

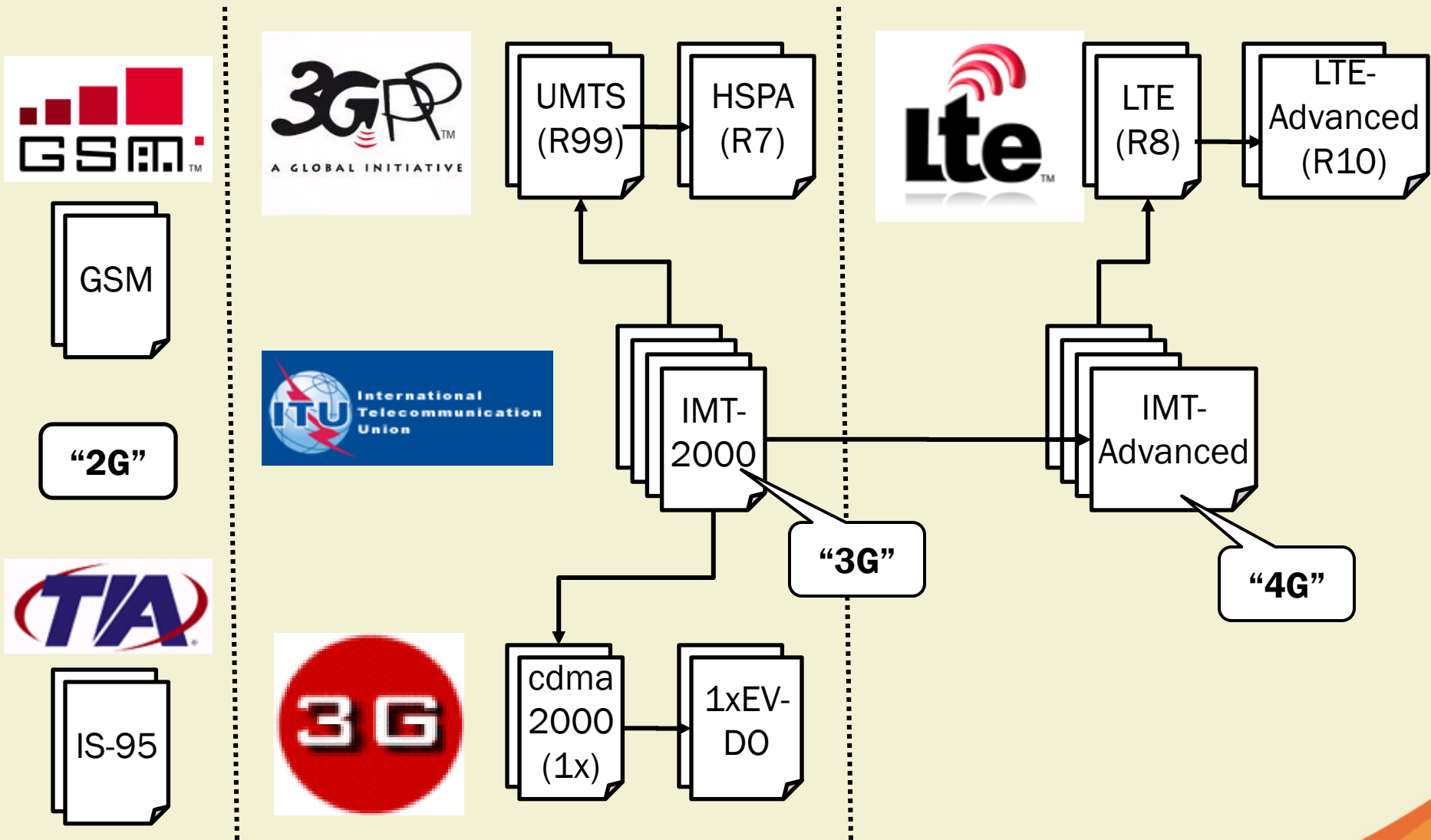
Upcoming Enhancements to LTE: R9 – R10 – R11!

