CONSTRUISONS ENSEMBLE
LA DÉFENSE DE DEMAIN

GENERATION OF A DVB-S SIGNAL FOR TESTING A RECEIVER

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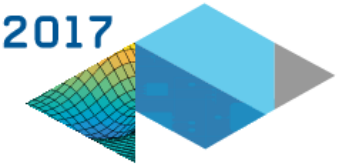

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DGA

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MINISTÈRE
DE LA DÉFENSE

INTRODUCTION

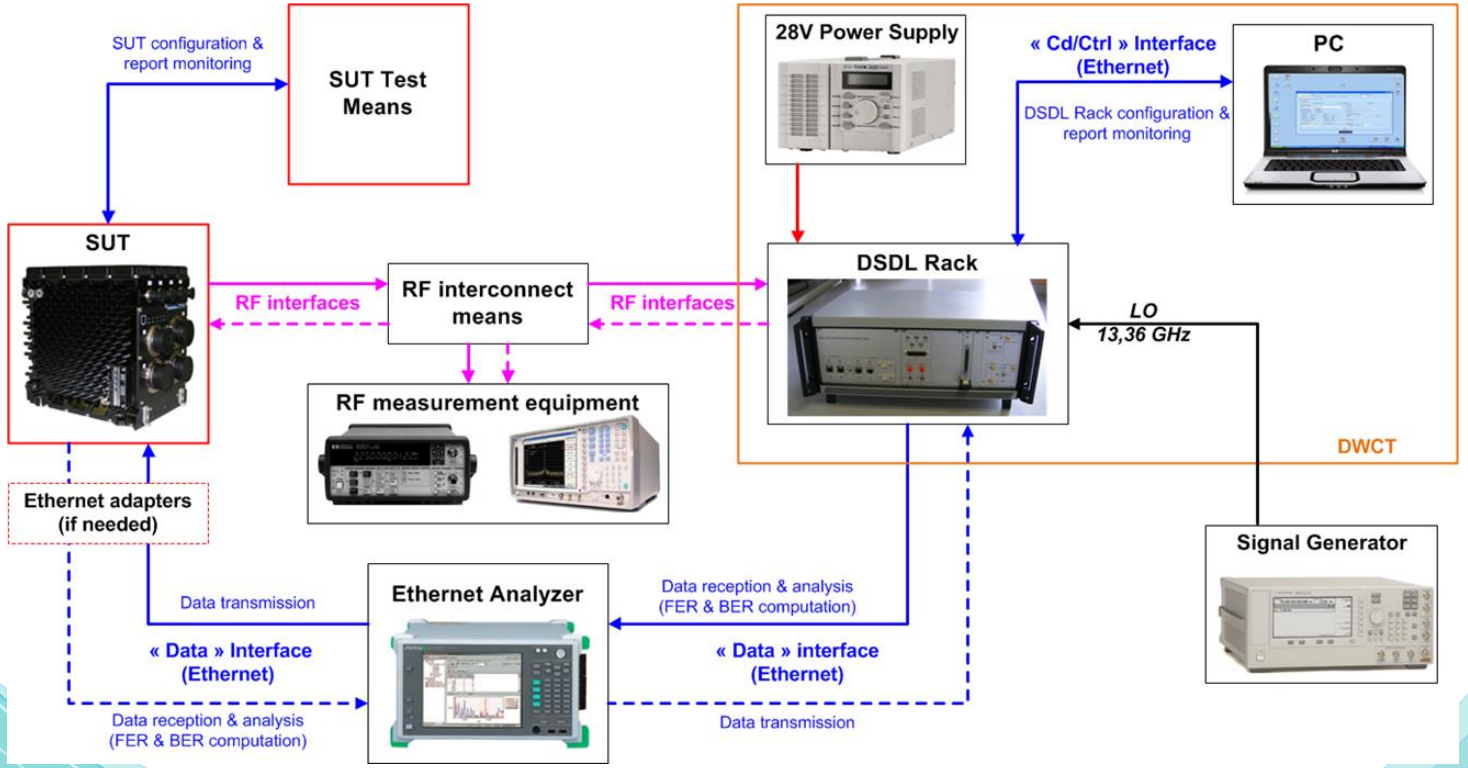
- **Minister of Defence needs Data Links for present & future UAV (Unmanned Aircraft Vehicle)**
  - For Uplinks (low data rates for Command and Control)
  - Downlinks (high data rates for Telemetry from payload and different sensors).
- **For military applications, interoperability is mandatory and is made possible by the use of STANAGs.**
  - Current STANAG for downlinks is STANAG 7085 based on the DVB-S waveform (digital transmission of TV by satellite with MPEG-2 format – 1993)

