September, 2014

LTE—Qualcomm Technologies Leading the Global Success

QUALCOMM®

LTE: Qualcomm Technologies, Inc. leading the global success

1. 
LTE FDD & LTE TDD – two modes, common standard, same ecosystem

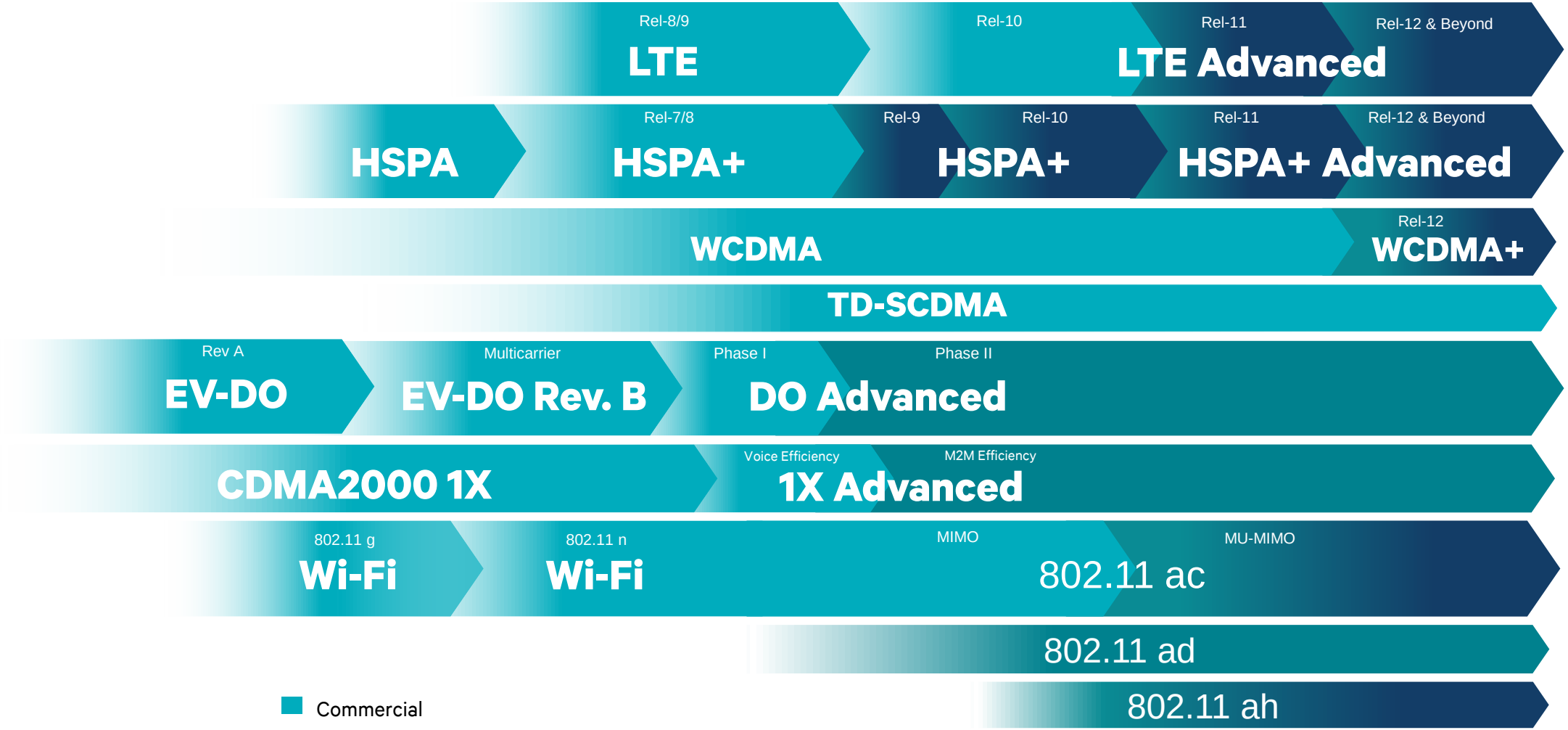
2. 
Successful LTE requires multimode, multiple bands, 3G interworking, seamless voice, and more

3. 
Qualcomm Technologies' unique advantage: solving the LTE product complexities

4. 

LTE Advanced commercial now—Evolving and expanding into new frontiers

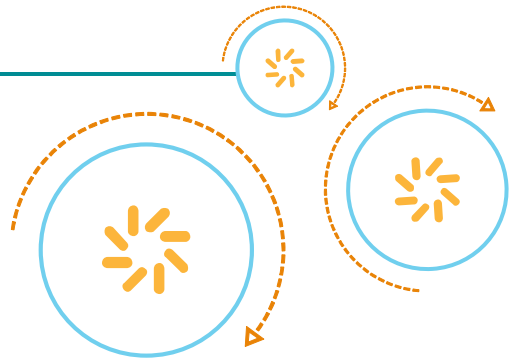
Qualcomm Technologies is a leader in wireless technology



Note: Estimated commercial dates.

