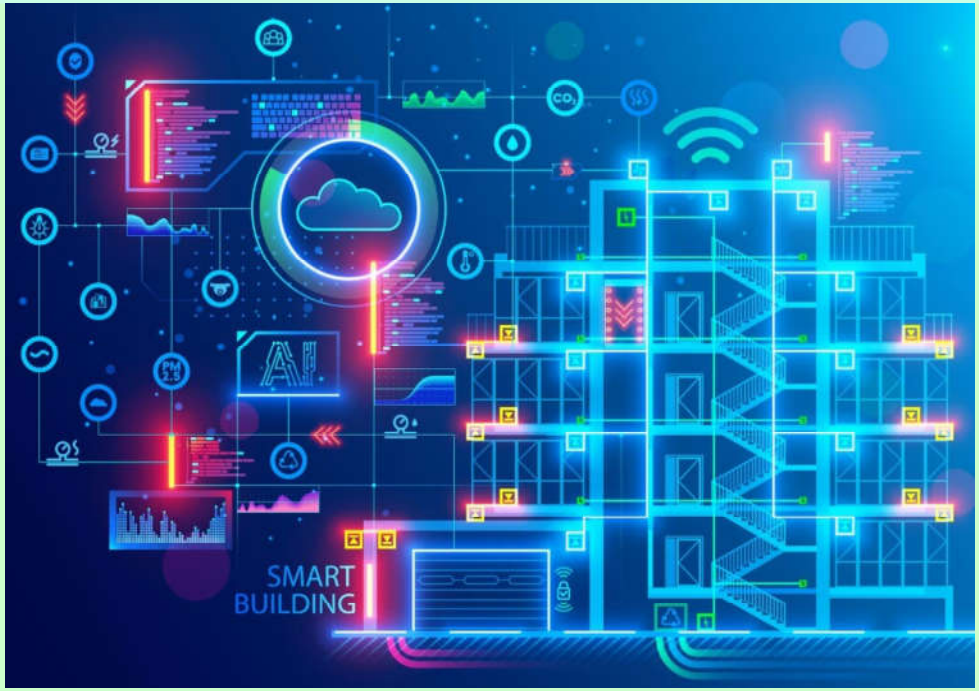
IDAT7219 Smart Building Technology

http://ibse.hk/IDAT7219/



智能大廈科技

Practical Examples

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The University of Hong Kong
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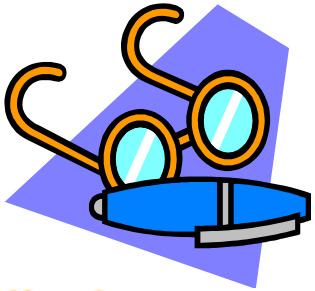
Sep 2024

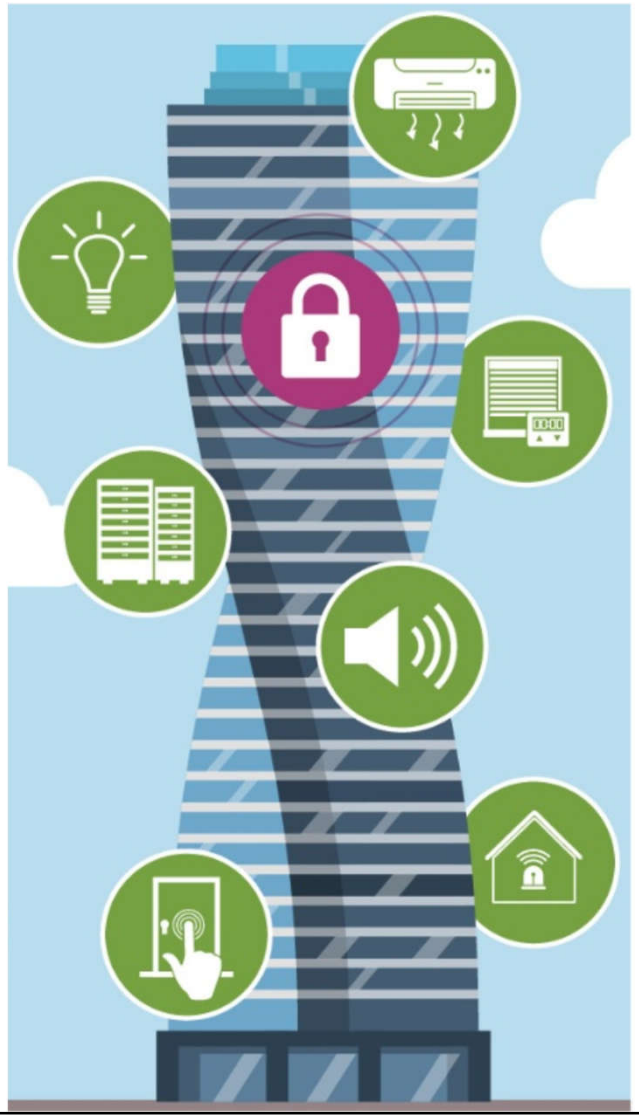
Contents

- Key factors
- Smart office examples
- Smart hotel examples
- Smart home examples
- Smart health living

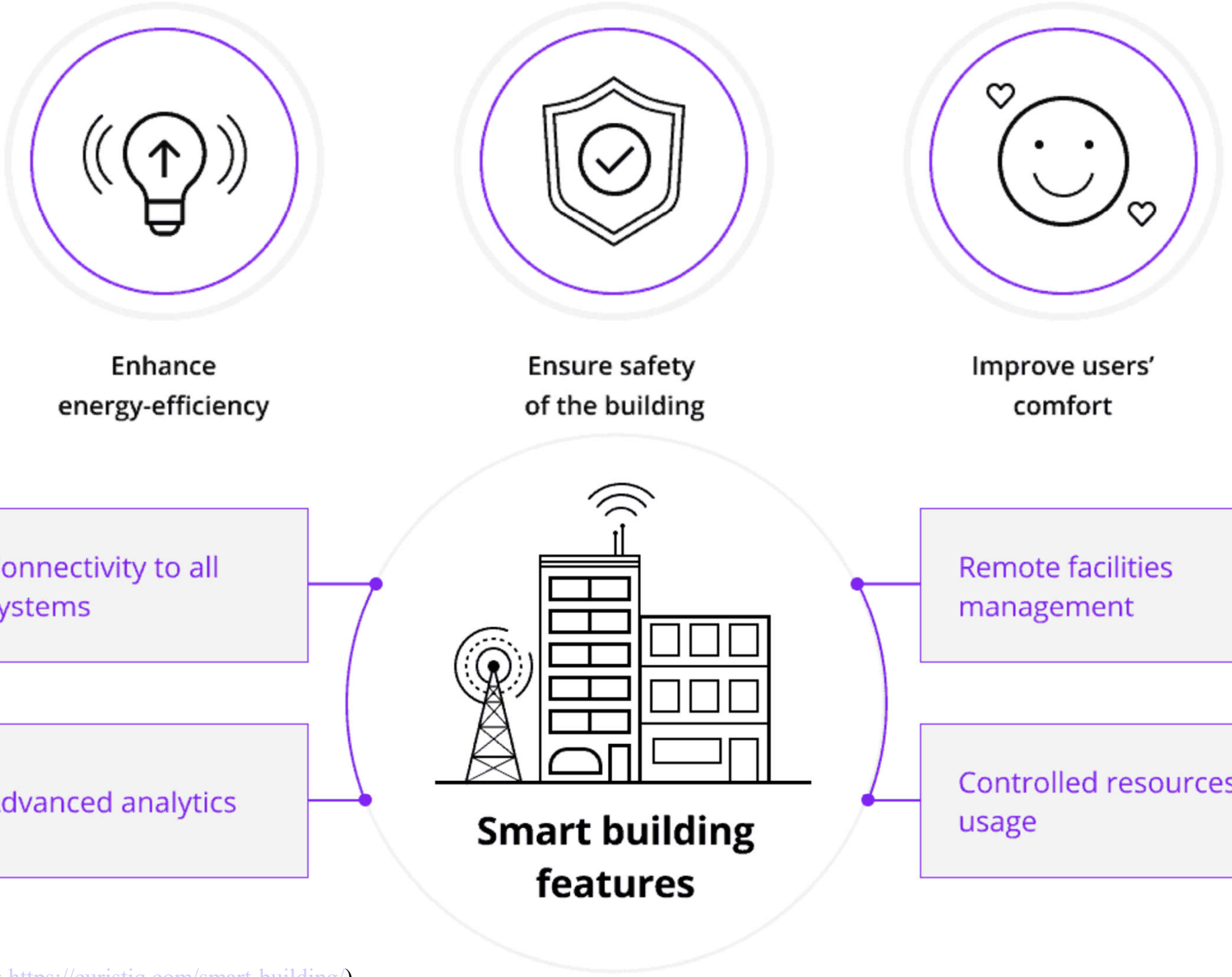
Key factors



- Smart building goals:
  - Enhance energy efficiency
  - Ensure safety of the building
  - Improve users' comfort
- Smart building features:
  - Connectivity to all systems
  - Remote facilities management
  - Advanced analytics
  - Controlled resources usage

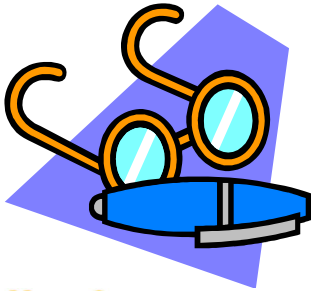


Smart building goals & features



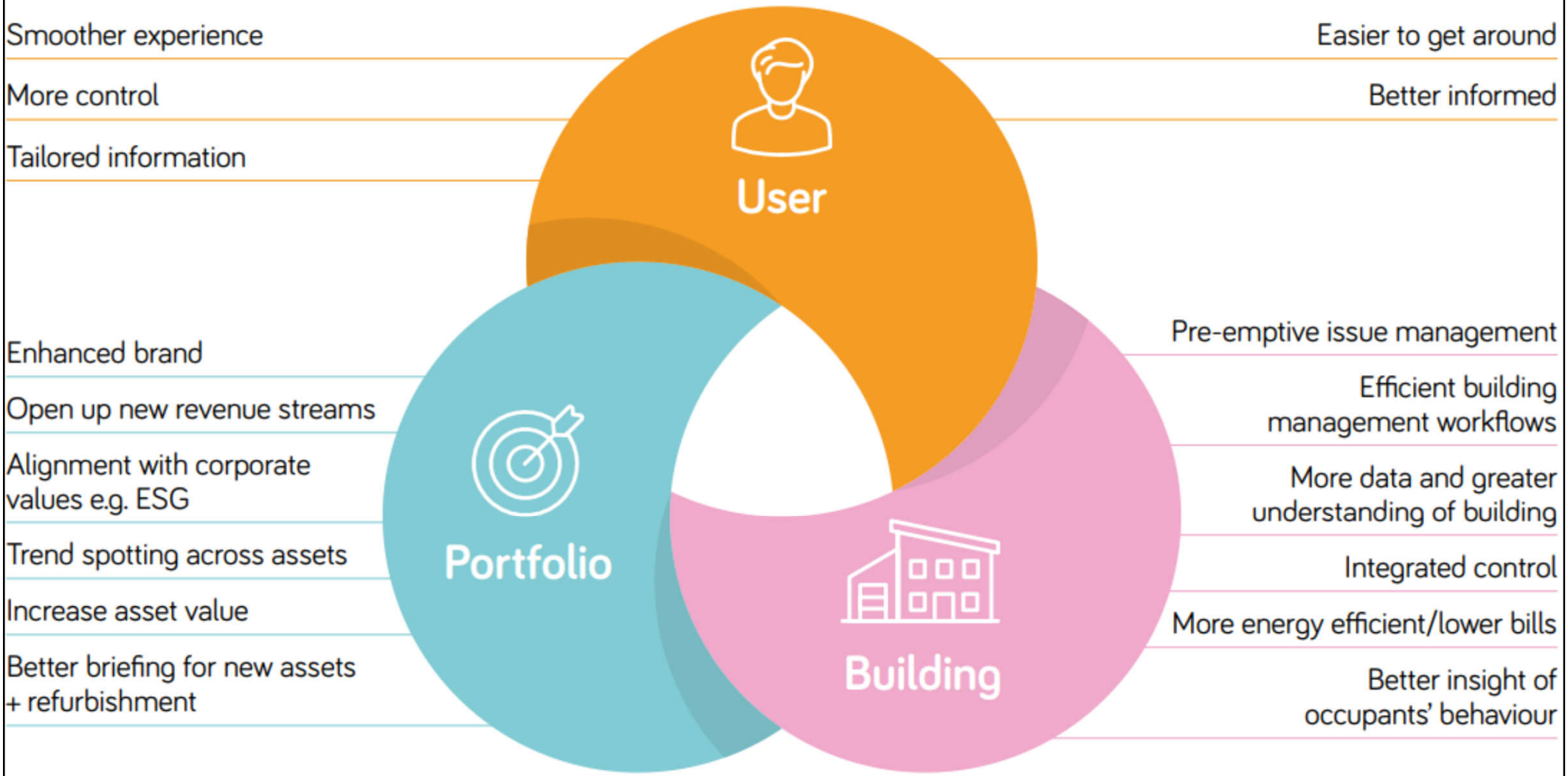
(Source: https://euristiq.com/smart-building/)

Key factors



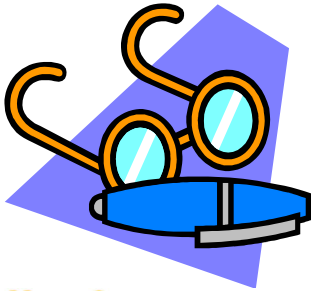
- Key opportunities of smart buildings:
  - Support business activities
  - Facilitate space versatility & management
  - Enhance maintenance regime
- Can benefit all building types, e.g. residential, healthcare, commercial, education & industrial
- Provide quantifiable data to assess actual performance to reduce operational costs & enhance financial & user comfort efficiencies

Smart building benefits from the user, building & portfolio perspective



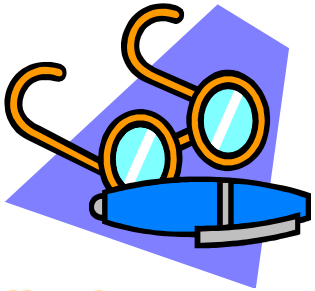
(Source: RIBA, 2024. *Smart Building Overlay to the RIBA Plan of Work*, Royal Institute of British Architects (RIBA), London. https://www.architecture.com/knowledge-and-resources/resources-landing-page/smart-building-overlay-to-riba-plan-of-work)

Key factors



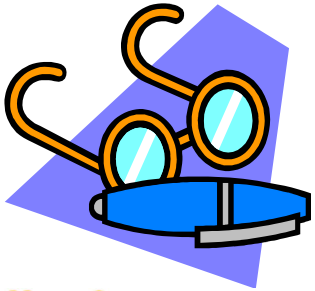
- The value in a Smart Building is not only the installation of the technology itself, but the improved outcomes created by the interaction between the people using the building & the technology
- It is at its most powerful when underpinned by a clear Digital Strategy, robust processes & appropriately skilled people using the data generated by a Smart Building

Key factors

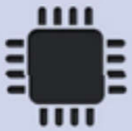


- 5 basic elements of smart buildings:
  - 1. Automation: to accommodate automatic devices or perform automatic functions
  - 2. Multi-functionality: to allow the performance of more than one function in a building
  - 3. Adaptability: to learn, predict & satisfy the needs of users & the external stress
  - 4. Interactivity: to allow interactions among users
  - 5. Efficiency: to provide energy efficiency & save time & costs

Key factors



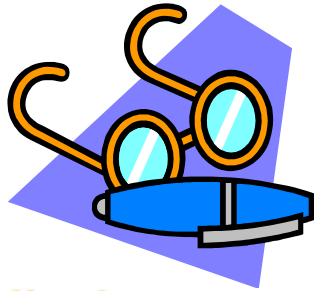
- Major considerations & components:
  - 1. End devices (e.g. sensors, smart meters)
  - 2. Gateway
  - 3. Connectivity (e.g. Wifi, Bluetooth)
  - 4. Data management & intelligence
  - 5. User interface (desktop, smart phone, tablet)
  - 6. Users (e.g. building manager, residents)
  - 7. Solution & service providers

7	Solution& Service Provider			Solution provider		Service provider: Paas, S2aaS...
6	Users			Building manager		Resident
				Support		
5	User Interface			Smartphone Tablet		Desktop
4	Data Management and Intelligence			Storage		Analytic
				AI		
3	Connectivity			Bluetooth		Wi-Fi
				Wired Ethernet		Wireless: Sigfox, LoRa
2	Gateway			Protocol gateway		Field gateway
1	End device			Wearables		Sensor
				Smart meter		

Smart building framework & considerations

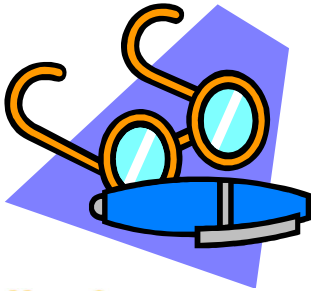
(Source: Xu W., Zhang J., Kim J. Y., Huang W., Kanhere S. S., Jha S. K. & Hu W., 2019. The design, implementation, and deployment of a smart lighting system for smart buildings, *IEEE Internet of Things Journal*, 6 (4) 7266-7281. https://doi.org/10.1109/JIOT.2019.2915952)

Key factors



- A smart building is a dynamic entity with interconnected components constantly communicating with each other, sharing data, & responding to real-time & anticipated needs
  - Each smart building ecosystem can be tailored to specific users & unique goals
  - For digital & AI transformations to succeed, companies need to understand the problems they want to solve & rewire their organizations for continuous innovation

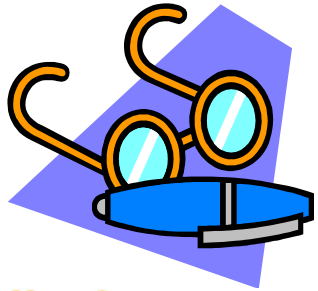
Key factors



- Five factors to accelerate smart building transformation:
  - 1. Adopt proactive maintenance (with predictive maintenance model)
  - 2. Invest in sustainable modernization
  - 3. Leverage sensors & communicating field devices (with smart sensors & controllers)
  - 4. Put data to work (with AI & data analytics)
  - 5. Harden building systems (cybersecurity)

(Source: Five factors to accelerate smart building transformation https://assets.new.siemens.com/siemens/assets/api/uuid:b37331fd-d9bf-4c3d-bc17-5078529c4435/Siemens-report-Five-factors-to-accelerate-smart-building-transformation.pdf)

Key factors



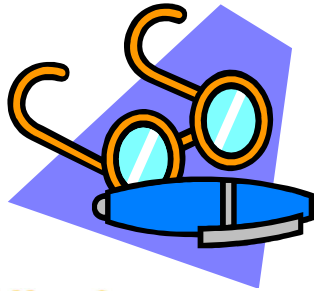
- Approach to support smart building projects:
  - Early planning & engagement is critical to successful outcomes & a cost effective project
  - Must address the crossover of technology, sustainability & the built environment
  - Require co-ordination with specialist supplier/designers to make timely decisions
  - Must consider the sensitivity of ‘current’ technology & future planning to anticipate emerging technology with clear requirements

Smart building digital capability categories

▪ **Spatial Engagement**: e.g. location, movement, environment sensing, navigation & wayfinding ▪ **Situational Awareness**: e.g. complex situation detection, AI situation composition, analytics ▪ **Connectivity**: e.g. wireless (Wifi, BLE, LoRa), roaming, human end user device, IoT endpoint ▪ **Access & Security**: e.g. identity, authentication, authorisation, permissions, context-aware authorisation, segmentation	▪ **Performance**: e.g. capacity, throughput, availability, reliability, accessibility, responsiveness, scalability ▪ **Architecture Quality**: e.g. modularity, interoperability, extensibility, future-proof, composability, portability ▪ **Service Management**: e.g. automation, policy-based security & provisioning, monitoring & alerts, configurable, multi-tenancy, self-service ▪ **Building Management**: e.g. HVAC, entry, monitoring & diagnostics	▪ **Smart Building Platforms**: e.g. integration broking, automation, process management, intelligence ▪ **Asset Management**: e.g. fixed and mobile assets, condition based maintenance ▪ **Estates & Facilities Management**: e.g. booking, scheduling, maintenance ▪ **Enterprise Management**: e.g. ERP, finance, customer, HR, supply chain, business intelligence

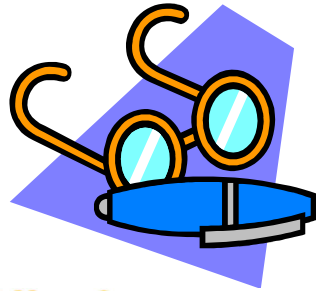
(Source: RIBA, 2024. *Smart Building Overlay to the RIBA Plan of Work*, Royal Institute of British Architects (RIBA), London. https://www.architecture.com/knowledge-and-resources/resources-landing-page/smart-building-overlay-to-riba-plan-of-work)

