Performance Comparison of Dynamic OFDM with 802.11n

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Authors:

Name	Company	Address	Phone	email
James Gross	Technical University Berlin	Einsteinufer 25 10587 Berlin, Germany	+49-30-314-23830	gross@tkn.tu-berlin.de
Marc Emmelmann			+49-30-314-24580	emmelmann@ieee.org
Oscar Puñal				
Adam Wolisz				awo@ieee.org

Abstract

Previous presentations about dynamic OFDM to the group raised the interest in a comparison to 802.11n In this contribution we compare the performance of 802.11n in various different settings to dynamic OFDM, demonstrating a significant performance advantage for dynamic OFDM. We propose to include the consideration of dynamic OFDM as possible technological direction into the PAR.

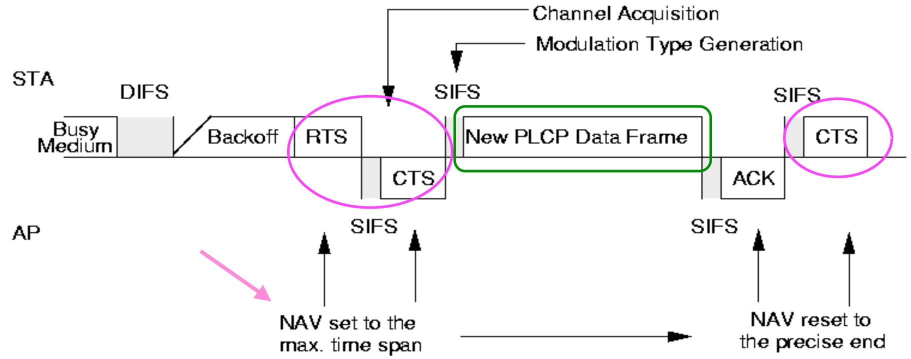
Introduction

- **OFDM-based physical layers are commonly used for high-speed wireless networks**
- **Dynamic OFDM schemes can**
  - employ a sub-carrier-specific modulation according to each sub-carrier's channel gain and
  - exploit multi-user diversity
- **Previous presentations have elaborated these aspects and proposed a simple method to introduce dynamic OFDM in 802.11 systems [cf. 1-6]**
- **Group requested comparison with 11n ➔ Focus of this presentation**

