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Draft of Consolidated Control Channel

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These notes on the form and function of the consolidated CXCC are based on discussions from 20 April 2007 to date.

- Four sub-channels are specified which carry the Coexistence Control Channel sub-frames and the ICSI/OCSI Fragmentary Bits.
- CXCC sub-frames and OCSI fragmentary bits are associated with a specific Master Frames.
- CXCC sub-frames and CSI slots often share common Master Frames.
- Silent or No Activity frames are used by slave systems during Master Frames containing the CXCC sub-frame. In these frames the slave transmission ceases.
- CSI slots for fragmentary signaling of RSSI are appended to the ends of Master Frames, at the TTG gap. The duration of the CSI slot is called Tcsi
- The TTG gap itself would not contain any signaling information. It would typically be ~2-5 us in duration. Details TBD.
- The downlink CXCC sub-frame is called the CXCC_DCnSn. This part carries messages such as BSD, radio signatures, and other types of CXP messages and signaling. The uplink CXCC part sub-frame is called the CXCC_UCnSn and it carries messages such as SSURFs and any other CXP messages. Cn is the CX_CSI cycle number of interest, Sn is the System of interest.
- When the Master frame of a specific system extends into the DL_CSI, the CSI Fragmentary Bit=1. When the DL_CSI is unoccupied, the CSI Fragmentary Bit =0.
- All CXCC slots as associated with specific systems (S1,S2,S3) and there respective OCSI. There are the 3 CXCC Sub-Channels. There is a fourth subchannel (ICSI) , only used for ICSI Fragmentary Bit transmission.
- (Io+No) interference measurement can take place during the Zero Fragmentary bits located at the end of the ICSI and OCSI subchannels. These measurements detect all interference due to Non-WirelessMAN-CX systems. The DL measurements taken during DL_CSI, will be undertaken by the SS. There will be similarly scheduled UL_CSI which allow the BS to undertake similar measurements. This measurement is essentially (Io+No)min.
- Similarly, the Fragmentary 1 bits can be used to determine the full level of interference, created by all of the BS in a region, as measured at a the SS. This measurement is essentially (Io+No)max.
- Specific CXCC sub-frames will be identified as universally vacant to allow absolute identification and measurement of the interference created by a system. These sub-frame will be occupied by a system on a randomly chosen, but thereafter periodic manner. The probability of two systems occupying the same sub-frame will be ~ 1%

The CXCC channel follows a fixed periodic structure that will allow any BS, once synchronized to a universal timing standards such as GPS, to determine the location of the CXCC sub-frames and the OCSI/ICSI Fragmentary bit slots. To facilitate this, a number of CXCC timing definitions are provided.

- The 4 Subchannels are consecutive.
- The 4 subchannels are repeated every (***P***) frames, which is called a CX_CSI cycle
- The duration of a CX_CSI Cycle is Tcx_cycle.
- Each CX_CSI Cycle has a Cycle Number (Cn) which has a value from 1 to 256.
- 256 CX_CSI cycles are required to completely transmit a CSI message composed of 256 Fragmentary Bits. This period is called an "Epoch".
- The duration of an Epoch is T_Epoch. {T_Epoch = 256 X (***P***) X (***FD***)}, where ***FD*** is the Frame Duration.
- The number of Epochs in a day is calculated by dividing (86,400 sec)/ T_Epoch
- Each Epoch can be specifically identified by its Epoch Number (Epoch_Nm)
- The current Epoch_Nm can be determined by an GPS slaved BS. It is simply {(INT [***T***]/T_Epoch) +1}……Where ***T*** is the time of day in seconds from UTC 00:00:00.
- The location of the CXCC slots can be determined simply by knowing the Frame Number of the transmissions. Each Epoch begins with Frame Number 0.

The CXCC consists of Four sub-channels which are labeled and have the following functionality as follows:

Sub-channel	Function	Details
CX_ICSI	*The ICSI channel*	*Used for initializing BS*
CX_OCSI_1	*The OCSI channel for System 1.*	*Used by the BS occupying System 1.*
CX_OCSI_2	*The OCSI channel for System 2*	*Used by the BS occupying System 2.*
CX_OCSI_3	*The OCSI channel for System 3*	*Used by the BS occupying System 3.*

Table 1 Sub Channels of the CXCC

- The OCSI slot of a Master system is a continuation of the Master system's downlink frame. (see Figure 2)..
- The CX_ICSI slot is found in the Shared Frame. Only an Initializing BS is allowed to transmit during this slot, regardless of any operating systems master frame.
- Over the duration of one Epoch each sub-channel has 256 CSI slots available to it and a smaller number (85) of CXCC_DxxSn/UxxSn sub-frames.