Created 05/07/2014

LTE FDD & LTE TDD
— two modes, common standard, same ecosystem



LTE has a vibrant ecosystem with two flavors: FDD and TDD

Global LTE network launches

318 Launches

577 Operators investing in LTE

LTE TDD momentum

39 TDD Launches

26 Countires

Large and growing device ecosystem

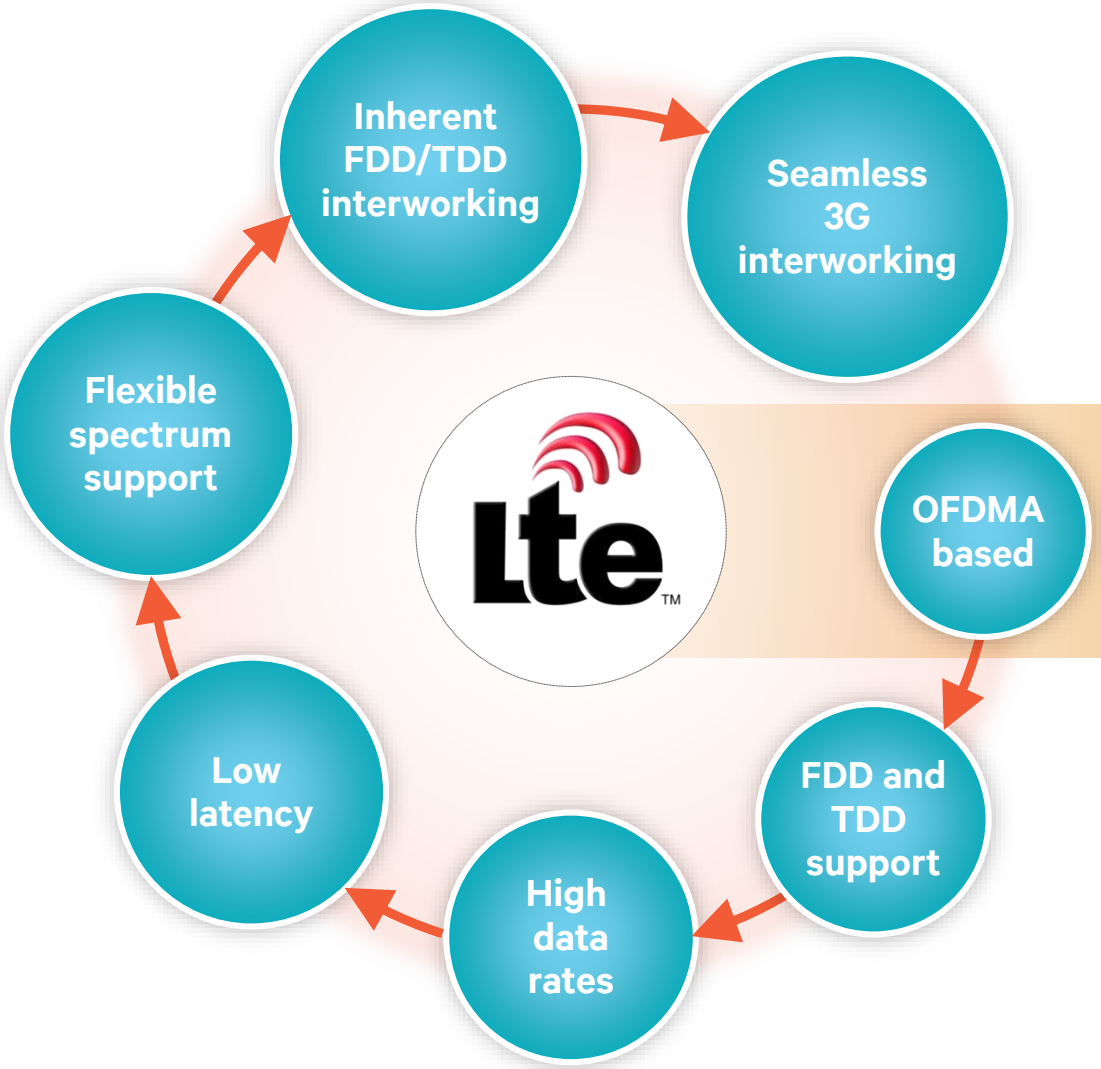
1889 Devices

168 Vendors

Global LTE/3G multimode connections reached **200 Million** in March 2014 – Informa

Source: www.gsacom.com July 28, , 2014

LTE is a common standard for paired and unpaired spectrum



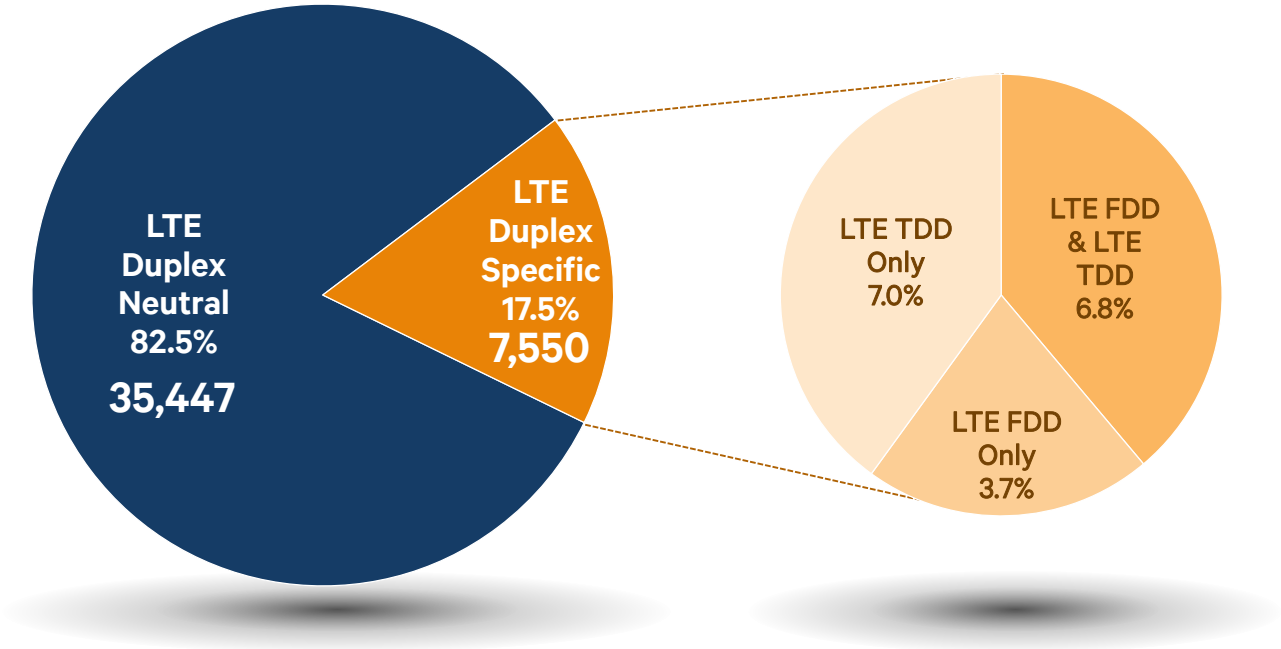
The same 3GPP specifications for LTE FDD and LTE TDD

- **Same features in same standards release**

The vast majority of the standard is the same for FDD and TDD

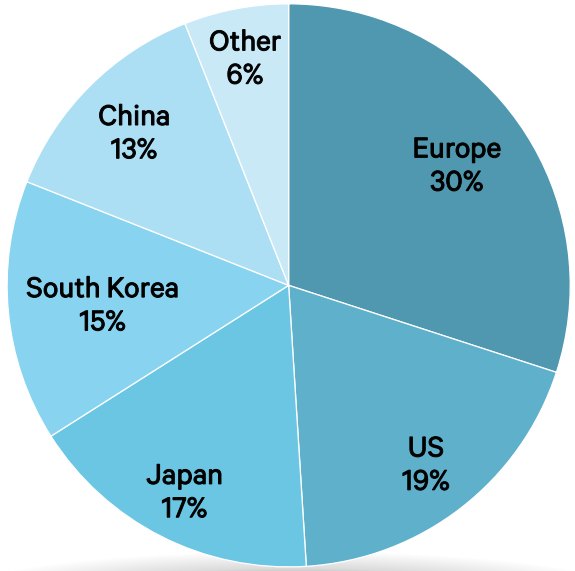
Independent research analyzing ~83,000 3GPP contributions

The vast majority of contributions applies equally to both FDD and TDD modes



The vast majority of the contributions made to 3GPP for LTE are common to both modes

