



Wireless Sensor Communication Systems for Bridge Monitoring

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In Japan, most of infrastructures were established in 1970's and have deteriorated rapidly.

In the next 20 years, the proportion of facilities that elapsed more than 50 years after construction is going to be higher with increasing speed.

Infrastructure equipment	2013/03	2023/03	2033/03
Road bridge 【About 400,000 bridges】	About 18%	About 43%	About 67%
Tunnel 【About 10,000 tunnels】	About 20%	About 34%	About 50%
River management facility (ex. Water gate) 【About 10,000 facilities】	About 25%	About 43%	About 64%
Sewerage pipe 【Total length : About 45,000 Km】	About 2%	About 9%	About 24%
Harbor quay 【About 5,000 facilities (water depth – over 4.5m)】	About 8%	About 32%	About 58%

Subsidence of a pier



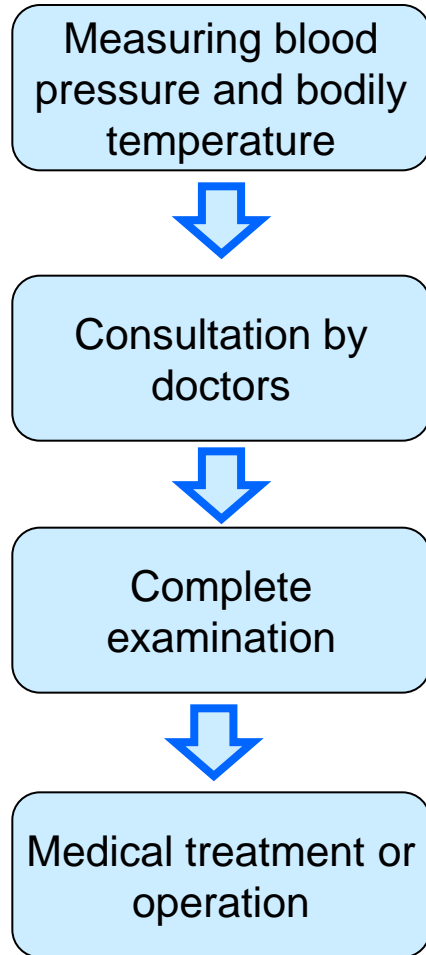
Break of a diagonal member



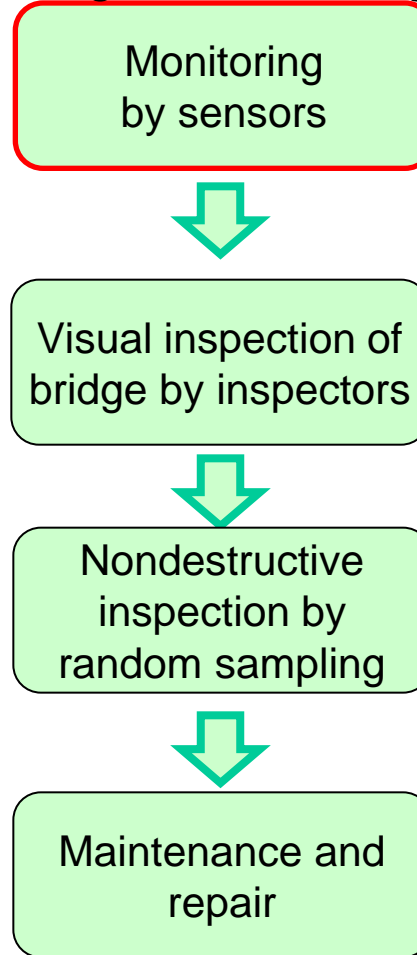
Ref. the Ministry of Land, Infrastructure and Transport document
<http://www.mlit.go.jp/hakusyo/mlit/h25/hakusho/h26/html/n1131000.html>

Monitoring by means of sensors is required to enable the efficient use of limited human resources for inspection activities.

