COMPARATIVE ANALYSIS OF LONG TERM EVOLUTION (LTE) & LONG TERM EVOLUTION-ADVANCED (LTE-A); USING 4G WIRELESS BROADBAND TECHNOLOGY

Juhi Dixit [1]
Assistant Professor, Dept. of ECE, Amity School of Engineering and Technology,
Amity University Madhya Pradesh, Gwalior – India [Email-jdixit@gwa.amity.edu]

Abstract
The Third Generation Partnership Project (3GPP), an industry trade group has developed "Long Term Evolution" (LTE), which is a 4G wireless broad- band technology. The term 4G LTE comprised of two technical aspects. Here 4G means the fourth generation of data technology for cellular networks– having 3G (third generation) as its predecessor and LTE is a standard for wireless communication of high-speed data for mobile phones and data terminals. This paper projects an overview of the research work carried out to meet the demands of 4G. The various technology components like wideband transmission and spectrum sharing, multi-antenna solutions, coordinated multiple trans -mission/reception (CoMP) and relaying, introduced to meet the requirements for LTE Advanced systems, have been discussed.

Keywords: *LTE, LTE-Advanced, Carrier Aggregation, Multi-antenna techniques, Coordinated Multiple Transmission/Reception, Relaying.*

Introduction
The International Telecommunications Union has defined the requirements for a fourth generation system.One of the systems for which the standardization process is already quiet advanced and compatible with the requirements set up by ITU-R for 4G system is the Third Generation Partnership Project Long-Term Evolution (3GPP LTE).The most important requirements identified for the LTE systems can be scrutinized in the following way:

1. Costreduction in network data transmission (per bit): (a) Improvement of spectrum efficiency
(b) Cost reduction in backhaul data transmission
2.Reduction in setup time and round trip delay
3.Improvement in functioning of quality of service (QoS) mechanisms for various service.
4. Focus on services utilizing the IP protocol
5.Broadening of multimedia multicasting services for selected groups of users (enhanced MBMS)
6.Increase in the transmission rate to over 100 mbps in the downlink and 50 mbps in the uplink direction 7.Flexibility in the use of existing and new spectral resourcespossibility of carrier allocation with different bandwidth, ranging from 1.25 to 20 MHz

The following elements can be distinguished in LTE architecture:eNB—E-UTRAN Node BeGW—access gatewayMME—mobility management entityUPE—user plane entity

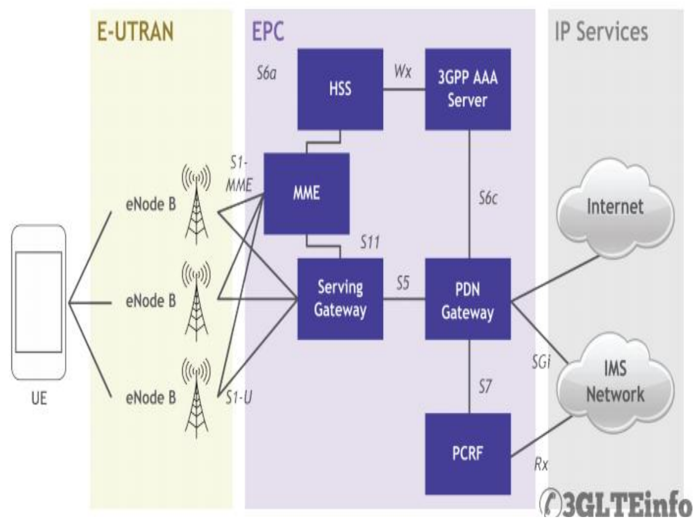
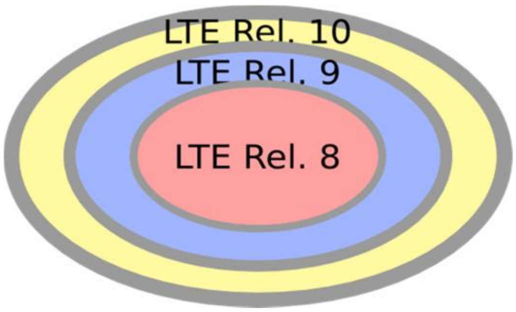


Figure: architecture of LTE

Universal Mobile Telecommunications System (UMTS)based (LTE) Release 8provides high speed data rates of 300 Mb/s on the downlink and 75 Mb/s on the uplink for a 20MHz bandwidth, and allows flexible bandwidth operation of up to 20 MHz. However currently, enhancements are being studied to provide substantial improvements to LTE Release 8, allowing it to meet or exceed International Mobile Telecommunications-Advanced (IMT-A) requirements. These enhancements are being considered as a part Of LTE-Advanced (LTE-A, also known as LTE Release 10), which includes carrier aggregation, Advanced uplink (UL) and downlink (DL) spatial. Multiplexing, DL coordinated multipoint (CoMP) transmission and heterogeneous networks with special emphasis on Type 1 and Type 2 relays.This article provides an overview of the technologies being considered for LTE-A. This paperis organized as follows. In the next section an overview of the LTE Release 8 physical layer(PHY) is provided. This is followed by an overview of evolved UMTS terrestrial radio access (E-UTRA) LTE-A requirements. In the following section a discussion on carrier aggregation is provided. We then provide an overview of DL andUL spatial multiplexing and fundamentals of DLCoMP design. We introduce the concept of heterogeneous networks, with by an emphasis on LTE relays. We compare the performance of LTE Release 8 and LTE-A in the context of IMT-A requirements. Finally, conclusions are drawn in the last section.



