The Vision of SpoVNet

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Outline

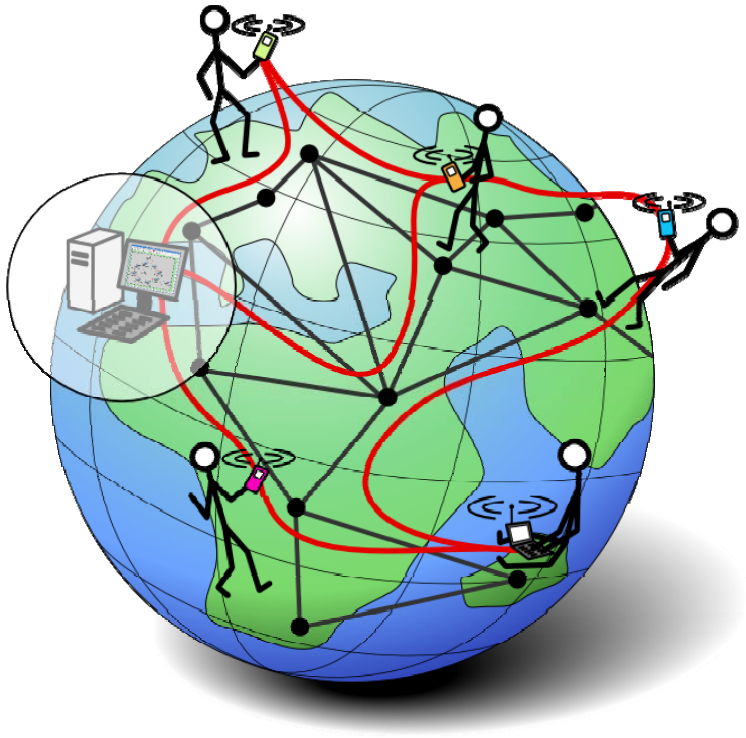
- Motivation and Objectives of SpoVNet
- The SpoVNet Architecture
- A SpoVNet Application Example

Motivation and Objektives

The Internet …

… a ubiquitous global communication infrastructure

- Increasing requirements
  - Quality of service
  - Security
  - Robustness
  - …



… but also new challenges

- Mobility
- Heterogeneity
- …

→ Deployment of new protocols is a difficult task

Creating the Internet of the Future?

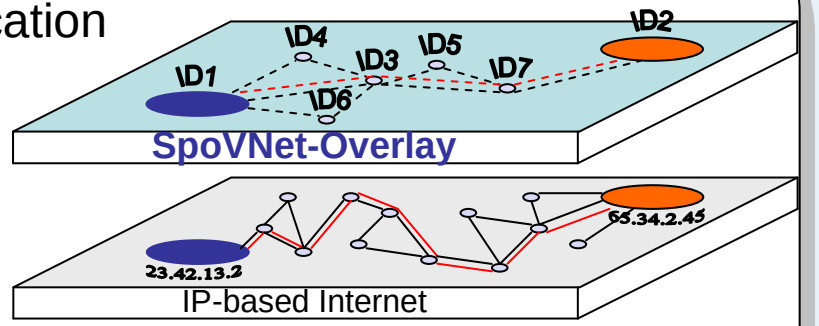
- A vast number proposals exist
  - Incremental improvements of the current Internet?
    - Result: Patchwork-Design with many drawbacks
      - E.g., TCP adaptations to wireless, mobile, ..
  - Completely new concepts and methods („clean slate“)
    - Major revision of the current architecture and its basic concepts
      - E.g., identifier vs. locator (… IP-addresses)
    - But: time horizon of 10 years and more?
      - E.g., NSF FIND-Program NSF (Future Internet Design): Collection of various independent projects
- How to evaluate new concepts?
  - Multitude of current testbed activities
    - E.g., US Initiative GENI
    - Mostly far from deployment
- What to do in between?
  - SpoVNet tries to fill the gap between the current and the future internet!

SpoVNet´s Mission

- Develop a framework for easy deployment and evaluation of future Internet services
  1. Provide communication services flexibly, adaptively and spontaneously on top of heterogeneous networks
     - Network- and application-oriented services
       - E.g., group communication, event notification, …
  2. Enable seamless transition from current to future networks
     - Incremental deployment and test of new (SpoVNet) services
     - Easy replacement of SpoVNet services by native network services

SpoVNet´s Major Aspects

- Systematic use of overlays for service provisioning
  - Spontaneous and flexible, per application
  - No infrastructure support required
  - Self-organizing, scalable and robust



- Overlays designed to be underlay-aware
  - Adaptive due to cross-layer information, e.g.
    - Handover events, congestion status …
  - Employment of underlay mechanisms for performance enhancement

- Integrated proof-of-concept
  - Implementation of both the SpoVNet architecture and examples for services and applications

The SpoVNet Architecture

Goals of the SpoVNet Architecture

- Provide a framework that
  1) Allow for comfortable creation of application supporting services in heterogeneous networks
  2) Assures that these services can be incrementally replaced by evolving underlay services

- Innovative Aspects
  - Framework provides generic (transport-)mechanisms to foster the comfortable creation of new overlay services and application
  - Optimization and adaptivity using cross-layer information

SpoVNet Architecture's Objective 1

- Allow for comfortable creation of application supporting services in heterogeneous networks
  - ⇒Overlay-based Architecture

