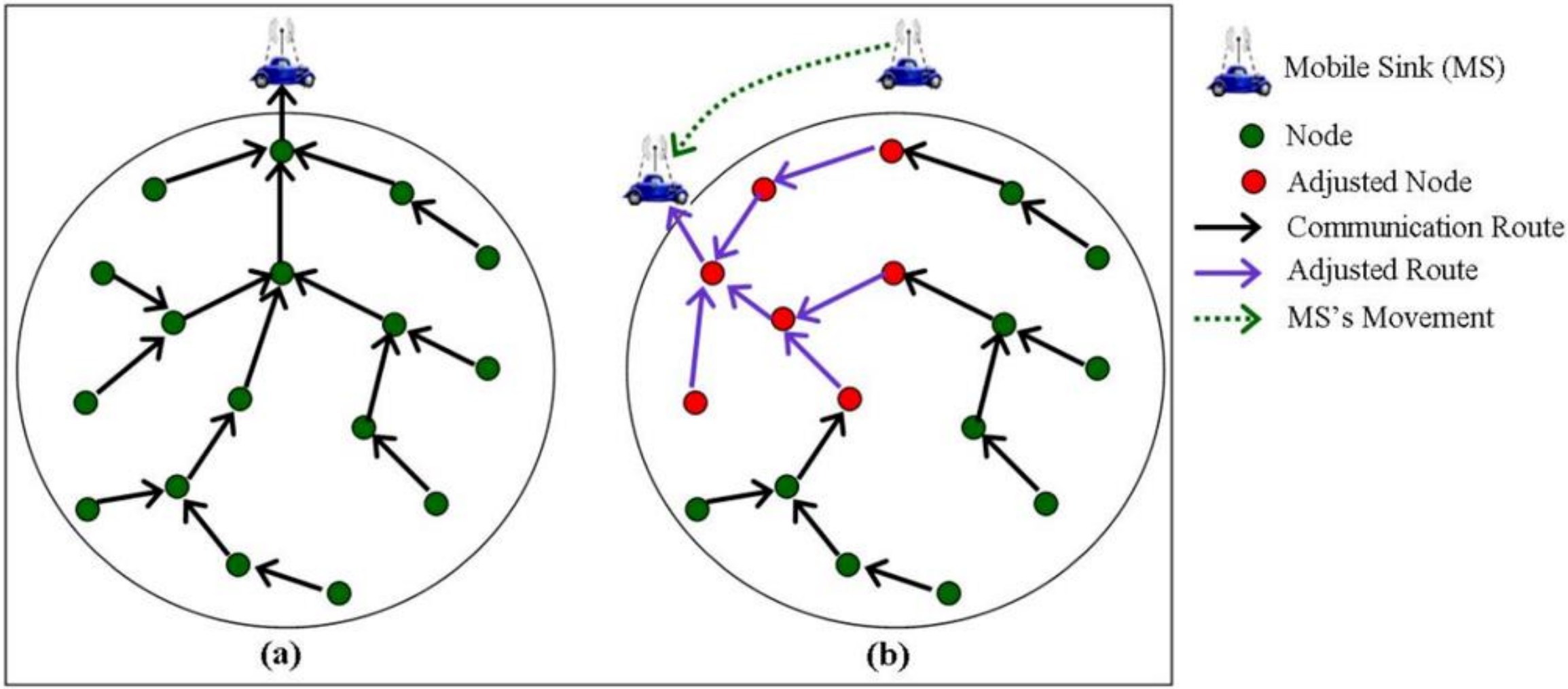
Sensor networks and applications

Mobility in WSN. Session and Application layers.

