

Long Term Evolution (LTE)

Technology Overview

Long Term Evolution (LTE) will ensure the competitiveness of UMTS for the next ten years and beyond by providing a high-data rate, low-latency and packet-optimized system. Also known as E-UTRA (Evolved Universal Terrestrial Radio Access), LTE is part of 3GPP Release 8 specifications. The innovations that LTE brings to the UMTS world include:

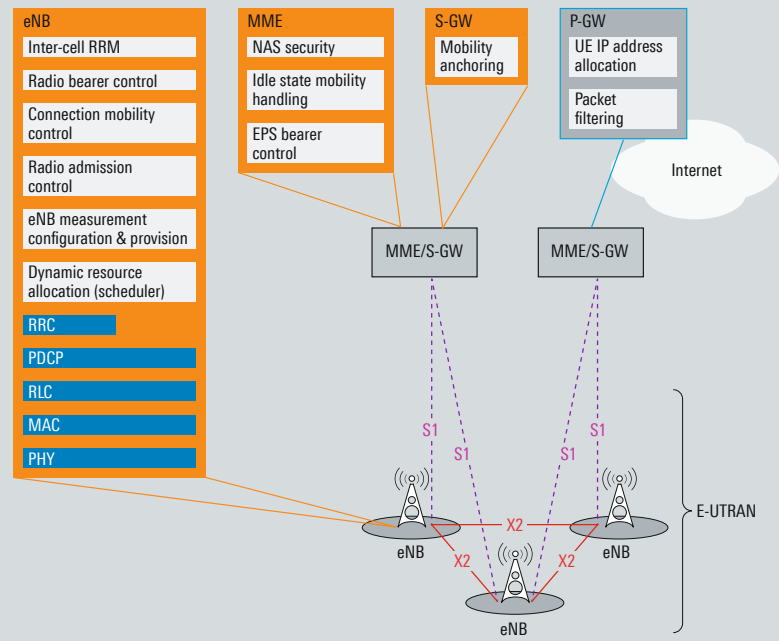
- New multiple access schemes for both LTE FDD and TD-LTE
- Scalable bandwidth up to 20 MHz
- MIMO antenna technology
- New data and control channels
- New network and protocol architecture
- Specific test and measurement challenges

Commercial LTE networks have been launched world-wide, starting with the first network in Sweden in December 2009. 3GPP Release 9 features added further enhancements to LTE. The 3GPP candidate technology submission for IMT-Advanced, developed as LTE Release 10 and beyond, has been accepted as a 4G technology. Known as LTE-Advanced, it complies with or exceeds the ITU established criteria in all aspects.

Rohde&Schwarz is the right partner for making your LTE products happen. Our test solutions were the first on the market and since then have evolved to a full product portfolio from a single-source supplier, covering applications from R&D to conformance.

