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Challenges to Commercialization of Low Earth Orbit



Laboratory for Atmospheric and Space Physics
University of Colorado **Boulder**

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NIST

National
Institute
of
Standards
and
Technology

University of Colorado at Boulder

Academic Departments

Department of
Astrophysical
and Planetary
Sciences

Department of
Atmospheric
and Oceanic
Sciences

Department of
Aerospace
Engineering
Sciences

NOAA

National
Oceanic
and
Atmospheric
Administration

Research Institutes

Joint Institute for
Laboratory
Astrophysics



Cooperative Institute
for Research in
Environmental Science

NASA

National Aeronautics
and Space
Administration

Unique Synergism within LASP

Student Involvement Throughout



Mission & Science Operations

Science

- Identify/Address Space Science Questions
 - Planetary
 - Atmospheric
 - Solar
 - Space Physics

- Spacecraft Operations
- Payload Operations
- Science Data Analysis
- Mission Scheduling



Development Flow



- Design, build, test space system hardware

Test & Calibration

Engineering

- In-House Facilities

Ground

Balloon &
aircraft

Sub-orbital

Low Earth
orbit

Transfer
orbit

Geostationary
orbit

Lunar orbit

Interplanetary

Mission Management

Instrument Development

**Spacecraft
Development**

Component Development

Launch Vehicle Integration Experience
(Space Shuttle, Atlas V, Pegasus, Taurus, and sounding rockets)

Mission Operations

CIO

RAISE YOUR DIGITAL IQ
C-level collaboration yields profits 8

BRIDGING THE GULF
Connect IT and marketing, peacefully 13

WHO WILL OWN BIG DATA?
CIOs and CMOs could share top billing 16

DISRUPTION ON WHEELS
Mobile apps transform the taxi industry 18

Big Data from Above

By analyzing a wealth of weather information, multiple industries now profit from the shifting winds of Mother Nature 28

BY KIM S. NASH

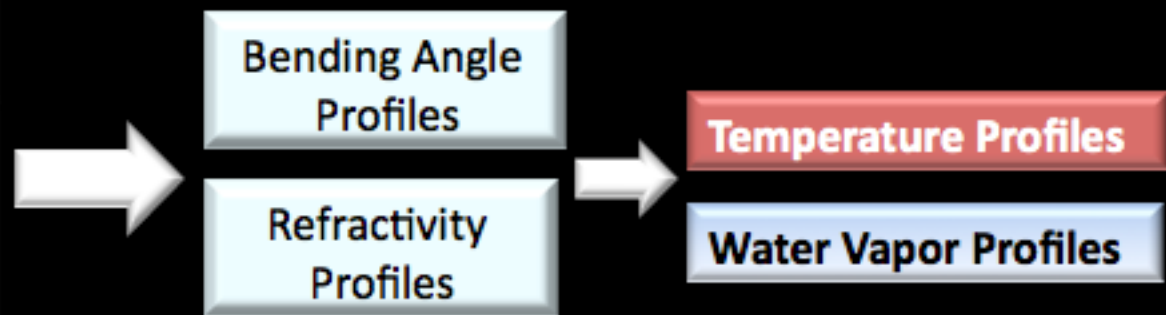
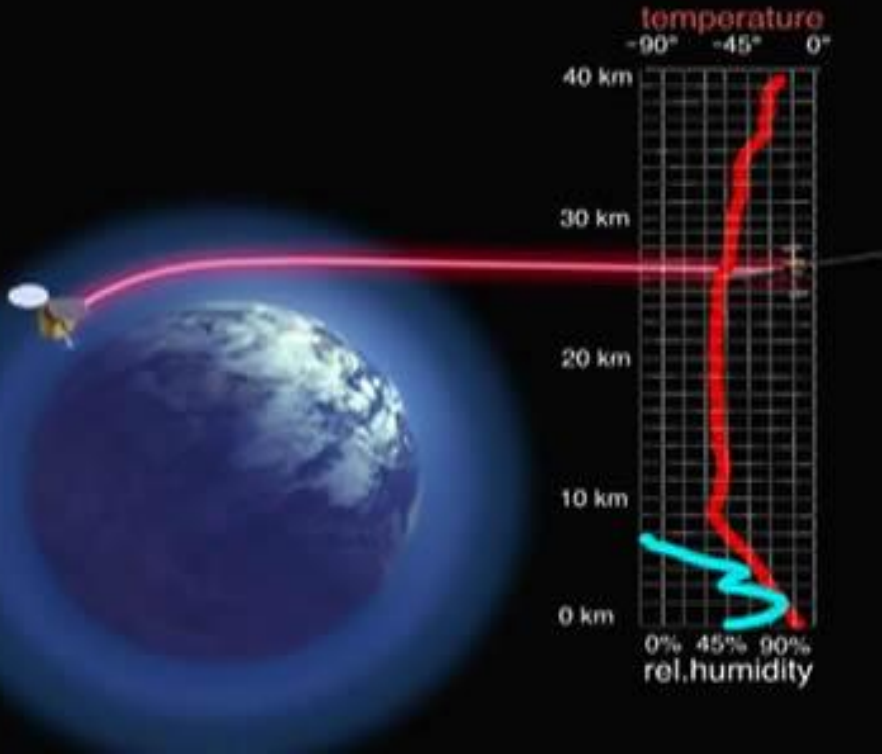
Commercial Value of Weather



