Internet on the train

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I. Introduction

An Internet connection on the train offers a lot of perspectives for the passengers [1]. Within the train they can now enjoy leisure activities like infotainment, on line gaming, web surfing, Video on Demand etc. Business travelers have a virtual office during their journey with applications such as e-mail and video conferencing.

But apart from gaining additional revenues due to both Internet access billing and increased ticket sales, an Internet connection comes with other additional advantages for train operators. Those include extra services towards the passengers such as travel and touristic information but also enhanced internal applications: fleet management, crew communication, CCTV, tele-diagnosis etc.

Although several trials and early commercial releases already deliver wireless Internet to passengers in fast moving vehicles, many issues remain unresolved:

- *Broadband Internet*: current solutions only provide a limited bandwidth to be shared by a many users
- *Continuity*: Uninterrupted Internet connectivity will only be possible through seamless handover between heterogeneous wireless access technologies
- *Quality of Service*: current solutions do not offer any QoS in terms of bandwidth and latency, and certainly do not take into account the specific QoS requirements of different applications

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II. Objective

This PhD targets the above mentioned issues and focuses on broadband wireless access solutions for train commuters. We will design a network architecture consisting of heterogeneous wireless access technologies and develop network solutions that support uninterrupted Internet connectivity and fast intra and inter system handovers in order to provide Internet services to the train with the necessary Quality of Service.

III. Results

In [2] we measured vertical handovers between available mobile networks of incumbent operators, indicating the need for an efficient mobility protocol. We developed an IP network architecture with QoS support in a transparent way: passengers on the train should not be aware of the handovers and should enjoy an uninterrupted seamless multimedia network experience.

Those activities led to the design of a Mobility Management Module, to be installed in all trains as well as in a central Network Operations Center of the train operator (see Figure 1). This Mobility Management Module covers both the *continuity* support and the *Quality of Service* (QoS) support for various applications for passengers and crew. Furthermore, those components are orchestrated by a Policy Decision Function (PDF) which notifies them of an imminent handover, based on link conditions, location information etc (see Figure 2).

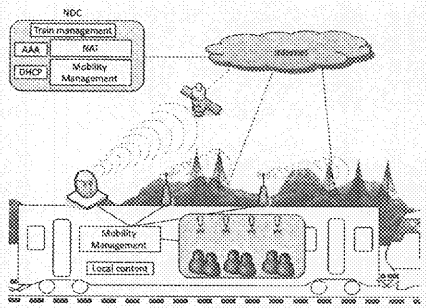

Figure 1. Global architecture

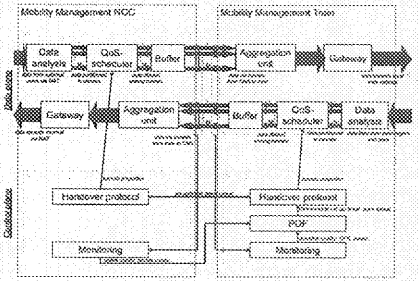

Figure 2. Mobility management architecture

As for the Mobility Management Module, we implemented with the Click Modular Router (a C++ networking library) [3] a mobility protocol founded on the Mobile Multi-Path Stream Control Transmission Protocol (MMP-SCTP) [4], [5], [6], [7]. We successfully investigated and demonstrated the possibility for using (MMP)-SCTP as the mobility and tunneling protocol between a train and a Network Operations Center (NOC) on the main land. The NOC serves as gateway, firewall and NAT (when using IPv4) for the trains toward the Internet.

We compared this protocol with Mobile IP (MIP) and obtained a better throughput in a WLAN for small packets sizes (e.g. VoIP packets) because of the packet bundling feature of SCTP. It furthermore has built-in packet delivery reliability due to the automatic retransmissions, which is beneficial when handovers are abrupt. It could also allow using multiple links at the same time and thus obtaining better *bandwidths*.

IV. Conclusions and Future Work

We have presented the building blocks of an IP train mobility network architecture and showed the possibility of using (MMP-)SCTP as the mobility and tunneling protocol between the train and the NOC of the train operator.

We will further examine the influence of packet aggregation on throughput in other (shared) media besides WLAN and we will continue to elaborate QoS mechanisms for the train.

Acknowledgment

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