VoLTE White Paper

(V2 Edition)

China Mobile Communications Corporation
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Contents

1. Foreword

In view of industry and market developments, China Mobile issues the technical requirements for VoLTE-oriented TD-LTE development in the coming two years, which cover key end-to-end technical requirements for the TD-LTE infrastructure, terminals, services and subscriber growth[1]. The purpose is to effectively facilitate the development of the equipment industry towards achieving China Mobile's TD-LTE needs.

This white paper is based on the original version in June 2013, and deeply clarifies the VoLTE technical requirements in the timeframe from 2014 to 2015. Time required for testing and verification of relevant functions should be considered by the equipment industry.

2. Vision Statement

China Mobile will follow the principles as outlined below for the development of TD-LTE, namely

- **Converged development of TDD and FDD**: comprehensive convergence of standards, products, industry and network operations;
- **Synchronous development of TDD and FDD**: launching new technologies and new products simultaneously;
- **Pursuance of first-class network performance**: maximizing the advantages of TDD and guaranteeing network competitiveness;
- **Use of open standards-based solutions**: Using open standard interfaces, guaranteeing interworking and building a healthy ecosystem;

[1] Not considered as purchase guarantee

In order to meet the VoLTE service requirements, China Mobile seeks to achieve, through facilitating coordinated efforts by the entire industry, the following four goals:

- **VoLTE becomes the mainstream voice solution globally**: cooperate with global operators and evolve VoLTE into a mainstream solution of voice and international roaming;
- **VoLTE provides high quality user experience for audio and video services**: support HD audio and video, adopt eSRVCC to support the continuity of voice services, and provide a much richer user experience by combining with converged communications;
- **VoLTE supports global roaming**: promote jointly with global operators the construction of VoLTE international roaming networks, via synergistic developments of FDD and TDD, to achieve true seamless roaming globally;
- **End-to-end network equipments and terminals shall be commercial ready by 2014 H2**.

3. Relevant Requirements for VoLTE-oriented TD-LTE

3.1General Overview

China Mobile's end-to-end TD-LTE network equipments and terminals

were required to follow 3GPP Release9. In 2014, end-to-end TD-LTE network equipments including IMS and terminals will mainly follow 3GPP Release10.

VoLTE is the main solution for China Mobile's TD-LTE voice service, with due consideration to CSFB solution simultaneously. Dual-standby terminal will co-exist for a long time as a terminal type. VoLTE call control is provided by the IMS network while the end-to-end QoS is guaranteed by PCC. When a VoLTE terminal moves out of the TD-LTE coverage area, voice service continuity is achieved by handover to GSM, which mainly follows the eSRVCC solution as specified by 3GPP Release10.

This white paper covers the end-to-end requirements for VoLTE and data services.

3.2 Wireless Network Aspects

3.2.1 Multi-Band Network

China Mobile owns multiple TD-LTE spectrum bands, thus inter-band coordination is mandatory to enable satisfactory network capacity and performance.

1) **Spectrum facts:** The main bands for China Mobile's TD-LTE

network deployment are B39 (1880-1915MHz) [2], B40 (2320-2370MHz) and B41[3] (2575-2635 MHz), where

- B39, B40 and B41 will be adopted at the same time;
- B39 will be used for both outdoor and indoor coverage, and devices working on this band is required to support 35MHz bandwidth;
- B41 will be used for both outdoor and indoor coverage, and devices working on this band is required to support 60MHz bandwidth;
- B40 will be used only for indoor coverage, and devices working on this band are required to support 50MHz bandwidth.

2) Key Configurations

- **Bandwidth:** flexible bandwidth configurations of 5MHz, 10MHz, 15MHz and 20MHz are supported to sufficiently utilize spectrum resources;
- **DL/UL configurations:** 3DL:1UL and 2DL:2UL are supported for B39, B40 and B41, with special subframe configurations of 10:2:2; for B39, special subframe configurations of 6:6:2 is also supported considered for co-existence with TD-SCDMA system on adjacent bands.
- **Synchronization:**

[2] To be clarified by telecommunications administration, possible to be adjusted in the future
[3] B38(2575-2615MHz) overlaps with B41(2575-2635MHz)

- To avoid the TDD-specific interference caused by misalignment of DL and UL timeslots, B39 devices should support DL/UL switching point alignment with TD-SCDMA system;
- TD-LTE network supports inter-band synchronization to reduce inter-frequency measurement time i.e. radio frame synchronization among B39, B40 and B41.

3) Key functionalities

- The network should support inter-frequency measurement and mobility with the same or different subframe configuration on different carriers.
- Different vendor's eNodeB should be able to interwork with the opened X2 interface. Load balance should be supported between single vendor's eNodeBs or different vendor's eNodeBs (including inter-band load balancing between B39 and B41 and inter-site load balancing between macro and micro eNBs).
- Broadcast of multi frequency band indication (mFBI) information should be supported to enable access of both B38 and B41 only terminals, and B38 and B41 terminals should be able to interpret the information correctly.

3.2.2 Continuous and Deep Coverage

Outdoor coverage is provided mainly by Macro eNB. Micro eNB (Integrated or distributed RRU), Enterprise and home class Pico eNB/Nanocell (with WiFi) and wireless Relay stations are required for blind area coverage, indoor deep coverage or capacity enhancement.

1) Outdoor coverage: 8-path eNB is the staple product for outdoor coverage due to the advantage on coverage and throughput performance. Wireless Relay or Micro eNBs can be used based on wired-backhaul availability to further enhance deep coverage while reducing the efforts on construction.

2) Indoor coverage: Multiple solutions can be adopted to provide indoor deep coverage, such as indoor distributed antenna system, Pico eNB/RRU, Nanocell, micro-repeater and relay. The equipment should support cell-combination functionality to reduce indoor handover and interference; daisy-chain type of connection for BBU-RRU interface is also required to reduce the complexity of construction for certain indoor scenarios.

Enhanced algorithms e.g. power boosting of common reference signal (CRS) and uplink coordination of multiple points (UL CoMP), should be introduced to guarantee better coverage of TD-LTE system, especially when outdoor base stations are used to provide indoor coverage.

3.2.3 Construction of Base Stations

TD-LTE eNBs can be built by reusing existing 2G/3G sites (co-site), or on new sites. The eNBs should support open BBU-RRU interfaces, support inter-system interference mitigation schemes, and can be deployed in centralized manner (based on optical fiber or IP transmission).

1) Base Station construction manner

- Co-site construction can be further divided into two ways, i.e. introduction of new equipment and upgrade from existing equipment. Both methods require the ability to effectively reuse existing on-site facilities e.g. backhaul, GPS, antenna and power. For the upgrade scenario, existing equipment eligible of upgrade should be able to select appropriate antennas for different deployment scenarios, new BBU boards can be added to exist 3G NodeB, and RRU can be software upgraded to support TD-SCDMA/TD-LTE dual modes. The BBU should support integrated 3G and LTE boards based on the same platform, and RRU should support TD-SCDMA/TD-LTE dual-mode working, e.g. 50MHz for B40 (indoor) and 35MHz for B39 (outdoor). IR (BBU/RRU interface) data compression technique should be supported to reduce the number of fibers needed between BBU and RRU. For 2G base station, chassis, backhaul and power can

be reused;

- **Antenna:** antennas support features like broadband, high gain, aggregated interface, embedded combiner and electric-adjusted downtilt can be adopted for different deployment scenarios (newly built, co-site independent antenna and feeder, co-site shared antenna and feeder) to improve performance and reduce efforts for construction

2) Inter-system coexistence: B39 TD-LTE equipment should consider interference with systems like LTE FDD, GSM900/1800, PHS and CDMA, particularly blocking interference with LTE FDD or GSM1800 on 1850～1880MHz. Therefore B39 TD-LTE equipment should satisfy the following blocking requirement: aggressing signals outside 5MHz of guard band, with 5MHz bandwidth and power of -5dbm should be withstood.

3) Innovative deployment methods: Centralized deployment can be utilized to reduce the cost and save site resources. C-RAN is the main way for centralized deployment, requesting the BBU to support centralized processing of signals from/to at least 18 eight-path RRU or 36 two-path RRU, while at the same time utilizing IR compression technique to reduce the number of fibers used.

