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SOFTWARE DEFINED RADIO INTEGRATED WITH FLIGHT SAFETY AND MISSION MANAGEMENT INTO IoT SUBSYSTEMS

A CASE STUDY AT AMAZONIAN SCENARIO

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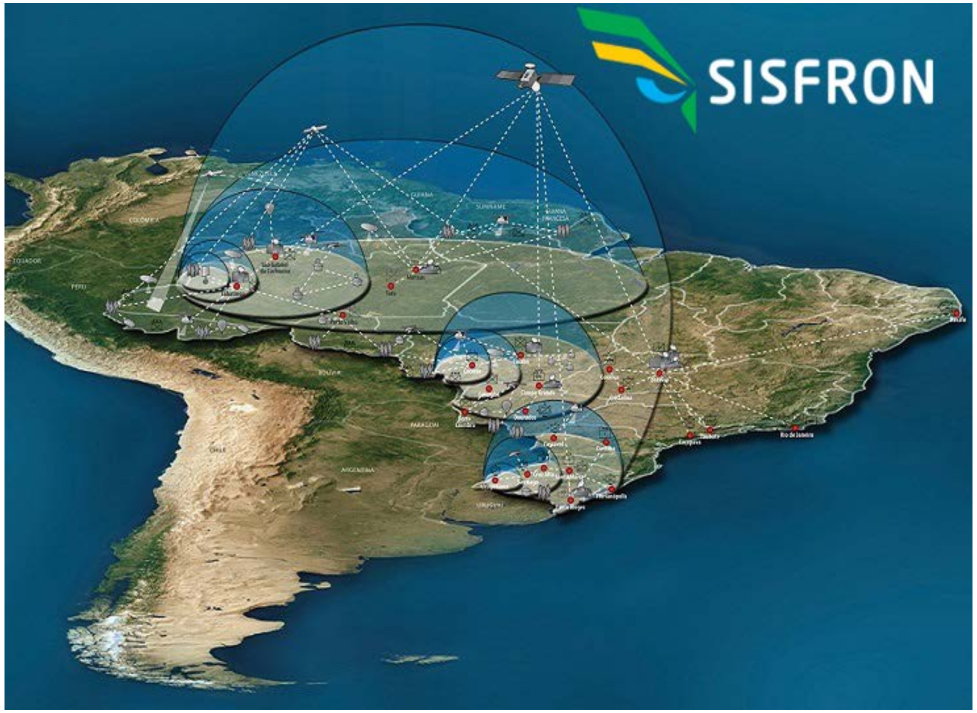
Outlines

- Introduction
- Brazilian SDR Program
- Cognitive Subsystems: Mission Oriented Sensors Array (MOSA) and In-Flight Awareness Augmentation System (IFA^{2}S)
- Integrating SDR with MOSA and IFA^{2}S
- Case Study – Amazonian Scenario
- Concluding Remarks
- Future Works

