TD-LTE Industry Briefing

March 9, 2017| No. 29

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Contents

GTI Held Workshop and Roundtables in Japan, Shifting to the GTI 2.0

The 17th GTI Workshop took place during Nov. 28-29, 2016 in Osaka, Japan, gathering more than 100 industrial leaders and experts from over 20 operators and 30 industrial partners and organizations to share the latest progress and discuss key issues as 4G evolves towards 5G, such as Massive MIMO and Uplink Enhancement, and innovative applications on cloud robot and Internet of Things.

Unlike previous ones, this workshop placed a strong focus on 5G including requirements and strategies on service development, standardization, networking, device and commercialization, and industrial opinions on feasibility and complexity of implementation options. Besides, GTI Secretariat proposed new scheme of technical work for GTI 2.0, underlining principles of goal-oriented and concrete deliverables, triggering more active involvement of operators and industrial partners.

Moreover, prior to the workshop, GTI hosted two roundtables on Connected Car and Cloud Robot on the Nov. 25th in Tokyo, which brought together cross-industry partners and triggered productive discussion how to collaborate for innovative services and applications in 5G era.

GTI Technical Work Refined to Gear up for the GTI 2.0

Motivation

- As a TDD camp, GTI needs to take **more concrete actions** to promote 4G evolution and 5G where TDD will play a significant role
- With strong focus on industrialization and commercialization, to unleash stronger synergy to benefit the whole industry, GTI needs **more active participation and contribution** from all partners
- GTI needs to be **goal-oriented** and with concrete deliverables to ensure the continuous development of the industry

Principles

Goal-oriented

- Programs, projects and tasks are all goal-oriented and need to be carried out with clearly defined objective, scope, plan and output

More than workshops

- Besides workshops as regular F2F meetings, we encourage more interaction (con-call, email…) periodically to keep pushing forward technical work

Concrete deliverables

- To ensure progress in industrial development, we expect tasks to create deliverables of types such as whitepapers, reports, prototypes, products, trials, showcases and etc.

Methodology

- Set up **Programs** to reflect GTI's focused areas
- Create **Projects** within programs to address key topics
- Break down projects into **Tasks** that produce deliverables and are assigned to one of the Working Groups (Network, Terminal, Spectrum, B&S)
- Program **Coordinators**, project and task **Leaders** to collaborate with WG chairs for concrete deliverables

GTI Technical Work Structure (e.g.)

	Program 1 4G & Evolution				Program 2 5G eMBB			Program 3 IoT	Program 4 IoV	Program 5 Cloud Robot	…
	Project 1: Massive-MIMO	Project 2: UL Enhancement	Project 3: VoLTE	…	Project 1	Project 2	…				
Spectrum WG	Task-s 1.1	Task-s 2.1	…	…							
Network WG	Task-n 1.2	Task-n 2.2	…	…							
Terminal WG	Task-t 1.3	Task-t 2.3	…	…							
Business & Service WG	Task-b 1.4	Task-b 2.4	…	…							

4G Towards 5G – TDD Spectrum Workshop Successfully Held in Bangkok, Thailand

On the afternoon of Nov. 14th in Bangkok, Thailand during ITU Telecom World 2016, 4G Towards 5G – TDD Spectrum Work shop was jointly hosted by ITU, GTI, China Mobile and TDIA, to promote a wider development space for TD-LTE, facilitate global spectrum harmonization and innovative spectrum utilization.

Top leaders and experts from ITU, MIIT, OFCOM, GSMA, GSA, China Mobile, True, TOT, Huawei, Nokia, ZTE, Ericsson and other leading organizations, operators and industry partners gathered together to share their views on TD-LTE global status and new business opportunities, as well as future spectrum allocation. In depth they discussed on the role that TDD plays in 5G, TDD spectrum planning and allocation at the global level and future spectrum strategies towards 5G.

The massive commercialization of TD-LTE have proofed the advantage of TDD technology adequately, which lays a solid foundation for 5G. Firstly, TDD can utilize the spectrum more efficiently, which better meets the need of extreme broadband in 5G era. Meanwhile, the application of TD-LTE Massive MIMO, as a footstone of 5G, deployed together with other advanced technologies in 4G network will provide sufficient capabilities of serving dramatic increase of data traffic.

Being successfully held, the workshop contributed as an important platform to promoting TDD development and its evolution to 5G as well as global spectrum harmonization.

V2X Workshop

The V2X Workshop was jointly hosted by the NGMN Alliance and GTI in Frankfurt, Germany on Oct. 11th, 2016, aiming to establish the dialogue across telco industry and automotive industry on V2X and to drive the development and success of V2X.

Top industry leaders and experts from China Mobile, Deutsche Telekom, Vodafone, TIM, Nokia, Huawei, Audi AG, Volkswagen, BMW, Toyota, Continental, Bosch, Savari and other leading international companies in the field of telecom industry and automobile industry gathered together and shared the latest progress and opportunities of V2X. Meanwhile, key issues on V2X application requirements, policies, regulations, and technology evaluation of LTE-V2X and DSRC were also openly discussed in depth.

