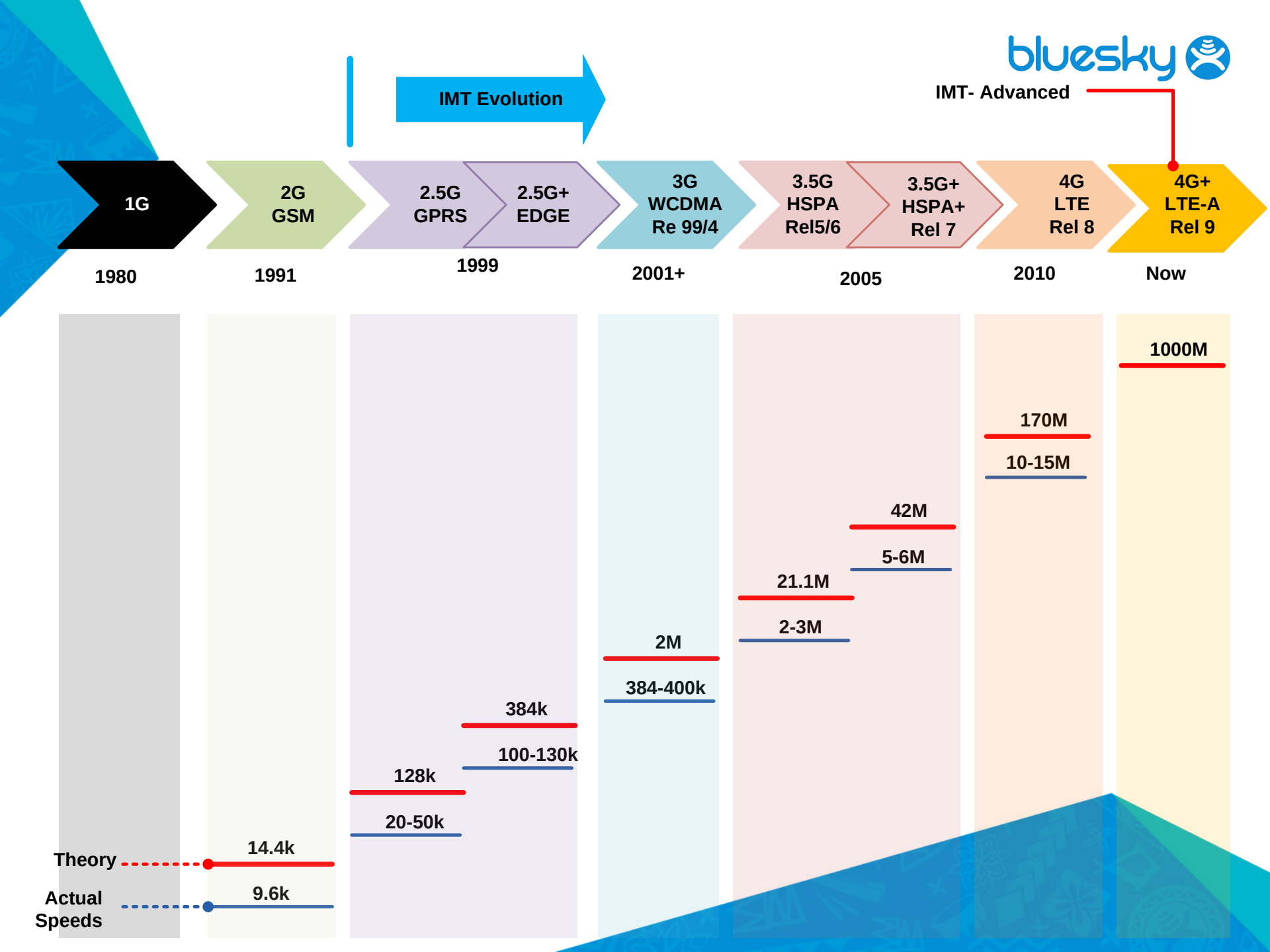
IMT – The Journey

IMT – Key Enablers

- The ever growing **Need for Speed**
- Need for **Capacity** – multiple devices
- Need for **reduced Latency** – targets for <1ms
- Secure all **IP based** mobile broadband solution
- Quality of Service/Experience (QoS/QoE). **One size doesn't fit all**. Different users have different expectation.
- Provide freedom through **mobility**

IMT - Challenges

- **Radio Frequency** – is a finite resource – have to do with what we have.
- RF cannot be contained in a single medium (unlike light in fiber), causes spillage (**interference**)- Spectrum Management essential
- Impacted by **environmental conditions** – signal attenuation, loss of data. Allocation of appropriate spectrum to add effeciency.
- Payload packing (modulation) needs to be made efficient to extract greater **spectral efficiencies** from same (RF) resource


bluesky
IMT Evolution
IMT- Advanced
1G
2G GSM
2.5G GPRS
2.5G+ EDGE
3G WCDMA Re 99/4
3.5G HSPA Rel5/6
3.5G+ HSPA+ Rel 7
4G LTE Rel 8
4G+ LTE-A Rel 9
1980
1991
1999
2001+
2005
2010
Now
1000M
170M
10-15M
42M
5-6M
21.1M
2-3M
2M
384-400k
384k
100-130k
128k
20-50k
14.4k
9.6k
Theory
Actual Speeds

