



# Snapdragon 820 - LTE and Connectivity

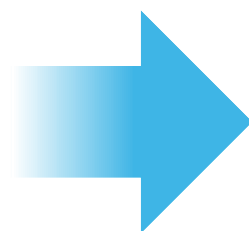
---

March 31, 2016  
Singapore

# Why the modem matters

## Top 10 consumer smartphone activities

- Phone calls
- SMS/text
- Browse Web
- Take/share photos
- Check weather
- Connect to Wi-Fi
- Check/write email
- Connect using 3G/4G
- Use location/GPS service
- View social media content

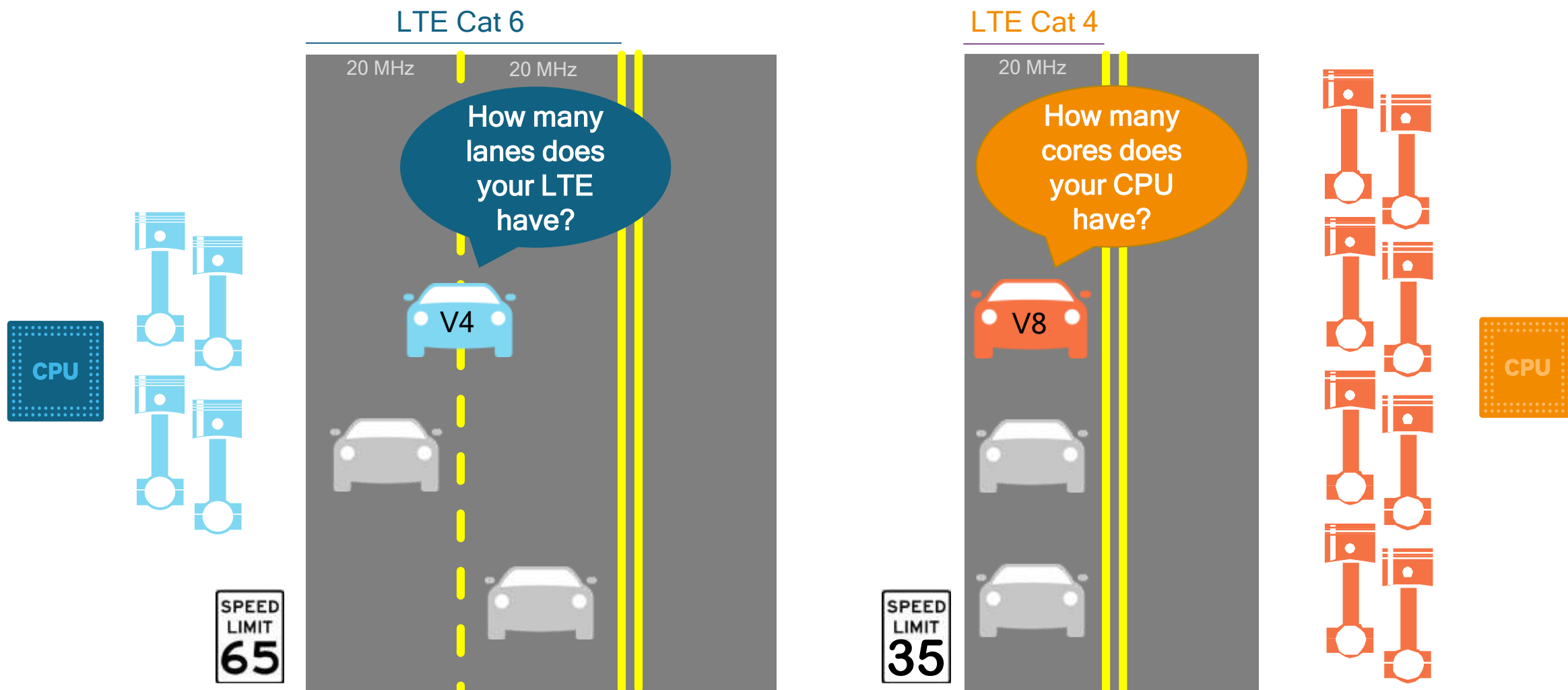


**The modem enables the vast majority of apps and use cases**

- AP benchmarking tools measure app performance essentially in **airplane mode**
- Modem performance matters in the user experience -- it's not just the network

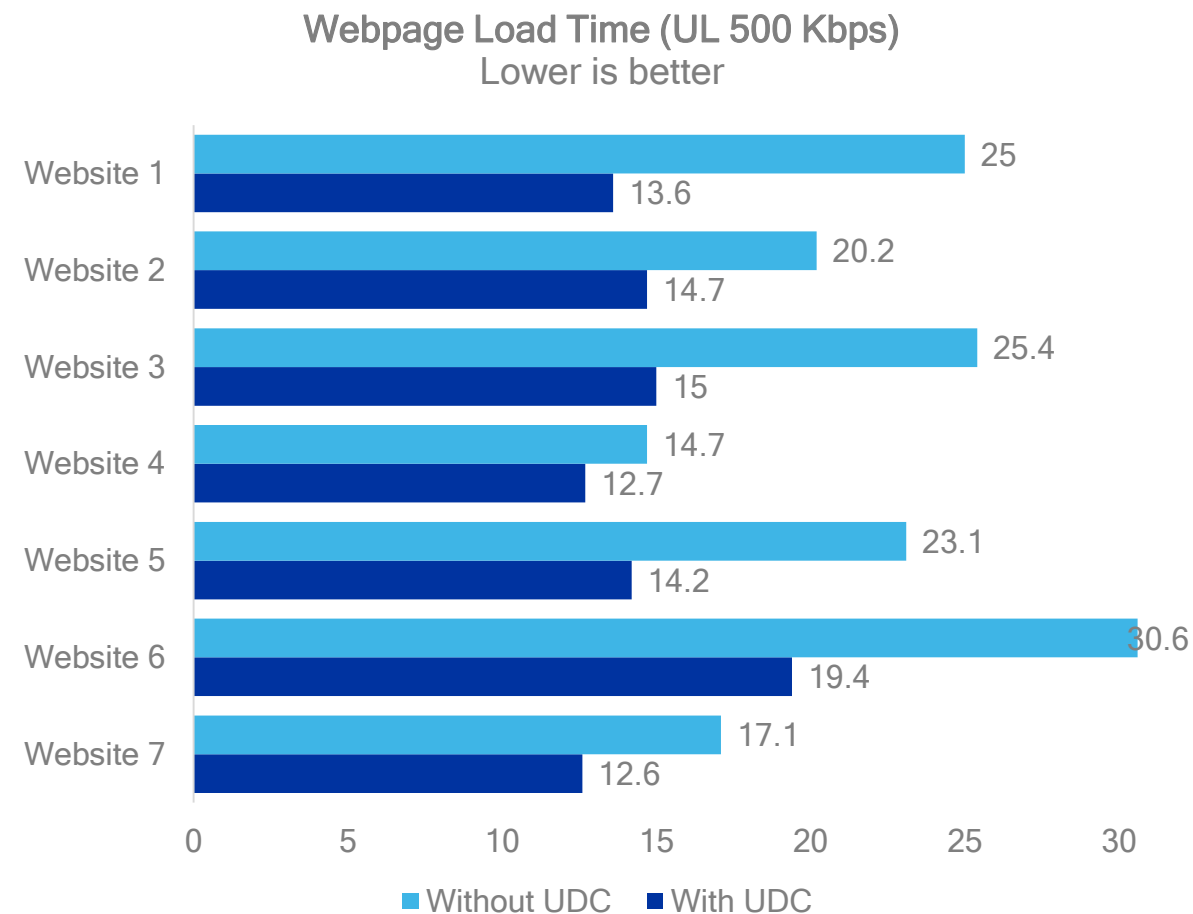
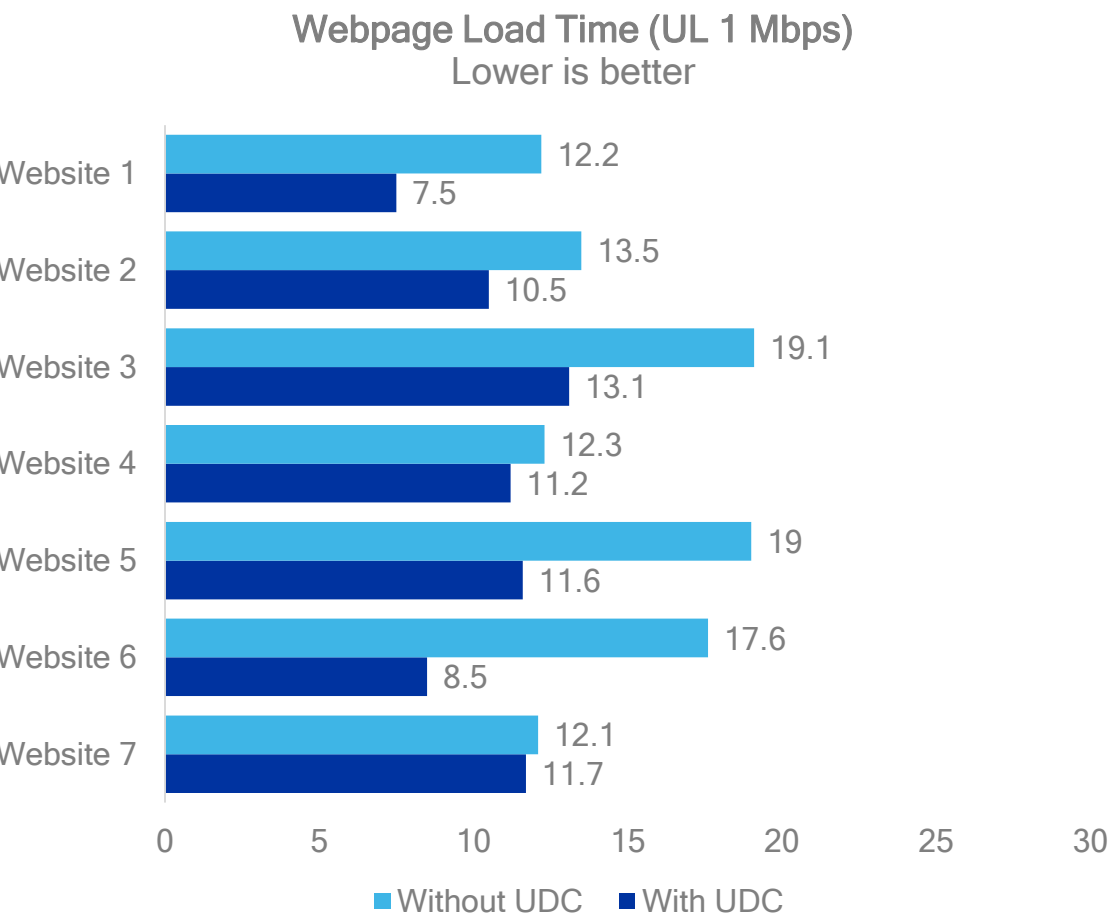
# Mobile experience cannot be boiled down to a single spec

