



# HF XL modem

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## Context and motivation

- ◆ HF high data rate communications
- ◆ HF XL paradigm

## HF XL transceiver and frame structure

- ◆ Proposed modem
- ◆ Frame structure

## Focus on some HF XL features

- ◆ Compatibility with ST 4539 3kHz waveforms
- ◆ Native resistance to a narrow band jammer (or channel perturbations)

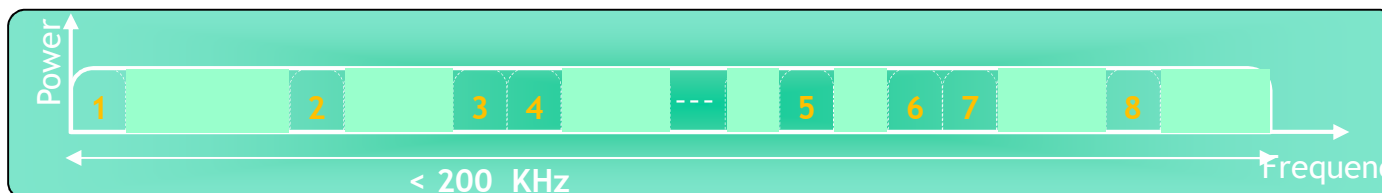
## Conclusions

## HF high data rate communications

- ◆ Providing customers higher data rate throughput
- ◆ Providing customers with IP capability over HF (64 to 128 kb/s requirements)
  - IP services in a BLOS deployment
  - back-up capability for satcom links
- ... with minimal (if any) impact on existing standards
- ... and tailored with respect to the particularities of the HF media

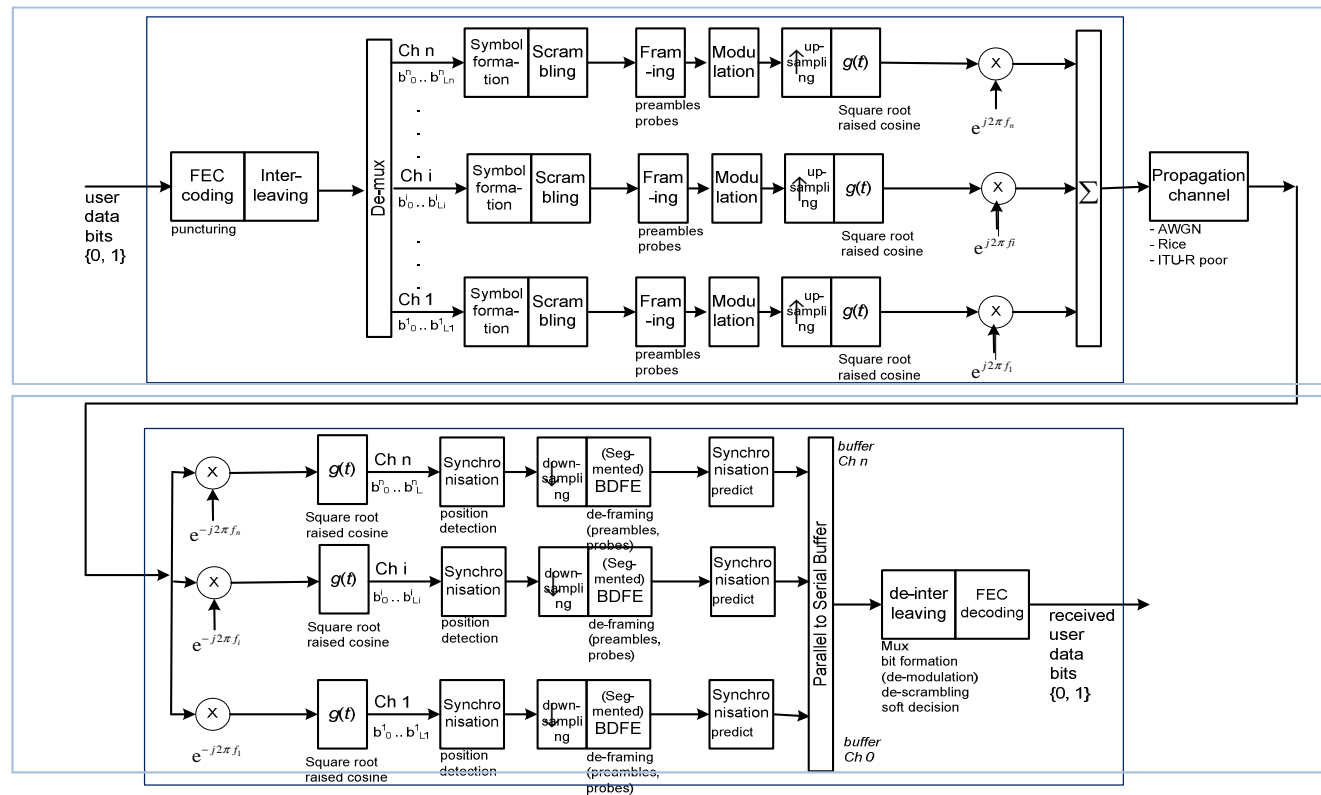
## Need for tactical BLOS services at an affordable price → IP over HF (64 to 128 kb/s requirements)

