

5G 載波聚合基本觀念

元智大學 李建育助理教授



Agenda

- Status of carrier aggregation
- RF aspects of carrier aggregation
- New topic of carrier aggregation

Shannon's Law

Still ways to improve system capacity



Number of
antennas



More
spectrum



E.g. Mitigate
interference

$$\text{Capacity} \approx n \cdot W \cdot \log_2 \left(1 + \frac{\text{Signal}}{\text{Noise}} \right)$$



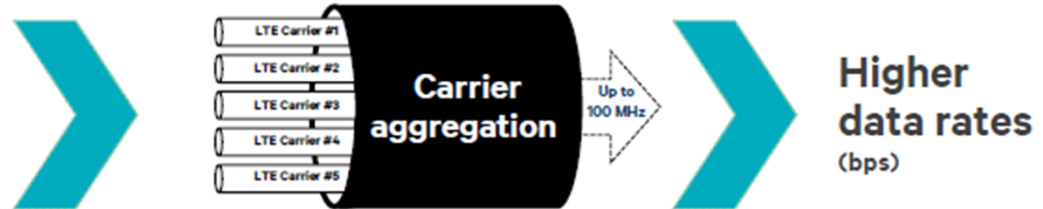
- *Increase number of antennas* : MIMO, Massive MIMO,...
- *Increase bandwidth* : Carrier aggregation, towards millimeter-wave,...
- *Improve SNR* : eICIC, antenna array,...

[Ref] : “LTE Advanced – Evolving and expanding in to new frontiers”, Qualcomm, Aug. 2014

LTE Advanced brings different dimensions of improvements

Leverage wider bandwidth

Carrier aggregation across multiple carriers, multiple bands, and across licensed and unlicensed spectrum



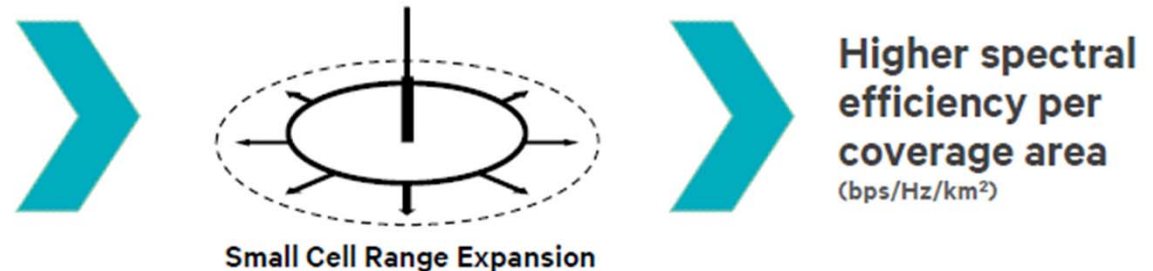
Leverage more antennas

Downlink MIMO up to 8x8, enhanced Multi User MIMO and uplink MIMO up to 4x4



Leverage HetNets

With advanced interference management (FeICIC/IC)



