UAccess

MF-TD-SCDMA Technology for Train Traffic Control Services

Solution overview

Date: 14th November 2013

Introduction

UAccess MF-TD-SCDMA solution offered by UAB Rigma, is a new generation broadband wireless access technology, which adopts the state of the art features such as CS-OFDMA, smart antenna, spatial nulling and joint detection.

MF-TD-SCDMA has many advantages, such as: wide coverage; high data throughput; flexible deployment; operation and maintenance simplicity; high-speed mobility support; voice/data, video and multimedia services support. Railway with its first appearance in 1820, through the development of more than a century, has become the leader in today's world transportation, fulfilling most of today's world tasks of passenger and cargo transportation.

At present, more than 100 countries around the world totally have built as long as 1.2 million kilometers of railways and the length of railroad is increasing continuously. However, operation of most of railways system remains at the phase of voice plus "pen and paper" level, manual switch/pull and turnover/signal control.

It significantly restricts the improvement of the efficiency, capacity, management and services of transportation. To meet such increasing requirements of economy development, there is a great demand for the telecommunication reform in dispatching, command, control, communication, and service of railways. MF-TD-SCDMA wireless broadband multimedia system provides an innovative solution of the global railways telecom system upgrade.

Technology overview

UAccess network provides high-speed data and voice services to both fixed and mobile users in NLOS environments.

Thanks to the advanced technologies, the system offers large coverage, high spectrum efficiency (up to 15 Mbps / 5MHz), an efficient combination of high speed and low speed services, low cost terminals, and support of high mobility applications and N=1 deployment.

The network is ideally suited to cover all usage scenarios including voice, broadband data, multimedia and trunking under fixed, portable and mobile conditions. With the advantages of integration of broadband and narrowband services, low cost and flexiblity, the UAccess network can be deployed rapidly and efficiently for both public and industrial users

Standard

"UAccess" network is based on TD-SCDMA, one of the three international 3G mobile communication standards (ITU-R M.1801-11, in Annex 7 for wireless access, April 2010). Its significant advantage is spatial division multi-access (SDMA), which makes TD-SCDMA superior to

the conventional CDMA. UAccess network solution is based on technology developed by Xinwei Telecom Enterprise Group.

Innovative technology - highlights

TD-SCDMA uses TDD, in contrast to the FDD scheme used in W-CDMA networks. By dynamically adjusting the number of timeslots used for downlink and uplink, the system can more easily accommodate asymmetric traffic with different data rate requirements on downlink and uplink than FDD schemes.

Since it does not require paired spectrum for downlink and uplink, spectrum allocation flexibility is also increased. Using the same carrier frequency for uplink and downlink also means that the channel condition is the same on both directions, and the base station can deduce the downlink channel information from uplink channel estimates, which is helpful to the application of beam forming techniques.

TD-SCDMA also uses TDMA in addition to the CDMA used in WCDMA. This reduces the number of users in each timeslot, which reduces the implementation complexity of multiuser detection and beam forming schemes, but the non-continuous transmission also reduces coverage (because of the higher peak power needed), mobility (because of lower power control frequency) and complicates radio resource management algorithms.

In TD-SCDMA networks the uplink signals are synchronized at the base station receiver, achieved by continuous timing adjustments. This reduces the interference between users of the same timeslot using different codes by improving the orthogonality between the codes, therefore increasing system capacity, at the cost of some hardware complexity in achieving uplink synchronization.

"UAccess" network can easily interface with the Next Generation Networks (NGN) and offer various rich features and services. Also, the system offers quality of service (QoS) to different types of traffic and grade of service (GoS) to different kinds of users. In comparison with the popular WiMAX system, "UAccess" network provides for significantly larger coverage, lower cost terminals, better tackling of multipath fading problem, and higher efficiency and higher reliability for supporting narrowband traffic such as voice.

Most importantly, WiMAX has difficulty in supporting N=1X1 deployments and require at least 3 bands to form a reliable network. On the other hand, "UAccess" is designed to work in those (N=1X1) hostile environments thanks to the superb interference cancellation capability and the special design of the frame structure and dynamic channel assignment schemes.

