A New Air Interface Concept for Wireless Multimedia Communications beyond the 3rd Generation

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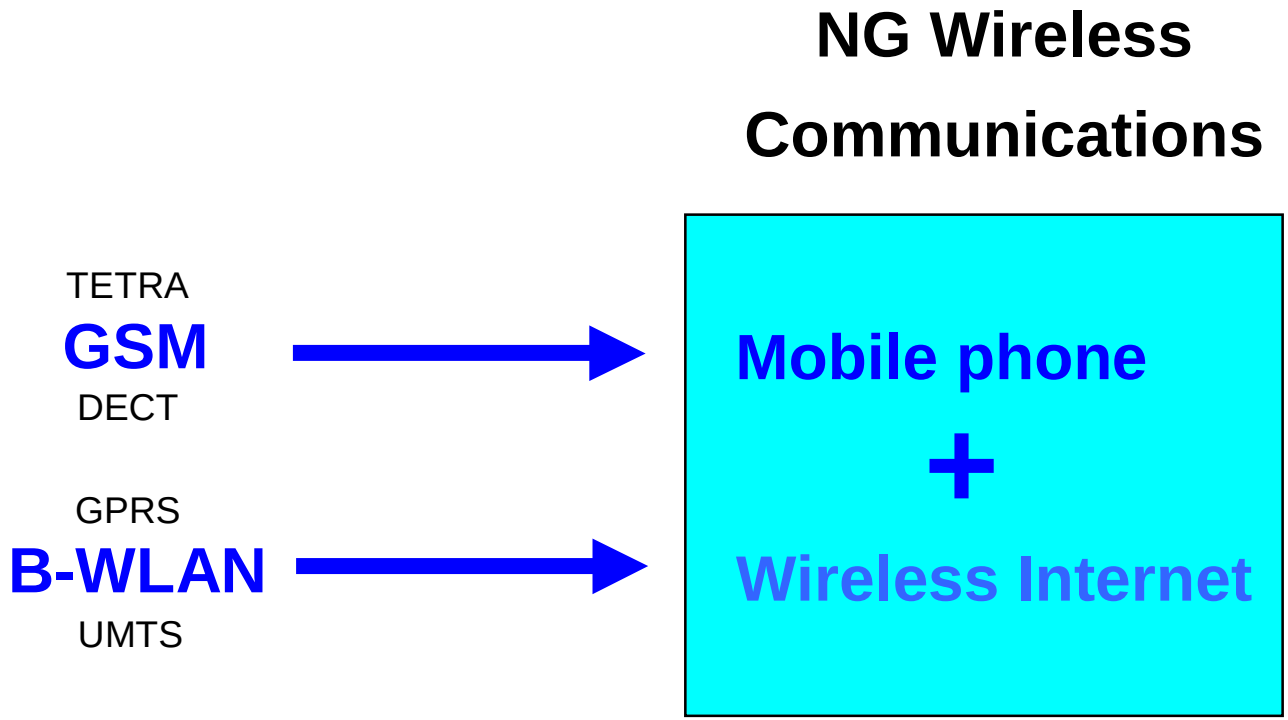
A Vision of Next Generation Wireless Communications



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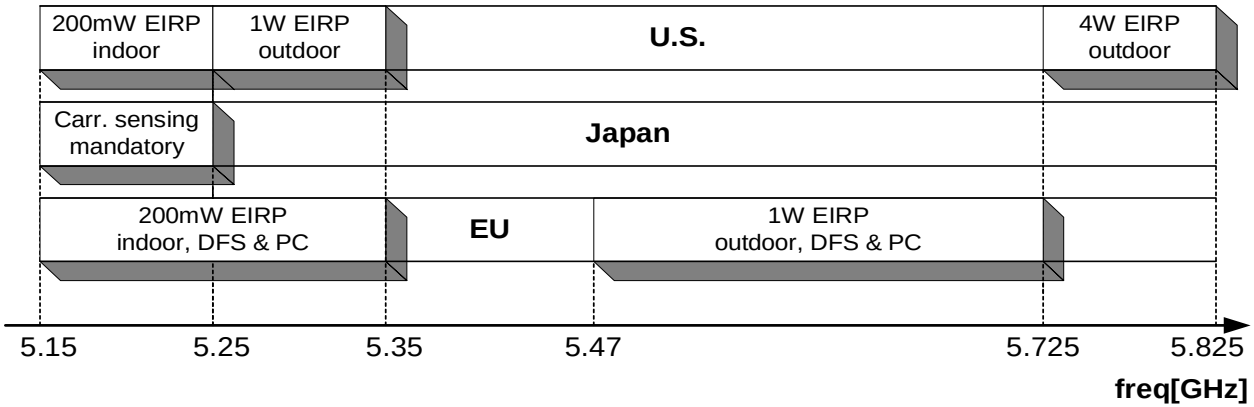
The license-exempt spectrum at 5 GHz



- 455 MHz in Europe
- 300 MHz in USA
- 100 MHz in Japan

- The most promising spectrum for broadband wireless networks
- ETSI HiperLAN/2 and IEEE 802.11a, both use this frequency spectrum.
- Unpredictable propagation characteristics and limited communication range
- Self-organising is a very attractive feature of networks working at this spectrum.
- Multihop capability is necessary to achieve a reasonable communication coverage.