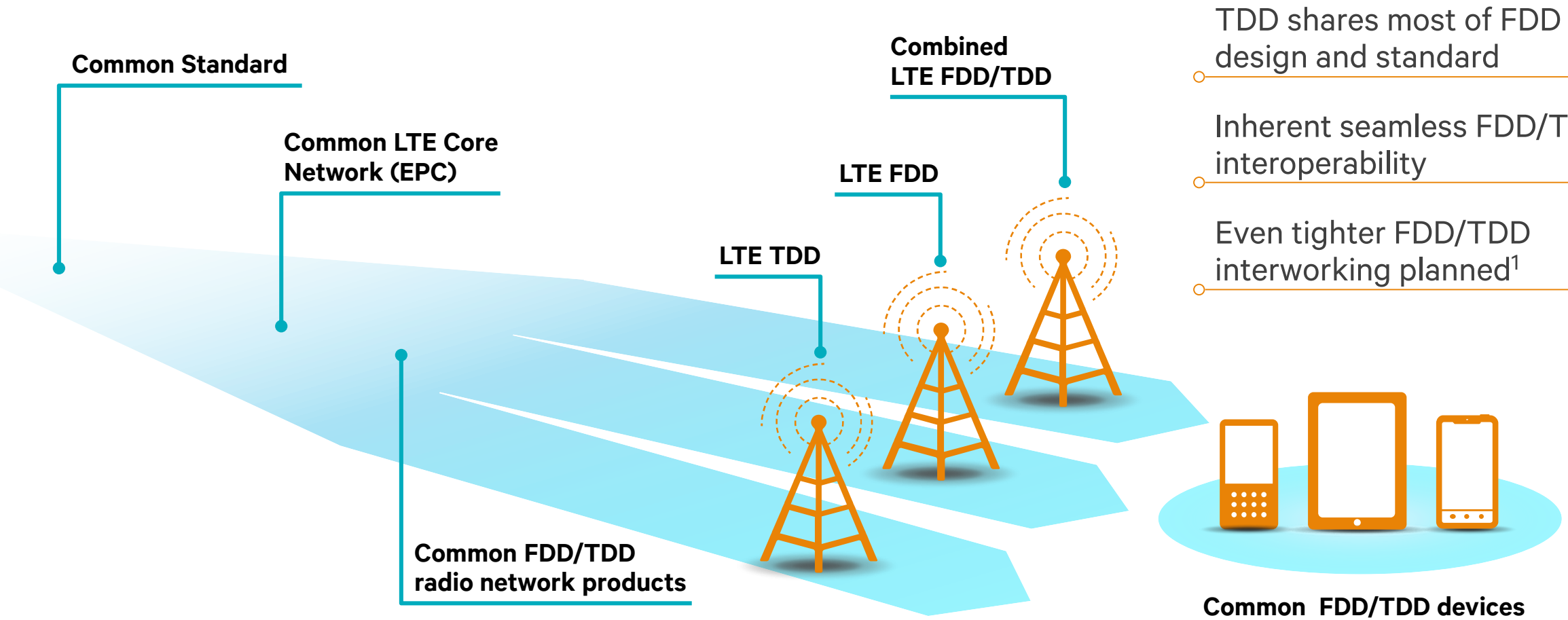
The global community contributed to the standard



LTE contributions per region

Source: Signals Research Group (SRG) report. SRG analyzed and classified nearly 83,000 3GPP contributions made during the LTE standardization process and Identified ~43,000 that pertained to the LTE standard, 7% of these applies to the TDD mode only.

Common LTE standard enables common FDD/TDD products



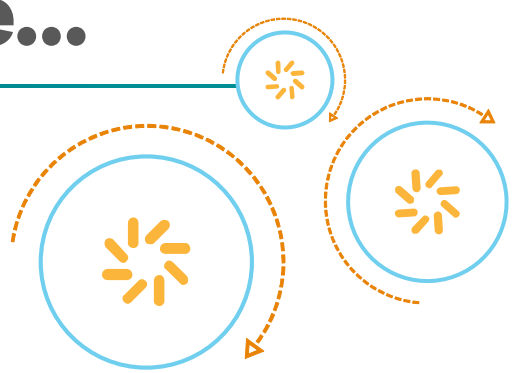
- TDD shares most of FDD design and standard
- Inherent seamless FDD/TDD interoperability
- Even tighter FDD/TDD interworking planned[1]

Common FDD/TDD devices

(with 2G/3G multimode and seamless 2G/3G interoperability)

1. Such as aggregation of FDD and TDD within the same node and different nodes (multiflow)

Successful LTE requires multimode, multiple bands, interworking, voice, and more…

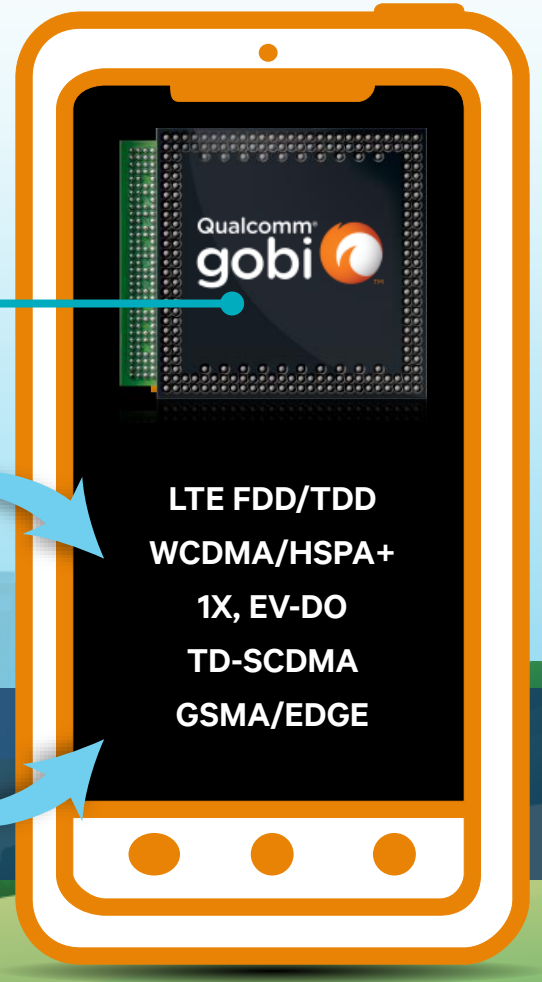


Seamless 3G interworking is the foundation to successful LTE

Enables consistent broadband experience outside LTE coverage

Enables global roaming for the foreseeable future

Enables ubiquitous voice services—even with VoLTE[1]



LTE (FDD and/or TDD)

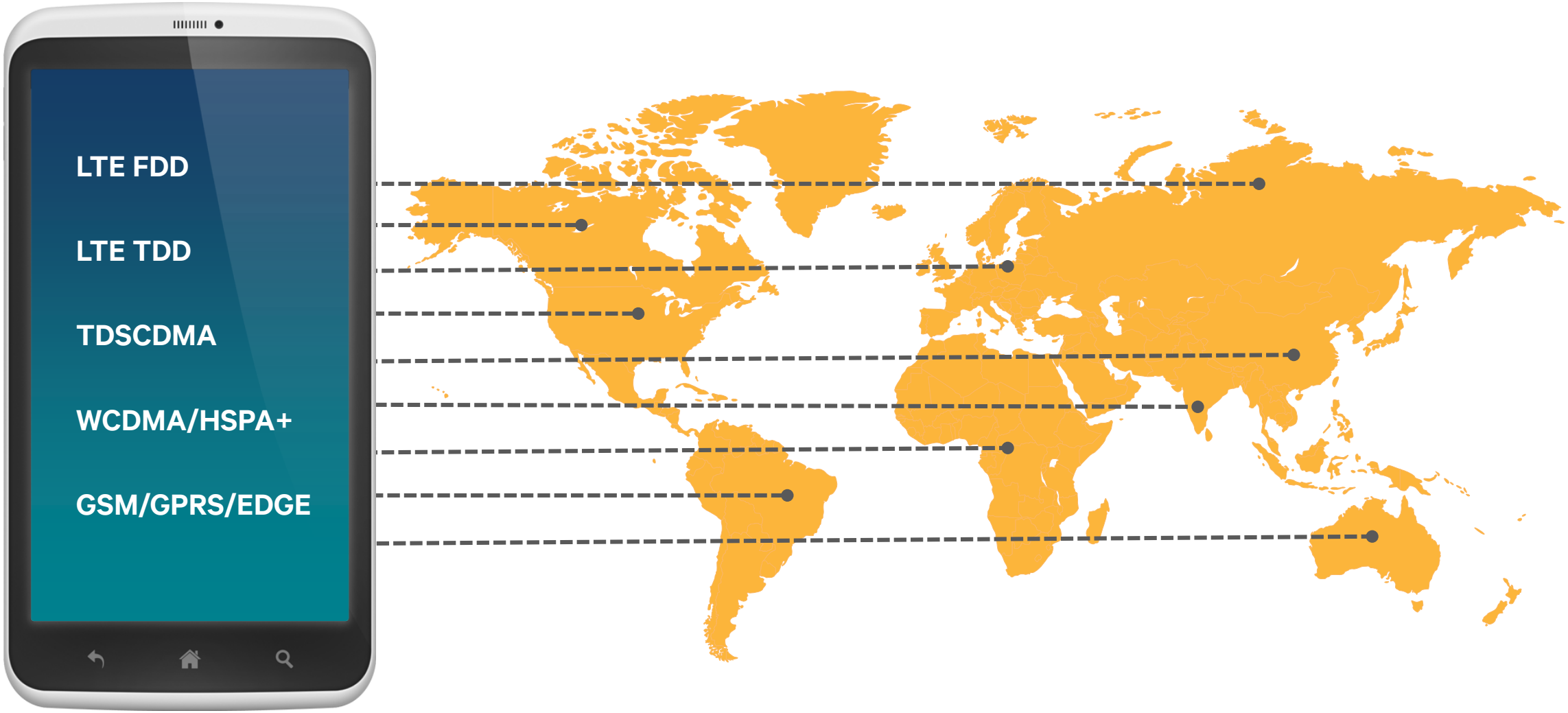
3G (and 2G)

