African Peering and Interconnection Forum

Unlocking Africa's Regional Interconnection

Inaugural Meeting
11–12 August 2010
Nairobi, Kenya

Summary of Proceedings

Organized by

Local host

Inaugural Meeting Sponsors

The Internet Society is a nonprofit organisation founded in 1992 to provide leadership in Internet related standards, education, and policy. With principal offices in Washington, D.C. and Geneva, Switzerland, and staff located around the globe, it is dedicated to ensuring the open development, evolution, and use of the Internet for the benefit of people throughout the world.

Internet Society
InternetSociety.org
info@isoc.org

Galerie Jean-Malbuisson, 15
CH-1204 Geneva
Switzerland
Tel: +41 22 807 1444
Fax: +41 22 807 1445

1775 Wiehle Ave.
Suite 201
Reston, VA 20190, USA
Tel: +1 703 439 2120
Fax: +1 703 326 9881

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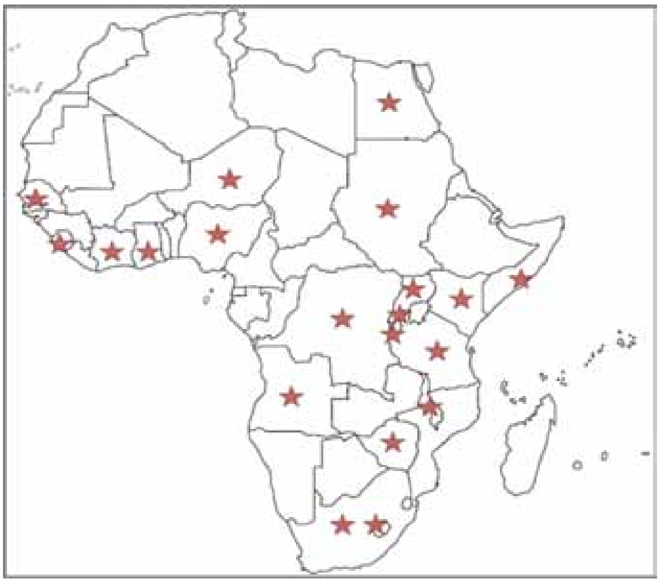
1. Introduction

Ongoing policy and regulatory changes in Africa have recently begun to shift the continent from being primarily dependent on satellite connectivity to fibre optic and terrestrial wireless networks. While these developments are addressing some of the challenges that have contributed to the slow Internet growth in the region, most of African cross-border Internet traffic is still exchanged in Europe and North America. This is a clear indication that the satellite routing policies are still predominant in a submarine fibre setting. A typical example is the path followed by an Internet packet from Nairobi, Kenya to Kigali, Rwanda. The packet from Nairobi will go to Europe before finally reaching Kigali. The anomaly is that Rwanda's international connectivity is provided by terrestrial and submarine fibre, which is routed via Uganda, Nairobi, and the Kenyan coastal city of Mombasa.

This pattern is replicated across the continent, and combined with the lack of cross-border connections between many neighbouring countries, this substantially reduces performance and consumes valuable intercontinental bandwidth, creating a barrier to growth, innovation, and limiting operational efficiency. As the Internet is a quickly evolving landscape, there is a need for African Internet business managers, technical engineers, and policymakers, among others, to obtain up-to-date knowledge, information, and skills on the opportunities for creating a more robust interconnection and traffic exchange landscape, how to manage the economics of the Internet to their benefit, and use network resources in more efficient, cost-saving ways.

To raise awareness of these issues, identify ways of addressing them, and build knowledge on the continent, the Internet Society organised the inaugural meeting of the *Africa Peering and Interconnection Forum* (AfPIF) at the Sorava Panafric Hotel in Nairobi in August 2010. The Internet Society's facilitation of the Forum is part of a multi-year programme aimed at advancing the interconnection and traffic exchange landscape in Africa in partnership with local stakeholders.

The two-day inaugural AfPIF event, themed "Unlocking Africa's Regional Interconnection," aimed to *discuss* the key interconnection opportunities and



Origin of African Registrations for the AfPIF Inaugural Meeting

challenges in Africa, and provide participants with global and regional insights on maximising regional opportunities. As a multi-stakeholder forum, the event sought to foster a robust discussion on cross-border interconnection approaches and challenges by encouraging the participation of the full range of key players—infrastructure providers, Internet Service Providers (ISPs), Internet Exchange Point operators (IXPs), and national regulators, among others.

AfPIF attracted over 150 registrations from 20 African countries[1] as shown in the map, as well as experts and participants from Canada, France, Malaysia, Netherlands, New Zealand, Sweden, United States, and the United Kingdom. In addition, a live audio stream of the event was broadcast over the Internet in order to provide remote participation opportunities for those unable to attend in person.

The agenda for the meeting was developed based on input from African Internet experts and stakeholders and organised around the following themes:

- **Peering vs. Transit Economics** to provide an update of current physical and Internet infrastructure in the region, covering IXPs, regional ISPs and telecom operators, terrestrial and submarine cables in the region. Panellists discussed the economic concepts of peering and transit in order to introduce the participants to the main interconnection concepts and how they affect the utility of the Internet.
- **Peering and Interconnection Strategies for Operators** to give strategic insights on how to identify the appropriate interconnection points in their region and globally. The emphasis was on different types of network tools and information needed. The underlying objective was for service providers to learn how to predict current and potential trends that will enable them make decisions on how to grow and develop their region's interconnection points.
- **Interconnection: The Cross-Border Policy and Regulatory Challenges** to capture the existing challenges and developments from a regulatory

1 Angola, Burundi, Cote d'Ivoire, DRC, Egypt, Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Niger, Nigeria, Rwanda, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe

perspective with respect to promoting cross-border interconnection. This presented the stakeholders with a special opportunity to engage with regulators to discuss the cross-border interconnection challenges. The objective was to end the session with some consensus on policy/regulatory reform that would catalyse regional interconnection.

- **Peering and Interconnection Contracts and Negotiations** to provide insights on negotiating interconnection contracts and sharing of experiences on contract negotiation strategies. The session also addressed dispute resolution considerations and identified the requisite skills that peering co-ordinators need in organisations engaged in interconnection negotiations.
- **Africa Peering and Interconnection Opportunities: The transition from national ISPs to regional carriers** to uncover growth opportunities that interconnection presents for the ISPs in the region, including the provision of peering and transit services across boarders. Case studies from successful cross-border operators were presented and the challenges of using submarine fibre cable for regional connectivity were examined.
- **Interconnection and the Content Equation** to focus on the role of content providers and Internet Exchange Points (IXPs) in peering and interconnection deliberations, aiming to raise awareness of the impact of content and applications providers such as gaming server and edge caching facilities providers in the peering and transit ecosystem. The session also highlighted content provider peering and transit policies in relation to their participation at IXPs.

This report provides a summary of the meeting's proceedings, an overview of the issues discussed, and a synopsis of the material presented at the Forum. Presentations and audio recordings from the meeting are also available for download on the conference web page.[2]

To improve the coherence of the report, summaries of some of the presentations have been regrouped. This has allowed the structure of this report to start with status and plans for telecommunications, Internet and IXP infrastructure on the continent, then to move onto the policy and regulatory issues before focussing on the nuts and bolts of peering and interconnection. The responses to some of the questions from the floor have been incorporated into the relevant sections of the presentations, and some paraphrasing has taken place to improve clarity.

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2 Available at http://www.isoc.org/isoc/conferences/africanforum2010 and http://www.afpif.org

Note to Readers: Individuals new to the concepts of Internet interconnection and traffic exchange may find it useful to refer to Section 3.5.1 *Peering Jargon* while reading this report for definitions of common terms used during the meeting. Introductory material on Internet interconnection, traffic exchange, and Internet Exchange Points is also available on the Internet Society website at: http://www.isoc.org/internet/issues/ixp.shtml.

The inaugural meeting of AfPIF was highly successful, with participants indicating it responded to a need for Africa to have a multi-stakeholder forum in which to exchange experience and perspectives, acquire world-class knowledge, and collaborate on key African interconnection and traffic exchange issues. As such, the Internet Society extended its support in helping to facilitate and organise AfPIF as an annual event in collaboration with the African Internet community. The second AfPIF meeting is expected to be held in West Africa in August 2011.

Acknowledgements:

The African Peering and Interconnection Forum meeting was made possible through the collaboration and contributions of a range of organisations and individuals. Special thanks are due to Tej Bedi—Chairman of the Board and Fiona Asonga—Chief Executive Officer of the Telecommunications Service Providers Association of Kenya (TESPOK) for serving as the local host of the inaugural AfPIF event, and the many participants and volunteers of the African Network Operators Group (AfNOG), the Registry of Internet Number Resources for Africa (AfriNIC), and other individual African experts for contributing to the AfPIF concept and inaugural meeting agenda. The Internet Society and TESPOK also wish to extend their special appreciation to the Honorable Minister of Information and Communications of Kenya, Samuel Phoghisio, for his presence and role in officially opening the event. Presenters who kindly lent their expertise to the meeting included: Fiona Asonga, Tej Bedi, Mike Blanche, Mike Jensen, Jane Karuku, Meoli Kashorda, Edmund Katiti, Kurtis Lindqvist, Jonny Martin, Paul Mugemangango, Michuki Mwangi, William (Bill) Norton, Nii Quaynor, Karen Rose, William Stucke, Mark Tinka, John Walubengo, and Job Witteman. Gratitude is also expressed to the following sponsors of the meeting: Amsterdam Internet Exchange (AMS-IX), German Internet Exchange (DE-CIX), Google, Orange Kenya, and Swedish Internet Exchange (NETNOD). The Internet Society would also like to thank Mike Jensen and Matthew Shears for their assistance in compiling this report.

2. Summary Observations from the Meeting

The discussions at the AfPIF meeting were robust and a number of key observations and recommendations emerged from the Forum, underlining the importance of events such as this for social networking, improving information exchange, developing interpersonal relationships, working together to find consensus viewpoints and identifying needed policy change and information gaps.

Overall, AfPIF highlighted the vital importance of improved local, national, and regional fibre infrastructure, knitted together with Internet Exchange Points (IXPs), in creating a widespread, high-performance, and competitive low-cost Internet ecosystem. While some countries have made considerable progress in achieving better connectivity, especially with regard to international submarine capacity, and exciting plans were heard for further infrastructure development, most countries are still at an early stage of development, and much still needs to be done, especially at the national and regional levels.

As became apparent from many of the presentations, barely more than a decade ago Europe was in much the same position as Africa with regard to high connectivity costs and limited interconnection between countries. The participants had the opportunity to learn from these experiences and hopefully avoid some of the early pitfalls that were made. In this context, it was noted that regulatory and industry actions that support the development of a robust Internet interconnection landscape (including IXPs) help advance the Internet and ICT market more broadly. The main aspects of this that were identified during the meeting included:

- **Reduced international and regional bandwidth costs** gained from off-loading local traffic at the exchange. In a competitive market reduced bandwidth costs for the operators ultimately result in better prices and services to the end-user.
- **Better performance**—improved local interconnection reduces latency on links and also makes more bandwidth available to the ISP, and thus to the end-user.
- **Increased resiliency/reliability**—alternative routes become available when the ISP's main link goes down and local services can still operate when international links are inoperable.
- **Reduced export of capital offshore**—local ISPs pay less to international providers for intra-African traffic. From an economic development

perspective this means more capital to develop the local economy. Building critical mass of the local Internet sector also means that international providers are more encouraged to come to the local exchange because of the aggregation of traffic there, further reducing off-shore capital flows.

- **Attracting investment**—a market that facilitates interconnection at the local, regional, and international levels is conducive to Internet and ICT industry growth, making it attractive for investment.
- **Keeping local content local, encouraging the creation of local content** and the local content industry. Local websites become much faster and more convenient to use with a fully interconnected local Internet ecosystem—without a strong environment that supports interconnection, including IXPs, there is less incentive to create local content.

Concerned about losing market share, dominant ISPs and incumbent telecom operators often resist interconnecting, participating at an IXP, and peering. As many participants in AfPIF pointed out, however, improved local interconnection and participation in exchanges actually helps grow the market as a whole and the amount of revenues generated for everyone increases. However it was noted that changing the viewpoint of the dominant providers may not happen immediately and often takes them time to become confident that interacting with smaller providers and participating at IXPs will ultimately result in greater demand in the future.

In helping to ensure better interconnection, the main outstanding issues that were highlighted during the event comprised the need to:

1. Accelerate moves to adopt policies that increase competition in order to drive down prices and improve the level of investment in local, national and regional infrastructure. These include:
    - Local loop unbundling and other facilities leasing
    - Provision of access to dark fibre
    - Imposition of limitations on the Significant Market Power of incumbent operators
    - Allowances for self-provisioning of infrastructure by ISPs
    - Reductions in the cost of operator and spectrum licences, which will lower the barriers to entry and ultimately the costs to the end-user,

- Elimination of special revenue-raising taxes, which increase end-user costs and therefore reduce demand, such as sales taxes on communication and import taxes on communication equipment.
- Eliminating content-provider and IXP licences where these are in place or being considered.
- Sharing of essential facilities, telecommunication infrastructure, civil works and access to alternative infrastructure provided by transport and energy operators, especially for land-locked countries.

2. Address the outstanding issues that limit the ability of infrastructure developers and Internet service providers to cross borders—in particular the need for harmonisation of regulations between neighbouring countries and addressing the issue of lack of clarity in permitting from governments in digging across no-man's land.
3. Promote the need for all local carriers, ISPs, and content providers to connect to IXPs and carrier neutral data centres so that the development of local content is encouraged and the aggregation of traffic allows Africa to become a region that the international providers wish to connect to, rather than Africa continuing to be the "client" continent of today where providers need to pay all of the costs of connecting to global backbones.
4. Recognise the important role of the public sector in financing infrastructure development in remote and less population dense areas, which may not be initially profitable for private operators, and/or to ensure that there is redundant infrastructure in these areas to improve the reliability of service provision.
5. Work with governments as united groups of operators and other stakeholders to resolve these constraints to improved interconnectivity. This could be achieved through:
    - Increasing the support for information sharing and multi-stakeholder consultation to help take into account the concerns of all affected parties in policy development and to build relationships and trust between the various players.
    - Increasing the level of support for relationship building, technical training, and skills development to ensure that Internet providers can more effectively use existing IXPs and to quickly implement IXPs in the countries where these are not yet present.

- Promote awareness at the top levels of leadership within government, in regional governmental agencies, and in the international development assistance community, of the importance of these issues and implementing the necessary policy changes. National regulators also need special focus and specific awareness-raising events may be needed for them. These events could be attached to existing fora such as the regional regulatory association meetings.

■ For network operators, the forum also identified many of the strategies and constraints to growing their networks, establishing successful IXPs, better peering and transit relationships, and more local content. Among the most important of these were:

  - Holding additional forums, meetings, and training workshops that help to build human capacity and especially to develop social networking and personal relationships between the staff of different network operators. This is particularly needed to bring in additional ISPs that have not yet participated in information-sharing events. More formal training could also be attached to events such as AfPIF, and the AfriNIC, AfrISPA, and AfNOG meetings, which already carry out some of these activities, although usually at a detailed technical level.

  - Ensuring there is a designated staff position as "Peering co-ordinator" to ensure that network traffic is properly analysed for identifying peering needs and opportunities, evaluating potential peering locations, in developing appropriate peering policies and in negotiating the best peering terms. Playing the Peering Game can help novice peering co-ordinators better understand many of the peering negotiation issues.

  - Aggregating as much traffic as possible at Internet exchange points to build critical mass, leverage economies of scale, and attract content providers.

  - IXPs need to adopt simple policies and fees that maximise potential membership. For example, IXPs that have mandatory multi-lateral or bi-lateral peering policies are less likely to be successful due to the limited interest of international transit and content providers in participating in these exchanges. Similarly, there is little need for perusing balanced traffic ratios in peering with the way the Internet works today—there are the content networks on the one side, and eyeball networks on the other. Traffic does not always flow “equally” in each direction, but each type of network needs the other.

- As the communications environment moves toward IP-based networks for both voice and data, operators will increasingly need to consider the advantages of using IXPs for voice interconnection between networks.
- Local content development can be stimulated by lower-cost local hosting, local ccTLD domain registration, and differential charges for local vs. international traffic. Differential international outbound vs. inbound transit products could also stimulate local content hosting.
- Special peering relationships and transit traffic agreements with academic networks are needed in order to help encourage human capacity development.
- Use of tools such as PeeringDB and sFlow are useful in helping to identify peering opportunities, potential peers, and peering locations.
- Establishing a mailing list of AfPIF participants to continue the forum dialogue.

Among the peering and interconnection achievements noted during AfPIF were:

- A total of 20Tbps of submarine cable capacity linking African countries to each other and the rest of the world will be in place by 2012.
- The key hub landing stations for submarine landing stations with three or more separate cables (existing and planned) are: Cape Town, Mtinzini (near Durban, South Africa), Douala, Lagos, Accra, Abidjan, Dakar, Alexandria, Port Sudan, and Mombasa.
- About 350,000 kms of terrestrial backbone fibre infrastructure is now present on the continent.
- The landlocked countries of East Africa (Uganda and Rwanda currently, Burundi shortly) have established backbones that gain access to submarine fibre at the same price as the coastal countries—$100 to $200/Mbps/month for international capacity is now becoming achievable.
- Extensions from the East African backbone are in progress for terrestrial links to the DRC, Ethiopia, and Somalia, and for the creation of regional backhaul rings to increase reliability.

- Progressive policies and regulatory guidelines have been adopted by EACO to encourage interconnection in the East African community member states.
- Twenty-four IXPs are now running in Africa—19 African countries, and multiple IXPs in South Africa, Tanzania, Kenya, and Nigeria.
- Last year, Africa had the largest growth in exchange traffic of all the regions (183% from mid-2009 to mid-2010). However, this was off a small base, as the aggregate traffic is only at 2.4Gbps while every other region is at least 50Gbps or more.
- There now five African IXPs with Root-Server instances, which improve DNS resolution within country.
- A number of regional ISPs are now emerging with presence in multiple IXPs.

African IXPs:

Angola: IXP-ang http://www.angola-ixp.ao/	Botswana: BINX
Cote D'Ivoire: CI-IXP http://www.ciixp.ci	Democratic Republic of Congo: KINIX http://www.ispa-drc.cd/kinix.htm
Egypt: CR-IX, GPX and MEIX (Middle East Internet Exchange), http://caix.tra.gov.eg, http://www.gpxglobal.net/	Ghana: GIX http://www.gixa.org.gh
Kenya: KIXP Nairobi & KIXP Mombasa http://www.kixp.or.ke/	Mauritius MiXP http://www.gov.mu/portal/sites/mixp/index.htm
Malawi: MiX http://www.mispa.org.mw/mix.html	Mozambique: Moz-ix http://www.mozix.org.mz/
Nigeria: Lagos and Ibadan iBiX http://www.ib-ix.net/ and NIXP http://www.nixp.net	Rwanda: RINEX
Sierra Leone (SLIX)	South Africa: JINX http://www.ispa.org.za/jinx/ and GINX http://www.ginx.org.za/
Swaziland: SZIXP	Tanzania: TIX and AIXP http://www.tix.or.tz, http://www.aixp.or.tz
Uganda: UiXP http://www.uixp.co.ug/	Zimbabwe: ZINX http://www.zispa.org.zw/zinx.html
Zambia: ZIX http://www.zispa.org.zw/zinx.html	

In the closing session, AfPIF participants indicated that the meeting responded to a need for Africa to have a multi-stakeholder forum in which to exchange experience and perspectives, acquire world-class knowledge, and collaborate on key African interconnection and traffic exchange issues. As such, the Internet Society extended its support in helping to facilitate and organise AfPIF as an annual event in collaboration with the African Internet community. The second AfPIF meeting is expected to be held in West Africa in August 2011.

In order to support continuefd dialogue, information exchange, and collaboration between meetings, an AfPIF mailing list has been established. Individuals interested in participating can subscribe to the mailing list by sending an e-mail to mailman-request@afpif.org with the word “Subscribe” in the subject line. An AfPIF website is also under development at http://www.afpif.org.

3. Account of the Forum Dialogue

3.1 Welcoming Remarks

3.1.1 Karen Rose: The Internet Society’s Motivation in Organising the Event

Karen Rose, Director of Regional Development at the Internet Society (ISOC), welcomed delegates to the AfPIF meeting, with special thanks to local host TESPOK, the meeting sponsors, and the Honorable Minister of Information and Communication of Kenya, Samuel Phoghisio.

ISOC is an independent, international nonprofit organisation dedicated to the growth and advancement of the Internet globally. It has been involved in assisting Internet growth in emerging economies since its inception in 1992, and for nearly 20 years ISOC has run international Internet capacity-building programmes for emerging countries and has played an important role in helping to establish and support Internet connections around the world.

