

# LTE ADVANCED

Iván Corral Viñas



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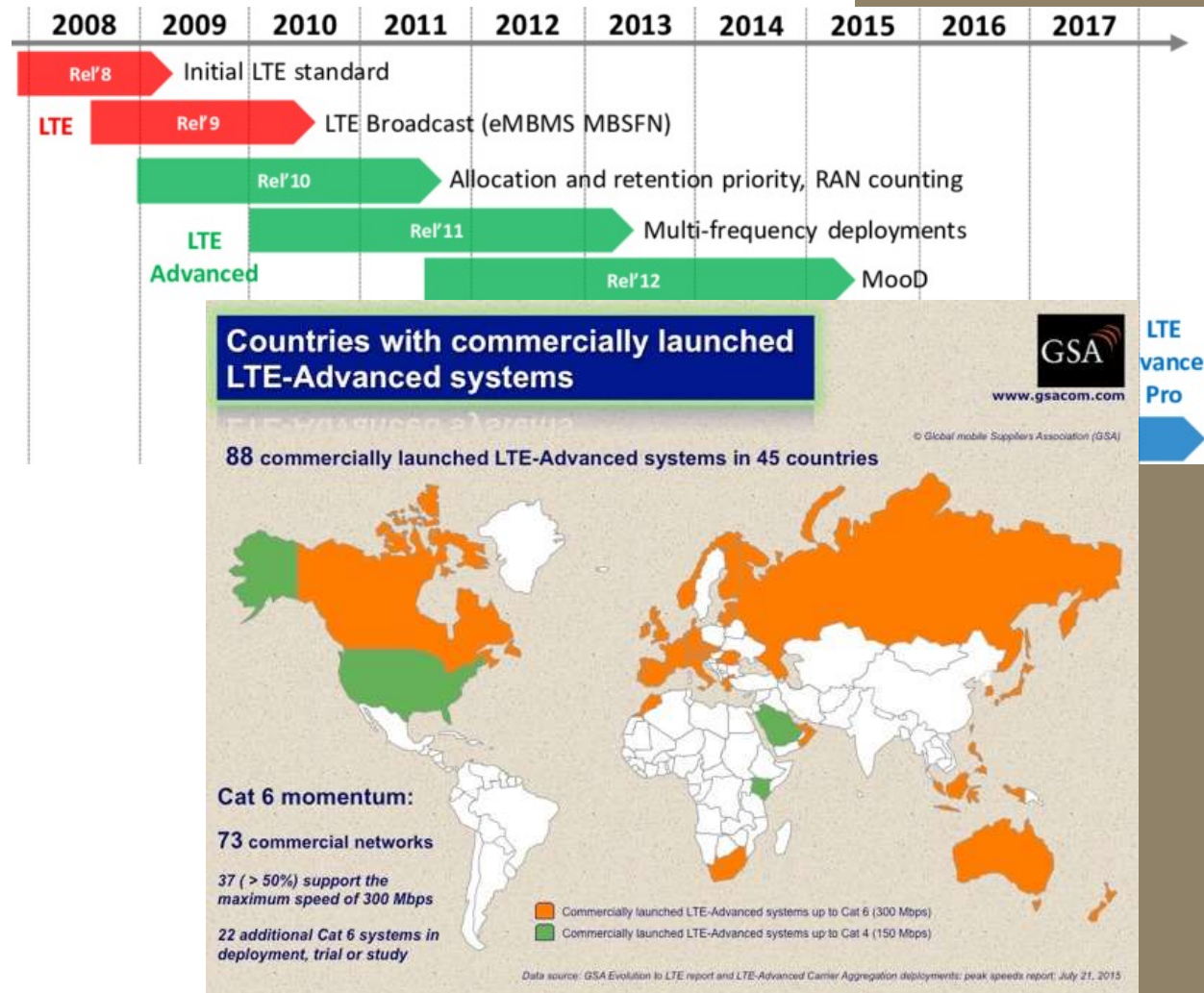
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# INTRODUCTION

LTE Advanced (LTE+) is a mobile communication standard and a major enhancement of the Long Term Evolution (LTE) standard.

