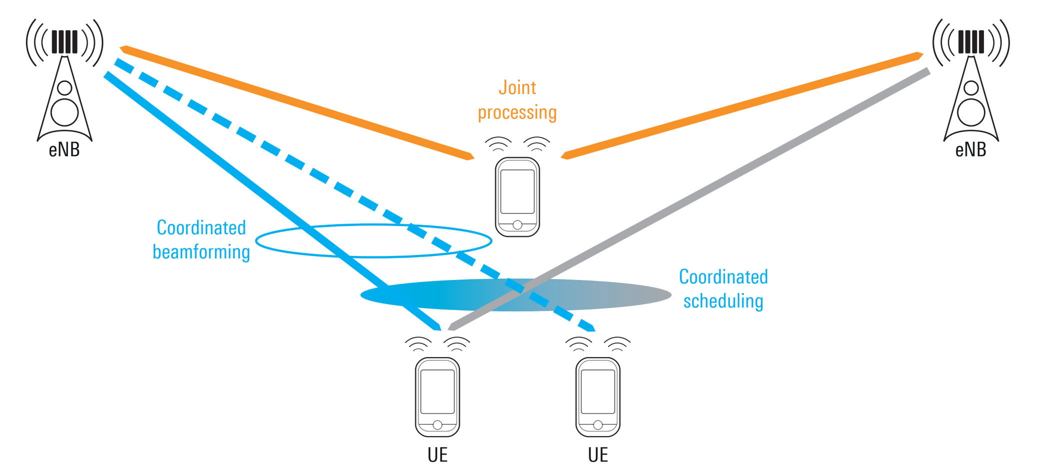
LTE-Advanced Technology Overview

The International Telecommunication Union (ITU) has coined the term IMT-Advanced to identify mobile communications systems with capabilities that go beyond those of IMT-2000 (International Mobile Telecommunications). IMT-Advanced requirements include compatibility with IMT-2000 systems, interworking, high-quality service support and increased data rate requirements. To support advanced services and applications, mobility scenarios – with 100 Mbit/s for high mobility and 1 Gbit/s for low mobility – must be implemented. The 3GPP partners made a formal submission to the ITU proposing that LTE-Advanced, i.e. LTE as of 3GPP Release 10 and beyond, be evaluated as a candidate technology for IMT-Advanced. LTE-Advanced maintains the basic LTE approach to a large extent. Enhancements include carrier aggregation, higher order MIMO schemes in DL and UL, enhanced UL transmission, coordinated multipoint (CoMP) transmission/reception and the support of relay stations. According to 3GPP LTE-Advanced fulfills and partly exceeds the IMT-Advanced requirements. Therefore, mobile operators running commercial LTE networks are able to provide an evolutionary path towards a true 4G system.

Rohde&Schwarz test solutions for LTE were the first on the market and since then have evolved to a full product portfolio. The modular and highly flexible solutions can easily be extended to cover LTE-Advanced testing needs. From GSM to 4G, from R&D to conformance, from testing chipsets and assembled end-user devices to infrastructure equipment, Rohde&Schwarz is the right partner to satisfy your test requirements.

