



# An Architecture for Supporting Future Internet Applications

Sebastian Mies

Institute of Telematics, University of Karlsruhe (TH), Germany

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The SpovNet Consortium: University of Karlsruhe (ITM), University of Mannheim (PI4),  
University of Stuttgart (IPVS, IKR), University of Tübingen (RI)

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# Future Internet



- Internet has evolved from 4-node network to ubiquitous, global communication network
  - But ... is it flexible enough for the future?
- Patchwork design and deployment problems
  - “half” layers: IPsec, MPLS (2.5); TLS (3.5) ...
  - TCP adaptations to wireless, mobile etc.
  - Multicast, MobileIP Deployment?
- How to improve flexibility?
  - Calls for new architectures !?
  - Clean slate ... time horizon of 10 years and more?
  - Overlay-based architecture ... the way SpoVNet goes!

# Spontaneous Virtual Networks Objectives



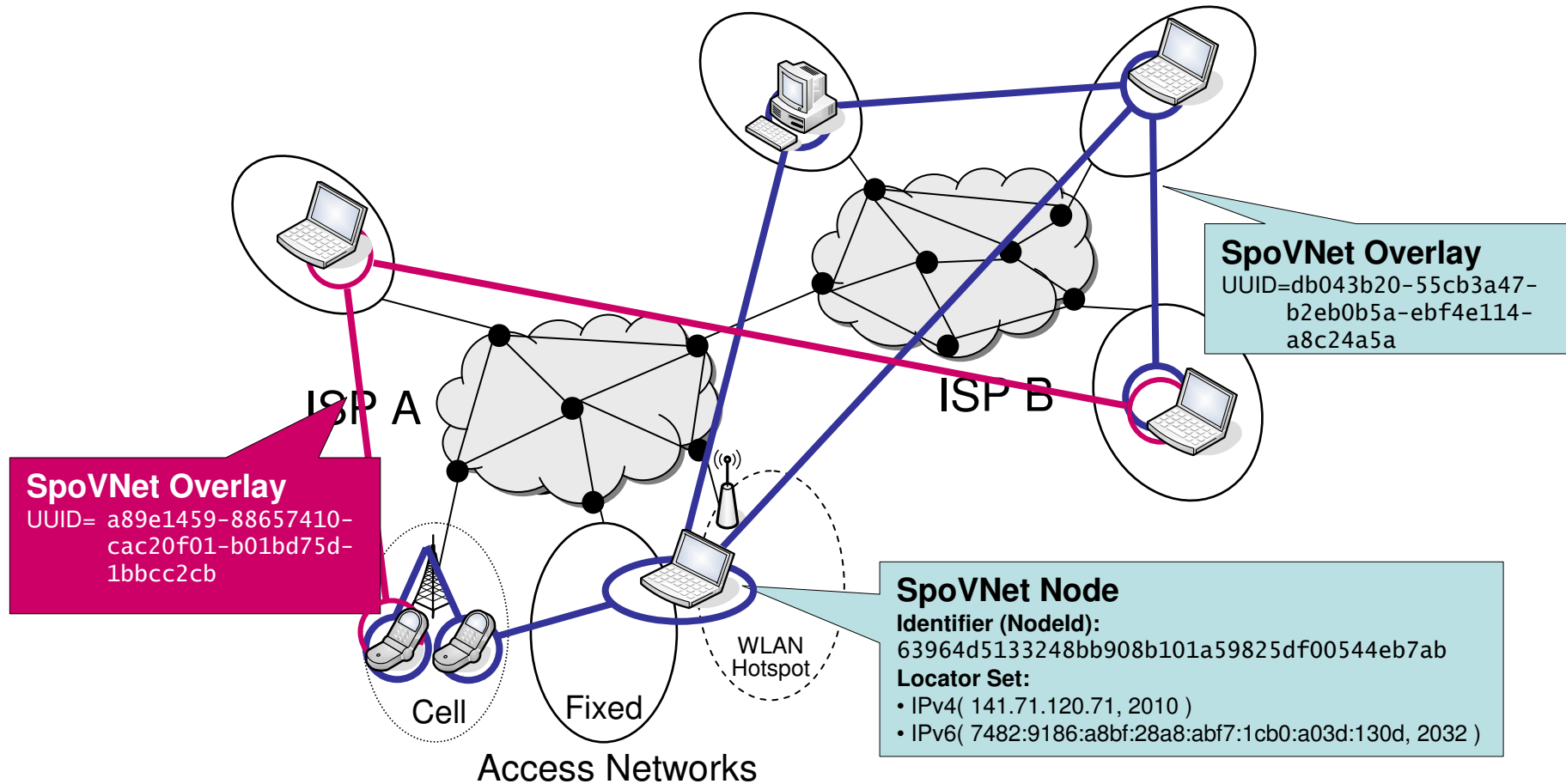
- 1) Provide communication services **flexibly**, **adaptively** and **spontaneously** on top of heterogeneous networks
- 2) Enable **seamless transition** from current to future networks

