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Pervasive Networked Systems FROM RFID TO THE INTERNET OF THINGS

An application and Industrial perspective

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- More and more everyday items will have embedded wireless interfaces.
- New interesting business opportunities:
 - Life support
 - Healthcare
 - Logistics
 - Robotics
- Problem: Items are often power constraint
⇒ Long links to base stations not feasible

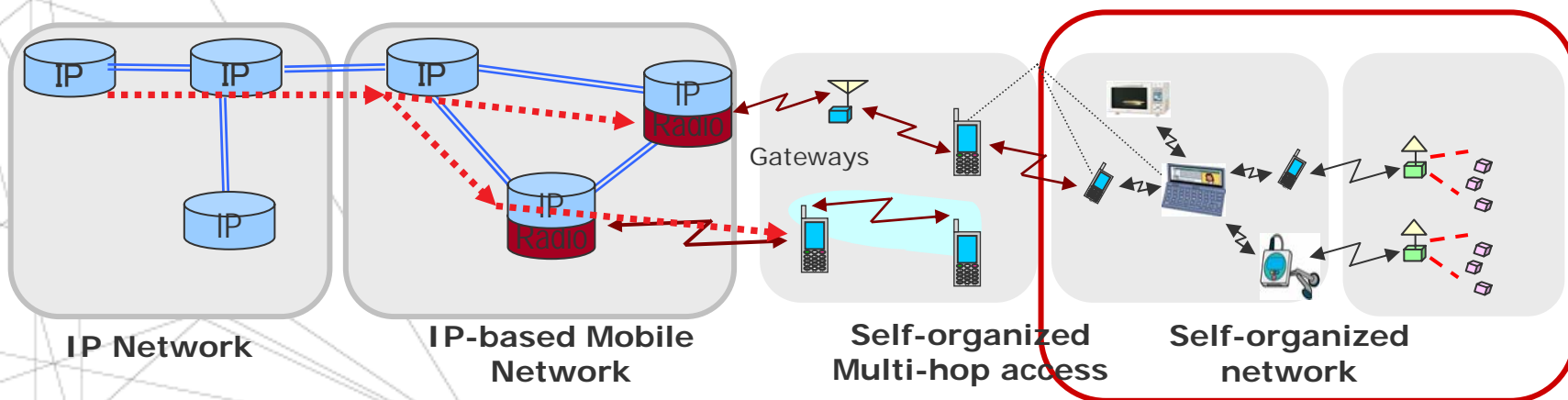


"Internet of things"

Mobile Adventure

Ubiquitous Networks

- Ubiquitous networks are becoming more and more of a reality
- Explore the impact on and possible role of a network provider in such networks



Some ingredients for future wireless networking

- Find and understand new business **opportunities** beyond 3G.
- Develop technologies and protocols for networking of **ubiquitously** embedded tiny devices and sensors.
- Develop protocols that help to master the increasing **complexity** and **heterogeneity** in mobile communications.
- Find novel approaches for **spectrum** allocation and sharing.
- Develop service platforms and applications for **ambient intelligence**.



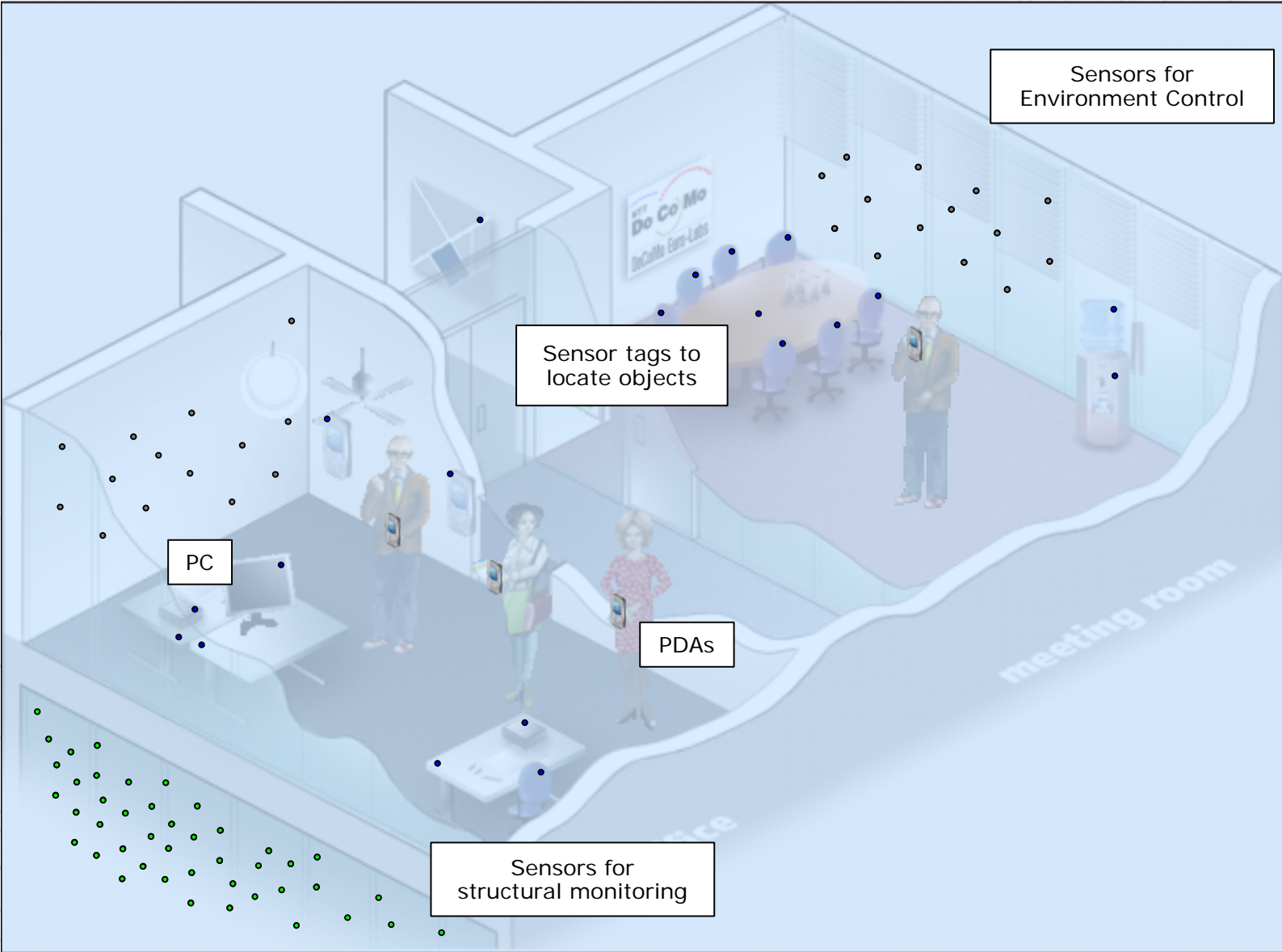
Nutrition Facts
Serving Size 1 oz. (28g)
Servings Per Container 16

