The RapidEye Mission
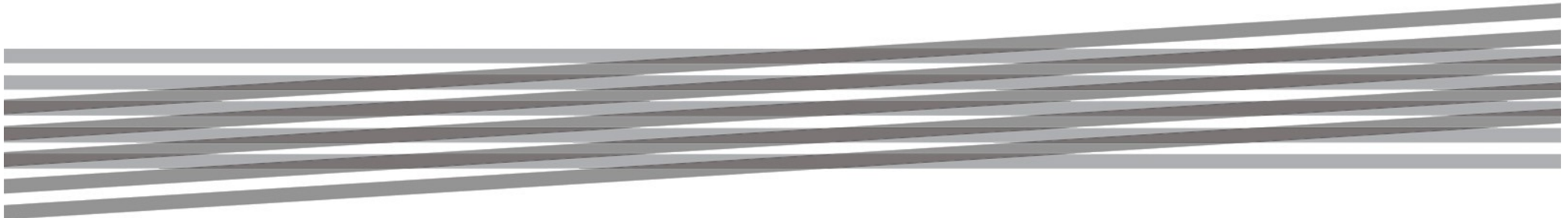
WGISS-24 Host Workshop
Michael Oxfort / Oberpfaffenhofen / 17th October 2007

Contents

Business Concept

> Global supplier of agricultural and cartographic information products and services on a worldwide basis

     ⟶   delivering **frequent**, **reliable** supply of **near real-time**, customized information products and service

   or:

> **What** is growing **where**, **how** and **how much**?
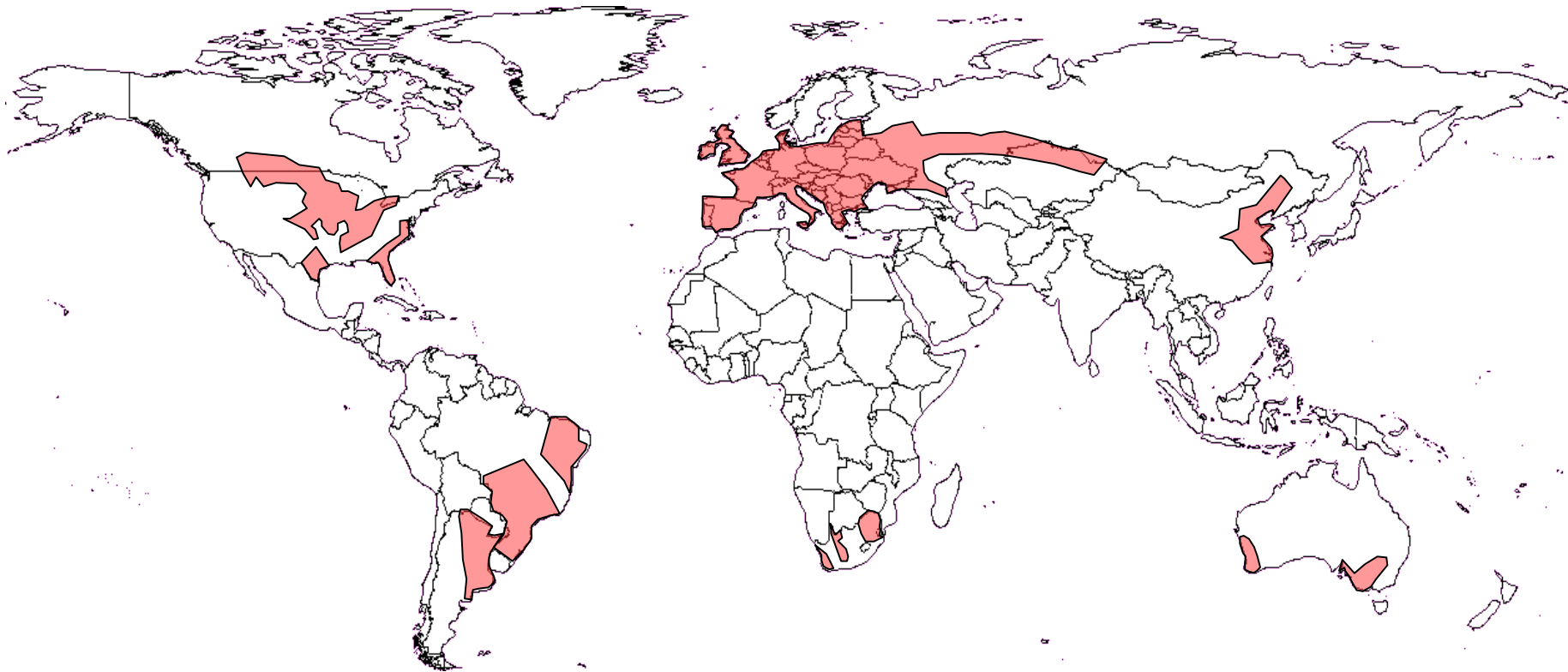
   and:

> **What changed** worldwide during the **last few days**?

What is Growing ....

Corn

Wheat

Rapeseed

➜ **Crop typing**

.... Where ....

➡ **everywhere** in the world (shown: **main** agricultural areas)
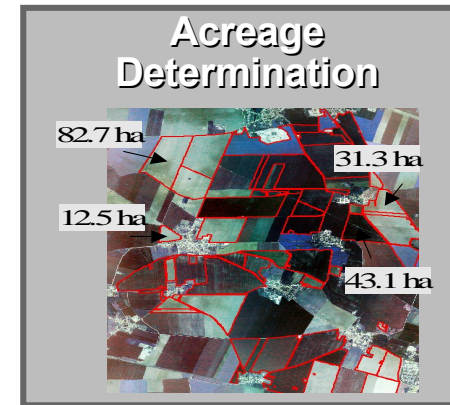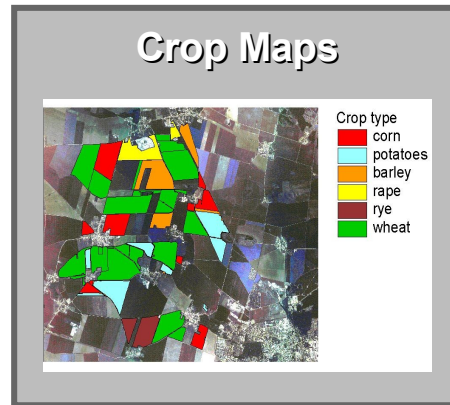
... How and How Much?

crop vigor and damage assessment

quantification by monitoring large areas
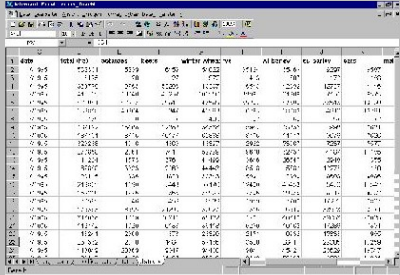
Markets & Segments

> **Agriculture**

>> Insurance, Inputs, Production, Processing, Trading, Service Providers

> **Forestry**

>> Insurance, Logistics, Production, Forestry Services

> **Power & Communication**

>> Insurance, Telco, Energy, Oil/gas

> **Spatial Solutions**

>> Navigation, Internet Service Providers

> **Government**

>> Land Cover Analysis, Homeland Security, Natural Resources, Crop Monitoring, Disaster Management

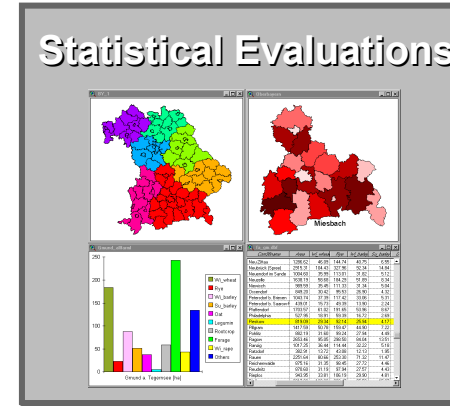# Products and Services (Agriculture)

