UBIQUITOUS DIGITISATION

Connecting People and Objects to People and Objects

by

Pekka Silvennoinen

VTT, TECHNICAL RESEARCH CENTRE OF FINLAND

Digital Information Systems

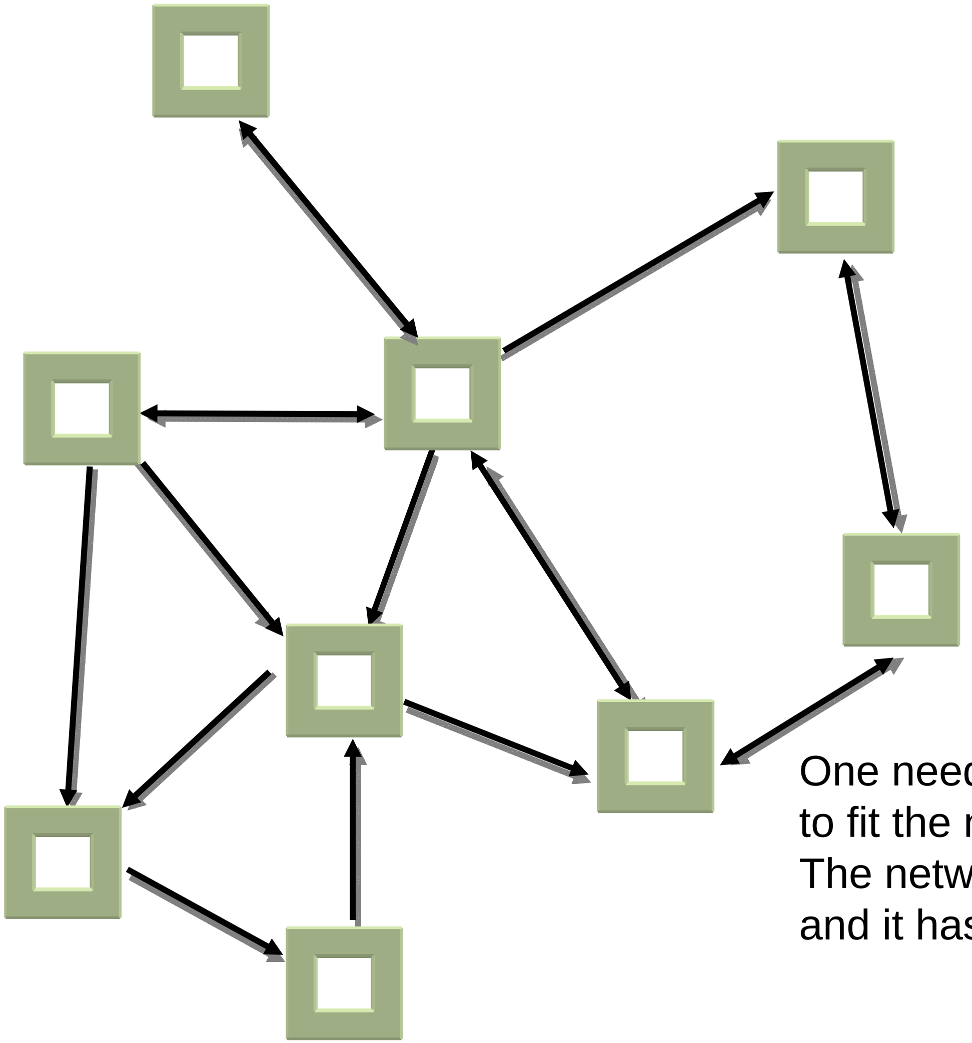
AXIOMS OF UBIQUITOUS DIGITISATION

- All services and processes that can be digitalised will be
- Data and information masses are distributed all over
- Added value of information/knowledge sharing increases
- Digitisation contributes to re-engineering of services and processes
- Ubiquitous connectivity is (will be) made possible.

RUDIMENTS

- There will be a number, however large, of processors embedded into artefacts in our environment.
- These artefacts, devices or appliances will have a recognisable object identifier.
- They are able to receive and transmit information concerning their state, behaviour and/or location.
- An object "in the network" has an identity that helps one to find relevant additional data and information "on the web".

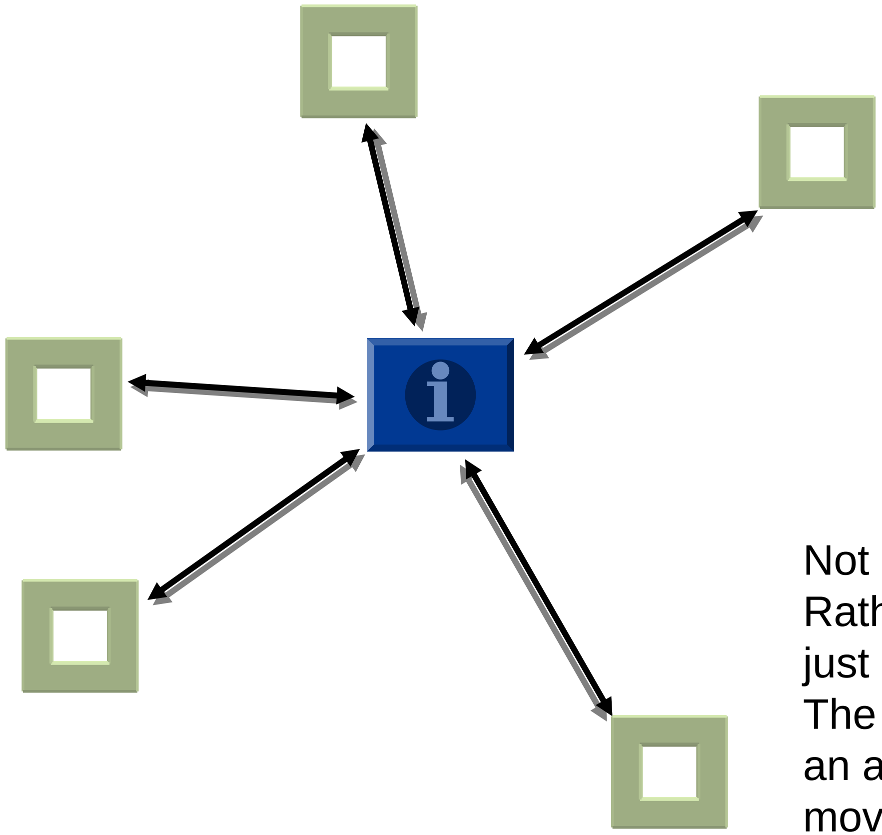
SELF-CONFIGURABLE SENSOR NETWORK



Mesh topology
Peer-to-peer architecture

One needs to develop application interface software to fit the network to the existing infrastructure.
The network is ad-hoc in its nature
and it has to be supported by smart protocols.

