NEW WORLD NETWORKS AND TECHNOLOGY TRENDS

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Agenda

- 2 different “Internets”
- Advances in technology
- Future developments
- Final thoughts
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• 2 different “Internets”
• Advances in technology
• Future developments
• Final thoughts
The Internet

- Not only it’s not lost, it’s exactly the other way around
- Number of Internet users will increase from 400 million this year to 900 million by 2004
- Bandwidth at the core of the Internet is doubling every 6 months
- Broadband penetration in the World is ~ 3%
- Investment in e-business is increasing by 25% annually
- It’s just that companies need to take the Internet seriously!

Sources: IDC, TeleChoice and Strategis Group, 2000
The Internet has Changed Networking...

To Intelligent & Distributed Network Architecture

- User Awareness
- Content & Application Routing
- Operational Automation
- Network Services
  - QoS, Multicast, Routing
  - Content mgmt, security
  - Addressability, tunneling
  - Traffic engineering, etc
Agenda

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- **Advances in technology**
- Future developments
- Final thoughts
IP, The Invisible Glue – Disruptive Technology

- Mobile & Wireless
- SAN
- CDN
- Scale Services
- Scale Connectivity
- Scale Networks
- VoIP
- Optical
- LAN
- MAN
- WAN
Aggregation

Access  Aggregation  Backbone

Dial  DSL  Cable  Fixed Wireless  Mobile Wireless

ATM Core  Optical Core  Circuit Core

IP
The IP Wave

Source: Gartner Group

AND! This Slice is 17% Bigger than 1996

Source: Gartner Group
## Some Examples of Disruption

**Old World**
- Telephone, PCs and TVs
- Voice dominates the network
- Proprietary & specialized networking
- Internet & Public network separate
- High tariffs for long-distance services
- Dial and Leased Internet Access
- Owned Applications

**Internet World**
- Multifunctional devices with network interfaces
- Now Data, later multimedia dominates
- Totally open and interoperable networks
- A global network of PACKET-based NETWORKS
- Toward Bundled/Services model
- Internet Broadband Access & VPN
- Rented Applications & Services to ASPs
VoIP
Data/Voice/Video Conversion

- Voice and Video converting to packet
- Enables new applications
- Telecom and Datacom Enterprise WAN, Networked PBX Service Providers
- Entertainment, information and educational video
Data/Voice/Video Drivers

- New Applications
- Technology Investment
- Economics of Packet Switching
- Internet Broadcasting

Paradigm of the Past
- Network Architecture - VHF/PSTN
- Programming Environment - Proprietary
- Device - TV+ Phone
- User Environment - Separated
- Interactivity - Low / Slow
- Market approach - Broadband

Paradigm of the Future
- Network Architecture - Head-End distribution Managed Services
- Programming Environment - IP/Standards
- Device - all IP ready
- User Environment - Adaptive
- Interactivity - Online/Rtime
- Market approach - Broadband
- Individual & Community
Implications of Internet Telephony

- VoTDM
- VoIP

$ per Minute

Number of Services

Making a call from a PC to a phone

Using Internet technologies, dialpad.com has begun offering free long-distance calls in the U.S. Using this service, you need a Windows 95 or newer computer with a modem or ISDN connection, and a compatible software client. Here's how:

1. The call starts from your PC and travels to your Internet service provider.
2. The ISP sends it to a server owned by dialpad.com.
3. The dialpad.com server contacts the GTE network.
4. The call enters GTE's IP network, which carries it across the country.
5. The call leaves the GTE network and is passed on to a local telephone network.
6. This local phone network delivers the call to its final destination.

O¢ PER MINUTE

Long-distance calls can be made for free with PC, new service

BY CHRIS O'BRIEN

The news is getting just how cheap long-distance calls can get, here's your answer. For a few cents, free-based dialpad.com has launched a service that allows anyone with a PC to make free long-distance calls through the Internet.

Don't throw out your old telephone just yet, though. Dialpad.com doesn't match the traditional telephone system. A typical call on dialpad.com sounds like an analog voice call and goes through a busy person's phone and onto the Internet.

The big long-distance carriers aren't exactly shaking in their boots. But they do agree that dialpad.com provides a glimpse into the not-too-distant future when high-speed data and phone calls will be free. The world will be a better place for it.
Unified Communications

- Universal Access from any device, anywhere
- Unifies all communications into a single infrastructure
Personal Network Assistant

If it’s my wife, call me everywhere! Otherwise I’ll sleep with the dog !!
Transport & Access
80% of the Internet Access is still Analog/leased transmission. like 20 years ago...
Scaling the Internet – The Bandwidth Tsunami
Last Miles

- Managed Services (VPN, hosting, video, webcaching, etc)
- Service Reach
- Mass market provisioning & services level automation/mgmt
- Consumer services
- Business Services
- Interoperability
- Standards
Optical Networking

Bandwidth

- Wavelength proliferation
- From 2.5G to 10G to 40G
- Dramatic improvements

IP Optimized

- Controlling optics with IP
- Eliminating multiplexing layers

Segmentation

- Storage
- Metro/Ethernet
- Long and ultra long haul
- Legacy traffic
Architectural Layering