## CPU core analogy: V4 vs. V8 engine

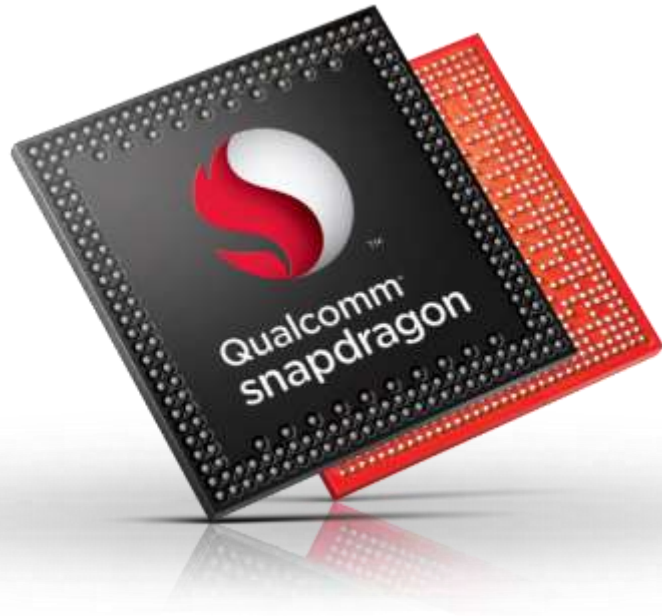


# What Web browsing benchmarks can't show you

## Web user experience enhanced by Uplink Data Compression



# Qualcomm® Snapdragon™ 820 processor with X12 LTE



Industry's 1<sup>st</sup> 14nm FinFet LTE SoC

Up to 600 Mbps Cat 12 DL

---

Up to 150 Mbps Cat 13 UL

---

Multi-Band Wi-Fi 2.4GHz, 5GHz, 60GHz

---

LTE-U and LWA convergence with unlicensed

---

Next-gen Calling enhanced mobility + quality

---

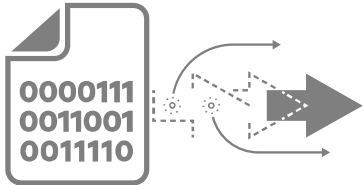
# Qualcomm® TruSignal™ Technology

Fewer dropped calls, more bars, longer battery life\*



## Call Reliability & Quality

- Up to **30%** reduction in dropped calls\*
- Improved\* voice quality



## Faster Data

- Up to **49%** improvement\* in data speeds in real use scenarios
- Better signal quality\* in the presence of signal impediments

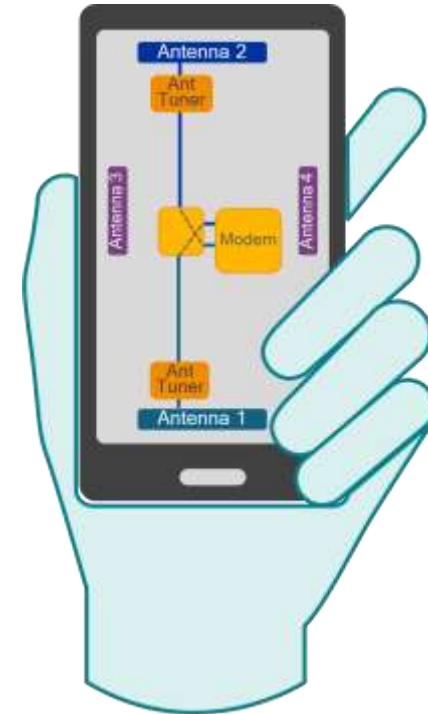


## Longer Battery Life

- Up to **20%** longer\* battery life
- Lower power consumption\* for the same throughput



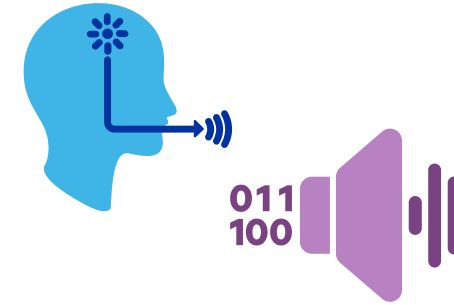
**TruSignal is designed to optimize signal strength at all times no matter how the device is held**



# Snapdragon 820 supports superior VoLTE experiences

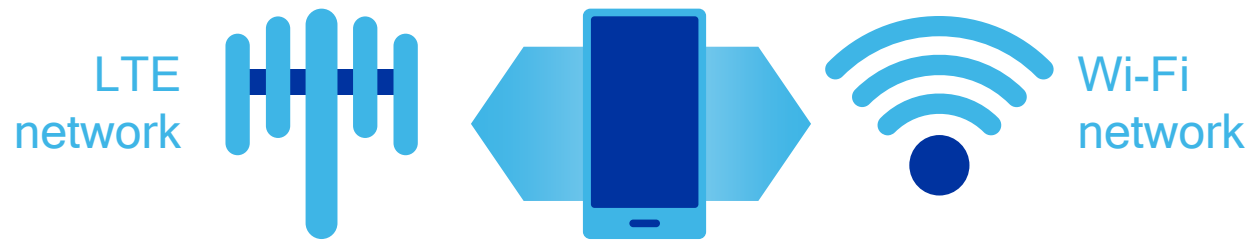
## Ultra HD voice with next gen EVS codec

