NerveNet:
A Self-distributed Wireless Mesh Access Network Platform with In-network Contents Caching, Processing and Forwarding

National Institute of Information and Communications Technology

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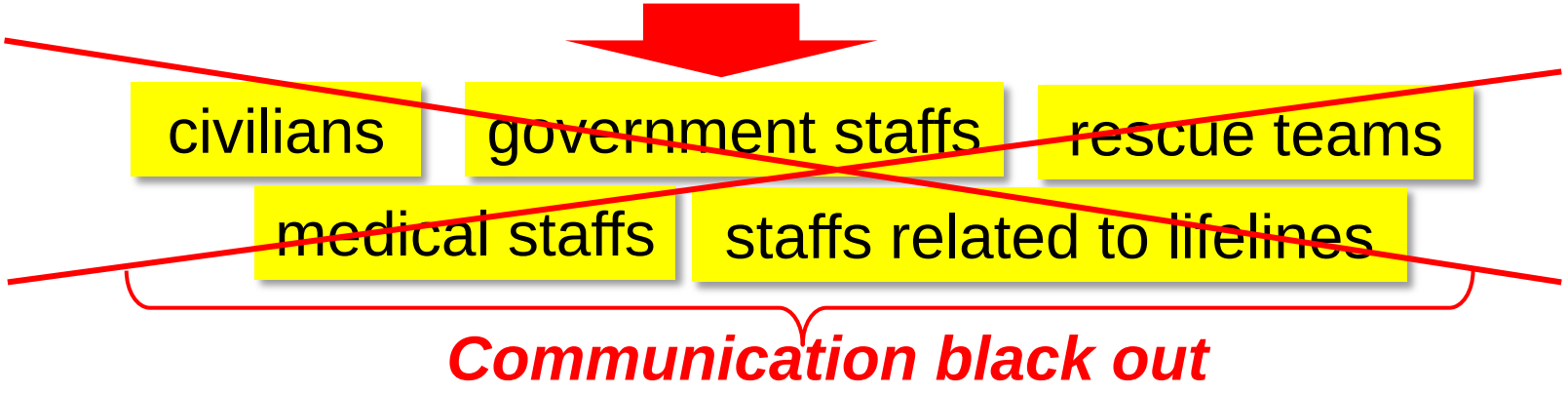
Background
- The Great East Japan Earthquake -

Giant quake **Giant tsunami** **Nuclear accident**

- Cellular base stations: max. 14,000 BSs 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.

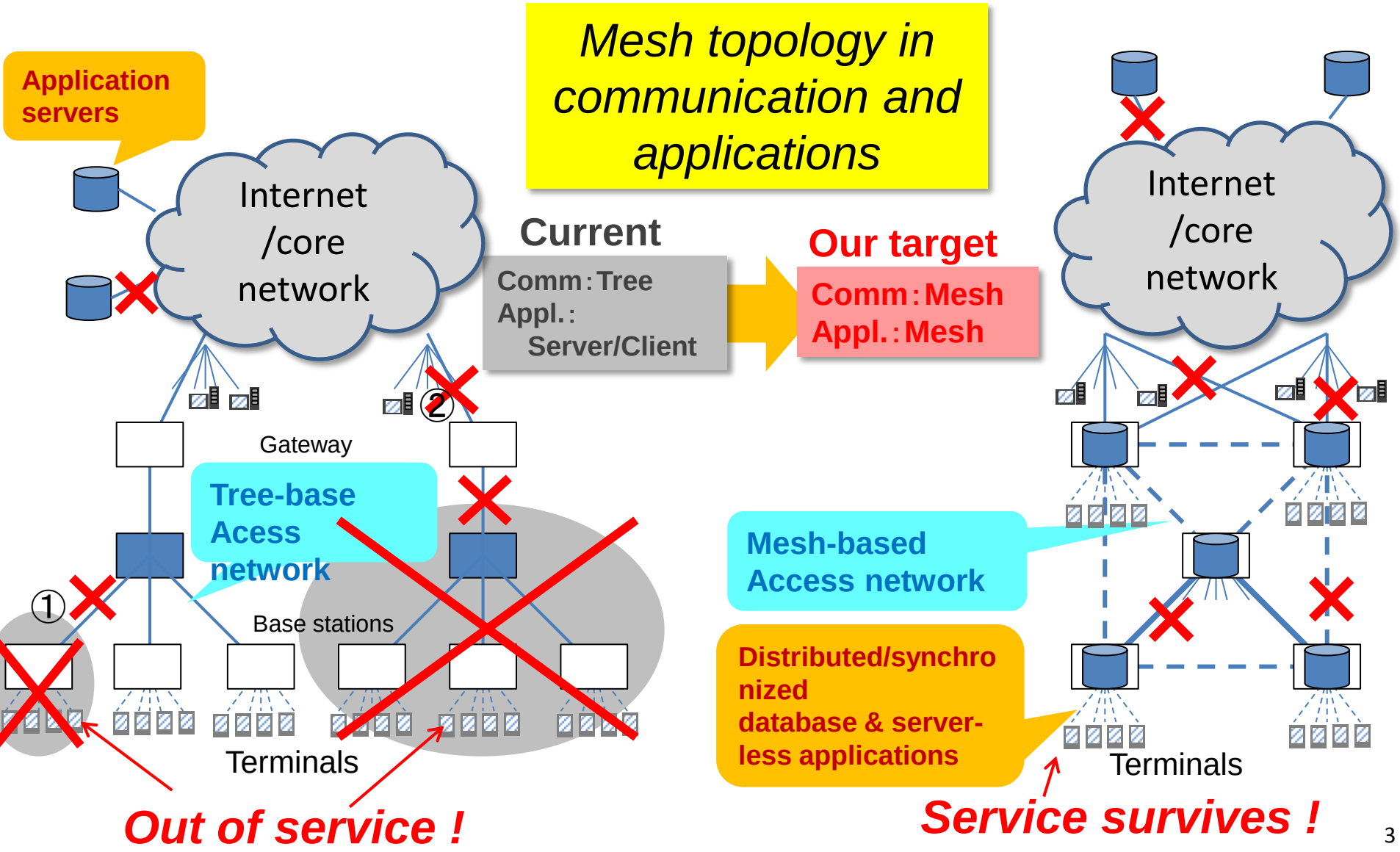


First response for post disaster activities : significantly delayed

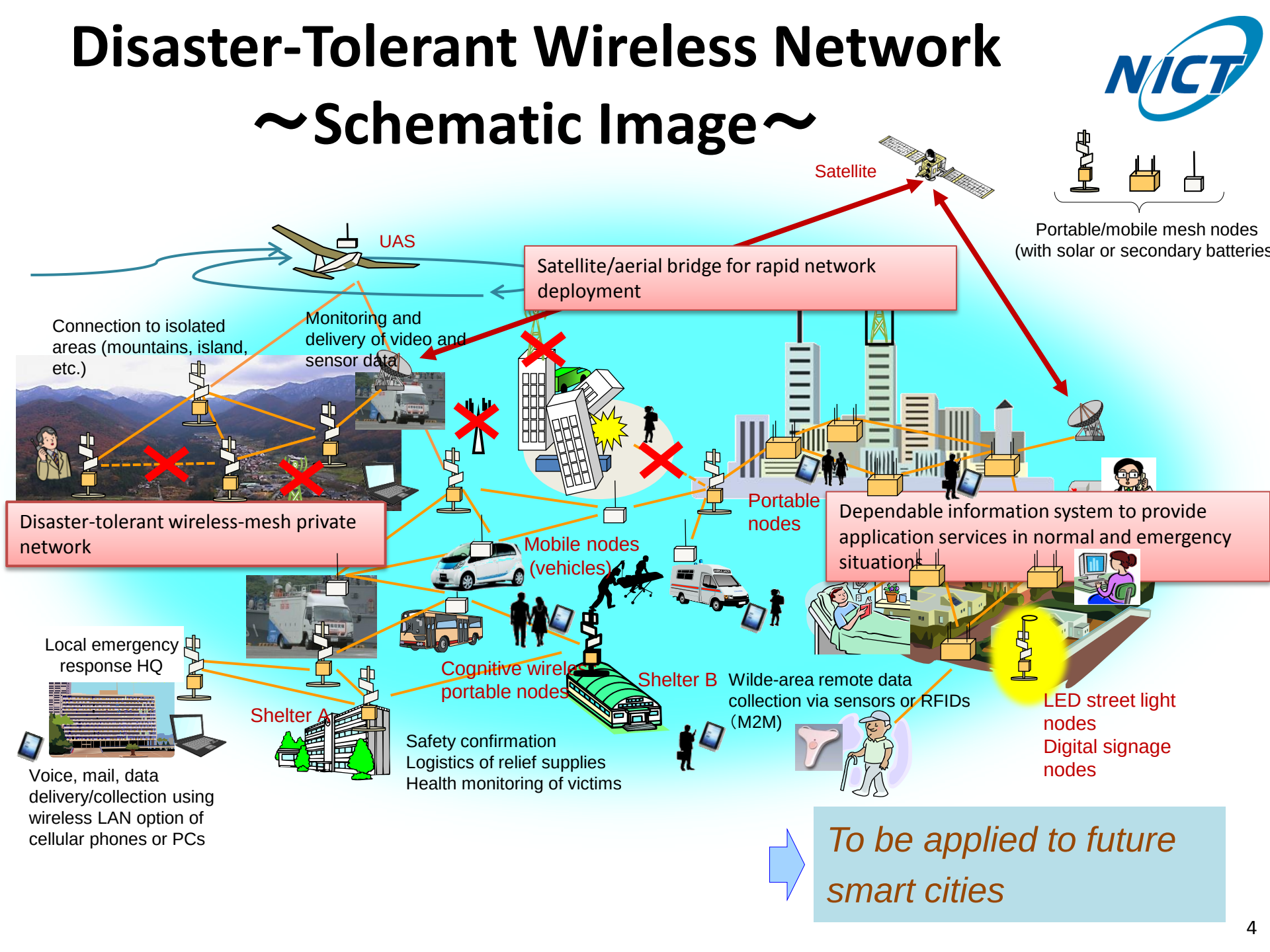
Too much trust should not be placed on cellular networks in emergency.
Then, what should we do ?

