

THALES



SALAMANDRE trials with French MOD – Dec 2016

C. Lamy-Bergot, P. Crambert, M. Rabineau, J-M. Elzaouk, J-L. Rogier, J-Y. Bernier, M. Dhakouani and G. Venuti



www.thalesgroup.com

OPEN



Outline

Context

- SALAMANDRE study programme
- Experimentation objectives
- Experimentation settings

Obtained results

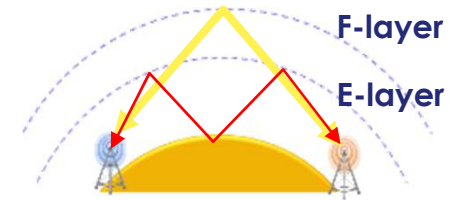
- Usage
- Resilience
- IP capability

Conclusions

This document may not be reproduced, modified, adapted, published, translated, in any way, in whole or in part or disclosed to a third party without the prior written consent of Thales - © Thales 2015. All rights reserved.

Context: Desired evolution for HF communications

Communicate beyond the horizon ...



A traditional media that had to evolve... in line with the general trend



SALAMANDRE* has demonstrated the feasibility of this evolution!

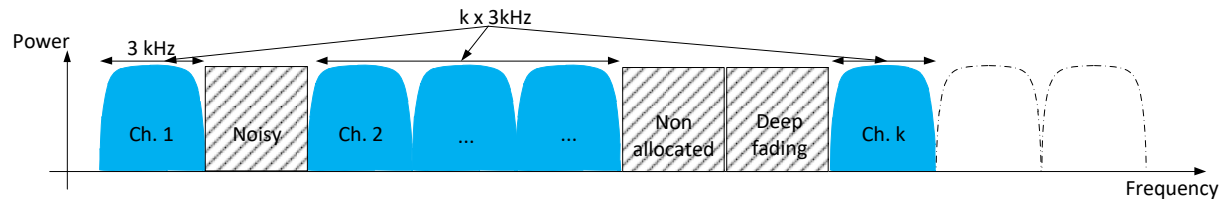
* : SALAMANDRE, study programme sponsored by French MOD and awarded to THALES

The technical solution: overview of HF XL (1/2)

An integrated approach to provide a substantial gain

- Compatible of regulatory frequency allocations and spectrum usage
- Allowing for higher performance: resilience and throughput with maintaining “mobility” capability

➔ The solution: wide band (XL) and cross-layer (XL) optimization



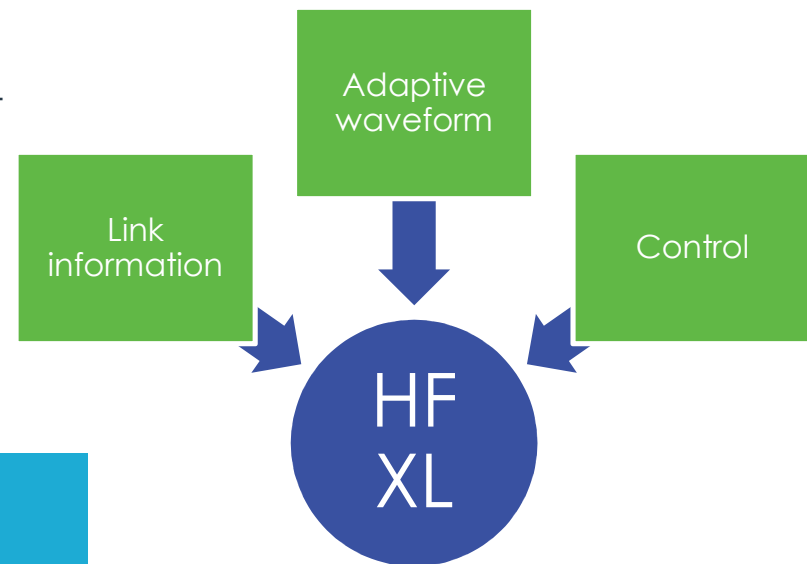
Going beyond a “modem” approach to consider the whole protocol stack