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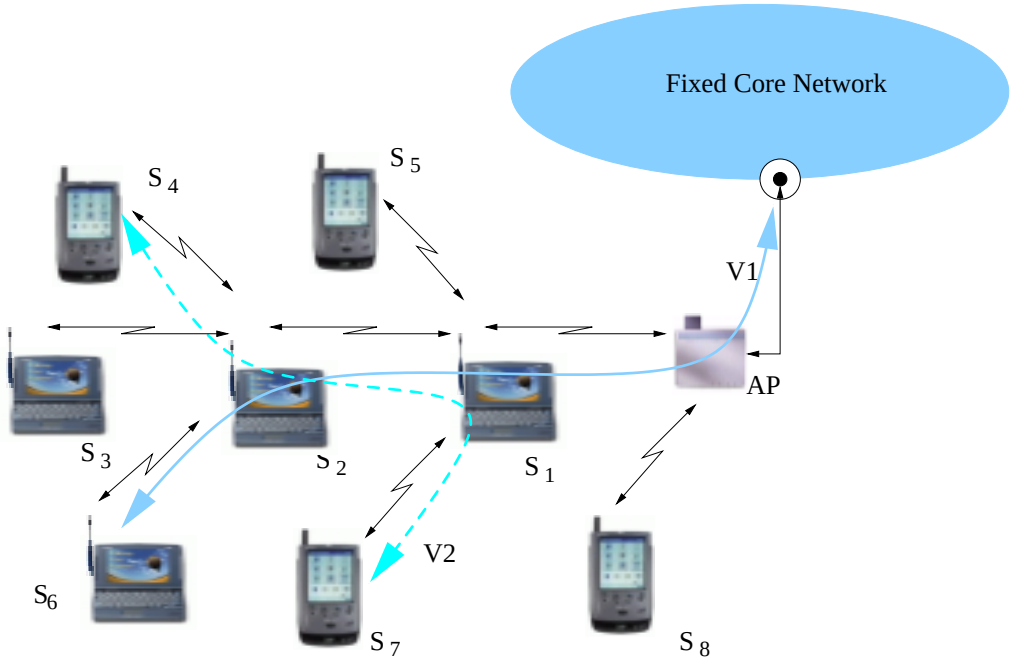
W-CHAMB: A CHannel-oriented Ad-hoc Multihop B-WLAN



Advanced features:

- Self-organising
- Multihop capability
- Decentrally controlled MAC
- QoS guarantee
- Ad hoc networking
- Date rate up to 54 Mb/s

Application scenarios:

- Broadband wireless internet access at hot-spots
- Ad hoc networking among pocket- and handheld- PCs anywhere at anytime
- Wireless computing in laboratories, companies and factories

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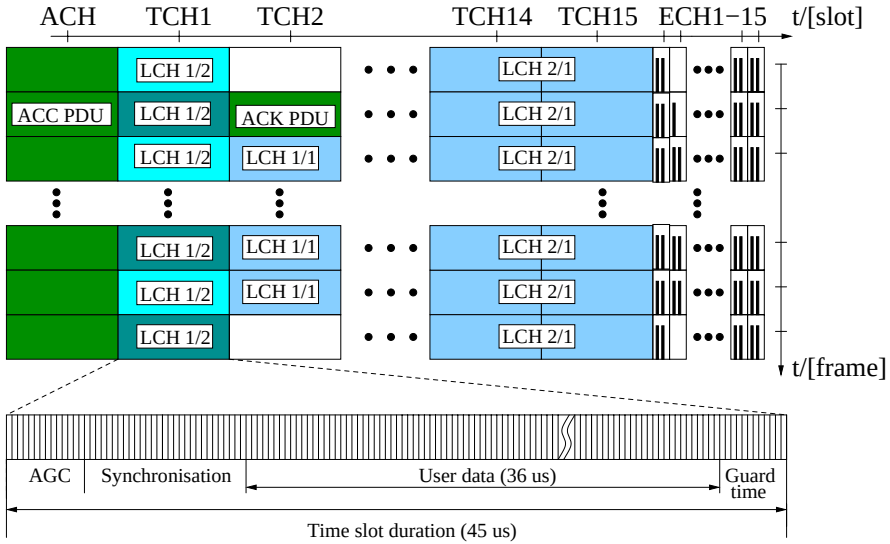
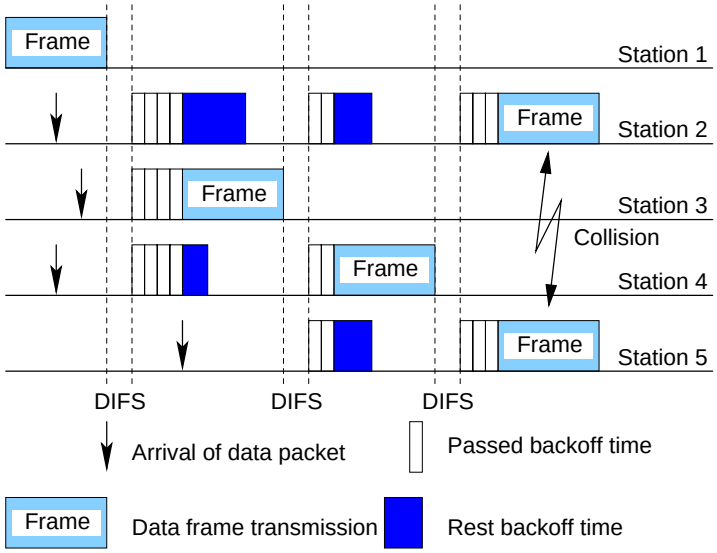
W-CHAMB, HiperLAN/2 and IEEE 802.11

