
# IoT Implications on Networks & People

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Glare/Guard

# Agenda

Perspective - History

Today - Real Use Cases

Future - 6G Holograms & 7G Teleportation

# Perspective


April 3, 1973, by Motorola engineer Martin Cooper from Sixth Avenue in New York while walking between 53rd and 54th streets.


1983 using a slimmer 16-ounce model that cost between $3,500 and $4,000

# MUST HAVE - Collection Motorola DynaTAC 8000X - 25 piece brick phone

2 viewed per hour

Condition: --

"*Megarare* - The COMPLETE Motorola DynaTAC Collection -- Motorola AD say in 1983 -- " Motorola " ... Read more

Price: **US $8,000.00**

$385 for 24 months *

Buy It Now

Add to cart

Best Offer:

Make Offer

♡ Add to watch list

13 watchers

100% positive feedback

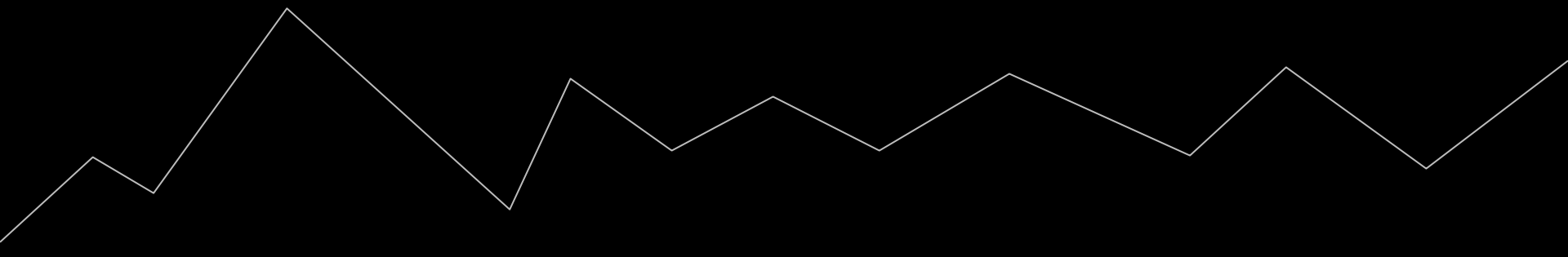
Shipping: **$250.00** Economy Shipping | See details

International items may be subject to customs processing and additional charges.

Item location: Satu Mare, Romania

Ships to: Worldwide

# How did the **Internet of Things** begin?




PINKS
HTWEIGHT,
H-DEFINITION
LOR

Kevin Ashton coined the term

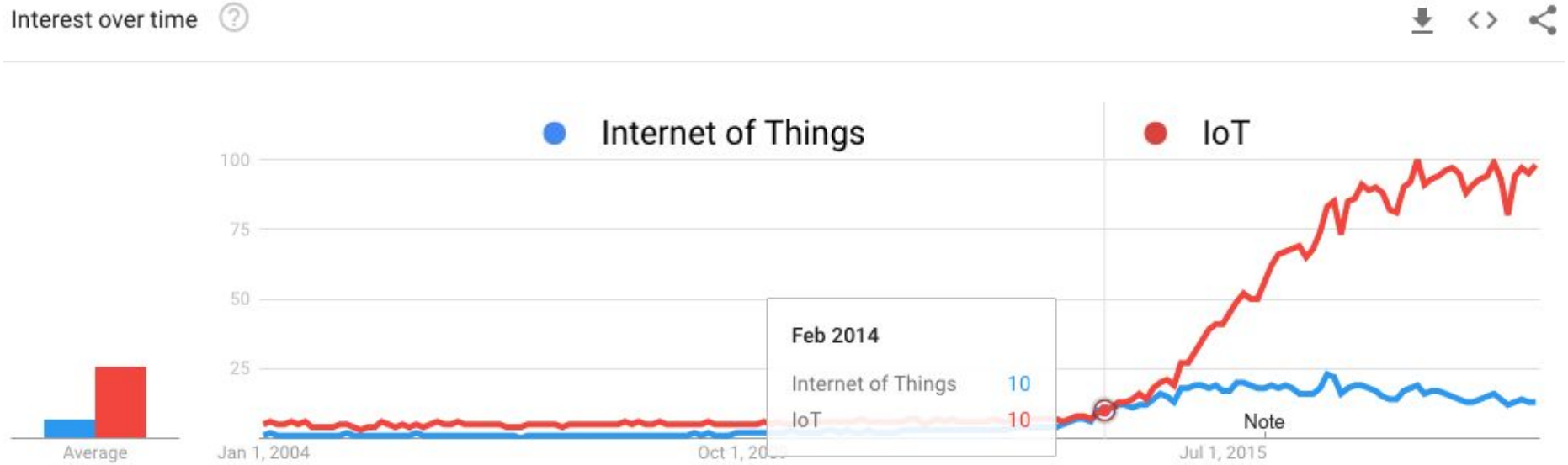
“Internet of Things”

RFID Lipstick on Shelf

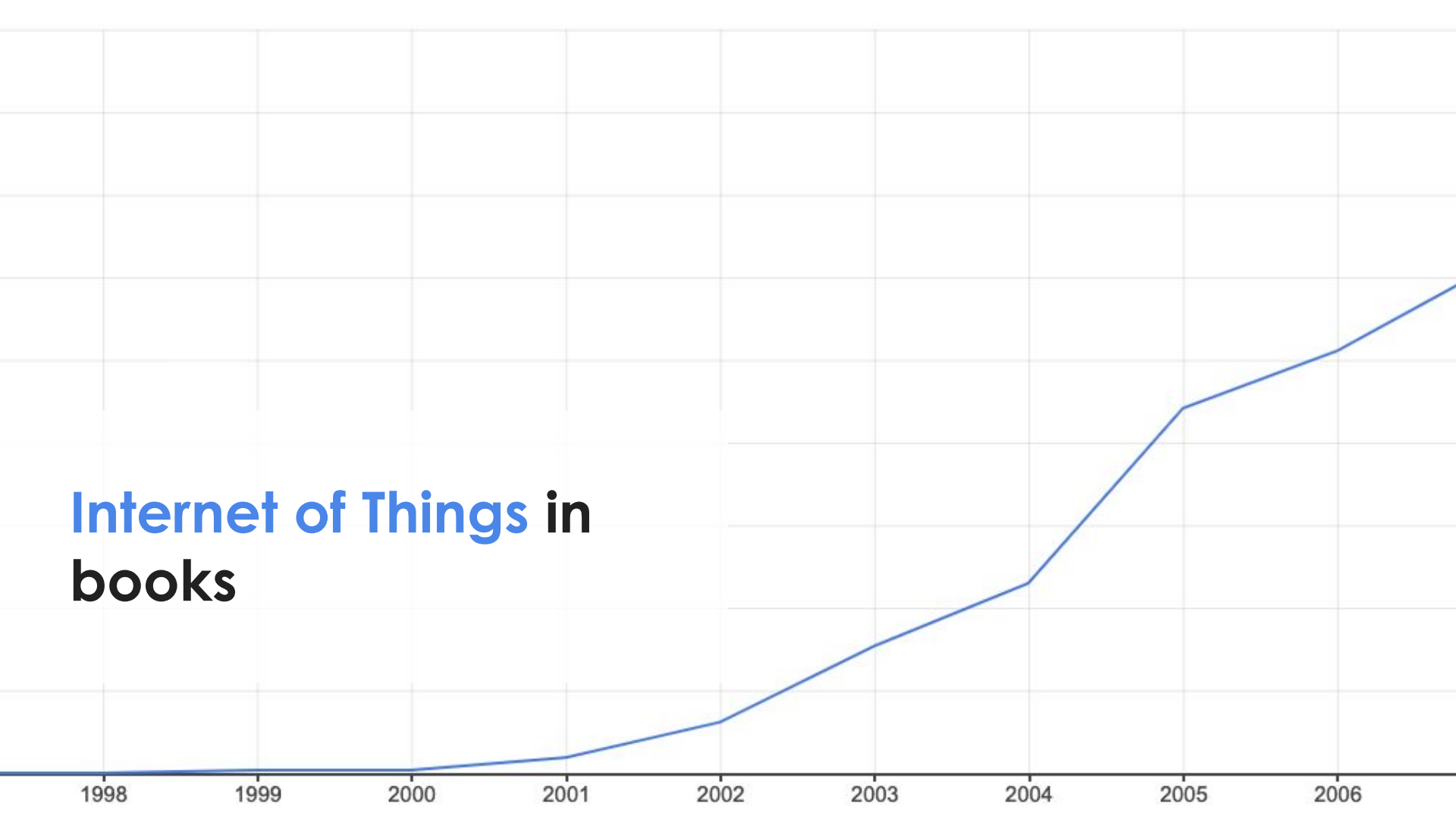
# **NOT** Ashton Kutcher


https://web.archive.org/web/20020322014026/http://www.forbes.com/global/2002/0318/092.html#274ea2cc3c3e

