Recent Developments and Enhancements in IoT at 5G Technology in the Field of Medical Studies

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18 April 2019

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INTRODUCTION

This talk aims to

- highlight the role of 5G in enhancing efficient education in medical sciences that requires big data analysis in terms of convergence, connectivity, and energy consumption.
- investigate and identify how these emerging technologies of IoT in 5G will be integrated on education sciences like medicine.
- present how learners will get quality education through improvements in digital imaging, decision on diagnostics, and knowledge to treatment.

INTRODUCTION

IoT and 5G

- Since past three decades, use of computers and network-based devices have increased rapidly, especially in last decade, growing popularity and developments on portable devices and mobile communications, many large, confidential and interesting collections of materials are available electronically.

- It is expected to have around 25 to 50 billion devices to be online by 2020.

- IoT is defined as combination of embedded technologies such as wired and wireless communications, sensors, and the physical objects connected to the Internet
  - In IoT things talk to other things. People and machines can give inanimate things instructions on what to do.
  - Wireless sensor networks (WSNs), intelligent sensing, remote sensing, radio frequency identification (RFID), near field communications (NFC), low-energy wireless communications, and cloud computing.

- 5G is apprehended to create a “Networked Society”, providing an unlimited access to information and data at anytime, anywhere by anyone and anything.
  - major improvements and developments are required to create in latency, energy efficiency, accuracy of terminal location, reliability and availability fields, as well as flexibility to accommodate future applications.

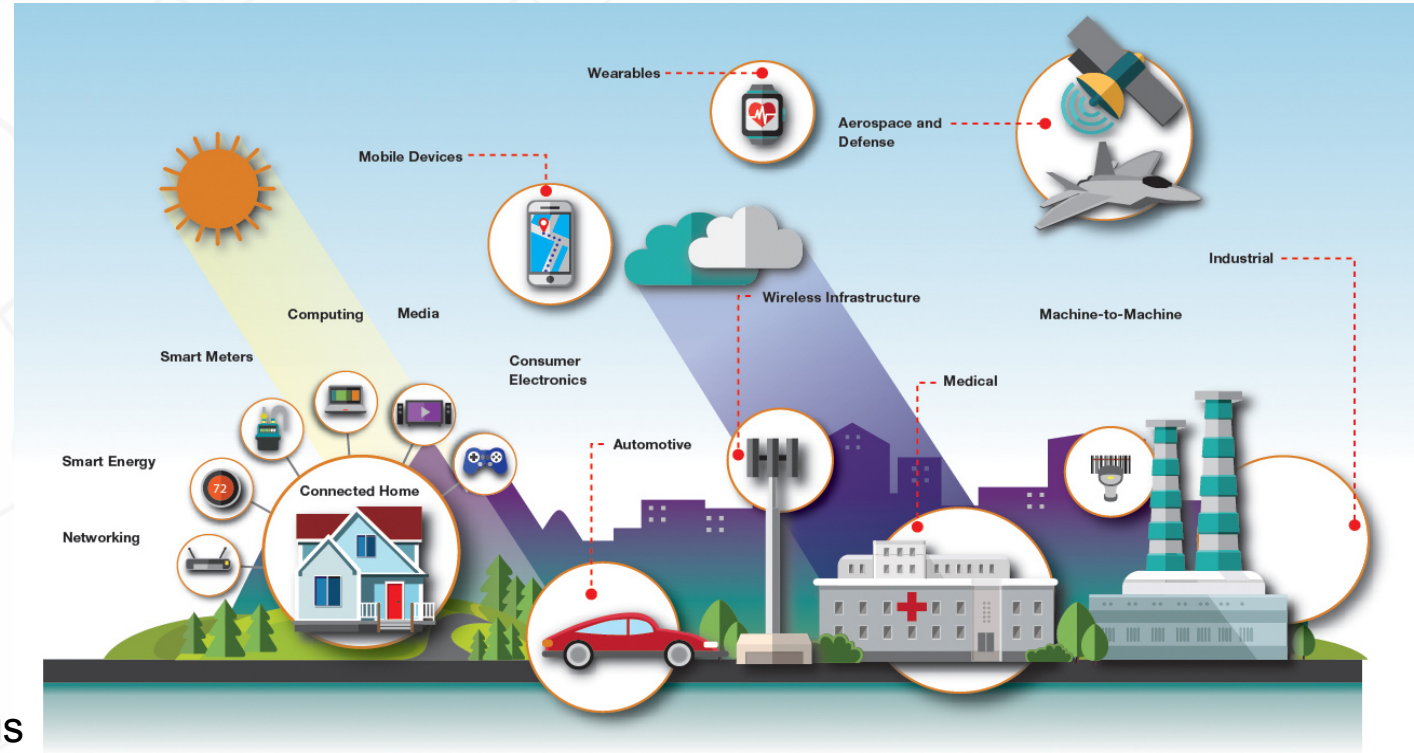
INTRODUCTION

EDUCATION-TECHNOLOGY

- The relationship between education and technology is as long and complex interference.
- Since 1990s, face of the higher education has improved and number of attending learners to any higher education institute has been increased drastically
  - teaching and learning in higher education have been improved in order to plan effective learning situations
- The new developments for communication technologies, new ways and methods for educators are created to communicate with learners.
  - Blended learning approaches have been emerged. This adopts use of virtual learning environments (VLEs) into traditional teaching mechanisms
  - Many rich digital resources more available to the learners beyond the physical limits of the classroom.
  - Approaches in mobile technology, and IoT changed education perspectives. Augmented Reality (AR) and Virtual Reality (VR) are already used in many applications such as gaming.
- Future learning model is stated as:
  - an environment that is international, immediate, virtual, and interactive. This new model will be considered as learner-centric, skill-centric, on-demand and personalised

