Interference Mitigation in Satellite Communications

AVIO-601 Interference Mitigation in SatCom

PROJECT SUMMARY

OBJECTIVES

DETECT .. CHARACTERIZE .. LOCATE .. MITIGATE .. MONITOR

1- DETECT => DETECT THE PRESENCE AND IDENTIFY ALL TYPE OF INTERFERENCE SOURCES

2- CHARACTERIZE => RECOGNIZE, MEASURE AND CLASSIFY INTERFERENCE SIGNAL SIGNATURES

3- LOCATE => DETERMINE THE INTERFERENCE POSITION AND ORIENTATION

4- MITIGATE => REMOVE IN REAL-TIME INTERFERENCE (MITIGATION), OR AT LEAST REDUCE ITS RESIDUAL EFFECTS

5- MONITOR => RF SPECTRUM MANAGER, RFI ATLAS AND COUNTER-MEASURES AND RFI PREDICTION

TO ENSURE IN REAL-TIME AND FOR ALL SATCOM BANDS :

1) Robustness 2) Reliability 3) Integrity 4) Quality of Service (QoS)
5) Continuity 6) Availability 7) Accuracy 8) Quality of Experience (QoE)

PROJECT DETAILS

- **Project Title:** Interference Mitigation in Satellite Communications
- **Project Code** AVIO-601
- **Project Start Date:** 01 October 2016
- **Project End Date:** 30 September 2020
- **Project Duration:** 4 years
- **Research work plan:**
  - PHASE 1 - RESEARCH PROCESS (2016-2017)
  - PHASE 2 - DEVELOPMENT PROCESS (2017-2018)
  - PHASE 3 - INTEGRATION PROCESS (2018-2019)
  - PHASE 4 - DEMONSTRATION PROCESS (2019-2020)

APPROVED







CHALLENGES

1 - Define technical support, data sharing and expertise capabilities
2 - Define strategic alignment with partners' interests and technologies
3 - Characterize practical Interference mitigation techniques and models
4 - Determine the degree of performance to achieve alongside technical development
5 - Setup efficient, consistent and repeatable real-time tests environments
6 - Build end-to-end full-duplex Satellite Emulator : Hardware-in-the-loop
7 - Find an optimal trade-off between implemented techniques and hardware integration cost
8 - Meet targeted goals : detection, characterization, geolocation, mitigation and monitoring
9 - Ensure technology transfer to our industrial partners

EXPECTED OUTCOMES

1 - advanced techniques in SatCom Interference mitigation (Software / Hardware modules)
2 - Robust Software-Defined Radio platforms integrating developed techniques
3 - Atlas Software platform capable of surveying in real-time the integral SatCom spectrum
4 - Complex SatCom Interference scenarios
5 - Technical reports, scientific publications and patents

SENIOR RESEARCHERS TEAM

UNIVERSITY CORE TEAM:
ÉTS • CONCORDIA • INRS • POLY • UQÀM

Prof. René Jr. Landry (ÉTS, Principal Investigator)
Prof. Wessam Ajib (UQÀM - University du Quebec à Montreal)
Prof. Long Le (INRS - Institut National Recherche Scientifique)
Prof. Jean-Jacques Laurin (Polytechnique Montreal)
Prof. Chahé Nerguizian (Polytechnique Montreal)
Prof. Yousef R. Shayan (Concordia University)

INDUSTRIAL CONSORTIUM :
THALES • VIGILANT • ATEM • TELESAT
+20 PROFESSIONAL ENGINEERS

PROJECT INNOVATION

PROBLEMATIC

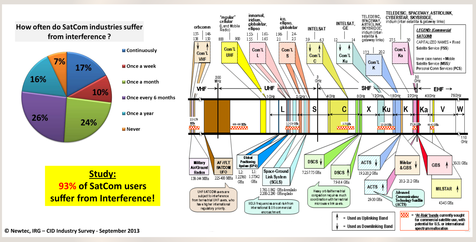
1 - THERE IS A NEAR SATURATION ON SATELLITE COMMUNICATIONS BANDS (L / S / C / KU) BECAUSE OF THE STEADY GROWTH OF DEPLOYED SERVICES AND NEW APPLICATIONS

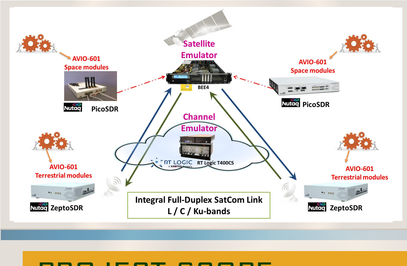
2 - THE CONGESTION OF CONVENTIONAL FREQUENCY BANDS IS CAUSING A SCARCITY OF RF SPECTRUM WHICH IS A MAJOR BARRIER TO THE DEPLOYMENT OF NEW SERVICES

