SEND_S Signaling for 1000BASE-T1 Initial Synchronization

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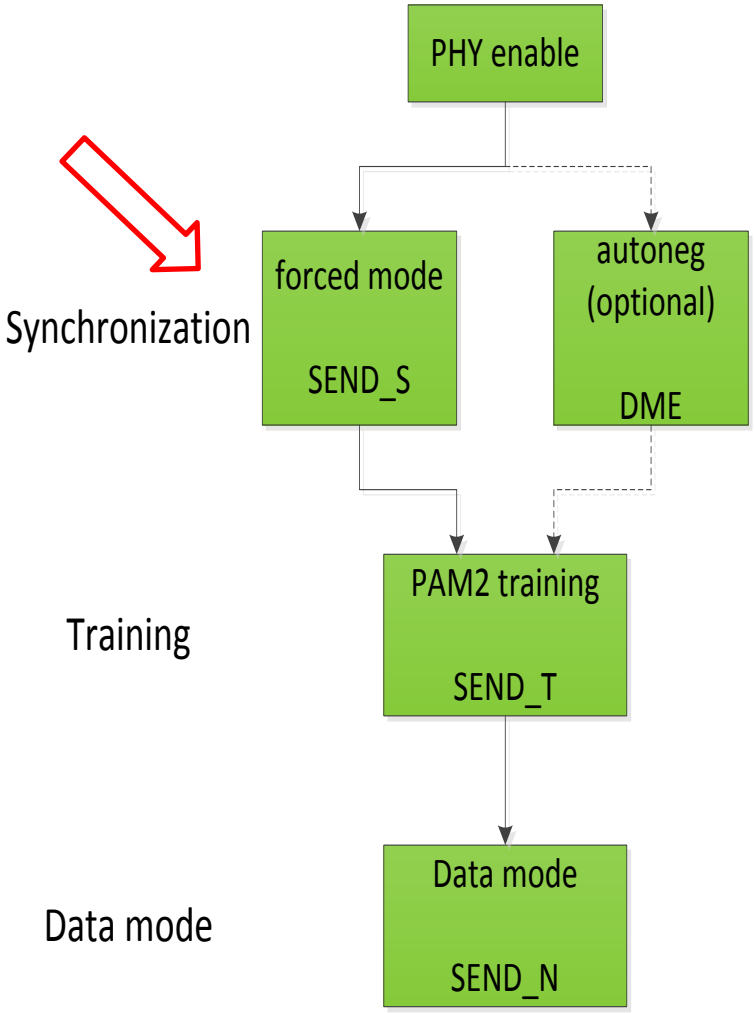
Overall Startup Sequence



TX Mode	Definition
SEND_Z	Send all zeros
DME	Differential Manchester encoding for autoneg
SEND_S	Send special periodic PAM2 sequences with good correlation properties
SEND_T	Send PAM2 training sequence
SEND_N	Send normal data

Overview

- **In July 14' plenary, a synchronization & start-up method was proposed (wang_3bp_01_0714.pdf)**
  - Detailed analysis was provided for a robust & fast handshake mechanism
  - Several corner cases were discussed
  - Essential timer values were defined (link_fail_inhibit_timer & break_link_timer)

- **In this contribution,**
  - SEND_S signaling is defined
  - Master and Slave Synchronization State Machines are refined
  - Simulation results are shown for various noise conditions