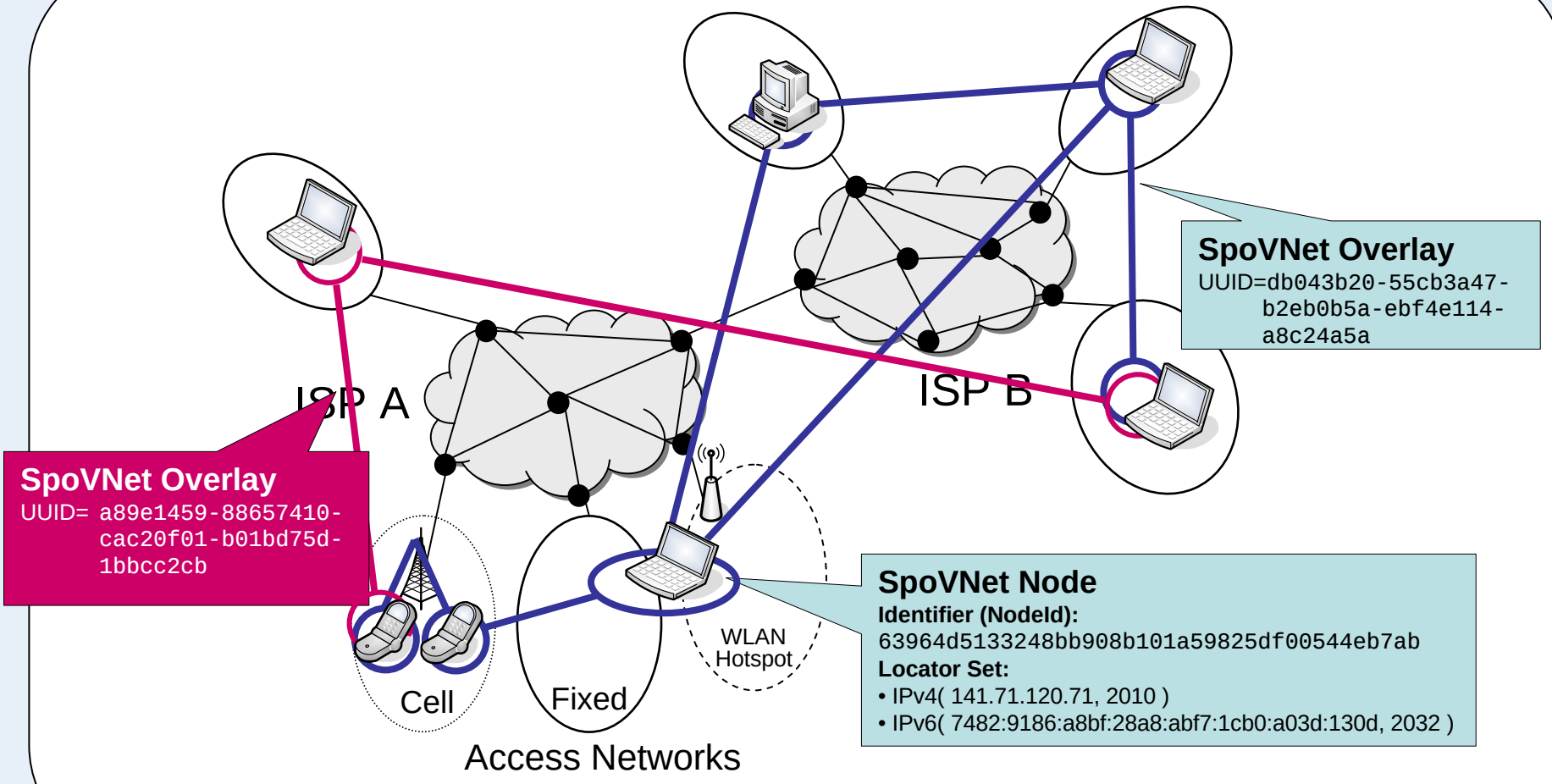
The Base Overlay: Providing Basic Connectivity

- SpoVNet Node
  = Device participating in a SpoVNet application

- All SpoVNet nodes participating in the same instance of a SpoVNet application …
  … make up a SpoVNet Instance
  … are connected by the Base Overlay

- Base overlay allows for easy creation of overlay-based services
  - Provides persistent addressing scheme, handles connection setup, …

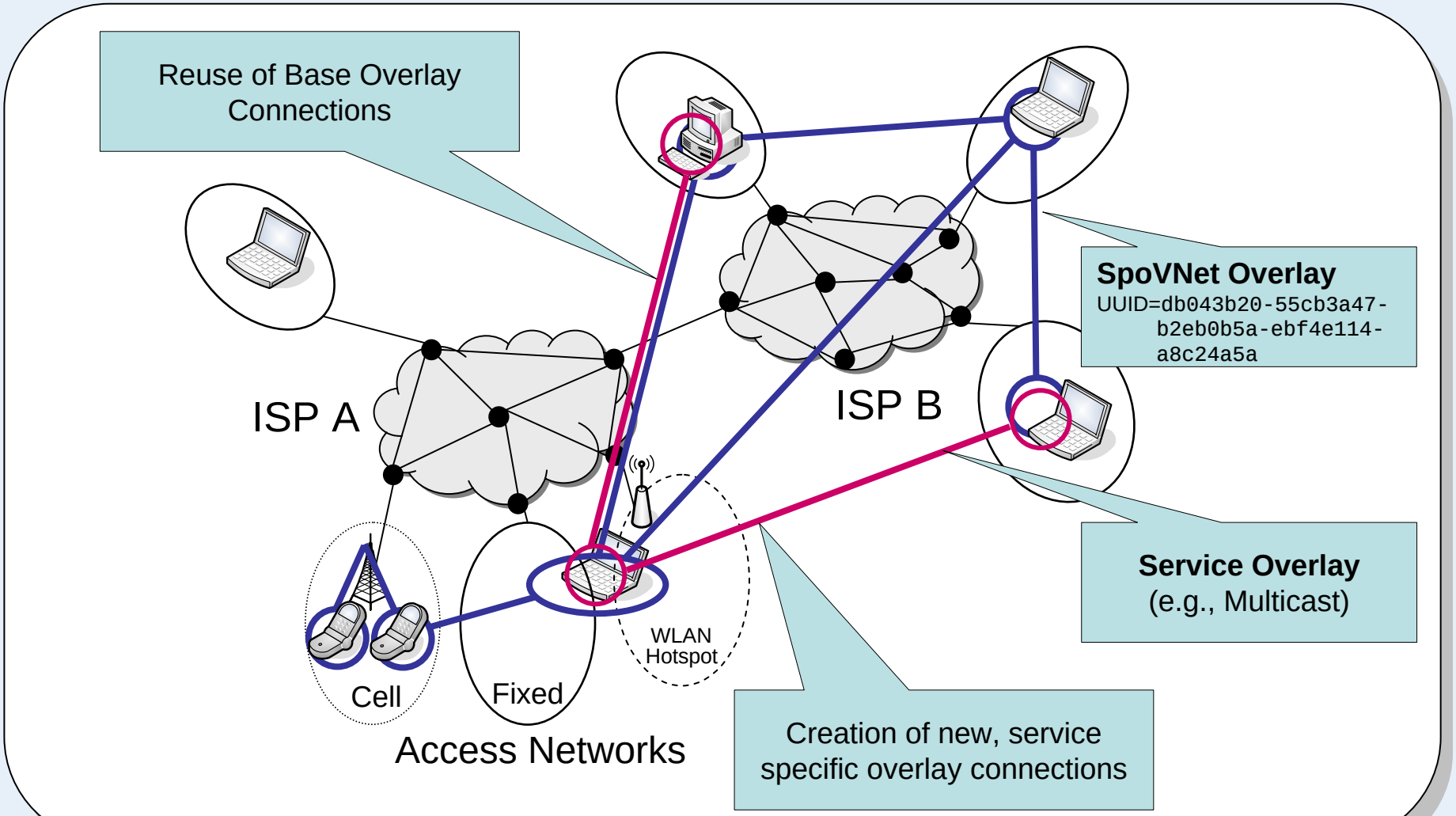
Example: SpoVNet Nodes, the Base Overlays and SpoVNet Instances



Overlay-based Services

- SpoVnet Services are typically implemented by overlays
  - Build upon basic connectivity provided by base overlay
  - Structure of service overlay may differ significantly from basic overlay structure

