

Issues on Body Area Networking and Standardization for Telehealth

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- BAN standardization
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■ Introduction

Necessity of Telemonitoring

- There are limitations in scheduled services delivered by nurses
 - Small fluctuations over a day or two may be indication of health changes
 - The number of healthcare people is limited
- Sophisticated remote monitoring could strengthen the services with ROI



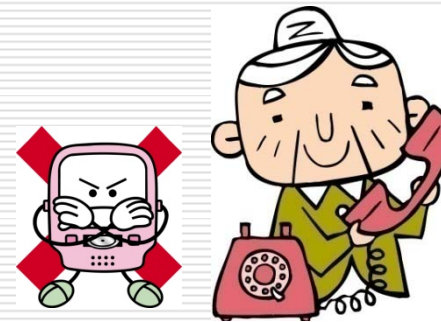
EHR and Telemonitoring

- ❑ An Electronic health record (EHR) refers patient medical records and makes it a meaningful part of the care service
- ❑ The technology creates a new, interactive means to allow interventions, real-time and integrated data analysis, and timely communication between patients and healthcare people, especially between medical staffs
- ❑ The EHR systems are expected to increase efficiency and promote standardization in medical treatments, but they lack functions to handle remotely measured vital data received by remote monitoring

■ Direction of Telehealth

Consumer Telehealth

- ❑ Traditional telehealth is intended for medical treatments, but consumer telehealth is targeted for preventive telehealth
- ❑ Consumer telehealth transactions will occur in an on-demand and ad-hoc manner that are different from well-structured traditional models
- ❑ Consumers are less likely to tolerate the inconveniences of today's healthcare devices

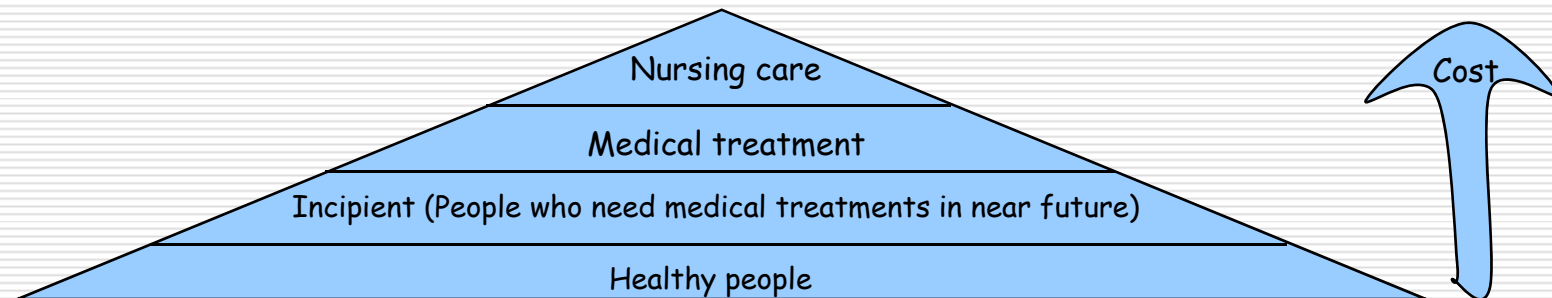


Group-driven Telehealth

- The group, such as community, initiated and promoted telehealth based on the hypothesis that group-driven initiatives are more likely to become sustainable
- But, it depends on excessive burdens of the main group members such as employers, local government, ...

Improvements in Telemonitoring for Consumer Telehealth

- There are three topic areas, each with near- and far-term components
 1. Consumer-friendly healthcare/medical services
 2. Integration into medical information systems
 3. Financial management of services especially in underserved rural area
- Focus on consumer-friendly healthcare/medical services based on the movement from in-hospital treatments to preventive healthcare

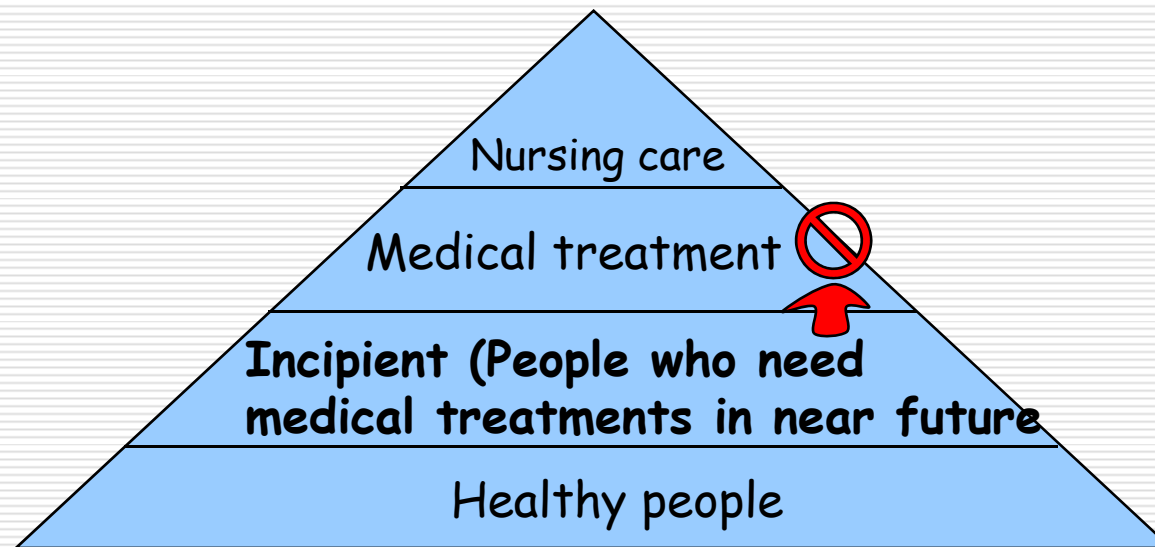


Disease and Number of Patients in Japan

Disease & condition	Related department of diagnosis and treatment	Number of patients
High blood pressure (related to cerebral infarction, apoplexy, kidney disease, and diabetic)	Internal medicine Circulatory organs	Called high blood pressure are 30 million or more
Heart disease	Internal medicine, Circulatory organs	More than one million
Sleep apnea syndrome(SAS)	Respiratory Medicine, otolaryngology, Circulatory organs, Internal medicine	More than 2.5 million
Chronic obstructive pulmonary disease (COPD)	Respiratory Medicine	More than 5.3 million

Consumer-friendly Healthcare/Medical Services

- Prevent lifestyle-related illnesses for incipient and healthy people
 - Expect no attachment to body or small-and-light devices
 - No wiring to the backend watch-over systems
 - Inexpensive and easy-to-use



