COMMUNICATION NETWORKS

WITH

LAYERED ARCHITECTURES

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INTRODUCTION

In addressing the standards for Broadband Wireless Access a review of network switching techniques, types and functions my help to set the stage for the work before the Broadband Wireless Access Study Group. This paper provides a review of Communication Networks, the principles for Layered Network Architectures, and an overview of the International Organization for Standardization (ISO/ANSI) Open Systems Interconnections (OSI) layered architectures.

Communication systems that are efficient and easy to use involve several types of networks that are coexisting and integrated to form a system for which the elements are transparent to the users. The sections of this overview of networks are the following.

- -NETWORKING SWITCHING TECHNIQUES
  - -Circuit Switching
  - -Message Switching
- -TYPES OF NETWORKS
  - -Circuit Switched Networks
  - -National Circuit Switched Networks
  - -Packet Communication Networks
    - -Point-to-point Store and Forward, Mesh/Star
    - -Multi-access Broadcast
    - -Store and Forward Multiple Access
- -NETWORKS
  - -NETWORK FUNCTIONS
  - -PRINCIPLES FOR LAYERED ARCHITECTURES
  - -ISO OSI LAYERED ARCHITECTURE-Reference Model
    - -The Physical Layer
    - -Data Link Control
    - -Network Layer
      - -Signaling and Call Processing

NETWORK SWITCHING TECHNIQUES

Two major network switching techniques exist; Circuit Switching and Message Switching.

Circuit Switching:

The total communication path is setup at the time of call initiation. This is accomplished via a signaling protocol with an acknowledgment response. Once the circuit is established data messages are then exchange.

Message Switching

Message switching is accomplished by formatting a block of data with an address header and error correction/check sum. Message switching has communication bandwidth dynamically allocated to support store and forward and packet switching protocols.

TYPES OF NETWORKS

The type of network will generally be defined by the switching technique utilized.

-Circuit Switched Networks are
generally designed to be a Star Network configured with a single switch in the middle of the network.

-National Circuit Switched Networks are
a Mesh configuration with Star local networks configured to connect the local users.

-Packet Communication Networks are

1. Point-to-point store and forward Mesh networks for those users of a large geographical scope, and a
   Star topology with a packet switch at the center of the local network for local area communication networks.

2. Multi-access broadcast types (i.e., LMDS and Satellite Systems) have a single transmission medium that is shared by all users.

3. Store and Forward multiple access or broadcast types.

2

NETWORKS

Network Functions

The basic network function is to connect geographically separated users for communication.

Network Architecture

Network architectures that utilize a linearly hierarchical model with the functions organized in a linear succession of layers tend to prevent ad hoc network designs which could lead away from a standard by generating a proliferation of designs. If the interfaces between adjacent layers are specified in a general way, independent of the protocols at the interacting layers, then it should be possible to modify the protocols at some of the layers without affecting the rest of the system.

"This is important for new technologies to prevent major redesign of the system when change is needed."

The International Organization for Standardization (ISO) Open Systems Interconnections (OSI) standard is a seven layered architecture that defines the services to be performed by a layer or the next higher layer, independent on how performed.

Principles for Layered Architectures

The basic principles for layered architecture development are given as follows.

