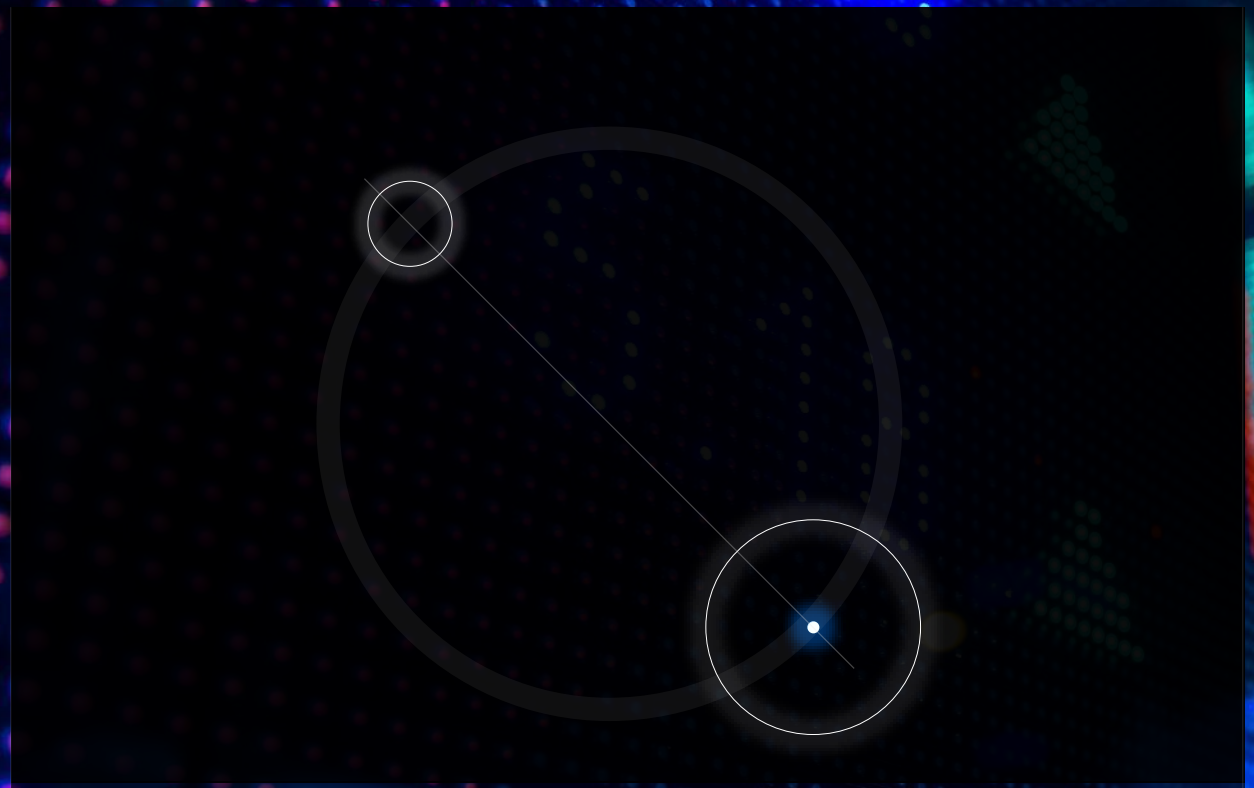


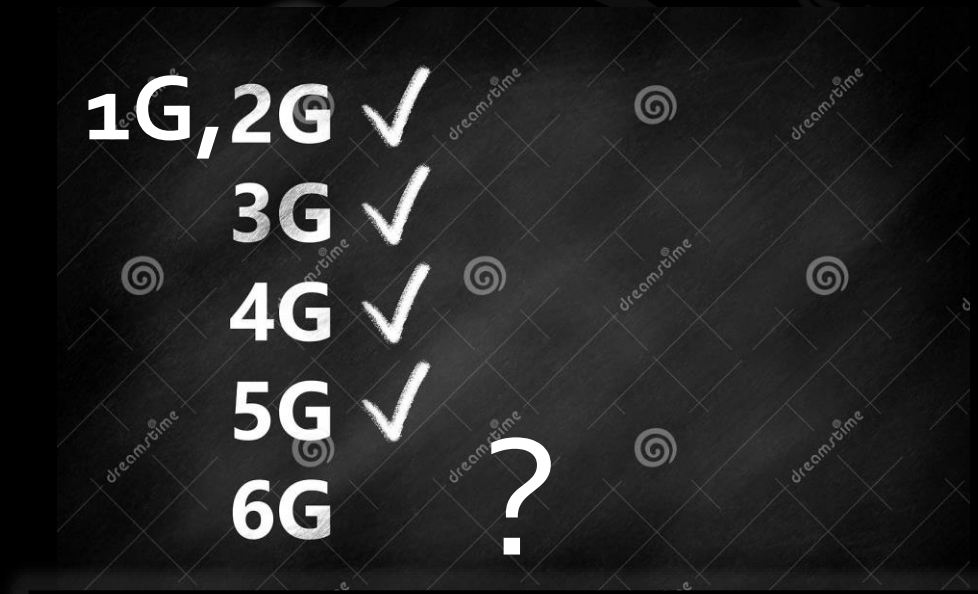
Exploring the Road to 6G

FOUNDATION FOR INTELLIGENT MOBILE NETWORKS

Vipin Chandran