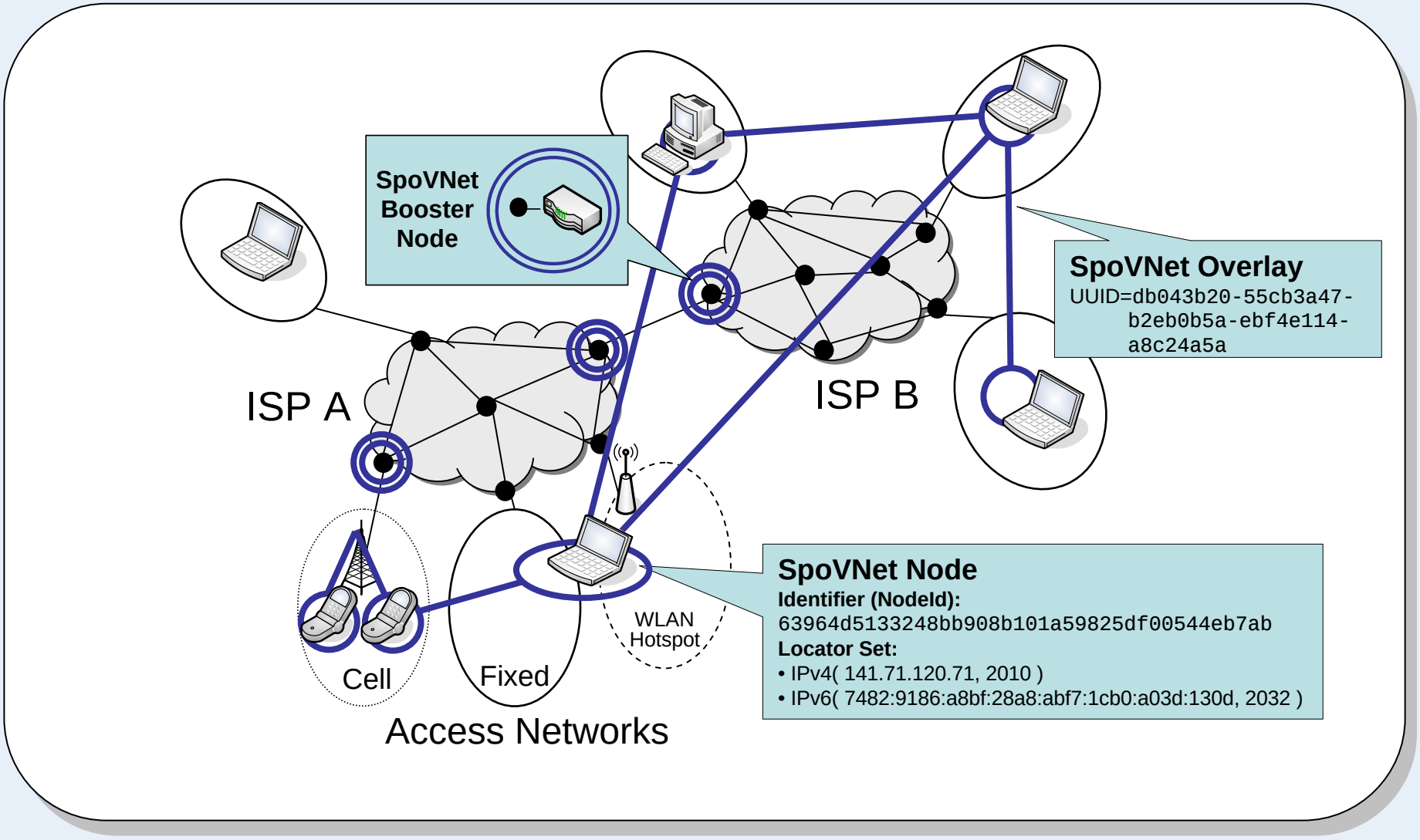
Example: Creating a SpoVNet Service



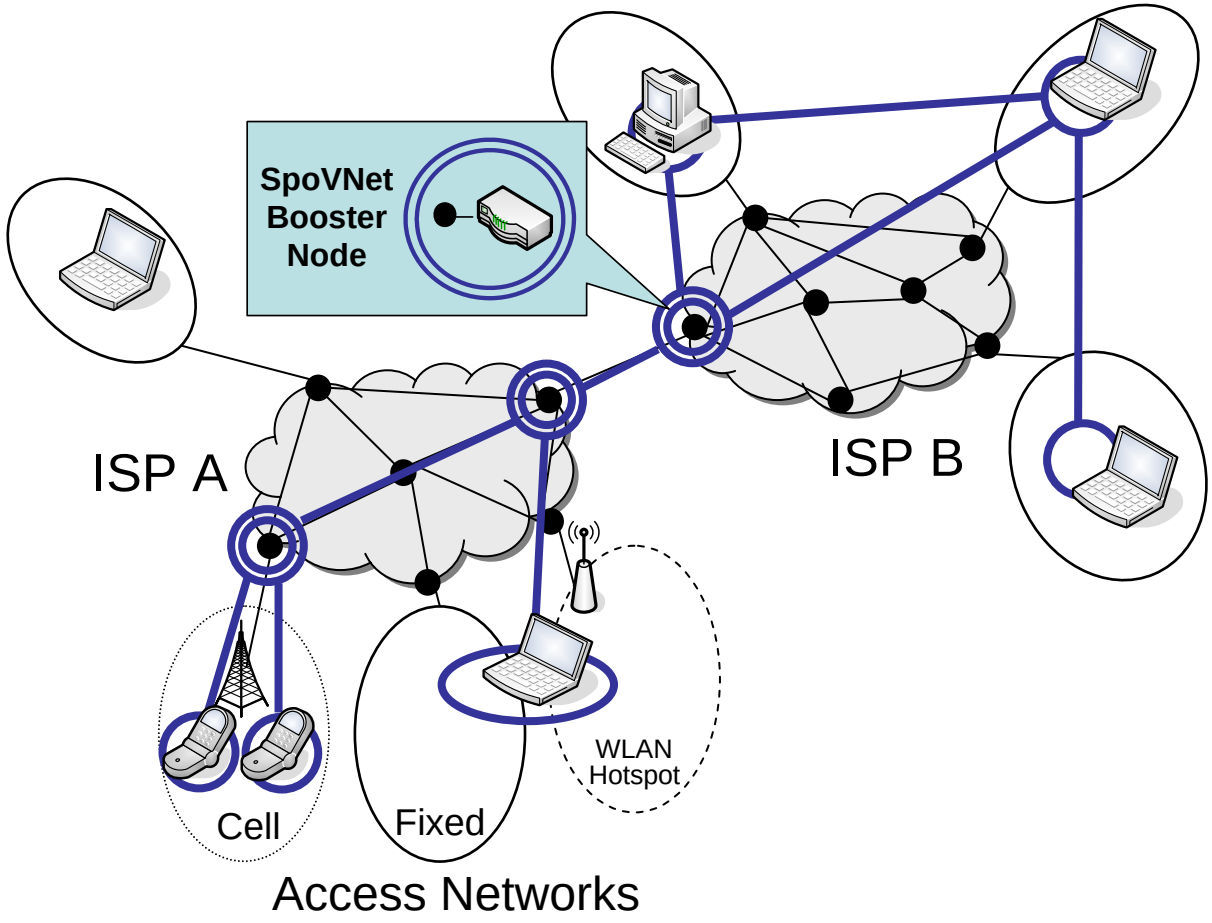
Underlay Awareness

- Most overlays are “blind” for the underlay
  - End-system based
  - Mismatch of overlay and underlay topology
  - Cannot adapt to underlay changes
- SpoVNet support for underlay awareness
  - Adaptation and optimization based on cross-layer information
    - Distributed measurement and information collection
  - Transparent employment of underlay features
    - Changes in applications are not required
  - Integration of Booster Nodes
    - Powerful SpoVNet nodes in “strategic positions”

