

September, 2014

LTE TDD—the global solution for unpaired spectrum

QUALCOMM®



LTE TDD: the global solution for unpaired spectrum



1



LTE is a common global standard for paired and unpaired spectrum

3



Inherent tight TDD/FDD interworking and seamless 3G interworking

2



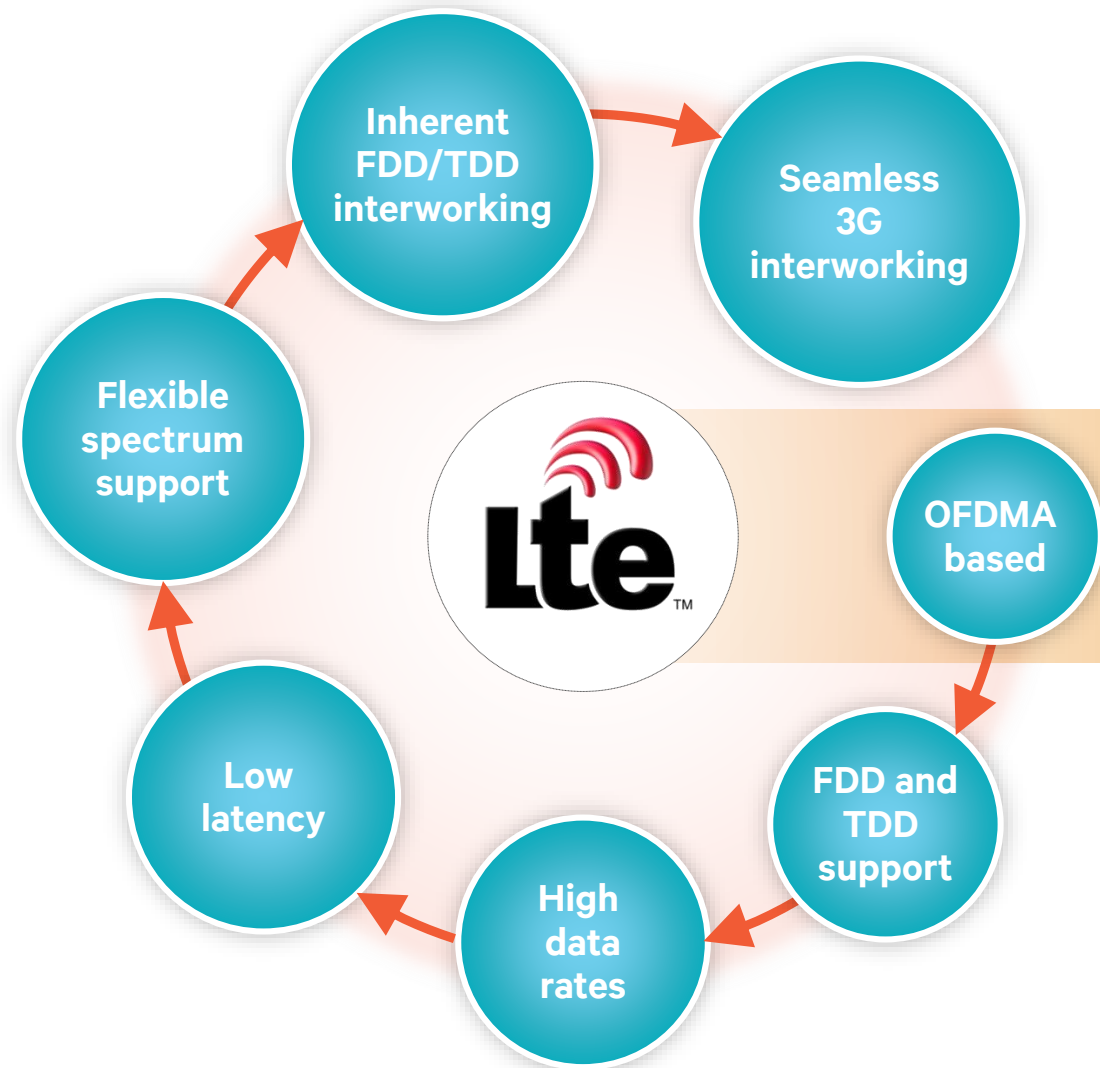
Common FDD/TDD technology ecosystem, common products

4



Key to access higher spectrum bands on the path to 1000x

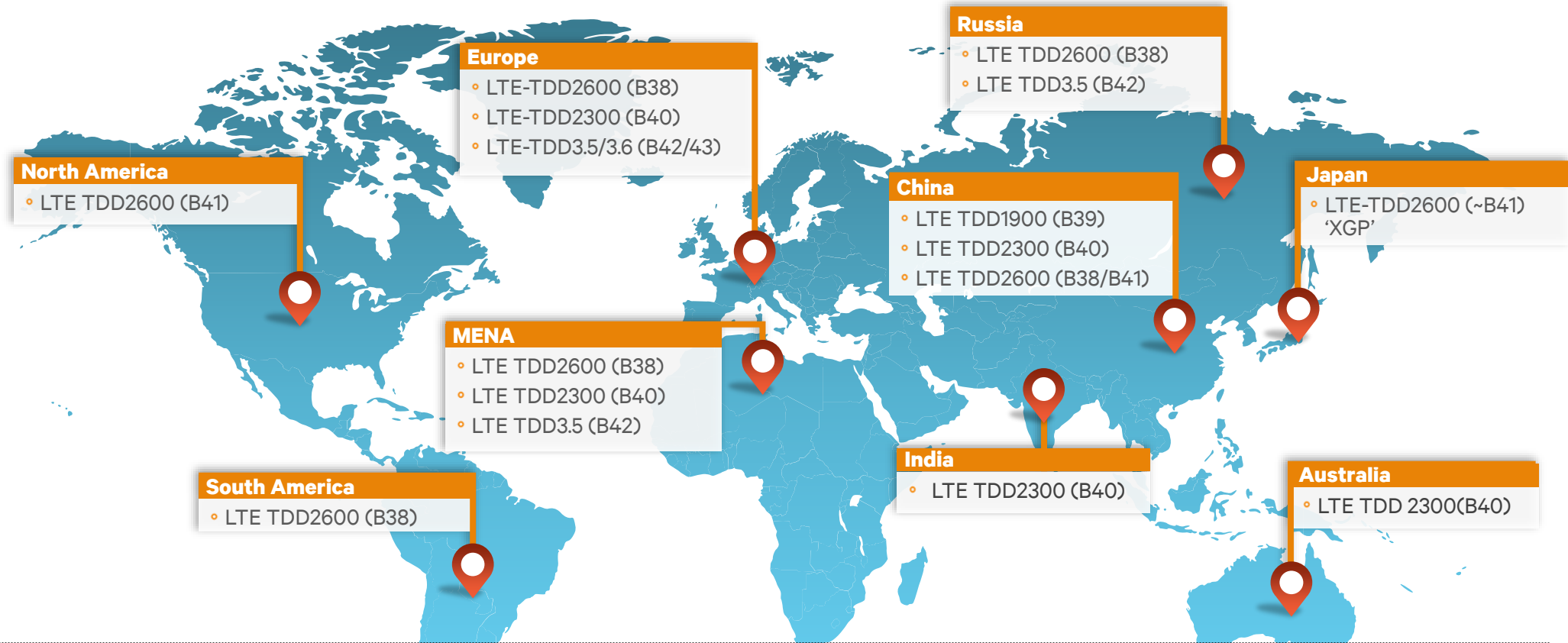
LTE is a common standard for paired and unpaired spectrum



