LTE 1800MHz

ZTE's Solution for LTE in the 1800MHz Band

Product Type Technical Description

Version	Date	Author	Approved By	Remarks
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V1.01	2011-04-11	M McGroarty		

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1 Introduction

1.1 Mobile Data Evolution

To keep pace with the rapidly increasing demands on mobile data networks radio access network technologies are constantly evolving. To this end the 3GPP has introduced a new standard, a further development of UMTS called Long Term Evolution, LTE. LTE enables more powerful and more spectral-efficient mobile radio transmission of up to 5bps/Hz Downlink and 2.5bps/Hz Uplink. LTE will realize instantaneous peak data rates of 100 Mbps DL and 50 Mbps UL, also LTE will offer reduced latency for packet transmissions all of which will be required to support the mobile data requirements of the future.

According to the Cisco Visual Networking Index (VNI) Global Mobile Data Traffic Forecast (Cisco VNI, 2011) overall mobile data traffic is expected to grow to 6.3 Exabytes per month by 2015, a 26-fold increase over 2010. Mobile data traffic will grow at a CAGR of 92% from 2010 to 2015.

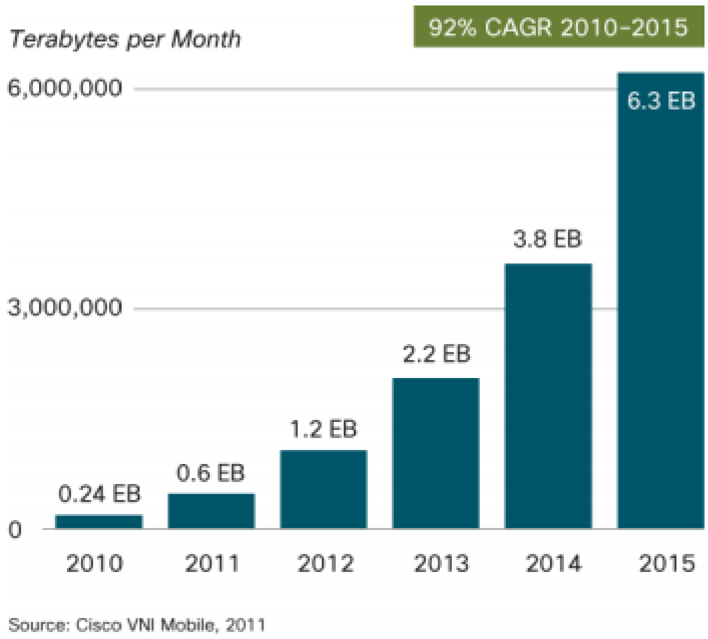

Figure 1 - Cisco VNI 2011

Also according to research by Juniper (Juniper Research, 2011), Embedded Mobile devices and Machine-to-Machine Mobile connected devices will rise to over 400 million by 2014. Along with the increased dependency on mobile devices as the primary internet device, this results in huge growth in mobile data demands. LTE is needed to address this demand and take mobile broadband to the wider market.

LTE can use new or re-farmed spectrum and provides flexibility in its implementation. LTE supports scalable bandwidths from 1.4MHz up to 20 MHz and can use FDD or TDD. It has multiple benefits over legacy technologies, including higher spectral efficiency, lower latency and higher peak and user data rates. Also LTE provides up to 5 times greater spectral efficiency than most advanced 3G networks, reducing the cost per bit and allowing better economics for operators and end users.

1.2 LTE Development

LTE is the fastest developing mobile communications system technology. As of 12th January 2011 180 operators in 70 countries are investing in LTE. With 17 commercial LTE networks launched by the end of 2010 and at least 64 LTE networks are anticipated to be in commercial service by end 2012 (Global mobile Suppliers Association, 2011). LTE is the natural migration choice for GSM/HSPA operators.

LTE can be deployed in new spectrum(s) such as; 2.6GHz which is currently being allocated in many regions, the 700MHz band which has been released as part of the Digital Dividend in the USA and the 800MHz band which will be released from the Digital Dividend in Europe and elsewhere. However the auction for the digital dividend spectrums has yet to take place in many countries, resulting in a long delay for operators planning to roll out LTE networks in this band.

Due to both the delay in the allocation of new 'Digital Dividend' spectrum bandwidth and the associated cost of bidding for new licenses operators are looking at reusing the spectrum that is currently available. Much of the initial focus in LTE development has been in the use of newly allocated frequency bands and has overlooked the importance of reusing existing spectrum. The 1800MHz band, which is widely used today for GSM, is becoming a key band for LTE deployments. It is particularly well suited to be used for high capacity and high throughput broadband wireless networks, as many operators have significant bandwidth on the band, allowing 20MHz configurations.

