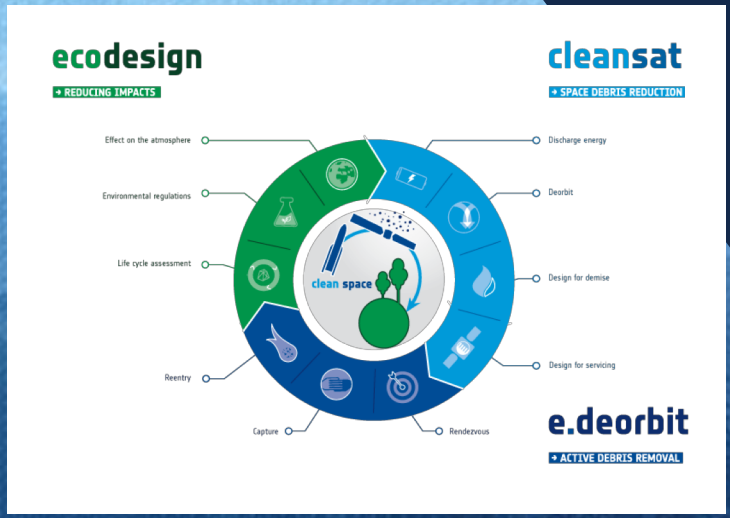
LCA Ground Segment
CSID Conference 2018

ESA Contract No.
4000123991/18/NL/GLC/as
Ground Segment Life Cycle Assessment – Methodological and Quantitative



23th October 2018

Project Introduction

Main Objective:

- **Assess the environmental performances** and the applicability of **eco-design** principles to **Ground Segment** through the elaboration of a **specific methodology**, the involvement of ground segment experts and the in depth evaluation of the most promising options

- This can be obtained though:
  - Expertise in Ground Segment (GS)
  - Expertise in Life Cycle Assessment (LCA)
  - Expertise in eco-design

RINA Presentation

OVER 150 YEARS OF EXPERIENCE

RINA provides a wide range of services across the Energy, Marine, Certification, Transport & Infrastructure and Industry sectors through a global network of 170 offices in 65 countries.

RINA is a member of key international organisations and an important contributor to the development of new legislative standards.

DEIMOS SPACE

- Space consultancy, engineering and expertise with high added value
- Software development for ESA space missions
- Design and supply of turn-key solutions with high technological content

+15	+300	30 M€
Years Expertise	Qualified Employees	2016 Turnover

6
Countries Presence

Space related expertise


Mission Analysis and Systems Engineering


Ground Segment Systems


Space Surveillance, Space Weather & NEOs


Flight Systems and on-board software


Turn key Earth Observation (EO) solutions

Multi-sector activities

- Aerospace
- Maritime
- Transport
- Industry & Utilities
- Telecom & Media

BERTIN TECHNOLOGIES
Industrial & Technological Innovation

- Design and supply of products and systems with high technological content
- Software publishing, development of solutions and services
- Consulting, engineering and expertise with high added value

60 years
Of innovation

~700
Partners

~90 M€
2016 Turnover

10%
Devoted to R&D using its own capital

1/3
In exports

asrc
à la source de l'innovation pour l'industrie

4 major fields of activity

- Consulting & Engineering
- Systems & Instrumentation
- Information Technology
- Pharma & Biotechs

Multi-sector activities

- Defence and Security
- Aerospace and Big Science
- Energy and Environment
- Life Sciences
- Industry and services