The same 3GPP specifications for LTE FDD and LTE TDD

- Same features in same standards release

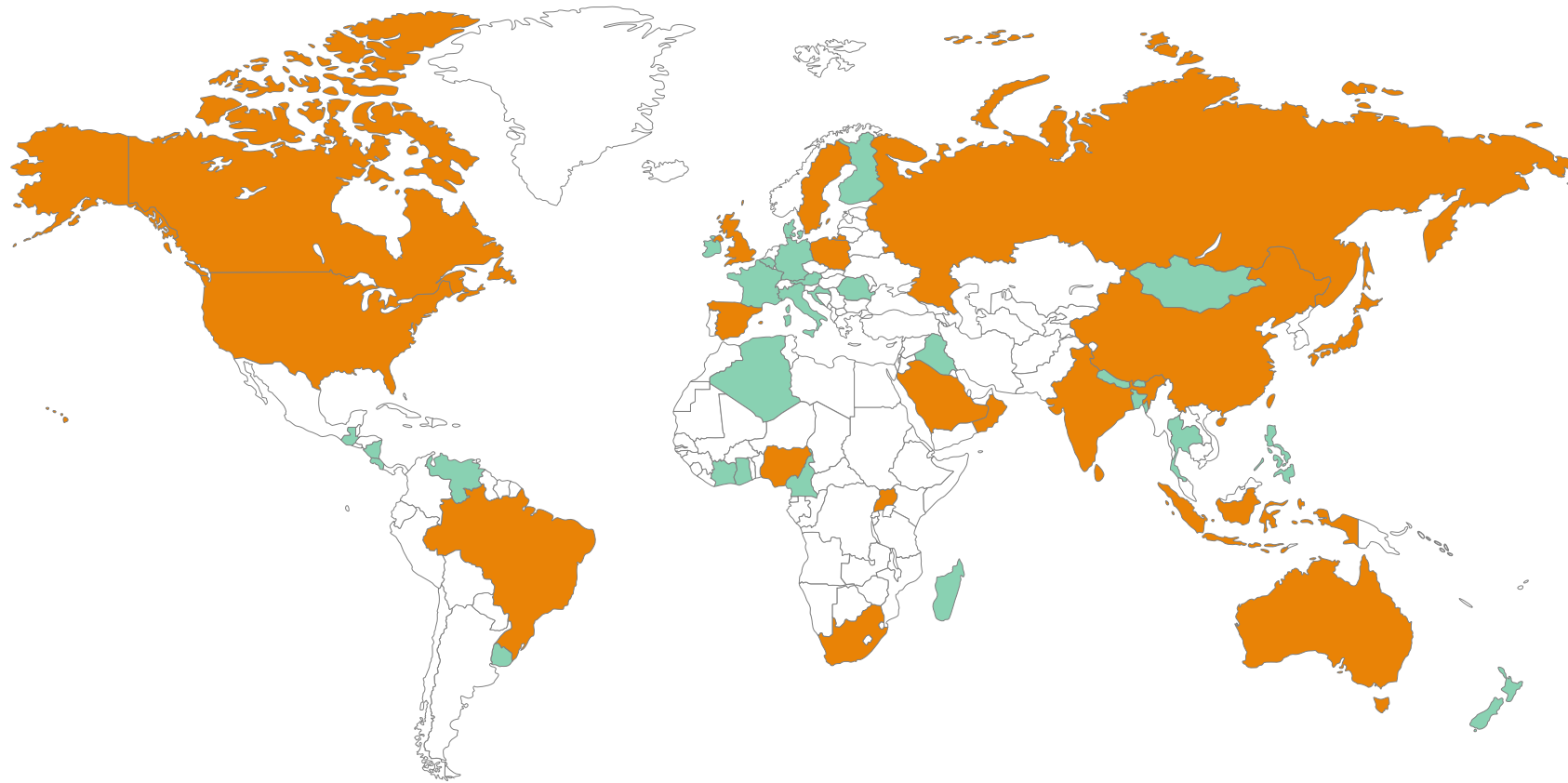
Global LTE TDD spectrum opportunities



Global unpaired spectrum	1.9 GHz (B39) 1880 MHz to 1920 MHz	2.3 GHz (B40) 2300 MHz to 2400 MHz	2.6 GHz (B38) ¹ 2570 MHz to 2620 MHz	2.6 GHz (B41) 2496 MHz to 2690 MHz	~3.6 GHz (B42/43) 3.4 to 3.6 and 3.6 to 3.8
Potential Spectrum	40MHz	100 MHz	50 MHz	194 MHz	400 MHz

¹IMT extension band provides 50 MHz TDD in addition to 70 MHz + 70 MHz FDD in most countries.