S7 ECE
Roll : 61
College of Engineering, TVM

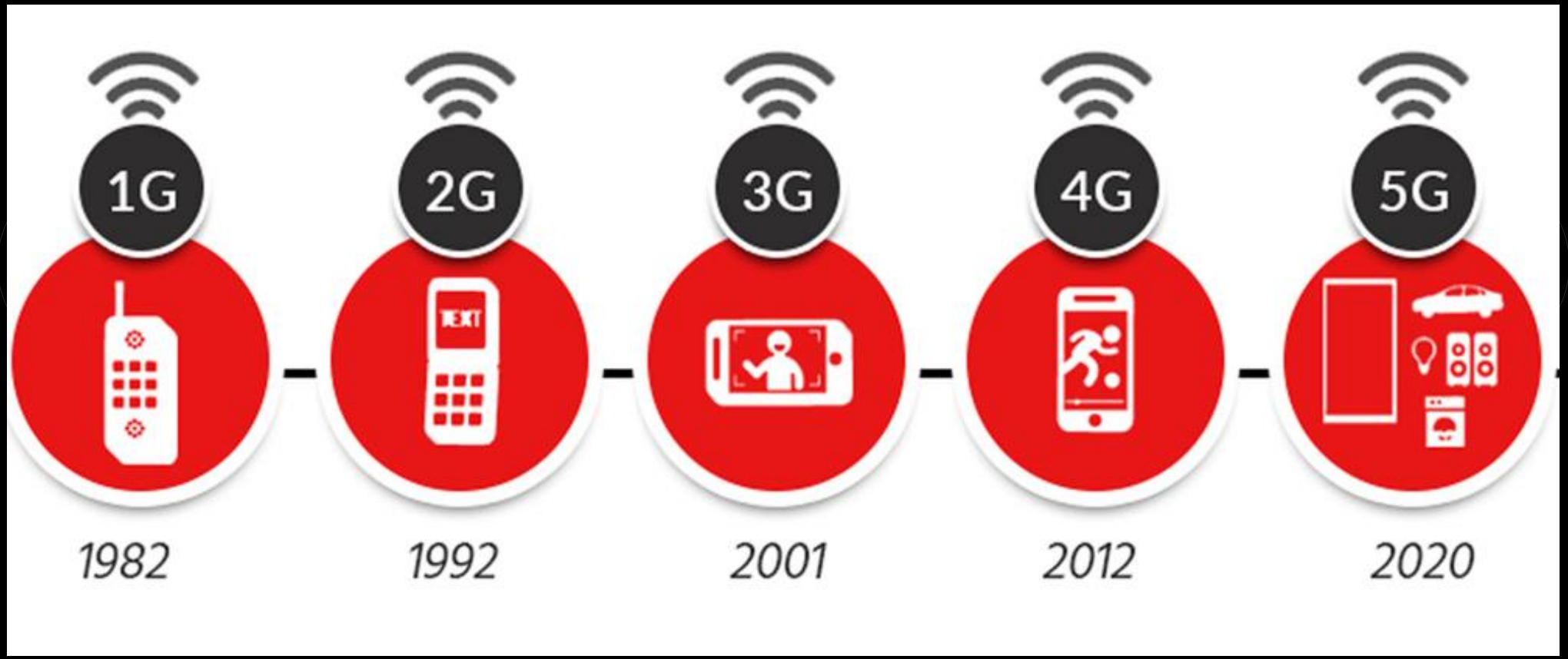
Guided by : Mrs. Jijina N,
Assistant Professor ECE

WHY ?



WHEN 6G ?

