3GPP RAN Workshop on 5G
Phoenix, Arizona, September 17 – 18, 2015

RWS-150028

A Straight Path towards 5G

Agenda Item: 2

Source: Straight Path Communications Inc.

Document for: Discussion

The Big Picture – A Growing ICT Industry

Communication

- 1G ➔2G➔3G➔4G➔5G
- 11b➔11g➔11n➔11ac & 11ad ➔11ax & NG60

Computing

- Mainframe➔PC➔Smartphone➔IoT

Internet

- Email➔Web➔Search➔Social Network➔Cloud Computing

Content

- Voice➔Video➔HD/UHD/4K/8K➔360º Video➔Virtual Reality➔…

Big Data

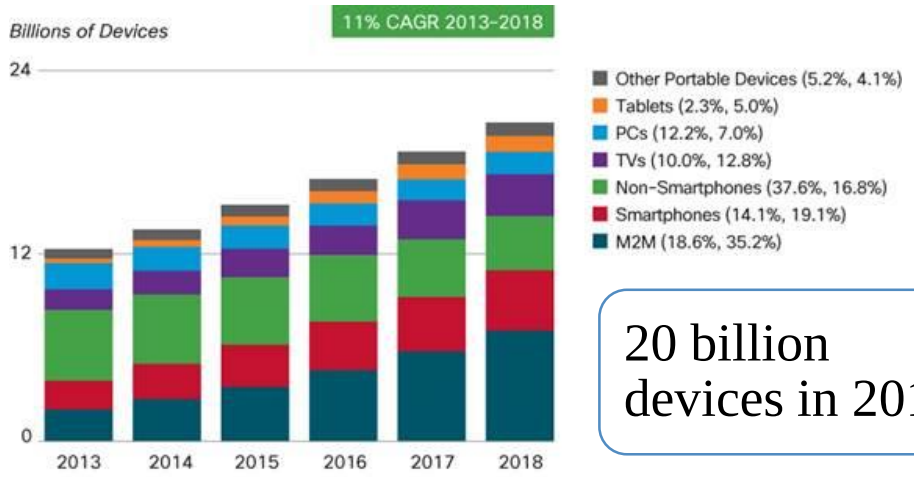
- Big data database, analytics, visualization, deep learning, …

Robotics

- Remotely controlled and self-operating cars, drones, robots, …

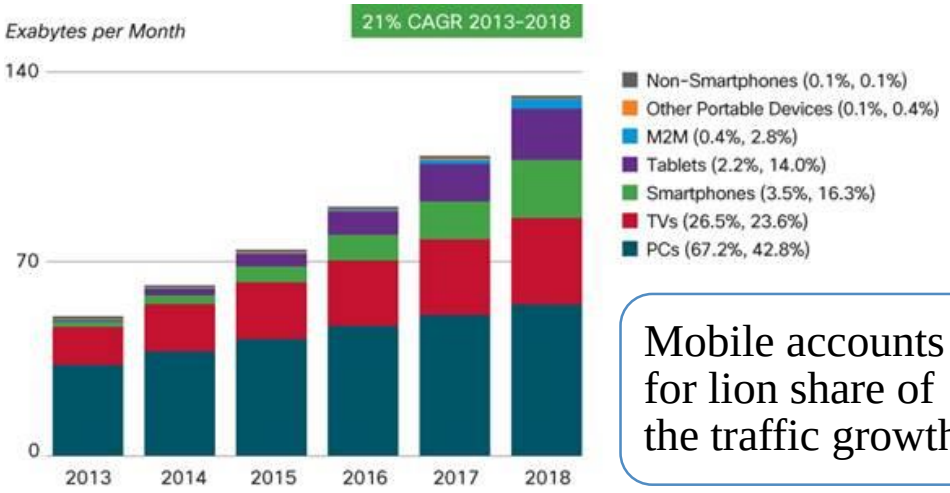
Applications and Services

- Think of anything? There is an app for that (If not, somebody will make one)
- Everything is possible (although not everything will be successful)



Source: Cisco VNI, 2014
The percentages in parentheses next to the legend denote the device share for the years 2013 and 2018, respectively.