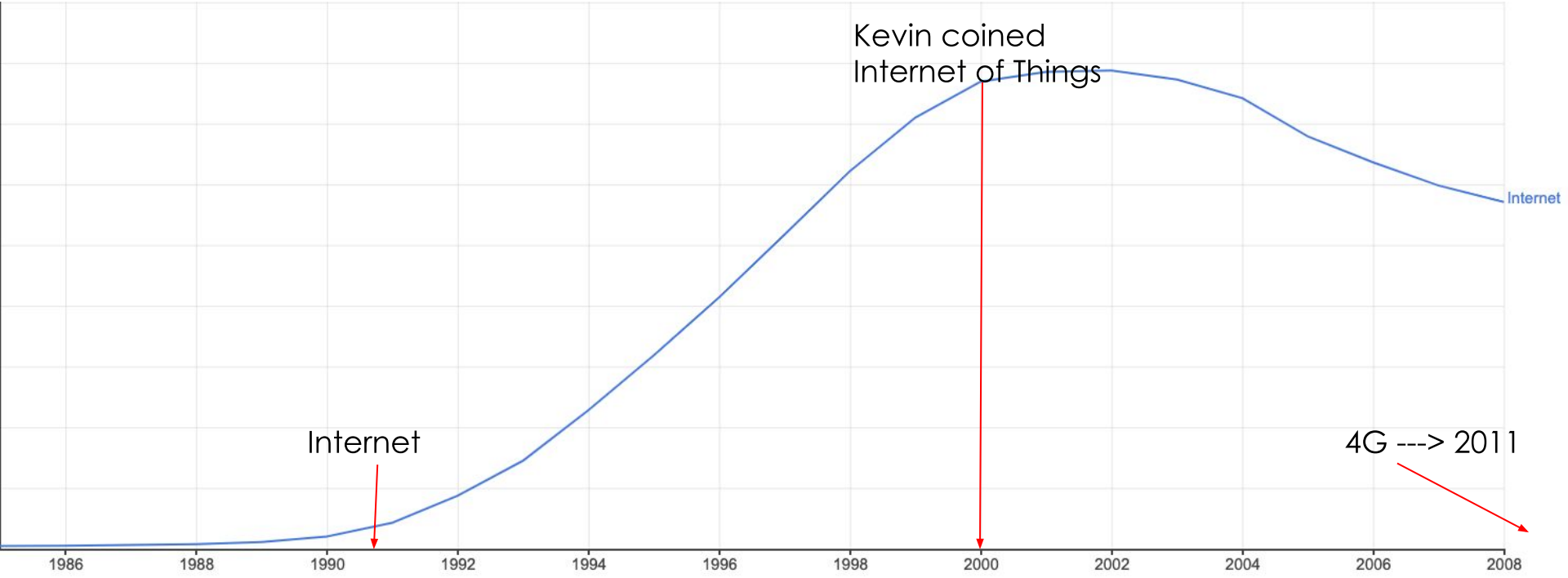
# Internet of Things vs IoT online



# Internet of Things in books

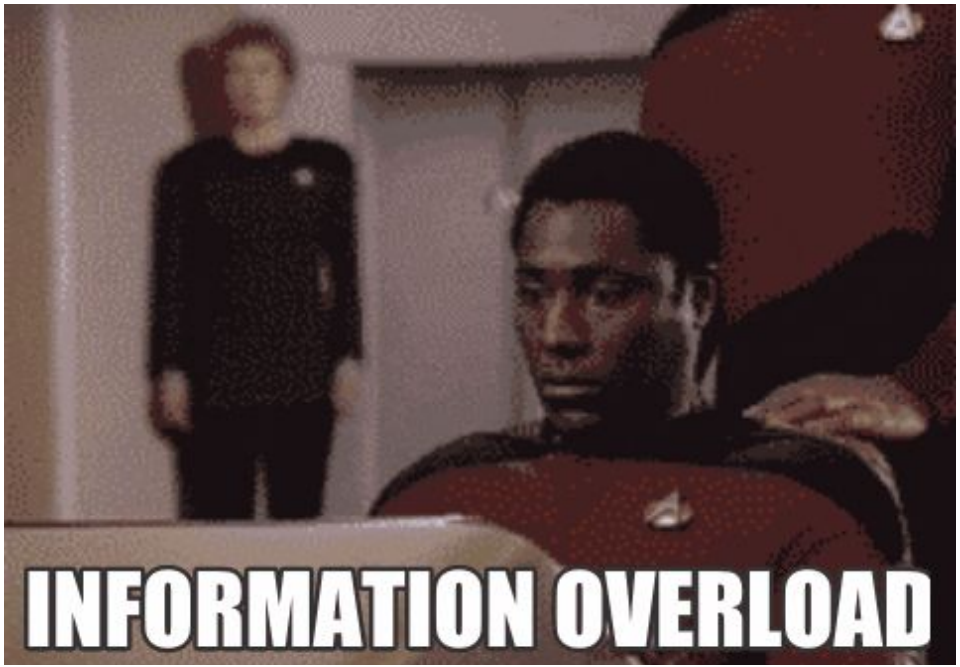


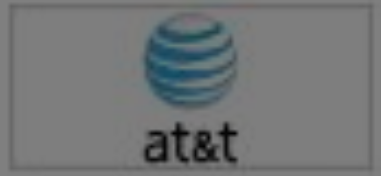
# The word **Internet** in books



**Billions of IoT Devices**

**Will overwhelm 4G**






**Tom Keathley**
SVP Network & Product Planning


**Bruce Rodin**
VP Wireless Technology


**Ameet Shah**
Group Strategy Director


**Li Zhengmao**
EVP

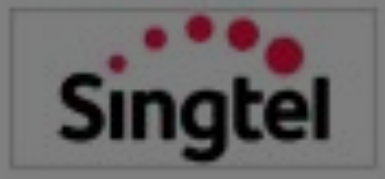
**Bruno Jacobfeuerborn**
CTO


**Jacob Groote**
VP Mobile Operations


**Seong-Mok Oh**
Senior EVP & Head of Network Group


**Seizo Onoe**
EVP & CTO


**Alain Maloberti**
SVP




**Tay Soo Meng**
Group CTO

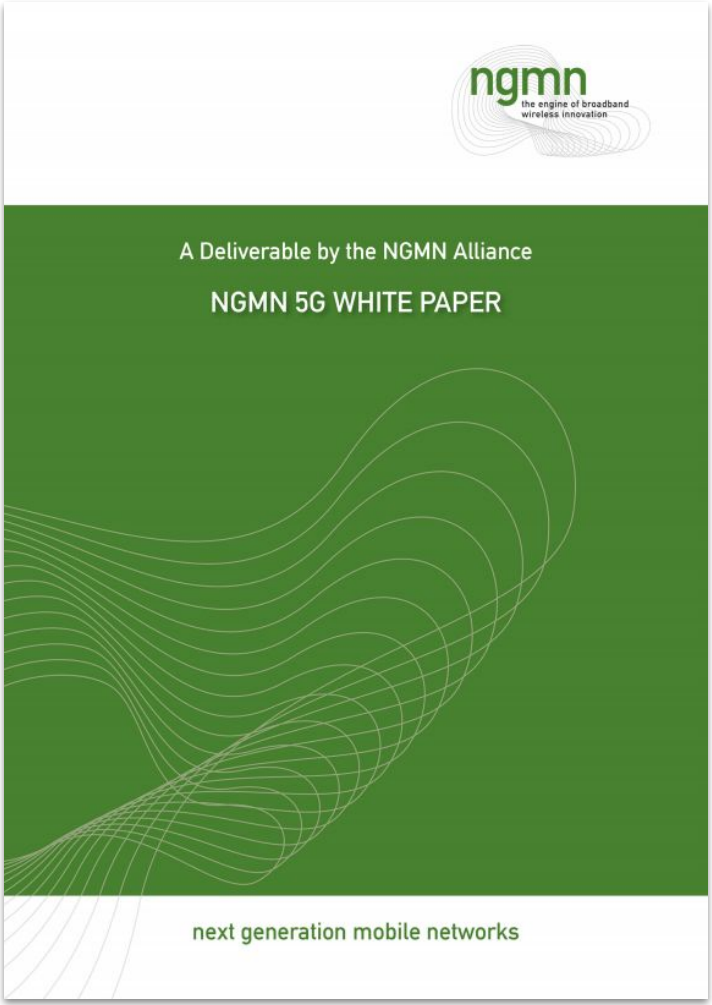

**Alex Choi**
CTO


**Joachim Horn**
Group CTIO

# Let's make IoT happen
# We need 5G Network


https://www.ngmn.org/fileadmin/ngmn/content/downloads/Technical/2015/NGMN_5G_White_Paper_V1_0.pdf


5G is everything.
Low Latency
Ultra Reliability
High Throughput


ngmn
the engine of broadband wireless innovation
A Deliverable by the NGMN Alliance
NGMN 5G WHITE PAPER
next generation mobile networks

In 5G, NGMN anticipates the need for new radio interface(s) driven by use of higher frequencies, **specific use cases such as Internet of Things (IoT)** or specific capabilities (e.g., lower latency), **which goes beyond what 4G and its enhancements can support**. However, 5G is not only about the development of a new radio interface. NGMN envisions 5G as an end-to-end system that includes all aspects of the network, with a design that achieves a high level of convergence and leverages today's access mechanisms (and their evolution), including fixed, and also any new ones in the future.

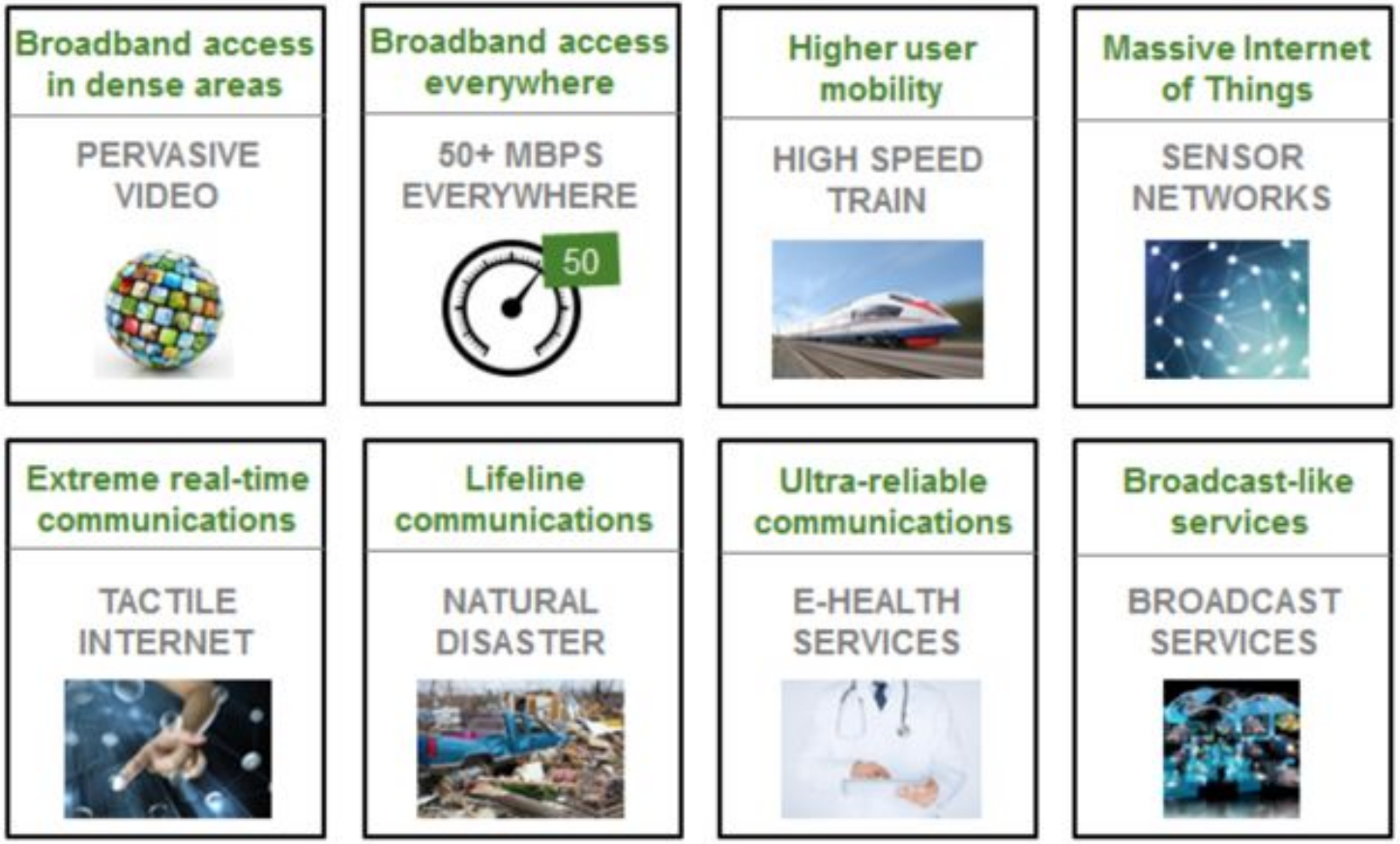



**Figure 1: 5G use case families and related examples**

# ITU

## International Telecommunications Union

formed 1865. the oldest intergovernmental organization in the world.