1.3 1800MHz Spectrum Advantages

LTE at 1800 has numerous advantages over other spectrums currently being considered for LTE development:

- The 1800MHz spectrum contains 2x75MHz of prime spectrum: harmonized, underutilized unfragmented
- Currently the LTE1800 device ecosystem is in full development, with devices set to be available by the spring of 2011.
- Multi mode devices and multi radio base stations allow operator flexibility in spectrum refarming
- The 1800MHz band makes it easier to refarm enough spectrum for LTE worldwide, which is an important factor for international roaming.

1800MHz has been harmonized for GSM1800 across Europe, APAC, India, China, Africa and the Middle East. It is unfragmented and partly utilized in many countries, making it easier to free up enough spectrum for HSPA or LTE. According to Qualcomm (Qualcomm LTE presenation, 2011) 60% of 1800MHz spectrum in top 7 EU markets* is available in slots of 10Hmz or wider, compared to 35% of the 900MHz spectrum.

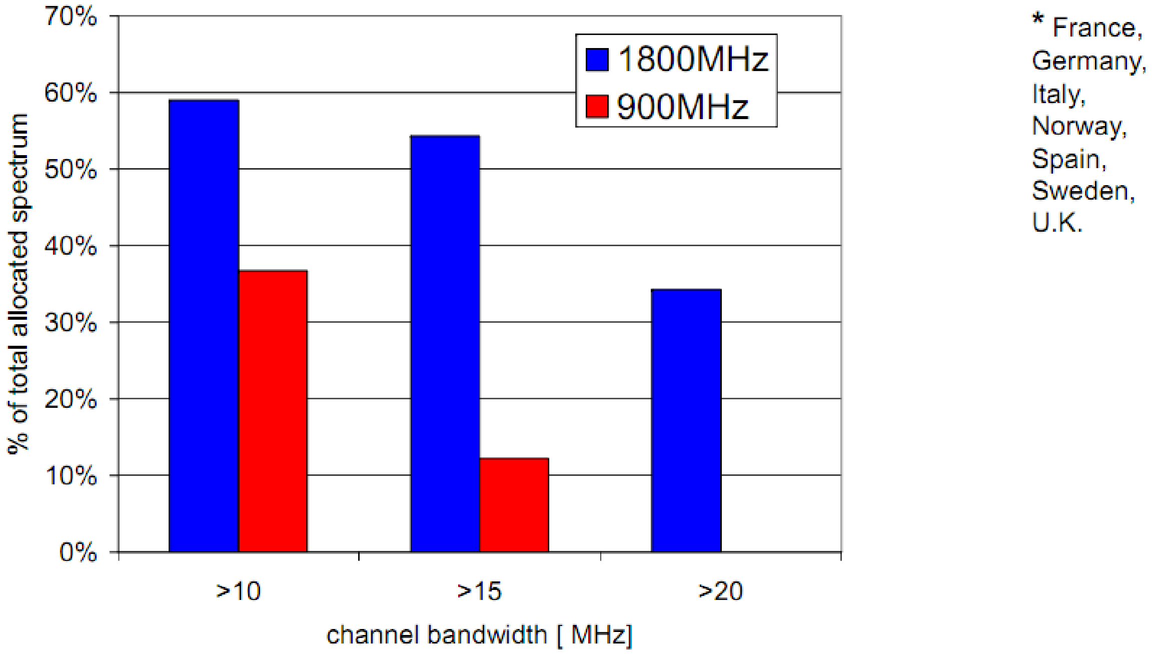

Figure 2 - 1800MHz availability in European Markets

Over sixty percent of the worldwide GSM1800 network is part of a GSM900/1800 dual band network, which means most of the GSM1800 network is used for load sharing of GSM900 and carries data traffic. Refarming the GSM1800 network to LTE will dramatically improve data capacity for operators.

Refarmed 1800MHz spectrum enables LTE1800 to provide up to twice the coverage of LTE2600, which lowers the TCO, and makes it suitable for coverage from urban to suburban and rural.

		Dense Urban	**Urban**	**Suburban**	**Rural**
Cell Edge User Throughput	Kbps	512	256	128	64
1.8GHz					
UL Cell Range	Km	0.38	0.68	2.78	7.13
Coverage Area	Km^2	0.28	0.90	15.10	99.07
2.6GHz					
UL Cell Range	Km	0.27	0.48	1.93	4.93
Coverage Area	Km^2	0.14	0.44	7.28	47.45

Figure 3 – 1800MHz coverage comparison

1.4 Multi RAN Deployment

For the GSM1800 operator, it is easy to deploy mixed RAN technology with simultaneous GSM, UMTS & LTE. Deploying the multi RAN solution enables operators to reuse antennas, MHAs, antenna feed-lines, site room, power facilities and the transmission backhaul of GSM1800.

