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**APT REPORT**

**REQUIREMENTS AND FRAMEWORK OF**

**IOT OLDER PERSON CARE SOLUTION**

***Edition: May 2024***

**The 36th APT Standardization Program Forum (ASTAP-36)**

**20 – 24 May 2024, Bangkok, Thailand**

**(Source Document: ASTAP-36/OUT-19)**

**No. APT/ASTAP/REPT-58**

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1. **Scope**

This report focuses on various components required for the implementation of IoT older person care. The scope of this report is as follows:

* Introduction to Older person care ecosystem including the need for older person care solutions
* Use cases of older person care solution
* Requirements of the older person care solution
* Existing older person care solutions that have been deployed and challenges within the scope of implementation

1. **References**

* Active ageing: a policy framework. Geneva: World Health Organization, 2002
* Decade of Healthy Ageing: Plan of Action. Geneva: World Health Organization, 2020
* Leveraging digital technologies to achieve universal health coverage and improve heath outcomes: World Health Organization Global Strategy on Digital Health 2020 – 2025
* World Population Prospects 2022: United Nations Department of Economic and Social Affairs

1. **Terms and Definitions**

Terms used in this report are as follows:

* 1. **active ageing [WHO]:** The process of optimizing for health, participation and security to enhance quality of life as people age.
  2. **device** [ITU-T Y4000/Y.2060]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.
  3. **healthy ageing** [WHO]: The process of developing and maintaining the functional ability that enables well-being in older age.
  4. **Internet of Things (IoT)** [ITU-T Y.4000/Y.2060]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving, interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – In a broad perspective, the IoT can be perceived as a vision with technological and societal implications.

1. **Abbreviations and Acronyms**

Abbreviations used in this document

AAL Ambient Assisted Living

API Application Programming Interface

BAN Body Area Network

ECG Electrocardiogram

EHR Electronic Health Records

HIPAA Health Insurance Portability and Accountability Act

IoT Internet of Things

SDG Sustainable Development Goal

SSL Secure Socket Layer

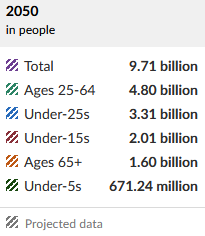
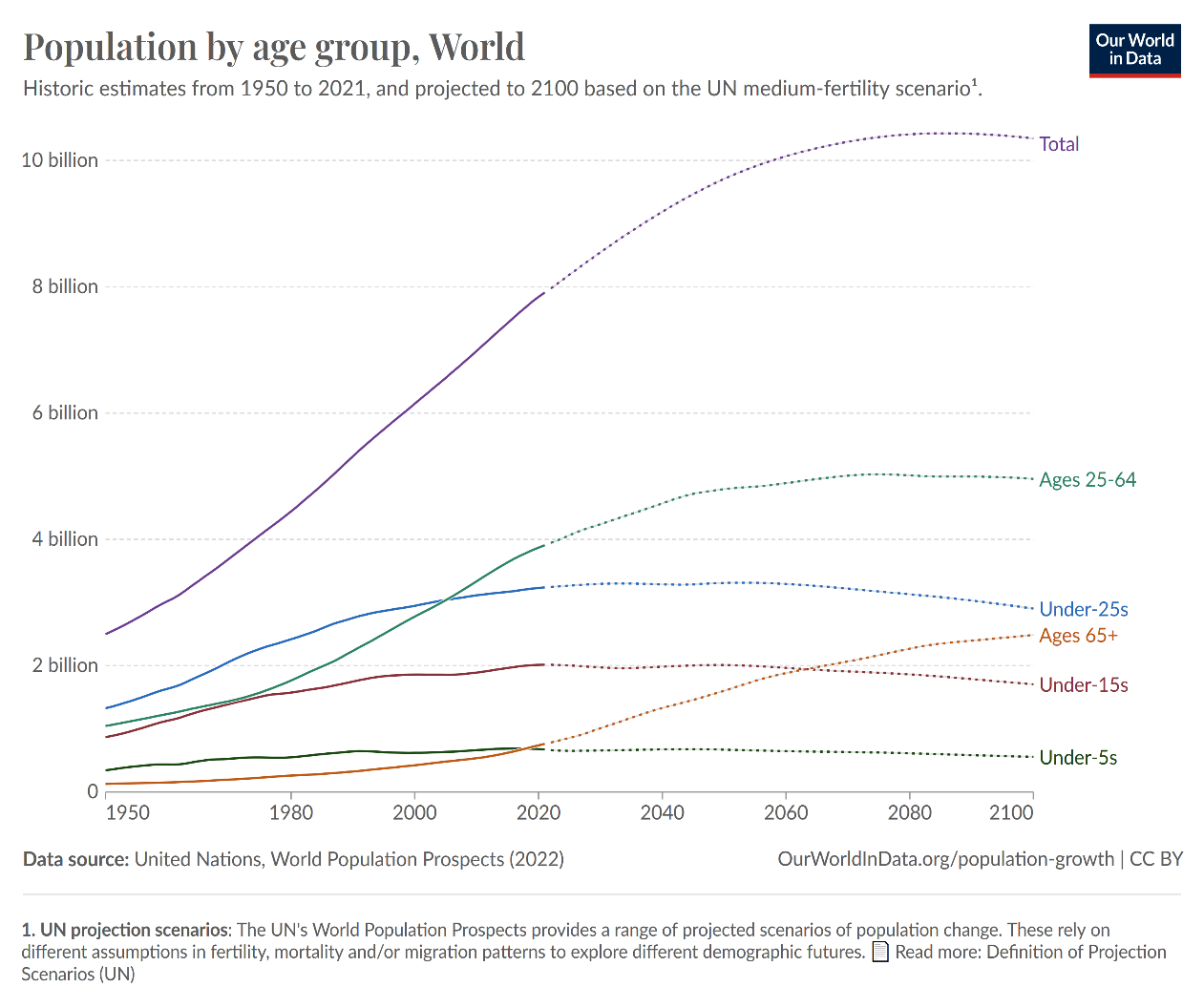
TLS Transport Layer Security

1. **Introduction of IoT Older Person Care Solution**

According to United Nation’s World Population Prospects, 2022, it is projected that there will be a rapid increase in the percentage of aging population throughout the world.

