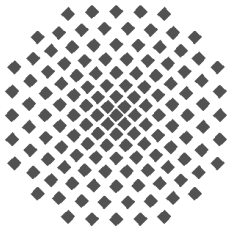

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Nexus – A Platform for Context-aware Applications

KuVS Fachgespräch “Ortsbezogene Anwendungen und Dienste”

2004-06-24

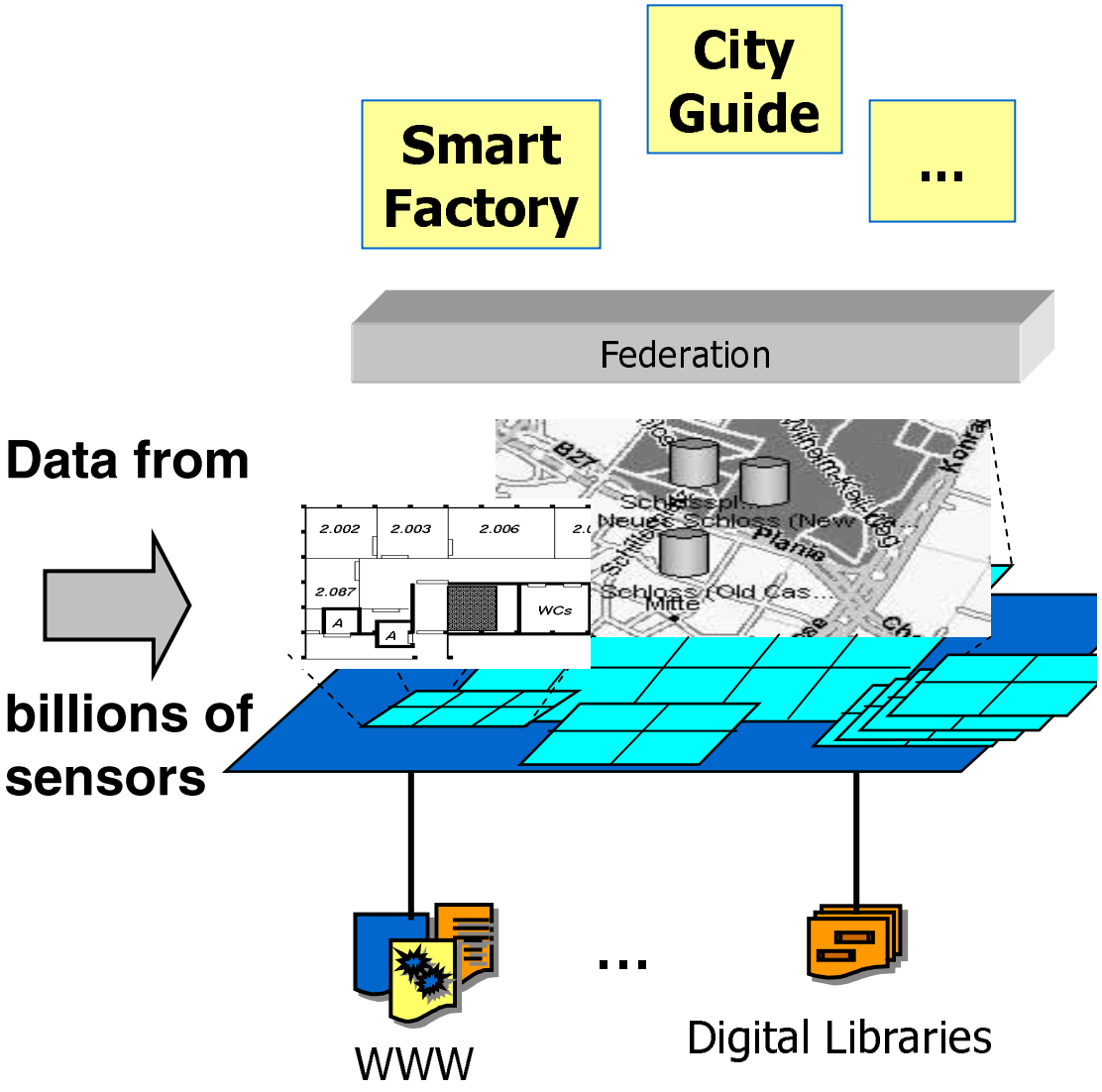
Frank Dürr, Nicola Hönle, Daniela Nicklas, Christian Becker, and Kurt Rothermel

Overview

- Vision
- Nexus Platform
  - Architecture & Core Services
  - Value-added services
- Geocast based on Nexus Platform
  - Location model and addressing
  - Message forwarding
- Summary

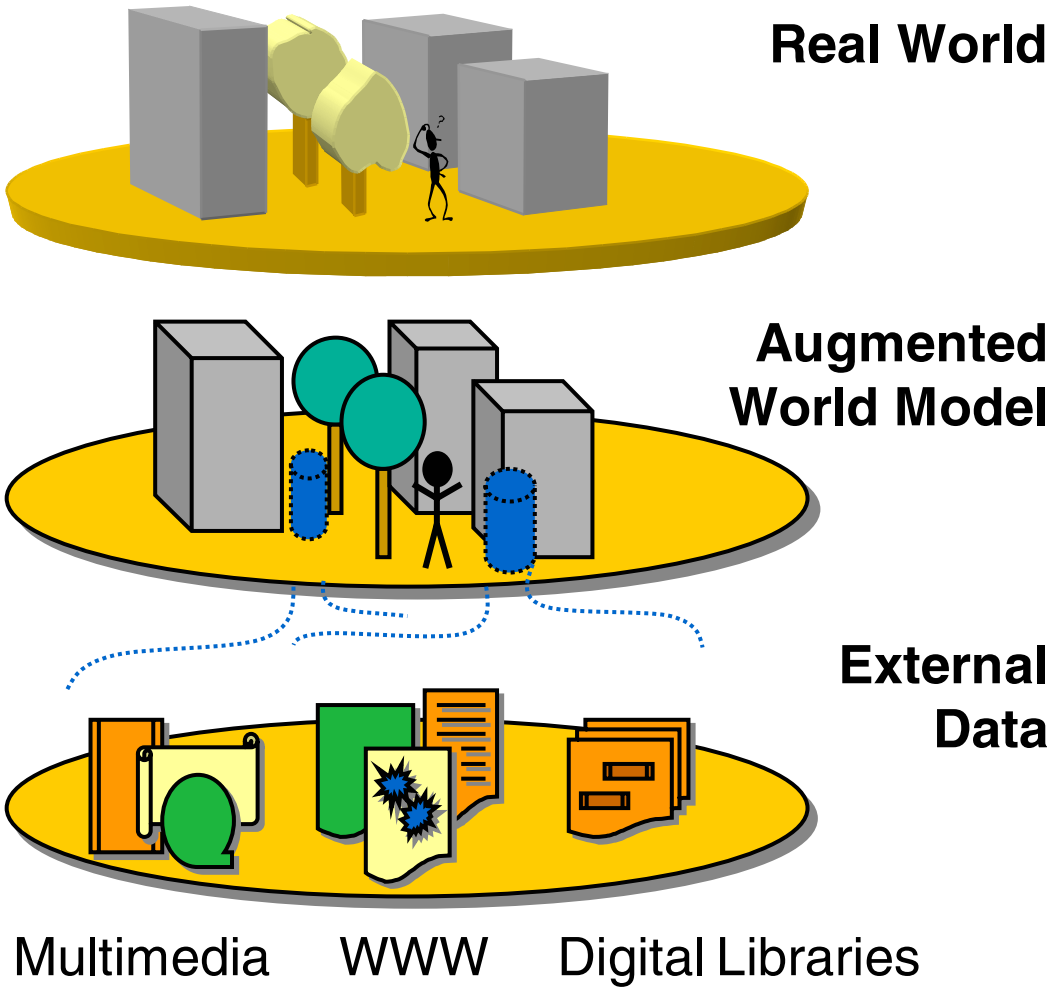
Vision: Federated, Shared World Models

- Context Model: information for Context-aware applications
  - location, identity, time (primary context)
  - environment, POIs, sensor data, relevant web sites
- Shared: enables interoperability between applications
  - modeling is expensive
  - shared resources
- Federated: combining local world models to a global view
- Open