- Enhanced call reliability
- Superior sound quality
- Higher network capacity



---

## Smart Wi-Fi calling



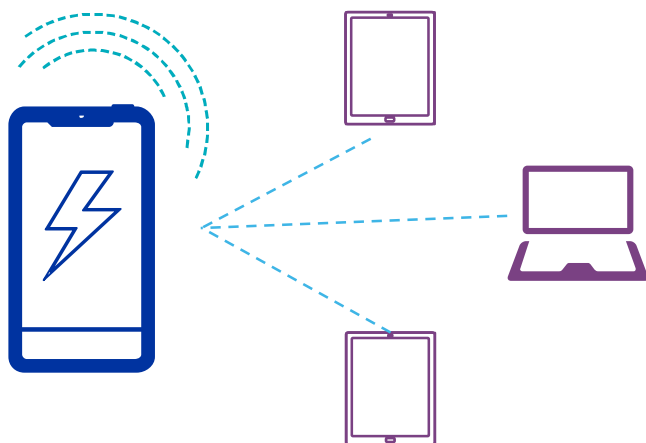
Seamless mobility

- Wi-Fi signal quality
- Internet reachability
- End-to-end Wi-Fi throughput

# Device-level convergence

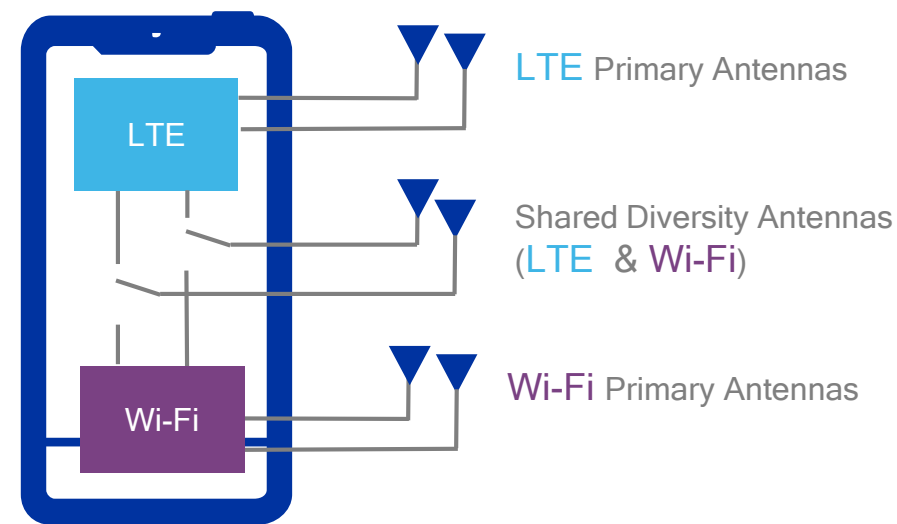
On path to deeper hardware-level sharing of components

## Power efficient hotspot



- Hotspot functionality with extended AP sleep
- Up to 45% lower power consumption\*

## LTE - Wi-Fi Antenna sharing



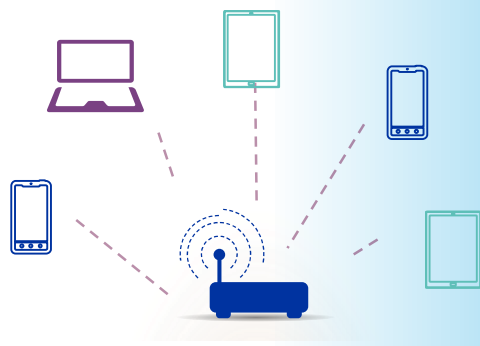
- Enabling attractive form factor with fewer antennas
- Intelligent switching between LTE/Wi-Fi:
  - LTE 4x4 MIMO, Wi-Fi 2x2 MU-MIMO and LTE-U
  - Superior performance

\* Based on Qualcomm Technologies Inc. testing, as compared to the previous generation



# Multi-band Wi-Fi improves capacity and user experience

## 11ac MU-MIMO for 2-3x performance



- Up to 3x user throughput & capacity in crowded places\*
- Peak rates of 867 Mbps
- Optimized for platform power and performance

## 802.11ad for multi-gigabit connectivity



- Multi-gigabit islands in homes & businesses
- Up to 4.6 Gbps data rate in 60GHz (3<sup>rd</sup> Wi-Fi band)
- Low latency media experiences