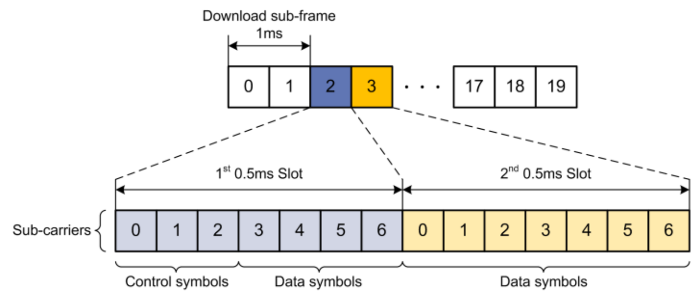
Main requirements of LTE, and LTE-Advanced;

	LTE		LTE-Advanced	
	Downlink	uplink	Downlink	Uplink
Peak spectrum usage efficiency (b/s/Hz)	>5	>2.5	30	15
Average spectrum usage efficiency (b/s/cell)	1.6-2.1	0.66-1.0	2.4-3.7	1.2-2.0
Cell-edge spectrum usage efficiency (b/s/user)	0.04-0.06	0.02-0.03	0.07-0.12	0.04-0.07
Operating bandwidth (MHz)	1.4-2.0		Up to 100	
User plane delay (unidirectional) (ms)	<5		<5	
Connection setup delay (ms)	<100		<50	

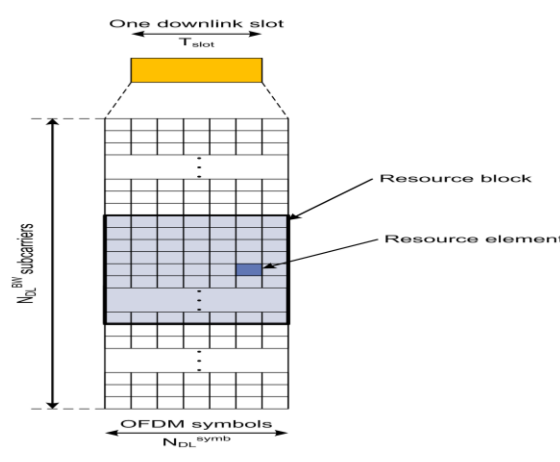
Transmission Techniques in the LTE System

OFDM i.e. Orthogonal Frequency Division Multiplexing plays vital role as the signal bearer and also the associated access schemes, orthogonal frequency division multiple access (OFDMA) and single carrier frequency division multiple access (SC-FDMA).Due to the difference in directions and compatible equipment requirements the actual implementation of the technology will be different in the downlink and the uplink operation. However OFDM was chosen as the signal-bearer format because it is very resilient to interference. It is also a modulation format that is very suitable for carrying high data rates which is one of the key requirements for LTE.

(A)Long-term Evolution OFDMA in the Downlink Direction –The principle of the OFDMA is based on the use of narrow, orthogonal subcarriers .In LTE regardless of the total transmission bandwidththe sub-carriers spacing is kept 15KHz.The transmission is done after a fast fourier transform (FFT) block, which is used to change between the time and frequency domain representation of the signal.Within the OFDM signal it is possible to choose between three types of modulation:QPSK, 16QAM, 64QAM.The duration of the LTE system frame is 10 ms and the system consists of ten sub-frames with two slots each. Within one slot, seven OFDM symbols are transmitted, with a short cyclic prefix, and six OFDM symbols, when a longer cyclic prefix is used.

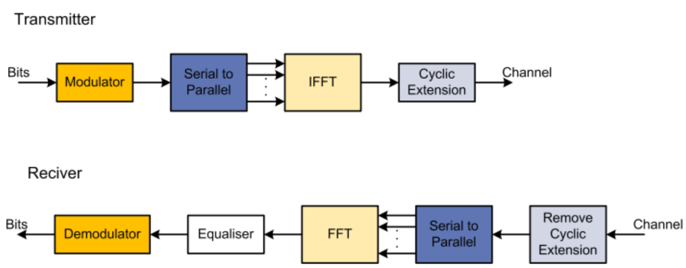


The OFDM signal includes NBW subcarriers. The signal on a single subcarrier in one OFDM symbol is thus of fundamental importance. There are therefore $6N^{BW}$ or $7N^{BW}$ such elements depending on the length of the cyclic prefix.The total resources of a single slot are divided into the so-called physical resource blocks, each being composed of 12 subsequent subcarriers allocated in a given time slot.The physical resource block is the basic unit for radio resource allocation.Figure shows a block diagram of the transmitter and the receiver of the signal in the downlink direction in the case where single antennas are used .A data block from the nth interval of the modulation can result from multiplexing several streams generated by users.Then it is arranged in the radio resource allocation block and the data is mapped in symbols from the constellation of elementary symbols (QPSK, 16-QAM, 64-QAM) which are then attributed to appropriate subcarriers. Signal samples in the time domain are performed with the help of M -point IFFT transformation.



