



**Internet of Things enabling technologies
for personal health care applications**

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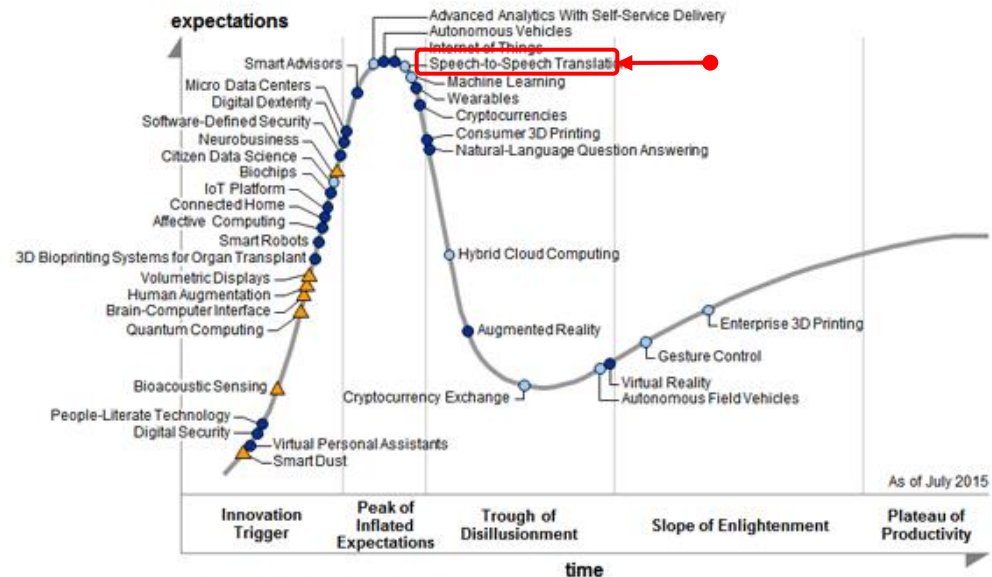
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- **IoT – Internet of Things**
- **IoT based personal connected health system**
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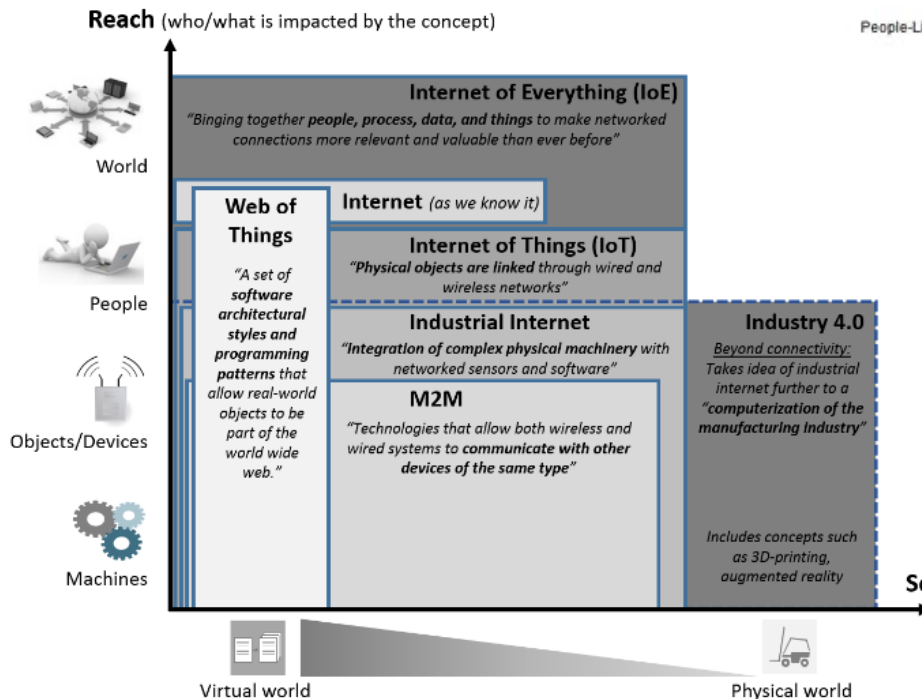
IoT – Internet of Things (1)

