Traffic Capacity Estimations for Location and Context Based Services

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Outline

Context- and Location-Based Services

Definition

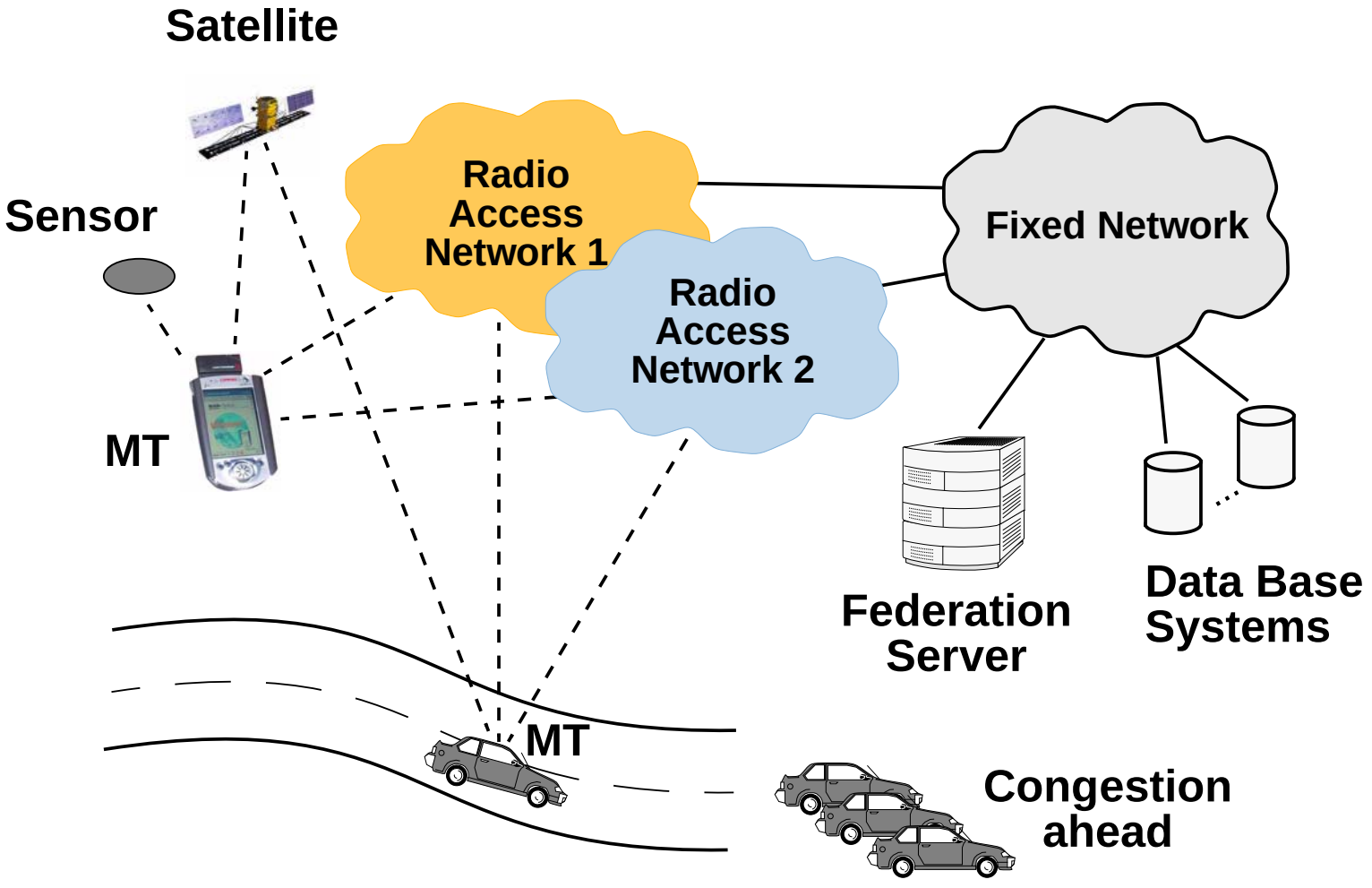
- **A LBS is a service for mobile users, where the awareness of the current, past or future location is an integral part of the service**
- **A CBS is a service, where the application context initiates automatically a communication activity**

Examples

- **Intelligent Navigation Support**
- **Rescue/Emergency Support**
- **Mobile Working Environment**
- **Spatial Information Systems**
- **Location/Context-Based Events**

