SAMARA UNIVERSITY

Space Mission Analysis. Introduction

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Samara

Space activities include:

– creation (including design, manufacture and testing);

– use (operation) of space technology, space materials and space technologies;

– exploration and use of outer space;

– provision of services related to space activities.

The main **areas of space activities** include:

– remote sensing of the Earth from space, including environmental monitoring and meteorology;

– space technology for communications, television and radio broadcasting;

– satellite navigation;

– manned space flights;

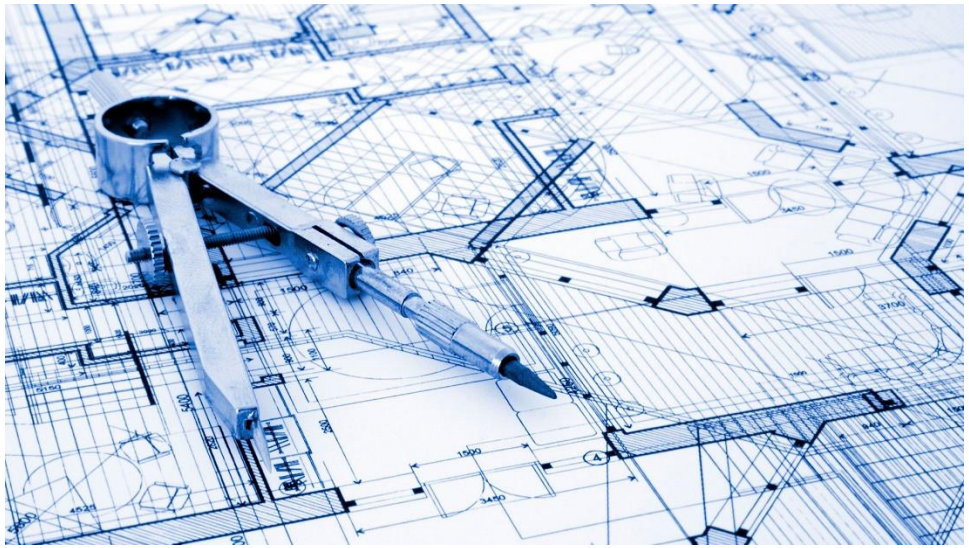
– space technology, space materials and space technologies in the interests of defense and security;

– observation of objects and phenomena in outer space;

– production of materials and other products in space .

Space mission analysis and design begins with one or more broad objectives and constraints and then proceeds to define a space system that will meet them at the lowest possible cost.

Analysis and design are **iterative**, gradually refining both the requirements and methods of achieving the objectives.



Space is expensive.
Cost is a fundamental limitation to nearly all space missions.

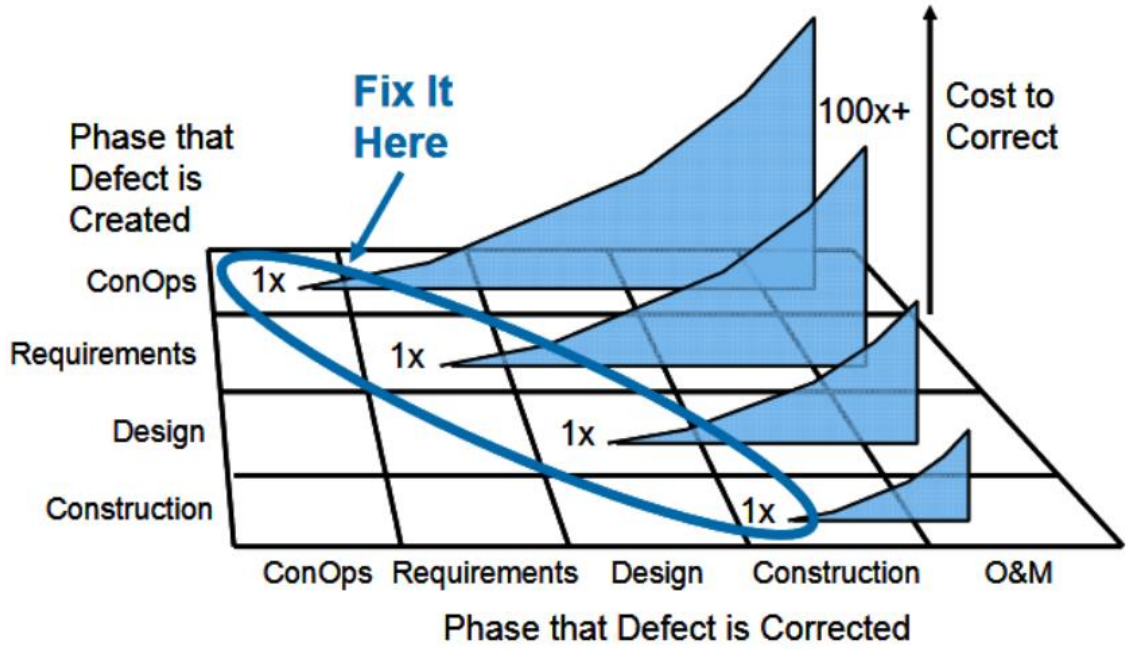
Purpose of space mission analysis:

– increasing the probability of success of a space project;
– decreasing of risks associated with various aspects of activity;
– reducing the total cost of the life cycle of the project.

Principles of space mission analysis:

– identification of the problem, customer and consumer;
– use of performance criteria based on customer needs;
– formulation and management of requirements;
– identification and evaluation of alternatives that can be converted into specific design solutions;
– verification and validation of the requirements and characteristics of the design solution;
– using orderly and documented processes;
– management according to plans.

The main result of mission analysis is expressed in risk reduction at an early stage of a project.



Early risk identification prevents problems during production, integration and testing, reducing time and cost.

An example of ignoring the principles of system engineering

Swedish warship
«Vasa»
1625 - 1628

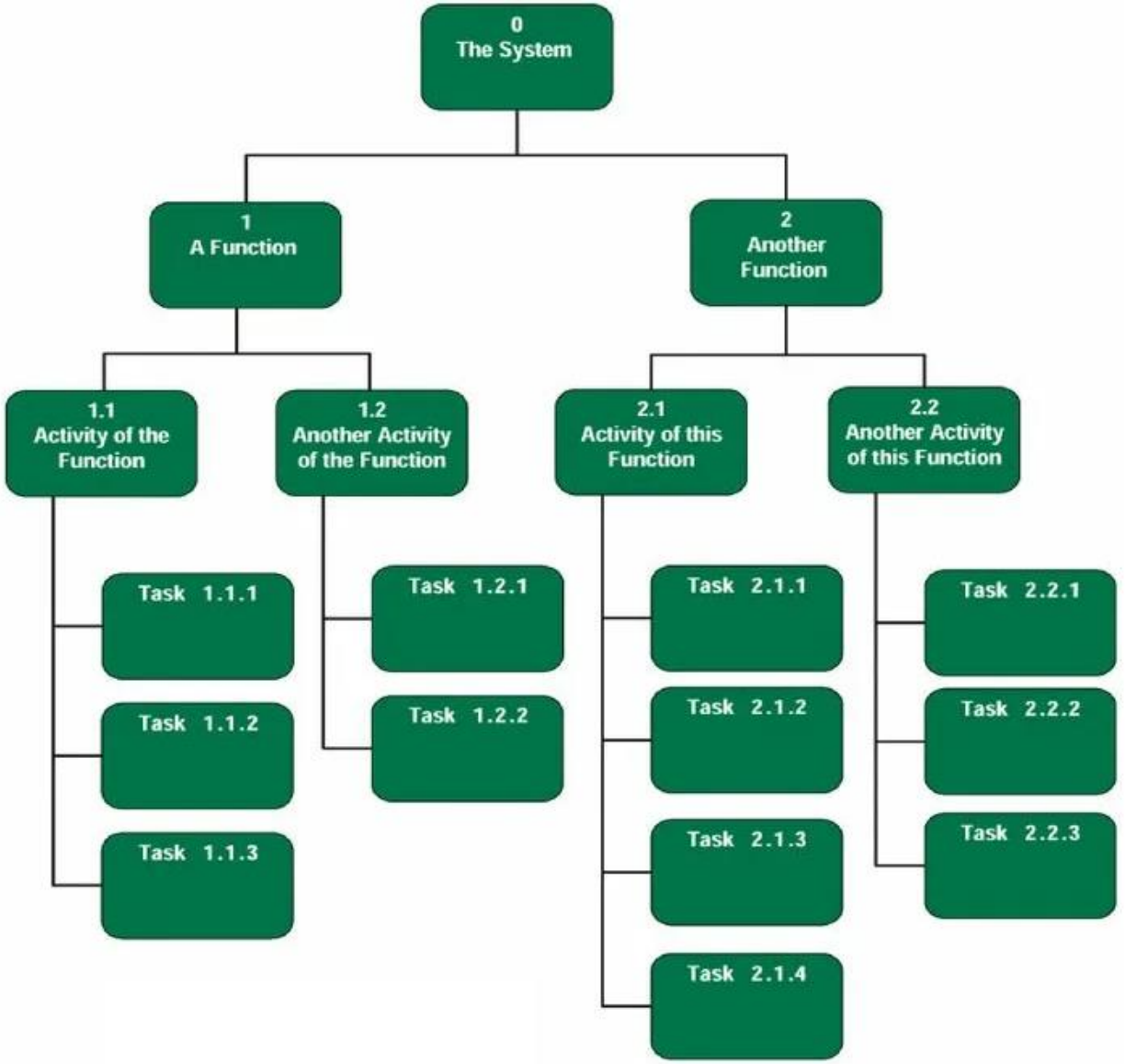
Reasons for the shipwreck:
- haste in construction;
- King Gustavus Adolphus personally approved the size of the ship;
- the ship was initially designed as a single-deck, but the king ordered to add another gun deck;
- Admiral Fleming revealed the instability of the ship during the tests, but did not dare to stop the exit of the ship from the dock.