LTE-Advanced Downlink

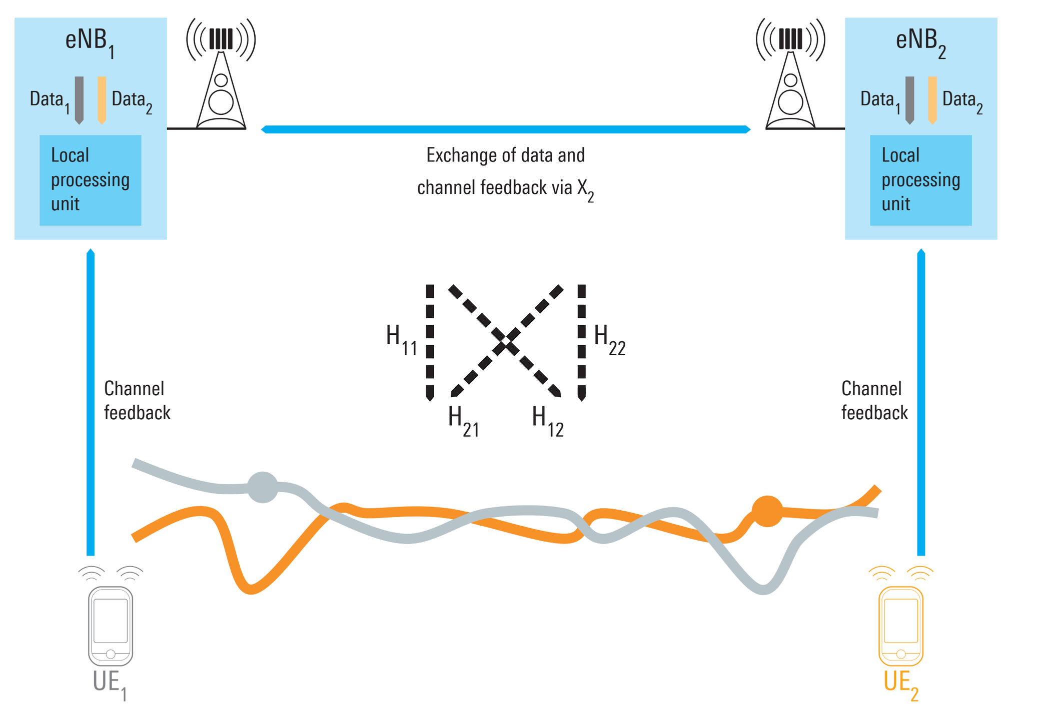
Extended downlink MIMO schemes and CoMP



Extended downlink MIMO schemes up to 8×8 including space-frequency block codes and frequency-switched transmit diversity.

Coordinated multipoint (CoMP) transmission/reception improves the coverage of high data rates, specifically enhances the cell-edge throughput and increases system throughput.

Example of CoMP in a distributed network architecture



CoMP aims to turn the inter-cell interference into a useful signal specifically at the cell border.

CoMP must be supported by multiple geographically separated eNBs to enable dynamic coordination in scheduling/joint transmission and also joint processing of received signals.

User data availability at multiple eNBs enables two modes of downlink operation: joint transmission, simultaneous transmission of user data from multiple eNBs to a single UE, and dynamic cell selection, data transmission from one eNB at a time. Both modes require detailed UE feedback on channel properties.

LTE-Advanced Uplink

Precoding for uplink spatial multiplexing (two TX antennas)

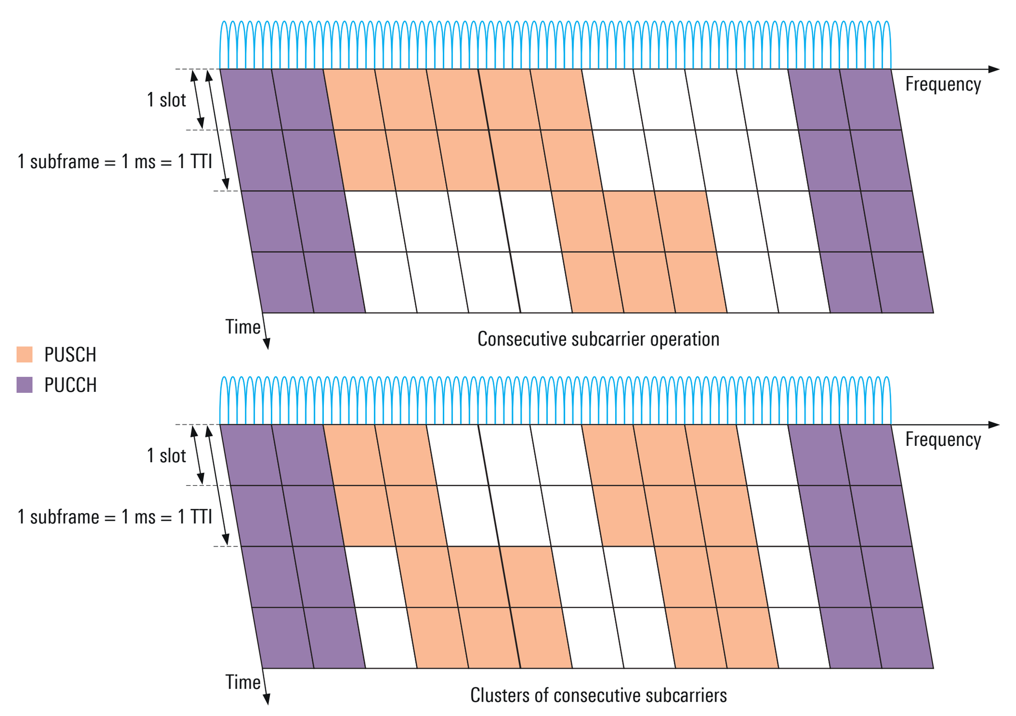
Codebook index	Number of layers	
	1	2
0	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1&0\\0&1\end{bmatrix}$
1	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-1\end{bmatrix}$	
2	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\j\end{bmatrix}$	
3	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	
4	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\0\end{bmatrix}$	
5	$\frac{1}{\sqrt{2}}\begin{bmatrix}0\\1\end{bmatrix}$	

Extended uplink MIMO operation up to 4x4.