Agricultural Monitoring

Crop Maps

Crop type
- corn
- potatoes
- barley
- rape
- rye
- wheat

Acreage Determination

82.7 ha

31.3 ha

12.5 ha

43.1 ha

Yield Estimates

Damage Assessment

Statistical Evaluations

Customer-driven System Requirements

> **Guaranteed data availability**

>> daily access of any point on earth possible

>> proven technology and system redundancy

> **Rapid response after unforeseen events (< 7 days)**

>> integrated system from data to products

> **Continuous monitoring of global agricultural areas**

>> large area coverage (~ 4 million sqkm per day)

>> multispectral sensors

> **Customer-specific, low cost information**

>> customized service/product portfolio

Realization

> **Experienced General Contractor (GC)** - MacDonald Dettwiler & Associates, Canada

>> turn-key contract - space and ground segment included

>> „in-orbit" delivery and acceptance

>> firm fixed price

> **Low Risk, Proven Spacecraft Technology**

>> flight heritage used extensively

>> no deployable parts

> **Redundant Design**

>> constellation level: one redundant satellite

>> satellite level: cold redundant sub-systems, graceful degradation

System Overview

Satellite Control Centre

X-band Station(s)

Data Management System
- archive
- preprocessing
- order handling
- catalogue
- planning

Turn-Key

Product Processing System

E-Commerce Platform

Customer

Registered Customer

External Data Providers
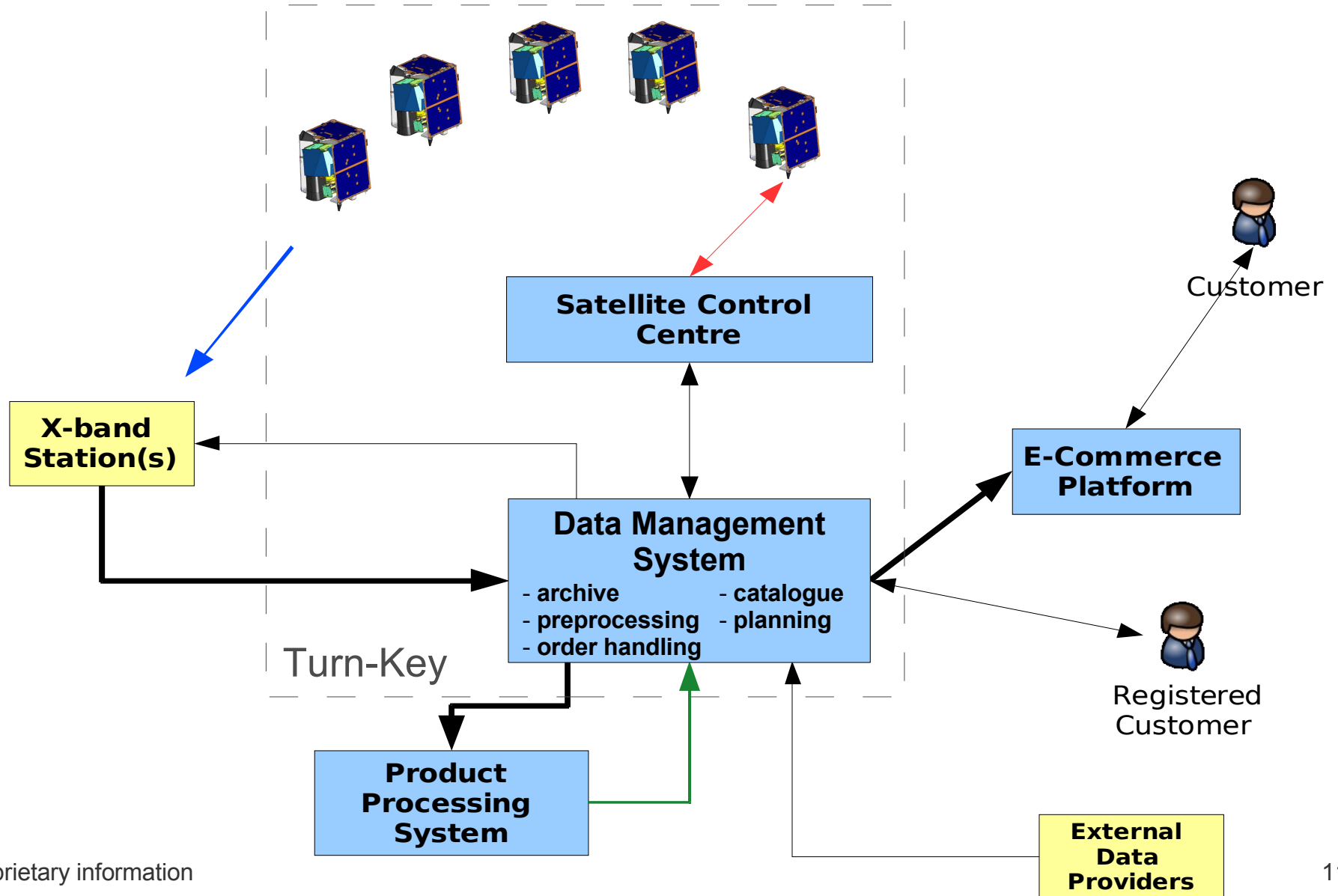
Space Segment
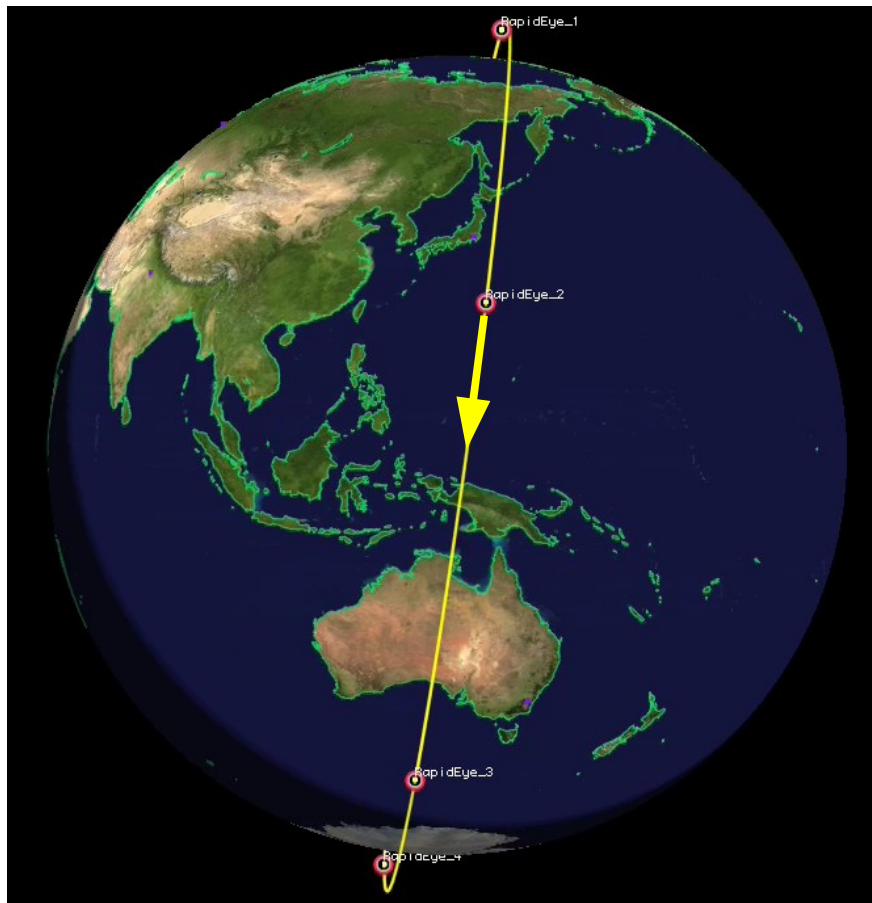## Orbit Characteristics

> No. of satellites: 5

> Orbit altitude: 630 km (max.)

