

Aggregation in 802.16j –Enhanced Concatenation and MPDU Construction

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Purpose:

Propose enhancements to the concatenation and packing mechanisms defined in current IEEE 802.16e for application on relay link.

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Aggregation in 802.16j

– *Enhanced Concatenation and MPDU Construction*

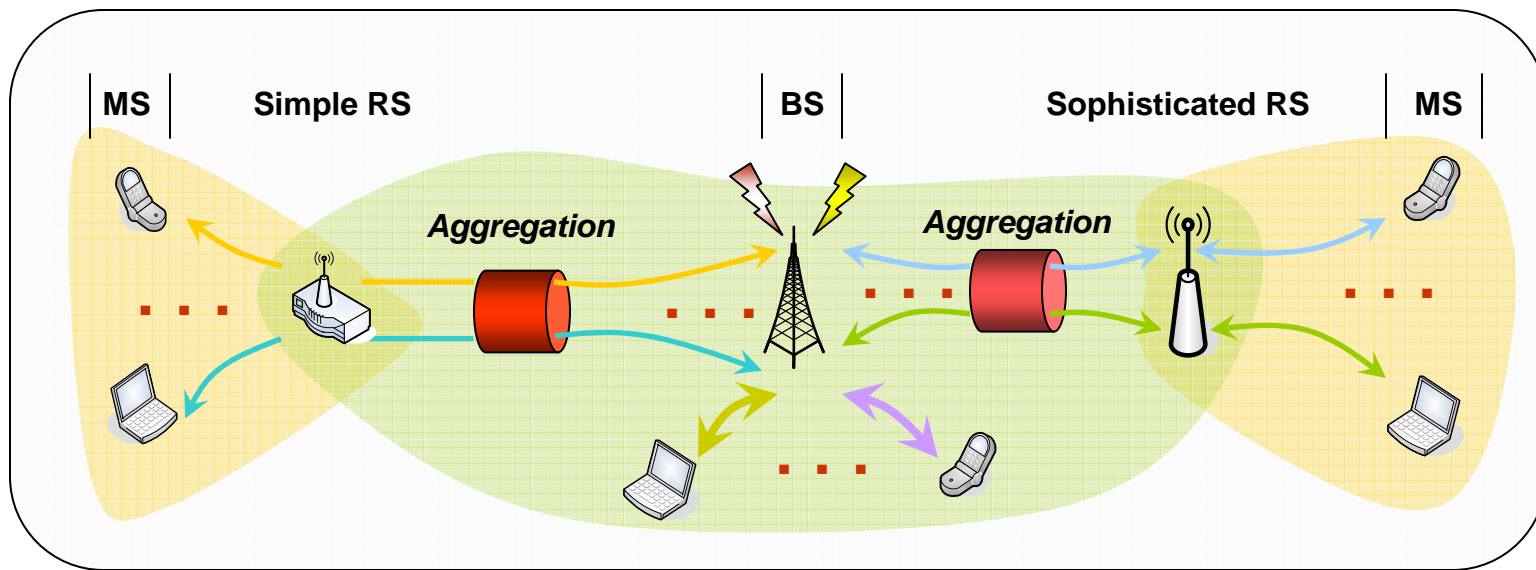
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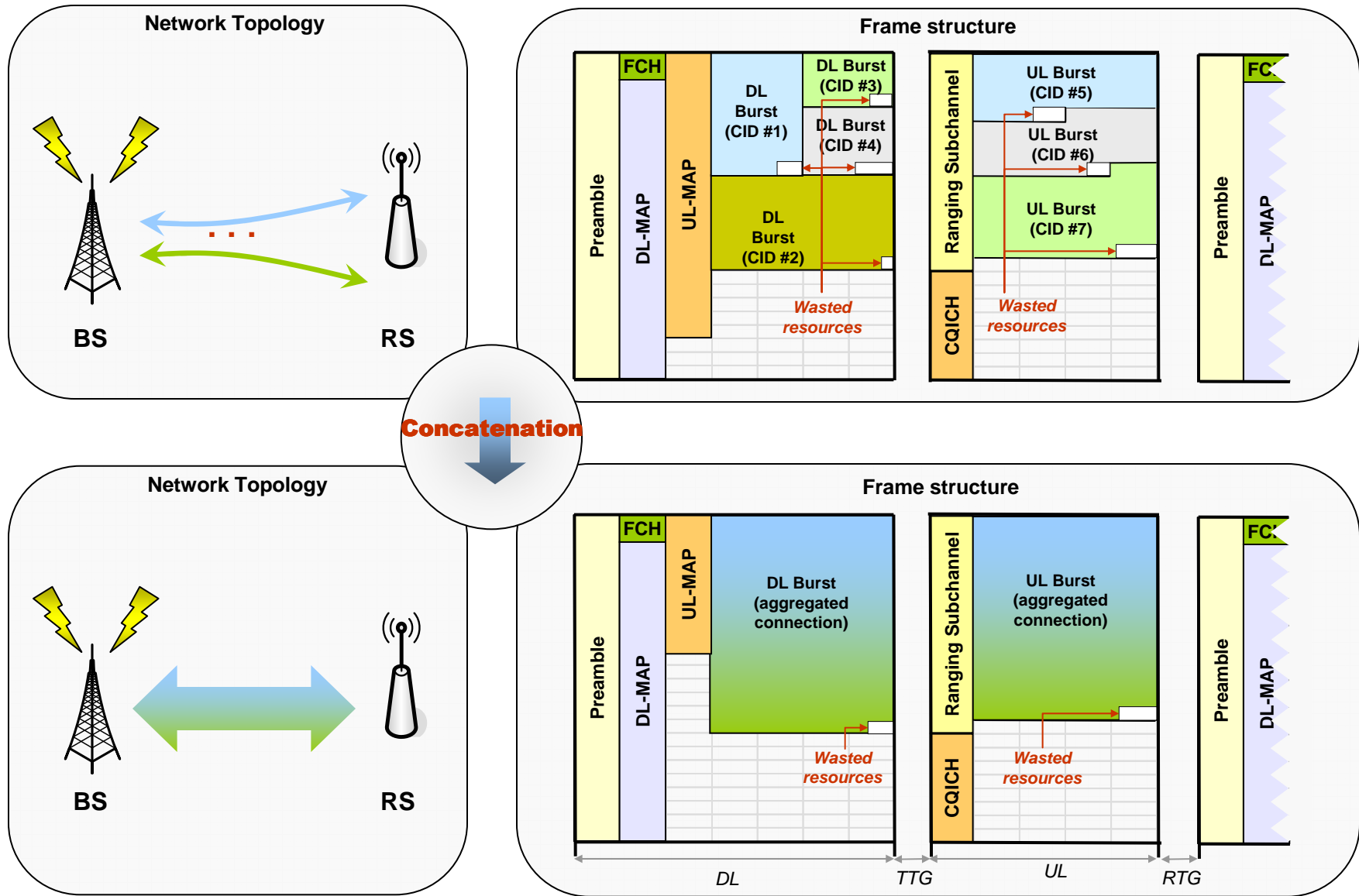
Aggregation