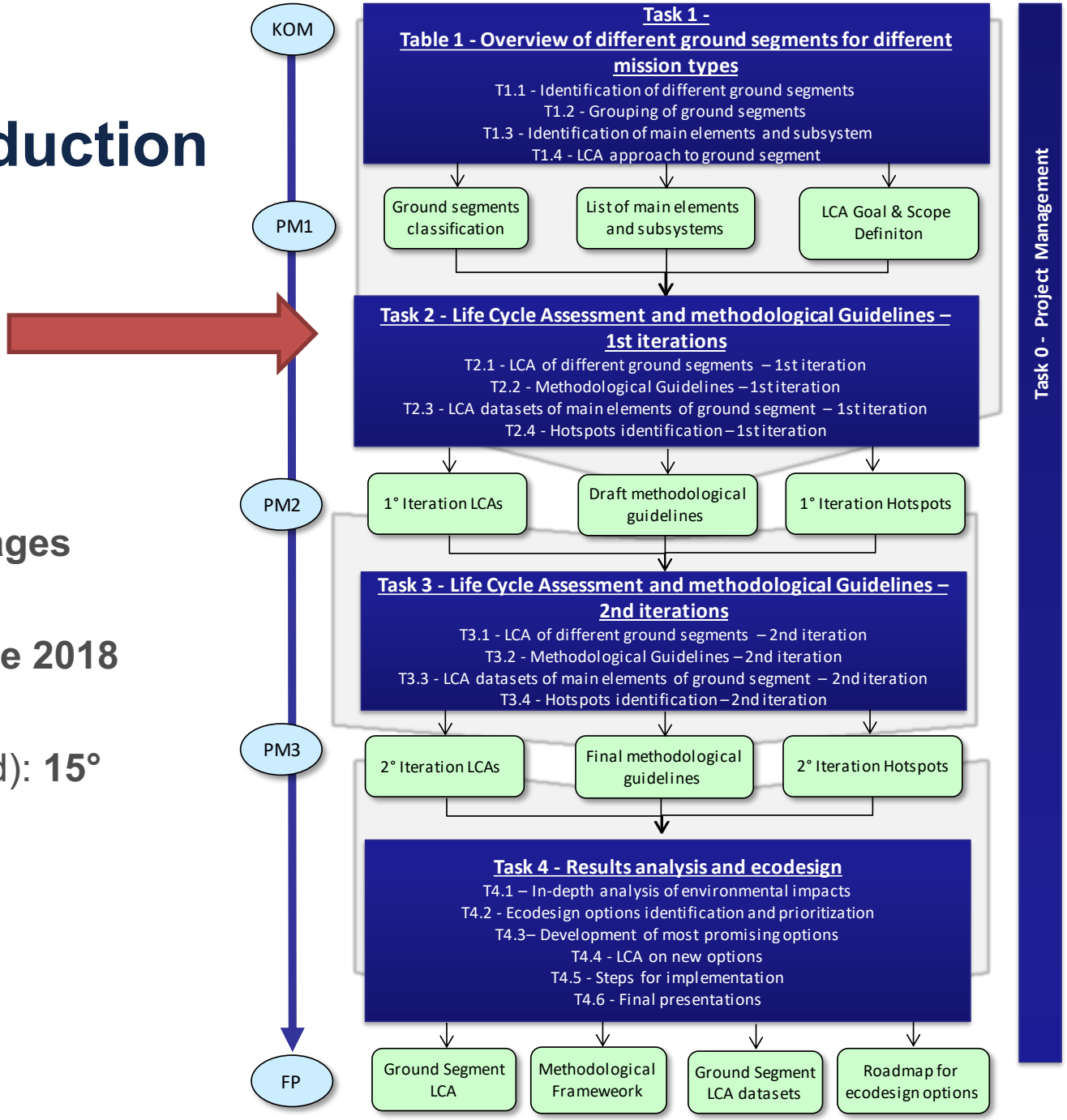
Project Introduction

Main Objectives:

- **Identify and define various "generic families" of Ground Segment (GS)** representatives for Telecommunication (TC), Navigation (NAV), Scientific, Earth Observation (EO), etc. missions, covering their specific infrastructures and operations
- **Perform Life Cycle Assessment** (LCA) of the environmental impact of the various GS families
- **Provide data sets and methodological guidelines about LCA methodology** applied to GS in order to update/complete the ESA LCA Handbook and Database.
- **Investigate innovative eco-design options** (technical solutions, spin-ins and/or new technologies, innovative processes, etc.) by also considering non-technical aspects (cost and risks, TRL, implementation roadmap, etc.) which can be applied to the various GS family's infrastructures and operations in order to reduce their environmental impact

Project Introduction

- **4 (+1) Work Packages**
- Start date: **15° June 2018**
- End date (expected): **15° June 2019**