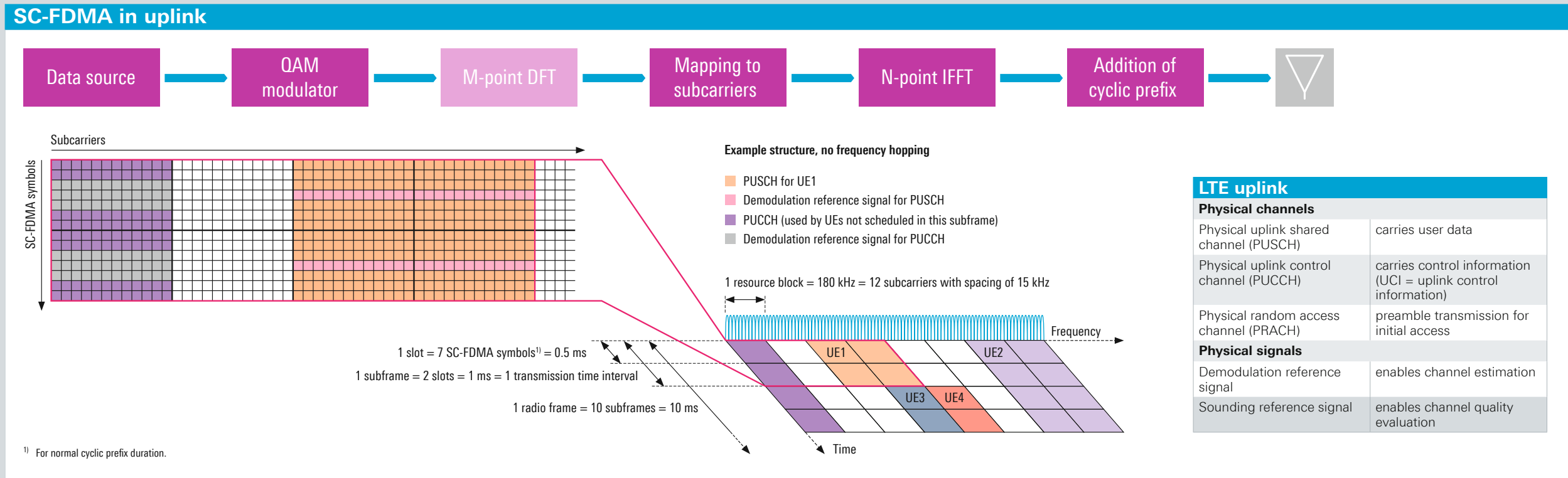
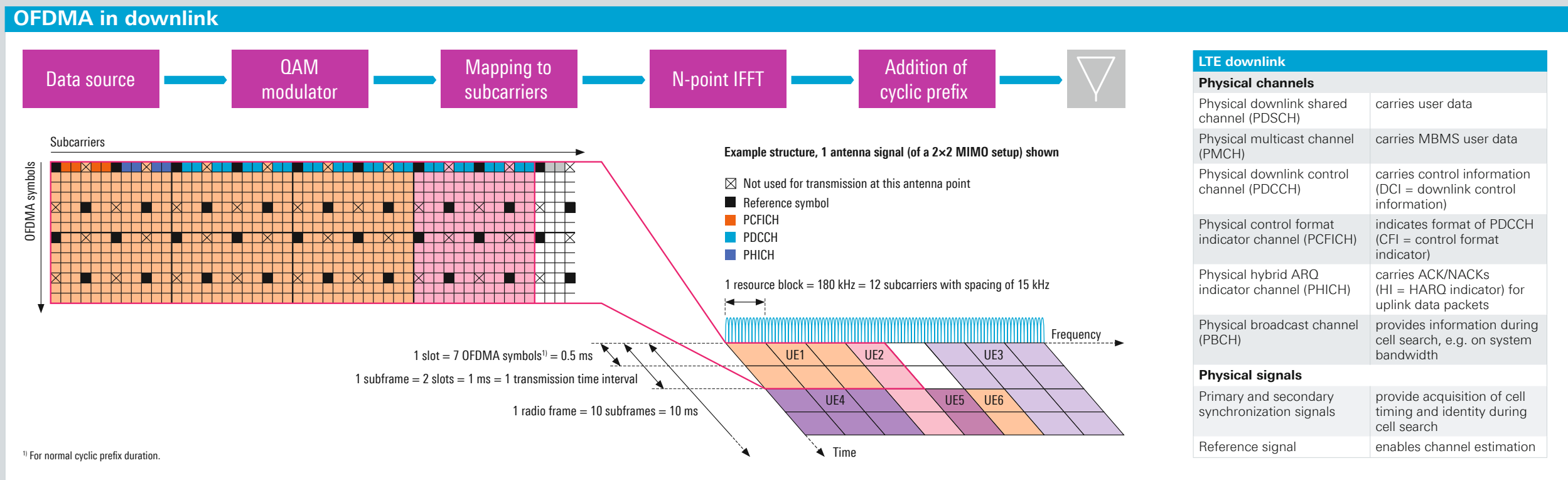
Key parameters				
Frequency range (E-UTRA bands)	FDD (in MHz):			
	1) UL: 1920	to 1980	DL: 2110	to 2170
	2) UL: 1850	to 1910	DL: 1930	to 1990
	3) UL: 1710	to 1785	DL: 1805	to 1880
	4) UL: 1710	to 1755	DL: 2110	to 2155
	5) UL: 824	to 849	DL: 869	to 894
	6) UL: 830	to 840	DL: 875	to 885 ¹⁾
	7) UL: 2500	to 2570	DL: 2620	to 2690
	8) UL: 880	to 915	DL: 925	to 960
	9) UL: 1749.9	to 1784.9	DL: 1844.9	to 1879.9
	10) UL: 1710	to 1770	DL: 2110	to 2170
	11) UL: 1427.9	to 1447.9	DL: 1475.9	to 1495.9
	12) UL: 699	to 716	DL: 729	to 746
	13) UL: 777	to 787	DL: 746	to 756
	14) UL: 788	to 798	DL: 758	to 768
	15) UL: 1900	to 1920	DL: 2600	to 2620 ²⁾
	16) UL: 2010	to 2025	DL: 2585	to 2600 ²⁾
	17) UL: 704	to 716	DL: 734	to 746
	18) UL: 915	to 930	DL: 860	to 875
	19) UL: 830	to 845	DL: 875	to 890
	20) UL: 832	to 862	DL: 791	to 821
	21) UL: 1447.9	to 1462.9	DL: 1495.9	to 1510.9
	22) UL: 3410	to 3490	DL: 3510	to 3590
	23) UL: 2000	to 2020	DL: 2180	to 2200
	24) UL: 1626.5	to 1680.5	DL: 1525	to 1559
	25) UL: 1850	to 1915	DL: 1930	to 1995