The Ecosystem

Some of the major components (but not limited to) for successful/sustainable evolution on IMT are:

- **Spectrum** – harmonized for Global reach and adoptability. Harmonizing spectrum minimizes interference across national borders, increases the size of mobile markets for equipment and services thereby reducing costs, and enables international roaming.
- **Devices** - Range and Affordability

Spectrum – Harmonization (LTE)

- Release of new sets of frequency bands (eg: Digital Dividend)
- Re-farming existing 2G/3G spectrums
- ITU assigned bands – 2600 MHz

Allocation of Spectrum

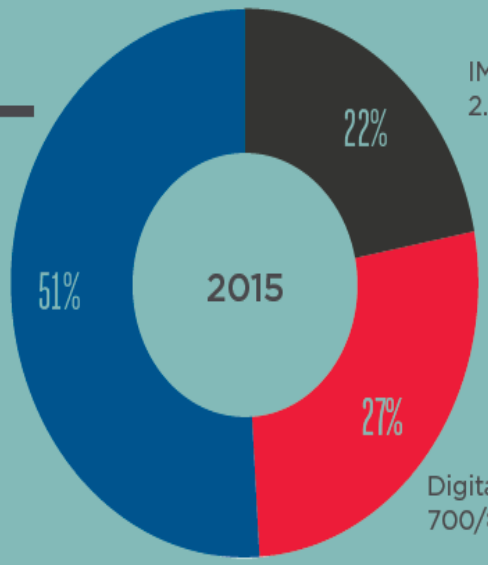
	Region 1 (Europe)	*Region 2 (USA)*
1st Generation	**900 MHz** (880–915/925–960)	**850 MHz** (824–849/869–894)
2nd Generation	**1800 MHz** (1710–1785/1805–1880)	**1900 MHz** (1850–1910/1930–1990)
3rd Generation	**2 GHz** (1920–1980/2110–2170)	**AWS:** (1710–1755/2110–2155)
4th Generation	**800 MHz** (832–862/791–821) **2.6 GHz** (2500–2570/2620–2690)	**700 MHz:** (698–716/728–746 and 777–788/746–757) **2.6 GHz** (2495–2690—unpaired)

How are the Operators Managing the Evolution?

MAPPING 4G-LTE DEPLOYMENTS BY FREQUENCY BANDS

451 operators have commercially launched 4G-LTE networks across 151 countries worldwide as of the end of December 2015

