Development of Intelligent Sensor Node for Rescue Information Infrastructure

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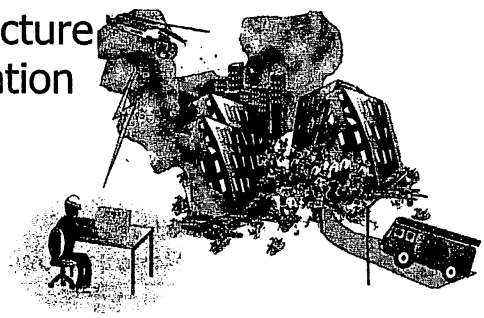
International Rescue System Institute

Motivations

When disasters happen,

- The situation of the disaster should be recognized as soon as possible to determine the strategy for rescue
- Rescue corps, robots, and citizens need to acquire and share information on the damage, evacuation, whether the family are alive or not, where they are, etc. by any means
- The information infrastructure (networks, mobile phones, etc.) may be destructed in a disaster situation

Development of information infrastructure which can be utilized in disaster situation



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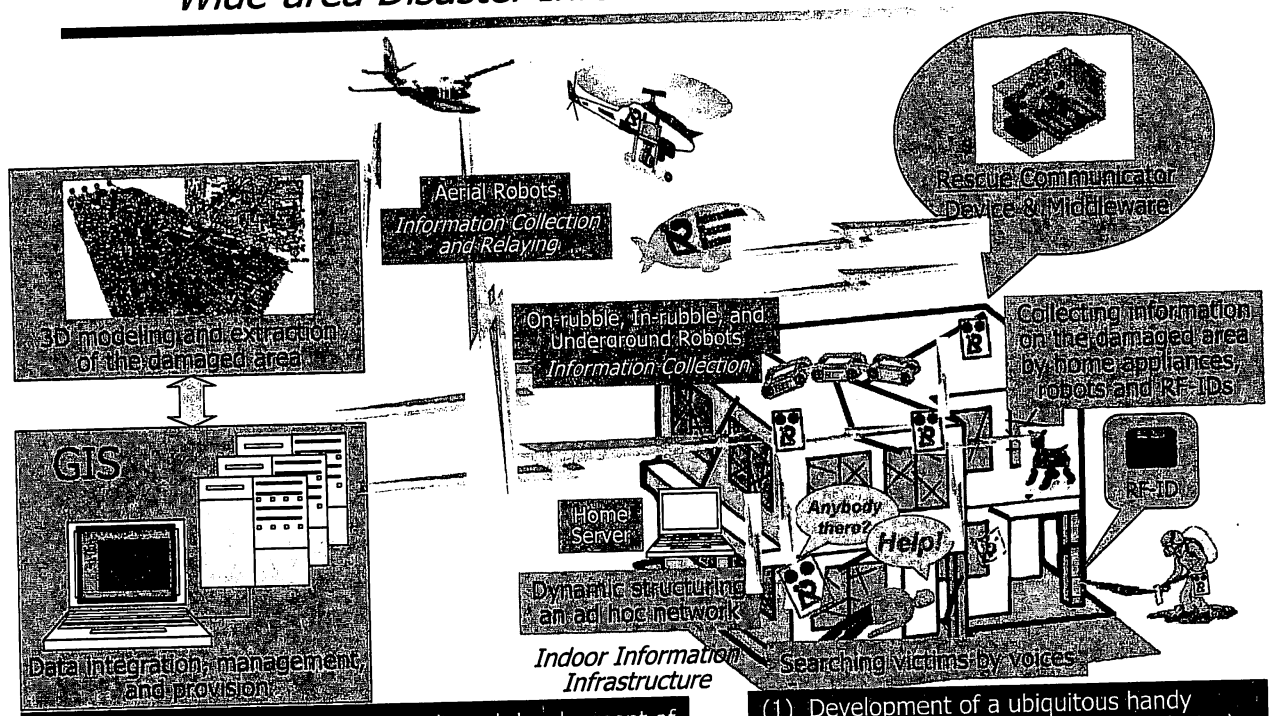
Mission Unit for Social Infrastructure for Collecting Wide-area Disaster Information



(2) Design of communication protocols and development of a technology to integrate the collected information on the GIS system

(1) Development of a ubiquitous handy terminal device (*rescue communicator*) and a technology for structuring an ad hoc wireless communication network

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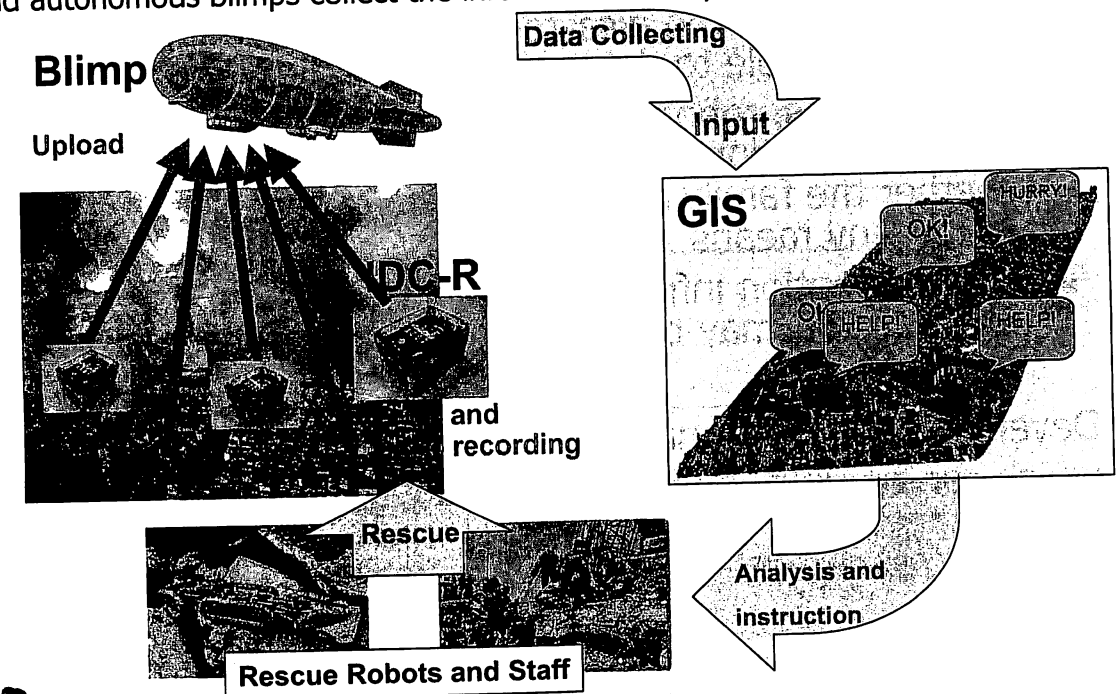
Development of Victims Search System using Intelligent Data Carriers for Rescue

(RIKEN/ Univ. of Tokyo)

Intelligent Data Carriers (IDCs) collect victims' information, i. e. voices, and autonomous blimps collect the information widely using wireless communication.



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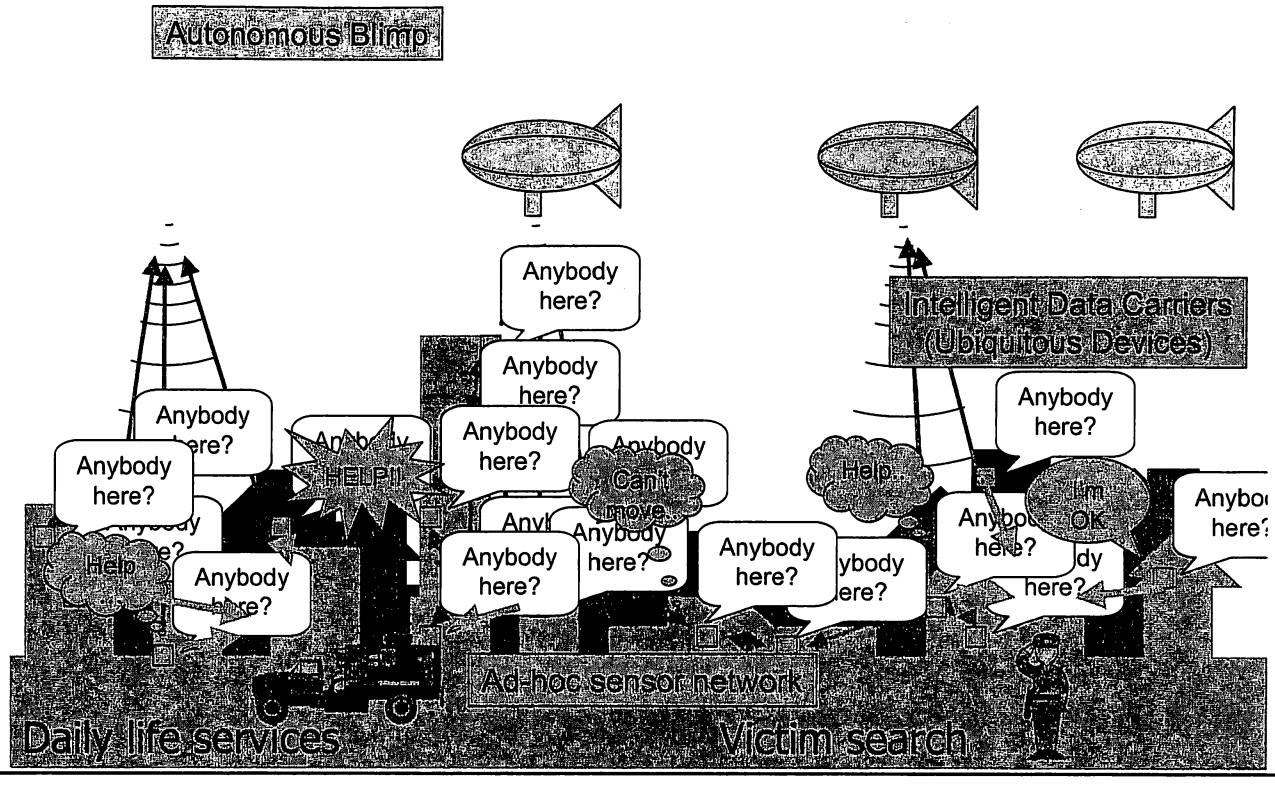
Global Victims Search using Intelligent Data Carriers and Autonomous Blimp