Disaster-Tolerant Wireless Network

～Based on decentralized M2M mesh architecture～



Disaster-Tolerant Wireless Network ～Schematic Image～

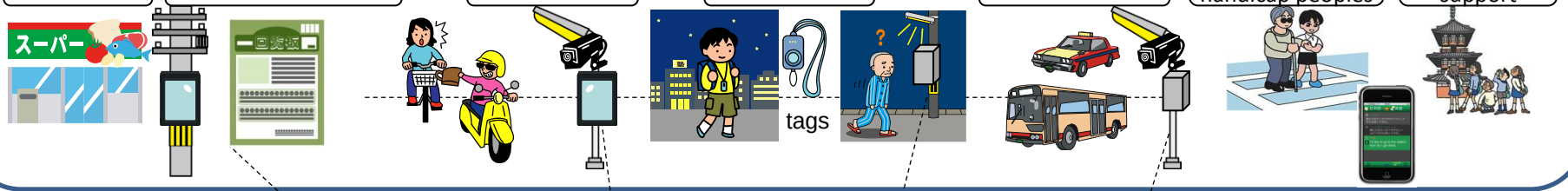


Safe and dependable society
Based on disaster tolerant wireless mesh networks

Common ICT Platform： Regional Wireless Mesh Network including server

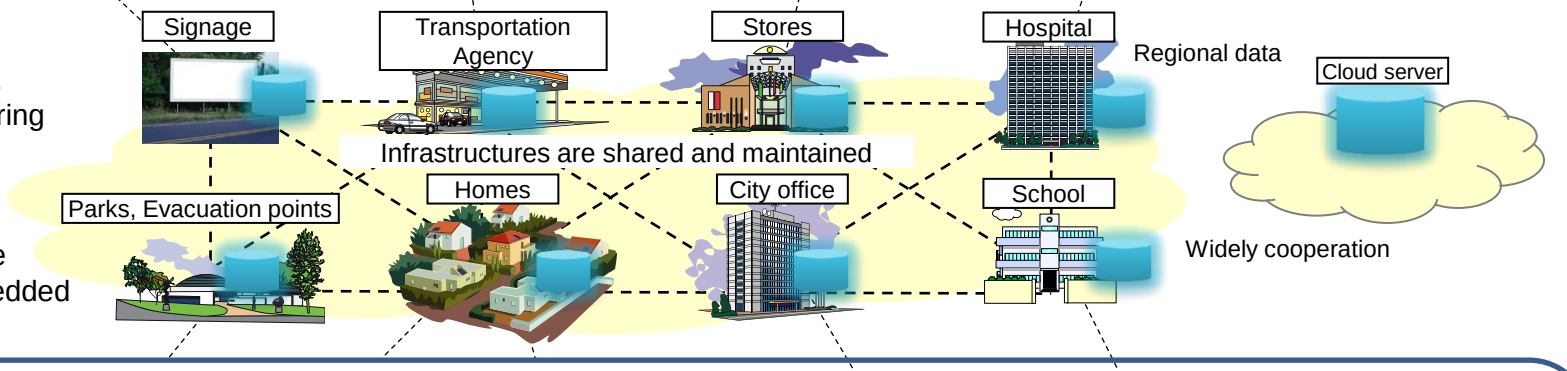
Ordinary applications：

Sales Ads. | Public Announcement | Public safety | Security service | Traffic monitoring | Support of handicap peoples | Travel guide support



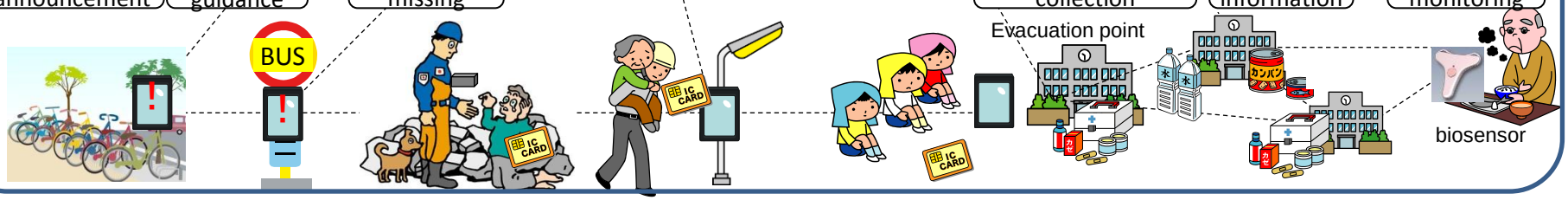
Mesh node functions
- Communication
- Information storing, processing and sharing
- sensors
- signage

Mesh node shapes
- Transportable node
- Infrastructure embedded



Disaster or emergency applications：

Disaster announcement | Evacuation guidance | Search for missing | Location registration | Safety confirmation | Disaster information collection | Relief supply information | Biosensor monitoring

