MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

A Systems Engineering approach for specifying a combined Compact Antenna Test Range and Near-Field Scanner facility

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Summary

- LIT's current capabilities
- Future scenario for LIT
- LIT's extension project
- Antenna and satellite testing facilities
- LSIS Systems Engineering Approach
- Application of the LSIS SE Approach
- Conclusions

LIT's current capabilities

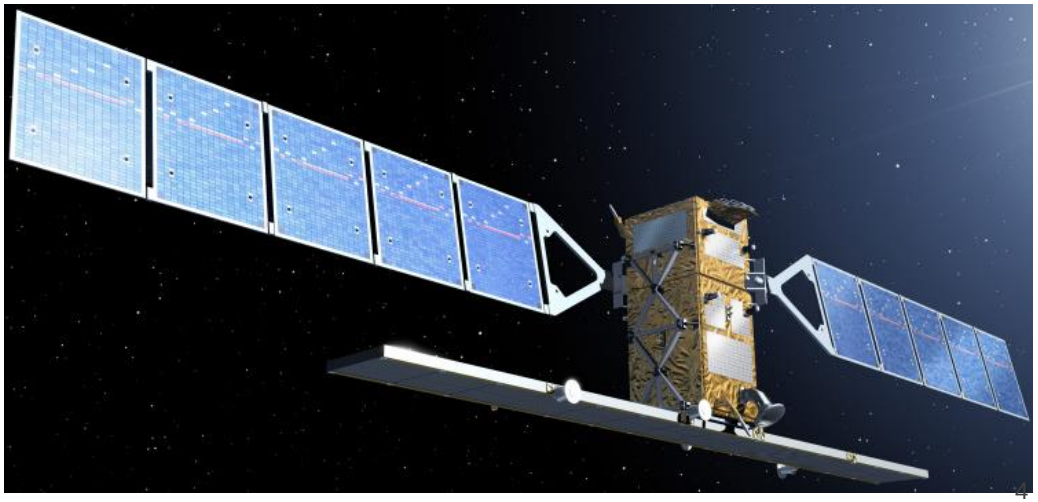
Future scenario for LIT

- Current and future Brazilian space programs were assessed.

PNAE

PESE
PROGRAMA ESTRATÉGICO DE SISTEMAS ESPACIAIS

- Most probable scenario includes larger satellites:
  - Telecommunication satellites
  - Radar satellites



