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NANOSATC-BR3 CONCEPT DESIGN USING MODEL-BASED SYSTEMS ENGINEERING (MBSE)

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SUMMARY

1. NANOSATC-BR program;
2. NANOSATC-BR3;
3. OBJECTIVES;
4. MODEL-BASED SYSTEM ENGINEERING;
5. CAPELLA - ARCADIA;
6. NCBR3 CONCEPT DESIGN WITH MBSE;
7. NCBR3 MISSION CONCEPT;
8. DISCUSSION;
9. CONCLUSIONS.

NANOSATC-BR PROGRAM

NANOSATC-BR1

- 1U platform and GS purchased from ISL/ISIS, through international bid in 2010;
- Magnetometer (INPE/MCTIC), Fault Tolerant FPGA (UFRGS) and IC on/off driver (SMDH/UFSM);
- Operational since 2014

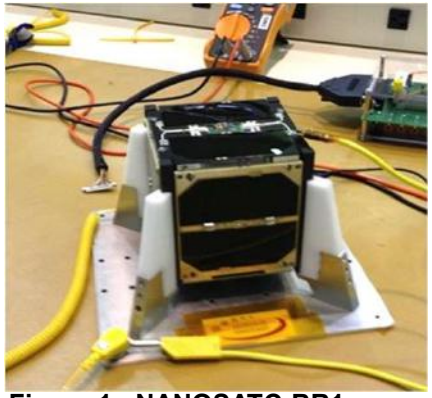


Figure 1 - NANOSATC-BR1

http://www.inpe.br/crs/nanosat/galeria.php

NANOSATC-BR2

- Langmuir Probe (INPE/MCTIC), Attitude Determination System (Cooperation INPE/MCTIC with UFMG - UFABC), Other ICs (SMDH and UFRGS) and two magnetometers;
- Currently at Assembly, Integration & Tests process.

Figure 1 - NANOSATC-BR2 EM

NANOSATC-BR3

- Currently in its **Conceptual Phase of Development**;
- To study **Space Radiation** and develop **Capacity building**;
- Constraint: **Reuse** NANOSATC-BR1 EM;
- Stakeholders and their needs:
  - **INPE Scientists** need to validate a radiation protective material in space.
  - **UFRN/CRN** technologists need to validate their transceiver in space environment.
  - **UFSM and UFRGS** technicians and Professors need to validate their integrated circuits against space radiation.
  - **Galileo Mission Scientists** need to analyze the dynamics of trapped particles in radiation belts and their influence on embedded electronics.

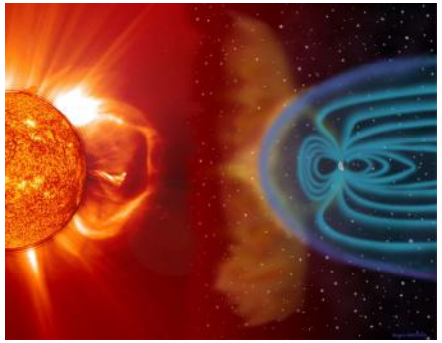
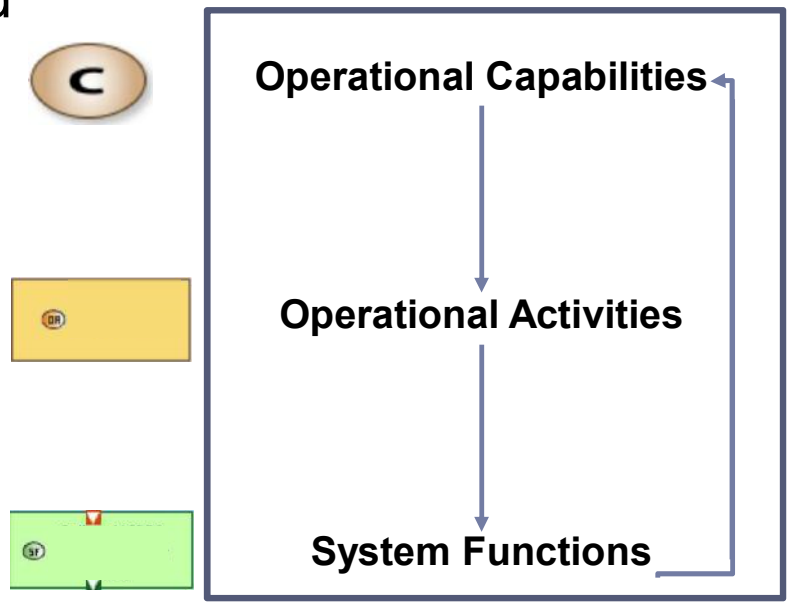


