EVDORa, VoIP, and Flat IP RAN
A Solution for Enterprise and Campus Applications

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Market Drivers & Implications

IMS and multimedia services will change the game for mobile data networks

- Person to content → person to person AND person to content
- VoIP telephony, push-to-speak, video telephony, and broadcast/multicast multimedia are key apps
- Increased importance of QoS and controlled latency management

Changing data communication patterns will drive changes in traffic patterns

- In person to person traffic, most traffic stays within a local switching center
- For location-based multimedia information services, content can be cached locally for more efficient distribution

To meet the needs, mobile data network architectures need to “flatten”

- Shift away from large, centralized internet POPs to more distributed IP network connectivity for user services
- Move user application IP termination closer to the user
- Need for smaller scale, more distributed “data access gateways”

FMC* Offerings benefit from flat IP architectures, enabling “access agnostic” services

- “Grand Slam” offerings - Telephony, High Speed Internet, Video Content, Mobile Services
- Security, access controls, content billing, Lawful Intercept, etc.
- Common policy and rules enforcement across different access methods - e.g. EVDO, 802.11, cable, ...
  - Common approach to QoS, SLAs, roaming agreements, etc.

* FMC = Fixed Mobile Convergence
EV-DO Architecture Evolution & the CDMA BSR

Evolution to a flat architecture:
- Involves evolution of the RAN, PDSN and the Transport Network
- Must support all services including VoIP
- *Coexistence of next gen BTS (BSR) with traditional RAN architecture* needed to preserve investment in current EV-DO infrastructure

The Home Agent provides a Mobile IP anchor point
- Enables the user to move seamlessly within a network of BSRs and between BSR and surrounding networks
- Mobility within the BSR network combines the best of IP and lower layer mobility protocols for superior performance

Present Hierarchical Network

<table>
<thead>
<tr>
<th>Cell</th>
<th>RNC</th>
<th>PDSN</th>
</tr>
</thead>
</table>

BSR

| Cell/RNC/PDSN |

**CDMA BSR combines the BTS, RNC, and PDSN in a single edge node close to the end-user**
Market considerations for CDMA BSR

**Market enablers & barriers:**

- **Drive for cost-effective in-building enterprise coverage**
  - Couple with enterprise PBX interworking for more targeted services, location based billing, & public network offload
  - Converged wireless/wireline service offerings
  - OPEX savings by linkage with enterprise PBX for local enterprise calling and PSTN interconnect through PBX trunking

- **New spectrum allocations - VoIP only, greenfield approach**
  - E.g., 700 MHz and AWS spectrum
  - New devices needed for new spectrum, why not DOrA VoIP that drop down to 1x in legacy spectrum

- **Rural “drop-in” networks that have difficult business case due to backhaul costs**

- **Barrier to ubiquitous deployment: high speed, metro-E/optical facility availability**

**User applications to complement BSR deployment and deliver on value proposition:**

- Enterprise VoIP services/interworking & Wireless/Wireline convergence
- Push-to-talk, Video telephony, and other IMS person-to-person multimedia services

**Mobile technology enablers:**

- Complementary to EVDOra macro coverage (leveraging RNC architecture)
  - Stimulate EVDOra VoIP handset demand - enterprise-first value-added capabilities to leverage premium devices first, prior to availability of lower cost consumer handsets
- Drive traffic onto IMS networks
Example Service Concept

Target Market
- Larger Enterprise mobile users. This user segment needs mobility at corporate locations, in the wide area network, in their homes, and around the globe. Such users will benefit from carrying a single handset device.

Service Concept
- Offer most popular enterprise and regulatory required cellular services
  - Core telephony features, SMS, seamless roaming, 911, 411, abbreviated dialing, push to talk, enterprise voice features like call park, pickup, coverage, email, content downloads, ...
  - Available in the enterprise over EVDOrA and BSR, with local routing of traffic between mobiles and wireline endpoints, saving on backhaul and PSTN costs for intra enterprise user groups; location based “all you can eat” billing while serviced on the BSR
  - Available in the macro network with same capability set at normal airtime rates
  - Available in the home either by voice over WLAN or EVDOrA femtocell using broadband internet connection at reduced rates

Handset Devices
- The high tier handset would support access methods for voice services of EVDOrA VoIP, WLAN VoIP, 3G1X circuit voice, with preference for service in that order
- The lower tier handset would support EVDOrA VoIP and 3G1X circuit voice, but eliminate WLAN VoIP, and corresponding reduced-rate in-home VoWLAN access
  - unless the customer purchased an EVDOrA femtocell to get reduced in-home rates
Service Architecture

Enterprise Voice Convergence Application Servers (Telephony, Messaging, 3G1X Interworking, PoC, etc.)

