
The Evolution of the Communications Network #3

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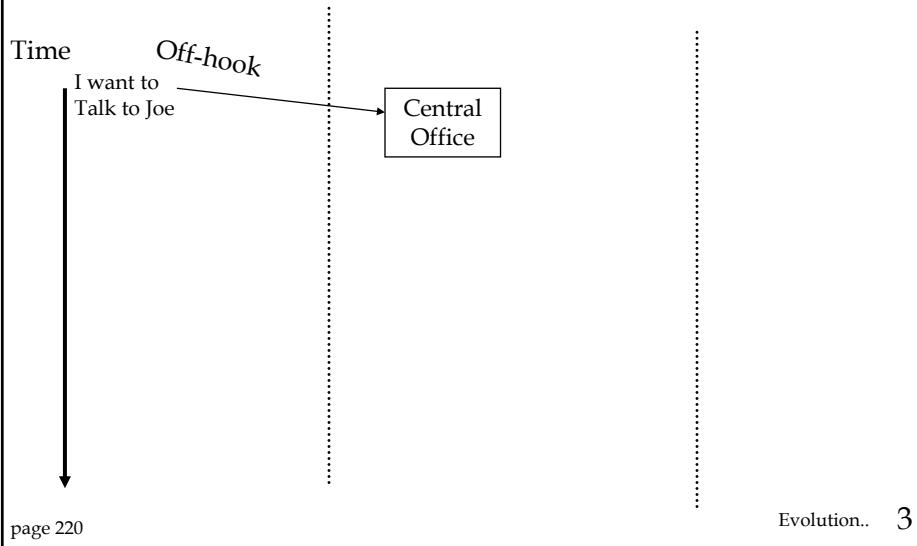
Evolution.. 1

The Evolution of the Communications Network

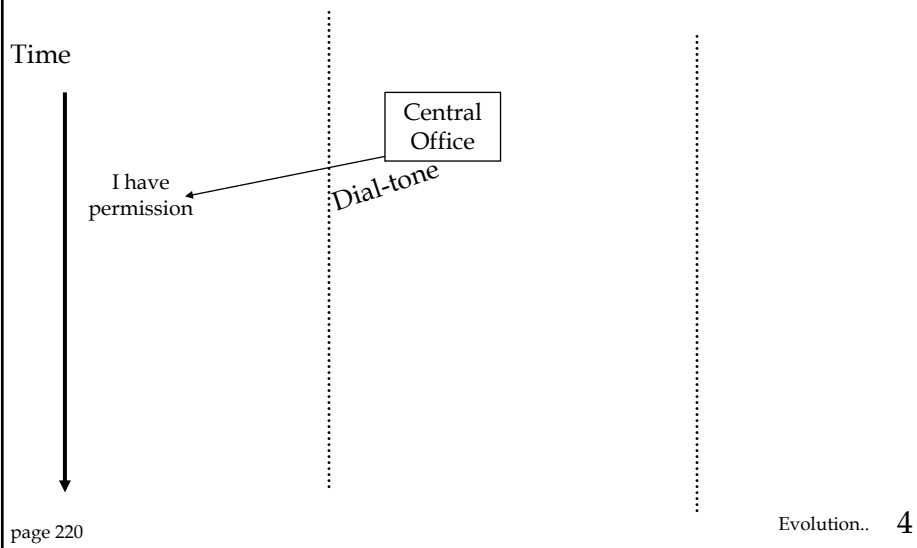
- What makes communication systems work.
- How the network evolved
- How network provided more services for less cost
- Predict where technology is going and the impact of future services.