(RIKEN/The Univ. of Tokyo)

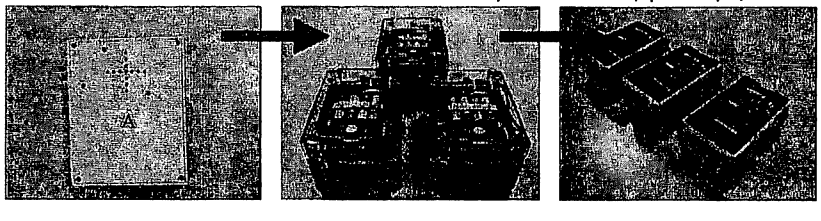


Intelligent Data Carriers for Rescue (IDC-R)

Rescue Communicator

Improvement in com. functionality

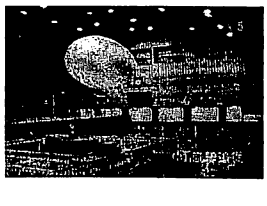
Improvement in size, power, I/F

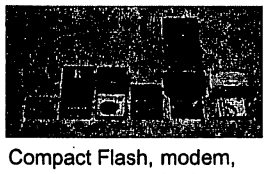


1st model (2002)
(for testing basic function)
RF communication
Voice playback and recording
Data transmission

2nd model (2003)
(for fast & distant com.)
Extension of Wireless comm.
(2800times speed , 133times distance)
Anti-shock, dust-proof

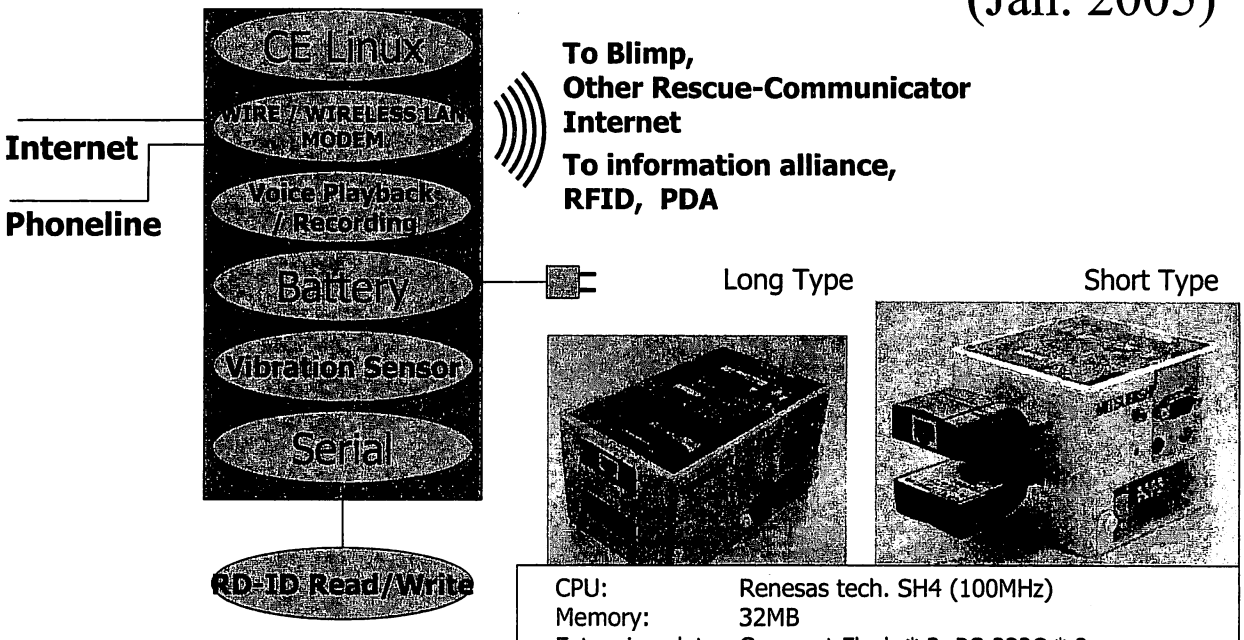
3rd model (2004)
(for common platform for research)
Downsized, long buttery life
(1/3 size, 9 times longer)
Extension of communication I/O
(LAN, waveLAN, modem)
(Ad-hoc network)
Detection of earthquake, power failure, water leak, etc.





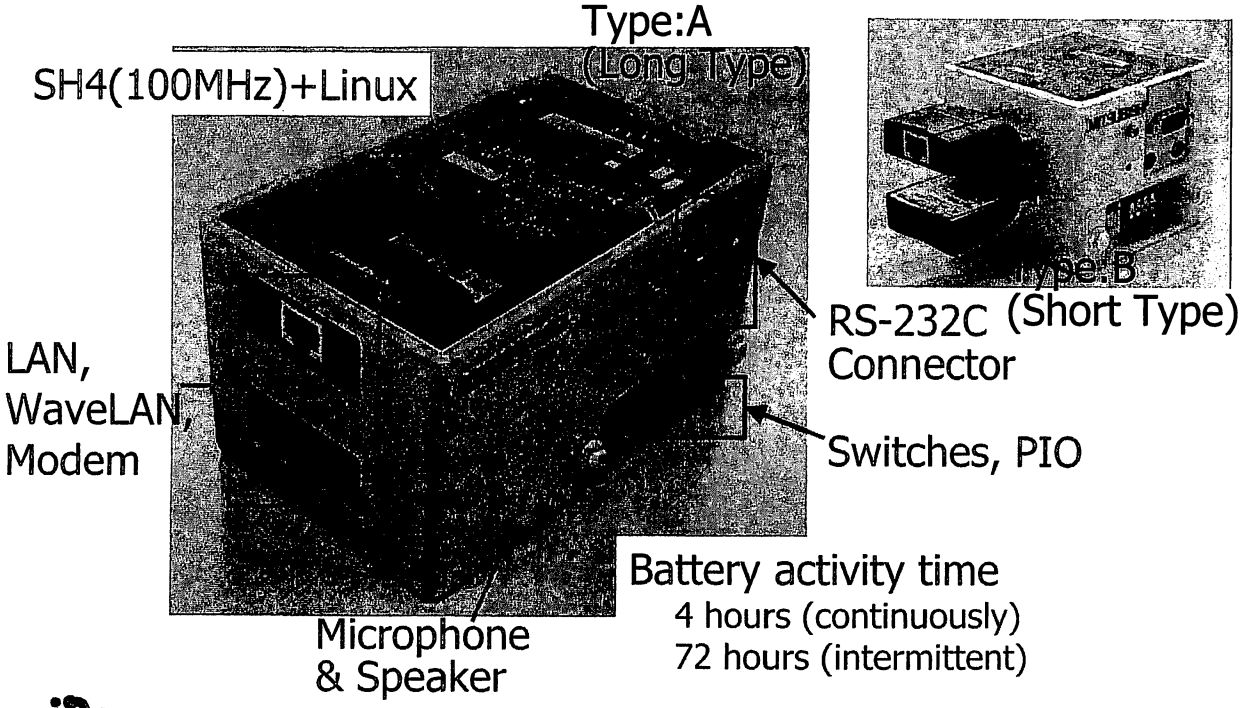
Compact Flash, modem, LAN,waveLAN, GPS

Intelligent Sensor Node: *Rescue Communicator* (Jan. 2005)



CPU:	Renesas tech. SH4 (100MHz)
Memory:	32MB
Extension slot :	Compact Flash * 3, RS-232C * 2
Communication:	Wired/ Wireless LAN, InfraRed, Modem etc.
Other Interface:	Speaker / Microphone / Parallel, etc.
Size:	87.5x142.5x79.0(long)87.5x92.0x79.0(short)
Acting time:	4hours(continuous) 72hours(intermittent)

