UNIVERSITEIT GENT

FACULTEIT INGENIEURSWETENSCHAPPEN

Protocols for session continuity and Qos in a train environment

Protocols for onboard mobility management

Overview

- Partners involved and objectives
- Starting point: OSS
- Wireless extensions
- Handovers
- *Challenges*
- *Implementation details*
- *Simulations*
- *Hardware*
- *Paper*
- *Conclusions*

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Partners involved

Objectives

- **Our fundamental goal is**
  - to allow mobile users, in particular train passengers and train crew
  - to traverse seamlessly across different network technologies
  - while ensuring service continuity and a certain level of QoS

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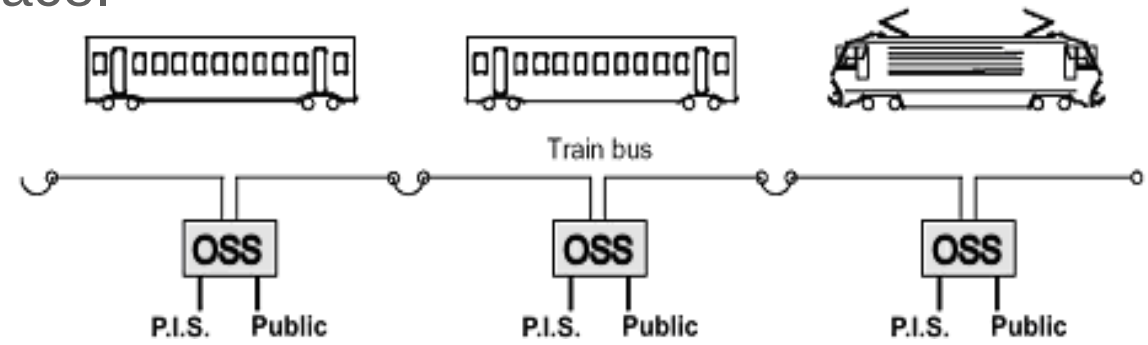
Starting point: Onboard Service Switch

- module recently developed and implemented by Televic and IBCN
- provides network connectivity between train vehicles
- vehicles communicate with each other using the Ethernet protocol
- has 4 external interfaces: two to interface to neighbor OSS, one public interface and one train specific interface.



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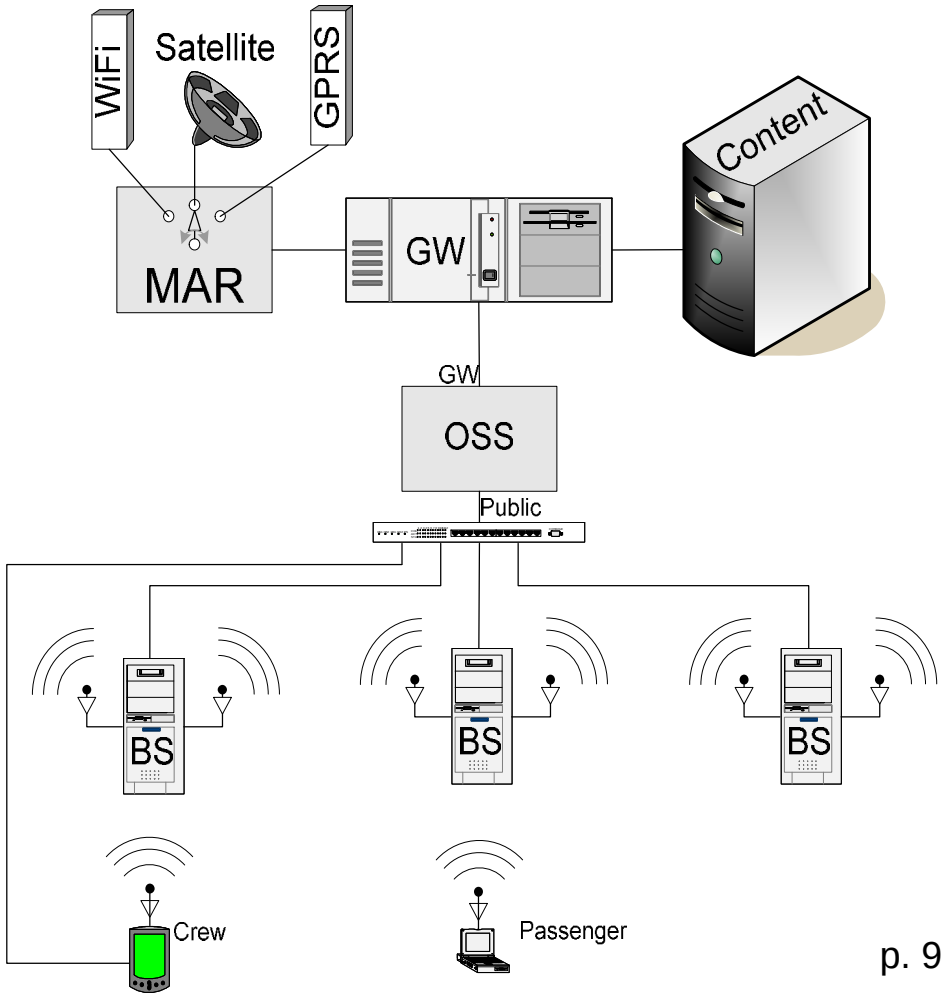
Wireless extensions