It was formally submitted as a candidate 4G to ITU-T in late 2009  
It was standardized by 3GPP in 2011



# CHARACTERISTICS



## PEAK DATA RATE

Dnlink: 1 Gbps  
Uplink: 500 Mbps



## SPECTRUM

x3 efficiency compared to LTE.  
Supports scalable bandwidth use  
& spectrum aggregation



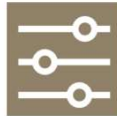
## LATENCY

Conection time: 50 ms  
Packet transmission:: <5 ms



## THROUGHPUT

Cell Edge user: x2  
Average user: x3



## ACCESS POINTS

OFDMA  
SC-FDMA



## COMPATIBILITY

LTE+ can internetwork with  
LTE and 3GPP legacy  
systems

CHARACTERISTICS

	UMTS	HSPA+	LTE	LTE+
DL Speed	384 kbps	1-28 Mbps	10-100 Mbps	1 Gbps
UL Speed	128 kbps	11 Mbps	5-50 Mbps	500 Mbps
Latency	150 ms	50 ms	10 ms	<5 ms
Access Methdology	CDMA	CDMA	OFDMA & SC-FDMA	OFDMA & SC-FDMA

## EVOLVED PACKET CORE

It is based on IP and supports voice connections using voice over IP (VoIP) via packet switching.

It supports user equipment security and receives and sends packets between the base stations and the core network.

## EVOLVED UMTS TERRESTRIAL RADIO ACCESS NETWORK

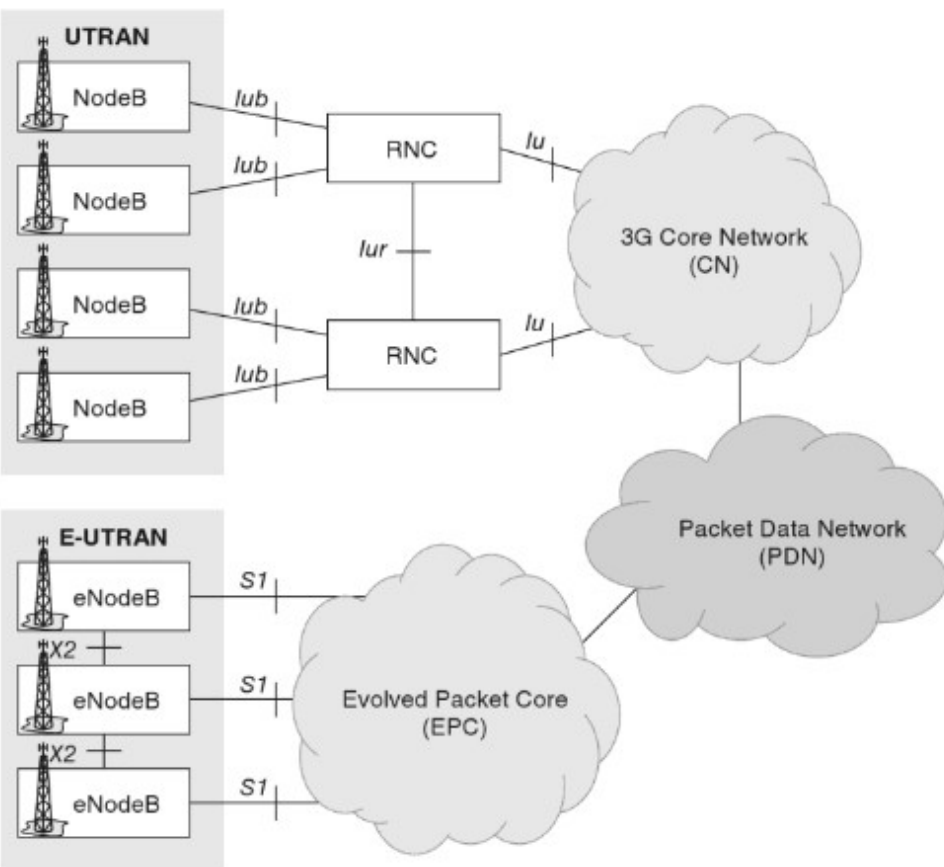
It gives IP connectivity to the terminal for both data and voice services.

All radio functionalities are situated there.