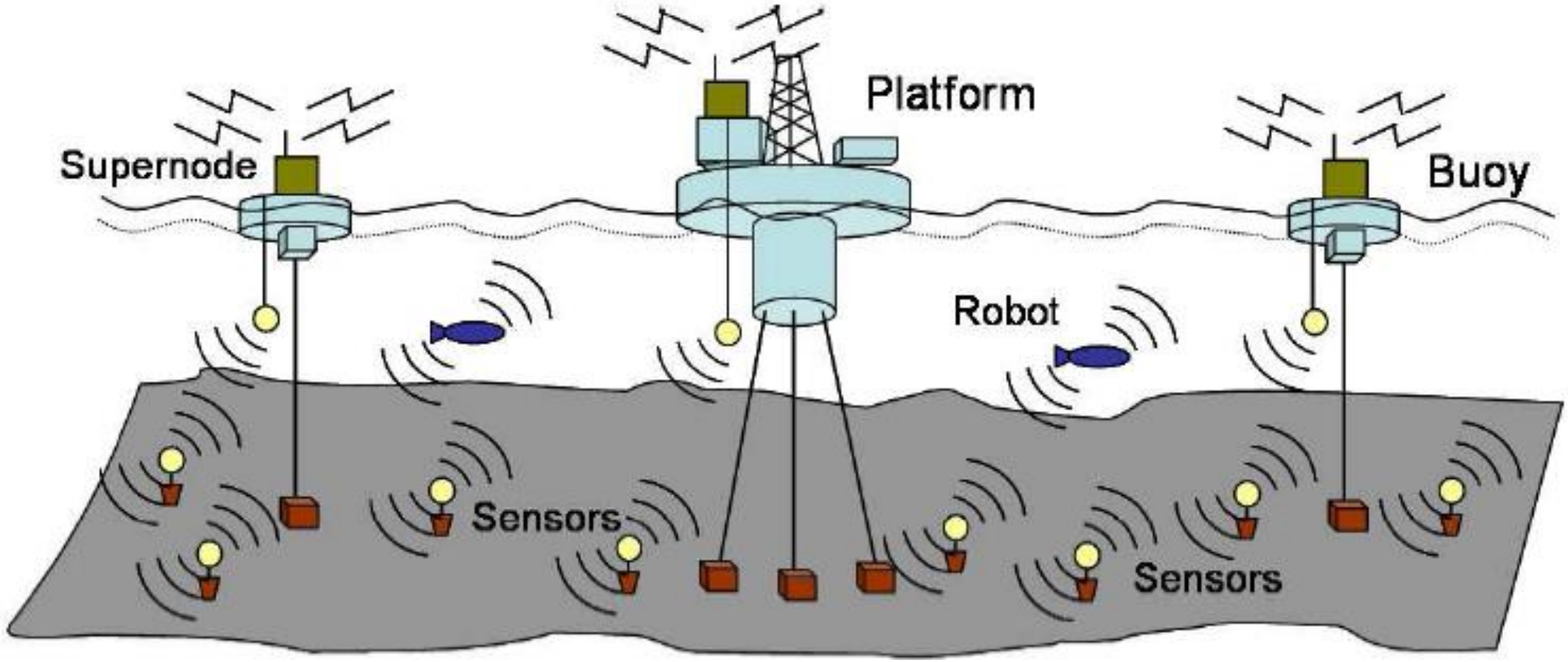
BS controlled mobility

- Using **controlled BS mobility**, the trajectory and timing can be planned using a preferred strategy.
  - E.g., the BS is moved to the area that is interesting for us.
- Advantage:
  - total control → more options to choose from
  - More BSs can be controlled together.
  - Data quality can be guaranteed (QoS).
- Note: The cost of BS mobility must be taken into account!

BS controlled mobility (example)



BS controlled mobility (example)



Sensor mobility

- In contrast to BS mobility, moving sensor nodes can be critical from energy and cost point of view!

- Sensors can move randomly, or in a controlled way.

- **Random mobility** for the sensors is typical, when they move along with the environment or medium, in a passive way.
  - E.g., Sensors in rivers, on the surface of water, underwater, in air, on glaciers, etc.
  - E.g., Sensors mounted on animals or vehicles…

Sensor mobility

- Using **controlled mobility** for sensors, it is possible to …
  - increase coverage,
  - provide connectivity,
  - ensure energy efficiency.
- In many cases the sensor can be moved only once, just after deployment to reach the desired topology.
  - E.g., uncovered areas, uneven node density, communication „holes” (=**topology control**).
- Sometimes only a small subset of the sensor nodes are mobile.

Sensor mobility

- In event-driven networks, sensors can **move adaptively** towards more „interesting” areas.
- The strategy for sensor mobility can be…
  - **reactive**: sensors move by reacting to events
    - E.g., they move closer to the events
  - **proactive**: sensors try to spread out optimally (evenly).
- A possible group of algorithms for sensor mobility is based on **potential fields**.
  - E.g., electrostatic field emulation, where same charges push themselves apart.