Since the Since spectrum in most cases is a limited resource and spectrum consumption of data services is significantly higher than voice services, N=1 deployment, i.e., network deployment with one frequency band, is critically important to wireless broadband access. If all base stations operate in one frequency band, there is always serious intercell interference in both uplink and downlink.

One of the key technologies utilized within "UAccess" network is smart antennas. The network provides two kinds of beams: the broadcast beam and the service beam. The broadcast beam is implemented in broadcast time slot and broadcasts to the whole cell. So it is required to have a broad beam to cover the cell seamlessly. In this case, its cell coverage is the same as that implemented by the antenna of GSM and CDMA of 2G systems.

The service beam is set up when the communication link built up and used to track the user. In this case, a very narrow beam will be produced for every user and varies with the position change of the user. Due to the fact that the beam is very narrow, the signal power will be concentrated in the direction towards the user, thus the smart antenna can enhance the signal on the user side by 3~8 times with the same transmit power, meanwhile decrease the interference from users in other direction by tens time.

For the focused signal power, the transmitter can decrease the transmit power, so the smart antenna is a good choice to save power, and it can be called a real “green antenna”. As it can produce the broadcast beam and service beam as required, and also the service beam can track the moving of the user and adjust the transmit power.

Main features

Services: Mobile communications, Internet, PTT, Data & Video Surveillance

Throughput:

- 15 Mbps at 5 MHz base station bandwidth
- 120 concurrent voice calls
- 20 concurrent PTT groups

Coverage: up to 70 km, NLOS, low band in rural areas
SINR Coverage: 26 dB in most coverage, suitable for 64 QAM; Breath & edge fading negligible
Co-frequency network: Common frequency networking (N=1 network) keeps over 85% capacity
Terminals: Plenty of long time commercialized terminals
Trunk Radio: Better than or equal to Tetra specifications except mobility
Mobility: 80-200 KM/H, 3.5 GHz to 300 MHz; Make Before Break
Video Conference: Without channel blocking
Typical BTS Planning: 8.1 Mbps down + 2.7 Mbps up + 40 phones + 10 PTT groups
Typical cell coverage: 1-3 km in the city; 8-13 KM suburban; 5-50 km, rural

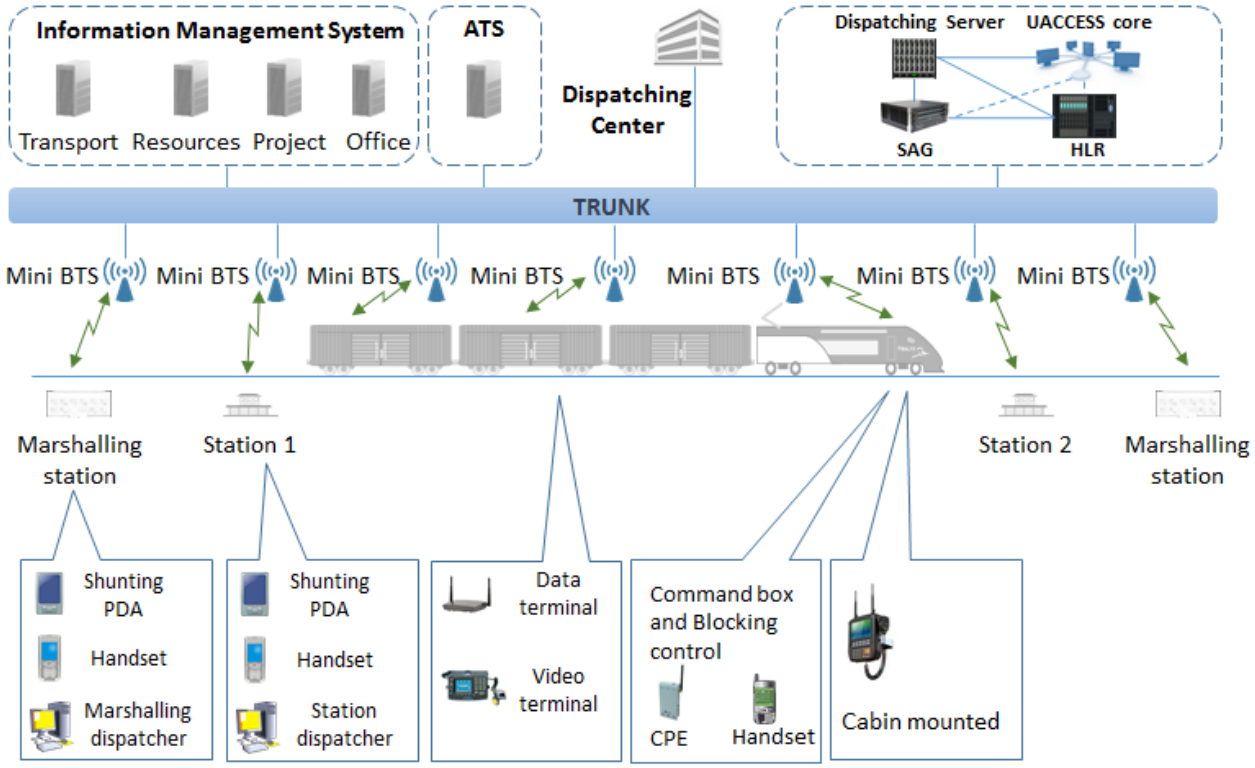
Users planning per BTS:

- 400 mid-level Internet users
- 800 phones
- 30 PTT groups

MF-TD-SCDMA Solution for railways

MF-TD-SCDMA provides a variety of functions for railway operations including online monitoring, management and scheduling. MF-TD-SCDMA can improve the stability and reliability of operation and increase transportation capacity and the ability to handle emergency incidents.

System structure



As shown above, MF-TD-SCDMA network is the basement of operation, management and dispatch platforms; it is a layer for the whole processes. The main functions include wireless control and dispatching, video surveillance, station and train management, communications among locomotives and stations, mobile office support and command automation.

Unified Service Platform

System consists of several IP application platforms. Their functions include the railway transportation management, resource management, production management, dynamic monitoring, etc. Servers and databases are used for IP addresses allocation, users' access control management, information exchange among railway departments. Application platforms have service-oriented architecture (SOA) that consists of monitoring system, emergency command management and scheduling, control of subsystems. The platform is modular designed and can be easily configured by operators. Traditional approach to management and system control has been completely changed by MF-TD-SCDMA technology implementation. Its model pushes up all kind of train service information to the terminal; the railway staff is being kept informed of railway conditions and has access to information at any time and from everywhere.

MF-TD-SCDMA communication platform

Core platform, including Signaling Access Gateway (SAG) and value added services equipment, functions as the interface unit for voice services with public exchanges. Its network management platform manages and monitors the network equipments (base stations and terminals).

Radio Access platform includes MF-TD-SCDMA base stations (BTS) and terminals.

MF-TD-SCDMA has several options of base station types, such as:

- Macro stations,
- Micro base stations,
- Repeaters.

Wide choice of base station meets requirements of different terrain conditions.

MF-TD-SCDMA terminals are:

- PDA,
- Vehicle-mounted terminals,
- Handsets,
- Embedded communications modules,
- Customer Premises Equipment (CPEs).

Applications

Train tail device communication

When locomotive is moving, its rear pressure is a guarantee of traffic safety. Air pressure devices and the locomotive instruction boxes keep communication by means of MF-TD-SCDMA. Drivers control exhaust pressure locally or remote system checks pressure through the tail box – in case of troubles the tail execution unit must feedback immediately. Train tail equipment keeps communication by MF-TD-SCDMA with center command computer and pressure value is being monitored by operator on the screen.

Moving block

Information of the front moving train should be sent via control system to the following trains; that control information is being continuously generated. Equipment on train and on the station or control center exchanges information through MF-TD-SCDMA and make in such way the speed control. Central Station Monitor represents online current locations of all locomotives, their status and state parameters in the form of electronic map.

Wireless Dispatching

MF-TD-SCDMA group and peer-to-peer voice calls provide communication between dispatcher (Station Attendant) and drivers (known as big Triangle Communications), or among Station Attendant - drivers - conductor (known as the small triangle communications). The dynamic call addressing, supported by system, simplifies call establishment and reduce the error probability.
Dispatcher calls specific drivers remotely, accepts and identifies the incoming calls, or sets call up (or transfer data) for all drivers on scheduling basis. In case of needs locomotive drivers are able to make emergency call to the dispatcher.