- ◆ THALES HF XL approach (multi-narrow band approach) :  $n \times 3\text{kHz}$  in a 200kHz band



## Multi-narrow band transmission : a straightforward evolution from the ST4539/MIL 188-110C app F standards

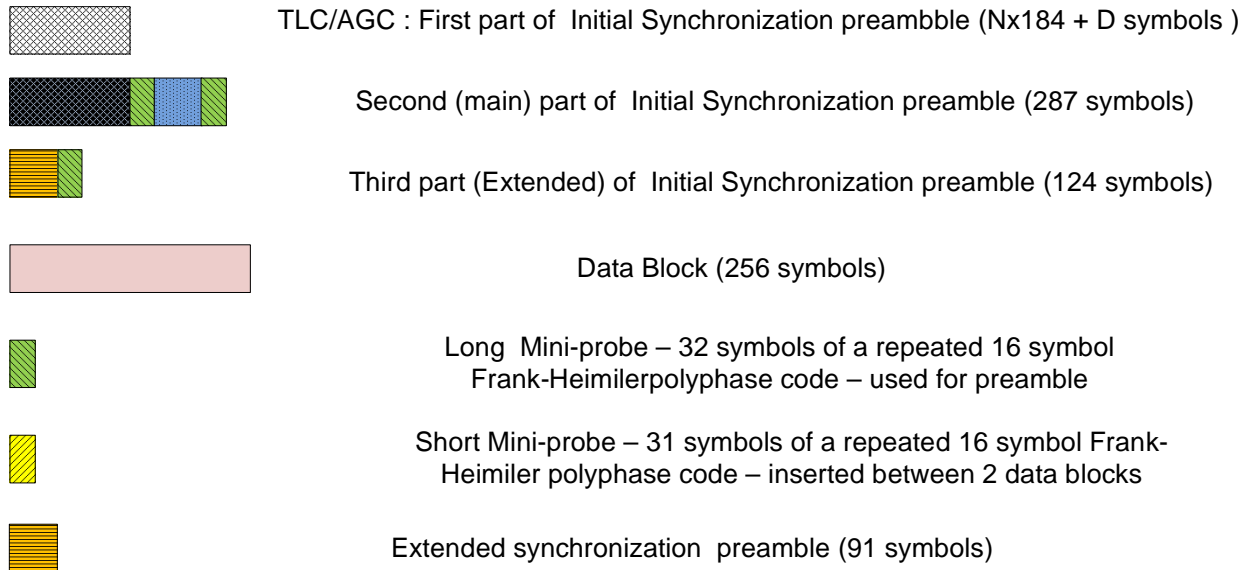
### ◆ Modem approach



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## Common channel frame structure

### ◆ Evolution from the ST 4539 (SSB) frame structure



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Frame structure directly derivated from ST4539 SSB one

## Focus on the autobaud fields

- ◆ Similarly to ISB: identification of wideband mode via modulation tritbit

Data Rate	Modulation
ISB mode	000
SSB 3200	001
SSB 4800	010
SSB 6400	011
SSB 8000	100
SSB 9600	101
SSB 12800	110
HFXL mode	111

