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Driving VoIP Solutions

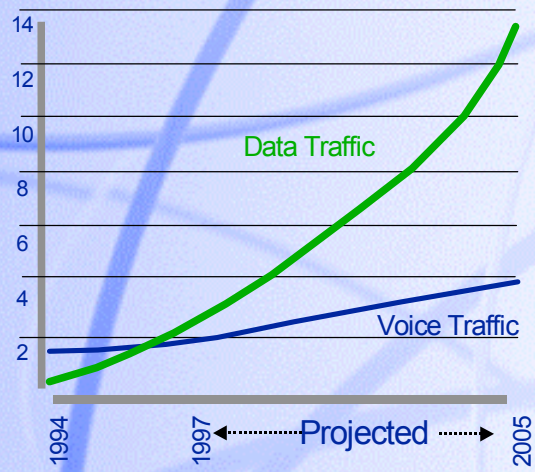
The Reality of the Technology and the Market

Phil Edholm, CTO and VP, Network Architecture

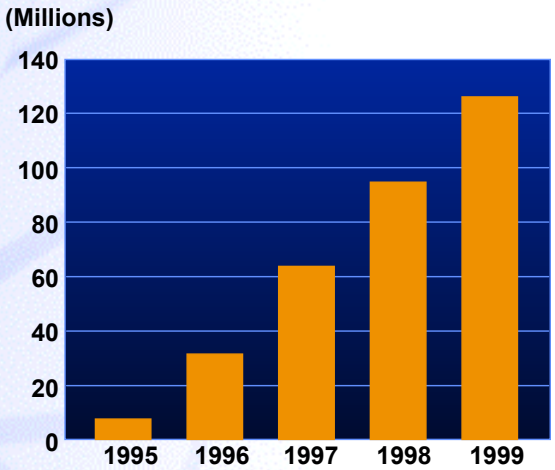
Enterprise Product Portfolio

Drivers of Change

Wide Area Traffic Growth

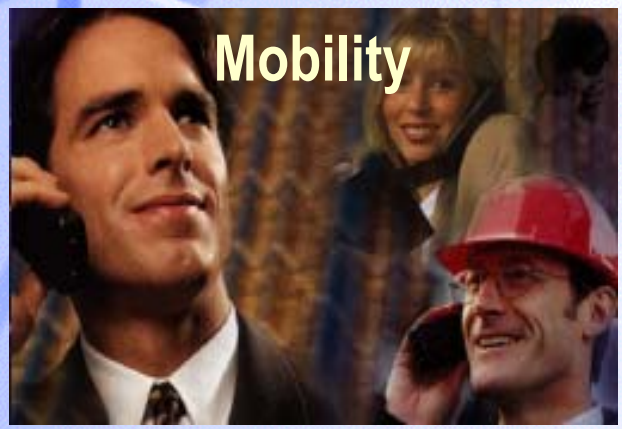


Worldwide Internet Users



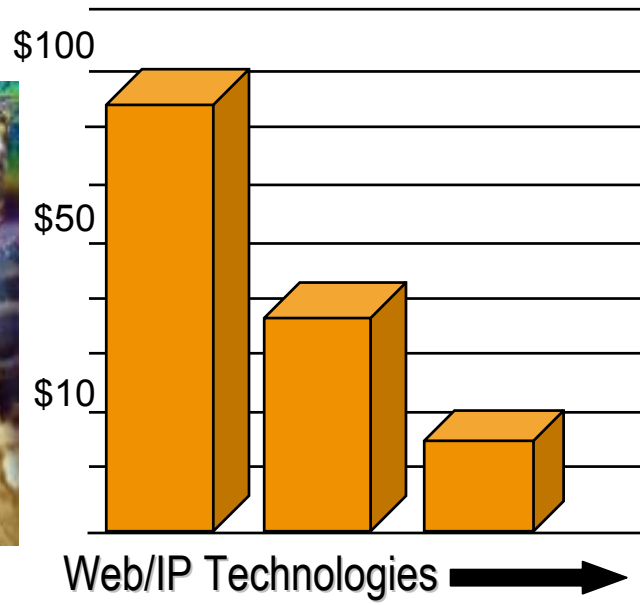
Source: International Data Corporation

Switched L2/L3



Deregulation

Business Costs



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What's IP got to do with it?

- It's open and ubiquitous
- It's connectionless
- It's not sensitive to distance, time or usage
- It rides Moore's & Metcalf's laws
- It's transport independent
- It's application independent
- It's potential is unlimited
- It's getting better at QoS

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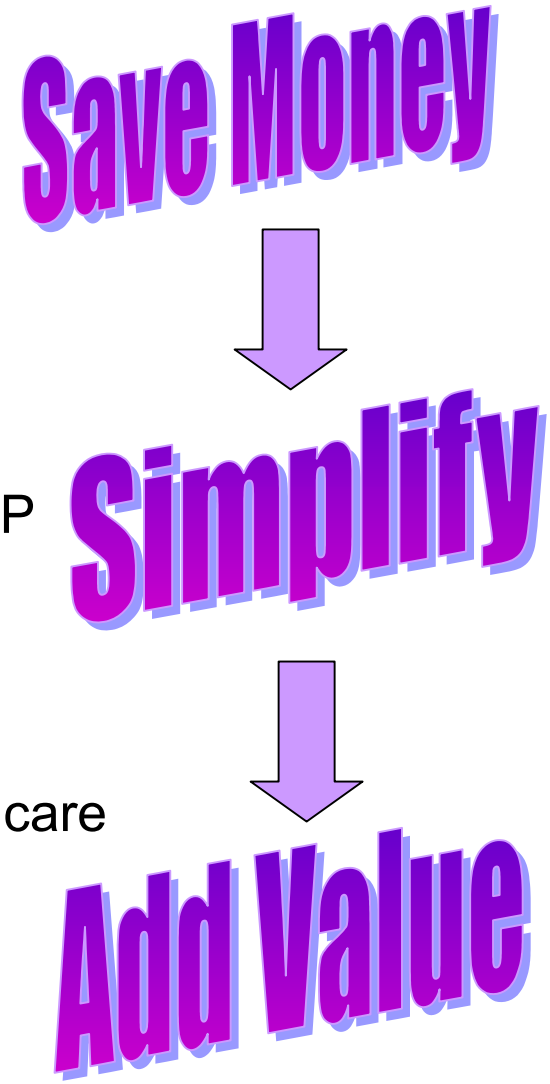
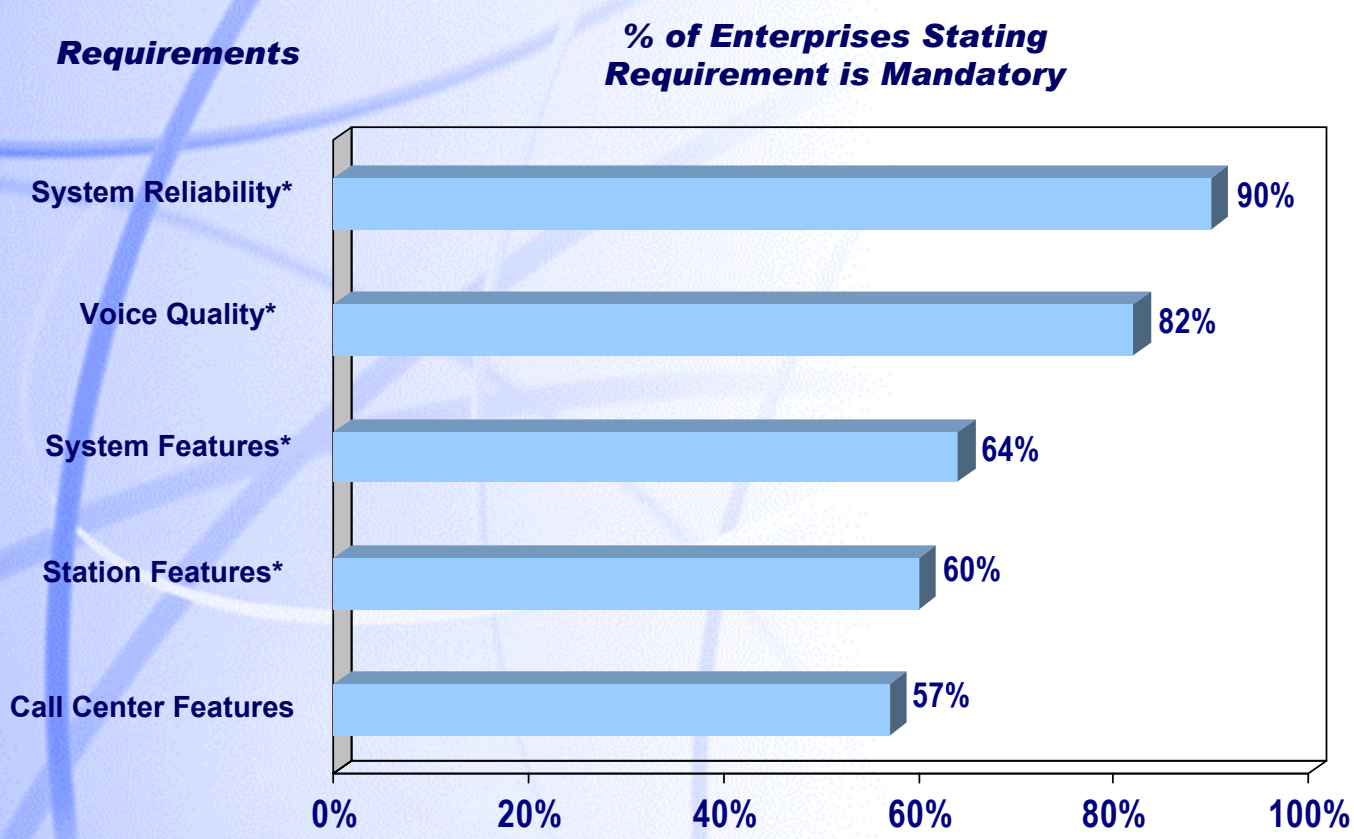
Why IP Telephony is good for customers?

- **Hard Dollar cost reduction**
  - WAN Cost Reduction
  - Improved WAN Price/performance
  - Consolidation of multiple networks in one
- **Operational Improvement**
  - LAN/Campus Integration
  - Simplified moves, adds and changes via IP/DHCP
  - Policy and Directory Consolidation
- **Enhanced Applications**
  - Unified Messaging = improved productivity
  - Web enabled Call Centers = improved customer care
  - Collaborative/ Mobility/Open Applications
  - The WWWs 350M users by 2003



Customer Internet Telephony Requirements

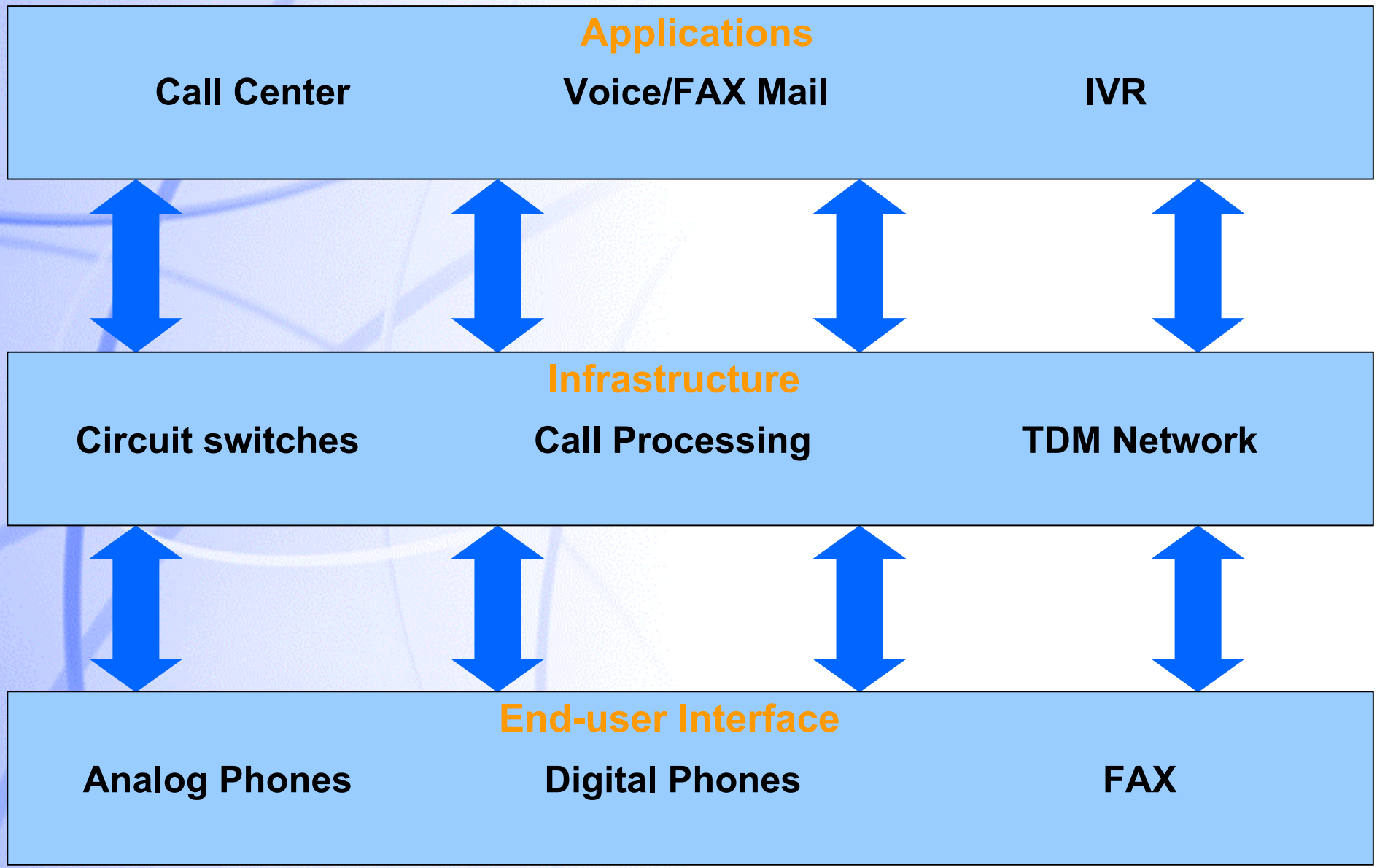


Requirements	Voice Decision Makers	Data Decision Makers
System Reliability*	88%	92%
Voice Quality*	85%	78%
System Features*	65%	64%
Station Features*	61%	58%
Call Center Features	62%	51%