Wireless Video Surveillance

- ✧ Train Dynamic Monitor: surveillance cameras installed on train monitors wirelessly the moving trains' status and equipment in the control room in real time.
- ✧ Rail way Condition Monitor: Capturing and transferring the real-time video via wireless terminals to the moving train and the control center. The observed distance range of drivers can be greatly extended.
- ✧ Emergency Relief: By wireless video operator is able to observe the scene of emergence occurred and that way improves the relief more efficiently.

Train dynamic online tracking

Dynamic remote wireless monitoring of locomotive and drivers in the whole driving process effectively prevents and reduces unnecessary stacking, locomotives fires, incidents. The stored video files also provide evidence to help analyzing reasons of troubles further.

Communication between train and station

Data exchange on moving the train such as real-time cargo information, shunting command can be transmitted to the station wirelessly. Control center accordingly is able to send the information through MF-TD-SCDMA to the trains back.

Railway station remote wireless control advantages.

1. Man-machine integration and real-time scheduling.
2. Data instructions dispatching replaces the old voice-oriented dispatching.
3. Transportation operations become visualized, wireless and digitalized.
4. Wireless video can provide visual information for disaster prevention and gives more safety for the staff.
5. Online surrounding monitoring and locomotive location tracking.

Wireless internet access services for residents along railway

MF-TD-SCDMA provides broadband multimedia telecommunication applications, such as voice, data, and real-time video transmission. From other side MF-TD-SCDMA not only satisfies the railway needs, but also provides wireless access to internet for residents on trains or along railway. Therefore the railway gains an extra value.

Features and advantages of MF-TD-SCDMA solutions

System Features and Advantages

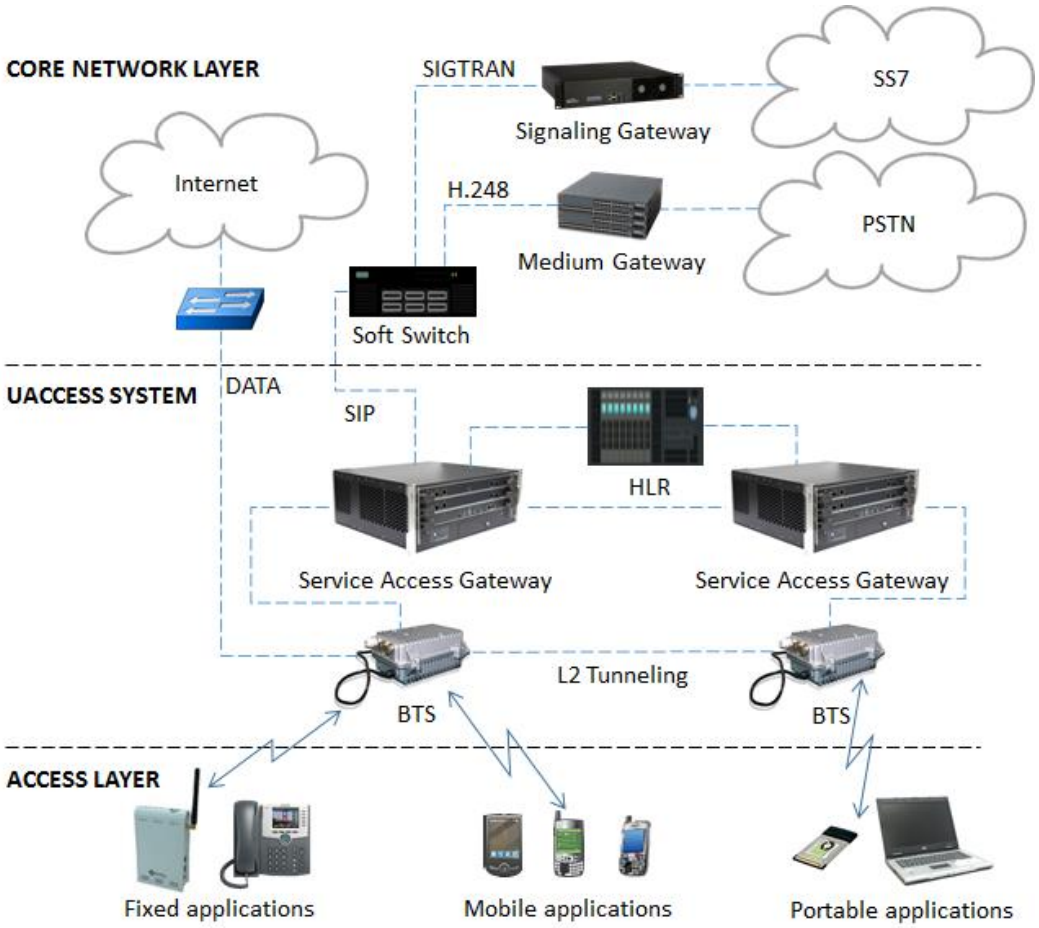
- Large coverage radius. Single BTS covers distances up to 30 ~ 50km in LOS conditions.
- High system capacity. Single BTS throughput is 5-8 Mbps (depends on real environmental conditions0.
- Services supported in move at speed up to 200 kmph. (Threshold can be increased on demand).
- Voice, data and video services support.
- Due to MF-TD-SCDMA IP network nature it is easy to integrate system with other IP based solution or/and extend.
- MF-TD-SCDMA can be integrated with existing railway network such as TETRA.
- System frequency and applications customization according to the requirement of railway demands.
- Wide range of terminal types and applications.
- One platform - many applications. Less investment and better performance/price ratio.
- Carrier-class reliability and high commercial key parameters identity (KPI).