Simulated Dynamic OFDM Schemes

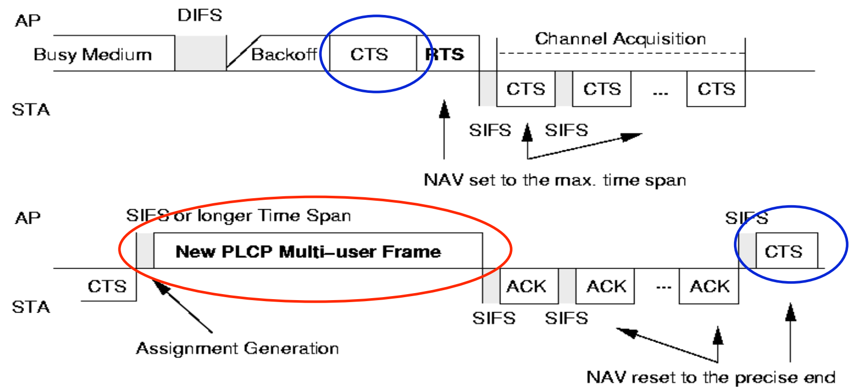
- **Dynamic Single-User OFDM [1,4-6]**

  --> different modulation per sub-carrier according to sub-carrier channel gain



- **Dynamic Multi-User OFDM [2]**

  --> additionally exploit multi-user diversity



→Protocol overhead to include Dynamic OFDM considered in simulation results

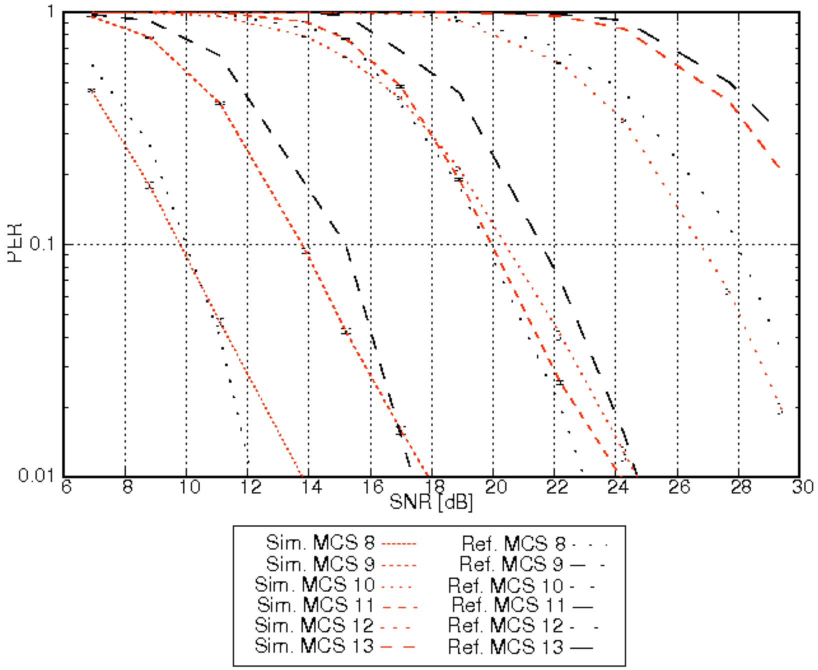
802.11n & Channel Model

- **Simulations for 11n considering**
  - A-MPDUs Frame Aggregation [10]
  - 2x2x20 MHz Spatial Multiplexing with MMSE receiver [10]
  - Channel Model E (Large Office) [8,9]
  - Convolutional coding

- **Sub-Carrier Specific Attenuation**
  - MatLab used to generate impulse response of channel for each transmission [8,11]
  - Impulse response used to calculate channel matrix H
--> sub-carrier specific attenuation

Verification of Simulator

- **PERs for 11n (2x2x20MHz, channel E, 1000 Byte PDU)**
  - as presented in 11-06/0067r3 TGn Joint Proposal Phy Results
  - as obtained with our simulator



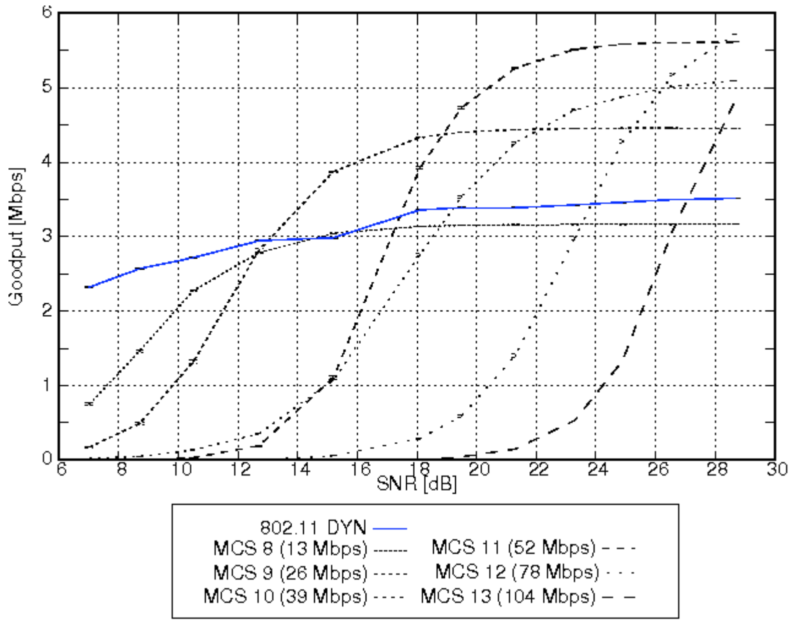
Simulation Details

- **Large PDUs (1536 Byte) & small ones (200 Byte)**
- **Saturation mode (always “enough” packets in queue)**
- **P2P scenario: one transmitter, one receiver, no further stations, one-way traffic only**
- **P2MP scenario: one transmitter, several (4) receivers, no further stations, one-way traffic only, all receivers at same distance to transmitter**
- **Performance metric: MAC Goodput [bit/s]**