Augmented World Model

- Spatio-temporal object-oriented information model
- Real-world objects
  - Static and mobile
  - Relations
- Virtual objects
  - Metaphors for external information, e.g. Virtual Information Towers



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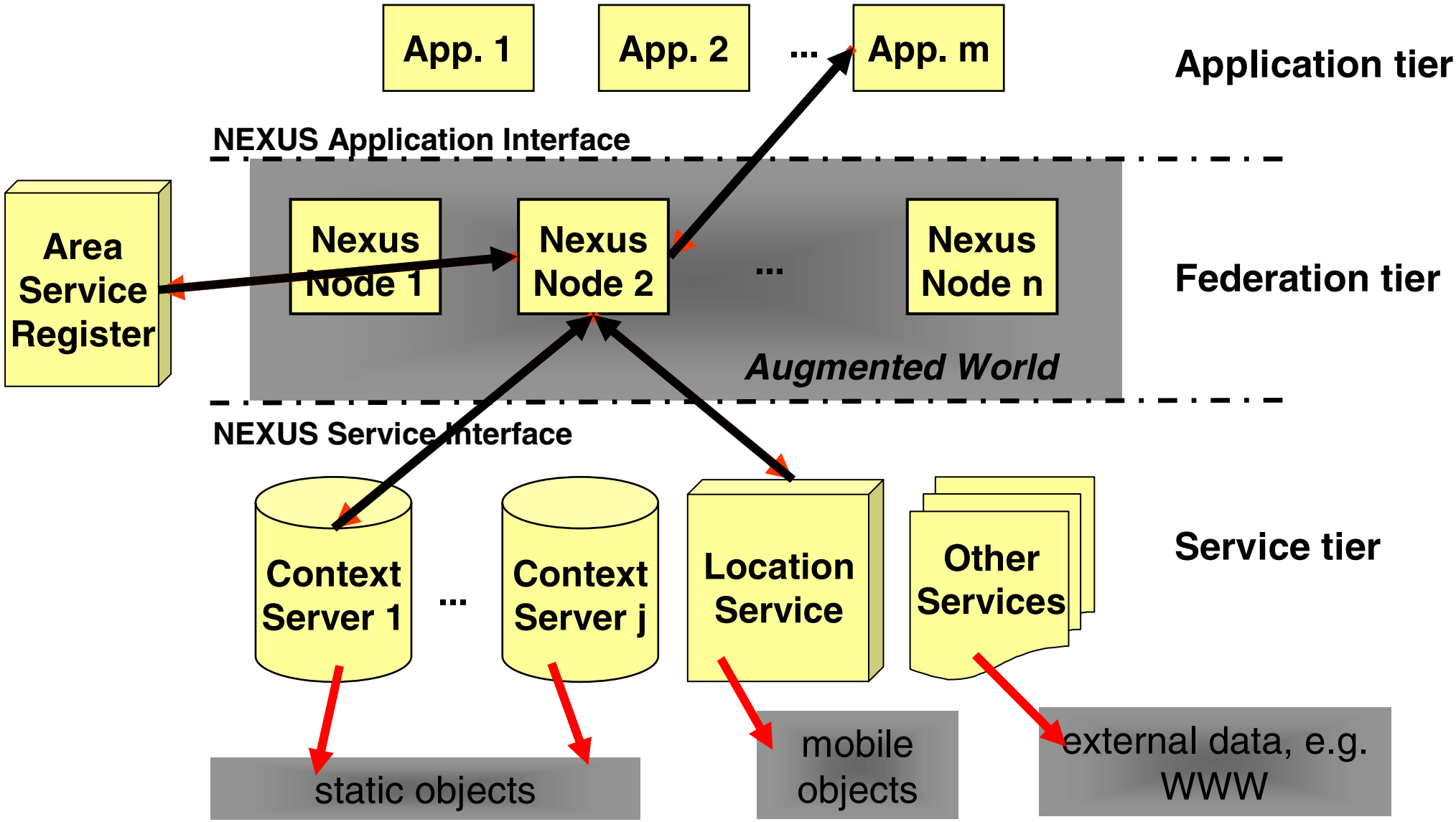
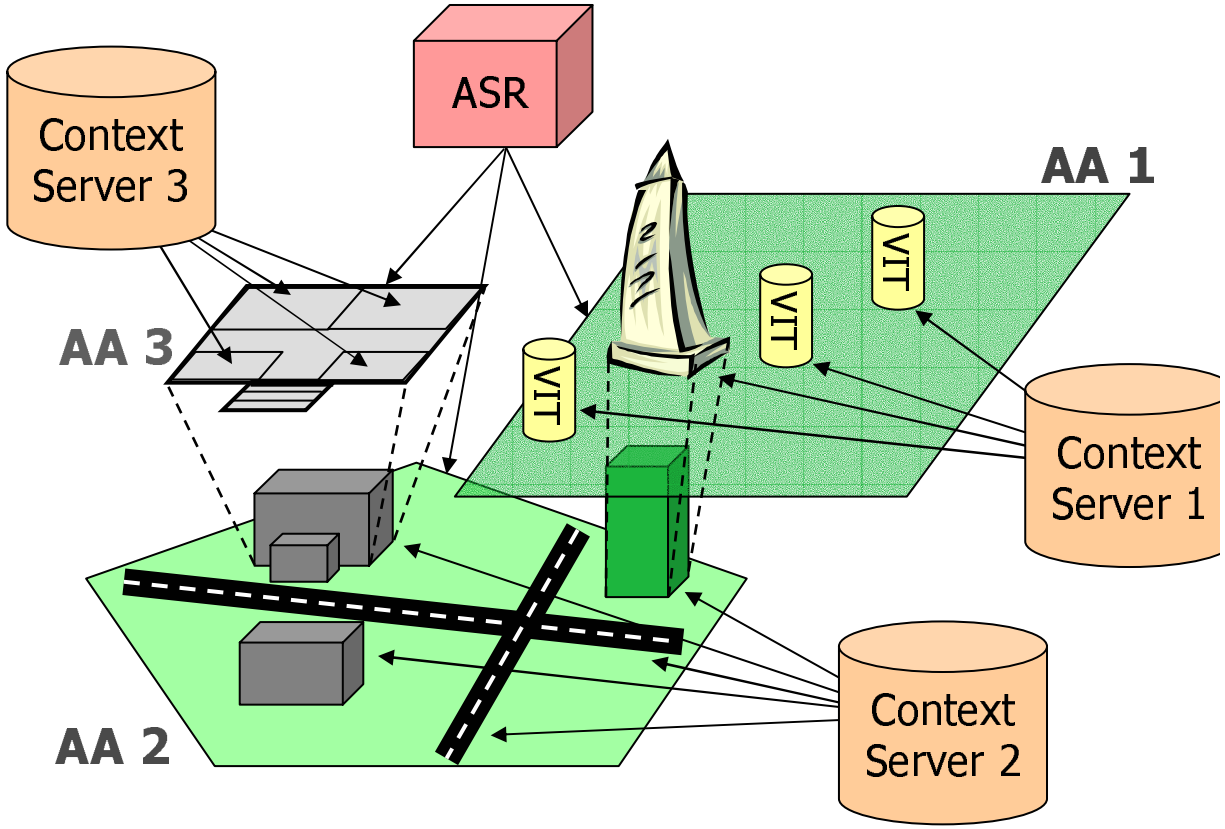
The Nexus Architecture



Augmented Area

- Covers a certain area
- Contains only certain types of objects
- Consistent in itself
- Stored on one Context Server

