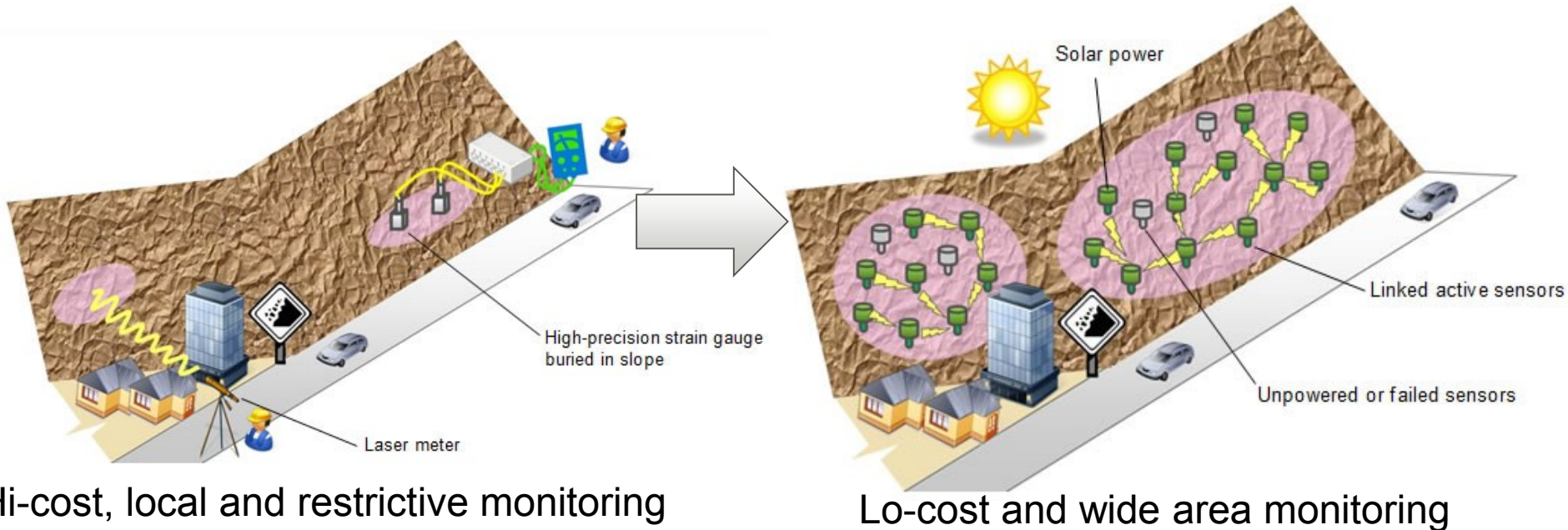


Scheduling Methodology for Wireless Sensor Network System over the Winter Season

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Fujitsu Laboratories LTD.
Network System Laboratories

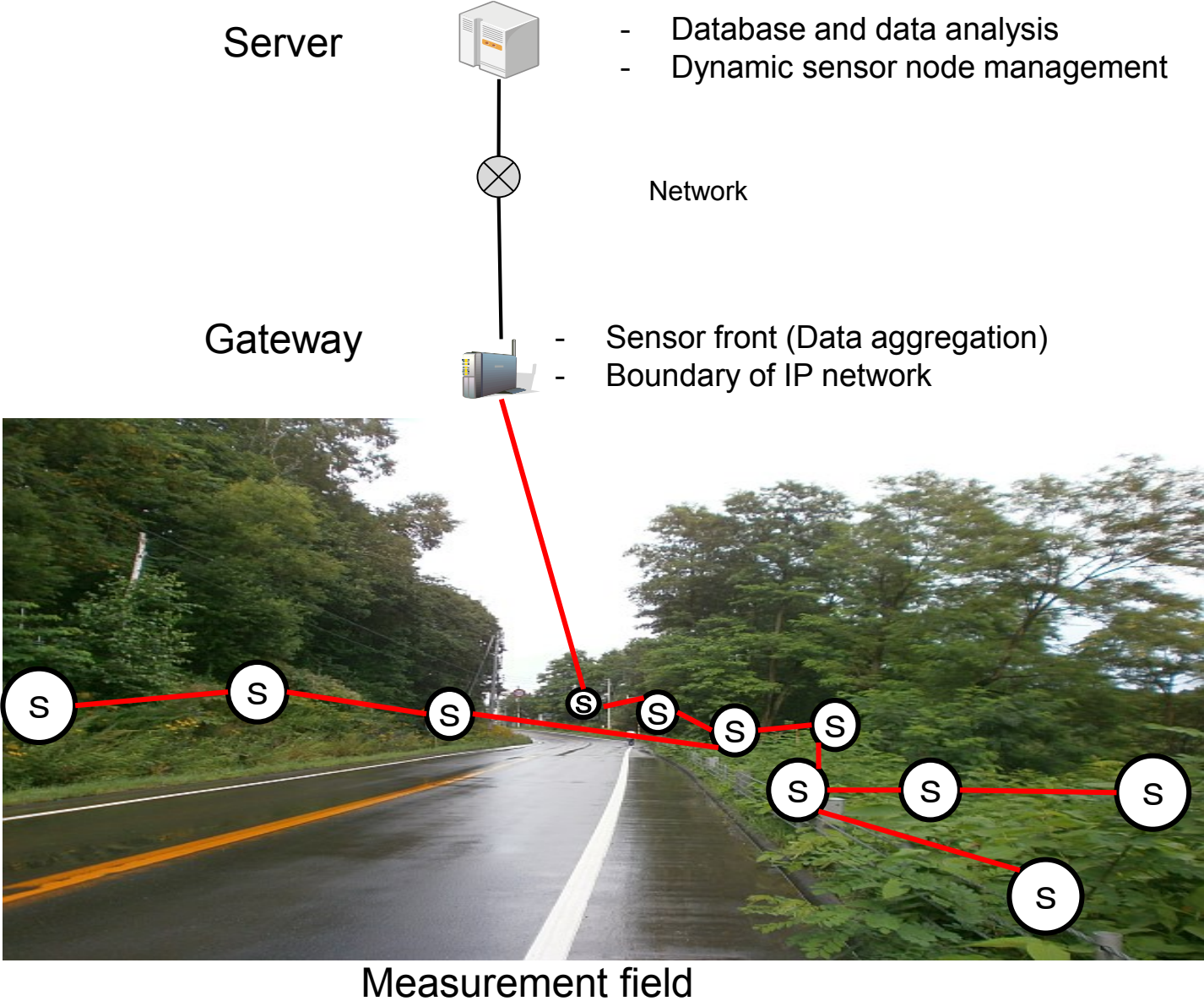
Background ~ Our mission

Existing technologies for environmental monitoring have not spread to here and there... difficulty of installing, running cables, replacing batteries, and cost. They have only been deployed over small areas, and the promise of effectively collecting data in a grid over a wide area has not yet been realized.



- Long-term operation without such as a battery replacement. The cost is not only device cost, maintenance cost is also taken into.
- Wide range, multi-point observation. Observation point is to determine in terms of civil engineering. The network is built to correspond to the original vegetation, the terrain and the climate.
- The node architecture is a simple configuration with a general-purpose part. In consideration of the installation costs, to reduce the minimum size of such as a handy-size battery.

