WiFi Mesh networking and solutions

2011 Nov. 11

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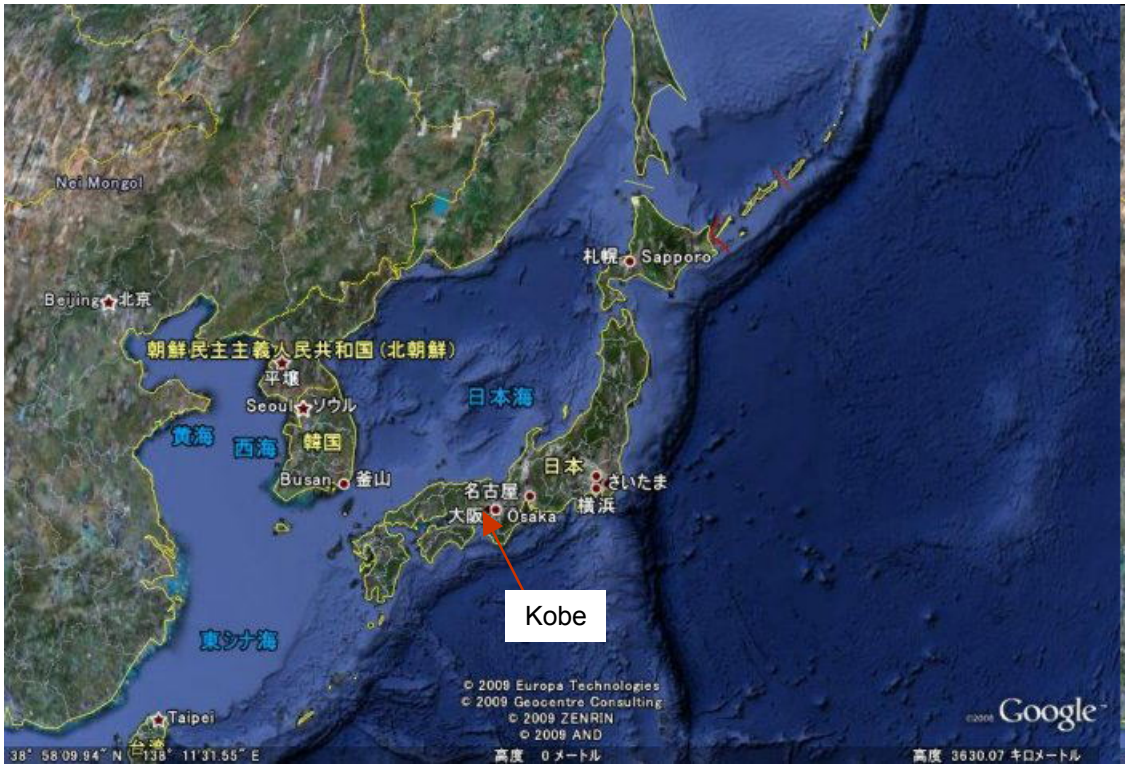
Topics

- Introduction
- Thinktube RT Wireless technology
- Application Exapmles
- Useful WiFi tools at deployment and follow-up analysis
- Video demonstration

Thinktube

- Thinktube focuses on Research and Product development in Advanced Network Technology.
- Our mission is to develop product which will function as RT (Robot Technology) communication server, in Ubiquitous Systems. Our Mesh Router Series, ***RMR***, is chosen in various projects.
- We have been working with NiCT, to implement advanced communication system in Hospitals.



- Thinktube Inc.
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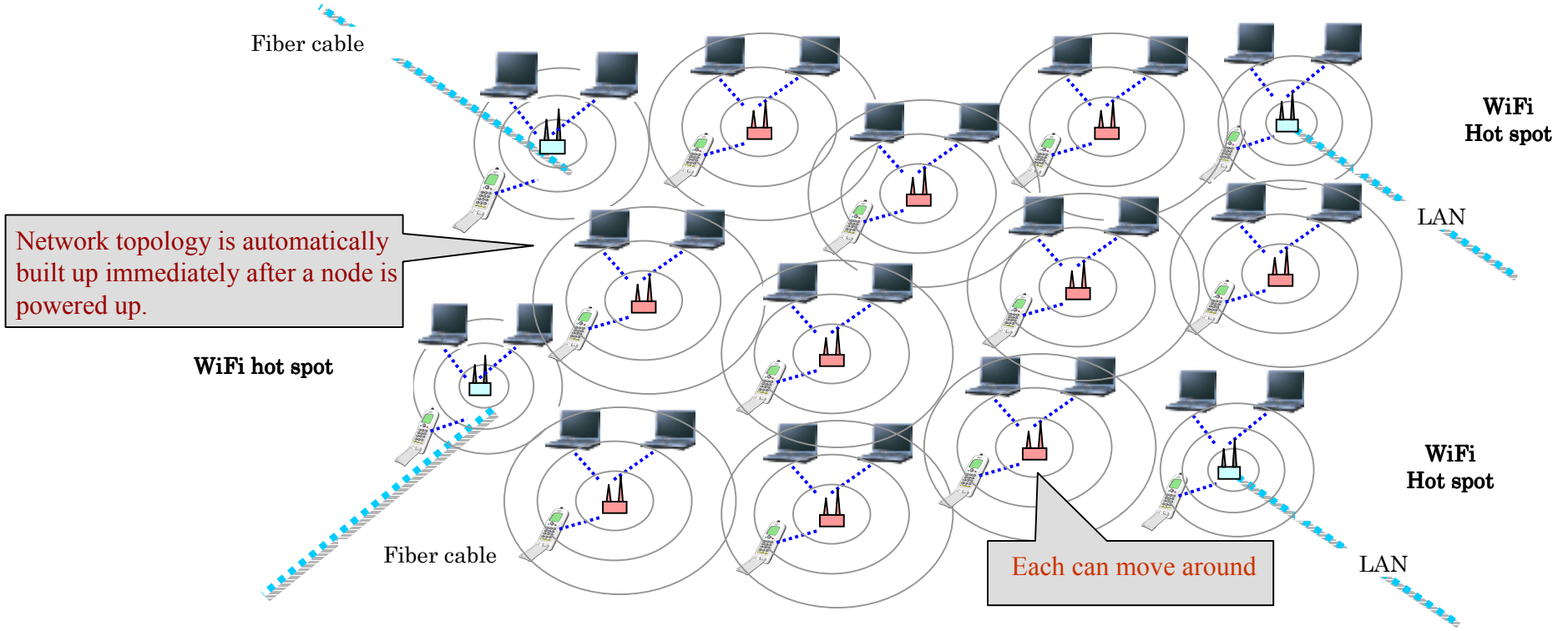
  - www.thinktube.com
  - Phone +81-78-857-8390

What is “mesh network” ?

•Definition

Wireless network where each nodes are connected to other nodes via wireless link and reach non-neighbor via multi-hop wireless links

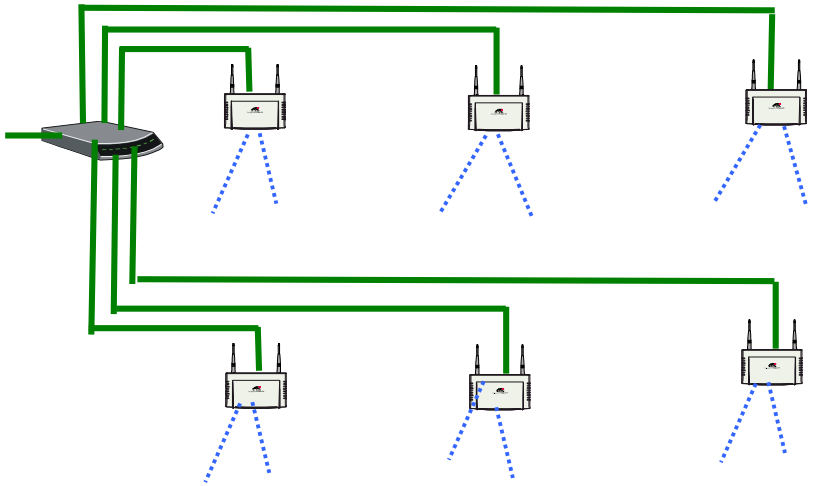


Thinktube
Wireless technology
(mesh router solution)

RT: Robot Technology

General Wireless Access Point

(General Wireless Access Point) **AP (Access Point)**



【Pro】

1. Large Selection of AP Devices

- There are many brands to choose from because of its prevalence.

【Cons】

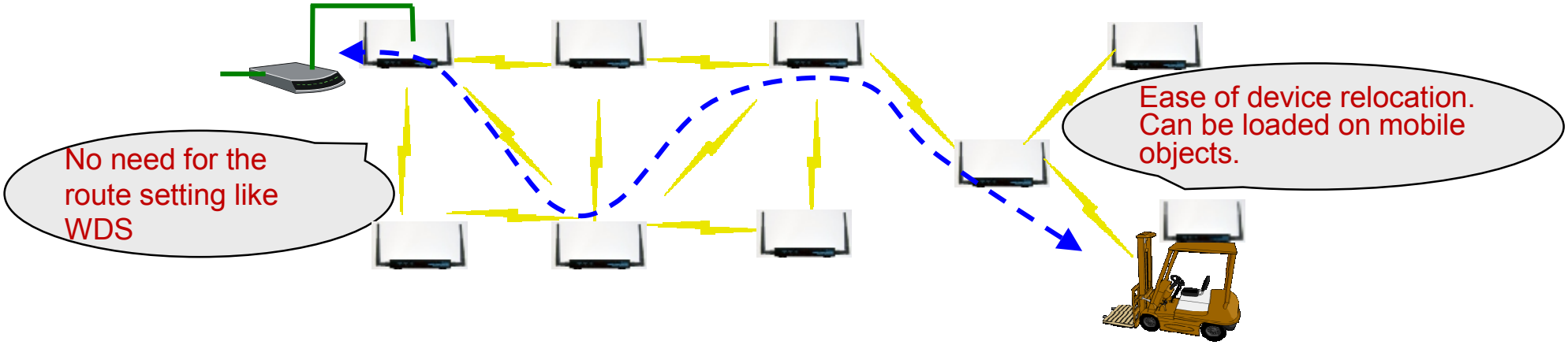
1. Expensive Construction of Cable Implementation

- Despite its prevalence, the construction of wired network is costly and difficult at outdoor locations.

2. Difficult to Detect the Problem Site

- When network connection is disrupted, it is difficult to identify the problem site: if something is wrong in a cable, AP, or terminal.

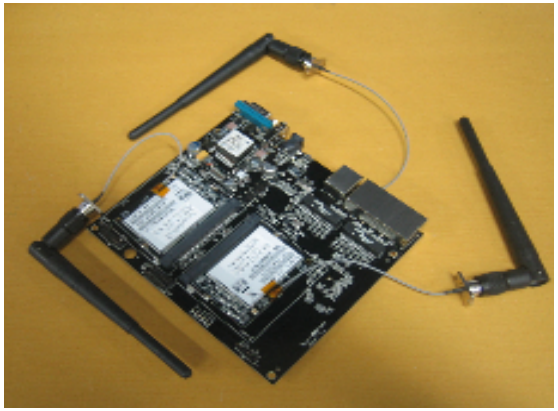
Wireless LAN Mesh Network

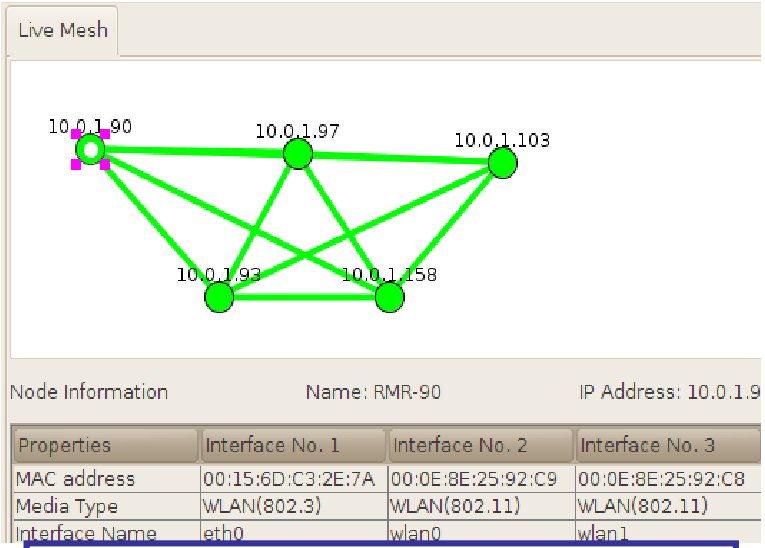


- 【Feature1】 Autonomy
  - Autonomously constructs the most efficient route depending on varying wireless network situations.
  - Autonomously constructs a mesh IP network once the power is on.
- 【Feature 2】 Redundancy and Stability
  - Mesh topology can create redundancy in networking routes.
  - Compared to tree topology, mesh topology is able to provide more stable communication services when wireless links are unstable.