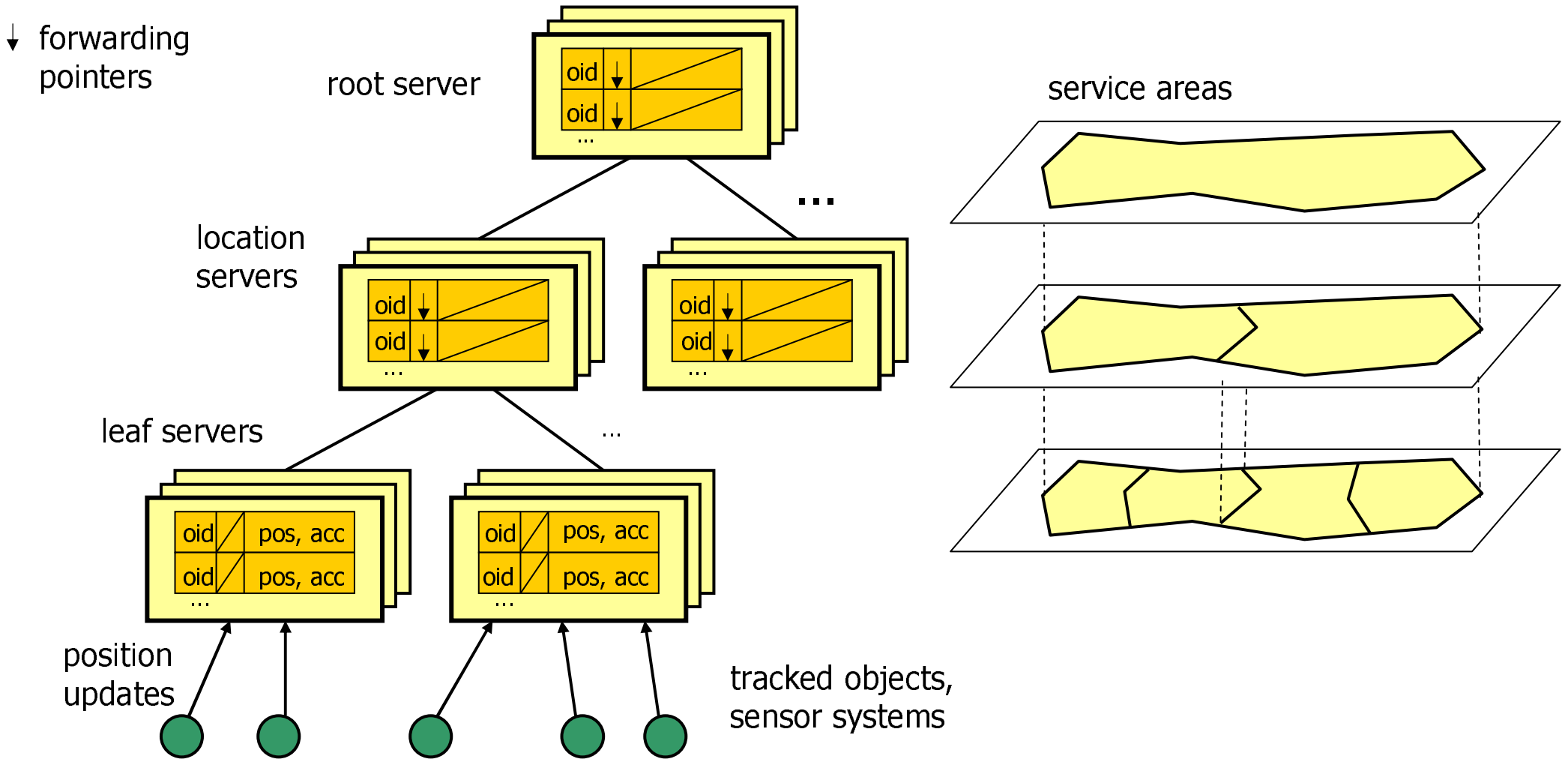
- Augmented Areas may overlap
  - Multiple representations of objects
  - Relations between objects faciliate federation



Location Service

- Management of mobile objects
  - Main memory based approach
- Supported queries:
  - Position query
  - Range query
  - Nearest neighbor query
- Key issues:
  - High accuracy → efficient processing of position updates and queries
  - Management of large number of mobile objects → scalability

Location Service Architecture



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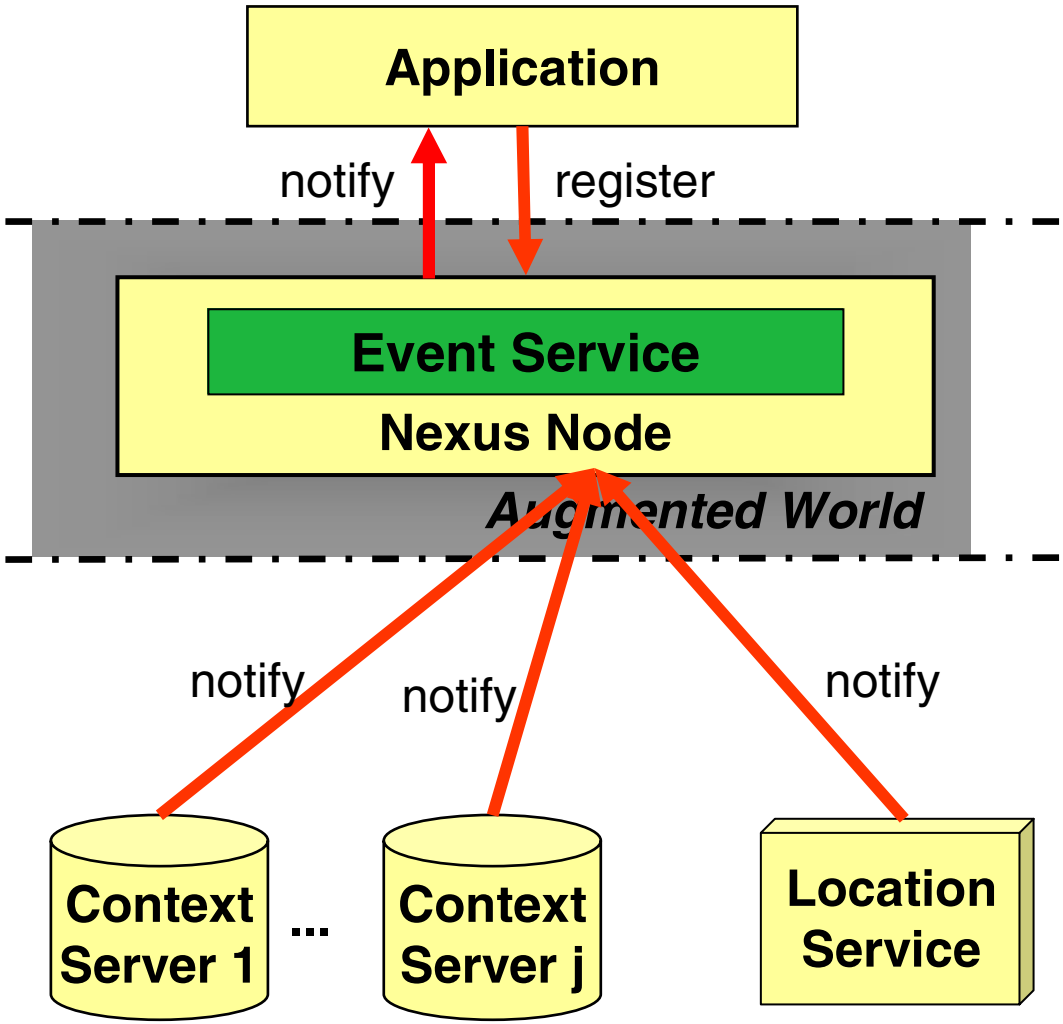
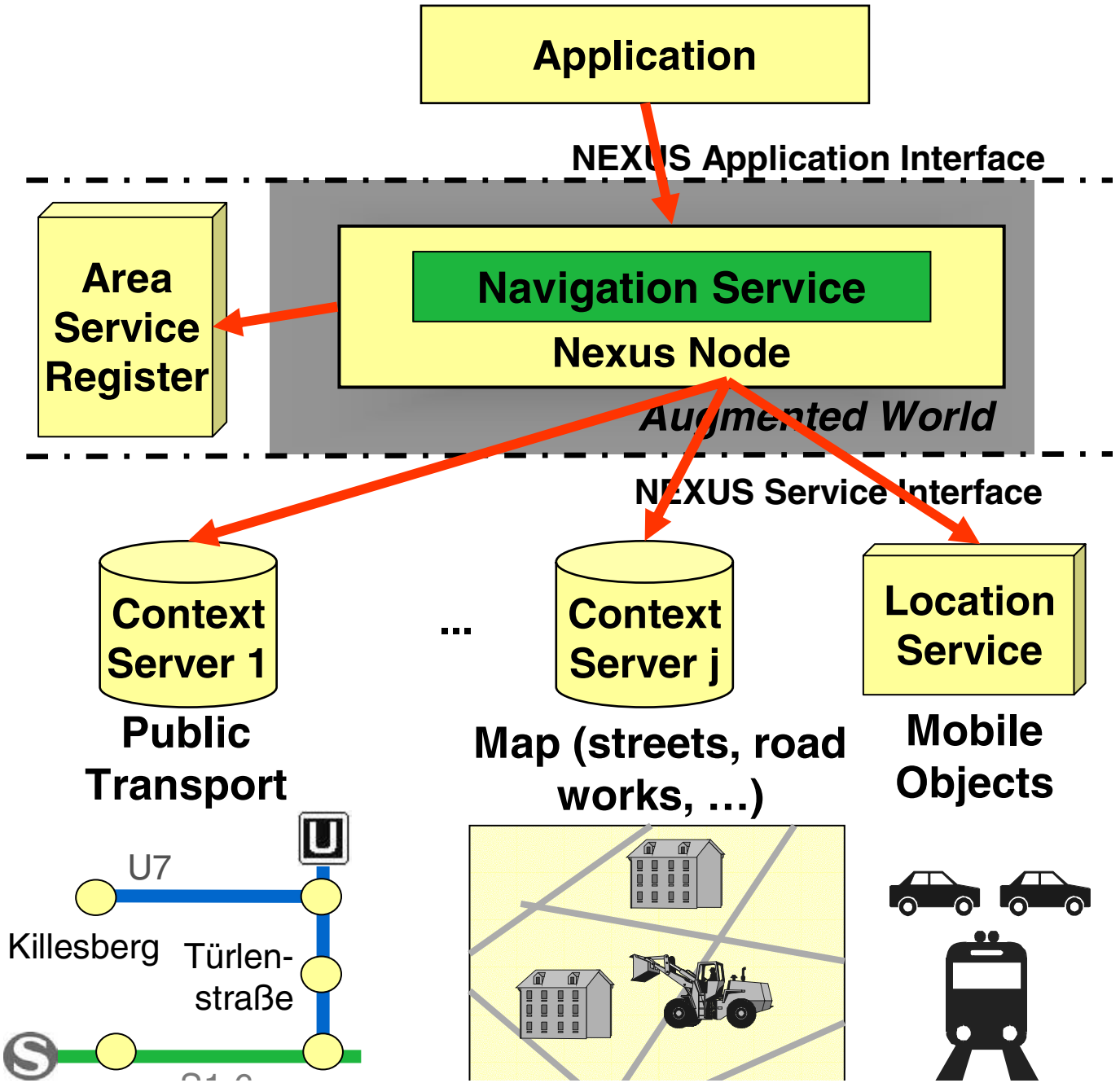
Event Service