- The concept of “relay” intrinsically implies a notion of *aggregation*.
- The logical aggregation on downlink and uplink between BS and RS leads to more efficient channel resource utilization.



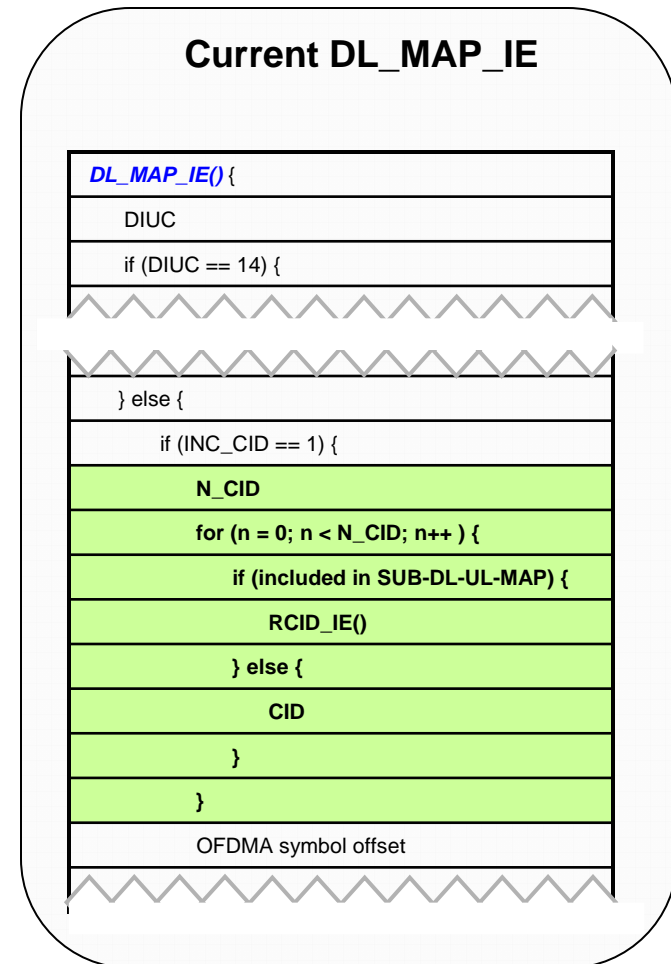
- Enhancements to 802.16e standard are needed to enable and leverage the inherent notion of “aggregation”.