Introduction



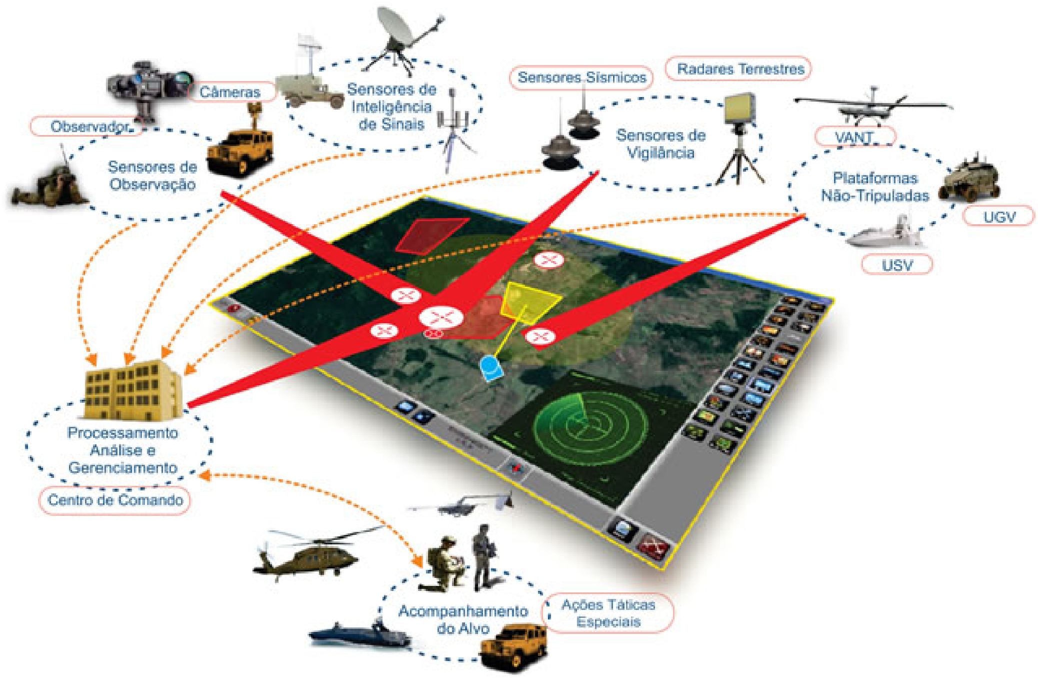
source: http://www.epex.eb.mil.br

State-of-the Art of Military Thought
- ➢ Joint Operations
- ➢ Network-Centric Warfare

Interoperability
- ➢ A Major Technological and Operational Challenge

Technological Challenges
- ➢ Vertiginous Advancement in Communications
- ➢ Diversity of Communication
- ➢ Proprietary Solutions
- ➢ Examples: Safety and CODECs

Introduction



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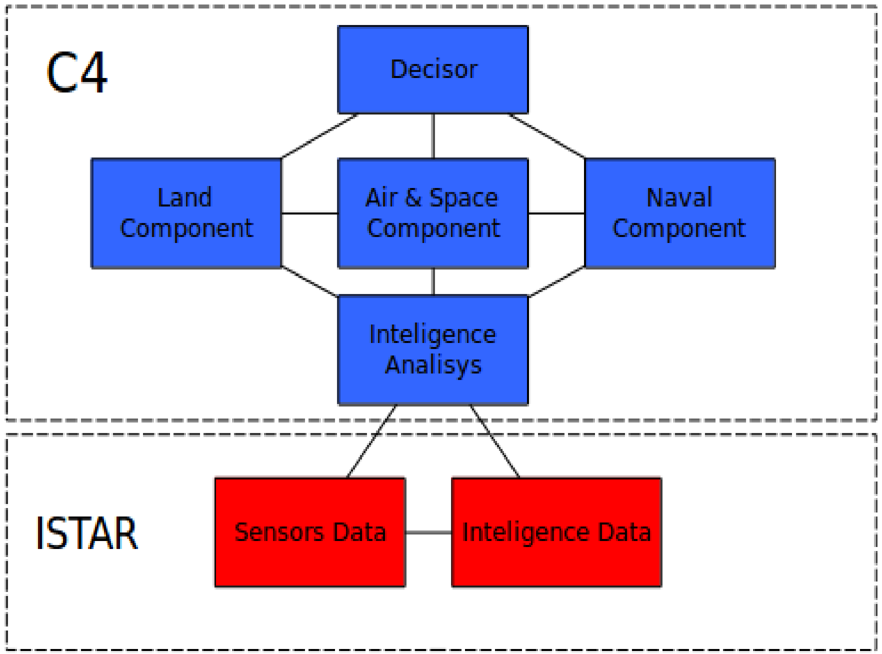


- Mission Oriented for C^4ISTAR
- Embedded Systems
  - SDR
  - Sensors Array (e.g. to Flight Safety and Mission Management)