- Distributed event observation and notification of spatial events, e.g.
  - on enter/leave area
  - on meeting
- Combination of simple events to complex events



Navigation Service

- Multimodal navigation
  - Integration of navigation data from different providers
- Context-aware navigation
  - Current traffic situation (traffic jams, train delays, etc)



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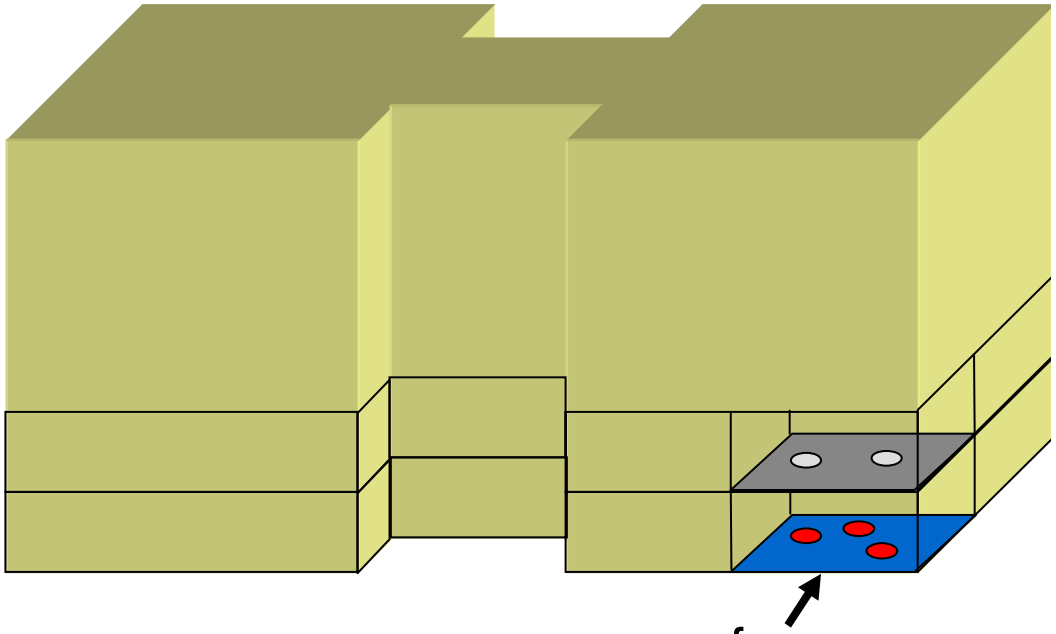
Context-aware Communication: Geocast

Send message to all hosts in geographic target area

- Message to area close to fire: “Toxic smoke. Keep windows shut!“
- Send presentation slides to everyone in conference room

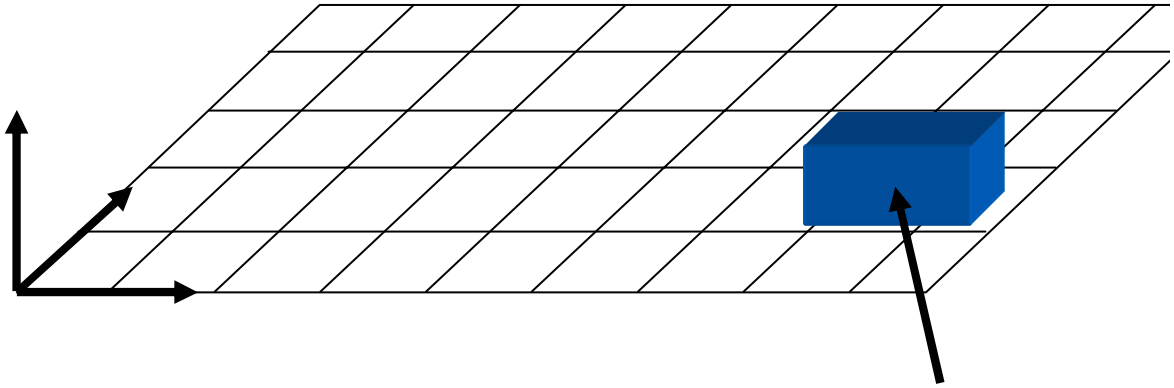


Requirements

- Fine-grained addressing scheme based on Nexus location model
- Scalable geocast routing algorithms
  - small receiver groups (e.g. one room) up to large groups (e.g. a whole city)