- **A baseline proposal for the synchronization is now complete**

Highlights

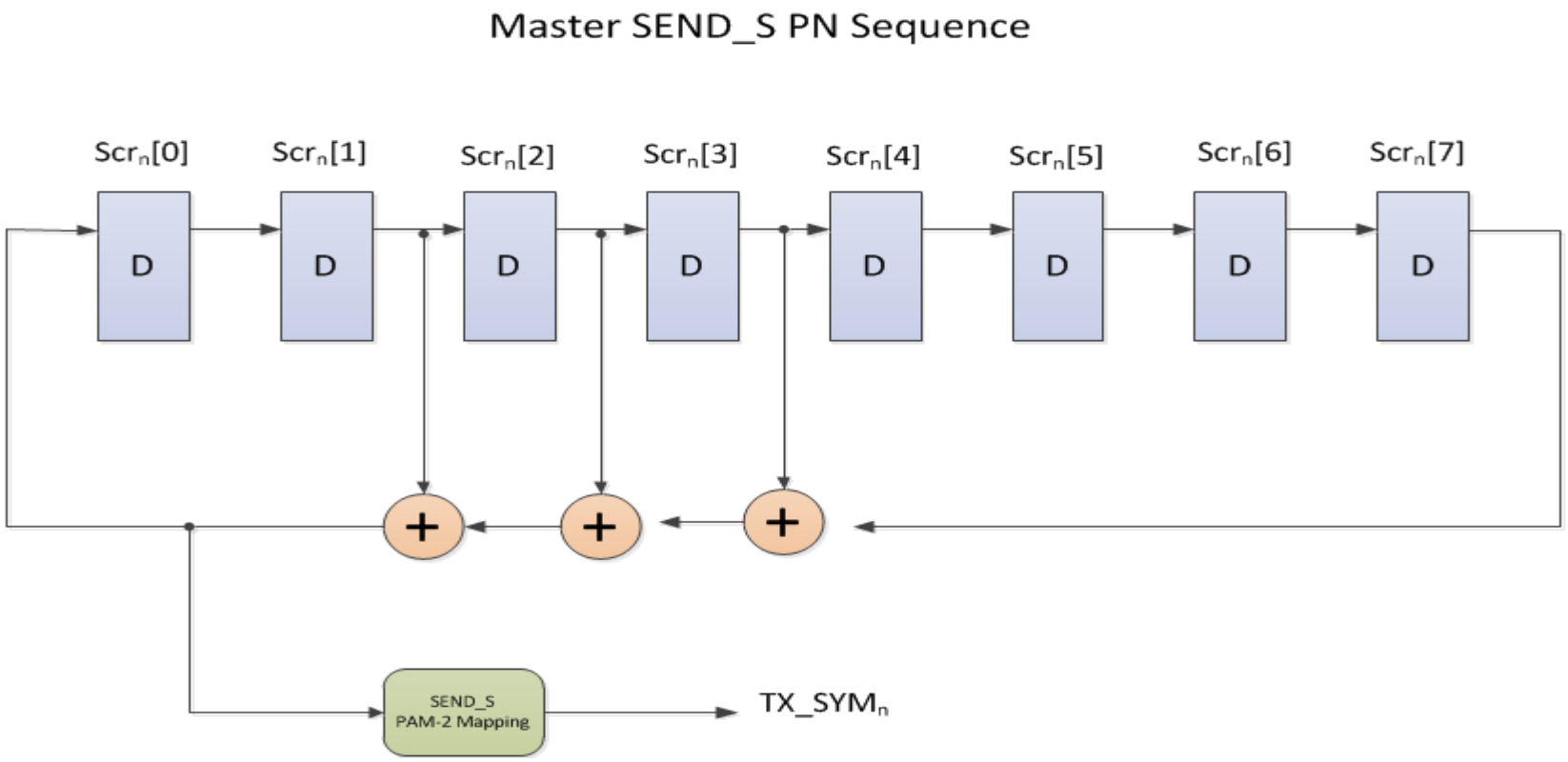
- SEND_S is based on wideband PAM-2 PN sequence
- The PN sequence should have a good autocorrelation characteristic
- Both Master and Slave will send its own 255 PN sequence (based on its 8^{th} degree polynomial)
- Matched Filter-based correlator can be used for PN sequence detection of SEND_S
- Simulations show that we can achieve very reliable detection of SEND_S under the worst case NBI or burst noise conditions

SEND_S Signaling

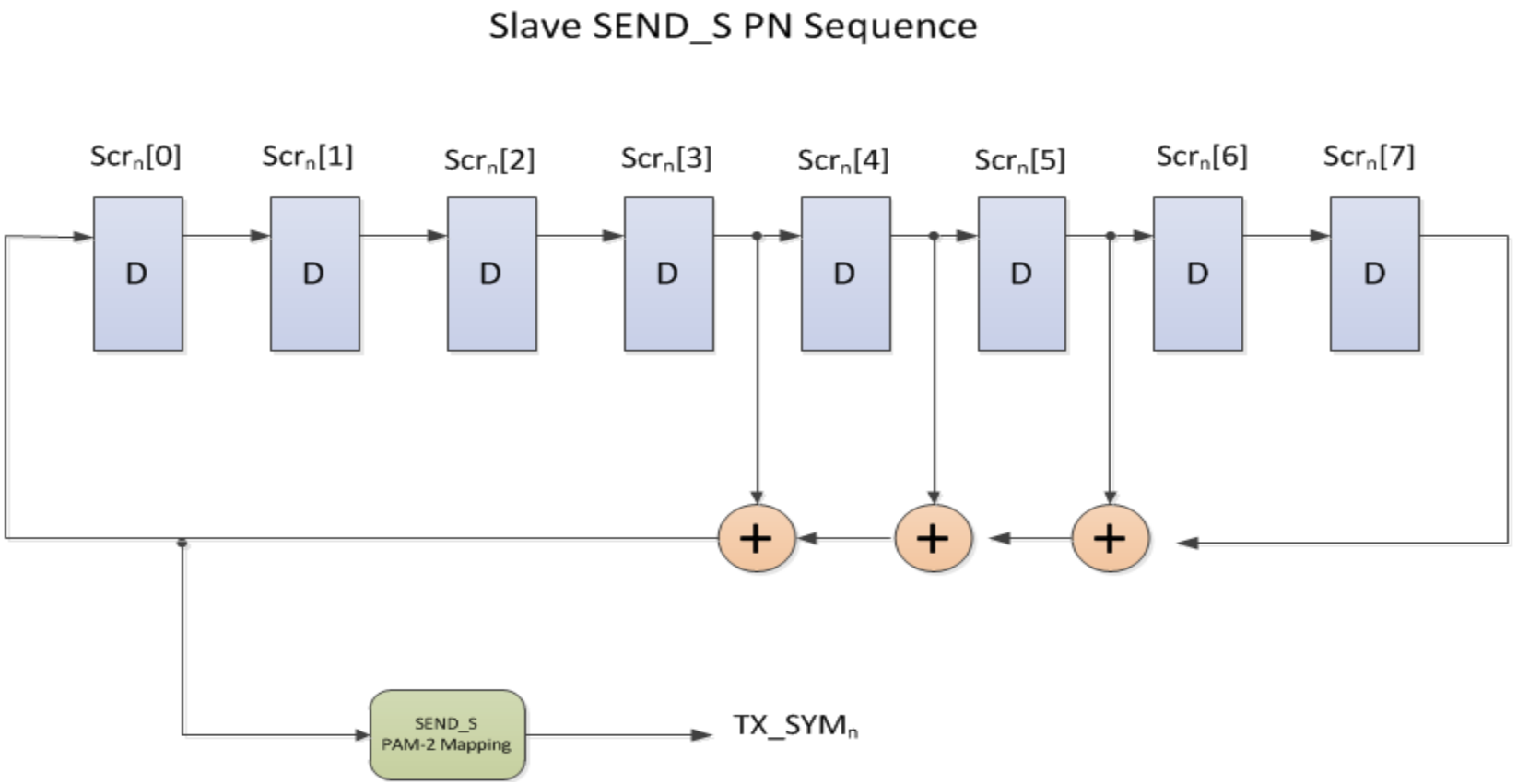
- Master and Slave polynomials for 255 PN sequence:
  - The scrambler generator polynomial for Master : $g_M(x) = 1 + x^2 + x^3 + x^4 + x^8$
  - The scrambler generator polynomial for Slave : $g_S(x) = 1 + x^4 + x^5 + x^6 + x^8$
  - The PN sequence has the period of 255 ($2^8 - 1$).
- PAM2 Signaling
  - PAM-2 signal is based on the scrambler output $Scr_n[0]$:

$Scr_n[0]$	$TXSYM_n$
0	-1
1	+1

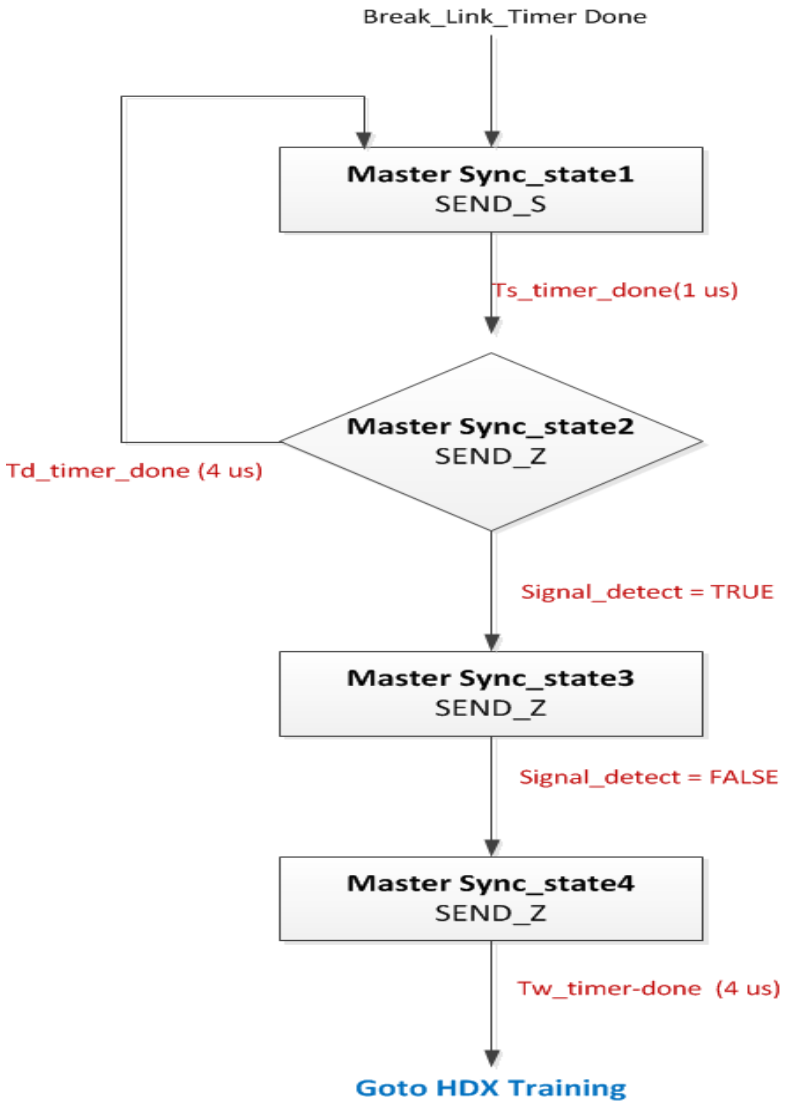
Master SEND_S Signaling



Slave SEND_S Signaling

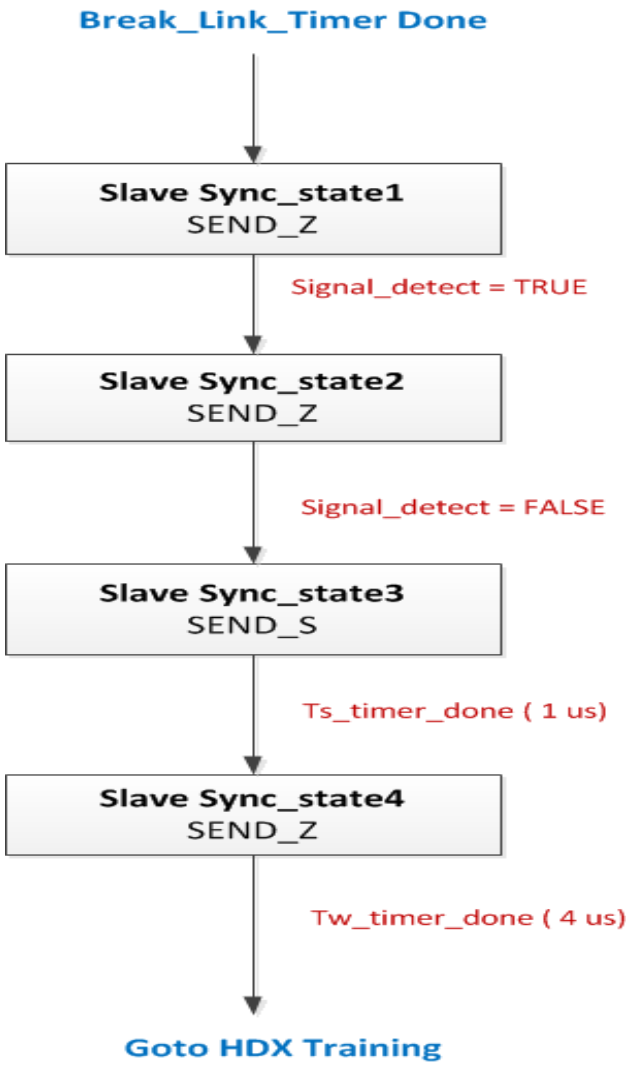


Master SEND_S State Machine



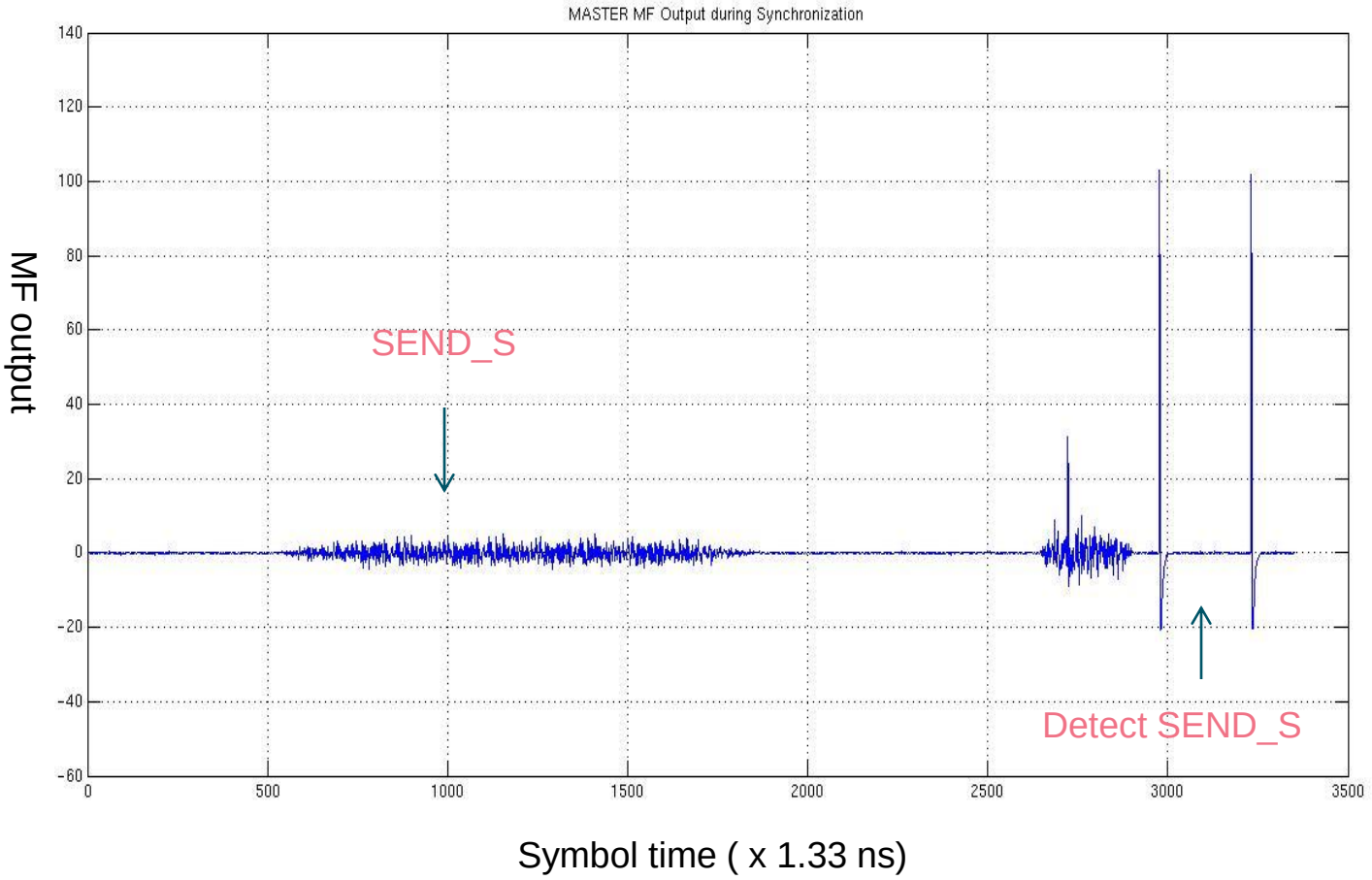
- **Ts_timer_done** is the duration for SEND_S (send 4 frames to the slave)
- **Td_timer_done** is the maximum time Master will stay in Sync_state2 to detect SEND_S from Slave
- **Tw_timer_done** is the time that both Slave and Master will stay in its Sync_state4 to wait 4 us