Figure 2 - NASA / SOHO

Figure 3 – NCBR3 EM

OBJECTIVE

- Use an MBSE software with an embedded Systems Engineering method to:
  - **Identify Mission needs and their interrelation;**
  - **Identify high level system functions;**
  - **Develop a mission concept;**
  - **Capture requirements;**
  - **Build the first NCBR3 Model;**
  - **Introduce the use of MBSE in the Program.**



MODEL-BASED SYSTEM ENGINEERING

"*Formalized application of modeling to support requirements definition, design, analysis, verification and validation activities*"

- One of the main Goals:
  - **Integrate** information, communication and the analysis of systems engineering products.

- Modeling is based on three pillars:
  - **Tool**: Concerns to the instrument (usually software) that will be used to develop the work;
  - **Language**: Method of communication between the user and the tool (similar to a programming language);
  - **Method**: process that sometimes is conveniently embedded in the tool.

CAPELLA - ARCADIA

- Integration of all model views;
- Open source;
- Largely used by space industry;
- Meets all three pillars;
- Four steps of development;
- Interactive and recursive method.

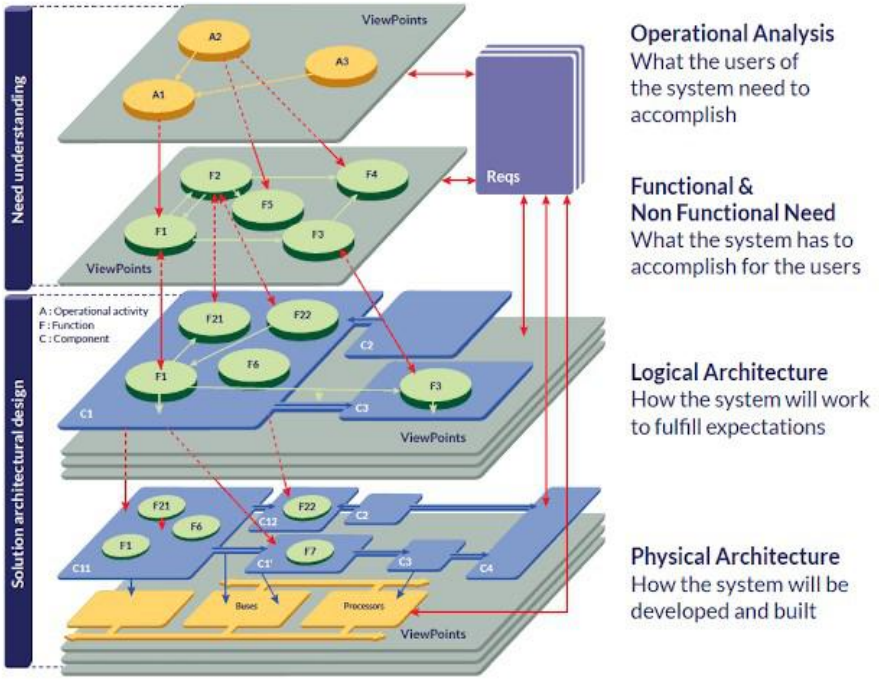


Figure 5: The Arcadia Method
Source: https://www.eclipse.org/capella/arcadia.html

NCBR3 CONCEPT DESIGN WITH MBSE

Operational Capabilities:

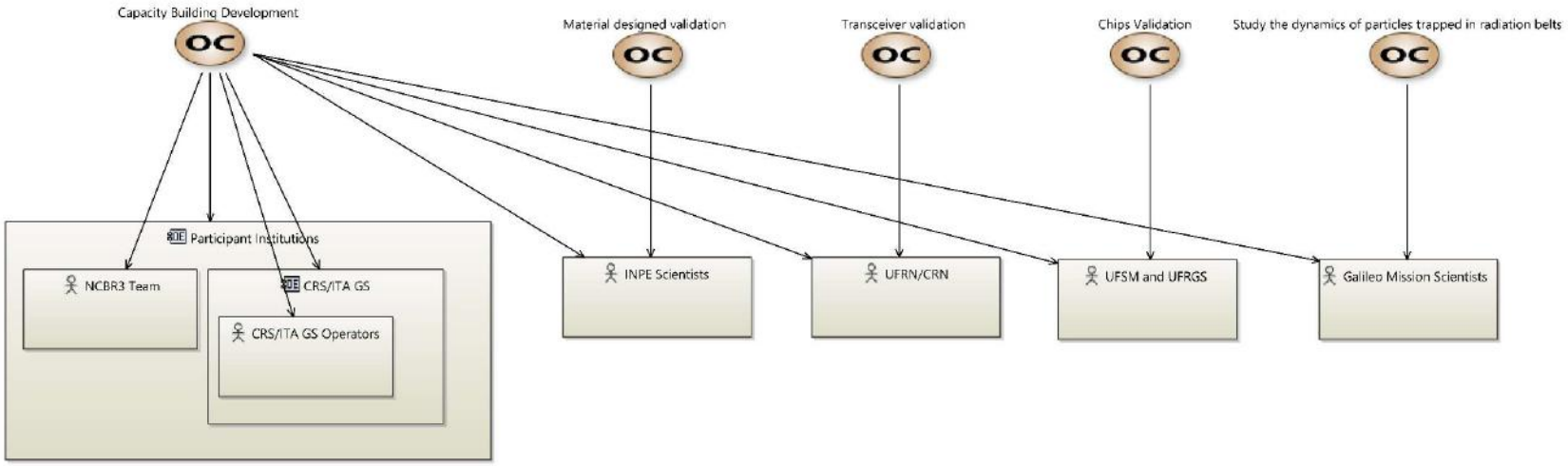
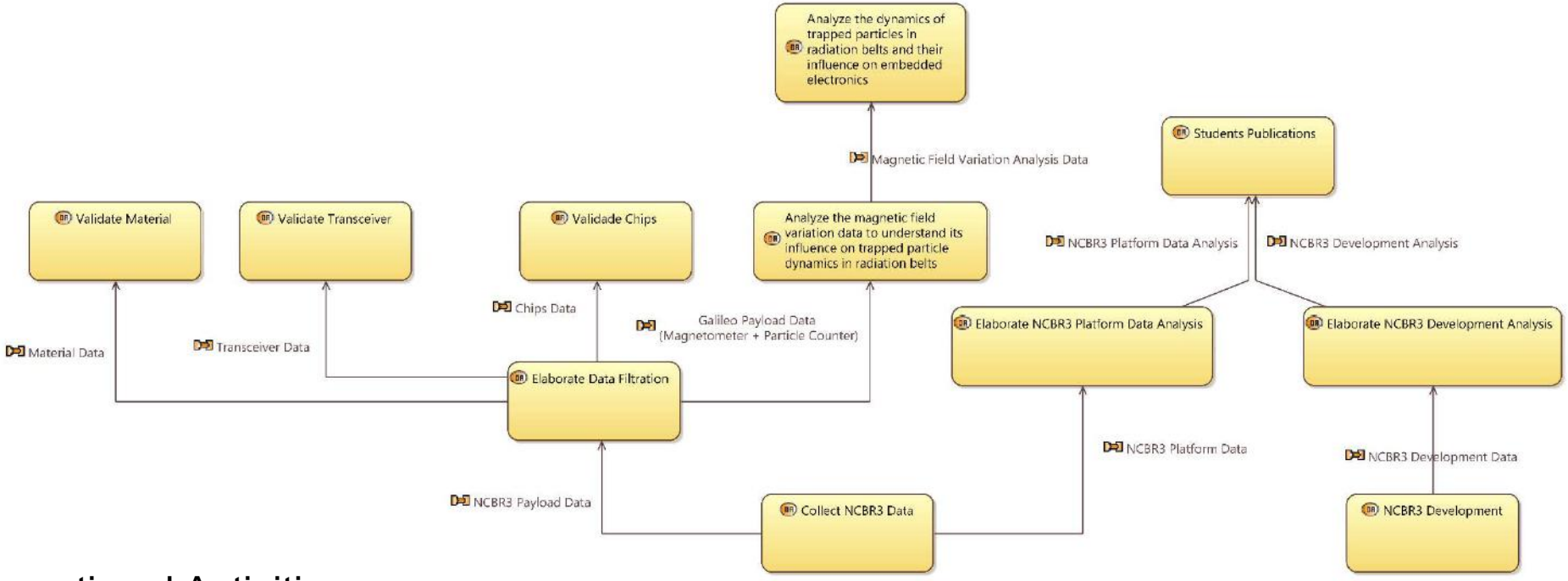


