MPSoC 2014

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Evaluation of Architecture Search Simulator for Wide-range Grid Wireless Sensor Network

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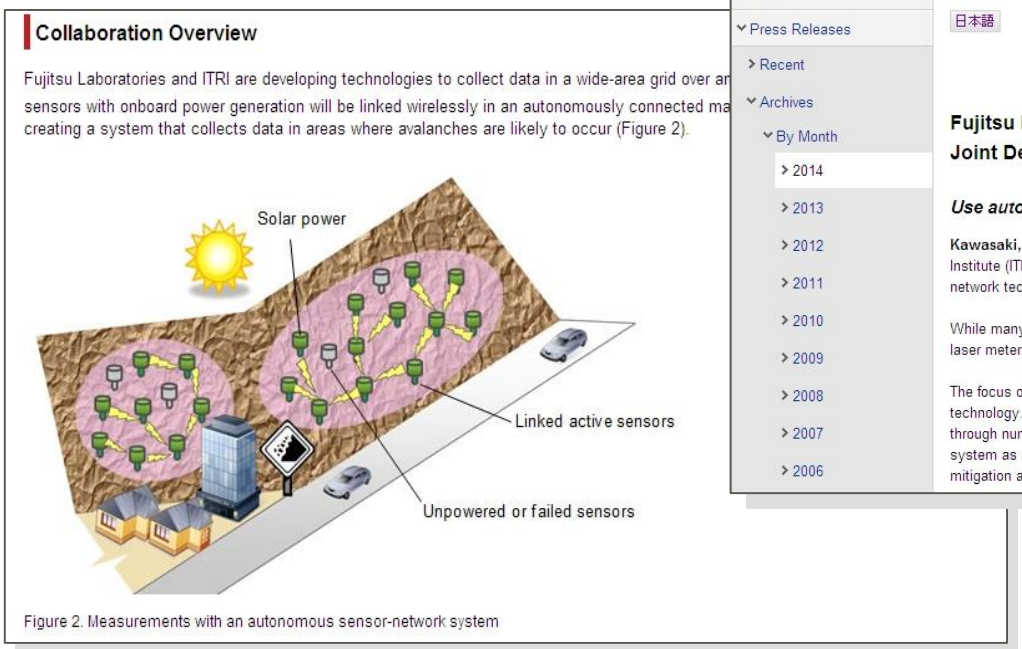
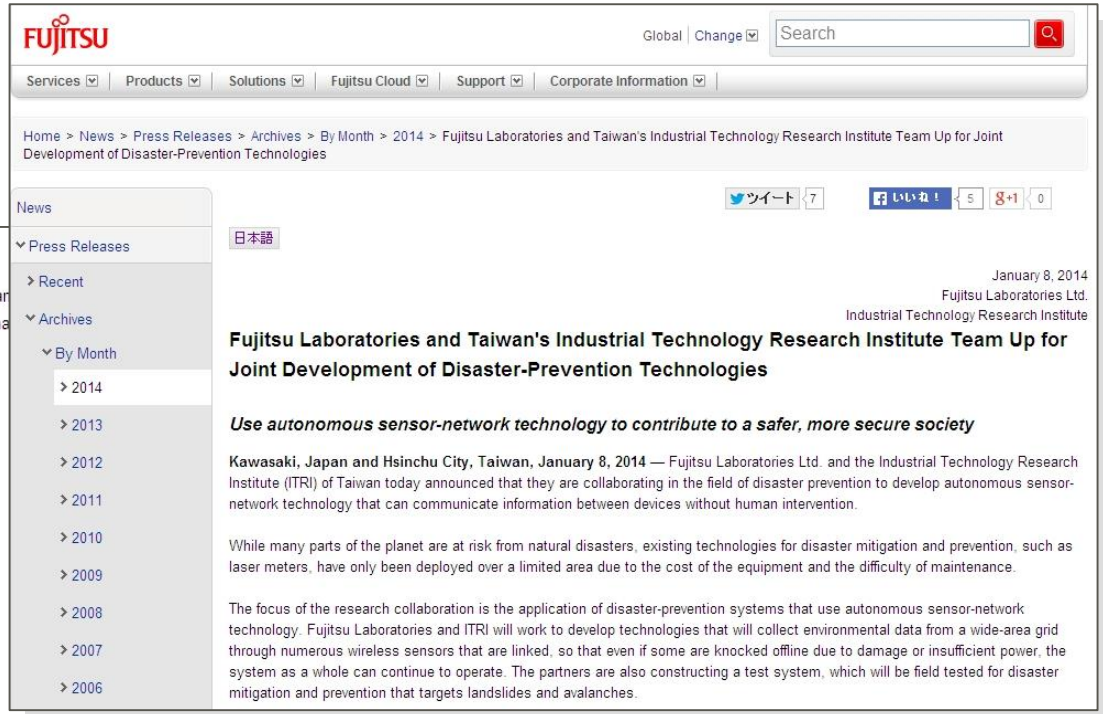
We have just begun