Spectrum scenarios used in global 4G-LTE deployments

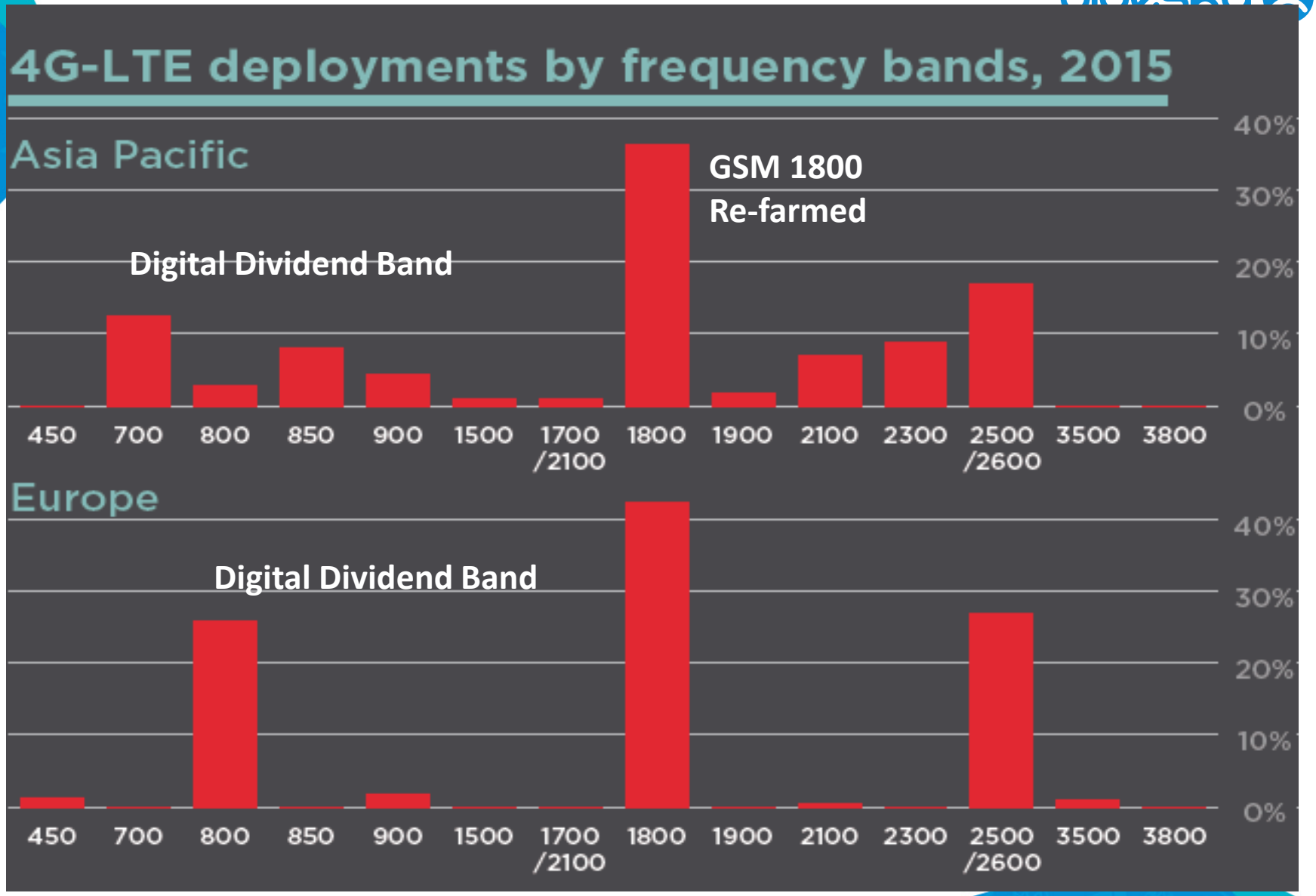


To date, the majority of 4G-LTE deployments worldwide are running on refarmed spectrum in existing bands

Refarmed 2G/3G spectrum

Only 64 countries worldwide have assigned digital dividend spectrum bands

Source: GSA


4G-LTE deployments by frequency bands, 2015
Asia Pacific
GSM 1800
Re-farmed
Digital Dividend Band
40%
30%
20%
10%
0%
450
700
800
850
900
1500
1700 /2100
1800
1900
2100
2300
2500 /2600
3500
3800
Europe
Digital Dividend Band
40%
30%
20%
10%
0%
450
700
800
850
900
1500
1700 /2100
1800
1900
2100
2300
2500 /2600
3500
3800

Source: GSA


US.
700MHz
57
DD800
93
2.6GHz
FDD
108
AWS
46
2
450 MHz
1.9GHz
21
10
900MHz
1.8GHz
213
12
11
12
APT700
2100MHz
850MHz
Source: GSA

What is happening in the Pacific?

Band	Duplex Mode	Freq (MHz)	USA				ANZ							Pacific Islanbds							
			US_AT&T	US_T-Mobile	US_Sprint	US_Verizon	Aus_Telstra	Aus_Vodafone	Aus_Optus	Aus_NBM Co	NZ_Spark	NZ_2 Deg	NZ_Vodafone	Fj_Vodafone	Fj_Digicel	Fj_Telecom	PNG_Digicel	PNG_Telikom	Vnu_Wantok	Vnu_Telecom	Vnu - Digicel
2	**FDD**	**1900**	■	■		■															
4	**FDD**	**1700**	■	■	■	■															
12	FDD	700		■																	
13	**FDD**	**700**				■															
17	FDD	700	■																		
25	FDD	1900			■																
26	FDD	850			■																
41	TDD	2500			■																
3	**FDD**	**1800**	■	■	■		■	■	■												
5	FDD	850		■																	
7	FDD	2600	■		■																
28	**FDD**	**700**	■		■		■		■												
40	TDD	2300			■	■															