	26) UL: 814	to 849	DL: 859	to 894
	27) UL: 807	to 824	DL: 852	to 869
	28) UL: 703	to 748	DL: 758	to 803
	29) UL: —	—	DL: 717	to 728
	30) UL: 2305	to 2315	DL: 2350	to 2360
	31) UL: 452.5	to 457.5	DL: 462.5	to 467.5
	32) UL: —	—	DL: 1452	to 1496
	TDD (in MHz):			
	33) 1900	to 1920		
	34) 2010	to 2025		
	35) 1850	to 1910		
	36) 1930	to 1990		
	37) 1910	to 1930		
	38) 2570	to 2620		
	39) 1850	to 1920		
	40) 2300	to 2400		
	41) 2486	to 2690		
	42) 3400	to 3600		
	43) 3600	to 3800		
	44) 703	to 803		
¹⁾ Band 6 is not applicable.				
²⁾ Europe only (ETSI EN 301 908-2).				
Channel bandwidth	1.4 MHz	3 MHz	5 MHz	10 MHz 15 MHz 20 MHz
Resource blocks (RB) (1 RB = 180 kHz)	6	15	25	50 75 100
Modulation schemes	DL: QPSK, 16QAM, 64QAM UL: QPSK, 16QAM, 64QAM (optional for UE) DL: OFDMA UL: SC-FDMA			
Multiple access	DL: 150 Mbit/s (UE category 4, 2x2 MIMO, 20 MHz), 300 Mbit/s (UE category 5, 4x4 MIMO, 20 MHz), 75 Mbit/s (UE category 5, 20 MHz)			
Peak data rate	DL: 150 Mbit/s (UE category 4, 2x2 MIMO, 20 MHz), 300 Mbit/s (UE category 5, 4x4 MIMO, 20 MHz), 75 Mbit/s (UE category 5, 20 MHz)			