Rescue Communicator



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Rescue Communicator

CPU	SH4(SH7751R) 100MHz, System Bus : 25MHz
OS	CE_Linux1.0 (Linux2.4.20)
RAM	SDRAM 32MB
ROM	FLASH ROM 8MB
Extension slot	Compact Flash * 3 (LAN, WaveLAN, Modem). Available for mass storage (Microdrive)
Voice function	Microphone , Speaker
Serial port	RS232C * 2
Power	DC9V, or Internal NiMH Battery.
Console Panel	Power / Shutdown / Wakeup / Reset switch, User custumizable switch / Power LED, User custumizable LED
Battery activity time	72 hours (intermittent) / 4 hours (continuous) AC power is available to use
Size	Type(A: Long Type) 87.5(D)×142.5(W)×79.0(H), 985cc Type(B: Short Type) 87.5(D)× 92.0(W)×79.0(H), 635cc

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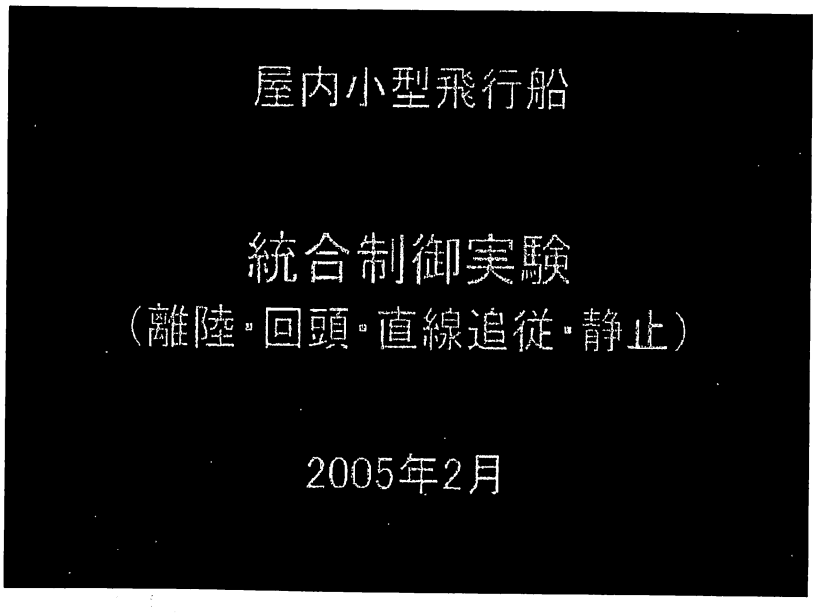
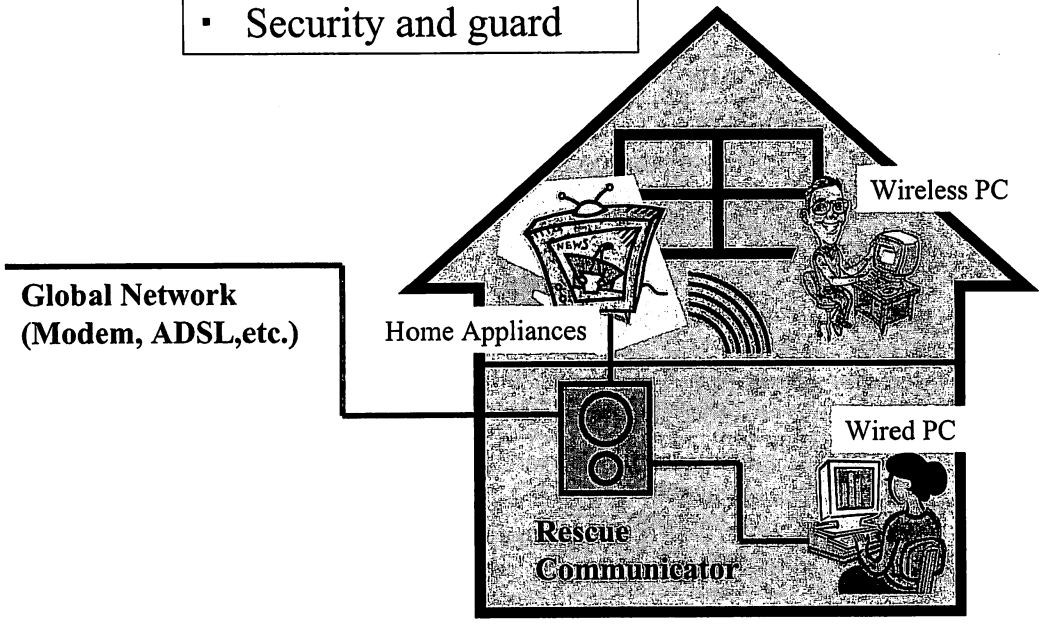
Autonomous Blimp Operation & Search

(Autonomous blimp and a rescue communicator)



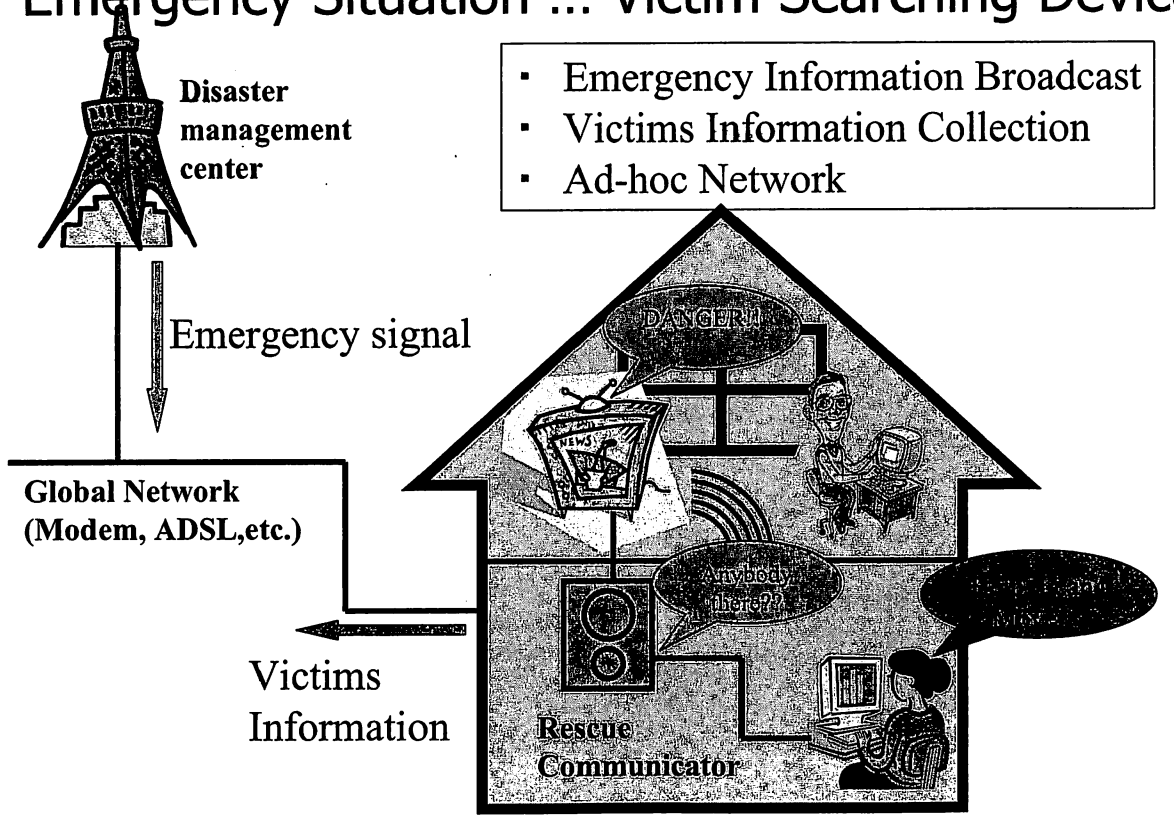
In Normal Situation ... Information Appliance

- Home Network Server
- Nursing old people
- Security and guard



Emergency Situation ... Victim Searching Device

- Emergency Information Broadcast
- Victims Information Collection
- Ad-hoc Network