Device Roadmap

PRESS RELEASE

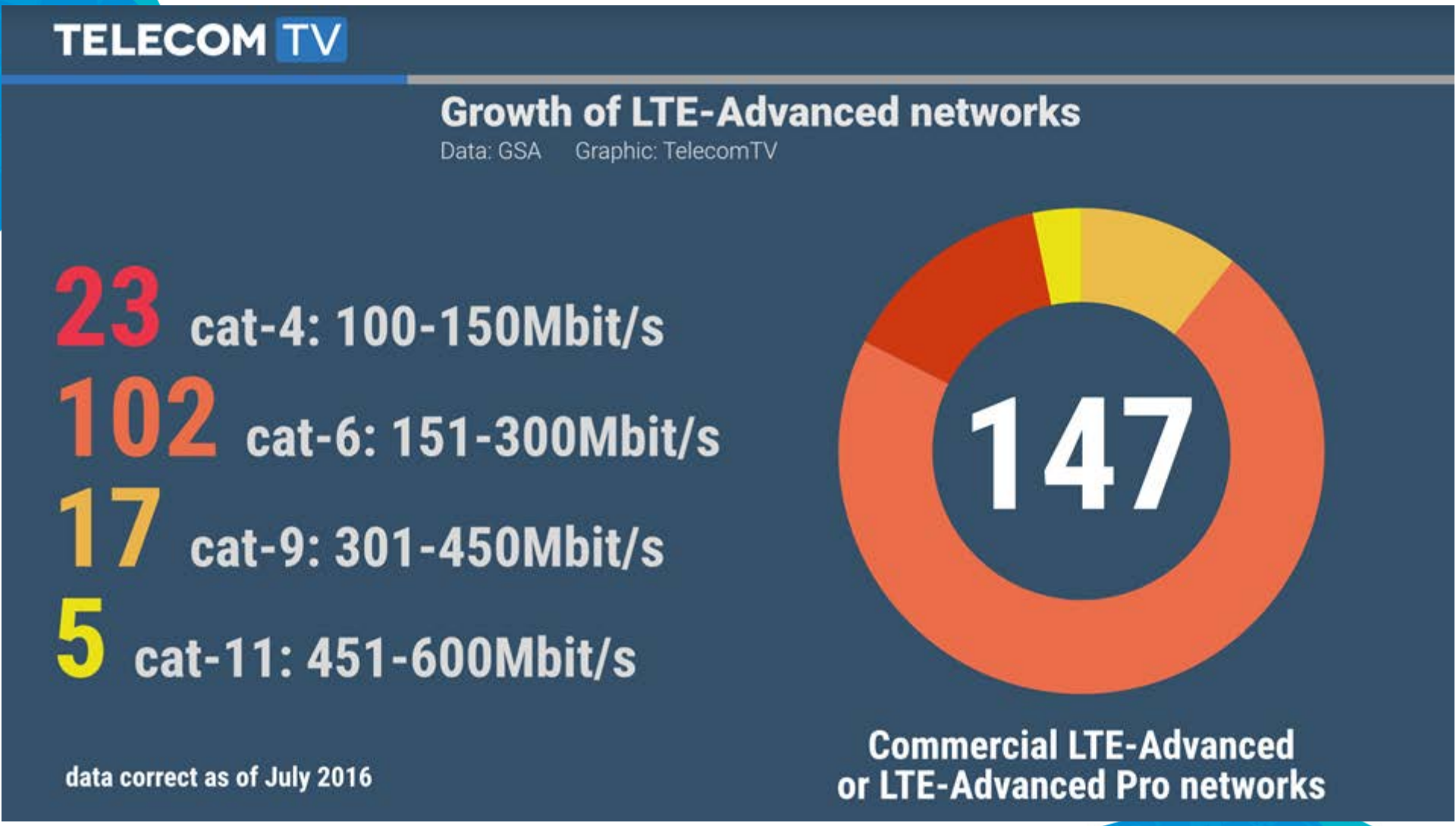
GSA confirms 4,416 LTE user devices, researches new bands

February 12, 2016: The latest update to the Status of the LTE Ecosystem report published this week by GSA (Global mobile Suppliers Association) confirms accelerating growth of the LTE ecosystem and expansion in the availability and performance of LTE-Advanced devices. The report covers LTE FDD and TDD (TD-LTE) devices. 4,416 LTE user devices, including frequency and operator variants, from 369 suppliers are verified by GSA as announced in the market. 1,770 devices have been added to GSA's LTE devices database (GAMBoD) since February 2015, confirming 67% annual growth. The number of LTE device suppliers grew 34% in the same period.

LTE FDD	
1800 MHz band 3	1,543 devices
2600 MHz band 7	1,381 devices
2100 MHz band 1	1,185 devices
800 MHz band 20	812 devices
AWS band 4	727 devices
800/1800/2600 tri-band	739 devices
850 MHz band 5	684 devices
900 MHz band 8	668 devices
700 MHz bands 12 or 17	650 devices
1900 MHz band 2	535 devices
700 MHz band 13	457 devices
1900 MHz band 25	194 devices
APT700 band 28	139 devices
700 MHz band 12	106 devices