■ Hype Cycle for Emerging Technologies

■ IoT vs. M2M, Industry 4.0, WoT, IoE



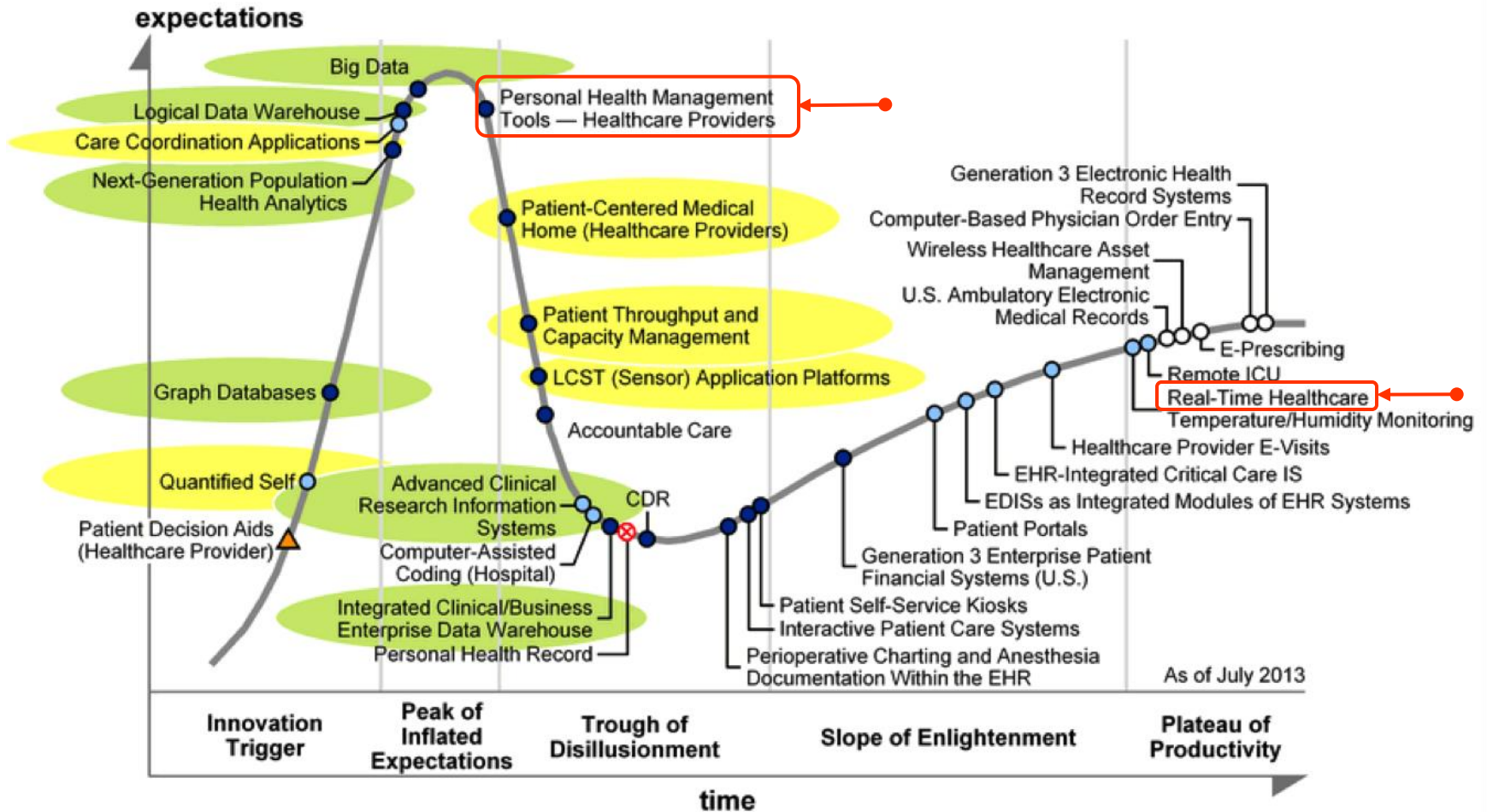
Source: Gartner (August 2015)



Source: Knud Lasse Lueth, "IoT basics: Getting started with the Internet of Things", White Paper, at <http://iot-analytics.com/>, 2015.

IoT – Internet of Things (2)

