Distribution concepts in Space Applications

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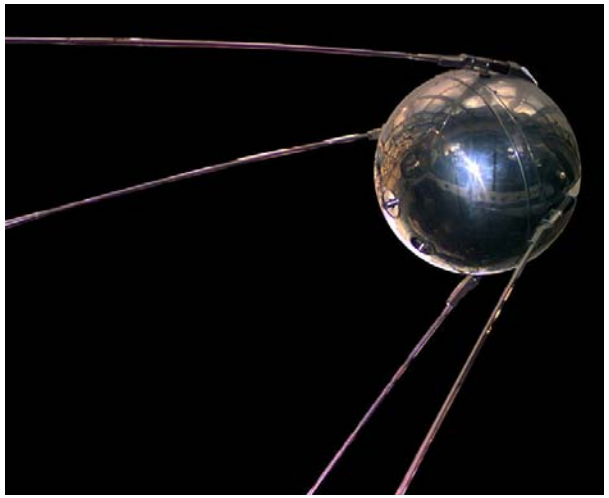
Presentation content

- The Beginning
- Space Systems Today
- The Big Picture of the Future

The Beginning

- Sputnik 1
  - Launch: Oct. 1957, ~80Kg
  - « bip-bip » on 20 and 40 MHz



- Sputnik 2
  - Launch: Nov. 1957, ~500Kg
  - One instrument – radiation sensor
  - Analogue modulation
  - No on-board recording

- Explorer 1
  - Launch: Feb. 1958, ~14Kg
  - Several instruments
  - Analogue modulation
  - 17 reception stations

Space System

Ground Segment

Launcher Segment

Space Segment

Space System

- Is by nature a distributed system
- Very remote locations (terrestrially and in space)
- Exchange of data everywhere
- Data handled in different distributed applications
- Today Space Systems are consumers of advanced IT solutions in
  - Networks
  - Distributed applications

The Space Segment

- The general architecture of a satellite is divided into two main parts
  - The platform, also called the service module
  - The payload, or payload module
- The platform provides the main satellite support functions, such as
  - Management of housekeeping data
  - Telemetry downlinks, command uplinks and tracking
  - Power generation and storage
  - Control of attitude (orientation in space) and orbit (position in space)
  - Propulsion
- The payload, or payload module, is mounted on the service module
  - The instruments
  - The data management and communications (BUS)
  - The electrical distribution, solid state memory

The Space Segment

- All modern spacecraft carry digital computers
  - For the platform management
  - In the various instruments