- Extra interface on the OSS for gateway
  - **Internet connection via a MAR**
  - **Onboard content server**
- AP-like devices on the public interface



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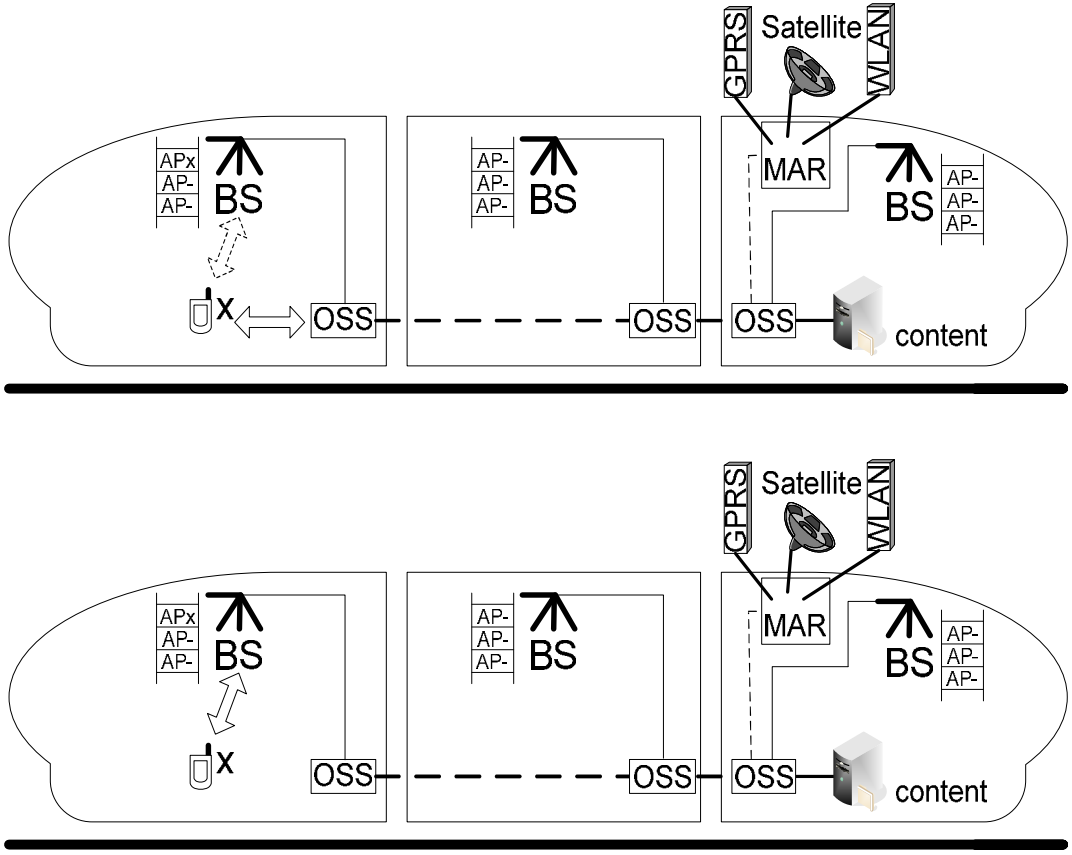
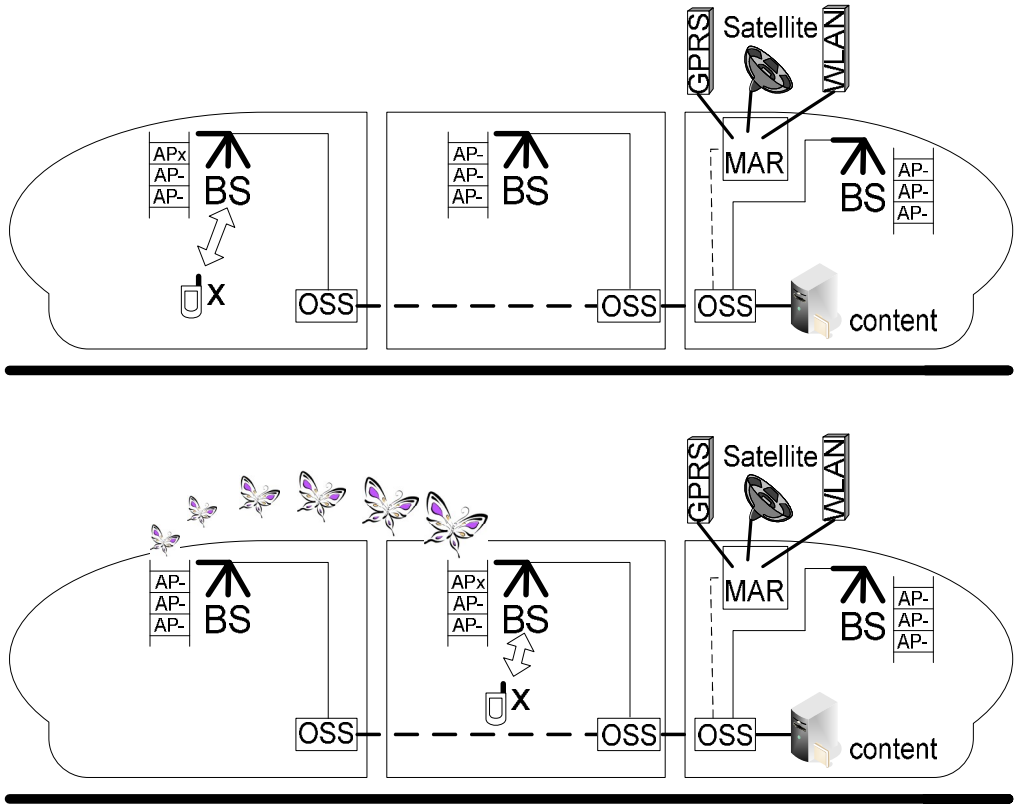
2 types of handovers

