Business from technology

Opening embedded information of devices for intelligent applications

Workshop on Ambient Intelligent Infrastructures

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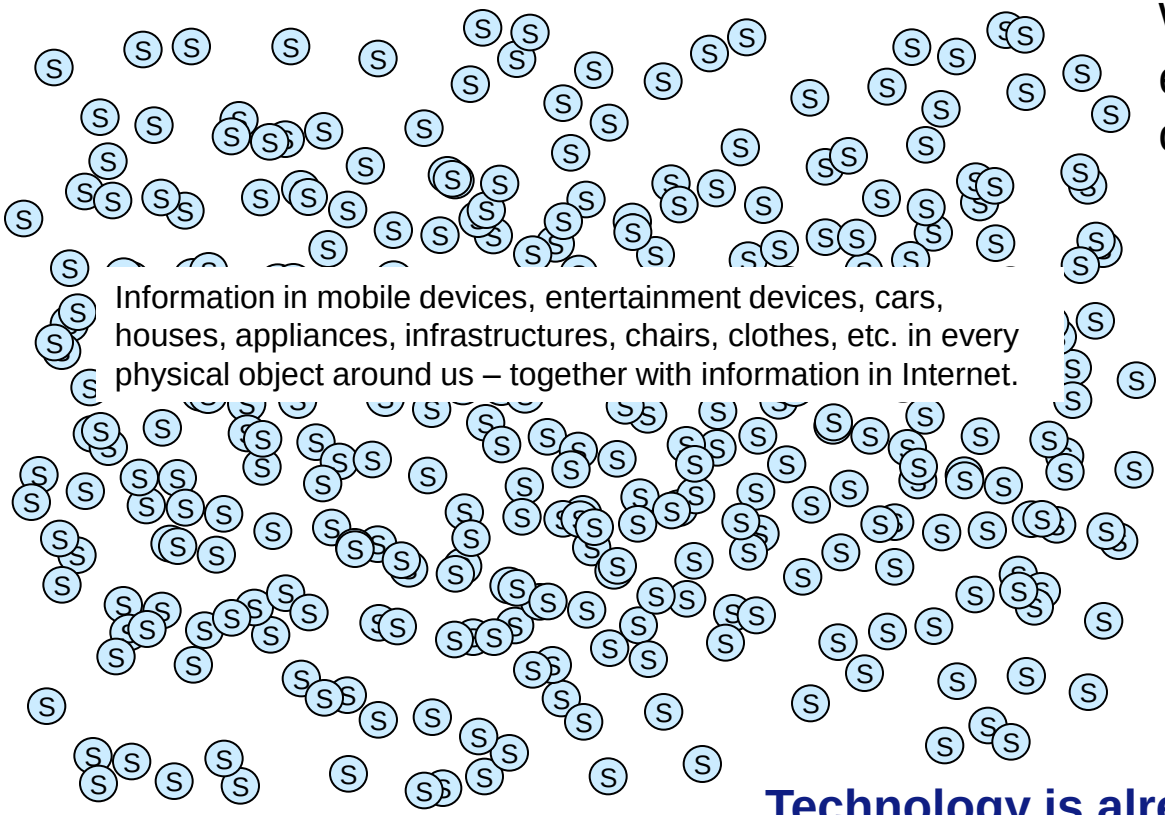
Information environment is the vision of the future



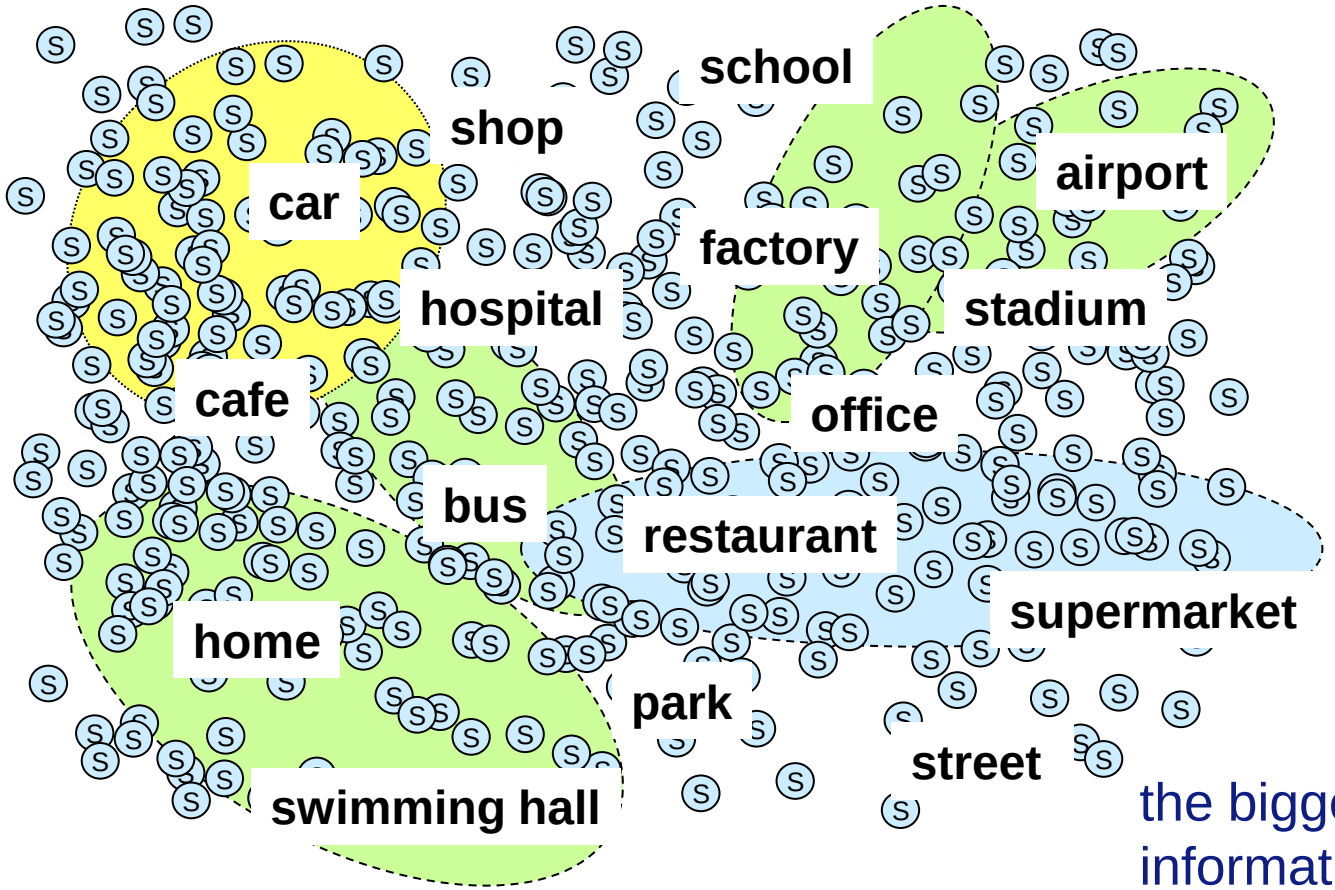
World is full of information embedded into devices and objects around us.