The location of the CXCC sub-frames in an Epoch is determined by counting the CX_MAC_NO. CX_MAC_NO = 0 always denotes the beginning of an Epoch. The following table gives the locations and identities of all the control channel zones in an Epoch.

CXCC or CSI Function	**Content of DL_CSI or CXCC Sub Frame**	**Content of UL_CSI Or CXCC Sub Frame**	**CX_MAC_NO of Specified CXCC Sub Frame or CSI Slot (Cn is the Cycle number)**
CX_OCSI_1 "1" bits for OCSI start	Extended Master Sub-Frame S1 (Io+No)Max	UL CXP Messages	(Cn-1)xP Cn=1-8
CX_OCSI_2 "1" bits for OCSI start	Extended Master Sub-Frame S2 (Io+No)Max	UL CXP Messages	1+(Cn-1)xP Cn=1-8
CX_OCSI_3 "1" bits for OCSI start	Extended Master Sub-Frame S3 (Io+No)Max	UL CXP Messages	2+(Cn-1)xP Cn=1-8
CX_ICSI "1" bits for CSI start	Extended Master Sub-Frame (Io+No)Max	UL CXP Messages	3+(Cn-1)xP Cn=1-8
CX_ICSI information bits	Extended Shared Sub-Frame	Not applicable	3+ (Cn-1)xP Cn=9-248
CX_OCSI_1 information bits	Extended Master Sub-Frame S1	Not applicable	(Cn-1)xP Cn= 9-248
CX_OCSI_2 information bits	Extended Master Sub-Frame S2	Not applicable	1+(Cn-1)xP Cn= 9-248

CX_OCSI_3 information bits	Extended Master Sub-Frame S3	Not applicable	2+(Cn-1)xP Cn= 9-248
CX_ICSI "0" bits for CSI start	Nothing (Io+No)min measure by SS	Nothing (Io+No) measure by BS	3+(Cn-1)xP Cn= 249-256
CX_OCSI_1 "0" bits for CSI start	Nothing (Io+No)min measure by SS	Nothing (Io+No) measure by BS	(Cn-1)xP Cn= 249-256
CX_OCSI_2 "0" bits for CSI start	Nothing (Io+No)min measure by SS	Nothing (Io+No) measure by BS	1+(Cn-1)xP Cn= 249-256
CX_ICSI_3 "0" bits for CSI start	Nothing (Io+No)min measure by SS	Nothing (Io+No) measure by SS	2+(Cn-1)xP Cn= 249-256
CXCC_D/UCnS1	DL CXP Messages	UL CXP Messages	(Cn-1)xP Cn=(1+3k) k=0-85
CXCC_D/UCnS2	DL CXP Messages	UL CXP Messages	1+(Cn-1)xP Cn=(1+3k) k=0-85
CXCC_D/UCnS3	DL CXP Messages	UL CXP Messages	2+(Cn-1)xP Cn=(1+3k) k=0-85

Table 2: Allocation of CXCC Sub Frames and OCSI/ICSI Slots to their respective CX_MAC_No during one Epoch

General Control Channel Sub-Frames

Control Channel Sub-Frames for a System occur during that system's Master Sub Frame. Whether they are used for control channel purposes or for regular data traffic, is up to the system. The Master Frames used by the system for CXCC purposes are special however in that the Slave Systems must cease all transmissions. This differs in comparison to usual operation where the Slave System can transmit during the slave sub-frame, but only on a non-interfering basis. Master Frames used for CXCC are less prone to interference as a consequence.

The General Control Channel Sub-Frames can be used for any type of CXP inter-system messaging, for detection of interference, Radio Signaling, etc.

Each sub-system has its set of CXCC sub-frames, which are located either in absolute time or by CX_MAC_No according to the above table and calculations.