Enables ubiquitous data coverage, voice services, and global roaming

1. Fallback to 3G/2G (CSFB) since 2012; VoLTE with SRVCC ensures seamless voice, CSFB still needed for roaming

Qualcomm Gobi is a product of Qualcomm Technologies, Inc.

Multimode LTE devices enable global roaming



Inherent LTE FDD/TDD interworking and seamless voice

Initial launches
LTE data devices

LTE for data only

LTE TDD/FDD with 2G/3G multimode launched globally[1]

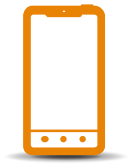
Inherent seamless TDD/FDD interworking for data

Initial voice solution
LTE data handsets

LTE for data 2G/3G for voice

Circuit switched fallback (CSFB) to 2G/3G voice launched globally (FDD and TDD)

Inherent seamless TDD/FDD interworking



Long-term voice solution
LTE VoIP handsets

Simultaneous LTE VoIP and rich data services

VoLTE with single radio voice call continuity (SRVCC) + CSFB to 2G/3G voice for roaming

Inherent seamless TDD/FDD interworking for VoLTE

2G/3G coverage continuity and roaming

1. Including seamless data LTE and 3G interworking with mobility through redirection, and packet switched handover.

Qualcomm Technologies' VoLTE technology leadership

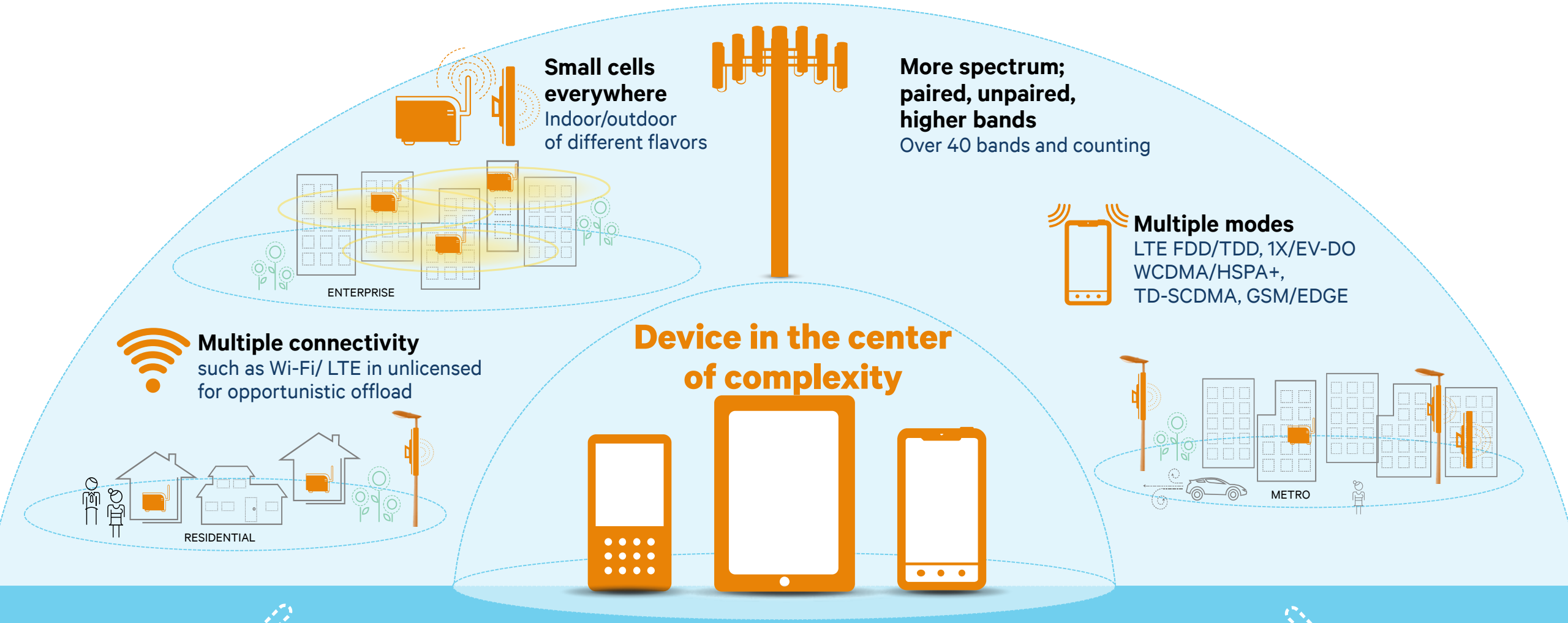
Working closely with ecosystem for VoLTE deployments

Global VoLTE Solution

- World's 1st commercial integrated VoLTE modem and IMS solution with SRVCC
- Chipsets enabled 1st major launches in Korea (Aug. 2012) and US (May 2014)
- Chipsets and IMS solution powered 1st nationwide launch in Japan (June 2014)

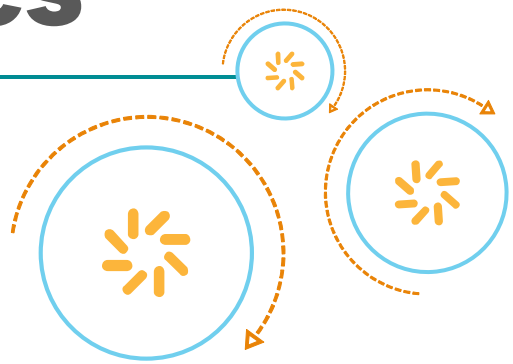
Long history of trials and deployments with major operators and infra vendors