- Vertical handovers when a crew terminal switches between the wired and the wireless connection



2 types of handovers

- Horizontal handover when a user is moving inside the train



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Challenges

Challenges "User moves in the train"

- Vertical handover
  - **Session continuity over multiple interfaces**
  - **Always choose the best connection**
  - **Fast handover**

- Horizontal handover
  - **Standard 802_11 handover can take up to > 500mS**
  - **we need a vendor-independent solution which is 802.11 compatible.**

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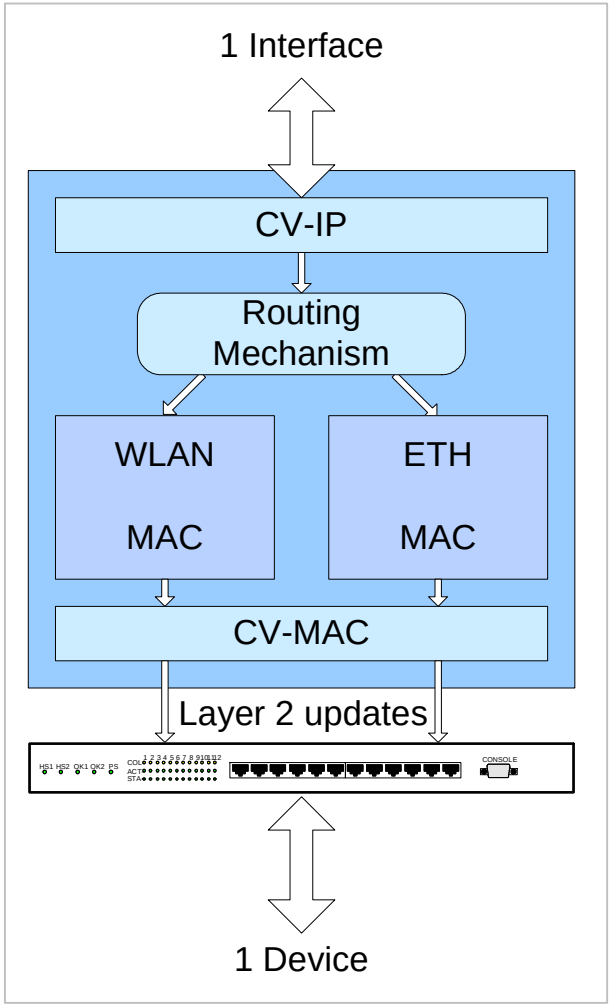
Details: vertical handover

