Networking for the Millennium

FRAME RELAY
INTRODUCTION

What is Frame Relay?

Frame Relay is a fast packet technology developed to improve upon the X.25 packet technology.

Two factors responsible for development of Frame Relay technology

– Wide spread development of optical fiber-based transmission.

– Intelligent customer premises equipment (CPE)
Market Drivers for Frame Relay

• Traditional networks based on dedicated Leased Line connections
• Growth of branch office networks makes leased line (LL) option very expensive, especially for any-to-any connections
• Pace of technological change, mergers and acquisitions within the networking industry
Frame Relay Evolution

Worldwide Services and Equipment

Revenue ($ billion)

1st Public FR Service
1st FR Forum Meeting
FR Forum Membership Tops 300
More Than 30,000 FR Customers
Over 500,000 Ports Installed

Source: Vertical Systems Group

Copyright Frame Relay Forum, 1998
Worldwide Frame Relay Service - Ports

Source: Vertical Systems

ROW = Rest of World
Benefits of Frame Relay

• Savings over Private Lines
  – Reduces number of dedicated devices which reduces equipment costs
  – Reduces complexity for network managers
• Greater Bandwidth Flexibility than Private Lines
• Higher Reliability and Resiliency than Private Lines
• Lower Cost of Ownership and Better Bandwidth Utilization
  – Growth of Branch Office Networks
Benefits of Frame Relay (cont’d)

• Consolidation of LAN, SNA, On-net Voice, and/or Packetized Video
  – Simplifies Network Architecture
  – Reduces Operations and Administrative Costs
  – Improves Application Performance and Network Efficiency

• Smooth migration to ATM
  – Service and Network Interworking with ATM (FRF.5 and FRF.8)
FRAME RELAY FIELD FORMAT

Frame Relay format has five different fields

- Flag field
- Address field
- Information field
- Frame check sequence (FCS) field
- Trailing flag field

Every field is of varying length and is responsible for a specific function.
# FRAME RELAY FORMAT

<table>
<thead>
<tr>
<th>FLAG</th>
<th>ADDRESS</th>
<th>INFORMATION FIELD</th>
<th>FCS</th>
<th>FLAG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PACKET HEADER</td>
<td>X.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HEADER</td>
<td>IP DATA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HEADER</td>
<td>SNA DATA</td>
<td></td>
</tr>
</tbody>
</table>
FRAME RELAY ARCHITECTURE:

- Physical Layer
- Data Link Layer
- Network Layer
- Upper Layers of OSI Protocol

Terminal

Routers

Frame Relay Network

Routers

Terminal

Network Layer

DATA LINK LAYER

Physical Layer

Upper Layers of OSI Protocol

Network Layer

DATA LINK LAYER

Physical Layer

Upper Layers of OSI Protocol

Network Layer

DATA LINK LAYER

Physical Layer

Upper Layers of OSI Protocol

Network Layer

DATA LINK LAYER

Physical Layer

Upper Layers of OSI Protocol

Network Layer

DATA LINK LAYER

Physical Layer
FRAME RELAY ARCHITECTURE:

• Router performs the function of the bottom three layers of the OSI protocol: network, datalink and physical.

• In Frame Relay network the bottom two layers of the OSI protocol are used to forward the forms.

• The Last or physical layer actively transports bits from point one to another.

• The next layer or data link layer performs the error check on the frames at each node in the network.
SAMPLE FRAME RELAY NETWORK:
Types of FR Networks - Private

- Leverages Existing Network and Equipment
- Improves Trunk Utilization
- Security is Maintained because User Controls Core Network
Types of FR Networks - Public

- Core Network Outsourced to Service Provider
  - Service Provider Manages Backbone
  - Ownership Costs are Reduced (Management and Equipment)
- Single Network Access Supports Multiple Remote Connections and Protocols
- Connection-oriented Environment (PVCs) Maintains Privacy and Security

Copyright Frame Relay Forum, 1998
Types of FR Networks - Hybrid

• Provides Control over Critical Network Links
• Allows Cost/Benefit Analysis on Site-by-Site Basis
• Optimizes Network Price-to-Performance Ratio
# Service Comparison

<table>
<thead>
<tr>
<th>Private Lines (TDM)</th>
<th>Frame Relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer Network for Peak Traffic Needs</td>
<td>Engineer Network for Average Traffic Needs</td>
</tr>
<tr>
<td>CSU/DSU per Leased Line per remote site</td>
<td>CSU/DSU per Leased Line that can access many remote sites</td>
</tr>
<tr>
<td>Time Division Multiplexing</td>
<td>Statistical Multiplexing and Burst Capability</td>
</tr>
<tr>
<td>Resiliency is Not Inherent</td>
<td>Resiliency is Inherent in Network</td>
</tr>
</tbody>
</table>
Frame Relay Complements Other Technologies