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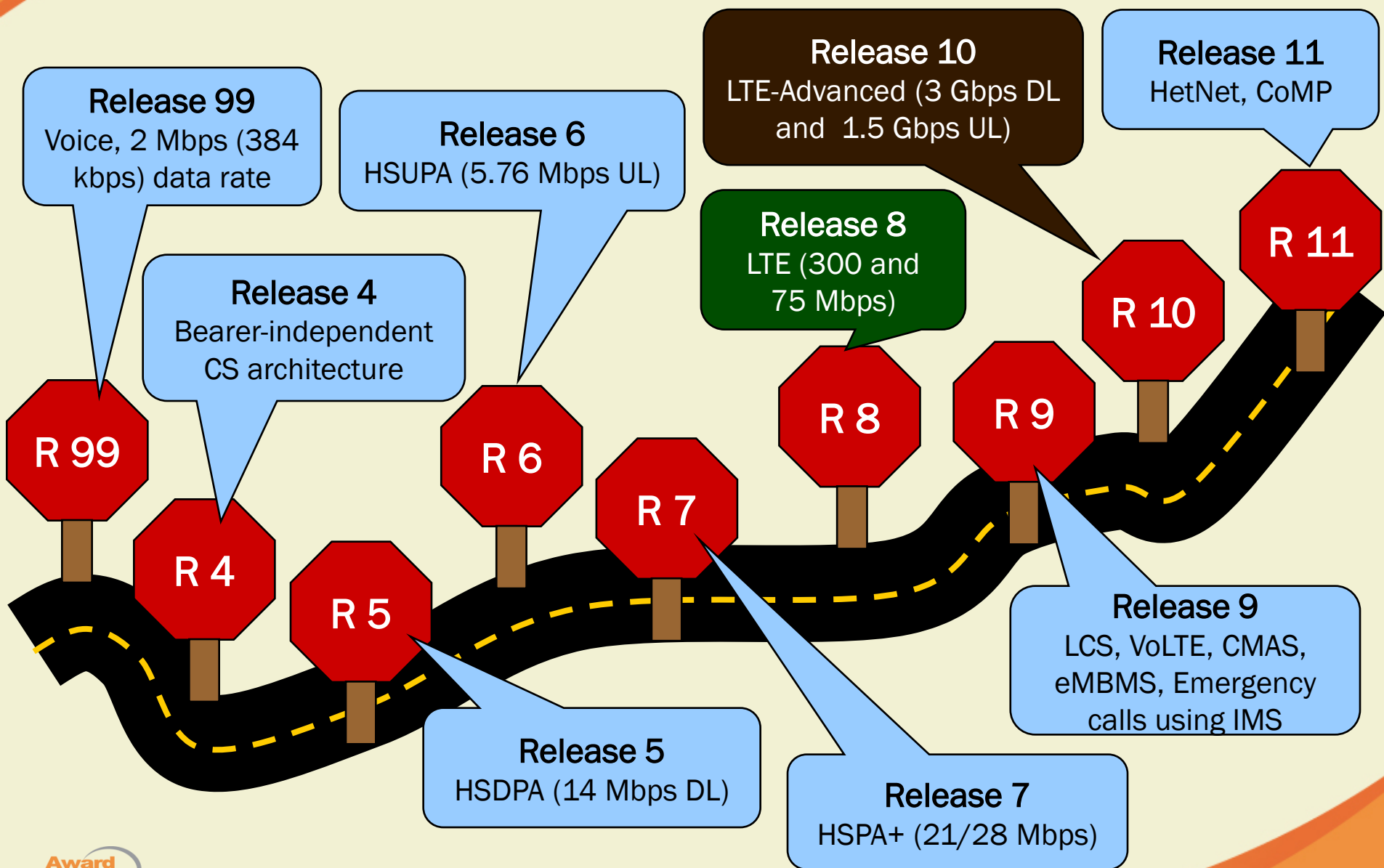
Award Solutions

- Dallas-based wireless training and consulting company
 - Privately held company founded in 1997
- Deliver nationwide training programs for most major operators in North America
 - LTE, UMTS-HSPA, EVDO, IP, Ethernet, MPLS, IMS, ...
- Often provide consulting help to operators when rolling out new technologies
 - Writing technical sections of RFPs, comparing RFP responses, defining KPIs, acceptance test plans, etc.
- Vendor-agnostic, unbiased provider of technical expertise

Evolution to 4G Standards



3GPP Evolution: Toward LTE-Advanced



Voice Options for LTE

How do we support Voice Calls?

Circuit-Switched Fallback

- Circuit-Switched call
- At call setup, push over to CS domain
- IMS is not required

Single-Radio Voice Call Continuity

- VoIP call
- Handover from VoIP in LTE to Circuit Switched (UMTS/1x)
- IMS Based

Voice over LTE (VoLTE)

- VoIP in LTE using IMS
- SMS over IP using IMS
- Industry-wide initiative



Circuit Core



IMS



IMS

VoLTE: What and Why



Goals: 1. Simplify 2. Common VoIP Solution

Basic IMS:
Too many features
(not all needed in
deployment)

IMS Too Flexible:
Multiple ways of
doing same task
(e.g., authentication)