The percentage of the global population aged 65 and above is expected to rise from 9.7% in 2022 to 16.4% in 2050 , with profound effect to the health care and support systems. It is projected that by 2050, the number of individuals aged 65 years or above across the world will be twice the number of children under age 5 and almost equivalent to the number of children under 12 years.

Figure 5.1. United Nations World Population Projection



As people age, the intrinsic capacity (physical and mental capacities) tends to decline while their health issue becomes chronic and complex. This rapidly aging demographic will directly affect social, economic and health outcomes. It is known that multimorbidity (presence of multiple chronic conditions at the same time) is increasingly prevalent with age. Some of the ailments includes dementia and Alzheimer’s disease, frailty Parkinson’s and cardiovascular disease. Hence, existing healthcare systems must be tuned to support older person and solutions that allow active and healthy ageing.

Digital technologies can assist in healthy ageing and contribute to achieving multiple SDGs, including good health and well-being (SDG 3), no poverty (SDG 1), gender equality (SDG 5), reduced inequalities (SDG 10), and sustainable cities communities (SDG 11), by boosting quality healthcare services and addressing the medical needs for the older person population. These technologies can help to constantly monitor the movement and conditions of older person and provide intervention if required. Interconnected sensing technology, such as IoT wearables and devices, provide reliable solutions with remote monitoring, alleviating the burden of caregiver effort and supporting clinical decision making.

IoT and other technologies such as artificial intelligence, can provide an excellent support system for healthy ageing. There are various IoT solutions for older person care such as using wearable devices to measure health parameters, detect a fall, send alert when the wearer moved out of a boundary, IoT health devices to record and update health readings, and using cameras to detect movements. Data generated from these devices is useful for generating predictions, and sending alerts based on a pre-configured rule.

1. **Use Cases of IoT Older Person Care**

There are few use cases of IoT older person care, and each has its own components.

* 1. **Health monitoring and healthy ageing**

One of the key aspects for older person care is remote monitoring of health parameters. Constant remote monitoring provides efficient care and immediate action based on the health data. System with analytics features could further provide more informed decision making with prediction of the individual health condition. Health data generated from IoT devices is sent to IoT platform or system for further action.

Table 6.1. Health monitoring and healthy ageing use case

|  |  |
| --- | --- |
| Scenario | * Measure the health parameters like heartbeats, blood pressure, glucose level, temperature and send the readings to a system for monitoring. |
| Actors | * Devices to measure the health parameters and connected to network to send data to a system. The device could be a standalone device or a wearable device like a watch. * User – person to monitor using the devices. The user would get the readings personally or with assistance at regular time or use a wearable device that sends data periodically to a monitoring and management system. |
| Stakeholders | 1. The individual being monitored 2. Family members 3. Care centres 4. Hospital / clinics 5. Government |
| Preconditions | * For wearable device, wearer must wear the device all the time (except when it requires charging for some) to ensure measurement is taken constantly * For manual device, user must conduct regular measurements |
| Triggers | * Send alerts either from the end device or from the system when there are abnormal readings. |
| Use case brief | **Wearable device**   1. Device is configured to automatically measure and send the data at a regular period 2. User wears the device 3. Device measures the parameters and send to IoT platform or system 4. System records and analyses the data 5. System displays the data using various means including dashboard and mobile application 6. System uses analytic algorithm for prediction 7. System sends alerts if abnormal readings detected   **Standalone device**   1. User conduct manual measurement at suggested intervals using IoT device/s 2. Device sends data to IoT platform or system 3. System records and analyses the data 4. System displays the data using various means including dashboard and mobile application 5. System uses analytic algorithm for prediction 6. System sends alerts if abnormal readings detected |

* 1. **Safety and movement monitoring**

Healthy ageing also involves the movement monitoring of the older person at home. Some older person with diseases like dementia, must constantly be monitored to ensure their whereabout and safety.

Fall detection systems alert the user and healthcare provider after a fall has occurred, telling them to call for immediate medical aid. They also constantly measure the user’s speed of movement in all directions. Such devices have accelerometers and processors that can tell the difference between regular activity and a sudden fall. Automatic fall detectors are equipped with wearable sensors that can be integrated into belts, watches, and shoes.