# Objective 1: Communication Services

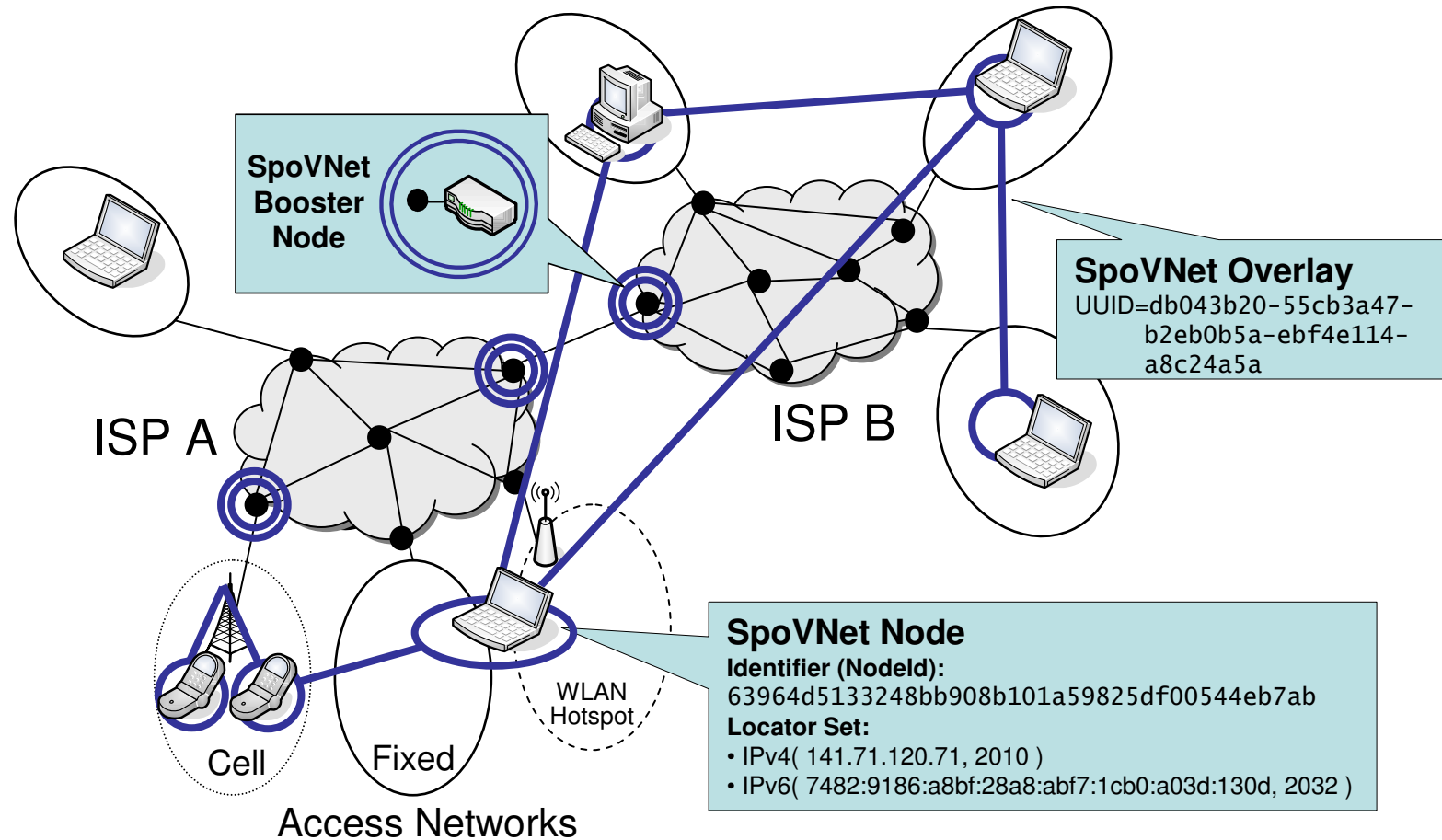


- Extensible set of services implemented by **overlays**
  - **Spontaneous** and **flexible** per application
  - No infrastructure support required
  - Self-organizing, scalable and robust
- Overlays designed to be **underlay-aware**
  - **Adaptive** due to cross-layer information, e.g.
    - Handover events, congestion status ...
  - Handling of **heterogeneous** networks