Areas of Focus

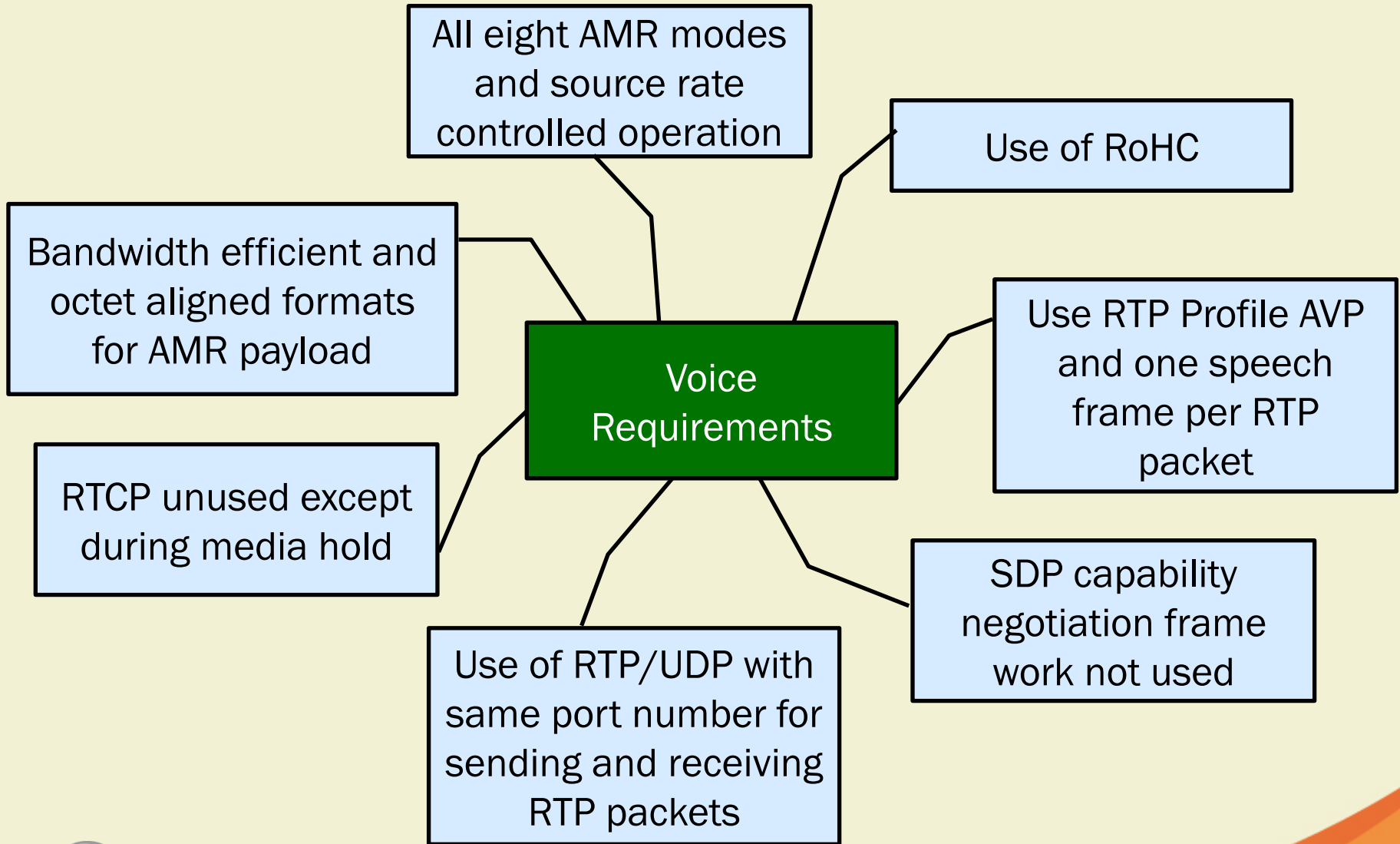
Basic Functions
and Supplementary
Services
(Ex: IMS-AKA for
authentication)

Media
Characteristics
(Ex: AMR Codec)

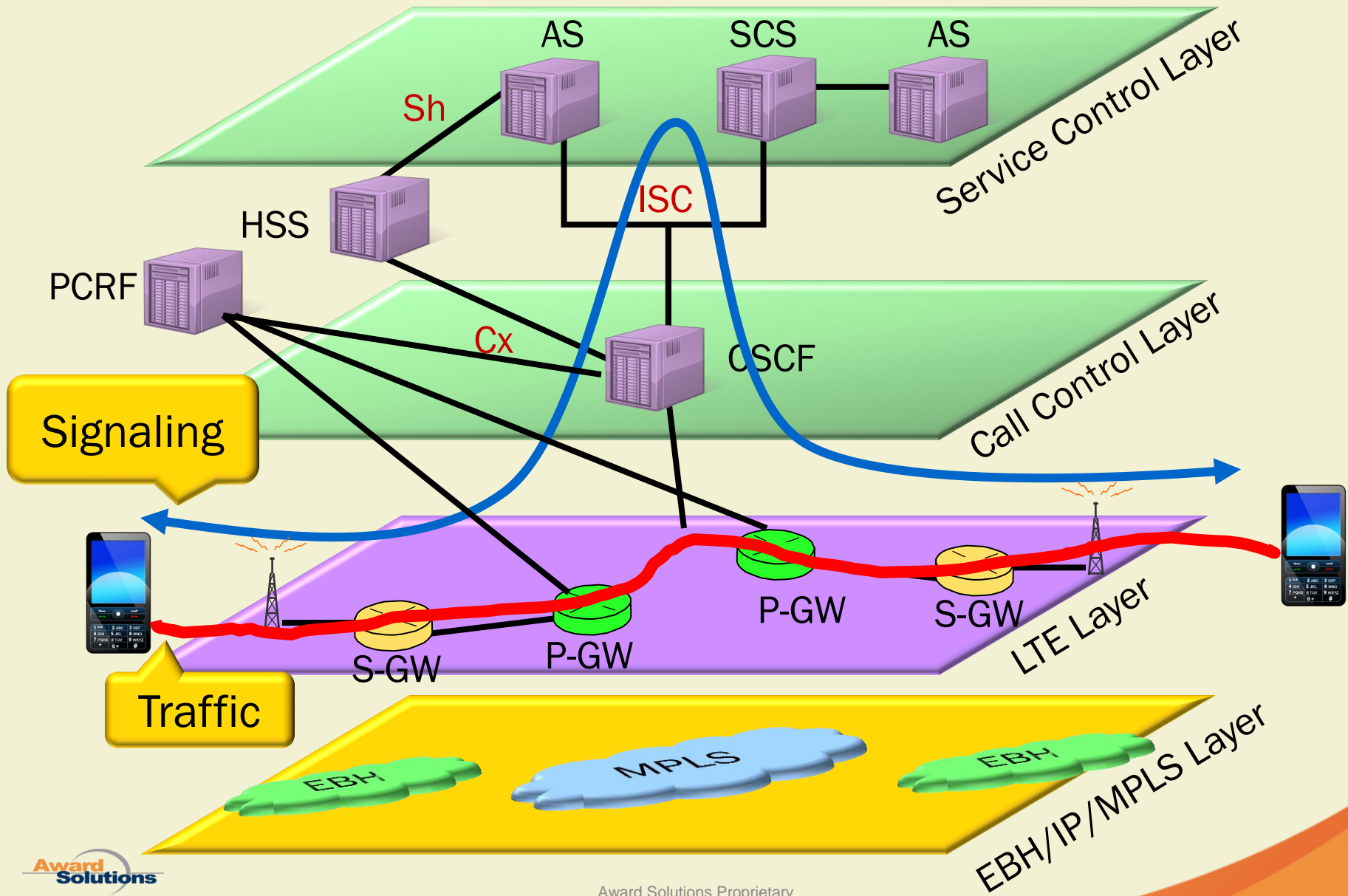
EPS
Capabilities
(Ex: RoHC)

