Potentials of Information-Centric Networking in a 5G Environment and Its Deployment in a Specific Industrial Context

Matthias Waehlisch
FU Berlin

Dirk Kutscher
Huawei German Research Center

Thomas Schmidt
HAW Hamburg

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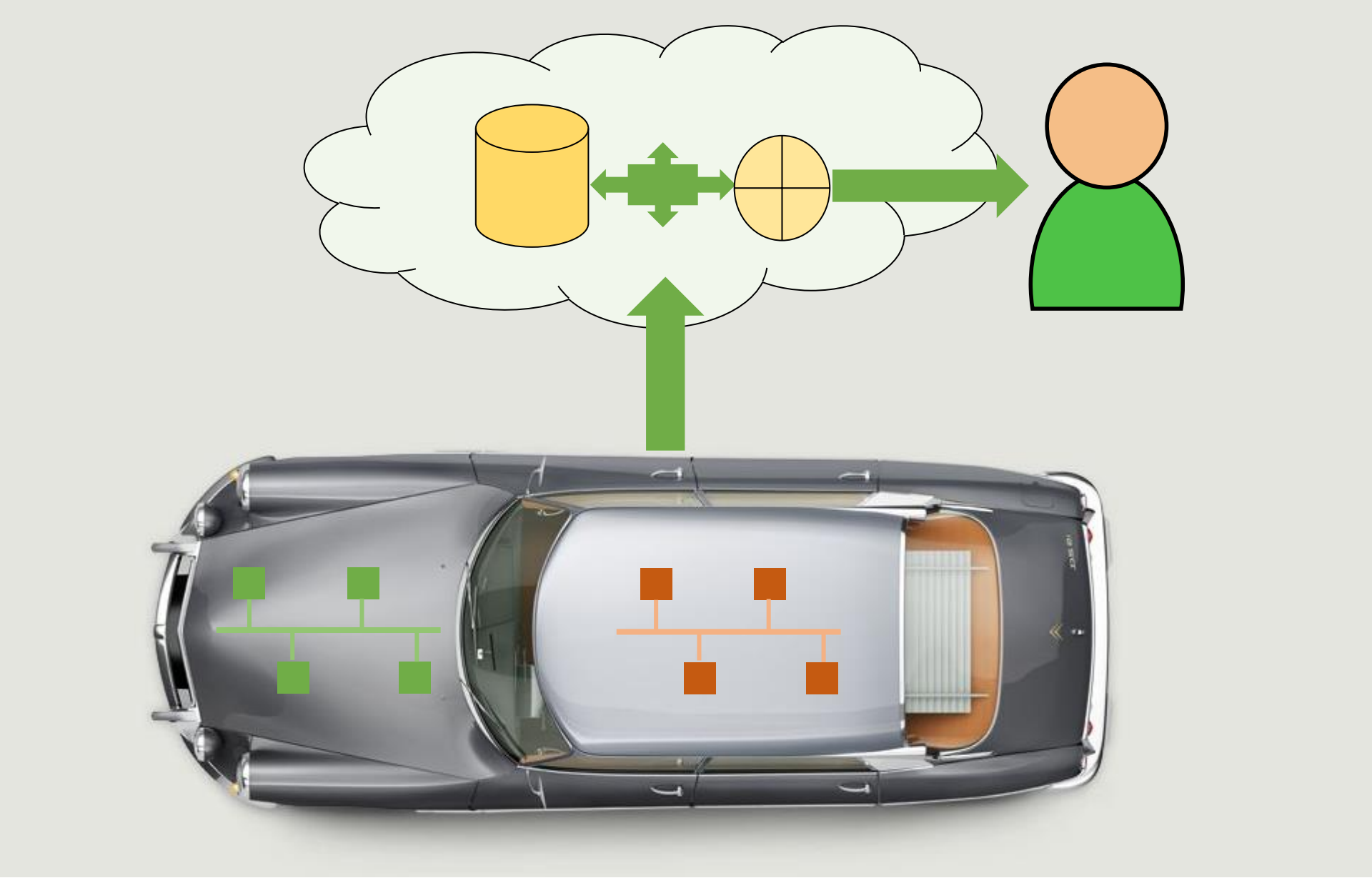
5G IoT Networking

