Computer Networks

-An Engineering Design Approach

Lecture-5:

Of Network Architectures, and Network Programming

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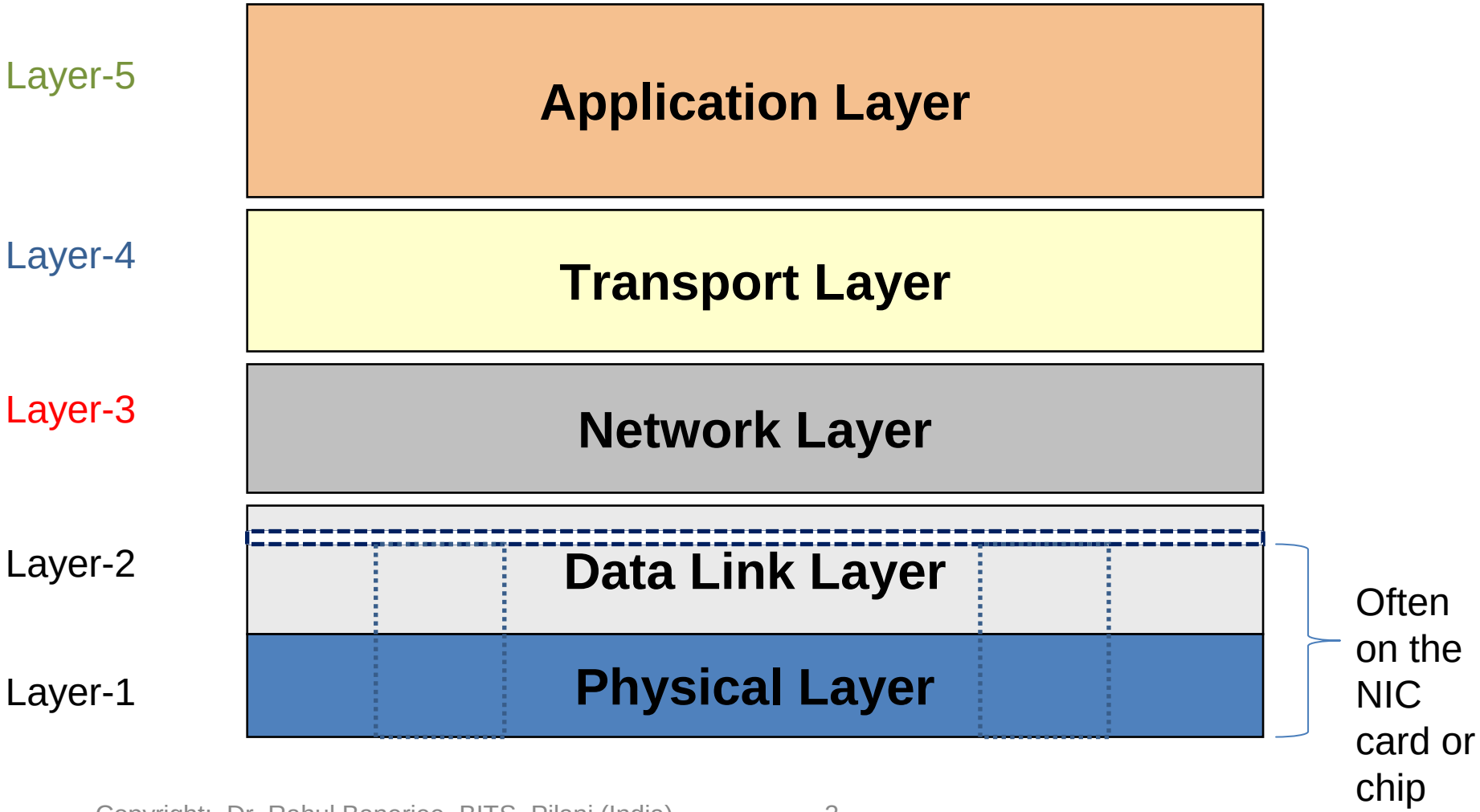
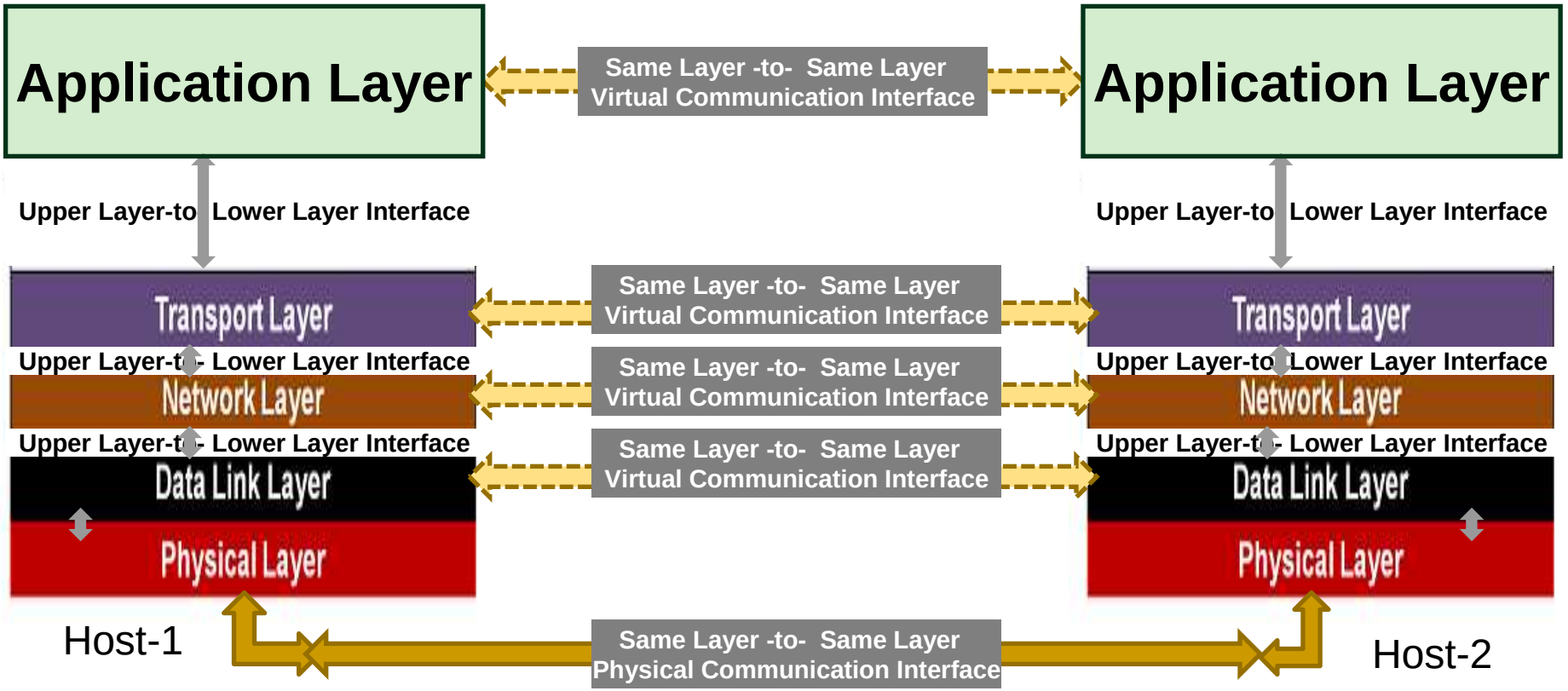
Interaction Points

