A Miniaturized NanoSatellite Communications System

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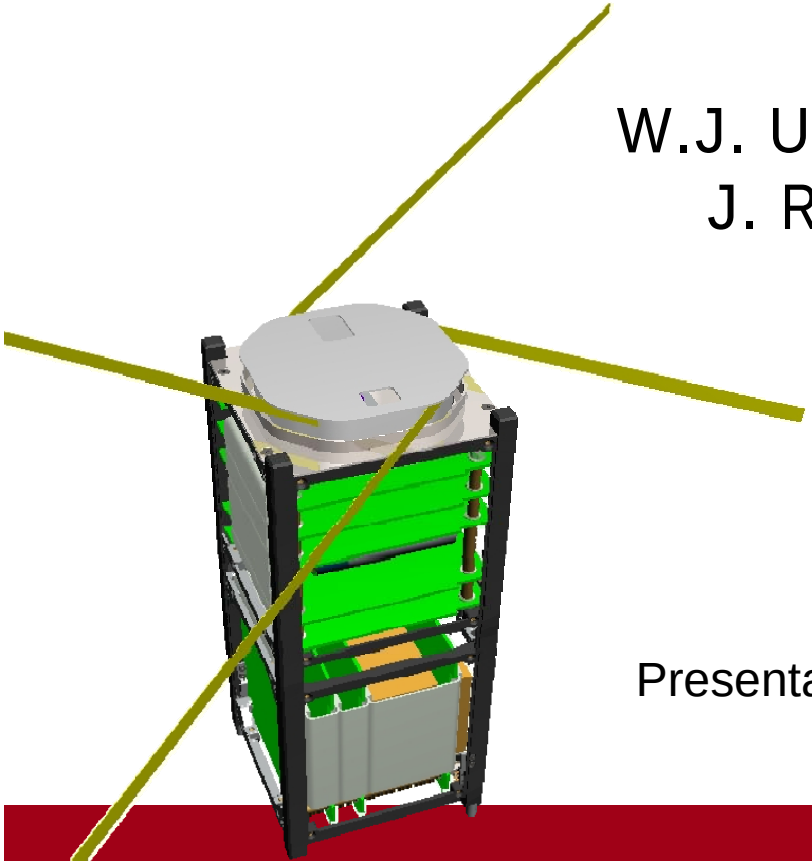
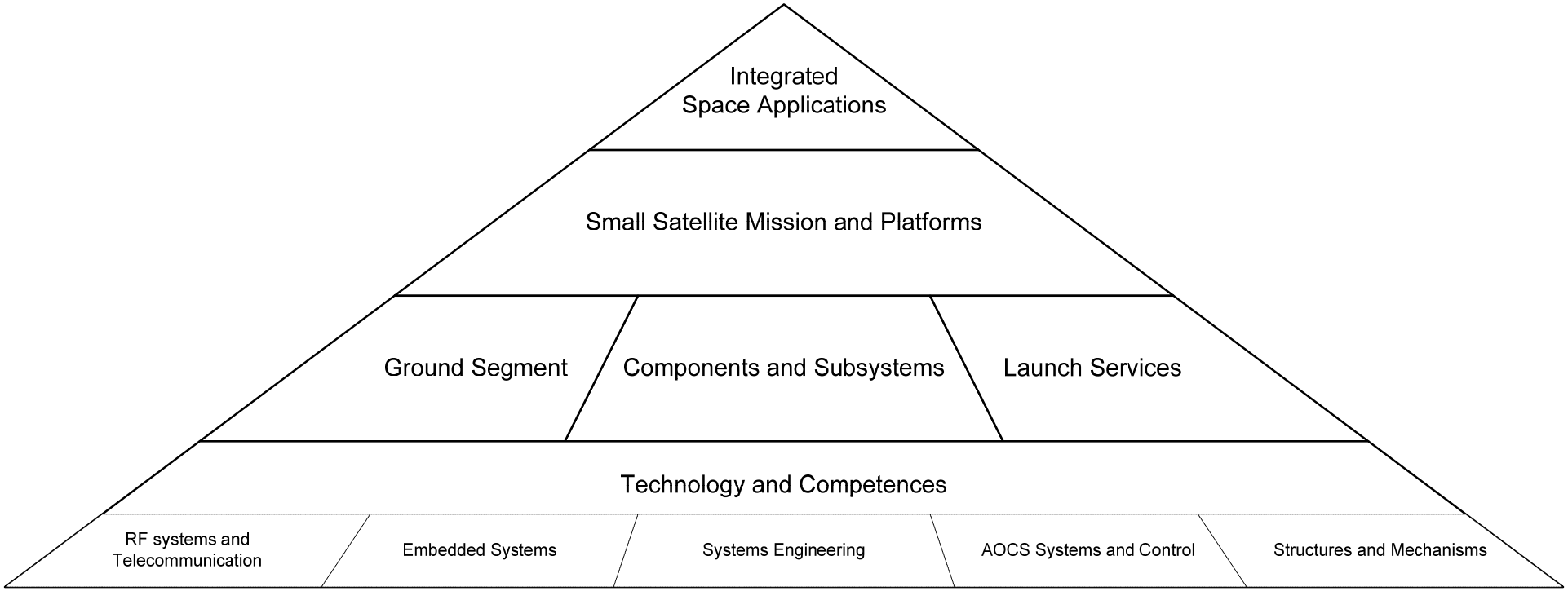