- Communication in local networks
  - Home/factory/car networks etc.
  - Facilitating local connectivity and discovery
  - Usable security
  - Overcoming challenges with constrained devices and intermittent connectivity
- Connecting edge clouds to the Internet / Cloud
  - Making data available for application platforms, big data
  - In-network processing
  - Data security and privacy
  - Overcoming silo approaches

Example: Connected Mobility



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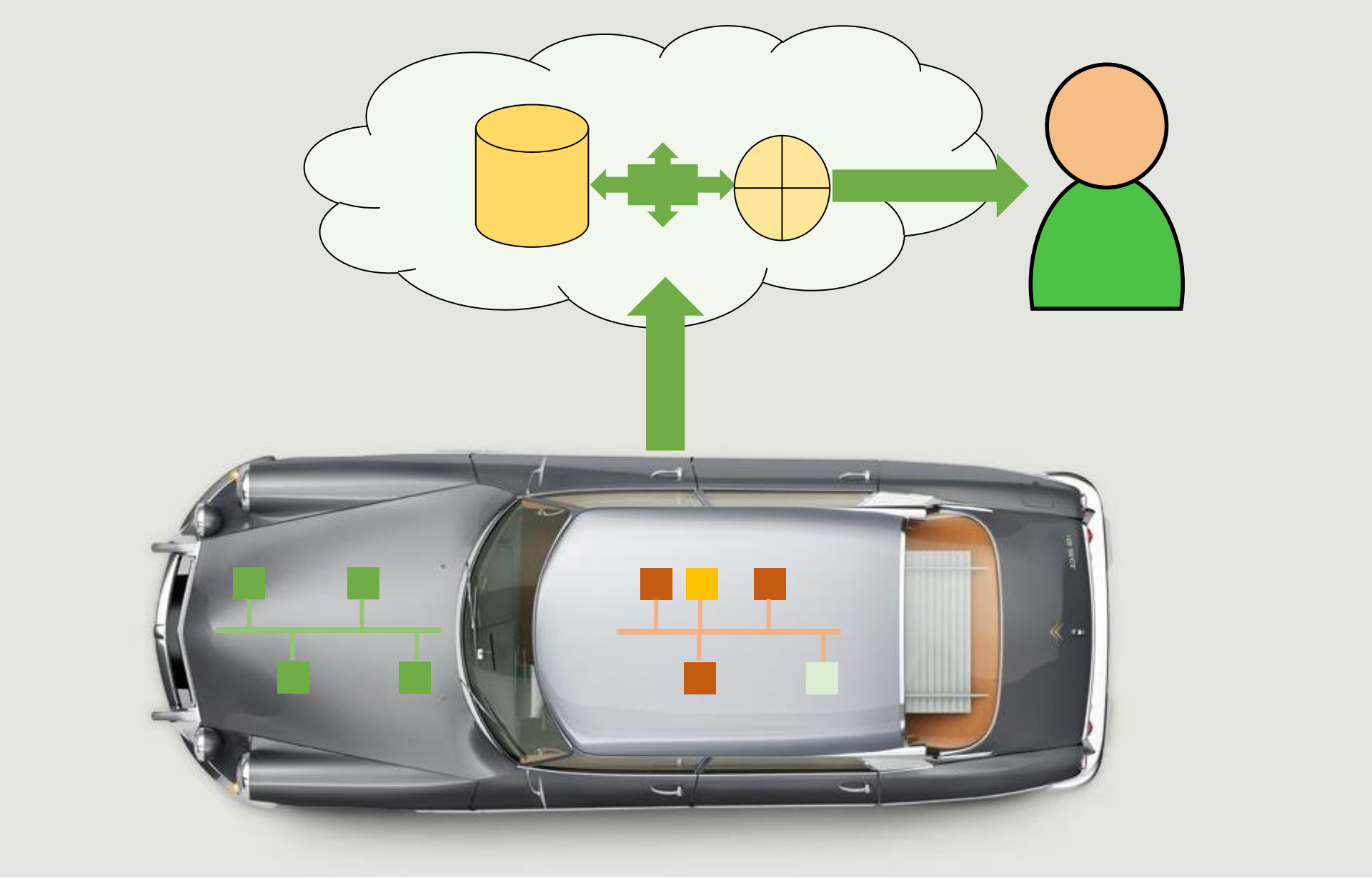