Challenges



Challenges

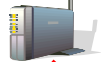
Server



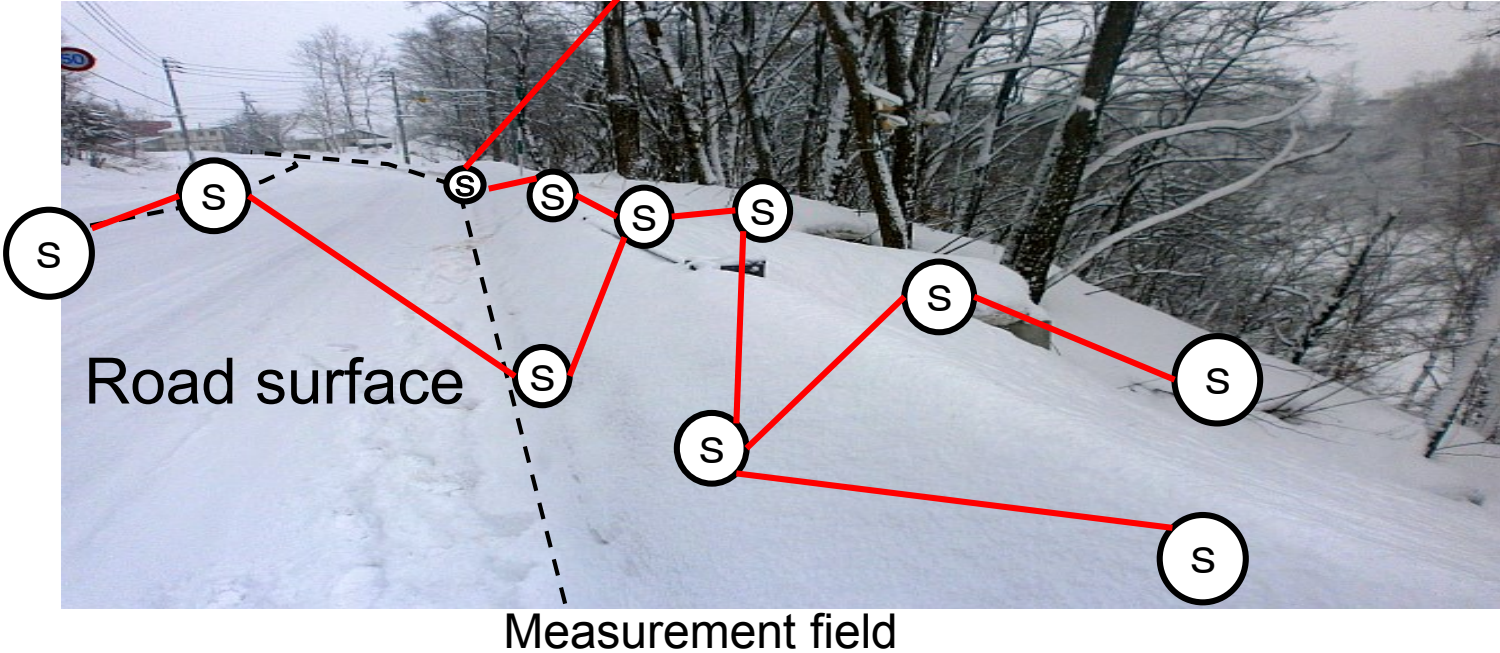
- Database and data analysis
- Dynamic sensor node management