LCA Definition

- The **Life Cycle Assessment** is a technique to **assess environmental impacts associated with all the stages of a product/process/service's life** from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling [*SETAC, 1993*]

Task1 – Overview of different GS for different mission types

Task 1 approach: sequential analysis following a three steps approach:

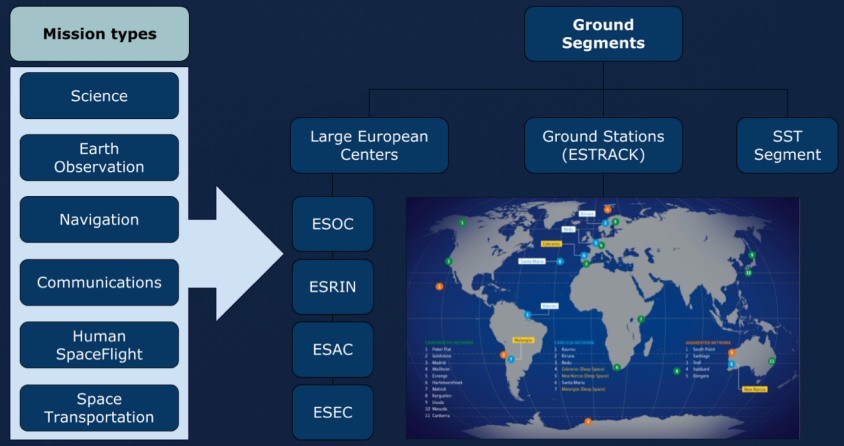
- Subtask 1.1: Identification of different Ground Segments
- Subtask 1.2: Grouping of Ground Segments
- Subtask 1.3: Identification of main elements / subsystems

Main output of Task1 is the consolidation of GS LCA families

To GS major Building Blocks

Bottom - Up

From Mission



From GS Building blocks

Top - Bottom

To Equipment

LEAFSPACE deimos grupo elecnor hispasat GALILEO

Task1 – Overview of different GS for different mission types

Task 1.1 – Identification of different ground segments

- **Inputs**: Survey of more than twenty ESA / non-ESA missions
- **Process**: Identification of **Ground Segment "Major" Building Blocks**
- **Outputs:** Four (4) major components identified

Mission TYPE	Mission Operations Centre	Science Operations Centre	Data Processing Centre	Ground Station(s)
SCIENCE	X	X	X	X
EARTH OBSERVATION	X		X	X
NAVIGATION	X		X	X
TELECOMS.	X			X
HUMAN SPACEFLIGHT	X			X
NEW SPACE	X		X	X
SST	X		X	X

MOC: Mission Operations Centre

SOC: Science Operations Centre

DPC: Data Processing Centre

Ground Station(s)

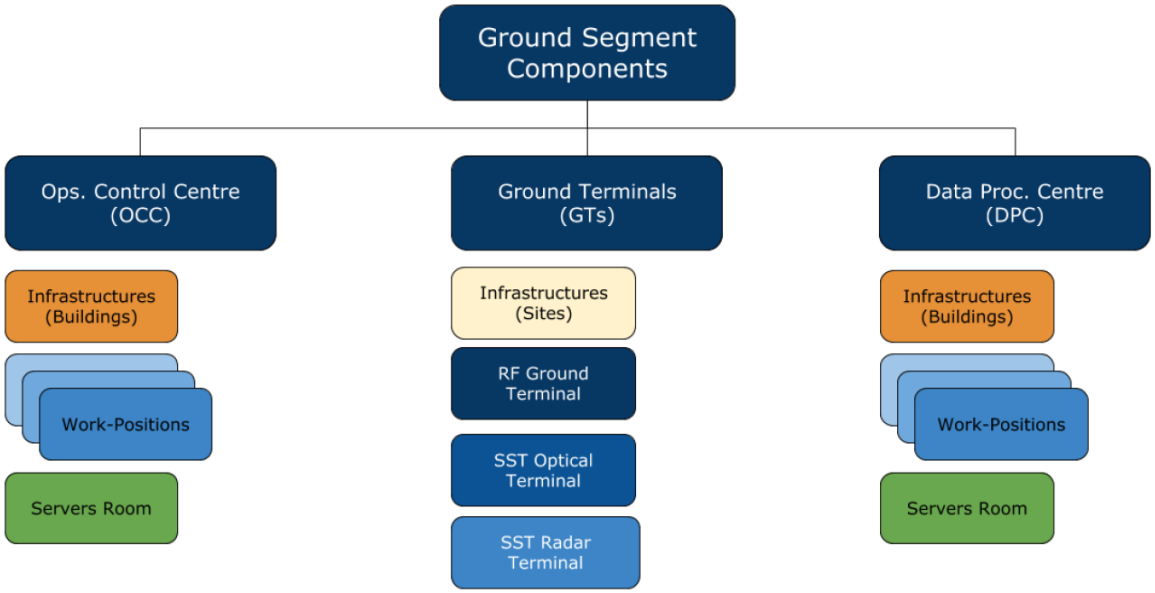
Task1 – Overview of different GS for different mission types