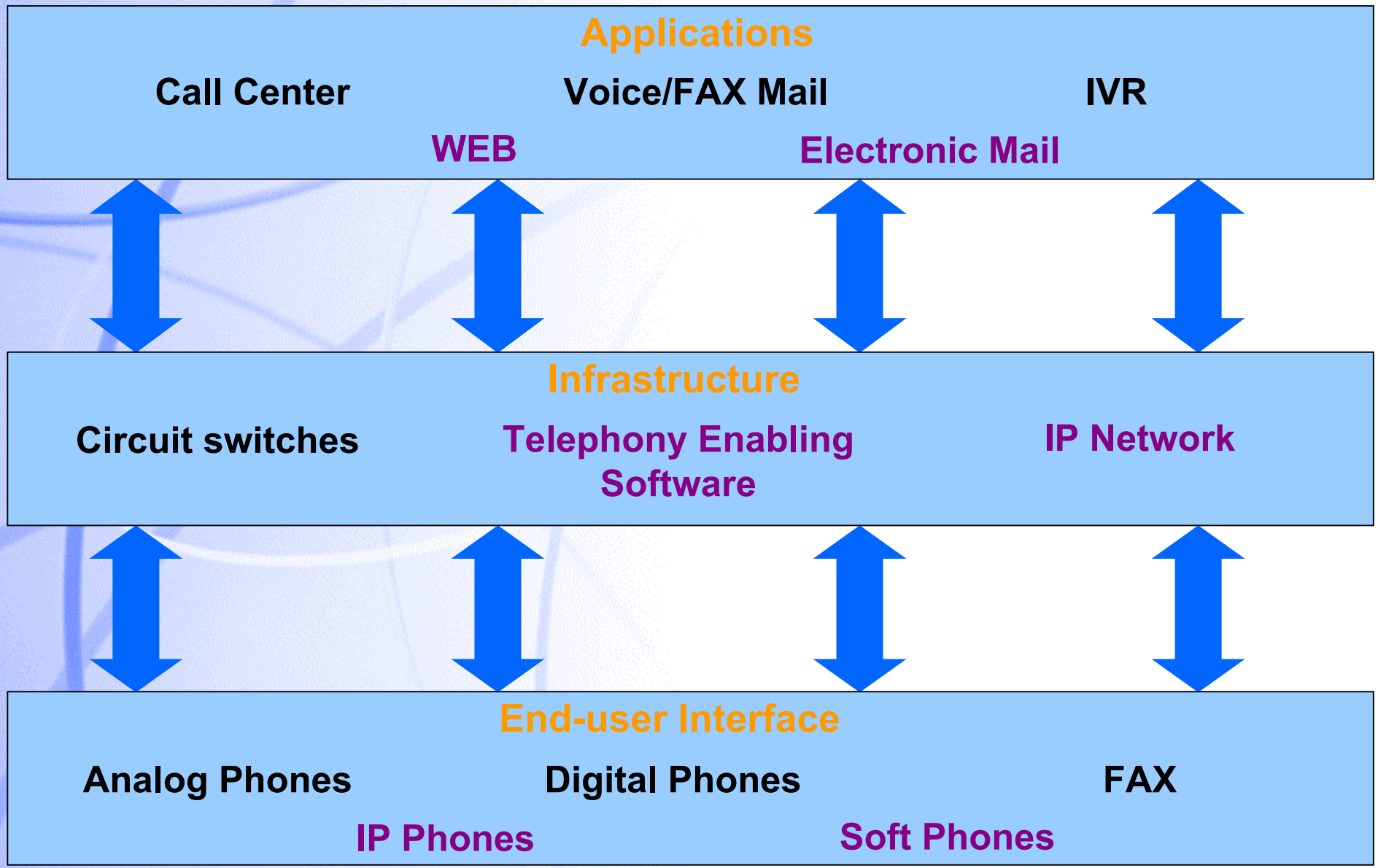
* Equivalent to PBX

Source: Phillips InfoTech

Telephony


Applications
Call Center
Voice/FAX Mail
IVR
Infrastructure
Circuit switches
Call Processing
TDM Network
End-user Interface
Analog Phones
Digital Phones
FAX

Internet Telephony



What to look for in Internet Telephony?

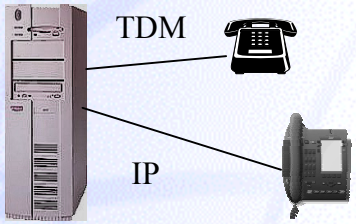
- Quality Telephony
- Extensive feature sets & applications
- Global capability
- Bullet-proof reliability
- Low Total Cost of Ownership
- Scalability
- Skills & support availability

Enterprise Communications

1. Various Roles and Services:
   - Executives
   - Secretarial
   - Customer Engagements
   - Consulting
   - Sales
   - IT
   - Customer Service
   - Customer Care

2. Various Voice Communication Product Solutions:

–Hosted / Centrex



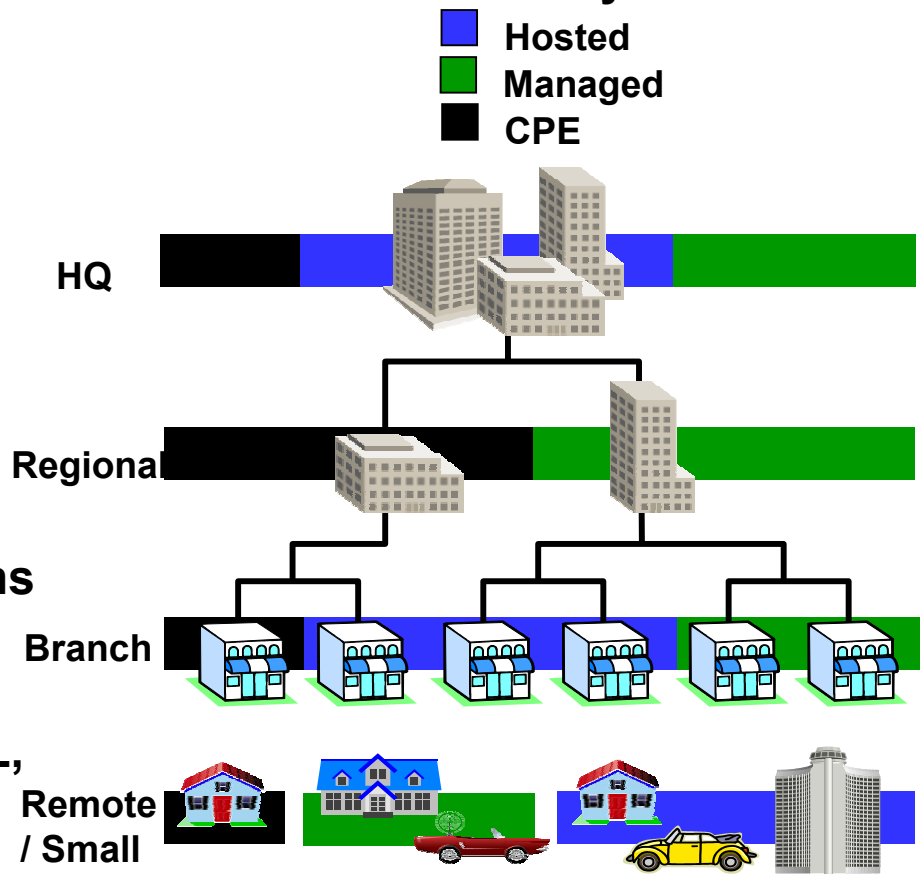
–PBX and IP PBX

–Key System and Small Office solutions

–Dial Access, VoDSL, Mobility

3. Various Locations

4. Various Business Delivery Models:



Enterprise Communications Model is not Homogeneous
VoIP migration must address this environment