Along with the development of 4G and 5G, network performance is being vastly improved. This is vital in providing intelligence, safety and reliability for connected vehicles and autonomous vehicles. Thus, in order to settle key issues and promote the development of V2X, there is a need to strengthen cross-industry cooperation. Being successfully held, the workshop contributed to provide a dedicated platform promoting a collaborative approach across industries and accelerating the maturity of V2X, stepping forward to construct a brilliant V2X era.

India Spectrum Auction Further Expands TD-LTE Market

After 5 days and 31 rounds of bidding, India's biggest ever spectrum auction has finally concluded. After China, Japan and the United States, India has become the fourth biggest country where 190MHz spectrum at 2.6GHz band was all as TDD (Band 41).

In the 2.5GHz band (Band 41), 370 MHz out of 600MHz (in India, spectrum is calculated by different circles) that had been put up for sale was sold. Idea Cellular picked airwaves in 16 circles while Vodafone bought the spectrum in 15 circles. Both operators plan to expand 4G LTE network in the coming months across the country. Given below is the chart of the spectrum won in 2.5GHz band along with the winning bid value.

Circle	Operator	Spectrum	Winning Price
Andhra Pradesh	Idea	10 Mhz	680 cr
Assam	Idea	10 Mhz	20 cr
	Vodafone	10 Mhz	20 cr
Bihar	Idea	10 Mhz	60 cr
Delhi	Vodafone	20 Mhz	2860 cr
Gujarat	Idea	10 Mhz	390 cr
	Vodafone	20 Mhz	780 cr
Haryana	Idea	10 Mhz	80 cr
	Vodafone	10 Mhz	80 cr
Himachal Pradesh	Idea	10 Mhz	10 cr
Jammu and Kashmir	Idea	10 Mhz	10 cr
Kerala	Idea	10 Mhz	160.8 cr
	Vodafone	10 Mhz	160.8 cr
Kolkata	Vodafone	20 Mhz	660 cr
Madhya Pradesh	Idea	20 Mhz	160 cr

Circle	Operator	Spectrum	Winning Price
Maharashtra	Idea	10 Mhz	580 cr
	Vodafone	20 Mhz	1160 cr
Mumbai	Vodafone	20 Mhz	3380 cr
North East	Idea	10 Mhz	10 cr
	Vodafone	10 Mhz	10 cr
Odisha	Idea	10 Mhz	40 cr
	Vodafone	10 Mhz	40 cr
Punjab	Vodafone	10 Mhz	210 cr
Rajasthan	Idea	10 Mhz	60 cr
	Vodafone	10 Mhz	60 cr
UP East	Idea	10 Mhz	90 cr
	Vodafone	10 Mhz	90 cr
UP West	Idea	10 Mhz	120 cr
	Vodafone	10 Mhz	120 cr
West Bengal	Idea	10 Mhz	50 cr
	Vodafone	10 Mhz	50 cr

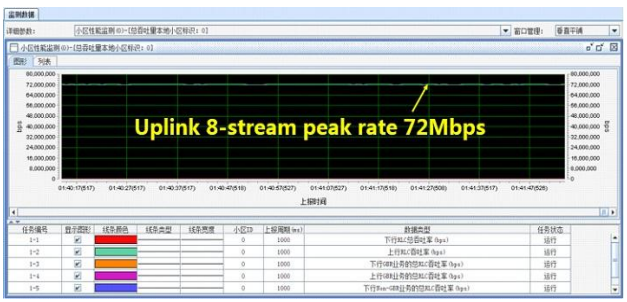
Before the auction, Bharti Airtel the largest operator by subscriber base in India has already deployed TD-LTE network. Now, TD-TLE market in India will be further expanded.

In the past few years, GTI has always been committed to promote TD-LTE global deployment and has successfully built global end-to-end TD-LTE ecosystem. TDD has been widely commercialized in the global market. As of Q3 2016, 85 TD-LTE commercial networks have been deployed in 46 countries, and 97 TD-LTE commercial networks are in progress.

China Mobile Launched World's First Commercial Wideband Massive MIMO in Shanghai

On November 4, 2016, China Mobile Shanghai Branch and Huawei jointly deployed the world's first wideband Massive MIMO site. This is another key milestone delivered after the world's first Massive MIMO solution was launched in Shanghai in September 2015. An achievement marking a great leap forward for large-scale commercial Massive MIMO technology and the beginning of a planned series of events outlined in the timetable for 5G large-bandwidth evolution. This solution has significantly improved single site capability in the 4G era indicated by a 5-fold increase, achieving 5-6 Giga capability of a single site.

The Massive MIMO solution is the primary wireless innovation project that China Mobile has predominantly focused on in 2016. This solution can greatly improve 4G network spectral efficiency and help effectively handle any capacity challenges encountered during rapid mobile development. This solution is perfectly suited for the effective enhancement of coverage and interference mitigation capabilities to meet specialized coverage requirements (such as coverage of high-rise buildings). As a significant component of China Mobile's prospective research on 5G technologies, these activities help steer towards an important direction for the further development and 5G evolution.



