Overview

- IS-95A/J-STD-008 cdmaOne
- IS-95B Enhancements
- cdma2000 1xRTT Overview
  - 3xRTT
  - W-CDMA
  - G3G
- High Speed Data

**IS-95A + TSB-74/J-STD-008 cdmaOne**

- 1.25 MHz RF Channel Bandwidth
- Two Vocoders - Rate Set 1 & 2
  - 8 kbps IS-96A Vocoder at a rate of 9.6 kbps
  - 13 kbps CDG Vocoder at a rate of 14.4 kbps
- 8 kbps Enhanced Variable Rate Codec (EVRC) is Currently Being Deployed (IS-127)
  - EVRC Improves Air Interface Capacity
    - 20 - 24 users/sector for EVRC vs. 13 - 17 users/sector for 13 kbps
- Circuit Switched Data
  - 9.6 & 14.4 kbps
- Short Message Service (SMS)
  - Up to 128 character ASCII text message via Paging Channel

**IS-95A Performance Issues**

- IS-95A Standard has Performance Issues in the Field
  - Active set list is frozen and best pilot is selected once access begins even though the RF environment is rapidly changing
  - No handoffs until a traffic channel is obtained
  - Results in Too Many Access Failures > 2%
- Inefficient Soft Handoff (SHO) Algorithm Adds Pilots (Sectors) Even when a Strong Signal is Present - TADD
- Pages may not be Received when a User Drives Across a F2/F1 Hard Handoff (HHO) Border in Idle Mode
  - Grey zone problem
  - Handset is still monitoring F2 Paging Channel in F1 coverage area
  - Pages are sent on F1 Paging Channel

**IS-95B Enhancements**

- IS-95B Provides the Following Enhancements
  - Access improvements; begin handoff during access state
    - Access Entry Handoff
    - Access Probe Handoff
    - Access-Handoff
    - Channel Assignment into Soft Handoff
    - Soft handoff algorithm: new SHO algorithm in handset or infrastructure will reduce base station channel element usage
    - System Reselection: solution to border cell paging issue
  - Most Service Providers are Deploying 1xRTT HSPD Instead of IS-95B HSPD
  - New IS-95B Handsets are Required
    - Only subscribers with new handsets will see improvements
cdma2000 Phase 1 = 1xRTT = 3G1X

Features of the cdma2000 1xRTT Standard

- 2X Voice Capacity (Erlangs) Compared to cdmaOne
  - 35 Users per sector or 24.6 Erlangs per sector at 1% GOS
- 144 kbps High Speed Packet Data Capability
  - 153.6 kbps raw data rate
- Increased Coverage & Capacity Compared to cdmaOne
  - Fast Forward Link Power Control
  - QPSK vs. BPSK modulation
  - Turbo codes and Viterbi codes
  - Coherent detection added to the reverse link - Lower Eb/No
- 128 vs. 64 Walsh Codes for Fixed Wireless Access
- Orthogonal Transmit Diversity (OTD) on Forward Link

cdma2000 Air-Interface Enhancements

- Fast power control
- Transmit diversity
- Auxiliary pilot
- Turbo code
- Fundamental & Supplemental channels
- MAC
- Coherent reverse link
- Dedicated control channel (multiplexed onto the traffic channel)

Target: 2x IS-95 Capacity

Features of the cdma2000 1xRTT Standard

- Quick Paging Channel
  - Extends handset battery life
- Data Burst Negotiation
  - Fundamental Channel data rate is 9.6 kbps
  - Bandwidth on demand using Supplemental Channel
  - 9.6 · 153.6 kbps Supplemental Channel data rate
- Short Data Bursts
  - Short Data Bursts delivered on the Paging/Access channels
  - Does not use traffic channel resources
- MAC Layer Modes for Resource Management
  - Active, Control Hold, Suspend, and Dormant modes

1xRTT Network Solution

- BSC
- MSC
- Other Vendor BSC
- IVSHO
- A3/A7
- HLR
- PDSN
- Internet
- Managed IP Network
- IP
- New PDSN
- PDSN - Packet Data Service Node
- 1x CEM - 1x Channel Element Module
- T1/Optical Backhaul V5.2
- TDM Voice
- Circuit Switched Data
- PSTN
- TDM Voice
- V5.2 Circuit Switched Data
- PSTN
PDSN (Packet Data Service Node)

- Routes IP Packets To/From External Packet Data Network and the Internet
- RP Interface between BSC and PDSN
- Connectivity to Routed IP networks to Provide Access to Commercial, Off-the-Shelf Functions
  - AAA Server
  - Fire Walls
  - Off-board billing processor
- Supports Simple IP & Mobile IP Access Methods

Efficiency of 1xRTT Packet Data

1xRTT Packet Data MAC Layer Operational Modes

- Active Mode: Traffic, PC, & Control Channels Assigned
- Control Hold Mode: PC & Control Channels Assigned
- Very Fast Traffic: Channel Reallocation
- Suspended Mode: No Dedicated Channels Assigned
- No BS, MSC Resources, PPP State, Maintained
- Short Data Bursts