# ITU IMT-2020 Requirements for 5G

Requirement for bandwidth at least 100 MHz

**Bandwidths up to 1 GHz are required for higher frequencies (above 6 GHz)**

**Minimum requirement for connection density is 1 million devices per km2**

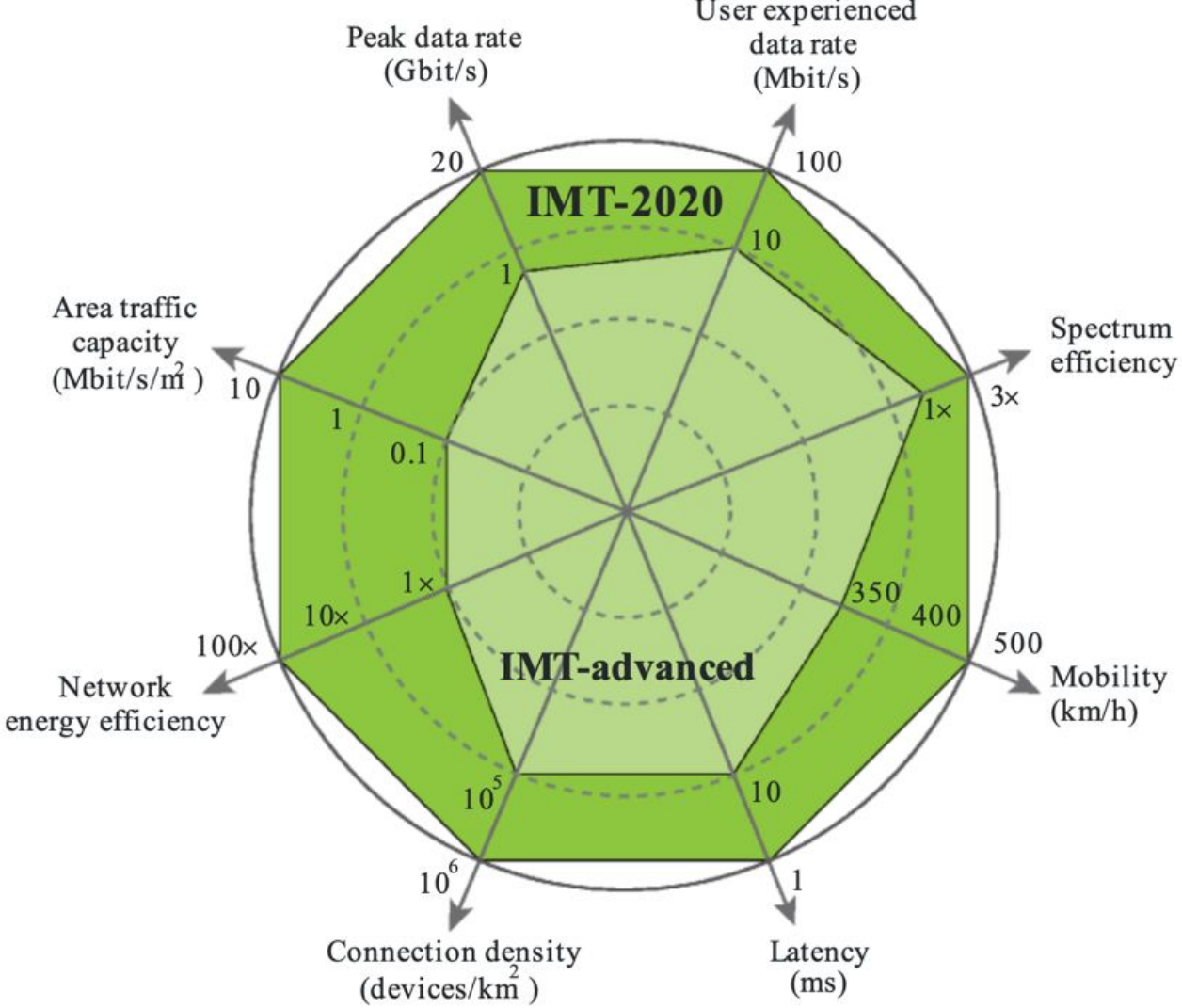
Downlink peak data rate of 20 Gb/s

Uplink peak data rate of 10 Gb/s

https://www.itu.int/md/R15-SG05-C-0040/en

Target downlink "user experienced data rate" of 100 Mb/s

Target uplink "user experienced data rate" of 50 Mb/s




**IMT-2020 (5G) stretched the requirements beyond IMT-Advanced (4G)**

# 3GPP
# 3rd Generation Partnership Project
## develops protocol for 5G

Previous work: GSM, GPRS, EDGE, UMTS, HSPA, LTE

A GLOBAL INITIATIVE



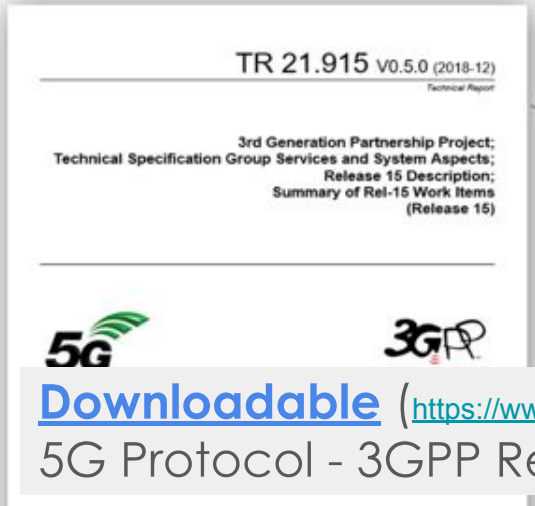
# Release 15

*Update of January 25, 2019*

With each new Release, the Work Plan manager produces a Release Description:

Release 14: TR 21.914

Release 15: TR 21.915...


TR 21.915 V0.5.0 (2018-12)
Technical Report

3rd Generation Partnership Project;
Technical Specification Group Services and System Aspects;
Release 15 Description;
Summary of Rel-15 Work Items
(Release 15)

5G 3GPP

Rel-15

Includes work on:

- The 5G System - Phase 1
- Machine-Type of Communications (MTC) and Internet of Things (IoT)
- Vehicle-to-Everything Communications (V2X) Improvements
- Mission Critical (MC) improvements
- WLAN and unlicensed spectrum
- System enhancements
  - Control plane – user plane separation
  - Quality of Experience (QoE)
  - Security-related improvements

**Downloadable** (https://www.3gpp.org/release-15)

5G Protocol - 3GPP Release 15

## Search

3GPP Website: Search for...

*Search and download specs, docs, CRs and more from the 3GPP FTP Server:*

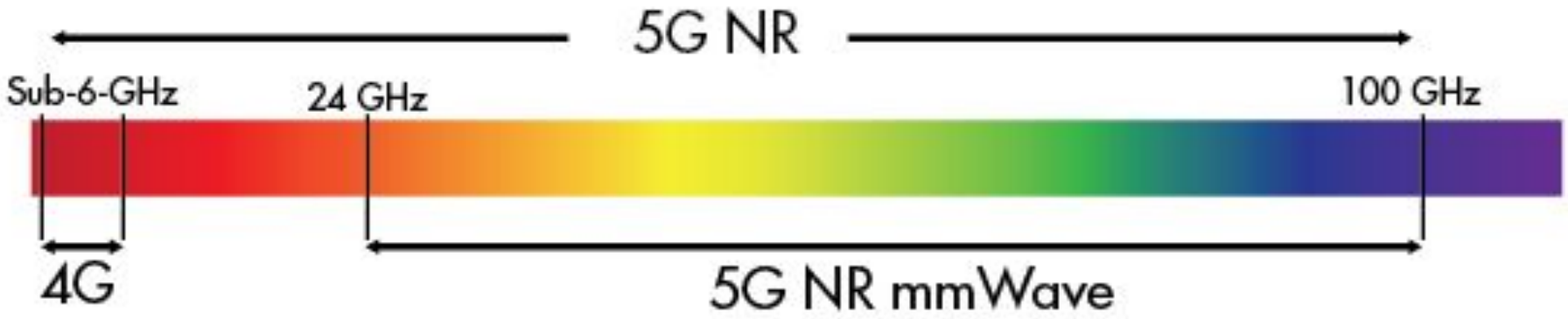
ADVANCED FTP SEARCH

## More News:

- TV and radio services over 3GPP systems
- 5G for Control Applications in Vertical Domains
- Specifications - RAN adjusts schedule for 2nd wave
- Interoperability and compatibility of NR specifications

| | LTE | 5G NR |
|---|---|---|
| Radio Frame | 10 ms | 10 ms |
| Half Frame | N/A | 5 ms |
| Subframe | 1 ms | 1 ms |
| Slot size | 0,5 ms | $\Delta f=1/2^{\mu}$ ms<br>1; 0,5; 0,25; 0,125 or 0,0625 |
| Slot description | 14 OFDM symbols with Normal CP and 12 symbols with Extended CP | 14 OFDM symbols with Normal CP and 12 symbols with Extended CP |
| Mini [illegible] | N/A | 2, 4 or 7 OFDM symbols |
| Subcarrier Spacing | 15kHz or 7.5KHz in case of MBMS | $\Delta f=2^{\mu}$ * 15kHz<br>$\mu$=0..4<br>15; 30; 60; 120 or 240 |
| Bandwidth | 1,4; 3; 5; 10; 15 or 20 MHz<br>UE is aware about total bandwidth (Broadcasted in MIB) | 5; 10; 15; 25; 30; 40; 50; 60; 80 and 100 MHz for frame range 1 (below 6 GHz)<br>50; 100; 200 and 400 MHz for frame range 2 (Above 24.25 GHz) |

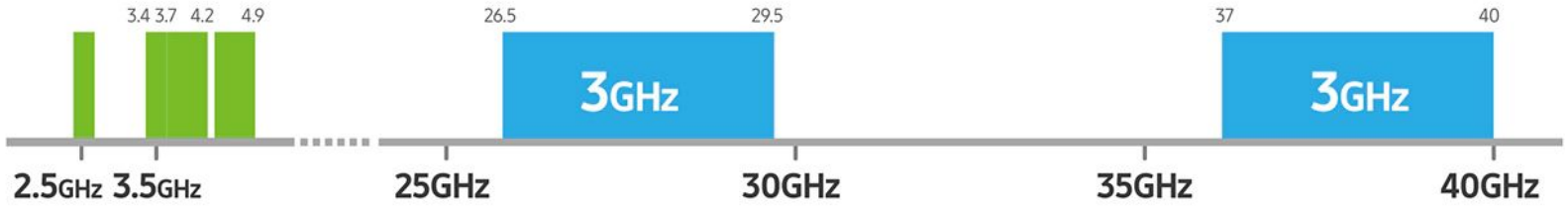
# 5G NR (New Radio protocol)




More “real estate”/bandwidth @ >6GHz

# Below 6GHz

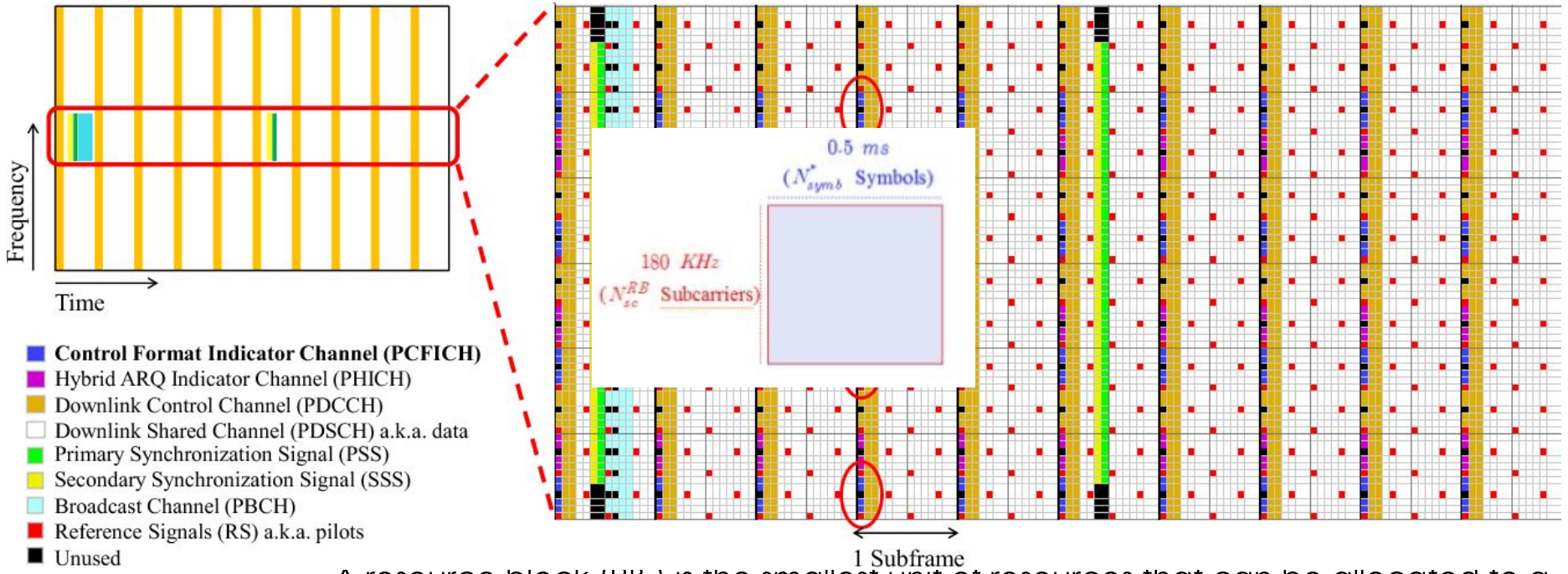
# Above 6GHz




| | |
|---|---|
| USA | 2.496 - 2.69GHz |
| Europe | 3.4 - 3.8GHz |
| Korea | 3.4 - 3.7GHz |
| Japan | 3.6 - 4.2GHz, 4.4 - 4.9GHz |
| India | 3.3 - 3.4GHz |

| | |
|---|---|
| USA | 27.5 - 28.35GHz |
| Europe | 24.25 - 27.5GHz |
| Korea | 26.5 - 29.5GHz |
| Japan | 27.5 - 29.5GHz |

| | |
|---|---|
| USA | 37 - 40GHz |




A resource block (RB ) is the smallest unit of resources that can be allocated to a user