To the head of block of the generated samples the cyclic prefix is added. This prefix is known as the sub-block of the sequence of samples which are copied from the rear of the block (trailer).The signal generated in this way, with the in phase and quadrature components (the real and the imaginary part of the complex block of IFFT samples respectively), is then regenerated into analogform, converted to radio band and increased to be expel by the antenna. The dual process takes place at the receiver side. The cyclic prefix is thus removed when the signal is converted to base band and digital blocks. Using FFT method the sub carrier signal and refrence signal are related to each other. On the basis of estimated characterstics of the transmission channel the FFT output coreesponding to the frequency domain is correlated.The samples interpretated in this way from individual subcarriers are then represented in the constellation points that referto the positions of the symbols mapped in the constellation.

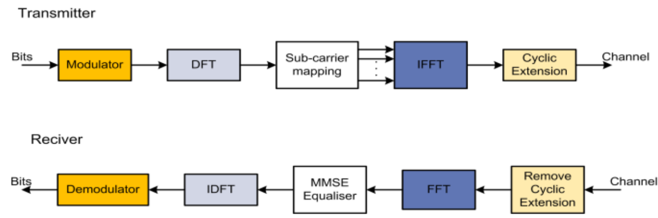
On the basis of symbols the binary block is determined. The final decision on the properly received signal block is included here.



(B) Long-term Evolution SCFDMA in the uplink Direction-

In the LTE uplink, for the access technique a newer concept is used. The implementation is called single carrier frequency division multiple access. Limited power resource derived from the battery energy is a fundamental problem of OFDM. Hence, skilfulness of radio blocks is of main significance of the power enhancer. The OFDM signal is measured by a high value of peak power ratio to average power, which shows the need for a high degree of linearity in the power enhancer and a lessen the average power of transmitted signal with respect to signals for which the peak power ratio to the average ratio is undistinguished. Therefore SC-FDMA is used in the uplink. Thedata which is binary in nature are first mapped into constellation points, and then these constellations are chosen according to the modulation quality. The symbols are then arranged in blocks with the length N. This is treated as a sequence of samples in time domain and then goes under frequency transformation by DFT algorithm.

In SC-FDMA modulator these obtained frequency samples are then mapped. The block of samples which are obtained within the frequency domain is then converted into the time form by the block that performs the IFFT algorithm. The block of samples in time is preceded with a cyclic prefix and to filter the spectral properties the whole block signal are shaped. Dual operations are performed in the receiver.



Transmission Techniques in the LTE-Advanced System-

the focus is on higher capacity: The driving force to further develop LTE towards LTE–Advanced - LTE Release10 was to provide higher bit-rates in a cost efficient way and, at the same time, completely fulfill the requirements set by ITU for IMT Advanced, also referred to as 4G.

1. Increased peak data rate, DL 3 Gbps, UL 1.5 Gbps.
2. Higher spectral efficiency, from a maximum of 16bps/Hz in R8 to 30 bps/Hz in R10.
3. Increased number of simultaneously active subscribers.
4. Improved performance at cell edges, e.g. for DL 2x2 MIMO at least 2.40 bps/Hz/cell.

The main new functionalities introduced in LTE-Advanced are;
Carrier Aggregation (CA), Enhanced use of multi-antenna techniques, Coordinated multipoint (CoMP) transmission and reception, Support for Relay Nodes (RN), Heterogeneous Networks.

CARRIER-AGGREGATION:

The capacity is increased on adding more bandwidth. Since it is important to keep backward compatibility with R8 and R9 mobiles this increase in bandwidth of LTE-Advanced is given through aggregation of R8/R9 carriers. In both FDD and TDD Carrier aggregation is used FDD and TDD.
Bandwidth extension in LTE-A is supported via carrier aggregation. Carrier aggregation allows deployment bandwidths of up to 100 MHz, enabling peak target data rates in excess of 1 GB/s in the DL and 500 Mb/s in the UL to be achieved. In addition, it can be used to effectively support different component carrier types that may be deployed in heterogeneous networks. Carrier aggregation is attractive because it allows operators to deploy a system with extended band- width by aggregating several smaller component carriers while providing backward compatibility to legacy users. Three different types of component carriers are envisioned:

• **Backward-compatible carrier**: All LTE UE can access this type of carrier regardless of the supported release. In this case all of the current.LTE features must be supported.
• **Non-backward-compatible carrier**: Only LTEA UEs can access this type of carrier. This carrier may support advanced features such as control-less operations or the anchor-carrier concept not available to LTE UE.

