e-Health in Japan
Introduction of Telemedical Care System —Body Area Network (BAN) at NICT

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Background

- **Percentage of total population aged 65 years or older in Japan is world's top in 2010.**

  (Japan: 23.1%, Thailand: 7 %)
- **Healthcare cost to GDP is increasing.** (Japan: >9%)
- **Earthquake and Tsunami produced —**
  - Huge number of displaced persons(>100,000),
  - Serious doctor shortage in damaged area, and
  - Strong demand of healthcare and environmental monitoring not only for residents, but also for workers for clearing debris and nuclear plant recovery.

Advanced Wireless ICT as a Support for Medical Treatment & Healthcare

Declining Birthrate and Aging Population

Increasing need for nursing,
Increasing amount of necessary medical budget
Decreasing labor force, Insufficiency of nurses, Increasing insurance costs

In order to solve these problems…

Medical Assistance
Enhances medical standard
Reduces burden in medical care

Prevention of Plagues
Saves medical cost by disease prevention

Less Burden on Nurses
Assistance for the limited number of nurses

Ubiquitous Medicine by Advanced Wireless ICT

Improved efficiency
Budget Saving
Improved accessibility
Reduced Incidents

Management of Medical Supplies
Prevention of medical malpractice

Rehabilitation Assistance
Effective assistance in rehabilitation and for disabilities

Nursing Assistance
Reduces nursing costs
Secured daily lives

Wearable Vital Sensors

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

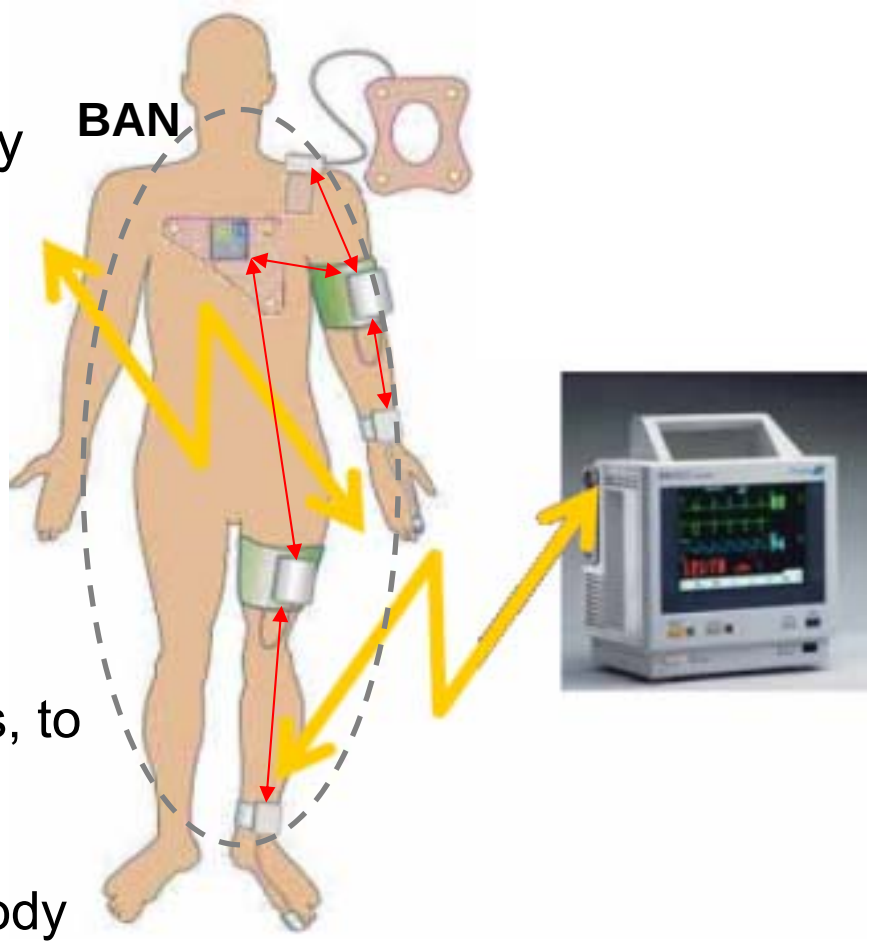
Disease & condition	ECG	Blood pressure	Breath	SpO2	3D Accel.	Related department of diagnosis and treatment
High blood pressure (related to cerebral infarction, apoplexy, kidney disease, and diabetic)	△	○	△	△	○	Internal medicine Circulatory organs
Heart disease	○	○	△	△	△	Internal medicine Circulatory 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

What are features of Wireless Body Area Network ?

- A ***wireless sensor networking*** technology optimized for low power devices and operation **on, in or *around human body***