■ The Health Data Analytics Hype Cycle



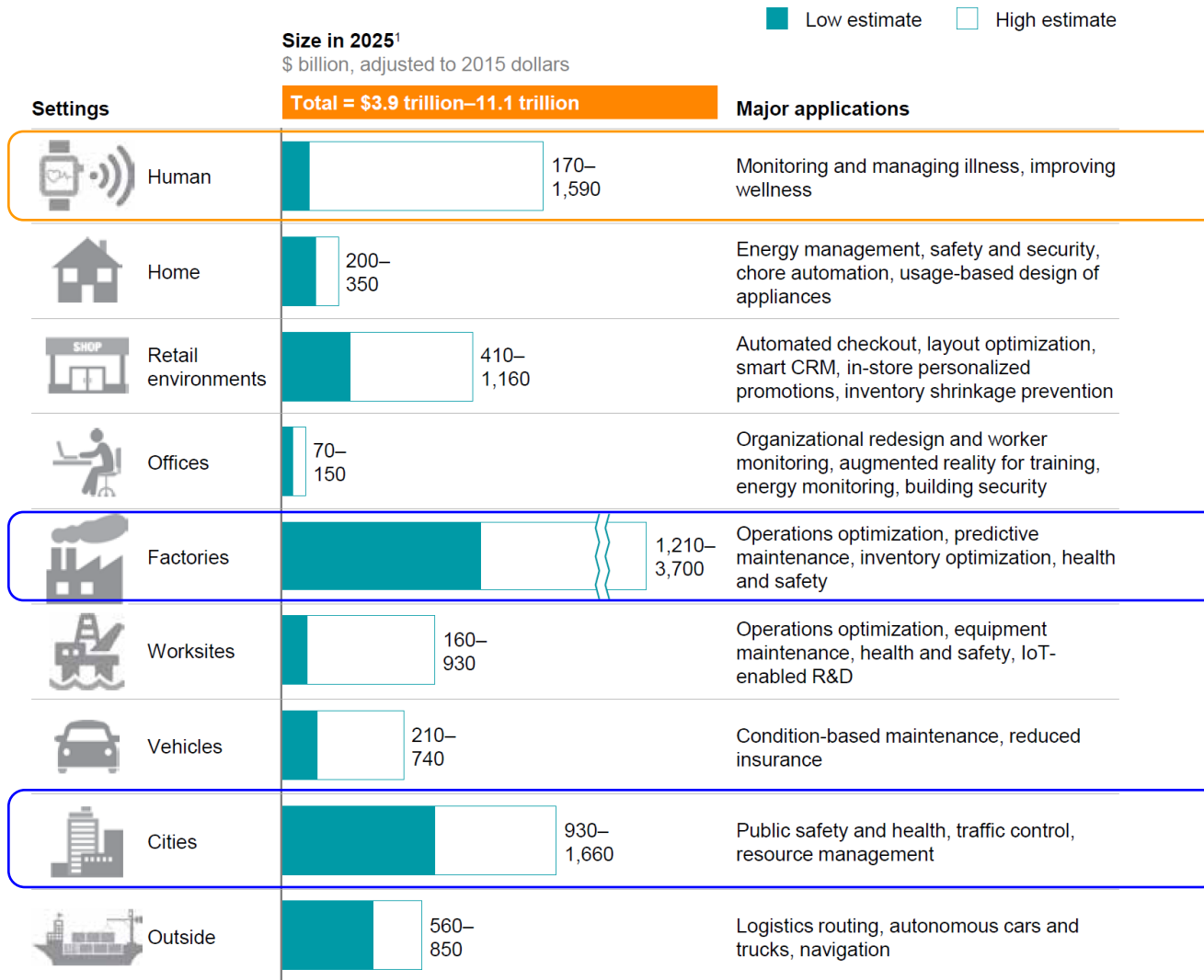
Plateau will be reached in:

○ less than 2 years ● 2 to 5 years ● 5 to 10 years ▲ more than 10 years ⊗ obsolete before plateau

Source: Gartner (2013)

IoT – Internet of Things (3)

■ Potential economic impact of IoT in 2025



Source: J. Manyika *et al.*, *Internet of Things: mapping the value beyond the hype*. McKinsey Global Institute, San Francisco, CA, June 2015.

¹ Includes sized applications only.
NOTE: Numbers may not sum due to rounding.

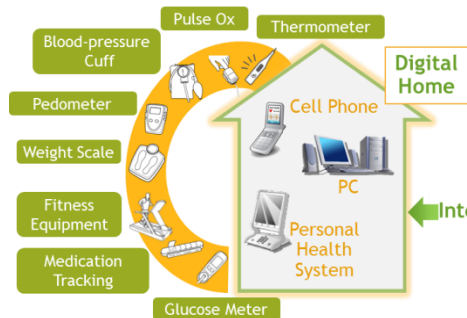
IoT – Internet of Things (4)

Handbook: Internet of Things Alliances and Consortia

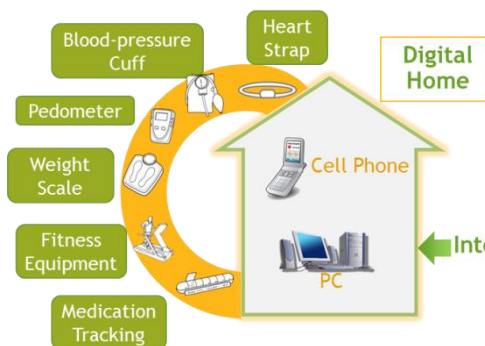
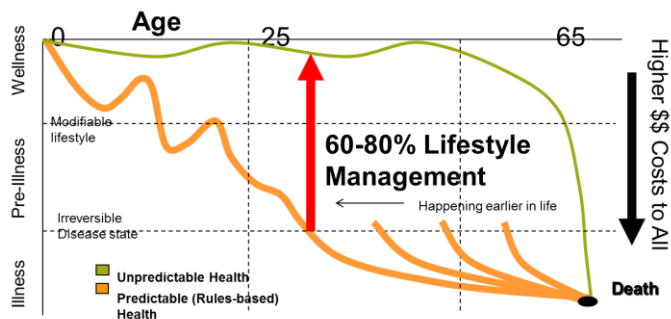