Key factors



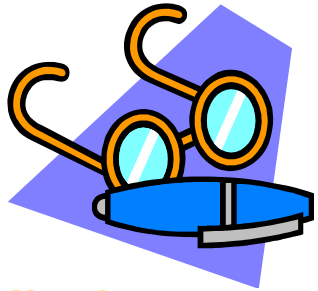
- The impact of including smart building technology on a design or retrofit is not limited to the mechanical & electrical services
- In fact, this is a multi-disciplinary design challenge which may impact many spatial, functional & aesthetic elements of a project
- Early inclusion of smart building specialists to support the design process, construction, commissioning & building operation

Key factors



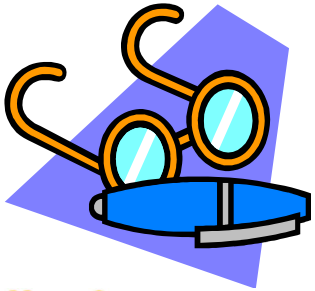
- Smart Building Specialist
  - Brings together a deep understanding of construction, engineering & IT to design, implement & manage smart building systems
  - Help clients to understand the digital landscape & the value that technology & digital services can bring to a development in increased revenue, reduced bottom line costs, increased productivity & sustainability, & greater end-user experience

Key factors



- Duties of Smart Building Specialist:
  - Work as consultants to design & implement smart building systems to make buildings more efficient & sustainable
  - Consult with stakeholders on smart building technology options
  - Analyze & interpret data from smart building systems to provide insights & recommendations
  - Provide training & support to building management teams

Key factors



- Latest smart building trends:
  - 1. Integration of IoT & AI in smart buildings
  - 2. Embracing sustainability & green technology
  - 3. Advanced security systems
  - 4. Prioritizing health & well-being
  - 5. Enhanced connectivity & 5G integration
  - 6. Smart building as a service (SBaaS)
  - 7. Cloud-based building management systems

(Source: 7 Smart Building Trends in 2024 https://sensgreen.com/7-smart-building-trends-in-2024/)

Smart buildings & IoT trends

Smart Buildings and IoT Trends, 2021

QUOCIRCA
www.quocirca.com

DOWNLOAD
EXECUTIVE SUMMARY FINDINGS

How smart building technology is supporting a safe return to the office

Quocirca research study conducted amongst 260 organisations in the UK, France, Germany and the US

Top factors influencing smart building technology investments

Long term cost savings	57%
Minimise business risk	51%
Improving health and safety	48%
Reducing energy costs	45%
Improving analytical insight	45%
Occupant comfort and wellbeing	44%

Smart building technology being implemented

Smart heating	44%
Smart lighting	42%
Touchless access control	36%
Voice assistants	36%

The value of IoT analytics

Respondents who consider as very valuable

Environmental sensors (e.g.indoor air quality)	54%
Security monitoring of IoT devices	54%
Energy monitoring and usage	47%

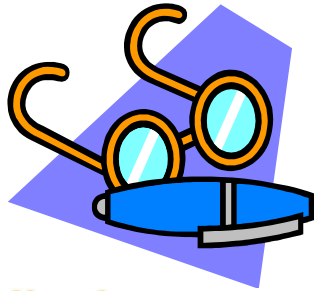
76% have increased IoT investment plans in 2021

81% consider smart MFPs/ printers part of the IoT landscape

53% are concerned with IoT data security

(Source: https://quocirca.com/)

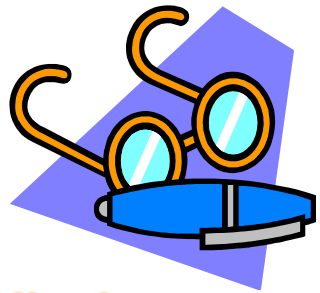
Smart office examples



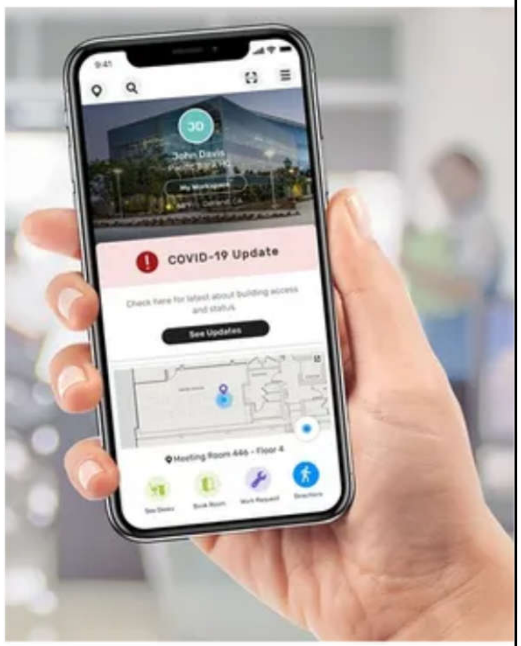
* Especially during & after COVID-19

- Latest trends in office workplace:
  - 1. Hybrid/Flexible working (mixture of home, office & coworking spaces)
  - 2. Digital workplace experience (flexible & healthy workspaces)
  - 3. Social, collaborative hub (maintain community & culture in the workforce)
- Empower employees & enhance the working experience, linking the virtual & the physical, and serving the individual & the collective

Smart office examples



- Types of office space:
  - (a) Single office desk
  - (b) Private/soundproof desks/booths
  - (c) Open plan/collaboration areas
  - (d) Meeting rooms
  - (e) Retreat areas/break/relaxation areas

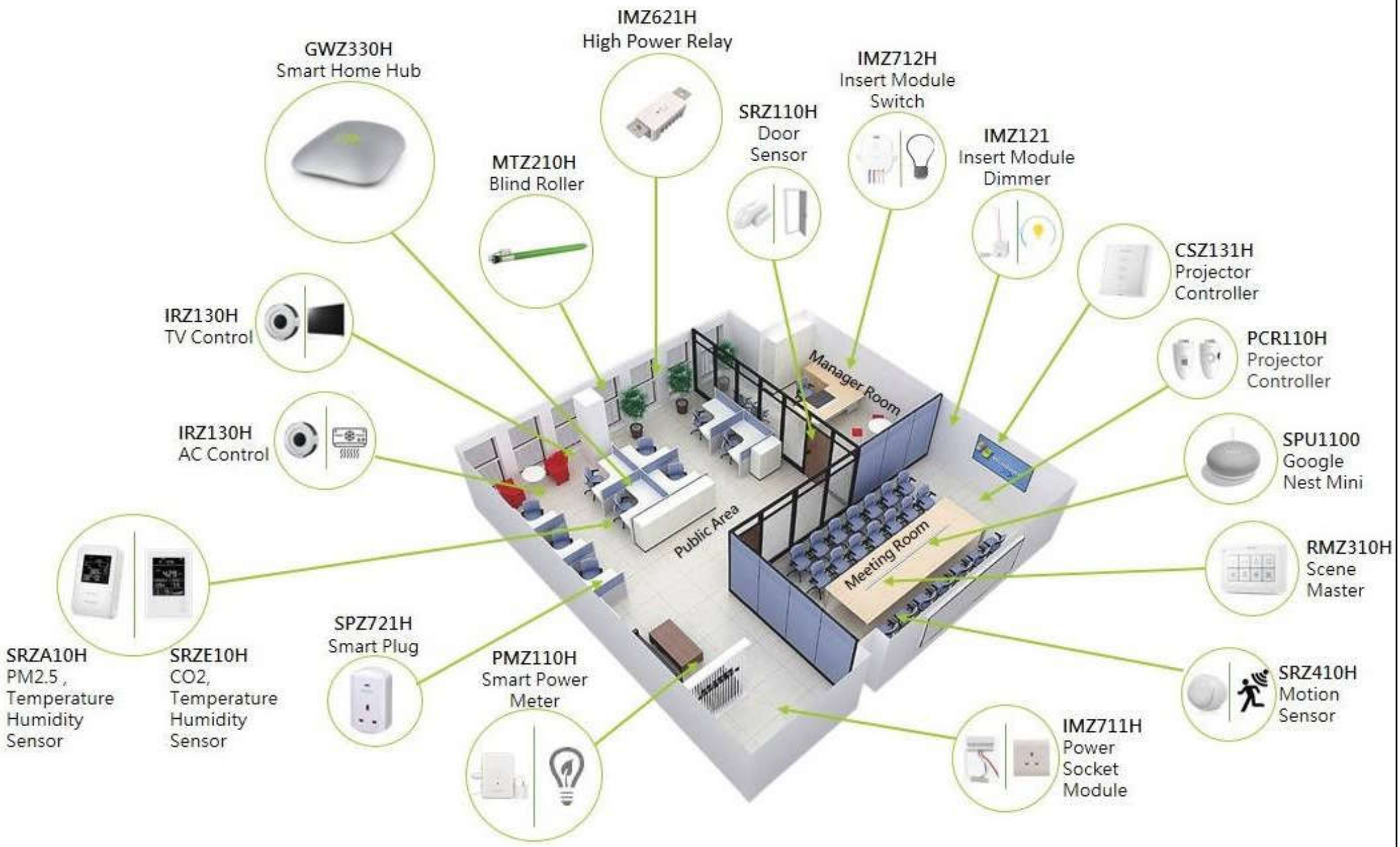


- Use of workplace apps & tools to maximise value of time spent in the office & achieve a seamless workplace experience

Example of smart office spaces

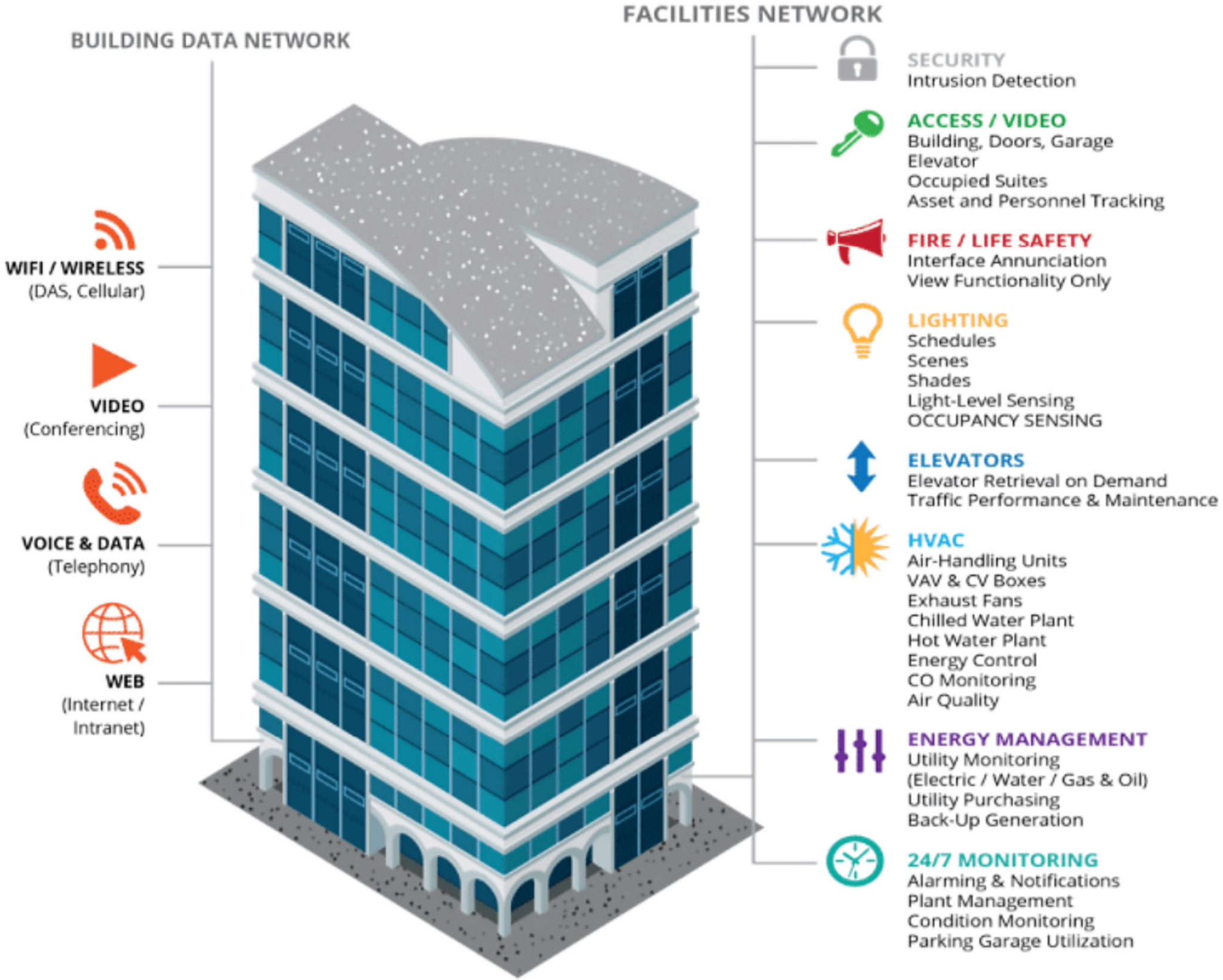
(Source: https://wow-webmagazine.com/with-an-80-year-old-history-the-italian-smart-office-looks-ahead)

Example of smart office components



(Source: https://www.tronico.com.hk/zh/showcase/)

Integration of building data network & facilities network in smart office



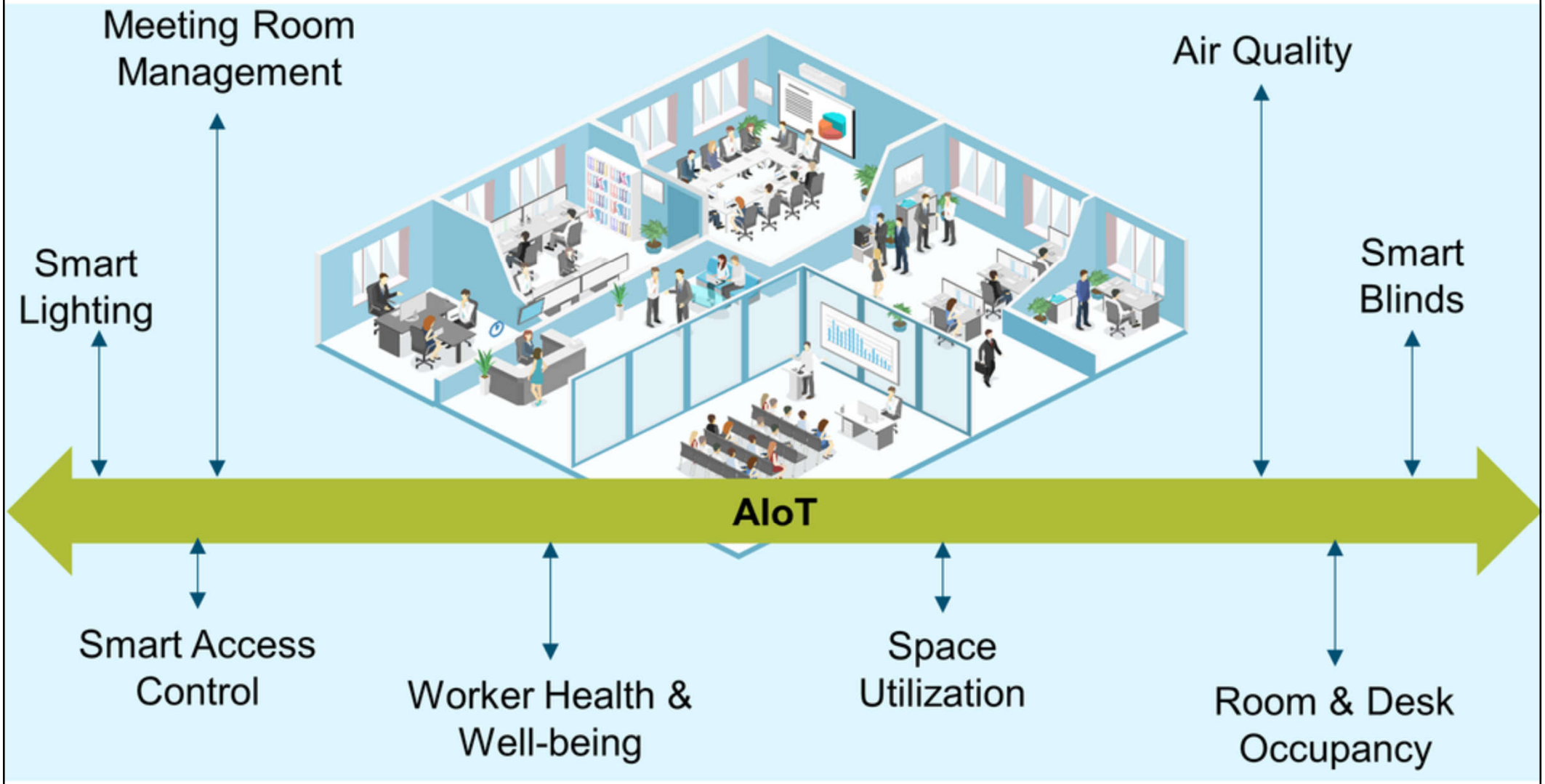
(Source: https://www.insight.tech/cities/transform-smart-building-data-into-kpis-that-matter)

Comparison of communication interface methods

Method	Type	Range	Bandwidth	Power Consumption	Suitability
Ethernet	Wired	Short	High	High	Suitable for high-speed data transfer & reliable connectivity
Wi-Fi	Wireless	Short	High	High	Suitable for providing wireless internet connectivity
Cellular	Wireless	Long	Low to High	Low to High	Suitable for remote & ubiquitous connectivity
CAN	Wired	Long	Low to High	Low	Suitable for high-speed data transfer & long distances
LoRaWAN	Wireless	Long	Low	Low	Suitable for remote areas with low power consumption
Zigbee	Wireless	Short	Low	Low	Suitable for low-power IoT systems
Z-Wave	Wireless	Short	Low	Low	Suitable for low-power IoT systems with long battery life
Bluetooth	Wireless	Short	Low to Medium	Low to Medium	Suitable for remote monitoring & control with smartphones & tablets
RS-485	Wired	Long	Low to Medium	Low to Medium	Suitable for connecting sensors & controllers in an IoT system

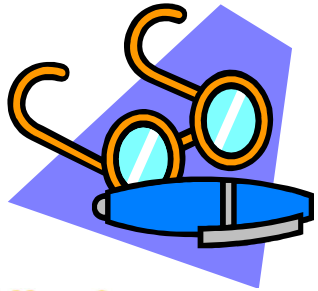
(Source: https://www.dusuniot.com/blog/smart-elevator-management-based-on-iot-solutions/)

Smart office functions supported by AIoT (artificial intelligence & Internet of Things)

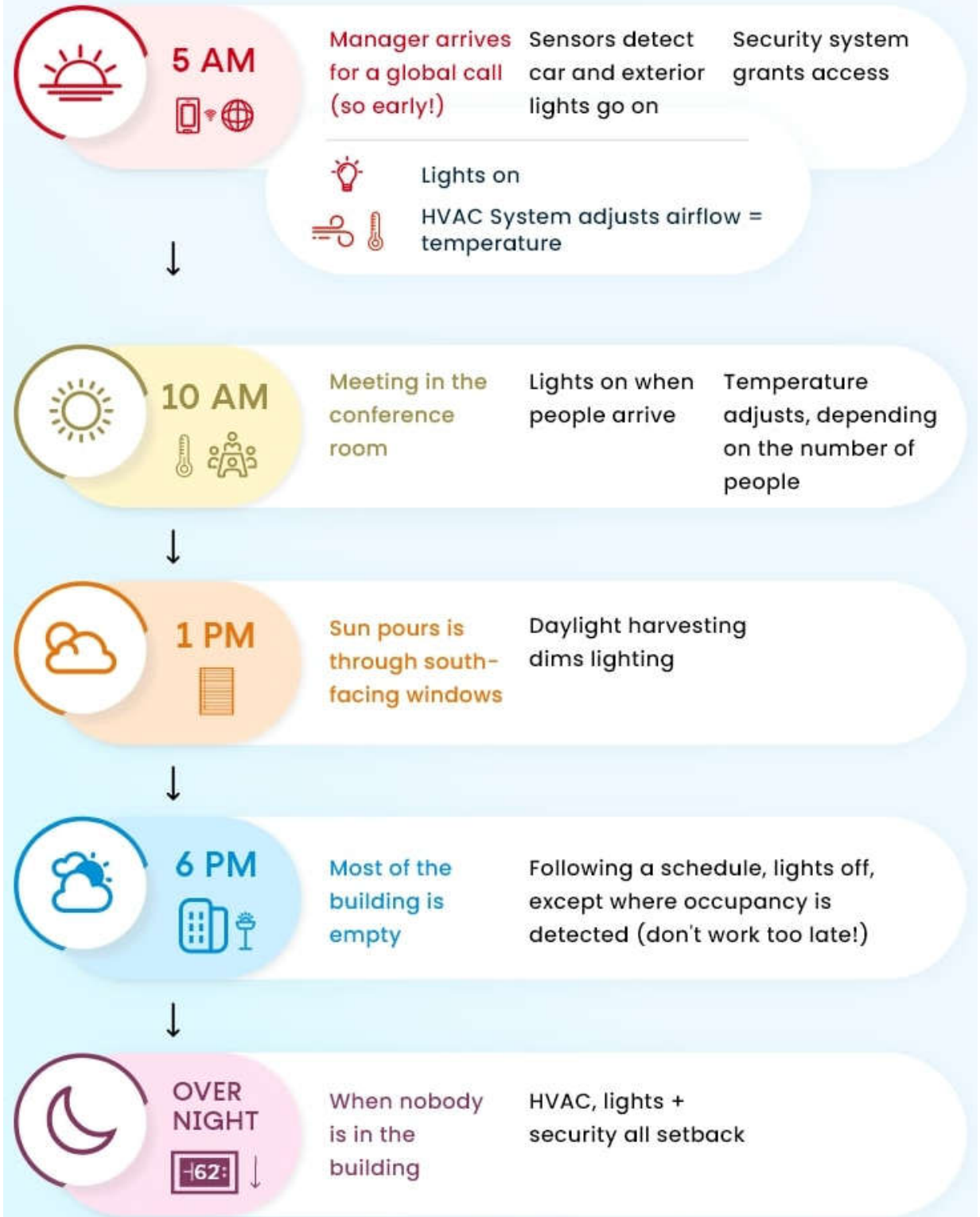


(Source: https://www.digitalplaybook.org/index.php/Home:_digital.building)