	Preamble 2 <sup>nd</sup> part			Preamble 3 <sup>rd</sup> part						
	$D_0$	$D_1$	$D_3$	$D_3$	$D_4$	$D_5$	$D_6$	$D_7$	$D_8$	$D_9$
MSB	1	1	1	R=0	$K_0$	$K_2$	$X_0$	$X_2$	$M'_0$	$M'_2$
LSB	$M_0$	$M_1$	$M_2$	$M_3$	$K_1$	$K_3$	$X_1$	$X_3$	$M'_1$	$M'_3$

- ◆ More bits used to define number of channels, current channel number, current interleaver & coding scheme, current modulation and another channel modulation (R=0 : solution for  $n \geq 3$  channels)
  - ◆  $K_i$  : number of channel (i)
  - ◆  $M_i$  : modulation info, current i channel
  - ◆  $M'_i$  : modulation info, i+1 channel
  - ◆  $X_i$  : modulo 3, identifies FEC, interleaver or total number of channel used

## Compatibility with ST 4539 3kHz waveforms

- ◆ Used with only one channel, an HFXL modem will be equivalent to SSB ST4539
- ◆ HFXL modem will integrate by default legacy SSB/ISB modes

## Native resistance to a narrow band jammer (or channel perturbations)

- ◆ The serial/parallel conversion after the encoding+interleaving allows to introduce frequency diversity in the modem
  - ◆ The redundancy in the autobaud allows to recover information needed for deinterleaving and decoding when one (and possibly more) channel is lost
- ➔ The waveform is natively resistant to a narrow band jammer



## Testbench

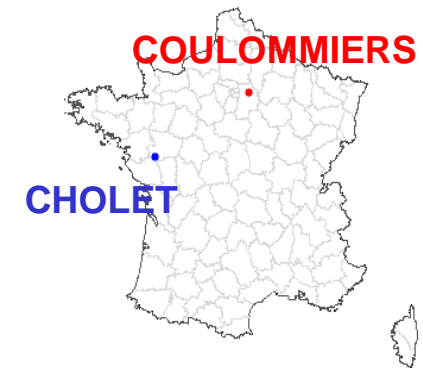


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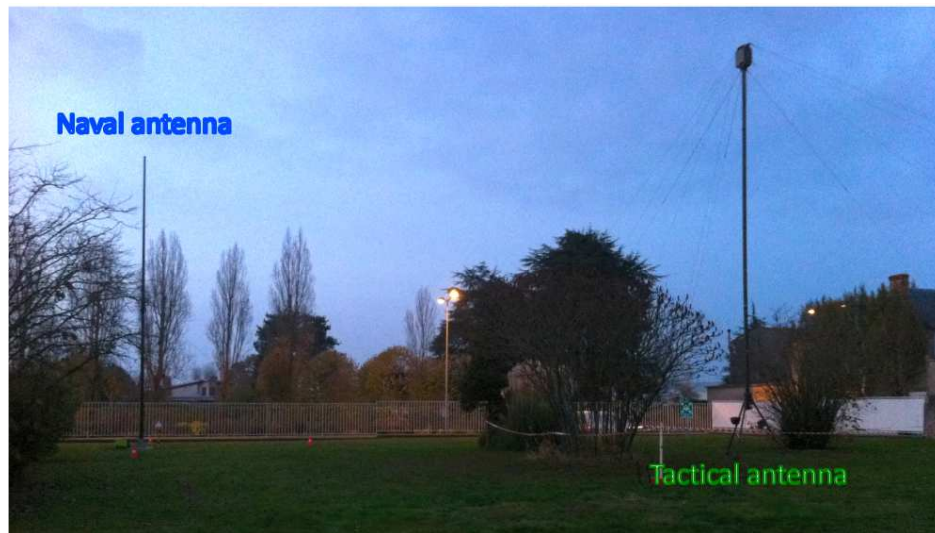


## Over the air field trials

- ◆ Using wideband tunable antennas prototypes
  - ◆ Naval and tactical configurations
- ◆ Simplex transmission
- ◆ Tactical PA 400W used