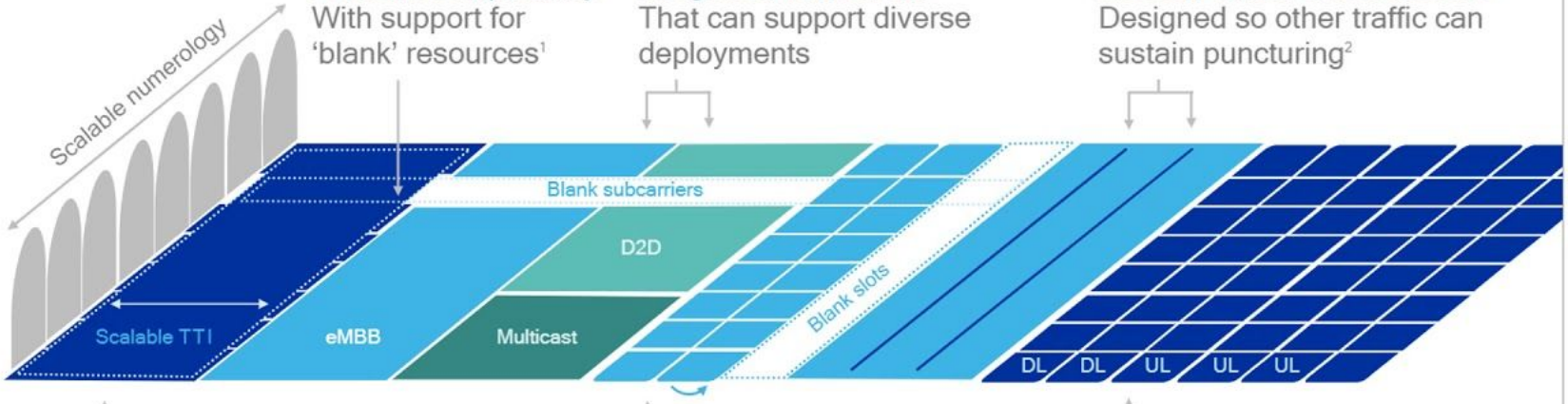
# Flexible, forward compatible framework efficiently multiplexes envisioned and future 5G services

5G NR

**Forward compatibility**
With support for 'blank' resources[1]

**Integrated framework**
That can support diverse deployments

**Mission-critical transmissions**
Designed so other traffic can sustain puncturing[2]




**Scalable transmission time interval (TTI)**
Capable of latencies an order of magnitude lower than LTE

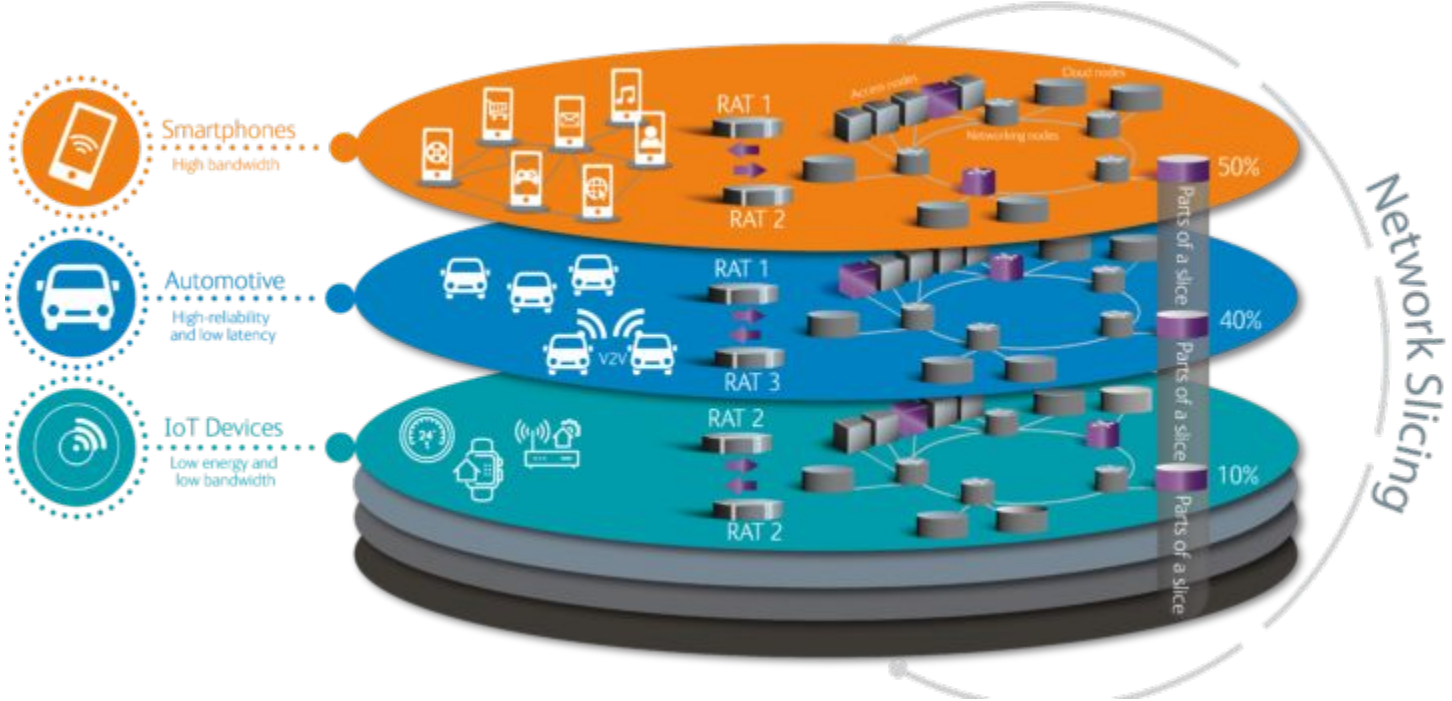
**Self-contained slot structure**
UL/DL scheduling info, data and ACK in the same slot

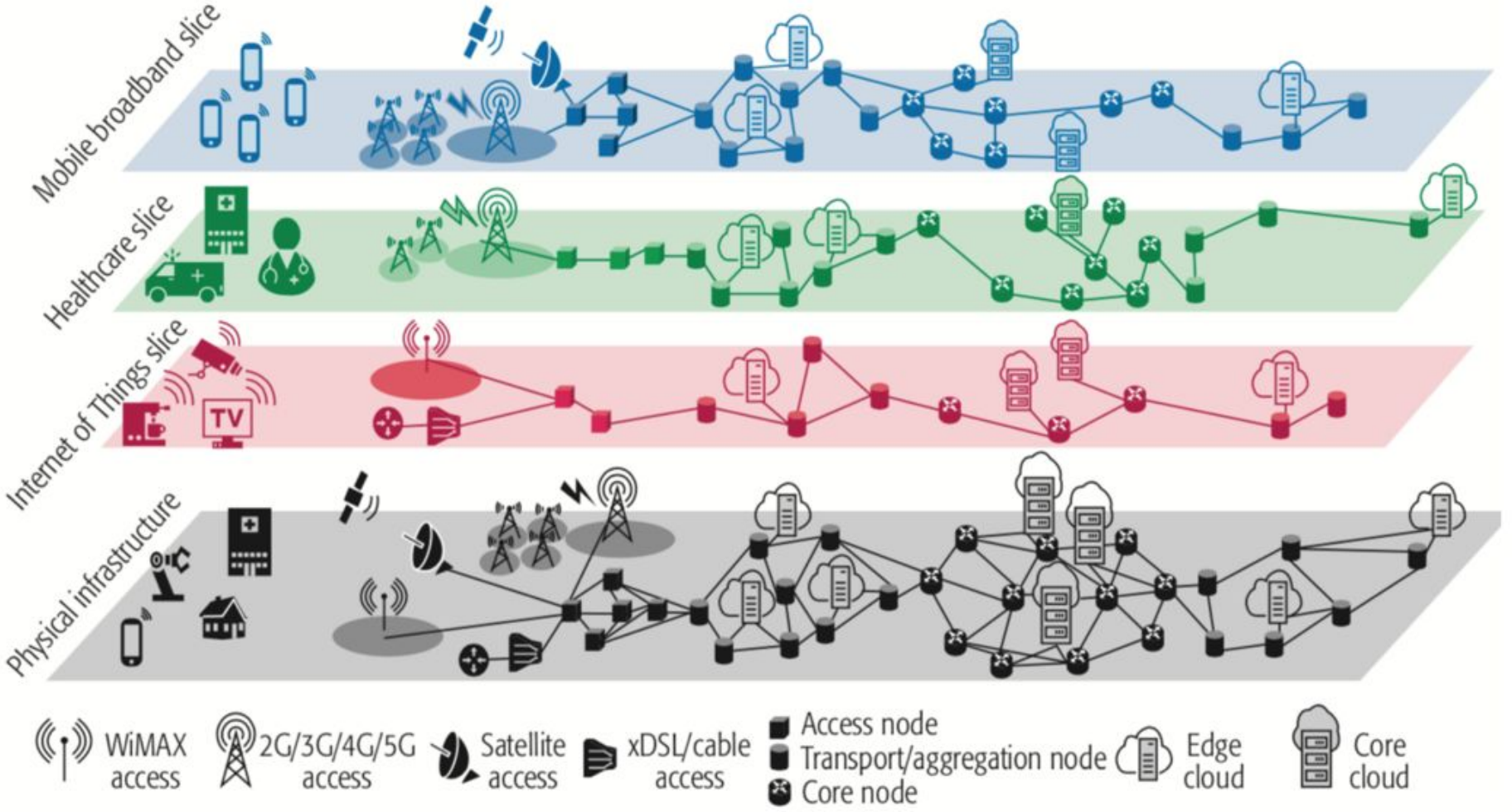
**Dynamic uplink/downlink**
Faster switching for more flexible capacity allocation

1. Blank resources may still be utilized, but are designed in a way to not limit future feature introductions
2. Nominal 5G access to be designed such that it is capable to sustain puncturing from mission-critical transmission or bursty interference

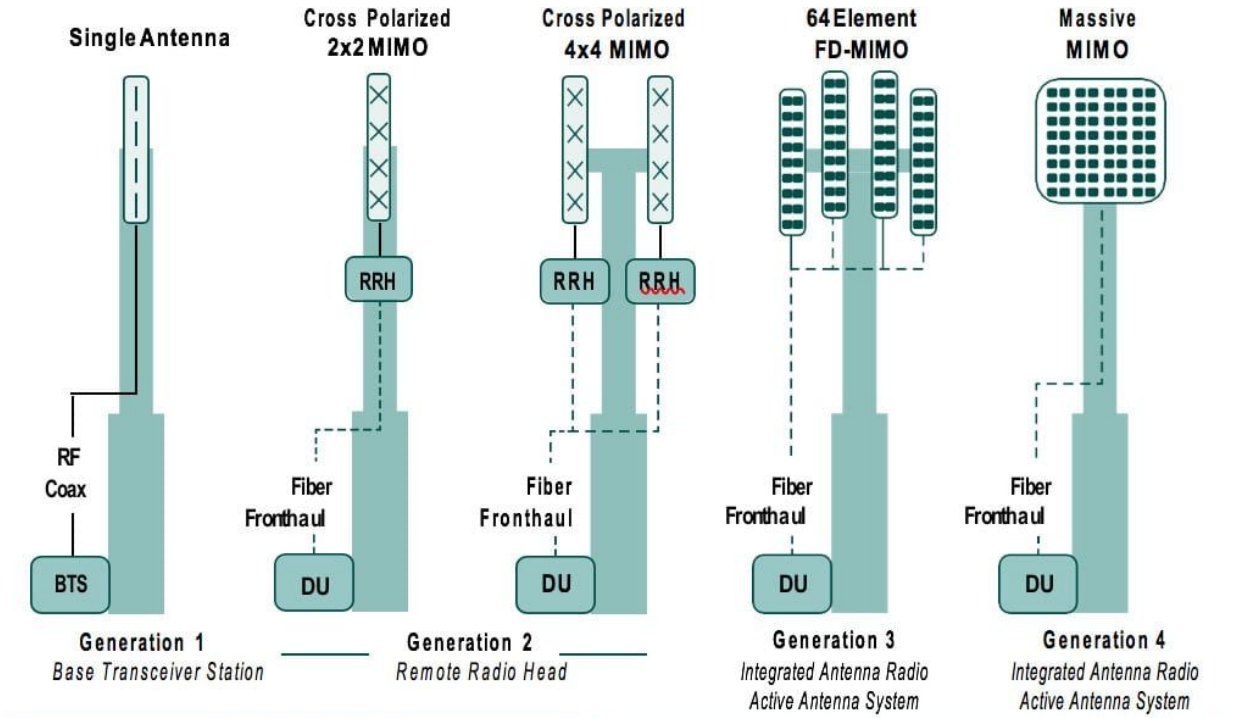
Source: Qualcomm

# Network Slicing




Mobile broadband slice
Healthcare slice
Internet of Things slice
TV
Physical infrastructure
WiMAX access
2G/3G/4G/5G access
Satellite access
xDSL/cable access
Access node
Transport/aggregation node
Core node
Edge cloud
Core cloud