> Orbit inclination: 97.9° (sun-synchronous)

> Satellite phasing: all 5 satellites equally spaced in one plane

> Flight path: descending

> Equator Crossing Time: 11:00 am ± 1 hour

> Orbits/satellite/ day: ~15

> Imaging orbits/satellite/ day: at least 10

Space Segment
Orbit Characteristics (cont'd)

sun – synchronous orbit
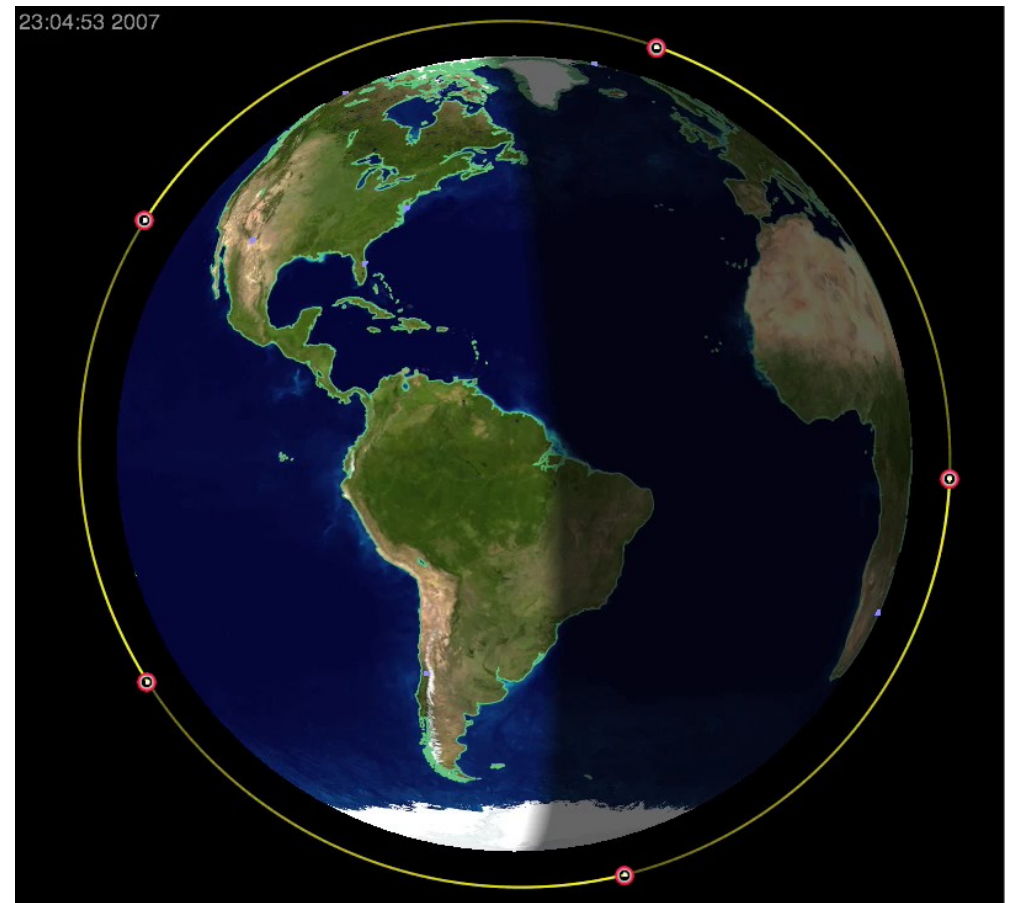
equally spaced in one orbital plane

Space Segment
Key Characteristics

> Image Swath: 77 km

> Typ. Image Length: 1,500 km

> Ground Sampling Distance: 6.5 m (at nadir)

> Re-visit Time: 1 day (from –84 to +84 deg lat)

> Average Coverage Repeat Period: 4.8 days at 45° latitude
                                        6.7 days at equator

> Image Capture Capacity on Ground: > 4 M km^2 / day

> Image Processing Capacity: > 2.1 M km^2 / day

> Downlink Data Rate: 80 Mbps

> Onboard Storage: 48 Gb

RapidEye Spacecraft

Spacecraft Mass

Bus: 128.1 kg

Payload: 38.3 kg

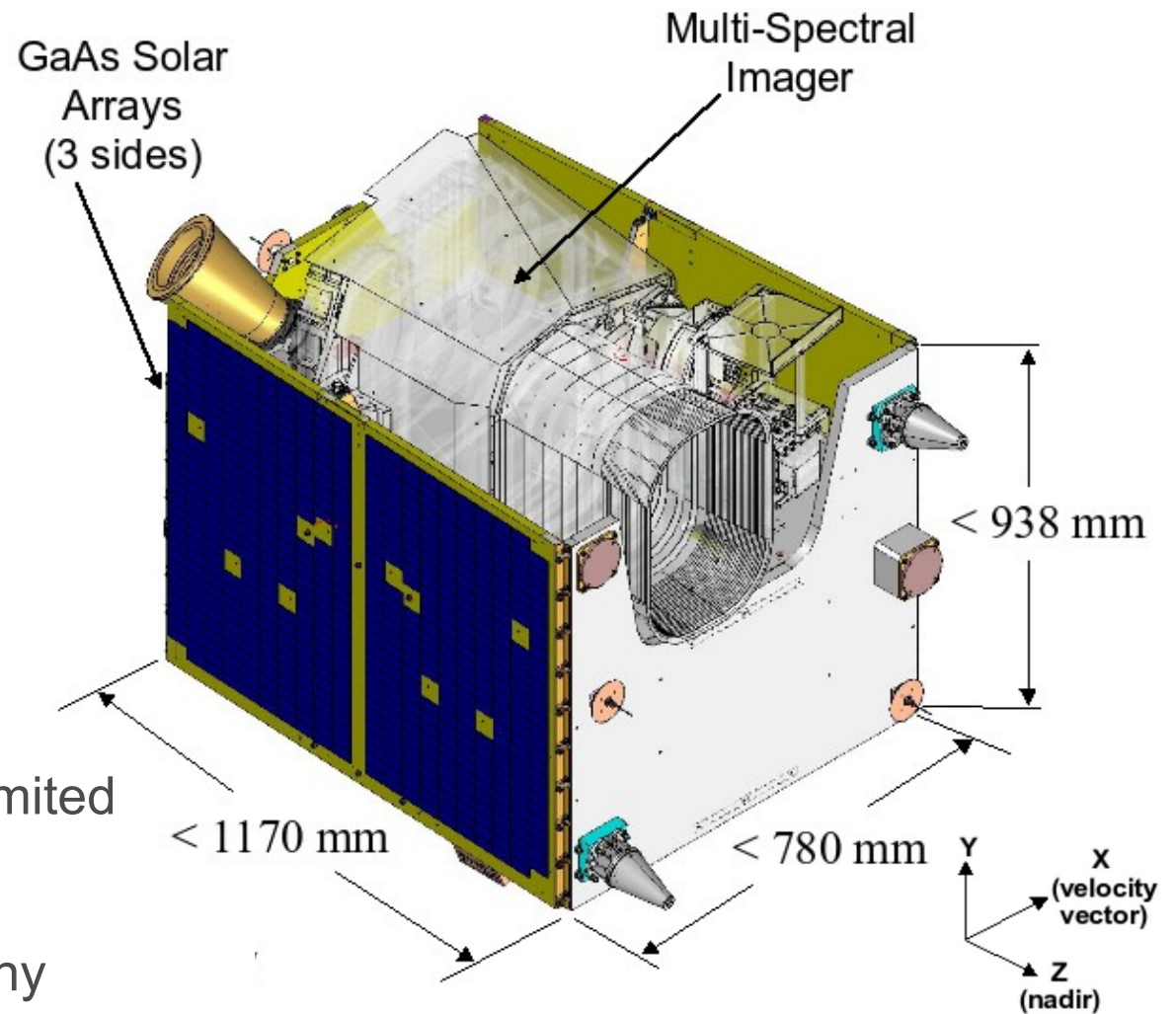**Total: 166.4 kg**

Lifetime: 7 years

Manufacturer:
Bus:
Surrey Satellite Technology Limited (SSTL) / England
Payload:
Jena-Optronik GmbH / Germany

GaAs Solar Arrays (3 sides)

Multi-Spectral Imager

< 938 mm

< 1170 mm

< 780 mm

Y

X (velocity vector)

Z (nadir)

RapidEye Spacecraft (cont'd)