Ubiquitous RT Mesh Network deployed by Thinktube

High performance, Industry grade
WLAN Mesh Router *RMR Series*





High Performance Mesh
with

- Multiple WLAN Mesh Interfaces （max 3　WiFi)
- WiFi based 802.11a/b/g
- Atheros AR5414chipset cards (including high power)
- Wired/Wireless seamless Mesh Link
- Can Support Mobile nodes
- USB2/GPIO
- Wide　operating temperature range　–20 to 65℃
- Compact
- Low Power consumption

MeshVista
with

- Visualize wireless links
- Provide detailed link condition
- Log and Review
- Alert Notification

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無線メッシュネットワークルータ　屋内用（RMR9000）仕様

RMR mobile Mesh Router

無線LANメッシュ	2.4GHz帯 IEEE 802.11b/g 及び　5GHz帯　IEEE 802.11a ■ﾒｯｼｭ　802.11g×3　または ■ﾒｯｼｭ　802.11g×2　及び　AP　802.11b/g×1 屋内においては 5GHz帯 IEEE 802.11a メッシュの混在利用も可能（要 アンテナオプション）	
AP セキュリティー	WPA2、WPA、WPA2-PSK、WPA-PSK、IEEE802．1X/EAP、WEP、MACアドレスフィルタリング、ESSIDステルス	
ﾒｯｼｭｾｷｭﾘﾃｨｰ	アクセス制限：一般機器からのアクセス不可　　暗号化：WEP-64/128	
LANポート	WAN　x 1ポート（PoE兼）　LAN x　3ポート　10/100Mbit RJ-45	
ｼﾘｱﾙﾎﾟｰﾄ	DB9 x 1ポート	
USBﾎﾟｰﾄ	USB 2.0　x　1ポート	
SDメモリー	1スロット	
寸法	153×210×36mm　（筐体ｻｲｽﾞ・ｱﾝﾃﾅ、突起物含まず）	
重量	約590g（アンテナ3本含む）	
消費電力	メッシュルータとしての通常使用において　6-9W	
電源	DC	24-56V
		40-56V　消費電力が　12W　を越える場合は40V以上でのDC供給
	PoE	802.3af (48V) 互換
環境条件	稼動温度ﾚﾝｼﾞ：　ﾎﾞｰﾄﾞ：-30～+75℃　　WLANﾓｼﾞｭｰﾙ：-20～+65℃　を採用　湿度：10-80%　結露なきこと	
特長	高温となる工場内･屋外など過酷な環境におけるご利用を想定した部材選択を行っております。多重ﾒｯｼｭと指向性アンテナの組合せ利用による広域センシングを実現。また、OpenWRTをベースにし、様々なオープンソースのソフトウェア資源・新規開発モジュールを追加搭載することが可能です。インテグレータの皆様には、エンドユーザ様の多様なご要件に対応した付加価値の提供を低コストで実現頂けます。	

アンテナオプション

5GHz帯用

2.4GHz帯用

Antenna options for RMR

- TELEC certified

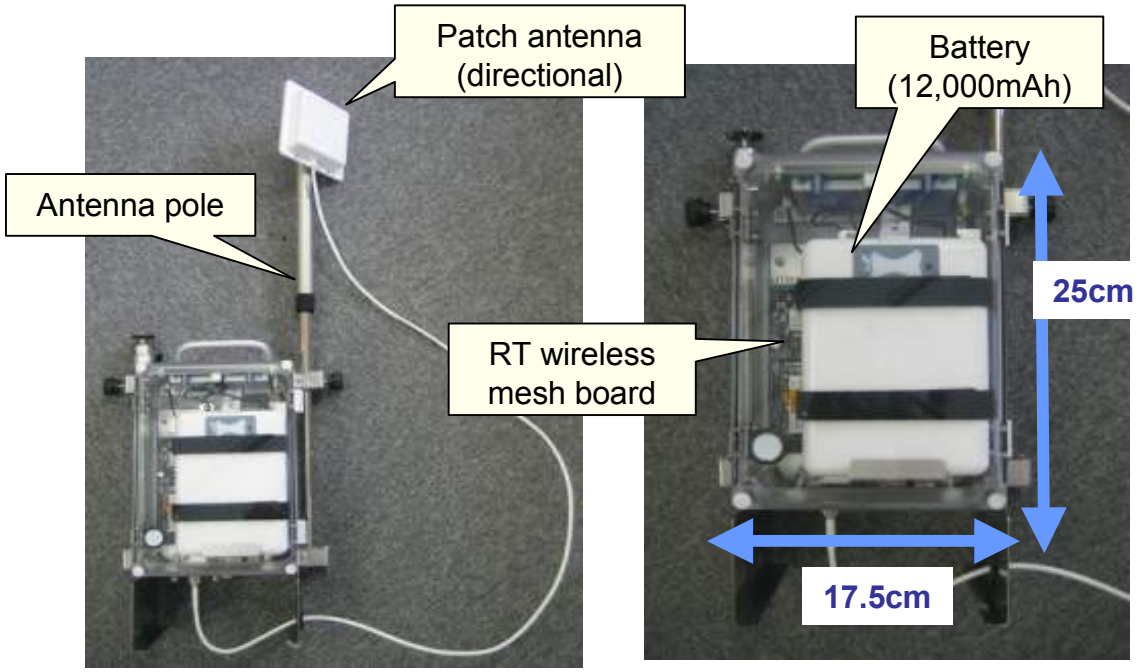
【無指向性アンテナ】





【指向性アンテナ】


Ubiquitous RT Mesh Network deployed by Thinktube



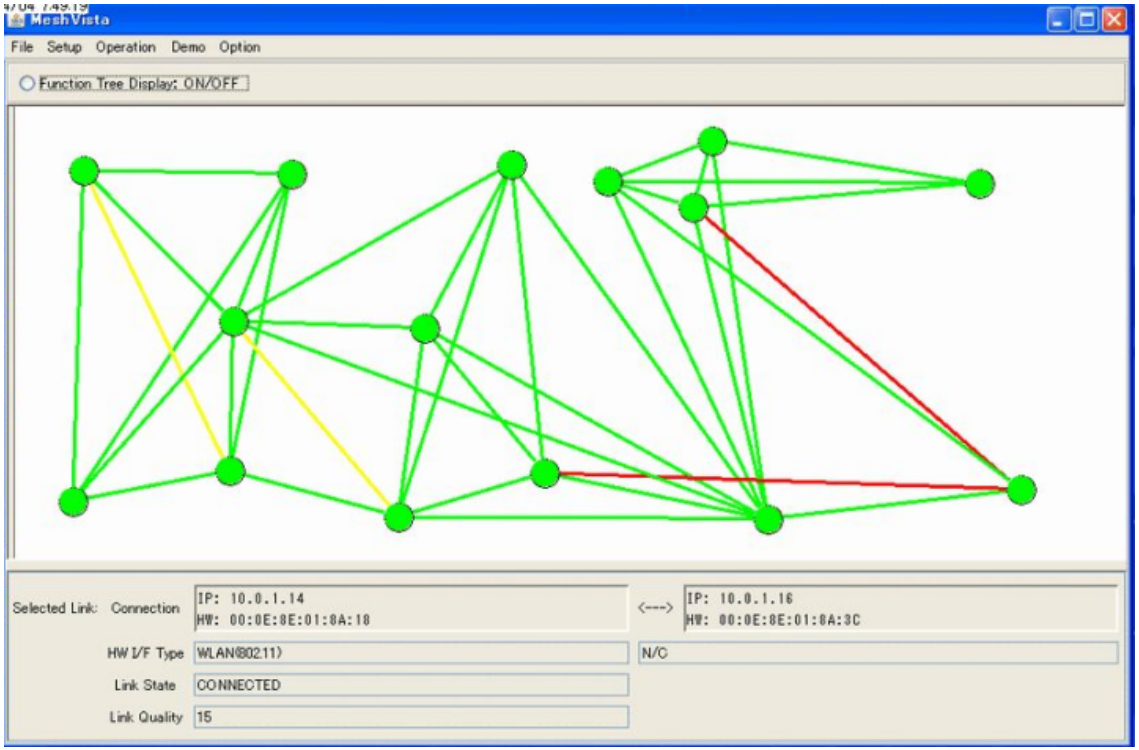
- portable, easy to carry
- operate 24hr with battery
- extendable antenna pole
- easy to mount on a pole / place on the ground

RMR advanced features

- Multiple mesh radio interfaces
- Can use directional antennas
- Fast roaming for WiFi clients
- Customizable / Do-it-yourself device
  - ✓ Linux Platform
  - ✓ OpenWRT base : widely accepted network software package platform
  - ✓ Add-on : sensors , USB devices, Digital Camera, etc.
  - ✓ Good for skill up