Evolution.. 2

Elements of Communications

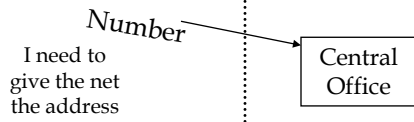


Elements of Communications



Elements of Communications

Time

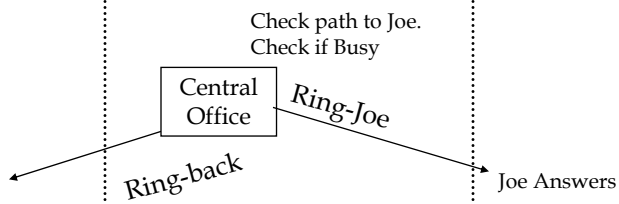


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Evolution.. 5

Elements of Communications

Time



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Evolution.. 6

Elements of Communications

Time



Talk to "hello"

Central Office

Joe Answers
"hello"

page 220

Evolution.. 7

Elements of Communications

Time



I hang up

"hang-up"

Central Office

"hang-up"

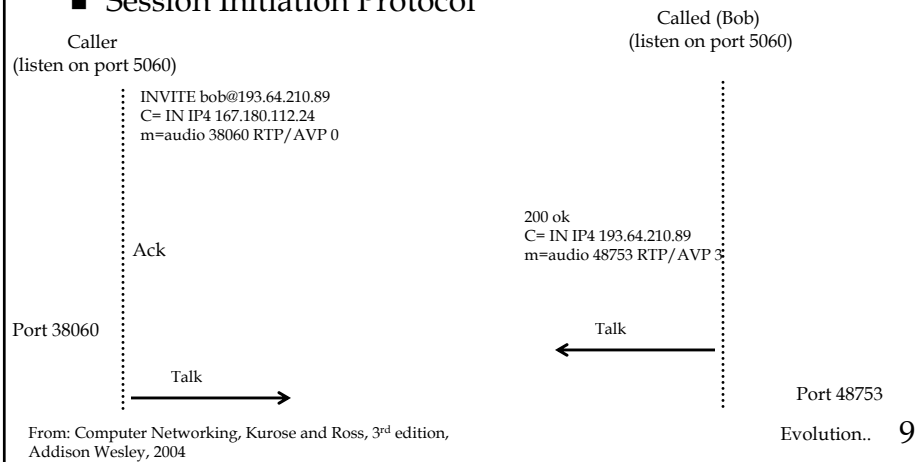
Joe Hangs up

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Evolution.. 8

Voice over IP (VoIP)

- One signaling protocol for VoIP is SIP
- Session Initiation Protocol

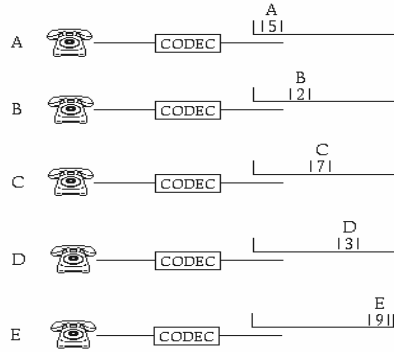


Elements of a Communications System

- Transmission
- Switching
- Signaling

TDM

Time Division Multiplexing



Time Division Multiplexed Signal

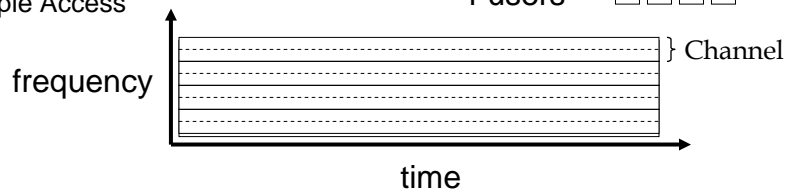
A	B	C	D	E	A	B	C	D	E
5	2	7	3	9	6	1	8	2	10

Circuit Switching: FDMA and TDMA

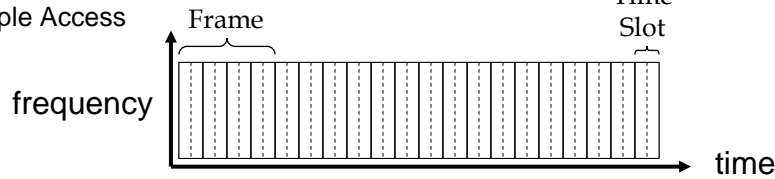
FDMA= Frequency Division Multiple Access