Peak rate test results of uplink 8-stream Massive MIMO

Peak rate test results of downlink 16-stream Massive MIMO

This newly introduced next-generation Massive MIMO solution is oriented specifically towards large-scale commercial use for China Mobile and assumes the lead in providing large-bandwidth capabilities. A single module supports activation of three carriers on 2.6GHz. Distributed network supports smooth evolution to CloudRAN architecture and ensures that hardware is sufficiently prepared and ready for 5G evolution. The average spectral efficiency of cells can be improved by 3-fold. Along with the rapid development of video services, the spectral efficiency can be increased to more than 5-fold. Huawei in-house-developed chips, new materials, and new techniques are used to provide increasingly compact and lighter site equipment. The expedient delivery of this solution is guaranteed as only one optical fiber and one power cable are required to ensure smooth deployment from an engineering perspective. The adoption of the latest chips helps provide processing capabilities 4-fold higher than that of the industry standard, clearly demonstrating the performance advantages inherent to Massive MIMO.

Huawei's next-generation Massive MIMO solution leads the way in providing an uplink 8-stream capability configuration to continuously enhance the uplink performance of China Mobile's TD-LTE networks. The live network in Shanghai acts as a verification platform, with impressive peak cell throughput rates reaching 72 Mbps uplink, and 630 Mbps downlink, effectively dealing with any challenges related to network capacity.

China Mobile has constructed the world's fastest-growing 4G network and must continuously innovate to address growing network development challenges. Shanghai China Mobile will continue to engage in close cooperation with Huawei to develop the capability of applying 5G technologies on 4G networks. The main objectives will be to target new network architectures, service development, continuous innovation, and encourage additional cooperation with partners to improve competitiveness of 4G mobile networks to deliver an optimal MBB user experience. The future is coming and well worth the wait.

Softbank And Wireless City Kick Off 5G Project

Softbank and its affiliate company, Wireless City Planning, have officially launched the '5G Project'.

As the first phase of the project, which was announced in Tokyo, Softbank plans to roll out commercial services based on Massive MIMO technology from September 16, a move which Softbank says will make it the world's first cellco to provide such services.

Under the plan, SoftBank will be deploying the technology across 100 base stations in 43 cities across Japan, of which 30-40% will be deployed in downtown areas of the Tokyo capital.

At the media conference for the launch, Shubun Kitahara, director of the network planning department of SoftBank's mobile technology division, tested at four locations in downtown Tokyo, which showed that Massive MIMO increased communications speed by 6.7 times on average.

According to Softbank, corresponding terminals only need to support SoftBank 4G (compatible with TD-LTE). The service is also available on the SoftBank 4G terminals customized for Y!mobile.

Aiming for 5G commercialization in 2020, Softbank last year signed separate research collaboration agreements with Huawei and ZTE covering the development of stopgap technologies on the road towards 5G.

SoftBank has teamed with ZTE to help develop networking equipment based on ZTE's Pre5G technology, such as the vendor's Massive MIMO base stations.

Massive MIMO base stations have the capacity to support more than 100 antenna elements, allowing up to eight users to transfer data simultaneously.

SoftBank already has cooperation agreements covering Massive MIMO as well as ultra-dense networks and multi-user shared access technology.

ZTE Wins Best Wireless Broadband Innovation Award for Pre5G Massive MIMO

20 October 2016, Shenzhen, China, ZTE announced that it has won the Best Wireless Broadband Innovation award for its Pre5G massive multiple input, multiple output (MIMO) technology at Broadband World Forum in London.

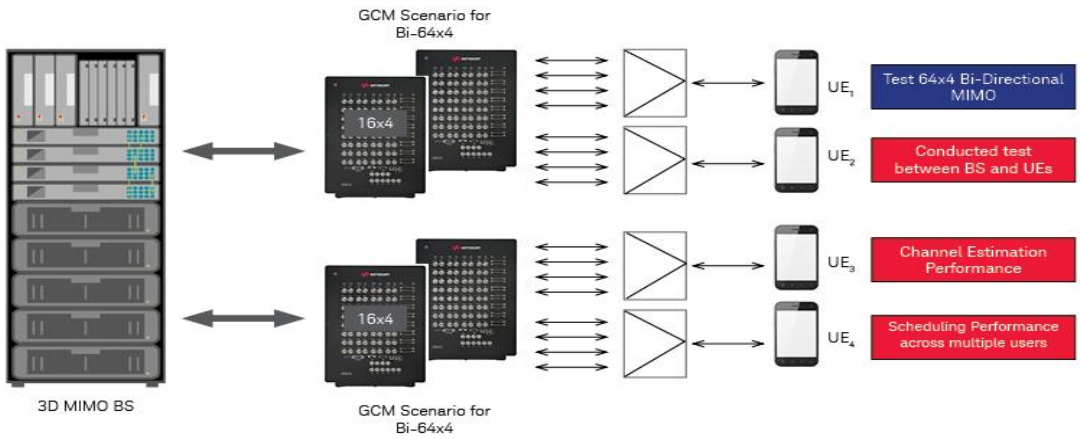
Sponsored by Informa, the global business media company, Broadband World Forum is an important event in the broadband industry and this award further recognizes ZTE's innovation in Pre5G Massive MIMO technology.