Challenge is to make information available as easily as electricity or mobile phone service is today.

Challenge is to use this information to create smart environments

Technology is already available

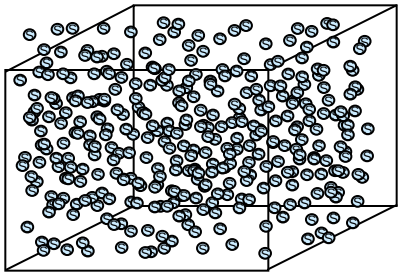
Diversity of information



the biggest risk is that information is encapsulated in silos!

Objective for Ubiquitous Computing research

All the information
wanted, needed and should known from local place **easily available**



"1000 devices/person in 2017"

Common, open way of accessing information of devices in space.

Novel, **innovative applications** for users

Safety
Comfort
Efficiency
Happiness
Peace of mind

Open sharing of information is a fundamental change to everyday life!

Technical goals

Making information available in digital format in physical space from all objects and devices
(make information usable)
(Analogy to electricity)

"TCP/IP" type of enabler for physical space
(generic way of making things happen)

Enabling simple, local mash-up applications based on open, shared data and devices
(keeping in mind the privacy, security, etc.)

Connecting real physical world with information world
(getting information from physical world: sensors, objects, devices, etc.)

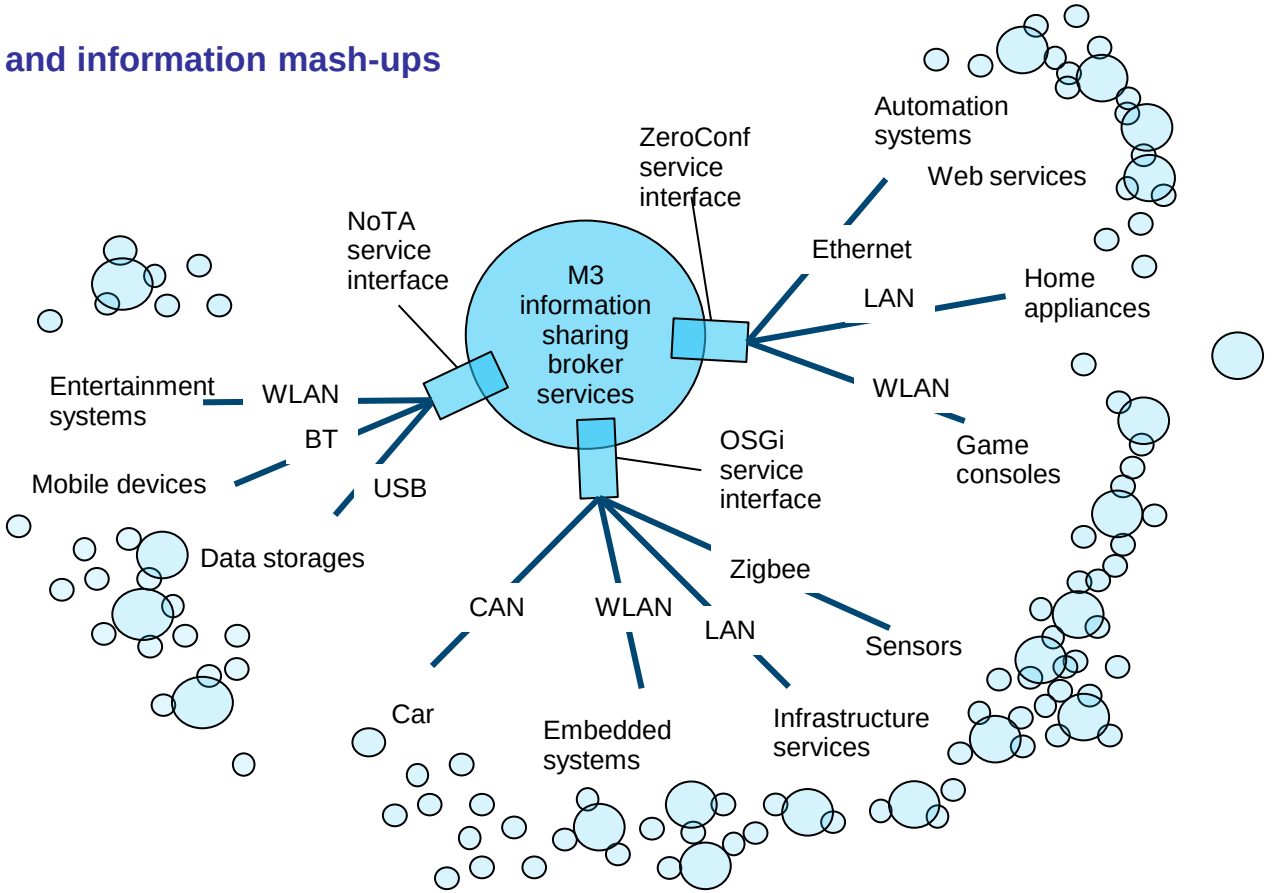
New innovation platform supporting rapid deployment
(platform for novel ideas that can not be predicted at the moment - we see the potential but not the actual ideas)