Choices related to the vertical handover

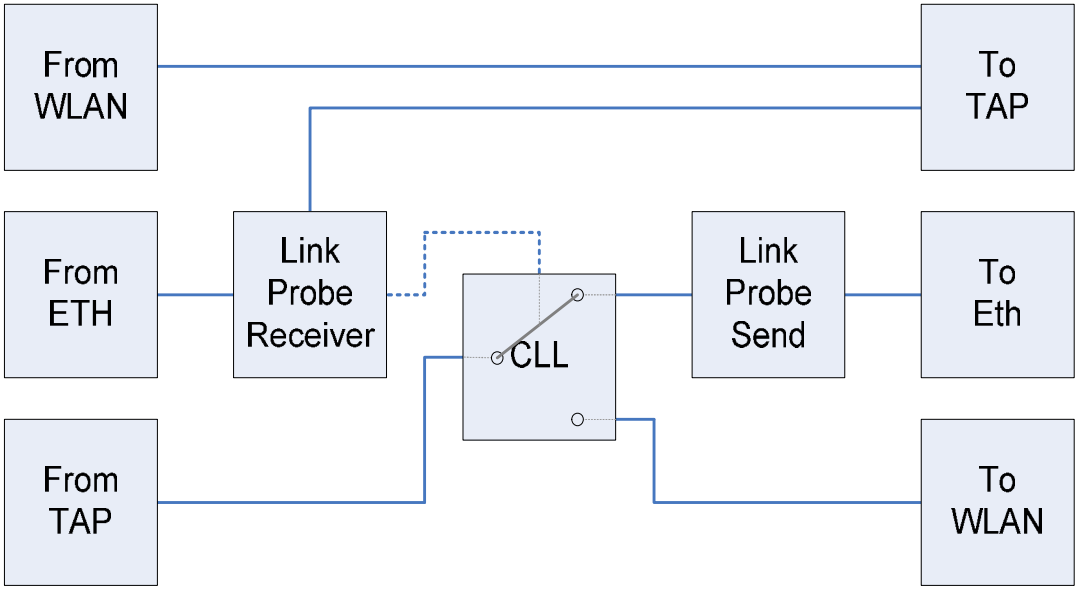
- Use the same MAC address on all the interfaces
- The wired connection is the preferred one.
- Two techniques are used to detect if the wired connection is available:
  - Link probes
  - Catch the cable interrupt

- Every time the active connection changes a route update is transmitted to the switch (802.2 Type 1 LLC Exchange ID Update Response)

Details: vertical handover



- **Implementation details related to the vertical handover**
  - we implemented a convergence layer
  - On top of the CL we install a virtual interface