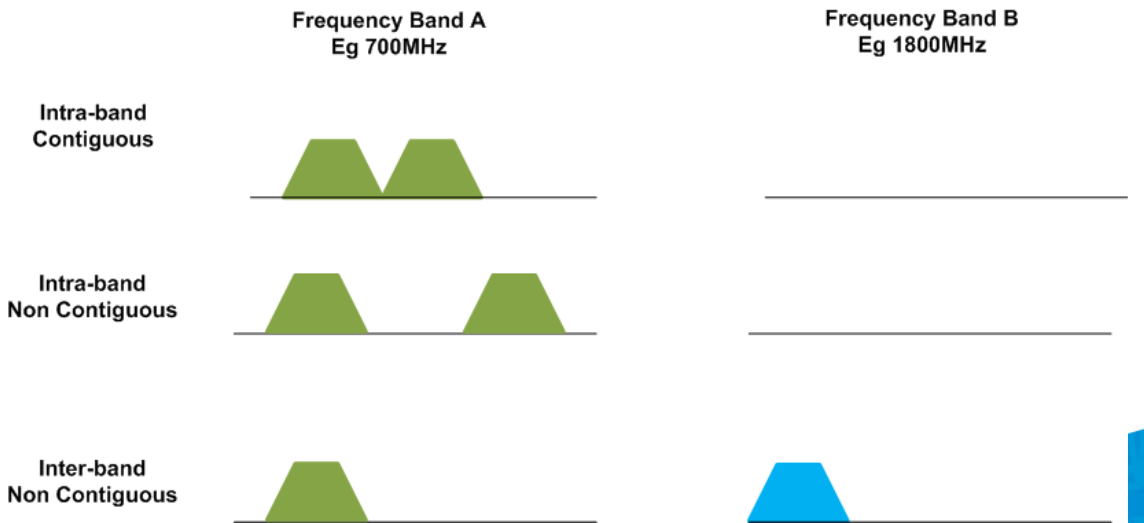
1800 MHz

DD (APT)


TELECOM TV
Growth of LTE-Advanced networks
Data: GSA Graphic: TelecomTV
23 cat-4: 100-150Mbit/s
102 cat-6: 151-300Mbit/s
17 cat-9: 301-450Mbit/s
5 cat-11: 451-600Mbit/s
147
Commercial LTE-Advanced
or LTE-Advanced Pro networks
data correct as of July 2016

Future – Beyond Now… LTE Advance

- **3GPP Rel: 10** – Focuses on carrier Aggregation (CA). Receiving 2 of more carriers thru the same RX path (at UE) to increase down link thru put. Later the TX (from UE) can be done the same way to increase the Uplink thru-put



Future – Beyond Now…
5G

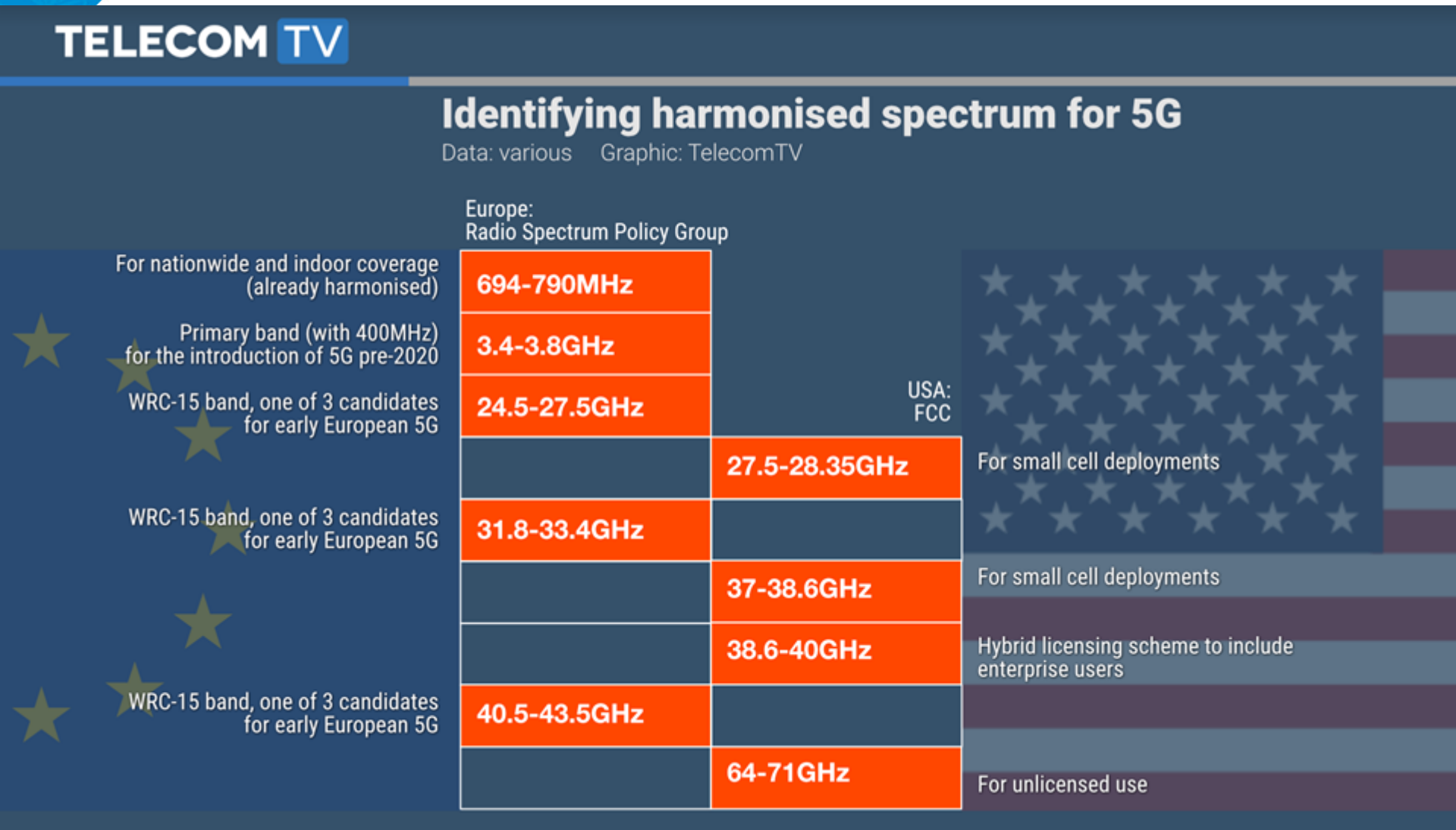
3GPP Rel: 15 → 5G standards will be finalized by 2018 and expected service by 2020. ***(Ovum)***