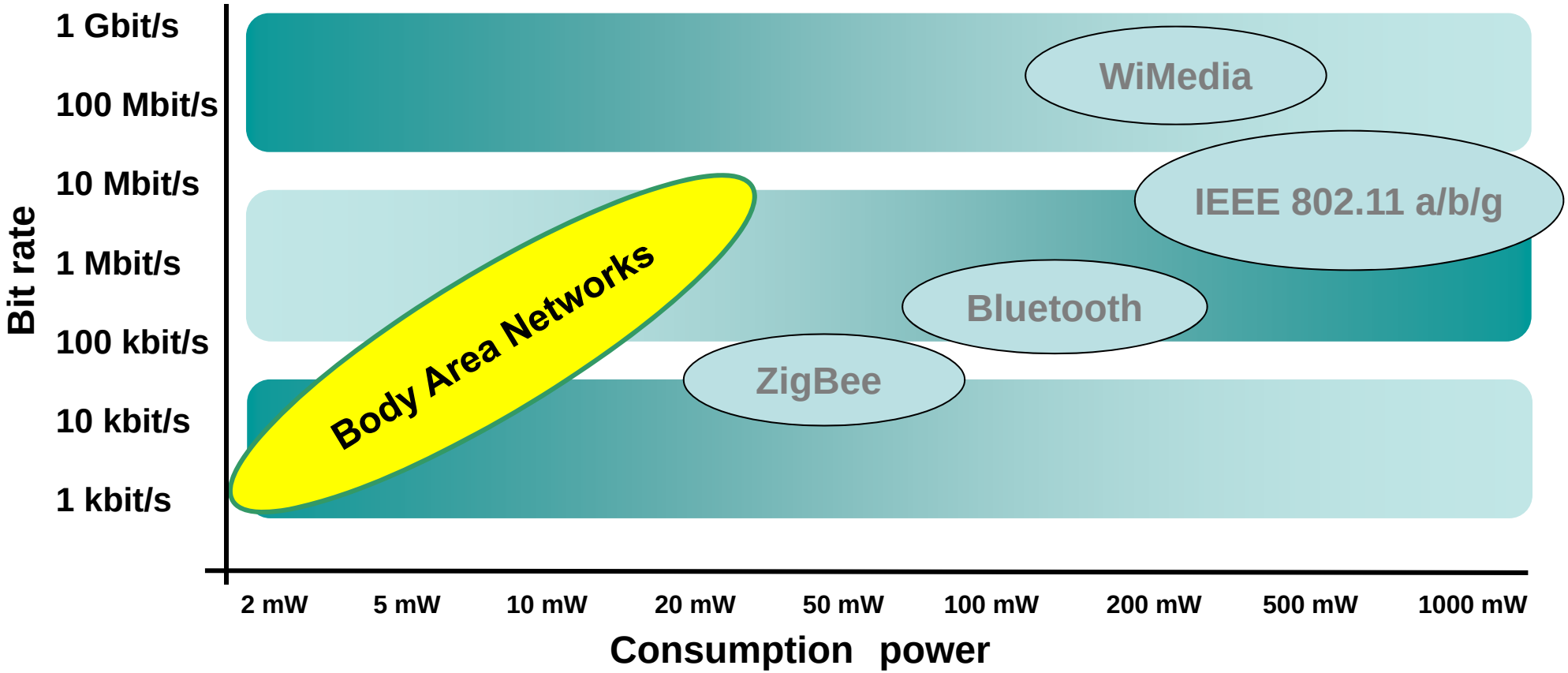


- Features:
  - (a) Wireless coverage: around 2-3 meters, corresponds to body size
  - (b) High reliability and secure communications, to protect personal information
  - (c) Specific absorption rate (SAR) should be considered to lower thermal influence to body
  - (d) Low power consumption, for long battery use