Presentation by: Gerard Aalbers

ISISpace

- Founded in January 2006
- Spin-off from Delft University satellite program Delfi-C3
- Office in Delft on the Delft University of Technology Campus

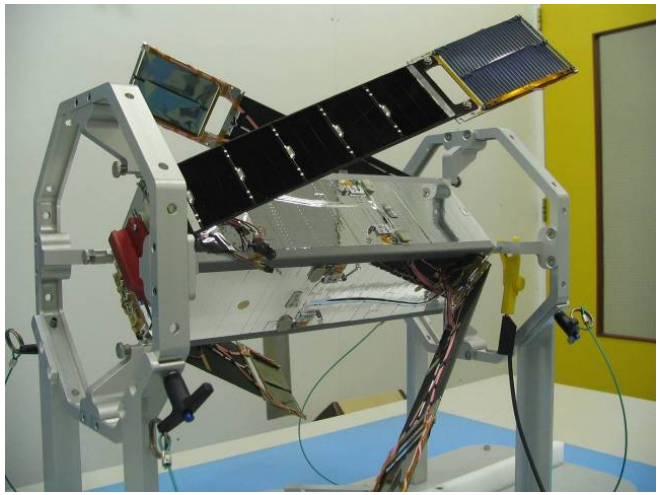
Company Overview

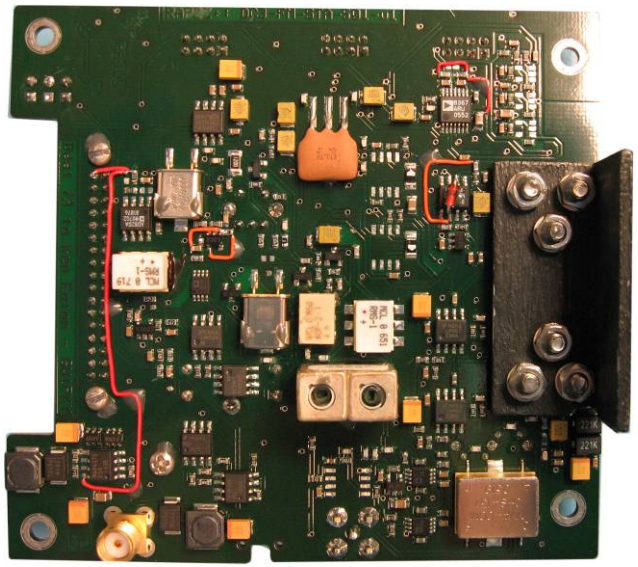


- Focus on the micro- and nanosatellite niche (1-50kg)
- Products, services and turnkey solutions
- Focus on responsive and innovative applications
- Miniaturization of satellite systems

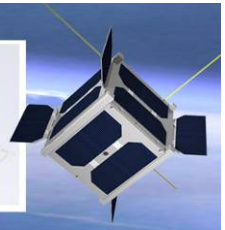
Delfi-C3 Transceiver

- 100% mission success, both radios show nominal ops
- Strong Signal, receivable with handhelds
- BPSK modulation in combination with soundcard demodulation proven very effective
- Very good command uplink performance



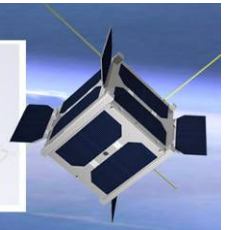


Development goals



- Compatible with the CubeSat standard
- Specifically designed for use in space
- Full duplex design
- Low rate VHF / UHF links (amateur / commercial bands)
- CW beacon for easy spacecraft acquisition
- Easy to receive downlink on VHF with reduced complexity in the link.
- PA DC → RF efficiemcy > 70%

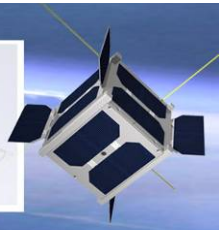
Modulation schemes



- AFSK is commonly used on CubeSats
- BPSK is a better choice
- Downside: spectral efficiency
- Spectral shaping → non-constant envelope

Modulation scheme	EB/N0 for BER 10-5	Constant envelope?	Spectral efficiency
AFSK	23dB	Y	Bad
BPSK	9.6dB	Y	Bad
Shaped BPSK	9.6dB	N	Good