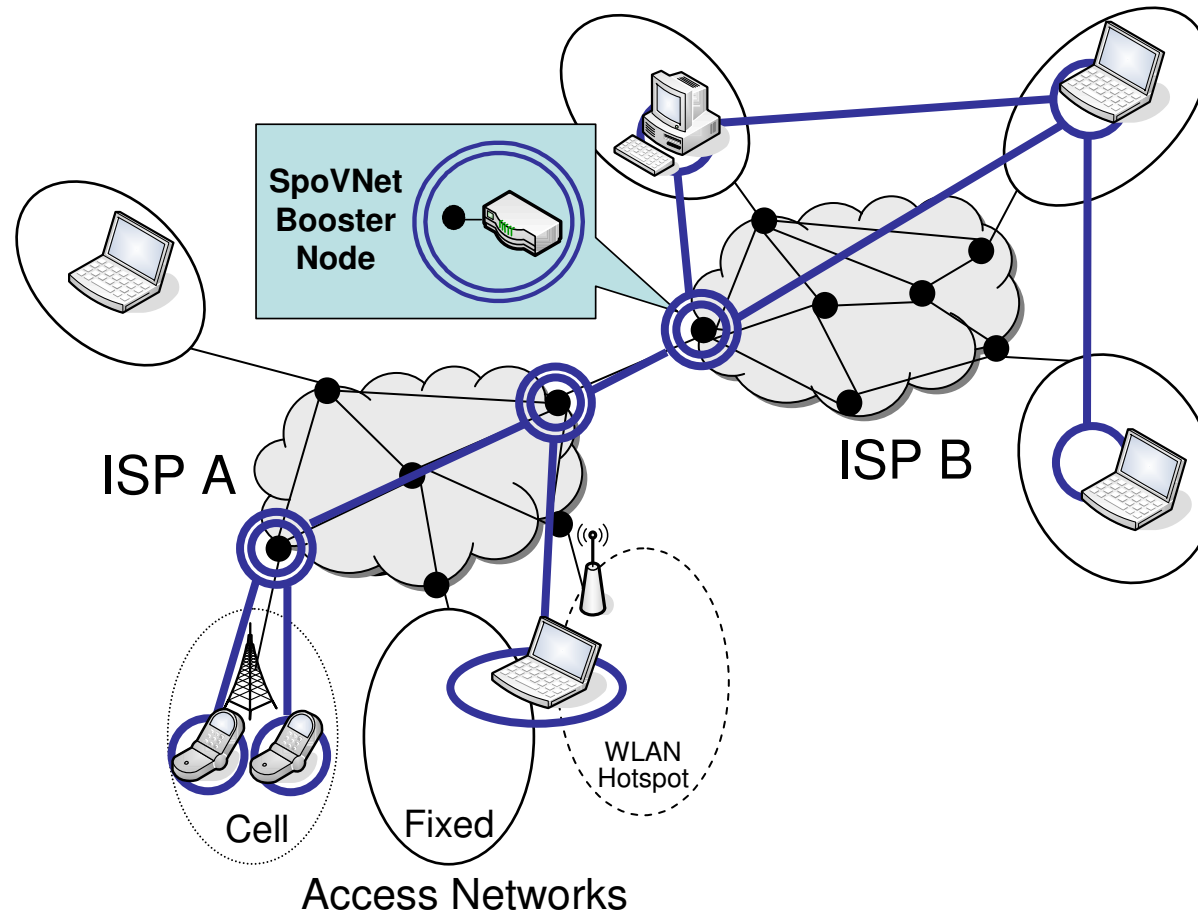
# SpoVNet Overlay



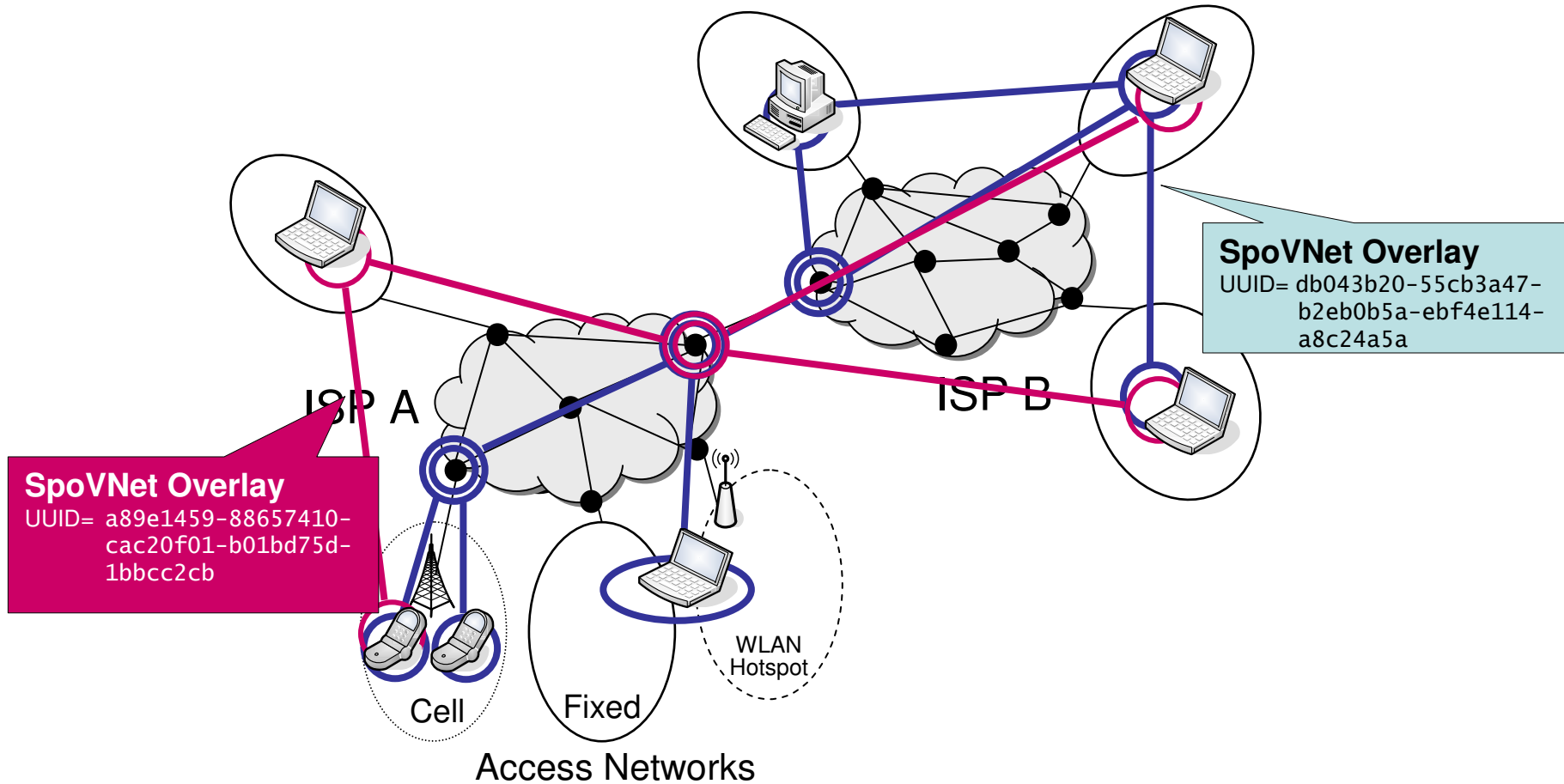
# SpoVNet Overlay with Booster Nodes



# SpoVNet Overlay with Booster Nodes



# Multiple SpoVNet Overlays



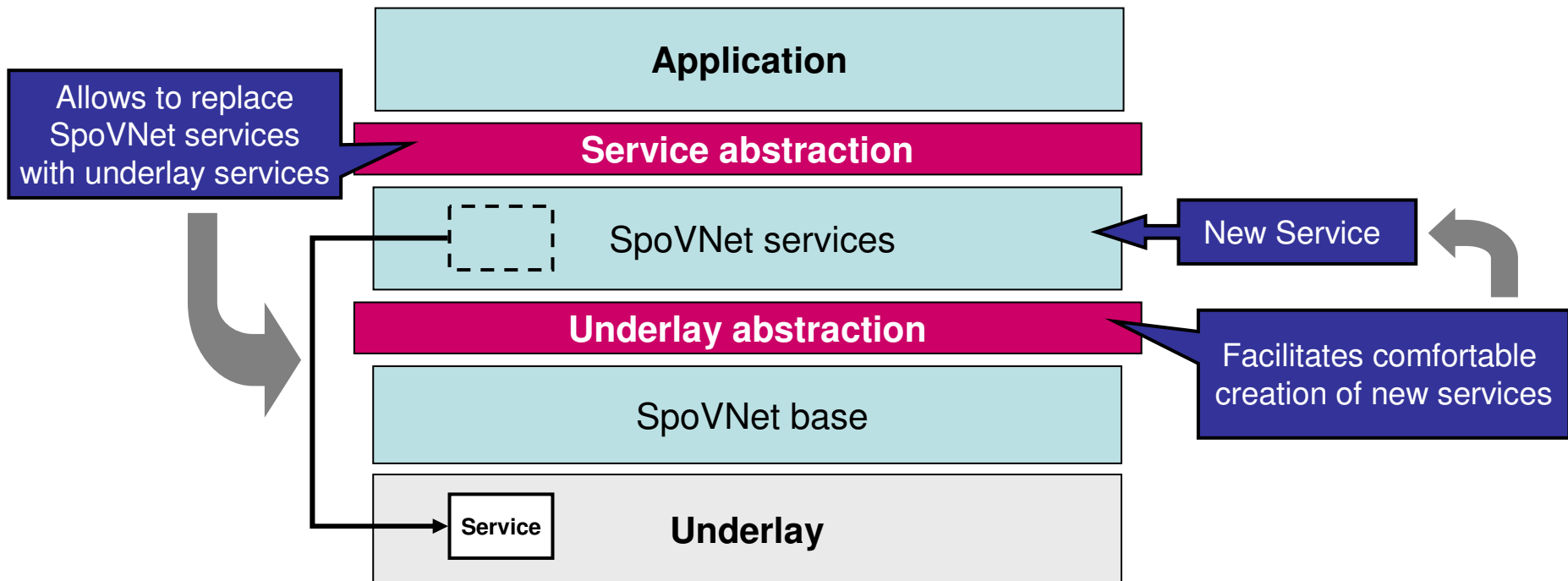
## Objective 2: Seamless Transition to Future Networks



