Interoperability with Next-Generation OFDM-Based Mobile Broadband Solutions In IP Networks

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Introduction

- Areas to considered for Inter-technology Interworking and Handoff:
  - Radio Capability of the Hybrid terminal
  - Core Network Architecture
  - Handoff Control: Network or Terminal
  - Intersystem functionalities: Loose and Tight Coupling
  - Service continuity across network boundaries
  - Ability to make measurements in target system

- Delivering IP-based Capabilities in the Network
  - What are they?
  - Why does an operator need them?
  - When will they become reality?
  - How do they work?
Radio Capability of Hybrid Terminals

- **Dual Radio**: Dual Rx/ Dual Tx
- **Single Radio**: Dual Radio Rx/ Single Radio Tx

Increasing terminal complexity/cost/interference
Reducing HO solution complexity

Reducing terminal complexity/cost/interference
Increasing HO solution complexity

**OFDM-CDMA Interworking Optimized with Single Radio Terminals, Also Allowing Dual Rx / Dual Tx Devices**
Core Network Architecture

- The Interworking architecture must cover:
  - Mobility
  - Authentication / Security
  - Policy and Charging
  - Fixed / Mobile convergence

- Current agreed architectures for OFDM-CDMA Interworking
  - HRPD-LTE: based on 3GPP Evolved Packet Core (EPC) (agreed in 3GPP and 3GPP2)
  - HRPD-UMB: based on 3GPP2 Converged Access Core (CAN)
  - WiMAX-HRPD: based on “commonalities” between 3GPP2 & WiMAX NWG
Supporting an Access Aware Network

Add LTE as Overlay: Trials 3Q08
- Separate IP’s, No Network Interaction

Add Mobile IP: trials 1Q09
- Provides network mobility for non-real-time applications & common services

Add Seamless Mobility: Trials 3Q09
- Optimizes network mobility for real-time applications & services

Add HO to 1xRTT Voice: Trials 3Q09
- Extends coverage of LTE VoIP by adding seamless mobility to 1xRTT

Move to an All-IP, Simpler, Flatter, Cost Effective Network
3GPP Evolved Packet Core
(Example of Roaming Arch in TS 23.402)

HRPD and WiMAX are considered Trusted Non-3GPP Access
Handoff Control
Network or Terminal Triggering

- Network Triggered:
  - Target selection (in the network) may be enhanced with additional parameters to finely tune the handoff criteria.
  - Network can be tuned to trigger handoff based on highly granular information (e.g. aggressive handoff regiment depending on deployment circumstances)

- Mobile Triggered:
  - The mobile makes the HO decision, potentially with assistance from the network.
    - Network push
    - Network receives measurement information.
  - The degree of network assistance (i.e. what information is provided) will determine the performance of the handoff

Network Controlled Handoff Optimizes Access Network Interworking
Inter-system Functionalities

Loose coupling

a) "Break Before Make"
- Little or no inter-system functionalities
  - UE-centric L3 mobility based on (P)MIP
- Resources are released in the source system prior to Handover execution
  - Service break is significant

b) "Dual-radio MBB"
- Resources in target system are obtained prior to HO execution directly over target radio interface - "seamless mobility"
  - Requires dual radio capability, simultaneous transmit.

Tight coupling

"Make Before Break"

"Network-controlled"
- Requires inter-system functionalities
  - Network-controlled; L3 mobility based on (P)MIP (S101)
- Ability to configure and report measurements of the target system
- Inter-system interface for establishing resources in target system prior to HO execution
- Possibility of data forwarding
- Suitable for single radio devices, but also applicable to dual radio devices
Requirements for Mobility and HO

• The connected systems…
  • Shall support terminals with single radio and dual radio solutions.
  • Shall support voice service continuity between access networks.
  • Shall support bidirectional service continuity between access networks to enable both best effort and real-time applications.
  • Shall minimize impact on service quality, e.g. Quality of Service (QoS), reduce interruption times.
  • Should minimize the coupling between access networks (e.g. by using transparent signaling through the source system) allowing independent protocol evolution in each access.
  • Shall be based on the principles of network controlled radio access mobility.
Principles for Optimised Handovers

• Inspired from the A21 interface defined for HRPD=>1xRTT voice call continuity
• Terminal interacts directly with target system (LTE or HRPD) to perform handover preparation
• Source system provides “tunnelling” capability (S101) for terminal to interact with target system
• In the LTE=>HRPD direction there are two distinct steps
  • 1) Pre-registration: when conditions are such that a handover to HRPD may be required, the source system provides the UE with sufficient information to perform pre-registration with the target HRPD access and core network, over the S101 tunnelling interface
  • 2) HO execution: if conditions subsequently warrant that a handover should occur, the handover signalling will also be performed over the S101 tunnelling interface, whereas data forwarding takes place on S103
• Similar logic applies in the HRPD=>LTE direction
  • Pre-registration also triggers the HO execution
Voice Continuity with the Legacy CS Domain: OFDM to CS HO