The most common "standard" set of mistakes of mission analysis

- Systems integrated from parts built by different development groups do not provide the required functions. Most often the product breaks at the joints.
- Project managers and chief engineers tried to pay attention only to those issues in which they themselves were competent.
- Prices were always inflated compared to the approved estimate, delivery schedules were disrupted due to delays in manufacturing.

Mission analysis provides a systematic approach that allows each member of team to determine what they need to do for the success of the whole project

Reductionism is a philosophical idea regarding the associations between phenomena which can be described in terms of other simpler or more fundamental phenomena. It is also described as an intellectual and philosophical position that interprets a complex system as the sum of its parts.



Space Mission Elements

Spacecraft

The system composed of one or more elements that carries and provides all the required services to the payload

Payload

The set of instruments that achieve the (science) objectives of the mission

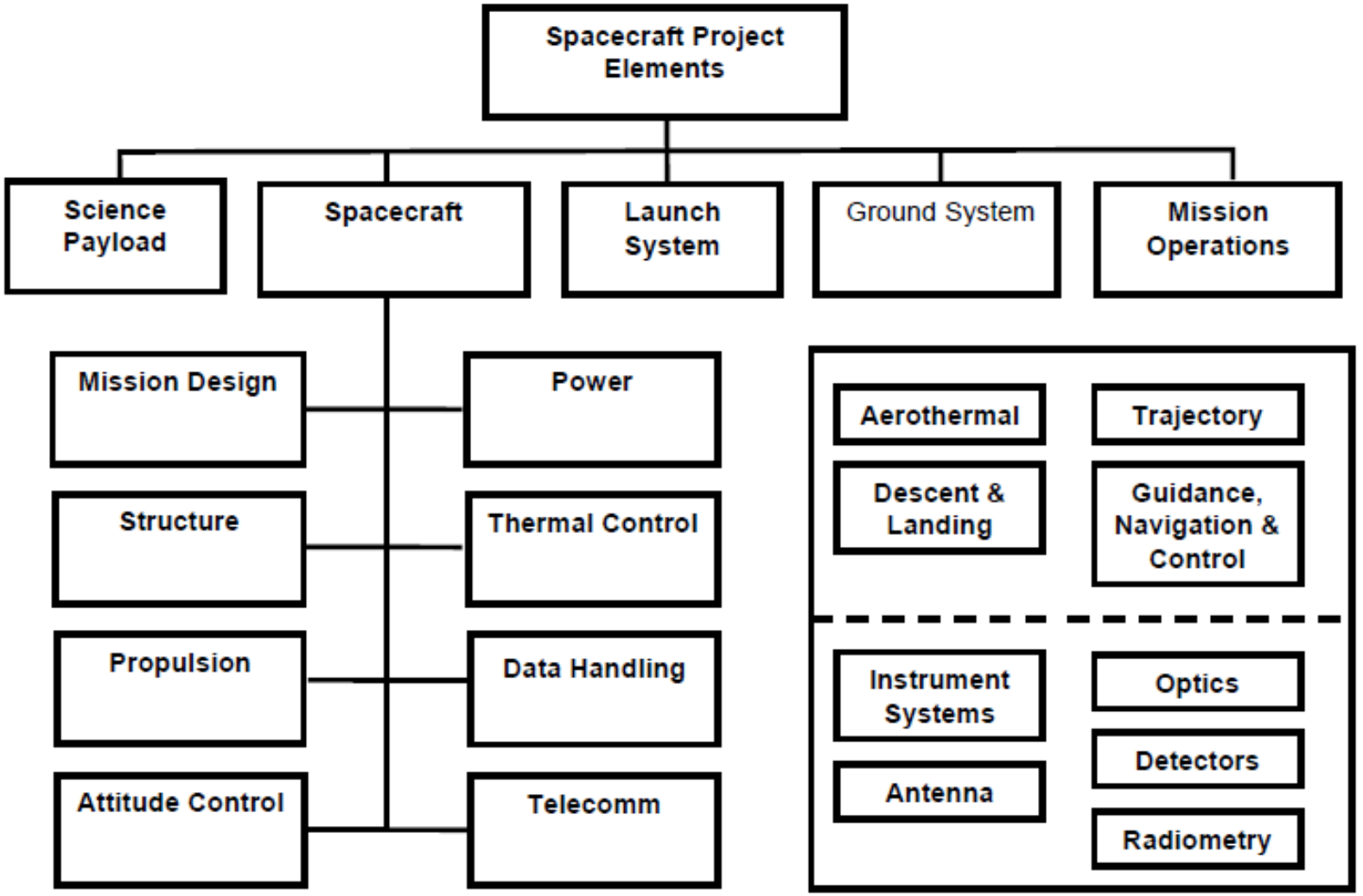
Ground System

The Control centre(s) that operate the spacecraft and the payload from Earth

Launcher

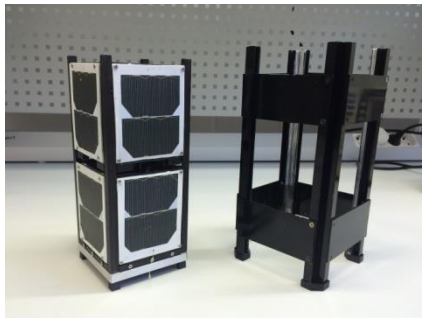
The mission design shall find the optimal combination of the elements above to achieve th given mission objectives

Space Mission Elements

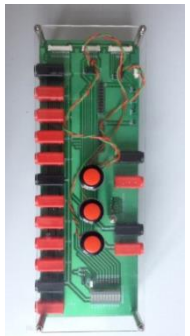


Space Mission Elements

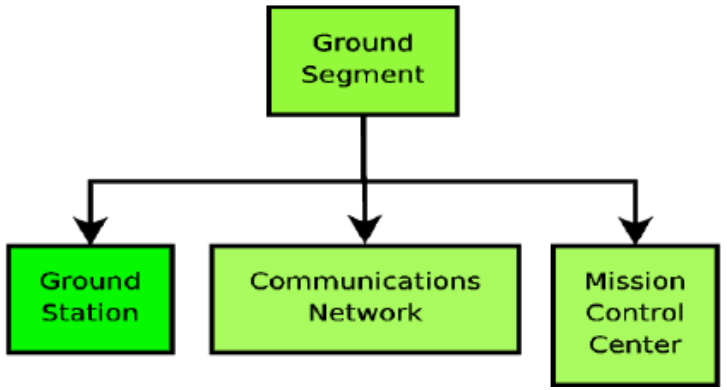
Design and Manufacture stage	Pre-launch stage	Launch stage	Flight stage	
			Flight test stage	Operating stage
Design organization	Launch preparation		Design organization	Design organization
	Launch pad			Final operating organization