Example: Booster Nodes



Example: Booster Nodes



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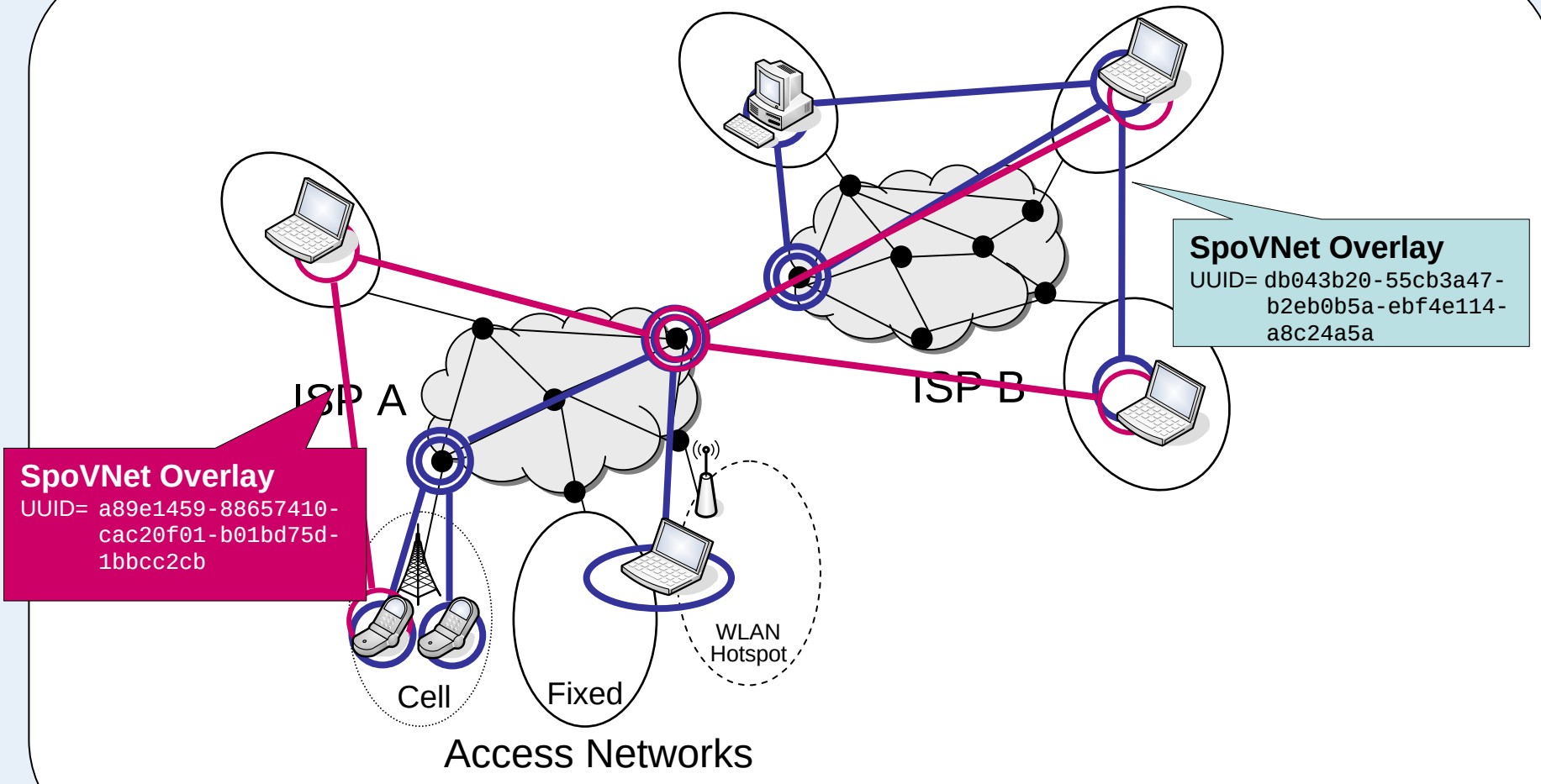
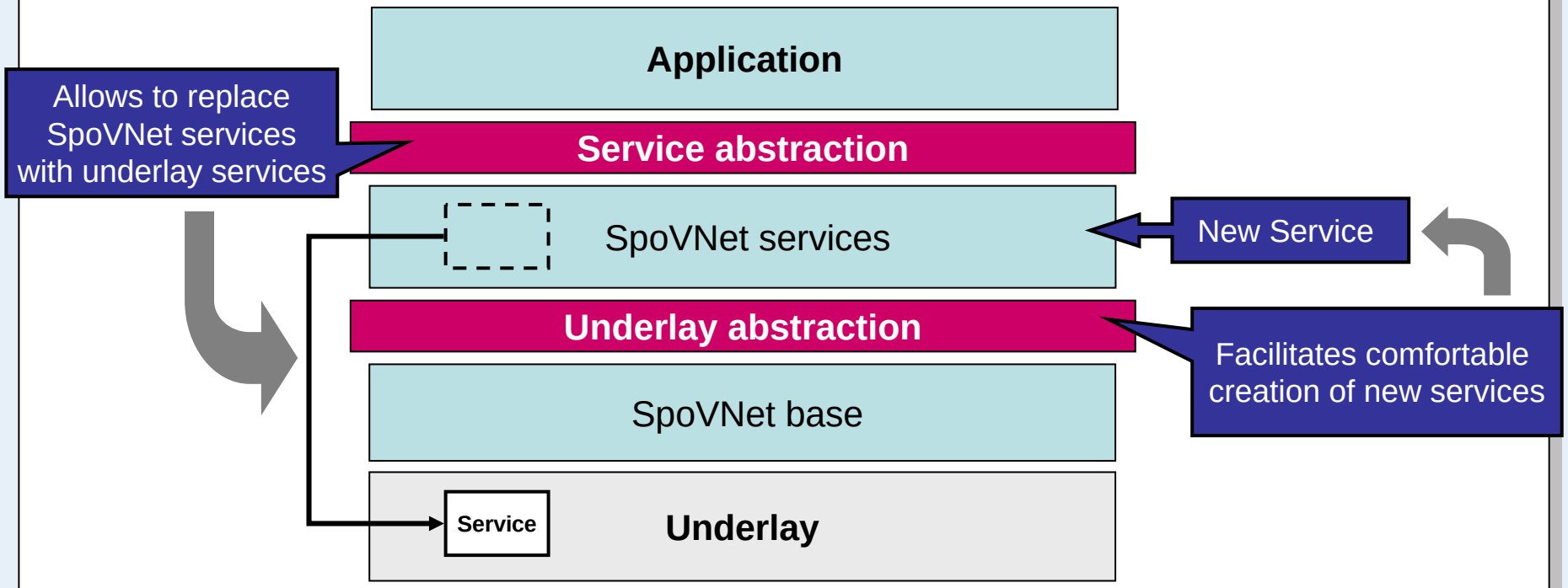