Rose described ISOC’s presence and role in Africa: 20 local chapters, an African regional Bureau, and staff located in Ethiopia, Kenya, and South Africa. The organisation engages in numerous capacity-building, policy, and development projects across the continent—working with many partner organisations and regional bodies, industry, technologists, government, and other stakeholders.

The Internet Society is engaged in this work, not just to expand the Internet for its own sake—but because the Internet is a fundamental driver of economic growth and social development around the world, and a foundational tool for improving business opportunities and entrepreneurship, scientific advancement, health care, education, and public administration.

Yet these benefits cannot be realised, Rose noted, unless critical Internet infrastructures and related investments have the environment and tools to grow and flourish. The long-term sustainability of the Internet in any region—including Africa—relies on the ability of ISPs and other data network operators to conduct their operations efficiently, manage costs, provide reliable service to users at reasonable prices, and take advantage of growth opportunities. This is true for small and large networks, and for-profit companies or nonprofit networks.

There have been many exciting developments in the Internet landscape in Africa in recent years. They include new undersea cable landings, new domestic and foreign investments, and increased dialogue between government, industry, and other stakeholders on the development of access-enabling public policies. However, Rose pointed out that significant challenges still remain to achieving sustainable, efficient, and cost-effective networking on the continent—and many relate to the interconnection and peering topics of this Forum.

The lack of network interconnections between many countries in Africa, especially those in the interior, means that data traffic destined to neighbouring countries is often shipped overseas, just to return back to Africa. With per megabit satellite connectivity costs of $2,000 to $5,000 dollars or more in many African countries, this not only contributes to high end-user access prices that dampen growth, it also ships precious financial resources overseas that could be used to grow stronger networks here in Africa.

Further, in some countries that have physical connections to undersea cables, much traffic still flows through inefficient routes. A good example is the path followed by an Internet packet from Nairobi, Kenya to Kigali, Rwanda. The packet from Nairobi will be sent offshore to Europe then back around to Kigali, despite the fact that terrestrial fibre infrastructure is present between Rwanda and Kenya. On a domestic level, network operators in many countries are yet to establish Internet exchange points, or maximize the use of IXP infrastructures already in place.

Rose said that the Internet Society’s vision is an Internet in Africa that is truly interconnected: one in which its reach and benefits are spread to all people across the continent and where network providers can sustainably grow and provide new services, and do so on a cost-effective basis.

The Internet is also a network where businesses and entrepreneurs realize new economic opportunities, where e-enabled services sustainably support the aims of the Millennium Development Goals, where African universities can affordably empower the next generation of leaders with on-line access to the best of African and global knowledge, and the richness of Africa's cultures and creativity can be accessed by the world.

This is a vision that many of the AfPIF delegates share, Rose stated. Achieving the vision of a ubiquitous and cost-effective Internet in Africa will take efforts on many fronts. But one important step will be achieving greater regional interconnectivity and developing local capacities to manage current and new network resources more efficiently.

Fundamental to this is ensuring that network operators—and governments—understand the unique economics of the Internet and can leverage them to the greatest benefit, are equipped with global and regional insights in order to maximize interconnection opportunities, and that space is provided for constructive cross-sectoral discussions on African interconnection approaches and challenges.

Rose said that the African Peering and Interconnection Forum is a response to the need for such a space. Providing a platform in which world-class knowledge can be acquired, experience and perspectives exchanged, and where representatives of industry across Africa, as well as government and other stakeholders, have the opportunity to interact.

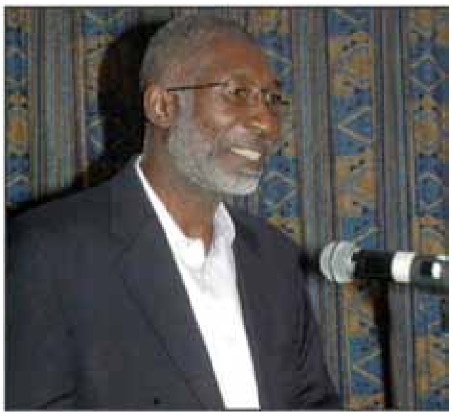
She said that it is ISOC's hope and desire that it would be the first meeting of an ongoing Forum, supported not only by physical meetings but also through on-line tools. Facilitating the Forum is one of part of a multi-year ISOC project to advance the interconnection and traffic exchange landscape in Africa, which aims to contribute to the growth of the Internet on the continent in partnership with local stakeholders and technical communities.

Rose outlined the agenda of the inaugural meeting: two days covering the fundamentals of Internet economics—including peering and transit arrangements—peering and interconnection strategies for operators, cross-border policy challenges, factors in growing regional operations, and the role of content in the interconnection and peering equation. In addition to sparking interest in advancing these issues further, ISOC hoped that the delegates would be able to apply some of the information from these two days when returning to their own network environments.

Rose emphasized that social networking with peers and colleagues was also an important part of the meeting and ISOC hoped delegates would take the opportunity to seek out for discussions during the breaks, lunch, and evening receptions. The event attracted representatives from over 20 African countries spanning South

Africa to Egypt, and from The Gambia to Somalia. Rose concluded by saying that the Internet Society looked forward to working with the many stakeholders represented to advance the work, and help deliver on the promise of the Internet in Africa.

3.1.2 Dr. Nii Quaynor: The "Af-Star Community"—A Regional and Historic Perspective



Dr. Nii Quaynor, the "grandfather" of the Internet in Ghana, and long-time supporter of Internet development in Africa, made a presentation based on his extensive experience in the region.

For Dr. Quaynor, AfPIF is a very important addition to the Internet's technical community in Africa—its emergence, while being timely in context of current infrastructure developments all around Africa, deepens the efforts of the African technical community while focussing on building relevant expertise in a specialised area in support of Internet development in Africa.

The group referred to as the African technical community traces its history to the ISOC's INETs and Network Training Workshops. At that time there were few technical experts and the ISOC community provided a welcome umbrella. In 1998, following the IAHC process leading to formation of ICANN, this group planned one of the first Internet governance meetings in Cotonou, Benin, with Pierre Dandjinou as host. Dandjinou's foresight in choosing the theme "Internet Governance in Africa" in 1998 was commendable. At this meeting the focus was on the role for Africa in ICANN and how Africa would respond to the then-changing landscape on Internet technical co-ordination and administration.

At the meeting in 1998, Dr Quaynor presented a paper that postulated an assortment of needed technical institutions to bring focus to the work of expanding the reach of the Internet in the region. Among the proposals were institutions for holding the community together, capacity building, numbers registry, African ccTLDs, Internet societies, providers, research, and other communities.

These proposals evolved into well-organized institutions including African Network Operators Group (AfNOG), African Numbers Registry, African ccTLDs AfTLD and African Research and Educational Networks AfREN, ISOC Africa, and a few others all at different stages of maturity. These groups became affectionately known as the Af* (pronounced "Af-Star") Community. The Af* Community organisations have played key roles in Internet development and their contribution to Interconnection to date are:

- AfNOG—The capacity building that included advanced routing techniques and IXPs that have a role to play in Interconnection.
- AfriNIC—Their role in promoting IPv4 and IPv6 uptake, including by African ISPs that had previously only used IP addresses from their upstream providers. The increased uptake of these resources is important for the technical implementation of peering and interconnection. The AfriNIC Anycast program, which has helped implement a Root-Server instance in Tanzania, is a value-added initiative aimed at bringing more value to peering at IXPs in the region.
- AfTLD—Their role in strengthening ccTLDs in Africa by the use of national domain names is a fundamental catalyst for local content development and hosting. With local content and hosting it helps build a case for regional peering and interconnection.
- AfREN—It has played a significant role in supporting the establishment of National research and Education networks, learning from the experience of the western/developed countries where NRENs play a key role in their Internet growth and development. AfREN has two networks in operation Ubuntunet Alliance and WACREN.
- ISOC Africa—Its role in influencing social and policy issues of the Internet in Africa and having direct contributions into national policies as well as building national technical capacity through ISOC chapters and building institutional capacity ccNOGs, among others.

The AfPIF was not one of the activities anticipated in 1998 and for a good reason; back then there were bigger barriers in the digital divide and the impediments of the time were immediate and pressing. Dr Quaynor expressed his gratitude for an approach that encouraged independent yet coordinated growth—one that has made long lasting partnerships since the first coming together in AfNOG-1 in May 2000 in Cape Town, South Africa. AfNOG has since provided a meeting space for all Af* to gather, to do their work, and share in the larger common community with their own agenda and activities. Some of the global partners at the just-ended AfNOG-11 meeting in Kigali included ISOC, Cisco, NSRC, Google, AfriNIC, KAIST, Oreilly, FreeBSD, and OBIT. The host of local sponsors is impressive and includes RDB, RICTA, KIST, RwandaTel, Altech stream, MTN Rwanda and Artel. Over the years the Af* organisations have welcomed support from the UNDP, World Bank, Carnegie Corporation, and IDRC to mention a few.

The role governments have played in supporting the Af* organisations is also well recognized. The setting up of AfriNIC, one of the flagship organisations in Af*, was embraced by several governments and intergovernmental organisations, and AfriNIC received handsome seed contributions from the governments of Egypt, South Africa, and Mauritius. The hosting of Af* meetings at AfNOG enjoyed government support through regulatory and development agencies partnering with the local technical community.

Increasingly the efforts of the Af* community are being recognised. In Ghana, where the technical community had been out of favor from 2002 to 2008, Internet pioneers (the Admin and Tech POC for the .GH domain) have been recently appointed as the Chairman of Board and Director General of a new National IT Agency (NITA). This is an unprecedented opportunity for the Af* community to help rebuild Ghana's Internet Infrastructure.

Dr. Quaynor concluded by welcoming the AfPIF to the Af* community and recognizing its potential impact on Internet developments in Africa

3.1.3 Tej Bedi: TESPOK Welcoming Remarks to Attendees

Mr Tej Bedi, Chairman of the Telecommunications Service Providers Association of Kenya (TESPOK), and local host organisation for this AfPIF meeting, addressed the attendees of the AfPIF meeting.

Underlining the importance of information sharing across the region, Mr. Bedi pointed out that 2010 had been an amazing year for Kenya, with the hosting of ICANN and now the first AfPIF. There had been an upsurge of submarine cable along the East coast of Africa, and operators in this region would like to hear of the experience of counterparts on the West coast. The landing of three submarine cables in East Africa has facilitated the need for operators to change their business models to make the most of the opportunities that have been made available. It has also created a need for regulators to adjust their licensing frameworks to move the industry to the next level. In addition, the arrival of the submarine cables has highlighted the needs of landlocked countries to benefit from the new infrastructure.

East Africa has seen the opening up of the Internet market and heavy involvement of the large telecom operators in what was previously perceived as the ISP space.

The implications are that the ISPs have to change their business models to take advantage of the gaps in creating new local business opportunities. In particular, the areas of content development, terrestrial fibre deployment, and universal access, coupled with the need for regional interconnection, is changing the business space.

Over the last eight years TESPOK has run and managed the Kenya Internet Exchange Point (KIXP) as a value-added service to members who wish to exchange traffic at no cost. This has seen peering members save costs by diverting local traffic away from the more expensive international links to a local connection and traffic growing at a rate of over 150% annually.

Notable challenges in facilitating faster growth of the KIXP have been the dependence on global content managers who do not host or cache content locally and low levels of local content. Whereas various operators and their respective governments are working together to generate and host as much content as possible locally, the TESPOK chairman expressed his hope that the establishment of strong local content managers will draw the attention of the more popular global content producers such as Google and Akamai to host in at least more than one African location.

From an operator's perspective, TESPOK does not believe that cross-border Internet traffic should be exchanged in Europe or North America, as has been the case. In May 2010 the 17th East Africa Communications Organisation congress in Uganda adopted TESPOK's proposal to facilitate interconnection by operators within the region at the member state IXPs without the need for a local licence.

Bedi indicated that this marked the beginning of a new era for operators within the EAC member countries, and it is the hope of the association that its proposal will be implemented shortly and that other African telecom regulatory agencies will follow suit. It is the policies developed by the respective governments that will influence the pace at which operators on the continent can interconnect and peer with each other. TESPOK's appeal to African governments and regulatory authorities is that they continue to play a facilitating role in reducing the capital flight incurred when operators have to exchange traffic outside Africa.

He underscored that the opportunity for much higher levels of local and regional interconnection exerts a multiplier effect on the economic and technical performance of regional networks, as well as opening the door to higher levels of content production.

TESPOK was established in 1999 as a professional nonprofit organisation representing the interest of telecommunication service providers in Kenya. Its mission is to be “An industry voice in telecommunications, providing policy and direction within the industry and government.”

Mr. Bedi concluded by recognizing the importance of hosting the AfPIF inaugural event and acknowledging the support of TESPOK’s partners—the Internet Society, Google, the Swedish Internet Exchange Point, the German Internet Exchange, and Orange Kenya—whose efforts have been key to hosting the forum.

3.1.4 The Honourable Samuel Phoghisio, Minister of Information and Communications of Kenya: Official Opening of the AfPIF Meeting

The Honourable Minister of Information and Communications of Kenya, Samuel Phoghisio, welcomed the participants and delivered remarks as part of his official opening.

The Minister stated that the AfPIF is a first step for African operators to discuss and chart the way forward in facilitating the interconnection of IP traffic between African countries. It is the Ministry’s expectation that the forum will lay the ground for further meetings to map strategy for the development of acceptable telecommunications policies within the African region.

Internet growth within Africa has been slow, hampered by poor infrastructure and low levels of investment. There are signs of change on the horizon with recent investment in submarine cables, terrestrial infrastructures, and mobile and wireless data technologies, all of which are addressing the problems. Kenya alone has seen in the last year the landing of three submarine cables, with more expected before the end of 2011. The west coast of Africa has also seen its fair share of submarine cable initiatives, having been the first African coastline to have this infrastructure in place. These investments have brought all players into a new era, with new realities as to how to interact to best benefit from the opportunities provided by new and upcoming cable systems. This has completely changed the game plan of how business is to be conducted within the region.

In the past few months operators have made significant efforts to roll out national infrastructure to enable all parts of the country to benefit from these new developments. Universal access has become the main drive for promoting access to marginalized groups within the region. This year alone the government has waived the Universal Access Fund in return for developing digital villages throughout the country. There have also been improvements in the regulatory regime that have contributed to changes, with a number of regional operators setting up in several countries within Africa.

Governments have also had to change the way they do business as liberalisation opens up the market and new business opportunities are created. At the East African Community level the member states are involved in a number of efforts to put in place the East African Backhaul System (EABS) that will serve Kenya, Tanzania, Uganda, Rwanda, and Burundi. In addition, the ongoing policy and regulatory changes have made a positive impact on the region and created new opportunities for regional and global connectivity.

The Ministry of Information and Communications in Kenya has commended the efforts of the local operators through TESPOK for always being at the forefront of dialogue and industry initiatives with the Ministry. In this regard the Minister thanked TESPOK, ISOC, and the sponsors for organising the Forum and suggested that the deliberations during the Forum would go a long way in providing government with direction on relevant policy developments. The Minister also indicated the government's commitment to continued multi-stakeholder consultations in policy-making, welcomed the Forum's contributions, and looked forward to receiving recommendations from the Forum.

Minister Phoghisio then outlined a number of challenges and opportunities for the AfPIF participants. He suggested that follow-through and persistence are necessary to ensuring that recommendations will be effective. Persisting until the changes that are desired on the African continent are a reality will call for diplomacy and visibility with governments and organisations responsible for the communications environments in question. Change occurs slowly and without persistence and consistency it may not be visible.

Political goodwill is also essential—in Kenya the government from the very top has bought into the idea that ICTs and the Internet are the way to drive economic development. That same top-level commitment has to occur in all countries.

The Minister noted that the promise of cables lowering the cost of Internet is but part of the equation. No matter the low cost of Internet access and all the software necessary, if the hardware is not affordable then there is a problem. Equally, if the service and equipment is affordable but only available within the main towns and not the rural areas or the furthest flung areas, then a good number of Africans will be left out.

Finally, Minister Phoghisio noted the importance of funding and media awareness to the success of fora such as AfPIF. He encouraged the sponsors to remain committed and media to take a greater interest in such events given the potential to bring about change across the African continent.

3.2 The Current Status of the African Peering and Interconnection Environment

3.2.1 Africa's Fibre Assets

Presented by **Mike Jensen**, Independent ICT Consultant

Mike Jensen started by outlining the infrastructure and interconnection state of play in Africa. Over the last 12 months many new submarine cables and cross-border links have been completed or are being completed, and capacity on existing links is being increased. The majority of submarine cables have now landed on the east coast, and with the new ones planned for the west coast, by 2012 there will be at least 18 Tbps of submarine fibre—over 100,000 kms at a cost of about $US 4 billion.

Terrestrially, by mid-2010 there were over 585,000 kms of transmission network operational, under deployment and proposed, with 332,000 kms of fibre. This represents an increase of 26% compared to mid-2009, with an additional 60,000 kms entering service in 2010. As a result of this new infrastructure, Africa's total international Internet bandwidth went past 300Gbps in the first quarter of 2010, and sub-Saharan Africa went past 100Gbps.

Number of African countries connected to fibre:

Year	2009	2010	2011	2012
Number African countries connected	34	40	46	52
% of countries connected	63	74	85	96

In recent developments subregionally over the last six to nine months, extensive backbone deployment by the second network operator in South Africa has taken place, reaching up through new fibre projects in Zimbabwe to connect to Zambia and from Mozambique to Malawi.

He indicated that in central Africa there are quite a few developments with more fibre in Angola and the DRC, a newly announced project in Gabon running east across the continent, plus proposals for fibre running up the Congo river close to the Rwandan border and also running from Cameroun north up through Chad and to Niger.

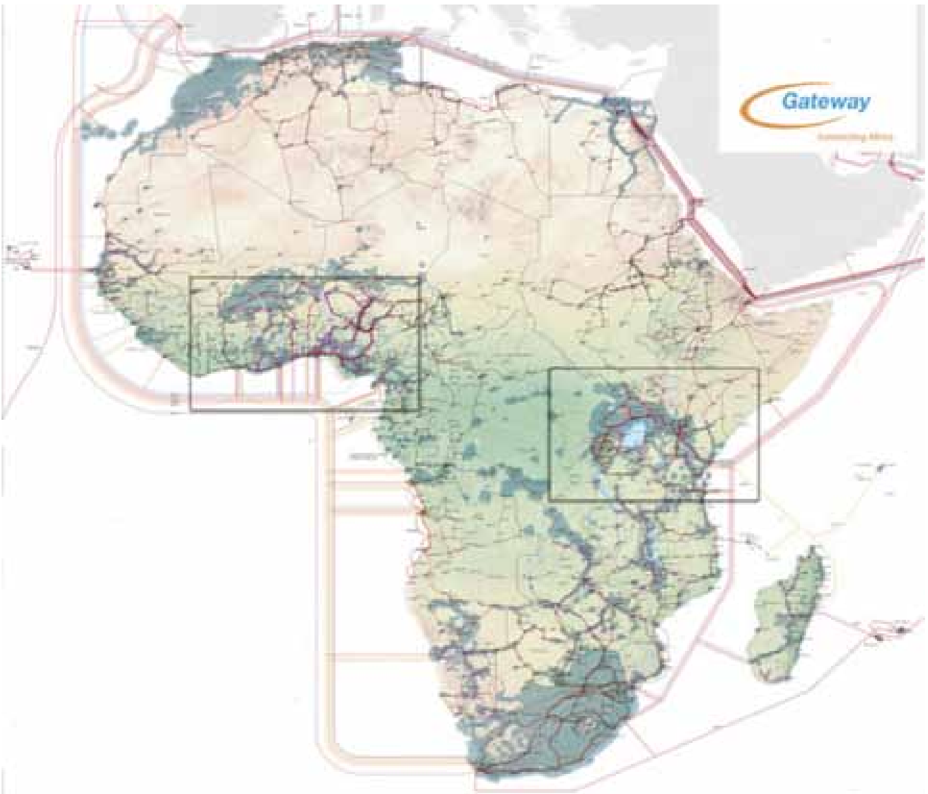
In East Africa the new infrastructure includes deployments of significance in Kenya and newly announced infrastructure in Tanzania, Malawi, and the DRC. Ethiopia and Madagascar have also become much more connected nationally.

Jensen noted that in West Africa there has not been as much development yet, a little in the far west coast with cross-border fibre links running across Gambia, connecting southern Senegal, with plans to connect Guinea Bissau and Guinea. More notable is the now very extensive backbone in place in Nigeria, and extension of infrastructure north from Benin and Togo up to Burkina Faso and Niger, and also plans for a national backbone across Ghana into Cote d'Ivoire. In North Africa there has been extensive deployment of fibre infrastructure in Libya.

