TESA general presentation

Cooperative laboratory, with broad partnership (1998)

Non-for-profit research organization (Nov. 2004)

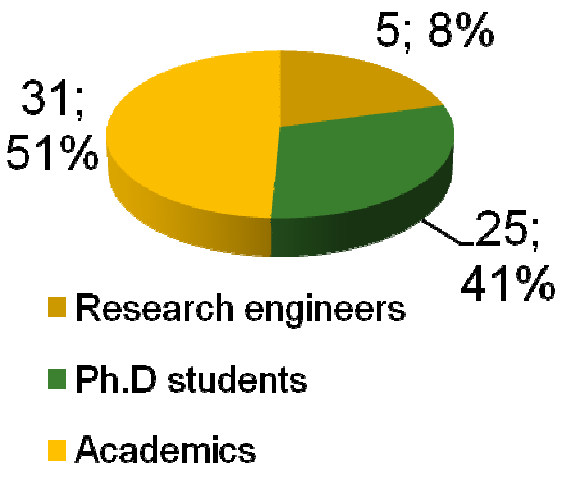
Objectives

- ✓ Coordinate research efforts and expertise of the partners.
- ✓ Gather the expertise through all the layers of telecommunication and navigation systems.
- ✓ Intense Ph.D. program.

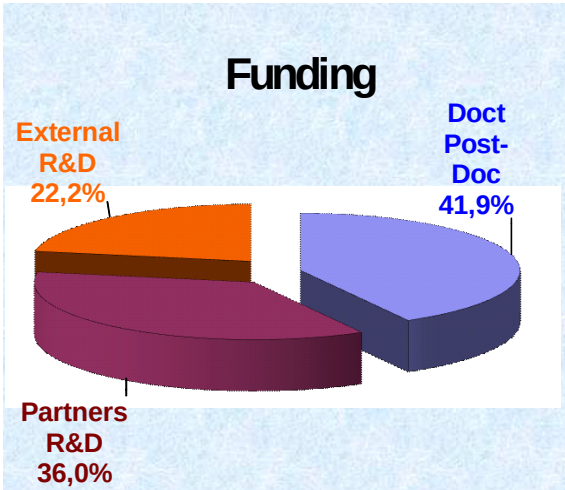
TeSA

Space and Aeronautical Telecommunications

Staff



Funding



TESA general presentation

Modulation, channel and source coding

- **Modulation techniques for fixed and mobile satellite communications / navigation systems**
- **Channel and source coding**
- **Compression techniques**
- **Image compression for satellite remote sensing and earth observation**

Signal Processing for communication and navigation

- **Signal processing techniques (communications and navigation systems)**
- **Radar signal processing**
- **Smart antennas (satellite and ground terminals)**

Satellite navigation and positioning systems (GNSS)

- **Performance assessment and augmentation techniques**
- **Services et applications**

Networks and multimedia communications

- ***Networking techniques***
- ***Network architectures and dedicated networks***

Propagation and air interfaces

- ***Propagation modeling***
- ***Fade mitigation techniques***
- ***Air interface and radio access***

Software and hardware architectures

- ***Neural networks***
- ***GNSS receiver architectures***
- ***Galileo navigation***
- ***Software defined***