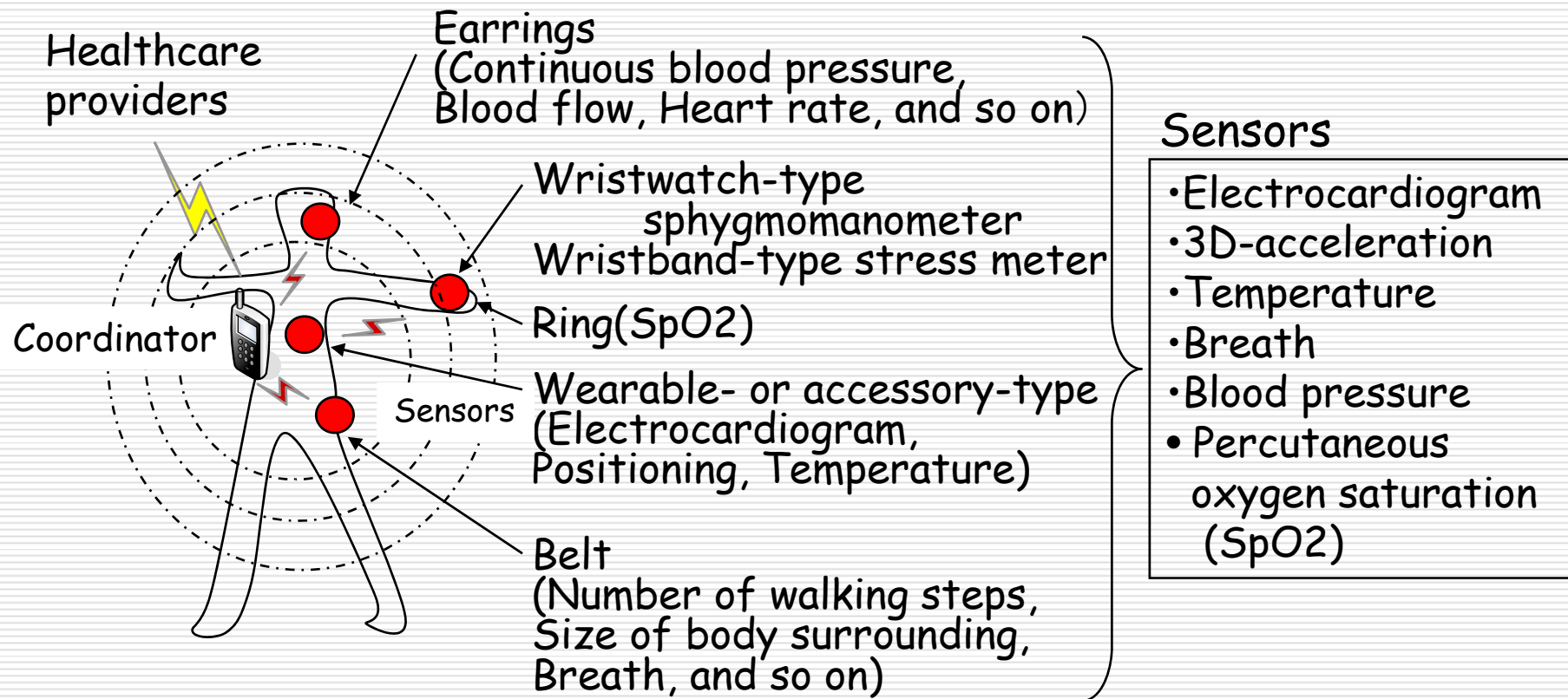
■ BAN and Wearable Vital Sensors

Body Area Network

- Body Area Network (BAN) consists of a set of mobile and compact intercommunicating sensors, either wearable or implanted into the human body, which monitor vital signs and body movements
- The ad hoc network is becoming popular and is expected to enhance Quality of Life
 - It does not need wire at home
 - It is easy to use because it does not access legacy network
 - It does not require communication fee

BAN and Wearable Vital Sensors

□ Unconsciousness for users



Wearable Vital Sensors

- Five wearable sensors for diseases
 - Electrocardiograph
 - Blood pressure
 - Breath
 - Percutaneous oxygen saturation (SpO2)
 - 3D-axes acceleration



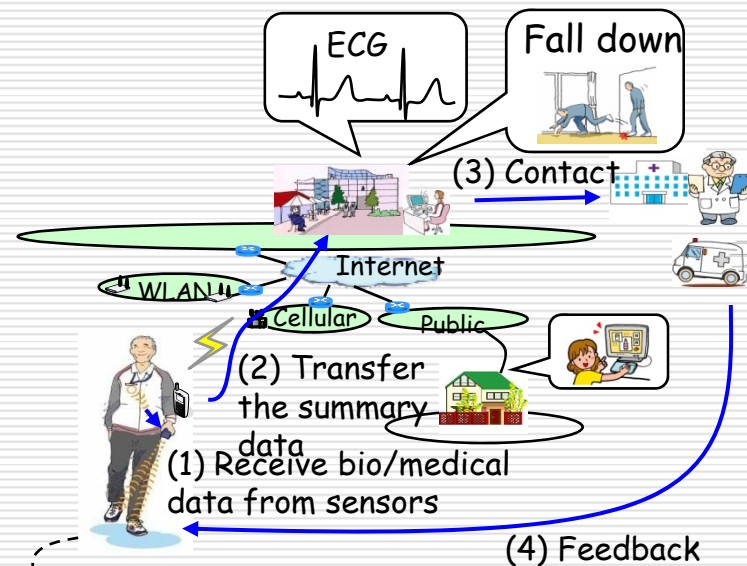
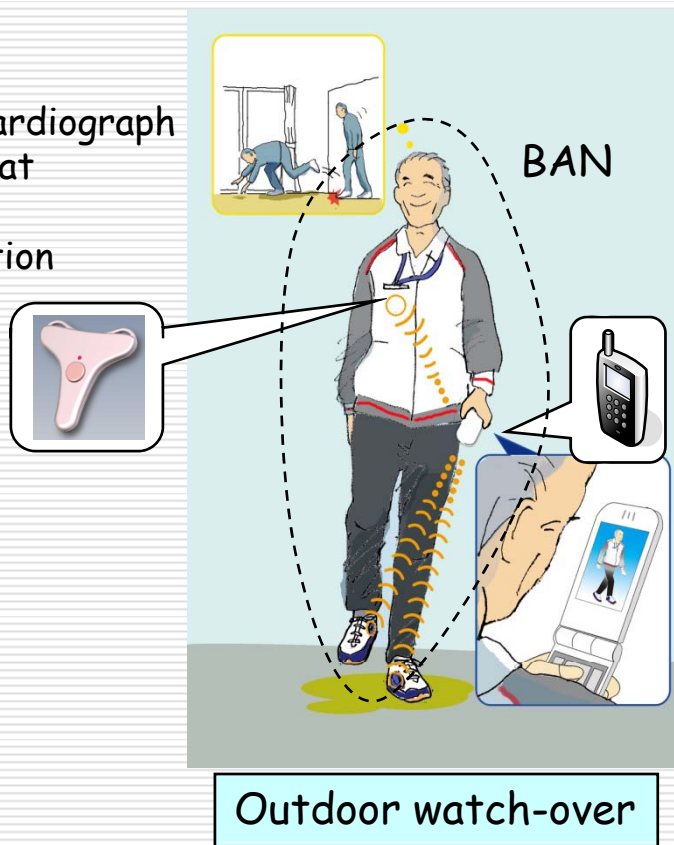
Disease & condition	ECG	Blood pressure	Breath	SpO2	3D Accel.	Related department of diagnosis and treatment
High blood pressure (related to cerebral infarction, apoplexy, kidney disease, and diabetic)	△	○			○	Internal medicine Circulatory organs
Heart disease	○	○	△	△	△	Internal medicine Circulatory organs
Sleep apnea syndrome(SAS)	△	△	○	○	△	Respiratory Medicine otolaryngology Circulatory organs Internal medicine
Chronic obstructive pulmonary disease (COPD)	△	△	○	○	△	Respiratory Medicine