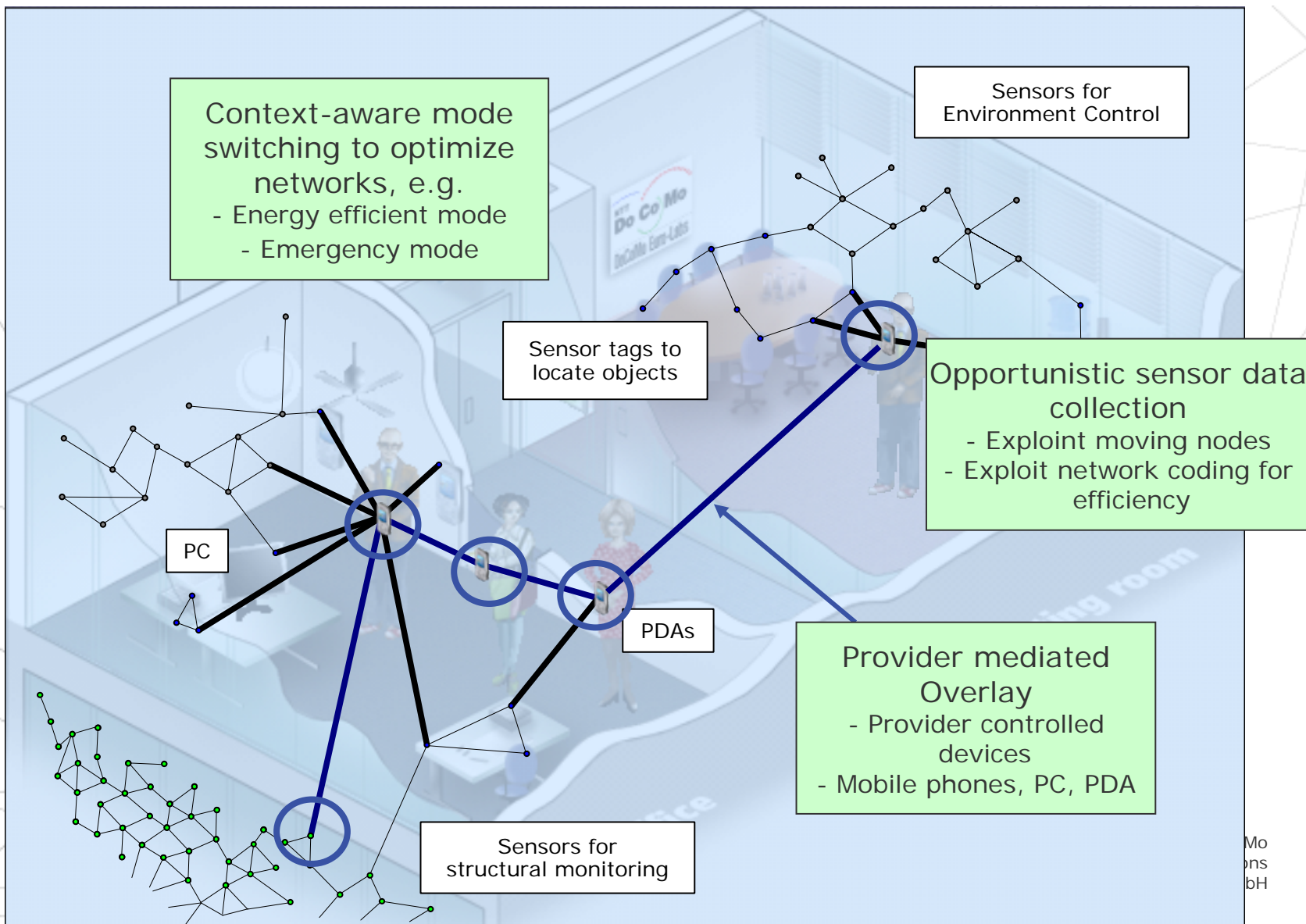
Amount Per Serving
Calories 190 **Calories from Fat** 150