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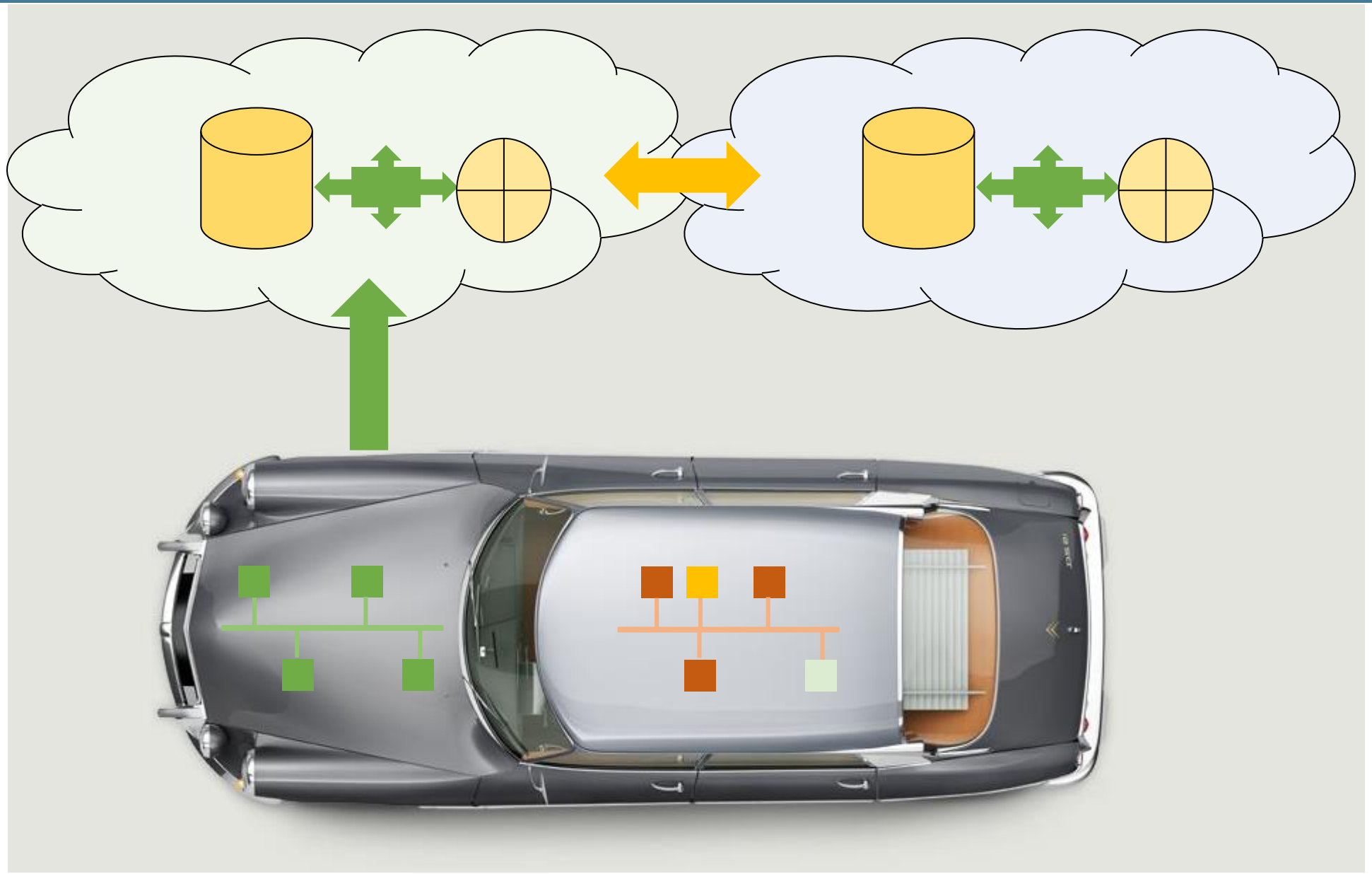
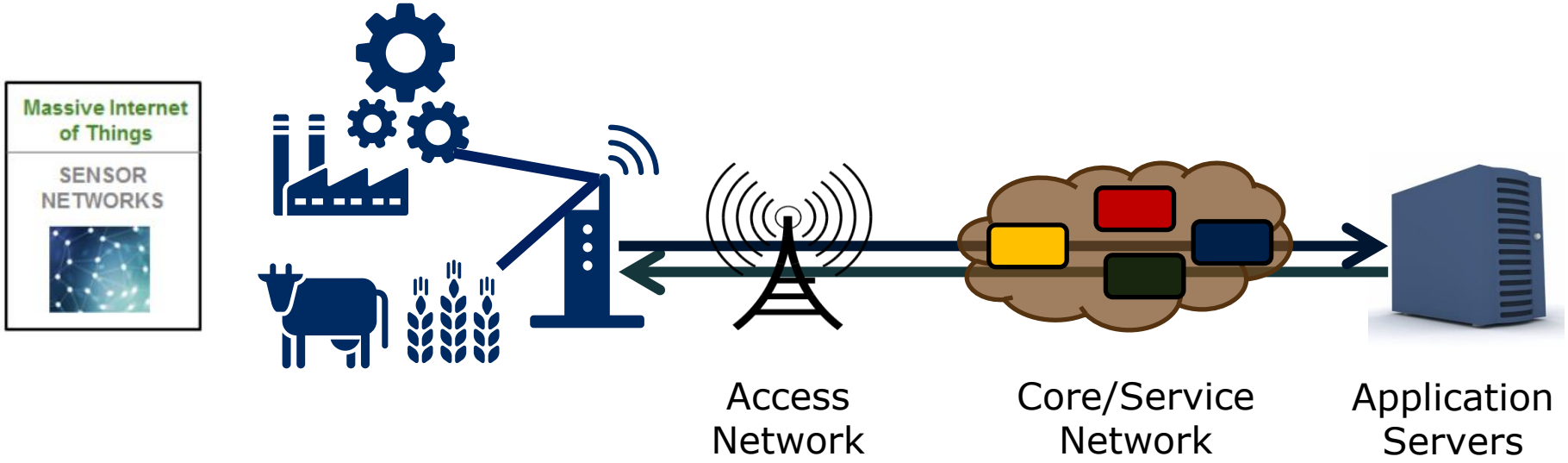


