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Source(s)	Shulan Feng Hisilicon Tech. Co., LTD Bld.17, No.8, Dongbeiwang West Road, Hai-Dian District, Beijing, P. R. China Voice: +86-10-82829151 Fax: +86-10-82829075 e-mail to : fengsl@hisilicon.com Wu Xuyong Huawei, Huawei Industry Base, Bantian, Longgang, Shenzhen, China 518129 Voice: +86-755-28976776 Fax: E-mail to : wuxuyong@huawei.com，
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Abstract	This contribution analysis the backward compatibility problem of CX-Frame and gives the solution which could be get better backward compatibility.
Purpose	Accept.
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Consideration on CX-Frame backward compatibility

Shulan Feng
HiSilicon Technologies Co., LTD
Xuyong Wu
Huawei Technologies, Co., LTD

Introduction

To improve the frequency efficiency and avoid interference, 4-frames time sharing frame structure, CX-Frame, is used in 16h. There are at least four types of CX-Frames in current 16h working document, including

☐ Master/Borrowed/Shared CX-Frame structure shown in section 6.4.2.3.4

☐ Master/Slave/Shared CX-Frame structure shown in figure h53 of section 15.4.2.1.2

☐ Master/Slave/Shared/common CX-Frame structure shown in figure h54 of section 15.4.2.1.2

☐ CXCBP frame structure shown in section 15.4.2.1.3

In all these CX-Frame structure, preamble and MAP are transmitted every DL subframe and frame. Then SS in interference free area may receive more than one preamble and MAP in one frame. And SS in interference area can't receive any preamble and MAP during some frames. The following figure shows one example in case of three systems sharing one channel. Blue arrows indicate the preambles SS can receive. Black arrows indicate the preambles that SS can't receive.
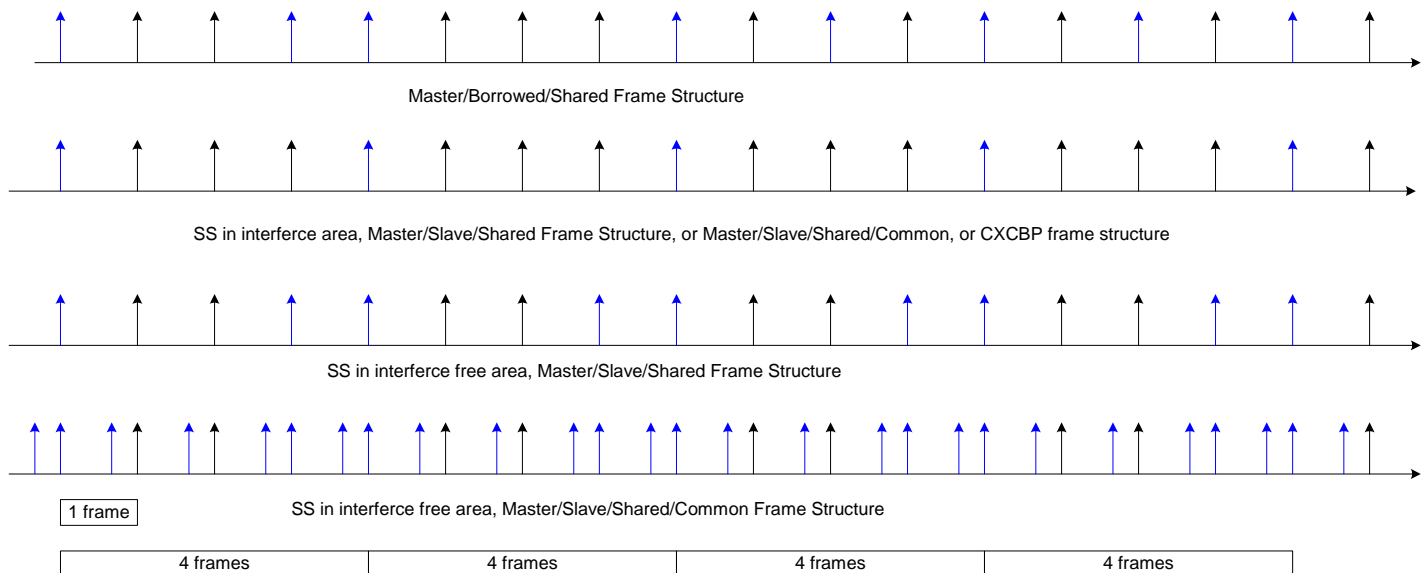

Figure 1

Non-periodic preamble and MAP make the PHY change corresponding to legacy standard and make SSs hard to perform synchronization. More than four types of CX-Frame structures further make the situation worse. To get good compatible to legacy standard, preamble and MAP had better to be transmitted fixed and periodic.