Multiplexing, Protection, and Management at Every Layer

B-ISDN

IP

ATM

SONET/SDH

Optical Adaptation Layer

IP over ATM

IP

ATM

Optical Adaptation Layer

IP over SONET/SDH

IP

SONET/SDH

Optical Adaptation Layer

IP over Optical

IP

SONET/SDH

Optical Adaptation Layer

Optical Layer—WDM/OXC
IP-over-WDM Architecture

Electronic Layer

Opto-electronic Layer

Optical Layer

The IP Layer performs Layer 3 Functions (E.g., Addressing and Routing)

GMPLS Layer provisions Services Packet Services. This includes Packet Assembly, WDM Topology and Resource Dissemination, Survivability Etc.

Monitoring Layer

The Physical Layer performs functions for packet switching, wavelength conversion, delay/buffering, optical amplification etc.

Monitoring and Detection: This May of May Not Use Data Framing (E.g., For Control Channel)

Direct Lambda (λ) Labeling, MPLS-Based Approach
The Role of DWDM

- Uses Wavelengths as virtual fiber
- Point-to-point connectivity
- Increased bits/fiber, reduced cost/bit
- No optical *networking*
Putting the network in optical networking

- DWDM transmission
- Mesh topology
- End-to-end provisioning

- Wavelength switching granularity
  - Open protocols
Content Networking
Traditional Web Growth

Web Sites Are Centralized

Web Grows:
More Users
Richer Content

To Manage Growth, Server and Bandwidth Are Added
Anatomy of a Network

Origin Server Scalability, Speed of Light

Gigabit Optical Network

Peering Point Congestion

“Middle Mile”

Peering Capacity, ISP Network Capacity

Cross-Internet connections

Available Bandwidth

Last Mile

E1, DSL, Cable Modem Dial-up Wireless

10 Mb to 1 Gb Ethernet

Internet Backbone

Premises Network

Local Loop
The #1 Barrier for e-Business Applications: Bandwidth Bottlenecks

Origin Server Scalability, Speed of Light

Available Bandwidth

Gigabit Optical Network

Peering Capacity, ISP Network Capacity

E1, DSL, Cable Modem Dial-up Wireless

10 Mb to 1 Gb Ethernet

Datacenter

Internet Peering Connections

Local Loop

Edge Network
Content Delivery Networks

Five key Elements

Bypass Bottlenecks
Storage Networking
Key Drivers

- Exponential growth in storage
- Velocity of information accumulation
- Acceleration of higher bandwidth networking technologies
- Externalization of storage network
- Shortage of IT staff, ever increasing management costs

Source: International Data Corporation
Key Drivers

- Exponential growth in storage
- **Velocity of information accumulation**
- Acceleration of higher bandwidth networking technologies
- Externalization of storage on the network
- Shortage of IT staff, ever increasing management costs

Source: EMC Corporation
Key Drivers

- Exponential growth in storage
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Source: Storage Networking Industry Association
Key Drivers

Most Storage Will Be Networked by 2005

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- Velocity of information accumulation
- Acceleration of higher bandwidth networking technologies
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Source: International Data Corporation
Key Drivers
Price-per-Gigabyte Decreasing 40% per Year But...

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Source: International Data Corporation
Key Drivers
Nearly 1 Million Open IT Jobs

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Storage and Network Convergence

- IP Networking
- External Storage
- Optical Networking

Storage Networking
Network Storage: Generation I

- All storage resides in servers
- Storage sharing creates CPU overhead
- Network burdened with disk I/O traffic
- Limited scalability and low performance
Generation II: SAN and NAS

SANs Create Two Separate Networks

- Pre-Gigabit Ethernet bandwidth assumptions
- Two different networks
- Limited Interoperability
- Isolated “SAN Islands”
- Minimal storage security
The Vision for Next Generation Storage Networking

Universal Access to Data and Storage

Network Storage Pool

- Utilizes best features of SAN and NAS
- Leverages capabilities of intelligent IP and optical network infrastructure
- Cost-effective scalability for e-business
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Chasing the Tornado

Layers 4-7

TCP
UDP

Security

Content Networking

Layer 3

Multiprotocol Routing
IP Routing

IP

Layer 2

Multiprotocol LAN/MAN
LAN Switching

Ethernet SONET/SDH

Layer 1

Copper
DSL Cable

Optical/Wireless
Research Programs

- Electronic Persistence
- Ubiquitous Computing
- Instant Messaging
- Mobile, wireless & nomadic access
- Personal Locator Services
- DIFFSERV, MPLS, QoS
- Web Caching, ORBs
- Routing/Congestion Control
- Active Routing
- Micronets
- Network Processor
- Optics manufacturing
- H/W Simulation tools
- ASICS and beyond

(Directories, Policy Servers)
- Network Management (Agent-based, Smart Nets)
- Security, Multicast
- SOHO services
- Optics, DWDM, Switched DWDM
- L3 restoration
- Lambda switching
- Metropolitan
- Mirrors & Lasers
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We cannot solve problems by using the same kind of thinking we used when we created them.
Gracias

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