CXCC subframes can be sent in the downlink and uplink. Downlink frames are called CXCC_DCnSn; where Cn identifies the CX_CSI cycle number in the Epoch and Sn identifies the System to which the CXCC is assigned to. There are 85 CXCC_DCnSn sub-frames per system giving a total of 255 per Epoch. The CXCC sub frames occur at every 3rd Cycle and the time between consecutive CXCC_DCnSn frames is calculated by {(P)x(Fd)x3}

Low Interference Control Channel Sub-Frames

While the CXCC sub-frames are sent during silent slave frames with co-channel interference from neighboring WirelessMAN-CX systems will generally quite low, there is still a liklihood that interference, especially at the periphery of a cell will be prevalent. In order to detect and quantify this type of interference, three (3) special control sub-frames are used per OCSI/ICSI sub-channel, of which a system randomly selects one for use. Once selected, that sub-frame is used every fourth Epoch. In this manner, two co-channel systems, located in the same geographical and are within interference range of each other will have a probability less than 1% of interfering with each other. This CXCC sub-frame will only be used for CXP messaging and will not be used for normal data carrying uses.

CXCC_D/U007S1	CXCC_D/U007S2	CXCC_D/U007S3

CXCC_D/U127S1	CXCC_D/U127S2	CXCC_D/U127S3
CXCC_D/U241S1	CXCC_D/U241S2	CXCC_D/U241S3

Table 3: Low Interference CXCC Sub-Frames for transmission of CXP Messaging. Randomly selectable and used only every fourth Epoch.

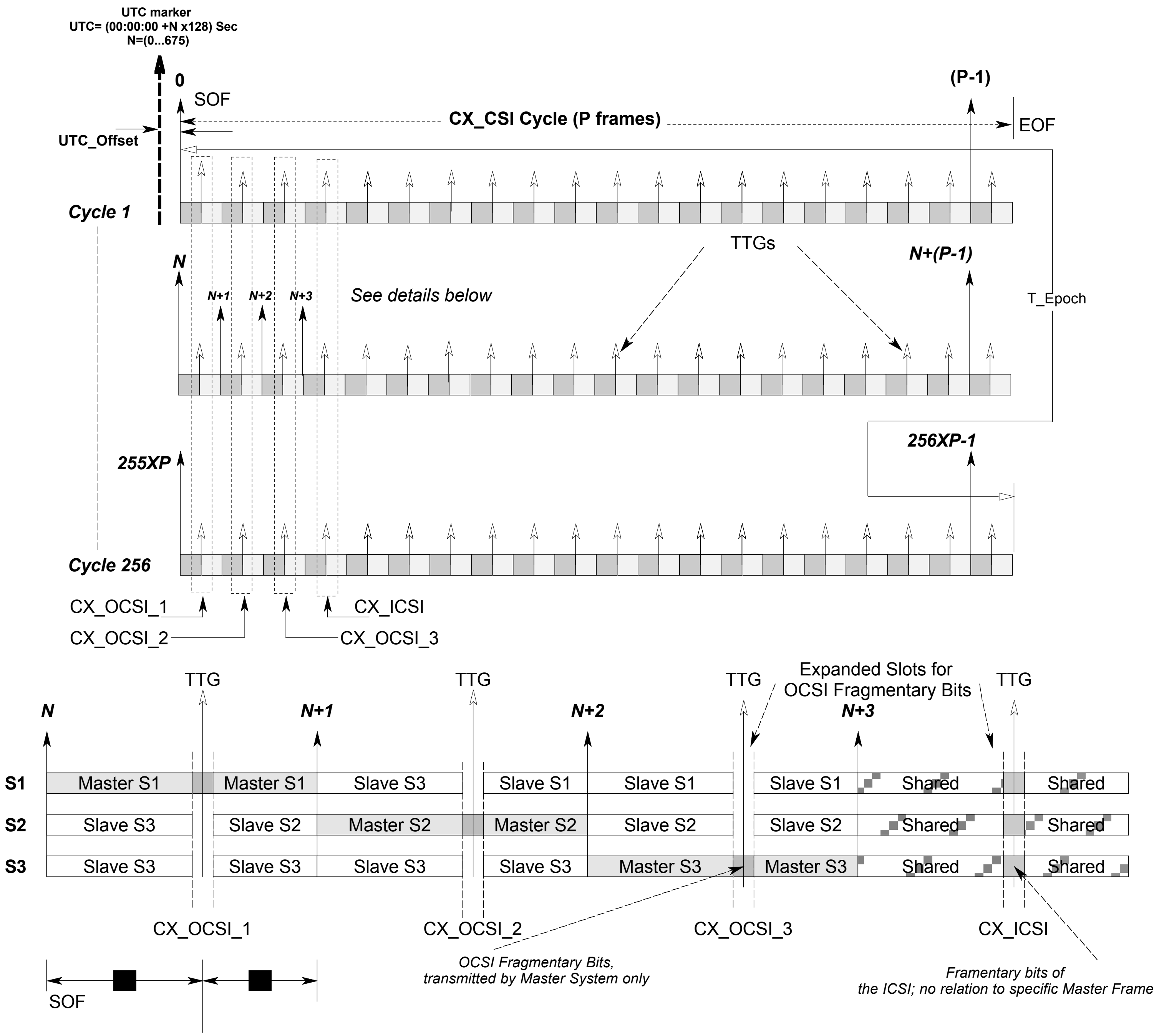
(Io+No) Noise Minimum and (Io+No) Noise Maximum Measurements