Re-Enforcement of Efficient RF Capacity Usage

- Secure sufficient resources for voice calls
- Provide optimum level of packet data services

1xRTT HSPD vs. IS-95B HSPD

- 144 kbps vs. 64 kbps User Data Rates
- IS-95B Provides No Coverage Improvements over IS-95A
- 1xRTT has More Walsh Codes to Support FWA
- 1XRTT Provides Better Framing with Less Overhead
- Better Coding & Interleaving for Large Blocks of Data
- Data Burst Negotiation
- Short Data Bursts
- More MAC Layer States for Future Applications

What Lies Beyond 1xRTT?

- cdma2000
  - IS-95 evolution, developed by TR45.5
  - UWC-136
  - TDMA 136 evolution using GSM EDGE, developed by UWCC and TR45.3
  - W-CDMA/NA and WIN (Wireless Multimedia and Messaging Services)
  - W-CDMA/NA. Aligned with UMTS W-CDMA proposal (T1P1/1R46)
  - Being converging into one standard WP-CDMA (wide-band packet CDMA)
  - Chinese TD-SCDMA (Time-Division Synchronous) Proposal
  - For FDD operations only
  - Korean TT1 and TT2 Proposals
  - TTA1 aligns with cdma2000
  - TTA2 aligns with W-CDMA
  - Japan ATR Proposal
  - Aligned with W-CMAC and has been working on convergence with cdma2000
  - DECT Proposal
  - Extension of the DECT standard
  - UMTS W-CDMA Proposal
  - LTE/GSM proposal for FDD operations

- cdma2000 3xRTT Key Features
  - Three 1.25 MHz Channels in a 5 MHz Bandwidth to Support High Speed Data (HSDP) Services
  - High Speed Packet Data Rates from 384 kbps with Full Mobility to 2 Mbps for Stationary User
  - Simultaneous Voice and High Speed Packet Data
  - 3G CDMA 2000 Signaling Structure
  - Full RTT MAC Layer Support
  - Advanced Multi-Media Quality-of-Service (QoS)
  - Enhanced 3G Privacy, Authentication, and Encryption

Major 3G RTT Submissions (Air Interfaces)
The Multi-Carrier and Direct Spreading Modes

- Both approaches have similar bandwidth
- Performance is the same
- Multi-carrier can be overlayed on top of IS-95 and therefore is more flexible

Global 3G (G3G) Harmonization

Why G3G Harmonization

- Global Economy of Scale
- Possibilities of International Roaming Between all Regions including the US and North American
- Possibilities of Global Seamless Service
- Competitions for Services not Standards - End User will Benefit
- Harmonization Helps by Reducing the Number of Products Needed for Different Markets, thus Reducing R&D Costs

Harmony Requirements

- The Radio Access Network shall support ANSI 41 and GSM MAP based services in all 3G CDMA modes
- Support functionality based on synchronous operation
- Support seamless handoff between the harmonized DS and MC modes
- Minimize the complexity of dual-mode and multi-band terminals and equipment

Physical Layer

- G3G MC Mode physical layer is the same as that of cdma2000
- G3G DS Mode physical layer is harmonized from 4.096 Mcps to 3.84 Mcps

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<td>3.84 Mcps</td>
<td>3.4608 Mcps</td>
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The OHG Agreement

- 8 CDMA RTTs harmonized to 3 modes
- Support from 35 operators & 13 vendors & more
- Minimize impacts to L1 & L3+ MM, CC
- Flexible Connectivity

Radio Access Modes Supported by the G3G Core Network Family

Family of G3G Core Networks

Inter-Core-Network Roaming
High Speed Data (HSD)

- Competing Technologies with Data Rates that Exceed that of 3xRTT or W-CDMA in a 1.25 MHz Bandwidth
- Probably will Supercede 3xRTT in US Markets
- Qualcomm and Lucent Support High Data Rate (HDR)
- Motorola and Nokia Support 1XTREME
- Nortel Does Not Support Either Proposal Due to Technical Deficiencies and Proposes Changes to Both in Order to Create a Single Open HSD Standard
- Disagreement within the Industry!
- Service Providers Want One Open Standard

Network Evolution: IP Network

- All IP Network including VoIP
- Wireline-Wireless and Voice-Data convergence
- Air interface technology independence: UMTS/1X/3X/GSM
- Separation of services and routing

Summary & Conclusions

- 1xRTT is the Best Evolution Story in the Industry
  - Voice capacity gains
  - High Speed Packet Data
  - Graceful migration
  - Leverage cdmaOne S/W and H/W investment
  - Leverage cdmaOne optimization & operations experience
  - Wireless data with efficient traffic management
  - Evolution to G3G or HSD
- Still Much to be Done with HSD
  - Industry moving in the right direction
  - Nortel Networks is providing leadership in standards efforts