Reconfigurable Wireless Link Layer Protocols

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Context:

- Results of the IST Project MOBIVAS (99-02)
- MOBIVAS focuses on the provision of Value-Added-Services
  - Downloading of applications to mobile terminals
  - Charging
  - Security
  - *Wireless link layer adaptation*

Motivation:

- Well-known limits of wireless

- Assure Communication Service for Internet over wireless links.
- Adapt to application, channel quality, and channel usage

- Use enhanced data link protocols.
- Apply the boosters paradigm!

What are Protocol Boosters?

Per definition („Protocol Boosters“ by Feldmeier et al.)

- „A protocol booster ... transparently improves protocol performance.“
- „The booster can reside anywhere ...“
- „It may add, delete or delay protocol messages, but never originates, terminates, or converts that protocol.“
- „protocol booster will not prevent end-to-end communication“

One best-known boosters is TCP Snoop.

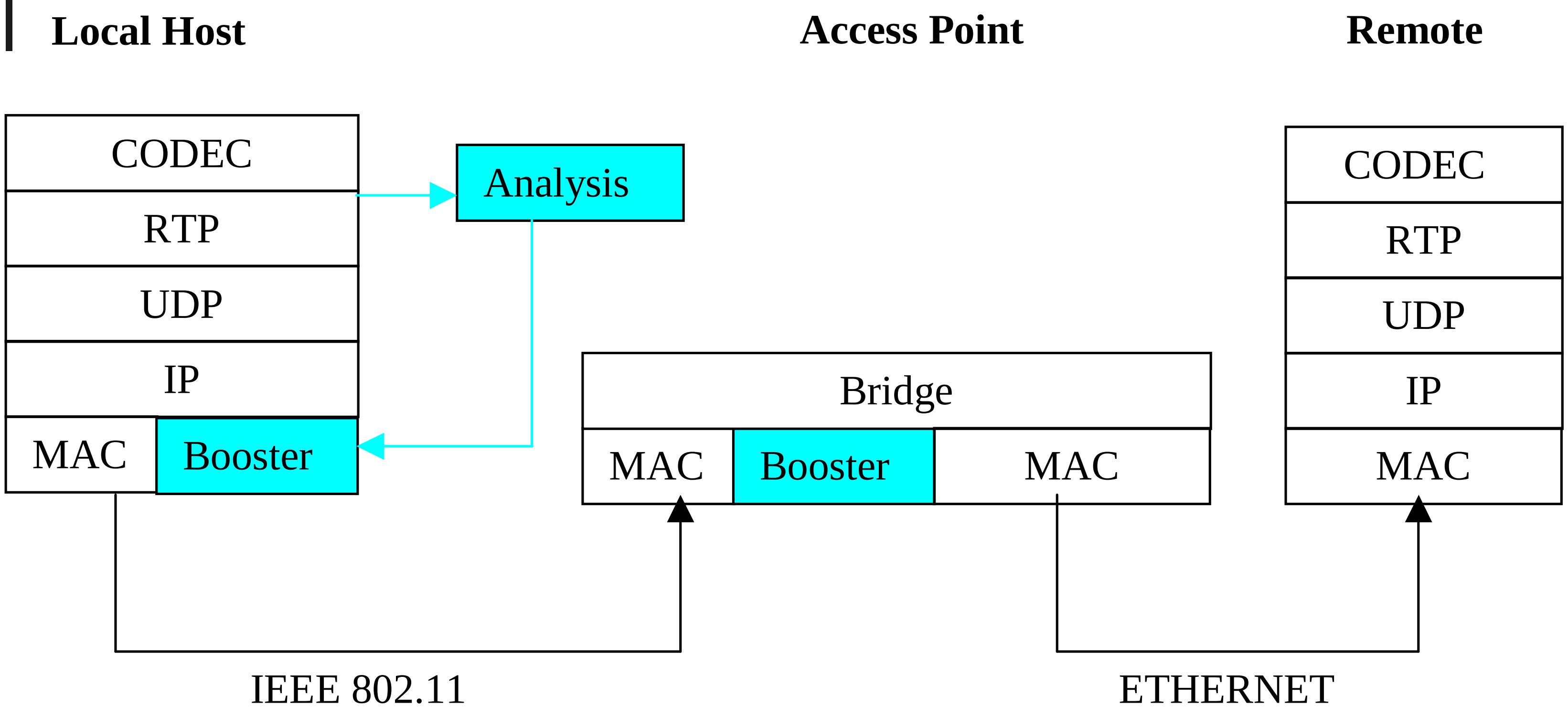
Content

- One Example: *SPB Booster*
- Current QoS mechanisms is not sufficient.
- An architecture to support data link boosters
- Mobile Adaptation System to deploy boosters
- Summary

Speech Property Based (SPB) Booster for VoIP on IEEE802.11b

- Improves the perceptual quality
- Use speech properties to
- adapts link layer protocol on a per packet basis
- Based on observation from Sanneck:
    - Segment losses at unvoiced/voice transitions are most important
    - Because frame based codecs (e.g. G.729) conceal of lost segment worse

