TECH DAYS

What is it & Why Do We Care

June 7, 2019

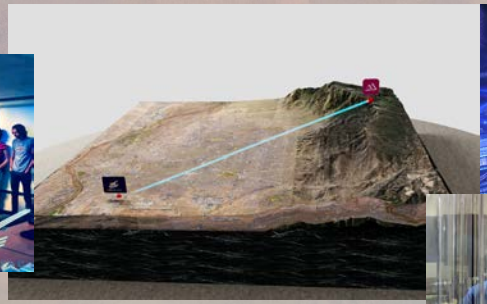
COSMIAC

- COSMIAC proudly serves as a Tier-2 Research Center under the School of Engineering at the University of New Mexico
- COSMIAC's role is to promote aerospace innovation through the reliable and responsible use of configurable technology in military and defense systems
- COSMIAC's over 15,000 square foot facility provides excellent design capabilities including laboratories, offices and cleanroom space
- All COSMIAC personnel in New Mexico are US citizens with active security clearances (up to TS or Q for DOE)
- COSMIAC consists of approximately 50 staff, students, consultants and faculty

COSMIAC Partners

- AFRL Space Vehicles and Directed Energy Directorates
- National Aeronautics and Space Administration Defense Threat Reduction Agency
- Millennium Engineering and Integration Company (RISE)
- Northrop Grumman
- KBRWyle Corporation (under FILMSS)
- AEgis Technologies (under D3I HSV and SCRA ABQ)
- Lockheed Martin (under EDS)
- ATA (under SVAT)
- Blue Origin
- Verus Research and other small businesses

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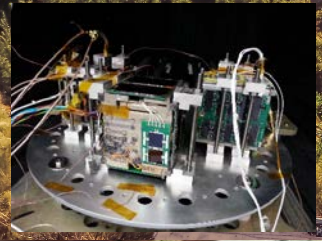


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LOBOS
VR
05
VR

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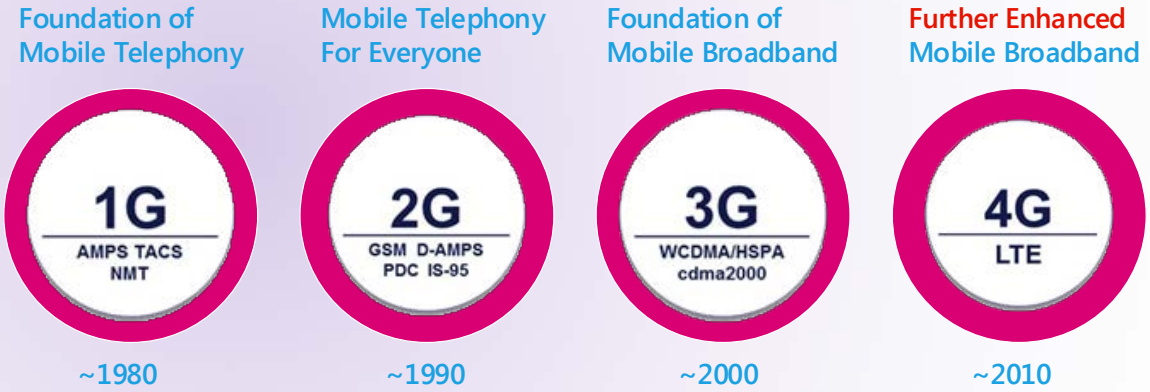
What is 5G?

40 years of mobile communications

- Each generation adapts to societies needs
  - First Generation: Mobile Voice Communication
  - Second Generation: Target clearer voice, start digital transmission
  - Third Generation: Beginning High quality mobile Broadband
  - Forth Generation: Higher end user data rates