Enhanced Concatenation (EC)



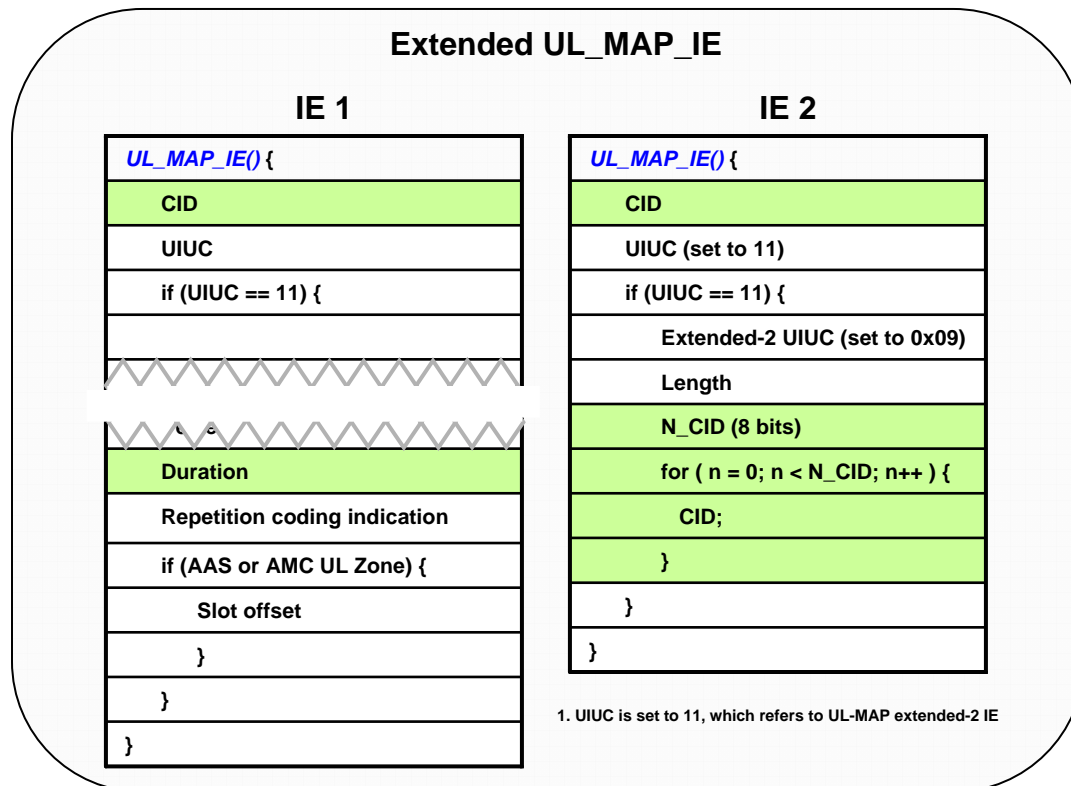
Enhanced Concatenation: the Detail

- Data plane
 - The concatenation defined in current 802.16 standard can support this operation.
 - Concatenation essentially is an MPDU level aggregation.
- Management plane
 - Downlink: The DL-MAP IE for OFDMA-PHY defined in current 802.16 standard can accommodate multiple CIDs, and thus could be used to support downlink concatenation.