% Daily Value*

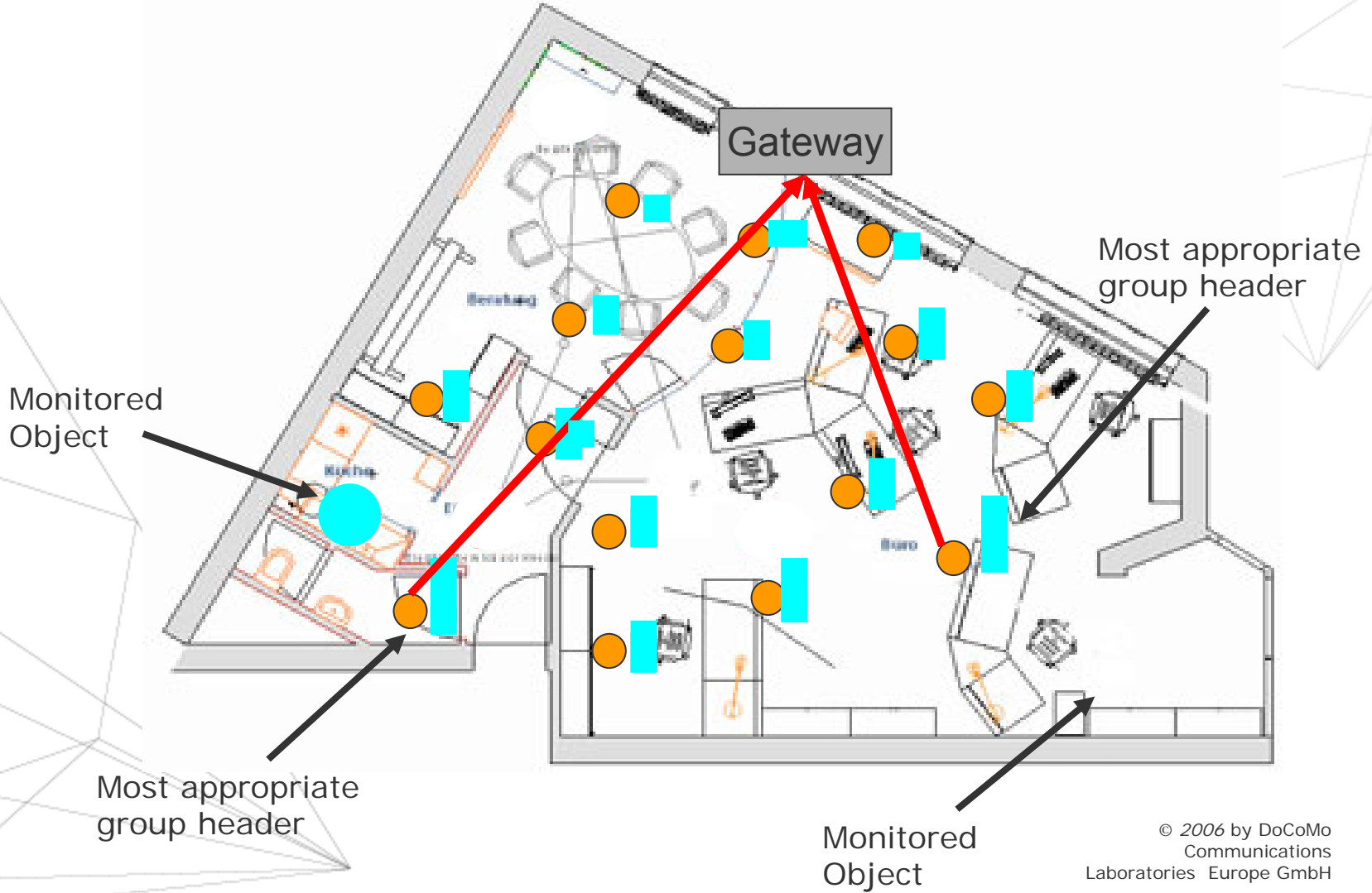
Total Fat 17g	25%
Saturated Fat 2g	10%
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 6g	2%
Dietary Fiber 3g	13%
Sugars 1g	
Protein 7g	







Mobile Adventure Monitoring Example



Mobile Adventure Node Role(s)

Some nodes might have special roles in Wireless Sensor Networks

- Group header
- Cluster header
- Concatenate node
- Data processing point
- Control node



Selection of such node can greatly affect network performance

- Completeness of cached data influences result accuracy
- Battery, memory and processing power influence speed of calculation and life time
- Position of node influences communication efficiency

other affecting parameters

Frequency of the gateway request

Radio link quality

Mobility, quasi mobility (sleep mode, switch on and off)

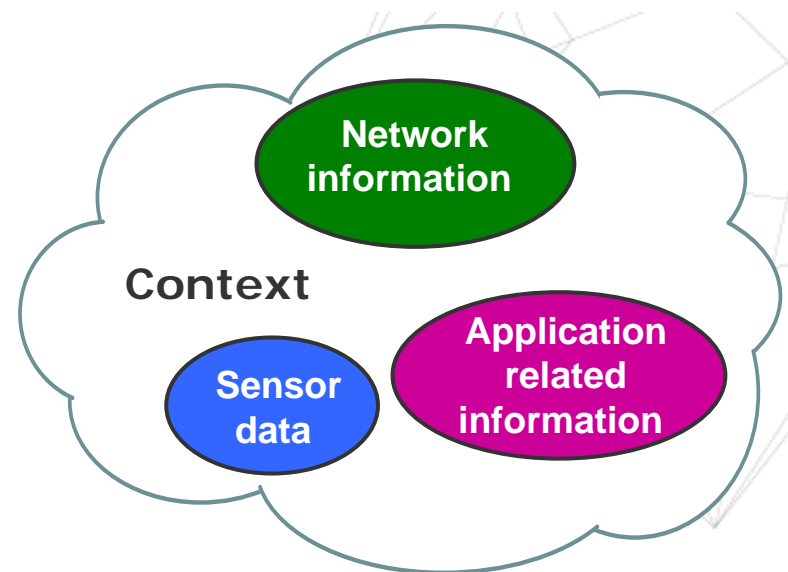
Context Management in Wireless Sensor Networks

Goal

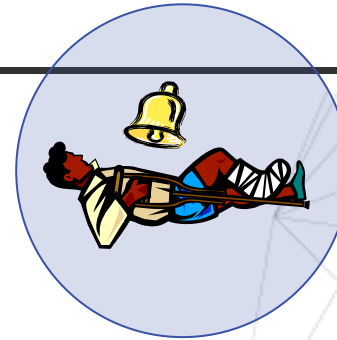
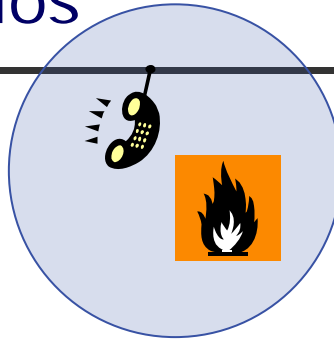
- context information can be distributed, processed and leveraged to optimize efficiency within a wireless sensor network

Value

- Optimize network performance
- Better satisfy the application requirements
- Sensor network adaptable to context changes (e.g., emergencies)
- Enable self-organization
- Help in-network data processing



Mobile Adventure Application Scenarios



Different Applications

- Wireless sensor networks applications have **different behavior**
 1. continuous monitoring
 2. fast alert
 3. reliable alarm



Different Network Requirements

- Sensor networks must provide **different characteristics**
 - energy efficiency
 - low latency
 - redundant data transfer

One network ↔ multiple applications
One network ↔ multiple optimization goals
possible Solution: **network modes**

Normal Mode

- allow **energy-saving** mode (e.g. sleeping) of nodes
- data aggregation
- tolerating **reduced responsiveness** and speed
- allow optimizing network topology

Monitoring

Direct Mode

- no **energy-saving** mode
- no data aggregation
- direct connection with least intermediate node
- however maybe long wireless link
- data forwarding with minimum delay