Network

Gateway

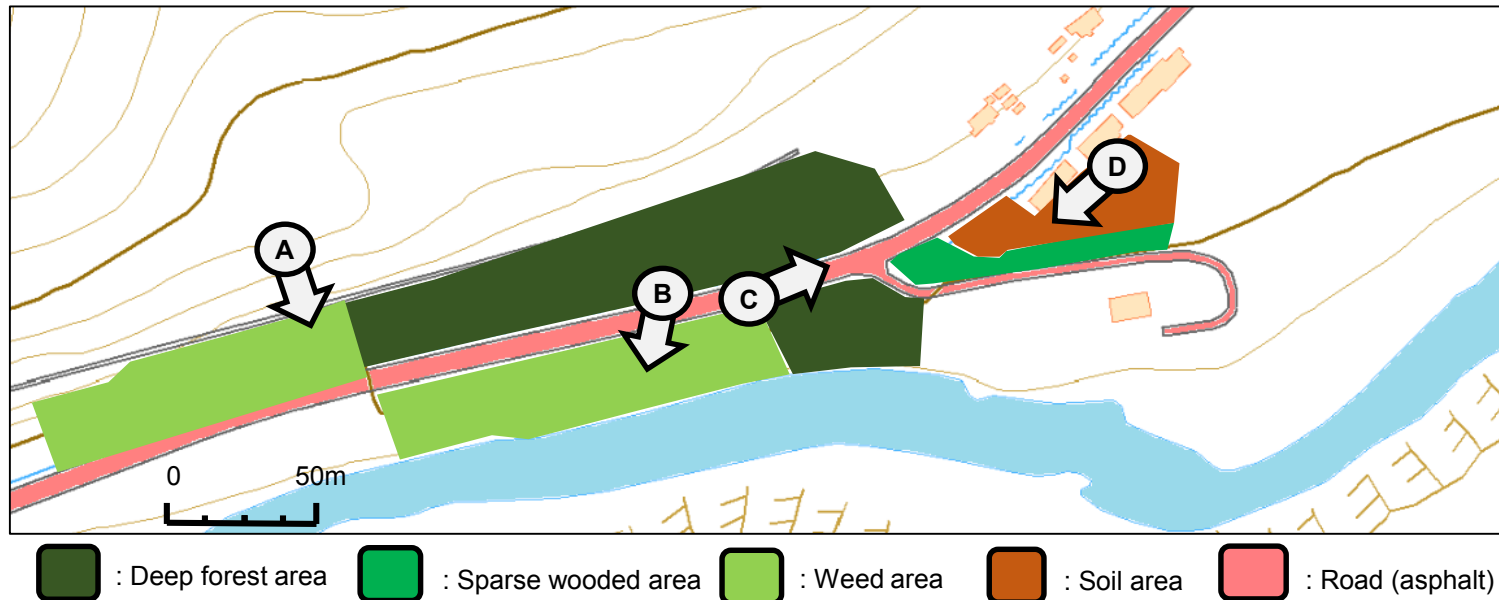


- Sensor front (Data aggregation)
- Boundary of IP network

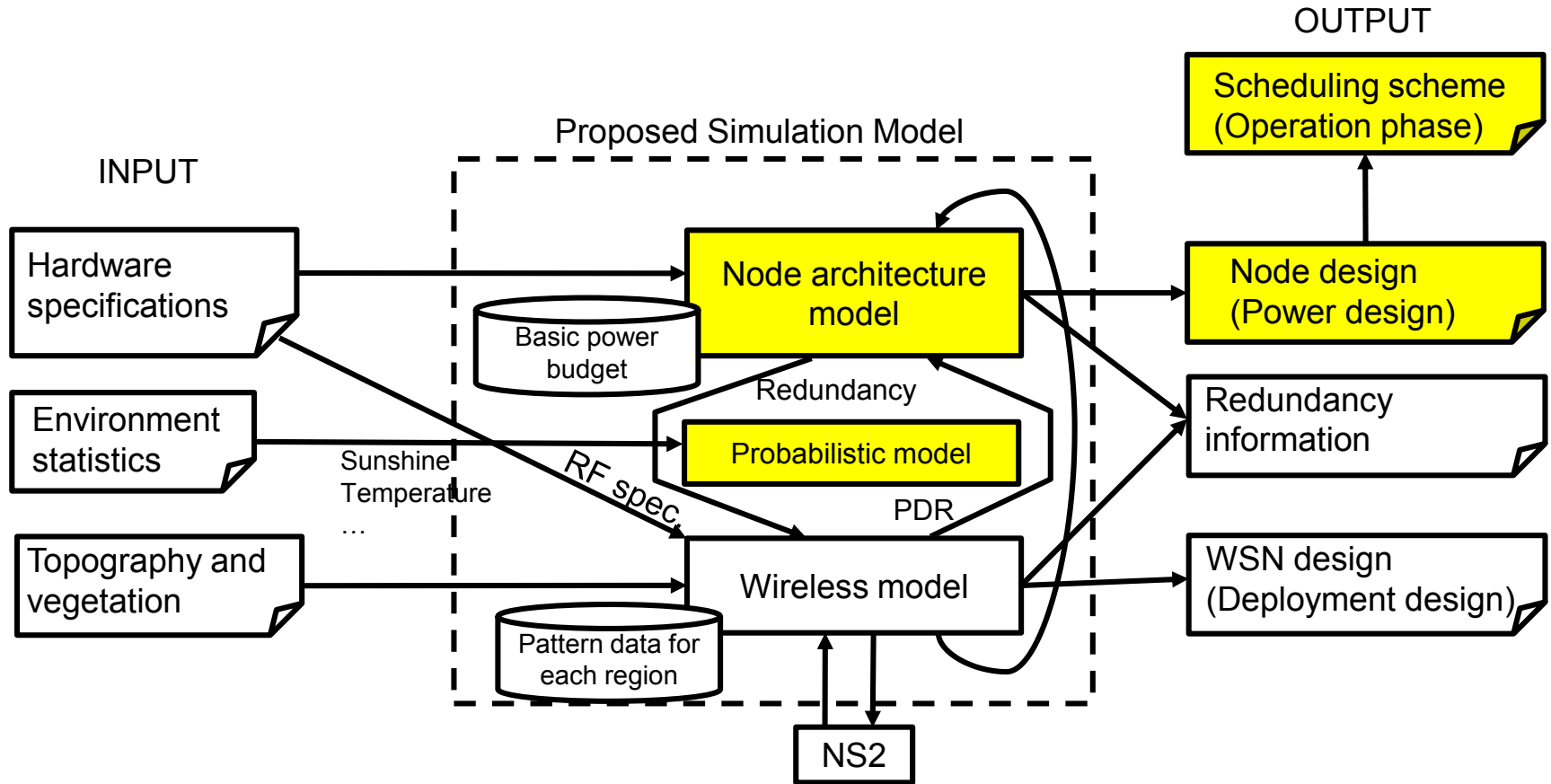


Location

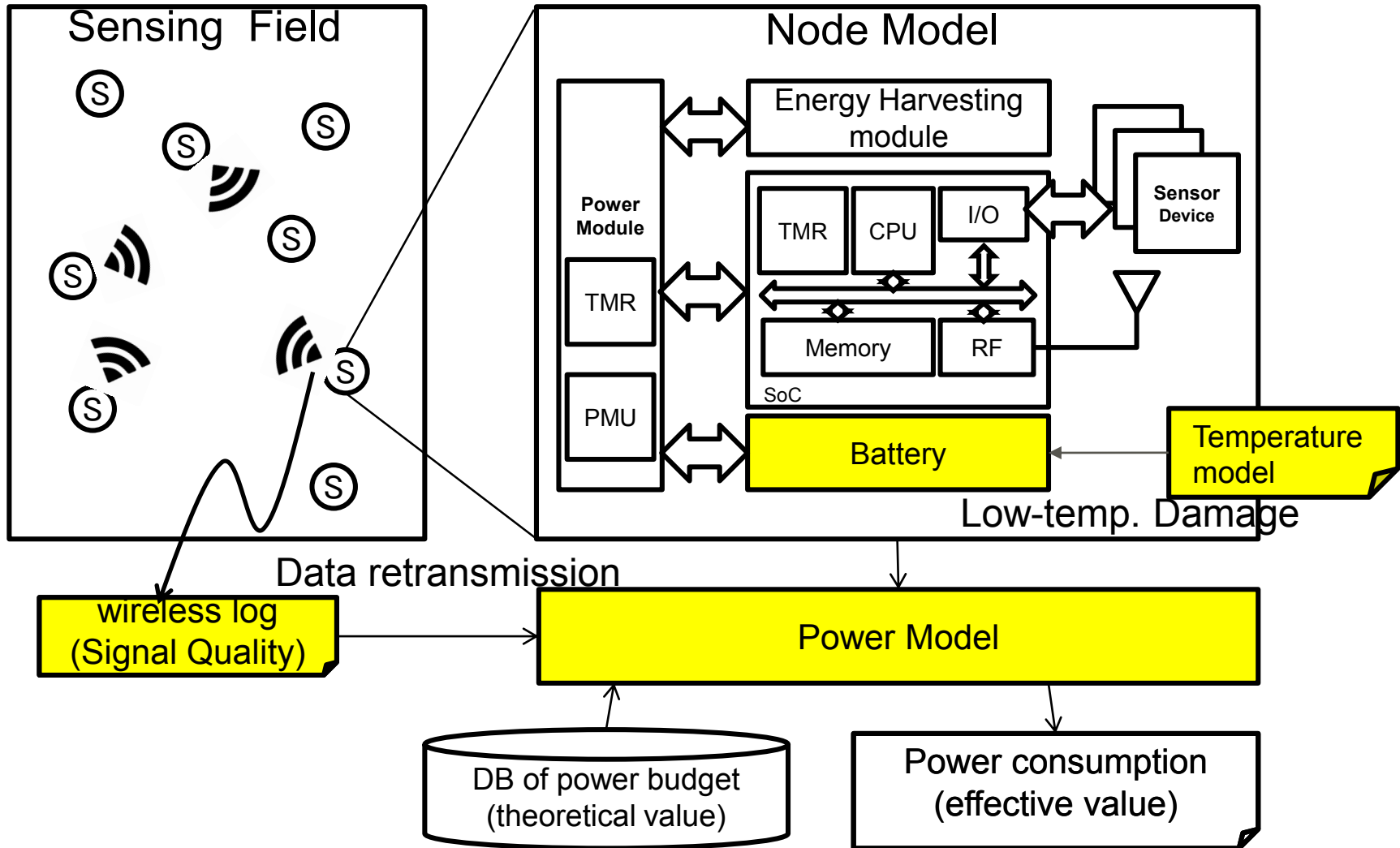
- There is composed of a slope that is sandwiched between the river and the mountain. A range of about 300m along the road, there are slopes, which is up to 30 degrees, windbreaks by conifers and deep weed. This is a typical style of local national freeway.
- it is located at 142 degrees north latitude, belongs to the subarctic humid climate. This climate classification the most widely distributed on the earth.
- Target location, 5-6 months of winter season is piled up snow more than 2 meters, the minimum temperature is minus 20 degrees [C]. In activities the slopes of volcanic ash and peat, roads were damaged by snow or underground water of snow melting past few years.