Enhanced Concatenation: the Detail

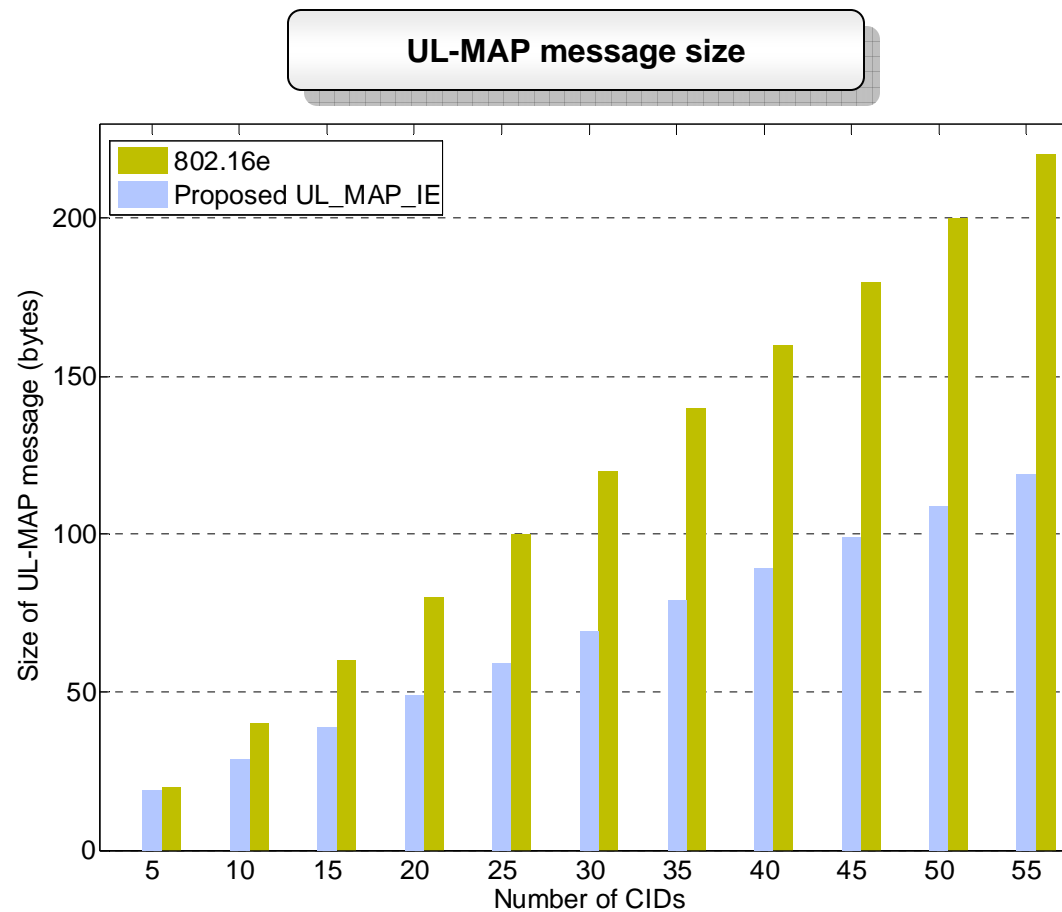
- Uplink (management plane):
 - Current standard supports one CID per UL-MAP IE.
 - An extension of current UL-MAP IE format is needed.
 - Provide support for uplink concatenation,
 - Reduce overhead in the management plane.
 - Maintain backward compatibility with legacy MSs/SSs.
 - The duration field may need to be lengthened.
 - Current size is only 10 bits.



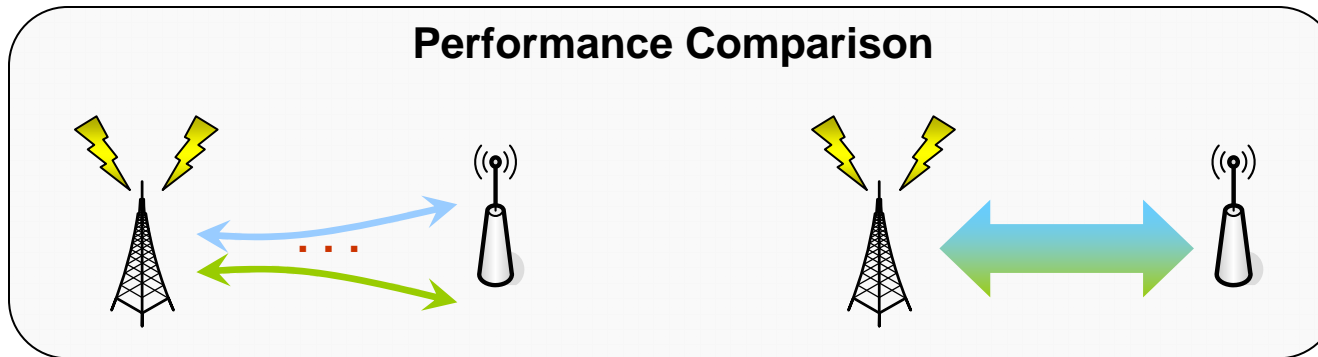
Management Message Overhead

- Major findings:

- The proposed simple scheme can reduce management plane overhead by more than 50%.