SPB Booster: Architecture



SPB Booster: Design and Implementation

Design:

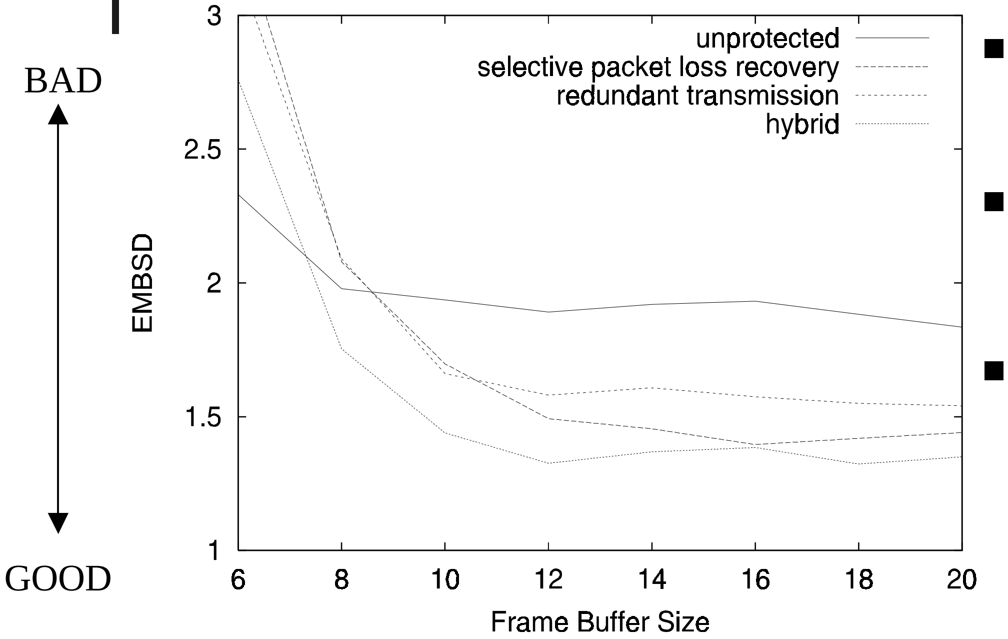
- Protecting of important Packets with three algorithms

1. Selective Packet Loss Recovery
2. Redundant Transmission
3. Hybrid mechanism

Measurements:

- Conducted experimental measurements
- Using commercial WLAN and a modified device driver.

SPB Booster: Results



Measurement Results : EMBSD / Buffer Size for all the analyzed cases

- Improvement of Voice Quality at high error rates
- A better losses distribution
- Improvement of the QoS at the link layers are possible!
- Simulations have confirmed the results

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QoS Metrics

- Do not at abstracted networkings parameters (e.g. throughput, delay, jitter)
- Use perceptual measurements
- Objective measurement tools simulated human perception
- Available for audio, speech and video

- Networking QoS ≠ Perceptual QoS

Common QoS is not enough

For better Internet performance we need

- QoS for each packet (like DiffServ)
- Fine grain QoS requirements (like IntServ)
- Dynamic define QoS requirements based on flow requirements and transmission history of previous packets

If over-provisioning in the backbone,
QoS support only for wireless link?

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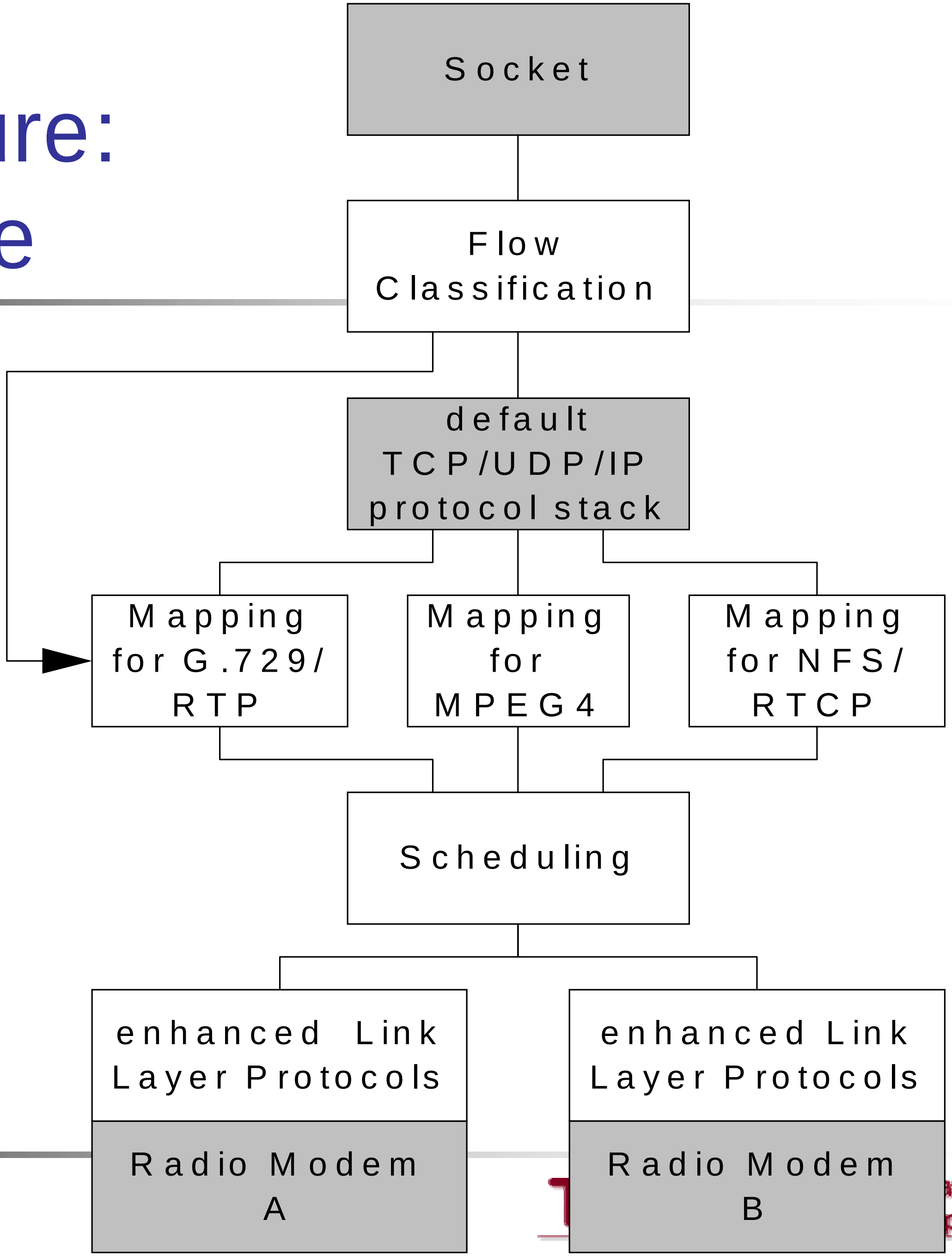
Architecture