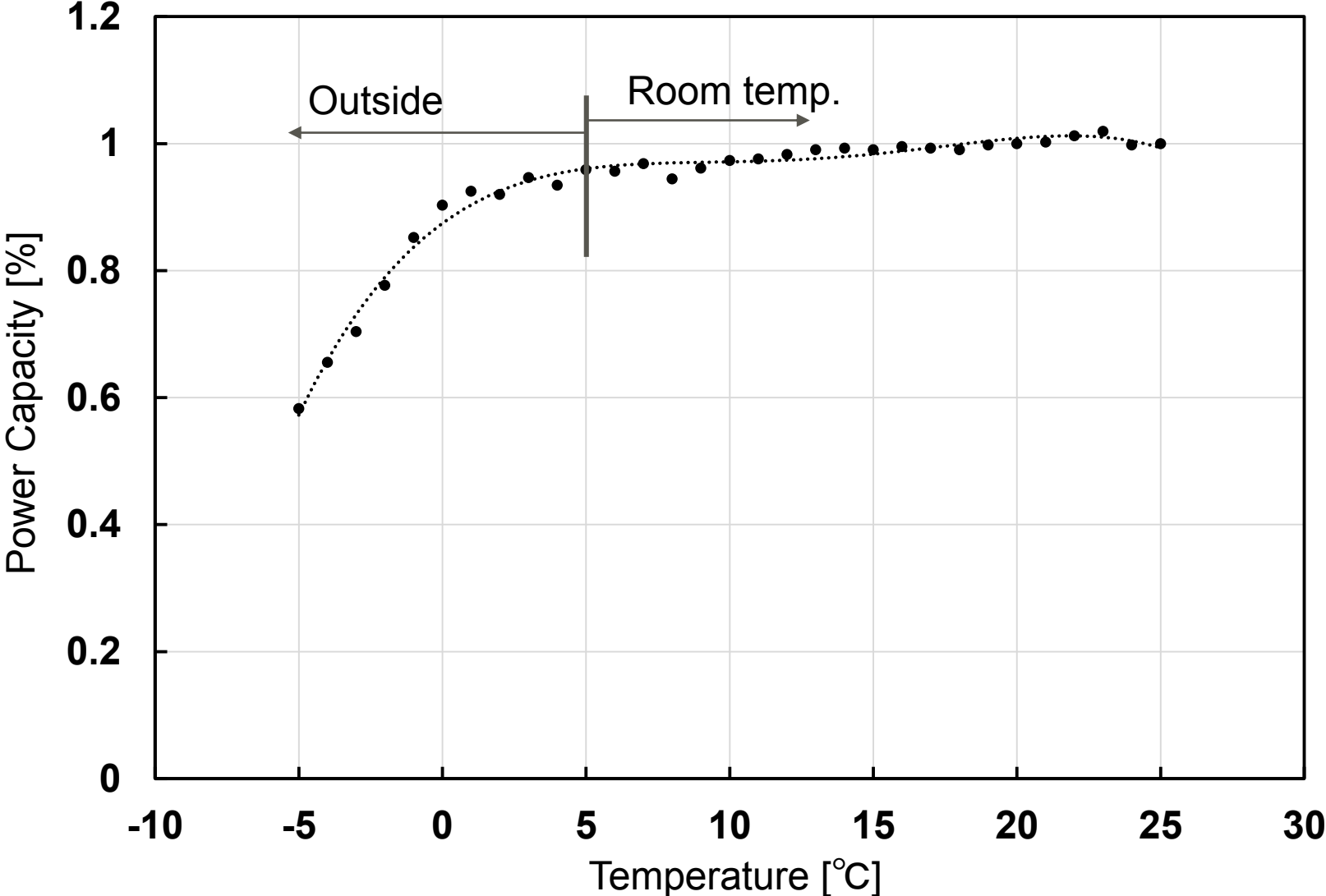
Proposed workflow



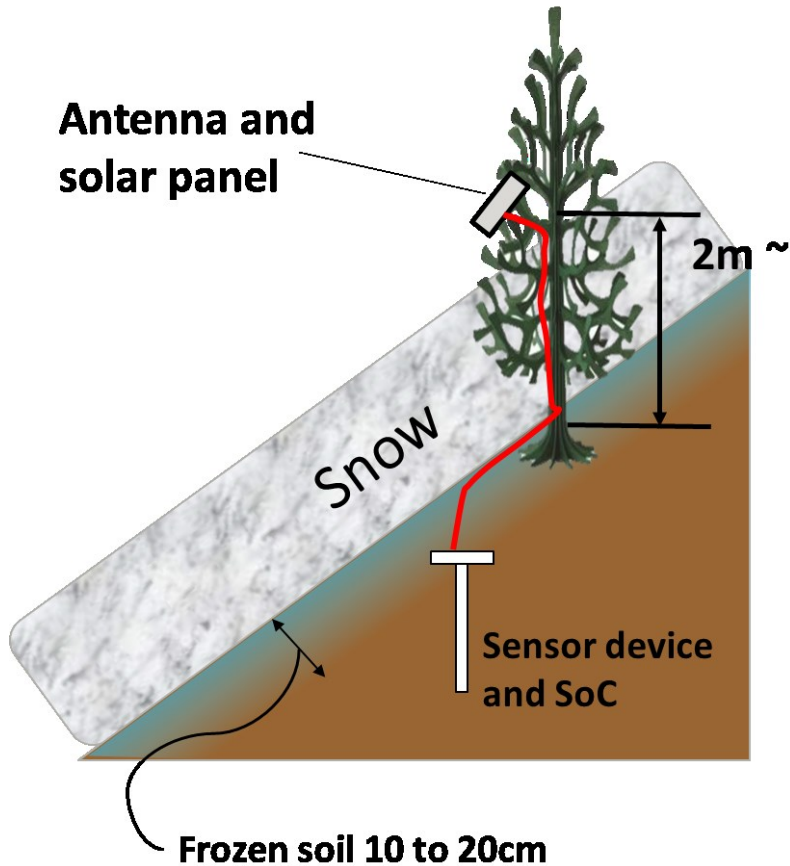
Design model



Relationship between the temperature and the battery



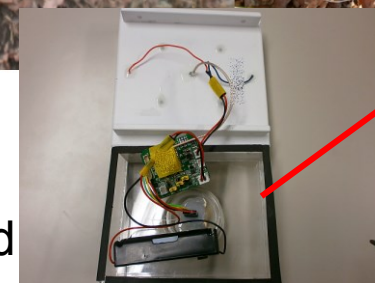
Devised Installation



Antenna and solar panel

