Chapter 1

The Data Communications Industry

Topics

- Industry Overview
  - Basic Terms and definitions
- Regulatory Process
- Standards and the Standards Process
- Industry Forces
- The Top Down IST Approach
- Communication Models and Communication Protocols
  - OSI Model
  - TCP/IP
- Critical Skills

Approach to Data Communications

- It is impossible to ever know everything about data communications.
  - Each professional has their own perspective
- It is important to be honest concerning what you don't know
  - If you can't admit what you don't know, you can't get started learning it!

Data Communications Defined

- “The encoded transmission of data via electrical, optical, or wireless means between computers or network processors.”
- See also Claude Shannon’s work.

http://en.wikipedia.org/wiki/Claude_Shannon

  - Note that Claude Shannon has been called "the father of information theory"

The Data Communications Industry

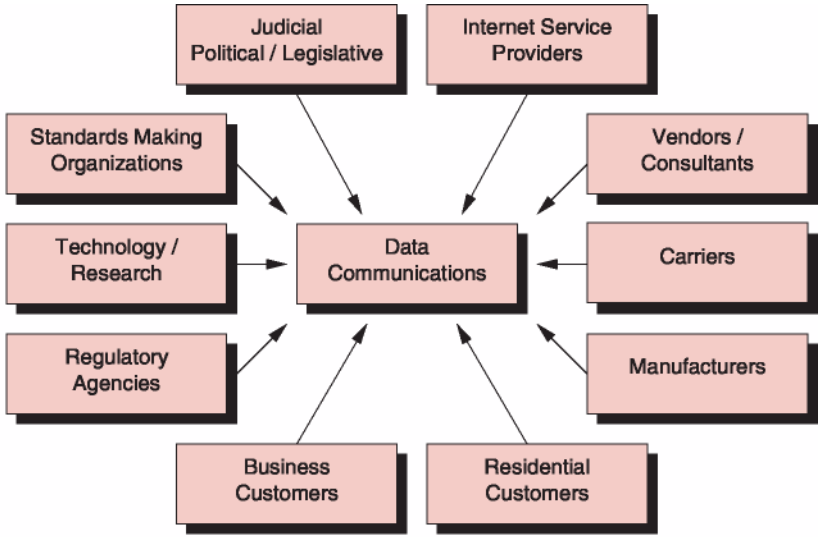


Figure 1-1 The Data Communications Industry: A Series of Interacting Components

- The Data Communications industry has many stakeholders with complex relationships
- Sometimes it evolves.
- Sometimes it changes disruptively

The Regulatory Process *One*

- Two tightly dependent components in a constant and ongoing state of change are the:
  1. **Regulatory** and
  2. **Carrier** components.

Regulatory Component

- Regulatory component represents
  - local,
  - state, and
  - federal

  agencies charged with regulating telecommunications

Carrier Component

- Carrier component represents companies such as
  - Telephone and
  - Cable TV
- That sell transmission services.

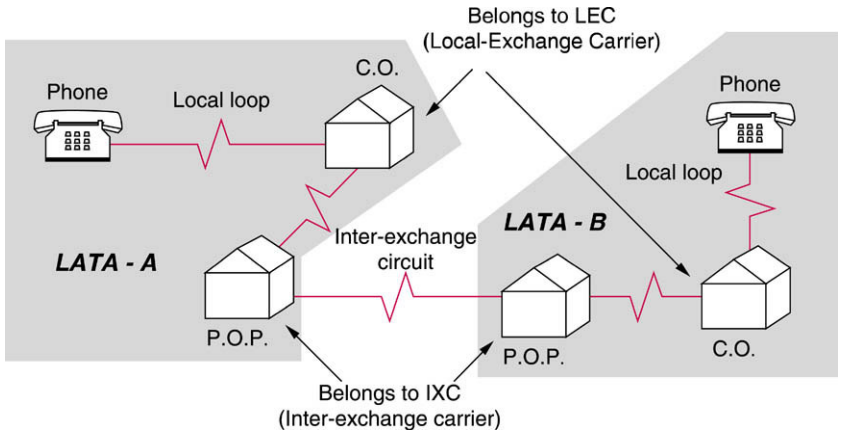
The Regulatory Process *Two*

- Interaction in a formal process as a series of proposals, known as tariffs.
- Tariffs are submitted to state and federal regulatory agencies by carriers, and rulings and approvals are issued in return

The Regulatory Process *Three*

- Carriers and agencies interact in the formation of tariffs.

