

Standardization of Location Data Representation in Robotics

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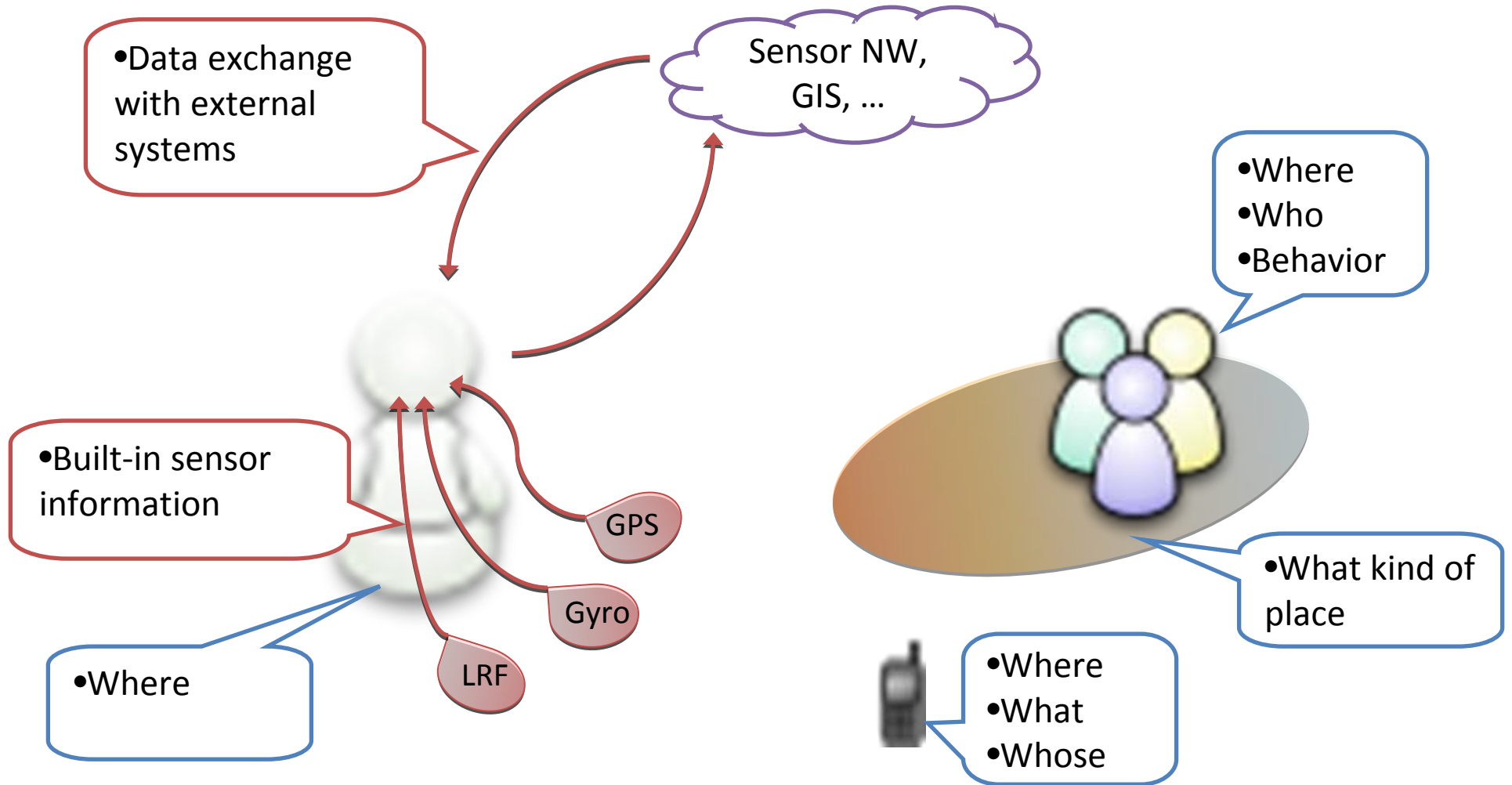
Kyoto, Japan

Why a Standard for Robotic Localization?

- Every robot requires location data
- But nothing standard yet
- For making research/development of robots easy, a standard is required

- Also important for interoperating with heterogeneous systems
 - indoor-outdoor seamless operation requires connecting to GIS and other Sensor Network Systems

Localization Data in Real Environments



I am Cam2, I see 3 entities
table: ID=23,
pos=(10,20)table: ID=73,
pos=(-23,72)
robot: ID=12, pos=(-53,56)

I am Cam1, I see 3 entities
person: ID=14, (34,21)
robot: ID=25, (58,55)
sofa: ID=134, (93, 42)

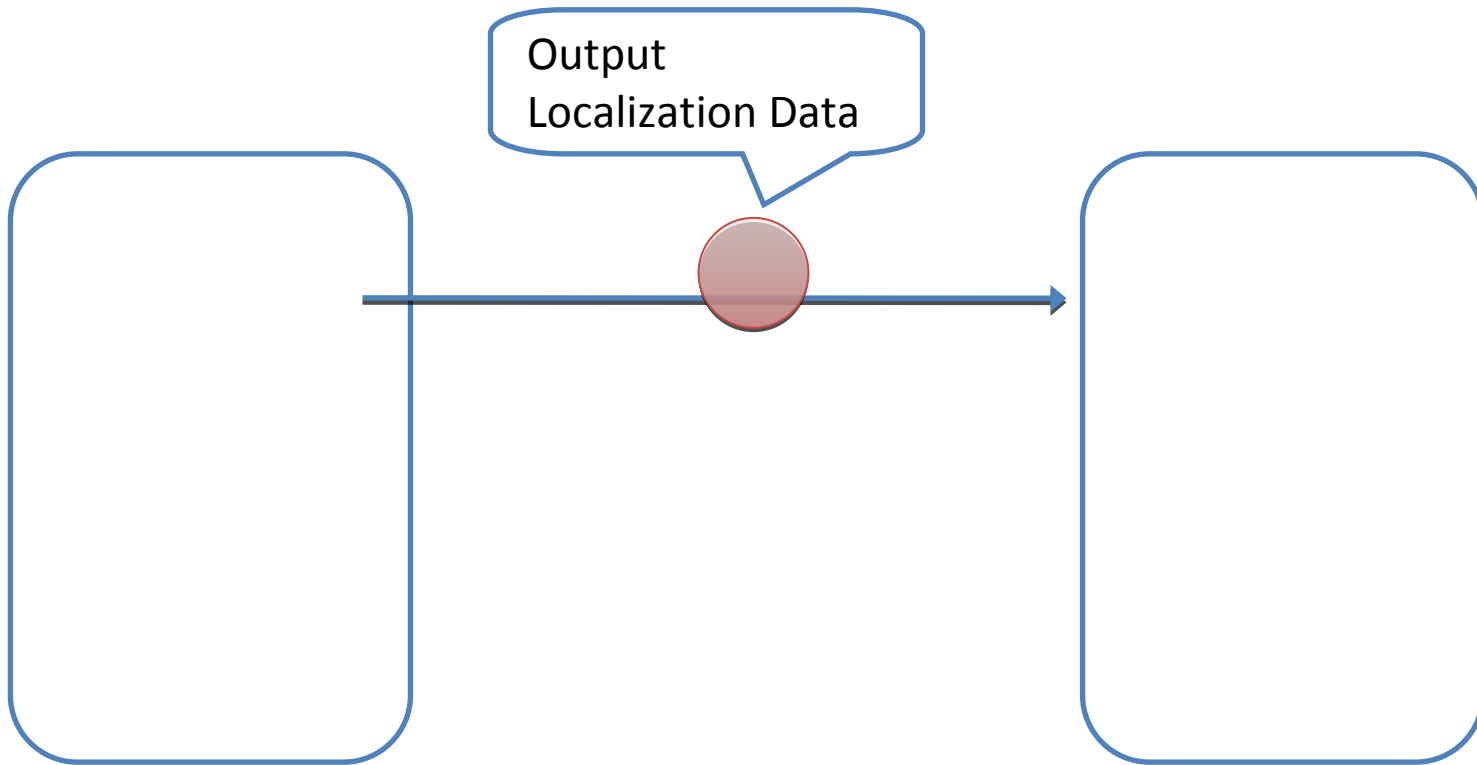
I am RFID reader1 on a table,
I feel the phone ID=823 is
within my range