RELATED WORKS: IoT and 5G

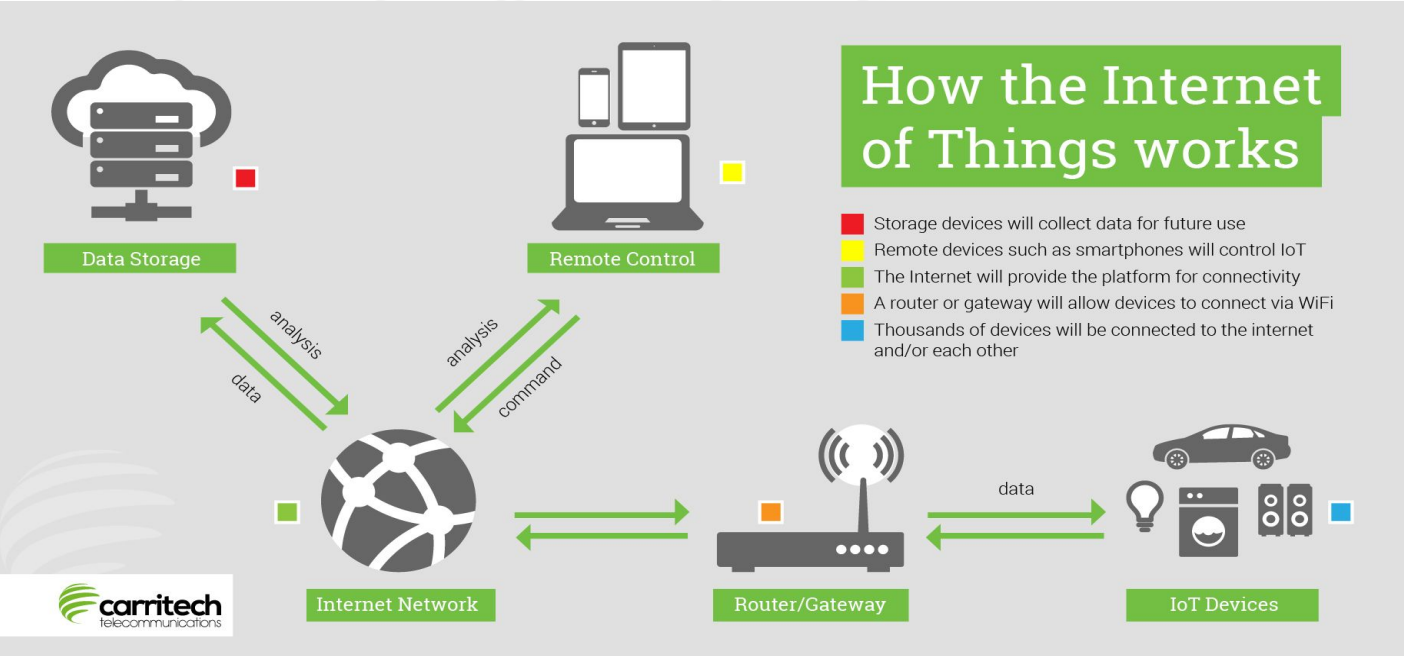
What is IoT?



- The Internet of Things
- The concept of connecting any device (so long as it has an on/off switch) to the Internet and to other connected devices.
- A giant network of connected things and people – all of which collect and share data about the way they are used and about the environment around them.
- It includes four main components named as sensors, processing networks, analysing data, and monitoring the system

RELATED WORKS: IoT and 5G

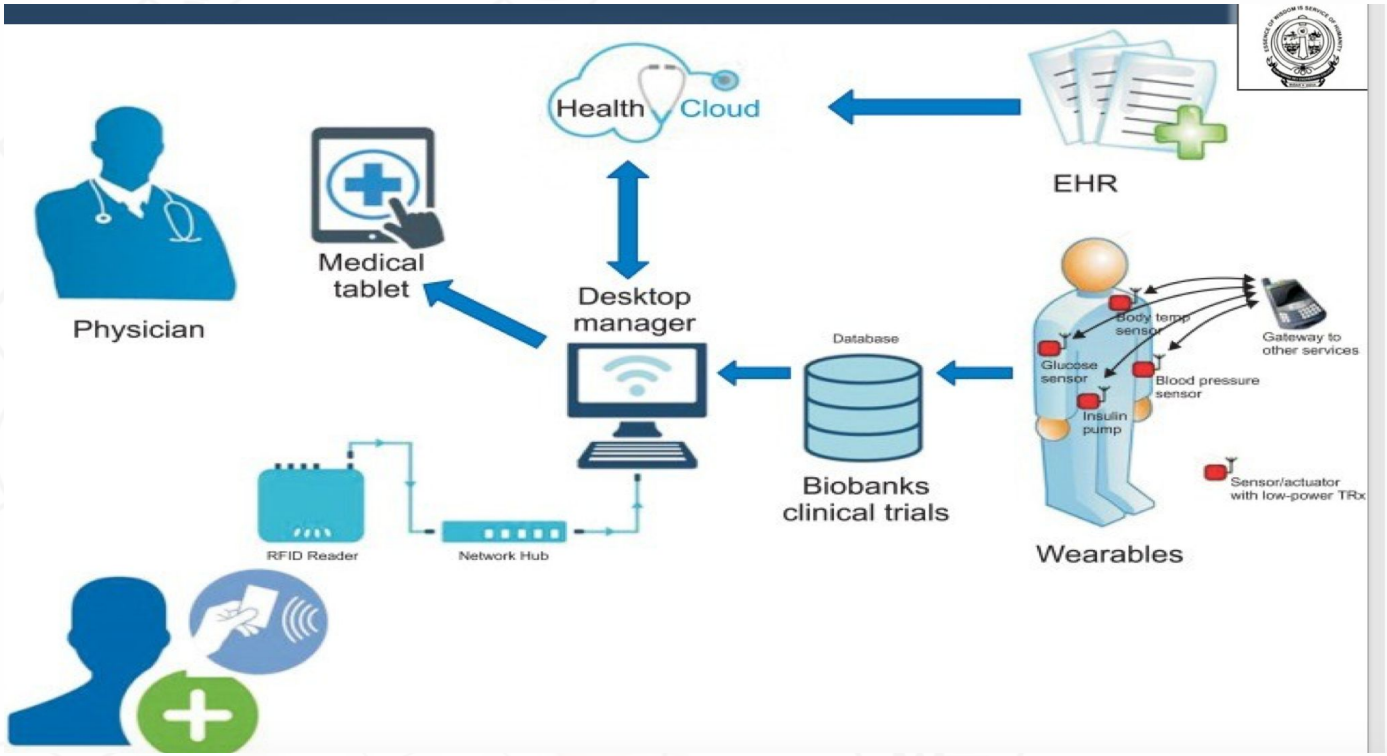
How does IoT work?