Task 1.2 – Grouping of ground segments

- **Inputs**: Major GS components from previous step as well as its top level architectures

MOCs

SOCs

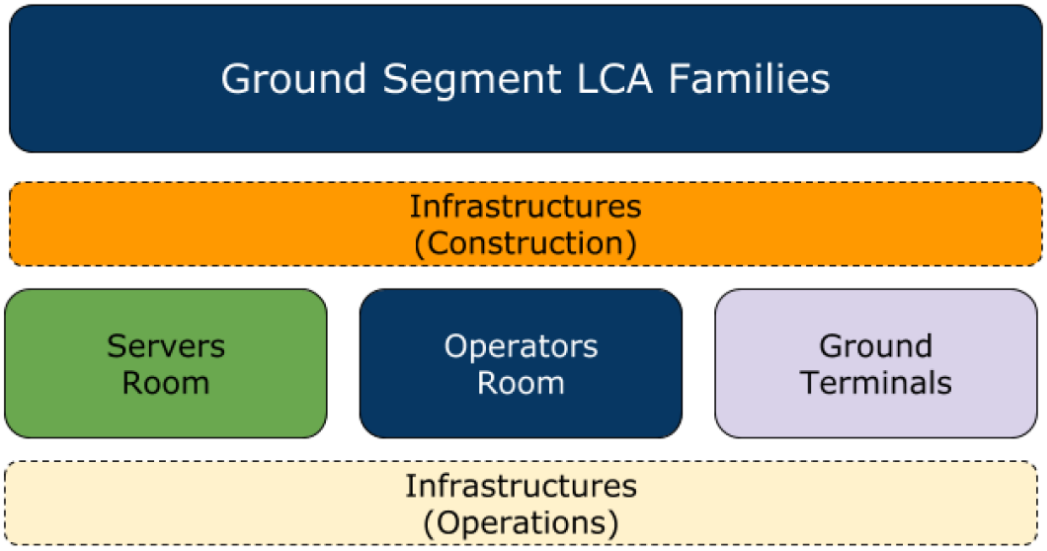


- **Process:** Identification of commonalities among major GS Components

Task1 – Overview of different GS for different mission types

Task 1.2 – Grouping of ground segments

- **Outputs**: Ground Segment LCA Families



Infrastruct: Transversal Service

Servers Room

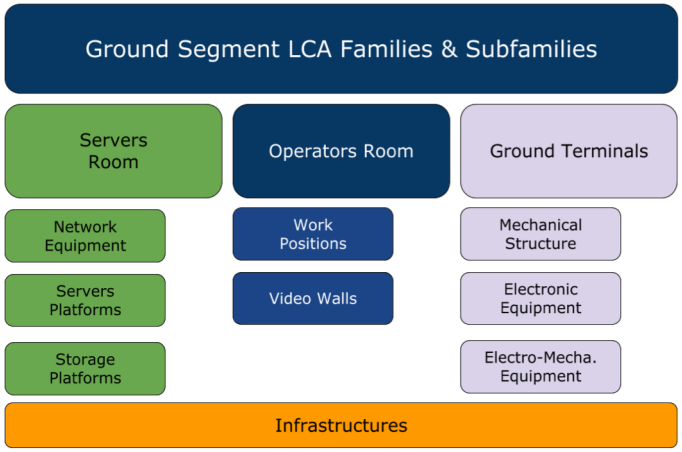
Operator Room

Ground Terminal

Task1 – Overview of different GS for different mission types

Task 1.3 – Identification of main elements and subsystems

- **Inputs**: Twelve (12) study cases covering the complete range of missions types
- **Process-a**: Hierarchical atomization of each study cases in its lower level elements down to subsystems → parts / equipment (including infrastructures)
- **Process-b**: Dissemination of the LCA Questionnaire and field data collection
- **Outputs**: Consolidation of the LCA families and **sub-families**



Task1 – Overview of different GS for different mission types

Task 1.4 – LCA approach to ground segment

- **Goal of the Analysis**: to assess the energetic and environmental impacts of different Ground Segment typologies, across their entire life cycle. The Ground Segment can manage different missions: Navigation, Earth Observation, LEO and GEO satcoms, Science missions, LEO CubeSat missions

- **Functional Unit**: the fulfilment of requirements of Ground Segment for 1 year for the following mission types: Navigation, Earth Observation, Science, Telecommunication, CubeSat