Snapdragon 820

# Strong MU-MIMO and 11ad ecosystem

MU-MIMO is becoming main-stream

11ad is gaining momentum



Letv



TP-LINK



acer



World's first devices announced  
at CES 2016

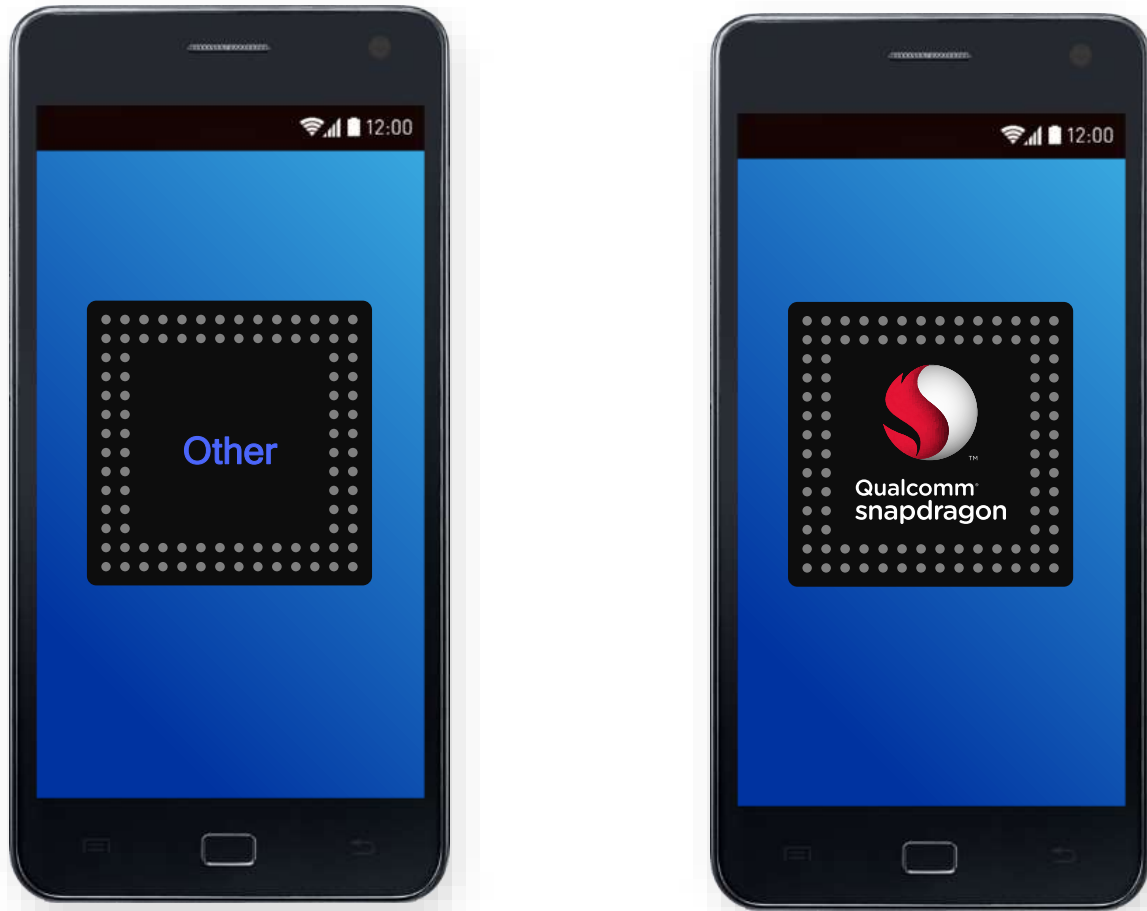


# Snapdragon LTE Modem

A history of setting higher expectations for premium smartphone

# Snapdragon Premium Tier Modem Superiority

## Competitor A's 2015 premium LTE modem vs. Snapdragon X10 LTE



### Snapdragon Advantage

#### Throughput

- Up to 31% faster<sup>1</sup>

#### Power

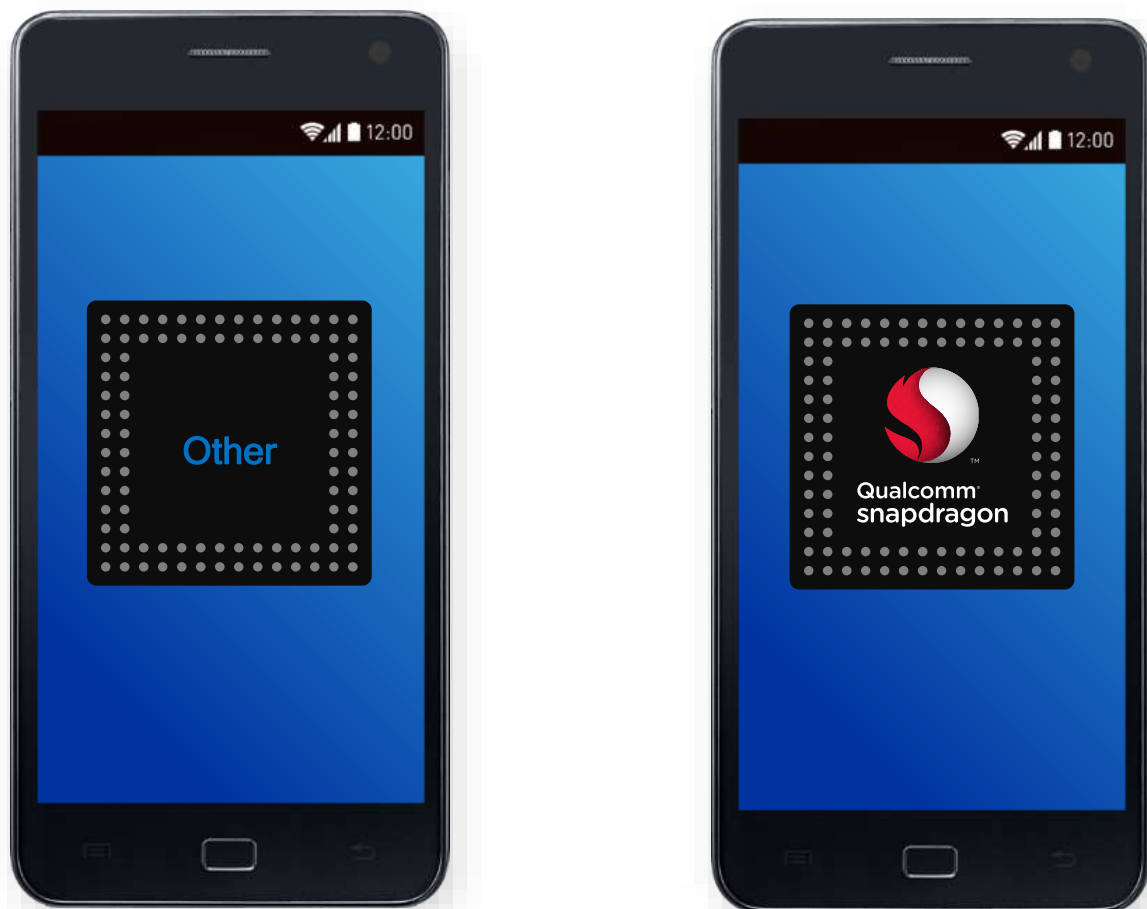
- Up to 35% lower<sup>2</sup>

#### Quality

- 0% call drop vs 15%<sup>3</sup>

# Snapdragon Premium Tier Modem Superiority

## Competitor B's 2015 premium LTE modem vs. Snapdragon X10 LTE



### Snapdragon Advantage

#### Throughput

- Up to 31% faster<sup>1</sup>

#### Power

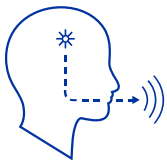

- Up to 24% lower<sup>2</sup>

#### Quality

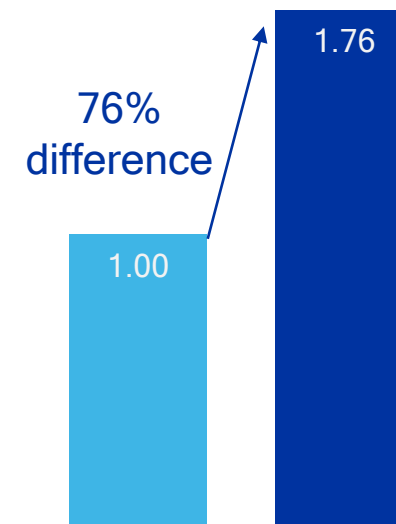
- 0% call drop vs 13%<sup>3</sup>

# Snapdragon leads LTE voice performance

## Comparison with competitors

	Metric	Snapdragon	Competitors
 quality	CSFB (3G) call failures	0%	13 - 20% failures <sup>1</sup>
	Return to LTE after call	best	6 - 10 sec longer <sup>2</sup>
	Packet handover failure	0%	25 - 28% failures
 Power	VoIP over LTE (VoLTE)	best	up to 76% worse
	CSFB (3G) voice power	best	9 - 122% worse

Relative VoLTE  
Power Consumption  
(lower is better)





# X16

## LTE Modem

### Quick Facts

## A 14nm FinFET discrete LTE Advanced Pro Modem

Up to 1 Gbps - **Cat 16 DL**

4x4 MIMO on 2xCA + 2x2 MIMO on 3<sup>rd</sup> carrier; up to 4x20 MHz CA supported with 2x2 MIMO

---

Up to 150 Mbps - **Cat 13 UL**

via 2x20MHz CA and 64-QAM

---

LTE-U and LAA - **Convergence with unlicensed**

Globalizing access to LTE in unlicensed spectrum

---

3.5 GHz band support - **New 3GPP bands**

Additional licensed LTE spectrum access

**Sampling now**

**Commercial devices expected in 2H 2016**

# The Snapdragon X16 LTE modem represents several firsts\*

Continuing the tradition of technology leadership by Qualcomm Technologies

1<sup>st</sup>

announced Cat 16  
Gigabit Class LTE  
modem

1<sup>st</sup>

LTE Advanced *Pro*  
(3GPP Rel. 13)  
modem

1<sup>st</sup>

LTE modem to support  
Licensed Assisted  
Access (LAA)