Smart office examples



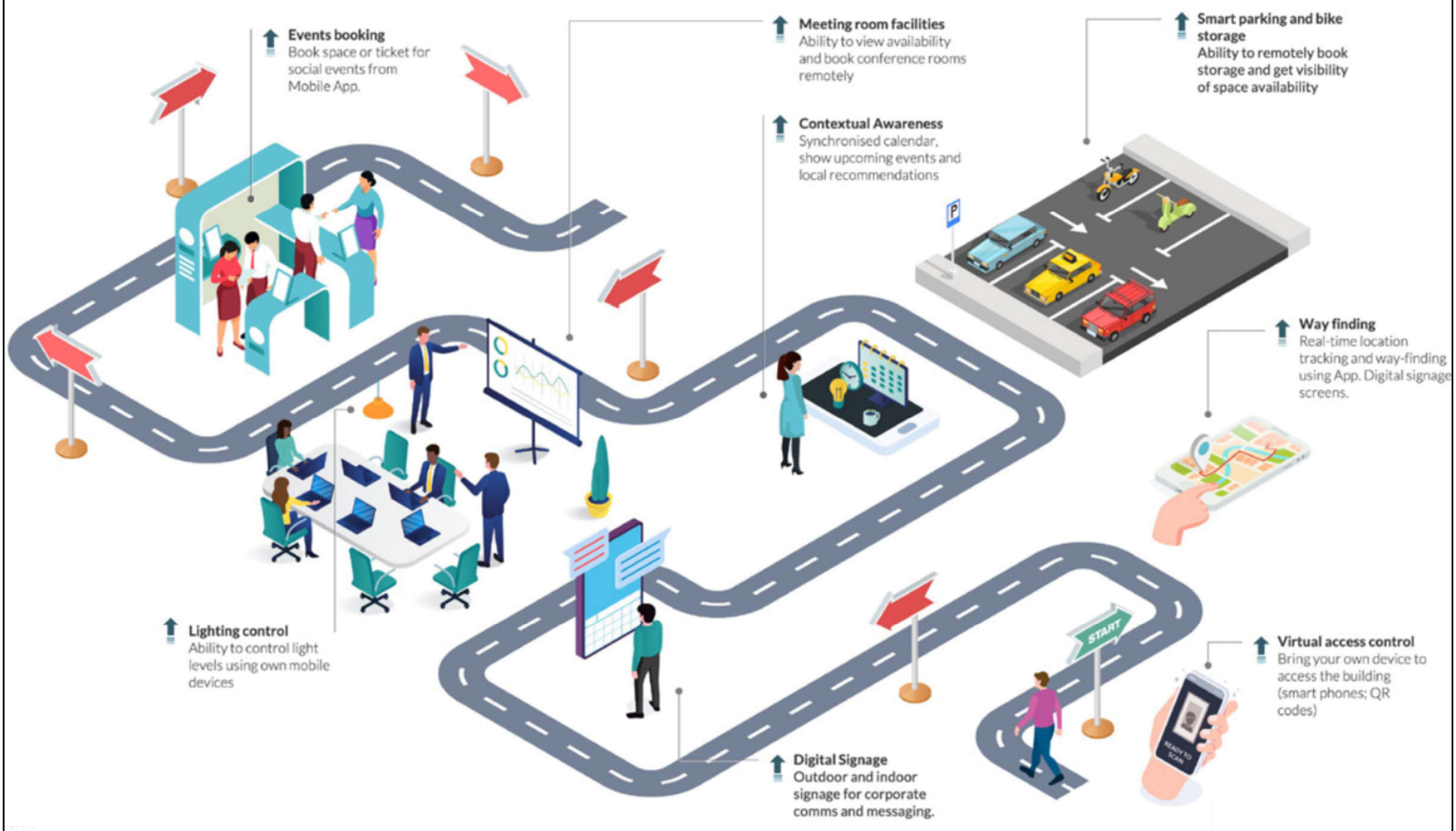
- The digital integration of smart building offers new opportunities for building operators & building users to interact with building systems locally or remotely using digital control systems & applications, e.g.
  - Offices that allocate desks to employees whose mobile phone is approaching the building
  - Improve space utilisation & human-centric building experience through a better understanding of building user needs



Example of smart corporate building (one day process)

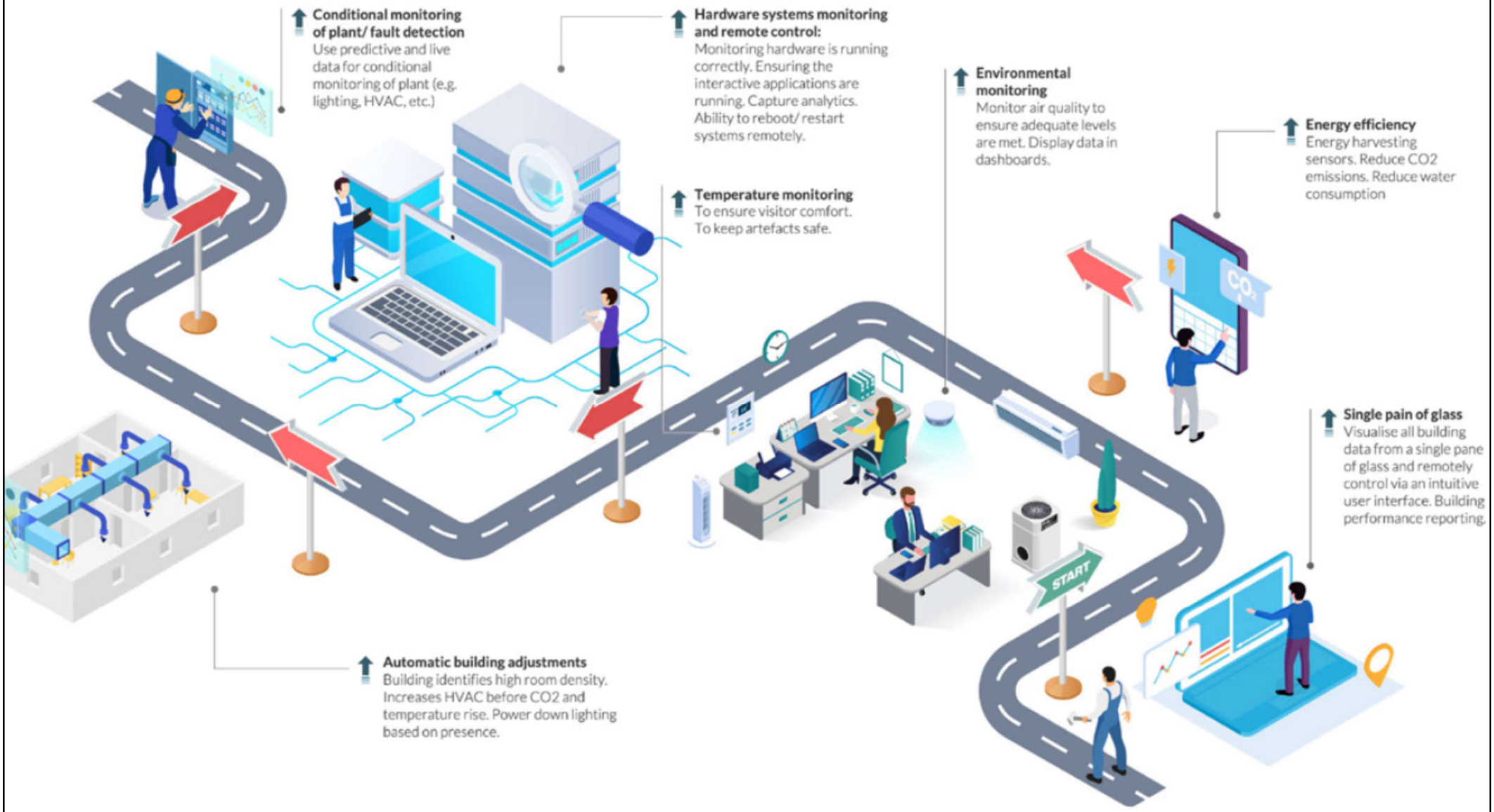
(Source: https://www.excellentwebworld.com/smart-building-technology/)

Smart opportunities to enhance the experience of end users in offices



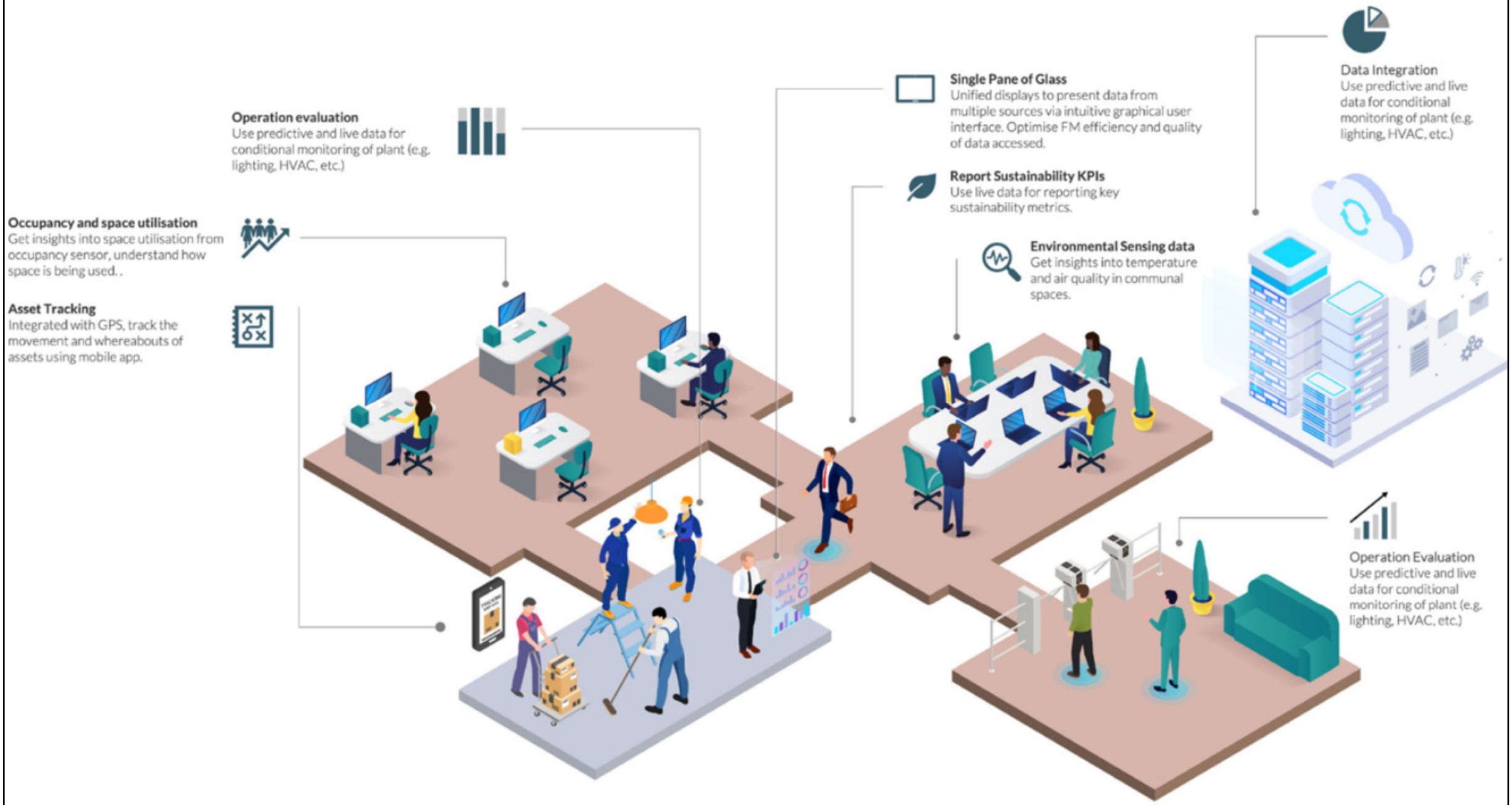
(Source: RIBA, 2024. *Smart Building Overlay to the RIBA Plan of Work*, Royal Institute of British Architects (RIBA), London. https://www.architecture.com/knowledge-and-resources/resources-landing-page/smart-building-overlay-to-riba-plan-of-work)

Smart opportunities to optimise building operation



(Source: RIBA, 2024. *Smart Building Overlay to the RIBA Plan of Work*, Royal Institute of British Architects (RIBA), London. https://www.architecture.com/knowledge-and-resources/resources-landing-page/smart-building-overlay-to-riba-plan-of-work)

Smart building opportunities to improve business performance



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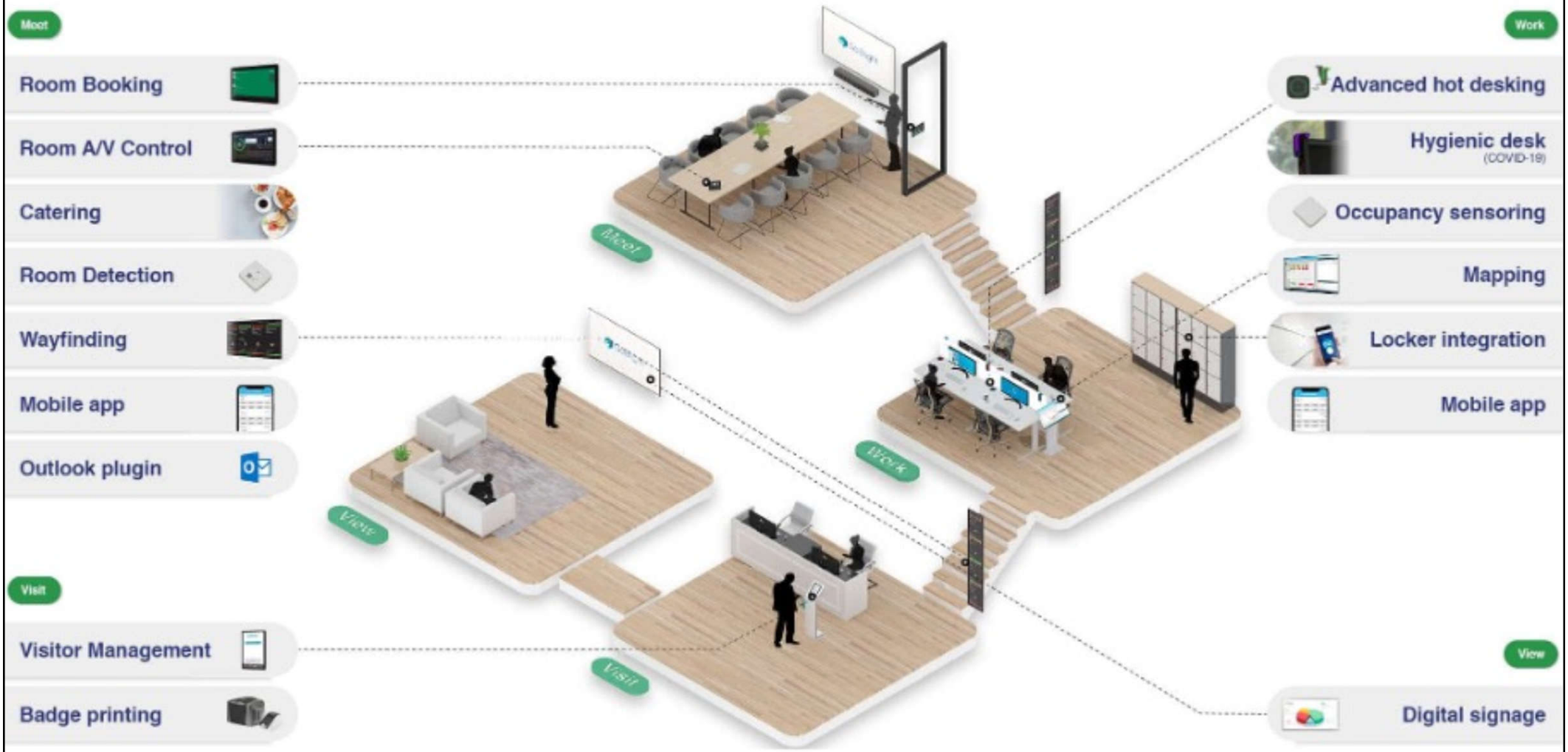
Example of smart office elements



(Source: https://www.speranzainc.com/smart-home-system-pros-cons-iot-based-buildings/)

Example of smart office features

(Source: https://mounishkokkula.wordpress.com/smart-office-buildings/)

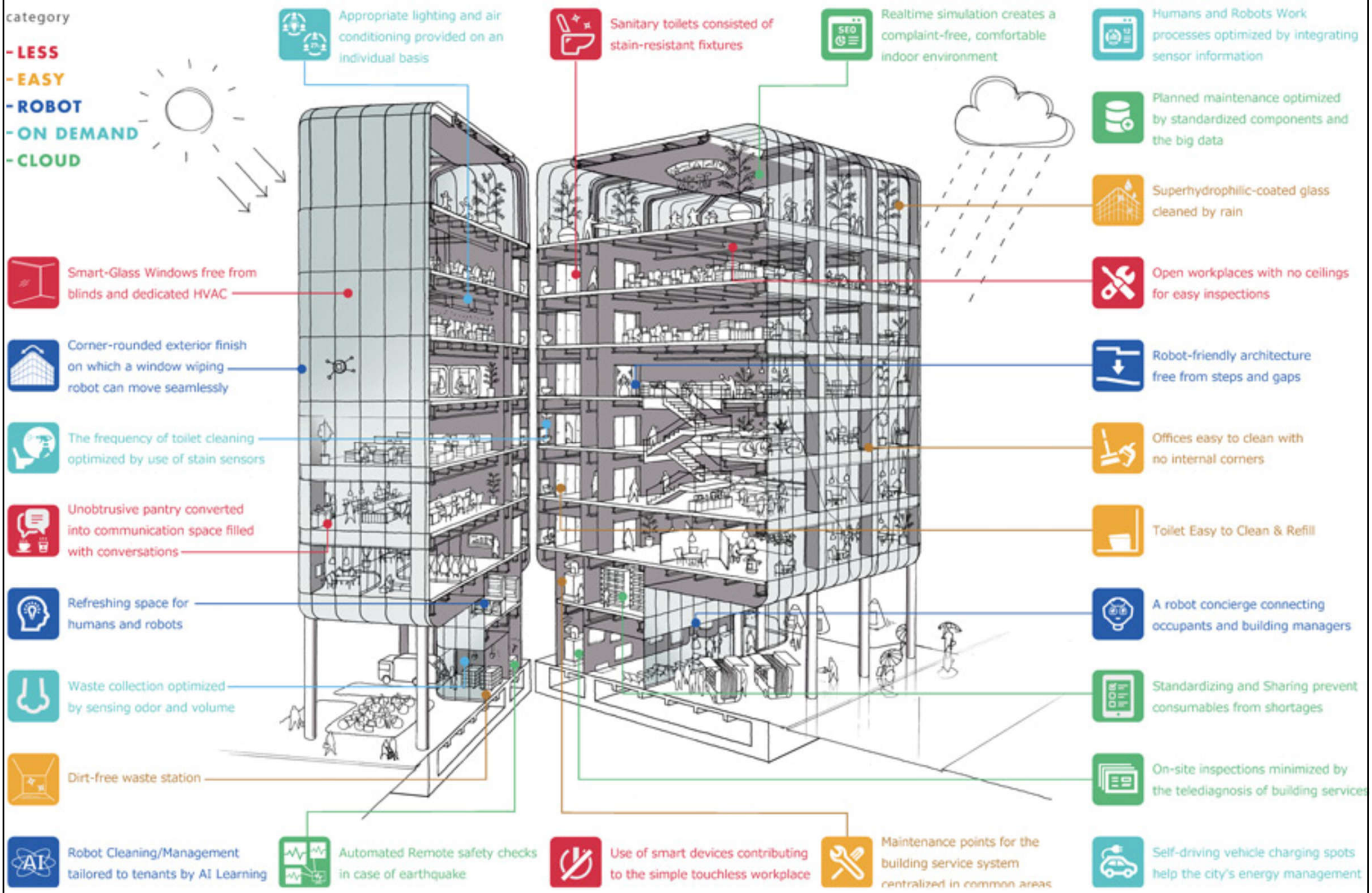
Smart building solutions for offices

(Source: https://www.extremenetworks.com/resources/blogs/building-for-the-future-smart-building-solutions-for-offices)