5G Requirement – Some expectations

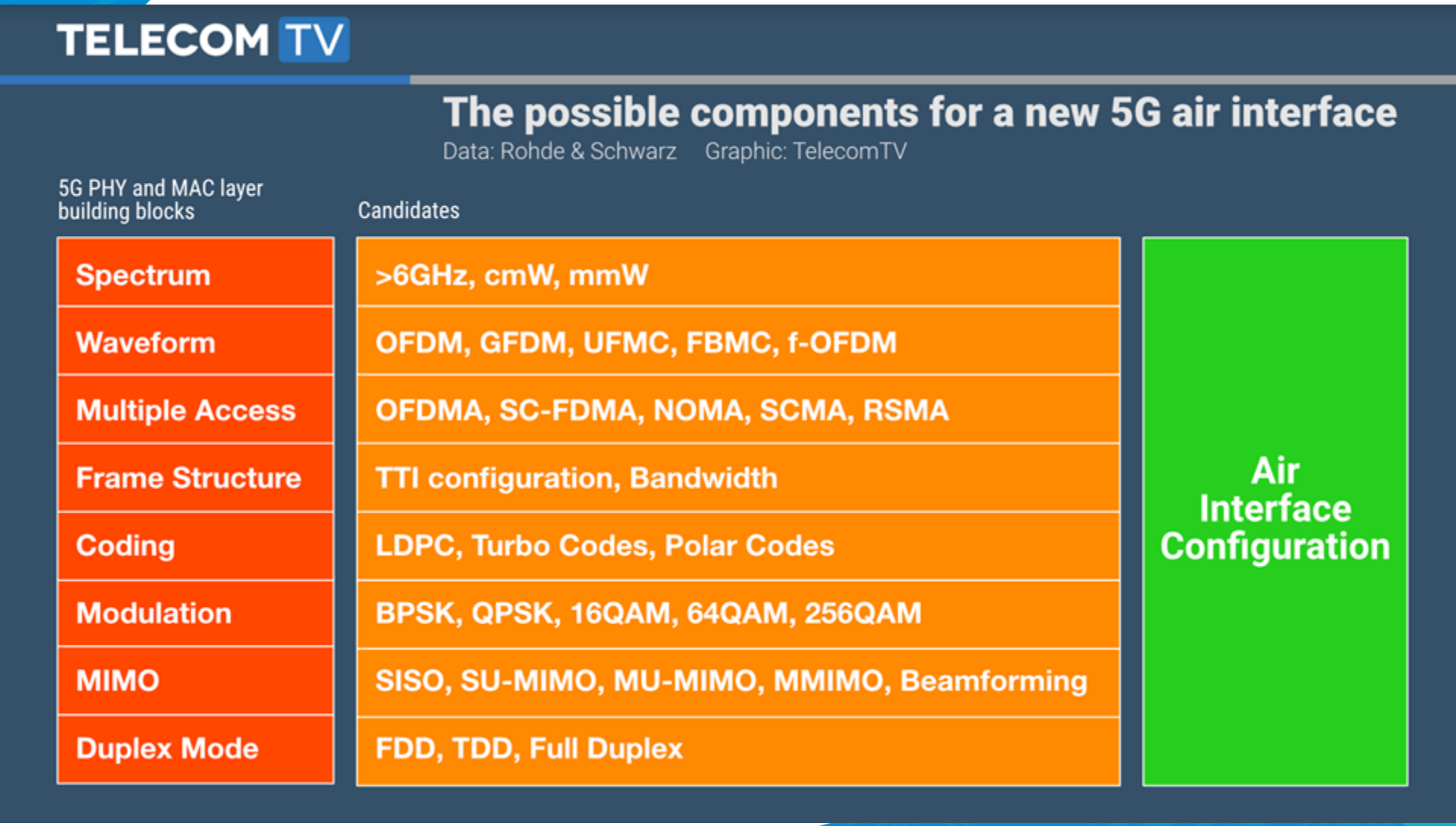
- **1-10Gbps** connections to end points in the field (i.e. not theoretical maximum)
- **1 millisecond**– latency
- 10-100x number of connected devices
- Perception of 99.999% **availability** and of 100% **coverage**
- 90% reduction in network **energy usage**
- Up to 10 year **battery life** for low power, machine-type devices
- One of the key issues with the 5G requirements is that there are **many different interested parties** involved, each wanting their own needs to be met by the new 5G wireless system. This leads to the fact that **not all the requirements form a coherent list**. No one technology is going to be able to meet all the needs together.