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

## Two-tier abstraction architecture

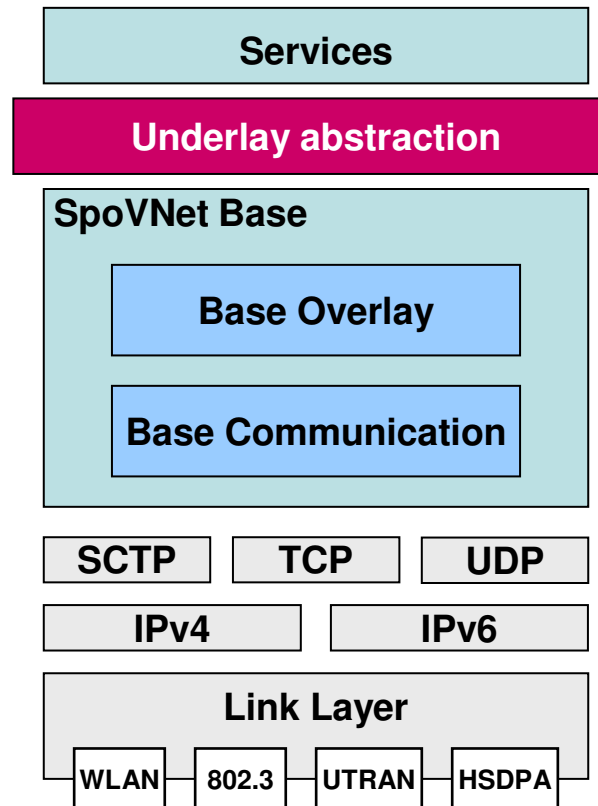
# Two-Tier Abstraction



# Underlay Abstraction



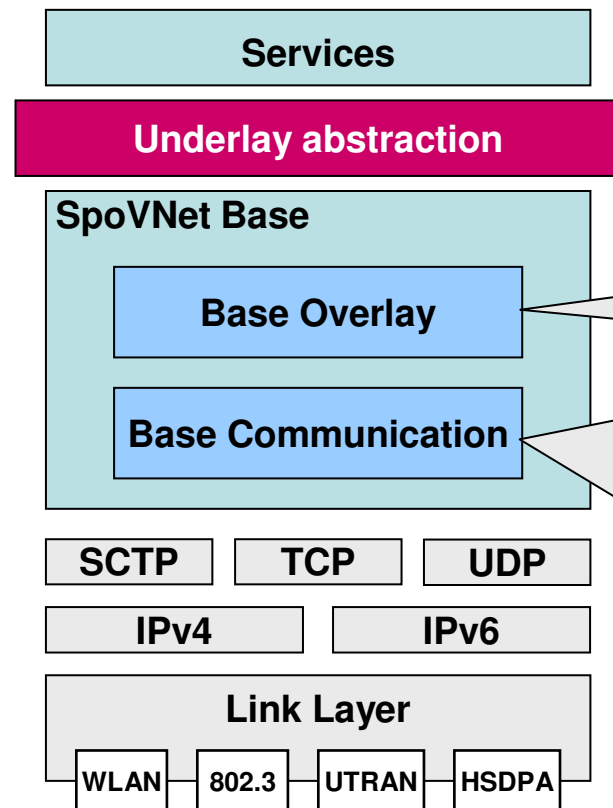
- Provides abstract transport connectivity hiding mobility, multi-homing and heterogeneity



# Underlay Abstraction



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



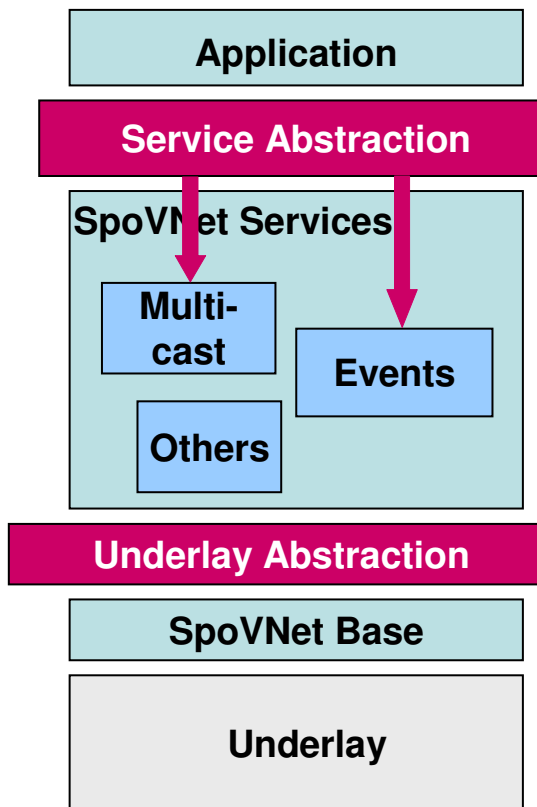
## Example:

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



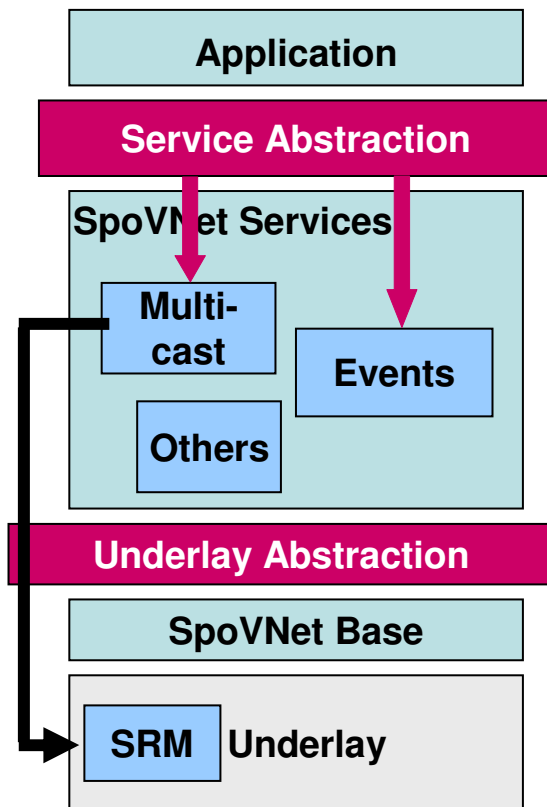
- SpoVNet services supply well-defined interfaces to the application



# 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

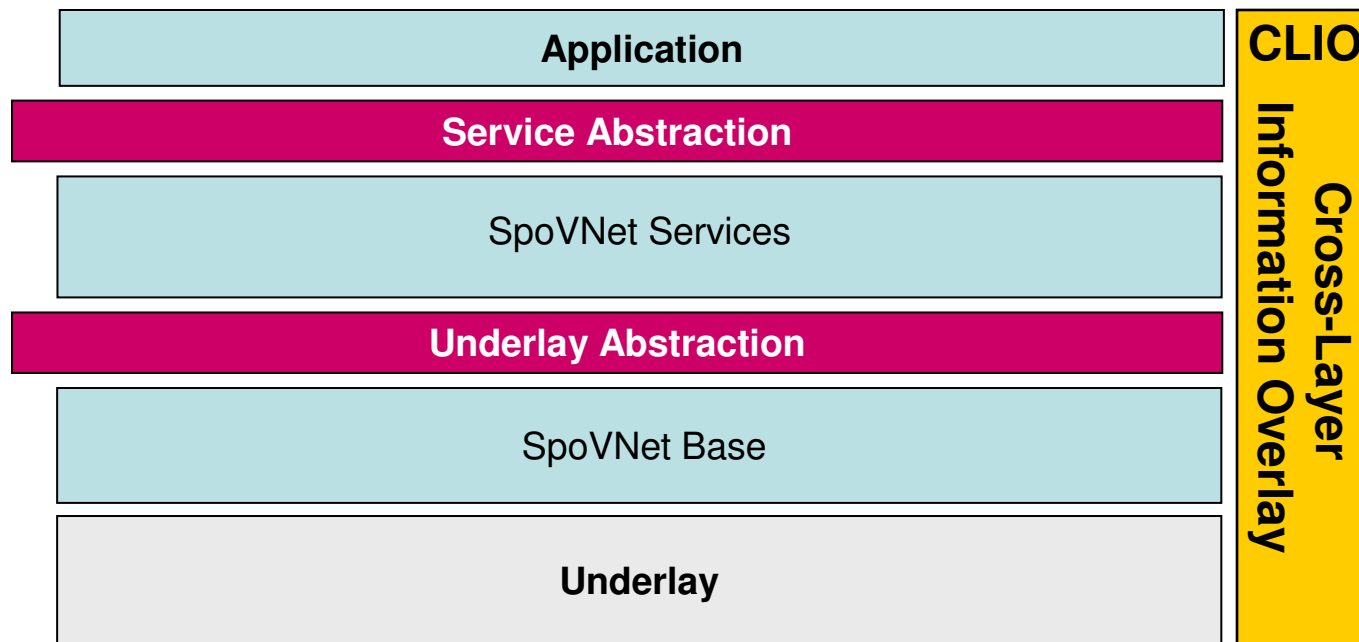
- the **multicast service** for data dissemination, e.g. `createGroup( MultiSource, QoSReq, SecReq )`

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 source-routed multicast to enhance SpoVNet multicast service

# Cross-Layer Abstraction



- The **Cross-Layer Information Overlay (CLIO)** provides abstract cross-layer information  
Services and applications can now **adapt autonomously** to changing network conditions

# ... also supported by SpoVNet



- Quality-of-Service
  - Meet constraints with help from CLIO or use underlay support
    - Overlay optimization based on cross-layer information
    - Monitoring of QoS parameter values
- Security
  - Base overlay provides basic security building blocks
  - Advanced security features provided by specific services
- Robustness
  - Achieved, e.g. by supported redundancy in the overlay graph