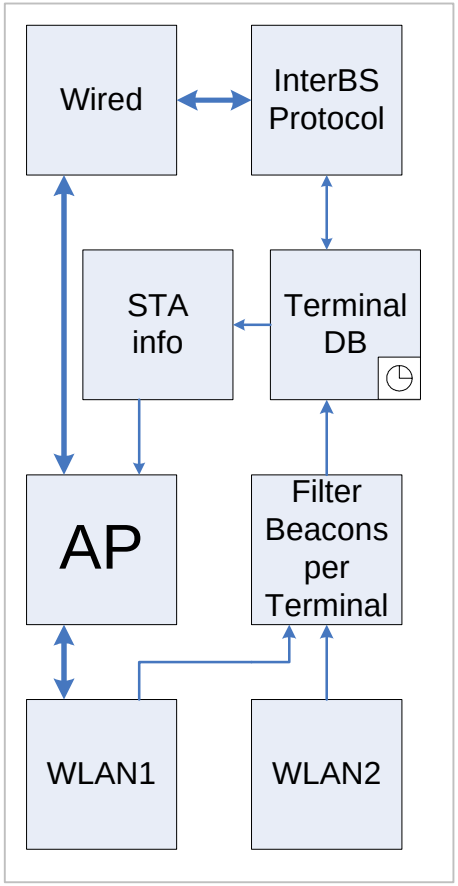


Details: horizontal handover

- **Visualization of the horizontal handover**
  - MAP.html

Details: horizontal handover

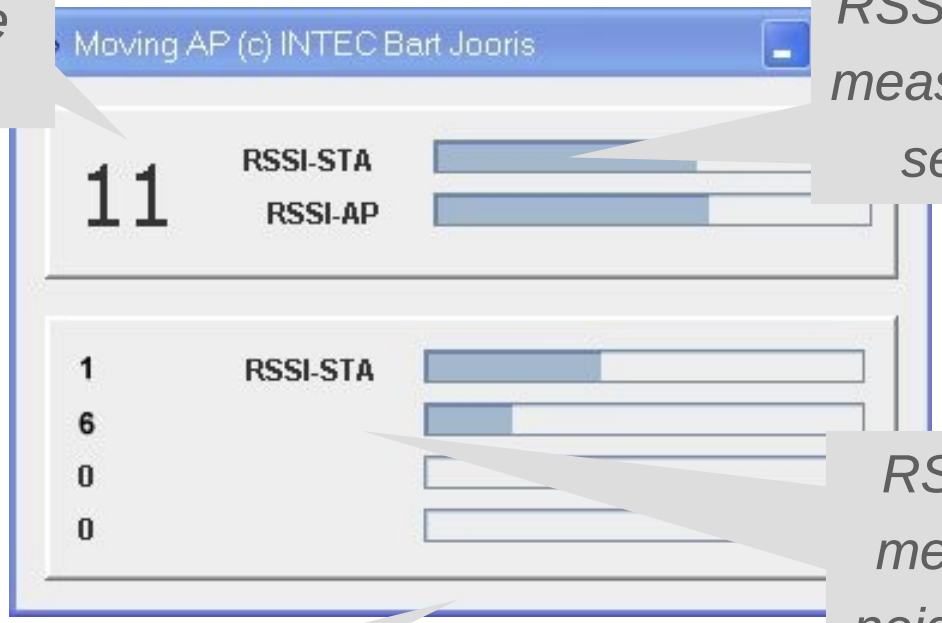
- **Implementation details related to the vertical handover**
  - BS = AP + extra functionality
    - **Extra WLAN NIC (passive)**
      - listens to neighbor channel
    - **Info per received Terminal**
      - the MAC address
      - a flag passive/active
      - Avg. RSSI
      - IP address
      - If active
        - » Avg. RSSI per neighbor
      - If passive
        - » IP address of the BS
    - **Inter BS protocol**
    - **Terminal info protocol**



Details: horizontal handover

n Vendor independent software package

Channel of the terminal



RSSI of terminal measured on the serving BS

RSSI of terminal measured on the neighbor BSs, with their channels

Sends beacons to the access network every X mS

Details: horizontal handover

- Mechanism
  - **This algorithm is scheduled several times per second**
    - For each record
      - If received on the passive interface **inter BS protocol**

        we send a message report to the BS where the terminal is connected to.

      - If received on the active interface **terminal info protocol**

        if a stronger average RSSI is seen on a neighbor BS. we will send a terminalHop message to the terminal