LTE TDD is truly global—many combining FDD and TDD



LTE TDD investments worldwide

Commercial deployments Trials, studies, deployments

79

TDD Networks commitments

39

Commercial launches

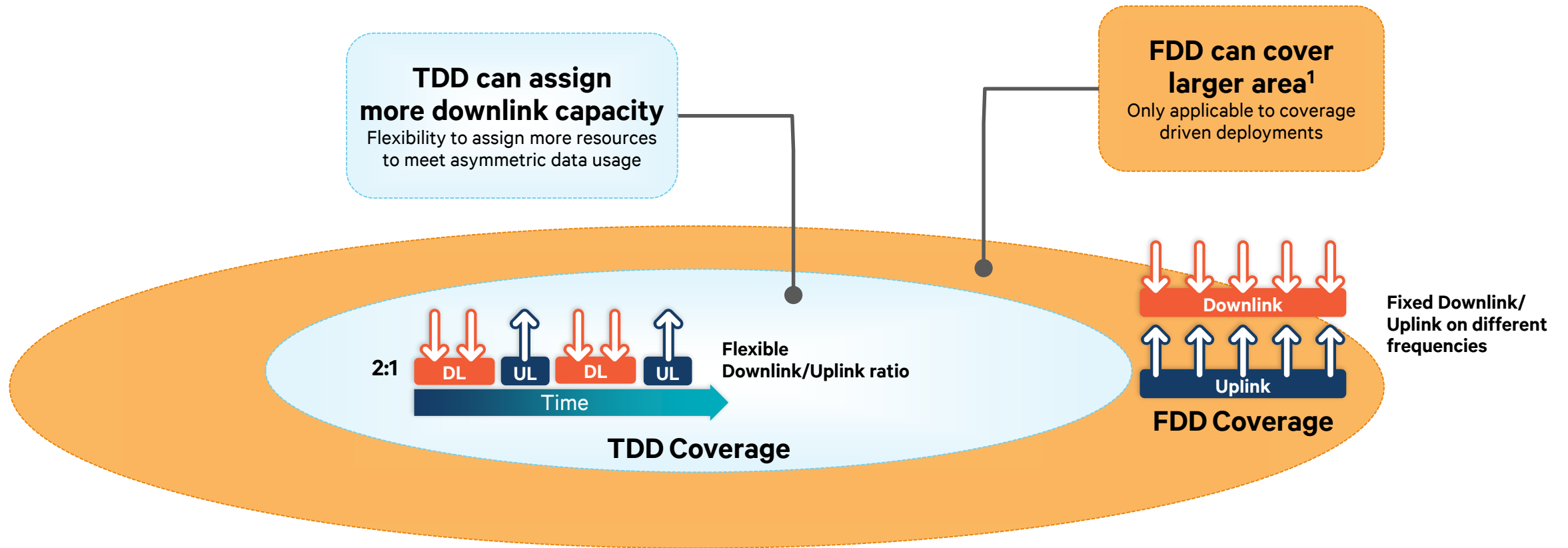
26

Countries

13

Combined TDD and FDD

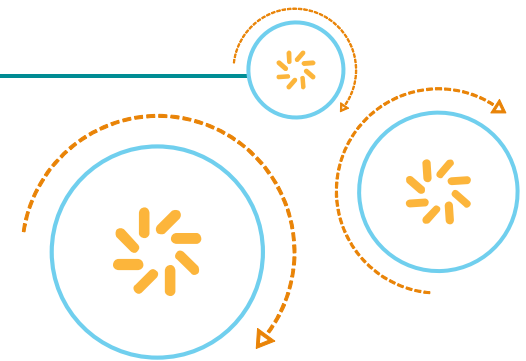
There is a TDD/FDD tradeoff—eventually most will deploy both



1. Assuming same transmit power . The main reason for reduced coverage is that the uplink device power is used part of the time for TDD but continuously for FDD . As an example, an 1:1 UL/DL allocation means a duty cycle of ~50% in the uplink which contributes to a ~3dB reduced link budget; In capacity driven deployments, there is no coverage advantage.



Common LTE FDD and LTE TDD technology ecosystem, common products



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

Countries

Large and growing device ecosystem

1889

Devices

168

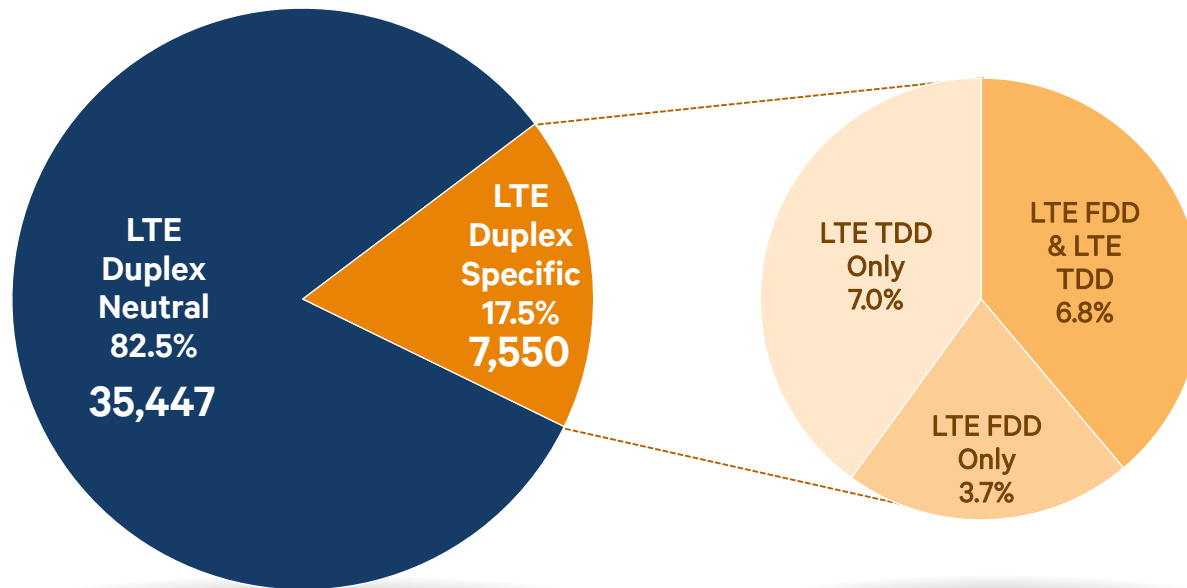
Vendors

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

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

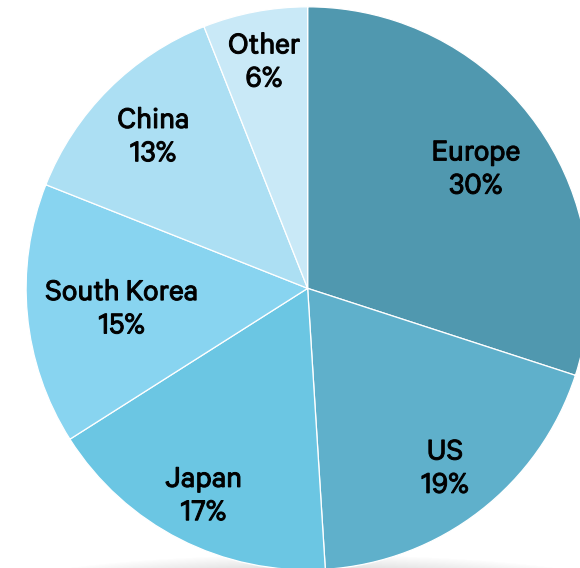
Independent research analyzing ~83,000 3GPP contributions