In terms of the ownership of this infrastructure, on the submarine side there is a range of ownership models, Jensen said. Consortia of local and foreign operators have established some of the cables such as WACS, ACE, and EASSy. Others are completely private dedicated submarine operators, such as MainOne and SEACOM. In a unique case Glo-1 is one of the few cables in the world which is wholly owned by one telecom operator—Nigeria's Globacom. Generally pricing is higher on the privately owned cables than it is for the consortium members in a consortium built cable.

In terrestrial cables, Jensen indicated that most of the infrastructure is owned by incumbent operators and to some extent the mobile operators. There are some special cases such as Kenya where a new private operator (KDN) is building cable, and there are a number of government-owned infrastructure projects such as in Kenya, Ghana, Zambia.

Of the 23 operational IXPs in Africa, 21 are in cities connected to submarine fibre; the other 2 will be connected by 2012.



Map: Africa's Terrestrial and Submarine Communication Infrastructure

Source: http://www.africabandwidthmaps.com

The main submarine fibre interconnection points—where three or more cables land—are likely to become the most cost-effective/profitable places to connect with—Mombasa, Mtinzini, Cape Town, Douala, Lagos, Accra, Dakar, Tunis, Alexandria and to some extent Djibouti, if it establishes links with its neighbours.

Despite these achievements, there remain a number of outstanding interconnection-related issues, Jensen suggested, including:

- Limited national backbones are now the main bottleneck—with the increased availability of submarine landing points currently in place or planned, outside of East Africa, which has fairly well-developed national networks, the main constraint will be national fibre backbones to distribute the international capacity locally and bring connectivity out of the capital cities and to neighbouring countries.
- Lack of East-West links—there are no regional terrestrial backbones in place yet linking the east of the continent with the west, and while there are plans for better infrastructure in the DRC, it is not clear how long it will take. However submarine fibre can help, although this will require purchasing capacity from at least two different cable systems.
- Lack of redundancy (alternative physical routes) will still be an issue for most countries for some years—recent fibre cuts on fibre cables have highlighted the importance of redundancy because it can take some time to repair fibre. At least two, if not three, independent links are necessary to ensure reliability.

With regard to the issue of Africa having to pay for both ends of the international circuit and thereby effectively subsidising the cost of developed country traffic to Africa, there have been proposals that developed countries should intervene to address this issue. But the idea that special policies could be implemented by the developed countries to reduce Africa’s transit costs are likely to be opposed by the large international operators in what is essentially a free market. What really counts, Jensen concluded, is traffic aggregation at the key hubs in Africa, which will attract the international operators to locate there and allow African providers to negotiate peering terms based on the large amount of traffic that will be exchanged.

3.2.2 Overview of African IXPs

Presented by **Michuki Mwangi**, Internet Society Senior Regional Development Manager—Africa

According to Michuki Mwangi, the African Internet infrastructure challenge is that many countries still mainly depend on satellite. The cost for satellite bandwidth ranges from $2,000 to $5,000USD/Mbps/month and up to $9,000 has been observed. While the two main submarine cables in operation since 2001 serving the west coast and South Africa (SAT3 and SAFE) provide faster connections and more bandwidth than satellite, these links can be even more expensive—prices have not come down as much as expected and have ranged from $4,500 to $12,000 per Mbps/month. East Africa is now catching up fast, with three cables in place and this is expected to bring down prices. So much capacity has been bought that special offers are being widely promoted with increased bandwidth for end-users.

There has been increased investment in recent years in terrestrial fibre by both public and private entities. He noted, however, that much of the infrastructure remains owned by incumbent operators, has been largely limited to major urban centres and towns, and many of the laid fibre cables remain unlit. Governments have joined the race and are building fibre networks, although it is not clear yet how the capacity will be made available to operators. Competition in service and infrastructure provision between cities remains underdeveloped, and as a result, related terrestrial circuit prices have remained high. While mobile operators have invested heavily in infrastructure in response to the growing market for wireless voice and data services, backhaul capacity and provisioning remains a key challenge for many operators.

The cross-border element is still a bottleneck, Mwangi stated. There is a lot of infrastructure within the country and to the border, but there is often a problem when it comes to crossing no-man's land where no one seems to be able to agree who should dig across the border to put the fibre in the ground. So operators have often had to traverse no-man's land using wireless technology—this can also introduce a third party in the link.

Mwangi indicated that there is also the routing problem on cross-border links, such as the traffic from Kigali to Nairobi that must travel to Europe and back before reaching its destination, even although the fibre passes right through Nairobi. This clearly adds to the costs and reduces performance and means that if the undersea cable is cut then, for example, Rwanda cannot talk to Kenya. So without interconnection and exchange points outages outside the region will affect connectivity within the region. It is important that governments try to fix these problems from the policy and regulatory aspects. Cross-border infrastructure is the least developed in the region, partly because it is subject to cumbersome legal and regulatory approval. It is primarily used for voice interconnection between incumbents and mobile operators, and regional circuit costs are comparable to satellite.

Mwangi indicated that the key challenges that this environment has created are:

- Limited interconnection—national or regional interconnection is almost nonexistent and local, and regional access ranges from "ok–poor," and is expensive
- Lack of reliability—with cable cuts that can last for three days or sometimes more than a week, this means that providers are often cut off from each other
- High operating costs—cost of Internet capacity is high regardless of mode, there is little local content and few services hosted domestically, and as a result, local traffic is billed at same rate as internationally accessible content
- Legal and regulatory—operators and providers are subject to significant regulatory barriers and fees, and the lack of competitive choices keeps prices high

In this environment IXPs have a particularly important role in lowering costs and enhancing available infrastructure, by keeping local traffic local through peering, by improving local resiliency, and also by attracting nontraditional members to the IXP—the more networks, the higher the IXP's value. IXPs should also strive to provide value-added services to enhance the local Internet infrastructure. This includes:

- Root, gTLD, and ccTLD—servers that mean that name resolution continues to work in the event of international infrastructure interruptions
- Time servers for local network time synchronisation—many radio stations, for example, do not report the same time
- FTP mirrors and looking glasses
- Network measurement tools

He noted that there are now 23 IXPs in Africa—19 African countries (35%), and multiple IXPs in South Africa (3), Tanzania (2), and Nigeria (2) (Kenya now has a second exchange point, in Mombasa). West Africa has lowest number of IXPs in the region (30%). This leaves 65% of the countries without IXPs.

At least 4 ISPs peer in more than one IXP in Africa, however they peer using different AS Numbers, either because each operation has a different ASN or because the ISPs have been linked through acquisitions and mergers. This also means most traffic goes via transit and it is hard to see which ISPs are present in more than one country.

When looking at the Packet Clearing House (PCH) IXP traffic statistics for the past year, Africa has had the largest percentage growth in exchange traffic of all the regions (183% increase between mid-2009 and mid-2010). However, it could be better, Mwangi pointed out, as the aggregate traffic is only at 2.4Gbps while every other region is at least 50Gbps or more. Out of the world's top 15 exchange points that grew the most over the last 12 months, three African exchange points were present. South Africa is one of them, partly because the IXP used to have a policy that restricted some members from exchanging traffic and when that was removed it saw traffic grow to a peak of 1.2Gbps. Kenya has seen an 82% increase and Tanzania is also in the top 15.

There now five African IXPs with root-servers instances, which improve DNS resolution within country, assisted by the AfriNIC Anycast Program supported by ISOC and other partners. In-country root servers will most likely be required to be located at an exchange point. Nigeria, Mozambique, and Malawi are in the pipeline.

African IXP Locations

Root-Servers Located in Africa

Mwangi summarised the spinoff network and developmental benefits of IXPs:

- Reduced dependence on international links—aside from cutting international bandwidth costs, outages on international links do not affect local traffic flow, and there is reduced capital flight resulting from the savings made on peered traffic as only transit traffic capacity is bought from upstream providers
- More skilled technical capacity resulting from exposure to interconnection techniques such as BGP
- More competitive pricing for local links—for example, it now costs less than $75 per Mbps/month in Kenya for a local loop link on fibre

There is little research that shows the impact of IXPs on reducing bandwidth costs, partly because the data is quite difficult to collect and there are lots of other concurrent reasons contributing to price reductions. But it is easy to demonstrate the cost savings that ISPs can make by moving some of their traffic from transit to peering arrangements. Most IXPs will graph the aggregate traffic at the exchange point and if that traffic were to be exchanged over international capacity it would be paid traffic, the cost of which can be easily calculated.

The key aspects for building Internet Exchange Points, Mwangi suggested, are technical resources, addressing social challenges, and developing a sustainability model. It should be noted that the technical issues are only a small problem and it is the social engineering that takes 80 to 90% of the resources or time.

In terms of technical resources, an IXP requires a neutral facility/location with stable power, a switch, and IP resources (IP address and ASN) from a Regional Internet Registry (RIR). In addition, technical capacity needs to be built within the ISPs and for the operators of the IXP.

The social challenges mainly relate to addressing ownership and trust concerns for the prospective members, and for them to get to the level where all understand the benefits—many have not sat down before to analyse how much traffic they are sending to their competitors in the same market. There can also be the problem of dominant incumbent operators who feel the IXPs are a threat to their business—they need to understand that the exchange will not undermine their dominance but actually add more value.

The sustainability model needs to ensure financial stability, which yields autonomy —vital for sustaining the neutral position of the IXP. This enables the IXP to grow its resources and provide efficient services.

Mwangi then went on to outline the Internet Society's African IXP Development Initiative that consists of four complementary programmes based on the stage and requirements of each country:

- Technical training and capacity building to improve the skills of operators exchanging traffic
- New IXP implementations—helping the operators talk to each other—this can often take 6 to 8 months
- Value added services—helping to introduce IXPs to services such as domain servers and content caching
- Regional IXP Forums and Communities of Practise—such as AfPIF

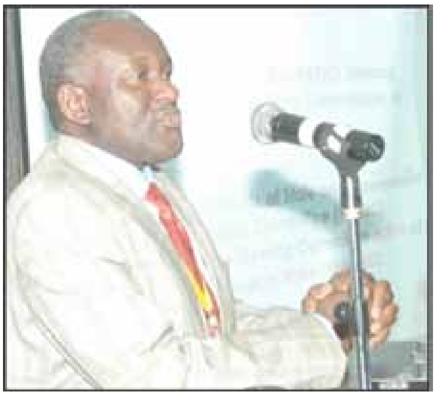
Project collaboration is seen as the key to success, and several financial and technical implementation partners such as AfriNIC, Cisco, and NSRC are assisting in the programme, and additional support is being sought to grow and strengthen efforts. The key goal here is to switch the traffic pattern from 80% going out of the region to 80% staying in the region.

ISOC IXP Information Page with resources in English, French, and Spanish is at: http://www.isoc.org/educpillar/resources/ixp.shtml.

In the discussion that followed the presentation, the important point was made that the presence of an exchange point creates a much more competitive market for bandwidth. The IXP attracts multiple carriers to locate there and bandwidth prices come down because there is a free market available for ISPs to choose the lowest cost transit—at a moment's notice a simple configuration change at the IXP allows the customer to switch providers.

Another important point made following Mwangi's presentation was that the cost of national capacity can be higher than international capacity, which creates a major disincentive to connecting to an IXP. In South Africa, for example, it is actually cheaper to peer in London than it is to peer locally. But local peering still takes place because the quality of service factor is even more important than the cost-saving factor. If there is sub 30 msec connectivity, it makes it possible to run back-end services that could not be run otherwise, such as Internet banking and other locally hosted services that need low-latency connections.

3.2.3 NEPAD ICT Broadband Infrastructure Programme: Umojanet



Presented by **Dr. Edmund Katiti**, Policy and Regulatory Advisor, to the NEPAD e-Africa Commission

Established in 2001, the NEPAD e-Africa Commission's mandate is to accelerate the development of African connectivity and promoting conditions for Africa to be an equal and active participant in the global information society. In 2003, African Governments met under the auspices of the African Union at the 12th Summit of the NEPAD Heads of State and Government Implementation Committee and gave the e-Africa Commission the mandate to ensure that the continent is fully interconnected and linked to the rest of the world with a fibre optic network.

A key objective of the project, Dr. Edmund Katiti said, is to address the disparity in cost of communication between Africa and the rest of the world where, for example the monthly cost of an international E1 leased line is $5,000 vs. $10 to 20.

Work on the network was divided into two parts, one covering countries in Eastern and Southern Africa and the other covering West, Central, and North Africa. In 2004, a basic broadband network for the East and Southern region was agreed on, consisting of a terrestrial segment and a submarine segment.

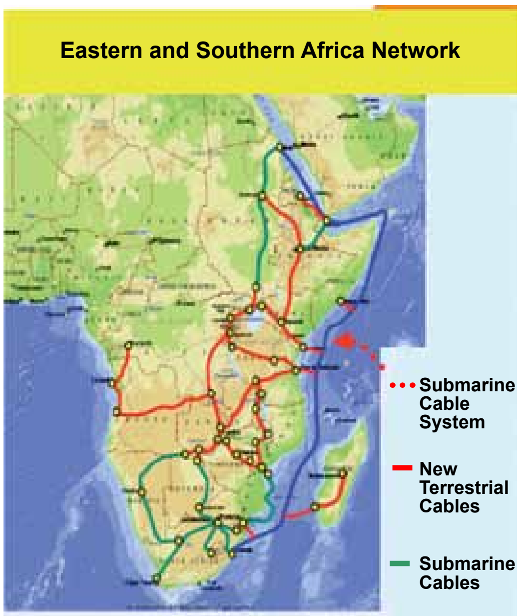
The network aimed to integrate a number of existing infrastructure initiatives in the region, such as COMTEL, SRII, and EASSy. The following year a similar network was developed for West, Central, and North Africa. Dr. Katiti indicated that a study to verify the proposed network was carried out in 2007 to 2008, and a series of regional stakeholder workshops were held in 2010 to update the network plan and chart the way forward. NEPAD does not work at the national level, except to encourage countries to harmonise their policies so that the regional project can go ahead.

Dr. Katiti said it was recognized that the removal of regulatory barriers would be necessary for the establishment of the cross-border network, and to encourage broad private sector investment in the network. The policy principles adopted were:

1. The application of open, nondiscriminatory and affordable access;

Dr. Katiti indicated that this means that any licenced ICT provider would be free to access bandwidth on the same terms and conditions. Countries are also free to go beyond the licenced providers to allow entities such as academic and research networks to access capacity.

Umojanet Network Plan



2. Equitable joint ownership of the backbone infrastructure;
3. Acceptance that cross-border terrestrial and submarine cable segments of these networks can be developed, owned, and maintained by Special Purpose Vehicles (SPVs)—legal entities with shareholders;
4. Basic broadband infrastructure be viewed as “public good” and;
5. Application of the principle of public private partnerships (PPP) to these networks.

These principles apply to the submarine as well as the terrestrial segments of the network, and it was proposed that a protocol be signed by countries to underpin their collaboration in developing the network. Dr. Katiti said that by the end of 2006, 12 countries had signed the “Kigali” protocol and it came into force in 2008 after it was ratified by more than half of the countries that signed it. The countries that signed were Botswana, Lesotho, South Africa, Mauritius, Rwanda, Malawi, Zambia, Madagascar, Uganda, Tanzania, Zimbabwe, and the DRC.

Countries that were unable to sign the protocol within the agreed upon timeframe, may now accede to it, and countries outside Eastern and Southern Africa can also accede to the protocol. In 2010, the Commission started a campaign to explain the protocol to stakeholders and involve them in a review of the protocol. He indicated that stakeholder workshops have taken place in:

- ECOWAS region—March 15–16, Abuja, Nigeria
- ECCAS region—April 20–22, N’Djamena, Chad
- North Africa region—September 21–22, Egypt

Uhurunet Submarine Cable Plan

These regional workshops are being followed by in-country workshops to obtain country positions regarding the review of the protocol and regional Inter-Governmental Working Committee (IGWC) meetings will be held to obtain regional consensus positions before the protocol is amended.

In 2007, the submarine cable part of the network was named Uhurunet and the terrestrial network Umojanet, and the name for the submarine cable company was called Baharicom.

In 2009, Baharicom signed an MoU with France Telecom’s Africa Coast to Europe (ACE) submarine cable consortium to reduce the cost for countries on the West African coast to participate in the system, which will stretch 14,000 km from France to South Africa, connecting almost every country along the West coast of Africa. ACE is expected to be operational in mid-2012.

Dr Katiti indicated that discussions are on-going with other cable developers (Seacom, TEAMS, EASSy, and LION) for collaboration on the Eastern and Northern coasts of Africa where the expectation is that Uhurunet will be achieved in segments that will be completed at different times. Although the segments may have different specifications and capacities, the aim is that it will operate seamlessly. A business plan has been developed, and investment in Uhurunet is being sought, with several MoUs signed with interested parties. A study on the Umojanet terrestrial network focused on:

- Identifying all broadband optical fibre infrastructure in region
- Identifying gaps in existing fibre optic infrastructure along the routes
- Identifying plans to close such gaps
- Determining cost of leasing fibre optic cable capacity from existing operators/cable owners and building of new fibre optic cable infrastructure where necessary
- Estimating the cost of operating a regional operations and data centre from which the entire network would be monitored and managed
- Estimating the costs of establishing and equipping nodal points in each country.
- Undertaking a detailed study of traffic flow in the network
- Proposing an optimum network in terms of network economics, configuration, and costs

In East and Southern Africa, of the total 29,200 kms that the terrestrial network is estimated to comprise, 60% is already operating (based on existing operator infrastructure, including alternative providers), 8% is under construction, and 23% is already planned, leaving a new build requirement of 9% (2,900 km).

In March 2010, the IGA approved a proposal by a group of African investors to set up a Special Purpose Vehicle (SPV) that will implement Umojanet, which is currently engaged in discussions with several international operators with view to identifying a technical partner. Umojanet has identified two regions to start rolling out

(Eastern and Southern Africa, and West and Central Africa) and business plans have been completed for the two regions.

It is the intention of Umojanet to collaborate with national IXPs in order to develop one continental IP network. Dr. Katiti remarked that the prospect of a single cross-border network is seen as necessary to eliminate the problems of crossing borders, and Umojanet plans to make agreements with owners of existing infrastructure to establish the network. But it was recognised that many of the incumbent operators do not like the idea of open access and so Umojanet expects to find it easier to make agreements with owners of alternative infrastructure. Also, the Kigali Protocol grants Umojanet the right to build its own infrastructure where that is more cost effective.

In terms of who would be the operators of the two networks, for the submarine cable network, Baharicom will be the owner/operator, but it is still looking for more African investors (it is supposed to be majority African-owned and does not yet have any non-African investors). For the terrestrial network there is a company that has come forward with some initial investors to work on the business plan and is working to interest some international companies, but they also still need to attract African investors.

Dr. Katiti concluded by outlining how NEPAD is also working with a number of philanthropic agencies outside Africa that wish to provide educational institutions, health institutions, and so forth with bandwidth free of charge. They see the NEPAD networks as an effective vehicle to receive these donations and make them available to the recipient institutions.

3.2.4 The SEACOM Business Case and Model

Presented by **Jean-Pierre de Leu**, Senior Vice-President, SEACOM

SEACOM is an African project, the first East African submarine cable, beginning operations in mid-2009. There were some initial problems, caused by a cut in the SE-ME-WEA cable (on which SEACOM depended for upstream bandwidth), which took two weeks to be repaired. Also, there was an unusual problem with one of the many hundred repeaters on the cable, which happened to be over 1,000 kms from Mombasa and at 4,000 m depth during a period of rough seas.

The interesting result, Jean-Pierre de Leu suggested, was that given the very high number of complaints received, the cuts underlined how important fibre access to the Internet has become. With the increased competition caused by the other new cables that have since arrived, SEACOM has adjusted its pricing downward. Other features of SEACOM are:

- The landing station in Mombasa is a state-of-the art facility that has cost more than $12M.
- Along the coast at up to 1,000 m sea depth the cable is buried under the sea bed.
- Content companies such as Google and Facebook are expected to co-locate servers at SEACOM's points of presence.
- The cable now has full redundancy in all the countries where there is a SEACOM landing station.
- SEACOM will purchase capacity on the other cables landing in Mombasa to help ensure reliability.
- An IP transit service is being established, which will offer European and Asian routes, or a subset of routes on a customer-by-customer basis. Routes can also be shared between customers, peers, and transit providers. Interoute is one of SEACOM's partners in providing the service.

The business model for SEACOM is high-volume, low-price. This, de Leu said, responded to the fact that file sharing and streaming video are totally changing the way the Internet is used, and require huge amounts of bandwidth—daily U.S. television viewers are up to 50 million, while daily YouTube visitors are more than 100 m. With the availability of high bandwidth it is expected that call centres will give many new job opportunities to countries like Kenya. In addition, Africans can participate in global on-line distance learning activities that use real time voice and video.