3.2.4 Network Performance

TD-LTE network should meet baseline performance requirements and can improve performance via enhanced interference mitigation and enhanced wireless transport technologies.

1) Baseline network performance requirements:

- With 20MHz bandwidth and 3DL:1UL configuration, peak data rate of 110Mbps/10Mbps should be achieved; with 2DL:2UL configuration, peak data rate of 80Mbps/20Mbps should be achieved.
- Maximum number of RRC connected users in a single cell should exceed 200.

2) Enhanced network performance requirements:

Should support advanced technologies like multi-antenna enhancement (including uplink SU-MIMO with dual-stream, downlink multi-user beam-forming), carrier aggregation (including 40MHz B40/B41 intra-band CA and B39+B41 inter-band CA(DL), 35MHz B39 intra-band CA), MSA, uplink 64QAM, DL CoMP , high-speed railway deployment optimization, MDT to improve network performance and operate efficiency. It is required that:

- With 40MHz bandwidth and 3DL:1UL configuration, peak data rate of 220Mbps/40Mbps should be achieved; with 2DL:2UL configuration, peak data rate of 160Mbps/80Mbps should be

achieved.

- Maximum number of RRC connected users in a single cell should exceed 400.

3.2.5 Requirements for Radio Network to Support Voice and Data Service Interoperation with Legacy Network

1)VoLTE: eNodeB should support radio bearer combinations of voice and video services; eNodeB should support relevant features including robust header compression (RoHC), semi-persistent scheduling (SPS), Discontinuous Reception under RRC_CONNECTED (CDRX), TTI bundling and eSRVCC.

2)Interoperation of data services: Radio equipment should support TD-LTE interworking with 2G/3G to leverage superior coverage of existing 2G/3G networks for the continuity of data services.

3.2.6 TDD-FDD Converged Network

TD-LTE equipment, based on synchronous development with FDD, should have the ability of integration of FDD/TDD networking, to give full play of TDD and FDD advantages under FDD/TDD LTE common coverage area. Through the cooperation between FDD and TDD network, TDD/FDD convergence can upgrade service experience of users, and provide similar or better network performance than single-mode with

multiple-bands network.

- Convergence of equipment: baseband equipment supports TDD and FDD convergence on hardware and software levels, and boards of different modes can work together within the same BBU. Thus economy of scale and cost-reduction can be achieved;
- Network cooperation: optimal network re-selection, handover and load-balancing based on signal strength and link quality are supported in FDD/TDD common coverage areas;
- Convergence of antenna and feeding system: dual-frequency dual-path antennas can be adopted to realize deployment with shared antenna and feeding.

3.3 Core Network Aspects

3.3.1 IMS Supporting VoLTE/Voice Handover

The call control of VoLTE is provided by IMS network, which cooperates with EPC network and CS network to provide voice continuity for VoLTE（eSRVCC, aSRVCC, SRVCC for mid-call features）:

- P-CSCF/SBC should support ATCF/ATGW functionalities, which can anchor and switch voice media from EPC to Circuit Switch network;
- P-CSCF/SBC should interact with EPC network via the Rx

interface, to guarantee end-to-end VoLTE QoS by applying PCC architecture. Meanwhile, P-CSCF/SBC should also support retrieval via PCC procedures and insertion into SIP signaling of user access location information which can be used for emergency call or local number normalization.

- SCC AS should provide IMS session transfer and perform domain selection by querying registration states of the subscriber from HSS via the Sh interface;
- IMS network should support functionalities of Precondition and Early Media.

3.3.2 Converged EPC Core Network

The objective of EPC is to realize fully converged core network for 2G/3G/LTE access. EPC will provide access to the IMS and eSRVCC functionalities.

1) Requirements for converged core network:

- EPC equipments should be capable to converge with 2G/3G core networks;
- EPC and SGSN which have the interoperability relation with the EPC should support IPv6 and IPv4v6 PDN type;
- EPC should support converged PCC architecture for 2G/3G/LTE;

- P-GW should support general APN convergence, redirection and intelligent traffic steering;
- MME and S-GW should support MSA related function.

2) Requirements for VoLTE:

- MME should support VoLTE capability indication to UE to choose voice solution;
- P-GW should support the P-CSCF discovery function allocating P-CSCF address to UE;
- MME should support IMS PDN connection reestablishment to optimize traffic routing in case S-GW and P-GW are located in different provinces;
- MME should support the Sv interface and eSRVCC handover control function;
- PCRF should guarantee end-to-end QoS by interworking with IMS and service platform via the Rx interface;
- SAE-GW should support the establishment of dedicated bearer with QCI=1 and QCI=2;
- SAE-GW should support IPv6 PDN type.

3.3.3 HSS

VoLTE requires HSS to support the following functions:

- HSS should provide converged HLR/EPS-HSS/IMS-HSS

function to support VoLTE related user data management and inquiry;

- HSS should support the domain selection feature, including the capability of query from SCC AS of the subscriber registration states via the Sh interface;
- HSS should follow layered hardware architecture;
- The service provisioning interface on HSS should meet the high performance requirement during the provisioning busy hour.

3.3.4 Diameter Signaling Network

To meet the demand of signaling routing for new Diameter interfac es of PCC and VoLTE, and to provide the flexible Diameter signal ing routing for disaster recovery and backup mechanism of EPC/PC C/IMS core network, DRA should support the following functionalit ies:

- Session binding between Gx interface and Rx interface by differentiating services, e.g. VoLTE, data service or IMS emergency call;
- Synchronization of session binding information between paired DRAs(the binding information including: IMSI, MSISDN,IP address, APN, PCRF address ,PCEF address and Session ID);
- Signaling addressing for Diameter interfaces including EPC

Diameter(S6a), PCC Diameter(Gx/Rx) , IMS Diameter(Cx/Sh/Zh) and Location service (SLh/SLg);

- Flexible Diameter signaling routing to the backup destination node with destination host name replacement.

3.3.5 Circuit Switch Network

Circuit Switch network should support eMSC functionality to provide eSRVCC, aSRVCC, mid-call SRVCC handover procedure via the Sv interface and IMS session transfer invocation.

3.3.6 Emergency Service

IMS should support the following functionality to provide VoLTE Emergency Service.

- IMS should support E-CSCF and LRF.
- IMS should support EATF to provide SRVCC of Emergency Service.
- IMS should get users' location information.
- IMS should support Emergency Register and Emergency Call identified by UE or initiated by UE after the indication of network.
- ENUM/DNS should support the configuration of the analytic data of E-STN-SR.

EPC should support the following functionality.

- MME should identify Emergency Call, instruct Emergency SRVCC, and support configuration of Emergency Configuration Data.
- EPC should support Emergency Attach and Emergency PDN connection.
- EPC should feedback users' location information to IMS during PCC.

eMSC should support the following functionality.

- eMSC should configure E-STN-SR.

3.3.7 Supporting Network Disaster-Tolerance Capability

VoLTE Network involves EPC and IMS network, including devices such as MME, SEA-GW, PCRF, convergence HSS, VoLTE SBC/P-CSCF, I/S-CSCF/BGCF, ENUM/DNS, VoLTE AS, MGCF, etc..

Bearing new voice, VoLTE network should appear high service reliability and provide disaster-tolerant capability to recover services after equipment failure, blackout, or a natural hazard, capability that initiating fault detection, and switching to standby device after detecting failure.

3.3.8 LTE Backhaul

LTE backhaul network introduces a flat all-IP architecture, which is

constructed mainly by PTN. When a large bandwidth and/or long transmission distances are required, OTN are deployed together with PTN.

1) Backhaul solution in Metro area:

- In the metro core layer, L3 PTN is introduced to set up a static L3 VPN which achieves X2 and S1-Flex flexible forwarding;
- Legacy L2 PTN should be used in the metro aggregation layer and access layer, and E-Line services are deployed for LTE backhauling.

2) Backhaul solutions in the province backbone: L3 PTN over OTN solution should be used to meet the TD-LTE EPC centralized deployment requirements.