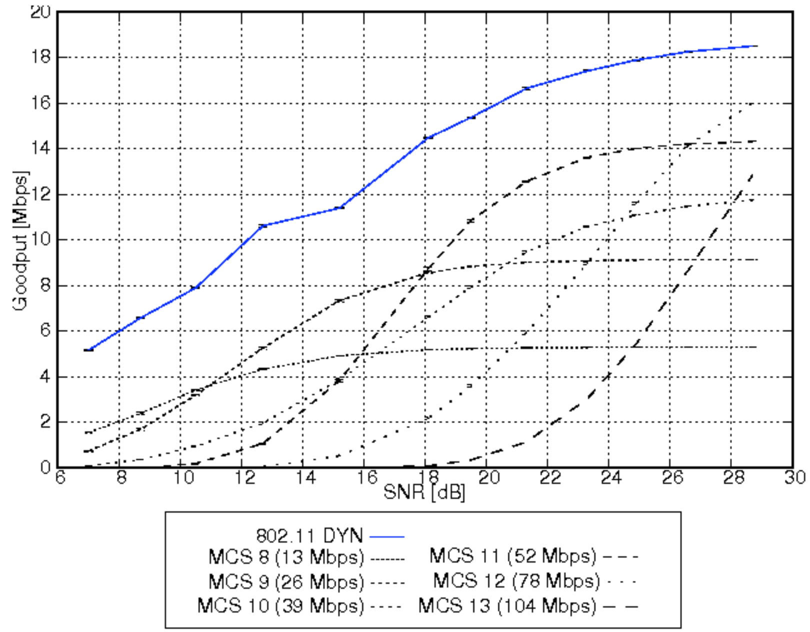
Results I – Baseline

- **1 spatial stream, no frame aggr., P2P scenario**

Small PDUs (200 Byte)



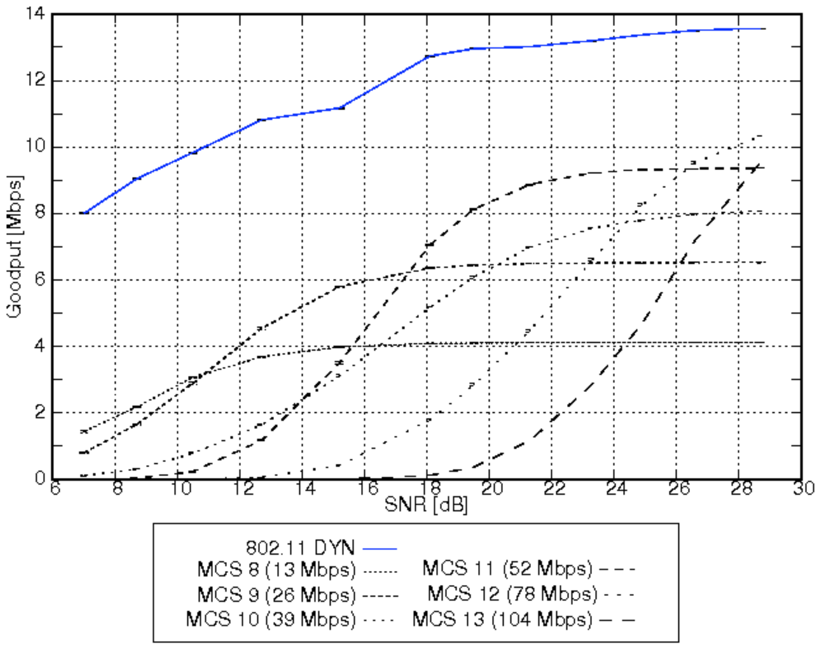
Large PDUs (1536 Byte)