Medical examination



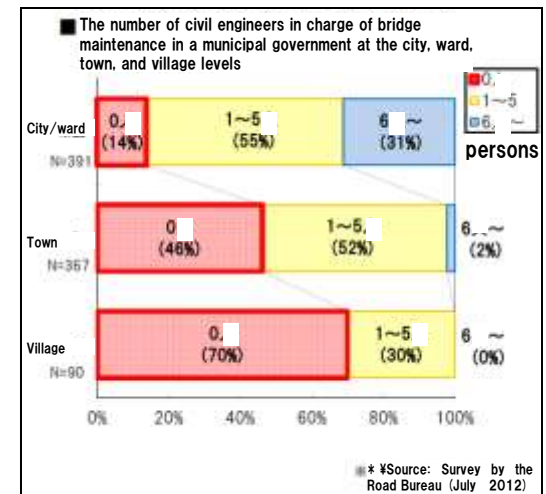
Diagnosis of bridge



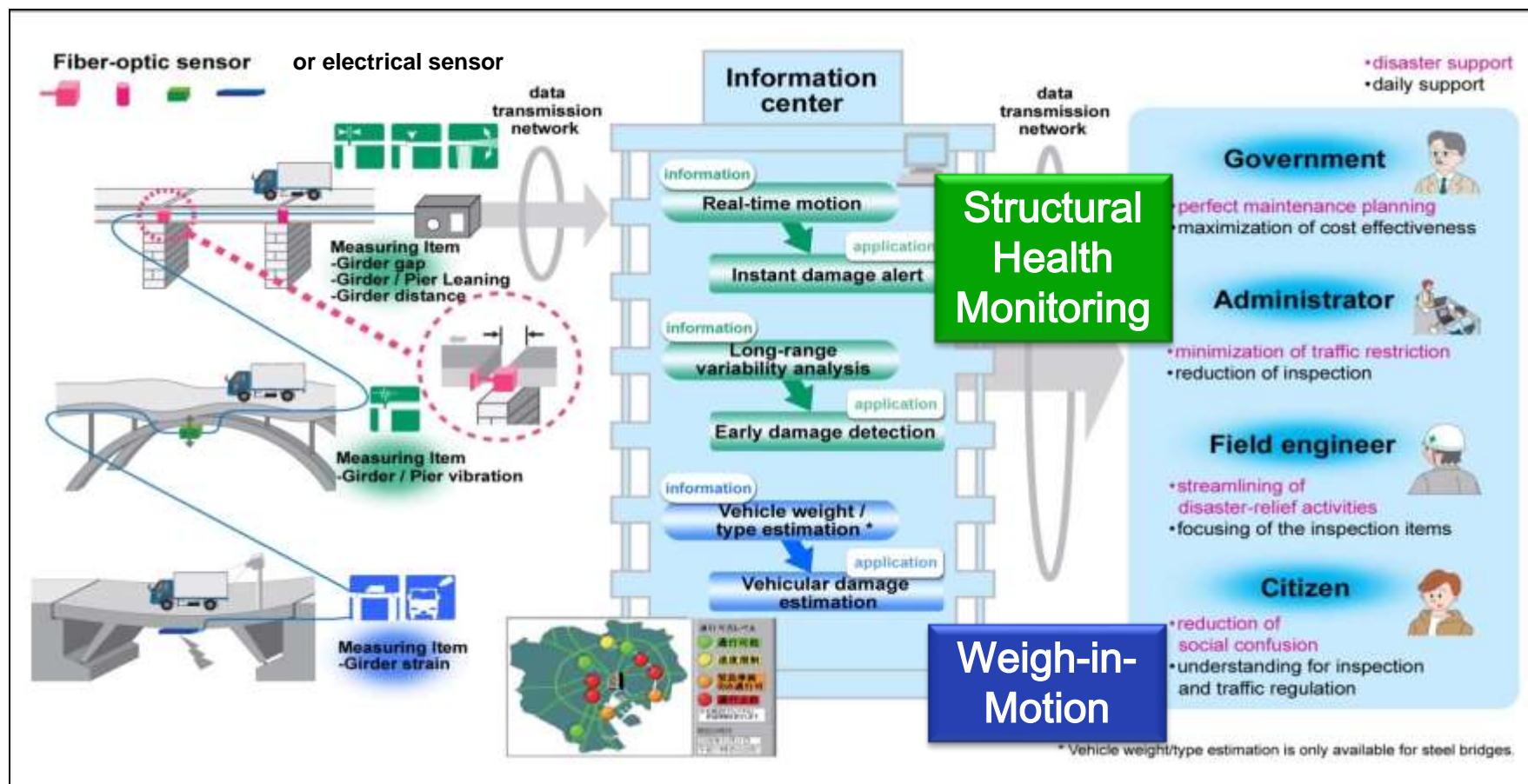
Identification of bridges requiring inspection