Wireless, Networking, Low-power

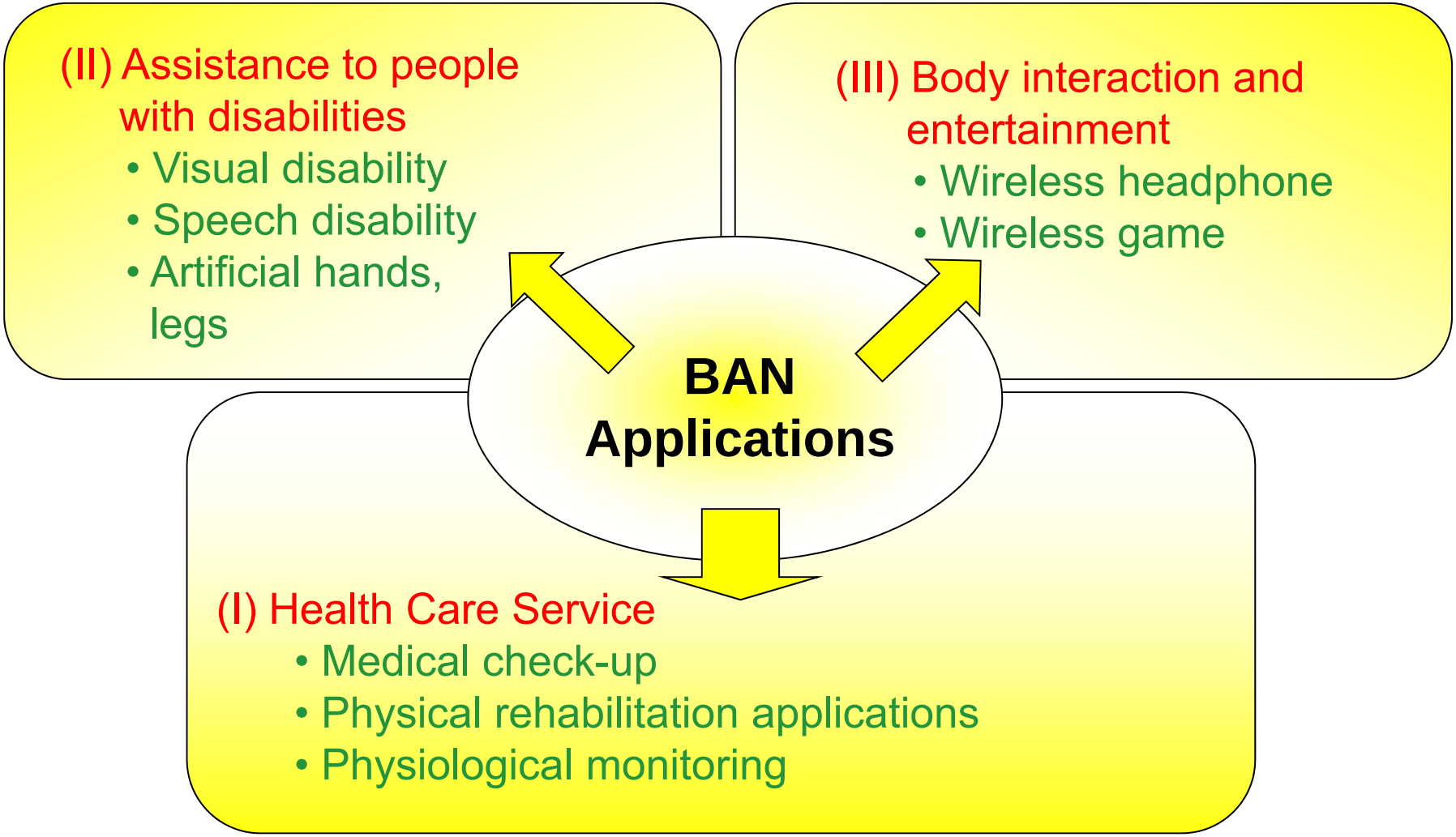
Source: IEEE802.15.6

BAN: Target Position

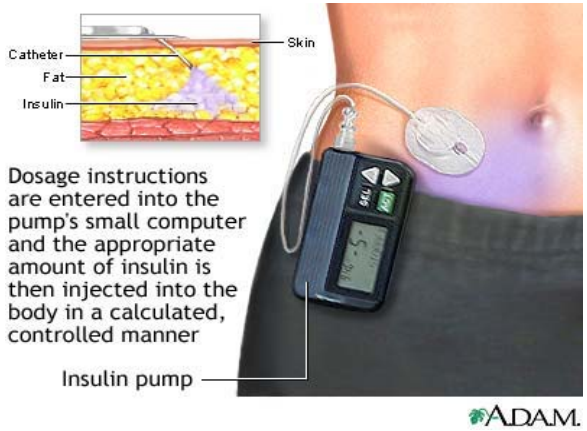


Ref. Doc.: IEEE802-15-06-0046-00-wng0

BAN Applications



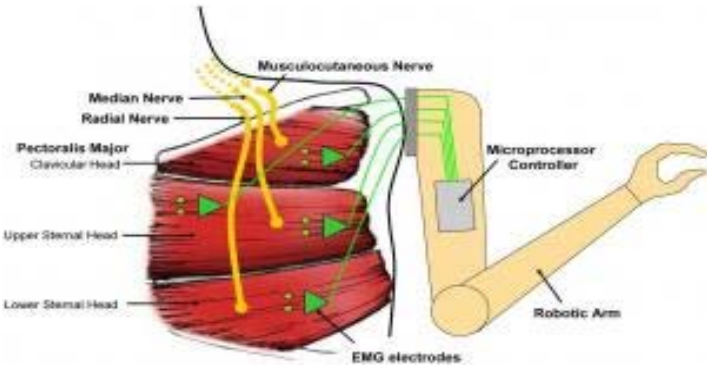
Other Application Examples



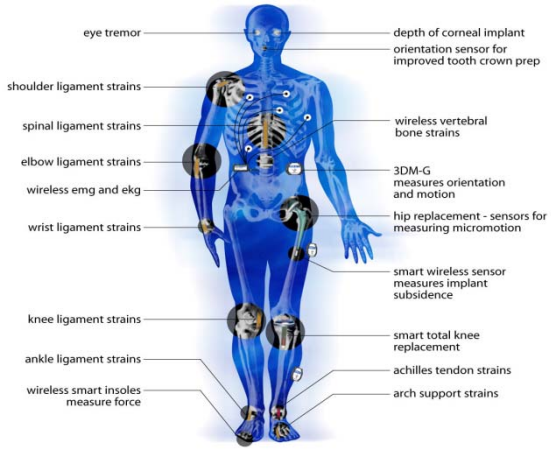
Remote control of medical devices
Insulin pump

Fitness monitoring
Pacing information etc.

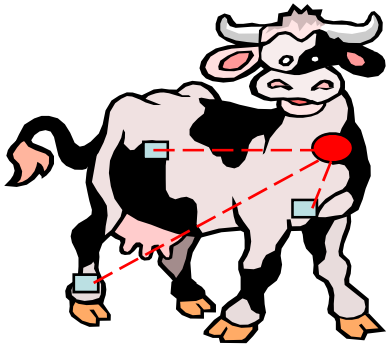
Wearable audio and video
Collaborative function



Disability assistance
Muscle tension sensing and stimulation



Implantable sensor
www.microstrain.com



Animal applications
Health monitor and infectious disease control in early phase, e.g. bird flu

UWB-BAN Prototypes

UWB high-band (7.25-10.25GHz, -41.3 dBm/MHz)
IEEE802.15.6 MAC (TDMA)
Pulse rate=50M pps

Body temp.

Three-axis accelerater

(for detection of stumbling/falling)

Blood pressure

Voice

(for nurse call)

Hub/PC monitor

real-time monitor of sensor data by values, curves, and voice
Control of the sensor terminals

SpO2 and pulse

(optical sensor in fingerstall)

Electrocardiogram

(three-electrode sensor)

Weight

UWB BAN to Support People with Visual Disabilities

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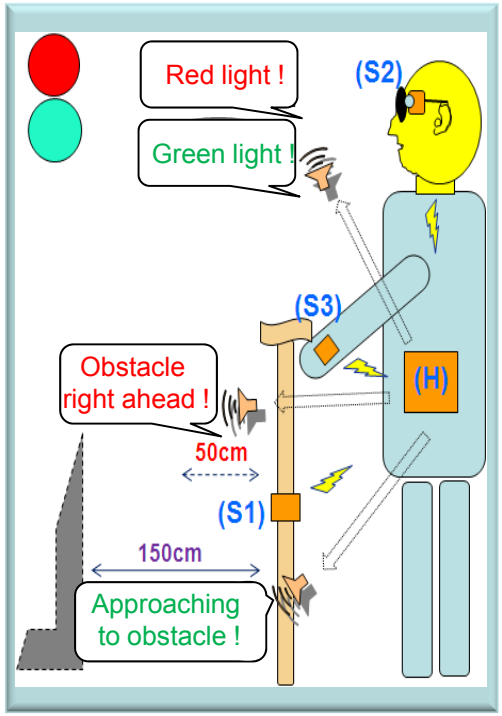


Application image

(H) Coordinator unit on waistband

(S1) Super sonic sensor unit on stick to detect obstacles

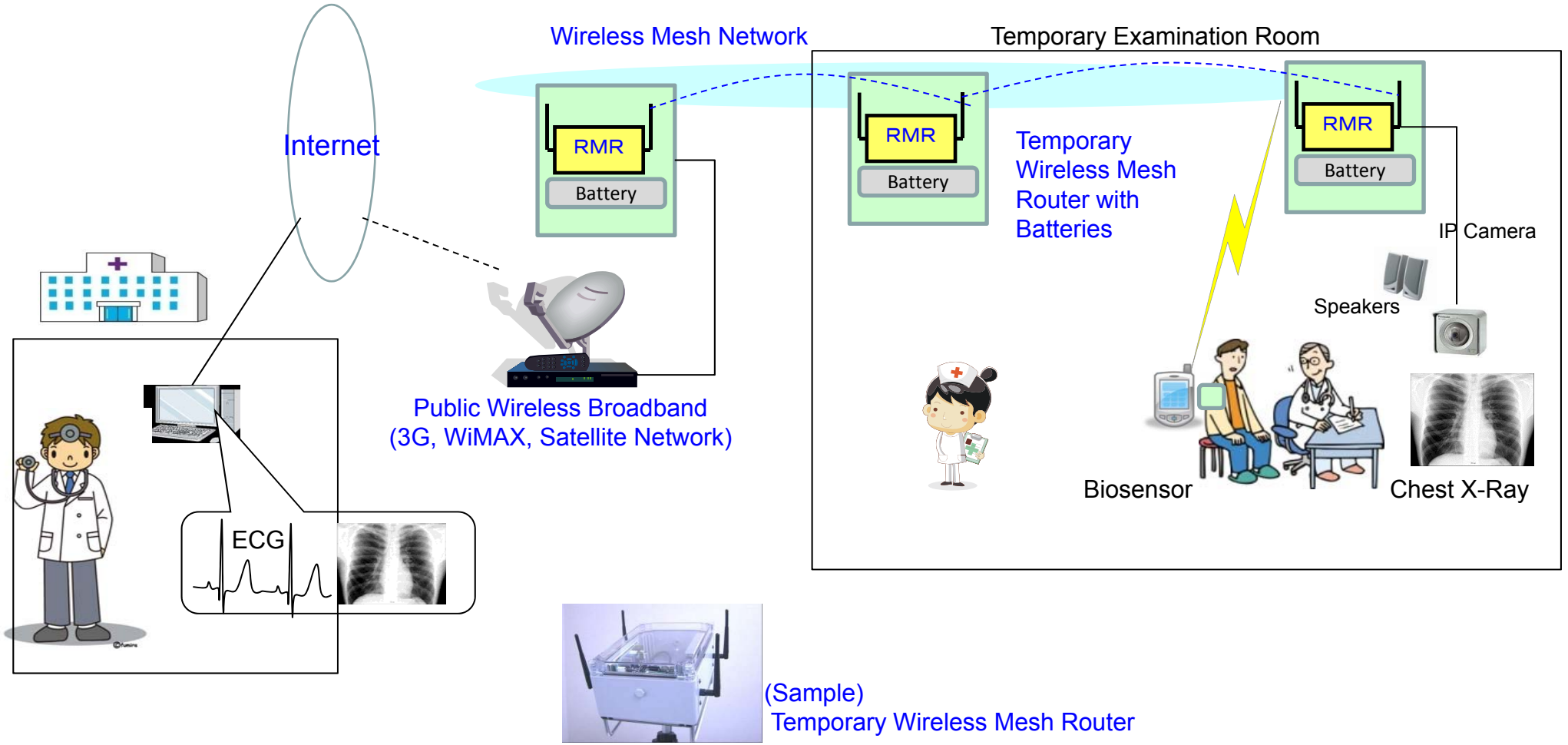
(S1) Camera unit on glasses for discrimination of traffic signals