○: Required, △: Better

From Dr. Yamasue, Medical School, Yokohama City University

Usage Model for Vital Sensors in BAN

Electrocardiograph
Heart beat
3D-axes
acceleration



Sensors satisfy Product Liability Act and
Pharmaceutical Affairs Law in Japan

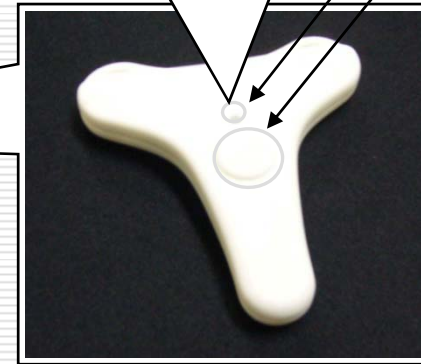
Accessory-type Wireless ECG Sensor

1. Use a couple of months or more with no recharge
2. Easy-setup privacy for data transfer



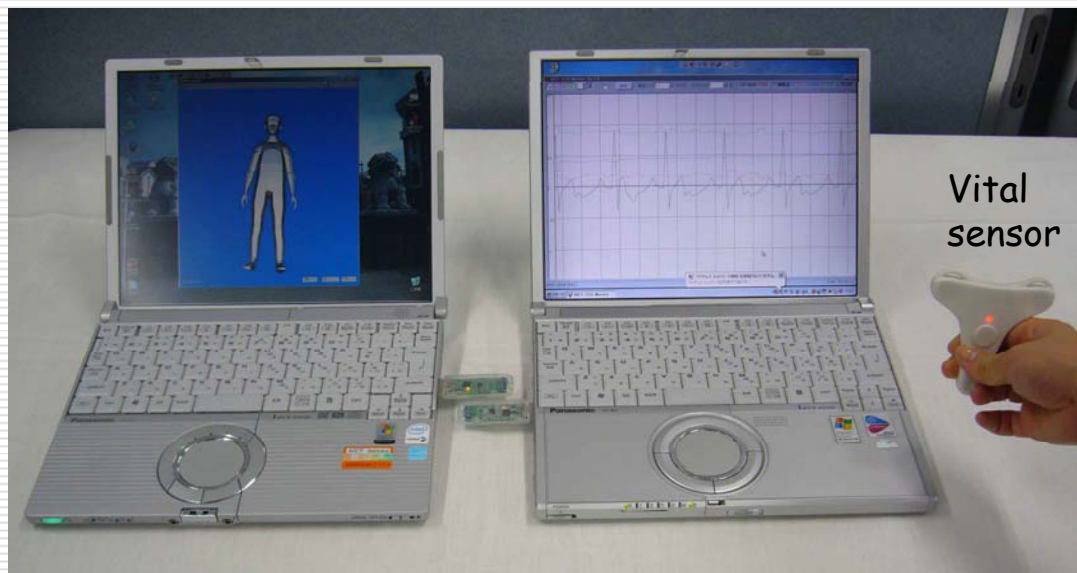
Electrocardiograph
Heart beat
Body temperature
3D-axes acceleration

LED
Button

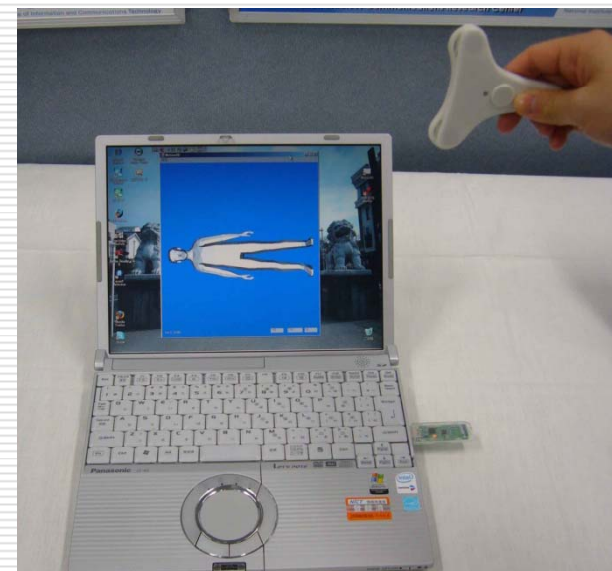


- 3 dry electrodes device for arrhythmia detection
- Light to wear 365 days
- Push button when feel uncomfortable
- Last 24 hours continuous operation under the Pharmaceutical Affairs Law