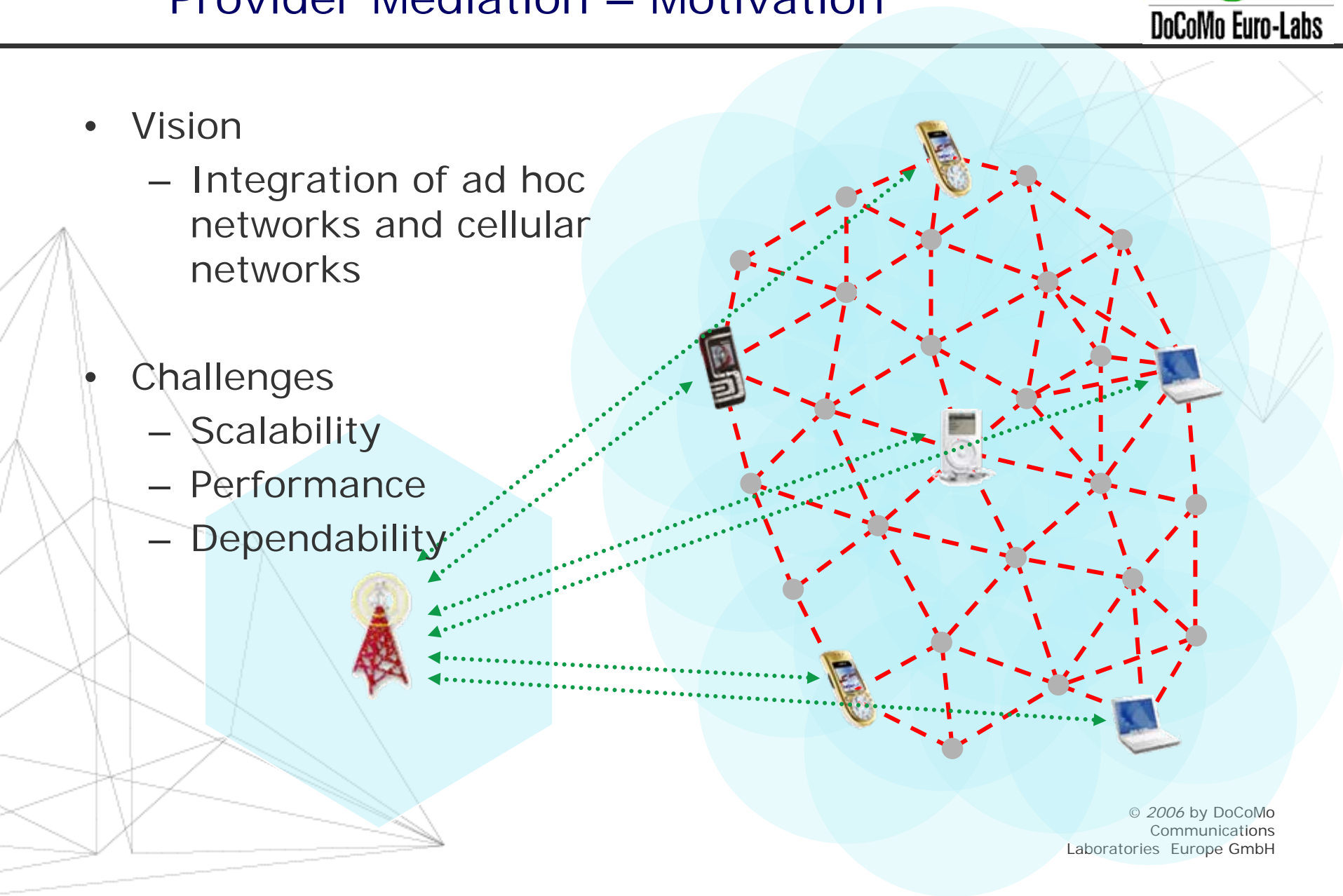
Alert Mode

Redundant Mode

- prevent use of power-saving and sleep mode of nodes
- no data aggregation
- allow **redundant data**
- use **redundant routing** paths