INTRODUCTION

- **DGA-MI has to validate the STANAG 7085 compliance (physical layer) for equipment developed by a contractor**

- **First step : the test bench must comply with the STANAG 7085**
  - **Possible solutions:**
    - Use a DVB-S Transmitter: not available on our site, too long to buy a new DVB-S equipment
    - Develop an application with MATLAB (the cheapest and fastest way)
      - Complete STANAG 7085 simulation including transmit and received parts.

ARCHITECTURE OF THE BENCH

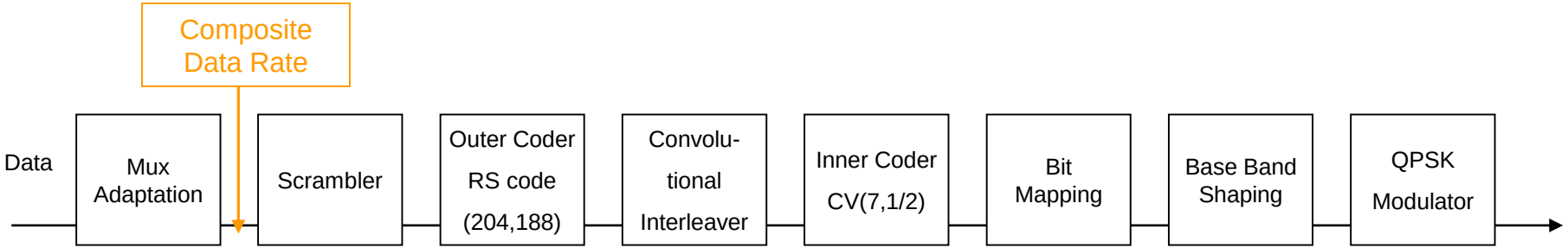


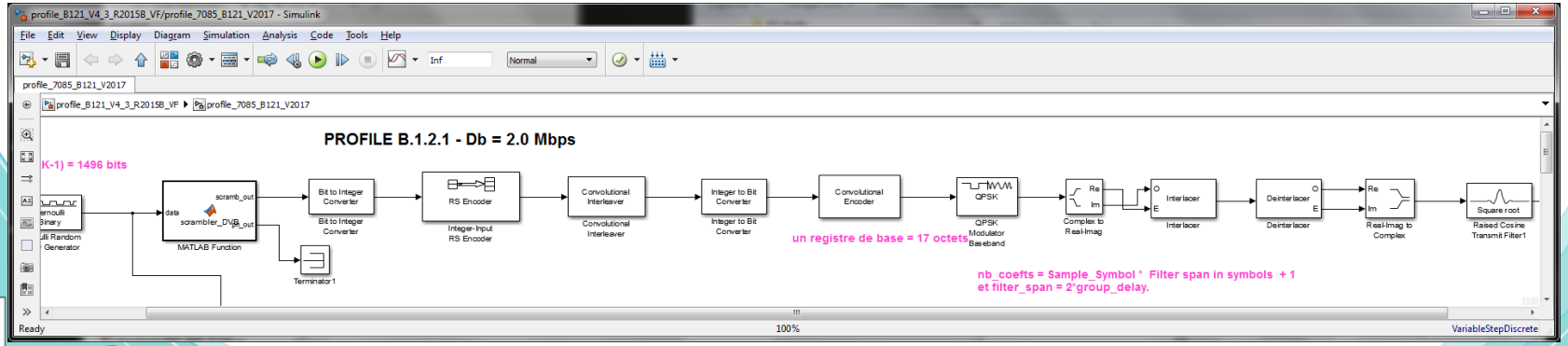
DEVELOPMENT WITH MATLAB

- **Our application was developed with MATLAB**
  - Need to add specific functions for the scrambling/de-scrambling functions in the DVB-S
- **A second application was developed with Simulink**
  - Comparison of the outputs at different levels on the Transmit side (scrambling, encoder, interleaving, QPSK modulator) → OK
  - Computation of the performances using BER → OK
    - close to the specification in DVB-S by ETSI