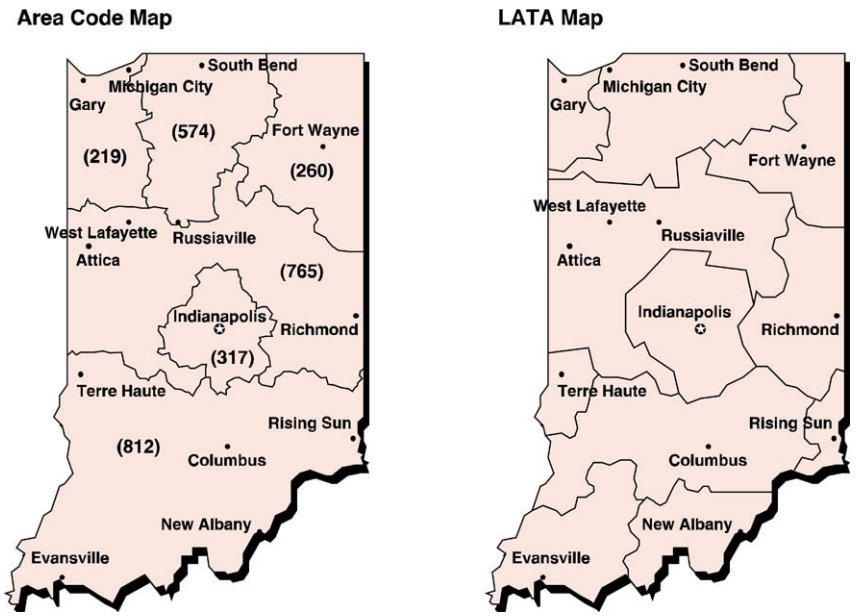
LATA's and Basic Infrastructure



- **Local access transport areas (LATA)** were established as a result of the breakup of AT&T to segment long-distance traffic
- See:

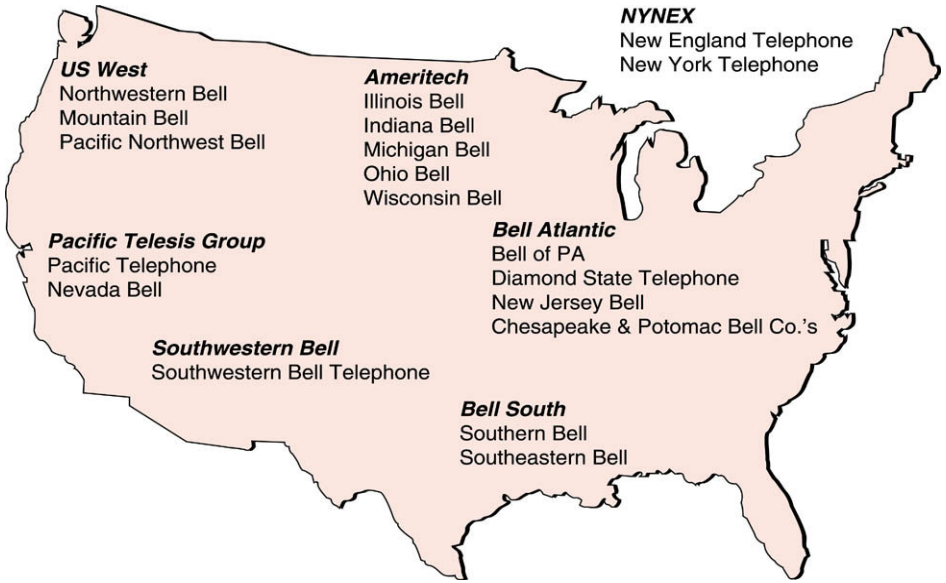
  `http://www.mackinac.org/article.aspx?ID=6769`