(S3) Sensor unit on watch for pulse, SpO2, and body temp.

Prototype units

- ✓ World-common UWB high-band is used:
  center freq.~8GHz, BW~500MHz, TX power<-41.3dBm/MHz.
- ✓ Advantage of UWB:
  - low interaction to human body by low power density
  - low power consumption

Telemedicine Support System



(Sample)
Temporary Wireless Mesh Router

- Actively constructs an in-hospital WLAN and efficiently uses public wireless broadband networks
- Information of patients collected by biosensors, IP cameras, etc. are shared among hospitals at remote locations, supporting the practice of telemedicine. (remote control of devices such as IP cameras is also possible)

Sensor node product (Micro Medical Device, Japan)

The product includes

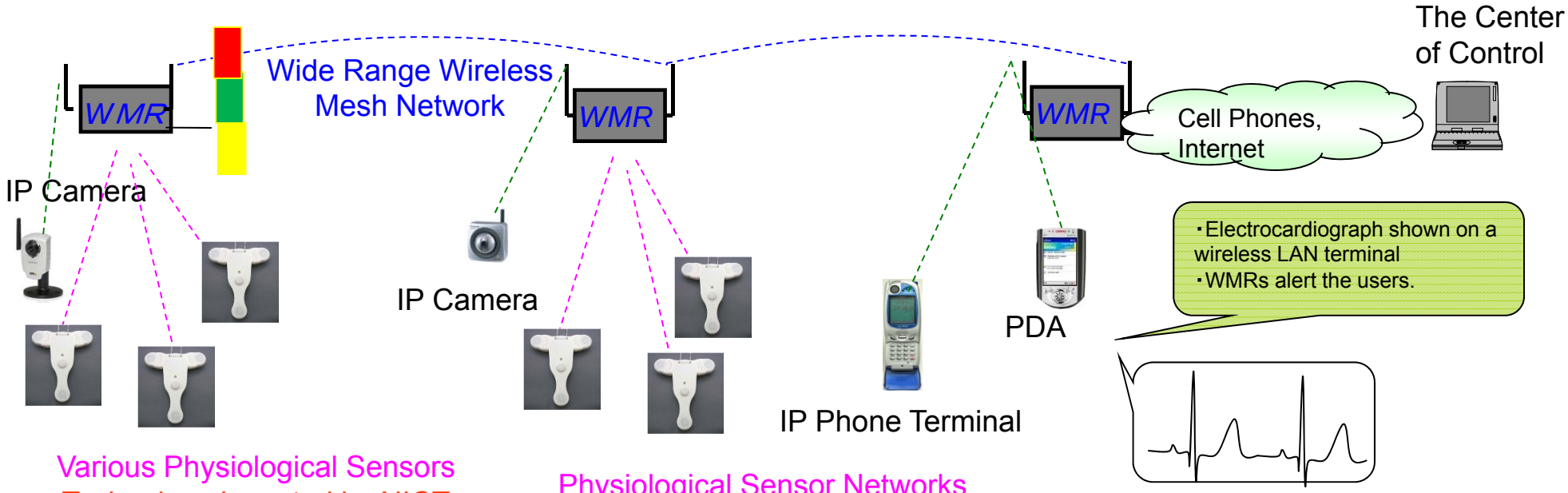
ECG, 3D motion sensor and temperature sensor

-Dimensions 40 x 35 x 7.2 (mm) (±2) Including a battery
-weight:12 g
-Material ABS Resin (Plastic) Safe to human body
-Electric wave 2.4 GHz band low power data communication system
-Transmitting frequency 2404MHz to 2429 MHz, 5MHz interval, 5 waves.
-Transmitting power 1mW (0dbm)
-Data transmitting rate 1Mbps
-Power consumption 2.5 mA in action
-Communication distance 20 m
-Duration of continuous operation 48 hours
(120 hours for measuring ECG only)
25℃, varied depend on environment

Realization of Wide Range Sensor Network with Automatic Detection & Alert Function

【Features】

- The combination of the existing cell phone network and “Wireless Mesh Network” will enable a wide range sensor network.
- Wireless Mesh Routers (WMR) employ Linux-base system, which provides an environment that can be customized by users.
- Because WMRs can be used as access points for wireless LANs, it will be possible to achieve a simultaneous operation between various sensors and IP cameras. They can also be used to invent such application systems that show the information from sensors at wireless LAN terminals.



Various Physiological Sensors Technology invented by NICT

Physiological Sensor Networks Technology invented by NICT

WMR Example:

Cooperation between Sensors and Cameras

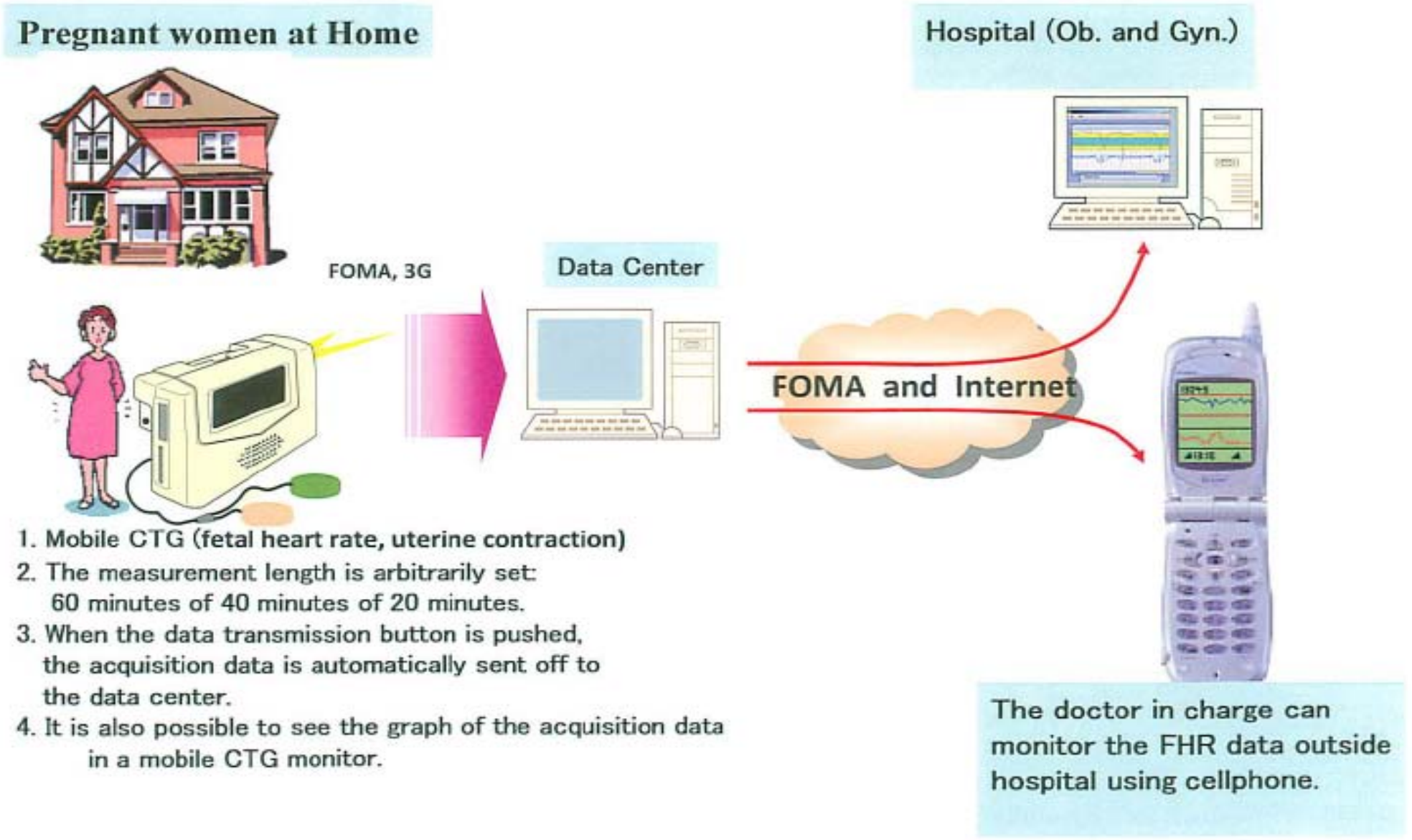
Adjustment of the frame rate of and storing pictures from IP cameras that cooperate with sensors.

WMR Example:
Sensor Server Function

WMRs can be equipped with various additional functions, such as GW function for various sensor networks, sensor server function, logging of sensor data, alert function, etc.

Transmission Image of FHR Information

FHR; Fetal Heart Rate



The network of perinatal telemedicine

National Institute of Information and Communications Technology

Mobile CTG Monitor

MC－711

- This unit is intended to manage high-risk pregnant women at home.
- Measuring the fetal heart rate and maternal contractions in pregnant women at home. This device sends measurement data to the CTG server by FOMA.
- The doctor can see measurement data on the PC or mobile phones through the Internet.

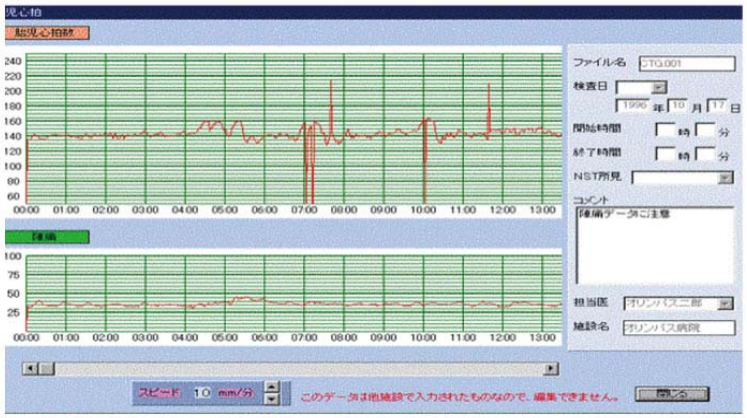
Specifications

Measurement: monitoring fetal heart rate and labor
Display: LCD display with touch panel
External Interface: FOMA card
Dimensions: 240 (W) × 180 (H) × 90 (D) mm
Weight: 2.0kg
Power: AC100V 50/60Hz 55VA

The network of perinatal telemedicine

National Institute of Information and Communications Technology

- The Perinatal Electronic Medical Records is used for the pregnant mother and her baby
- It enables sharing of medical information among multiple facilities through the internet

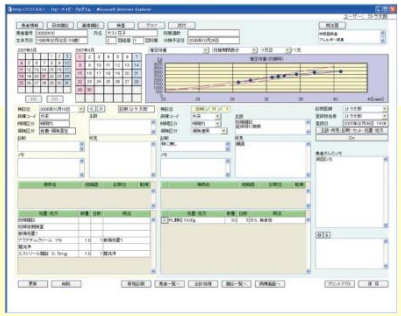


- It enables you send the fetal heart rate date and the pains of childbirth by mobile phone at home
- Doctors can check the fetal growth graph by using their mobile phone

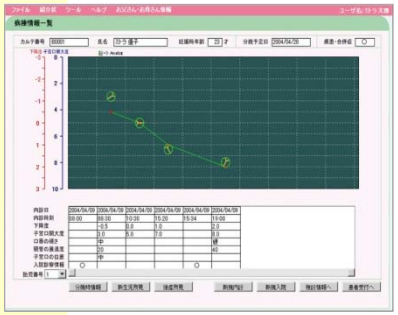
HELLO BABY PROGRAM

ハローベィビープログラム

The Perinatal Electronic Medical Records



Medical exam picture



Hospitalization delivery screen

Home Monitoring System for Pregnant Woman

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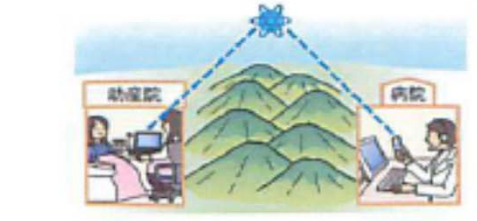


