

A Study of Service Architecture For Probe Vehicle Information Systems including Smart-phone networks

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Introduction

- ▶ The purpose of our paper
 - ▶ This paper is submitted to show our activities for discussing issues on sharing probe data.
 - ▶ Our proposal is now still conceptualistic.
 - ▶ This work was supported by Project to Promote Strategic International Standardization on New Energy and Industrial Technology Development Organization (NEDO), Japan in 2010
- ▶ The purpose of this presentation
 - ▶ I will talk about our proposal for structuring of PVS services, as the work in progress
 - ▶ We would like to hear several opinion for the way to share probe data, quality of service, ...

Background

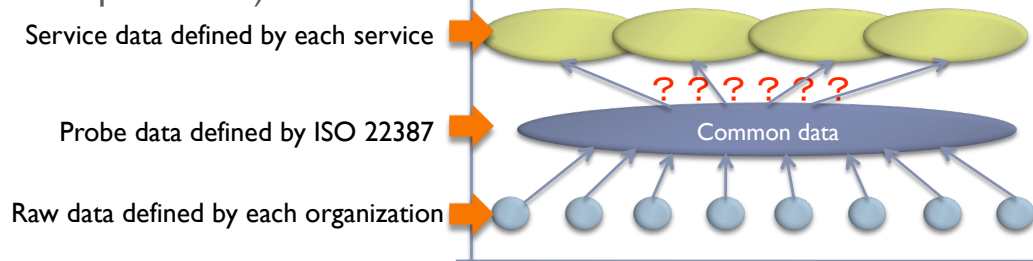
- ▶ Many probe vehicle information systems (PVS) are now developed and deployed around the globe.
 - ▶ The formerly trend of PVS is applied to collect sensing probe data from the dedicated in-vehicle devices but also smart-phones, PND, or other nomadic devices.
 - ▶ Novelty services leveraging the sensor data are developed in the ITS market.
 - ▶ The diversity of communication media and configuration for V2V and V2C is emphasized.
 - ▶ Sharing some kinds of probe data could press for improvement in quality of services with low cost.
- ▶ For the definition of probe data by ISO 22837
 - ▶ → we can share the probe data *technically*
- ▶ However...

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- ▶ We can share the probe data *practically*?
 - ▶ still unclear the service domain
 - ▶ Inadvertent data sharing also caused some problems
 - ▶ The threat against personal data
 - ▶ Difficulty of validation or consensus for freshness, reliability, responsibility, or granularity of data
 - ▶ they will be caused by unclear requirements
- they are the troubles from noncommittal service domain (and its requirements)



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Additional issue on background for PVS

- ▶ The mainstream of PVS, called as automotive telematics, used to collect probe data by dedicated in-vehicle equipment.
- ▶ Nowadays there are some novel applications using probe data with smart-phone or other nomadic devices.
 - ▶ They has been intergraded into many aspects of our lives not only ITS area
 - ▶ Ecological services
 - ▶ Shopping recommendation
 - ▶ ;
- ▶ The general design of PVS, such as service architecture, is still formless.
 - ▶ There is much to be done for sharing valid data with some different PVS to enhance the applications even though the international standard for probe data.
 - ▶ The level of personal data protection
 - ▶ Quality of services

Our purpose

- ▶ That is why...
 - ▶ We abstract the PVS including the sensing data from new devices,
 - ▶ To discuss about the common terms and indexes, which shall be compliant with the international standards, to deliberate comprehensively with some different systems,
 - ▶ To study about a basic framework for service architecture
- ▶ Our purpose
 - ▶ We will intend to make an abstraction of service architecture for some PVS to achieve mutual understanding objectively
 - ▶ And to enable to leverage the valid data among different PVS or services on the internet.
 - business and economic aspects of ITS