3) Requirements for Synchronization

- PTP(precise time protocol) is shared by TD-SCDMA and TD-LTE;
- Metro OTN and PTN equipments should support Sync-E Function and IEEE1588v2 time synchronization function.

3.3.9 LTE Traffic Service

TD-LTE network should support the flexible charging and differentiated QoS functions to meet operator's charging policies and business requirements.

1) Functional requirements for flexible Charging:

- Support converged online charging, offline charging and content-based charging for 2G/3G/TD-LTE;
- Support the charging capability by differentiating user type, time, User Location Information, QoS and RAT Type;
- Support the charging capability by service data flow detection based on IP 5 tuple/URL/characters detection/pattern recognition to implement content-based charging;
- Support internet service retail sale and internet service wholesale.

2) Functional requirements for service differentiation: provide the users with differentiated QoS/bit rates/application priority by using the end-to-end QoS capability based on the PCC architecture.

- Support 2G/3G/TD-LTE converged PCC;
- Support PCC domestic roaming architecture using the Gx interface to ensure policy consistency;
- eNB/MME/SAE-GW should support end-to-end QoS control, multi-bearer management, QoS parameter mapping ;
- PCRF should support interworking with P-CSCF over the Rx interface to allocate appropriate network resources based on differentiated QoS requirements from IMS service;
- PCRF should support interworking with OCS to implement the QoS control and management based on real-time account status.

3.4 Terminal Aspects

3.4.1 Multi-Mode and Multi-band

To meet the requirements for domestic frequency access and international roaming, five radio modes including LTE FDD, TD-LTE, TD-SCDMA, WCDMA, and GSM should be supported by China Mobile TD-LTE terminals. The multi-mode and multi-band requirements are as follow.

- GSM: Band3, Band8 and Band2 are mandatory. Besides, Band5 is recommended.
- TD-SCDMA: Band34 and Band39 are mandatory.
- TD-LTE: Band39, Band40 and Band41 (at least supporting 2575-2635MHz) are mandatory from July 1st, 2014. For the Flagship and Middle-end terminals, the whole band of B41 is mandatory. If the terminals support Band 41 without Band 38, it must support the frequency mutual identification via mFBI.
- WCDMA: Band1, Band2 and Band5 are mandatory.
- LTE FDD: Band3 and Band7 are mandatory. Besides, Band1, Band17, Band4 and Band20 are recommended.

Additionally, other multi-mode and multi-band terminals could also be introduced in according to market demand.

3.4.2 General Requirements for VoLTE Terminal

Different tiers including high-end, mid-end and low-end terminals should be supported to promote the scale of terminal industry.

To achieve excellent user experience, VoLTE terminals should have performance requirements that are comparable with the mainstream commercial terminals, in the following aspects: operation system, hardware, software, MTBF, standby time, communication duration.

Regarding the outbound roaming requirement, VoLTE handsets should support CSFB from LTE to WCDMA/GSM and support four kinds of functions for VoLTE:

1) RAN Features

- Support SPS,TTI-Bundling, RoHC, Connected-DRX and its combinations; Support interoperation from LTE to GSM via eSRVCC, aSRVCC, mid-call SRVCC; Support SRVCC related measurement capability and capability report;
- Support UE-based Fast Return to LTE after SRVCC CS Call ends
- Support IPv4、IPv6 and IPv4v6 dual-stacks;
- Support multi-PDN connections; Delete IMS PDN when moving out of VoLTE coverage.
- Support EPS bearer combinations for VoLTE service; support End to End QoS.

2) IMS function on control plane

- Support the standard SIP/IMS protocol in order to inter-work with the global IMS networks;
- Support derivation of IMS identifiers from USIM ,if ISIM is not introduced;
- Support IMS Exceptions Handling;
- Support RTP/RTCP;
- Support the IMS authorization and authentication etc;
- Support Early Media;
- Support Precondition;
- Support upgrade and downgrade between voice and video call;
- Support Supplementary Service configuration via Ut/XCAP.

3) IMS function on media plane

- Audio Codec: AMR-NB & AMR-WB;
- Video Codec: H.264 640*480@30fps; 720P@30fps is recommended;
- Quality Enhanced Features: Noise Suppression, Echo Cancellation, Jitter Buffer, Lip Sync.

4) Services Requirements

- Voice Call
  - Support standard Voice call & HD Voice call;
  - Support Voice domain transition between VoLTE and CSFB;

Support Voice Continuity among different scenarios;

- Support SilentRedial.

- Message
  - Support SMS over IP, SMS over CS;
  - Support MMS.
- Video Call
  - Support video call when UE within VoLTE coverage;
- Supplementary Services
  - Support IMS Supplementary Services;
  - Supported Enhanced Conference call.
- IMS Emergency Service

3.4.3 Interoperation Requirements for Terminal

1) Interoperation of data service requirements: TD-LTE terminal should support interoperation of data service between TD-LTE with LTE FDD, TD-SCDMA, WCDMA and GSM.

- Interoperation between TD-LTE and LTE FDD: Terminal should support cell reselection in idle mode and PS handover and RRC redirection in connected mode between TD-LTE and LTE FDD;
- Interoperation from TD-LTE to TD-SCDMA: Terminal should support cell reselection from TD-LTE to TD-SCDMA in idle mode and measurement to TD-SCDMA cells in TD-LTE

connected mode, and can move from TD-LTE to TD-SCDMA network by RRC redirection (R8) and recover service. In addition, terminal shall support the optimization mechanism to auto-search available network in the event of failure when the terminal moves from TD-LTE to TD-SCDMA by RRC redirection;

- Interoperation from TD-SCDMA to TD-LTE: terminal must support cell reselection from TD-SCDMA to TD-LTE in idle mode and measurement to TD-LTE cells in TD-SCDMA connected mode, and can move from TD-SCDMA to TD-LTE network by RRC redirection (R8) and recover service;
- Interoperation from TD-LTE to GSM: Terminal should support cell reselection from TD-LTE to GSM in TD-LTE idle mode;
- Interoperation from GSM to TD-LTE: Terminal should support cell reselection from GSM to TD-LTE in GSM idle mode and can move from GSM to TD-LTE by NC0 cell reselection and recover service.

2) Interoperation of Voice service: VoLTE terminal should support eSRVCC from LTE to GSM to ensure the continuity of voice service**.**

3.4.4 International Roaming Requirements for Terminal

VoLTE terminal should provide data, voice, SMS, etc. during international roaming.

Regarding the data service continuity, terminal should support bi-directional cell reselection, handover and redirection in connected mode between TD-LTE/FDD LTE and WCDMA. Regarding the voice service continuity, the terminal should support eSRVCC between TD-LTE/FDD LTE and WCDMA as well.

VoLTE handset should support VoLTE roaming or CSFB roaming, and legacy 2G/3G roaming. VoLTE handset should support VoLTE roaming as the primary solution, and CSFB roaming as the secondary in order to support roaming to networks which only support CSFB. In order to achieve global IMS based roaming for VoLTE, joint efforts are strongly urged among LTE operators to deploy commercial VoLTE as early as possible.

3.4.5 Support LTE-A Partial Function Step by Step

The terminal chipset should support intra-band (B40 and B41) CA in 40MHz bandwidth in downlink and uplink, inter-band (between B39 and B41) CA in 40MHz bandwidth in downlink and uplink, and inter-band (B39) CA in 35MHz bandwidth in downlink and uplink, and should support uplink 2*2MIMO, uplink 64QAM, uplink and downlink MSA, and MDT.

3.4.6 USIM

USIM is supported by TD-LTE terminal. If SIM is inserted, the LTE multimode terminal should not report its LTE capability. The standard UICC, USAT and OTA protocols should be supported between terminal and USIM.

3.5 Interworking and International Roaming Aspects

3.5.1 Interworking Requirements

VoLTE interworking scenarios include VoLTE to VoLTE subscribers, VoLTE to other IMS subscribers and VoLTE subscribers to PSTN/PLMN users.