- Brief overview of the SpoVNet architecture
- Application of SpoVNet

# Virtual World Online Game

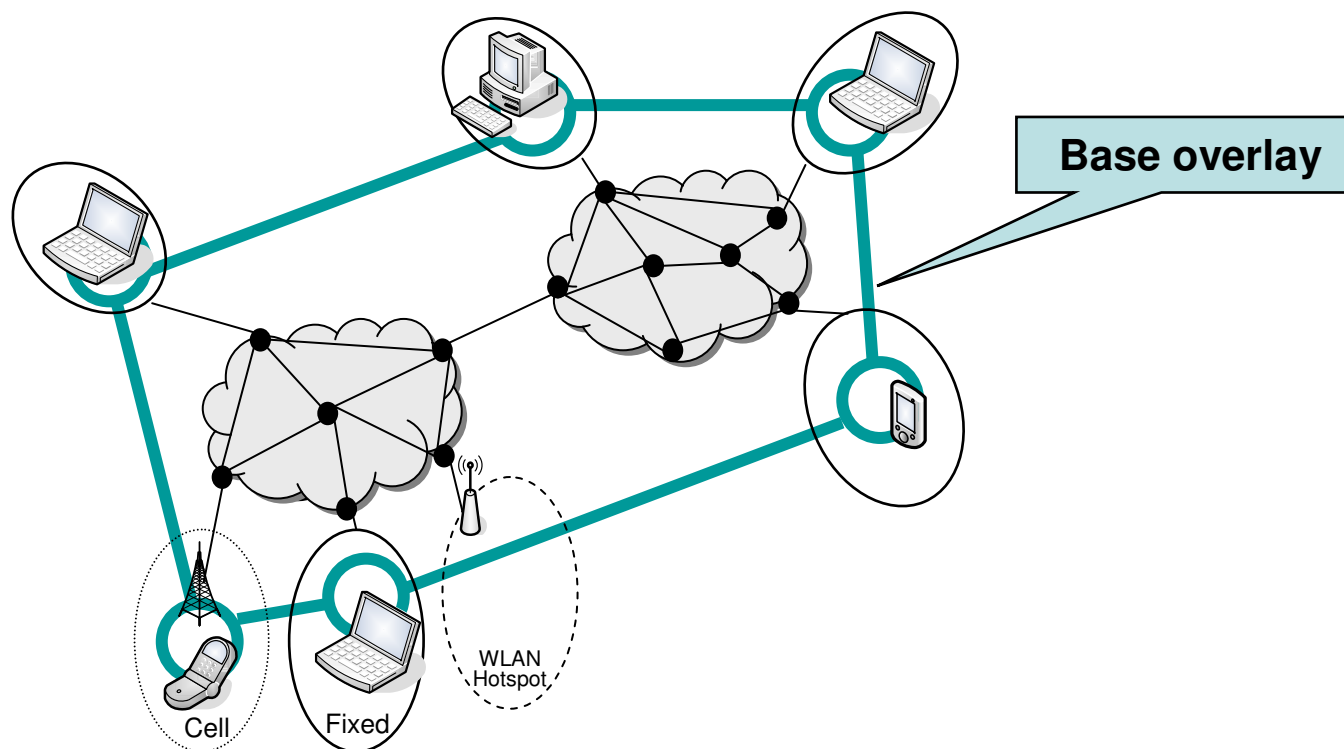


- During the game, players may
  - move between access networks
  - build sub-groups
  
- Some communication requirements
  - Basic connectivity between players
  - Dissemination of events to players nearby
  - Intra-game group chat communication

# Virtual World Online Game



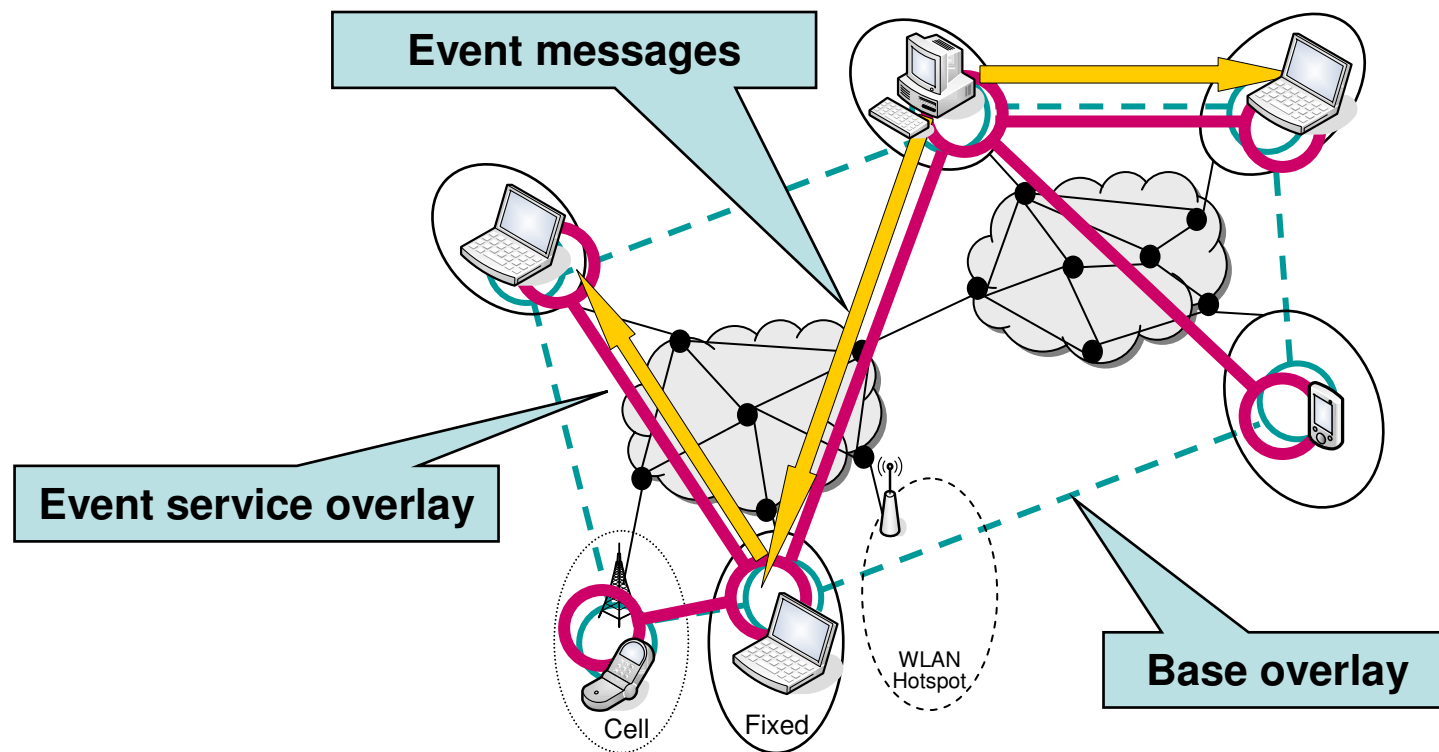
- Basic connectivity between all players
  - SpoVNet base overlay connects all nodes
  - Each player can join or leave this overlay