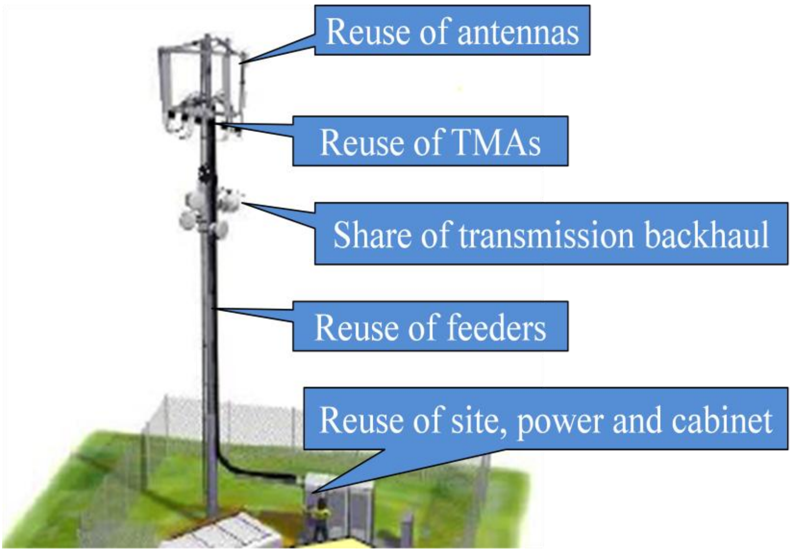

Figure 4 - Multi RAN deployment

1.5 LTE1800 Market Status

Current LTE market status according to the Mobile Broadband Market and Technology Update from Global mobile Suppliers Association (GSA - Global mobile Suppliers Association, 2011):

- World's first LTE1800 network commercially launched by Mobyland, Poland
- CSL Ltd, Hong Kong has launched an LTE/DC-HSPA+ network LTE initially uses 2.6 GHz spectrum; 1800 MHz LTE sites being introduced in the second phase
- Telstra deploying LTE initially in 1800 MHz spectrum
- VHA is trialing LTE in 1800 MHz spectrum
- Optus is expanding its LTE trials to include 1800 MHz
- In Finland LTE can be deployed in 2.6 GHz and 1800 MHz spectrum
- Elisa FI launched LTE2600 and is trialling LTE1800
- TeliaSonera FI launched LTE2600 and will launch in 1800 MHz when dual frequency modems become available - expected Spring 2011
- Bouygues Telecom is trialling LTE1800
- Cosmote has trialled LTE1800
- LTE1800 deployments are expected in Singapore following confirmation by the regulator that 1800 MHz can be used for LTE; StarHub plans to trial LTE1800
- Smartone-Vodafone (HK) is committed to LTE1800 network deployment
- Deutsche Telekom is interested in deploying LTE1800 in selected European markets

2 LTE1800 Deployment Scenarios and Solutions

2.1 New Deployment of LTE1800 Single Mode Only

In this case, the BBU configures LTE BP (Baseband Processing) board and CC (Clock and Control) board. The RRU operates in LTE single mode only, and connects with the BP board through fiber. Figure 5 shows a typical LTE single mode deployment.

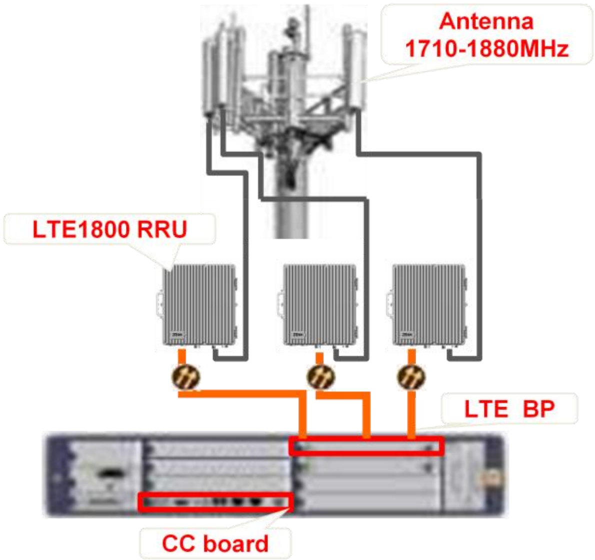

Figure 5 - Single Mode

2.2 New Deployment of LTE1800 and GSM1800 Dual Mode Simultaneously

In this case, the BBU configures LTE BP board, GSM BP board, FS (Fabric Switch) board and CC board. The CC board supports GSM and LTE dual mode. The RRU operates in LTE and GSM dual mode simultaneously, and connects with the FS board through fiber. Figure 6 shows a typical LTE & GSM dual mode deployment.