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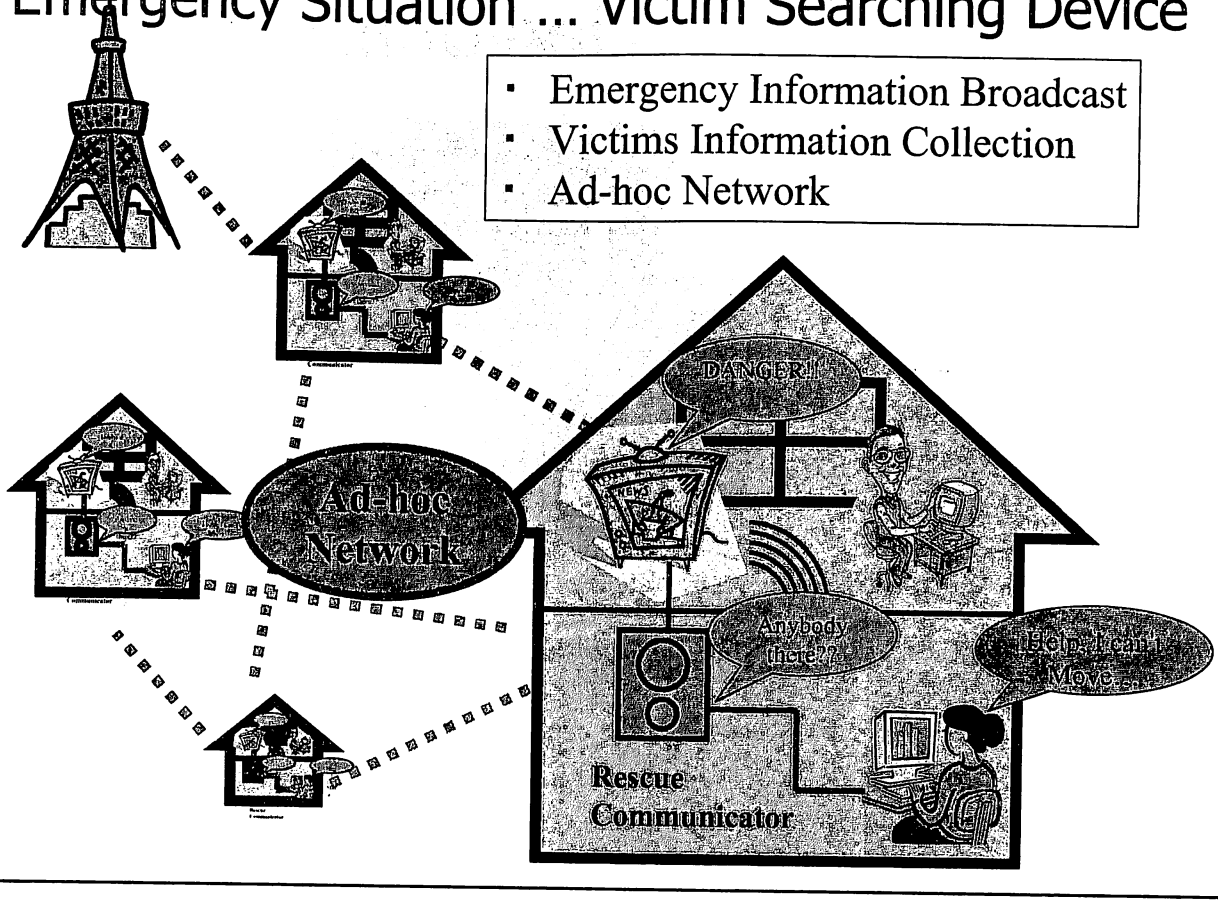
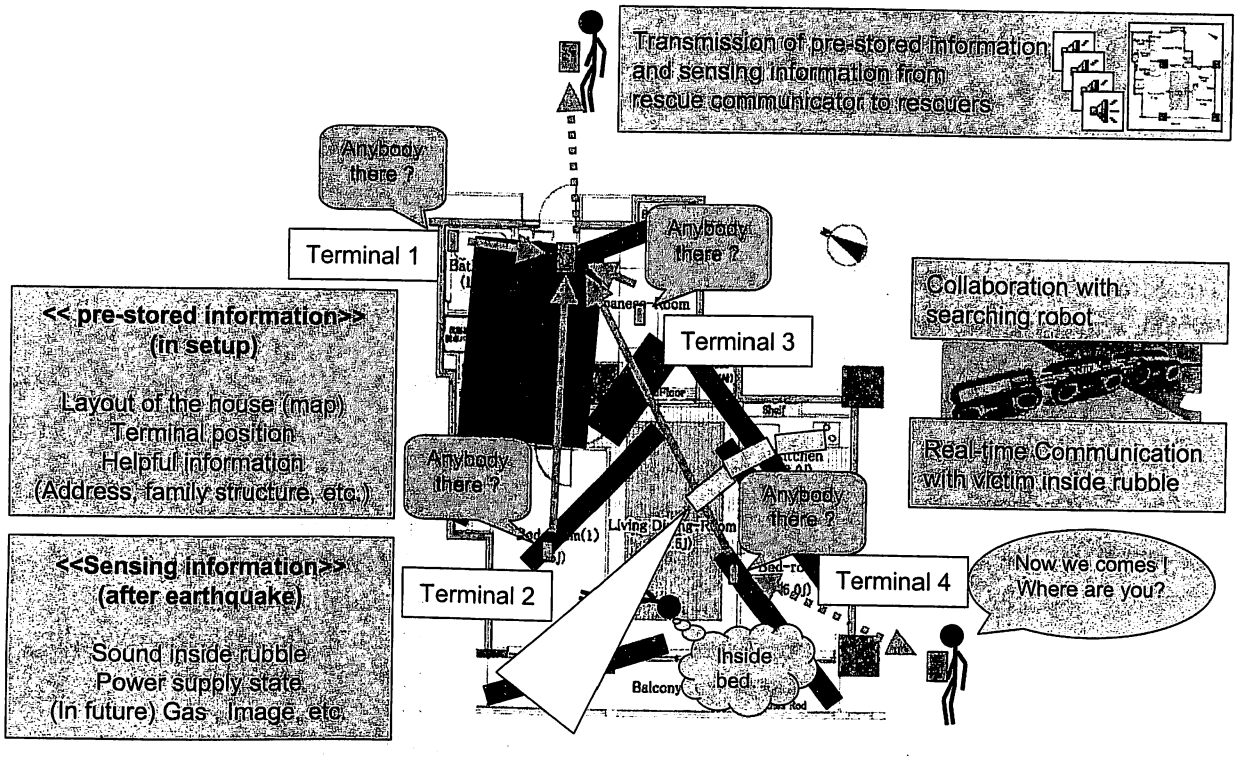
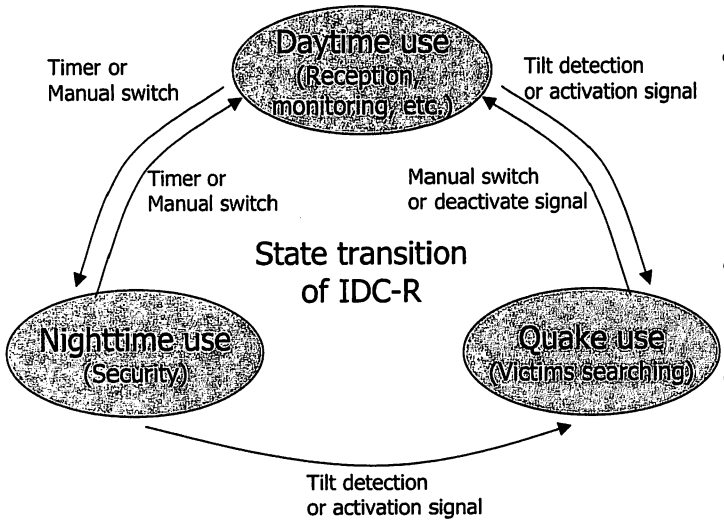


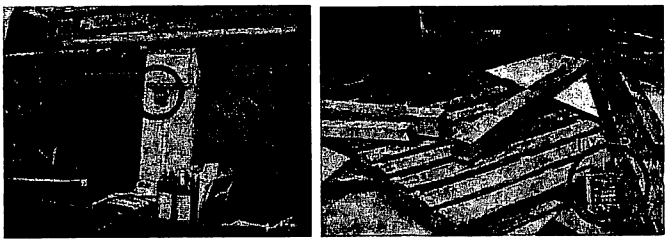
Concept of Local collaborative victim searching

(IDC-Rs, rescue robots, and rescuers)



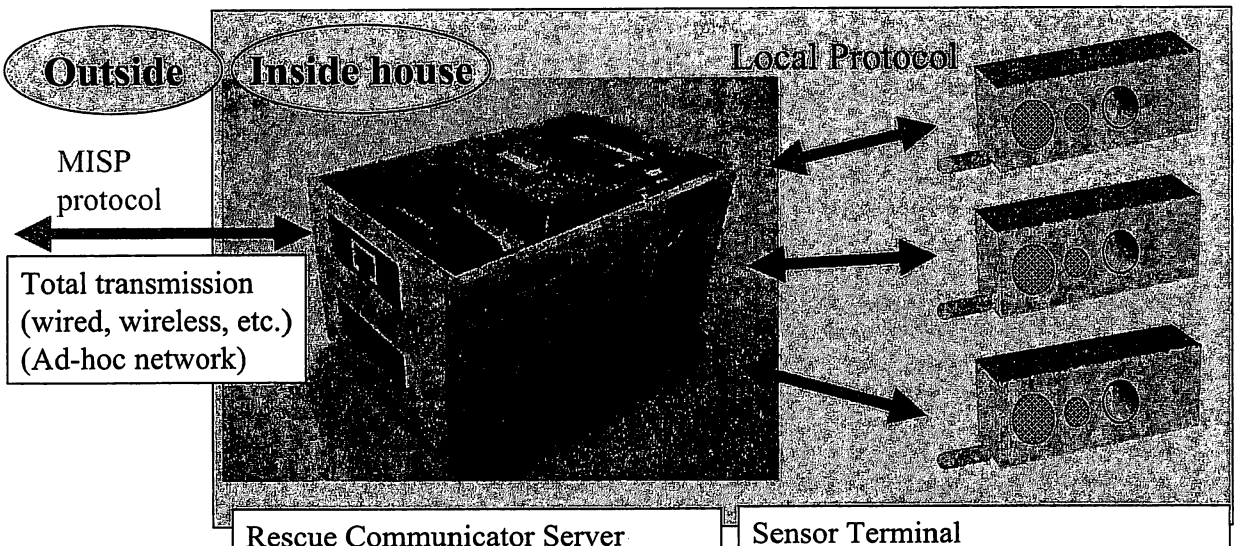
State transition of IDC-R





- In daily use (daytime)
  - Guest reception
  - Childcare watch
    - Using microphone and infrared sensors, etc.
  - Gus and electricity monitoring
- In daily use (nighttime)
  - Intruders detection
  - Make emergency call
- In quake use
  - Open network
  - Victims searching
    - Using microphone and infrared sensors, etc.
  - Victims information transfer
    - Using Ad-hoc network