"..that brings together people along with things, data, applications, transport systems and cities in a smart networked communications environment." - ***The International Telecommunications Union's Secretary General, Houlin Zhao***

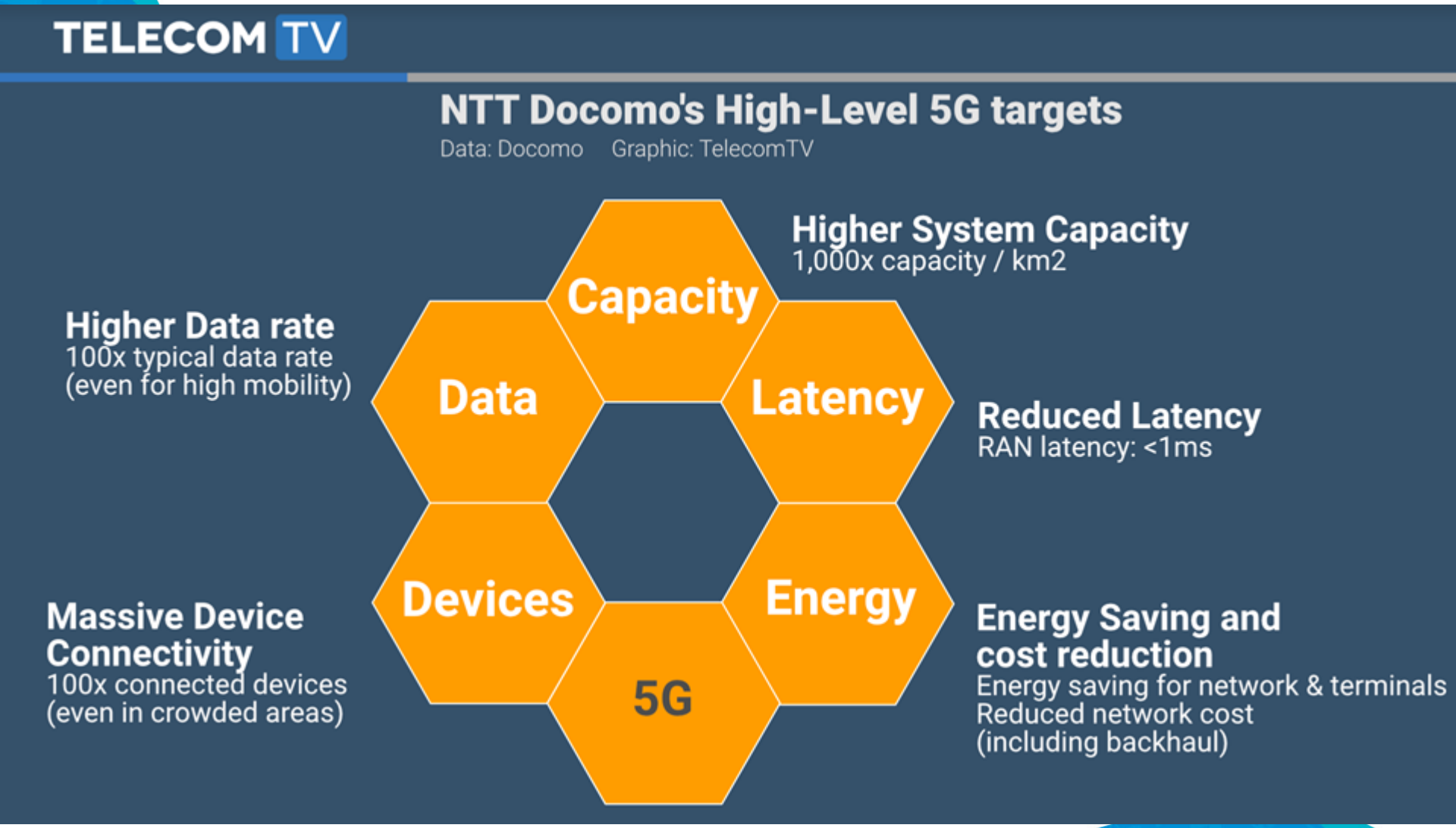
What is making the news….