- This approach will give the possibility **to evaluate the impact of specific sites** among those selected and **to provide impact results on GS during the design of entire space mission**

Task1 – Overview of different GS for different mission types

Boundary limits

As regard **equipment manufacturing and next use**, the main steps are:

1. Extraction of raw materials (minerals, metals, etc.)
2. The production of finished or semi-finished components
3. The assembly of components for having the different equipment
4. All the transportation phases between suppliers, GS facilities

As regard **infrastructure and building construction and next operational phase**, the main steps are:

1. Extraction of raw materials (minerals, metals, etc.)
2. The construction phase and insertion of equipment and furniture
3. The operation phase for the missions management
4. All the transportation phases between suppliers, GS facilities and business trips

Task2/3 – LCA and Methodological Guidelines – 1° and 2° Iteration

Task2 and Task3 are related to the LCA activities, applied to Ground Segment, used for the management of different space missions

The main activities are:

- LCA of different Ground Segment Families, identified in Task1
- Elaboration of methodological guidelines, in line with Space System LCA guidelines (ESA, 2016)
- Providing of datasets of main elements constituting Ground Segment
- Identification of hotspots

This approach is firstly applied in Task2 and then re-iterated and finalised in Task3

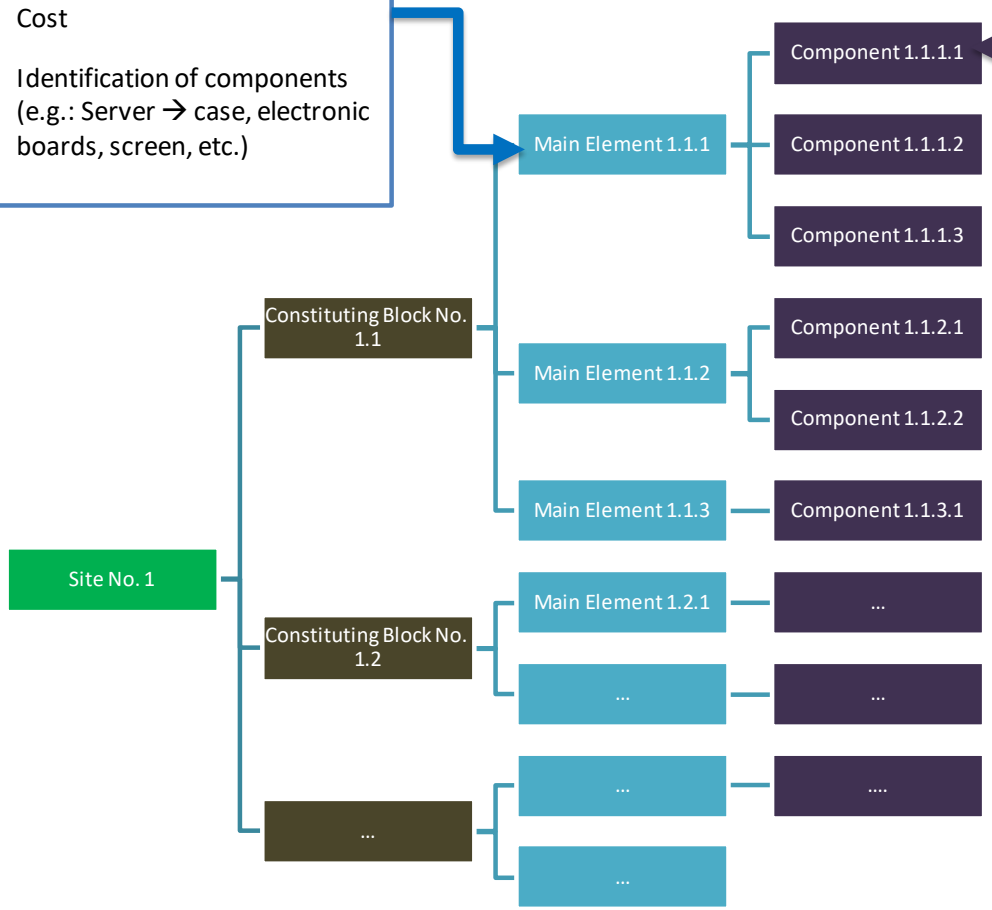
Task2/3 – LCA and Methodological Guidelines – 1° and 2° Iteration – Data Collection