MeshVista

- Monitoring software for RMR mesh network



Green: stable condition

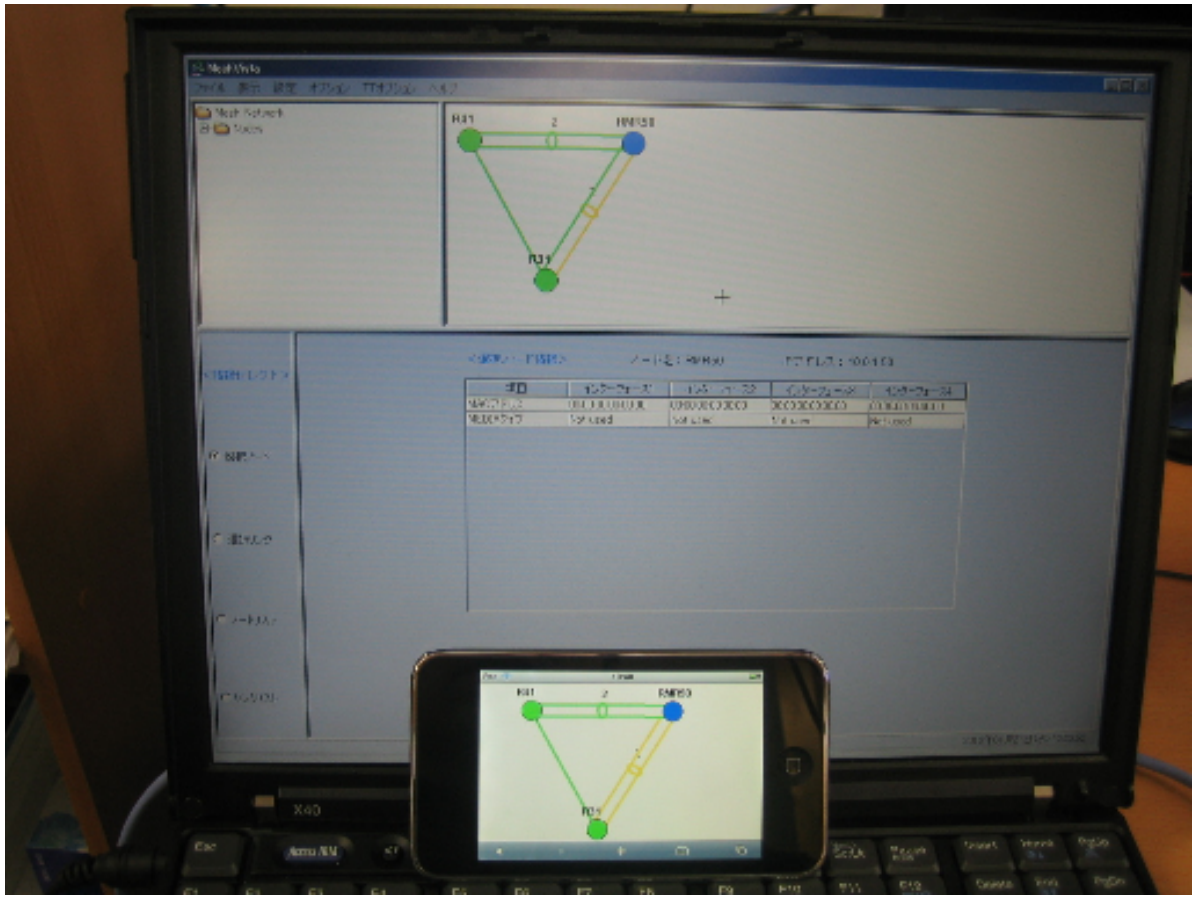
Yellow: unstable condition

Red: disconnected recently

- Optional features
  - Logging, replay
  - Email alert

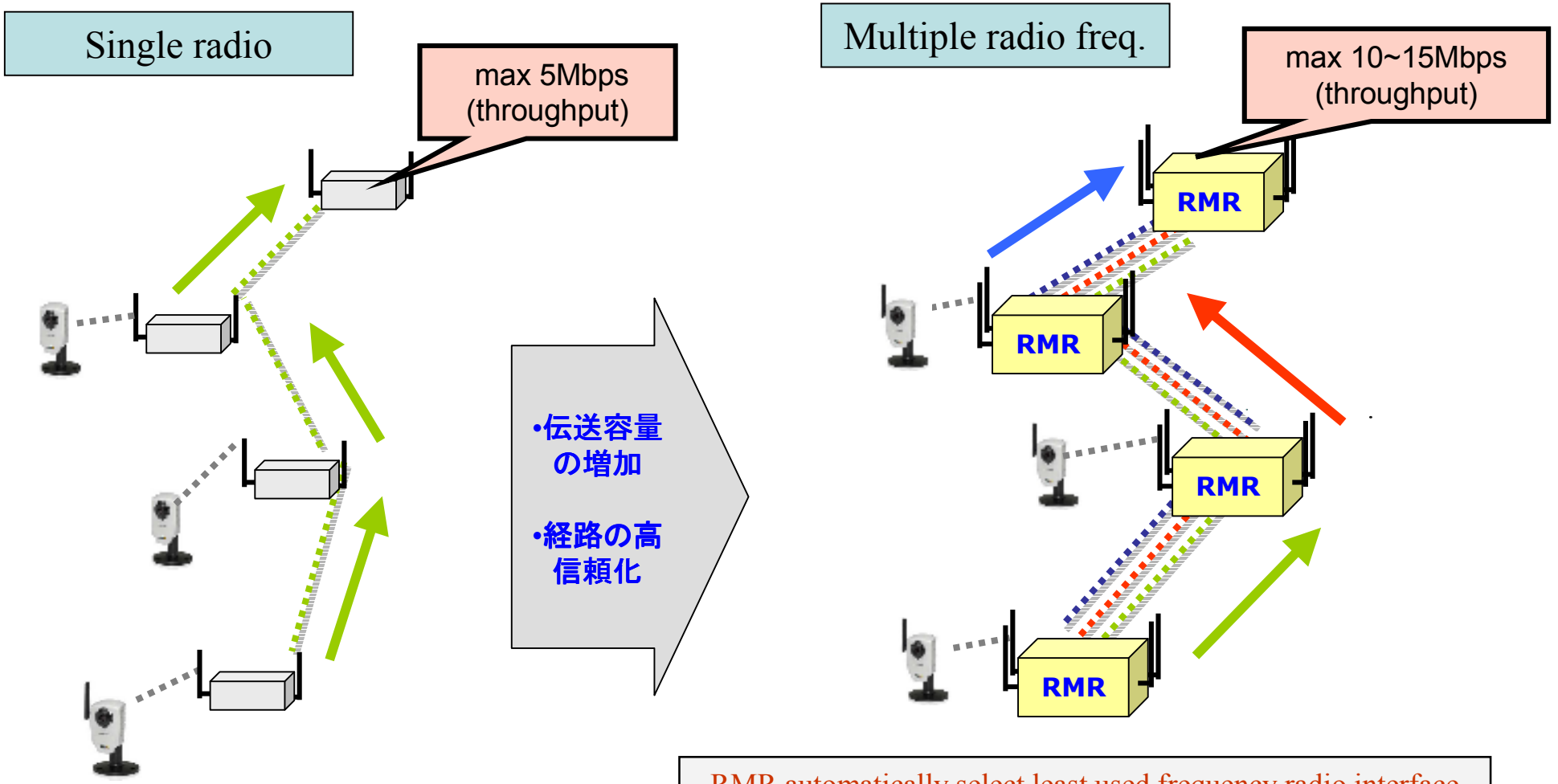
MeshVista

- Webブラウザを使ってインターネット経由での表示も可能



iPod, iPhoneでのモニタ例

RMR support Multiple Radio: increase xmit capacity



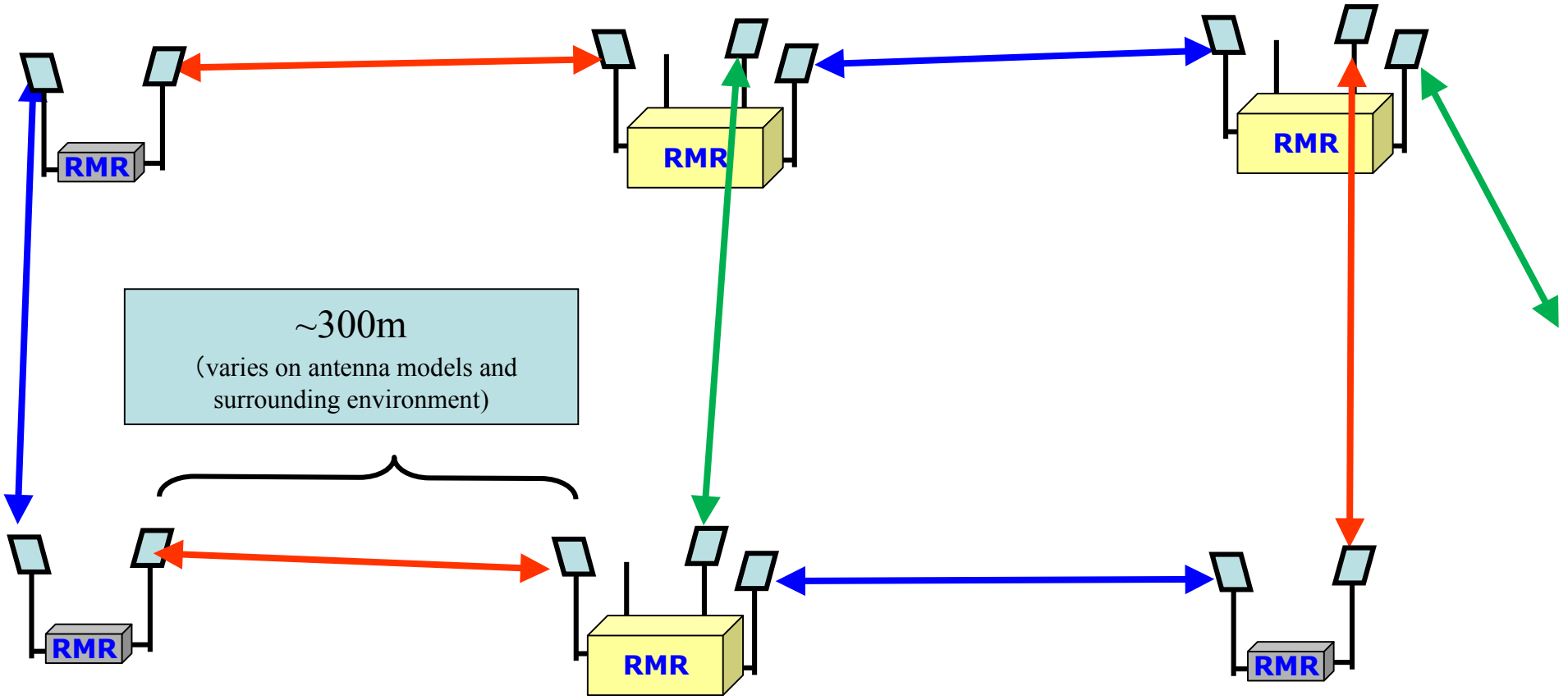
同一チャネルによる電波干渉発生

RMR automatically select least used frequency radio interface

近隣RMRのチャネル使用状況をモニタして使用率の低いチャネルを優先的に使用する機構をRMRは有する。(事前に3インターフェースに異なるチャネル設定行い送信インターフェースを自律的に選択する。)

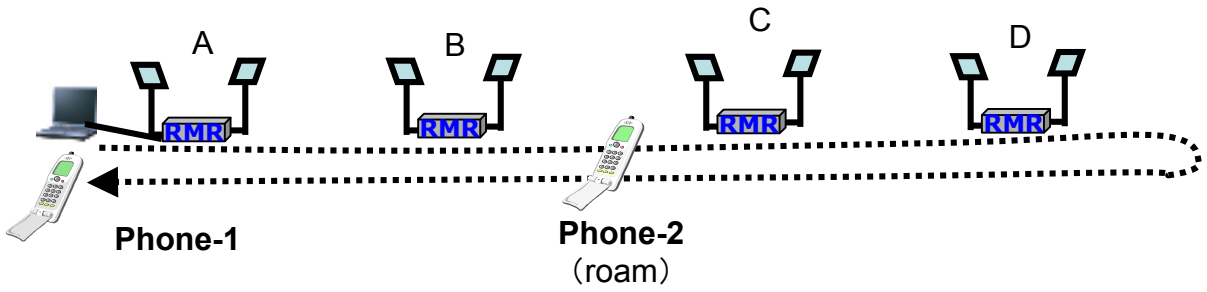
RMR support Multiple Radio: longer distance

- With single radio, use omni-directional antenna in general
- With multiple radios, can use directional antenna

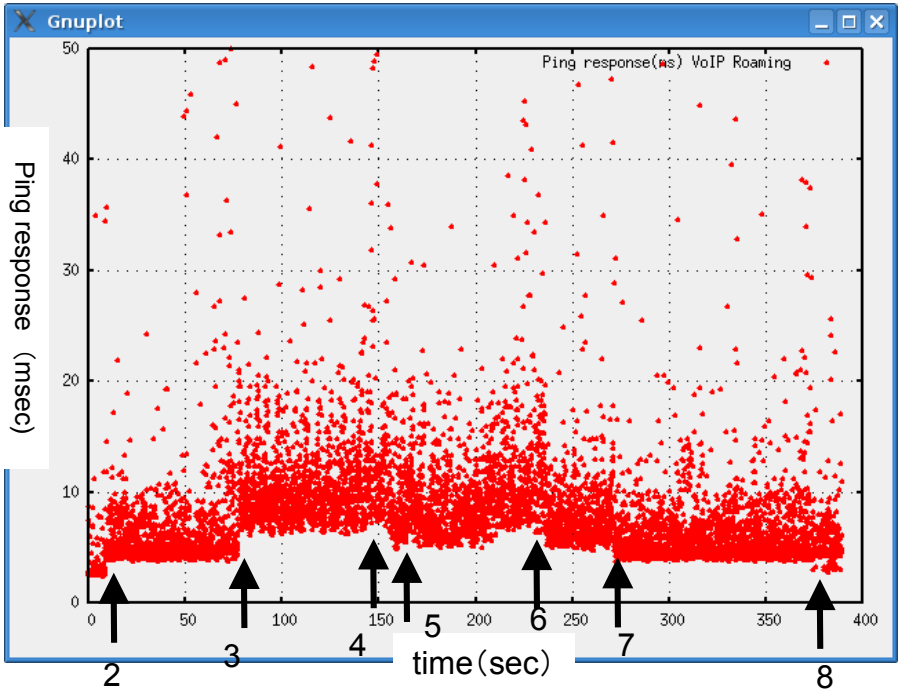


Fast and smooth roaming support of RMR

- VoIP roaming
  - Test scenario
    - Phone ：NTT N906iL
    - 50m away for each RMR
    - Roam around while talking over phone
    - Measure ping response time to Phone-2 (from PC)



	time	Route to the phone	Lost packet
1	0	A→P2 (phone-2)	0
2	9	A→B→P2	1
3	77	A→B→C→D→P2	1
4	150	A→B→D→P2	0
5	165	A→B→C→D→P2	0
6	235	A→B→C→P2	1
7	270	A→B→P2	1
8	370	A→P2	0



No disruption while roaming

It takes less 100msec for L2 and L3 operation while roam to other AP

RMR case study

RMR application area

- Large Factory
- Power Plant, Water & Sewage Plant 、Gas Plant, Chemical Plant
- Construction Site, Tonnel/Airport/Port Construction, Dam Construction

Long Range Transmission of video/sensor data

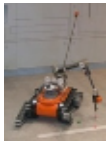
OnSite Temporary Network (Ad Hoc)

- Construction Site
- In-ship network on Tanker for trial voyage
- Highway Accident
- Disaster and emergency site

RMR **application**

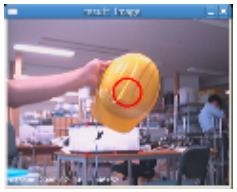
Network Between Mobile Devices

- Crane, Tractor, Heavy Construction Vehicles
- Mobile Robot
- Trains in Plant



Wireless network for Distributed Processing

- Camera and Video Processing
- Location/Sensor data processing



Long Range and last one mile Wireless

- River, Volcano, Earthquake & disaster monitoring

Expanding WLAN Network
(Hotspot → Hotspace)

- Large scale factory, Plants,Hospitals

Introduction & Testing of Wireless Mesh Network *"RMR Series"* 2009-3

APs in Cities/Valleys/Islands

Kobe Rokko Island Public WLAN Service

900m × 400m wireless mesh network provides communication services in the large area.

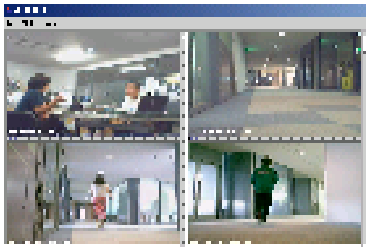
Large-Area IC Tag Network

"Ubiquitous City Monitoring Robot Project" in Osaka

Wireless mesh is mounted on the top of vending machines, which transmits information from children's IC tags

Image Network

Wireless Surveillance Video Network in a Bldg.



8 nodes are set in a building to create wireless mesh network for surveillance

Environment Sensor Network

Field Server (for Farm Sensors)

National Agricultural Research Center (NARC)

Crop growth monitoring using environment sensors and cameras on fields

Mobile Object Sensor Network

Tractor Maneuver Monitoring Network

NARC

Info. collected from GPS sensors and cameras mounted on vehicles helps detect accidents early.

Group Control Network of Rescue Robots

NPO International Rescue System Institute.

UMRS-NBC

Multiple robots at a disaster site are connected through network, which expands the area of control

Ad-Hoc Sensor Network

Sensor Network at Construction Sites

Construction management by collecting the real-time information from noise detectors, etc.

Ad-Hoc Network for Gauge Testing in Ship Construction

Information collected by various gauges is sent to a cabin

Voice Network

In-Factory Wireless VoIP Network

Wireless communication network using SIP server and wireless WiFi phones.

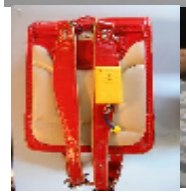
Security & Safety

“KIDS’ Safety Robot” by IC Tag and RT wireless mesh

IC Tag reader network for Kid’s location tracking (when going to /coming back from School)

“KIDS’ Safety Robot” on Vending machines communicating Kids’ tag information through ***RMR 700 & 500 Series*** Mesh Network.

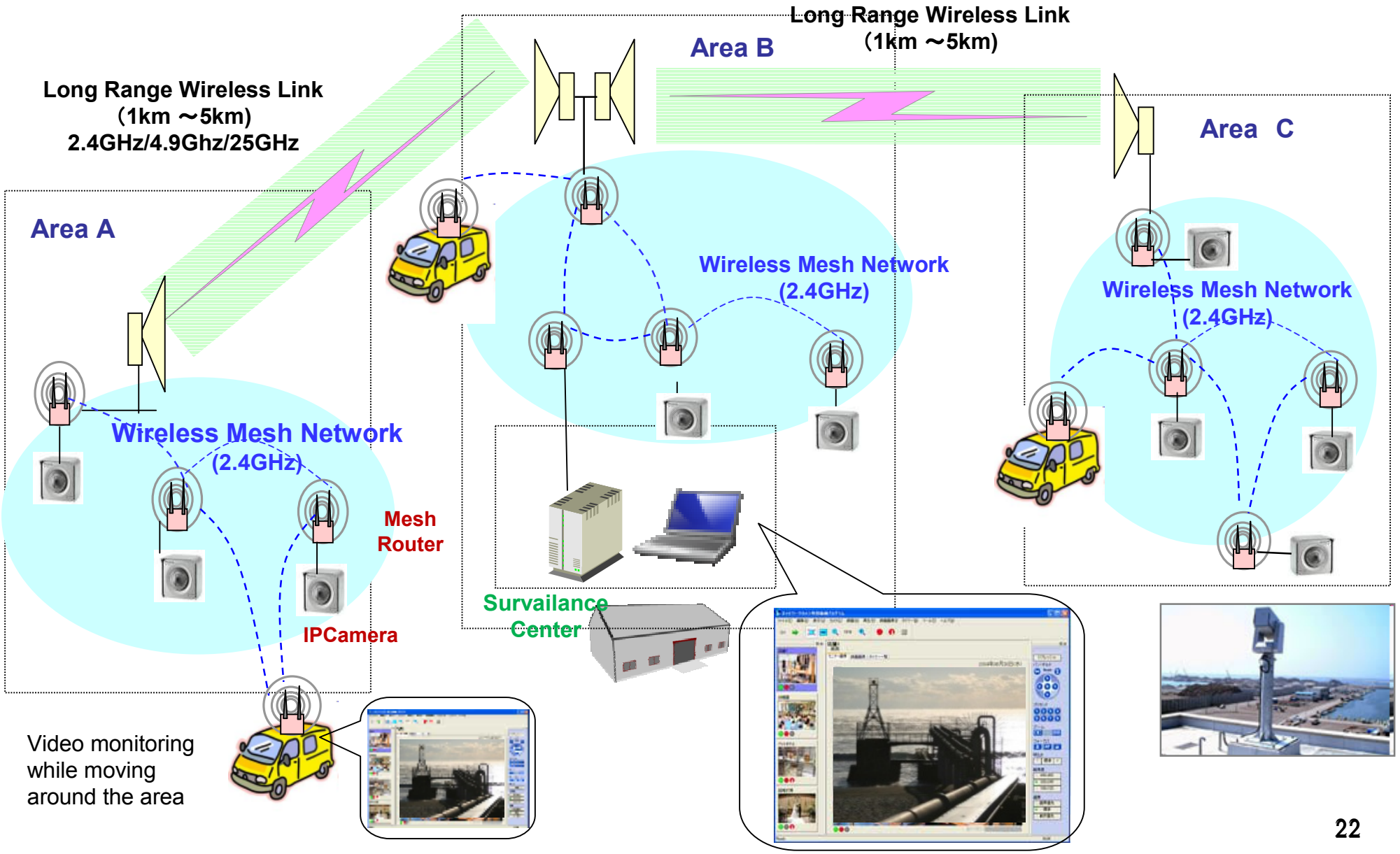
“KIDS’ Safety Robot”, combination of Tag reader, Box-PC, ***RMR*** on top of Vending Machine.