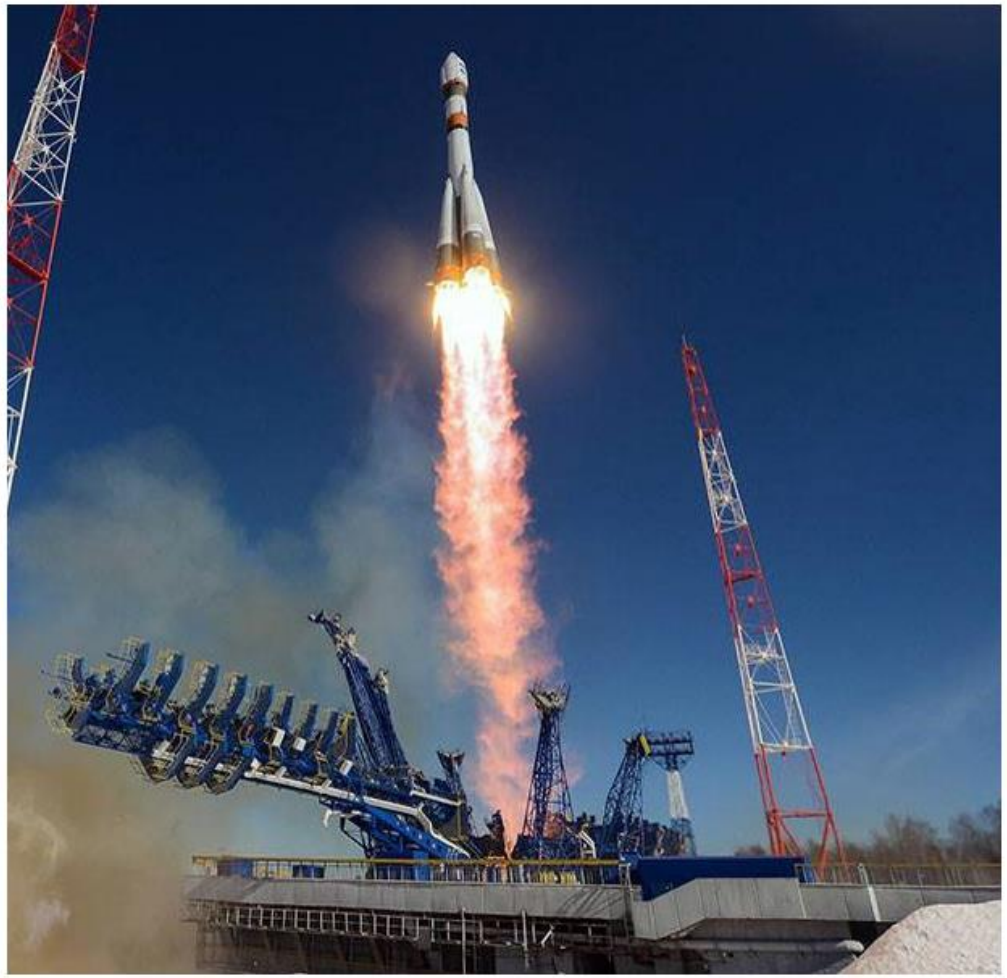
Mechanical Ground Support Equipment



Electronical Ground Support Equipment

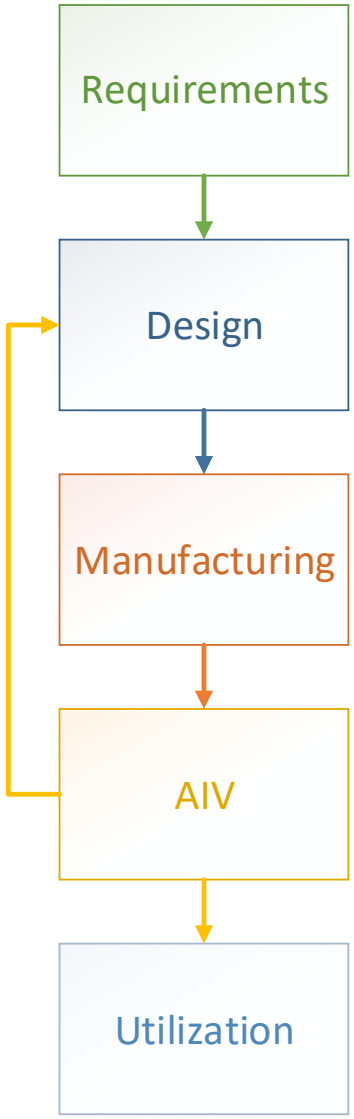


Launch vehicle



Deployer

The Space Mission Life Cycle



Team meetings and mission analysis to determine detailed nanosatellite mission requirements.

Stage of the nanosatellite design. Include Preliminary Design Review and Critical Design Review. Detail drawings, schematics and cad-models.

Stage of nanosatellites subsystems manufacturing.

Assembling, **I**ntegration and **V**erification stage. Satellite redesign. Requirements confirmation

