

INTERNET OF MEDICAL THINGS

THE FUTURE OF HEALTHCARE
TECHNOLOGY

2021



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What is IoMT ?

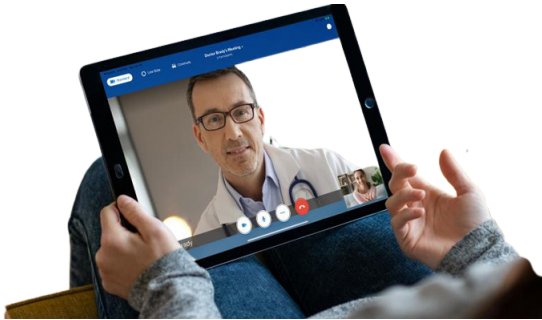


Fig - Remote monitoring

The internet of medical things (IoMT) is a term that is referred to a medical technology in which patient's health is monitored by various interconnected healthcare devices such as ECG monitor, healthcare wearables, smart beds, blood pressure monitor, sleep monitor, ambulatory heart monitor, smart apps and so on. The data monitored through these smart medical devices/apps is further sent to the healthcare experts to take the appropriate medical actions for the concerned disease. The major goal for implementing this technology is to reduce human errors, reduce rehospitalization, lower healthcare expenses, make patients self-reliant, and ultimately improve healthcare outcomes.

Wireless sensor networks are utilized in this healthcare technology to generate, collect, & transmit medical data or personal health information, which is then examined to make treatment recommendations. For example, an electrocardiogram sensor can be incorporated to monitor heart's activity, an electromyogram sensor for muscle's activity, an electroencephalogram sensor to monitor brain's activity, a blood pressure sensor for blood pressure monitoring, and a tilt sensor for trunk position monitoring. All of these sensors ensure that they are not only beneficial to patients, but also allow doctors and physicians to keep tabs on patients regardless of whether they are at home or in a hospital.



Fig - Healthcare Sensors

The recent Covid-19 pandemic has exposed the importance of social distancing, managing hospitals & health professionals' workload, medicine intake, treatment accuracy and has drawn our attention to the persisting healthcare industry's limitations and problems, as well as the importance of implementing IoMT technology.

The IoMT market will certainly grow in importance as a result of the current outbreak. In fact, Fortune Business Insights forecasts that the worldwide IoT in the healthcare market will grow in an eight-year time frame, developing from \$57.62 billion USD in 2019 to \$352.88 billion USD by 2027. And, this report would also outline the significance of IoMT& digital data to improve patient care, reduce costs, and improve workflow.

Importance of IoMT & current use in Healthcare System



Fig - Connected Inhaler for real-time monitoring of asthma patient

Considering the recent outbreaks of deadly viruses such as Covid-19, the importance of integrating the IoMT technology in the healthcare industry should be acknowledge. Presently, the medical technology is already being implemented in numerous treatments and systems such as cancer treatments, automated insulin delivery systems, drug management, coagulation testing, personal emergency response system, fitness tracking & diagnosis. These systems provide real-time health data leading to accurate decisions & reducing human errors. For example, patients suffering from asthma can be monitored in real-time by connected inhalers, that transmit data to a software application. The application triggers out alerts to notify patients in instances when the inhaler is left at home or when the inhaler is being used improperly.

In recent times there has been a significant rise in the workload of the healthcare system due to an increase in the number of Covid-19 cases, and IoMT has been influential in addressing this situation. Recently, a cloud-based patient management solution namely Masimo SafetyNet was launched by Masimo, an American medical technology company, has enabled hospitals to remotely monitor patients in alternative care units, such as emergency care facilities and homes. It monitors a patient's pulse rate, perfusion index, blood oxygen saturation, and respiration rate via a tether-less, single-patient-use sensor. It is especially beneficial for cancer patients who have infected with the coronavirus, as they would be at a higher risk of deteriorating symptoms or death if admitted to a hospital.



Fig - Cloud-based clinic management

Fortune Business Insights also quotes that, if given the option, around 62% of world's population would opt for virtual technology over the conventional methods used for health advice. In comparison, 57% of people consider remote monitoring of health issues via home gadgets is a smart idea. So, according to above opinion of people, the continuous contact among patients and doctors can be decreased altogether by utilizing IoMT concept, particularly in situation like Covid-19

Difference between IoT and IoMT

IOT

- The world's first Internet of Things device (IoT) was created at Carnegie Mellon University in the early 1980s.
- Any system of physical devices that receive and transmit data through wireless networks with little human interaction is referred to as the Internet of Things (IoT).
- IoT is usually more consumer-oriented, with the goal of providing maximum ease and usability.
- For example: Smart locks which allows the user to manage their doors from any location hassle-free, Smoke alarms that think, speak & alerts your mobile phone about any un-wanted emergencies in your residential environment, Footbot's reliable IoT device which is helpful in measuring indoor pollution and leads to improved air quality in houses, workplace etc.