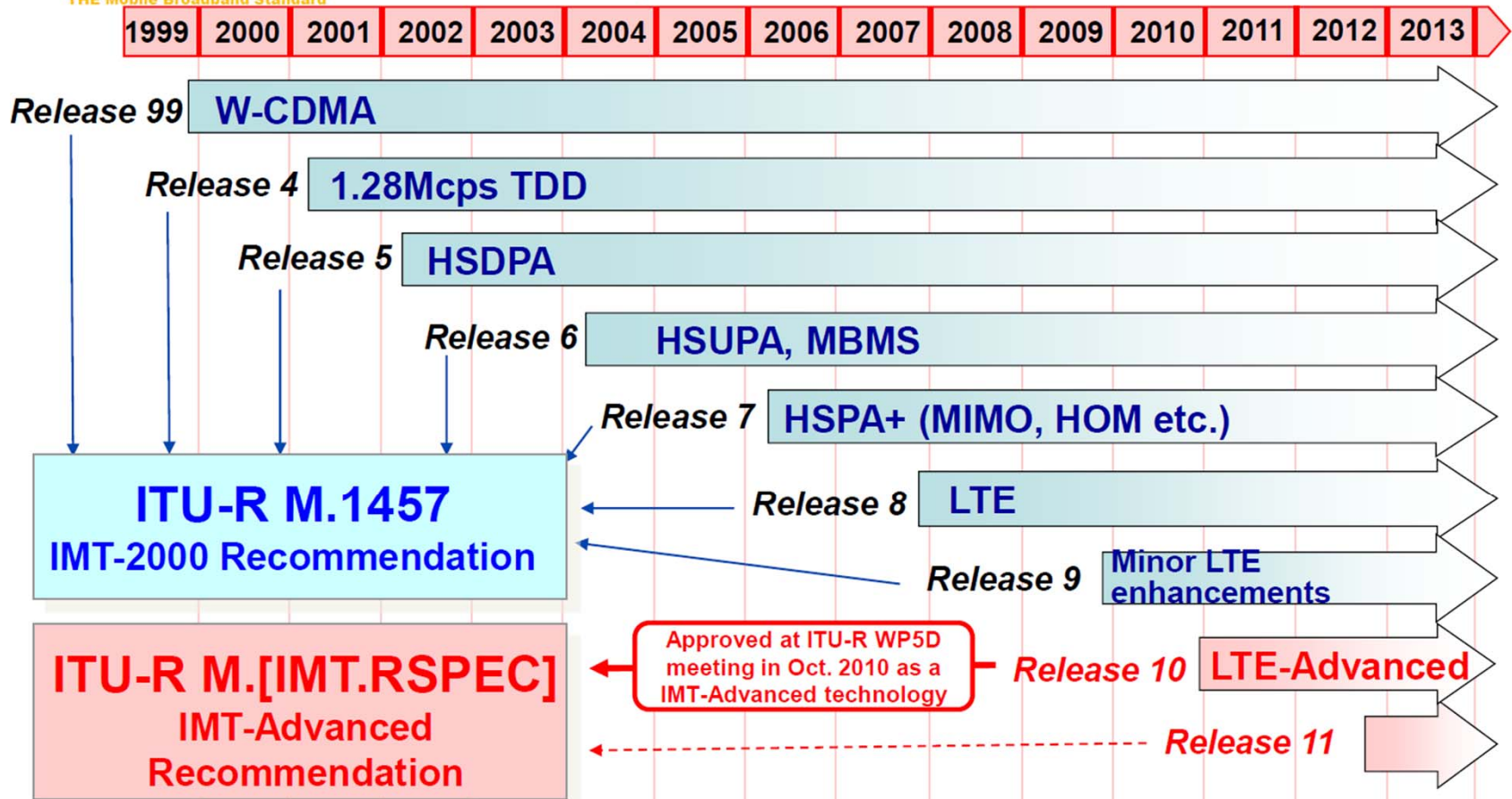
[Ref] : “LTE Advanced – Evolving and expanding in to new frontiers”, Qualcomm, Aug. 2014

3GPP Spec.