遠隔医療のしくみ

赤ちゃんの様子を検診する機械とパソコン

検診を受ける千葉さん

テレビ電話での診察

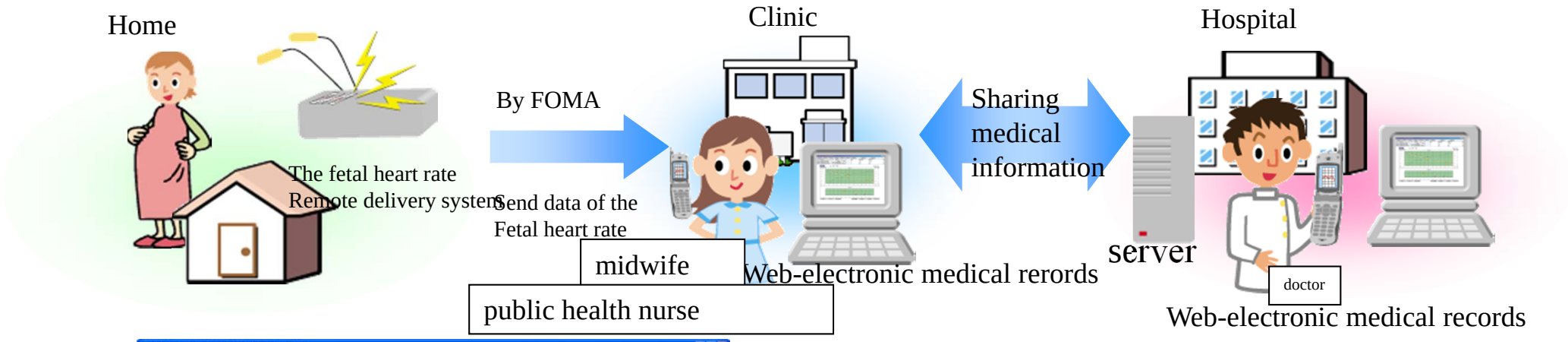
診察する医師

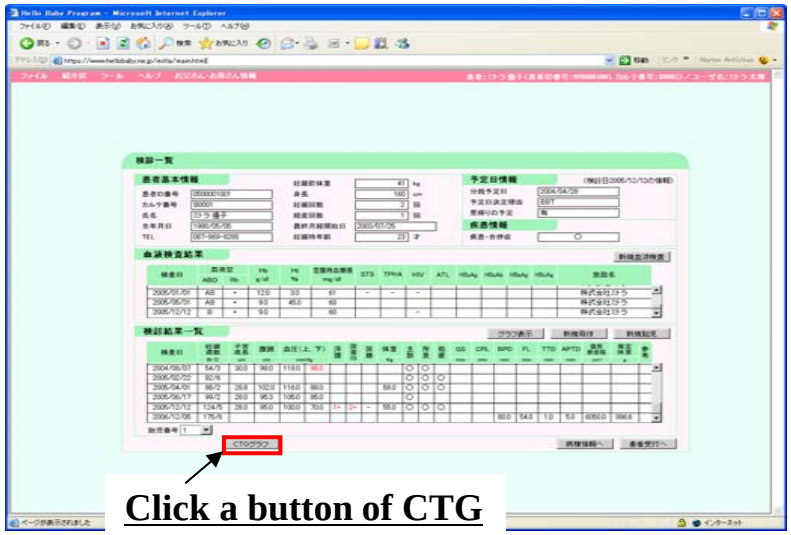
Mobile CTG (Cardio TocoGram)

Pregnant Woman talking with Obstetrician through TV meeting system

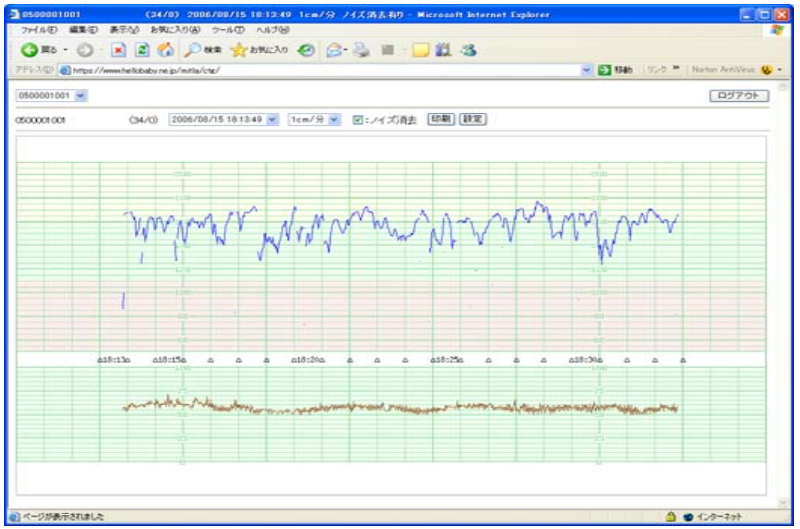
The network of perinatal telemedicine

How to operate the Telemedicine System





Perinatal Electronic Medical Records screen on WEB ver.