Smart office & intelligent spaces

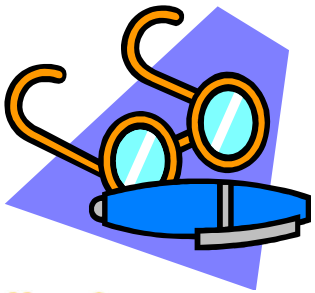
(Source: https://blogs.arubanetworks.com/industries/smart-office-and-intelligent-spaces/)

25 ideas of smart operation building



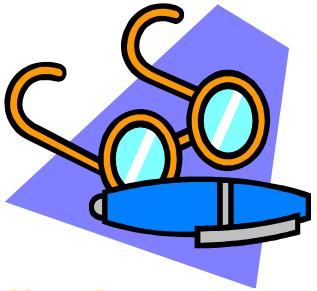
(Source: https://www.nikken.jp/en/insights/smart_operation_building.html)

Smart office examples



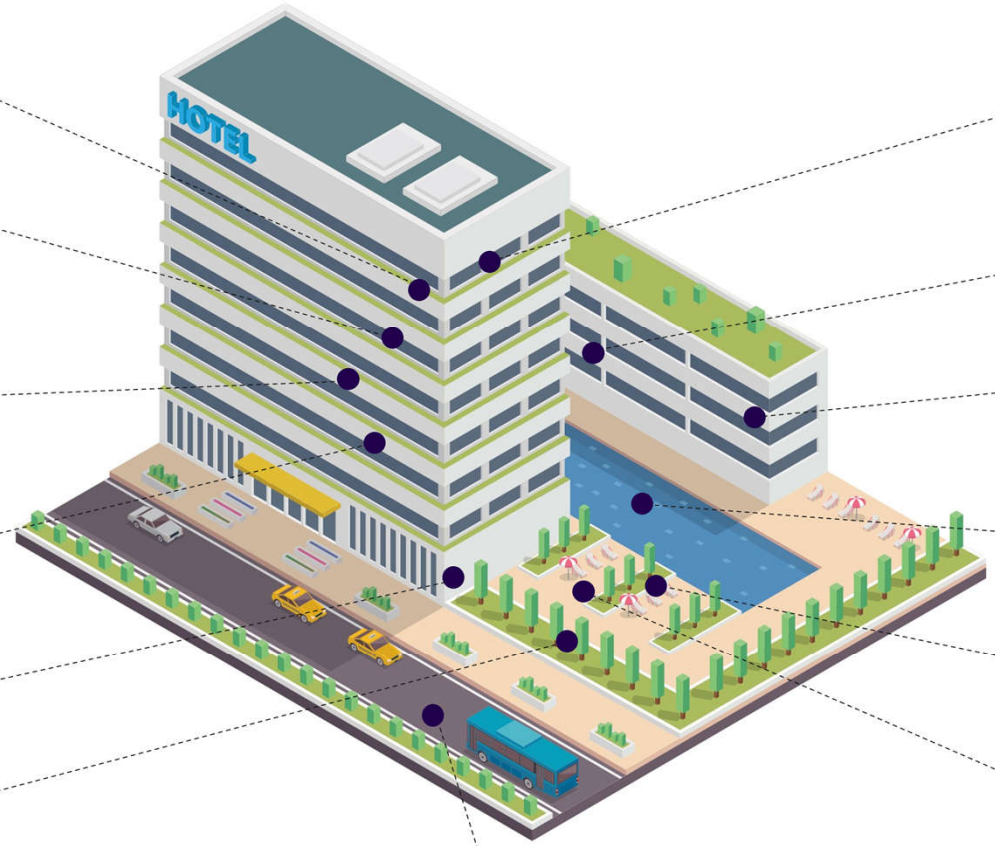
- 6 Amazing Smart Office Buildings From Around the World https://www.acquisition-international.com/6-amazing-smart-office-buildings-from-around-the-world/
  - 1. The Edge, Amsterdam
  - 2. Legion House, Sydney
  - 3. The Bullitt Center, Seattle
  - 4. Intel SSR, Bangalore
  - 5. The Crystal, London
  - 6. Burj Khalifa, Dubai

Smart hotel examples



- A hotel can satisfy the market as well as guest demands & become a smart hotel by
  - Providing frictionless guest experience
  - Operating sustainable building
  - Ensuring seamless security
- Smart building technology supports employees to work together as a smooth service team & enables hotels to become greener, as well as more profitable

Smart building solutions for hotels



High-Density Wi-Fi Connectivity

Unfettered Consumer, Associate, and Application Usage

Mobile QR code and Contactless Services

IPTV, Digital Signage, Content Distribution, and Electronic Shelf Labels

IoT Connected Devices

360 Analytics for IT, Operations, Marketing

5G-LTE and Wi-Fi Carrier Offload

Location-based Services and Insights (wayfinding, asset tracking, etc.)

Biometric Screening and Payment

Digital POS/Payment, Touchless Transactions

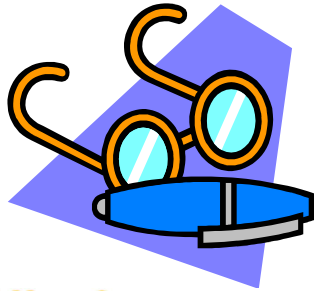
Interactive Security/ Public Safety

Digital Twin to Stage, Validate, and Deploy a Network

Intelligent POE Lighting, HVAC, and Energy Management

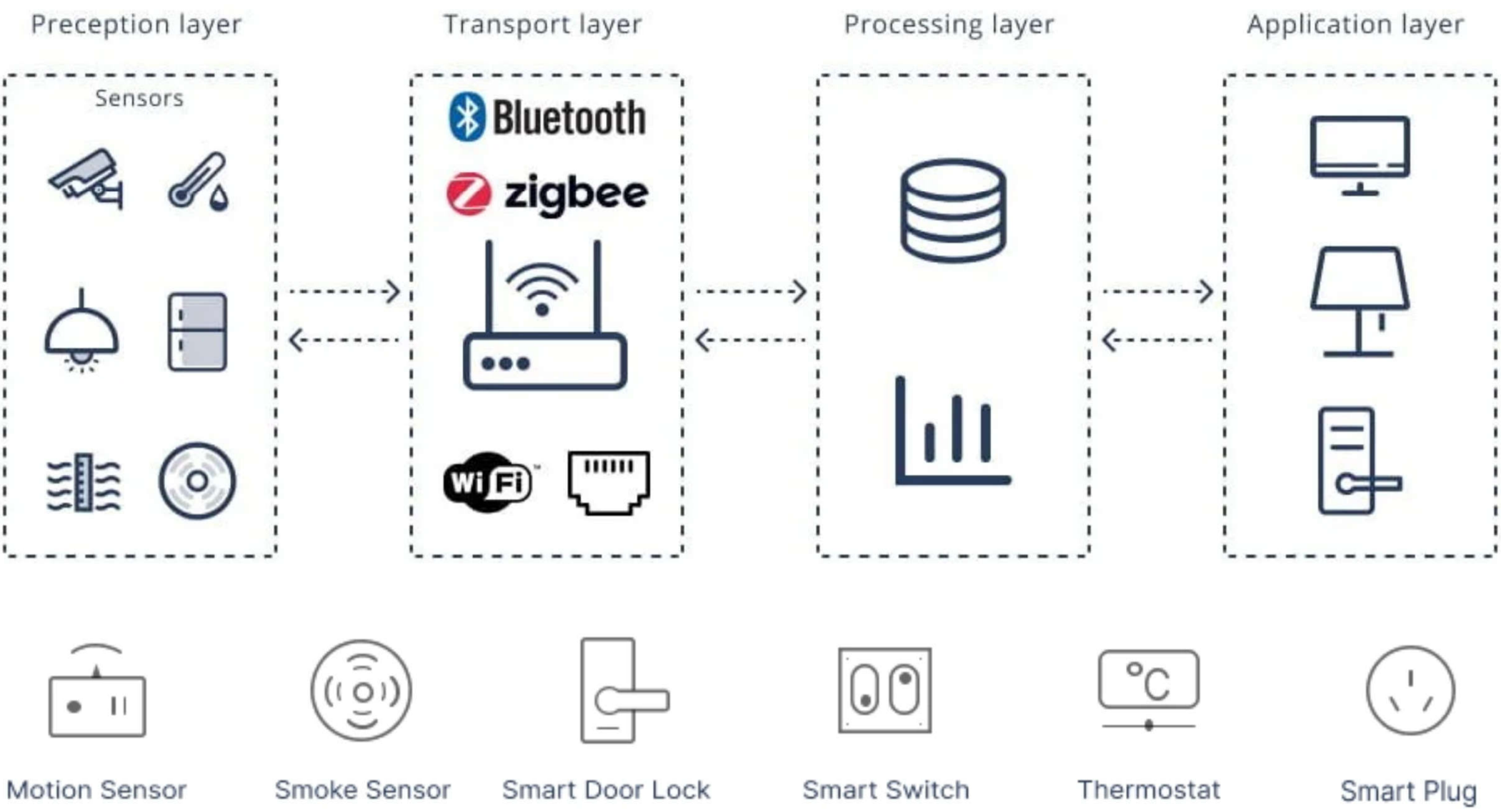
(Source: https://www.extremenetworks.com/resources/blogs/building-for-the-future-smart-building-solutions-for-the-hospitality-industry)

Smart hotel examples



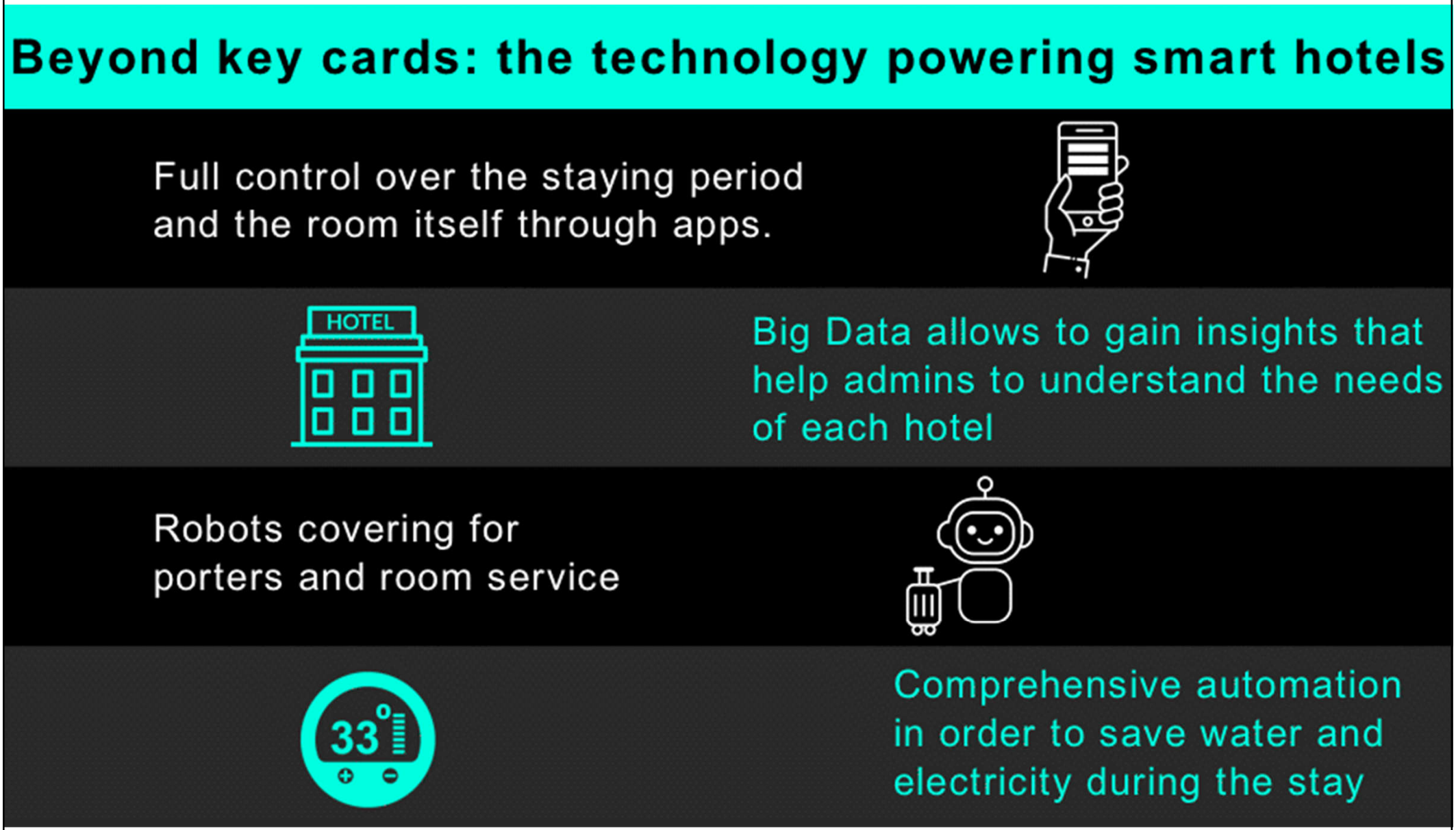
- Smart hotel features:
  - 1. Automated room controls: utilize IoT technology to control HVAC, lighting for comfort
  - 2. Voice recognition technology: implement voice-controlled devices like smart speakers
  - 3. Smart hubs & personalization: hotel services for easy guest access & personalized experiences
  - 4. Mobile integration: for check-ins, room access, & communication with hotel staff
  - 5. Data security & management: protect guest data

Smart hotel infrastructure & devices



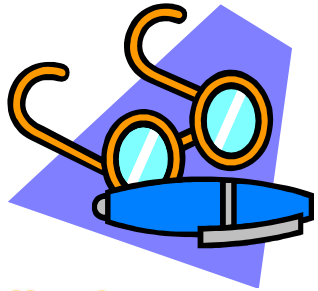
(Source: https://www.dusuniot.com/case-study/enable-iot-smart-hotel-solution-for-hospitality-industry-with-dusun-iot-devices-services/)

Smart hotel technology



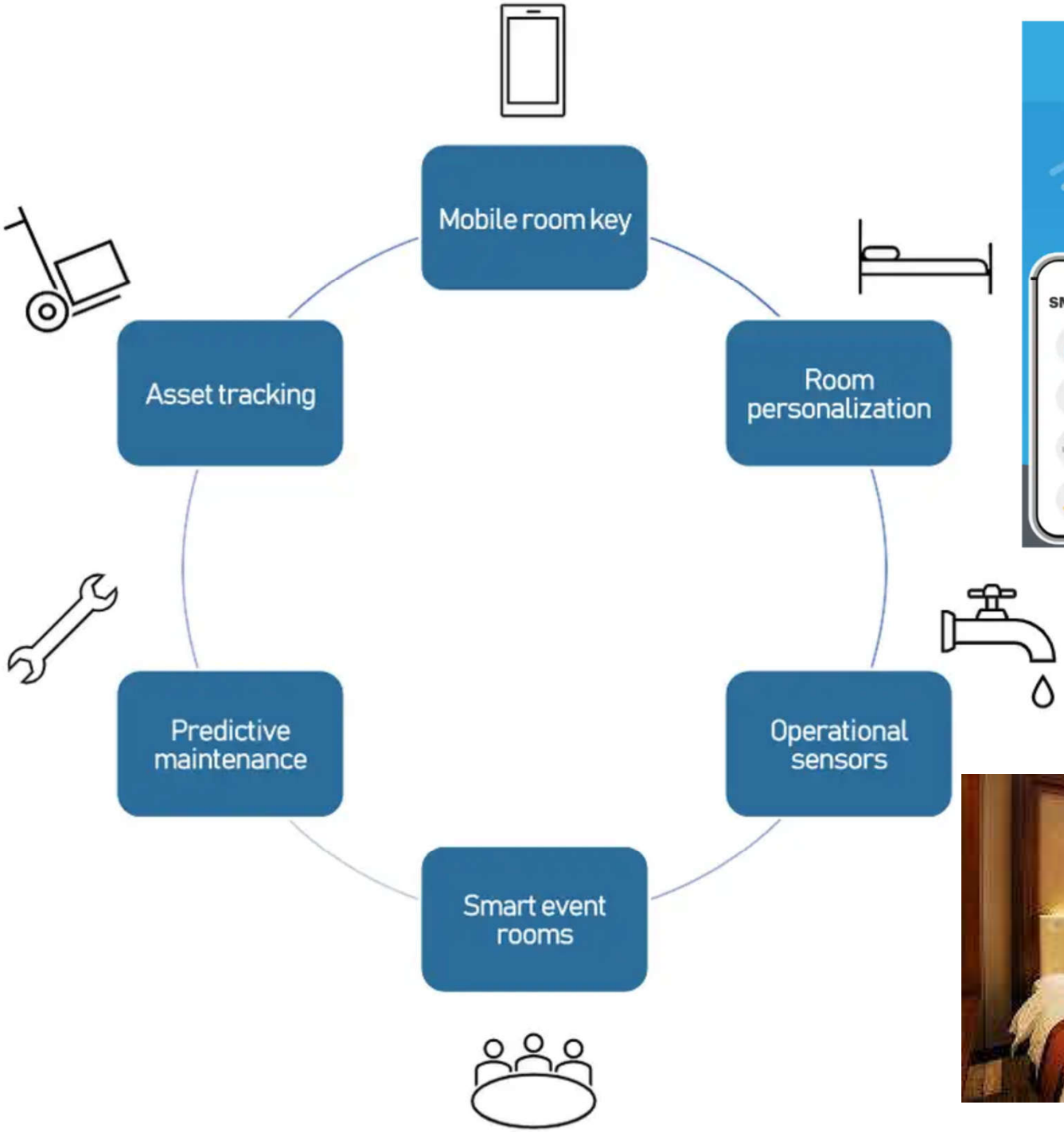
(Source: https://www.tomorrow.city/smart-hotel/)