- **Fujitsu Laboratories and Taiwan's Industrial Technology Research Institute team up for joint development of environmental monitoring technologies (Jan. 8, 2014)**





http://www.fujitsu.com/global/news/pr/archives/month/2014/20140108-01.html

Sensor network for environmental monitoring

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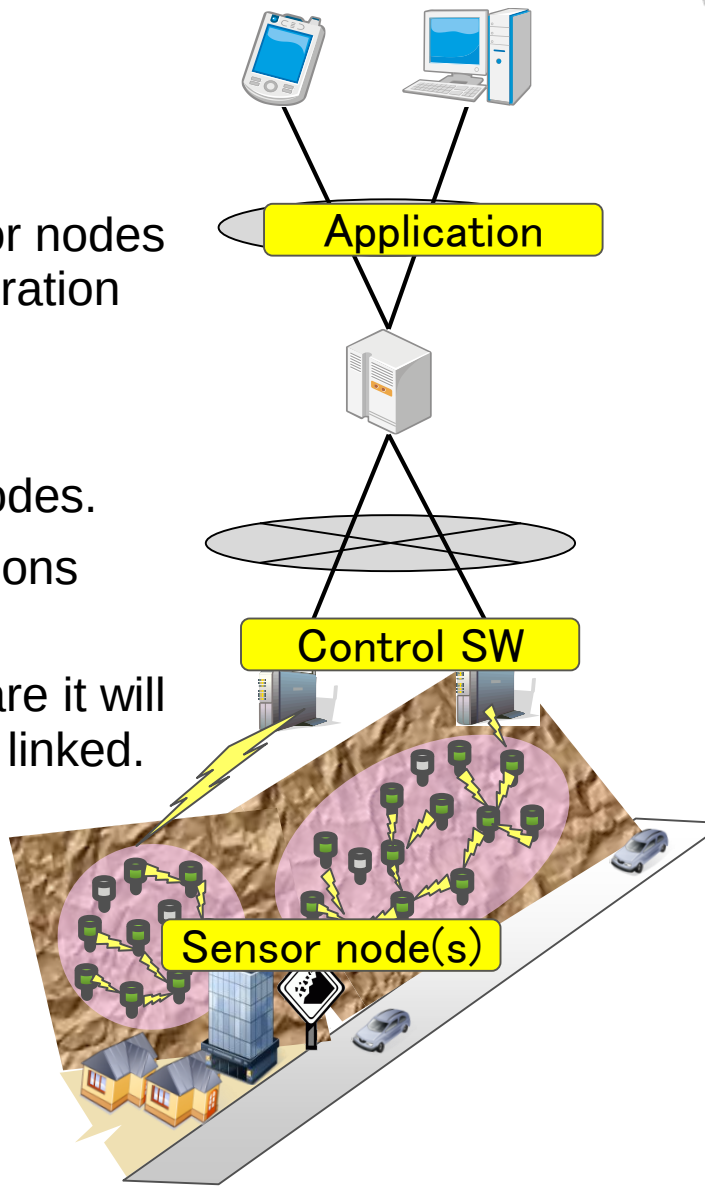
Most of the Earth is affected by weather-related natural disasters, such as from storms and floods.

A localized torrential downpour in Kyusyu-island (2013 Aug.)

To collect data in a **wide-area grid over an area to be monitored**. Numerous sensors will be linked wirelessly in an autonomously connected M2M sensor network.

Technical assignment

- Hardware :
  - The sensor nodes and gateway.
  - Wireless firmware, and power control.
  - Solar panel with RF antenna technology, the sensor nodes will have efficient communications and power-generation capabilities.
- Software :
  - The autonomous-control software for the sensor nodes.
  - Remote control and avoiding errors in communications between sensors.
  - Using distributed processing and embedded software it will create a system that allows adjacent sensors to be linked.
- Affiliates :
  - Civil-engineering specialists from local universities, as an application.



Difficulty of this distributed architecture

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	Typical computer	Proposed M2M architecture
Processing	Data-processing operation with neighbor node(s)	
Power supply	Stable	Unstable. Depending on sunshine and weather
Inter-connection	Wired	Wireless. With the influence of a noise.
Routing	Based on data or I/O dependency	Based on data dependency and quality of a connected state
Clustering	Parallelism of processing	Data accuracy by interpolation
System reliability	OS for strict scheduling and error evasion and restoration	Natural environment. God knows !?