Table 6.2. Safety and home security monitoring use case

|  |  |
| --- | --- |
| Scenario | * Monitor the movement of the older person, especially those with dementia and Alzheimer disease and those who are staying alone. |
| Actors | * Devices to measure the location of the wearer or device to detect fall or device that triggers certain actions. Another input device is video camera to monitor movement * User – person being monitored (location and fall detection) |
| Stakeholders | 1. The individual being monitored 2. Family members 3. Care centres 4. Hospital / clinics 5. Government |
| Preconditions | * For wearable device, wearer must wear the device all the time (except when it requires charging for some) to ensure measurement is taken constantly * Fix devices must be active all the time to check on the movement of older person |
| Triggers | * Send alerts either from the end device or from the system when there are abnormal readings. |
| Use case brief | **Wearable device**   1. Device is configured to automatically measure and send the data at a regular period 2. User wears the device 3. Device measures location and other fall detection and send to IoT platform or system 4. System records and analyses the data 5. System displays the data using various means including dashboard and mobile application 6. System uses analytic algorithm for prediction 7. System sends alerts if abnormal readings detected such as wearer goes out of a boundary or a fall is detected   **Standalone device**   1. Device sends data to IoT platform or system either at regular interval or when a fall is detected or when an action is performed (like opening or closing the main door) 2. System records and analyses the data 3. System displays the data using various means including dashboard and mobile application 4. System uses analytic algorithm for prediction 5. System sends alerts if a fall is detected |

* 1. **Social engagement for older person**

Social engagement is an important aspect of older person care, as it can help reduce loneliness and improve mental health. IoT technology can be used to facilitate social engagement in older person care in various ways.

Table 6.3. Social engagement use case

|  |  |
| --- | --- |
| Scenario | * IoT and other types of devices are used to facilitate social interaction and engagement for older person |
| Actors | * Devices used for interaction with the older person * User – older person interacting with the devices |
| Stakeholders | 1. Family members 2. Care centres 3. Hospital / clinics 4. Government |
| Preconditions | * Social robots must be customized to cater for the specific need of the older person * Internet connection available all the time |
| Use case brief | 1. Smart speakers: These devices which can play music, audiobooks, or podcasts and engage older person in conversation. These speakers can also send relevant information to the stakeholders 2. Social robots: These robots are specifically designed for social interaction such as companion robots or robotic pets. They can engage in conversation, play games, and provide entertainment for older person. 3. Video conferencing system: These includes tables, smartphones, smart TV and other devices that can be used in video calls between the older person and their loved ones or caregives. |

The choice of IoT devices used in older person care social engagement will depend on the specific needs and preferences of the older person and their caregivers. By leveraging a combination of these devices, it is possible to provide tailored and meaningful social experiences for older person, which can improve their mental well-being and quality of life.

1. **Requirements of IoT Older Person Care**

An ecosystem for IoT older person care consists of 5 main components as highlighted in the Figure 7.1 below. The subsection will provide more information for each component.

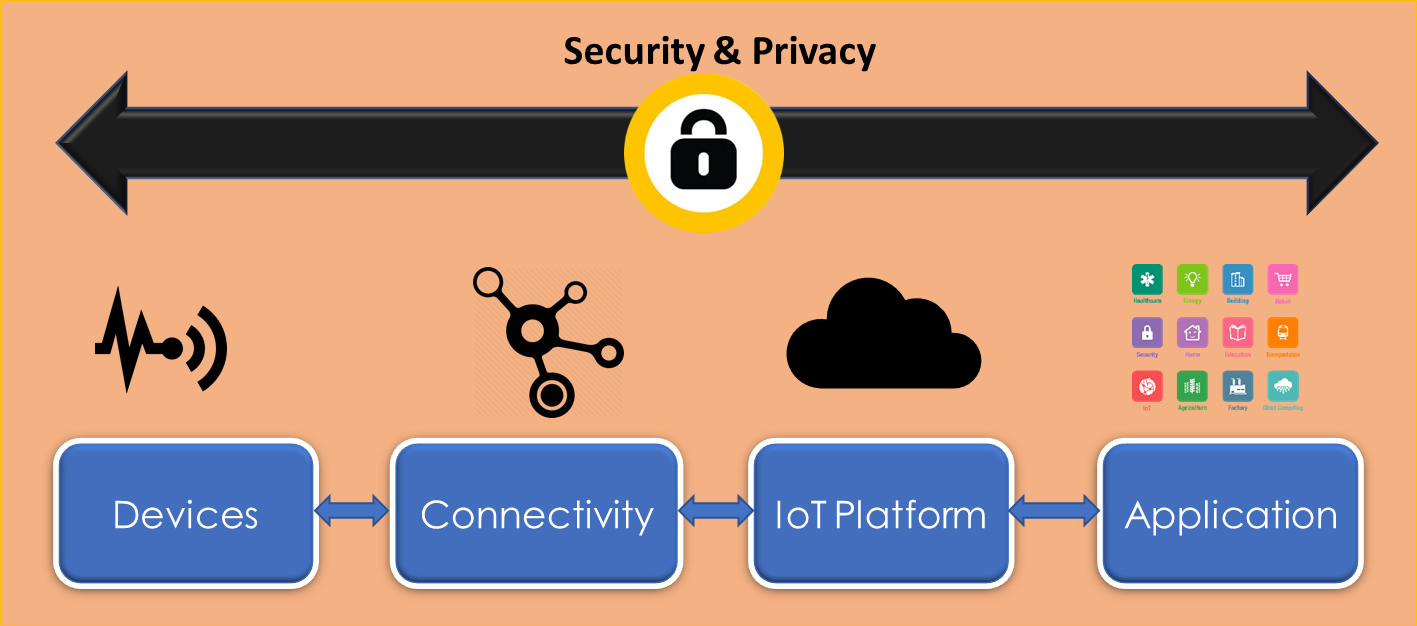


Figure 7.1. IoT Older person care ecosystem components

* 1. **Devices**

This section provides the IoT devices and sensors for the care of older person. The list of devices and sensors provided here are not exhaustive.