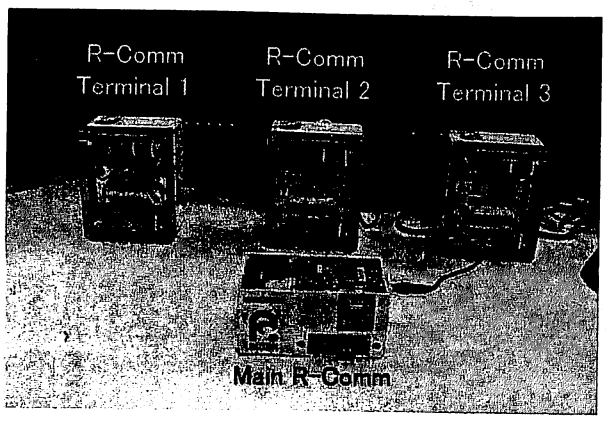
Home Rescue Network for Local Victim Search

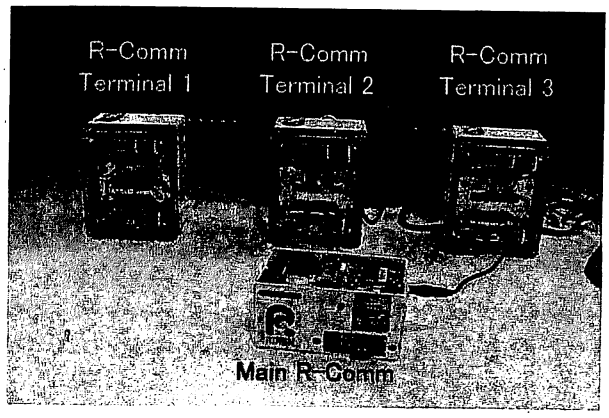


Rescue Communicator Server
(Storage and gateway)
- Detection of earthquake
- Activation of sensor terminals
- Information storage
- Gateway to outside

Sensor Terminal
(Terminal for each room)
- Reception of activation
- Sound playback and recording
- Sound transmission
- (Ad-hoc network)

Coordinated search between IDC-Rs in home network





Main IDC-R server (rescue communicator)
- Earthquake (tilt) detection
- Transmission activation signal to 3 terminals
- Transmission voice data to rescuers or blimp.

Terminal IDC-Rs
- Voice playback and recording
- transmission voice data to server

Main IDC-R server (rescue communicator)
- Power-cut detection
- Transmission activation signal to 3 terminals
- Transmission voice data to rescuers or blimp.

Terminal IDC-Rs
- Voice playback and recording
- Transmission voice data to server

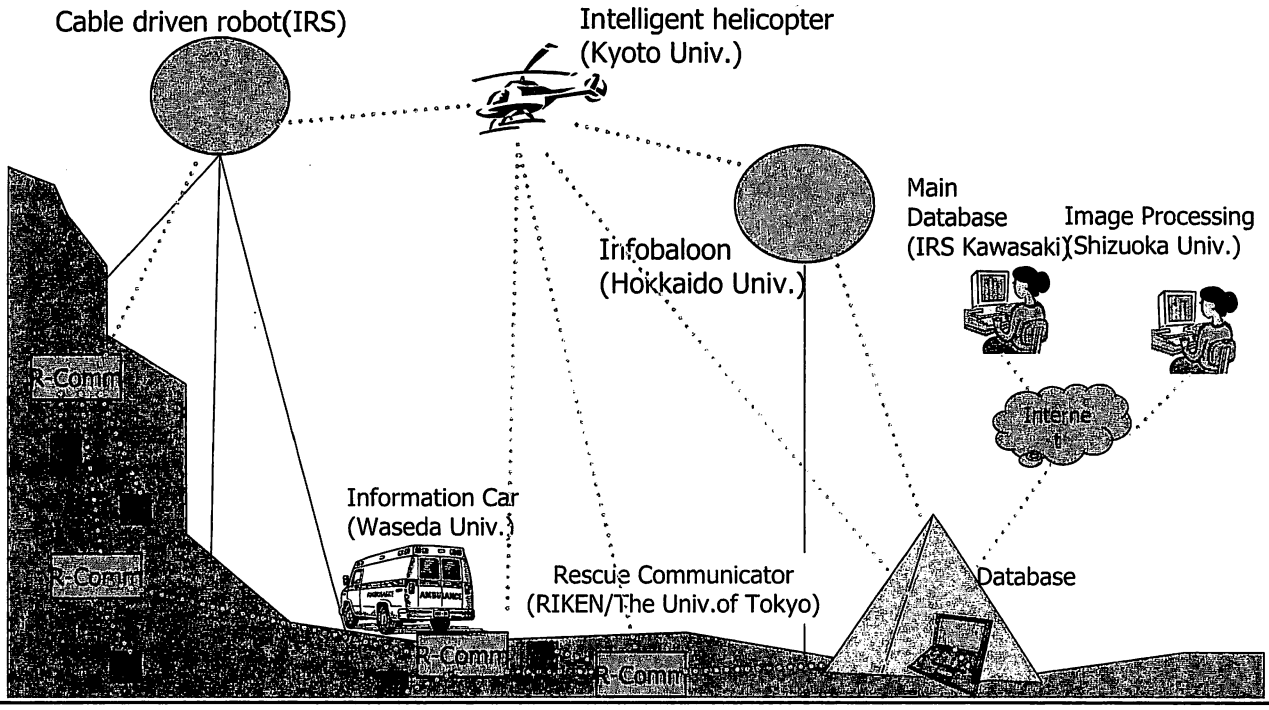
Global and Local Victims Search

– Global Victims Search
- to decide target rubble for rescue staff deployment.
- Wide area (km~), thousands of sensors.
- Mass deployment as social infrastructure is essential.

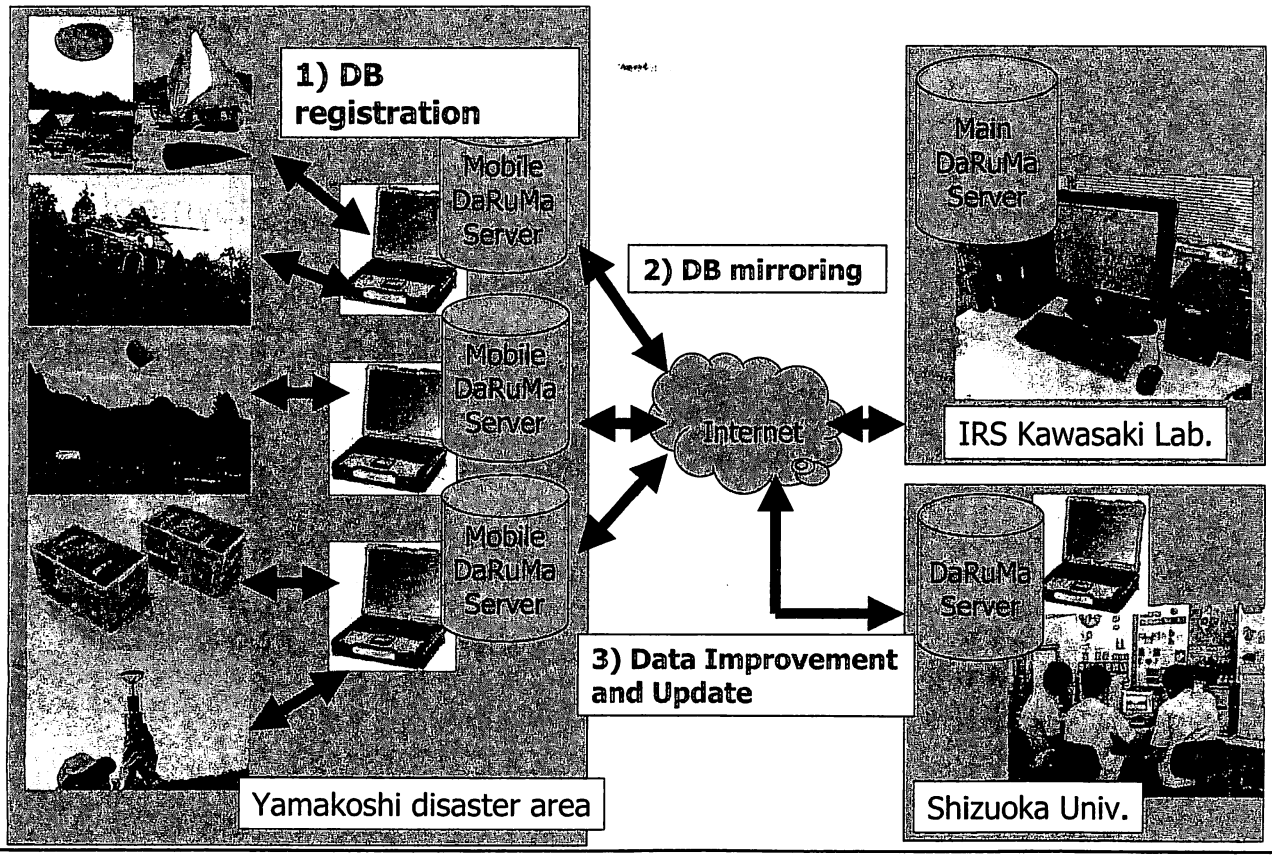
– Local Victim Search
- to survey of victims' location and plan to rescue.
- Narrow area (~100m), small number of sensors
- Cost reduction is essential.