## Role of Active vs. Passive Antennas




**BTS:** Base Transceiver Station/Base Station
**DU:** Digital Unit/Baseband
**RRH:** Remote Radio Head/Radio Unit

# Practical Use-Cases Today

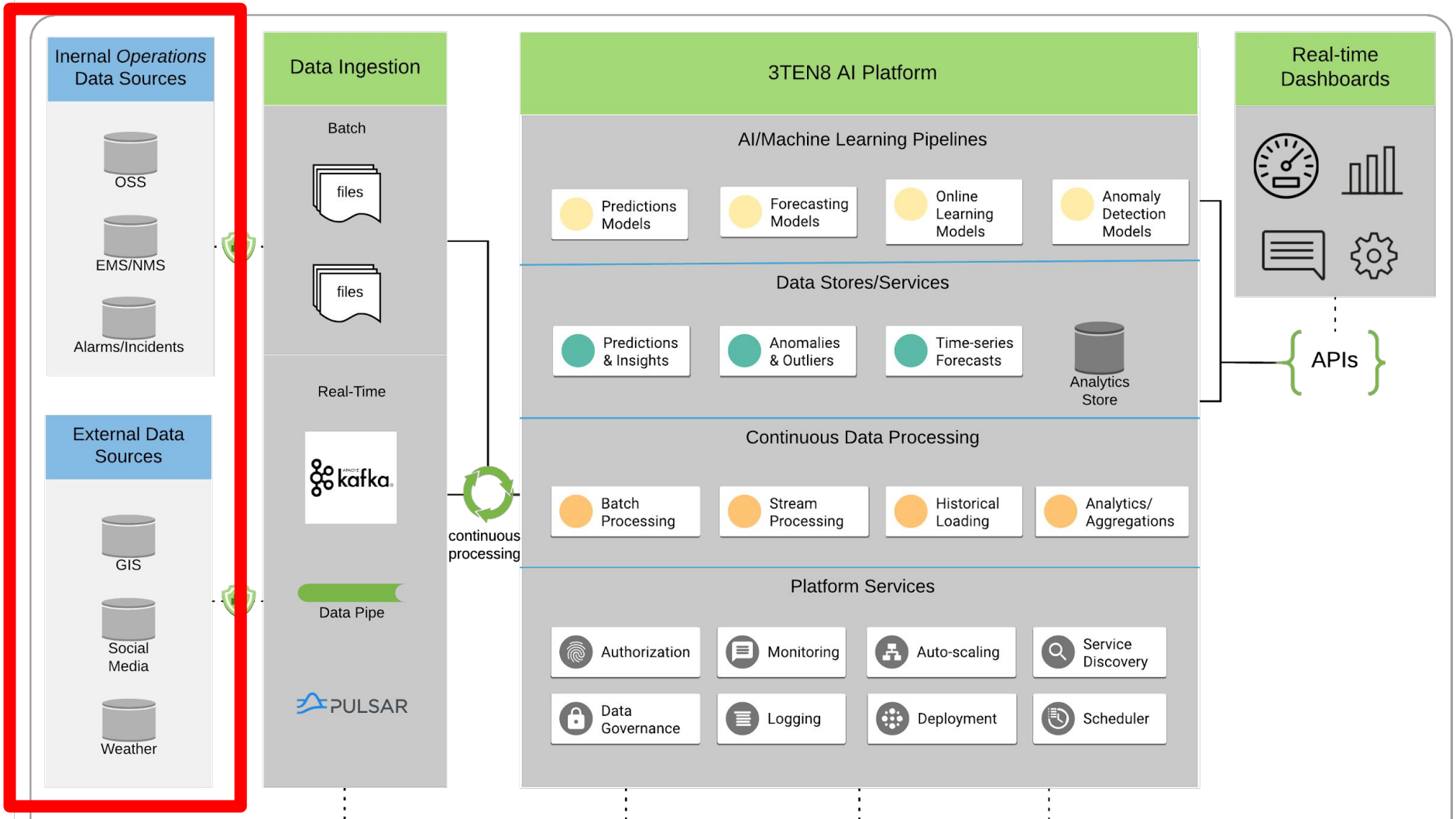
# Self-Healing Networks

# 3 Types of data collected

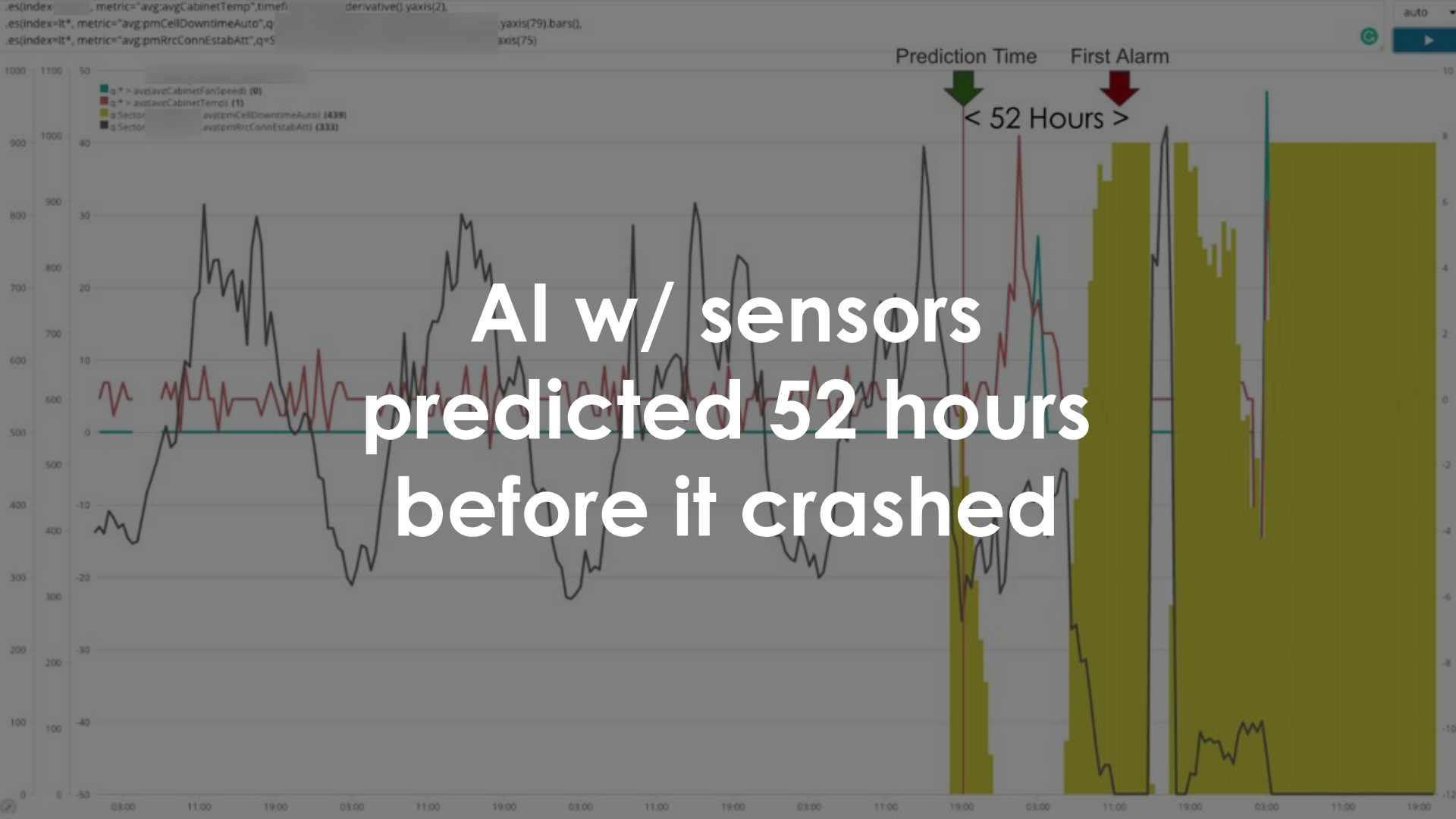
Performance

Configuration

Fault


Inernal Operations Data Sources
OSS
EMS/NMS
Alarms/Incidents
External Data Sources
GIS
Social Media
Weather
Data Ingestion
Batch
files
files
Real-Time
kafka
Data Pipe
PULSAR
continuous processing
3TEN8 AI Platform
AI/Machine Learning Pipelines
Predictions Models
Forecasting Models
Online Learning Models
Anomaly Detection Models
Data Stores/Services
Predictions & Insights
Anomalies & Outliers
Time-series Forecasts
Analytics Store
Continuous Data Processing
Batch Processing
Stream Processing
Historical Loading
Analytics/ Aggregations
Platform Services
Authorization
Monitoring
Auto-scaling
Service Discovery
Data Governance
Logging
Deployment
Scheduler
Real-time Dashboards
APIs

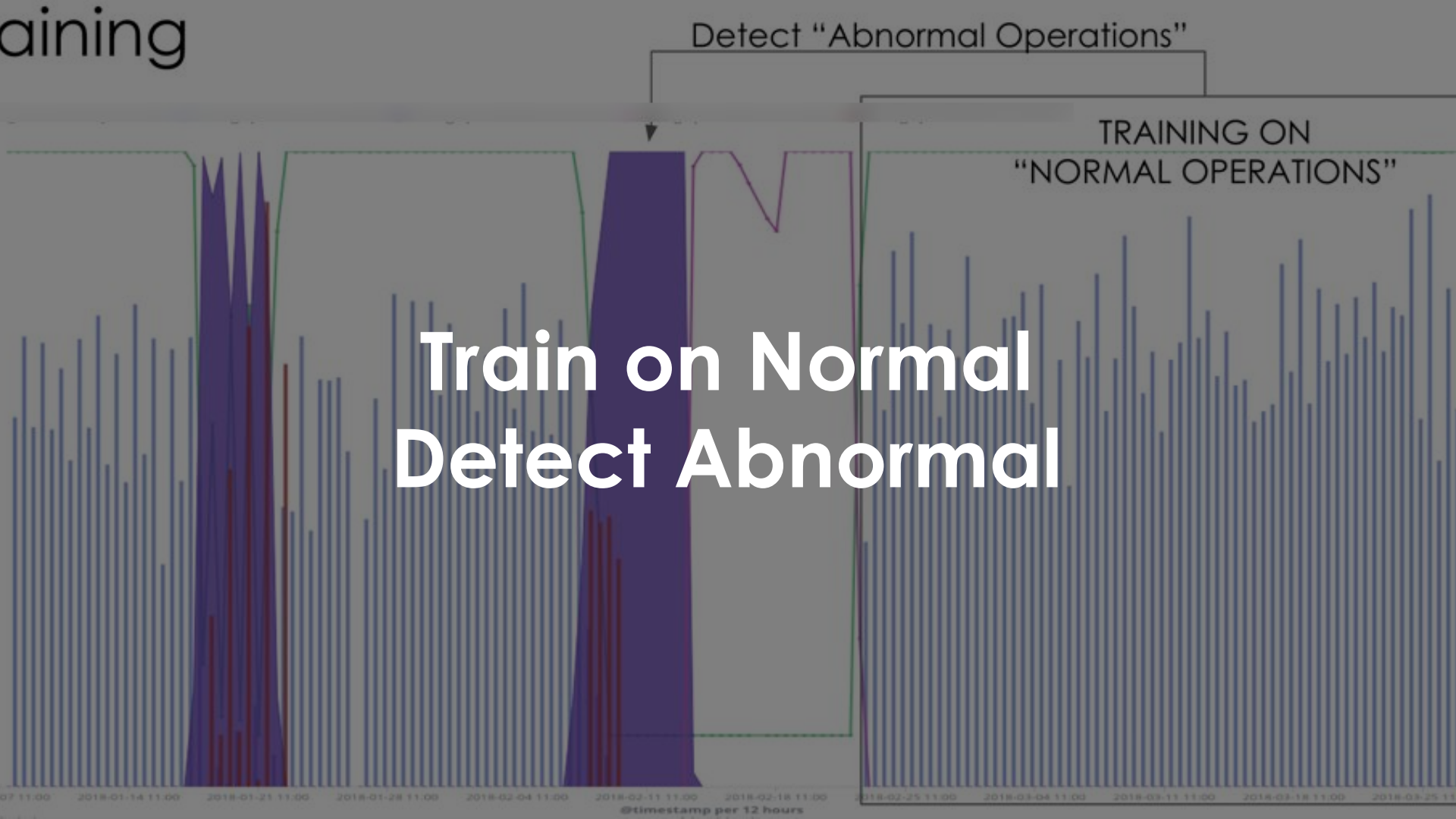
**This cabinet got really hot and crashed the site**