VS

IoMT

- Compact, portable devices worn as necklaces or attached to clothes have been around since 1500. They were invented by Peter Henlein, a locksmith & clockmaker from Germany.
- IoMT is a network of interconnected health-care devices and IoMT is a subset of IoT. In both the technologies reduced human interference is a common objective.
- IoMT is more concerned with healthcare accuracy, reliability, and most importantly healthcare data security.
- For example: Defibrillator used to detect the heart's rhythm, Blood compressor to prevent blood clots, Glucose monitoring device to monitor glucose level, Swallow-able smart pills equipped with ingestible sensors to help patient be compliant with their prescribed medication etc.

IoT Devices



Fig - August Smart Lock for remote house monitoring



Fig - Nest Smoke Alarm to detect smoke

IoMT Devices



Fig - N-Stryker Defibrillator to detect the heart's rhythm







Fig - Cardinal blood Compressor to prevent blood clots




Components of IoMT



PATIENT

-  **Image Digitalization**
Comprises main document camera/scanner
-  **Measurement Device**
Comprises ECG, BP measure & Oxygen monitor
-  **User Display**
Visual data to mobile or computer screen
-  **Modem/Router**
Transforms digital data into electrical signal

DOCTOR

-  **Doctor's Display**
Used for remote intervention & monitoring
-  **Modem/Router**
Receives real-time data from network
-  **Doctor's Camera**
Includes main, auxiliary and document camera

Wireless **network** for data transfer



Data processing for monitoring



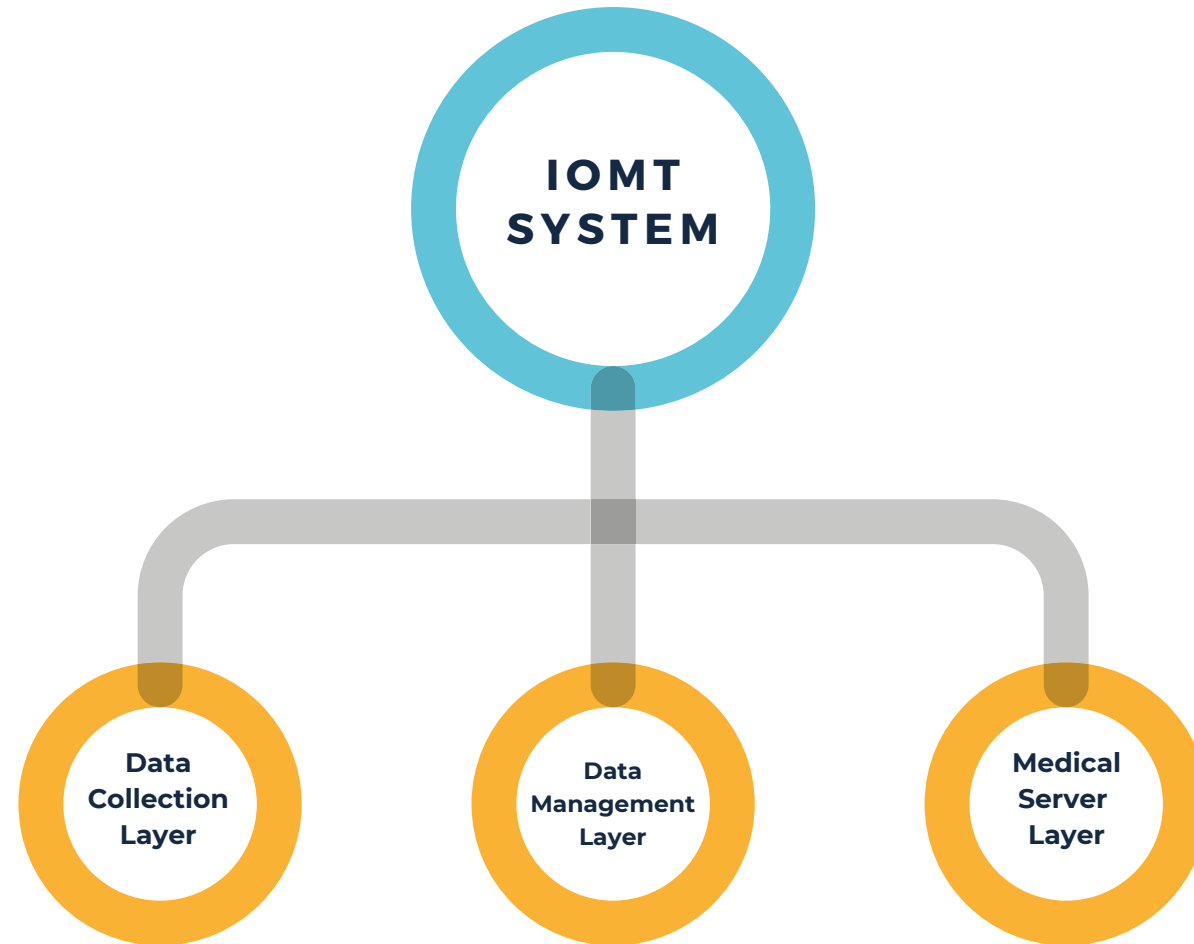
Data storage Device

Home-care Unit

COMMUNICATION NETWORK

Healthcare Terminal

Architecture of IoMT



IoMT technology architecture is composed of three layers, namely; Data management layer, Data collection layer, and Medical server layer. Healthcare sensors that are present in the data collection layer measure vital patient data and export the collected data to the data servers that are situated in the data management layer. The measurements are captured at the edge servers which are installed in the patient proximity before transmitting them to data servers located in the data management layer for further pre-processing. The data servers in the data management layer acquire, process, and interpret the detected clinical data by supplying to approved healthcare professionals with access interfaces in the medical server layer. After acquiring and reviewing patient health data on the medical server network, the associated healthcare professionals provide patients with expert advice to take further immediate actions. Further are the three layers explained in brief.