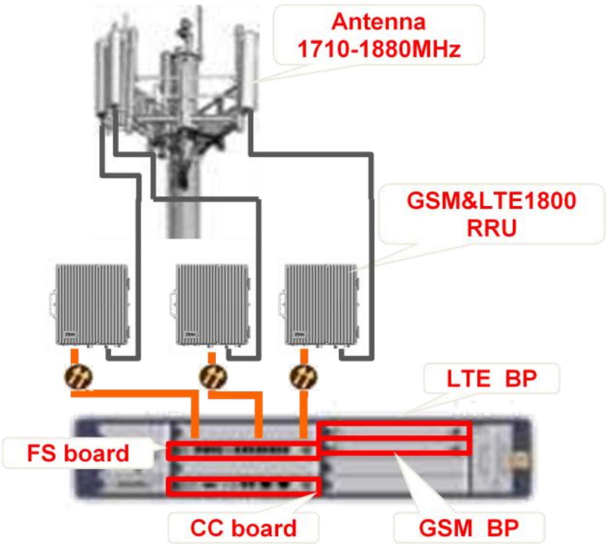

Figure 6 - Dual Mode

2.3 Initial Deployment of GSM1800, Evolving to GSM & LTE1800 Dual Mode.

In stage 1, the BBU configures GSM BP board and CC board. The RRU operates in GSM single mode, and connects with the GSM BP board through fiber. As shown in Figure 7.

In stage 2, the LTE BP board and the FS board were added to the BBU. The CC board and the RRU are software upgraded to support GSM and LTE simultaneously. The RRU connects to the FS board through fiber. As shown in Figure 8.

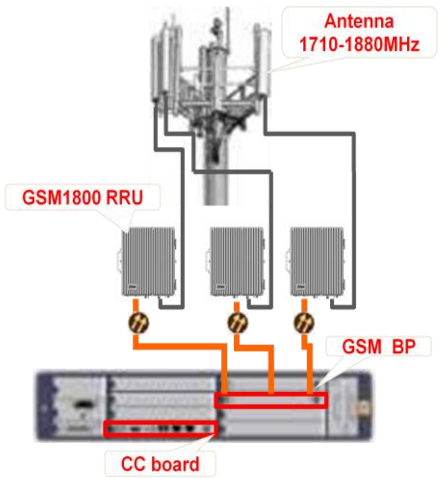

Figure 7 - GSM Only

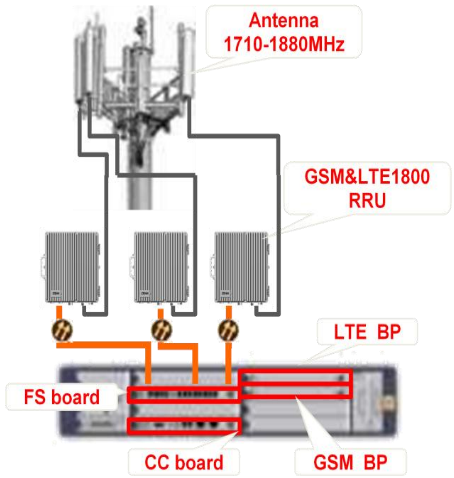

Figure 8 – Dual Mode

2.4 Reusing GSM1800 RAN to Deploy GSM & LTE1800 Dual Mode RAN

In this case, the BBU configures LTE BP board and CC board. The RRU operates in LTE single mode only, and connects with the BP board through fiber.

The GSM1800 radio signal and the LTE1800 radio signal are combined together at the antenna through a combiner. The GSM1800 RAN, the antenna feeder-line and the antenna were reused. Figure 9 shows the typical Dual Mode mixed vendor deployment.

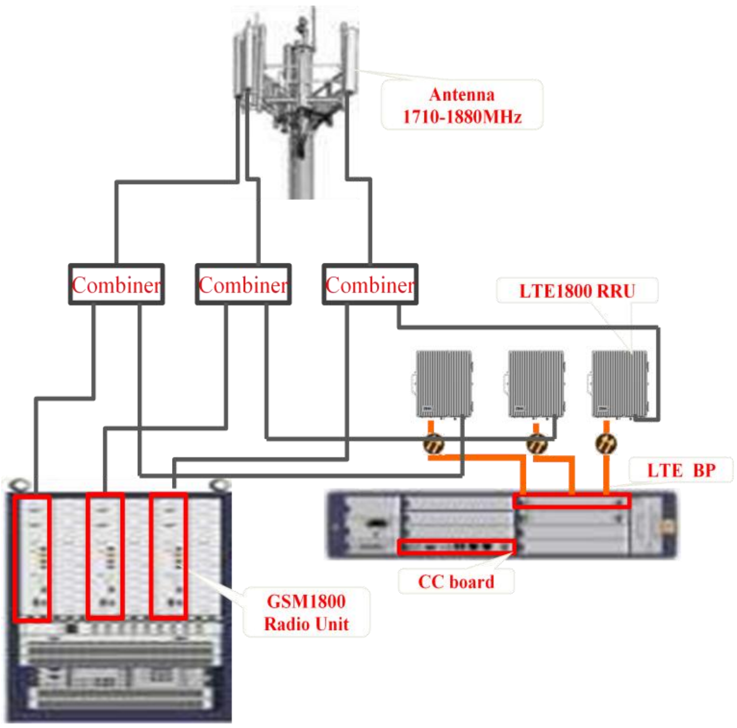

Figure 9 – Dual Mode Mixed Vendor

3 Solutions for Traffic Migration of GSM & LTE1800 Dual Mode System

The advent of dual GSM and LTE RAN networks necessitates new traffic models and user equipment (UE) behavior characteristics. When the UE is in idle mode, the preference is for it to camp in the LTE cell, and reselect GSM cell based on LTE coverage availability. When the UE is in connected mode, the voice service migration solution is as follows:

1. In stage 1, the GSM coverage is often better than that of LTE, and voice over LTE is not mature. The voice service is carried in GSM network, one way handover from LTE to GSM is preferred to avoid repetitive handover for better user experience.
2. In stage 2, the LTE network has matured and coverage is improved, two way handover can be supported, and the voice service is carried in GSM and LTE network simultaneously based on load balance and radio quality.
3. In stage 3, the LTE network carries more and more traffic, and the GSM network is incrementally reduced.

The LTE network provides enhanced user experience for data services, which results in following;

- LTE -> GSM reselection/handover can be performed only when LTE coverage is not available.
- GSM -> LTE reselection/handover should be performed for better user experience when LTE coverage is available.
- PS handover feature is useful for fast handover without data service interruption for better user experience.

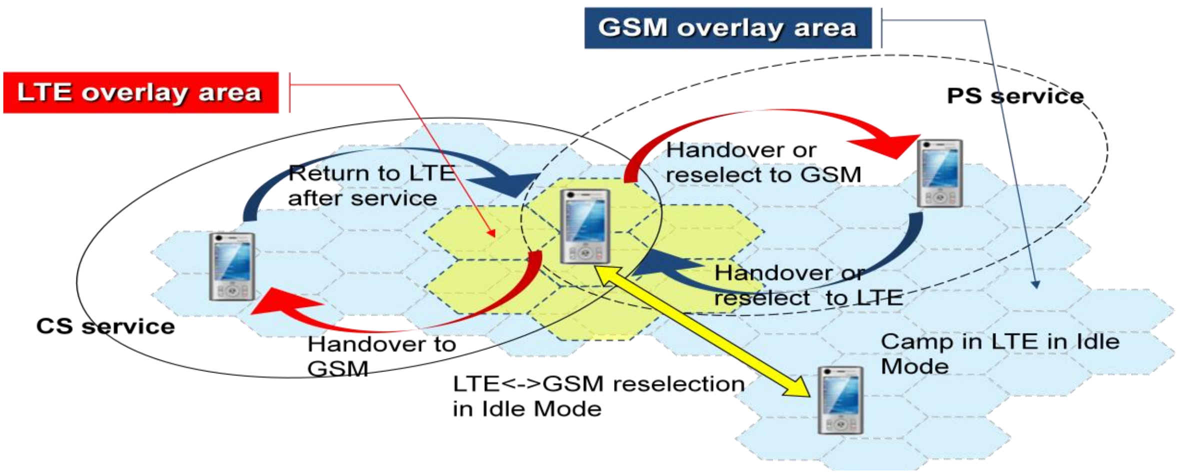

Figure 10 – GSM to LTE Traffic management

4 Solutions for Traffic Migration of LTE1800 & HSPA Dual Mode System

The traffic migration strategy of LTE1800 and HSPA is envisaged as a two-stage strategy, depending on the penetration ratio of LTE capable devices.

1. In stage 1, the penetration of LTE capable devices is lower than the required capacity threshold. All of the LTE capable users' camp in the LTE network and their traffic is carried over the LTE network. This results in better user experience for both LTE and HSPA users, as the non-LTE devices can also benefit through lower load on HSPA network.

2. In stage 2, the penetration ratio of LTE capable devices has reached the capacity threshold; seamless load balancing between LTE1800 and HSPA occurs. The VIP LTE capable users will camp in the LTE network and all of their traffic is carried over the LTE network, for optimum user experience. Other LTE capable devices camp in HSPA network based on load balancing optimization, they can reselect to LTE network for latency-sensitive or throughput-sensitive services such as real-time gaming and FTP downloading.

5 CSL LTE1800 Case study

5.1 Overview

ZTE helped CSL to launch Asia's first commercial LTE service and world first LTE/DC HSPA+ dual band network on Nov. 25th, 2010 in Hong Kong. Furthermore, an extra 40 sites of GSM & LTE1800 dual mode RAN are currently under deployment, the network will be test available in Q2, 2011. Figure 11 shows the CSL network deployment model.

