中国移动通信
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VoLTE White Paper

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China Mobile

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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 TD-LTE equipment industry towards achieving China Mobile's TD-LTE needs.

This white paper focuses on technical requirements in the timeframe from 2013 to 2014. 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.

In order to meet the VoLTE service requirements, China Mobile seeks to achieve,

[1] Not considered as purchase guarantee.

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 mid-2014**.

3. Relevant Requirements for VoLTE-oriented TD-LTE

3.1 General Overview

Currently, China Mobile's end-to-end TD-LTE network equipments and terminals are 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), B40 (2320-2370MHz) and B41[2] (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 and 3:9:2; for B39, other special subframe configurations e.g. 6:6:2 are also considered for co-existence with TD-SCDMA system on adjacent bands.
- **Synchronization**

[2] B38(2575-2615MHz) overlaps with B41(2575-2635MHz), and the frequency range listed for B41 is a prediction of spectrum allotment by the government in 2014.

- 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 eNode B should be able to interwork with the opened X2 interface. Load balance should be supported between single vendor's eNode Bs or different vendor's eNode Bs (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 coverage extension or capacity enhancement.

(1) Outdoor coverage

8-path eNB is the mainstream for outdoor coverage due to the advantage on coverage and throughput performance. Wireless Relay can be used in addition to Micro eNBs to further enhance deep coverage while reducing the efforts on construction.

(2) Indoor coverage

Multiple solutions can be adopted to provide indoor deep coverage, for example indoor distributed antenna system, Pico eNB 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 systems. Additionally, components and antennas of distributed indoor systems should be able to work up to 2.6GHz band, and indoor cross-polarized antennas should be deployed where appropriate.

Enhanced algorithms e.g. power boosting of common reference signa (CRS) and link adaptation for downlink control channel (PDCCH), should be introduced to guarantee 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 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 a C-RAN (cloud RAN).

(1) Co-site construction

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.

- **Upgrade from existing equipment**: 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 combination of 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 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 supporting 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 interference mitigation

B39 TD-LTE equipment should consider interference with systems like LTE FDD, GSM1800 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 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.
- 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 MU-MIMO, DL dual-stream beam-forming (TM8) and downlink multi-user beam-forming), carrier aggregation (40MHz B40/B41 intra-band CA and B39+B41 inter-band CA), uplink SU-MIMO and CoMP to improve network performance. It is required that:

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

Converged development of TDD and FDD LTE is important for the whole industry including operators and suppliers. Cooperated TDD and FDD networks can operate same as sigle-mode with multi-band like GSM 900/1800. 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.

- 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: broadband dual-path antennas with embedded or external combiner can be adopted to realize deployment with shared antenna and feeding.

3.3 Core Network Aspects

3.3.1 Converged EPC Core Network

The objective of EPC is to realize fully converged core network step by step 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.

(2) Requirements for VoLTE

- P-GW should support the P-CSCF discovery function allocating P-CSCF address to UE;
- 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.

3.3.2 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 domain selection function for the call originated from Circuit Switch domain, and support 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.

3.3.3 IMS Supporting VoLTE/eSRVCC

The call control of VoLTE is provided by IMS network, which cooperates with EPC network and CS network to provide voice continuity for VoLTE:

- P-CSCF/SBC should support ATCF/ATGW functionalities, which can anchor and

switch voice media from EPC to Circuit Switch network;

- 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 interact with EPC network via the Rx interface, to guarantee end-to-end VoLTE QoS by applying PCC architecture.

3.3.4 DRA

To apply policy control and Diameter signaling routing for VoLTE and LTE data services, DRA should support the following functionalities:

- Session binding between Gx interface and Rx interface by differentiating services, e.g. VoLTE or data service;
- Synchronization of session binding information between paired DRAs (the binding information including: IMSI, MSISDN,IP address, APN, PCRF address and Session ID);
- Signaling addressing for Diameter interfaces including EPC Diameter (S6a), PCC Diameter (Gx/Rx) and IMS Diameter (Cx/Sh).

3.3.5 Circuit Switch Network

Circuit Switch network should support eMSC functionality to provide eSRVCC handover procedure via the Sv interface and IMS session transfer invocation.

3.3.6 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.