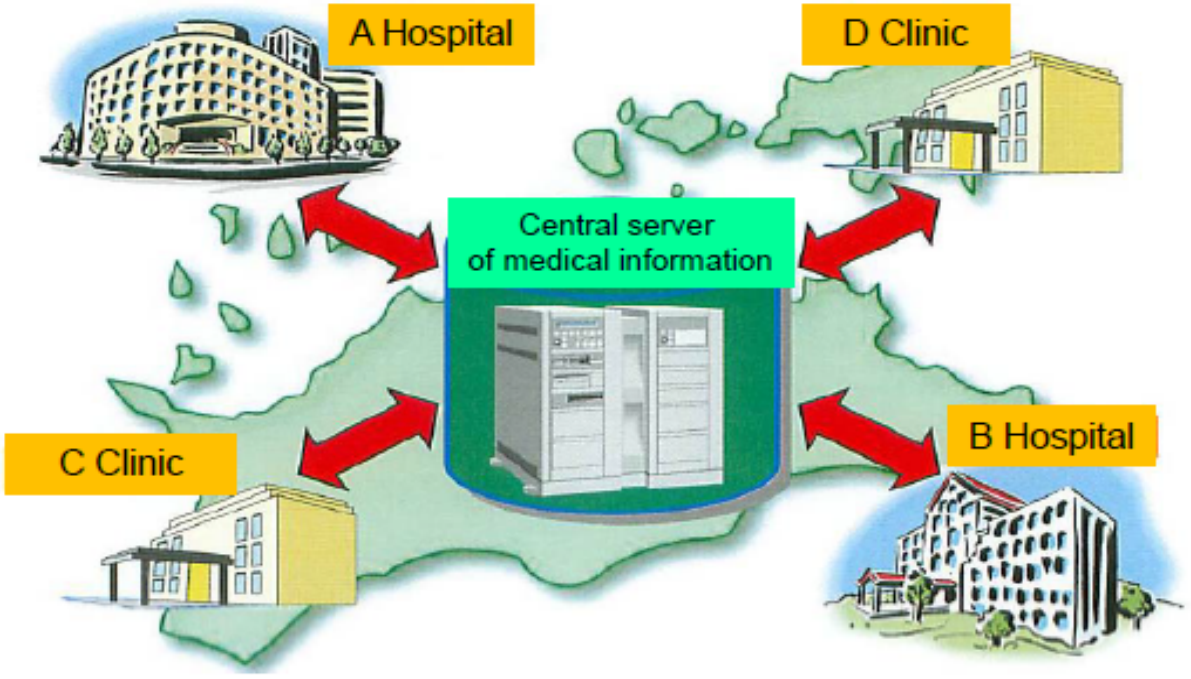
Fetal heart rate table screen

- The time scale on the display table can be changed. It supports noise canceling for background noises
- You can print-out above data by clicking a button

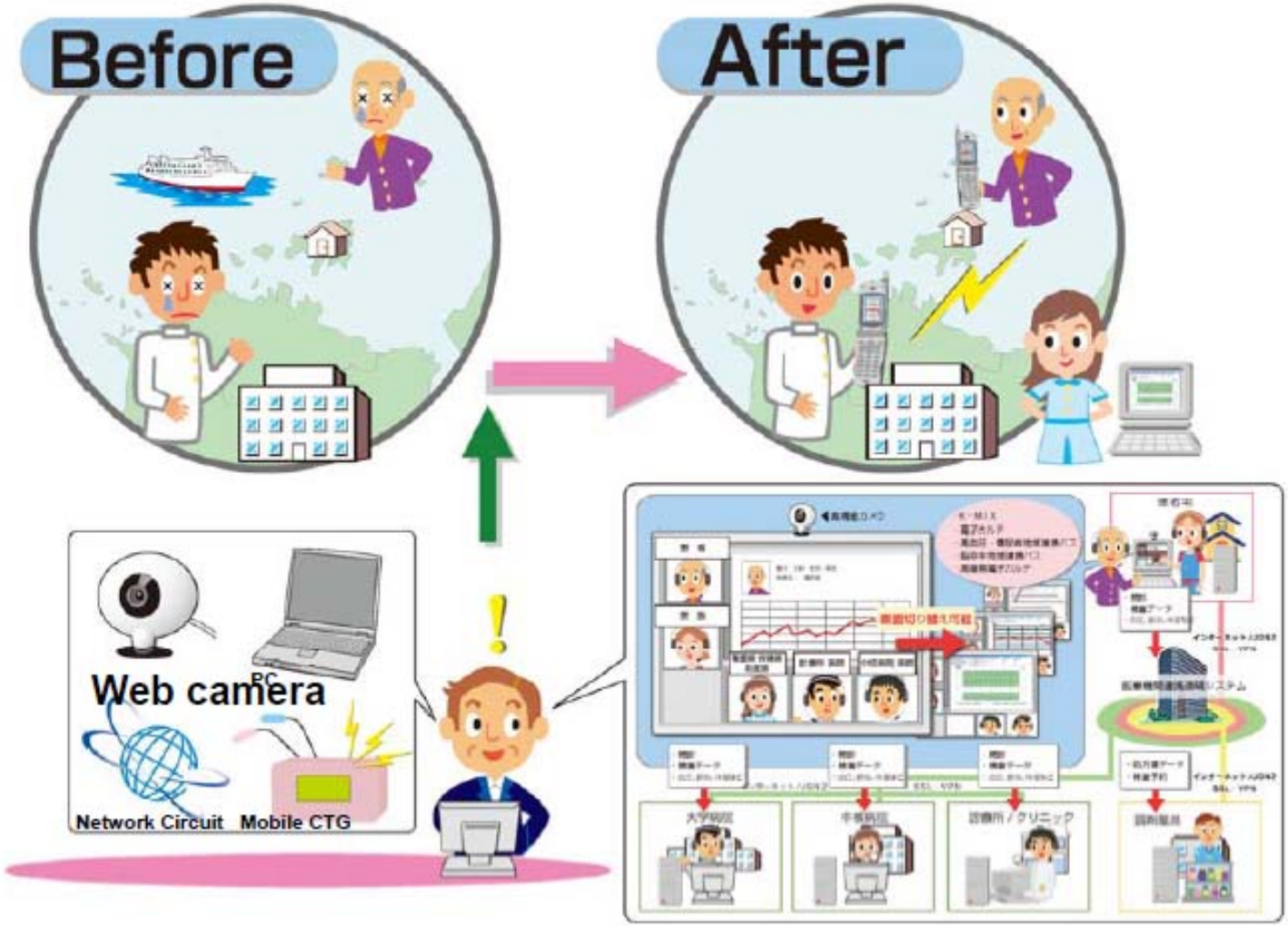
3) Functional integration with the Kagawa-Medical Internet Exchange:

In Kagawa Prefecture, the K-MIX (Kagawa-Medical Internet Exchange, an epoch-making image center project on remote medicine has been operating since June 2000. We will integrate and strengthen the functions of the Kagawa Perinatal Network and the K-MIX. (http://www.m-ix.jp/)

System for ASP of data center consolidating type



Health Advice via Video Telephone Application



Merits

- Home care checkup support
- Real-time consultation and guidance when nurses visit
- Follow-up for chronic invalid
- Following and remote guidance advice after health examinations
- Teleconference system of large areas among doctors
- Consultation of administering and guidance among doctors and pharmacists
- Side effect prevention of administering medication treatment

demerits

- can't see face to face
- can't administer face to face
- no remuneration

Damage of Cellular Networks upon the Great East Japan Earthquake

Powerful quake | Giant tsunami | Nuclear plant accident

- Cellular base stations: max. 14,000 stations went to OOS on the day after the shock (breakdown in system and power)
- Call traffic increased to 50～60 times.

  → Operators decided on call restriction at max. 90%
- Wired networks were entirely destroyed.

Not only the civilians, but also government staffs, rescue teams, medical staffs, and staffs related to lifelines got into blackout in communication.

First response for post disaster activities was significantly delayed.

Too much trust should not placed on cellular networks in emergency.
Then, what should we do ?