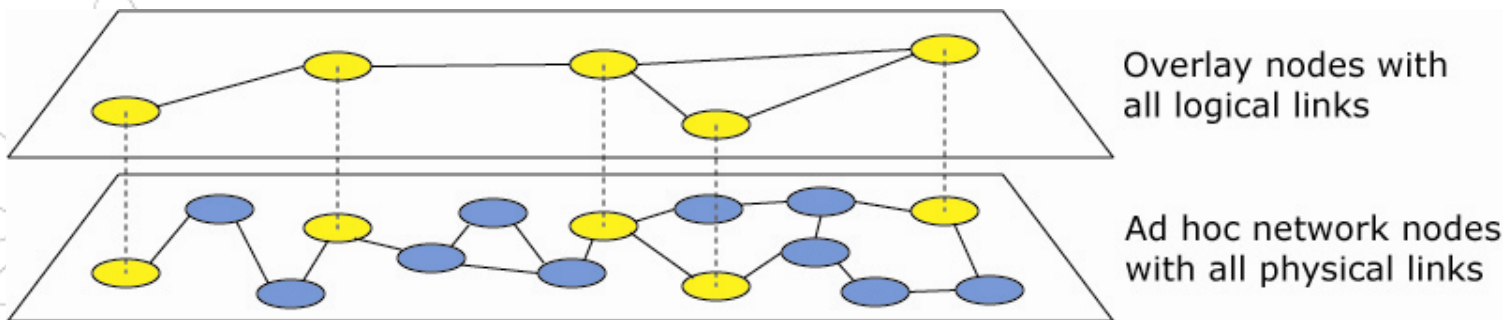
Alarm Mode

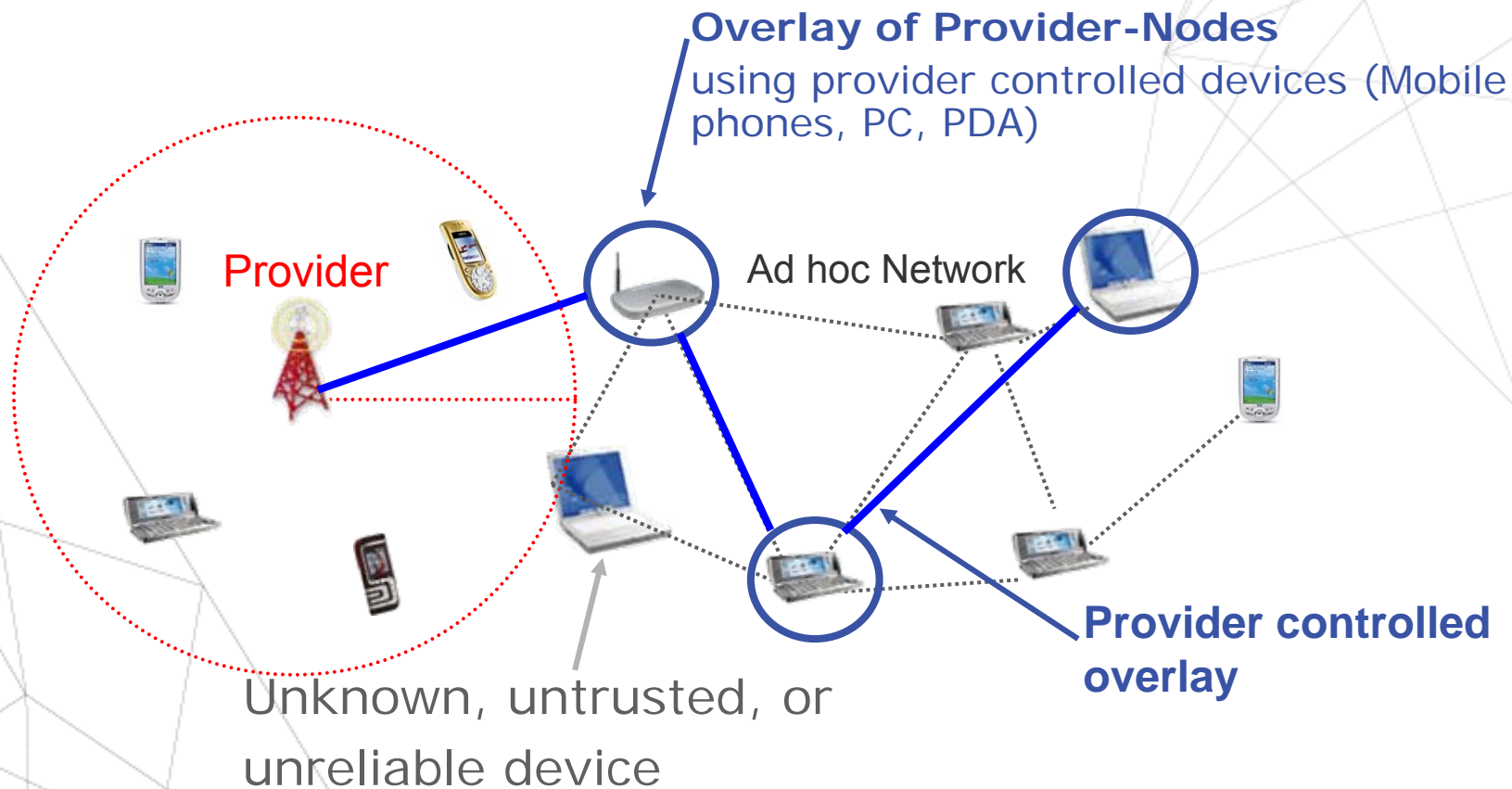
- Vision
 - Integration of ad hoc networks and cellular networks
- Challenges
 - Scalability
 - Performance
 - Dependability



Mobile Adventure Provider Mediation

- **State of the art in ad hoc networks**
 - Nearly all ad hoc routing protocols assume cooperation
 - Malicious nodes influence routing protocols disastrously
- **Goal for integration with cellular networks**
 - Establish dependability mechanisms in ad hoc networks
- **Research approach for ad hoc networks**
 - Overlay on top of an ad hoc network
 - The overlay comprises (all/only) nodes of a provider
 - We refer to it as provider-mediated communication





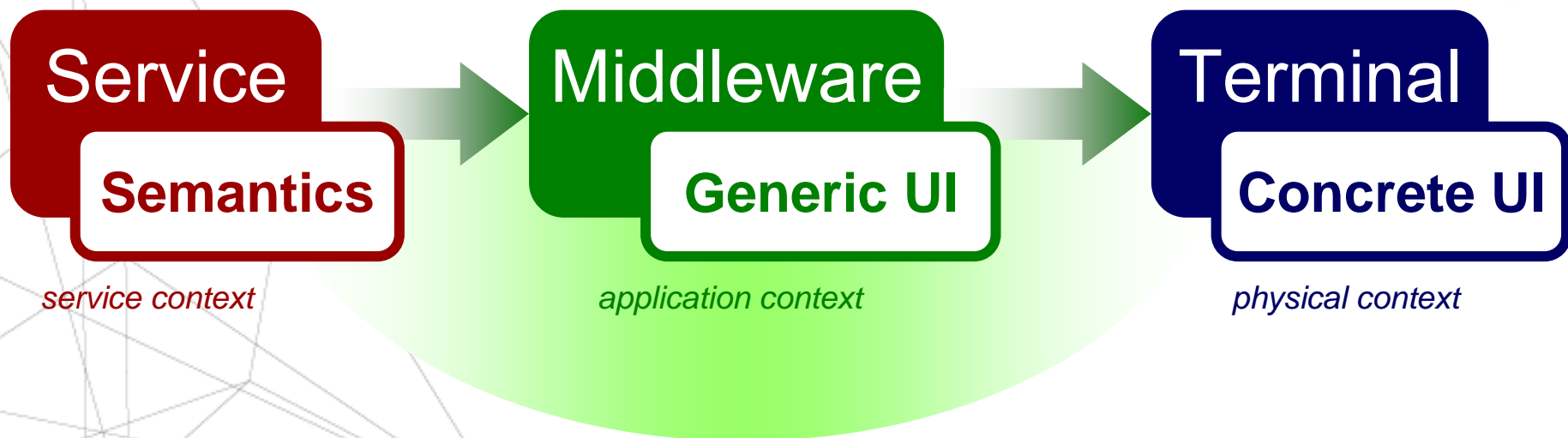
- Challenges: scalability, performance, coping with misbehavior



- The way we interact with services is changing!
- ➔ Multiple interaction styles
 - **Implicit vs. Explicit**
 - User context
 - Keyboard input
 - **Physical vs. Virtual**
 - Tags, NFC
 - Web identity



