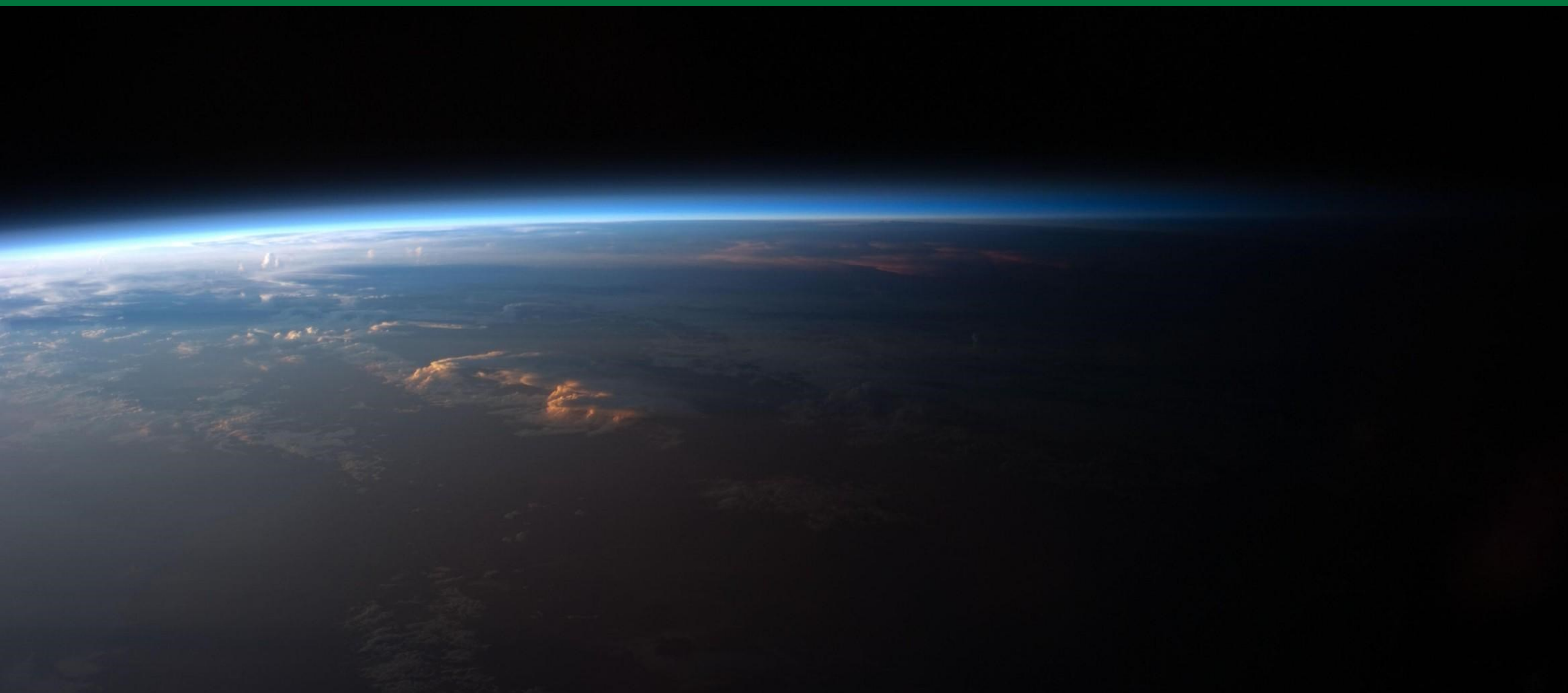
HERMES-II

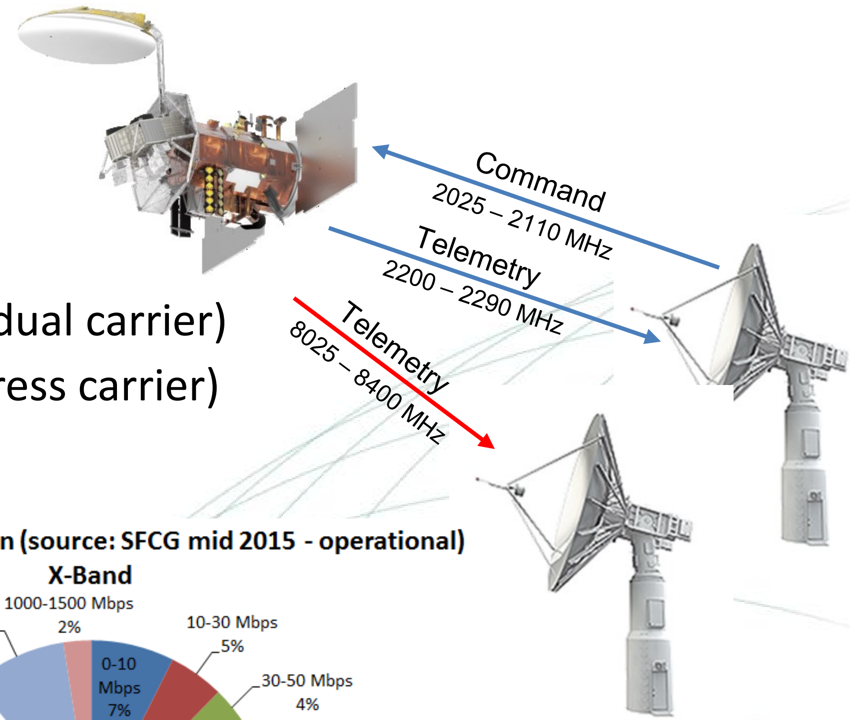
High Data Rate Communication Unit
COTS Use Approach for LEO Satellites



ITU Symposium on Small Satellites
Ing. Hernan Sineiro

Today and Future Needs

In today standard Earth Exploration (LEO) missions is possible to find the following comm scenario:



S-Band

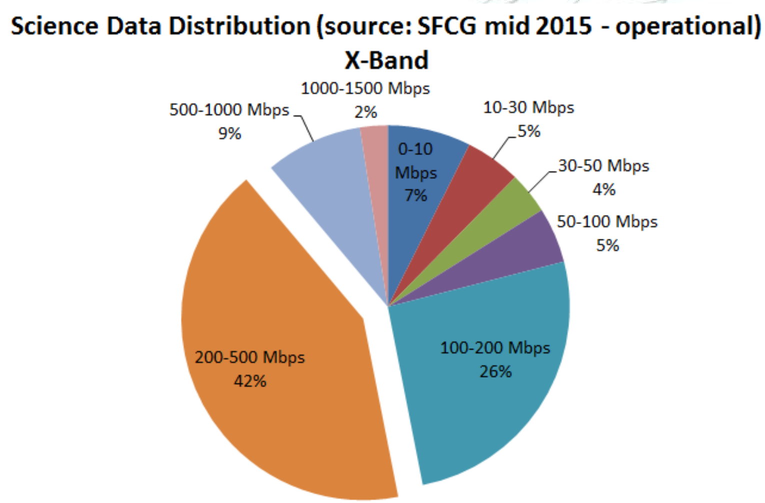
256 Kbps max. for command (residual carrier)

1 Mbps max. for RT telemetry/science data (residual carrier)

2 Mbps max. for RT telemetry/science data (supress carrier)

X-Band

300 Mbps ave. for Science Data (QPSK most of the time)



Today and Future Needs

One of the main issues of a standard LEO orbit is the contact time with the ground station

This issue can be minimized by:

- More ground stations →$$
- More orbit height (not always possible) → $$

The operation concept needs to take into account the lack of contact (i.e. sending time tag commands, etc.) by an anticipated planning.

Additionally, limit the amount of Science data that can be downloaded each day

Get closer to Shannon seems one way to minimize this limitation with a reasonable effort

Today and Future Needs

For Science Data downloading the QSPK is the most used modulation order due its simplicity in change of bandwidth.

According to CCSDS 401.0-B-26 the modulation methods are (for X-band and Ka-Band):