Figure 4: Operational Capabilities

- Operational Capabilities (Needs);
- Actors (Stakeholders).

NCBR3 CONCEPT DESIGN WITH MBSE

Operational Activities Interaction:

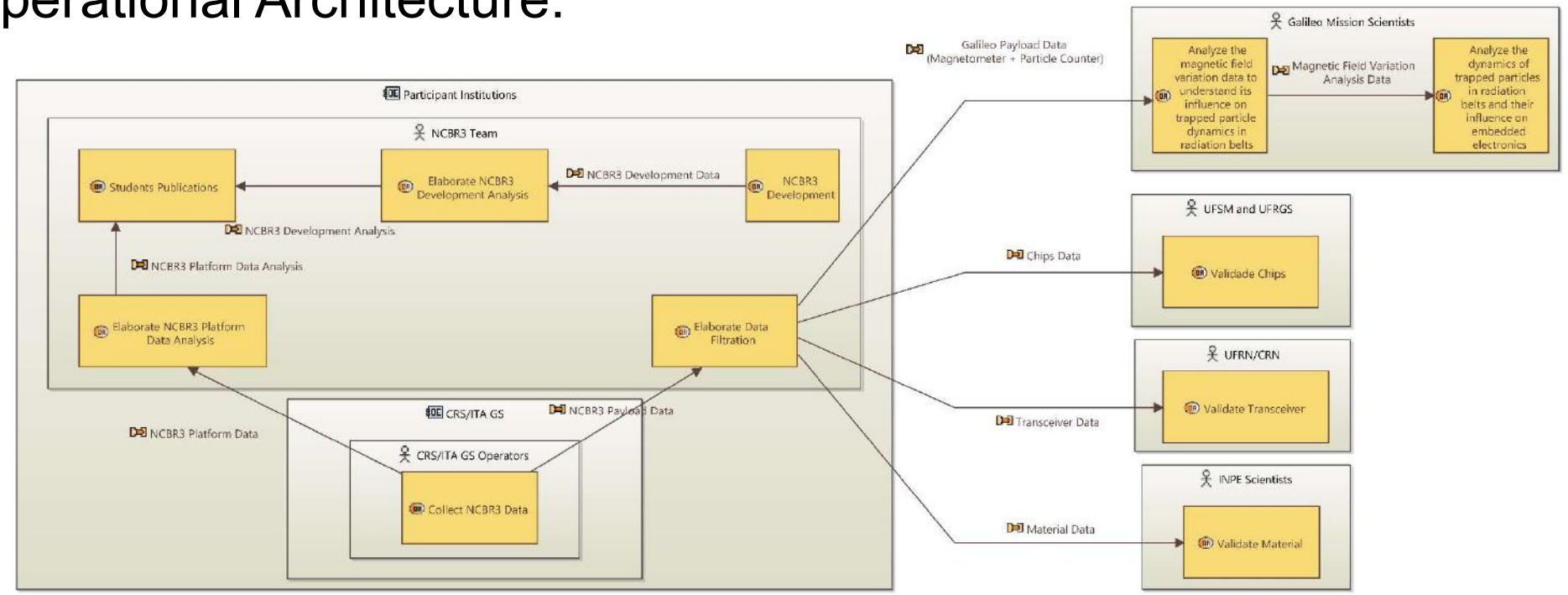


- Operational Activities;

Figure 6: Operational Activities Interaction

NCBR3 CONCEPT DESIGN WITH MBSE

Operational Architecture:



- Operational Activities;
- Actors.