Core challenges

- How the enable the interaction between devices in this heterogeneous and diverse world where the first priority is the survival
- How to make physical objects smarter so that they can react based on the situation and capabilities of the physical place they are in?
- How to make the situation visible across all boundaries that can exist in the physical place (e.g. domains, devices, languages, platforms, businesses)?

M3 Information sharing approach

M3 technology and information mash-ups

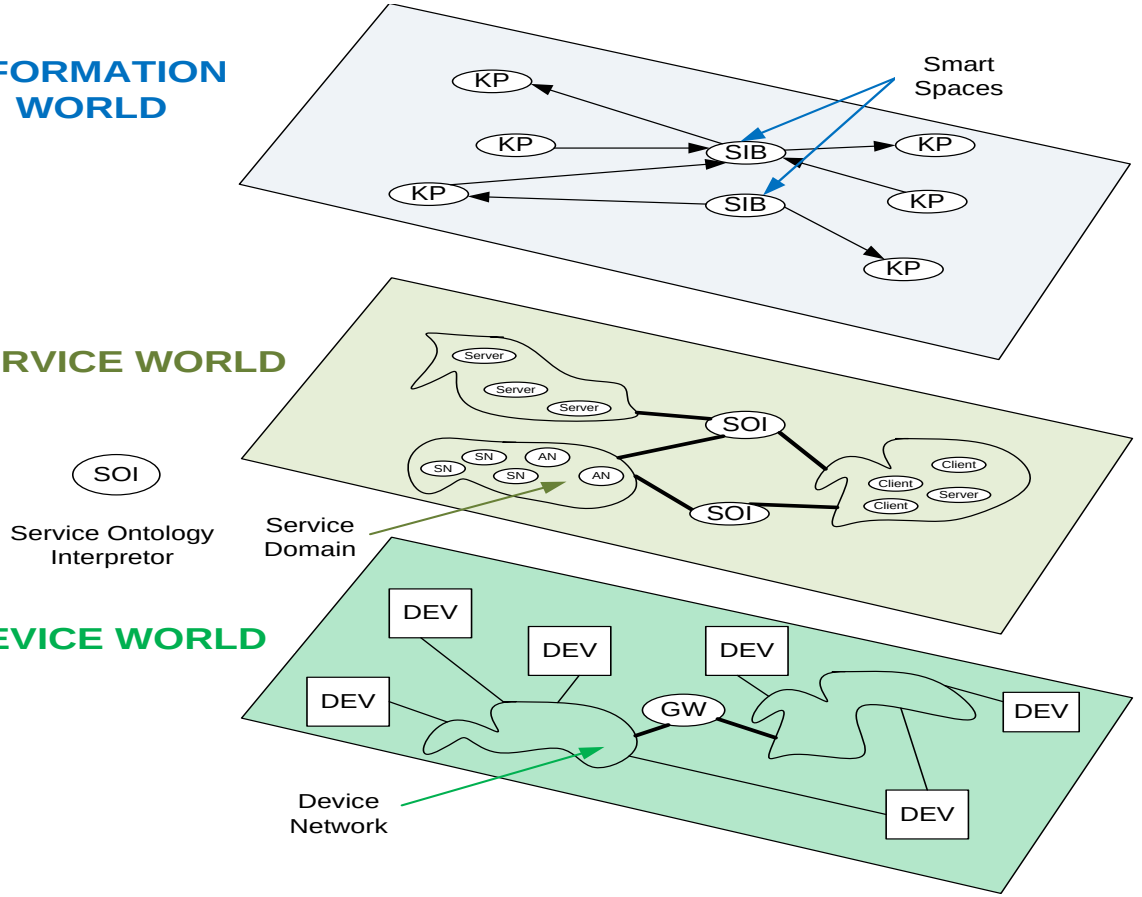


Separation of Concerns

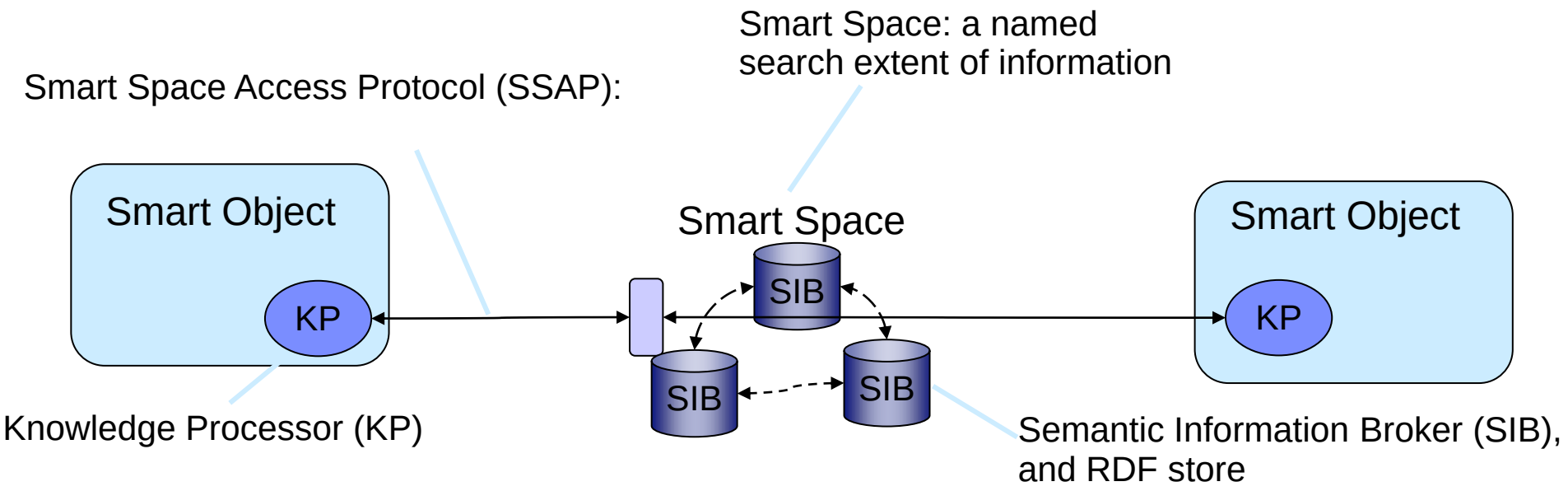
Focus

SOA solutions, protocols

Radios, communication



Basic idea: Sharing information



- KPs modify the information in SIB using SSAP
- KPs may be physically distributed, no guarantee on execution order

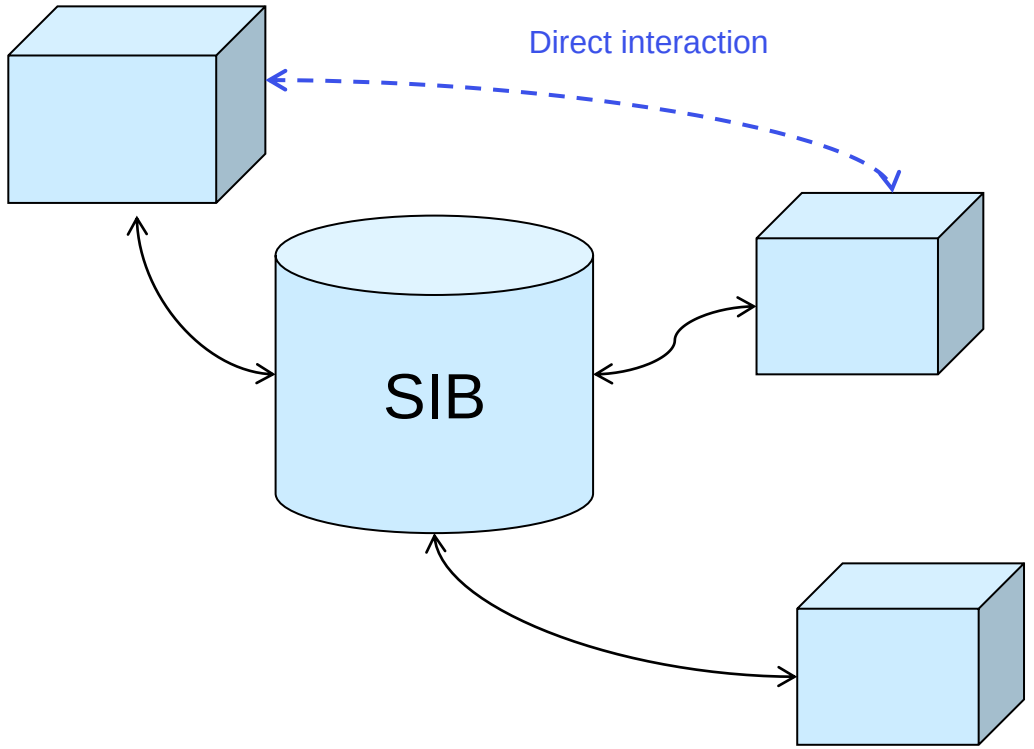
System construction principle

Devices are independent agents that share their information (or part of it) through SIB service