3.3.7 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/charaters 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 FDD LTE, TD-LTE, TD-SCDMA, WCDMA, GSM should be supported by China Mobile TD-LTE terminals, which are divided into the basic type and the enhanced type: the basic type terminal should support 5 modes and 10 bands, the enhanced type terminal should support 5 modes and 12 bands. Furthermore, terminals with other multi-mode and multi-band capabilities can be introduced to meet the market needs.

Supporting the Band41（2496-2690MHz）is mandatory for TD-LTE terminals in 2014. If the terminal support Band 41 without Band 38, it must comply with the 3GPP TS36.331 R8.H.0 and later versions, while for the terminal with both Band41 and Band38, it is not needed to support the 3GPP TS36.331 R8.H.0 version.

The terminal needs to support the special subframe optimization, inter-frequency measurement and mobility with the same or different subframe configurations on different carriers, and the frequency mutual identification via mFBI.

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) Functional requirements for wireless in terminal

- Radio protocol version based on R10;
- Support radio bear combination for VoLTE service (including high definition voice call and high definition video call);
- Support interoperation from LTE to GSM via eSRVCC, correlation measurement and eSRVCC capability report;
- Other functional requirements that will keep the consistence with those of the RAN side.

(2) Functional requirements of SIP-IMS in terminal

- Support the standard SIP/IMS protocol, guarantee inter-working with the global IMS networks;
- Support the dedicated APN settings and multi-PDN connections;

- Support the IMS authorization and authentication etc.

(3) VoLTE service requirements

- Support the QoS guarantee for end to end service;
- Support standard, HD voice call (WB-AMR codec), HD video call service (at least H.264 720P@30fps codec);
- Support emergency call, various supplementary service and SMS/MMS; and support combination with the converged communication.

(4) Miscellaneous requirements

- The VoLTE terminals supporting converged communication service should apply native integration with user dial panel, to provide audio/video call, converged message and enhance address book, etc;
- Support derivation of IMS identifiers based on USIM, if ISIM is not introduced;
- Support service management and configuration based on the Ut/XCAP interface;
- High processing performance for audio/video media codec (such as hardware codec);
- Terminal configurations for VoLTE and CSFB;
- Support IPv4、IPv6 and IPv4v6 dual-stacks.

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 MDT and intra-band (B40 and B41) CA in 40MHz bandwidth, gradually support inter-band (B40 and B41) CA in 40MHz bandwidth, support uplink 2-antennas and other LTE-A functions.

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 International Roaming Aspects

The terminal and the network should support the TD-LTE global roaming strategy, i.e., supporting outbound roamers and inbound roamers of China Mobile simultaneously.

(1) Requirements for TD-LTE data roaming architecture

- International gateway equipments, P-GW/GGSN and DNS, should support roaming for the TD-LTE user plane;
- I-DRA should support roaming for 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 dedicated APN to support Local breakout of voice media;
- IMS network should support loopback routing;
- IPX network should support IMS proxy gateway functionalities.

3.6 Operation Aspects

3.6.1 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.

3.6.2 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 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.

3.6.4 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.

3.6.5 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.

3.6.6 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 routine 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.

3.6.7 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.

3.6.8 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.

3.6.9 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.

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 (2575-2615MHz)	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 40MHz bandwidth	2013
eNB	B41 (2575-2635MHz), 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 special subframe configuration 9:3:2 and relevant optimizations for co-existence with TD-SCDMA system on adjacent bands	2014
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 eight-path 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 20% at the speed of 120km/h, and no more than 30% at the speed of 300km/h	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

（continued）

Network elements	Technical Requirements	Time Table
eNB	Support network re-selection, handover and load-balancing based on signal strength and link quality in FDD/TDD common coverage areas	2014
eNB	Supports TDD and FDD hardware and software convergence and boards of two modes can work together within the same BBU	2014
eNB	BBU supports centralized processing of signals from/to at least 18 eight-path RRU or 36 two-path RRU	2014