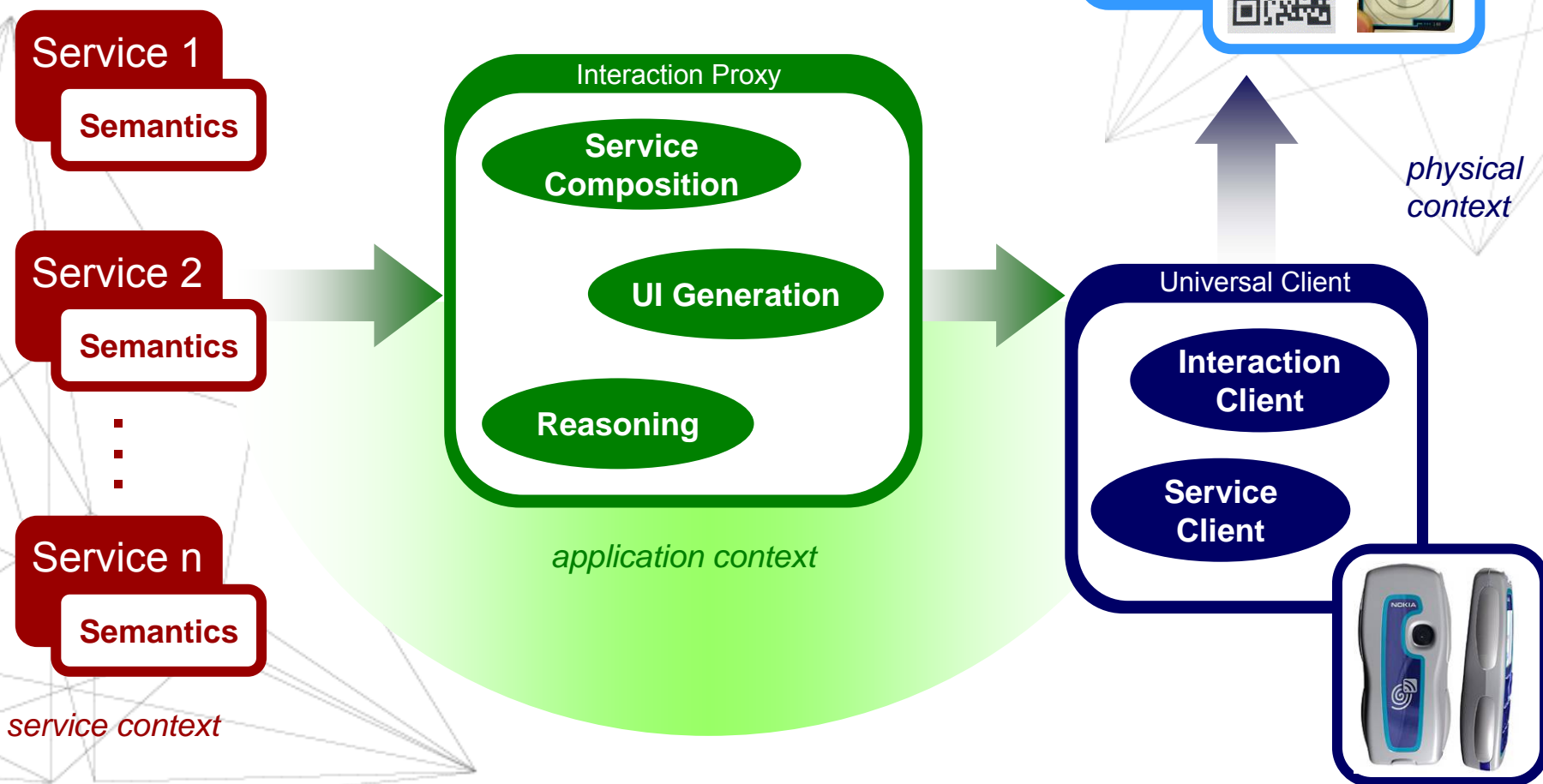
- New service paradigms will be needed to coherently support interaction with the Web of Things
- Pervasive Service Interaction
 - Generic support of UIs & interaction
 - Semantic Web services
 - Service-oriented approach



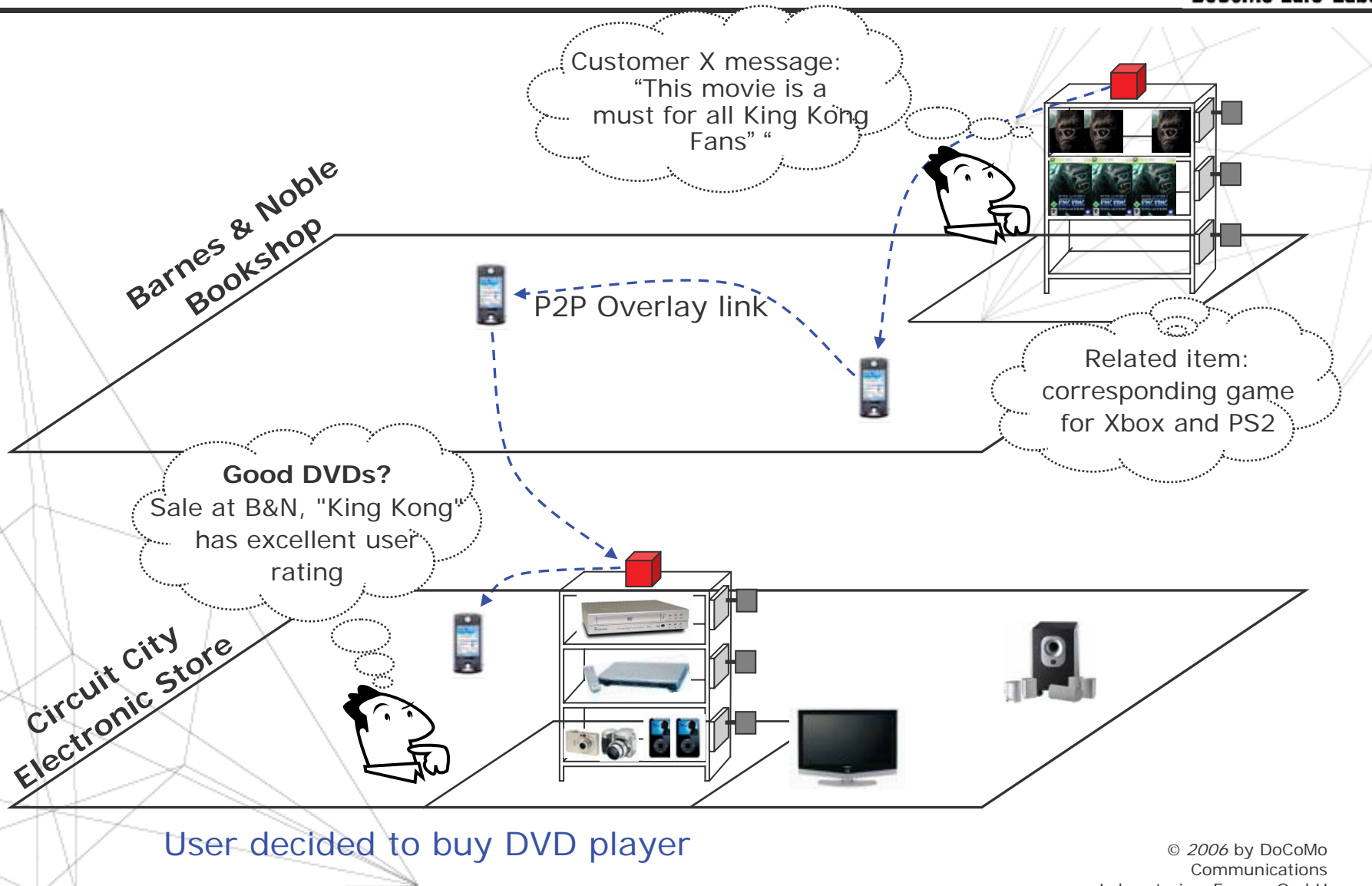
- Ticketing: Have it your way!
 - An example for mixed interaction (physical, virtual, explicit, implicit)



