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Poster Conceptualization and Specification of the Machine-to-Machine Payload System on NIMPH Satellite for IoT-Based Medical Monitoring Applications

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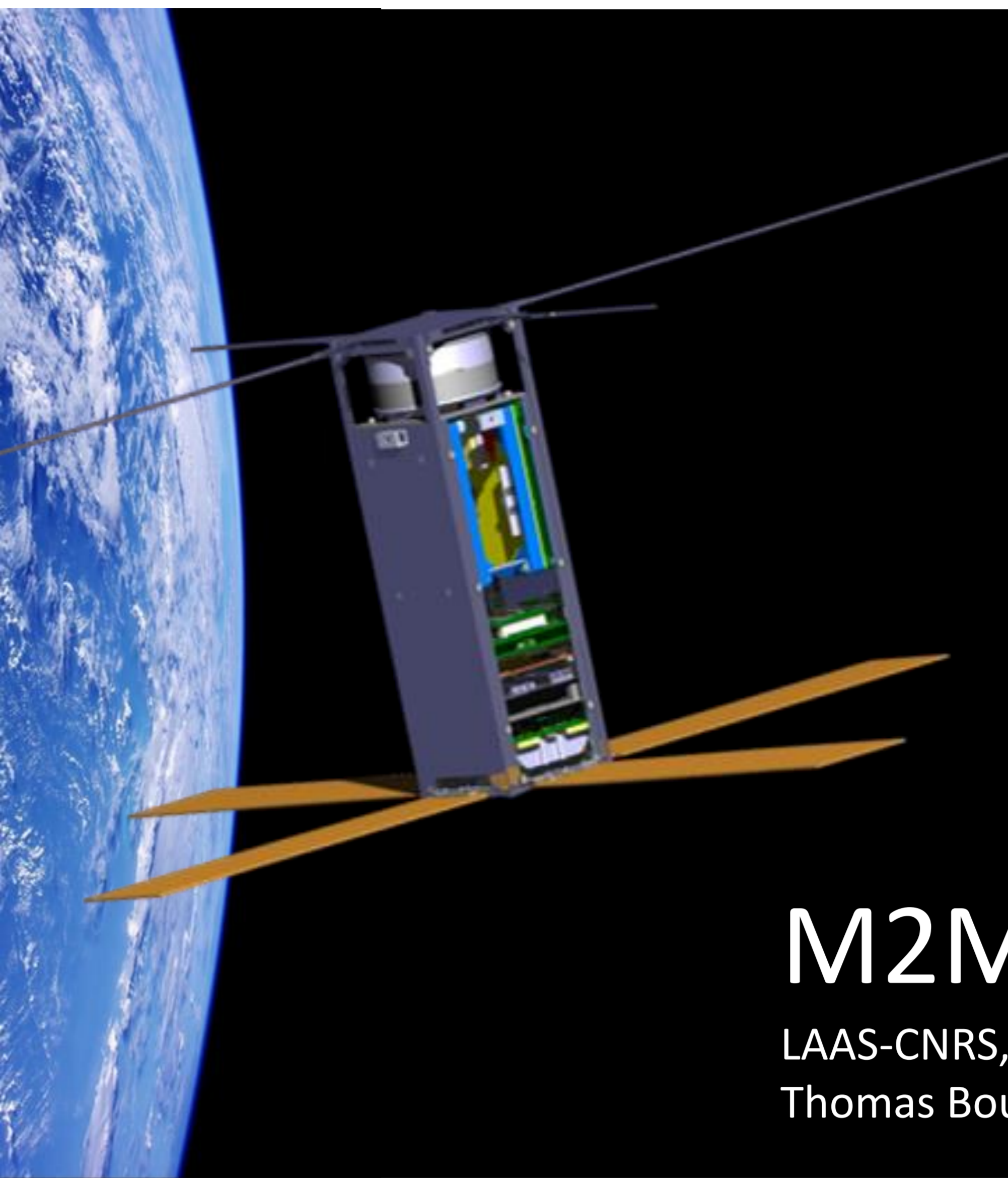
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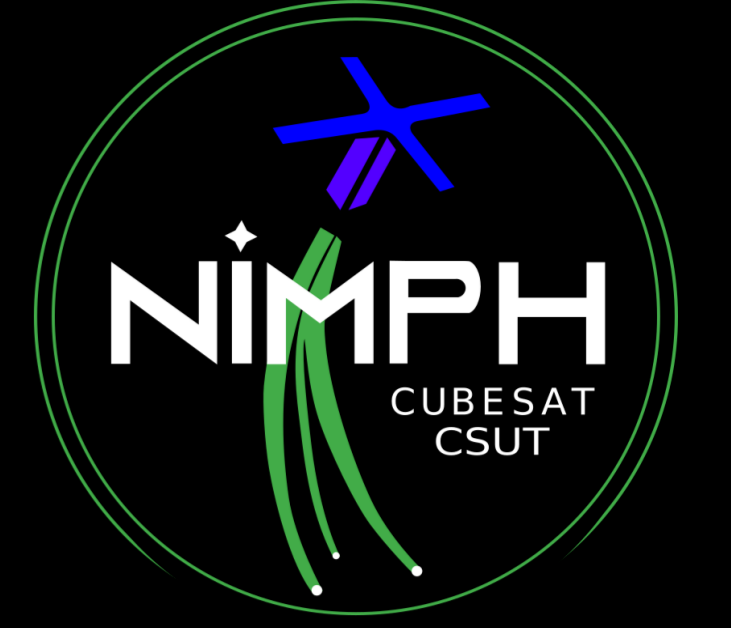
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NIMPH, Nanosatellite to Investigate Microwave Photonics Hardware