LATA v. Area Codes



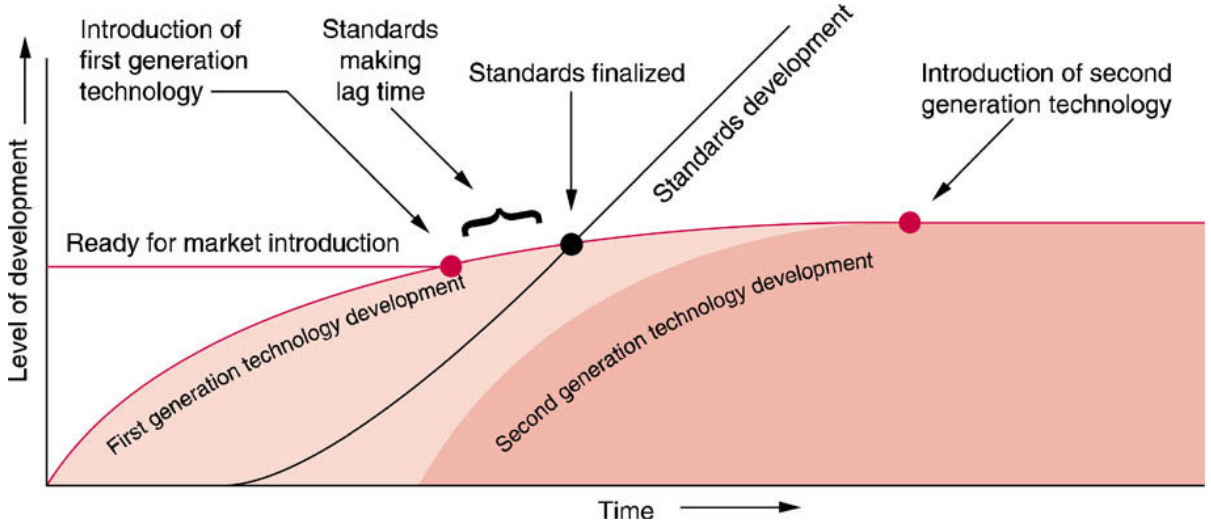
- **LATA's do not correspond to area codes**

RBOC's at the time of the AT&T breakup (pre-1996)



- How does this differ from the ownership and control structure that exists today?

Technology and Standards Development



- The development of a standard generally lags the development of the technology.

Telecommunications Act of 1996

- Sought to encourage competition in all aspects and markets of telecommunications services including:
  - Switched and dedicated local and inter-lata traffic,
  - Cable TV
  - And wireless services such as paging, cellular, and satellite services.
- Directs the FCC to produce the rules that will allow LECs and IXCs to compete in each other's markets