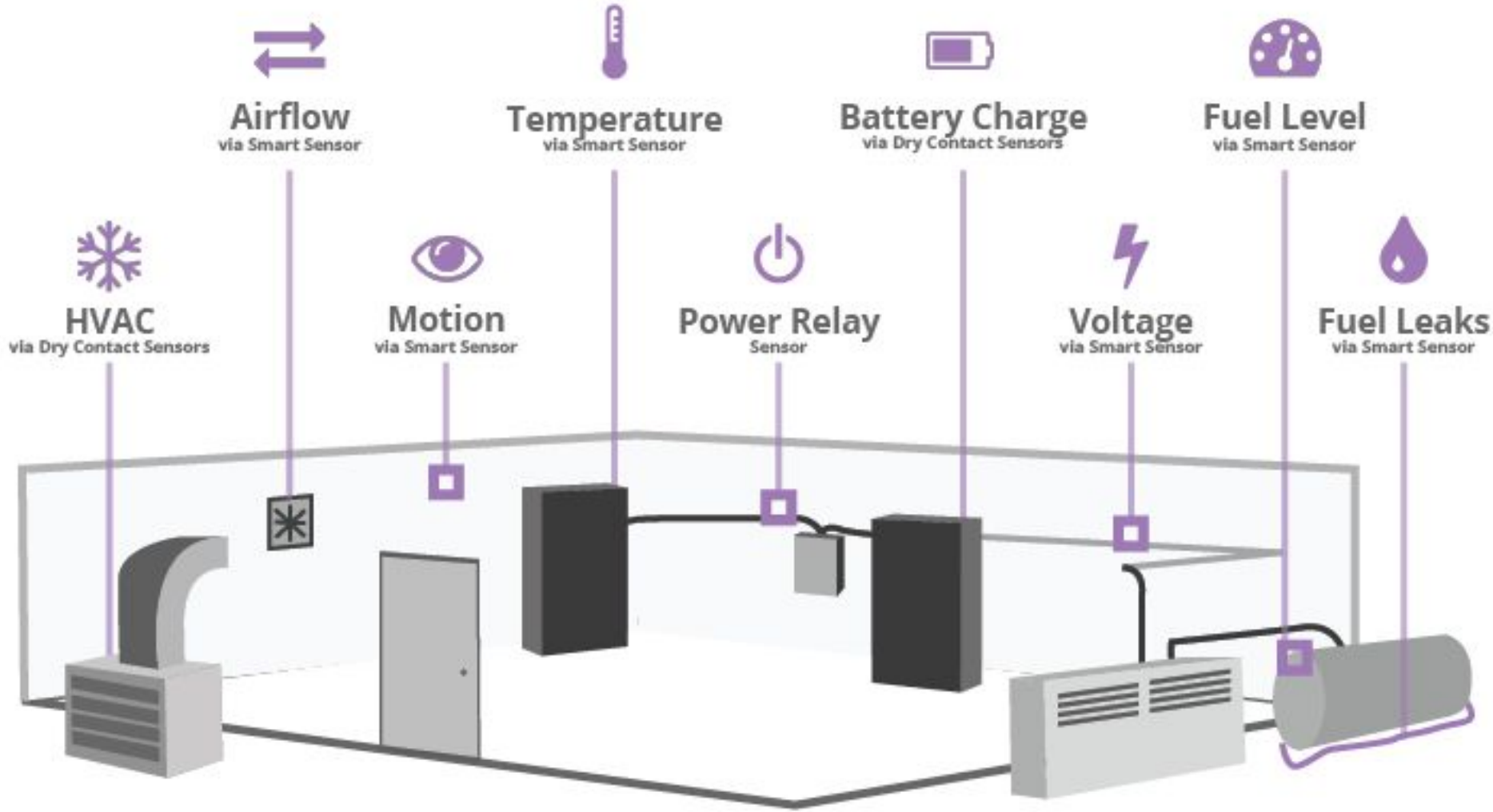

Prediction Time
First Alarm
< 52 Hours >
AI w/ sensors
predicted 52 hours
before it crashed

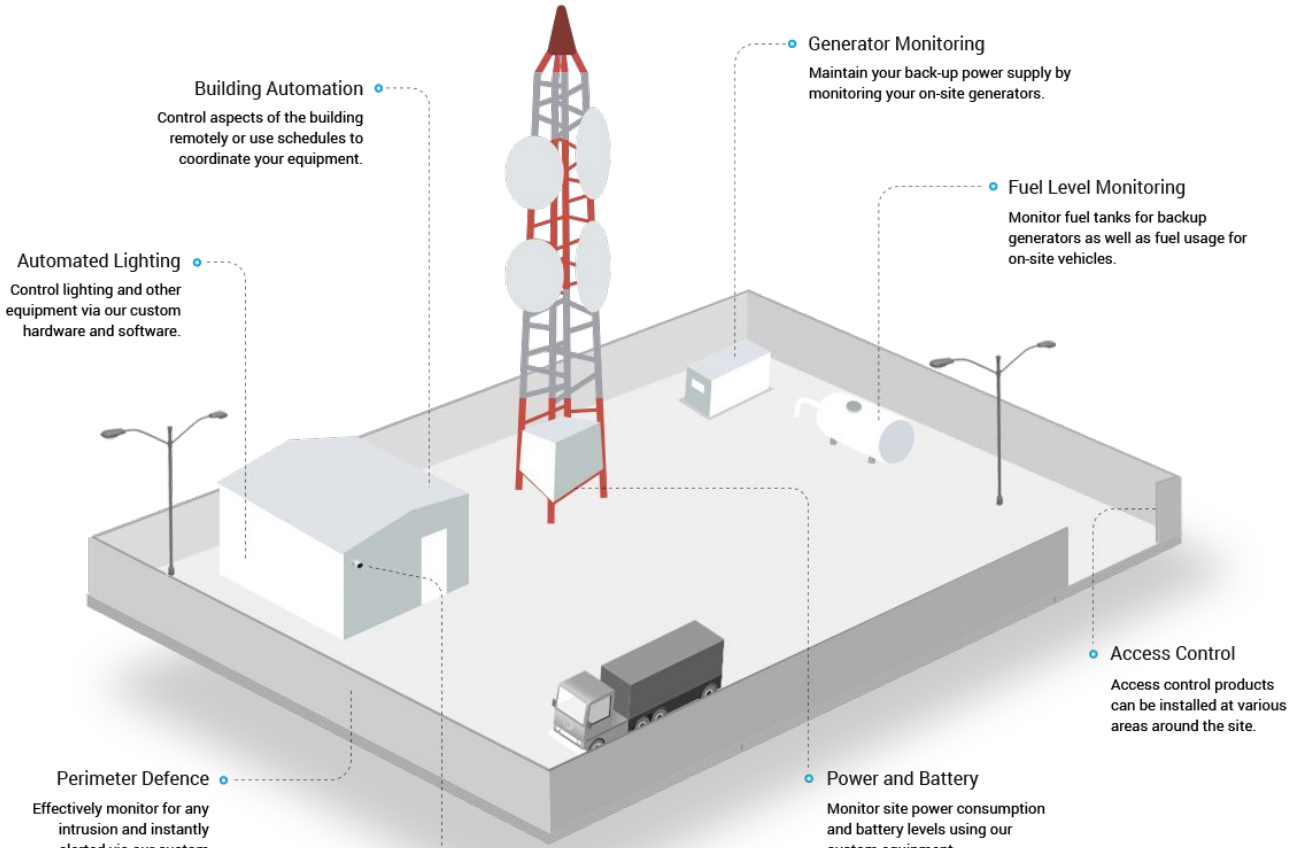
# 7,838 Alarms vs 1 Prediction with AI

7,838 - Uninsightful (AutoDowntime & Remote IP Address Unreachable)

3TEN8 - 1 prediction with insights to prevent fault/outage


aining
Detect "Abnormal Operations"
TRAINING ON
"NORMAL OPERATIONS"
Train on Normal
Detect Abnormal
@timestamp per 12 hours


Airflow
via Smart Sensor
Temperature
via Smart Sensor
Battery Charge
via Dry Contact Sensors
Fuel Level
via Smart Sensor
HVAC
via Dry Contact Sensors
Motion
via Smart Sensor
Power Relay
Sensor
Voltage
via Smart Sensor
Fuel Leaks
via Smart Sensor



### Building Automation

Control aspects of the building remotely or use schedules to coordinate your equipment.

### Generator Monitoring

Maintain your back-up power supply by monitoring your on-site generators.

### Fuel Level Monitoring

Monitor fuel tanks for backup generators as well as fuel usage for on-site vehicles.

### Automated Lighting

Control lighting and other equipment via our custom hardware and software.

### Access Control

Access control products can be installed at various areas around the site.

### Perimeter Defence

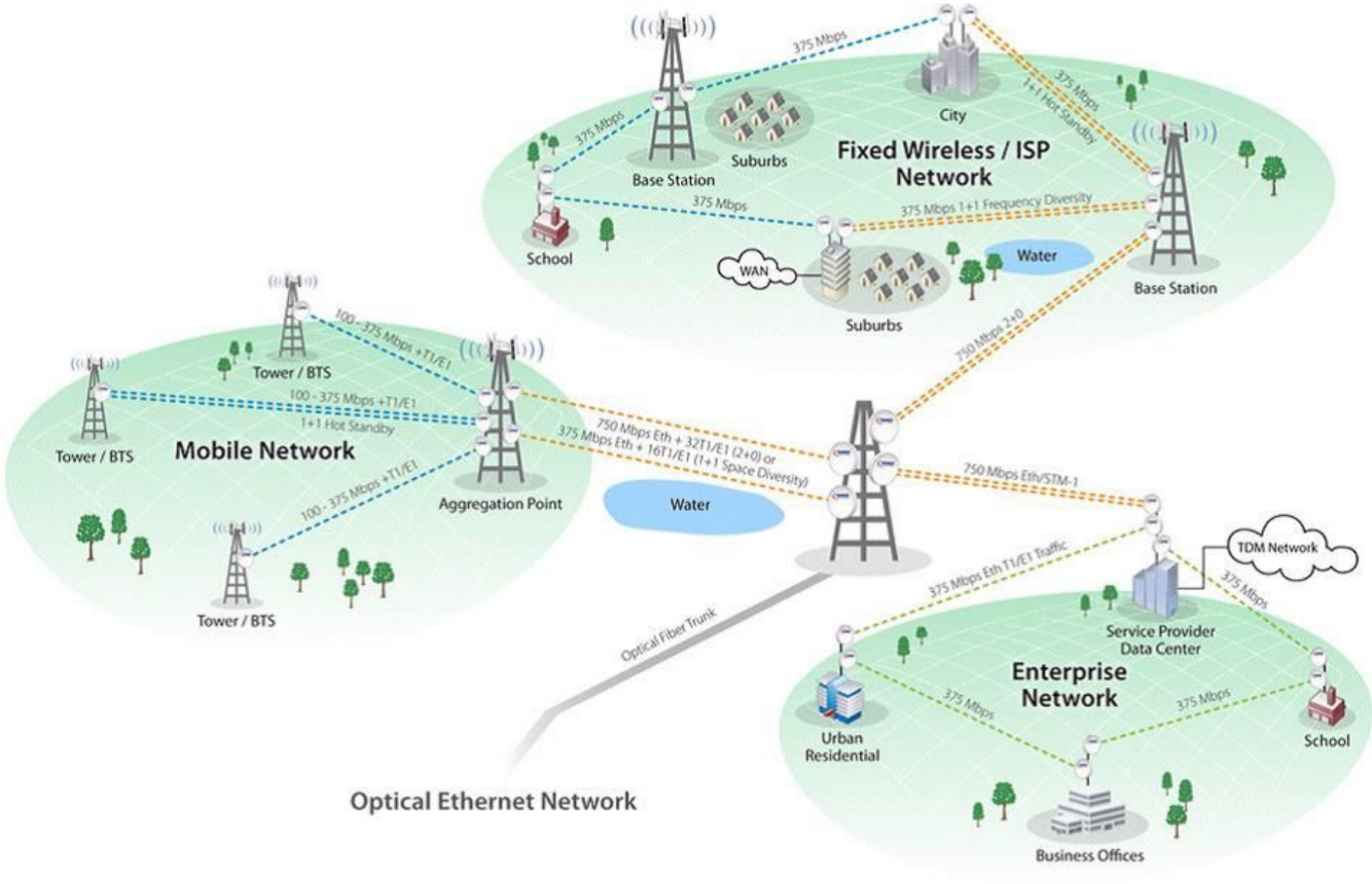
Effectively monitor for any intrusion and instantly alerted via our custom notifications.