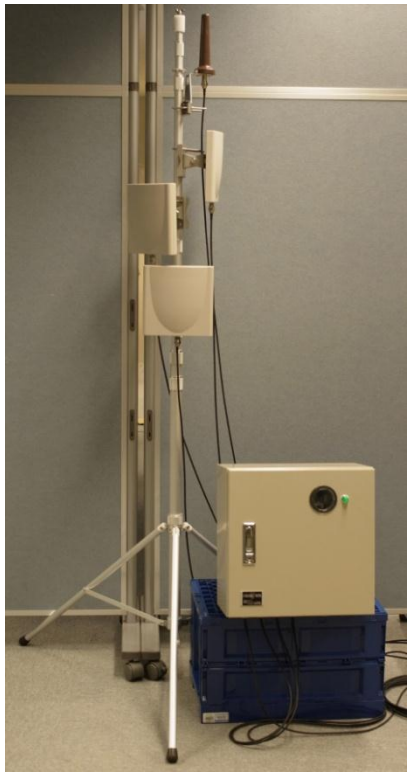


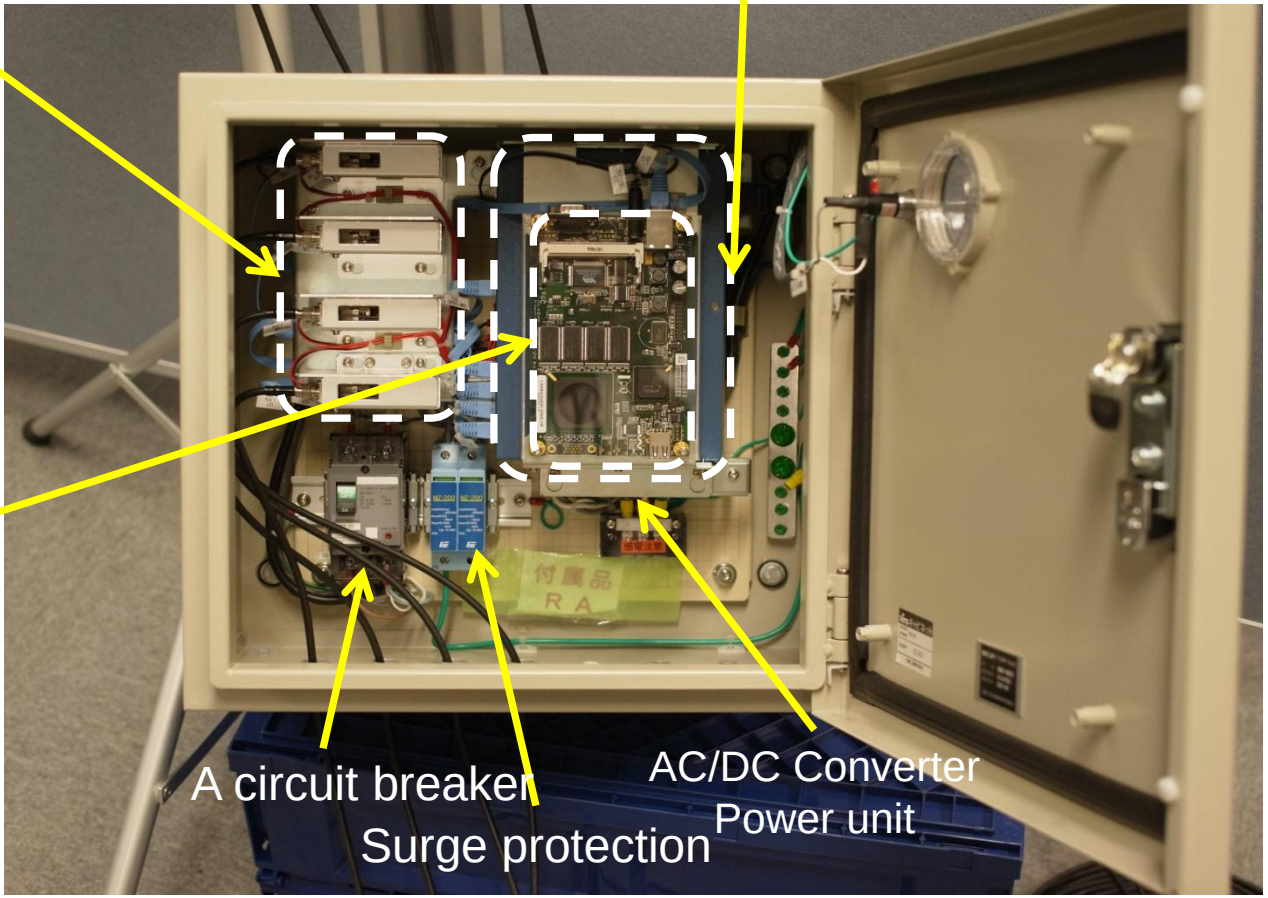
April 10, 2012, MIC, An informal gathering for discussion of local amenity creation and global expansion utilizing ICT, http://www.soumu.go.jp/main_content/000155044.pdf

NerveNet Base Station Prototype

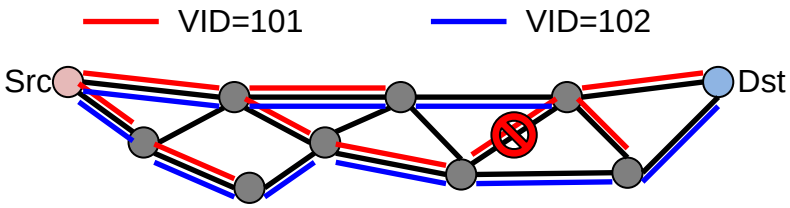
Wireless LAN I/F（JRC CMN-727B）
IEEE802.11a/b/g
x4 (1 for WiFi service, 3 for BS interconnection)

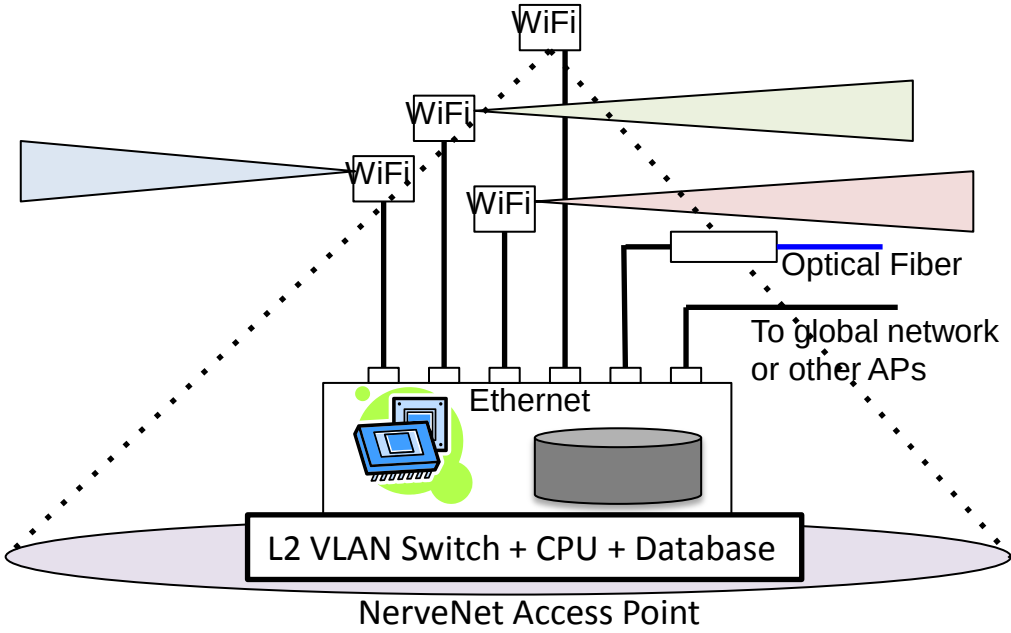
L2 VLAN Switch
Hirakawa Hewtech HS-508MA



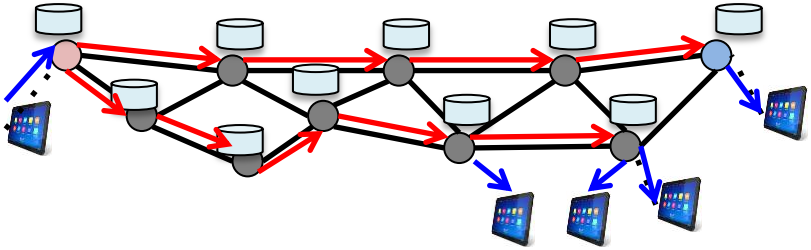


Mesh topology Wired/Wireless Hybrid Access Network :“NerveNet”