Table 7.1. List of devices and sensors for older person care

|  |  |  |
| --- | --- | --- |
| Device Categories | Device Types | Descriptions |
| Wearable | * Wrist-worn * Headband * Pendant * Smart ring / bracelet * Camera clip * Clothing | * Wearable are worn on the body and use technology to monitor and track various aspects of health and wellness. These wearables can help seniors stay active, maintain their independence, and manage chronic health conditions. * The sensors in these wearable devices may have motion tracker and biometric sensors to measure vital signs and to detect fall |
| Smartphones | * Smartphones | * Various sensors in a smartphone can be used in older person care. This includes detecting location using GPS, measure pulse oxygen saturation, camera, and microphone. |
| Home monitoring sensors | * Presence / Motion sensor * Contact sensor * Smoke detector * Air quality sensor * Gas detector * Flood sensor * Camera * Microphone * Weighing scale * Biometric sensors | * Usually ambient and unobtrusive in an AAL context. * Consists of indoor positioning systems, emphasizing on human activity recognition, biometric sensors, smart home sensors (example: bed occupancy sensor), as well as environment sensor such as gas detectors. * Motion sensors in smart home can be used detect a fall * Cameras are used in surveillance/movement of older person * Microphone placed at strategic location or within the smartphone can help to gather sound from older person * Some of biometric sensors includes measuring body temperature, electrocardiogram (ECG), pulse oxygen saturation, blood pressure, blood glucose. |
| Daily activity monitoring | * Wearable devices * Bed occupancy sensor * Chair occupancy sensor * Toilet presence sensor * Sleep monitoring | * Bed/chair/toilet occupancy to detect the movement of older person and send the data to the IoT Platform * Sleep monitoring is to measure and track various physiological and behavioral aspects of sleep, such as heart rate, movement, sleep cycle. This useful data provides valuable insights into sleep patterns and help older person to improve their sleep quality |
| Home actuators | * Emergency push button * Smart lamp * Door lock * Speakerphone * Automated doors | * Devices that can be installed in homes to assist with various tasks and activities of daily living for seniors. |
| Gateway | * Aggregation points * Gateways * Mobile Gateways | * Aggregation points gather data from sensor nodes and transmit it to the IoT platform / cloud through a Gateway. * Gateways and mobile gateways receive data from aggregation points or sensor nodes and transmit it to IoT platform. It also sends the data to the actuators. |

* 1. **Connectivity and Communication**

This section provides the various connectivity channels and the communication types that can be used to send data from IoT older person care devices and sensors to an IoT platform.

Depending on the type of device and the type of solution, device connectivity ranges from short range to long range. Examples of IoT older person care devices connectivity is given in table below.

Table 7.2. Examples of IoT older person care device connectivity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Connectivity category** | **Wireless Tech.** | **Frequency** | **Range** | **Data Rate** | **Maximum Nodes** |
| **Short range** | **RFID** | 13.56 MHz 860–960 MHz | 0–3 m | 640 kbps | 1 at a time |
| **Bluetooth** | 2.4–2.5 GHz | 1–100 m | 1–3 Mbps | 1 M + 7 S |
| **BLE** | 2.4–2.5 GHz | 1–100 m | 1 Mbps | 1 M + 7 S |
| **HomePlug GP** | 1.8–30 MHz | ~100 m | 4–10 Mbps | - |
| **EnOcean** | 902, 928, 868 MHz | 30–300 m | 125 kbps | - |
| **ZigBee** | 2.4–2.5 GHz | 10–100 m | 250 kbps | 65,533 |
| **WiFi** | 2.4–2.5 GHz | 150–200 m | 54 Mbps | 255 |
| **DASH7** | 315–915 MHz | 200 m–2 km | 167 kbps | - |
| **Insteon** | RF: 869.85, 915, 921 MHz powerline: 131.65 KHz | 40–50 m | 38 kbps (RF) 2–13 kbps (powerline) | 64,000 nodes per network |
| **NFC** | 13.56 MHz | 5 cm | 424 kbps | 1 at a time |
| **Wireless HART™** | 2.4 GHz | 50–100 m |  | - |
| **6LoWPAN** | 2.4 GHz | 25–50 m | 250 kbps | - |
| **ANT** | 2.4–2.5 GHz | 30 m | 20–60 kbps | 65,533 in one channel |
| **Z-Wave** | 860–960 MHz | 100 m | 9.6–100 kbps | 232 |
| **Long range** | **Mobile Telecommunication** | 2G, 4G, 5G, 6G | 15 km | Up to 1 Gbps | - |
| **Sigfox** | 868/902 MHz | 10–50 km | 10–1000 bps | 50,000 |
| **LoRA** | EU868/US915/IN865 MHz  2.4 GHz | 10 – 20 km | 50 kbps | 10,000 |

* 1. **IoT platform**

IoT platform is used to aggregate data from various IoT older person care devices. There are different types and functionalities of IoT platform; vertical IoT platforms which are specifically used for IoT older person care solution, and horizontal platforms which are used for any IoT solutions. Figure 7.2 provides a general platform architecture which can be used for IoT older person care devices and solutions.

