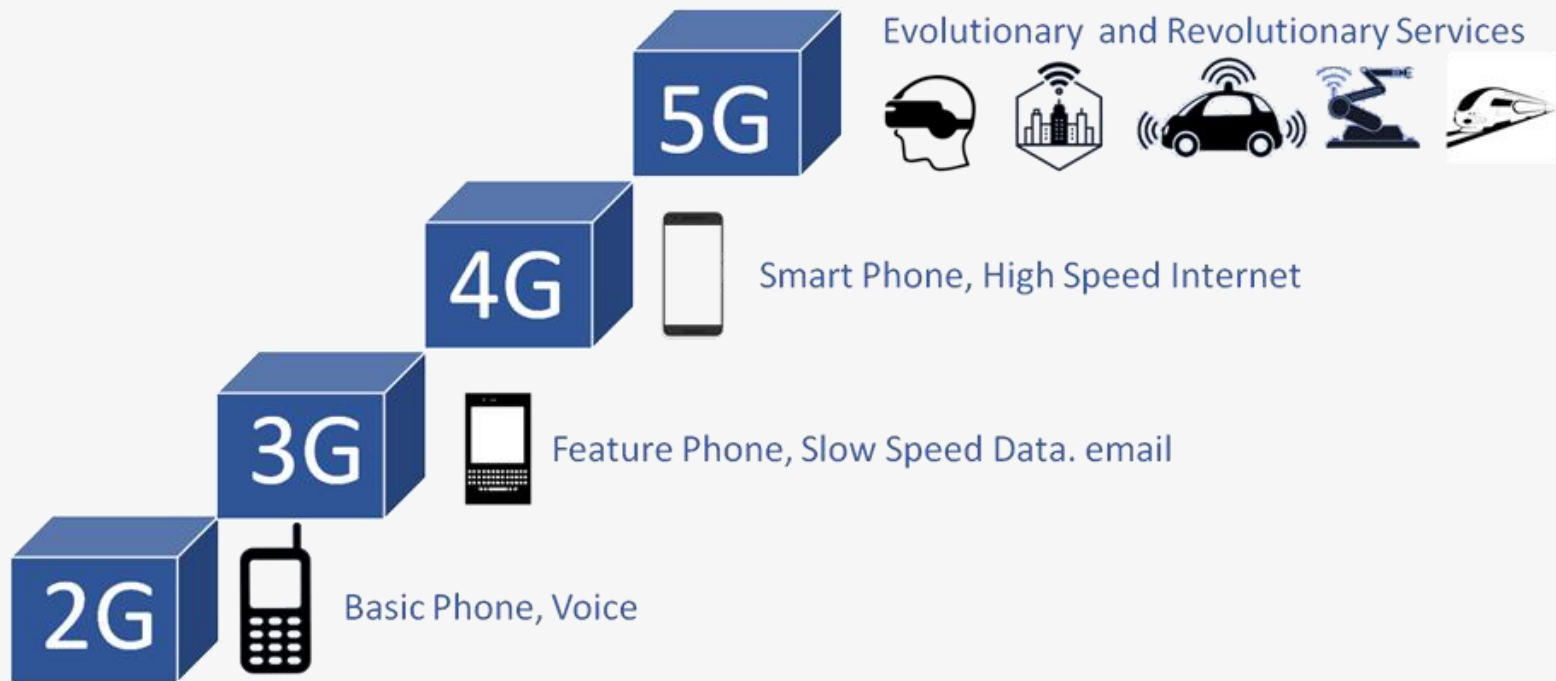




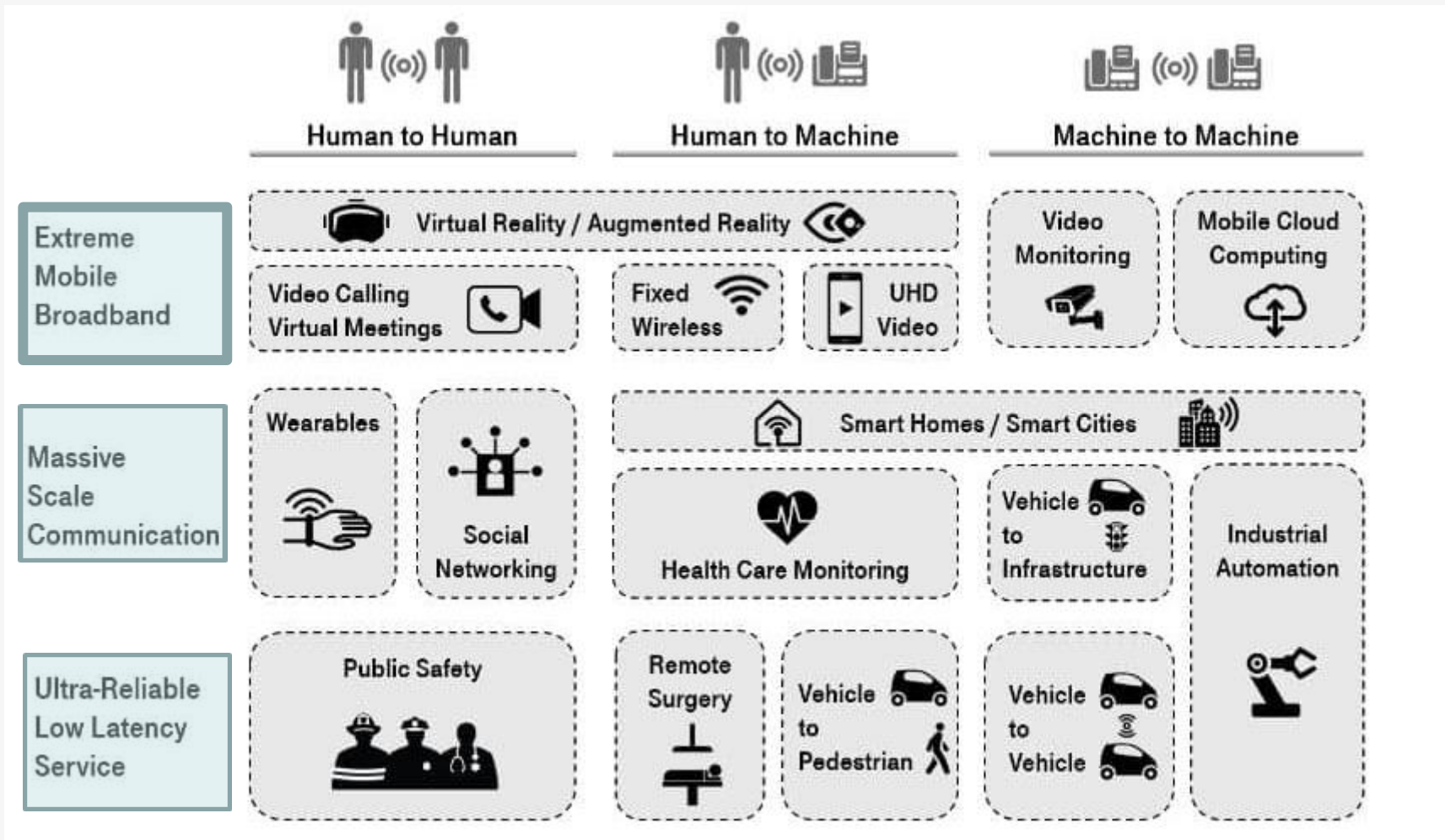
# The Promise of 5G

Arogyaswami Paulraj  
Stanford University

# More than an Another G



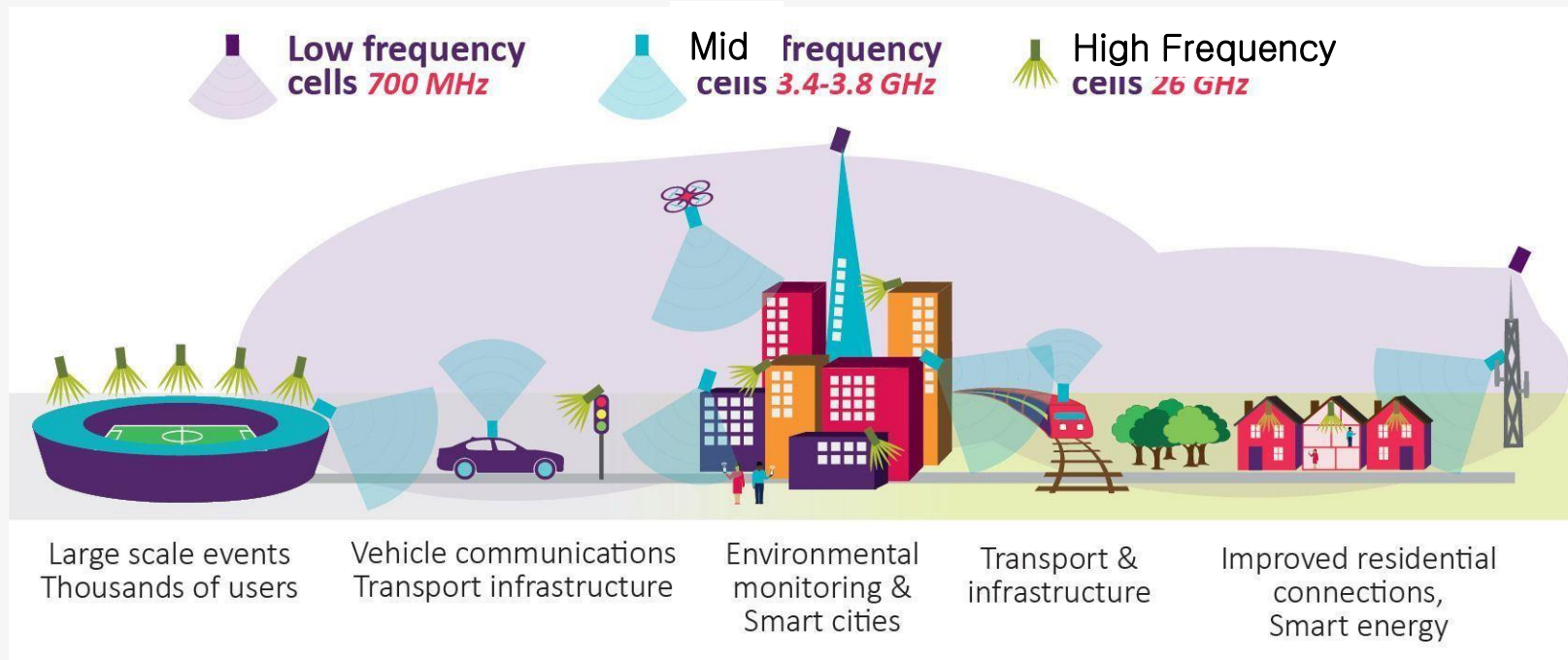
# 5G - Transformational Fabric



# Vision of 5G

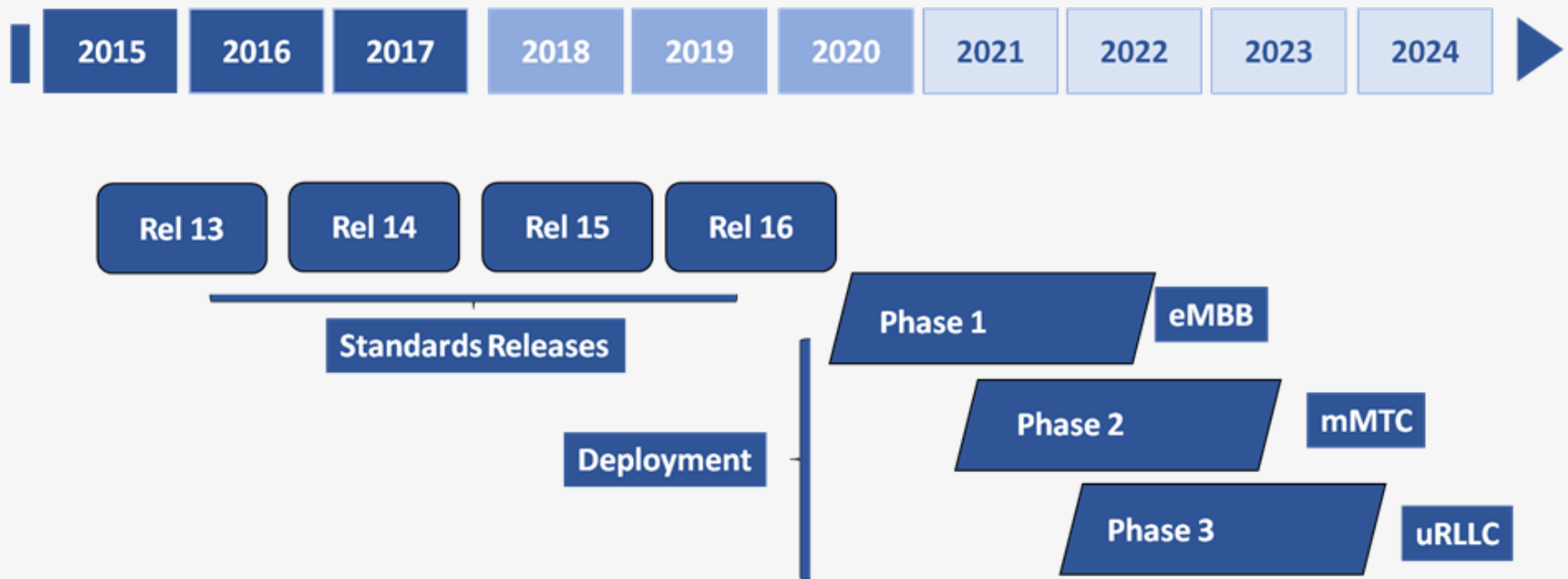
- NGMN - 5G is an **end-to-end ecosystem** to enable a **fully mobile and connected society**. It empowers **value creation** through **existing and emerging use cases** delivered with **consistent experience** and enabled by **sustainable business models**.
- DOT 2018 Report - 5G technology has the potential for **ushering a major societal transformation in India** ..... India must **embrace this opportunity by deploying 5G networks early, efficiently, and pervasively**, ..... (and) to make it a **truly inclusive technology**.

# Frequency Bands



Cable Labs

# Standards and Deployments



## 5G Today - eMMB (Another G)

- Devices - Phones, MyFi, CPE
- Peak 2 Gbps evolving to 20 Gbps
- 20x lower cost/bit
- Mostly FR1 (mid band)



## Global Eco-System Status

- Deployment – 40 countries and 75 Carriers, 80 Million Subs. (70% in China)
- Infra Eqpt Suppliers – Huawei, ZTE, Nokia, Ericsson, Samsung,..
- Semiconductors – Qualcomm, Huawei, Samsung, Mediatek, ..
- Phones – LG, Samsung, Huawei, Xioami, ZTE, Moto, (Apple)



## 5G Global R&D

- Core Technology same as 4G (MIMO-OFDMA)
- Development start ~ 2004
- 120,000 R&D engineers
- 10 B \$ / year investment
- About 100 M \$ / year on standards development (3GPP,...)
- Intellectual Property Owners – Huawei, Qualcomm, Samsung, ZTE,..

## Summary

- Full maturity in 5 years
- Transformational potential
- Perhaps only 1% of eventual 5G applications are now visible
- Leap frog opportunity for India, we should seize it