Common
Functions
(Ex: IPv4 and
IPv6 support)

Media for VoLTE



Delivering Services (e.g. voice) Using IMS



Location Services (LCS)

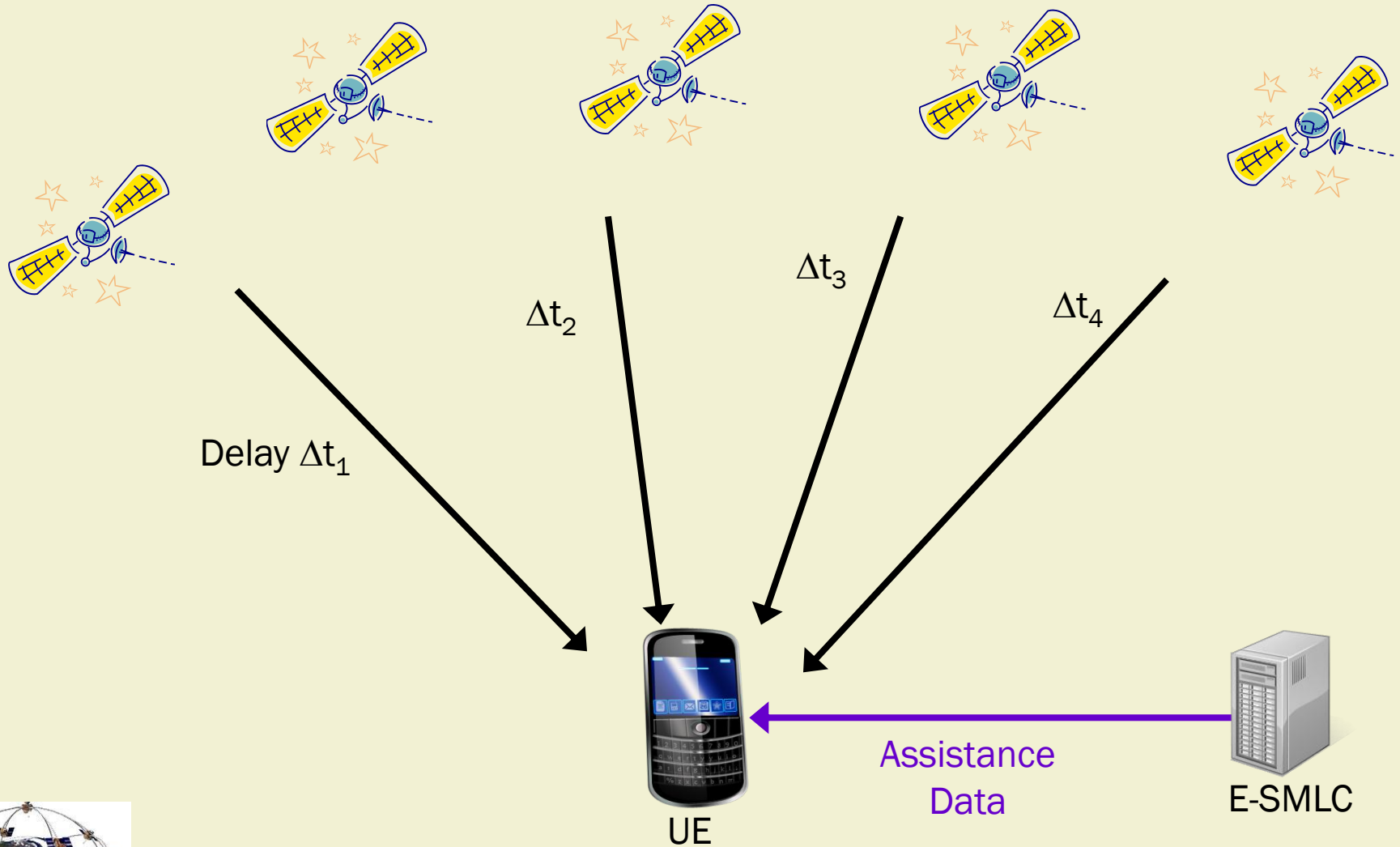
Types of Services

- Value Added Services