Communication Abstractions for IoT



- Traditional IP communication model not perfect for IoT
  - Host IP addresses vs. application-layer names
  - TCP-based protocols vs. connection-less and disruption-prone communication
  - Routing overhead in more complex networks

5G: Optimized Forwarding for Heterogenous Access

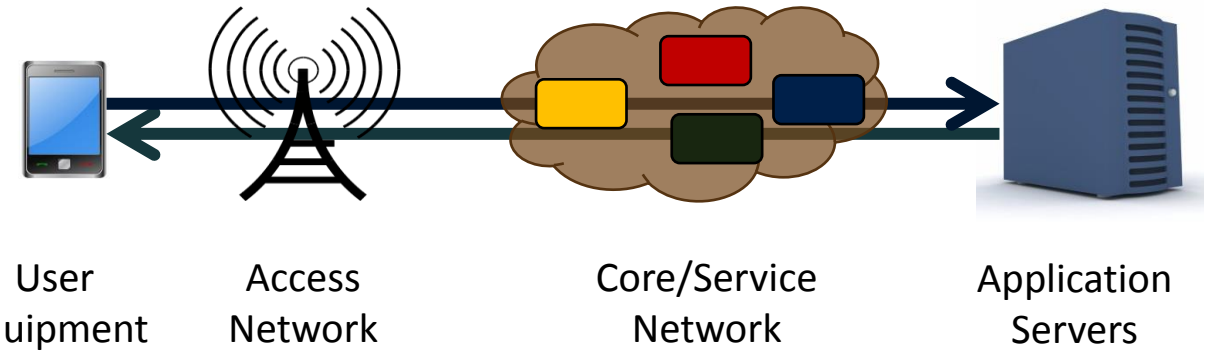
- Low latency, high-bandwidth
  - Fiber, new radios

- Slow, ad-hoc, unpredictable
  - Low-power radios, sleep/duty cycles
  - Constrained devices

- Massively scalable distribution
  - Server-push or pub/sub style
  - Possibly in-network adaptation

- Variable performance
  - Dynamically changing network conditions
  - Disruptions and delays
  - On-board caching for all applications & protocols

Optimized Forwarding for Heterogenous Access



- Difficult to implement with TCP as is
  - Limited deployment options for application-layer gateways
- Network of TCP proxies?