SEACOM is evolving toward a global carrier model—based on the understanding that the backhaul to neighbouring countries is a vital component. When the landing station in Mombasa was built, capacity was purchased from different providers to allow the same quality of service (at the same price) to Uganda, Rwanda, and Burundi, and ultimately to make a complete ring in the region via Tanzania. A link via Rwanda to the DRC is also envisaged, as well as a 700-km link under Lake Tanganyika to link Burundi with Tanzania and southeastern DRC.

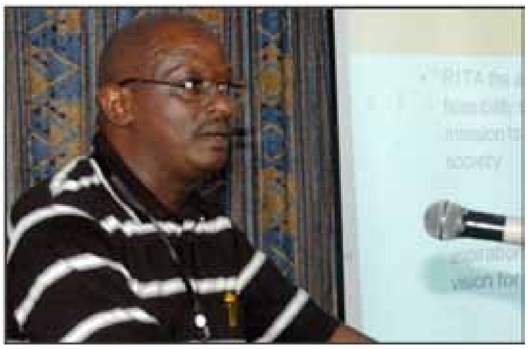
De Leu stated that there were many challenges in setting up the backhaul infrastructure, which increased the cost of the service, especially because alternative links are necessary to ensure reliability. Contracts have been signed with operators in all the countries and the infrastructure will be in place this year so that the price of SEACOM capacity includes the cost of the backhaul. This means everyone pays the same price regardless of where they are in East Africa. SEACOM has a price advantage because it is the only cable on the East African coast that will land directly in Europe once the problem in Egypt is addressed (involving moving the cable from the Sinai side of the Red Sea to the left side at the request of the Egyptian Ministry of Defence). The charges for cables transiting Egypt are also very expensive but SEACOM's partnership with Telecom Egypt for the cable section from Cairo to Marseilles is expected to help with this.

International bandwidth pricing on fibre today, de Leu asserted, is mainly influenced by the cost of the backhaul—the bandwidth charge for 400 or 500 kms of backhaul in East Africa is the same as the cost from Mombasa to London. So SEACOM's main aim is to find the lowest backhaul costs. This is not easy because where there is only one route, the operator can take advantage and charge whatever it likes. SEACOM is expecting that access to NOFBI will improve the situation and also hopes that CCK and the Ministry of Communications will intervene in these situations to ensure that backhaul pricing is more reasonable.

De Leu concluded by discussing the relationship between SEACOM and one of its regional partners, South Africa-based Altech Stream East Africa, which has a 51% stake in KDN, and has a presence in Uganda as Infocom, which connects to its sister company in Rwanda—Altech Stream Rwanda (ASR). Connectivity is also provided in Burundi and the DRC, as Africa Data Networks, and in Tanzania through Six Telecoms. With this infrastructure the group plans to offer peering across the East African region and to South Africa where sub 60 ms latency is being achieved. Altech has found that crossing borders is a very big challenge, both legally and commercially and vandalism and sabotage are ongoing issues.

3.2.5 National Fibre Optic Infrastructure in Rwanda

Presented by **Paul Mugemangango**, MTN Rwanda



Paul Mugemangango outlined the Rwandan government's Vision 2020 strategy goal of transforming the country into an information-based economy, including the goal of a national fibre optic backbone connected through EASSy and SEACOM to the global backbones. It is estimated that the project will help provide coverage for 70 to 90% of the population. By the end of 2010 it was planned that all 30 districts will be connected. Once complete, the project will be handed over to a private company to operate the infrastructure, which will also be made available to all operators in the country. The Rwanda Development Board is the owner of the national backbone project through its subsidiary organisation, the Rwanda Information and Technology Agency (RITA). Once in place, the network is expected to:

- Support e-transactions between all government agencies
- Improve affordability of access to citizens
- Link schools and other government institutions
- Encourage new foreign investors

MTN Rwanda has also established a fibre backbone, which covers the main regions in the country and provides links to all borders. Apart from MTN, the national utility company (RECO&RWASCO), which supplies water and energy, has its own fibre connectivity in the country and it intends to provide 550 kms of fibre capacity to telecom operators. Sharing of infrastructure is mandatory in Rwanda.

The key challenge, according to Mugemangango, is the slow pace of backbone infrastructure development and ICT policy adoption by Rwanda's neighbours, so the national infrastructure can reach its full potential by connecting across all borders. For example, Rwanda had a connection to the Ugandan border two years ago, but there was no fibre on the Ugandan side of the border. Also, being landlocked, Rwanda will face higher costs in getting to the submarine landing stations. No-man's land is also an issue in some cases, especially where there is a large distance between the two borders, and where there are security issues along the border.

3.2.6 National Fibre infrastructures: What's In It for Regional Carriers? The East African Case: Telkom Kenya/Orange

Presented by **Jane Karuku**, Deputy Chief Executive Officer of Telkom Kenya/Orange

Jane Karuku described the Kenyan telecommunication's market and reviewed the variety of different players—fixed-line operators, local-loop operators, mobile operators, and fibre networks. The end-user market consists of about 250,000 fixed lines, 20 million mobile phone subscribers and 3.4 million Internet users. Telkom Kenya (TK) provides fixed PSTN (copper), CDMA with EVDO coverage, GSM with Edge coverage/3G and corporate data via leased lines and IP VPN. TK is 49% owned by the Kenyan government and 51% owned by France Telecom.

TK has its own fibre network and also manages the government-owned National Optic Fibre Backbone Infrastructure (NOFBI). Many of NOFBI's ducts are inside TK exchanges and the relationship with government is basically an operations and maintenance contract, where TK will also be a NOFBI customer. Deployment of NOFBI is proceeding with the linking of key towns across the country and a large backbone infrastructure is now available. TK is also a shareholder in the TEAMs and EASSy submarine cables. It also leases capacity on the SEACOM cable and will obtain additional capacity from parent France Telecom's LION Indian Ocean submarine network when it lands in Kenya in 2011.

Karuku said that costs are still higher than Europe and the United States—International E1s cost $5 to 10/month in Europe while in Africa costs are $2,000 to $3,000/month with satellite, and $200 to $300 with submarine cable. Prices should come down with increased economies of scale needed to take place by broadening the customer base, investing in diversity, and countering shortcomings of outages with a secure redundancy plan, which can be costly in the short run.

TK has a backhaul focus, which involves connecting to neighbouring countries. Links to Tanzania and Uganda are complete, the Ethiopia connection is at advanced stages with fibre already laid to the border, and the Somalia connection is underway. TK also aims to reach Rwanda, Burundi, and the DRC.

Mombasa has become the hub for international operations, being the landing point for TEAMS, SEACOM, and EASSy, and shortly LION (TK hosts TEAMS and EASSy, and will probably host LION as well). Having access to multiple cables allows balancing of traffic between the cables, better aggregation of regional traffic, and wider population coverage.

From Telkom Kenya's perspective the challenge is achieving sufficient coverage and affordable pricing for the public, especially with the legacy systems that are in place. Karuku suggested that this would require:

- Exploiting the national backbone (NOFBI for example is very under-utilised)
- Interconnecting to our all our neighbours, especially the ones in the north—Somalia and Ethiopia
- Ensuring reliability and sufficient speed of access

Co-ordination of infrastructure build-out, use of civil-works, and infrastructure sharing are also important issues. For example, in Nairobi it is common to see the same stretch of road being dug up three times for different cable-laying projects, which considerably adds to the overall cost of capacity.

Karuku then summarized the key challenges for TK:

- Infrastructure development that requires large Capex outlay
- Competition with several other carriers with similar capacity
- Need to develop the retail market and provide more accessibility to the masses—more investment required to complete the local loop
- Vandalism/High maintenance costs—one of the biggest challenges for TK is vandalism—cuts take place on a daily basis and last year over 2bn in Kenya shillings in revenue were lost

3.2.7 Internet in Africa and Cross-border Connectivity

Presented by **William Stucke**, South African ICT Expert and Former Chair of AfrISPA

William Stucke indicated that connectivity dynamic in Africa needs to take into account:

- The Internet is a network of interconnected networks—about 200,000 networks make up the global Internet
- An ISP only ever has a very small fraction of all the web pages and email addresses/subscribers on his own network
- An ISP is actually selling access to other people's networks, when it sells access to "The Internet"

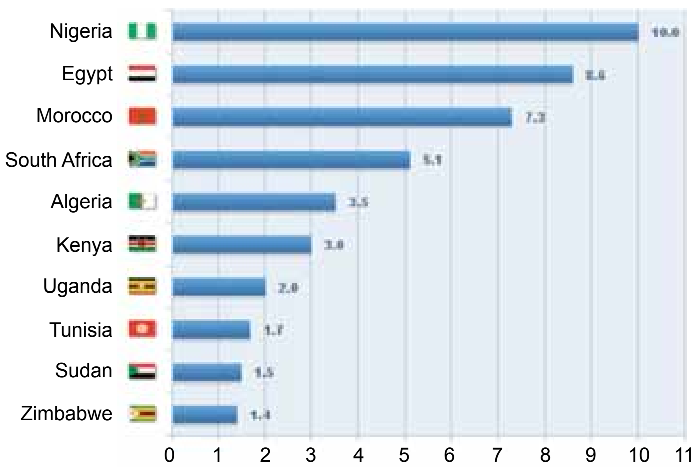
This means, Stucke said, that it is critical that ISPs cooperate with each other, at the same time as they compete. In this respect an Internet Exchange Point is a critical piece of Internet infrastructure where ISPs co-operate to exchange traffic.

Generally, international peering and transit is now solved in Africa—there are very competitive rates at the major global exchange points in Europe, Asia and North America, and competitive submarine cables have landed or are landing in Africa. It is less of a happy situation with the national backbone—while there is a lot infrastructure that has been laid or is being laid, that quantity that is lit and competitively priced is much smaller.

Stucke gave South Africa as an example—20,000 kms of fibre is needed to reach the 150 largest cities and towns (over 10,000)—only one operator, the incumbent Telkom, has that network. Others are building out infrastructure and it is being solved but this will take some time. Metro networks are slightly less of a problem, and private operators as well as some municipalities are building this infrastructure. The main problem is the last mile—here again it is only Telkom that has that network, and the cost of building the last mile network dwarfs the cost of the national backbone—to build the network just to go down each street in Johannesburg would require 9,000 km of infrastructure, and double that to reach each household or business premises. Under ideal circumstances fibre to the home can be built for about US1,000 per link, which if amortised over three years is less than the current cost of a DSL circuit.

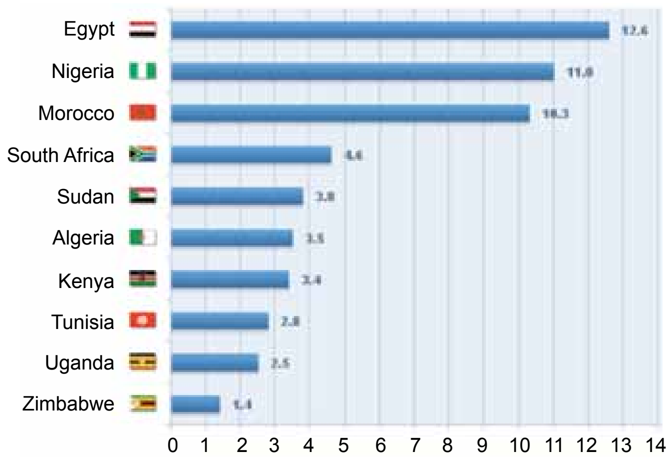
Looking at Africa's Internet connectivity as a whole, between March 2008 and June 2009 the ranking of Africa's top Internet countries has changed, with Egypt and Nigeria swapping places:

Africa Top 10 Internet Countries March 2008



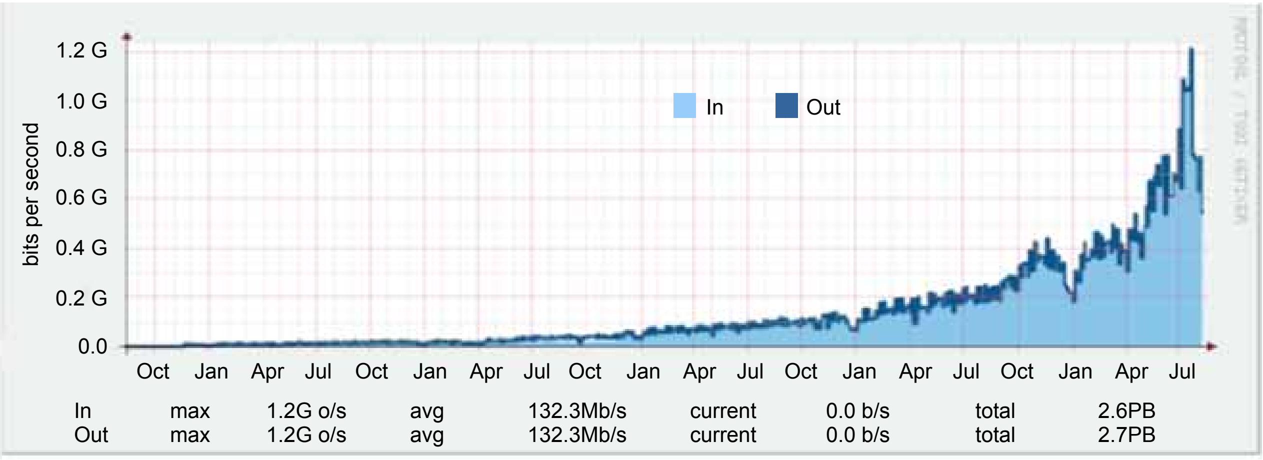
Source: Internet World Stats—www.internetworldstats.

Africa Top 10 Internet Countries June 2009



Source: Internet World Stats—www.internetworldstats.

The experience of the Johannesburg Internet Exchange (JINX) is of interest—it has 23 Peers with over 1Gbps of traffic exchanged. JINX has an open peering policy with no requirement to be a member of the South African ISP association (ISPA), although not all ISPs are open for peering.



Stucke referred to the chart above as it showed an interesting effect of the recent SEACOM cable outage, which underlines the benefits of an IXP. The visible spike in traffic at JINX in July was because the SEACOM outage left one lambda working and the owner of that lambda made it available to other ISPs via the IXP, so traffic through the exchange more than doubled.

In the national policy/regulatory environment those selling services need a licence while those buying services generally do not. Interconnection policies knit these two together, however it becomes a bit more complex in the international environment. For example, in South Africa any infrastructure operator is obliged to provide a connection and facilities leasing to any other licenced operator unless it is financially or technically infeasible. So if a Kenyan ISP were to buy a circuit from Nairobi to Johannesburg and connect with JINX, they would not require any licence to do so. However, without a South African licence they would not be able to *oblige* a local operator to interconnect with them.

Crossing the border can also be difficult, Stucke pointed out. The options are to buy services from an incumbent telecom operator or lay fibre to the border (in which case there is the issue of getting across “no man’s land”), or to lay fibre all the way. The difficulty of laying fibre all the way is a regulatory issue—regulations are not harmonised across countries yet. So in peering at a foreign IXP there is the problem of obtaining carrier services across the border that may need to be obtained separately (your side/other side), there may be different IXP membership/rules and peering agreements and possibly licensing issues.

Regional IXPs are politically popular—everyone says We’re building a Regional IXP! Clearly it is a good idea to help keep traffic within the region. However, connectivity is the key. Stucke noted, and there are still a few regional fibre infrastructures where this makes sense and the cost of national infrastructure needs to come down to levels that are closer to international for a regional IXP to be viable. Also, once national IXPs are in place, the next step is not to go bigger, but to focus on smaller geographic areas. Next, district level IXPs are needed to increase the efficiency and associated benefits. That is why there are 86 IXPs in the United States alone. Stucke referred participants to the 2006 paper http://www.afrispa.org/dpages/PositionPapers/RegionalExchanges.pdf.

The example of the efforts in East Africa to establish a regional IXP was also brought up during the discussion. This initiative was put on hold after it was overtaken by the arrival of the submarine cables in the region and it was decided to focus more on driving the regional interconnection policy agenda.

It was also pointed out during the discussion that extending the national IXP model regionally could even have a negative effect on ISPs. A good example is India where they connected up all the IXPs in the different states for about four years and it affected the growth of the ISPs that were in the business of providing this interstate connectivity. By not interconnecting the exchanges, the ISPs have a better opportunity to grow and this will actually do a better job of lowering costs. So the question in Africa is how to achieve better international interconnectivity—the bigger ISPs will go into other countries and either peer or sell competitive transit, pushing down the costs to levels we see at other big international exchanges in Europe. So in effect the regional IXP function is performed by the large international ISP combined with the large IXP where many international ISPs peer.

3.2.8 Cross-border and Regulatory Policies in East Africa

Presented by **Fiona Asonga**, Chef Executive Officer of TESPOK

Information exchange among national regulators and telecom operators in the region is supported by the East Africa Communications Organisation (EACO) which used to be known as the East Africa Regulatory, Postal and Telecommunications Organisation (EARPTO). Initially the membership consisted of Kenya, Tanzania, and Uganda but this was expanded to include Rwanda and Burundi in 2008. EACO has become part of the formal East African Community (EAC) structure and is responsible to the East African Council on Transport and Communication, which in turn is answerable to the EA Council of Ministers, guided by the Heads of State Summits.

Fiona Asonga outlined EACO's three committees: Interconnection and Access, Infrastructure and Service Providers, and Spectrum Monitoring and

Management. These committees are still in the process of formal establishment. There is currently no formal policy at the regional level on interconnection, and each national regulator has its own set of regulations that only apply within the national boundaries. The objective of EACO's interconnection guidelines are:

- To achieve regional integration of telecom infrastructure and services
- Equitable investment recovery and attract further investment to the community
- Allow value added-service providers to tap the potential of the East African market

The main features of the guidelines are:

- Removal of policy and regulatory barriers that would inhibit any operator licenced in the region to have direct interconnection. It was approved in principle at the last EACO Congress that operators may place their equipment at the exchange points in the member states without requiring any additional licensing, which should mean that it will be much easier to exchange traffic within the region.
- Direct regional interconnection is to be mandatory by all licenced public telecom service and infrastructure providers. It is expected that by next year the five regulators will be in a position to enforce this.
- In the event that interconnection is not technically or commercially viable the national regulatory authorities may agree to limit this obligation, but operators will need to explain why this is the case.
- All technical and commercial agreements for interconnection should be a matter of agreement between the parties involved, subject to the provision of the guidelines and the competition provisions of the respective countries.
- The need to bring EACO operations within the legal framework, preferably the EAC, in order to give its decisions the force of law. This has already taken place as mentioned earlier.
- All licenced providers in partner states who subscribe to the EACO Congress will be bound by the guidelines and any other regulations as prescribed by the Congress, and all operators will be encouraged to become members.

The rights and obligations for high-capacity system providers (submarine cable operators) are:

- Access to submarine landing station by connected and requesting operators must be guaranteed
- Cable system operators shall ensure a good quality-intrusion detection system to protect the networks
- All traffic transmission data shall be retained for a period of six months, subject to existing regulations in each country.
- Operators shall be encouraged to use public national backbones as transit routes to the landing stations of submarine cable operators. This has happened in some countries already.
- High capacity providers shall provide access to their facility to all service providers at reasonable nondiscriminatory and transparent terms.

REGIONAL INFRASTRUCTURE STATUS MATRIX AS AT SEPTEMBER 2009					
Issues	**Status**				
	Burundi	Kenya	Rwanda	Tanzania	Uganda
Capacity of Backbone Infrastructure	Initial capacity— 1 Gbps	10Gbps	10Gbps	2.5Gbps	2.5Gbps
Ownership –Private and public	Public and Private	Public and Private	Public	Public and Private	Public
National Backbone connectivity at borders-points of border connection, synchronization	• Rugombo • Kobero • Kabonga • Kanaru	• Namanga • Isebania • Busia • Malaba • Taveta	• Rusumo • Kagitumba • Katuna • Goma • Bukavu • Akanyaru • Nemba	• Matukula • Horohoro • Sirari • Kabanga • Manyovu • Tunduma • Kasumulo • Namanga	• Malaba • Busia • Katuna
Date for connection/ completion dates of national backbone	2010	2009	2010	2010	2010
Redundancy and restoration arrangements	Meshed network	Multiple separate fibres	Ringed circuits (7 rings)	Ringed circuits (3 rings)	Ring network
Management of national backbone infrastructure	Operations & Maintenance to be outsourced	Operations & Maintenance to be outsourced	Not yet defined	TTCL earmarked to manage the backbone	Operations & Maintenance to be outsourced
Right of way issues	No policy	Existing laws	Existing laws	No policy	Provisions in the Comm. Act
Fiona Asonga, CEO, TESPOK					

In the treatment of transit and regional traffic, Asonga suggested that international cable systems should be required to link to national exchange points to ensure that regional traffic remains in the region. In addition:

- Transit traffic from all transiting national backbone operators through the landing point shall be separated from regional traffic
- All licenced networks have guaranteed access to the cable's landing points without discrimination
- There is freedom of choice to transit traffic and that traffic must be properly guaranteed at all times
- The freedom to transit must not infringe on the legitimate interests of the transiting countries
- National regulatory authorities (NRAs) must take into consideration the overlapping legal jurisdictions in coordinating and harmonizing their approaches to cross-border connectivity
- Terrestrial links to national backbones and submarine landing points should be positioned or laid in nonrestrictive areas for purposes of easy access and cross-border connectivity.