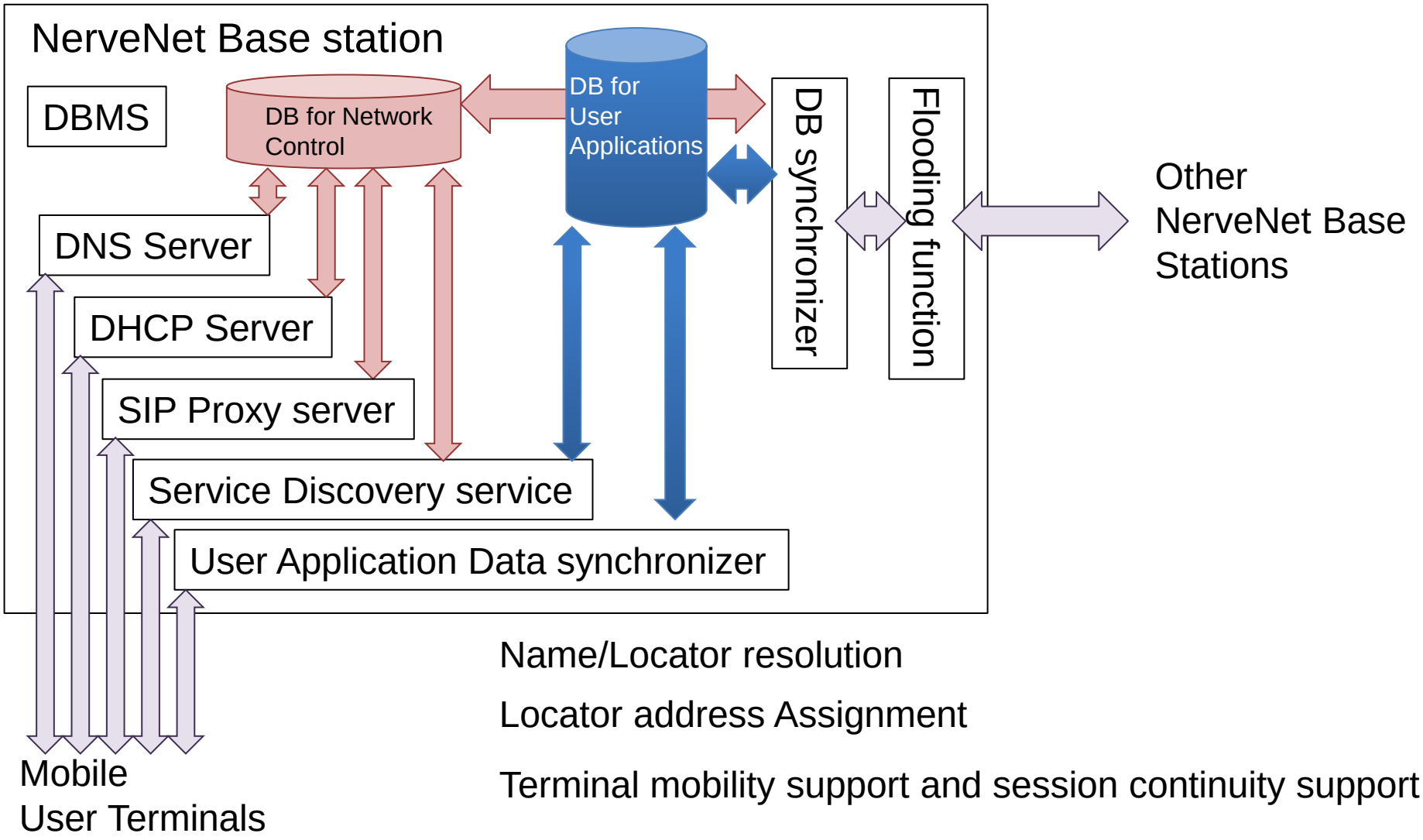


Creates multiple tree (VLAN) layers.
- AP selects minimum cost VLAN for each destination.
- If link is disconnected, swap to other VLAN which the disconnected link is not included.



- Reliable flooding and database synchronization mechanisms among APs.
- APIs for service discovery and application database synchronization are provided to mobile terminals

Server included network architecture



Name/Locator resolution

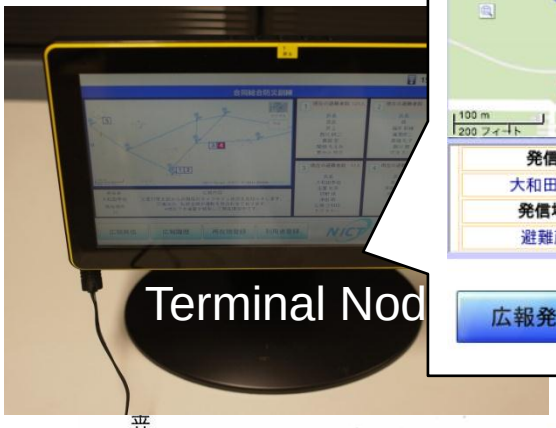
Locator address Assignment

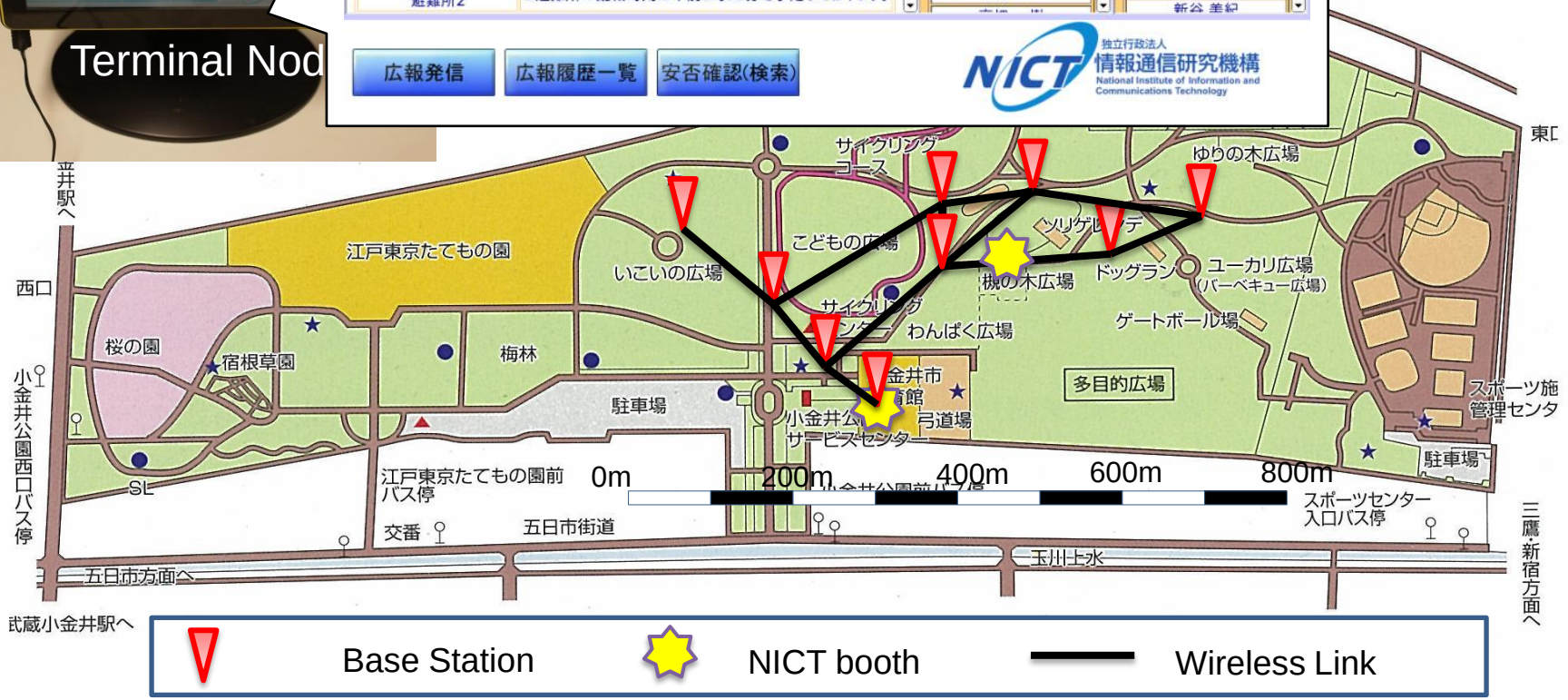
Terminal mobility support and session continuity support

User Application database synchronization support

Delay/Disruption tolerant network function support

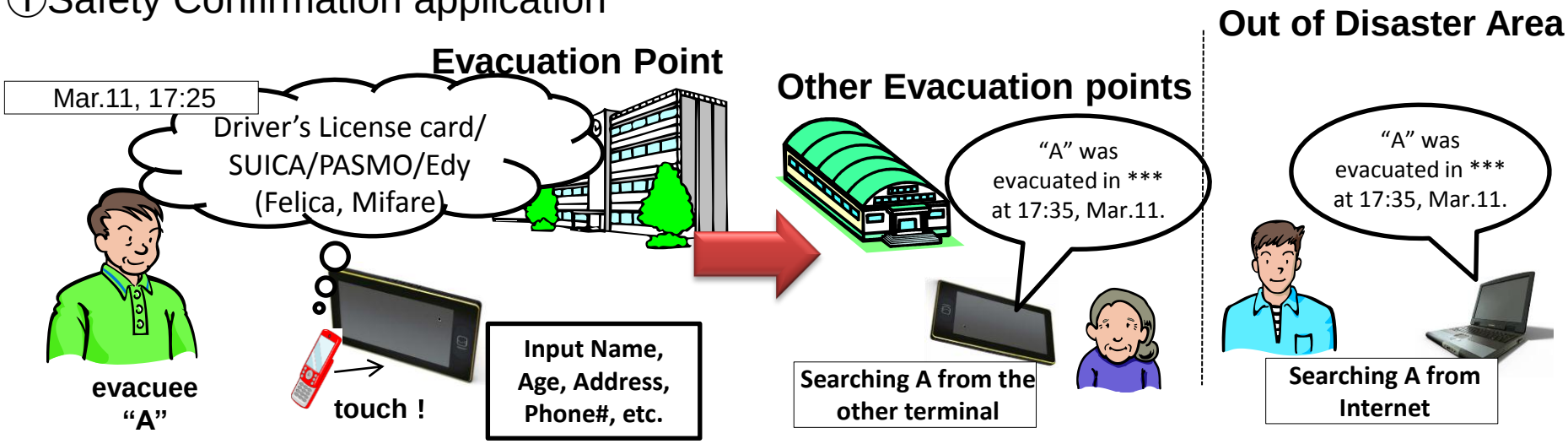
Oct.29, 2011 9:00-12:00
Tokyo Metropolitan and 4 city Joint Disaster drill @ Koganei Park
http://wirelesswire.jp/News_in_Japan/201110291856.html