Example:

4 users



TDMA= Time Division Multiple Access

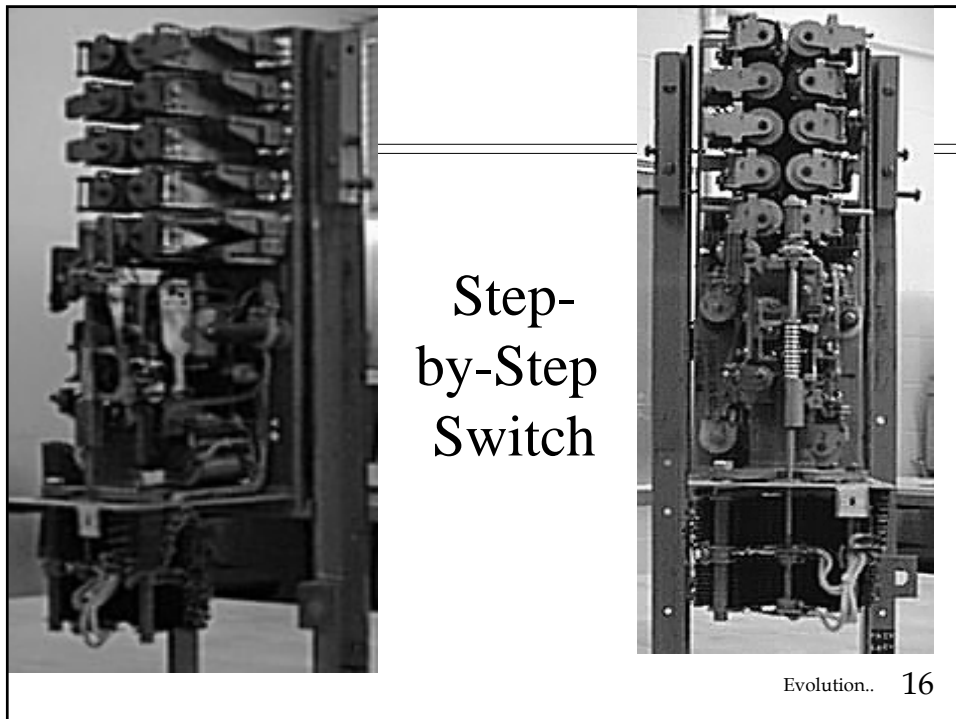


Modified from: *Computer Networking: A Top Down Approach Featuring the Internet*, 2nd edition. Jim Kurose, Keith Ross Addison-Wesley, July 2002.

Switching

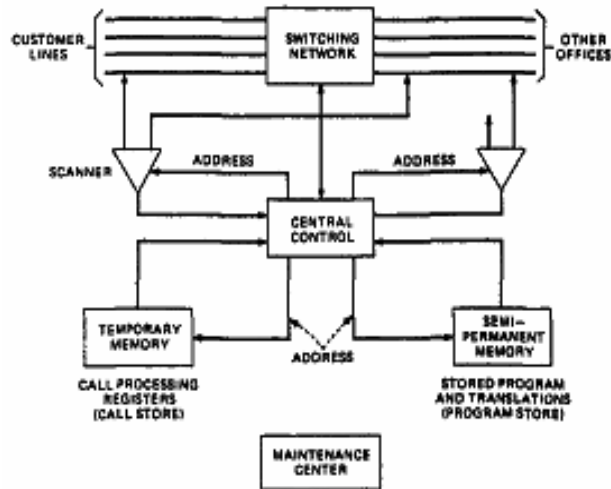
- Manual
- Step-by-step
- Crossbar with stored program control
- Digital Switching
- Packet Switching
- Optical Switching