The technical solution: overview of HF XL (2/2)

Automated Waveform adaptation to radio link variations by leveraging on accurate and regular link information

- Extended information collected from the radios/modems + prevision tool, and shared with the remote station
 - Radio measurements, propagation forecast
- A waveform with multiple modes
 - bandwidth, modulation at channel level, slot size, SLA...
- Advanced algorithms to rule them all

Enables unmatched link persistence and efficient operation in crowded spectrum



The SALAMANDRE demonstrator

SALAMANDRE proves the validity of HF XL solution

- Physical layer with non-contiguous carriers
- Adaptive and dynamic link management
 - ALE/ALM, DRC
 - Cognitive engine

A single radio can support the others HF waveforms

- Demonstrated with:
- Modem MIL STD 188-110C (2 modes)
 - Modem ST4539 : legacy narrowband waveform

➔ **Interoperability capability with 3kHz radio and medium band (3-24kHz) ones**



shed, translated, in any way, in wh
of Thales - © Thales 2015. All rights

This document may not be reproduced, modifie
third party without the prior

Demonstration set-up

Content may not be reproduced, modified, adapted, published, translated, in any way, in whole or in part, without the prior written consent of Thales - © Thales 2015. All rights reserved.



Ionosphpherical propagation over 730km

Tactical OTH antennas, 400W tactical PA

Legacy & IP applications, with QoS; incl. stream priorities management

HF XL: resilience for IP services “over the air”

Results

Various modes available: ST4539-H, ST4539 but also MIL 110C configs

The screenshot shows the SALAMANDRE configuration interface. At the top, there is a header with the SALAMANDRE logo and the text 'Local station : Station 1 Simulono' and 'ARQ state : Offline'. Below the header is a 'Configuration choice' section containing a table with the following columns: Name, Mode, Cognitivity (WB), TDD profile (WB), Wave format, Interleaver, and Data rate.

Name	Mode	Cognitivity (WB)	TDD profile (WB)	Wave format	Interleaver	Data rate
Interactif_Dynamic_Autonomie	Multichannel	Autonomous	1.5s / 1.5s	4539-H	Defined by TDD	Auto
HD_FullDplx_Dynamic_Previson	Multichannel	Propag. model	9s / 9s	4539-H	Defined by TDD	Auto
HD_pour_Appelant_Dynamic_Previson	Multichannel	Propag. model	9s / 1.5s	4539-H	Defined by TDD	Auto
HD_pour_Appetele_Dynamic_Previson	Multichannel	Propag. model	1.5s / 9s	4539-H	Defined by TDD	Auto
Interactive_dynamic_Autonomie	Multichannel	Autonomous	1.5s / 1.5s	4539-H	Defined by TDD	Auto
Interactive_Dynamic_Previson_3200SLR	Multichannel	Propag. model	1.5s / 1.5s	4539-H	Defined by TDD	Auto
Interactive_Prudent_Previson	Multichannel	Propag. model	1.5s / 1.5s	4539-H	Defined by TDD	Auto
Interactif_Prudent_Autonomie	Multichannel	Autonomous	1.5s / 1.5s	4539-H	Defined by TDD	Auto
Interactive_Dynamic_Reactualisation	Multichannel	Propag. sensor	1.5s / 1.5s	4539-H	Defined by TDD	Auto
HD_FullDplx_Dynamic_Autonomie	Multichannel	Autonomous	9s / 9s	4539-H	Defined by TDD	Auto
Interactive_Dynamic_Previson_64K_test	Multichannel	Propag. model	1.5s / 1.5s	4539-H	Defined by TDD	Auto
MIL 110C-24kHz	Channel 24kHz	-	-	MIL 110C 24 kHz	short	76800 bps
MIL 110C_3kHz	Channel 3kHz	-	-	MIL 110C 3 kHz	short	9600 bps
NB_4539_4800_US	Channel 3kHz	-	-	4539	Ultra short	4800 bps
BE_3200_VL	Channel 3kHz	-	-	4539	Very Long	3200 bps
BE_3200_L	Channel 3kHz	-	-	4539	Long	3200 bps
BE_3200_S	Channel 3kHz	-	-	4539	short	3200 bps
BE_4800_S	Channel 3kHz	-	-	4539	short	4800 bps
BE_6400_S	Channel 3kHz	-	-	4539	short	6400 bps
BE_8000_S	Channel 3kHz	-	-	4539	short	8000 bps
BE_9600_S	Channel 3kHz	-	-	4539	short	9600 bps
BE_9600_L	Channel 3kHz	-	-	4539	Long	9600 bps

