Industry Standard
CDG Mobile Station Certification Process

Presentation at RITT/CDG Mobile Station Certification & System Test Team Meeting
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By
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Agenda

• Overview of Requirements & Processes
  – Minimum Performance Testing
  – CDG Stage 2 & 3 Interoperability Testing
  – Optional System Performance Testing
  – Regulatory Testing
  – Advanced Features Testing

• Market Variations & Time Lines
CDMA
Industry Standards
CDMA Industry Standards

• Carrier Requirements
  – Total Requirements

• Minimum Performance Testing

• Interoperability Testing
  – “CDG Stage 2 Interoperability Testing” (CDG57 rev 2.0)

• Carrier Testing
  – “CDG Stage 3 Interoperability Testing” (CDG28)
  – Carrier Unique Features
CDMA Industry Standards

- **Optional Testing**
  - “CDG Stage 4 Optional System Performance Tests”

- **Regulatory Testing**
  - FCC & SAR

**TIA Documents:**
Global Engineering Documents
15 Inverness Way East
Englewood CO 80112 USA
Phone: (800) 854-7179
Fax: (303) 754-4030
Email: http://global.ihs.com/

**CDG Documents:**
http://www.cdg.org/

**FCC Documents:**
http://www.fcc.gov/
Test Processes
Test Process - U.S.

- Define Carrier Requirements
  - Bottom Line
- Development Testing
  - Internal Test Requirements
- Minimum Performance Testing
  - TIA/EIA-98-D
  - At Independent Test Lab
Test Process - U.S. (cont.)

• Interoperability Testing (CDG Stage 2)
  – Upon Completion Of Minimum Performance
  – Repeated At Each Infrastructure Vendor Lab

• Carrier Testing
  – Regression & CDG Stage 3
  – Advanced Features

• Regulatory Testing
  – At FCC Authorized Testing Body
CDMA Industry Standard: Minimum Performance Testing
Overview

• Industry Standard TIA/EIA-98-D
  – Recommended **Minimum** Performance Standards for Spread Spectrum Mobile Stations
    • Handoff Timing        Power Control
    • Pilot Detection      RF Output Power
    • Demodulation         Supervision
  – Essential To Ensure Network Performance
• CDG Stage 2 Entrance Requirement
TIA/EIA-98-D (cont.)

• **CDMA Receiver Minimum Standards**
  
  – Frequency Coverage
  
  – System Acquisition
    • Idle Handoff
    • Soft Handoff
    • Access and Access Probe Handoff
    • Candidate Frequency Single Search
  
  – Forward Common Control Channel Demodulation Performance
    • Non-Slotted Mode Paging Channel
    • Slotted Mode Paging Channel
    • Broadcast Control Channel in AWGN Channel
    • Broadcast Control Channel in Multi-Path Fading Channel
    • Forward Common Control Channel
    • Common Assignment Channel and Reception of Common Power Control Channel
TIA/EIA-98-D (cont.)

- Forward Traffic Channel Demodulation Performance
  - Forward Traffic Control Channel in AWGN
  - Forward Traffic Control Channel in Multi-Path Fading Channel
  - Forward Traffic Channel During Soft Handoff
  - Decision of Power Control Bits for Channels Belonging to Different Power Control Sets During Soft Handoff
  - Decision of Power Control Bits for Channels Belonging to the Same Power Control Set
  - Demodulation of Power Control Subchannel During:
    - Soft Handoff
    - Reverse Pilot Channel Gating
    - Reverse Fundamental Channel Gating
  - Demodulation of Forward Traffic Channel in Multi-Path Fading Channel with:
    - Closed Loop Power Control
    - Outer Loop Power Control and Closed Loop Power Control
    - Closed Loop Power Control and Transmit Diversity
TIA/EIA-98-D (cont.)

- Receiver Performance
  - Receiver Sensitivity and Dynamic Range
  - Single Tone Desensitization
  - Intermodulation Spurious Response Attenuation
  - Adjacent Channel Selectivity
  - Receiver Blocking Characteristics

- Limitations on Emissions
  - Conducted Spurious Emissions
  - Radiated Spurious Emissions

- Supervision
  - Paging Channel
  - Traffic Channel
TIA/EIA-98-D (cont.)

