Telecom Technology for the 21st Century

Lawrence Rabiner

Rutgers University and the University of California at Santa Barbara

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Key Technology Directions

	20th Century	21st Century
• New Access	narrowband voice	broadband multimedia
• New Network	circuit-switched	packet switched (IP)
• New Traffic Engineering	circuit traffic model	packet traffic model
• New Platforms	intelligent network elements	distributed network intelligence
• New Operations	people-oriented	self-provisioning, web-based billing, web-based customer care, automated testing
• New Devices	telephone, computer	universal communicator (anywhere, anytime)
• New Services	voice, data	communication, messaging, find, help, sell, entertain, control, store, community

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Broadband Initiatives

- ***Infrastructure:***
  - **provide broadband access everywhere (at home, on the road, in the office) and for the business enterprise**
  - **build next generation IP network to efficiently and reliably handle broadband traffic volumes and advanced services**
- ***Operations:***
  - **provide capability to automatically manage customers, end-to-end networks, and services**
  - **real time data publishing, billing, provisioning, order tracking, customized service, on-demand service**
- ***Services:***
  - **platform capabilities for service creation, content distribution, service management**
  - **new and enhanced services for business, consumer, wireless**

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Cost Issues with Network

Network Cost Structure

$ Cost / Minute

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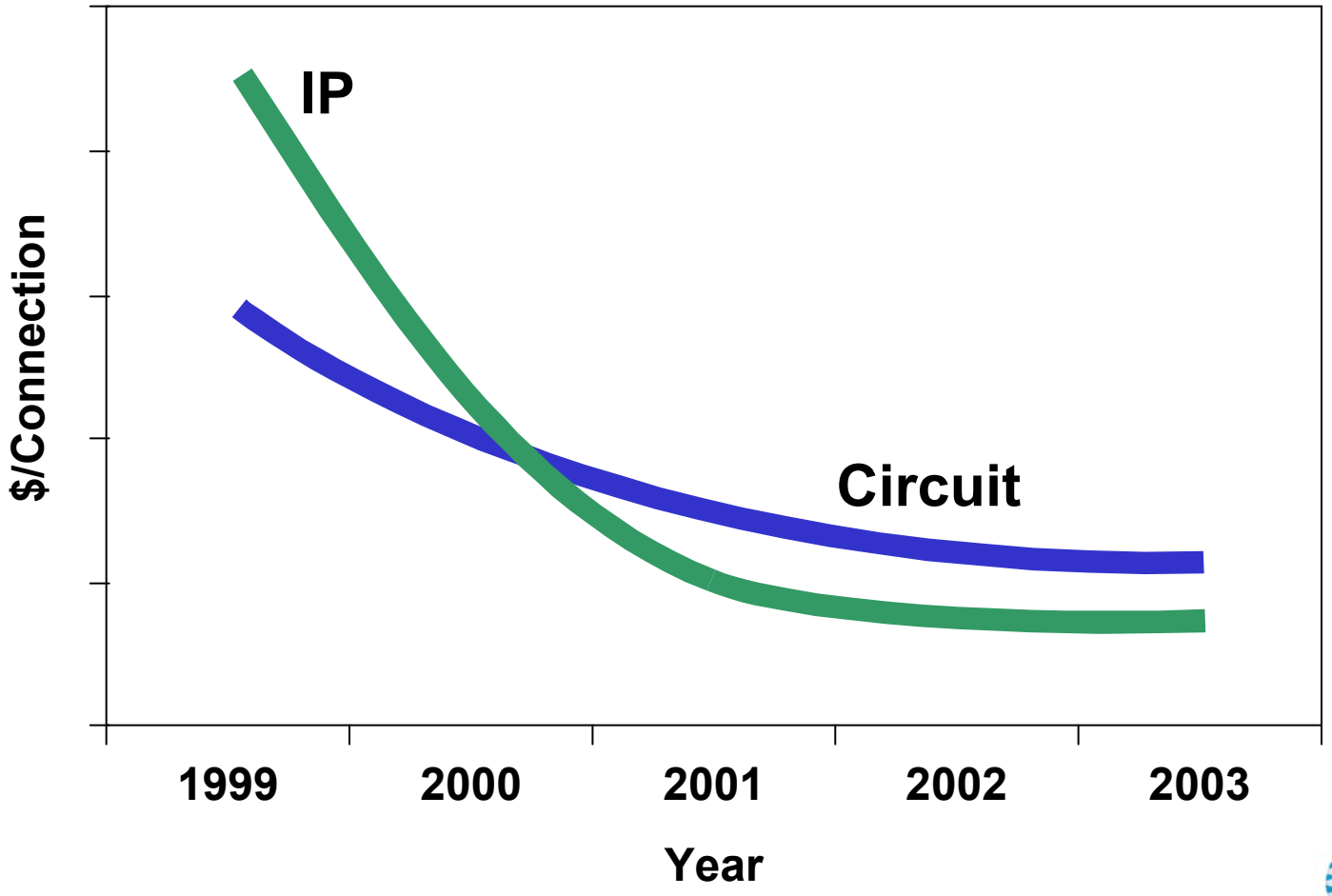
Circuit vs. IP Cost Trajectory



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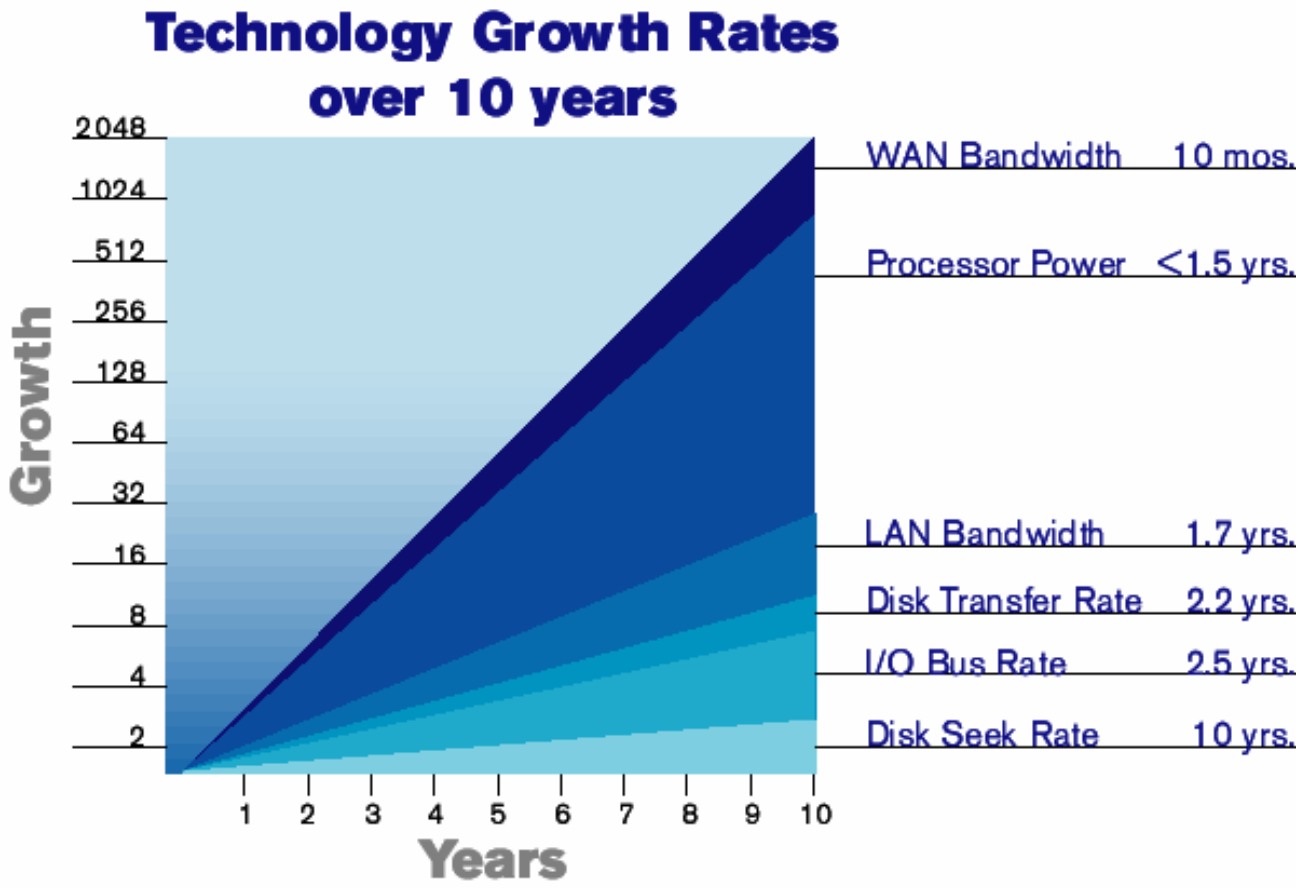
Effects of Moore's Law (and Beyond)

Where is Technology Taking Us? Growth!



Transport, Switching/Routing Moving from Electronics to Optics

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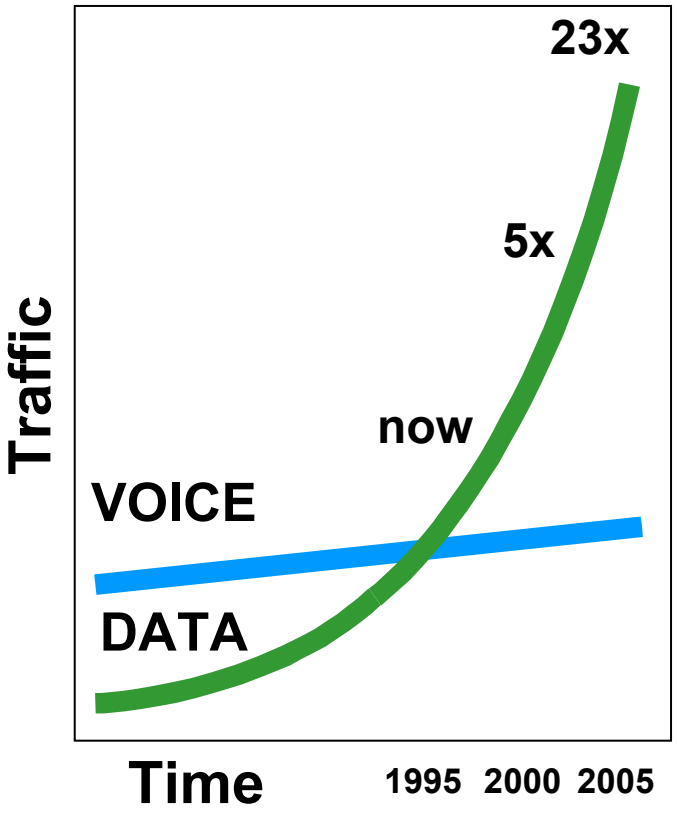
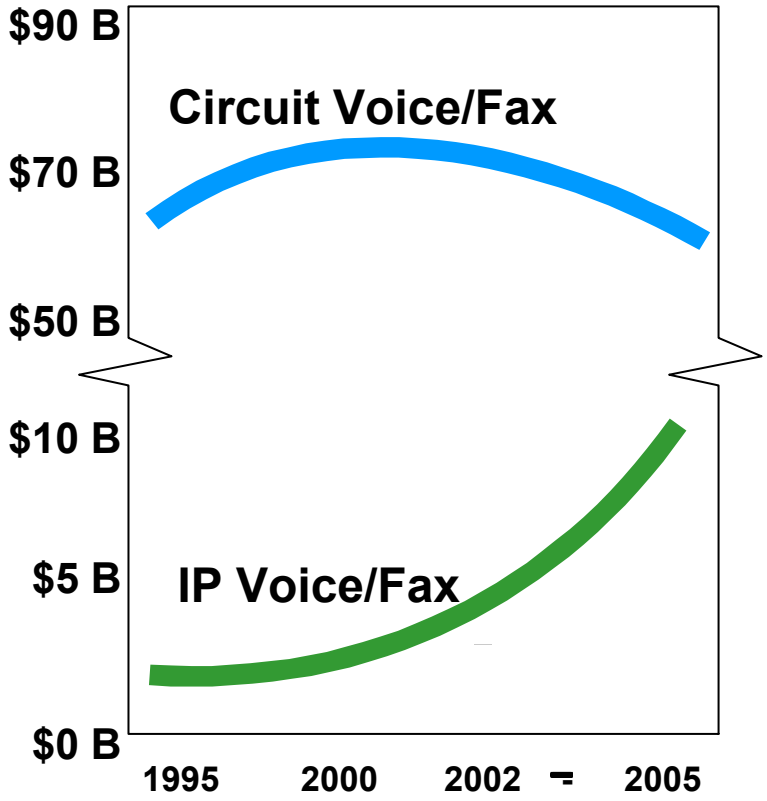
Growth in Voice and Data

Driving Forces - The Internet Explosion

Voice & Data Traffic Growth

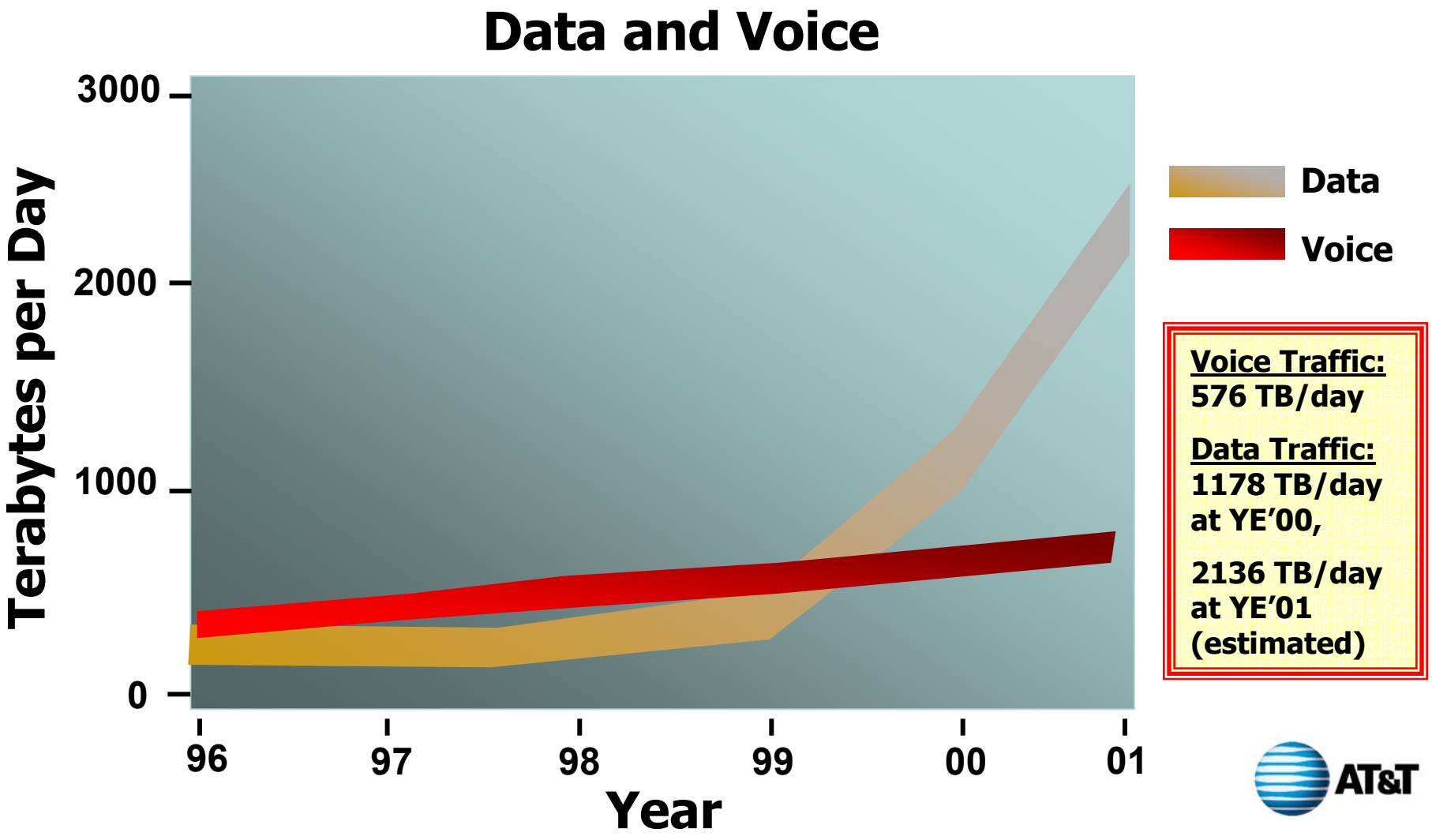


Circuit & IP Voice/Fax Revenue Growth



Source: Probe Research

Growth in Network Traffic



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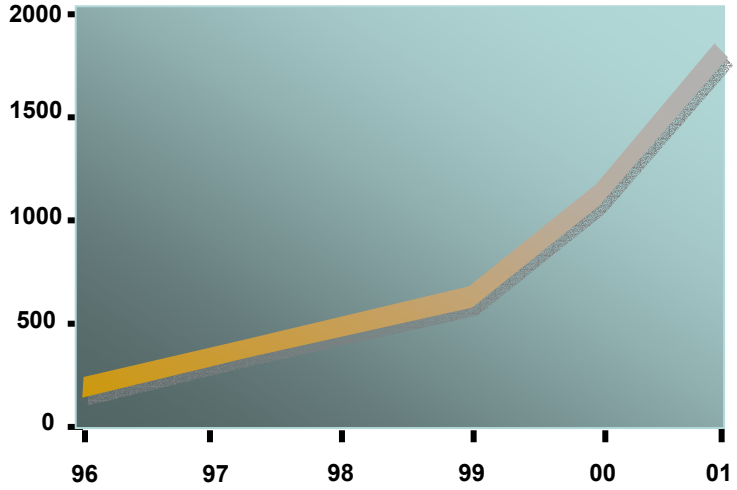
AT&T Network Services
Terabytes of Demand