The Importance of Standards

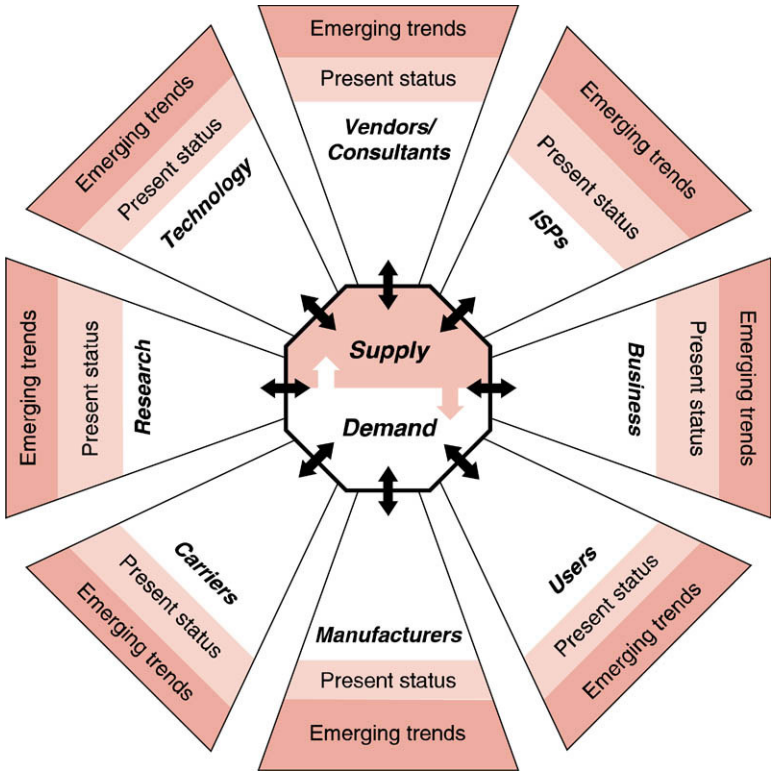
- Without standards, data communications would be nearly impossible
  - End-users can be confident that devices will operate as specified and will interoperate successfully.
- **Standards** allow multiple vendors to manufacture competing products that work together effectively.
  - Standards can have a tremendous potential economic impact on vendors

The Standards Process

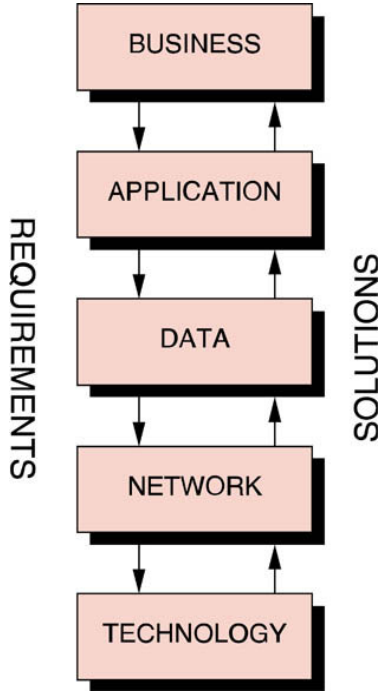
1. Recognition of the need for a standard
2. Formation of some type of committee or task force
3. Information/recommendation gathering phase
4. Tentative/alternative standards issued
5. Feedback on tentative/alternative standards
6. Final standards issued
7. Compliance with final standards

Standards may be imposed by a regulatory agency or they may be ad hoc.

Driving Forces in the Datacomm Industry



The Top-Down Approach



- Business needs drive solutions.

The OSI Model *One*

- Open systems interconnection (OSI) network reference model.

  http://en.wikipedia.org/wiki/OSI_model

- **OSI Model** consists of a hierarchy of 7 layers that loosely group the functional requirements for communication between two computing devices.

The OSI Model *Two*

- OSI Model, officially known as ISO Standard 7489, is open and flexible.
- Used to organize and define protocols involved in communicating between two computing devices.
- Reference telecommunications model

Protocols

- A **protocol** is a set of rules that govern communication between hardware and/or software components.
- There are many well known as well as a few obscure protocols used in telecommunications.