Devices adapt their functionality based in open information shared in SIB

Joint functionality creates intelligent functionality in current location

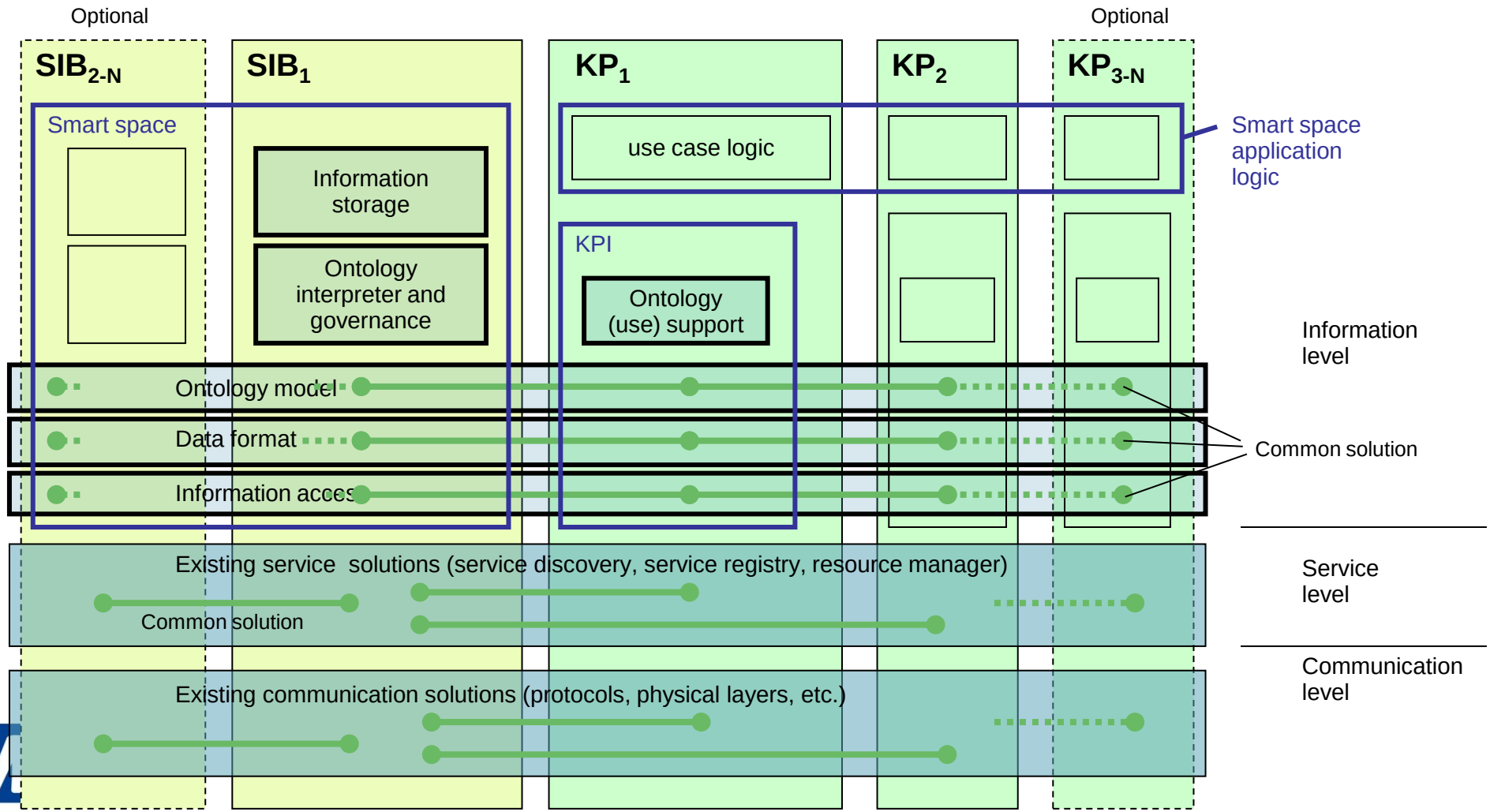
Functionality can be extended with other interaction mechanisms