- Emergency Services
- PLMN Operator Services
- Lawful Intercept

How do you determine Location?

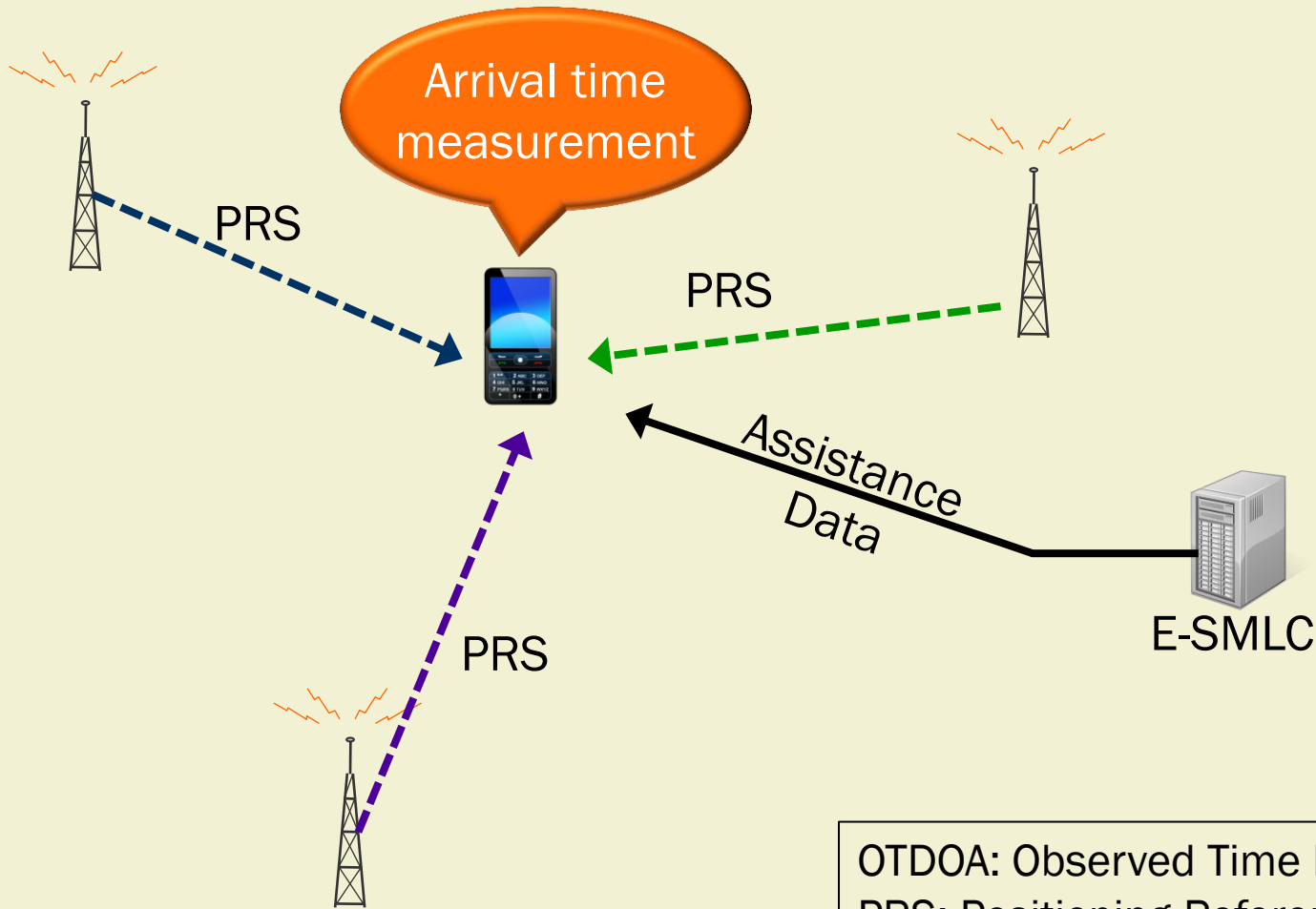
- Assisted GPS (A-GPS)
- Observed Time Difference of Arrival (OTDOA)
- Enhanced Cell ID (E-CID)