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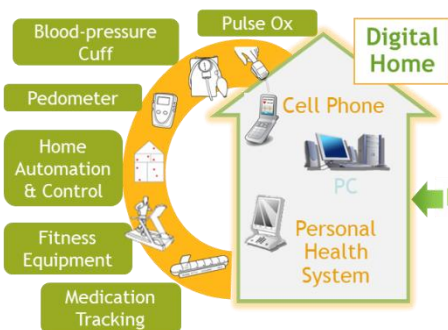
IoT based personal health care system (1)



Manage Chronic Conditions



Health & Wellness



Living Independently Longer



Source: *Continua Health Alliance*

IoT based personal health care system (2)

■ Manage Chronic Conditions

- *Extend health care into the home / Improve overall disease management care*
- *Monitor specific disease progression utilizing biosensors and activity*
- *Schedule appointments / Trend analysis and alerts*
- *Remote consultation: e-mail, chat, video conferencing*

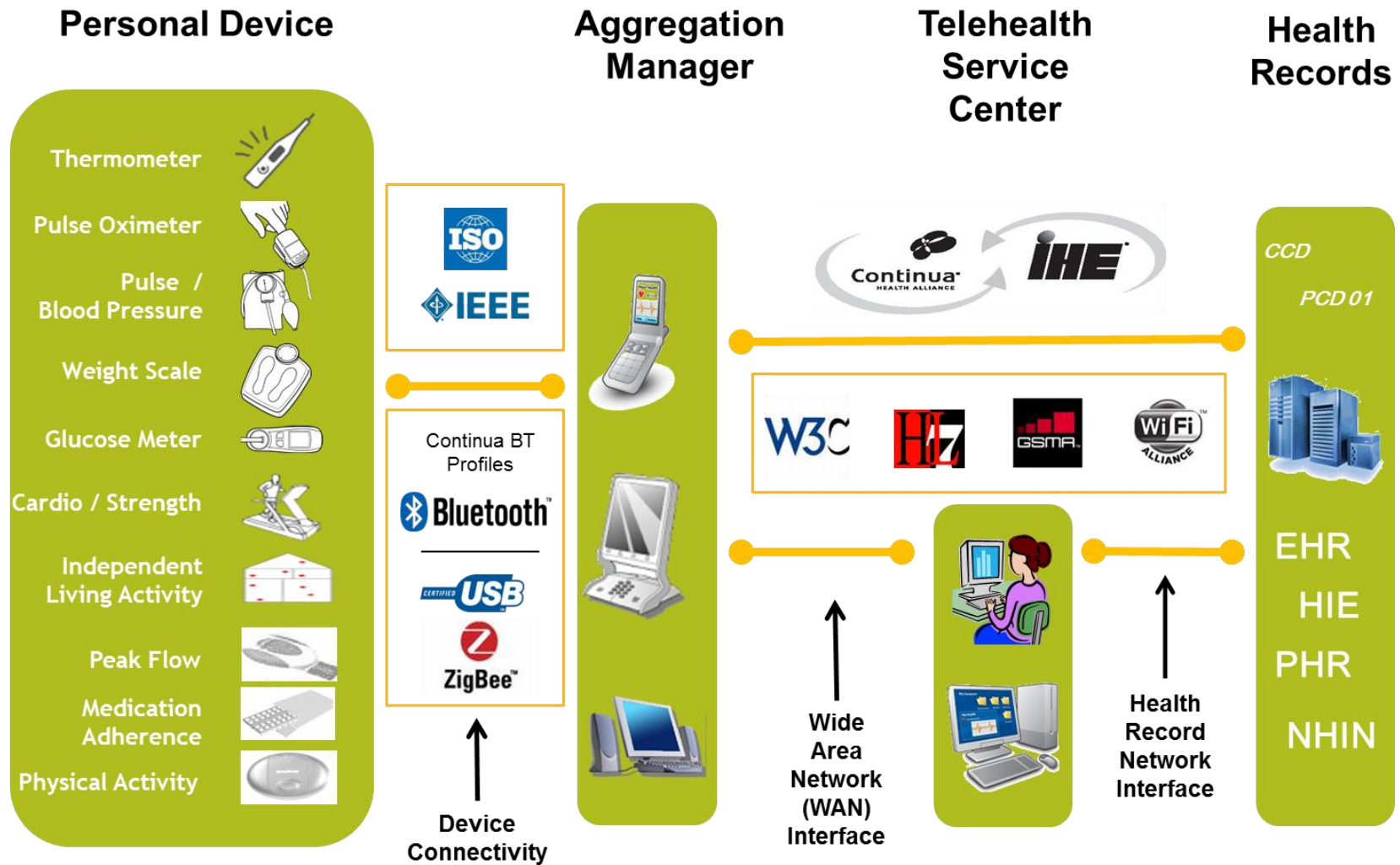
■ Health & Wellness

- *Extend health care system into the home*
- *Perform initial triage utilizing biosensors, images, e-mail/chat/video*
- *Schedule appointments / Record personal health data / Weight loss / Fitness*
- *Collect long-term data for medical baseline / Predictive alerts for high-risk conditions*