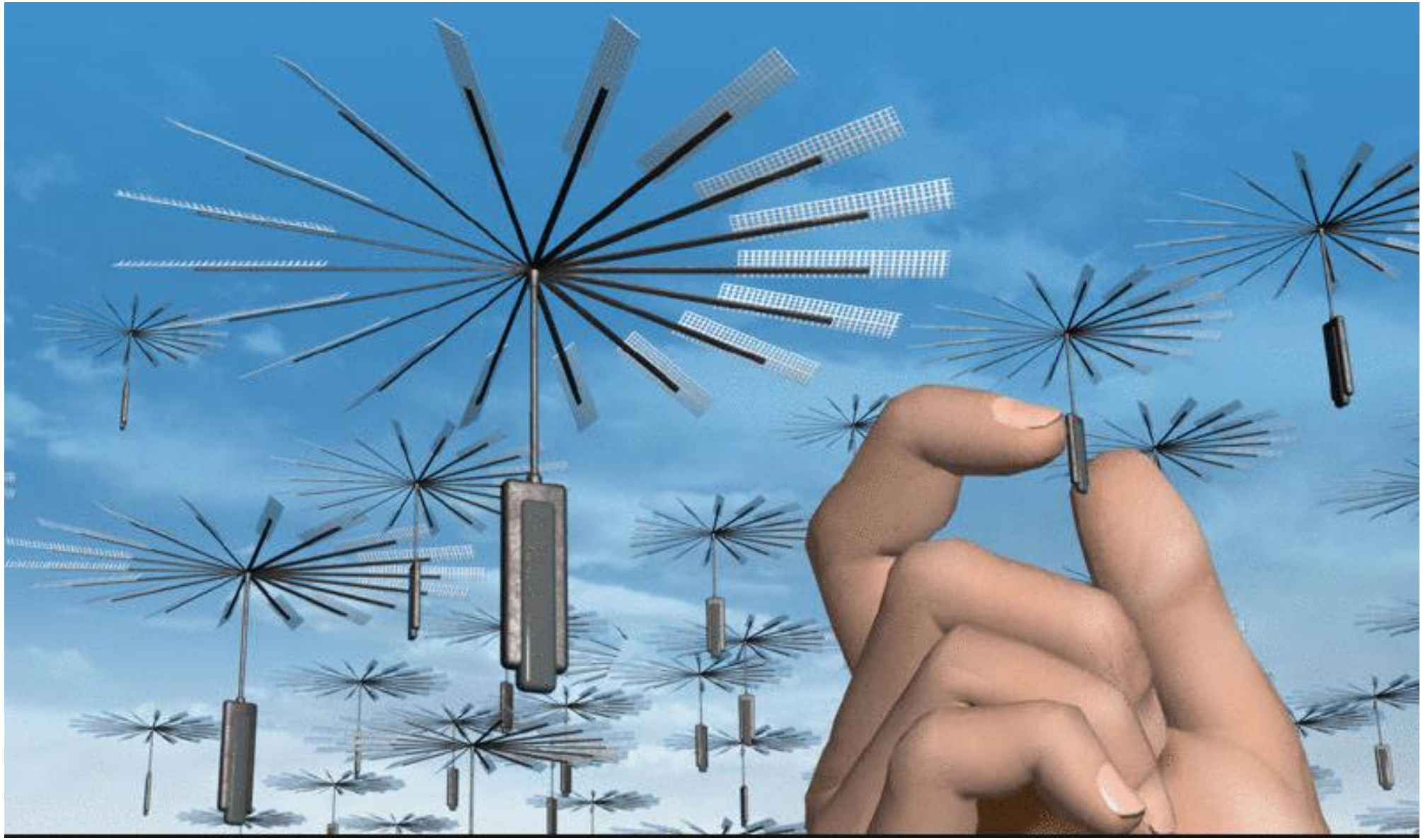
„Virtual” mobility in sensor networks

- **Mobile agents**: Agents are code segments, that can move within the network and executed on some network nodes.