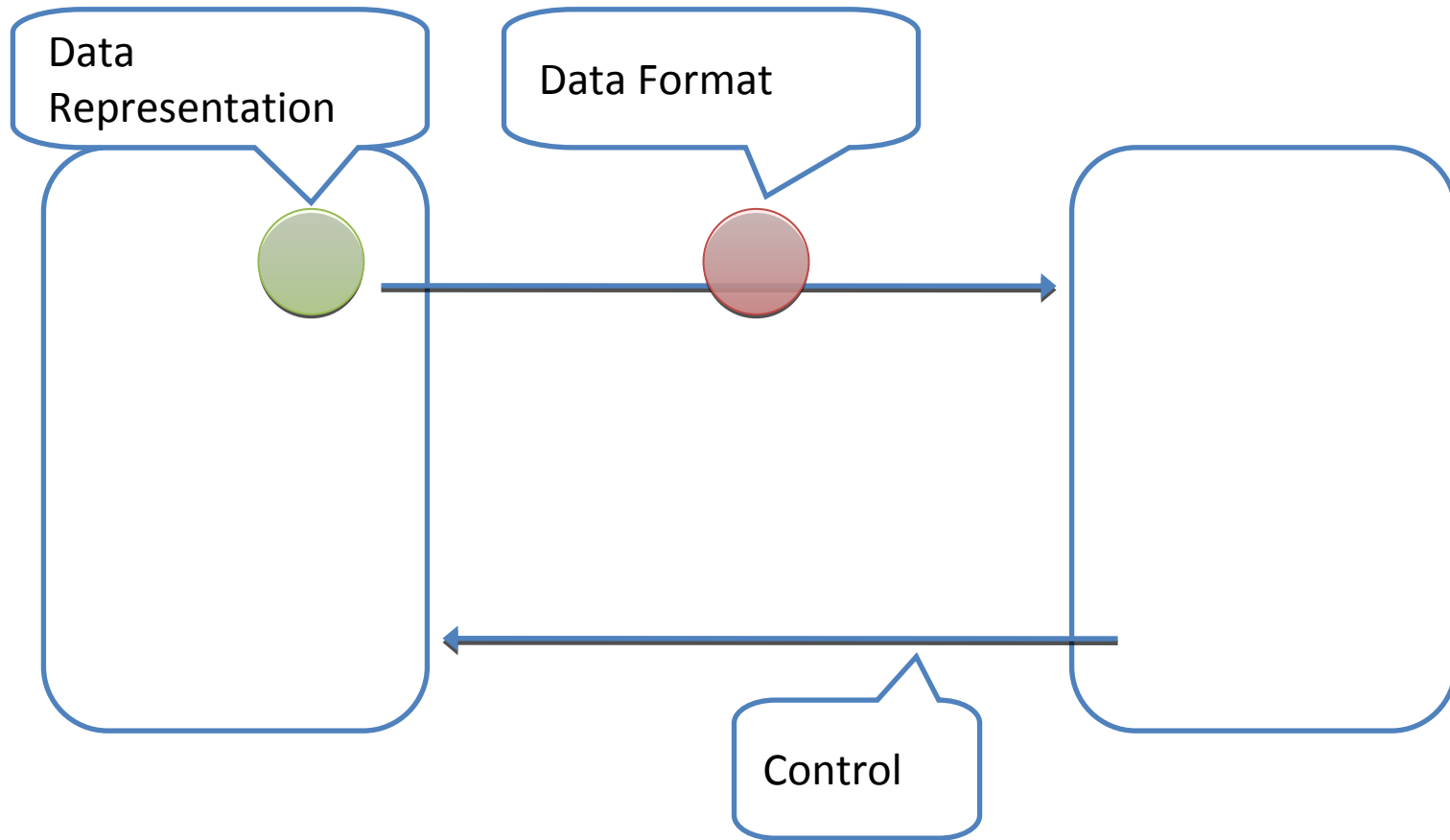
I am Robot 32, my Laser
detected 3 entities:
table: d=32, $\alpha = 40$
table: d=67, $\alpha = 123$
robot: d=99, $\alpha = 187$

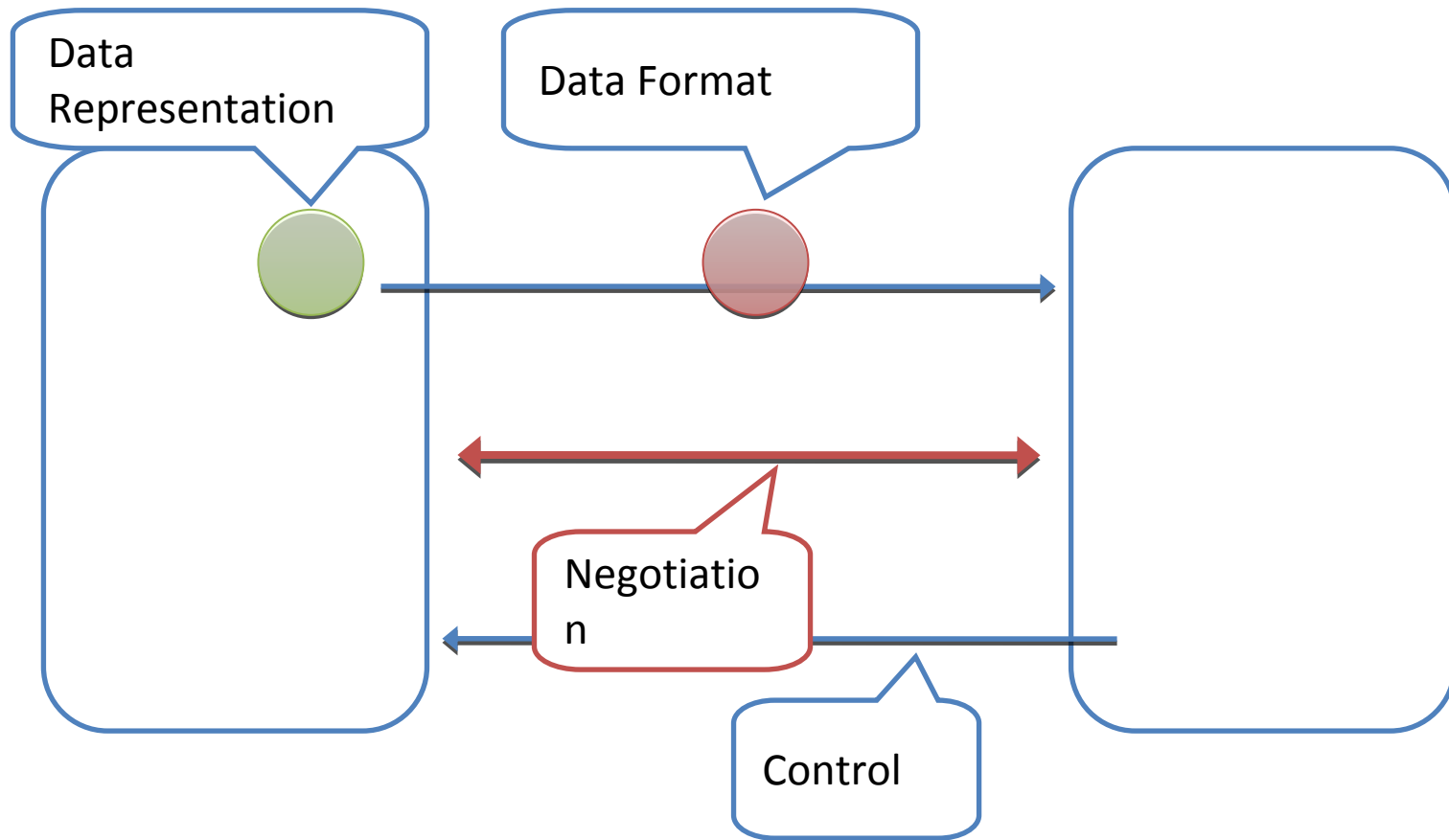
Where is my Phone ?
Robot 21, bring it to
me !