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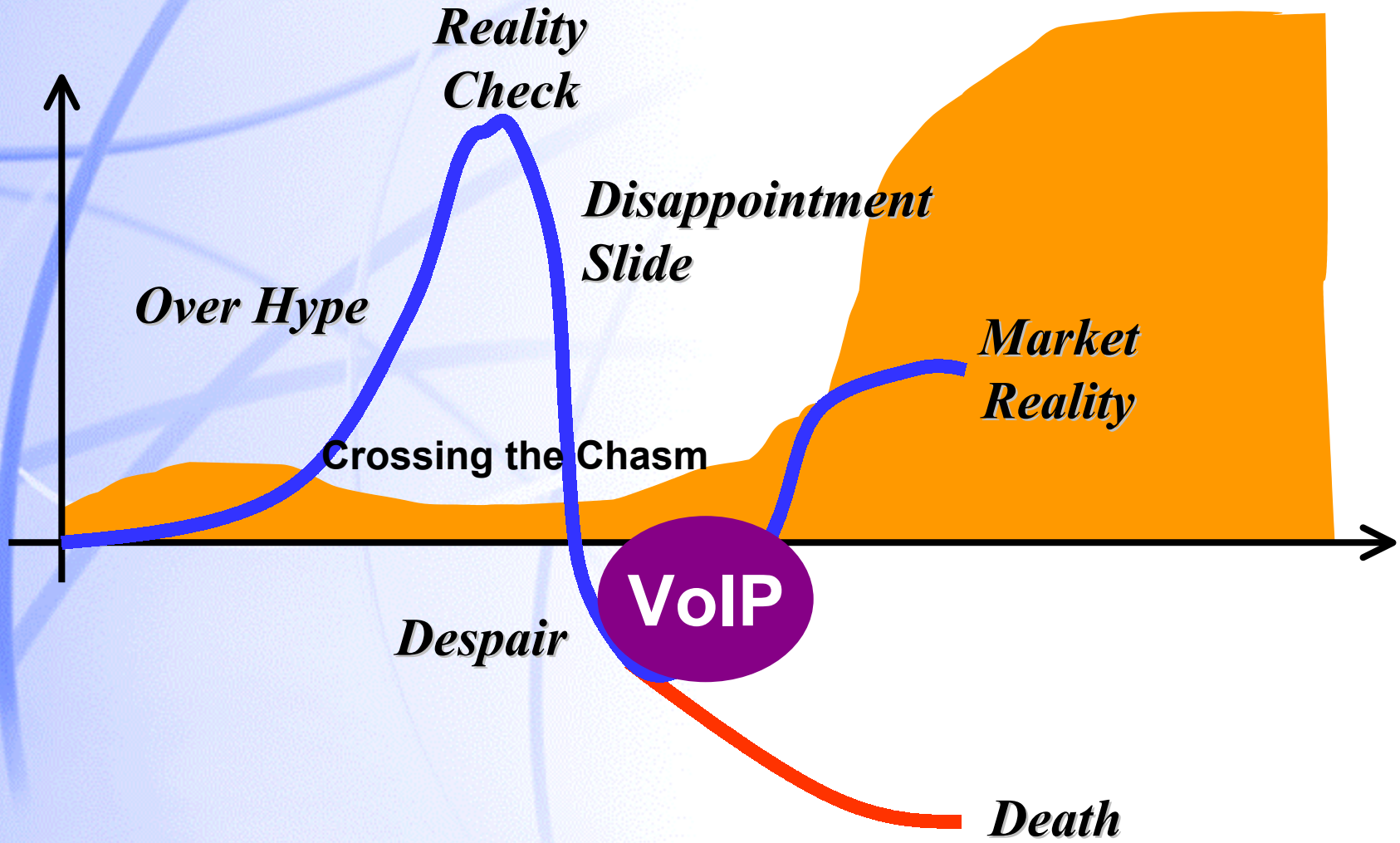
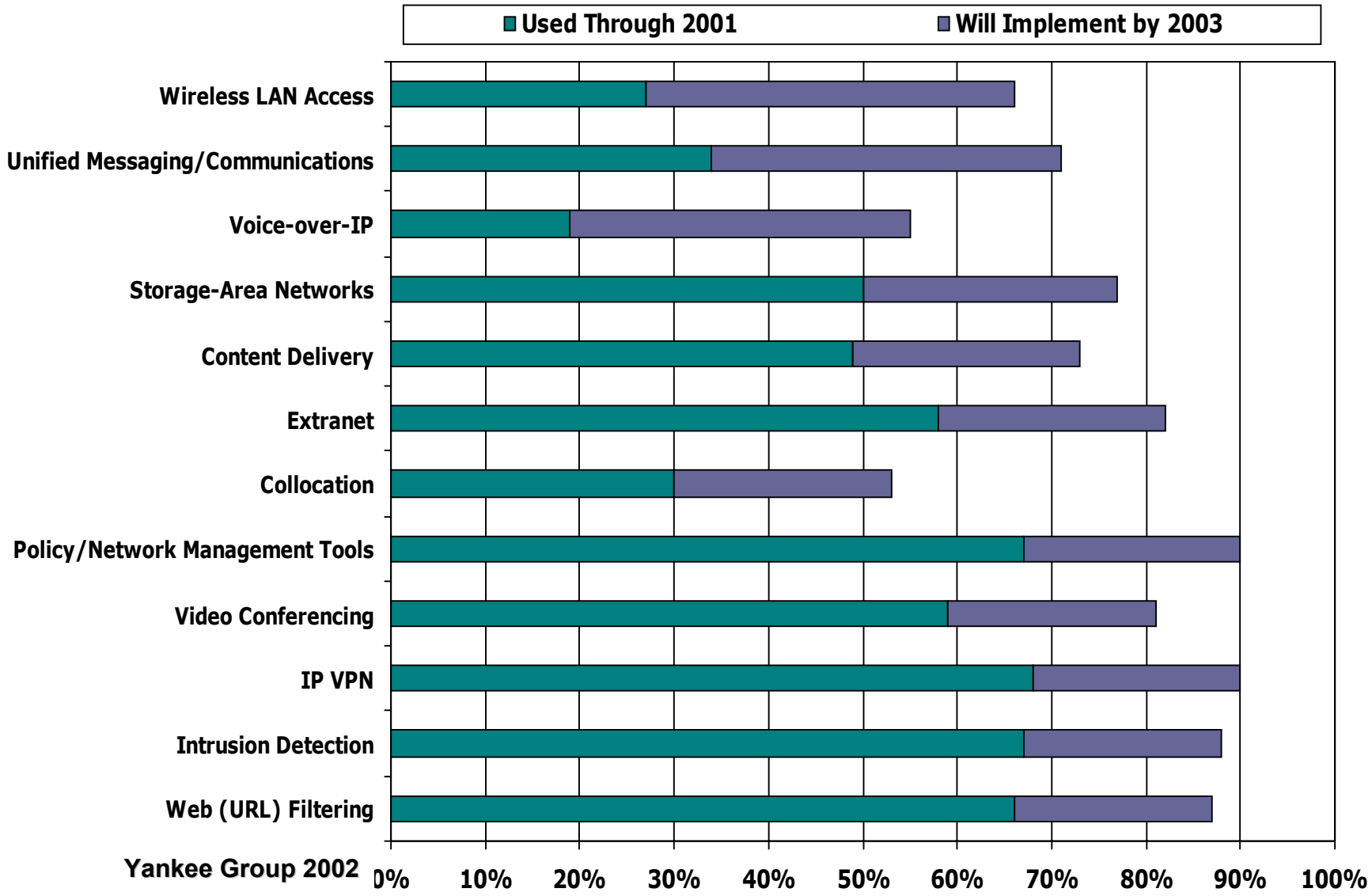
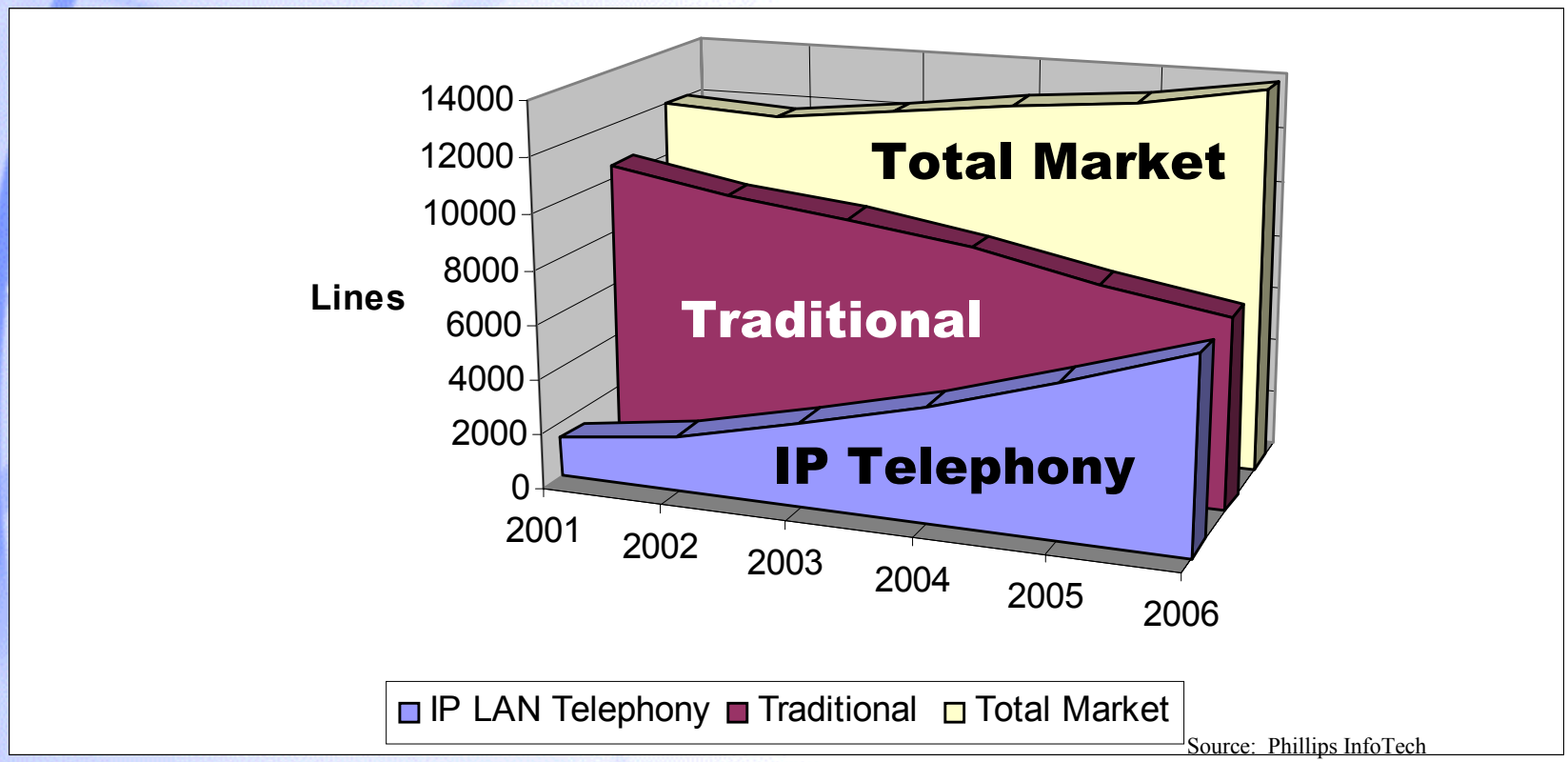
New Technology Introduction Curve...




Used Through 2001
Will Implement by 2003
Wireless LAN Access
Unified Messaging/Communications
Voice-over-IP
Storage-Area Networks
Content Delivery
Extranet
Collocation
Policy/Network Management Tools
Video Conferencing
IP VPN
Intrusion Detection
Web (URL) Filtering
Yankee Group 2002
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

Migration Rate to IP PBXs

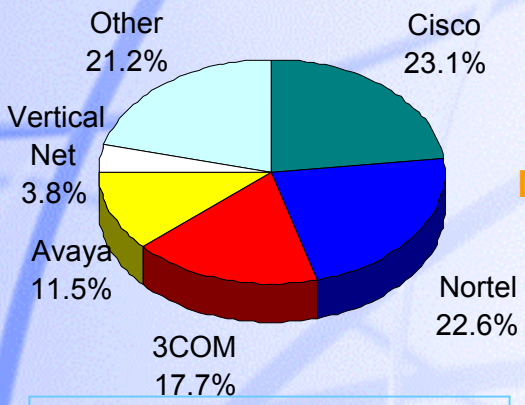
- IP Telephony CAGR at 36%, crossover point for IP and traditional lines in 2006
- The Migration will be Business Case driven – not hype drive



Source: Phillips InfoTech

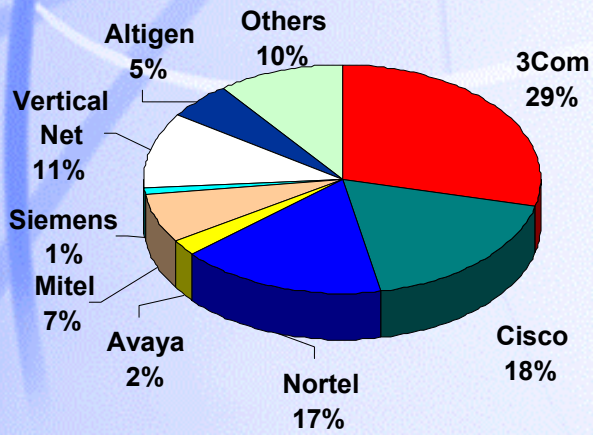
2001 US VoIP Market Share

2001 US Market Share
(Total Lines Shipped)

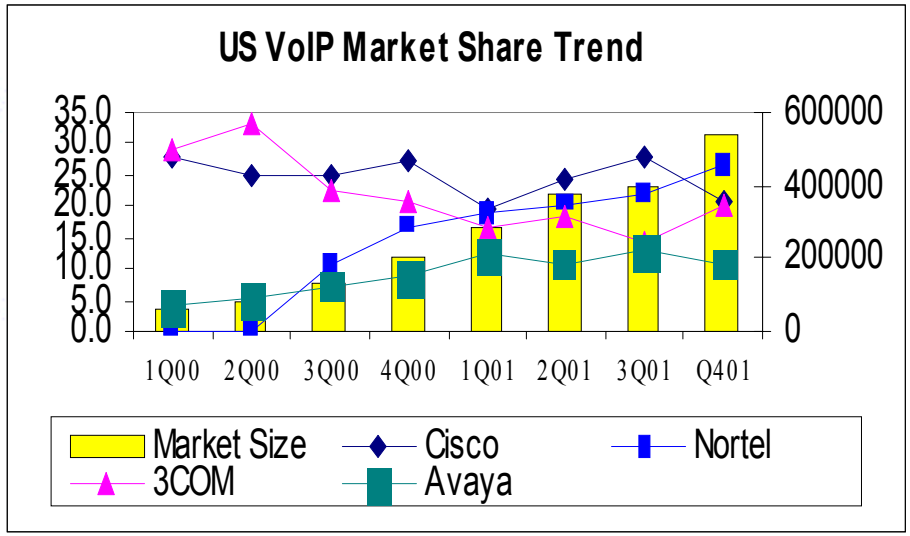


Market Size
$832M

2001 US Market Share
(Total Systems Shipped)



1Q00-4Q01 Market Share Trend
(Lines Shipped)



- **The Enterprise VoIP market grew another 34.4% Q4'01 over Q3'01, and over 229% year over year.**
- **Nortel .5% behind Cisco for 2001 total lines shipped (all categories combined)**
- **Nortel #1 in IP-Enabled segment of VoIP for 2001**
- **Nortel #1 in Converged segment of VoIP for 2001**

Nortel #2 in US Enterprise VoIP 2001

Sources: Phillips InfoTech, April 2002 & Cahners In-Stat

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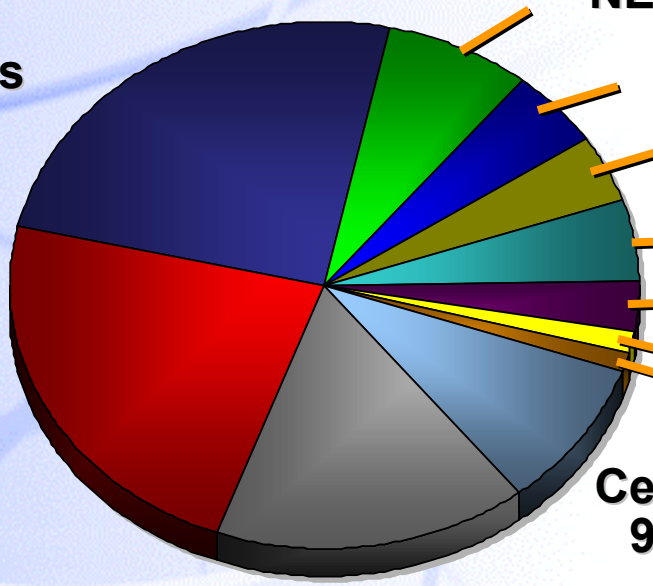
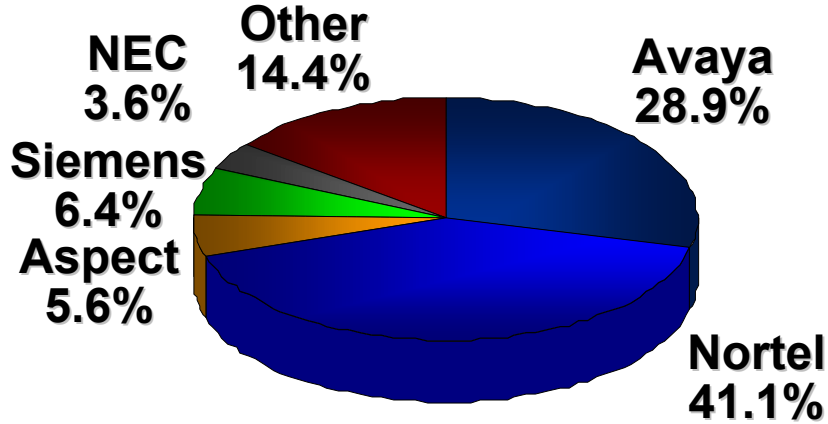
North American Voice Market Share

