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Cross-layer!

OPTIMISATION FOR 4G BROADBAND WIRELESS COMMUNICATION NETWORKS

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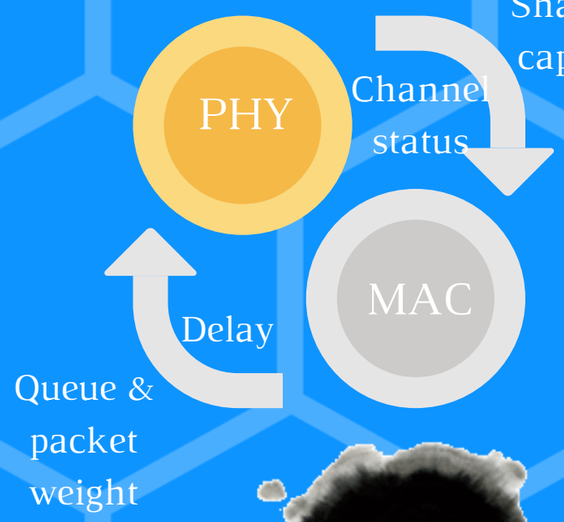
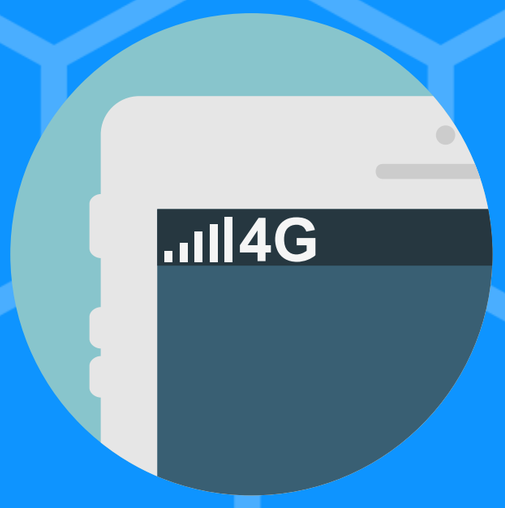




Why?

- Remove the boundaries between layers
- Access 'private' data of other layers
- Dynamic feedback and compensation

Where?

- Power allocation: Equal and (Weighted) Water-filling algorithm
- Subcarrier allocation: Random and (Weighted) Maximum Capacity
- Data scheduling: Modified Largest Weighted Delay First and Packet dependent scheduling [1]

What?

- To utilise the spectrum and power efficiently
- To meet requirements of different services
- To improve system performance (throughput, delay, packet drop rate)

How?

- OFDM system, downlink traffic
- PHY Layer: Channel status (subcarrier gain & power, Shannon capacity)
- MAC Layer: Packet information (queue & packet weight, delay)

Applications: OFDM based Networks (4G, WLAN, WiMax, and possibly future 5G [2]).

Real-case utilizations: (1) Place that data to be served can change dramatically (Stadium, station, etc.).
(2) Users with heterogeneous traffic that have a high requirement for delay, throughput and packet drop rate.

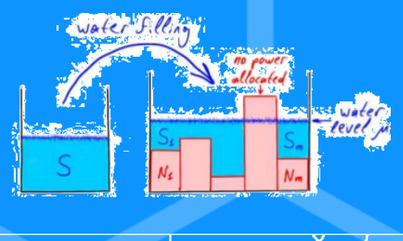
Potential problems: encryption and security - channel states and packet information are more likely to leak.

Subcarrier Allocation

- (Weighted) Maximum Capacity: Subcarriers are allocated to users with the best (weighted) gain.

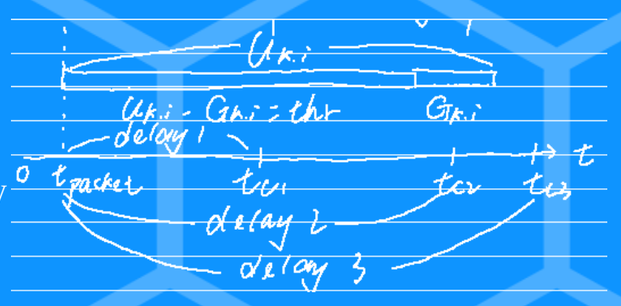
Power Allocation

- (Weighted) Water-filling: allocate power based on the (weighted) subchannel states.

