VoLTE Production Deployment
Case Study

Next Generation Services- RCS, VoLTE and Beyond

ETSI / GSMA / MSF Operator Workshop

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Imagination Technologies

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VoLTE Implementation case study

Outline

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2. VoLTE Market drivers
3. High Level Objectives
4. VoLTE Handset Requirements
5. Application Processor based VoLTE vs. Modem based VoLTE
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7. 3 Greatest Challenges
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Company overview

- **Leading Silicon, IP Clients & Cloud IP supplier**
  - Graphics/video/comms, VoLTE/Video/RCS, Cloud
  - Played significant role in creating Smartphone Segment by offering industry leading multimedia technologies
  - Played leading role in world’s first commercial VoLTE deployment

- **Shipped by most major consumer brands**
  - Smartphones, tablets, TVs/STBs, games consoles
  - Radios, connected audio & video devices
  - Automotive dashboards, navigation, communication

- **Established technology powerhouse**
  - Founded 1985; London FTSE250 (IMG.L)
  - Employees: 1,200+, World Class Team
  - UK HQ; operations world-wide
  - Global customer base

- **Total Revenues**
  - 2008-2009 YR: $104.11m/£64.1m
  - 2009-2010 YR: $131.40m/£80.9m
  - 2010-2011 YR: $159.17m/£98.0m
  - 2011-2012 YR: $207.08m/£127.5m
Market Opportunity & Challenge

Need for single integrated clients to address multiplatform challenge
Solution: Multi-Platform / Multi-OS
VoIP/VoLTE/RCS Stack with HW-Accelerated Video

- Optimized Media Engine
- Voice Codecs
- AEC
- AJB/PLC
- VAD/CNG

Applications Processor
- Hardware Accelerators – Video
- Modem – 3G/LTE/WiFi

VoLTE
- SIP
- RTP/RTCP
- RCS/IMS
- VCC/IP2IP

Multi-OS

Multi-Platforms
## Products

**V.VoIP, VoLTE, VCC, IMS and RCS**

| HelloSoft Mobile V.VoIP VDK | • Comprehensive, multiplatform mobile device solutions for delivering the multi-party real-time voice and video communications
| | • Supported on fixed, Wi-Fi and GSM/CDMA/2G/3G/LTE wireless access networks
| HelloSoft VoLTE & VCC | • Fully standards compliant with 3GPP Voice over LTE and IR-92 specs
| | • Incorporates award winning multiplatform HelloSoft VoIP, IMS, VCC technology featuring AEC (Acoustic Echo Cancellation) and NC (Noise Cancellation)
| HelloSoft IMS Stack | • Complies with 3GPP IMS, 3GPP2 IMS, 3GPP & IETF compliant SIP & SIMPLE
| | • Supports Instant Messaging (IM), Presence-enabled active phonebook, video share and seamless handoff between VoIP and cellular phone calls
| HelloSoft Handoff Technology | • Supports SRVCC (Single Radio VCC) per VoLTE requirements, DRVCC (Dual Radio VCC) for seamless handoff between circuit-switched and packet-switched networks
| | • Supports IP2IP for seamless handoff between IP networks
| HelloSoft Rich Communication Suite (RCS) | • Supports advanced features such as enriched audio and video calling, enhanced address book/contacts, video share, and image/file transfer.
| | • SMS/MMS over MSRP. Group Chat, and Social Profile Information
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Overall High Level Objectives

1. First VoLTE production network deployment in the world
2. Initial deployment is VoLTE, followed by RCS
3. Uses a 3rd party VoLTE client
   - other options such as SemiCo based VoLTE not ready or mature enough
4. Ensure VoLTE device solution can readily scale across devices
5. Ensure outstanding voice quality and user experience
   ( “better than circuit switched voice” )
VoLTE Production Deployment Case Study

VoLTE Market Drivers

1. **Deployment efficiencies**
   a) Higher spectral efficiency than Circuit Switched Cellular
   b) Ability to re-farm spectrum blocks
   c) Ability to deploy full IMS solution

2. **Major new service capabilities**
   a) Ability to seamlessly move between IP bearers
   b) Ability to seamlessly move between devices

3. **Major new device capabilities**
   a) Ability to migrate to LTE only handsets
   b) Ability to perform simultaneous voice/data
   c) Ability to seamlessly migrate users from existing user experience
      (e.g. seamless integration of VoLTE into existing handset or tablet UI)

4. **Ability to launch new / enhanced services and capabilities**
   a) HD Voice
   b) Video share/chat
   c) RCS 5.0 (enhanced contact list, enhanced messaging, capability exchange, video share/chat, VoLTE, …)
   d) Many other new capabilities
VoLTE Handset Requirements