PLUS
Doing Business Without Borders

Global expansion requires IT that unifies the company 3

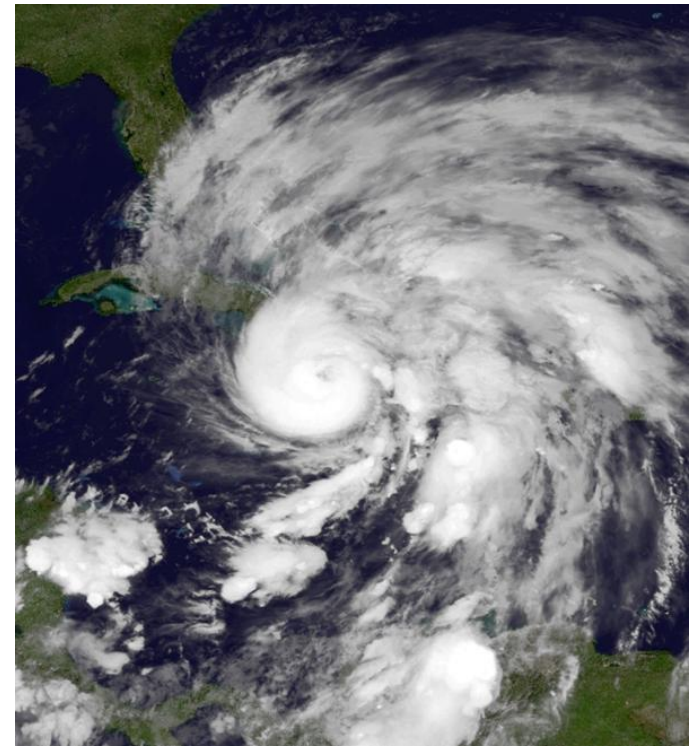
GPS/RO