Phillips InfoTech, Enterprise Communications 2002 report



NA CPE Total Line KTS-PBX-VoIP Aggregate Share 2001

2001 Market Share Market Size: $2,096B



Contact Centers

Interoperability and Standards

- **Control Standards**
  - H323
  - Megaco
  - SIP
- **Codec**
  - Seems to be converging on:
    - G729
    - G711 – PCM

Summary of Market Data

- Internet Telephony is a reality - it will happen
- Knowing how and when is the challenge
- Customers will NOT adopt incomplete solutions
- Installed based TDM transition is a key requirement
- Inter-working is critical
- Common components should be offered
- Standards are needed for openness

Delivering Voice Services over IP Networks

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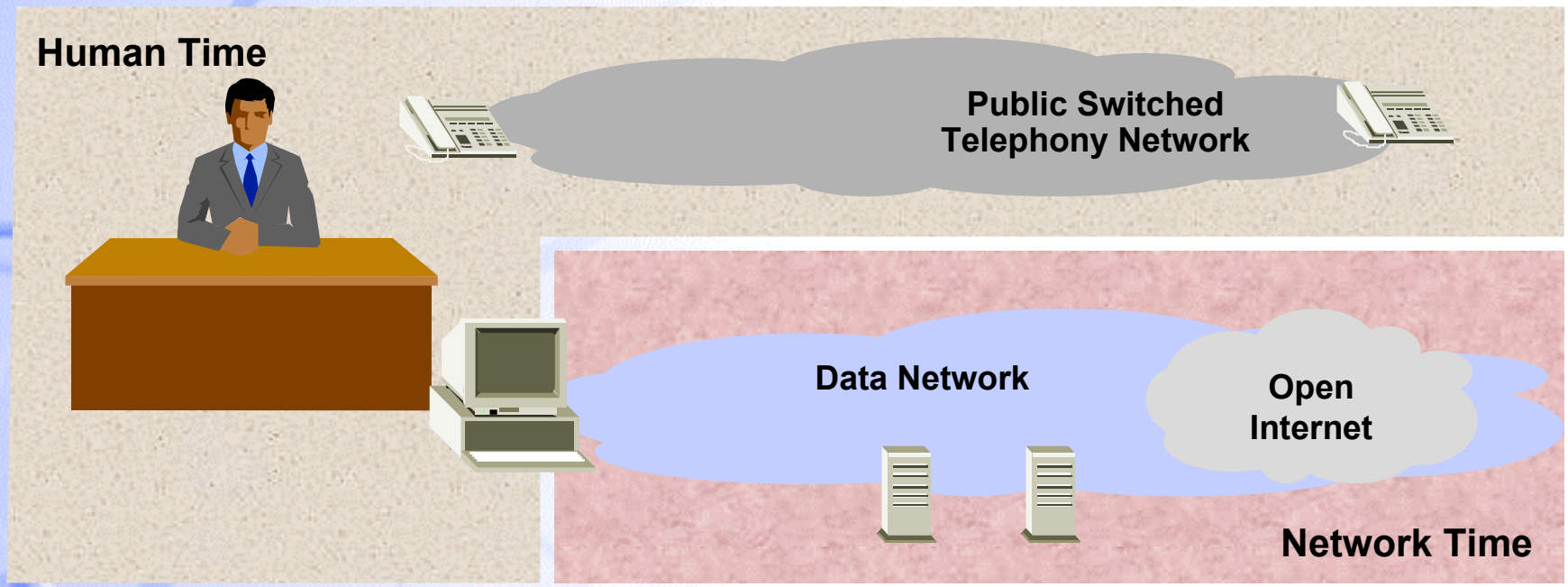
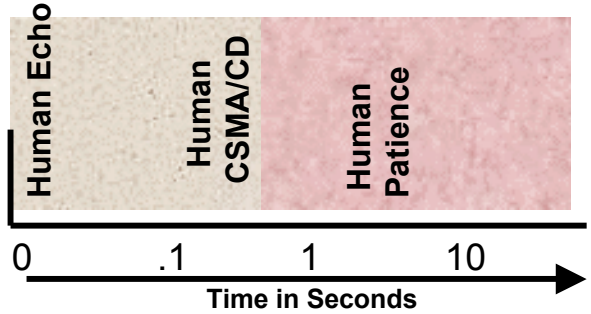
Human Time Versus Network Time

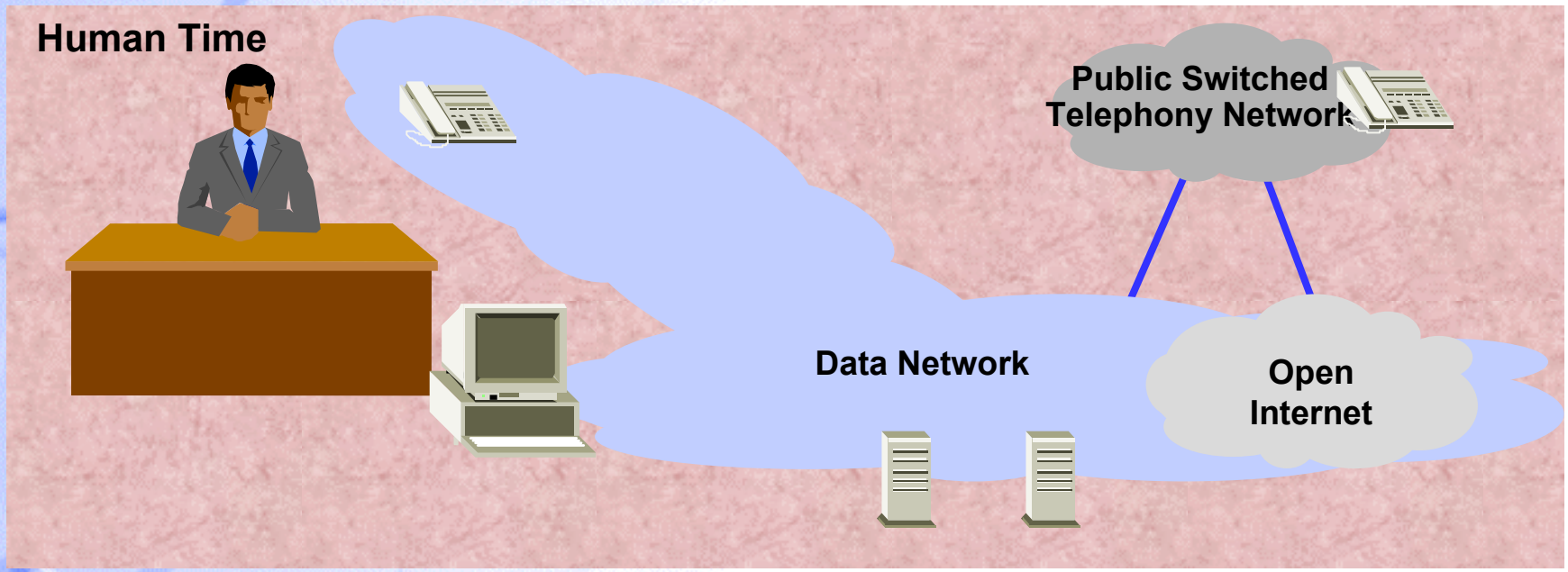


- Human time is based on interpersonal communications and human tolerance for delay
- Human time dominates voice and video communication
- The PC operates in human time to the user and isolates him from network time
- Data network time is for batch functions (file transfer, printing, Web pages, etc.) and is based on patience
- Human interaction "CSMA/CD" defines the edge of human time at about 250-300 msecs

Human Tolerance of Delay

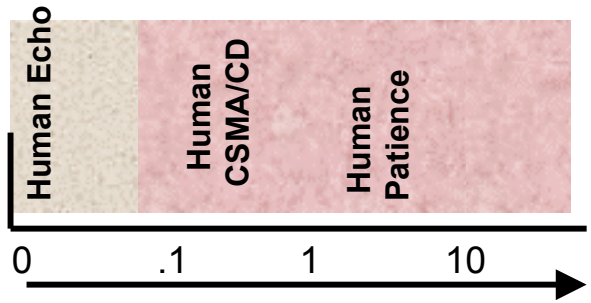


Data networks must operate in human time



- Data networks must support human time in the future
- VoIP and VideoIP require human time
- Collaboration and community applications on the data network have strong interaction component and must operate in human time to succeed
- Network computing and thin clients require human time services
- Policy and QoS are the only way to meld human time onto the data network and maintain the overall capabilities of the system

Human Tolerance of Delay



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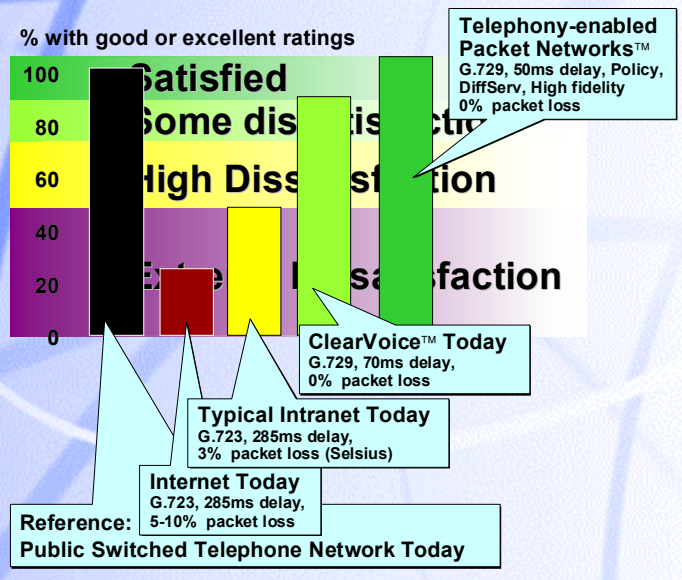
Telephony Session Quality

Nortel Networks test of consumer expectations for voice quality, 1998



Delay Impact on Perceived Voice Quality

Round Trip Delay	%Poor or Worse
150 msec	3
175 msec	4
200 msec	5.5
225 msec	6.5
250 msec	8
300 msec	10.5

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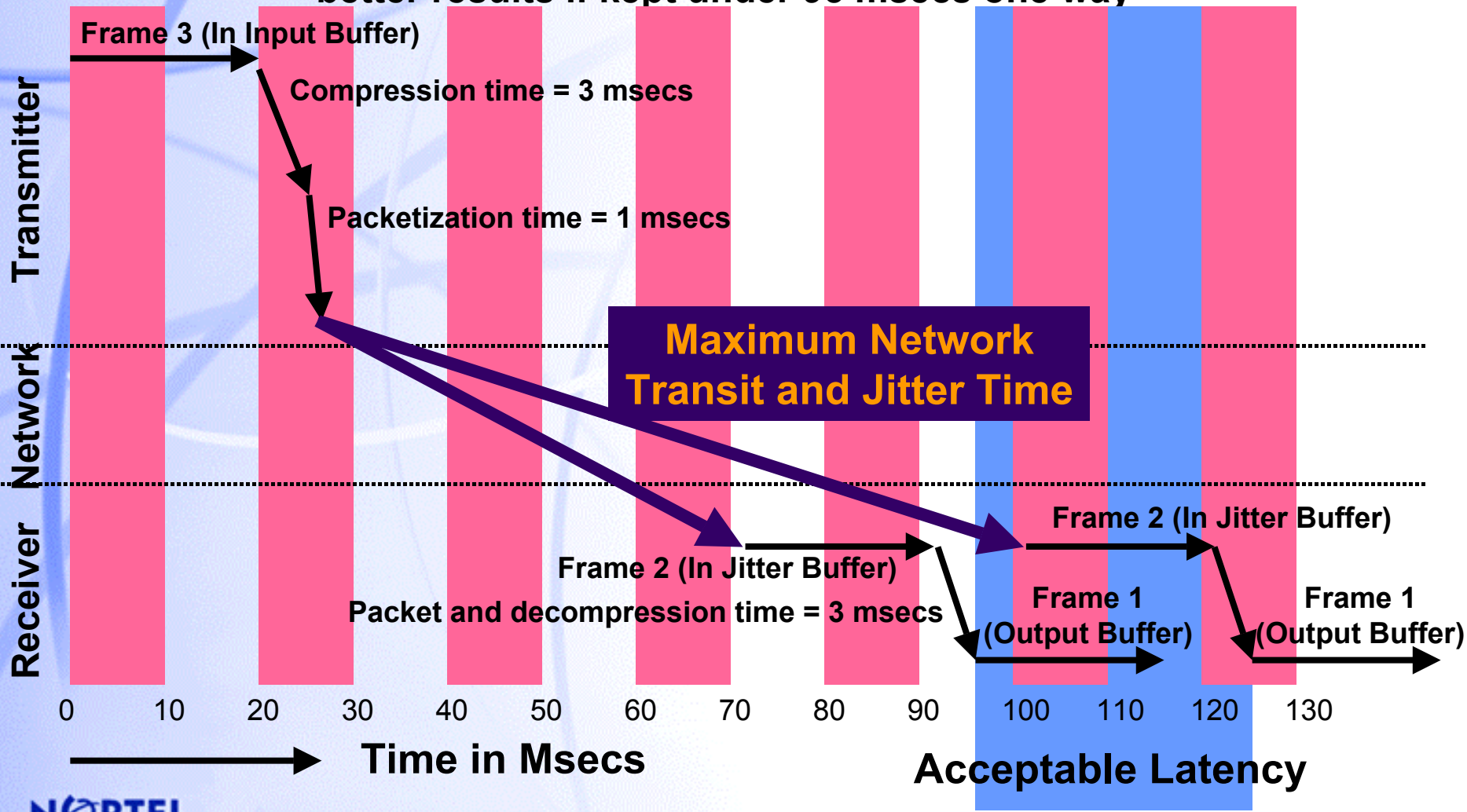
Latency is a sum of the parts