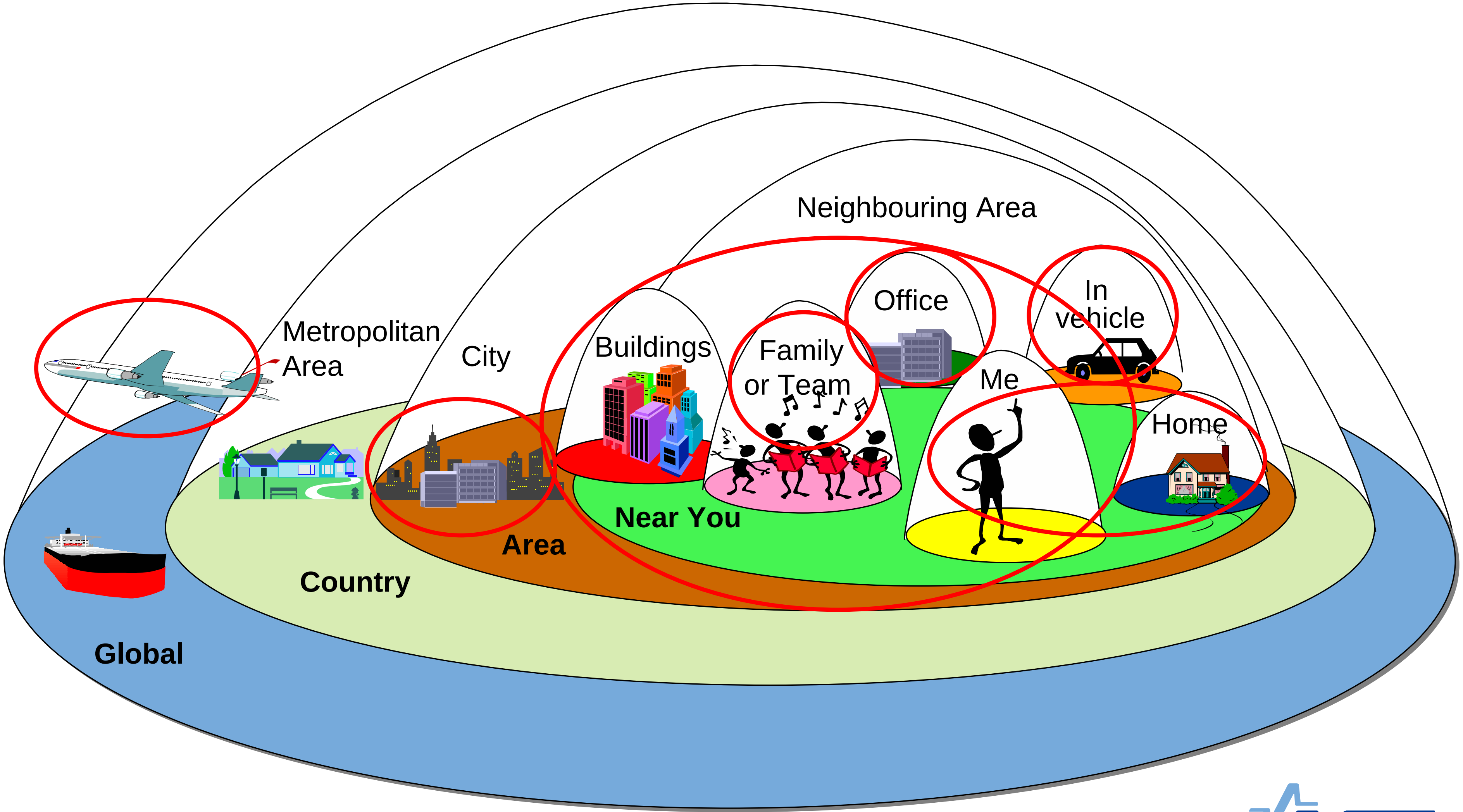
TERMINAL-CENTRIC CASE



Star topology
Master-slave architecture

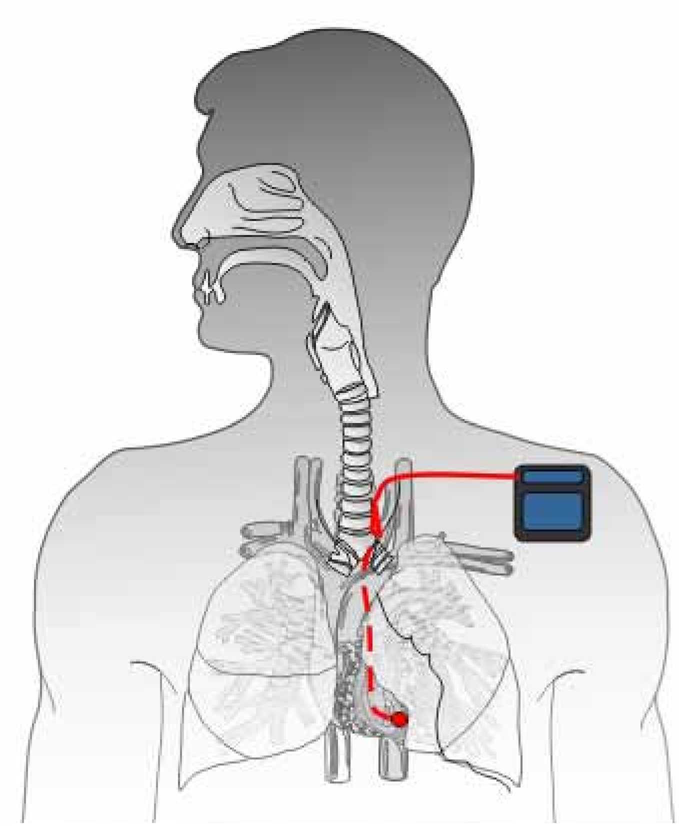
Not every single device needs to be smart. Rather there may be stupid artefacts possessing just a minimum amount of memory.
The intelligence could be handled by a person or an artefact, such as a mobile phone or a robot moving physically across the network.