I am RFID reader2 on a table,
I feel the phone ID=123 is
within my range

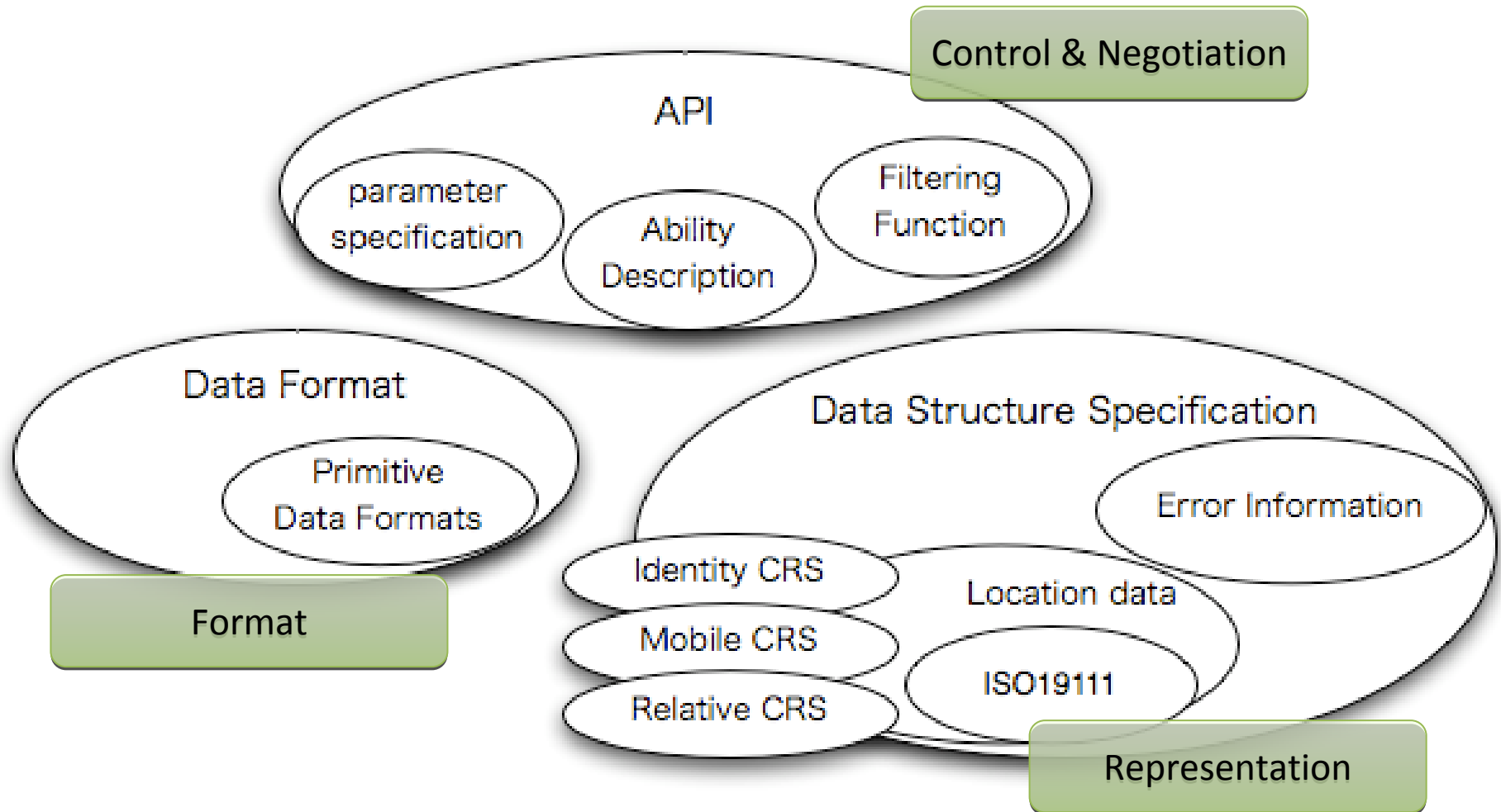
?!?!?!?







Robotic Localization Service



Object Management Group (OMG)



<http://www.omg.org/>

- Non-profit organization for standardization activity
- CORBA, UML, ...

- Process opened to users
- Specifications are made public free of charge
- Requires implementation

RLS current status

<http://www.omg.org/spec/RLS/>

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Robotic Localization Service (RLS)