1<sup>st</sup>

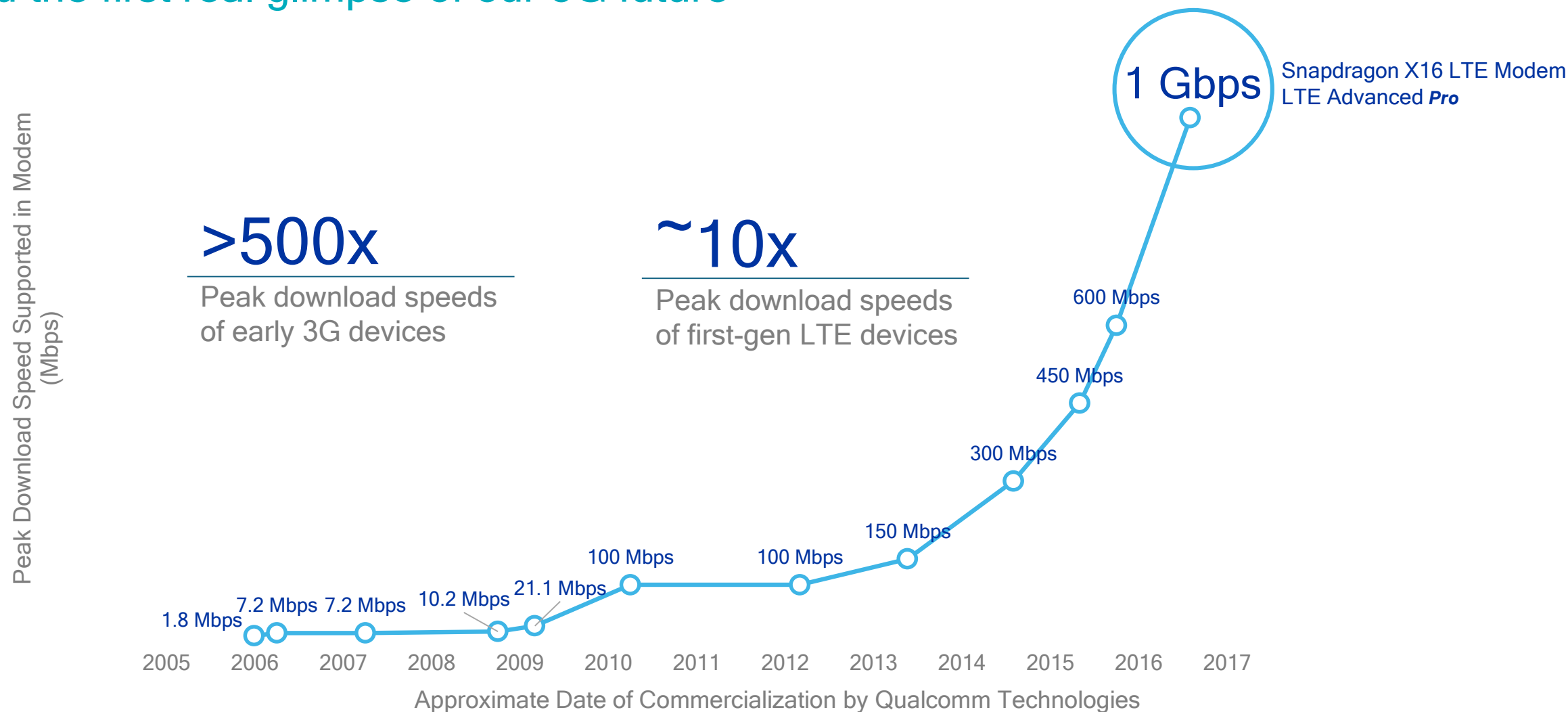
discrete LTE modem  
built on 14nm FinFET  
process

\*Firsts with respect to public announcement of a commercial LTE modem chipset.



# A significant milestone for the entire mobile industry

And the first real glimpse of our 5G future






















# Premium-tier features cascade quickly to mid and low tiers











	2013	2014	2015	2016
<b>Premium/ 800</b>	<div>Cat 4 LTE</div> <div>10+10 CA</div> <div>VoLTE</div> <div>7-Mode</div> <div>802.11ac*</div> <div>LTE-B</div>	<div>20+20 CA</div> <div>Wi-Fi Calling</div> <div>11ac MU-MIMO</div>	<div>20+20+20 CA</div> <div>Uplink CA</div> <div>EVS</div> <div>FDD/TDD CA</div> <div>BT 4.2</div>	<div>Gigabit LTE</div> <div>LAA</div> <div>802.11ad</div>
<b>600</b>		<div>Cat 4 LTE</div> <div>VoLTE</div> <div>7-Mode</div> <div>802.11ac</div> <div>LTE-B</div>	<div>20+20 CA</div> <div>Uplink CA</div> <div>Wi-Fi Calling</div> <div>FDD/TDD CA</div> <div>11ac MU-MIMO</div> <div>BT 4.2</div>	<div>EVS</div>
<b>400</b>		<div>Cat 4 LTE</div> <div>10+10 CA</div> <div>VoLTE</div> <div>7-Mode</div> <div>LTE-B</div>	<div>Wi-Fi Calling</div> <div>802.11ac</div>	<div>20+20 CA</div> <div>Uplink CA</div> <div>EVS</div> <div>FDD/TDD CA</div> <div>11ac MU-MIMO</div> <div>BT 4.2</div>
<b>200</b>			<div>Cat 4 LTE</div> <div>10+10 CA</div> <div>VoLTE</div> <div>7-Mode</div> <div>Wi-Fi Calling</div> <div>LTE-B</div>	

\*802.11ac was supported since 2012

# Superior modem features in mid- and low-tier

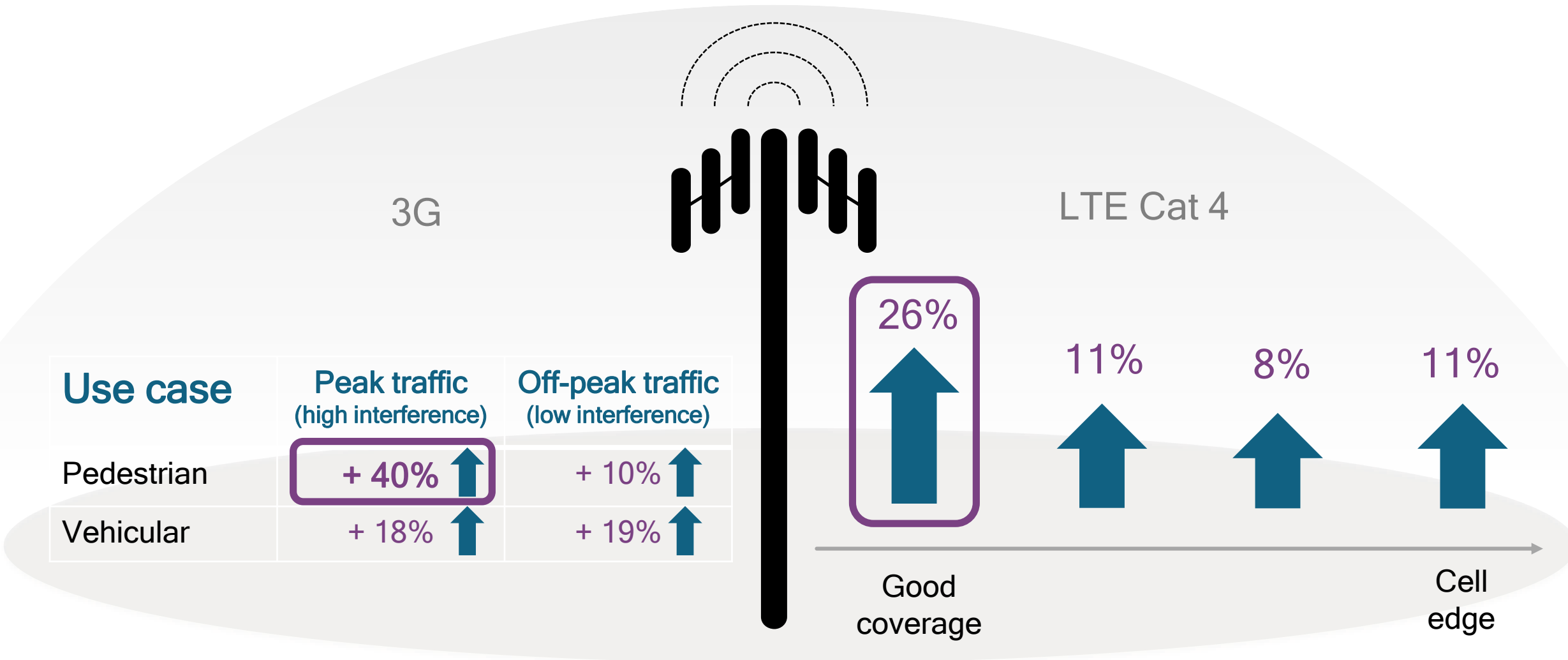
## Snapdragon advantage vs. competitor C