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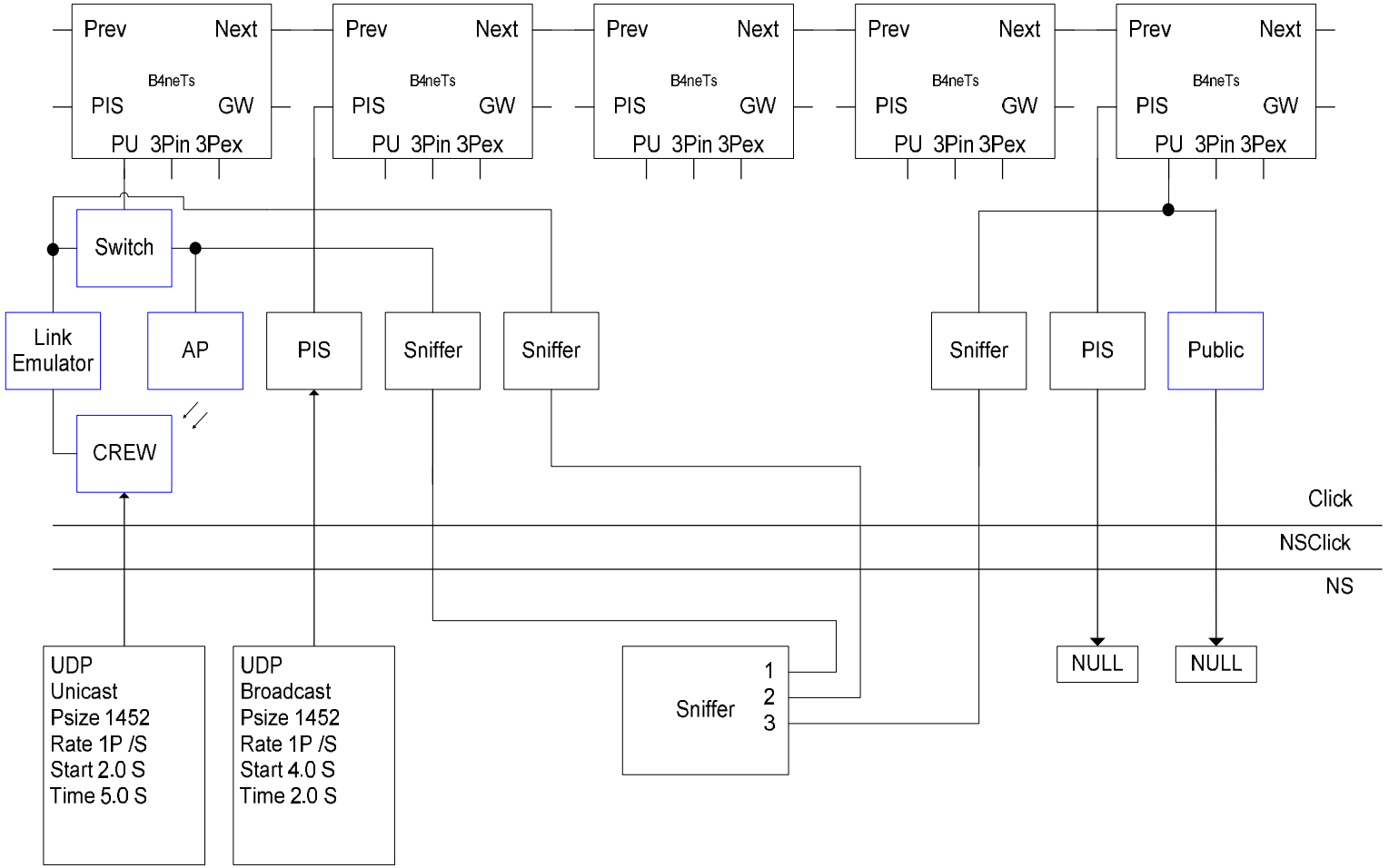
Simulation convergence layer:

- We patched nsclick to let it work with raw 802.11 packets
- The ns script describes the topology and the traffic agents
- Every node represents a click router
- Traffic can be visualized with xplot and analyzed with ethereal