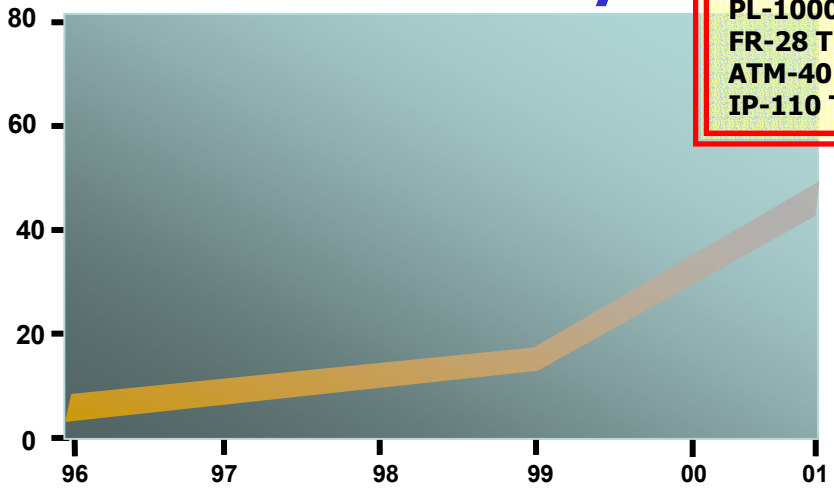
YE'00: 1178 TB/day

YE'01: 2136 TB/day

Private Line

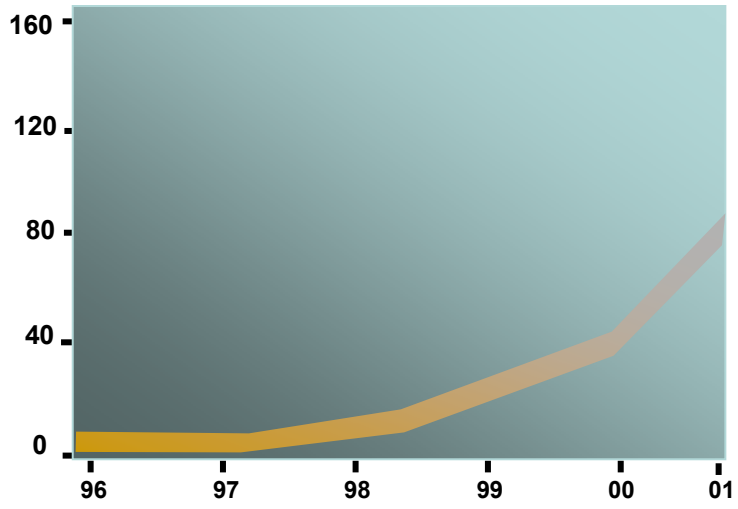


Frame Relay

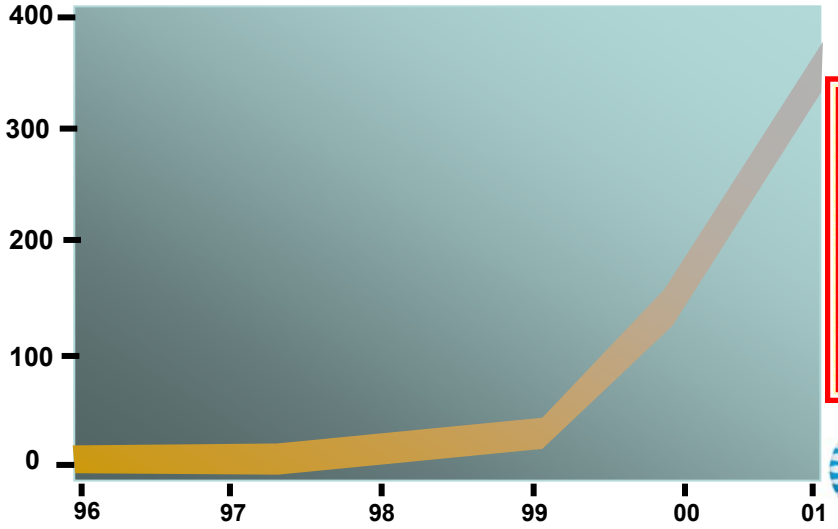


YE 2000:
PL-1000 TB/day
FR-28 TB/day
ATM-40 TB/day
IP-110 TB/day

ATM



Internet / IP



CAGR:

PL-67%

FR-50%

ATM-100%

IP-214%

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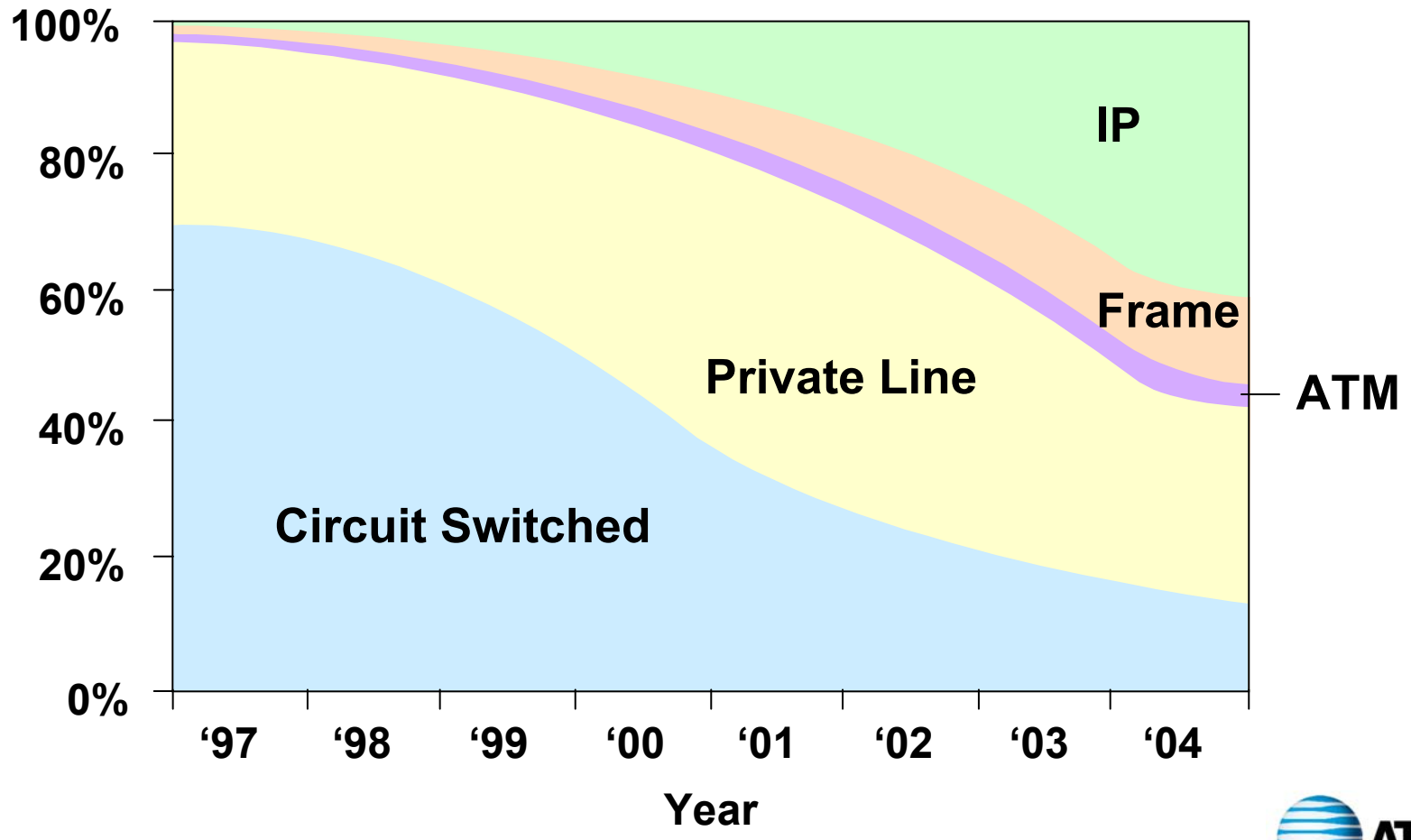
AT&T's Daily Traffic Load



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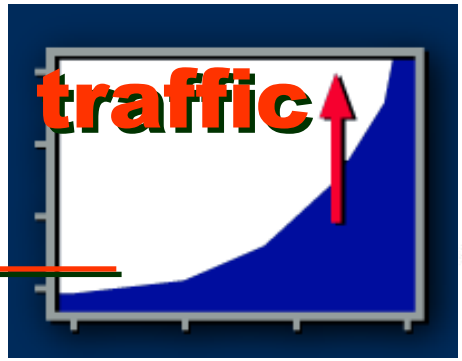
Impact of the Internet on the Network

The Internet Explosion (5/2002)

2,000,000,000 **Web Pages**

Internet Hosts **150,000,000**

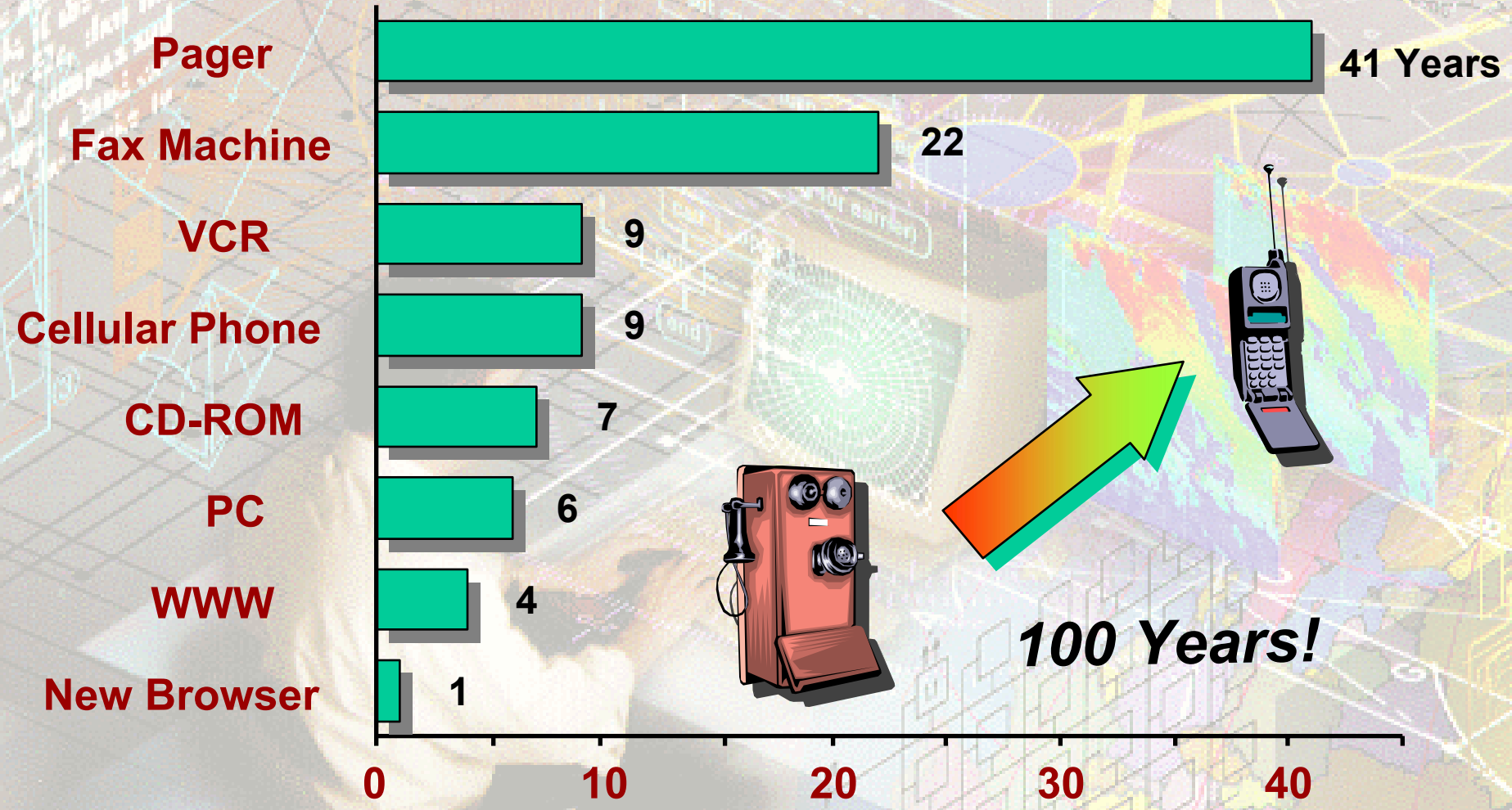
500,000,000 **Worldwide Users**



CAGR since 1998 **100%**

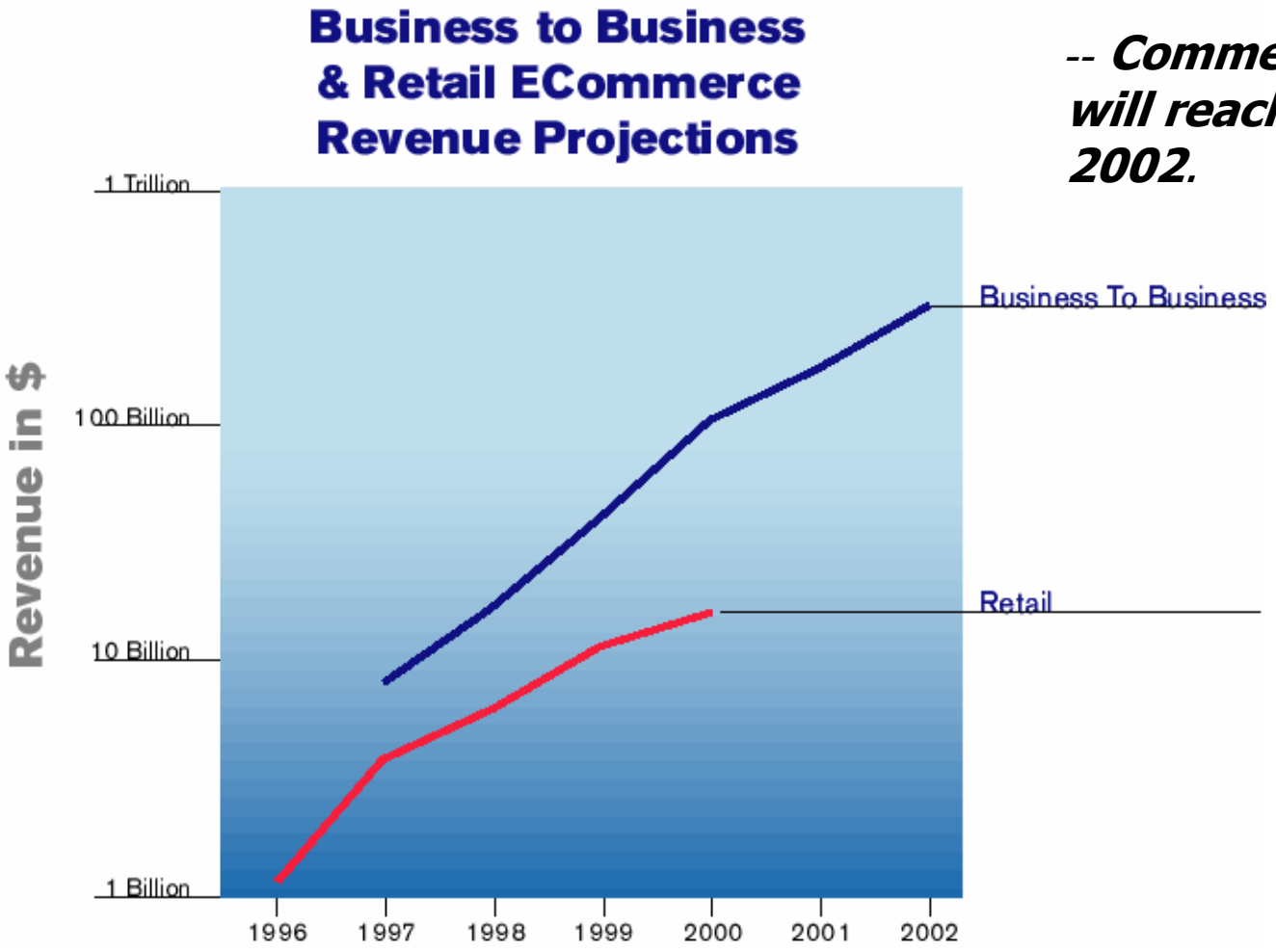
Decreasing Technology Adoption Rates

Time To Reach 10 Million Customers



Sources: Apple, AirTouch Cellular, Info Tech and USA Today

E-Commerce Revenue



-- Commerce on the Web will reach $350 Billion by 2002.

Source: Forrester Research, BancAmerica Robertson Stephens

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Access Architecture for Home, Business and on the Road

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The Local Access Dilemma

customer premises

how do we

efficiently

connect

The Last Mile

with

Subscribers

?

- ISP
- VPN
- PSTN
- ATM
- FR

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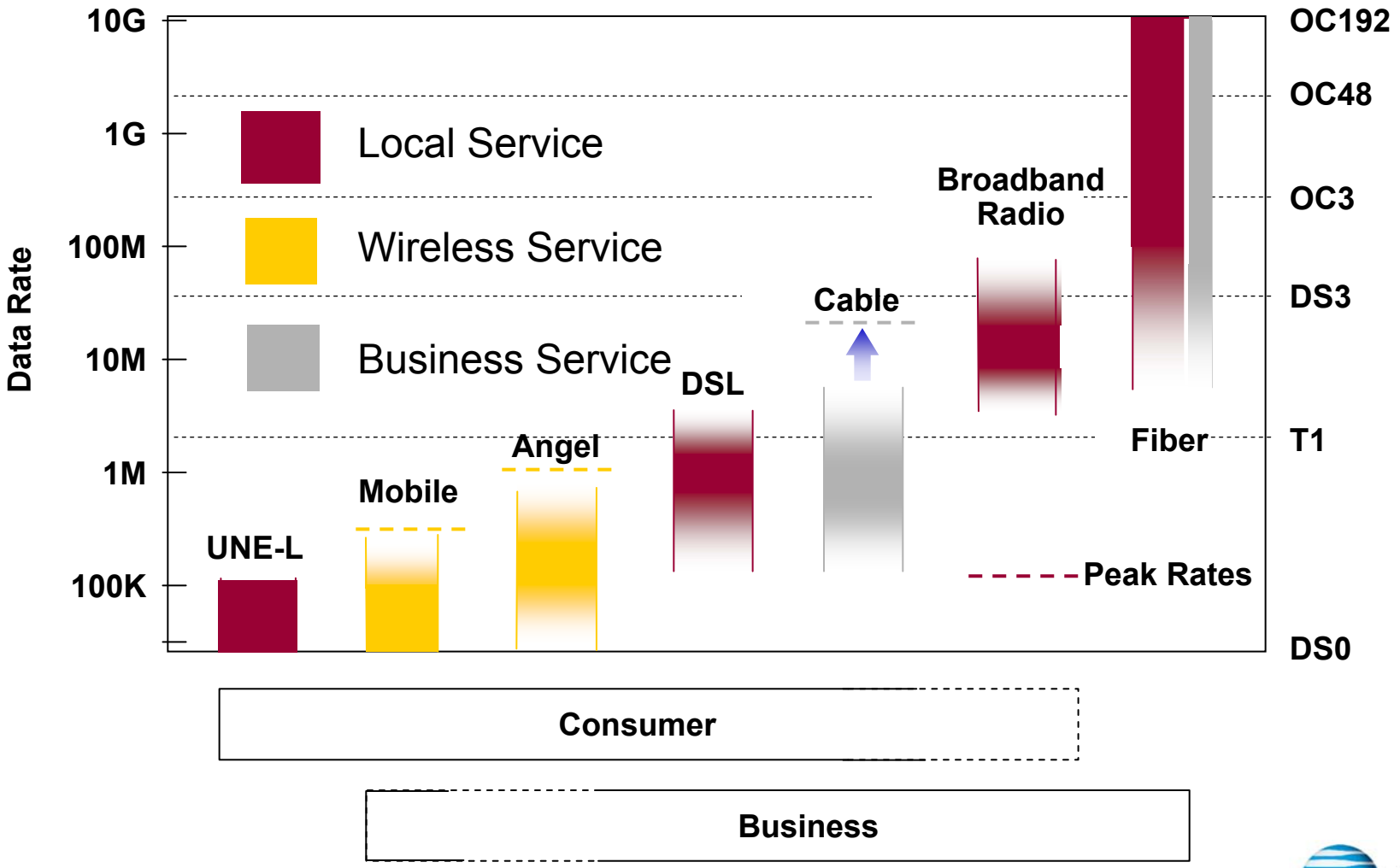
Access Alternatives: Summary