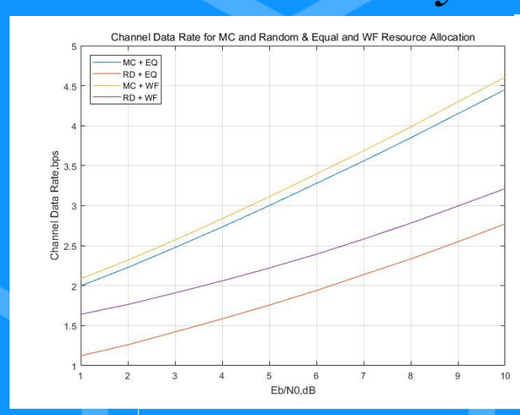


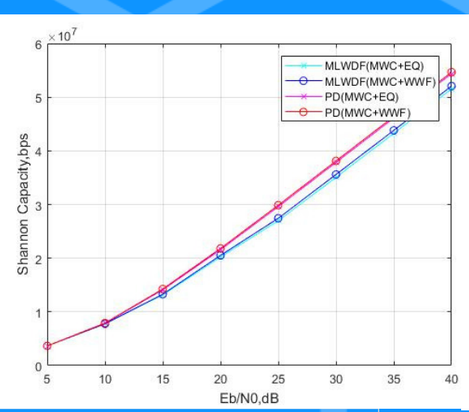
Data Scheduling

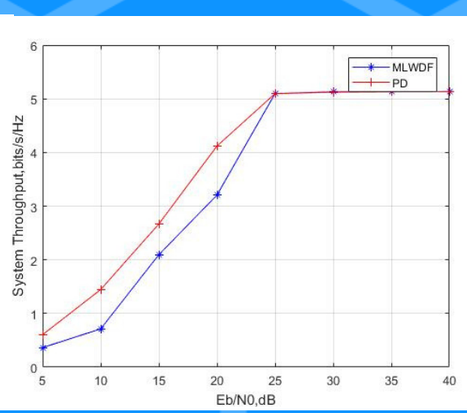
- Modified largest weighted delay first: Serve the queues on service nature, delay and queue length.
- Packet dependent scheduling: Data is sent packet by packet with different weights: depends on QoS, delay and size of packets.

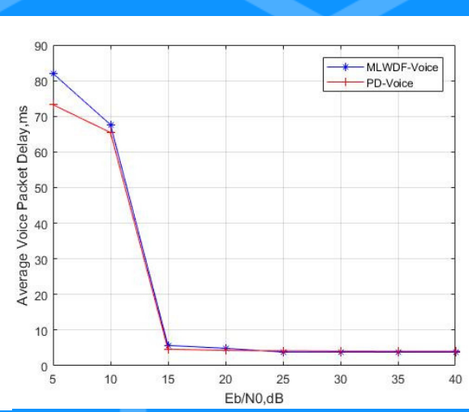


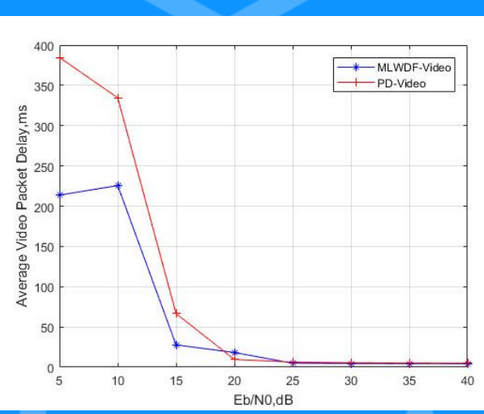
Result & Analysis

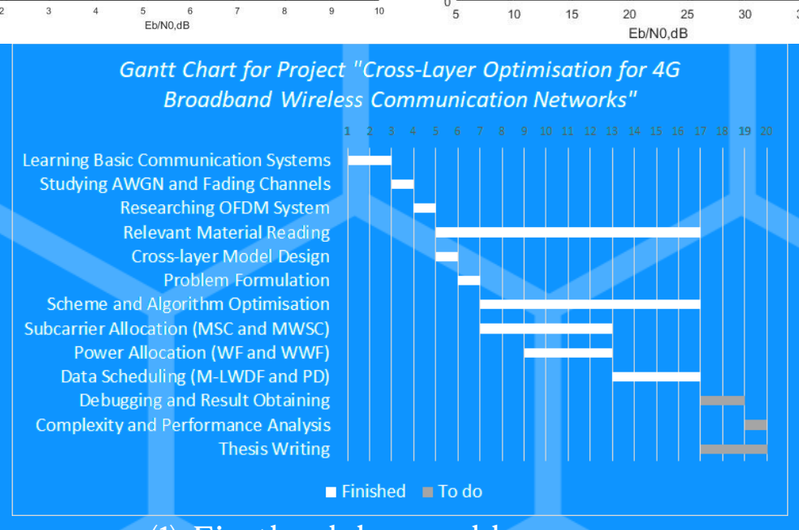












- Shannon Capacity: [Subcarrier Allocation] MC>MWC(PD)>MWC(M-LWDF)>random;
  [Power Allocation] WF>WWF>equal;

System Throughput: [Data Scheduling] PD>M-LWDF;

Average voice packet delay: PD<M-LWDF;

Average video packet delay: (not as expected) M-LWDF<PD;

Conclusion & Comments

- MC and Water-filling algorithm can improve channel data rate significantly and slightly. Although the introduction of weight has a small impact on the data rate, it can guarantee the system throughput, efficiency and delay.
- The system performance in terms of Shannon Capacity and throughput demonstrates the PD scheduling scheme, which is more flexible dealing with packets, is more advanced in efficiency and delay. Nevertheless, the cost is the system complexity.
- For delay estimation, we consider packets sent only. The problem might be solved by taking dropped packets into account.

Future Works

(1) Fix the delay problems.
(2) Check the packet drop rate.
(3) Repeat the work for a different number of user sets.
(4) If possible, consider weight design for VR/AR services.

[1] N. Zhou, X. Zhu, Y. Huang & H. Lin, "Low complexity cross-layer design with packet dependent scheduling for heterogeneous traffic in multiuser OFDM systems", *IEEE Transactions on Wireless Communications.* vol. 9, no. 6, pp. 1912-1923, Jun. 2010.

[2] K. Nagapushpa & C. Kiran, "Studying Applicability Feasibility of OFDM in Upcoming 5G Network", *International Journal of Advanced Computer Science and Applications.* vol. 8, no. 1, pp. 216-226, 2017.