Comparison of UACCESS MF-TD-SCDMA and TETRA

Item	MF-TD-SCDMA	TETRA
Air Interface Protocol	MF-TD-SCDMA	TETRA
Push To Talk	Supported	Supported
Simultaneous Group Call on one BTS	20	4
Simultaneous Individual Call on one BTS	100	4
User Numbers in One Group Call	Unlimited	Unlimited
Peek Net Throughput for Packet Data Service	15Mbps (in real conditions 5-8 MBps)	7.2kbps@1 slot/28.8kbps@4 slot
Ready to Speak (Call Set Up)	≤500ms	≤500ms
Start to Speak (PTT Set Up)	≤200ms	≤300ms
Broadband Data Service	Supported	Not Supported
Multimedia Service	Supported	Not Supported
Video	Supported	Not Supported
Video Surveillance	Supported	Not Supported
Short Message Service	Supported	Supported
Group Call	Supported	Supported
Call Initialized by Dispatcher	Supported	Supported
Call Dropped by Dispatcher	Supported	Supported
Call Interception/Monitor by Dispatcher	Supported	Supported
Emergency Call	Supported	Supported
Call Prioritization	Supported	Supported
Call Time-limited	Supported	Supported
Busy Queuing	Supported	Supported
Late Entry	Supported	Supported
Call Group Scanning	Supported	Supported
Broadcast Call	Supported	Supported
Individual Call	Supported	Supported
Conference Call	Supported	Supported
Voice Encryption	Supported	Supported
Talking Party Identification (Group ID/Calling ID)	Supported	Supported
Terminal Status Presentation	Supported	Supported
Calling line Identification Presentation	Supported	Supported
Called line Identification Presentation	Supported	Supported
Dynamic Group Call Channel Assignment	Supported	Supported
Dynamic Group Number Assignment (DGNA)	Supported	Supported
Wireless VPN	Supported	Supported
Fail-Soft Mode	Supported	Supported
Direct Mode Operation (DMO)	Supported	Supported
Inter-System Interface	PSTN/ISDN/PABX /PLMN/NGN	PSTN/ISDN/PABX /PLMN/NGN
Roaming	Supported	Supported
GPS and Location Based Service	Supported	Supported
Frequency Band Customization	Flexible	Not Good