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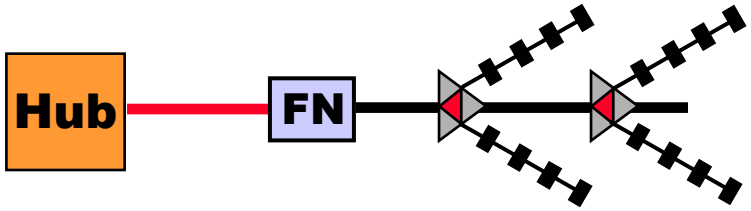
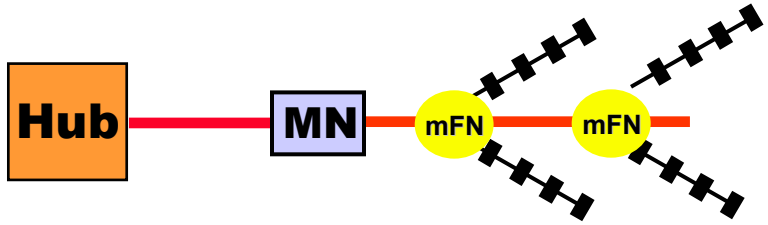
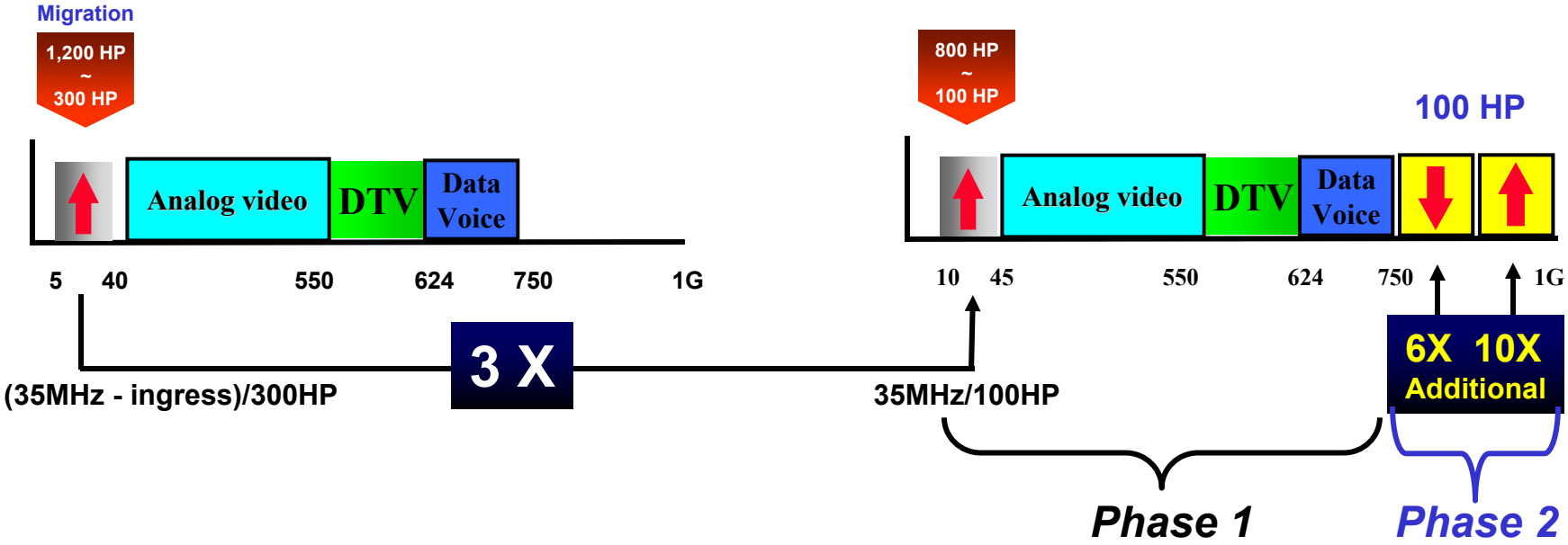
Cable Network Evolution

Conventional HFC



Advanced Cable Network





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Mobile Cellular Wireless: A Short History

	1ST GENERATION UBIQUITY	2ND GENERATION DIGITAL	3RD GENERATION DATA
Time	1980s	1990s	2000s
Technology	Analog	Digital (TDMA,CDMA)	Packet
Services	Voice, Data Modems	Voice, Circuit + Packet Data	Multimedia
Systems	AMPS, TACS …	IS-136, IS-95, GSM, PDC, …	EDGE, W-CDMA, cdma2000, …
Data Rates	10 Kb/s	~ 20 Kb/s	384 Kb/s and higher
Key Issues	***viability***--would cellular work	***coverage and capacity***--would cellular meet demands	***wireless web, location based services***--what data service drives demand

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Wireless Web Services

- *Communication*—voice telephony, video telephony
- *Unified Messaging*—Instant Messaging, Short Message Services, e-mail, chat
- *Video Services*—instant digital photos, live views from video cams, live video support for home/office repairs, movie previews
- *Mobile Commerce*—hotel reservations, car rental, movie tickets, small purchases (Coke machine)
- *Data Services*—horoscopes, comics, animated Pokemon characters, checking flight departure and arrivals
- *Location-Based Services*—directions, find nearest ATM machine, find best traffic route
- *Time Critical Services*—investments, new headlines and stories, business updates
- *Status Monitoring*—alerts and alarms
- *IP Telephony, Video Conferencing, Video Telephony*
- *Streaming Audio and Video*—web radio, web TV, jukebox
- *Games*—find nearest players and join in

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3G Mobile Terminals

Feature Phone

Voice centric design

WAP browser

Bluetooth connectivity

PC Cards

Integrated Handhelds

Data centric design

Voice capability

Video Phone

Unique design concepts

Color camera and screen

Integrated applications

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The Network of the 21st Century

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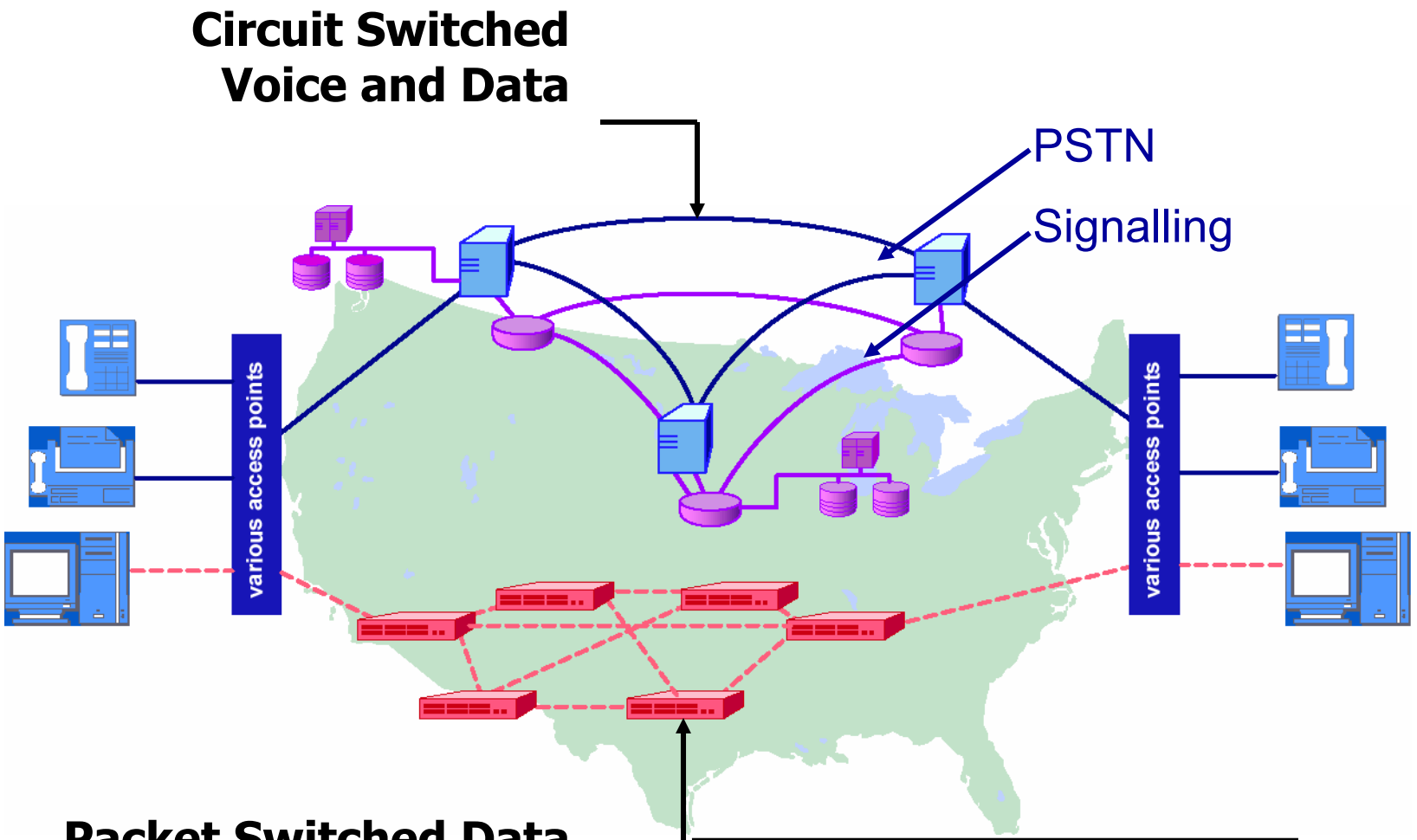
20th Century Network Design



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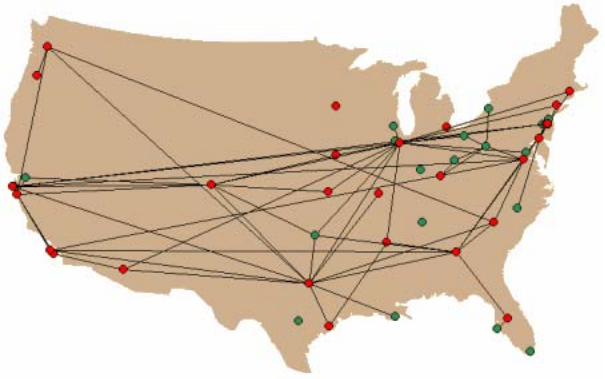
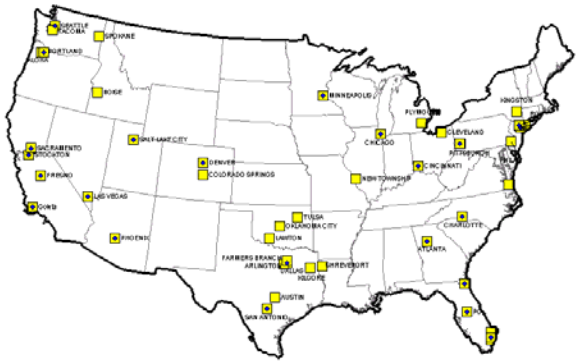
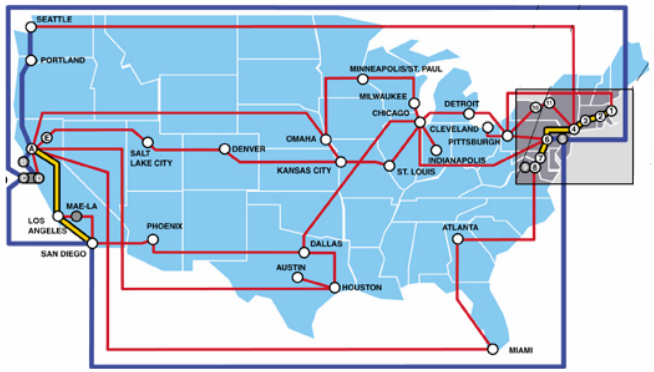
Current Networks (20th Century)



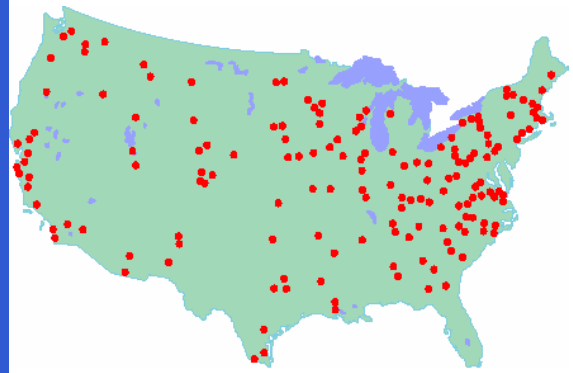
ATM/Frame



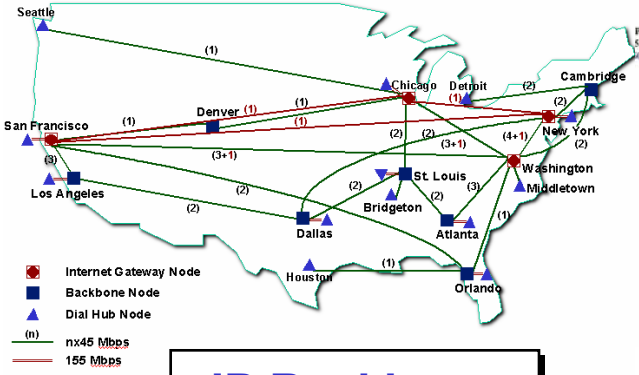
Wireless



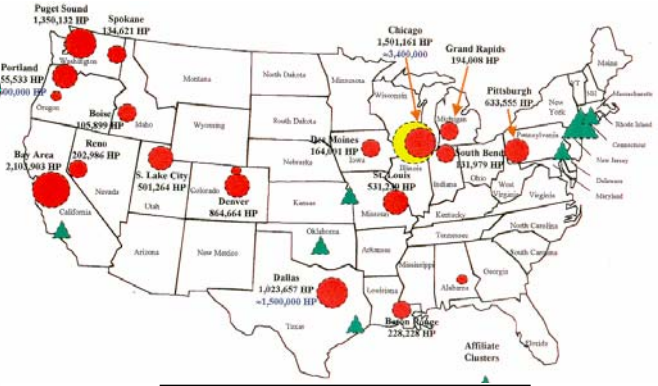
TCG/CERFnet



Voice



IP Backbone



TCI

- integrating backbone layer to merge all networks
- need to integrate OSS for each network and service

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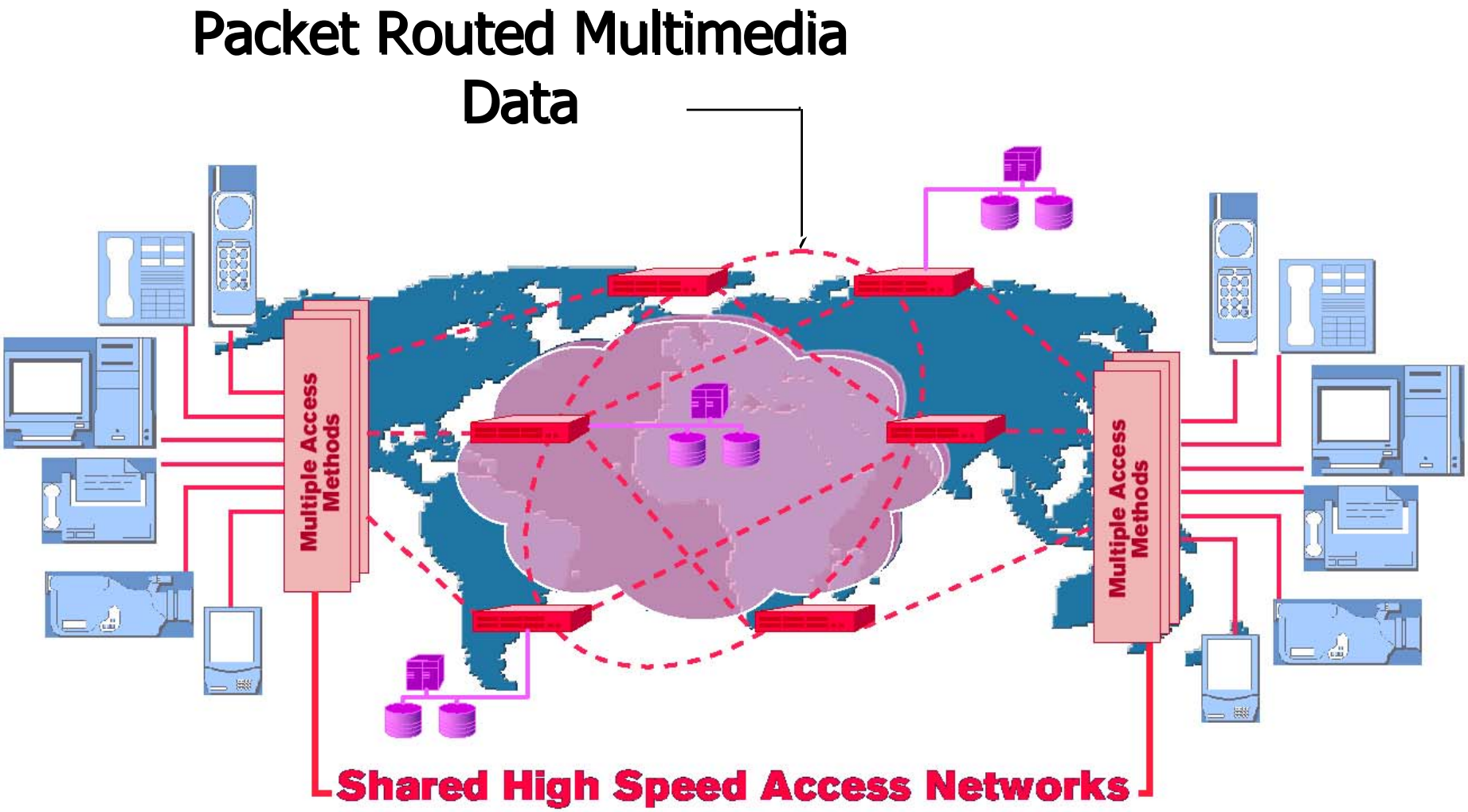
21st Century Network Design



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Network Priorities

- ***Growing the Network***
  - integration of multiple formats, rates, services
  - high speed access/multiple access
  - OTS OC-192/OC-768 backbone transport
  - λ-routers => intelligent optical switching (IP backplane control)
  - web hosting centers
  - Intelligent Content Distribution (ICD)
- ***Improving Reliability and Performance***
  - network scalability => number of endpoints, number of nodes, speed
  - classes of service via DiffServ, IntServ, MPLS
  - QoS => predictable performance (SLA), VPN, traffic classes, admission control
  - policy-based networking, directory-enabled networking (DEN)
  - network traffic engineering => multi-service fractal traffic
- ***Adding Features and Intelligence***
  - IPv6 (bigger address space, class of service, security)
  - PKI, IP-sec, privacy, authentication
  - multicast traffic control
- ***Operating Smarter and More Efficiently***
  - scalable network management tools => BRAVO, netdb, mmdump, Marvel, Minc
  - information model of network => access and view traffic, services, bills
  - process improvements => instant provisioning