- An IoT system consists of sensors/devices which "talk" to the cloud through some kind of connectivity. Once the data gets to the cloud, software processes it and then might decide to perform an action, such as sending an alert or automatically adjusting the sensors/devices without the need for the user.
- But if the user input *is* needed or if the user simply wants to check in on the system, a user interface allows them to do so. Any adjustments or actions that the user makes are then sent in the opposite direction through the system: from the user interface, to the cloud, and back to the sensors/devices to make some kind of change.

RELATED WORKS: IoT and 5G

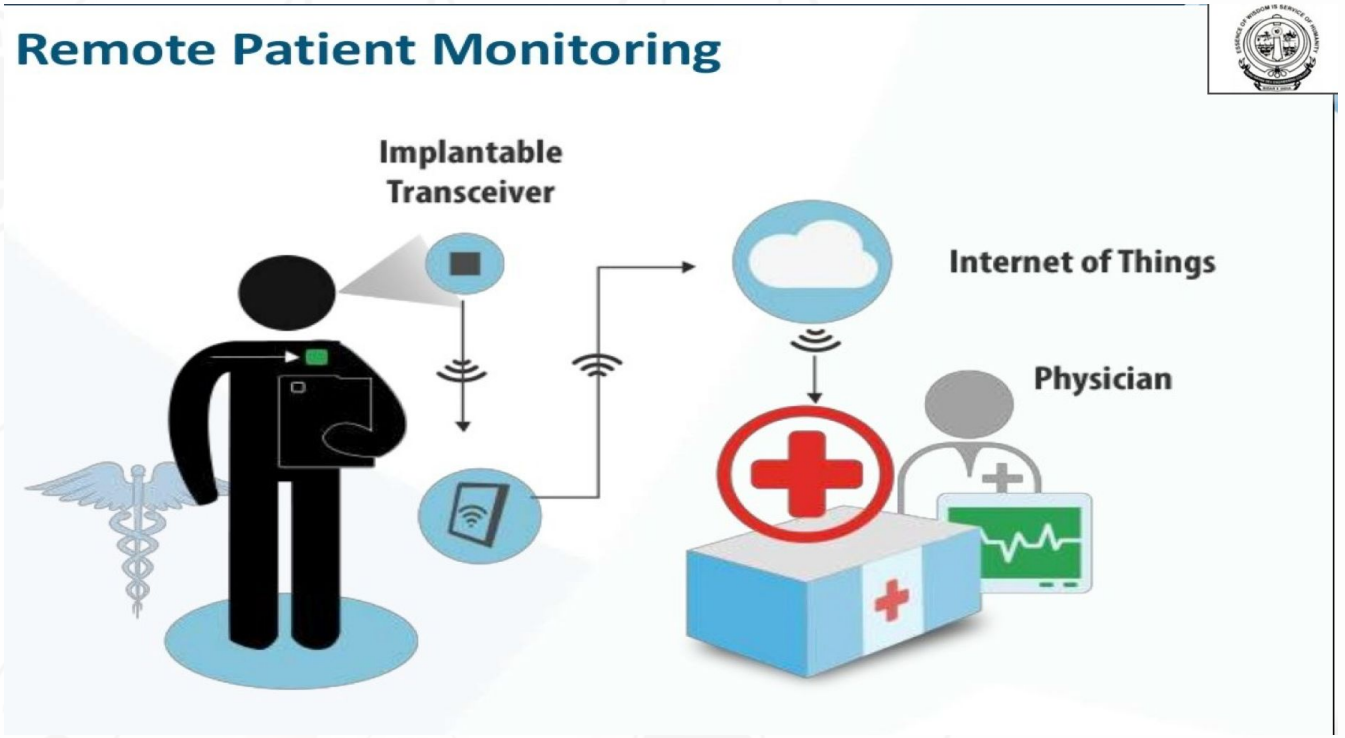
What is IoMT?



- The Internet of Medical Things
- The collection of medical devices and applications that connect to healthcare IT systems through online computer networks.
- Medical devices equipped with Wi-Fi allow the machine-to-machine communication.

RELATED WORKS: IoT and 5G

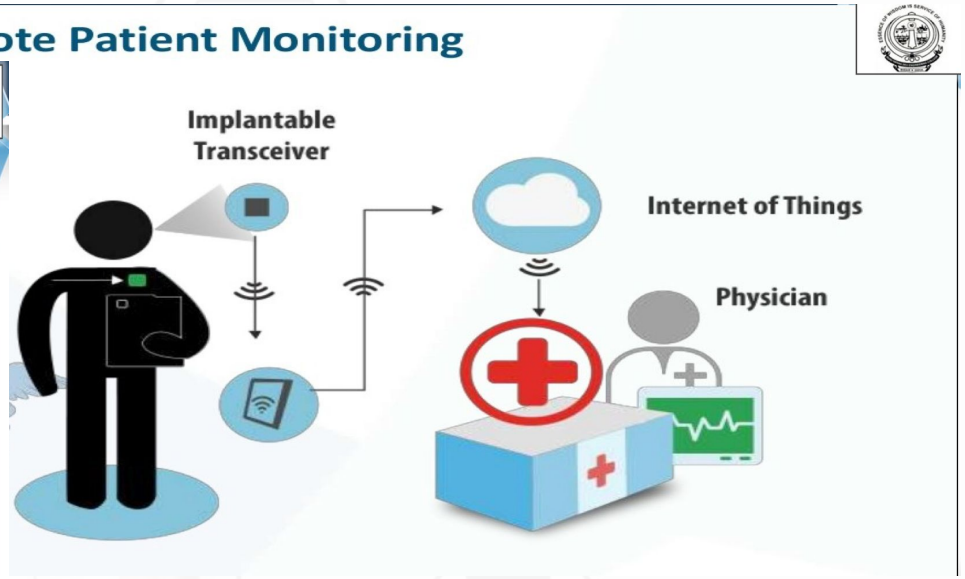
How does IoMT work? Applications of IoMT