# Virtual World Online Game



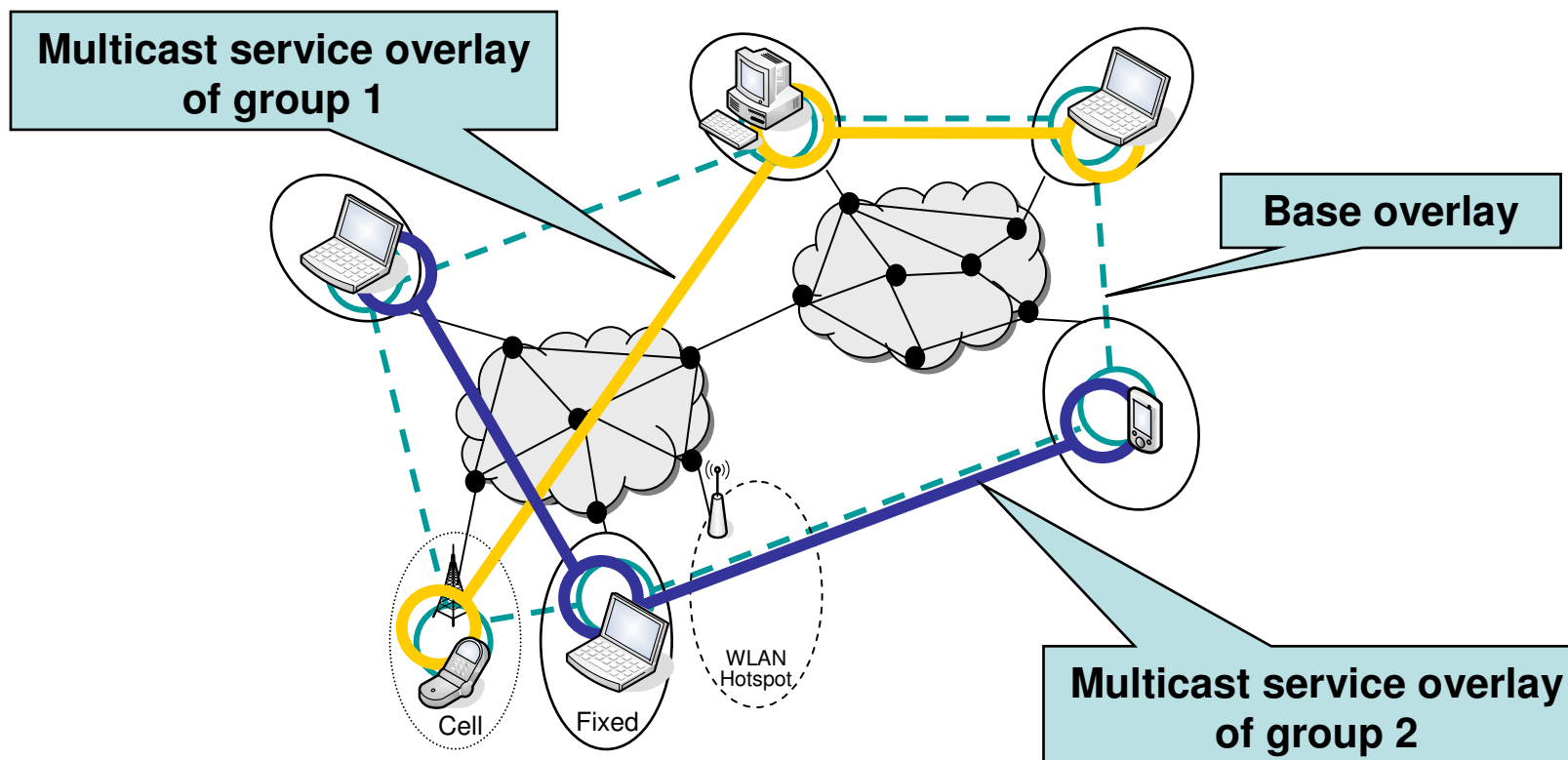
- Players must be informed about events inside the game
  - SpoVNet event service overlay to disseminate events



# Virtual World Online Game



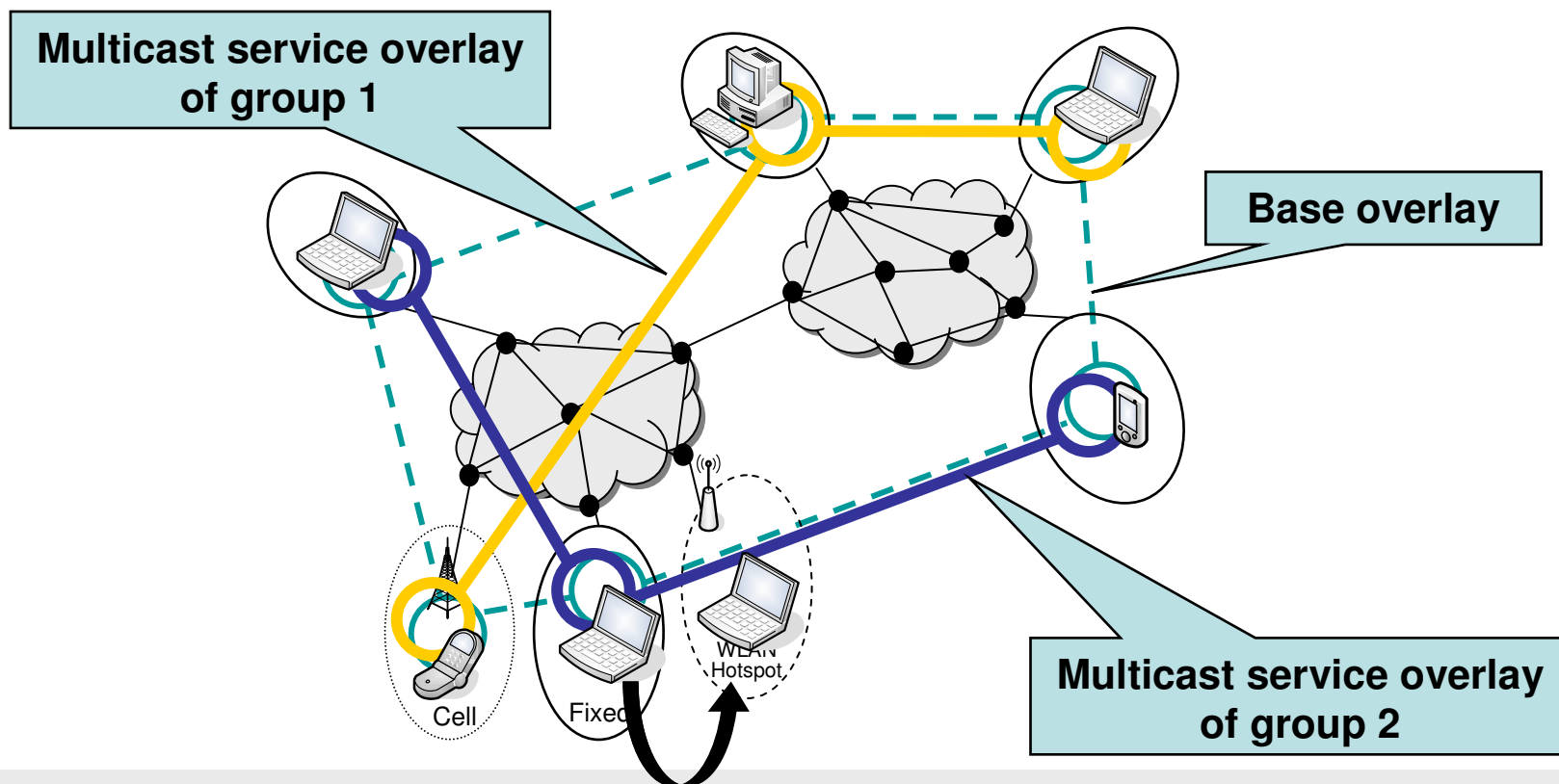
- Players want to chat with each other
  - SpoVNet multicast service is used to exchange chat messages