- Quantitization time (10-30 msecs) - the sample time to generate a discretely sampled element
- Compression time (2-10 msecs) - the time it takes to compress the voice into packet form
- Packetization time (1msec) - processing time to assemble and transmit the packet
- Network transit time (variable) - the time to transition the network
- Reverse packet and decompression (2-3 msecs) - the time it takes on the receiving end to output the samples
- Latency is for a round trip

Time model of network

Round trip time must be less than 250 msecs or 125 msecs one way (voice input to output) to meet criteria for telephony quality interactive voice - better results if kept under 95 msecs one way



Network transit time

- **Additional Jitter Packets = 20 msecs each**
- **Packet Transmission time =** $\frac{\text{Distance}}{.8*\text{SoL}} + \frac{\text{Packet Length}}{\text{Tx speed}}$
- **For 5000 miles = 38 msecs**
- **Switch or Router hops**
  - Switch hops with cut-through < 1 msec
  - Routers can add time - 1-3 msecs
- **Total must be less than 75 msecs at all times**
  - For a ten router hop net with two extra jitter packets and a 5000 mile trip, the total is: 98 msecs

Keys to successful voice is minimizing jitter packets through QoS/CoS, and grooming the network for router hops

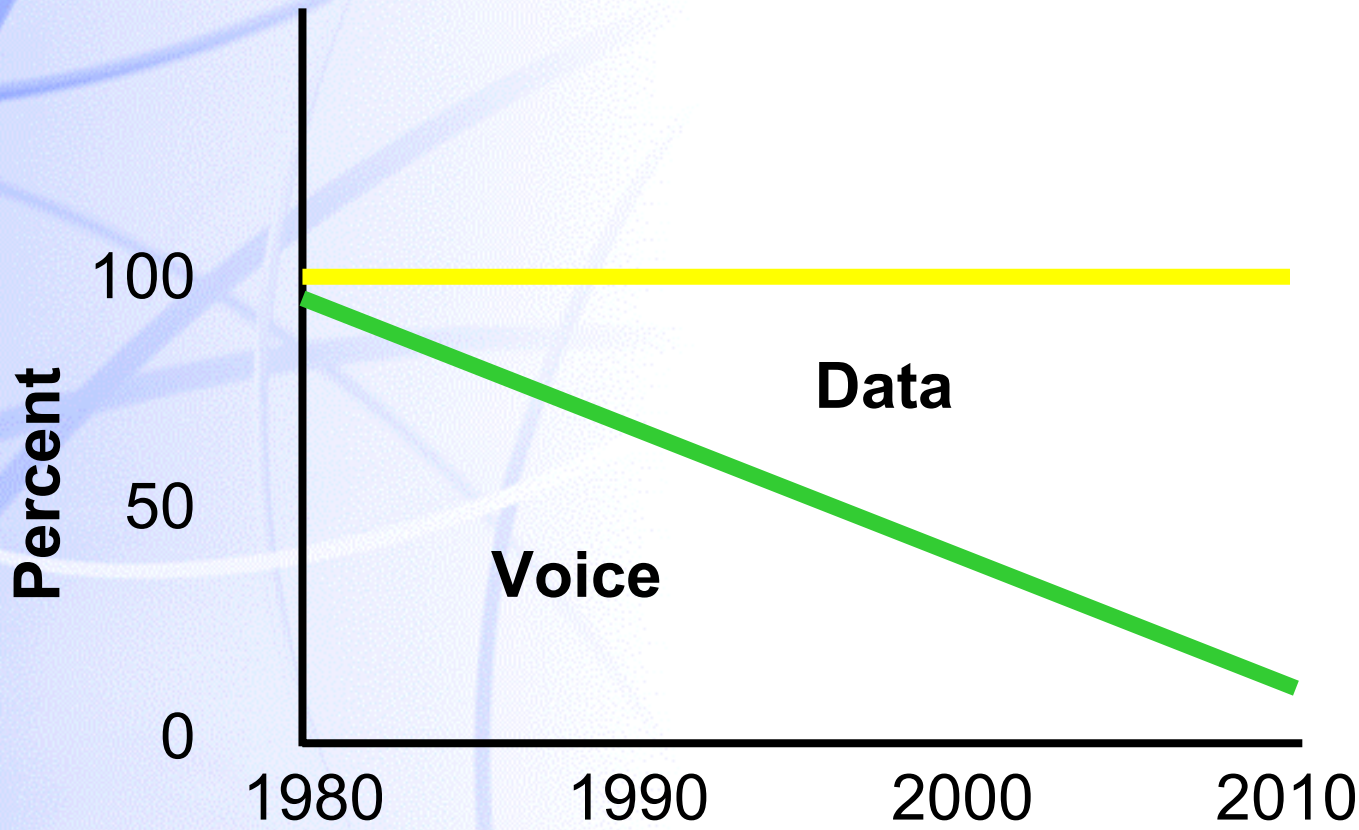
Lost Packets

- **Each packet represents about 20 msecs of voice**
  - A single lost packet is noticeable (there is no time for error correction)
  - Multiple packets lost (or underruns) is interpreted as bad quality
  - Packets are lost due to errors or congestion
- **Typical Bit Error Rates of current networks generate acceptable performance**
  - BER = 10^{-8} (100,000,000 bits transmitted without an error)
  - Assume total of transited hops is 10

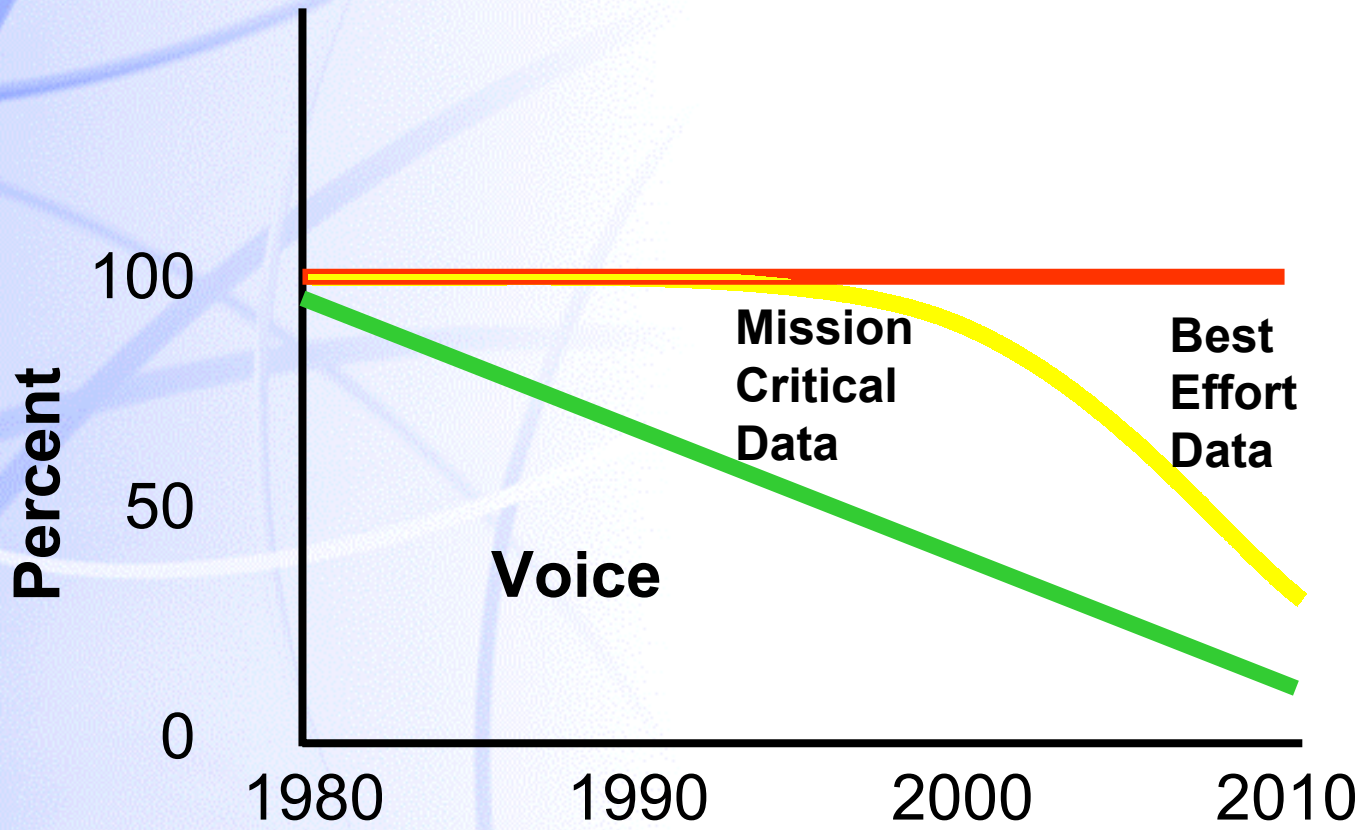
$$\frac{10^8 \text{ bits}}{(10 \text{ hops})(15000 \text{ bps} * 60\text{s/m})} = 11 \text{ minutes between occurrences}$$

Reliable BER generates acceptable voice, lost packets due to congestion (no QoS queuing) will dramatically degrade quality as will high BER networks paths or circuits