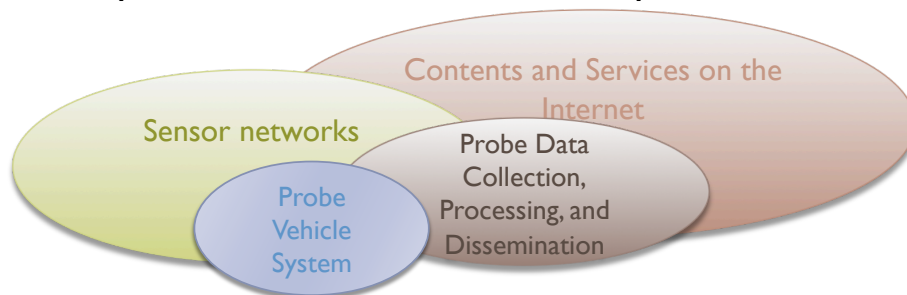
Approach

- ▶ Approach to define / construe a service architecture for PVS
 - ▶ We focus on the probe VEHICLE information system on the ITS area, so it is necessary to define / construe the boundary domain of PVS.
 - ▶ Surely it is included the system using multipurpose nomadic devices.
 - ▶ We will abstract and classify the common elements, functions, and attributes in terms of data flow
 - ▶ And marshaling service domain in terms of service flow
- ▶ We'll structure the model of service architecture as a logical puzzle using the function and attribute of the classified elements on each service domain.

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To construe the boundary domain of PVS

- ▶ PVS mean, “the several systems for probe data collection, processing, and dissemination”.
 - ▶ The target of collecting probe data on broad PVS is not limited for vehicles.
 - ▶ The origination can be small-fixed sensors or data on huge data constellation managed on the Internet.
- ▶ For defining the service architecture as the general design of PVS, it is necessary to define/construe the boundary domain of PVS.



- ▶ Existing “probe vehicle systems”, “vehicle sensor” and “probe data” are defined by ISO 22837:2009 (chapter 4: Terms and definitions).
 - ▶ 4.1 *probe vehicle system*
 - ▶ **system consisting of vehicles which collect and transmit probe data** and land-based centres which collate and process data from many vehicles to build an accurate understanding of the overall roadway and driving environment.
 - ▶ 4.2 *vehicle sensor*
 - ▶ **device within a vehicle** that senses conditions inside and/or outside the vehicle or that detects actions that the driver takes.
 - ▶ 4.3 *probe data*
 - ▶ vehicle sensor information, formatted as probe data elements and/or probe messages, that is processed, formatted, and transmitted to a land-based centre for processing to create a good understanding of the driving environment.

Our construction for PVS domain

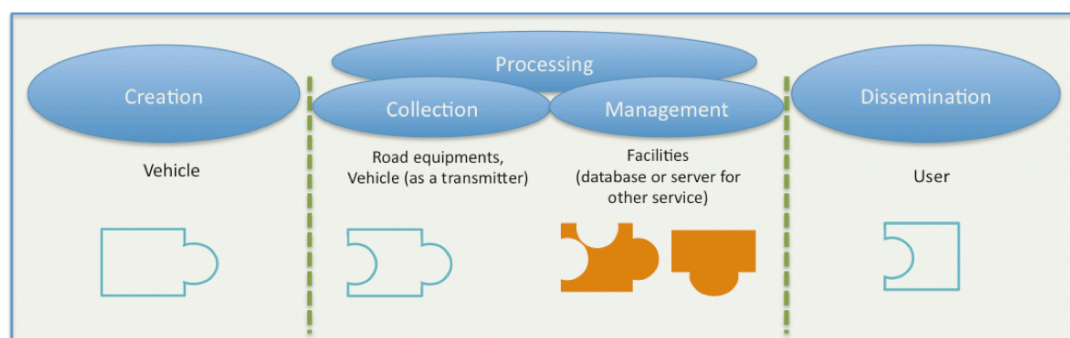
- ▶ The sensing devices on some PVS as the target of collecting probe data are not limited for the equipments on vehicles
 - ▶ we construe that *the origination* of PVS have to be a vehicle.
 - ▶ “The origination” means the source in terms of data flow
 - it includes some sensor data from vehicle onboard equipments, from smart-phones on the seat, and from other nomadic devices in-vehicle, which can transmit as “*a probe data from vehicle*” logically.
 - ▶ “A probe data from vehicle” means that a sensing data formatted as probe data elements and/or probe messages
 - that binds the special and temporal information, which determine the position of the vehicle on the Earth’s surface.
 - ▶ The origination vehicle of PVS includes two wheels.