1) Requirements for interworking with other operators between VoLTE and VoLTE or other IMS subscribers:

- Service capabilities：Should support HD voice call, HD video call and multiparty call interworking.
- Interconnection Border Control Function (IBCF/TrGW) should be used to interworking with both domestic and international operators. The IBCF/TrGW should support interworking functions such as protocol mapping, codec translation, billing, network topology hiding, security isolation and routing, etc.; Interworking method includes 1-to-1 direct connection or multiple operators

interconnect through IPX. For the case of IPX interworking, the IPX network should provide IMS transfer for control plane and user plane, and should support QoS bearer based on service type to ensure the international interworking quality.

- Tier one ENUM/DNS server should be configured with operator subscriber data to ensure correct addressing.

2) Requirements for interworking between VoLTE subscribers and PSTN/PLMN subscribers:

- Service capabilities：interworking of voice call and multiparty call should be supported.
- Media Gateway Control Function (MGCF) and IM Media Gateway (IM-MGW) should be applied to support interworking functions such as protocol mapping, codec translation, video call falling back to voice call, early media suppression and record announcement suppression and routing, etc.;
- The interworking with other domestic and international operators should follow the current network interworking policies, route through MGCF/IM-MGW to city-level GMSC or international ISC, respectively.

Note: VoLTE subscriber in this interworking requirement section is assumed to attach to LTE access network and its service is provided by IMS core network.

3.5.2 International Roaming Requirements

The terminal and the network should support TD-LTE international roaming, which means both outbound roaming and inbound roaming of China Mobile should be supported simultaneously.

1) Requirements for TD-LTE data roaming architecture

- International gateway equipments, P-GW/GGSN and DNS, should support roaming of TD-LTE user plane;
- I-DRA should support roaming of TD-LTE signaling plane;
- International interconnections should be based on IPX networks.

2) Requirements for VoLTE roaming architecture

- EPC network should be able to resolve IMS well-known APN to support Local breakout of VoLTE traffic ;
- IMS network should support RAVEL architecture;
- IPX network should support IMS proxy functionalities.

3.6 Operation Aspects

3.6.1 Provisioning Requirements

VoLTE provisioning should support the following scenarios: VoLTE provisioning for new subscriber, VoLTE provisioning for legacy subscriber, service provisioning for VoLTE subscriber.

VoLTE provisioning for legacy subscriber should inherit the subscribers' existing 2/3G services, and the network equipment should co-operate

with business support system to complete the provisioning data modification for the services like ODB, supplementary services, IN services, multimedia ringtone, multimedia printing, one number, etc. Besides converged HSS, VoLTE AS and ENUM/DNS, the following network entities should be involved during the procedure of VoLTE provisioning:

- SCP;
- IMS-HSS dedicated for fixed access subscribers;
- Multimedia ringtone AS;
- Multimedia printing AS;
- Centrex AS;

3.6.2 Charging Requirements

To support different charging polices, VoLTE network should have offline charging, online charging, and content based charging capabilities.

VoLTE network should support duration based charging and data volume based charging pattern.

- Time based off-line and online charging: should collect CDRs or CCR message at VoLTE AS.
- Data volume based charging: should collect CDRs or CCR message at P-GW.

3.6.3 Network Management Requirements

3.6.3.1 Alarm Management

To reduce the alarm number, meaningless events should be avoided. Correlation must be implemented on all levels (network element & element manager), alarm floods of instances which did not cause the failure need to be blocked, and alarms per incident should be cut down. Alarms must be generated once network elements were abnormal and must reveal the network issues exactly.

- **Alarms should be precisely correct**: Correct alarms must be generated and forward once NEs were abnormal. When customer experience was affected due to the equipment's performance degradation and service quality deterioration, related alarms should be produced and forwarded. Events that don't need engineer intervention should not be reported as alarms in order to avoid too much meaningless information. Notifications about alarm clearance must be reported after failure recovery.

    - **Alarm text should be explicit and concrete:** Alarm texts should be clearly related to a specific network resource. For example, the alarms on board card-level should include the information of chassis, sub-rack, frame, slot position and physical ports. Link/linkset alarm text should include information of the

other side NE's name, IP addresses, Signaling Point Code etc. The alarm description should include probable cause, NE impact, service impact and a clear repair action.

- **Alarm Standardization**: The alarm text should include the information of vendor's name, equipment type, object's type, network element name, alarm title, alarm priority, alarm location, alarm description, alarm occurred time, alarm logical type and sub-type etc. Alarm title or alarm ID should be unique and related to a specific alarm text.

With the development of TD-LTE networks, NE's alarm management should be all around optimized to implement roll out alarm indication, alarm flood restraint, alarm correlation, alarm customization, automatic routing check and alarm reminding.

3.6.3.2 Security Management

1) Management with different region and different authority: Centralized deployed HSS and DRA should support virtual equipment functionalities to satisfy the requirement of service fulfillment and maintenance of different regions with different authority.

2) Information security: Effective control mechanism should be provided according to China Mobile equipment's security specifications.

3) Disaster recovery and backup: HSS, DRA, MME/SGSN and

SAE-GW/GGSN should support inter - system disaster recovery and backup.

4) Networking security: Seamless service handover should be implemented in the case of FE/BE software failure, connection failure, data update confliction and signaling link failure due to the distributed HSS network in LTE network.

5) Board card security: Redundancy of key boards/cards and hot-plugging should be supported.

3.6.3.3 System Upgrade

Online software upgrade should be supported.

Upgrade should not be too much in a specific period. Service outage duration should be reduced when upgrade. No more than two different versions are allowed with the same hardware platform within China Mobile's network.

3.6.3.4 Key Functionalities of NEs' O&M

1) Backward-compatible: The O&M function of DRA, HSS, MME and SAE-GW should be compatible with STP, HLR, SGSN, and GGSN in 2G/3G networks. And support 2G/3G related NE's basic performance indicators and O&M functionality.

2) Signaling monitor and trace: At least 10 subscriber's control plane

information can be monitored and traced by IMSI, MSISDN of MME, DRA and SAE-GW Related data packet can be parsed and exported.

3) Dynamic resource sharing SW/HW: Resource on signaling/media plane should be allocated and optimized automatically after LTE core network equipments converged with current networks.

3.6.3.5 Self-Organizing Networks

To reduce O&M work's complexity and reduce the costs, Self-Organizing Networks (SON) technology with the features of self-configuration, self-optimization and Minimization of drive tests (defined in 3GPP TS32.500,32.501,etc.) should be introduced.

3.6.3.6 Solution for Network Management Northbound Interface

China Mobile has already developed a complete network technology oriented network management system. And these NMS managed the multi-vendor's network through the northbound interfaces provided by the vendor's EMS or NEs. China Mobile has the detailed requirement list below for the vendor's EMS or NE's northbound interface:

1) Interface protocol: China Mobile has already defined the requirements of northbound interface protocol for different scenarios according to our O&M work and related 3GPP standards. To be specific:

- FTP should be used as the protocol in CM and PM interface. And

the data should be forward to NMS with standardized XML files;

- CORBA should be used as protocol in Fault management interfaces;
- There is no specific protocol enforcement for the direct access (defined in 3GPP TS32.102) from NMS to NE currently.

2) Interface functionalities:

- The northbound interface of EMS should support standard interface connection, notification and connection routines check with NMS.
- Periodical statistics report should be provided from CM/PM interfaces, and certain delay was required:
  - With the 5 minutes data sampling granularity, latency should be less than 5 minutes;
  - With the 15 minutes data sampling granularity, latency should be less than 10 minutes;
  - With the 30 minutes data sampling granularity, latency should be less than 20 minutes;
  - With the 60 minutes data sampling granularity, latency should be less than 30 minutes.
- Fault management interface should be capable of prompt alarm

notification and active alarm synchronization;

- Direct access from NMS to NE (defined in 3GPP TS32.102) should be provided.

3) Interface information model

- The information model of network resources/performance management interfaces should align with following requirements:
  - It should be compliant with the latest version OMC northbound information model (including network resource model and performance measurement data);
  - It should support the reports of standardized network optimization parameters.