# Virtual World Online Game



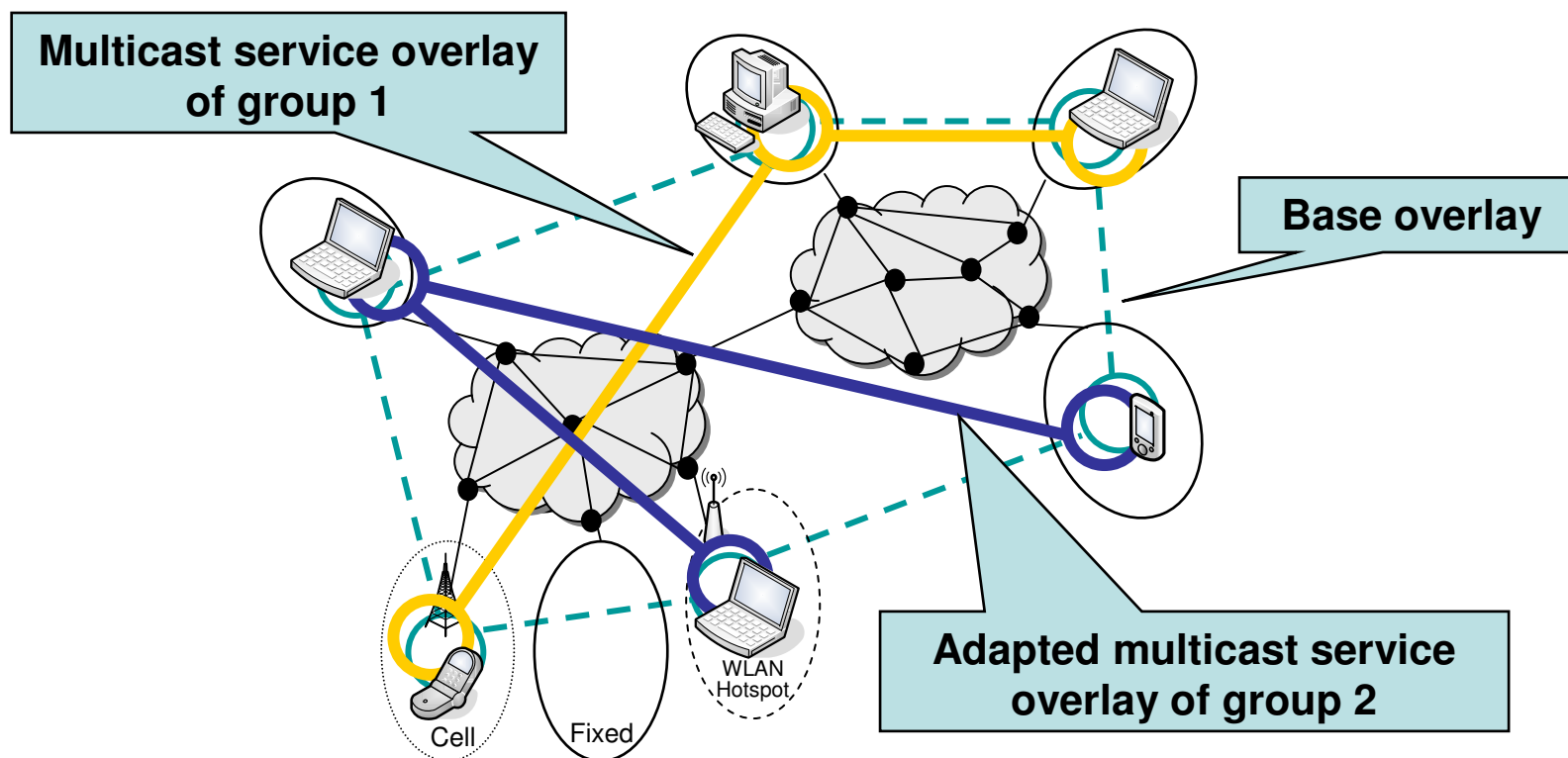
- Players may move between access networks
  - Service overlays need to adapt



# Virtual World Online Game



- Players may move between access networks
  - Service overlays need to adapt



# Summary



- The SpoVNet objectives are to
  - provide **adaptive, spontaneous** communication services over **heterogeneous** networks
  - enable **seamless transition** from current to future networks

SpoVNet fosters future services today and **runs out of the box**

- The SpoVNet project
  - supplies an architectural framework for flexible service provisioning by overlays
  - features fundamental research on enhanced services

# Thanks! Questions?



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