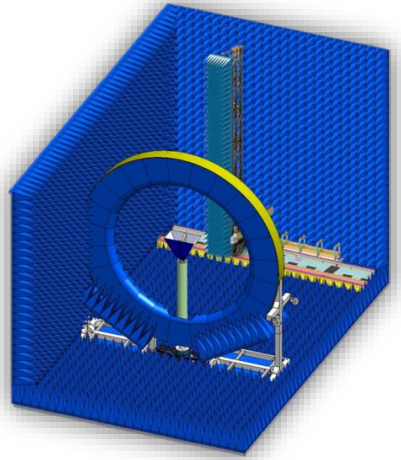
LIT's extension project

Larger satellite integration hall

New larger satellite vibration system

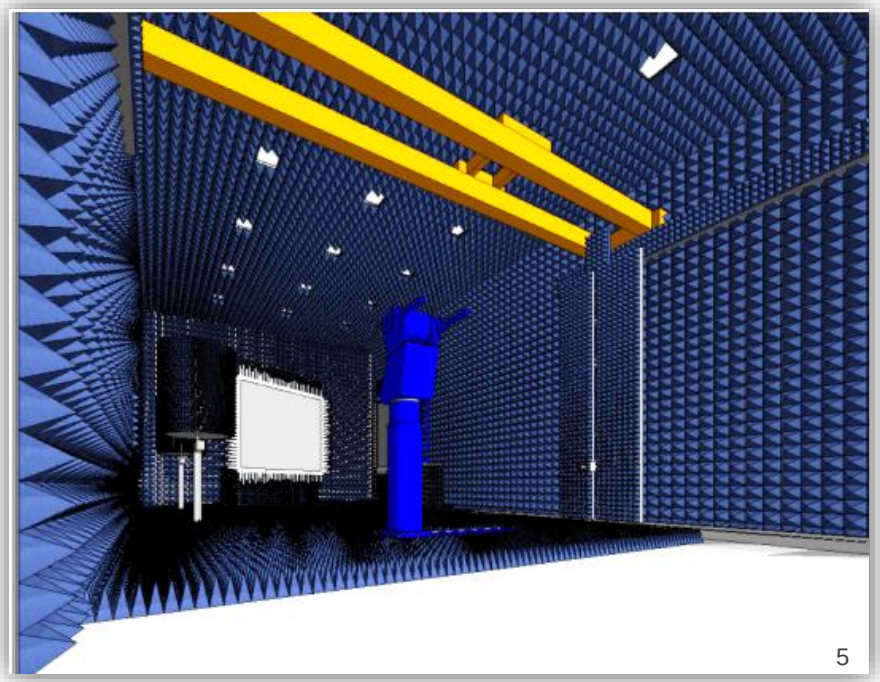
New EMI/EMC Chamber

New small Antenna Measurement System (NFS)



Compact Payload Test Range (CPTR) Project

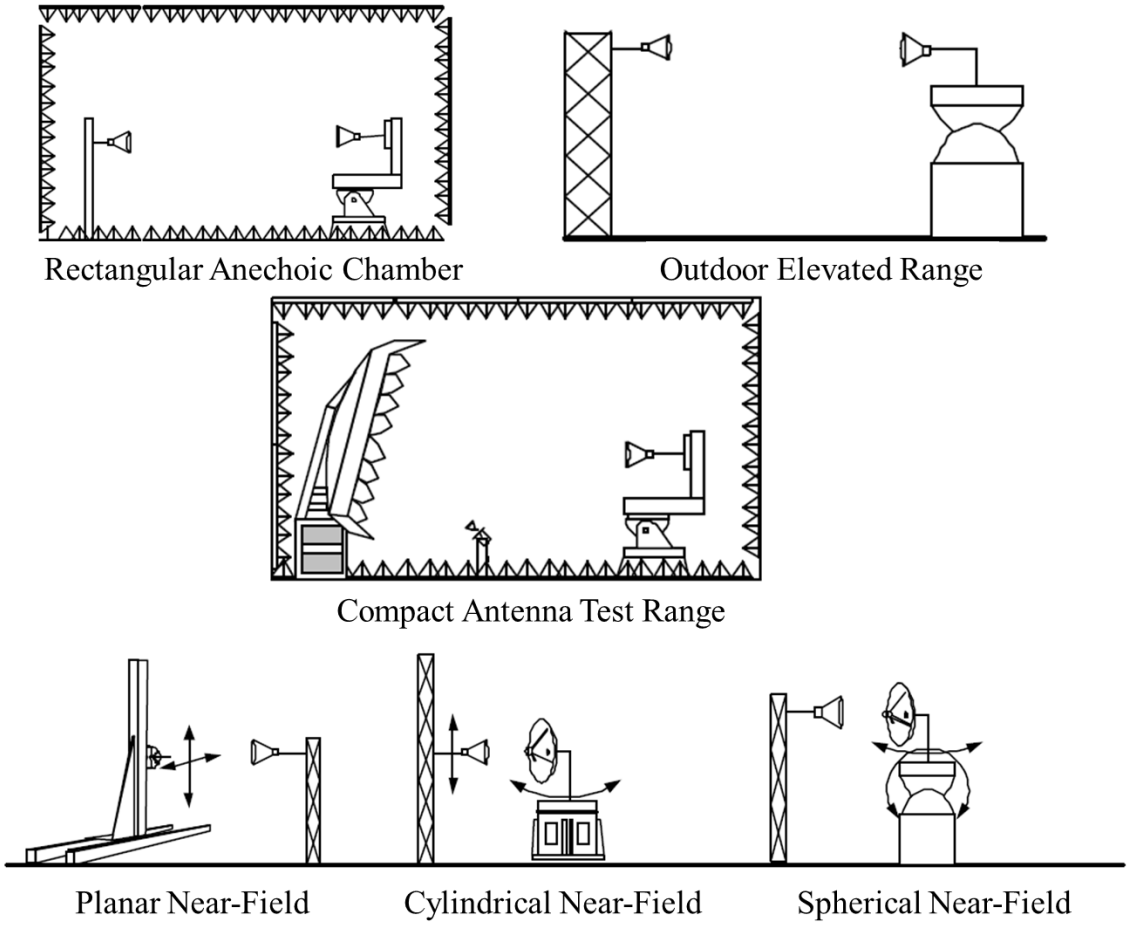
Large antenna measurement system



Antenna and satellite testing facilities

There are two types of measurement systems:

- Far-field systems:
  - Outdoor range
  - Anechoic chamber
  - Compact range
- Near-field systems:
  - Planar
  - Cylindrical
  - Spherical



Alternatives of antenna and satellite measurement systems. Adapted from [7].