- A Hypothetical Five-Layer Network Reference Model
- Mapping functionalities to layers
- How the protocols in the Lowermost two layers work?
- Examples
- Summary

A Hypothetical Network Reference Model for Easy Conceptual Understanding



A Simplified Network Reference Model <for Instruction>



Application Layer

- Application Layer is a layer of the Network Architecture that is primarily concerned with getting TPDU from the lower layer (usually Transport Layer) and delivering it to the Application and vice-versa (with or without explicit presentation and session management support).
- Examples: HTTP, DHCP, DNS, SNMP, FTP (in the context of the TCP/IP Architecture).
- Web-services, Video-on-Demand over the network, Video/Voice-conferencing over the network etc. are examples of Applications that reside atop the protocols belonging to this layer.

Application Layer Responsibilities

- It primarily deals with:
  - Accepting messages from the Application Layer through the APIs
  - Processing these messages and generating APDUs
  - Deciding transport connection requirements (for further transmitting this DU after encapsulating it within an APDU)
  - Passing this packet through the SAP to the lower layer (TL)
- It also deals with ...
  - Accepting APDU from the lower layer through the SAP
  - Processing the APDU
  - Removing the encapsulation and passing the messages to the respective destination application
  - Provide diagnostic support for network monitoring, configuration, management and trouble-shooting at the Application Layer or lower layer

Transport Layer: What is it?

- Transport Layer is a layer of the Network Architecture that is primarily concerned with:
  - getting TPDU from the upper layer (usually Application Layer) and
  - delivering it to the same layer at the intended destination node (through the underlying Network Layer).
- Converse is also true of the targeted set of responsibilities of this layer.

Transport Layer Responsibilities

<another perspective>

- It primarily deals with:
  - Accepting APDU from the Application Layer through the Service Access Point (SAP)
  - Processing these APDU
  - Deciding transport connection requirements (for further transmitting this DU after encapsulating it within a TPDU)
  - Passing this packet through the SAP to the lower layer (NL)
- It also deals with ...
  - Accepting TPDU from the lower layer through the SAP
  - Processing the TPDU
  - Removing the encapsulation and passing the messages to the respective destination application
  - Provide diagnostic support for network monitoring, configuration, management and trouble-shooting at the Application Layer or lower layer

Network Layer

- Network Layer is primarily concerned with getting NLDU / Packets from the source node and delivering it to the intended destination node (through none or many intermediate nodes).
- Additional responsibilities of this layer include:
  - Providing support for connection-oriented / connectionless services as the case may be (depending upon the protocol stack and need)
  - Provide diagnostic support for network monitoring, configuration, management and trouble-shooting at the Network Layer or higher layer.
- Packet handling, packet management, Routing are its major responsibilities.
- In the context of packet routing, network layer structural design goals include:
  - Ensuring the shortest possible delay and thereby the highest throughput at the least possible cost
  - Ensuring acceptably reliable packet delivery (may be optional in some cases)
  - Ensuring secure packet delivery (may be optional in some cases)

Data Link Layer

- Data Link Layer consists of two sub-layers:
  - Media Access Control (MAC) sub-layer &
  - Logical Link Control (LLC) sub-layer.
- Major Issues involved in the design of the Data Link Layer include:
  - Which services are to be provided to each of the adjacent layers?
  - Exactly when to provide these services?
  - How to provide them?
  - To whom should they be provided?