Data Collection Layer



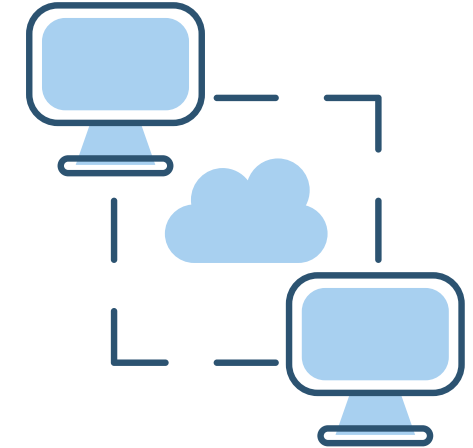
The data collection layer includes healthcare sensors, and edge servers. Healthcare sensors are those that are embedded, worn or attached to the clothes to collect details of vital parameters such as blood glucose, blood pressure, respiration rate, pulse rate, ECG etc. The edge servers are placed on wireless access systems such as wireless routers, IoT gateways and base stations. Edge servers also impart warning signals to the concerned health professional when some health parameters exceed the threshold value.

Data Management Layer



Basically the main function of the data management layer is to manage the data collected from the data collection layer in an organized structure. This layer will be responsible to save process and interpret the important parameters gathered. Data management is a critical aspect with reference to the confidentiality of patient data. Therefore this layer also conducts specific identification verification and makes management framework feasible.

Medical Server Layer



This layer allows healthcare professionals to access patient healthcare data through their credentials for authorization. Now, according to the data processed in the data management layer, doctors are presented with patients' visual data. And, if the data changes then immediately the doctor will be notified and quick corrective measures can be taken. This layer is very useful in optimizing the treatment by reducing the amount of hospital visits or examination.

Devices to watch for in IoMT

As the Internet of Medical Things (IoMT) devices range continues to grow, there are a wide variety of IoMT devices that offer support in human life and perform work with great results when compared to human beings. Here are some examples of IoMT devices that are mentioned below:

Devices attached on body

Devices attached on body are broadly classified into public health wearables and surgical wearables. Public health devices consist of bands for personal exercise, fitness apps, sporty smart watches, smart hearing devices etc. Fitbit, Misfit & Samsung Galaxy buds are devices that are working in this area. Surgical wearables includes Active Protective's smart belt for hip safety, Halo neuroscience's Halo sport helmet used for brain muscle control and agility & smart surgery glasses etc.



Fig - Starkey Livio's smart hearing device



Fig - Vuzix's surgery glasses

Devices for home

Devices for home comprises a private emergency management system (PEMS), virtual patient management system (VPMS) and virtual telehealth services (VTS). PEMS, a wearable device for emergency calls, is offered to elderly patients who generally have less access to mobility. VPMS, a patient monitoring system, is utilized to constantly keep an eye on the patient's lifelong recovery at their residence. And finally VTS, an online appointment system for patients to get necessary medications or their treatment plans. For ex, virtual testing.



Fig - Empatica's epilepsy tracking wearable



Fig - AliveCor's ECG monitoring device

Devices for hospitals

Devices for hospitals are gadgets that can be utilized for therapeutic or functional purposes. These are advanced devices that are centrally operated by skilled operators. For example, Rijuven's Bag Clinic, a cloud-based tool which allows doctors to monitor patients at any moment, Thyrocare virtual monitoring system for head, lungs and abdomen diagnosis, Think labs automated stethoscope, GE Healthcare's bone and metabolic health imaging system, Philips Versatile hospital ventilation systems, etc.



Fig - GE Healthcare's bone health imaging system



Fig - Philips Versatile ventilation systems

Benefits of IoMT

Real-time monitoring of patients via connected devices which helps doctors to immediately respond to medical emergencies, such as asthma attacks, heart failure etc. Also, there is very less chance on missing any healthcare update.

IoMT in healthcare ensures **adherence to doctor's orders**, i.e. doctors can rely on the medical devices for timely intake of medicines during their absence. This also helps patients to keep a track on their health status.

Medical sensors help in **improvement in drug management**, as doctors can now track compliance with prescriptions. Also, this helps in keeping a track on drug inventory.

Higher infrastructural cost is another obstacle that relates to IoMT concept. Although, long-term goal of IoMT is to reduce the overall healthcare costs but the costs associated with building Healthcare IT infrastructure are massive.

With so many suppliers and manufacturers of medical devices that are competing for scalability and a shorter time to market, **standardization of IoMT devices** becomes a problem.

Challenges offered by IoMT

Maintaining data security

remains a constant challenge when it comes to healthcare data. And according to a study by Force Point, security incidents in the healthcare industry are comparatively 340 % higher than that of any other industry.

Interoperability of data is another challenge when it comes to IoMT devices. Currently, very less devices are interoperable & it is critical that all IoMT devices are compatible with one another in order to fully leverage the benefits of IoMT.