National regulatory authorities, Asonga asserted, have the responsibility to ensure satisfactory end-to-end communications to all users, the need to stimulate a competitive market, interconnection of national networks, and interoperability of services, as well as regional access to these services. The NRAs are also required to:

- Co-operate with their counterparts in partner states
- Take into account the need to ensure development of an East African telecommunication market that includes the development of trans-regional networks and services
- Take into account the need to resolve disputes effectively and efficiently regarding regional interconnection and access
- Appoint members to the Interconnection Committee
- Provide technical and financial support to the committee activities

Asonga noted that operators also have responsibilities under the regional policy that include ensuring interconnection of public telecom networks and services for all users in the EAC and ensuring these services are maintained in the event of catastrophic network breakdown.

Operators must also provide technical and financial support to the Interconnection Committee's activities. Finally, the operators must take the necessary steps to ensure the integrity of the public networks is maintained. There are high penalties envisaged for noncompliance here, with the possibility of three years of imprisonment.

Participants pointed out that for these requirements to be effective there needs to be stiff penalties for sabotage of network infrastructure, which has become a serious problem in the region.

One of the key issues raised in the discussion was that there are no consistent policies on how interconnection will be handled across borders in the region. The different countries are still working on the development of their policies.

3.2.9 Peering and Transit Regulations—The Best Approach for African Governments

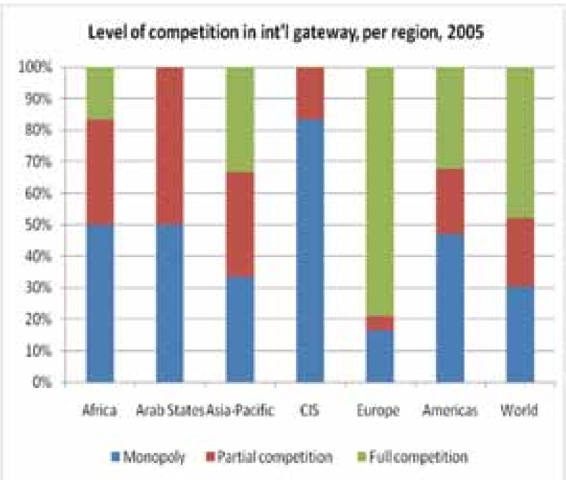
Presented by **Mike Jensen**, Independent ICT Consultant

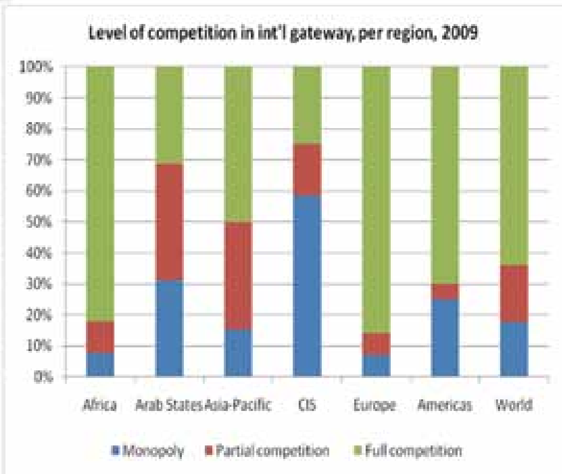
There needs to be less focus on government intervention on mandating interconnection and more focus on simply ensuring the underlying market environment is as fertile as possible for service providers to flourish, Mike Jensen suggested. That way service providers will then be able to form their own interconnection and peering agreements. In this respect the key requirements to improve demand for ISP services, interconnection and peering, is to promote fibre infrastructure development by allowing increased competition in the sector. While taking into account the wide variation in policy and regulatory environments between different countries in Africa, in general, for this to take place there is a need to address:

- The low overall levels of competition in most countries at the national backbone level, in international gateways, and in the local loop—especially the high cost of national backbone capacity where competition has not driven down prices

- Regulatory restrictions on alternative infrastructure operators (transport/ energy networks) providing access to their fibre or to their rights of way which could be used by fibre operators.
- Lack of regulatory requirements on operators to share/provide cost-based access to their infrastructure. Sharing of infrastructure in this context needs to be encouraged especially in the smaller and less wealthy countries which may not be able to cost-justify multiple competing private networks.
- High indirect costs—poor or deficient electric power, high taxation, delays in permitting
- Policy grey areas or outright restrictions on cross-border links

Part of the problem, Jensen asserted, is that many policy makers and regulators mistakenly think that they already have competitive markets. Here, for example, is a chart from the ITU that appears to show that Africa's international gateways are the most competitive in the world after Europe. The large number of mobile operators in most countries is also taken as indication that the lack of market competition has been addressed.





There are of course other factors at play here, too, but Africa's international capacity costs are the highest in the world, and this is largely due to the lack of competition—just having two licenced international providers is not sufficient to drive down prices—what is necessary is a fully open market, and regulated cost-based pricing where markets are restricted due to the limited availability of international infrastructure.

Jensen outlined what he believed the scope of government action to encourage competition should be:

- Introduce regulations to reduce the dominance or significant market power (SMP) of incumbents, especially provisions for mandatory access to essential facilities, infrastructure sharing, and co-location rules
- Increase the number of licences issued to increase competitive pressure on prices
- Reduce cost of licensing and speed up the licensing process, which often causes delays for operators in getting up and running. The high cost of licensing creates barriers to entry by small players or ends up being passed on in higher prices to the end-user.
- Promote shared passive and alternative infrastructure consortia—ducts, masts, energy grid, and rail links, and so forth—both through regulation and providing tax incentives
- Eliminate multiple taxation, and reduce taxation on communications services—often there are taxes at both national and local levels that add to the costs for the end-user. Especially worrying is the trend of high levels of sales or value-added taxes on communication services for the end-user
- Improve enforcement—capacity-building of regulators and competition boards and improve dispute resolution processes. It often falls to general competition law that is not specific to the telecommunication sector to resolve these issues
- Smooth the process for cable-laying permits, including X-border rights of way and adoption of UN Convention on the Law of the Sea (UNCLOS), which affects how submarine cable operators can transit neighbouring countries.
- Government-built backbones or public private partnerships to ensure infrastructure is built to more remote and rural areas where it might otherwise be unprofitable to do so
- Better collaboration between regulators and harmonisation of regulations between neighbouring countries
- No licensing required for IXPs
- Systematic consultation with all stakeholders

While retail price regulation has been suggested to encourage the reduction of prices to the consumer, Jensen suggested that this should probably be a method of last resort. Determining what price should be charged by an operator is not easy and such regulations can end up distorting the market. While it can take some time to work through the system down to the end-user, the introduction of competition is the most effective way of driving down prices. Price regulation may be justified at the wholesale level but only after all other efforts to introduce competition into the sector have failed.

Finally, Jensen said that given the vital importance of adequate power supply for using the Internet there needs to be increased investment in national power generation/production and introduction of Independent Power Producer (IPP) policies that allow those who have established their own energy-producing facilities to sell excess capacity back to the grid.

3.3 Peering and Interconnection—Lessons and Best Practises from Around the World

3.3.1 Building Critical Mass at an Internet Exchange

Presented by **Job Witteman**, Managing Director, Amsterdam Internet Exchange (AMS-IX)

AMS-IX is one of the world's largest exchanges and is in effect a regional, rather than national exchange. Founded in 1997 as a neutral exchange, it manages 7 different sites with 26 employees supporting about 360 members who transfer 960Gbps of traffic, and AMS-IX has a turnover of about Eur10 million.

Job Witteman pointed out that "critical mass" is the tipping point that every IXP needs to achieve to begin autonomic growth—a point where at least 15 members have begun exchanging traffic, although financial break-even should normally be reached before this. IXPs actually need to make a surplus in order to be able to re-invest in new equipment and new sites. The key features needed to set up the exchange in a way that it is possible to achieve critical mass are:

- Carrying out thorough market research to identify potential participants
- Being a trusted operator, which means staying out of member/customers' business and not being a stakeholder in their business—for example, in the beginning Am-Six outsourced its operations to the academic network, Surfnet.

- Having reliable power, cooling, and sufficient space—be picky! Don’t settle for second best
- A licence to operate, if needed
- Having an operational model that suits local conditions
- Defining a clear “charter” and identity for the exchange—is it academic, commercial or nonprofit, for example. Keep focused on the charter and stick to it.
- Defining the geographic scope of the exchange—is it local, national, regional, global
- Ensuring the IXP is operated professionally—being responsive to member support requests, answering e-mail and the phone

The basic ingredients for this are:

- Carrier neutrality—not being dependent on single upstream carrier
- A simple and open model that avoids complexity in contracts, in policies, in charging models, and in billing
- A location that has access to fibre
- Reliable hardware and engineering—optimized network utilization, minimised latency, and cost-effective redundancy
- Understanding member needs
- A useful user portal which shows sFlow traffic stats on a per-peer basis

A particularly important aspect is to understand the nature of the business of being an IXP. This means being aware that:

- Eyeballs need content
- Content needs eyeballs
- Carriers need customers

The incumbent operator is unnecessarily afraid of IXPs, Witteman suggested, often thinking that the exchange will cause it to lose market, when in fact new markets for incumbent infrastructure are created by the IXP, as well as cost-cutting opportunities.

The IXP needs to attract the right mix of customers—access providers and content providers, and to take note of the response of the incumbent. The advantages of autonomy also need to be stressed. This allows members to have better buying power with upstream providers. The IXP website is an important component of this value, but it needs to be kept up to date, and as informative as possible.

IXPs need to be open about failures or problems—otherwise prospective members will not trust the exchange.

Building the community of members/customers is important—host mailing lists and social events, invite interesting speakers, and help members get to know each other and to become ambassadors for the IXP.

In developing strategy for an IXP, consult all available sources for assistance, such as other successful exchanges, and draw on the resources of the Euro-IX association of over 40 IXPs.

Witteman said that a particularly important aspect of setting up and running and IXP is avoiding complexity—have simple policies, simple contracts, and limit the number of rules that have to be enforced. Simple charging models are also key—a flat fee per port is all that is necessary—traffic charging will discourage participants from using the exchange.

He concluded by listing some of the more convincing arguments to encourage prospective participants in the exchange:

- Better buying power—when multiple carriers are present at the exchange they can be played off against each other—transit can now be had at Am-six for $1–1.5/Mbps now.
- Better network optimisation—increased efficiency, lower latency, and so forth.
- Redundancy—if the network is present in one exchange then connecting to your exchange will give it better reliability
- Marketing value—being a member of the exchange will make the network more attractive since it will be better connected
- Useful traffic statistics for members

3.3.2 IXP Peering Policies

Presented by **Kurtis Lindqvist**, Chief Executive Officer, NETNOD, Swedish IXP

Kurtis Lindqvist began by providing an example of the benefits of connecting to an IXP with some real data from a provider in a small land-locked country. At the time they started they had a satellite link to Singapore, and they obtained a presence at LINX in London. On day one they picked up 11,000 routes from the route server and an additional 40,000 routes by simply announcing they were present at LINX, without having to contact anyone. Today they are connected at two different exchanges and they now peer away more traffic than they send by transit. What this shows, he suggested, is that providers can make big savings by buying international capacity to one of the big hubs and should not just buy international transit from a Tier-1. This does mean the provider needs to install active equipment at the remote IXP but there is usually someone who can do this on behalf of the provider, and IXPs are helpful in providing the contacts of people who can do this.

IXP peering policies have varied a lot over time and in different regions—virtually all possible combinations and options for policies have been adopted, and many have failed. Most new policy ideas have been tried and tested, Lindqvist said—over time, most exchange points have tended to evolve toward the same set of policies.

Among the important policies are the barriers to entry, or the criteria for who can join. Technical requirements such as needing to have a public AS number and public IP address space are particularly common. Some IXPs also allow use of private AS numbers. The business models of the prospective member/ customer are also often used as criteria for access. The requirement to be a legally registered entity in the same country as the IXP has been adopted by some exchange points, but this seems somewhat pointless and counterproductive.

Transit sales may also be restricted—some IXPs ban the sale of transit through the IXP, but in general as long as the IXPs are not part of the deals of connected operators there should be no problem.

The degree of "openness" of the IXP varies, Lindqvist noted. The most common model is that operators who connect to the IXP are free to peer with who they choose, based on business decisions. The advantages of this model is there is no barrier of entry into the IXP, and it underlines the neutrality of the IXP. In this model most IXPs use a route-server located at the IXP and routes can be filtered or accepted as required. There are few disadvantages to this model, although it may be harder to know the amount of traffic that can be peered away. To do this the provider needs to be running traffic-flow analysis tools to determine the most common AS numbers in the traffic statistics.

A different model of IXP openness is the forced bilateral peering model where operators who join the IXP must establish peering over the IXP with all other connected operators. The advantages of this model is that operators know the number of peers they will have and can make a straightforward calculation of the advantages of joining. The disadvantage is that this model prohibits analysis of the business needs for individual peers. It can also act as a barrier to entry for operators who are unhappy with not being free to select peers.

Lindqvist pointed out that when the exchange in Helsinki, Finland dropped this requirement they almost doubled in size and gained international transit providers who were previously unwilling to connect to the exchange. Often the international transit providers will want to peer with some of the exchange members, but not with all of them, so forced bilateral or multi-lateral peering is a strong barrier to their participation. Google, for example, will not normally peer at exchanges that force multi-lateral peering.

A variation on the same theme is the forced multi-lateral model, where the joining operator must establish peering sessions with a route-server and all peers with the route-server exchange all routes. The limited advantages are the same as for the forced bilateral model. There is less configuration work (handy for ISPs with little BGP knowledge) and it makes for a more stable technical solution but, Lindqvist said, the disadvantages are same as for the forced bilateral model. These models are often adopted to ensure the incumbent has the same conditions as the smaller players, but overall, the disadvantages (especially the disincentive to the participation of international operators) strongly outweigh the advantages.

Sflow can be used by IXPs to determine what peering is actually taking place at the exchange, and if the exchange's peering policies are being observed. Sometimes the member networks may request that sflow is not used because peering can be seen as a private business decision, but this may hamper operational decision making at the exchange.

Generally IXPs do not impose minimum traffic levels on participants, but minimum port speeds can be required, and the cost of this could be seen as a barrier for very small ISPs to join. In Sweden this issue generated debate, but netnod decided that

1Gbps would be the minimum port speed because the cost of maintaining lower speed ports was not justified, and the number of networks that cannot afford a 1Gbps port is very small. Netnod did, however, lower the charge for 1Gbps ports to encourage smaller ISPs to join. There is also a smaller exchange present in Stockholm that caters to smaller ISPs and has lower port-speed equipment. Having different IXPs segmented along these lines can also make sense for the Internet ecosystem.

In a nonprofit model, charges for membership, ports, and so forth comes down as the IXP grows and has more participants over which to share the cost of staff, equipment, and marketing, for example.

In comparing these models Lindqvist concluded that almost all successful IXPs have similar properties and policies—they are carrier and operator neutral and do not discriminate among their potential membership, and they do not force any particular peering arrangement or business decision on participants. The value of an IXP is in keeping traffic local, improving redundancy/resiliency for national infrastructure, and lowering transit costs. The value is in the volume of traffic that is exchanged and in the uniqueness of particular routes or members who are at the exchange. In these respects, complex policies do not help with creating value at an exchange and are therefore counterproductive most of the time.

Lindqvist also suggested that peering does not always have to happen through an exchange point, and it can be done directly between two providers. Bill Norton drew attention to his DrPeering white paper called The Great Debate, Public vs. Private Peering, which was based on asking 100 peering co-ordinators when they prefer public vs. private peering. It turns out that this is question has strong proponents on each side of the debate—some insist that private peering is the only way to go, others felt that public peering is much better. Cogent, for example, only does private peering because public peering would require statistical analysis of traffic data generated by NetFlow, while private peering can be managed cheaply and easily using a low-cost Ethernet blade that can be polled with SNMP to determine traffic levels to inform when to carry out link upgrades. The other reason that has been given is the “blind over-subscription problem,” which occurs if a network connects with a big port onto a shared Ethernet fabric—in this case the network has no visibility into the congestion/over loading problems of its peers.

Finally, Lindqvist noted that with regard to the privacy of the traffic information, there is a fundamental challenge for exchange point operators. If there is no visibility into where the traffic is going to or coming from, because the privacy concerns are so strong, then it is very difficult for the exchange point operator to answer strategic questions like “who is the next ISP that we need to encourage to join”? (based on observed traffic to that ISP).

3.3.3 Evaluating Peering Locations

Presented by **Jonny Martin**, Packet Clearing House (PCH)

The key goal in identifying the best peering location should be to minimise the cost of doing business, which also includes providing a “good quality” service. In this respect, Jonny Martin said, an IXP is more than just a switch, it is:

- A common peering fabric and meet-me point (a building with a lot of providers and customers—easy to interconnect with for technical or business arrangements)
- A hub for innovative and new businesses
- A focus point for connectivity and fibre
- Often in or surrounded by co-location facilities
- A community and people hub

Considerations in actually building an IXP are similar to those when deciding which IXP to connect to. Some of the points often discussed with prospective users of an IXP include:

- Determine need (Sufficient users? How much local traffic? Are there other existing facilities?)
- Identify a good geographic location—a successful IXP is always going to be well connected (are there fibre facilities, “near” participants in a network sense)
- Decide on the density of the facility (a single switch centralized in one room? or campus style?) In larger exchanges there might be a number of buildings connected together.

Other issues to be considered include:

- Building Management—Telco hotel? University or city facility? Can also be some space an ISP has donated to help get an exchange going.

- In-building facilities—Pathways for cables, power, cooling, access/security
- Services—Switch fabric, cross connects? Route-server? DNS and other servers?
- Business Structure—Incorporated? Staffed/volunteer? Not-for-profit? Ownership model? Cost recovery model?
- Peering policies—Bilateral/multi-lateral/mandatory multi-lateral peering?
- Extensible switch fabric?
- Privacy policy?

So what makes an IXP attractive? For Martin, the key is lots of routes and lots of participants, either on the switch fabric, or co-located in the facility, although that does not necessarily mean that everyone there is going to peer with everyone else there. The number of participants, however, is probably the best metric of the IXPs benefits.

In addition networks of specific interest can add to the attraction, such as local content, caching, Google, and other content distribution networks such as Akamai.

There are various ways in which the cost of the traffic from these content providers can be recovered. If one large provider is paying for bringing the content down they may wish everyone else to become customers. Alternatively, the participants can divide the cost equally, but this can result in disputes between those who feel that the value received is not equal. Measuring the actual traffic between the cache and the ISPs sharing it can be one way to more equitably share the cost, but competitive pressures can still make this difficult if there is not a spirit of co-operation among all the participants. It could be said that the content-provider should pay for some of the cost but this may not be a priority for them.

The presence of DNS servers at the exchange are also important, Martin noted—not for saving much traffic, but for reliability of service. Suitable co-location can also be an attractive feature.

The key benefits connecting to an exchange can be summarised as:

- Ideally, reduced bandwidth costs by offloading traffic at the exchange
- Higher performance—lower latency and “more” bandwidth (additional circuits to run traffic over, which would normally be cheaper than the ones available without using the exchange)

- Increased resiliency—alternative routes when the main link goes down
- Reduced export of capital offshore—from an economic development perspective this means less capital to develop the local economy. Governments should be rightly concerned about this, also because off-shoring traffic stifles the growth of the local Internet economy. Building critical mass of the local Internet sector also means that international providers are more encouraged to come to the local exchange because of the aggregation of traffic there.
- Keeping local content local, and encouraging the creation of local content and the local content industry. There is probably more local traffic than is generally assumed, and it is also a chicken-and-egg situation—without the exchange there will be less incentive to create local content—a cycle that needs to be broken.
- Marketing: "We support local industry."

Martin did note that there are additional costs involved that add to the ISPs existing cost structure, such as getting to the IXP, paying for participation in the IXP and additional network management (especially if the IXP is remote from the peering ISP—remote hands, and so forth). However in general, even for small amounts of traffic the cost of peering will be less than paying for the peered traffic via transit providers. In addition to the cost savings must be added the benefits of improved performance, increased resiliency, and the fostering of the local ISP community. Also, even with a small exchange point with not much local traffic, that traffic is likely to be quite important to customers who need the local traffic to work well.