20 billion devices in 2018



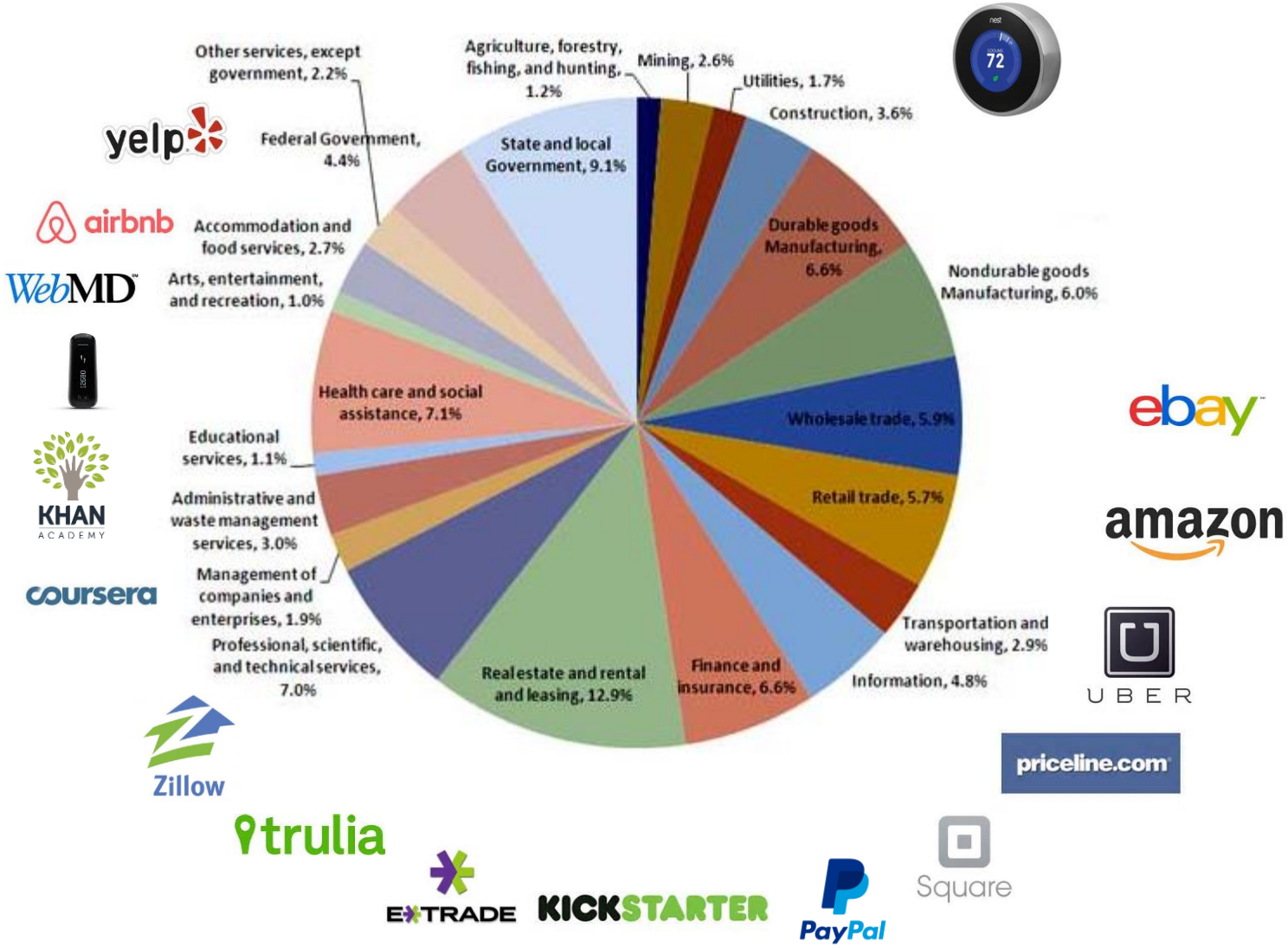
Source: Cisco VNI, 2014
The percentages in parentheses next to the legend denote the device traffic shares for the years 2013 and 2018, respectively.

Mobile accounts for lion share of the traffic growth

The Bigger Picture - A Connected World

A rising tide lifts all boats

- ICT accounts for 4.8% of U.S. GDP (2012)
- ICT contributes to
  - 60% of U.S. total factor productivity growth in 1996 - 2007
  - Virtually all growth in labor productivity in U.S. in 1995 – 2002