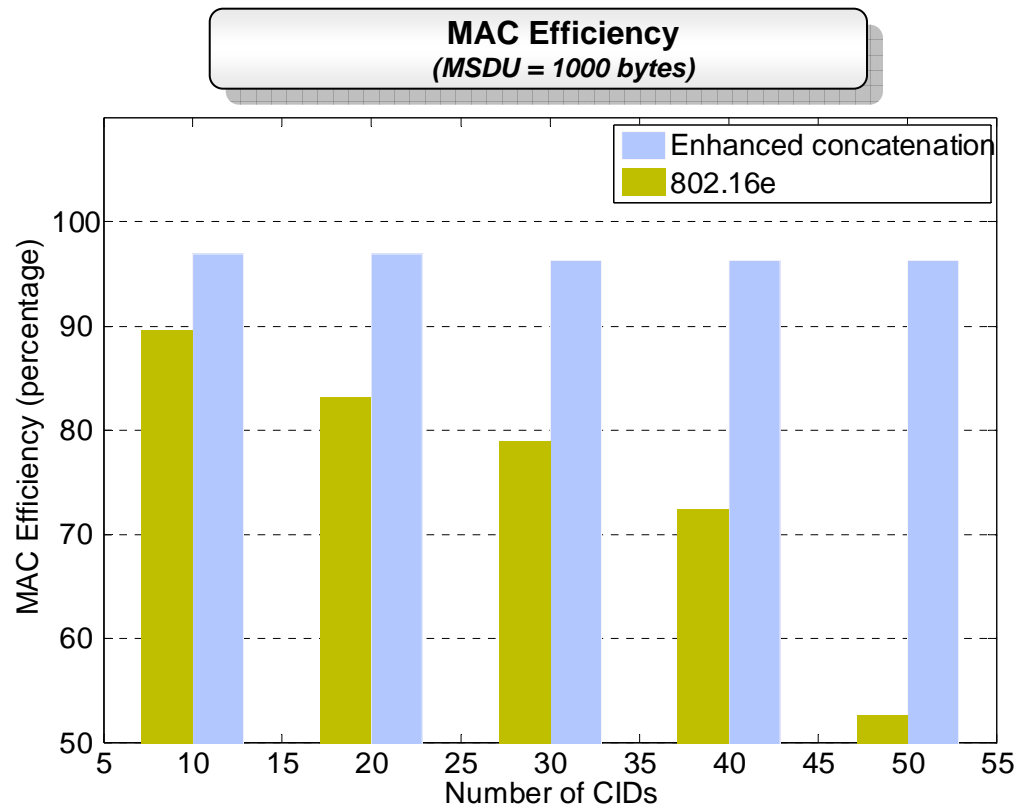
EC: Performance Evaluation



| Parameter | | | |
|--------------------------|------------------------------------|---|----------|
| DL | <i>PUSC (2 symbols per slot)</i> | Number of subchannels (DL PUSC) | 30 |
| UL | <i>PUSC (3 symbols per slot)</i> | Number of data subcarriers per subchannel (DL PUSC) | 24 |
| FFT size | 1024 | Number of subchannels (UL PUSC) | 24 |
| Channel bandwidth (BW) | 20 MHz | Number of data subcarriers per subchannel (UL PUSC) | 35 |
| MCS for data | <i>64 QAM with 3/4 coding rate</i> | Number of UL BW/RNG subchannels | 6 |
| MCS for preamble and MAP | <i>QPSK with 1/2 coding rate</i> | RTG | 10 us |
| Cyclic prefix (G) | 1/32 | TTG | 10 us |
| Sampling factor (n) | 28/25 | MSDU size | Variable |
| Period for DCD/UCD | <i>Every 10 frames</i> | Number of CIDs | Variable |
| Frame size | 20 ms | | |