Constant regulatory challenges

are offered by IoMT devices as clinical grade medical devices need prior approval & clearance from the FDA to be able to launch in the market.

IoMT helps in **healthcare asset management** as IoMT devices can monitor the functionality of medical equipment & raise alerts if any medical device need repairs.

Remote patient monitoring leads in reduction of in-person visits, & hospital readmissions, which in turn paves the way for **reduction in the costs involved.**

Recent advancements in IoMT

Research



Researchers from Sejong University, Korea and University Kebangsaan Malaysia are developing edge computing with multi-message multi-receiver signcryption for secure and reliable wireless internet of medical things communications. For improved performance & reliability, the suggested methodology integrates certificate-based signcryption with hyperelliptic curve cryptography (HECC).

Cynerio, a leading provider of healthcare IoT cybersecurity, recently partnered with Keysight, a leader in automated security control systems, to enhance real-time visibility and automate medical device data security responsiveness for medical devices (IoMT).

Partnership



Virtual Care



At a recent time, Wellteq, a leading provider of corporate wellness solutions has launched beta production of Internet of Medical Things (IoMT) HealthHub with API as a Service. Wellteq's condition monitoring and virtual primary healthcare platform namely "Wellteq Plus," is built on the Health Hub and API. From well-being to virtual primary care, the Wellteq Plus IoMT platform tracks the individual throughout the care continuum.

Startup



At a recent time, an Indian 7 months old health-tech startup DoctCo is supporting patients in tier 2 and tier 3 cities to obtain access to super-specialist doctors as the majority of who are stationed in metro cities. To facilitate online consultation between super-specialists and patients, each centre is equipped with IOMT (internet of medical things) devices and a telemedicine suite.

Recent news suggests that Cylera, a leader in IoT & medical device (IoMT), have announced their business expansions in the U.K. Cylera provides specialized competencies in data security in medical devices, which includes detecting and analyzing linked medical devices.

Business Expansion



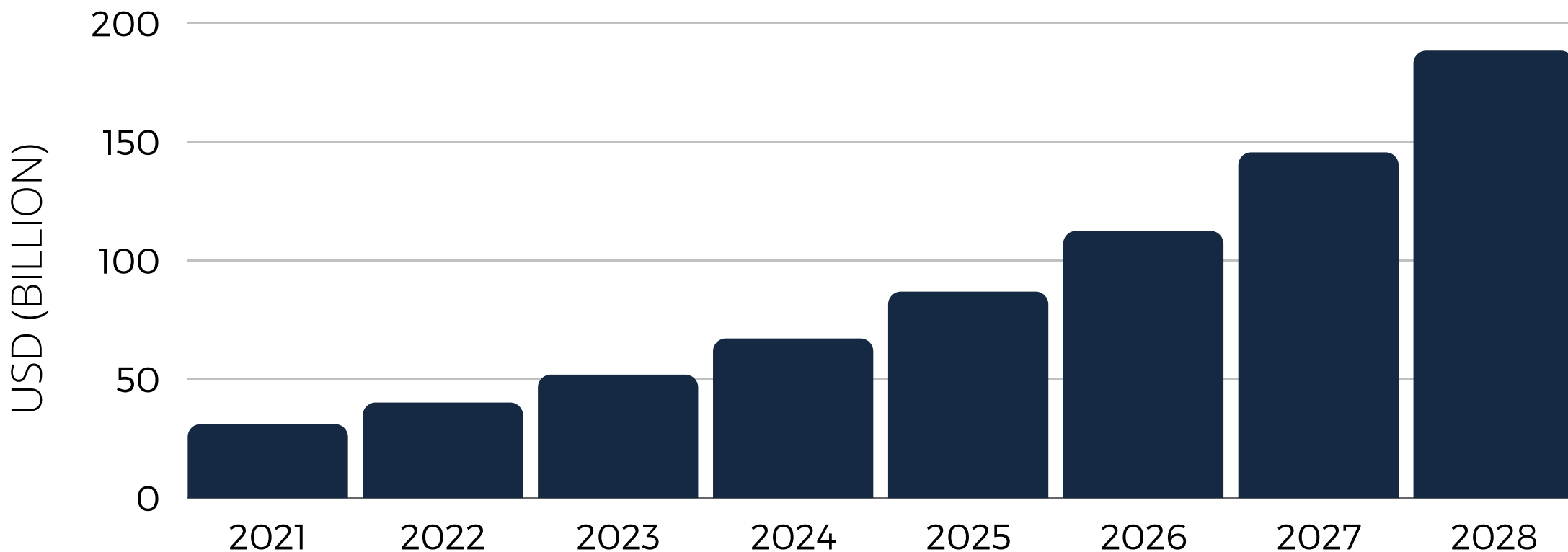
Partnership



Recently, Armis, a leading asset visibility & security platform provider, and Nuvolo, healthcare's leading Integrated Workplace Technology Solution (IWMS), have announced a strategic partnership to secure the patient journey by strengthening data sharing. The Armis platform will be utilized to perform asset discovery, device vulnerability detection, & threat intelligence curation for all devices on the network, further strengthening Nuvolo Connected Workplace.