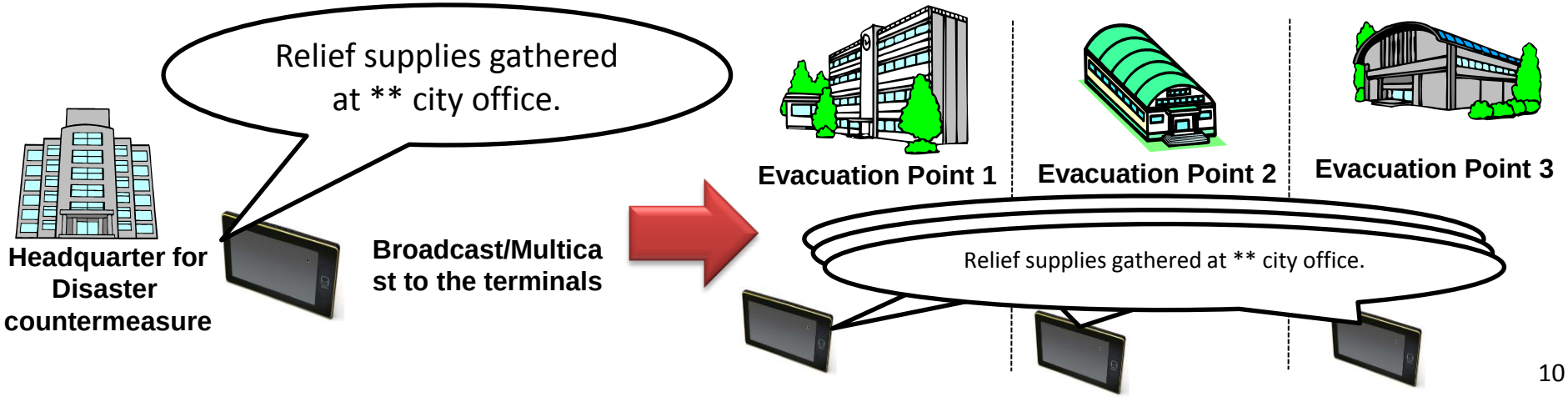


Safety Confirmation and Announcement Application

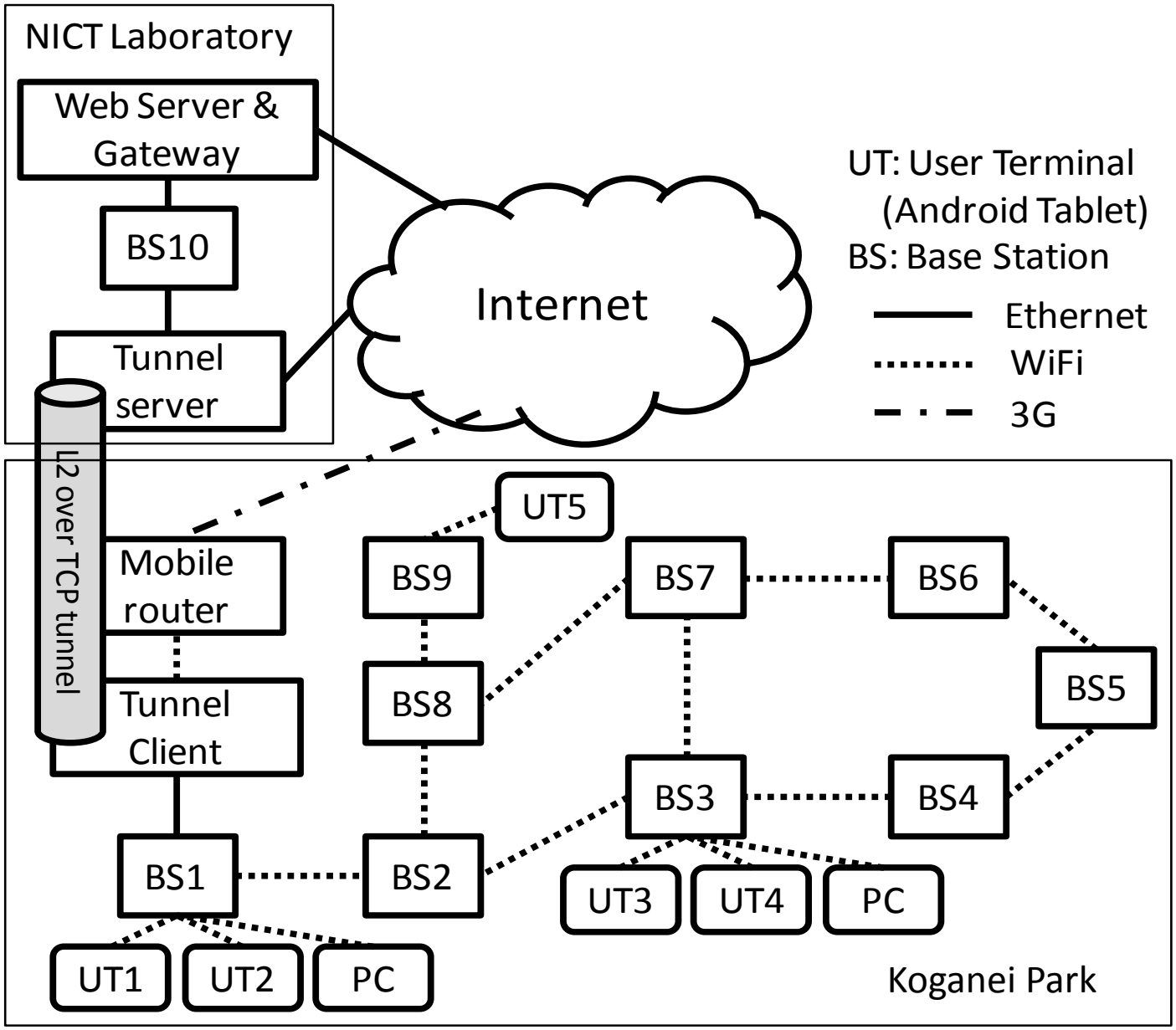
①Safety Confirmation application



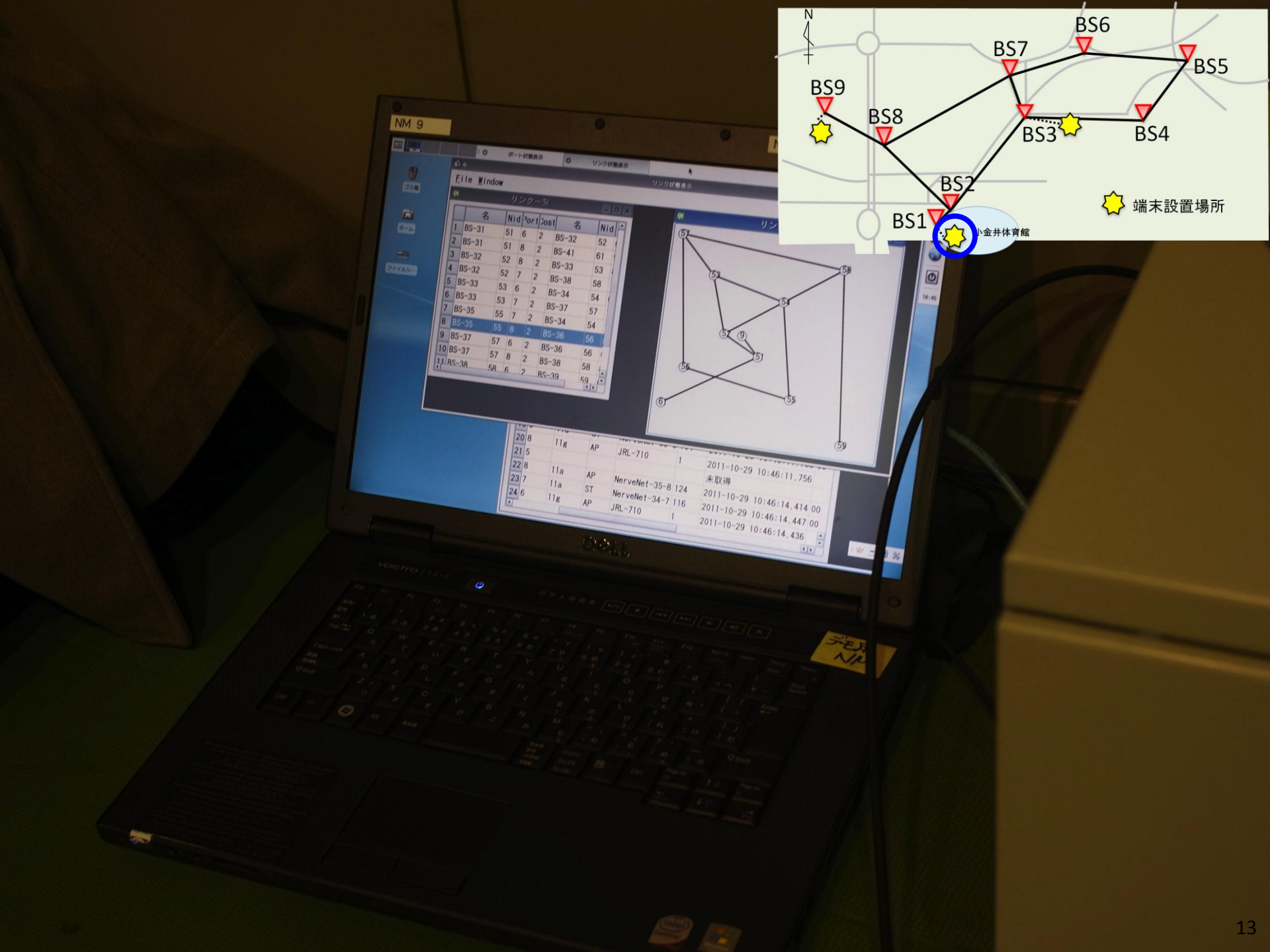
②Publicity announcement application