SpoVNet Architecture's Objective 2

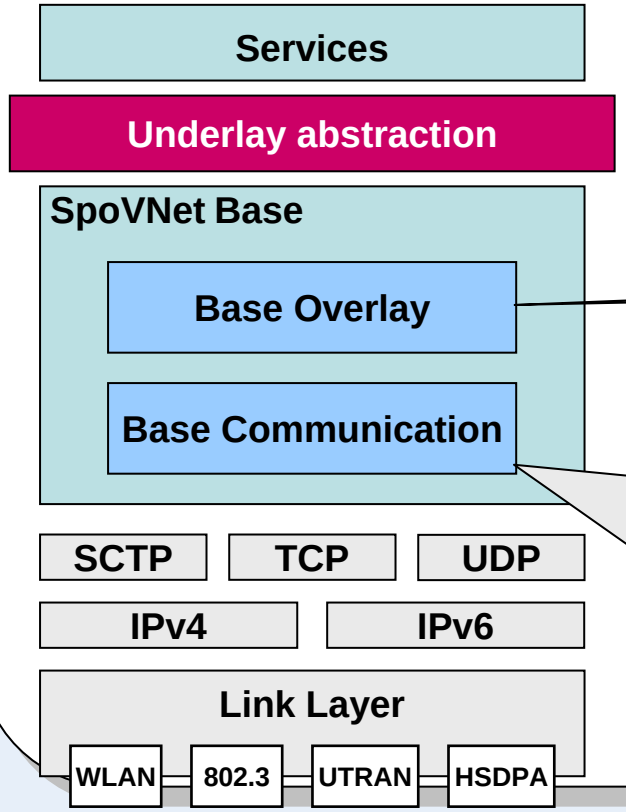
- Assures that SpoVNet services can be incrementally replaced by evolving underlay services
  - ⇒Two-layer abstraction architecture

Abstraction Layers in the SpoVNet Architecture



Underlay Abstraction

- Provides abstract transport connectivity hiding mobility, multi-homing and heterogeneity

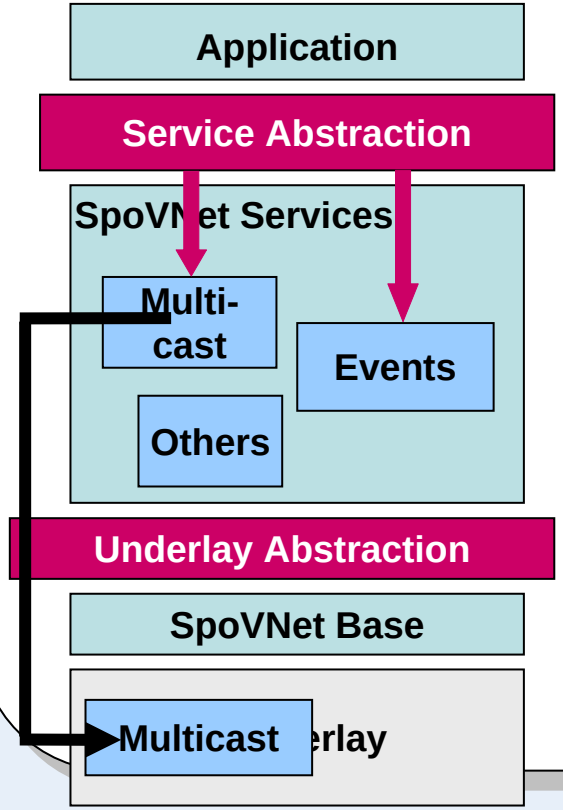


Example:

1. Service requests a connection, e.g.
   `CreateConnection( NodeId, QoSReq, SecurityReq )`
2. Base Overlay resolves *NodeId* to locator set
   - Handles multi-homing
3. Base Communication provides direct transport connectivity
   - Selects appropriate protocols and network access
   - Handles heterogeneity
4. Persistent connection handle is returned to service
   - Locator set may change
   - Handles mobility

Service Abstraction

- SpoVNet services supply well-defined interfaces to the application



- Applications may utilize none, one or more SpoVNet services

  Example: a virtual world online game may use
  - the multicast service for data dissemination, e.g. `createGroup( MultiSource, QoSReq, SecReq )`

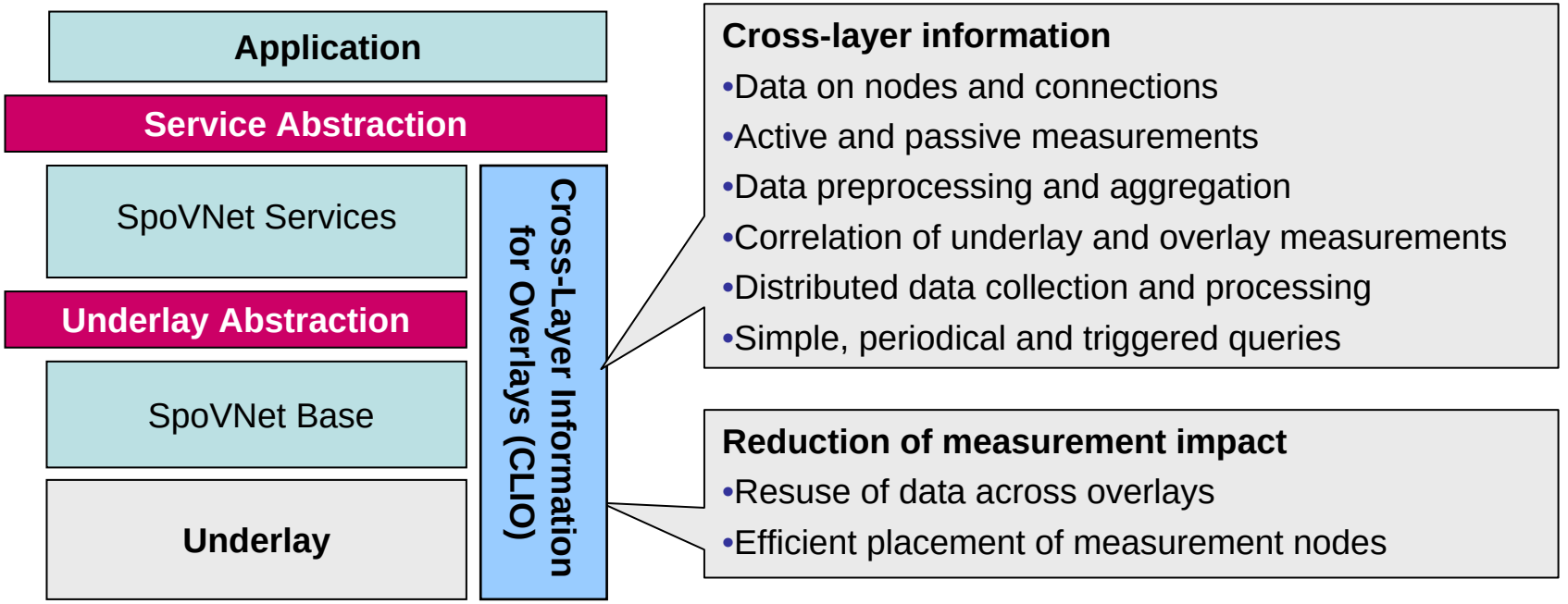
  and
  - the event service for in-game event notification, e.g. `subscribe( Id, EventClass, QoSReq, Listener )`

- Take advantage of incrementally evolving underlying network services
  - e.g. use native multicast to enhance SpoVNet multicast service

Cross-Layer Information

- The Cross-Layer Information for Overlays (CLIO) component provides abstract cross-layer information

  →Services and applications can now adapt autonomously to changing network conditions



