

**Suggestions by Prof. Huzur Saran, IIT DELHI**

## Status of 5G in Advanced Countries

- South Korea, China, and the United States are the countries that lead the world in building and deploying 5G technology.
- All major phone vendors now offer 5G phones though many are limited to sub 6Ghz bands due to cost considerations. All major communication chip vendors are able to provide 5G communication solutions. 5G base stations and core networks are now available from major OEM's internationally.
- In the US all three operators have commercially rolled out 5G. However coverage is still limited.
  - In <6 Ghz band some operators have rolled out using 2.6Ghz and 600Mhz bands with wider coverage top few hundred cities.
  - operators have rolled out MMWave 5G but coverage is limited to limited high density areas of major cities.
- Current deployments are Non-Stand Alone 5G networks which need to work in tandem with the 4G network and the focus is on Enhanced Mobile Broadband. Support for **Ultra reliable Low Latency** services and 5G advanced features such as **Network Slicing** are still in trial stages the technology still lacks maturity and vendor interoperability and so is far from commercial deployment.
- Wider coverage and advanced features may take time and vary from country to country some like Korea & China may be ready by late 2021 others in Europe may take till 2022.
- Current measured user speeds are in 500Mbps range in Korea and China while far less in Europe for example median 5G download speed in Belfast was 121.3Mbps and that its maximum 5G download speed in London was 146.4Mbps. In the US Average 5G download speeds are 50.9Mbps as of Aug 2020.

## Status of 5G in India

- Trials have begun
  - [Reliance Jio and Qualcomm have announced that they are in advanced testing for the project, and have already achieved over 1 Gbps speeds. Oct 21, 2020](#)
- Reliance Jio has announced its plans of bringing 5G to India at Qualcomm's 5G Summit. The telecom giant has partnered with Qualcomm to expand "efforts to develop open and interoperable interface compliant architecture based 5G solutions with a virtualized RAN. This work is intended to fast track the development and roll-out of indigenous 5G network infrastructure and services in India," the two companies said in a joint statement after the event.
- In response to a fresh Department of Telecommunications (DoT) demand for a set of "priority vendors" for [5G](#) trials, Jio has named Samsung, Nokia and Ericsson besides applying to trial its own technology. Bharti Airtel and Vodafone Idea have opted for Finland's Nokia and Sweden's Ericsson while BSNL plans to partner state-run Centre for Development of Telematics (C-DoT), said people with knowledge of the matter. Vodafone Idea will also conduct trials with US-based Mavenir.
- Formal Spectrum allocation for commercial rollout has not yet happened — May Happen in 2021.
  - Spectrum allocation for sub 6Ghz 5G in 3.5Ghz band i.e 3300 to 3400 MHz and 3425 to 3600 MHz
  - and in MMWave bands 26Ghz i.e 24.25-27.5 GHz band
- 5G Initial Commercial rollout may then happen by 2022.

## **Status of Next generation i.e. 5G++/6G**

- China officially stated a 6G initiative in 2019. In Europe and elsewhere 6G is still at an early research stage and no formal definitions have happened. Others talk in terms of 5G++ since the features in 5G are being rolled out in stages as per the various 3GPP release cycles.
- Release 16 was finalized early in 2020 and Release 17 which is currently being worked upon and standardisation is expected by mid 2021 will bring most 5G features. However further advanced which may be called 5G++ or 6G may be expected in stages in future releases to fix the limitation of early 5G technologies.
- In terms of pure research prior to any standardization efforts, different countries are investing in research on next generation technologies including terahertz waves for communication.