In a commercial network, the single-carrier peak rate of Pre5G Massive MIMO exceeds 400 Mbps, increasing spectral efficiency by four to six times as compared with that of existing 4G networks. In addition, Pre5G Massive MIMO technology is compatible with existing 4G terminals (such as 4G customer premises equipment CPE and handsets) so that users can enjoy a high-speed broadband experience without changing their terminals. In fact, this is highly practical for both mobile carriers and fixed network carriers.

High Capacity Channel Emulation for Massive MIMO BTS Performance Test

When it comes to verifying Massive MIMO technology, there are some key challenges that we face, including the system requiring specialized geometric channel models in order to conduct beamforming testing of the Massive MIMO base station. There are also challenges relating to network design which require system independent integrated testing. A 64-element antenna array is needed for Massive MIMO, which means that the number of antennas is increased by more than 8 times, compared to 4G technologies which require a maximum of an 8-base station antenna array. Massive MIMO tests require a higher number of logical channels i.e. bi-directional 64x4 test requires a total of 512 logical channels, by 4G technologies. A single channel emulator cannot perform the whole test requirement and so a multi-unit sync-up based test system is needed which provides accuracy and automation. Keysight is the only test device vendor to provide validated Massive MIMO BTS performance test solution. Full 3D based geometric modeling method is also mandatory for the test, including the parameters such as height of BTS, down tilt, distance between BTS and buildings, height and spatial info of each UE. Keysight's Geometric Channel Modeling tool can support this with its newest 3GPP defined 36.873 model.

Keysight has once again demonstrated 5G technology leadership by being the only test device vendor to offer a performance test system with only one GUI that support as many as 64-element Massive MIMO base station and 4 UEs, by linking together four channel emulators to behave like one. Keysight's prosim channel emulator is the only validated performance test device by CMRI since TD-LTE technology from the year of 2011, because we are the only test device to keep inter-logical channel phase-error less than +/-5degree within one week, another benefit of prosim is that unique modeling toolset named as GCM, enables the user to create dynamic MIMO and beamforming models, which solves the complexity of creating arbitrary emulation scenarios that may include movement, multiple base stations and devices, and a range of antenna arrays and patterns. The high capacity system will also be able to support radiated testing for Massive MIMO scenarios in the future.



Channel Propagation Measurements for 5G Wireless Communication (1)

Mobile communication systems operating at millimeter-wave frequencies are a very promising solution to boost capacity in 5G systems due to the possibility to provide much larger transmission bandwidths (on the order of 1 GHz or more) as in the frequency region below 6 GHz. The World Radio-communications Conference WRC15 has identified a number of frequency bands ranging from 24 GHz up to 86 GHz for possible future allocation. In these higher frequency bands, the wavelength and therefore the antenna elements, are smaller, facilitating the implementation of large antenna arrays for massive MIMO: Multi-user MIMO enabling throughput gains by parallel data channels and beamforming in order to direct the signal energy efficiently to the receiver and to compensate for propagation losses (which are more prominent for mm-waves) in the mobile radio channel.

One of the key requirements for the development of the 5G physical layer is the availability of adequate channel models which describe the propagation characteristics. For mm-waves the existing channel models need to be enhanced to include spatial information which in turn requires the measurement of spatial information such as the direction of arrival DoA and direction of departure DoD of the signal at the receiver and transmitter, respectively.

Measurement Approach: Channel Sounding Techniques

In order to measure the complex transmission properties of the radio channel, ideally an infinite bandwidth Dirac pulse would be transmitted periodically in order to excite the channel and measure the time-variant channel impulse response (CIR), i.e. the arrivals of that impulse at the receiver side. Owing to multi-path each pulse response is attenuated, delayed and phase-shifted.

In reality, the bandwidth is finite and provides the limit of the time resolution (inverse of the bandwidth) to detect multi-path reflections and echoes.

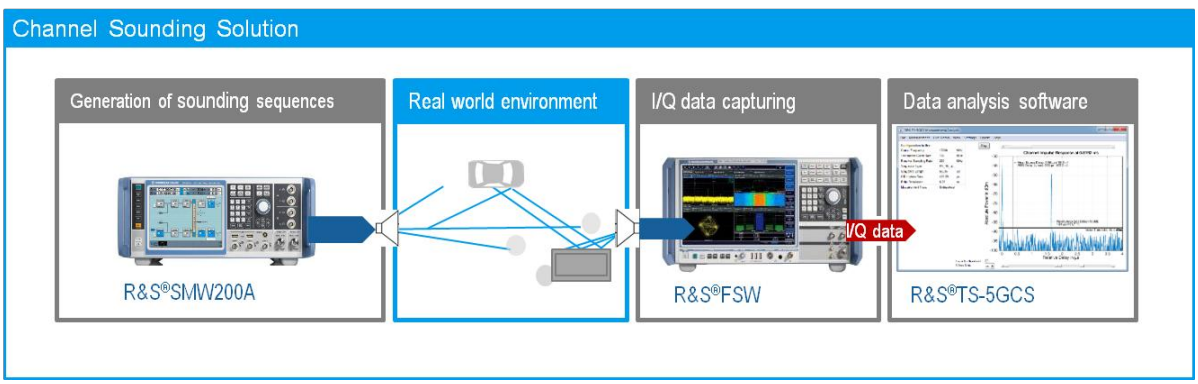


Figure 1: Time-domain sounding setup with transmitter, channel, receiver and data analysis.