IMS Infrastructure

Home Agent, Media GW, MRF

Broadband IP access

Home 802.11 or EVDOa femtocell

Anywhere EVDO or 1X

Enterprise Office EVDO

Tri-Mode EVDOa, WLAN, 1X

Handset w/ IMS client

Local HA/MGW

BSR
## Key Enterprise Features for Service

- Mobile simultaneous ring (with desk phone)
- Outgoing, Incoming caller ID
- Common Voicemail
- Unified Dial Plan (HQ and Branches)
- Abbreviated dial (4/5 digit dialing, private user groups)
- Call forwarding
- Call transfer, drop
- Mobile-Desk Seamless Call Movement
- Multiple Line Appearances (4+)
- Bridged Line Appearances (device extensions)
- Meet-me conference
- Ad-hoc conference (3 - 6 way)
- Call coverage (6 steps)
- Emergency Services (911)
- Call Pickup (directed, group, extended)
- Priority calling (selective distinctive alerting)
- Distinctive ringing
- Transfer recall
- Hold recall
- Music on hold
- Auto redial
- Whisper page (secretary-boss)
- Auto Callback (busy, no-answer)
- One Touch Call Recording
- Call park and Retrieve
- Busy Indicator
- Do Not Disturb - Send all Calls
- Account codes
- Authorization codes
- Attendant Transfer, Conf, Etc.
- Call Restrictions
- SMS (Mobile originated, terminated, and compatibility with major SMS service profiles)
- Attendant line monitoring
- Hotline
- Enterprise directory click-to-dial via portal
- Enterprise administration of their subscribers
- Network “slicing” by enterprise
Enterprise Market Focus - Illustrative Example with EV-DO BSR & operator hosted PBX (top down view)

Key:
- Applications Servers
- Control Elements
- Media Bearing
- RAN Specific

Enterprise Voice Convergence
Application Servers
(Telephony, Messaging, 3G1X Interworking, PoC, etc.)

IMS Infrastructure

Operator IP network

HA & IP Services

Large Scale MRF

Large Scale MGW

VPN-GW

Internet

SS7
PSTN/PLMN

MSC
(1x Ckt & Pckt)

RNC + PDSN

BSR / Macro Network Interworking

PRI (optional*)

Enterprise SIP phones

BSR

DOA VoIP Mobile

_operator at Enterprise

Local MGW

Local MRF

Local HA

Network

Backhaul

Cell Site

* Depending on operator business model in offering enterprise service, the PSTN interface could be local and paid for by enterprise, or connected via the operator's large scale MGW.

EV-DO BSR can be used as a standard cell or paired with a Distributed Antenna System
Enterprise Market Focus - Illustrative Example with EV-DO BSR and enterprise PBX interworking

Key:
- Applications Servers
- Control Elements
- Media Bearing
- RAN Specific

EV-DO BSR can be used as a standard cell or paired with a Distributed Antenna System like RadioStar
Potential Advantages of a BSR-based Enterprise VoIP Solution

Reduces Total Cost of Ownership for enterprise in-building service delivery

- Reduction in Backhaul and PSTN Interconnect costs
  - Calls between mobiles on premises never get backhauled
  - With local MGW interconnected with PBX, calls between mobiles and PBX extensions never get backhauled or touch the PSTN
  - Calls from mobile to PSTN could use local PRI or PBX trunks to offload PSTN interconnect costs from the network
- Offloads macro network spectrum for in-building calls
- Offers capability for PBX Service interworking for increased ARPU

Value added enterprise VoIP capabilities, leveraging client/server applications

- Enterprise directory, voice mail integration, SMS services, enterprise dial plans, ...
- In-building/campus Push-to-Talk Over Cellular Services leveraging EVDOra QoS
- Service transparency when moving between in-building and EvDOra macro network

Improved Quality of Service

- Leverages Mobile Operator licensed spectrum for managed interference (vs. WiFi)
- QoS-aware BSR provides admission controls for VoIP services

Standard EVDOra Mobiles

- Promising wider selection and lower cost than CDMA/ WiFi dual mode handsets
- CDG certified handsets assure service quality - no similar process for CDMA/WiFi handsets
- Enhanced VoIP services can be maintained when leaving the premises via the EVDOra wide area network.
Economic Model Overview

**Objective:** To determine the economics of In-building BSR solution vs traditional BTS

**Scope:** Campus/enterprise environment

**Input/Assumptions (from operator):**
- Campus layout: 3 buildings, 5 floors/building, 100K sq. ft. per building
- Subscriber: 200 sq. ft. per sub, 1500 total
- Traffic demand: 3 BHCA/sub, 3 CCS per sub

**Scenario Definitions:**
- **Scenario 1:** Premises BTS - less use of PBX, people using mobiles more because of better in-building coverage. Higher wireless usage
- **Scenario 2:** Premises BSR - in-campus calls do not leave campus - backhaul savings; service provider can pass on savings from backhaul.