Wideband equipment
 - Medium band (24kHz)
 - Wideband (200kHz)

Legacy modes
 - ST4539

This document may not be reproduced, modified, adapted, published, translated, in any way, in whole or in part or disclosed to a third party without the prior written consent of Thales - © Thales 2015. All rights reserved.

Results

Ease of use: just one click and you're on the air!



Communication is possible in wideband even if some frequencies are jammed

Communication remains even if perturbancies occur in middle of the communication

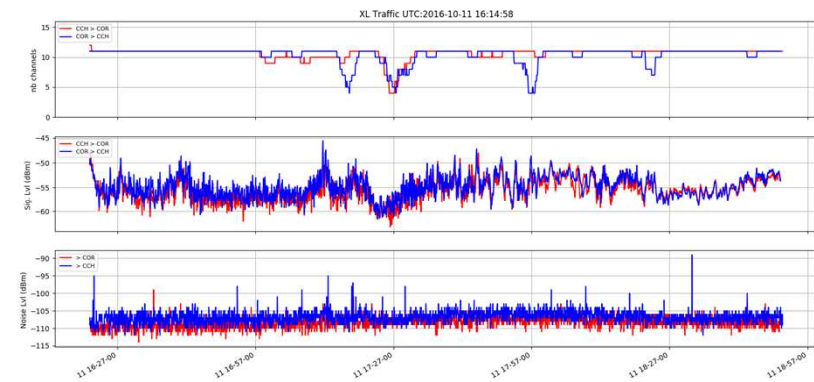
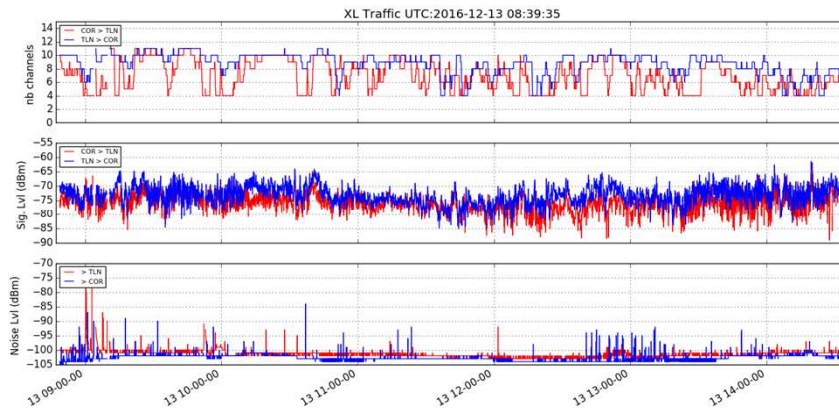


This document may not be reproduced, modified, adapted, published, translated, in any way, in whole or in part, without the prior written consent of Thales - © Thales 2015. All rights reserved.

Results

Resilience, link maintenance

- Link is maintained for hours without operator operation
- Frequency diversity allows to remain for hours on the same band: ALM becomes very rare, no more time lost back into ALE, no link lost when an urgent message arrives ...