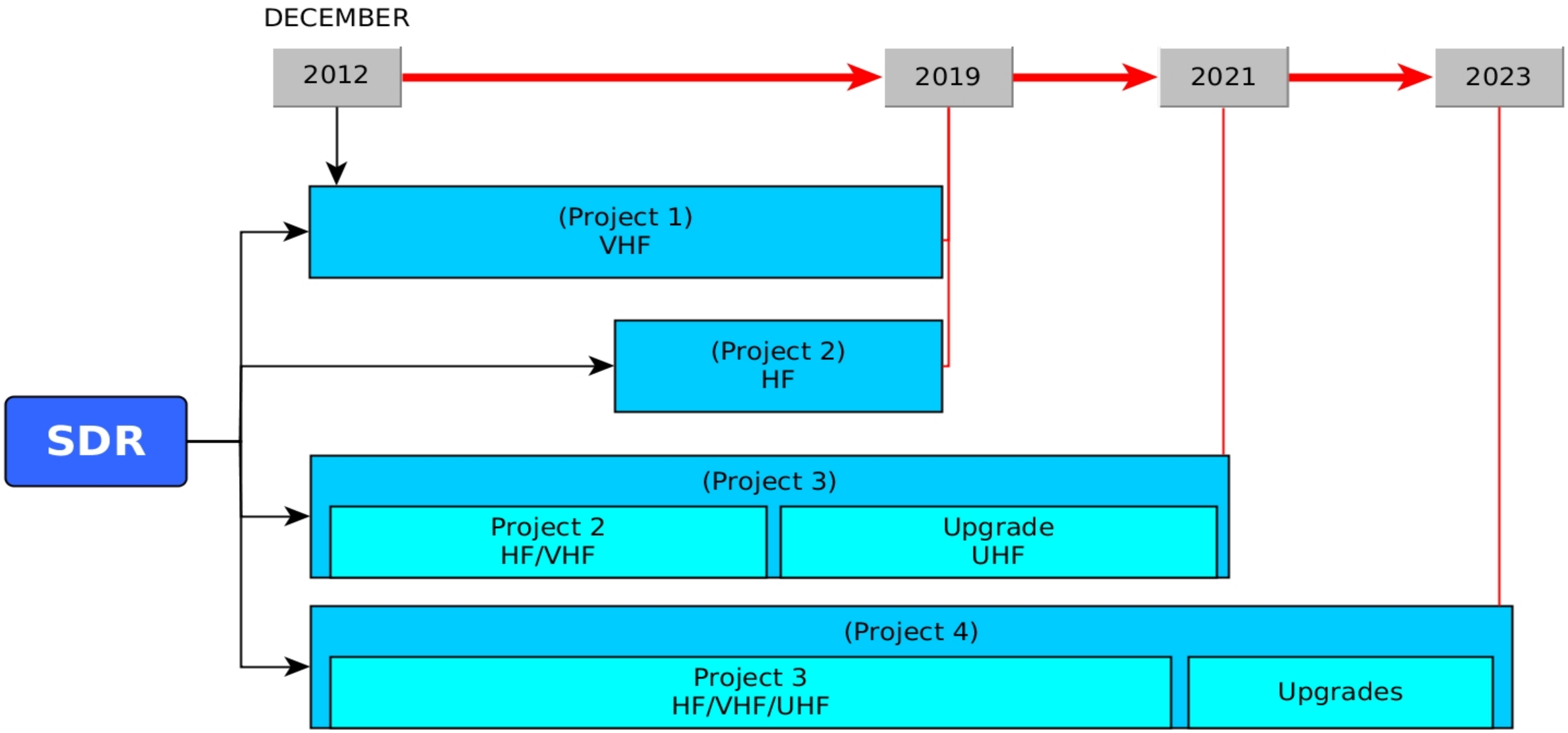
The Brazilian SDR Program

Objectives

- Interoperability, technological independence, flexibility and security
- Freedom of action in the Cyber Space
- Foment the national industry
- Links between science and technology institutions
- Training and improvement of highly qualified personnel
- Create conditions to enable cognitive radios R&D

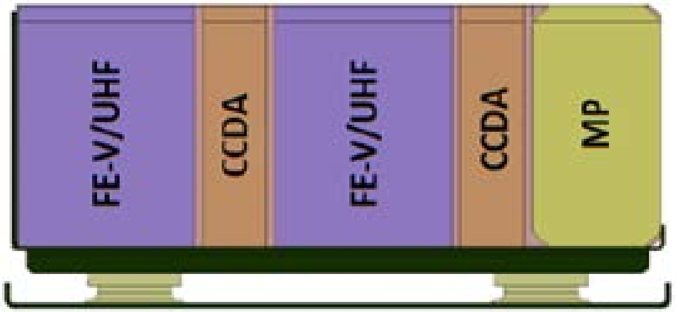
The Brazilian SDR Program

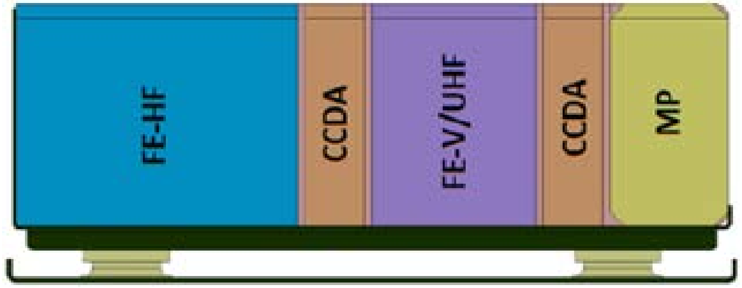
Vehicular Version



The Brazilian SDR Program

Modules & Integration Test





MOSA Concepts

➢ Intelligent subsystem of a Unmanned System to provide processed and ready-to-use information in real time and avoid the transmission of high amounts of raw data.