Geocast: Addressing Schemes

- **Geometric addressing**
  - “Arbitrary” target areas
  - Complex location model



conference room:

polygon(vertex1, …, vertexN), altitude, height

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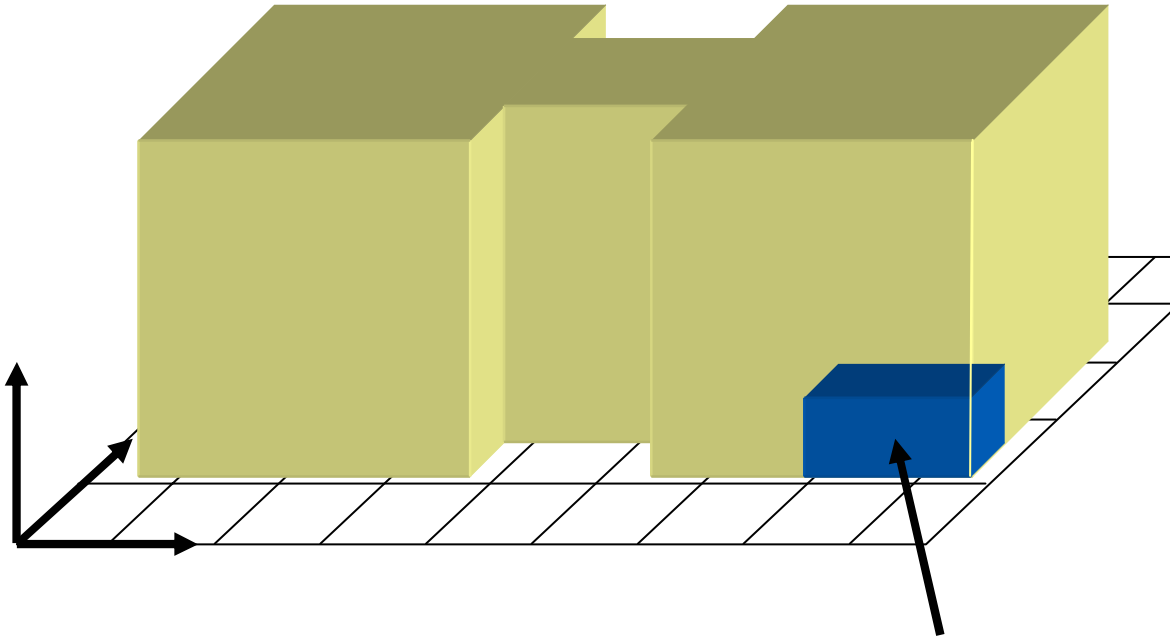

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Geocast: Addressing Schemes

- Geometric addressing
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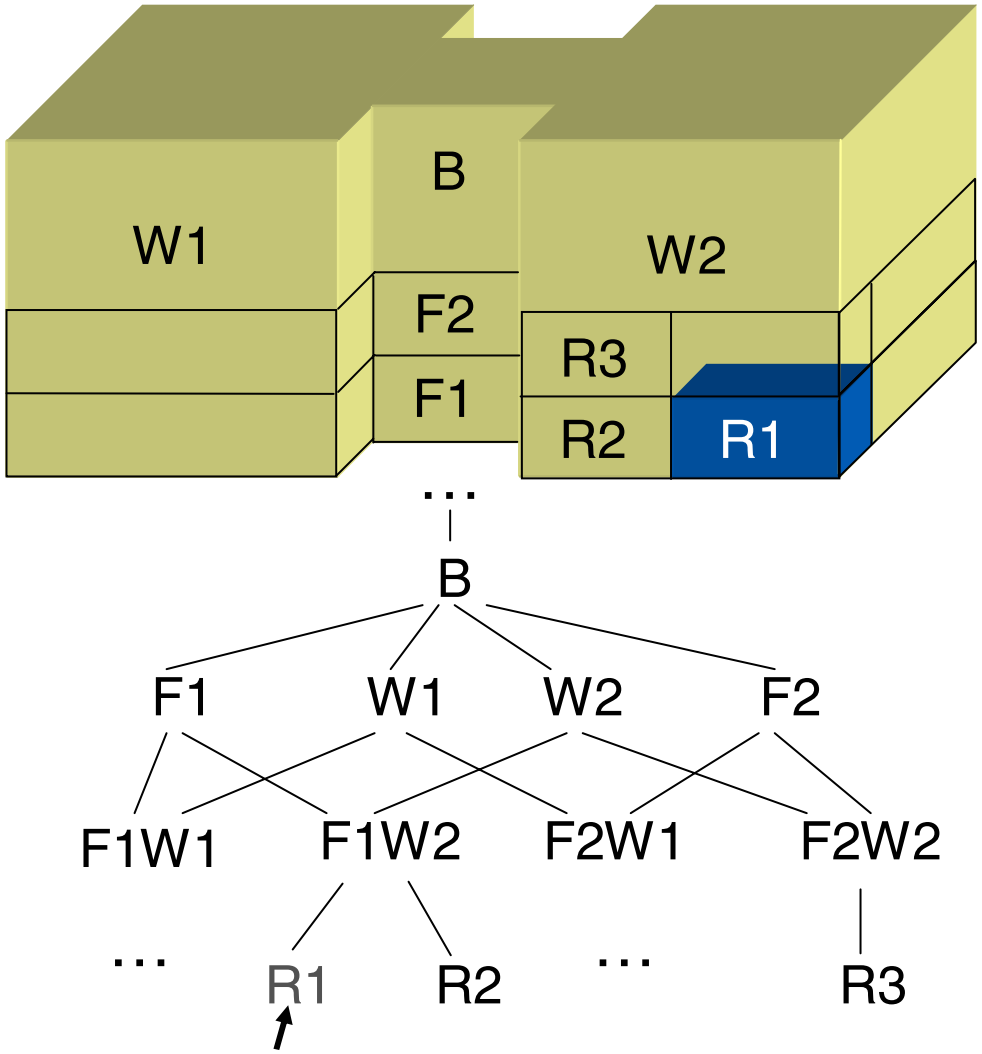
- **Symbolic addressing**
  - Intuitive to use
  - Simple location model
  - Target areas dependent on symbolic location model and addressing scheme [UbiComp ’03]



conference room:
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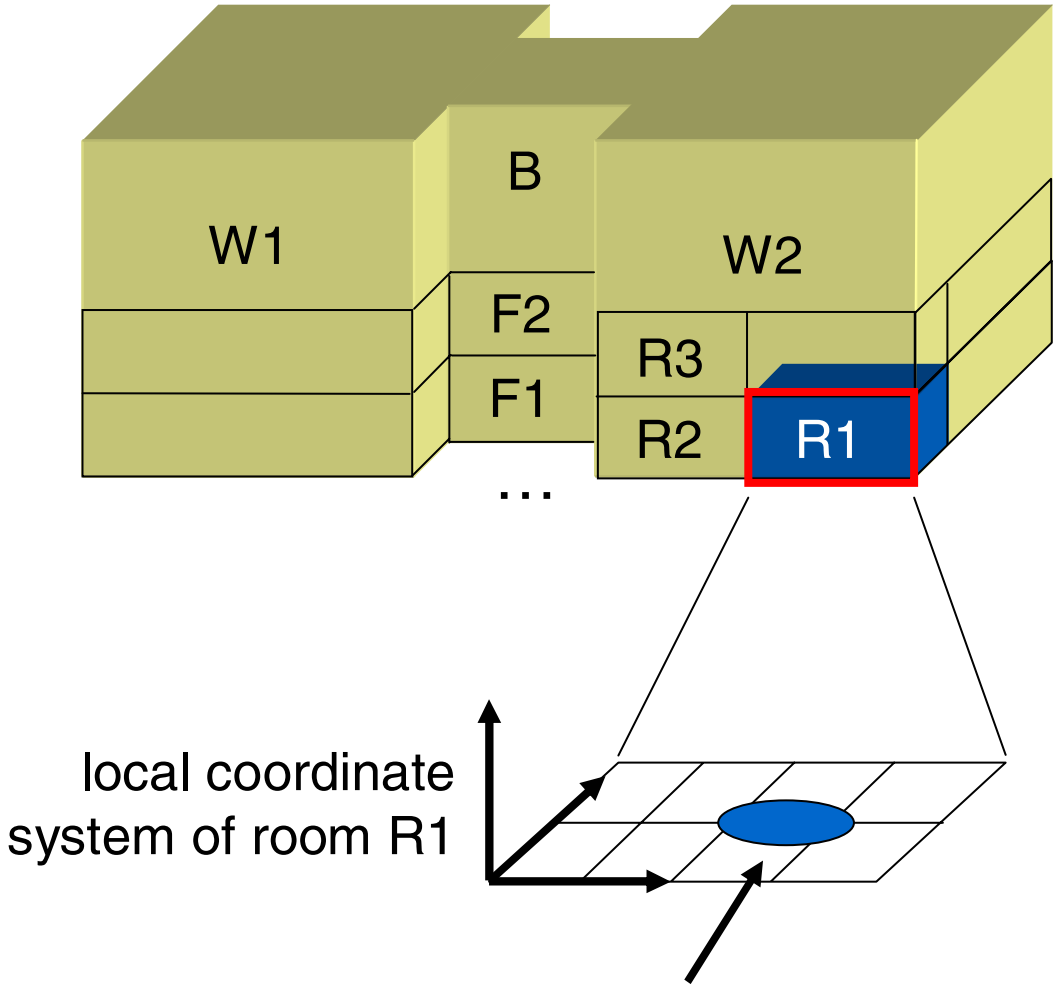
  - “Arbitrary” target areas
  - Complex location model
- Symbolic addressing
  - Intuitive to use
  - Simple location model
  - Target areas dependent on symbolic location model and addressing scheme [UbiComp ’03]
- **Hybrid addressing**
  - Geometric & symbolic