Evolution of the G's



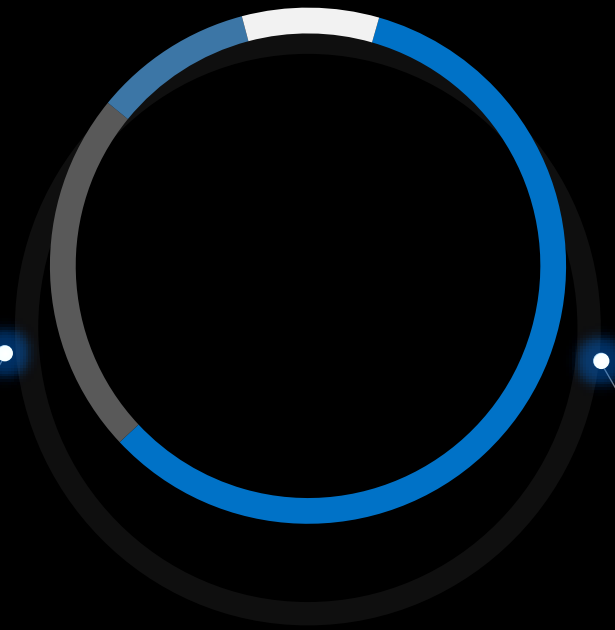
1G Vs. 2G Vs. 3G Vs. 4G

1G

- Analog Technology
- Access System : FDMA
- Data Rate : Upto 2.4Kbps

2G

- GSM Technology
- Access System : TDMA
- Data Rate : 14.4 to 64Kbps



4G

- LTE Technology
- Access System : OFDM
- Data Rate : 100Mbps to 1Gbps

3G

- UMTS Technology
- Access System : CDMA
- Data Rate : Upto 2Mbps

5G REVOLUTION

5 Technologies That Made It Possible

Fig 1 : mm Wave

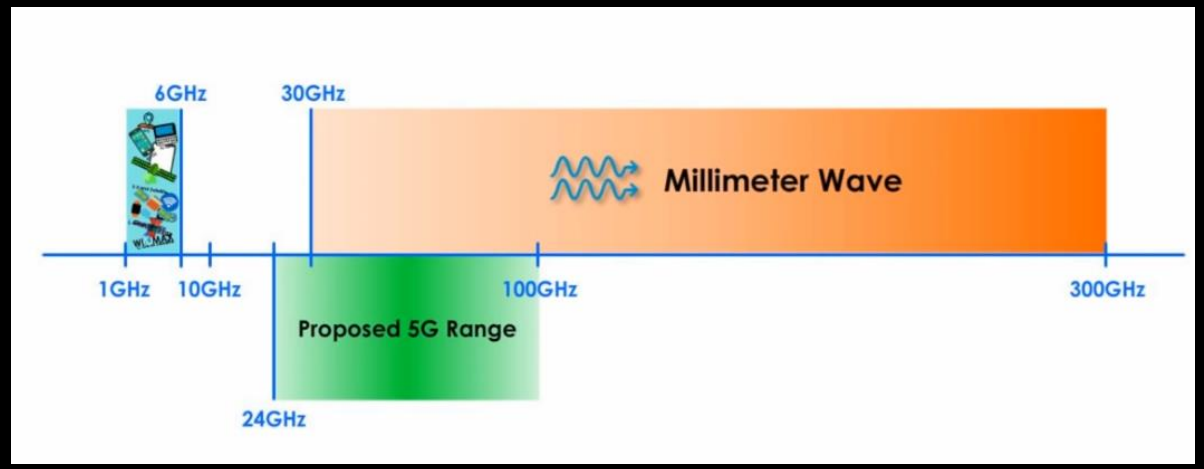
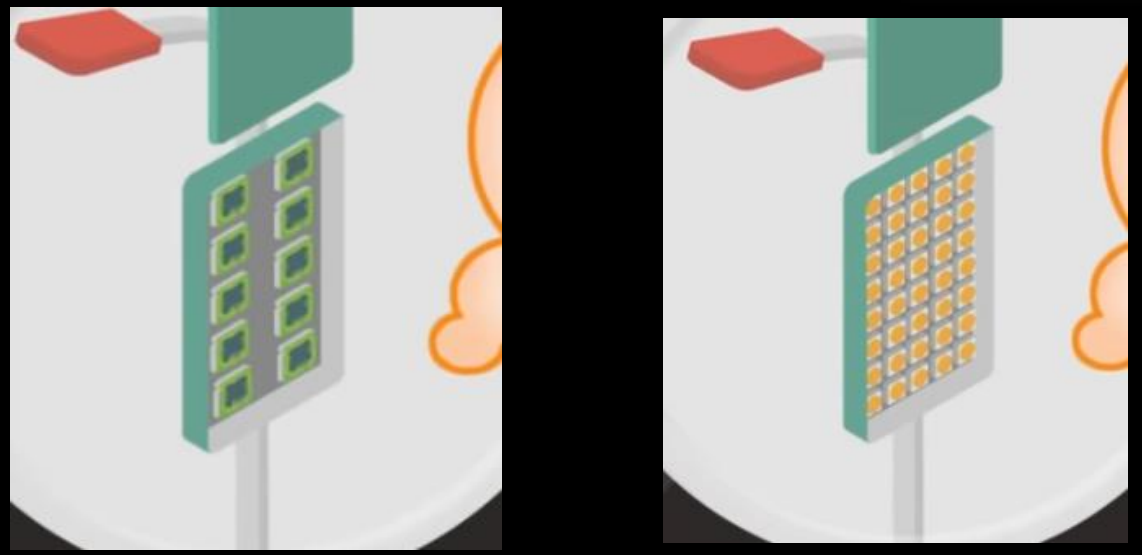
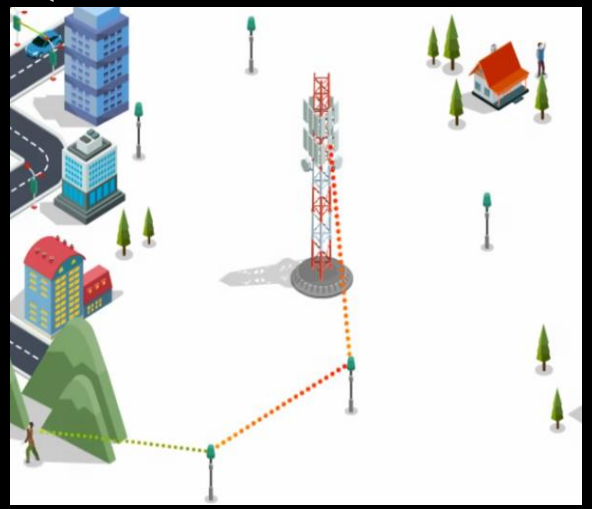


