AfriSIG 2025

Tutorial Training on Internet Architecture, Protocols, and Governance

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How the Internet Works

Technical Overview:

- The Internet is a global network of interconnected computers and servers using standardized protocols. It relies on the TCP/IP model and the OSI 7-layer model.
- Core concepts include packet switching, IP addressing, DNS for domain resolution, and routers for path selection.

Example(s):

When you access a website, your request travels through your ISP to the destination server via various network nodes.

Africa Context and Challenge(s):

Limited infrastructure, affordability, and rural access are key challenges. Growing mobile penetration is a major opportunity.

Daytime Prompt Question:

What are the key steps or actions that could address this challenge in your local or national context?

Evening Practicum Prompt:

Develop a short case study or role-play scenario based on this topic that highlights a specific African country's challenge and how stakeholders (government, ISPs, civil society) could collaboratively solve it.

Internet Protocols and Standards Development

Technical Overview:

Protocols like HTTP, TCP, and BGP are standardized by the IETF using RFCs (Requests for Comments). These protocols are developed through open collaboration and consensus to ensure interoperability, vendor neutrality, and global scalability.

Example(s):

HTTP, SMTP, and DNS are examples of protocols standardized by the IETF.

Africa Context and Challenge(s):

Many African countries lack local participation in standards development. There's a need for more regional technical capacity.

Daytime Prompt Question:

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Evening Practicum Prompt:

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Overview of Internet Architecture and Governance

Technical Overview:

Internet architecture includes the physical infrastructure (undersea cables, routers), logical layers (protocols like TCP/IP), and governance (ICANN, RIRs, IETF). It functions through layered communication and multi-stakeholder coordination.

Example(s):

Multinational telecoms run backbones, while local ISPs connect users to the global network.

Africa Context and Challenge(s):

Fragmented infrastructure and policy environments make coordination difficult. Local collaboration is improving.

Daytime Prompt Question:

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IETF (Internet Engineering Task Force)

Technical Overview:

The IETF develops protocols through working groups that submit Internet-Drafts. These drafts are reviewed and, if accepted, published as RFCs. The IETF emphasizes consensus and openness in protocol development.

Example(s):

RFC 791 defines IPv4; IETF also oversees standards like TLS (encryption).

Africa Context and Challenge(s):

Few African engineers participate in IETF processes. Capacity building is essential for regional relevance.

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IRTF (Internet Research Task Force)

Technical Overview:

The IRTF conducts longer-term research into the future of Internet technologies, often with a more academic focus. Topics include quantum networking, security, privacy, and congestion control mechanisms.

Example(s):

Research groups like GAIA (Global Access to the Internet for All) investigate low-cost connectivity.

Africa Context and Challenge(s):

Limited research funding and institutional participation from Africa in IRTF groups.

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ISOC (Internet Society)

Technical Overview:

ISOC supports the development of the Internet through education, policy advocacy, and funding initiatives. It runs programs like MANRS and supports IETF and IRTF operations. ISOC is key to promoting open standards and inclusive growth.

Example(s):

ISOC's initiatives in Africa include Internet exchange point development and policy support.

Africa Context and Challenge(s):

More African chapters are needed to advocate for Internet growth and inclusive governance.

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Undersea Cables

Technical Overview:

Undersea cables use fiber optics to transmit data as light pulses. Repeaters along the cable amplify signals. Landing stations connect them to terrestrial networks. These cables handle over 95% of intercontinental data traffic.

Example(s):

The Africa Coast to Europe (ACE) and WACS cables connect West Africa to Europe.

Africa Context and Challenge(s):

High costs and geopolitical risks. Many African countries rely on few cable landing points.

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Backhaul

Technical Overview:

Backhaul connects access networks (e.g., cellular towers) to core networks using fiber, microwave, or satellite links. Fiber provides high speed and low latency, while microwave is cheaper but more affected by weather and distance.

Example(s):

In Kenya, Safaricom uses microwave and fiber-optic backhaul from rural BTS to core network.

Africa Context and Challenge(s):

Rural areas often lack quality backhaul. Wireless links are common but less reliable than fiber.

Daytime Prompt Question:

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Backbone

Technical Overview:

The backbone is formed by Tier 1 ISPs and high-capacity fiber routes. It uses MPLS and other technologies for efficient data forwarding. Peering agreements allow traffic exchange between major networks without charges.

Example(s):

Seacom and MainOne operate backbone links in Africa that carry massive data loads.

Africa Context and Challenge(s):

Dependence on foreign-operated backbones. Need for more intra-African connectivity.

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Internet Exchange Points (IXPs)

Technical Overview:

IXPs are physical locations where ISPs exchange traffic directly. They use BGP for routing between networks. IXPs improve latency, reduce costs, and increase data sovereignty by keeping local traffic local.

Example(s):

Kenya Internet Exchange Point (KIXP) allows local ISPs to route domestic traffic efficiently.

Africa Context and Challenge(s):

Not all countries have IXPs. Regional peering is underdeveloped, increasing costs.

Daytime Prompt Question:

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IPv4 (Internet Protocol version 4)

Technical Overview:

IPv4 uses 32-bit addresses, structured into Classes A to E. Due to exhaustion, NAT (Network Address Translation) is widely used to allow multiple devices to share one public IP address.

Example(s):

A public IP like 197.248.120.1 is an example of an IPv4 address assigned to a user.

Africa Context and Challenge(s):

IPv4 scarcity leads to NAT usage, limiting network scalability and innovation.

Daytime Prompt Question:

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IPv6 (Internet Protocol version 6)

Technical Overview:

IPv6 uses 128-bit addresses, enabling a massive address space. It supports autoconfiguration, improved multicast, and better end-to-end connectivity. Deployment often uses dual-stack with IPv4.

Example(s):

IPv6 address example: 2001:0db8:85a3:0000:0000:8a2e:0370:7334

Africa Context and Challenge(s):

Slow IPv6 adoption due to lack of awareness, technical skills, and economic incentives.

Daytime Prompt Question:

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Routing

Technical Overview:

Routing directs data packets from source to destination using protocols like BGP (between networks) and OSPF (within networks). Autonomous Systems (AS) exchange routes and can be vulnerable to hijacking.

Example(s):

Google and Facebook use BGP to route data efficiently across their networks.

Africa Context and Challenge(s):

Routing security is a concern. Many networks lack route filtering or use outdated configurations.

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Interoperability

Technical Overview:

Interoperability ensures devices and applications from different vendors work together. This relies on open standards, APIs, protocol translation, and conformance testing for compliance and functionality.

Example(s):

E-mail sent from Gmail to Outlook works due to interoperable protocols like SMTP and MIME.

Africa Context and Challenge(s):

Legacy systems and lack of uniform standards enforcement hinder seamless interoperability.

Daytime Prompt Question:

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Asante Sana!

Aika Sana!