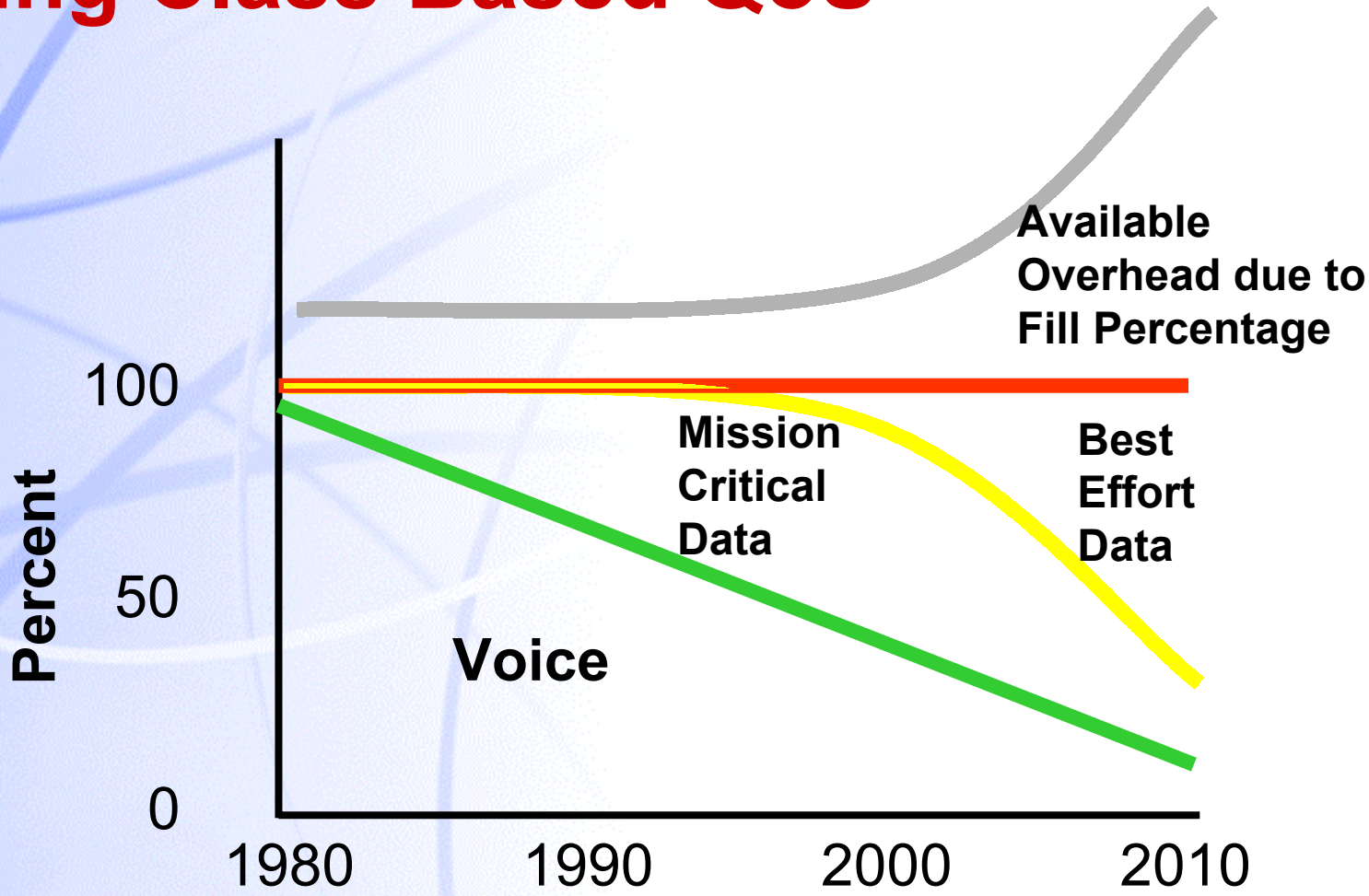
Driving Class Based QoS



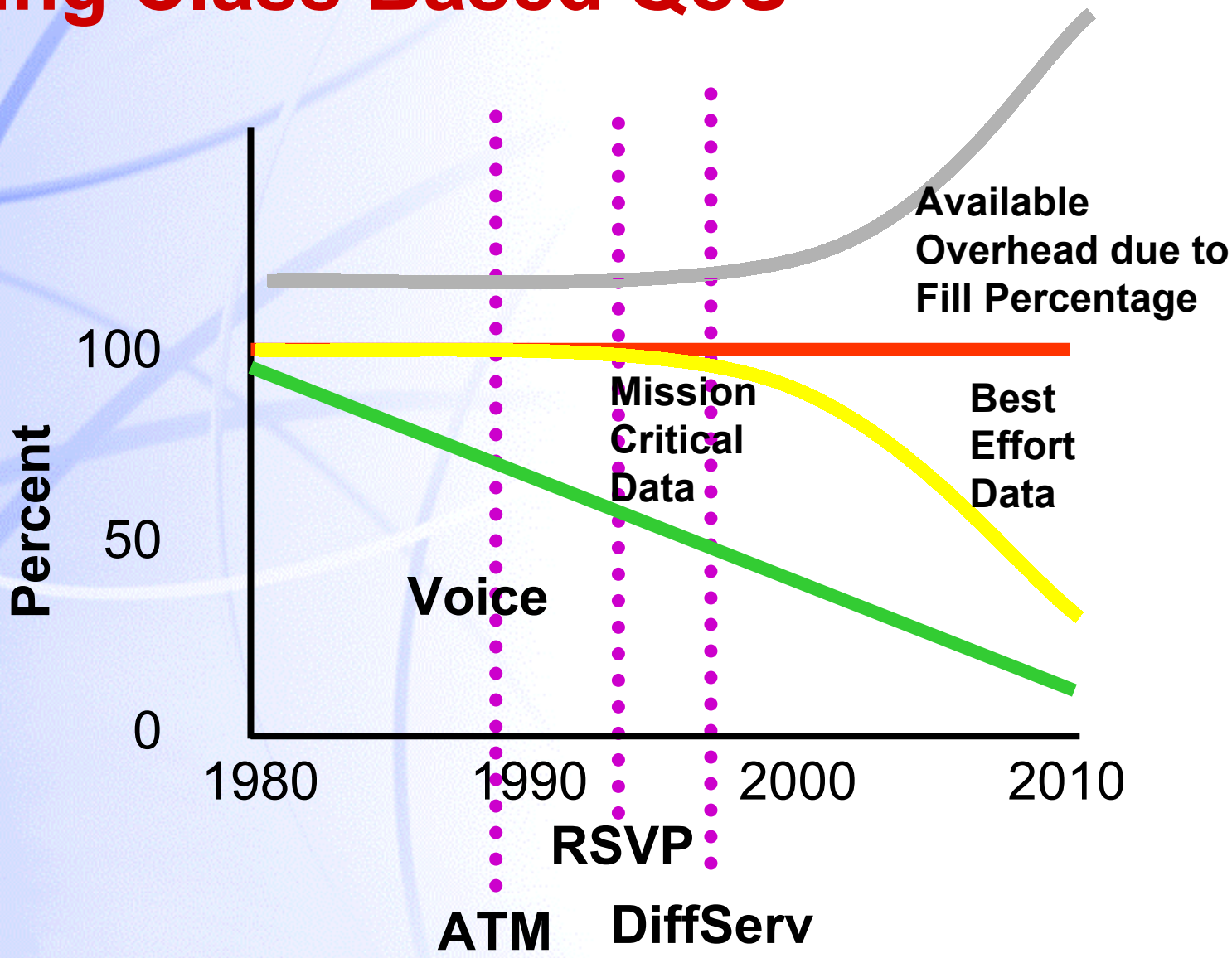
Driving Class Based QoS



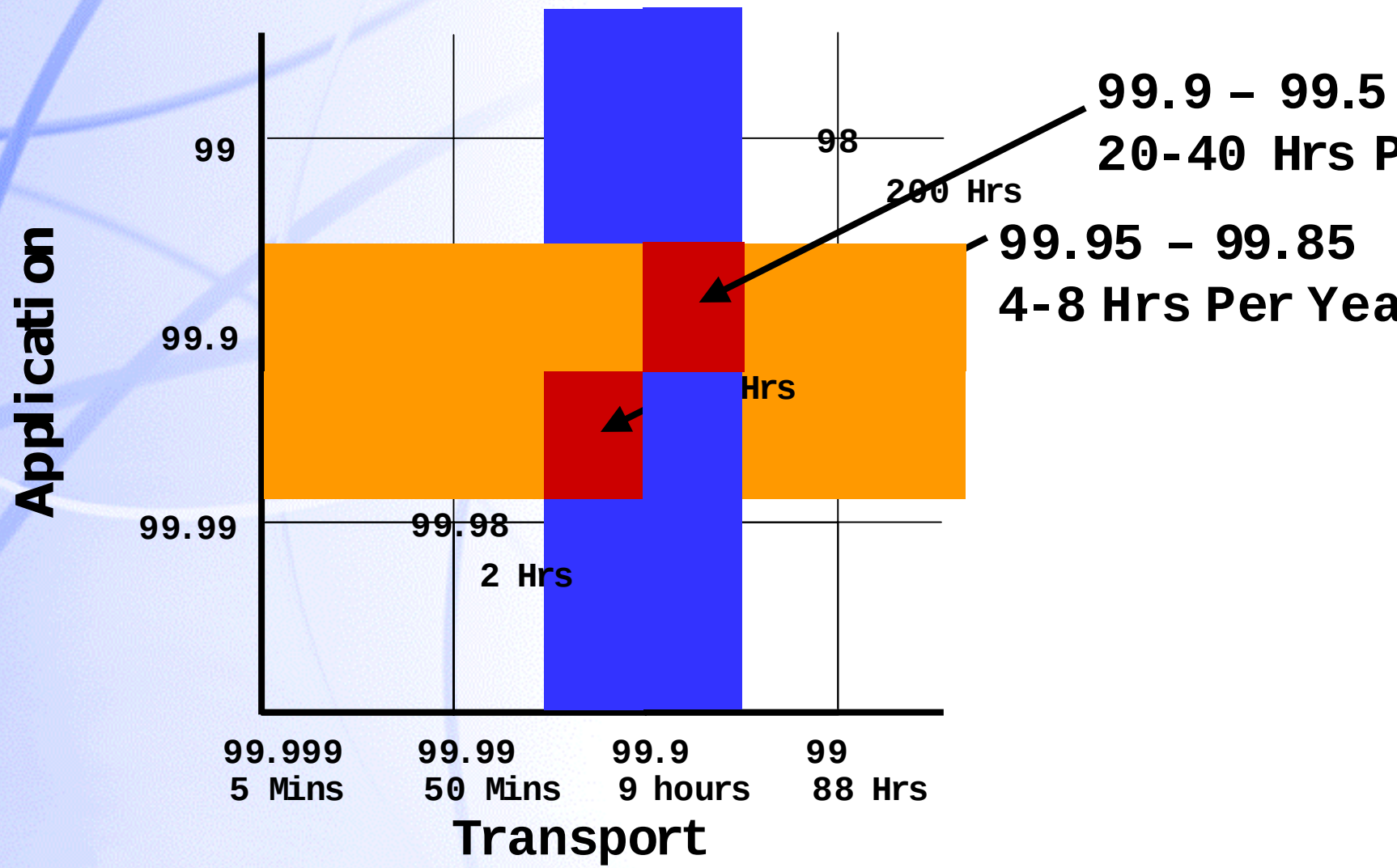
Driving Class Based QoS



Driving Class Based QoS



Reliability Transformation



Decision Values of VoIP

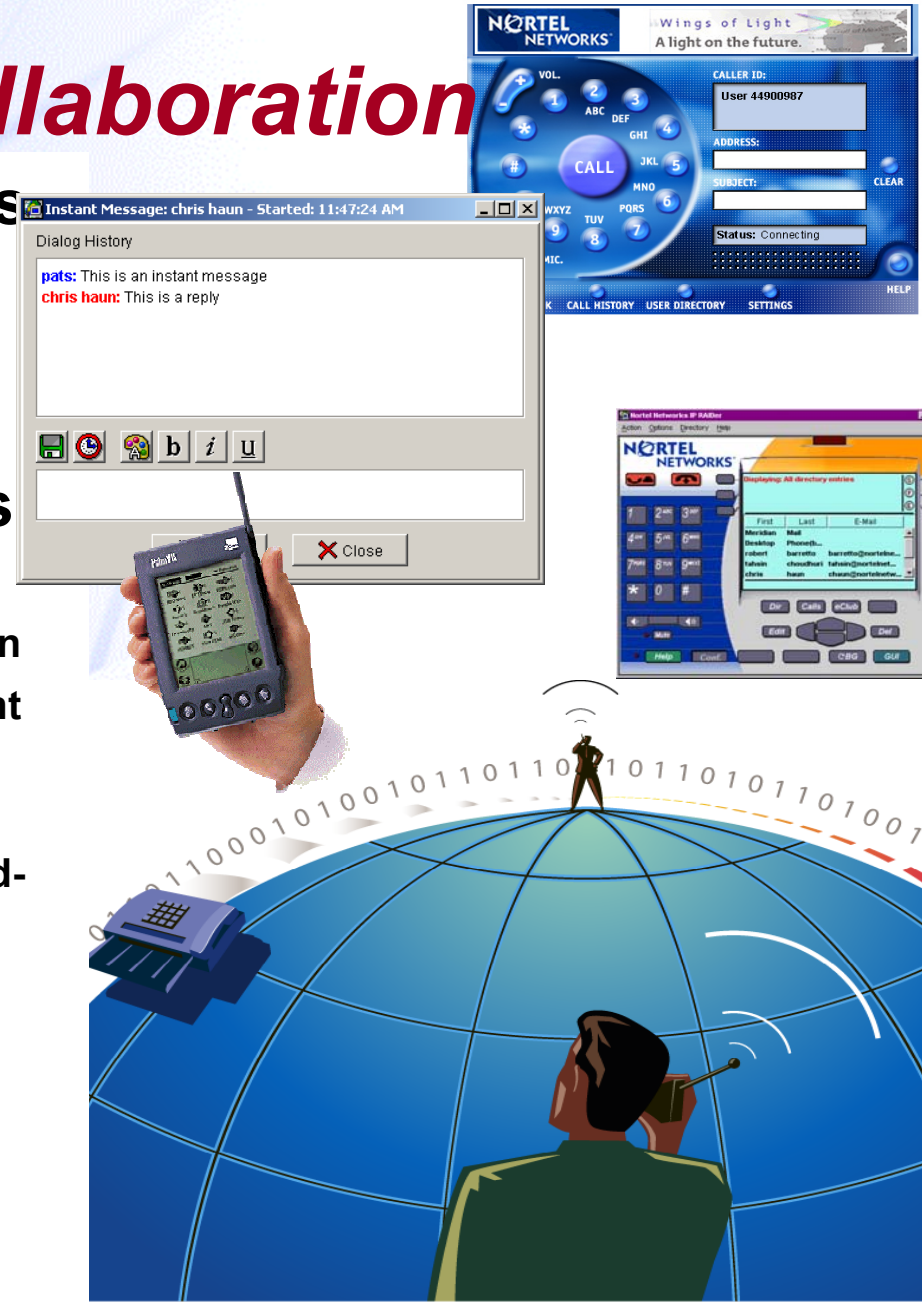
- Control Integration
- Media Integration
- Cost