Considering in CX-Frame structure, all SSs can communicate with its serving BS's during master subframe/frame. And the master subframes are periodic. So we propose preamble and MAP are transmitted once every CX-Frame and they are transmitted only in master subframes. That is, the MAP in master subframes includes the resource allocation MAP of shared frame, borrowed frame, CXCBP frame and common subframe. SSs in interference area will be scheduled to master subframe and SSs in interference free area can be scheduled to any of subframe.
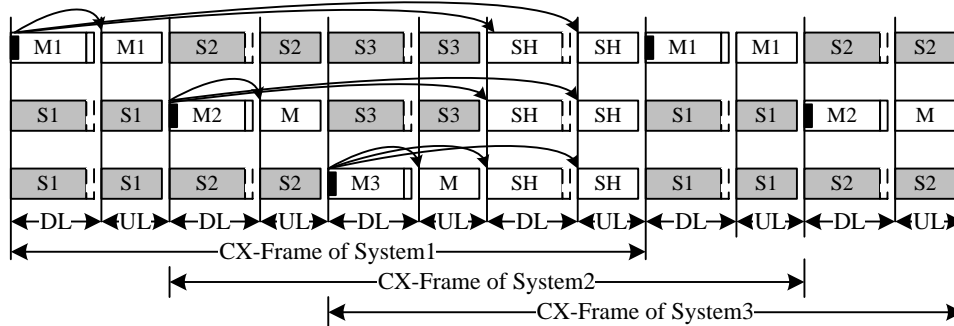

Figure 2 example of three 16h systems coexistence within neighborhood using CX-Frame

Then for SSs, no matter what CX-Frame structure is used, they think the CX-frame structure as a 20ms frame. It also looks like CX-Frame structures don't introduce any PHY change. And since preamble and MAP are transmitted once every four frames, the bandwidth efficiency is improved too. Another big advantage is that it can be compatible to all four CX-Frame structures in [1].

Actually, 16h working document [1] has already included part of this idea some degree. For example, [1] requests ranging slot be scheduled only in master slot. And in CXCBP mode, resource allocation of CXCBI is included in the MAP of master subframe too.

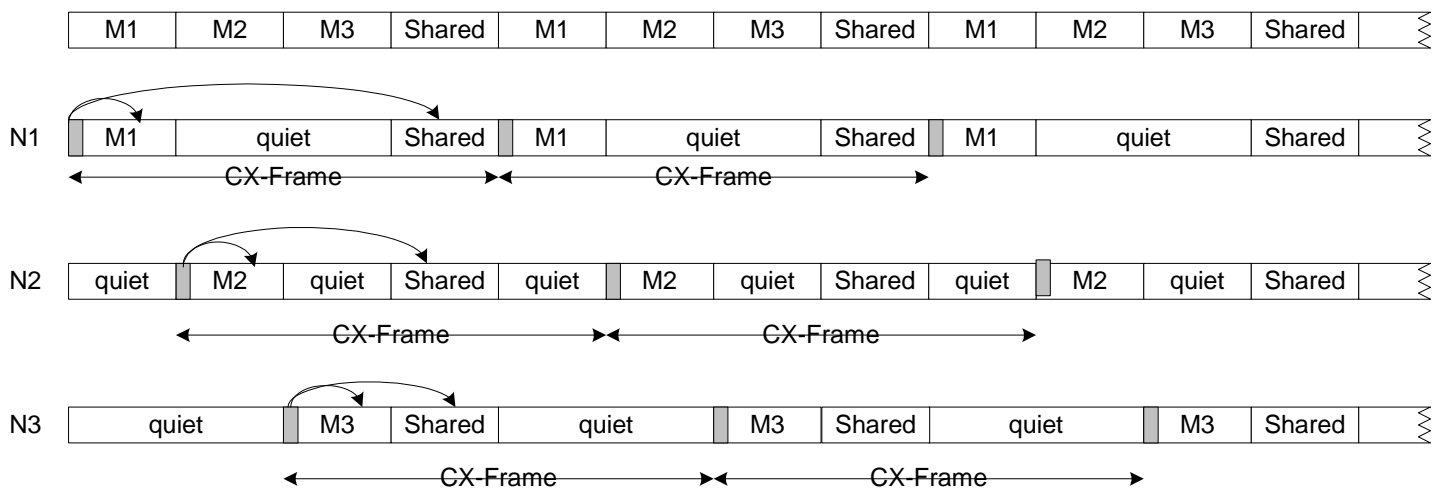Following figures show some applications of this idea.