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- ▶ The diversity of communication media and configuration for V2V and V2C is emphasized.
 - ▶ Though **most of PVS are built as the specified services.**
- Our goal is to make a structured design for diversity of PVS
- ▶ With extracting some common elements, functions or attributes on the PVS
 - ▶ extract the elements of PVS as three series including two parts
- ▶ 3 series including 2 parts
 - ▶ **Creation**
 - ▶ **Processing**
 - ▶ Collection
 - ▶ Management
 - ▶ **Dissemination**

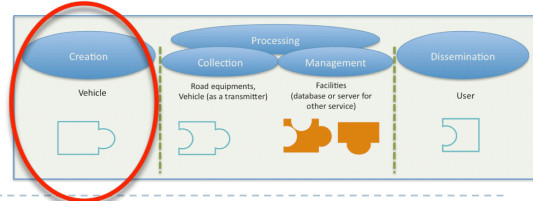
The definition of series and parts

- ▶ The instance of specific elements
 - ▶ Creation: probe vehicle
 - ▶ Processing:
 - ▶ Collection: road equipment, vehicle as a transmitter
 - ▶ Management: facility (server or database on the internet)
 - ▶ Dissemination: users



Creation series

- ▶ “Probe vehicle” in the Creation series
 - ▶ is the origination vehicle on the Earth’s surface
 - ▶ it creates probe data from vehicle onboard equipments, smart-phones on the seat, and other nomadic devices in-vehicle.
 - ▶ after creating a probe data
 - ▶ They will transmit them using some communication infrastructure.
 - ▶ The samples of attributes
 - ▶ two wheels / four wheels
 - ▶ commercial / public / personal / emergency
 - ▶ the type of communication devices
 - ▶ ;



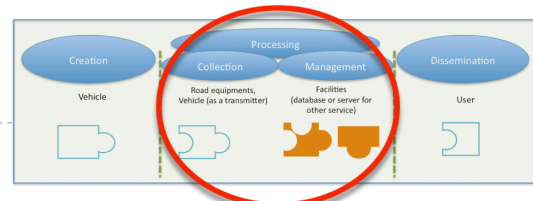
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Processing series

- ▶ “Processing series” is divided to 2 parts
 - ▶ *Collection and Management*
 - ▶ address per primam and secondary (n-th extension) probe data.
- ▶ The Collection
 - ▶ The instances of the Collection part are road equipments such as signals, vending machines on roadside or vehicles as a transmitter that does not create probe data.
 - ▶ They collect the primary probe data
- ▶ The Management
 - ▶ The instances of the Management part are some facilities on the communication infrastructure
 - ▶ They are in common services, and receive primary probe data from the instance of the Create or the Collection, and manage them as the secondary or n-th probe data,
- ▶ The samples of attributes
 - ▶ Service domains (e.x. public traffic information, weather news, environments analysis),
 - ▶ Communality, Anonymity, ..



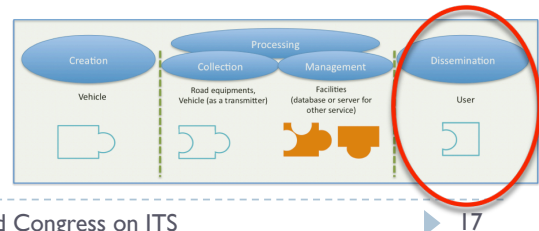
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Dissemination series

- ▶ The instance of the Dissemination series is users
 - ▶ web browser on the officer or car navigation system
 - ▶ They receive the n-th probe data
 - ▶ which created as a useful service of the driving environment by the instance of the Management.



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- ▶ The instance and role of each element for PVS

	Create	Collection	Management	Dissemination
The instance	Probe Vehicle	Road equipment, Vehicle (transmitter)	Facilities (common server, database)	User
Roles on PVS	Probe data element	Primary probe centre	Secondary / n-th centre (Other data source)	User



Personal information
Is NOT included.