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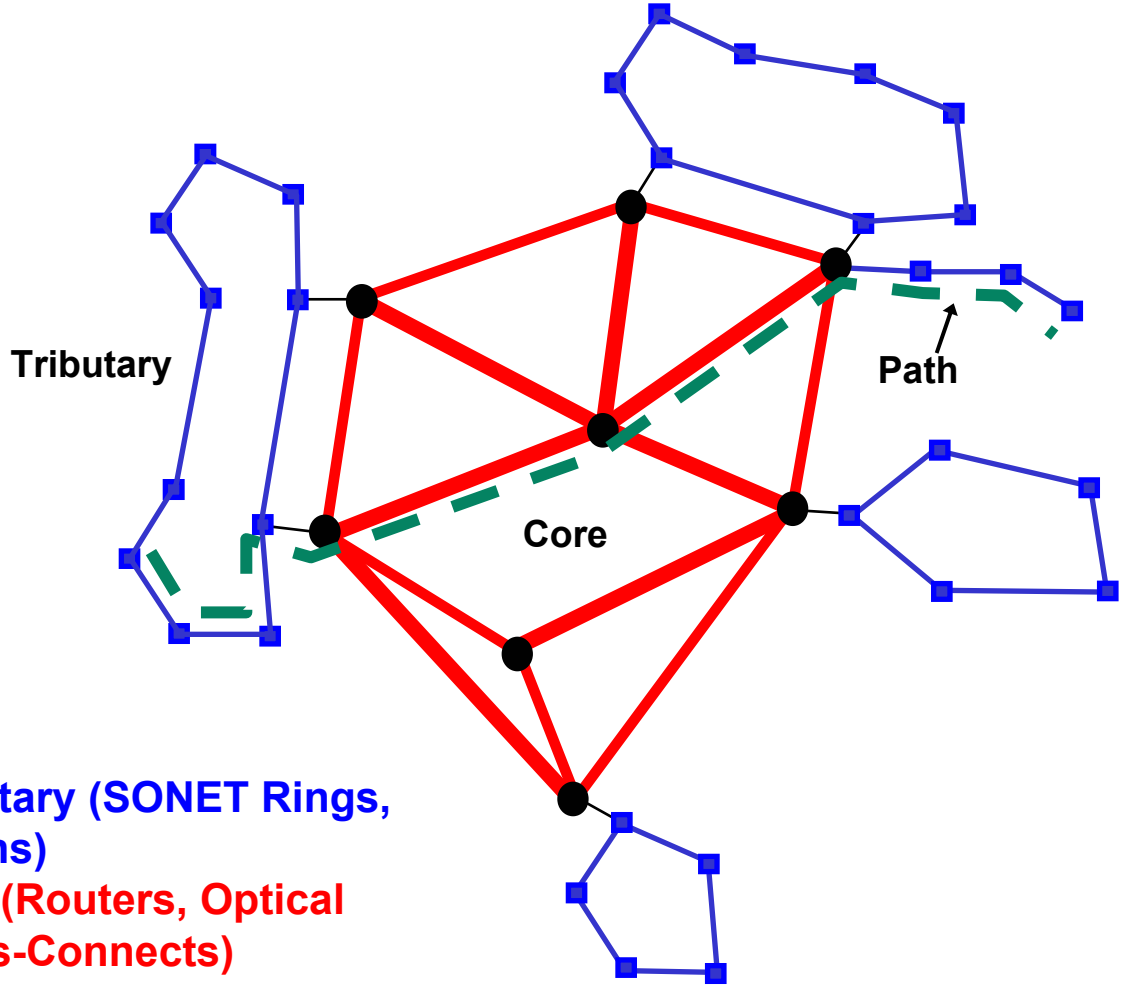
Core/Tributary Baseline Architecture

Core:

124 4E Offices

Tributary:

450 Regional Offices



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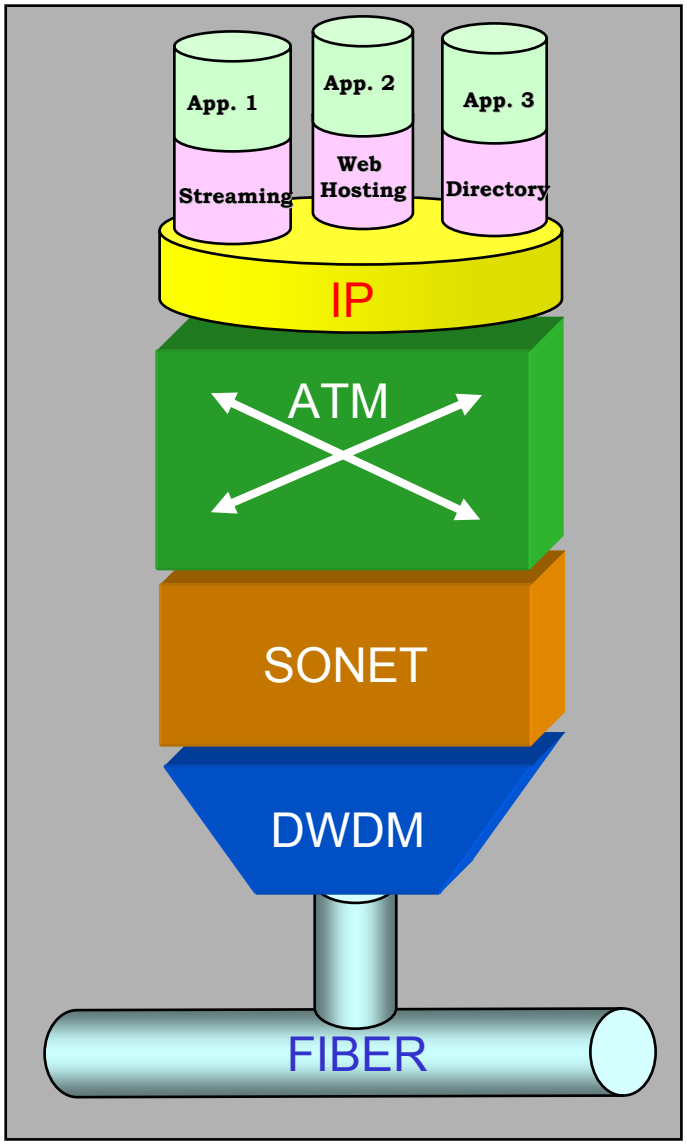
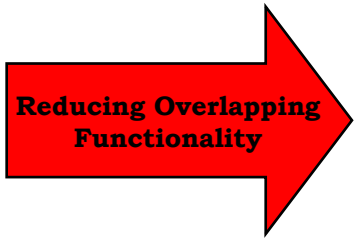
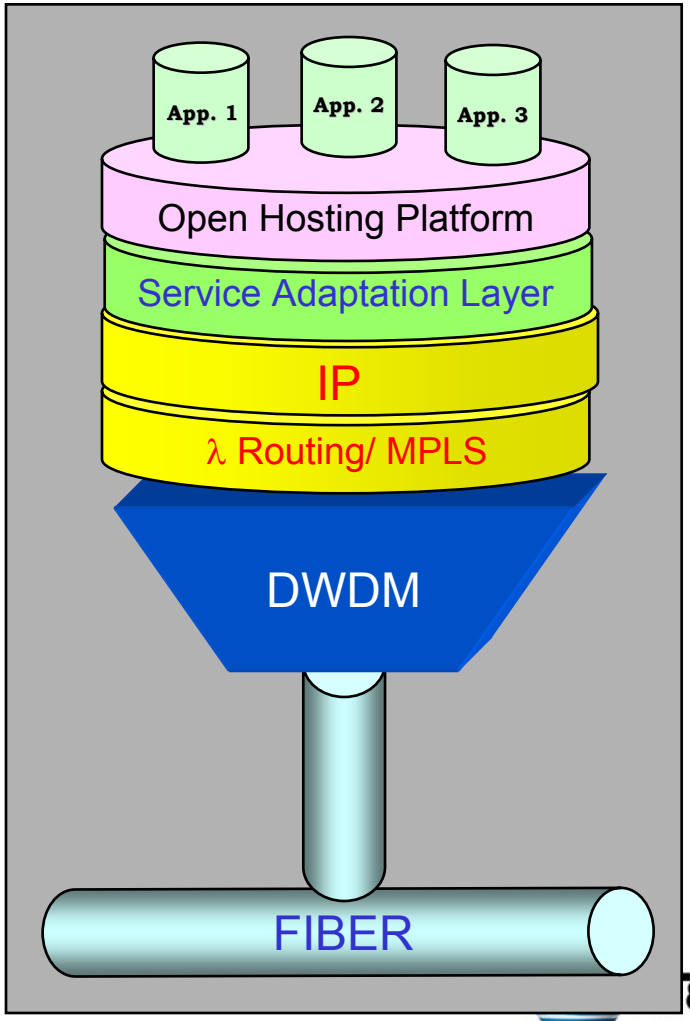
Functionality Migration

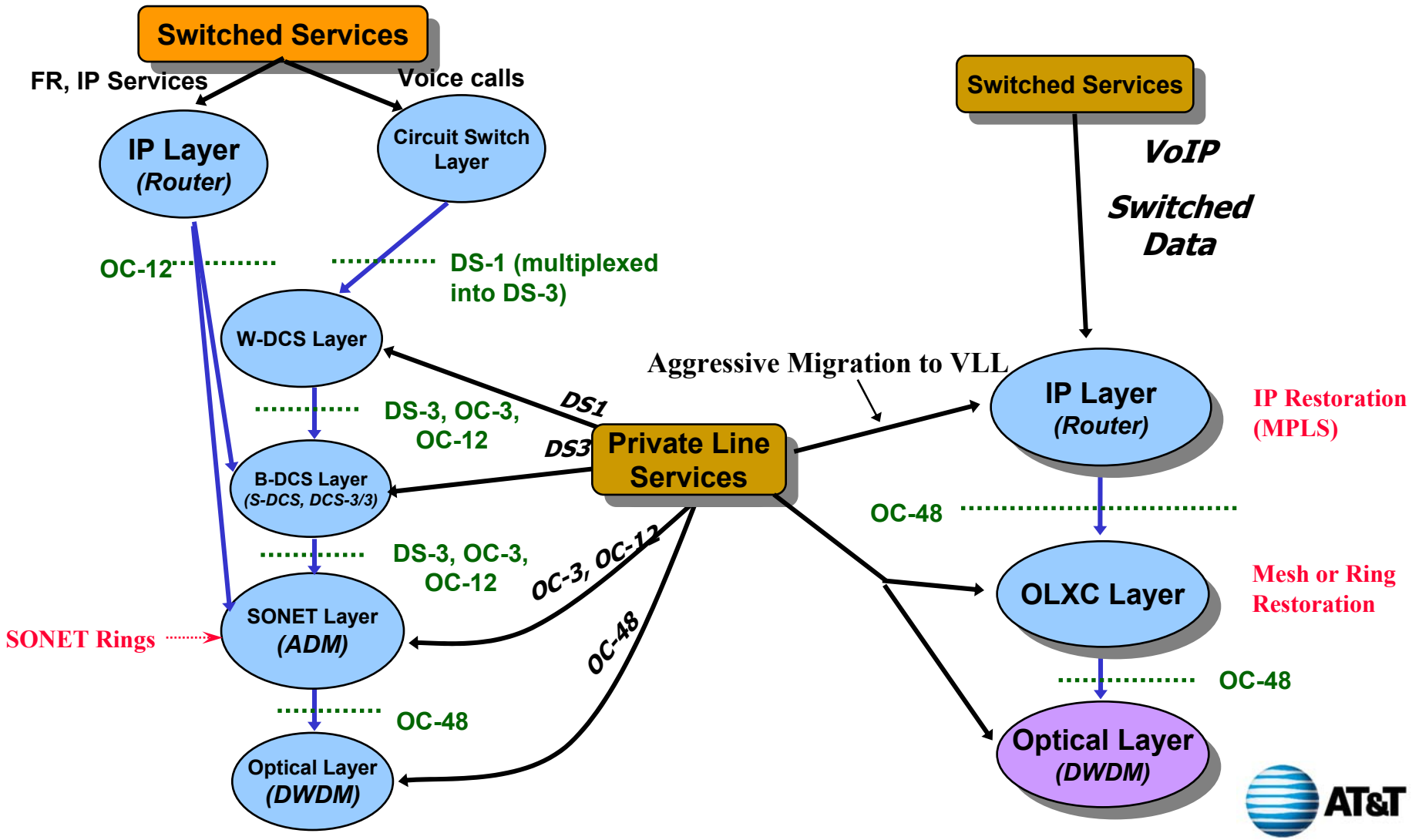
Migration of Functionality to Element With More Rapid Price-Performance Improvement







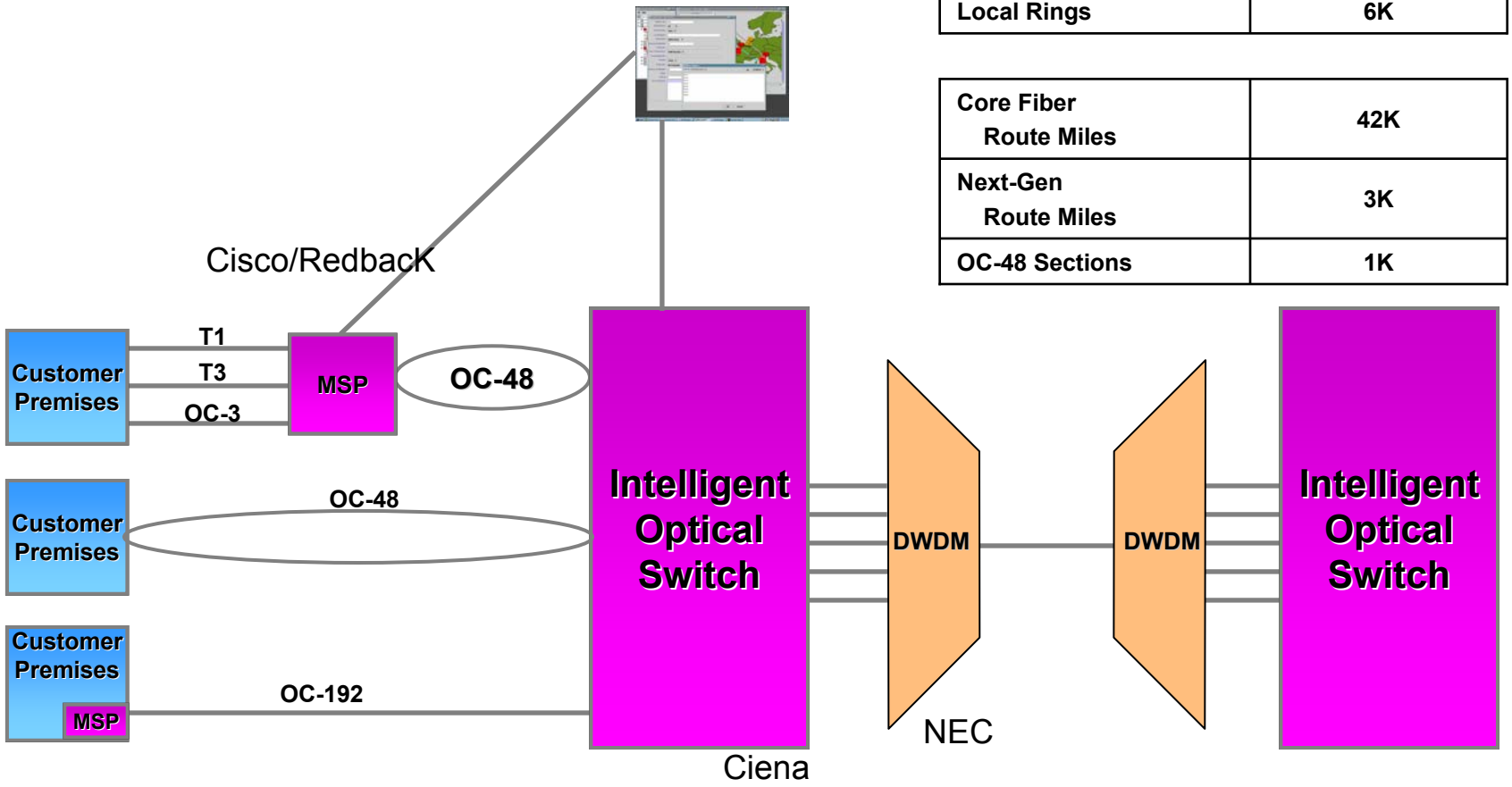
IP Transport Network Evolution (Services View)



Next Network Architecture

Local Fiber Route Miles	16K
Local Rings	6K

Core Fiber Route Miles	42K
Next-Gen Route Miles	3K
OC-48 Sections	1K



Optical Switching
- Point & Click Provisioning
- ½ Price, Floor Space and Power
- Mesh Restoration

DWDM
- 16, 32, 80 Wavelengths → 160
- OC-48, OC-192 → OC-192, 40Gbps

MSP: Multi Services Platform

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Network Services/Network Engineering