DOMAINS IN DIGITAL TERRITORY

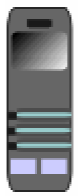


source: Beslay&Hakala

BODY AREA NETWORK

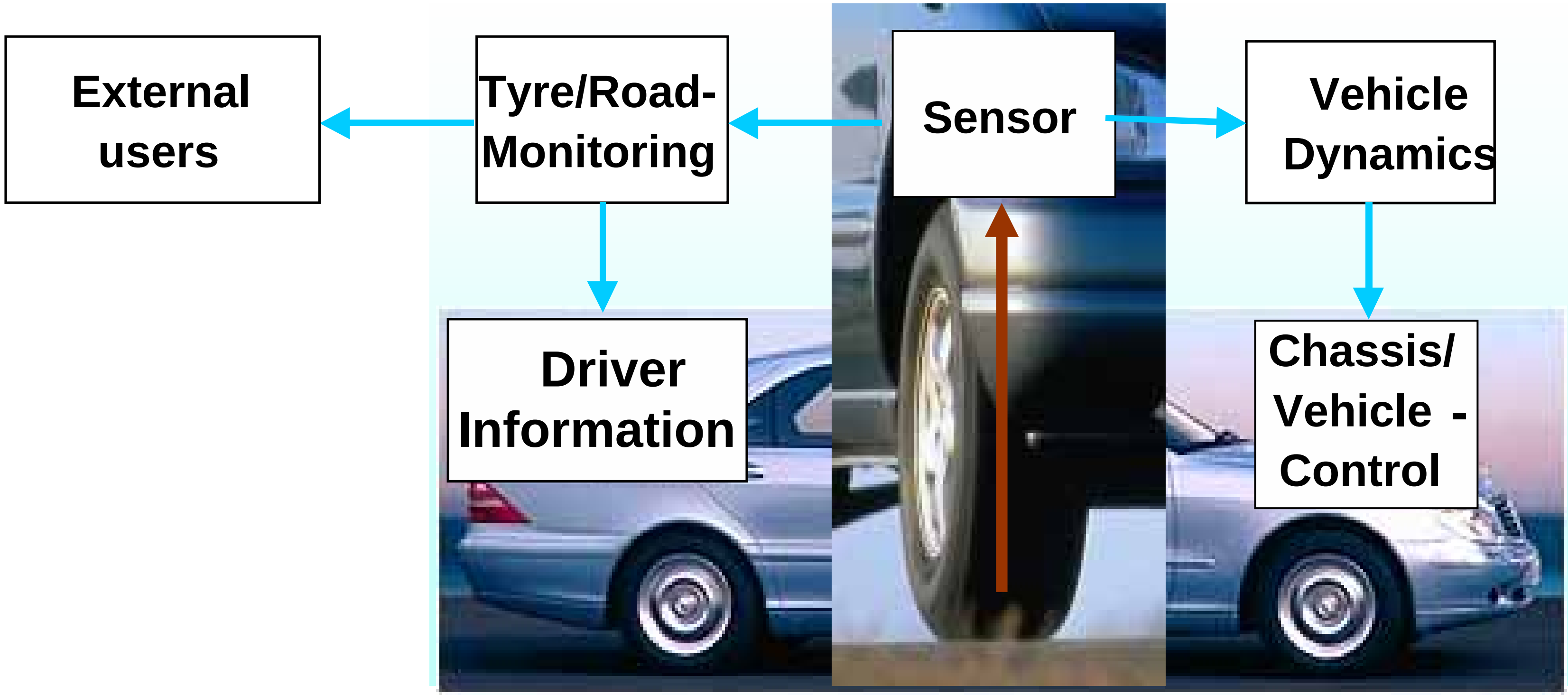


miniaturised antenna
implanted into the body



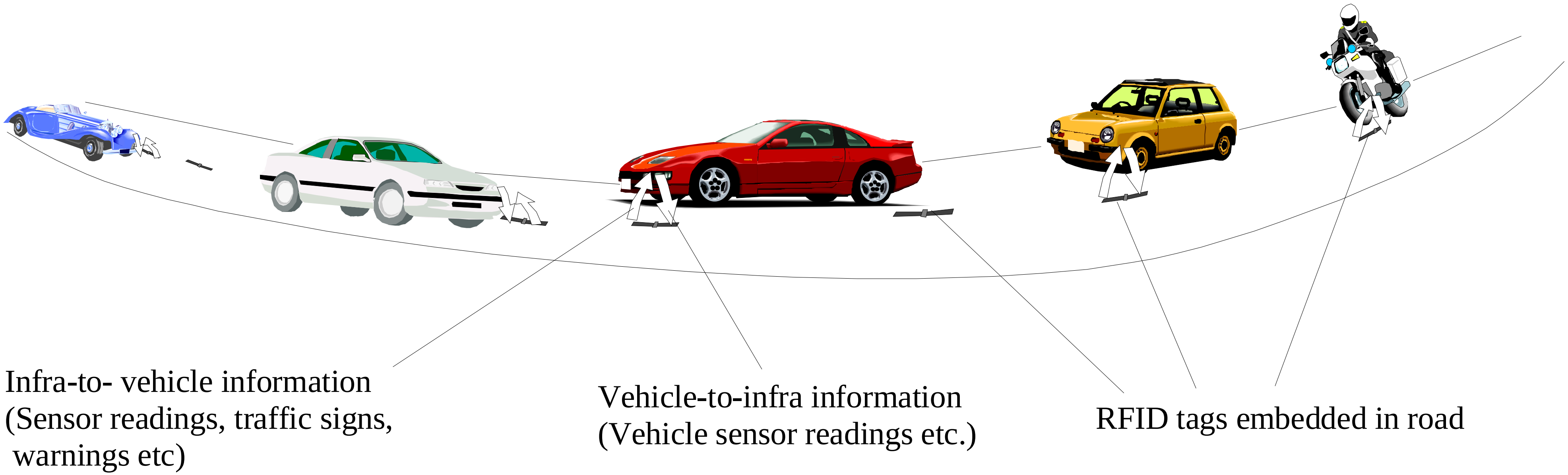
monitoring over an RF link