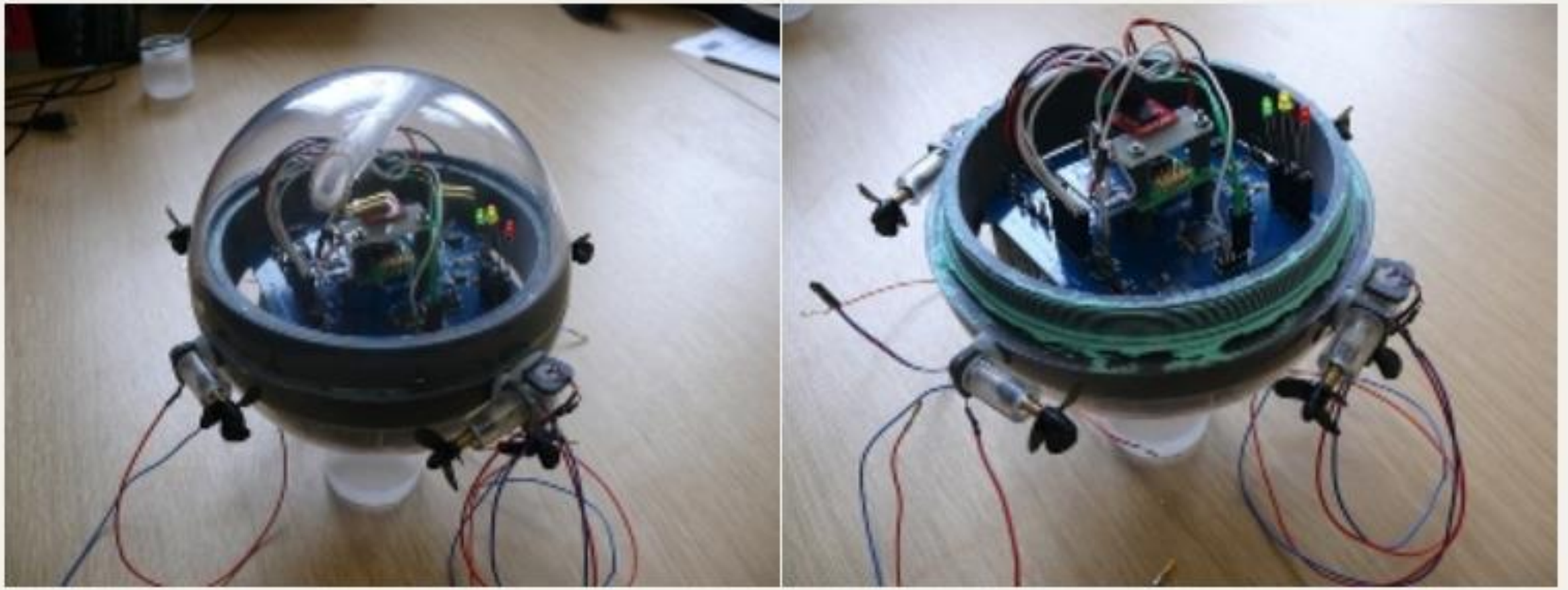
- It can be useful to process the data within the network right where the data was collected.

- The network can be reconfigured by **virtually move (relocate) the BS(s)**.

Sensor mobility (example)



Sensor mobility (example)



Robot Prototype (Photos from Simon Watson, University of Manchester)