The argument to make to the large ISP or telco that may be worried about losing market share by participating in an exchange is that the exchange will help grow the market as a whole (the richer the local connectivity, the faster the market will increase), so that even if market share is lost, the amount of revenues generated for everyone will increase. Changing the viewpoint of the dominant providers may not happen immediately and it often takes some time because the incumbent has to become confident that the risk of foregoing immediate revenue will ultimately result in greater demand in the future.

In determining the value of connecting to a particular IXP, Martin suggested talking to the IXP operators and looking at their websites, using PeeringDB (see below) to determine who is there and what their policies are. These will help in determining how much traffic can be passed on to the exchange. To help identify the IXPs in the service area, the IXP directory at http://www.pch.net/ixpdir provides a convenient view of many IXPs. The directory provides information on traffic volumes, number of prefixes/subnets, and when the exchange points were established. IXPs help to keep this updated.

3.3.4 Demonstration of PeeringDB (Peering Database)

Presented by **Mark Tinka**, AfriNIC Participant, African Internet Expert, and Chief Network Architect, Global Transit and TIME (Malaysia)

Mark Tinka opened by suggesting that in the past there have been difficulties with maintaining the data needed to make peering decisions, such as who is peering and where, contact information of the peering co-ordinators, and so forth. Some of this information is maintained by individual data centres, but where data centres don't have exchange points it is hard to find out which customers may be willing to peer at a data centre.

PeeringDB is a free web-based tool to provide a centralised information source where ISPs can search for the information they need. Data mining of peers in PeeringDB for selling transit is frowned upon. ISPs need to register to obtain a login, allowing the maintainers to establish if the applicant is a real network and not just a salesperson. Accounts can be read-only or read-write for updating records. The information placed in PeeringDB is optional, so some networks choose to limit the amount of information they make available. Many data centres and IXPs are included in the database as locations to peer at.

Tinka suggested that it is useful for networks to have an entry in PeeringDB even if the network is not yet peering anywhere. The peering co-ordinator should be a dedicated resource to handle all aspects of peering, and this is a particularly important role for content networks which need to peer a lot rather than pay for transit. Keeping the PeeringDB up to date is extremely important because the first thing a network's peering coordinator will do after receiving a request will be to go to PeeringDB to check out the details of the requesting network. If the information is not up to date it could potentially prevent the requesting network from obtaining a peering relationship.

Tinka indicated that even without a PeeringDB account a peering co-ordinator can log in as a guest user to look at records. If the AS number is known then it is very easy to find the network.

http://www.peeringdb.com

3.4 The Content Equation in Peering

3.4.1 The Role of Content Providers

Presented by **Mike Blanche**, Managed Peering and Content Distribution Platform Division (EMEA), Google

Mike Blanche indicated that key challenges for content providers in Africa are:

- Limited international capacity
- Limited national and regional fibre backbones
- Lack of local peering and interconnection

And the effects of this are:

- High internet access costs for end-users
- Limited bandwidth
- High latency
- Lack of local content

Blanche noted that content drives interconnection and peering, so these causes and effects are a vicious cycle that reinforce each other. Africa is not the first place to face this challenge. In the United Kingdom and Europe in the mid-1990s, the situation was very similar, with most of the content that was accessed being hosted in the United States. As a result, each European country had its own independent international connection to the United States, with very little interconnectivity between European countries. At that time the British academic network only had a 2Mbps connection to the United States for a million students and it cost $3M a year. Even U.K. websites were hosted in the United States where it was much cheaper.

However, following deregulation in the European telecommunication markets, which allowed multiple operators to come in and dig fibre across Europe (cross-border issues did not seem to be much of a problem as they are in Africa). Introducing these pan-European fibre links meant that traffic stayed in the region, so for example, traffic between the United Kingdom and Germany no longer had to go via the United States. This also helped the Internet exchanges in these countries grow and develop because content was now being brought into the region. The net result was that generally more than 50% of traffic could be peered at European Internet exchanges. Costs for ISPs decreased because less bandwidth to the United States was needed, and also because trans-Atlantic fibre prices came down.

In Kenya there is little locally hosted content—the most popular Kenyan websites are hosted abroad—for example, the Nation Group's Daily Nation news site is hosted in the United Kingdom, Standard Media is in Germany, SuperSport is in South Africa, Uchumi is in San Diego, Nakumatt is in Los Angeles, and Kenya Airways is in London. The main reason for this is probably because it is hundreds of times more expensive to host these websites locally in Kenya.

How much content is there? Blanche pointed to an *Arbor Networks* study carried out in 2009 where servers at Internet backbones across the world were monitored and the traffic from various networks measured. The top ranked network was Level 3, with 9.4% of traffic, followed by Global Crossing with 5.7% and Google with 5.2%. Other big networks, which include Akamai and Limelight Networks, distribute traffic on behalf of popular websites such as CNN, didn't feature in the study because their traffic is usually delivered deep inside operator networks, rather than over traditional transit links. The study found that traffic distribution had consolidated substantially since the previous study was carried out two years ago, when thousands of different networks were responsible for 50% of the traffic. In last year's study, 50% of the traffic was carried by just 150 networks, mainly through the huge growth of particular sites such as Facebook and YouTube, for example.

For Blanche, one of the critical questions is how to get more content locally hosted and improve the Internet ecosystem to encourage local content development. To answer this question it is useful to look at the global models for content distribution. Most of the big international content providers—Yahoo!, Google, Facebook, Microsoft—host their content from big data centres in the middle of nowhere where land, labour, and energy are cheap. These companies rely on transit and peering providers to get their content to users.

The traditional way of creating a content distribution network is to build links from the remote data centre to co-location facilities or data centres in large cities such as New York, London, and Frankfurt, for example. This would be the edge POPs of the content network and from there, links to transit providers deliver the content to the end-user via their links to local ISPs.

The main problem with this model, Blanche suggested, is the cost—the Internet is a "two-sided market" where money flows toward the middle. So on the one side, advertisers pay content providers who in turn pay the transit and backbone providers. On the other side, users pay ISPs or mobile providers for access, and they in turn also pay the transit providers to receive the traffic. The challenge, especially in Africa, is that these charges are high, and the main beneficiary is the transit provider in the middle. Also, content providers do not think they should be paying the transit providers so much.

But there is the alternative of using peering to carry the traffic. In this model the content provider's edge POPs would connect directly to some eyeball networks, and indirectly to others via public exchange points, thereby minimising the need to pay the transit provider for all traffic. This not only reduces transit costs, but also improves performance for users and saves ISPs money because they also no longer have to pay for so much transit traffic. Peering can also more reliable because there is just a cable directly connecting the two networks and there is less reliance on a third party, which could add an additional point of failure.

The economic model for content providers with peering is still advertisers paying content providers and users paying ISPs, but ideally connecting the two is settlement-free peering. It is free because it is mutually beneficial for each side.

Blanche said that there had been some discussion about the need for balanced traffic ratios in peering, but noted that is not how the Internet works in 2010. There are the content networks on the one side who want to deliver their content, and the eyeball networks on the other, whose users want to see the content. Traffic does not flow equally in each direction, but each network needs the other.

The Arbor Networks study found that over the two-year study period Google increased the traffic peered away from 30% to 65%. At the same time the volume of traffic has been increasing rapidly because of the growth of video traffic and Internet-use in general. Content providers usually peer at all the major Internet exchange points and co-location facilities where many other networks are—the west and east coasts of the United States (Miami for Latin America), London, Amsterdam, Frankfurt, Tokyo, Hong Kong, and Singapore. Google is at almost all the major IXPs in Europe as it is very keen on building out its network. PeeringDB is very useful to see where networks peer—search for the ASN or network name.

Google and most other content providers have open peering policies and will peer with just about anyone. There are no guarantees of universal peering, but Google will generally peer with 98 to 99% of the networks that ask, anywhere where Google has network presence. Peering contracts and peering ratios are not required, but a 24/7 NOC is required (at least someone reachable by phone 24/7). Google's main requirement, Blanche said, is that peering needs to take place as close to the end-users as possible—if Google has the in-country infrastructure, then peering needs to take place at this location. In high-traffic situations Google generally peers directly/privately, in medium traffic cases BGP sessions are usually set up between the routers at an exchange. In low traffic situations Google will use the route-server so that only one connection needs to be set up to reach everyone on the route-server, thereby minimising the configuration/administration overhead.

Google is taking advantage of the new submarine cables landing in Africa to bring its content closer to local ISPs and their user-base. Google has built a POP in Lagos, Nigeria, and will build one in East Africa, either in Mombasa or Nairobi. These local POPs will both improve performance for users, increase reliability, and cut costs for ISPs that will no longer need to pay international transit for Google traffic. Blanche suggested that other locations will be added, depending on the presence of various features, in particular:

- National and regional aggregation of traffic, such as a vibrant Internet Exchange Point
- Carrier-neutral data centre facilities for hosting server/router equipment that does not have to be tied to use of one particular carrier/ telecommunication company
- Open access cable landing station—needed for bringing in international capacity at reasonable cost and without having to go into special negotiations with the owner of the landing station.
- Multiple competing national fibre networks enables Google to obtain better access to peers, and in the future to build out its network further into the country or region.
- Friendly regulation—Google does not want to be licenced as an ISP or a telco.

Blanche then considered what an ISP should do if Google cannot meet them locally. (Google is unlikely to build local facilities in all 53 countries.) Hopefully, there will be a Google POP nearby that can be accessed without too much difficulty, such as a short submarine or terrestrial link from Tanzania to the POP in Kenya. Another option would be to use a Content Delivery Network (CDN) to save bandwidth and serve more traffic locally. For example, when Google's Global Cache goes live at the IXP in Uganda shortly, the traffic across the exchange is expected to increase by several orders of magnitude.

A CDN is a distributed content delivery platform that brings content closer to end-users, by caching content locally (only one copy is brought down the international link which is then stored so that subsequent requests use the local copy) and by using connection proxies. Not all CDNs do the latter, but Google does, through what is known as TCP termination. The local CDN keeps a permanent connection open with the remote content server, which minimises TCP handshake times and improves performance for users considerably. Because the user experience improves, usage generally increases as well, and users may upgrade to higher bandwidth services as a result, generating more revenues for the ISPs.

Aside from Google Global Cache, other examples of CDNs include Level 3, Limelight, and Akamai, which are paid by content-generating networks to distribute their content more efficiently around the world.

Blanche said that Google is deploying its CDN platform in Africa to help seed and develop Internet exchanges by improving the attractiveness of connecting to the exchange. Google sees IXPs as a key way to help the Internet in Africa develop, and as a way of consolidating traffic so that content providers such as itself can more efficiently serve content to the many small, low-traffic networks in Africa—one caching server can serve the whole country in this way. This also allows Google to work with providers equally so that all have the opportunity to realise the benefits.

Even if an IXP is not yet in place, if there are enough ISPs interested in supporting one, Google will try to help with its establishment. Google has donated equipment for IXPs via the Network Startup Resource Centre (NSRC), but the harder part is the social engineering, so that the ISPs can work together as a community against the common enemy of high-transit costs.

Blanche noted that the Google Global Cache (GGC) platform itself does not require many resources—gigabits of traffic can be served by three servers consuming less than 1Kw of power and about 6U of rack space. The facility needs to be secure and air-conditioned, otherwise the servers will overheat, with a UPS and preferably generator backup if power is unreliable. While the GGC and associated equipment is provided free, one ISP usually needs to take responsibility for hosting and populating the cache with content. While it is possible for an IXP to host the GCC, Blanche indicated that space constraints and a lack of access to transit capacity are often limiting factors.

The hosting ISP is expected to make the content available to other local ISPs based on a mutually agreed business relationship. If there are too many complaints then Google will move the cache to another ISP that offers more equitable terms that will benefit the Internet community as a whole, rather than letting one ISP see it as a way of obtaining competitive advantages over other ISPs.

Sometimes the host of the GGC will be a dominant ISP that has spare capacity and is gaining the most advantage from hosting the cache, and so will give access to others for free. In other cases the ISPs agree to share the cost of the international transit, or it might be an academic network that is a neutral third party not competing with the commercial ISPs. In some cases, such as in Rwanda, the GGC has encouraged the dominant incumbent operator to work more collaboratively with the other ISPs.

Blanche concluded with an illustration of the bandwidth savings at one recently observed cache was that it was delivering about 250Mbps of traffic to users (almost two STM-1s) while using only about 25Mbps of international capacity to fill the cache. So over 200Mbps at peak time is saved by using the cache. Typically between 10 and 20% of the capacity served to users is needed for the upstream link to Google.

3.4.2 A Local Perspective on Specialised Connectivity and Content Provision

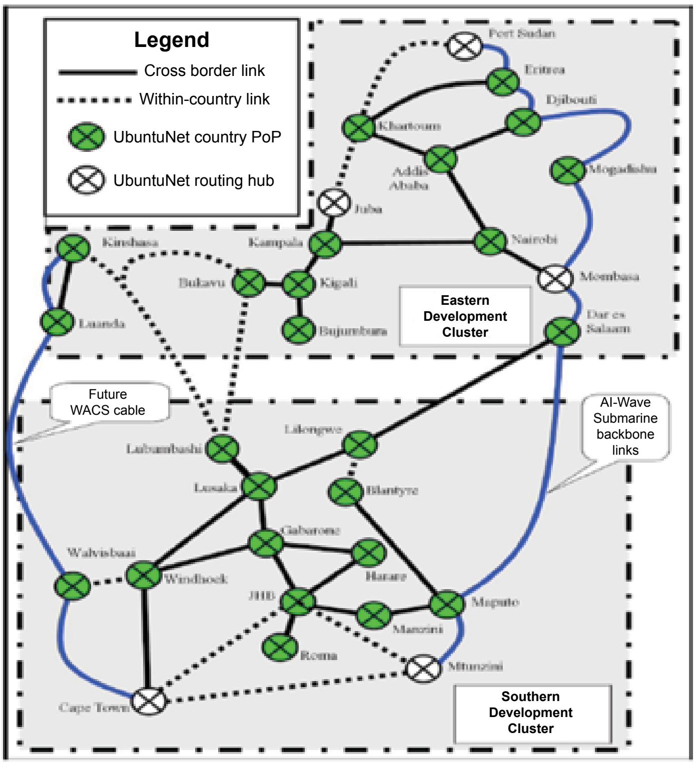
Presented by **Meoli Kashorda**, Executive Director, KENET, the National Research & Education Network (NREN) of Kenya

KENET is a trust that supports 77 academic and research institutions, 59 of which have fibre links to its network via POPs in six cities, supporting over 220,000 students in total. Although it has its own operator's licence, KENET partners with commercial operators for layer 1 and layer 2 services, and is connected to the Kenyan Internet exchange, KIXP, with a fibre link provided by local service provider *KDN*. The link operates at 10Mbps but sometimes bursts to 60Mbps, partly because it hosts Open Source software and will soon host Microsoft download facilities as well.

Meoli Kashorda said that for international connectivity KENET distributes about 500 Mbps of undersea bandwidth via a 350Mbps burstable KDN link to the SEACOM undersea cable, plus a SEACOM STM-1 IRU to London. The network connects with the London Internet Exchange (LINX) for peering, and commodity Internet transit is also purchased there at a cost of EU5/Mbps. In addition, KENET continues to operate a satellite earth station with 101Mbps of bandwidth, mainly because a two-year contract was signed, and it has not proved possible to terminate it early.

KENET acquires and allocates IP addresses for its members, and IPv6 is now being implemented across the network.

There are a wide variety of applications that depend on KENET's network. Kashorda described how in the early days many universities hosted their websites outside the country, but most universities have now moved their websites back to



Kenya. The universities also plan to deploy e-learning content via Moodle or Blackboard and the target for large universities is to make 20% of courses online, including streaming video and video conferencing applications to cater for the more than 50% of the university students who live off-campus. Many of these applications will be hosted in KENET's data centre, rather than on campus. In addition, student loan services and a repayment portal will be hosted by KENET for the Higher Education Loans Board. University ERP systems are becoming web-based with on-line registration, grade information, calendars, and payment systems.

Capacity and peering is also being increasingly required for the large number of international research institutions that are present in Kenya that host a variety of databases, such as the ILRI, ICIPE, ICRAF, the UN, and KEMRI. Many of these organisations are given free access to KENET, partly because many of them host postgraduate students. EBSCO's online journals are also now being made available, university libraries are being automated, and research projects/theses are made available online. Also, about 50Mbps of Google traffic is being generated.

Kashorda said that KENET believes peering with mobile operators and with e-government sites will be next on the agenda. The problem is that for off-campus students using 3G networks, which are charged on the basis of total data traffic, there is no cost-advantage to route the academic traffic via the KIXP exchange into KENET. This could change if the 3G networks distinguished between local and international traffic and between commercial and academic traffic.

NRENs in Africa

One of the problems in minimising international traffic is that most students, and much of the general public, use international e-mail providers such as Gmail, Yahoo!, or Hotmail because there is little trust in local e-mail providers. However, local e-mail addresses may still be needed for official purposes.

KENET is a member of the African network of NRENs known as the UbuntuNet Alliance, which is assisting its members in linking to each other and to other regional research and education networks such as GEANT in Europe. Kashorda said that traffic from NRENs in Africa is likely to grow massively over the next few years as these networks become established and the extent of fibre on the continent increases. NRENs in Africa are now being supported by the European Commission–funded AfricaConnect EU14 million project to help them obtain access to the necessary cross-border infrastructure. The procurement process has started in East Africa, driven by Dante, the European academic network operator.

3.4.3 The Role of Carrier Neutral Data Centres

Presented by **Jonny Martin**, Packet Clearing House (PCH)

There is still a divergent variety of interpretations over what "carrier neutrality" means for data centres: Not owned by a carrier, or not run by a carrier, multiple carriers present, or simply, cheap. Nondiscrimination tends to be the main issue where one carrier does not have any special advantages over others.

Other key features, Jonny Martin suggested, include:

- A space where all comers are welcome
- Open access with both customers and providers present (less and less distinction these days between providers and customers)
- No artificial constraints to participation such as cost, rack space, power, connectivity, and so on. Access to sufficient power can be particularly important when gaining access to incumbent facilities, where the design may not have included provisions for additional operators
- No competition by the data centre with its customers

The main reasons why carrier neutrality is important are:

- No impediments to competition—in the vast majority of cases, robust competition will fix any problems present in a market

- Low barriers to new entrants
- Promotes fostering of new and innovative services

If carrier neutrality is not present, Martin said that there can be an abuse of market power by the carrier or whoever is operating the data centre. Even where there is no abuse of power, there is a natural suspicion from competitors. In addition, customers will not have access to all the providers they need and, at worst, they will only have access to one provider. And where the facility is hosted by a single carrier, it is free to change the rules, which also creates confusion for customers.

Types of Carrier Neutral Spaces in the market are:

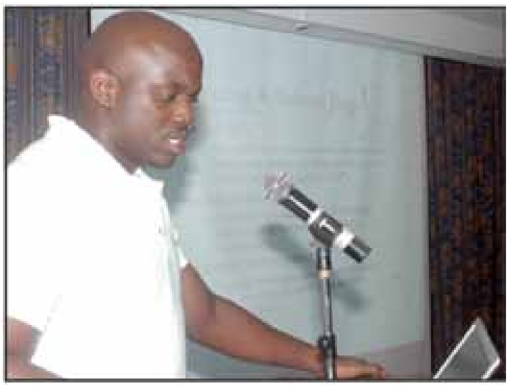
- Carrier hotel where the building owner leases space to many service providers. For landlords this can be a great use for old buildings in undesirable locations for other businesses. In these cases the owner may not get involved in provisioning of anything other than power.
- Fully fledged data centre run by a single party
- Somewhere between these two

The role of Carrier Neutral Spaces is to provide a single convenient point of connectivity to many customers and many providers, including different types of operators—metro fibre/wireless providers, transit providers, submarine capacity providers, and content services. The more customers using the facility, the more attractive it becomes to others. IXPs are often located in these facilities, because exchange points and common meet-me-points are complementary, but are not the same entity. An IXP is often just a rack or half-rack of equipment consisting of the switch and routers connecting to the switch. A carrier-neutral space is typically significantly larger than an IXP, with space for many more functions. In a hosting facility there may be many racks of servers and other equipment that could make up the core network of a provider.

From an operational or business perspective the main guideline is that the IXP does not compete with its members for services. So the IXP could provide data-centre type facilities if none of its members do.

3.5 Peering Strategies—The Details

3.5.1 Peering Jargon



Presented by **Mark Tinka**, AfriNIC Participant, African Internet Expert, and Chief Network Architect, Global Transit and TIME (Malaysia)

Mark Tinka noted that one of the difficulties with peering is that not everyone agrees on the same terminology and sometimes different words are used to mean the same thing. The following list attempts to cover the most common definitions.