4. Network performance

Network elements	Technical Requirements	Time Table
eNB	RRU power efficiency ≥25%	2013
eNB	RRU power efficiency ≥30%	2014
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 inter-band (B39 and B41) carrier aggregation of 40MHz bandwidth	2014
eNB	Support multi-cell (3-sector) coordination on the same site, support UL joint reception and DL joint transmission	2014
eNB	Support uplink SU-MIMO i.e. uplink dual-stream	2014
eNB	Support downlink two-user MU-MIMO, i.e. to streams per user	2014

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

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Network elements	Technical Requirements	Time Table
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 and IPv6	2014
eNB	Support of SPS fucntionality	2014
eNB	Support of uplink TTI bundling	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
SAE GW	Support of access to IMS network, the IMS P-CSCF discovery and delivery to UE	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
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	2014
SCC AS	Support of domain selection mechanism, session transfer and maintenance and notification of session states	2014
MMTel AS	Support of telephony services and supplementary services, e.g. voice call, video call and multi-party call	2014
Converged Communication AS	1. support of converged messaging service, including converged SMS, MMS and IM, with media types as texts, picture and voice/video. 2. support of enhanced address book functions, including grouping, dynamic update and communication capability discovery. 3. support of services policy definition	2014

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Network elements	Technical Requirements	Time Table
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 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	2013
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 of RoHC	2013
UE	Support of SPS	2013
UE	Support of TTI bundling	2014
UE	Support of DRX in connected mode	2014
UE	Support of VoLTE voice call, HD voice call, HD video call, NB-AMR, WB-AMR, H.264 etc	2014
UE	Support of SMS,MMS emergency call, supplementary service	2014
UE	Support of converged communication service by applying native integration with user dial panel, to provide audio/video call, converged message, enhance address book etc	2014
UE	Support of derivation of IMS identifiers based on USIM, if ISIM is not introduced	2014
UE	Support service management and configuration based on Ut/XCAP interface	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. 4.Support of Diameter Message Processing methods defined by RFC6733	Required in 2013
DRA	Support of 3GPP Cx/Sh 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)	2014
DRA	Support of routing management, including load-sharing, backup, loop avoidance, Failover/Failback, re-routing base on error code, and Diameter nodes redundancy routing method	2013
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. 3.Support Session-binding information synchronization between a pair of DRAs when IP-CAN session being set up, modified, and deleted	2014

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 requriement: 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 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	2013

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.	2013

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Network elements	Technical Requirements	Time Table
SAE GW	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	Basic type (5 modes and 10bands): Support TD-LTE Band38/39/40, TD-SCDMA Band34/39, WCDMA Band1/2/5, FDD LTE Band7/3, GSM Band2/3/8. TD-LTE Band41 is recommended	2013
UE	Enhanced type (5 modes and 12 bands): support TD-LTE Band38/ 39/40/41, TD-SCDMA Band34/39, WCDMA Band1/2/5, FDD LTE Band1/3/7/17, GSM Band2/3/5/8. FDD LTE Band 4/20 are recommended	2013
UE	Support of Band41	2014
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 random access, HARQ/ARQ, PDCH, system information reading, DRX, cell selection/reselection/handover, paging, PLMN selection, Location registration, 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 IPv4, IPv6 and IPv4/v6	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/HSS/DRA/PCRF	1.Support connectivity detection 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	2013
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 base station in OMC's topology view and highlighted from single mode base station	2013
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

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Network Element	Technical Requirements	Time Table
SCA	1.Support data traffic encapsulation on dedicated receive port and 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. 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	2013

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
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
eNodeB	Evolved Node B
EPC	Evolved Packet Core
eSRVCC	Enhanced Single Radio Voice Call Continuity
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
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
LTE	Long Term Evolution
MAC	Media Access Control
MBSFN	Multimedia Broadcast Multicast Service Single Frequency Network
MDT	Minimization of Drive Tests
MIMO	Multi Input Multi Output
mFBI	multiple Frequency Band Indicator
MME	Mobility Management Entity
MR	Measurement Report
MS	Mobile Station
MSC	Mobile Switching Centre
MSISDN	Mobile Subscriber International ISDN/PSTN number
NFC	Near Field Communication

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OCS	Online Charging System
OMC	Operation Management Center
OTA	Over the Air
OTN	Optical Transport Network
PCC	Policy Charging Control
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
TD-SCDMA	Time Division-Synchronous Code Division Multiple
TRF	Transit and Roaming Function
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