Source: http://www2.itif.org/2014-raising-eu-productivity-growth-ict.pdf

Source: http://www.economicpopulist.org/content/gdp-industry-2012-5511

Data source: BEA

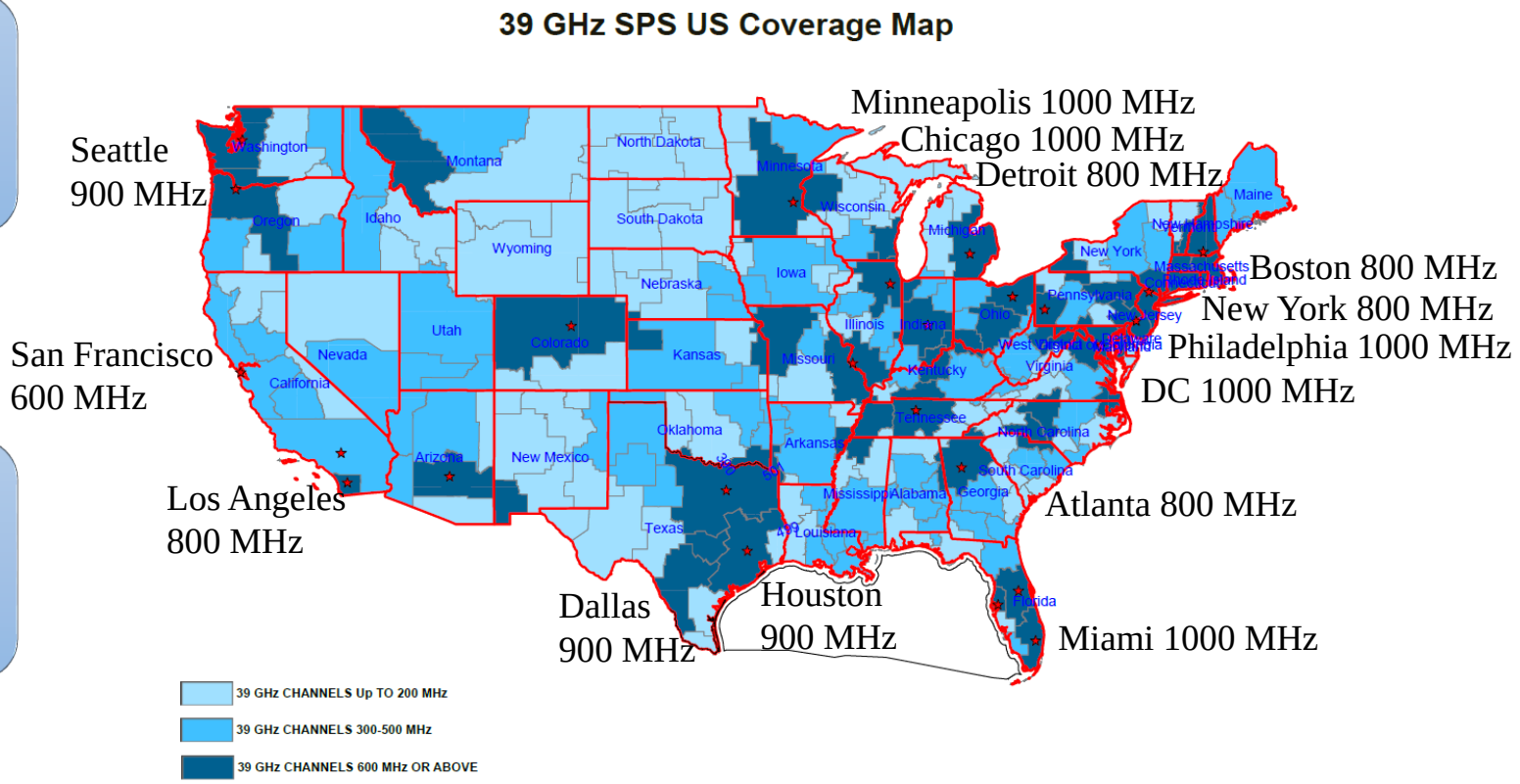
Overview of Straight Path Communications

Incumbent operator in the mmWave bands

- Extensive spectrum holdings in 39 GHz and LMDS bands
- 216 Billion MHz-POP with over 800 MHz average in NFL cities in 39 GHz

Business and technology innovator to maximize utilization of mmWave spectrum

- Effectuating spectrum regulations to enable 5G in mmWave bands
- Developing fundamental 5G technologies



Straight Path 5G Vision

Gbps

- Gbps user experience
- Multi-Gbps cell throughput

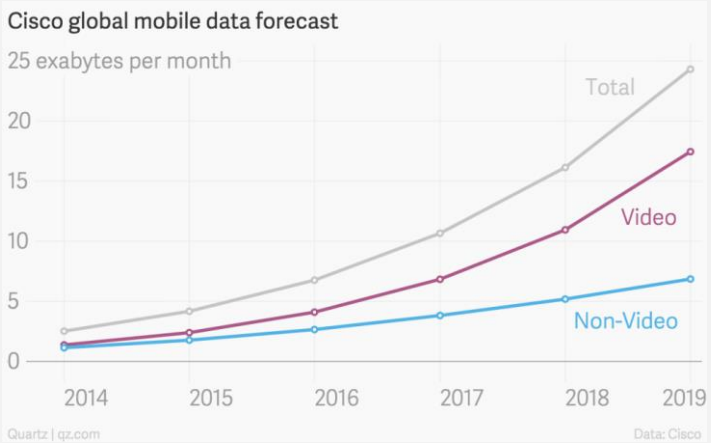
Mobility

- Wide area cellular networks
- Vehicle-speed mobility

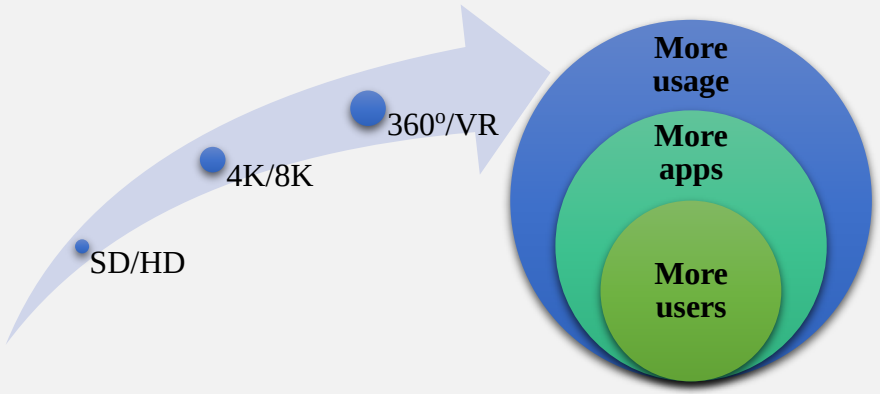
Typical Value	LTE R8	5G
Bandwidth	20 MHz	500 MHz
Sector Spectral Efficiency	2.5 bits	10 bits
Cell throughput (3-sector)	150 Mbps	15 Gbps
Cell-edge throughput	~1 Mbps	~100 Mbps
50%-tile throughput	~10 Mbps	~1 Gbps
Outdoor cell radius	100 m – 10 km	100 m – 1 km