MSI Telescope

FPM

FEE

Baffle

FEE Pwr Converters

Solar Panel

MSI Substructure & Towers

Star Tracker

Solar Panels

PEU

Stack

Earth-facing Panel

Payload Panel

Separation Panel
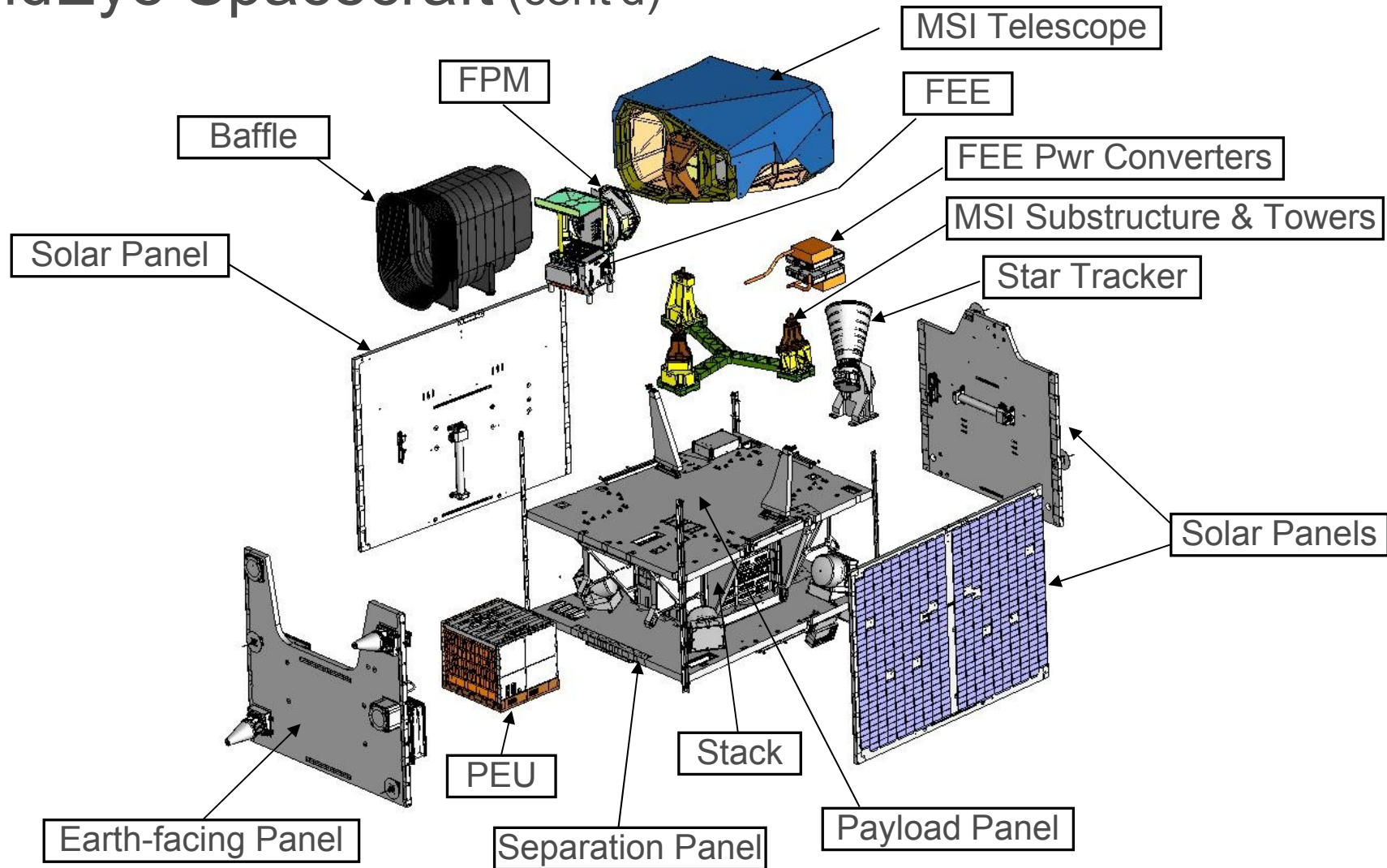
RapidEye Spacecraft (cont'd)
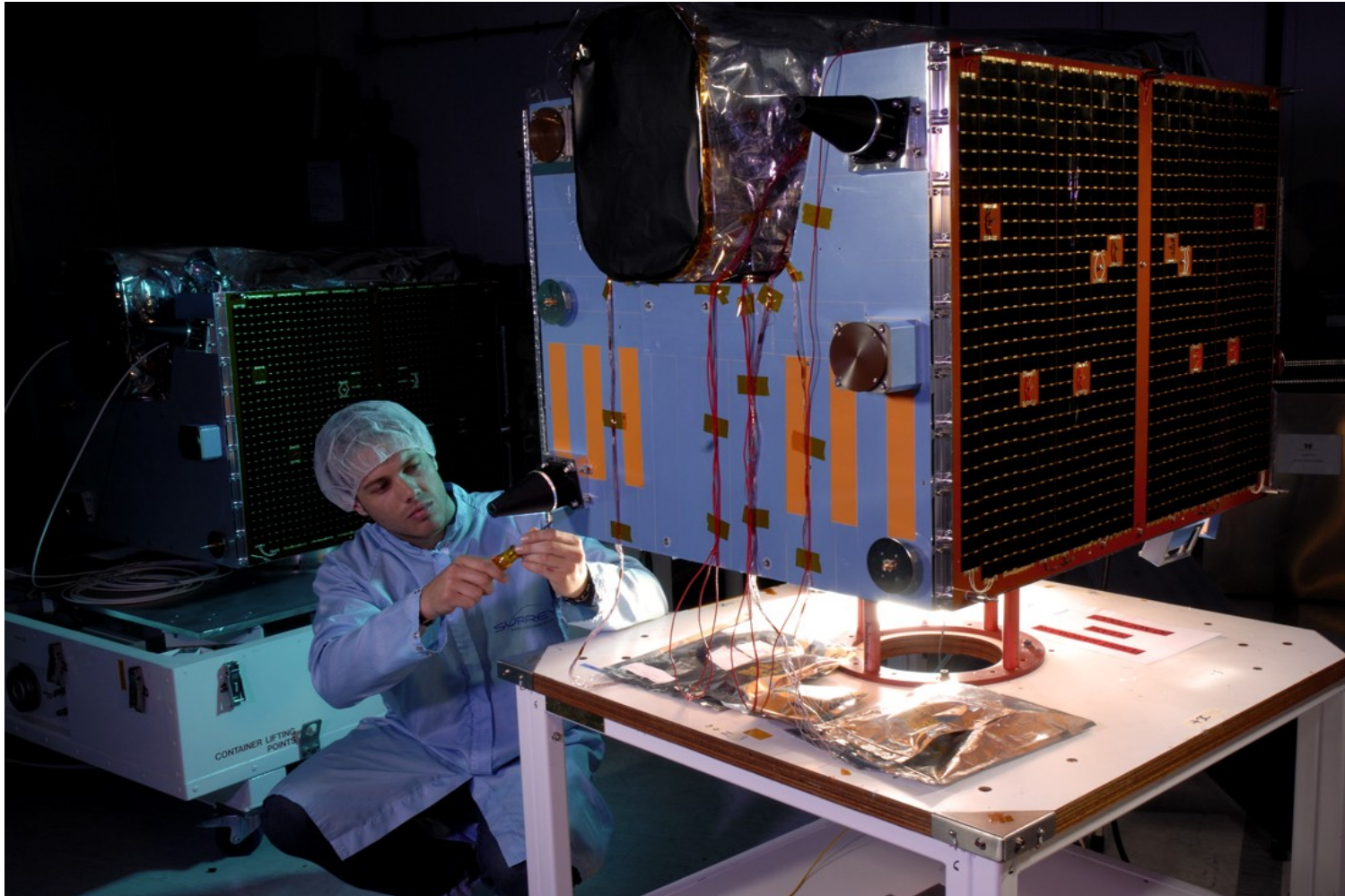
Optical Camera Payload
Architecture
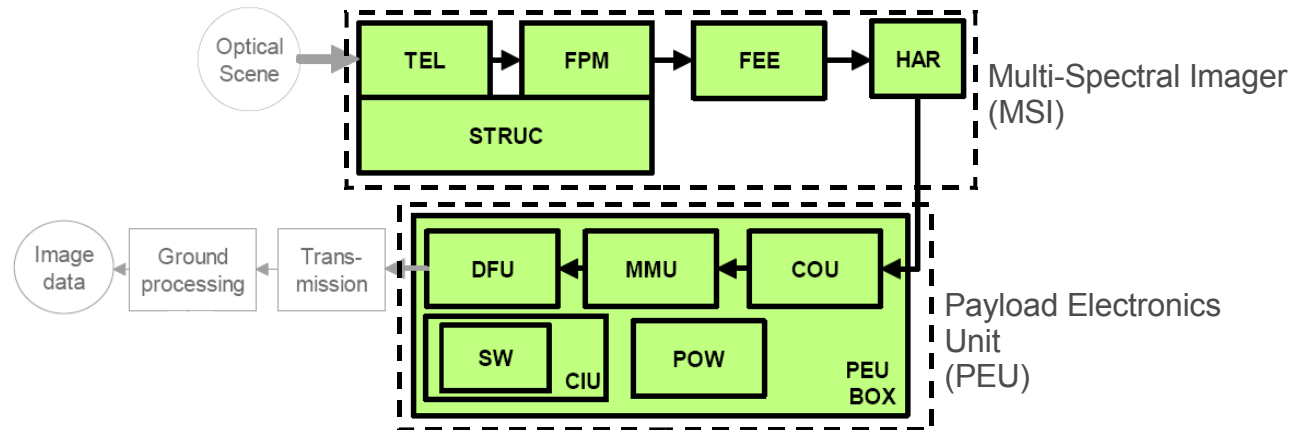
Abbreviation	Name	Sub-System	Main function
TEL	Telescope (including baffle)	MSI	Imaging
FPM	Focal-Plane Module	MSI	Spectral filtering & detection
FEE	Front-End Electronics	MSI	Analogue processing and A/D conversion; including power supply
STRUC	Instrument Structure (including cover)	MSI	Support TEL and FPM mechanically
HAR	Harness Interface to PEU	MSI	Electrical, Mechanical, and Structural interface between MSI and PEU
COU	Compression Unit	PEU	Data compression and formatting
MMU	Mass Memory Unit	PEU	Image data storage
DFU	Data Formatter Unit	PEU	Format image data for X-Band transmission to the ground
CIU	System Control and Interface Unit	PEU	Hardware for central control of electronics; spacecraft-to-bus I/F
SW	Embedded Flight Software	PEU	Internal control flow; spacecraft command interpretation
POW	PEU Power Supply	PEU	Power supply for PEU electronics
PEU BOX	PEU Electronics Box	PEU	Contains PEU electronics boards