Ability to support true heterogeneous networks



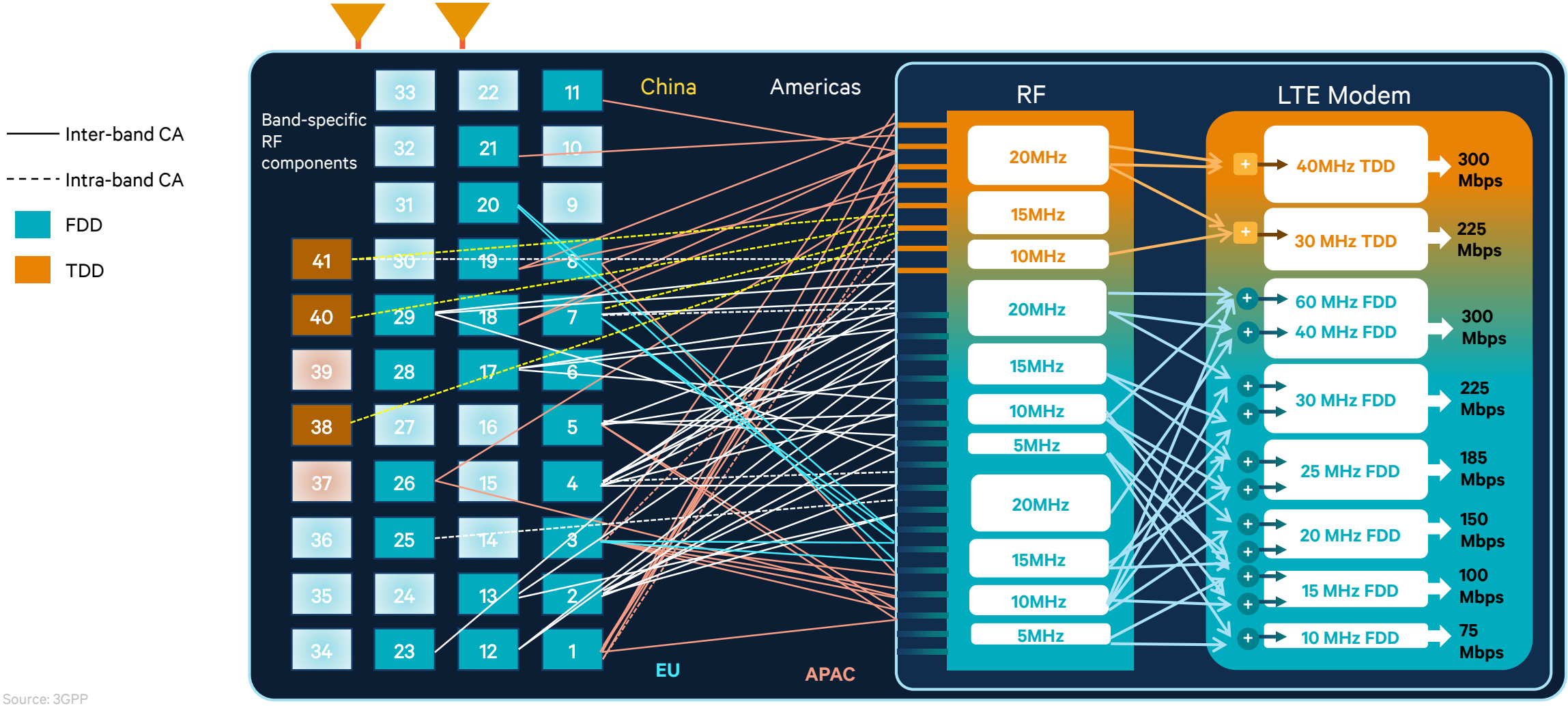
Seamless experience across technologies, cells, bands

Qualcomm Technologies solves the LTE product complexities



Qualcomm Technologies solves LTE complexities

Hiding the complexity underneath the most seamless mobile connectivity



Source: 3GPP

Qualcomm® Gobi™ LTE modems: Four generations of unparalleled leadership

Continuously increasing level of features, interworking and integration

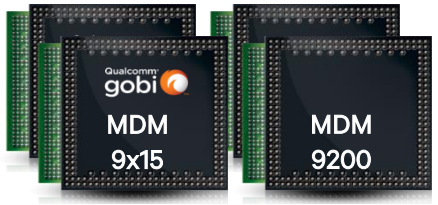
First Generation

World's first integrated LTE/3G

- 100Mbps/50Mbps DL/UL
- FDD and TDD

Second Generation

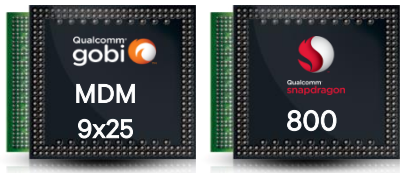
World's First Mobile Platform with integrated LTE/3G Multimode



- TD-SCDMA
- LTE Broadcast (eMBMS)
- VoLTE

Third Generation

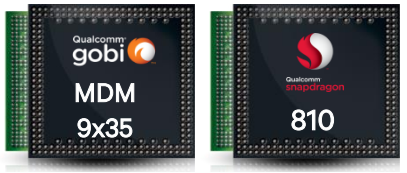
World's First LTE/3G multimode with Cat4 and Carrier Aggregation



- 150Mbps/50 Mbps DL/UL
- LTE Advanced - Carrier aggregation

Fourth Generation

LTE/3G multimode with Cat6 with 3x Carr. Agg. and 60 MHz support



- 300Mbps/50 Mbps DL/UL
- Aggregating carriers across two spectrum bands

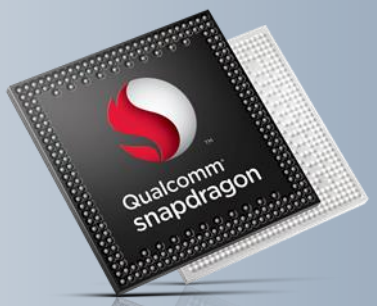
2010 | **2011 - 2012** | **2013** | **2014**

Note: Qualcomm Snapdragon™ processors integrates the Gobi modems, but Gobi modems are also offered as a standalone modem product;

Qualcomm Snapdragon and Qualcomm Gobi are products of Qualcomm Technologies, Inc.

Enabling LTE TDD and FDD in all tiers

Scale across the tiers, scale across the globe!



Snapdragon™
210

Snapdragon
410

Snapdragon
610/615

Snapdragon
808/810

The Snapdragon advantage

- A comprehensive 4G LTE solution across all tiers
- Qualcomm® RF360™ front end solution, CDMA support allow for truly global solution