Internet Protocol TCP/IP

http://en.wikipedia.org/wiki/TCP/IP

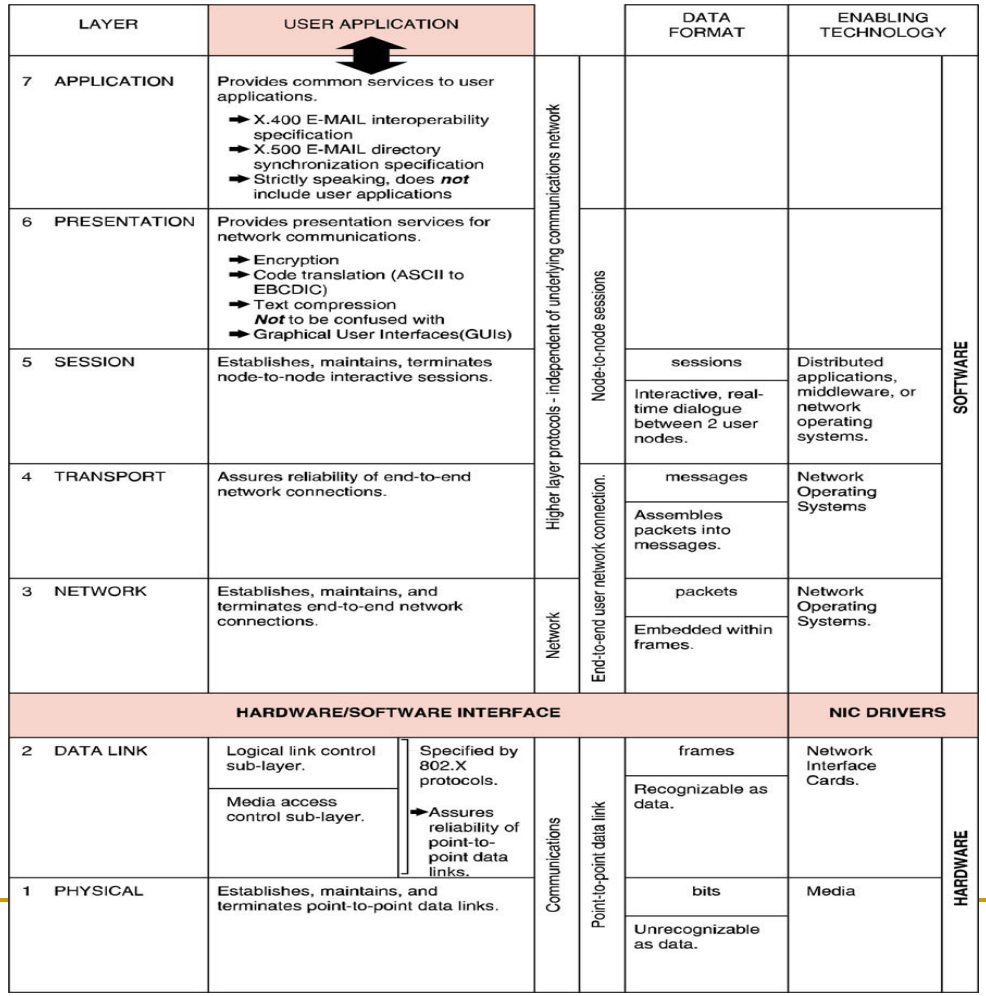
Understand that

- TCP/IP predates the ISO/OSI Model
- ISO/OSI model is not an implementation
- What you actually use is TCP/IP

Note

- *While there are other protocols that you may encounter on a LAN or other private network, most people will never encounter anything other than TCP/IP.*

OSI Model Overview



LAYER	USER APPLICATION			DATA FORMAT	ENABLING TECHNOLOGY	
7 APPLICATION	Provides common services to user applications. ➡ X.400 E-MAIL interoperability specification ➡ X.500 E-MAIL directory synchronization specification ➡ Strictly speaking, does ***not*** include user applications	Higher layer protocols - independent of underlying communications network				SOFTWARE
6 PRESENTATION	Provides presentation services for network communications. ➡ Encryption ➡ Code translation (ASCII to EBCDIC) ➡ Text compression ***Not*** to be confused with ➡ Graphical User Interfaces(GUIs)		Node-to-node sessions			
5 SESSION	Establishes, maintains, terminates node-to-node interactive sessions.			sessions Interactive, real-time dialogue between 2 user nodes.	Distributed applications, middleware, or network operating systems.	
4 TRANSPORT	Assures reliability of end-to-end network connections.		End-to-end user network connection.	messages Assembles packets into messages.	Network Operating Systems	
3 NETWORK	Establishes, maintains, and terminates end-to-end network connections.	Network		packets Embedded within frames.	Network Operating Systems.	
HARDWARE/SOFTWARE INTERFACE					**NIC DRIVERS**	
2 DATA LINK	Logical link control sub-layer. Media access control sub-layer. Specified by 802.X protocols. ➡ Assures reliability of point-to-point data links.	Communications	Point-to-point data link	frames Recognizable as data.	Network Interface Cards.	HARDWARE
1 PHYSICAL	Establishes, maintains, and terminates point-to-point data links.			bits Unrecognizable as data.	Media	