Channel Propagation Measurements for 5G Wireless Communication (2)

The measurement technique depicted in Fig. 1 uses a wideband signal generator, i.e. an arbitrary waveform generator and a receiver with correlator. Special “sounding signals” with outstanding autocorrelation properties are used such as m-sequences or Frank-Zadoff-Chu sequences. The receiver then correlates the incoming signal with the known sounding sequence, which directly yields the CIR. A very similar technique is used for GPS, where each GPS satellite sends a signal with distinct PRN (pseudo-random noise) sequence and the GPS receiver can calculate the time delay by correlation measurement for each satellite and thus obtain the exact position.

The sampled IQ baseband data captured by the R&S FSW signal and spectrum analyzer is post-processed by a software correlator R&S TS-5GCS to calculate the complex channel impulse response.

Spatial channel characteristics

In order to derive the spatial channel properties, the following method can be applied: An omni-directional antenna (at the receiver side) is moved circularly and the channel is sampled regularly in space on a virtual circular array. The advantage of this method is that it is suitable up to frequencies up to 100 GHz and has good accuracy at a very short measurement duration of 100 ms, which can be reduced further to the ms-range, thus allowing fast measurements in mobile vehicular environments.

To obtain the spatial angular information from the measurement data, the MUSIC (Multiple Signal Classification) method is applied.

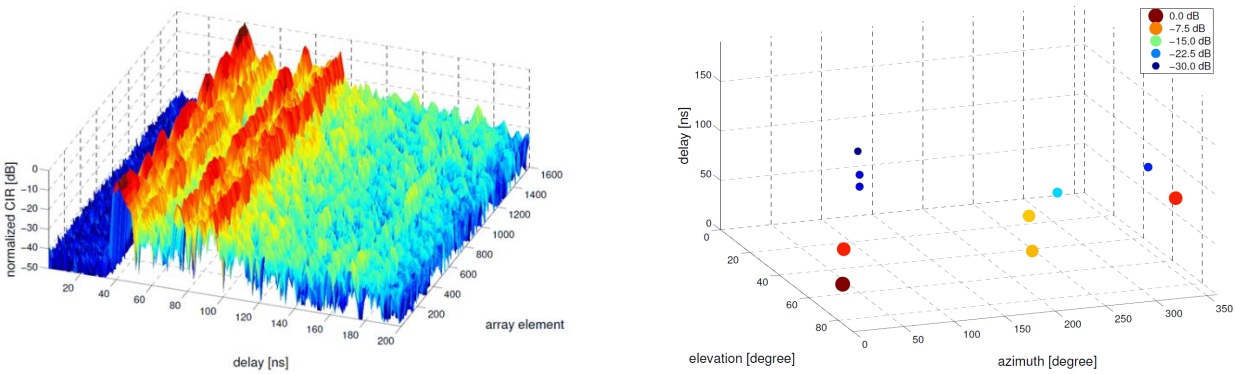


Figure 2: Left: Evolution of CIRs over the virtual circular array element position. Right: DoA results (elevation, azimuth) derived from MUSIC spectrum.

NB-IoT Lab Testing Solutions Help to Overcome the Challenges

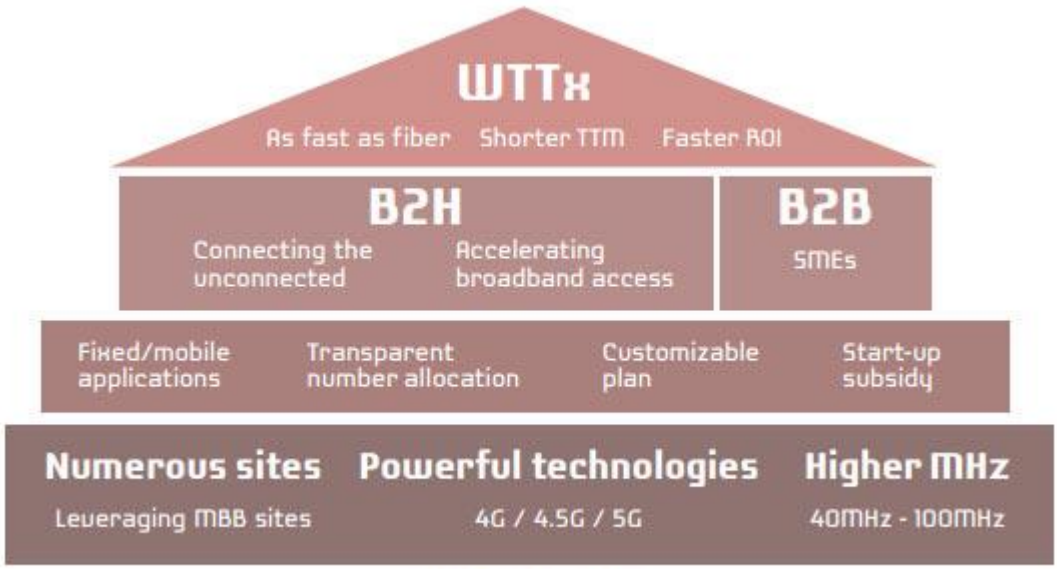
The first version of 3GPP NB-IoT standard was released in June 2016, as a part of Release 13. As a new cellular air interface, the NB-IoT is fully adapted to the requirements of growing demand for LPWA (Low Power Wide Area) services and applications. Recently, Rohde & Schwarz provides lab testing solutions to the technology partners in the NB-IoT industry.