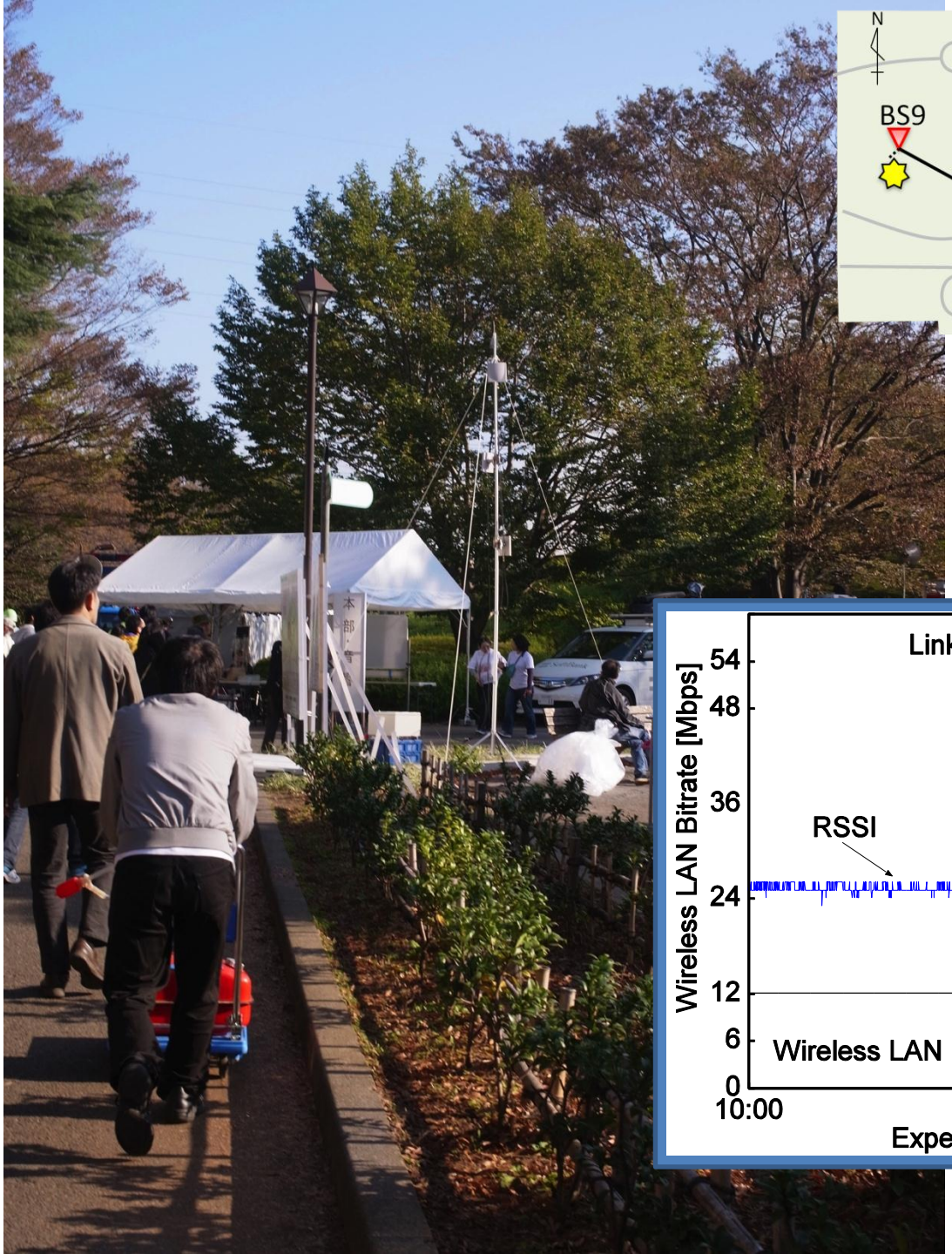


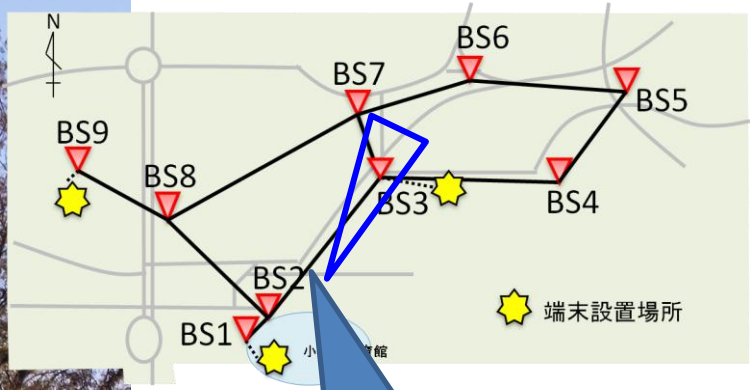
Network Topology

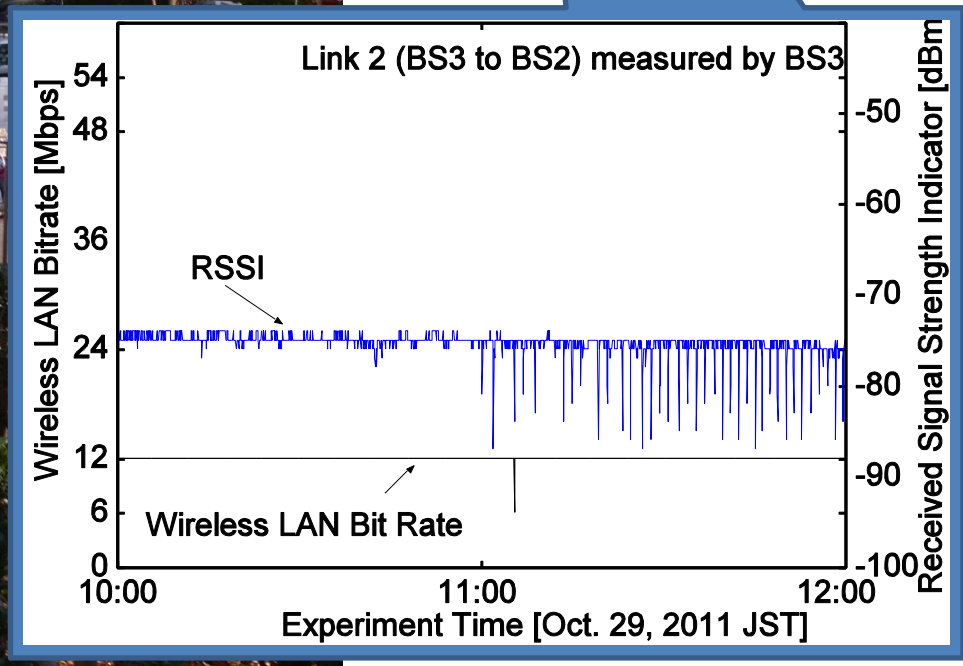


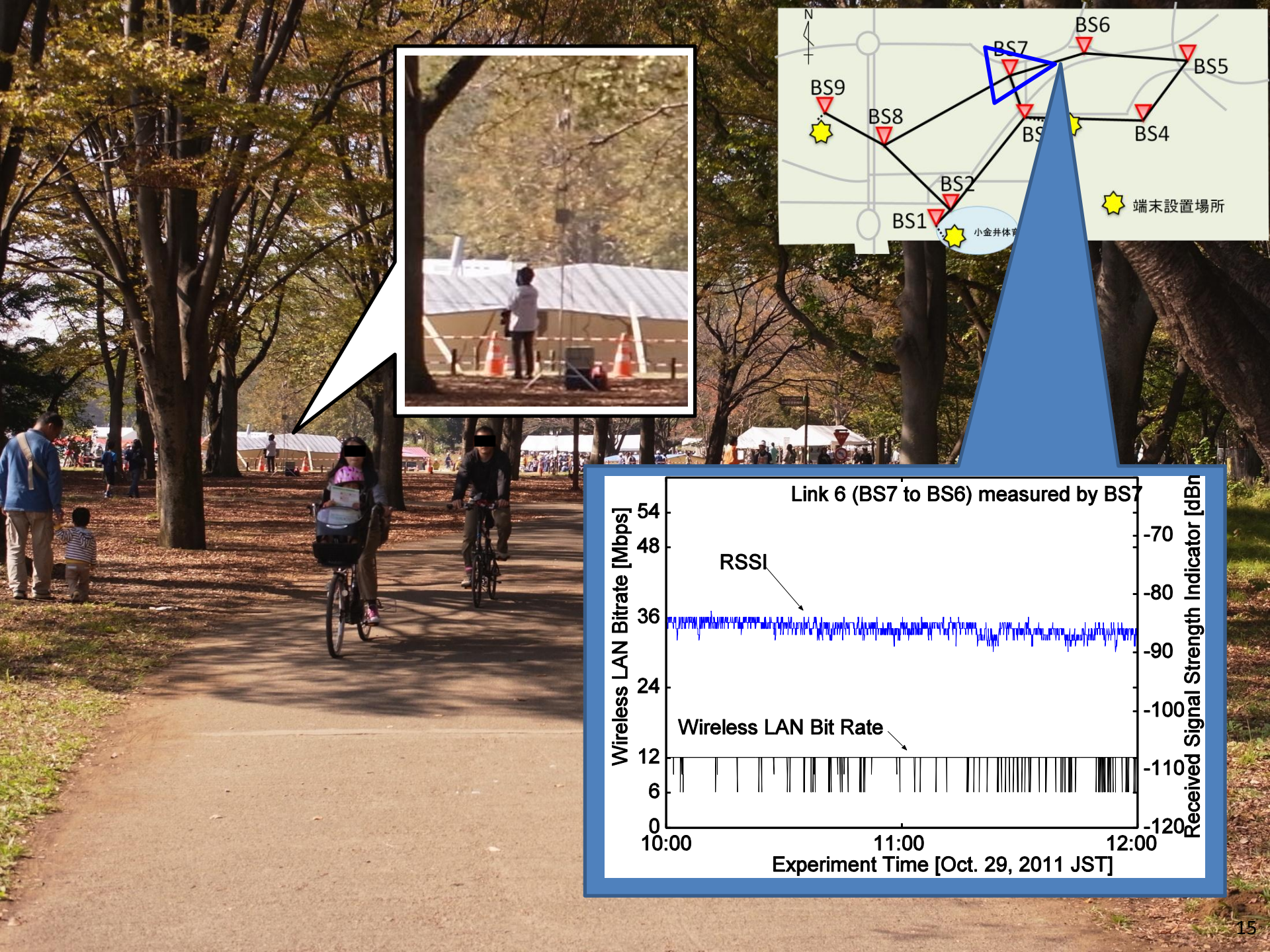

NTT東日本
特設公衆電話設置中(無料)
小平市
NiCT
N
BS1
BS2
BS3
BS4
BS5
BS6
BS7
BS8
BS9
小金井体育館
端末設置場所