➢ Composed by sensors array, controllers, processors and a specific communication protocols to connect MOSA with the platform;

➢ Different missions can run in parallel using the same data sources

➢ MOSA can also provide:

- ❖Payload interchangeability among different vehicles;
- ❖A standard, model based, hardware/software development platform.

IFA$_2$S Concepts

- A decision-taker on-board the aircraft aiming to improve flight safety;

- It provides a platform-centric Situational Awareness (SA), instead of relying on human pilot's perceptions;

- Makes the UAV more conscious about its subsystems conditions (internal health), flight profile, intruders presence (other aircraft), and surrounding conditions (ground and meteorological), keeping pilots on the ground as system managers;

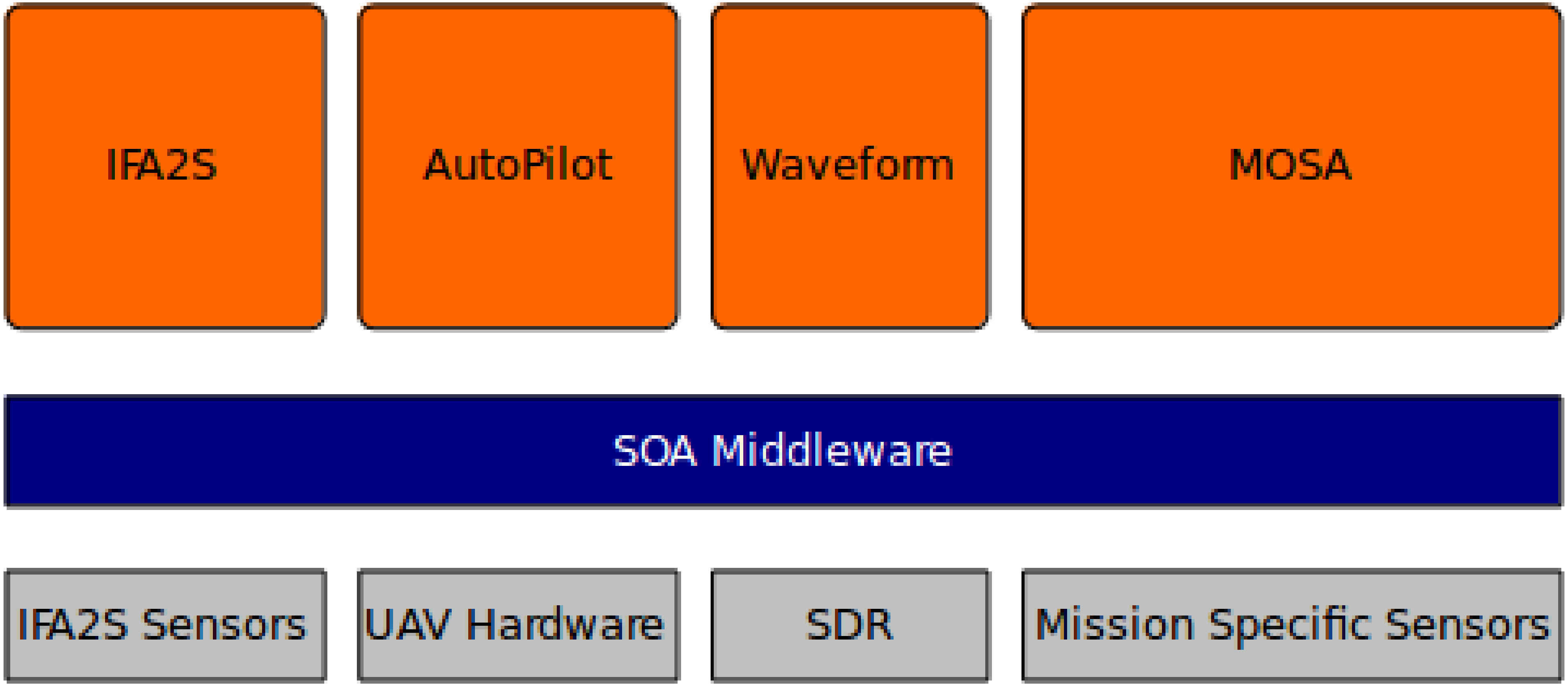
- It allows the system to act as soon as it identifies a situation that potentially leads to an accident;