Transport and application layers

Transport and application layers

Sensor network architecture

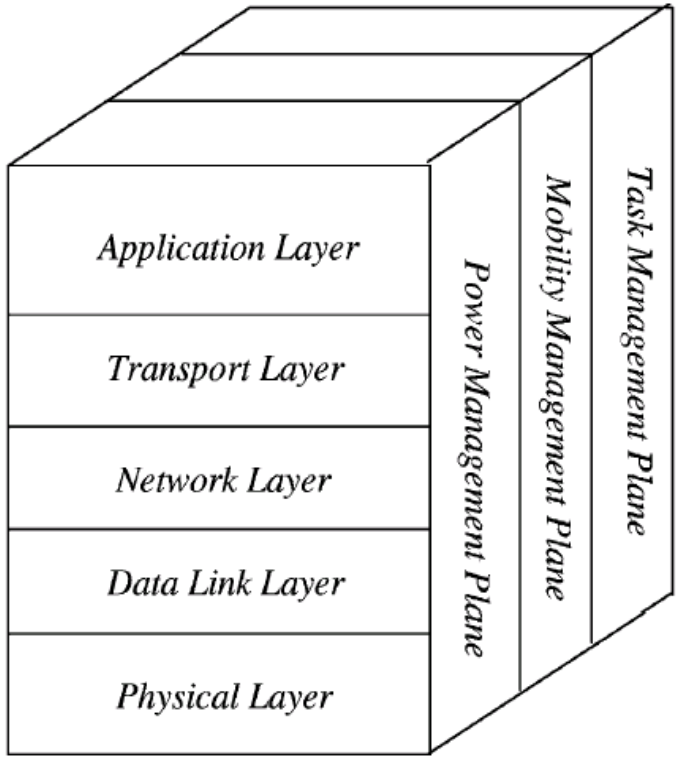
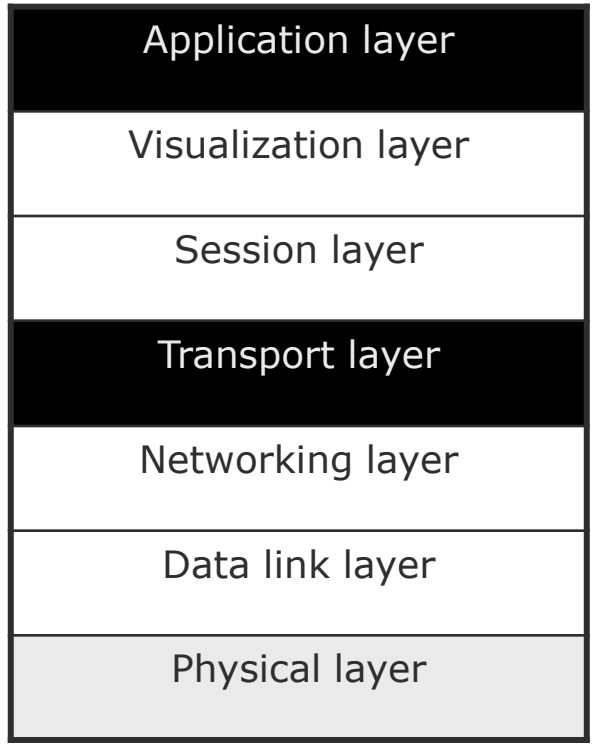


