IoT in Healthcare

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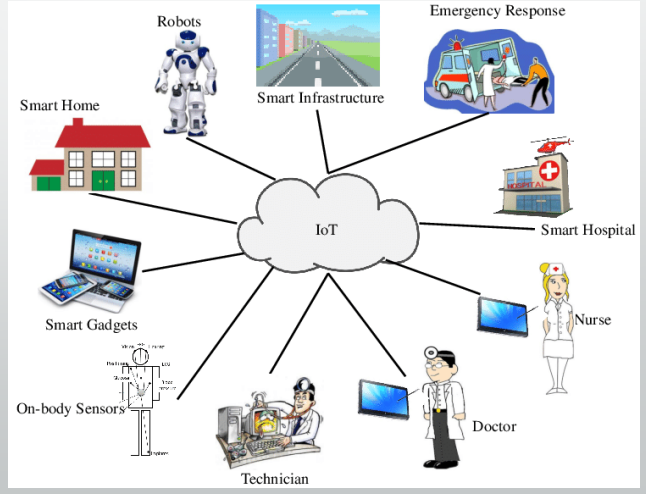
CSC 8566

10/30/2019



https://www.researchgate.net/figure/The-IoT-is-the-Backbone-of-Smart-Healthcare_fig1_322583582

IoT in Healthcare Overview

Patients:

- Wearable Devices
  - Fitness bands
  - Wireless connected devices such as
    - Blood pressure monitors
    - Heart rate monitors cuffs
    - Glucometer and others
  - Reminders
  - Monitoring
  - Alerting

IoT in Healthcare Overview

Physicians:

- Allows patients' tracking in a timelier and more efficient way.
- Monitor adherence to treatment plan
- Address emergencies
- Collect more precise data to prescribe a more suited treatment plan for the patient.

IoT in Healthcare Overview

Hospitals:

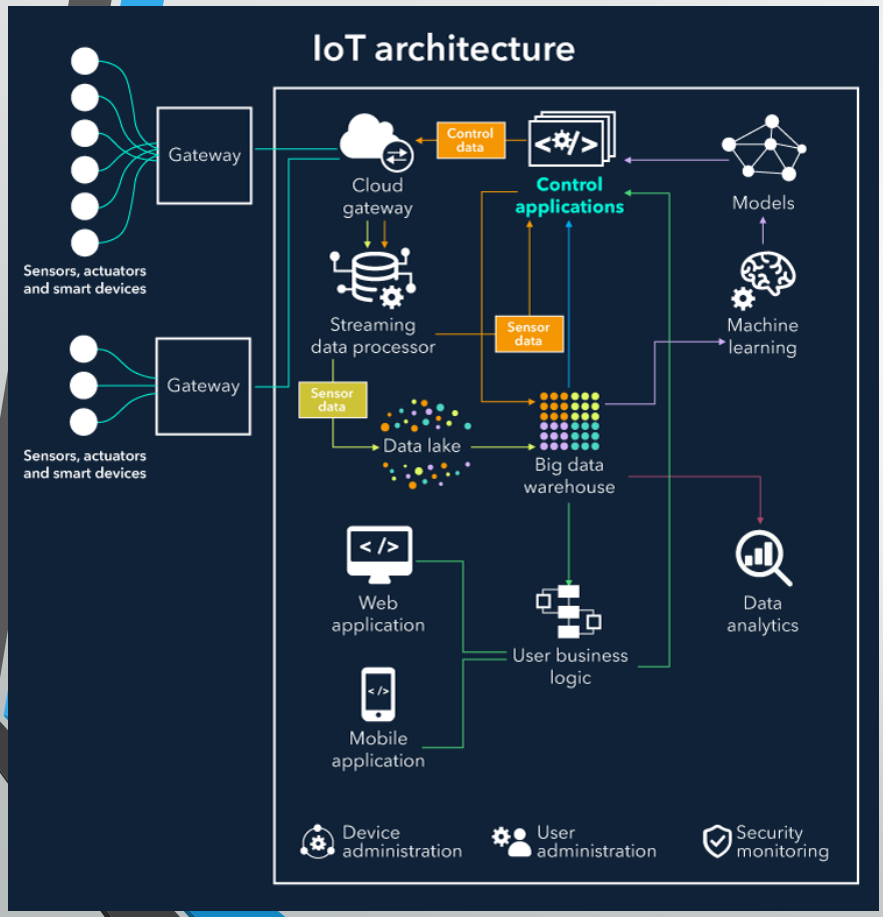
- Monitoring medical devices and equipment
- Real time usage and location
  - Tagging devices with sensors
- Equipment, such as wheelchairs, oxygen masks and others can be monitored.
- Utilization of medical staff can also be monitored and analyzed in the same manner.
- Asset management – pharmacy inventory control and environment monitoring
- Cost reduction, improve operational and service efficiency.