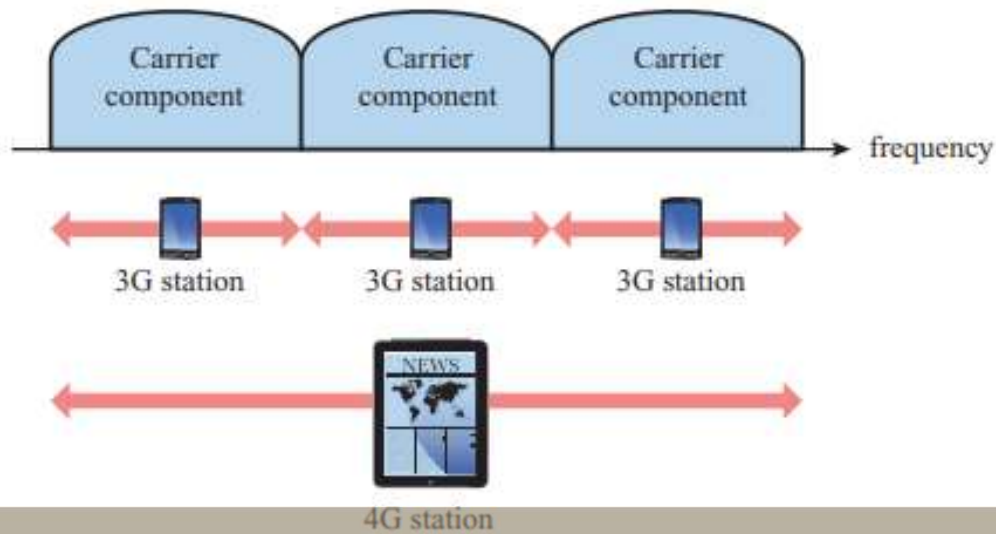
## USER EQUIPMENT

End-User Terminal.

UE category	Max. data rate (DL/UL) (Mbps)	Downlink				Uplink		
		Max. # DL-SCH TB bits/TTI	Max. # DL-SCH bits/TB/TTI	Total soft channel bits	Max. # spatial layers	Max. # UL-SCH TB bits/TTI	Max. # UL-SCH bits/TB/TTI	Support for 64 QAM
Category 1	10/5	10296	10296	250368	1	5160	5160	No
Category 2	50/25	51024	51024	1237248	2	25456	25456	No
Category 3	100/50	102048	75376	1237248	2	51024	51024	No
Category 4	150/50	150752	75376	1827072	2	51024	51024	No
Category 5	300/75	299552	149776	3667200	4	75376	75376	Yes
Category 6	300/50	[299552]	[TBD]	[3667200]	*	[51024]	[TBD]	No
Category 7	300/150	[299552]	[TBD]	[TBD]	*	[150752/102048 (Up to RAN4)]	[TBD]	Yes/No (Up to RAN4)
Category 8	1200/600	[1200000]	[TBD]	[TBD]	*	[600000]	[TBD]	Yes



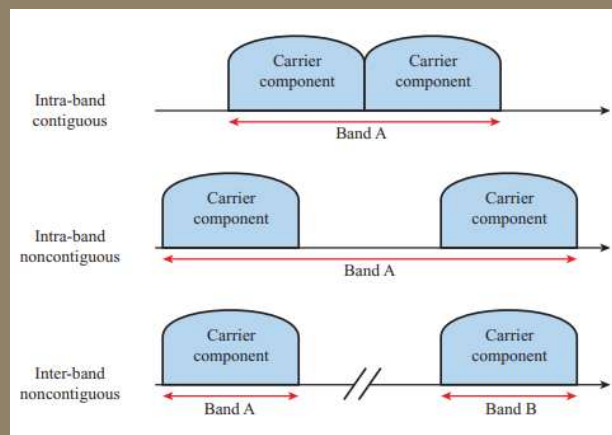
# CARRIER AGGREGATION



Carrier aggregation (CA) is used in LTE-Advanced to increase the **bandwidth** and increase the **bit rates**.

To keep compatibility, **LTE carriers** are used. Each one is known as Component Carrier.

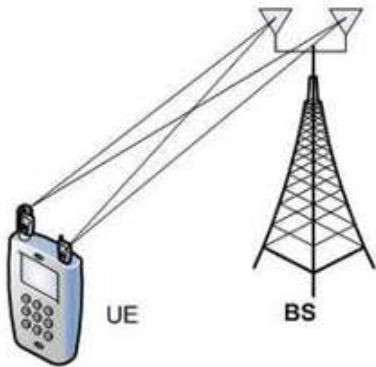
Carrier bandwidth is of 1.4, 3, 5, 10, 15, or 20 MHz and a maximum of five component carriers can be aggregated



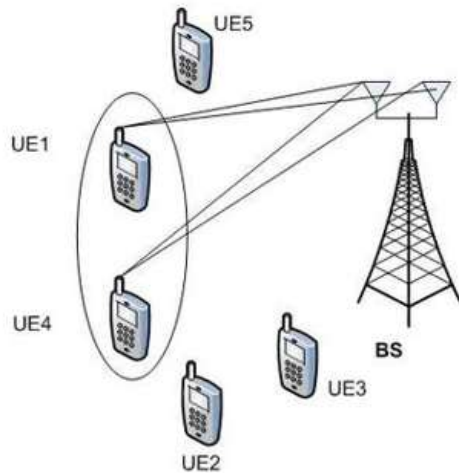
Physical and MAC layer protocols are affected by carrier aggregation