- Remote patient monitoring **(RTM): Telemedicine:** A type of ambulatory healthcare that allows a patient to use a mobile medical device to perform a routine test and send the test data to a healthcare professional in real-time.

RELATED WORKS: IoT and 5G

How does IoMT work? Applications of IoMT

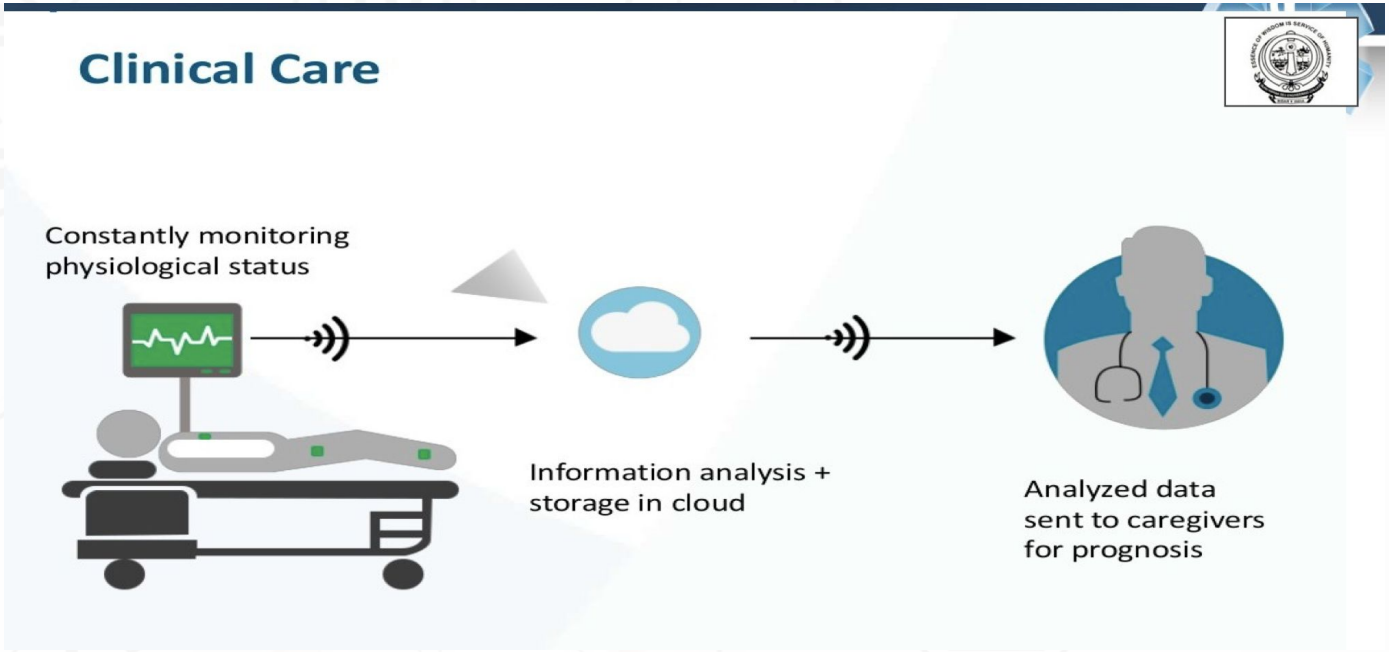


- People with chronic or long-term conditions; tracking patient medication orders and the location of patients admitted to hospitals; and patients' wearable mHealth devices, which can send information to caregivers.

- RPM technology includes daily monitoring devices such as glucose meters for patients with diabetes and heart or blood pressure monitors for patients receiving cardiac care. Data can be sent to a physician's office by using a special telehealth computer system, by using a special software application installed on the patients' smart devices.