– First global search, then local search
- using common Rescue-Communicator system

Experimental system for information collection in Yamakoshi area



Collaboration using Distributed Database



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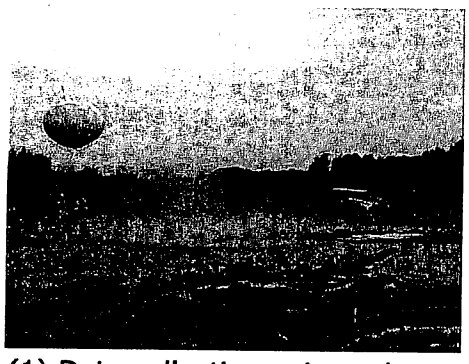
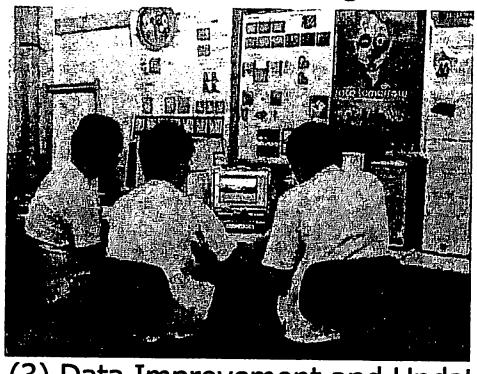
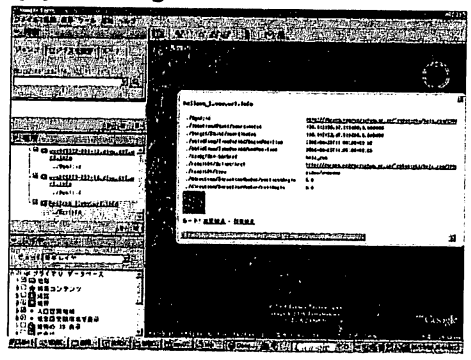


(1) Data collection using robots

(2) DB Registration via Internet



(3) Data Improvement and Update

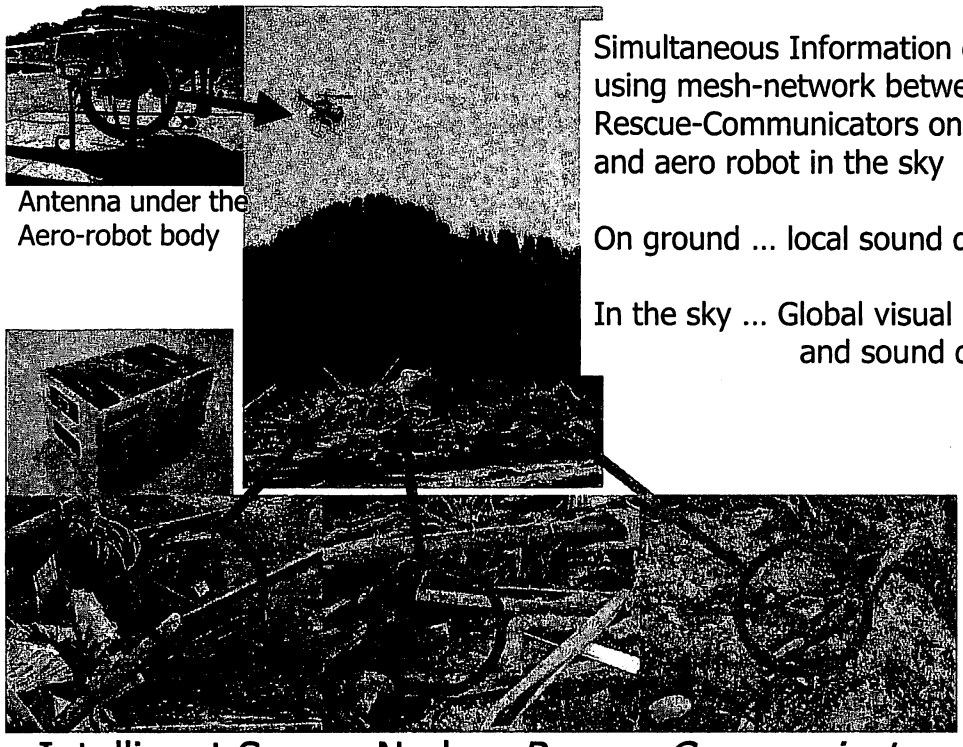


(4) Display in GIS(GoogleEarth)

Registered data to DaRuMa

- Intelligent Aero-Robot (Kyoto Univ.)
  - Camera movie, Position
- Cable-driven balloon (IRS)
  - Camera movie, position, wind speed
- InfoBaloon, Info-Tetra (Hokkaido Univ.)
  - Camera image
- Rescue-Communicator (RIKEN/the Univ. of Tokyo)
  - Sound information
- Omni-Directional camera (Shizuoka Univ.)
  - Omni-Directional movie
  - Improved movie by image processing

Information collection using mesh-network



Antenna under the Aero-robot body

Simultaneous Information collection using mesh-network between Rescue-Communicators on ground and aero robot in the sky

On ground ... local sound data inside rubble

In the sky ... Global visual information and sound data from R-Comms

Intelligent Sensor Nodes, *Rescue-Communicators* inside rubble

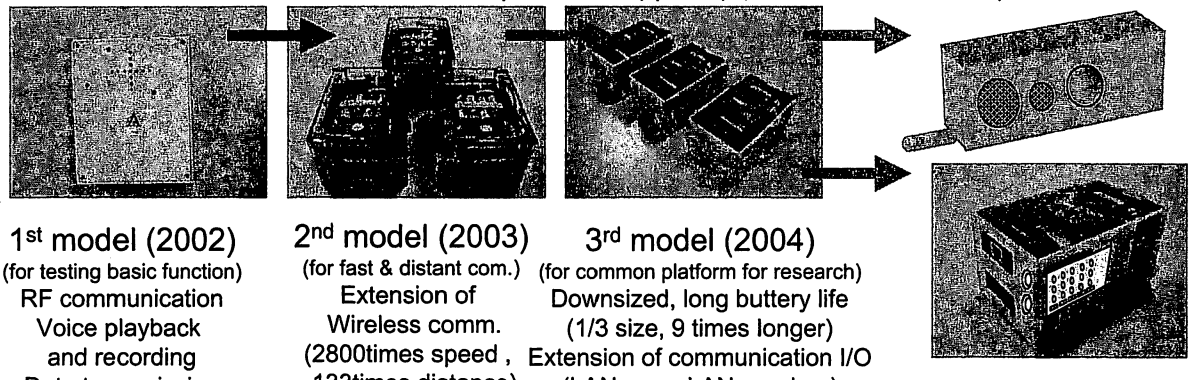
Intelligent Data Carriers for Rescue (IDC-R)

Rescue Communicator

Improvement in com. functionality

Improvement in size, power, I/F

Improvement for practical use



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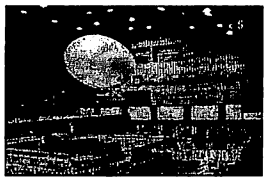
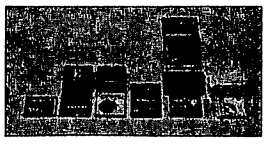