Enabling LTE world phone – Qualcomm RF360™ front end solution

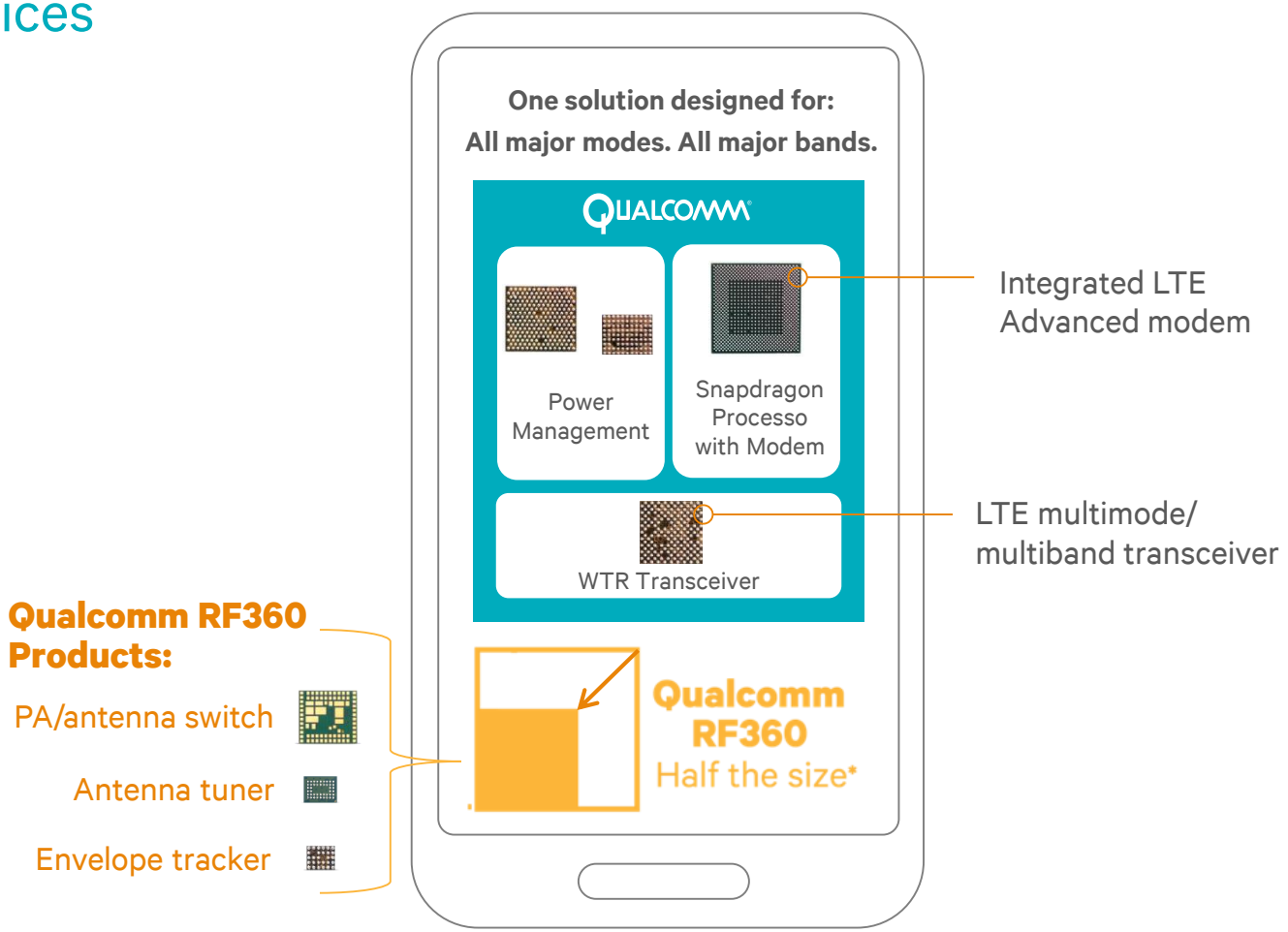
First truly global RF solution for LTE Devices

Advantages

- Global design, economies of scale
- Power
- Performance
- Size
- Reduced development time

Enabled by

- System-level solution
- RF CMOS integration advantages
- Optimized end-to-end performance



*As compared to the previous Qualcomm RF solution.;
Qualcomm RF360 is a product of Qualcomm Technologies, Inc.

The modem is the foundation—the bar is getting higher

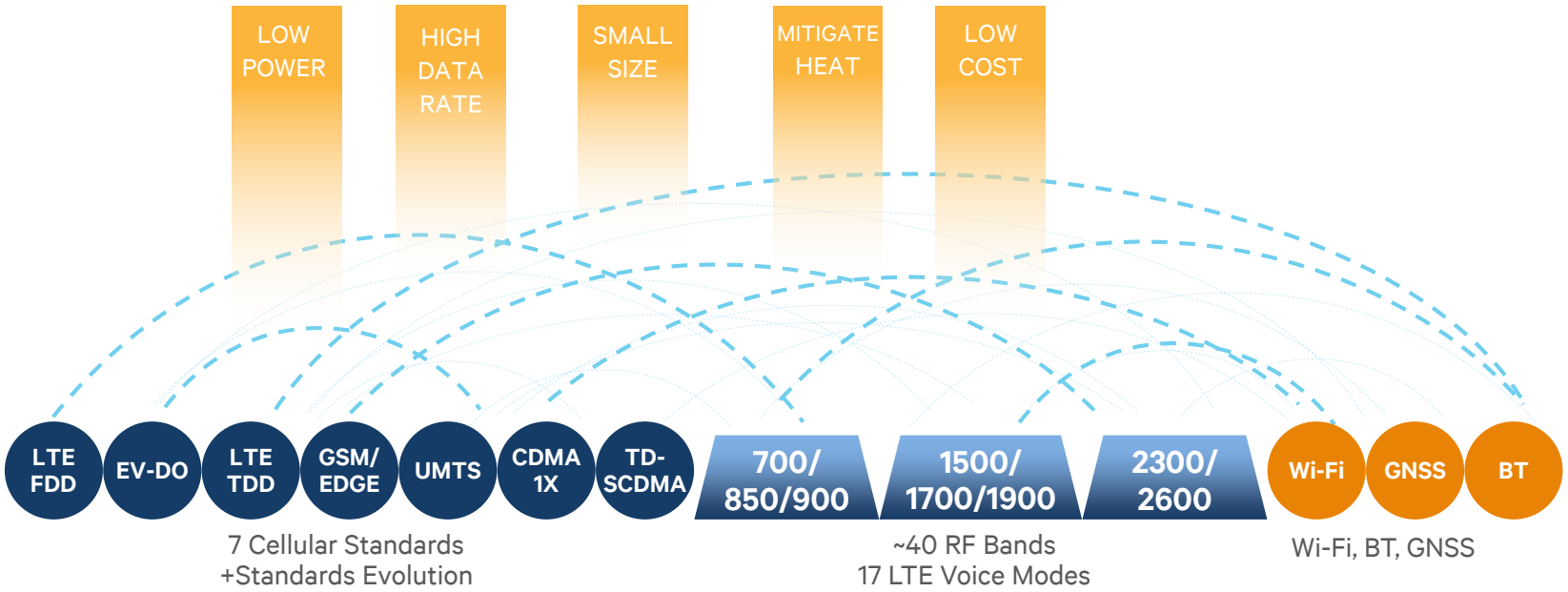
Then you can integrate mobile computing, graphics and multimedia components

THE BAR IS GETTING HIGHER AND HIGHER

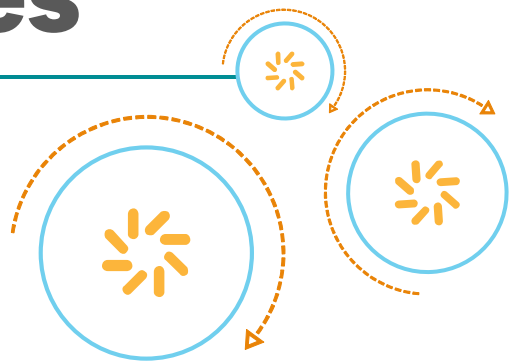
Optimize power and performance in a mobile environment

Solve interworking complexity

Support all technologies, bands, modes, ...



LTE Advanced global proliferation—Led by Qualcomm Technologies

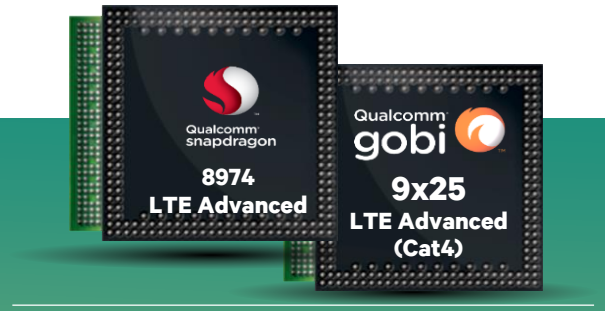


Qualcomm Technologies leading LTE Advanced

Carrier aggregation— first step of LTE Advanced

World's 1st LTE Advanced carrier aggregation

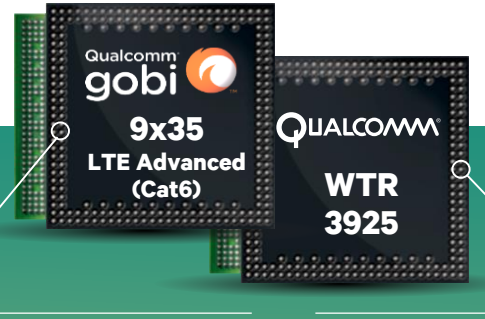
(Launched Jun 2013)