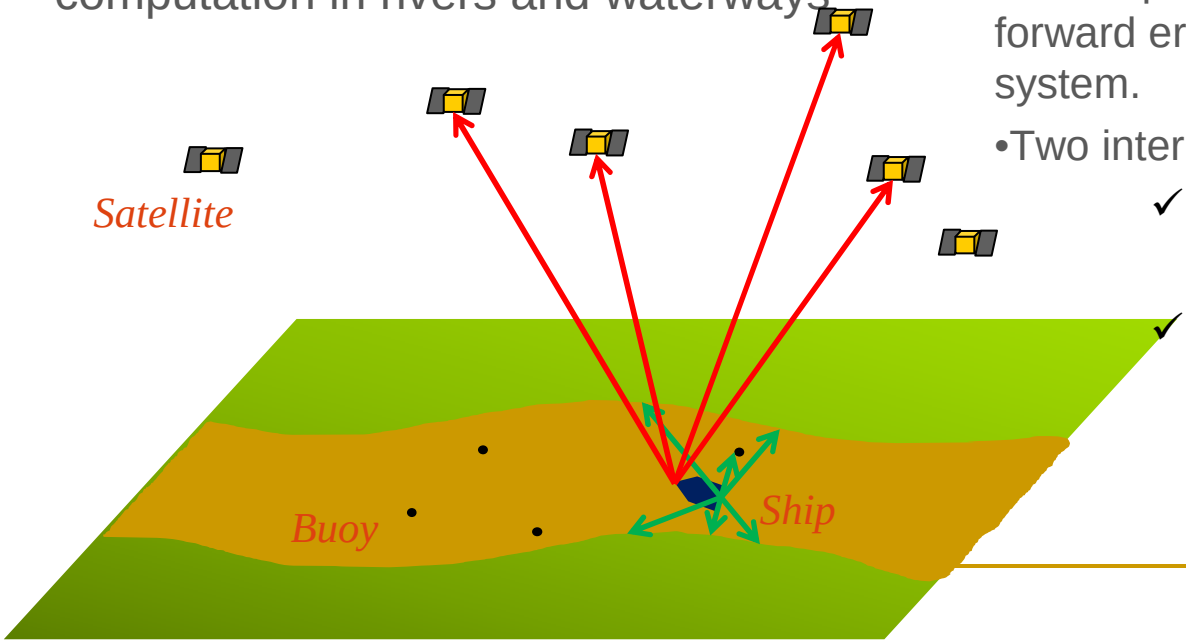
TESA general presentation

Examples of projects and achievements

SINAFE

RADAR / GNSS hybridization

Purpose: to jointly use RADAR and GNSS measurements for position computation in rivers and waterways



AIS (Automatic Identification System)

Purpose: Reception by LEO satellites of AIS messages exchanged between ships. Localization of ships without GPS data.

- Development of innovating demodulators and forward error correction codes fitted to the AIS system.
- Two international patents:
  - ✓ Viterbi algorithm with conditional transitions
  - ✓ Multi-encoding error correction with extended trellis

Satellite reception of AIS messages

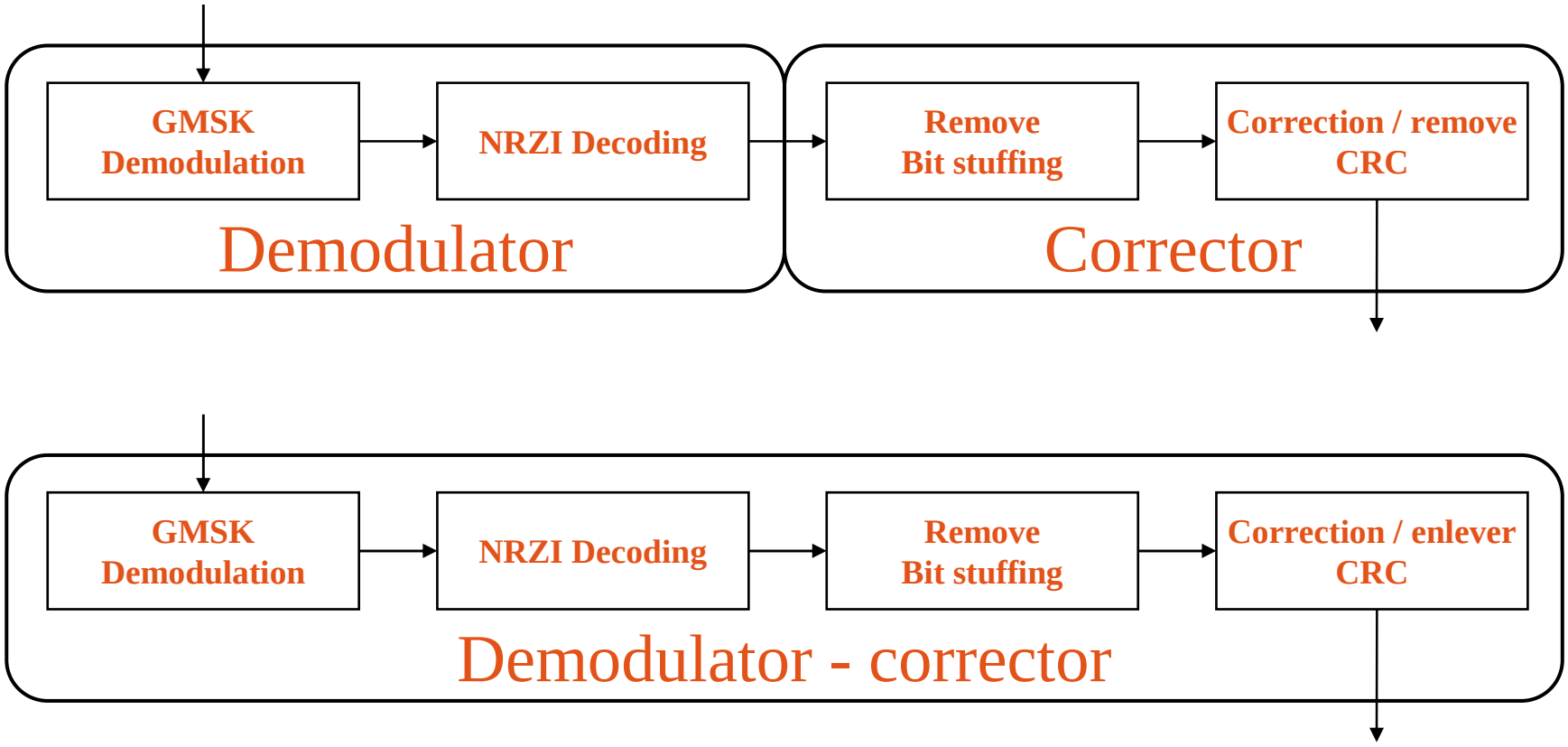
- Collision avoidance maritime VHF system. Vessels communicate their ID and GPS position to each other.
- A satellite reception can lead to a global supervision of the maritime traffic allowing lots of military and civil applications
- TESA Laboratory has been working with the CNES (French Space Agency) and the DGA (French army) since 2008 on the subject.
  - 3 research projects
  - 1 technical assistance
  - 1 PhD (still in progress)