Optical Camera Payload
Three Mirror Anastigmat (TMA)

RapidEye™
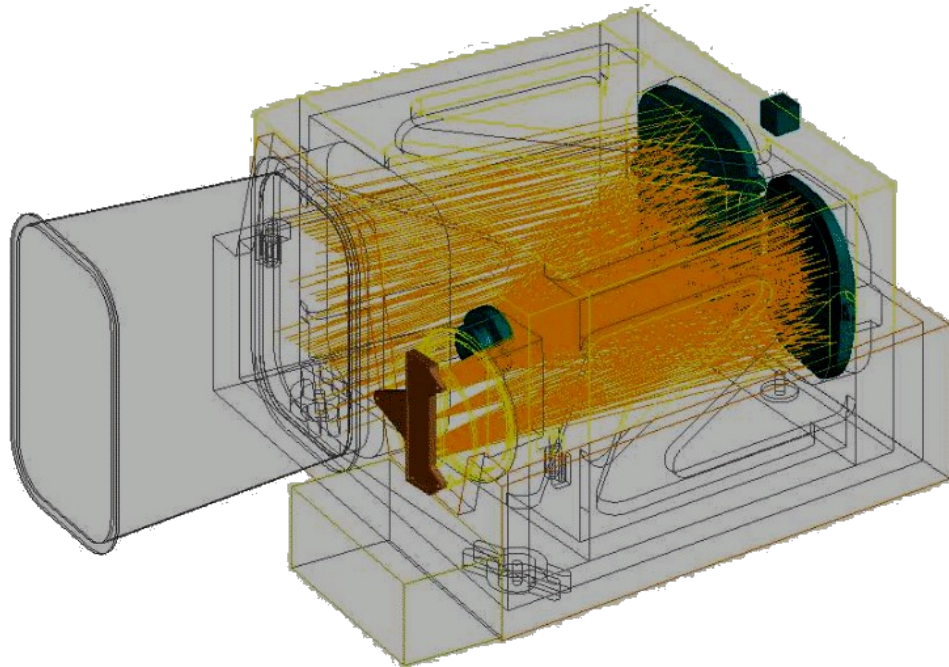
Design: All Aluminium TMA

Eff. focal length: 633 mm

Entrance Pupil Dia.: 147 mm

f-number: 4.3

CCD supplier: Atmel (AT71544)
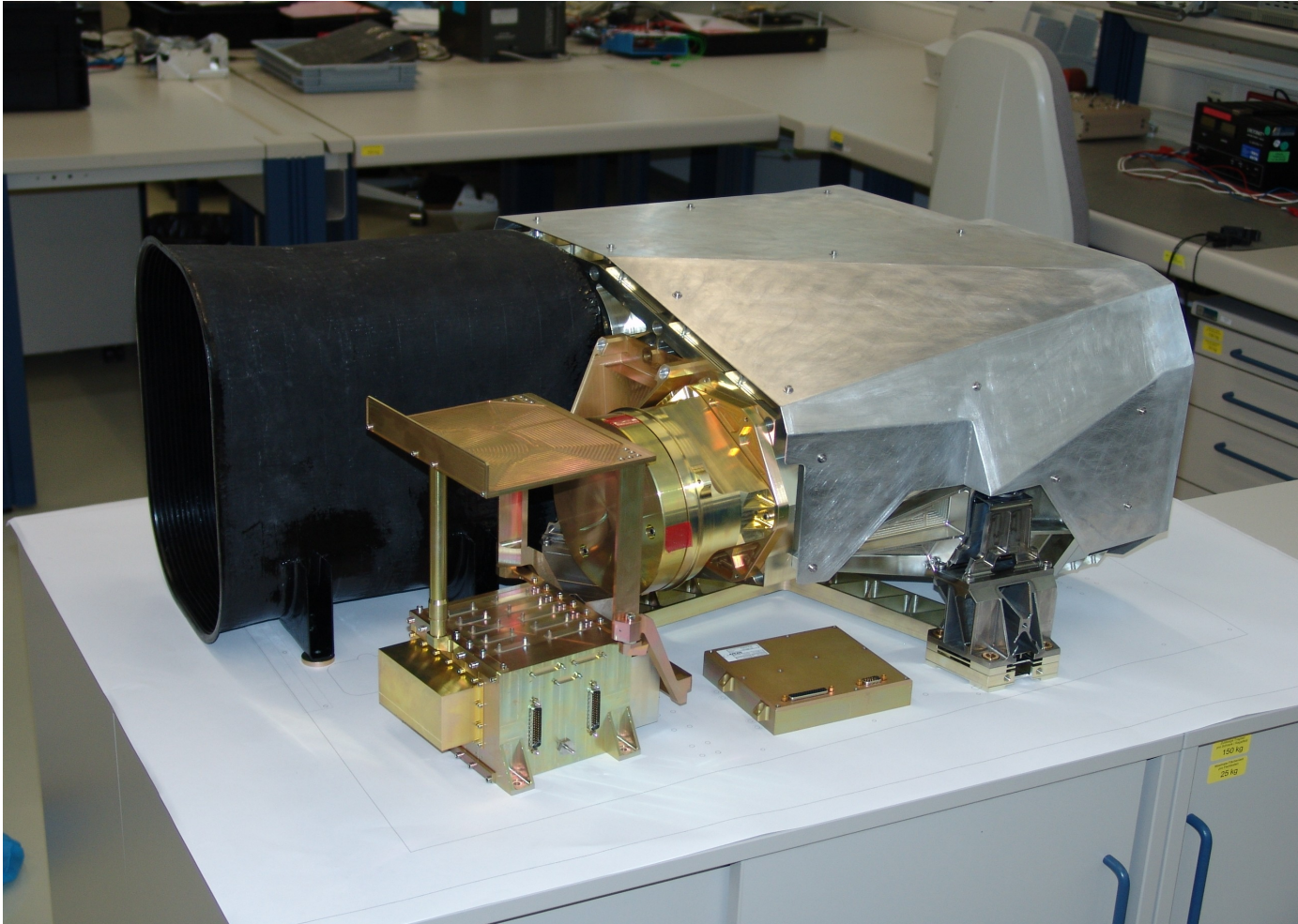
Pixel per line: 12,000