Slave SEND_S State Machine



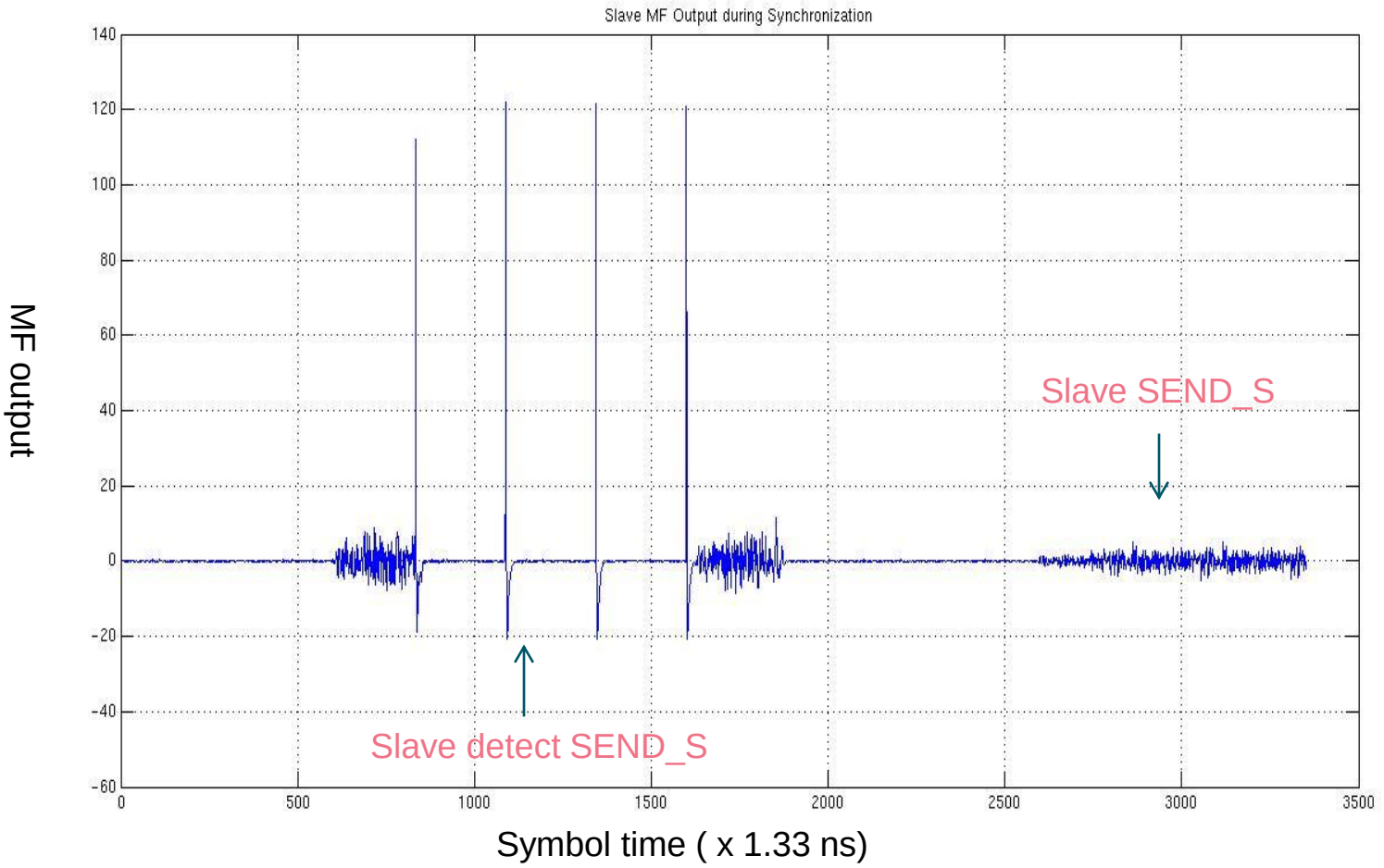
Master SEND_S Detection

- Master MF output during synchronization (without noises):



