Overview

Background—
New Challenges for Heavy Haul Railway
The application of the capacity-increasing technology on the heavy haul trains raises new challenges for railway mobile communications. Stable, reliable access to mobile communications on higher capacity trains requires larger, more reliable train-to-ground broadband to reliably extend support for existing GSM-R services and new services. Heavy haul railway safety issues, such as the need for comprehensive track monitoring, increases the load on traditional mobile telecom systems. New techniques and technologies, a new broadband telecommunications system, is needed to break through the limitations of the old system.

The Solution—eLTE
With LTE, railway operators can start shifting their dedicated wireless networks from GSM to LTE. The Huawei broadband eLTE network for heavy haul railway has high reliability, high bandwidth, short delay, and excellent mobility. It can guarantee higher capability and safer operation.
Solution & Application Scenarios

Application 1: Multi-Locomotive synchronous control to improve train capacity

The increased length of heavy haul trains results in a greater distance between locomotives. The master locomotive at the front needs to be able to communicate with the controllable tail at the back, to solve the longitudinal impulse problem of long trains. Traditional telecommunications systems are not up to this task.

- With Huawei LTE wireless system, multi-locomotive synchronization system for heavy haul trains is able to link cars over 2500m apart and can do it with less than 100ms of delay.
- The locomotive synchronization system is made up of an on-board communication unit (OCU), a controllable train-tail, a ground wireless multi-locomotive server, and an LTE network.

Application 2: Voice dispatching to increase inter-departmental efficiency

The Huawei LTE-based communications and dispatching system not only provides all of the standard voice dispatching functions of a GSM-R based system; it can also interwork with FAS to support dynamic group calls between locomotives. Voice dispatching can:

- Enhance interdepartmental efficiency between the dispatchers, various attendants, engineers, emergency workers and other related personnel.
- Provide voice dispatching services, telephone services at the station and the yard, and telephone services between stations. It supports personal calls, emergency calls, and group or conference calls.
- Include vehicle terminal CIR and handheld terminals, an FAS dispatching console, a trunking dispatching console, a trunking server, and an LTE network.

Application 3: Video surveillance and running status monitoring to guarantee operational safety

The LTE network can be used to conduct on-board video surveillance and status recording from the command center. This surveillance can assist in handling emergency situations and in making evaluations of responsibility after events.

- Real time surveillance over important roadways
- Real time on-board video surveillance
- Real time running status reporting
Multiple Levels of Network Redundancy

Secure and reliable communications are core issues for heavy haul railway telecommunications. The eLTE heavy haul broadband mobile telecom system must transmit train control signals such as synchronous control signals and controllable train tail signals. In addition, it transmits signals for dispatching commands, train number checking, and emergency calls. These services are all necessary to ensure train safety. This is why Huawei designed an LTE solution with enhanced reliability built in on three levels: network architecture, key network elements, boards and modules. They all have been designed with automated backup systems and redundancies that enhance the overall reliability of the LTE system to 99.999%.

Service Prioritization

Service prioritization ensures that when the system is overloaded, important services are preferentially guaranteed. Various LTE QoS mechanisms are implemented so that, when the network is congested, eNodebs and the evolved packet core (EPC) use mechanisms such as admission control, congestion control, and service pre-emption to ensure that high-priority services such as locomotive synchronization control, train tail control, and emergency calls remain unaffected.

Railway Voice Dispatching over IP

The LTE QoS mechanism guarantees reliability of CS services over the PS bearer, and has allowed for trunking dispatching communications performance to reach that over GSM-R, with some performance indexes even better. Moreover, it provides other railway-specific functions such as admission control, congestion control, and service pre-emption to ensure that high-priority services such as locomotive synchronization control, train tail control, and emergency calls remain unaffected.

Dual-Network Coverage

A dual network load sharing design is employed to ensure that heavy haul railway safety services are never interrupted and to double the frequency usage. When a transmission link between a UE, eNodeb, or the EPC, malfunctions, dual-network redundancy guarantees that synchronization control and train tail services continue uninterrupted. Two networks can bear voice dispatching services for different CIRs and handheld devices. In addition, the dual network design provides twice the bandwidth utilization of the traditional active-plus-standby network configuration and more robust support for network services.

Robust Network

The eLTE solution is based on advanced LTE technology, and can achieve downlink data rate of 100 Mbit/s and uplink data rate of 50 Mbit/s. The system uses the cell combination feature to reduce the total number of handovers and extend cell coverage areas. This extends the single site coverage and reduces the probability of service drops because handovers or cell reselections are not required when UEs move between the coverage areas of the RRUls. Moreover, the ability to reduce interference has improved significantly through interference rejection combining (IRC) advanced receiver technology, effectively increasing network quality.

Interworking with FAS and CTC

The connection between the PoC server and the FAS switching center provides unified dispatching between wired and wireless systems. The PoC trunking server is connected to the EPC and interconnects with the FAS through the E1 port. A handheld trunking terminal can access the LTE network, the PoC trunk server and the FAS primary systems to establish a VoIP connection between the PoC handheld terminal and the FAS dispatching system.

To guarantee safe and efficient operations, LTE for heavy haul railway flexibly adapts to the varying demands of each LTE public network with a variety of high tech solutions.
The network management system provides carrier level management for a wide range of wireless network elements, including the eNodeBs and core network (eCNS600).