Process / Manage for
specific use of probe data
(i.e. anonymize data)

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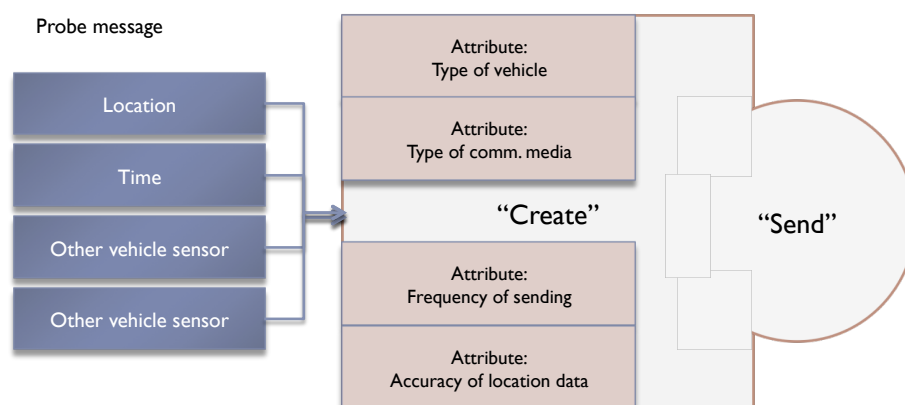
Functions

- ▶ The main functions of elements for PVS are communication, store and processing.
 - ▶ Communication
 - ▶ the instances of the Create must have the “send” function since they create probe data and send them to the instance of the Processing
 - ▶ the instances of the Collection in Processing must have the “receive and send” function since they get the primary probe data from the instance of the Create, and send them to the instance of Management or Dissemination
 - ▶ the instance of Management have “send” function since they provide the n-th probe data to the Dissemination, but the “receive” function is optional
 - If the instance may perform the common service domain as the n-th server, they do not need to get any probe data
 - ▶ the instance of Dissemination must have the “receive” function
 - ▶ As a future work,
 - ▶ we will discuss the details of other attributes and functions
 - ▶ the type of vehicle, the type of communication media, access control for database, data lifetime, frequency of update the database, synchronous requests with common services, ...
 - ▶ The number and kind of attributes / functions are different from each series or parts.

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- ▶ To make the common terms or indexes to deliberate comprehensively with some different probe vehicle information systems
 - ▶ it needs to define the level of requirements like accuracy or quality of information acceptable for the service providers.
 - ▶ These requirements are derived from each use case or services.
- ▶ → we may *organize the service domain for PVS*
 - ▶ The inquest about service domain is extracted from service flow, and needed for collaborative systems to counsel the concrete attributes and functions, such as data precision or time synchronization.
 - ▶ For this inquest, we propose the **piece of attributes** for the element of probe vehicle information systems like the pieces of jigsaw puzzle.

- ▶ In terms of the service flow
 - ▶ Quality requirements are different from various services
 - ▶ accuracy of data, frequency of update, degree of confidence...
 - ▶ Quality Analysis and Quality Assurance are absolutely necessary for the collaboration (the sharing data)



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- ▶ This piece of attributes for each element makes the relationship with different PVS simply as the service-oriented architecture in term of service flow.
 - ▶ These attributes will be described as the common terms or indexes to consider the possibility of collaboration.
 - ▶ As the future work...
 - ▶ We will have to design the details of these pieces to describe some levels of requirements and the relationship with other collaborative service domain.

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Service Domain

- ▶ The attribute in term of service flow is construed depending on the service domain (especially depending on levels of requirements and the relationship).
 - ▶ Traffic information service
 - ▶ Weather information service
 - ▶ Environmental information service
 - ▶ Operational status of society's infrastructure
 - ▶ ;
- ▶ We studied some main service domains based on the report published by Ministry of Land, Infrastructure, Transport and Tourism, Japan.
 - ▶ “public nature, social nature” or “value-added, differentiated”
 - ▶ “anonymous data” or “onymous data”

Conclusion

- ▶ **Consideration**
 - ▶ We're focused on the leverage of the information sharing/utilizing through some current PVS including smart-phone network.
 - ▶ Discussed a basic framework to make an abstraction of Service Architecture (SA)
 - ▶ Construed the boundary of PVS, and extracted the elements
 - ▶ Discussed the piece of attributes for the element
 - ▶ We offered a glimpse at the direction the collaboration with PVS including multipurpose devices.
- ▶ **Future works**
 - ▶ We have to make this proposal more sophisticated.
 - ▶ discuss the details of other attributes and functions
 - ▶ We will propose to the standardization at ISO/TC204/WG16
 - ▶ For exchanging / sharing the valid probe data effectively.

Thank you for your attention

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