Network and protocol architecture



Glossary:
3GPP = 3rd Generation Partnership Project, 4G = 4th Generation Mobile Communications Technology, ARQ = Automatic Repeat Request, DFT = Discrete Fourier Transformation, DL = Downlink, eNB = evolved NodeB, EPS = Evolved Packet System, E-UTRA = Evolved Universal Terrestrial Radio Access, FDD = Frequency Division Duplex, HARQ = Hybrid ARQ, IFFT = Inverse Fast Fourier Transform, IMT = International Mobile Telecommunications, IOT = Interoperability Testing, IP = Internet Protocol, ITU = International Telecommunication Union, MAC = Medium Access Control, MBMS = Multimedia Broadcast Multicast Service, MIMO = Multiple Input Multiple Output, MME = Mobility Management Entity, NAS = Non Access Stratum, OFDMA = Orthogonal Frequency Division Multiple Access, PGW = Packet Data Network Gateway, PBCH = Physical Broadcast Channel, PCFICH = Physical Control Format Indicator Channel, PDCCH = Physical Downlink Control Channel, PDCP = Packet Data Convergence Protocol, PDSCH = Physical Downlink Shared Channel, PHICH = Physical HARQ Indicator Channel, PHY = Physical Layer, PMCH = Physical Multicast Channel, PRACH = Physical RACH, PUCCH = Physical Uplink Control Channel, PUSCH = Physical Uplink Shared Channel, QAM = Quadrature Amplitude Modulation, QPSK = Quadrature Phase Shift Keying, RACH = Random Access Channel, RAT = Radio Access Technology, RF = Radio Frequency, RLC = Radio Link Control, RRC = Radio Resource Control, RRM = Radio Resource Management, S-GW = Serving Gateway, SC-FDMA = Single Carrier Frequency Division Multiple Access, TD-LTE = Time Division - Long Term Evolution, TDD = Time Division Duplex, UE = User Equipment, UL = Uplink, UMTS = Universal Mobile Telecommunications System.

Multiple access schemes and physical layer signal generation



MIMO antenna technology

LTE MIMO characteristics	
Number of eNB transmit antennas	1, 2 or 4
Number of UE receive antennas	2 or 4
DL transmit diversity	space frequency block coding (SFBC)
DL spatial multiplexing	codebook-based precoding, maximum of 2 parallel code words
DL cyclic delay diversity	antenna-specific cyclic shifts
UL MIMO mode	multi-user/collaborative MIMO, transmit antenna selection

LTE enhancements

3GPP LTE Release 9	
Feature	Objective
Multimedia broadcast/multicast services (MBMS)	support for efficient point-to-multipoint transmission
LTE positioning	support for network-assisted global navigation satellite system (GNSS), observed time difference of arrival (OTDOA), and enhanced cell ID positioning
LTE dual layer beamforming	MIMO spatial multiplexing support in case of beamforming
Multicarrier/multi-RAT base stations	RF requirements for base stations supporting multiple carriers and/or multiple radio access technologies (RAT)
Public warning system (PWS)	broadcast reception mechanism and associated paging to accommodate reception of alert messages (extension of the earthquake and tsunami warning system (ETWS) in LTE Release 8)
Home eNB/femtocell	RF requirements tailored to different base station classes (wide area, local area and specifically home base stations)
Self-organizing networks (SON)	additional support for mobility robustness optimization, mobility load balancing optimization and RACH optimization use cases