n Simulation convergence layer: topology



n Simulation convergence layer: time script

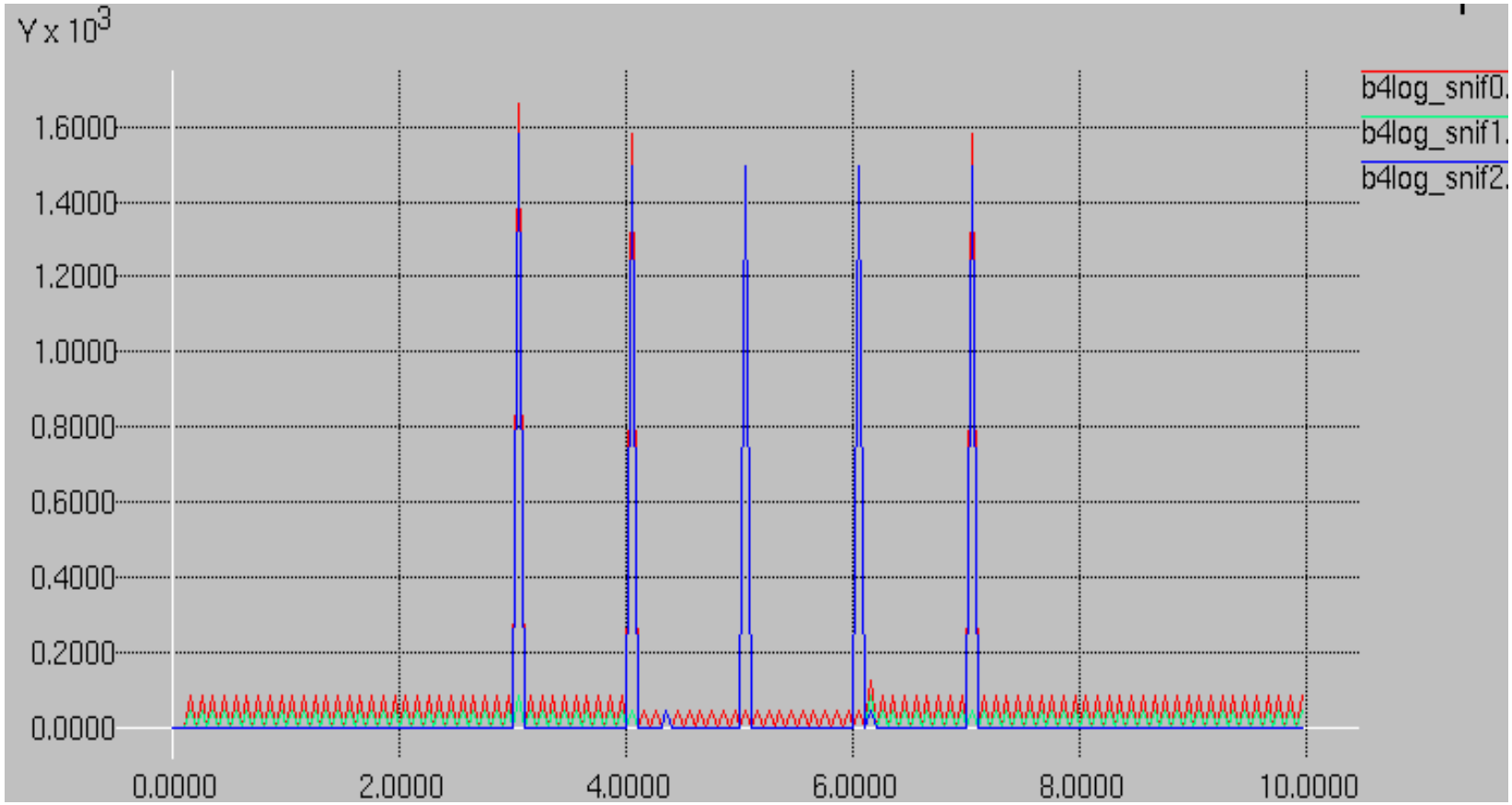
```
$ns_ at 0.0 "record"

$ns_ at 0.0 "LinkEmulatorUp"
$ns_ at 1.5 "puts \"try to auth\""
$ns_ at 1.5 "Station_Auth"
$ns_ at 1.6 "Station_Assoc"
$ns_ at 1.7 "Station_Auth_Check"

$ns_ at 3.0 "[lindex $Cbr 1] start"

$ns_ at 4.1 "LinkEmulatorDown"
$ns_ at 6.1 "LinkEmulatorDown"

$ns_ at $opt(stopTime).000000001 "finish"
```

Simulation convergence layer:

- screenshot ethereal (auth & assoc)

Time	Source	Destination	Protocol	Info
0.999860	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]
1.099760	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]
1.199780	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]
1.299720	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]
1.399940	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]
1.399940	00:44:55:56:65:01	00:44:55:56:40:01	IEEE 80	Authentication
1.401280	00:44:55:56:40:01	00:44:55:56:65:01	IEEE 80	Authentication[Short Frame]
1.499900	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]
1.499900	00:44:55:56:65:01	00:44:55:56:40:01	IEEE 80	Association Request, SSID: "EW"
1.500842	00:44:55:56:40:01	00:44:55:56:65:01	IEEE 80	Association Response[Short Frame]
1.599640	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]
1.699760	00:44:55:56:40:01	Broadcast	IEEE 80	Beacon frame, SSID: "EW"[Short Frame]

n Simulation convergence layer: xplot



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Hardware

Easy Wireless Eureka 2007 exhibition EP, Brussels

Hardware

- **WRAP board (http://www.pcengines.ch)**

Hardware

WRAP cost november 2006:

Board 2 NIC and 2 mini-PCI	82.00 €	
Case	6.40 €	
CF 128Mb	4.70 €	
Wireless card CM9	23.50 €	x2
Pigtail	1.50 €	x2
Antenna	1.90 €	x2
AC-Adapter 18V	4.00 €	
Total	**150.90 €**	
+VAT 21%	182.60 €	

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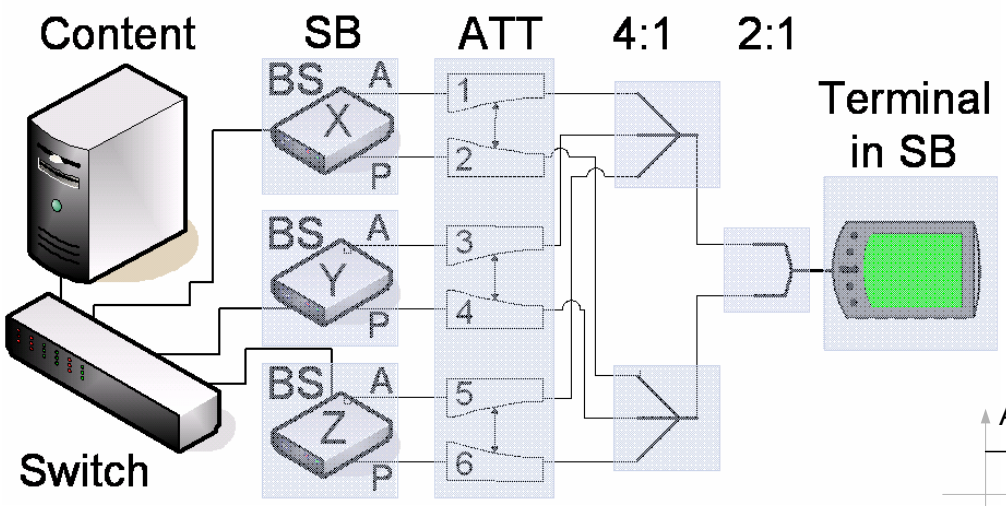
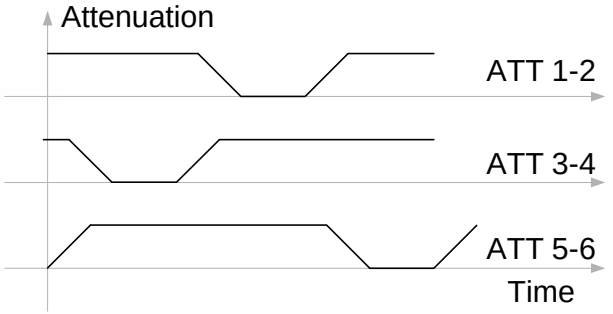
Demonstrator

Accepted paper (ID 510) IST mobile summit 2007



Sending 20Mb/s UDP
with iPerf tool
from server to terminal



- Simulate motion
- handoff every 15 seconds
- average of 15 lost packets per handoff
- lost packets ranged from 10 to 50 packets
- 30 of the 37 handoffs → less 14 lost packets
- Results in < 10ms disconnection time

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Conclusions

- We created solutions for both handovers which are compatible with the standards 802.3 and 802.11
- The hardware used for our proof of concept demonstrator is close to prototype hardware
- Both handoff implementations are fast
  - **< 50 ms**

References

- [1] E. Kohler, “The click modular router,” Ph.D. dissertation, Massachusetts Institute of Technology, Feb 2001. [Online]. Available: http://pdos.csail.mit.edu/papers/click:kohler-phd/thesis.pdf
- [2] TGr Task group 802.11r : IEEE, Inc. [Online]. Available: http://grouper.ieee.org/groups/802/11/Reports/tgr_update.htm
- [3] Wireless Router Application Platform (ALIX). [Online]. Available: http://www.pcengines.ch/alix.htm
- [4] Madwifi driver. [Online]. Available: http://www.madwifi.org
- [5] ns2-click. [Online]. Available: http://systems.cs.colorado.edu/Networking/nsclick/
- [6] Qosmotec. [Online]. Available: http://www.qosmotec.com/international.shtml
- [7] Smartbits SMB-2000. [Online]. Available: http://www.spirentcom.com/