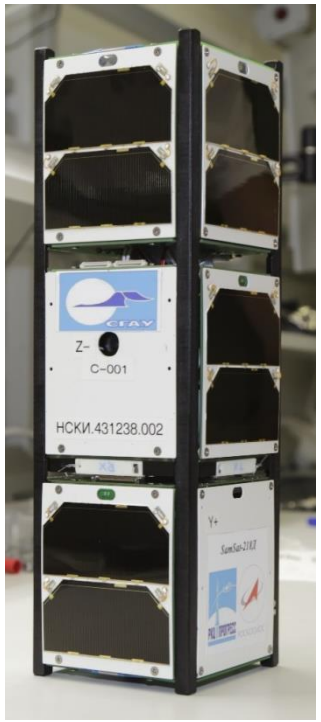
Launch and Nanosatellite operation

Design philosophy

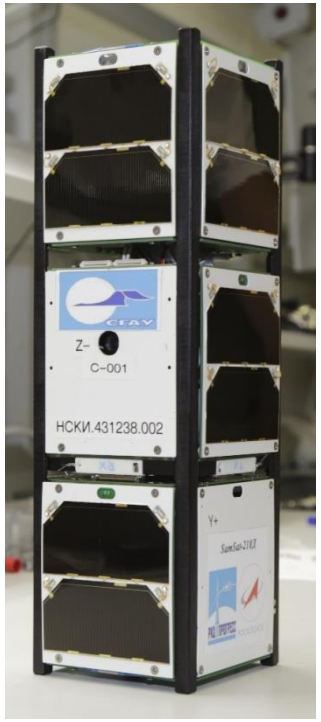
EM/FM

Protoflight

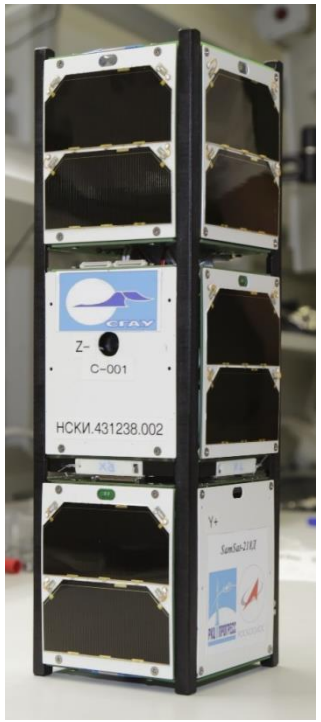
Hybrid



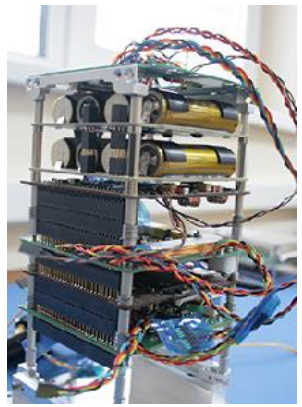
Engineering Model



Flight Model



Flight Model

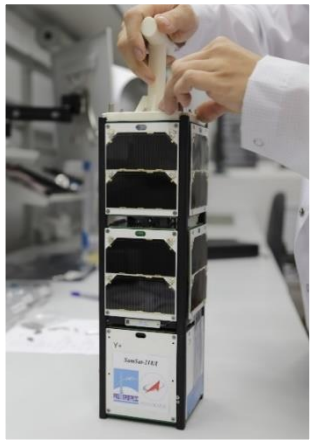


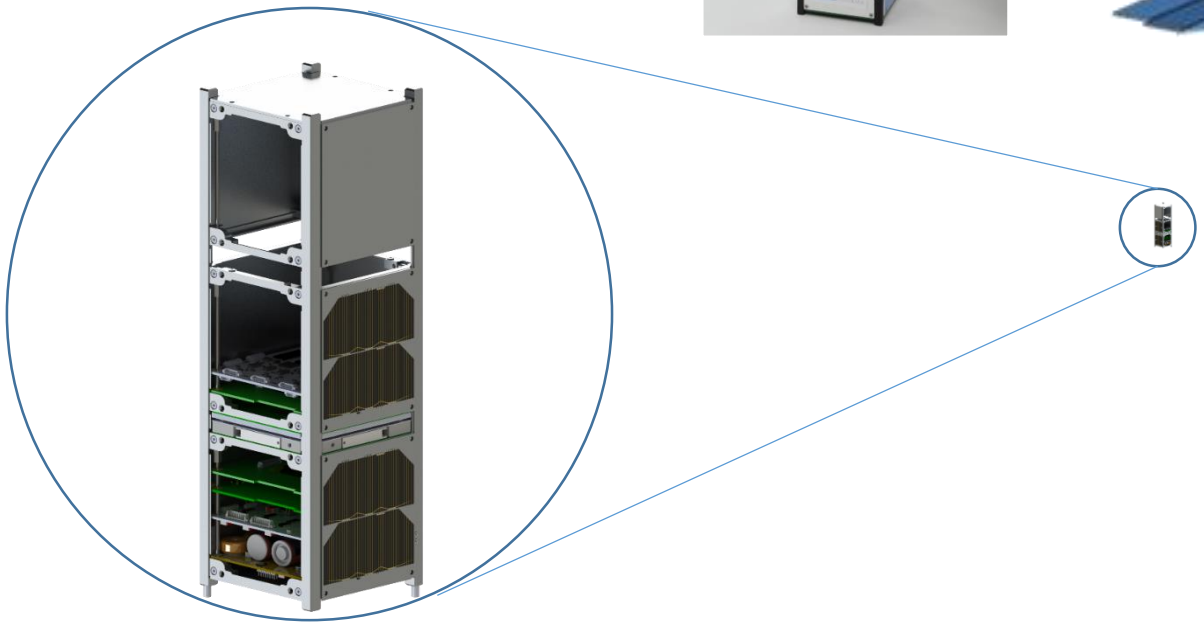