RELATED WORKS: IoT and 5G

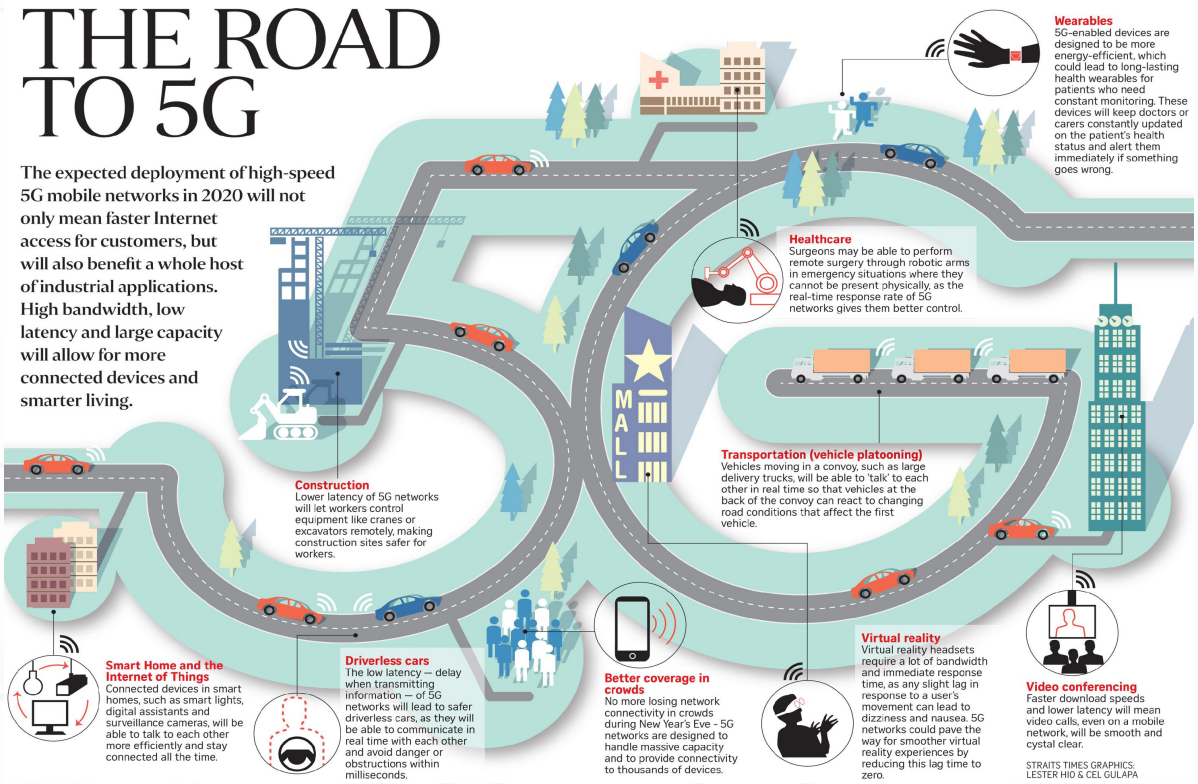
How does IoMT work? Applications of IoMT



- **Patient monitoring: Clinic care:** Infusion pumps that connect to analytics dashboards and hospital beds rigged with sensors that measure patients' vital signs are medical devices that can be converted to or deployed as IoMT technology.

RELATED WORKS: IoT and 5G

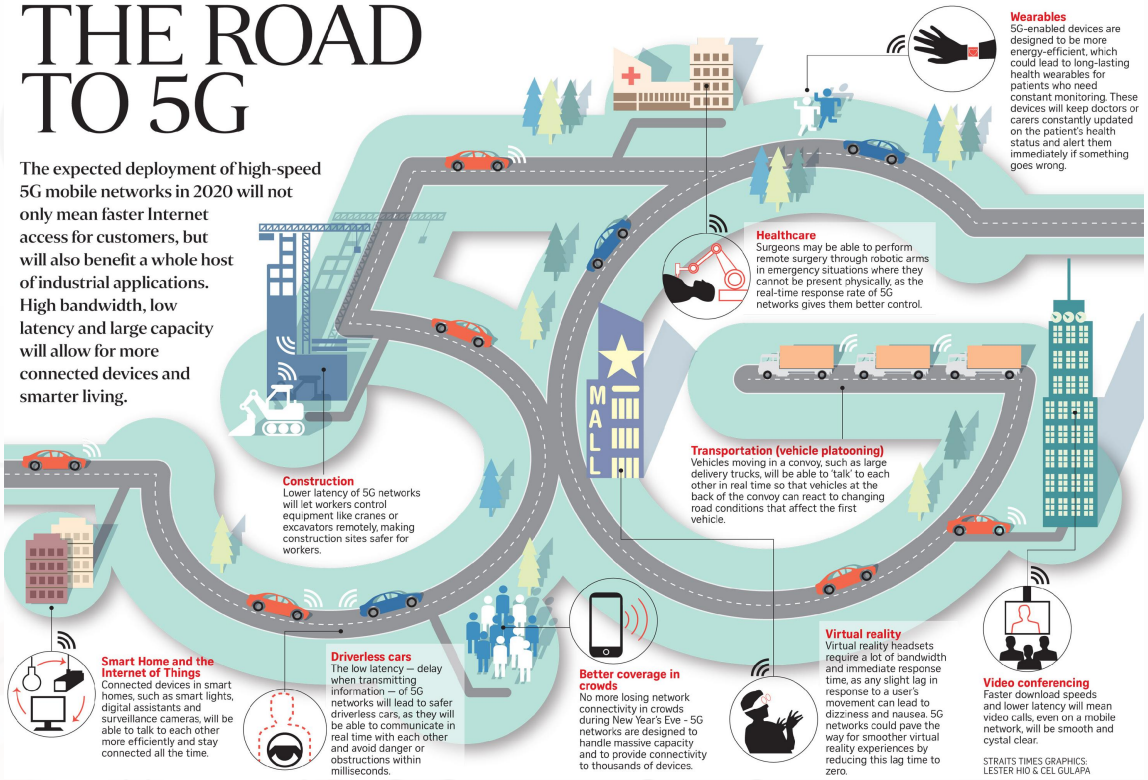
What is 5G?



- **5th Generation** mobile communication network
- Includes a heterogeneous network that integrates 4G, Wi-Fi, and other wireless access technologies.
- Cloud infrastructure, a virtualised network, intelligent edge services, and a distributed computing model (data generated by billions of devices) will be combined.

RELATED WORKS: IoT and 5G

What is 5G?



- It is an end-to-end system that senses data from billions of devices and moves those communication packets seamlessly, using the appropriate processing platform with fast and intelligent networks, back-end services, and extremely low latency.
- These qualities enable enhanced mobile broadband, machine-to-machine communications, artificial intelligence, and advanced digital services.

RELATED WORKS: VLE and Blended Learning

What is VLE?

- A **virtual learning environment** (**VLE**) in educational technology is a Web-based platform for the digital aspects of courses of study, usually within educational institutions.
- They present resources, activities and interactions within a course structure and provide for the different stages of assessment.
- VLEs also usually report on participation; and have some level of integration with other institutional systems.