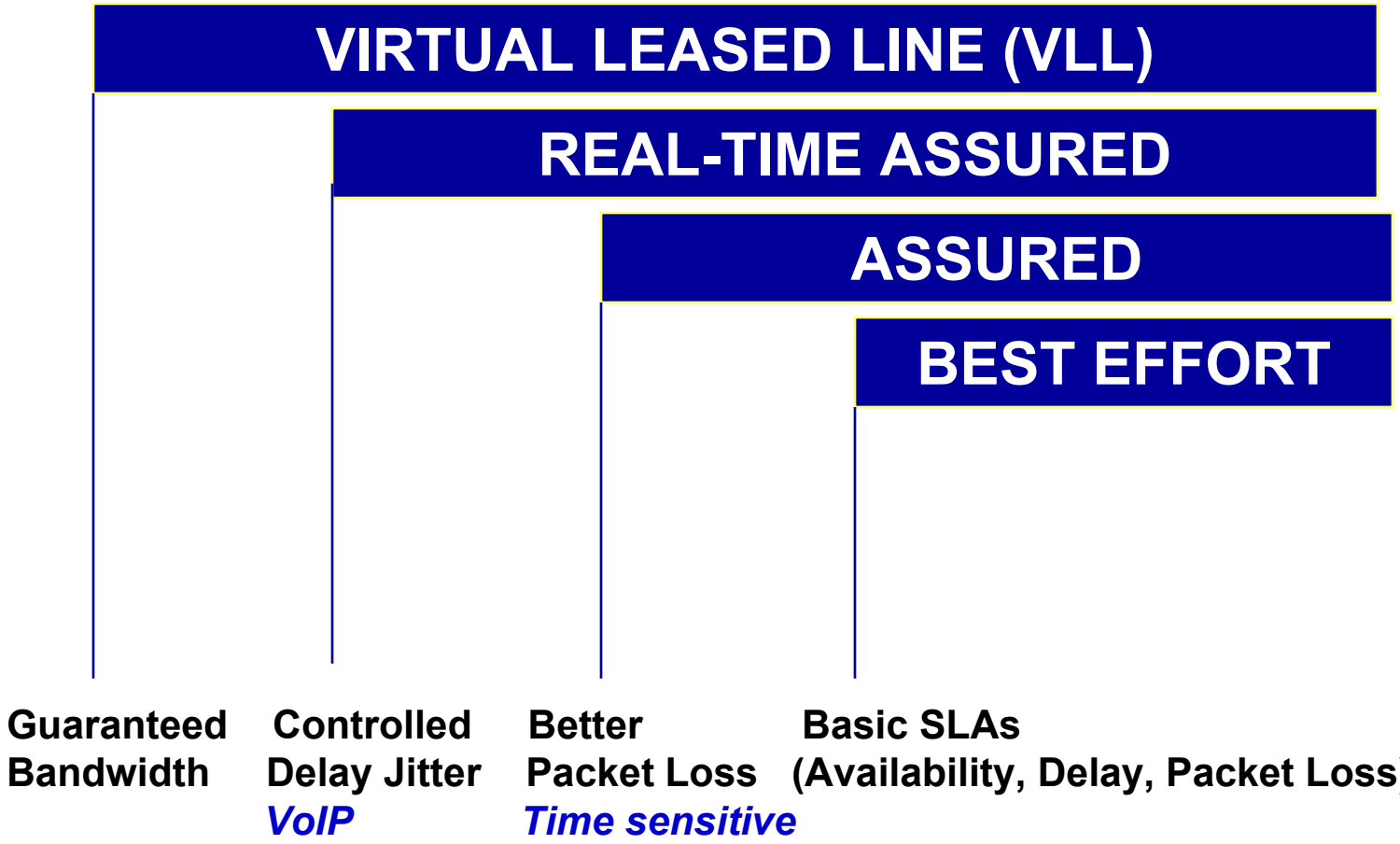
Key Network Services

- *QoS (Quality of Service)*—how can you guarantee packet delivery over an IP (best effort) network
- *VPN (Virtual Private Networks)*—how can you create secure connections between sites (point-to-point), across firewalls, and across multiple infrastructures (private nets, Internet)
- *CDN (Content Distribution Networks)*—how can you move both static and dynamic content across the network (to network edges, to local POPs, to service centers, to hosting centers, etc) to reduce congestion at every point in the network

QoS Solutions

- ***Virtual Leased Lines (VLL)*—permanent virtual circuits**
- ***ATM* with Class of Service routing—switched virtual circuits**
- ***Integrated Services (IntServ)*—assigns traffic class to each flow, uses RSVP (Resource Reservation Protocol) to reserve end-to-end network resources**
  - cannot guarantee resources
  - works on a per flow basis (no aggregation of multiple flows with same traffic class)
  - doesn't scale => wastes network resources
- ***Differentiated Service (DiffServ)*—appends tag to each packet with service class**
  - allows aggregation of packets with common tags
  - more efficient use of network resources
- ***MPLS (Multi-Protocol Label Switching)*—attach label (tag) to packets at edge routers so that IP packet headers don't have to be read at each hop**
  - in between routers only read MPLS tags
  - label swapping at intermediate routers leaves a packet route trail for future packets

Diff-Serv QoS End-to-End (MPLS-Based)



Four classes of service (2002)

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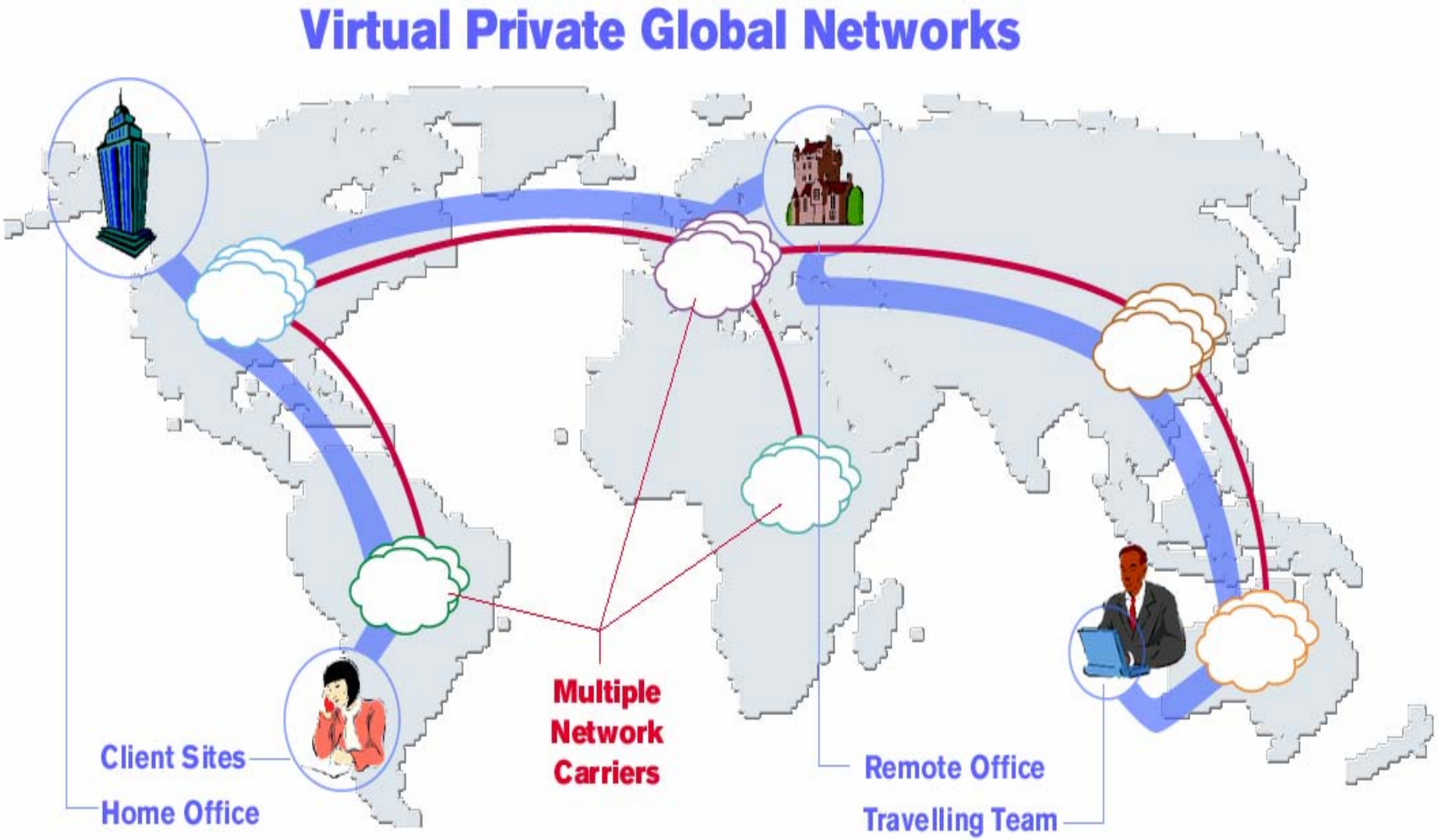
Business/Enterprise Networking Issues

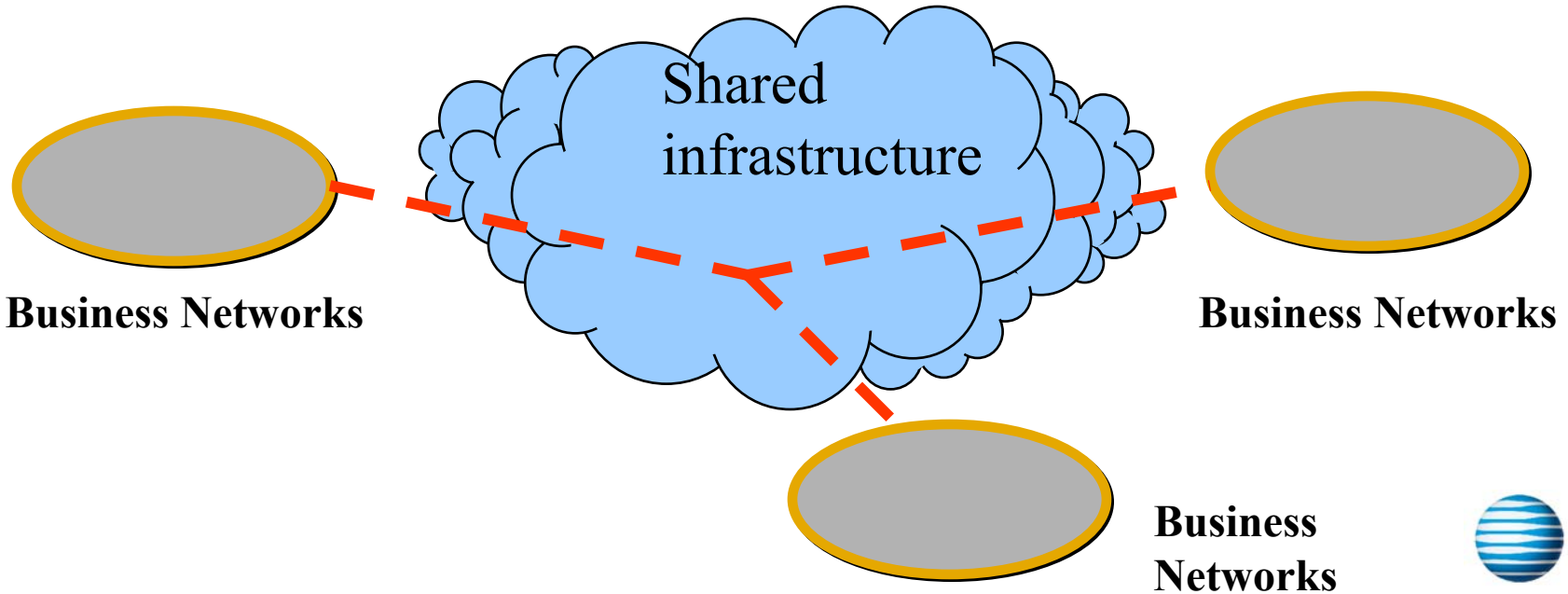
What Customers Will Want



IP Virtual Private Networks (VPNs)

Partitioning a shared infra-structure to create a virtual network that provides participants

- Connectivity
- Traffic Isolation
- Access Control
- QoS
- Security.



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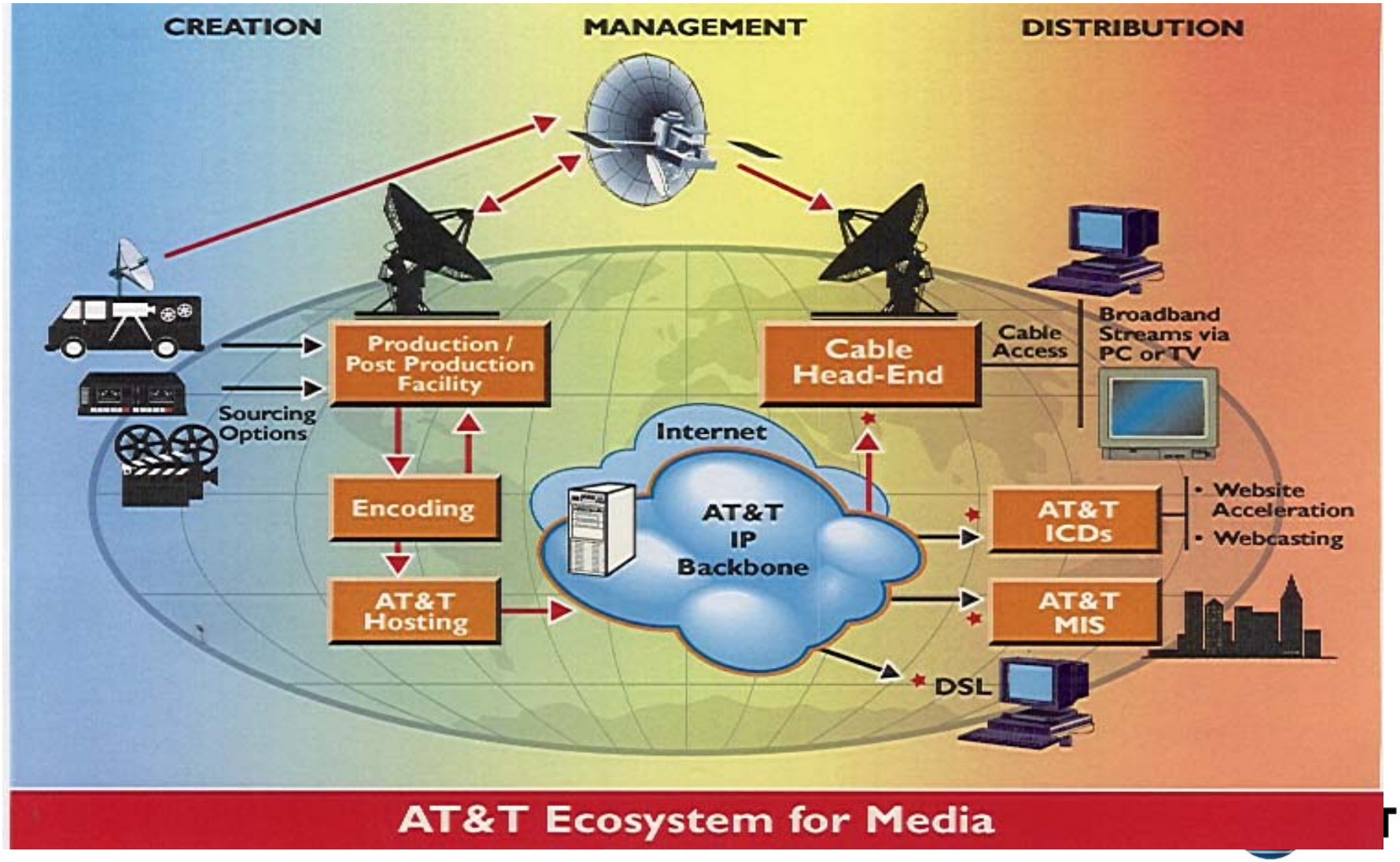
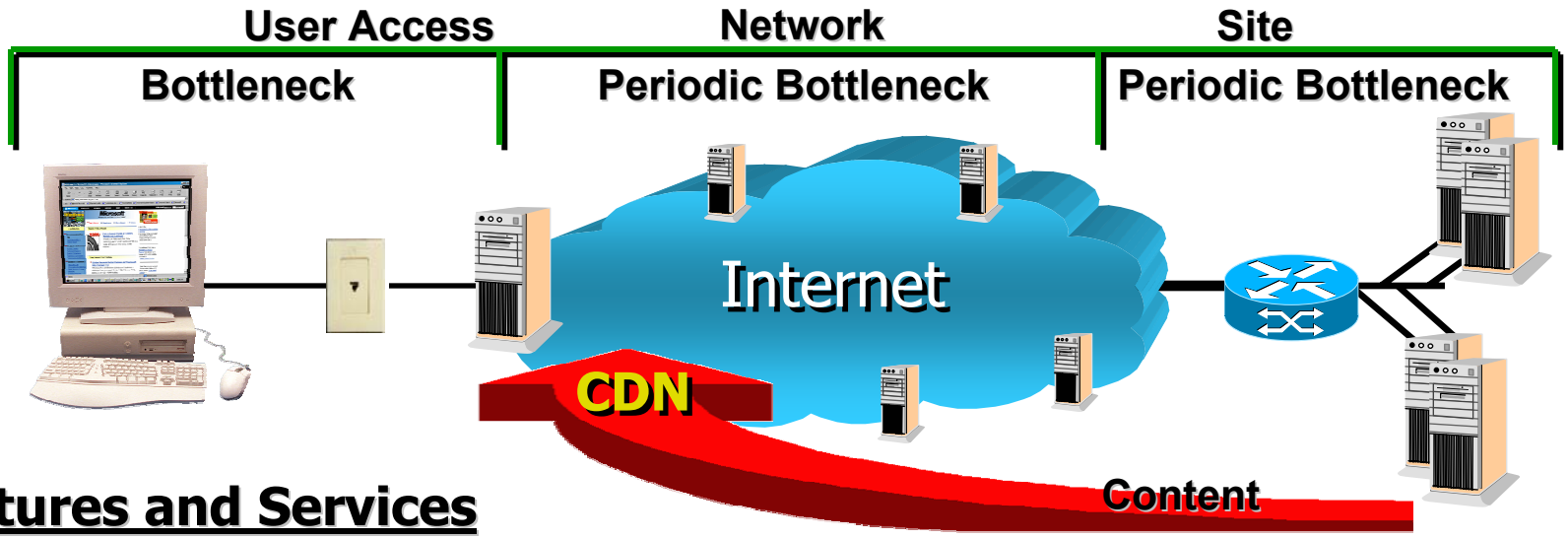
AT&T Ecosystem for Media

e-Media benefits from e-Business solutions



Content Delivery Networks (CDN)

Distributed System improving 'net Performance, Reliability, & Economics'



Features and Services

- Accelerate web page downloads
- Bring content to the edge of network
- Scale capacity on demand
- Multicast routing
- Multimedia portal for Interactive TV
- Reduce single point of failure vulnerabilities

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ABS Functional Structure

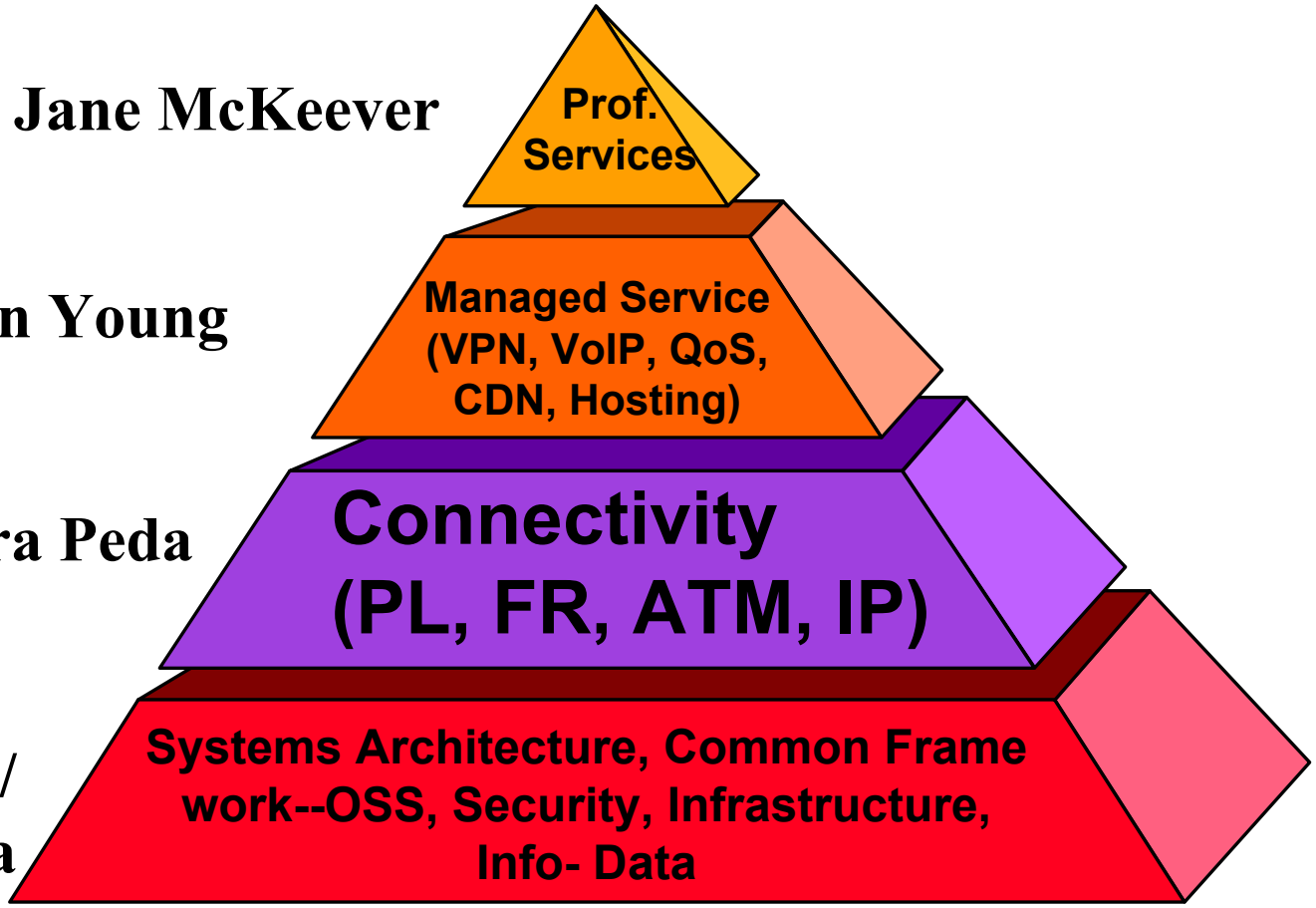
Business Unit

Mary Jane McKeever

Robin Young

Barbara Peda

Robin Young/ Barbara Peda



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OPERATIONS

(Database Technology, Data Mining, Visualization, Data Compression, Signatures, Query Languages, Data Analysis, User Interfaces)

Learning From Data—Data-Driven Business Operations and Network Management

- ***Data Hoarding*—measure the right things about the way the company does business, severely restrict access to the data, then store it away safely (sometimes forever), look at it only when things go wrong**
- ***Data Publishing*—make all the data within the company broadly available throughout the corporation, encourage people at all levels to study and use the data to provide competitive advantage, learn how to run the business more efficiently based on lessons learned from the data**
  - ***everyone in the organization is on the same 'web' page***

- **Understand the market first**
- **Act on changing market conditions with more insight than your competition**
- **Do it consistently**

WIN!!