- **CDMA Transmitter Minimum Standards**
  - Frequency Accuracy
  - Handoff
    - CDMA to CDMA Hard Handoff
    - Transmit Power After Hard Handoff
  - Modulation
    - Time Reference
    - Reverse Pilot Channel to Code Channel Time Tolerance
    - Reverse Pilot Channel to Code Channel Phase Tolerance
    - Waveform Quality and Frequency Accuracy
    - Code Domain Power
  - Limitations on Emissions
    - Conducted Spurious Emissions
    - Radiated Spurious Emissions
    - Occupied Bandwidth
TIA/EIA-98-D (cont.)

- RF Output Power Requirements
  - Range of Open Loop Output Power
  - Time Response of Open Loop Power Control
  - Access Probe Output Power
  - Range of Closed Loop Power Control
  - Maximum RF Output Power
  - Minimum Controlled Output Power
  - Standby Output Power and Gated Output Power
  - Power Up Function Output Power
  - Code Channel to Reverse Pilot Channel Output Power Accuracy
  - Reverse Pilot Channel Transmit Phase Discontinuity
  - Reverse Traffic Channel Output Power During Changes in Data Rate
Test Equipment

- Integrated Test Suite
- Base Station Emulators
- Faders
- Path Emulator
- Diagnostic Monitor
- Spectrum Analyzer
- Signal Generator
- Code Domain Analyzer
- Network Analyzer
- Noise Generators
- Thermal Chamber
- RF Screen Room
- RF Shield Box
- Power Supplies
- Multi-Meters
- Power Meters & Sensors
- Personal Computers
- Printers
- Mass Storage
- Attenuators
- Splitters
- Combiners
Engineering Resources

• Electrical engineering background with focus on digital communication, understanding of CDMA theory and implementation particularly on the air interface, call processing, and messaging; familiar with telecom test equipment and RF measurement, and components.

• A big plus: familiar with TIA/EIA-98 standard and understand the parametric testing issues of handsets; scripting programming capability
Impact of Non-Compliance

• Ensure Minimum Handset Performance
  – Can Operate On Any IS-95 Network

• Ensure Maximum Network Capacity
  – Measure Hand-Off Timing
  – Measure Power Control

• Maximize End-User Experience
  – Minimize Call Drops
  – Maximize Voice Quality
Impact of Non-Compliance

- MS transmits more than the required or less than the required power while transmitting probes. This may increase the call setup time and increase the FER in other voice calls due to higher noise density. Phone may act like a jammer when it is close to a BS.

- Failure to detect neighboring cell site pilots while in a call. This causes delayed or failed hand off and poor voice quality due to rapid degradation of the active pilot energy.

- Phone fails to demodulate the paging channel after wake-up in slotted mode. This is generally caused by poor link maintenance by the RF front end causing the phone to spend significant amount of time in system acquisition. Higher number of missed calls.
Impact of Non-Compliance

- Failure to transmit at the correct power level after hard handoff to a different frequency. Some phone or BS may take longer than the required time to complete this operation. **Handoff failures or muted audio** can be experienced.

- Insufficient Tx power at low temp or poor receiver sensitivity during vibration. This may cause a mobile to send access probes with insufficient power from the cell boundaries that may **reduce the system capacity**. Can also cause **higher call drops** while driving.
CDMA Industry Standard: CDG Stage 2 - Interoperability Testing
Overview

• Industry Standard “CDG Stage 2 Interoperability Testing”
  – Demonstrate Mobile / Base Station Compatibility (Cabled Environment)
    • Regression
    • POTS
    • Registration
    • Authentication
    • Subscriber Calling Features
    • Data Services
    • Over-The-Air Services
    • System Selection

• CDG Stage 3 Entrance Requirement
CDG Stage 2 Tests

- Air Interface*
- POTS*
- Handoff*
- Power Control
- Registration*
- Authentication
- Service Redirection*
- Short Message Service

* Candidates for Commercial Test Equipment
CDG Stage 2 Tests (cont.)

- Subscriber Calling Features
- Asynchronous Data and Fax Services
- Packet Data Services
- Medium Speed Packet Data
- High Speed Packet Data
- Over-The-Air Services
- System Selection For Preferred Roaming*
- Message Driven Indicators*

* Candidates for Commercial Test Equipment
CDG Stage 2 Tests (cont.)