Need more powerful forwarding layer and transport services

- Hop-by-hop forwarding strategies, multipath support
- Caching for local retransmissions

5G Network Challenge

Need

- Better security & user privacy
  - Connection-based security good – but not enough
  - Object-based security
- More functionality in the network
  - Transport performance
  - Supporting Increasing heterogeneity

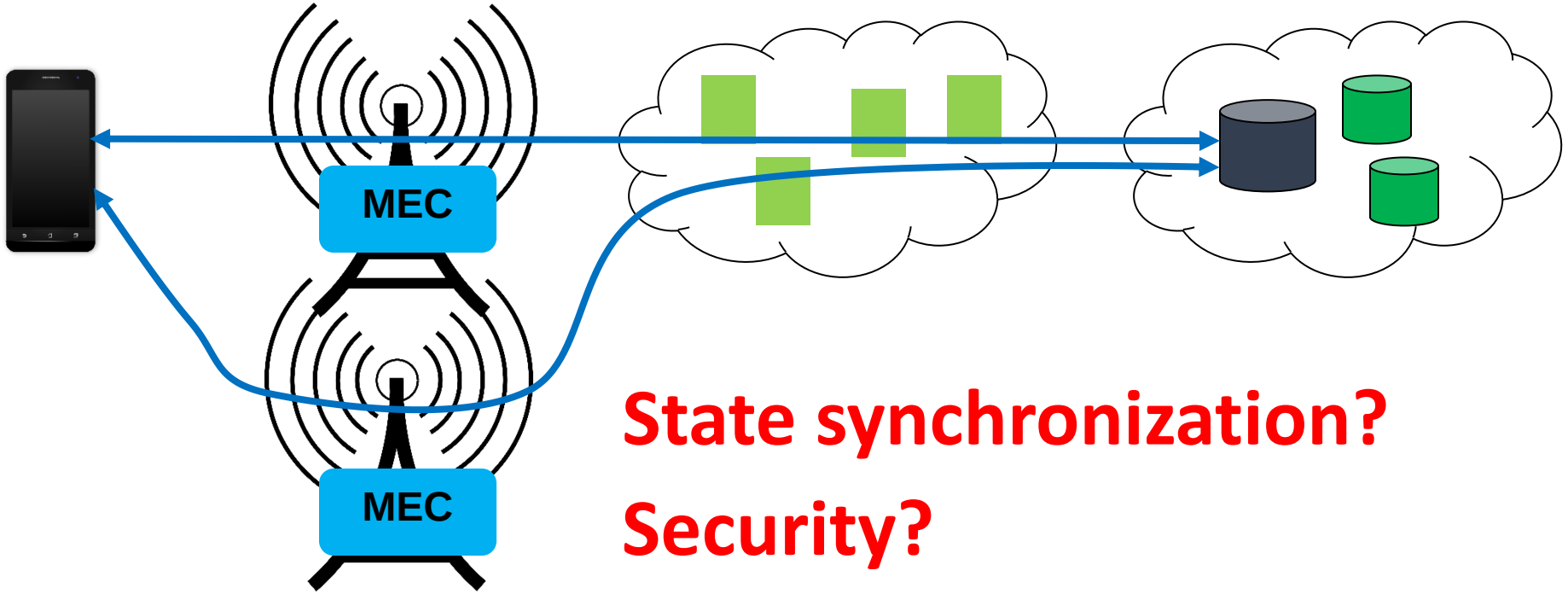
Want to keep

- Permissionless innovation
- End-to-end communication principle

Challenge

- Right transport abstraction
  - Empowering forwarding layer – but not too much
- Sufficient general-purpose network capabilities

Mobile Edge Computing (MEC)?



State synchronization?

Security?