Fig 2 : Massive MIMO





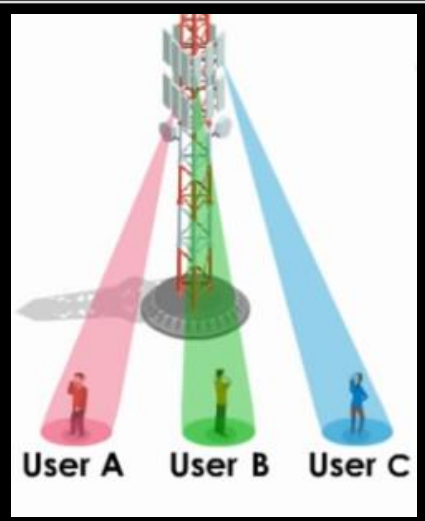


Fig 3 : Small Cell and Beam Forming

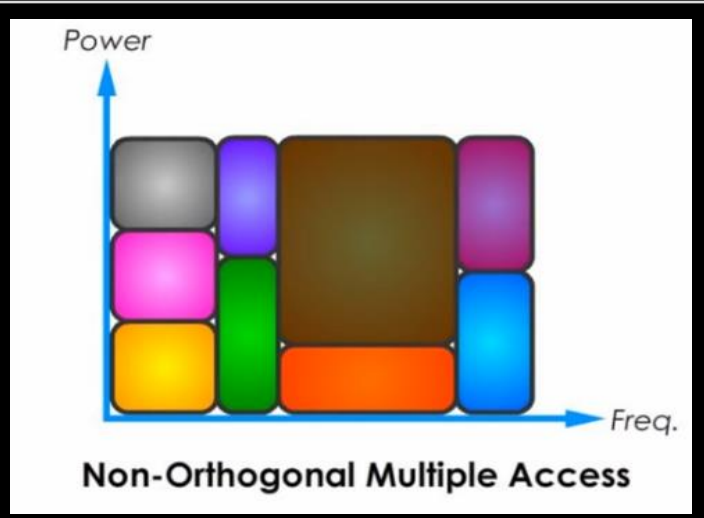


Fig 4 : NOMA

5G to 6G Transformation Needed??