W-CHAMB

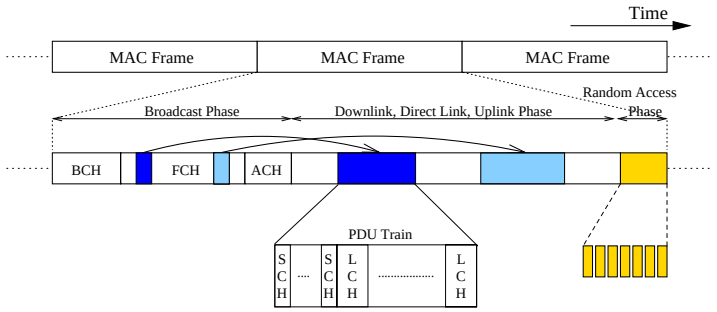


IEEE 802.11



- W-CHAMB: decentral control, channel-oriented transmission, dynamic RCC reservation
- IEEE 802.11: DCF/PCF, packet-oriented transmission, CSMA/CA, RTS/CTS
- HiperLAN/2: central control, scheduler-oriented transmission, dynamic slot assignment

ETSI HiperLAN/2



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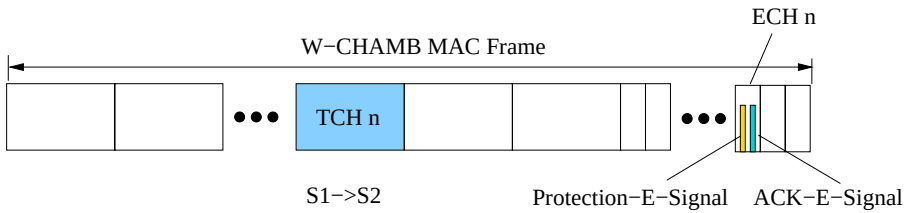
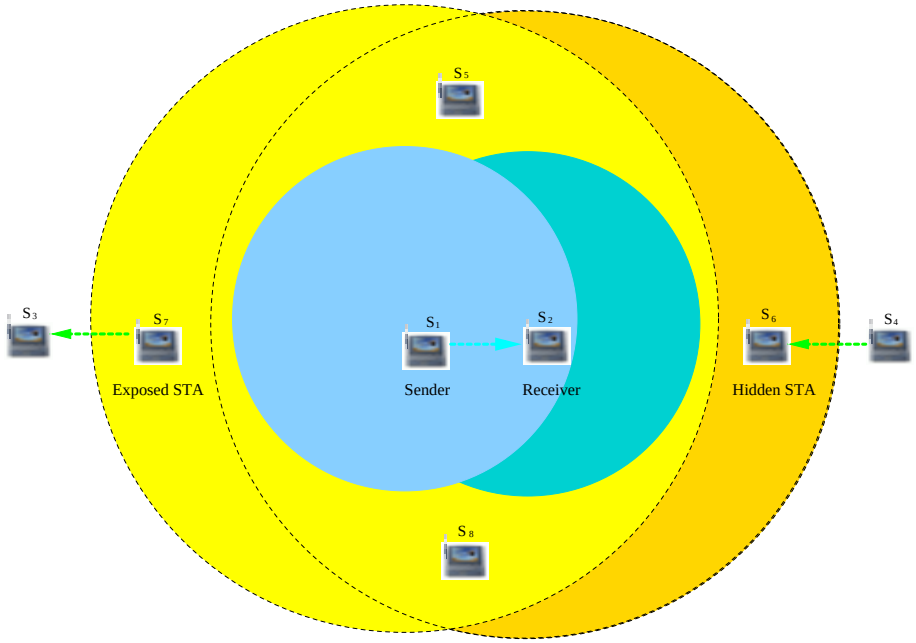
W-CHAMB channel status and E-Signals



- The hidden station problem is solved by Protection-E-signal completely.
- ACK-E-signal is used for the MAC level acknowledgment to realise the fast ARQ.