INTELLIGENT TIRE



source: EU,Apollo

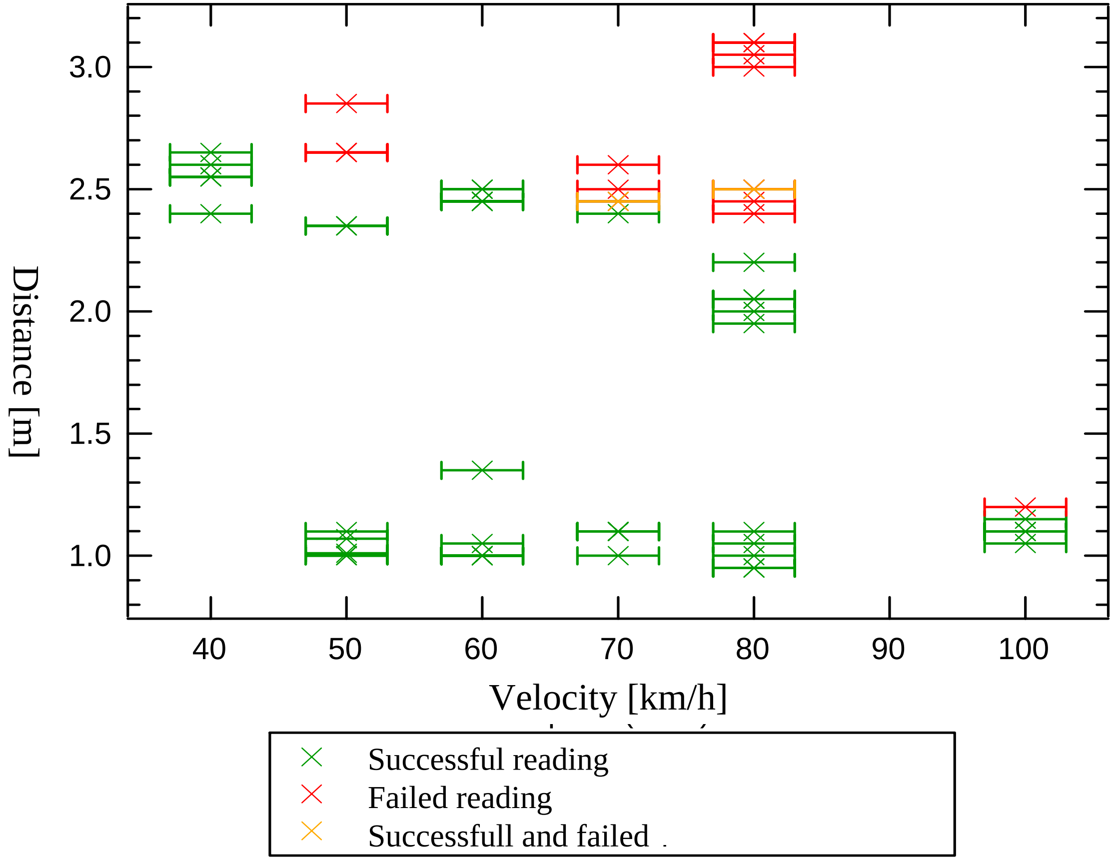
RFID FOR COOPERATIVE SYSTEMS ON ROAD



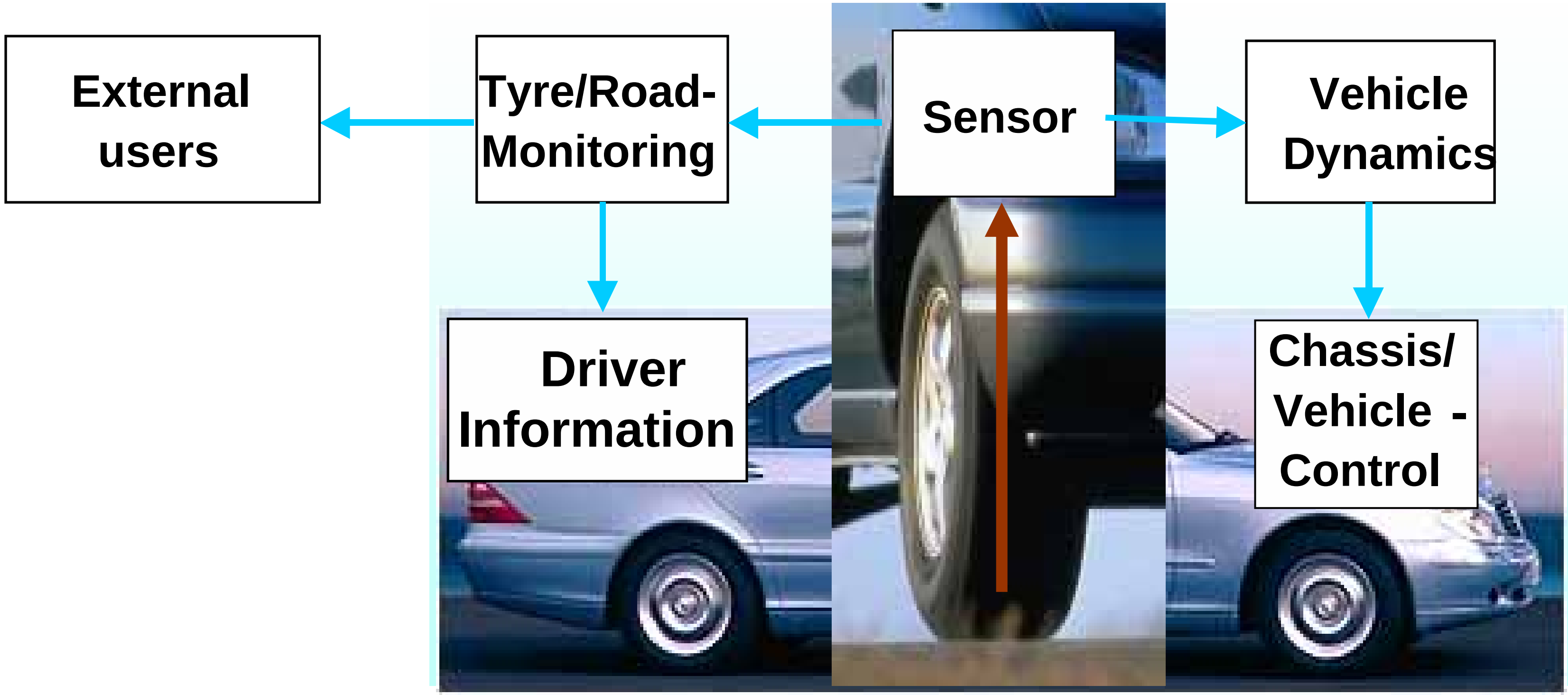
MOVING VEHICLE IDENTIFICATION WITH RFID

RFID tag

reader



INTELLIGENT TIRE

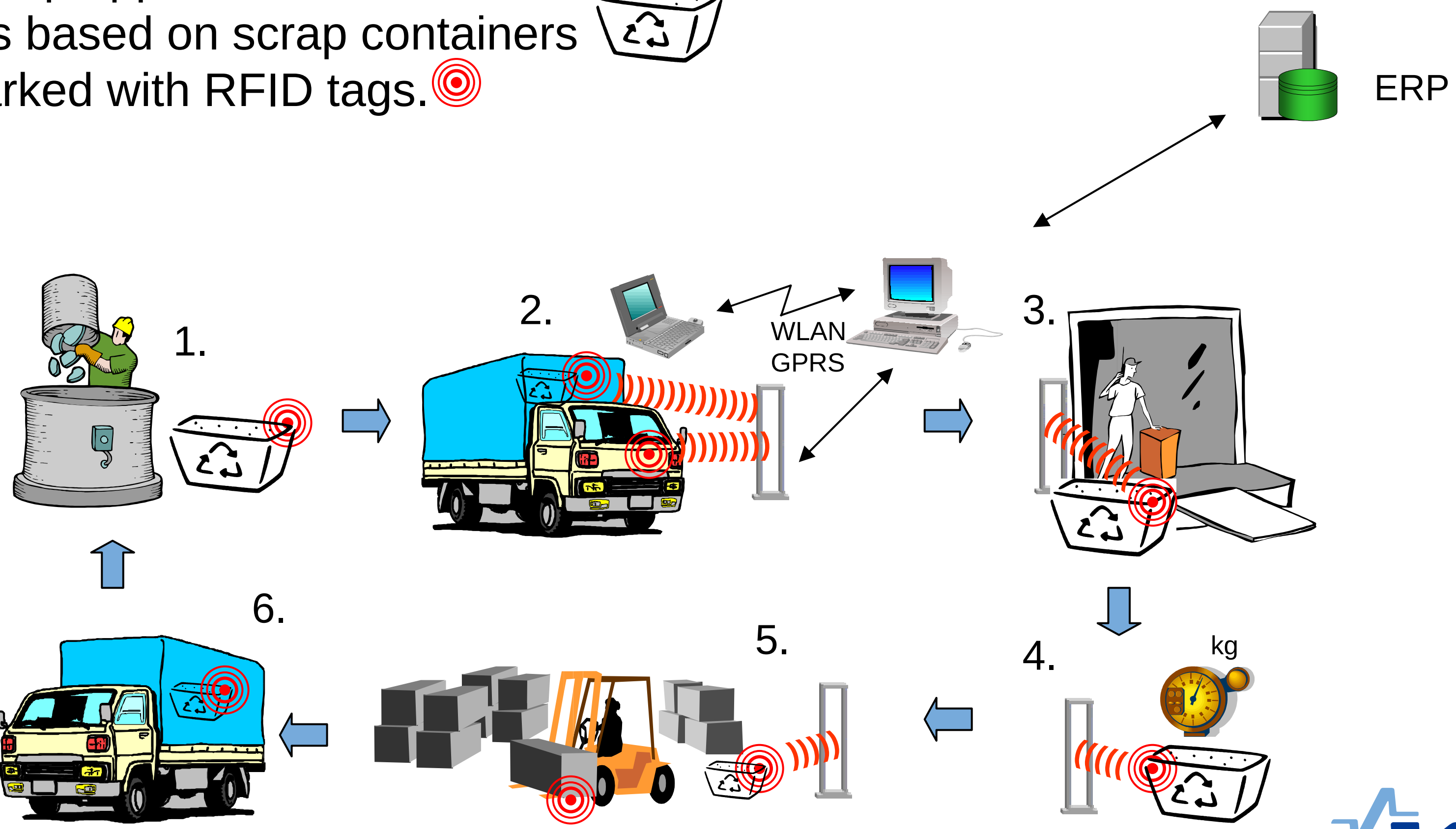