Compact Flash, modem, LAN,waveLAN, GPS

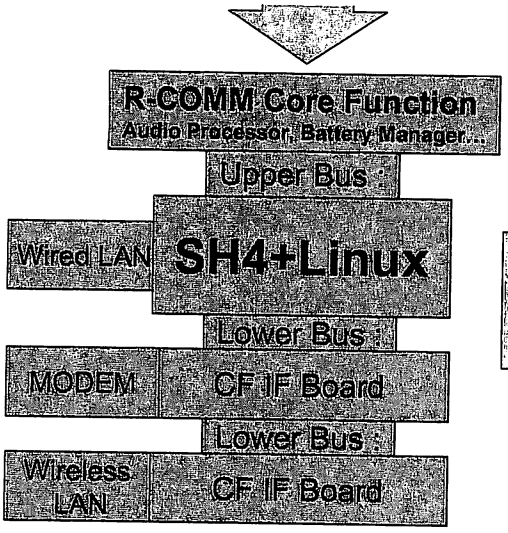
2005 models
(under development)

- Sensor terminal
  -Small and cheap
- Handy terminal
  -Video I/O
- Robot controller

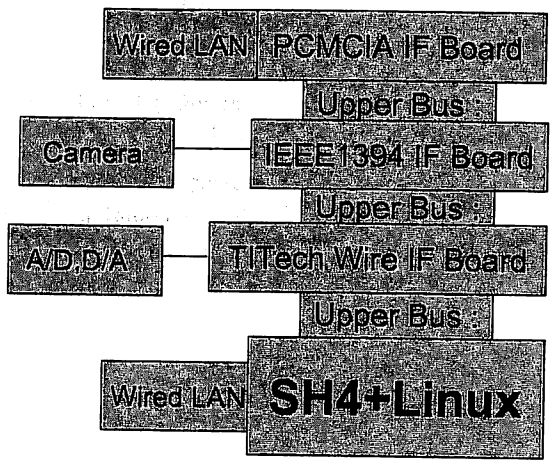
R-COMM setting for Robot control

•R-COMM has functions for
- ➢Communication sever/router in the normal situation
- ➢Intelligent Data carrier/Data logger in the disaster situation

These functions are implemented here



Most robots do not need "R-COMM core functions" but need signal interfaces.



R-COMM as Robot Controller

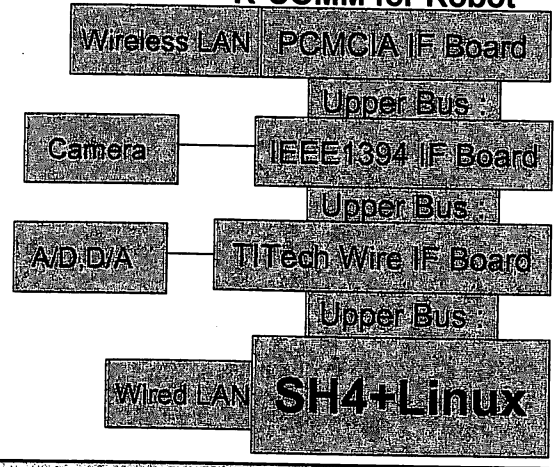
•R-COMM has functions
to acquire various information and communicate with GIS server by adding various interface board.

CARD BUS IF: giving high expandability to add various function; Wireless LAN(54Mbps)

IEEE 1394 IF: controlling image acquiring device such as camera.

TITech Wire IF: giving high expandability to add function to control the robots; ADC, DAC, Counter, Motor Drive…

R-COMM for Robot



Two ways of installation
- As a controller : R-COMM controls robots and communicates with the GIS server
- As a data logger: R-COMM hooked to sensor data lines sends the acquired information with the least change of the conventional control system

Expandable R-COMM

•R-COMM has functions
to acquire various information and communicate with GIS server
by adding various interface board.

CARD BUS IF: giving high expandability to add various function; USB, Wireless LAN(54Mbps)

IEEE 1394 IF: controlling image acquiring device such as camera.

USB IF: giving high expandability to add various function; camera, Wireless LAN

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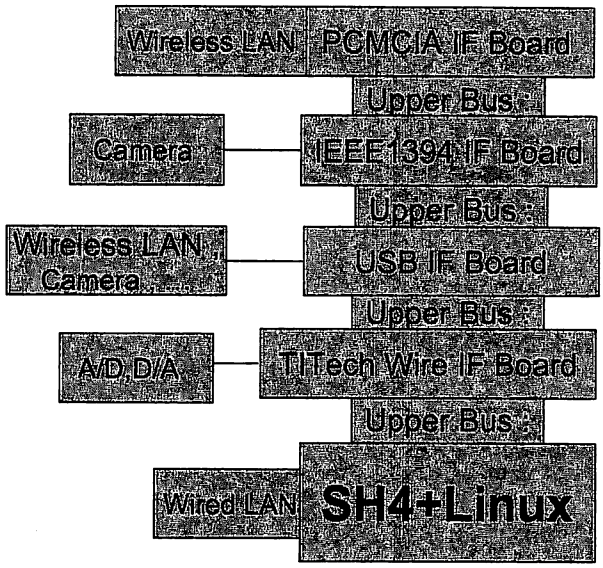

Expandable R-COMM

•R-COMM has functions
to acquire various information and communicate with GIS server
by adding various interface board.

R-COMM Application Board: giving the function for the rescue communicator; voice recording, audio communication …

IEEE 1394 IF: controlling image acquiring device such as camera.

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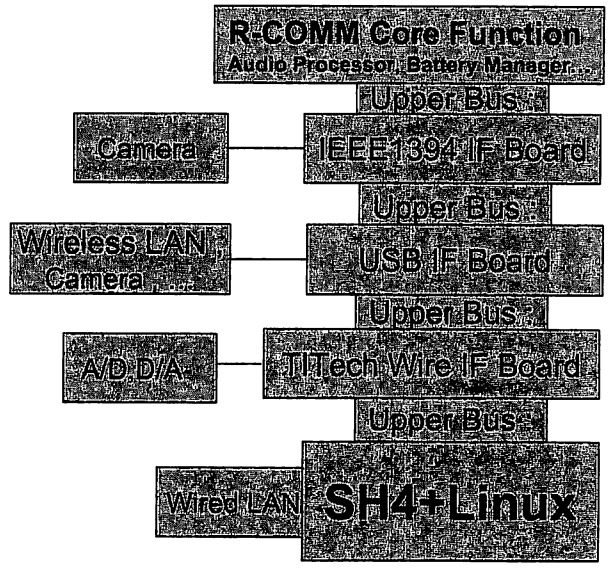
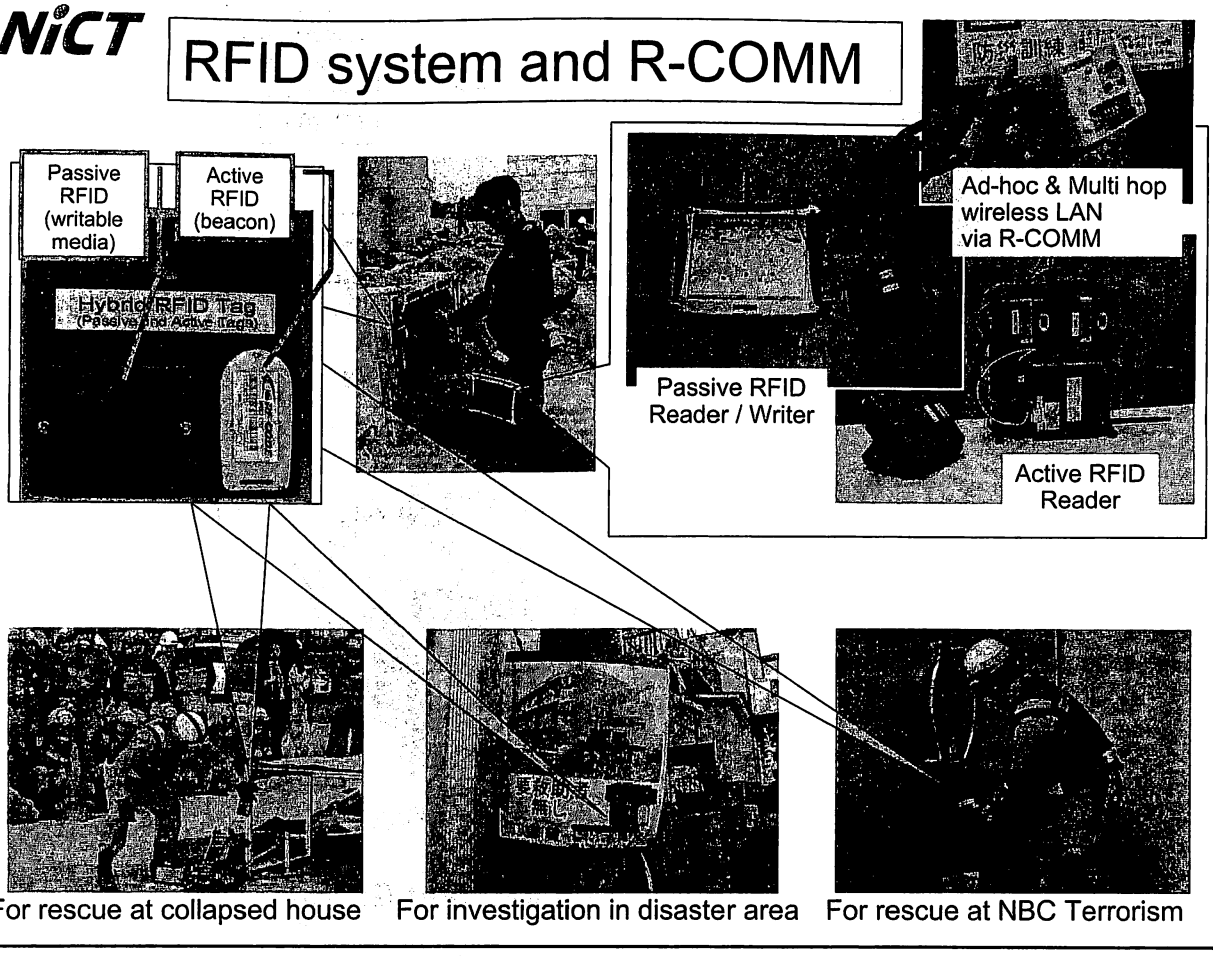