• **Extension carrier**: The extension of another carrier operates as this type of carrier. It can also be used as, for example, in the presence of high interference from the macro-cell it is used to provide services to home eNBs. As a part of a carrier aggregation set UE can only access this type of carrier. A separate PDCCH is used to address the extension carrier and a separate HARQ process is used.

Each aggregated carrier is also known as a component carrier. The component carrier can have 1.4, 3, 5, 10, 15 or 20 MHz of values for its bandwidth and aggregation of maximum of five component carriers can take place. So 100MHz is the maximum bandwidth. In DL and UL the numbers of aggregated carriers are different, however the number of DL component carriers is never smaller than the number of UL component carriers. The individual component carriers can also have different bandwidths.

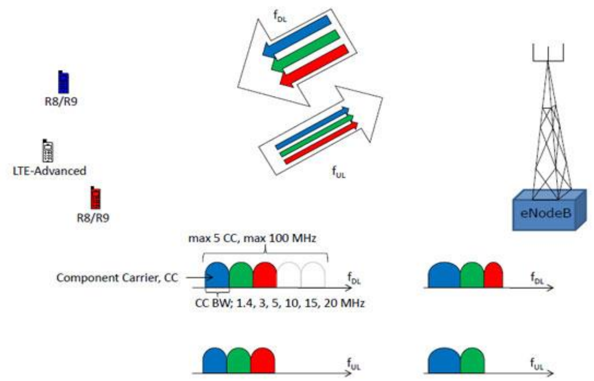


Figure: Carrier Aggregation – FDD the R10 UE can be allocated resources DL and UL on up to five Component Carriers (CC). The R8/R9 UEs can be allocated resources on any ONE of the CCs. The CCs can be of different bandwidths.

Different carrier aggregation configurations for practical reasons – specified by e.g. combinations of the number of component carriers andE-UTRA operating band - are introduced in steps. In R10 there is only one component carrier in the UL (hence no carrier aggregation in the UL)andtwo component carriers in the DL and, in R11 one or two component carriers in the UL andthere are two component carriers DL when carrier aggregation is used. Use of contiguous component carriers within the same operating frequency band is the easiest way of arrangement (as defined for LTE), so called intra-band contiguous. Due to frequency allocation scenarios, this might not be possible. It could either be intra-band, for non-contiguous allocation i.e. the component carriers, are separated by a frequency gap, butbelong to the same operating frequency band or it could be inter-band, in which case the these belong to different operating frequency-bands.

There is a number of serving cells, one for each component carrier when carrier aggregation is used. There is difference in the coverage of the serving cells – due to e.g. component carrier frequencies. The RRC connection is served by the Primary component carrier (DL and UL PCC) and handled by one cell, the Primary serving cell,. The other component carriers are all referred to as Secondary component carrier (DL and possibly UL SCC), serving the Secondary serving cells. In the inter-band CA example shown in last figure, of all the three component carriers, the carrier aggregation is only possible for the black UE, the white UE is not within the coverage area of the red component carrier.

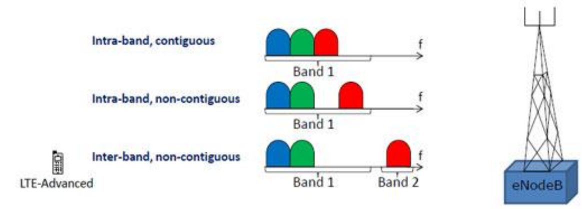


Figure: Carrier Aggregation – Intra- and inter-band alternatives.

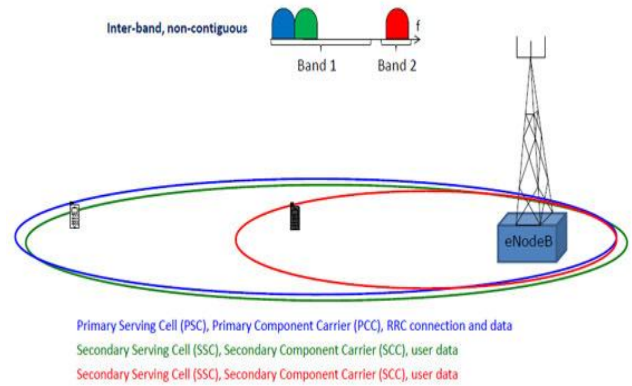


Figure: Carrier Aggregation; Serving Cells Each Component Carrier corresponds to a serving cell. The different serving cells may have different coverage. The MAC and the physical layer protocol are influenced byintroduction of carrier aggregation, but also RRC must be able to make decisions about addition/removal of secondary CC and the RLC buffer must be larger.

Multi-antenna Techniques: To increase the overall bit-rate through transmission of two (or more) different data streams on two (or more) different antennas using the same re-sources in both frequency and time, separated only through use of different reference signals - to be received by two or more antennas MIMO is used.