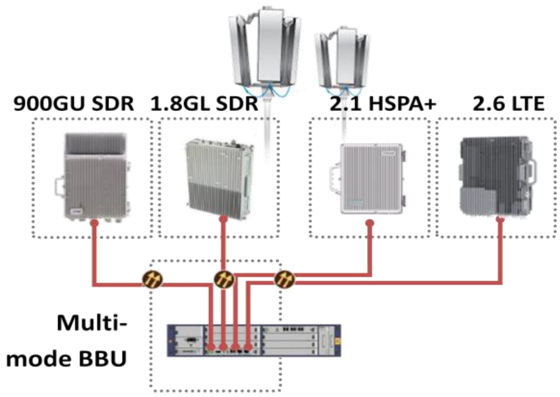

Figure 11 - CSL LTE1800

5.2 Three challenges faced by CSL

Based on detailed research and inspection of related technology and other key indicators, CSL chose ZTE to carry out the full turnkey project, entitled "Single Network", in February 2008. Before the network construction, CSL and ZTE faced three major challenges:

Firstly, the physical environment is very restrictive. Hong Kong is a metropolitan city, known for its dense high-rise buildings and mountainous terrain, including waterside and seaside geographical features. Moreover, the city is thickly populated by 6,925,000 people living on a land area of 1,092 km2.

Secondly, the existing network, made up of various types of base stations made network construction rather complicated. The replacement of the current network for a single network including 2G, 3G and LTE involves not only the replacement of existing sites, but also the acquisition of new sites.

The third challenge came from the ambitious rollout schedule. CSL required thousands of base stations to be deployed within 12 months.

5.3 LTE Market Drivers

The following factors were instrumental in driving CSL to be an LTE pioneer:

External Drivers	Internal Drivers
Macro Factors 1. 174% mobile penetration(Dec 09), highly saturated voice market; 2. 64% 3G market share (Dec09), mobile handsets are the main promoters; rapid growth of mobile broadband; 3. Higher GDP PPP, and consumers have been accustomed to ubiquitous broadband access services; 4. 102% fixed broadband penetration rate, one dominant monopoly; 5. Fierce competition between operators, some operators are running at a loss.	**Market Pressure** 1. Market share & ARPU are declining; 2. Lower user loyalty due to MNP. 3. Fierce price competition; 4. High demand for new applications & services 5. High demand for larger bandwidth; 6. New business model brought about by the advent of smart-phones and data intensive mobile applications.
Micro Factors 1. High population density; high throughput for single base station; 2. Advanced broadband technologies of Hong Kong operators. 3. Large subscriber youth group, high demand for data service types and qualities.	**Network Pressure** 1. Complicated network structure; high CAPEX and lower network efficiency; 2. High OPEX and limited network expansion; 3. Difficult for network evolution due to network capacity limitation.

In brief, compared with 2G/3G technologies, LTE can effectively reduce per bit cost; greatly decrease network deployment cost and increase operator's profit margin.

CSL's original four networks with three frequency bands led to high maintenance cost and weak competitiveness in data service. The complicated network structure made it difficult to upgrade and prevented a smooth evolution. To realize the goal of Creating a Simple Life and real breakthrough, CSL adopted ZTE Uni-RAN solution based on unified SDR platform. ZTE's distributed base station architecture achieved zero additional site footprint, eliminating the difficulty of site acquisition and property negotiation. Currently, CSL operates a multi-RAN 2G/3G/LTE network, and the ZTE solution greatly simplifies the network structure in terms of wireless side, core network and network management. The total operation and maintenance cost is reduced up to 61.4%, and a true 'green' network is achieved.

At the beginning of 2009, CSL successfully upgraded its Next G to support HSPA+ that increased the data rate to 21Mbps. This successful software upgrade made Next G the fastest mobile network in the world and enabled CSL to stand out in the competitive markets and to be at the forefront of the global mobile communication industry. The dual-band LTE network will leverage CSL's spectrum position to provide customers with better coverage and enhanced penetration for a more satisfying communications experience.

5.4 Network evaluation and performance

In June 22 2010, independent standard measurement consultant firm Celfinet of Portugal evaluated CSL‘s network coverage, voice quality and data throughput. Celfinet’s report confirmed CSL’s network performance claims. Compared with 2100MHz band, the Next G UMTS900 network achieved more than 10Db gain, and it provides stronger signal and superior user experience for both voice and data.

In recognition of the advanced technologies and excellent performance of the Next G network, CSL and ZTE were awarded the National Mobile Services Award at the Global Telecoms Business Innovation Awards Ceremony held in London in June 2009. One year later, In June 2010, ZTE and CSL won the Global Telecoms Business LTE Infrastructure Innovation award, the award was selected and awarded by Global Telecoms Business magazine and recognized the major corporations and innovations that have helped shape the telecoms industry over the last 12 months. The selection of the ZTE SDR solution resulted in a substantial reduction in OPEX; CSL's OPEX was reduced from HKD 225.4 million to HKD 86.9 million a year, saving HKD 138.5 million.