3.6.3.7 OMC Key Function

Multi-mode base station will be deployed in China Mobile's converged TD-SCDMA and TD–LTE network. The management of dual-mode base stations is a fundamental function for EMS/OMC. Meanwhile, EMSs/OMCs should be designed as logically one system to satisfy the requirements of O&M centralization.

1) Management of multi-mode base station: Configuration management, alarm management, release management and topology management of multi-mode base station should be supported with

EMS/OMC;

2) Logically one centralized system: Only one logically centralized OMC/EMS is permitted for each vendor's network within a province. Engineers can monitor a province's network and access for a specific NE of a specific vendor conveniently without changing the OMC/EMS terminal.

3.6.3.8 MR Data

Measurement report data is primarily came from the report and events of physical layer, MAC layer, RLC layer and wireless resource management calculation of UE and eNodeB. The scope, period of sampling, the reporting period, the collection and measurement items, the configuration of reporting events should be support by the vendor's OMC-R, and the MRS(MR Statistic) , MRO&MRE (Sampling data) should be provided with a standardized format. The report should be accessed with FTP.

3.6.3.9 Signaling Information Software Built in Collection

With the flat LTE network architecture evolution, the original mechanism such as optical splitter or high-ohmic cross-connection can't obtain required raw data for network daily operations and maintenance. As the results, The Uu and X2 interfaces of TD-LTE wireless network equipment should have the ability to export the raw signaling data, which is called the software built in collection for signaling information.

Network elements should have an interface to export the raw data of the network signaling and various service data, the interface can be activated/ deactivated in the vendor's OMC-R. Signaling Convergence Adapter (SCA) is responsible for collecting the data traffic on the software built in interface.

3.7 Security Aspects

3.7.1 General Requirement

The VoLTE oriented network shall provide strict security and privacy protection for the communication services.

The VoLTE oriented network shall be divided into different security network domain based on different threats and risks. Security borders shall also be set to distinguish security domains.

The VoLTE oriented network shall comply with related regulation and security management requirements.

3.7.2 Network Security

The VoLTE oriented network shall provide mutual authentication, encryption and integrity protection based on existing LTE and IMS security schemes. In order to provide continuous protection, it shall support unified management for user authentication parameters, and support security context conversion during handover between different

networks. Finally, it shall support to store encrypted user information to prevent user private information from leakage.

3.7.3 Terminal security

VoLTE terminal shall use USIM to access LTE and IMS network. It shall support corresponding security features to provide network security access protection. Meanwhile it shall support local security protection and software protection, and support security requirement defined by “Technical Requirements for Security Capability of Smart Mobile Terminal” defined by CCSA, in order to prevent user private information from leakage under attack.

3.7.4 Operation Management Security

Operation Management security features shall support the user authentication and authorization, management for username/password, logs storage and operation security, IP protocol security, device security, 4A management security, etc. It shall also have risk management mechanism to protect user private data from unauthorized access by operation management personnel.

4 Conclusion

In addition to the key technical issues outlined above, the introduction of VoLTE should also consider issues of network provisioning, operation

and optimization that will require resolutions built upon collective knowledge and experiences accumulated through continuous practices.

It is highly expected that the commercial deployments of VoLTE and global seamless roaming will be achieved as early as possible through concerted cooperation efforts across the global industry.

Annex 1: Summary of Technical Requirements

1. Multi-band network

Network elements	Technical Requirements	**Time Table**
eNB	Supported bands: B39(1880~1920MHz),B40(2320~2370MHz),B41（2575~2635MHz）	2013
eNB	B39 RRU supports a minimum of 35MHz bandwidth	2013
eNB	B40 RRU supports a minimum of 50MHz bandwidth	2013
eNB	B41 RRU supports a minimum of 60MHz bandwidth	2014
eNB	Addition of multi-band indication in broadcast messages	2013
eNB	Support flexible bandwidth configurations of 5MHz, 10 MHz, 15 MHz and 20MHz	2013
eNB	Support DL/UL subframe configurations of 3DL:1UL and 2DL:2UL	2013
eNB	Support special subframe configurations of 3:9:2,10:2:2	2013
eNB	Support special subframe configuration 6:6:2 for co-existence with TD-SCDMA system on adjacent bands	2013
eNB	Support inter-frequency measurement and mobility with the same or different subframe configuration on different carriers	2013

eNB	Support inter-vendor handover and load balancing based on received power level, link quality and load condition on open X2 interface	2014

2. Coverage

Network elements	Technical Requirements	**Time Table**
eNB	Support distributed Macro eNB, Micro eNB, Pico eNB and Relay	2013
eNB	Support cell combining among different types of RRU, with a minimum number of 6 RRUs	2013
eNB	Support minimum four-level cascading of two-path RRU supporting 20MHz bandwidth	2013
eNB	Support power boosting of cell common reference signals	2013
eNB	Support automatic adjustment of CCE occupation and transmission power of PDCCH	2013
eNB	System performance degradation should be no more than 30% at the speed of 300km/h for downlink, and no more than 20% for uplink	2013

3. Network construction

Network elements	Technical Requirements	**Time Table**
eNB	LTE TDD and FDD share BBU hardware platform	2014
eNB	B39 equipment should be able to endure aggressing interference with 5MHz bandwidth and power of -5dbm, outside 5MHz of guard band	2013
Antenna	Support schemes of broadband, high gain, aggregated interface, embedded combiner and electric-adjusted downtilt	2013
eNB	Support network re-selection, handover and load-balancing based on signal strength and link quality in FDD/TDD common coverage areas	2015
eNB	Supports TDD and FDD hardware and	2015

	software convergence and boards of two modes can work together within the same BBU	
eNB	For C-RAN deployment, BBU supports centralized processing of signals from/to at least 18 eight-path RRU or 36 two-path RRU; For other deployment, BBU supports centralized processing of signals from/to at least 9 eight-path RRU or 18 two-path RRU	2015

4. Network performance

Network elements	Technical Requirements	**Time Table**
eNB	With 20MHz bandwidth and 2DL:2UL configuration, peak data rate of 80Mbps/20Mbps should be achieved; with 3DL:1UL configuration, peak data rate of 110Mbps/10Mbps should be achieved	2013
eNB	Maximum number of concurrent users in a single cell should exceed 200	2013
eNB	Support uplink multi-user multiplexing a.k.a. UL MU-MIMO	2013
eNB	Support DL transmission mode 8 (TM8) a.k.a. DL dual-stream beamforming	2013
eNB	Support DL TM3/8 adaptation	2013
eNB	Support DL transmission mode 8 (TM8) multi-user beamforming a.k.a. DL MU-BF	2013
eNB	Support uplink interference rejection combining a.k.a. IRC receiver	2013
eNB	Support inter-cell interference cancellation a.k.a. ICIC	2013
eNB	Support intra-band (B40 or B41) carrier aggregation of 40MHz bandwidth	2013
eNB	Support intra-band (B39) carrier aggregation of 35MHz bandwidth	2013
eNB	Support inter-band (B39 and B41) carrier aggregation of 40MHz bandwidth	2014
eNB	Support UL/DL MSA	2015
eNB	Support 2-sector coordination on the same site, support UL joint reception	2013
eNB	Support inter-site multiple-cell DL joint	2014

	transmission, including CS/CB adaptation	
eNB	Support uplink SU-MIMO i.e. uplink dual-stream	2015
eNB	Support downlink two-user MU-MIMO, i.e. two streams per user	2015

5. Interworking of data services

Network elements	Technical Requirements	**Time Table**
eNB/UE	Idle mode cell re-selection between TD-LTE and TD-SCDMA cells, data re-direction for connected mode	2013
eNB/UE	Idle mode cell re-selection between TD-LTE and GSM cells, UE returns from GSM to TD-LTE autonomously	2013
UE	Support connected mode measurements of TD-LTE in TD-SCDMA mode and report of measurement results	2013
MME	Support of IDLE mode reselection interoperation between LTE and 2G/3G and CONNECT mode redirection interoperation between LTE and 3G	2013
MME	Support of gateway selection based on the priority and weight factor	2013
SGSN	Support of 5-tuple authentication functionality of USIM card	2013
SGSN	SGSN should support gateway selection functionalities as follows: 1. Support of EPC node selection based on the EPC Capability element in UE Network Capability reported by the terminal; 2. Support of transferring P-GW hostname via Gn interface when LTE multi-mode terminal performs cell reselection from 2/3G to LTE or another SGSN; 3. Support of gateway selection based on priority and weight factor.	2013