■ Living Independently Longer

- *Assistance with daily health and monitoring tasks*
- *Medical reminders*
- *Activity prompts*
- *Monitoring and early warning using bio-sensor data collection*
- *Automated dietician*
- *Emergency response*
- *Real-time alerts and communication*

IoT based personal health care system (3)



Source: Continua Health Alliance

IoT enabling technologies (1)

| Research needs | 2015–2020 | Beyond 2020 | Research needs | 2015–2020 | Beyond 2020 |
|-----------------------------------|--|--|--|---|--|
| Identification Technology | <p>Convergence of IP and IDs and addressing scheme</p> <ul style="list-style-type: none"> • Unique ID • Multiple IDs for specific cases • Extend the ID concept (more than ID number) • Electro Magnetic Identification – EMID | Multi methods – one ID | Internet of Things Architecture Technology | <p>Code in tags to be executed in the tag or in trusted readers</p> <ul style="list-style-type: none"> • Global applications • Adaptive coverage • Universal authentication of objects • Graceful recovery of tags following power loss • More memory • Less energy consumption • 3-D real time location/position embedded systems | <p>Intelligent and collaborative functions</p> <ul style="list-style-type: none"> • Object intelligence • Context awareness • Cooperative position cyber-physical systems |
| IoT Architecture | <p>Internet (Internet of Things) (global scale applications, global interoperability, many trillions of things)</p> | | | | |
| Internet of Things Infrastructure | <p>Application domain-independent abstractions & functionality</p> <ul style="list-style-type: none"> • Cross-domain integration and management • Large-scale deployment of infrastructure • Context-aware adaptation of operation | Self management and configuration | Communication Technology | <p>Longer range (higher frequencies – tenths of GHz)</p> <ul style="list-style-type: none"> • Protocols for interoperability • On chip networks and multi standard RF architectures • Multi-protocol chips • Gateway convergence | Self configuring, protocol seamless networks |
| Internet of Things Applications | <p>IoT information open market</p> <ul style="list-style-type: none"> • Standardization of APIs • IoT device with strong processing and analytics capabilities • Ad-hoc deployable and configurable networks for industrial use • Mobile IoT applications for IoT industrial operation and service/maintenance • Mobile IoT applications for IoT industrial operation and service/maintenance • Fully integrated and interacting IoT applications for industrial use | <p>Building and deployment of public IoT infrastructure with open APIs and underlying business models</p> <ul style="list-style-type: none"> • Mobile applications with bio-IoT-human interaction | | | |
| SOA Software Services for IoT | <p>Quality of Information and IoT service reliability</p> <ul style="list-style-type: none"> • Highly distributed IoT processes • Semi-automatic process analysis and distribution | Fully autonomous IoT devices | | | |

IoT enabling technologies (2)