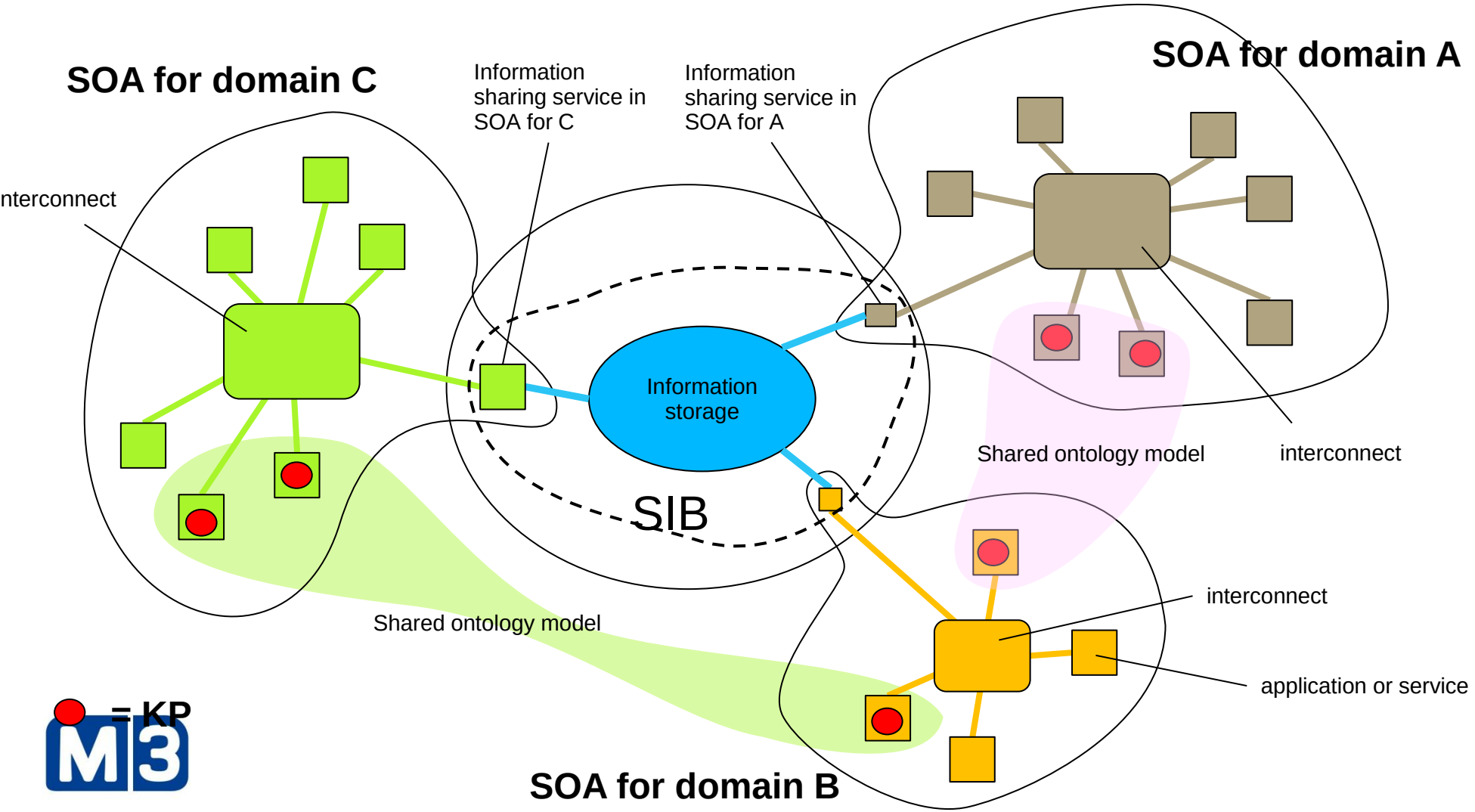
Main IOP principles

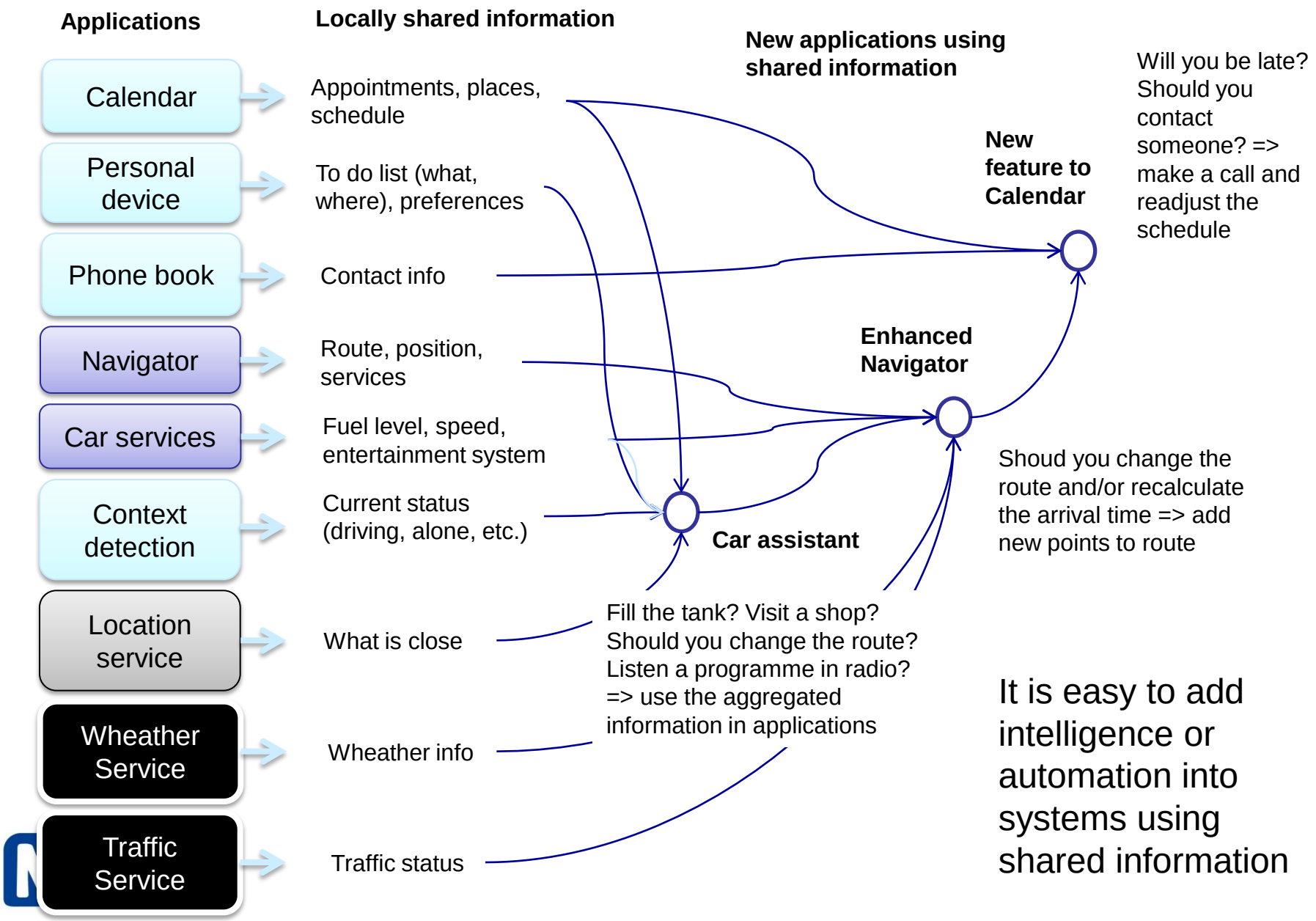
1. IOP manages shared information that is represented in **uniform** and use case **independent** way and that information is based on **ontology** models
2. IOP deals only with information (simplicity principle), but it can be extended with other interoperability approaches
3. IOP is **agnostics** w.r.t ontology, application programming language, service platform, communication, and hosting device
4. Information sharing is a **service** in a SOA (service principle)
5. IOP **notifies** applications subscribed to information changes
6. Access control can be implemented both at service and information levels
7. IOP implementations can be extended by domain ontology and information manipulation capabilities through the concepts of IOP extensions and core services