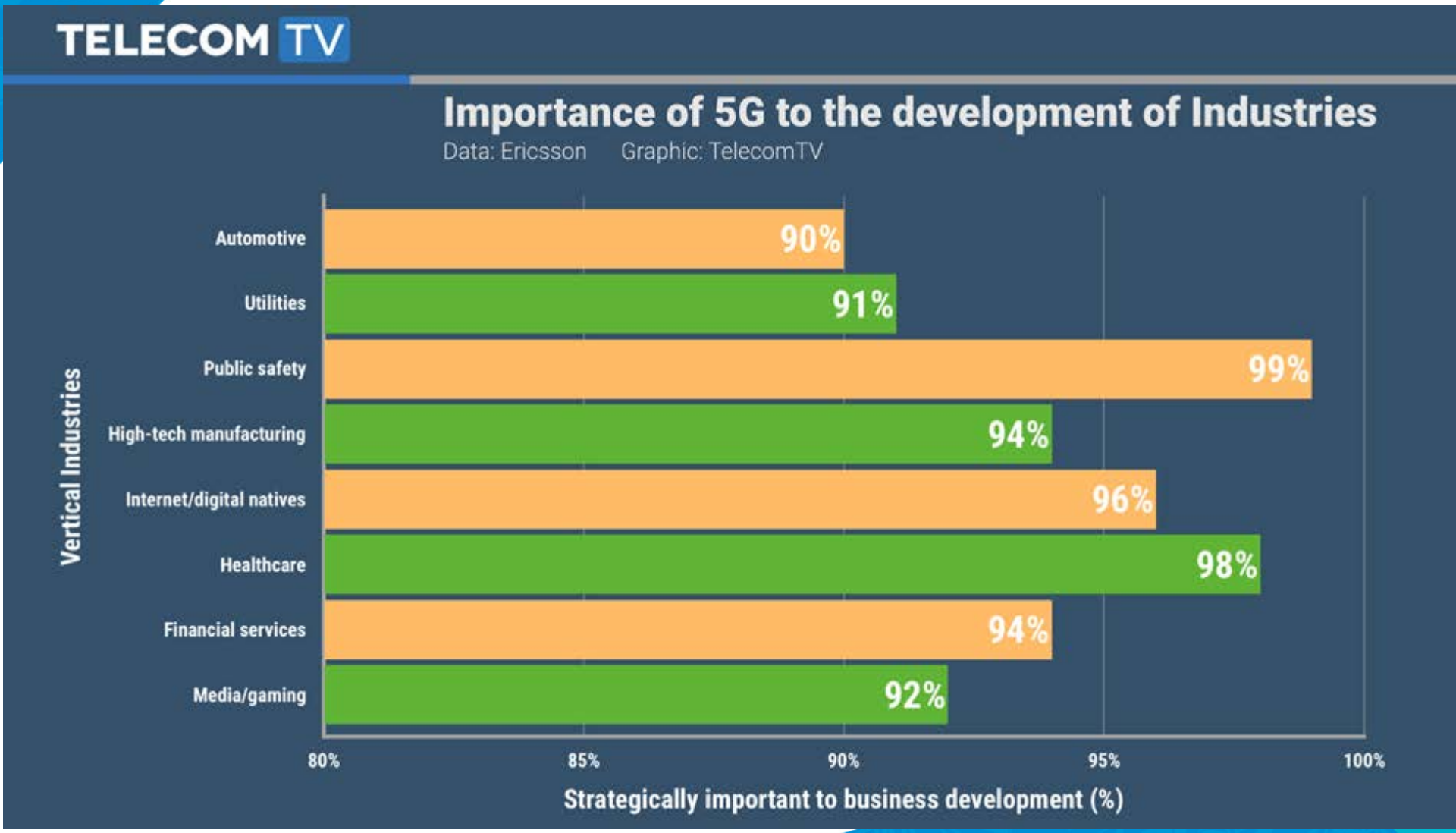
From the Engineers…



From the Operator….



From the Industry….



Can we Wait for 5G to Arrive?

- ITU specified the requirements for 4G in 2008: vendors and operators started putting “4G” labels on equipment and services just months later.
- What’s certain is that the IoT and Wearables market will continue to expand – and those of us working in the area will “find a way” to connect our products, whatever shape the standards eventually take.
- 5G is a wide, encompassing ideal, but there’s no need to wait: the future starts now.

Thank You