Display Positions and ECG Data

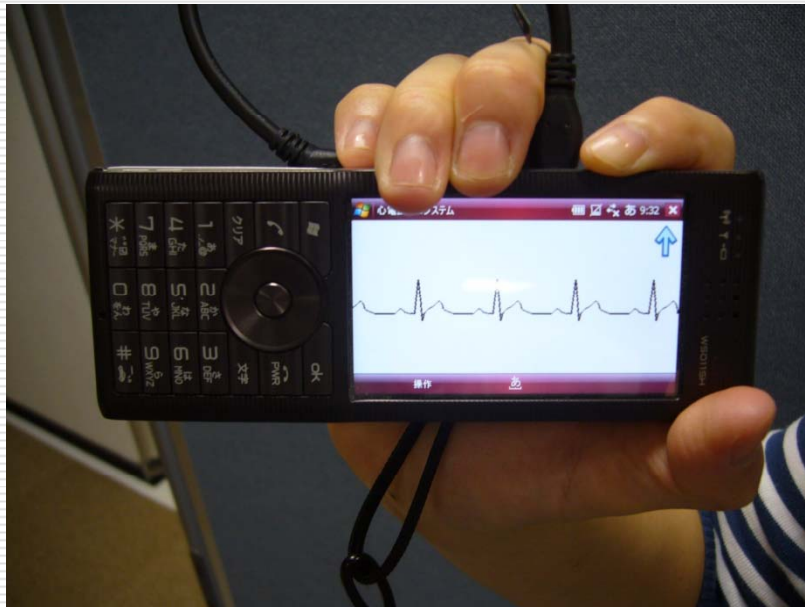


Display position and ECG data



Display fall down position

Display Position and ECG in a Cellular Phone



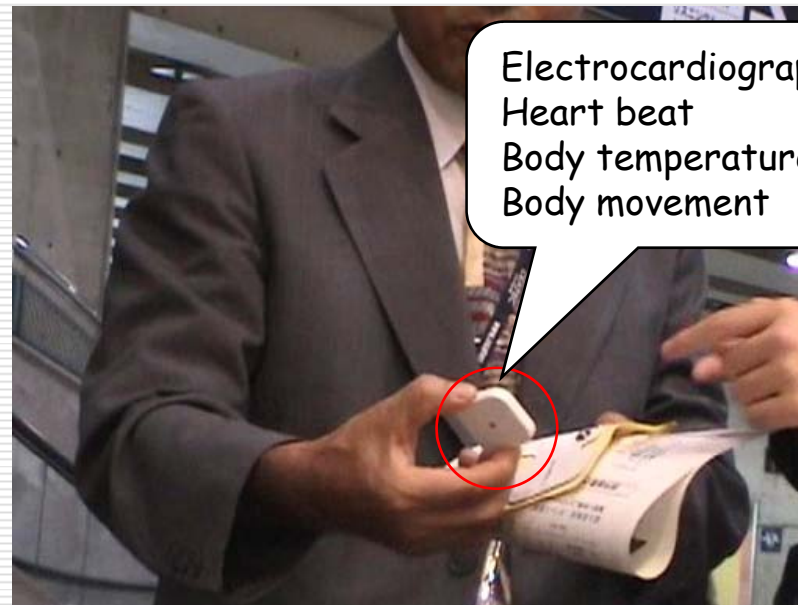
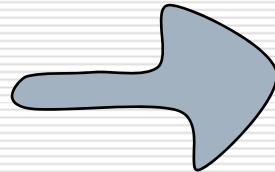
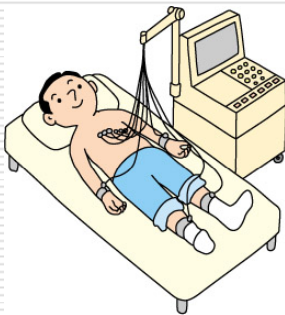
Display ECG and position in a BAN coordinator
(Cellular phone)



A BAN coordinator and wearable vital sensor

Holter-type Wireless ECG Sensor

- Easy-setup and default security



•Last 24 hours continuously operation under the Pharmaceutical Affairs Law

Wireless SpO2 Sensor

- Percutaneous oxygen saturation (SpO2) for asthma



•Last 24 hours continuously operation under the Pharmaceutical Affairs Law

Wireless Breath Sensor

- Monitor breath to detect sleep apnea syndrome(SAS)



•Last 24 hours continuously operation under the Pharmaceutical Affairs Law

■ Standardization activities

- PHD in USB-IF
- MDP in Bluetooth SIG
- ISO/IEEE 11073 Personal Health Device Specifications
- MediCAN
- Continua Health Alliance

PHD in USB-IF

- The Universal Serial Bus Implementers Forum (USB-IF) formed a Personal Healthcare Device Working Group whose charter was to enable seamless interoperability between consumer electronic devices and personal healthcare devices via USB.
 1. Consumers send daily living data from fitness devices, such as exercise watches, to collection and analysis devices, such as PCs or cell phones via USB
 2. Individuals with a chronic condition send data from disease management devices, such as blood pressure monitors or glucose meters, to devices such as health appliances

MDP in Bluetooth SIG

- The Bluetooth Medical Device Profile (MDP) defines the requirements for qualified Bluetooth medical and health & fitness device implementations
 - How to connect data-source devices such as blood pressure monitors, weight scales, glucose meters, thermometers, and pulse oximeters to data-sink devices such as mobile phones, laptops, desktop computers, and health appliances
- MDP provides application level interoperability by operating with the ISO/IEEE 11073-20601 Personal Health Data Exchange Protocol to represent the device data

ISO/IEEE 11073 Personal Health Device Specifications

- The ISO/IEEE 11073 defines point-of-care medical device communications to unify interfaces of all medical devices
 - A generic medical data references, not specific categorization
 - A common data exchange protocol for point-to-point communication with link negotiation
- The protocol is focused on defining the requirements of the application layer and is designed to allow other transport standards, including the Bluetooth Medical Device Profile and USB Personal Health Device Class
- The Continua Health Alliance relies on devices using this protocol to define the data payload to qualify as an interoperable Personal Health Device

MediCAN

- Similar to ISO/IEEE 11073
 - Both are under HL7/HER
 - Both are poll-base data retrieval from a primary node (gateway,BCC)
- Data structure and context are more specific
 - MediCAN is tightly-coupled on a CAN* bus
 - MediCAN deals with complex parameters that are specific to instruments