OQPSK

GMSK

SRRC-4D 8PSK TCM

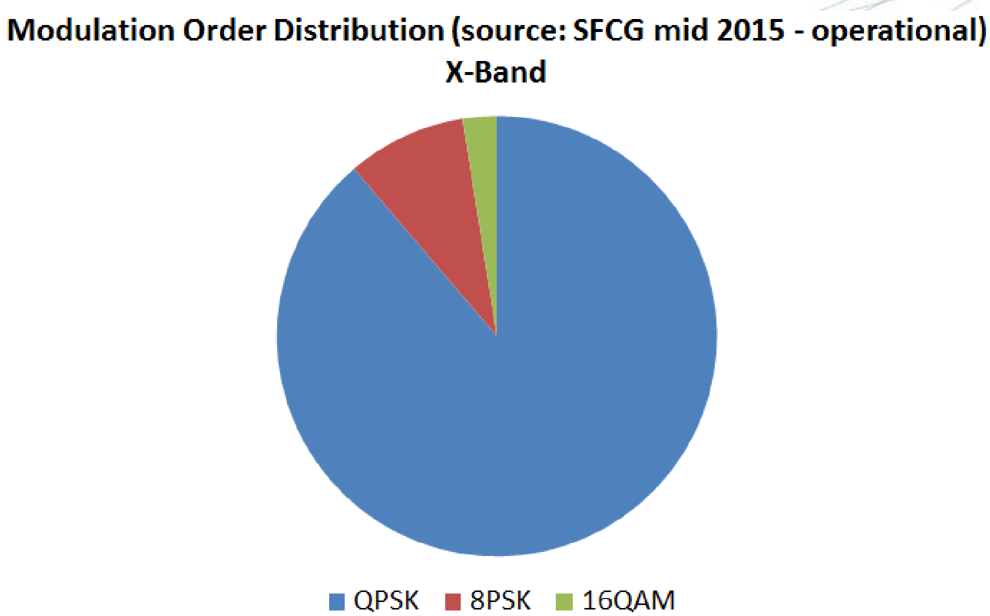
SRRC 8PSK BiCM

16APSK

32APSK

64APSK

CCSDS 131.2-B-1
Since March 2012



Today and Future Needs

Other way to increase the satellite TMTC and science data availability is using a data relay networks

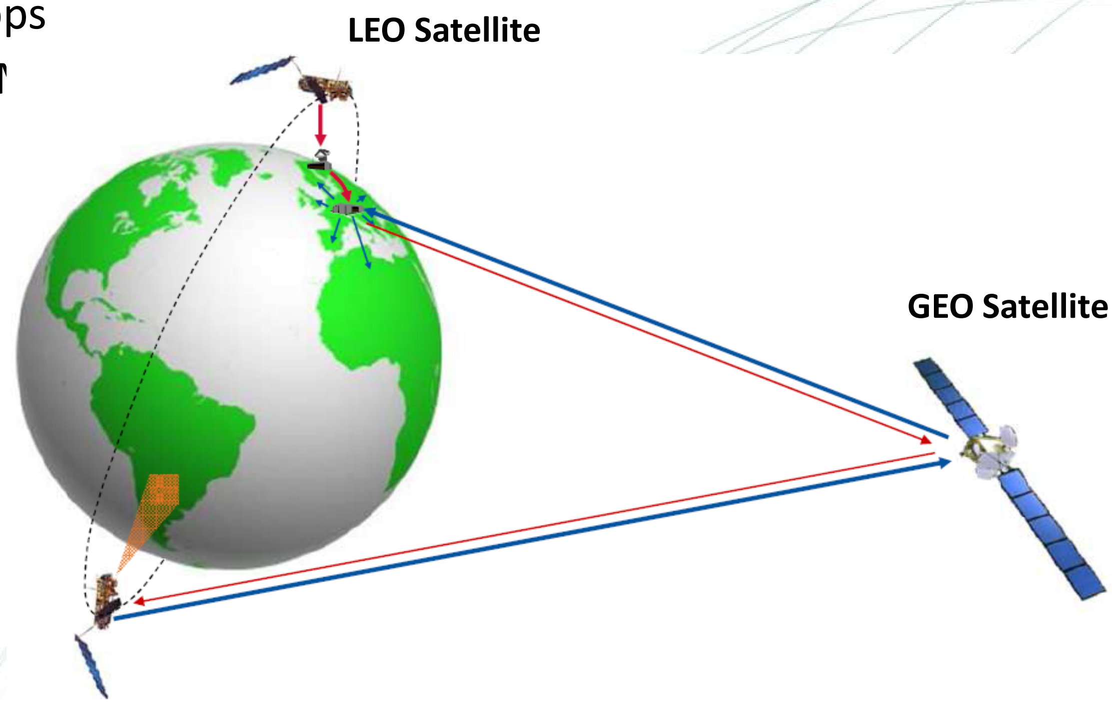
Today there are two main data relay networks:

- EDRS (ESA-Airbus) – 2016
  - Optical User link: up to 1.8Gbps
  - Ka-Band User link: up to 300 M

- TDRSS (NASA) – 1970

S-Band User link: 6 Mbps

Ka-Band User link: 300 Mbps



Today and Future Needs

DRS Pros:

- 24 Hrs. of continuous availability (except for EDRS for now)
- More downlink capacity per day
- The operation concept is real time (on-line planning)
- No interference issues in the case of EDRS optical link
- No weather availability involved (LEO-GEO link)

DRS Cons:

- The user needs to install this optical payload (Mass: 35 Kg; Power Consumption: 120 W; Volume: 0.5 m x 0.5 m x 0.6 m)
- The communication is point to point (optical EDRS)
- The power required is higher (LEO to Ground vs LEO to GEO) as well as the time used (power consumption & dissipation orbital average increase)
- Usually there is a charge ($) for its use (it is not cheap)