Efficient use of resources for inspection activities

Approx. 50% of town-level municipalities and approx. 70% of village-level municipalities do not have any civil engineering expert to take charge of bridge maintenance.



The System remotely monitors bridge in real time and provides valuable source of information to various users. Collected data is utilize to detect abnormality and develop maintenance plans.



NTT DATA installed a monitoring system to CanTho Bridge, VIETNAM in 2013

Data

- Strain
- Vibration
- Displacement
- Bridge Condition
- Temp /Rain/Wind

Usage

- Detect abnormality
- Plan effective maintenance

Bridge length 2750m



- Heavy works for their deployment on existing bridges and the risk of open circuit resulting from hazard led to increasing **needs for wireless bridge monitoring.**
- Since wireless systems are powered by batteries, which impose a limit on the number of years they may remain operable, it is necessary to **develop a communication scheme that can operate at low power consumption.**

Wired bridge monitoring

○ Issues

- The deployment of cables for wired systems is costly and **involves major works.** Moreover, there is **a risk of open circuit being caused by hazard.**

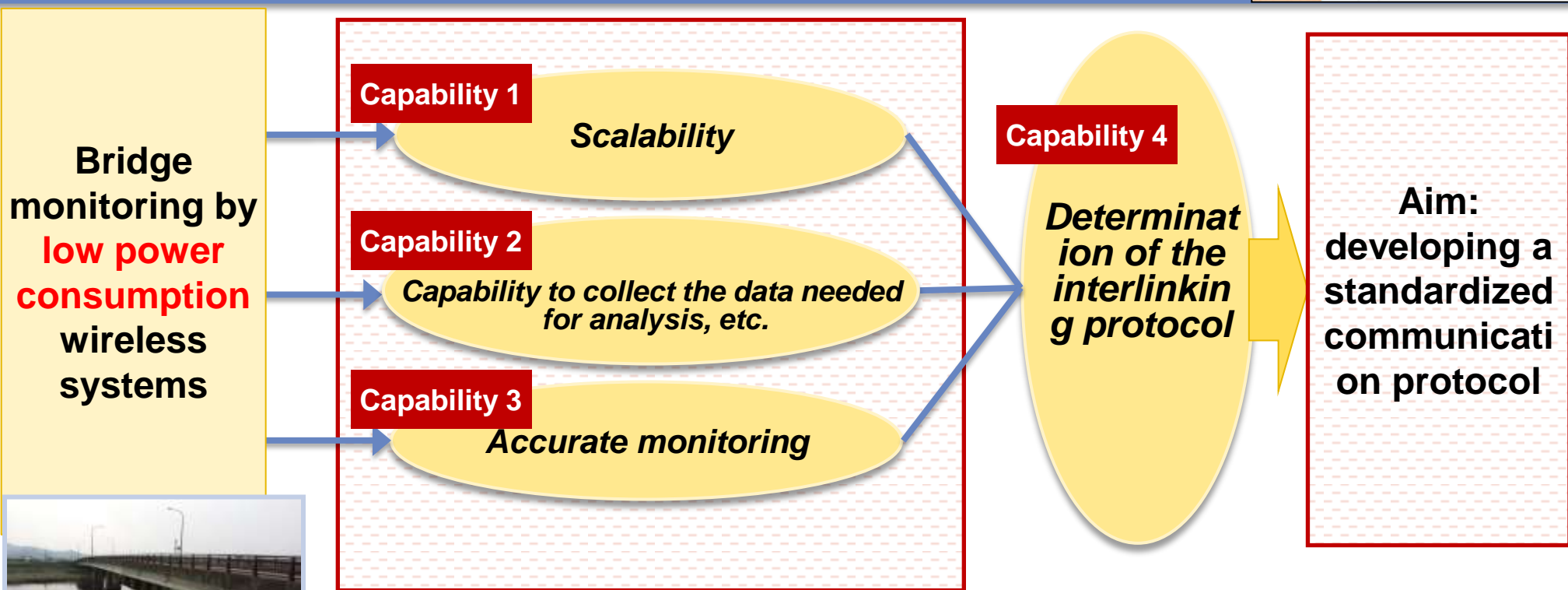
Wireless bridge monitoring

○ Needs for enabling the deployment

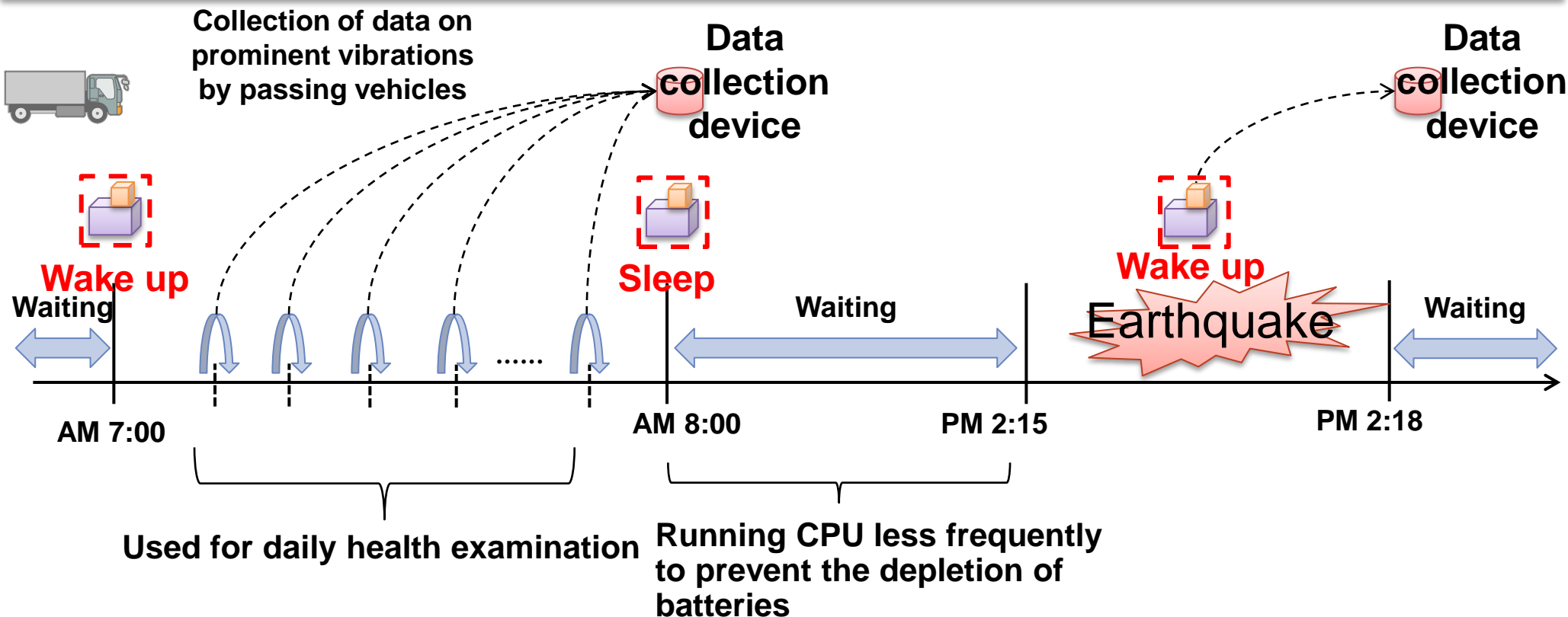
- Wireless systems allow **easy deployment with simple installation works** at limited budget.