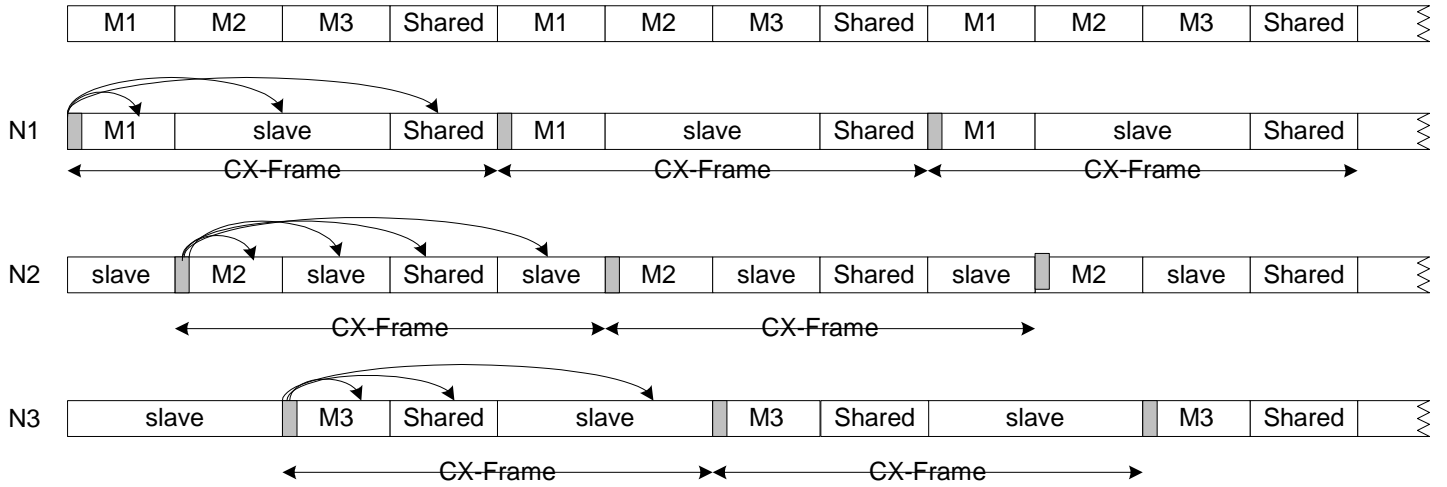Figure 3 Master/Shared CX-frame structure

| M1 | M2 | M3 | Shared | M1 | M2 | M3 | Shared | M1 | M2 | M3 | Shared |

N1 | | M1 | slave | Shared | | M1 | slave | Shared | | M1 | slave | Shared |

CX-Frame ← → CX-Frame ← → CX-Frame

N2 | slave | | M2 | slave | Shared | slave | | M2 | slave | Shared | slave | | M2 | slave | Shared |

CX-Frame ← → CX-Frame

N3 | slave | | M3 | Shared | slave | | M3 | Shared | slave | | M3 | Shared |

CX-Frame ← → CX-Frame

Figure 4 Master/Slave/Shared CX-frame structure

| M1 | M2 | M3 | S1 | M1 | M2 | M3 | S2 | M1 | M2 | M3 | S3 | M1 | M2 | M3 | S1 |

N1 | | M1 | quiet | S1 | | M1 | quiet | | M1 | quiet | | M1 | quiet | S1 | |

CX-Frame ← → CX-Frame ← → CX-Frame ← → CX-Frame

N2 | quiet | | M2 | quiet | | M2 | quiet | S2 | quiet | | M2 | quiet | | M2 | quiet |