1. VoLTE Compliant with IR-92 with Dedicated Bearer support
2. Fully integrated with native UI (dialer, call history, call logs, etc)
3. VoLTE must be transparent to the end user. i.e. Whether the user is on Circuit-switched network or on VoLTE network, the user experience must be same (other than voice quality and the “4G” icon on the UI)
4. “Better than CS” voice quality in the coverage area
5. Network selection of VoLTE where available, else circuit switched voice calls
6. CS Fall-back for Emergency Calls only
7. Support for multiple LTE chipsets & multiple application processor chip sets
8. Support for phones from multiple OEMs
9. VoLTE vendor must be “full service” … and complete handset integration, functional testing, QA, IOT, Lab Trials, Performance Testing including drive tests on production network in coverage area, and Production Launch
10. Upgradable to support
   a) VCC handoff to Circuit-Switched calls & vice versa
   b) Upgradable to RCS 5.0
   c) Over-the-air updates
Case Study Background
Application Processor based VoLTE vs. Modem based VoLTE

ADVANTAGES:
• Allows for a single IMS stack on the application processor
• VoLTE can be easily integrated into other applications.
• Provides better audio/video integration because the video subsystem is on the application processor
• Lower power in some cases
• More power efficient and better architecture for supporting multiple IP bearers e.g. for VoLTE to VoWiFi seamless handoff

DISADVANTAGES:
• Cannot power off the application processor during voice calls (although in practice, generally the AP is not powered off)

ADVANTAGES:
• More familiar model since this is the legacy partitioning used for circuit switched voice
• LTE modem vendors such as Qualcomm & others may offer this approach
• Claims to be lower power in some cases (e.g. if you could power off the application processor during a voice call) but in other cases it is not

DISADVANTAGES:
• Dual IMS stack – one stack on the modem for VoLTE and one on the AP for everything else
• Voice-video synchronization must span both modem and AP processors
• Handoff to multiple IP bearers such as WiFi are difficult and inefficient
• Less flexible and voice feature upgrades tied to the modem

Decision was made to go with Application Processor based VoLTE
## Case Study Background
Production signoff – Multi-vendor IOT

### Dependencies on 7 infrastructure vendors for handset IODT/IOT test cases

<table>
<thead>
<tr>
<th>Infrastructure Component</th>
<th>Number of IOT Test cases dependent on that vendor for testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAN</td>
<td>5%</td>
</tr>
<tr>
<td>TAS</td>
<td>5%</td>
</tr>
<tr>
<td>S/I-CSCF</td>
<td>4%</td>
</tr>
<tr>
<td>MGCF/MGW</td>
<td>3%</td>
</tr>
<tr>
<td>HSS</td>
<td>12%</td>
</tr>
<tr>
<td>SBC / P-CSCF</td>
<td>14%</td>
</tr>
<tr>
<td>HLR</td>
<td>6%</td>
</tr>
</tbody>
</table>
Voice Quality comparison is done by simultaneously measuring voice quality on 4 channels while driving with handsets side-by-side.
Reference: “Good grades for VoLTE – Validating VoLTE end-end”, Ericsson Review, 1/2012, Michel Anehill et al,

Voice Quality depends on codec, bit rate, frame error rate as well as algorithms such as packet loss concealment
3 Greatest Challenges
Multi-party IOT

Handset IOT

Stack IOT

Integration

Integration

Infra-structure

OEM

VoLTE RCS Provider

AP+LTE Chipset + Drivers

Significant investment / schedule time in the Multi-party IOT
3 Greatest Challenges
Challenge #2 – getting “the right” carrier stewardship model

1) CARRIER CENTRIC
   - Carrier vendor selection/business terms/integration
   - Carrier mandates client to OEM
   - Carrier “supervises” integration/execution

2) HYBRID #1
   - Carrier responsible for vendor selection/business terms
   - Carrier effectively sublicenses to OEMs

3) HYBRID #2
   - Carrier responsible for vendor selection
   - OEM’s responsible everything else

4) OEM CENTRIC
   - Carrier sends requirements to OEMs
   - OEM responsible for vendor selection/business terms/integration
   - OEM drives execution including IOT

5) SemiCo CENTRIC
   - Carrier sends requirements doc to OEMs
   - OEM’s send requirements to SemiCo’s
   - SemiCo IODT’s reference design
   - OEM completes IOT with device

Initially, carrier must drive and have high control “carrier centric” model
As the ecosystem matures and scales, a shift to the “device centric” model occurs
### 3 Greatest Challenges