Parents receive e-mail when the kid passes through school gate, and can track where the kids are.

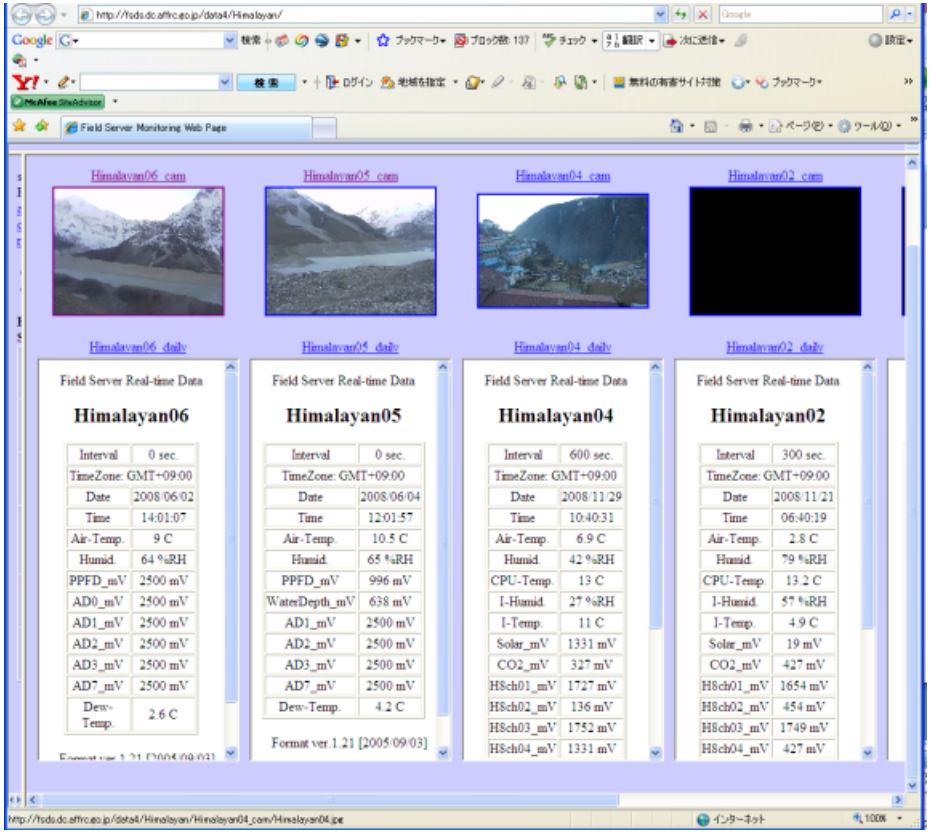
Wide area, 1.1km north to south, 800m east to west, covered with 25 ***RMR***s.

Coast area guard : Wireless Video Monitoring System



Environment monitoring

Monitoring Imja Glacial lake in Himalayas

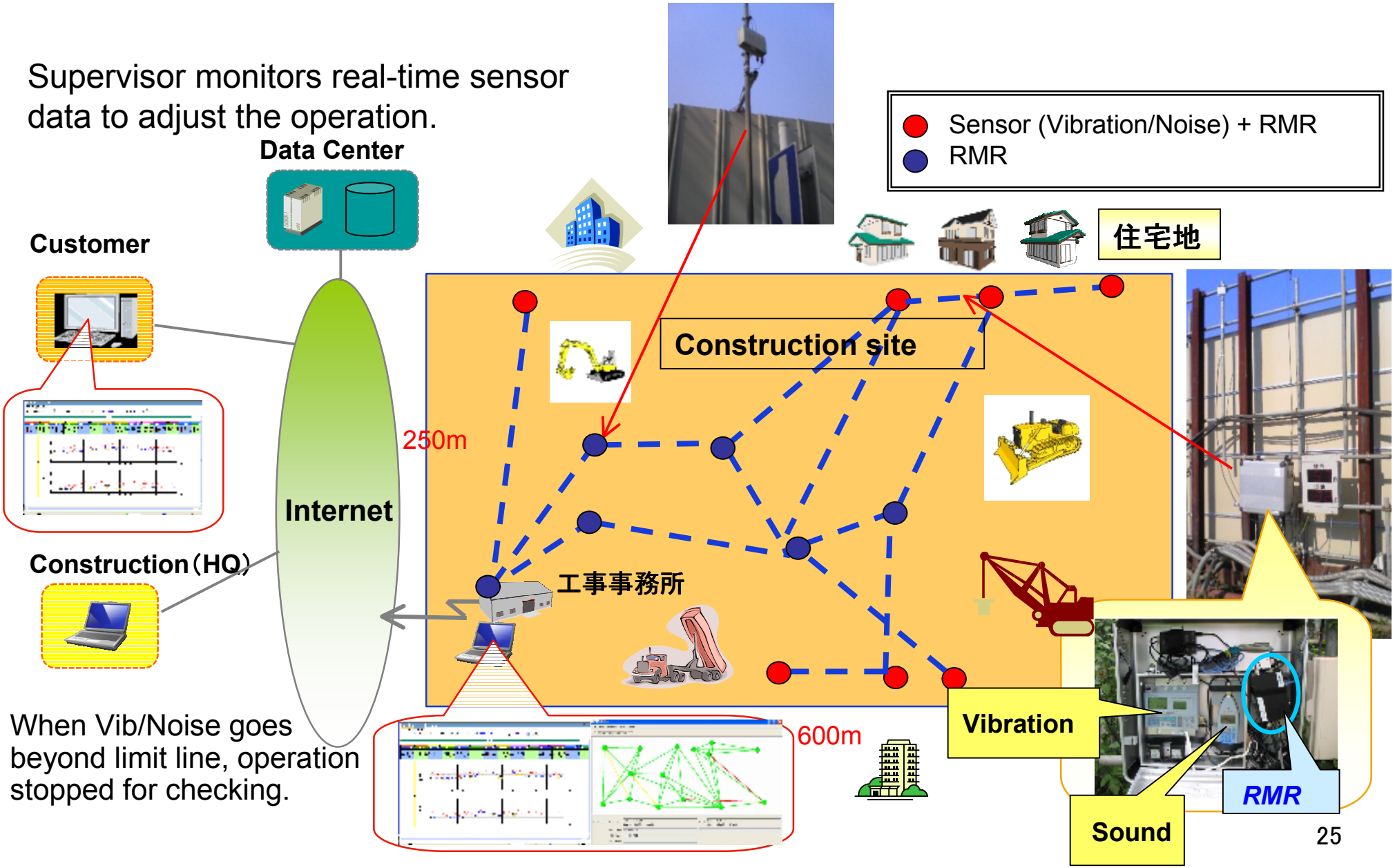


Imja Glacial Lake Outburst Flood Monitoring (Himalayas)
Professor Hiromichi Fukui (Keio Univ., Japan) is monitoring Imja Galcial Lake that has a possibility of outburst due to global warming

Photos provided by Elab Experience

Construction site Monitoring (in operation 2007～)

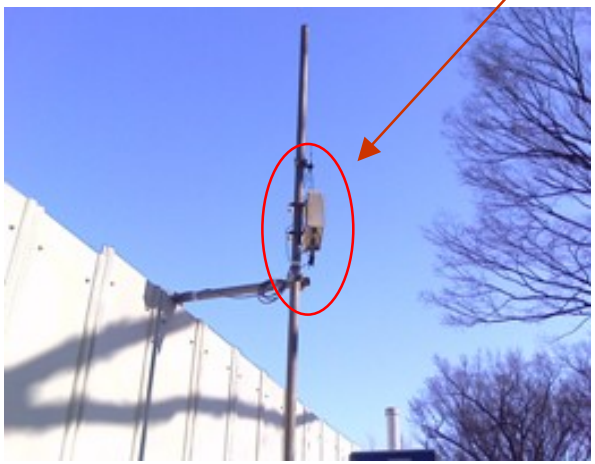
Supervisor monitors real-time sensor data to adjust the operation.



When Vib/Noise goes beyond limit line, operation stopped for checking.

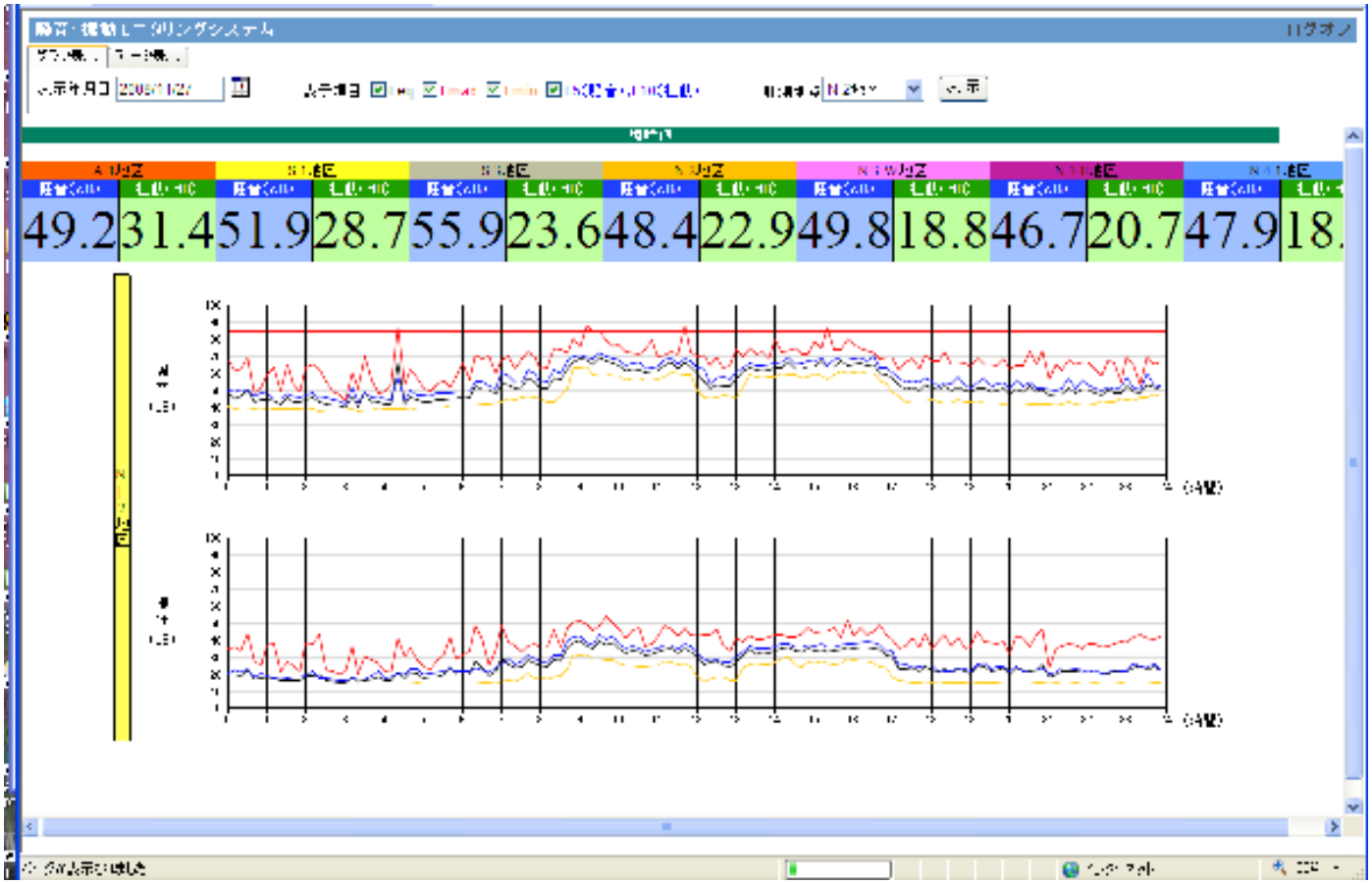
Construction site: remote monitoring of noise/vibration