System Equipment

Topology



Mini BTS

Parameter		Index
Frequency range		**The following frequency bands are available:** • 400-430MHz; • 700 MHz; • 1785 MHz-1805 MHz; • 2150-2180MHz; • 2525-2560MHz; • 698-746MHz; • 2400-2483.5MHz; • 3300-3500MHz; • Other frequencies are available on demand.
RF bandwidth		1MHz x N（N＝1，2，3，4，5)，the maximum RF bandwidth is 5MHz
Max RF output power		+33 dBm
Receiving sensitivity		-110 dBm
Duplex mode		TDD, downlink and uplink timeslot ratio is adjustable
Connection of RF system		Direct coax cable interconnection with antennas, cable losses – lesser than 1 dB
Power supply		DC-48V / DC+24V / AC220V
Power consumption		The maximum:120W, average: 40-50W
WAN interface	Communication control card	Corresponds UNI3.1, Bridge RFC2684(LLC，SNMP)
	IP	10/100M Ethernet, 802.1d（bridge), 802.1p/Q(VLAN), ARP agent(RFC1027), SNMP(RFC1157), Mobile IP(RFC3344) Dynamic access control list
Calibration		manual and automatic (on predefined schedule) adjustments
Software upgrade		Local or Remote software upgrade via EMS system
Application design		All the boards can be inserted and pulled out (swapped) at anytime
BTS enclosure		Fully outdoor solution
Weight		8 kg
Operating temperature		-40～+50
Storage temperature		-60～+70

Antennas

Typical antenna parameters

Type of antenna array	Omni-directional 360 degree antennas (two)， panel - 65-90 degree antennas
Frequency band	On customer requirements, typical bands are 1800 and 400 MHz
Diversity	X or space with vertical polarization
Tilting	2°~4° (electrical or mechanical)
Antenna gain	Omni-directional: 9-11.5dBi， Panel antenna: 14-18 dBi
Vertical plane lobe width	Omni-directional: 7.5 degree，Panel：5 -7 degree
Installation fixture	Diameter 11.4cm vertical bar
Operating temperature	-40～+50
Storage temperature	-40～+70
humidity	Any

SAG (Service Access Gateway)

MF-TD-SCDMA core network equipment supports hybrid voice and data network deployment, providing the user service information management, terminal authentication and management, base station management, mobility and handover management, roaming and many other functions.

Signaling Access Gateway is one of the main structure nodes; management can be realized in several options - locally or through the IE browser, without a dedicated client. SAC network management features include SAC configuration management and fault management.

Dispatcher

As the man-machine interface and the client of dispatch control system, dispatchers can originate dial call, group call, data broadcasting and user state monitoring.

Terminals

Terminal for trains

CPE type	QRt-4
Freq. band, MHz	1785-1805; 330-350 (others are on demand)
Max. throughput	1.8 mbs
Battery backup	6 hours
Antenna type	Omni, 2-5 dBi
Services supported	Dial voice, Data, video
Features	DHCP server, VLAN support, NAT function
Qty of Ethernet ports	4
Encryption	AES 128/256
Weight	1.8 kg

Mobile terminals and CPE options

System Roadmap

Today - MF-TD-SCDMA Version 6

Core Technologies： MF-TD SCDMA technology, multicasting, Smart Antenna, CS-OFDMA, software defined radio, spatial nulling, dynamic channel allocation, QoS/GoS support, Make-Before-Break (MBB) handoff, adaptive modulation (up to 64QAM)

Main Services： Fixed, portable and mobile voice and data communications, trunk radio

Main Products： 5MHz BTS, SAG/HLR, single/dual-mode handsets, USB-modem, desktop 1MHz CPE, and 5MHz super CPE

Main Capabilities： Support up to 15Mbps, N=1 deployment, roaming, voice & data handoff, asymmetric TDD, interfacing with NGN, multimedia multicasting

Under R&D - Version 7

Core Technologies： MF-TD-SCDMA V6 core technology, SDMA/MIMO

Main Services： Mobile voice & data

Main Products: Full V6 product support, 10-20MHz channel BTS, 10-20MHz MIMO terminals

Main Capabilities: MF-TD-SDCMA V6, MIMO, SDMA, up to 120Mbps throughput for 20MHz BTS