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IOT-105

IoT Trends - Inside the Connected Health Revolution

Brian Blum, Owen Troy | August 2023

 IOT

Agenda

- Medical Industry Challenges
- IoT as a Solution
- Life Examples of Changing Healthcare

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Medical Industry Challenges

Healthcare Megatrends



HEALTH AWARENESS

Healthy lifestyles – Prevent sicknesses and keep us productive

The share of adults meeting the US aerobic-activity and muscle-strengthening guidelines has risen from 14% to 24% over 1998-2018.



AGING POPULATION

More old people, increasing lifestyle diseases burdening healthcare systems

The number of people over the age of 60 to double from 1 to 2 billion by 2050. 422 million people worldwide have diabetes.



HEALTHCARE COSTS

Healthcare costs are growing – Transformation towards outpatient care

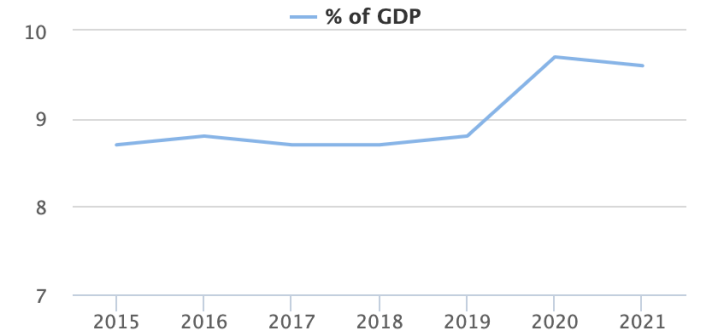
The domestic government health expenditure per capita rose 22% between 2008-2018. Remote home treatment can cut healthcare costs by 50%

Challenges in Medical Industry

- **Care is expensive**
 - Past limited to brick-and-mortar-based care
 - Too much human involvement
 - Inefficiencies w/ isolated diagnostic and treatment plan
- **Data is discrete**
 - Failure to see trends in data leading to chronic conditions
 - Limited Biometric data captured after a problem occurs
 - Inability to cross-reference data from multiple sources
 - Inaccuracy of data with single / spot measurements
- **Manual processes are inefficient**
 - Manual care steps introduce human error/bias
 - Equipment loss or misplacement results in inefficiency



**Health spending
increased by 6%
in 2021**



Source: [OECD Health Statistics 2022](#)



National Health Expenditures (NHE)

2021

- NHE grew 2.7%
- \$4.3 trillion in total
- \$12,914 per person
- 18.3% of GDP

2022 - 2031

- Average growth 5.4%
- GDP growth 4.6%
- 19.6% of GDP in 2031

NHE – National health expenditures represent the amount spent on health care and related activities such as private and public health insurance, health research, and public health activities