- For teachers and instructors who edit them, VLEs may have a de facto role as authoring and design environments.
- VLEs have been adopted by almost all higher education institutions in the English-speaking world.
- VLE learning platforms commonly allow:
  - **Content management** – creation, storage, access to and use of learning resources
  - **Curriculum mapping and planning** – lesson planning, assessment and personalisation of the learning experience
  - **Learner engagement and administration** – managed access to learner information and resources and tracking of progress and achievement
  - **Communication and collaboration** – emails, notices, chat, wikis, blogs
  - **Real time communication** – live video conferencing or audio conferencing

RELATED WORKS: VLE and Blended Learning

What is BL?

- **Blended Learning (BL)** is an approach that seeks to combine traditional and online methods in a way that leverages the strengths of both and opportunities for interaction online with traditional place-based classroom methods.
  - It requires the physical presence of both teacher and student, with some elements of student control over time, place, path, or pace.
- Education researchers use the terms blended learning and blended instruction interchangeably.
  - Reasons for using BL methods include: improved pedagogy, easy access to knowledge, more interaction among learners, personal presence, cost effectiveness, and ease of revision of learning content.
- BL focuses on optimizing achievement of learning objectives by applying the "right" learning technologies to match the "right" personal learning style to transfer the "right" skills to the "right" person at the "right" time.
- **Diverse Blended Learning**, however, can be described as adopting different blended learning approaches that create different learning experiences for the learners and educators.

RELATED WORKS: VR and AR

What is VR?

- **Virtual reality (VR)** is an interactive computer-generated experience taking place within a simulated environment.
- Current VR technology most commonly uses virtual reality headsets or multi-projected environments, sometimes in combination with physical environments to generate realistic images, sounds and other sensations that simulate a user's physical presence in a virtual or imaginary environment.
  - It incorporates mainly auditory and visual feedback, but may also allow other types of sensory feedback.
  - This immersive environment can be similar to the real world or it can be fantastical.
- A person using virtual reality equipment is able to "look around" the artificial world, move around in it, and interact with virtual features or items.
  - The effect is commonly created by VR headsets consisting of a head-mounted display with a small screen in front of the eyes, but can also be created through specially designed rooms with multiple large screens.

RELATED WORKS: VR and AR

What is AR?

Augmented reality (AR) is a type of virtual reality technology that blends what the user sees in their real surroundings with digital content generated by computer software. The additional software-generated images with the virtual scene typically enhance how the real surroundings look in some way. AR systems layer virtual information over a camera live feed into a headset or smart-glasses or through a mobile device giving the user the ability to view three-dimensional images.

- **Augmented reality** is used to enhance natural environments or situations and offer perceptually enriched experiences. With the help of advanced AR technologies the information about the surrounding real world of the user becomes interactive and digitally manipulable.
- Information about the environment and its objects is overlaid on the real world. This information can be virtual or real, e.g. seeing other real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they actually are in space.

RELATED WORKS: VR and AR

Examples/Applications of AR

- Mobile game allowed users to view the world around them through their smartphone cameras while projecting game items, including onscreen icons, score, and ever-elusive Pokemon creatures, as overlays that made them seem as if those items were right in your real-life neighbourhood

- Google announced a new feature for its Maps mobile app, called the AR Visual Positioning System. It provides navigation via a layer of augmented reality, plastered over actual reality as seen through your phone's camera. To use it, you lift the phone in front of your eyes a the software gives you directions via arrows which show where you need to go.

- Need help visualizing new furniture in your living room? The IKEA Place app will provide an overlay of a new couch for that space before you buy it so that you can make sure it fits

RELATED WORKS: 5G, IoT in Education

- 5G, is envisaged to bring a “Networked Society”, providing an unlimited access to information and data at anytime, anywhere by anyone and anything.
- Recent developments in mobile access technologies have provided the possibility of having higher availability of the rich digital resources beyond the physical confines of the classroom.
- Advances in mobile technology, IoT and Tactile Internet, can open a new chapter in education.
- **Possible use cases related to Connected Education:**
  - Tactile Internet & Skillset communication
  - Virtual Reality & education
  - Augmented Reality & education
  - Walled-off classroom
  - Personalised learning
  - Student wireless backpack
  - Student with especial needs
  - IoT & Smart Classroom/Smart Campus

5G AND INTERNET OF MEDICAL THINGS FOR EDUCATION

5G in Education

- IoT communications are enabled by cellular, Wi-Fi and similar technologies and 5G is the network that will connect IoT.
  - It is expected that 5G will support IoT devices with different capabilities (long battery life, fast speed and reliable connectivity) and data usage.
  - enable new horizons for health care including digital imaging, decision on diagnostics, data analytics, and learning new treatments. It is called **Internet of Medical Things (IoMT)**
- Today, there are a number of health applications that require high bandwidth and reliable connectivity, and these applications are part of the emerging different 5G test cases and industries.
  - However, these test cases have not been yet considered for medical education field.

5G AND INTERNET OF MEDICAL THINGS FOR EDUCATION

Digital Imaging

- Advances in computing speed and networking, low latency, and high-frequency bands are offered in 5G communications.
  - Higher frequency bands (around 60,000 MHz) are considered to be implemented.
- Underlying idea is to explore real-life scenarios with products and industrial standards, as a new knowledge for learners.
  - High definition, even 3D images will be accessed remotely and rapidly in order to share information across globe, without any time delay and long distances.
  - Considering enhancements in biomedical and bioengineering fields, taken digital images such as X-rays or CT scans are in high definition. High-speed transmission of these images will be enabled patients and consultants to obtain second or third opinions quickly, as well as the learners will be able to easily access these as learning materials at anytime, anywhere for strengthen user engagement and improve the learning experience
- Learners and educators gain access to learning materials and experiments, as well as enables learning outcomes on expertise fields.
- Learners and educators in order to get access to high quality medical assistance, continuous refinement of research areas, and respective curriculum.