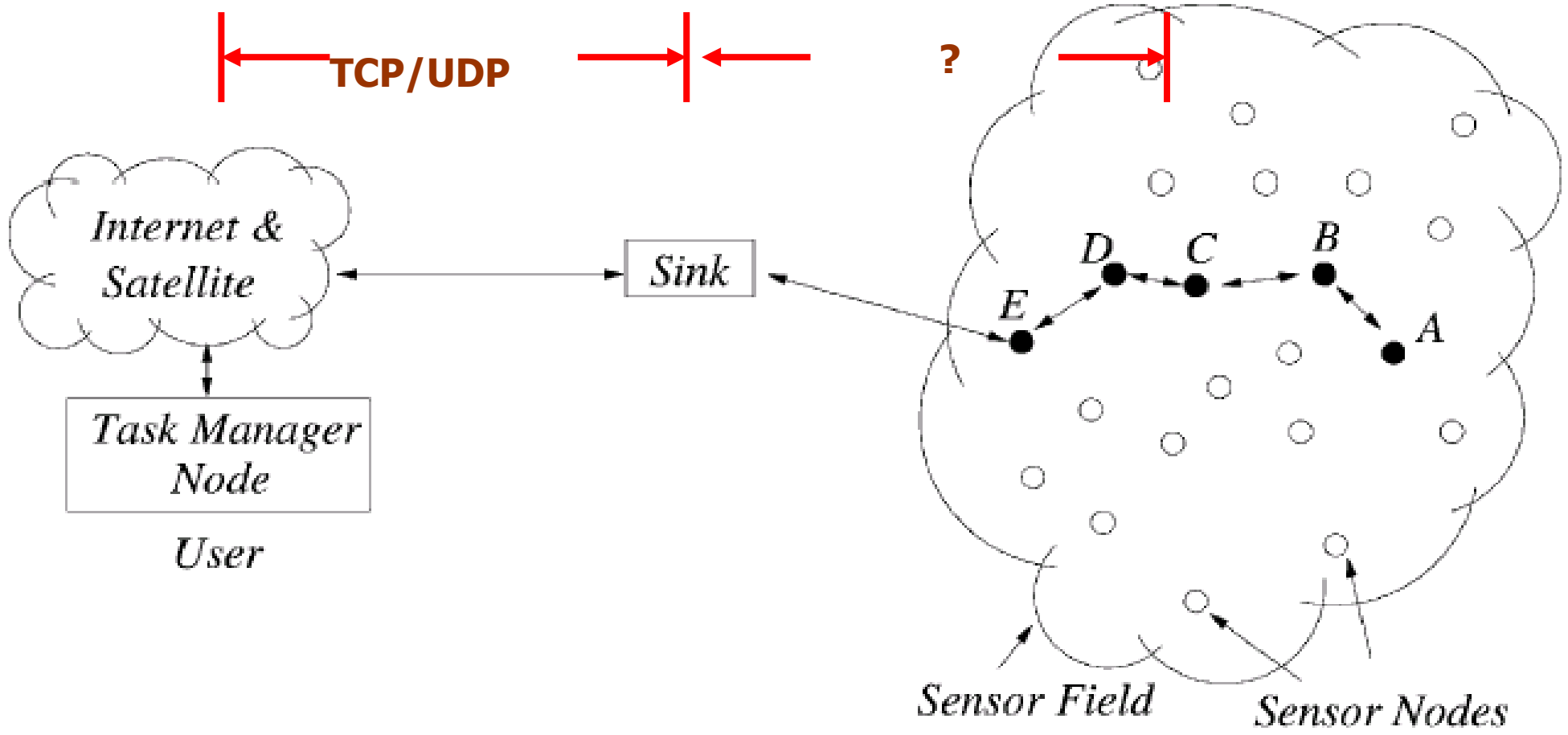
Fig. 3. The sensor networks protocol stack.

ISO OSI



Transport layer

- The transport layer solution is necessary when the sensor network is accessed via the Internet.



Transport layer

- The TCP-like solutions can not be directly applied to WSNs
  - Unique addresses are not always available.
  - There is not enough memory in the nodes.
  - TCP handshaking and acks can be a huge overhead.
  - Congestion management is not necessary, and is too complex.
- UDP-like solutions are more preferable in WSNs.
- „TCP-splitting”: The TCP connection is terminated at the BS, and only datagrams are used within the sensor network.

Application layer

- In contrast to the wide range of applications, there are no universal application layer protocols in WSNs.
- Possible management protocols:
  - **SMP – Sensor Management Protocol**
  - **TADAP – Task Assignment and Data Advertisement Protocol**
  - **SQDDP – Sensor Query and Data Dissemination Protocol**

- Note: These protocols are not yet defined and standardised!

SMP – Sensor Management Protocol

- The **network and sensor management** is an important task.
- The task for an application-layer management protocol is to make the lower (software and hardware) layers **transparent** to the application.
- The system administrators can use SMP to interactively manage the network.
- Without global addressing, SMP has to deal with attribute- and location-based addressing as well.

TADAP – Task Assignment and Data Advertisement

- An important task is to query and get useful data from the network.
- Possibilities:
  - The user commands the sensors and tells what information is needed.
  - Sensors advertise the available data to the user. The user only asks for the data that is interesting to him/her.