For increasing the spectral efficiency the important role is played by multiple antenna technique. Advanced multiple antenna solutions help the rising 4G cellular technologies like LTE-Advanced and WiMAX to attain superior peak data-rates over the air interface (e.g., in excess of 100 Mbps for DL and 50 Mbps for UL). In the downlink theLTE advanced specifies up to 8 layers, which enables the 8 x 8 spatial multiplexing in the downlink.

In the UE 8 receivers are required. Similarly for supporting upto 4 transmitters to enable 4 x 4 transmissions in the uplink when combined with 4eNB receivers UE will be required.LTE systems should be changed in order to support up to 8 antennas in LTE-Advanced systems according to the UE specific demodulation reference signal (DMRS) pattern. Further it is used to modify the channel state information reference signals (CSI-RS) and UE feedback in the CSC codebook design. To meet the LTE-Advanced requirements the equivalent changes for downlink control system will have to be incorporated. Relinquish 10 emphasizes on dual layer spatial multiplexing increased by 4 antenna beam streaming as compared to pure8 layer spatial multiplexing approach. This would require 8 receive antennas in the UE for LTE-Advanced systems andwould offer higher peak rates.

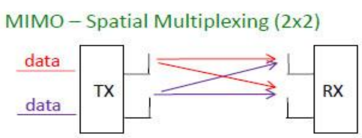
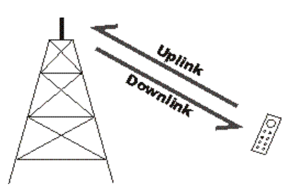


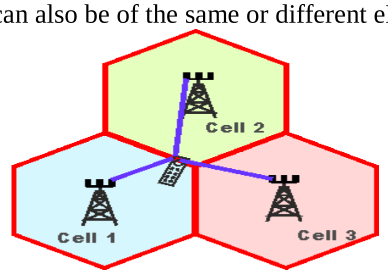
Figure. Simplified illustration of 2x2 MIMO (Spatial Multiplexing). Two different data streams are transmitted on two TX antennas and received by two RX antennas, using the same frequency and time, separated only by the use of different reference signals.

Coordinated multipoint (CoMP) transmission and reception:

LTE-Advanced continues to develope. New CA configurations are contributed (additions of new bands for CA are not bound to specific releases) and there are new features presented in coming releases of the 3GPP specifications, such as Coordinated Multi Point (CoMP) introduced in R11. Theintroduction of CoMP is the main reason to improve network performance at cell edges. In CoMP a number of TX (transmit) points gives coordinated transmission in the Downlink (DL), andin the Uplink (UL) a number of RX (receive) points provide coordinated reception.



A TX/RX-point comprises of a set of co-located TX/RX antennas supplying coverage in the same sector. The set of TX/RX-points used in CoMP can either be at different locations, or co-sited but supplying coverage in different sectors, they can also be of the same or different eNBs.



The coordination can be done for both *homogenous networks* as well as *heterogeneous networks*and CoMP can be done in a number of ways.

CoMP, Coordinated Multipoint falls into two major categories:

Joint processing: Where there is coordination between multiple entities thejoint processing occurs - base stations - that are simultaneously transmitting or receiving to or from UEs.

Coordinated scheduling or beamforming: This is often known as CS/CB (coordinated scheduling / coordinated beamforming) is a form of coordination where a UE is transmitting with a single transmission or reception point - base station. However exchange of control among several coordinated entitiesis made with the communication.

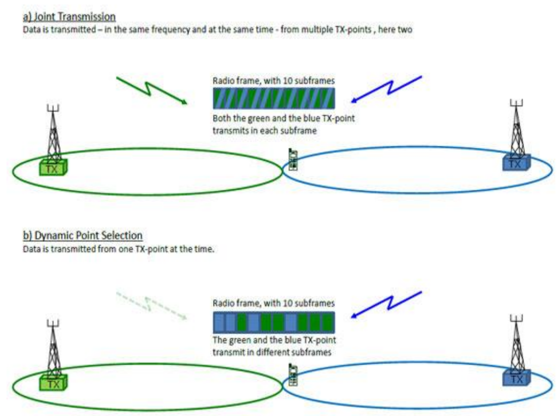


Figure: DL CoMP (a) Joint Transmission; two TX-points transmit to one UE in the same radio resource, (b) Dynamic Point Selection; two TX points are ready to transmit, but only one will be scheduled in each sub-frame.

For the uplink and downlink the techniques used for coordinated multipoint are very different. This results from the fact that the handsets or UEs are individual elements whereas eNBs are in a network, connected to other eNBs.

Downlink CoMP Transmission:

The downlink LTE CoMP needs dynamic coordination amongst various geographically separated eNBs transmitting to the UE. For the downlinkthe two formats of coordinated multipoint are divided:

Joint processing schemes for transmitting in the downlink: From a number of different eNBs, using this element of LTE CoMP, data is transmitted to the UE simultaneously. The objective is to mend the received signal quality and strength. It may also have the objective of actively cancelling interference from transmissions that are intended for other UEs.Form of coordinated multipoint places a high need onto the backhaul network because the data to be transmitted to the UE needs to be sent to each eNB that will be transmitting it to the UE. Depending upon how many eNBs will be sending the datathis may easily double or triple the amount of data in the network. In combination to this, joint processing data needs to be sent between all eNBs included in the CoMP area.