Difficulty of this distributed architecture

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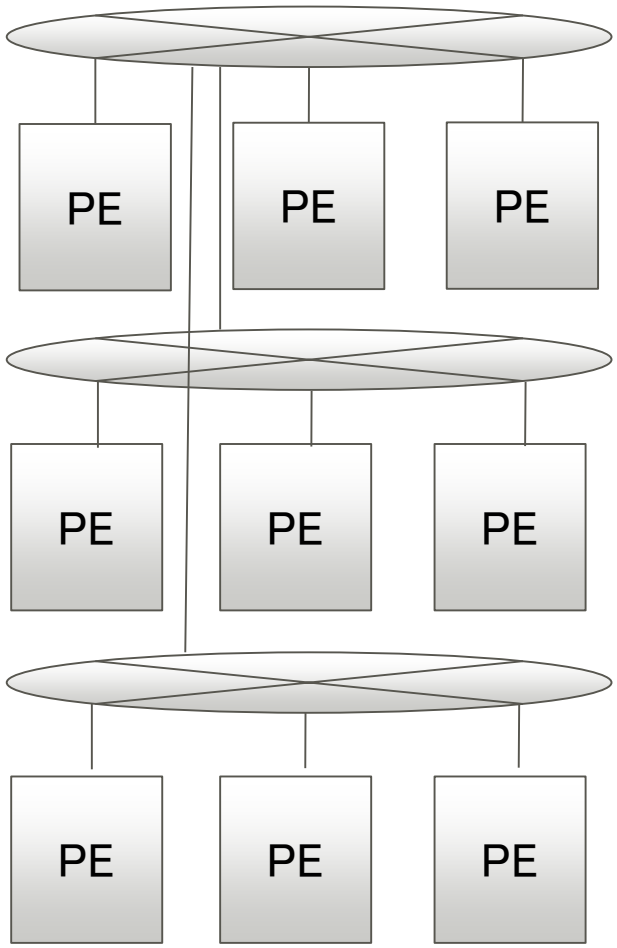
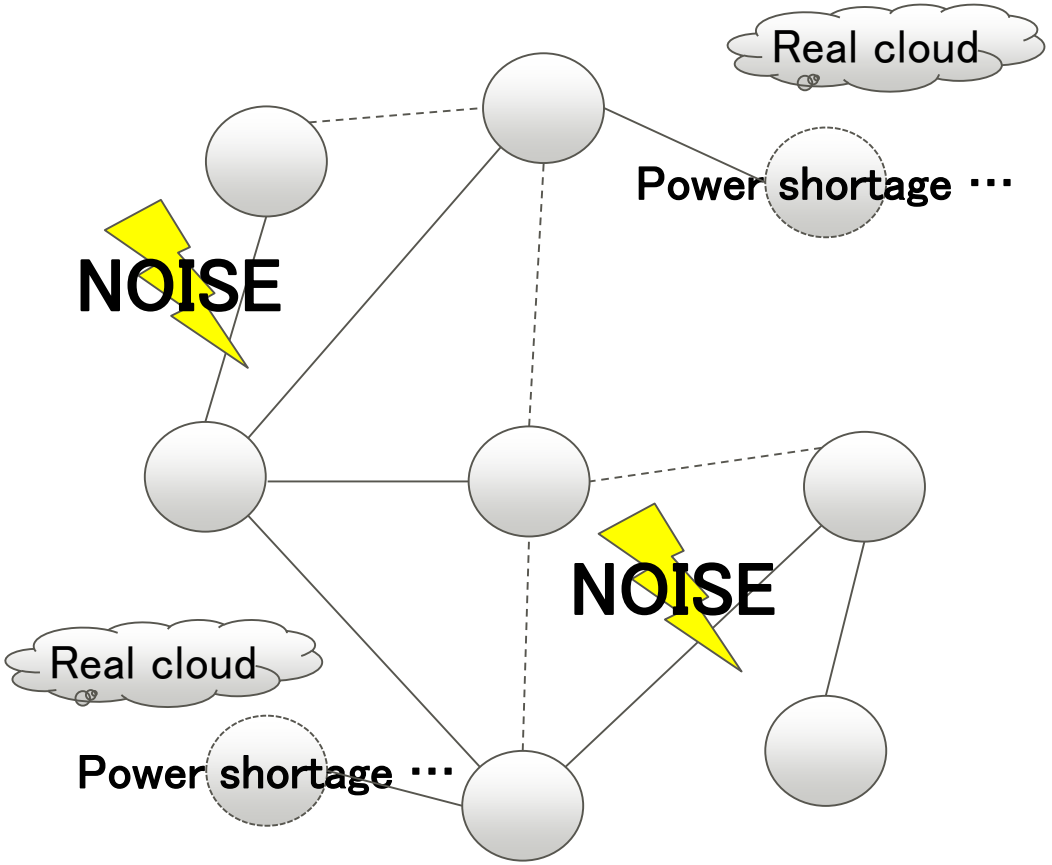


Typical computer

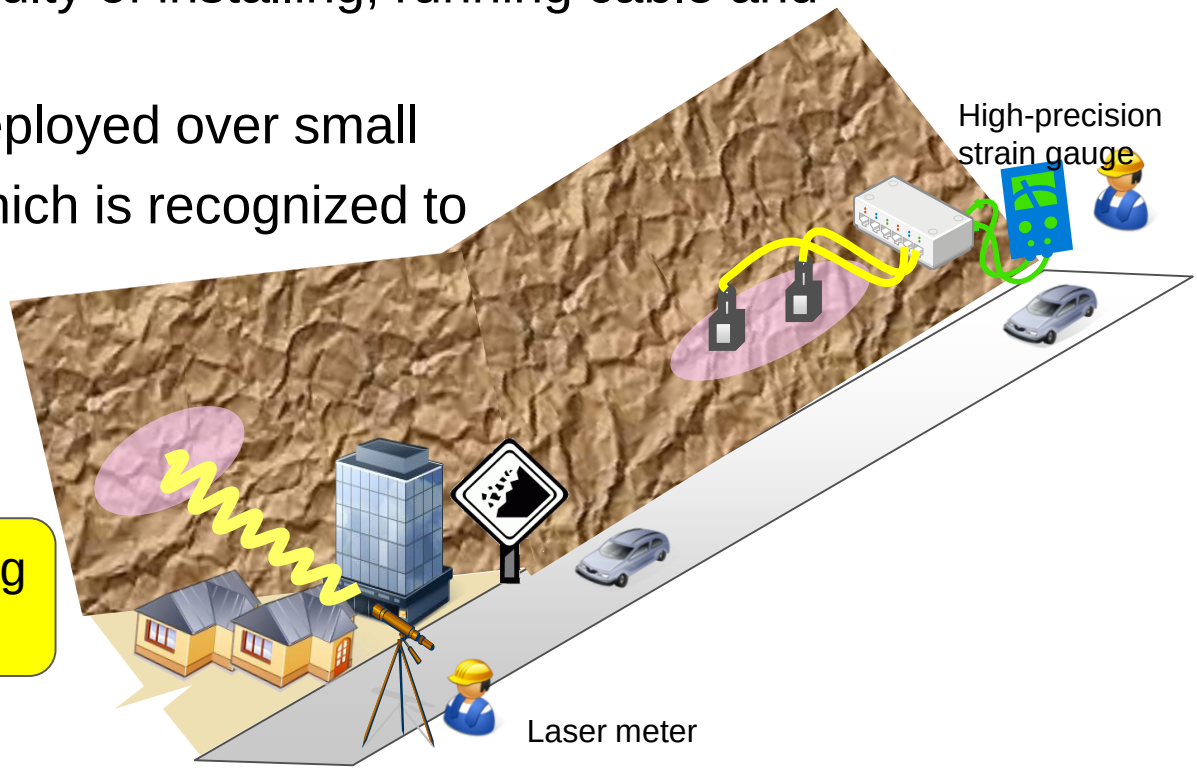


M2M sensor node architecture

Related research (Civil-engineering)