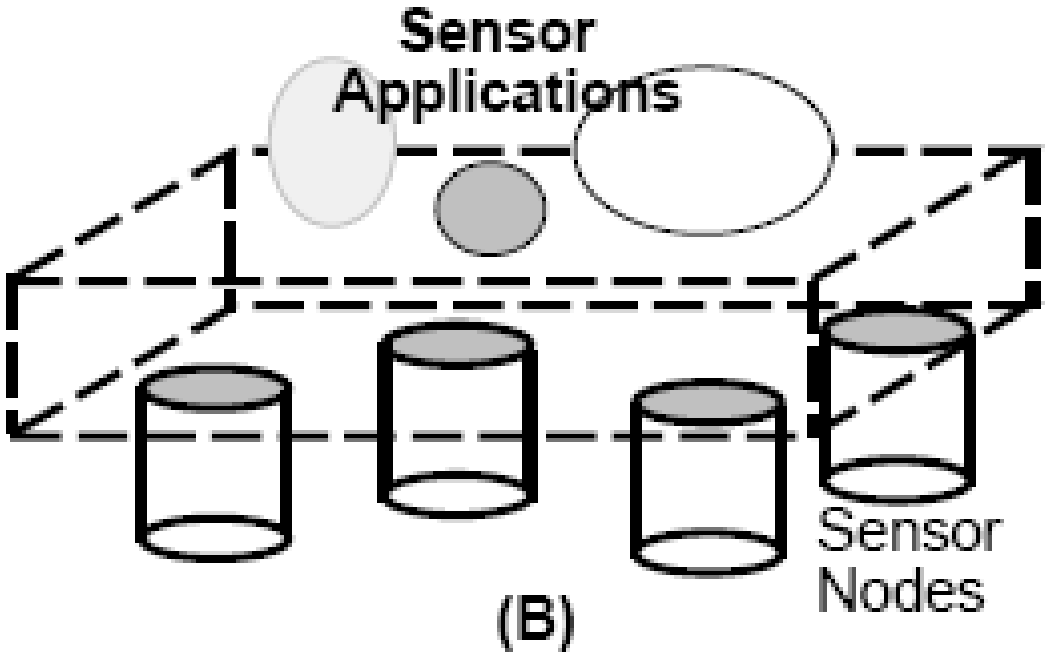
- An application layer protocol for task assignment or data advertisement can be a great help for the operation of lower layers (e.g., routing).

SQDDP – Sensor Query and Data Dissemination Protocol

- The SQDDP provides an interface towards the applications for
  - sending queries,
  - disseminating the data,
  - collecting the answers.
- It uses attributum- and location-based addressing
  - E.g., „Where are those sensors that measure temperature values higher than 70 degrees?”
  - E.g., „What is the temperature in the North-West sector?”
- There can be different SQDDP variants depending on the applications.

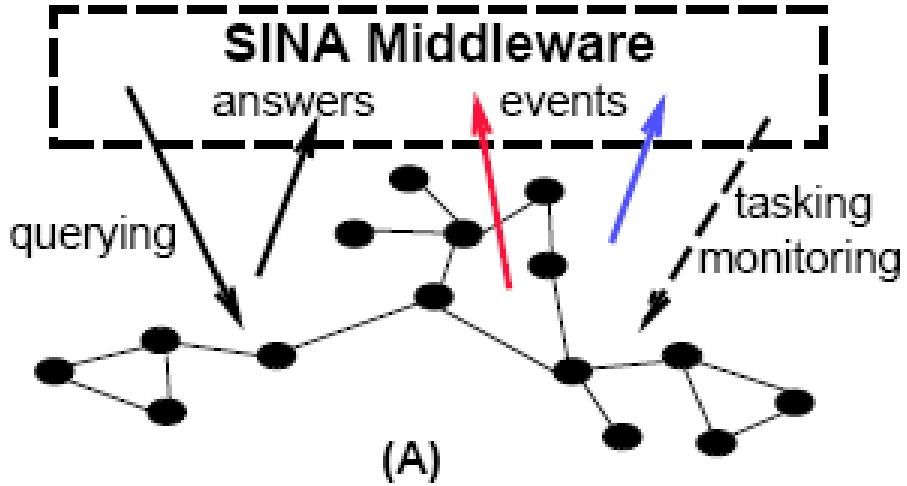
SINA and applications

- SINA = Sensor Information Networking Architecture
- Abtraction: The sensor network is seen as the collection of distributed objects (database!).
- SINA middleware



SINA architecture

- The role of SINA middleware: it makes possible for the applications to...
  - initiate queries,
  - distribute tasks,
  - collect answers and results,
  - monitor the network state.