- Challenges in combining different
 - Context and domains
 - Service and interaction paradigms

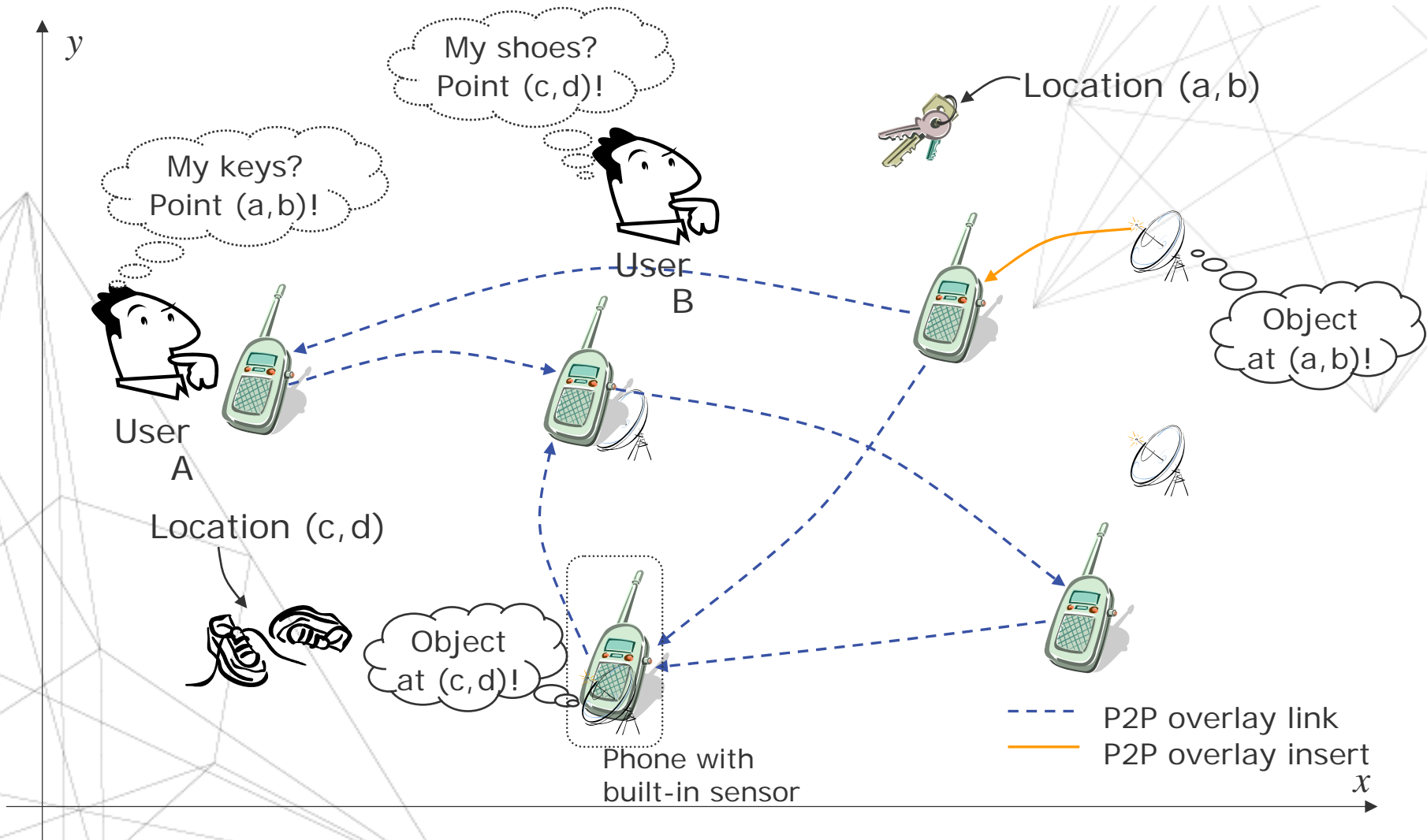


- Goal: Build a P2P application to support exchange of product information and opinions among customers in a shopping mall
- Motivation
 - People often use Internet to find products, reviews, opinions
 - Create platform for local exchange **for a specific location** for product opinions, new items, related items
 - Provide new platform for creation of new local services
- Involved physical equipment (minimal list):
 - Sensors in shops, incl. RFID tags
 - Responsible for maintaining and advertising product information in a shop
 - Mobile terminals
 - Maintain a P2P overlay to manage the product data advertised by the sensors in the shops
 - Data storage by shop or mall owner (optional)
 - Store information collected by customers
 - Distribute data to customers (only selected, as needed)