Modulation symbols associated with each of the transport blocks are mapped onto one or two layers according to the same principle as for LTE Release 8 downlink spatial multiplexing.

Different codebooks are defined depending on the number of layers used; only the identity precoding matrix is supported in UL direction.

Enhanced uplink transmission scheme



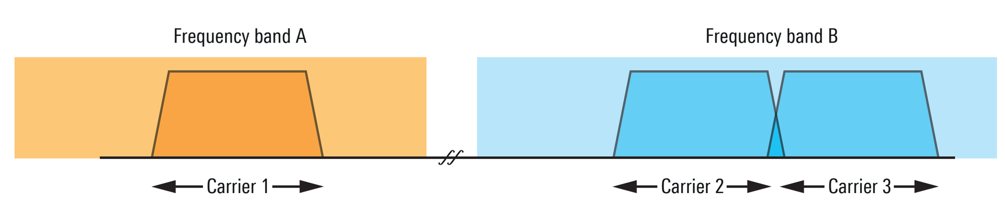
Single carrier frequency division multiple access (SC-FDMA) is maintained as the basic LTE-Advanced uplink transmission scheme.

New enhancements are control-data decoupling (simultaneous PUCCH and PUSCH transmission) and non-contiguous data transmission.

Uplink transmission is no longer restricted to the use of consecutive subcarriers. Instead, clusters of subcarriers can be allocated. This enables frequency-selective scheduling, which will increase link performance.

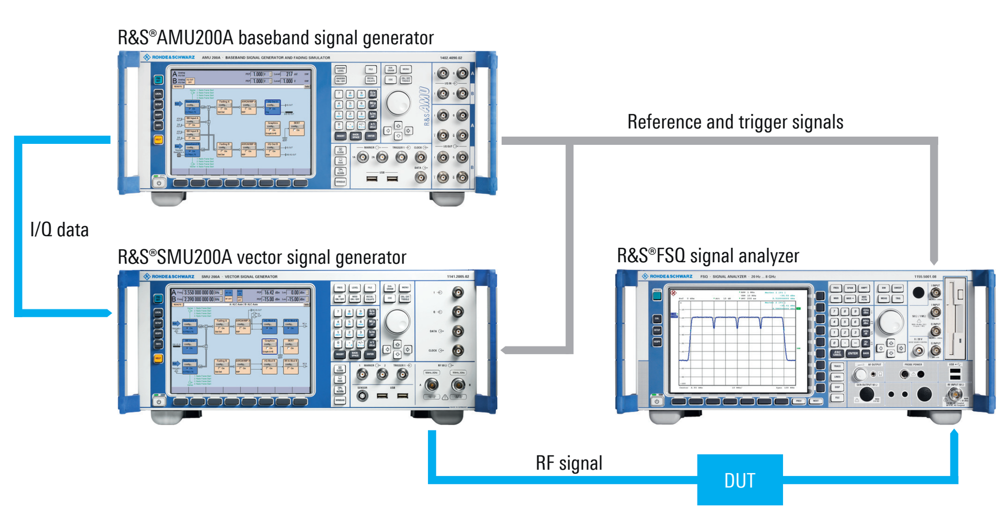
Carrier Aggregation

Example of non-contiguous band aggregation



Two or more component carriers are aggregated to support wider transmission bandwidths up to 100 MHz. Spectrum deployment can be either contiguous or non-contiguous.