NiCT

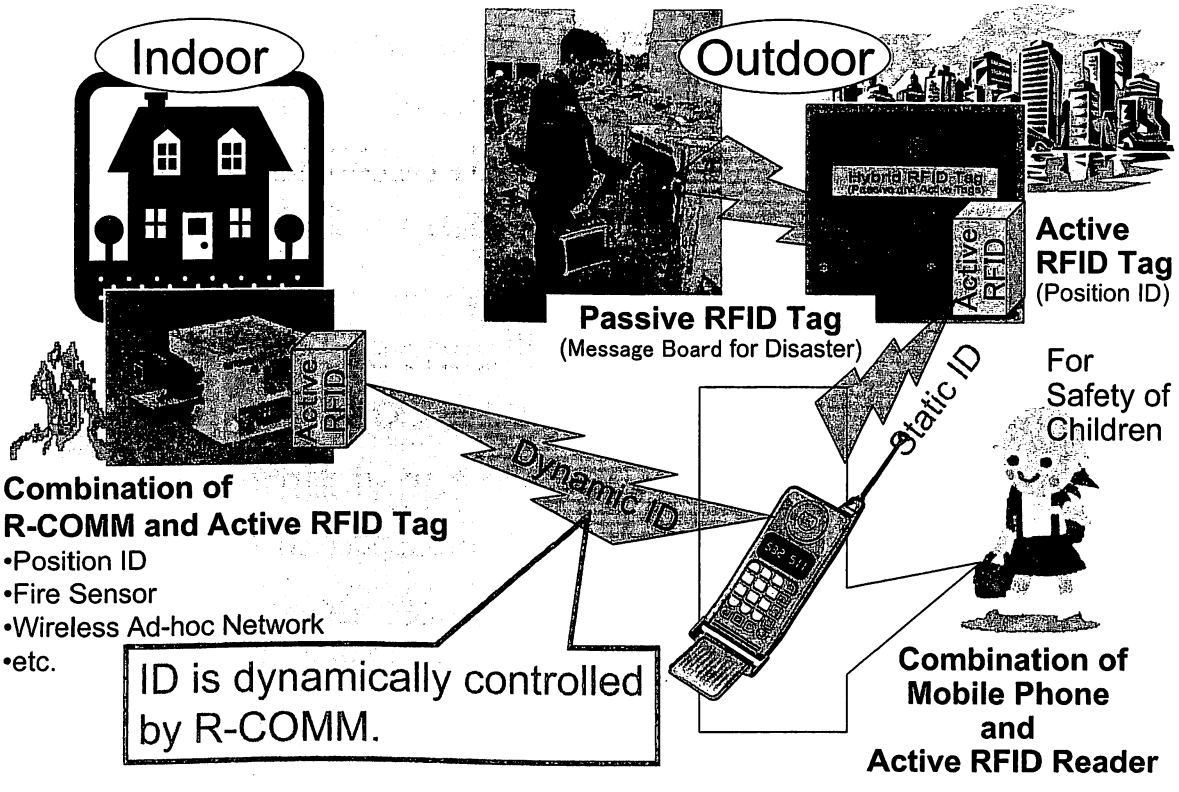
RFID system and R-COMM

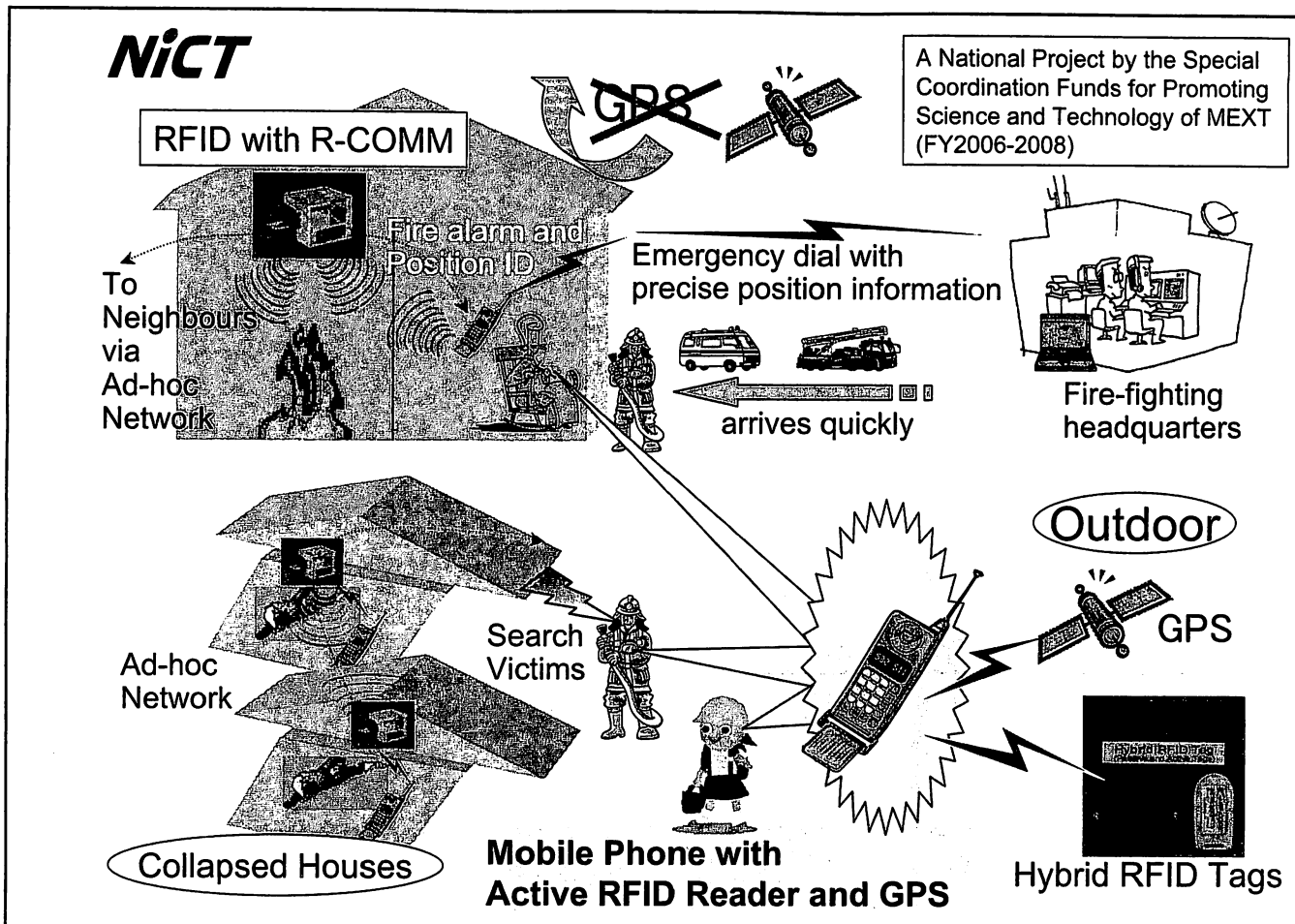


For rescue at collapsed house | For investigation in disaster area | For rescue at NBC Terrorism

NiCT

[Future Plan] RFID-based Positioning System for Enhancing Safety and Sense of Security





Summary

- Introduction of research activities in mission unit for rescue information infrastructure in DDT project
- Development of intelligent sensor node: rescue communicator (R-Comm)
- Application of R-Comm for victim search and disaster information collection and integration
- Experiment at real disaster area

文部科学省大都市大震災軽減化特別プロジェクト

被害者救助等の災害対応戦略の最適化

レスキューロボット等次世代防災基盤技術の開発

第五回国際シンポジウム論文集

平成18年11月24日

神戸国際会議場

主催：特定非営利活動法人国際レスキューシステム研究機構

協賛：計測自動制御学会SI部門, IEEE RAS Japan Chapter,

日本機械学会ロボティクスメカトロニクス部門

後援：独立行政法人防災科学技術研究所, 兵庫県, 神戸市

International Rescue System

特定非営利活動法人

国際レスキューシステム研究機構