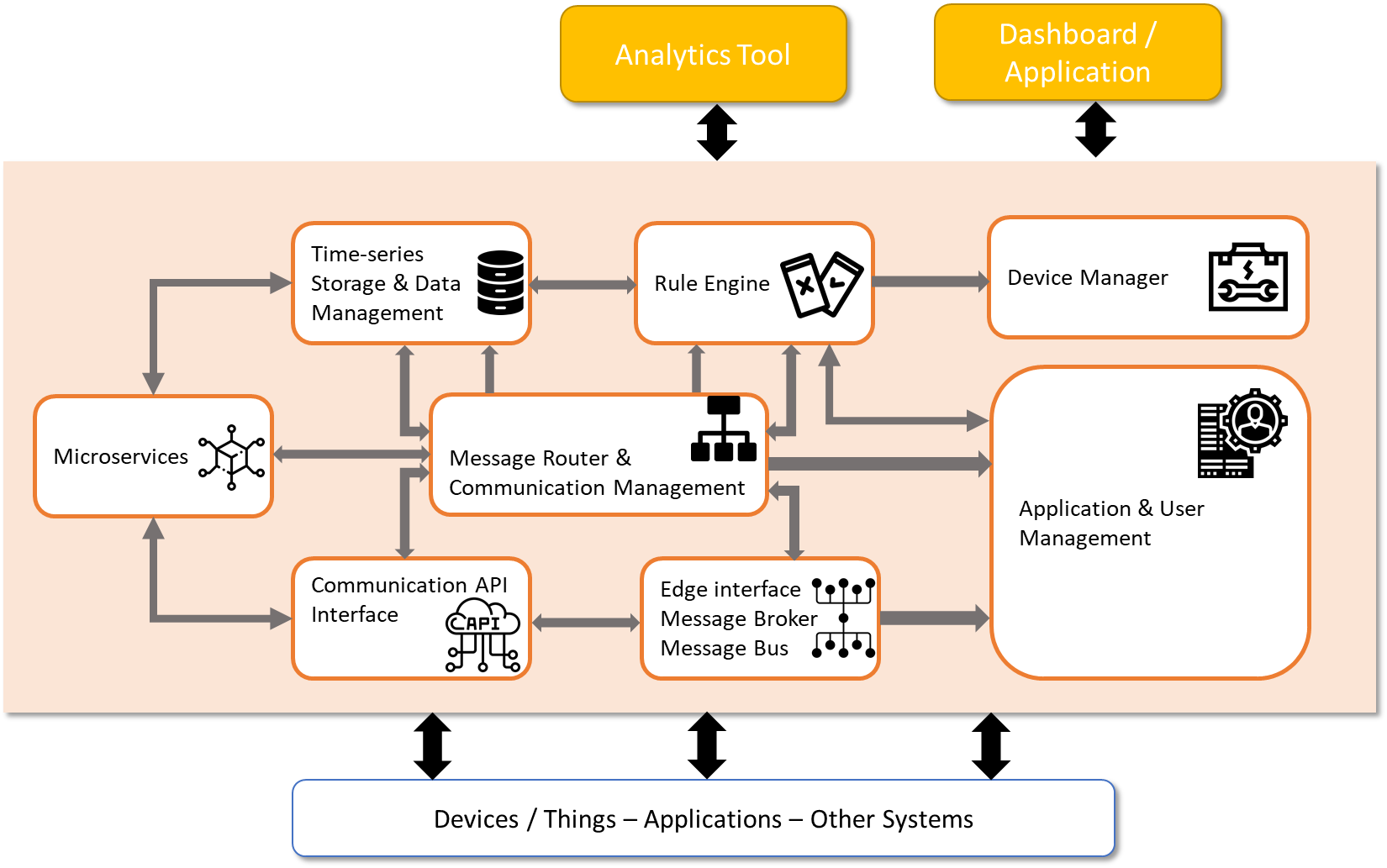


Figure 7.2. General IoT Architecture. *(Figure adapted from “Build Your Own IoT Platform”, Anand Tamboli, APress)*

* 1. **Applications**

Some of the IoT older person care applications are given in section 9.

* 1. **Security and privacy**

IoT-based health care devices and applications are expected to deal with critical personal information such as private health data. Older person care monitoring is an area where privacy is particularly complex. The IoT devices may be connected to global information network to make them easy to be accessed at any point in time from any location. As such, the data must be safeguarded using some mechanism to avoid it being used by cyber criminals or people with interest.

* + 1. **Data security**

Data security is an important concern when it comes to older person care, as it involves the collection and storage of sensitive personal information about older person. Some of the data security considerations related to older person care include:

1. Confidentiality: Healthcare providers and caregivers must ensure that the personal and health-related information of older person is kept confidential and not shared with unauthorized individuals or entities.
2. Availability: This refers to the ability to access and use critical data related to the care of older person when needed. It includes personal and medical information such as medical history, medications, treatment plans, and other relevant data that are important for delivering high-quality care.
3. Integrity: Data integrity in older person care refers to the accuracy, completeness, and consistency of personal and medical information related to the care of older person. Maintaining data integrity is essential for ensuring that caregivers have access to reliable and accurate information about an older person’s medical history, current condition, and care plan.
4. Data storage and access: Electronic health records and other personal data must be stored securely and only accessible to authorized individuals who have a legitimate need to access the information.
5. Cybersecurity: Healthcare providers and caregivers must take steps to protect electronic systems and devices from cybersecurity threats, such as malware, phishing, and hacking.
6. Physical security: Healthcare facilities and homes must be secure to prevent theft, unauthorized access, or physical damage to personal and health-related information.
7. Compliance with regulations: Healthcare providers and caregivers must comply with laws and regulations related to data privacy and security, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States.
8. Data backups and disaster recovery: Healthcare providers and caregivers must ensure that data is regularly backed up and that there are plans in place to recover data in case of a disaster or data breach.
   * 1. **Data accessibility**

Data accessibility in older person care involves ensuring that relevant personal and health-related information is available to authorized individuals when needed. The following are some of the data accessibility aspects in older person care.