- IFA^{2}S stays in "idle" state until a risky situation occurs, for example, bad weather, low altitude etc;

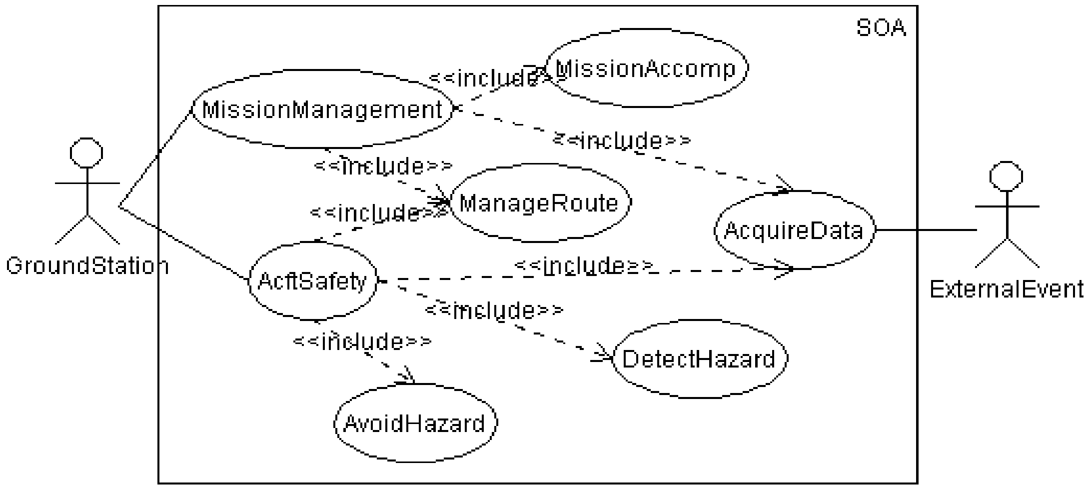
- Mission accomplishment is no longer priority and IFA2S sends directives for changing aircraft route and/or attitude.