Radiometric resolution: 12 bit

5 multi-spectral channels
> blue   440 - 510 nm
> green: 520 - 590 nm
> red: 630 - 685 nm
> red-edge: 690 - 730 nm
> near infrared: 760 - 850 nm

Optical Camera Payload (cont'd)

Data Management System (DMS)
Overview

> The DMS is comprised of the following six main subsystems:

1. **Order Handling Subsystem (OHS)** - responsible for order taking and product delivery. It submits each received Order to the Product Processing System

2. **Acquisition Planning Subsystem (APS)** - responsible for scheduling the acquisition and downlink of new raw imagery, based on Acquisition Requests received from the Product Processing System

3. **Data Processing Subsystem (DPS)** - responsible for reception of raw image data from X-Band Reception Stations, pre-processing of this data, and for the generation of standard imagery products on request from the Product Processing System

4. **Archive Management Subsystem (AMS)** - responsible for storage and cataloguing of raw image data, spacecraft ancillary data and imagery products

5. **DEM Generation Subsystem (DGS**) – responsible for the generation of RapidEye Digital Elevation Products from archived RapidEye image data.

6. **Sensor Calibration Subsystem (SCS)** – responsible for performing periodic radiometric calibration of the payload

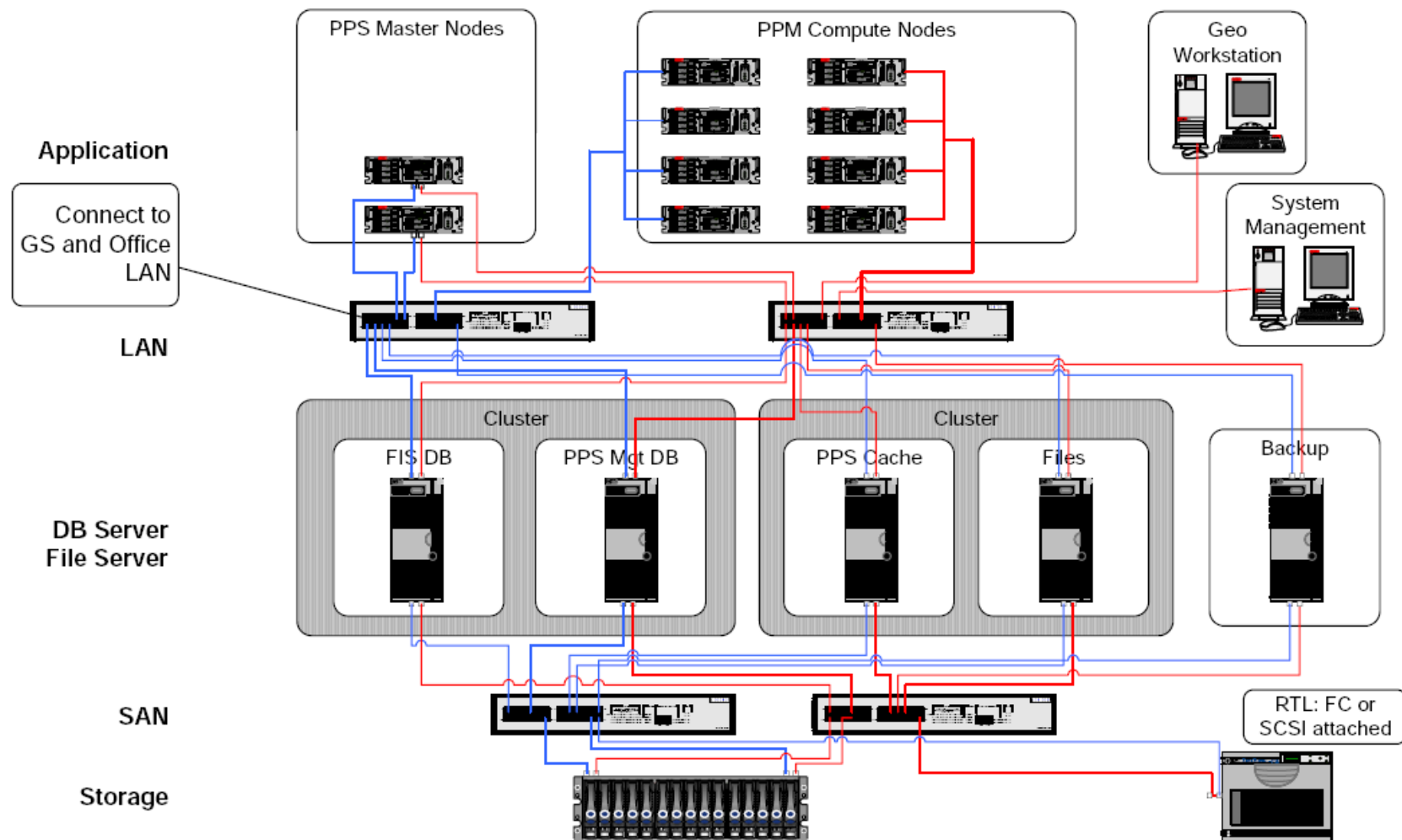# Data Management System (DMS)
Decomposition and Data Flow
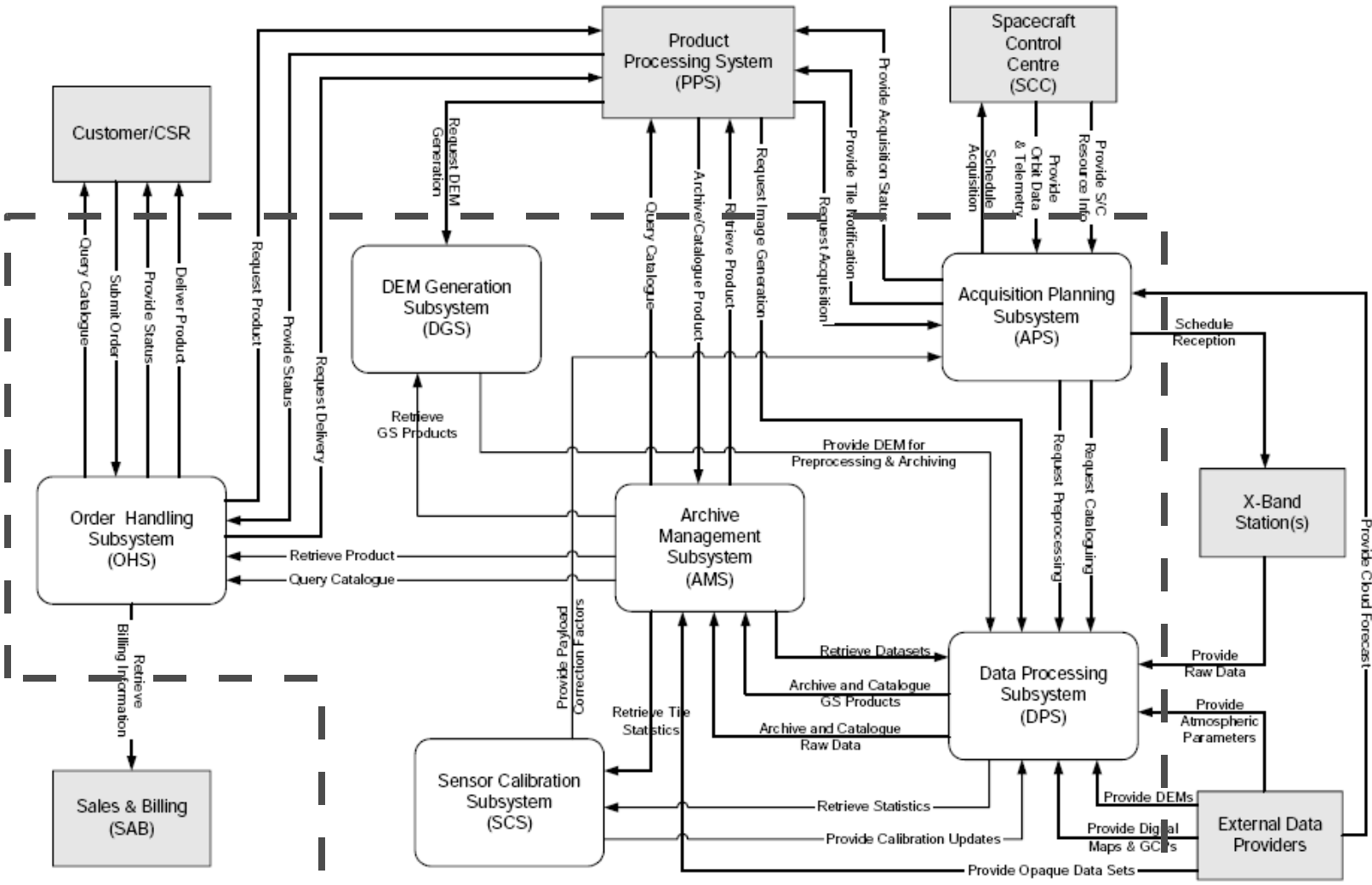
DMS