Smart hotel examples



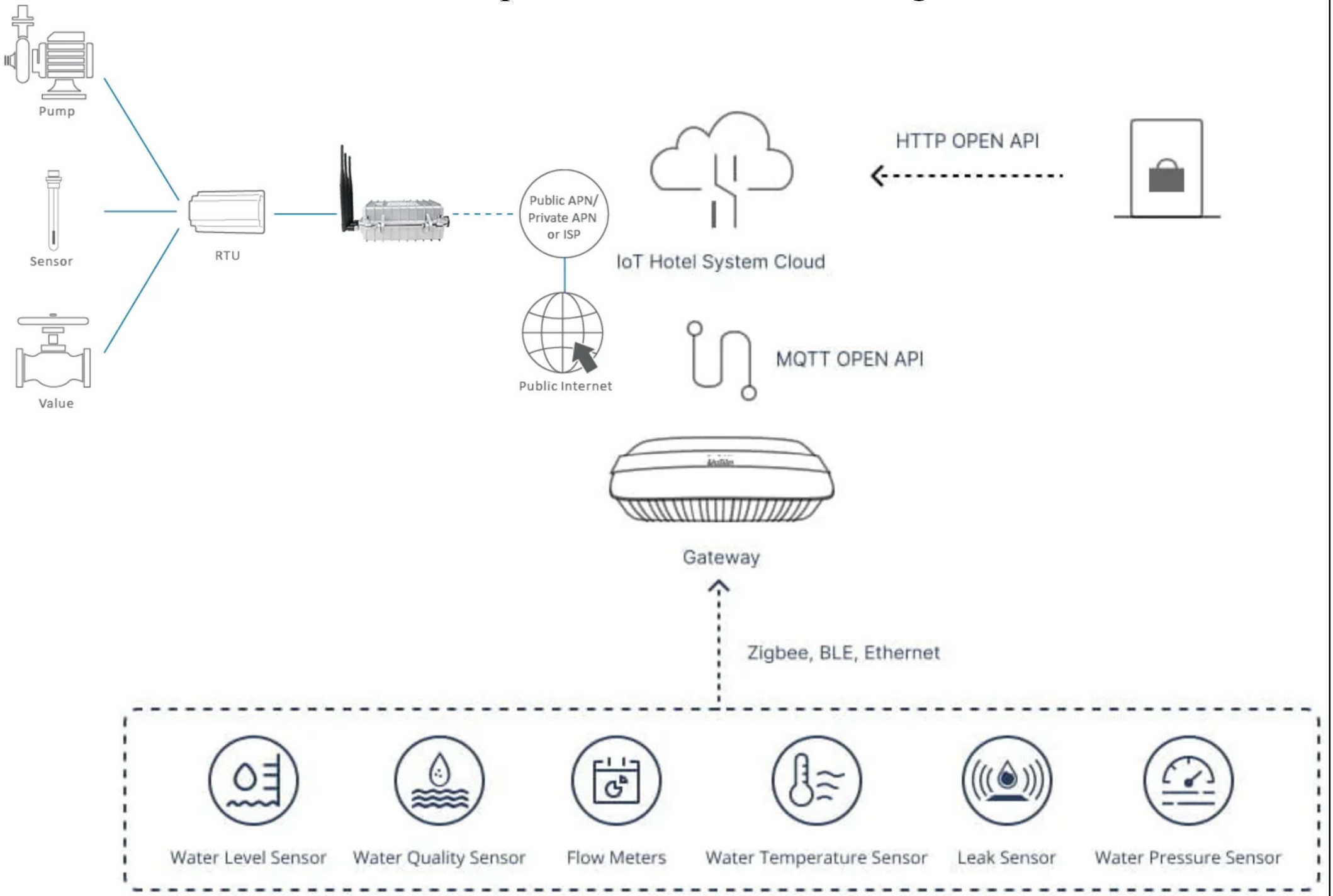
- Common functionalities of a smart hotel:
  - Access control & security (CCTV centralised monitoring system)
  - Smart rooms (provide information on occupancy, room service request, comfort temperature, etc.)
  - Control of building expenditure & consumption
  - Management of common spaces (meeting rooms, restaurants, gymnasium)
  - Parking control (vehicle access & parking space)

Examples of smart hotel applications



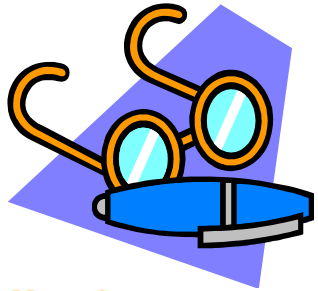
(Source: https://www.altexsoft.com/blog/smart-hotel-infrastructure/)

Basic concept of smart water management



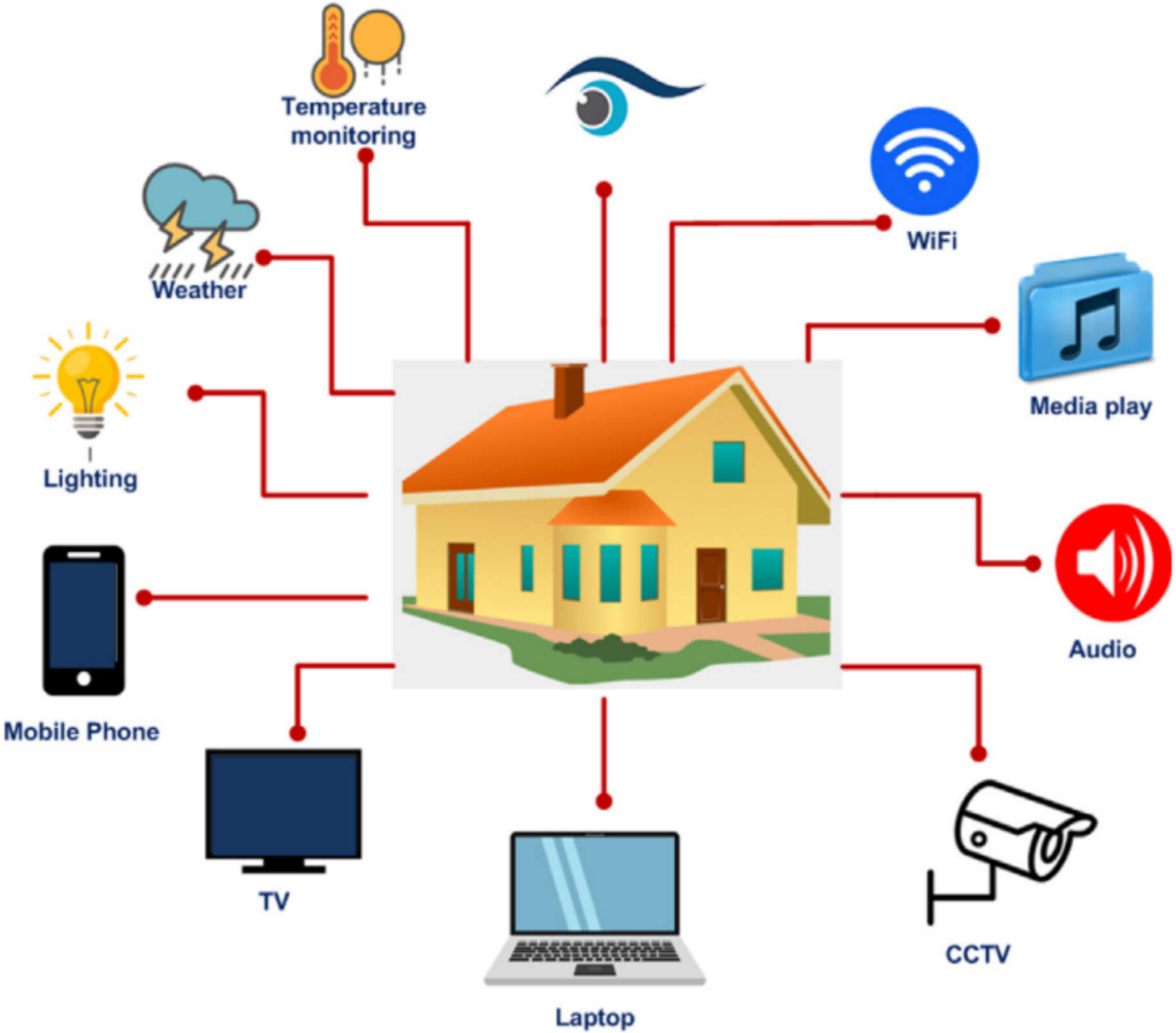
(Source: https://www.dusuniot.com/blog/smart-water-management-revolutionize-your-water-usage/)

Smart home examples



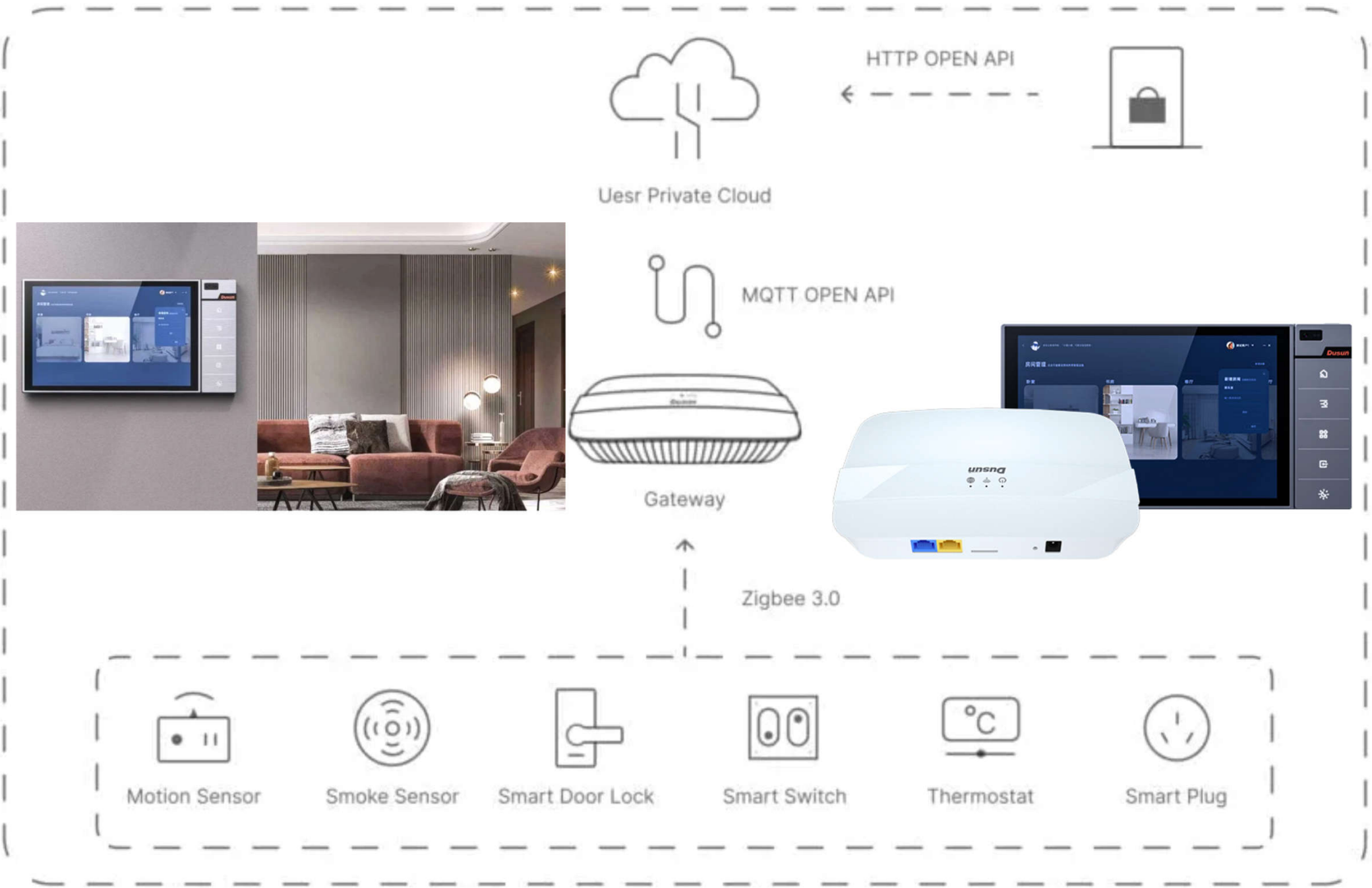
- Benefits of smart homes:
  - 1. Convenience: e.g. smart light switch/thermostat
  - 2. Security: e.g. smart cameras & doorbells
  - 3. Savings: on electric bills & maintenance
  - 4. Entertainment: syncing the entertainment system (music & video) with streaming libraries
  - 5. For new parents: e.g. smart baby monitor
  - 6. For elderly: safety & health monitor

Elements of the smart home



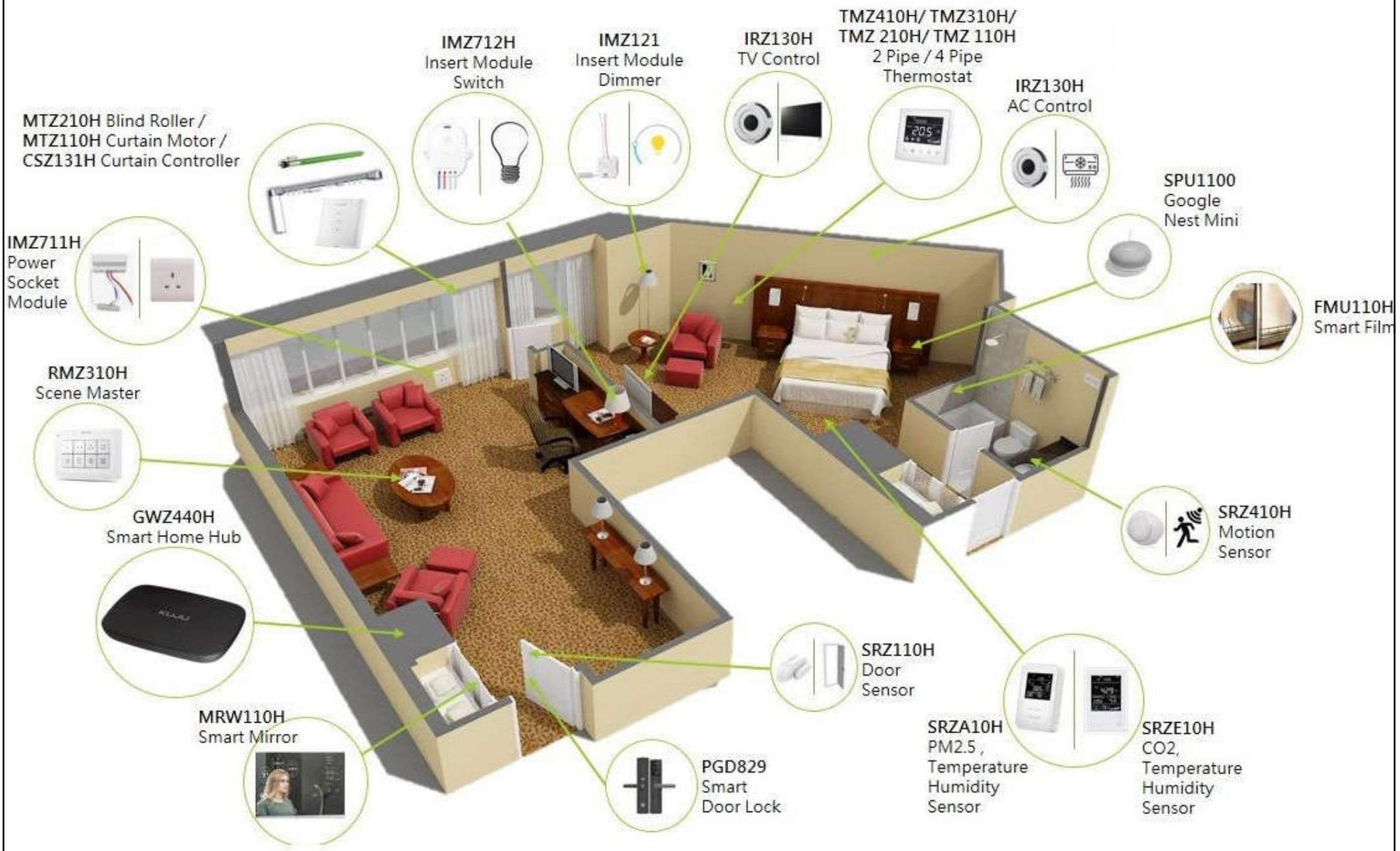
(Source: Pandiyan P., Saravanan S., Usha K., Kannadasan R., Alsharif M. H. & Kim M.-K., 2023. Technological advancements toward smart energy management in smart cities, *Energy Reports*, 10: 648-677. https://doi.org/10.1016/j.egyr.2023.07.021)

Example of a smart apartment hardware solution



(Source: https://www.dusuniot.com/solution/smart-apartment-solution/)

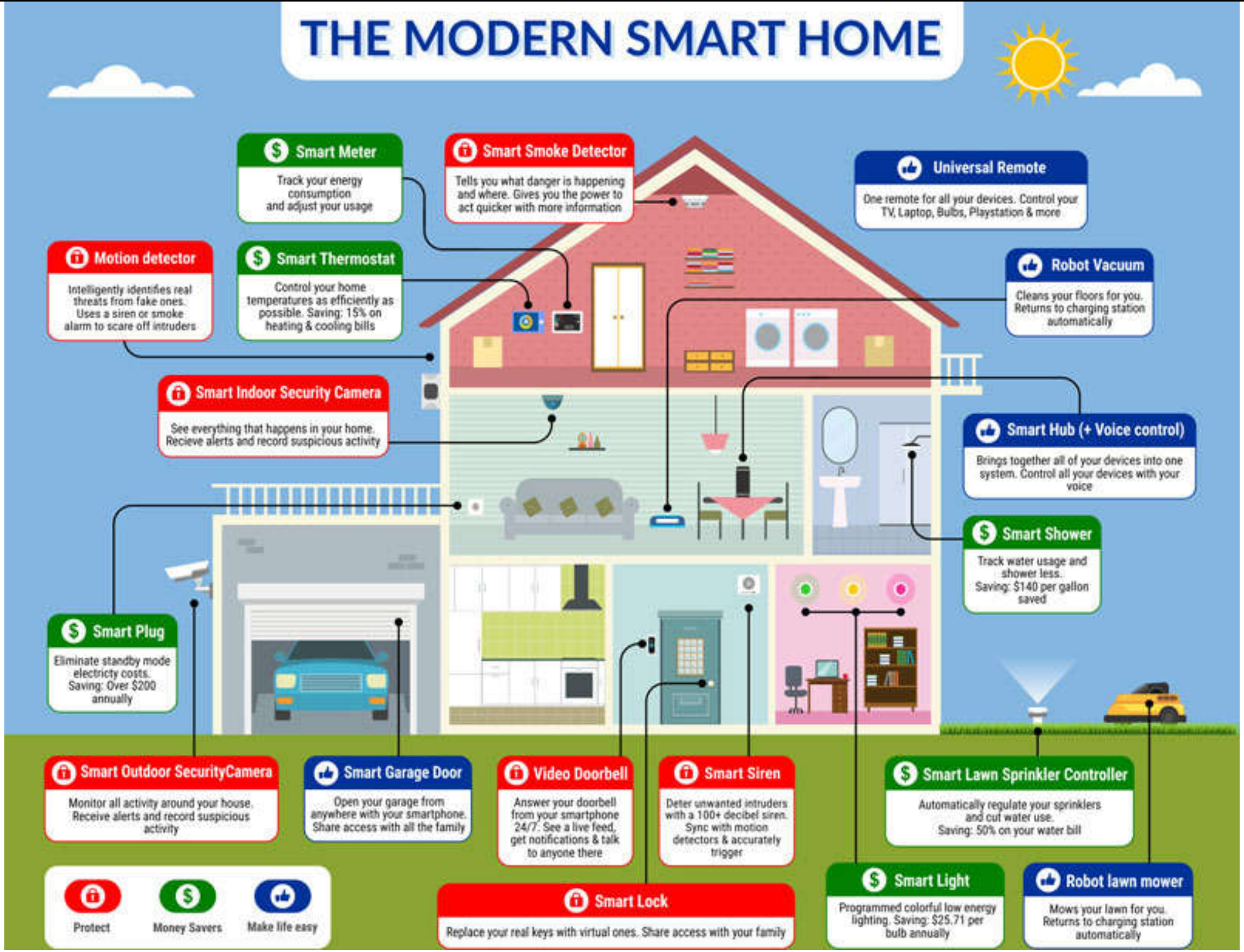
Example of smart home technologies & components



(Source: https://www.tronico.com.hk/)

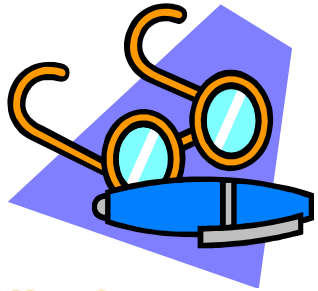
Smart home examples

- Examples of smart home devices:
  - Smart assistants – e.g. Google Home
  - Smart switches for lighting & small appliances – e.g. Belkin Wemo Mini Smart Plug
  - Thermostats – e.g. Nest Learning Thermostat
  - Video doorbells – e.g. Nest Hello Doorbell
  - Security devices – e.g. Nest Cam Indoor/Outdoor
  - Smart speakers – e.g. JBL Link Wifi, Bose Solo
  - Smart streaming – e.g. Google Chromecast Ultra
  - Smoke & carbon monoxide detectors – e.g. Google Nest Protect



(Source: https://www.best-infographics.com/the-modern-smart-home-ideas/)

Smart home examples



- Smart enabled home in Singapore
  - Elderly Monitoring System
    - For the well-being & safety of elderly relatives, especially if they are living alone at home
    - The system learns the daily habits of seniors through the help of motion sensors & alerts you or other caregivers in times of need or when irregular patterns in behaviour are detected
  - Utilities Monitoring System
    - To save energy & water at home