<table>
<thead>
<tr>
<th>Application</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAN</td>
<td>FR, SMDS, ATM</td>
</tr>
<tr>
<td>LAN &amp; SNA</td>
<td>FR, ATM</td>
</tr>
<tr>
<td>Data &amp; On-net Voice</td>
<td>FR, ATM</td>
</tr>
<tr>
<td>Data, On-net Voice &amp; Packetized Video</td>
<td>FR, ATM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speeds</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.5 Mbps</td>
<td>FR</td>
</tr>
<tr>
<td>1.5 - 45 Mbps</td>
<td>FR, ATM</td>
</tr>
<tr>
<td>&gt;45 Mbps</td>
<td>ATM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interworking Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR - ATM</td>
</tr>
<tr>
<td>FR - SMDS</td>
</tr>
</tbody>
</table>

Copyright Frame Relay Forum, 1998
Understanding Public Frame Relay Services

Public Frame Relay

- ATM
- X-25
- Internet Access
- ISDN
- Dial Access

International FR

- DS-3/E-3
- DS-3/E-3
- DS-1/E-1
- DS-0
- ISDN

Management Reports
Access Alternatives Offer Flexibility

- Dedicated, Dial, and Frame Relay Access Options are Supported
- Costs are Optimized on a Site-by-Site Basis
Network Management Reports Give Insight

- On-line Reports, SNMP Statistics, and Hardcopy Reports are Available
- Gives Insight into Network Performance and Actual Network Utilization
- Helps Network Manager with Capacity Planning and Cost/Benefit Analysis
FR Access To Internet Reduces Costs

- Gateways to the Internet Reduce Cost of Separate Router and Access
- Firewalls Combined with PVCs Provide Security
- Can use the Internet to Extend Network
International Connectivity Depends On Needs

- Frame Relay Service is Available to and Within Many Countries
- X-25, IP, Internet, and Private Lines can be Used Where More Available, Practical, or Cost-effective
Managed Network Services Free Resources

- Managed Network Services Combine Equipment, Transmission, Network Monitoring, and Operation into a Single Service
- Reduces Operational Costs of Training and Support
- Frees Resources to Focus on Core Business
Migration To ATM Through Interworking

- Frame relay to ATM Interworking provides seamless connectivity between a frame relay site and an ATM site.
- Most Service Providers Offer, or Plan to Offer, Interworking with ATM
- ATM is More Complex than Frame Relay, Interworking makes it possible to introduce ATM in stages as required
FRAME RELAY APPLICATIONS:

Applications that can benefit from Frame Relay are as follows:

- IS Applications
- client-server computing
- CAD/CAM applications
- graphics applications
- other applications that generate bursty traffic.
SUMMARY

• Frame Relay relays the frames one behind the other in a predetermined path.
• Frame Relay is a switched service positioned to improve communications performance through reduced delays, more efficient bandwidth utilization and decreased equipment cost.
Summary
Advantages of Frame Relay:
• port and link sharing
• bandwidth on demand
• high throughput and low delays
• ease of network expansion
• ease of transition from existing X.25 network
• simplified network administration
• technology based on global standards
• cost advantages
Summary

• Frame Relay is Widely Accepted and Deployed Globally

• Frame Relay’s Longevity and Visibility as a Technology is Fostered by its Ability to Co-exist and Complement Legacy as well as Emerging Technologies

• Standards Continue to Evolve to Meet Changing End User Environments and Requirements

• Accelerated Growth in Frame Relay Implementations is Expected to Continue
Frame Relay Basics: Terms And Definitions

• **User to Network Interface (UNI)**
  – Specifies signaling and management functions between a frame relay network device and the end user’s device

• **Network to Network Interface (NNI)**
  – Specifies signaling and management functions between two frame relay networks

• **Virtual Circuit (VC)**
  – The connection between two frame relay ports

• **Permanent Virtual Circuit (PVC)**
  – A pre-defined VC

• **Switched Virtual Circuit (SVC)**
  – A VC that is established dynamically

• **Data Link Connection Identifier (DLCI)**
  – Virtual Circuit Identification Number
Frame Relay Terms And Definitions (cont’d)

- **Committed Information Rate (CIR)**
  - The bandwidth defined for a VC

- **\( B_c = \text{Committed Burst} \)**
  - Maximum number of committed bits to be transmitted over time interval

- **\( B_e = \text{Excess Burst} \)**
  - Number of Excess bits that will be transmitted over time

- **\( T_c \) Time interval**
  - Time measurement based how much bandwidth is available for data to burst on to the network
Frame Relay Terms And Definitions (cont’d)

• FECN Forward Explicit Congestion Notification
  – Bit set by the network node (FR Switch) that is experiencing congestion
  – Sent in the direction of the receiver (destination)

• BECN Backward Explicit Congestion Notification
  – Bit set by the network node that is experiencing congestion
  – Sent in the direction of the sender (source)
Frame Relay Reference Material

- Frame Relay Forum Web page www.frforum.com
- Data Communications Magazine www.datacomm.com
- Network World www.nwfusion.com
- Internet Week (formerly CommWeek) www.internetwk.com