Status of TCH n

- ***Reserved for transmit***, S1
- ***Reserved for receive***, S2
- ***Free***, S3 and S4
- ***Busy***, S5 and S8
- ***Hidden***, S6
- ***Interfered***, S7



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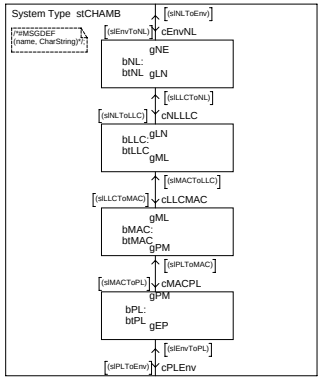
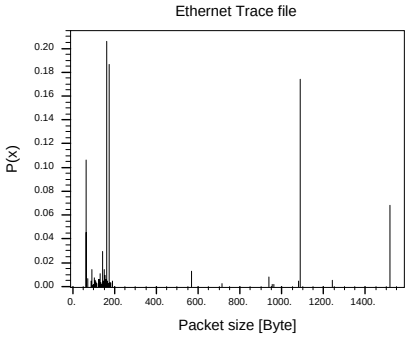
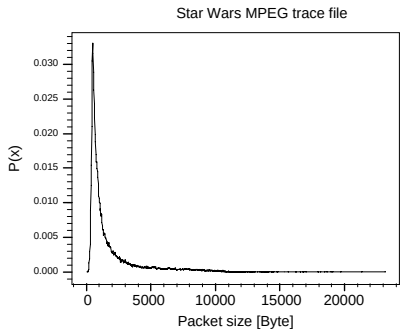
Simulation tool