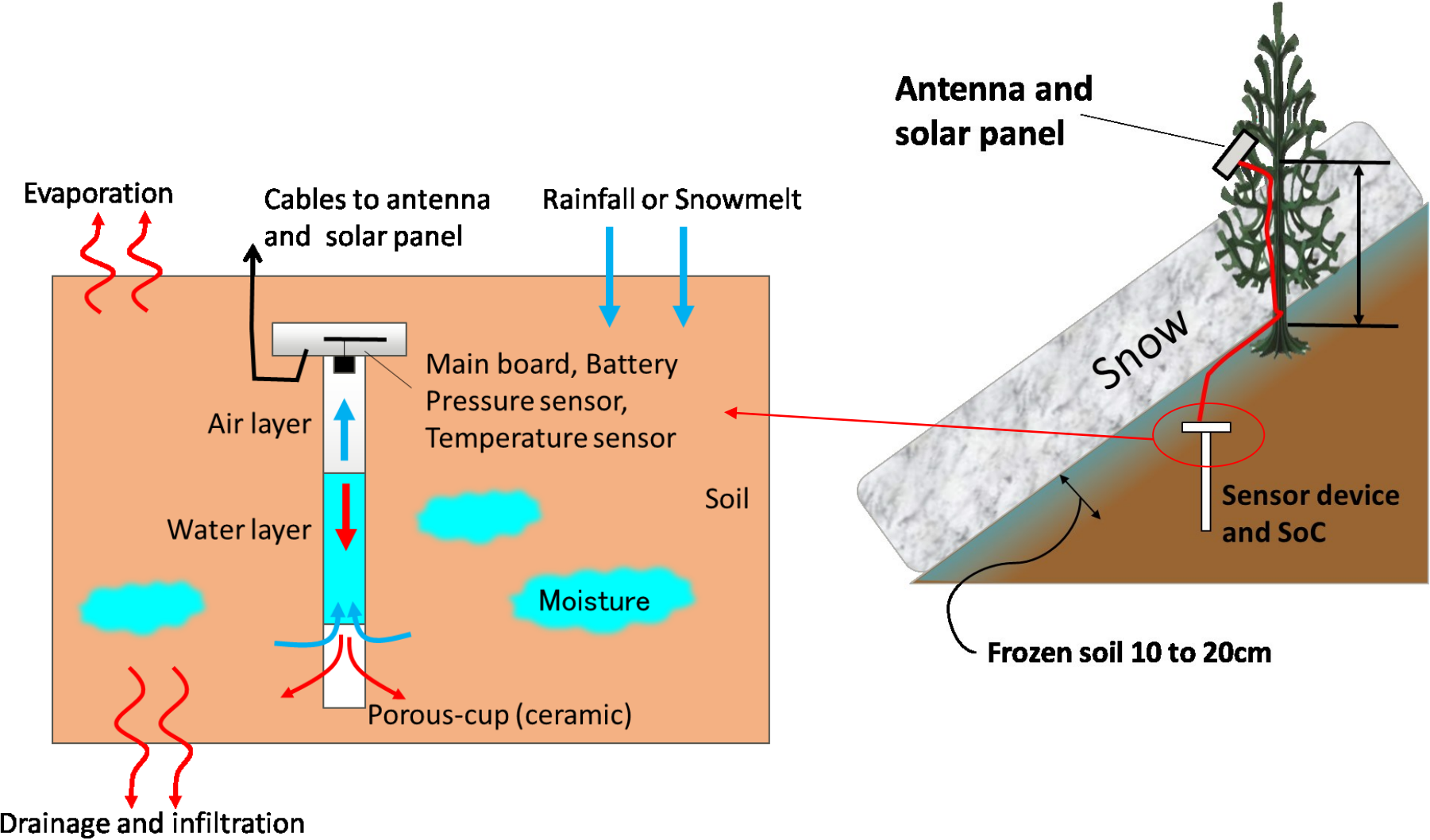


Sensor and main unit

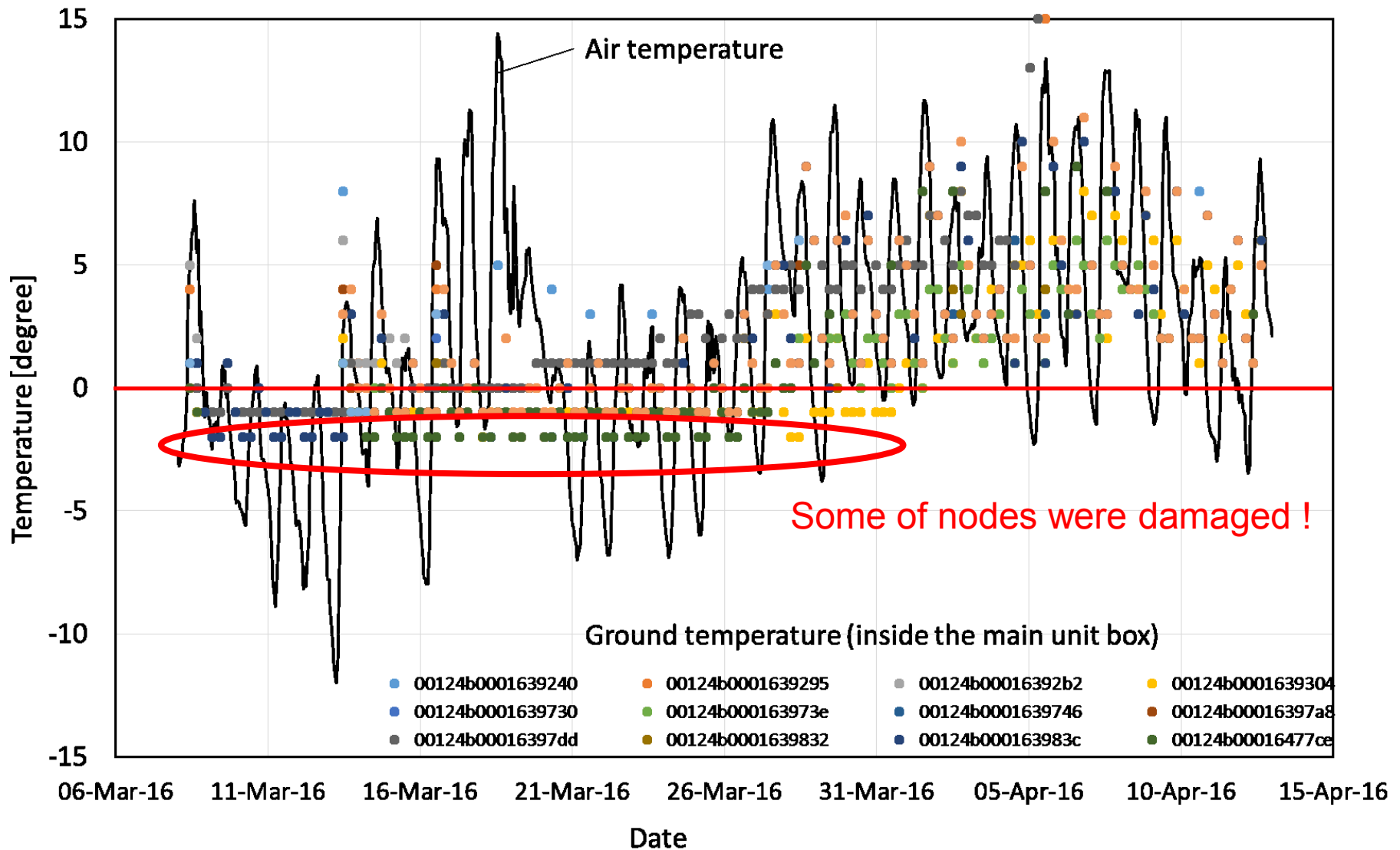


Li-Battery and main board

Sensing mechanism

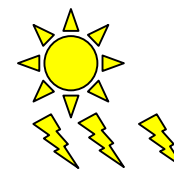


Air temperature and battery temperature

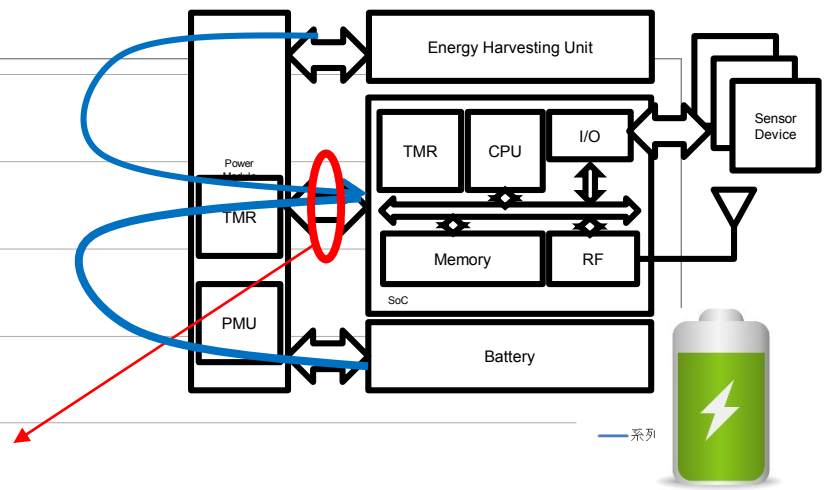
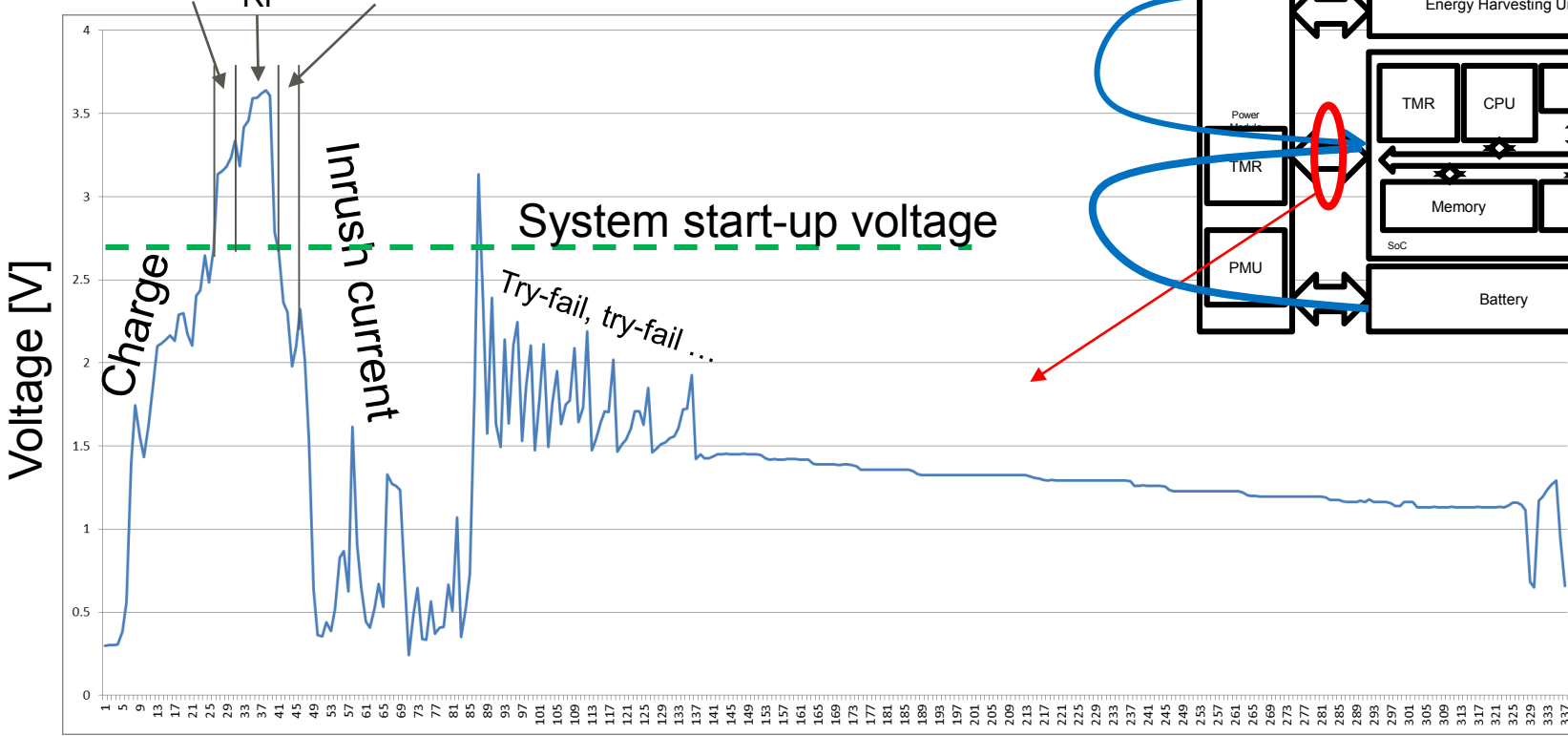