Brief History Standards

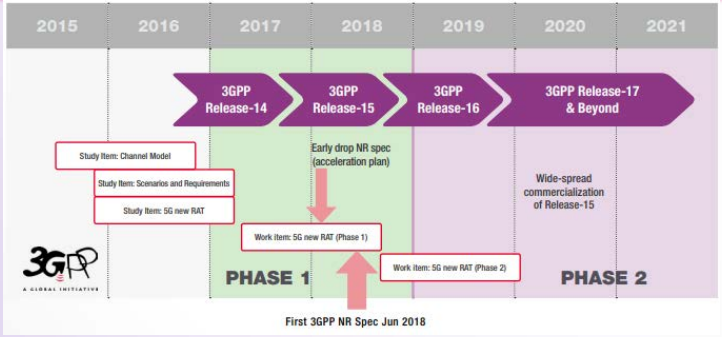
- Global Standardization has been the goal since the first generation of mobile communications.
  - 1G) AMPS: developed in North America by Nordic Mobile Telephony
  - 2G) GSM: Developed by European Telecommunications Standards Institute ETSI
  - 3G) True global standardization given regional bodies (ETSI, TIA, ARIB) working on similar 3G technologies, especially true for WCDMA
- 1998 the regional standardization organizations came together and jointly created the Third-Generation Partnership Project (3GPP) *[Developed 4G LTE, 5G standards]*

ITU and 3GPP 2020 requirements for 5G

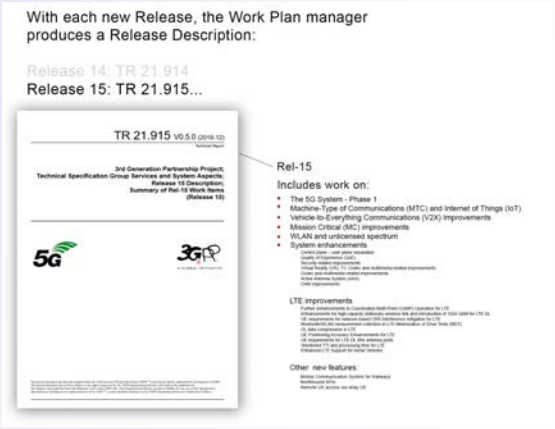
- **The International Telecommunication Union (ITU)** : United Nations organization that regulates the global use of mobile telecommunication. The ITU sets the guidelines and requirements by which 3GPP must work.
- **Main Requirements for 5G**
  - >10 Gb/s peak data rates
  - 98% Spectral Efficiency
  - >1 M/km2 connections
  - Very low Latency
  - Ultra High Reliability

Metric	Requirement
Peak Data Rate	DL: **20 Gb/s** UL: 10 Gb/s
Peak Spectral Efficiency	DL: **30 b/s/Hz** (assuming 8 streams) UL: 15 b/s/Hz (assuming 4 streams)
User Experienced Data Rate	DL: 100 Mb/s UL: 50 Mb/s
Area Traffic Capacity	Indoor hotspot DL: 10 Mb/s/m^2
User Plane Latency	eMBB: 4 ms URLLC: **1 ms**
Control Plane Latency	20 ms (encouraged to consider **10 ms**)
Connection Density	1M devices per km^2
Reliability	99.9999% success prob.
Bandwidth	>100 MHz; up to **1 GHz in > 6 GHz**

5G Standardization & Timeline



- Schedule confirmed March 2017
- 3GPP split the 5G standard into two releases:
  - Release 15 (5G Phase 1 posted June 2018) Defines New-Radio 5G-NR and Phase 1 of new core 5GCN
  - Release 16 (5G Phase 2 set to post March 2020) Continues with 5G NR optimization and introduces new use cases