CX-Frame ← → CX-Frame ← → CX-Frame

N3 | quiet | | M3 | quiet | | M3 | quiet | | M3 | S3 | quiet | | M3 | quiet |

CX-Frame ← → CX-Frame ← → CX-Frame
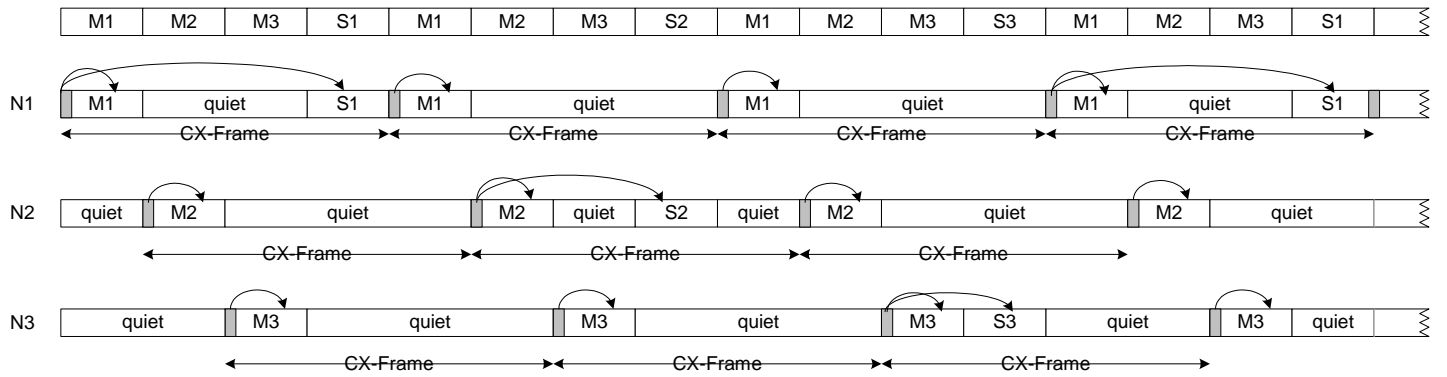
Figure 5 Master/Borrowed/Shared CX-frame structure

| C | M1 | C | M2 | C | M3 | Shared | C | M1 | C | M2 | C | M3 | Shared |

N1 | C | | M1 | C | slave | C | slave | Shared | C | | M1 | C | slave | C | slave | Shared |

CX-Frame ← → CX-Frame

N2 | C | slave | C | | M2 | C | slave | Shared | C | slave | C | | M2 | C | slave | Shared |

CX-Frame

N3 | C | slave | C | slave | C | | M3 | Shared | C | slave | C | slave | C | | M3 | Shared |
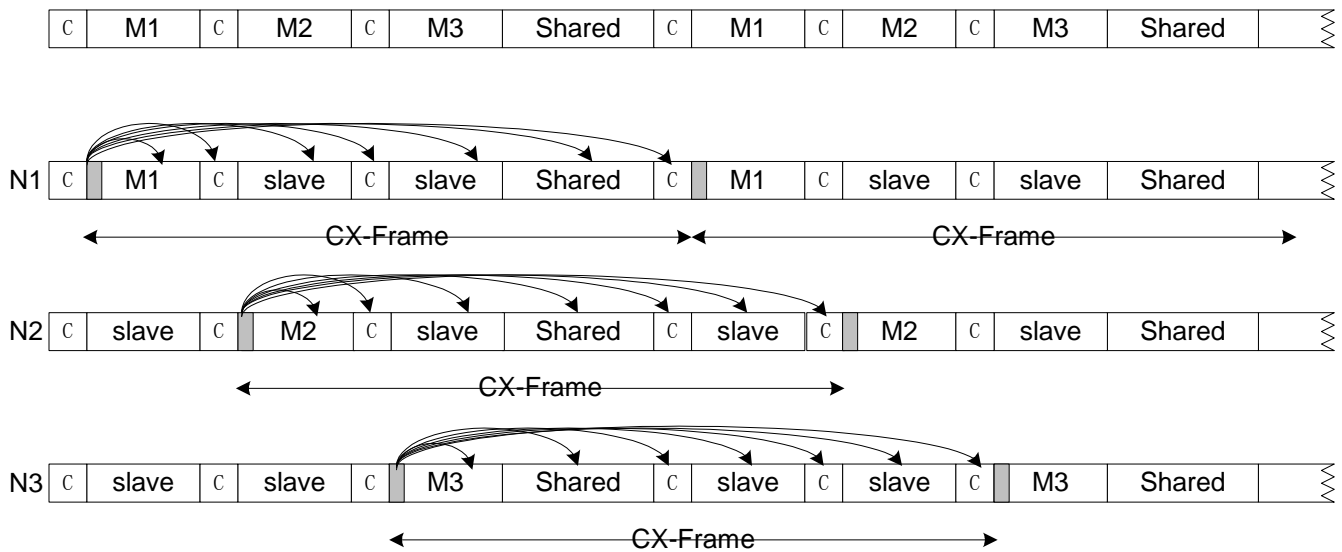
CX-Frame