Peer: A network with whom you exchange traffic.

Peering: The act of exchanging traffic with a peer.

Peering Policy: A set of guidelines by which network operators will peer with external networks. Types of Peering Policy:

- **Restrictive:** A network implementing this policy is normally not interested in peering with any other networks (typically large ISPs, Tier-1s).
- **Selective:** A network implementing this policy is normally happy to peer provided a minimum set of criteria are met, such as a minimum number of common peering locations, or minimum amount of traffic.
- **No:** A network implementing this policy is not interested in peering with any other network.
- **Open:** A network implementing this general policy is happy to peer with any other network without restriction.

Types of Peering:

- **Paid:** Is similar to Transit where one network pays another for access to its backbone, but here, the network being paid provides connectivity only to its customers, and not the whole Internet routing table. This can be a step leading to free peering.
- **Private:** Peering that does not typically involve any public exchange points, i.e., back-to-back agreements or cables between routers in a data centre. Sometimes private peering is implemented to improve performance where the IXP is operating at capacity or is unreliable, and sometimes because of unacceptable peering policies at the exchange (such as

mandatory multi-lateral peering). Paid peering combined with an SLA is often done privately. Inter-AS MPLS peering is not really peering but a way of extending a network's reach.

Public: Peering typically done within a public exchange point.

- **Settlement-free** (a.k.a. SFI): Neither party pays the other for the exchange of traffic. The is the normal arrangement between two peers.
- **Settlement-based:** One of the networks pays the other for the exchange of traffic, such as Transit.
- **Bi-lateral:** Peering relationships set up "directly" between two networks (opposite of multi-lateral peering).
- **Multi-lateral:** Peering with a group of networks through a single negotiated policy (opposite of bi-lateral peering). Multi-lateral peering is not a necessity at public exchange points—even if all participants are sharing a single-switched Ethernet fabric it is still possible to implement bi-lateral peering using individual BGP sessions with the peers.
- **Mandatory:** A situation where members at an exchange point are "forced" to peer with one another. Some regulators (e.g., in Malaysia) force everyone to peer, including with the regulator.
- **No-peering:** Where a network does not wish to peer with anybody else and just sells transit.

Transit: A service where a network pays another for access to the global Internet.

Peering Co-ordinator: An individual within an organisation that handles all peering-related matters for that network, including contracts. Often this role gets relegated to network engineers who may have insufficient time for peering co-ordination.

Point of Interconnect (PoI): A location, mutually agreed on by peering parties, where peering will occur.

Transit-free: A situation where a network does not purchase any Transit from any other network, and usually has a full view of the global Internet, i.e., the Tier-1 providers.

Carrier-neutral data centre: A facility where customers of the data centre can purchase network services from "any" other carrier within the facility (in some cases some data centres do no allow other carriers to be present at the facility to sell transit).

Cold-potato routing: A situation where a network retains traffic on its network for as long as possible (opposite of hot-potato routing). This is usually done to try to guarantee quality of service.

Hot-potato routing: A network's routing strategy to hand traffic off to other networks at earliest possible moment. This is to reduce the cost of handling the traffic.

Co-location (Co-lo): Typically a data centre where customers can install their equipment and house their network/service infrastructure.

Dark fibre: Fibre pairs offered by the owner of the infrastructure, normally on a lease basis, without any electronic equipment at each end of it to activate it. Dark fibre is usually leased on an annual basis. The benefits of dark fibre is that the customer can increase the bandwidth available to them on the link without paying more to the provider, simply by upgrading their equipment used to light the fibre.

Lit fibre: Fibre pairs owned by network operator that has attached equipment at either end to generate bandwidth from them. The downside of buying lit fibre is that the customer cannot increase the bandwidth without paying more to the operator.

Data centre: A purpose-built facility that provides space, power, cooling, and network facilities to customers.

Demarcation (Demarc): Information about a target customer/peer's facility in the data centre, e.g., rack number, floor level, patch panel, and port numbers, and so on, to allow the initiating to peer/customer to issue instructions for the interconnect.

Default Free Zone (DFZ): A situation where the network runs their routers with the full Internet BGP routing table and no default route.

De-peer: A situation where a network terminates a peering relationship with another.

Downstreams: A network's customers.

Upstreams: Typically networks to which you hand off traffic and pay a fee (e.g., transit providers).

Eye-balls: End-users of a network that are purchasing content/access to online resources—content providers are looking to reach more eye-balls.

Facility: May be synonymous with a data centre or co-lo site, where networks house their infrastructure.

Full circuit: A link provided by a network operator as an end to-end connection between two points of interest to the customer.

Half circuit: One side of an end-to-end circuit that is provided to a border, before it is picked up by another network operator for completion on the remote end.

Interconnect charges: Monies paid by peering parties for them to interconnect (e.g., cost of cabling). In the case of settlement-free peering, each party will pay half the cost of the circuit, or each will pay for the cost of getting to the interconnect point/exchange.

International Private Leased Circuit (IPLC): A leased line that spans two or more countries.

Looking glass: A useful resource that permits anyone who needs the information to analyze a network's view of the Internet. Customers can use this to see the extent of a network's connectivity to the Internet. Can be command line or web-based interface.

Meet-Me Room: A centralized, passive, cable switching panel in a data centre where interconnects between networks occur. This is easier for the data centre operators, because they just have to run cables within the meet-me room and not across the entire data centre.

Off-net traffic: Traffic that is handed off to another network at some point in its route. Customers need to understand that SLAs for off-net traffic are more difficult (if not impossible) to guarantee.

On-net traffic: Traffic under the control of the same network, i.e., the origination and termination of traffic remains occurs on the same network. SLAs are more easy to guarantee.

Route registry: A centralized database that contains routing information (e.g., prefixes, AS_PATH's, ASN's, and so on).

Route server: A centralized router at a public peering exchange point that is able to serve all member routes via a multi-lateral peering strategy. Makes configuration easier, but is not as flexible in terms of policy management. Should not be mistaken with a "route reflector."

Traffic ratio: The balance between how much traffic a network sends to its peers vs. what it receives from them. Some argue that this is relevant in determining the peering arrangement, and may only wish to peer if the traffic is equal; some networks say it is irrelevant.

3.5.2 A Guide to Peering and Interconnection—Contracts and Negotiations*,* The Peering Game*, and* The Peering Playbook

Presented by **William (Bill) Norton**, Executive Director, Dr.Peering International

Bill Norton noted that peering policies of ISPs vary along a spectrum from open to selective to restrictive to no peering:

- Open—will peer with anyone—encourages peering
- Selective—will peer but with some articulated prerequisites that explain how to apply
- Restrictive—inclination not to peer with anyone else—tough/impossible to meet requirements, changing when you do—or may not have publicly available peering policy
- No Peering—inclination not to peer—no peering policy available

In a survey DrPeering carried out of 28 major ISP peering policies it was found that policies were broadly similar and many peering clauses were almost identical as a result of lawyers using the same boilerplate. Three categories of peering policies were identified:

1. Operational clauses—operations/backbone requirements
2. Technical/routing/interconnect clauses that consist of interconnection and distribution of traffic requirements and technical/routing requirements
3. General clauses

    1. *Operational clauses:*

        - 24/7 NOC (25 of 28)—not just a beeper rotation system among the technical support.
        - Traffic volume requirements (20 of 28)—the network needs at least 10Mbps of traffic.
        - Interconnect capacity requirements (19 of 28)—the size of the links at the interconnect points which, if too small, would result in congestion.

- Work to fix things (19 of 28)—since both networks mutually depend on the connection to satisfy customers, there is often an obligation for both networks to work diligently to fix any problems.
- Geographic diversity and peering in all places in common (13 of 28)
- Traffic ratio requirements (9 of 28)—the problem is if the traffic goes above the designated ratio by even a small amount the traffic may routed via a more circuitous route.
- Maintenance and outage notification and interactions for network planning and monitoring/managing interconnect (6 of 28)—there are many different ways of doing outage notifications so these are often specified.
- Escalation path (5 of 28)—this might include contact information of staff doing the escalation.
- Use of IRR route registration, not as common as expected (6 of 28)
- Registration in PeeringDB—only 2 of 28

2. *Technical routing requirements in peering policies:*
   - Consistent route announcements across all interconnect points (21 of 28)
   - Hot Potato or Shortest Exit clause (8 of 28)
   - BGP Multiple Exit Discriminator (MED) signalling (2 of 28)
   - MD5 BGP authentication (4 of 28)
   - Do not abuse peering (18 of 28)—”do not point default at a peer” (stealing bandwidth)
   - Filtering, prefix-length minimum, minimum number of announced prefixes or ASNs (8 of 28)
   - Provide access to in-network monitoring tools (some cases)
3. *General clauses:*
   - Cannot be a customer and a peer (18 of 28)—some policies even say that the requesting network cannot have been a customer in last 18 months

- Method of peering request (17 of 28)
- Suspension and termination exceptions and no-peering guarantee (15 of 28)
- Paid peering “advertised” as an option (4 of 28)—”If you do not meet our peering requirements, consider our paid peering products.”
- Peering in reciprocal markets (2 of 28) “I as a Tier-1 in my country will peer with you provided you are a Tier-1 in your home country.”
- Non-disclosure agreements (NDAs) in peering contracts (9 of 28)
- Policy may change (10 of 28)
- Demonstration of financial viability requirement (2 of 28)

He added that it can also be noted that redundancy requirements to minimize the effects of the peering applicant’s network outages were also present in a number of peering policies.

In developing a peering policy and strategy he suggested to go through the clauses of other network’s peering contracts and decide what is important. There are two recommended options—take the entire policy clause list document and select the desired clauses or start with the AT&T or Comcast policy documents and add/delete. He also invited the attendees to reference the DrPeering white paper *The Great Debate* on public vs. private peering.

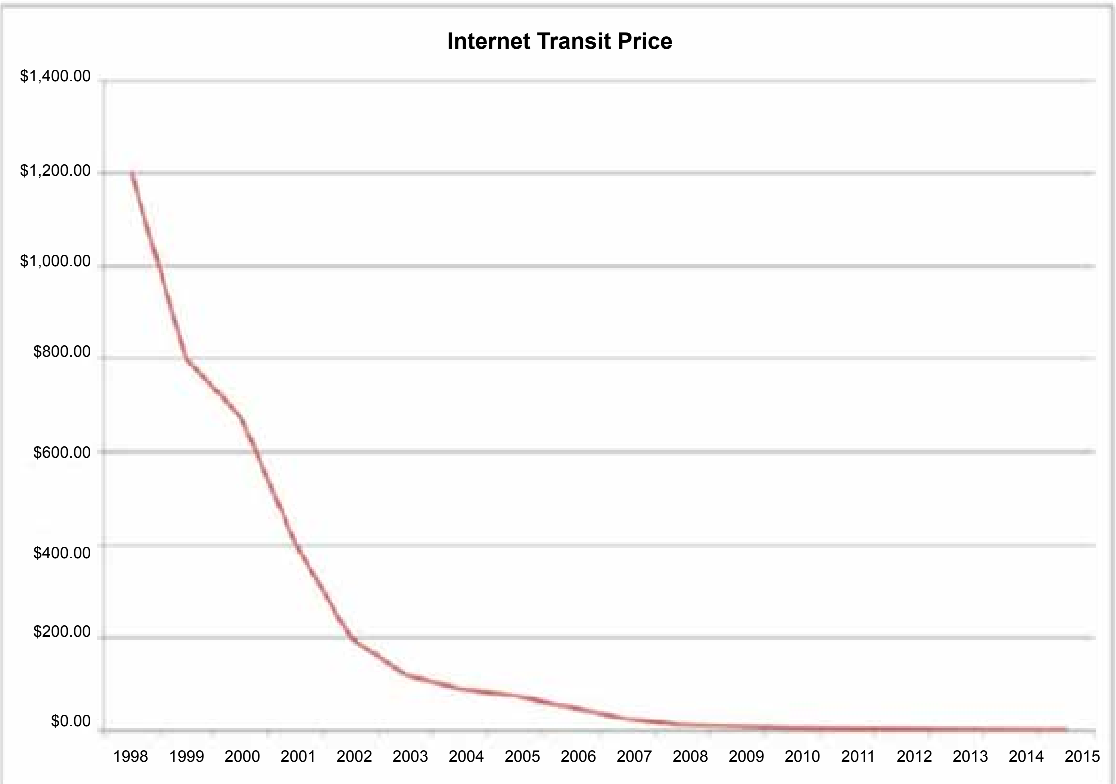
He recommended that the composition of the peering team should be considered. Aspects include—how many people, the variety of their technical knowledge, the roles that each member of the team plays, and rotation of the team members. The peering application process also needs to be regularly reviewed.

Mr. Norton also ran a session to introduce delegates to the Peering Simulation Game, which provides an interactive approach to learning about peering policies. This was introduced with some basic definitions:

- The Internet is a network of networks
- The ISP sells access to the global Internet
- An ISP must itself get attached to an ISP already attached to the Internet
- “Transit” is service whereby one ISP sells access to the Internet—A port in the wall that says “Internet this way.”

- Transit fees are typically based on what is known as the 95th percentile—the volume of traffic that is passed over the link 95% of the time, based on traffic that is sampled every 5 minutes
- Peering is the business relationship whereby ISPs reciprocally announce reachability to each others' transit customers

His presentation include the chart below to illustrate how transit prices have dropped considerably since the start of the Internet, although the decreases are now levelling off.

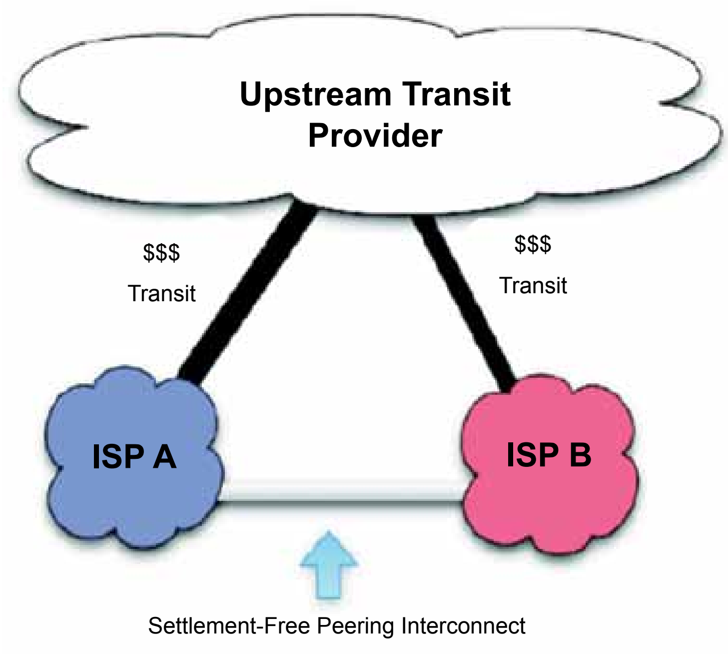


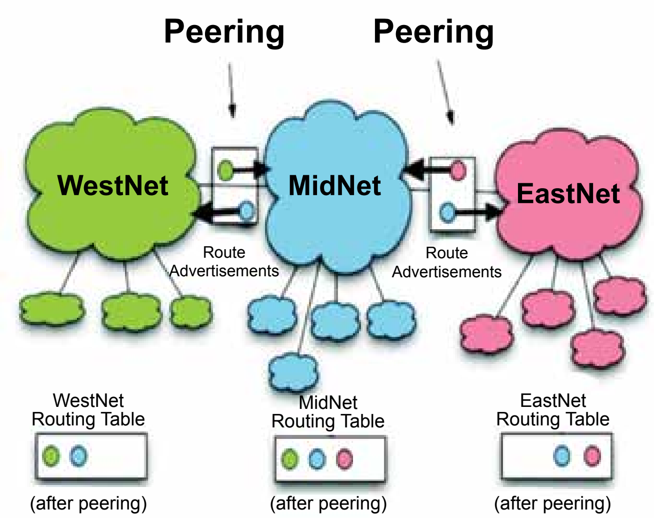
As Internet transit in the United States is available for $5/Mbps/month. So why bother peering? His research surveyed 100 ISPs to ask why they peer. The main reasons given were:

- Lower transit costs
- Performance reasons—lower latency

- Usage-based traffic billing—you can actually pass and sell more capacity if the links are lower latency
- Marketing benefits—the ISPs network appears much bigger, more widely dispersed, and better performing

The definition of peering most widely accepted by peering co-ordinators is "the business relationship whereby two ISPs reciprocally announce reachability to each other's customers."





Ecosystem Member: Tier 1 ISP

- Definition: A Tier 1 ISP has access to the ENTIRE Internet Region routing table solely via Peering Relationships, and does not buy transit from anyone to reach any destination in the Internet
- Motivation: Is NOT motivated to peer in region to reduce transit fees, is NOT motivated to peer with anybody else
- Behavior: "Restrictive" Peering Policy

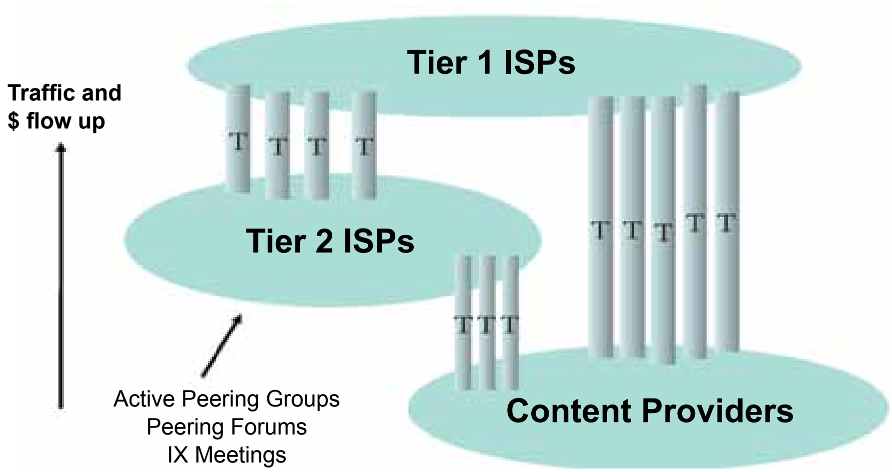
Ecosystem Member: Tier 2 ISP (everyone else)

- Definition: A Tier 2 ISP is an ISP that has to purchase Transit to access some part of the Internet
- Motivation: Is motivated to peer in region to reduce transit fees
- Behavior: "Open" peering or "selective" peering policy and is active in peering forums

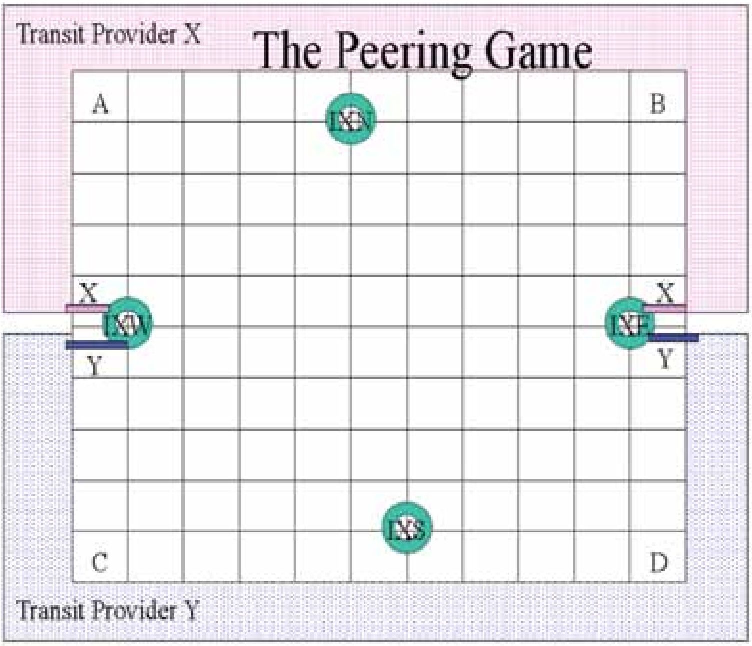
Ecosystem Member: Content Providers

- Definition: A content provider focuses on content development and does not sell access to the Internet
- Motivation: SLAs with a well known ISP
- Behavior: "No Peering" policy

Diagram: The Internet peering ecosystem



To assist in understanding these dynamics Mr. Norton introduced a Peering Simulation Game, which he created to help illustrate the issues and trade-offs between peering and transit. The game generally involves four players who take on the role of a peering co-ordinators at four different ISPs, two that take on the role of transit providers, and one that takes on the role of possible Internet Exchange Points.