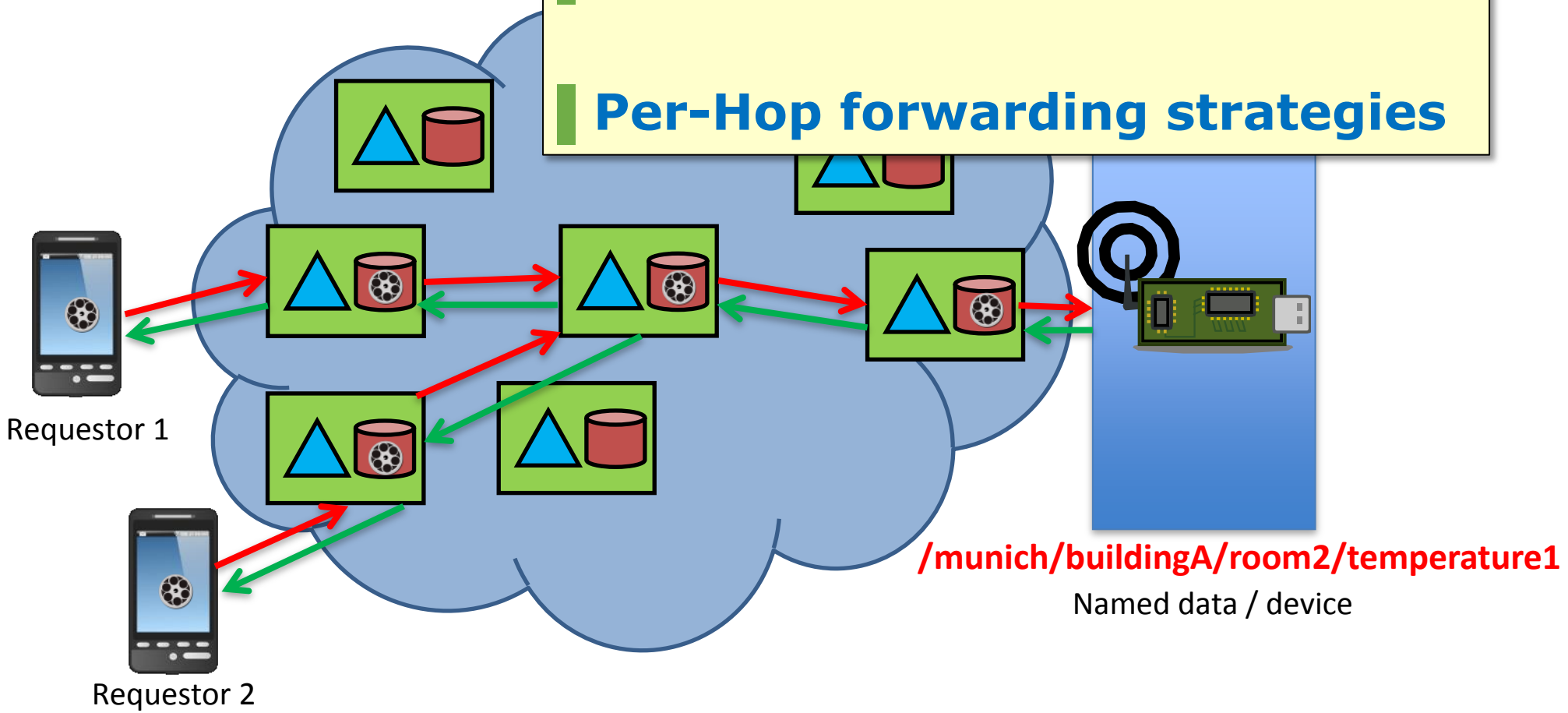
User Equipment | Access | Core | Internet / Cloud

Observations

- In most networking use cases today, we are not interested in establishing a (virtual) pipe to a peer host
- Rather: accessing named data
  - IoT sensor value
  - Netflix video chunk
- Application layer APIs *can* work that way
- But: under the hood, it‘s still connections
  - With the problems illustrated earlier
- Idea: Accessing named data as a network service
  - Making the next steps from telephone circuits and connections to a truly data-based approach

Information-Centric Networking (ICN)

- **Accessing Named Data Objects**
- **Data-centric security approach**
- **Ubiquituous Caching**
- **Per-Hop forwarding strategies**



The Case for ICN in IoT

- **Simplified, natural API**
  - GET /de/heidelberg/city-hall/0220/temp
- **Increased robustness through caching**
  - Good for lossy links and sleepy nodes
- **Faciliating data diffusion through hop-wise replication**
- **Inherent auto-configuration**
- **Data-oriented security**

Baccelli, Mehlis, Hahm, Schmidt, Wählisch; Information-Centric Networking in the IoT; ACM ICN Conference 2014

I3: Information-Centric Networking for an Industrial Internet

- Starting point: Surveillance of industrial environment
  - Collaboration with MSA
  - Major deployment target: oil platforms and refineries
- Special focus: Distributed Gas sensing
  - Regular reporting about overall situation
  - Alerting in cases of dangerous emissions
- Safety-critical information flows
  - Requirements on reliability
  - Requirements on timing
- Can ICN outperform IP in a full-fledged solution?