OMG Released Versions Of RLS

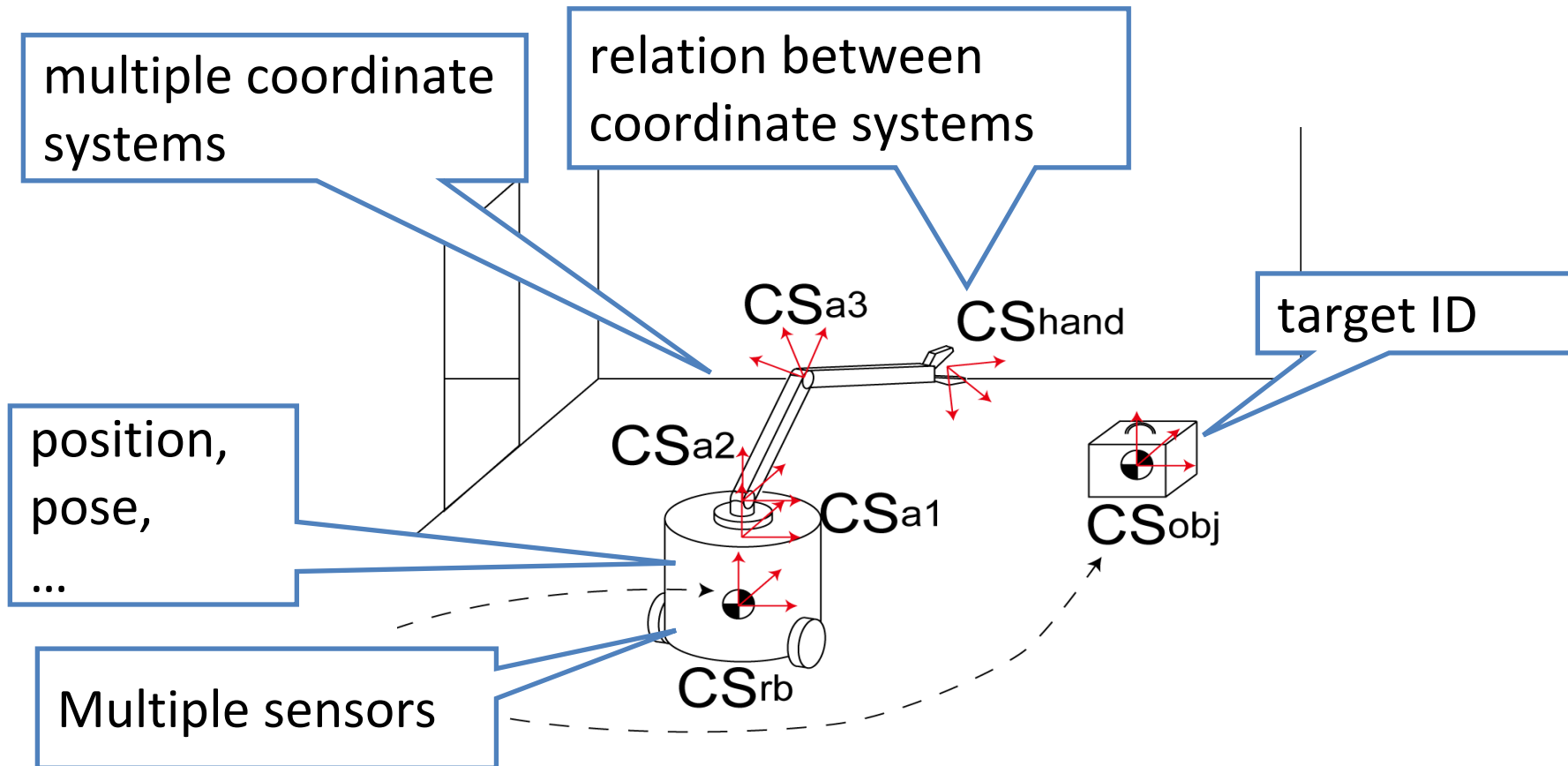
The current version is found at: <http://www.omg.org/spec/RLS/Current>

Version	Release date	URL
Version 1.0 - Beta 1	July 2008	http://www.omg.org/spec/RLS/1.0/Beta1

Background / Scope of RLS-RFP

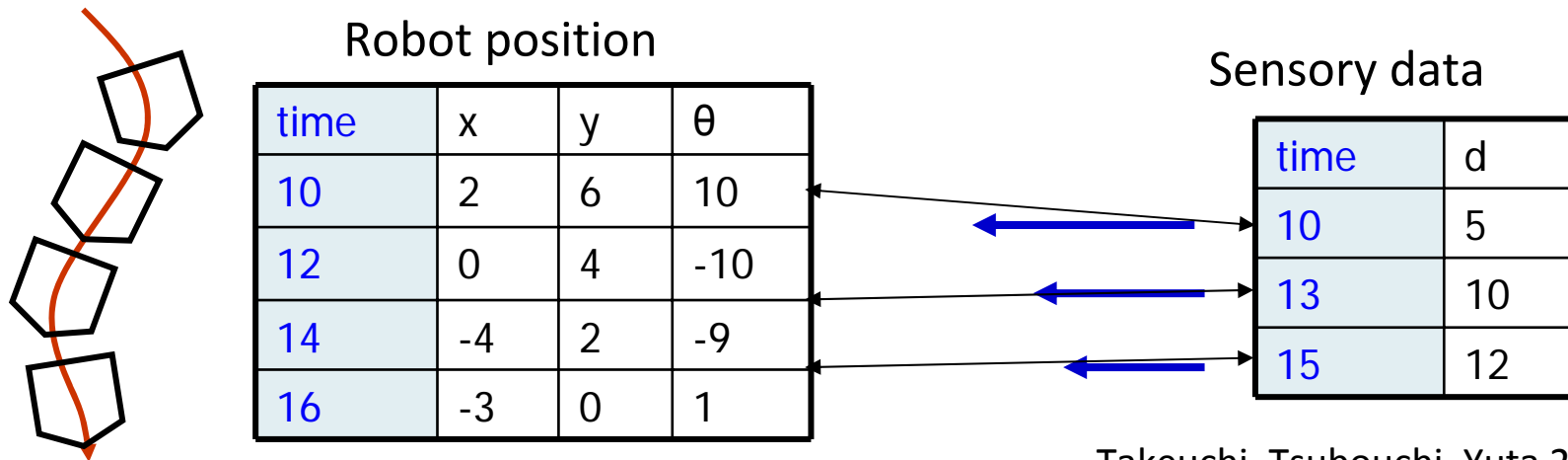
- Localization Service independent to specific sensors or algorithms
- Robots may use info from equipped sensors as well as those from other robots or sensors in the environment(**Network Robot**)
- Robots may perform services to people (**Service Robot**, not just industrial robots)
- Treat location information of **people or objects** (not just the robot itself)

Requirements in Robotics (1)



Requirements in Robotics (2)

- Navigation or Manipulation requires **High-Precision** localization
 - **Measurement Time** and **Error Information** is Essential
 - Especially when mixing multiple sensor outputs