Power behavior of damaged node

There is a tendency that the voltage drop becomes larger when a large current discharge at low temperature

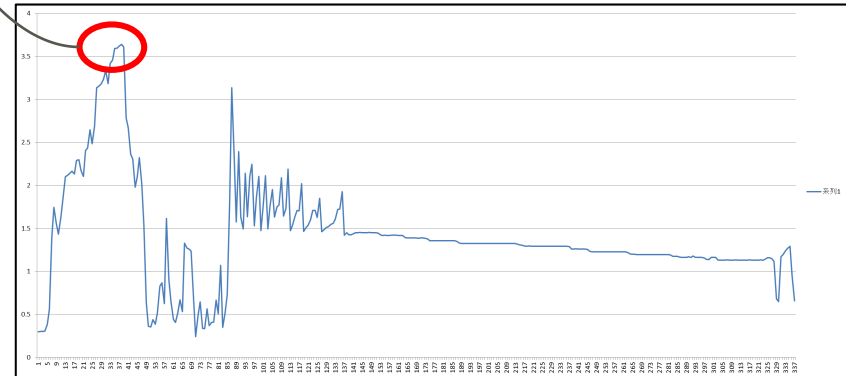
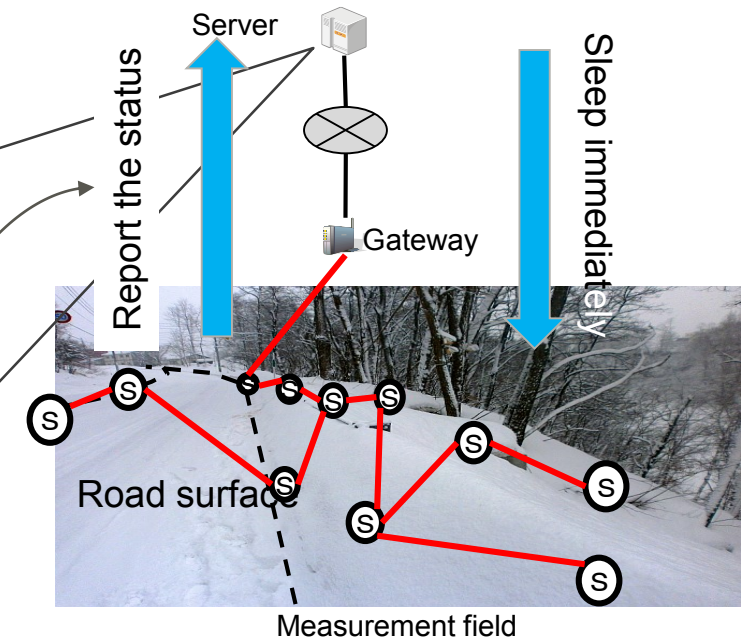
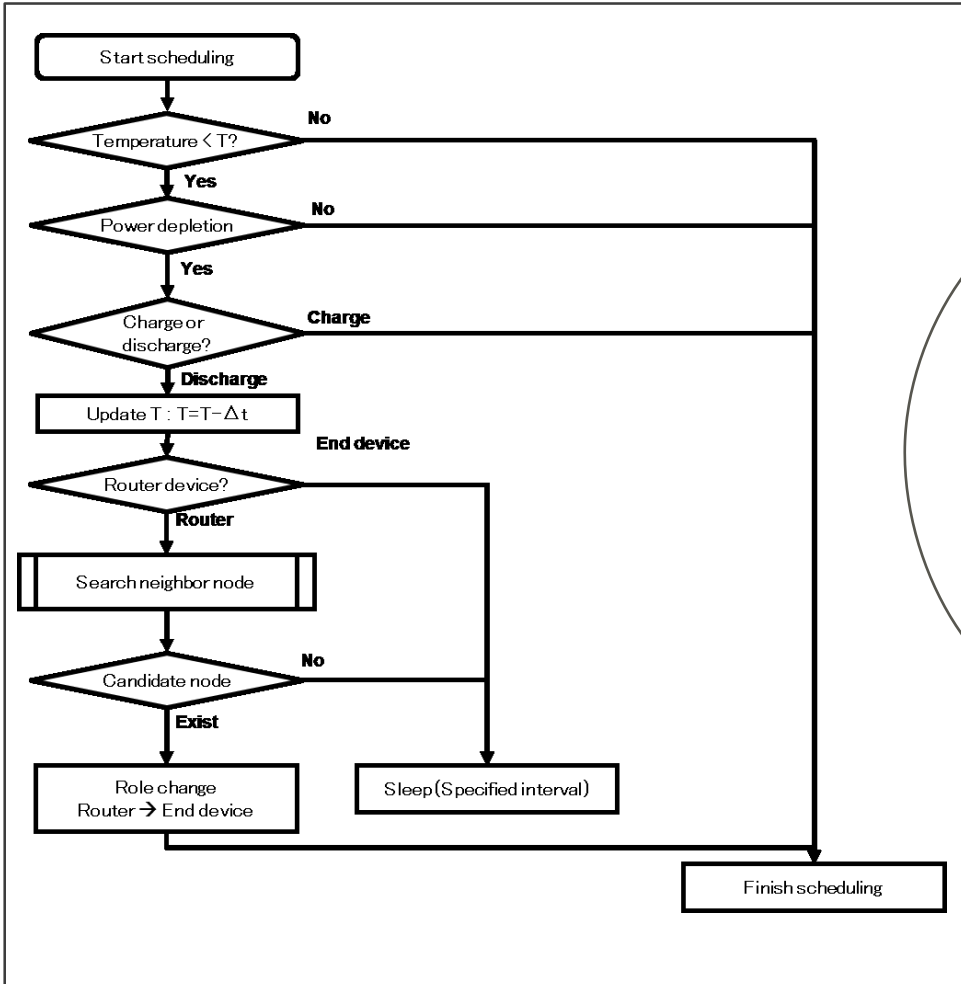