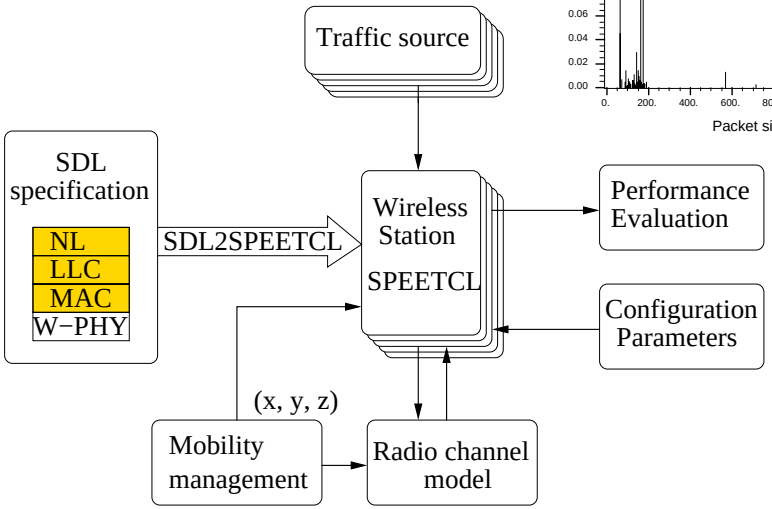


- Protocols implemented in SDL

- Traffic sources: Stochastic models, Trace files





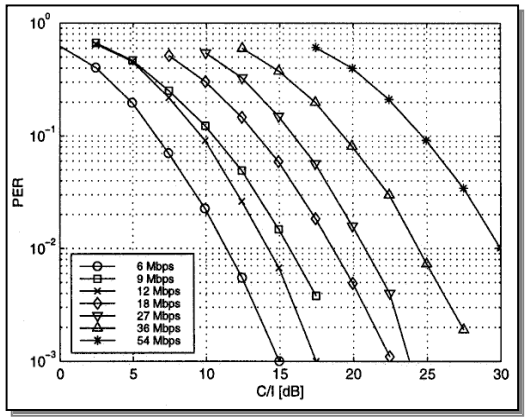


- Channel model

$$C = k \cdot d^{-\gamma} \quad \gamma = 3 \sim 5$$

$$C/I = \frac{C}{\sum_i I_i + N}$$

$$PER \propto C/I$$



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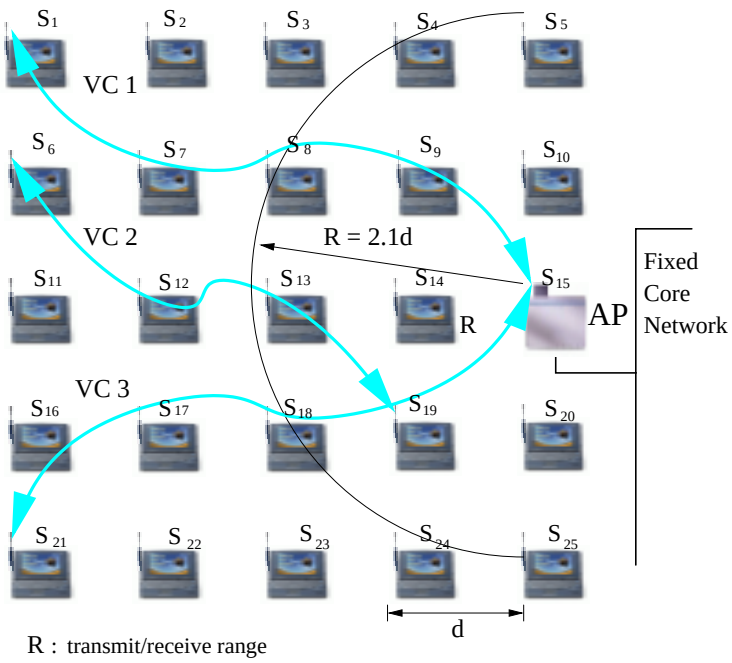
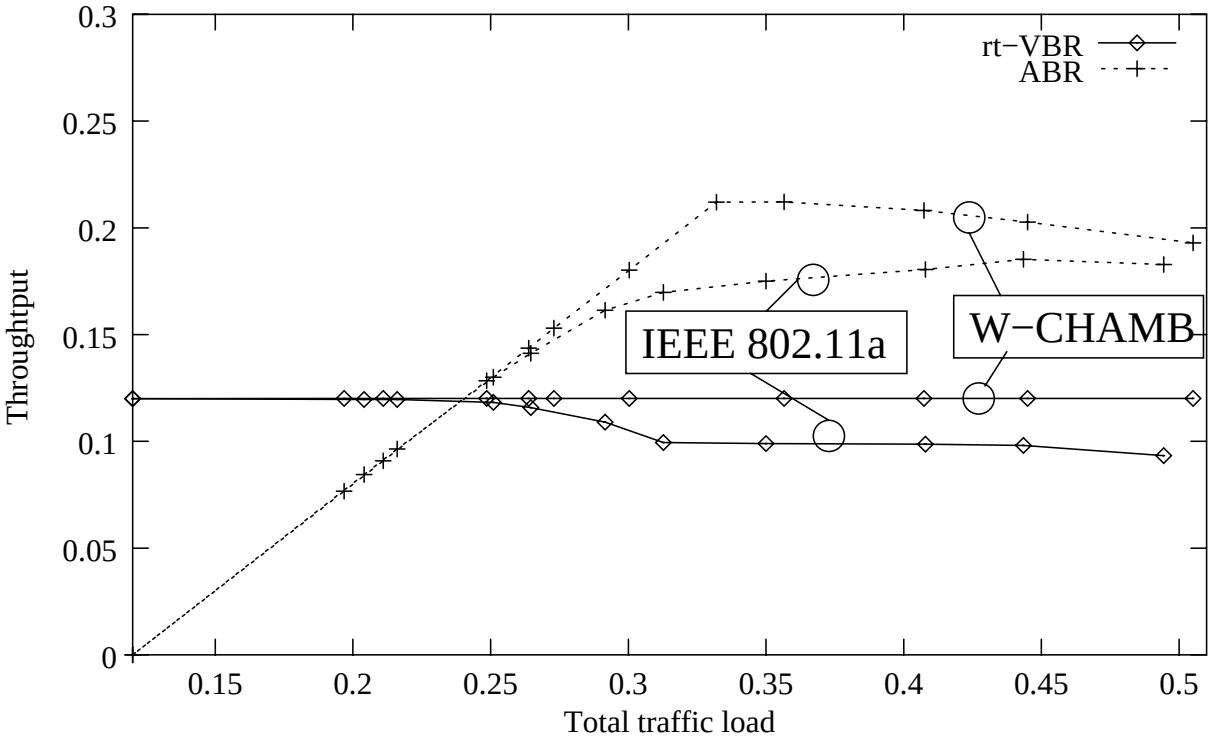
Multihop multimedia scenario



Multihop multimedia scenario

- Traffic load consists of 5 download rt-VBR VCs and 10 download ABR VCs from AP to WSs, 5 upload ABR VCs from WSs to AP, and 5 directload ABR VCs from WS to WS.
- The packet sizes of ABR traffic are read from the Ethernet trace file. Date rates are varied to model the different loads.
- The Packet size of rt-VBR traffic is modelled by an autoregressive Markov process with a mean of 3060 bytes and a maximum of 6120 bytes. 24 packets are generated per second by each rt-VBR source.
- Min-hop routing algorithm is used to establish a multihop VC.
- The transmission rate is 24 Mb/s.

Maltimedia traffic performance with QoS guarantee



- The prioritised rt-VBR traffic is completely served at all load conditions in W-CHAMB, whereas the throughput of rt-VBR traffic decreases with the increasing loads in IEEE 802.11a.
- W-CHAMB achieves higher throughput of ABR service traffic than IEEE 802.11a.