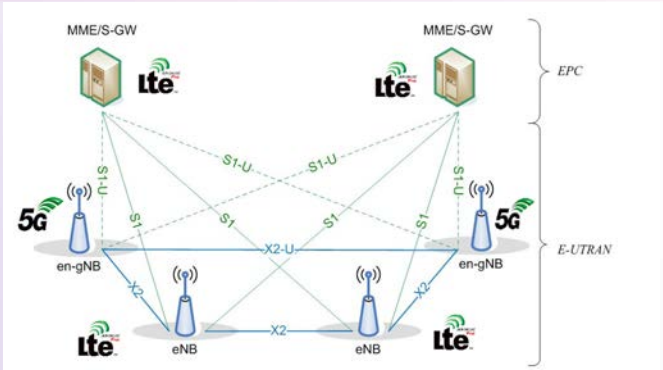


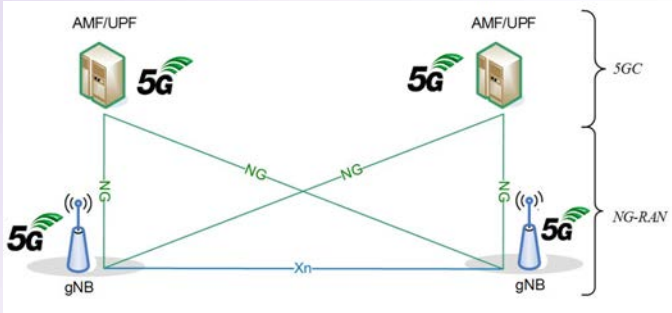
Release 15: NR Phase 1 Common elements between LTE and NR

	LTE	NR
Frequency of Operation	Up to 6 GHz	Up to 6 GHz, ~28 GHz, ~39 GHz, other mmWave bands (Upto 52 GHz)
Carrier Bandwidth	Max: 20 MHz	Max: 100 MHz (at <6 GHz) Max: 1 GHz (at >6 GHz)
Carrier Aggregation	Up to 32	Up to 16
Analog Beamforming (dynamic)	Not Supported	Supported
Digital Beamforming	Up to 8 Layers	Up to 12 Layers
Channel Coding	Data: Turbo Coding Control: Convolutional Coding	Data: LDPC Coding Control: Polar Coding
Subcarrier Spacing	15 kHz	15 kHz, 30 kHz, 60 kHz, 120 kHz, 240 kHz
Self-Contained Subframe	Not Supported	Can Be Implemented
Spectrum Occupancy	90% of Channel BW	Up to 98% of Channel BW