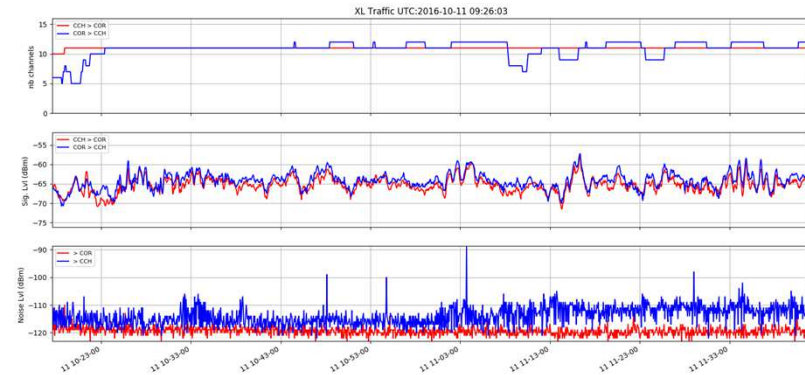
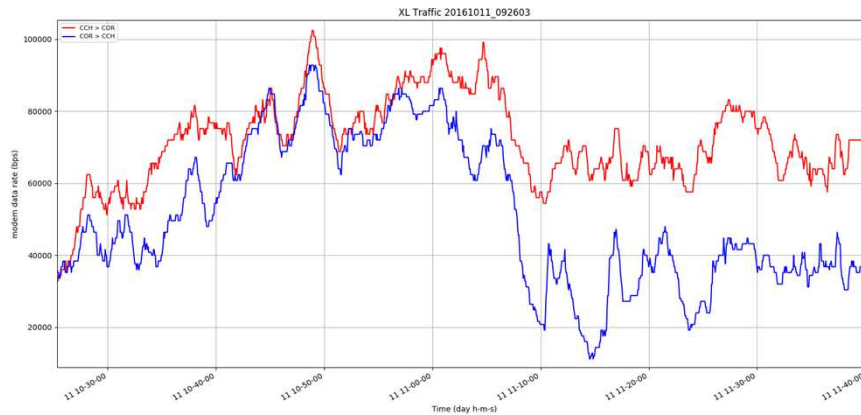


HF XL: the link is there

Results

Throughput

- Mean data rate observed 40-80 kb/s for 300km, 20(noisy RX)-50kb/s for 730km with 400 tactical PA and OTH antennas



HF XL: IP connectivity is there

Results

IP usage, but also legacy

This document may not be reproduced, modified, adapted, published, translated, in any way, in whole or in part or disclosed to a third party without the prior written consent of Thales - © Thales 2015. All rights reserved.



Results

Bidirectionnal, logs monitoring ...

The image displays three overlapping screenshots of the ARQ 5066 XL MMI (3.0.9.0) software interface. The top-left window shows the 'S5066 Stats' and 'Total Data D_PDU Stats' panels. The middle window shows the 'Outgoing Emails' table with columns for Status, To, From, Remote S5066, Subject, Size, Progress, Component, Start Time, and End Time. The bottom-right window shows the 'Outgoing ACP127 Messages' and 'Incoming ACP127 Messages' tables with columns for Message ID, Status, Recipient/Sender, Priority, Encoding, Delivery Mode, Size, Progress, Start Time, and End Time. The interface includes a 'File' menu, 'RAPI/RIPC Interface' title bar, and a 'Connected' status indicator at the bottom.

This document may not be reproduced, modified, adapted, published, translated, in any way, in whole or in part or disclosed to a third party without the prior written consent of Thales - © Thales 2015. All rights reserved.

Conclusions

SALAMANDRE demonstration in December, as well as the different industrial trials in the last trimester have permitted to prove the good function of HF XL waveform and the strength of its cross-layer approach

- Multi-tone modem compatible of existing frequency allocations
- Evolution of ARQ5066 with
 - Modem driven DRC over the 200kHz frequency band to adapt to the channel variations and presence of jammers/other users
 - TDD scheme for better resilience and managed latency
 - Link establishment and maintenance with help of Cognitive Engine
 - Higher data rate up to 153 kb/s

THALES is now working on the integration of this capacity in its products

HF XL : simpler to use, resilient, IP capable

THALES

THALES



Thanks for your attention

[catherine.lamy-bergot](mailto:catherine.lamy-bergot@thalesgroup.com) AT thalesgroup.com

With heartfelt thanks to the whole SALAMANDRE team, without whom nothing would have been possible!

www.thalesgroup.com

OPEN