	Features	Snap-dragon	Competitor C	Benefit
3G	LTE Cat 6/7 & above	✓	✗	001111001    
	Interference cancellation	✓	-	001111001    
	TD-SCDMA	✓	✓	
	TD-SCDMA RxD	✓	✗	001111001    
	HS Cell FACH	✓	✗	001111001 
Advanced Features	LTE to 2G/3G/4G IRAT	✓	✓	
	VAMOS	✓	✗	001111001
	CnE (LTE, Wi-Fi smart selection)	✓	✗	 
	NSRM (Gating signaling traffic)	✓		
	Fast return to LTE	✓	Only in TDD	

	Features	Snap-dragon	Competitor C	Benefit
eMBMS	eMBMS (LTE Broadcast)	✓	✗	001111001 
	eMBMS+G DSDS	✓	✗	
Voice/ Dual SIM	Mature, global VoLTE	✓	✗	
	Smart Wi-Fi calling	✓	✗	
	VoLTE+ G DSDS	✓	✗	
	Global SKU	✓	✗	
Carrier/OEM Features	hVoLTE/1xSRLTE	✓	✗	
	Data Retry	✓	✗	
	MASC/Smart pipe	✓	✗	
	DAC/UDC (UL compression)	✓	✗	001111001 

# Superior throughput in mid- and low-tier

## Snapdragon advantage vs. competitor C



# Superior LTE multi-mode experiences in mid- and low-tier

## Snapdragon advantage vs. competitor C

Snapdragon performance advantage over competition

	LTE ↔ GSM	LTE ↔ 3G (UMTS)
Paging Failure Rate (CSFB)	0% vs. 12%	
LTE → GSM/3G Reselection Failure Rate	0% vs. 10%	0% vs. 4%
GSM/3G → LTE Reselection Failure Rate	0% vs. 10%	0% vs. 16%
LTE → GSM/3G Reselection Delay	49%	38%
GSM/3G → LTE Reselection Delay	50%	36%
LTE → GSM/3G CSFB delay	19%	0%
GSM → LTE Return time	173%	
LTE → 3G CSFB Page Failure rate		0% vs. 22%
LTE → 3G CSFB PS Handover Failure Rate		0% vs. 5.5%
LTE → 3G CSFB PS Handover Delay time		13.4%

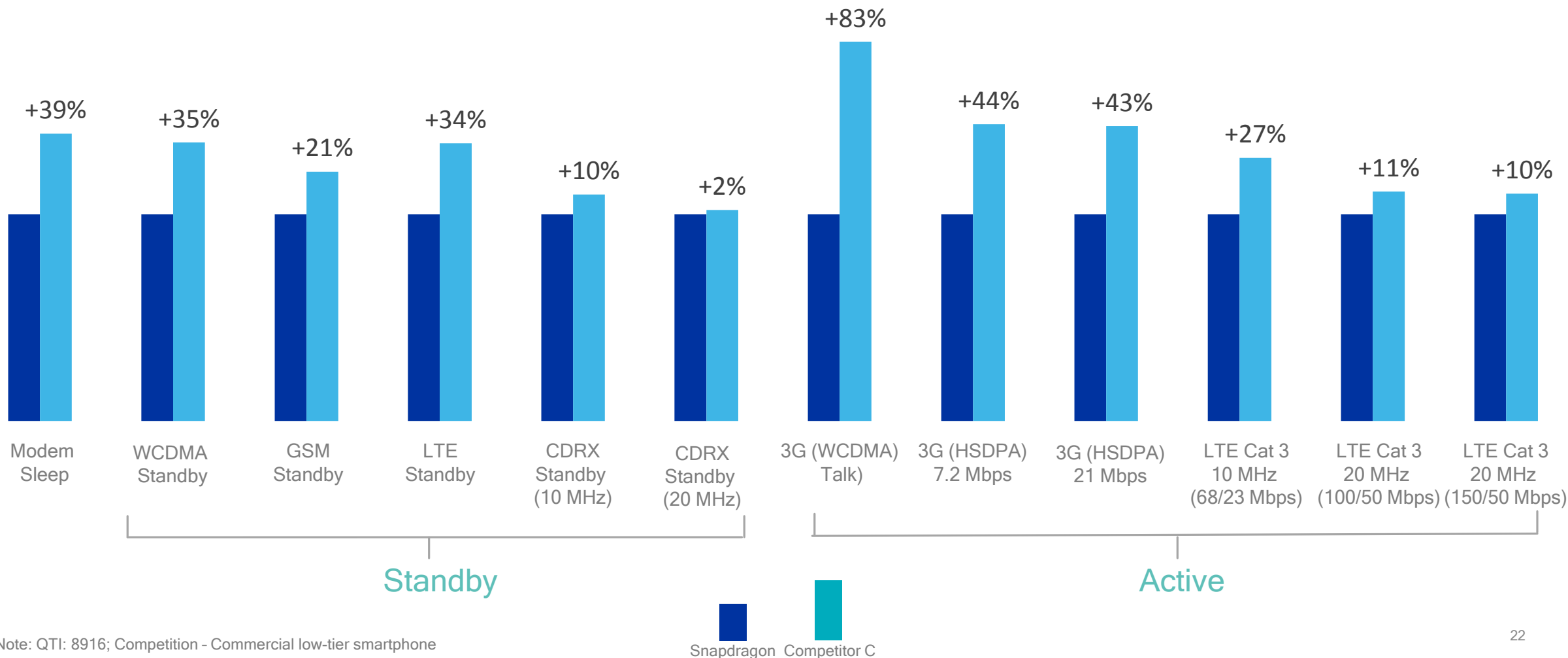
Higher reliability and more seamless experience

Fewer missed and dropped calls and data interruptions  
Camping on the optimal technology/network

# Superior power efficiency in mid- and low-tier

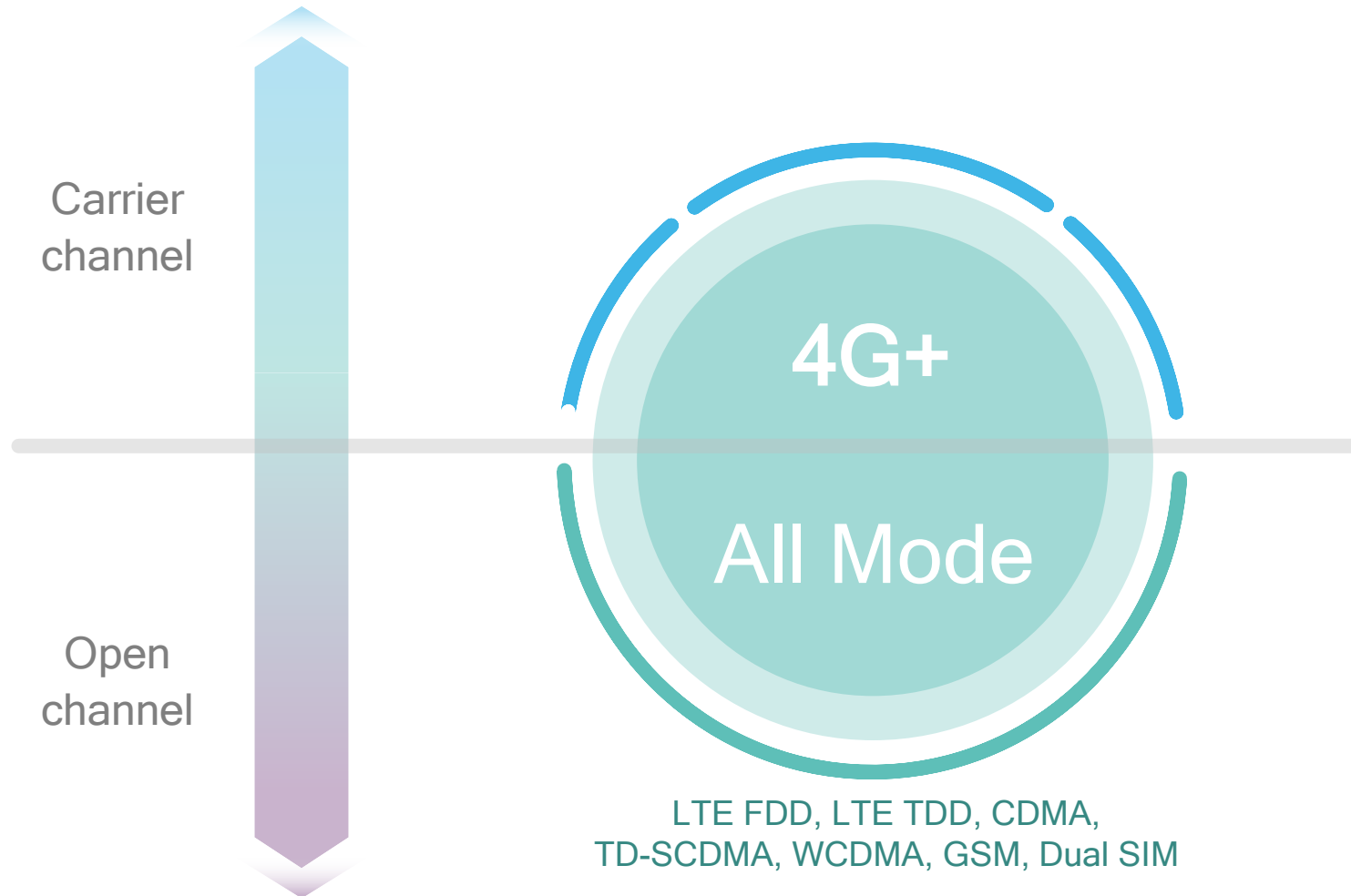
## Snapdragon advantage vs. competitor C