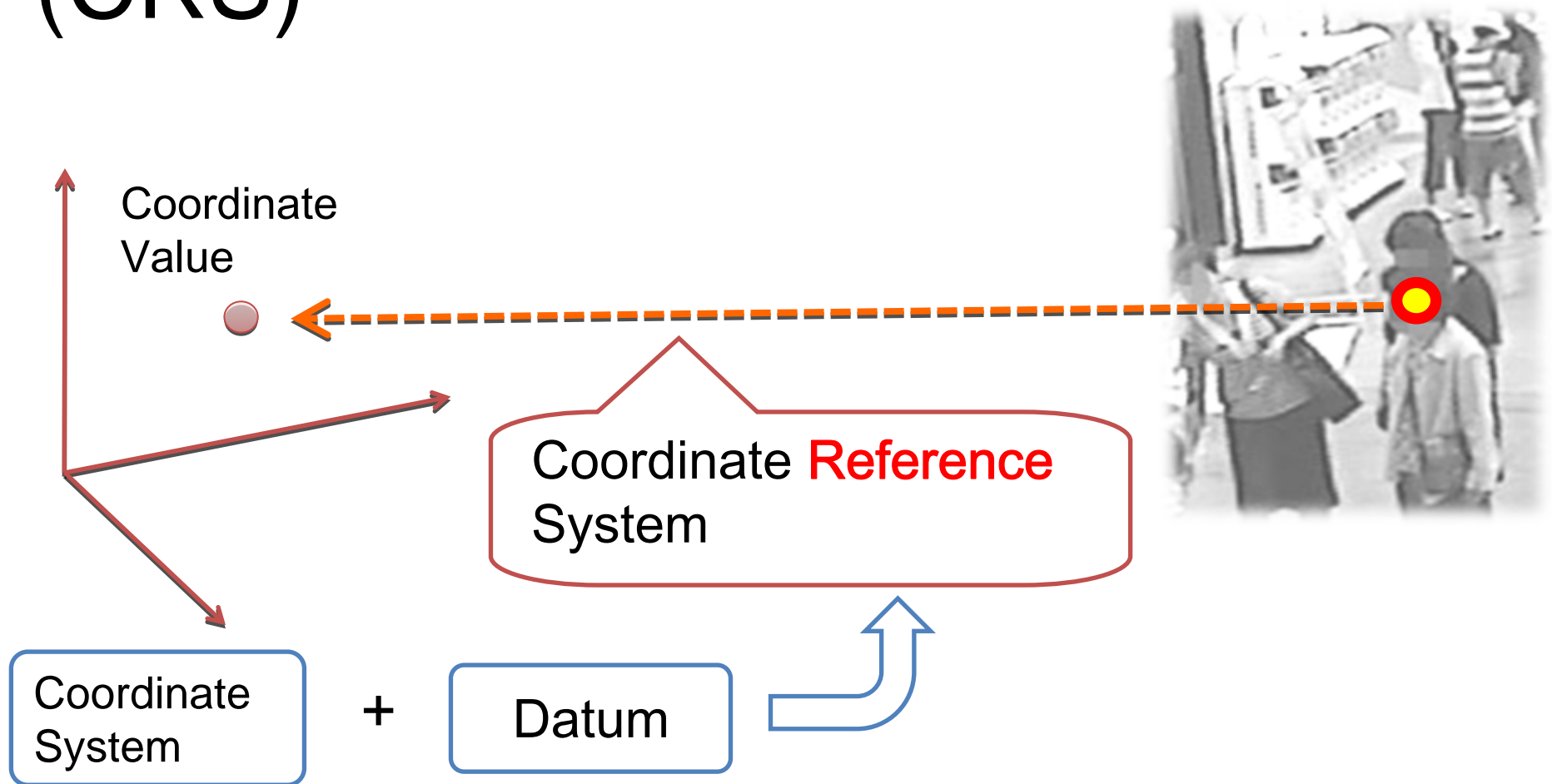


Takeuchi, Tsubouchi, Yuta 2005

Extensions for Robotics

- Based on ISO 19111
- Define a general Information Structures
 - for combining various information (from multiple sensors)
 - RoLo (**R**obotic **L**ocalization) Architecture
 - representation of
 - **Error**information and **IDs**
 - **Mobile** / **Relative** Coordinate Systems
- Allow flexible and formal definitions of **CRSs** and **Data Formats**
 - metadata repository
 - allow exchanging *meaning* of data
- Require modules to provide *ability information* metadata
 - for robot plug-n-play and efficient development

Coordinate Reference System (CRS)

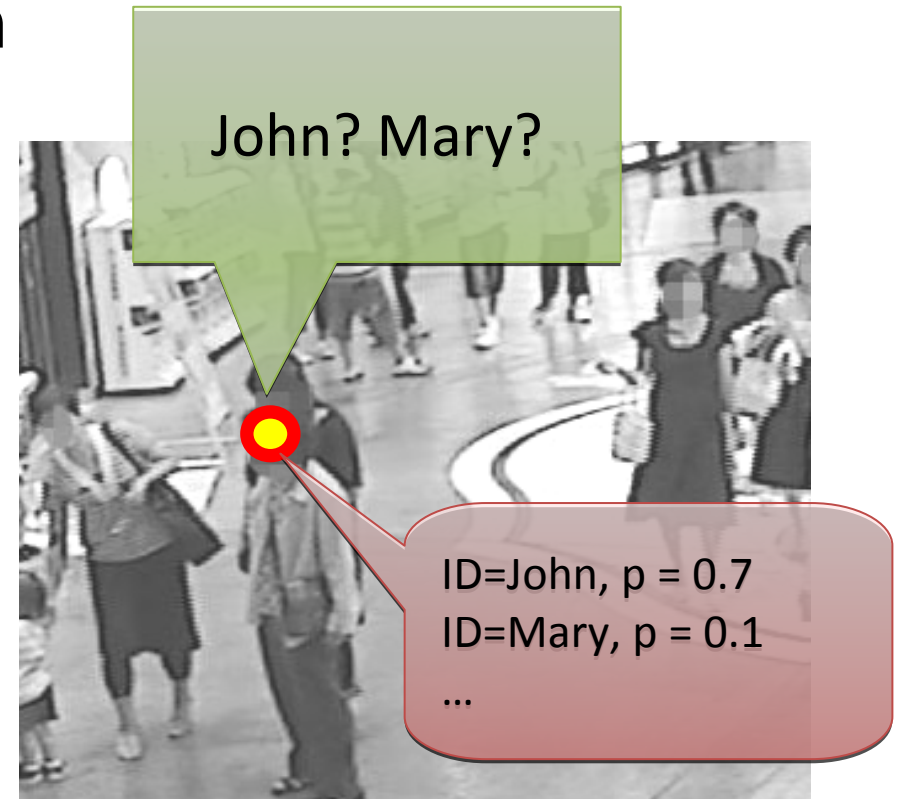


“Location” is probabilistic

- Location information in GIS systems are always *deterministic*
- However, real-world localization results are *always probabilistic*
 - due to sensor measurement noise, etc.
- A flexible, extendable framework for describing **error information** is required
 - reliability / covariance matrix / MoG / particles...