Assisted GPS (A-GPS) Method



Three satellites needed for 2D position, four for 3D

OTDOA



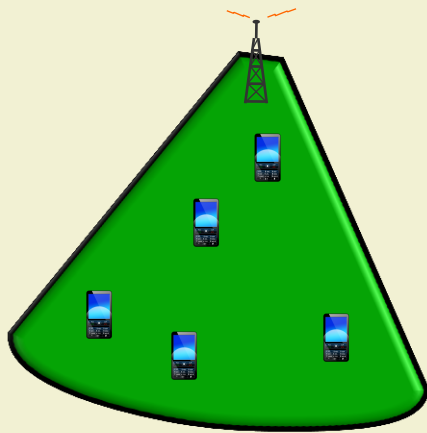
OTDOA: Observed Time Difference Of Arrival
PRS: Positioning Reference Signals

At least 3 cells needed to position the UE

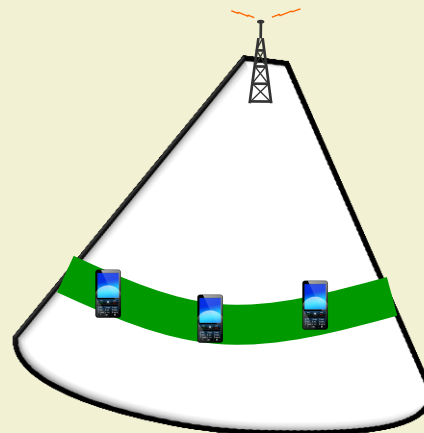
E-CID – AoA and RSRP Map

1. Angle of Arrival (AoA) enhancement

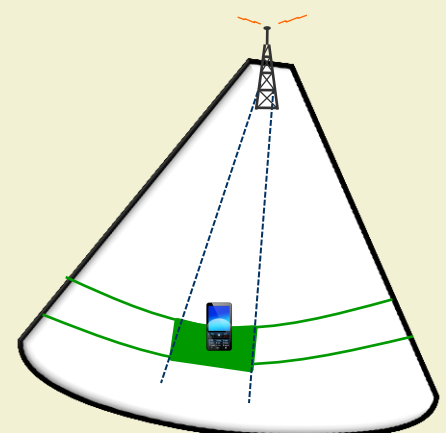
- eNB estimates the direction UE signals come from
- Builds on RTT measurements



Basic Cell ID



Cell ID + RTT



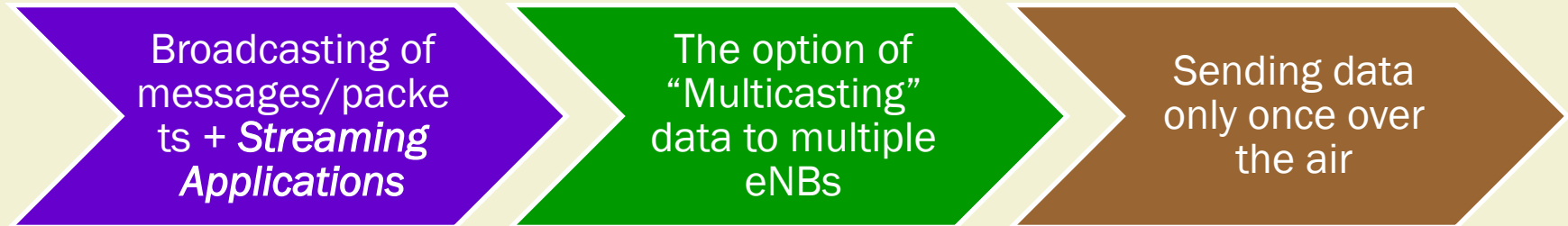
Cell ID + RTT + AoA

2. RSRP Map enhancement

- Matches the UE's signal strength to location

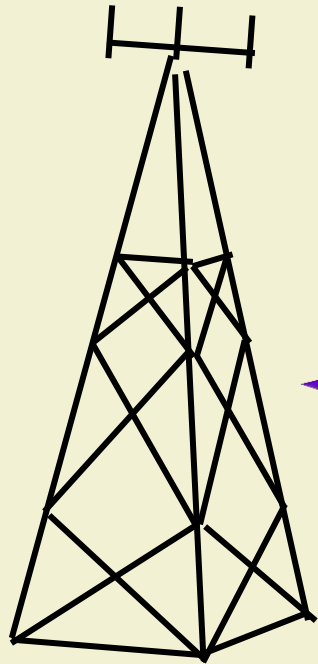


Multicast Broadcast in LTE



Parameters	Values
Bandwidth (MHz)	1.4, 3, 5, 10, 15, 20
Subframe duration	1 ms
OFDM symbols per slot	Only 6
Modulation schemes	QPSK, 16QAM, 64QAM
MIMO scheme	Only a single antenna

What's New with eMBMS?