• **Key Elements**
  - System Selection
  - Soft and Hard handoff in fading 30km/hr 100km/hr 3km/hr
  - Power control tests- PMRM,EIB
  - Land to Mobile calls in all service options
  - Reverse Link Failure during Call setup
  - Forward Link failure during call setup
  - Radio Link Failures during call
  - No Traffic Resource available
  - Search Window as per Neighbor
  - Access Entry Handoff
  - DTMF Signaling
  - Data and SMS services-IWF, IP, Packet Data etc
Test Equipment

- Integrated Test Suite
- Base Station Emulators
- Network Emulator
- Faders
- Vector Signal Analyzer
- Network Analyzer
- Spectrum Analyzer
- Signal Generator
- Diagnostic Monitors
- Noise Generators
- AWGN Filters

- Data Server
- RF Shield Box
- Power Supplies
- Multi-Meters
- Power Meters & Sensors
- Personal Computers
- Printers
- Mass Storage
- Attenuators
- Splitters
- Combiners
Engineering Resources

- Strong knowledge on digital wireless communication, thorough understanding of CDMA system and strong background in wireless communication standards and protocols is required. Familiar with IS-95/IS-2000 or IS-98/JStd.-018 CDMA/Amps protocols & standards would be helpful. Experience in executing s/w protocol and HW & RF tests on Wireless products in different commercial infrastructure is necessary.

- Experience in one or more of the following disciplines:
  - Protocol test engineer
  - Analog/Digital Communication engineer
  - Wireless Communication & System Engineer or equivalent
  - MSEE with specialization in Wireless/Personal Communication is preferable
Impact of Non-Compliance

- High Message Error Rate in slotted mode operation. This may increase the rate of **missed pages**.
- Traffic channel initialization failure during call setup. Preamble timings are off. This may cause **higher call origination failures**.
- Non-compliant to access parameter message. This will cause more probes to be sent out from the phone for call setup. **Poor stand by time / talk time**.
- Data services failures can cause **loss of data** during sending/receiving faxes or call setup failures between the computer and the access terminal.
- 3 way **handoff failures** for fast rising pilots. May be caused due to miss-detection of the candidate set Ec/lo.
- Timer based registration failures. **Unnecessary pages** to the mobile when it's outside of the network.
CDMA Industry Standard:
CDG Stage 3 -
Interoperability Tests
Overview

• **Carrier Specific Test Program**
  – Vary Considerably In Scope Between Carriers

• **Industry Standard “CDG Stage 3 Interoperability Testing”**
  – Demonstrate Mobile / Base Station Compatibility (Carrier Network)
    • Regression Suite Of Stage 2
    • Over-The-Air Environment
CDG Stage 3 Tests

- Air Interface *
- POTS
- Handoff *
- Power Control*
- Registration
- Authentication *
- Service Redirection

* Requires Access To Base Station Logs
CDG Stage 3 Tests (cont.)

- Short Message Service *
- Subscriber Calling Features
- Data Services *
- Voice Quality
- Minimum Entrance Criteria

* Requires Access To Base Station Logs
CDG Stage 3 Tests (cont.)

• Key Elements
  – System Acquisition
  – Idle Handoffs
  – Soft and softer handoffs
  – Hard handoffs
  – Power control tests — Forward & Reverse
  – Registration
  – Calling features-3way, 2 way, caller id
  – DATA -Async & Fax
  – Call Originations
  – Page Response
  – Long Calls
  – Short Calls
Test Equipment

- Test Van
- Mobile Diagnostic Monitor s/w
- Spectrum Analyzer
- Laptop Computers
- Data Processing Tools
- Serial Cables for Test Phone w/ RF Connectors
- Service Programming Tool
- Inverter
- Data Storage/Transfer Devices
- External Antenna
- LNA & Duplexer
Engineering Resources

• Strong knowledge on digital wireless communication, thorough understanding of CDMA system and strong background in wireless communication standards and protocols is required. Familiar with IS-95/IS-2000 or IS-98/JStd.-018 CDMA/Amps protocols & standards would be helpful. Experience in executing s/w protocol and HW & RF tests on Wireless products in different commercial infrastructure is necessary.
• Experience in one or more of the following disciplines:
  – Protocol test engineer
  – Analog/Digital Communication engineer
  – Wireless Communication & System Engineer or equivalent
  – MSEE with specialization in Wireless/Personal Communication is preferable
Impact of Non-Compliance

• **High call drops** in the test drive route due to higher erasures. Poor receiver or transmitter performance in radiated mode.