About MSA

- Manufacturer of **worker's** and **facilities safety** products
- Main customer segments
  - Oil, gas, chemical industries
  - Fire fighters and first responders
- Core product groups
  - **Gas detection**
  - Personal Protective Equipment (PPE) and Self Contained Breathing Apparatus (SCBAs)
  - Fall protection

Area of application for gas detection products

- Industrial environments
  - Dangerous events may occur
    - Gas exposure
      - Toxic (H2S in refineries)
      - Combustible gases
    - Oxygen depletion
    - Gas leaks and flames
  - Areas are heavily regulated
    - Constrained access
    - Mandatory equipment
    - Mission protocols and logs
- Fire fighters and first responders
  - Unknown environments
  - Time pressure

Opportunities with ICN for I3

- Mobility
  - Mobile devices are common for the use cases
  - Content counts, not addresses
- Security
  - False alarms may lead to shutdowns
  - Dropped alarms may lead to health risks
- Network management
  - Easy deployment and auto-configuration
  - Reducing total cost of ownership
- Network caches
  - May reduce latency for multiple services
  - Fixed devices provide network caches

Network Scenarios

- Sparse deployment (of fixed devices)
- Inhomogeneous node coverage
- Partitioned networks
- Mobility
- Intermittent connectivity
- Selected uplinks into a cloud environment

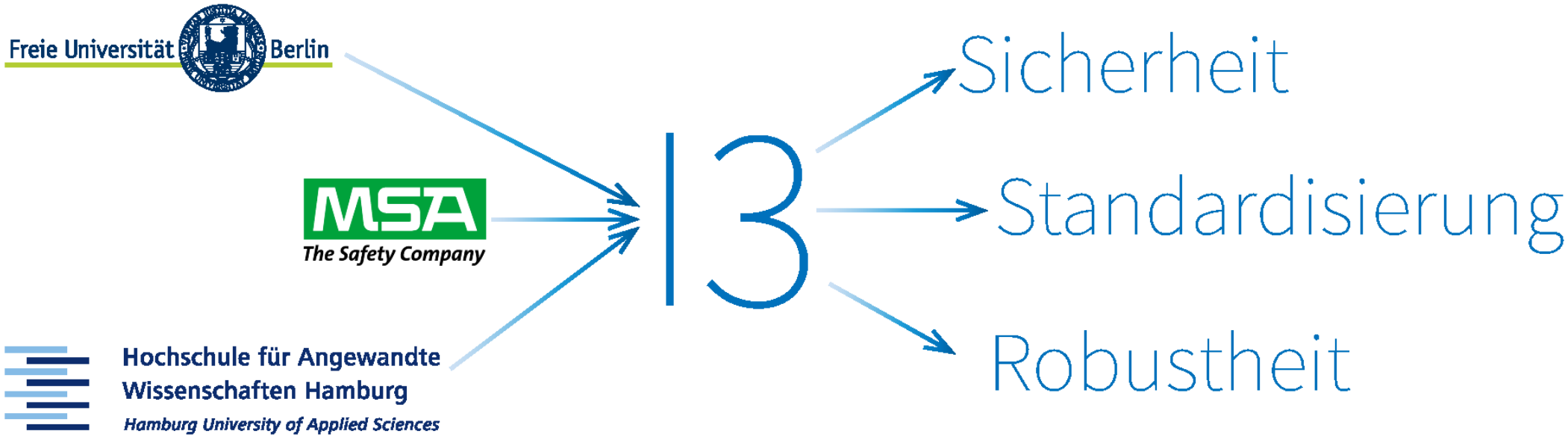
Typical IoT Communication Patterns in I3

- Request/response:
  - Access of configurations, system state, management policies, …
- Periodic reporting
  - Data tracking and archiving (possibly in the cloud)
- Event-triggered reporting
  - Alerting in cases of anomaly detections
- Tentative: Multicast and convergecast

Research Challenges

- ICN Routing & Mobility
- Security & Resilience
- Reliability & Caching
- I3 Environment

Questions & Discussions?



- http://i3.realmv6.org/

http://riot-os.org/