5G Market Drivers – Content & Commerce

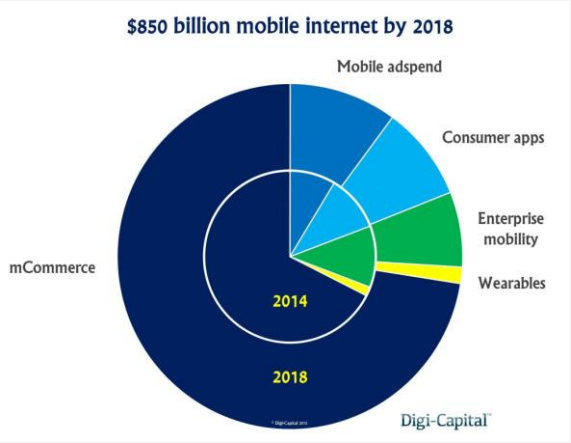
Content drives demand for capacity



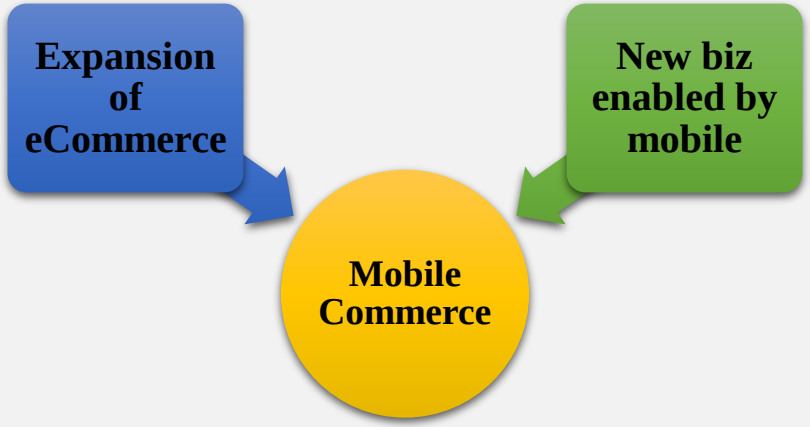
Video to drive >60% of mobile traffic



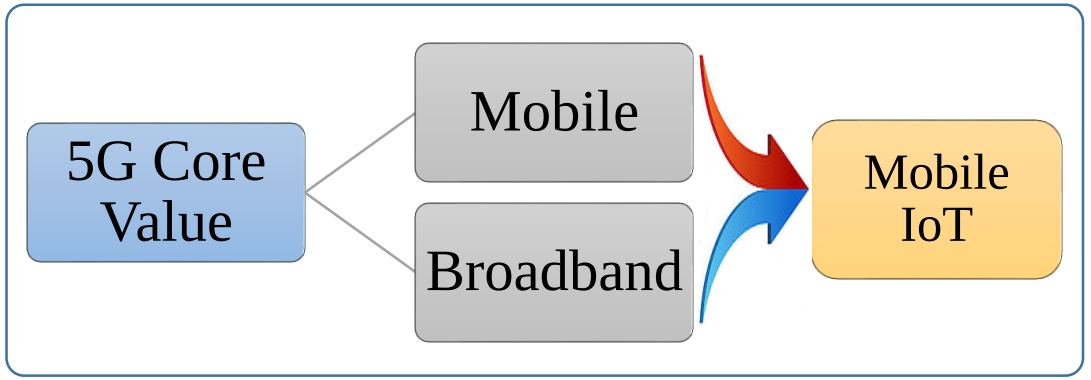
Commerce drives demand for availability



Commerce to generate >70% of mobile Internet revenue



5G Market Drivers – Mobile IoT