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

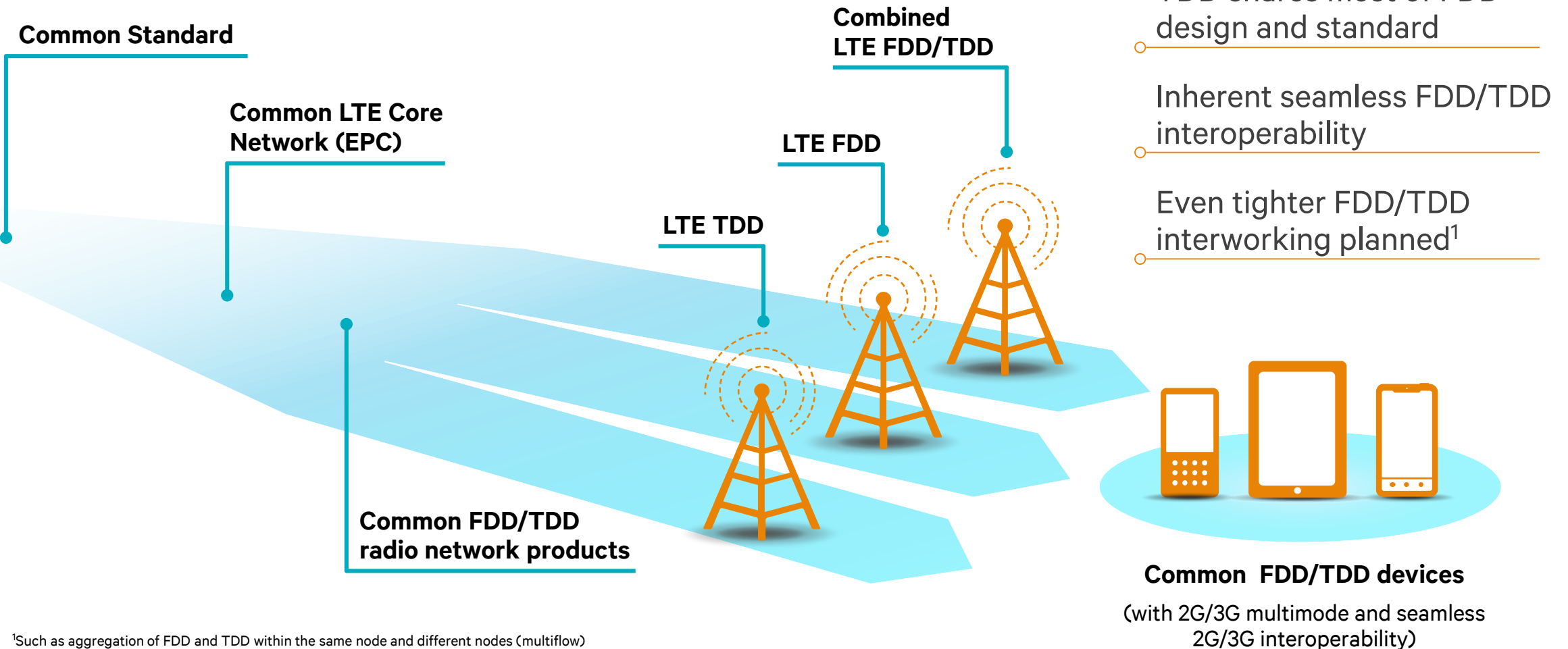
The global community contributed to the standard



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



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

Qualcomm® Gobi™ LTE Modems: Four generations of FDD/TDD leadership

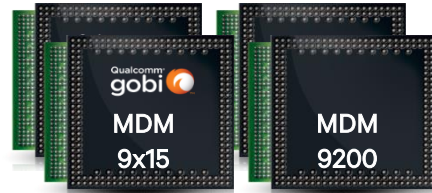
First Generation

World's first integrated LTE/3G



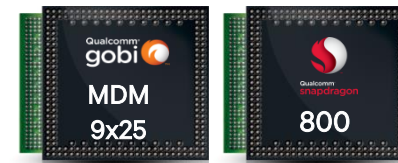
Second Generation

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



Third Generation

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



Fourth Generation

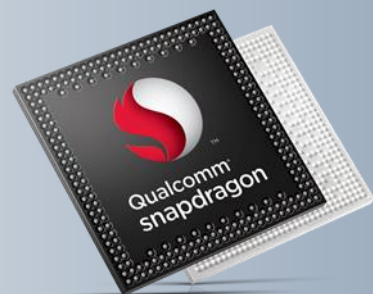
LTE/3G multimode with Cat6
with 3x Carr. Agg. and 60 MHz
support



Common LTE FDD/TDD platform and FDD/TDD interworking

Enabling LTE TDD and FDD in all tiers

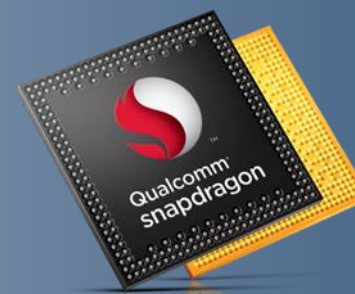
Scale across the tiers, scale across the globe!



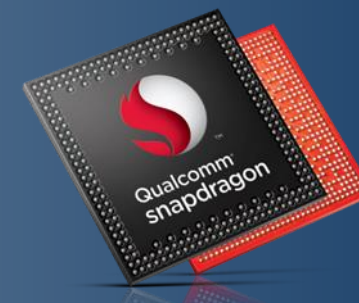
Snapdragon™
210



Snapdragon
410



Snapdragon
610/615



Snapdragon
808/810

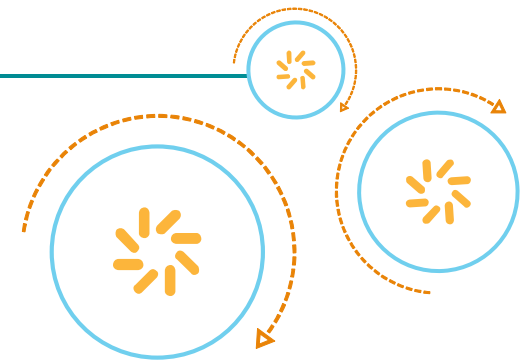
The Snapdragon advantage



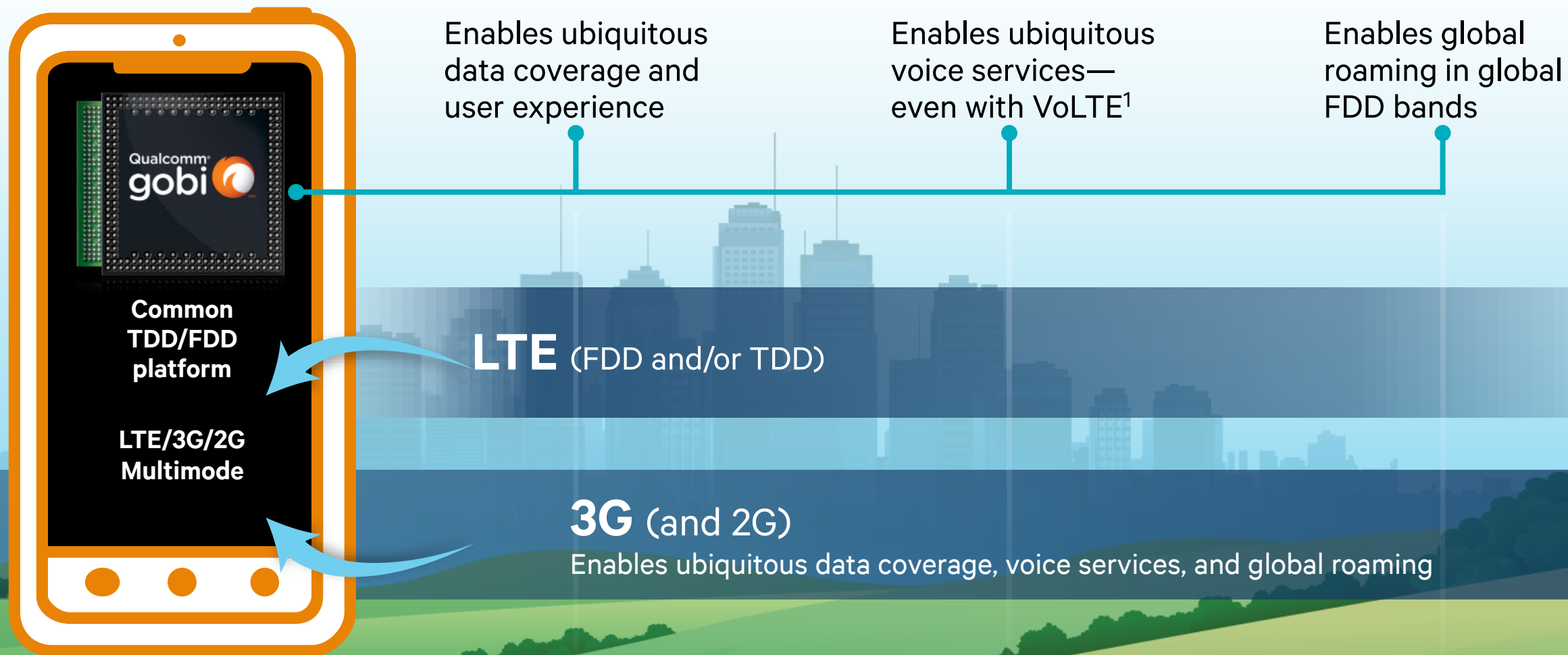
- A comprehensive 4G LTE solution across all tiers
- Qualcomm® RF360™ front end solution, CDMA support allow for truly global solution