Mapping the OSI model

Layer	OSI	INTERNET	Data Format	Protocols
7	Application	Application	Messages or Streams	TELNET FTP TFTP SMTP SNMP HTTP
6	Presentation			
5	Session	Transport or Host-Host	Transport Protocol Packets	TCP UDP
4	Transport			
3	Network	Internet	IP Diagrams	IP
2	Data Link	Network Access	Frames	
1	Physical			

- The OSI model maps to the Internet model and corresponding protocols.
  - *Note, that that's datagrams rather than diagrams.*
  - *Change Figure 1-14 in text as well.*

The OSI model

- Network analysts may describe activities in terms of the OSI model i.e. layer 3 device.
- When troubleshooting network problems, the network analyst will first attempt to isolate the problem to a single ISO level
- Another benefit of the OSI model is that it allows discussion about the interconnection of two networks or computers in common terms without dealing in proprietary vendor jargon
  - That is, you equipment doesn't have to have a custom interface with my equipment as long as we can both talk TCP/IP.

Physical Layer

- Establishes, maintains, and terminates physical connections between communicating devices.
- Transmits and receives a stream of bits.
- No data recognition at the physical layer.

Data Link Layer

- Delivers reliable point-to-point connections
- Organizes the bit stream into structured **frames** which add addressing and error checking information.
- Additional information added to the front of data is called a **header,**
- Information added to the back of data is called a **trailer.**
- Data link layer protocols provide error detection, notification, and recovery

Data Link Layer (NIC's)

- Data-link layer frames are built within the **network interface card** installed in a computer according to the pre-determined frame layout
  - Frame layout is particular to the specific network architecture of the installed network interface card.
- Network interface cards are given a unique physical address in a format determined by their network architecture.
- These addresses are usually assigned and pre-programmed by the NIC manufacturer.
  - Along with IEEE

Data Link Layer – Sub Layers

- The IEEE 802 committee views the data-link layer as two sub-layers :

1. **Media access control** or **MAC sub-layer**
   - Interfaces with the physical layer and the LLC
   - Represented by protocols which define how the shared local area network media is to be accessed by the many connected computers
2. **Logical link control** or **LLC sub-layer**
   - Represented by IEEE 802 protocol (IEEE 802.2).
   - Interfaces with the MAC layer and level 3

LLC Sub-Layer

- Offers transparency to the upper layers (network and above)
- Allow the MAC sub-layer protocol to vary independently.
- Allows a given network operating system to run equally well over a variety of different physical network architectures as embodied in network interface cards

Network Layer

- Required when computers that are not physically connected to the same LAN need to communicate.
- Network layer protocols:
  - Provide network layer (end-to-end) addressing schemes and for
  - Enable inter-network routing of network layer data **PDUs.**

Packet Data Units (PDUs)

- The term ‘packets’ is usually associated with a variety of different quantities.
- For example, at the network level PDUs are normally called Datagrams or Packets.
- The term frames is usually associated with data link layer protocols.
  - Messages
  - Datagrams and Segments
  - Datagrams(Packets)
  - Frames
  - Bits
  - *See*:

http://en.wikipedia.org/wiki/OSI_Model#Description_of_layers

Transport Layer

- Can provide reliable end-to-end network layer connections.
- Responsible for end-to-end error recovery and flow control.
- Transport protocols also provide mechanisms for sequentially organizing multiple network layer packets into a coherent **message.**