Engineering Model of Systems

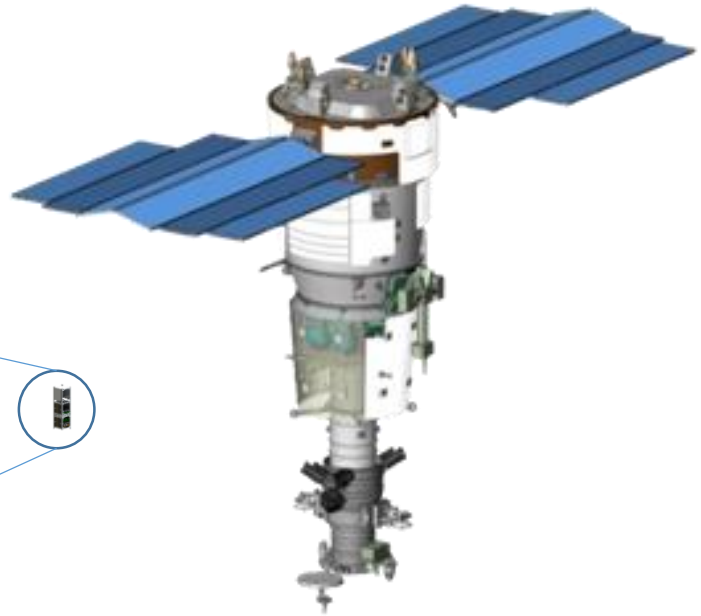
Flight Model

Nanosatellite

Mass of a nansatellite <10 кг
Dimensions of a unit 100x100x100 mm







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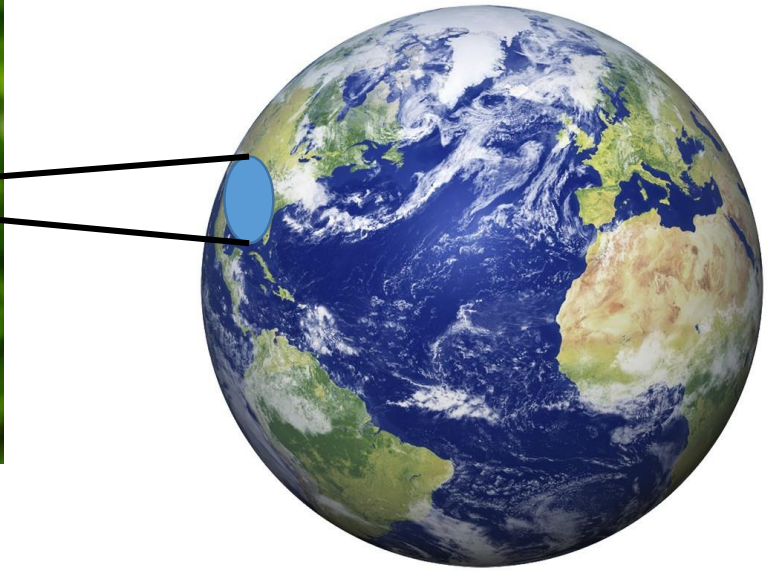
Why nanosatellite?



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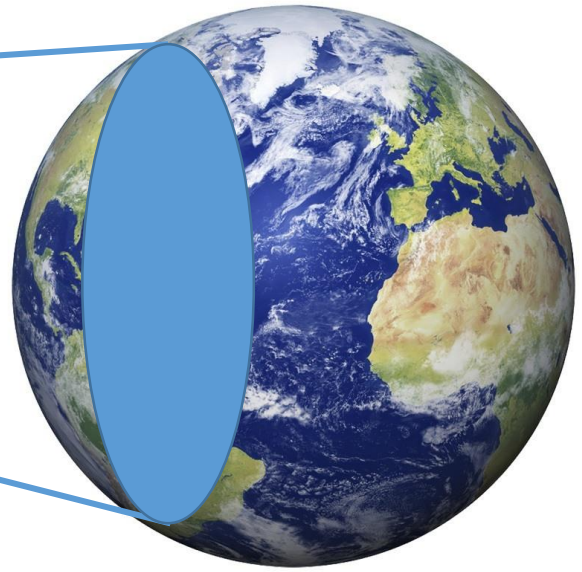


Why nanosatellite?