Evolution.. 15



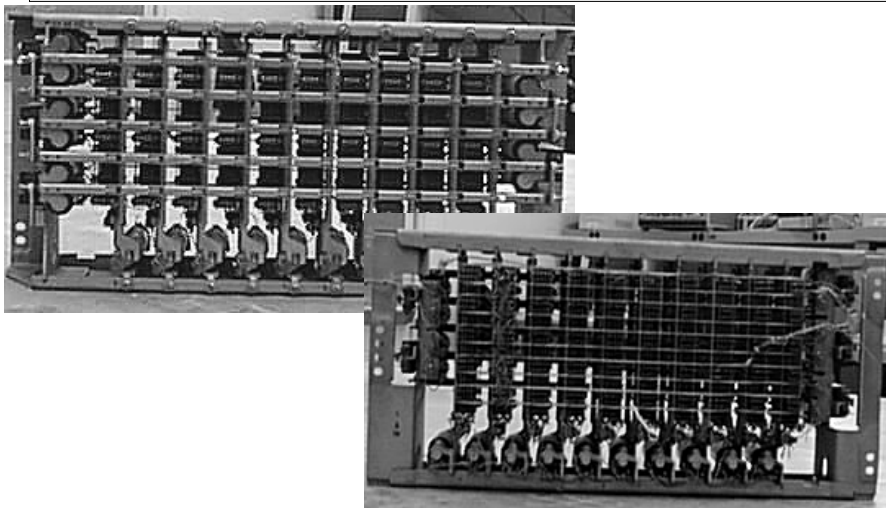
Stored Program Control System

(from *Engineering Operations in the Bell System*)



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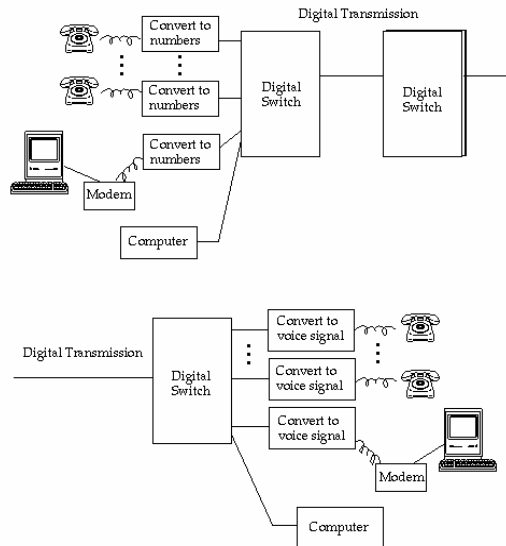
Crossbar Switch



Evolution.. 18

Digital Switching

Switching (cont.)



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Packet Switching

- Existing switching methods allow connections at discrete information transfer rates, e.g., 64 Kb/s, or 1.544 Mb/s
- Customers "will demand" dynamic allocation of bandwidth
- Packet switching will provide dynamic allocation of bandwidth
- One infrastructure for voice, data, video
- VoIP and Video over IP