Inherent tight TDD/FDD interworking and seamless 3G interworking



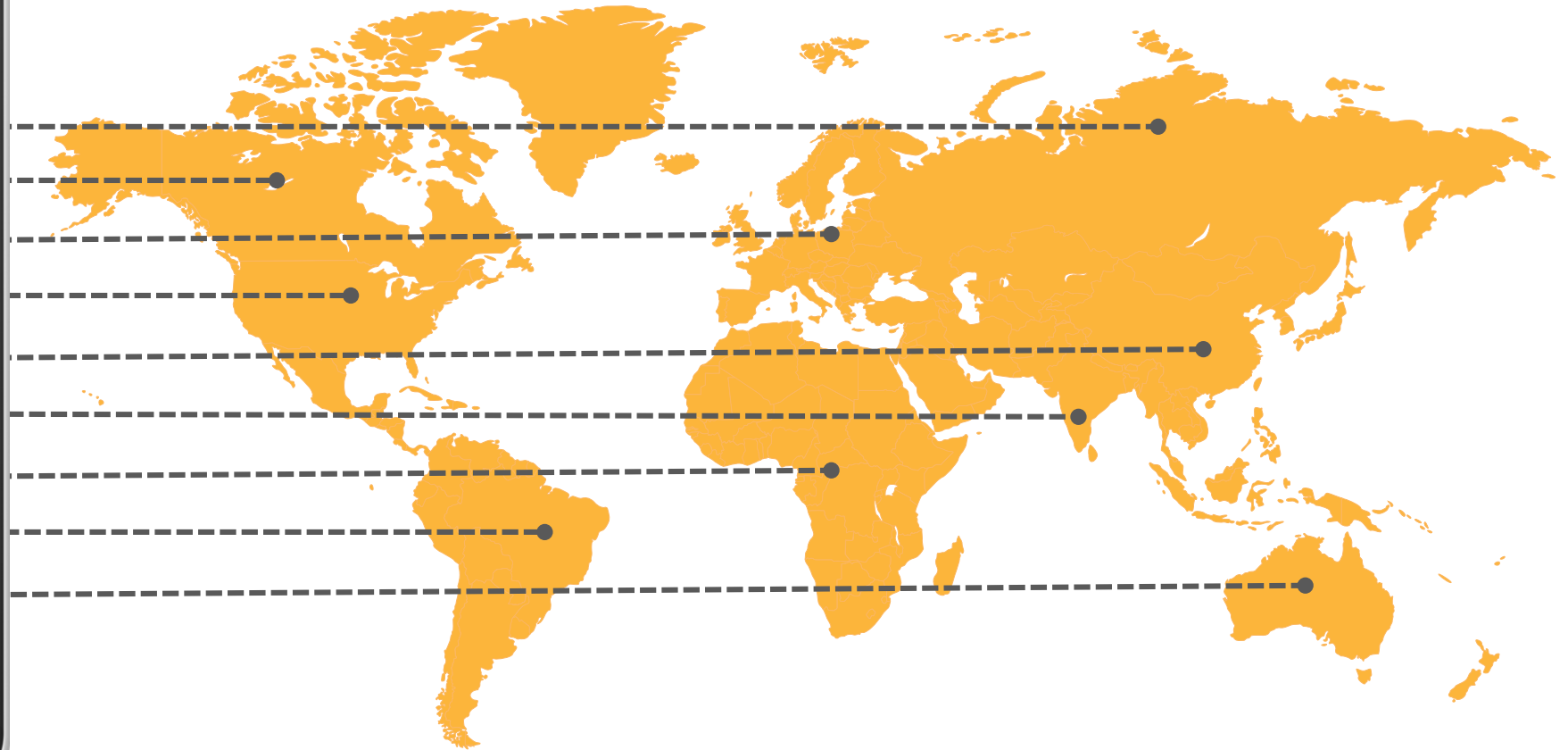
Seamless 3G interworking is the foundation to successful LTE



¹Fallback 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



Initial voice solution
LTE data handsets



Long-term voice solution
LTE VoIP handsets

LTE for data only

LTE TDD/FDD with
2G/3G multimode
launched globally¹

Inherent seamless TDD/FDD
interworking for data



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



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

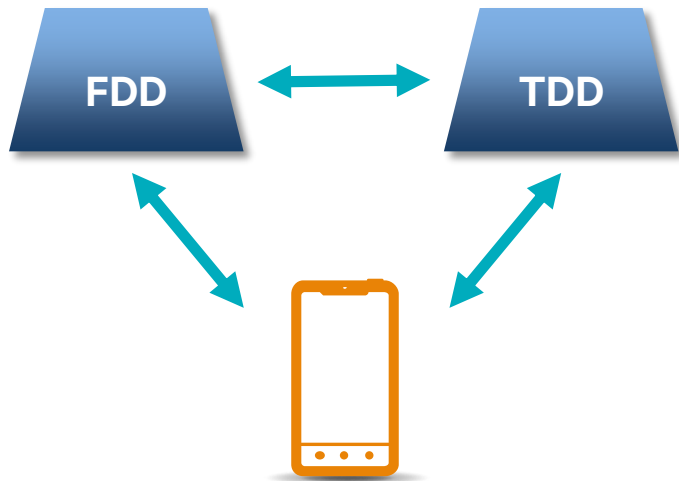
Global VoLTE Solution

- 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)