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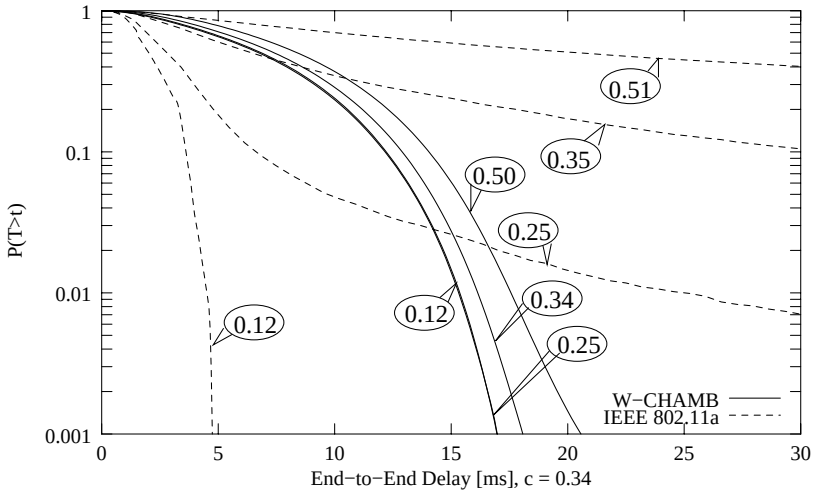
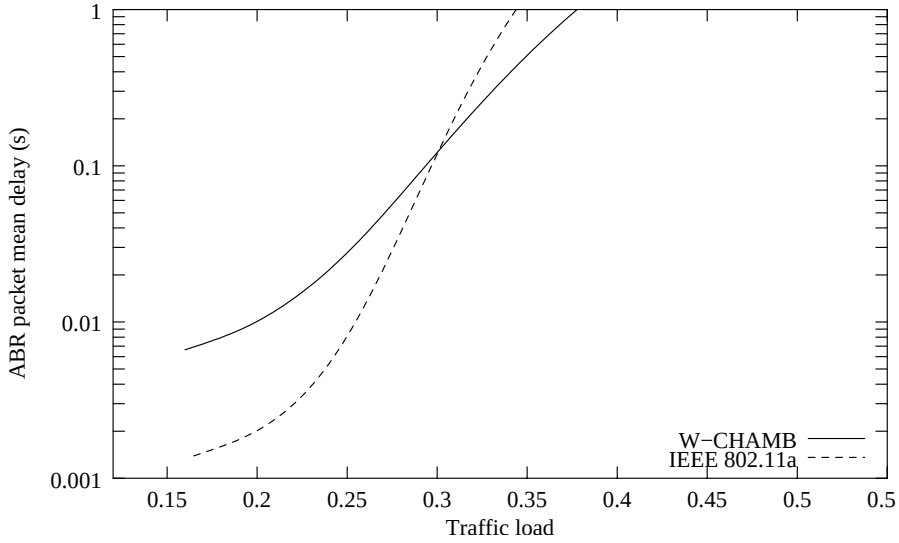
Multimedia traffic performance with QoS guarantee





- W-CHAMB is able to guarantee QoS for rt-VBR traffic even at a heavy overloaded situation (0.5).
- IEEE 802.11a is not able to differentiate rt-VBR and ABR traffic. The delay performance of rt-VBR traffic degrades rapidly with a slightly increasing load.
- IEEE 802.11a has a better mean delay performance of ABR service than W-CHAMB at a low traffic load situation.

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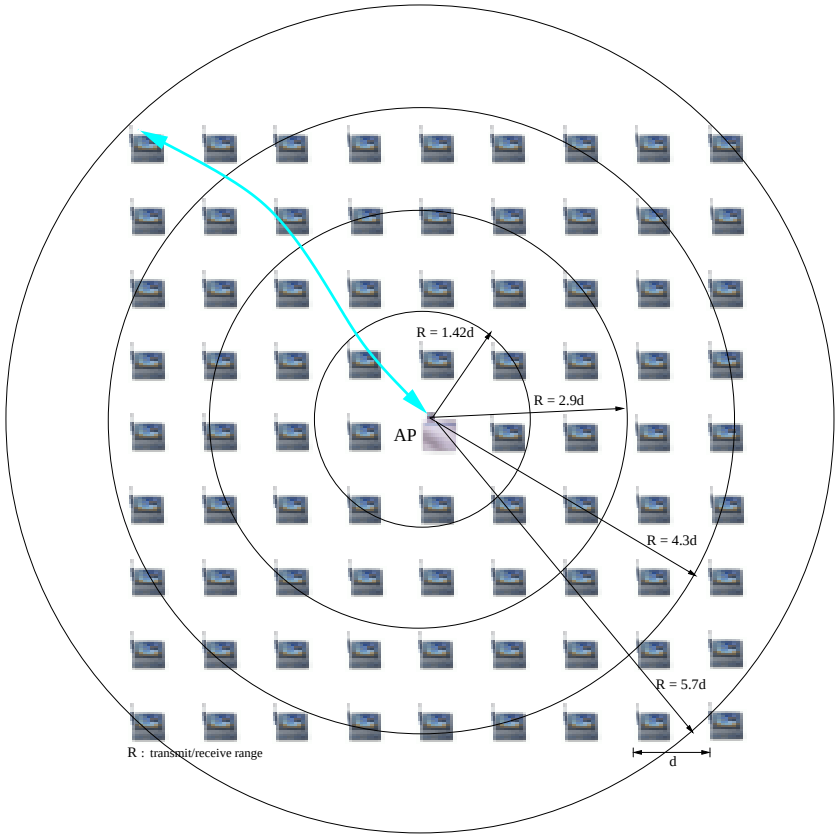
The Impact of multihop transmission on performance



One-AP scenario

- Each WS communicates with the AP using up- and download ABR VCs.
- The packet sizes of ABR traffic are read from the Ethernet trace file. Date rates are varied to model the different loads.
- The communication range is varied from 1.42d to 5.7d to model the different network connectivity
- Min-hop routing algorithm is used to establish a multihop VC.
- The transmission rate is 24 Mb/s.