1. Electronic health records (EHRs): EHRs can improve data accessibility by allowing authorized individuals to access and share information across different healthcare settings and providers.
2. Interoperability: Interoperability refers to the ability of different systems and devices to exchange and use data. Interoperable systems can improve data accessibility by allowing authorized individuals to access and share information across different platforms.
3. Care coordination: Care coordination involves ensuring that different healthcare providers involved in the care of an older person have access to relevant information to facilitate communication and collaboration.
4. Consent and authorization: Healthcare providers and caregivers must obtain consent and authorization from older person or their authorized representatives to access and share personal and health-related information.
5. Telehealth: Telehealth involves the use of technology to deliver healthcare services remotely. Telehealth can improve data accessibility by allowing healthcare providers to access and share information with older person who are not physically present.
6. Patient portals: Patient portals are online platforms that allow patients and their authorized representatives to access personal and health-related information. Patient portals can improve data accessibility by allowing older person and their caregivers to access information from any location.
   * 1. **Identification**

Identification involves verifying the identity of older person and ensuring that they receive the appropriate care and services. There are various identification methods for older person care. Some of the identification methods are as follows.

1. Identification documents: This includes identification document, government-issued ID and other documents that are legally recognised.
2. Biometric identification: Biometric identification, such as fingerprint or facial recognition, can be used to verify the identity of older person and ensure that they receive the appropriate care and services.
3. Medical identification: Medical identification, such as a medical alert bracelet or necklace, can provide important information about an older person’s medical conditions and history to healthcare providers in case of an emergency.
4. Caregiver identification: Caregivers and healthcare providers may need to provide identification to verify their identity and credentials, and to ensure that they have appropriate authorization to provide care to older person.
5. Electronic health records (EHRs): EHRs can be used to verify the identity of older person and ensure that they receive appropriate care and services across different healthcare settings and providers.
   * 1. **Intrusion and surveillance**

Intrusion and surveillance involve monitoring and tracking the activities of older person. While intrusion and surveillance can be useful in ensuring the safety and well-being of older person, it is important to balance these measures with respect for their privacy and autonomy. Below are some considerations related to intrusion and surveillance.

1. Legal and ethical considerations: Intrusion and surveillance in older person care must be conducted in accordance with applicable laws and ethical principles, such as the right to privacy and the right to make decisions about one's own life.
2. Informed consent: Older person or their authorized representatives must provide informed consent before intrusion or surveillance is conducted.
3. Types of surveillance: There are different types of surveillance, including video monitoring, GPS tracking, and biometric monitoring. The type of surveillance used should be appropriate for the specific needs and preferences of the older person.
4. Transparency and communication: Healthcare providers and caregivers should communicate openly and transparently with older person and their families about the purpose and scope of intrusion and surveillance.
5. Respect for privacy: Intrusion and surveillance should be conducted in a manner that respects the privacy and autonomy of person being monitored. This may include avoiding monitoring in certain areas or during certain activities or using non-intrusive methods of monitoring.
6. Security and data protection: Intrusion and surveillance in older person care must be conducted in a manner that ensures the security and protection of personal information and data.
   * 1. **Data secondary usage**

Data secondary storage is an important consideration in older person care, as it involves storing personal and health-related information about older person in a secure and accessible manner. There are few methods to store older person care data safely and securely.

EHRs are electronic records of personal and health-related information that can be accessed and shared by authorized individuals across different healthcare settings and providers. EHRs can improve data secondary storage by ensuring that relevant information is accessible when needed.

Cloud storage is used to store data on remote servers that can be accessed over the internet. Cloud storage can improve data secondary storage by providing a secure and scalable solution for storing large amounts of data. It is important to have secondary data storage and recovery as it can ensure that important data is not lost due to unforeseen events.

This data secondary storage in older person care must be conducted in compliance with applicable laws and regulations, such as Health Insurance Portability and Accountability Act (HIPAA) in the United States.

* + 1. **Device security**

As the growing use of IoT devices in older person care offers tremendous benefits, it is important to ensure their security by safeguarding the privacy and well-being of older person. Below are some considerations related to IoT device security:

1. Strong Authentication**:** Implement robust authentication mechanisms to prevent unauthorized access. This could include passwords, two-factor authentication, or biometric authentication where appropriate.
2. Secure Communication**:** Ensure data transmitted between devices and servers is encrypted to protect privacy and prevent interception. Secure protocols like TLS/SSL should be used.
3. Regular Updates**:** Maintain and update device firmware regularly to patch vulnerabilities and address security flaws.
4. Device Management**:** Implement a centralized management system to monitor device health, track activity logs, and detect potential security incidents.
5. User Education**:** Educate older person about basic cybersecurity practices, such as avoiding suspicious links and keeping passwords confidential.
6. Minimal Data Collection**:** Limit the amount of data collected by devices to only what's essential for care purposes.
7. End-of-Life Management**:** Develop a plan for securely disposing of or recycling retired devices to prevent data leaks.
   1. **Legal requirements**

Legal and ethical implementation of relevant technologies for older person care is important, especially considering the sensitivity of personal data and the vulnerability of older person. To ensure responsible and compliant solutions, several key legal requirements are suggested as follows:

1. Compliance with Data Protection Regulations: Comply with data privacy regulations, including local and global laws, regarding data collection, storage, usage, and user consent.
2. Transparency and Consent: Clearly inform users about the data collected by the system, its purpose, how it will be used, and who will have access to it. Obtain consent from users before collecting any data.
3. Data Minimization: Only collect the minimum amount of data necessary to fulfill the care objectives. Avoid collecting sensitive data unless essential.
4. Right to Access and Control Data: Users should have the right to access, rectify, and delete their data collected by IoT devices upon request.
5. Transparency in Data Usage: Clearly explain how user data will be used for care purposes and avoid any secondary use without explicit consent.
6. Data Ownership: Determine ownership rights of collected data. In most cases, the older person would likely retain ownership, with the care provider acting as a custodian.
7. Ethical Artificial Intelligence (if applicable): Ensure that data processing is ethical, unbiased, transparent and readily explained for responsible caregiving.
8. **IoT Framework for Older Person Care**