*From the paper "Medical Instrument Data Exchange" at IEEE EMBC2008 Conference

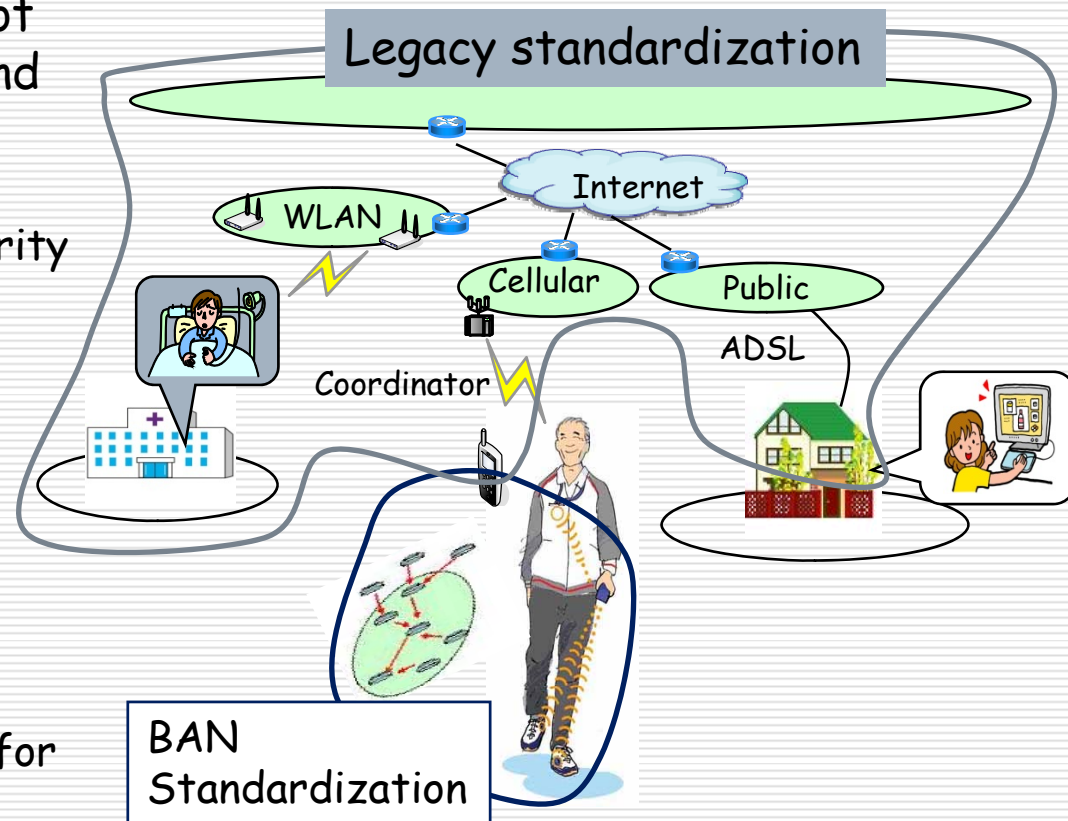
*CAN: Controller area network, ISO 11898

Continua Health Alliance

- ❑ Continua has adopted various standard protocols, such as Bluetooth Medical Device Profile, ISO/IEEE 11073-20601 Personal Health Device Communication Protocol and the ISO/IEEE 11073-10404 Pulse Oximeter Device Specialization, for the Personal Area Network interface communication
- ❑ These protocols define details of service discovery, pairing, set-up & tear down of the Bluetooth control & data channels and the transfer of 11073 data
- ❑ The Continua Health Alliance provides certificates for an inter-operable personal health device

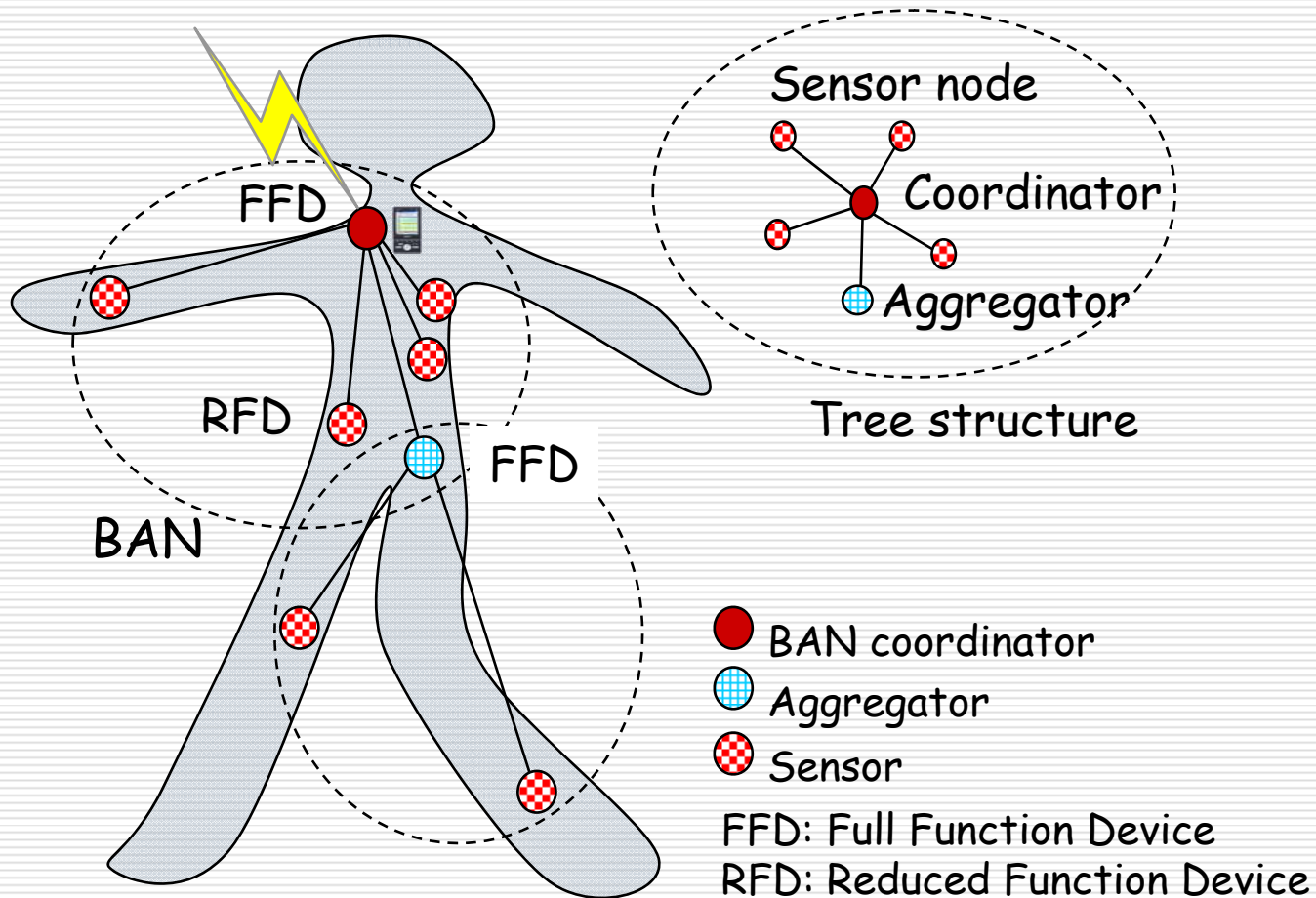
Current Activities ...