- 150 Mbps peak data rate (cat 4)
- 10 + 10 MHz in downlink
- 3rd generation Qualcomm® Gobi ™ LTE modem
- HSPA+ 3 carriers DL & 2 carrier UL aggregation

LTE Advanced Cat 6 (300 Mbps)

(Launched in Jun 2014)



4th Generation LTE modem

- 300 Mbps peak data rate (cat 6)
- 20 + 20 MHz in downlink
- 4th generation Gobi LTE modem
- HSPA+ 3 carriers DL & 2 carrier UL aggregation

One chip, all carrier aggregation combinations

- Supports next gen LTE Advanced wideband CA
- 4th generation LTE transceiver
- 1st 28nm RF
- ~3x* more CA band combinations

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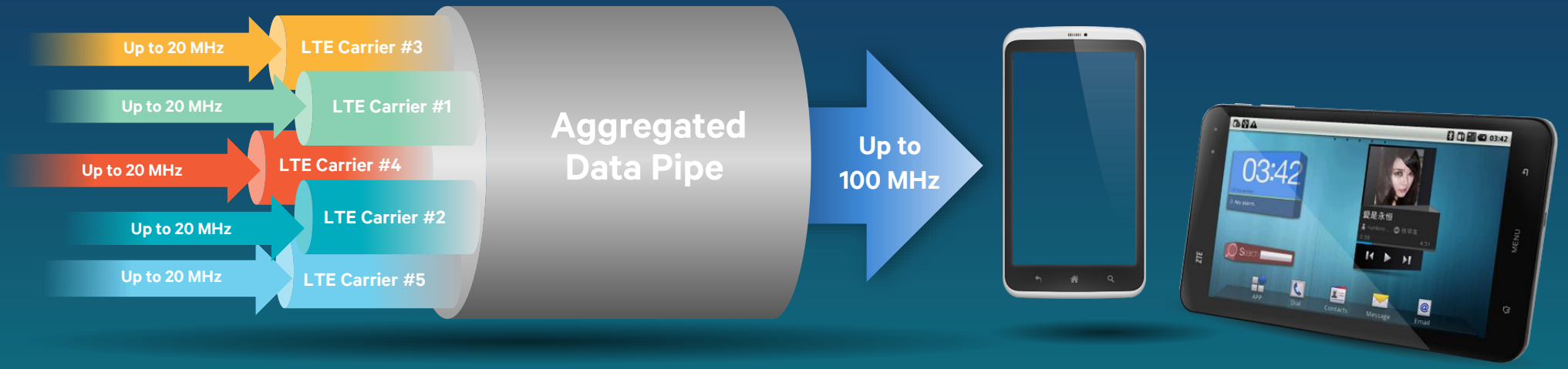
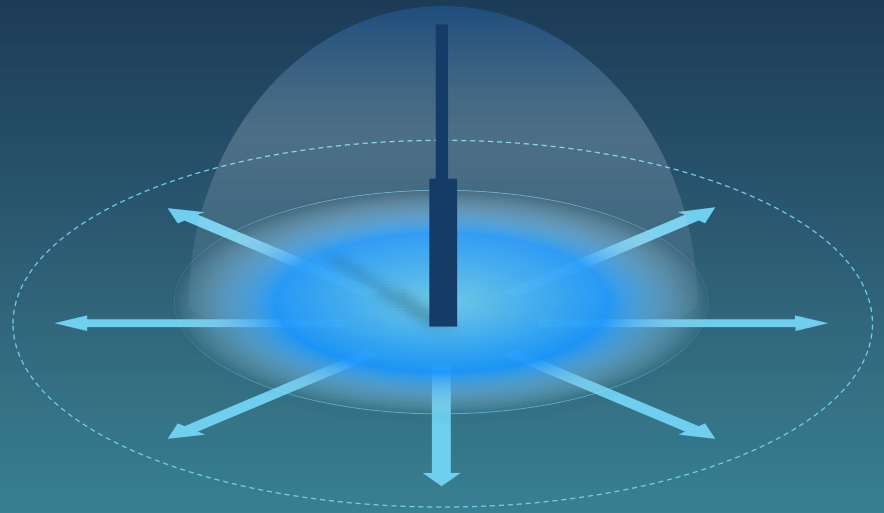


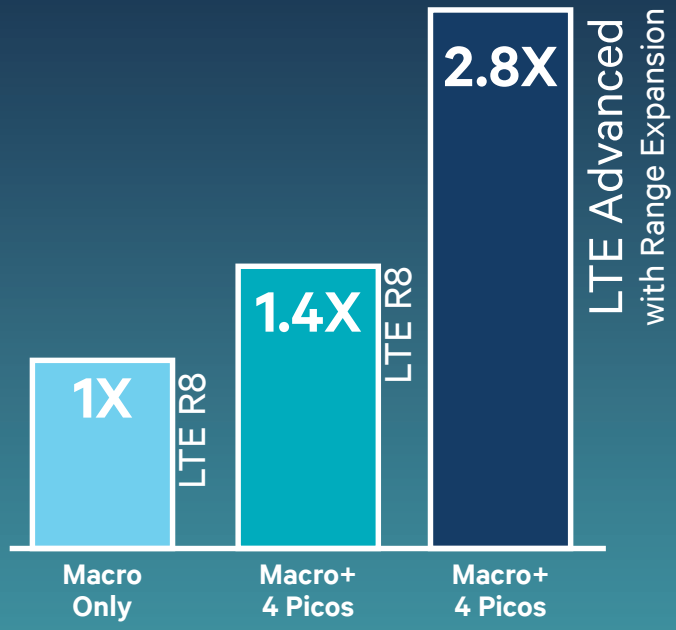
Higher peak data rates	Higher user data rates and lower latencies for all users	More capacity for typical 'bursty' usage[1]	Utilizes all spectrum assets

Carrier Aggregation—fatter pipe to enhance user experience

[1]The typical bursty nature of usage, such as web browsing, means that aggregated carriers can support more users at the same response (user experience) compared to two individual carriers, given that the for carriers are partially loaded which is typical in real networks. The gain depends on the load and can exceed 100% for fewer users (less loaded carrier) but less for many users. For completely loaded carrier, there is limited capacity gain between individual carriers and aggregated carriers,



Small cell
Range Expansion
(FeICIC/IC)