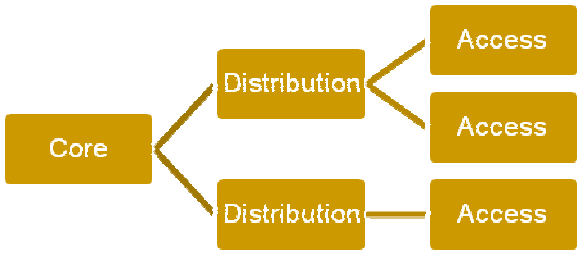
Physical Layer

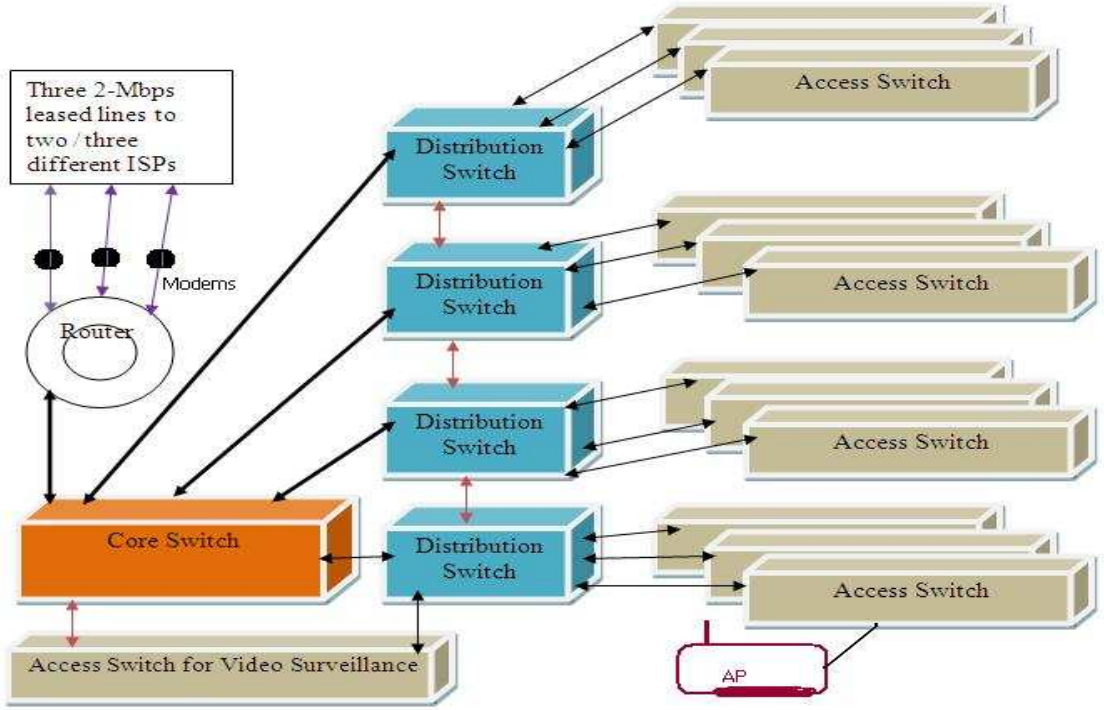
- Physical Layer deals with transmission of raw digital data using analog or digital signal.
- This layer is concerned with the logic type (negative or positive), amplitude of the signal, signal representation, bit-length, direction of transmission etc.
- It deals with connection-establishment and termination.
- This layer is, in a nutshell, a layer that deals with various electrical and mechanical characteristics of every physical component of a computer network.
- Exact electrical, mechanical and procedural Interface Definition is therefore its responsibility.
- Choice and use of the physical medium are the Physical Layer Design Issues.

A Few More Networking Terms

- Repeaters / Repeater Hubs / Shared Hubs: where usually Physical layer / level exist with L1-protocol data unit (raw bits) regeneration and onward transmission
- Managed Hubs / Layer-2 Switching Hubs: where Physical and Data Link layers / levels exist with ability to handle and deliver Layer-2-protocol data unit (frame)
- Bridges: where Physical and Data Link layers / levels exist with L2-protocol data unit (frame) processing and forwarding
- Switches: where Physical and Data Link and / or Network (sometimes even higher) layers / levels exist with Layer-2 and / or Layer-3-protocol data unit (frame / packet) processing, switched routing / forwarding
- Routers: where Physical and Data Link and Network layers / levels exist with L3-protocol data unit (packet) processing, routing and forwarding
- Gateways: where two or more different networks meet and may require protocol / message translation capabilities
- Clouds: abstraction of node connectivity in the networking context <details hidden>