Satellite reception of AIS messages

- Main addressed challenges:
  - Demodulation: New correction methods (taking advantage of the CRC in each AIS message) have been developed in order to obtain acceptable Packet Error Rates at the lower possible SNR
    - 3 scientific articles
    - 2 patents pending (DGA/CNES/TESA)
  - Interference mitigation (based on a multi-sensor input): Several antenna processing methods developed and evaluated using a CNES simulator
    - Re-estimation of the beamforming weights in Decision Directed
    - Inclusion of already demodulated and reconstructed signals as dummy transducers among the real sensors to detect and demodulate secondary signals

Satellite reception of AIS messages

- Demodulation



Satellite reception of AIS messages

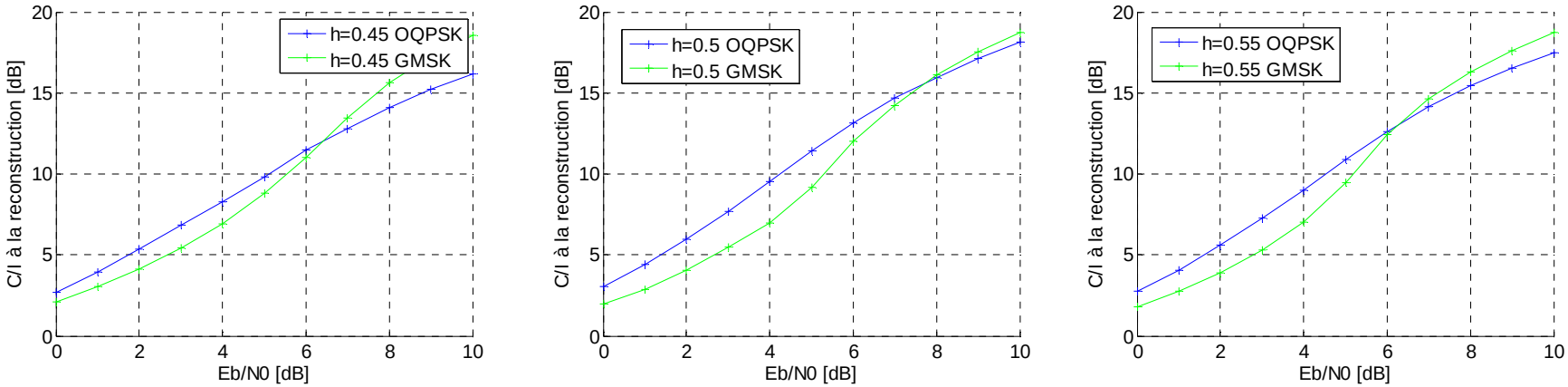
- Demodulation
  - Demodulators using CRC have excellent performance (gain of approximately 5 dB) but high complexity
  - Use of intelligent demodulation strategy (more and more complex demodulators up to obtain CRC OK)
  - Real AIS signals (terrestrial) analyzed (CNES “Ouessant” measurement campaign)
  - Realistic CNES satellite reception simulator