NIMPH summary

The project:

NIMPH is an academic research project led by the Centre Spatial Universitaire de Toulouse (CSUT). It involves numerous Master's students from Paul Sabatier University (UPS) and the ENSEEIHT engineering school, mainly through internships, research projects and practical work, under the supervision of professors and permanent staff from LAAS - CNRS.

Nanosatellite characteristics :

- Volume 3U (300 cm³)
- Weight 2 kg
- UHF radio (430 MHz)
- Sun-synchronous low-Earth orbit
- Power consumption: 7 W
- Mission duration: 2 years
- 3 payloads: EDMon, RADMon, M2M
- C phase

M2M (NIMPH Payload):

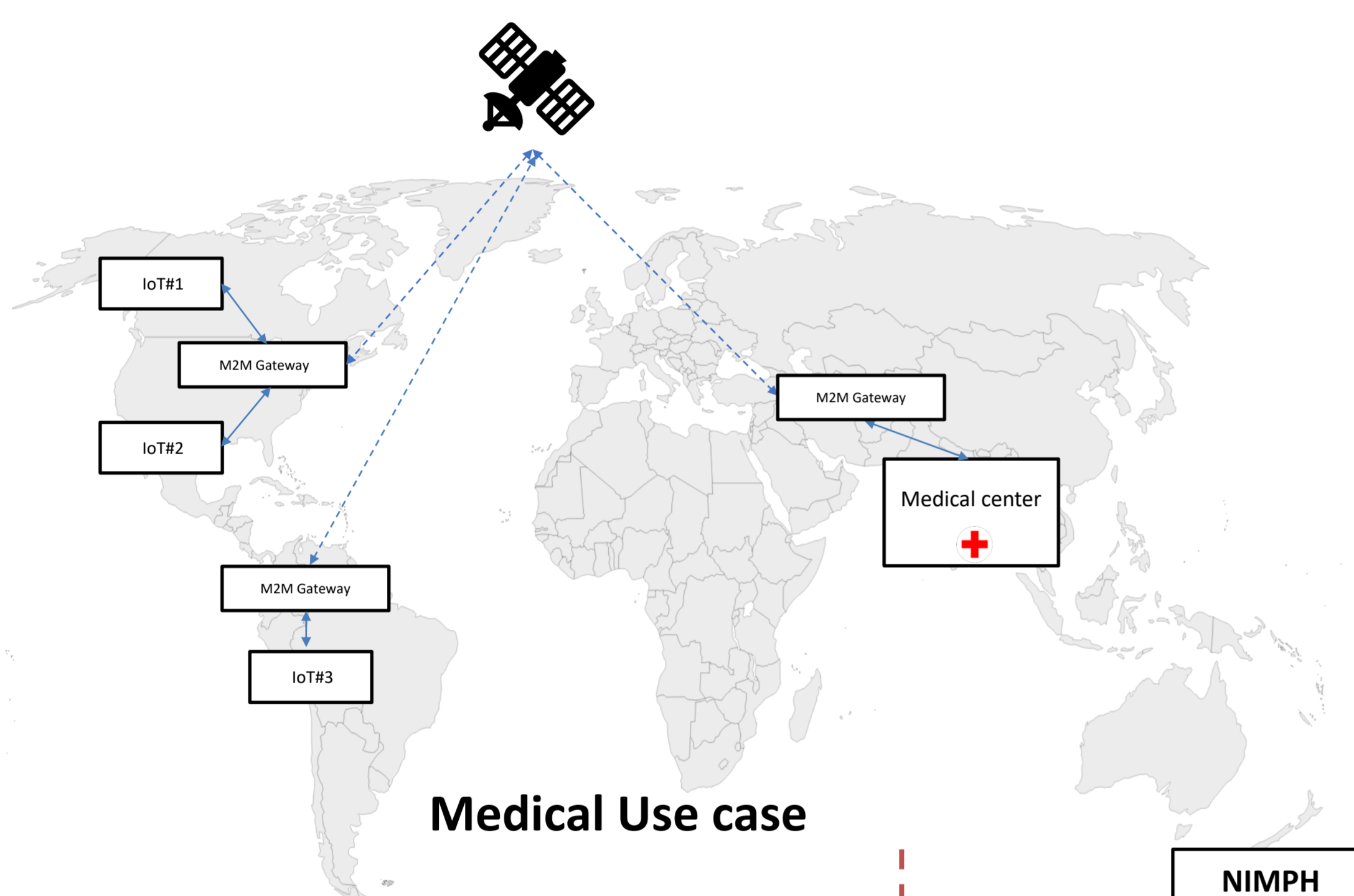
The NIMPH project's M2M system is designed to establish efficient, reliable, long-range communication between IoT devices and servers via a nanosatellite. The heart of the system is the NIMPH M2M payload, which enables data transmission between IoT devices and servers via satellite links.