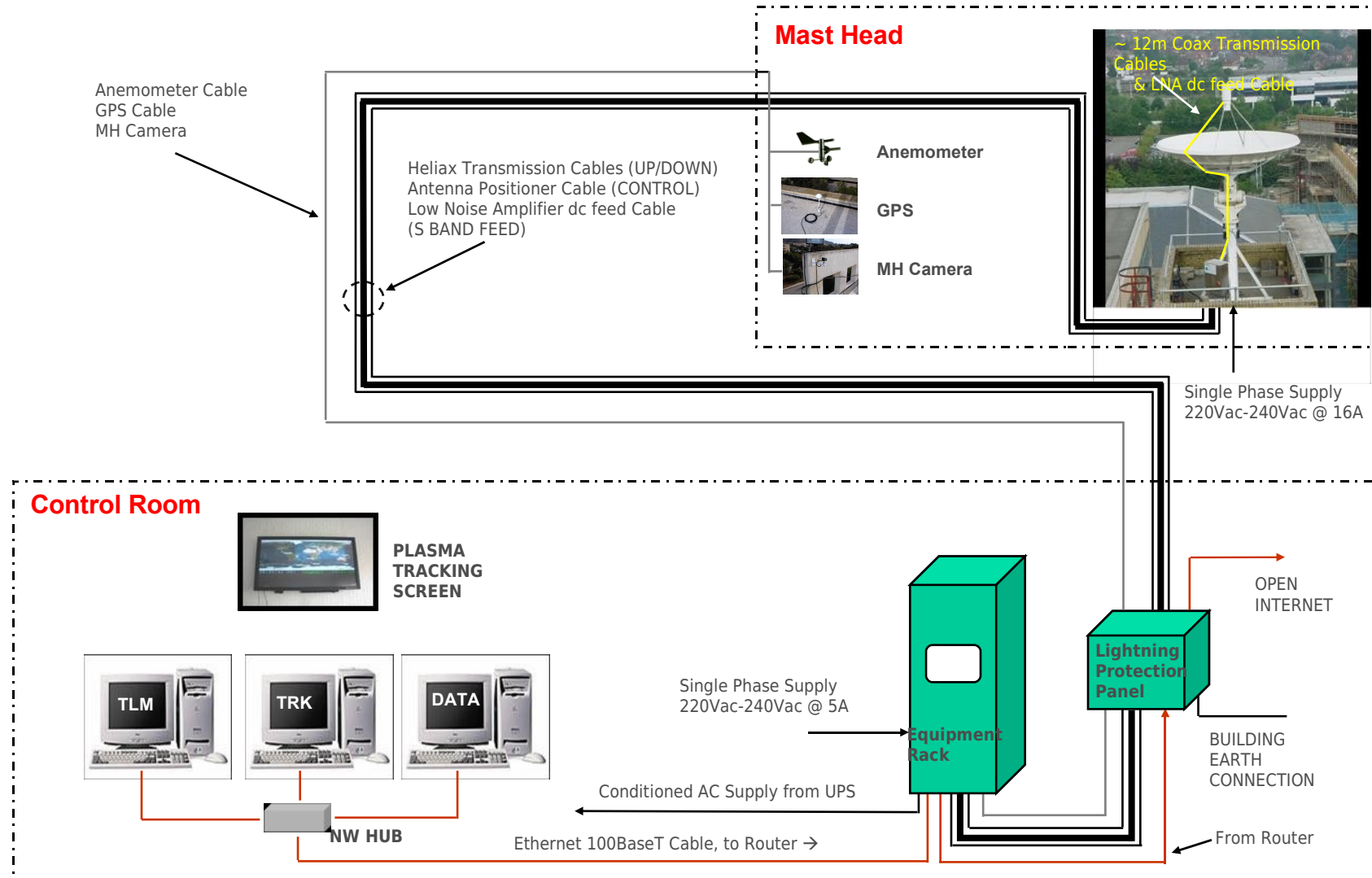# Data Management System (DMS)
Hardware Configuration
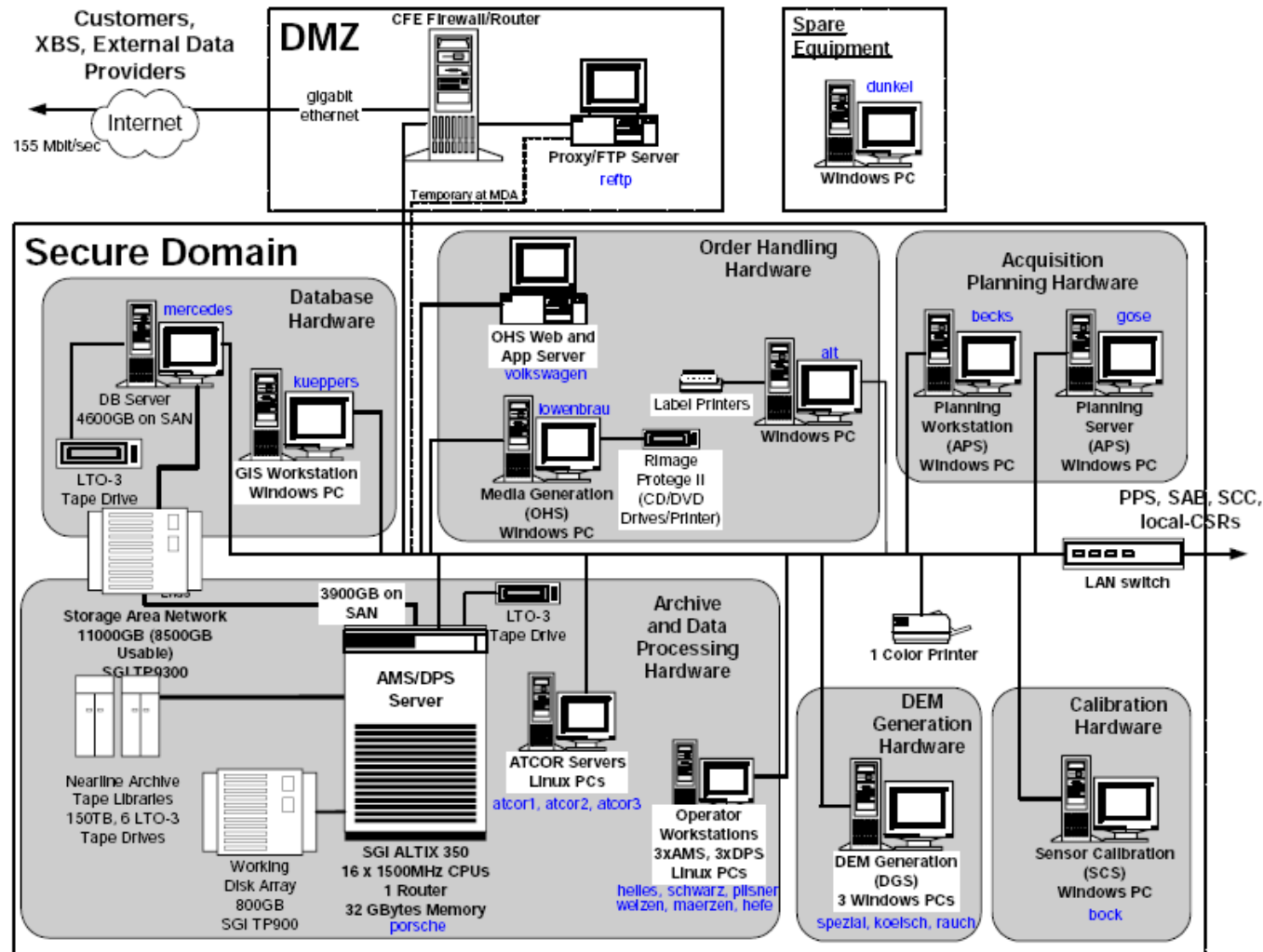
Product Processing System (PPS)
Overview

