The Wireless IP project

Adaptive transmission

Fast link adaptation and scheduling

Our system must support mobile users, i.e channels might fade over time.

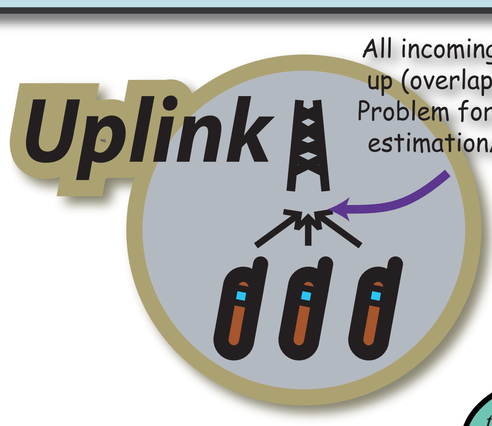
We schedule users and let them use different modulation formats depending on their respective channel quality.

Users may use any of eight different modulation formats depending on channel quality.

Scheduling takes time, so we need to predict the fading channels and report the predicted channel qualities to the scheduler at the base station.

The fading channels are modelled by a state space model that takes both correlation in time and in frequency into account.

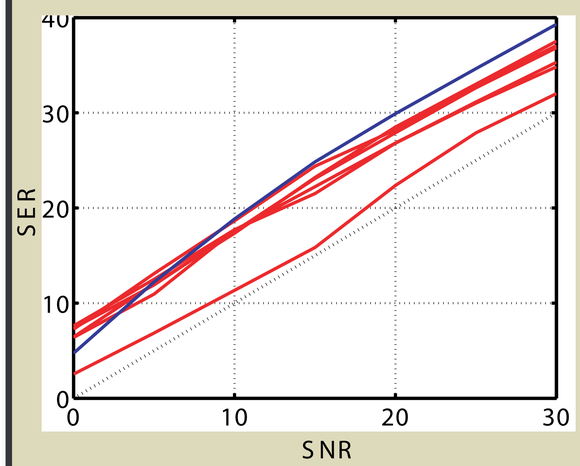
Results : Fast link adaptation and time-frequency scheduling works in downlinks up to 100 km/h at 2 GHz.
Adaptive transmission almost doubles the cell throughput.



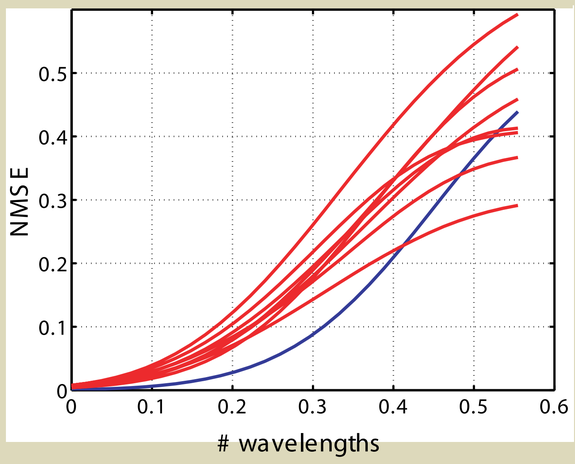
Use a TDMA link...

...or use the same OFDM system as in the DL?

Uplink channel estimation and prediction



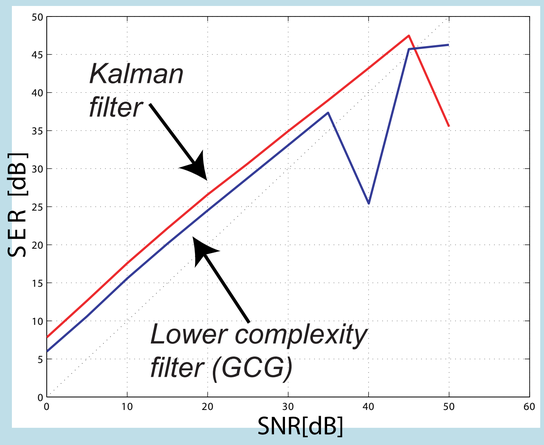
The Signal-to-Estimation error Ratio versus SNR for one user (blue) and six users (red). The target is to stay well over the noise level (dashed). Four parallel subcarriers were used.