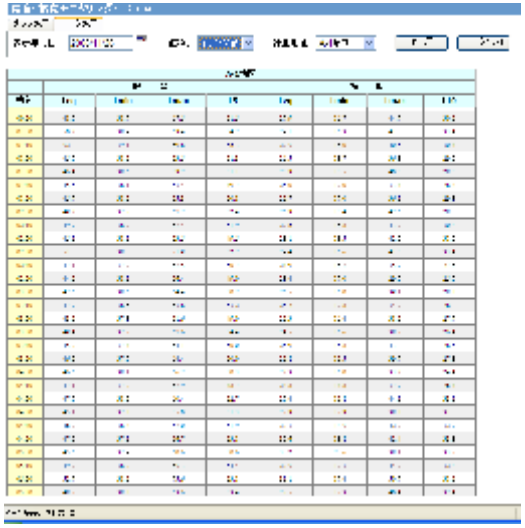
RMR on top of poles



Construction site: server application

- graph of noise/vibration data

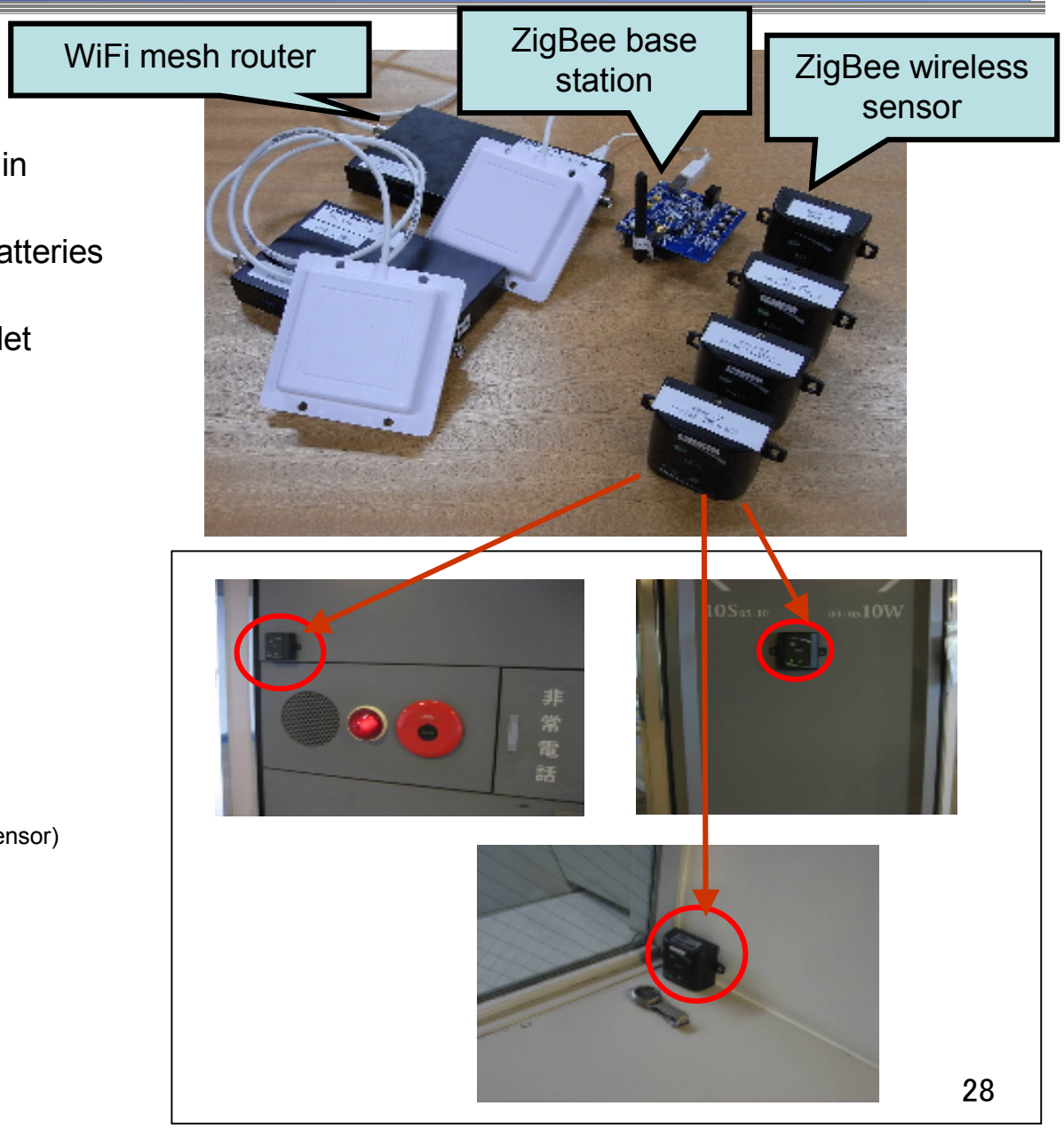




Commercial Building : Environment monitoring

Features

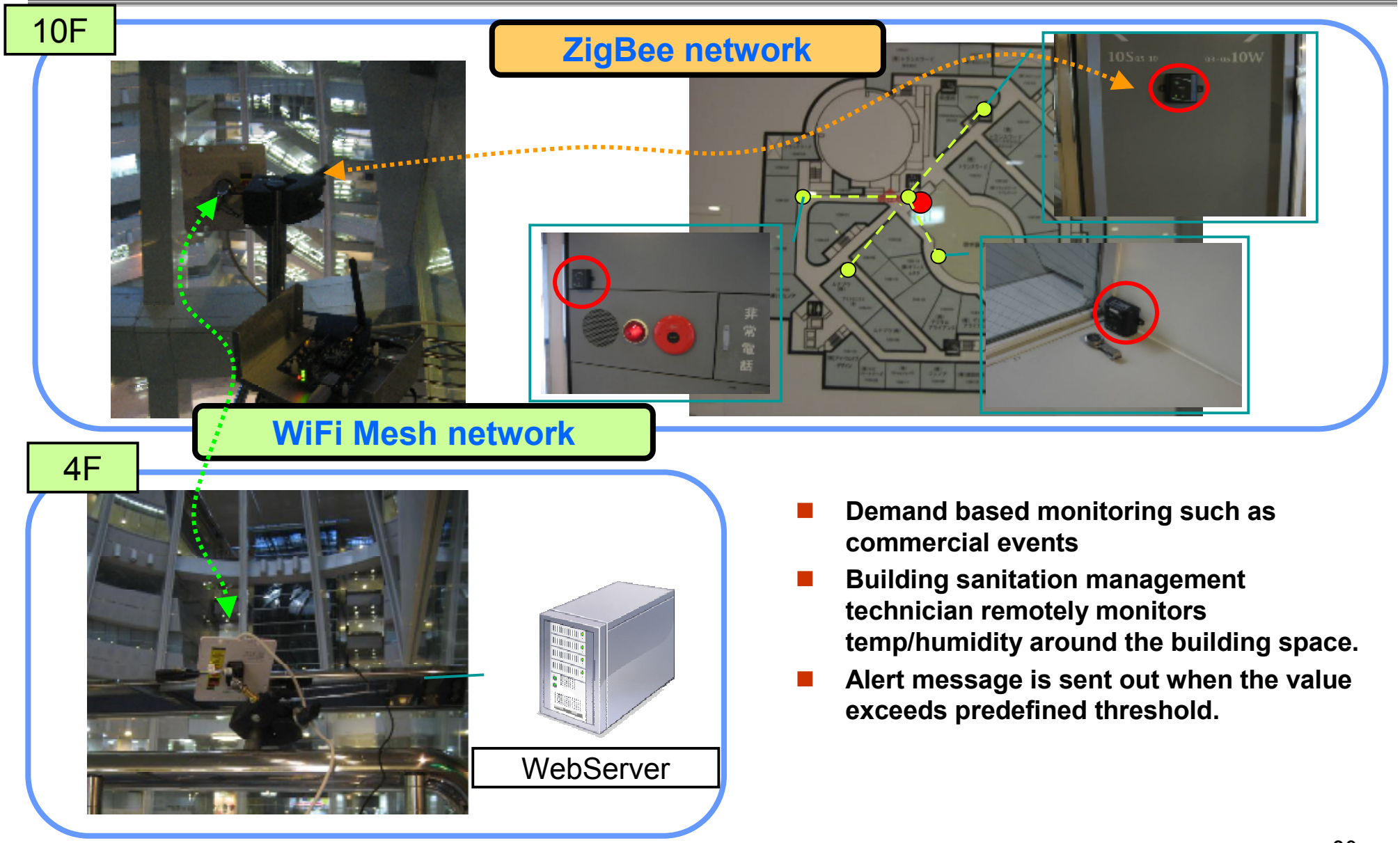
- Monitor temperature/humidity for anywhere in building space, extremely portable.
- ZigBee sensor node operates with 2 AAA batteries (for a week)
- WiFi mesh node operate by power from outlet
- Aggregated by WiFi and ZigBee wireless technology



System Components

- *RokkoMeshRouter* (WiFi mesh router)
- XBee base node
- XBee Sensor node (with temperature/Humidity sensor)
- Central server

Commercial Building : Environment monitoring



- Demand based monitoring such as commercial events
- Building sanitation management technician remotely monitors temp/humidity around the building space.
- Alert message is sent out when the value exceeds predefined threshold.

Commercial Building : Environment monitoring

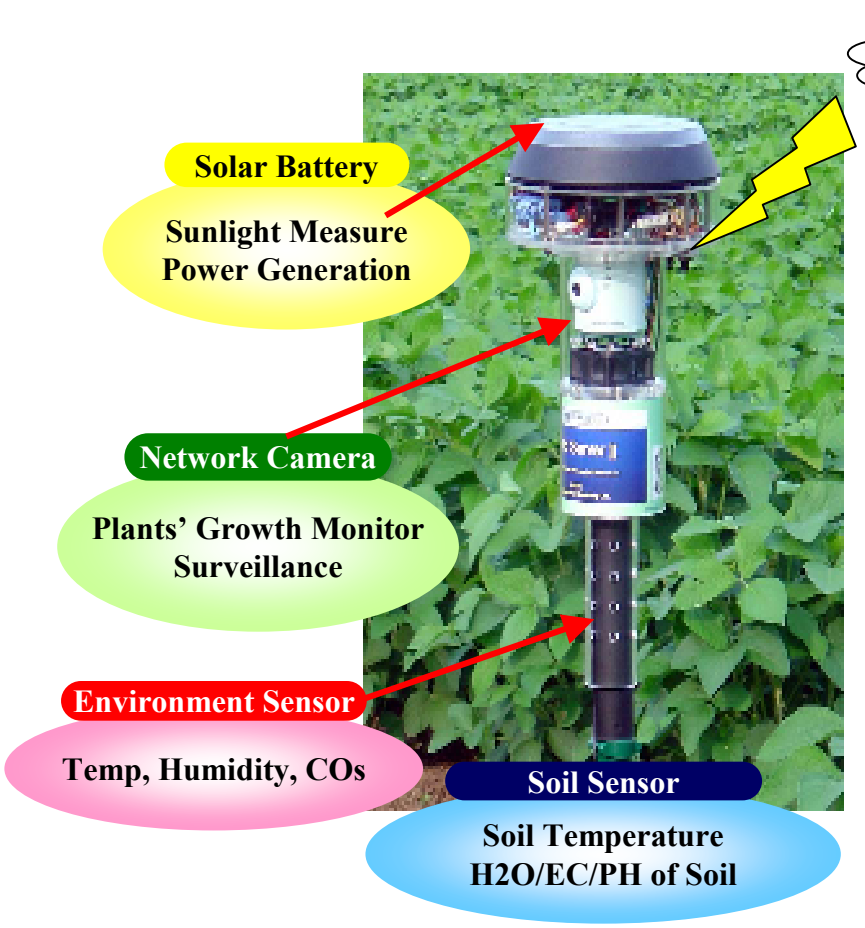
- GUI application on server system

Agricultural application

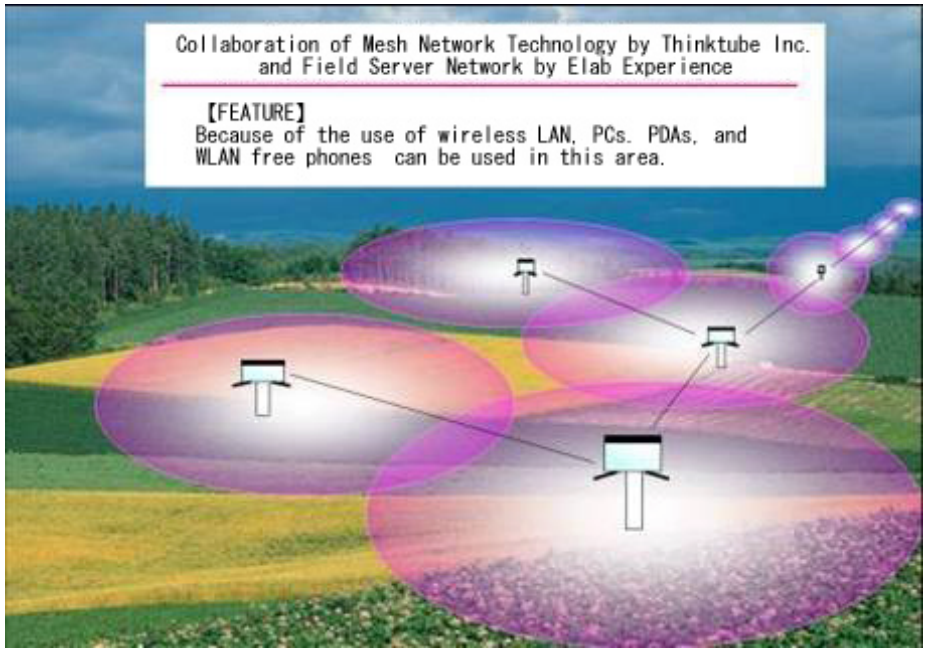
Field Server (Farm Sensor) Network

【DESCRIPTION】

Monitoring system run by farm environment sensors. Developed by National Agricultural Research Center and manufactured by Elab Experience. Adopts ***RMR*** by Thinktube Inc. as a field server communication device.



