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 TYPES OF INTERFERENCE SOURCES

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

3- LOCATE => DETERMINE THE INTERFERENCE POSITION AND THE AFFECTED AREAS

4- MITIGATE => REMOVE IN REAL-TIME THE INTERFERENC, OR AT LEAST REDUCE ITS RESIDUAL EFFECTS

5- MONITOR => BUILD AN ATLAS DATABASE FOR SPECTRUM MANAGEMENT ALLOWING REAL-TIME EFFECTIVE INTERFERENCE COUNTER-MEASURES

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 2014
- **Project End Date:** 30 September 2018
- **Project Duration:** 4 years
- **Research work plan:**

PHASE 1 - RESEARCH PROCESS	(2014-2015)
PHASE 2 - DEVELOPMENT PROCESS	(2015-2016)
PHASE 3 - INTEGRATION PROCESS	(2016-2017)
PHASE 4 - DEMONSTRATION PROCESS	(2017-2018)

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)
Dr. Omar Yeste (ÉTS - École de Technologie Supérieure)
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 :
MDA • NUTAQ • ATEM • TELESAT
+20 PROFESSIONAL ENGINEERS

PROJECT INNOVATION

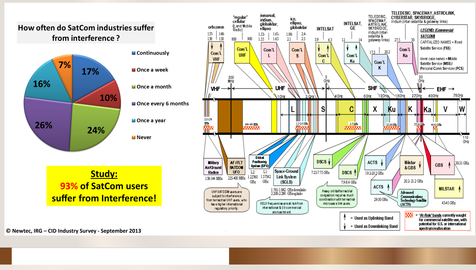
PROBLEMATIC

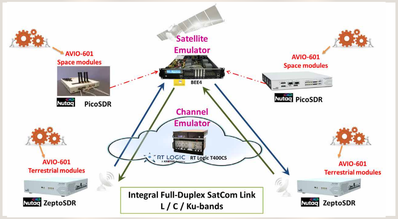
1 - NEAR SATURATION OF SATELLITE COMMUNICATIONS BANDS (L / S / C / Ku)
There is a steady growth of deployed services and new applications

2 - SCARCITY OF RF SPECTRUM
The congestion of conventional frequency bands is a major barrier to the deployment of new services

3 - INCREASE OF INTERFERENCE EVENTS, MORE COMPLEX WITH SEVERE IMPACTS
Radio Frequency Interference continues to degrade transmissions and disrupt the satellite communication industry

4 - 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





WORLD 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 BEE4 SDR platform :** 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)

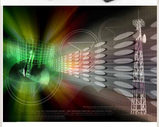
PROJECT SCOPE

1- Characterization of SatCom interference environment and effects
2- Development of practical models based on fundamental and state-of-art theories
3- Simulation, analysis and demonstration of the five AVIO-601 goals and linked modules
4- Building of a full-duplex SatCom Emulator and interference scenarios testbeds
5- Integration of developed modules on SDR platforms
6- Performance analysis of the integrated prototype in SatCom Emulator and real environments
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

MADE IN CANADA
FABRIQUÉ AU CANADA

RFI COUNTER-MEASURES

- **Detection techniques :** sense the interference (RFI)
  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
  Software-Defined Radio (SDR), adaptive antennas, Cognitive Radio (CR), Dynamic Monitoring, etc.

PROJECT PARTNERS

MDA™ · Nutaq · ÉTS Le génie pour l'industrie 40 ans · Université Concordia University · Telesat™ · Atem RF & Microwave · Polytechnique Montréal · UQÀM Université du Québec à Montréal · INRS Université d'avant-garde · CRIAQ · NSERC CRSNG

MORE INFO

LASSENA Laboratoire des technologies spatiales systèmes embarqués, navigation et avionique

lassena.etsmtl.ca