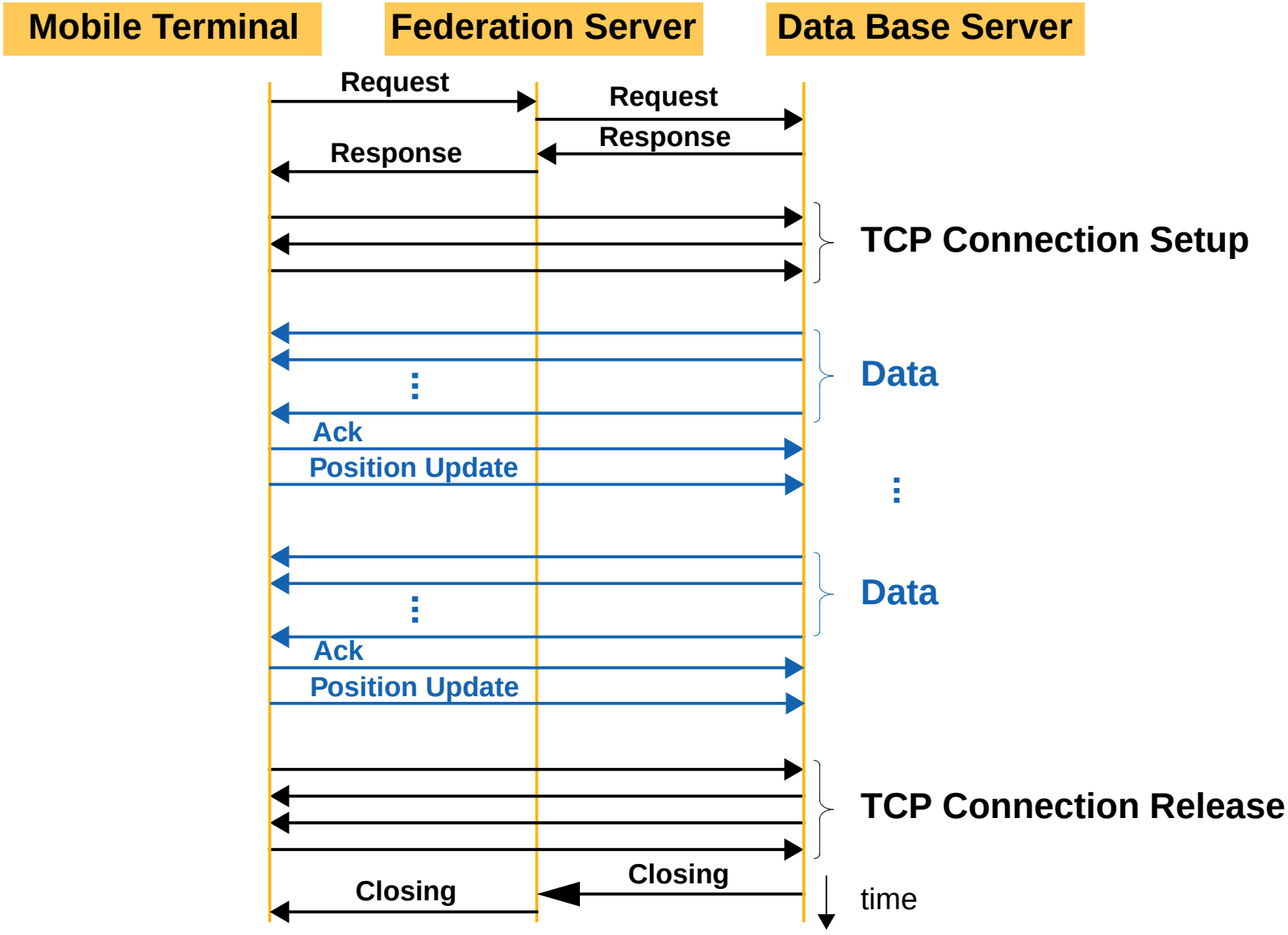
Application Scenario

Navigation Support



Application Scenario

Signalling for Navigation Support



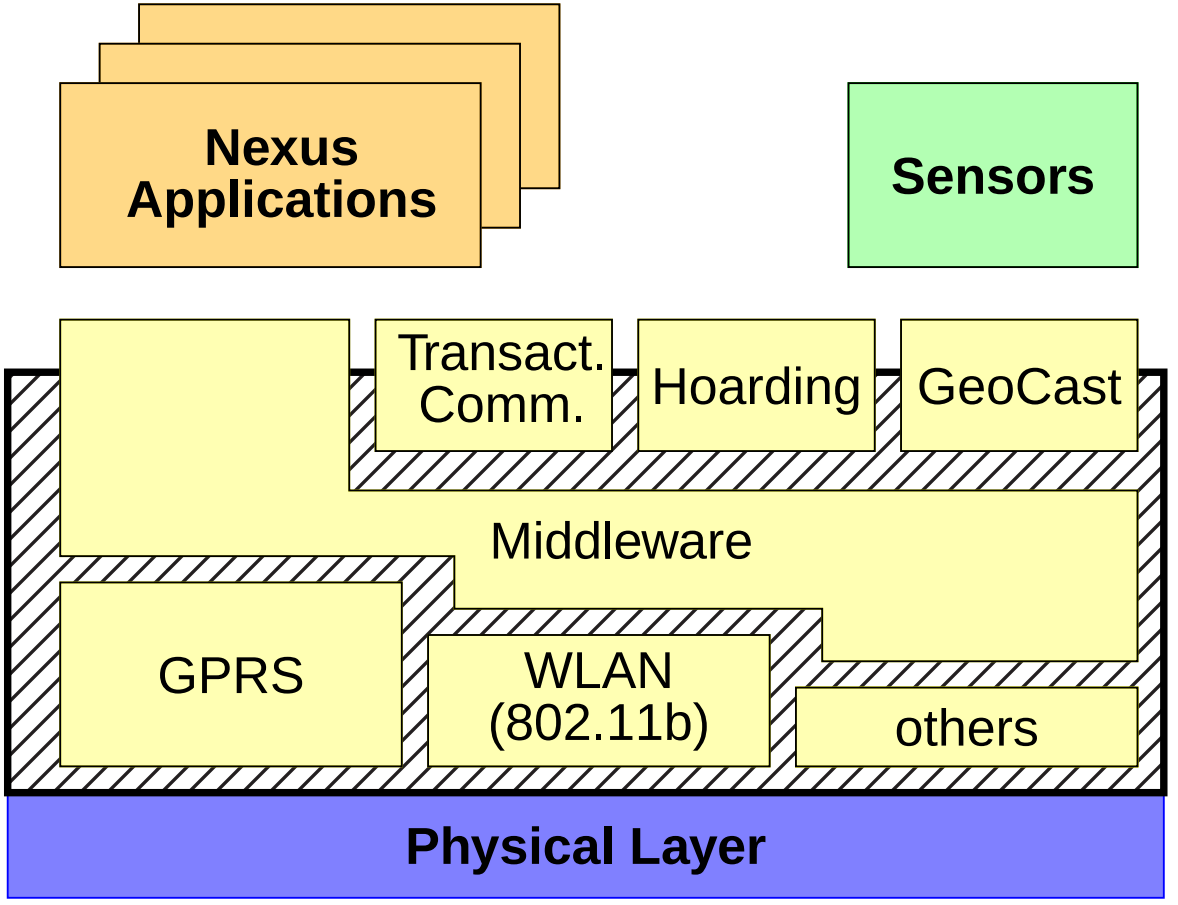
Architectures for LCBS

Principal Approach:

- **Abstraction from underlying network infrastructures**
- **Abstraction from network transport functions**
- **Provision of higher-level service primitives**