… also supported by the SpoVNet architecture

- Quality-of-Service
  - (Probabilistic) guarantees with help from CLIO or underlay support
    - Overlay optimization based on cross-layer information
    - Monitoring of QoS parameter values
- Security
  - Base overlay & security component provide basic security building blocks
  - Advanced security features provided by specific services
- Robustness
  - Achieved, e.g. by supported redundancy in the overlay structure
  - Employment of underlay mechanisms for performance enhancement

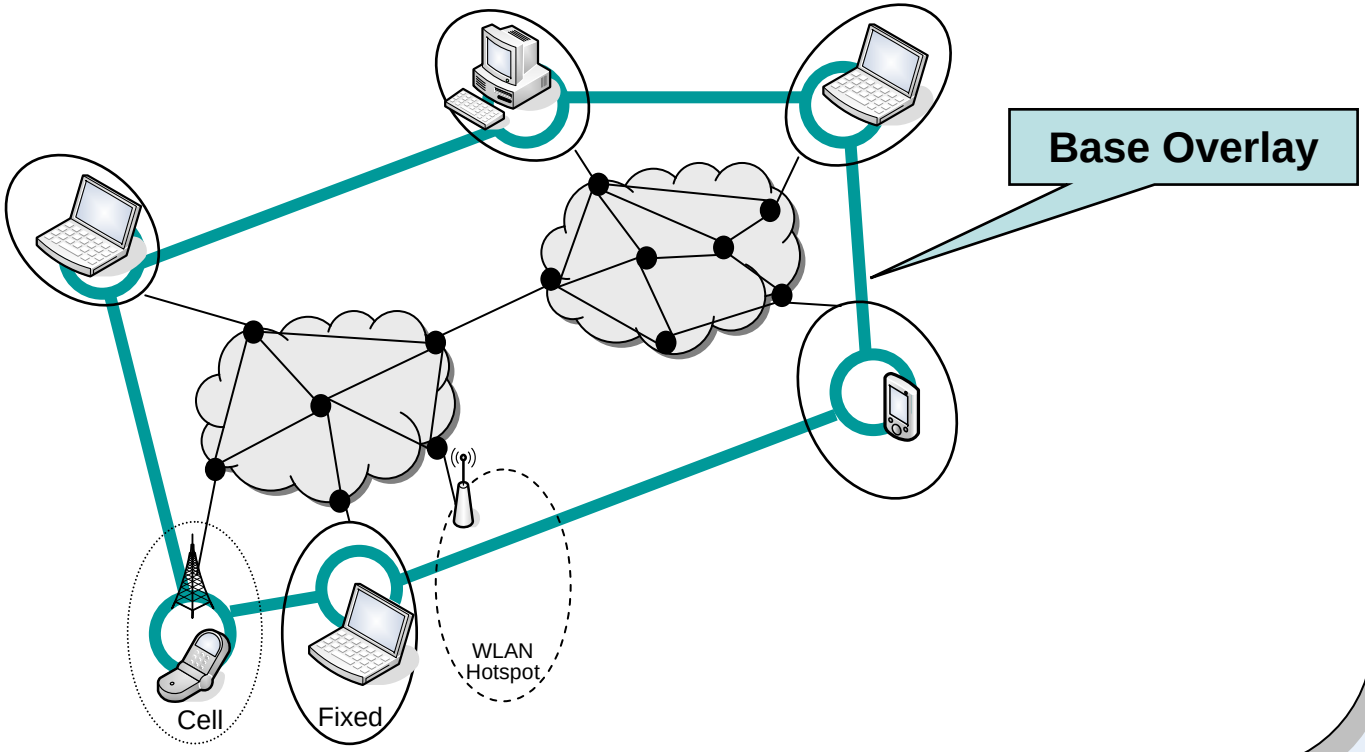
Application Example:
Virtual World Online Game

Example: Virtual World Online Game

- Game Scenario
  - People fly around in aircrafts and try to shoot each other
- During the game, players may
  - in the virtual world
    - generate events (e.g., position updates)
    - interact with a set of other players defined by proximity
  - in the real world
    - move between access networks in real world
- Some communication requirements of the game application
  - Basic connectivity between players
  - Notification and correlation of game events
  - Group communication for information dissemination
  - Adaptation to underlay changes

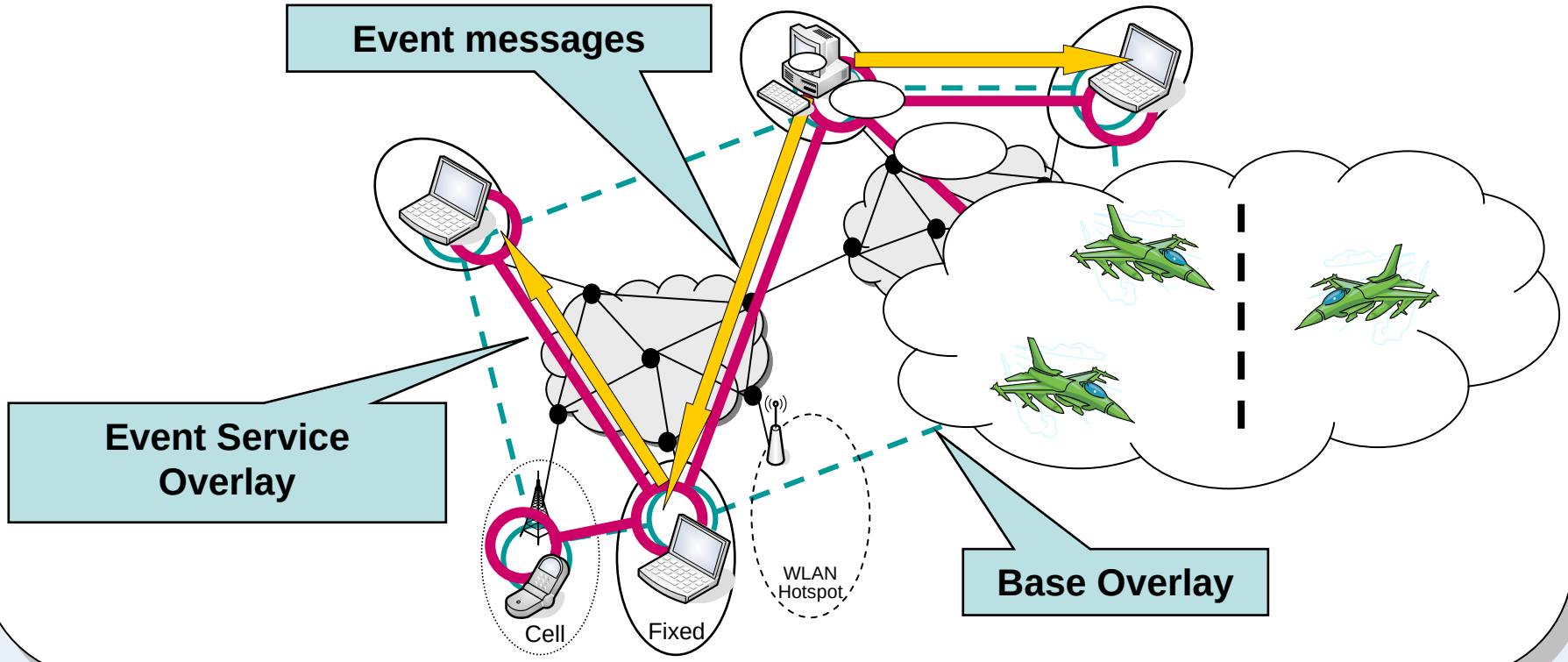
Basic Connectivity in Online Game

- Basic connectivity among players
  - SpoVNet Base Overlay connects all nodes
  - Provides identifier-based addressing
  - Players may join / leave arbitrarily