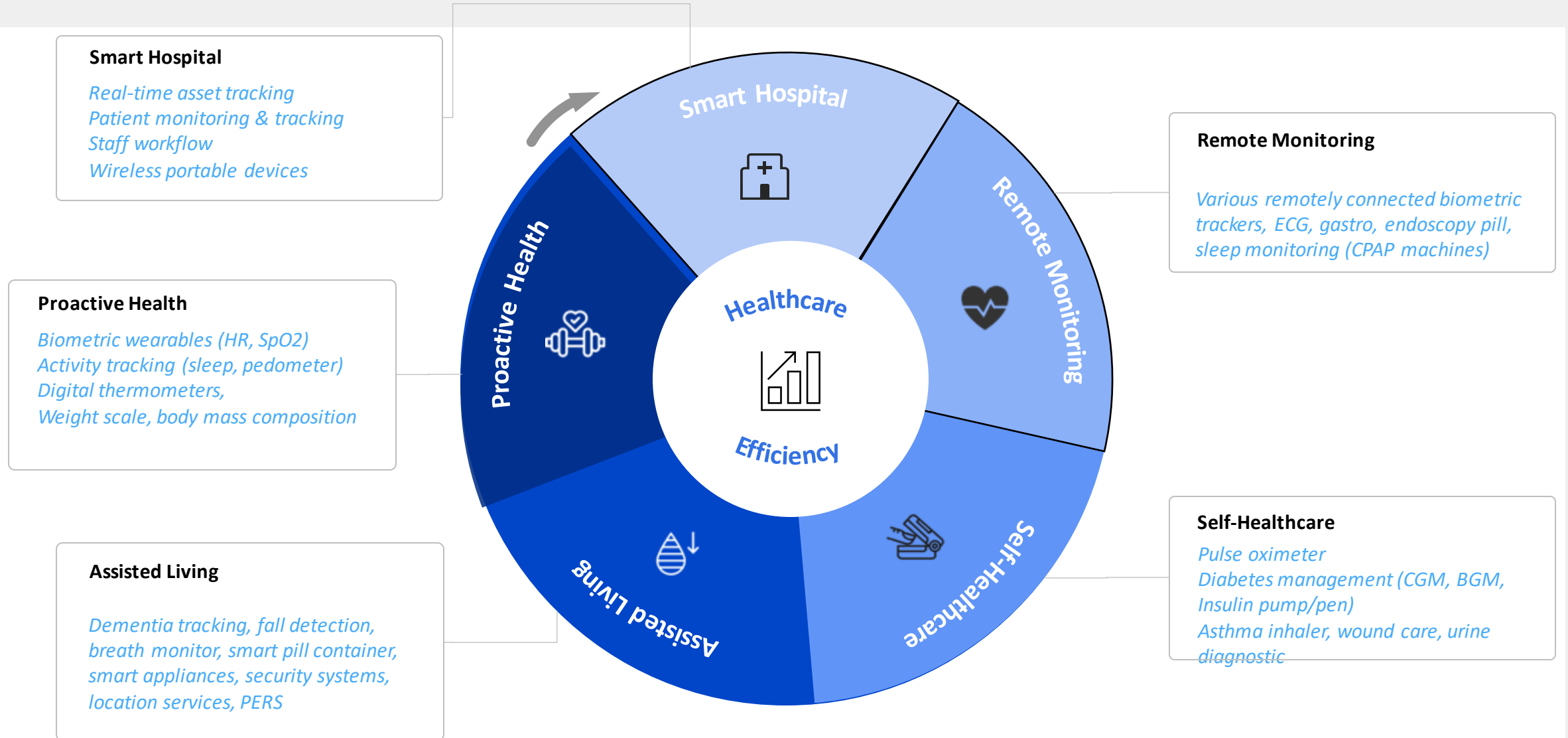


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IoMT Transformation

IoMT Devices and Their Role in the Patient Journey



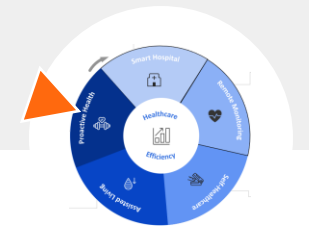


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Five Examples of IoMT

Proactive Health Tracking



■ Past Challenges

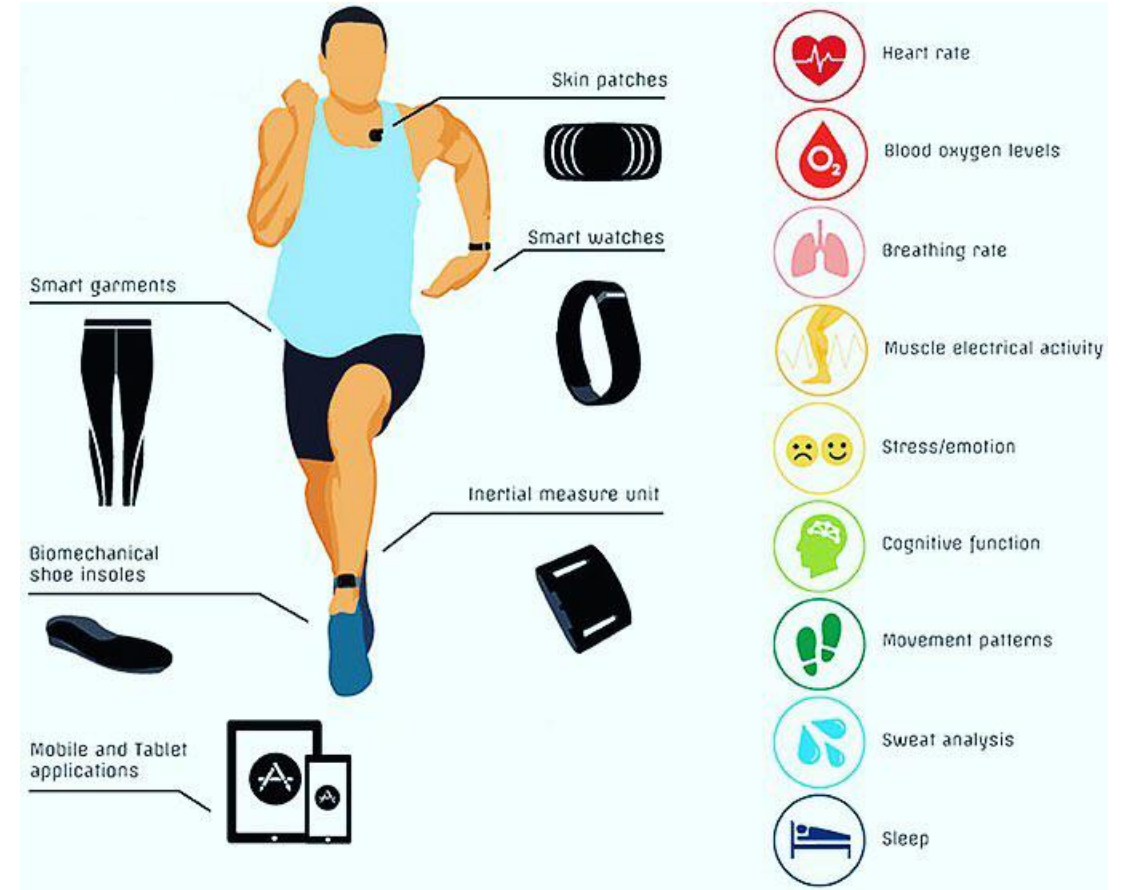
- Body analysis required physicals
- Health devices for single health aspects such as weight or heart rate
- Required physical trainer for coaching, setting goals, and developing a healthy lifestyle.

■ Health Tracking Today

- Devices to track nearly every aspect of daily life
- Data siloed in different clouds
- Data analyzed by the user only

■ The Future

- The devices will collect expansive and varied data
- Data siloes will be torn down
- Data can be used holistically by the user, doctor, healthcare statistics
- AI/ML performing real-time data analysis