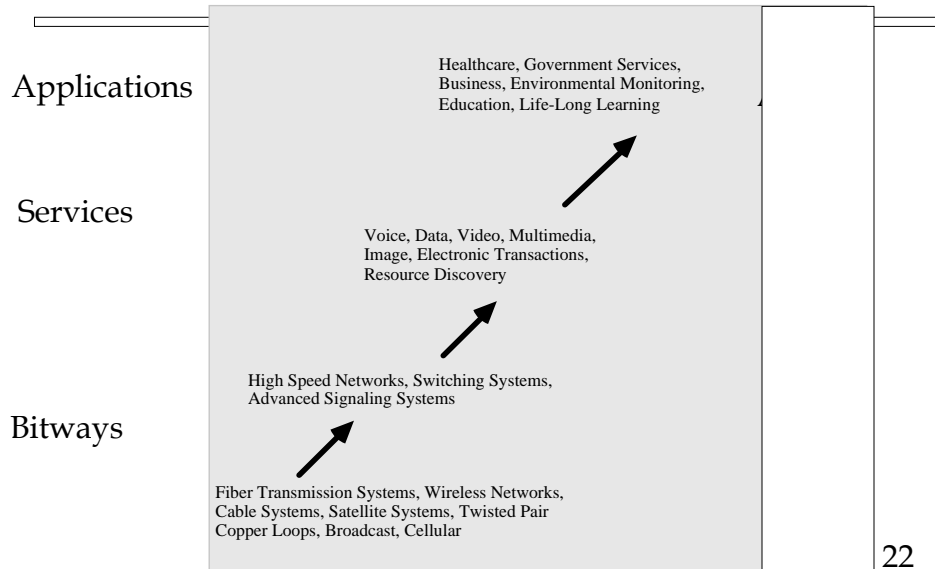
Evolution.. 20

Packet Switching

- Internet Protocol (IP)
 - Longer variable length packets
 - Deployed to the desktop
- Asynchronous Transfer Mode (ATM)
 - Short fixed length packets called **cells**
 - Deployed in Backbone Networks
- Packet switching leads to the potential integration of all services on one infrastructure

Evolution.. 21

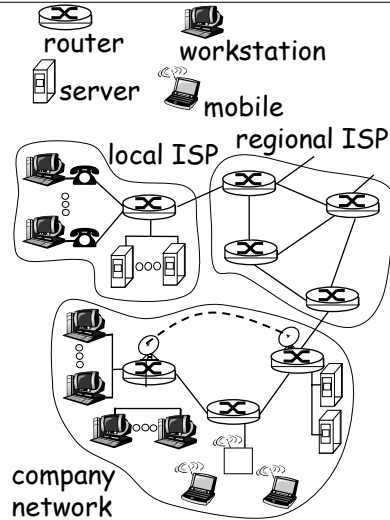
Integration → Architecture of the Global Information Infrastructure



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What's the Internet: "nuts and bolts" view: how do packet flow over the internet

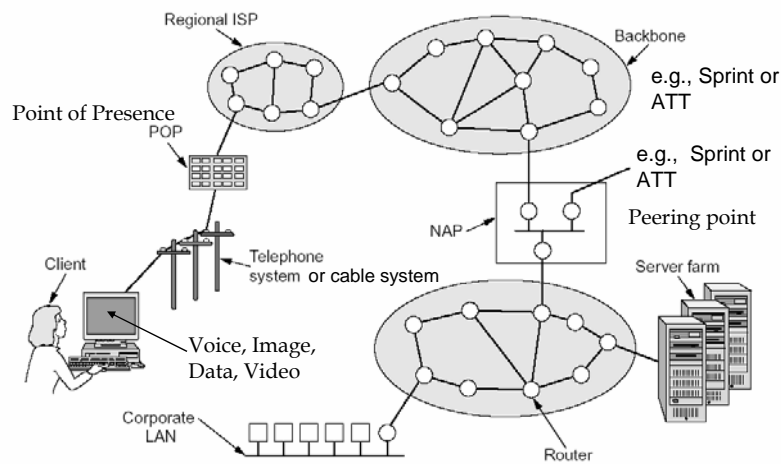
- millions of connected computing devices: *hosts, end-systems*
 - PCs workstations, servers
 - PDAs phones, toasters
- *running network apps*
- *communication links*
 - fiber, copper, radio, satellite
 - transmission rate = bits/sec
Some times called *bandwidth*
- *routers: forward packets (chunks of data)*



From: *Computer Networking: A Top Down Approach Featuring the Internet*, 2nd edition. Jim Kurose, Keith Ross Addison-Wesley, July 2002.