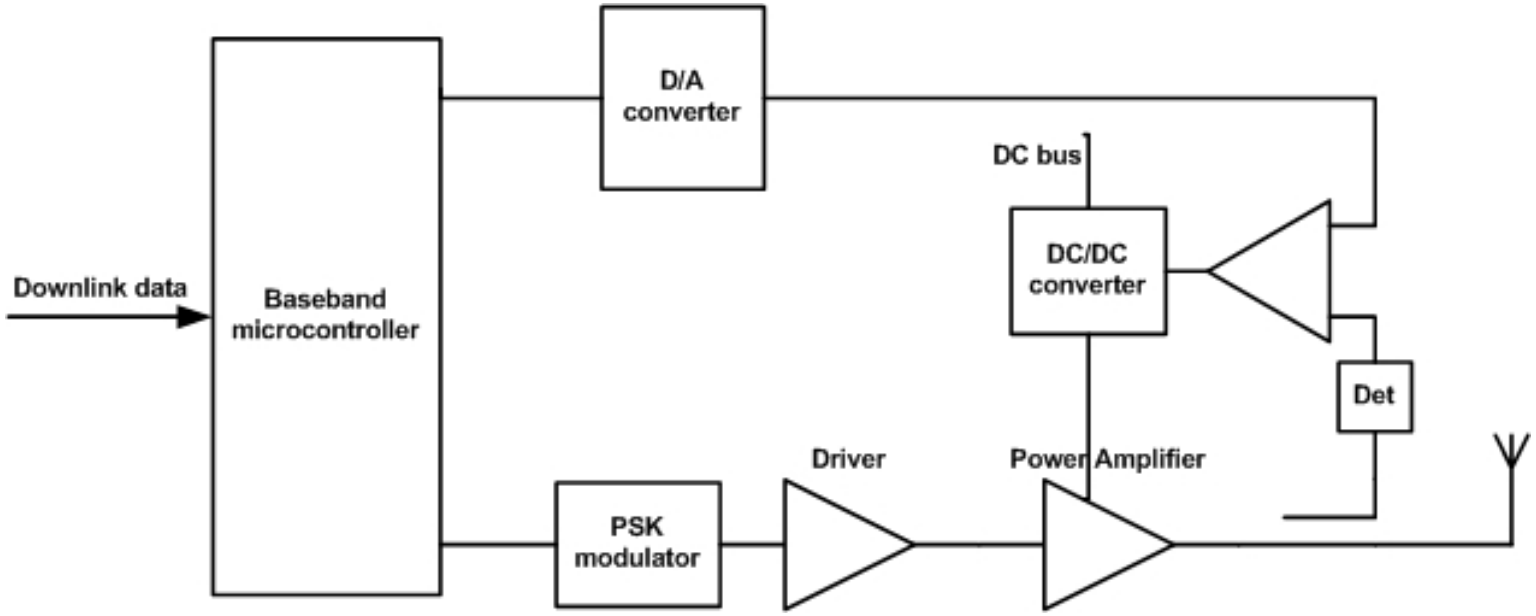
Implementation



- Step-by-step integration of (MiSat) MST building blocks in satellite transceivers to save power
- Single-board design
- High efficiency PA with variable power settings
- Modular design to allow implementation in a wide range of small spacecraft (not limited to CubeSats)

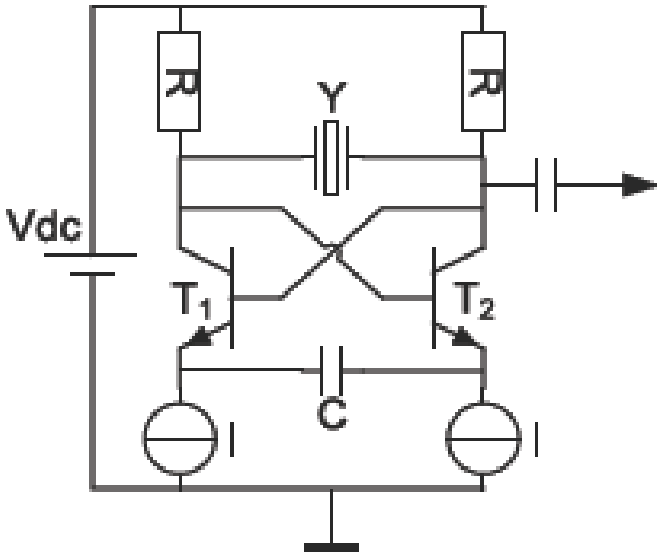
Envelope feedback

- Envelope restoration and feedback transmitter structure, allows non-constant envelope BPSK
- Class E PA



Local Oscillator

- Resonator Synchronized relaxation oscillator
- Example of integrating MST elements (MEMS resonator)

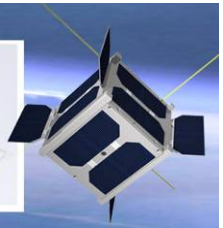


ISIX Protocol

- Optimize for space use
- Matching downlink software – coherent demodulation scheme
- LEO Doppler tracking in software

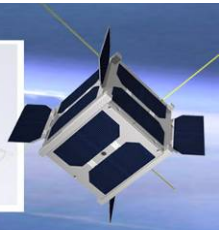
IDLE	SYNC VECTOR	HEADER	DATA	CRC

Interfaces



- Mass: < 200gr
- Mechanical: 90*96*30mm, on a single Printed Circuit Board
- Electrical interfaces:
  - DC power interface
  - Serial data interface
  - RF input: 50 ohm, SMA
  - RF output: 50 ohm, SMA

Applications



- CubeSat / microsatellite low rate TT&C
- Loopback ranging, determine range and range-rate (non-coherent)

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