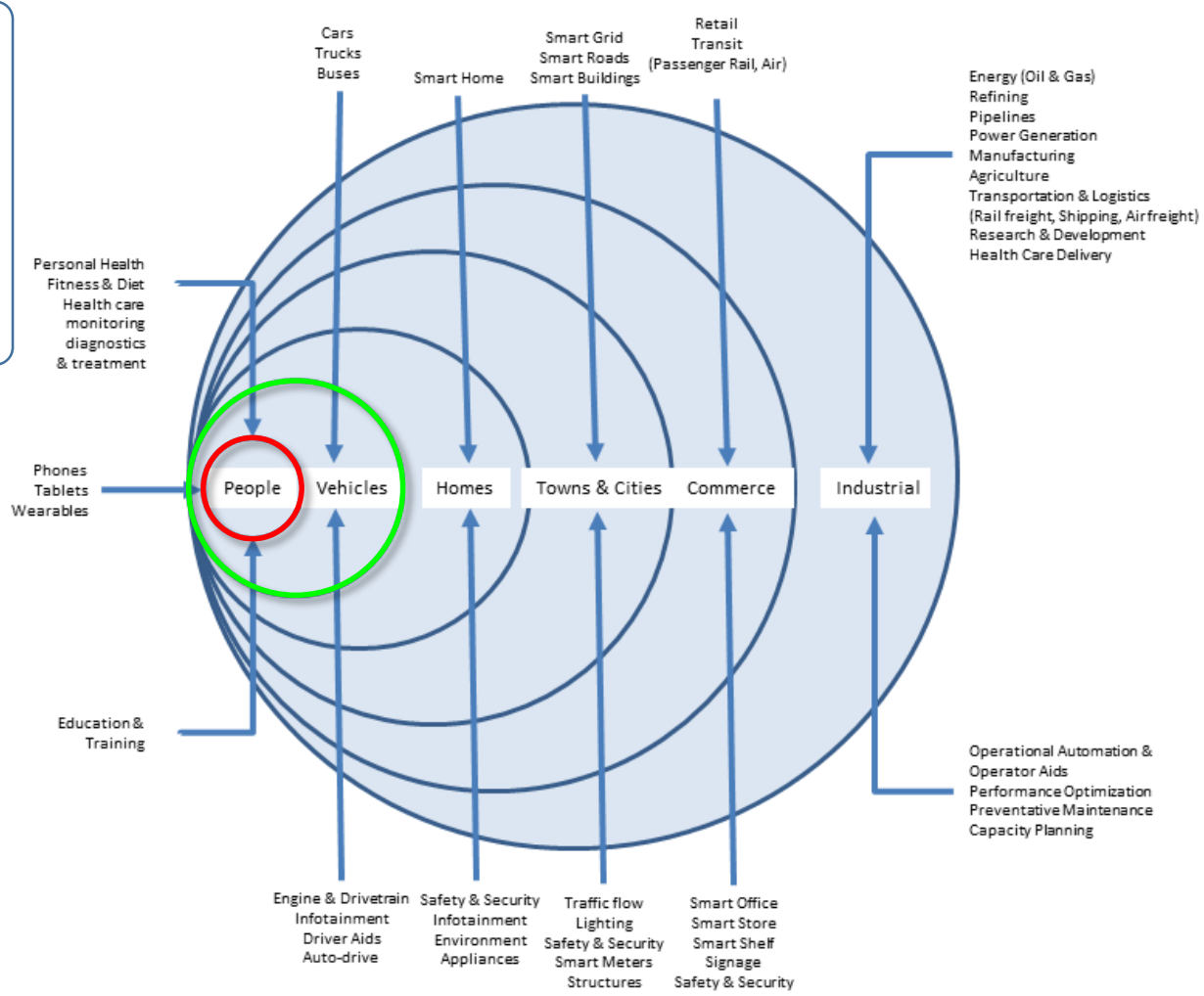
Technology

- Mobile Broadband
- Cameras & sensors
- Signal processing
- Intelligence

Disruption

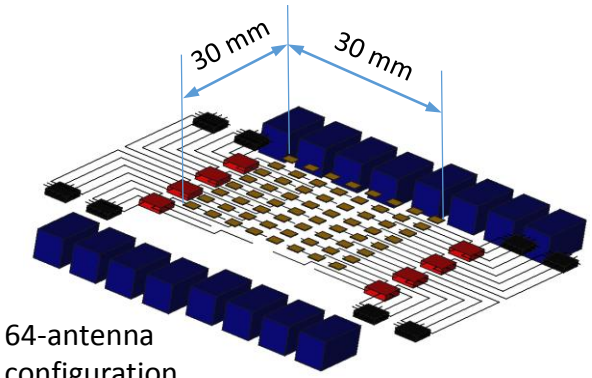
- Transportation
- Retail
- Service
- Lifestyle

Example – Autonomous Vehicles

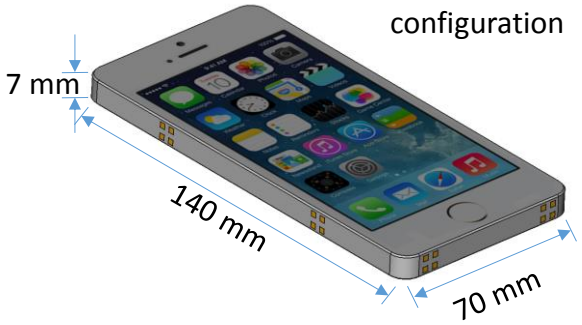


Source: Based on Goldman Sachs Global Investment Research. Additional analysis by WMG