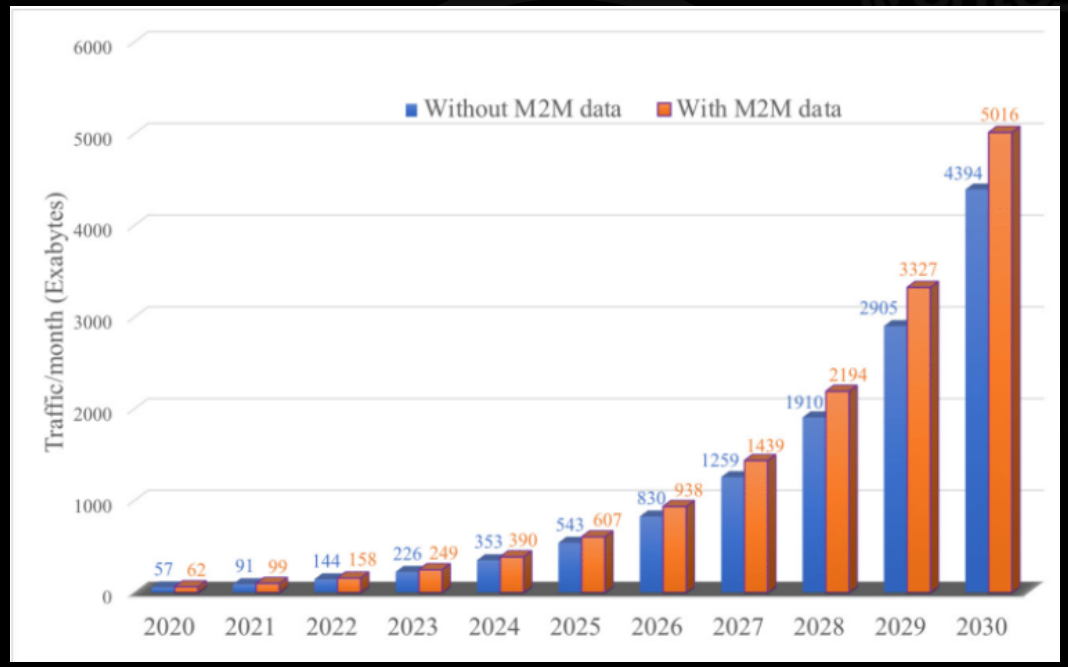


Fig 5 : ITU Global Mobile Data Traffic Prediction [1]

- ❑ Increased Smart Device Density
- ❑ Ultra Low Latency Requirement

1 **Exabyte** (EB) = 10^{18}bytes

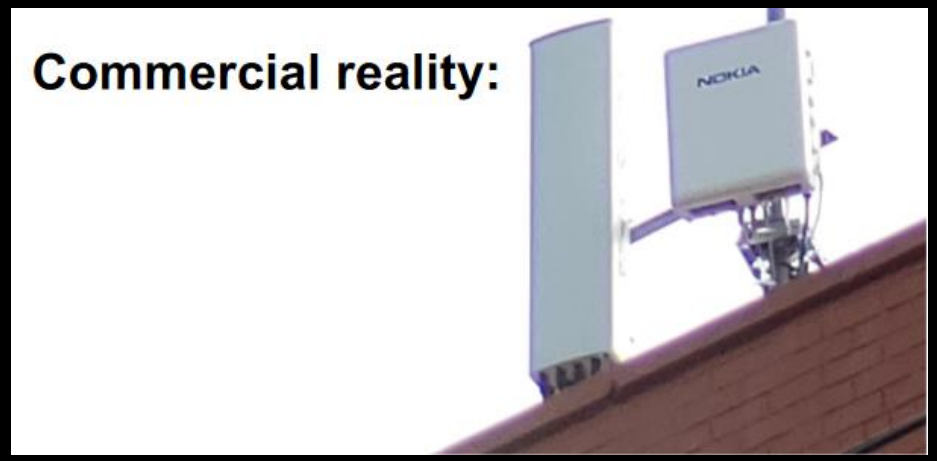
Characteristics	5G	6G
Operating frequency	3 - 300 GHz	upto 1 THz
Downlink data rate	20 Gbps	1 Tbps
Uplink data rate	10 Gbps	1 Tbps
Latency	0.5 msec	0.1 msec
Processing delay	100 ns	10 ns
Localization precision	10 cm on 2D	1 cm on 3D
Uniform user experience	50 Mbps 2D	10 Gbps 3D
AI integration	Partially	Fully

WHATS's Next ?

Massive MIMO in 2010

Considered as an unrealistic
" science fiction "

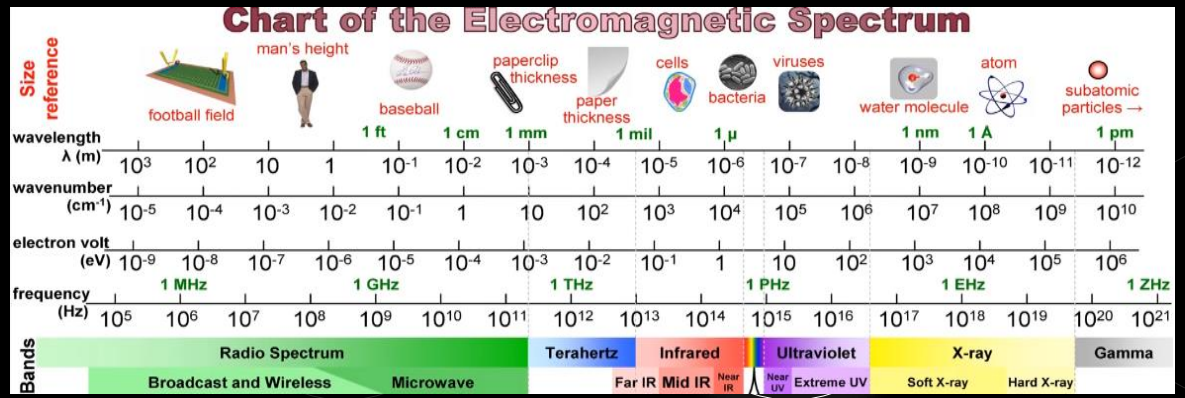
Massive MIMO in 2020



Which "**science fiction"** idea from 2020 will become reality in 2029 ?