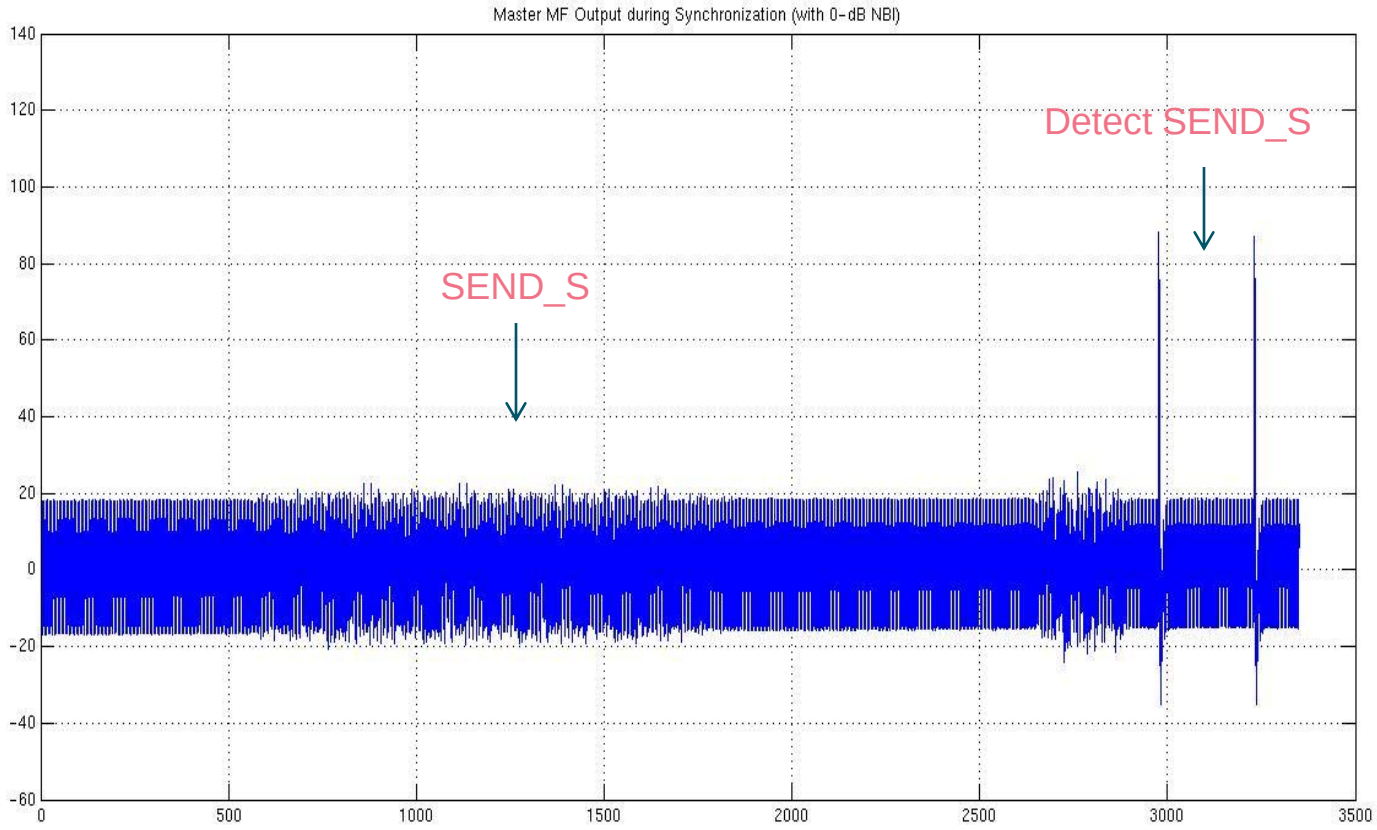
Slave SEND_S Detection

- Slave MF output during synchronization (without noises):