- Technical Data Sheet/Brochure
- Provider/Manufacturer
- Brief Description
- Weight or Lenght
- Lifetime
- Cost

- Identification of components (e.g.: Server → case, electronic boards, screen, etc.)

For Each component, provide info on:

- Weight
- Materials identification and correspondent weight (e.g.: PE, PP, aluminium, composite, etc.)
- Cost (if available for the specific component)

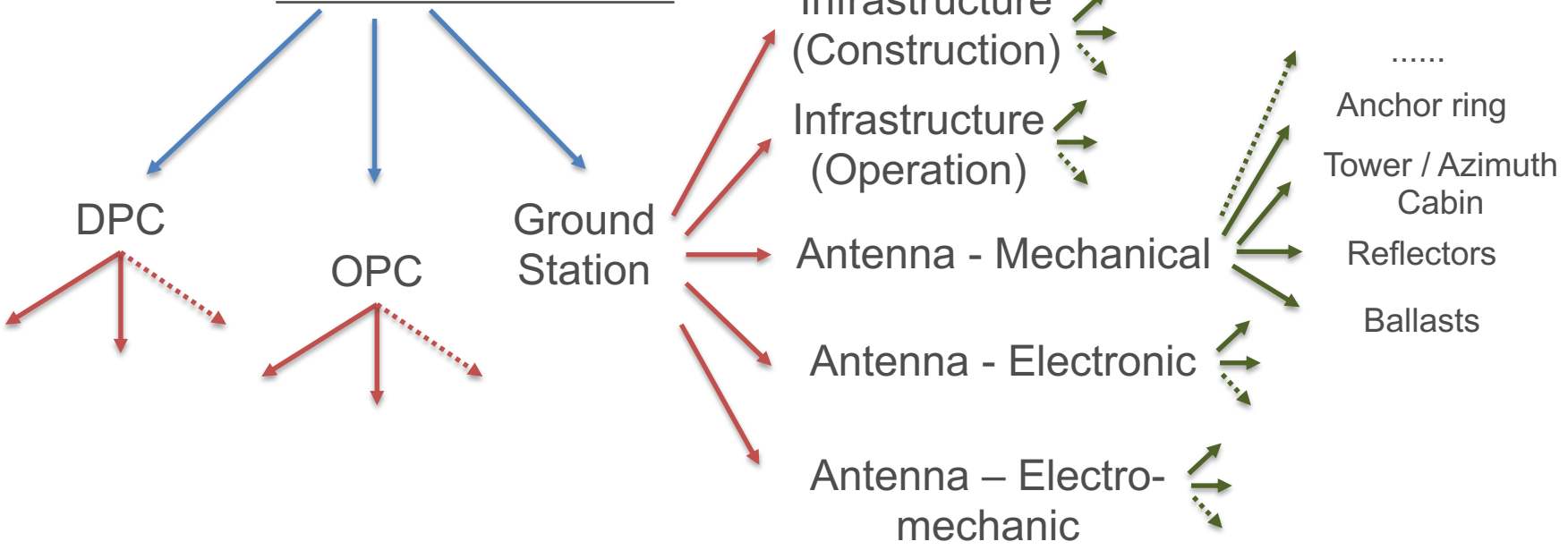


Task2/3 – LCA and Methodological Guidelines – 1° and 2° Iteration – Data Collection

- The study of the different GS Sites is giving the possibility **to understand which families and subfamilies are present in each one of them**, which can be classified according one of the four typologies

- Once understood the structure of the different sites, **a step by step analysis** is under execution to study the main building blocks

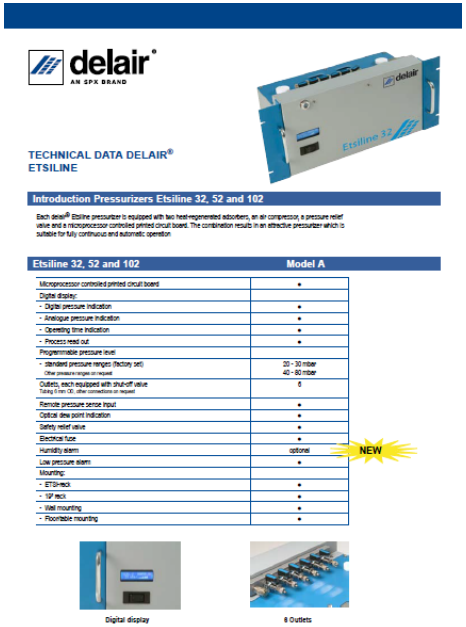
- For instance for DEIMOS Puertollano

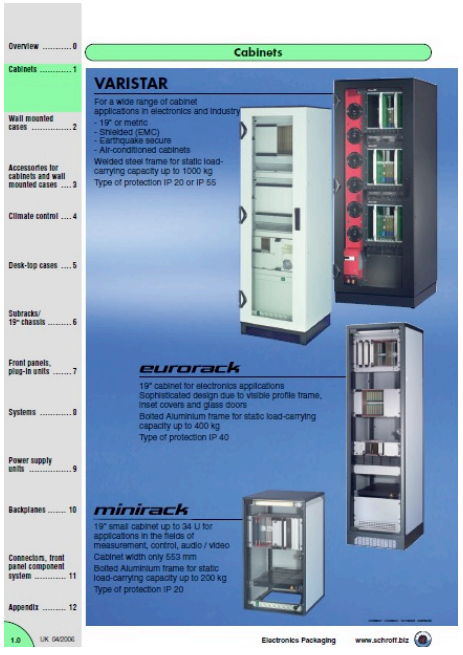


Task2/3 – LCA and Methodological Guidelines – 1° and 2° Iteration – Data Collection

- Through the questionnaires/field visit/data mining of ESA databases, we are collecting info related to the different elements for the different sites

- Through DEIMOS experience, direct involvement in the project and management of Ground Segment site of Puertollano, the **detailed information on the single elements** (weight, materials, providers, lifetime, etc.) are going to be collected





Task2/3 – LCA and Methodological Guidelines – 1° and 2° Iteration – Data Collection

Example of dataset:

- Name
- Functional Unit
- Brief Description
- System boundaries
- Dataset breakdown:
  - Materials inputs
  - Transport Constributions
  - Manufacturing Processes
  - Waste Production

- Using **Ecoinvent Database**
- In line with **Space System Life Cycle Assessment (LCA) Guidelines**

Task4 – Result Analysis and Ecodesign

Task4 is related to the Eco-design activities, applied to LCA results of Ground Segment

The main activities are:

- Eco-design options identification, prioritization and development
- LCA of the most prominsing ones
- Development of most promising ones

Thanks for the attention!

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