6. VoLTE Solution

Network elements	Technical Requirements	**Time Table**
eNB	Support of RoHC functionality for IPv4	2014

	and IPv6	
eNB	Support of SPS functionality	2014
eNB	Support of uplink TTI bundling(2DL:2UL)	2014
eNB	Support of eSRVCC detection, neighbor cell list selection, and eSRVCC initiation	2014
MME	Support of transferring “IMS voice over PS supported” indication to the terminal	2014
MME	Support of the field of IMS voice preference(e.g. IMS voice preferred)	2014
MME	Support of Sv interface and eSRVCC handover control	2014
MME	Support the parameters in S6a interface including STN-SR, C-MSISDN etc; Support of parameter storage and delivery to eMSC	2014
MME	Support of notification to eNodeB about the information whether UE and core network support the eSRVCC capability in S1 interface	2014
MME	Support of the storage about SRVCC capability of the terminal	2014
MME	Support of IMS PDN connection reestablishment to optimize traffic routing in case S-GW and P-GW are located in different provinces	2014
SAE GW	Support of access to IMS network, the IMS P-CSCF discovery and delivery to UE	2014
SAE GW	Support of eSRVCC related procedure	2014
PCRF/SPR	Support of AF session binding	2014
PCRF/SPR	Support of VoLTE service policy configuration for voice and video call	2014
PCRF/SPR	Support of Rx interface and Diameter session management over Rx interface	2014
PCRF/SPR	Support of query user location info from P-GW, and response to SBC/P-CSCF	2014
P-GW	Support of request of user location information to MME and delivery to PCRF/SPR	2014
MME	Support of response of user location information based on request of PGW	2014
SBC/P-CSCF	Support of ATCF/ATGW function, which can locally anchor IMS signaling and media, or switch media path from EPC to CS network, support of getting user	2014

	location info (TAI and ECGI) from PCC, and transfer them in SIP message.	
P-CSCF	Support of telephone number normalization for local call	2014
SCC AS	Support of domain selection mechanism, session anchoring and transfer and maintenance and notification of session states	2014
VoLTE AS	Support of telephony services and supplementary services, e.g. voice call, video call and multi-party call	2014
MGCF	Support of early media and record announcement suppression according to the Feature-caps provided by the VoLTE AS	2014
MGCF	Support of video call falling back to voice call by setting video port to 0 of m line in SDP when sending the SIP message to CS; Support of rejection of CS video call based on the operator's configuration	2014
eMSC	Support of eSRVCC, aSRVCC, and SRVCC for mid-call	2014
HLR/HSS	1. support of user authentication for 2G/3G/LTE, and user data storage, including user attributes, subscriptions, registration states and mobility management information; 2. support of MAP interface for 2G/3G and S6a interface for LTE 3. support of virtual HSS functionality; 4. support of interface to LTE LBS application platform; 5. support of handling of Notify request from MME; 6. support of location restriction service for 2G/3G/LTE users; 7. support of Diameter routing management; 8. support of layered architecture, with real-time backup between BEs and	2013

	N+1 backup between FEs; 9. support of multiple hostnames of HSS to avoid impacts on other entities when automatically switching and recovery are performed 10. support of unified SOAP based provisioning interface of China Mobile	
HLR/HSS	1. support of IMS-HSS function 2. support of domain selection function 3. support of Sh interface 4. support of restoration, inquiry for eSRVCC related parameters and delivery by S6a and Sh interface	2014
HLR/HSS	The service provisioning interface should meet the high performance requirement during provisioning busy hour. The performance requirements should follow linear growth rules with the basic unit as 100 commands per second for one million users	2013
UE	Support of R9 RRC redirection (compatible with R8 RRC redirection) to CSFB from LTE to GSM. Support of optimization for call setup delay for R8 RRC redirection	2013
UE	Support of Fast Return from GSM to LTE and Fast Return optimization	2013
UE	Support of CSMO、CSMT、CSMO emergency call to be reported in Extended service request message; Support of CSMT flag (R8/R9) to be reported in Location Update request message	2013
UE	Support SPS,TTI-Bundling, RoHC, Connected-DRX and its combinations; Support interoperation from LTE to GSM via eSRVCC, aSRVCC, mid-call SRVCC; Support SRVCC related measurement capability and capability report	2013
UE	Support UE-based Fast Return to LTE after SRVCC CS Call ends	2014
UE	Support IPv4、IPv6 and IPv4v6 dual-stacks	2013

UE	Support multi-PDN connections; Delete IMS PDN when moving out of VoLTE coverage	2014
UE	Support EPS bearer combinations for VoLTE service Support End to End QoS;	2013
UE	Support the standard SIP/IMS protocol in order to inter-work with the global IMS networks	2013
UE	Support derivation of IMS identifiers from USIM ,if ISIM is not introduced	2013
UE	Support IMS Exceptions Handling	2014
UE	Support RTP/RTCP	2014
UE	Support the IMS authorization and authentication etc	2014
UE	Support Early Media	2014
UE	Support Precondition	2014
UE	Support Precondition; Support upgrade and downgrade between voice and video call	2014
UE	Support Supplementary Service configuration via Ut/XCAP	2014
UE	Audio Codec: AMR-NB & AMR-WB	2013
UE	Audio Codec: AMR-NB & AMR-WB Video Codec: H.264 640*480@30fps; 720P@30fps is recommended;	2014
UE	Quality Enhanced Features: Noise Suppression, Echo cancellation, Jitter Buffer, Lip Sync	2014
UE	Support standard Voice call & HD Voice call	2013
UE	Support Voice domain transition between VoLTE and CSFB; Support Voice Continuity among different scenarios	2014
UE	Support SilentRedial	2014
UE	Support SMS over IP, SMS over CS	2014
UE	Support MMS	2014
UE	Support video call when UE within VoLTE coverage	2013
UE	Support IMS Supplementary Services	2014
UE	Supported Enhanced Conference call	2014
UE	IMS Emergency Service	2014

7. EPC core network supporting 2G/3G/LTE convergence

Network elements	Technical Requirements	**Time Table**
MME	1. MME should be based on 3GPP Release9. 2. Support of access control, mobility management, user data management, session management, network element selection, APN revise, Pool, Diameter routing, PCC related, security, etc. 3. Support of converged SGSN	2013
SAE GW	1. SAE GW should be based on 3GPP Release9 2. Support of UE IP address allocation, session management, route selection and data transferring, location management, user data management, access to PDN, security, redundancy and backup, service identification, common APN convergence, PCEF, charging, etc. 3. Support of co-located S-GW and P-GW as SAE GW with converged GGSN functionality	2013
HLR/HSS	Support of the HLR/EPS-HSS convergence, and the interfaces of Gr and S6a	2013
HLR/HSS	Support of the HLR/EPS-HSS/IMS-HSS convergence	2014

8. Signaling Network

Network elements	Technical Requirements	**Time Table**
DRA	Support of Diameter peers management, including Capabilities Exchange, Multiple Connections between diameter peers, link configuration within linkset, and DWR/DWA for transport failures detection	2013
DRA	1. Support of Diameter agents function, including relay agent and proxy agent; 2. Support of 3GPP S6a/Gx/Rx applications; 3. Support of Diameter Request routing based on IMSI/MSISDN/IP address/Destination-Host;	2013