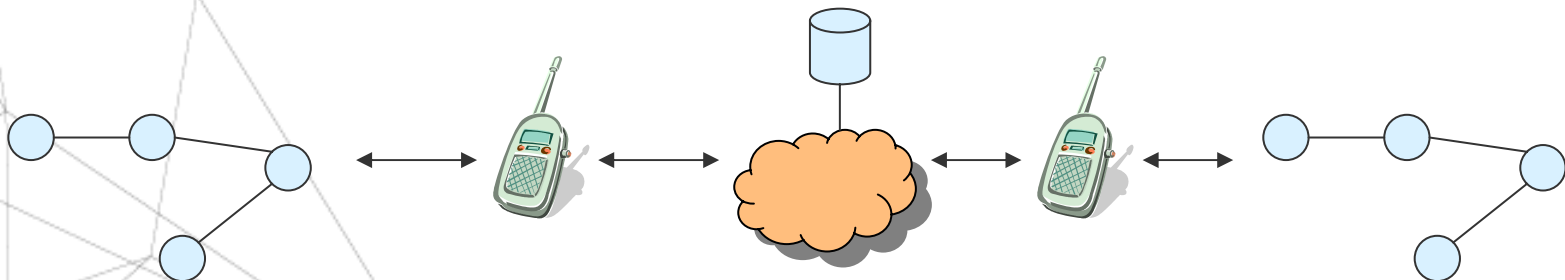


- Goal: Build a P2P application enabling users to quickly find lost personal belongings
- Solution concept: structured P2P system to maintain information about observed items and their positions
- Involved physical equipment:
 - Sensors
 - Observing items in their proximity and sending info about them to nearby mobile terminals
 - Mobile terminals
 - Maintaining the P2P overlay, enabling fast lookups of the locations of the lost items

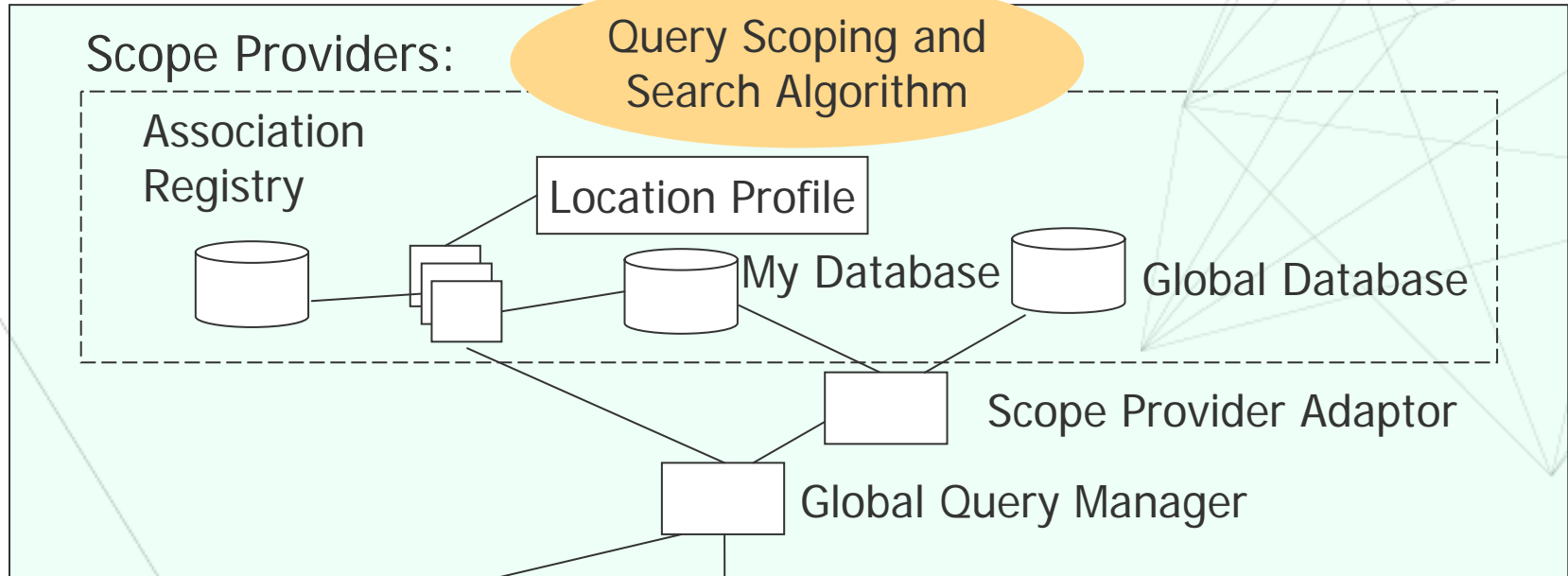
Personal Belongings Tracking Scenario



- Service Platform for the Ubiquitous Gateway
 - Supporting a range of middleware services
- The UG to integrate two worlds
 - Distributed system interconnected by the GNs
 - SNs using an ad-hoc networking paradigm providing limited processing and communication capabilities
 - Distribution of functionality across heterogeneous nodes

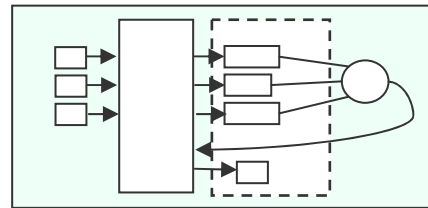


GN




User Agent

UG



Query, Storage, Event Router

SN



Mobile Adventure

Core elements

- Tagged objects (**TO**)
 - Keys, credit cards, documents, bags, shoes
 - Are made “senseable” by radio technology
 - E.g., through attached RFID tags or Bluetooth
- Object sensors (**OS**)
 - Any device with ability to sense a *Tagged Object*
 - WLAN access point, Bluetooth device, RFID reader
- Ubiquitous gateway (**UG**)
 - Mobile-network enabled device
 - User interface for searching items
 - Can also function as OS or gateway to OS

- Remember Loss Context
 - Triggered if an owned object is out of range
 - Store context data such as:
 - Location, other persons present, etc.
- Find Object
 - Send query to remote UGs
 - Query scope based on different criteria (e.g., time and space)
 - Installed queries on remote UGs which trigger whenever the object becomes in range
- Other use cases (install query on remote UGs)
 - Hanger (in restaurant) guard my coat, i.e. delegation of control
 - Lab gate sensor record which object leaves with whom



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thank
you