- Sometimes expect wireless devices, but not for wearable devices and BANs
 - Target for bedside instruments and security is option
 - Bedside instruments have enough power supply
- Wearing BANs need to work on small battery
 - A new standard are necessary for vital sensors environment for Telehealth



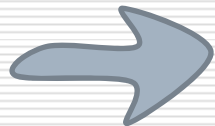
■ BAN Standardization

BAN and Components



Technologies for BAN

- Extremely power-efficient PHY
 - Less transmission power and interference
 - Clock drift
- Simple MAC for sensors to connect to a coordinator
 - Less traffic from a coordinator to sensors
 - Expect plug-in any sensor, such as SPO2, at setup
 - Data synchronization
 - Protect from attacks/analogism
- Data format/protocol for applications
 - Data size reduction
 - Must protect privacy, not option



Light-weight, Easy-to-use, Keep privacy

PHY and MAC

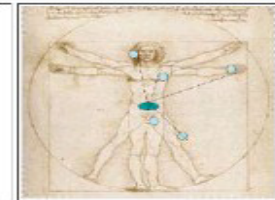
- IEEE802.15.6 activity

IEEE 802.15 WPAN™ Task Group 6 Body Area Networks (BAN)

Thursday, 2 October 2008

Overview

The IEEE 802.15 Task Group 6 (BAN) is developing a communication standard optimized for low power devices and operation on, in or around the human body (but not limited to humans) to serve a variety of applications including medical, consumer electronics / personal entertainment and other.



From <http://www.ieee802.org/15/pub/TG6.html>

- Data synchronization/re-synchronization among BAN nodes
- Low-power Bluetooth and its profile is coming up, but is not an open standard

An Example: A Proposal from GE Medical at IEEE802.15TG6

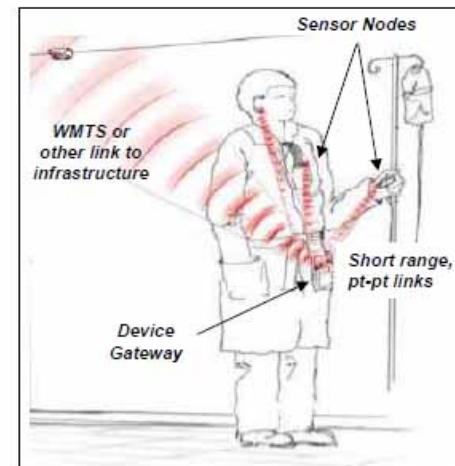
July 2008

doc.: IEEE 802.15-08-0491-00-0006

Body Sensor Network (BSN) for Medical Monitoring

A wireless network of sensors around a patient
providing multiple clinical benefits

- Patient mobility, comfort, infection control
- Monitoring flexibility and scalability
- Extension of monitoring into care areas that are currently unmonitored
- Reduced clinical errors
- Reduced overall monitoring costs



* Reference = Medical Body Area Network Application, 15-08-0108-01-0006-medical-body-area-network-application.pdf

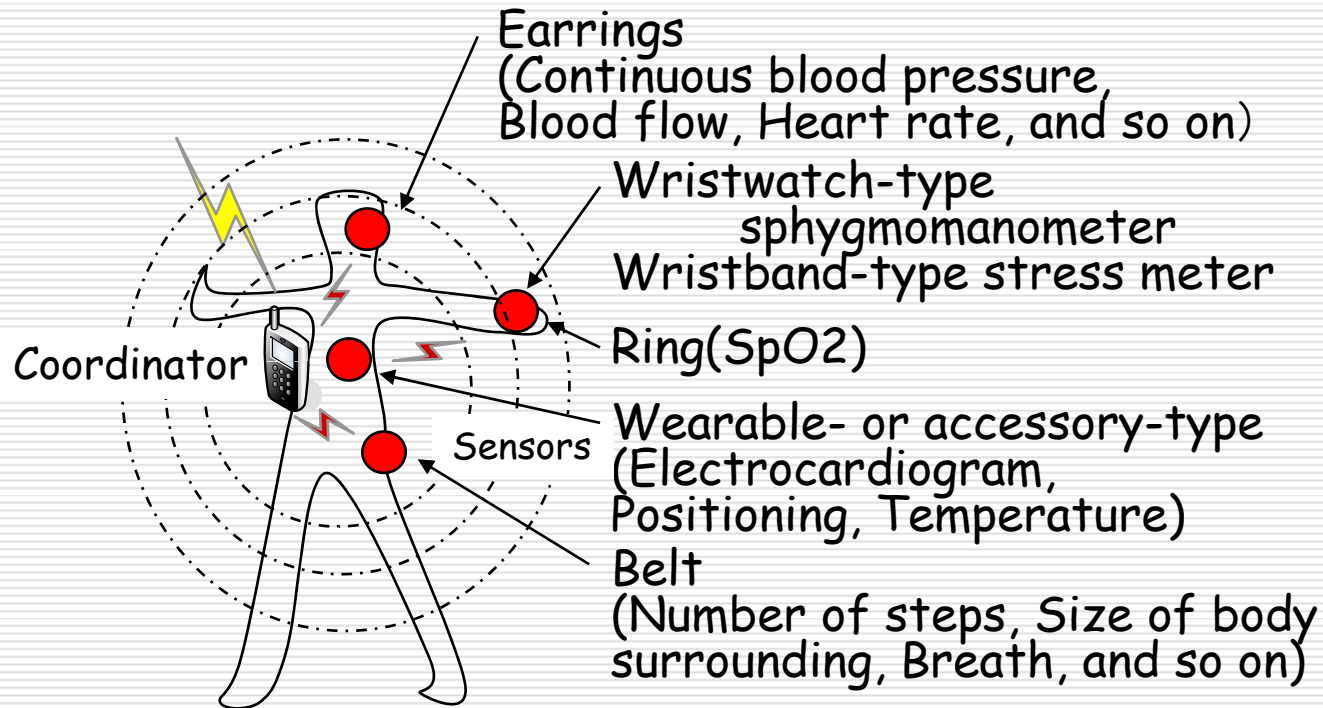
Submission

Slide 4

David Davenport, GE Global Research

Light-weight & Easy-to-use

- Not an instrument, but an accessory with no wire
 - 8bit CPU in a few MHz, 16-32 KB ROM, 2-3 KB RAM
- Not to wear, but to locate invisible