#### #3 – getting the 1st VoLTE handset across the finish line “on time”

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Target</th>
<th>Actual First Handset</th>
<th>Additional Handset OEM</th>
<th>Additional Handset Same OEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kickoff</td>
<td>1 month</td>
<td>1 month</td>
<td>1 month</td>
<td>1 month</td>
</tr>
<tr>
<td>API’s</td>
<td>2 months</td>
<td>1 month</td>
<td>1 month</td>
<td>1 month</td>
</tr>
<tr>
<td>Integration Complete</td>
<td>1 month</td>
<td>1 month</td>
<td>1 month</td>
<td></td>
</tr>
<tr>
<td>IODT Complete (Lab)</td>
<td>1 month</td>
<td>1+ month</td>
<td>1 month</td>
<td></td>
</tr>
<tr>
<td>Production IOT + Drive Tests.</td>
<td>1 month</td>
<td>1 month</td>
<td>1+ month</td>
<td></td>
</tr>
</tbody>
</table>

#### Total Time
- 5 months
- 9 months
- 6 months
- 4 months

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**NOTES:**

1. First handset incurred additional time in IODT (Lab) / IOT (production).
   Much of this time was due to multi-vendor infrastructure dependencies.

2. Having the 3rd party VoLTE solution allows scalability, risk reduction, and cost savings and time to market advantage across many devices.
3 Most Important Lessons Learned
Lesson #1 – get “full service” support for 1st wave of devices

Ensure the right on-site/multi-site / multiparty support, test environment and support through the life cycle

Have a well developed and sophisticated multi-site integrated Project Management process
### 3 Most Important Lessons Learned

**Lesson #2 – evaluate the performance of client solutions carefully**

<table>
<thead>
<tr>
<th></th>
<th><strong>Downlink MOS</strong></th>
<th><strong>Uplink MOS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Imagination DL</td>
<td>Competition DL</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>3.42</td>
<td>2.42</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>0.29</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>Maximum Score</strong></td>
<td>3.65</td>
<td>2.71</td>
</tr>
<tr>
<td><strong>Count</strong></td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td><strong>% MOS greater than or equal to 3.2</strong></td>
<td>87.93%</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>% MOS less than 3.0</strong></td>
<td>5.17%</td>
<td>100.00%</td>
</tr>
<tr>
<td><strong>% MOS less than 2.0</strong></td>
<td>1.72%</td>
<td>5.17%</td>
</tr>
<tr>
<td><strong>% MOS less than or equal to 1.8</strong></td>
<td>0.00%</td>
<td>1.72%</td>
</tr>
<tr>
<td><strong>Scoring Algorithm</strong></td>
<td>PESQ</td>
<td>PESQ</td>
</tr>
</tbody>
</table>

#### Voice Quality during Drive Testing

![Voice Quality during Drive Testing](image)

Large difference in performance observed between VoLTE solutions
### 3 Most Important Lessons Learned

**#3 – VoLTE is not coming, it’s here now & much better quality than CS**

<table>
<thead>
<tr>
<th></th>
<th>Downlink MOS</th>
<th>Uplink MOS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CS Call Downlink</td>
<td>VoLTE Downlink</td>
</tr>
<tr>
<td>Average</td>
<td>2.39</td>
<td>3.85</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.28</td>
<td>0.30</td>
</tr>
<tr>
<td>Maximum Score</td>
<td>2.91</td>
<td>4.06</td>
</tr>
<tr>
<td>Count</td>
<td>141</td>
<td>165</td>
</tr>
<tr>
<td>% MOS greater than or equal to 3.2</td>
<td>0.00%</td>
<td>95.15%</td>
</tr>
<tr>
<td>% MOS less than 3.0</td>
<td>100.00%</td>
<td>3.64%</td>
</tr>
<tr>
<td>% MOS less than 2.0</td>
<td>11.35%</td>
<td>0.00%</td>
</tr>
<tr>
<td>% MOS less than or equal to 1.8</td>
<td>3.55%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Scoring Algorithm</td>
<td>PESQ</td>
<td>PESQ</td>
</tr>
</tbody>
</table>

**Voice Quality for VoLTE vs. Circuit Switched**

VoLTE voice quality significantly exceeds that of circuit switched.
Conclusions

1. VoLTE is giving much better voice quality than circuit switched calls
2. Significant differences in voice quality performance between VoLTE solutions
3. IOT is multi-vendor and of course the maturity cycle in multi-vendor IOT is in the early stages.
4. Once a VoLTE protocol stack is through production on one handset, it can be readily scaled across many handsets
5. Project start (for VoLTE integration) to production shipment can be achieved in 9 months, for the first handsets, with a target of 4 months for subsequent “waves” of handsets, including IOT
6. “Full service” support from vendors is critical for first wave of handsets. Once the first “wave” of handsets is through, additional handsets can be brought out quite quickly
7. Modem based VoLTE vs. Application Processor based VoLTE
   Modem based has the advantage of a familiar approach to CS
   … but …
   Application Processor based VoLTE provides more flexibility for integration with future “rich media” applications
8. VoLTE is not just in lab trials
   … production handsets are here now and VoLTE works very well, thank you!
VoLTE is here now and works much better than circuit switched

Thank you

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