source: EU,Apollo

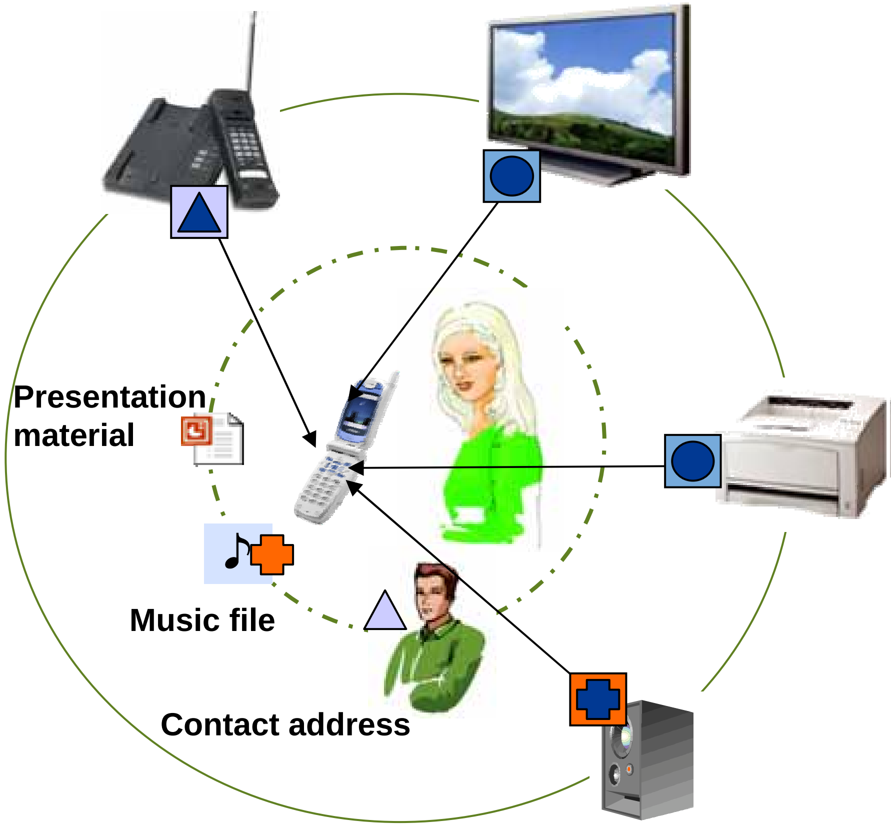
UBIQUITOUS SHOPPING

RFID IN RECYCLING SCRAP

Application of RFID to the recycling logistics of scrap appliances.
The system is based on scrap containers which are marked with RFID tags.