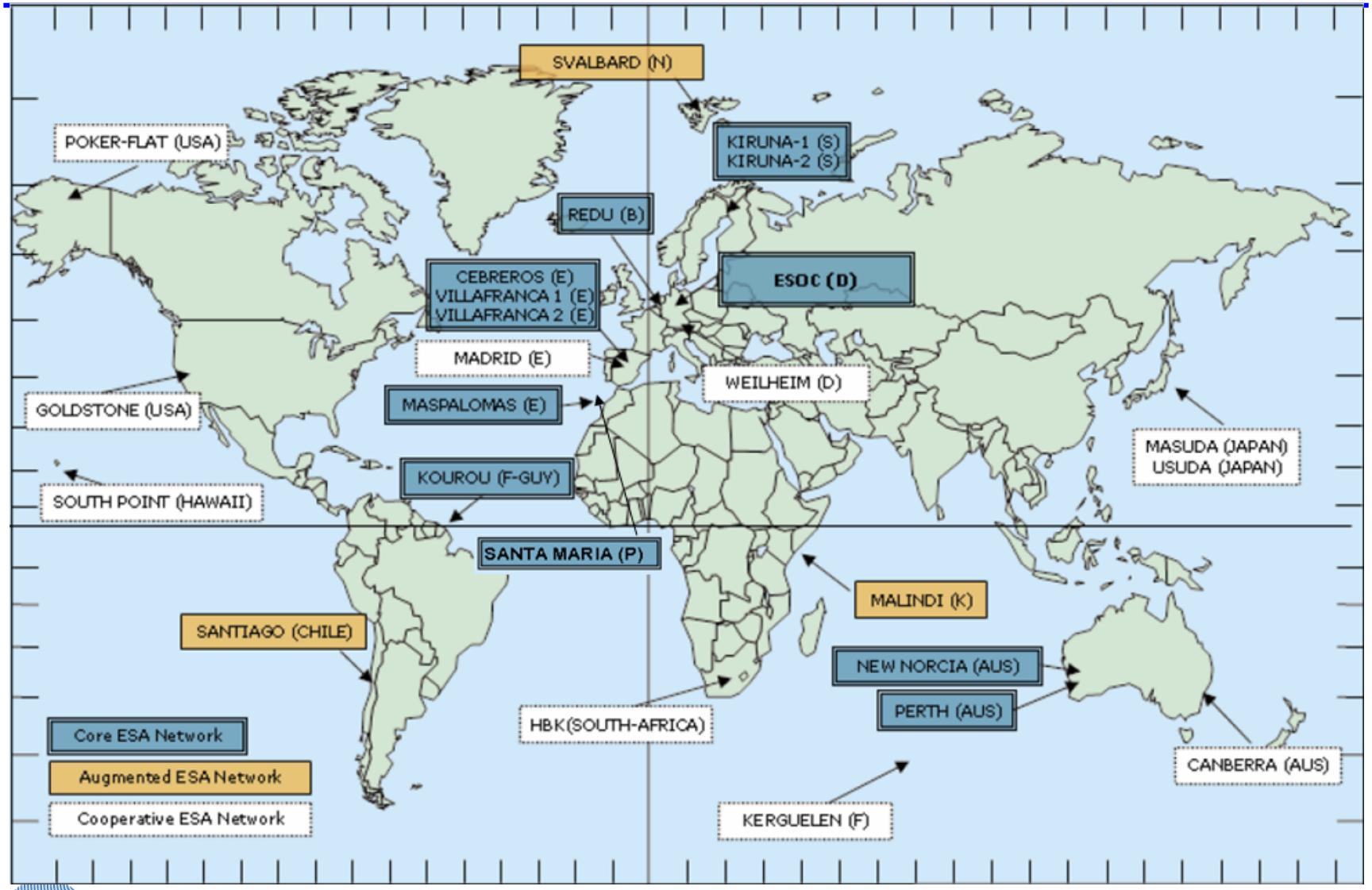
- ESA's Envisat Earth observation satellite
  - Some 50 processors

- International Space Station (ISS)
  - SW upgrades are using IP based internetworking internet protocols
  - Onboard LANs to exchange data onboard
  - VOIP based phone calls between ISS and ground, e-mailing

The Ground Segment

- It comprises typically at least the following
  - Several ground stations
  - One (or more) mission control system
- The ground stations provide
  - The link to the space segment
  - The link to the mission control system
- Space – Ground links
  - Specific communication protocols are needed
  - Protocols defined by Consultative Committee for Space Data Systems (CCSDS)
    - Set up in 1982 as an international body with main Space agencies
    - Now part of ISO (TC20 / SC13)
    - Aim of promoting governmental and commercial interoperability for space missions
    - Space cross-support
    - Terrestrial cross-support

ESA Tracking Station Network: ESTRACK



ESA Mission Control System

- Latest generation based on
  - Distributed architecture: Server – Client
  - SUN / Solaris and Intel / Linux
  - Systematic migration towards Linux for both clients and servers

- But as a consequence
  - Proliferation of Clients (1400 Workstations)
  - Fast evolution of HW and OS impacts application software
  - Difficult and expensive change management

- Solution
  - Virtualisation
  - Simple terminals / devices (not workstations) in operations rooms
  - Distributed operations (tele-presence)