Session Layer

- Establish, maintain, and terminate sessions between user application programs.
- Sessions are interactive dialogues between networked computers and are of particular importance to distributed computing applications in a client/server environment

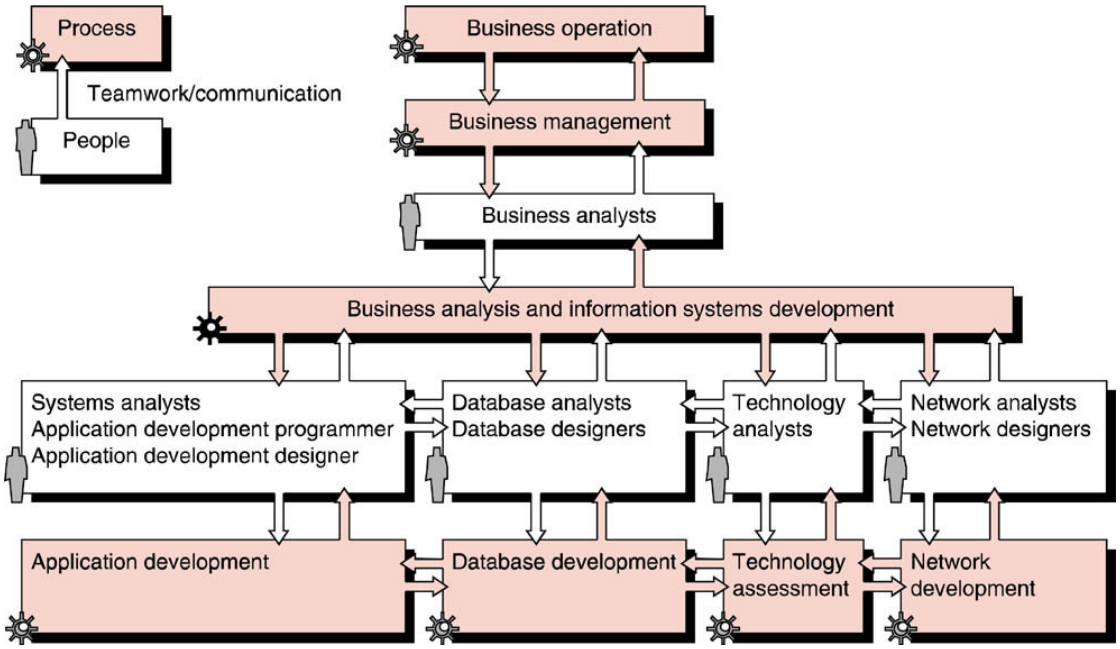
Presentation Layer

- Provide an interface between user applications and various presentation-related services required by those applications.
- Serves as translator
  - Data encryption/decryption protocols are considered presentation layer protocols
  - Protocols that translate between encoding schemes such as ASCII to EBCDIC
  - Compression schemes as well

Application Layer

- Includes utilities and network based services that support end-user application programs.
  - Best examples of application layer protocols are the OSI protocols X.400 and X.500.
- DNS, Domain Name Service, which is an Internet protocol that resolves a computer's common or domain name to a specific IP address, is also considered an application layer protocol

The Top-Down Approach to Information Systems Development



- Networking and Telecomm in the ISD context.

