Future Internet

- Internet has evolved from 4-node network to ubiquitous, global communication network

- However: Patchwork design and deployment problems
  - “half” layers: IPsec, MPLS (2.5); TLS (3.5) …
  - TCP adaptations to wireless, mobile etc.
  - Multicast, MobileIP → Deployment?
  → But … is it flexible enough for the future?

- 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 Node Identifier (NodeId):
63964d5133248bb908b101a59825df00544eb7ab
Locator Set:
• IPv4 (141.71.120.71, 2010)
• IPv6 (7482:9186:a8b6:28a8:abf7:1cb0:a03d:130d, 2032)

SpoVNet Overlay UUID=
db043b20-55cb3a47-b2eb05a-ebf4e114-a8c24a5a

SpoVNet Overlay Link

SpoVNet Booster Node

Access Networks

ISPs

WLAN

Hotspot

Cell

Fixed

SpoVNet Overlay with Booster Nodes
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

Allows to replace SpoVNet services with underlay services

Application

Service abstraction

SpoVNet services

New Service

Underlay abstraction

SpoVNet base

Facilitates comfortable creation of new services

Underlay

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, for 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
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
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

Basic connectivity between all players
- SpoVNet base overlay connects all nodes
- Each player can join or leave this overlay
Players must be informed about events inside the game
- SpoVNet event service overlay to disseminate events

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

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
SpoVNet is funded by the Landesstiftung Baden-Württemberg within the Förderprogramm Informationstechnik Baden-Württemberg (BW-FIT)