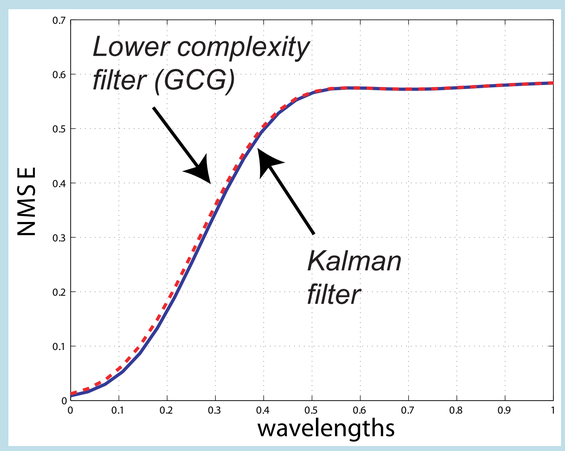
The Normalised Mean Square Error of the channel power versus prediction horizon for one user(blue) and eight users(red). The target 0.1 at 0.2 wavelengths is fullfilled by 6 out of 8 users.

...but his scheme imposes an extreme computational load on the system.

Downlink channel estimation and prediction



Channel signal to error ratio (SER) versus SNR for channel tap data based on real measurements. Four parallel subcarriers were tracked at a time. The performance stays well over the target SER=SNR.

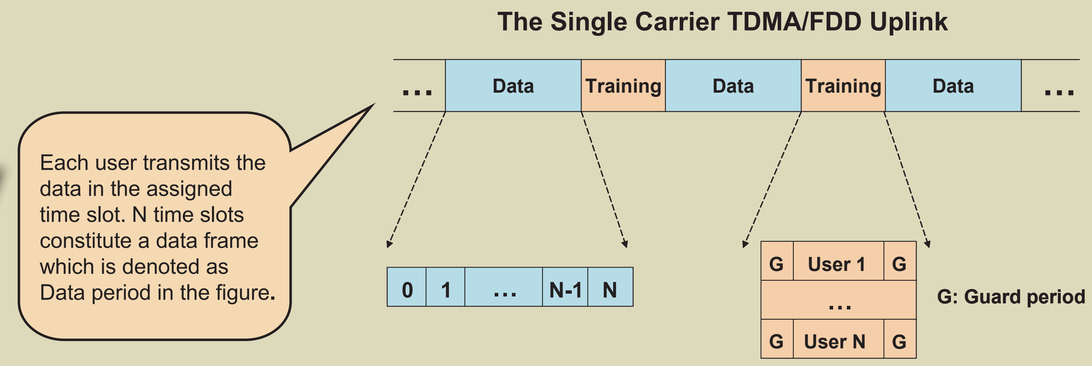


Example of normalized Mean Square Error (NMSE) versus prediction horizon for channel tap data based on real measurements.

TDMA/FDD based single carrier system for the uplink

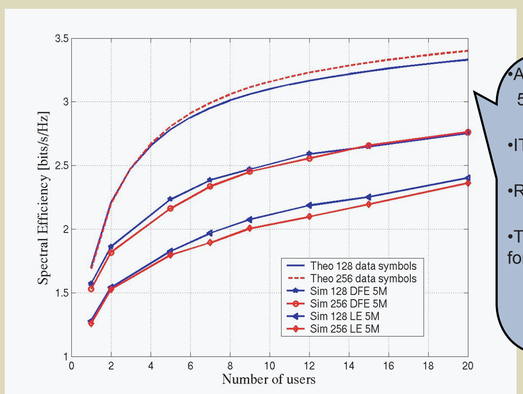
Singel carrier transmission is more power efficient than OFDM. Therefore it is of potential interest in the uplink.

Our uplink proposal requires channel estimation for all the active users in order to allocate the resources. To make the channel estimation efficiently, all the users will transmit the pilots simultaneously.



Each user transmits the data in the assigned time slot. N time slots constitute a data frame which is denoted as Data period in the figure.

All active users send their pilots simultaneously during the Training period. Channel estimation and prediction are performed at the base station. A scheduler optimizes the resources according to the predicted channel conditions of different users. Users who have the best predicted SNR are allowed to utilize the channel. Decisions are sent through the downlink control information symbols.



- All terminal velocities 50 km/h.
- ITU-iv channel A
- Received SNR=16dB
- The used modulation formats are:
  BPSK, 4-QAM, 8-PSK, 16-QAM, 32 Cross-QAM, 64-QAM, 128 Cross-QAM and 256-QAM

Conclusions

The equalized channels are more time-variable in a narrow-band single-carrier system.
The multiuser diversity gain is limited in wideband systems.
OFDM-based uplinks seem to provide larger potential multiuser scheduling gains.

This scheme also requires both accurate estimation of the power delay profile and efficient equalization.