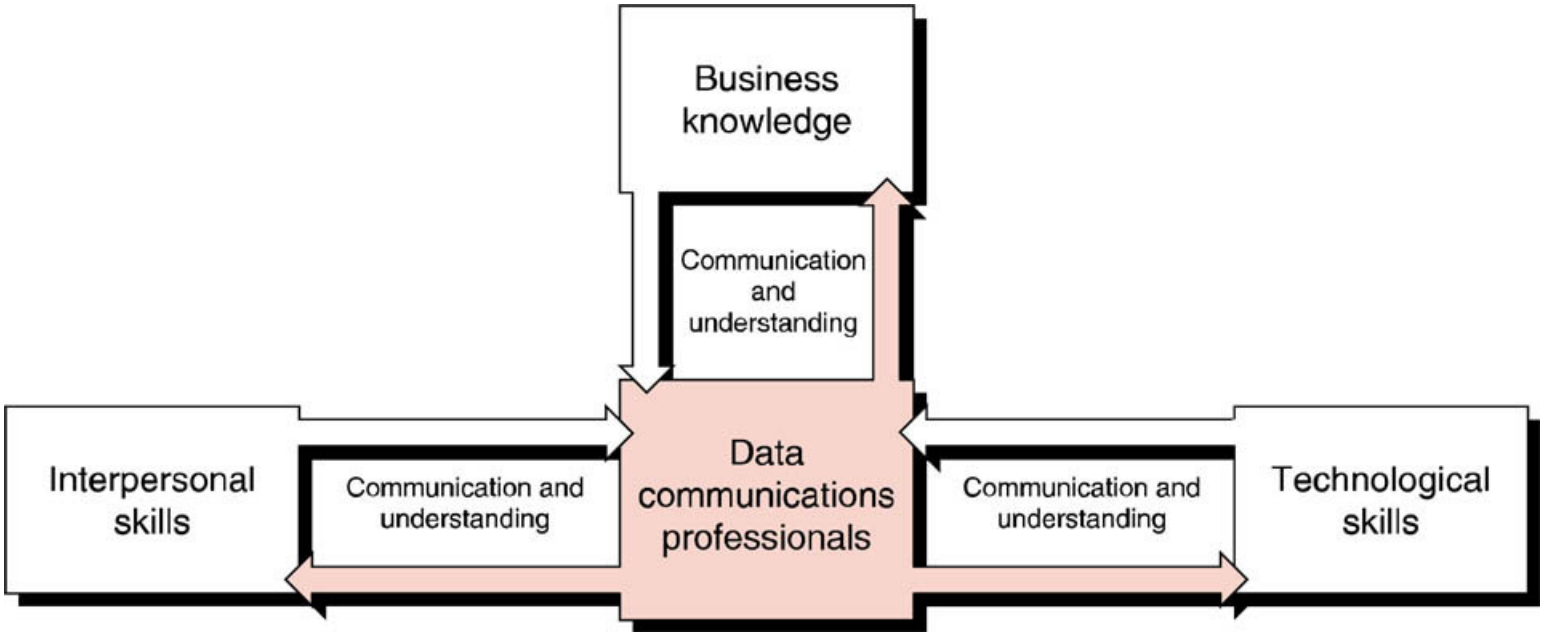
Certification

- Certification as an indication of a level of competency with a particular technology.
  - May be important in some employment situations.
  - Value is relative to the perceiver
- There are a number of well known certifications.

Certification Concerns

- The amount of practical, hands-on experience required to earn a given certification.
- The amount of continuing education and experience required to retain a certification.
- Vendor-specific certifications do not provide the broad background required for today's multivendor internetworks.

Critical Skills for Data Communications Professionals



Critical Skills for Data Communications Professionals

- Understand and can speak “business.”
- Demonstrate an ability to own and solve business problems in a partnership rather than consultative role.
- Demonstrate an ability to look outside their own expertise for solutions.
- Exhibit an understanding of the need for lifelong learning.

Critical Skills for Data Communications Professionals

- Demonstrate an ability to evaluate technology with a critical eye as to cost/benefit and potential for significant business impact.
- Understand comparative value and proper application of available network services
- Can work effectively with carriers to see that implementations are completed properly and cost effectively.
- Communicate effectively, verbally and orally, with both technically oriented and management personnel.

Critical Skills for Data Communications Professionals

- Observe
- Analyze
  - Create appropriate problem statement
  - Implement appropriate solution
- Communicate
- Understand technology
- Understand organizational science
- Apply technology to organizational process

Questions?