The first challenge in lab testing phase for base station is the RF performance. These include tests cases in area of transmission power, spectrum analysis, group timing and delay, and coverage capability. Rohde & Schwarz is the first to offer a base station testing solution for generation and analysis of NB-IoT signals. The well-established solution consisting of the R&S SMW200A vector signal generator and the R&S FSW signal and spectrum analyzer have been already used at leading manufacturers of mobile network infrastructure for base station tests. The NB-IoT signal analysis is performed by a R&S VSE Vector Signal Explorer software option which is available soon. Users will be able to upgrade to NB-IoT capability to support NB-IoT eco system success.

Currently, the solution is verified by all the major technology leading companies incl. CMCC and Huawei. The NB-IoT specifications are expected to continue to evolve beyond Release 13, with support for multicasting and positioning towards the new 5G NB-IoT standards. Rohde&Schwarz will follow the development of standards closely to ensure the significant quality and standardized network deployment.

Sprinting the Last Mile with WTTx

WTTx is an effective 'new approach' to solve the 'old problem' of the last mile. Using WTTx can avoid the challenges of trenching and wiring over the last mile, for quicker time to market, faster user growth rate, and shorter payback period.



WTTx Value House

WTTx Uses Wireless Broadband to Provide 'The Last Mile'

According to data from Ovum, the number of global 4G users crossed the 1 billion mark in 2015, and strong double-digit growth in those numbers will continue over the next five years. It took less than six years for 4G user numbers to surpass 1 billion, and compared to 3G mobile broadband and fixed-line broadband, 4G has great vitality and growth potential.

If 4G is used to provide 'the last mile' of broadband, it will prove a landmark turning point. Yet, 4G mobile broadband has only found commercial success in developed countries and urban areas in emerging markets. This means that there are still economic obstacles to using a mobile broadband model to complete 'the last mile' in fixed scenarios. If 4G and its evolution technologies, 4.5G and 5G, are integrated with fixed-line broadband scenarios, which can be termed WTTx, will this be able to provide a wireless access solution with an experience similar to FTTx? Use of WTTx can avoid the challenges of trenching and wiring over the last mile for quicker time to market (TTM), faster user growth rate, and shorter payback period (PBP).

Testing Mobile Devices under High Speed Train Scenarios

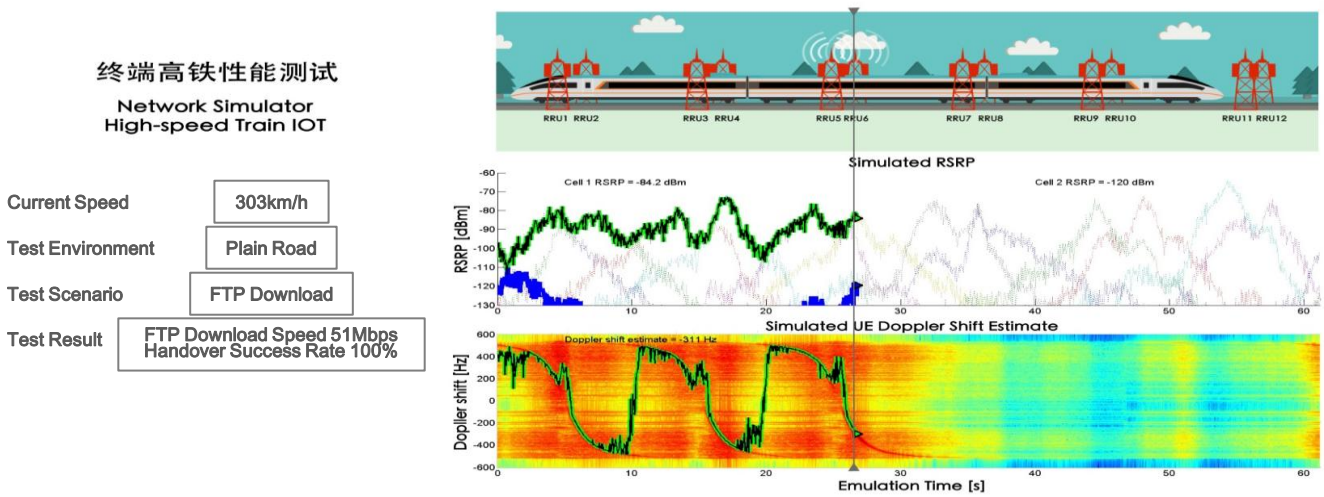
Leading TD-LTE mobile operator and mobile device manufacturers face a growing challenge to quickly and cost-effectively deploy new TD-LTE mobile terminals equipped with more features and technologies including MIMO, Carrier Aggregation and VoLTE. All these have to seamlessly co-operate with legacy wireless technologies in application level and deliver mobility without dropping calls across a vast range of field network configurations and conditions, especially the critical High Speed Train environment with a speed up to 300km/h or even higher.