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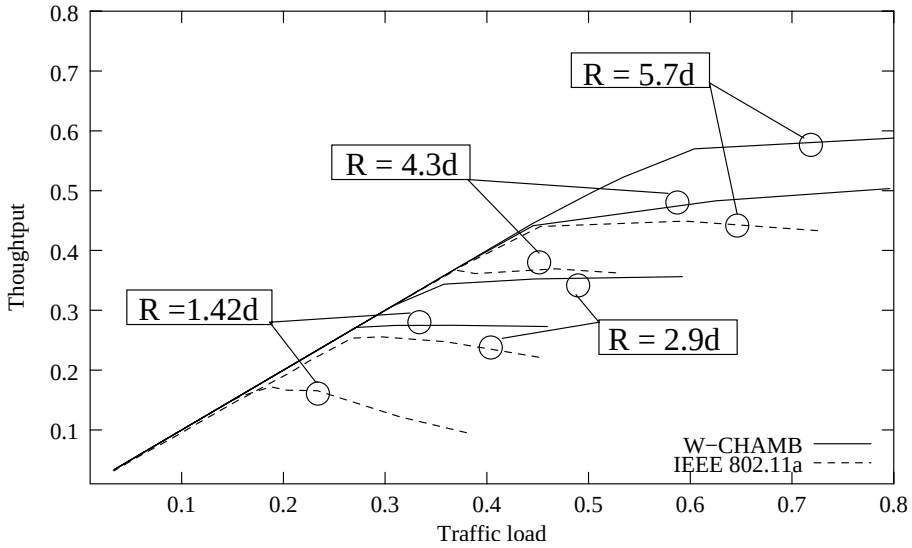
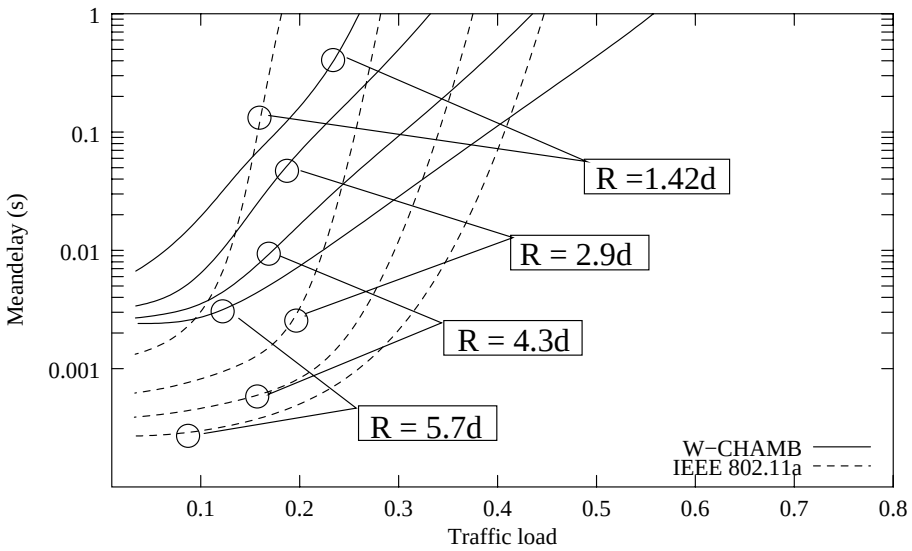
The Impact of multihop transmission on performance





- Reduced communication range (transmission power) degrades the traffic performance at the one-AP scenario.
- W-CHAMB achieves much higher throughput that IEEE 802.11a.
- IEEE 802.11a has a better mean delay performance of ABR service than W-CHAMB at a low traffic load situation.

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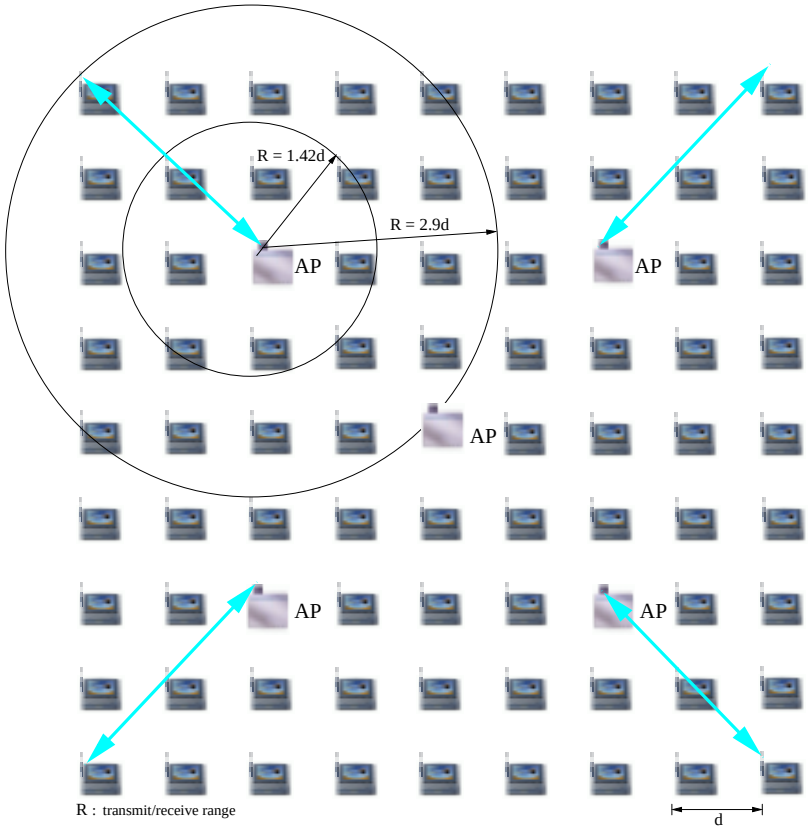
The Impact of multihop transmission on performance