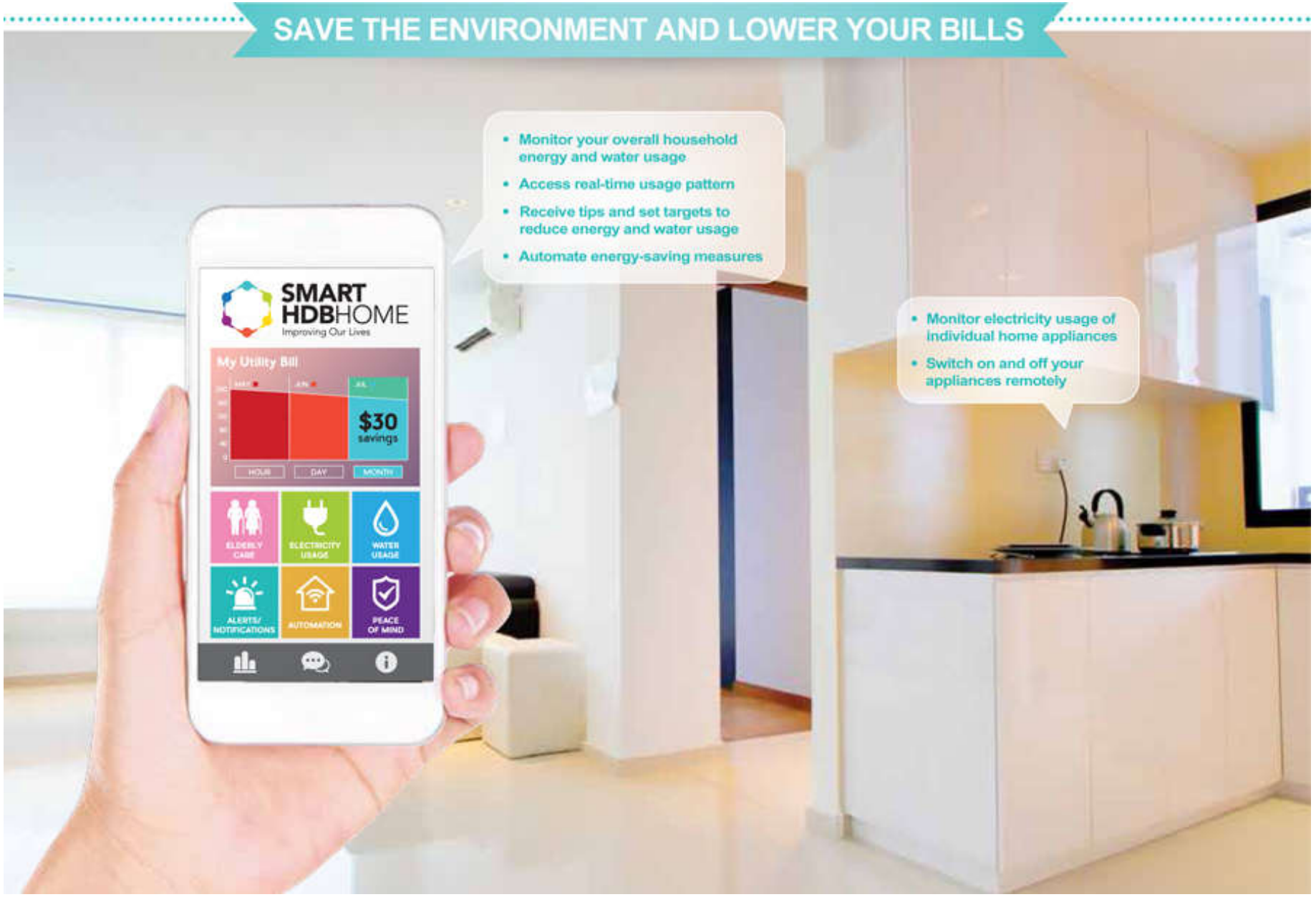
Elderly Monitoring System

(Source: https://www.hdb.gov.sg/about-us/our-role/smart-and-sustainable-living/smart-hdb-town-page/hdb-smart-home-exhibition)

Utilities Monitoring System

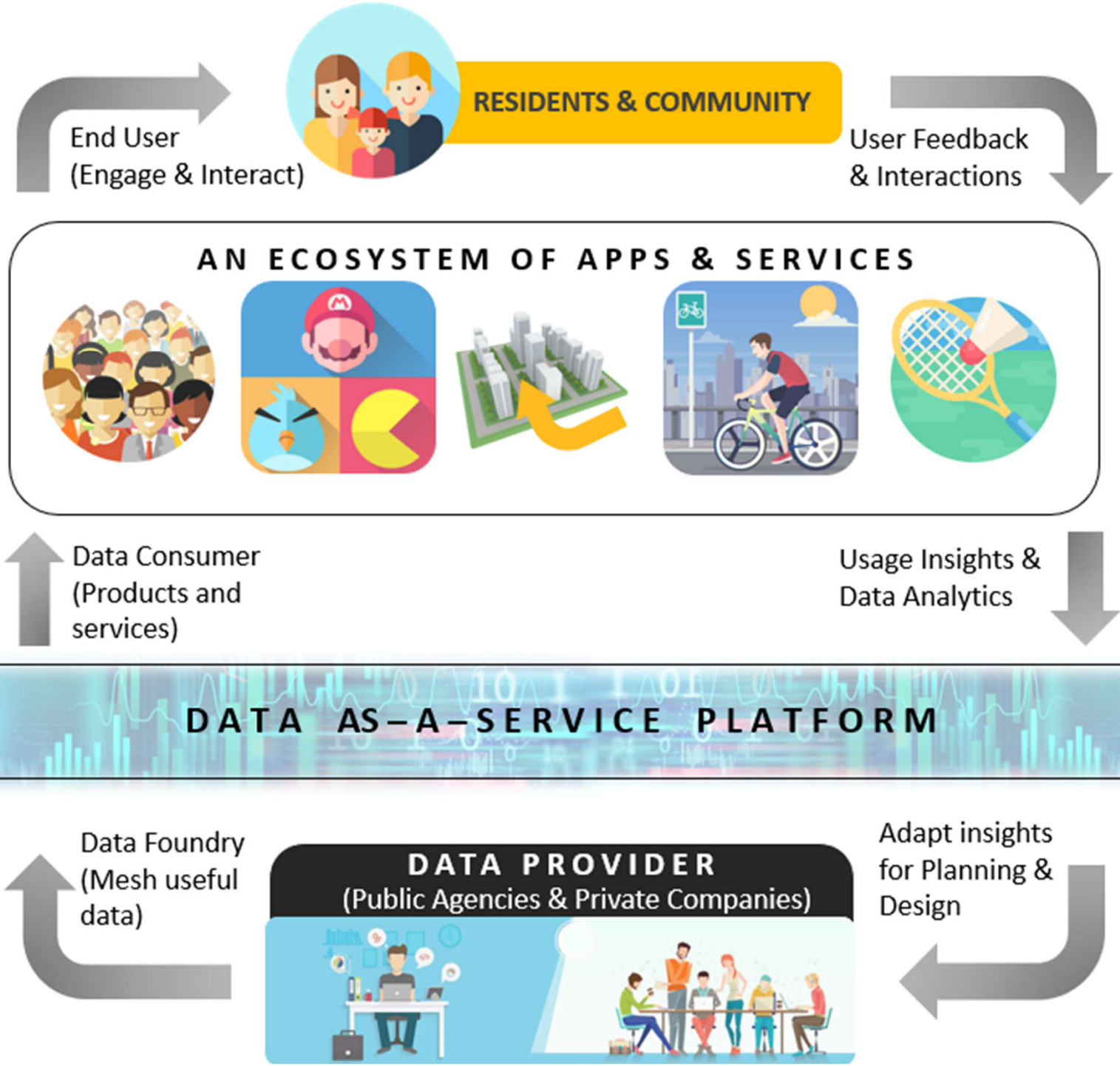
Monitors overall household energy consumption and individual home appliances

Monitors overall household water consumption



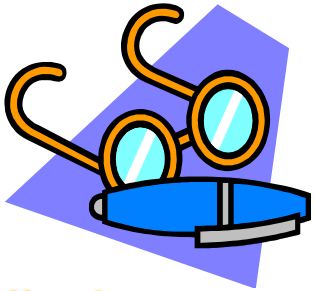
(Source: https://www.hdb.gov.sg/about-us/our-role/smart-and-sustainable-living/smart-hdb-town-page/hdb-smart-home-exhibition)

Smart community digital ecosystem of applications & services



(Source: https://www.hdb.gov.sg/about-us/our-role/smart-and-sustainable-living/smart-hdb-town-page)

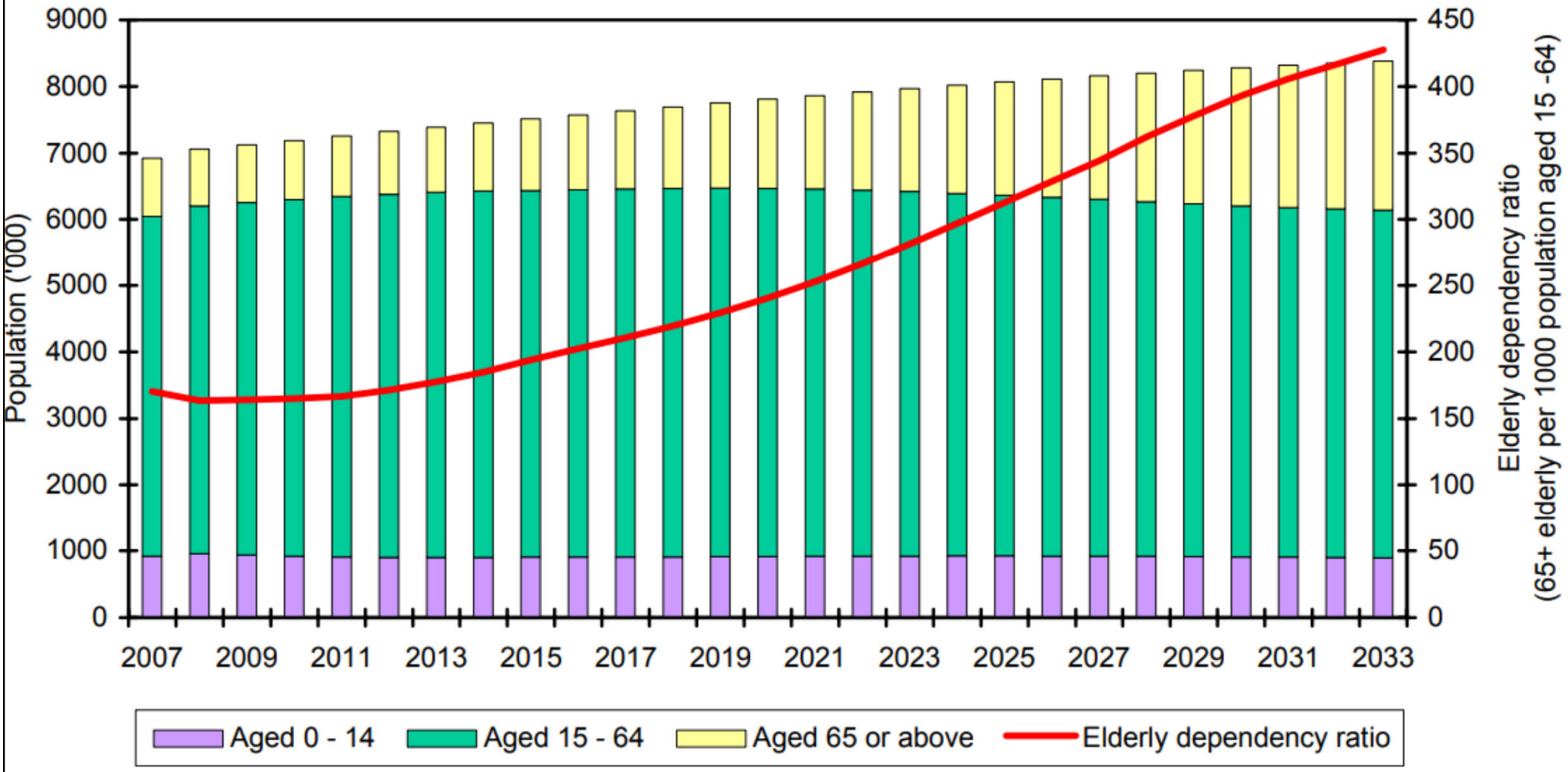
Smart health living



- Ageing problem & healthcare in the society
  - All countries face major challenges to ensure that their health & social systems are ready to make the most of the demographic shift (population ageing)
    - The elderly population has greater healthcare needs

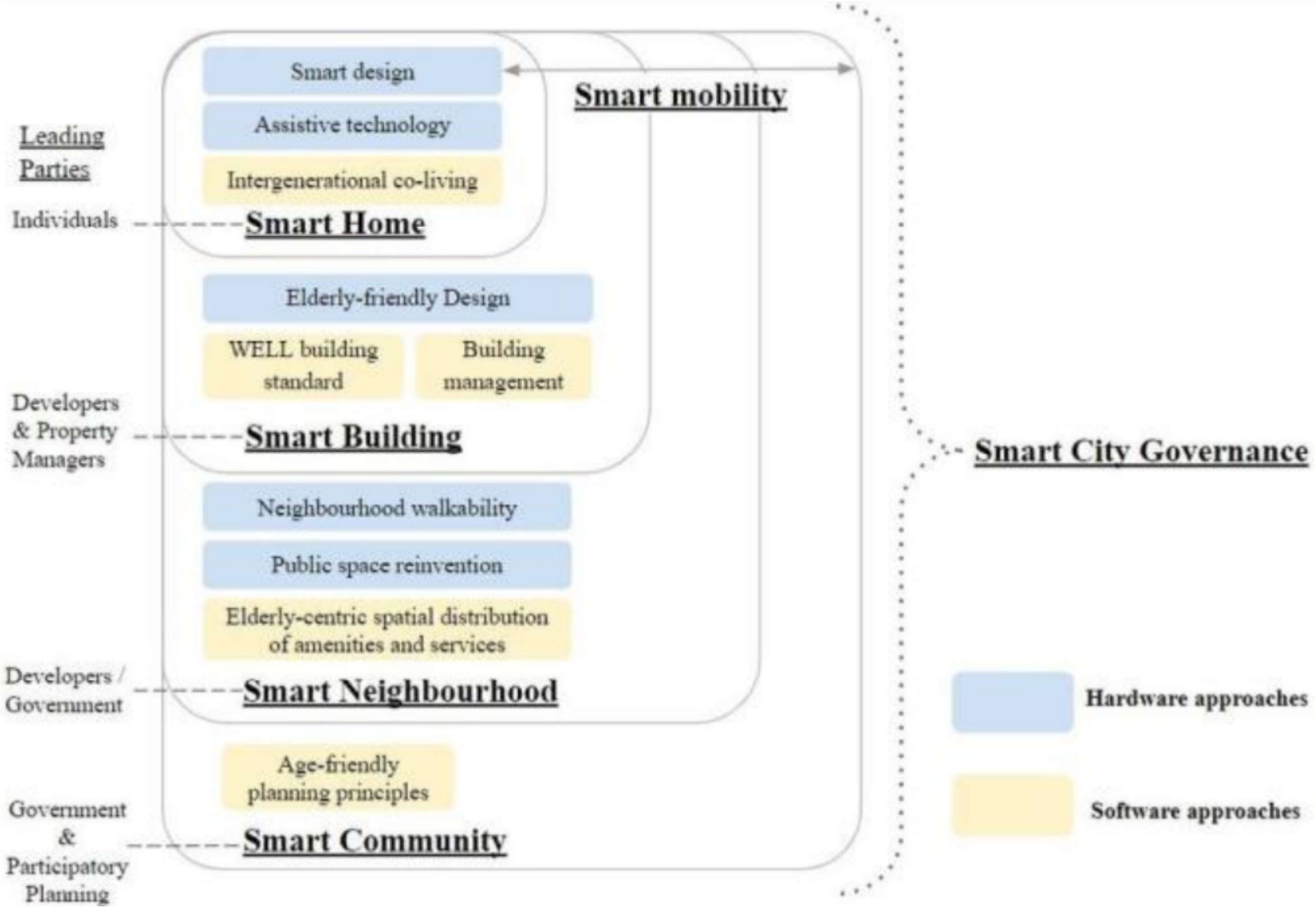
- Embracing ageing with smarter solutions
  - Achieve an age-friendly smart city
    - Data enabled, digitally connected & uses AI technology to help older people receive their healthcare, social welfare & other necessary services

Hong Kong has a rapidly ageing population - Projection of total population, elderly population & elderly dependency ratio, 2007-2033



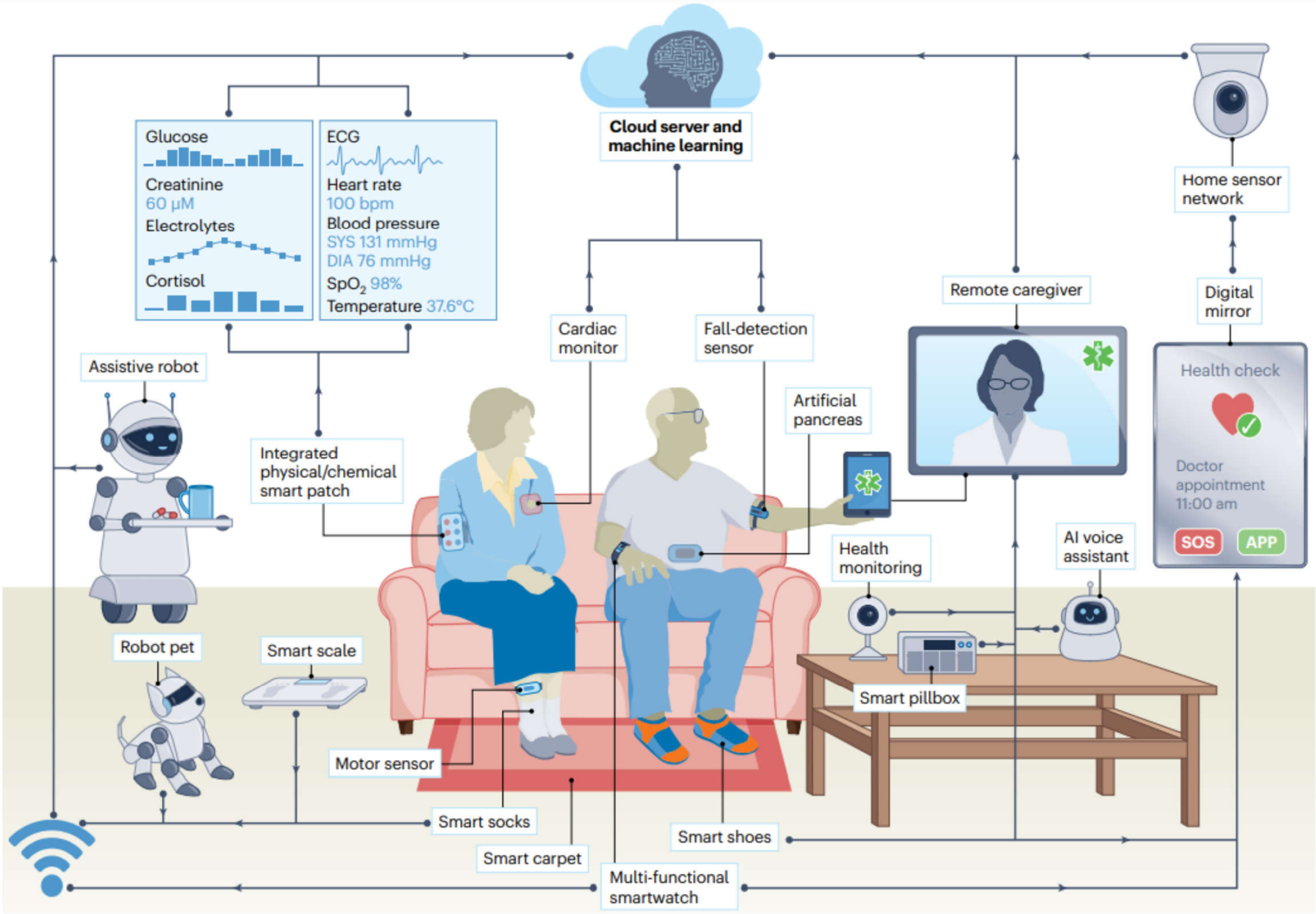
(Source: Hong Kong Population Projections 2004-2033, Census and Statistics Department)