Struck situation of Miyagi Prefecture (Onagawa and Oshika peninsula)

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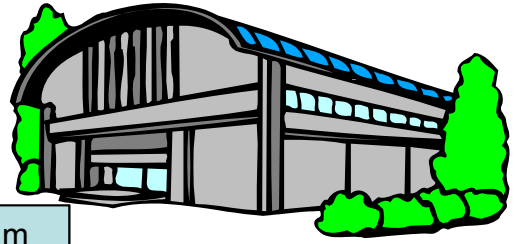
Onagawa established by the town hospital

From Yoreisohama of the Oshika peninsula

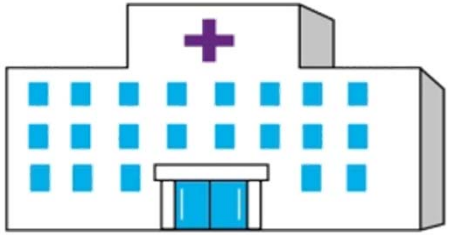
Onagawa fishing port

Toles and pebbles of Yoreisohama 2011,05,27

Integrated Network Design including WBAN and Other Access Networks

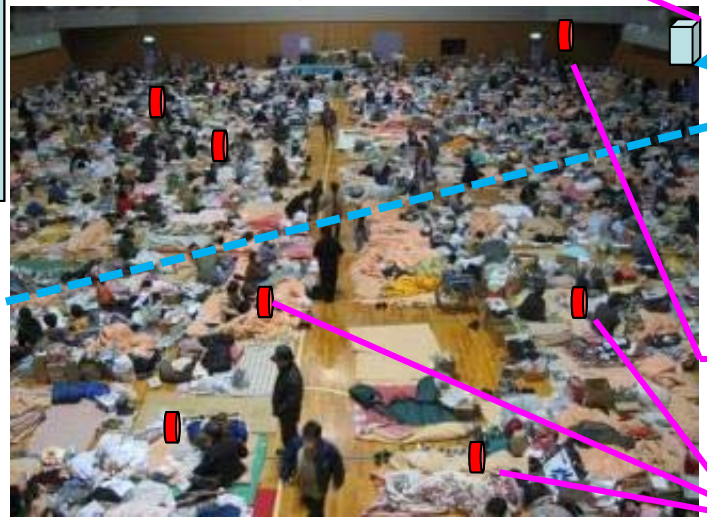


Hospitals/Medical centers



Coordinators/Terminals

Electrocardiogram
Pulse count
SpO2
Body Temp.
Motion measurement
…



Data transmission by cellular, LAN/Internet, etc.

Environmental sensors

Are they really always reliable?

Vital sensors

Coordinators

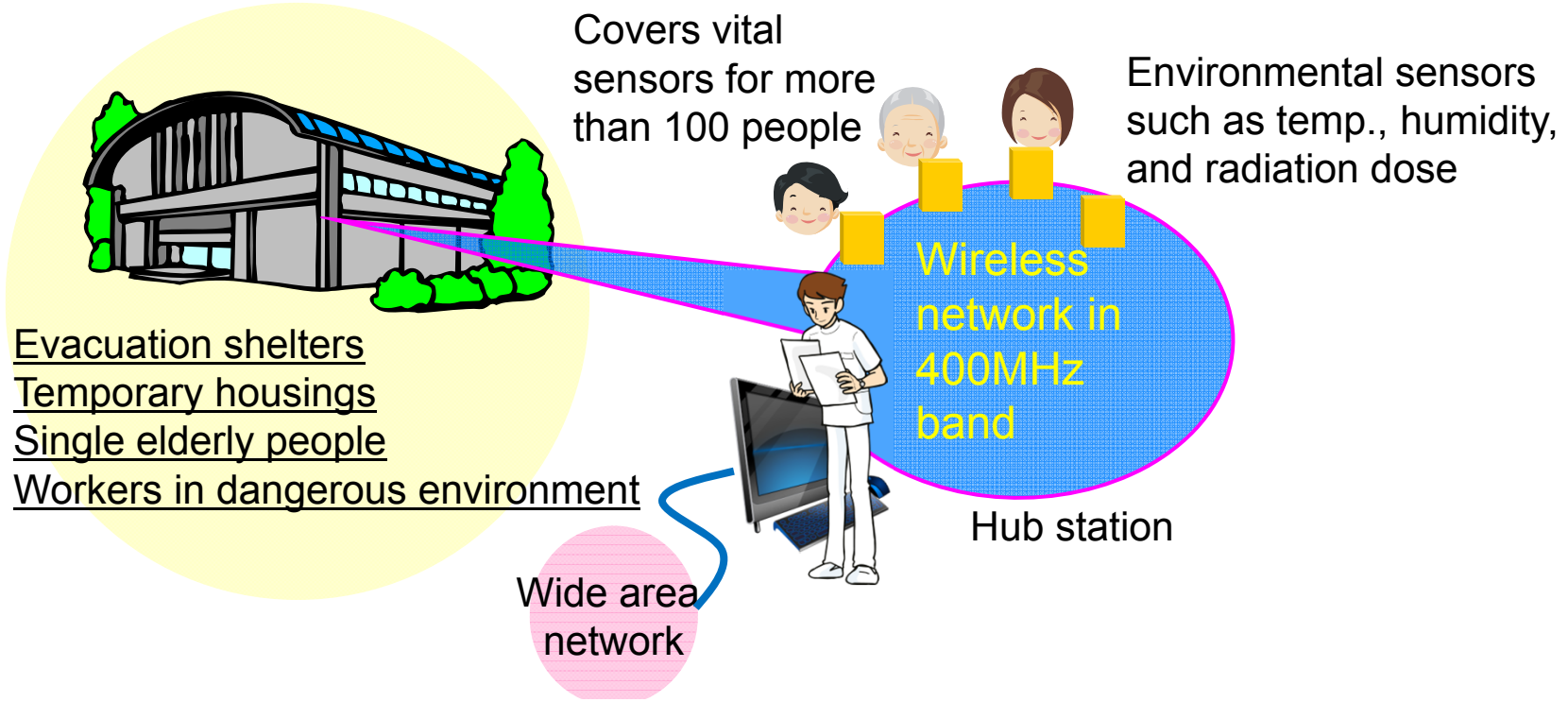
Vital sensors

BAN

- Shelters
- Temporary housings
- Nuclear plant etc.

Remote Health and Environmental Monitoring Using 400 MHz-WBAN

- More stable in propagation around human body in 400MHz band than in 2.4GHz band.
- Suitable for narrow band remote health monitor
- Single hop communication distance ~20m
- Larger coverage expected with multi-hop scheme



Concluding Remarks

- **According to population aging, *WBAN technology* will play an important role in terms of market for industry and new R&D paradigm for academia**
- **NICT is focusing on *UWB* and *narrow-band 400 MHz WBAN* for health and environmental monitoring applications. These applications also play significant roles in disaster recovery activities.**
- **NICT is one of main contributors for *IEEE802.15.6*, PHY and MAC standardization of BAN - refer to IEEE802.15 web-site**

We look forward to keep a good relationship with your countries in the area of BAN and other wireless technologies.