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TCP/IP over Air

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Introduction:

In a joint project with Siemens AG ICM, we are investigating how in the future a match between the air interface and Quality of Service (QoS) requirements of different types of applications can be achieved, to improve the performance of cellular systems. Specifically, we are interested in the possibility of adapting MAC and link-layer protocols to the variability of a wireless channel and exploiting channel state predictions to influence packet scheduling behaviour. Adaptive mechanisms are used, which adapt sending parameters to the channel characteristics, taking into account the QoS requirements of the applications - channel-aware mechanisms. These include adaptive modulation and power at the physical level, adaptive packet length, ARQ and FEC at the MAC level, and

scheduling at the link layer level.

As proper decisions largely depend on the application's requirements, we are also looking at means to characterise such application requirements and also consider the problem of a flexible implementation context.

This page will be actualised as needed, following the developments in the work.

Research Topics References

Research Topics:

- Characterisation of traffic loads relevant to future communication networks
- Influence of channel prediction accuracy in the performance of the channel-aware link layer mechanisms
- Channel- and QoS-aware link layer scheduler
- A MAC protocol which can implement the adaptive mechanisms of the link layer

Characterisation of traffic loads relevant to future communication networks

A survey of existing load models for different application types has been made. The effects of the error-prone wireless medium was taken into account. Load models for the following applications are discussed:

- Internet Voice Telephony
- Video
- TCP (bursty and interactive)
- WWW
- File Systems (NFS and SMB)
- Network Games (multiple client)

Especially for network games, traffic characterisation and influences of the wireless medium on the quality of the game environment were investigated within the scope of a student project.
It is also necessary to know how the different flows can be identified and classified, and the QoS parameters can be communicated to the entity which needs them. This is under investigation.

Influence of channel prediction accuracy in the performance of the channel-aware link layer mechanisms

Channel-aware mechanisms need an estimate of future channel state as an input. This input can be the result of an estimation of the channel state based on a heuristic (e.g. one-step prediction), or the output of a prediction algorithm. The prediction, not being 100% accurate, influences the performance of the channel-aware mechanisms.
A framework for the evaluation of this influence has been developed: it is based on a bit-level digital channel model (a 0 stands for a correctly transmitted bit and a 1 for a transmission error); prediction inaccuracy is modelled as the probability that a predicted bit is the same as the corresponding channel bit.
Results obtained thus far show that the performance of a channel-aware scheduler with a single degree of freedom (the transmission time) is strongly reduced, both in terms of throughput and of energy efficiency, when the channel estimates are inaccurate.
A new framework based on an analog channel model is under development so that experiments with adaptive modulation and transmission power can also be made.

Channel- and QoS-aware link layer scheduler

A channel-aware scheduler is one which adapts the transmission time of a packet to the predicted channel conditions. A QoS-aware scheduler tries to meet certain application dependent QoS requirements. The channel- and QoS-aware scheduler under study in this project is one which adapts transmission parameters to the predicted channel conditions to try to meet the QoS requirements of different flows. The scheduler is under development. Further information will be given when results are available.

A scheduler-friendly MAC protocol

The scheduler decides at which time which packet from which flow and user will be sent. The medium access has then to be controlled in such a way that it is possible to implement the scheduling done by the channel- and QoS-aware scheduler. The medium access has to be able to implement the decision taken by the scheduler. The details of how this can be done depend highly on the system under consideration. For example, if uplink and downlink do not have to contend for the medium, the implementation of the downlink scheduling is straightforward. However, the decisions for the uplink still have to be communicated to the terminals, and the terminals probably have to contend for medium access. This is a question which still needs to be further explored.

References:

This is under development.

- A. Aguiar, H. Karl, H. Miesmer, and A. Wolisz, "A Framework for Evaluating Effects of Channel Prediction Inaccuracy on the Performance of Channel Adaptive Techniques", In *Proc. of Intl. Conf. on Wireless Networks (ICWN)*, Las Vegas, Nevada, USA, June 2003. (PDF)
- A. Aguiar, H. Karl, and A. Wolisz, "Effects of Prediction Inaccuracy on the Performance of Channel-State-Aware Link Layer Schedulers", In *Proc. of 1st Intl. Conf. on Mobile and Ubiquitous Multimedia*, pp. 21-33, Oulu, Finnland, December 2002.

(PDF)

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