IoT in Healthcare Overview

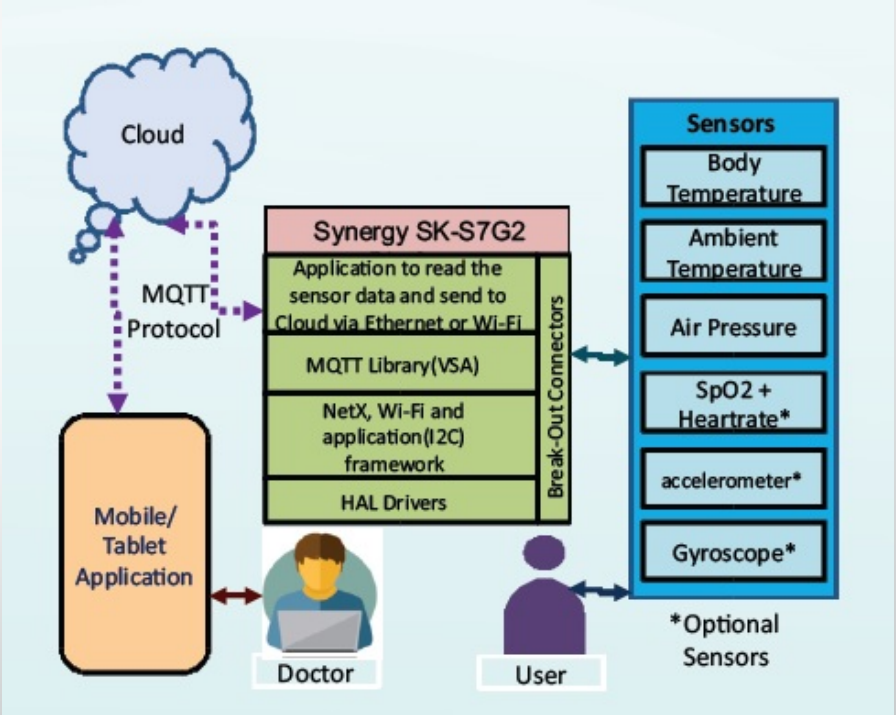
Health Insurance Companies:

- Leverage data captured through health monitoring devices for their underwriting and claims operations
- Help to detect fraud
- Better Transparency
  - Lowering the costs
  - More accurate claims validation
- May offer incentives to patients

IoT in Healthcare – Architecture



https://www.scnsoft.com/blog/iot-architecture-in-a-nutshell-and-how-it-works



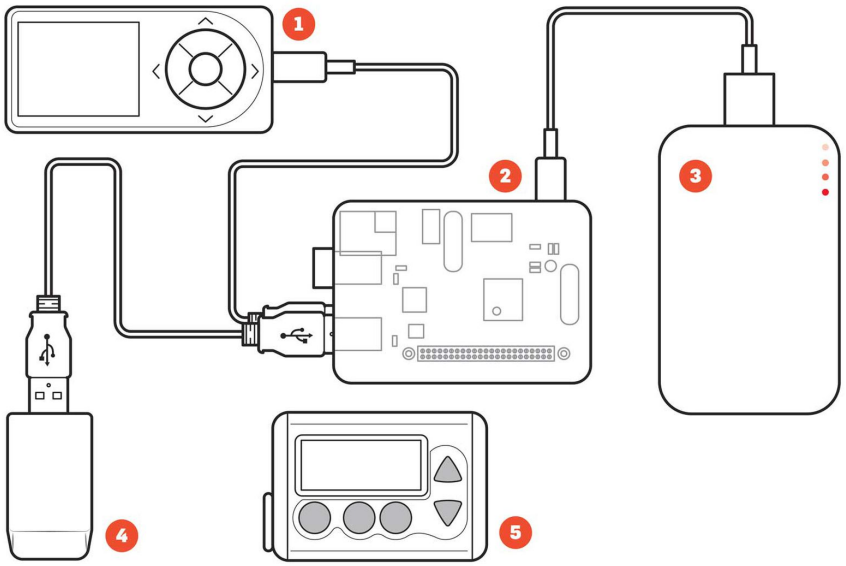
https://www.iwavesystems.com/healthcare-iot-using-renesas-synergy