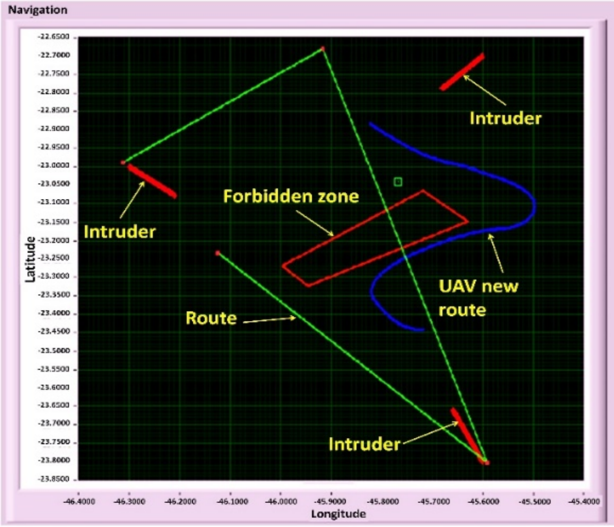
MOSA and IFA$_2$S

Functional Organization



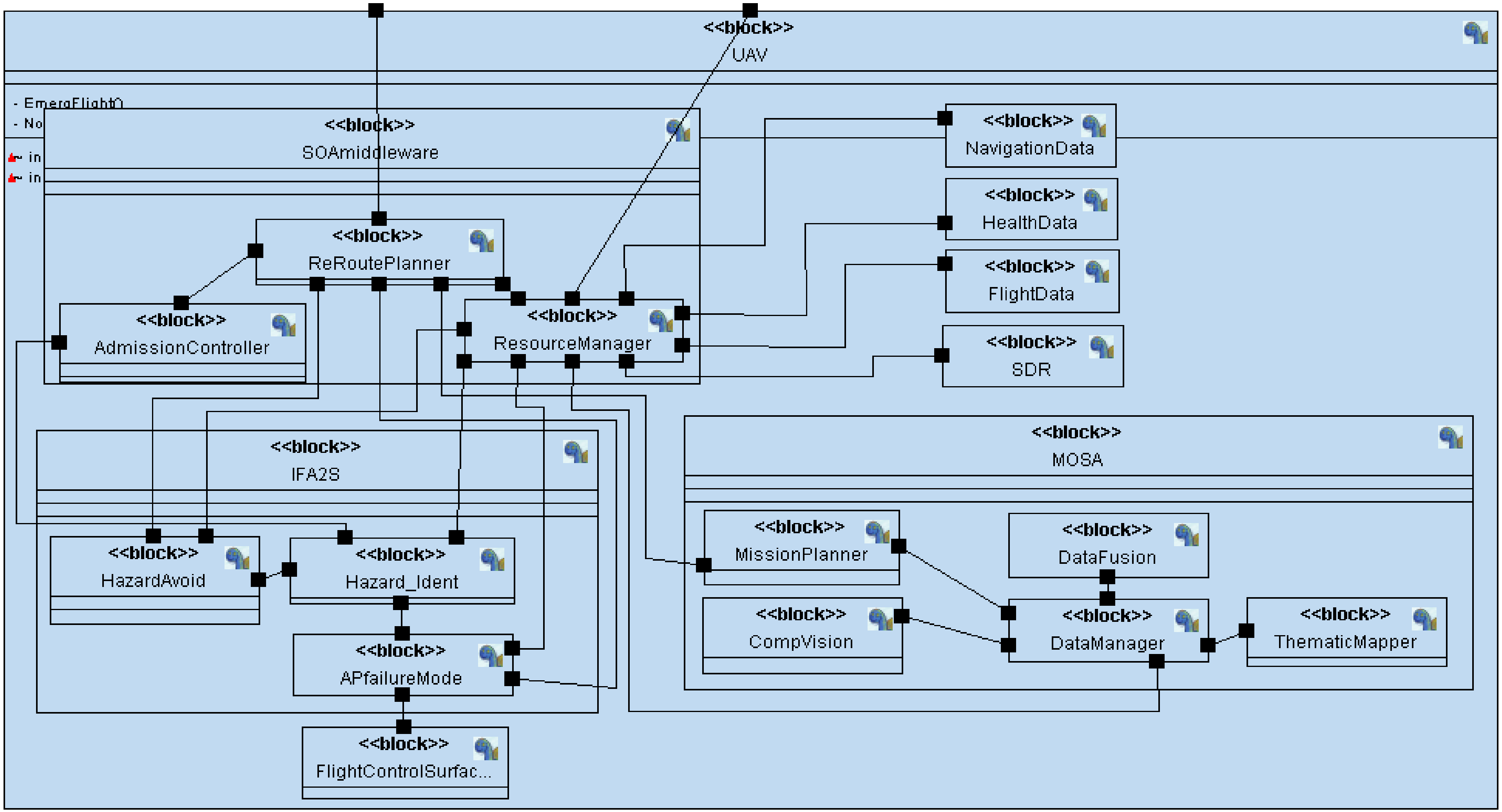
MOSA and IFA_2S





Hazard Identified	IFA2S action	Consequence to MOSA
Overflight of Forbidden Area	Avoid Overflight of Forbidden Area	MOSA loses control of the route route until the area is avoided
Strong turbulence	Abort mission accomplishment and sends aircraft back home	Mission cancellation
Abnormal Attitude: 60° < roll angle < 85°	Attitude correction	Mission stops momentarily with possible loss of information
Catastrophic failure	Ends flight and open parachute	Mission ends.