SIB 2
MBSFN Subframe Config

Updated for eMBMS
(identifies eMBMS
subframes)

SIB 13
MBSFN Area Information List
MBSFN Notification Config

Location of the
eMBMS channels

Physical MBMS Channel
MBSFN Area Configuration Message
Broadcast Data

eMBMS Data

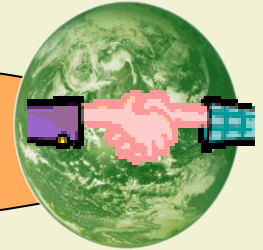


Requirements of IMT-Advanced



Very High Data Rates
(1 Gbps for low mobility,
100 Mbps for high mobility)

Interworking and
Global Roaming

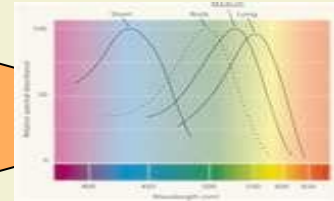


Enhanced Capacity

~40 VoIP users per sector/MHz)



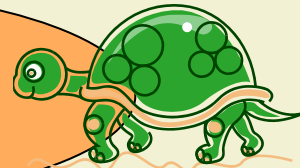
Wider Spectrum
(Up to 40 or 100
MHz)



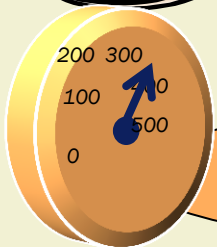
High Spectral Efficiency
(Peak: 15 or 6.75 bits/s/Hz)



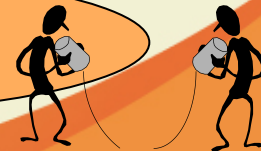
Low Latency
U-plane: < 10 ms
C-plane: < 100 ms



Mobility up to 350
km/hr



Handover Interruption
(27.5 or 40 ms)



LTE-Advanced Targets



High Data Rates

DL: 3 Gbps,
UL: 1.5 Gbps

Mobility

Up to 350 or 500 Kmph

Low Latency

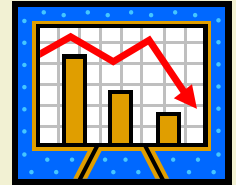
< 50 ms (Idle → Connected),
< 10 ms (Dormant to Active in
Connected)

Spectral Efficiency

DL: 30 bits/sec/Hz
UL: 15 bits/sec/Hz

Low Cost

- Deployment cost of infrastructure and UE cost
- Power efficiency
- LTE-based backhaul
- SON optimization



New Spectrum Support

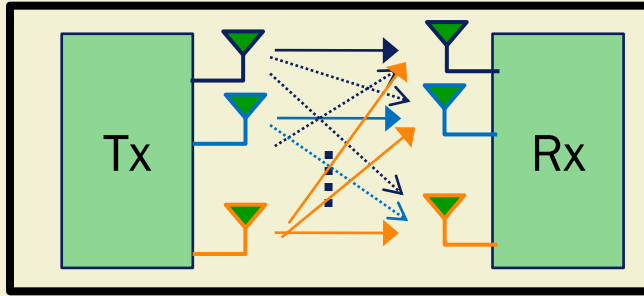
Examples:

- 450 to 470 MHz band
- 3.4 to 4.2 GHz band

Better than IMT-

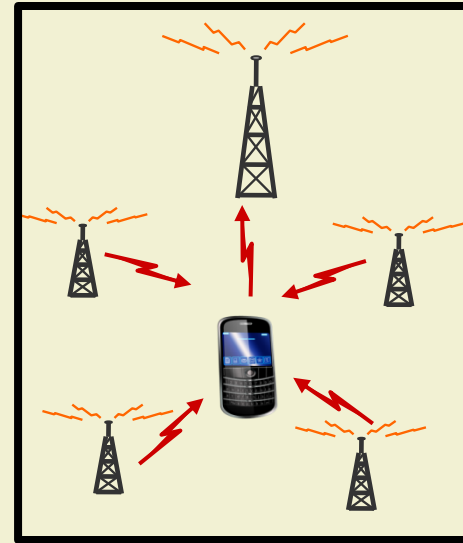
Advanced

Key Features of LTE-Advanced

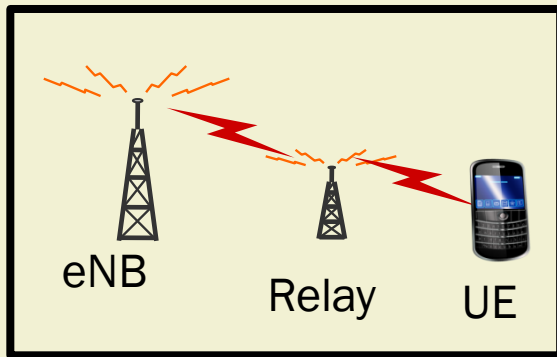


Enhanced Multiple-Antenna Techniques

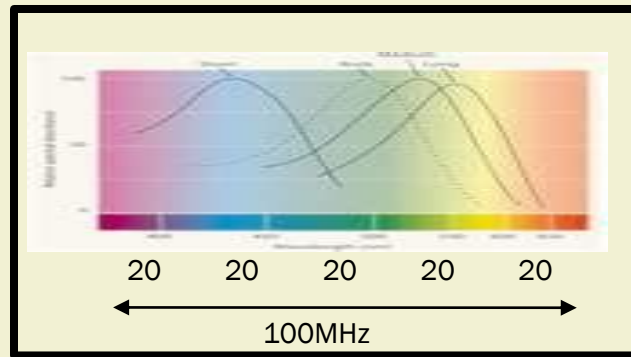
- (8x8) DL SU-MIMO
- Enhanced DL Beamforming
- (4x4) UL SU-MIMO