Research Directions to 6G

1) Terahertz Band



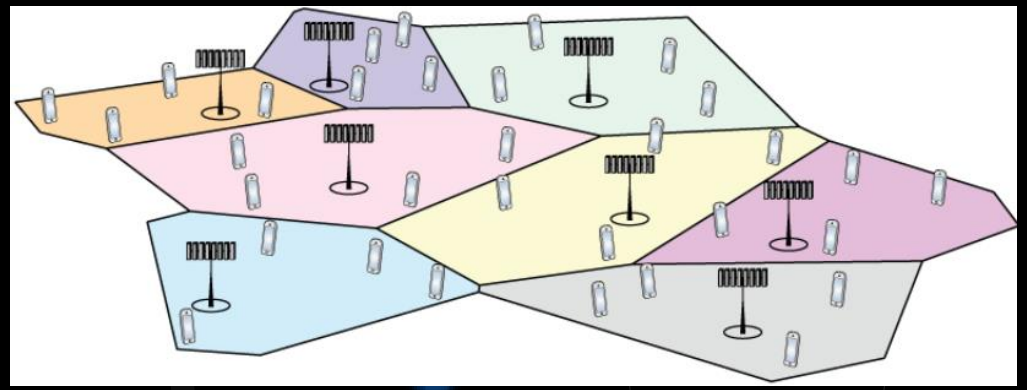
- ❑ Proposed Range is 0.1THz to 10THz
- ❑ More Bandwidth, Ultra High Data rate
- ❑ Up Conversion or Down Conversion
- ❑ Increased Attenuation
- ❑ "Optics is fast, Electronics is slow"

2) Cognitive Spectrum Use

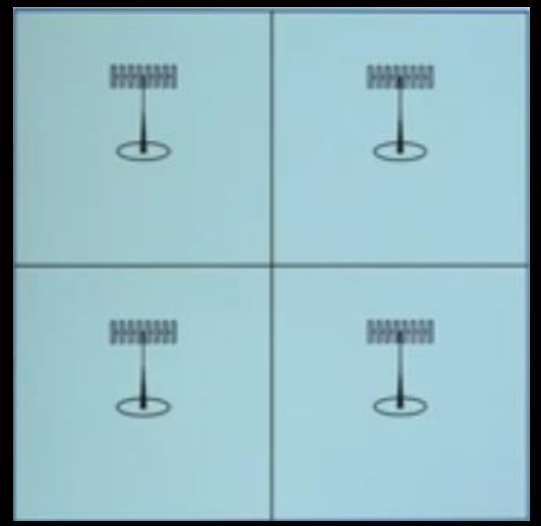
- ❑ Heterogeneous Communications
- ❑ Spectrum Shared between Operators
- ❑ Increased Spectrum Reusability
- ❑ SDR Techniques

3) Cell-free / Distributed Serial Massive MIMO Networks

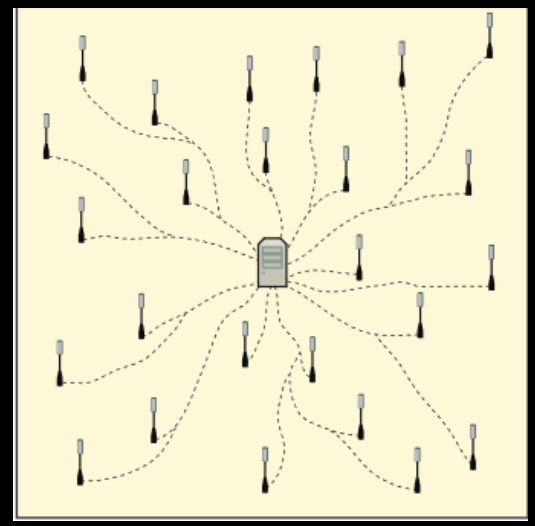
- Massive number of distributed antennas
- M antennas >> K users
- Connection to Cloud RAN
- Alternatively known as Radio Stripes
- Reinforcing the Radiations
- Coherent Reception and Transmission
- Increased Cable Length and Complexity
- Not Scalable