ID is also probabilistic

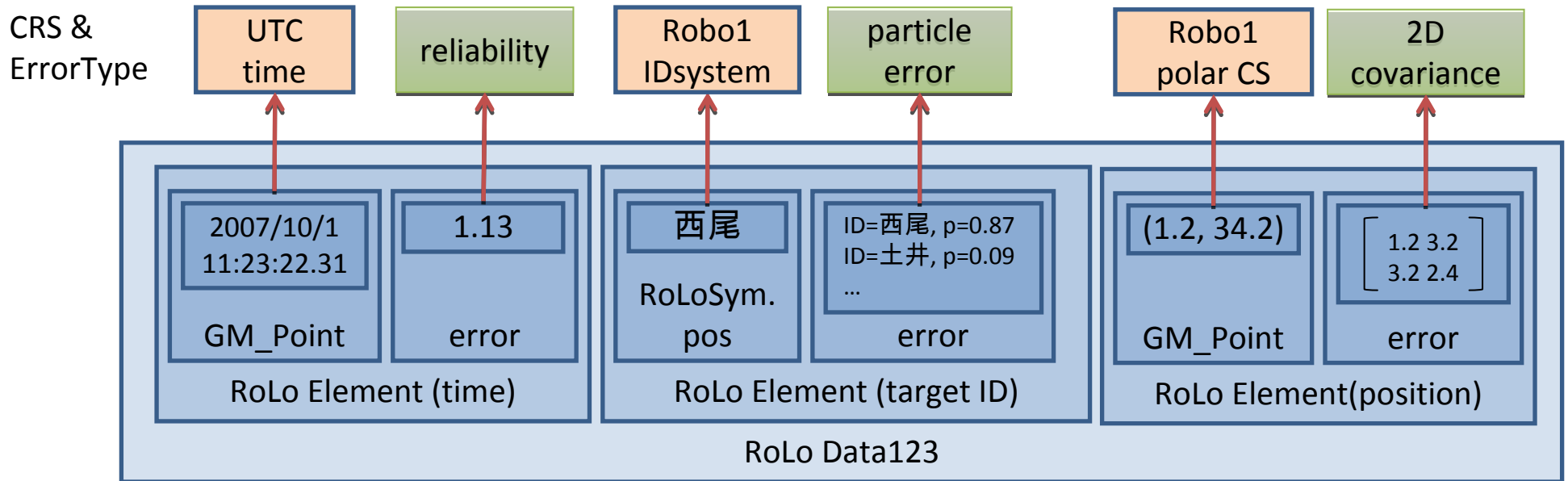
- Ambiguity in identity information may exist
- Identity information shall be treated just like other location-related information



Identity information (ID)

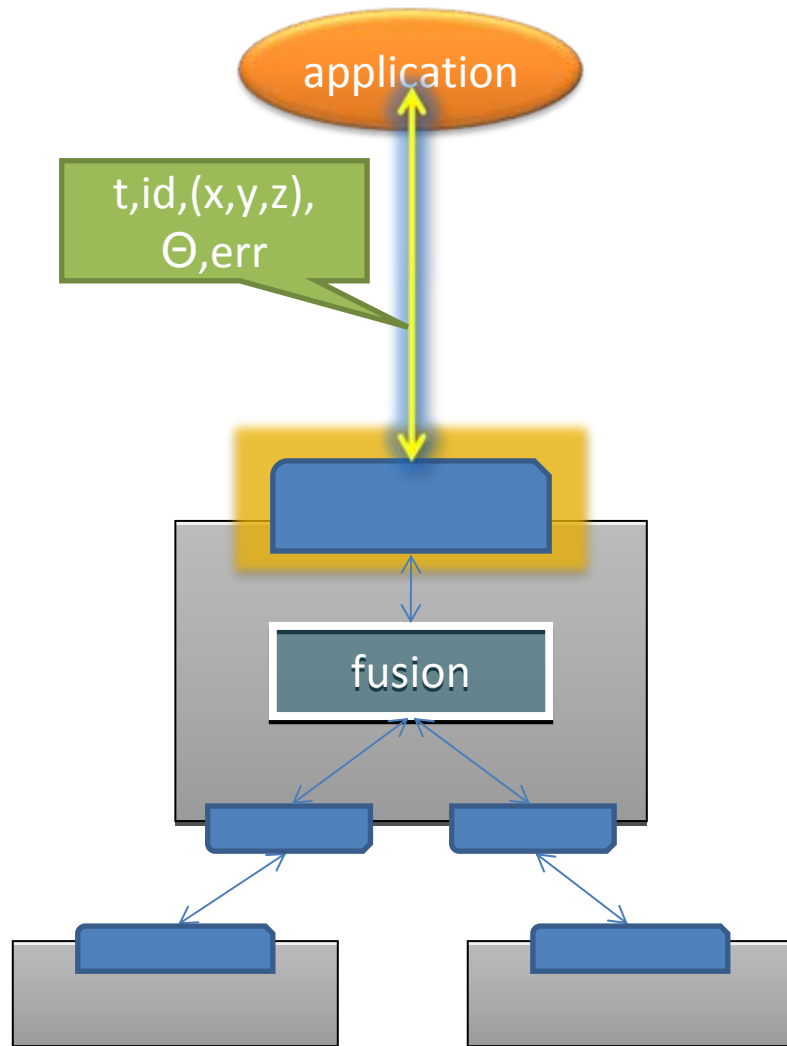
- Required for specifying target of measurements
- IDs are also commonly described using multi-dimensional space
 - ex) MAC address, IP address
- Can be defined under GIS framework
 - Extension for allowing symbolic information
 - Define coordinate systems / coordinate reference systems for IDs

Representing Relations



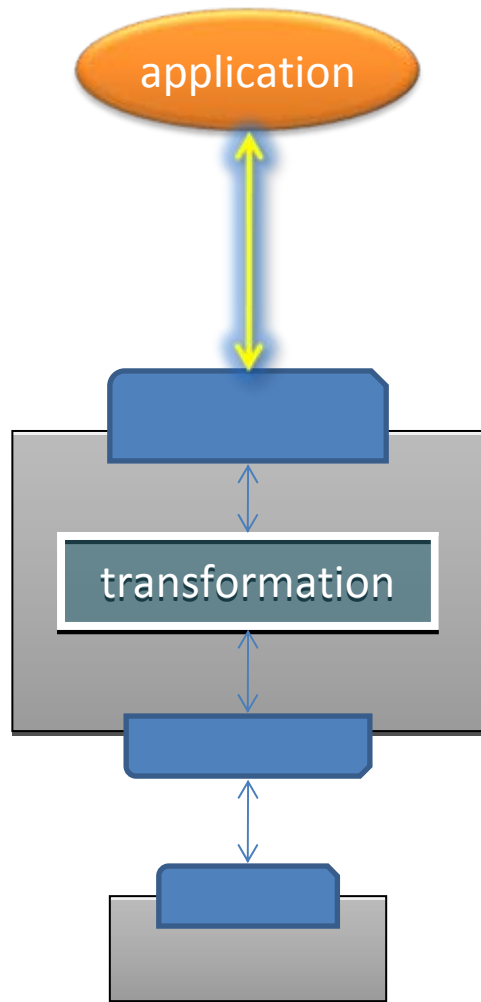
Treat various types of location-related information in ***a uniform manner***