Evolution.. 23

Architecture of the Internet

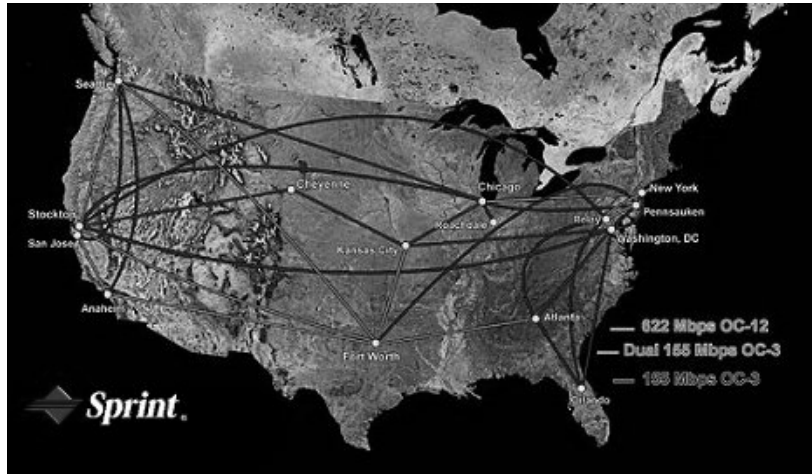


Modified from: *Computer Networks*, A. S. Tannenbaum, 4th Ed, Prentice Hall, 2003

Evolution.. 24

Tier-1 ISP: e.g., Sprint

Sprint US backbone network-Fiber map

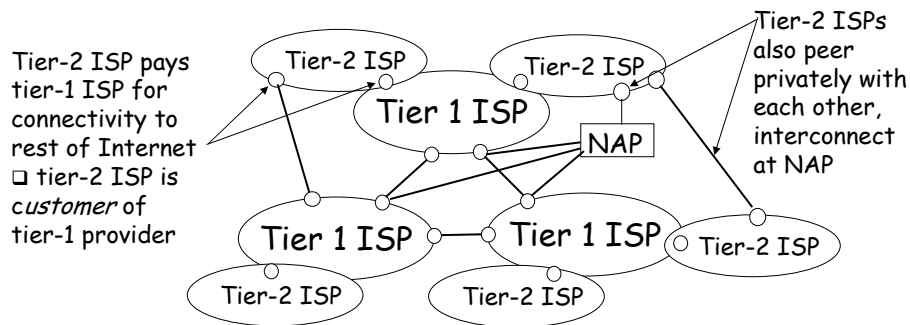


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Evolution.. 25

Internet structure: network of networks

- “Tier-2” ISPs: smaller (often regional) ISPs
 - Connect to one or more tier-1 ISPs, possibly other tier-2 ISPs