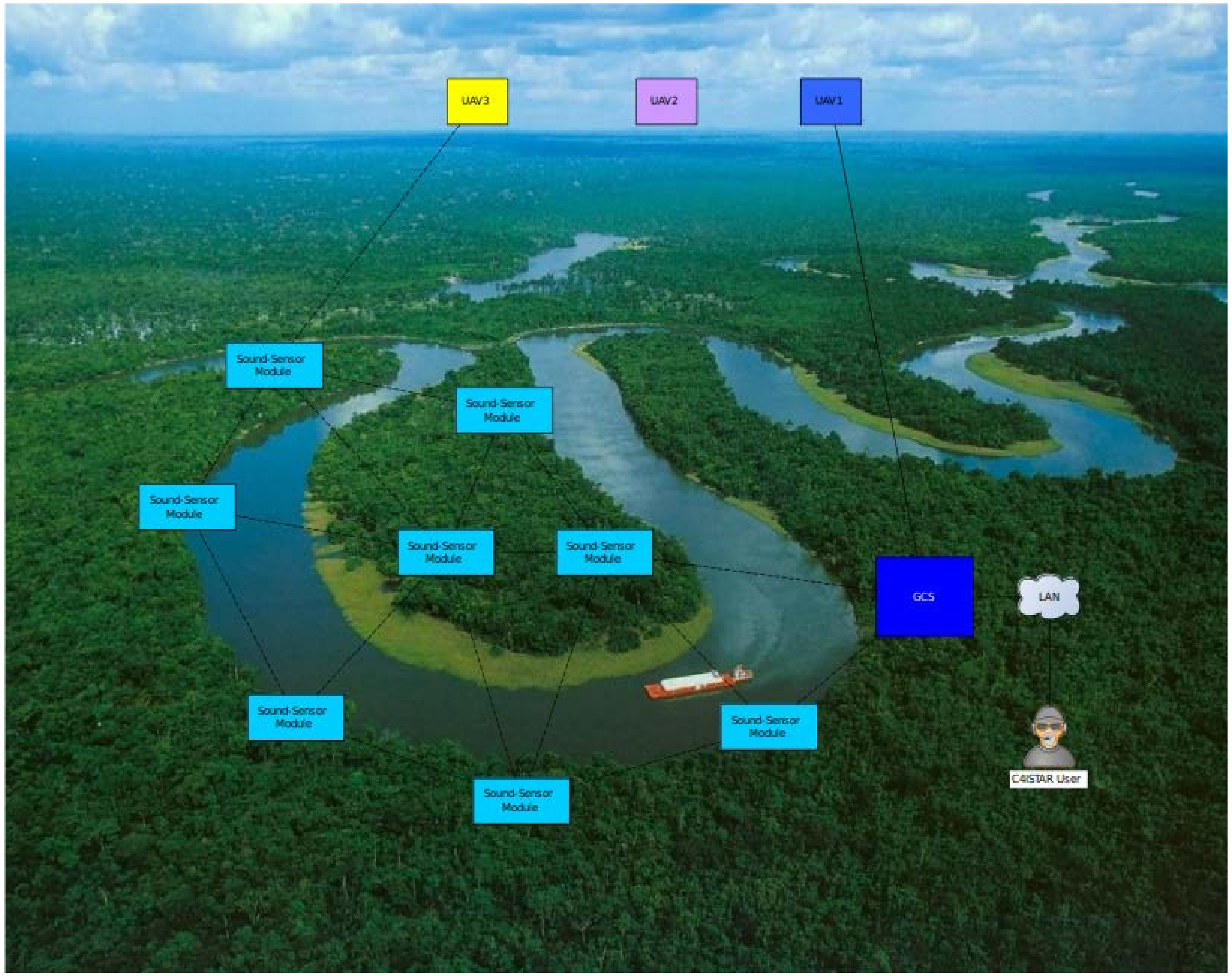
MOSA and IFA$_2$S



- RTSOA using Model Based Space System Engineering: SysML (TTool)

Case Study

Amazonian Scenario



- ➢ Illegal Activities: Detection of gunshots, fire and electromagnetic transmission;
- ➢ Region: Amazonian National Park
- ➢ Ground Sensor Network : MANET IoT System
- ➢ Platform: UAV Ararinha
- ➢ Sensors: Spectrum Analyzer, thermal camera, flight sensors (IMU, GPS)
- ➢ Data link: SDR (USRP)
- ➢ Waveforms: Low Power Network (LPN) and Orthogonal Frequency-Division Multiplexing (OFDM)