Aggregation



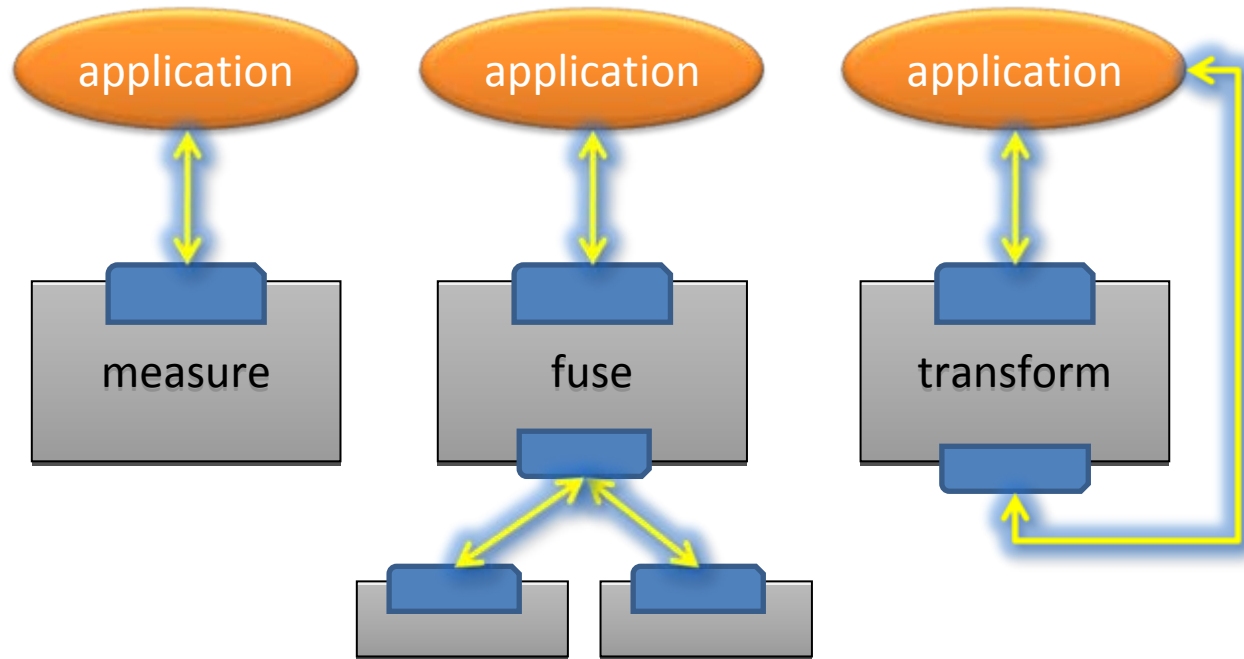
- the aggregator appears as basic localization component
 - what's happening inside is not important for users
- use the same interface as basic component
 - detailed aggregation parameters set by vendor interface
- holds also input interfaces

Coordinate Transformation



- the transform module also appears as basic localization component (to application)
 - what's happening inside is not important for users
- use the same interface as basic component
 - detailed transformation parameters set by similar configuration interface
- holds also input interfaces

uniform architecture



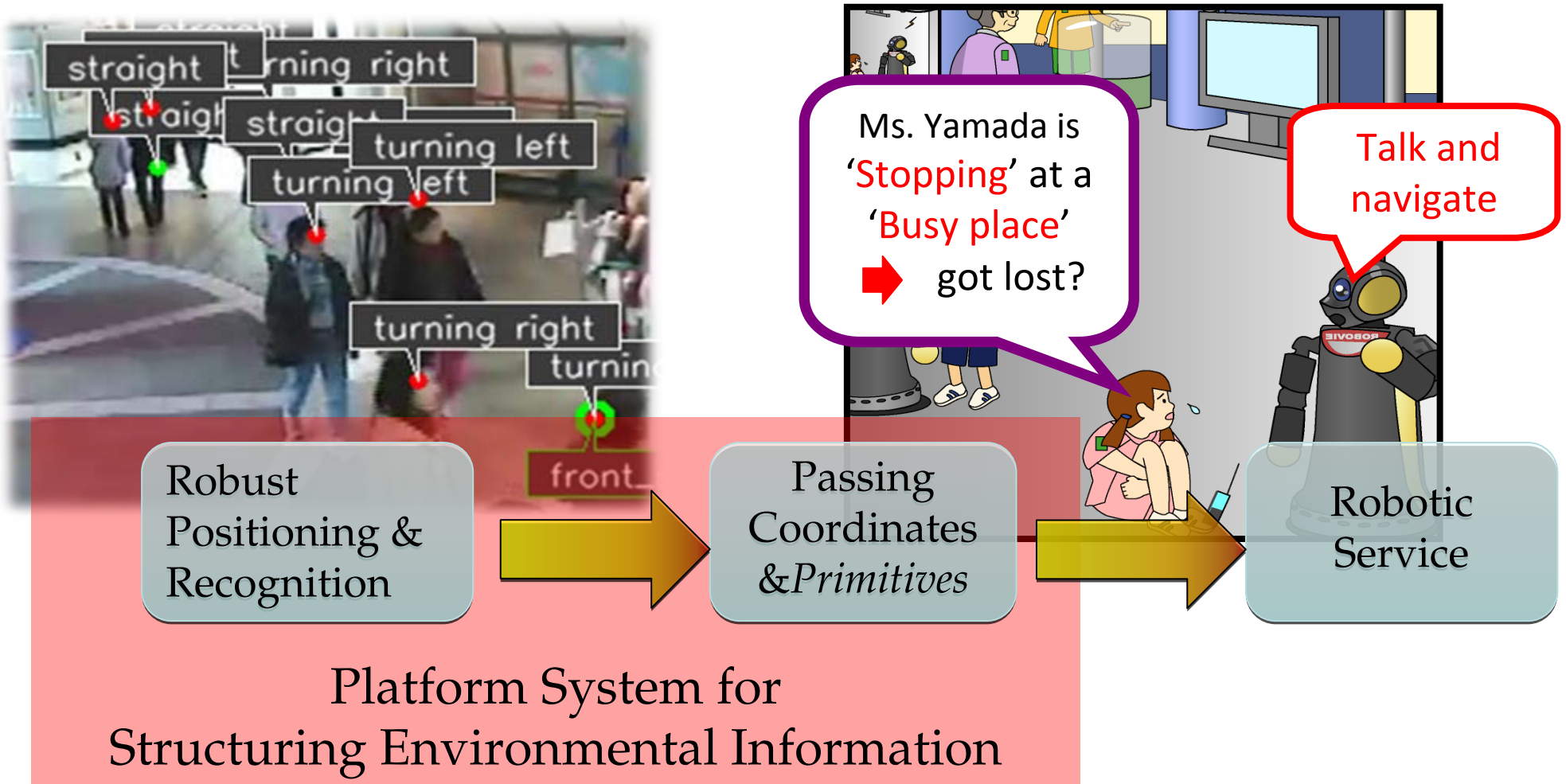
Homogeneous n-input, 1-output interface

- High reusability
- Allow recursive or cascading connection

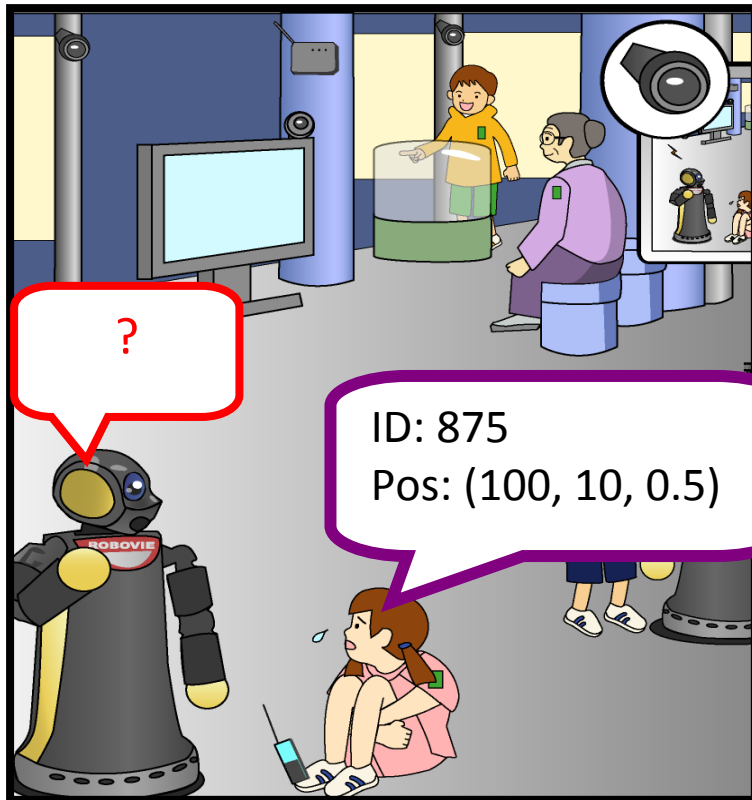
Forthcoming Standardization Issues

- Meta-Info Management Architecture
 - Distributed, Large-Scale System
- Common Framework for Robot Control
- Inter-Robot Coordination Framework
(Network Robot)