Figure 7: Operational Architecture

NCBR3 CONCEPT DESIGN WITH MBSE

System Architecture:

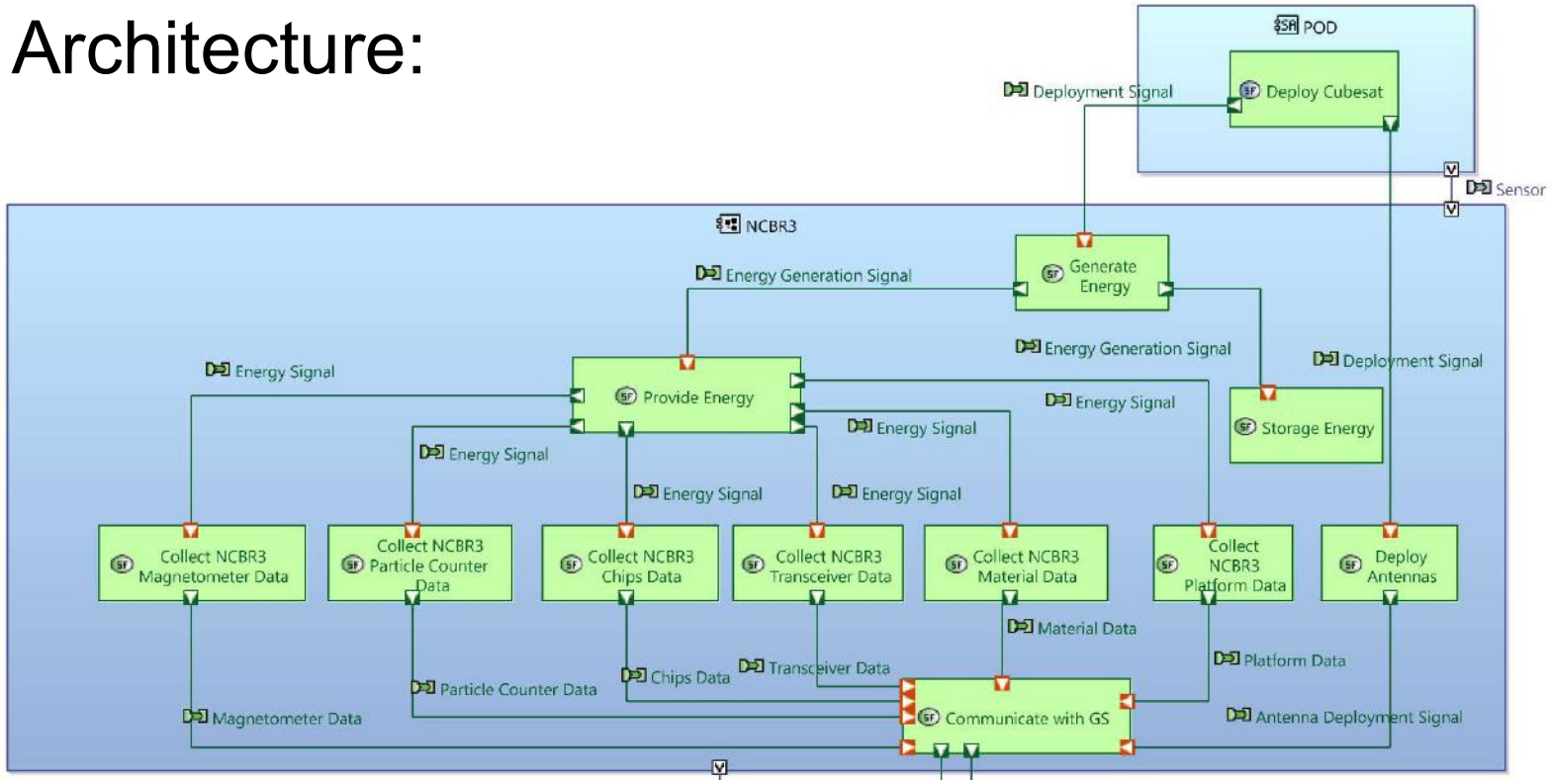


Figure 8: System Architecture

- Actors;
- System;
- System High-Level Functions.