BLOCK DIAGRAM OF THE RETURN LINK

- **Transmit side: idem to DVB-S**

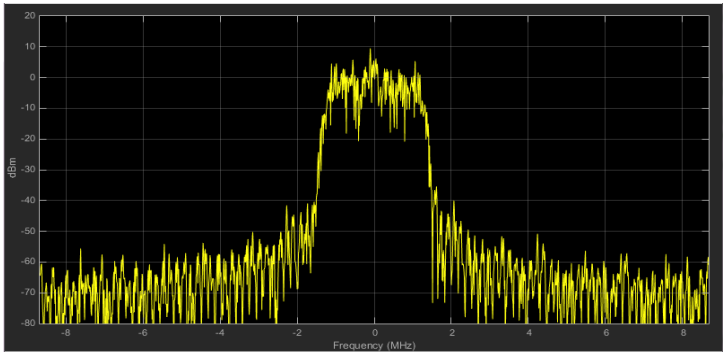


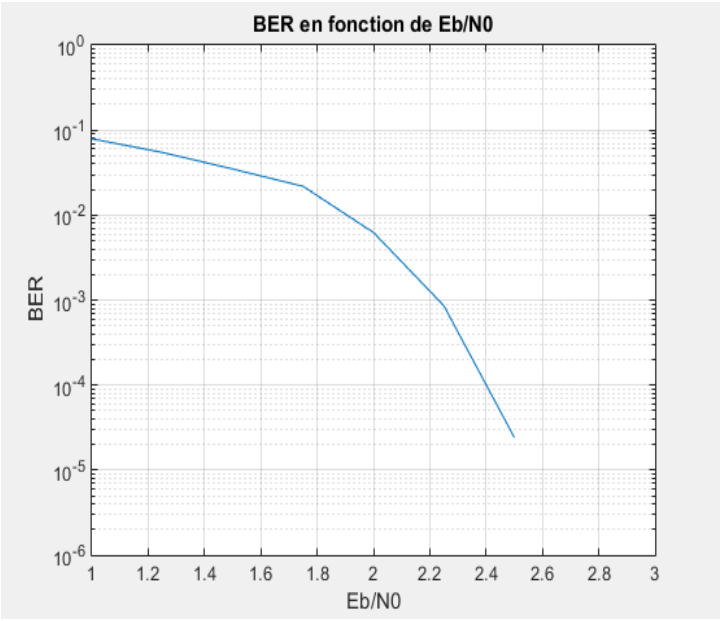


Simulation sous Simulink

WAVEFORM PERFORMANCE

- **Performance in MATLAB**
  - BER with AWGN and spectrum for a 2 Mbps link





TEST OF DVB-S COMPLIANCE

- **Transmit part simulation generates a real signal with a VST (Vector Signal Transceiver) and LabVIEW**
  - VST is able to generate 'Real Time' RF signal in L band to the DVB-S receiver
- **Advantages of VST instrument:**
  - can be used as a Vector Signal Generator (VSG) to generate RF signals as well as a Spectrum Analyzer (ASA)
  - It is fitted with a programmable FPGA. The PXIe-5644R from NI has been used.

TEST OF DVB-S COMPLIANCE

- **First solution: emulating the MATLAB code within LabVIEW and using a USRP board to generate the signal in L Band (1 GHz)**
  - MATLAB code is encapsulated in a LabVIEW simulation (no modification but the inputs/outputs)
  - The VST generates 'Real Time' RF signal to the DVB-S Rx
  - Feasible only with a MATLAB script (not with Simulink)
  - Constraints:
    - some limitations in terms of computation load and so in data rate.
    - constraints on the limited choice of the sampling frequency with USRP

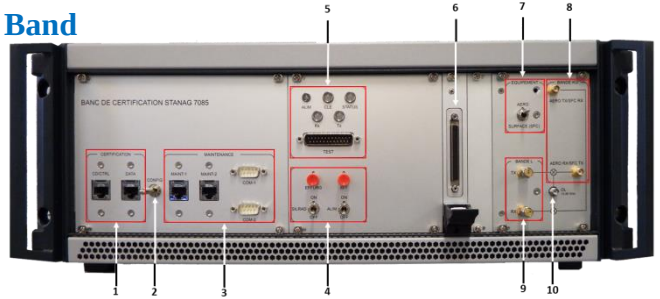
OVERVIEW OF THE TEST WITH THE BENCH

On LabVIEW:

Reads the .MAT File generated with MATLAB

VST + LabVIEW
Generates and transmits the RF signal (L Band)

L Band



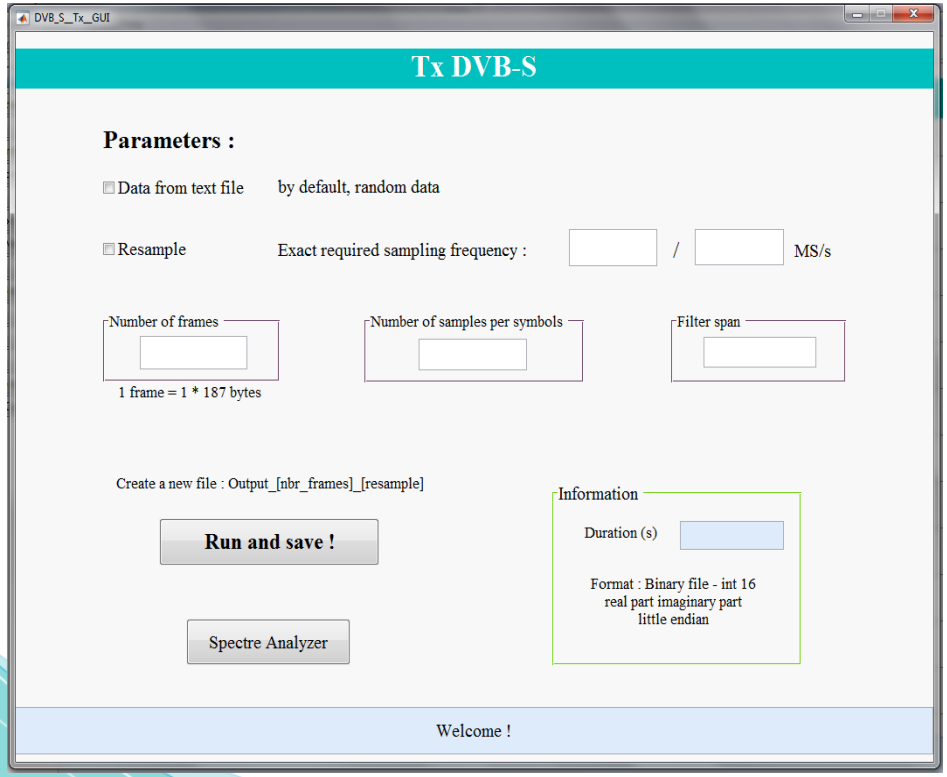
Test bench for STANAG 7085
In 'Rx' mode

- Scheme of the test with the test bench and the VST

TEST WITH A VST EQUIPMENT (NI)

- **Second solution:**
  - MATLAB file of complex (I,Q) signals generated and then loaded in LabVIEW as input file (No real time at this level).
- **Transmit part simulation generates (I,Q) complex samples in a file**
  - Step 1: Easy with MATLAB with a .mat file
  - Step 2: the .mat file feeds the VST interfaced with LabVIEW
    - VST generates 'Real Time' RF signal in L band to the DVB-S receiver

TEST WITH A VST



- **GUI developed with GUIDE (in MATLAB) to generate the .mat file of (I,Q) samples**
  - Quick to develop and convenient to use

TEST WITH A VST EQUIPMENT (NI)

- **Then with LabVIEW + VST, we generated in real time a RF signal at 2 Mbps**
  - signal sent to our DVB-S receiver at the required data rate
  - the synchronization of the DVB-S demodulator in the test bench receiver was achieved successfully (using the SYNC symbols of DVB-S: **LED Rx in GREEN**)
- **Further work: to test the data bits and the protocol layer**
  - Record samples (I,Q) on Tx side of the Test bench and analyze them with MATLAB

CONCLUSION (1)

- **MATLAB and Simulink are convenient tools to build signal generators for civil standards and STANAGs**
  - Easy and quick to develop and modify
  - Easy to add specific and custom-coded functions
  - Capability to add custom-code functions in C/C++ if required
  - Communications with measurement equipment very easy with MATLAB

CONCLUSION (2)

- **MATLAB and Simulink provide an easy and fast capability to simulate, generate and test waveforms**

- **Capability to test these waveforms with new electronic boards and equipment (USRP, VST, …)**
  - Use of the power of the FPGA programmable by the user
  - Increases the performance in terms of processing, data rate.

Thank you for your attention!

Questions?