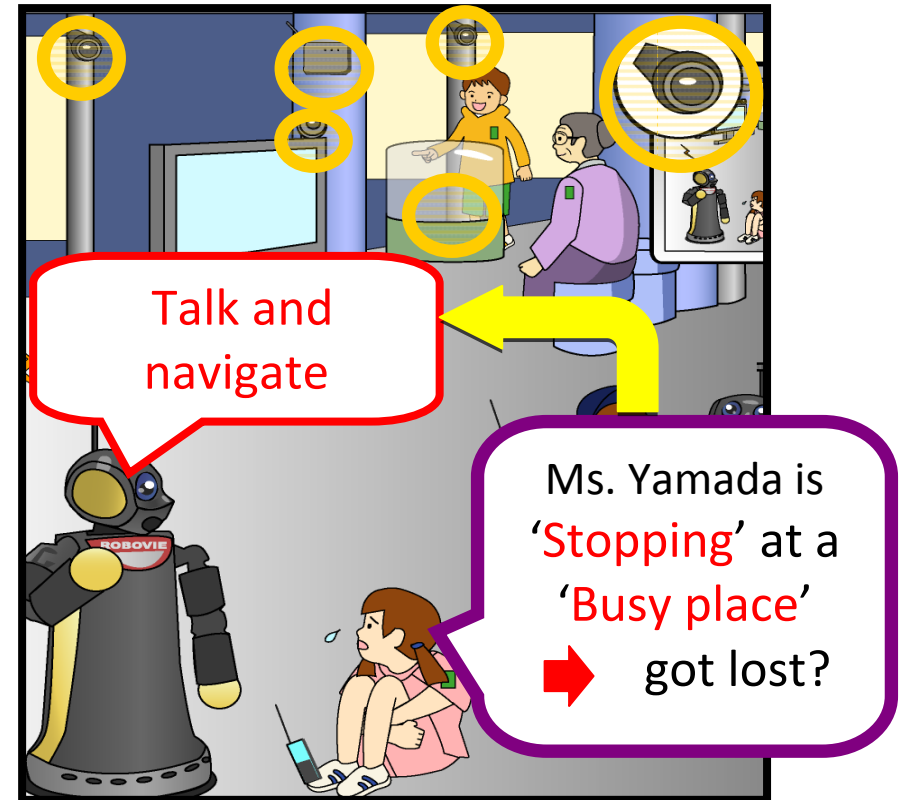
RLS Implementation Example



Robotic Service by *Primitives*



without *Primitives*

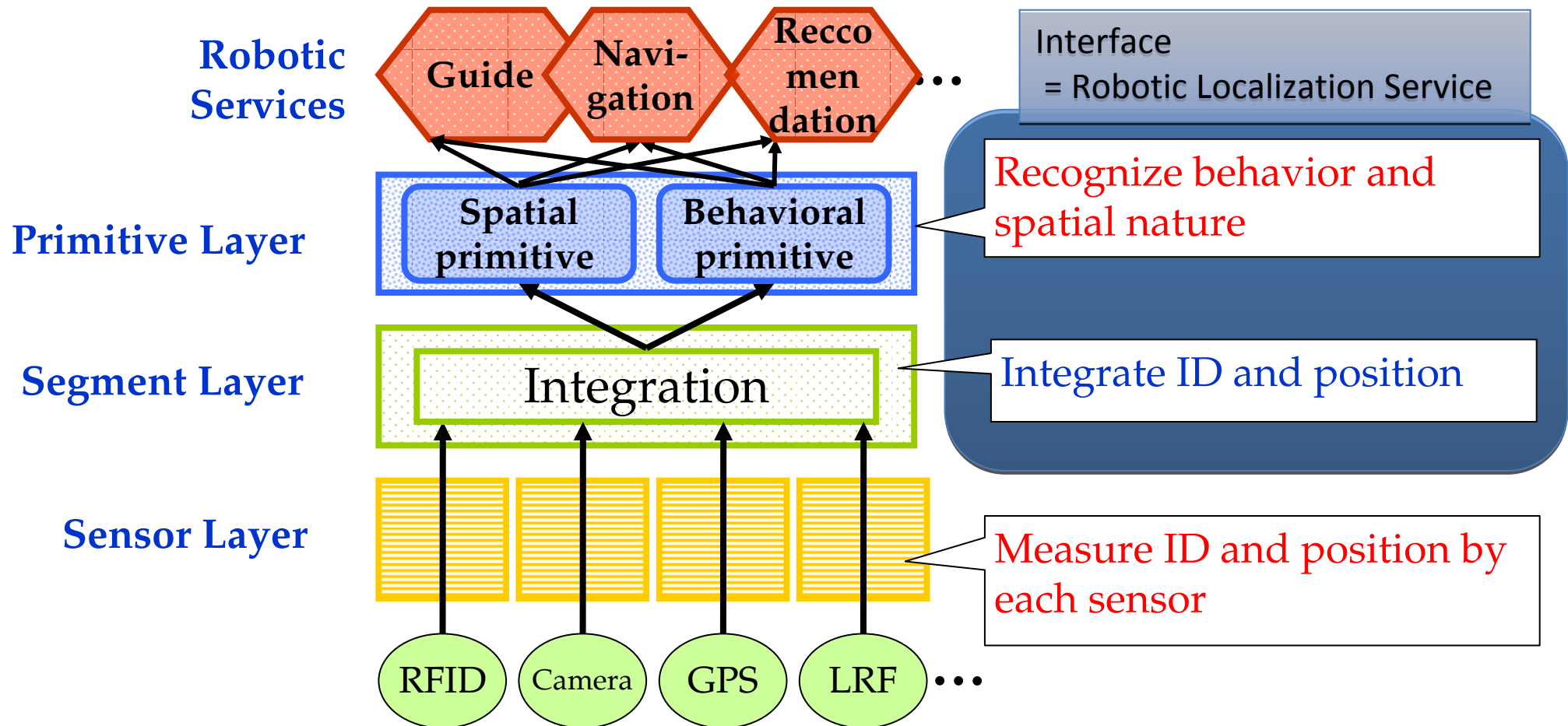


with *Primitives*

Tracking/Recognition Result



Four-Layer Model



Robotic Service: An Example