OPENAPS.ORG

#WeAreNotWaiting to reduce the burden of Type 1 diabetes

Case Study #1

OpenAPS - "Artificial Pancreas System"



https://www.popsci.com/hacker-medicine/

- DIY System For Glucose Control
  Designed by digital communications specialist & network engineer for personal need
  - https://openaps.org/
  - As of September 2019 more than 1,569 known implementations worldwide
- Designed algorithm that calculates patient's insulin needs based on the monitor's readings.
- **Algorithm** is programmed and loaded onto a **Raspberry Pi** that connects to a **battery**, the **glucose monitor**, and a **medical USB stick**.
- When Glucose level is unsafe the program sends correct dosage of insulin to **USB stick**
- **Medical USB Stick** wirelessly commands the **insulin pump** to inject

OPENAPS.ORG

#WeAreNotWaiting to reduce the burden of Type 1 diabetes

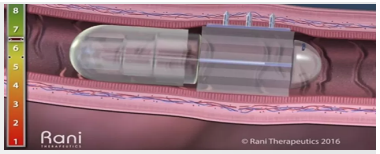
Case Study #1
OpenAPS - "Artificial Pancreas System"

https://www.popsci.com/hacker-medicine

- Gathers data from:
  - Pump
  - CGM - continuous glucose monitoring
- Collects data, runs through an algorithm that calculates and decides how patient's basal rates might need to be adjusted
- Communicates with the insulin pump to inject if needed.
- Open source solution – GitHub solution
- https://openaps.readthedocs.io/en/latest/docs/Understanding%20OpenAPS-Overview/how-openaps-works-overview.html

AbilifyMyCite
(aripiprazole tablets with sensor)
2, 5, 10, 15, 20, 30 mg

Case Study #2- Smart Pill



- Abilify MyCite - First FDA approved smart pill
- Tiny pill has a drug and an ingestible sensor.
- The sensor gets activated when it comes into contact with stomach fluid to detect when the pill has been taken.
- Data is transmitted to a wearable patch
- Patch transmits data to a paired smartphone app and cloud application.
- Doctors and caregivers, with the patient's consent, can then access the data via a web portal.

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AbilifyMyCite
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Case Study #2- Smart Pill

A Pill - tablet embedded with an Ingestible Event Marker (IEM) sensor

A Patch - Once the IEM sensor activates it communicates to a wearable sensor called the MYCITE® Patch. The patch detects and records the date and time of ingestion, as well as your activity level

An App - The data in the patch is communicated to the MYCITE® APP, a smartphone application (app) on a compatible mobile device. The app allows you to review your medication ingestion data and activity level. It also allows the patient to enter self-reported mood and quality of rest.

The Dashboard – secure web based postal. Access to healthcare providers and authorized users to monitor patient. 30 minutes up to 2 hours ingestions will be detected.

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Virtual Solutions

Case Study #3
Health Net Connect (HNC)

Internet of Medical Things (IoMT)

Telemedicine

- VideoDoc 360°™ software is used with
  - medical cart, camera, and computer hardware, which allows the doctor to remotely view the patient as well as remotely zoom and rotate the camera up to 360 degrees via our software.
  - Enables patient/doctor messaging, patient vital-taking via FDA-certified peripherals, medication scheduling, and patient data tracking via our VideoDoc 360°™ cloud-based provider portal

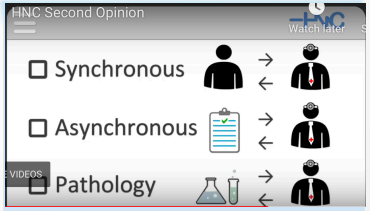
Remote Patient Monitoring

- Remote Patient Monitoring is remote communication between a patient and a healthcare professional used to monitor chronic disease patients. Patients remotely upload their vitals for real-time and later review by their healthcare professionals. Vital information, such as blood pressure, blood glucose, and weight is encrypted and securely transmitted using FIPS 140-2 encryption, and transported to our HIPAA-compliant portal for review by healthcare professionals from any web capable device.