Light-weight & Easy-to-use Privacy

Sensor

(1) Easy to use

How easy to setup a key

(2) Small and light

How to compute in a small re-chargeable battery

To make it casual use and use less electric power

Security

(1) Key generation

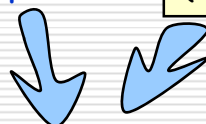
How difficult to find an encryption key

(2) Encryption by a key

How difficult to compute (decrypt) by a high-speed computer

(3) Pair-wise encryption/decryption

To make it difficult and use huge electricity



Effective security requires,

(1) Flexible cipher integration

(2) Simple key pre-distribution with re-keying to maintain strong security

(3) Less traffic authentication between nodes

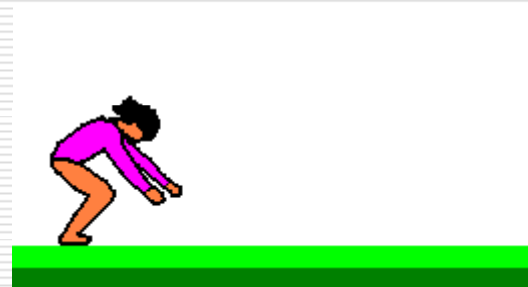
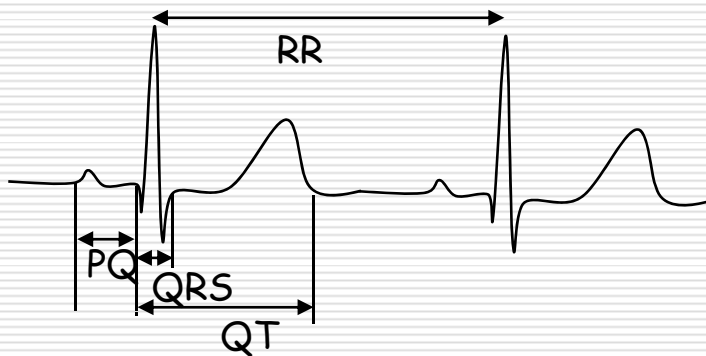
(4) Protection from unintentional attacks with restricted power supply

We have proposed one-way mutual authentication protocol which expects less computation in key generation and wireless communication. It uses time-varying behavior/vital sign data, such as movement and ECG, in key generation.

*From the paper "Empirical Evaluation of Zero-admin Authentication for Vital Sensors in Body Area Networks" at IEEE EMBC2008 Conference

Key Generation Candidate

- Vital sign data are also candidates for the information
 - Standard and deviation of ECG data of a user
 - 3D movement of a user

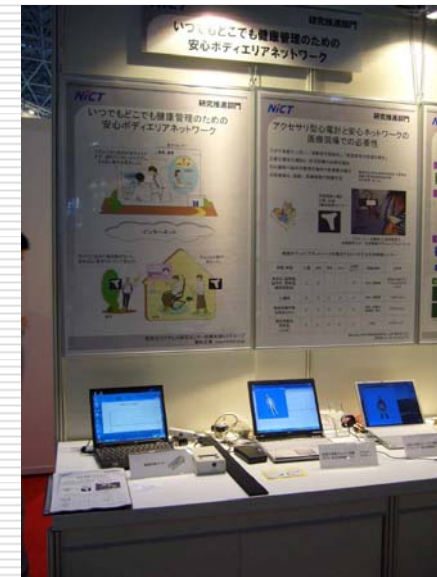


- UMe Project: Ubiquitous Healthcare and Medical System

UMe Project



"UMe" (yu-me) means dream in Japanese



CEATEC 2008 exhibition in October



Purpose, Targets, and Members

□ Purpose

- The project defines standard interfaces in BAN environment and develops on-demand healthcare and medical services that provide easy-to-use and human friendly interface