/de/stuttgart/keplerstr/9/floor1/wing2/room1: circle(X,Y)

Geographic Multicast

- Nexus Augmented World Model contains more than location information
  - Object classes, e.g. pedestrians, vehicles, etc
  - Object attributes

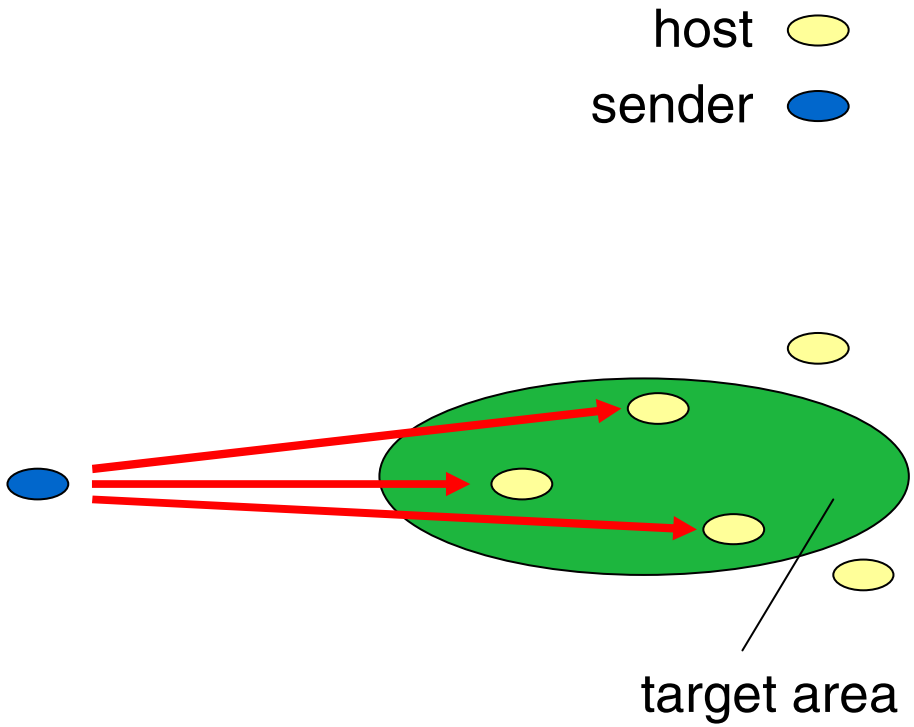
→ Receiver group can be refined to address groups within geographic areas (geographic multicast)

- Examples:
  - Message to all taxis near the main station of Hagen

Simple Directory-based Geocast
Message Forwarding

1. Query directory for all hosts in target area
   - static hosts: Context Server
   - mobile hosts: Location Service
2. Send message to these hosts
   - one unicast message per host

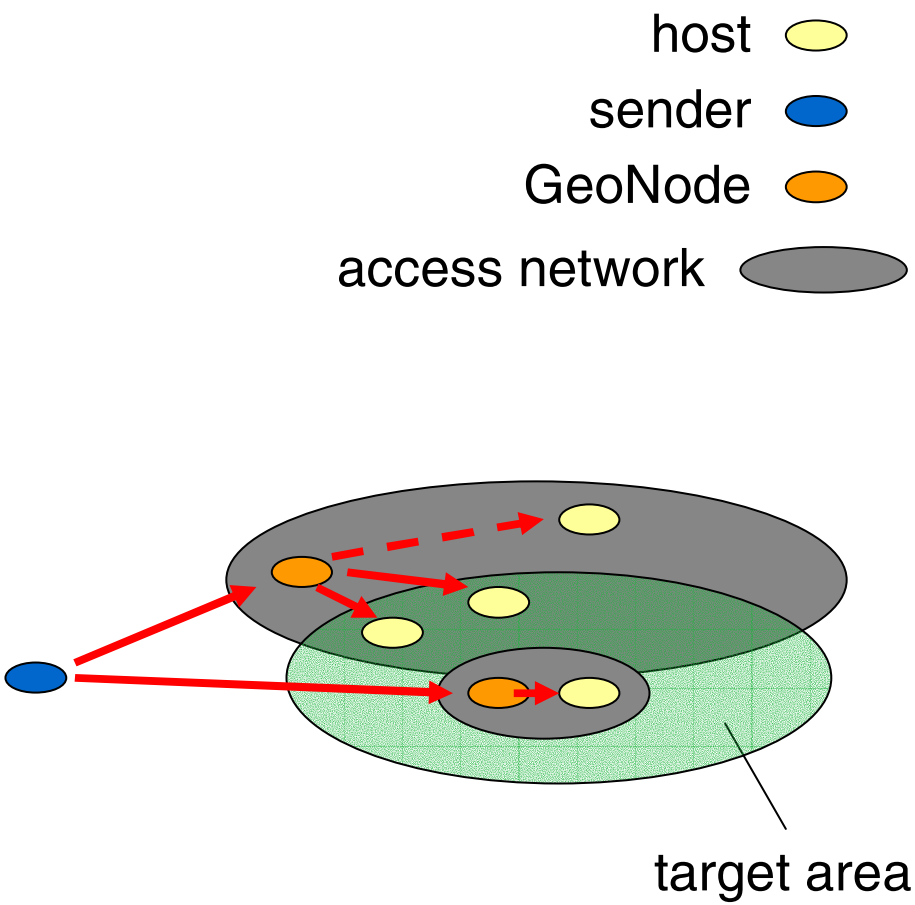
Applicable to small receiver groups → poor scalability



2-Phase Directory-based Geocast Message Forwarding

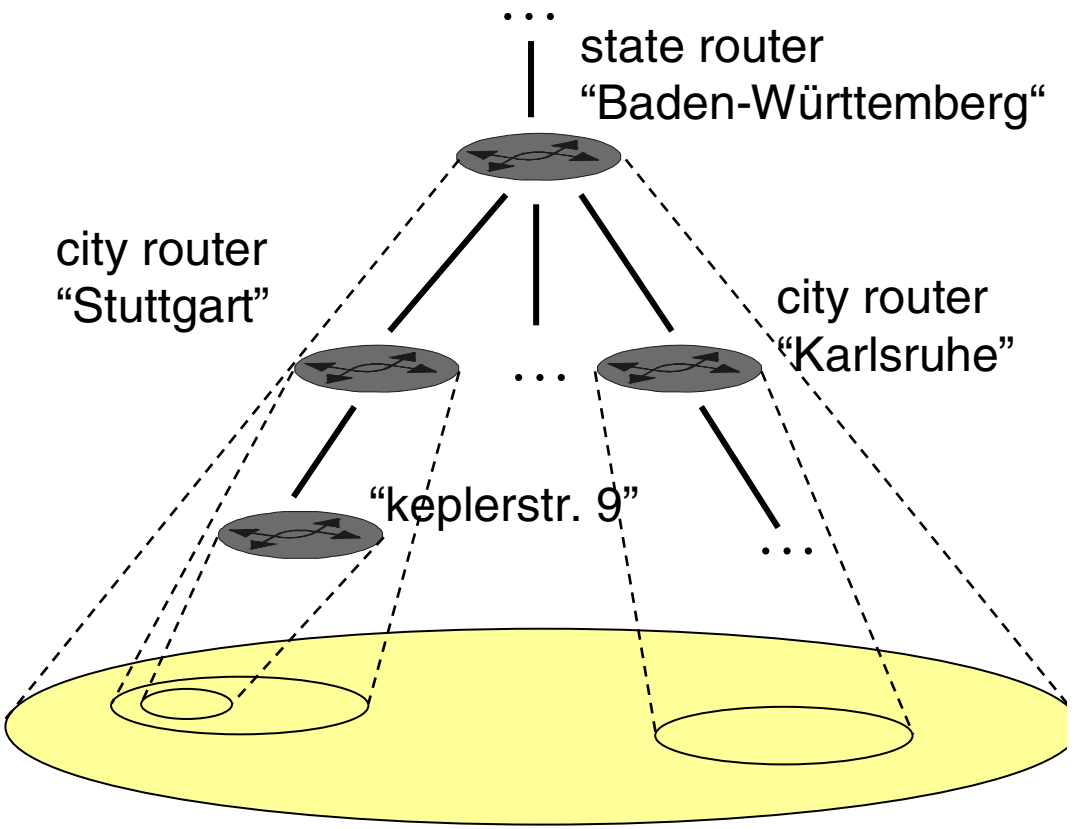
1. Query directory for all access networks intersecting target area
   - spatial model of access networks required
2. Send message to each access network's GeoNode
   - one unicast message per access network
3. Distribute message within access network
   - broadcast or multicast