Bridge monitoring by low power consumption wireless systems

Through R&D at the Ministry of Internal Affairs and Communications (2014 to 2016), we will try to achieve the four capabilities mentioned below (Capabilities 1-4) not solely by the performance of wireless sensors but by **the overall performance of the whole system including the communication protocol**, aiming to develop **a standardized communication protocol**.

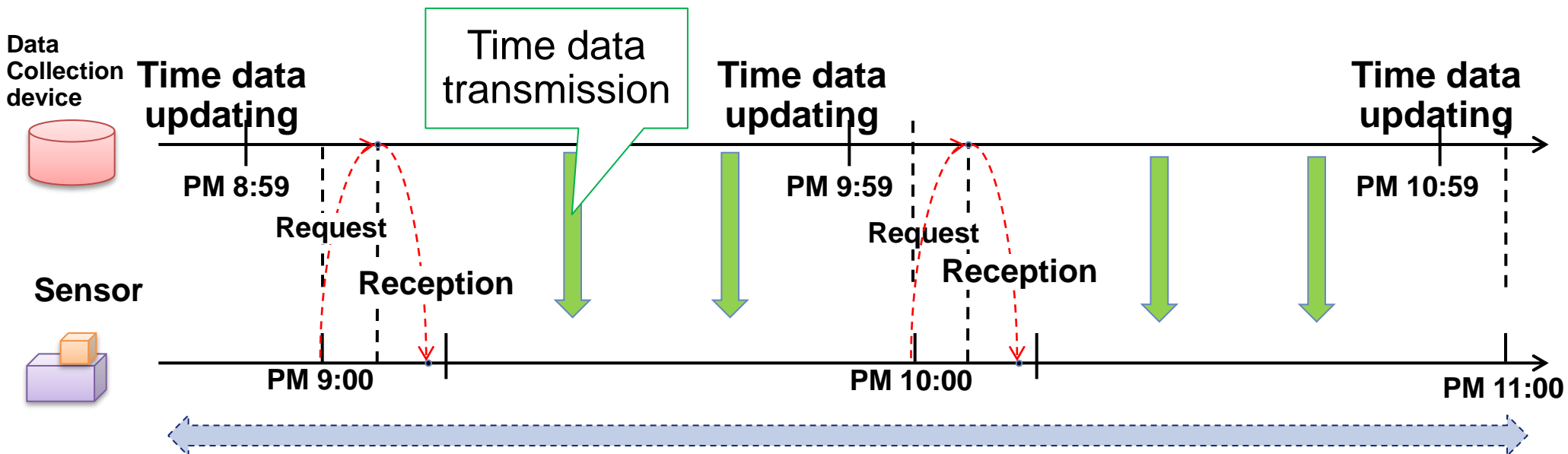


- There is no need for real-time data collection, transfer and analysis. The needs are for **the simple monitoring of bridge conditions, which is more like daily health examinations.**
- Therefore, we shall develop a low power consumption wireless communication control technology for **the transfer of bridge monitoring data with a capability to determine the priority on the basis of the urgency of the collected data.**



R&D target: the technology for timing synchronization at low power consumption

- To be able to correctly determine the behavior of the entire bridge structure, it is necessary to synchronize the operations of all sensors attached to it for measurement.
- Therefore, we shall develop a low power consumption technology for timing synchronization that consists of **updating time data of different sensors (synchronizing time) by regularly sending time data to them from a local base station.**



The power consumed by timing synchronization is minimized by waking up the sensors only when they receive the time data.



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