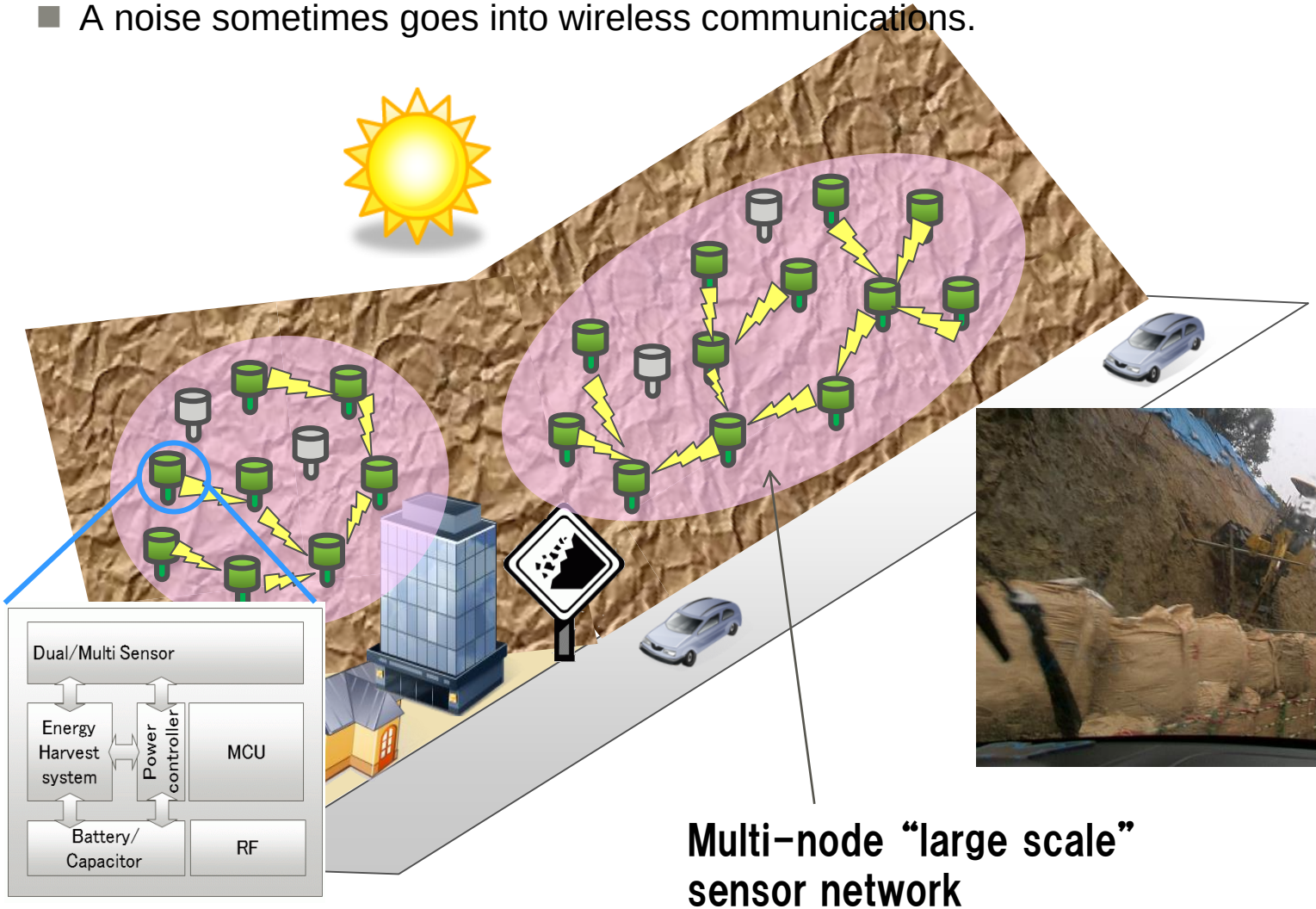
- Existing technologies
  - In particular, include laser meters and high-precision strain gauges that are buried in slopes for underground measurements
- Problems
  - Combined with the difficulty of installing, running cable and replacing batteries…
  - They have only been deployed over small areas or limited area which is recognized to be dangerous.

Grid over a wide area monitoring has not yet been realized



Challenges

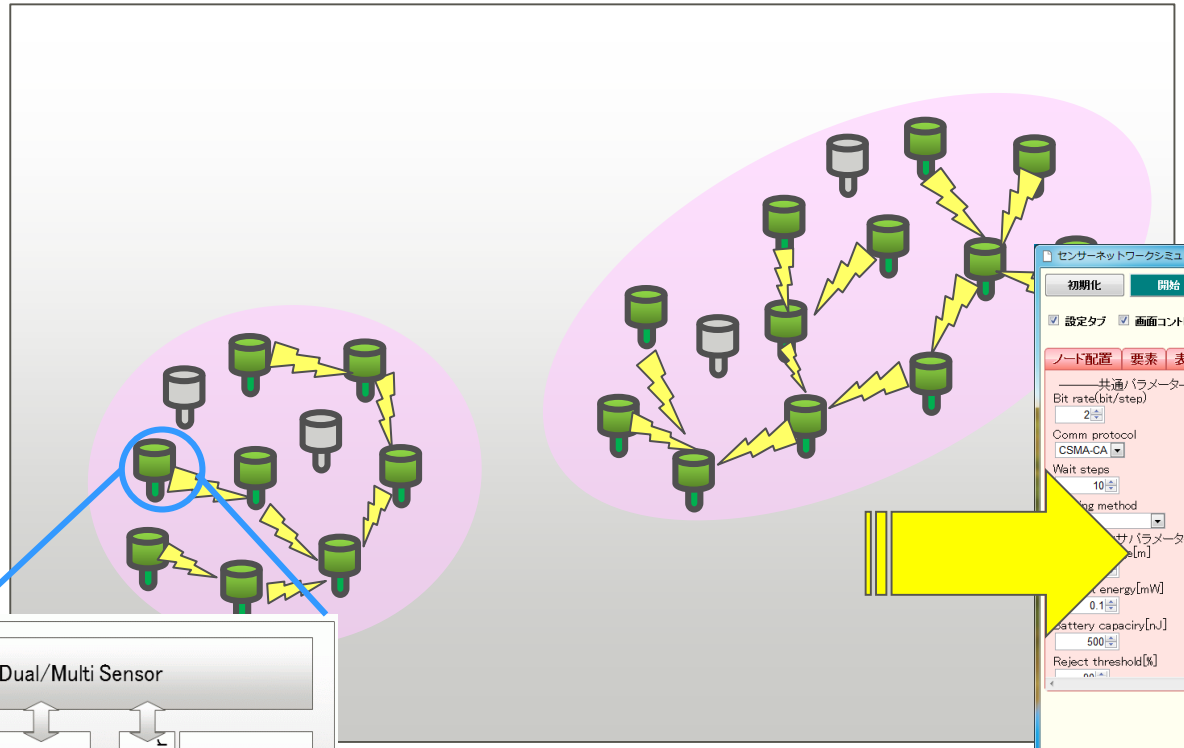
- Difficulties (Even if it is the fine-optimized system…)
  - The sensor which sometimes runs short of productions of power.
  - A noise sometimes goes into wireless communications.