N
BS6
BS7
BS5
BS9
BS8
BS3
BS4
BS2
BS1
端末設置場所
小金井体育館
NM 9
File Window

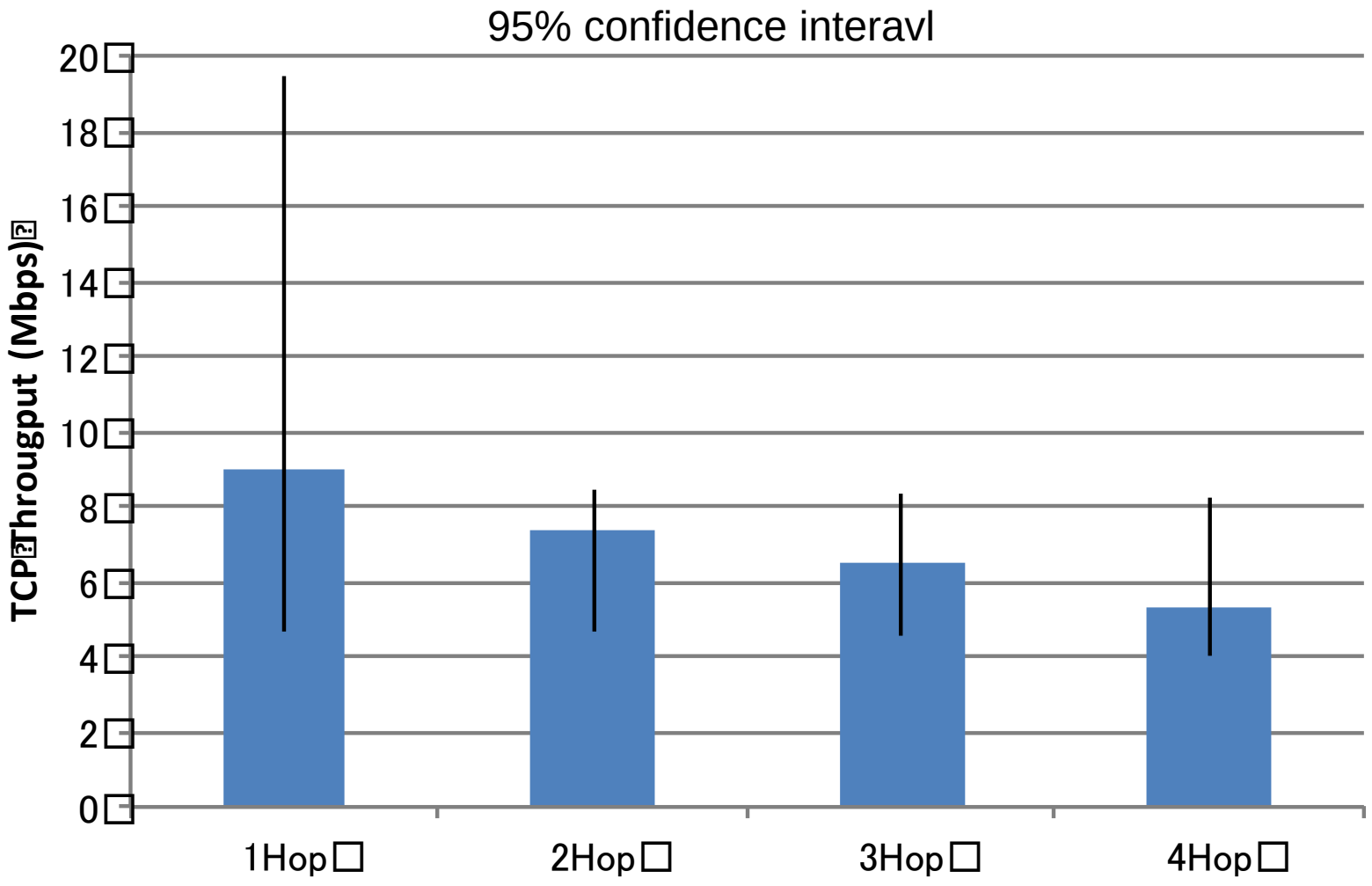



N
BS6
BS7
BS5
BS9
BS8
BS3
BS4
BS2
BS1
端末設置場所

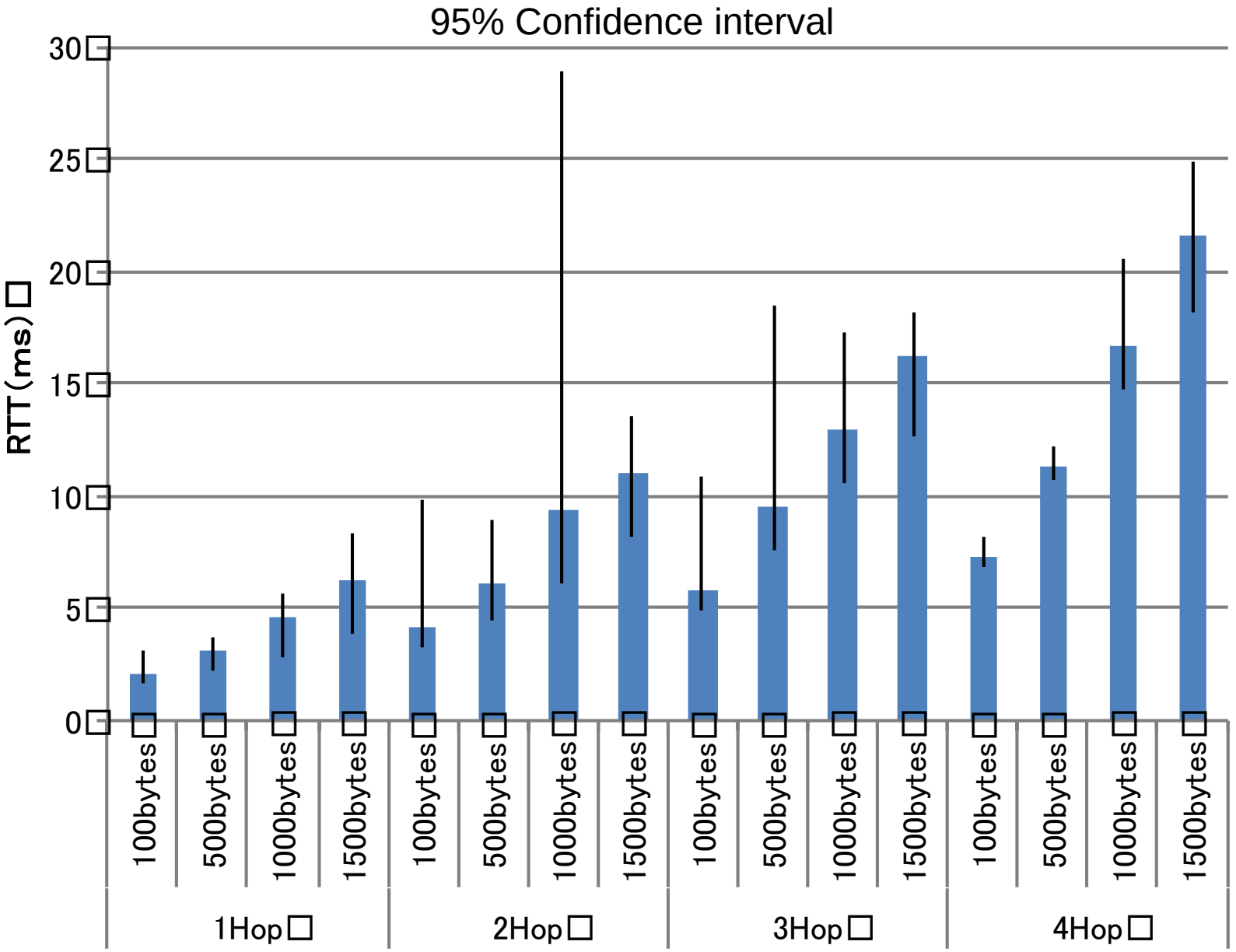

Link 2 (BS3 to BS2) measured by BS3
Wireless LAN Bitrate [Mbps]
Received Signal Strength Indicator [dBm]
54
48
36
24
12
6
0
-50
-60
-70
-80
-90
-100
RSSI
Wireless LAN Bit Rate
10:00
11:00
12:00
Experiment Time [Oct. 29, 2011 JST]


N
BS6
BS7
BS5
BS9
BS8
BS4
BS2
BS1
端末設置場所
Link 6 (BS7 to BS6) measured by BS7
RSSI
Wireless LAN Bit Rate
Wireless LAN Bitrate [Mbps]
Received Signal Strength Indicator [dBm]
54
48
36
24
12
6
0
-70
-80
-90
-100
-110
-120
10:00
11:00
12:00
Experiment Time [Oct. 29, 2011 JST]

TCP throughput between BS



ICMP packet size and RTT



Simulator and model implementation

Communication model

NerveNet AP

IEEE802.11a IFx3
(for backbone link)
IEEE802.11g IFx1 (for UT)

UAV

IEEE802.11a IFx1
NNAP features

Satellite

Long delay link(800ms)
Bandwidth (2Mbps)

UT(user terminal)

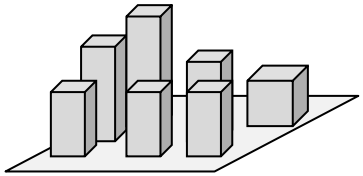
IEEE802.11a IFx1
Applications (voip, e-mail,
DB sync app.)

Human behavior model

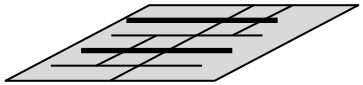
Agents

- Human
  - Student
  - Worker
  - Other
- Car
- Bus
- Train
  - Traffic light
  - Traffic jam
  - Time table
- UAV
  - Flight plan

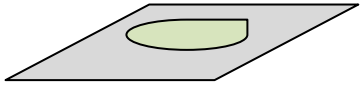