By adopting energy-saving SDR base stations and intelligent temperature control technology, and reducing the load on the power system, air conditioners and ventilation system, CSL has reduced the yearly energy consumption of the overall network by 39% and the emission of carbon dioxide by 7,187 tons.

At the Mobile Asia Congress 2010 held in Hong Kong, GSMA, CSL, and ZTE successfully made an IMS-based VoLTE call on CSL’s LTE network. The call was made using conventional 2G/3G handsets and was crystal clear. This was the first time a VoLTE call had been made using inter-operable LTE and 2G/3G networks.

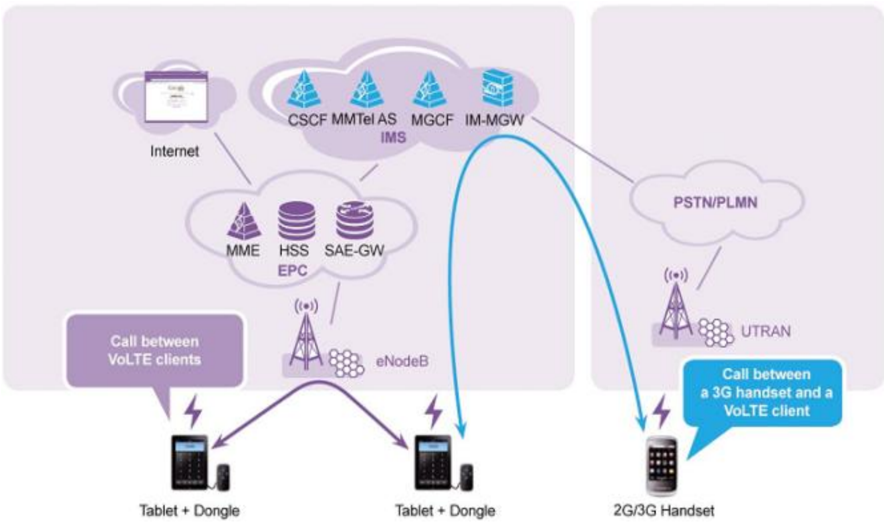

Figure 12 - VoLTE Call on CSL Network

6 Appendix A: ZTE's Technology and Products for the LTE1800 Solution

6.1 ZTE's Uni-RAN Technology and eRAN Products

ZTE's Uni-RAN technology provides unified infrastructure to ensure multi-mode operation, and supports smooth evolution to maintain network flexibility. This results in performance and efficiency improvements and reduced equipment room footprint requirement.

ZTE's eRAN products are based on ZTE's distributed Uni-RAN platform, it consists of a BBU (Baseband Unit) and a RRU (Remote Radio Unit), both of which support standard CPRI interface. The RRU can be installed near the antenna and is connected to the BBU by fiber. The split architecture of eRAN minimizes power consumption, cooling requirements and equipment footprint. It also provides greater power and performance at the antenna.

The BBU can support multiple types of wireless access technologies simultaneously, including GSM, UMTS, CDMA, WiMAX and LTE, which share the common control function and backhaul transmission. The BBU supports several different configurations, in the typical configuration of one baseband board, the BBU supports 200Mbps DL and 75Mbps UL. Increasing the number of baseband boards increases the data rates, up to a maximum of 600Mbps DL and 300Mbps UL. The BBU can support a maximum of 18 cells with six baseband boards.

The RRU is fully software defined. It supports 30MHz bandwidth, supports multi-mode at the same frequency band simultaneously and supports up to 2 X 80W transmit power. Furthermore, a GSM/UMTS/CDMA RRU based on the RRU platform can be upgraded to LTE RRU at the same frequency band through software update only.

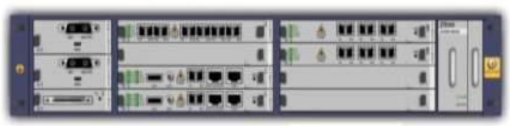

Figure 13 - ZTE's BBU

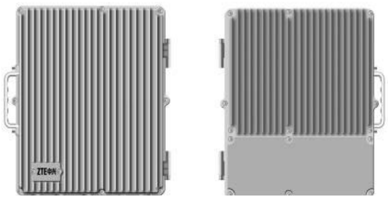

Figure 14 - ZTE's RRU

6.2 ZTE's Unified Packet Core Technology and Products

Based on 3GPP SAE architecture, ZTE has put forward "ZEPS", an innovative mobile broadband integrated access solution. By classifying functions of network elements into the various access modes, operators can build a simplified, converged and access-agnostic network, which supports multiple access modes and smooth evolution to LTE/LTE+.
ZEPS consists of the following elements:

ZXUN uMAC - ZTE's unified mobile access controller. uMAC can support 2G, 3G and LTE, it is based on the ZTE developed enhanced ATCA platform (ETCA). Configuration options of the uMAC include: MME, SGSN, MME+SGSN