To address these challenges, Keysight offers Anite Virtual Drive Testing (VDT) Toolset, an automated performance test solution for cost-effective assessment of mobile terminals in a laboratory environment. The TD-LTE ecosystem is thereby able to cost-effectively and more quickly verify and benchmark the end-user quality of experience across different mobile terminals before market introduction.

TD-LTE mobile operators and mobile device manufactures use VDT Toolset to validate the performance of the device in high speed train scenarios. Anite's field-to-lab solution uniquely supports mandated NS-IOT test plans to enable cost-effective verification of device performance on high speed trains.

It uses network signaling and RF propagation log data captured from the mobile operator field network to create realistic mobile device performance testing in a laboratory environment. The solution enables mobile operators to validate a mobile device's real performance across a vast range of other mobility scenarios in city, urban, vehicle and indoors, including high speed train scenarios. VDT Toolset SN uses typical end-user applications to test and collect key performance indication metrics on mobile device performance (e.g. voice calls and data transfer ftp, web browsing etc.).

VDT Toolset takes into consideration extreme signal propagation conditions including dynamic shadowing profile, PDP profile, Doppler Effect, dynamic channel delay and interference, as well as multi-RAT and multi-cell handover. Furthermore it simulates high speed train wireless network signaling parameters, and uses typical end-user applications to test and collect key performance indication metrics on mobile devices.



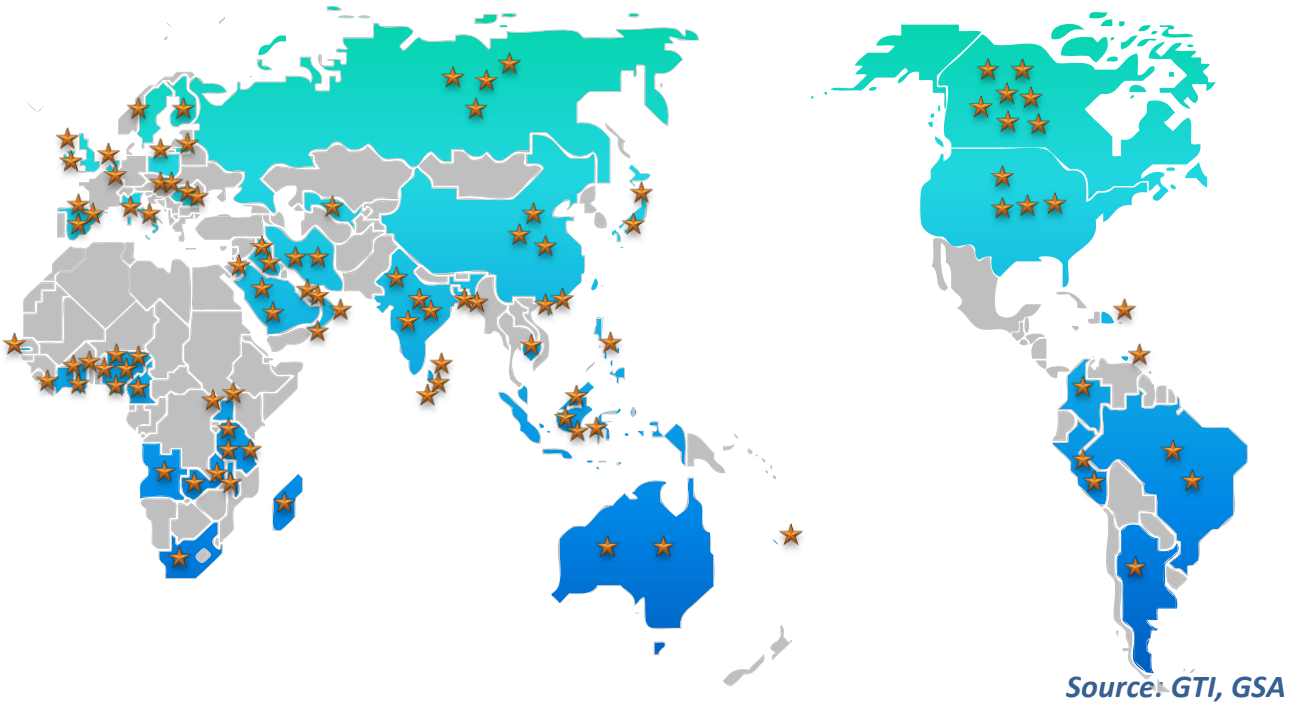
Example High-Speed-Train Channel models from field in VDT-SN system

TD-LTE Global Market Overview

Global Deployment as the Mainstream Mobile Broadband Technology

99 *TD-LTE commercial networks have been launched*

Additionally, over ***92*** *TD-LTE commercial networks are in progress or planned*



Source: GTI, GSA
As of the end 2016

LTE Multi-mode Multi-band Terminals Have Reached Full Maturity

504+ suppliers have launched 4717+ TD-LTE terminals,
including 3672+ TD-LTE Smartphones.