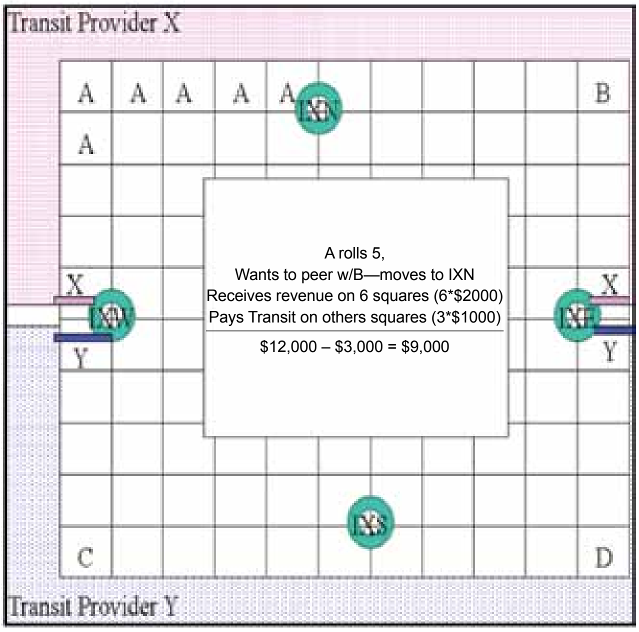


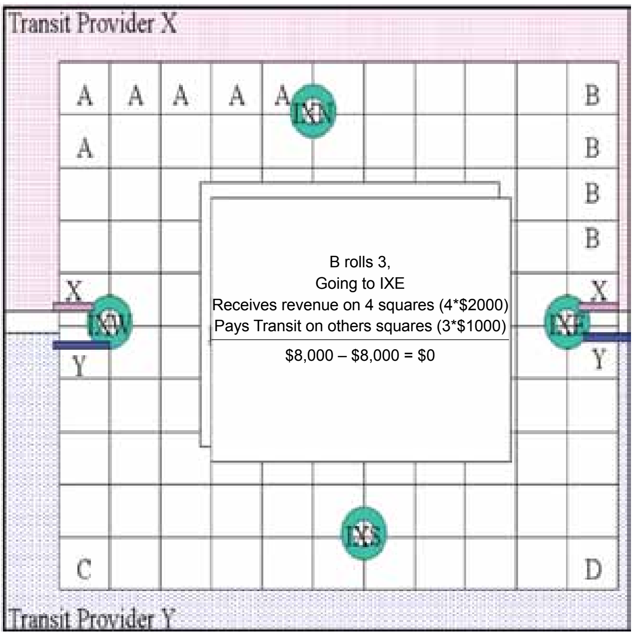
There are three rules to the game:

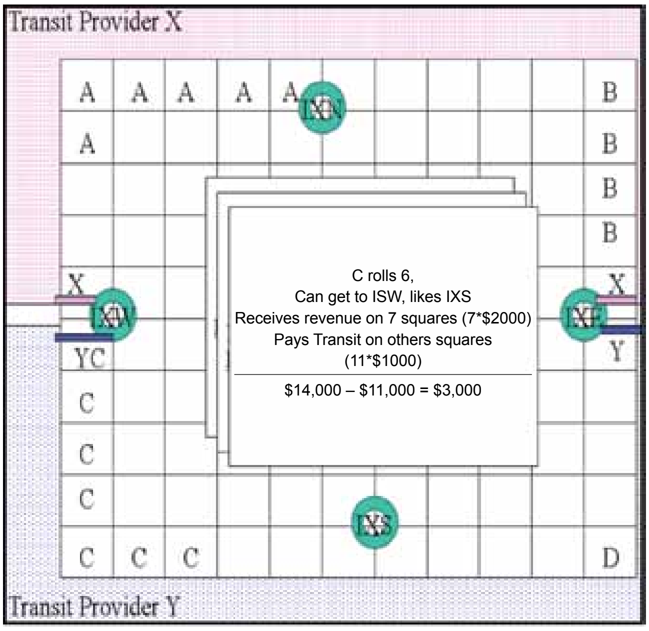
1. Goal: Maximize bank holdings. Make money by acquiring customers and reduce transit costs by peering.
2. Play: Roll the dice and expand your network by selecting that many adjacent "squares" of customers:
   - Gain transit revenue of $2,000 for each customer square you own
   - Pay transit fees of $1,000 for each square of traffic that other ISPs own
   - If at Exchange Point, two ISPs can negotiate peering:
     - $2,000 recurring cost and loss of two turns, ISPs negotiates who covers the costs of peering
     - Peering ISPs do not have to pay transit for each others' squares starting the next turn

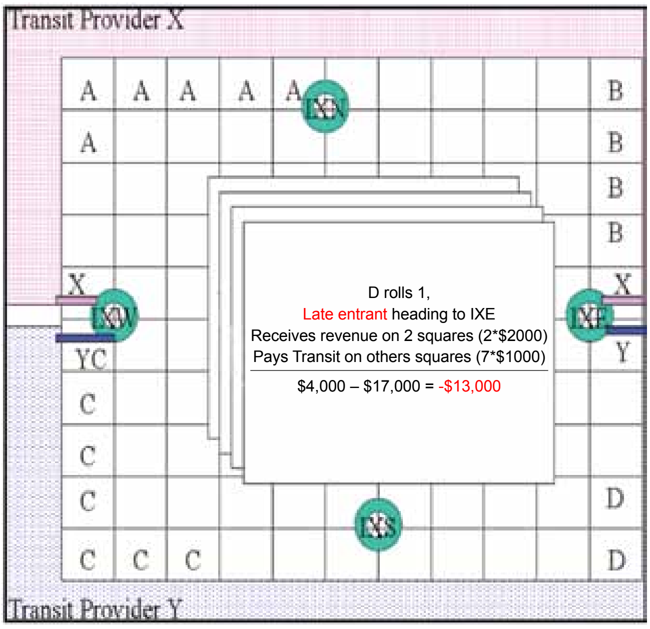
The winner is the ISP with the largest bank account at the end.

A game example:





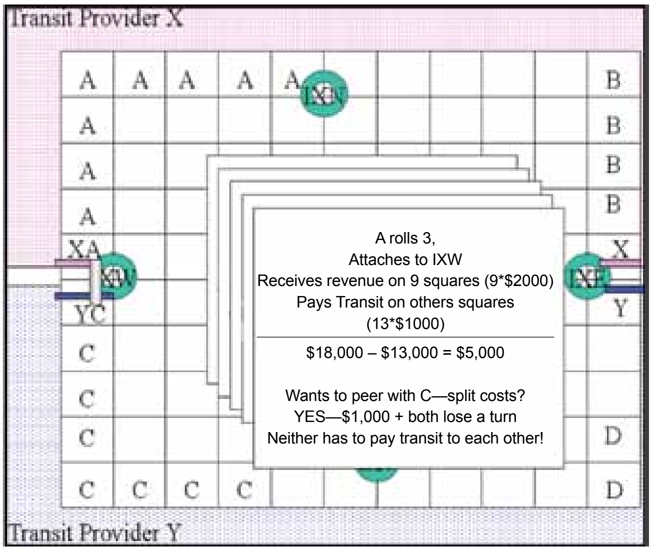


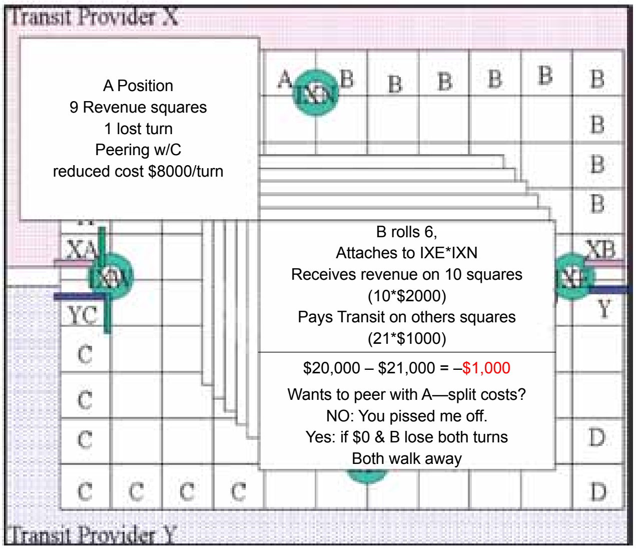


Scoreboard after Round 1

ISP A: $9,000, ISP B: $0, ISP C: $3,000, ISP D: –$13,000

Round 2:





An session of the Peering Game was lead by Bill Norton and played by a group of AfPIF audience volunteers. One of the major benefits of playing the game is to investigate the logic and choices made in peering negotiations. The game does need to be played for a sufficient number of rounds to demonstrate that the benefits are not short term but long term, so that the disadvantages of a short-term strategy not to peer are made more apparent. Also, what becomes clear is that the game shows that relationships matter and building these relationships is a key part of the peering process.

He also presented *The Art of Peering: The Peering Playbook* that compares U.S. vs. European IXP models and outlines different strategies to establishing peering relationships. Comparing European with U.S. IXPs:

European IXPs	U.S. IXPs
Are nonprofit associations founded by a set of ISPs—IXPs have “members.” Much more public peering, traffic stats are public. IXPs tend to cooperate with each other and share information, but competition increasing.	Are commercial entities, IXPs are typically for-profit—IXPs compete for “customers.” Less public peering and more private peering—stats typically private
Run best-quality switches	Run best-quality switches
Are Co-lo-Neutral: Some university-grade co-lo IXP customers choose co-lo facility that meets their needs. Separate contracts with co-lo and IXP operator. Co-lo provider may subsidise or pay for elements of IXP within their facilities (co-lo space more valuable with IXP there).	Own financial/commercial-grade co-lo infrastructure. U.S. IXP may spread across multiple co-lo facilities—pays for fibre between facilities that it resells to customers for private peering. Co-lo operators also operate the IXP—one point of contact. Co-lo space becomes more valuable with IXP access there, too.
Member meetings and voting on changes to policies and fees	Follow interests of customers, stockholders, employees
Fixed contracts and fees, everyone pays the same published fees	Negotiable contracts and private, variable fees
Modest capital and operating budget	Large capital and operating budget
Low prices, approximating cost	High(er) prices set on what market will pay
24/7 on-call support	24/7 on-site support with back-up processes

He noted that there are exceptions to the above pattern. For example, the Seattle Internet Exchange (SIX) is perhaps the largest IX that more closely resembles the European model.

Mr. Norton also gave the audience “insider insights” on tactics used by peering co-ordinators. He outlined a list of 20 “Tricks of the Trade” that have been used, but are not necessarily recommended, but are good to know, as if you are a peering target, they might be used on you!

First, there is a need to clearly distinguish peering requests (reciprocal access to each others' customers) from transit requests (selling access to entire Internet)—the former made to peering co-ordinator, the latter to salesperson. Transit vs. peering requests need to take into account potential volume of traffic in each direction, this includes both fictitious traffic and packet-loss ridden traffic.

Tactic #1—*The Direct Approach* uses peering@<ispdomain>.net, phone calls, face-to-face meetings, or otherwise direct interactions with Peering Co-ordinators to establish peering. The top 10 ways Peering Coordinators contact a target ISP:

1. Face to face at informal meeting in an Internet Operations forum like NANOG, IETF, RIPE, GPF, APNIC, AFNOG, and so forth
2. Face to face at Commercial Peering Forums like Global Peering Forum (you must be a customer of one of the sponsoring IXes)
3. Face to face at IX member meetings like DECIX, LINX, or AMS-IX member meetings
4. Introductions through an IX chief technical liaison or a peer who knows the right contacts via e-mail
5. Using the pseudo-standard peering@ispdomain.net or a personal contact, but this can be directed to sales, although this can help get the discussion going
6. From contacts listed on an exchange point participant list, or peeringdb registrations
7. With tech-c or admin-c from DNS or ASN registries
8. Google for peering contact/AS peering
9. From the target ISP sales force, at trade show or as part of sales process
10. From the target ISP NOC

In conclusion, it can be said that personal face-to-face interactions are probably the most effective method of establishing peering.

Tactic #2—*The Transit with Peering Migration* tactic

This tactic leverages an internal advocate to buy transit with a contractual migration to peering at a later time. Transit negotiations with sales leads to peering (if peering prerequisites are met).

Tactic #3—*The End Run Tactic* minimizes the need for transit by enticing a direct relationship with the target ISP's largest traffic-volume customers.

Tactic #4—In Europe, the *Dual Transit/Peering* tactic separates the peering traffic from the transit traffic using separate interface cards and/or routers.

Tactic #5—*Purchase Transit *Only* from Jerk Tier 1 or Large Tier 2 ISPs Tactic* to reduce the risk of being a customer of a potential peer. Reducing "I already hear your routes for free from a peer" (One less barrier to overcome during peering negotiations).

Tactic #6—*Paid Peering* as a manoeuvre is positioned by some as a stepping stone to peering for those who don't immediately meet the peering prerequisites.

Tactic #7—In the *Partial Transit* tactic, the routes learned at an exchange point are exchanged with the applicant peer for a price slightly higher than transport costs. Routing announcements forward all customer and peering point routes (almost peering—maybe costs less). The peering applicant gets some routes (at virtually zero cost to the target ISP) without having to go through the whole painful peering process and they get more direct access than they might by going through a transit provider. Also done to "help a buddy out."

Tactic #8—The *Chicken* tactic involves de-peering in order to make the other peer adjust the relationship. Who will blink first? A<->B Traffic has to go somewhere, but the service disruption affects both parties. See the GTE/Exodus clash and the Level 3 /Cogent de-peering example—each party had different public explanations for the event.

Tactic #9—*Traffic Manipulation and the Nature of Web Traffic* tactic—Traffic is typically asymmetric between ISP and end-user—client browsers generate low-traffic requests and result in larger traffic responses. Big-content providers leverage this and temporarily force traffic along the network path that makes peering appear most cost effective. B hears A's route "for free" through Peer L, A forces traffic over B's transit—one month later contact peering co-ordinator—We should Peer! Clever, but may or not be ethical—games that improve peering are good for business. Also see the "Folly of Peering Ratios" white paper.

Tactic #9b—*For Access Heavy Guys*—In the Traffic Manipulation tactic, the applicant ISP a) stops announcing routes, or b) inserts Target AS# into announcement to trigger BGP Loop—suppression to force traffic along the network path that makes peering appear more cost effective.

Tactic #10—*The Bluff* manoeuvre tactic is simply overstating future traffic volumes or performance issues to make peering appear more attractive (e.g., some upcoming spot event that will generate a lot of traffic. “You better peer with me now because lots of transit fees are coming otherwise!”

Tactic #11—*The Wide Scale Open Peering Policy* tactic signals to the peering co-ordinator community the willingness to peer and therefore increases the likelihood of being contacted for peering by other ISPs. From the highest mountain “We will Peer with Anyone!”—announce at industry events.

Tactic #12—*The Massive Co-lo Build* tactic seeks to meet the co-location prerequisites of as many ISPs as possible by building POPs into as many exchange points as possible. “Meet Us in 3 Time Zones.”

Tactic #13—*The Aggressive Traffic Buildup* tactic increases the traffic volume by large-scale market and therefore traffic capture to make peering more attractive. “Cheap Transit for sale ${belowCost}/Mbps!”

Tactic #14—*Friendship-based Peering* leverages contacts in the industry to speed along and obtain peering where the process may not be in place for a peering. Forums to meet Peering Coordinators—GPF, NANOG, APRICOT, RIPE, IETF.

Tactic #15—*The Spam Peering Requests* tactic is a specific case of the Wide Scale Open Peering tactic using the exchange point contact lists to initiate peering.

Tactic #16—*The Honey Approach*—easier to lure flies with honey . . . than with vinegar—publicly promote the attractiveness of peering with the candidate.

Example: Yahoo! policy=“Yes”, millions of streaming hours

Example: Rogers—650K Internet subs, 2.3M cable subs, largest cable company in Canada.

Tactic #17—*Purchasing Legacy Peering* provides an immediate set of peering partners.

Tactic #18—*The Bait and Switch* tactic leverages a large corporate identity to obtain peering even though ultimately only a small subset or unrelated set of routes are actually announced.

Tactic #19—*The False Peering Outage* tactic involves deceiving an ill-equipped NOC into believing a nonexisting peering session is down.

NOC-A: Hey—Emergency! Our Peering Session with You Went Down!

NOC-B: Strange. <looks on router> I don’t see it configured.

NOC-A: It was. Don’t make me escalate to <famous person>

NOC-B: Ah—I bet it was that last config run that trashed it. Give me a few minutes to fix it on both ends.

Tactic #20—*The Leverage Broader Business Arrangement* tactic takes advantage of other aspects of the relationship between two companies to obtain peering in exchange for something else. Peering Tied with “Other” Fibre/Dial-in deal, racks, transport, strategic deal.

Mr. Norton noted that copies of *The Art of Peering: The Peering Playbook*, *The Great Debate*, a tutorial on The Peering Game and other research and information related to his presentations are freely available at his website, http://www.drpeering.net. He welcomed AfPIF attendees to visit the website or contact with direct inquiries via e-mail at wbn@drpeering.net.

APPENDIX 1: AfPIF Detailed Agenda

Day 1: August 11, 2010

08:00-09:00	*Registration*
09:00-10:30	**Opening Remarks** • Internet Society Representative: Karen Rose, Director of Regional Development, ISOC • African Regional Representative: Dr. Nii Quaynor, Convener of AfNOG • TESPOK Representative (Local Host): Tej Bedi, Chariman of TESPOK • Kenyan Government Representative and Distinguished Guest: The Honourable Samuel Poghisio, Minister for Information and Communication
10:30-11:00	*Coffee Break*
11:00-13:00	**Setting the Stage: Peering vs Transit Economics** *Moderator: Kurtis Lindqvist, Chief Executive Officer, NETNOD* • African Fibre Assets: Mike Jensen, ICT Consultant • Africa IXP Assets: Michuki Mwangi, ISOC Sr. Development Manager • The Peering Game: Bill Norton, drpeering.net • Q&A
13:00-14:15	*Lunch*

14:15-16:15	**Interconnection: The Cross-Border Policy and Regulatory Challenges**
	Moderator: Dr. Nii Quaynor, Convener of AfNOG
	• Overview of Existing Cross-Border Regulations and Policies:
	  o East Africa – EARPTO Activities: Fiona Asonga, Chief Executive Officer, TESPOK
	  o Southern Africa: William Stucke, South African ICT Expert, former chair of AfrISPA
	• NePAD Broadband Strategy and Umojanet: Edmund Katiti, NEPAD e-Africa Commission
	• Peering and Transit Regulations - Best approach for governments: Mike Jensen, ICT Consultant
	• Q&A

16:15-16:30	*Coffee Break*

16:30-18:00	**Peering and Interconnection Strategies for Operators** *Moderator: Mark Tinka, AfriNIC Participant and African Internet Expert* • The Art of Peering: Bill Norton, drpeering.net • How to Evaluate Peering Locations: Jonny Martin, Packet Clearing House • Q&A session
18:30-20:00	*Social Event Hosted by Orange Kenya*

Day 2: August 12, 2010

08:00-08:45	*Registration*
09:00-10:30	**A Guide to Peering and Interconnection Contracts and Negotiations** *Moderator: John Walubengo, Ag. Director of ICT Services, Multimedia University College, and AfriNIC Board Member* • Understanding the Jargon: Mark Tinka, AfriNIC Participant and African InternetExpert • Issues to Consider when Developing an Interconnection Policy: Bill Norton, drpeering.net • IXPs Peering Policies: Kurtis Lindqvist, Chief Executive Officer, NETNOD • Q&A session
10:30-11:00	*Coffee Break*
11:00-13:00	**Africa Peering and Interconnection Opportunities: The Transition from National ISPs to Regional Carriers** *Moderator*: *Dr. Nii Quaynor, Convener of AfNOG* • Identifying the Business Case and Model: Jean-Pierre de Leu, SEACOM • African Operators Peering and Interconnection Challenges: Paul Mugemangango, MTN Rwanda • National Fibre Infrastructures: What's In It for Regional Carriers?—East African Case: Jane Karuku, Vice-President, Orange Kenya • Q&A session
13:00-14:15	*Lunch*

14:15-16:15	**Interconnection and the Content Equation** *Moderator: Mike Jensen, ICT Consultant* • The Role of Content Providers: Mike Blanche, Google • Role of Carrier Neutral Data Centres: Jonny Martin, Packet Clearing House • NRENs whats their real content value: Prof. Meoli Kashorda, Ubuntunet Alliance and Executive Director, KENET • Building Critical Mass at an IXP: Job Witteman, Chief Executive Officer, AMSIX • Q&A session
16:15-16:30	*Coffee Break*
16:30-17:30	**Concluding Session – The Way Forward** *Moderators: Karen Rose and Chris Morris, ISOC* • Open Discussion and Q&A session
18:30-20:00	*Drinks Hosted by NETNOD & AMSIX*

APPENDIX 2: Photos from the Meeting