Coordinated scheduling and or beamforming: Using this idea, from one eNBdata to single UE is transmitted. The scheduling decisions as well as any beams are coordinated to control the interference that may be generated. The advantage of this approach is that the requirements for coordination across the backhaul network are considerably reduced for two reasons:

1.UE data does not need to be transmitted from multiple eNBs, and therefore only needs to be directed to one eNB.
2. Only scheduling decisions and details of beams needs to be coordinated between multiple eNBs.

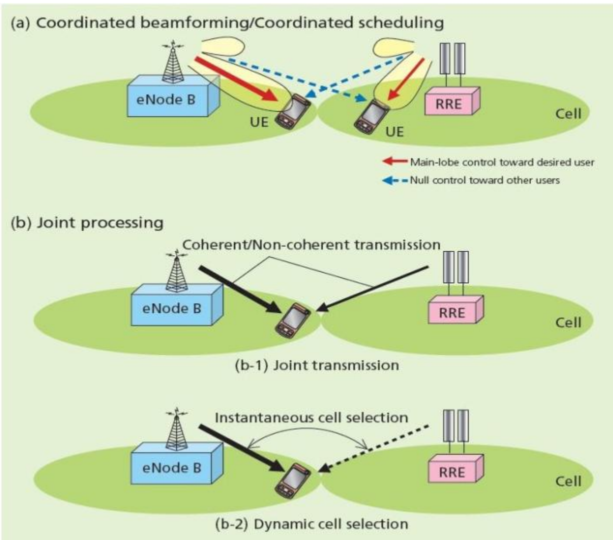


Figure: CoMP transmission in downlink: (a) coordinated Beamforming,(b)Joint processing; (b-1)joint transmission, (b-2) dynamic cell selection (DCS)

Uplink CoMP Reception:

There is for example Joint reception, a number of RX-points receives the UL data from one UE, and the received data is combined to improve the quality. When the TX/RX-points are controlled by different eNBs extra delay might be added, since the eNBs must communicate, for example in order to make scheduling decisions. When CoMP is used additional radio resources for signaling is required e.g. to provide UE scheduling information for the different DL/UL resources.

Joint reception and processing: The basic concept behind this format is to utilize antennas at different sites. By coordinating between the different eNBs it is possible to form a virtual antenna array. The signals received by the eNBs are then combined and processed to produce the final output signal. This technique allows for signals that are very low in strength, or masked by interference in some areas to be receiving with few errors.
The main disadvantage with this technique is that large amounts of data need to be transferred between the eNBs for it to operate.

Coordinated scheduling:
This scheme operates by coordinating the scheduling decisions amongst the ENBs to minimize interference. As in the case of the downlink, this format provides a much reduced load in the backhaul network because only the scheduling data needs to be transferred between the different eNBs that are coordinating with each other.

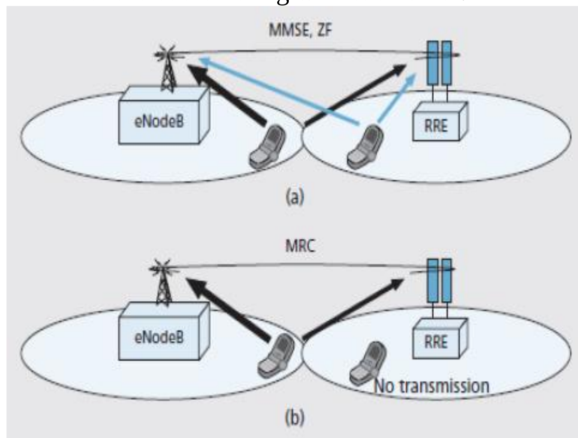


Figure: CoMP reception in uplink: a) multipoint reception with interference rejection combining; and b) multipoint reception with coordinated scheduling

CoMP brings many advantages to the user as well as the network operator-

Makes better utilization of network: By providing connections to several base stations at once, using CoMP, data can be passed through least loaded base stations for better resource utilization.

Provides enhanced reception performance: Using several cell sites for each connection means that overall reception will be improved and the number of dropped calls should be reduced.

Multiple site reception increases received power: The joint reception from multiple base stations or sites using LTE Coordinated Multipoint techniques enables the overall received power at the handset to be increased.

Interference reduction: By using specialized combining techniques it is possible to utilize the interference constructively rather than destructively, thereby reducing interference levels.

RELAYING:

Relaying is one of the features being proposed for the 4 G LTE advanced systems. The aim of LTE relaying is to enhance both coverage and capacity. The idea of relays is not new, but LTE relays and LTE relaying is being considered to ensure that the optimum performance is achieved to enable the expectations of the users to be met while still keeping OPEX within the budgeted bounds.

One of the main drivers for the use of LTE is the high data rates that can be achieved. However all technologies suffer from reduced data rates at the cell edge where signal levels are lower and interference levels are typically higher.