Architectures for LCBS

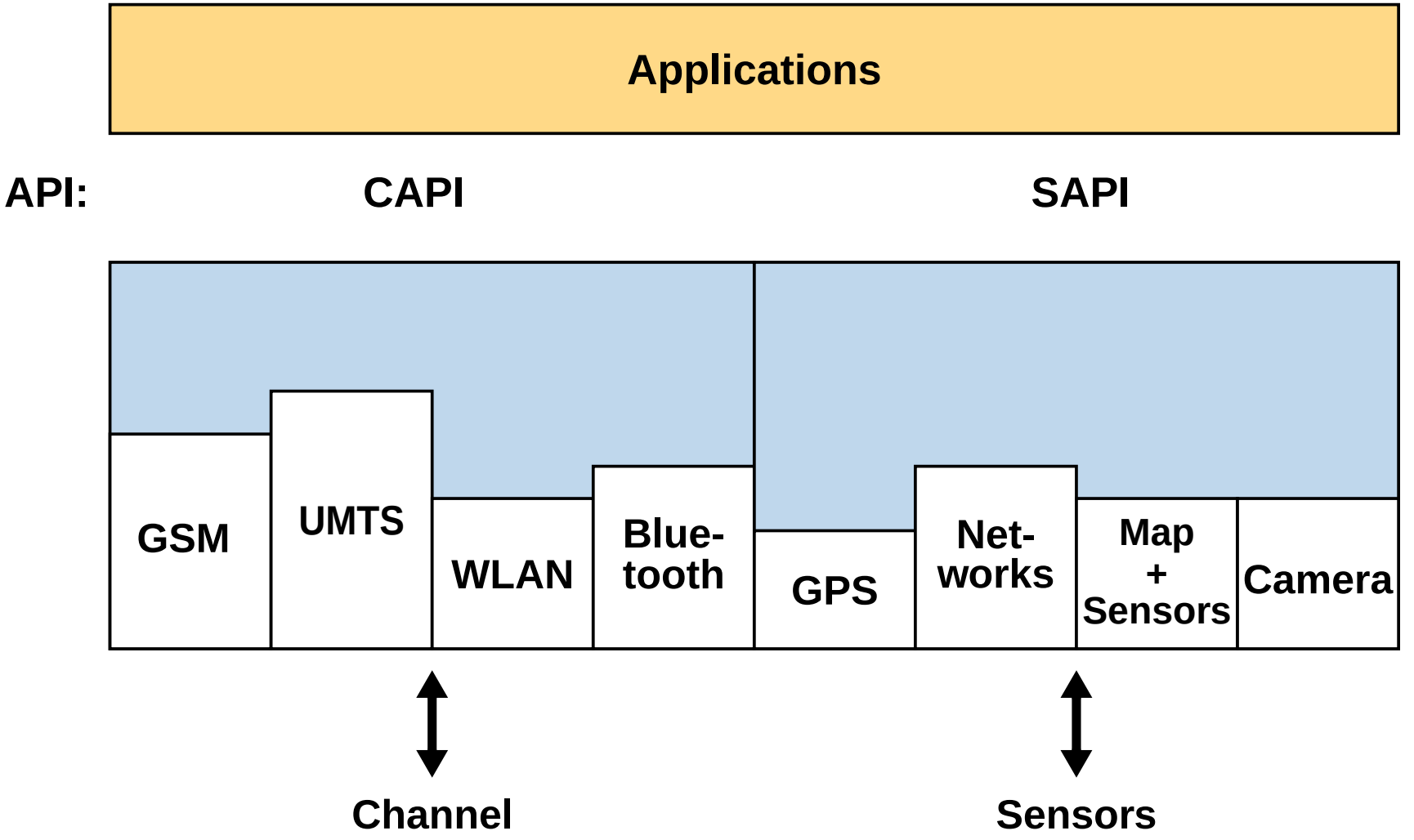
Station Architecture:



Location Awareness

- **GPS Global Positioning System by Satellites**
- **COO Cell-of-Origin of Mobile Phone Systems**
- **Handset Assisted / Network-Assisted Triangulation in Cellular Phone Systems**
- **Active Badges**
- **Electronic Map + (Vehicular) Sensor Data;**
  Map Matching
- **Direct User Input**

Nexus API (NAPI) 1



CAPI Communications API

SAPI Sensoric API

NEXUS API (NAPI) 2

CAPI

- **Automatic Network Indication**
- **Network Selection, dep. on:** **Bandwidth**
  Field Strength
  QoS
  Cost
- **Address Resulution:**
  Application Address (e.g. geo-Address) ⇔ IP Address
- **Service Discovery**

SAPI

- **Direct 2D / 2.5D / 3D Coordinates**
- **Spatial Coordinates derived from Raw Data (e.g. camera)**
- **Context Data (e.g. temperature, special event, ...)**

Multi-Network Access & Mobility Support

Network Access:

- GSM (2G)
- GPRS (2.5 G)
- UMTS (3G)
- WLAN
- Bluetooth

Mobility Support

- Horizontal Handover (identical technology)
- Vertical Handover (different technologies)
- Fixed Network Mobility based on Mobile IP

Data Base Support

Services

- **Registration Service for Mobile Terminals**
- **Address Mapping**
- **Maps**
- **Image of Real World Objects ("Augmented World Model")**
- **Existing Information Spaces (e.g., Web)**
- **Location Service, Geocast, ...**

Federation Service

- **Use of Heterogeneous Data Bases**
- **Unified View on Data of Different Origins**
- **Mediation, Broker and Retrieval Services**