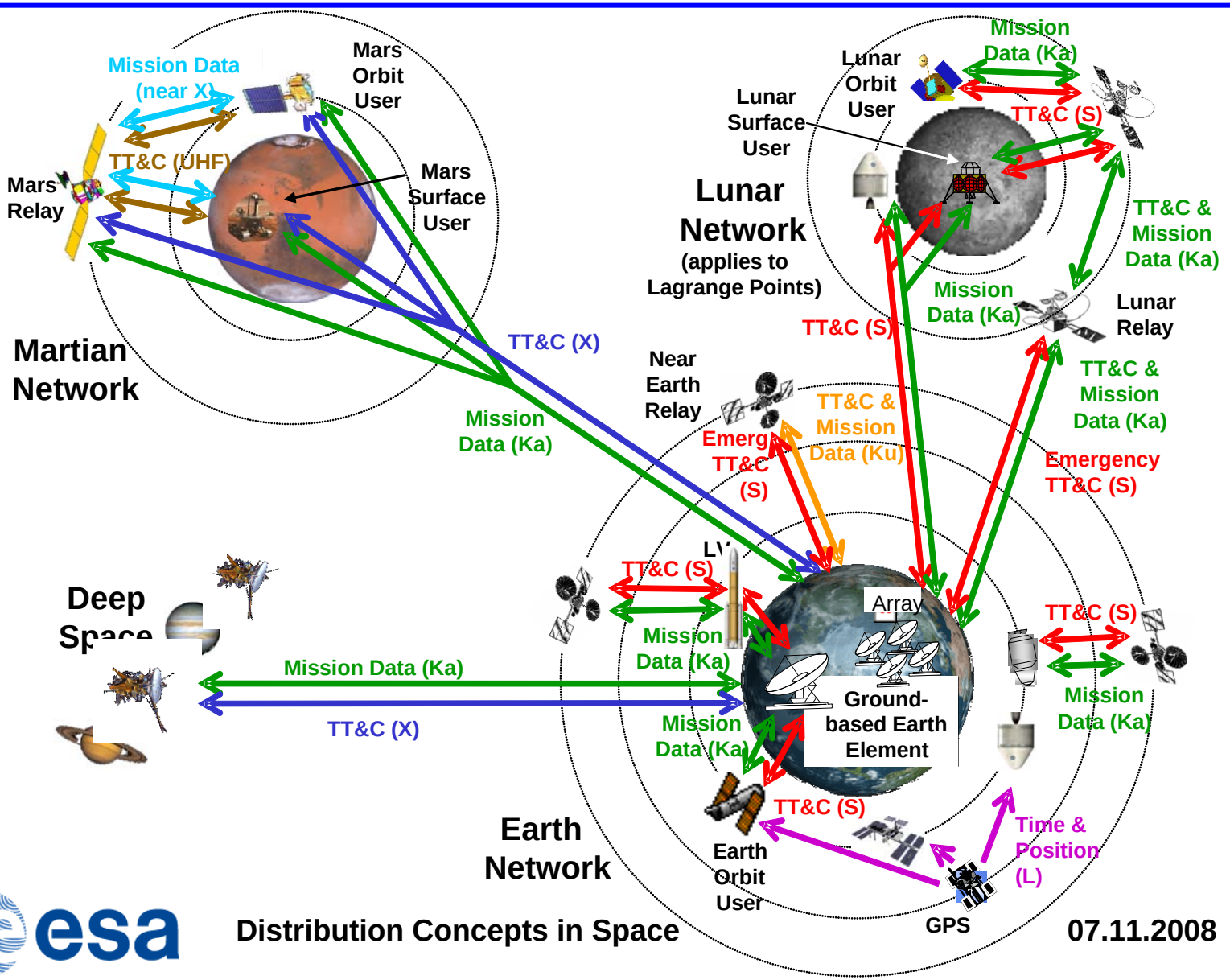
The Future

- International cooperation on exploration missions

- Only possible if based on standards
  - Communication protocols
  - Data exchange standards
  - Standard service at interface points
  - Sharing / accessing Space infrastructures

- Reuse of IT solutions
  - IP in Space, in limited areas of space (e.g. lunar)
  - Disruption Tolerant Networking (DTN) for larger distances (e.g. Mars exploration)

NASA: Communication Architecture in ~2025



Thanks for your attention