<table>
<thead>
<tr>
<th>Traffic Distribution</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBX-PSTN</td>
<td>35%</td>
</tr>
<tr>
<td>PBX-PBX</td>
<td>20%</td>
</tr>
<tr>
<td>PBX-Ext Mobile</td>
<td>5%</td>
</tr>
<tr>
<td><strong>PBX-Int Mobile</strong></td>
<td><strong>10%</strong></td>
</tr>
<tr>
<td>In Mobile-Ex Mobile</td>
<td>5%</td>
</tr>
<tr>
<td>In Mobile-In Mobile</td>
<td>8%</td>
</tr>
<tr>
<td>In Mobile-PSTN</td>
<td>10%</td>
</tr>
<tr>
<td>Ex Mobile-PSTN</td>
<td>7%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Carrier Opex affecting
Scenario 1: Premises BTS

Mobile to Enterprise PBX calls: no change

Mobile to Mobile calls: In-building mobile homes to Premises BTS, providing improved coverage;
Scenario 2: Premises BSR

Mobile to Enterprise PBX calls: traverse the SP IMS network, not the PSTN, reducing connectivity and backhaul costs for the SP and Enterprise.

Mobile to Mobile calls: the coverage advantages of prem-BSR Solution, plus Intra-premises mobile calls home to Prem-BSR, providing additional capacity relief.
Modeling & Results

Number of Subs 1500
BHCA 5
CHT (Min) 3

- Remote Radio Head: 45
- BSR 2400: Sector-carriers 14
- Media Gateway: 1 (small)
- Media Resource Server: 1 (small)
- Home Agent: 1 (small)

Note: It is assumed that the MGW will be controlled by the MGCF in operator’s Regional Center; capacity is not an issue

Scenario 1
- PBX-PSTN DS0s 282
- MSC-PSTN DS0s 180
- Premises BTS Backhaul equivalent DS0s 22

Scenario 2
- PBX-PSTN DS0s 197
- IMS Core MGW-PSTN DS0s 96
- Premises MGW Backhaul equivalent DS0s 19
- Premises MGW-PBX DS0s 85

Enterprise savings
Operator savings
Transport Capacity
BSR v. BTS TCO Comparison
Operator View

- Compare the cost of covering an enterprise location with a traditional BTS vs. a BSR
- BSR will reduce backhaul required back to the mobile network and PSTN.
- Enterprise - 3 buildings, 300K sq. ft., 1500 employees
- Traffic and revenues are constant across both scenarios
- Some incremental CapEx for BSR equipment
- Equipment OA&M, and SG&A expenses are same across both scenarios

<table>
<thead>
<tr>
<th>Year</th>
<th>BSR</th>
<th>BTS</th>
</tr>
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<tbody>
<tr>
<td>2008</td>
<td>$(2,747)</td>
<td>$22</td>
</tr>
<tr>
<td>2009</td>
<td>$(3,077)</td>
<td>$9,797</td>
</tr>
<tr>
<td>2010</td>
<td>$(5,063)</td>
<td>$9,990</td>
</tr>
<tr>
<td>2011</td>
<td>$9,900</td>
<td>$12,411</td>
</tr>
<tr>
<td>2012</td>
<td>$14,572</td>
<td>$14,572</td>
</tr>
</tbody>
</table>

Expense Savings
- 2008: $9,900
- 2009: $9,900
- 2010: $5,400
- 2011: $5,400
- 2012: $5,400

Investments (CapEx)
- 2008: $(10,228)
- 2009: $2,845
- 2010: $3,114
- 2011: $-
- 2012: $-

Free Cash Flow
- 2008: $(3,077)
- 2009: $9,797
- 2010: $6,923
- 2011: $3,809
- 2012: $3,809

CDCF
- 2008: $(2,747)
- 2009: $5,063
- 2010: $9,990
- 2011: $12,411
- 2012: $14,572

Operator payback with current assumption set is in less than one year; Enterprise cost savings are not considered, but reduction in PBX DS0 trunks by 30% should result in significant enterprise savings that could be passed through to enterprise as value-add, or taken as additional profit to operator.
Acronyms

AT - Access Terminal
BW - Bandwidth
BGW - Bearer Gate Way
BSR - Base Station Router
CRF - Charging Rules Function
CS - Cell Site
CSCF - Call State Control Function
EoS - Ethernet over Sonet
EPL = Ethernet Private Line
ETH - Ethernet
FA - Foreign Agent
GAUP - Generic Attribute Update Protocol
GPR = Gigabit Packet Ring
HA - Home Agent
HLR - Home Location Register
IA - Intelligent Antenna
IMS - IP Multimedia System
ISP - Internet Service Provider
LER - Label Edge Router
LSR - Label Switch Router
MGCF - Media Gateway Control Function
MGW - Media Gate Way
MIMO - Multiple Input Multiple Output
MPLS - Multi Protocol Label Switching
MRF - Media Resource Function
NAT - Network Address Translation
NG - Next Generation
PCF- Packet Control Function
PDF - Policy Decision Function
PSTN - Public Switch Telephone Network
RAN - Radio Access Network RN - Regional Node
RNC - Radio Network Controller
RPR = Resilient Packet Ring (IEEE 802.17)
SDMA - Sector Division Multiple Access
SN - Switch Node
SP - Service Provider
TCO - Total Cost of Ownership
VCG - Virtual Concatenation Group
VoIP - Voice over Internet Protocol