Test setup for band aggregation



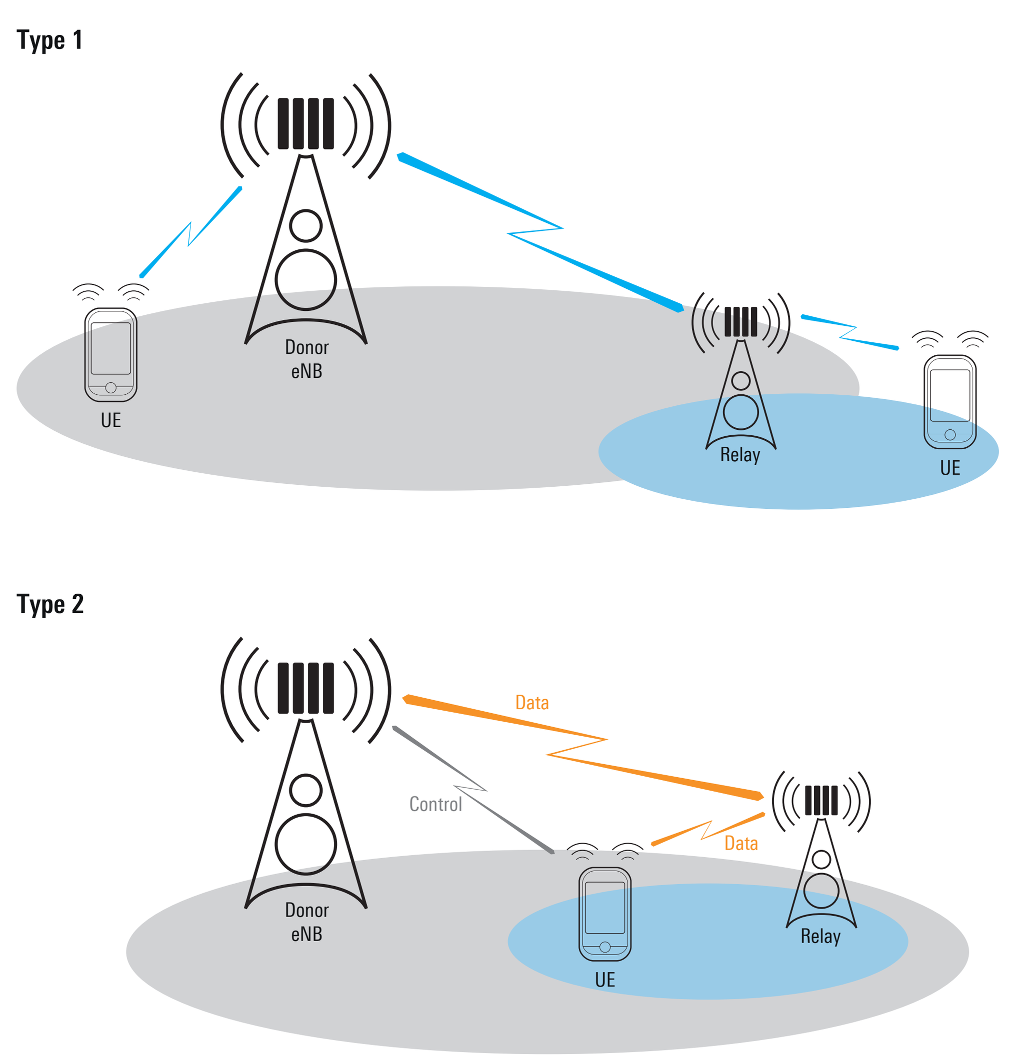
For example, up to four component carriers with 20 MHz bandwidth each are conveniently aggregated to a bandwidth of 80 MHz by means of the R&S®SMU200A and R&S®AMU200A signal generators which feature a two-path concept.

The high-performance R&S®FSQ or R&S®FSV signal and spectrum analyzers are ideal for detailed measurement of the individual component carriers.

Initial LTE-Advanced deployments are expected to be limited to two adjacent component carriers in the same frequency band or two single component carriers in different frequency bands.

Relaying

Type 1 and type 2 relay deployment scenarios



Relaying enhances coverage and capacity. The UEs communicate with the relay node, which in turn communicates with a donor eNB.

Relay nodes can optionally support higher layer functionality, for example decode user data from the donor eNB and re-encode the data before transmission to the UE.

Type 1 relay nodes control their cells with their own cell identity, including transmission of synchronization channels and reference symbols. Type 1 relays appear as a Release 8 eNB to Release 8 UEs, which ensures backward-compatible operation.

Type 2 relay nodes will not have their own cell identity. Therefore, the UE will not be able to distinguish between signal transmission from the donor eNB and the relay. Control information can be transmitted from the eNB and user data from the relay.

Glossary:
3GPP = 3rd Generation Partnership Project, 4G = 4th Generation Mobile Communications Technology, CoMP = Coordinated Multipoint, DL = Downlink, DUT = Device Under Test, eNB = enhanced Node B, GSM = Global System for Mobile Communications, IMT = International Mobile Telecommunications, ITU = International Telecommunication Union, LTE = Long Term Evolution, MIMO = Multiple Input Multiple Output, PUCCH = Physical Uplink Control Channel, PUSCH = Physical Uplink Shared Channel, SC-FDMA = Single Carrier Frequency Division Multiple Access, TTI = Transmission Time Interval, TX = Transmission, UE = User Equipment, UL = Uplink, X2 = Interface between eNBs.

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