Proposal

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Outline

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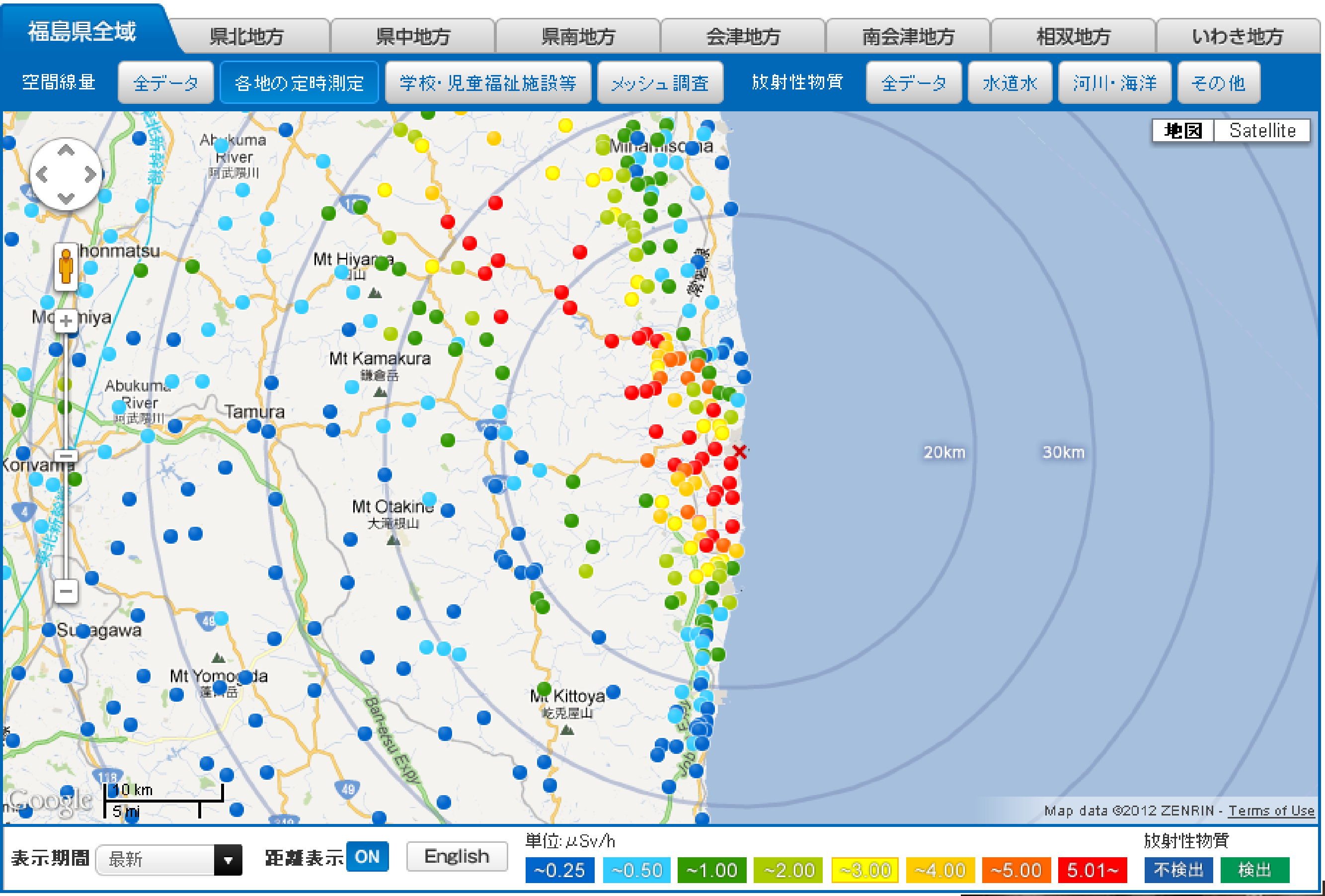
Motivation

- Fukushima Daiichi nuclear disaster
  - Tōhoku earthquake and tsunami on 11 March 2011
  - Radioactive material has been released from the Fukushima containment vessels.
  - Nuclear power plant has been destroyed, the power supply is constraint.
  - The radiation particle data (ex. iodine-131) distribution must to be report immediately to help the government determine the resident in which region should be migrated to the safety region.



Distribution of radioactive material

Satellite image of the nuclear power explosion

- Human health care
  - Daily amount of the radiation absorbed by human body is limited
  - More real time of radiate active particles’ report and more detailed distribution map can help people to avoid from the impact of radiation
- Wireless Sensor Network
  - With the low cost wireless sensor, we could spread the sensor node broadly and construct a higher resolution map, which could help us get more useful information to make decision.
  - Resource issue(ex. low power supply) can always exist in this kind of application.

- The correlation between data
  - With consideration of correlation between data, we may reserve the radio resource but achieve the same requirement of data accuracy.
  - We can design a scheduling mechanism to choose a set of sensor with lower correlation to prevent the redundancy in data acquisition.