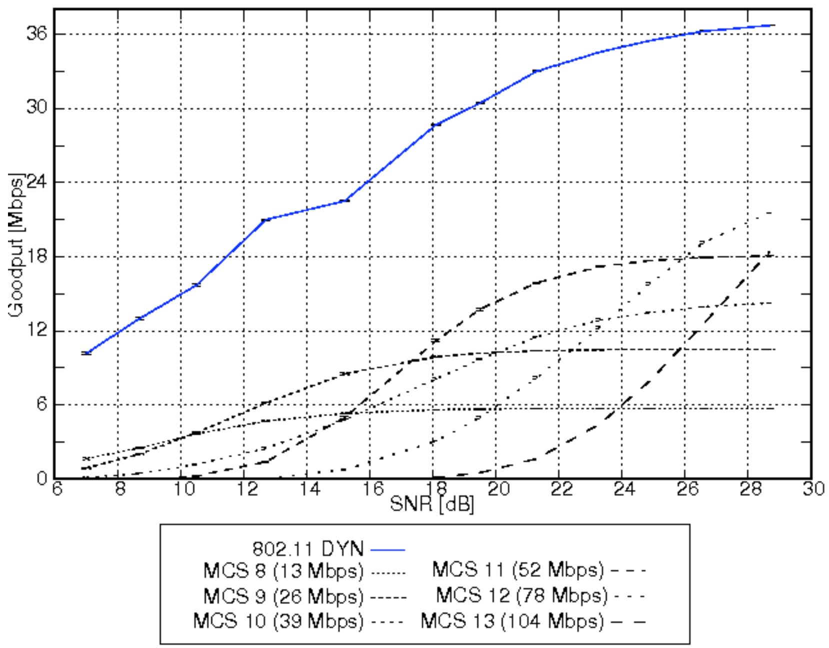
Results II – Reduction of MAC Overhead

- **1 SS, frame aggr. activated, P2P scenario**

Small PDUs (200 Byte) – FA with 4 PDUs



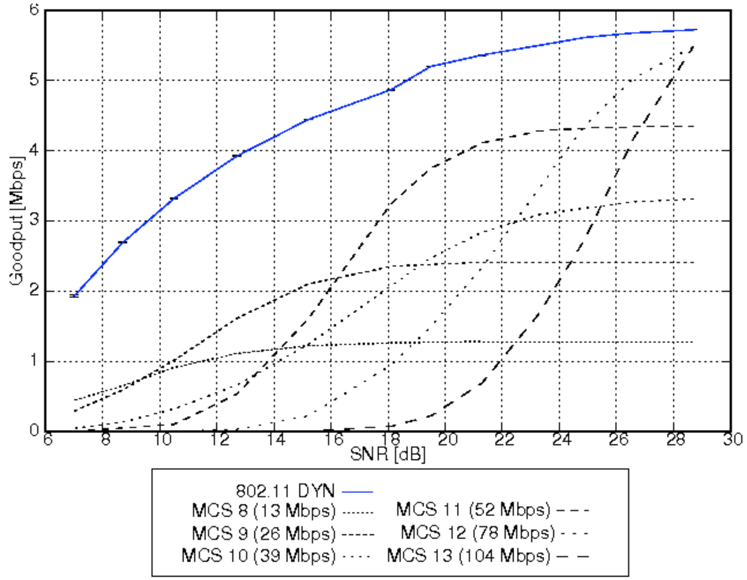
Large PDUs (1536 Byte) – FA with 2 PDUs



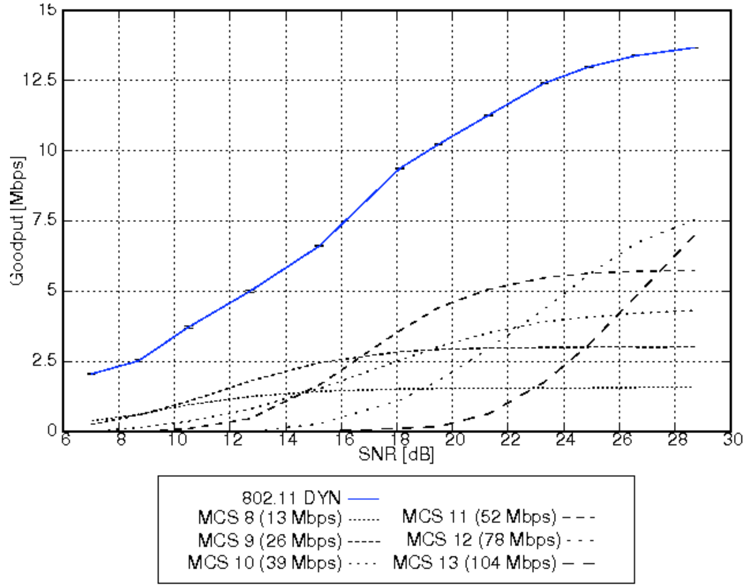
Results III – Adding Multi-user Diversity