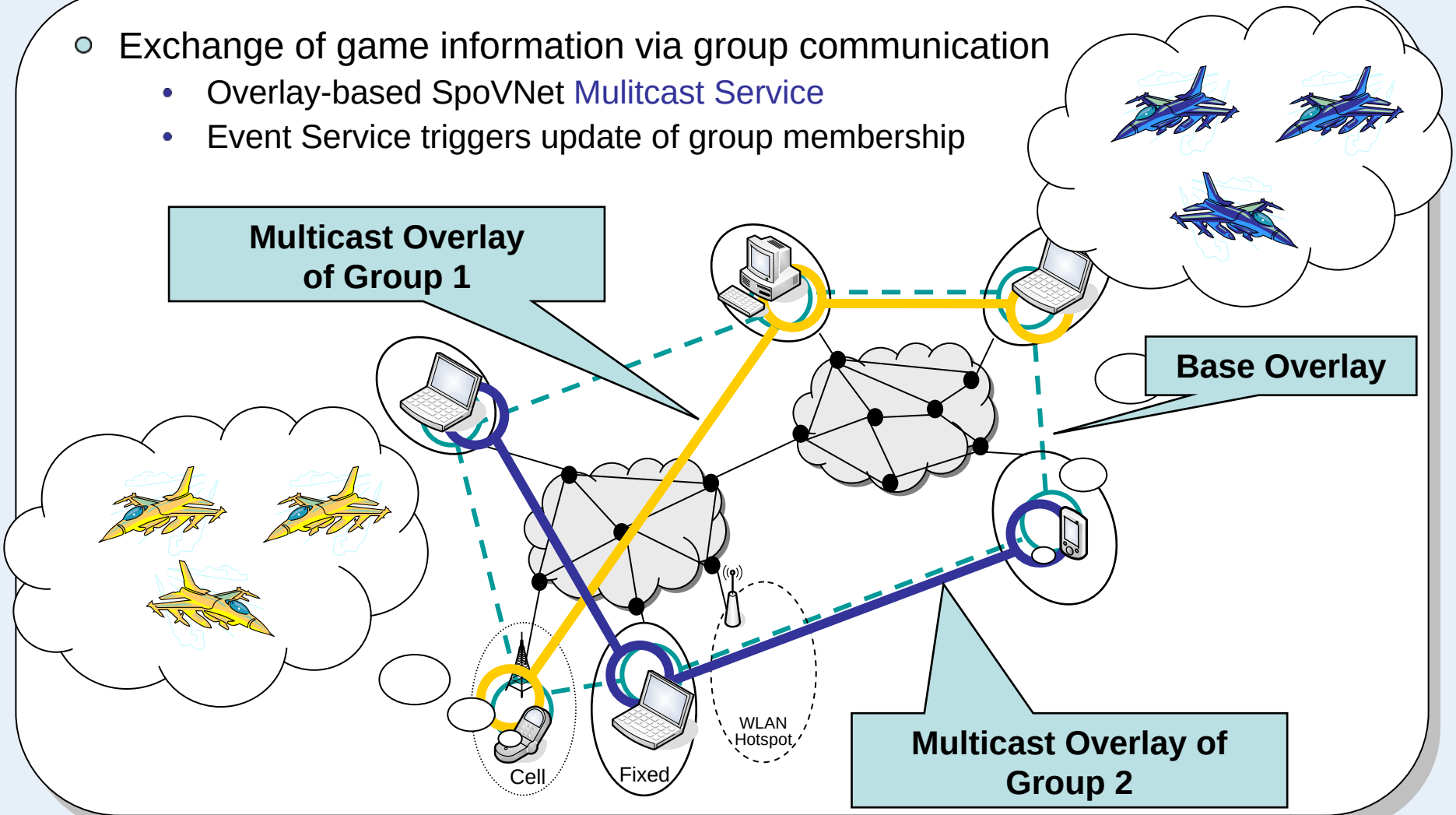
Event Correlation and Notification in Online Game

- Notify players about in-game events
  - Overlay-based SpoVNet Event Service
  - Relays and correlates event notifications within the network
    - E.g., Approaching objects in virtual world



