Impact of Smartphones and Computers on CDMA2000 Networks

CDMA Development Group

March 2011
Global Voice and Mobile Data Traffic Growth

Worldwide voice traffic increased by twelve percent and mobile data traffic more than tripled in 2009-2010

Voice and Mobile Data Traffic Worldwide: 2007 through Q2 2010

Source: Ericsson
Global Mobile Data Growth

Worldwide mobile data traffic is expected to increase ten-fold by 2015


Source: Ericsson
Mobile Data and Signaling Traffic Growth

Mobile data traffic grew by 20%, while signaling traffic grew by 70% in 2009

Growth of Mobile Data Traffic Versus Data Connection Attempts

Source: Airvana
1X Advanced
Key Messaging
1X Advanced: Benefits

1X Advanced can substantially improve an operator’s competitiveness by enabling:

- Up to a **four-fold** gain in voice capacity
- **More efficient** use of limited spectrum
- **Lower cost** per call or more available minutes of use
- Up to **70% greater** 1X coverage (tradeoff)
- Up to a **threelfold** increase in 1X data network capacity (tradeoff)

1X Advanced frees up spectrum for broadband data or more voice carriers

Source: CDG
### 1X Advanced Features and their Impact on Increasing Voice Capacity

<table>
<thead>
<tr>
<th>CDMA2000 Achievable today</th>
<th>1X Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>New handsets &amp; network software upgrade CSM6700</td>
<td>New handsets &amp; network channel card CSM8700 Rel. 1.1 CSM8700 Rel. 1.2</td>
</tr>
<tr>
<td>x Voice users</td>
<td>3.0x Voice users</td>
</tr>
<tr>
<td>1.5x Voice users</td>
<td>Mobile Rx Diversity</td>
</tr>
</tbody>
</table>

**Source:** CDG

x = Today’s baseline capacity for CDMA2000 1X; QLIC = Quasi-linear Interference Cancellation; RLIC = Reverse Link Interference Cancellation (RLIC), also known as Base Transmission Station IC.

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**1X Advanced:** Voice Capacity Benefit

1X Advanced can enable a four-fold gain in voice capacity.
1X Advanced: Voice Capacity for Coverage Tradeoff

1X Advanced can tradeoff voice capacity to increase coverage by 70%

Up to 400% Increase in Voice Capacity or 70% Increase in Coverage

Source: CDG
1X Advanced: Voice Capacity for Data Capacity Tradeoff

1X Advanced can tradeoff voice capacity to increase data capacity by a factor of three.

1X Advanced Tradeoff between Voice and 1X Data Network Capacity

Source: CDG
Optimizing Spectrum Utilization

1X Advanced frees up spectrum for broadband data

Evolutionary Steps to Greater Network Capacity by Freeing up Spectrum

- **EVRC** (Single RX)
  - 1X
  - 1X
  - 1X
  - 1X
  - Rev. A

- **EVRC-B** (RX diversity with QLIC)
  - 1X
  - 1X
  - Rev. A/B
  - Rev. A/B
  - Rev. A/B

- **1X Advanced** (RX diversity)
  - 1X Adv.
  - DO Adv.
  - DO Adv.
  - DO Adv.
  - DO Adv.

- **Multicarrier EV-DO**
  - EV-DO Rev. A (1x) 3.1 Mbps
  - EV-DO Rev. B Phase II (4x) 14.7 Mbps

Source: CDG
Simultaneous Voice and Data (SVDO)

New SVDO-enabled devices allow users to access data while on a voice call.

No infrastructure upgrade is required.
Multicarrier EV-DO Key Messaging
Multicarrier EV-DO Rev. B

Multicarrier EV-DO increases user data rates by combining up to three EV-DO carriers.

Forward and reverse link peak data rates are increased to 9.3Mbps and 5.4Mbps respectively, in 5MHz of spectrum.

Via a software upgrade and new EV-DO Rev. B devices.
Multicarrier EV-DO: Benefits

Beyond increasing speed, EV-DO Rev. B provides more capacity (e.g., users per sector) and is designed to handle smartphone applications.

Source: Qualcomm
Multicarrier EV-DO: Benefits (cont.)

Multicarrier EV-DO triples cell edge performance

EV-DO Rev. B User Data Rate Improvements

Source: CDG
EV-DO Rev. B Devices

Delivering up to 9.3 Mbps download speeds

Ten EV-DO Rev. B devices from six manufacturers

- Olive Telecom V-ME500
- ZTE AC2790
- ZTE AC600
- Sony Ericsson S005
- Fujitsu Toshiba X-RAY IS05
- Fujitsu Toshiba T006
- Pantech SIRIUS IS06
- Fujitsu Toshiba REGZA IS04
- Sony Ericsson G11
- Sony Ericsson CYBER-SHOT S006

Source: CDG
DO Advanced
Key Messaging
DO Advanced

DO Advanced introduces Smart Network techniques that exploit unevenly loaded networks to improve network capacity and performance without requiring new spectrum, channel cards or devices.

Typical Network Load Distribution During Busy Hour

Source: Qualcomm
DO Advanced enables operators to cost-effectively add data network capacity when and where it is needed.