Market Overview of IoMT

In 2020, the global internet of medical things (IoMT) market was accounted for USD 41.17 billion. COVID-19 had an extraordinary and astonishing worldwide impact, with the internet of medical things having demand in all countries during the outbreak. According to Fortune Business Insights, the global market surged by 71.3 % in 2020, compared to a year growth rate of 7.3% from 2017 to 2019. During the period 2021-2028, the market is expected to increase at a CAGR of 29.5 %, from USD 30.79 billion in 2021 to USD 187.60 billion in 2028



According to Fortune Business Insights, North America's market growth has reached USD13.53 billion in 2020, and it is expected to continue to lead the worldwide market over the forecasted period in terms of medical technology penetration and government insurance policies. Europe is anticipated to be the second-most dominant region in terms of market share. For instance, Horizon Europe, the EU's latest research and innovation programme, has been inaugurated with a budget of at least €95.5 billion of which major share is invested in healthcare sector

The Asia-Pacific market for healthcare technology according to Mordor Intelligence is expected to register a CAGR of 8.5% during the forecast period 2021 to 2026. A pandemic like Covid-19 is the major factor in this region for the growth of healthcare technology. For instance, China's JD health established a telemedicine service "family doctor" in August 2020 during Covid times to provide urgent patient treatment to the Chinese population.