5G AND INTERNET OF MEDICAL THINGS FOR EDUCATION

Decision on Diagnostics

- WSNs are one of the emerging technologies of IoT developments. Especially, body sensor networks (BSNs) technology.
  - patients can be monitored and diagnosed using a collection of tiny-powered and light weight wireless sensor nodes.
  - Therefore, the use of these wearable medical devices will be an important advancement in diagnostics.
- To the learners for continuous refinement of knowledge:
  - devices, and mobile technologies, patients suffering from serious or chronic health issues those need to have careful, continuous and critical attention such as cardiovascular disease, diabetes or cancer, are remotely monitored, their vital signs are tracked.
  - Emerged technologies in 5G and the advances could particularly be relevant for the field of examples cancer genomics
- Considering the software-defined networks combined with intelligent systems providing clinical decision support, learners can access to the latest and newest information on diagnosis and treatment in the literature.
  - Rather than relying on traditional ways of information provided in the literature, these systems supply gigantic sources of information to provide up-to-date resource, therefore helping learners be more accurate and precise on learning experiences and exploitation of the information.

5G AND INTERNET OF MEDICAL THINGS FOR EDUCATION

Knowledge on Treatment

- Big health data, and data mining will grow rapidly as mobile network infrastructure becomes more powerful, healthcare learners will get the learning needed.
- Another way for enabling rapid learning is assessing data in real time.
- Learners can combine and resolve available information in new and original ways.
  - They will have chance of learning in real time, to use the collected knowledge to come to a decision on the most effective treatments.
- An analytics platform named as the Collaborative Cancer Cloud (CCC) is a good example that combines patient information from a variety of organisations/institutions by sharing patient genomic, digital images and clinical data securely for highly available lifesaving discoveries.
  - The CCC platform allows researchers/educators or practitioners/consultants to make distinguished queries about particular cancers and get detailed combined information on these individual types.

5G AND INTERNET OF MEDICAL THINGS FOR EDUCATION

Knowledge on Treatment (2)

- Big health data, and data mining will grow rapidly as mobile network infrastructure becomes more powerful, healthcare learners will get the learning needed.
- Another way for enabling rapid learning is assessing data in real time.
- It is stated that WSNs are key enablers of IoT because of their great sensing ability and ability to generate and process big data.
  - Wearable devices such as BSNs are another way for initiation of the personalisation of the learners' learning experiences since they send out real-time data and records for observation of the patients and different learning structures will be developed among the learners.
  - Surgeons (as educators) will be able to use emerged developed virtual tools for certain kinds of procedures, and learners will have a chance of distance learning and distance team-working in hands on experience with expensive equipments and facilities.

CONCLUSIONS AND FUTURE WORKS

In this study:

- Emerging technologies of IoT in 5G on education, especially medicine are investigated and identified.
- In order to provide better and higher quality education, higher education institutes have started to follow new and popular advances in information technologies, and use of blended learning approaches, for advancing learning and teaching.
- Generation Z use e-learning materials more effectively and efficiently revision tools than their textbooks and their own notes respectively.

- It is found out that 5G technologies will anticipate especially to mobile learning as it efficiently providing the educators with efficient learning scenarios and satisfies high priority learner requirements.

CONCLUSIONS AND FUTURE WORKS

The study may consider the following for future:

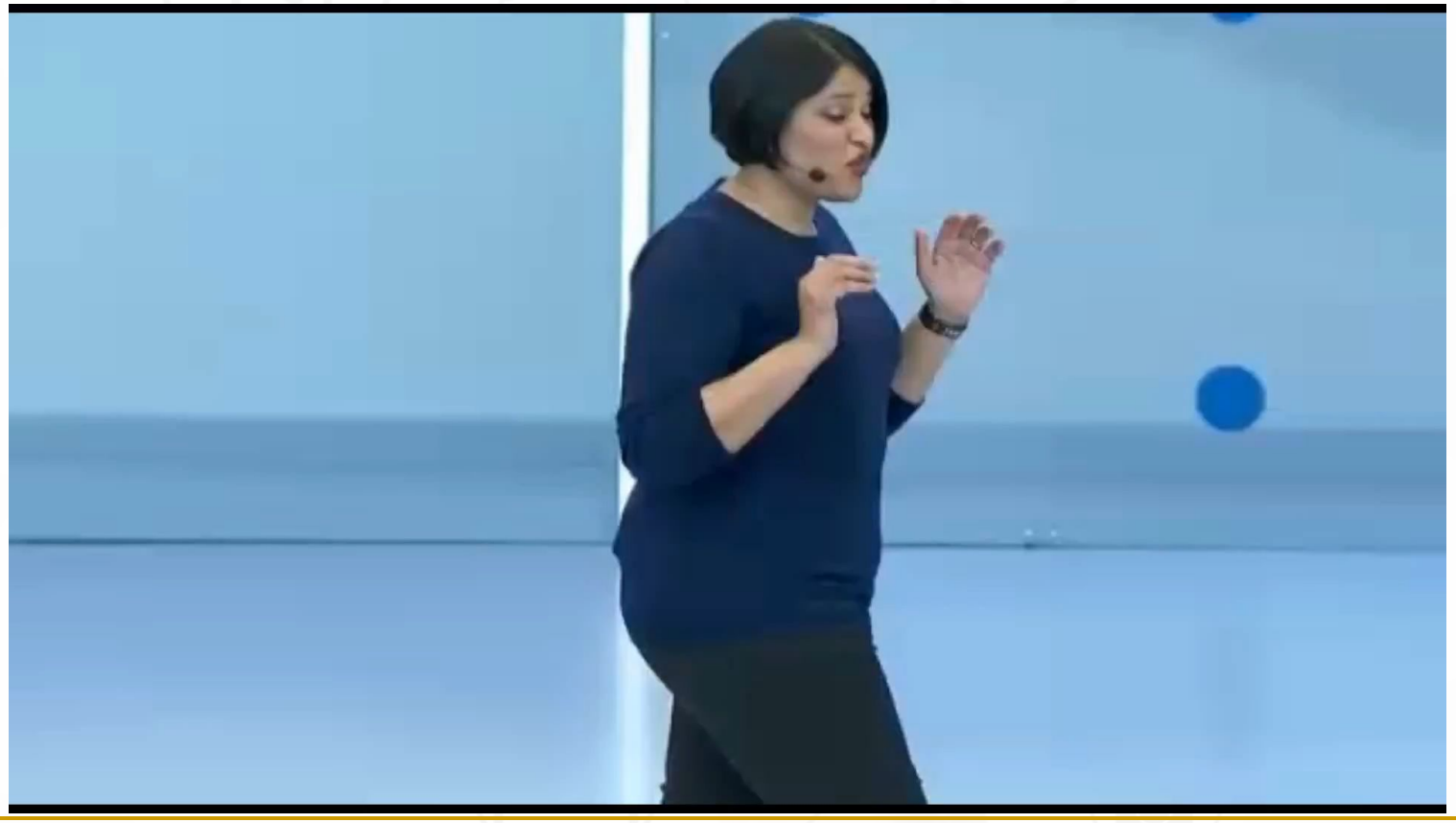
- Since emerging 5G technologies currently under design, testing and validation, it is important to find out the security and privacy aspects as well as the authentication mechanisms for efficient performance degradation.