Multi-APs scenario

- Each WS communicates with the nearest AP using up- and download ABR VCs.
- The packet sizes of ABR traffic are read from the Ethernet trace file. Date rates are varied to model the different loads.
- The communication range is varied from 1.42d to 5.7d to model the different network connectivity
- Min-hop routing algorithm is used to establish a multihop VC.
- The transmission rate is 24 Mb/s.

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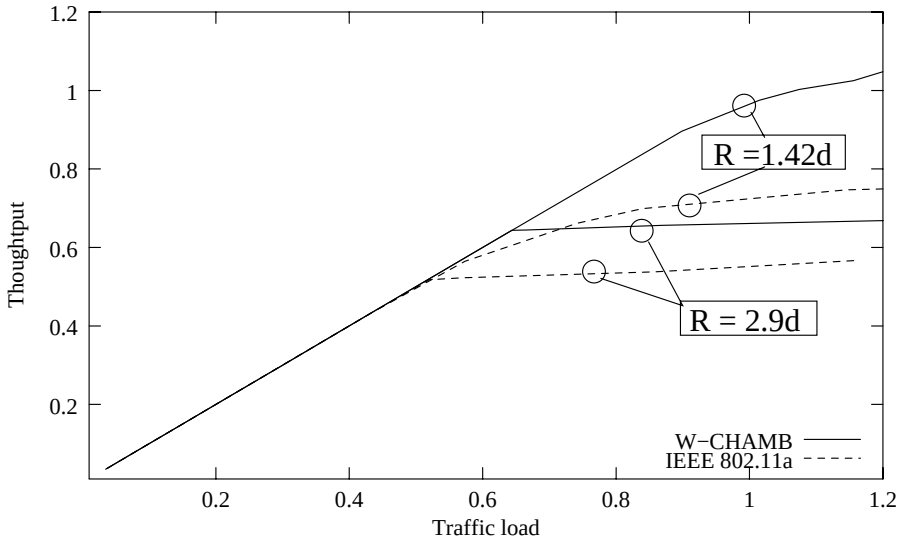
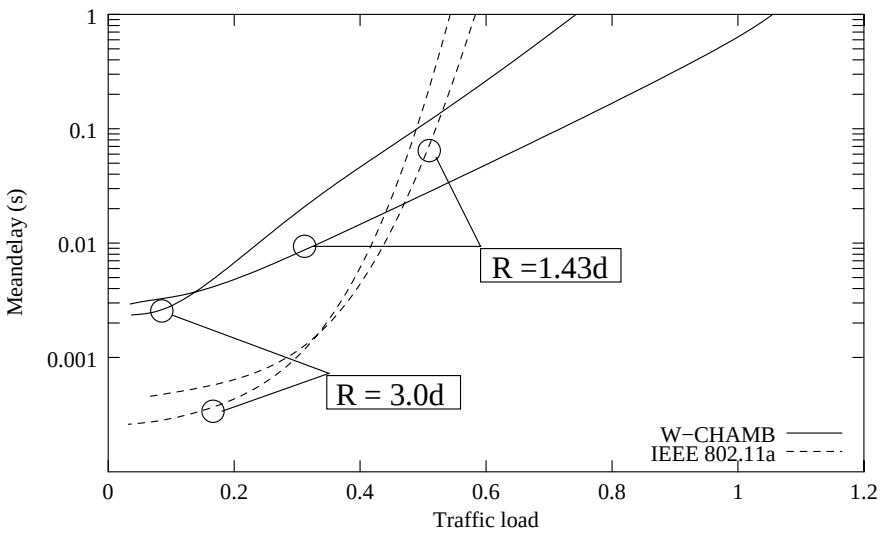
The Impact of multihop transmission on performance





- Reduced communication range (transmission power) improves the traffic performance at the multi-APs scenario.
- W-CHAMB achieves much higher throughput that IEEE 802.11a.
- IEEE 802.11a has a better mean delay performance of ABR service than W-CHAMB at a low traffic load situation.

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Summary

- B-WLAN is to take a significant role in the next generation wireless communications.
- Self-organising and multihop capability are two important issues for the B-WLAN operating at 5 GHz.
- W-CHAMB is able to guarantee QoS for real time traffic by a channel-oriented packet transmission, whilst IEEE 802.11a has no means to guarantee QoS in a multihop network.
- W-CHAMB achieves higher efficiency than IEEE 802.11a for ABR service.
- Reduced communication range (transmission power) increases the system efficiency at multi-APs scenario, but degrades the traffic performance significantly at the one-AP scenario.
- W-CHAMB has a fully decentrally controlled MAC protocol that is best suited to be operated at the license-exempt frequency spectrum.
- W-CHAMB seems to be a good solution for the next generation wireless Internet.