### Power and Battery

Monitor site power consumption and battery levels using our custom equipment.

### Camera Surveillance

CCTV requirements can be met using analog, IP, thermal, and explosion proof cameras


375 Mbps
City
375 Mbps 1+1 Hot Standby
375 Mbps
Base Station
Suburbs
Fixed Wireless / ISP Network
375 Mbps
375 Mbps 1+1 Frequency Diversity
School
WAN
Water
Suburbs
Base Station
750 Mbps 2+0
100 - 375 Mbps +T1/E1
Tower / BTS
100 - 375 Mbps +T1/E1
1+1 Hot Standby
Tower / BTS
Mobile Network
750 Mbps Eth + 32T1/E1 (2+0) or
375 Mbps Eth + 16T1/E1 (1+1 Space Diversity)
Aggregation Point
Water
750 Mbps Eth/STM-1
100 - 375 Mbps +T1/E1
Tower / BTS
TDM Network
375 Mbps Eth T1/E1 Traffic
375 Mbps
Optical Fiber Trunk
Service Provider Data Center
Enterprise Network
375 Mbps
375 Mbps
Urban Residential
School
Optical Ethernet Network
Business Offices


# Mark Williams
# Founder and CEO - Ladera Labs

# Multi-tenant Wireless Backhaul Site

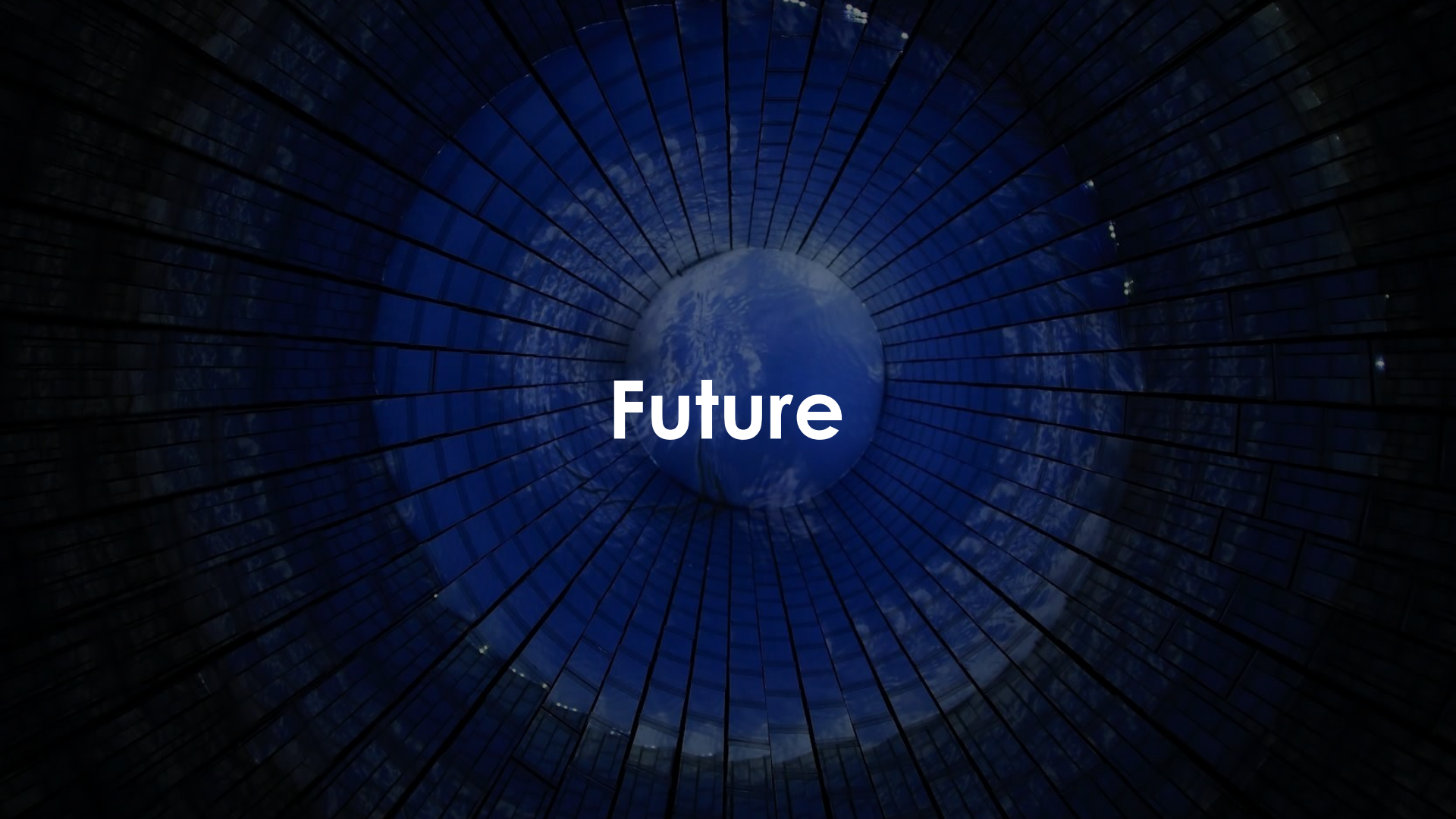
- Key backhaul infrastructure
- All major carriers on site
- Unattended facility
- ~1 day to get there in good weather
- 1000’s of sites like this in NA

# Critical Infrastructure – in difficult locations

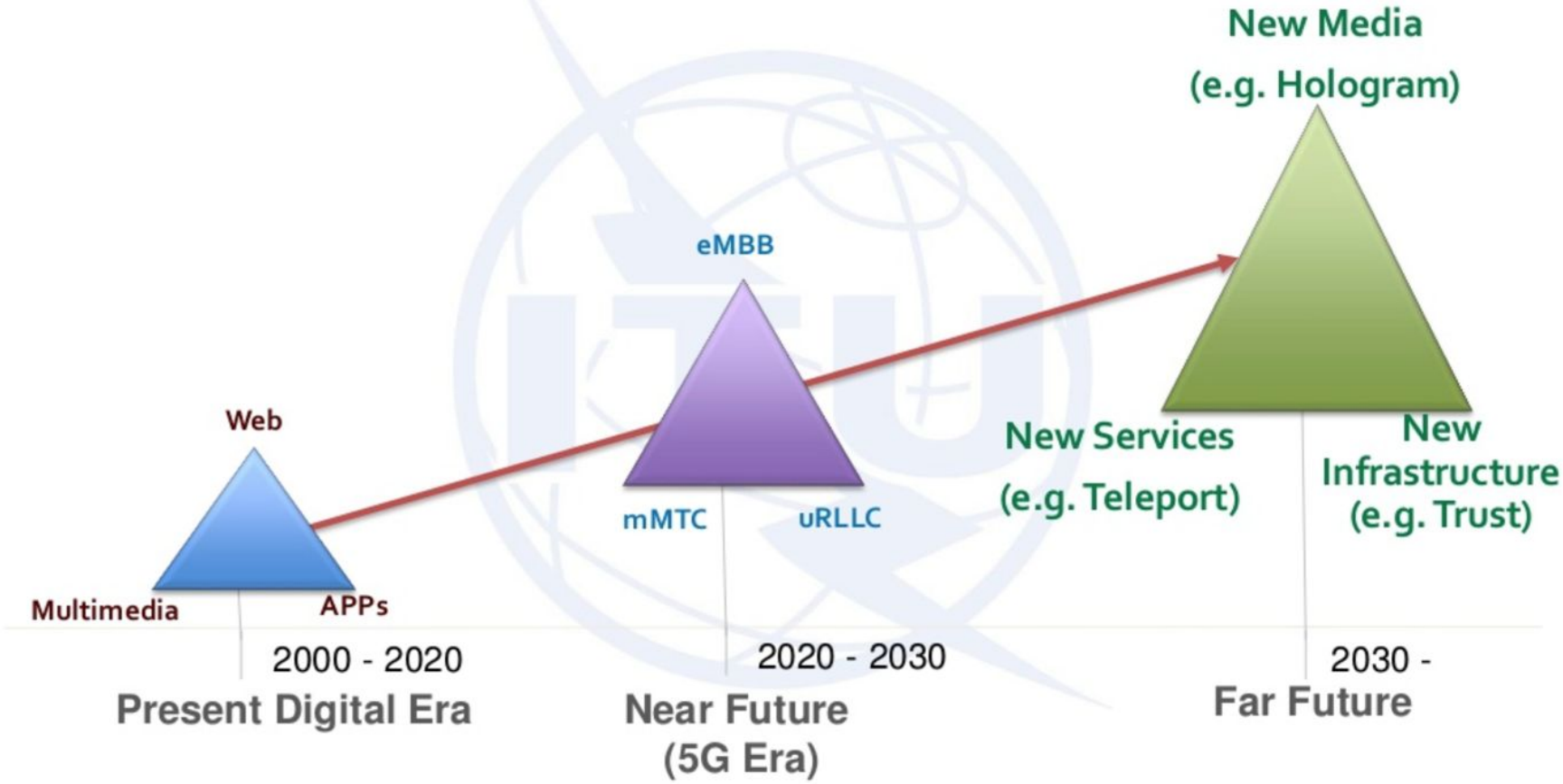
Accessible only by Snow Cat or helicopter 6 months of the year

# 24/7/365 Monitor and Control of Critical Assets


- Infrastructure health
- Environmental conditions
- Real-time notifications
- Failure prediction
- Remote reboot / restart

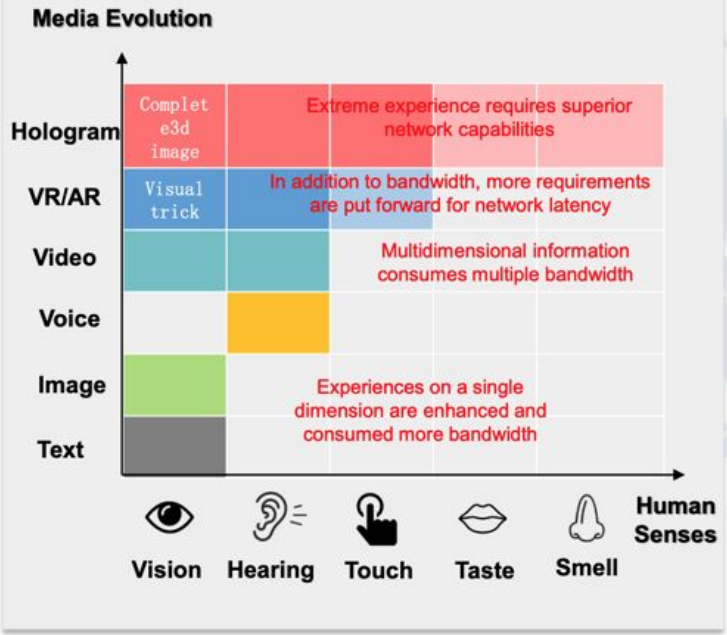

Future

# Internet: Past, Present, Future

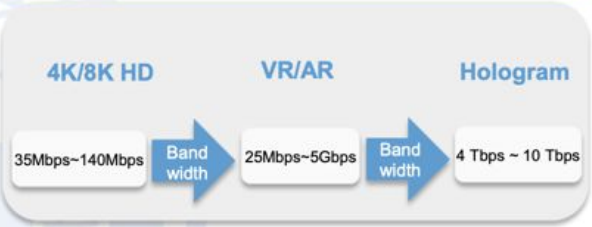


# New User Experience: Senses, Throughput and Latency

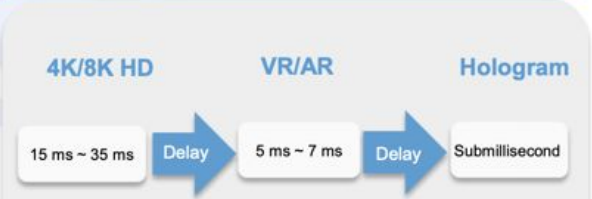
## User experience goes from single sense to five senses