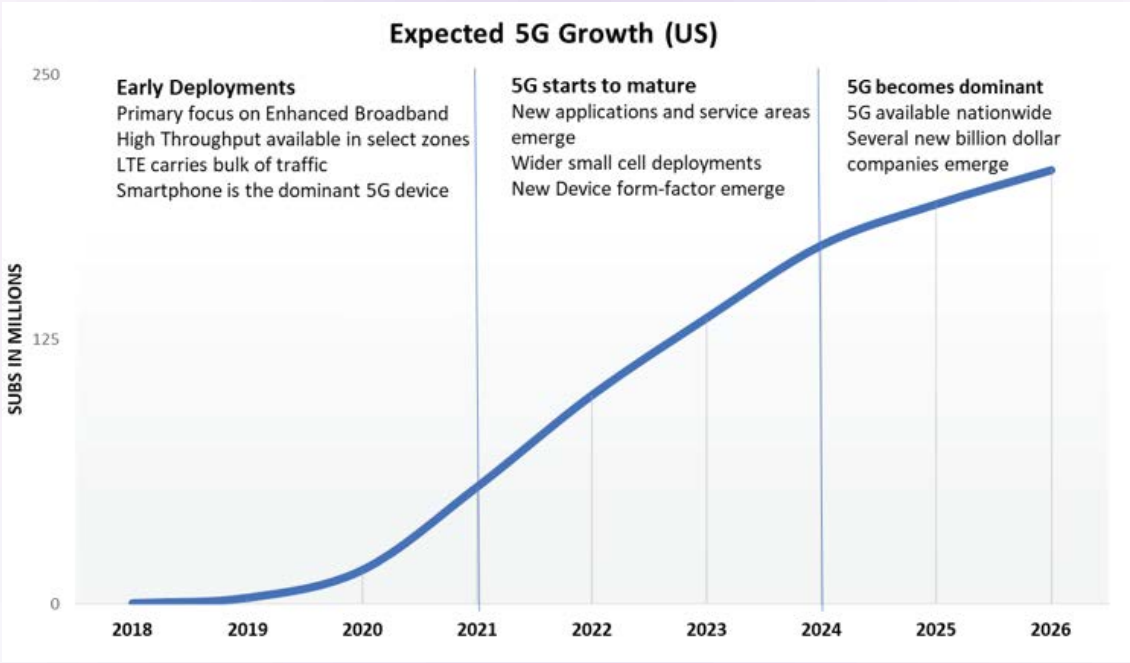
Transition to 5G

- Non-Standard Architecture (NSA)
  - In this configuration, only the 4G services are supported, but enjoying the capacities offered by the 5G Radio (lower latency, etc).
- Standard Archetecture (SA)
  - In the SA architecture, the NR base station (logical node "gNB") connects each other via the Xn interface. The NG-RAN for SA architecture connects to the 5GCN network using the NG interface.



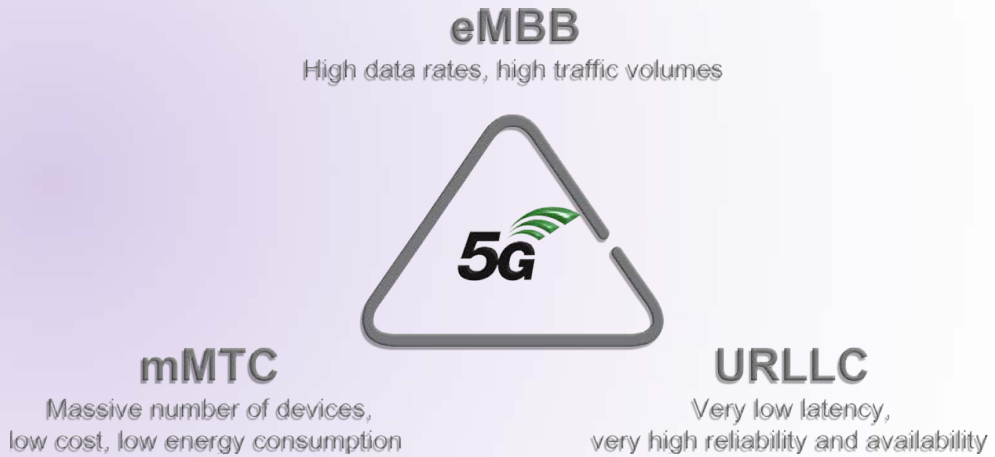


Not an Overnight Transition



Three Distinct Classes of 5G

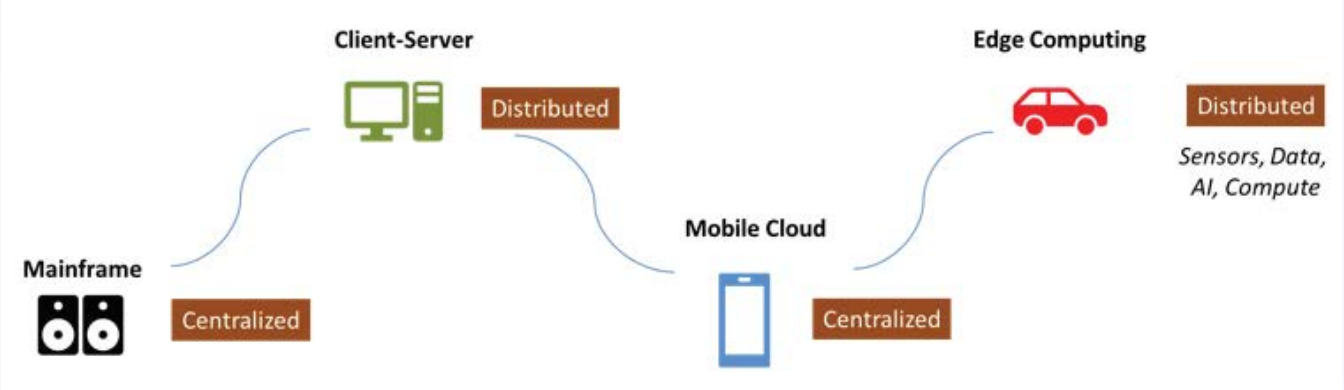
- Enhanced Mobile Broadband (eMBB)
  - Next evolution of the mobile-broadband services of today
- Massive Machine-type Communication (mMTC)
  - Services that are characterized by a massive number of devices, for example, remote sensors, actuators, and monitoring of various equipment.
- Ultra-reliable and Low-latency Communication (URLLC)
  - Type-of-services are envisioned to require very low latency and extremely high reliability