5G Technology Enablers – mmWave



64-antenna configuration



32-antenna configuration

Transceivers

Antenna
- Antenna array on PCB or package

Front End
- PA efficiency & linearization

RFIC
- Multi-channel multi-stage integration

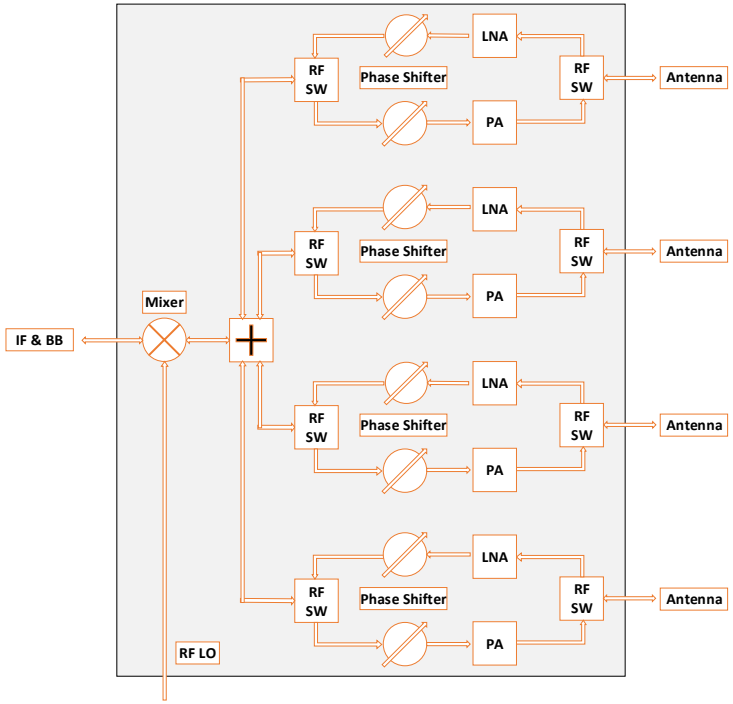
Air Interface System

Range
- 1-km cell radius & 150-dB link budget

Latency
- 100-ns TTI and 1-ms over-the-air delay

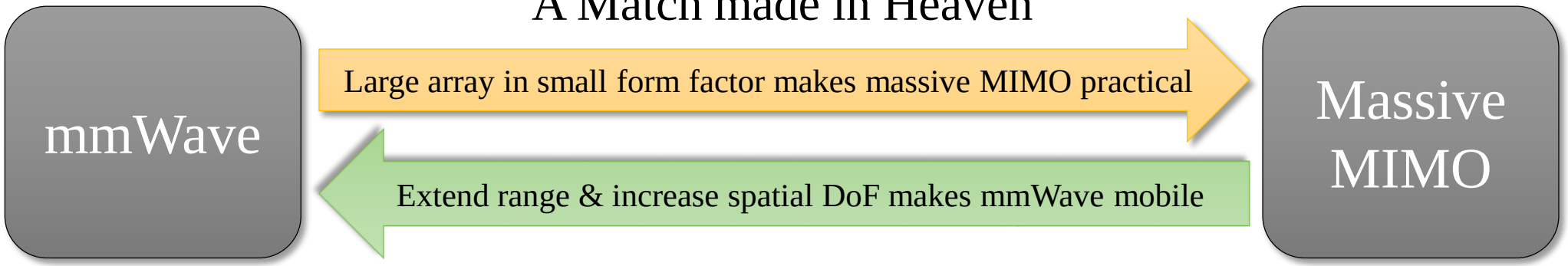
Mobility
- 120 – 360 kmph mobility

4-channel integrated MFE & RFIC



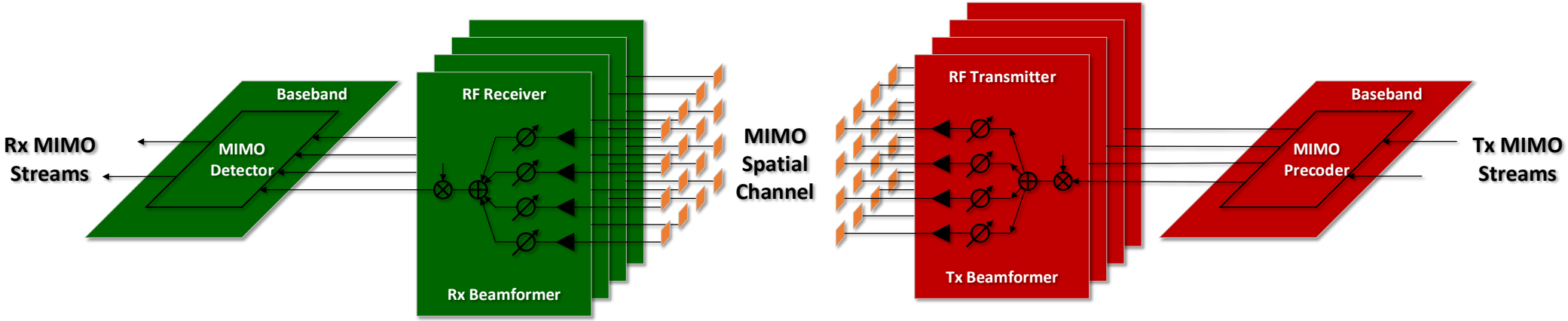
5G Technology Enablers – Massive MIMO

A Match made in Heaven



Analog Digital Array Processing Transceiver (ADAPT)

- Analog Beamforming to track large-scale channel characteristics (AoD, AoA of dominant paths)
- Digital MIMO processing on the effective channel given analog beamforming