Antenna and satellite testing facilities

Combined measurement systems (dual-use range facilities):

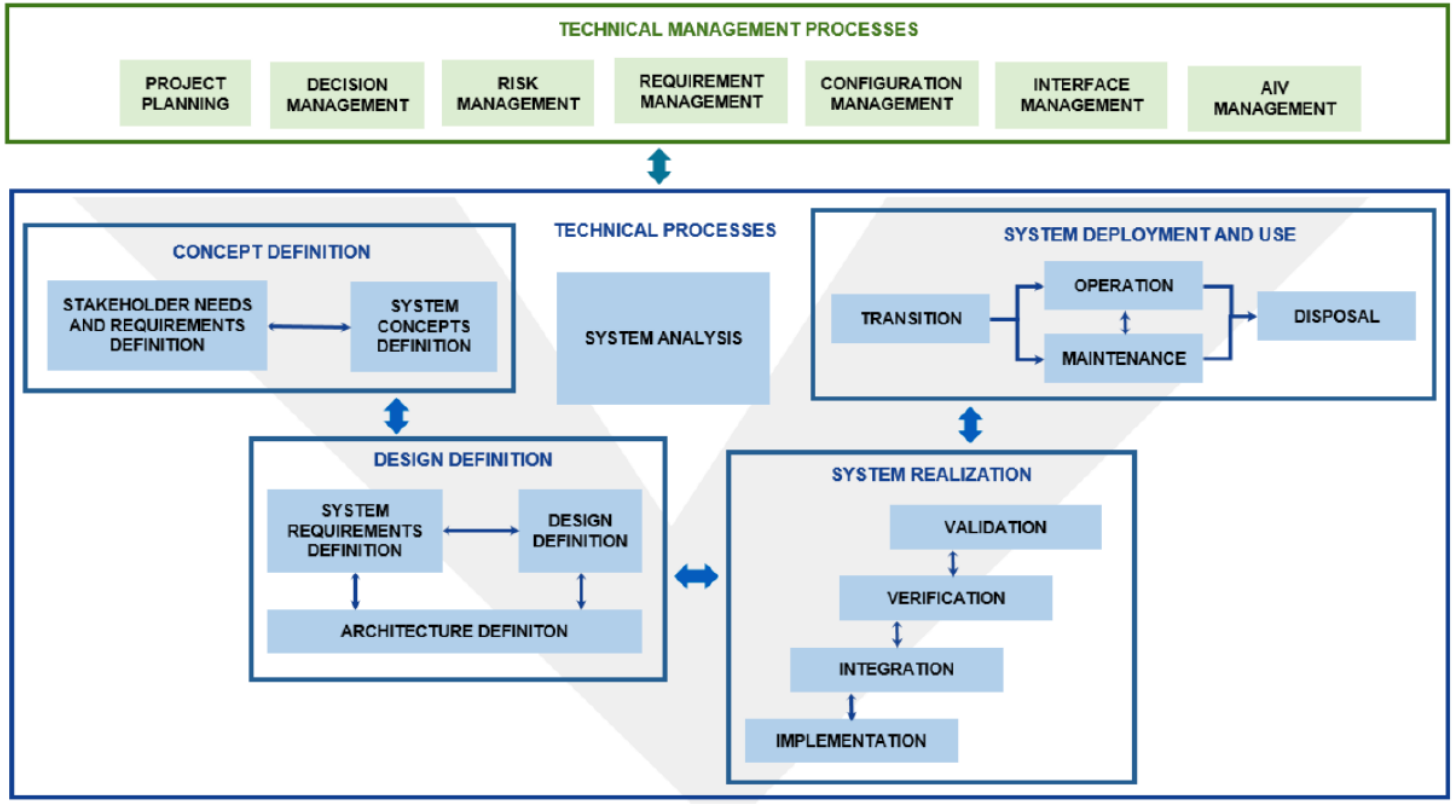
- Measurement capabilities over an extended range of frequencies.
- Test capabilities for larger antennas.
- More versatility.
- Comparative measurements.
- Shared instrumentation.
- Reduced costs when compared with the two separate systems.
- Combined measurement systems are uncommon.