HERMES-II

HERMES-II is a flexible and cost effective solution for Communications on the Next Generation of LEO Satellites

HERMES-II is base on a software defined radio concept

Today design merge a traditional S-Band TT&C and NG X-Band Science Data Downlink in a single unit fulfilling SWAP-C requirements

Main features:

- Average Downlink Throughput (X-Band): 2.4 Gbps (2 channels) with VCM
- Average Downlink Throughput (Ka-Band): 4.2 Gbps (2 channels) with VCM
- TT&C complaint with CCSDS/SFCG requirements
- Adaptable to new standards (even on flight)
- Consumption (peak): 80 W
- Mass: 5 Kg
- SpaceVPX (Vita 78/78.1) Tailored
- Design lifetime: 7 to 10 years

HERMES-II

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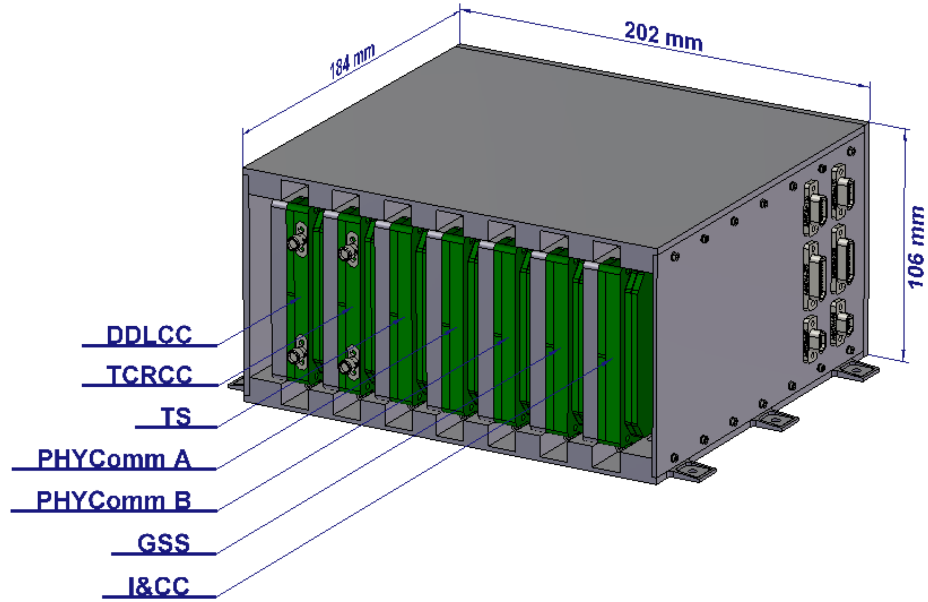
HERMES-II is capable of using:

- Standard isoflux antenna for S-Band (TT&C)
- Standard isoflux antenna for X-Band (less throughput)
- Horn with gimbal for X-Band (high throughput)



HERMES-II also can be provided with and active antenna (high throughput for optical missions)

	Antenna Type	Science Data Downlink Ave. Throughput@ BW:375 MHz [Mbps]	Max. Downloaded Data @ ~10 min pass [Gb]
HERMES-II (1 channel)	Isoflux	685	403
	Horn with Gimbal	1439	847
	Active Phase Array	1220	720
HERMES-II (2 channel)	Isoflux	1370	806
	Horn with Gimbal	2878	1694
	Active Phase Array	2440	1440

COTS Use Approach

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Basically to reach such amount of performance implies to use the last technology available in the market

Do not replace flight proven components by a COTS counterpart. In no case are upgraded parts less expensive than “Level-ready” parts.

The use of COTS in general allow us to:

- Reduce mass and size
- Increment the level of integration
- Be Flexible on design

But the COTS also have the following concerns:

- Low/high reliability/risk
- Several foundries/versions/providers (traceability doubts)
- Temperature grade
- Radiation Hardness

COTS Use Approach

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Many satellite manufacturers are dealing with this new approach doing avionics/payloads

The document PEM-INST-001 (from NASA Goddard) is a good start for defining:

- Screening testing
- Qualification testing
- Burn-in

For radiation hardness is important to determine the survival level through the following tests:

- TID by Protons
- SEU/SEL/SEFI by Heavy Ions

Conclusions

The communications scenario for the Earth Exploration is being developed for increasing the operational concept of the past years

The need for more information availability is a fact today and will increase in the coming years

The massive need for COTS technology will conduct to the commercial components industry, with some design tuning, into the next generation of space parts providers

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