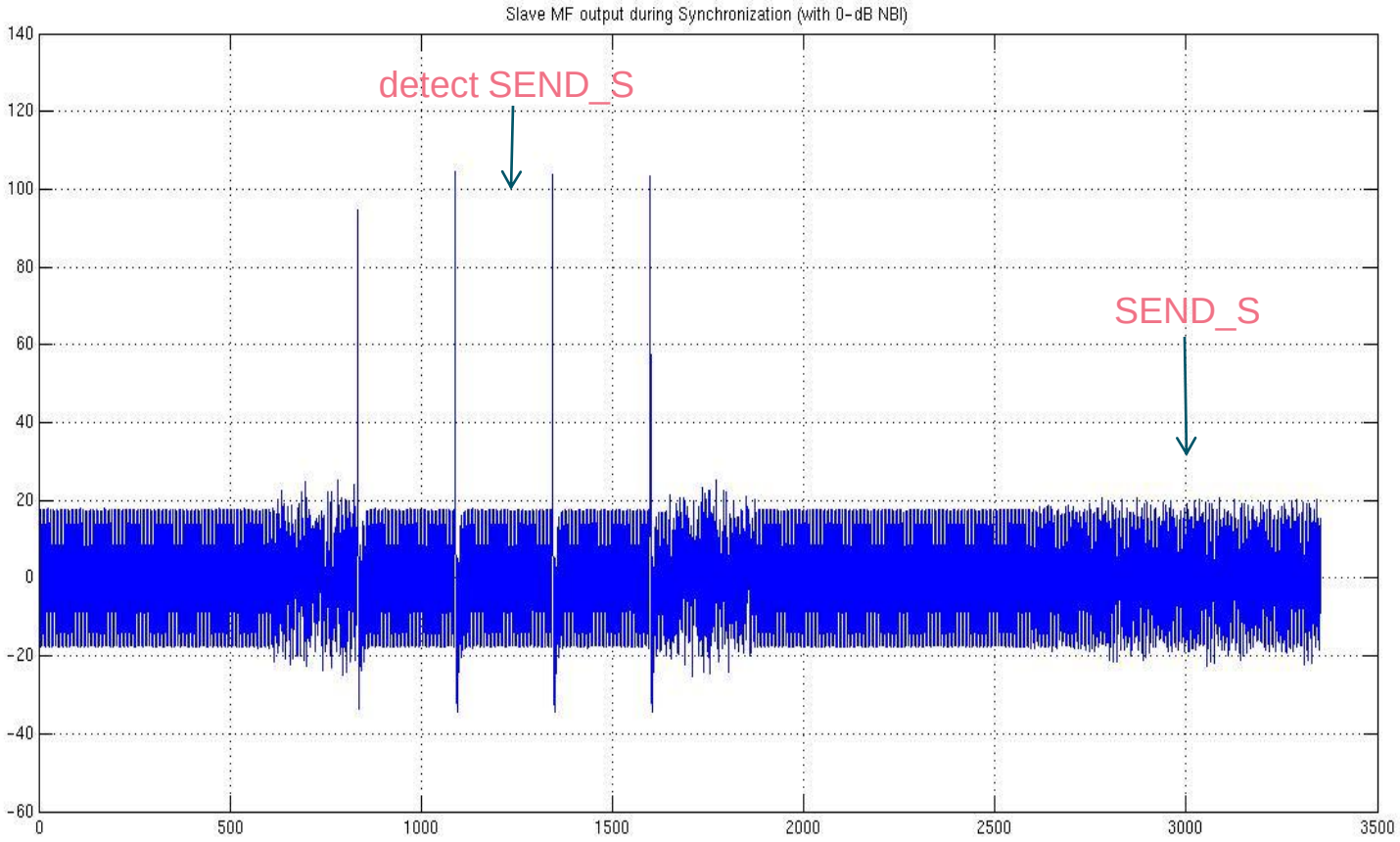
Master NBI Performance

- Master MF output during synchronization (with 0 dB NBI):