> The Product Processing System (PPS) has been designed, implemented, integrated and tested by RapidEye

> The PPS is comprised of the following main subsystems:

> **Central Message Handler (CMH)** - is the central connection/ communication point between the PPS and external entities

> **Process Manager (PM)** - internal process management including capabilities to plan and supervise the processes

> **Common Function Library (CFL)** - includes functions that are commonly used by different PPMs, e.g. communication with DMS

> **System Wide Functionalities (SWF)** - provides functionalities which are needed for PPS operations and maintenance

> **Product Processing Modules (PPMs)** – produces customer products, runs on the PPM cluster; In principle one PPM for each product or service

> **PPS Core Functionalities (CropEye, ASIS, FIS, WIS)** - sub-systems, which perform management tasks or complex "background" analysis tasks
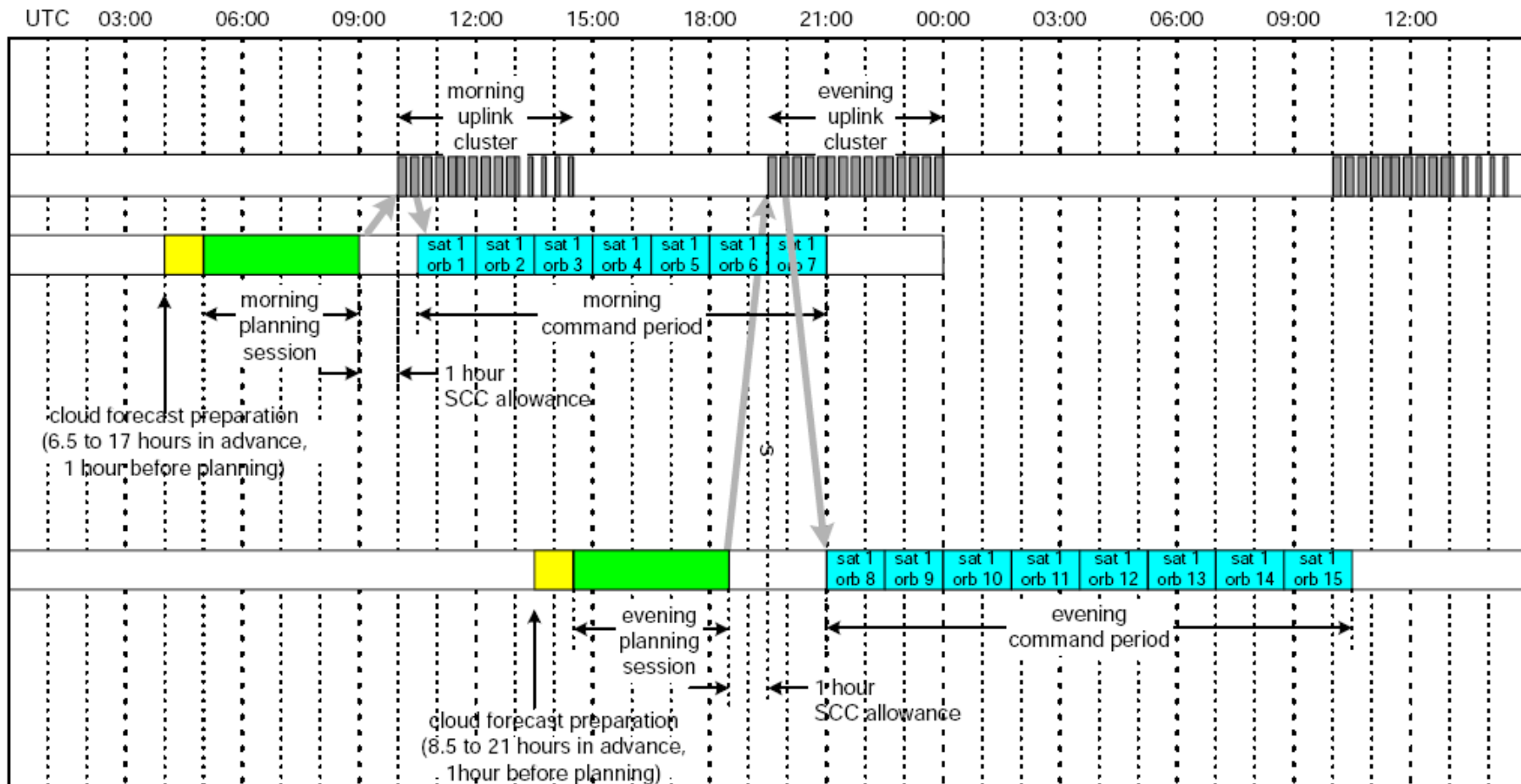
Product Processing System
Hardware Layout

Satellite Control Center (SCC)

RapidEye™

Mast Head

~ 12m Coax Transmission Cables & LNA dc feed Cable

Anemometer Cable
GPS Cable
MH Camera

Heliax Transmission Cables (UP/DOWN)
Antenna Positioner Cable (CONTROL)
Low Noise Amplifier dc feed Cable
(S BAND FEED)

Anemometer

GPS

MH Camera

Single Phase Supply
220Vac-240Vac @ 16A

Control Room

PLASMA
TRACKING
SCREEN

TLM

TRK

DATA

Single Phase Supply
220Vac-240Vac @ 5A

Equipment Rack

Lightning Protection Panel

OPEN INTERNET

BUILDING EARTH CONNECTION

Conditioned AC Supply from UPS

NW HUB

Ethernet 100BaseT Cable, to Router →

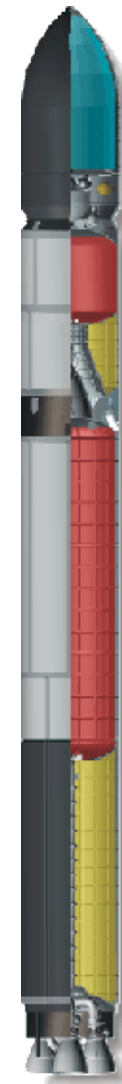From Router

Operational Concept

Launch Vehicle

Launch date: first half of 2008
                   (all five spacecraft together)

Dnepr (selected)**:**

- Former ICBM* (SS-18) with over 180 launches

*(Intercontinental Ballistic Missile)

Investors and Partner (alphabetical order)

Brandenburg (federal state of Germany)

Canadian Commercial Corporation (Canadian crown co.)

DLR (German Space Agency)

Federal Republic of Germany

Kayser-Threde (German space co.)

KfW, Commerzbank, EDC (banks)

MacDonald Dettwiler (Canadian space co., GC)

PCI Geomatics (Canadian software co.)

Pollux Unternehmensberatung

Vereinigte Hagelversicherung (German agro-insurance co.)