# ENHANCED MIMO

SU-MIMO



MU-MIMO



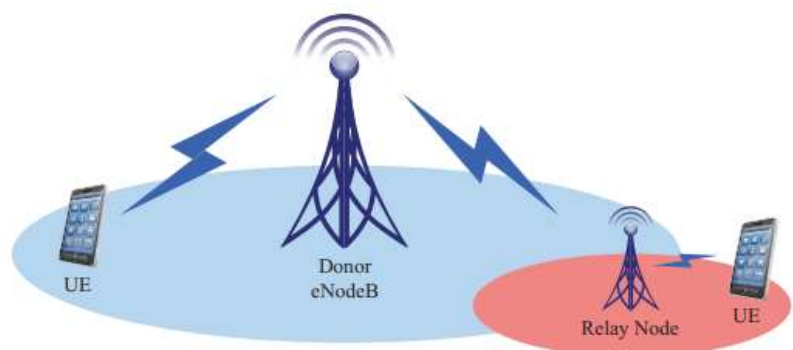
For LTE-Advanced single-user MIMO, up to **eight** separate transmissions can be sent on the downlink to the same UE (in LTE it was up to four).

As we have multiple users, Downlink reference signals are keys to MIMO functionality:

- **Rank Indicator (RI):** Recommended number of layers for SU-MIMO transmission.
- **Precoding matrix indicator (PMI):** Index into a codebook of matrices used at the base station
- **Channel Quality Indicator (CQI):** Index to table of recommended modulation and coding schemes.



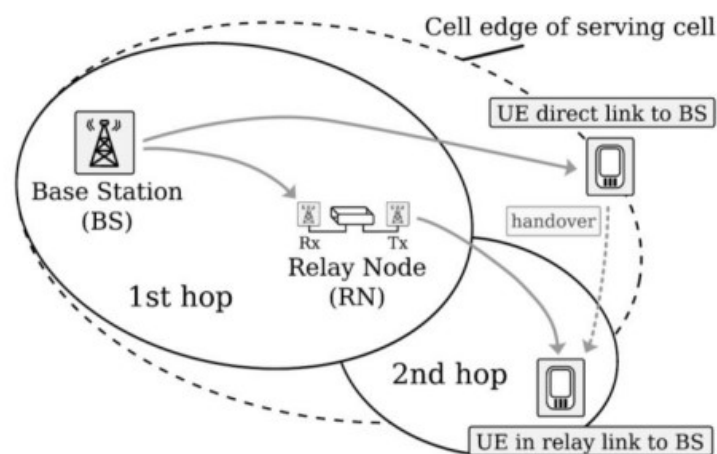
# RELAYING NODES



An LTE-Advanced base station experiences reduced data rates near the edge of its cell, due to lower signal levels and higher interference levels. Instead of reducing cell size, small relay nodes, were distributed around the periphery.

The Relay Node receives, demodulates, and decodes the data and applies error correction as needed, and then transmits a new signal to the base station.

RNs can use out-of-band communication using microwave links or inband Communication to avoid interferences.





## CONCLUSION

LTE+ uses the same architecture as LTE, but thanks to the technology evolution, it could reach the 4G features defined by the 3GPP.

3GPP: LTE-Advanced.

<https://www.3gpp.org/technologies/keywords-acronyms/97-lte-advanced>

Jyrki T. J. Penttinen: The LTE-Advanced Deployment Handbook: The Planning  
Guidelines for the Fourth Generation Networks

[https://books.google.es/books?hl=es&lr=&id=H67QCgAAQBAJ&oi=fnd&pg=PA59&dq=lte+advanced+architecture&ots=19Tjt97MJ5&sig=Tw3lfiVK6Onf9m-W8wYtsrnA\\_Mg#v=onepage&q=lte%20advanced%20architecture&f=false](https://books.google.es/books?hl=es&lr=&id=H67QCgAAQBAJ&oi=fnd&pg=PA59&dq=lte+advanced+architecture&ots=19Tjt97MJ5&sig=Tw3lfiVK6Onf9m-W8wYtsrnA_Mg#v=onepage&q=lte%20advanced%20architecture&f=false)

Fourth Generation Systems and LTE-Advanced.

<https://www.cs.uoi.gr/~epap/LO5/downloads/lt/LTE.pdf>

everythingRF: What is LTE-A?

<https://www.everythingrf.com/community/what-is-lte-a>