## Robotics & 5G Telematics in a post-pandemic world some points:

- Robots have traditionally been used for high precision higher end tasks and have normally very high requirements for precision and safety leading to high cost.
- While new robot tasks continue to emerge, well-established tasks such as welding and painting cars, assembling consumer electronics products and packaging consumer products will continue growing. There also are still tasks robots could be doing such as picking and packing that aren't being done at scale yet.
- In post-pandemic scenario suddenly the use of robots for more mundane and widely used tasks
  - hospitals have deployed specialized robot nurses with remote patient monitoring tech so that doctors can keep an eye on people from afar.
  - On May 27 The University of Southern Denmark announced that its researchers have developed the world's first fully automatic robot capable of carrying out throat swabs for COVID-19. The equipment uses a 3D-printed disposable arm that is automatically swapped after each patient.
  - Others are investigation using robotic arms for remotely doing tasks such as patient ultrasound, x-rays without direct human contact with patients.
  - robot cleaners that use UV-based tools to destroy bacteria and viruses.

- In retail, we're now seeing robots counting inventory, cleaning floors, delivering groceries and fast food which use self-driving cars and drones have evoked much interest.
  - positive change in perception around these autonomous tools in customer facing scenarios is pushing wider adoption
  - Improved enabling technologies such as machine vision, machine learning, cloud computing and other automation are opening new opportunities for robots.
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- collaborative robotics (cobots) — where robots and humans collaborate to complete tasks whether in factories or in other situations is emerging as an important area. The robots are fully autonomous, safely operating alongside and collaborating with workers to maximise productivity. Deployed as a multi-bot fleet, AMRs like the LocusBot, mean that more work can get done at a faster pace without adding more labour or disrupting existing operations.
  - Robot-to-Robot and Human-to-Robot communication and interfaces becomes extremely important in such scenarios
  - The communication links need to be high reliability and low latency to ensure minimal control loop delays.
  - Due to prevalence of Agile Autonomous Machines wireless communication is necessary and 5G and emerging 6G technologies which provide Ultra-reliable-low-latency-communication are a must.

- who else needs ultra-low latency? Autonomous vehicles. Factory robots. Also virtual reality, Augmented reality, piloting drones.
- 5G and newest mmwave technologies are being examined for long range autonomy and also to improve localization, perception and consensus behavior for a swarm of aerial vehicles.
- co-operating swarms of drones are being investigated for covering large areas such as in precision agricultural applications for inspecting crops, fruit orchards etc and even perform activities such as spraying, pruning, and harvesting. A company called FFRobotics has developed what it calls a fresh fruit robotics harvester that combines robotic controls with image processing software algorithms that allow it to find and distinguish between saleable and damaged produce as well as between fruit that is either not yet ripe or dead.
- Human-Robot interface design is a challenge — humans operate at a higher semantic level and mapping instructions received from humans to the more detailed guidance needed by robots requires higher levels of computation intelligence capabilities to embedded in the robots
- As with changing consumer habits after the current crisis ends — the present situation could spur significant robot adoption down the line. Many companies that previously hadn't considered using robots at all are now using them in regular operations. In the future, the success of these pilot programs is likely to have a big impact.

- while robotics designers aren't building robots to replace workers, the efficiency that robots create could lower labor demand in aggregate. Some economists are hopeful that the growth these robots produce will lead to the creation of new jobs, like robot technicians, that make up for the lost positions.
- good people and good techniques remain essential to business results. The people can quickly invent new processes for new problems that crop up, deal with exceptions, and make improvements. And the techniques — combinations of work processes and technology automation — offer improved reliability and capability, allowing managers to reallocate people to more complex work.
- At Bosch Rexroth in Bavaria, Germany, wheeled robots that zoom between manufacturing machines and robotic arms that help hoist and connect components come with an unusual new feature— 5G modems. The division sees 5G as a big future trend and has developed a modular production line where every piece of equipment—plus high-precision power tools—is connected via 5G.
- Coverage and adoption of 5G in public networks may take time. However Private stand alone 5G wireless network can guarantee coverage inside factory's/mines.
- Going forward 6G communication technology is a revolutionary technology that will be truly AI-driven and will enable Internet of Everything (IoE) which will also impact many technologies and applications and allow information from a vast array

of sensors to make decisions and perform functions, presumably a lot more accurately, reliably, and faster than humans.