| Research needs | 2015–2020 | Beyond 2020 | Research needs | 2015–2020 | Beyond 2020 |
|---|--|--|---|--|--|
| <div style="border: 1px solid blue; border-radius: 10px; padding: 5px; width: fit-content;">Network Technology</div> | <ul style="list-style-type: none"> Hybrid network technologies convergence 5G developments Collision-resistant algorithms Plug and play tags Self repairing tags | <p>Grid/Cloud network</p> <ul style="list-style-type: none"> Software defined networks Service based network Multi authentication Integrated/universal authentication Brokering of data through market mechanisms Scalability enablers IPv6-based networks for smart cities | <div style="border: 1px solid red; border-radius: 10px; padding: 5px; width: fit-content;">Hardware Systems, Circuits and Architectures</div> | <ul style="list-style-type: none"> Ultra low power circuits Electronic paper Nano power processing units Silent Tags Biodegradable antennae | <p>Need based network</p> <ul style="list-style-type: none"> Internet of Everything Robust security based on a combination of ID metrics Autonomous systems for non stop information technology service Global European IPv6-based Internet of Everything |
| <div style="border: 1px solid blue; border-radius: 10px; padding: 5px; width: fit-content;">Software and algorithms</div> | <p>Self management and control</p> <ul style="list-style-type: none"> Micro operating systems Context aware business event generation Interoperable ontologies of business events Scalable autonomous software | <p>Self generating “molecular” software</p> <ul style="list-style-type: none"> Context aware software | <div style="border: 1px solid blue; border-radius: 10px; padding: 5px; width: fit-content;">Data and Signal Processing Technology</div> | <p>Multi protocol front ends</p> <ul style="list-style-type: none"> Ultra low cost chips with security Collision free air to air protocol Minimum energy protocols Multi-band, multi-mode wireless sensor architectures implementations Adaptive architectures Reconfigurable wireless systems Changing and adapting functionalities to the environments Micro readers with multi standard protocols for reading sensor and actuator data Distributed memory and processing Low cost modular devices Protocols correct by construction Common sensor ontologies (cross domain) Distributed energy efficient data processing Autonomous computing Tera scale computing | <p>Heterogeneous architectures</p> <ul style="list-style-type: none"> “Fluid” systems, continuously changing and adapting |
| <div style="border: 1px solid red; border-radius: 10px; padding: 5px; width: fit-content;">Hardware Devices</div> | <p>Evolving software</p> <ul style="list-style-type: none"> Self reusable software Autonomous things: Self configurable Self healing Self management Platform for object intelligence <p>Polymer based memory</p> <ul style="list-style-type: none"> Ultra low power EPROM/FRAM Molecular sensors Autonomous circuits Transparent displays Interacting tags Collaborative tags Heterogeneous integration Self powering sensors Low cost modular devices | <p>Biodegradable antennas</p> <ul style="list-style-type: none"> Autonomous “bee” type devices | <div style="border: 1px solid blue; border-radius: 10px; padding: 5px; width: fit-content;">Discovery and Search Engine Technologies</div> | <p>Scalable Discovery services for connecting things with services while respecting security, privacy and confidentiality</p> <ul style="list-style-type: none"> “Search Engine” for Things IoT Browser Multiple identities per object On demand service discovery/integration Universal authentication | <p>Cognitive computing</p> <p>Cognitive registries</p> |

IoT enabling technologies (3)

| Research needs | 2015–2020 | Beyond 2020 |
|--|---|---|
| Power and Energy Storage Technologies | Paper based batteries <ul style="list-style-type: none"> • Wireless power everywhere, anytime • Photovoltaic cells everywhere • Energy harvesting • Power generation for harsh environments | Biodegradable batteries |
| Interoperability | Dynamic and adaptable interoperability for technical and semantic areas <ul style="list-style-type: none"> • Open platform for IoT validation | Self-adaptable and agile interoperability approaches |
| Security, Privacy & Trust Technologies | Low cost, secure and high performance identification/ authentication devices <ul style="list-style-type: none"> • Access control and accounting schemes for IoT • General attack detection and recovery/resilience for IoT • Cyber Security Situation Awareness for IoT • Context based security activation algorithms • Service triggered security • Context-aware devices • Object intelligence Decentralised self configuring methods for trust establishment <ul style="list-style-type: none"> • Novel methods to assess trust in people, devices and data • Location privacy preservation • Personal information protection from inference and observation • Trust Negotiation | Cognitive security systems <ul style="list-style-type: none"> • Self-managed secure IoT • Decentralised approaches to privacy by information localisation |
| Governance (legal aspects) | Legal framework for transparency of IoT bodies and organizations | Adoption of clear European norms/standards regarding Privacy and Security for IoT |

| Research needs | 2015–2020 | Beyond 2020 |
|---------------------|---|-------------|
| Economic | <ul style="list-style-type: none"> • Privacy knowledge base and development privacy standards Business cases and value chains for IoT <ul style="list-style-type: none"> • Emergence of IoT in different industrial sectors | |
| Material Technology | Carbon nanotube <ul style="list-style-type: none"> • Conducting Polymers and semiconducting polymers and molecules • Modular manufacturing techniques | Graphen |

Source: Ovidiu Vermesan, Peter Friess (Editors). *Internet of Things - From Research and Innovation to Market Deployment*. River Publishers, 2014.

Proposed ASEAN IVO joint IoT R&D project

■ **Project:** *“IoT enabling technologies for personal health care applications”*

■ **Objectives**

- *To develop IoT enabling technologies for personal health care applications*
- *To build IoT product prototypes for personal health care applications*
- *To deploy product prototypes in ASEAN countries*

■ **Contents**

- *Developing IoT enabling technologies for personal health care applications*
- *Developing IoT product prototypes for personal health care applications*
 - ⊕ *Personal smart devices, personal health system (Aggregation manager)*
 - ⊕ *Tele-health service system*
- *Testing the prototypes*
 - ⊕ *VNU.ITI – NICT – ASEAN IVO members testbed*
 - ⊕ *Setting up a trial of the prototypes in Vietnam and other ASEAN countries*
- *Building applications models for deploying the investigated enabling technologies and product prototypes for personal health care applications in Vietnam and other ASEAN countries*