National Agricultural Research Center

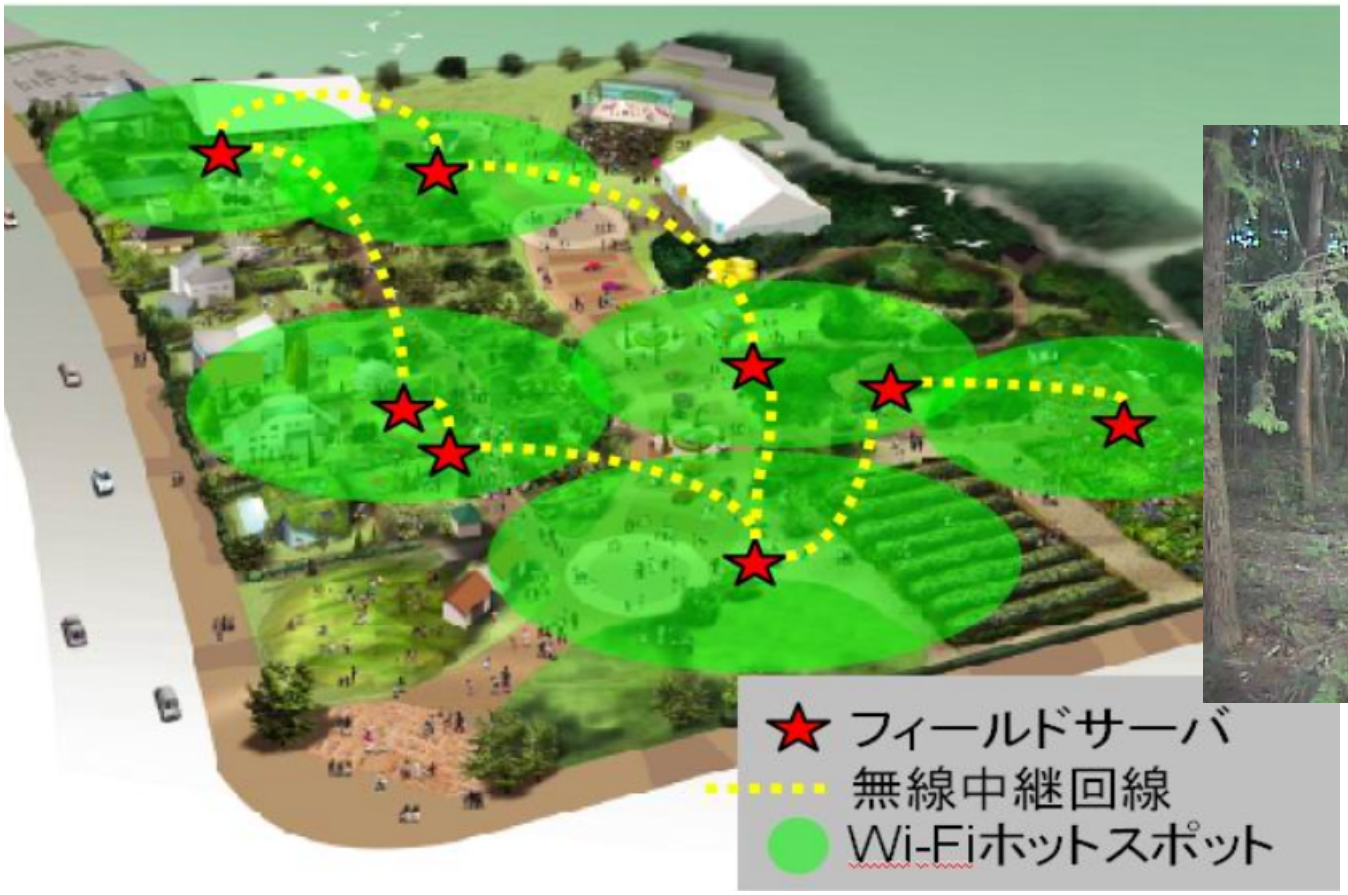


Reference: Elab Experience

Field Server Network

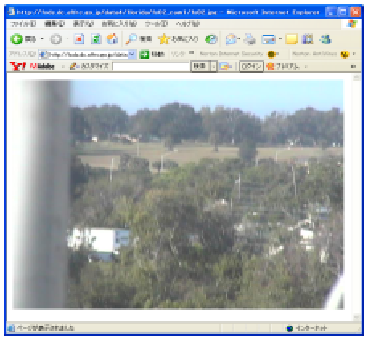
City area project 2007 : Ministry of Education, Culture, Sports, Science and Technology (Japan)

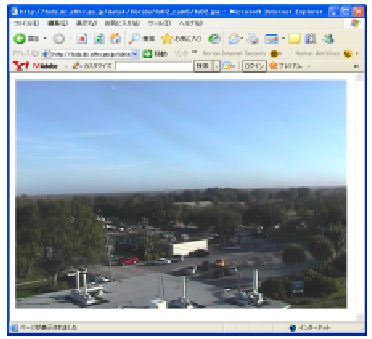
Tsukuba Festival

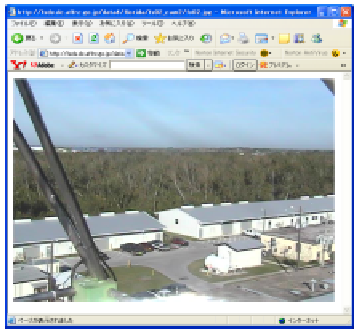


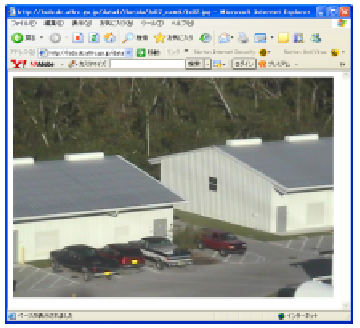
http://model.job.affrc.go.jp/FieldServer/TsukubaStyleFesta.html

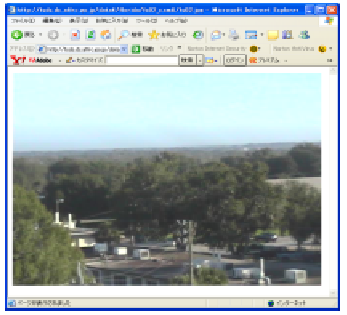
Field Server Network

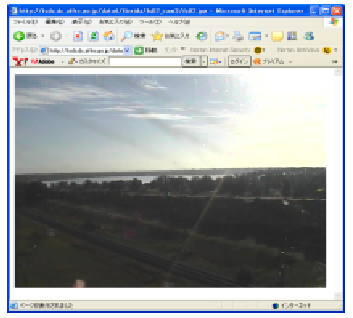












Field Server Network

- Greenhouse/Agricultural Irrigation

Strawberry and Tomato Growing (Mie Pref.)
Measures the amount of sunlight, temperature, humidity, soil temperature, and CO2 density in the house.

Land Improvement District for Irrigation in East Iwata (Iwata City, Shizuoka Pref.)
Management of irrigation at the lower reach of Tenryu River for the rice fields

Reference: Elab Experience

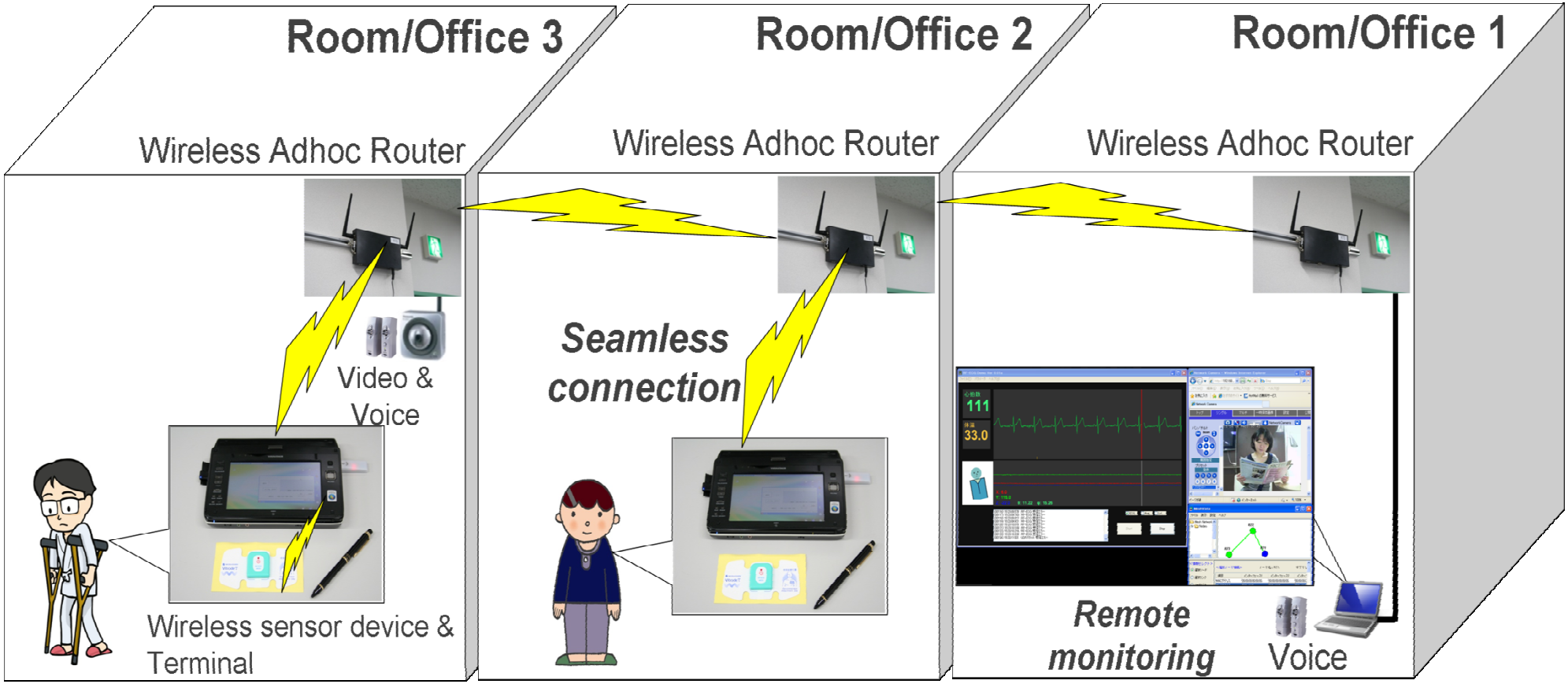
Medical application (integrated with BAN)

Integration of BAN and WiFi mesh network

Benefits:

- good for encouraging early recovery of patients

- encouraging patients to leave from beds and do light walk (their vital data is monitored in any where