EC: Performance Evaluation

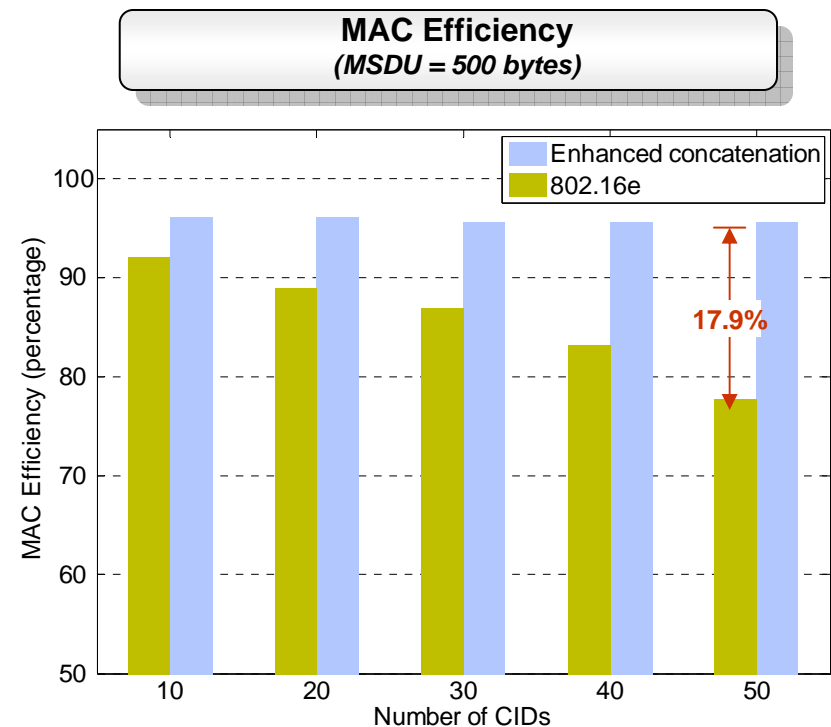
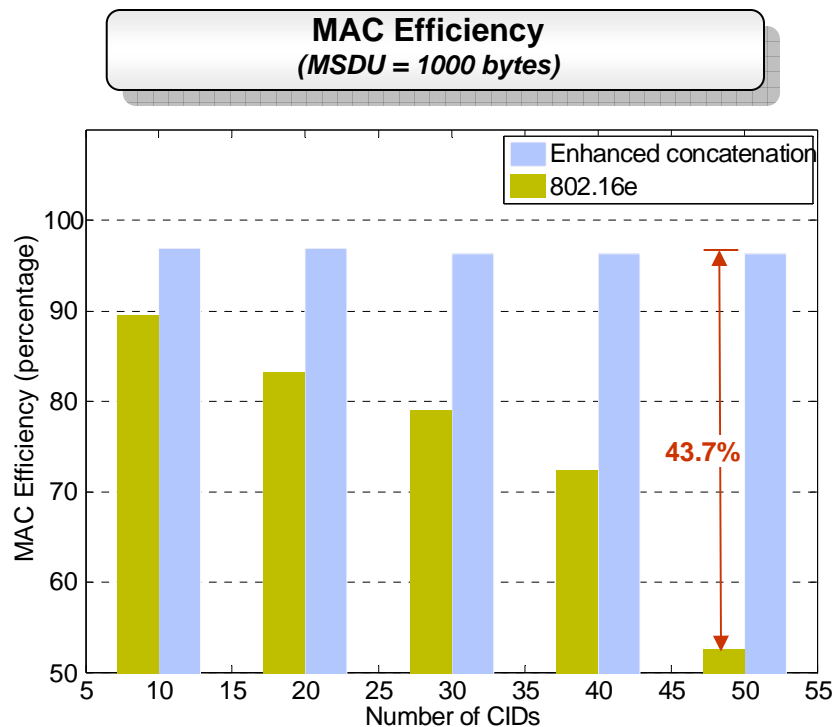
- Major findings:
 - The concatenation and UL-MAP IE extension provide significant MAC efficiency improvement (>40%)



EC: Performance Evaluation

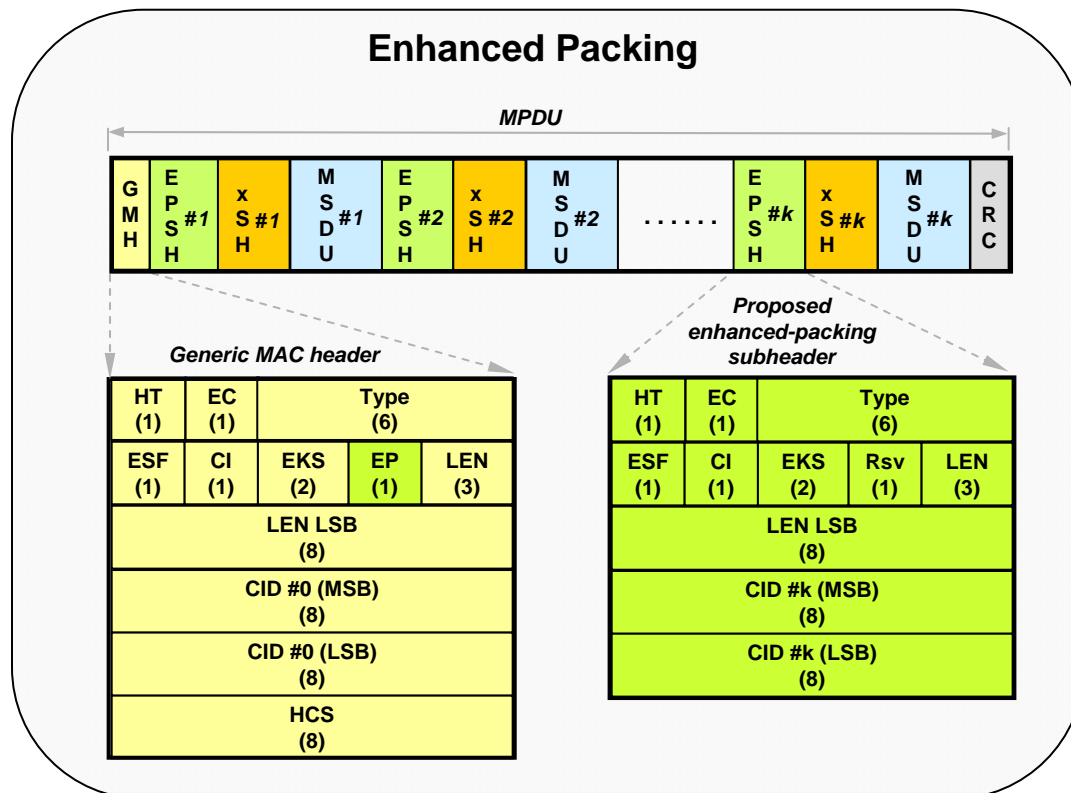
Major findings:

- The MAC efficiency is highly dependent on the *MSDU size*, and the *scheduling/OFDMA mapping* algorithm adopted.
- However, the efficiency improvement persists, throughout a wide range of MSDU size.



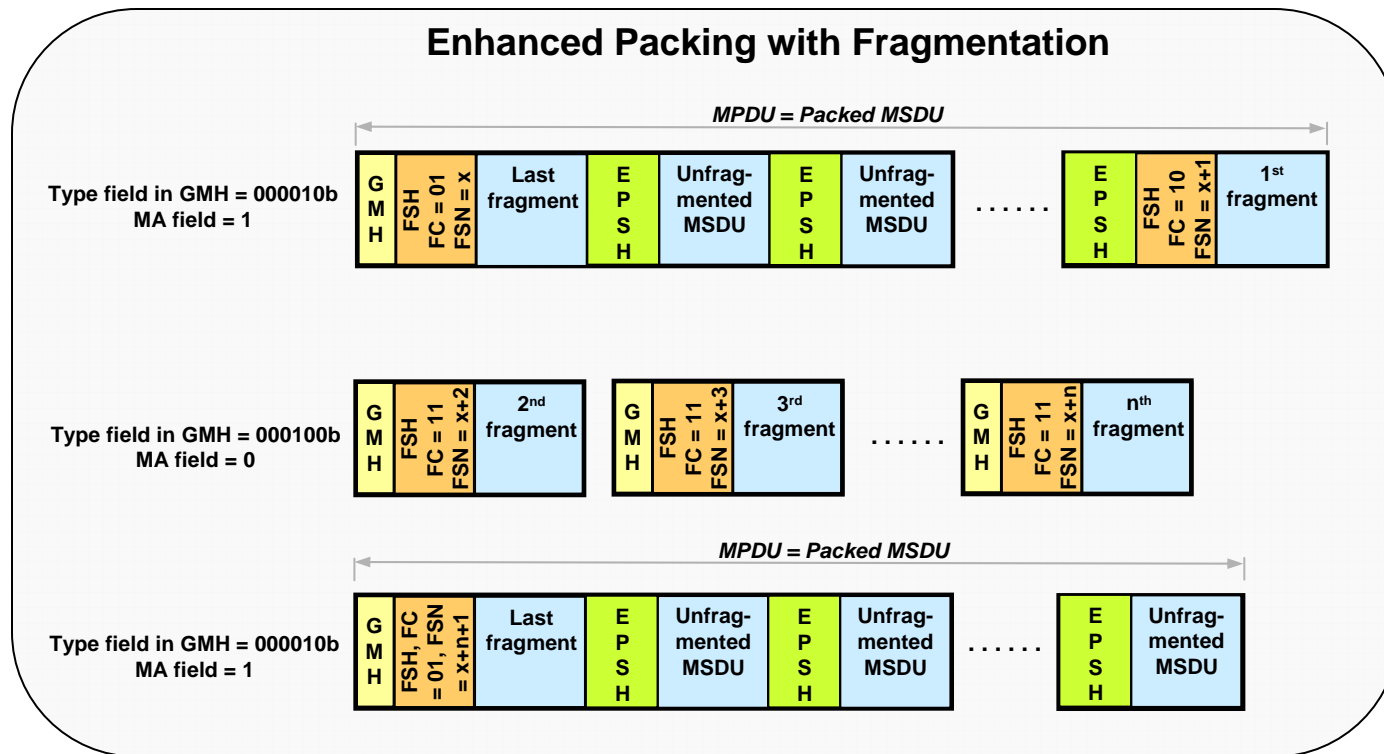
Enhanced Packing (EP)

- The packing defined in IEEE 802.16 only applies for MSDU of common CID.
- Enhanced packing attempts to extend the applicability of the packing to MSDUs of different CIDs but of common quality of service requirement.
- Options for EP indication:
 - The “Rsv” bit in the generic MAC header
 - The MSB of the type field in generic MAC header (**mesh bit**)
 - Any impossible combination of these 6 bits in the type field
- The “Length” field in the generic MAC header should describe the total length of the MPDU.
- The “CID” field in the generic MAC header is a CID that the intended destination can recognize.