IoT (Internet of Things) framework for older person care refers to a system of interconnected devices and sensors designed to improve the quality of life and care for older person. This framework typically includes various sensors, wearables, and smart devices that can monitor the health and well-being of seniors, detect emergencies, and provide assistance with daily activities. The data generated by these devices can be analysed and used to create personalized care plans and enable remote monitoring by healthcare providers or family members. This technology has the potential to enhance the independence and safety of older person, as well as improve communication and coordination between caregivers and healthcare professionals. Figure 8.1 shows the IoT framework for older person care.

Text

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Figure 8.1. IoT Framework for Older person care

The framework as given in figure consists of the following (but not limited to):

* IoT devices and sensors: IoT devices and sensors can provide valuable information to caregivers and healthcare professionals, help seniors maintain their independence, and improve the overall quality of care for older person. Some of the devices are given in section 7.1
* IoT Platform: IoT platform for older person care is a software solution that can integrate data from various sensors, wearables, and devices to provide a comprehensive view of a senior's health and wellbeing. Such a platform can offer features like real-time monitoring, analytics, and alerts that can help caregivers and healthcare providers make informed decisions. Details of the platform is given in section 7.3
* Applications: There are various applications that can help improve the quality of life and care for older person by providing valuable information to caregivers and health professionals, improving safety and security, and enhancing communication and collaboration between all parties involved in their care.
* Stakeholders: There are several stakeholders involved in the successful monitoring of older person using IoT technologies. These include family members, care takers and health professionals who will monitor, interact, and provide interventions based on the data collected from IoT devices.

1. **Existing IoT Solutions for Older Person Care**

There are several IoT solutions for older person care which are given in this section.

* 1. **Older person care solution in Malaysia**
     1. **Introduction**

Based on the study conducted by World Health Organisation (WHO), However, the tempo of population ageing will accelerate in the next few decades. Malaysia will be an ageing nation by around 2030 when 14 % of the population will be 60 years old and over.

One of the alarming facts is, there is little evidence to suggest that older person today are experiencing better health. Good health in the aging population also differs between and within the area we live in. As the population ages further, age-dependent chronic (non-communicable) diseases such as ischaemic heart disease, diabetes, cancer, stroke, arthritis and dementia are likely to increase in terms of the absolute number of people affected (Prince MJ, 2015). 80 % of people over 65 in Malaysia have long-term disorders and 5 % have disability that requires continuous medical supervision.

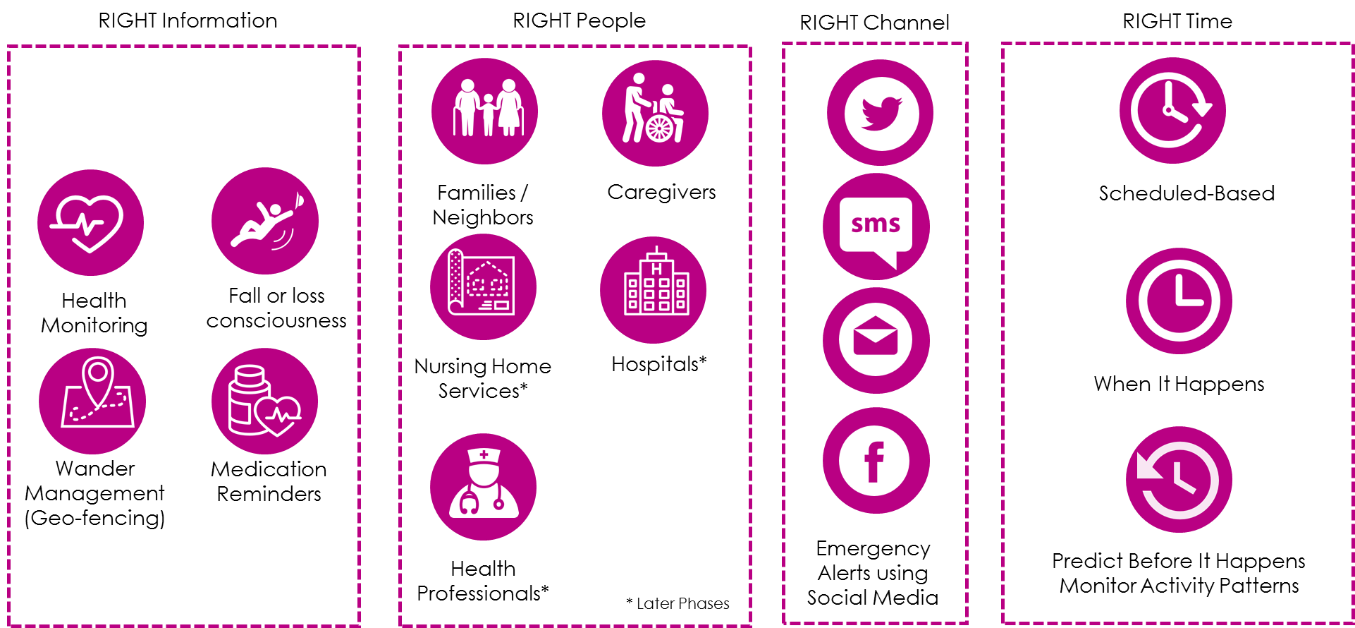
* + 1. **Solution**

One of the solutions is to use wearable device to monitor the older person’s location and basic health parameters. The devices used are consumer grade devices, hence the health data may not be accurate and cannot be used for medical diagnostic. However, these data are enough to provide relevant information to the stakeholders.