VoIP Control Integration

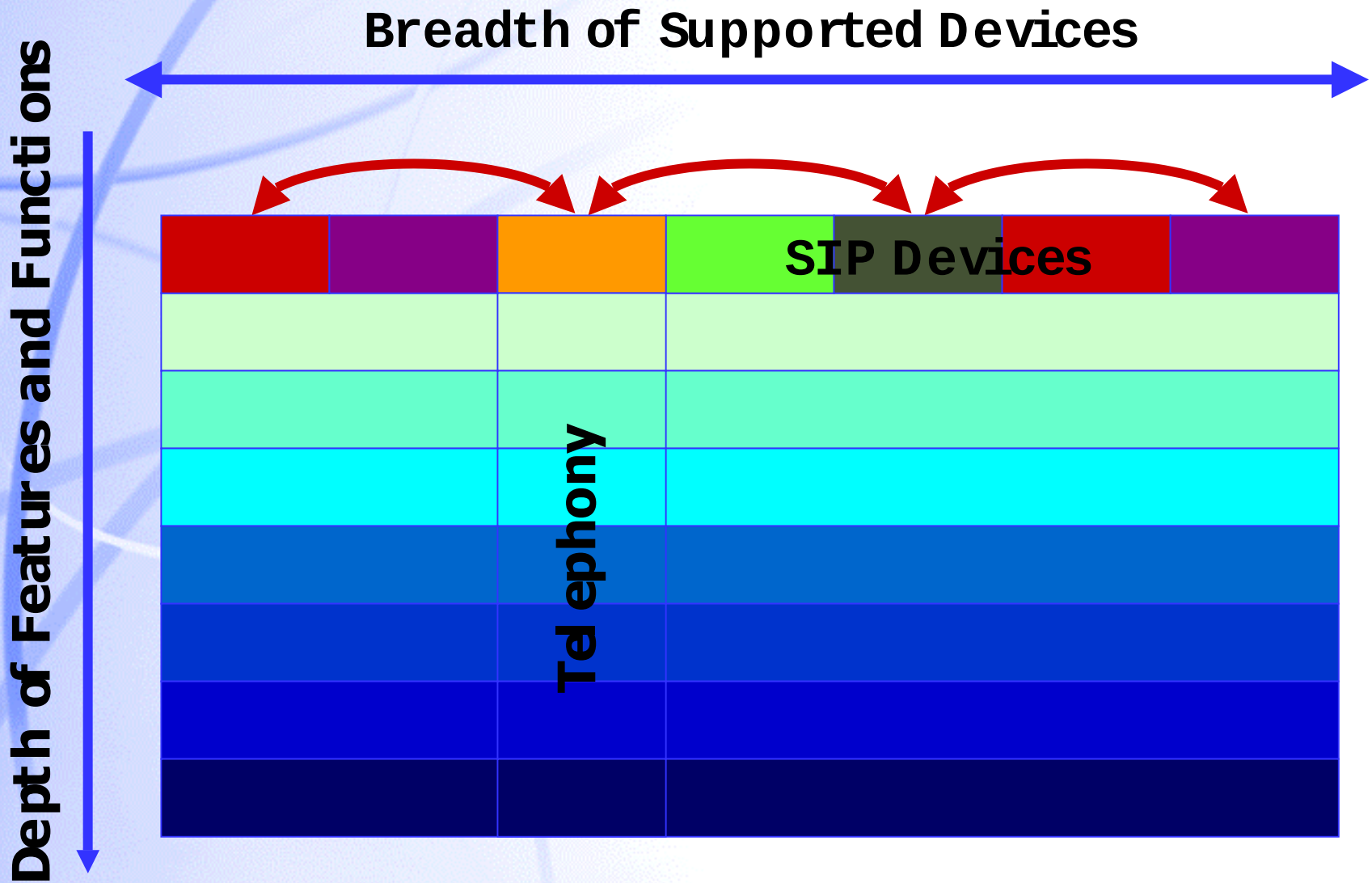
- **Will be the ultimate driver**
- **Application Integration**
- **Currently based on TAPI**
  - Just like a PBX
- **Future is web paradigm**

SIP Integration
Multimedia Collaboration

- **Multimedia Services**
  - Videoconferencing
  - Instant Messaging
  - Audio & video streaming
- **Telephony Services**
  - Call redirect
  - Multiple server registration
  - Real time call management
- **Mobility**
  - Dynamic registration, Find-me/Follow-me
  - Hoteling
- **Personalization**
  - Personal Call Agent
  - Dynamic Call Handling



SIP and Telephony



VoIP Media Integration

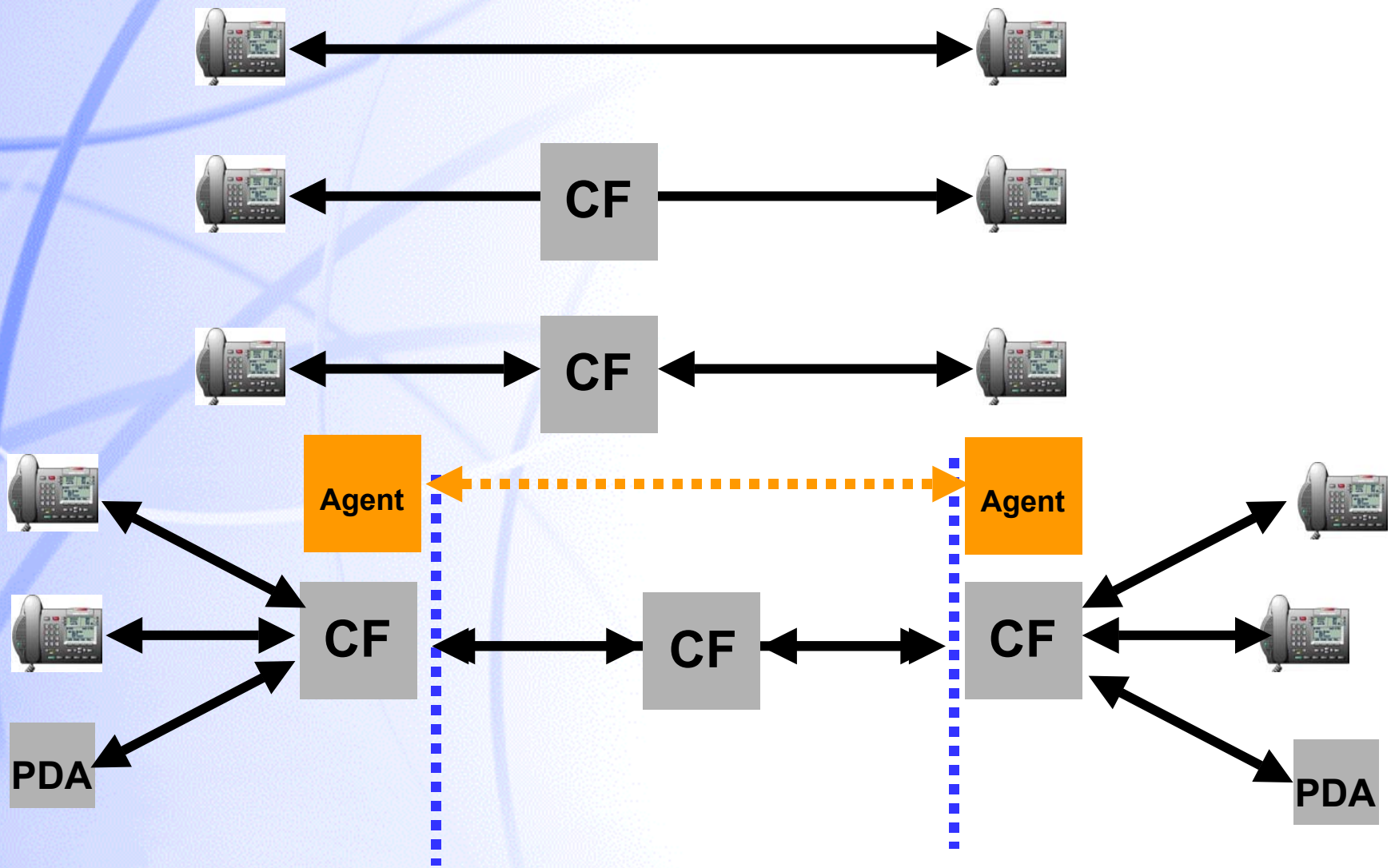
- **Single wire value**
- **Not typical - VoIP is emerging as a separate device from the PC**
- **Media integration values**
  - Recording
  - Synthesizing
  - Transforming

  → **Better as Server Functions**
- **As voice is person to person, media alterations reduce value**
  - Potential for handicapped access and dating
- **Future values of packetized voice will emerge**

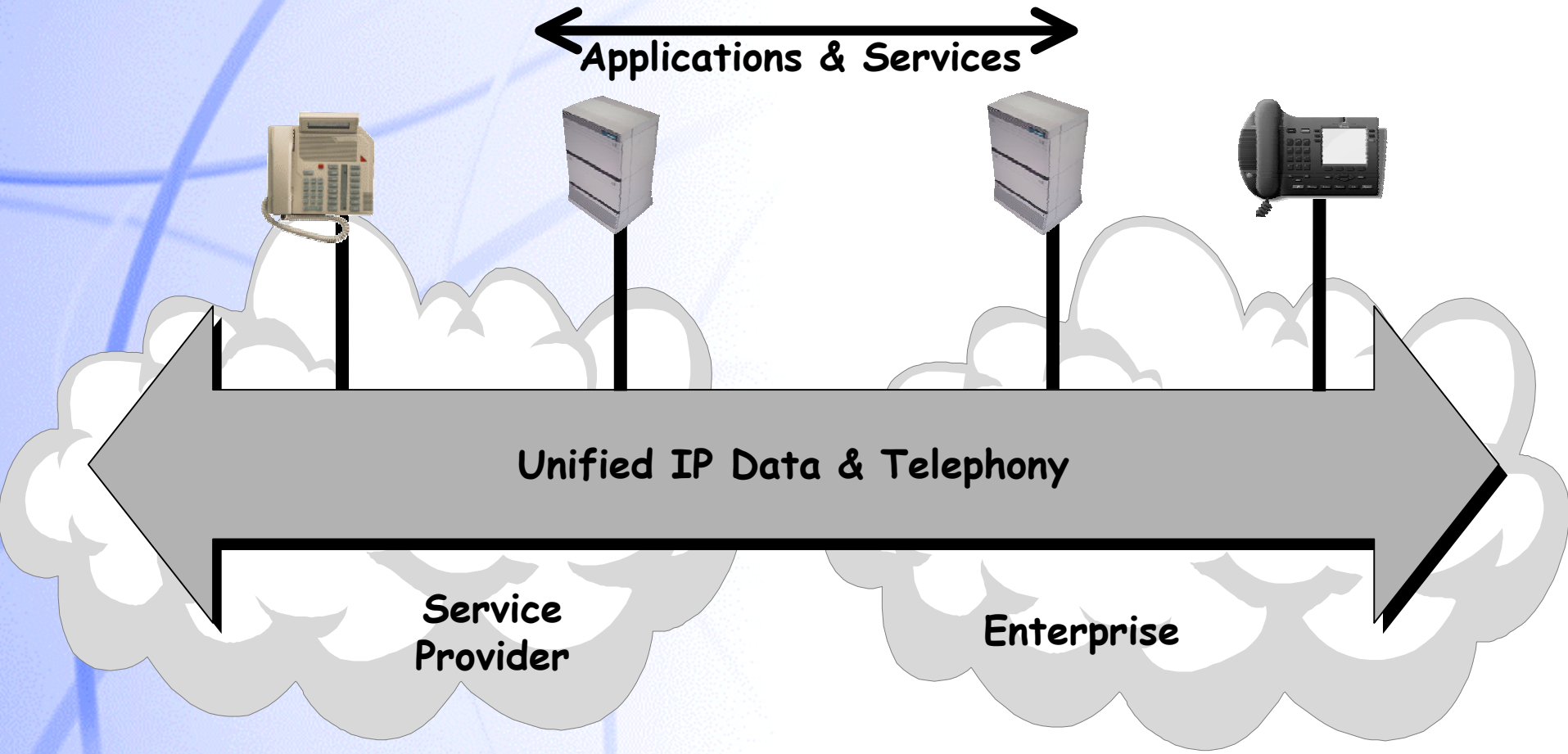
New Media Capabilities

- **New Conferencing Paradigm**
  - 500 microsec added latency
  - 10-100K conference ports on a PC
  - Fungible in growth
- **New Capabilities**
  - Constant Conferencing
  - Every Call includes a conference call
  - Audio “Virtual Space”
  - Integrated Personal Agent technology

Redefining Inter-human Communications



Think of telephony like we think of the Web



What is it like?

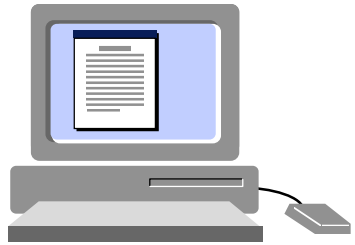
- "Phone calls can be URLs"
- A conference call is an object… you can "E-mail me a conference call"
- Telephony apps are buttons on Web pages
- Voice control panel is Web browser
- Like the Web, telephony value & content can be anywhere
- Streaming Web audio/video is now part of telephony
- Service creation is rapid
- This vision drives IP Enabled and Succession

VoIP Cost Impact

- **Acquisition cost**
  - VoIP equipment
  - IP capable network
- **Ownership cost**
  - MAC (Moves, Adds, and Changes)
  - Support
  - Other functions
    - 911 tracking

Note: all costs are in US Dollars

Desktop Cost Comparison



$1 per day
Nortel/Customer Analysis

$35 per day
Gartner Group Data ($68 total Computing)

Typical IT Dept spends less than 3% of budget on voice

Now VoIP?
- Intelligent Edge
- Distributed Intelligence
- Increased Support

Computing Trends
- Network Computing
- Network Displays
- Centralized models

Gut Feel - is this really going to be less?

Long Distance - the real value?