DO Advanced Features

- **Smart networks**
  - Network Load Balancing
  - Adaptive Frequency Reuse
  - Distributed Network Scheduler
  - Single Carrier Multilink
  - Smart Carrier Management

- **Enhanced connection management**
  - Advanced Topology Networks
  - Parameter optimization and implementation enhancements
  - Increased connection capacity with more efficient use of existing resources

- **Advanced devices**
  - Enhanced Equalizers
    - Improved performance for uneven and bursty traffic
  - Mobile Transmit Diversity
    - Higher UL capacity and data rates

Source: CDG
DO Advanced: Network Load Balancing

Network Load Balancing utilizes unused network capacity of lightly-loaded neighboring cells to achieve more than double the data rate under certain loading conditions.
DO Advanced: Adaptive Frequency Reuse

Adaptive Frequency Reuse reduces interference by adjusting the transmit power of lightly-loaded cells to increase overall network capacity and improve data rates.

Adaptive Frequency Reuse

- **High load**
- **Low load**

**Carrier #2**
Tx power (coverage) reduced for cells with lower demand. Results in better utilization of surrounding cells.

**Carrier #1**
Always at full Tx power (fixed coverage).

Source: CDG
DO Advanced: Distributed Network Scheduler

The Distributed Network Scheduler maximizes network capacity by prioritizing and allocating bandwidth across multiple carriers, serving sectors and cells.

Distributed Network Scheduler

<table>
<thead>
<tr>
<th>Today’s Multicarrier Networks</th>
<th>Distributed Network Scheduler</th>
</tr>
</thead>
<tbody>
<tr>
<td>All users served by all carriers</td>
<td>User served by most suitable carrier/s</td>
</tr>
</tbody>
</table>

- Larger coverage area of Carrier #2 because of lower interference (e.g. hotspots)
- Users closer to BTS are primarily served by Carrier #1

Example: User data rates
- 0.7 Mbps User on cell edge
- 2.4 Mbps User close to BTS
- 1.2 Mbps User on cell edge
- 2.4 Mbps User close to BTS

Source: CDG
DO Advanced: Single Carrier Multilink

Single Carrier Multilink extends the benefits of multicarrier EV-DO to single carrier networks
DO Advanced: Smart Carrier Management

Smart Carrier Management uses the signal strength **and** load on each carrier to assign the optimal combination of carriers for each device.
DO Advanced: Enhanced Connection Management

Enhanced Connection Management addresses connection capacity, signaling capacity, lower latency and longer battery life by connecting devices to the network in an optimal way that is based on the type of application being used.

- **Higher Connection Capacity**
  - Supports more interactive users such as “push-pull” mobile email
  - Efficient use of paging and access channels
  - Better traffic congestion management
  - Leverages advanced topology networks

- **Better User Experience**
  - Lower latency
  - Improved “Always On” experience
  - Improved battery life
  - Better user experience even during congestion

Source: CDG
DO Advanced: Advanced Topology Networks

Advanced Topology Networks offer the following benefits:

- Unified operations across macro-, pico-, micro-, repeaters and remote radio heads
- Increased bandwidth in high-traffic areas
- Higher network capacity
- Improved coverage
- Lower latency
- Less signaling traffic
- Improved user experience

Example: Improvement with DO Advanced Pico-cell deployment
DO Advanced: Enhanced Equalizers

Enhanced Equalizers take advantage of uneven and bursty traffic channel conditions to increase cell-edge data rates and forward link sector capacity.

### Enhanced Equalizer Performance Enhancements

<table>
<thead>
<tr>
<th>Cell-Edge Data Rate Improvement</th>
<th>DL Sector Capacity Performance Gain</th>
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<tbody>
<tr>
<td>Typical Network Load in a Densely Populated Area</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance between cell sites</th>
<th>1.5 km</th>
<th>0.5 km</th>
</tr>
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<tbody>
<tr>
<td>Improvement</td>
<td>25%</td>
<td>45%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load Scenarios</th>
<th>Full load scenario</th>
<th>Typical load scenario</th>
<th>Low load scenario</th>
</tr>
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<tbody>
<tr>
<td>Performance Gain</td>
<td>10%</td>
<td>20%</td>
<td>25%</td>
</tr>
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Source: CDG
DO Advanced: Mobile Transmit Diversity

Mobile Transmit Diversity, the reverse link companion to Mobile Receive Diversity, uses dual antennas to transmit data faster.

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<th>Mobile Transmit Diversity Performance Enhancements</th>
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<tr>
<td><strong>RL Cell-Edge Data Rate Improvement</strong></td>
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<tr>
<td>With RLIC (BTS IC)</td>
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<tr>
<td>80%</td>
</tr>
<tr>
<td>110%</td>
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</table>

Source: CDG

www.cdg.org
The CDMA2000 evolution path consists mostly of software upgrades that leverage existing standards, devices and infrastructure.
The evolution of CDMA2000 addresses network traffic growth through incremental, affordable and backward compatible enhancements, while preserving existing investments.
Smartphone sales are not waiting for new network deployments

Operators will continue to deploy additional CDMA2000 resources to meet the demand for mobile data traffic, even as they look to deploy LTE.