Limitations

Limited mass (depends of form factor 1-6 kg)

Limited energy

Limited performance (low-performance controllers)

Limited dimensions

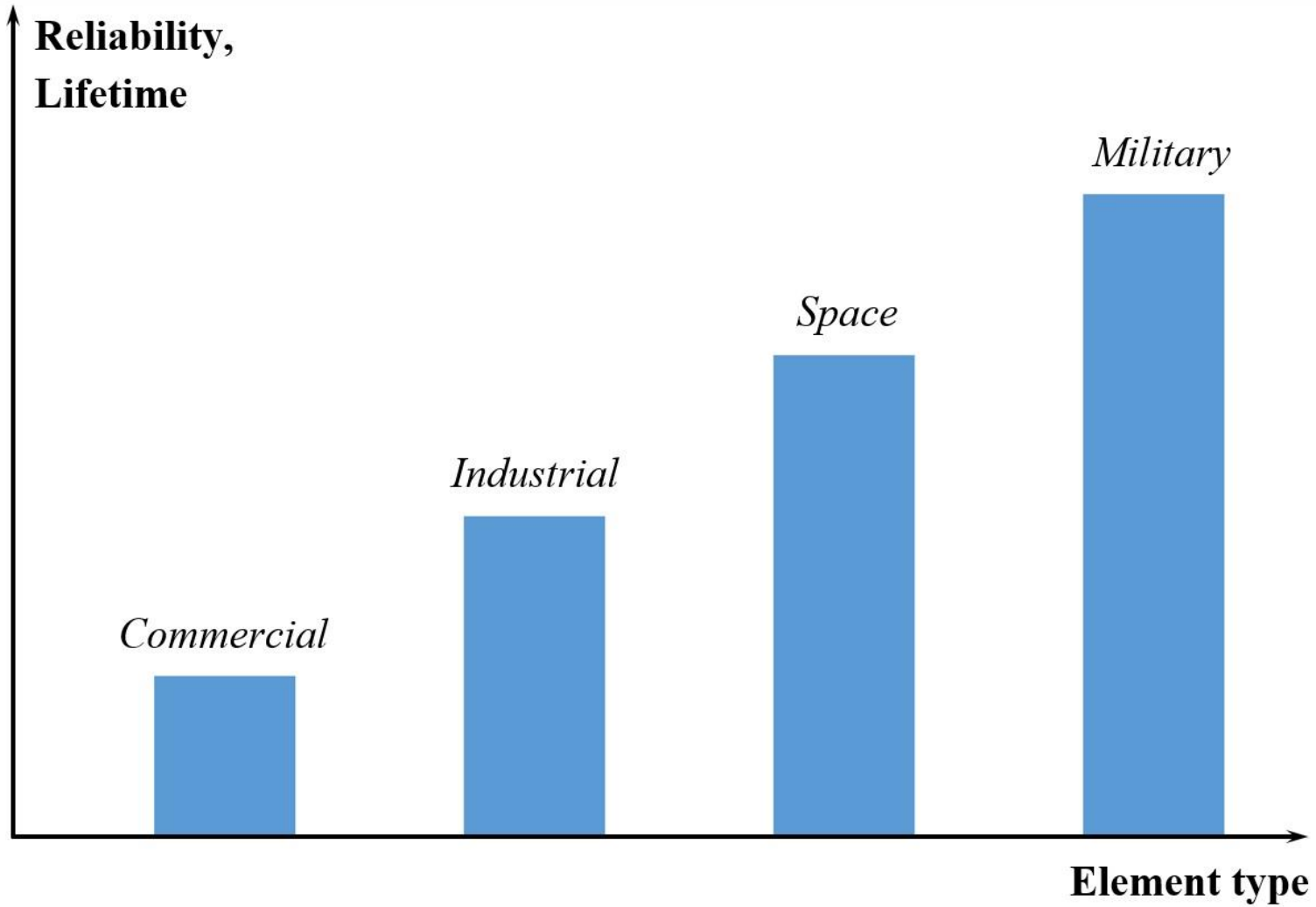
Limited budgets

Benefits

Simple design (Simpler than a large spacecraft’s design)

Low cost

Commercial Off-The-Shelf Components


Reliability,
Lifetime
Commercial
Industrial
Space
Military
Element type

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Thank you!