Applicable to medium-size receiver groups (small number of intersecting access networks) → medium scalability



Geocast: Geographic Routing

- **Overlay network of GeoRouters**
  - GeoRouters have geographic service area
  - GeoRouter hierarchy according to spatial containment relationship of service areas



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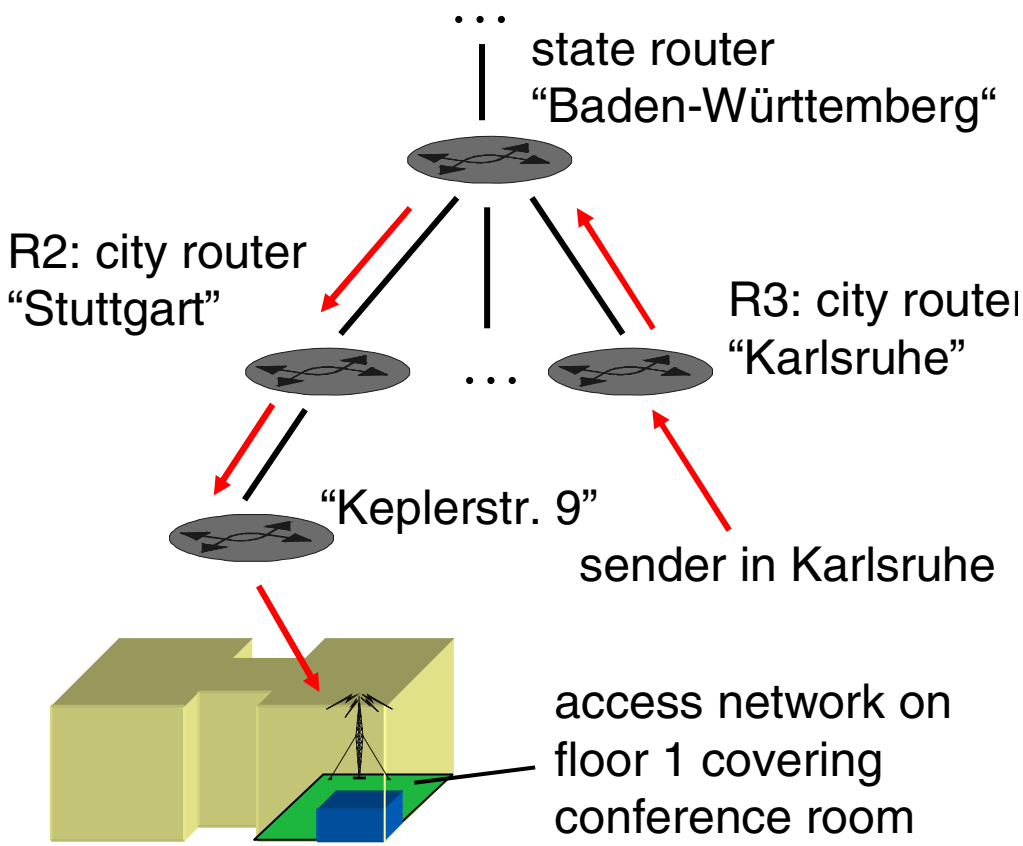

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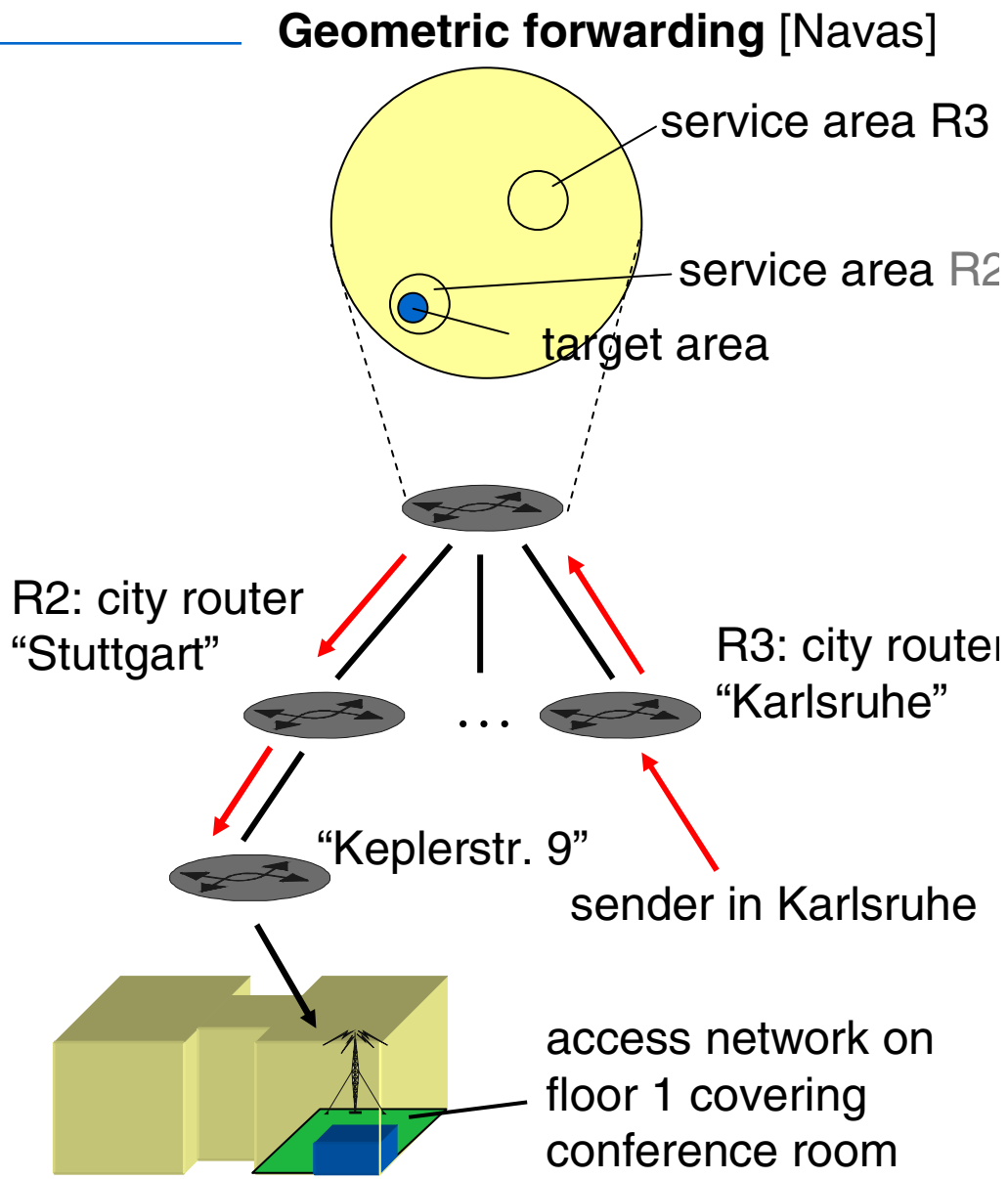

