RAPIDYE

AN EARTH OBSERVATION SMALLSAT CONSTELLATION FOR DAILY AGRICULTURAL MONITORING

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Presentation Overview

- The RapidEye Market
- Key Mission Requirements
- RapidEye Mission Overview
- Spacecraft Design
  - Bus
  - Payload
- Ground Segment Description
- Conclusions
RapidEye Market Segments

• Agricultural Insurance:
  – Regularly updated field maps providing quick and reliable information about damaged areas
  – help insurers by supporting the loss adjustment process

• Agricultural Producers (farmers):
  – regularly provide information about the crop conditions
  – will support the precision farming system
RapidEye Market Segments

- **International Institutions:**
  - Knowledge of the levels of expected crop harvests
  - Monitor the usage of subsidies and provide emergency relief in disaster situations

- **Cartography:**
  - RapidEye will be the first company to provide regular updates at a scale of 1:25,000
Key Mission Requirements

• Multi-spectral Optical Imager:
  – High quality ortho-rectified imagery required in 5 spectral bands
  – Ground Sampling Distance (GSD) between 5-10 m

• Global Daily Revisit:
  – Rapid turn-around from a customer's request for information products to delivery is a key requirement for RapidEye's market
  – The satellites must have daily revisit capability anywhere on the Earth
Key Mission Requirements

• Rapid Area Coverage:
  – provide large area coverage in less than 6 days in primary regions of interest
  – allows monitoring large areas of interest to provide frequent information updates to customers

• Large Data Capacity:
  – A significant ortho-image data capacity is required to allow building up and maintaining an extensive database of information for large areas of interest
RapidEye Market Positioning

RapidEye targets the decisive gap

- Revisit Time
  - daily
  - 3 days
  - 1 week
  - 2 weeks
  - 4 weeks

- Spatial Resolution
  - 15 km
  - 3 km
  - 120 m
  - 30 m
  - 10 m
  - 5 m
  - 1 m

Competitors:
- Meteosats
- SPOT 2, 3, 4
- Resource 21
- IRS 1C, D
- Space Imaging etc.

Competitors (2005?)
- SPOT 5
- Landsat

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RapidEye Mission Characteristics

- 5 identical spacecraft each with a 5 band multi-spectral imager
- 6.5m GSD at nadir & 80km swath
- spacecraft able roll 25 deg off nadir to increase FOR
- 620km Sun-Synch Orbit with satellites in one orbit plane
- 1500 km of image data onboard storage per satellite
- >60 Mbps data downlink (X-band)
- daily global revisit
- average coverage repeat period in Europe & N.A. is <5 days
- 7 year design life
- High reliability - proven hardware & two levels of redundancy
  - extra spacecraft (business objectives met with 4 spacecraft)
  - each spacecraft is fully redundant
  - microsat platform based on existing proven design
Spacecraft Configuration

Spacecraft Mass
- Bus: 115 kg
- Payload: 35 kg
- Total: 150 kg

Payload Electronics
- Multi-Spectral Imager
- Star Camera
- GaAs Solar Arrays (3 sides)

Dimensions:
- 720 mm
- 750 mm
- 865 mm

Axes:
- X (velocity vector)
- Y
- Z (nadir)
Payload Design

- Optical payload comprised of two separate units
  - Multi-Spectral Imager (MSI)
  - Payload Electronics Unit (PEU)

- MSI
  - 5 band pushbroom style imager
  - Three Mirror Anastigmat (TMA) optical design (15 cm aperture)
  - Focal plane has 5 parallel 12 K linear CCD detectors

<table>
<thead>
<tr>
<th>Channel</th>
<th>Spectral Band Name</th>
<th>Spectral Range (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blue</td>
<td>440 – 510</td>
</tr>
<tr>
<td>2</td>
<td>Green</td>
<td>520 – 590</td>
</tr>
<tr>
<td>3</td>
<td>Red</td>
<td>630 – 685</td>
</tr>
<tr>
<td>4</td>
<td>Red edge</td>
<td>690 – 730</td>
</tr>
<tr>
<td>5</td>
<td>Near IR</td>
<td>760 – 850</td>
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</table>
Payload Design

• PEU
  – 12 bit digital data transferred from MSI to PEU (765 Mbps)
  – separate processing chain for each CCD (plus one redundant chain)
  – real time data compression (2:1 lossless or up to 10:1 lossy)
  – onboard data storage (>35 Gbits)
  – Data formatting for X-band downlink (error correction & encryption)
  – payload controller & redundant power supplies
RapidEye Ground Segment

The Ground Segment provides the following key functions:

- customer order interface capability
- satellite acquisition planning function
- satellite command and control to task the constellation and maintain its health and safety
- image processing capability to convert raw imagery into ortho-products
- capability to extract DEMs from stereo imagery
- calibration capability to ensure the performance of the sensors and processing system
- product catalogue and multi-tiered data archive for raw data, ortho-products, DEMs and information products
Summary & Conclusions

• RapidEye is a unique commercial EO mission
  – focused on delivering the needed information to customers
  – system design driven by the business plan requirements
  – implementation approach uses highly cost effective constellation of 5 satellites with a proven ground infrastructure

• RapidEye offers a capability that presently does not exist
  – the system can monitor large areas within short time intervals and at the same time respond to specific requests within a single da