



Agenda

- Introduction: Moving voice to packet networks
- Factors affecting voice quality and methods to address
- VoFR vs. VoATM vs. VoIP
- VoFR as a delivery vehicle for packet voice

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• Conclusion

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Private Voice Networks

Building private voice intra-networks using leased lines between PBX's is very common



Moving to the packet world: Voice Processing

Analog to digital conversion

- 64K PCM used on digital networks
 - Circuit switching or leased lines
 - Time division multiplexing

Voice compression

- PCM voice compressed and packetized
 - Using 8K G.729 algorithm or others
 - Bandwidth efficiency, silence suppression comfort noise
 - Statistical multiplexing effect for voice and data
 - Can use shared networks (FR, ATM, IP)



Private Voice over Packet Networks

Building private voice intra-networks using PVC's between PBX's









Factors Affecting Voice Quality

Jitter

- Network might have low delays but highly variable packet arrival rate
- Jitter buffer compensates to deliver uninterrupted speech flow
- Adds to overall delay

High delay (more than 250 msec.)

• Switching to half-duplex voice communication

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- Similar to satellite telephony connection
- · Perceived as reduced voice quality



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Voice Over IP

VoIP IA based on H.323 protocol suite

Intranet can transport voice

- Low delays and small jitter are possible
- Additional overhead over limited speed WAN
 - Voice over IP over frame relay

Internet provides no guarantees

• Connectionless and no prioritization

IP VPN (tunneling)

• High overhead over low-speed access



Comparing Overhead – FR vs. IP Using typical 8K vocoder Voice over frame relay • 8K + 2 kbps overhead = 10 kbps total bandwidth Voice over IP • 8K + 12 kbps overhead = 20 kbps total bandwidth 100% more bandwidth required by VoIP • 6 VoFR channels possible on 64 kbps • Only 3 VoIP channels on 64 kbps · Less residual bandwidth for data Frame And what about end-to-end QOS???? Relav Forum N+I Paris - page 18 w.frforum.com

	Advantages	Drawbacks
Voice over FR	Bandwidth efficient - narrow/broadband QoS guarantees for FR Proven FRF.11 / 12 interworking FR public service transport	 Integration of voice & data at the building edge only Some vendor specific features
Voice over ATM	Effective multi-service traffic consolidation ATM QoS control mechanisms Low latency	 Bandwidth efficient for broadband only Integration of voice & data at the building edge only
Voice over IP	• Leverages IP ubiquity • Traffic consolidation at the desktop • H.323 vendor interworking	 Unpredictable speech quality dependent upon IP Infrastructure Scalability and Resilience still missing Performance over the Public Internet Overhead





Goals of Voice over Frame Relay

- Transport of compressed voice in FR frames
- Diverse voice compression algorithms
- Effective utilization of low-bit rate frame relay
- Multiplex voice and data sub-channels on a single frame relay DLCI
- Multiple voice samples within a frame





Technical Issues for Voice over Packet

Key technical issues:

- Delay across networks
- Jitter (delay variation) in voice packets
- Compression formats
- Resilience
- Ability to maintain priority PVCs (vendor implemented)

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Key FRF Standards to Support VoFR – FRF.9

Compression: FRF.9

- January 1996
- Compression used to:
 - Maximize integration of voice and data
 - Minimize cost
 - Lower access speed and CIR can be used
 - Must have capacity at central site to handle data compression

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• Lower latency and improved response time





Key FRF Standards to Support VoFR – FRF.12

Fragmentation – FRF.12

- Key to implementation of VoFR
- Data is fragmented
- Voice and data frames may be interspersed
- Ensures voice frames not delayed behind large data frames
- Reduces delay and jitter
- Fragments can be combined to utilise one PVC

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• Results in cost savings





Key FRF Standards to Support VoFR – FRF.15,16

Multilink FR – FRF.15, FRF.16

- Multiple physical links provide resilience
- Applicable to any link speed
- FRF.12 employed for fragmentation over physical links

- Fragments may be sent on all links
- Results in reduction of delay and jitter





Summary: Frame Relay Delivers Convergence of Data with Voice

- Frame relay is a VPN by nature
- Excellent standards support for voice
- Connection oriented and more predictable
- Mature technology
- Low overhead makes it efficient
- Low implementation cost
- Easily scaleable
- Coexistence with other packet voice technologies



Thank You				
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