Smart approach to ageing problem in the society



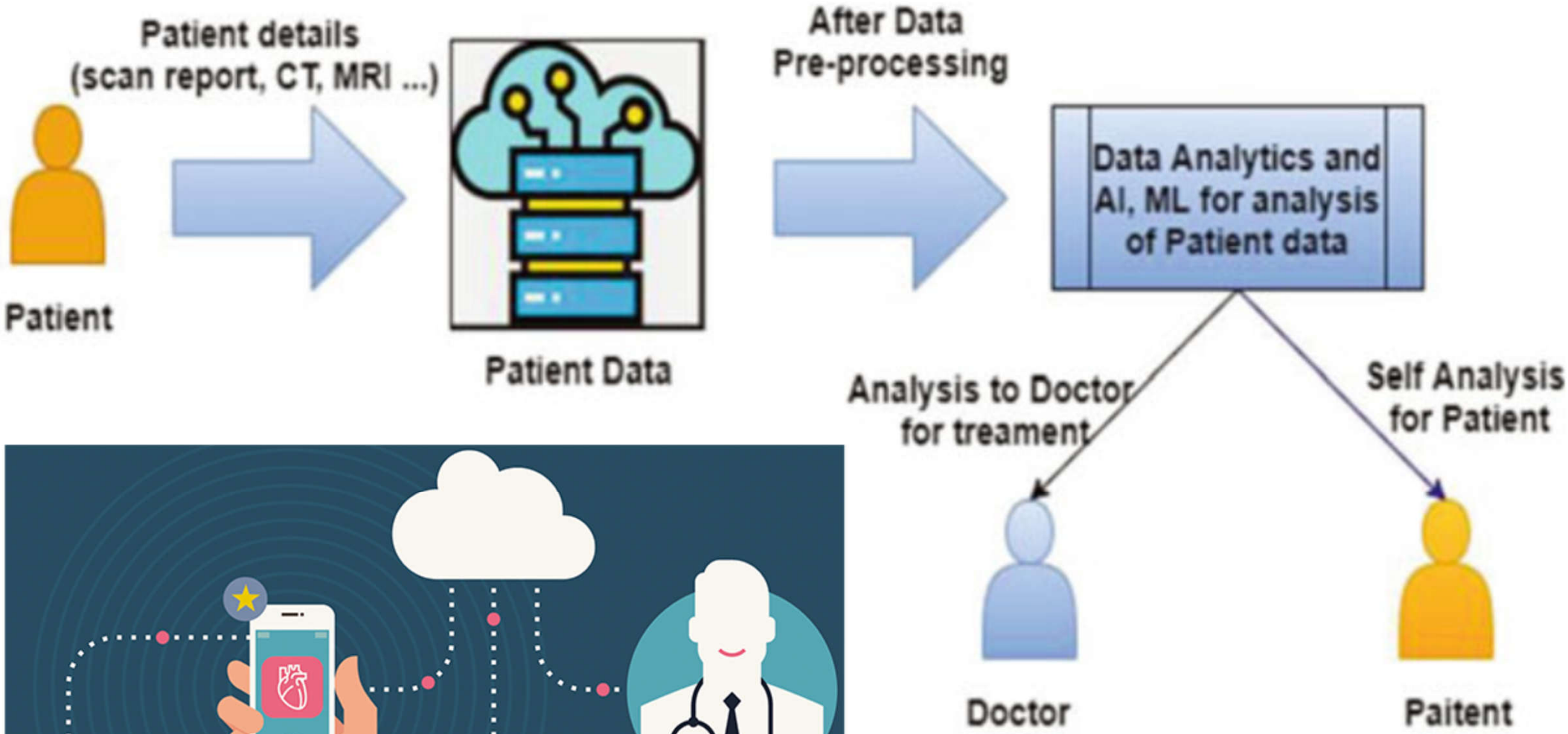
(Source: SCC, 2022. *Smart City Blueprint 3.0 Advisory Report: The Way Forward*, Smart City Consortium (SCC), Hong Kong. https://smartcity.org.hk/images/SCC_Paper_for_Blueprint_30_Final.pdf)

The future of geriatric healthcare in the home setting



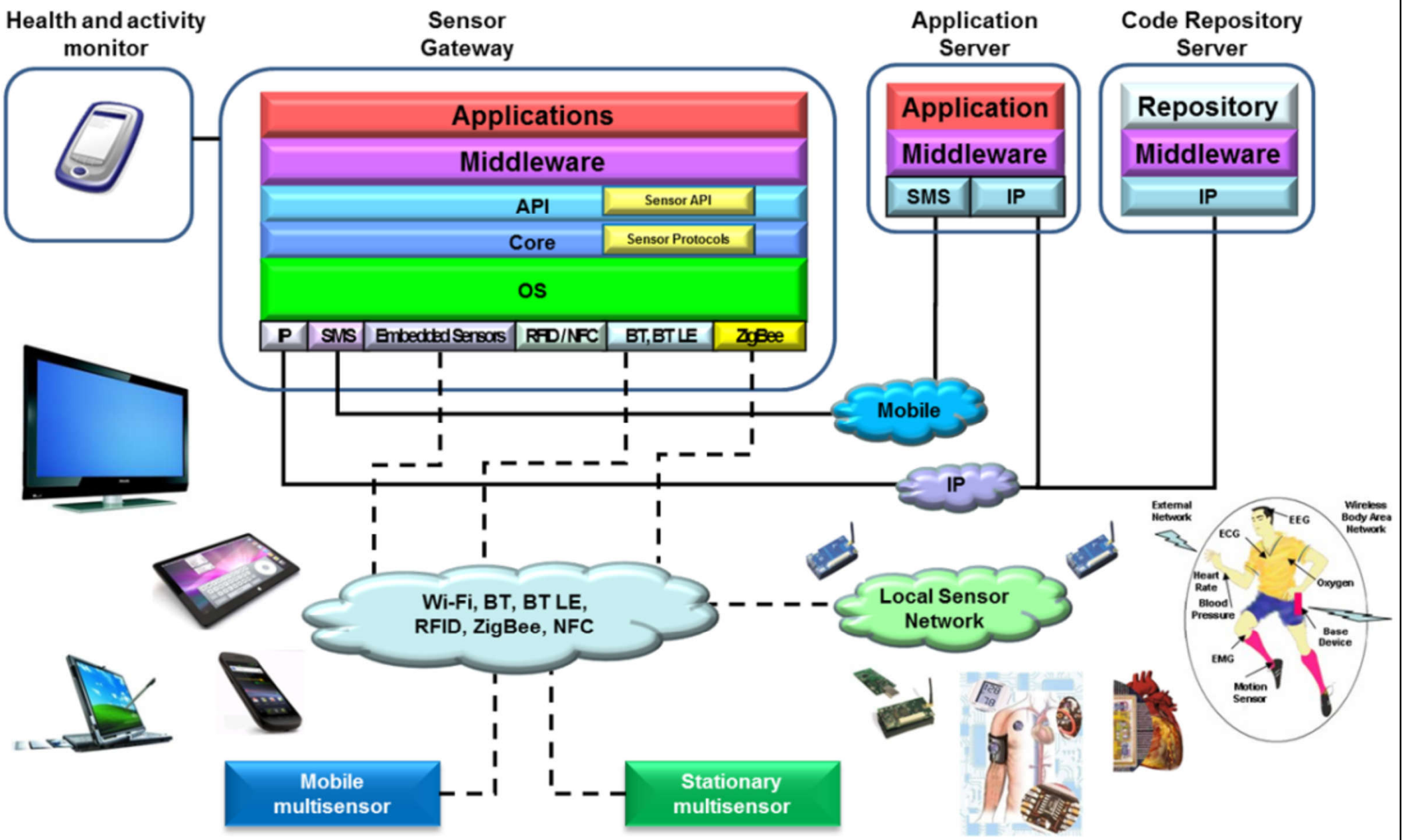
(Source: Chen C., Ding S. & Wang J., 2023. Digital health for aging populations, *Nature Medicine*, 29: 1623-1630. https://doi.org/10.1038/s41591-023-02391-8)

Role of artificial intelligence (AI) & data analytics in healthcare



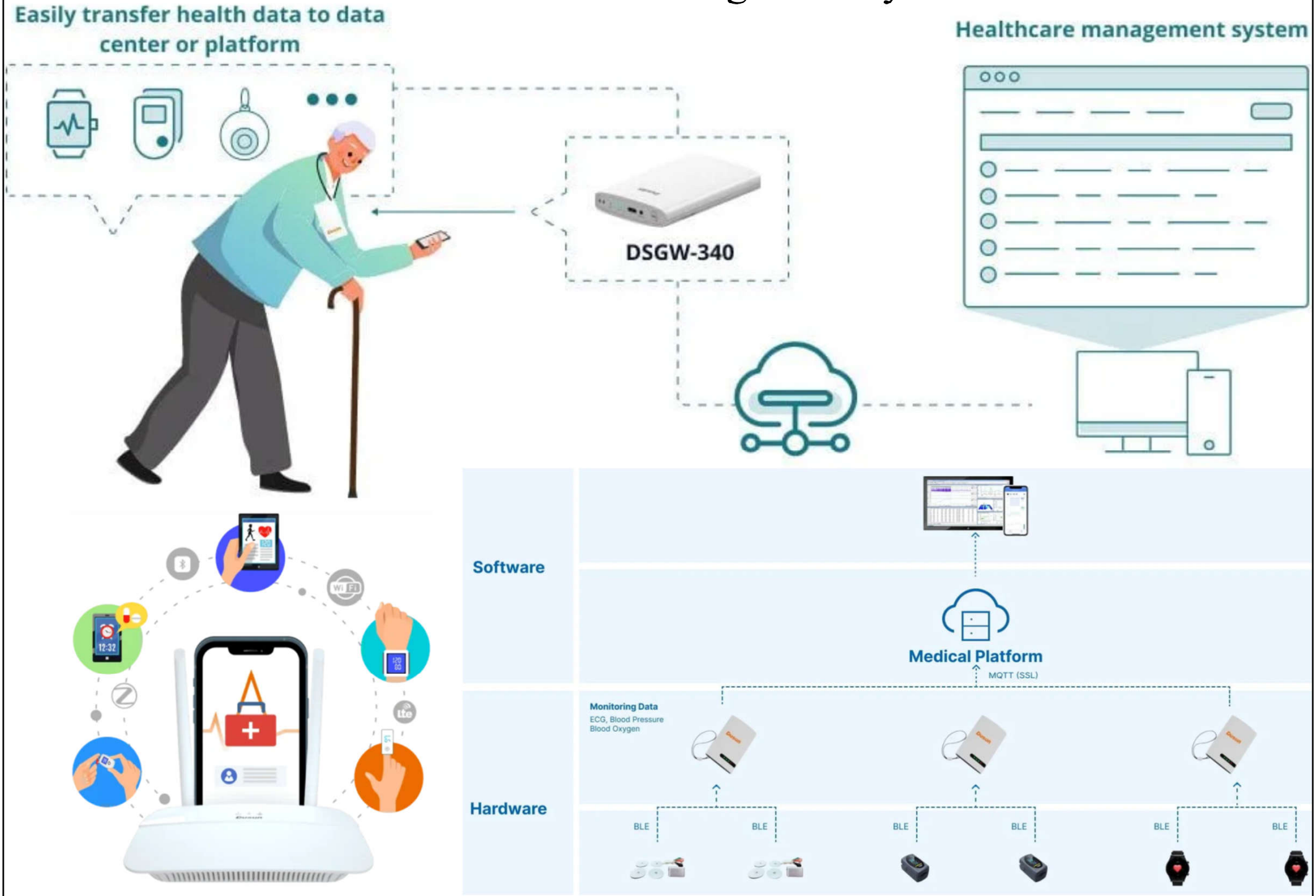
(Source: Srinivasa K. G., Siddesh G. M. & Manisekhar S. R. (eds.), 2022. *Society 5.0: Smart Future Towards Enhancing the Quality of Society*, Springer, Singapore. https://doi.org/10.1007/978-981-19-2161-2)

Smart health platform



(Source: Vermesan O. & Friess P. (eds.), 2014. *Internet of Things – From Research and Innovation to Market Deployment*, River Publishers, New York. https://doi.org/10.1201/9781003338628)

Smart healthcare management system

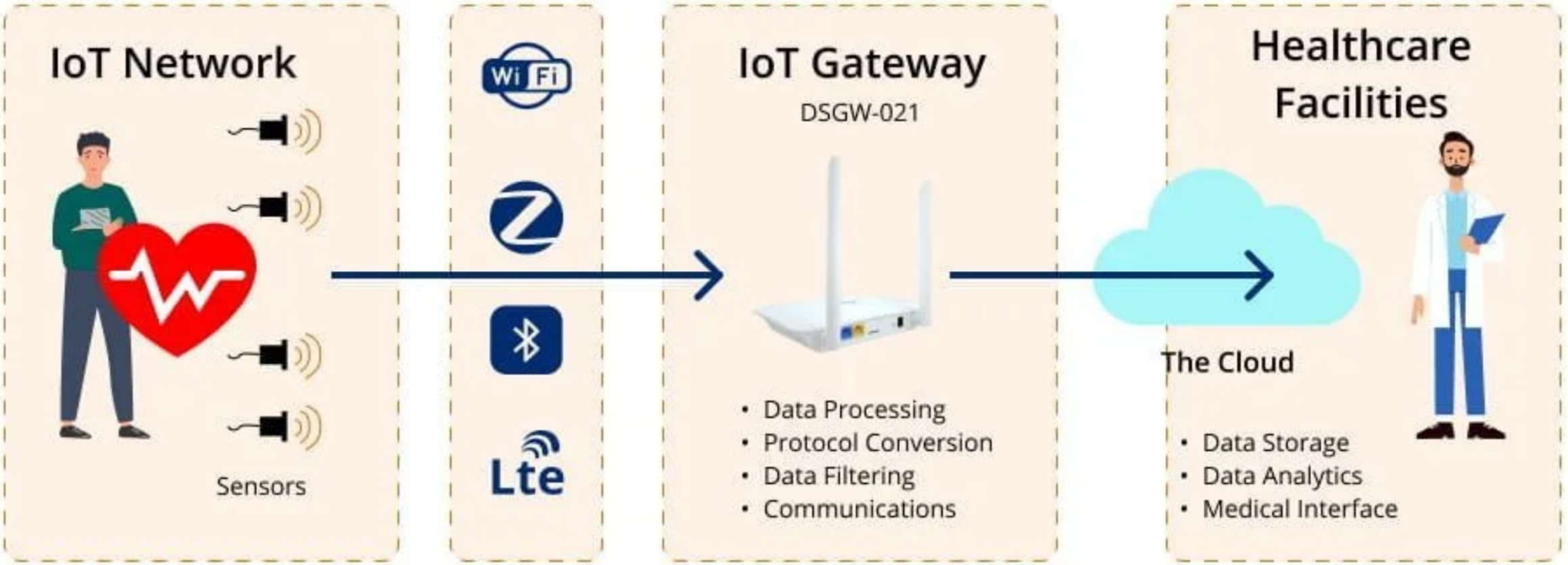


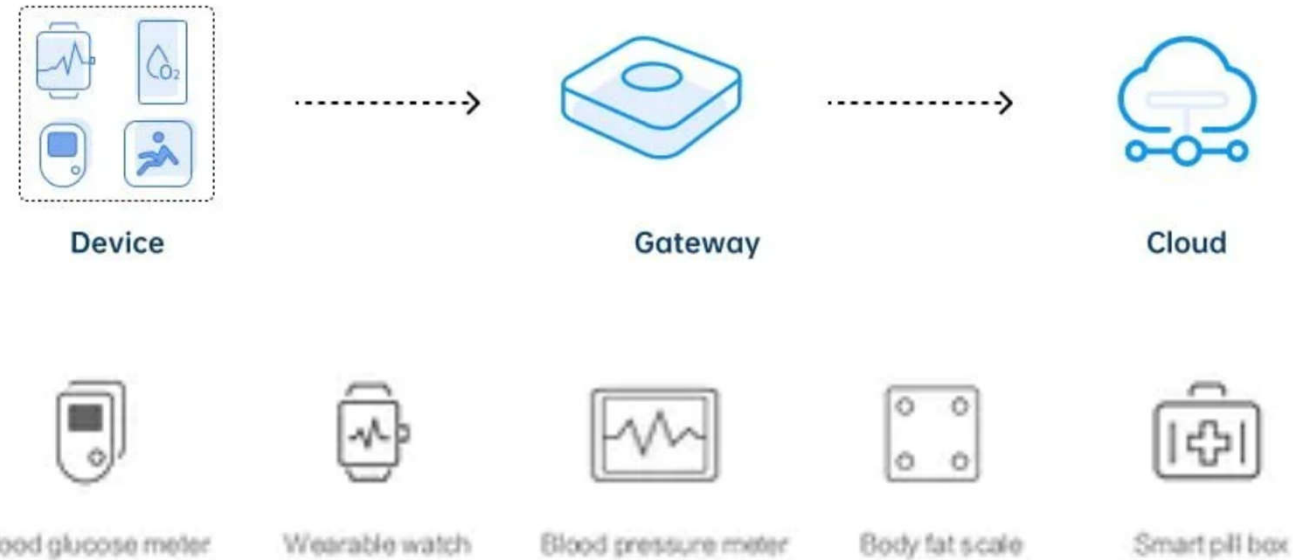
(Source: https://www.dusuniot.com/blog/how-to-send-sensor-data-to-cloud/)

Example of devices for smart elderly care solution

(Source: https://www.dusuniot.com/solution/smart-elderly-care-solution/)

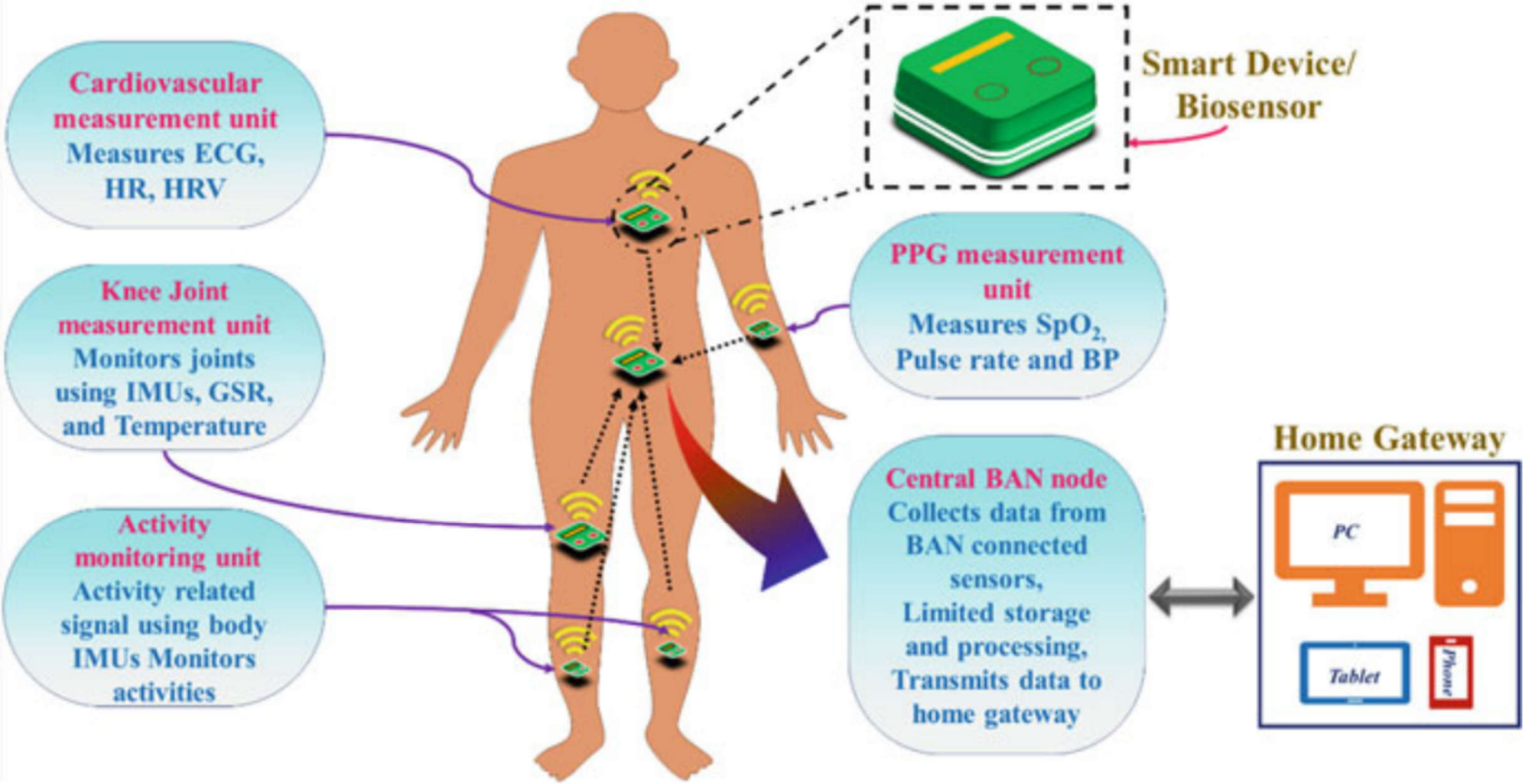
Smart health monitoring system & devices