• EPC/LTE is Packet Switched (PS) only system

• Voice continuity between LTE and 1xRTT Circuit Switched (CS) domain requires a transformation of a VoIP (on IMS) call into CS session and vice versa

• Requirement is that there should be minimum impact on the CS domain

• The solution to the problem falls in the Voice Call Continuity (VCC) with “single radio hybrid terminal” category
  • VCC = Voice Call Continuity between CS domain and PS via IMS
  • Because of the similarities with 3GPP2 VCC and 3GPP Rel-7 VCC, the problem is referred to as Single Radio VCC
  • Single Radio VCC for LTE-1xRTT is specified in 3GPP TS 23.216
SR-VCC Architecture for 1xRTT CS

- Based on the A21 solution in 3GPP2 A.S0008-C
  - While attached to EUTRAN, the UE initiates tunnelled establishment of the CS access leg (via Uu - S1-MME – S102 – A1)
  - After handover to 1xRTT, the LTE access behaves as if the UE has went out of coverage i.e. it performs the S1 release procedure and considers the UE to be in IDLE state
- 3GPP mostly specifies the transport of A21 messages over S102
Planning for Success

Device and Application Ecosystem

- 1x
- DO
- WiMAX
- LTE

Ethernet and Optical Connectivity

Common Core Architecture

Design, Engineering, Operations hosting

Bridging Today’s Networks with Tomorrow
What Can IP do for Operators?

END USERS
Demand Convenience, Simplicity and Freedom of choice

OPERATORS
Need to be the provider of integrated services
Benefits of Migration to IP

OPEX savings
• Recurring OPEX costs 30% to 50% lower than with E1/T1 Leased Lines
• Converging mobile flows onto single cost-effective transport architecture

Transport Efficiency
• TDM inherently inefficient:
  • Symmetrically provisioned links
  • Channels reserved even when idle
• Packet transport enabling superior link utilization and bandwidth recovery

Transport Flexibility & Scalability
• Highly scalable packet network vs “rigid” TDM networks
• Flexibility to deploy IP and TDM concurrently in the network
• Operational simplicity (Connection-less IP & Quick to scale)

Future-proof evolution
• Multi-generation 2G/3G/4G flows convergence onto single unified IP network
• Evolution to IP-centric networks for convergence and new applications
Momentum from the Wireless Data Waves

Wave 1 - Initial Wireless Data Service
- Voice & Text Driven – Low Volume
- Billing via legacy Circuit – Limited controls

Wave 2 – Wireless Data Service of Value
- Data rate acceptable – Traffic Approaches Voice
- Data Plans, Wireline explodes - Content Billing
- Carrier class Intelligent Packet Core Required

Wave 3 – Mass Market Mobile Broadband
- Consumer Devices, Multi-Access, Traffic >Voice
- Multi-nodes / Person, Flat Rate, Special Rate
- Carrier Class, COTS, Scalable, & QOS

DO Rev A is creating the Mass Market Mobile Broadband
Improve Operator Efficiency

Multiple devices
Multiple clients

PMO
- MMS
- PTT

Chat/IM Presence
- WAP
- Email

FMO
- PTx
- Dwnld
- Video

Chat
- IM

Single device
SIP client

Single network, common elements, enablers, & applications
Leverage LD bypass
Improved Voice quality and increased transport savings: keep native vocoder (TrFO & RTO)

SIP/SIP-T support: Packetization between regions and W-/W+
SIP to ISUP conversion: MGCF role for MMD & WLAN/CDMA convergence

Keep Traffic local
Central office consolidation

Cover Remote Areas
Packet Transport Saving

Bridge Application Domains

Via Multi-Function Core Solutions
Packetizing Voice Delivers Crystal Clear CDMA Calls

• Deliver high quality voice service while reducing operating costs
  • Improved Voice:
    • Reduction of end to end delay => better speech perception
    • Better Voice Quality = Higher MOS score
    • Higher MOS score reduces subscriber churn
  • Reduced Opex:
    • Reduces transport costs as native CDMA-encoded voice transported more efficiently in the Packet networks than legacy TDM
    • EVRC Voice transported over IP in 8k payload versus 64k TDM payload across network

Improve Voice Quality, Lower Operations Costs
How TrFO/RTO Enable Crystal Clear Calls

Legend

- Signaling - Circuit
- Signaling - Packet
- Bearer - Circuit
- Bearer - Packet
- BTS – EBSC Interface
- EVRC Voice Path
- TDM Voice Path
CDMA Provides Better Support For Low-latency Applications

High Quality Push-to-Talk

<table>
<thead>
<tr>
<th>Mobile VoIP</th>
<th>Handoff Interruption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inter-cell</td>
</tr>
<tr>
<td>EV-DO rev A</td>
<td>~23 ms</td>
</tr>
<tr>
<td>HSUPA</td>
<td>~100 ms</td>
</tr>
</tbody>
</table>

Call set-up time and signaling for EV-DO rev A have been optimized to provide high-quality PTT

EV-DO Rev A delivers much lower latency to support much better quality of experience in PTT

EV-DO Rev A Mobile VoIP provides superior end-user experience and results in fewer dropped calls

New features to deliver acceptable QoS on UMTS VoIP calls not available until UMTS Rel 8!