HERTZ dual-use range facility at ESA-ESTEC [10].

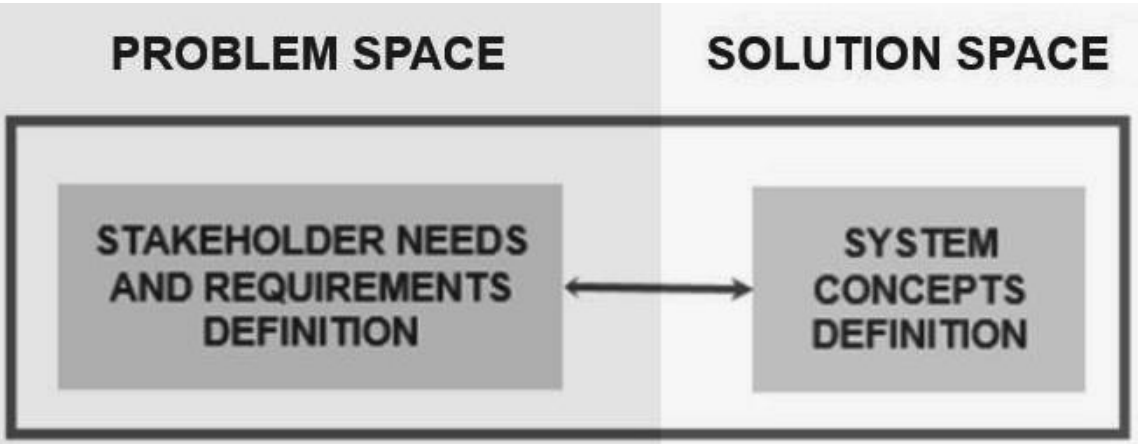
LSIS Systems Engineering Approach

It is a tailoring of:

- ISO/IEC/IEEE 15288: Systems and software engineering – System life cycle processes
- IEEE 15288.1-2014: Standard for application of systems engineering on defense programs