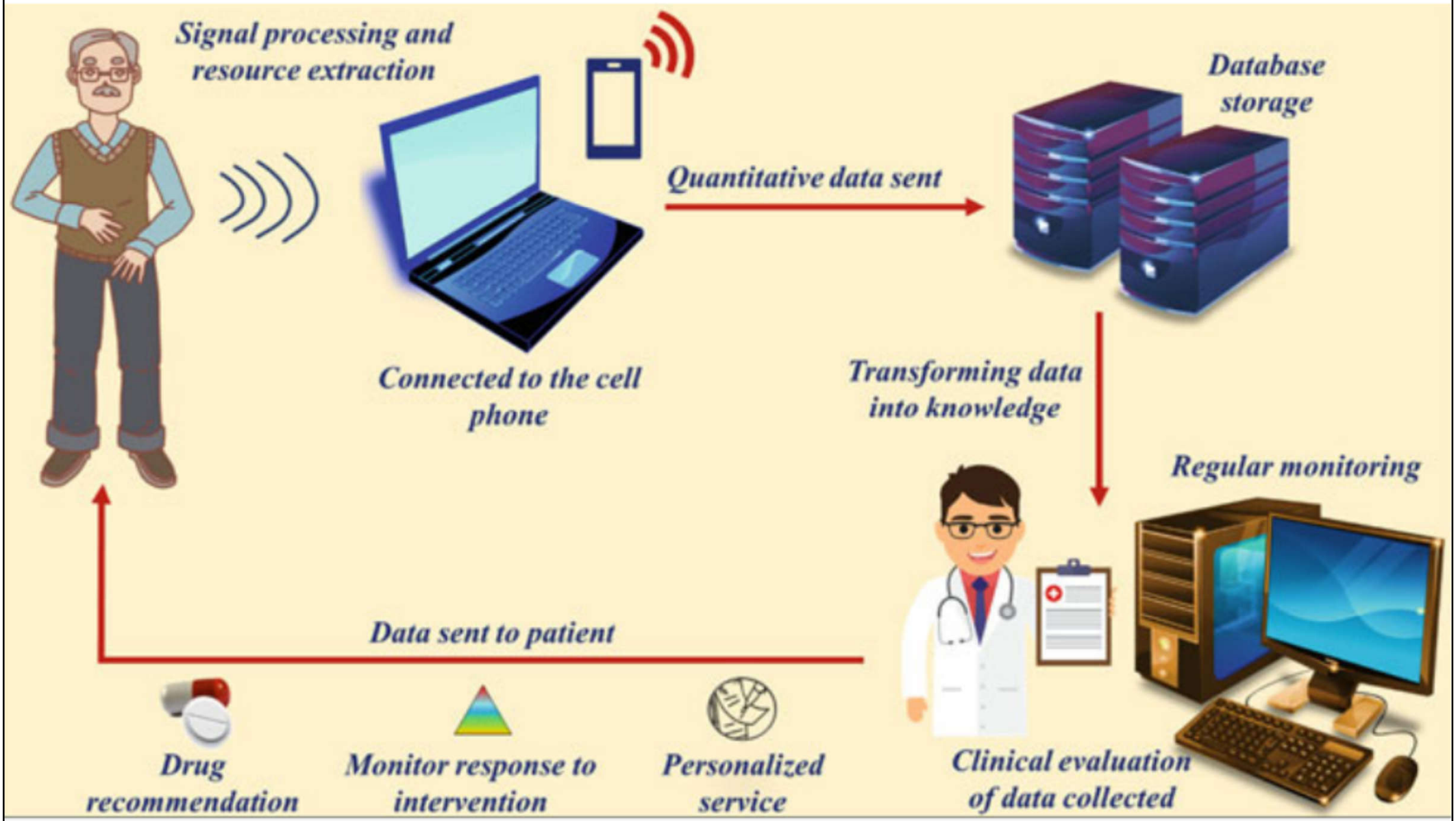
(Source: https://www.dusuniot.com/blog/home-health-monitoring-complete-guide/)

Application of smart device/biosensor helping in diagnosis of dysfunctions in various body organs



(Source: Sharma K., Kesharwani P., Prajapati S. K., Jain A., Mittal N., Kaushik R. & Mody N., 2020. Smart devices in healthcare sector: applications, In Hussain C. M. & Di Sia P. (eds.), *Handbook of Smart Materials, Technologies, and Devices: Applications of Industry 4.0*, Chapter 40, Springer, Cham, p. 1023-1049. https://doi.org/10.1007/978-3-030-84205-5)

Wearable devices in providing wholesome medical care based on remote monitoring of clinical manifestations in patients



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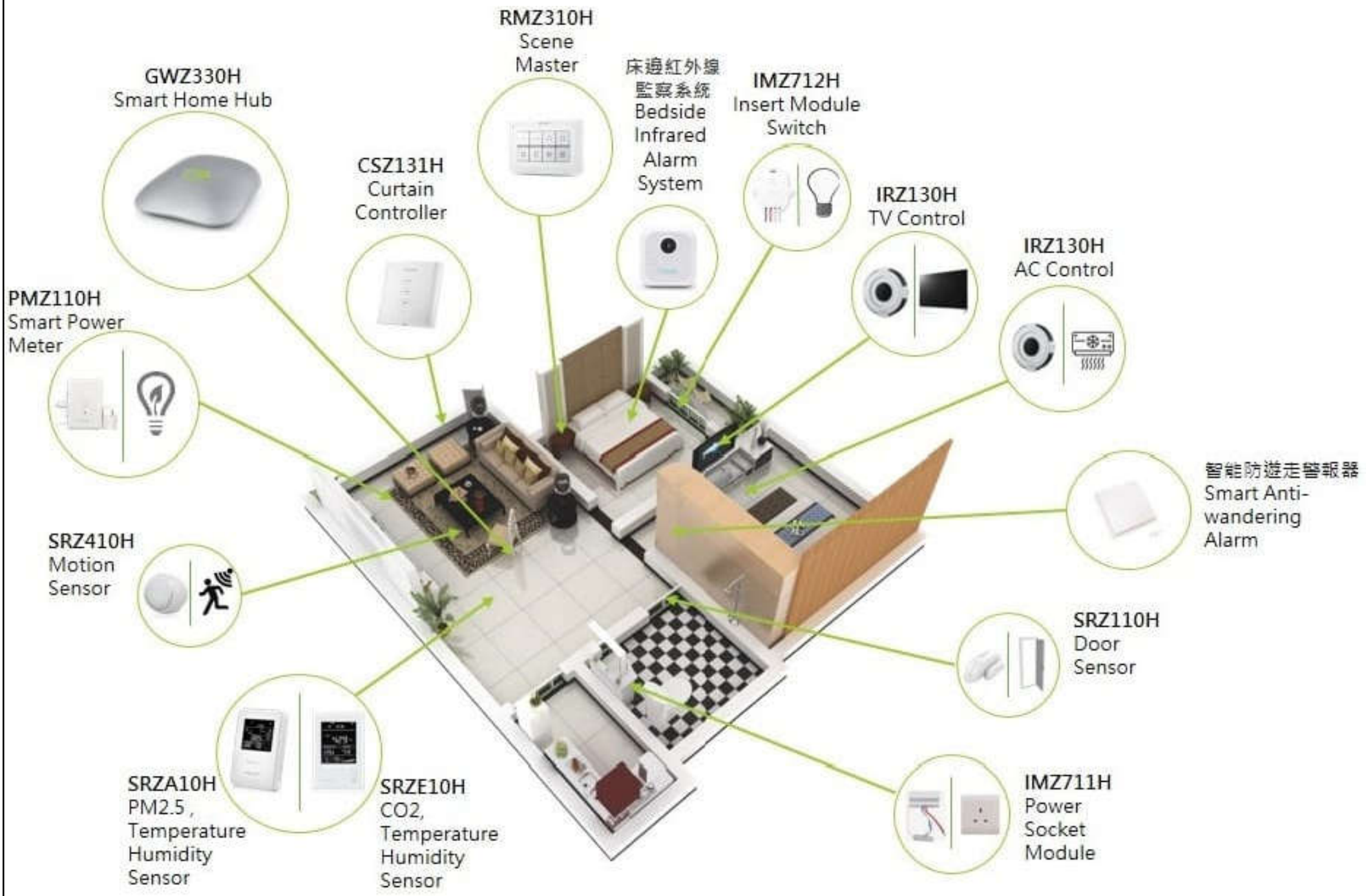
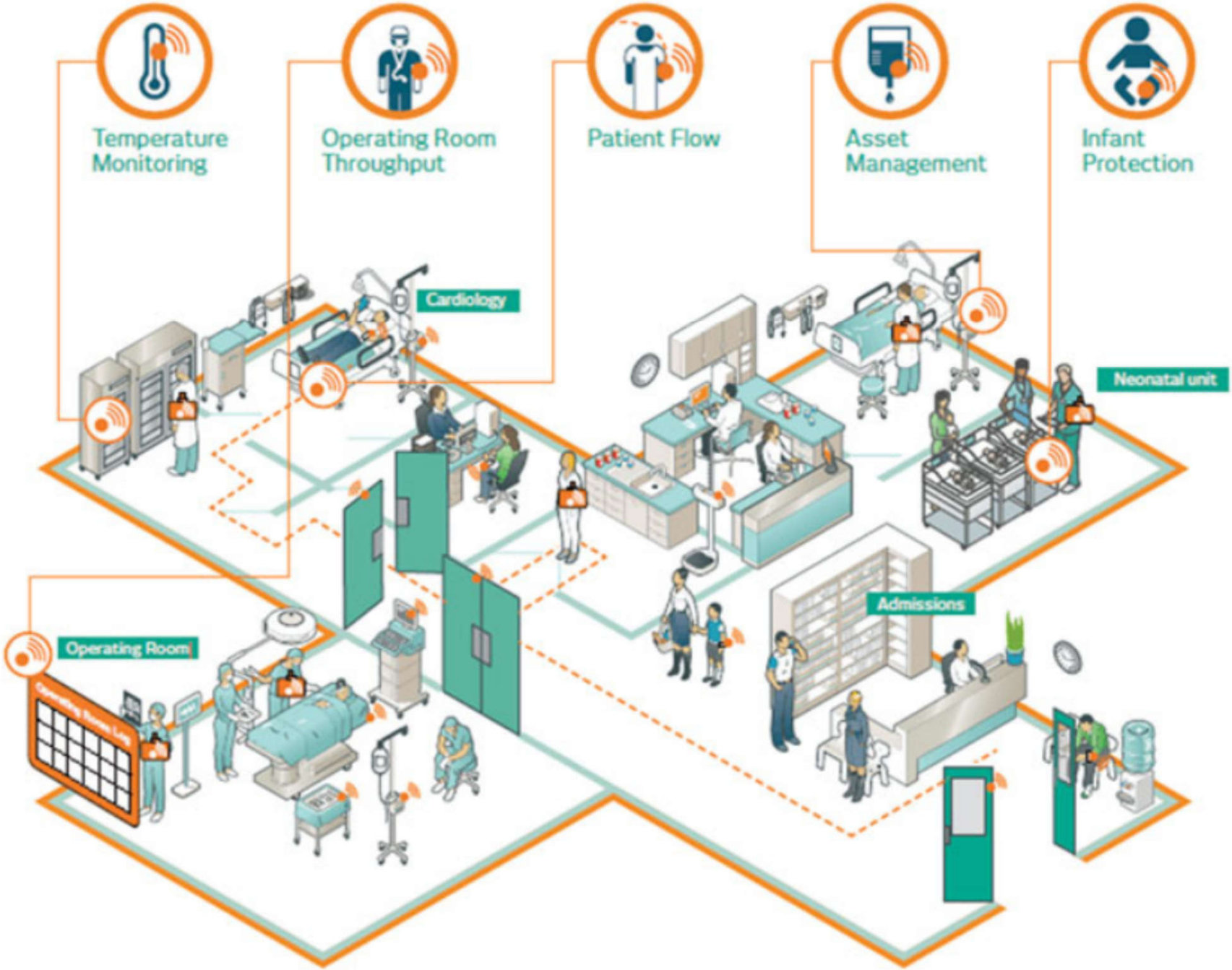
Example of smart elderly centre components



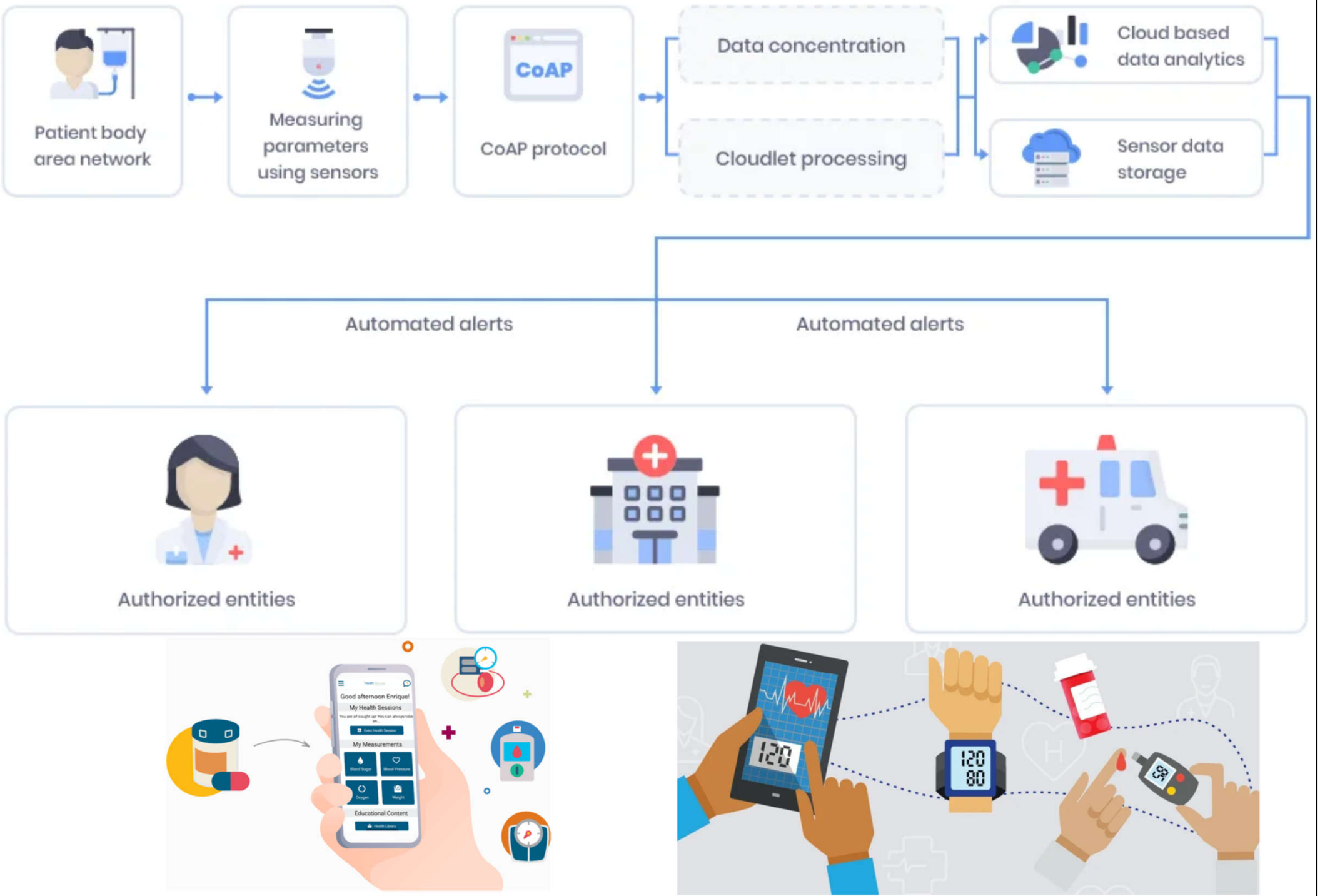
(Source: https://www.tronico.com.hk/zh/showcase/)

Smart medical facilities with indoor real-time location systems



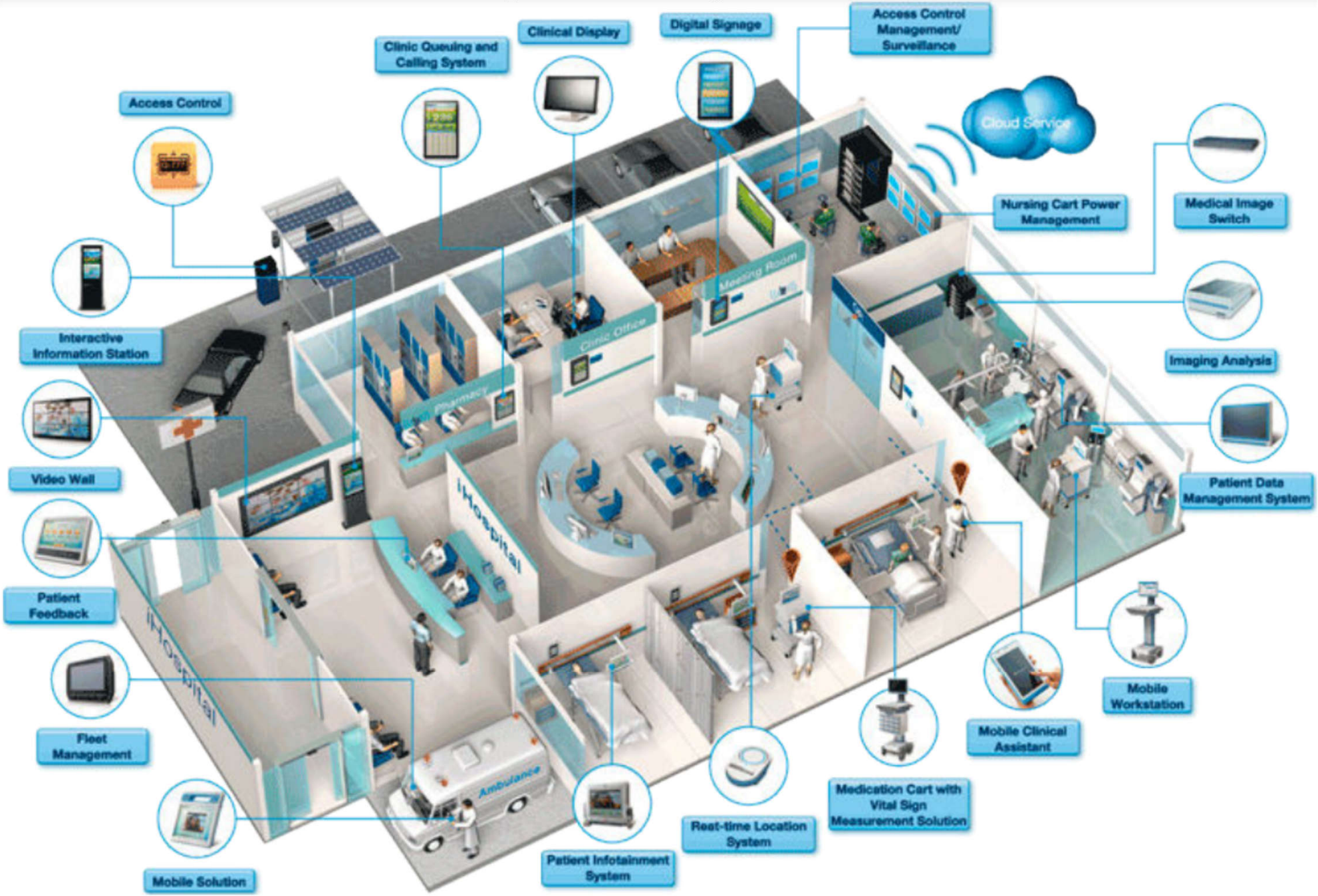
(Source: Kunst R., Ramos G., Righi R., da Costa C. A., Pignaton E., Binotto A., Favilla J., Ohta R. & High R., 2020. Industry 4.0: applications and future perspectives, In Hussain C. M. & Di Sia P. (eds.), *Handbook of Smart Materials, Technologies, and Devices: Applications of Industry 4.0*, Chapter 50, Springer, Cham, p. 1277-1306. https://doi.org/10.1007/978-3-030-84205-5)

Process flow of remote patient monitoring systems



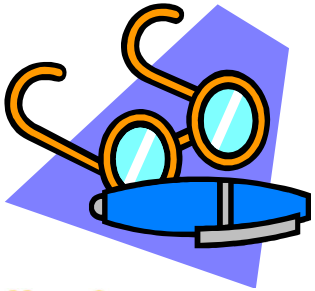
(Source: https://www.dusuniot.com/blog/parkinsons-disease-monitoring/)

Smart hospital basic plan & features



(Source: Rizwan P., Babu M. R. & Suresh K., 2017. Design and development of low investment smart hospital using internet of things through innovative approaches, *Biomedical Research*, 28 (11) 4979-4985. https://www.alliedacademies.org/articles/design-and-development-of-low-investment-smart-hospital-using-internet-of-things-through-innovative-approaches.html)

Smart health living



- Directions of future smart hospitals in HK (with examples of smart projects):
  - https://www3.ha.org.hk/uch/KECSmartHospital/SmartProjectList.html
  - 1. Modernized Healthcare
  - 2. Customized Patient Journey
  - 3. Smart Logistics
  - 4. Intelligent Workplace
  - 5. Cutting-edge infrastructure

Further reading

- Become a Smart Building Specialist: A Promising Career in Construction Technology
  https://www.constructionplacements.com/smart-building-specialist-career-guide/
- Smart building jobs in Hong Kong
  https://hk.jobsdb.com/smart-building-jobs
- The smart hotel and why it's part of a brilliant future
  https://lesroches.edu/blog/smart-hotel/
- KEC Smart Hospital
  https://www3.ha.org.hk/uch/KECSmartHospital/SmartProjectList.html