THANK YOU

RELATED WORKS: VR and AR

Examples/Applications of AR

- Google announced a new feature for its Maps mobile app, called the AR Visual Positioning System. It provides navigation via a layer of augmented reality, plastered over actual reality as seen through your phone's camera. To use it, you lift the phone in front of your eyes a the software gives you directions via arrows which show where you need to go.



RELATED WORKS: 5G, IoT in Education

- **Possible use cases related to Connected Education:**
  - Tactile Internet & Skillset communication:
  - Virtual Reality & education
  - Augmented Reality & education
  - Walled-off classroom

Having a network capable of transferring our tactile communication through Internet will help us to move from today's content and information delivery Internet to a manual skillset delivery Internet. This will create new ways of Tele-teaching and Tele-mentoring especially for manual training and skill development. The use of Tactile **Internet (Extremely low latency in combination with high availability, reliability and security will define the character of the *Tactile Internet*.)** in education can bring new definition and experience for distance learning and distance team-working. In order to have a natural haptic interaction of our limbs with video and audio feedback the response time of service should be very low, i.e., the round trip time of few milliseconds which can be only envisaged by 5G.

While the initial use case for VR was the entertainment industry, it also has relevance in education and training, and will have a big role in providing quality education and improving understanding-based learning among students. By tailoring these services to education, (e.g. by, having virtual tours of the human body with the possibility of interacting with models and moving the different layers of the body), the learning process can be more fun and much more interesting. This also can bring new experiences for distance learning, enabling the virtual presence of students (e.g., located in suburban area) in the classroom. This type of service needs very high bandwidth (bi-directional) and very low latency (i.e., 2-4ms).

Similar to the VR, AR has already started to show its relevance and usefulness in education. Providing the necessary information can make contextualised learning ubiquitous and pervasive. AR can be an efficient way of providing the right amount of information at the right time to the right audience. Also, immersive AR can enable new ways of learning and team working in education through services such as mobile cloud classroom and Virtual Presence. Enhancing the learning experience is not the only possible use case for AR. It can also help teachers to get necessary information about each student and be aware of their particular needs and capabilities. The requirements for implementing such services, including optimised routing, seamless wide-area coverage, virtual presence, low delay speech & video coding, need to be considered.

By combining Tactile Internet and VR, the future experience in teaching and learning could go far beyond today's experience. This can remove the physical location constraint for experimental practices, and facilitate and enable the sharing of resources between larger numbers of students irrespective of their current location. The impact would be more significant in hands-on experience with expensive equipment and facilities.

RELATED WORKS: 5G, IoT in Education

- **Possible use cases related to Connected Education:**
  - Personalised learning:
  - Student wireless backpack:
  - Student with especial needs
  - IoT & Smart Classroom/Smart Campus
- Personalised learning: Individual access to a mobile device holds the promise to connect each learner into intelligent personalised systems that can suggest learning pathways, enable aggregated analysis and through better data capture of learner experiences enable much better decision making about all aspects of a students' education. Categorising students in different groups and suggesting different multi-media contents can increase the load on the network. However, in-network caching technologies such as Content Centric Networks (CCN) and Information Centric Networks (ICN) can be used to improve efficiency by reducing the service response time and bandwidth consumption.
- Student wireless backpack: Today's cloud-based storage services have made it possible to access files irrespective of device of use. Due to the centralised architecture of cloud providers there is a notable delay in access to the content even with a relatively fast internet connection. Future mobile technology will enable single device content access anywhere by using distributed cloud and mobile edge computing. All the user needs is a device to access any of his personal content and stored files. Using this feature students can resume their work at a convenient time and place through different devices with an impression of immediate response time.
- Student with especial needs: Advances in mobile technology and robotics can open new opportunities to assist students with especial needs, making learning easier for them. Cloud-based robots can be considered as a full-time assistant for disabled students, helping them to interact with the education environment and their peers. Rather than having to call a teacher over for help (which can cost both the student and the teacher time they could be using more productively) the students can take care of the issue with the help of their robot.
- IoT & Smart Classroom/Smart Campus: IoT applications are affecting all aspect of our life, from smart building to smart healthcare. However, one of the fast growing area of these applications is in education which can improve our today's teaching, learning and campus operating experience. IoT applications can also help us change the role of teachers in the classroom, reducing the burden of administrative load on them and allowing them to concentrate more on individuals. Being automatically logged into the classroom as soon as entering to the class, being distracted by a signal as soon as losing concentration during lecture, real-time feedback to a lecturer about areas that students still have problem based on the real-time analyses of their notes, all are just few examples of how IoT and connected classroom can enhance learning and teaching experience.