Satellite reception of AIS messages

- Signal reconstruction
  - Reconstruct the received signal as accurately as possible for future interference cancellation
  - Gives the possibility to re-estimate all parameters (time, frequency, modulation index and phase) in Decision Directed for SIC (Successive Interference Cancellation) procedure
    - Improved performance using a second demodulation
- Reconstruction modes
  - GMSK from the demodulated information bits
  - OQPSK based on decisions
    - reconstruction more close to the channel (before removing stuffing bits introducing accumulated errors)

Satellite reception of AIS messages

- Signal reconstruction



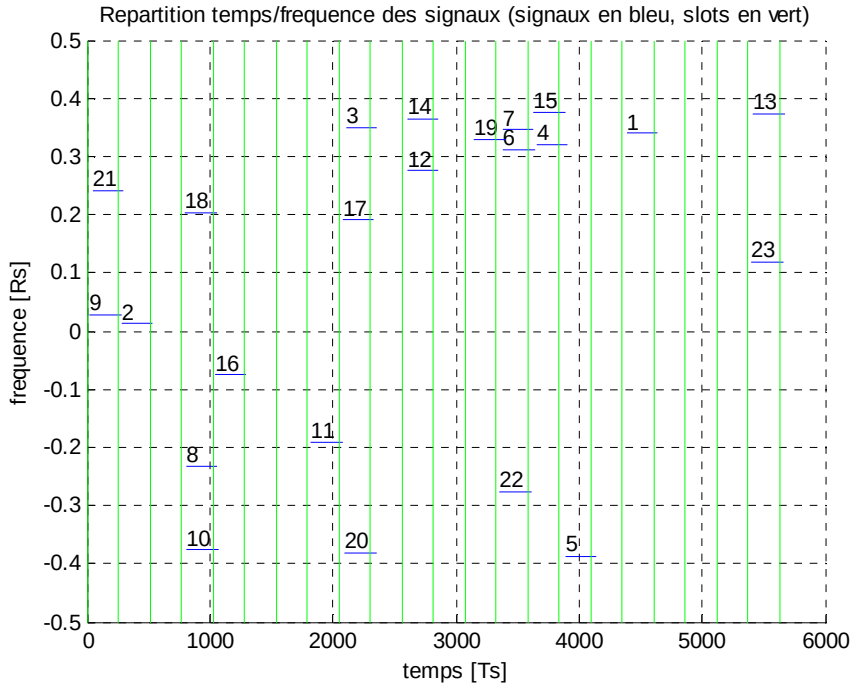
Reconstruction C/I (OQPSK and GMSK)