Boot-up : CPU RF Peripherals



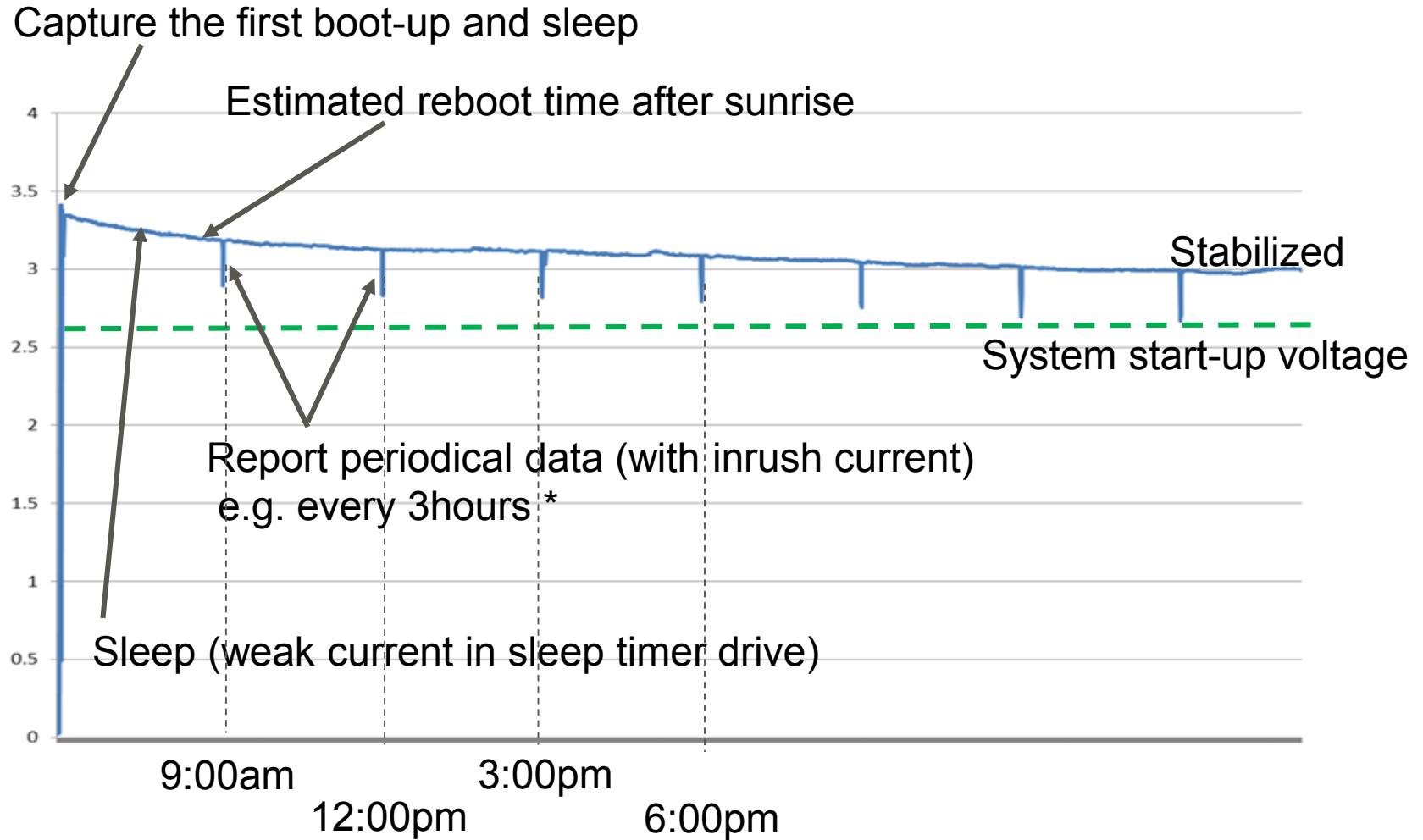
Hardware protection circuit is one of idea. But this circuit becomes a load for low-power consumption sensor node

Software scheduler for intrush protection



Scheduling key : Temperature, Power status of battery and **sunshine info from meteorological office**