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PSTN Data

- **Store CDR (Call Detail Records) on 350 million wired and wireless calls/day for up to 24 months**
  - generate ***detailed bills*** by service, customer, network
  - detect ***fraud*** from customer (usage) signatures
  - detect consumers whose ***calling patterns have changed***—e.g., they are running a business from their home at consumer rates
  - detect business customers who are using ***multiple carriers***—i.e., Low Toll Notifier alarms
  - detect business customers whose ***lines are being used fraudulently***—i.e., High Toll Notifier alarms, Net Protect (PBX hacking)
  - detect ***subscription fraud*** from customer Communities of Interest (COI)—fraudsters tend to communicate with other fraudsters
  - detect ***'phantom churn'***—i.e., cell phone customers who have closed an account and opened a new one, in order to get a new cell phone
  - detect ***movers***—i.e., people who have terminated service at one place and initiated service somewhere else, but with the same Calling Circle (COI patterns) of friends
  - detect ***Calling Card Fraud***—rapidly
  - detect ***International Calling fraud***—rapidly
  - do ***'Instant Marketing'*** based on immediate response to advertising—10-10-345 marketing campaign
  - support ***peering agreements*** between carriers based on actual traffic patterns—protect against arbitrage arrangements

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IP Traffic Data—2100 TB/day

- generate *pricing plan* that reflects actual network usage—i.e., WorldNet plan for $4.95/month low usage customers
- enable the GNOC to *display network traffic patterns* for any customer, any service, and any network traffic type (IP, ATM, FR, PL)
- enable the customer to *display their own network traffic patterns* for any link or router on the AT&T Network
- enforce *SLA agreements* based on measured data
- manage *dynamic network provisioning* based on measured traffic patterns
- *balance router, switch traffic dynamically*
- make *router tables consistent* and up-to-date
- detect *link and router failures*

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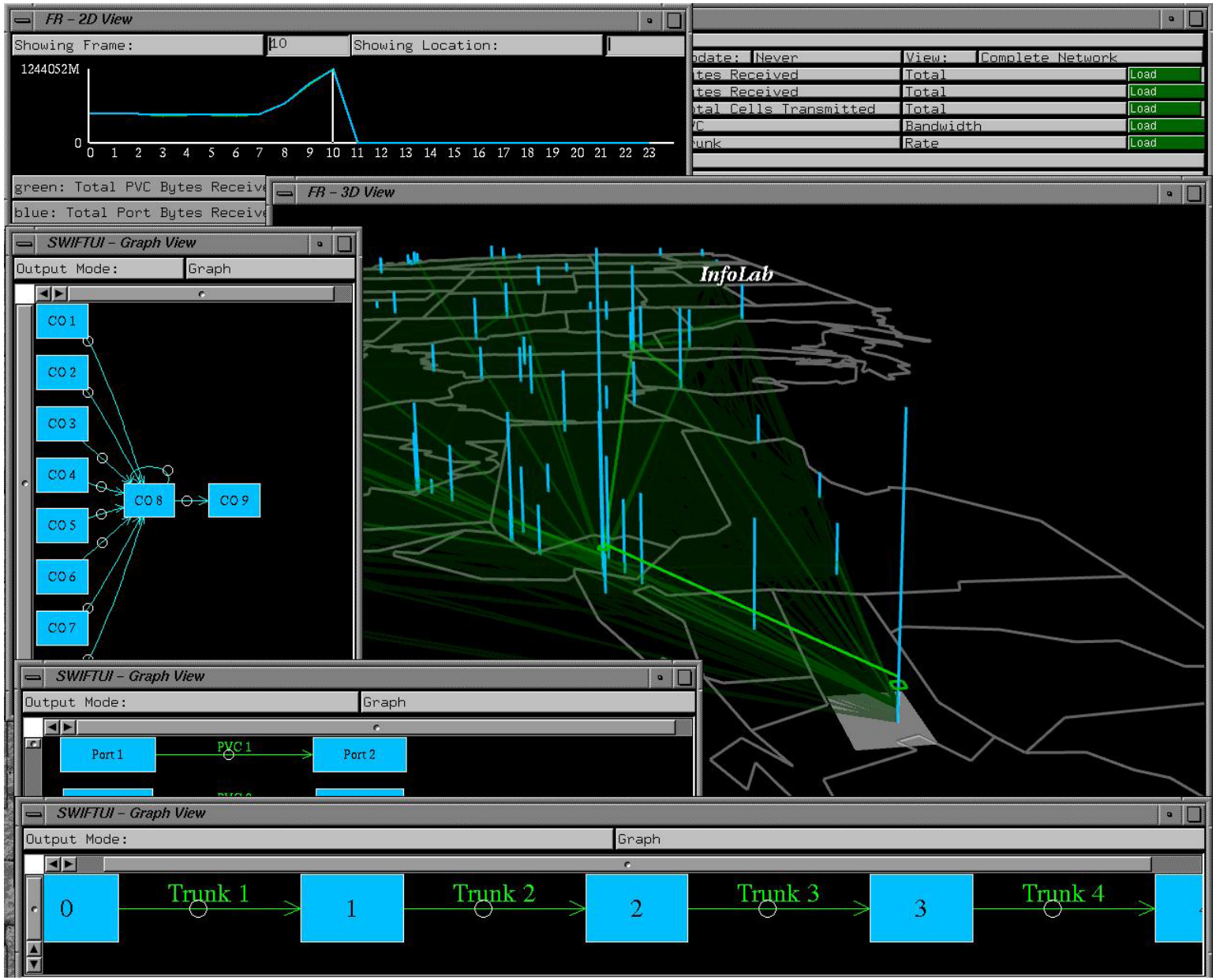
Finding Insights Visually



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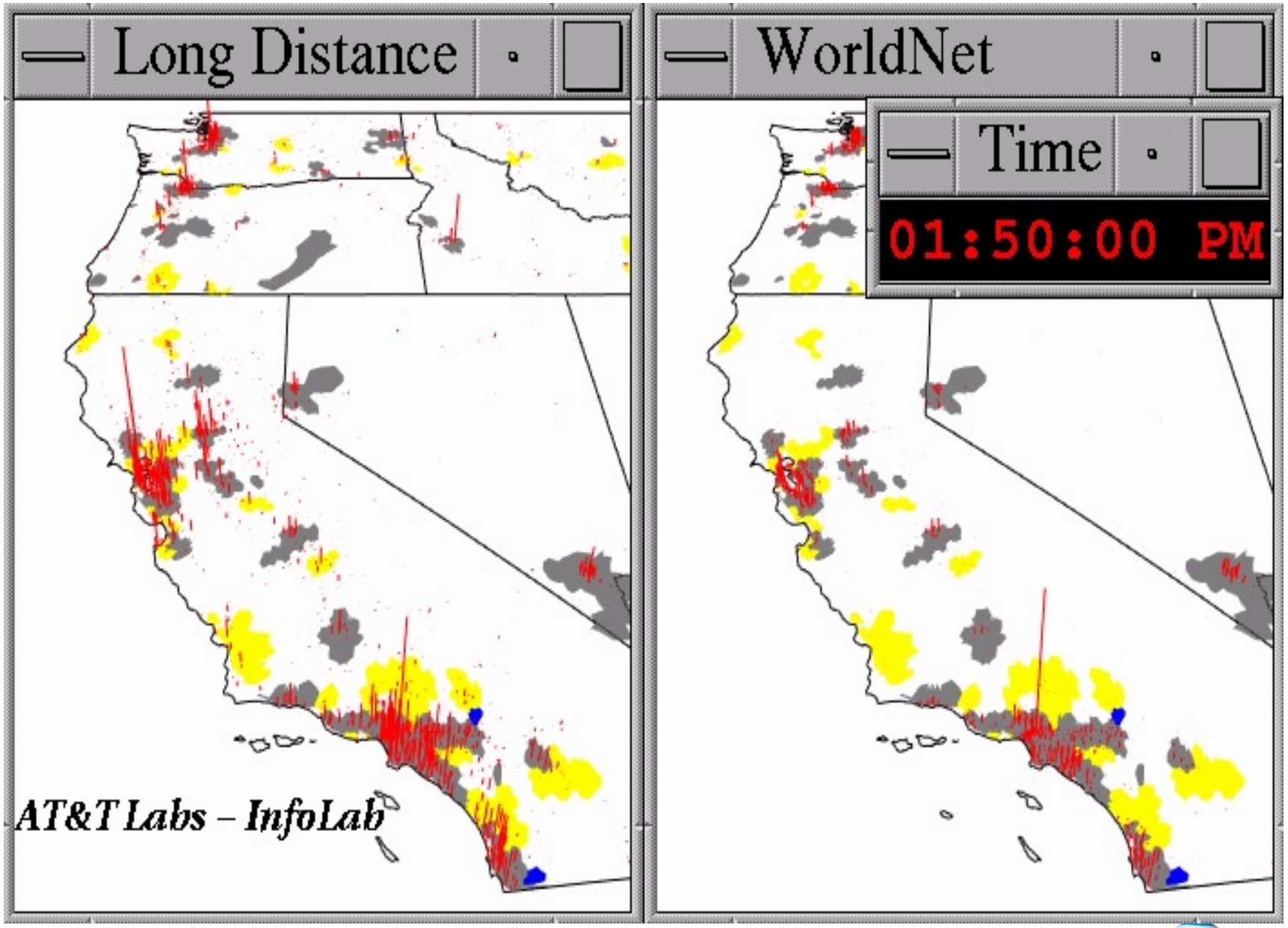
Long Distance
WorldNet
Time
01:50:00 PM
AT&T Labs – InfoLab

Devices—The Broadband Phone

Broadband phone

Enhancing everyday communications

Philosophy

It's a phone not a computer

Architecture

100% network centric

Cute feature

Both parties can see the same thing

Sound bite

Simple phone
Smart network

No operating system
No web browser
No downloadable code
Nothing to go wrong

Remote graphics protocol

Broadband IP Network

IP telephony

The screen comes from the network
The services are on the screen
The network is the phone

Enhanced applications

- Home shopping
- Reservations & Information
- Photo Albums
- Chat 'n' draw
- Fax & Mail
- Live video
- Web browsing

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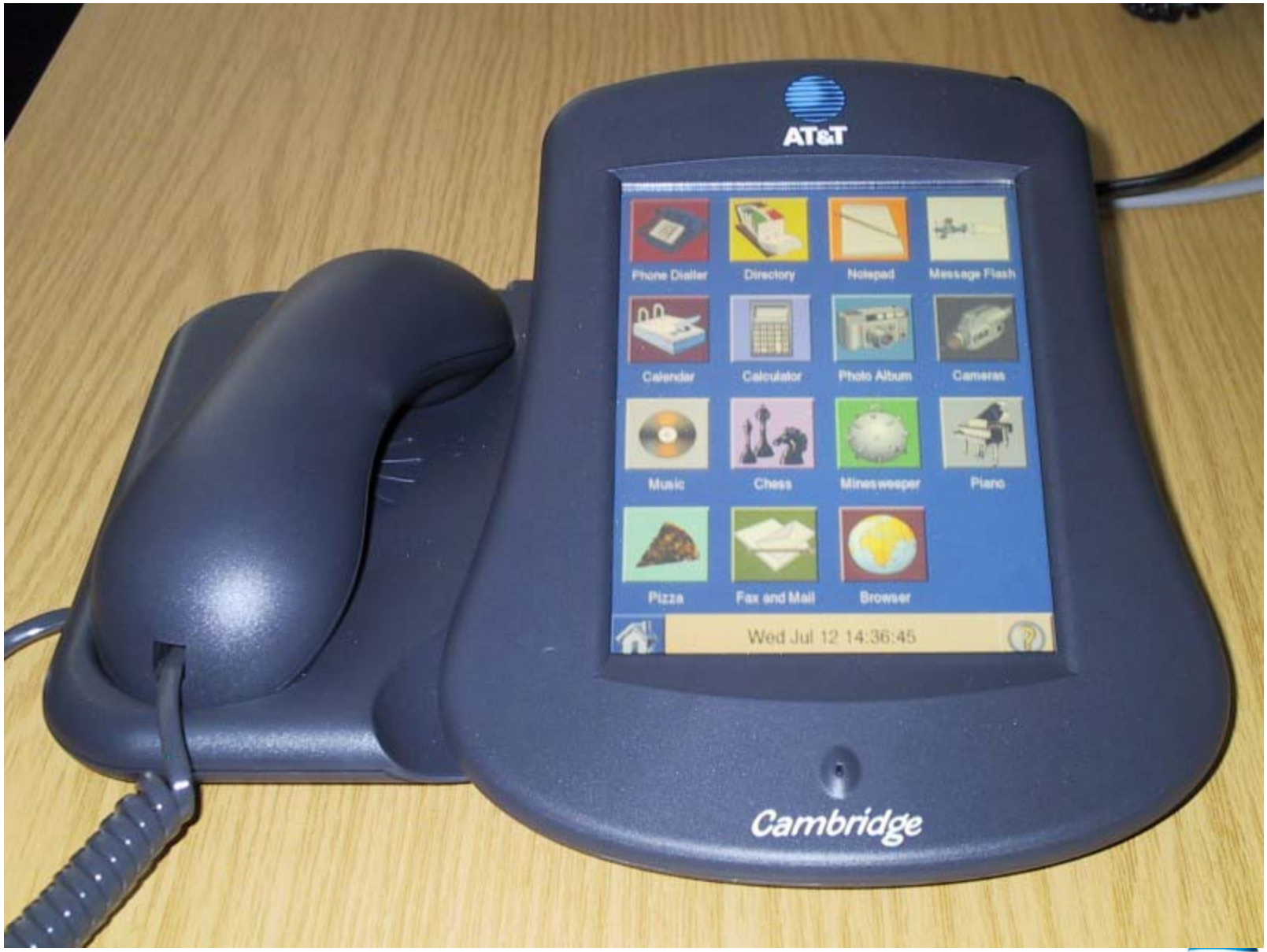
AT&T
Phone Dialler
Directory
Notepad
Message Flash
Calendar
Calculator
Photo Album
Cameras
Music
Chess
Minesweeper
Piano
Pizza
Fax and Mail
Browser
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Cambridge

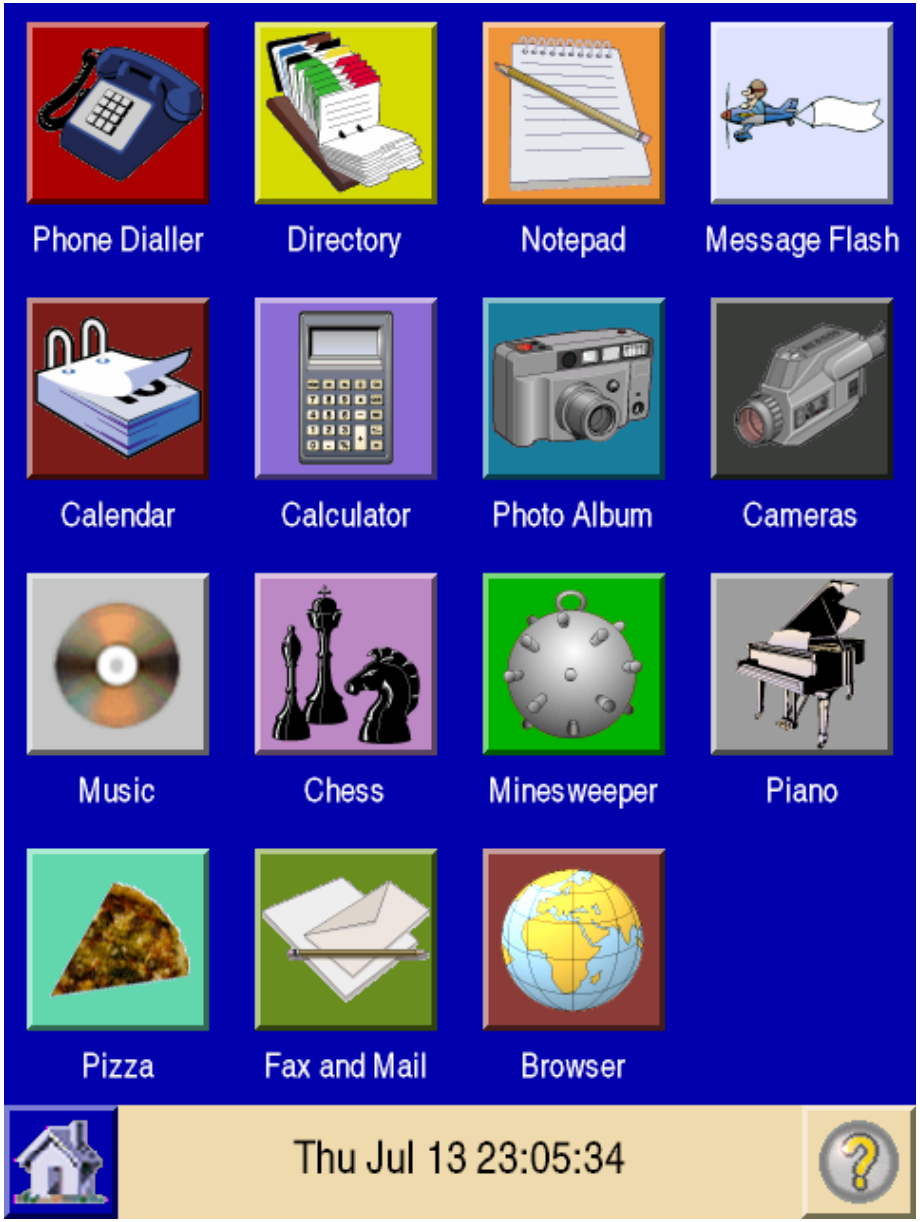
Phone Dialler
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Photo Album
Cameras
Music
Chess
Minesweeper
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Browser
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Clear
1
2
3
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5
6
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*
0
#
Phone 201