The use of technologies such as MIMO, OFDM and advanced error correction techniques improvised output under many conditions, but do not fully mitigate the problems experienced at the cell edge.

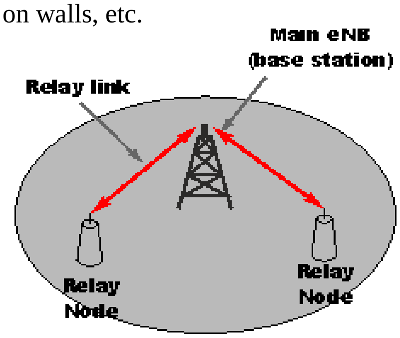
With cell edge performance becoming more critical, some of the technologies are being pushed towards their limits. it is necessary to look at solutions that will improve performance at the cell edge for a comparatively low cost. One solution that is being investigated and proposed is that of the use of LTE relays.

LTE relaying is different to the use of a repeater which re-broadcasts the signal. A relay will actually receive, demodulates and decodes the data, apply any error correction, etc to it and then re-transmitting a new signal. In this way, the signal quality is enhanced with an LTE relay, rather than suffering degradation from a reduced signal to noise ratio when using a repeater. For an LTE relay, 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.

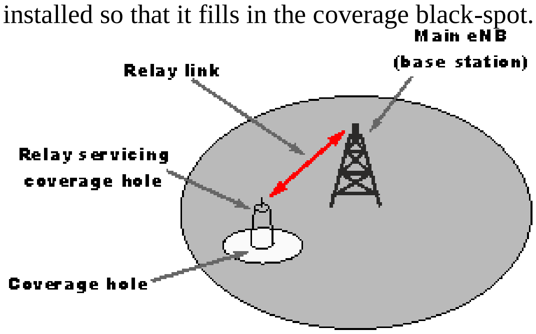
There are a many of scenarios where LTE relay will be advantageous:

Increase network density: LTE relay nodes can be deployed easily in situations where increasing network capacity is the aim by increasing the number of eNBs to ensure good signal levels are received by all users. LTE relays are easy to install as they require no separate backhaul and they are small enabling them to be installed in many convenient areas, e.g. on street lamps, on walls, etc.

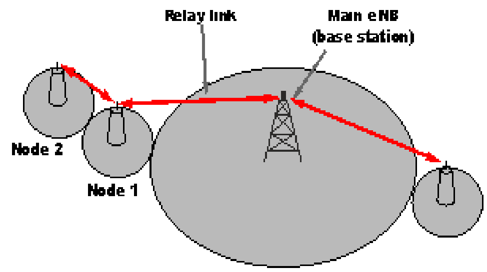


LTE relay used to increase network density

Network coverage extension: LTE relays can be used as a convenient method of filling small holes in coverage. With no need to install a complete base station, the relay can be quickly installed so that it fills in the coverage black-spot.

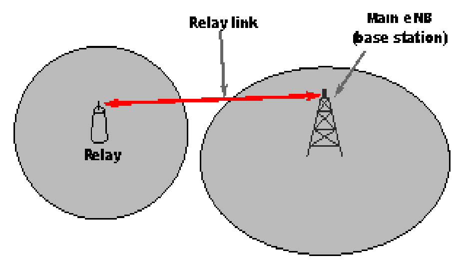


LTE relay coverage extension - filling in coverage hole
Additionally LTE relay nodes may increase the coverage outside main area. With suitable high gain antennas and also if antenna for the link to the donor eNB is placed in a suitable location it will be able to maintain good communications and provide the required coverage extension.



LTE relay coverage extension - extending coverage

It can be noted that relay nodes may be cascaded to provide considerable extensions of the coverage.
Rapid network roll-out: Without the need to install backhaul, or possibly install large masts, LTE relays can provide a very easy method of extending coverage during the early roll-out of a network. More traditional eNBs may be installed later as the traffic volumes increase.



LTE relay to provide fast rollout & deployment

LTE relaying full & half duplex-

LTE relay nodes can operate in one of two scenarios:

Half-Duplex: A half-duplex system provides communication in both directions, but not simultaneously - the transmissions must be time multiplexed. For LTE relay, this requires careful scheduling. It requires that the RN coordinates its resource allocation with the UEs in the uplink and the assigned donor eNB in the downlink. This can be achieved using static pre-assigned solutions, or more dynamic ones requiring more intelligence and communication for greater flexibility and optimization.

Full Duplex: For full duplex, transmission and receiving takes at same time. For LTE relay nodes this is often on the same frequency. The relay nodes will receive, process and then transmit signal on the same frequency with a small delay, although this will be small when compared to the frame duration. To achieve full duplex, there must be good isolation between the transmit and receive antennas.

When considering full or half duplex systems for LTE relay nodes, there is a trade-off between performance and the relay node cost. The receiver performance is critical, and also the antenna isolation must be reasonably high to allow the simultaneous transmission and reception when only one channel is used.