Key Players in IoMT

GE Healthcare



Microsoft



**Stanley
Black &
Decker**



Medtronic

When Life Depends on Medical Technology

PHILIPS

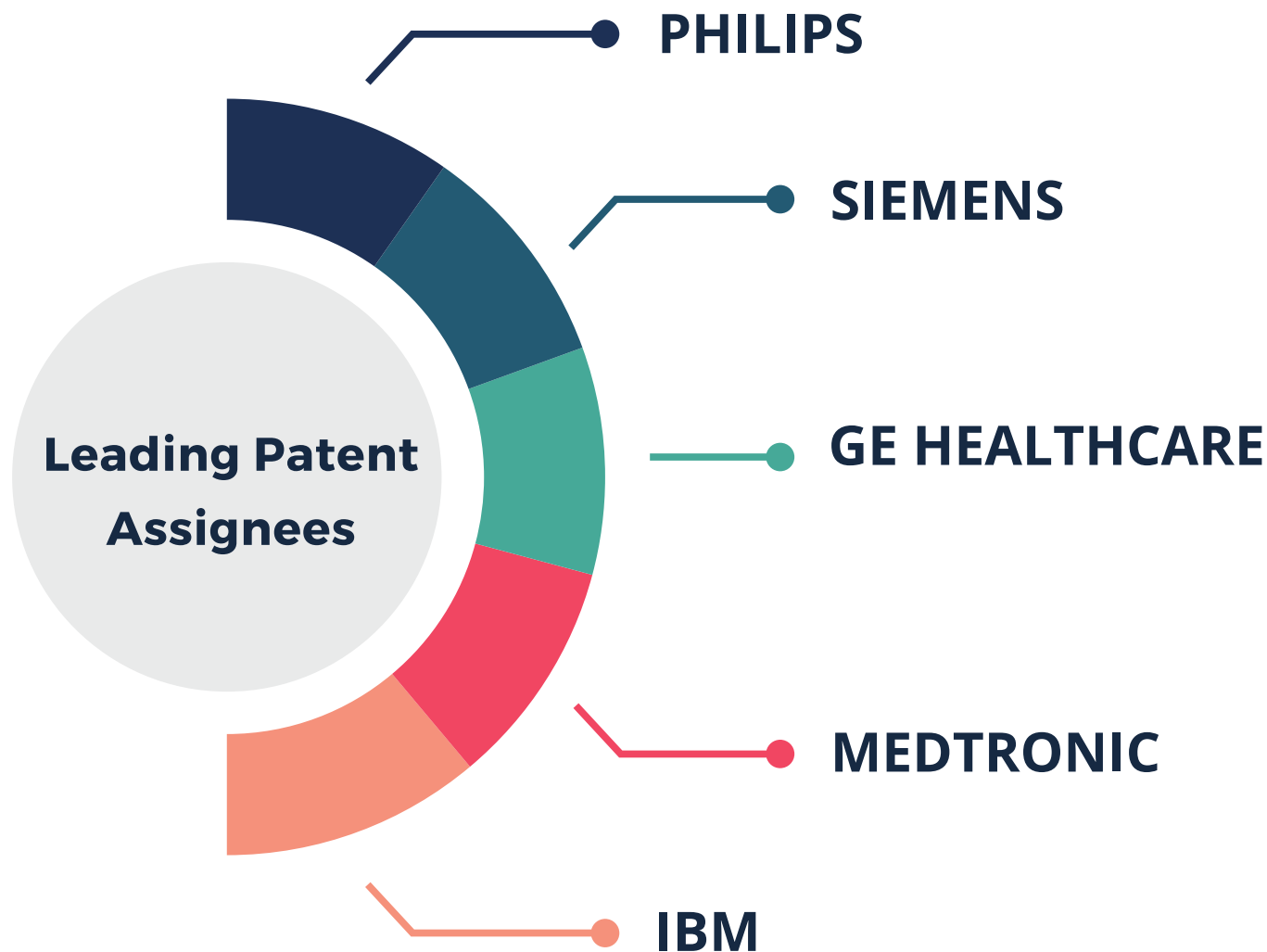
QUALCOMM LIFE
a Qualcomm company



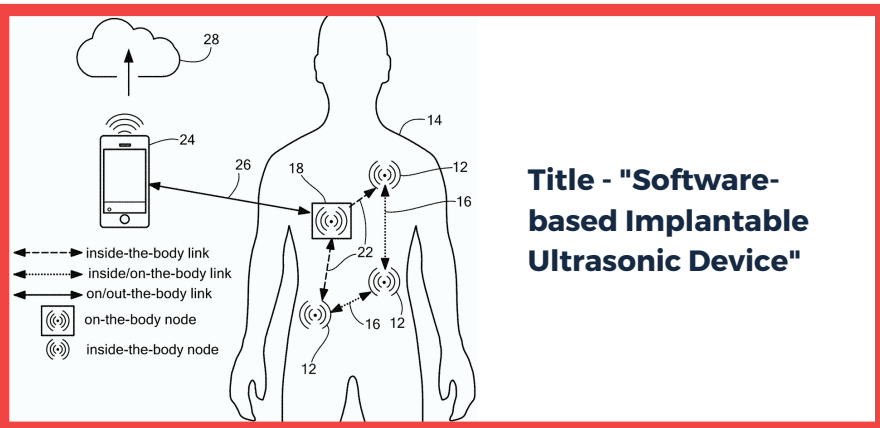
Breathometer™

Top Patent Assignees in IoMT technology

The leading patent assignees in IoMT technology are Philips, GE Healthcare, and Medtronic. IoMT products from Philips include heart monitoring, remote patient communication devices, and physiological parameter sensors. In existing monitoring devices, implants, and cardiac pacemakers, GE and Medtronic offer comprehensive integrated systems that support cloud-based technologies. Other organizations, such as Siemens and IBM, add top layers to their systems, allowing data analytics and cloud-based services to be applied to biometric data collected from physical devices and sensors.



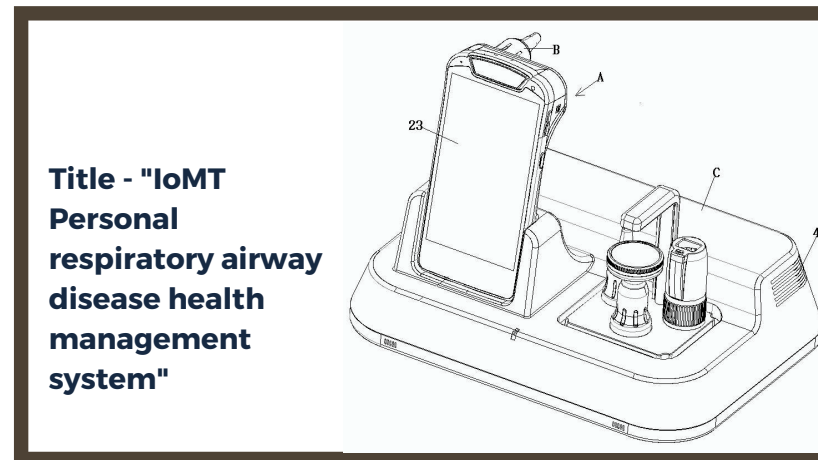
Notable patents in IoMT technology



Title - "Software-based Implantable Ultrasonic Device"

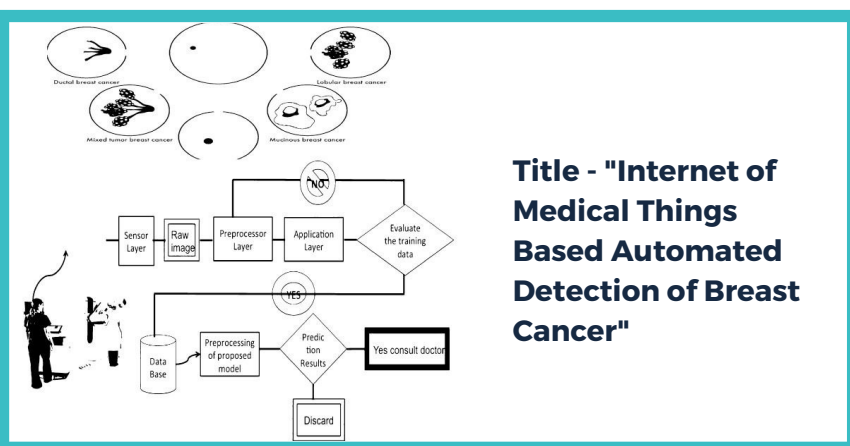
This patent (US11115475B2) belongs to Northeastern University in Boston. The patent elaborates about implantable & wearable device for transmitting signals ultrasonically through biological tissue. This system is implemented based on an Internet of Medical Things (IoMT) platform software & hardware architecture.

This patent (KR102271553B1) belongs to Aram Huvis Co Ltd in South Korea. The patent relates to a personal respiratory disease health management system that uses image, sound, biometric, and environmental sensors of the IoMT smart mobile. This multi-functional system performs collection and management of health data and home environment data for managing respiratory diseases.