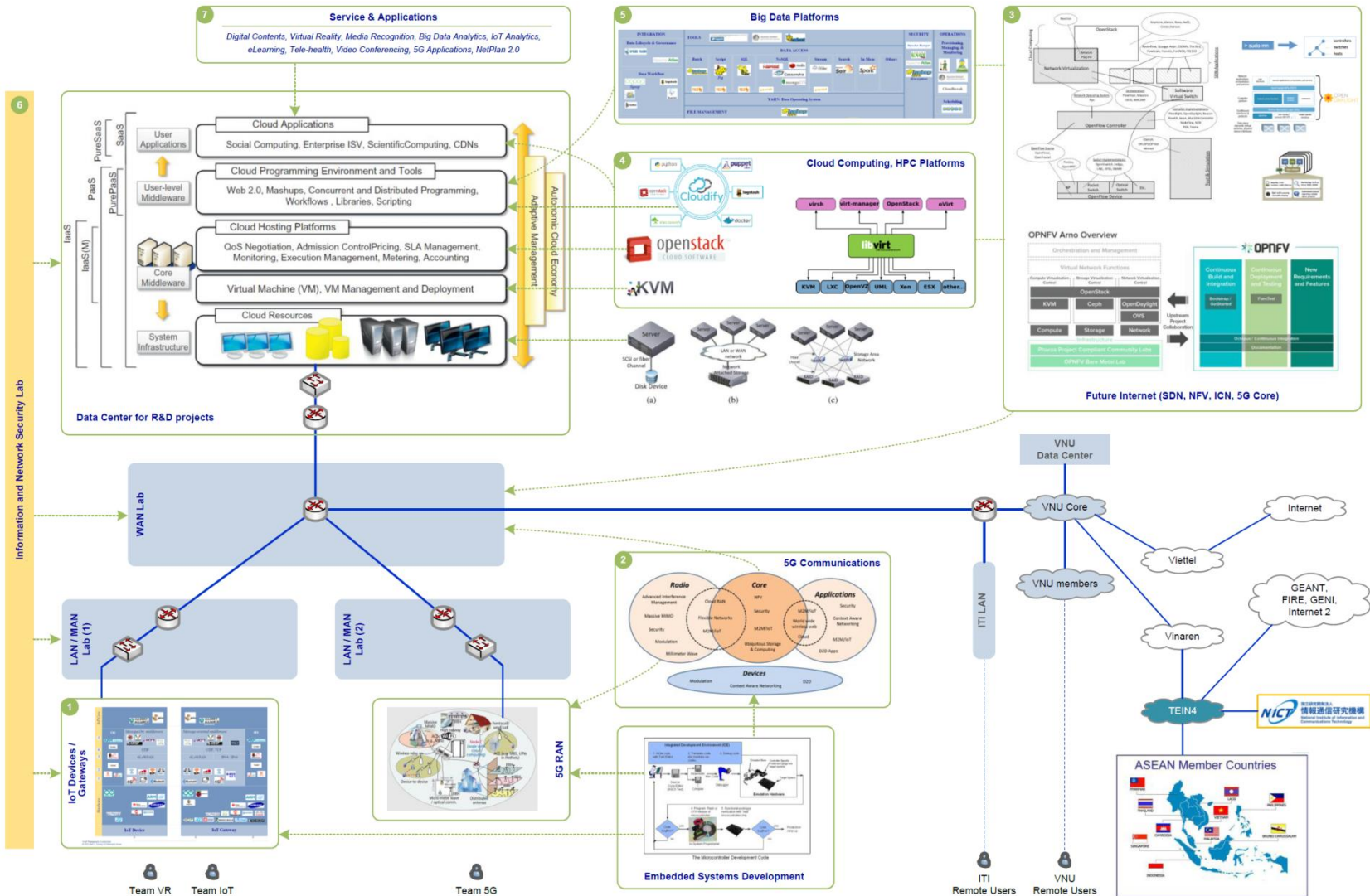
■ **Expected outputs**

- *IoT enabling technologies for personal health care applications*
- *IoT product prototypes for personal health care applications in ASEAN countries*
- *ASEAN IVO members’ joint research lab for studying IoT issues*

Implementation Approach (1)