3 - IN RECENT YEARS, THE INCREASE OF INTERFERENCE EVENTS HAVE CLEARLY SHOWN PROOF THAT RADIO FREQUENCY INTERFERENCE IS BECOMING MORE COMPLEX WITH SEVERE IMPACTS

4 - THERE ARE ISSUES ON KA-BAND : DESIGNED TO BRING NEW CAPACITIES AND SUPPLEMENT SATCOM BANDS, KA-BAND HAS NOT BEEN WIDELY ADOPTED BY OPERATORS DUE TO ITS SUSCEPTIBILITY FROM RAIN AND OTHER WEATHER CONDITIONS

5 - INVESTIGATE IRIDIUM AND INMARSAT INTEROPERABILITY ISSUES IN THE SAME AIRSPACE





UNIQUE LABORATORY SATCOM EMULATOR

- **Unique laboratory full-duplex SatCom link emulator :** Simulate in real-time a complete satellite network enabling advanced complex interference scenarios using Software-defined radios (SDR) and a powerful satellite channel emulator
- **RT logic T400CS :** World-class channel simulator featuring IF and RF hardware-in-the-loop testing: flight and ground system testing, interference and reference signal generation, compliance and performance loop-back testing, training capabilities
- **BEECUBE SDR devices :** full-speed prototyping platform serving as a complete Satellite Emulator enabling real-time implementation and emulation of satellite transponder functionalities
- **NutaQ SDR solutions :** featuring digital signal processing to enable the development and integration of AVIO-601 techniques developed by researchers (detection, characterization, geolocation, mitigation, monitoring)

PROJECT SCOPE

1- Characterization of SatCom Interference environment and effects
2- Development of innovative and visionary practical models based on SoA theories
3- Analysis, Design, Test and Demonstration of the five AVIO-601 goals
4- Study of Interference case between Inmarsat / Iridium
5- Integration of developed techniques (algorithms) on hardware platform (FPGA and SDR)
6- Performance analysis of the integrated prototypes (Emulators vs. in-field tests)
7- Validation and technology transfer to our industrial partners

PROJECT BENEFITS

1- To provide tools to detect, characterize, locate, mitigate and monitor interference
2- To deliver a transmission with a performant and consistent Quality of Service (QoS)
3- To improve Quality of Experience (QoE) for end-users
4- To enable regulators to easily manage spectrum requirements
5- To establish a productive international research collaboration between countries
6- To stimulate economy and influence establishment of R&D centers and enterprises
7- To train future space community leaders and provide HQP to industry
8- To enhance collective knowledge through improved education and advanced training
9- To engage stakeholders investigating satellite communications issues (interference, space security and sustainability) through technical, socio-economic and legal aspects

EVERYONE IS BENEFITING: OPERATORS, MANUFACTURERS, REGULATORS, BROADCASTERS, SCIENTISTS, OFFICIALS, INSTITUTIONS, ACADEMIA AND END-USERS

RFI COUNTER-MEASURES

- **Detection techniques :** Sense the interference
  - Multiuser, kurtosis, multi-channel, cross-frequency, etc.
- **Characterization techniques :** Define effective measurement approaches for interference signals
  - parameters: carrier frequency, doppler effect, power level, modulation type, bandwidth, etc.
- **Geolocation techniques :** Track interference location and orientation
  - Time / angle / power / frequency-of-arrival, Ephemeris Error Compensation, etc.
- **Mitigation techniques :** eliminate the interference or reduce its residual effects
  - spatial approaches (Beamforming, beam-nulling, beam-steering)
  - spectral approaches (adaptive filtering, adaptive spectral allocation, etc.)
- **Monitoring techniques (Atlas platform) :**
  - collect/record characteristics of RFI in real-time
  - React/adjust the unit accordingly
  - Predict Interference occurence

Software-Defined Radio (SDR), adaptive antennas, Cognitive Radio (CR), Dynamic Monitoring, etc.

PROJECT PARTNERS

THALES
Atem RF & MICROWAVE
ÉTS
Université Concordia
Telesat
VIGILANT GLOBAL
UQÀM Université du Québec à Montréal
POLYTECHNIQUE MONTRÉAL
CRIAQ
NSERC CRSNG
INRS Université d'avant-garde

MORE INFO

LASSENA LABORATOIRE DES TECHNOLOGIES SPATIALES, SYSTÈMES EMBARQUÉS, NAVIGATION ET AVIONIQUE

lassena.etsmtl.ca