GIS information base



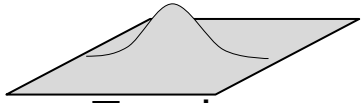
buildings



Roads, traffic lights

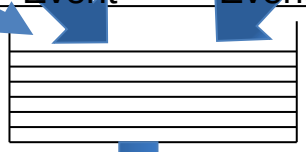


Parks



Terrain

Event Event Event



Event queue

Execute event

Discrete event simulation engine
(Scenargie Event scheduler)

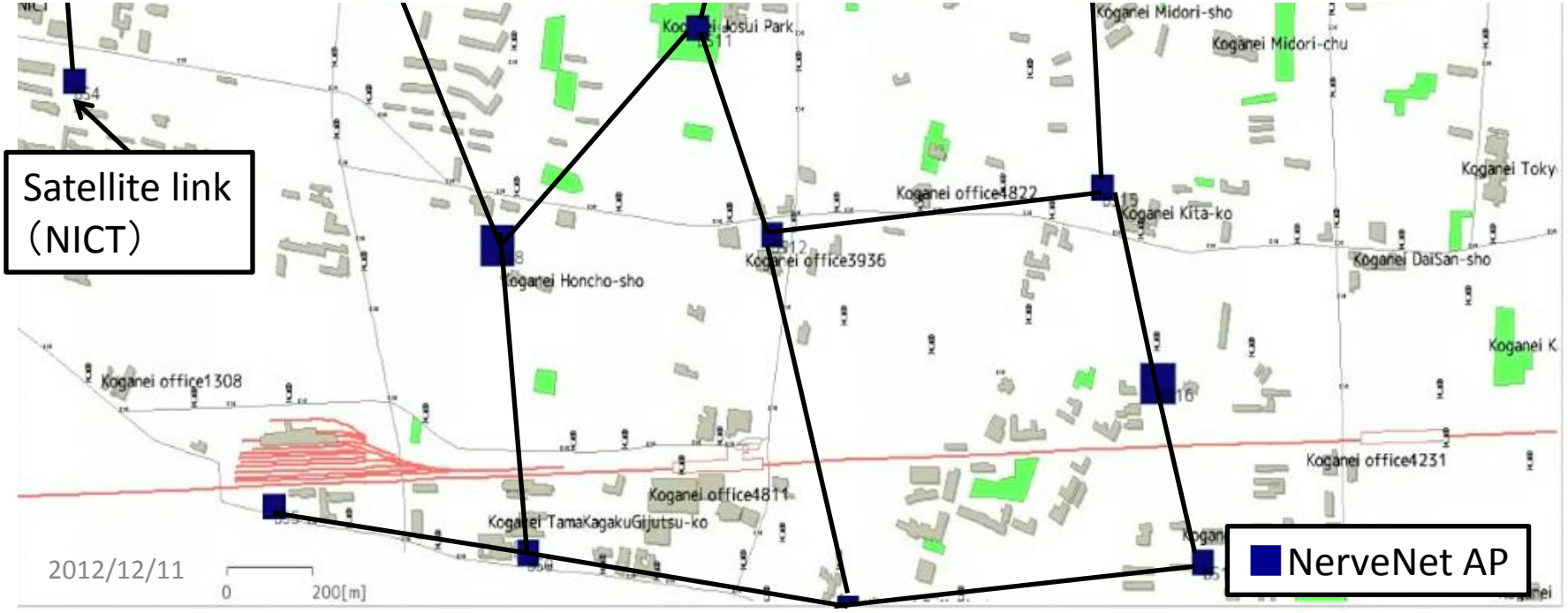
Human behavior with communications

Scenario assumptions:

- 8:00 AM, Koganei city in Tokyo, Japan, M7 earthquake occurs.
- Citizens evacuate to the nearest evacuation point, then move to Koganei park.
- People tries to contact at least 4 people to confirm their safety.

Communication system

- Wired and wireless telephone system are down.
- 18 NerveNet APs, 1 Satelite system exist, but the network is divided into two.
- Safety confirmation trial priority: voice call, E-mail, and DB sync application.
- Number of people to simulate: 1000 people(include communications).



Summary

- “NerveNet”
  - Distributed network platform with distributed servers; information caching, forwarding and delivering.
  - Applications are demonstrated:
    - Safety Confirmation Application
    - Disaster Management Announcement Application
- Demonstrated at the real field (Disaster drill) and simulation environment
  - Evaluated its performance at the real field test
  - Evaluated its scalability with a realistic human behavior

Thank you