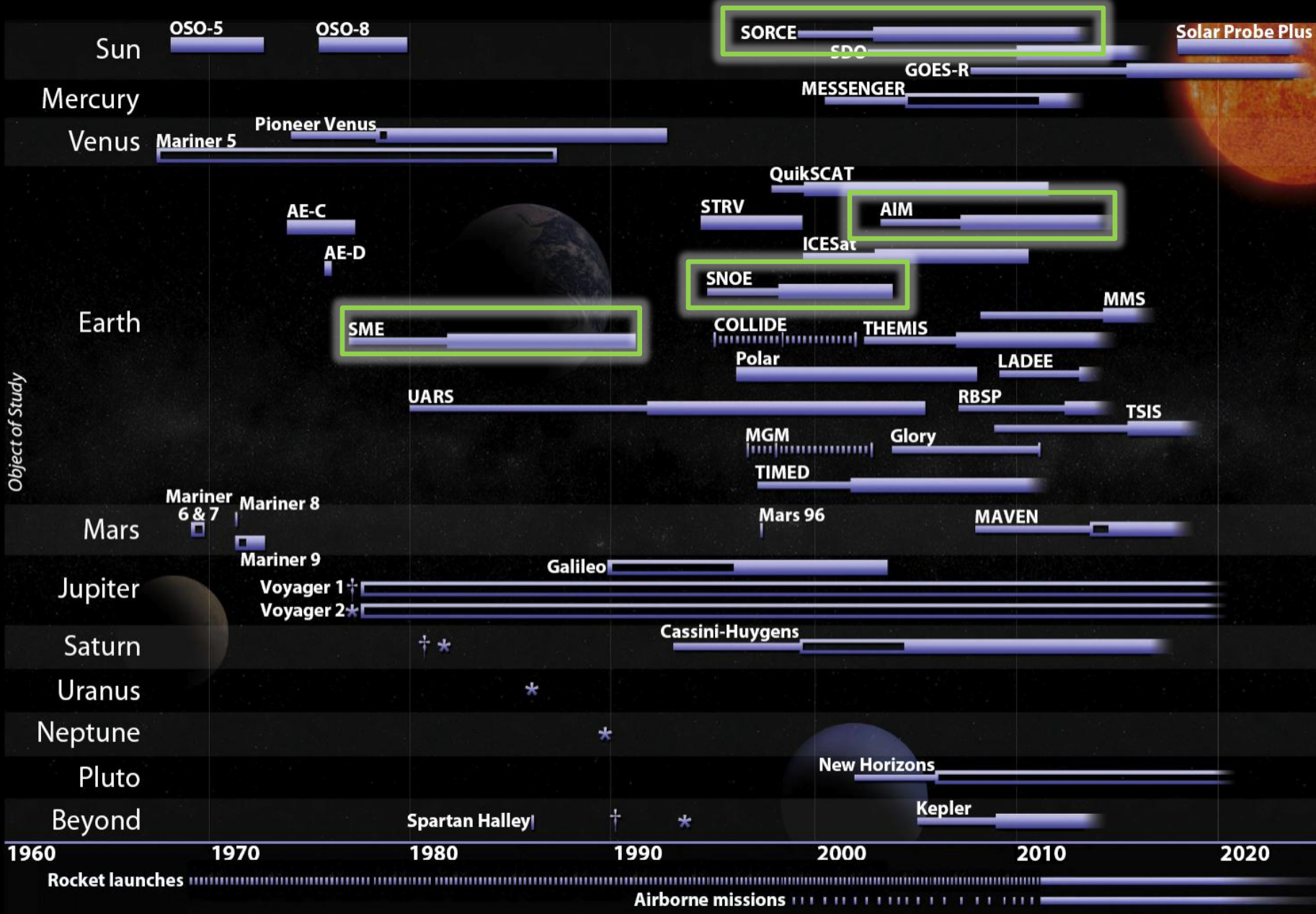




Mission Requirements Supporting Improved Prediction

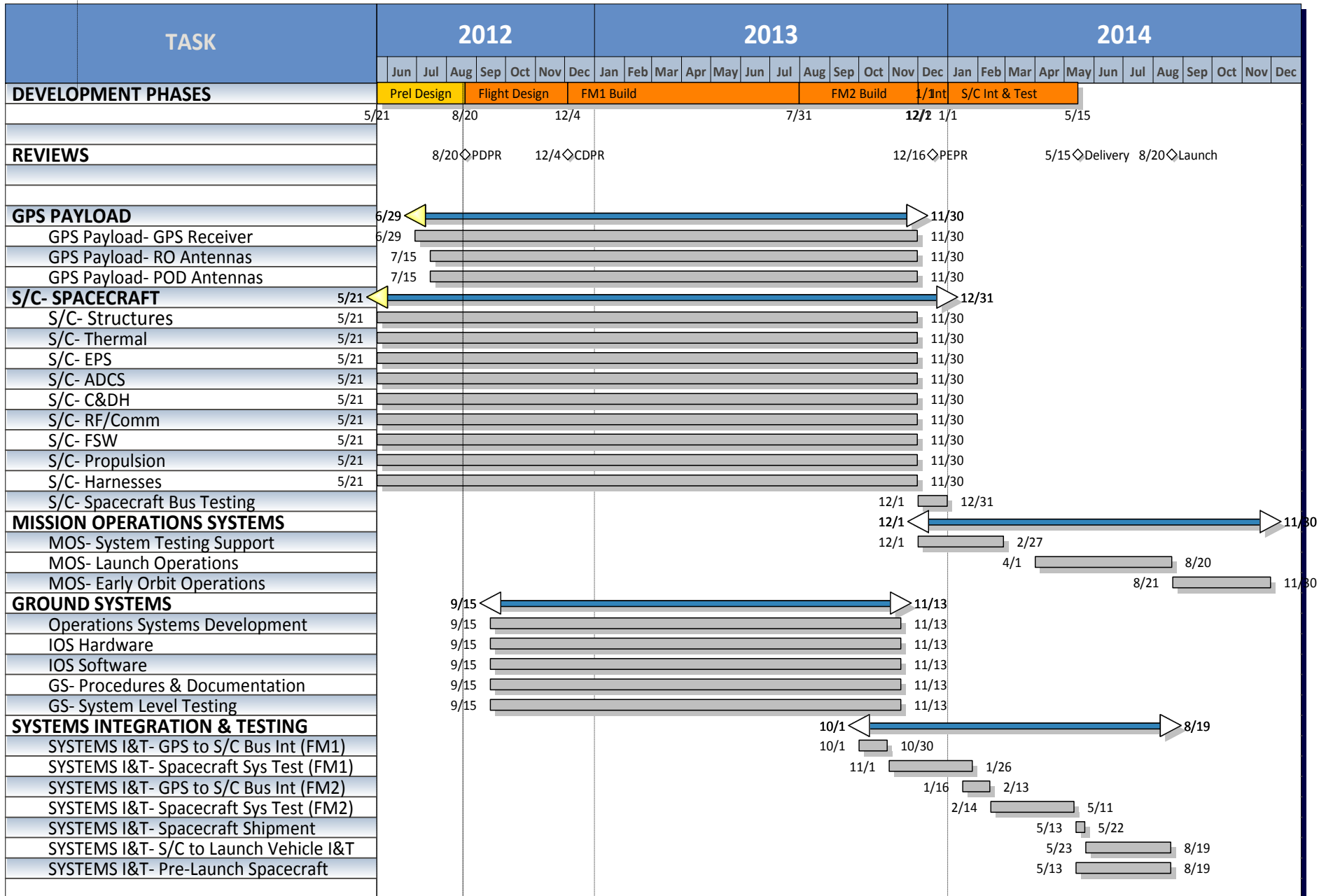
- Spatial and Temporal Coverage
 - More Frequent Sampling for Model Updates
- Data Latency – Processed in 30 minutes
- Minimize Overall Cost
- Minimize Overall Schedule
- Lifetime and Reliability