Figure 6 Master/Slave/Shared/Common CX-frame structure

3

| M1 | M2 | CXCBP | M1 | M2 | CXCBP | M1 | |

N1 | | M1 | slave | CBP | | M1 | slave | CBP | | M1 | |

CX-Frame ◄►◄ CX-Frame ►

N2 | slave | | M2 | CBP | slave | | M2 | CBP | slave | |

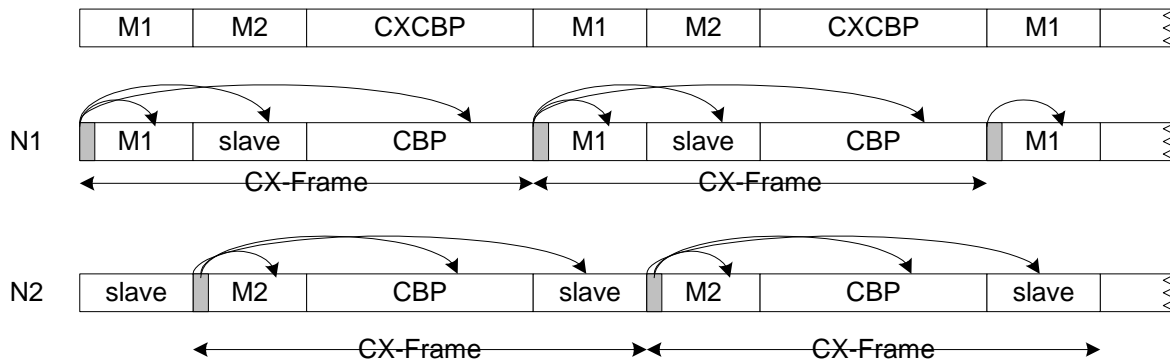CX-Frame ◄►◄ CX-Frame ►

Figure 7 CX-CBP CX-frame structure

Conclusion

The CX-frame structures in current LE working document [1], preamble and MAP are transmitted every subframe and frame. Then SS in interference free area may receive more than one preamble and MAP in one frame. And SS in interference area can't receive one preamble and MAP every frame. Non-periodic preamble and MAP make the PHY change corresponding to legacy standard and makes SSs hard to perform synchronization. More than four types of CX-Frame structures further make the situation worse.

So we propose preamble and MAP are transmitted once every CX-Frame and they are transmitted only in master subframes. That is, the MAP in master subframes includes the resource allocation MAP of shared frame, borrowed frame, CXCBP frame and common subframe. SSs in interference area will be scheduled to master subframes and SSs in interference free area can be scheduled to any of subframes.

Then for the SSs, no matter what CX-Frame structure is used, they think the CX-frame structure as a 20ms frame. So this setting can get good backward compatibility. And since preamble and MAP are transmitted once every four frames, the bandwidth efficiency is improved too. Another big advantage is that it can be compatible to all four CX-Frame structures in [1].

Proposed Text

15.1.4.2 Frame Structure for interference prevention & resolution

In order to isolate interference, repetitive MAC frame structures grouped in a CX-Frame are provided in the time domain. The CX-Frame includes Master and Slave sub-frames. During a Master subframe, the data transmission will use the maximum capable and allowed operating EIRP. The data reception will not be affected by harmful interference from other members of the coexistence community. The activity during the Slave sub-frames is restricted, such that it will not cause interference to systems using their Master subframe. If communication via the CXP Protocol cannot be established between two systems then their use of slave frames during each others' master frame allocations is forbidden.

Resource allocation shall be scheduled within CX-frame duration in WirelessMAN-CX systems. The Preambles and MAPs are transmitted in the DL master frames only. The MAPs in master subframes shall be used to

indicate the resource allocation of this system in a CX-Frame, possibly includes the resource schedule in master subframe, shared frame, slave subframe, borrowed frame, CXCBP frame and optional common subframe. SSs with harmful interference within neighborhood shall be scheduled to use master subframes. SSs without harmful interference within the neighborhood may be scheduled to use any of subframes within the CX-Frame.

The frame duration IE in DL-MAP message should be assigned to the duration of the CX-Frame.

Reference

[1] IEEE 802.16h-D2c: Air Interface for Fixed Broadband Wireless Access Systems: Amendment for Improved Coexistence Mechanisms for License-Exempt Operation
[2] IEEE 802.16-2004: Air Interface for Fixed Broadband Wireless Access Systems
[3] IEEE 802.16-2005: Air Interface for Fixed Broadband Wireless Access Systems: Amendment 2: Physical Media Access Control Layers for combined fixed and mobile operation in license band