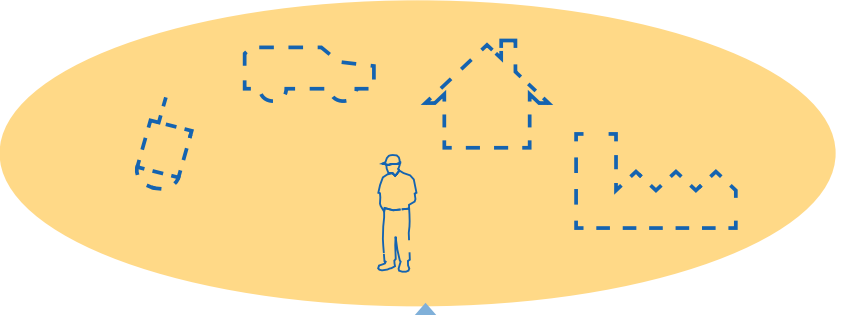
Open Platform for L&C-Based Services

Activities of a User within the Real World

Real World Objects

are supported by

Augmented World Model



Augmented World Model

Making Use of

External Information Spaces

External Information Space

Open Platform for L&C-Based Services

Components

Geo-Informatics	→	**Image Analysis, Object Recognition** **Sensor Integration** **Spatial Data**
Data Base Systems	→	**Data Modelling** **Integration of External Data** **Federation of Distributed Information Systems**
Communication	→	**Network Architectures** **Mobility Management** **Security & Privacy**
Distributed Applications	→	**Application Scenarios** **Management of Location Information** **Spatial & Context Events**

Architectures & Protocols

- **Unified Communication based on IPv6**
- **Communication across different Networks**
- **Mobility Management based on Mobile IP Concepts**
- **Dynamic Address Management**
- **Horizontal and Vertical Handover**
- **Integration of Ad Hoc Networks (infrastructureless)**
- **Middleware Concepts**
  Abstraction from Underlying Network Infrastructures
- **Design & Implementation**
- **Standardization**

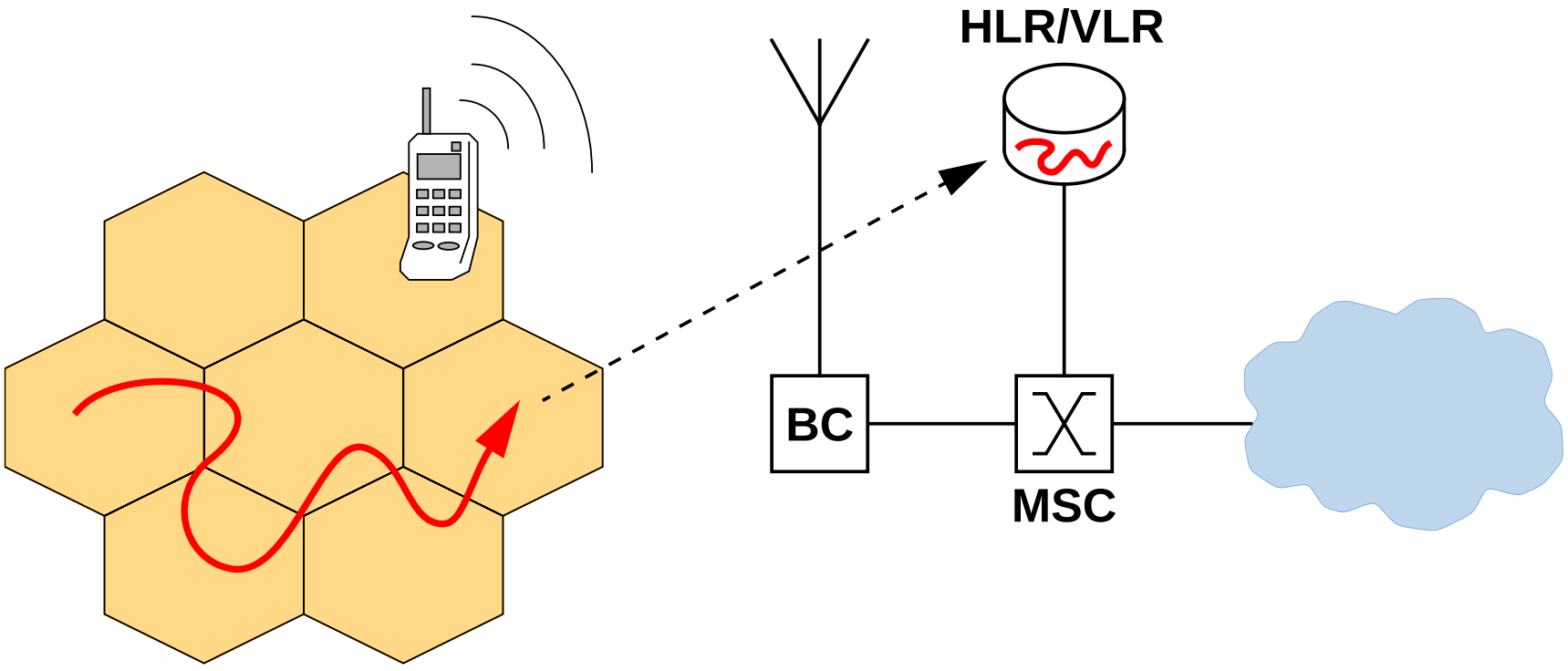
Research Topics - Communication & Security