- **1 SS, frame aggr. activated, P2MP (4 STA) scenario**
- **Equal PDU number aggregated into one channel access**

Small PDUs (200 Byte) – FA with 16 PDUs for 11n, FA with 4 PDUs for 11DYN



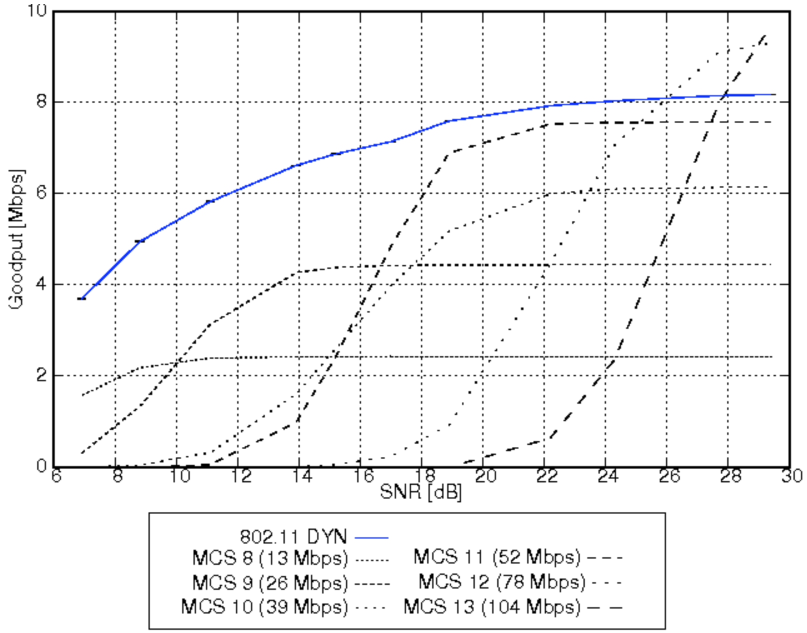
Large PDUs (1536 Byte) – FA with 8 PDUs for 11n, FA with 2 PDUs for 11DYN



