

Demonstration: Voice transmission over NATO Narrow Band Waveform Physical Layer with Low-Cost Software

Defined Radio Platforms

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Introduction

- There is currently no narrowband Combat Net Radio (CNR) STANAG waveform for international and combined missions providing interoperability in Network Centric Operations (NCO)
- The principal objective of the Narrow Band Waveform (NBWF) is to achieve coalition interoperability within lower tactical levels
- Military Software Defined Radio (SDR) equipment provides the flexibility to incorporate new waveforms and functionalities without having to upgrade or to replace hardware components.
- Therefore, the SDR technology provides an efficient and inexpensive way to implement the NBWF

Review of the NBWF Physical Layer (STANAG 5631)

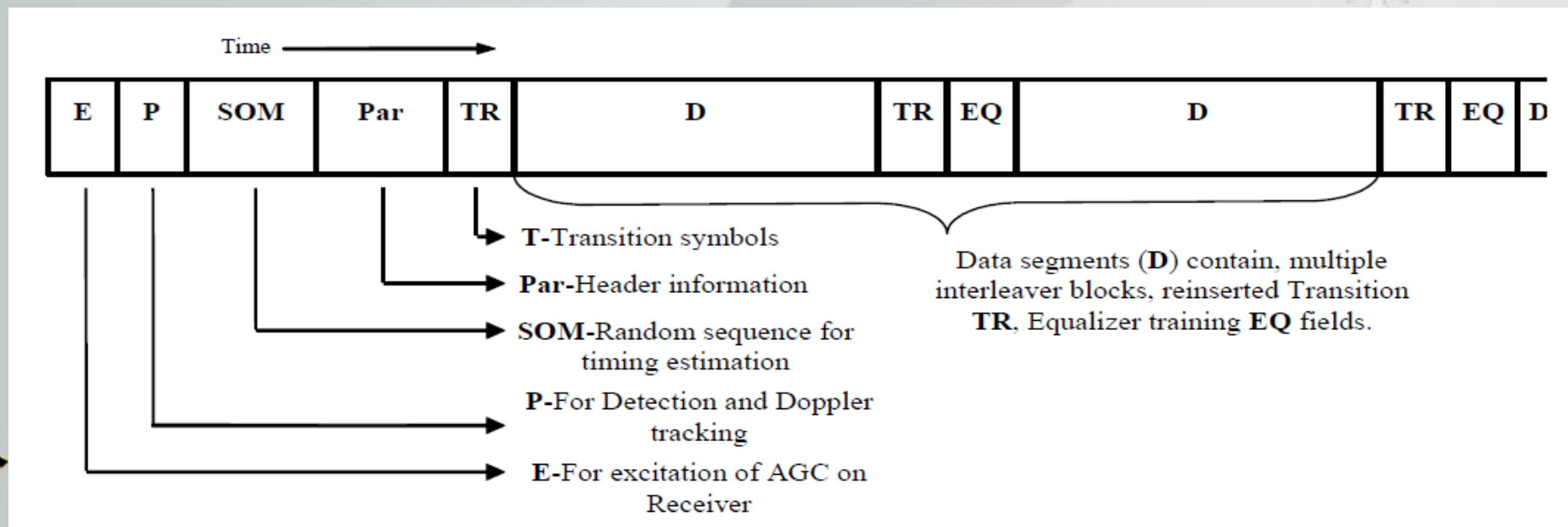
- The NBWF uses bandwidths of 25 KHz up to 50 kHz with on-air bit rates up to 82 kbps in the VHF or lower UHF bands with continuous phase modulation (CPM)

Waveform Modes	User Data Rates (kbps)	L	Mc	h	Pulse Shape	Code Rate	Symbol Rate(ksp/s)	Nominal 99% BW (kHz)
N1	20	2	2	1/2	REC	2/3	30	25
N2	31.5	2	2	1/4	REC	3/4	42	25
N3	64	3	2	1/6	REC	4/5	80	25
N4	82	3	2	1/9	REC	6/7	96	25
N5	40	2	2	1/2	REC	2/3	60	50
N6	63	2	2	1/4	REC	3/4	84	50
NR	10	2	2	1/2	REC	1/3	30	25

- L is the number of symbol intervals
- Mc is the alphabet size
- h is the modulation index