Case Study

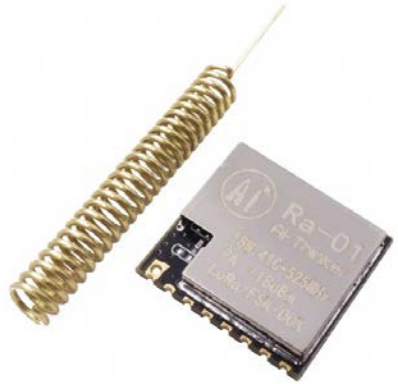
Amazonian Scenario

UAV Ararinha

USRP E312

Lepton
Thermal Cam

Spectrum
Analyzer
Anritsu

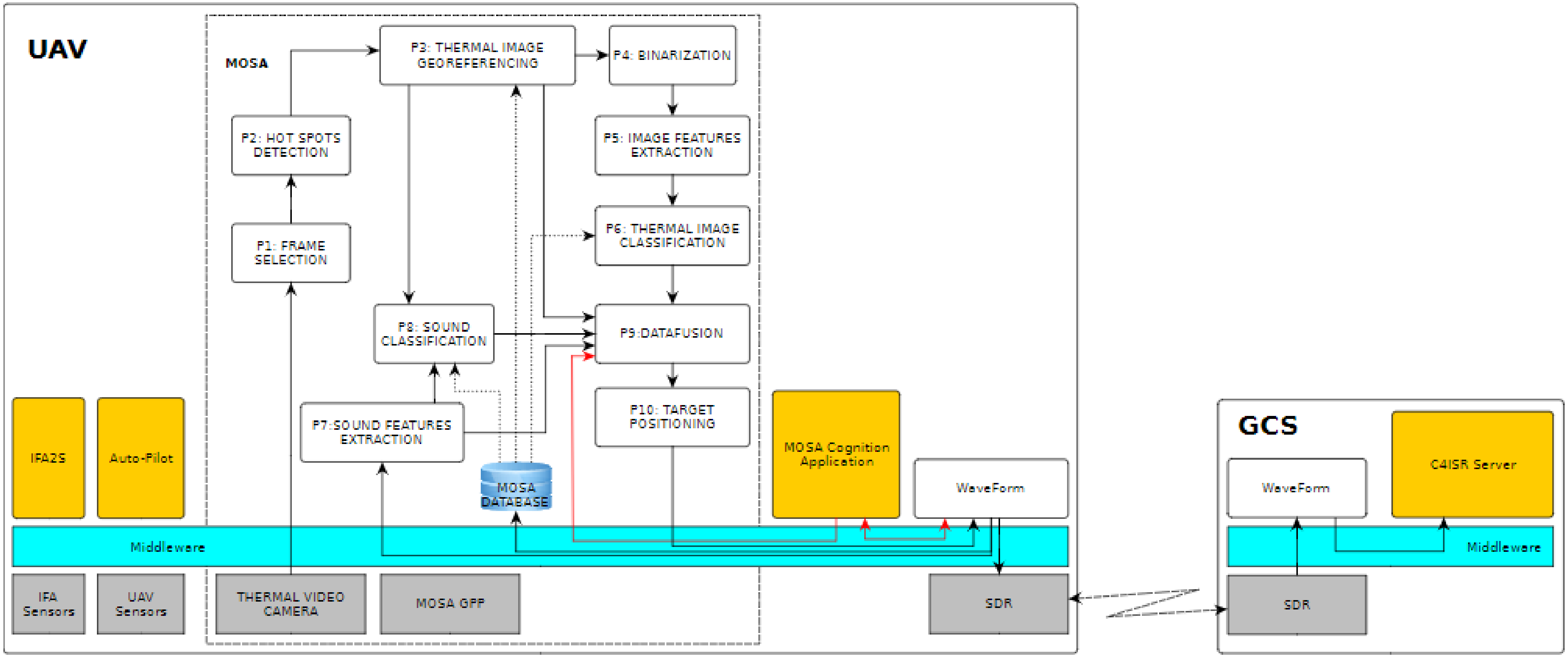


Modem
SX1278

Wave-Form	Spectrum	Range	BIT Rate	Band Width
LORA	ISM 433MHz and 968MHz	10km	37,5kBps	500kHz
OFDM	ISM 433MHz and 968MHz	1km	2MBps	5MHz

Case Study

SDR-SCA, MOSA and IFA_2S



Concluding Remarks

➢ Integration of SDR with MOSA and IFA^{2}S for C^{4}ISTAR applications in embedded processing on-board Unmanned Systems;

➢ The flexibility and modularity of an SDR, MOSA&IFA^{2}S, can optimize communications (selection, portability and dev. of waveforms);

➢ SDR is a key enabler of efficient, robust and adaptable communications between the MOSA-IFA^{2}S and a collaborative GSN; and

➢ The integration of MOSA, IFA^{2}S and SDR architectures seems possible and can represent a major step towards improving the usability and enhancement of Unmanned Systems.

Future Works

- ➢ Practical tests with the proposal architecture in an Amazonian scenario;

- ➢ Explore wireless communication concepts such as on-the-fly adjustments of Mission-Oriented waveforms; (e.g. Spectrum Sensing and Dynamic Spectrum Access);

- ➢ Evolve/Test this architecture in the following scenarios: In-site Channel Modeling, RF Coverage Map, Electronic Warfare, Search and Rescue Missions, Disaster Monitoring and Urban Surveillance.

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