Self-Healthcare Example CGM



■ Historic Challenges with Diabetes

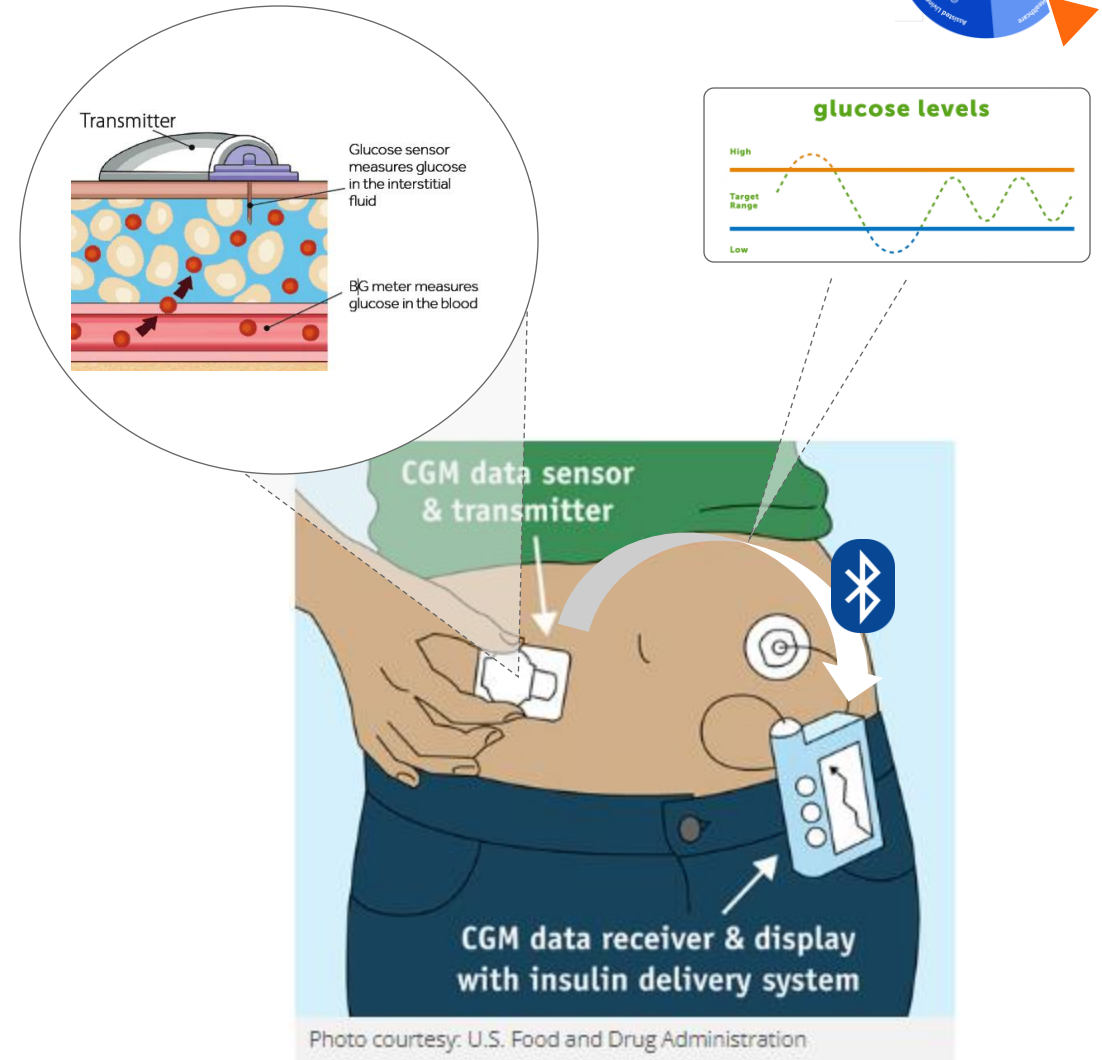
- Frequent painful finger pricks = reluctance, inconvenience, and discomfort
- Irregular or ad-hoc insulin doses = erratic blood glucose levels

■ How CGM has improved diabetes management

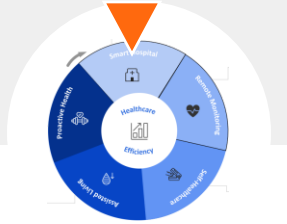
- Actively and continuously monitor glucose levels
- It's discreet and can provide readings for weeks without needing to be replaced
- Enables the patient to live a normal life without costly clinical care

■ The Future of Self-Healthcare Devices

- Non-invasive CGM worn as a ring on a finger or embedded on a tooth
- A smaller less intrusive insulin delivery system working in conjunction with CGM to provide steady insulin levels
- Both work together seamlessly, utilizing Edge AI/ML to provide extremely effective artificial pancreas
- The smart home and fitness trackers aid with ensuring a balanced diet, exercise, and overall healthy lifestyle
- Security is at the core so the data can be securely transferred to medical professionals, analysed, and used to improve treatment options for all



Smart Hospital Efficiency



Common Challenges

- Limited ability to care for multiple patients
- Traditional solution: more money, more beds, and more staff
- Data silos: Antiquated records that do not transfer
- Manual steps in distributing care – potential human error
- Unable to track patients moving through the care flow
- An average of 1 hour per shift consumed locating supplies and equipment

Smart Hospitals: Efficiency and better staff/patient experience

- Electronic Health Records (EHR) create the digital backbone for data collection
- Inventory management and equipment tracking – Hospital wing visibility
- Custom and automated staff workflows

The Future

- Continuous monitoring of untethered patient
- Monitor more patients remotely per nurse
- Monitor recovering patients at home – quickly analyze data – more patients per nurse
- “Bring your own device” – single interface to equipment
- Drug delivery automated – aligned with HER system to avoid errors
- Update the family as the patient moves through a particular process
- Room level/room quadrant level visibility for equipment tracking
- Adhering to new regulations, like proof of a hand wash before patient interaction