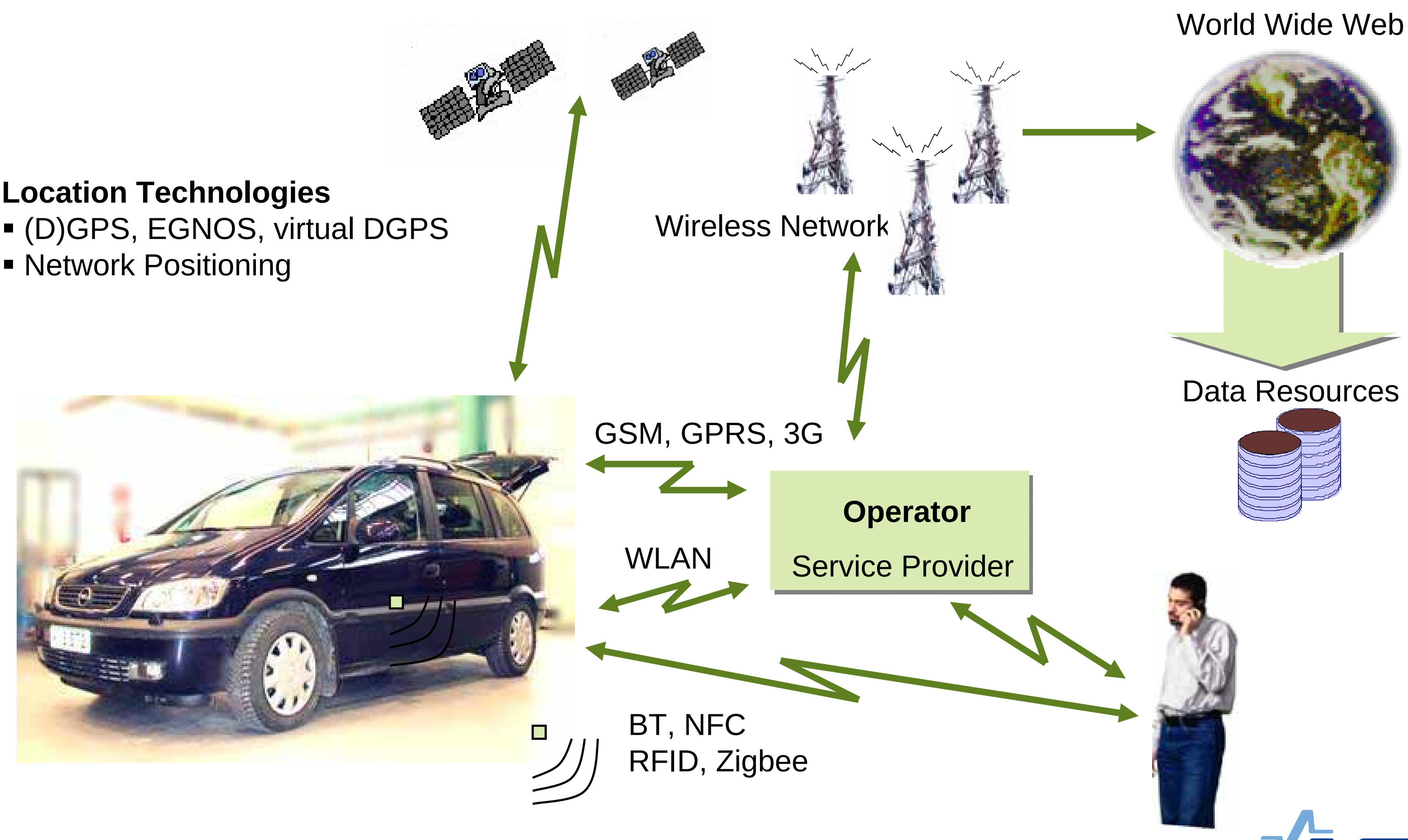


WEB SERVICES; NETWORK OF HUMAN COMMUNICATIONS

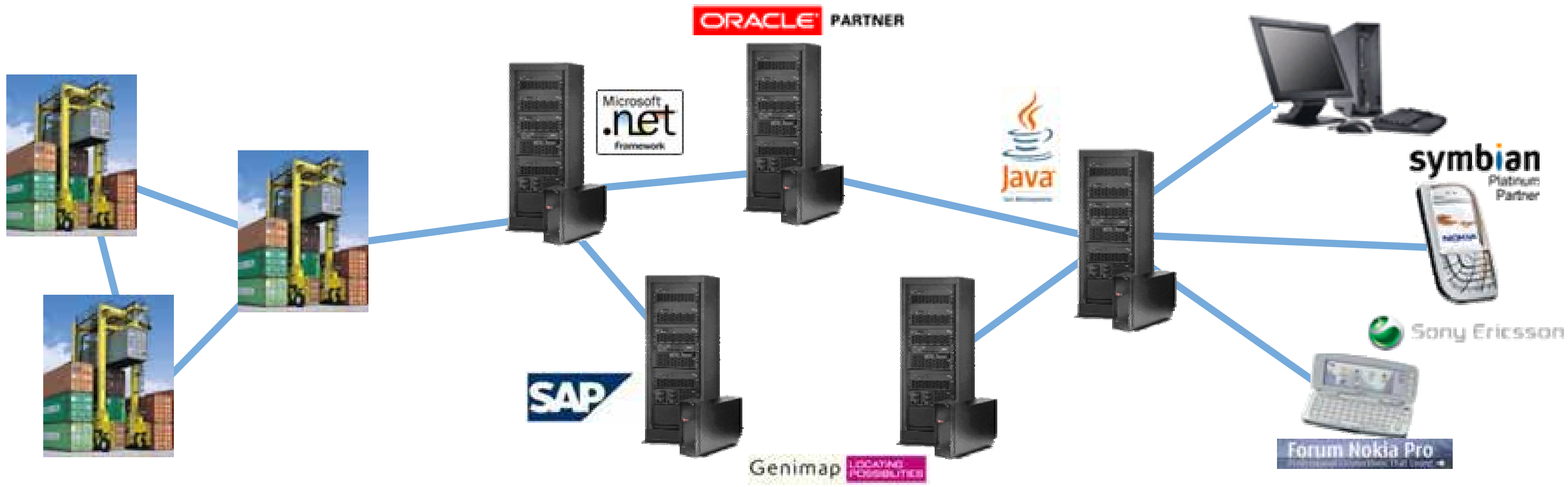


NETWORKING MOBILE OBJECTS

Location Technologies
- (D)GPS, EGNOS, virtual DGPS
- Network Positioning



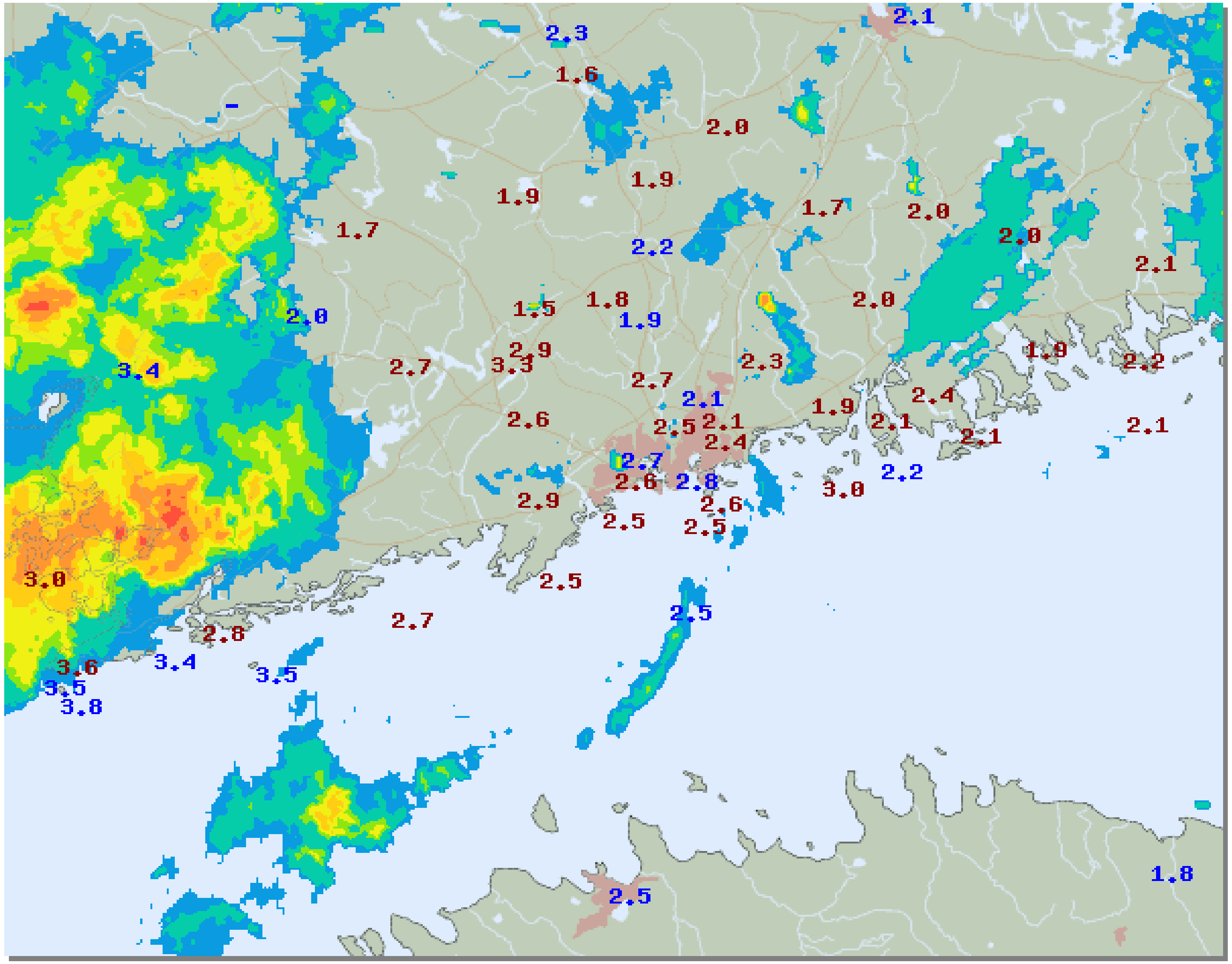
NETWORK FOR MANAGING LOGISTICS OPERATIONS



Embedded systems	Information systems	Terminal applications
Machine maneuvering	Integration	Internet
Machine-to-Machine	Data bases	Windows
Connectivity	Location-based systems	Mobile

source: Plenware

RAIN AND TEMPERATURE



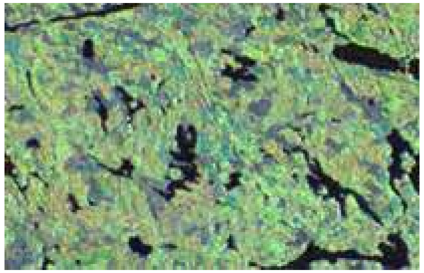
source: http://testbed.fmi.fi

RADIATION DETECTORS AND MEMS TECHNOLOGIES COMBINED WITH REMOTE SENSING METHODS

- Know-how of sensors on a large wave length range (x-ray, UV, Vis, IR, submm&mm).
- New avenues open when these sensors are combined with the methods of remote sensing.
- With MEMS mirror technology developed by VTT a light and compact midresolution (4 cm^{-1} – 10 cm^{-1}) FTIR device for VIS/NIR/IR range (400 – 6500 nm) can be realised.
- The figure shows a high-resolution stereo camera developed in a EU project. The camera utilises several CCD detectors.
- In the same way, cheap systems capable of generating 3D models can be realised with CMOS cameras.
- Cheap colour filters can be developed by combining tunable optical MEMS filters with CMOS cameras.