ZXUN xGW - ZTE unified packet gateway product. It can support 3GPP and non-3GPP and is based on the advanced ZTE developed T8000 router platform. Configuration options of the xGW include: SAE-GW, GGSN, PDSN, AGW, GGSN+SAE-GW

Different networks have different PDP and throughput requirements, ZXUN uMAC & xGW can provide flexible hardware configurations to meet operator's requirements and lower the TCO:

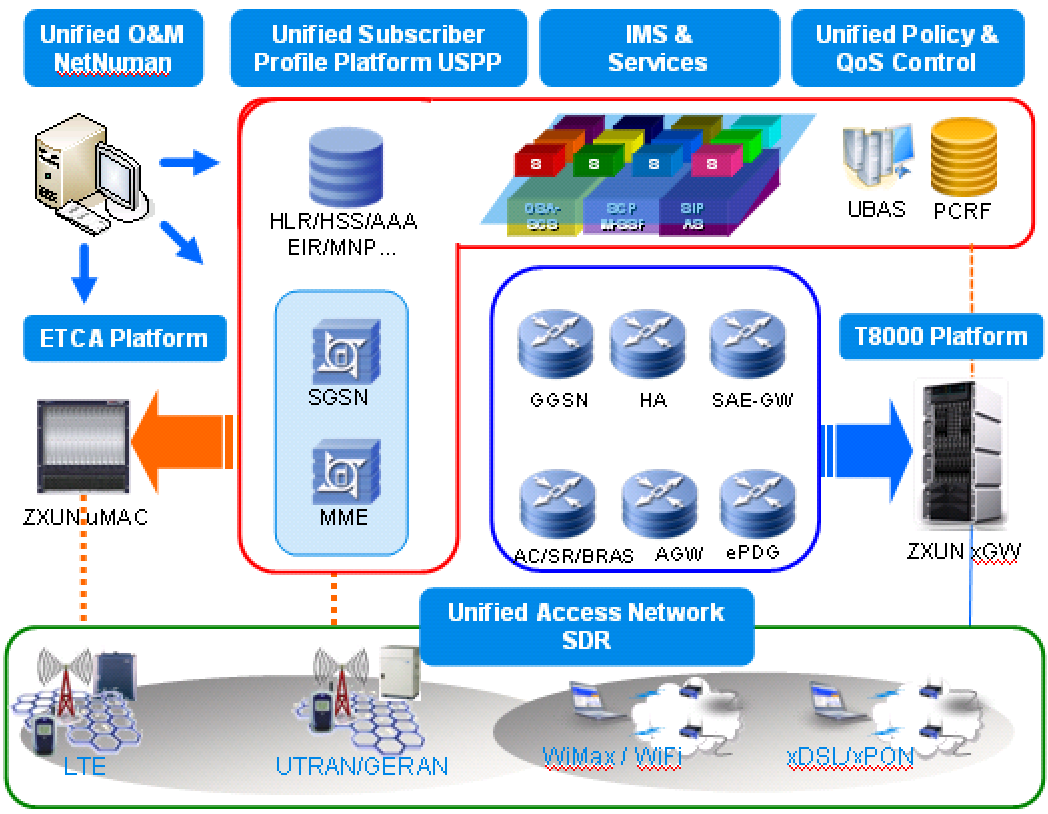

Figure 15 - ZEPS

6.3 ZTE's LTE Devices for combined GSM & LTE1800 Solution

ZTE has planned several types of devices for the GSM & LTE1800 solution; they are MF820 USB modem, V11L tablet and V5L smart phone.

Figure 16 - MF820

Figure 18 - V11L

Figure 17 - V5L

7 Appendix B: Glossary

3GPP	3rd Generation Partnership Project
AGW	Access Gateway
ATCA	Advanced Telecommunications Computing Architecture
BBU	Baseband Unit
CAPEX	Capital Expenditure
CC	Clock and Control
CS	Circuit Switched
CDMA	Code Division Multiple Access
CPRI	Common Public Radio Interface
DC-HSPA+	Dual-Carrier HSPA
ETCA	Enhanced ATCA
FDD	Frequency Division Duplex
FS	Fabric Switch
GGSN	Gateway GPRS Support Node
GSM	Global System for Mobile Communication
GSM-BP	GSM Baseband Processing
HSPA	High Speed Packet Access
LTE	Long Term Evolution
LTE-BP	LTE Baseband Processing
MHA	Mast Head Amplifier
MME	Mobility Management Entity
MNP	Mobile Number Portability
OPEX	Operational Expenditure
PDP	Packet Data Protocol
PDSN	Packet Data Serving Node
PS	Packet Switched
RAN	Radio Access Network
RRU	Remote Radio Unit
SAE-GW	System Architecture Evolution Gateway
SDR	Software Defined Radio
SGSN	Serving GPRS Support Node
TCO	Total Cost of Ownership
TDD	Time Division Duplex
TMA	Tower Mounted Amplifier
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
VoLTE	Voice over LTE

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