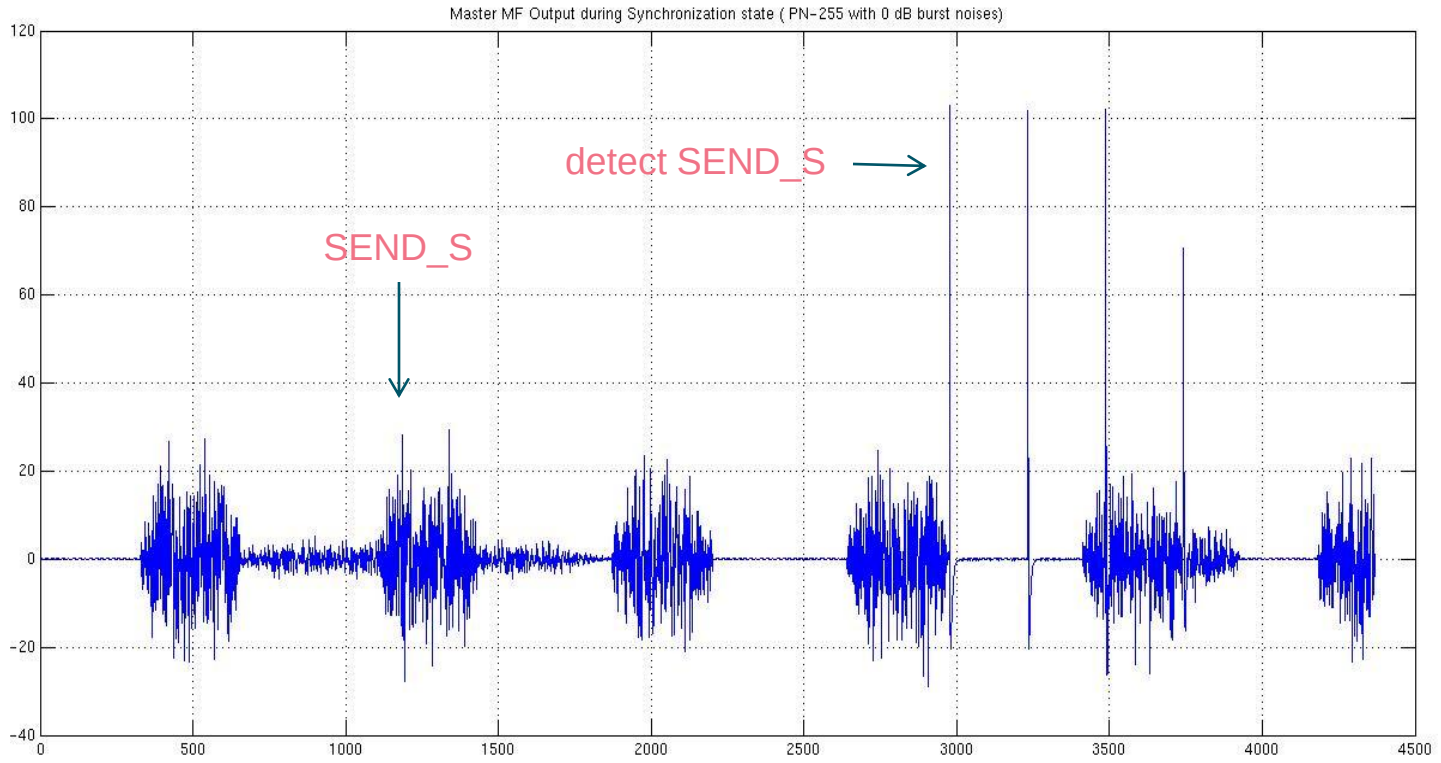
Slave NBI Performance

- Slave MF output during synchronization (with 0 dB NBI):



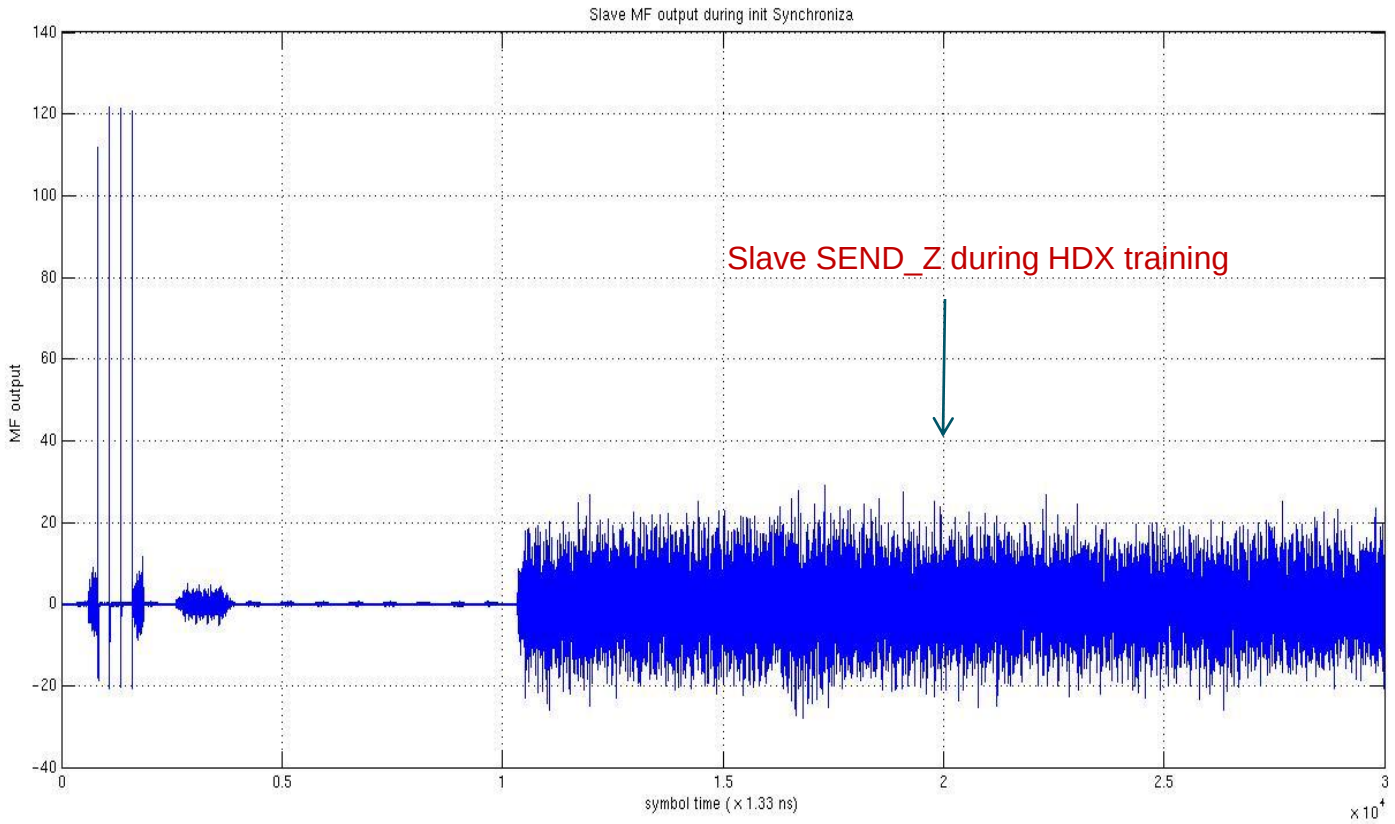
Master Burst Noise Performance

- Master MF output during synchronization (with 0 dB Burst Noise):



Slave Burst Noise Performance

- Slave MF output during synchronization and coming into HDX training:



Conclusions

- When AN is bypassed, a synchronization method is needed between Master and Slave in order to support both ***link_fail_inhibit_timer*** and ***maxwait_timer***
- Previously, a fast and robust synchronization method is proposed based on signal detection
- PHY Control state diagrams are proposed to support the new synchronization method and the link timers
- In this presentation, SEND_S signaling is defined in order to complete the baseline proposal