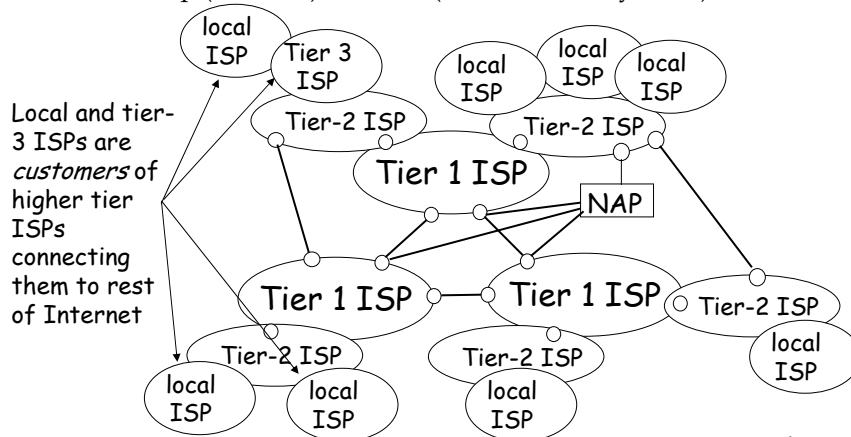


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Evolution.. 26

Internet structure: network of networks

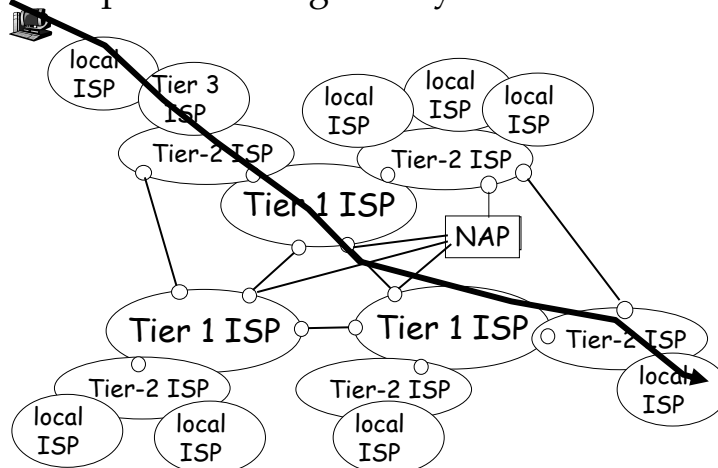
- “Tier-3” ISPs and local ISPs
 - last hop (“access”) network (closest to end systems)



Evolution.. 27

Internet structure: network of networks

- a packet passes through many networks!



Evolution.. 28

Optical Switching

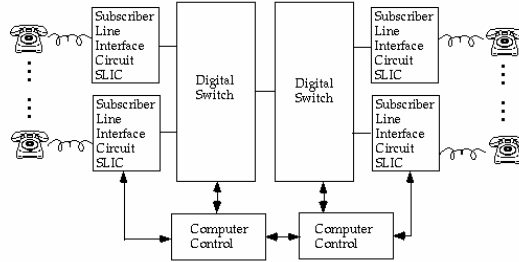
- All current switches are electronic
- Current switches require photon-to-electron conversions (optical to electronic (E/O)) interfaces
- Optical switching will eliminate these interfaces
 - Faster
 - Cheaper

Signaling

- Pulses --> In the same transmission path as voice signal
- Tones --> In the same transmission path as voice signal
- Computer Messages --> Outside of the transmission path.
 - Common Channel interoffice signaling (CCIS)
 - Signaling System #7, (SS7)
 - SIP
 - H.323
 - Others.....

Signaling (cont.)

Common Channel Signaling



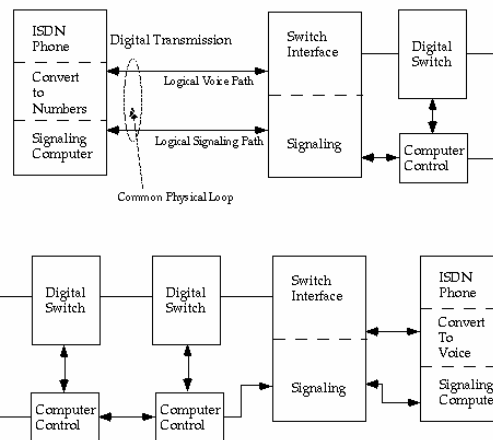
Enhanced Services from Digital Switching and CCIS

- 800
- 900
- Intelligent Network
- Caller Identification
- Speed Dialing
- Voice Mail
- Switched Data Services
- Call Forwarding
- Conference Calling
- Automatic Callback

Evolution.. 31

Signaling (cont.)

Integrated Services Digital Network (ISDN)



Evolution.. 32

Survivability

■ FIBER CUT

- Jan., 4, 1991 - New York metro area
 - 6 million homes without long-distance service
 - New York Mercantile Exchange and New York Commodity Exchange shut down
 - Fiber cuts are common

■ Survivability - SS7 FAILURE

- June, 10, 1991 - California 2 million homes without phone service
- June, 26, 1991 - Baltimore-10 million homes in 4 states without service & U.S. government phones affected

■ Survivability-SWITCH and POWER FAILURE

- September, 17, 1991 - New York metro area
 - 2 million homes without long-distance service
 - 3 major New York airports close for 6 hours