Design and Development of the İ.T.Ü. pSAT I Engineering Prototype

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The picture we promised last year!
pSAT I is getting ready for its 2008 launch...
Basic Realm

Satellite
Design / Analysis / Production

Test & Integration
Infrastructure / Payloads / Systems
Thermal Vacuum, Vibration, EMC

Ground Station
Mission

İTÜ pSAT I Project

Project objectives
- Development of a flexible bus
- Capturing & transmitting of low resolution images
- Examining the performance of the passive stabilization

Educational Objectives
- Practical studies for undergraduate courses
Subsystems

- CMOS Camera
- Sensor Board
- Passive Magnetic Stabilization
- Power Board
- Transceiver
- On Board Computer

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Launch & Orbit

- DNEPR 2008
  - 600-700 km circular polar orbit
  - Allows a comm window of ~50 min/day
Operational Modes

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## Mission Modes

<table>
<thead>
<tr>
<th>Active Payload</th>
<th>Beacon</th>
<th>On-Board Computer</th>
<th>Power Board</th>
<th>Radio-Modem</th>
<th>Payload 1</th>
<th>Payload 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standby</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>Off</td>
<td>Off</td>
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<tr>
<td>Communication</td>
<td>On</td>
<td>On</td>
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<tr>
<td>Sensor Packet SPA</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
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<tr>
<td>Sensor Packet SPB</td>
<td>On</td>
<td>On</td>
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<td>Off</td>
<td>On</td>
<td>Off</td>
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<tr>
<td>Taking a photograph</td>
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<td>On</td>
<td>On</td>
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<td>On</td>
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</table>

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Subsystems

CMOS Camera

Sensor Board

Passive Magnetic Stabilization

Power Board

Transceiver

On Board Computer
Bus – *approach philosophy*

- Simple design structured around COTS equipment
- Low risk

*Concurrent in-house development within SSDTL*

- Ever-growing involvement of undergraduate and graduate students
pSAT I Architecture
Systems Engineering

- Mass Budget
  - Left some headroom for surprises
- Power Budget
- Link Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Component</th>
<th>Brief Explanation</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Base structure</td>
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</tr>
<tr>
<td></td>
<td>Cables</td>
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<td></td>
<td>Fasteners</td>
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<tr>
<td>Payload</td>
<td>Payload #1</td>
<td>Sensor Board</td>
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<tr>
<td></td>
<td>Payload #2</td>
<td>Camera</td>
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<tr>
<td>Attitude Control</td>
<td>Magnet</td>
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<td>50</td>
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<tr>
<td>On-board Computer</td>
<td>Board</td>
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<tr>
<td></td>
<td>SD - Card</td>
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<td>10</td>
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<tr>
<td>Communication</td>
<td>Transceiver</td>
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<td>80</td>
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<tr>
<td></td>
<td>Antenna</td>
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<tr>
<td>Power</td>
<td>Solar Panels</td>
<td>25g x 6</td>
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<tr>
<td></td>
<td>Power System Board</td>
<td>Battery + circuit board</td>
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</tr>
<tr>
<td>Total Mass</td>
<td></td>
<td></td>
<td>820</td>
</tr>
</tbody>
</table>
Payload II – Imaging Experiment

- CMOS camera and interface board continental scale image capturing

- Camera C3188A (OV7620 chip)
  - Low resolution (VGA)
  - 5V

- Needs an interface circuit for MSP430!

- Might switch to a MCU at the same voltage level
Payload I – Passive Attitude Control Experiment

- Passive magnet and sensing board
  - Reports on I²C after ADC (Sensor Packet B)
- Sensors
  - Accelerometer – ADXL330
  - Gyros – ADXRS300
  - Magnetometer – HMC2003
- Passive AlNiCo magnet
Basic Realm

Satellite Design / Analysis / Production

Test & Integration
Infrastructure / Payloads / Systems
Thermal Vacuum, Vibration, EMC

Ground Station
Space Systems Development and Test Laboratory

- Thermal/Vac Chamber
  - 350 litre, $10^{-6}$ torr
  - $-60^\circ$ C – $90^\circ$ C at $1^\circ$ C / min steps

- Class 1000 Clean Room,
  - 25 m$^2$

- Access to university resources
  - Shake Table
  - EMI/EMC

- Ground Station
Facilities

- Access to researchers, students and small business initiatives from all around the world
  - Assemble and Test science payloads, and nano-to-micro satellites.
Ground Station – ITU TA1KS 😊

- Will operate as a part of GSN
- Typical amateur radio setup
- Dual transceiver

Will be up and running by the summer of 2007
Spacecraft Systems Design Course – The winner is …
ITU-nSAT Concept

Need for cheap on-orbit demonstration against key technologies.

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Nano-satellite Formation Experiment

- A true research platform for key control, micro-propulsion and imaging technologies:

20x20x20cm per unit; Total 12-14kg
Concepts developing…

- Space Qualifying New Processors
  - LPC2294 – Arm
  - MPC 555 – Motorola PPC

- Transition to CAN Bus
  - PIC based sensor interface boards
  - Other sensors

LPC2294

MPC555

Smart Sensor Nodes

CAN Interface
İTÜ pSAT I is on schedule for its 2008 launch…

See “it” at Recent Advances in Space Technologies 2007
June 14th -17th at Istanbul.
Thank You!

Any Questions?