SINA, SQTL

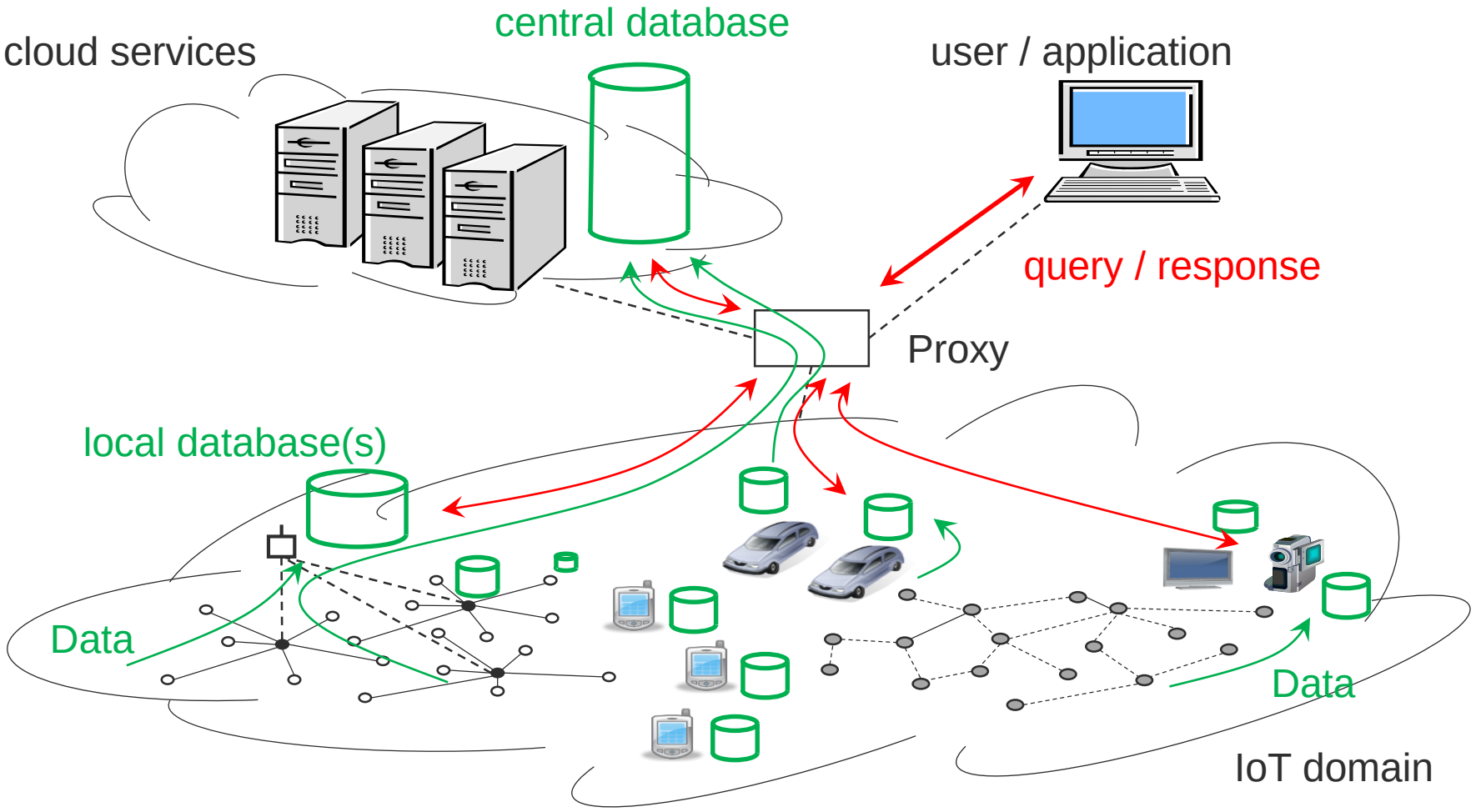
- SINA = Sensor Information Networking Architecture
  - SINA middleware
  - SINA architecture
  - SINA components
  - SINA query
- SQTL = Sensor Query and Tasking Language
  - SINA is part of the architecture

Sensor data in the cloud

- **Is it really necessary to send all data to the cloud?**
  - Radio communication is energy hungry
  - It is advisable to do some preprocessing and aggregation locally
  - The measurement and data transmission are two separate tasks
    - Measurements must be done according to the application's need
    - Data transmission must be done energy efficiently

Sensor data in the cloud

- Data in the cloud, but also in the IoT domain



Sensor data in the cloud

- Distributed database between the cloud and the IoT domain