SATELLITE AND AIRBORNE DATA TO TERRESTRIAL NETWORKS

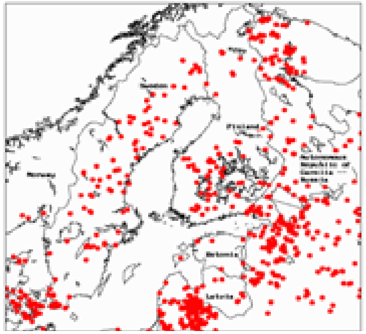
optical

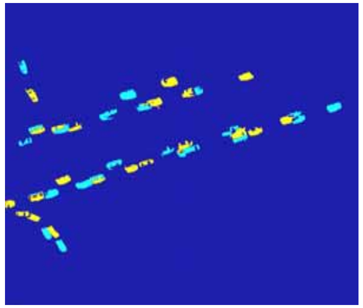


and

microvawe data

forest fire alarming

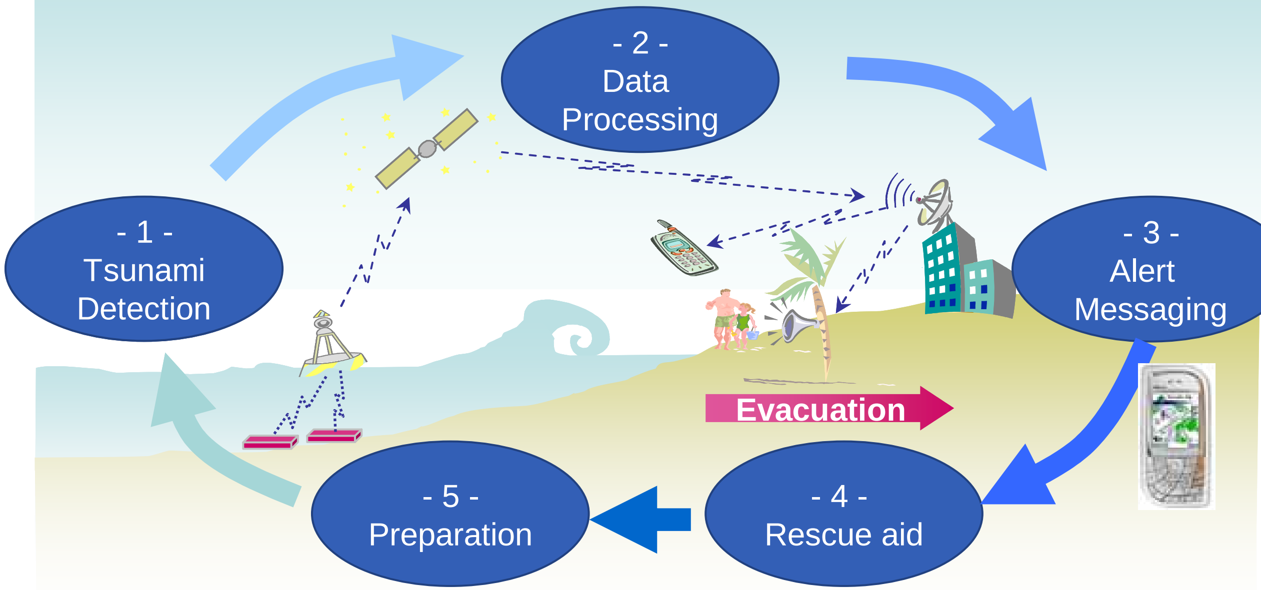




traffic speed monitoring

津波 tsu nami

TSUNAMI WARNING SYSTEM IN MOBILE ENVIRONMENT



1. Tsunami detection

- Sensor system for the detection of the earthquake and the tsunami wave
- Data transfer from surface to the processing centers

2. Data processing and data management

- Data collection and processing at the processing centers
- Derivation of alert messages including maps with evacuation routes

3. Alert message distribution

- Through the Internet
- To cellular phones, including evacuation routes

4. Rescue aid

- Alert message collection and analysis from the cellular phones
- Cellular phone location, including historical data
- Damage estimation using satellite data

5. Preparation

- Land cover maps and elevation information using satellite data for flood area simulations

VTT

CHALLENGES IN VIEW

- The future is unpredictable by definition. It may not warrant a clear-cut view nor a well-structured logical presentation of what will be.
- The **efficiency of the use of the radio spectrum** shall be enhanced. Whereas state-of-the-art efficiency is around 1 to 5 bit/s/Hz per cell, it will be increased by a factor of two, if not by an order of magnitude.
- For an Internet of things to become **affordable**, cheap production techniques have to be developed for microchip fabrication. Printable electronics could facilitate tags at a cost of pennies.
- **Standards** become indispensable. *This is already well advanced in the EPC area.*
- **Interoperability** becomes a major issue. Fortunately it is being dealt with **already now** in the connection of 3G and 4G wireless systems.
- Security, authorisation to acces the network.