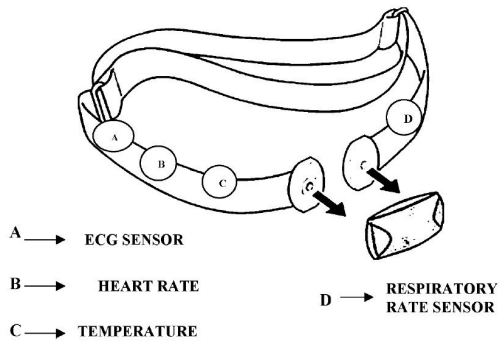


Title - "IoMT Personal respiratory airway disease health management system"

This patent (IN202141005960A) belongs to medical researchers in India. The proposed patent relates to the IoMT based computer aided detection technique for the early identification of the breast cancer, even without the help of the doctor any individual can know the status of the breast. The survival of the breast cancer patient fully relies on the early diagnosis of the detection. But country like India most of the people are not aware or do not go for routine health checkup, moreover the working women's do not get enough time to go for follow up, this end with critical situation. Hence this innovation can help detecting breast cancer at an early stage.



Title - "Internet of Medical Things Based Automated Detection of Breast Cancer"

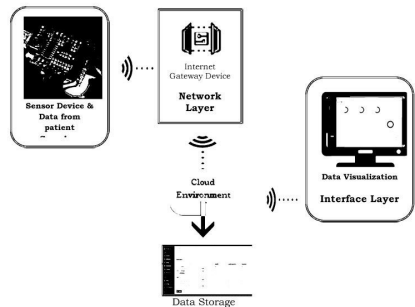
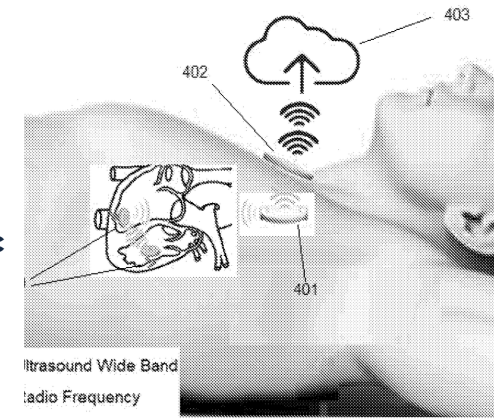


Title - "Chest strap for heart attack prediction using IoMT with deep Learning algorithm"

This patent (IN202041048476A) belongs to medical researchers in India. The invention relates to an IoMT device connected with chest strap for monitoring and predicting heart patient health condition either normal or abnormal. By using deep learning Artificial Neural Network (ANN) algorithm the alerts will be sent to doctor and patient if patient is predicted with heart attack.

This patent (US20210146144A1) belongs to Bionet Sonar in United States. The patent relates to wirelessly networked systems of implantable and non-implantable medical devices with networking protocols that allow for communications and energy transfer between different medical devices using ultrasonic waves. The networks are used to construct cardiac pacing, deep brain stimulation, and neurostimulation networks based on ultrasonic wide band technology.

Title - "The internet of medical things through ultrasonic networking technology"



Title - "IoMT based wearable patient monitoring and critical condition detection system for Covid patients"

This patent (IN202041038022A) belongs to medical researchers in India. The patent relates to design the IoMT based wearable patient monitoring and critical condition detection system for COVID patients. This detection system identifies the temperature and pulse rate of the patient by application of wearable sensors to monitor the health conditions. The infected patient is monitored and provided medical treatment based on the medical data reports without intervention among infected people and health care professionals.

Prototype design for the IoMT-based COVID-19 patient monitoring sys

Recent Innovative Breakthroughs



Vascular Flow Technologies Limited secured US Patent for peripheral stent. This marks the latest step in Vascular Flow's journey to commercialize medical devices using its platform Spiral Laminar Flow Technology (SLF).

BioSig Technologies, a medtech company, has commercialized a signal processing platform designed to improve signal fidelity and uncover ECG & intra-cardiac signals .



CardieX Limited, a global health technology company has announced that its subsidiary ATCOR was granted a new patent by the European Patent Office (EPO) for the company's SphygmoCor technology used in cuff-based blood pressure devices.

IoMT's Most Promising Startups

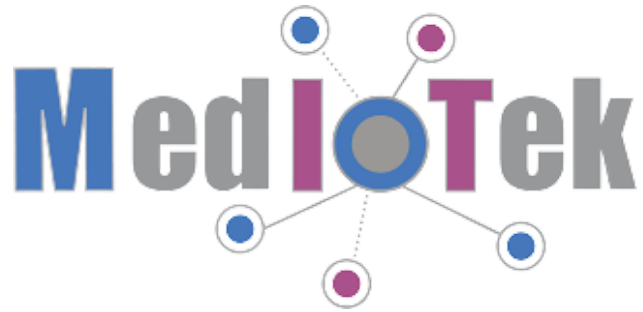
The logo for Commure, featuring the word "commure" in a bold, lowercase, sans-serif font.

Commure is a technology startup and established in the year 2017 at San Francisco, United States. Commure focuses on advancing healthcare software innovation. The company provides a FHIR-compliant (Fast Healthcare Interoperability Resources) development platform for health institutions, vendors, and startups to develop healthcare applications and software. Commure had launched its FHIR Standard-Based platform in 2020. Recently, Commure has acquired \$500 million in funding for its health software.