- Assume 1 hour per day per employee
- Assume 50% is intra-business (within the company)
- Current long distance at under $.05 going to 2 cents
- Cost of long distance at 2 cents is $288 per employee per year, $144 for intra-business
- Assume one pair of VoIP ports for every 3-5 employees
  - Trunk and line or trunk
- At $600 per port,and all intra-business long distance on IP and no charge for bandwidth:
- Payback is about 2-3 years

International Traffic is the Real Value

Is it really free?

A few decades hence, energy may be free - just like unmetered air.

John von Neumann, 1956

What if it is really free?

- **Assume that the VoIP equipment is free**
  - All telephones, gateways, gatekeepers, call processors, etc.
  - All maintenance and support
- **But …. You have to live with…..**

Data reliability of 99%

versus

Voice Reliability of 99.999%

In other words, telephones go from 5 minutes to 88 hours per year of unavailability to your customers

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The real cost of reliability loss

- **Assume that of the 88 hours, 30 occur during business time**
  - Average business is open 6x9 = 2815 hours per year
  - Total hours = 8760
  - Average open is 32%
  - 32% of 88 is 28 hours - round up because of Murphy's Law
- **Assume $300,000 revenue per employee with 50% gross margin**
- **Lost revenue = 30hrs/2815hrs * $300K = $3197 per year**
- **Assume 50% margin - margin/earning loss is = $1598 per year**

What a savings!!!!

To Save……

$1 per day
about $250 per year

….the business lost over

$1598 per year!

And the CIO lost his job….

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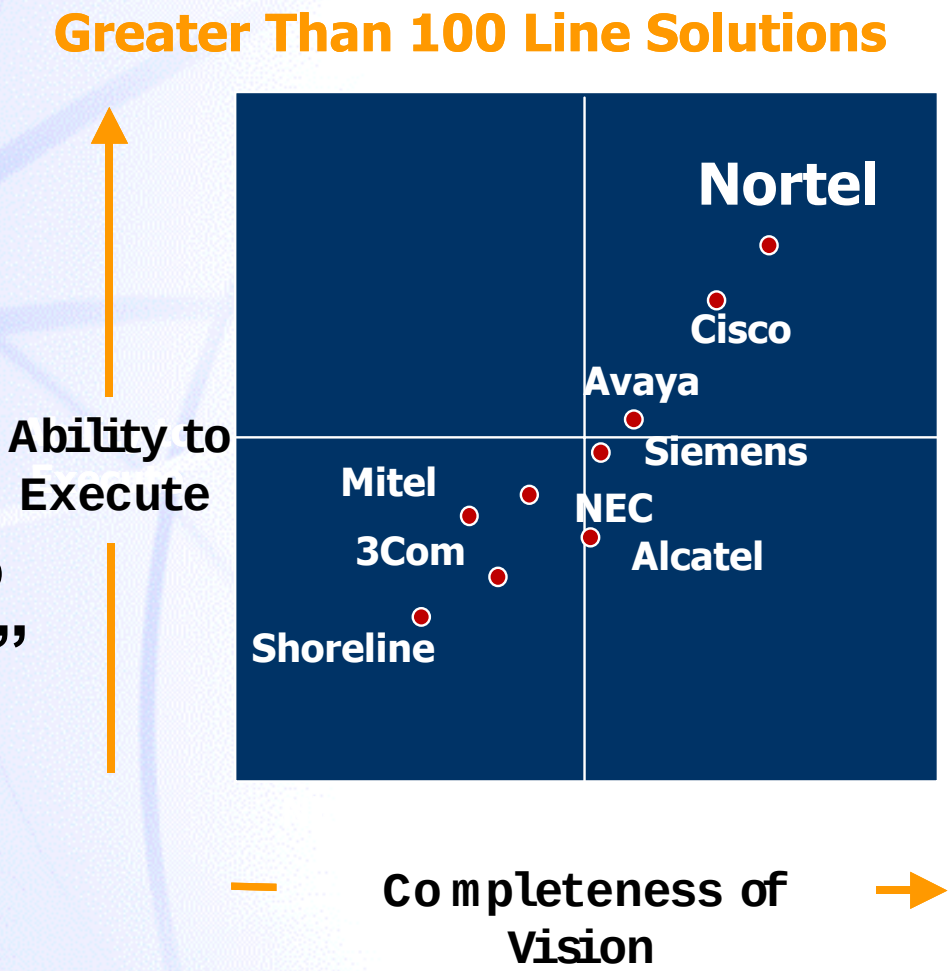
Defining the Future

"Nortel leads in both Vision & Ability to Execute."



SOURCE: Gartner Research, February 2002.

Nortel Networks Leadership

#1 CPE North America (Total Lines Shipped) - InfoTech

#1 VoIP US Q4 ’01 (Total Lines Shipped) - InfoTech, The Eastern Management Group

#1 VoIP US Q4 ’01 (Total Systems Shipped) - InfoTech

#1 VoIP IP-Enabled US (Total Lines Shipped) - InfoTech

#1 VoIP Converged US (Total Lines Shipped) - InfoTech

#1 KTS North America (Total Stations Shipped) - InfoTech

#1 KTS Canada (Total Stations Shipped) - InfoTech

#1 PBX Canada (Total Lines Shipped) - InfoTech

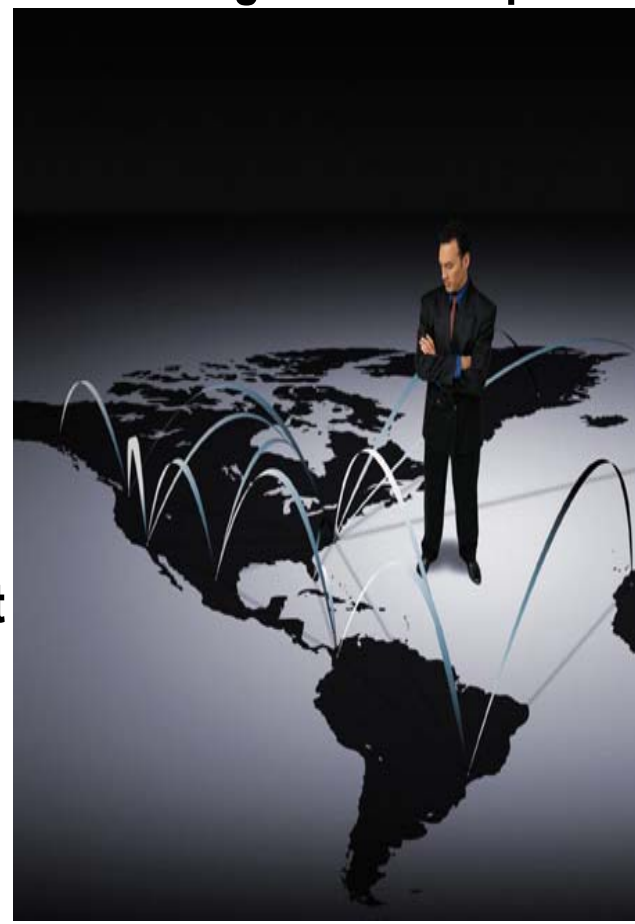
#1 in IP phone systems Q4 ’01 - (The Eastern Management

#1 Multiservice WAN Switch Q4 ‘01 - SRG, Dell’Oro, In-Stat

#1 Enterprise WAN Switch Q4 ‘01 - SRG, Dell’Oro, In-Stat

#1 ATM Core Switch Q4 ‘01 - Infonetics

#1 IP Service Switch Q4 ‘01 - SRG, Infonetics

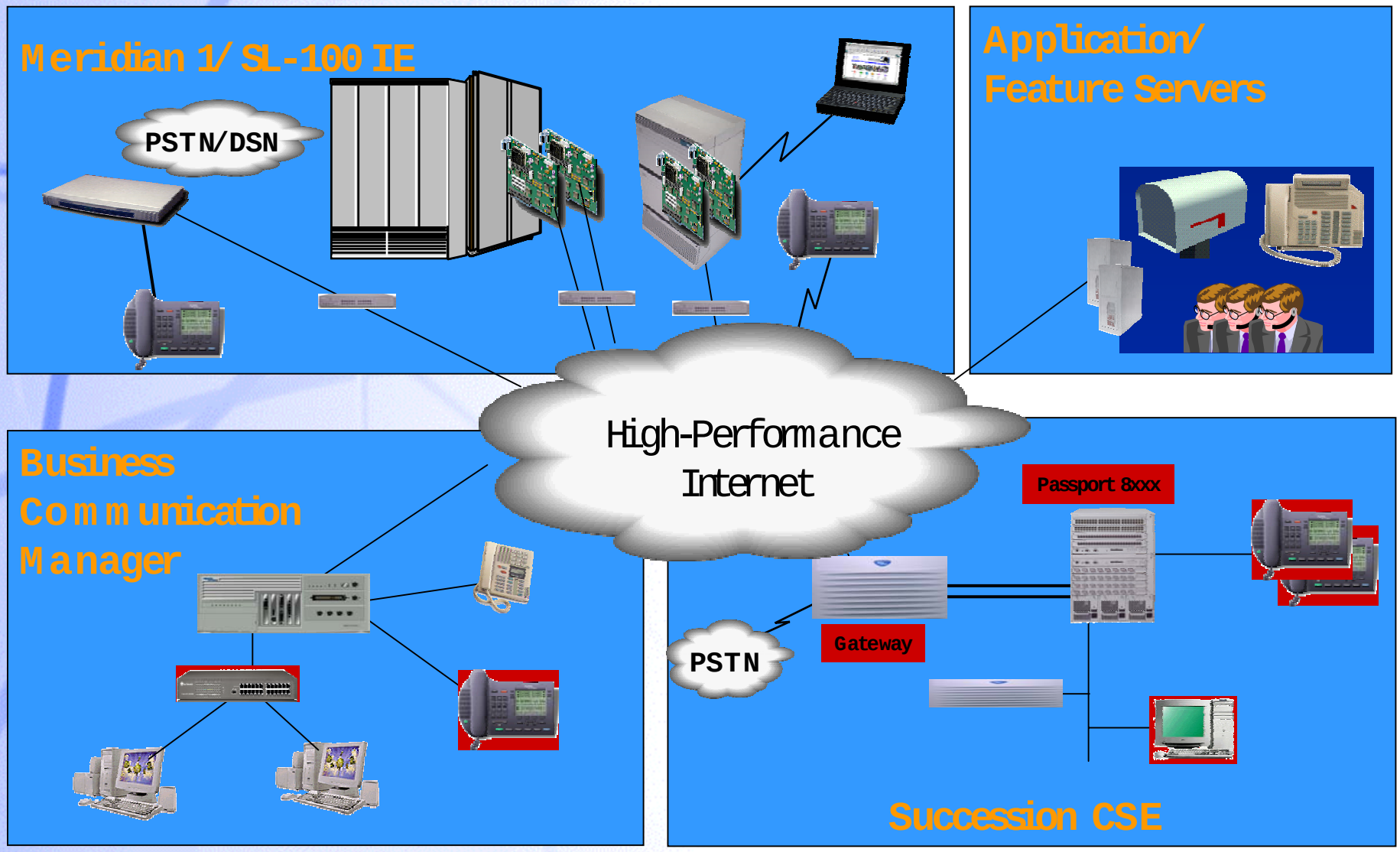


Enterprise Solutions
Nortel Networks Succession Strategy

Build Out Voice Values to Enterprise Network & Managed Services Emerging Market

NORTEL NETWORKS

Nortel Networks IP Telephony Portfolio



NORTEL NETWORKS

Succession Enterprise

Clients


39xx


802.11

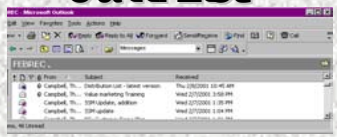

PC


i2004


SIP Enabled

Multimedia Applications

CallPilot


Unified Messaging


Symposium
Contact Center
Peripheonics Self-Service

Multi-Media


Collaboration

Call Servers


M1


SL-100


BCM

CSE 2000


Norstar

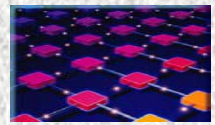

CSE 1000


CSE MX

Networks Access

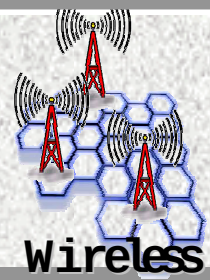
TDM

Passport


IP, Frame ATM

Optical


OpTera


Wireless


PRI-SIP

CSE MX brings it all together and completes our strategy

Introducing *CSE MX*

- CSE *M*ultimedia *X*change is a new VoIP Telephony Applications Platform

- Built in the Java programming environment

Multimedia applications

- *Collaborative, mobility, presence, Video services, personal call Management*

- *Xchange*
  - *VPN services, number plan consolidation, H.323, MGCP, SIP*

- Hardware independent

- SIP Applications development engine

- CSE MX has evolved from IMS &CS 3000

- Service provider heritage brings ultimate reliability

NORTEL NETWORKS

Conclusions - as if you weren't there already

- Nortel is the leader in Voice and Voice over Data, including IP
- We are firmly committed to IP based solutions
- VoIP needs to be implemented for the right reasons
- Convergence and applications values will drive the implementations
- Be careful of flimsy, poorly thought savings schemes that do not reflect reality
- VoIP will be driven, as the web was, not by IP, but by transformational communications value

NORTEL NETWORKS