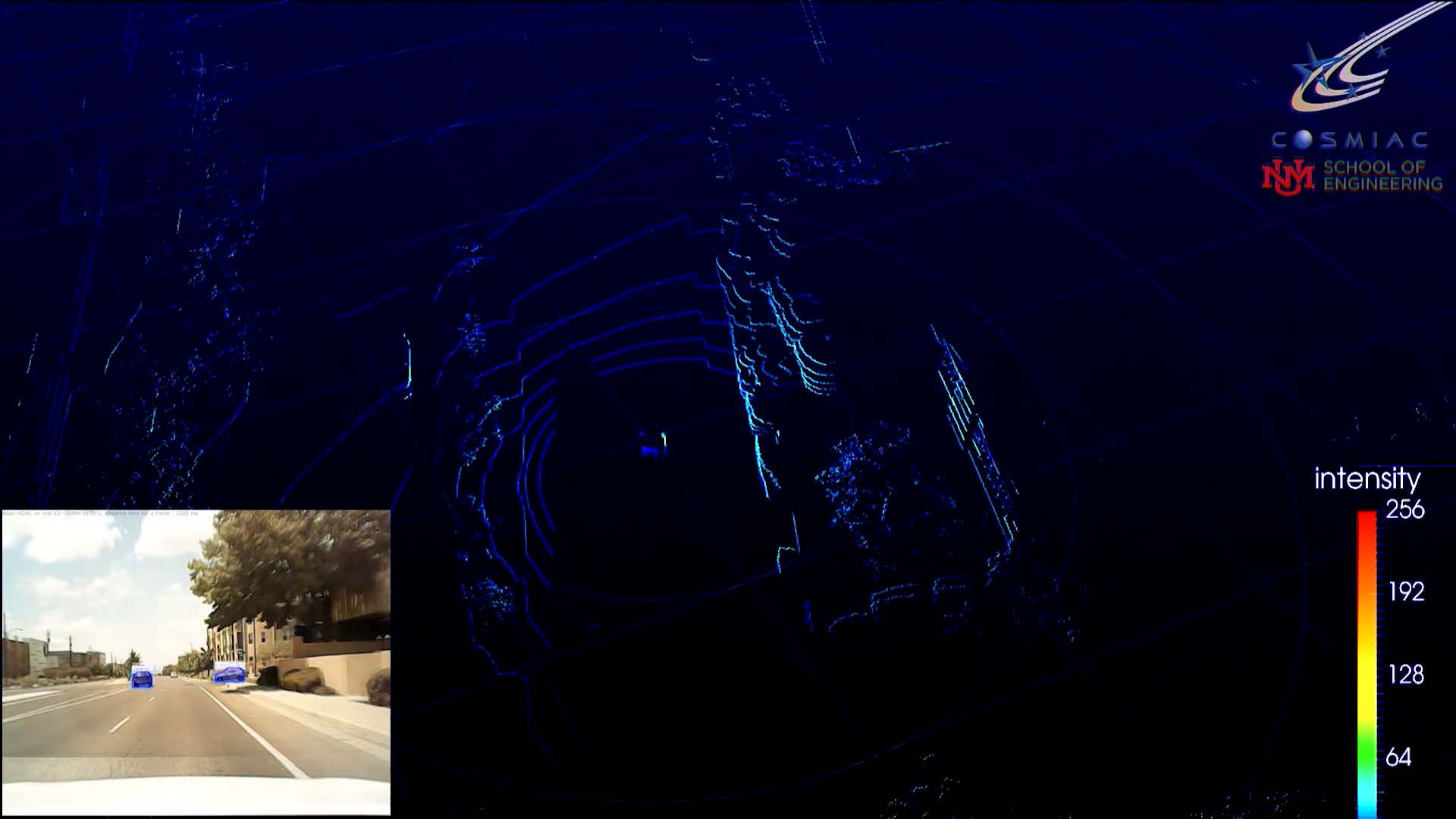


Why do We Care?