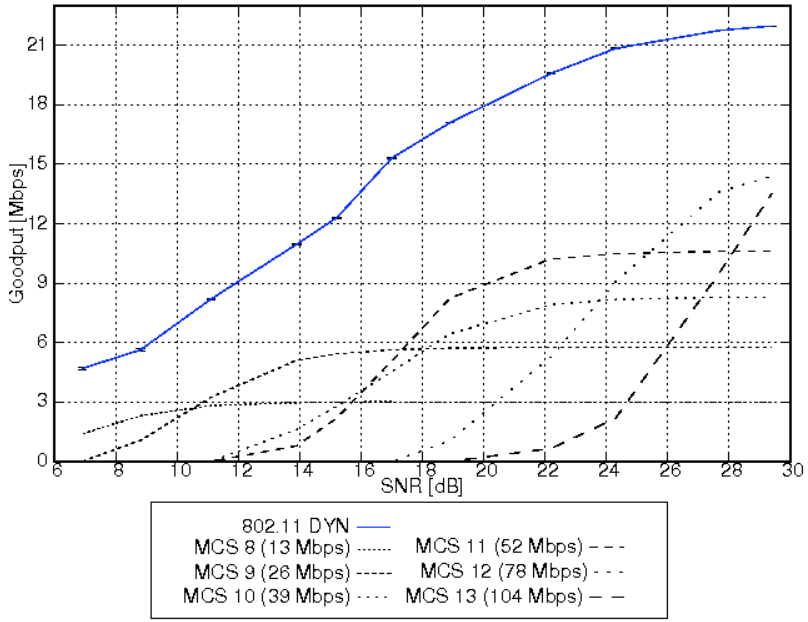
Results IV – Adding Spatial Layers

- **2 SS, frame aggr. active, P2MP scenario (4 STA)**

Small PDUs (200 Byte) – FA with 16 PDUs for 11n, FA with 2 PDUs for 11DYN



Large PDUs (1536 Byte) – FA with 8 PDUs for 11n, FA with 2 PDUs for 11DYN



Note: In all presented comparisons 802.11 DYN is applied to 48 (96) data subcarriers whereas 802.11n results are based on 52 (104) data subcarriers

Summary and PAR Recommendations

- **Even a simple approach to enhance 802.11 with dynamic OFDM (and hence include multi-user diversity) can outperform 11n**
- **Future work: Comparison to beamforming MIMO modes**

- We do not propose specific protocol means to include dynamic OFDM; but we strongly believe that
- **The PAR should** consider

dynamic (MIMO-)OFDM schemes **to** exploit multi-user diversity

and

sub-carrier specific modulation schemes

References

[1] 11-07/0720r2 -- Dynamic Point-to-Point OFDM Adaptation for IEEE 802.11a/g Systems

[2] 11-07/2062r1 -- Dynamic Multi-user OFDM for 802.11 systems

[3] 11-07/2187r1 -- Another resource to exploit: multi-user diversity

[4] J. Gross, M. Emmelmann, O. Puñal, and A. Wolisz, ”Dynamic Point-to-Point OFDM Adaptation for IEEE 802.11 Systems,” accepted for publication at IEEE/ACM International Symposium on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM), October 2007.

[5] J. Gross, M. Emmelmann, O. Puñal, and A. Wolisz: 802.11 DYN: Protocol Extension for the Application of Dynamic OFDM(A) Schemes in 802.11a/g Systems, Technical Report TKN-07-002, Telecommunication Networks Group, Technische Universitaet Berlin, May 2007.

[6] J. Gross, M. Emmelmann, O. Puñal, and A. Wolisz: Dynamic Point-to-Point OFDMA Adaptation for IEEE 802.11a/g Systems, doc. 11-07/720, IEEE 802.11 WNG SC Wireless Next Generation Standing Committee, Montreal, Canada, May 14 -- 18 2007.

[7] 11-06/0067r3 -- TGn Joint Proposal Phy Results

[8] 11-03/940r4 -- TGn Channel Models

[9] 11-03/802r23 -- Usage Models

[10] TGn Draft most rece3int verssion

[11] L. Schumacher “WLAN MIMO Channel Matlab program,” download information: www.info.fundp-ac-be/~lsc/Research/IEEE_80211_HTSG_CMSC/distribution_term.html