LTE relay types

There is a number of different types of LTE relay node that can be used. However before defining the relay node types, it is necessary to look at the different modes of operation. One important feature or characteristic of an LTE relay node is the carrier frequency it operates on. There are two methods of operation:

Inband: An LTE relay node is said to be "Inband" if the link between the base station and the relay node are on the same carrier frequency as the link between the LTE relay node and the user equipment, UE, i.e. the BS-RN link and the BS-UE link are on the same carrier frequency.

Outband: For Outband LTE relay nodes, RNs, the BS-RN link operates of a different carrier frequency to that of the RN-UE link.

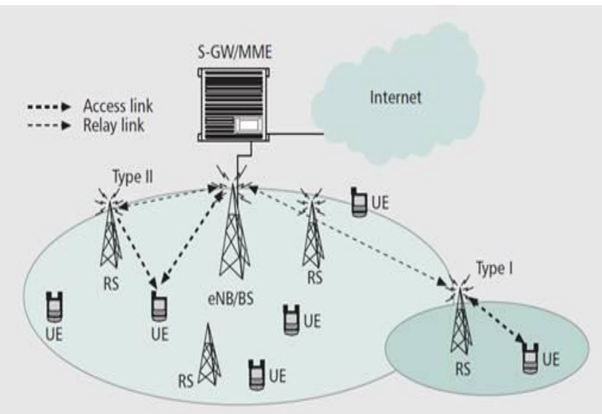


Figure: A network scenario with multiple RSs and multiple UE units.

For the LTE relay nodes themselves there are two basic types that are being proposed, although there are subdivisions within these basic types:

Type 1 LTE (or non transparency) relay nodes: These LTE relays control their cells with their own identity including the transmission of their own synchronization channels and reference symbols. Type 1 relays appear as if they are a Release 8 eNB to Release 8 UEs. This ensures backwards compatibility. The basic Type 1 LTE relay provides half duplex with Inband transmissions. There are two further sub-types-

A. These LTE relay nodes are outband RNs which have the same properties as the basic Type 1 relay nodes, but they can transmit and receive at the same time, i.e. full duplex.

B .This form of LTE relay node is an inband form. They have a sufficient isolation between the antennas used for the BS-RN and the RN-UE links. This isolation can be achieved by antenna spacing and directivity as well as specialized digital signal processing techniques, although there are cost impacts of doing this. The performance of these RNs is anticipated to be similar to that of femtocells.

Type 2 LTE(or transparency)relay nodes: These LTE relaying nodes do not have their own cell identity and look just like the main cell. Any UE in range is not able to distinguish a relay from the main eNB within the cell. Control information can be transmitted from the eNB and user data from the LTE relay. There is still much work to be undertaken on LTE relaying. The exact manner of LTE relays is to be included in Release 10 of the 3GPP standards and specifications.

CONCLUSIONS

One of the primary technologies based on OFDM is LTE Released 8 which is currently being commercialized. LTE Release 8,which is mainly deployed in a macro/microcelllayout, gives improved system capacity and coverage, high peak data rates, low latency ,reduced operating costs, multi-antenna support, flexible bandwidth operation and seamless integrationwith existing systems. LTE-Advanced(also known as LTE Release 10) significantlyenhances the existing LTE Release 8 and supportsmuch higher peak rates, higher throughputand coverage, and lower latencies, resulting in abetter user experience. Additionally

In this paper an overview of the techniques being considered for LTE Release 10 (LTEAdvanced)is discussed. It have bandwidth extension via carrier aggregation to support deployment bandwidth up to 100mhz, downlink spatial multiplexing including single-cell multi-user multiple-input multiple-output transmission and coordinated multi point transmission, uplink spatial multiplexing including extension to four-layer MIMO, and heterogeneous networks with emphasis on Type 1 and Type 2 relays. Finally, the performance of LTE-Advanced using IMT-A scenarios is presented and compared against IMT-A targets for full buffer and bursty traffic model.

Reference

[1] Jolly Parikh, Anuradha Basu Bharati Vidyapeeth's College Of Engineering Delhi, India.
[2]Amitava GHOSH, RAPEEPAT RATASUK, BISHWARUP MONDAL, NITIN MANGALVEDHE,AND TIM THOMAS, MOTOROLA INC.
[3]*Jeanette Wannstrom, for 3GPP*
[4] D.M.Sacristan, Jose F.Monserrat. J.Penuelas, et al., 2009, "On the way towards fourth-generation mobile: 3GPP, LTE and LTE-Advanced", EURASIP Journal on Wireless Communications and Networking, June 2009, article ID 354089.
[5] Daewon Lee and HanbyulSeo, LG Electronics Bruno Clerckx, Samsung Electronics Eric Hardouin, Orange Labs David Mazzarese, Huawei Technologies Satoshi Nagata, NTT DOCOMO Krishna Sayana, Motorola Mobility
[6] Ahmed Latrach, RaouiaNasri, and SofièneAffes INRS-EMT, 800, de la Gauchetière W., Suite 6900, Montreal, QC, H5A 1K6, Canada