### Other References

- A number of countries have started analyzing this sector.
- Report from Canada
  - <https://robotics.utoronto.ca/covid-19-white-paper/>
- <https://thenextweb.com/neural/2020/10/30/ai-to-help-worlds-first-removal-of-space-debris/>
- News reports from Australia
  - <https://www.hospitalhealth.com.au/content/facility-admin/news/robotics-companies-help-with-covid-19-response--1267466167#axzz6d0mKBfOp>
- <https://www.miamiherald.com/news/coronavirus/article247000912.html>
- [https://www.fastcompany.com/90557694/these-fog-spraying-robots-kill-the-coronavirus?partner=rss&utm\\_campaign=rss+fastcompany&utm\\_content=rss&utm\\_medium=feed&utm\\_source=rss](https://www.fastcompany.com/90557694/these-fog-spraying-robots-kill-the-coronavirus?partner=rss&utm_campaign=rss+fastcompany&utm_content=rss&utm_medium=feed&utm_source=rss)
- <https://www.dailymail.co.uk/sciencetech/article-8800139/Amazon-warehouses-robots-50-percent-injuries-without.html>
- Need to begin such analysis in India.

# Connected Robots

City Infrastructure



Automobiles



Home



Drones



## Cyber Attacks

Ukraine **power cut** 'was cyber-attack'

Mirai botnet: How CCTV cameras almost **brought down the internet**



Hackers remotely **kill a Jeep** on the highway

'I'm in your **baby's room**':  
A hacker took over a baby monitor

# Notorious Example



ANDY GREENBERG SECURITY 07.21.15 06:00 AM

## Hackers Remotely Kill a Jeep on the Highway—With Me in It

can target Jeep Cherokees and give the attacker wireless control, via [the Internet](#) to any of thousands of vehicles. Their code is an automaker's nightmare: software that lets hackers send commands through the Jeep's [entertainment system](#) to its dashboard functions, steering, brakes, and transmission, all from a laptop that may be across the country.

<https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/>

# New Security Issues

- Battery-operated energy-constrained devices
  - Traditional concerns about confidentiality, integrity, authentication, access-control
  - Trade-off between strong security measures and service life
- Real-time intelligent control
  - Disruptions through DDoS attacks
  - Intelligent reconfigurable radios can be exploited to disrupt availability
- Satellite networks<sup>1</sup>: Dependency for navigational systems<sup>2</sup>
  - Vulnerable to spoofing attacks
- Usage of ML/AI
  - Adversarial machine learning<sup>3</sup>

<sup>1</sup><https://www.en24news.com/2020/11/china-places-first-6g-satellite-in-orbit.html>

<sup>2</sup><https://www.mcafee.com/blogs/consumer/what-is-gps-spoofing/>

<sup>3</sup><https://bdtechtalks.com/2020/10/26/adversarial-machine-learning-threat-matrix/>

# New Privacy Issues

- Large volumes of data
  - Smart healthcare
  - Wearables
  - Industrial IoT
- Right to Privacy
  - EU has set a benchmark with General Data Protection Regulation
- Very challenging for developers to satisfy the regulation

# Countermeasures

- Mature directions
  - Security as a service for handling the complex security landscape<sup>1</sup>
  - Device and RF fingerprinting<sup>2</sup>
  - Blockchain
- Potential Directions
  - Quantum cryptography<sup>3</sup>
  - Physical-layer security<sup>4</sup>

<sup>1</sup><https://cybersecurity.att.com/solutions/security-as-a-service>

<sup>2</sup><https://www.cisco.com/c/en/us/solutions/security/medical-nac/index.html#~whats-inside>

<sup>3</sup><https://cloudblogs.microsoft.com/quantum/2020/02/26/cryptography-quantum-computers/>

<sup>4</sup><https://www.nano-di.com/blog/2019-implementing-physical-layer-security-in-iot-devices-using-additive-manufacturing>