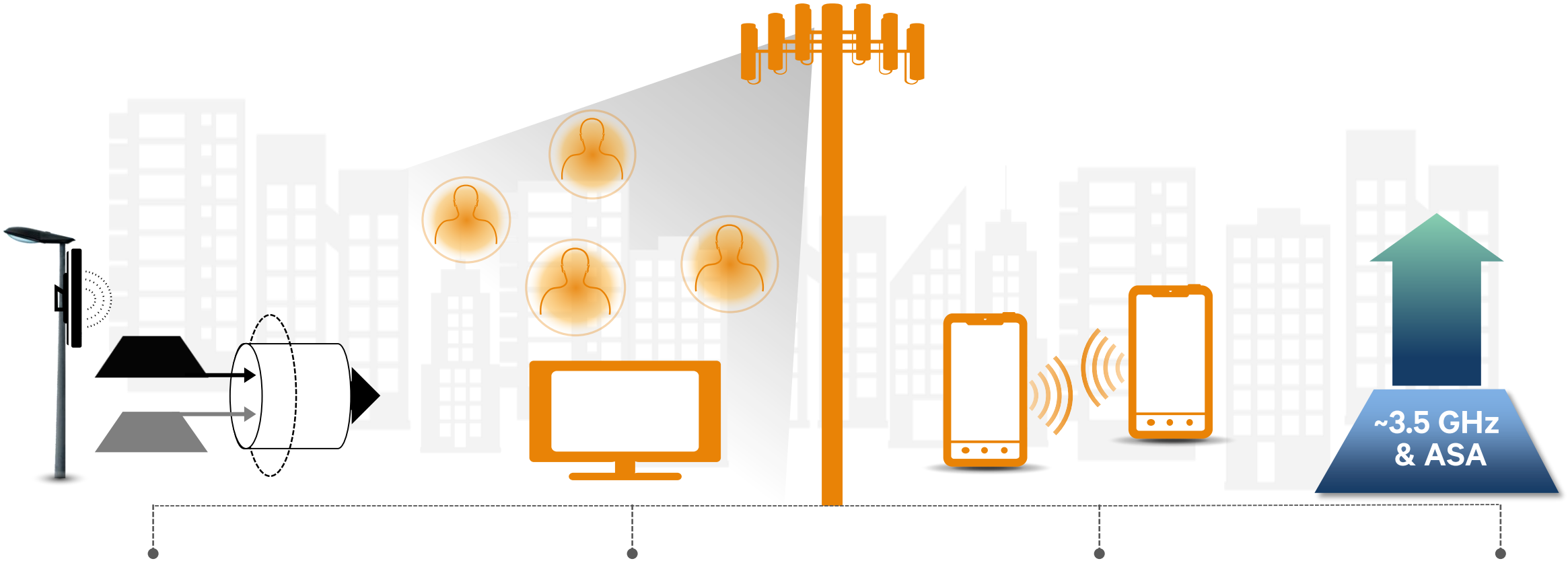


Data rate improvement[2]

It's not just about adding small cells — LTE Advanced brings even more capacity[1]

[1]By applying advanced interference management to HetNets. [2]Median downlink data rate. Assumptions: 4 Picos added per macro and 33% of users dropped in clusters closer to picos (hotspots) : 10 MHz FDD, 2x2 MIMO, 25 users and 500m ISD. Advanced interference management: enhanced time-domain adaptive resource partitioning, advanced receiver devices with enhanced RRM and RLM1Similar gain for the uplink

LTE Advanced evolves and expands into new frontiers



Extending LTE Advanced to unlicensed spectrum

Dynamic LTE broadcast. Going beyond mobile for terrestrial TV

LTE Direct for continuous device to device proximal discovery

Higher spectrum bands new licensing models—Authorized Shared Access

LTE Advanced is a key enabler to the 1000x data challenge

- Extend LTE to unlicensed spectrum
- Dynamic LTE Broadcast
- Enhanced receiver devices

- Carrier Aggregation (even across FDD/TDD)
- Authorized Shared Access (ASA)

- Hetnets with interference management (FeICIC/IC)
- Enabling hyper-dense networks for 1000x

More Small Cells is Key to 1000x

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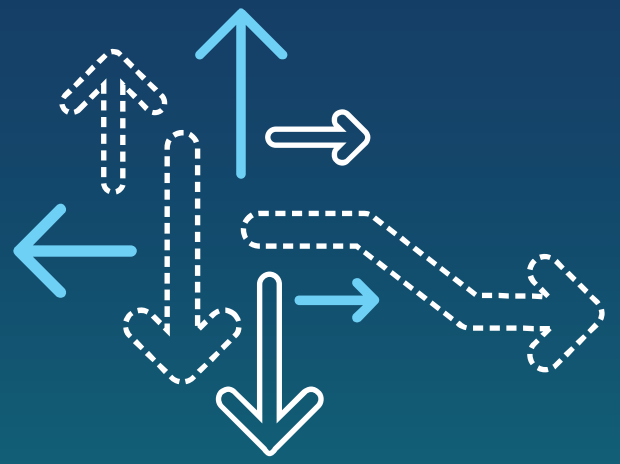
Questions? - Connect with Us



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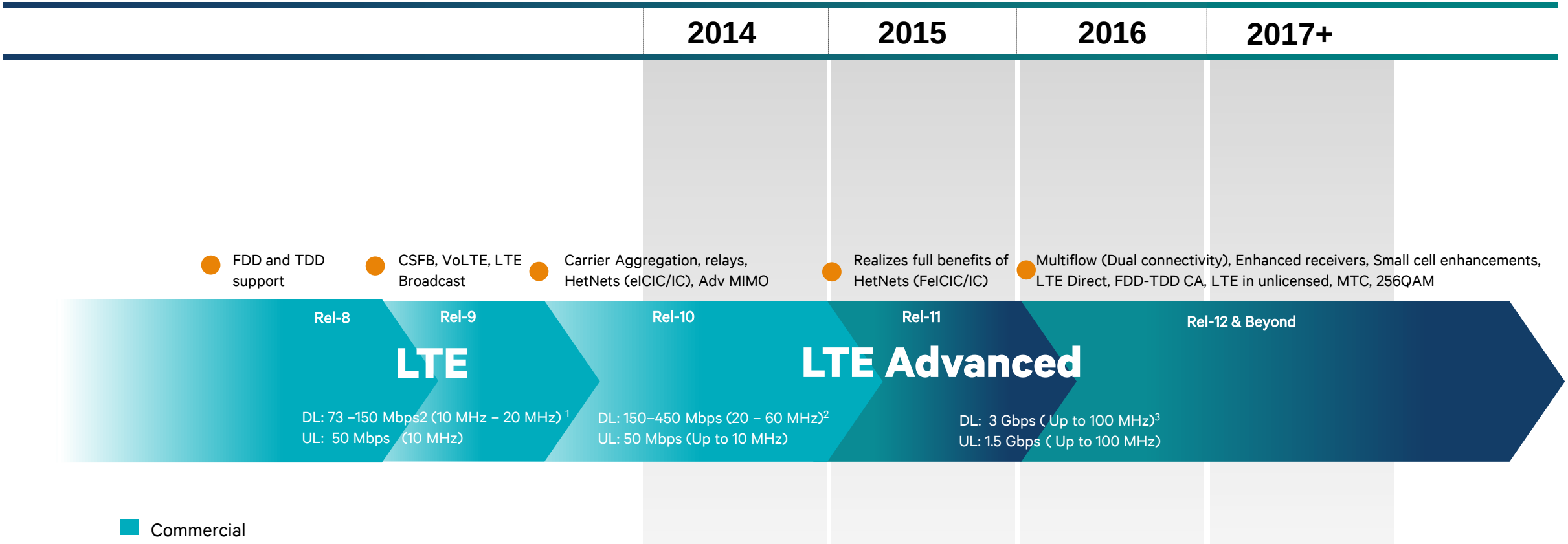
A strong LTE evolution path



1. Peak rates for 10 MHz or 20 MHz FDD using 2x2 MIMO, standard supports 4x4 MIMO enabling peak rates of 300 Mbps.
2. Peak data rates for 20 – 30 MHz (using CA) FDD and using 2x2 MIMO, standard supports much more higher (see note 3)
3. 3Gps with 8x8 MIMO and 100MHz of spectrum. Similarly, the uplink can reach 1.5Gbps with 4x4 MIMO. These rates are defined in Rel. 10, not expected to be supported in the initial Rel 10 commercial launches, but later with Rel 11/12 or beyond launches

Note: Estimated commercial dates.

Created 05/07/2014