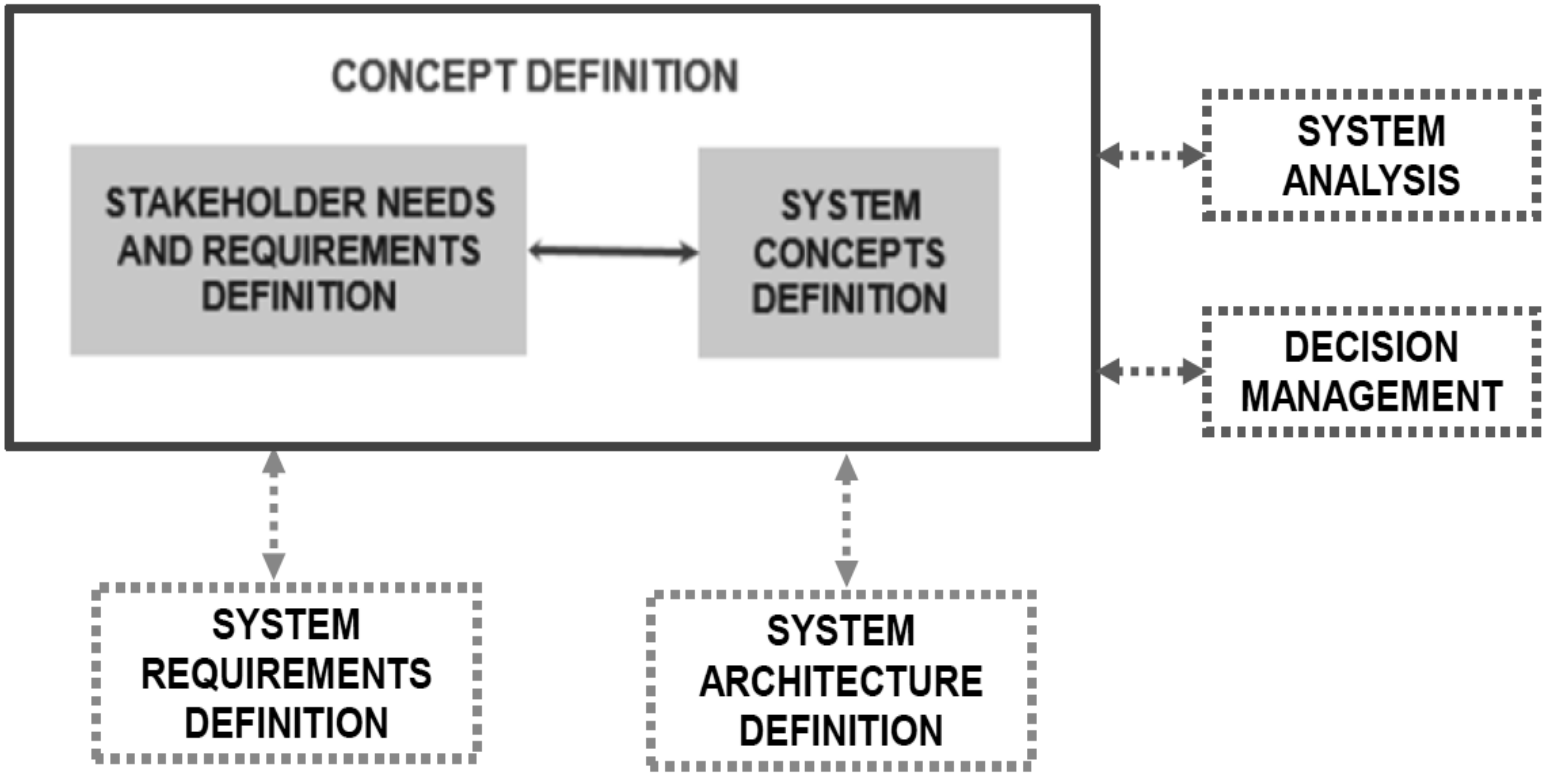
LSIS Systems Engineering Approach



a) Identification of stakeholders involved with the system throughout its life cycle, and their needs;
b) Characterization of the problem space;
c) Identification of the expected set of use scenarios of the system;
d) Transformation of the information gathered from previous steps into a common set of stakeholder requirements.

a) Definition of the business or mission problem or opportunity;
b) Characterization of the solution space via the definition of system life cycle concepts;
c) Determination, from system life cycle concepts, of potential solution class(es) that could address a problem or take advantage of an opportunity.

LSIS Systems Engineering Approach



Application of the LSIS SE Approach

Activities within CPTR Project

STAKEHOLDER NEEDS AND REQUIREMENTS DEFINITION

- Stakeholders identification (e.g. PNAE and PESE representatives, LIT's antenna tests operators, extension project chief).
- Semi-structured interviews to stakeholders.
- Documentation review (e.g. PNAE, PESE, standards, and LIT's capabilities documents).
- External consultancy.
- Identification of use scenarios and constraints.

SYSTEM CONCEPTS DEFINITION

- Life cycle stages identification.
- Life cycle concepts proposal.
- External consultancy.
- Visits to antenna and satellite payload test facilities.
- Bibliographic research on near-field, far-field, and dual-use ranges for antenna and satellite payload tests.

Application of the LSIS SE Approach

Activities within CPTR Project

ARCHITECTURE DEFINITON

- Identification of the major elements of the system (e.g. scanner, reflectors).
- Preliminary system modelling.