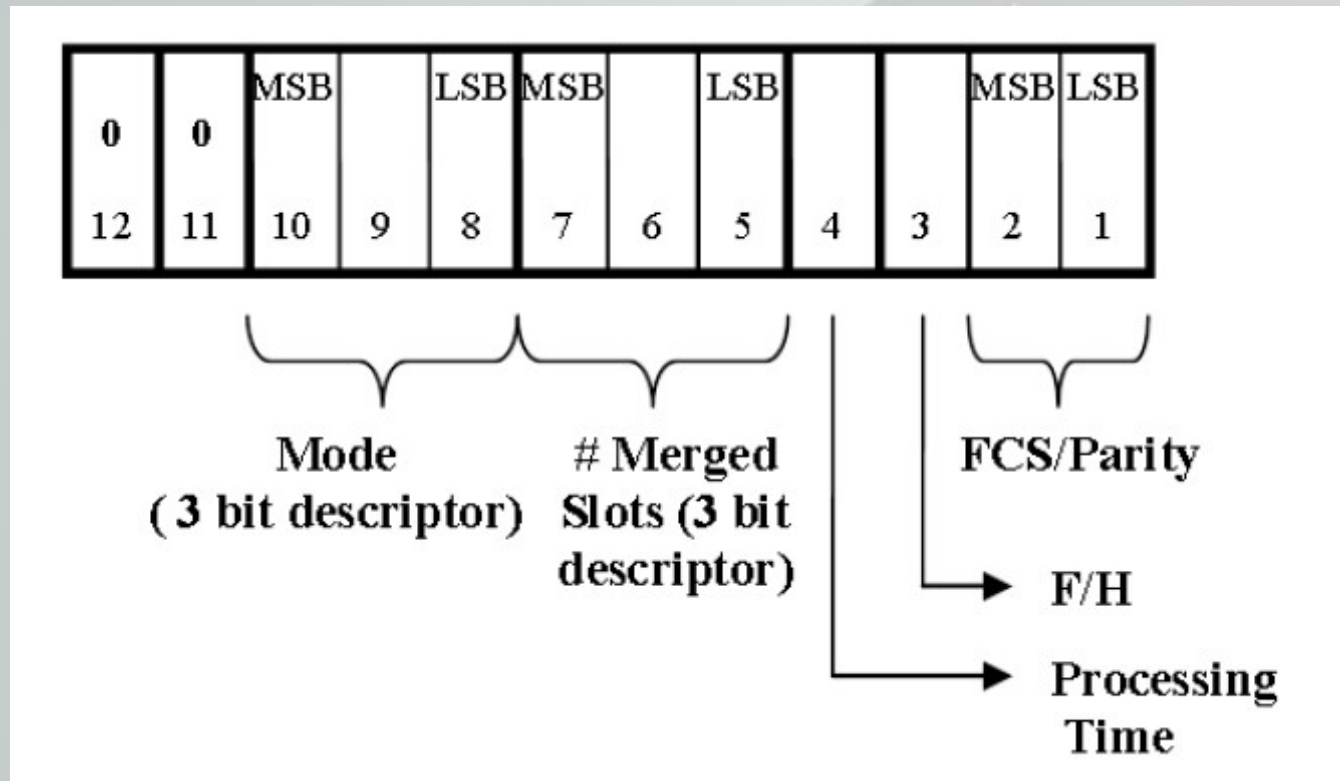
Review of the NBWF Physical Layer (STANAG 5631)

- The slot size of the NBWF is 22.5 ms (to be in accordance with MELP frame length). There can be single slots or merged slots with or without processing time applied to the final slot. P=45 symbols, SOM=63 symbols, Par=48 symbols, TR=2 symbols, EQ=16 symbols



Review of the NBWF Physical Layer (STANAG 5631)

- The contents of the “Par” register contains 12 information bits. These 12 bits are block coded using the extended Golay (24,12) code.