NCBR3 CONCEPT DESIGN WITH MBSE

System Architecture:

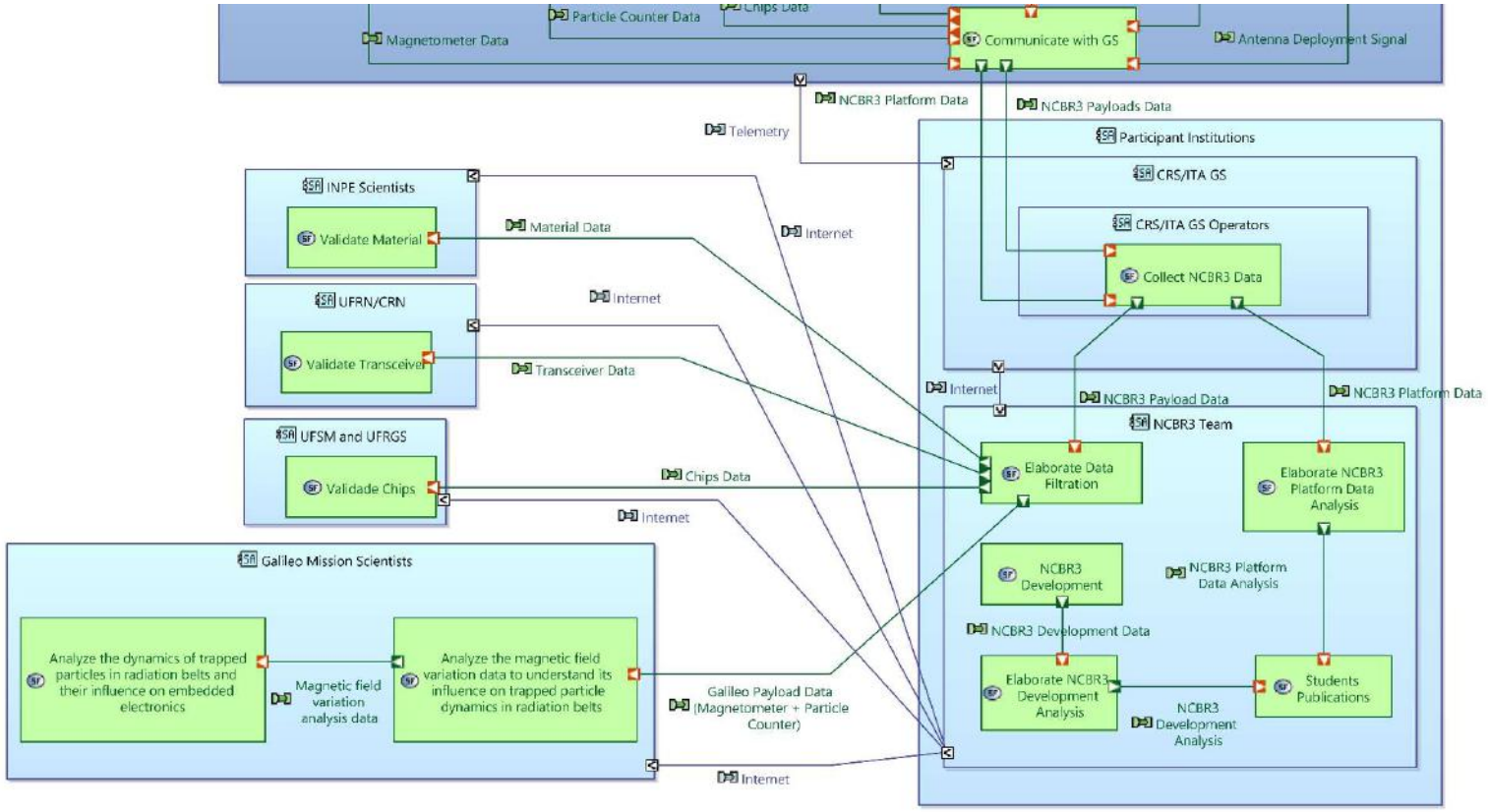


Figure 9: System Architecture

NCBR3 MISSION CONCEPT

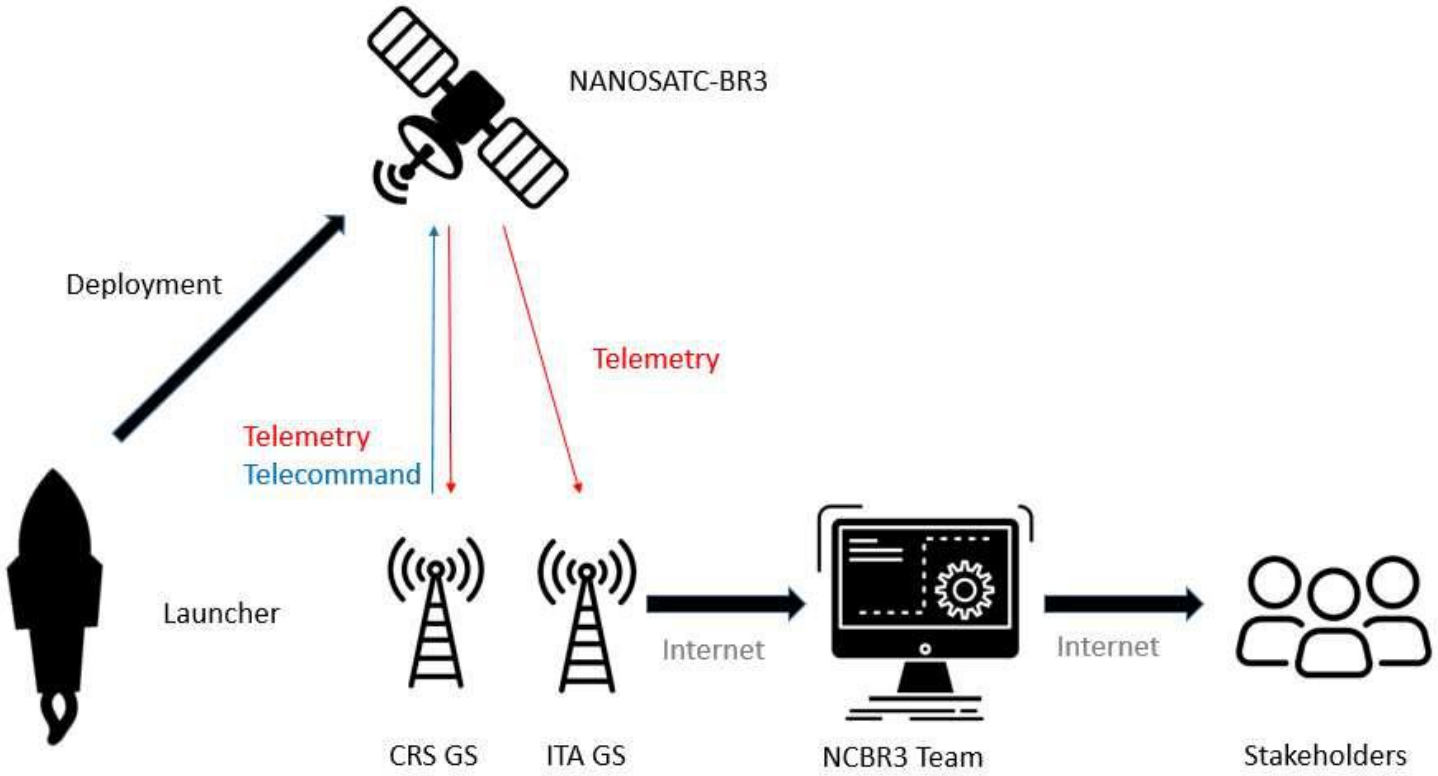


Figure 10: NCBR3 Mission Concept

DISCUSSION

- **MBSE** main contributions:
  - Hidden requirements;
  - Improve communication;
  - Visual tool – unify system understanding;
  - System boundaries and basic functions;
  - Viable system concept;
  - Reduced project paper work;
  - Traceability raises reliability.

CONCLUSIONS

- MBSE:
  - Made possible a much more structured mission **Phase 0**;
  - Has educational purposes competence;
  - **Consolidates** and **unifies** understanding;
  - Very useful to Project Reviews.

- Future Works:
  - Further modeling through next steps;
  - Encourage MBSE culture within NANOSATC-BR Program.

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The NANOSATC-BR Program site is: www.inpe.br/crs/nanosat/

Muito Obrigado

Thanks

Grazie

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