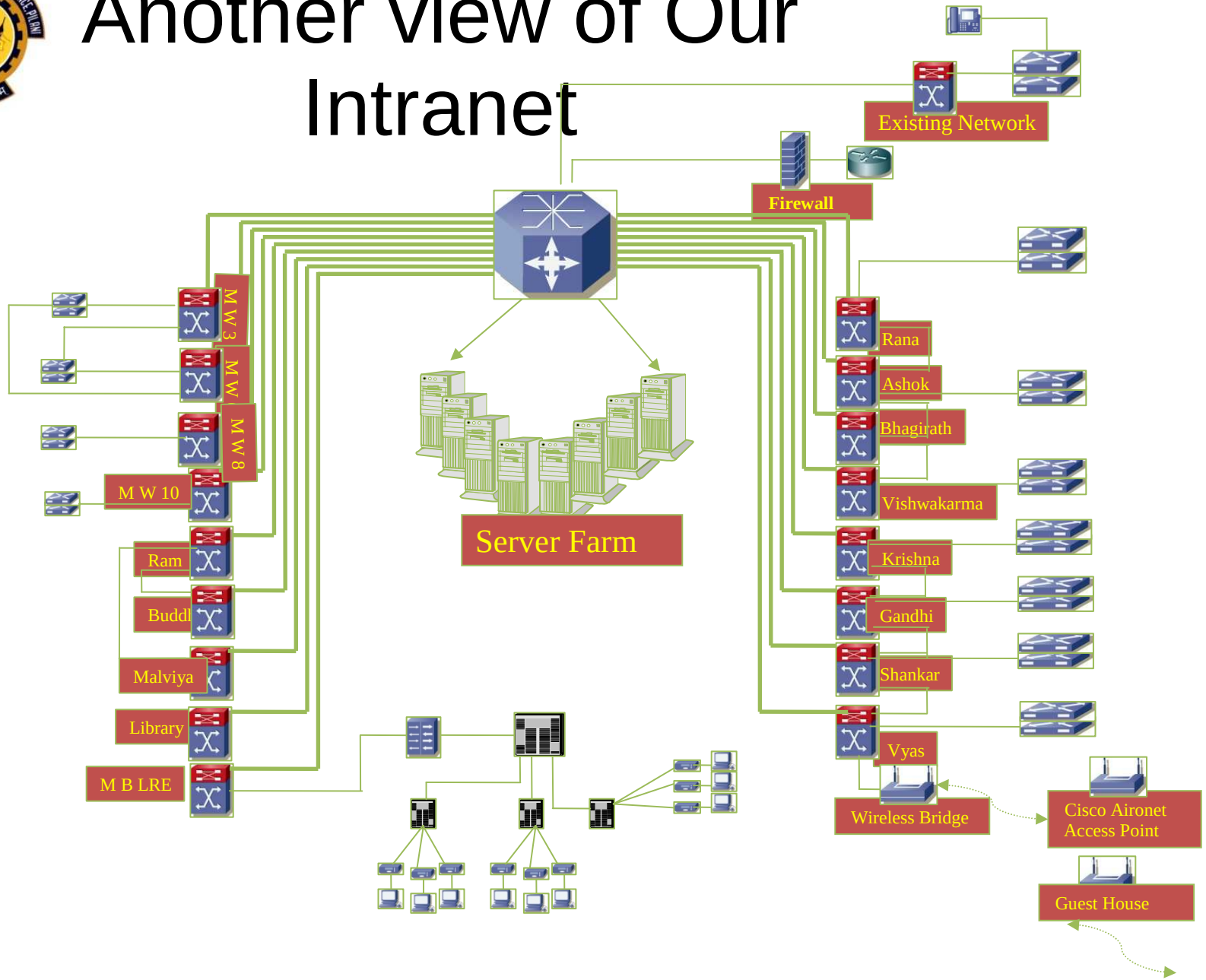
A Look at a Simple Network



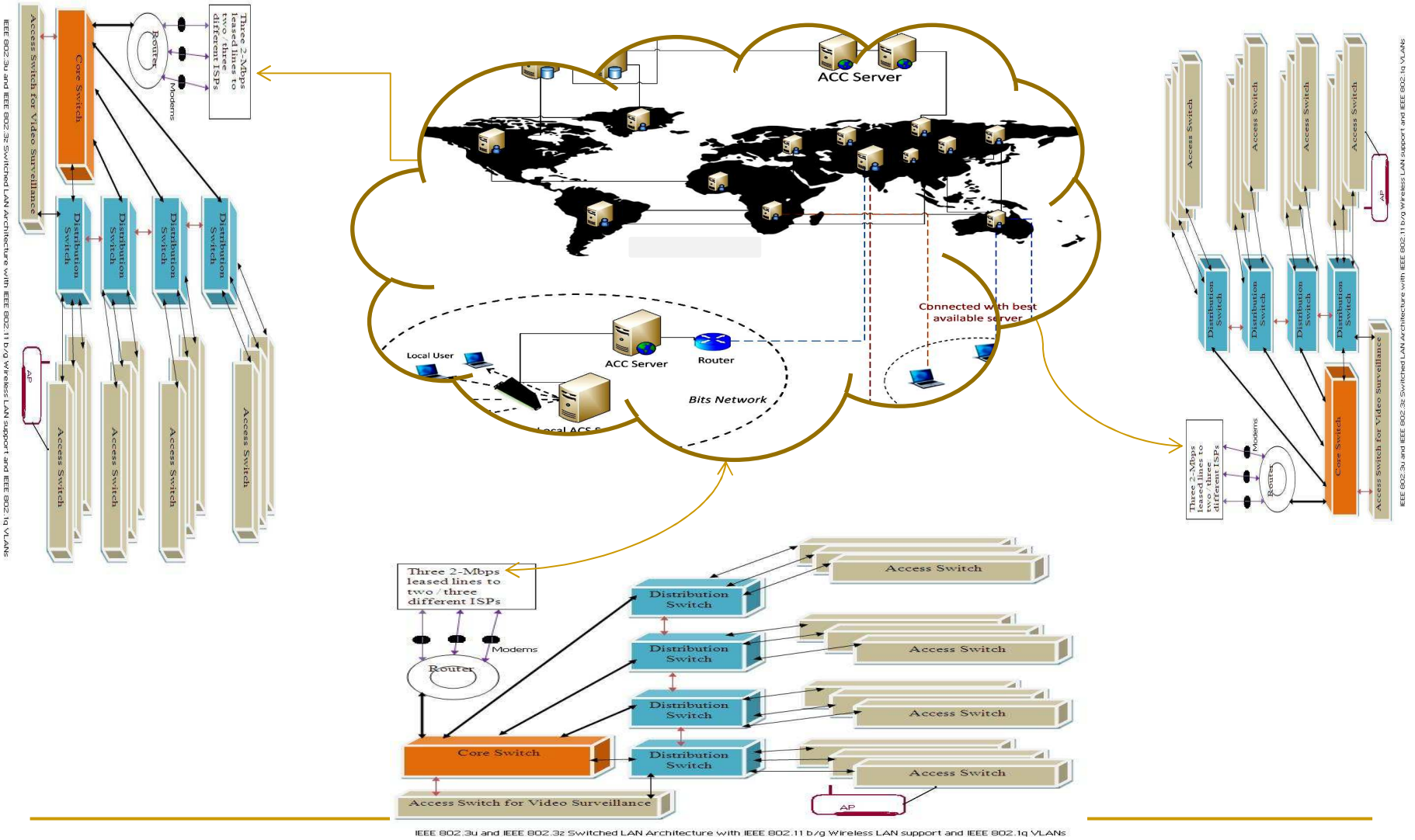


IEEE 802.3u and IEEE 802.3z Switched LAN Architecture with IEEE 802.11 b/g Wireless LAN support and IEEE 802.1q VLANs

Another view of Our Intranet



What is an Internetwork?



Summary of the Concepts & Terms learnt so far

Concluding remarks

- Networking support of some kind is already inside most of the operating systems we use today in variety of forms on Notebooks, Laptops, Workstations and Servers. All Smart-phones and several set-top boxes support it too.
- Most multi-layer network switches from major vendors around the world can now support IP.
- However, the degree of IP-readiness may vary.
- Internet Exchanges like the NIXI are already providing interconnectivity between Networks.
- Subsequent lecture shall introduce you to the following topics:
  - Performance
  - Quality of Service
  - Reliability
  - Security

Any question please?

Thank you for your kind attention!

For further details, you may contact at:

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    Part 3: CSMA/CD Access Method and Physical Layer Specifications —Amendment 4: Ethernet Operation over Electrical Backplanes
  - 802.11-2007 IEEE Standard for LAN/MAN — Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC)and Physical Layer (PHY) Specifications
  - 802.15.4a-2007 IEEE Standard for Telecommunications and Information Exchange Between Systems; PART 15.4: Wireless MAC and PHY Specifications for Low-Rate Wireless PANs (LR-WPANs) — Amendment 1: Add Alternate PHY
  - 802.1ag-2007 IEEE Standard for LAN/MAN — Virtual Bridged LANs — Amendment 5: Connectivity Fault Management

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