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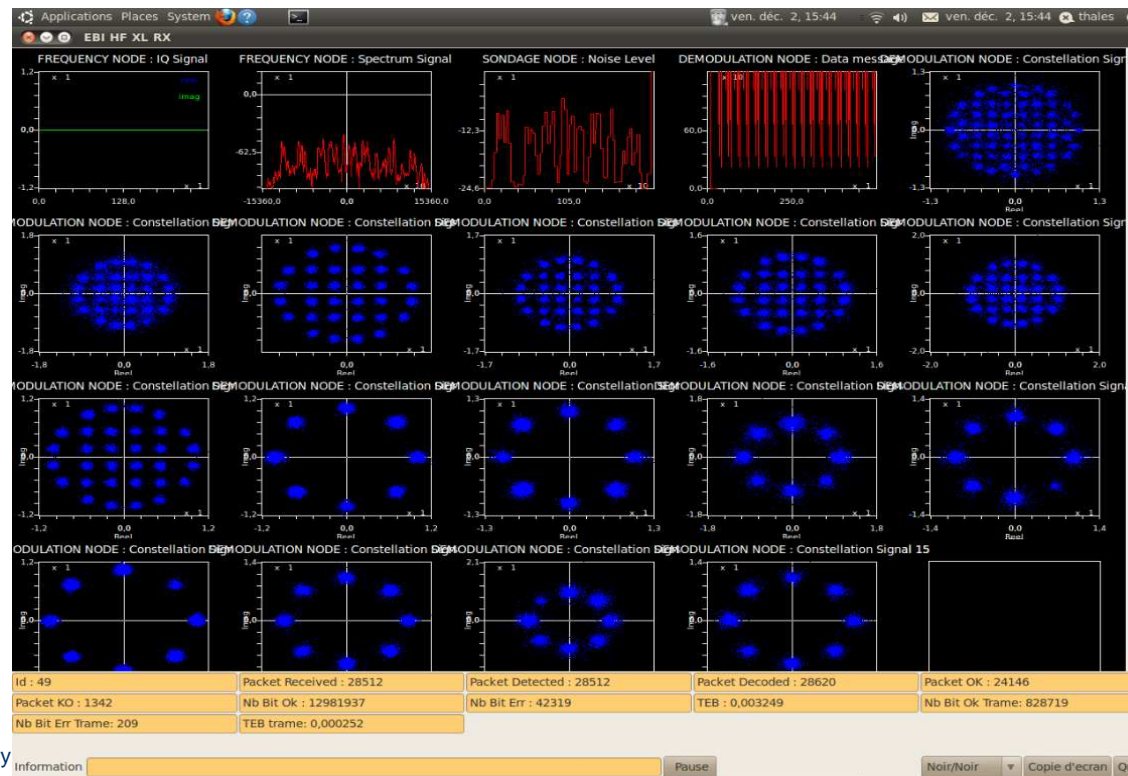


Wideband transmission  
(200 kHz)



## Over the air field trials – results

- ◆ Over one week (day time), 25% of time  $D > 64$  kbps
- ◆ High data rate obtained using 8 à 15 x 3 kHz non contiguous channels
- ◆ Demonstrating capability and interest to use different modulation schemes over the different channels
- ◆ Demonstrating the adaptability to the channel conditions



## An extension of ST4539 (SSB) and ISB approaches

- ◆ With  $n$  channels over a larger band for integration within the HF band taking into account spectrum availability

## Compatibility with existing 3kHz ST4539 modulations

- ◆ Operated in one channel, the waveform can be seen as an SSB one
- ◆ For  $n > 2$ , detection of the preamble as 'reserved mode', which will be skipped by the legacy modems

## Added features:

- ◆ Resilience to one or more channels perturbation
- ◆ Dynamic adaptation to channel conditions via modulation scheme adaptation and number of channels used

THALES has prepared a draft describing this modem proposal that could be considered for revision of STANAG 4539 to introduce such a wideband modem, in parallel to MIL STD 188 110C solutions (ISB, app. D, ...).





# Thanks for your attention

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