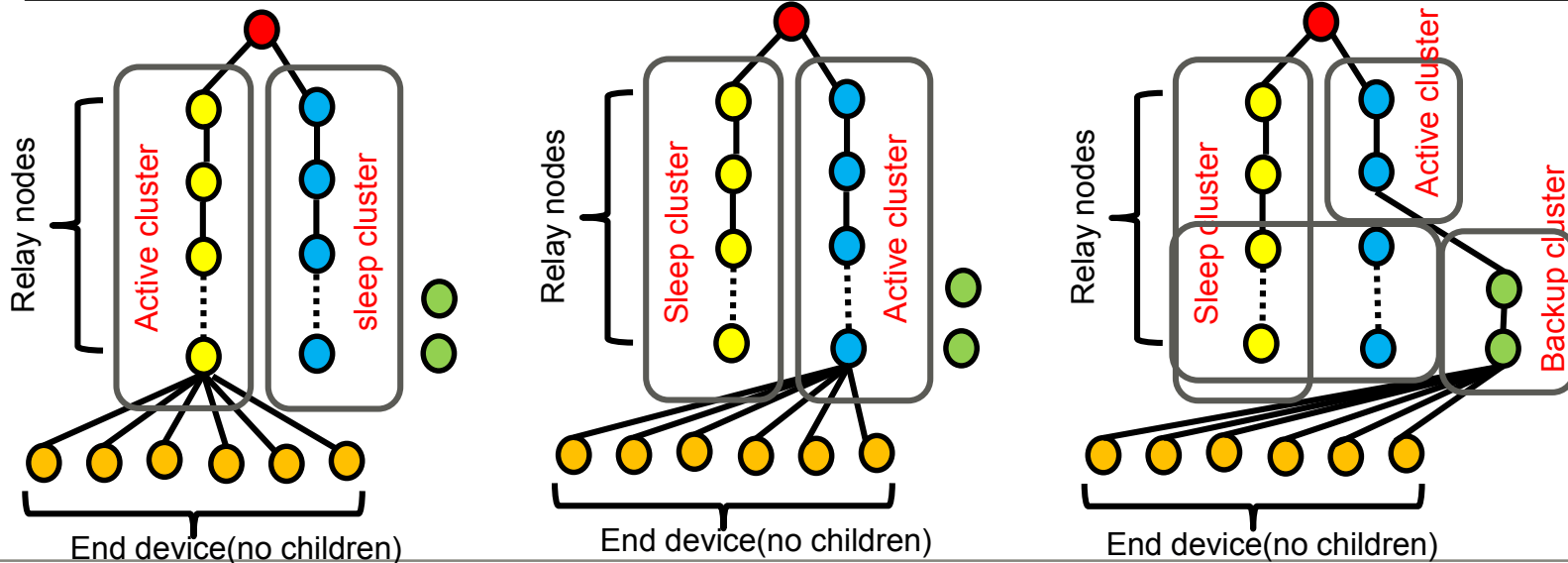
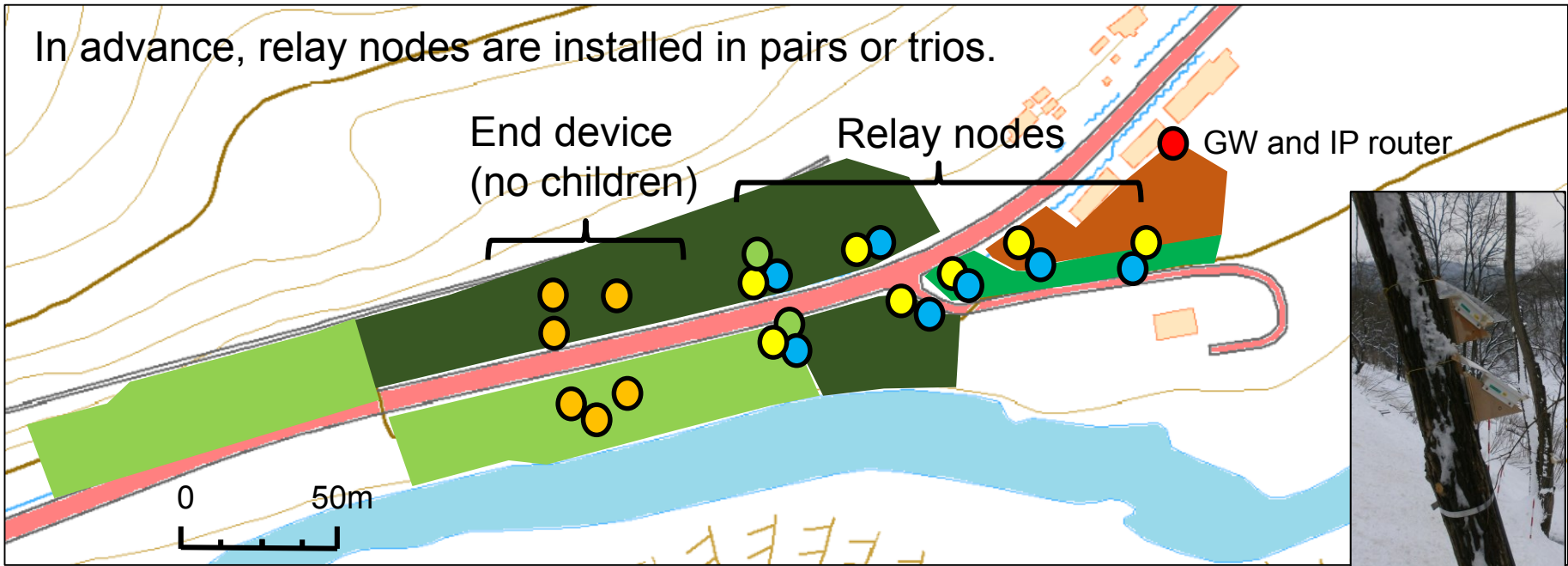
Scheduling result



*normal operation interval is 10 min.

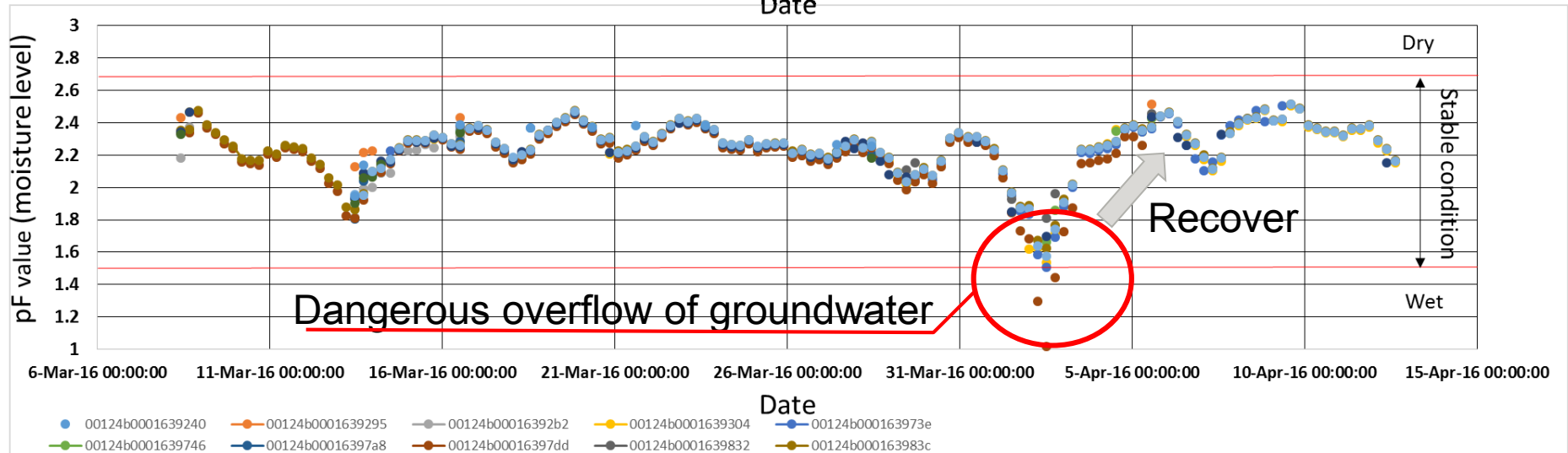
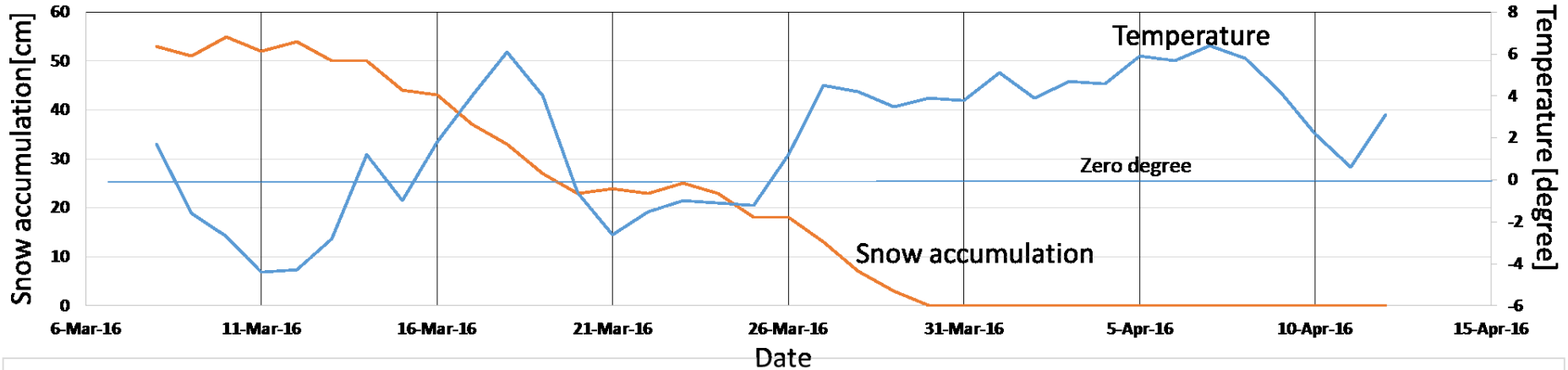
Scheduling target of node cluster


In advance, relay nodes are installed in pairs or trios.



Conclusion

■ We succeeded in real-time data collection of the snow-melt behavior with a simple system controlled by software





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