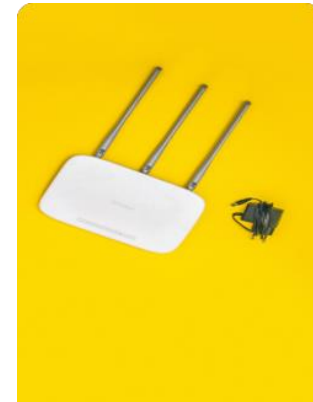
Asset Management



Patient & Staff Workflows

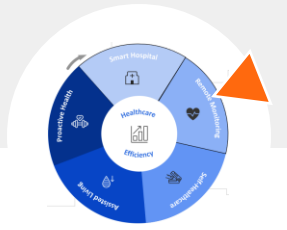


Connected Medical Devices



Secure Infrastructure

Remote Monitoring Post Discharge



■ Challenges before connected devices

- Post-follow-ups required physical visits – More load on the healthcare system
- Data delivered to the hospital on physical devices
- Patients not using the device or using it incorrectly
- Configuring/updating the device required a physical interaction

■ With IoMT Devices

- Continuous monitoring via cloud-connected device
- Interface to the device is on a tablet with clear examples
- A device is configured remotely by a professional

■ The Future

- Faster discharge & efficient follow-up monitoring
- Reduces hospital costs by early transitioning to home or outpatient care
- Continuous real-time data to the physician, patient, and family
- Compute is at the edge, and complications are detected instantly



Assisted Living

Common Challenges

- Non-acute senior care burdens the healthcare system - costly
- Forget to take pills
- Maintaining exercise and a balanced diet
- General mobility going to the store, doctor, or chores
- Burden often falls on family to help with daily life

Aided living applications enable aging in place

- Smart pillboxes / digital nurses help monitor and remind
- Wearables, trackers, and smart scales help ensure proper exercise and weight management
- A digital assistant coordinates meals and orders groceries for delivery
- Fall detection sensors, call buttons, and cameras offer peace of mind and a sense of security
- Overall reduces dependence on others and gives more freedom

The Future

- 24/7 personal digital assistant inside and out of the home
- A smart ecosystem of devices provides notifications and updates to family member condition, location, daily activity, and any signs of deteriorating conditions.
- Continuous data stream to physicians with AI/ML for detecting early signs of chronic or acute developing illnesses that might otherwise go unnoticed
- Hearing and vision aids, prosthetics/tools that enhance interaction with the world
- Robots in the home that help vacuum, feed pets, water the garden, provide massage and physical stimulation, and monitor hygiene
- Toilet monitor to track biometric data found in urine and stool for additional early warning signs of health and well-being



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IoT as a Solution

IoMT As A Solution – Benefits

▪ **Improves Care**

- More convenient, less costly, more efficient

▪ **Reduces Care Costs**

- Remote care includes IoT-based data collection and diagnostic tools
- Utilize tools and data to improve process efficiency
- Combined records and a centralized system w/ security

▪ **Centralized and Continuous data**

- Low-cost sensors enhance health resolutions
- Cross-referencing and trend analysis from inpatient and outpatient monitoring
- Data trends and AI/ML identify patterns, provide early detection, and notifications
- Increases data points for clinical research

▪ **Efficient, Automated Processes**

- Technology augments human abilities
- Equipment tracking and system scheduling

▪ **Can help with multiple tasks today**

- Remote patient monitoring
- Glucose monitoring
- Heart-rate monitoring
- Ingestible sensors
- Robotic surgery

Key IoMT Technology Enablers

■ Compute

- Critical components are a low power core (Cortex M33 or other), support for 1.5V supply, CSP package for extremely small size, high accuracy ADC and other analog and digital peripherals.

■ Bluetooth

- Allows for continuous monitoring / real-time data analysis of biometrics that give us a more complete and accurate picture of our health, applicable to a range of conditions.