IOP logical view

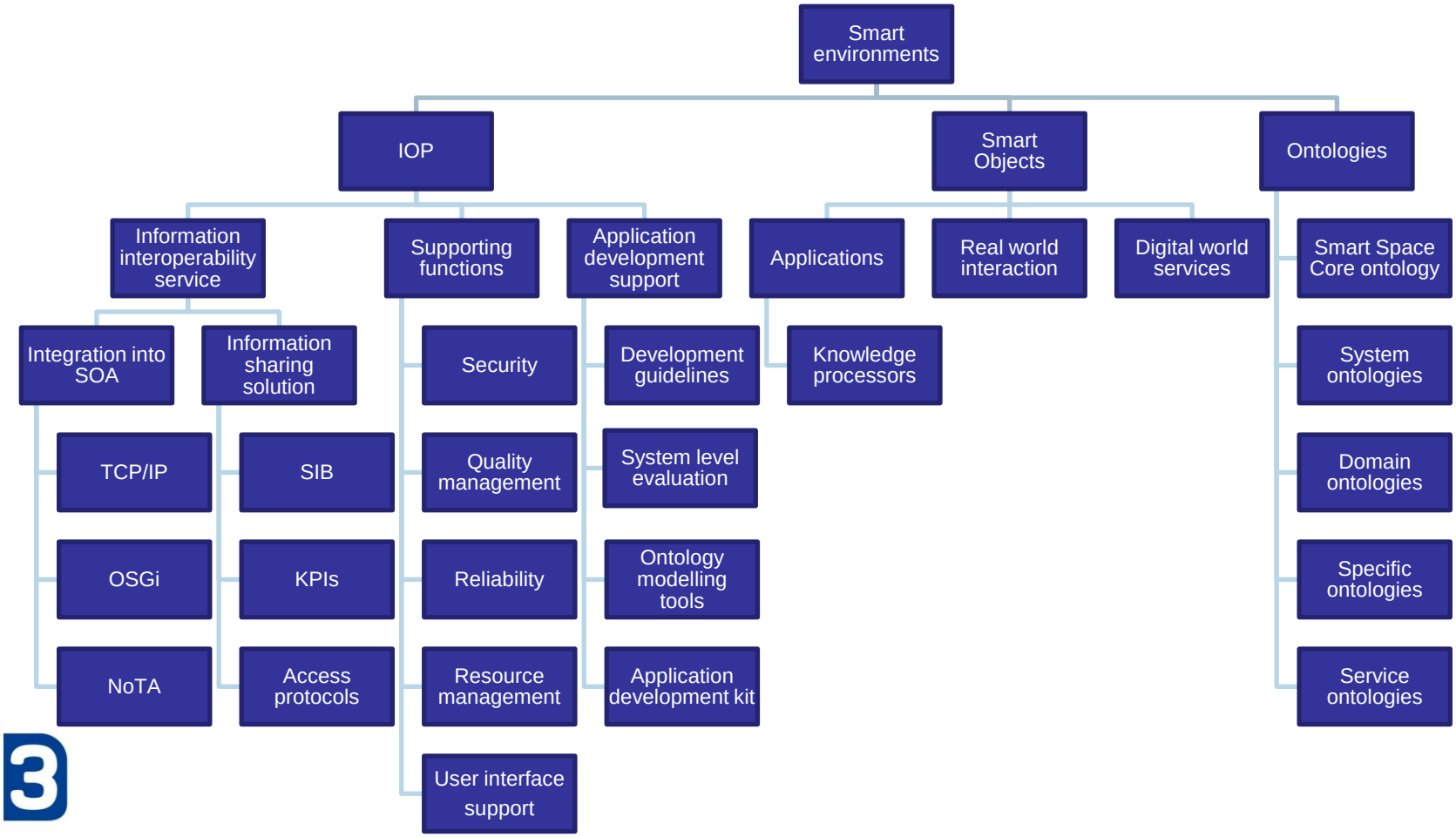


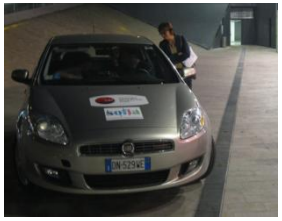
Service for several domains



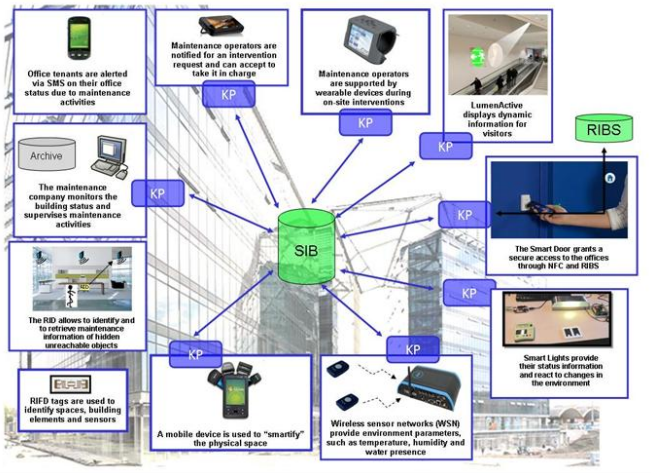

Applications
Locally shared information
New applications using shared information
Calendar
Personal device
Phone book
Navigator
Car services
Context detection
Location service
Wheather Service
Traffic Service
Appointments, places, schedule
To do list (what, where), preferences
Contact info
Route, position, services
Fuel level, speed, entertainment system
Current status (driving, alone, etc.)
What is close
Wheather info
Traffic status
New feature to Calendar
Will you be late? Should you contact someone? => make a call and readjust the schedule
Enhanced Navigator
Shoud you change the route and/or recalculate the arrival time => add new points to route
Car assistant
Fill the tank? Visit a shop? Should you change the route? Listen a programme in radio? => use the aggregated information in applications
It is easy to add intelligence or automation into systems using shared information