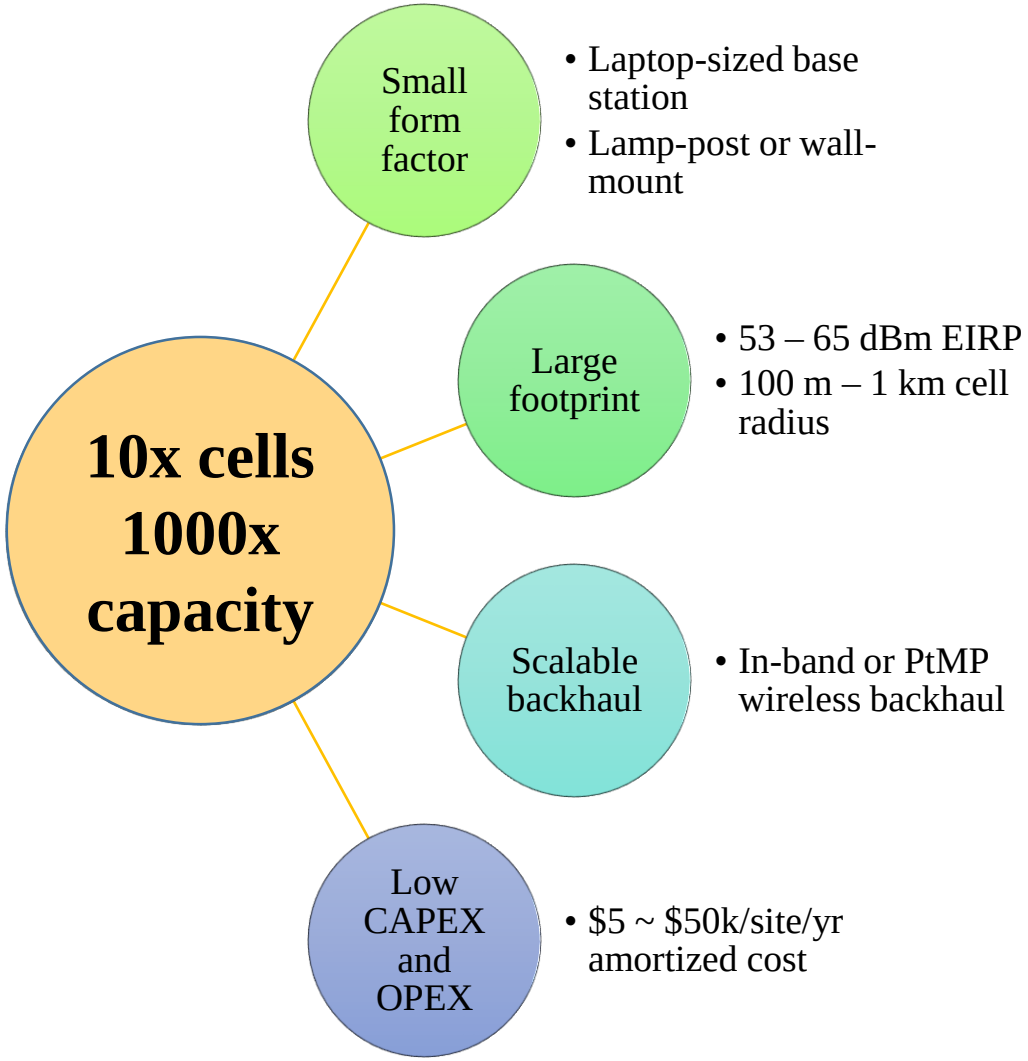
5G Technology Enablers – Small Cells

Small cells

- Low profile (size, weight, power)
- Low cost (CAPEX, OPEX)