A system can undertake noise measurement during any of its CXCC subframes in order to determine the level of interference during its Master Subframe. This interference will be generally free of WirelessMAN-CX interference.

Noise and Interference measurements absolutely free of WirelessMAN-CX activity can be obtained by measuring during the OCSI/ICSI Zero Fragmentary Bits intervals. The frames containing these WirelessMAN-CX interference free slots are given in the Table 1 above. Simarly, during the Fragmentary Bit intervals equaling 1, it is possible to measure (at the SS) the maximum (Io+No) noise due to the coexistence community.

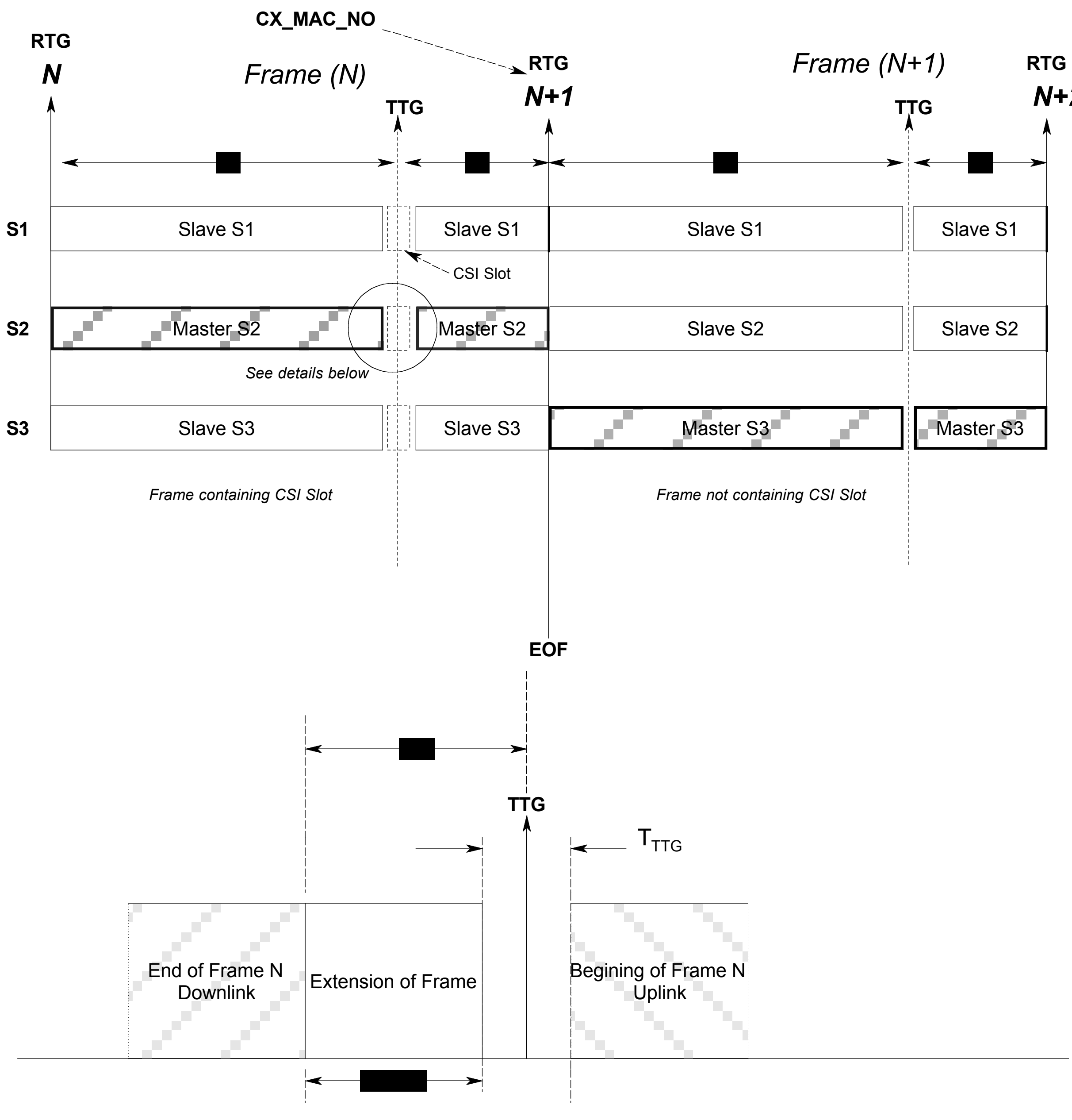
Frame Duration	5 msecs
P	100 frames
T_Epoch	128 Seconds
CX_CSI cycle time (Tcx_cycle)	500 msecs
Number of Epochs per day	675
UTC of CX_CTL channel slots	UTC + (0.5 sec x B) B=1-172,800
UTC of Frame 0 Epoch 1	UTC + UTC Offset
UTC Offset	2.0 Msec (assume DL/UL 3/2 ms)
% of Total Bandwidth used for CXCC	TBD
Tcsi	300 usec
Time Between CXCC_D/USn	1500 msec
No. Of CXCC per Epoch	85
Duration of CXCC_D/USn	TBD