Lower is better



# Snapdragon All Modem and LTE carrier aggregation (4G+)

Supports all major connectivity features deployed worldwide<sup>1</sup>



# 120+

Designs launched  
and in pipeline<sup>2</sup>

All 14 cellular and Wi-Fi modes

All 50+ mobile radio bands<sup>1</sup>

All 98 4G+ networks<sup>3</sup>

All 20 voice modes

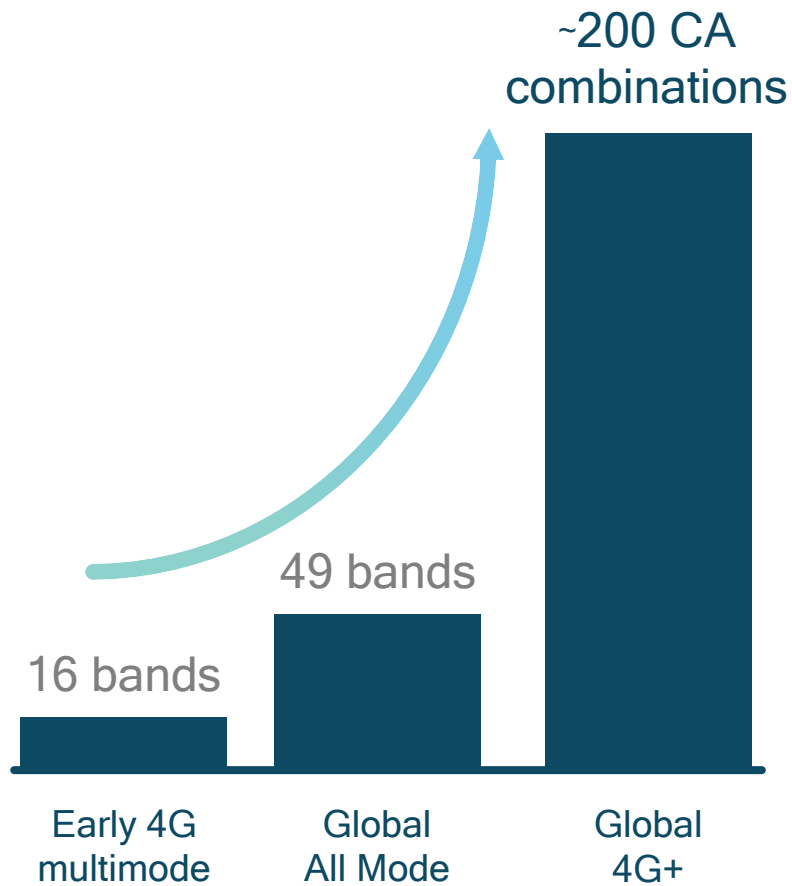
All 16 Dual SIM modes

<sup>1</sup>Includes 3GPP and Wi-Fi and other connectivity bands. Source: 3GPP, Qualcomm Technologies, Inc.

<sup>2</sup>China OEM designs; source: Qualcomm Technologies, Inc. <sup>3</sup>GSA, January 2016 and Qualcomm Technologies Inc.

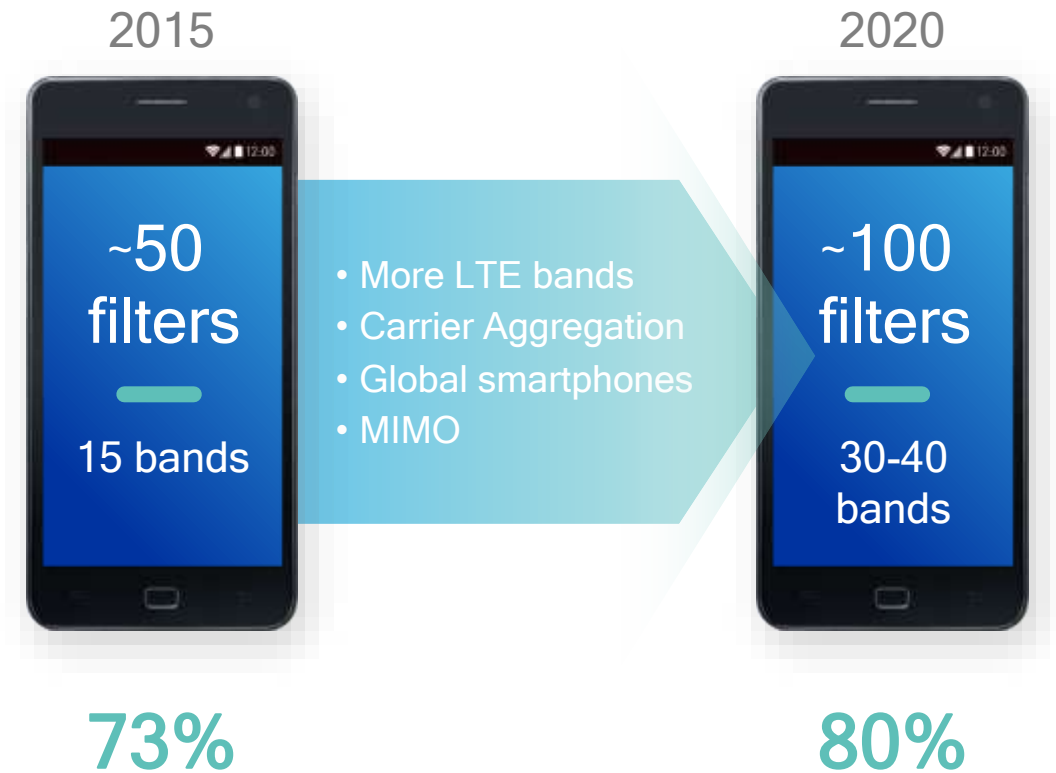
# RF complexity driving platform integration

## Band proliferation increasing front-end BOM



Modules  
(% of total)