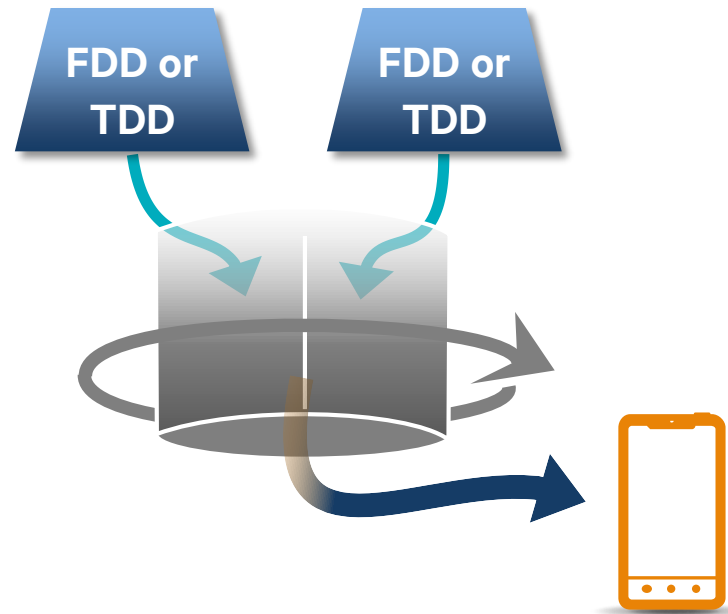
Long history of trials and deployments with major operators and infra vendors



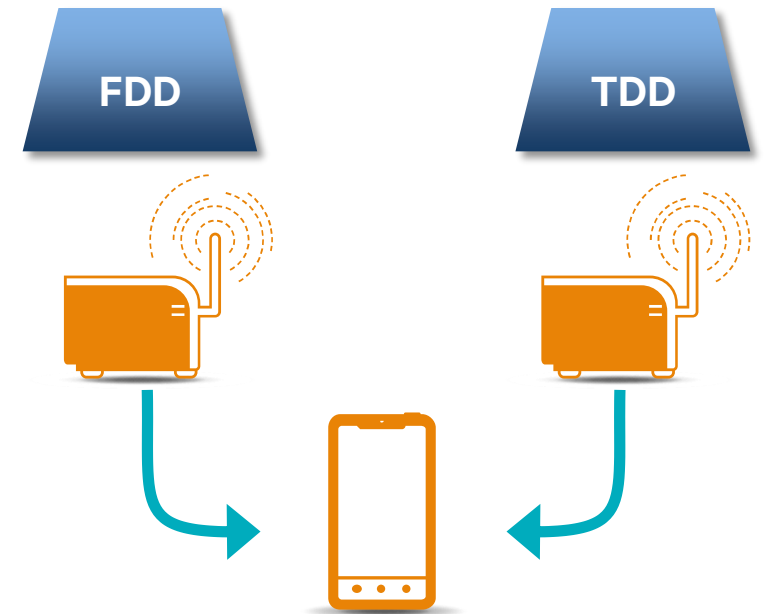
Even tighter FDD and TDD interworking



Available: Seamless interworking¹



June 2013: FDD Carrier Aggregation
Coming: TDD Carrier Aggregation

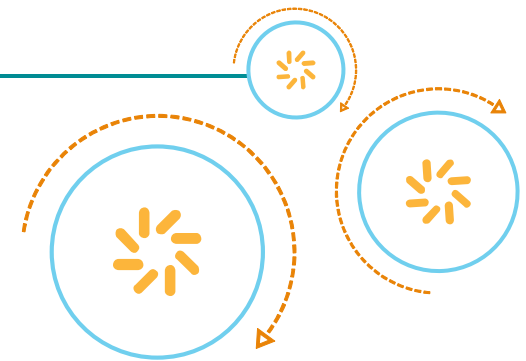


Future: Aggregate FDD + TDD,
even across nodes (multiflow)²

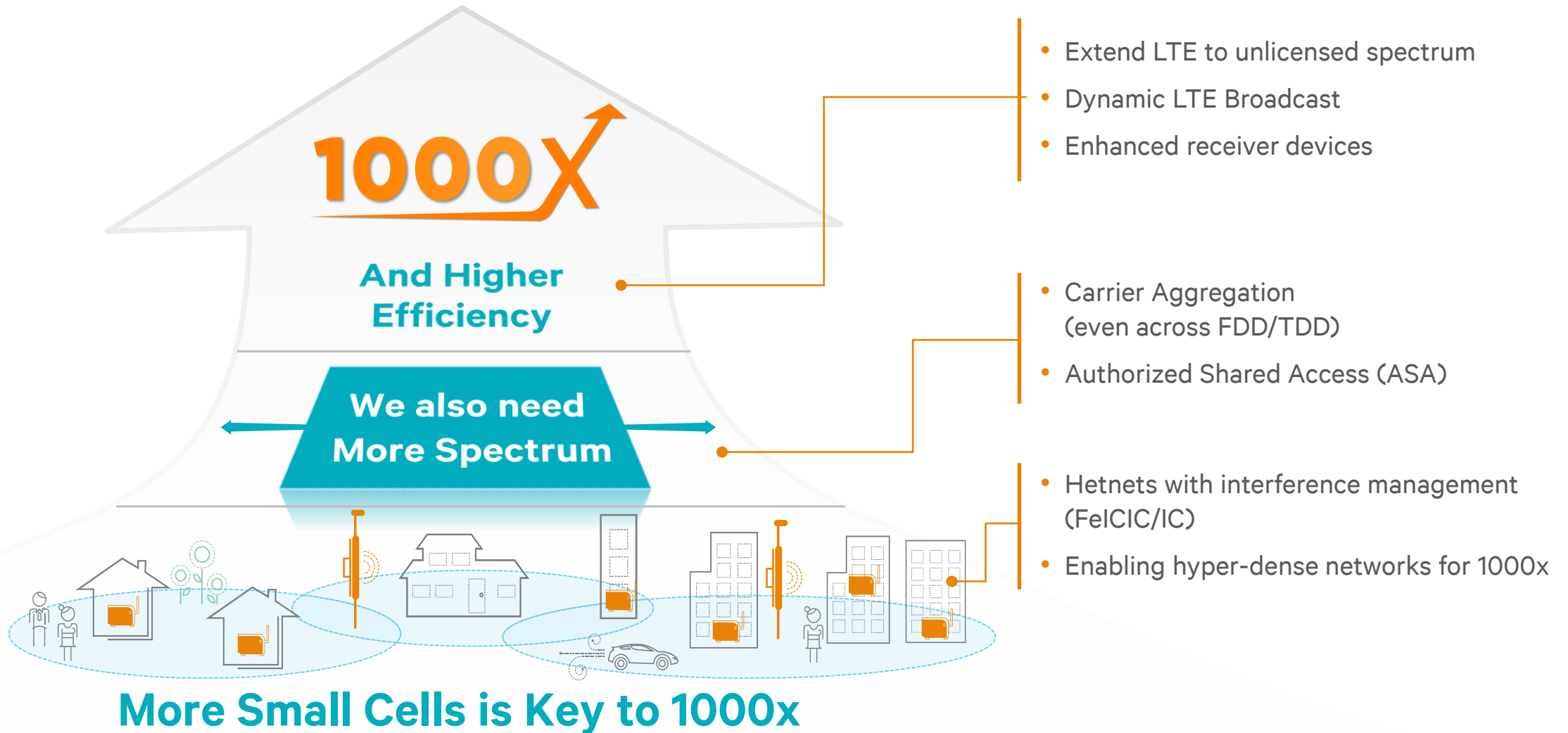
1. Data seamless data interworking with mobility. First step in voice interworking is fallback to 2G/3G (CSFB) which is available, then single radio VoLTE with SRVCC for seamless fallback to 2G/3G. 23GPP R12 candidates