Table 4 Example of pertinent values for 5 msec FD WirelessMA-CX Systems



Allocation of Fragmentary Bits for ICSI and OCSI signalling

Figure 1 Coexistence Control Channel (CXCC) Positions and WirelessMAN-CX Framing Structure



OCSI Fragmentary Bit=1 when Frame extends into DL _CSI
OCSI Fragmentary Bit=0 when Frame does not extend into DL_CSI

Figure 2: Details of CSI Slot at TTG

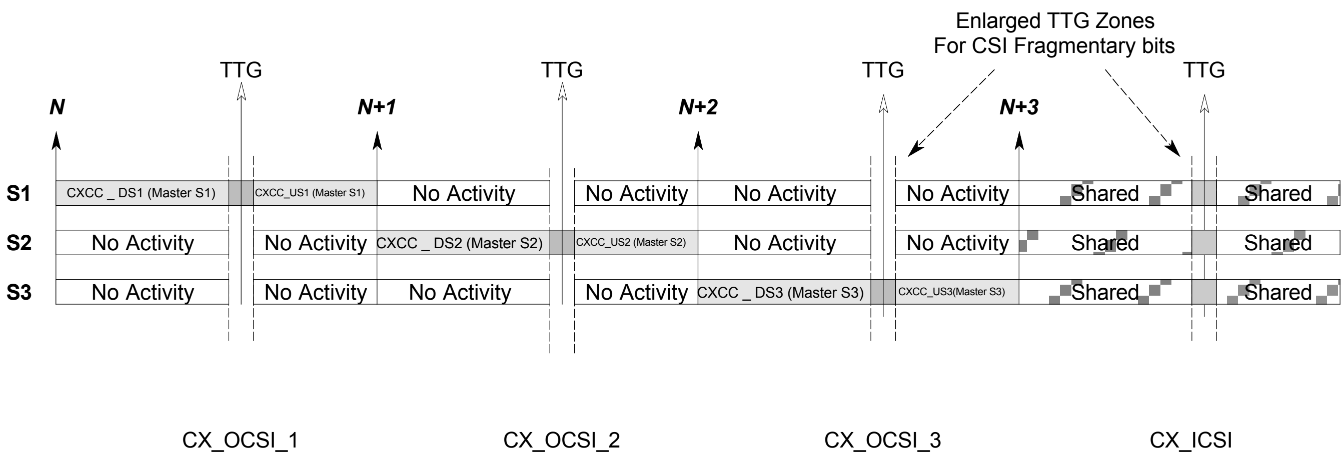


Figure 3: Allocation of CXCC Frames for Control sub-frame Usage