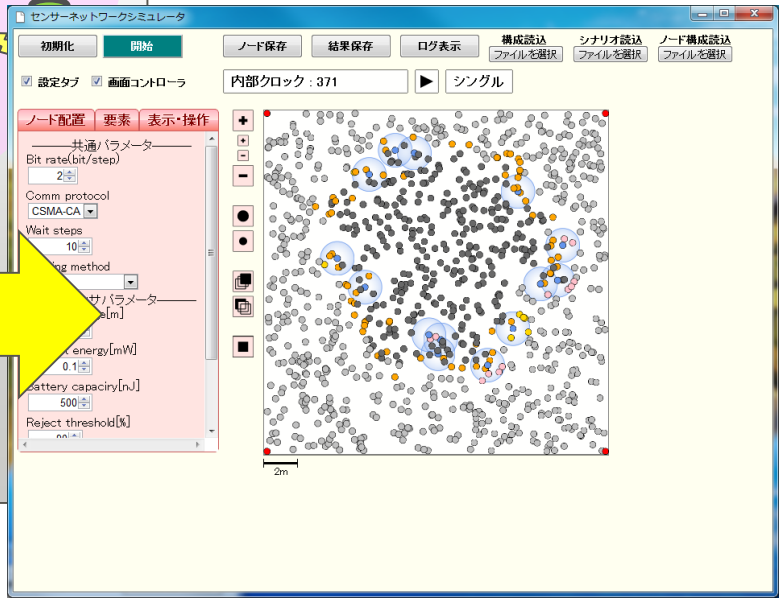


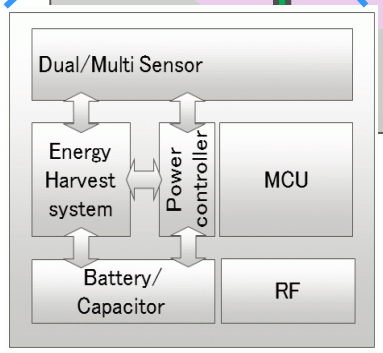
Example of node architecture

Challenges

- We developed a sensor network simulation with these phenomena.
- It is a tool with which the system design in consideration of the "variation" in the system which operates by natural environment is assisted.







Example of node architecture

Multi-node “large scale” sensor network simulator

Hardware

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- Only typical hardware modules are assumed

	Specs	**Power budgets**
Sensor	MEMS	0.2mW~
Energy harvesting module	Solar panel	5uW/cm^2 (200Lux)
MPU/Memory	8,16bit 8KByte RAM ~30MHz	~10mW
RF	IEEE802.15.4	Tx:90mW Rx:70mW (4.5dBm)
Battery	3.7V 800mAh/10cm^2	-

Sensor network simulator (MPSoC2013)