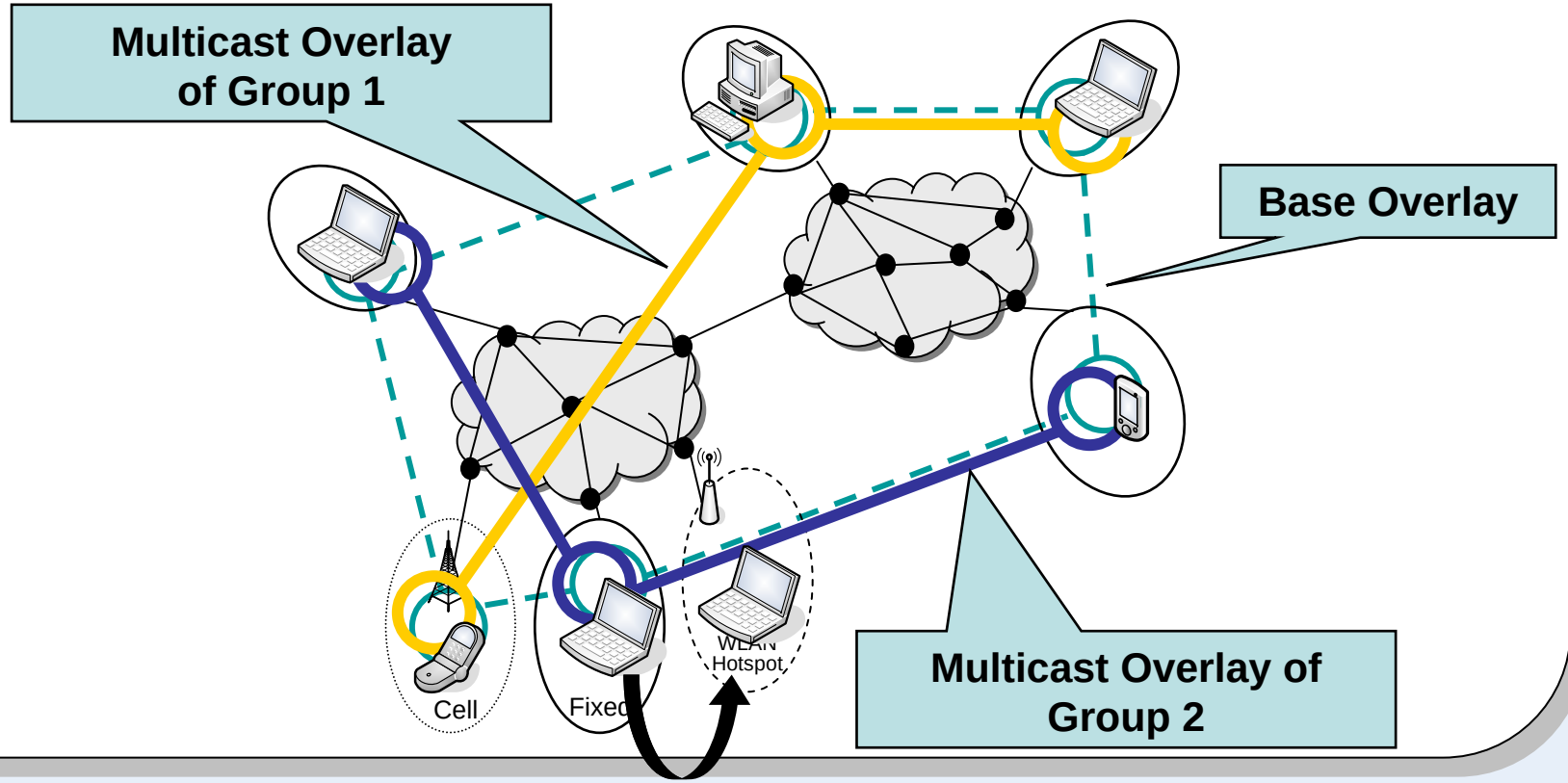
Multicast Service in Online Game

- Exchange of game information via group communication
  - Overlay-based SpoVNet Mulitcast Service
  - Event Service triggers update of group membership



Service Adaptivity in Online Game

- Players may move between access networks
  - Service overlay adapts based on cross-layer information



Service Adaptivity in Online Game

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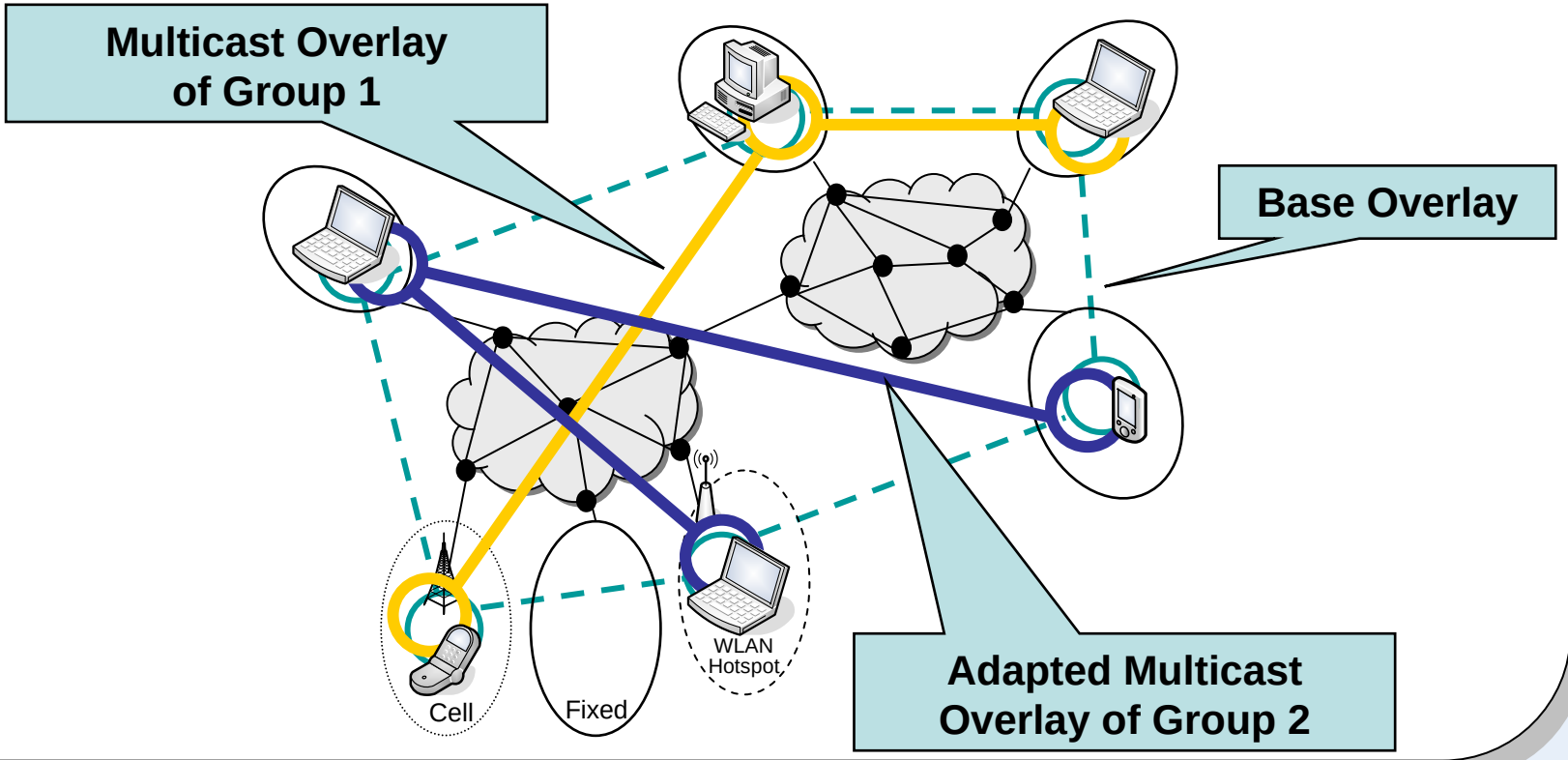

Conclusion

- Main aspects of SpoVNet
  - Systematic use of overlays for service provisioning
  - Overlays designed to be underlay-aware
  - Integrated proof-of-concept provided by examples for services & applications
- The SpoVNet architecture
  - supports providing adaptive, spontaneous communication services over heterogeneous networks
  - Enables a seamless transition from current to future networks

  →SpoVNet architecture fosters future services today and runs out of the box
- SpoVNet also supports fundamental research on enhanced services

Publications

- Roland Bless, Oliver P. Waldhorst, Christoph P. Mayer: The Spontaneous Virtual Networks Architecture for Supporting Future Internet Services and Applications, Jun 2008. (Vortrag auf dem Fachgespräch der GI/ITG-Fachgruppe "Kommunikation und Verteilte Systeme" Future
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- SpoVNet: An Architecture for Supporting Future Internet Applications. Presented at the sixth Würzburg workshop on IP: Joint EuroNGI and ITG Workshop on "Visions of Future Generation Networks"(EuroView2007), July 23-24 2007.
- S. Baehni, R.Guerraoui, B. Koldehofe, and M. Monod. Towards Fair Event Dissemination. Proc. 27th IEEE Int. Conf. on Distributed Computing Systems Workshops (ICDCSW 2007).

For details on publication and pdf download visit www.spovnet.de

The SpoVNet Team and Research Topics

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- Underlay Abstraction

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- Event-Correlation and Notification in Self-Organizing Networks

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Universität Mannheim

- Application Examples for Spontaneous Virtual Networks

Prof. Dr. Paul Kühn
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- Cross-layer optimization for Spontaneous Virtual Networks

Prof. Dr. Georg Carle
Universität Tübingen

- Cross-Layer Information for Overlays

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