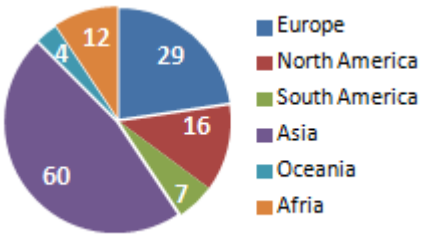
TD-LTE Device Type	Quantity	TD-LTE Device Type	Quantity
USB modems	136	*Smartphones*	3672+
MiFi/CPE	669	*Mobile Tablets*	124

**Source: GTI, GSA, TDIA*
**Note: Four Main Types Of The TD-LTE Terminals*

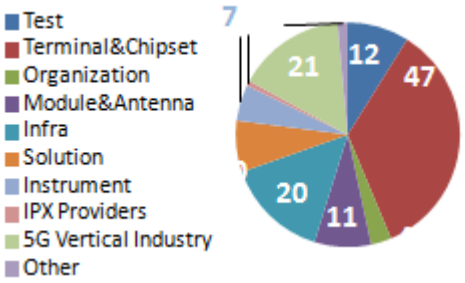
GTI Development Overview

128 Operators and 135 Partners Joined GTI by Jan. 2017

128 Operators



135 Industry Partners



6 MEMBERS ARE IN PROCESS

21 Vertical Industry Partners

Including IoT, IoV, Communication Capability, Industrial Internet, Cloud Robot, VR/AR

- BAIC
- Changhong
- CloudMinds
- EVE Energy
- Feitian
- GAEI
- Goertek
- Haier
- Hisense
- IESLab
- Jinan Towngas
- LeAutolink
- Neusoft
- Oviphone
- Philips Lighting B.V.
- SAFT SA
- Shougang Automation Information
- Taiyo Yuden
- WapWag
- Wireless Car
- Xiaomi

GTI Activities

2017	Jan/Feb	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec
Summit (2)	Time: 28th Feb. (MWC) Venue: Barcelona, Spain **GTI Summit (including GTI Awards 2016)**		Time: TBD (28th Jun.-1st Jul.) (MWCS17) Venue: Shanghai, China **GTI Summit**			
Workshop (3)	Time: 23th -24th Feb. (MWC) Venue: Barcelona, Spain **The 18th GTI Workshop**		Time: TBD (28th Jun.-1st Jul.) (MWCS17) Venue: Shanghai, China **The 19th GTI Workshop**		Time: TBD (during 25th -28th Sep.) (ITU Telecom World) Venue: Busan, Republic of Korea **TD-LTE Technology and Spectrum Workshop**	
Exhibition (3)	27th Feb. -2nd Mar (MWC) **Barcelona, Spain**		28th Jun.-1st Jul. (MWCS17) **Shanghai, China**		25th -28th Sep. (ITU Telecom World) **Busan, Republic of Korea**	
Others (1)	Time: 24th Feb. (MWC) Venue: Barcelona, Spain **GTI Night**					

Appendix 1 – Welcome to Join GTI (to operators)

More Information about GTI

To find out more information about GTI, please visit http://gtigroup.org or email us.

How to Join GTI

GTI Operators (with TDD Spectrum)

1. Fill out the application form (download from http://gtigroup.org/joinUs.html), and return to GTI Secretariat: GTI_Secretariat_list@lte-tdd.org and/or GTI@lte-tdd.org;

2. Sign the Accession Form and return the signed copy to 5 initiators;

3. Once the participation process finishes, a GTI website account and associated password will be assigned to the new participant.

GTI Observers (without TDD Spectrum)

1. Fill out the application form (download from http://gtigroup.org/joinUs.html), and return to GTI Secretariat: GTI_Secretariat_list@lte-tdd.org and/or GTI@lte-tdd.org;

2. Sign the declaration form and return the hard copy to GTI Secretariat;

3. Once the participation process finishes, a GTI website account and associated password will be assigned to the new participant.

Appendix 2 – Welcome to Join GTI Partner Forum (to non-operators)

More Information about GTI Partner Forum

To find out more information about GTI and GTI Partner Forum, please visit http://gtigroup.org or email us.

How to Join GTI Partner Forum

1. Fill out the application form (download from http://gtigroup.org/joinUs.html), and return to GTI Secretariat:
GTI_Secretariat_list@lte-tdd.org and/or GTI@lte-tdd.org; GTI Secretariat and Working Group Chairmen will review;

2. Sign the Declaration Form and return the signed hard copy to GTI Secretariat;

3. Once the participation process finishes, a GTI website account and associated password will be assigned to the new participant.

CONTACT GTI:

If you have any questions, comments, suggestions regarding TD-LTE or general enquiries regarding GTI, please contact:

GTI@lte-tdd.org