Cedar Inc is technology startup and founded in the year 2016 at Newyork, United States. Cedar deals with a billing platform named "Cedar Pay" in healthcare sector that brings in more transparency for patients regarding healthcare expenses. Cedar's intelligent tech provides highly seamless and easy digital payment experience for the patients, which lead to higher engagement and secure payments. Recently, Cedar has raised \$200 million in Series D funding to continue its growth as the industry's leading patient financial engagement platform.

The logo for LeanTaaS, featuring a blue bar chart icon to the left of the word "LeanTaaS" in a bold, black, sans-serif font.

LeanTaaS is a software company and founded in the year 2010 at California, United States. LeanTaaS focuses on analytical software that is designed to increase patient access to medical care. LeanTaaS product such as iQueue for inpatients beds helps healthcare institutions to deal with daily inpatient capacity management decisions at all stages including predictions for discharge and admissions for each unit by time of day. This helps healthcare institutions to create space for the right patient at the right time. Recently, LeanTaaS was announced as winner of "New Product of the Year" and "Case Study of the Year" by Business Intelligence Group.



MedloTek is a mobile health technology company and established in the year 2016 at Chennai, India. The healthcare startup has developed an IoMT platform named as "VinCense", which allows screening major COVID-19 risk parameters such as the respiratory rate, skin temperature, oxygen saturation, pulse rate, and blood pressure in two minutes. This coronavirus prescreening tool assists in the identification of groups of persons who require the COVID-19 test.

Unite Us Inc is an outcome-focused technology company and founded in the year 2014 at Newyork, United States. The company builds coordinated care networks to integrate health and social service providers together. The Unite Us care platform offers a unique end-to-end solution to address social determinants of health. The platform predicts community social care requirements, provides coordination between health and social agencies, and assesses effect to encourage social care investment. Recently, Unite Us has partnered with Bento to addresses food insecurity in the U.S. This platform uses text messages to connect individuals and families with nutritiously customized, pre-paid meals from restaurants and grocery stores.



Medable is a clinical trial software company and established in the year 2013 at California, United States. The company's cloud platform, Software-as-a-Service (SaaS), intends to provide a way to secure, HIPAA (Health Insurance Portability and Accountability Act)-compliant healthcare apps. The company's product such as "TeleVisit" for clinical trials provides the comfort of a clinic from the homes of patients and healthcare professionals. Recently, Medable has partnered with Vault Health and shared a commitment to bring clinical trials closer to patients through remote monitoring and high-touch patient services, making them more accessible.

Quick summary, Future scope & Parting thought



Although IoMT-based medtech applications are still in their infancy, but the use of interconnected devices does have the ability to profoundly enhance the healthcare diagnosis system. In summary, we observe that IoMT can assist in providing solutions to the problem of continuous health monitoring, which leads to timely medicinal intake, real-time monitoring, and other benefits. We've also witnessed a plethora of IoMT devices such as devices attached on body for immediate health alerts, devices for personalized care at home and in-clinic devices which can assist doctors in hospitals. Furthermore, IoMT is rapidly gaining traction, from the development of reliable wireless networks to the collaboration of organizations to secure data sharing, all with the goal of enhancing the patient's health recovery path.

Quick Summary



In the coming years IoMT could experience more innovative breakthroughs such as usage of Implantable & wearable ultrasonic devices for improved communication in diagnosis, IoT based smart healthcare solution for the prognosis of skin cancer using machine learning, systems for treatment of patients through IoMT sensors & 5g network & so on. Also, Blockchain will have an impact to strengthen the management of patient & hospital data, wherein data management module will be used for saving patient data in a corresponding patient ID using a blockchain module for each data, and then patient data will be placed in a repository by converting each data into a block. So, the future does look promising & we might see more applications if IoMT adopts an organized approach for public-private partnerships, cross-industry collaboration, & broader acceptance of technology.

Future Scope



In the future, the world might encounter more tough situations like Covid-19 and IoMT will definitely help the world prepare better for future pandemics. Apart from easing the burden on healthcare professionals, researchers can also conduct decentralized trials and perhaps speed up vaccine development by assessing patients' progress and the real-time effect of new medications and vaccinations. And with IoMT market reaching new heights in the healthcare industry, we can confidently predict that IoMT will hold the key in global healthcare ecosystem across the globe.

Parting Thought



ABOUT BAYSLOPE BUSINESS SOLUTIONS

Bayslope is an ISO certified company, with the vision to enable businesses and individuals maximize their potential for innovation, through a range of high-quality intellectual property services.

MISSION

To create long lasting IP value that is integral to our clients' patent strategy and IP journey.

VISION

We aspire to be your first choice as a quality patent service provider.

VALUES

Ethical Conduct
Quality & Consistency
Nurture Relationships

OUR OFFICES

US OFFICE

601, Lexington Avenue,
20th Floor, New York 10022
+1 646 349 9293

INDIA OFFICE

Level 10, Unitech Cyber Park,
Tower B, Sector-39
Gurgaon- 122003, Haryana
+91 844 775 1586