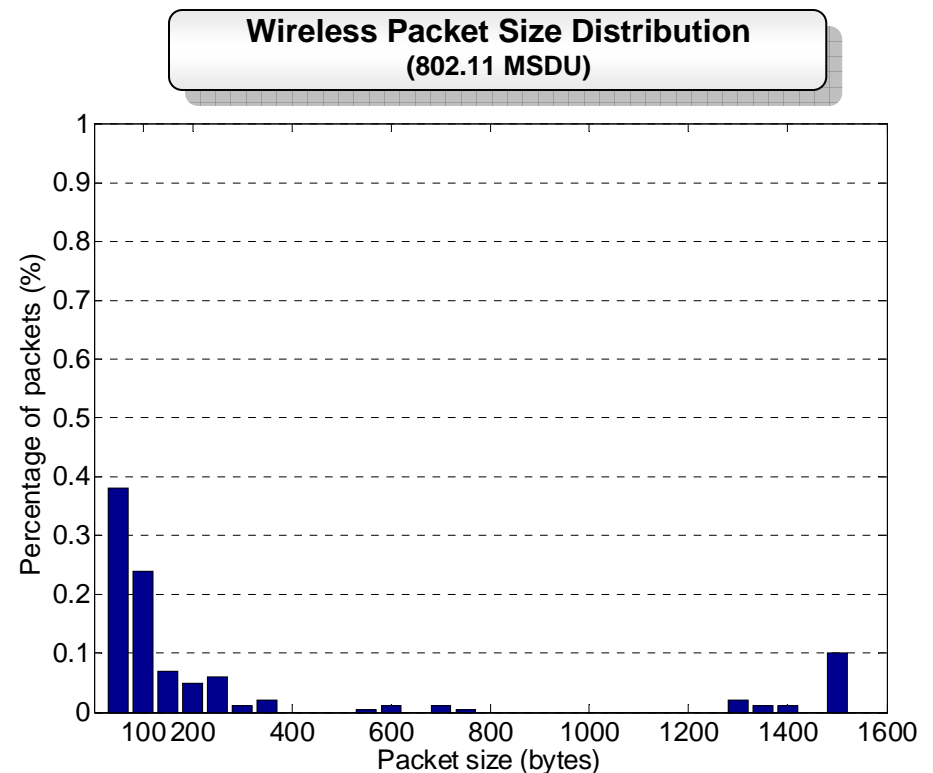
EP with Fragmentation

- Enhanced packing and fragmentation can occur in parallel, in the same way as the coexistence of packing and fragmentation.



EP: Performance Evaluation

- **Evaluation: Mixed traffic**
 - Short packets represent a significant portion of traffic in both wired backbone [1] and wireless access network [2][3].
 - IEEE 802.16e has also defined many short management packets.
 - Use the traffic statistics provided in [1~3], the overall MAC efficiency for 802.16e system and MSDU aggregation with *mixed traffic* can be computed.
- **Major findings:**
 - Enhanced packing can achieve similar level (**66%**) of efficiency improvement as legacy packing defined in 802.16-2004.



Key Observations & Summary

- Transmission between RS and BS (both UL and DL) can invoke the concatenation mechanism defined in 802.16/802.16e.
- The associated management messages (i.e., DL-MAP, DCD, UL-MAP, and UCD) describe the allocated resources in an aggregate manner for a set of connections between BS and RS.
- We propose to *enhance* the *current UL-MAP IE* format to support multiple CIDs in the UL.
- We propose to *enhance packing* to extend its applicability to MSDUs of different CIDs but same QoS requirement.

References

1. *IP Data Analysis*, Applied Research Lab of Sprint, January 10th, 2005, <http://ipmon.sprint.com/packstat/viewresult.php?NULL:pktsz:sj-01.0-050110:>
2. C. Na and T. S. Rappaport, “Measured Wireless LAN Public Hotspot Traffic Statistics”, *IEEE Electronics Letters*, Vol. 40, Issue 19, September 16, 2004
3. J. Yeo, M. Youssef and A. Agrawala, “Characterizing the IEEE 802.11 Traffic: The Wireless Side”, Technical report, Department of Computer Science, University of Maryland, March 1, 2004 <http://www.cs.umd.edu/~moustafa/papers/CS-TR-4570.pdf>