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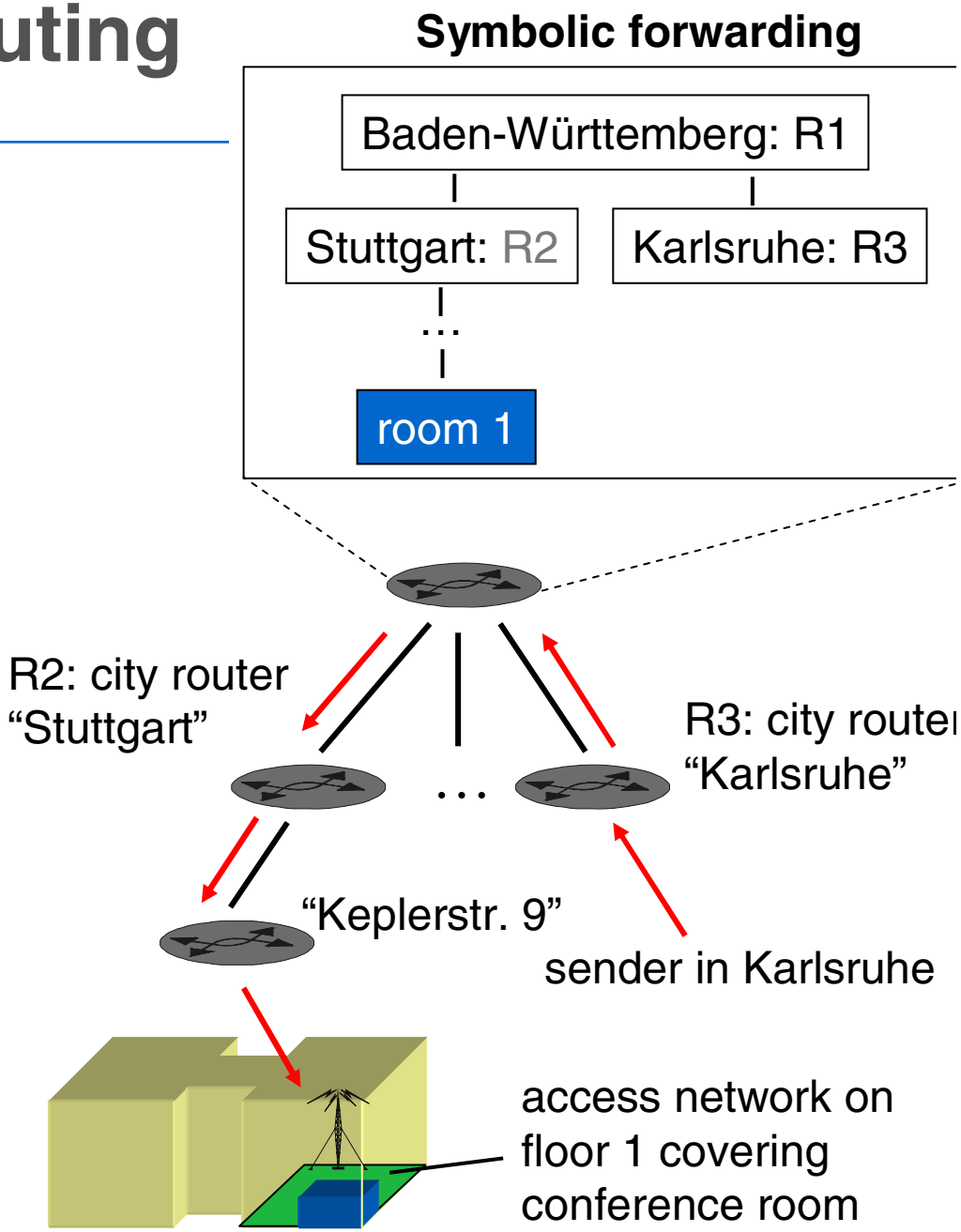

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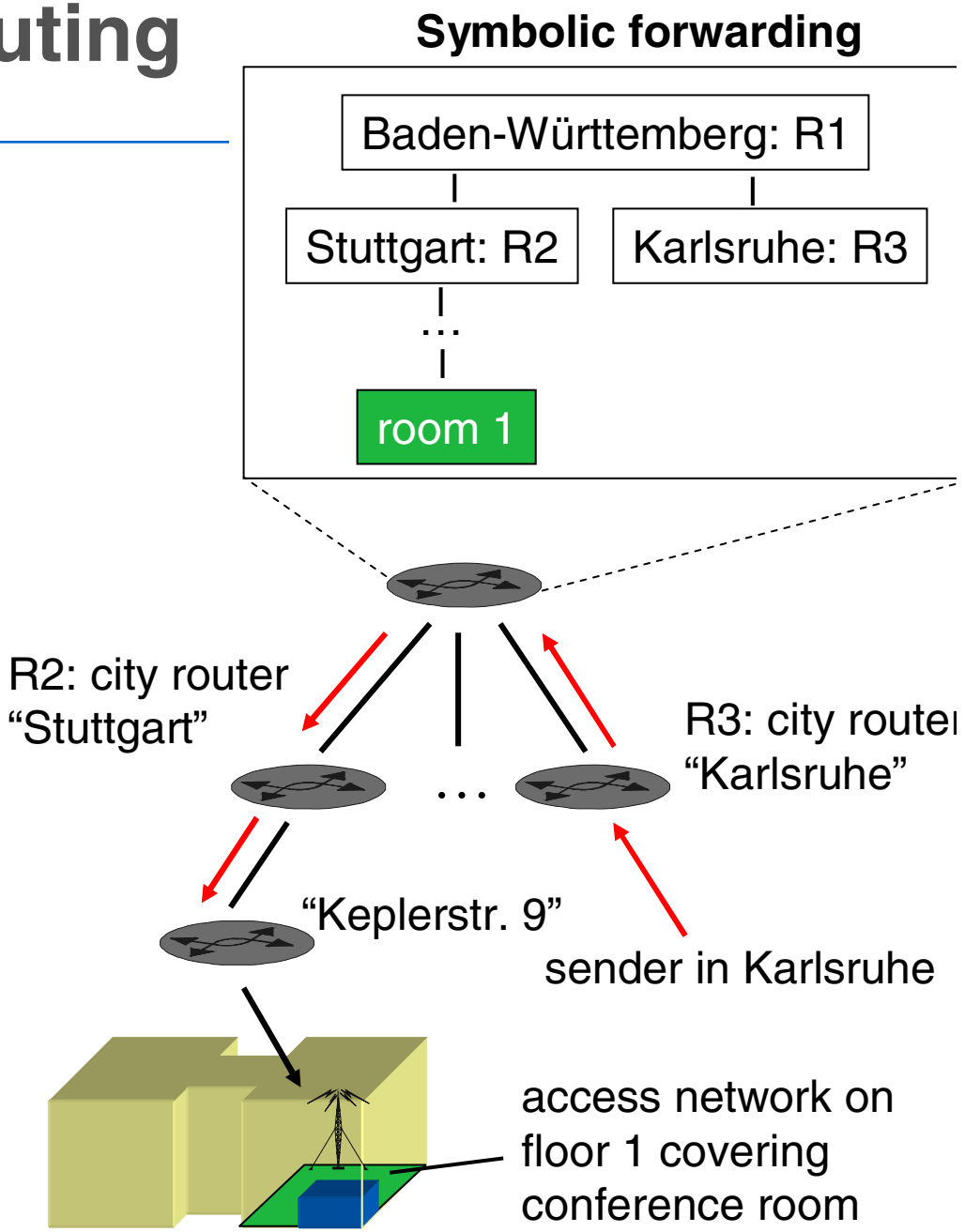
- **Evaluation:** up to ~100,000 forwarding decisions/sec for symbolic routing algorithm → scalable to large receiver groups



Summary

- Context-aware applications
  - Require context model, ***but*** high modeling effort for global and fine-grained model
- Nexus Platform for context-aware applications
  - Federation of local models → shared modeling effort
  - Value added services on basis of federated context model, e.g. event service, navigation service, etc
- Geocast based on Nexus Platform
  - Fine-grained addressing (symbolic, geometric, hybrid)
  - Efficient message forwarding

Discussion

Thank you very much for your attention!

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