Centralized MIMO



Distributed MIMO



Cooperation Clustering

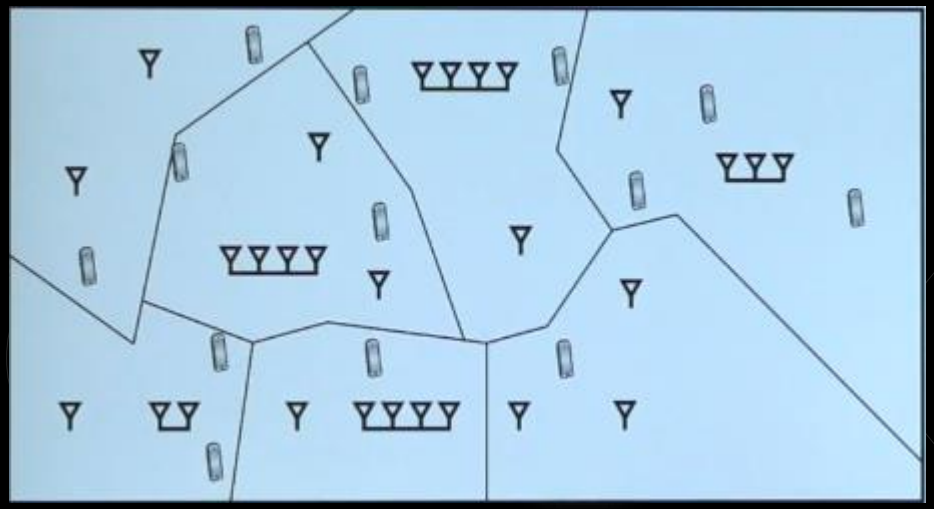


Fig 7 : Network-centric clustering

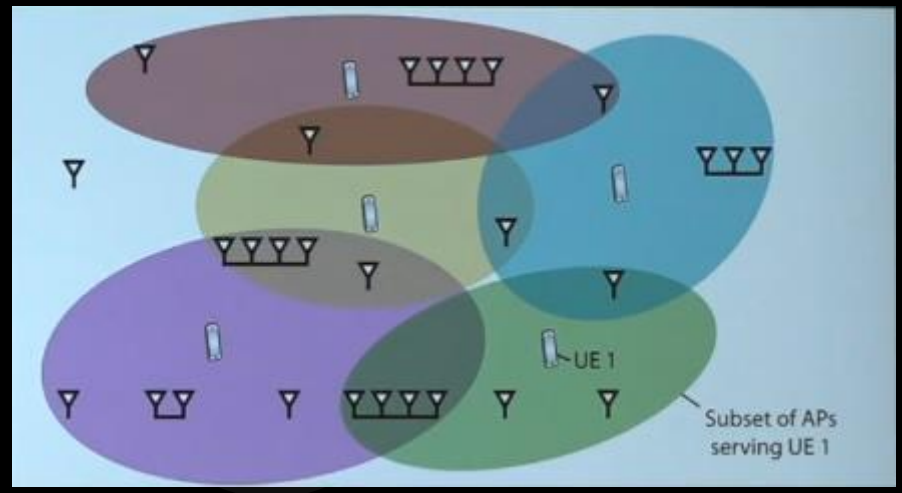


Fig 8 : User-centric clustering

Radio Stripes – Increased Device Density

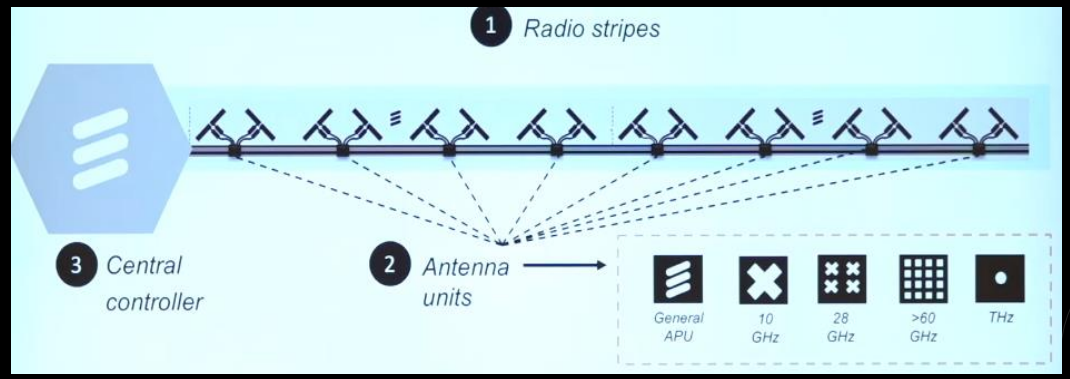


Fig 10 : Electronic Print View of a Radio Stripes

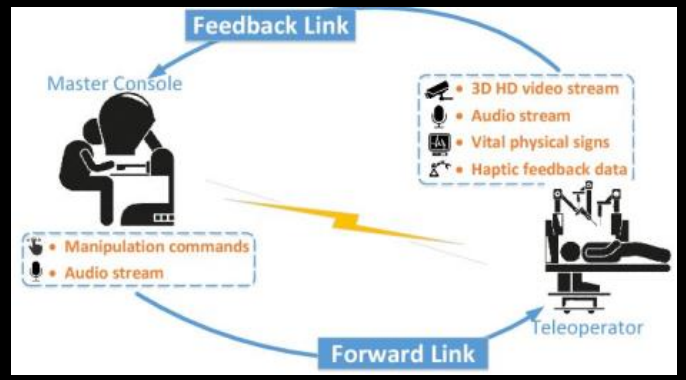
- Invisible Installation , Scalable , Cost Effective
- Passive Cables with Antenna Embedded
- Each Antenna at 3.5GHz band and can be increased by adding more dual polarized elements at Antenna Processing Unit(APU)
- Concept of SOC for APU's has been implanted from mobile chipsets.

Fig 9 : Implementation in a Stadium

Fig 10 : Implementation in a Cultural Place

Expected Emerging 6G Applications

E-Health

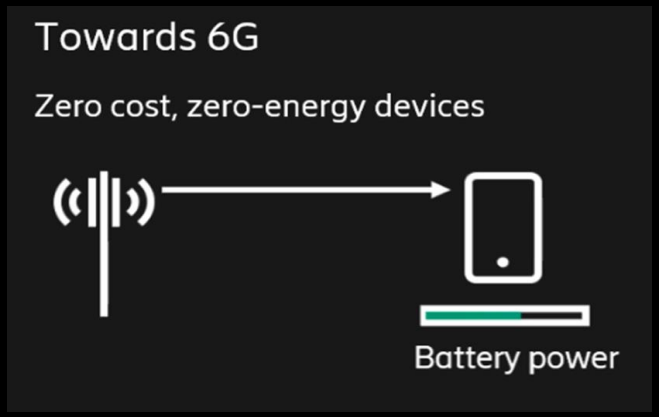


- Existence of Remote Surgery
- Automation and also the THz band allows for the development of nanosized devices to operate

Industry 4.0

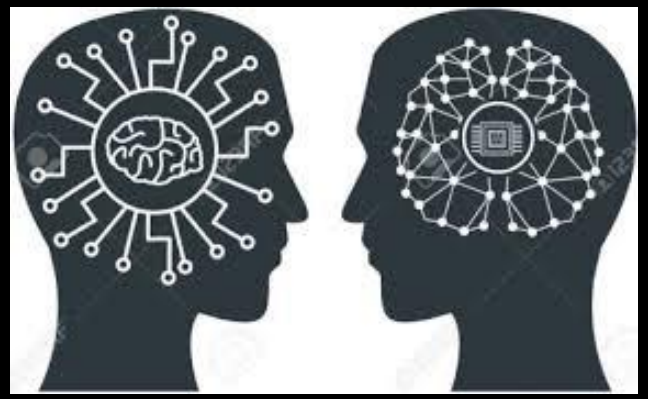
- Digital Technologies to Physical Industry
- Mm accurate control systems required
- Edge Cloud Architecture

WIET Technology



- Increased Power Consumption
- The base stations in 6G to transfer power as Wireless Information and Energy Transfer

Wireless BCI Applications



- Brain Computer Interface
- Analyzing and Translating Brain Signals
- 6G will support more applications such as the five sense information transfer

Multisensory XR