SYSTEM REQUIREMENTS DEFINITION

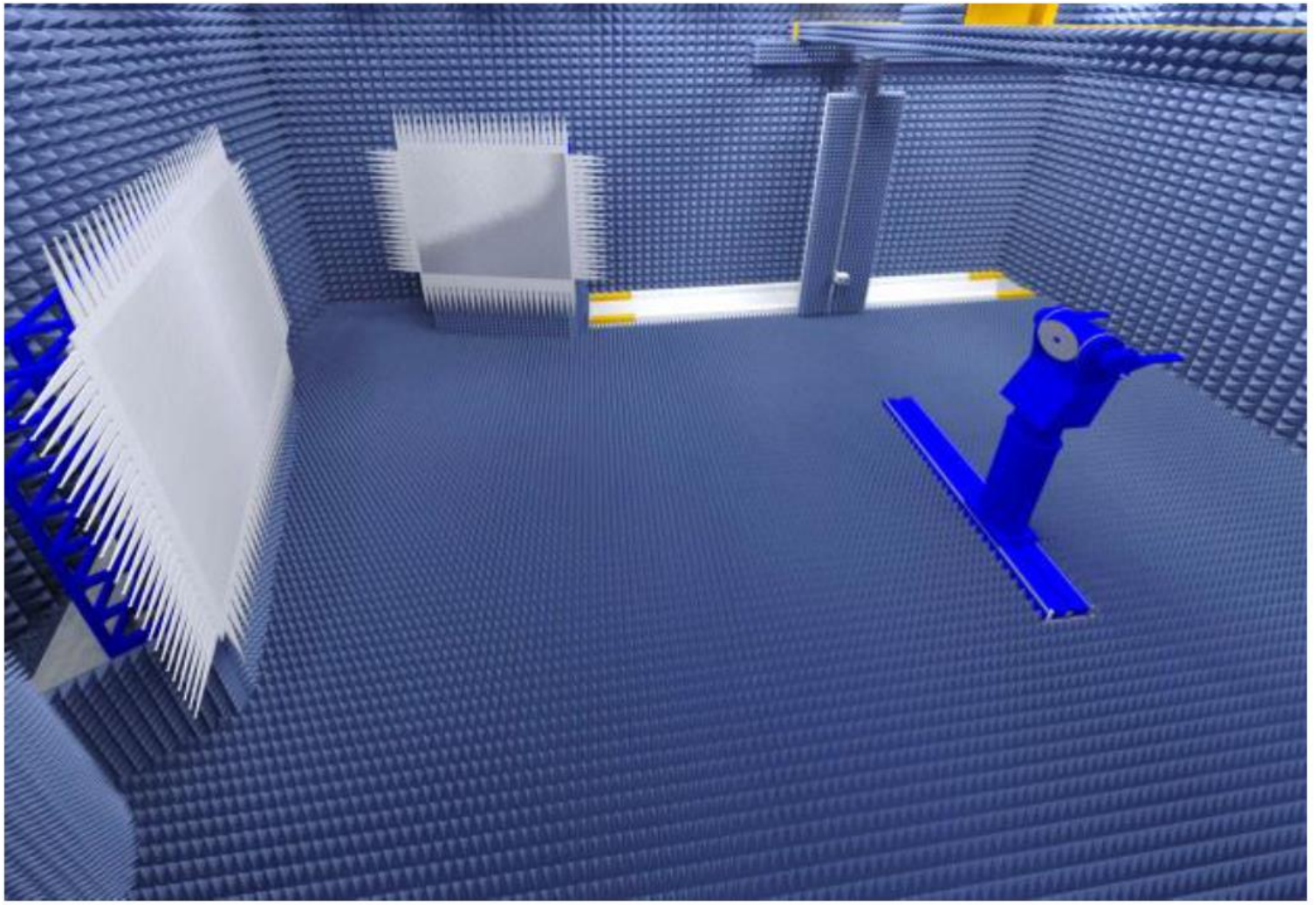
- Identification of preliminary system requirements.
- Identification of critical performance measures.

SYSTEM ANALYSIS

- Stakeholder analysis.
- Requirement analysis.
- Effectiveness analysis.
- Cost analysis.
- Technical risk analysis.
- Viability analysis.