### Typical high-end smartphone\*

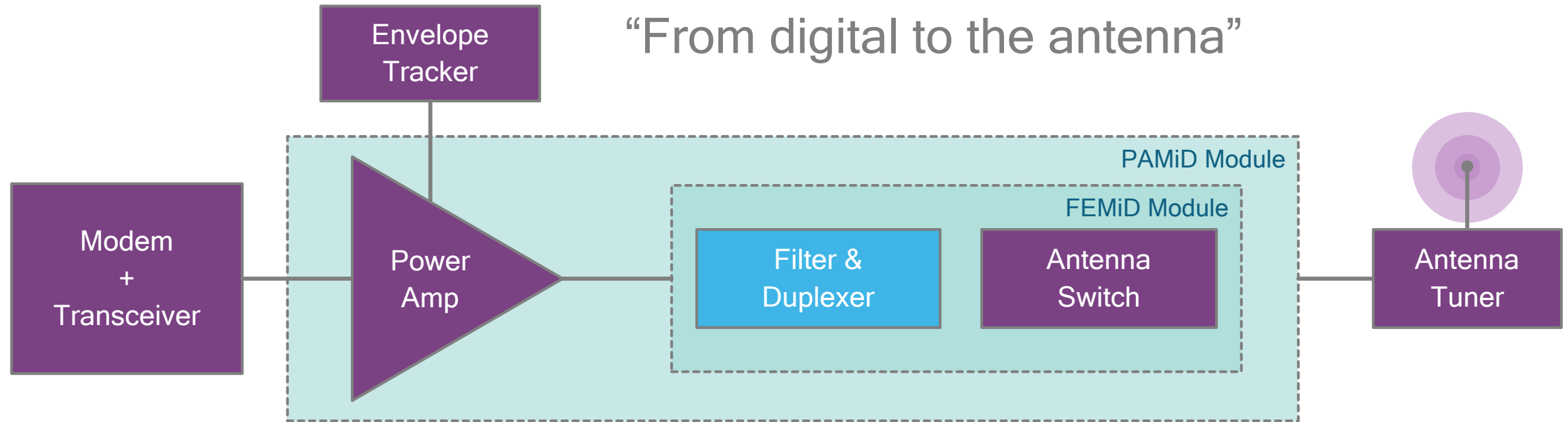


\*High-end smartphone example. Source: Linley Group, June 2015 Other data: Qualcomm Technologies, Inc.



# TDK's/QCT's technologies will provide comprehensive solution

## Extending the Qualcomm® RF360™ front end solution



Connectivity technology leadership now requires end-to-end system design



Current QTI products



Strengthened / enabled by JV



Current TDK products

# OEM profitability with single SKU

Supported by Snapdragon All Mode and Qualcomm® RF360™ solution



**Top Line**

Expand addressable customer base  
Faster time to global launch

## **SKU**

A unique design variant that can be tracked in inventory

## **SKU Consolidation**

Reducing the number of variants needed for world bands/modes

## **Single-SKU**

One consolidated SKU to support global and regional bands/modes

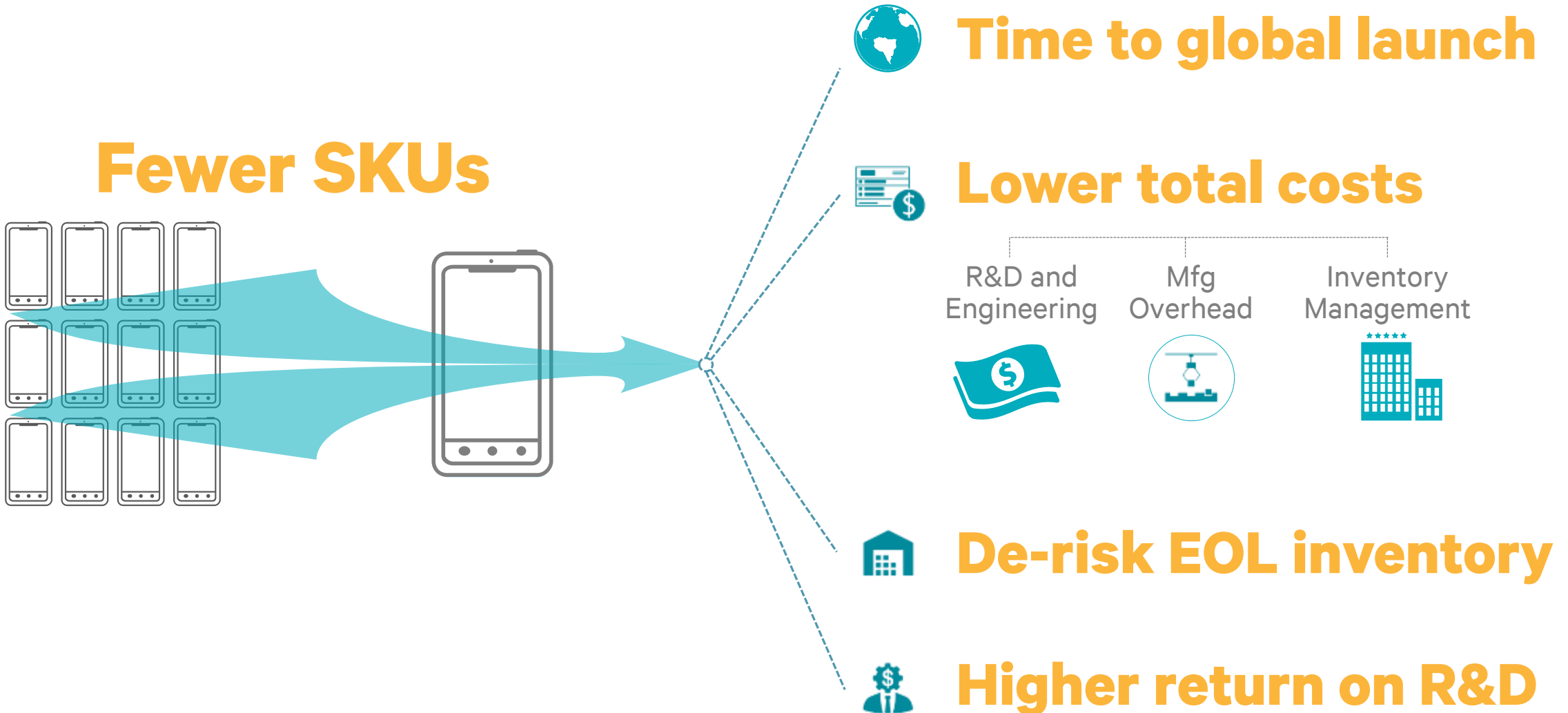
**Total Cost**



Efficiencies through SKU consolidation

# Single-SKU OEM Economics

Improved OEM profitability from Snapdragon All Mode and RF360 solution



# Defining next-gen connectivity experiences



## Ubiquitous and seamless

Connectivity everywhere, roaming across networks with full service continuity



## Contextual connectivity

Dynamically selects best link based on application, spectrum, and context



## Immersive user experiences

Connectivity that delivers stunning and unfettered video, multimedia, and gaming experiences



# Thank you



Follow us on:    

For more information, visit us at:

[www.qualcomm.com](http://www.qualcomm.com) & [www.qualcomm.com/blog](http://www.qualcomm.com/blog)

All data and information contained in or disclosed by this document is confidential and proprietary information of Qualcomm Technologies, Inc. and/or its affiliated companies and all rights therein are expressly reserved. By accepting this material the recipient agrees that this material and the information contained therein is to be held in confidence and in trust and will not be used, copied, reproduced in whole or in part, nor its contents revealed in any manner to others without the express written permission of Qualcomm Technologies, Inc. Nothing in these materials is an offer to sell any of the components or devices referenced herein.

©2016 Qualcomm Technologies, Inc. and/or its affiliated companies. All Rights Reserved.

Qualcomm, Snapdragon and RF360 are trademarks of Qualcomm Incorporated, registered in the United States and other countries. Other products and brand names may be trademarks or registered trademarks of their respective owners.

References in this presentation to “Qualcomm” may mean Qualcomm Incorporated, Qualcomm Technologies, Inc., and/or other subsidiaries or business units within the Qualcomm corporate structure, as applicable. Qualcomm Incorporated includes Qualcomm’s licensing business, QTL, and the vast majority of its patent portfolio. Qualcomm Technologies, Inc., a wholly-owned subsidiary of Qualcomm Incorporated, operates, along with its subsidiaries, substantially all of Qualcomm’s engineering, research and development functions, and substantially all of its product and services businesses, including its semiconductor business, QCT.