- But how to support Data Link Boosters?

- 1. Need to identify flows:
  e.g. based on RTP, UDP, IP headers
- 2. Map requirements of flows to different link layer protocols
- 3. Schedule different applications
- 4. Enhanced Link Layers

Architecture: Big picture



Socket

Flow Classification

default TCP/UDP/IP protocol stack

Maping Flows to Link Layer Protocols, e.g. for

Mapping for G.729/ RTP

Mapping for MPEG4

Mapping for NFS/ RTCP

Scheduling

enhanced Link Layer Protocols

Radio Modem A

enhanced Link Layer Protocols

Radio Modem B

Related Work

- Reiner Ludwig (UC Berkeley, now Ericcson) proposed application specific link layer protocols.
- George C. Polyzos (UC San Diego) studies application specific link layer and proposes an similar architecture
- IST Project WINE proposes an Wireless Adaptation Layer (WAL)
- UMTS PDCP Protocol maps IP to UMTS link layer (only header compression is supported yet)

Consequences

- Boosters change offer:
  - New applications and codecs are installed.
  - Mobile terminals move to different providers.

- Providers introduce boosters to provide an better service than their competitors
- Booster need to be standardized?
- Boosters need to be deploy dynamically
- Networking nodes have to adapted -> Programmable networks and SDR approach

Mobile Adaptation System

Dynamically updates the link layer protocols on mobile terminals

1. Discovery of service in the access network
2. Adaptation agent is downloaded
3. The link-layer protocol is downloaded and exchange

4. (and backwards)

Service Discovery

- Boosters provide an communication service
- We use the IETF Service Location Protocol (SLP)
- Standard solution

- Mobile Terminal sends SLP requests
- Access Network returns the download URL of an adaptation agent

Adaptation agent

- The agent adapts the link layer protocols and downloads a new version if needed.
- To avoid mobile code „problems“ we use Java.
- The agent runs in a Java sandbox.

- The link layer can not is written in Java, because this would be too slow. Native Code!
- We use the Java Archive (JAR) to download signed link-layer-code.

Downloading Link Layer Protocol (1)

- Link Layer Protocols are implemented best in device drivers of radio modem.
- Device driver are place in the kernel.
- We use the kernel extension mechanism to install device driver in the kernel.
- Agent install the device driver in the kernel.

Downloading Link Layer (2)

- Link Layer has to be exchanged dynamically.
- Hot-plugging loads dynamically device drivers, if hardware devices are plug-in.
- During exchange we simulate the removal and inserting of the radio modem.
- Instead of the default device driver, the downloaded dd. is used.

Implementation

- Implementation for Linux
- Using Java 1.3, Linux Kernel Modules and PCMCIA manager.
- Implemented a booster for Prism2 chipset

- It works and the source code is available
- http://www-tkn.ee.tu-berlin.de/research/dp

Measurement Results

- Download of SPB Booster
- Data transfer is about 50kbytes
- Communication service is interrupted for 9s.

- The common mechanisms are not sufficient for on-the-fly exchanges.
- Better code compression techniques are needed.

Summary

- Enhancement of QoS with Data-Link Boosters are possible
- One example: SPB Booster
- However:
- Need dynamic installation of code which decreases QoS