Performance Comparison of Dynamic OFDM with 802.11n

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Authors:

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Address</th>
<th>Phone</th>
<th>email</th>
</tr>
</thead>
<tbody>
<tr>
<td>James Gross</td>
<td>Technical University Berlin</td>
<td>Einsteinufer 25 10587 Berlin, Germany</td>
<td>+49-30-314-23830</td>
<td><a href="mailto:gross@tkn.tu-berlin.de">gross@tkn.tu-berlin.de</a></td>
</tr>
<tr>
<td>Marc Emmelmann</td>
<td></td>
<td></td>
<td>+49-30-314-24580</td>
<td><a href="mailto:emmelmann@ieee.org">emmelmann@ieee.org</a></td>
</tr>
<tr>
<td>Oscar Puñal</td>
<td></td>
<td></td>
<td></td>
<td><a href="mailto:awo@ieee.org">awo@ieee.org</a></td>
</tr>
<tr>
<td>Adam Wolisz</td>
<td></td>
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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
Results II – Reduction of MAC Overhead

- 1 SS, frame aggr. activated, P2P scenario
Results III – Adding Multi-user Diversity

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

![Graph showing performance for small PDUs (200 Byte) and large PDUs (1536 Byte)]
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
[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