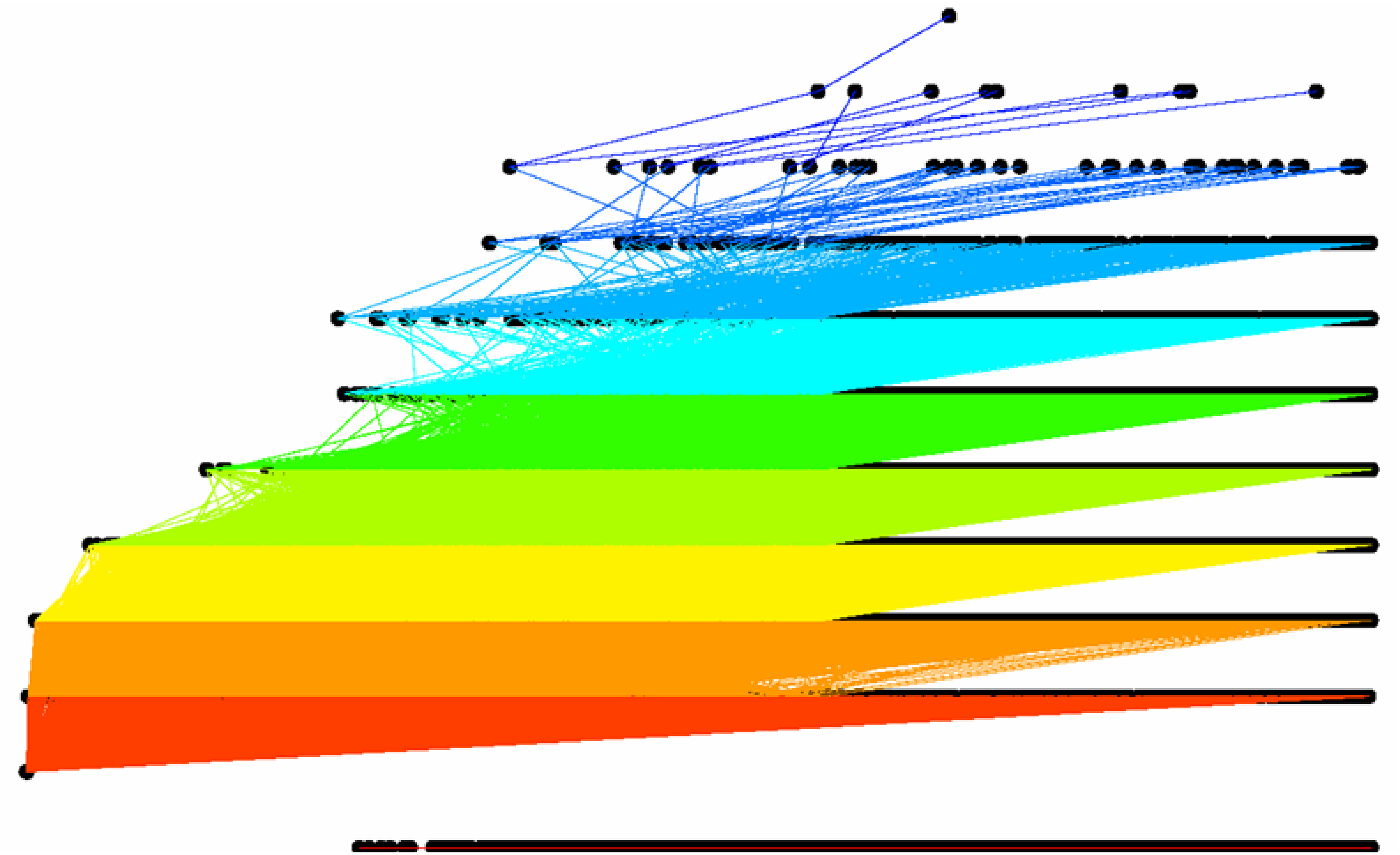
CHALLENGES continued

- **Congestion**; the Internet has been practically out of service a few times for reasons of excessive traffic. And we have just **seen the very benign beginning!**
- The main recipes for managing the quality of service have been to o**versize design capacity and set priority rules**. Barely ever the dimensioning of the capacity is determined by the considerations of **traffic theory**. Maybe it is time to take it more seriously?
- "The Internet of Things" greatly enhances the power of things and devices at the edges to make independent decisions. This will have an impact on the **congestion characteristics** of the network. This is an interesting, and indeed important, topic to be studied.

AN EXAMPLE: revisit

- Power-law random graph
- Take 100 000 nodes
- Distance typically of the order of loglog N
- Such a random network can be expected to describe meaningfully autonomous systems within the Internet (of objects).

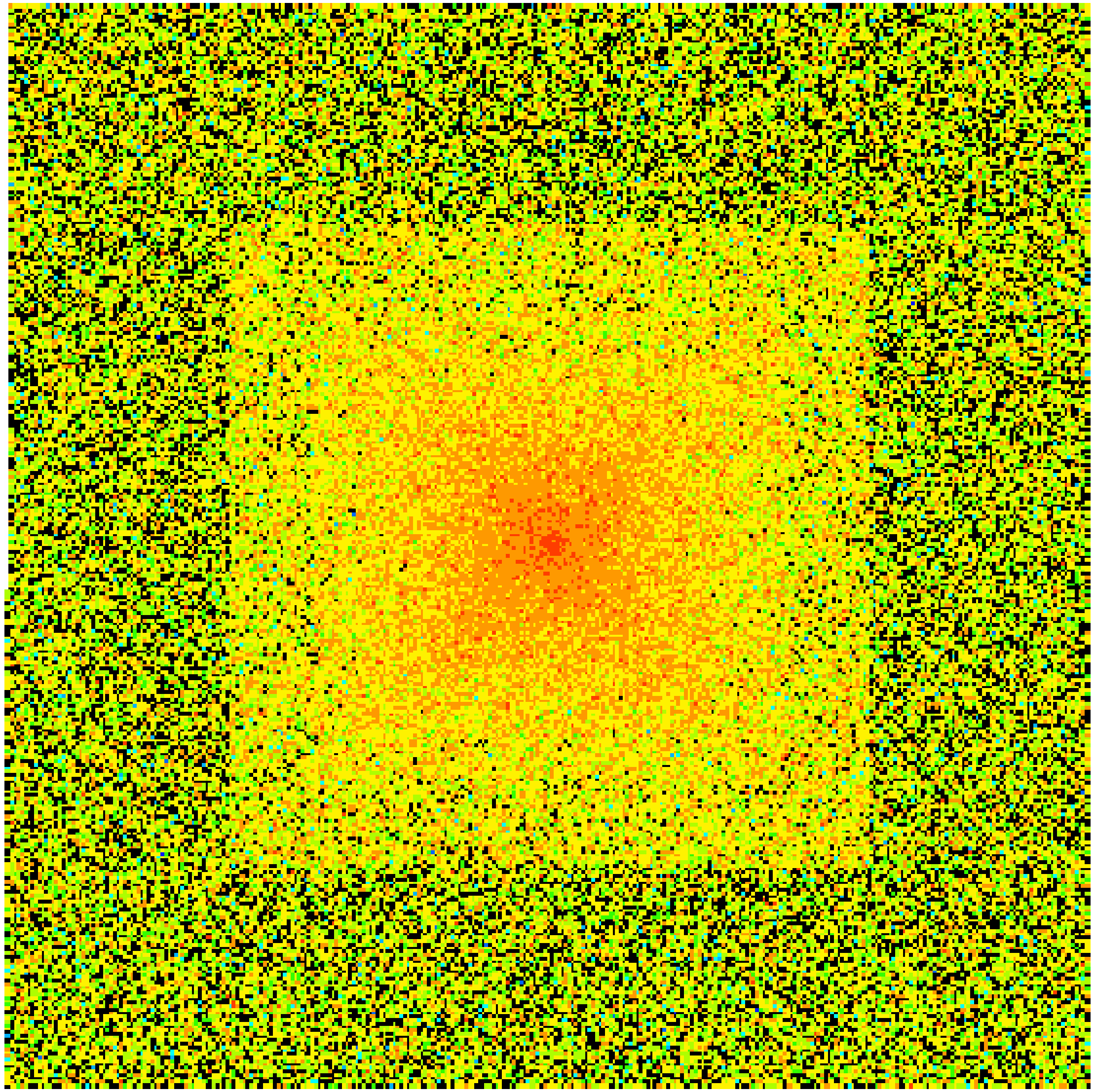
NUMBER OF HOPS BETWEEN NODES



source: Reittu&Norros,VTT

NODE DISTANCES

100 000 nodes



source: Reittu&Norros, VTT

CHALLENGES continued

- Congestion; the Internet has been practically out of service a few times for reasons of excessive traffic. And we have just seen the very benign beginning!
- The main recipes for managing the quality of service have been to oversize design capacity and set priority rules. Barely ever the dimensioning of the capacity is determined by the considerations of traffic theory. Maybe it is time to take it more seriously?
- The Internet of things greatly enhances the power of things and devices at the edges to make independent decisions. This will have an impact on the congestion characteristics of the network. This is an interesting, and indeed important, topic to be studied.
- We need powerful **search engines** to locate the myriad of objects in the Internet of things.

SOFTER ISSUES

- When tagging and sensing become ubiquitous, it is almost inevitable that some people will find their **intimacy offended**. Their acceptance by the public at large is by no means guaranteed.

- Another ethical question relates to the loss of personality in communication. The Internet of objects, where object refers to people and things, **must not contribute to one treating people as things.**