Medical ICT application : Mobile ECG monitoring

RMR/Camera

RMR

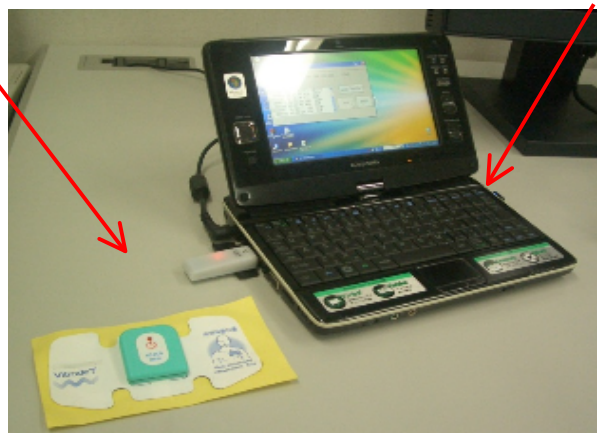
RMR

ECG sensor / Portable PC / Server PC

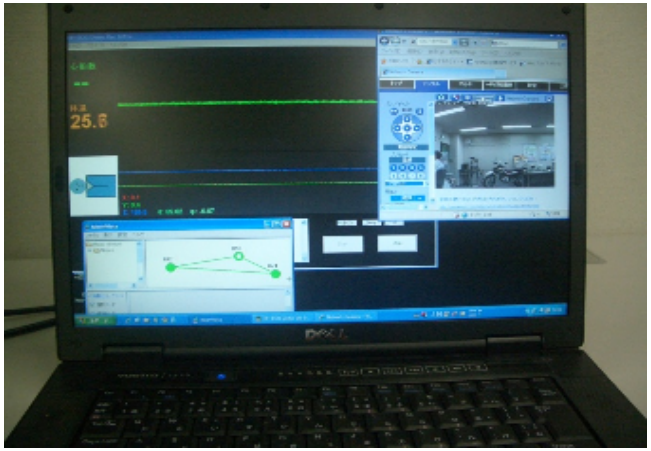
ECG receiver USB adapter

Wifi USB

IP camera / Speaker

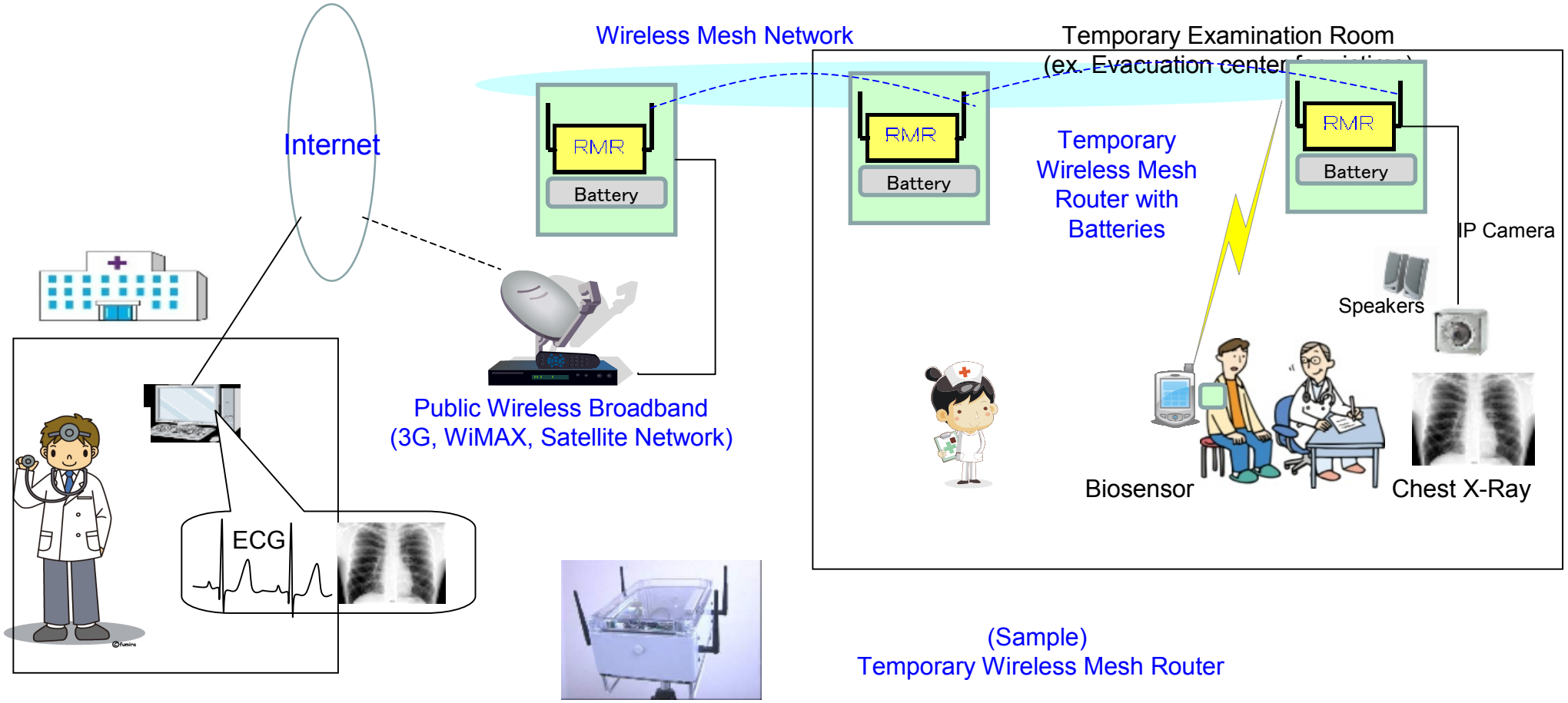


ECG sensor and portable PC



Server PC

Telemedicine Support System

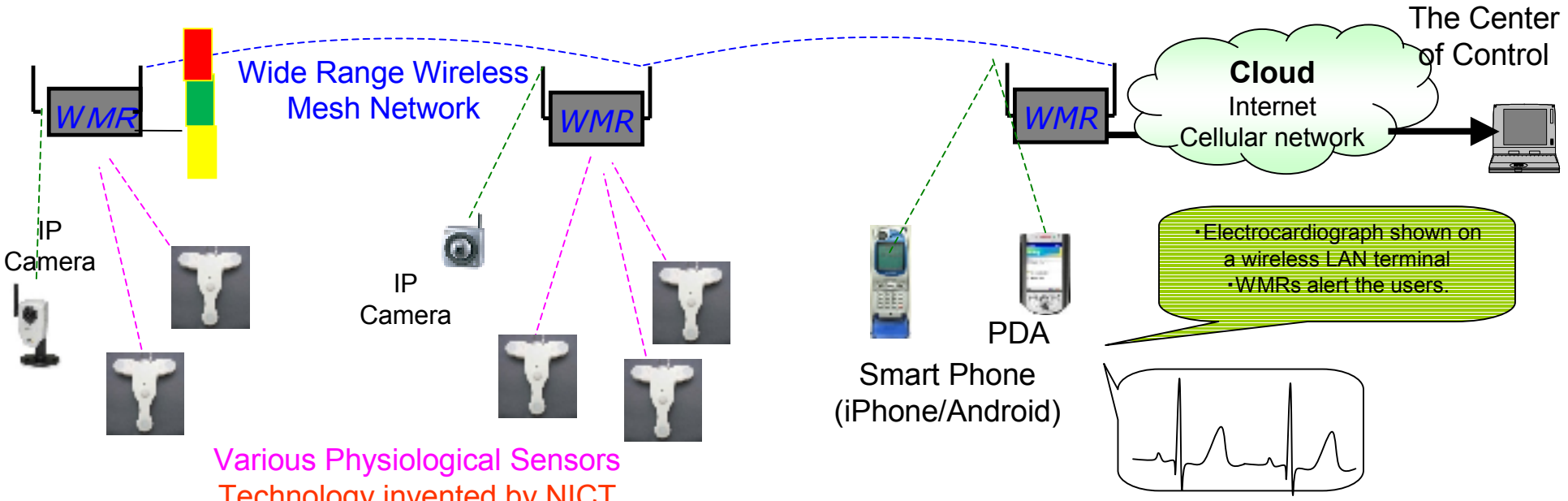


- Actively constructs an in-hospital WLAN and efficiently uses public wireless broadband networks
- Information of patients collected by biosensors, IP cameras, etc. are shared among hospitals at remote locations, supporting the practice of telemedicine. (remote control of devices such as IP cameras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

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 system, with LAN/USB2/RS-232C ports
- WMR can be used as access points for wireless LANs, they can be used to invent ubiquitous application systems with Smart Phones, IP cameras and sensors.



WMR Example:

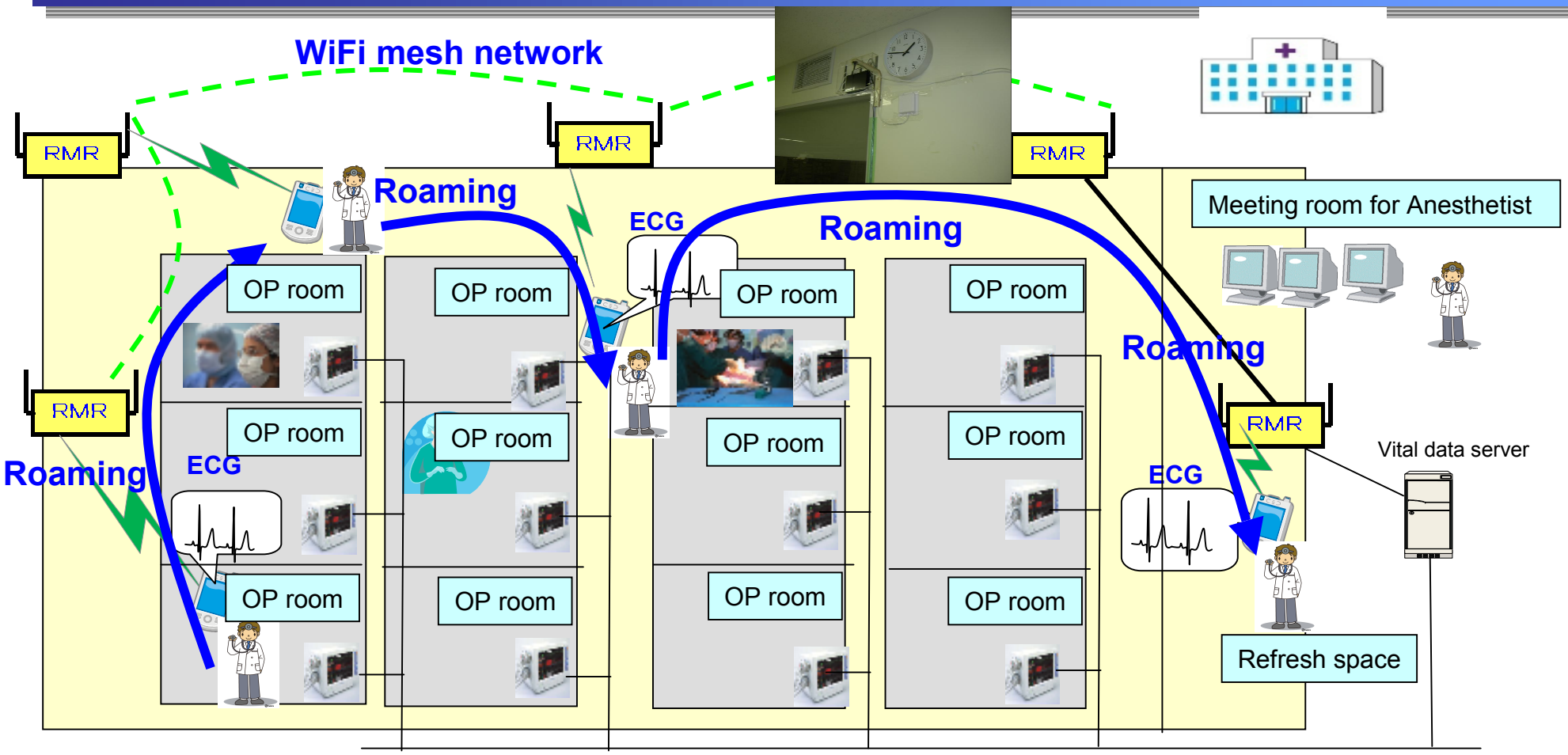
Cooperation between Sensors and Cameras

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.

Ubiquitous Vital sensor network system in surgery operation floor
（Anesthetist support system）

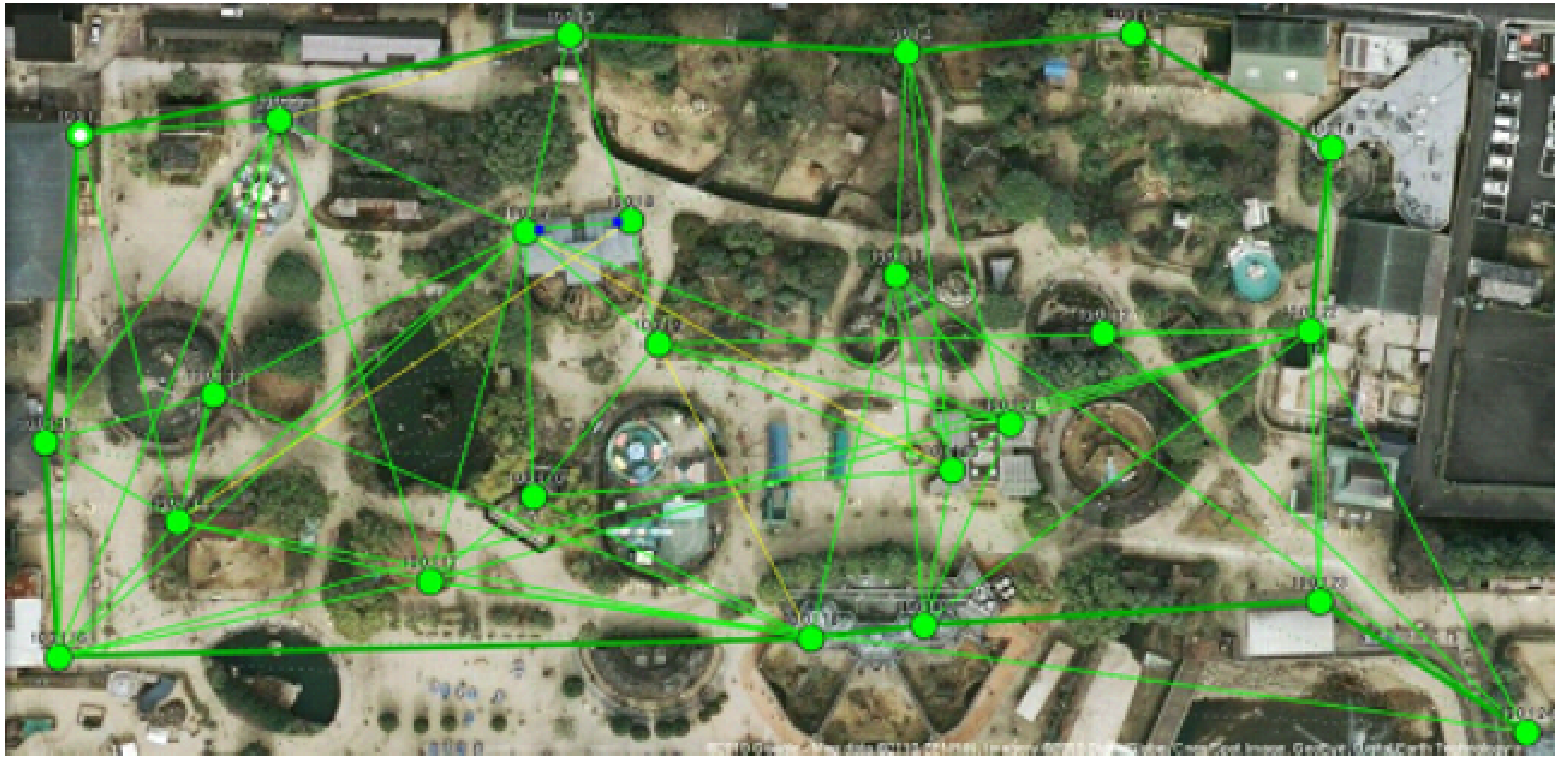


Effects:
Now, senior anesthesiologist can monitor all patients condition in multiple operation rooms simultaneously, from anywhere in this floor, even when he is walking around there

Remote video monitoring
(& computer vision)

WiFi Mesh network over Kyoto-zoo

- RMR9000　24 Units
  - Mesh by Wireless and Wired links
  - Application : Ubiquitous Video transmission, Smart Phone/ Tablet PC Roaming

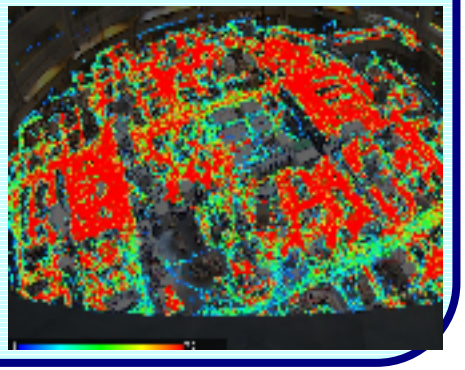


- 2010年8月　service in

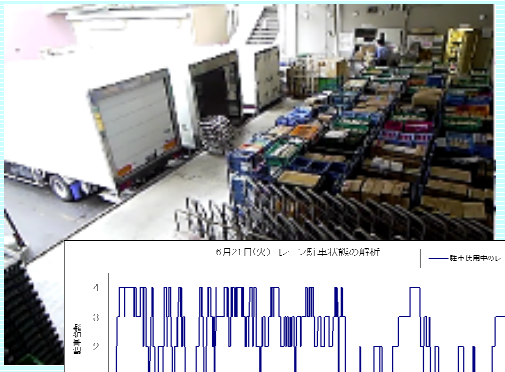
Wirelss mesh + Video data analysis (Computer Vision)