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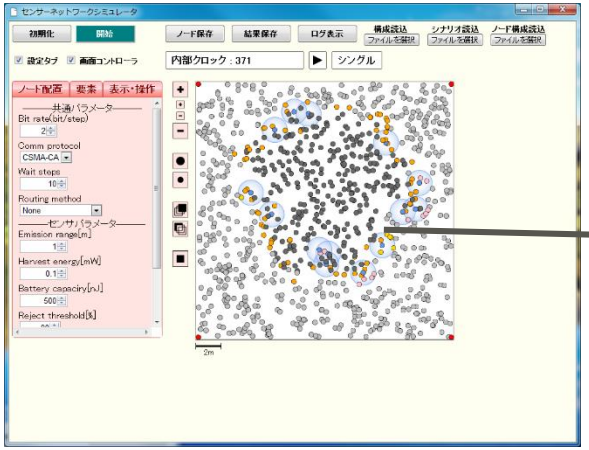
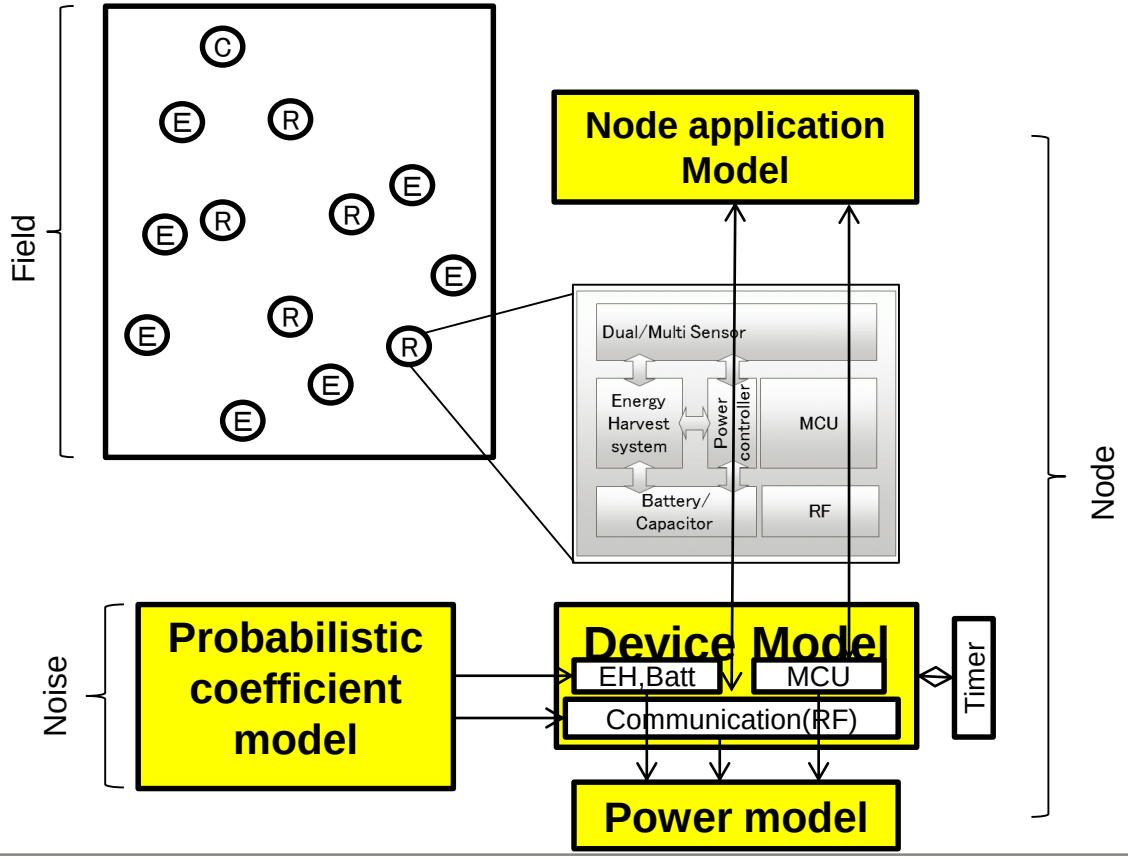
1. A node is composed of one thread that expresses the node architecture.
2. The user can freely set the parameter of the node architecture.
3. A large amount of node is expressed by starting a large amount of thread.
4. The uncertain characteristics are expressed by the probabilistic model (power and wireless noise).
5. Random location, autonomous networking (avoiding lack node(s))





The experiment by a simulator

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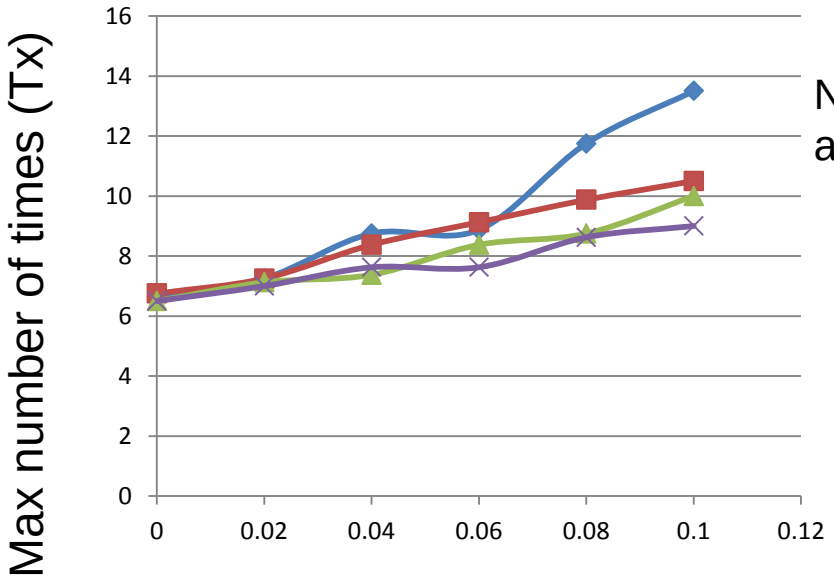
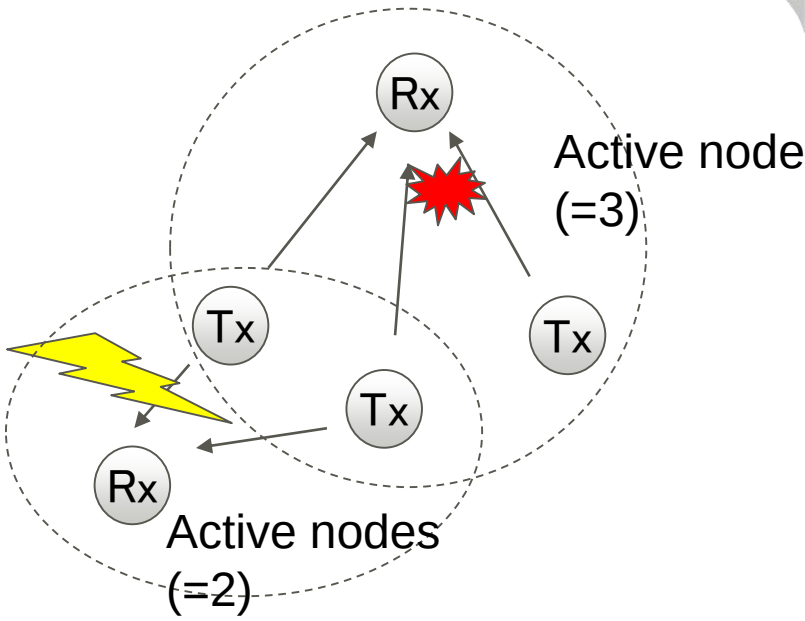
- The sensor network in which many nodes exist
- Each node is subject to the influence of the noise from the outside.
- Noises are acquired in an outdoor experiment.
- The simulator reproduces communication between nodes, and power state, and observes data retransmission and routing change.
- The conditions for acquiring the data information on 100 nodes.
  - How much is the redundancy of the number of nodes which constitutes the field?
  - How much does a node consume energy?
    - NOTE