	4. Support of Diameter Message Processing methods defined by RFC6733	
DRA	Support of 3GPP Cx/Sh/Zh/SLh applications routing by configuration for proxy mode	2014
DRA	1. Support of routing policy combination based on APN 2. Support routing policy of IMS IMPU (Public-Identity, both Fixed and Mobile phone number formats) 3. Support routing policy of IMS IMPI (Private-Identity) 4. Support of configuring and processing multiple home realms (including multiple MNC of EPC realm, IMS realm.)	2014
DRA	Support of routing management, including load-sharing, backup, loop avoidance, Failover/Failback, re-routing base on error code, flexible priority routing and Diameter nodes redundancy routing method	2013 (flexible priority routing is new in 2014)
DRA	Support Session-binding for PCRF and Session-binding information synchronization: 1. Support of Session-binding to the same PCRF when routing Gx and Rx Diameter Request related to one IP-CAN session; 2. Support of storage for Session-binding information during IP-CAN session. And the Session-binding information includes Session ID, IMSI, MSISDN, IP address, APN, PCRF address, PCEF address. 3. Support Session-binding information synchronization between a pair of DRAs when IP-CAN session being set up, modified, and deleted. 4. Support of Session binding between Gx interface and Rx interface by differentiating services, e.g. VoLTE, data service or IMS emergency call, base on APN. 5. Support of Session binding base on specific APN by configuration, 6. Support of synchronization interface for Session binding information, providing Incremental synchronization/ total amount synchronization/ inquiry mechanism and Service protection mechanism(during the	2014

	failure of a synchronization link)	

9. Transmission and Backhaul

Network elements	Technical Requirements	**Time Table**
SAE GW/MME/HSS/DRA	Redundancy: Devices should support L3 master-slave mode or load-sharing mode. **Fault Detection**: Devices should support BFD protocol for fast failure detection. The minimum detection interval must be less than 100ms. **Protection switching time**: BFD should be able to trigger switchover on L3 master-slave mode or load-sharing mode. Protection switching time must be less than 1 second.	2013
SAE GW	QoS: Device should support mapping between QCI and DSCP. The mapping rules should be configured by operator.	2013
P-GW	SGi interface should support separating VoLTE traffic from other data traffic.	2013
eNB	1. Synchronization requirements: eNB should support IEEE1588v2 time synchronization function, and be able to get the time synchronization through PTP interface and 1PPS + TOD interface from the transmission equipment. Ethernet interface should support Sync-E Function. 2 Interface Protocol: S1-C, S1-U, X2 interface supports IPv4 protocol 3, QoS requirement: eNB should support flexible mapping between LTE QCI and IEEE 802.1p and IP DSCP priority, and mapping rules can be configured by the operator	2013
PTN	1. A flexible forwarding capability: the Metro core PTN should support static L3 VPN functionality to achieve the X2 and S1-Flex flexible forwarding 2. protection requirements: In access and aggregation layer, L2 PTN should support PW dual-homing	2013

	protection, the core layer L3 PTN should support VRRP and VPN FRR function 3. the synchronization capabilities: PTN network elements should support synchronous Ethernet and IEEE 1588V2 boundary clock (BC) hybrid mode to provide the time synchronization 4. QoS capability: PTN DIFFSERV QoS model	

10. LTE Traffic service

Network elements	Technical Requirements	**Time Table**
eNB	1. eNB should support QoS control including Standardized QCI(1~9), extend QCI, ARP, UE-AMBR, MBR and GBR; 2. eNB should support Multi-bearer management, GBR bearer management, Non-GBR bearer management	2013
eNB	eNB should support priority access control for user	2014
MME	1. support of bearer activation, modification, deactivation 2. support of bearer QoS update, APN-AMBR modification, UE-AMBR modification	2013
SAE GW	1. Support of converged PECF specified by 3GPP Relase9; 2. Support of converged online charging, offline charging and content-based charging; 3. Support of QoS control; 4. Support of bearer activation, modification, deactivation procedure triggered by QoS modification; 5. Support of QoS control, gating control, usage monitoring control; 6. Support of traffic flow notification based on online charging	2013
SAE GW	Support of redirection and offloading based on PCC	2014

PCRF	1. Support of converged Policy control for 2G/3G/LTE specified by 3GPP Release9; 2. Support of domestic roaming architecture	2013
PCRF	1. Support of interworking with P-CSCF over Rx interface; 2. Support of interworking with third-party service provider to retrieve QoS requirement; 3. Support of interworking with OCS to implement QoS control based on the real-time account status	2014

11. Other aspects for terminal

Network elements	Technical Requirements	**Time Table**
UE	Support of various TDD and FDD bands, cell selection and handover function between FDD and TDD	2013
UE	Support of various bandwidth, special subframe configurations	2013
UE	The multi-mode and multi-band requirements are as follow. ● GSM: Band3, Band8 and Band2 are mandatory. Besides, Band5 is recommended. ● TD-SCDMA: Band34 and Band39 are mandatory. ● TD-LTE: Band39, Band40 and Band41 (at least supporting 2575-2635MHz) are mandatory from July 1st, 2014. For the Flagship and	2014

	Middle-end terminals, the whole band of B41 is mandatory. If the terminals support Band 41 without Band 38, it must support the frequency mutual identification via mFBI. ● WCDMA: Band1, Band2 and Band5 are mandatory. ● LTE FDD: Band3 and Band7 are mandatory. Besides, Band1, Band17, Band4 and Band20 are recommended.	
UE	Support of category3 or above	2013
UE	Support of downlink multi-antenna in TM2, 3, 4, 7, 8，Uplink signal antenna	2013
UE	Support of sounding, CQI, PDSCH resource allocation, pilot transmission etc in physical layer	2013
UE	Support of measurement for RSRP, RSRQ, ANR and related GAP	2013
UE	Support of intra-band （B40+B41）CA within 40MHz bandwidth	2014
UE	Support of inter-band （between B39 and B41）CA within 40MHz bandwidth	2014
UE	Support of intra-band（B39）CA within 40MHz bandwidth	2014
UE	Support of uplink 2*2MIMO	2015
UE	Support of downlink MAS	2015
UE	Support random access, HARQ/ARQ, PDCH, system information reading, DRX, cell selection/reselection/handover, paging, PLMN selection, Location registration, and L2/L3 function	2013

UE	Support of mFBI	2013
UE	Support of MDT	2014
UE	Support of MBSFN subframe configuration and measurement	2013
UE	Support of IPv6 and IPv4v6	2013
UE	Support inter-frequency measurement and mobility with the same or different subframe configuration on different carriers	2013
UE	Support of various TDD and FDD bands, cell selection and handover function between FDD and TDD	2013
UE	Support of various bandwidth, special subframe configurations	2013
UE	The multi-mode and multi-band requirements are as follow. ● GSM: Band3, Band8 and Band2 are mandatory. Besides, Band5 is recommended. ● TD-SCDMA: Band34 and Band39 are mandatory. ● TD-LTE: Band39, Band40 and Band41 (at least supporting 2575-2635MHz) are mandatory from July 1st, 2014. For the Flagship and Middle-end terminals, the whole band of B41 is mandatory. If the terminals support Band 41 without Band 38, it must support the frequency mutual identification via mFBI.	2014

	• WCDMA: Band1, Band2 and Band5 are mandatory. • LTE FDD: Band3 and Band7 are mandatory. Besides, Band1, Band17, Band4 and Band20 are recommended.	
UE	Support of category3 or above	2013
UE	Support of downlink multi-antenna in TM2, 3, 4, 7, 8, Uplink signal antenna	2013
UE	Support of sounding, CQI, PDSCH resource allocation, pilot transmission etc in physical layer	2013
UE	Support of measurement for RSRP, RSRQ, ANR and related GAP	2013
UE	Support of intra-band （B40+B41）CA within 40MHz bandwidth	2014
UE	Support of uplink 2*2MIMO	2015
UE	Support of downlink MAS	2015
UE	Support random access, HARQ/ARQ, PDCH, system information reading, DRX, cell selection/reselection/handover, paging, PLMN selection, Location registration, and L2/L3 function	2013
UE	Support of mFBI	2013
UE	Support of MDT	2014
UE	Support of MBSFN subframe configuration and measurement	2013
UE	Support of IPv6 and IPv4v6	2013
UE	Support inter-frequency measurement and mobility with the same or different subframe configuration on different carriers	2013

12. Network Management

Network Element	Technical Requirements	**Time Table**
eNB/SAE-GW/MME/HS	1. Support connectivity detection	2013