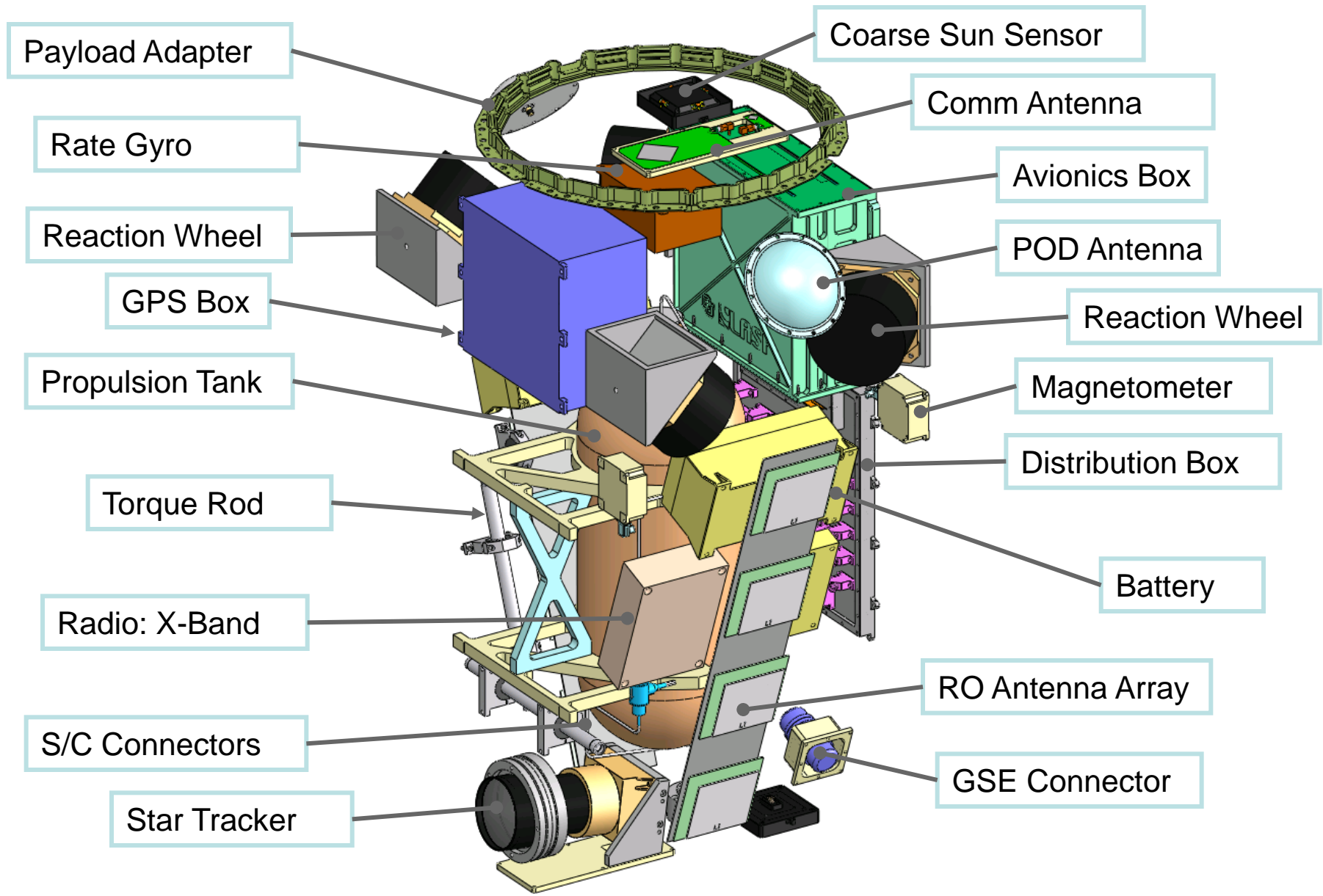




New Paradigm

Opportunity	New Thinking
Hardware Based C&DH	Software Based C&DH
Fasteners	1 Screw Size
Cables and Connectors	TCP/IP
Integration and Test	Web-based Integration
Schedule	Accelerated