Next Wave of Computing

"5G will transform computing itself and play a significant role in the rise of the edge computing cycle. Every decade or so we enter a new computing paradigm oscillating between centralized and distributed. After reaping the benefits of mobile+cloud, the Connected Intelligence Edge is going to transform industries and create new use cases. " **CTA Report** *"Market impact of 5G"* **Jan 2019**

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SCHOOL OF ENGINEERING
intensity
256
192
128
64


Mask-RCNN on Intel E3-1535m v5 CPU, Inference time for a frame : 3341 ms
COSMIAC
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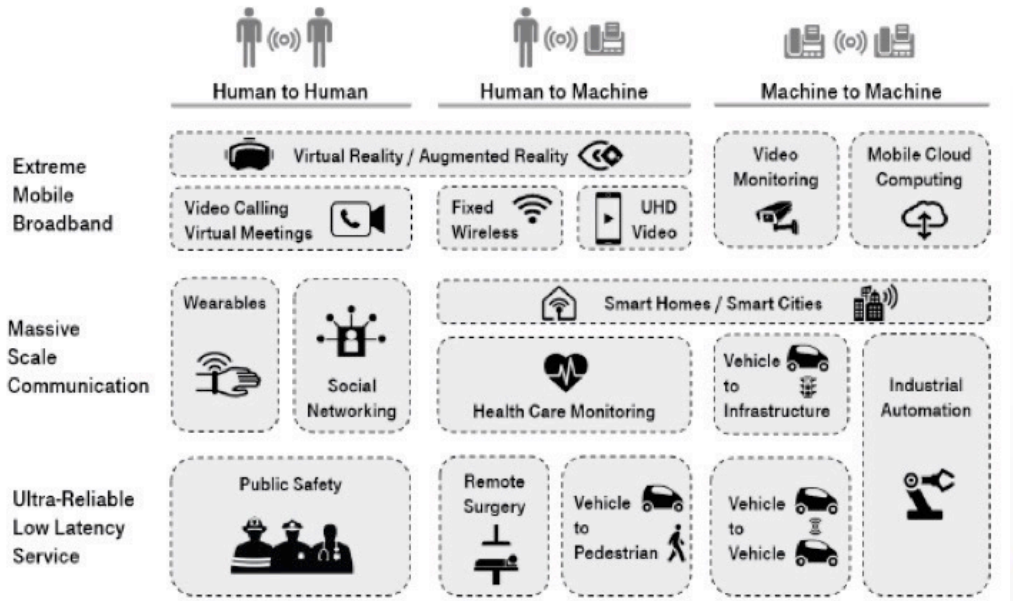
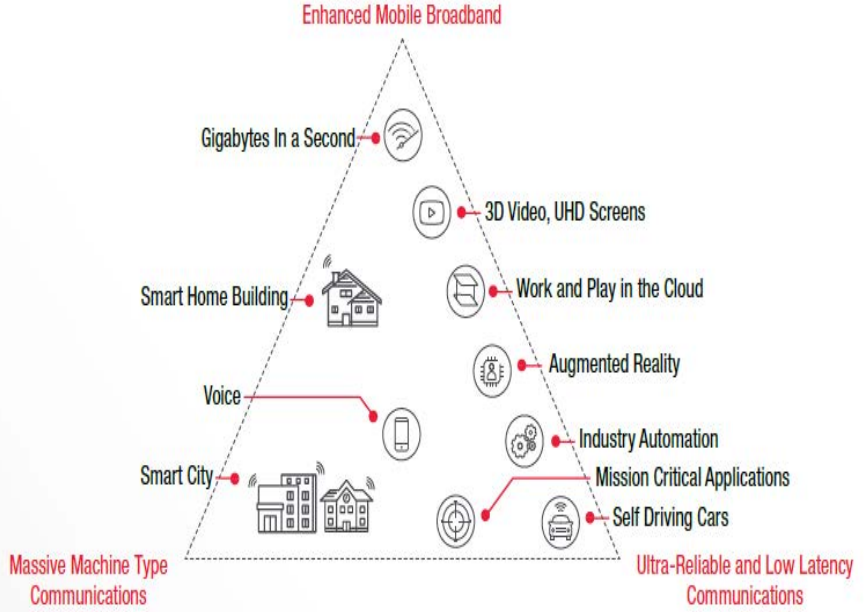
traffic light:0.99
traffic light:0.74
car:0.89
car:0.98
car:0.84
car:0.92
car:0.93
car:0.95
person:0.98
person:0.99
person:0.98