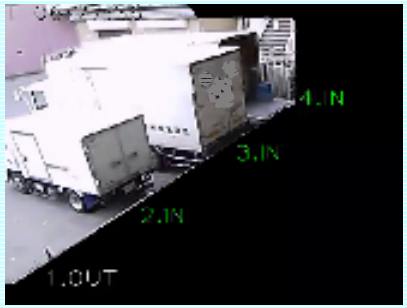
For marketing support

Trade show : flow and stay(dwell) analisys



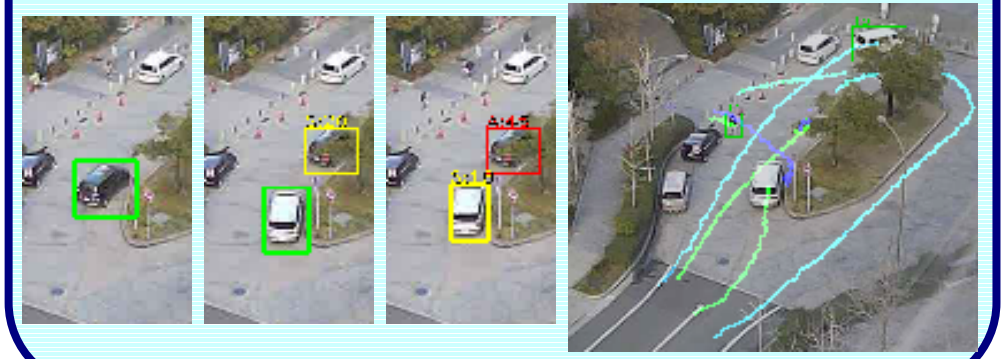
Track yard : lane space occupancy/congestion



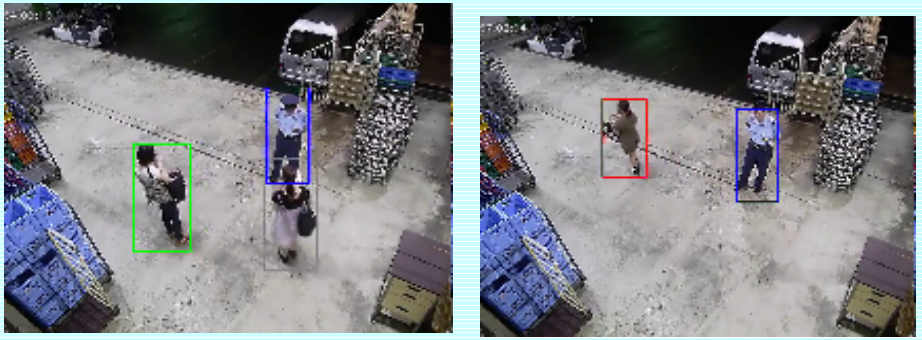


For security management

Alert : Car parking around restricted area



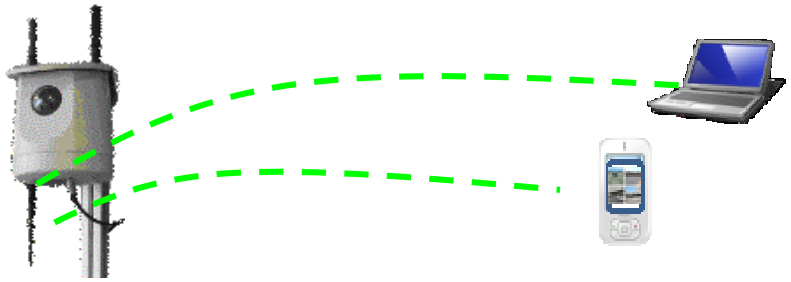
Check the compliance of security policy



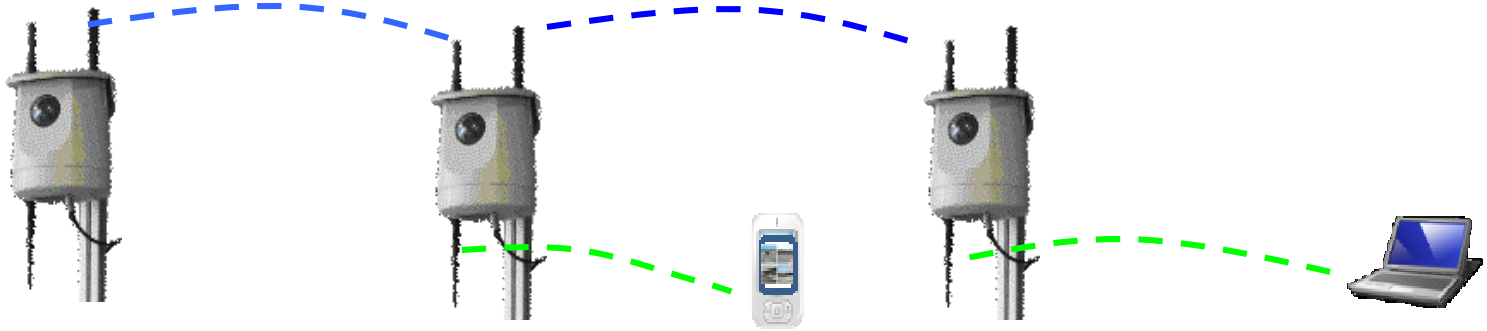
Wirelss mesh + Video data analysis (Computer Vision)

uROB Vision (*ubiquitous Robot Vision system*)

- Minimum set （***uROB Vision*** 1 unit、smart phone）



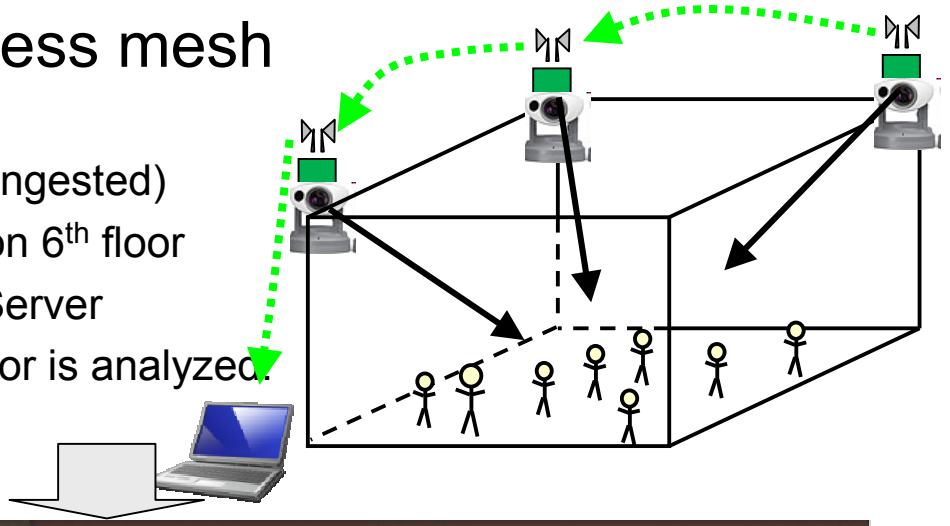
- Standard set（ ***uROB Vision*** 3 units、smart phone）



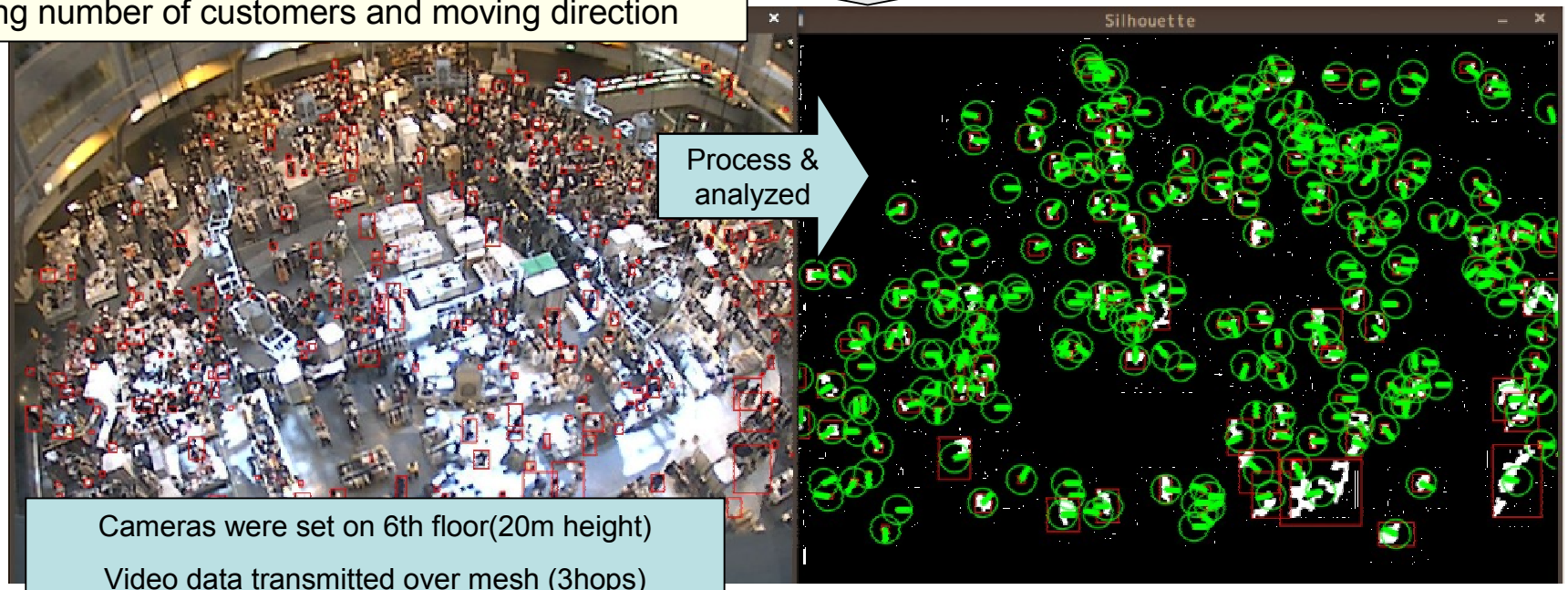
Commercial Building : Vision monitoring

- Computer Vision(CV) over Wireless mesh

  - Commercial events held on ground floor (congested)
  - 3 portable “wireless mesh IP cameras” set on 6th floor
  - Video data sent over wireless mesh to CV Server
  - Image data is processed and people behavior is analyzed.



Counting number of customers and moving direction

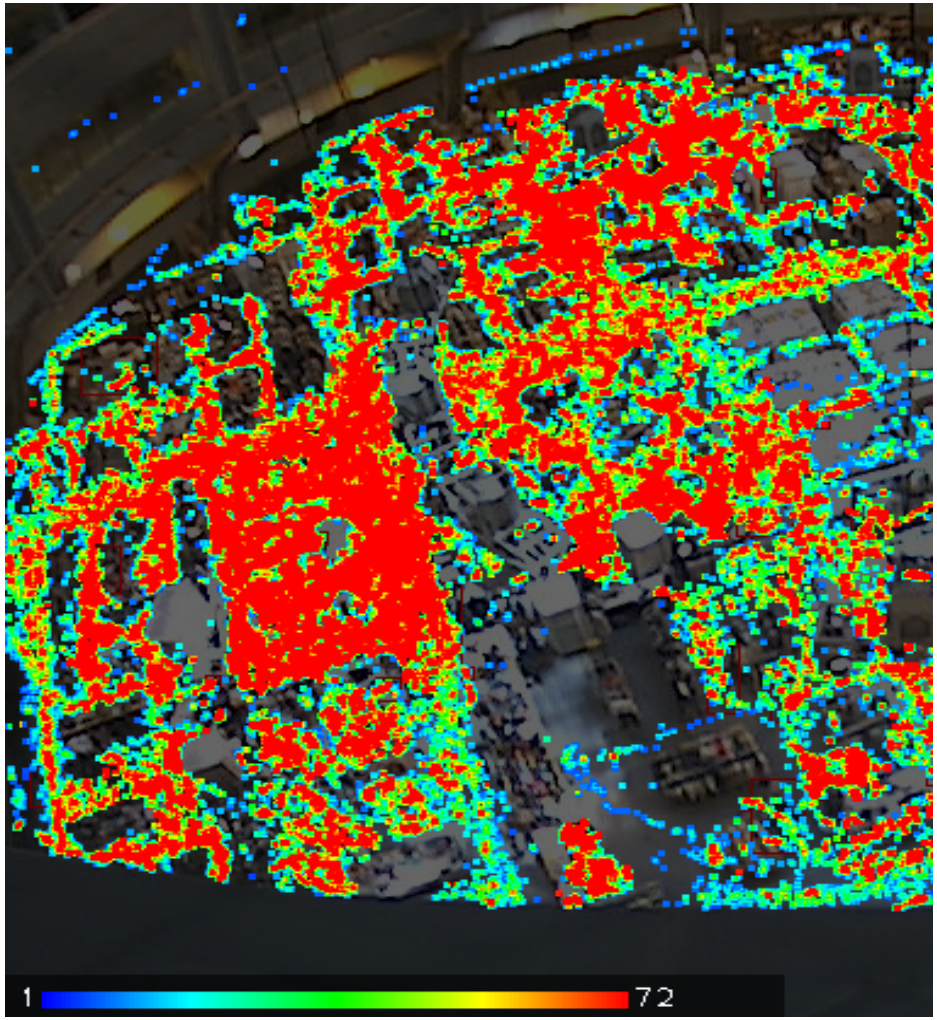


Cameras were set on 6th floor(20m height)

Video data transmitted over mesh (3hops)

Commercial Building : Vision monitoring

Length of customer's staying (stay or move ?) / Congested booth and inactive booth



- Color map
  - Red: shows staying trend
  - Blue: show moving trend
- Useful for evaluating
  - Get customers' attention
  - Get congested
  - Effect of an Attraction

Demonstration