Satellite reception of AIS messages

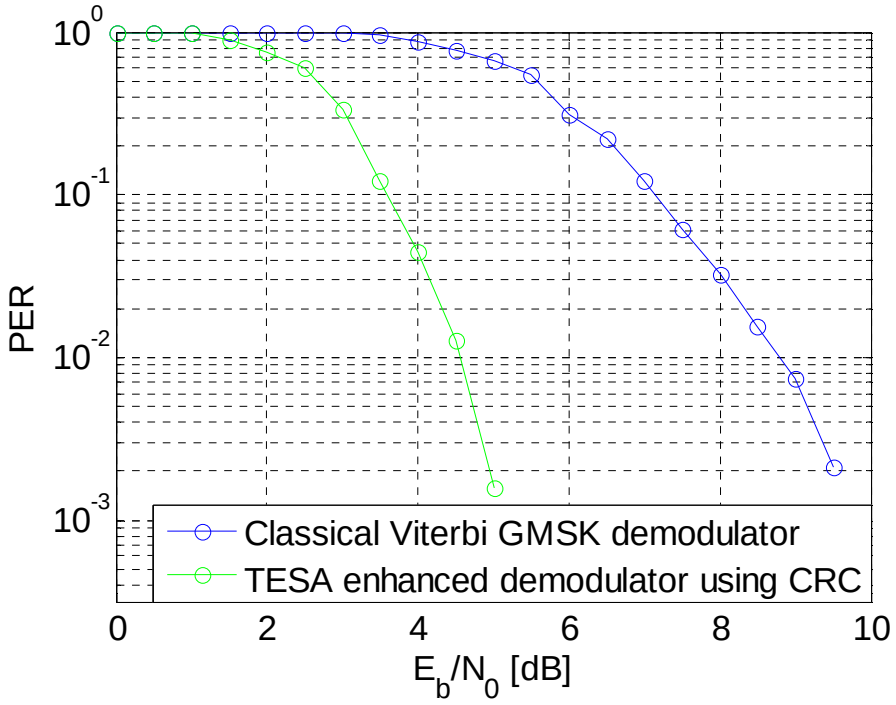
- Interference mitigation
  - The range of classical AIS equipments is approximately 20 to 25 Nautical Miles (NM)
    - leads to a self-organized system in small areas, between ships which are in VHF range from each other
    - On a larger scale, there is no more organization.
    - As the field of view from the satellite is much broader, time and frequency collisions of signals received by the satellite will occur.
  - Antenna processing methods: CNES plans to launch satellites with multiple antennae
  - Use of a realistic CNES simulator: signals received by satellite not available (classified)

Satellite reception of AIS messages

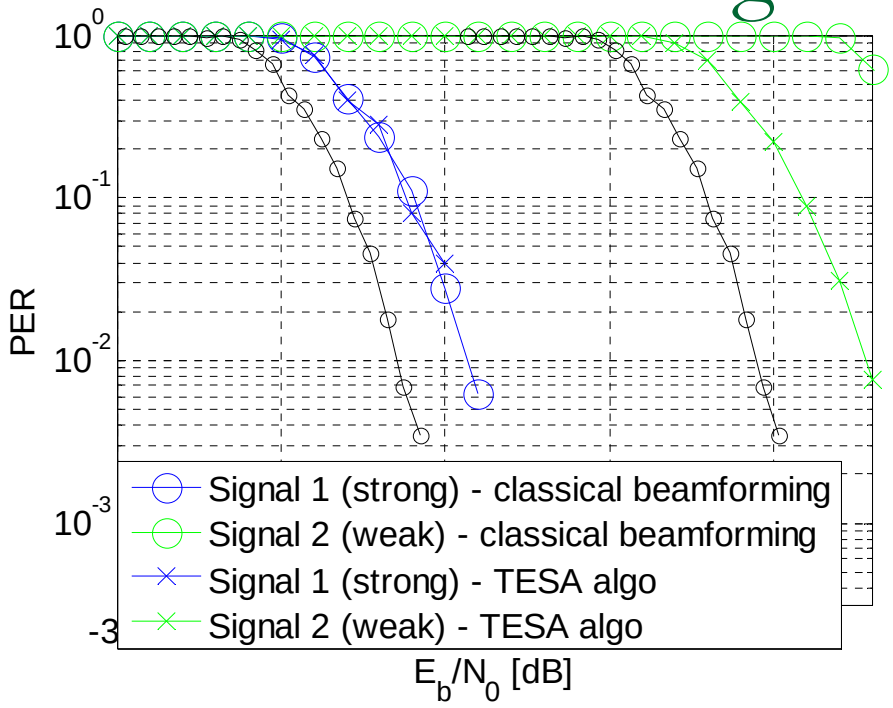
- Interference mitigation
  - Example of time/frequency repartition of the received signals with collisions (satellite above Mediterranean)



Satellite reception of AIS messages



4.5 dB gain improvement with TESA demodulator using CRC



Demodulation of weak signals with strong interference with TESA interference mitigation (dummy transducers)

Satellite reception of AIS messages

- Conclusion
  - Solid experience in
    - AIS demodulation
    - Interference mitigation techniques
  - Looking for partners to
    - Get real satellite signals
    - Improve other technical aspects
    - Answer to European tenders
      - Theoretical aspects for TESA
      - Need of a partner able to develop hardware receiver demonstrator (VHDL, …)
      - Need of Administrative and financial project management coordinator