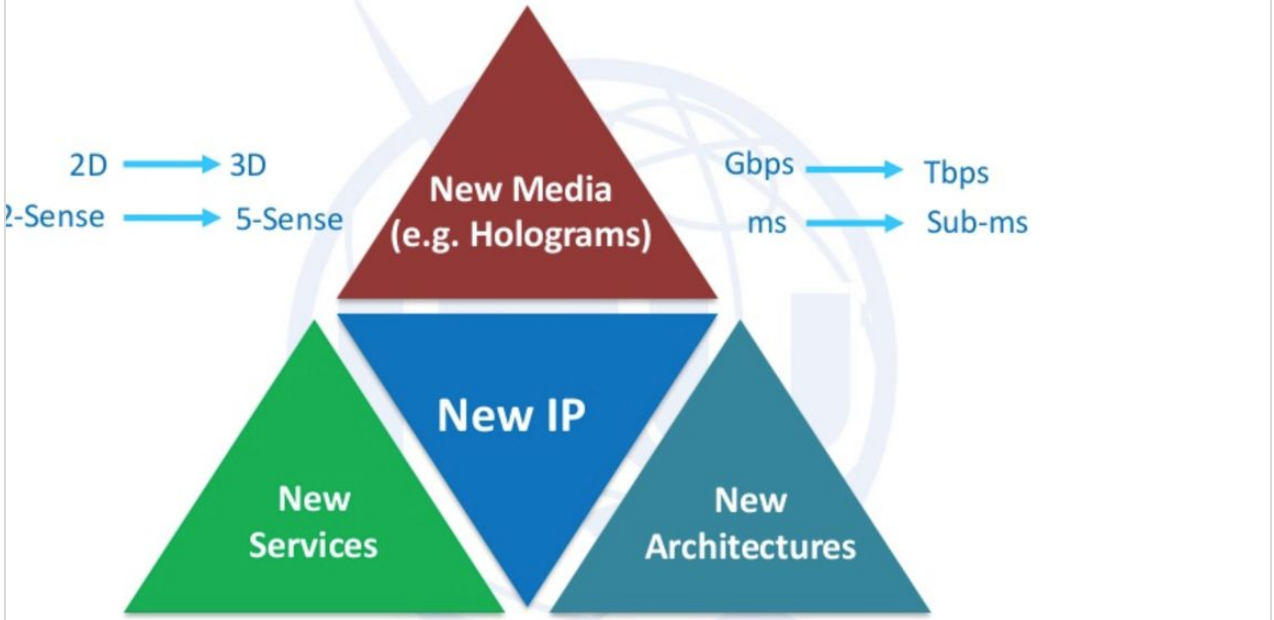

## Throughput goes up higher and higher




## Latency falls down lower and lower



# A New Horizon beyond 5G Era




Holographic Teleport
High-Precision Service
Deterministic Service
Best-Guaranteed Services

Integrated Terrestrial and Spac
Federated Networks
Decentralized Infrastructure
Trustable Infrastructure

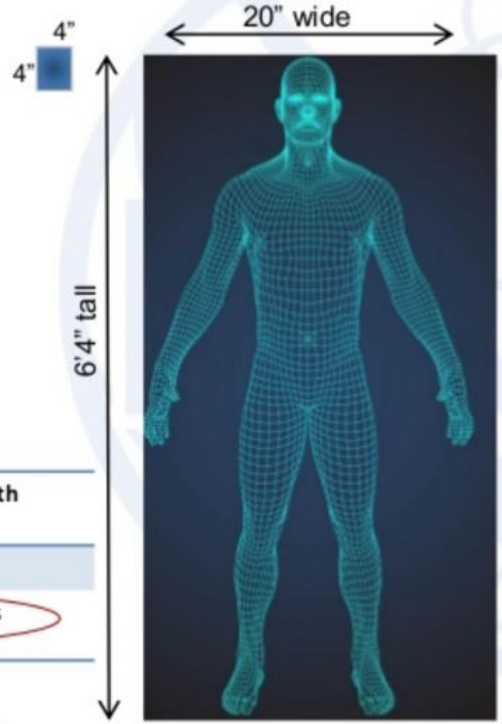
# New Media: Hologram

**Bandwidth requirement will grow up to terabits for holographic telepresence applications**

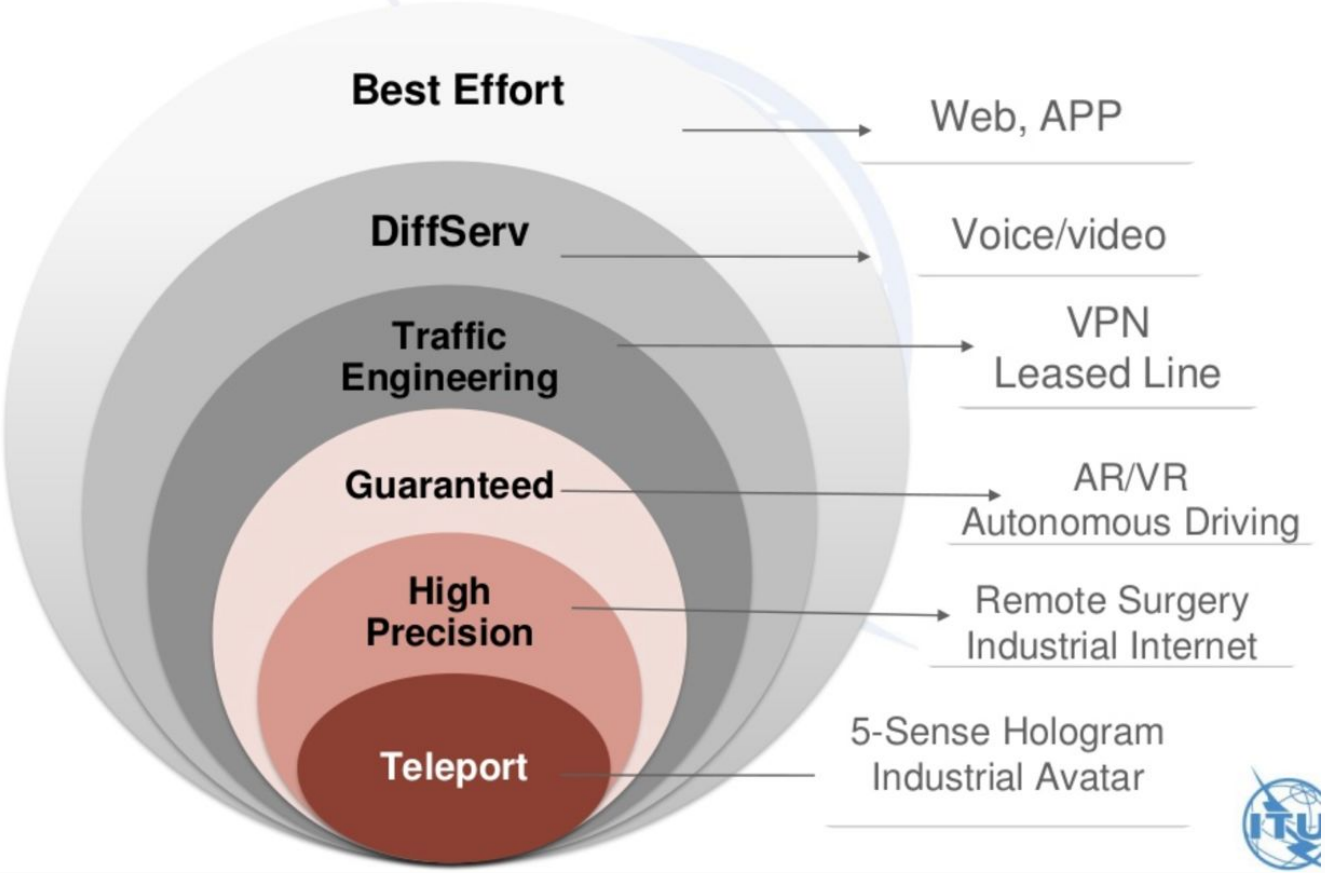
| Effective Pixel Count | Approx. Bandwidth Requirement |
|---|---|
| 31.5 M | 1 Gbps |
| 157 M | 10 Gbps |
| 755 M | ~75 Gbps |
| 1.19G | ~90 Gbps |
| 5.10 G | 300 Gbps |
| 19.1G | 1Tbps |

| | Dimensions | Bandwidth |
|---|---|---|
| Tile | 4 x 4 inches | 30 Gbps |
| Human | 77 x 20 inch | 4.62 Tbps |

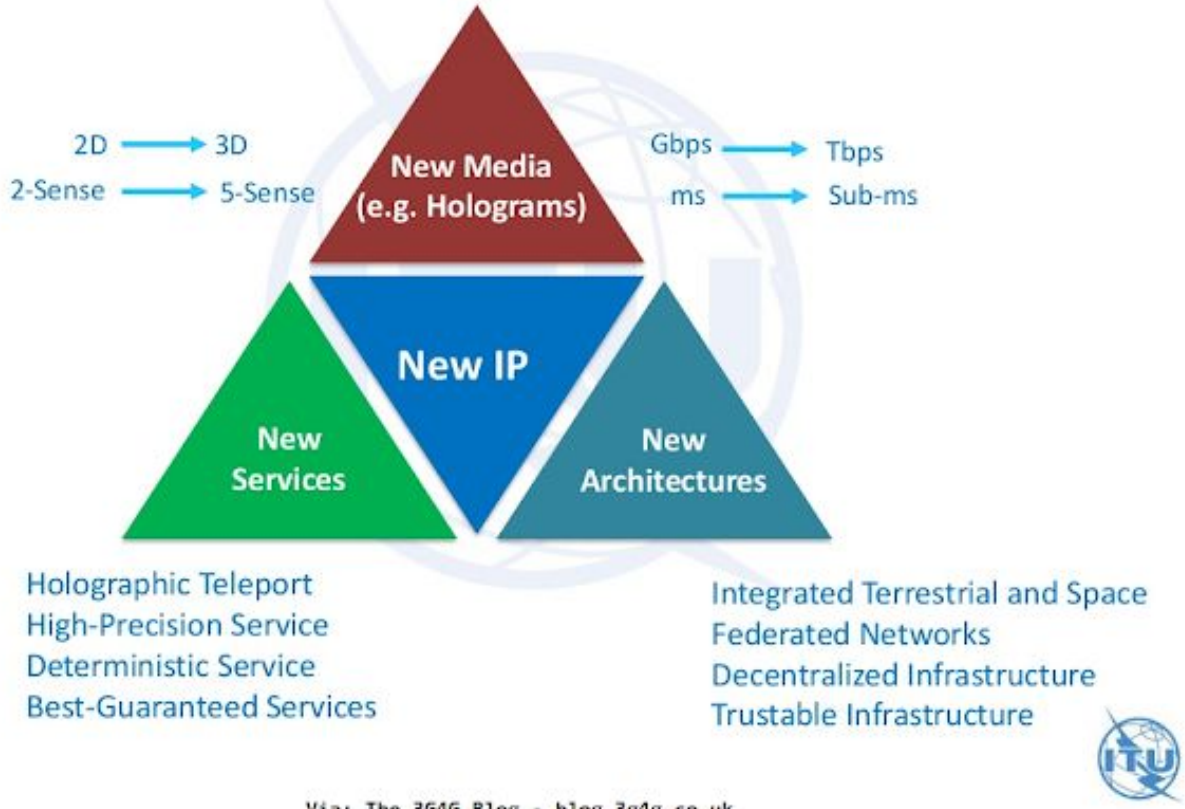
color, FP (full parallax), 30 fps




# New Services:
## Best-Effort to Guaranteed to High-Precision

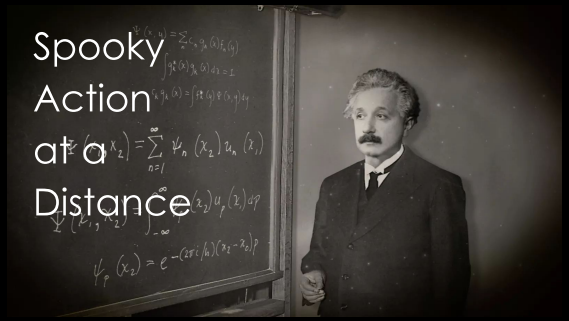


# A New Horizon beyond 5G Era




Via: The 3G4G Blog - blog.3g4g.co.uk

# Counterfactual Communications

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# I want 5G, and even 6G

# THANK YOU

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