Air dispersion model

- The Ermak solution, describe the heavy particles behavior.

$$c(x,y,z) = \frac{Q}{4\pi u r}\exp\left(-\frac{y^2}{4r}\right)\exp\left(-\frac{w_{set}(z-H)}{2K} - \frac{w_{set}^2 r}{4K^2}\right)$$

$$\times\left[\exp\left(-\frac{(z-H)^2}{4r}\right) + \exp\left(-\frac{(z+H)^2}{4r}\right)\right.$$

$$\left. - \frac{2w_0\sqrt{\pi r}}{K}\exp\left(\frac{w_0(z+H)}{K} + \frac{w_0^2 r}{K^2}\right) erfc\left(\frac{z+H}{2\sqrt{r}} + \frac{w_0\sqrt{r}}{K}\right)\right]$$

Scenario

- We choose single source and is located at (0, X, H), cluster head is located at (0,0,0)
- The wind direction and speed is fixed.
- The emission rate is a Gaussian random process.

Problem formulation

- Given the requirement of MSE, we can calculate the entropy H.

$$H \geq \frac{1}{2}\log_2\left(\frac{\left|\Sigma_v\right|}{(MSE)^N}\right)$$

- Then, if the accuracy must meet the requirement, the total entropy is constraint. And we want to minimize the total transmission time.

$$\min_{S \subseteq V} \quad \sum_{t_i \in S} t_i \;, \quad t_i = \frac{H\left(x_i\right)}{w \log_2\left(1 + \frac{G_i P_i}{W N_0}\right)}$$

$$\text{subject to} \quad h\left(x_s\right) \geq \frac{1}{2}\log_2\left(\frac{\left|\Sigma_v\right|}{\left(MSE\right)^N}\right)$$

$$\Rightarrow h\left(x_s\right) = \frac{1}{2}\log_2\left[\left(2\pi e\right)^{|S|}\det\left(\Sigma_S\right)\right] - \left|S\right|\log\Delta$$

$$= \frac{1}{2}\log_2\left[\left(\frac{2\pi e}{\Delta^2}\right)\det\left(\Sigma_S\right)\right] \geq \frac{1}{2}\log_2\left(\frac{\left|\Sigma_V\right|}{\left(MSE\right)^N}\right)$$

- Given the simulate value as the known, we can find the minimized MSE theoretically.

$$\min_{S \subseteq V} \sum_{t_i \in S} t_i \;, \quad t_i = \frac{H(x_i)}{w \log_2 \left(1 + \frac{G_i P_i}{W N_0} \right)}$$

Subject to $\quad Estimate\ value\ -\ exact\ value$

$Estimate\ value$ on discard sensors

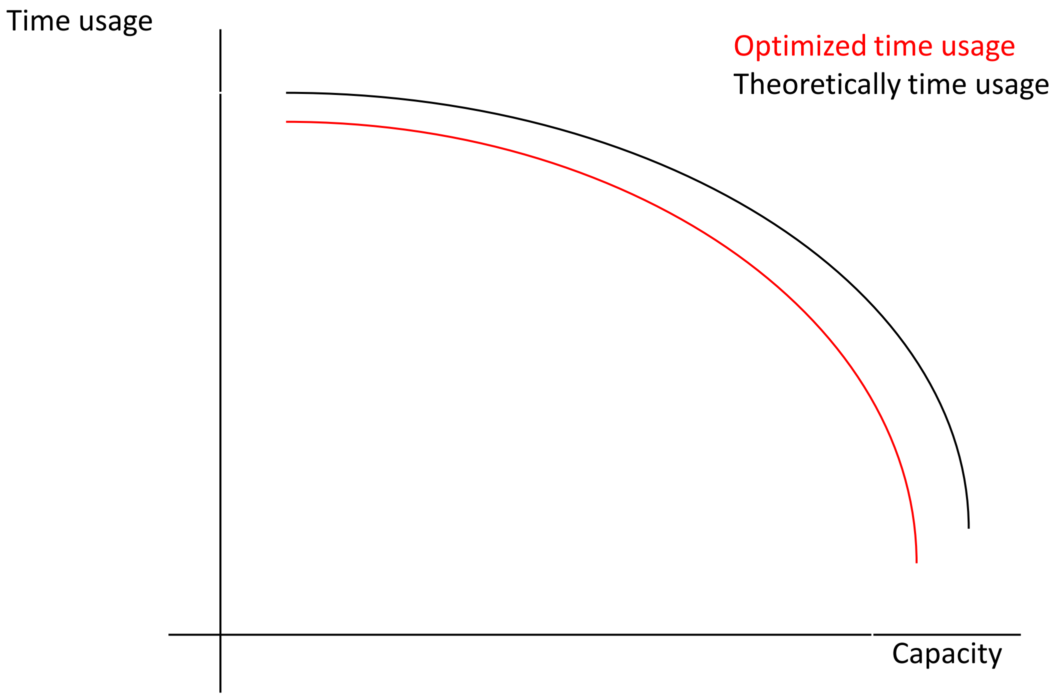
$= Q \times$ remain terms of $Ermak\ solution$

Q can be estimated by the chosen sensors

Comparison

- If we do not consider the correlation between the sensors, in order to meet the same requirement of the data accuracy all the sensors need to report their data.
- We can the compare the time usage between these two kind of mechanism.

- Expected result



- Reference

[1] http://fukushima-radioactivity.jp/

[2] http://people.math.sfu.ca/~stockie/atmos/