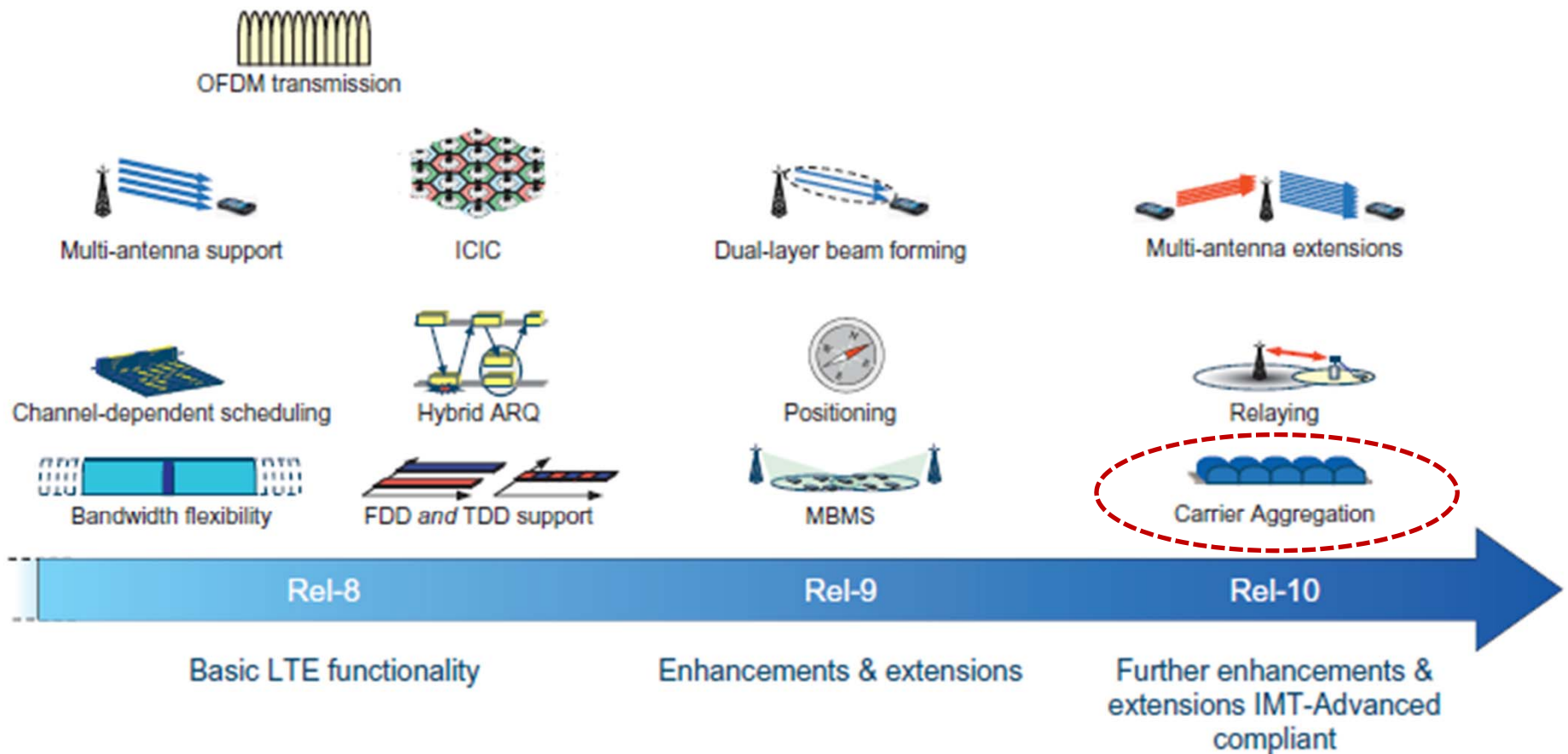


THE Mobile Broadband Standard

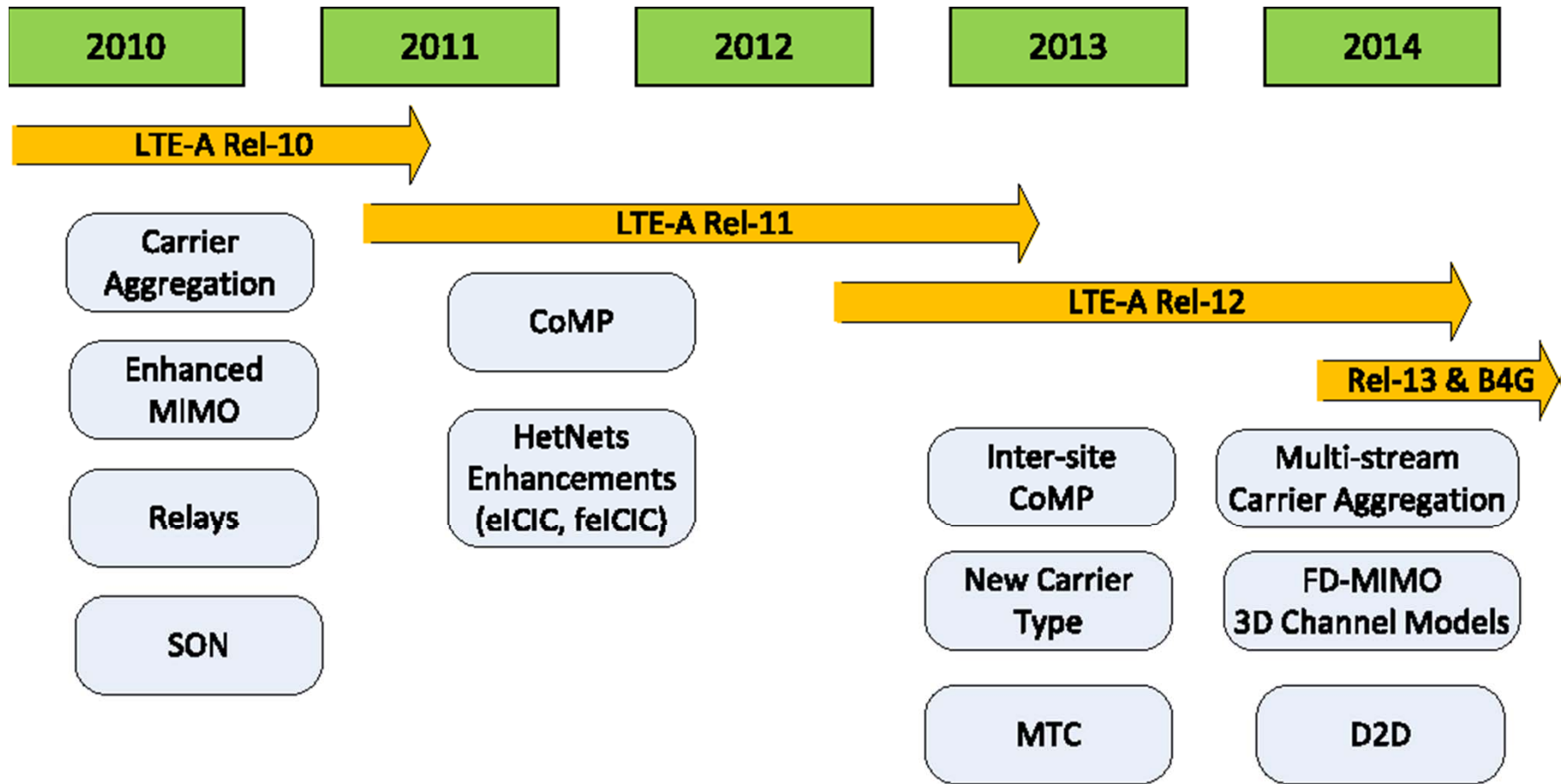
Releases of 3GPP Specifications



LTE Evolution

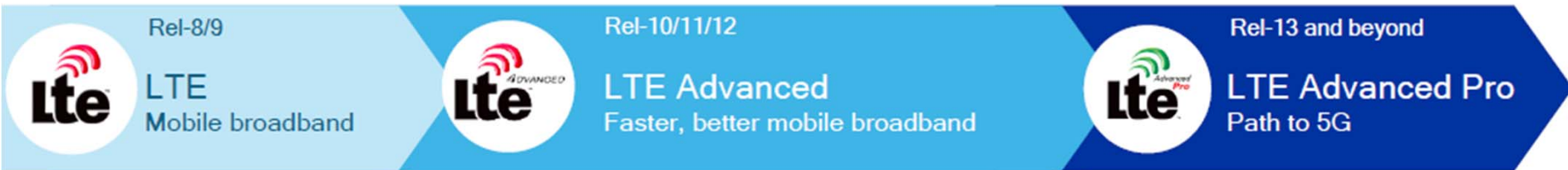


LTE Evolution (cont.)