- **Performance management**
- **Fault management**
- **Configuration management**
- **Security management**
- **Log management**
- **Resource management**
- **Alarm Management**

The eCNS600 is a compact EPC which integrates the functions of MME, S-GW/P-GW and HSS into only one subrack. It provides large throughput and subscriber management ability to meet railway needs.

- **Maximum subscribers:** 200,000
- **Maximum eNodeBs:** 1,500
- **Maximum throughput:** 40Gbps (1024 bytes per packet)
- **Dimensions:** 620 mm x 442 mm x 437 mm
- **Geographic redundancy, charging, roaming**

The MDS6800 is an eLTE distributed base station. It is composed of two basic modules: BBU and RRU, which can be flexibly deployed to meet diverse deployment requirements.

- **Frequency:** TD-L 14/18/3/2/3/4/3/5/8/9/7 G
- **Bandwidth:** 6/8/10/11/15/20/21/30/40/60/80/100 MHz
- **Weight:** BBU < 12 kg, RRU < 24 kg
- **One BBU supports 12 RRUs**
- **Installation mode:** Mounted on tower/wall/against wall/on rooftop

The DBS3900 is an eLTE distributed base station. It is composed of two basic modules: BBU and RRU, which can be flexibly deployed to meet diverse deployment requirements.

- **Frequency:** TD-L 14/18/3/2/3/4/3/5/8/9/7 G
- **Bandwidth:** 6/8/10/11/15/20/21/30/40/60/80/100 MHz
- **Weight:** BBU < 12 kg, RRU < 24 kg
- **One BBU supports 12 RRUs**
- **Installation mode:** Mounted on tower/wall/against wall/on rooftop

The EM350 is a Mini PCIe data module based on the TD-LTE technology, used for secondary development of terminals for customers.

- **Standard mini PCIe slot, handy adaption for PDA, Pad, video camera and other industrial devices, supports trunking and data transfer by wireless data interface**
- **400MHz/800MHz/1.4GHz/1.8GHz/3.5GHz**
- **Supports industry customized secondary development and flexible uplink and downlink timeslot ratios: 1:3, 2:2 and 3:1**

The eA660 is an outdoor LTE CPE for broadband access, featuring remote management for easy deployment of current and future broadband resources and centralized fault detection and recovery.

- **Frequency:** TD-L 18/23/26/35/37 GHz
- **Dimensions:** 280 mm x 250 mm x 90 mm
- **Ingress protection rating:** IP67
- **Working temperature:** -40ºC to 65ºC
- **Shock proof:** IEC61373 & MIL-STD-810F
- **Power consumption:** < 25W

The eH701 is a professional trunking terminal.

- **Supporting keyboard**
- **Technical standard:** LTE 3GPP Release 9
- **Size:** 140x60x35 mm (not including external antenna)
- **Weight:** ≤ 360g with battery
- **Working temperature:** -25ºC to +60ºC
- **Battery:** Li-ion, 3.7V, 4000mAh
- **Peak power consumption:** < 4W

**Products**

- **Core Network**
  - eCNS600

- **Base Station**
  - DBS3900

- **CPE**
  - eA660

- **Mini PCIe Data Module**
  - EM350

- **Network Management System**
  - M2000/U2000

- **Application Server**
  - MDS6800

- **Handheld Terminal**
  - eH701
The nearly 600-km long Shuohuang Railway is the longest heavy haul railway ever constructed by the Shenhua Group, the world’s largest coal supplier and a Fortune 500 company. In order to service the Chinese economy’s demand for coal, the Shuohuang Railway must see an increase in annual transportation capacity to 350 million tons, meaning the capacity of a single train trip needs to increase from 5,000 tons to 25,000 tons. Operating such huge, heavy haul trains requires synchronization between multiple locomotives. Meanwhile, the controllable train tail must be jointly acted with locomotive braking to solve the longitudinal impulse problem of heavy haul trains. This extends the communication distance requirement between the master and slave locomotives to over 2,500m. The existing analog communications system cannot meet this requirement.

With wide coverage, short delay, and high bandwidth, the Huawei eLTE solution for the Shuohuang Railway uses a TDD LTE network to successfully implement multiple-locomotive control over the 25,000-ton trains, extending transmission distance and reducing latency. To achieve high levels of reliability, the Huawei eLTE network provides a fully redundant solution to ensure 99.999 percent system availability. Innovative dual-network coverage and multiple-priority QoS mechanisms contribute to preventing any interruptions in railway operations. Meanwhile, the Shuohuang Railway has also achieved whole-line dispatching and driver room video surveillance, significantly enhancing dispatching efficiency and operational safety. The successful application of Huawei’s eLTE system in the Shuohuang railway is an innovation in the field of heavy haul rail communications, and serves as a role model in both China and the world for the development and operation of heavy haul rail.

Cao Yanping  
Deputy General Manager of Shuohuang Railway Development Co., Ltd.

Voice of the customer

“The LTE network has established a good foundation for the future transportation capacity of more than 350 million tons, along with enhanced communication and network security.”

World’s First LTE Network in a 25,000-ton Heavy Haul Train