Application of the LSIS SE Approach

Results

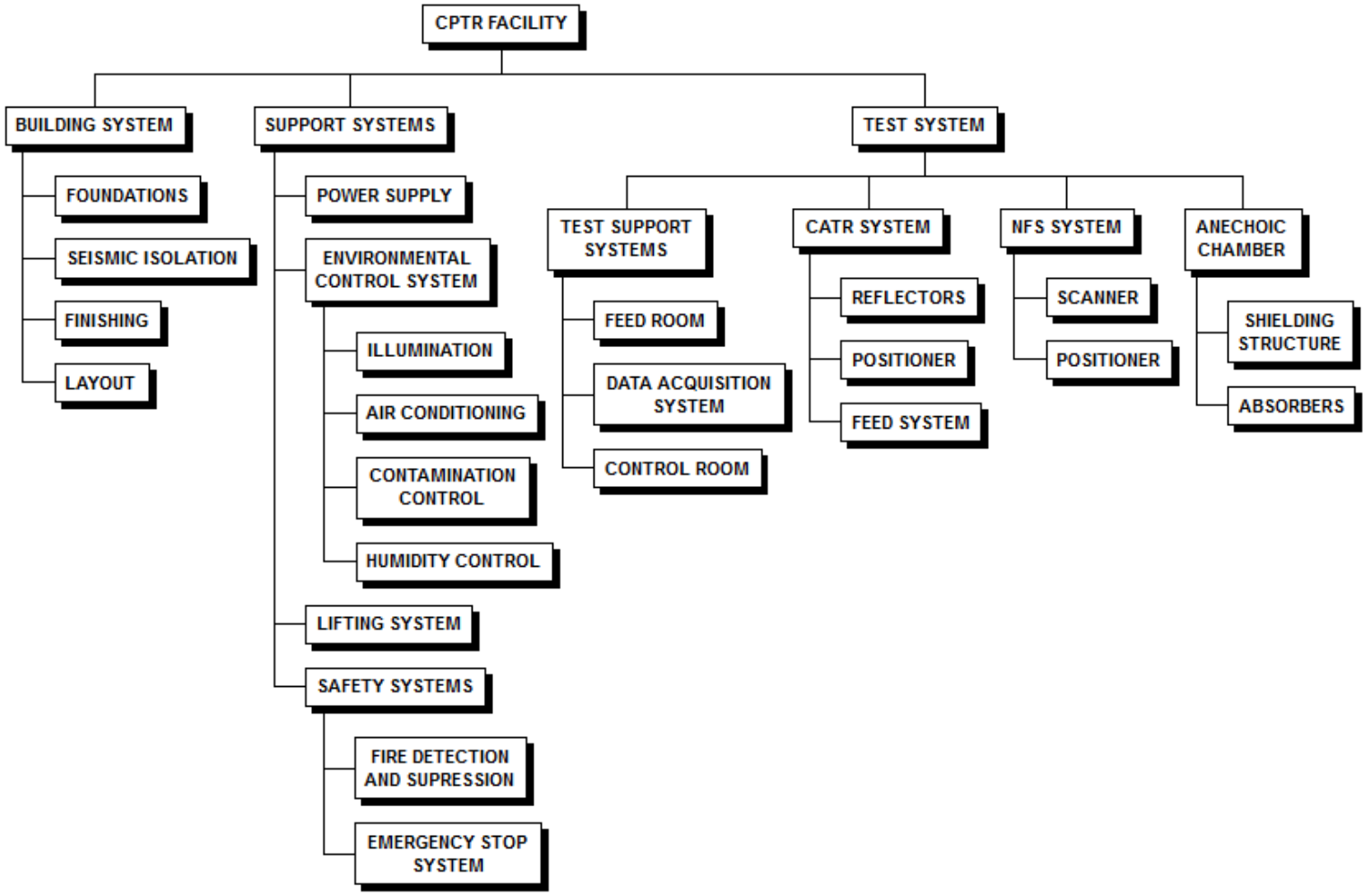


Compact Payload Test Range (CPTR) Facility

Reflectors	Size (m)	Quiet zone (m)	Frequency range	NFS
2	35x20x16 (LxWxH)	5.5x5x6 (LxWxH)	1 – 40 GHz	Yes

Application of the LSIS SE Approach

Results



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Application of the LSIS SE Approach

Current status:

- In progress.
- Some requirements are still To Be Confirmed (TBC, ex.: reflectors dimensions and absorbers dimensions) and To Be Determined (TBD, ex.: test equipment).
- Some elements achieved certain level of maturity and are being implemented. (Ex.: building foundations)
- SE is key since it shall ensure that undefined elements and implemented elements do not lack of cohesion when the whole system is finally implemented.

Conclusions

- The SE approach **enabled the definition of a concept and the system-level specification** of a test facility aligned with the future demands of Brazil.
- LIT will remain present in the **satellite testing industry** and it will be up-to-date with the latest developments and trends.
- LIT will enter the large satellite industry providing the complete range of tests needed for **AIV campaigns of large satellites**, such as telecommunication and radar satellites.
- **CATR and NFS** systems are expected to be implemented at separate stages, however, **conceiving both systems together** is expected to minimize future renovations, updates, and potential incompatibilities between both systems.
- Due to concurrent and iterative features of SE approach, some of its processes are still on-going. Consequently, the partial results exhibited may not be final.

Thank you for your attention…

Any question?