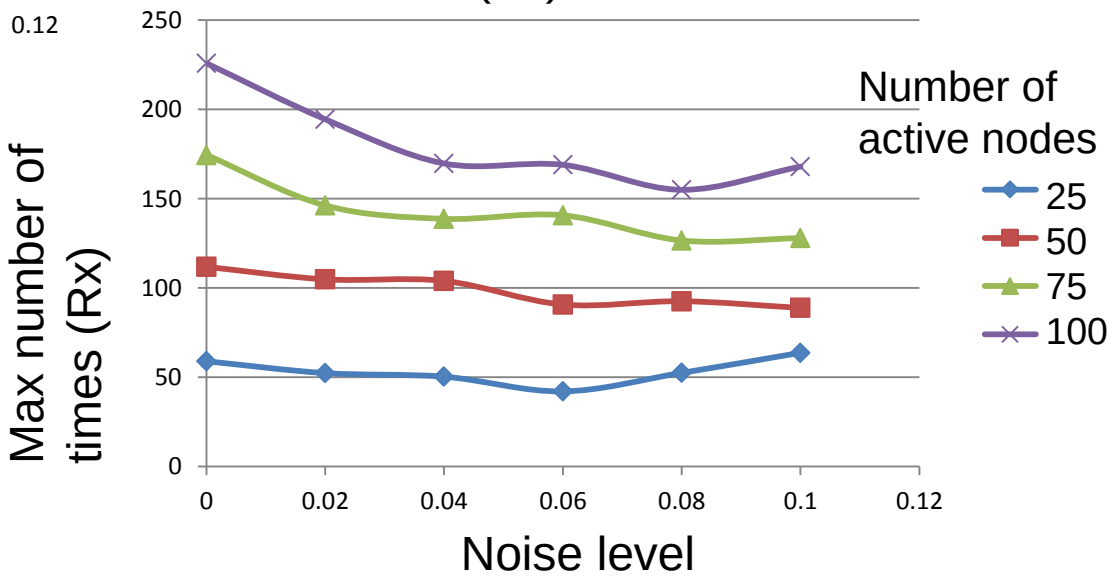
    Number of active node increases (nums of redundant node increases), frequency of wireless collision increases.

    If redundant node decreases, the big power capacity for carrying out recovery of the processing failure is required.

Result

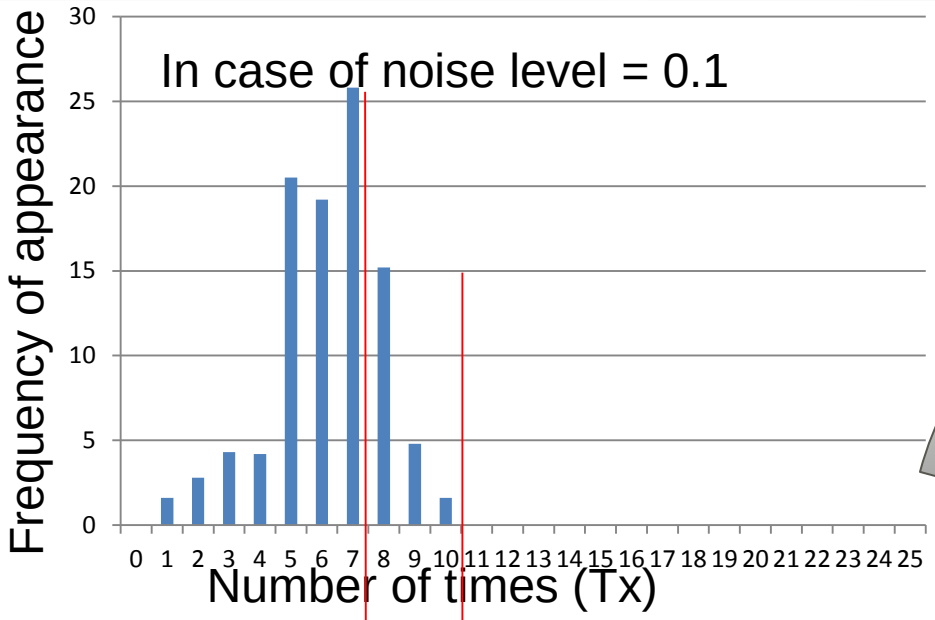






The number of times of re-communication serves as an expected value of power consumption.