ITL.VNU Lab

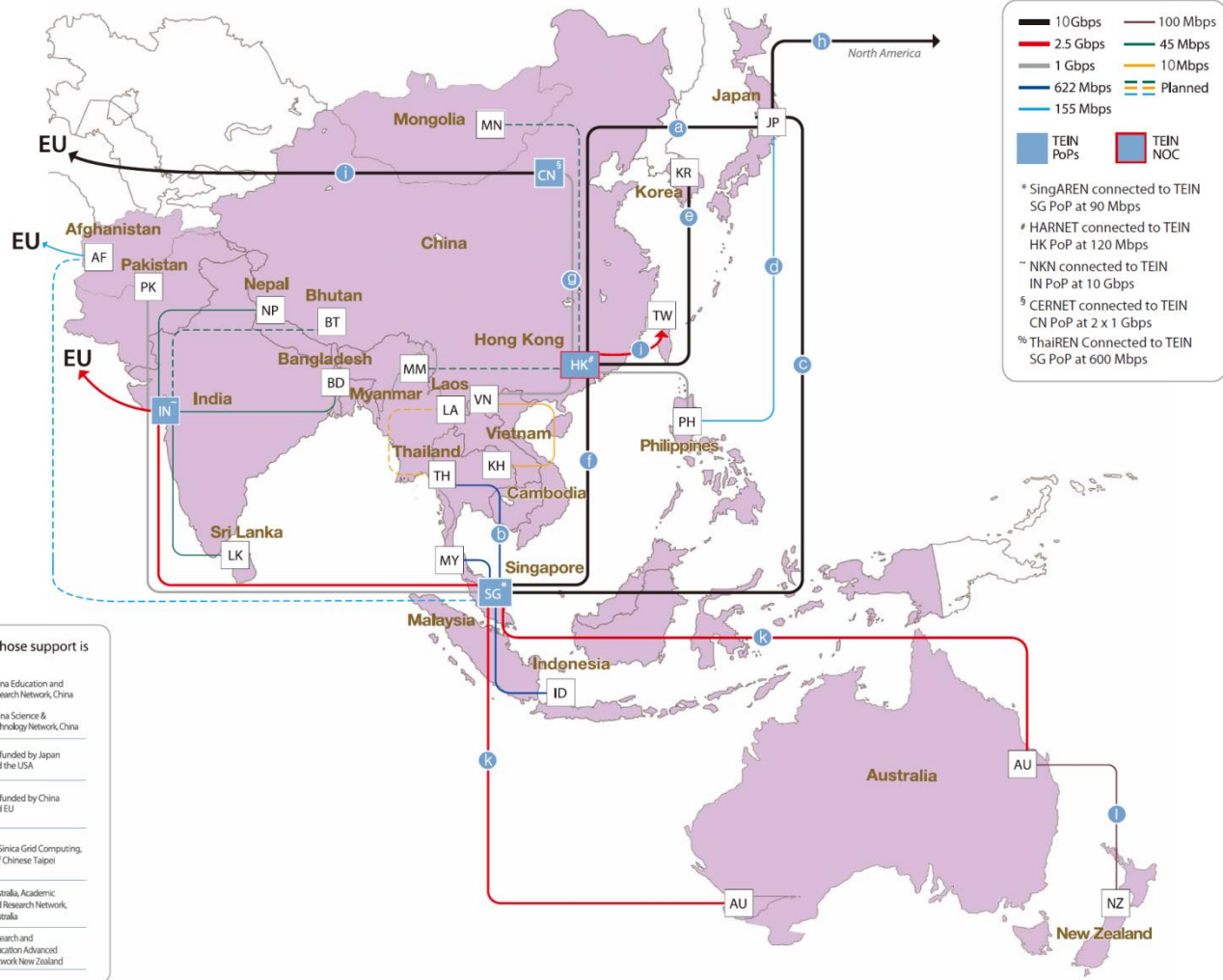
IoT enabling technologies for personal health care applications



Implementation Approach (2)

TEIN for connecting ASEAN IVO members' IoT Labs / Testbed

TEIN
Connecting Asia and Europe's Research and Education Communities
www.tein.asia



TEIN Project Partners

| | | |
|----------------|--------------|----------------|
| AF Afghanistan | ID Indonesia | NZ New Zealand |
| AU Australia | JP Japan | PK Pakistan |
| BD Bangladesh | KR Korea | PH Philippines |
| BT Bhutan | LA Laos | SG Singapore |
| KH Cambodia | MM Myanmar | LK Sri Lanka |
| CN China | MN Mongolia | TH Thailand |
| HK Hong Kong | MY Malaysia | TW Taiwan |
| IN India | NP Nepal | VN Vietnam |

The following links are fully financed by the link owners whose support is gratefully acknowledged.

| | |
|--|---|
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| c NII National Institute of Informatics, Japan | i ORIENT Plus co-funded by China and EU |
| d MAFRIN Ministry of Agriculture, Forestry and Fisheries Research Network, Japan | j ASAC Academia Sinica Grid Computing, Republic of Chinese Taipei |
| e NIA National Information Society Agency, South Korea | k aarnet Australia, Academic and Research Network, Australia |
| f NIA National Information Society Agency, South Korea | l REANZ Research and Education Advanced Network New Zealand |

As of July 2015

IoT enabling technologies for personal health care applications

Thank you !

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