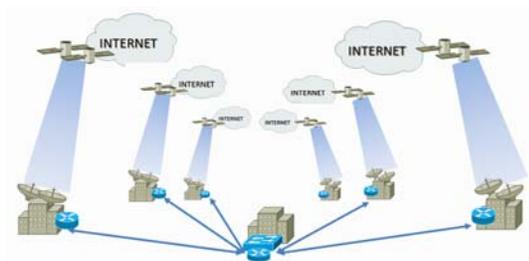


34

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



35

Case Study#04 – Afghanistan IX (3)

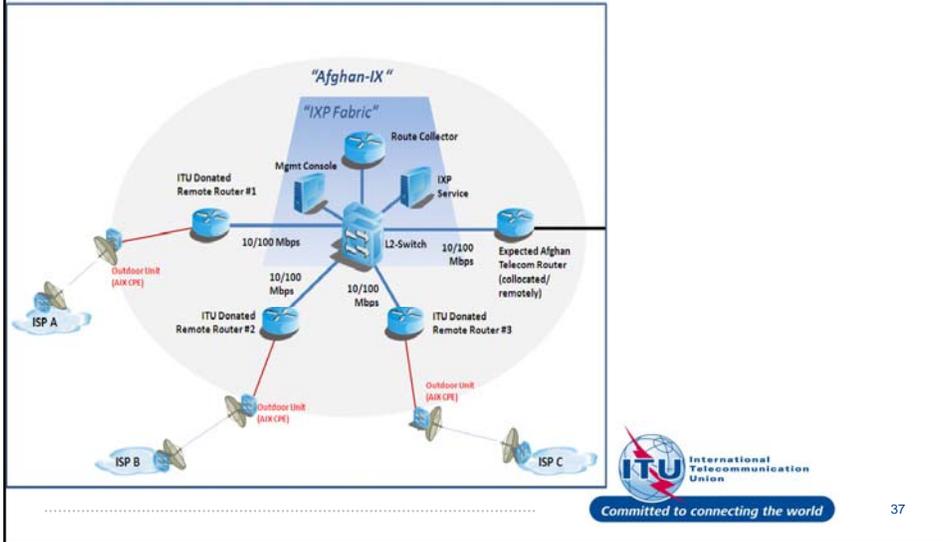
- From an IXP field survey sponsored by ITU which was conducted on July 2009 @ Kabul, Afghanistan, it was clear that IXP concept was different thing for different people. Some overheard comments:
 - 🗨 “.. We don’t want any pornographic materials in the exchange...”
 - 🗨 “... some of my customers are 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)



36

Case Study#04 – Afghanistan IX (4)

Design



37

Case Study#04 – Afghanistan IX (5)

Training, Site visit & Workshop



38

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.



39

INTERNET EXCHANGE – DISCUSSION



40

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)



41

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



42

Thank you

gganis@pacific.net.id