The objectives of the older person care solution are given below.

1. To constantly monitor the vital health parameters of older person using wearable devices.
2. To provide long-term affordable older person care solution.
3. To monitor the location of older person people and record their movement to avoid them being missing.
4. To provide a timely reminder for the older person to take medicines.

Figure 9.1 below shows the information collected from the devices, to whom the information will be sent, the right channel to send the data and when the information will be relayed.

Figure 9.1: Older Person Care Solution

The older person care solution provides is an ecosystem which consists of hardware, platform, application, analytics and connectivity to various group of people and relevant authorities. The ecosystem, as shown in Figure 9.2, requires collaboration with other local companies to provide hardware, application and systems.



Figure 9.2. Older Person Care Solution Ecosystem

The solution is a combination of hardware and software. In the first phase of implementation, we use one type of wearable devices. The watch sends data in two modes

* Periodically at predefined intervals. In this mode, the watch sends the recent number of steps, heart rate, location (if available) together with other communication related information
* After measurement of Blood pressure and ECG. In this mode, wearer must manually measure the blood pressure or ECG. The measurement data are then sent to the IoT platform for further processing and storage.

The watch communicates with the IoT platform using TCP/IP protocol whereas the front-end applications use REST API to interact with the platform.

The software consists of front-end application and back-end system. The back-end system is also referred as the IoT middleware.

Front-end applications consist of the following:

* Mobile App on both Android and iOS version

This application is for the next of kin or anyone who wants to monitor the wearer. They can view the latest location and other health parameters.

* Desktop Application – for individual account

The feature in this app is similar to the mobile app.

* + 1. **Summary**

The solution for older person is able to monitor the location, health and activity of the wearer anywhere with ease. Data analytics to calculate the health score as well as health prediction based on the collected data to be developed. Other development areas are fall detection and inclusion for more health-related parameters.

The solution would not only benefit the next of kin of the wearer but could also benefits other stakeholders such as the insurance companies, hospitals, pharmacies and Government health agencies.

This solution has greater potentials in other sectors as well such as monitoring people working at critical areas such as oil rigs, high rise buildings, etc.

* 1. **Older person care solution in Korea**
     1. **Introduction**

According to the statistics of Seoul Metropolitan City, as of 2023, the population of older person over 65 years old who are living alone is about 450,000, and about 140,000 of them are economically disadvantaged. In response to the need for real-time safety checks for older person living alone who are vulnerable to safety, health, and social relationships, Seoul City has conducted a health care service for older person living alone based on IoT device that can reduce the cost of initial introduction and alleviate the resistance to privacy invasion and/or feeling uncomfortable of wearable devices.

* + 1. **Solution**

The IoT-Based Older Person Care Service in Seoul is conducted through communication among the sensor installed in the target’s home, caregiver and monitoring center. As shown in Figure 9.3, sensor measures the movement of indoor objects, temperature, humidity, and brightness, and periodically sends it to the mobile phone app of the caregiver and the monitoring center.

A blue rectangle with arrows

Description automatically generated

Figure 9.3. Ecosystem of IoT-Based Older Person Care Solution of Seoul

The response method for each information collected by the sensor is as follows.

1. Movement: As shown in Figure 9.4, if no movement is detected for a certain period of time, the monitoring level rises, and if it reaches at certain alarm level, emergency procedure is taken.
2. Temperature: If the indoor temperature is above/below a certain level, visit the house to check the cooling/heating facilities and guide the evacuation center in case of facility failure.
3. Humidity: If the humidity continues to be above a certain level, it is diagnosed as a risk of harmful mold occurrence to the human body and supports facility improvement.
4. Brightness: If the indoor brightness is below a certain level, support for indoor lighting replacement.

A red and black sign

Description automatically generated

Figure 9.4. Sample of movement detection monitoring

The data collected by the sensor is periodically delivered to the mobile phone app of the caregiver and the monitoring center, and if there is a suspicion of abnormality, measures such as emergency report and facility check are taken. Monitoring information is managed not only 1:1 between the older person living alone and the caregiver/monitoring center, but also by aggregating data from multiple monitoring centers at the district and Seoul Metropolitan City levels. Through this, government can use the data as reference material for establishing welfare policies through analysis of the status of older person living alone and vulnerable points in the city.

* + 1. **Summary**

The older person health care service has been supplied to about 12,000 households from the start of the project in 2020 to 2022. As a result of this project, not only direct rescue of people who fell indoors or lost their way outdoors and could not return home for a long time, but also achievements such as improvement of living environment through repair/replacement of housing facilities were achieved.

1. **Conclusion**

The rapid growth of the ageing population necessitates a paradigm shift in caregiving. Fortunately, IoT technologies offer a promising approach to building a more efficient and supportive care ecosystem. These solutions empower independence for older person, enhance their safety, and provide valuable insights for caregivers and stakeholders. This vision paints a future where technology fosters a fulfilling and connected aging experience. However, unlocking the full potential of IoT requires responsible implementation. Robust security measures, ethical data practices, and adherence to legal frameworks are paramount. Continued research, development, and collaboration between healthcare professionals, technology developers, and policymakers are crucial to ensure a secure, dignified, and enriched life for our aging population.

This report equips members with a guide and case studies to facilitate the implementation of IoT solutions for older person care within their countries. It paves the way for a future where technology seamlessly supports well-being and independence for aging populations.