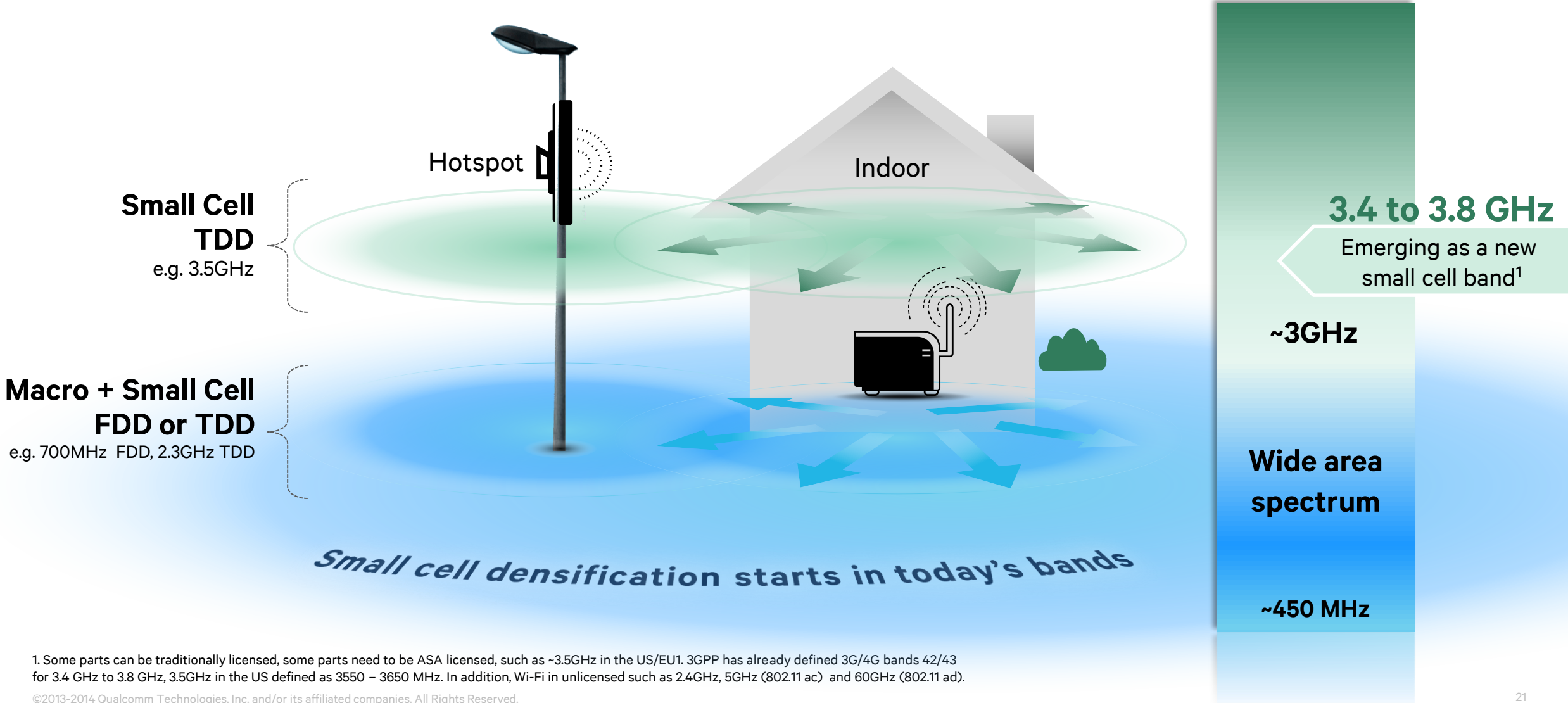
LTE TDD key to access higher spectrum bands on the path to 1000x



Multiple enhancements required to reach 1000x



Many higher spectrum bands suited to LTE TDD and small cells

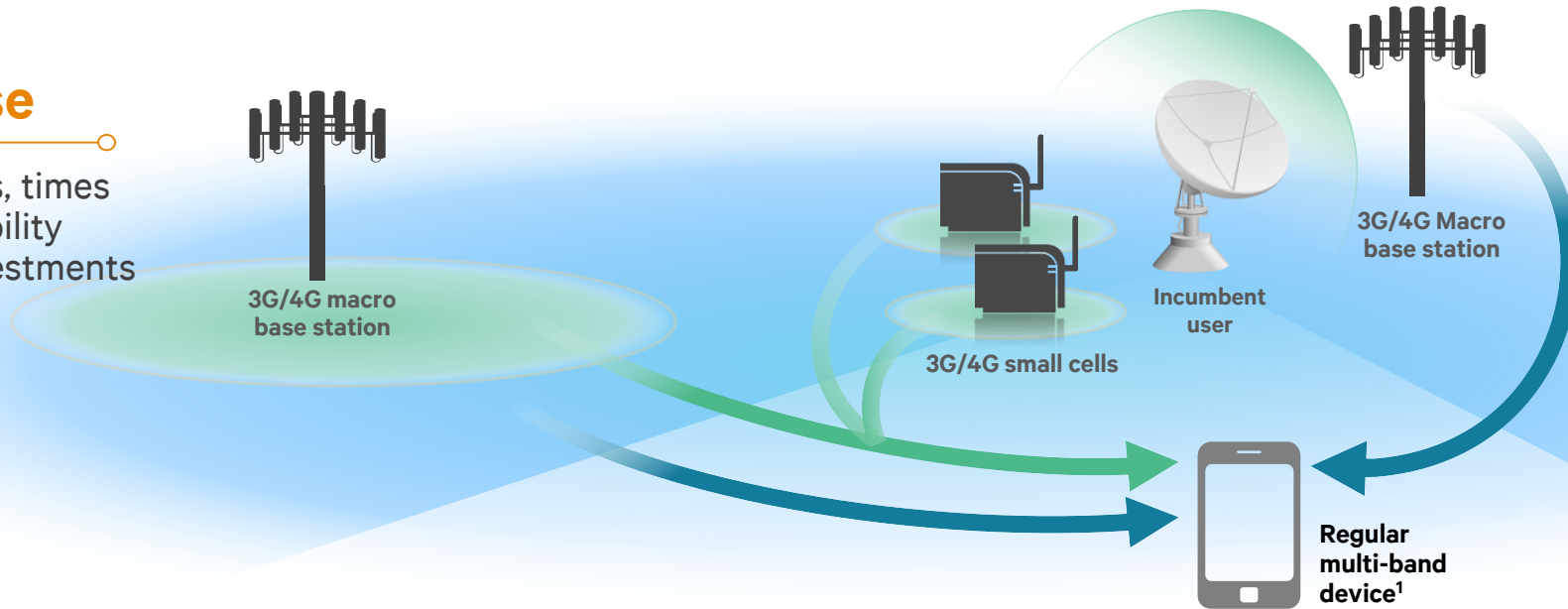


1. Some parts can be traditionally licensed, some parts need to be ASA licensed, such as ~3.5GHz in the US/EU1. 3GPP has already defined 3G/4G bands 42/43 for 3.4 GHz to 3.8 GHz, 3.5GHz in the US defined as 3550 – 3650 MHz. In addition, Wi-Fi in unlicensed such as 2.4GHz, 5GHz (802.11 ac) and 60GHz (802.11 ad).