Sofia IOP: multi-domain open innovation platform





SOFIA pilots



- Different **ecosystems (car and mobile media) were linked** through M3 for enhanced features (Media Follows user pilot)
- Smart Maintenance, Smart Maintenance on Move, and Video Surveillance pilots implemented **complex operational processes** involving devices and systems form different domains
- Virtual Wall and Virtual Graffiti pilots combined and displayed **information from various sources**
- SUM-S and Smart Home pilots **connected several M3 smart spaces and created technology mash-up**s.

- Use of common ontology models and creation of information based on them enabled the enrichment of functionalities that expand across domain and business boundaries.

Low-capacity demos

- In Smart Green House **control systems** M3 SIB was in a WLAN access point. The sensors were connected to M3 via gateways and the actors were designed so that they reacted on information in SIB instead of specific control interfaces.
- The semantic interface (KP) was implemented in active tag attached to a sensor. The **semantic sensor** was capable to publish its own information in RIBS, but also capable to react on information published by others.
- M3 has been used in connecting **tagging system** with local information servers in DineTender application. The idea was to create **a very local smart place with a possibility to share data** that is meant only for people in close proximity

Incremental development

- The Green House use case had several development cycles:
  1. It consisted of a wireless sensor network, manual control interface, and a couple actors.
  2. It evolved to an automatic control system. Tag-based automation was included, and
  3. Web-based plant growing instructions and more intelligence were added.
- During the time the core ontology remained untouched and the initial devices were not modified at all.
- The intelligence was added through **extension of ontology** and through **new KPs that manipulated the information**.

Main benefits of using M3

- Network based design becomes more easy due to simpler interfacing
- Responsibilities of systems functionalities can be given to companies that are truly focused on them
- Eventually will result to more optimal parts and improved overall system quality
- Room for easy adoption of new innovations.

Key success factors for creating ambient intelligence infrastructures

Intelligence and smartness implicitly refers to a potential to recognize and understand what is available and usable in a situation and capability to combine and extend them into usable information or service

Usability of operation principles for application purposes

Acceptance of the idea among industry and end users

Scalability of approach to all environments, domains, all uses and use cases

Flexibility to adapt to yet unknown needs and requirements

M3 in a nutshell

M3 in a product

- Lightweight, low cost, easy to integrate service
- Generic information sharing interface
  - For additional information and capabilities to your system
  - Way to offer information to others (increases attractives of your systems)
- Open source technology with BSD license (with no obligations to anywhere)

M3 interoperability solution

- Allows interaction with other systems with minimal dependencies
  - you exchange only information
- Common ontology model (that is easy to agree on) as a key interoperability mechanism
  - No need to agree on protocols, uses, or anything else
- Incremental development of combined functionalities as a built-in feature
- Preserves your integrity and independence

Contributions to Ambient intelligence infrastructures

Information level interoperability platform (Sofia IOP) has been defined and specified

+ Scientific papers

Reference implementations have been created

+ Open Source Code
+ Service implementations
+ Demos

Implementations have been used in pilots and they have been taken into use in other projects

Feasibility has been evaluated and results have been analysed

+ Sofia Community
+ open-m3.org

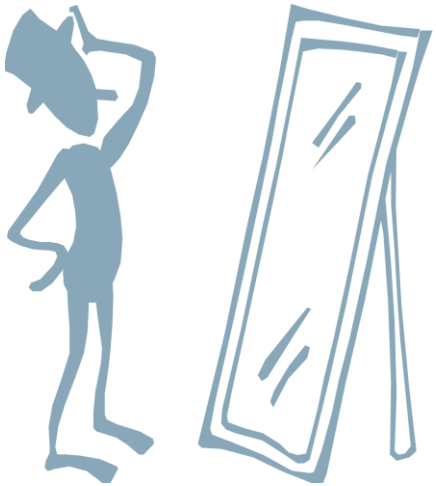
Potential to take results into business exists

Defined principles and promises related to multi-domain, multi-device, multi-platform interoperability

But, large scale experiments, commercial use – no.

Lessons' learnt

- Attempt to extend Semantic Web and Linked Data to local physical places and to embedded systems (and this will be the approach for the future)
- Basic idea is excellent (i.e. simplicity, ontology based interoperability)
- Quality and maturity of solution is extremely important even at early prototype level
- **Open solution** is the only alternative
- Reliability, security, trust – we did not take these seriously enough
- **Business constraints** must be taken into account from the start



Next steps towards ambient intelligence infrastructure

- Industry should adopt the idea of opening embedded information
  - Information has value and open information idea is against the traditional business thinking that focuses in protecting everything
- Open data and open information has some excellent success stories in the Internet. Cooperation with these approaches is needed
- Other challenges relate to
  - ontology governance issues
  - industrial collaboration required to networking in embedded domain
  - technical maturity and quality characteristics of SIB solutions for embedded devices
- The experiences with M3 show that these are solvable issues, but we need more collaboration with smart system designers, with designers working with intelligent systems, and with smart interaction research

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