M2M (Machine to Machine) payload - SARA Team

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Objectives and system architecture:

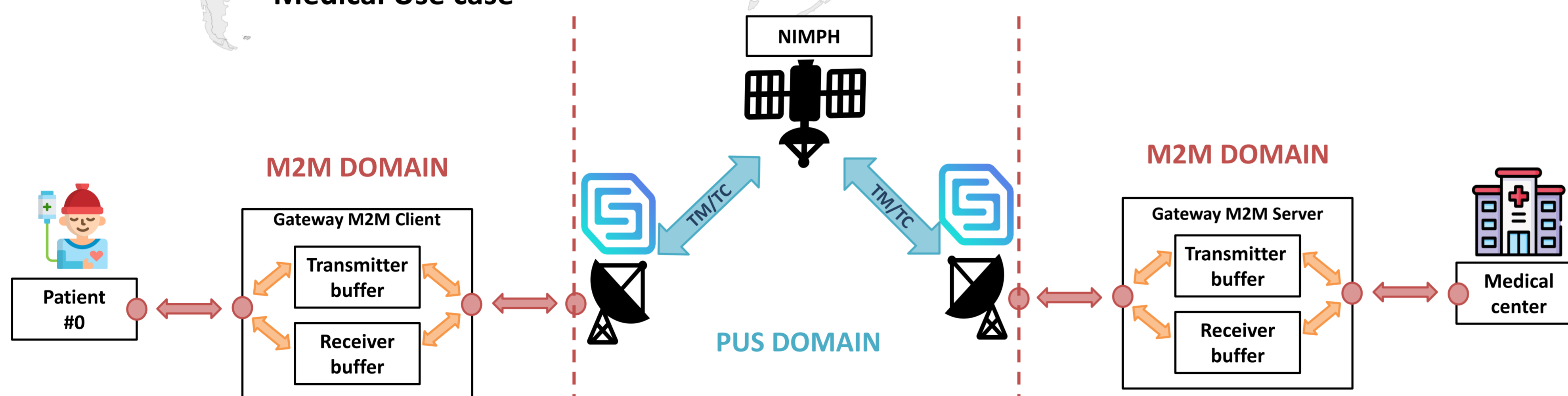


Objectives:

- The scientific challenges for IoT and M2M protocols in space are linked to the unique environmental conditions of space, the need to optimize the management of limited resources, and the reliability and security of space communications.
- Researchers and engineers are actively working on these challenges to enable the effective use of these technologies in space exploration and satellite management.

Architecture:

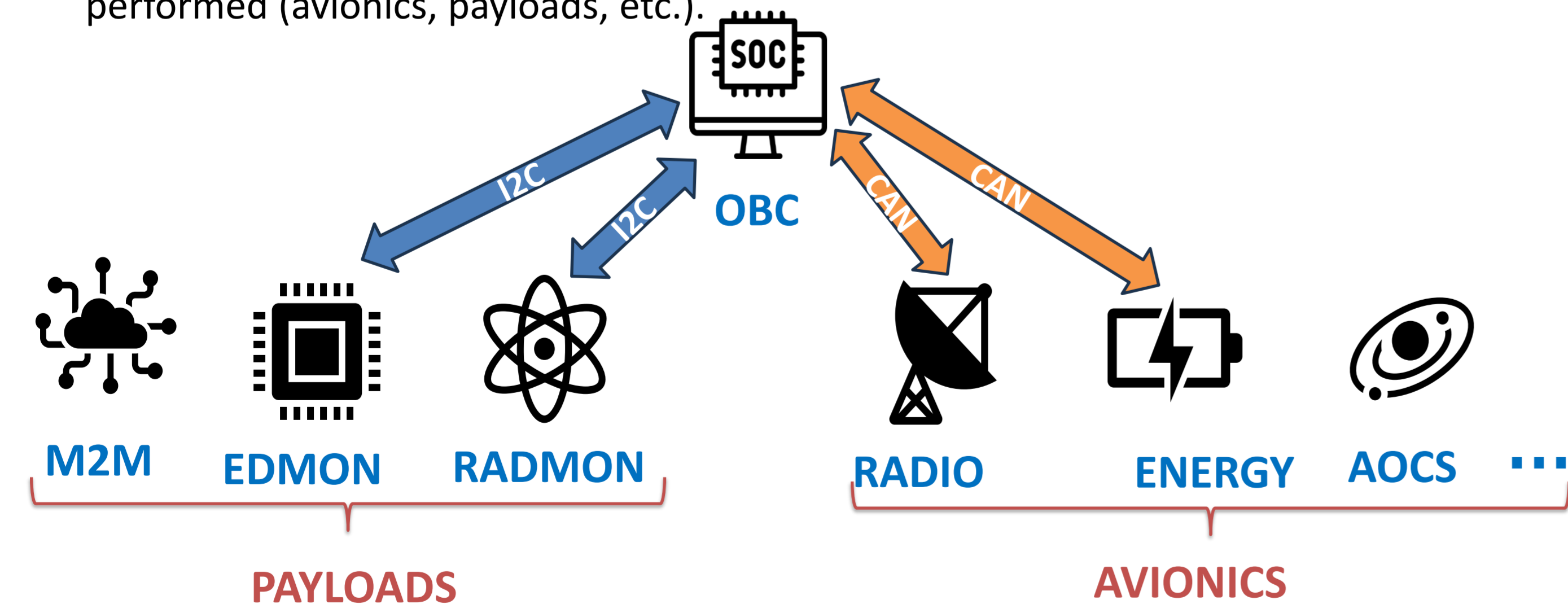
- **NIMPH M2M Payload:** An essential component of the NIMPH satellite, its main purpose is to manage Machine-to-Machine (M2M) communications between Internet of Things (IoT) devices and various IoT systems via the NIMPH satellite.
- **Generic gateway, IoT gateway:** a device designed to act as an intermediary between IoT devices and the NIMPH M2M payload. It is modular to adapt to different ground protocols, and enables IoT devices to communicate seamlessly with NIMPH.
- **Ground IoT systems:** technological infrastructure that collects, processes and manages data generated by connected objects, ensuring their communication with other systems and applications.
- Each IoT device may or may not be permanently connected to a gateway for data transfer to satellites (M2M PUS conversion).



Flight program:

Support Hardware M2M:

- The M2M payload is purely software.
- It does not require a specific electronic board within the satellite.
- Its program will be stored in the on-board computer (Ninano card) as a separate partition.
- The on-board computer will execute this payload according to its schedule of tasks to be performed (avionics, payloads, etc.).



Partition M2M:

The M2M partition within the NIMPH satellite is programmed to respond to different types of communications from the ground station (GS):

- **TC_133_1_DATA_M2M:** Sending a packet for registration in the packet list
- **TC_133_2_GET_DATA_M2M:** Transmits packet request for destination as argument

Its response will then be a telemetry of the desired packets.

- **TM_133_3_MESSAGE_M2M:** Returns the TMs containing the packets requested by TC_133_2.

Ground station and PUS protocol:

SCC ground station:

- The ground station used to communicate with the satellite is the SCC (Simple Control Center).
- The generic structure of a CCSDS 133.0-B-1 packet is described below.



Packet Primary Header						Packet data field		
Packet Version Number	Packet ID			Packet Sequence Control		Packet Data length	Packet Secondary header	User data field
	Packet type	Secondary header flag	Application process ID	Sequence flags	Packet Sequence Count or packet name			
3 bits	1 bit	1 bit	11 bits	2 bits	14 bits	16 bits	variable	variable
2 bytes				2 bytes		2 bytes	1 to 65536 bytes	

M2M <-> PUS conversion:

- There is no actual M2M to PUS converter.
- The M2M data is inserted in raw form into the PUS frame data.
- This data is then sent back to the gateways.

Advantages:

- Satellite invariance to terrestrial protocol: a protocol other than M2M could be used on the ground.
- Reduced on-board complexity: reduced risk to flight software
- Fast satellite processing: no M2M frame deconstruction.