■ Wi-Fi

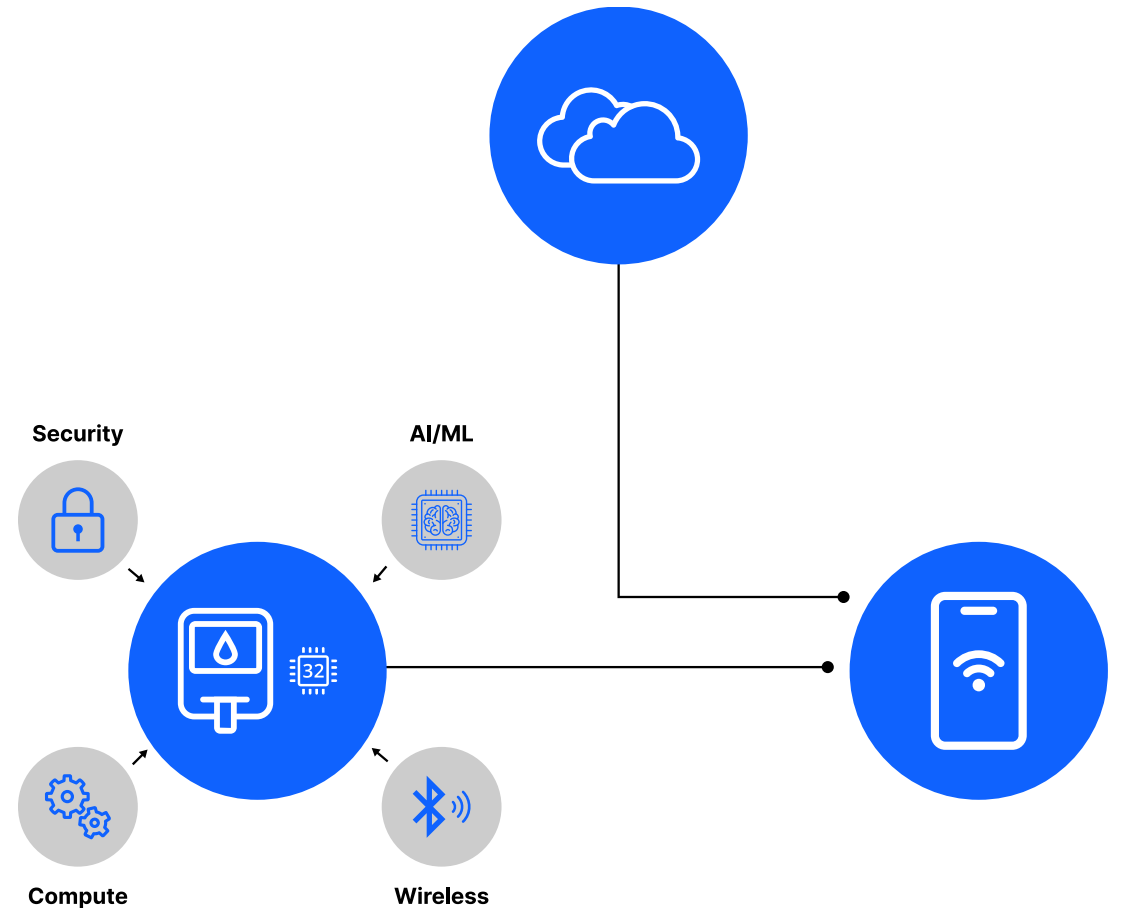
- Allows for home monitoring and integration of a variety of technologies into a life supporting application. Examples for Aging in Place include gait monitoring, location tracking, security, food and exercise management, and the combination of potentially hundreds or even thousands of data points to provide (to the person or family / caregivers) a real-time picture of the persons state and well-being.

■ AI/ML

- The continuous stream of multiple sources of biometric and other data related to a person allows for the real-time detection and notification of emergency conditions, trend changes, and an accurate view into an individual that was never before possible.

■ Security

- 82% of healthcare organizations have experienced a cyber-attack on their IoT devices. The average cost of resolving a healthcare IoT cyber-attack is \$346,205. Security solutions such as Secure Vault and regulations like DTSec, SESIP L3, IEEE 2621, IEC 62304, will help medical device makers to protect users from rapidly evolving cyber threats



Key Takeaways



- Pervasive IoT sensors and biometric data
 - More information to aid our decision making
 - Data collection where previously not possible
 - Continuous data for accurate picture
 - Data combined from multiple sources
- Real-Time view of ourselves and our loved ones
 - Early warning for preventative action
 - Monitor children or elderly for peace of mind
- Innovation in AI/ML and advanced computing
 - Extract valuable, actionable information out of this data
 - Optimize sensors / devices for longer battery life
- These technologies combined allow us to live longer, healthier, more satisfying lives

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Thank you!

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Q&A

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