- A truly immersive AR/MR/VR experience requires a joint design integrating not only engineering (wireless, computing, storage) requirements but also perceptual requirements stemming from human senses, cognition, and physiology

CRAS

- Connected Robotics and Automatic Systems
- Need for eMBB transmissions of HD maps
- Stringent Requirements across the rate-reliability-latency spectrum

6G : Open Problems and Challenges

- Compatibility with the Terahertz Band
- Device Capabilities
- Network Security
- Increased Radiation Health Hazards
- Transceiver and Antenna Design
- Increased Reliability and Connecting Everything
- Development of Improved mm Efficient Control Systems
- Need of protocols that can learn and adapt to the environment.

CONCLUSION

5G Telecommunication Technology that launched in 2019 will not fulfil the increasingly growing demands in 2030. Therefore researches in 6G should be conducted to be able to reach its goals by 2030. In this seminar, new features in 6G and the possible applications and technologies that will be deployed in 6G are provided .

5G will Enable

But

6G will make it Happen!

REFERENCES

[1] Samar Elmeadawy1 and Raed M. Shubair , "6G Wireless Communications: Future Technologies and Research Challenges" 2019 International Conference (ICECTA)

[2] Harish Viswanathan , Preben E. MOGENSEN ,"Communications In The 6G Era ", 2019 IEEE International Conference on Industrial Internet (ICII)

- https://www.6gsummit.com/

THANK YOU