Real-time Qt Application for NBWF

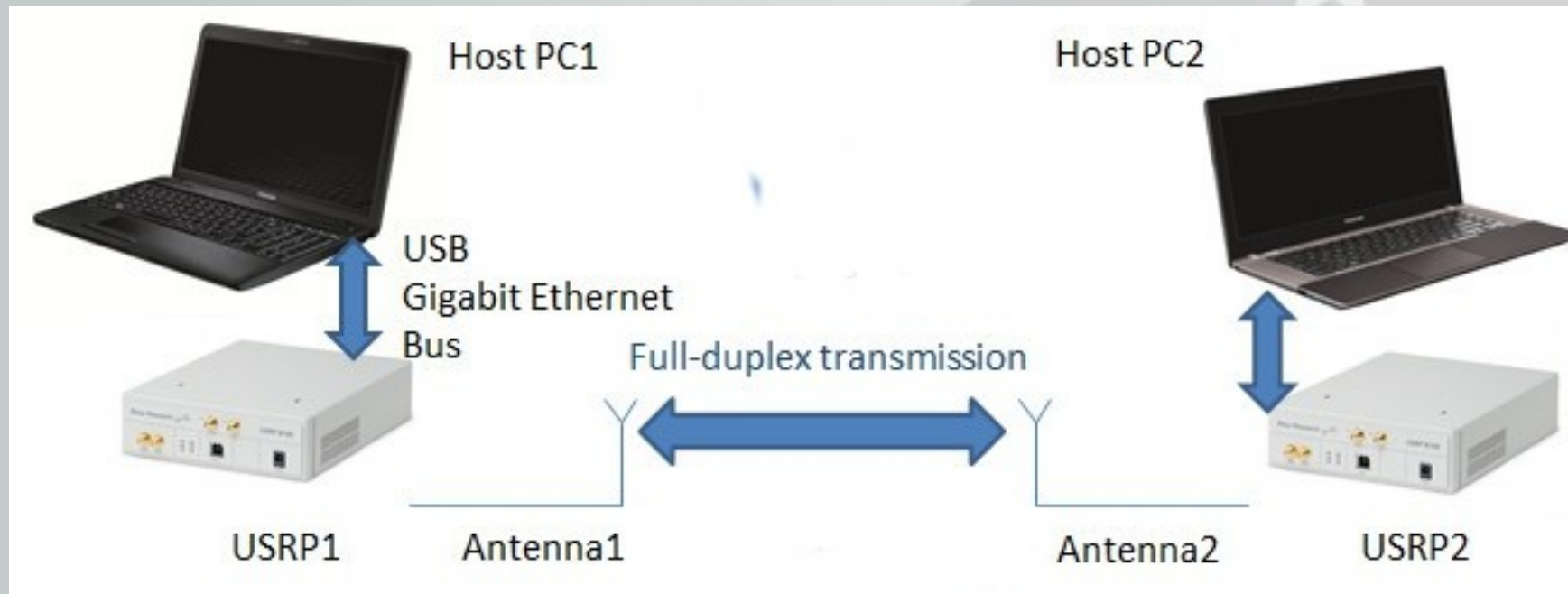
- Physical Layer (L1): select NBWF modes N1, N2, N3, N4, N5, N6, NR
- Parameters to control Tx and Rx rate, frequency, gains
- Link Layer (L2): select Point-to-Point TDD, Point-to-Point FDD, TDMA, NBWF TDMA
- Several applications (Video (M-JPEG), Audio (MP3 or MELPe, BER, Text message, IP traffic)

The screenshot shows a Qt application window titled 'MainWindow'. The interface is divided into several sections:

- Parameters:** A row of seven input fields for Tx Rate (Mpsps), Tx Freq (MHz), Tx Gain (dB), Tx Amplitude, Rx Rate (Mpsps), Rx Gain (dB), and Rx Freq (MHz).
- Buttons:** A row of four buttons: 'Start Node', 'Start Video', 'Start Audio', and 'Start BER TX'. Below them are 'Start BER RX' and 'Start IP' buttons.
- Address Fields:** Two input fields labeled 'My Address' and 'Dest Address'.
- Link Layer (L2) Selection:** Two dropdown menus labeled 'L1:N1' and 'L2:Point to Po'.
- Applications:** A large empty text area under the 'Applications' tab.

Real-time Qt Application for NBWF

- Demonstration of the Qt NBWF application using laptops or single board computers, USRPs, MioT or other SDR hardware.



Real-time Qt Application for NBWF

The screenshot displays a Qt IDE environment. The main window is titled 'MainWindow' and shows a real-time application for NBWF. The interface is divided into several sections:

- Project Explorer:** Shows the project structure for 'NBWF_PHY'. It includes headers like 'fec.h', 'packet.h', 'sensing.h', 'uhdevice.h', 'waveform_rx.h', and 'waveform_tx.h'. Source files include 'fec.cpp', 'packet.cpp', 'sensing.cpp', and 'uhdevice.cpp'.
- Code Editor:** Displays the 'packet.cpp' file with a line of code: `if (is_ber_count == true) {`.
- Application Output:** Shows a log of throughput and CRC status for multiple packets. The output includes lines such as 'Throughput: 18 kbps', 'CRC OK - Packet Number 141', and 'Throughput: 19 kbps'.
- Control Panel:** A sub-window titled 'MainWindow' contains a control interface with the following fields and buttons:
 - Tx Rate (Mpsps): 0.32
 - Tx Freq (MHz): 433.92
 - Tx Gain (dB): 31
 - Tx Amplitude: 0.1
 - Rx Gain (dB): 0
 - My Address: 1
 - Stop Node
 - Start Audio
 - Start BER TX
 - Stop BER RX
 - Rx Rate (Mpsps): 0.32
 - Rx Freq (MHz): 433.92
 - Dest Address: 1
 - 3.98e-03
- Spectrum Plot:** A graph showing Power (dB) on the y-axis (ranging from -100 to 0) and Frequency bin on the x-axis (ranging from 0 to 500). The plot shows a peak in power around 250-300 frequency bins. The plot is titled 'Spectrum' and has a dropdown menu set to 'N3' and another set to 'TDD'.

Conclusions and future work

- Conclusions
 - Implementation of NBWF Physical Layer
 - Implementation of some parts of the NBWF Link Layer
- Future work
 - Continue on the implementation of the NBWF Link Layer (STANAG 5632)
 - Implementation of the NBWF Network Layer (STANAG 5633)
 - Use the NBWF as a basic waveform in the EDA Cat B MAENA project for the VHF link
 - Use this work for a NATO reference implementation