Names | Faces | Places | page 1 of 2 | ...more

Directory

New | Delete | Send | < | > | Pen

Last Edited : Thu Jun 15 2000 14:08:56

Notepad : 1 of 9

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VNC: Broadband phone

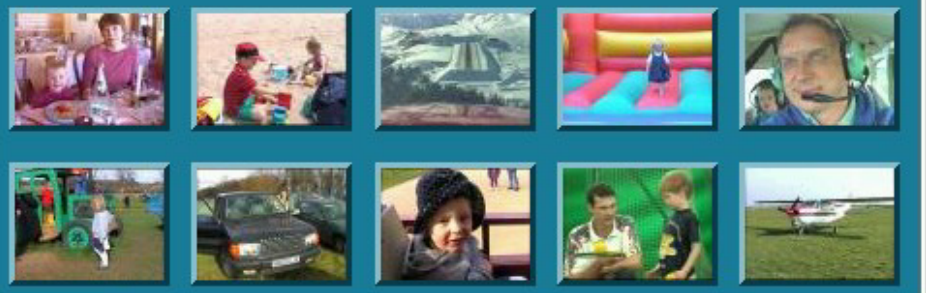

Photo Album

ABBA: Gold

Queen: Greatest Hits I

Beethoven: Sonatas

Moby: Play

Oscar Peterson Trio: Night Train

Puccini: La Boheme

Choose an Album

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IP Services

Families of IP Services

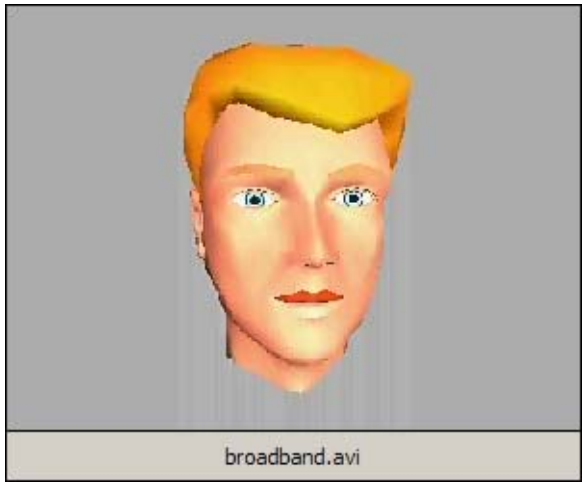
- **Service works well on narrowband connections**
  - traditional voice calls
  - email, voice messaging, FAX
  - low speed data services
- **Service works on narrowband connections; it works a lot better on broadband connections**
  - Internet browsing
  - streaming audio
  - streaming video
  - software downloads
  - network storage of photos, PIM
- **Service only works on broadband connections**
  - video on demand (MPEG-2, HDTV)
  - virtual reality
  - digital CATV
  - browsing catalogs, news, TV shows
  - streaming CD quality audio
  - interactive video agents

Giving Machines High Quality Voices and Faces

U.S. English Female:

U.S. English Male:

Spanish Female:



'Natural Speech'

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VTTS Demo

Au Clair de la Lune

Virtual Secretary

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Voice Dialogue System

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Customer Care Scenario

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Voice-Enabled Service Challenge

Problem:

How do we provide a natural language voice interface to take people out of 'IVR Touch-Tone Hell' and automate tasks like customer care.

Solution:

Exploit an intelligent voice dialogue system with a modern high quality speech synthesis system.

Business Implication:

HMIHY (How May I Help You) — a fully automatic system for voice-enabled applications with extremely high performance on tasks like Customer Care and Help Lines.

*** IVR—Interactive Voice Response**

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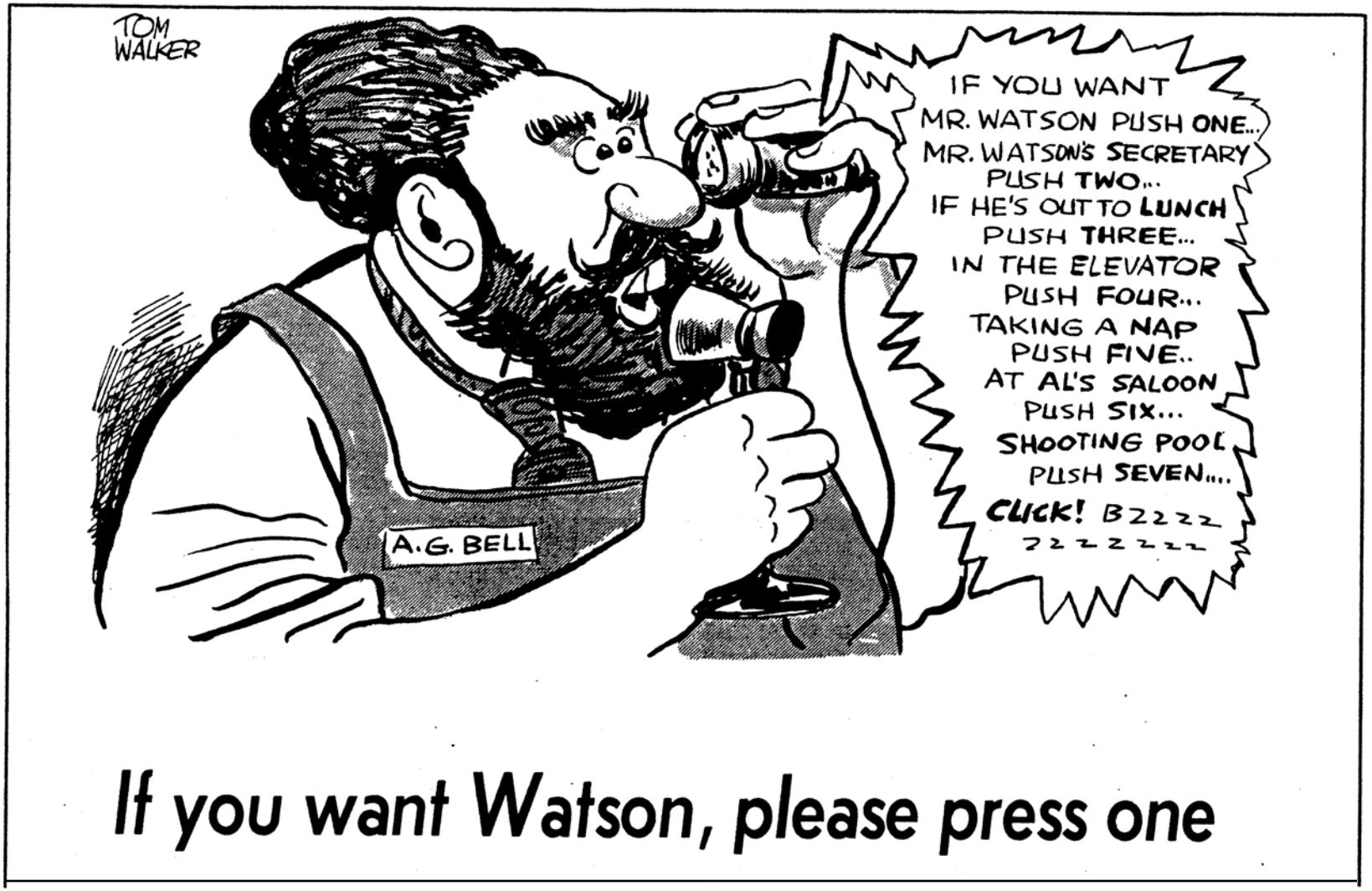
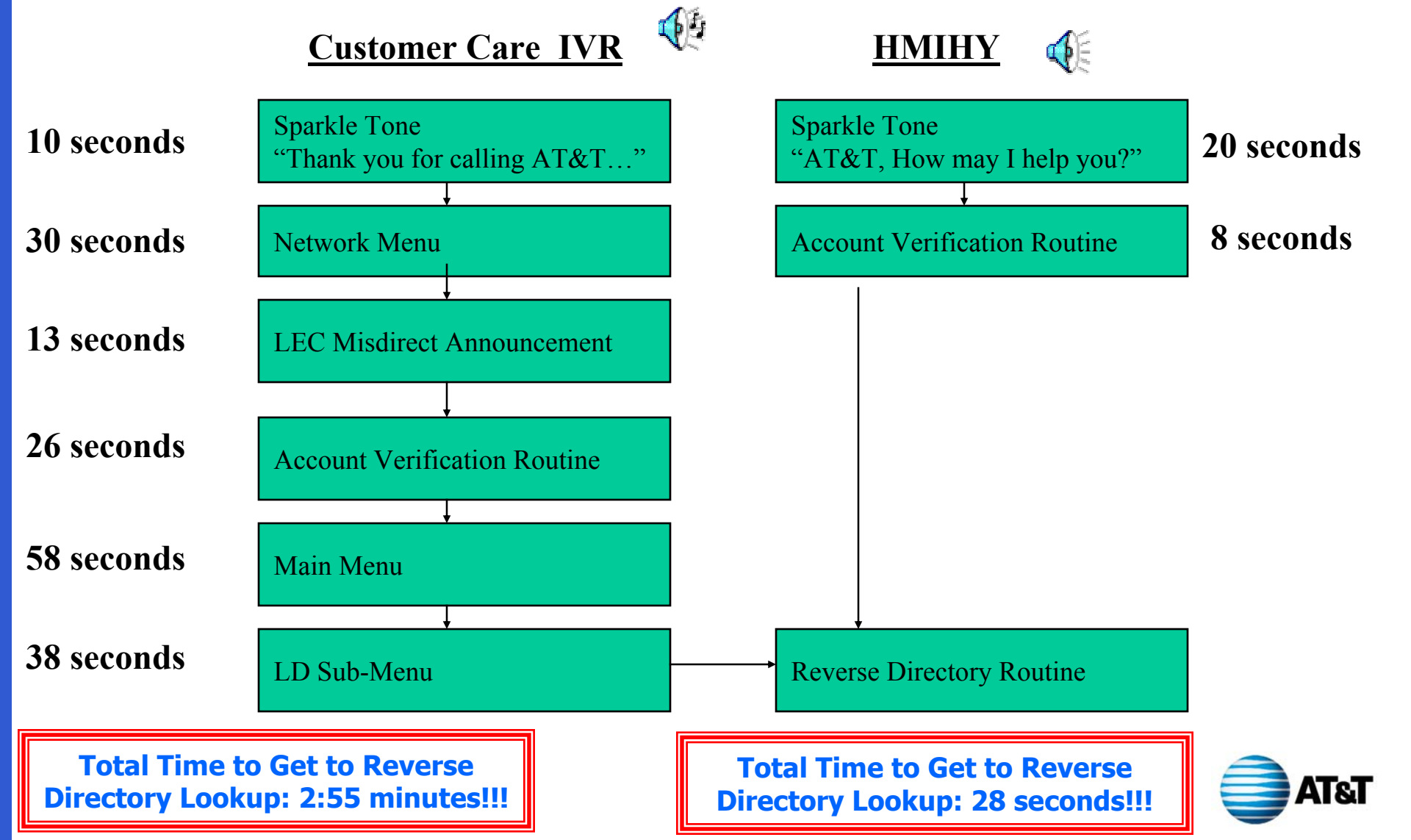
IVR Touch-Tone Hell



Customer Care IVR and HMIHY



Total Time to Get to Reverse Directory Lookup: 2:55 minutes!!!

Total Time to Get to Reverse Directory Lookup: 28 seconds!!!

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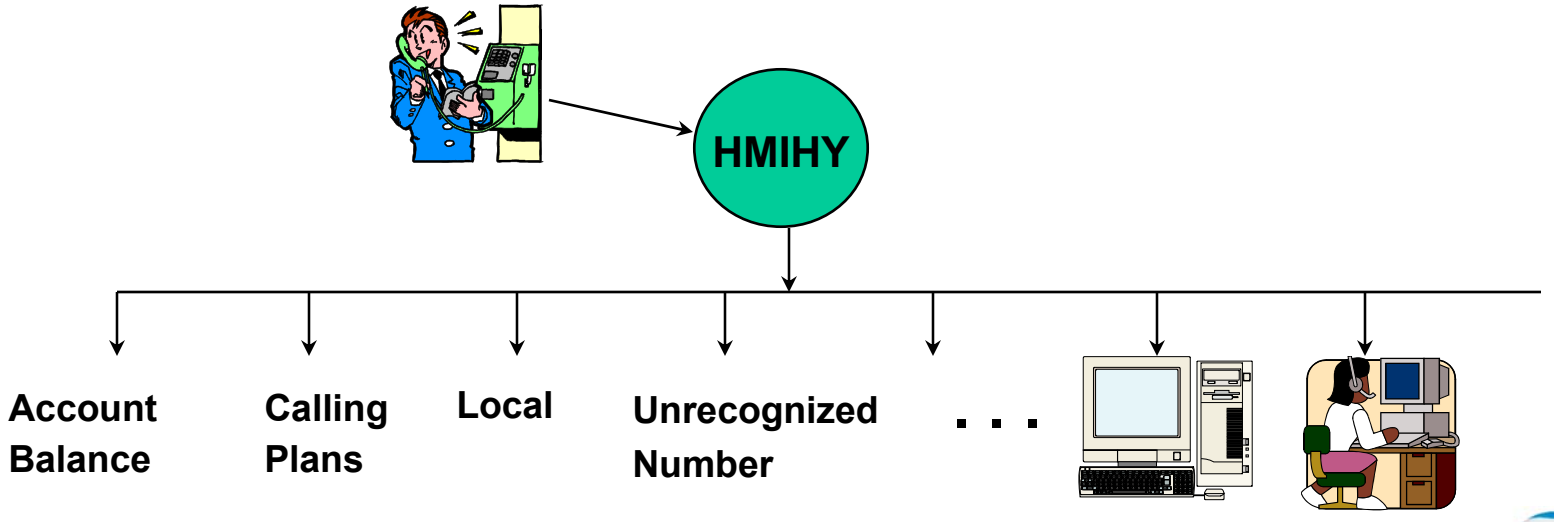
HMIHY—How Does It Work

- Prompt is *"AT&T. How may I help you?"*
- User responds with totally ***unconstrained*** fluent speech
- System **recognizes** the words and determines the **meaning** of users' speech, then routes the call
- **Dialog** technology enables task completion



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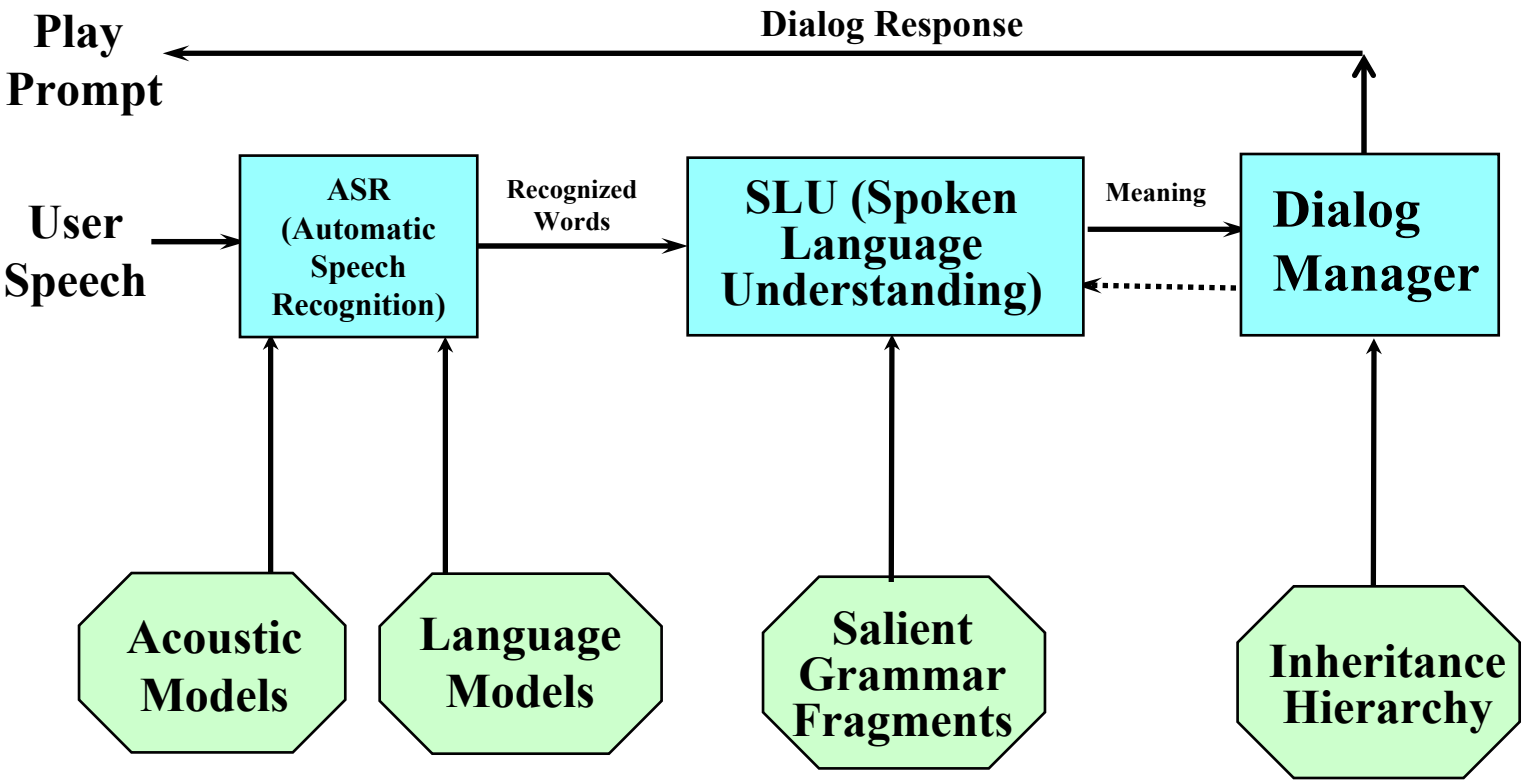
Architecture for Natural Spoken Dialog



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Example Dialogs

- Irate Customer
- Rate Plan
- Account Balance
- Local Service
- Unrecognized Number
- Threshold Billing
- Billing Credit

How Well Does It Work

- **HMIHY delivers expected value**
  - accurate classification and routing of calls; classification accuracy measures show customers are being directed to correct Service option
  - increased participation rates; customers are not bailing out of the service
  - reduced cost of service--$1.00/minute for live agent versus $0.13/minute for automated service agent
- **Improved customer satisfaction**
  - service is faster, easier to use, and more intuitive than IVR alternative
- **HMIHY provides new opportunities for automation of customer calls via self-service modes**
- **AT&T plans to use HMIHY for its 0300 Consumer Care service with 4000 lines of service by late 2001**

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Telecommuting and Remote Call Centers--the Future of Remote Access

Virtual Communication Services - Office & Agent

VCS-Office: "taking your desktop *anywhere*"—telecommuting solution

VCS-Agent: "customer contact agent working *anywhere*"—virtual call center solution

- **based on WISL (Wideband Internet Sales Link) and ROSE (Remote Office Services)**
- **emulates ISDN telephone (with all the calling features) via 'softphone' simulated on PC**
- **provides secure, private, Virtual Private Network access to corporate network (and PBX) using a hardware device (Yorkie)**

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Work Anywhere Service Concepts

ROSE (Telecommuter)

A *Virtual Office* that allows workers to have the *same functionality* they have in the Office with a *PBX*.