Many Diverse Applications/Users for 5G





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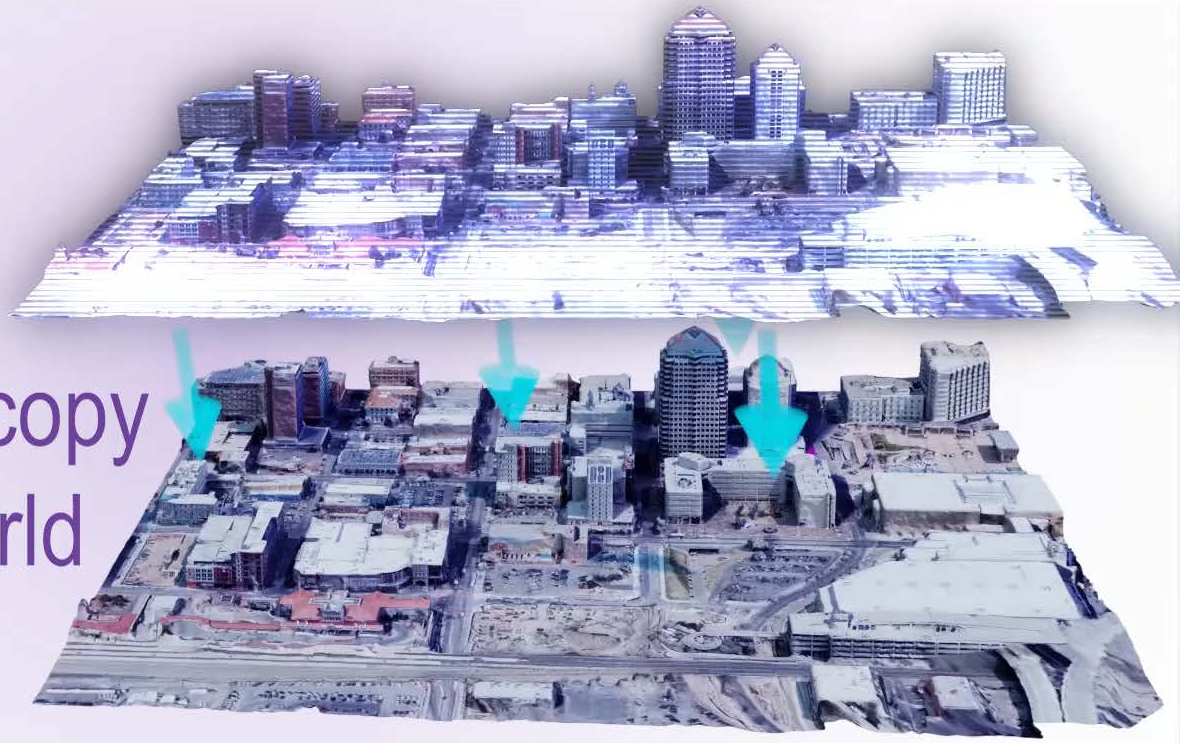
How much information is in a small area of Downtown?

This virtual space would become a livestream digital copy of the physical world



Thank You