• **Call drops** near a non-collocated interfering cell. Intermod problem.

• **Failure to perform handoff** in dynamic RF conditions.

• Subscriber calling features test such as 3-way calling, DTMF mailbox access, caller ID etc. SMS tests in dynamic RF environment can also cause **incomplete message deliveries**.

• Failure to periodic reporting of erasures through PMRM. This may cause the BS to operate at lower Eb/lo set-point and **choppy forward link audio** due to high erasures.

• **Pops or clicks** during 13k to EVRC handoffs.
CDG Stage 4 -
Optional System Performance Tests
Overview

- CDG Optional System Performance Tests
  - Audio Quality Tests
  - Mobile Station Talk Time/Standby Time Tests
  - Preferred Roaming List Tests
- Referred To As CDG Stage 4
FCC Regulatory Testing
Regulatory Requirements

- **Electromagnetic Compatibility (EMC):**

- **Essential Terminal Requirements**
  - FCC CFR Part 22 & 24 - Public Mobile Services
Regulatory Requirements

• RF Safety Requirements:
  – FCC CFR 47 Part 2 SAR (Specific Absorption Rate) Limits For Handheld Portable.

• Hearing Aid Interference Requirements:
  – Proposed FCC Ruling based on ANSI/IEEE C63.19 SC8 Committee Limits.

• Electrical Safety Requirements:
  – IEC 60950, UL 60950

• http://www.fcc.gov/
Advanced Features Testing
Overview

- IP Based Over-The-Air (IOTA)
- Web-Browsers
- E-Commerce
- GPS/Position Location/E-911
- RUIM
- Antenna Testing
- CLA Testing
Resources

• Capital Equipment
  – Varies Carrier To Carrier

• Engineering
  – Feature Dependent
Typical Timeline - U.S.

- **CDG 1** (Ind. labs): 2 week test + 4 week queue
- **CDG 2** (Infra. vendors):
  - Motorola: Average 5 week test + 5 week queue
  - Lucent: Average 5 week test + 5 week queue
  - Nortel: Average 5 week test + 5 week queue
- **CDG 3+** (Carriers): 9+ weeks
- **FCC**: 3 week test + 2 week queue (~ 8 week FCC approval)

Typical total ~ 26 weeks
Test Process - Japan

• Vendor Testing To Carrier Requirements
  – Regulatory Testing - TELEC, JATE
  – Product Quality Assurance - Vendor Lab
  – CDG Stage 2 Interoperability (Limited)

• Carrier Acceptance Testing
  – Regression Testing (Lab & Field)
  – Advanced Features Testing (Web, Email)
Typical Timeline - Japan

CDG 1 & 2  
Vendor Lab

2 - 8 weeks (estimate)

Advanced Features  
Carrier Lab

KDDI - Average 4 months

CDG 3+ Carriers  
6 weeks

JATE & TELEC

~ 4 weeks (including approval cycle)

Typical total ~ 26 weeks
Test Process - Korea

• Vendor Testing To Carrier Requirements
  – Basic Performance (Receiver / Transmitter)
  – Functional (Data, SMS, Battery Life)
  – Environmental (Temp, Vib, Humidity, Drop)
  – Regulatory (Radio Research Laboratory)

• Carrier
  – Minimum Performance Testing
  – Field Performance
Typical Timeline - Korea

Vendor Development Testing

2 - 8 weeks (estimate)

Typical total ~ 3 weeks

CDG 3+ Carriers

3 weeks

RRL

~ 4 weeks (including approval cycle)
Test Process - Review

- **U.S. Process**
  - Most Comprehensive, Long, & Costly
- **Japan Process**
  - Very Comprehensive & Long
- **Korea Process**
  - Very Efficient
  - Enabled By Vertical Integration & Short Market Cycle
- **China Process**
  - CDMA Opportunity For Best Of All Worlds
Summary

• Handset models must satisfy minimum operational requirements to help maximize end-user experience & ensure network capacity
  – Minimum Performance Testing
  – CDG Stage 2 & 3 Interoperability Testing
  – Optional System Performance Testing
  – Regulatory Testing
  – Advanced Features Testing
Thank You!