The *AT&T network* directs calls to/from those workers.

The *Internet link* provides the customer's application and performs call control.

A *Softphone* provides an Office multi-function phone.

The *Moat* provides the worker with secure and private access to the corporate network and to the ROSE server.

Workers have full *Mobility and Messaging* capabilities.

WISL (Virtual Call Center)

A *Virtual Contact Center* that allows agents and supervisors to have the same functionality they have in the Contact Center with an *ACD*.

The *AT&T network* directs calls to/from those agents and supervisors.

The *Internet* link provides the customer's application and performs call control, screen pops, agent/supervisor chat, screen capture, etc.

A *Softphone* provides a Virtual Contact Center multi-function phone.

The *Moat* provides the agent/supervisor with secure and private access to the corporate network and to the WISL server.

Supervisors (*service observers*) can listen, watch, and interact with calls from anywhere.

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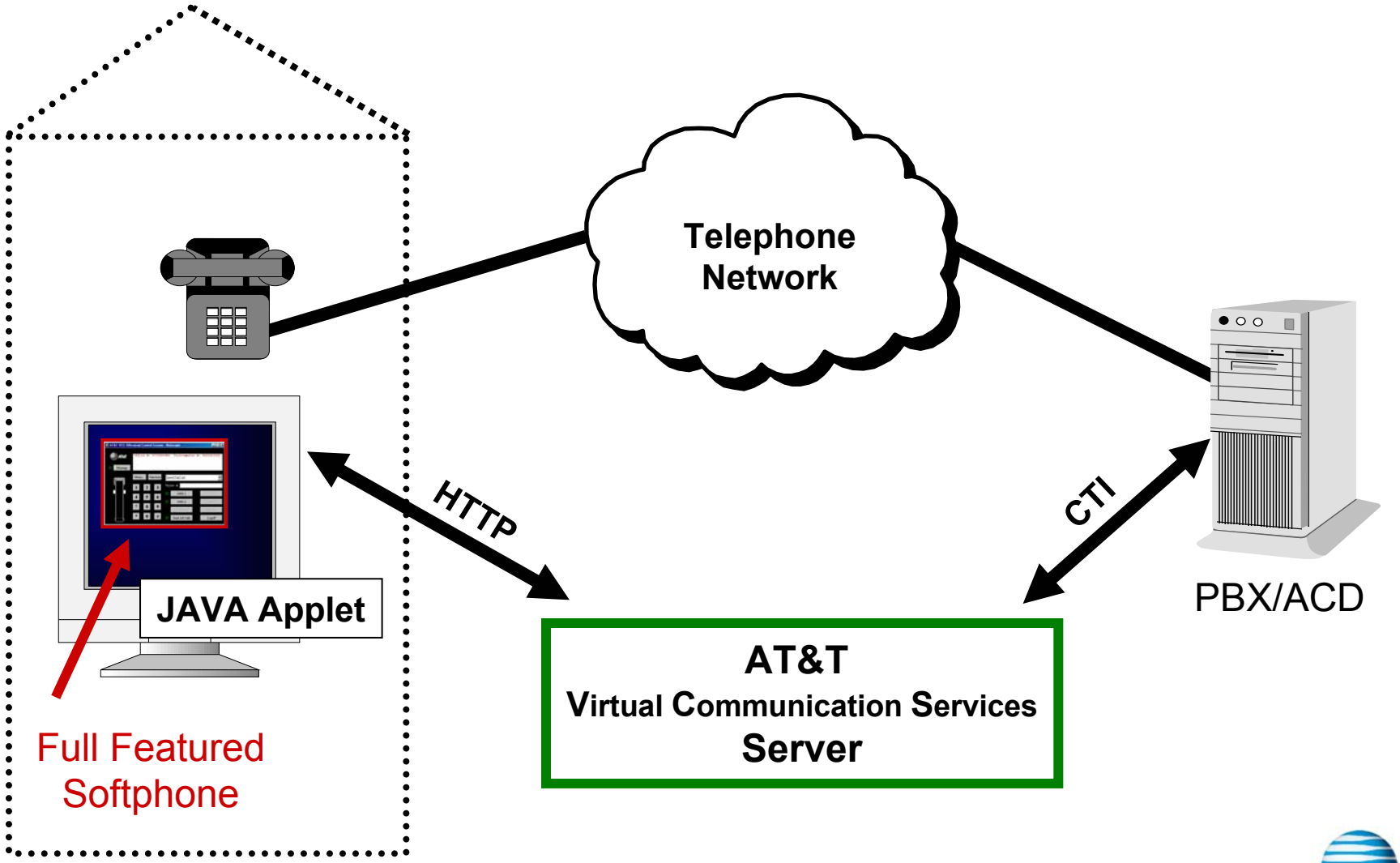
Virtual Communication Services

basic architecture



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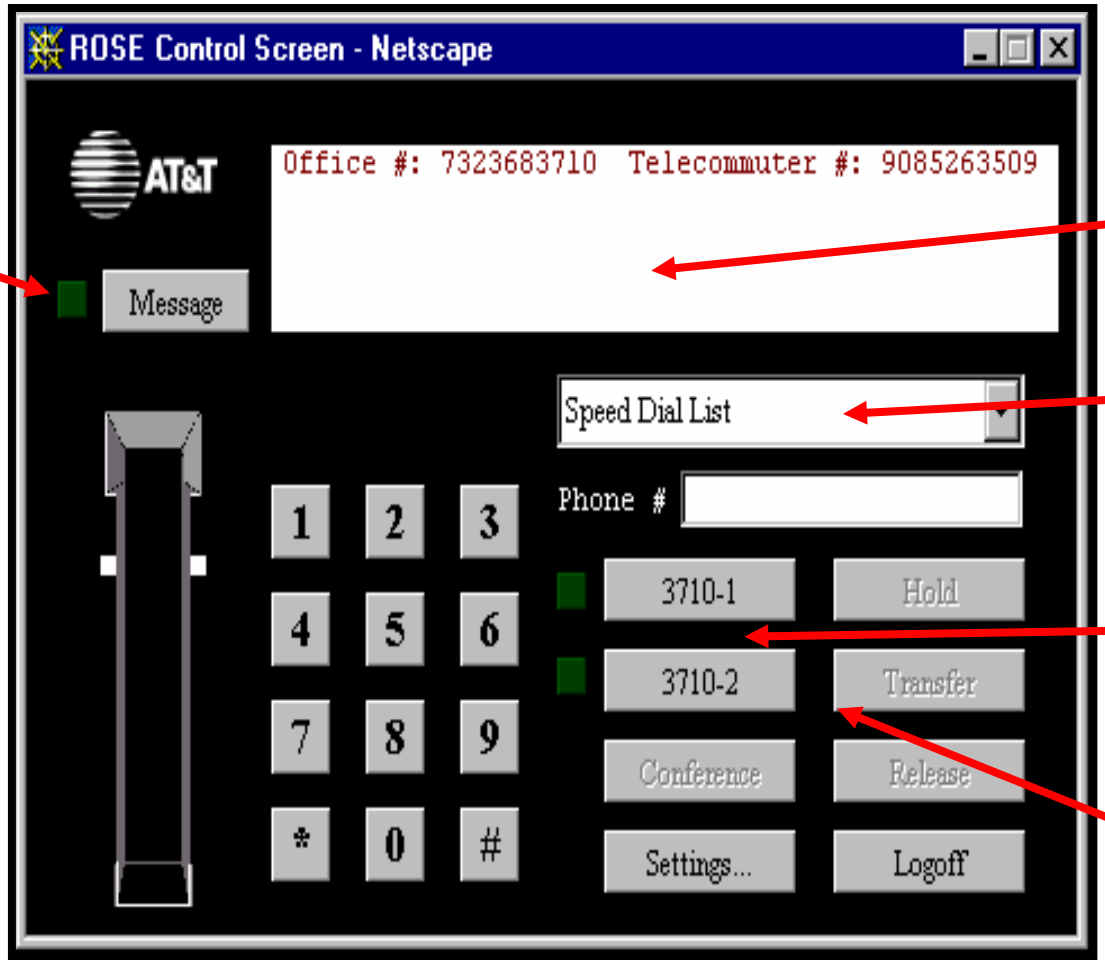
REMOTE OFFICE SERVICE (VCS-Office) SOFTPHONE



Message Waiting

Caller ID

Speed Dialing

Multiple Line Appearances

Hold, Transfer, Conference

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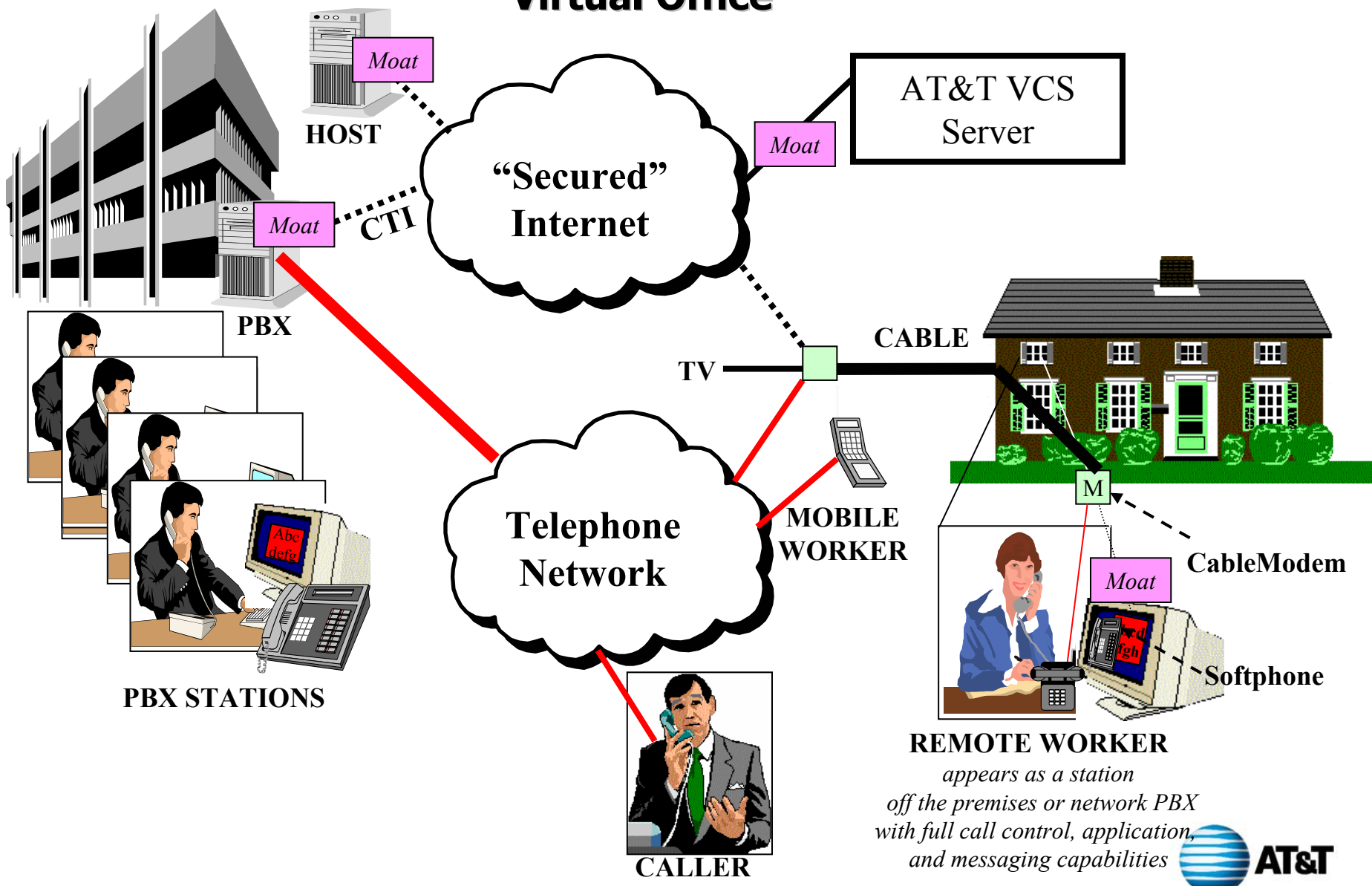
REMOTE OFFICE SERVICE (VCS-Office)

Virtual Office



YORKIE IMPLEMENTATION OF THE MOAT

- Bypasses Windows environment
- High performance using a dedicated box
- Off-the-shelf hardware & software components
- IP tunnels remotely administered
- IPSec security
- Portable

flash card

Pocket Yorkie

ethernet ports

power

serial port

- 5.6” x 4.9” x 1.25”
- Intel 220 MHz StrongARM processor
- 32 MBytes DRAM; 1 MByte Flash memory; CompactFlash socket (4-340 Mbytes)
- 2 ethernet ports & serial port; v2 has internal modem
- Linux operating system; Moat software (FreeS/WAN, ssh, xntpd, dhcpd)

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CALL CENTERS

3,000,000 total seats in U.S.

100,000,000,000 AT&T minutes/year

ROSE Demo

"Work Anywhere"

AT&T

Future Broadband Services

- ***videoconferencing, video mail, video meeting notes***
- ***multimedia access*** to documents, images, sound files, movies
- ***searchable, browsable multimedia documents***
- ***virtual reality*** experiences in games, entertainment, sports events, conferences
- and much, much more

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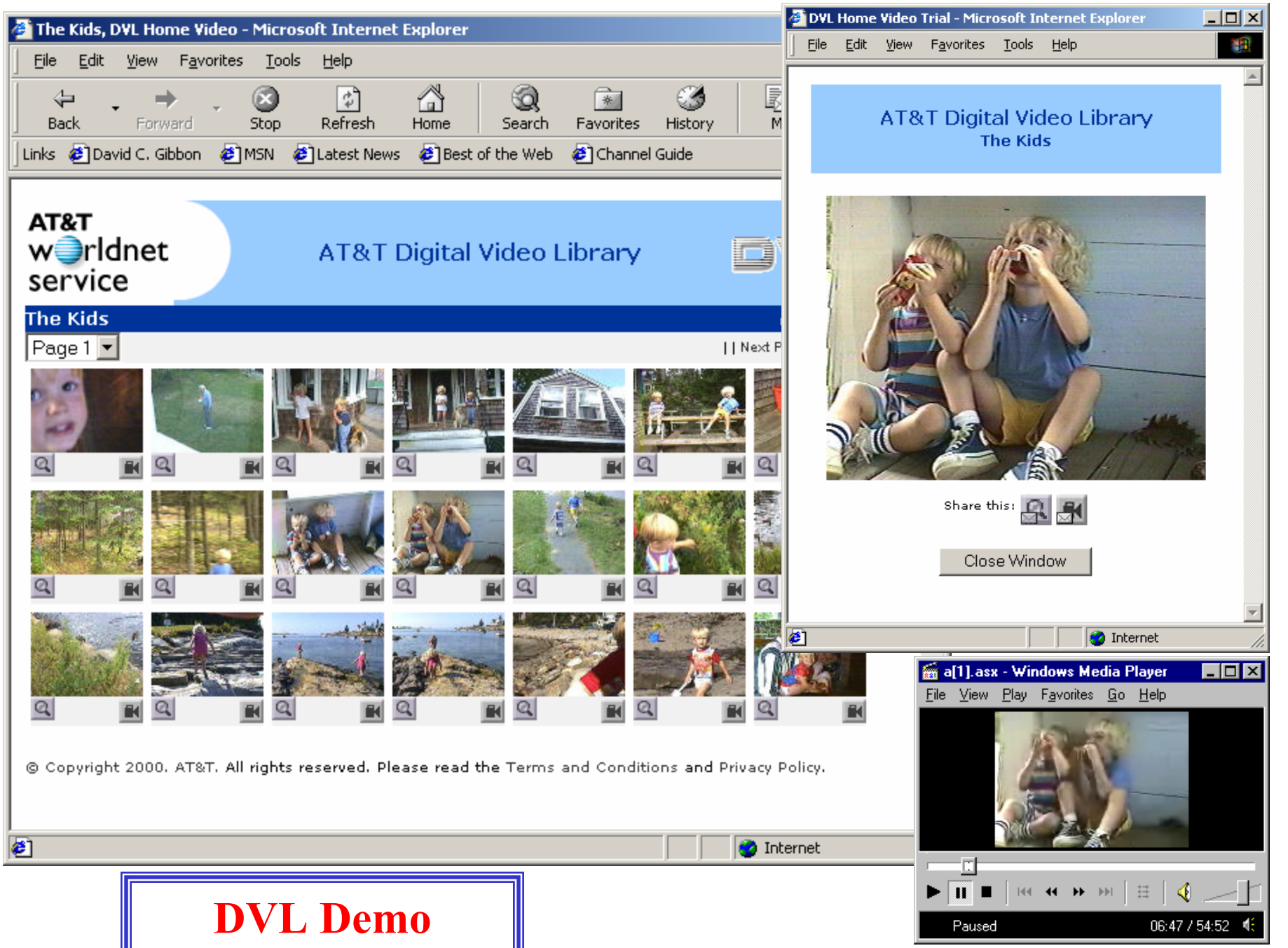
The Kids, DVL Home Video - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History
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Internet
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AT&T Digital Video Library
The Kids
Share this:
Close Window
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File View Play Favorites Go Help
Paused
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DVL Demo

Virtual Presence: Multimedia Call of the Future

Collaborative Work

Multimedia Messaging

Multimedia 800 Customer Service

Image Networking Services

Multimedia Information Storage/ Retrieval

Virtual Corporations Multimedia Virtual Networks

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Summary

- ***Broadband access*** **is coming to the office, the home, and eventually on the road via 3G and 4G wireless technologies**
- **The *network will be ready* to meet the heavy demands of both real-time (voice, video) and non-real-time broadband traffic**
- ***Operationally*** **we will be ready to manage the network, the services, and the customers with a new generation of services based on real-time access to published data**
- ***Broadband services*** **will stoke the pipes and continually push the rates at which customers will demand access to the network**

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