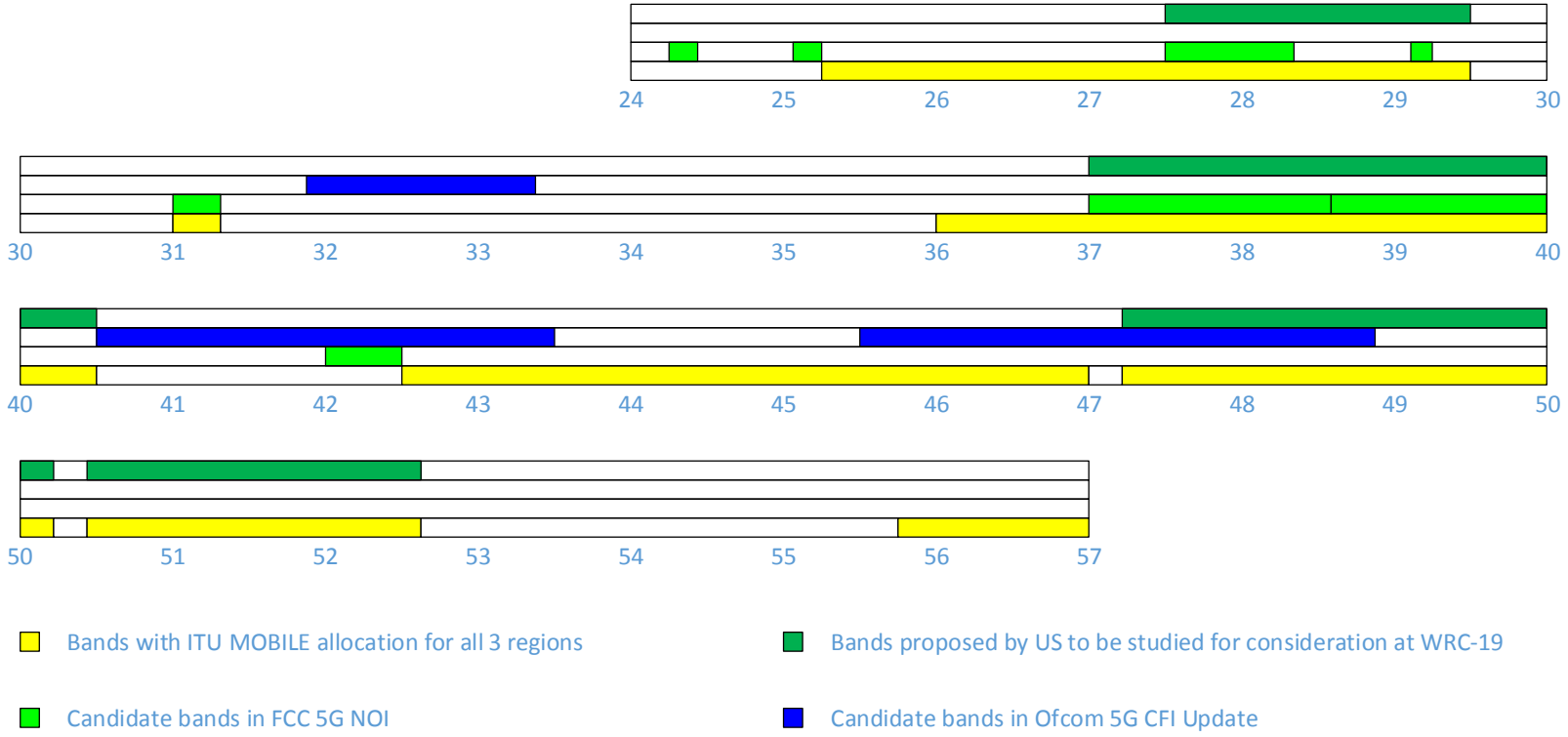
Not-so-small footprint

- 100 m – 1 km cell radius
- 100 MHz – 1GHz system bandwidth
- 10 bits cell spectral efficiency



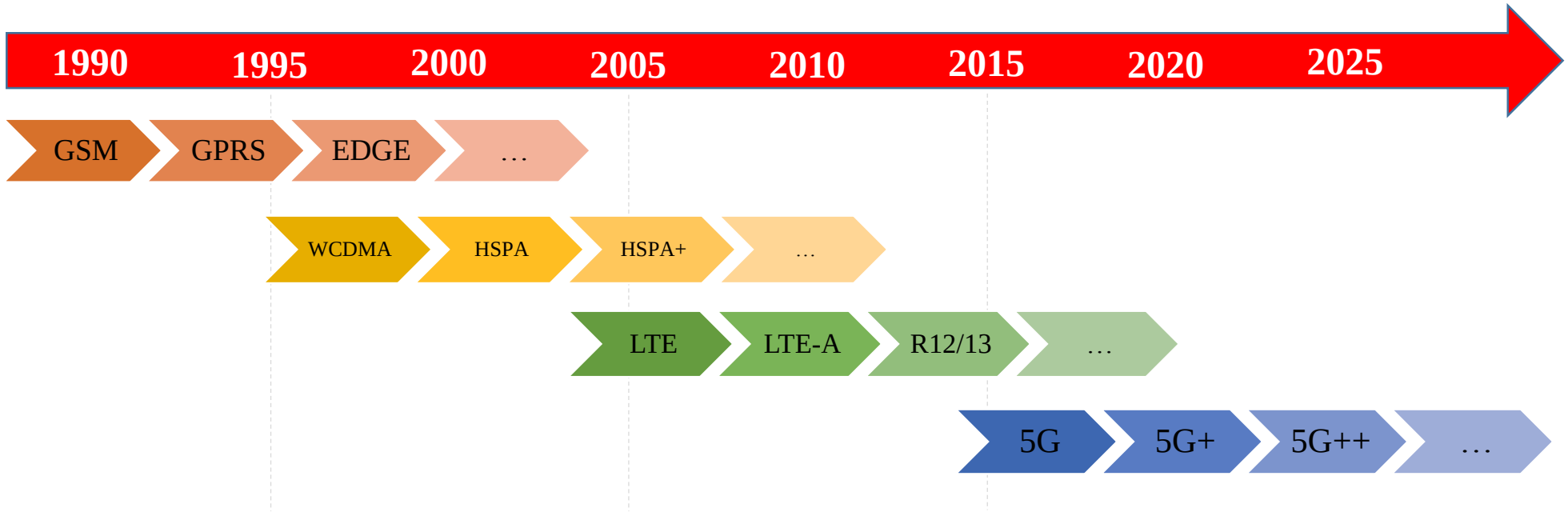
5G Spectrum

Focus on bands in 24 – 57 GHz with primary mobile allocation across all 3 ITU regions



Prioritize bands in 25.25 – 29.5 GHz and 36 – 40.5 GHz as targets to secure for 5G in WRC-19

5G Standardization



3GPP should progress 5G standardization in parallel with 4G evolution

Summary

5G should focus on core value proposition of Gbps mobile broadband

Content, Commerce, and mobile IoT are the key drivers for traffic and value growth for 5G

MmWave, massive MIMO, and small cells are key technologies to deliver Gbps Mobility for 5G

Mobile industry should focus on 24 – 57 GHz for globally harmonized spectrum for 5G

3GPP should progress 5G standardization and 4G evolution in parallel