Rohde & Schwarz LTE test solutions

RF development and production testing

Signal generators, and fading simulator

R&S*SGT100A

R&S*SMW200A

R&S*SMBV100A

Signal and spectrum analyzers

R&S*FSW

R&S*FSV

R&S*FPS

Oscilloscopes

R&S*RTO/RTE/RTM

R&S*NRP

Power meters

R&S*CMW500

Wideband radio communication tester

Mobile network testing

Benchmarking, optimization, drive tests

Diversity Ranger

Diversity Benchmarker II

SwissQual

R&S*TSME with R&S*ROMES

QualiPoc Android

Installation and maintenance

R&S*FSH/ZVH

Handheld spectrum/cable and antenna analyzer

Protocol stack testing and IOT

Application layer testing with IP analysis from ipoque

R&S*CMW500 protocol tester

ipoque

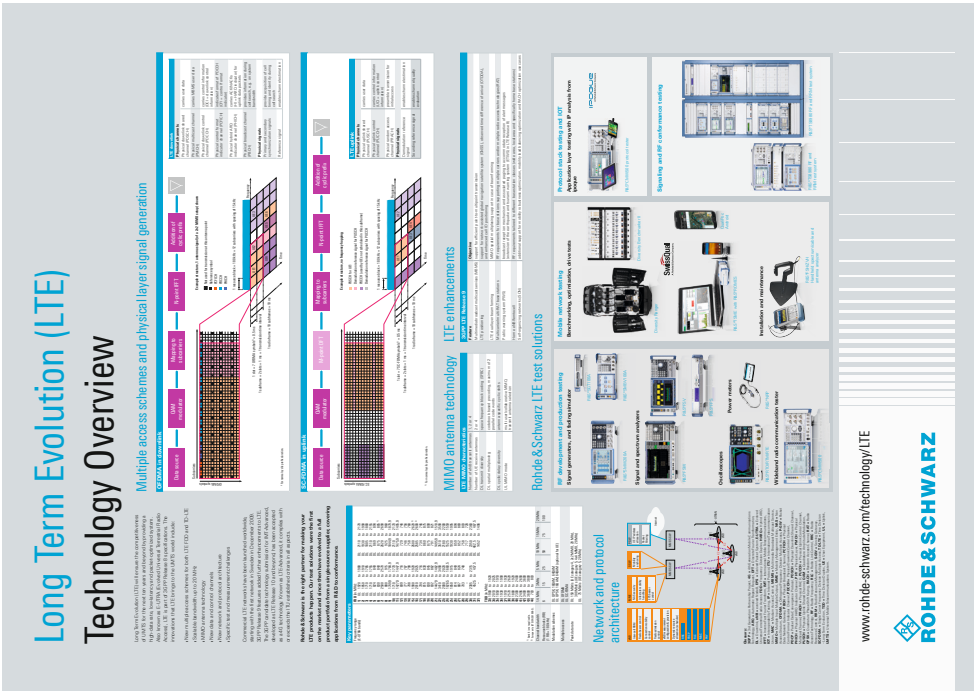
RF conformance and network operator acceptance testing

R&S*TS8980 RF and RRM test system

R&S*TS-LBS location based services test system

www.rohde-schwarz.com/technology/LTE



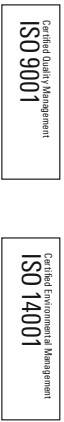


Long Term Evolution (LTE) Technology Overview

About Rohde & Schwarz

The Rohde & Schwarz electronics group is a leading supplier of solutions in the fields of test and measurement, broadcast and media, secure communications, cyber security, and radio monitoring and radolocation. Founded more than 80 years ago, this independent global company has an extensive sales network and is present in more than 70 countries. The company is headquartered in Munich, Germany.

- Sustainable product design**
- Environmental compatibility and eco-footprint
 - Energy efficiency
 - Longevity and optimized total cost of ownership



Rohde & Schwarz GmbH & Co. KG
www.rohde-schwarz.com

Regional contact

- Europe, Africa, Middle East | +49 89 41 29 12345
customer.support@eu.rohde-schwarz.com
- North America | 888 TEST RSA | 888 837 8772
customer.support@usa.rohde-schwarz.com
- Latin America | +1 410 910 79 88
customer.support.la@rohde-schwarz.com
- Asia Pacific | +85 65 13 04 88
customer.support.asia@rohde-schwarz.com
- Australia | +61 8 9405 5353
customer.support.china@rohde-schwarz.com