ASA leverages underutilized spectrum for exclusive use

Exclusive use

- At given locations, times ensures predictability for long-term investments



Both for macro and small cells

- Small cells can be closer to incumbent than macros without interfering

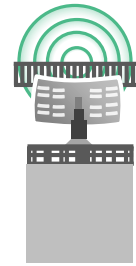
ASA required when spectrum cannot be cleared within reasonable timeframe, or at all locations

Protects incumbents

- Binary use—either incumbent or rights holder
- Protection zones



Satellite



Military radar



Public safety ...

1. No device impact due to ASA, just a regular 3G/4G device supporting global harmonized bands targeted for ASA. Carrier aggregation would be beneficial to aggregate new ASA spectrum with existing spectrum, but is not required.

ASA – Licensed Harmonized Spectrum

Leveraging global, available 4G technologies to ensure economies of scale

ASA CANDIDATE EXAMPLES	2.3 GHz (100 MHz)	2.6 GHz (100+ MHz)	~3.5 GHz (100-200 MHz)
Applicable Regions	EUROPE (Traditionally licensed in e.g. India)	MENA (Traditionally licensed in e.g. Europe)	USA, EU, LATAM, SEAP
Incumbent Users	Telemetry, public safety, cameras	Various	Naval Radar (US) Satellite (EU, LATAM, SEAP)
Suitable Technology	LTE TDD	LTE FDD/TDD	LTE TDD
Possible Launch	~2015		

3.4-3.8 GHz

Key band for licensed small cells
Traditional licensed in most regions
ASA licensed in US

2.3-2.4 GHz

LSA (Licensed Shared Access)
Endorsed by EU 27 member states
Endorsed by CEPT
Standardized by ETSI

¹3GPP has already defined bands 42/43 for 3.4 GHz to 3.8 GHz, 3.5GHz in the US defined as 3550 – 3650 MHz, but up to 200MHz could be targeted for ASA in e.g. SEA/LATAM. Note that ASA targets IMT spectrum bands, but the concept can be applied generally to all spectrum bands and other technologies

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<http://www.qualcomm.com/blog/contributors/prakash-sangam>



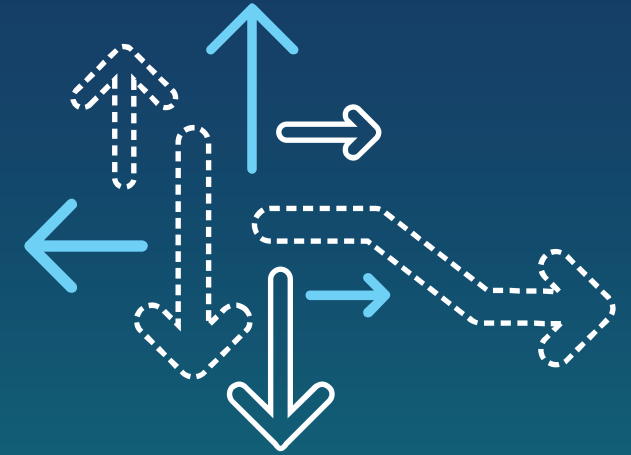
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<http://www.youtube.com/playlist?list=PL8AD95E4F585237C1&feature=plcp>



<http://www.slideshare.net/qualcommwirelessevolution>



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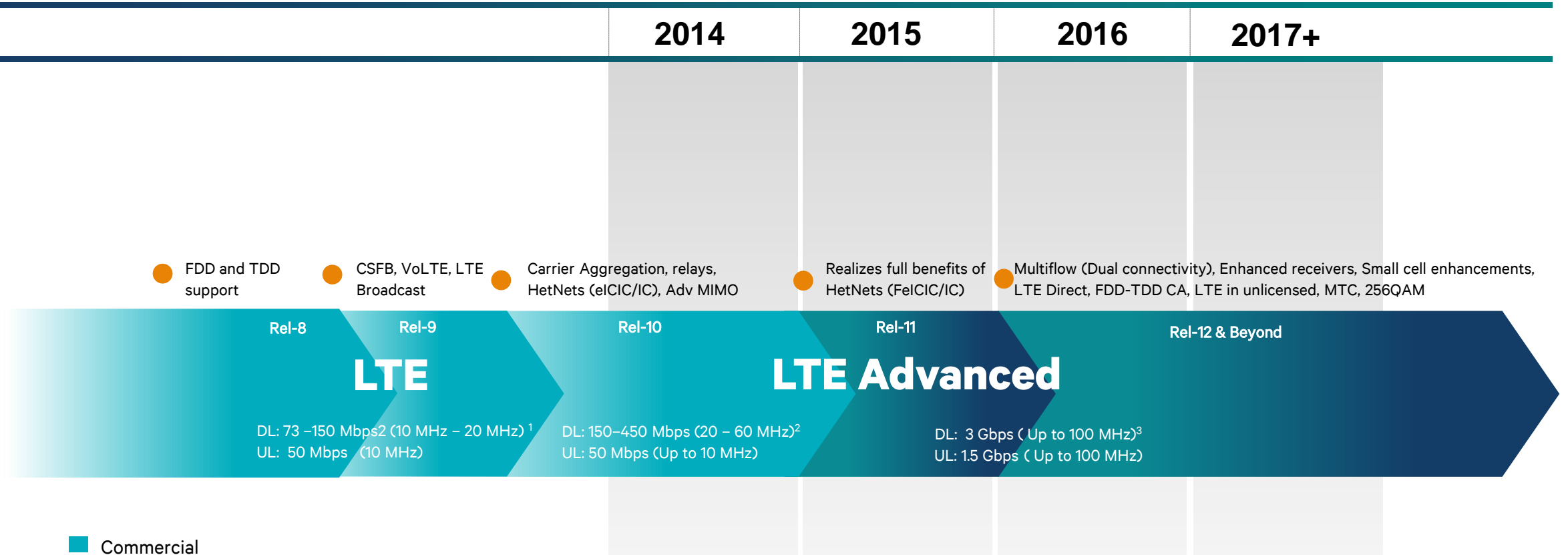
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A strong LTE evolution path



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.