Mobility

- **Modelling of Mobility of Users and Data**
- **Modelling of (Communication) Traffic**
  -spatial and temporal
- **Disconnected Operation (information Caching and Fuelling)**
- **Predictive Information Provision (Hoarding)**
- **Simulation Methods for Mobility**
- **Performance**

Research Topics - Security & Privacy

Example



- **Tracking of Location May Cause Severe Privacy Problems**
- **Similar Problems Arise from Recording of User Activities**

Research Topics - Security & Privacy

- **Protection Against Concatenation between Location Data and User Identity**

- **Methods:**
  - Pseudonymization
  - Authentication
  - Multilateral Security concepts:
    Negotiation of Protection Aims and Strengths
  - Accountability and Non-Repudiation
  - Integrity

- **Security Protocol Design**

Traffic Capacity Requirements (1)

Example

Dynamic Navigation Support by Downloads of Actual Traffic Maps

Volume Estimation

1. **HR Screen: 768 lines with 1024 pixels/line, 24 bpp**
   ➥ 18.9 Mbit/bitmap

2. **Redundancy Reduction + Reduced Resolution ➥ 0.2 bpp**
   ➥ 150 kbit/bitmap

Data Rate Estimation

Example: 1 bitmap / 15 s ➥ 10 kbit/s per user

Traffic Capacity Requirements (2)

Infrastructure Scenarios

1. **GSM (2G)** FD channel (22.8 kbit/s) allows 9.6 kbit/s net rate
   TX time per bitmap = 15.6 s
   Carried Traffic: 1 Erlang/user
   Conclusion:
   - only few additional users are possible
   - further reduction of update rate
   - updates only on-demand.

2. **GPRS (2.5G)** Shared packet bandwidth for all users in a cell
   Assumption: 36 channels/cell
   40 mErl./user
   Blocking Prob. 2% for voice calls
   M/G/n loss model: 27.3 Erl./cell
   682 users/cell
   8.7 idle channels/cell
   Conclusion:
   - up to 8 active users/cell with full rate
   - far too small number in urban environments
   - further reduction/only on-demand service possible

Traffic Capacity Requirements (3)

3. **UMTS (3G)** FD channels up to 2 Mbit/s
   Smaller Cell Sizes
   Conclusion:
   - Capacity estimation dependent on cell sizes and scenario
   - Dynamic support possible to a large extent but: probably too expensive

4. **Hybrid Schemes**

   1. **Proposal** Static part of bitmap derived from on-board CDROM on Infrastructure (map) + location information

      Dynamic part (current road traffic state) downloaded through the available mobile infrastructure

   2. **Proposal** Broadcasting of road traffic state by
      Making use of "Hot Spot" Technology as WLAN (IEEE 802.11)
      or by alternative technologies as Digital Video Broadcast (DVB).

Conclusion

- **Location and Context-Based Services open a New Dimension Enhancing Existing Concepts of Ubiquitous/Pervasive Computing and Mobile Communications**
- **Open Platforms are Important with Pespect to Use of Existing Infrastructures and Avoidance of Proprietary Solutions**
- **Extended Middleware Concepts and Augmented World Models are the Keys to Combine Multifunctional TE, Data Bases, Smart Sensors to Support LCBS**
- **First Traffic Capacity Estimations Show that Much More Traffic Load Will Be Generated by LCBS, but Existing Mobile Communications Infrastructures Will Allow for Initial Service Provision**