LTE Advanced: part of a rich roadmap of LTE technologies

2012 2013 2014 2015 2016 2017+ 2018+



Achieving Gigabit Class LTE

Carrier Aggregation (CA)
FDD/TDD CA
LTE-U / LAA
256-QAM
Advanced MIMO

Providing enhanced HetNets

Interference management
Best use of all spectrum
Dual connectivity
Coordinated multipoint
SON+

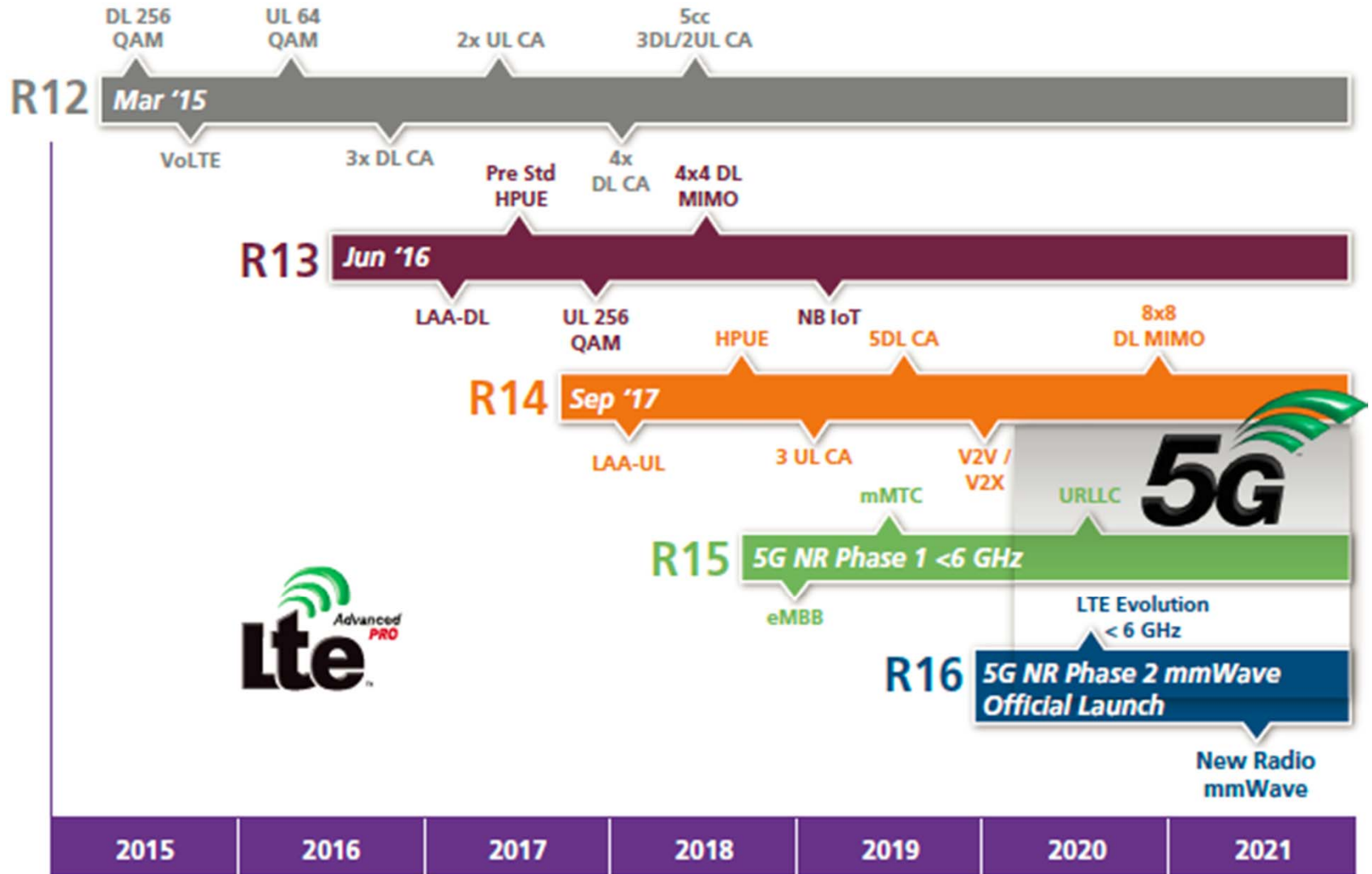
Bringing new ways to connect

LTE Broadcast
LTE Direct (D2D)

Note: Estimated commercial dates. Not all features commercialized at the same time.

5

3GPP RAN Standardization Timeline



3GPP Overall Timeline & Release Features