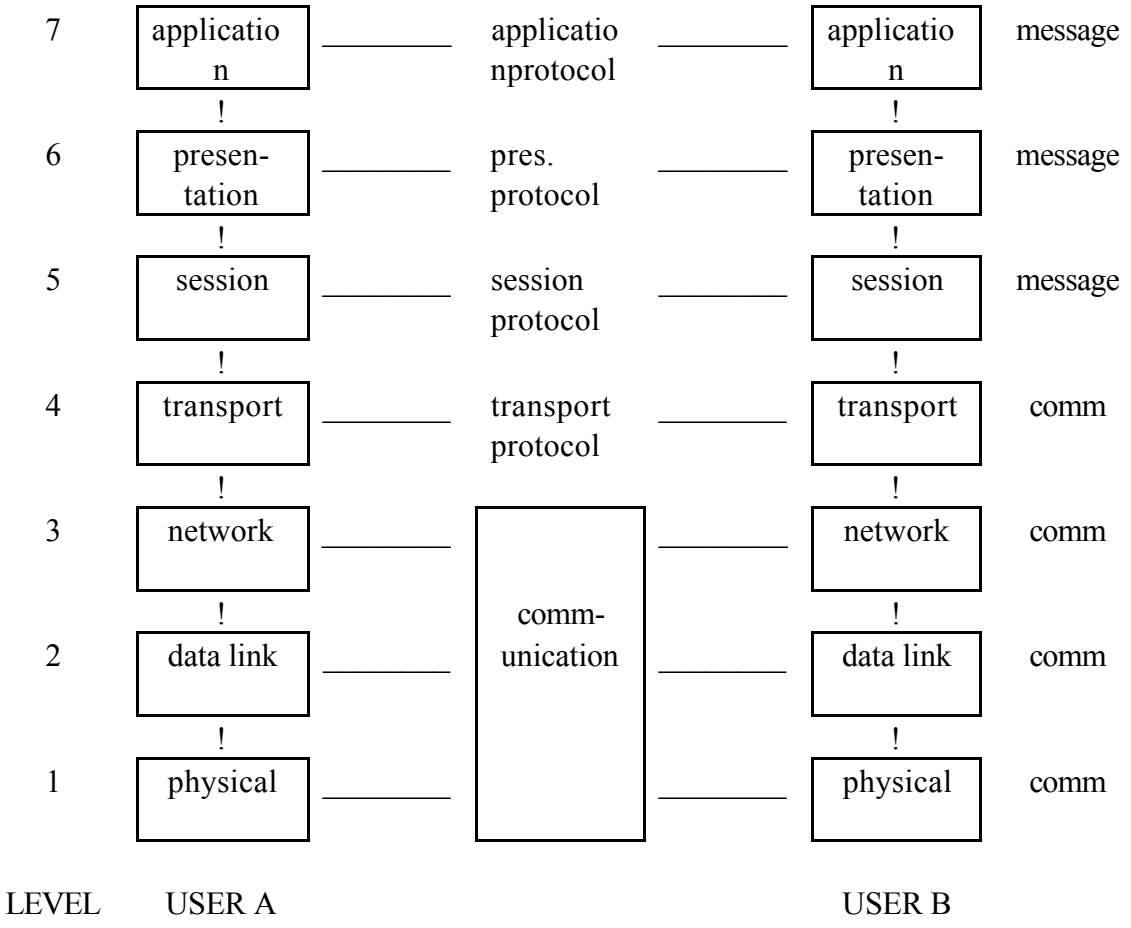
A. Collect similar functions into the same layer and separate those functions which are clearly apparent to be different into separate layers.

B. Create a layer of functions that are easily localized and that may be redesigned with technological advances without change of services or interfaces with adjacent layers.

C. Generate boundaries where interactions across the boundaries are minimized.

D. Limit the number of layers.

International Organization for Standards (ISO)
Reference Model



The first four layers of this model should be addressed and considered by the study group for the Broadband Wireless Access Standards. The following sections provide definition and function of the first three layers of the layered architecture model.

Physical Layer

The physical layer provides transparent transmission of a data bit stream across physical communication resources; i.e. wireless link. The physical layer has attributes such as data encoding, timing, levels and rates with either half-duplex or full duplex operation that can be synchronous or asynchronous.

This layer provides the physical with Data Terminating Equipment, (DTE) modem and Data Circuit Terminating Equipment, (DCE) that can be defined by mechanical, electrical, functional, and procedural characteristics.

The physical layer functional characteristics will define the number of circuits (bandwidth) and their assigned function; i.e., data, control, and timing.

The procedural characteristics provide the protocol or process by which the data and system test ad control process operate.

Data Link Control (DLC)

The Data Link Control layer provides the capability for error free transport of messages over the transport channel. An Upper DLC sublayer is always present and provides synchronization, error control and link management. A Lower DLC sublayer exist when a shared channel provides any-to-any connectivity and deals with the multi-access link control. Description of various DLC protocols are described by the following.

Asynchronous DLC Protocol

Bit synchronism is maintained only during the transmission time of a bit or character. Simple protocols are used for Asynchronous DLC's but lack inherent link control capability.

Synchronous DLC Protocol

A frame consisting of several characters are transmitted with bit synchronism being maintained during the transmission. This protocol provides frame synchronization, error control (acknowledgments and retransmission), link management, flow control and system recovery.

Multi-access DLC

The communication channel is shared by many users to provide a high degree of connectivity. Techniques used are fixed assignment, random access and demand assignment with central or distributed control.

Network Layer

The network layer contains the functions that control the transport of data over the network, makes use of the data link layer to accomplish error free transmission over the channels, handles network functions such as switching, routing and flow control, and exist at all switching nodes of the network. Signaling and Call Processing is a network layer function where the network establishes the virtual circuit for data connection. Establishment of a circuit requires knowledge of the addresses(s) of the data terminal equipment (DTE) and understanding of the call processing protocol and process. Signaling and Call Processing while being a network layer function spans the lower levels and interfaces to the upper transport level.

CONCLUSION

"Communication systems that are efficient and easy to use involve several that are coexisting and integrated to form a system that are transparent to users."

This has been a short review of work that has preceded that work now in front of the Broadband Wireless Access Study Group. It is hoped that this review of Communication Networks with Layered Architectures will be used as a reference and guide during the development of a Broadband Wireless Access Standard to be used by those who are to provide the broadband wireless systems and services of the future.