Rev A applications provide high penetration & lower churn

Source: Qualcomm
How Do You Want To Provide Service?

FMC Service Types

Access personal agent features
- GUI on mobile for routes, IM, presence
- “Mobile Assistant” (F, M)

Access fixed telephony services
- Turn the mobile into an enterprise extension
- “Mobile Extension” (M)

WiFi/cellular on one device
- Reduced call costs on WiFi
- “Converged Mobility” (F, M)
- “Voice Call Continuity” (M)

Cellular/PC call convergence
- Voice on mobile with multimedia PC GUI
- “Mobile Converged Desktop” (M)

Services on fixed & mobile
- Make/receive calls from any device
- Applicable to all solutions

F = applicable to fixed operator
M = applicable to mobile operator

FMC Provides Wide Range of Services to End-Users
Voice Call Continuity (VCC)

Key Attributes

End-user value

- Reduces calling costs  
  - Cheaper calls in WLAN
- Increased reachability with service integration across devices  
  - Basic telephony  
  - Enhanced telephony  
  - Multimedia
- Call handling across access types and devices  
  - WLAN/cellular handover  
  - Switch calls between fixed and mobile devices

Service-provider value

- Differentiated dual-mode offer  
  - Advanced services beyond cellular  
  - Tight integration with fixed devices
- IMS standards compliant solution  
  - Extends SIP/IMS applications into the cellular network  
  - Allows applications servers to be added for incremental services  
  - Future devices/client will align with IMS-VCC standard
- Supports new services on classic 2G device without client
- Can be enhanced with Mobile Assistant

<table>
<thead>
<tr>
<th></th>
<th>Solution Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrier</td>
<td>Mobile (IN integration needed)</td>
</tr>
<tr>
<td>Device/client</td>
<td>Dual-mode with client, or any mobile</td>
</tr>
</tbody>
</table>

Full Set of Features Supporting Multi-access, Multi-device
Testing with Qualcomm VCC Chipset

• Successful testing of Nortel solution & Qualcomm chipset
• Mobile Station Modem (MSM) chipset powering a test handset
• Nortel WMG 6000 with IMS network
• Capabilities
  • In-call handover using manual and automatic triggers
  • Authentication
  • Calls on cellular/WiFi
  • Variety of error cases
• Live cellular coverage

"The number of networks, devices and applications is exploding, and there is a pot of gold — a very large pot of gold — awaiting the vendors who do the best job of allowing data and applications to seamlessly flow between them all. Qualcomm and Nortel have taken a step in the right direction.”  IT Business Edge, Dec 2007
VCC Network Overview

Access services from any device and any access type

1XRTT, VoIP over DOrA, Wimax, LTE

WiFi, Femto

Any IP

Seamless selection of access domain

WMG 6000

Seamlessly Service Across Multiple Access Types

Reuse existing core elements

MGCF/ MGW

IMS multimedia services

IMS Core

Connect to any domain

Voice AS

IMS

Multimedia services

PSTN

Internet

Seamlessly Service Across Multiple Access Types

VCC Application
- Routes calls to correct domain
- Anchors calls for handover
- SMS to IM interworking

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Designed to Go Beyond WiFi and Femto

- IMS VCC plays a key role in 4G deployments
  - e.g. Seamless call handoff to 2G and 3G networks
  - e.g. LTE femtocells
- Nortel is continuing to drive the IMS Centralized Services (ICS) standards
  - World’s first ICS prototype available now
- Nortel is continuing to develop the VCC ecosystem

VCC Bridges Multiple Technologies, including WiFi, Femto, WiMAX, and LTE
Services Intertwine and Drive More Traffic

Voice & Video
- Imbedded Natively Everywhere.
- Multi-Device gaming on horizon, incorporates wireless

Peer to Peer
- 40% - 60% traffic is P2P today and moving from music to HD video.
- Microsoft’s LiveStation and others targeting mobiles with P2P

Communities Of Communications
- Xbox Live - largest social network in the living room (2.6 million IM, text voice messages /day)
- mobile.youtube.com. 4X cellphones than PCs – Just do the math!

Riding the Data Waves to Higher Revenue and Profits