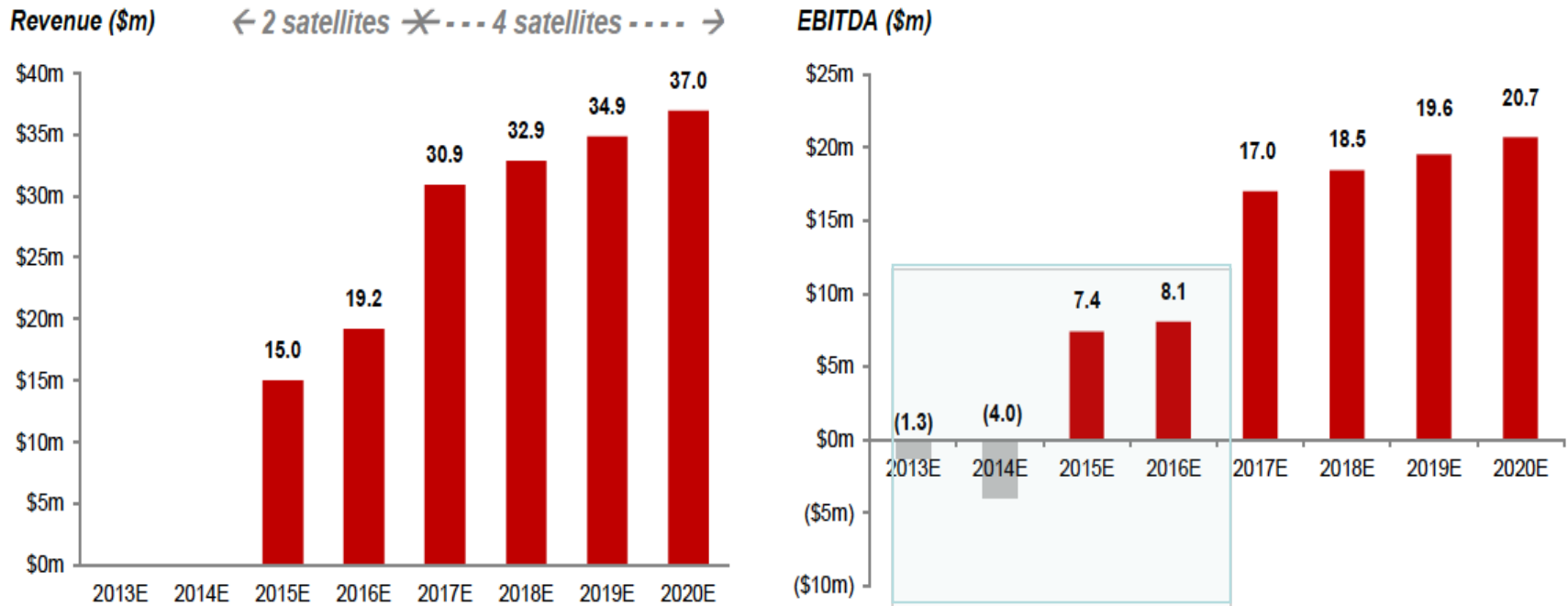
LASP Micro Bus

- Highly efficient and capable design using a combination of COTS miniaturized, space qualified components designed for small satellites and in-house builds



ROI: Valuing a Space Data Product

Exhibit 1: Financial Performance

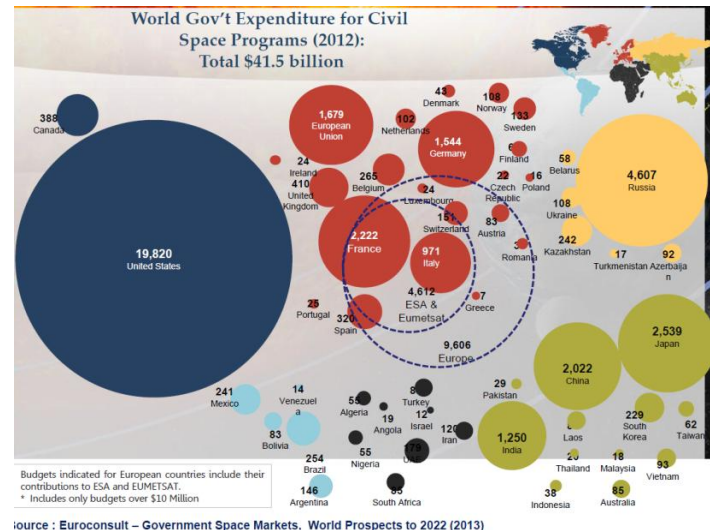


Lessons Learned

- Sensors: Drive overall spacecraft resources.
- Propulsion: Need significantly higher Isp for orbit raising and station keeping
- Avionics: Optimize board integration to reduce interconnects, cables, mass, power. (“Spacecraft on a hybrid chip” – the extreme on this scale).
- Data Downlink: Spacecraft crosslinks could reduce data refresh and/or reduce constellation operations costs.
- Power System: Reduced power needs of the spacecraft and instrument would allow further optimization.

Final Comments

- Record of Climate Becoming Critical
- Spacecraft Market Evolving



- Tall pole to a Commercial LEO constellation market is launch cost.
 - Need 10-20 kg spacecraft, much lower power, and reduced volume to satisfy commercial investors' ROI for 20 spacecraft constellation.
- Engineers and scientists must tell a focused story to attract investment.