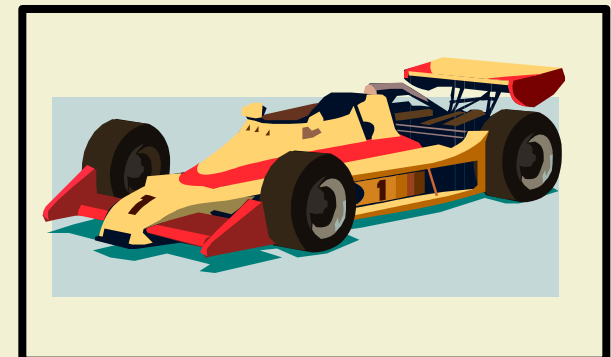
Coordinated Multi-Point Transmission/Reception



Relays

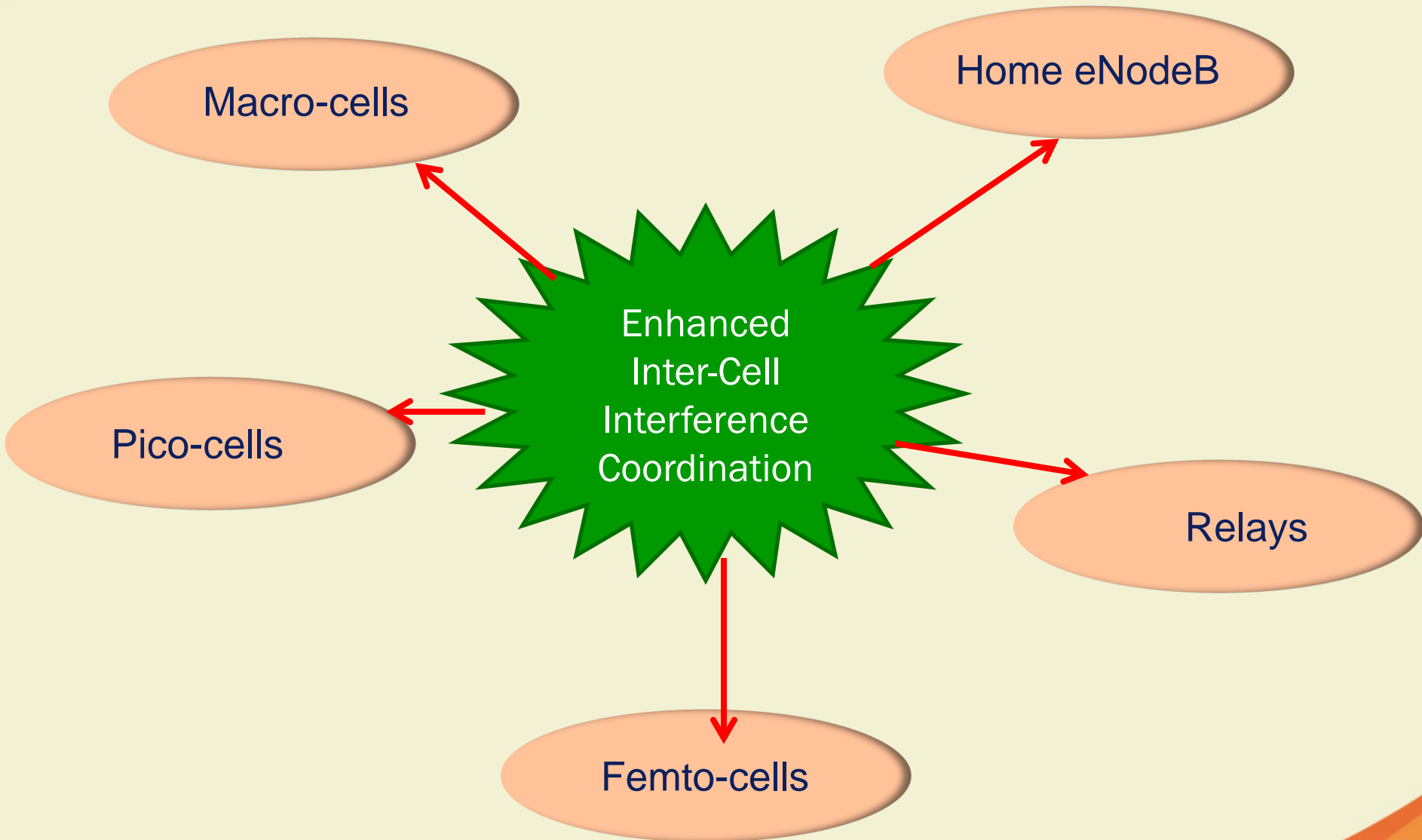


Carrier Aggregation



Latency Reduction

R11: Heterogeneous Networks



Conclusions

- LTE is here!
- LTE (R8) is just the beginning – prepare for a slew of upgrades
- VoLTE is a big step for the cellular industry – most rely on existing (3G) voice infrastructure at the outset
- LTE-Advanced (R10) is “true” 4G - it introduces a number of exciting features
- Heterogeneous networks are being deployed, but managing interference is a key challenge