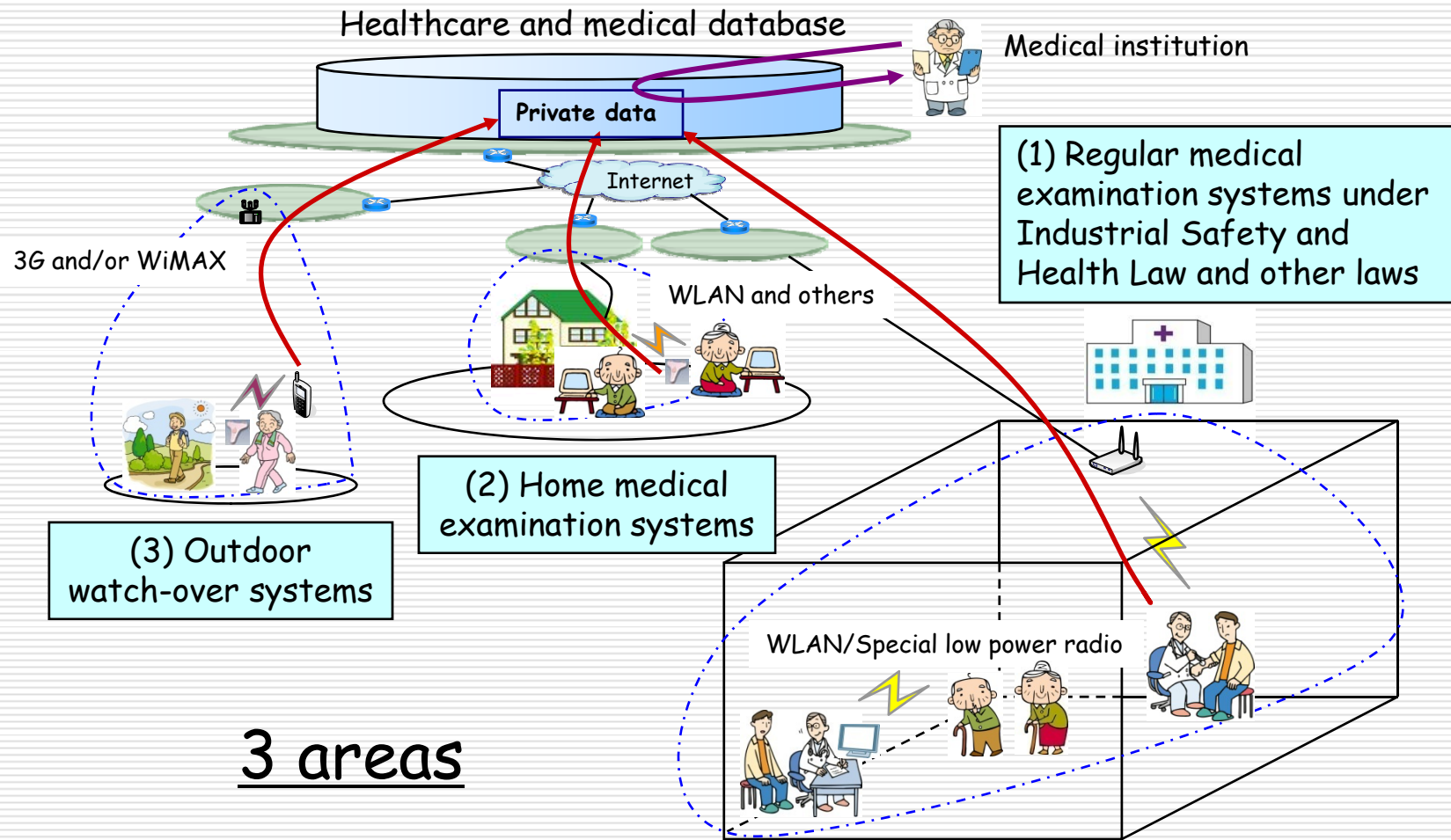
□ Targets

- The system provides a common interface among all vital sensors in BAN
- The system provides maintenanceability and scalability to minimize the influence of system downs even during emergency
- It provide default privacy depending on the vital data transfer
- It provides reliability and low cost under everyone's eyes by open sources

□ Members

- Kanagawa Association of Preventive Medicine in Japan
- Medical school, Yokohama City University
- National Institute of Information and Communications Technology
- Sensor, body area network, and system vendors

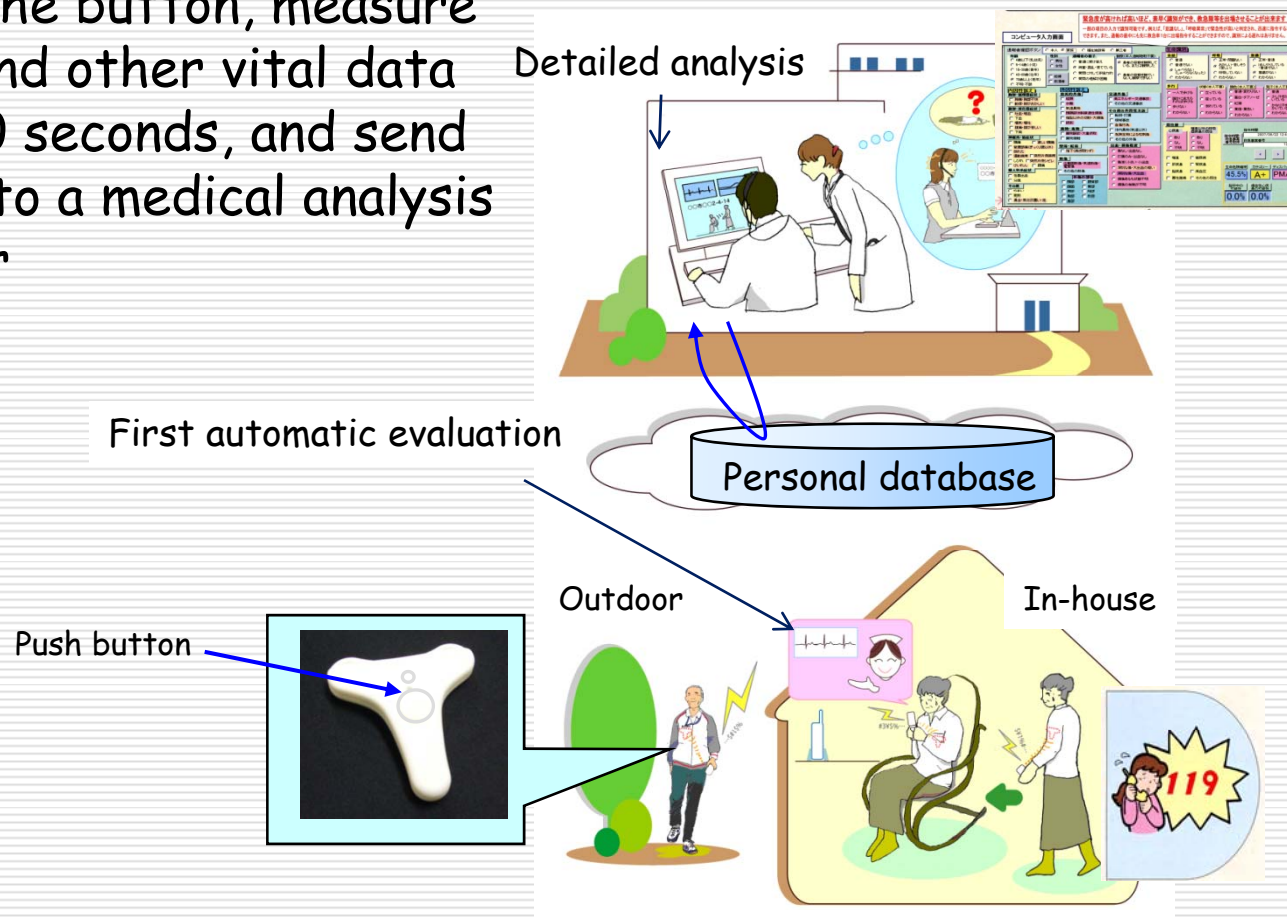
Ubiquitous Healthcare and Medical System



3 areas

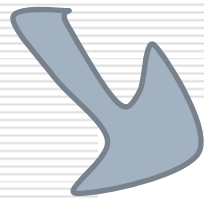
An Example: 119 Emergency Call (911 in US)

- Push the button, measure ECG and other vital data for 30 seconds, and send them to a medical analysis center



Common Data Representation/Interface/Protocol for BAN

- Currently evaluating the PHY/MAC and application data/protocol from the viewpoints of power consumption, easy-to-use, and healthcare applications using real devices
- We will provide sensors, workable BAN services, and the first specifications in a few months

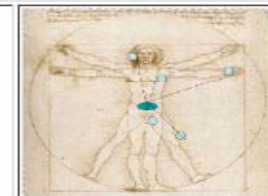


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From <http://www.ieee802.org/15/pub/TG6.html>

Conclusion

- We looked at the direction of telehealth from medical treatment to preventive healthcare
- We introduced small-and-light vital sensors and their power-efficient networking
- We overviewed standardization activities and expected a new standard for future telehealth using BAN
- We introduced the Ubiquitous Healthcare and Medical System (UMe project) and the expected outputs for BAN standardization and also products