S/DRA/PCRF	with heartbeat notification on northbound interface; 2. Support modification of the heartbeat notification period by hand; 3. Performance report can be provided every 15 minutes on the PM interface; 4. Support real time and total NE alarm report to upper network management system. The delay should be less than 10s; 5. Support historical activity alarms report with file format by the requirement of upper NMS; 6. Support the activity alarm confirmation by upper NMS; 7. Support various alarm related notification report, e.g. changes of alarm's priority and alarm's status; 8. Provide machine readable and executable command line; 9. Satisfied the requirement of NE's routine check list and service parameter batch configuration defined in CMCC's O&M EIB.	
eNB	1. Support the configuration of public physical resource, public transport resource, TD-SCDMA NodeB wireless resource, TD-LTE eNodeB wireless resource for multi-mode base station; 2. Support indicating the alarm impact on OMC alarm's views of multi-mode base station, i.e. TD-SCDMA mode, TD-LTE mode and TD-SCDMA&TD-LTE mode; 3. Support software upgrade and rollback of multi-mode base station of GSM/TD-SCDMA/TD-LTE network at the same time; 4. Support the display of multi-mode	2013

	base station in OMC's topology view and highlighted from single mode base station.	
eNB/SAE-GW/MME/PCRF	1. When different users login the logical OMC, he can configure all the NEs within his rights; 2. When different user login the logical OMC, he can configure the performance job, query the performance data and statistics within his rights; 3. When different user login the logical OMC, he can manage the alarm, query the history alarm within his rights.	2013
eNB/SAE-GW/MME/HSS/DRA	1. Signaling message can be mirrored and export to a monitor port which was equipped of LTE NEs without impact the normal communication Compared with communication signaling message, the delay of mirrored and exported message on monitor ports should be less than 10ms; 2. Support O&M of the built-in monitor ports; 3. Support statistics of the mirrored data traffic; 4. Data traffic collection can be configured on each NE. Mirrored signaling message can be active/deactived and configured on logical interface of each network element; 5. Support O&M of SCA. Once SCA was abnormal, alarm should be reported at the same time.	2013
SCA	1. Support data traffic encapsulation on dedicated receive port and the traffic can be forward to servers of shared layer; 2. SCA can implement and forward one or multi-copy encapsulated data traffic at the same time;	2013

	3. SCA can forward data to the shared layer with DDN or IP network; 4. SCA can forward data to the shared layer with both UDP and TCP; 5. SCA can monitor and diagnose the running status of the port and related NE. An error message should be forward to OMC when port failure, no data traffic, or link failure occurred; 6. Data traffic statistics of each port can be reported by SCA. Peak and average traffic of each import and export ports should be included in the statistics; 7. Support timing synchronization.	

13. Emergency Service

Network Element	Technical Requirements	**Time Table**
UE	Support EPC Emergency Attach and PDN Connection.	2014
UE	Support IMS Emergency Register.	2014
UE	Support of Emergency Call after MME sending Emergency Number List to UE(UE could save Emergency Number List issued by MME)	2014
UE	Support of mapping the Category in URN from P-CSCF to the Category in MSC; Support of mapping the Category in Emergency Number List from MME to the Category in MSC.	2014
MME	1. Support of identification Emergency Call by Emergency PDN Connection. 2. Support of SRVCC indication to eMSC by Sv interface.	2014
MME	Support of Emergency Configuration Data, including: Emergency APN, Emergency Number, Emergency QoS, and so on.	2014
MME	Support of sending Emergency Number List to UE.	2014
DRA	The function of addressing and session binding of Gx interface should support Emergency APN.	2014
S/P-GW	Support of notification whether network could support Emergency PDN Connection when UE attach normally.	2014

S/P-GW	Support Emergency Attach and PDN Connection.	2014
E-CSCF	1. Support of getting the information of nearest Emergency Center by querying LRF. 2. Support of the route to Emergency Center.	2014
LRF	1. Support of providing users' location information. 2. Support of mapping users' location information to the information of nearest Emergency Center.	2014
EATF	Support of SRVCC of Emergency Call as signaling anchor point.	2015
P-CSCF	Support of notification to UE by 380 response when UE un-recognize Emergency Number.	2014
P-CSCF	Support of getting TAI by Rx interface.	2014
P-CSCF	Support IMS Emergency Register.	2014
ENUM	Support of the analytic data configuration of E-STN-SR.	2014
I-CSCF S-CSCF HSS	Support IMS Emergency Register.	2014
MSC	Support of E-STN-SR configuration; Support of using E-STN-SR according to the indication of MME when SRVCC occurred.	2014
MSC	Support of Emergency Category configuration.	2014
eNB	Support of broadcasting whether network permits UE initiating Emergency Call without USIM cards.	2014
eNB	Support of Emergency RRC Connection and relevant scheduling of resources.	2014

Annex 2：Abbreviations

ANR	Automatic Neighbor Relation
APN	Access Point Name
AS	Application Server
ATCF	Access Transfer Control Function
ATGW	Access Transfer Gateway
BBU	Baseband Unit
BF	BeamForming
BGCF	Breakout Gateway Control Function
CCE	Control Channel Element

CoMP	Coordinated Multiple Point
CQI	Channel Quality Indicator
C-RAN	Cloud-Radio Access Network
CSFB	Circuit Switch Fall Back
DRA	Diameter Relay Agent
DRX	Discontinuous Reception
EATF	Emergency Access Transfer Function
E-CSCF	Emergency Call Session Control Function
eNodeB	Evolved Node B
EPC	Evolved Packet Core
eSRVCC	Enhanced Single Radio Voice Call Continuity
E-STN-SR	Emergency Session Transfer Number for SRVCC
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
FTP	File Transfer Protocol
GSM	Global System for Mobile Communications
HLR	Home Location Register
HSS	Home Subscriber Server
IBCF	Interconnection Border Control Function
IM-MGW	IP Multimedia Media Gateway
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IRC	Interference rejection combining
ICIC	Inter-cell interference coordination
IP	Internet Protocol
IPX	IP eXchange
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
LRF	Location Retrieval Function
LTE	Long Term Evolution
MAC	Media Access Control
MBSFN	Multimedia Broadcast Multicast Service Single Frequency Network
MDT	Minimization of Drive Tests
MGCF	Media Gateway Control Function
MIMO	Multi Input Multi Output

mFBI	multiple Frequency Band Indicator
MME	Mobility Management Entity
MR	Measurement Report
MS	Mobile Station
MSA	Multi-Stream Aggregation
MSC	Mobile Switching Centre
MSISDN	Mobile Subscriber International ISDN/PSTN number
NFC	Near Field Communication
OCS	Online Charging System
ODB	Operator Determined Barring
OMC	Operation Management Center
OMR	Optimized Media Routing
OTA	Over the Air
OTN	Optical Transport Network
PCC	Policy Charging Control
PCEF	Policy and Charging Enforcement Function
P-CSCF	Proxy-Call Session Control Function
PCRF	Policy and Charging Control Function
PDCCH	Physical downlink control channel
PDN	Packet Data Network
PDP	Packet Data Protocol
P-GW	PDN Gateway
PTN	Packet Transport Network
QoS	Quality of Service
RAT	Radio Access Technology
RLC	Radio Link Control
RoHC	Robust Header Compression
RRC	Radio Connection Control
RRU	Remote Radio Unit
RSRP	Reference Signal Received Power
SCC AS	Service Centralization and Continuity Application Server
SIP	Session Initiation Protocol
SGSN	Serving GPRS Support Node
STP	Signal Transfer Point

SPS	Semi-Persisting Scheduling
SRVCC	Single Radio Voice Call Continuity
TD-SCDMA	Time Division-Synchronous Code Division Multiple
TRF	Transit and Roaming Function
TrGW	Transition Gateway
TTI	Transmission Time Interval
UE	User Equipment
UI	User Interface
UICC	Universal Integrated Circuit Card
USAT	USIM Application Tool kit
USIM	Universal Subscriber Identity Module
UTRAN	UMTS Terrestrial Radio Access Network
VoLTE	Voice over LTE
VPN	Virtual Private Network
XCAP	XML Configuration Access Protocol
XML	Extensible Markup Language