Commercial-Grade VoIP over 1xEV-DO Rev A

CDG VoIP Summit
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Outline

• VoIP Performance over 1xEV-DO
• QoS for 1xEV-DO
• Mobility & Handoffs
• Intersystem Operation
• Summary
Voice over IP over 1xEV-DO
Voice Quality vs. Delay (ITU-T G.114)

- CDMA2000 1X mobile-to-mobile latency: ~ 280 ms
VoIP Capacity over 1xEV-DO
- Simulation Results -
VoIP Assumptions

• Full Rate EVRC
  – 1/8\(^{\text{th}}\)-rate frames are blanked
• 1 RTP/UDP/IP packet per voice frame (no bundling)
• ROHC Header Compression
  – 2 byte overhead per VoIP packet
Mobile-to-Mobile Latency Breakdown

- End-to-End FER = 3%
Airlink Simulation Assumptions

- 19 3-sector cells
- 3GPP2 channel model and evaluation methodology
- Users randomly distributed in the coverage area
  - 3GPP2 mixed speed distribution
- 2 km cell-to-cell distance with 138 dB max path loss
- All neighbor sectors generate forward link interference 100% of the time (conservative)
- All key Rev A features simulated
  - Multi-user packets, QoS scheduler, H-ARQ, D-ARQ, etc.
Mobile-to-Mobile Call Latency (1 AT Ant)

- Target FER = 3%
Mobile-to-Mobile Call Latency (2 AT Ant)

- Target FER = 3%
• Less than 1% outage at 7 dB at 40 Erlangs
### Capacity and Latency Summary

- **Latency at 40 Erlangs Load**

<table>
<thead>
<tr>
<th>Coverage</th>
<th>98%</th>
<th>95%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-to-M 1 ant</td>
<td>300 ms</td>
<td>280 ms</td>
<td>270 ms</td>
</tr>
<tr>
<td>M-to-M 2 ant</td>
<td>230 ms</td>
<td>225 ms</td>
<td>220 ms</td>
</tr>
<tr>
<td>Landline 1 ant</td>
<td>235 ms</td>
<td>220 ms</td>
<td>210 ms</td>
</tr>
<tr>
<td>Landline 2 ant</td>
<td>185 ms</td>
<td>180 ms</td>
<td>180 ms</td>
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Quality of Service for VoIP over 1xEV-DO

• Flow-Aware Radio Network
• FL & RL Prioritization
• Admission & Overload Control
Multi-Flow RLP

Best Effort Flow

1xEV-DO RAN

- RLP NAK: Enable, DARQ: Disable, Scheduler: BE
- RLP NAK: Disable, DARQ: Enable, Scheduler: EF

High-Priority Flow

- 1xEV-DO Rev A allows the RAN to differentiate between different flows of the same user; e.g., VoIP & Best Effort
- Allows subscribers to use applications with different QoS requirements simultaneously
1. PDSN detects VoIP bearer packets based on Source IP address and port number – sends over one of two A10 tunnels

2. RNC places incoming octets into one of two RLP flows based on which A10 tunnel they arrive

3. RN Applies QoS priority scheduling to VoIP packets

4. AT de-multiplexes received packets into two RLP flows

5. AT recovers original IP packets by independently HDLC decoding RLP Flows
VoIP Reverse Link Data Flow

1. AT feeds bearer packets received from the VoIP application to a separate HDLC encoder

2. AT feeds the two HDLC-encoded octet streams into two separate RLP flows

3. AT Applies QoS priority scheduling to expedite VoIP packets

4. RNC de-multiplexes received packets into two RLP flows

5. RNC sends resulting octet stream to PDSN over the two A10 tunnels
Flow-Aware 1xEV-DO Network

High-Priority IP Flow

High Priority Link Layer Flows
RLP Flow & RLMAC Flow

High-Priority A10 Tunnel

Best Effort IP Flow

Best Effort Link Layer Flows
RLP Flow & RLMAC Flow

Best Effort A10 Tunnel
QoS Signaling for VoIP over 1xEV-DO

AT

EVDO RAN

PDSN

EVDO Session Configuration

IS-835 PPP Setup

IP Flow Reservation Request/Grant

RLP Flow & RLMAC Flow Setup

IS-835 Reservation Request/Grant

TCH Setup w/ ReservationOn

A10 Tunnel Setup - BE

A10 Tunnel Setup - HP

Packet Filters Established

VoIP Flow
Prioritization & Resource Management

• Prioritization
  – Forward Link Airlink Scheduler
    • Radio-link aware scheduling increases voice capacity
  – Reverse Link
    • Prioritization based on T2P resource allocation (MFRLMAC) & low-latency mode

• Admission & Overload Control
  – Connection-level
  – Flow-level
Mobility & Handoffs

• Softer Handoff
  – Sector switching latency around 20-30 ms

• Soft Handoff
  – Typical sector switching latency around 20-40 ms using Rev A DSC channel

• Inter-RNC & Inter-PDSN Handoffs
  – IP-based radio architectures offer seamless handoffs across RNC boundaries
Compatibility with CDMA2000 1X

- CDMA2000 1X Network
  - CDMA2000 1X Phone

- 1xEV-DO Network
  - 1xEV-DO VoIP Phone

* Tandem-free operation
* Vocoder compatibility
Intersystem Handoffs

CDMA2000 1X Region

CDMA2000 1X Network

Hybrid VoIP Phone

1xEV-DO Region

1xEV-DO Network

* VoIP-to-Circuit Voice Handoffs
Summary

• Evolution to VoIP is the next major transition in wireless networks
• 1xEV-DO Rev A is designed to carry data/voice traffic in all-IP format
• With a well-engineered IP core network, commercial-grade VoIP over 1xEV-DO Rev A is promising
Thank You