Result

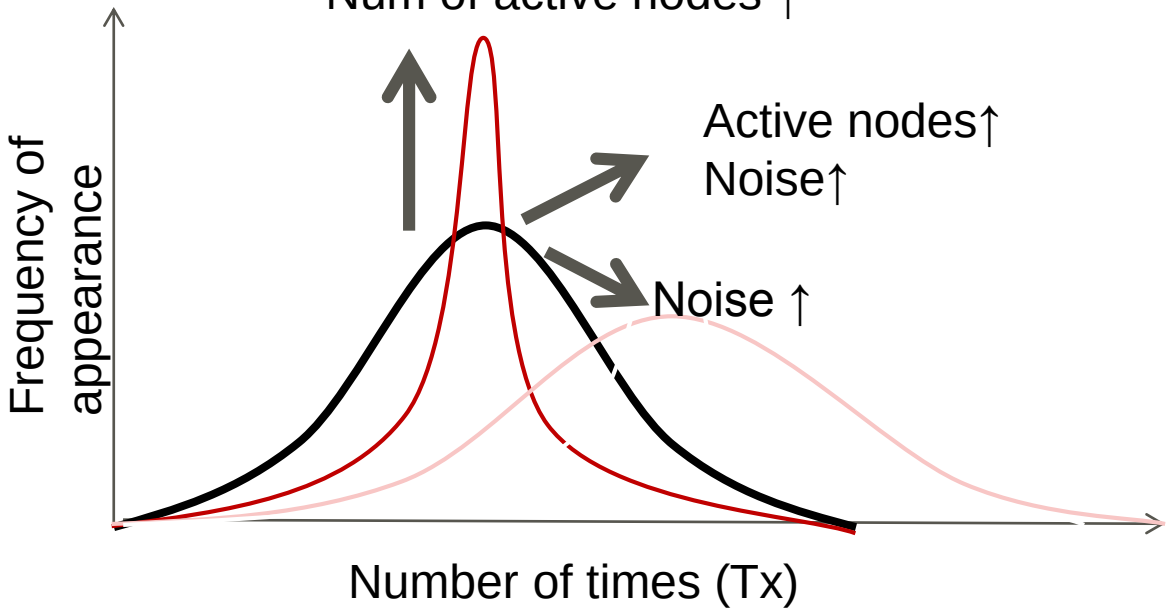


If the amount of noises changes, a tendency will also change…

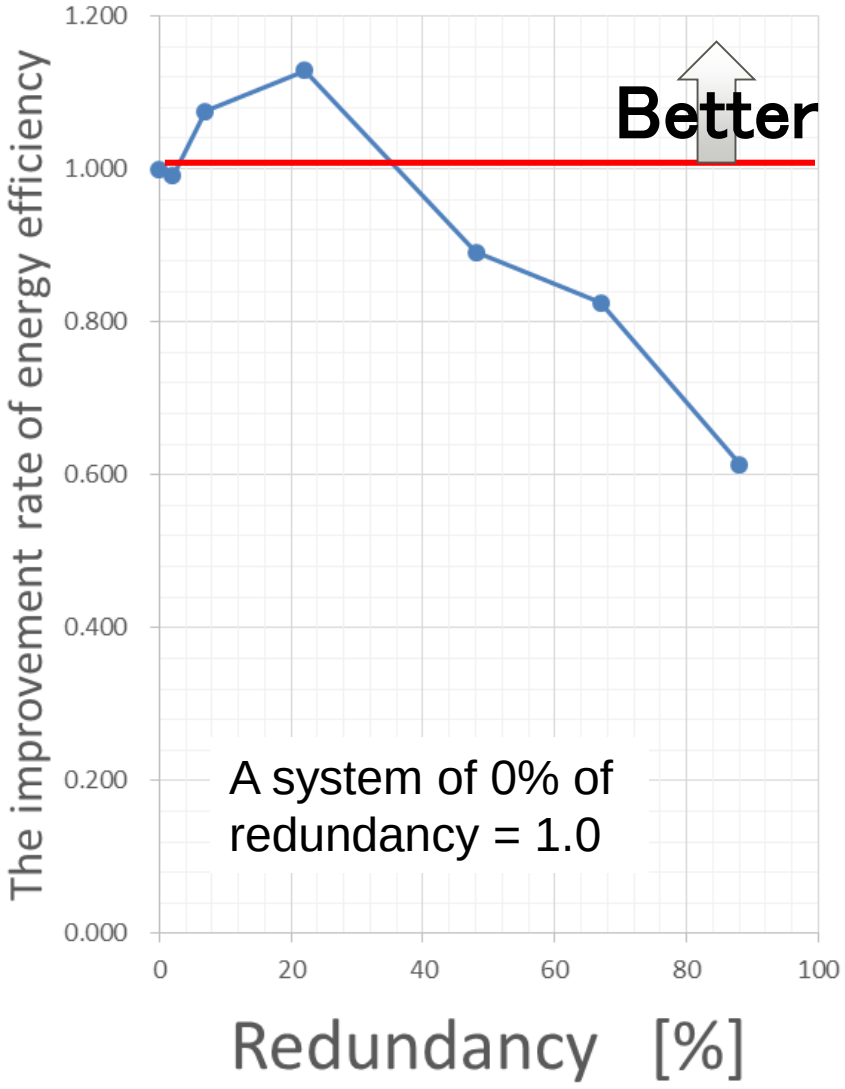
Where is the minimum gross area!?

If a system has 30% of redundancy, 7 times of the RF power budgets are required

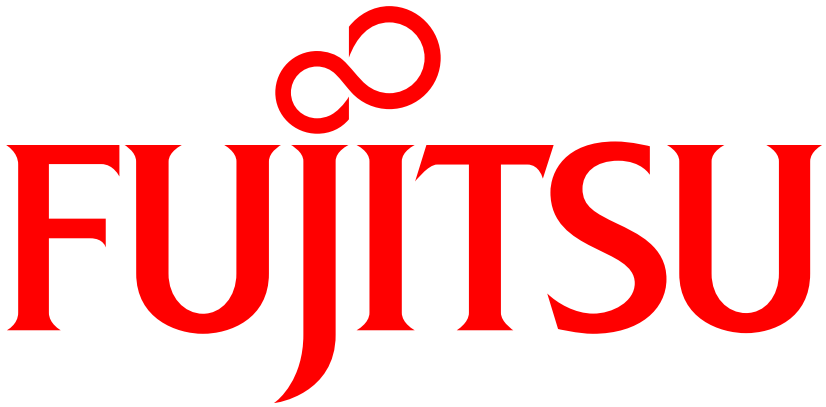
If a system has 1% of redundancy, 10 times of the RF power budgets are required



Conclusion



- The moderate redundancy can improve energy efficiency.
- The reliability of a system is still satisfied.
- The proposed simulator can analyze the relation of the trade-off with a noise and redundancy.



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