Consumer Model

- The doctors set their availability and are then available to consumers on-demand. If the doctor is currently in a consultation, the next patient is placed in queue.
- The patient logs in and schedules a virtual appointment with the doctor to be performed later

Second Opinion



Kiosk Solution

- Kiosk Solution is similar to the Remote Patient Monitoring program, except that it allows for a user list so that the practitioner is able to select the patient for testing in the software. This would be used for a practitioner going room to room taking vitals, or a travelling nurse aid going house to house in an assisted living scenario.

Virtual Solutions

Case Study #3
Health Net Connect (HNC)
Internet of Medical Things (IoMT)

VideoDoc 360°™

Thermometer

Scale

Pulse Oximeter

Blood Pressure Monitor

https://healthnetconnect.com/offerings/telemedicine/kiosk-solution/

11" VideoDoc™

+ 11" Tablet given to patients for home use
+ HIPAA and HITECH compliant videoconferencing solution

https://healthnetconnect.com/offerings/remote-patient-monitoring/

Wearable

2 in 1 BP/BG Monitor

Tech Support

Spirometer

PT/INR

Pulse Oximeter

Scale

Thermometer

Summary

Many Benefits but also many issues and concerns

- Security
  - Unauthorized access to device/sensor/ data/ storage
  - Unauthorized use or change of communication information
  - Denial of service
  - Malware and viruses
- Privacy
  - Device
  - During communication
  - Processing
- Missing data – inaccurate/bad medical decisions
  - Interrupted monitoring
  - Ubiquitous connection
- Interoperability
  - Lack of standardization
  - Integration into EHR , EMR and HIE
  - Tremendous amount of data

References

- https://www.grandviewresearch.com/industry-analysis/internet-of-things-iot-healthcare-market
- https://www.wipro.com/en-US/business-process/what-can-iot-do-for-healthcare-/
- https://medium.com/sciforce/iot-in-healthcare-are-we-witnessing-a-new-revolution-6bboecf55991
- https://econsultancy.com/internet-of-things-healthcare/
- https://healthitanalytics.com/features/explaining-the-basics-of-the-internet-of-things-for-healthcare
- https://www.colocationamerica.com/blog/iot-revolutionizing-healthcare
- http://www.manufacturingnews24.com/iot-healthcare-market-future-opportunities-market-analysis-outlook-to-2024/
- https://exclusiveindustryreports.com/38842/global-iot-healthcare-market-share-to-reach-approximately-14660-million-by-2022/
- https://arxiv.org/pdf/1804.04250.pdf
- https://www.sciencedirect.com/science/article/pii/S1877050915005682/pdf?md5=898f89cea21a389ab8fece54b2c12559&pid=1-s2.0-S1877050915005682-main.pdf&_valck=1
- https://www.wipro.com/en-US/business-process/what-can-iot-do-for-healthcare-/

References

- https://www.iotforall.com/5-challenges-facing-iot-healthcare-2019/
- https://www.popsci.com/hacker-medicine
- https://healthnetconnect.com
- https://openaps.readthedocs.io/en/latest/docs/Understanding%20OpenAPS-Overview/how-openaps-works-overview.html
- https://www.wearable-technologies.com/2018/05/how-smart-pills-could-revolutionize-healthcare/
- https://www.abilifymycite.com/about
- https://www.qulix.com/about/blog/iot-smart-pill-and-the-future-of-medicine/
- https://openaps.readthedocs.io/en/latest/docs/Understanding%20OpenAPS-Overview/how-openaps-works-overview.html
- https://www.sciencedirect.com/science/article/pii/S0167739X18316480
- https://www.medicaldevice-network.com/projects/standardising-usb/