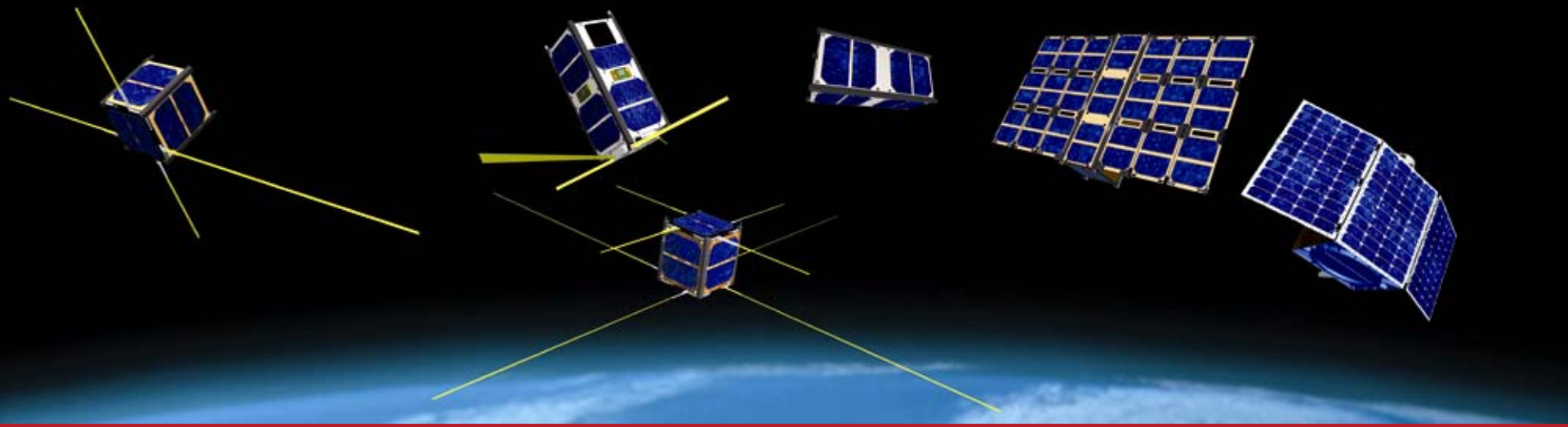
CubeSat Developments and Future Challenges

ISIS – Innovative Solutions In Space

Abe Bonnema, Jeroen Rotteveel

CubeSat Summer Workshop 2010, 08 August, Logan, Utah

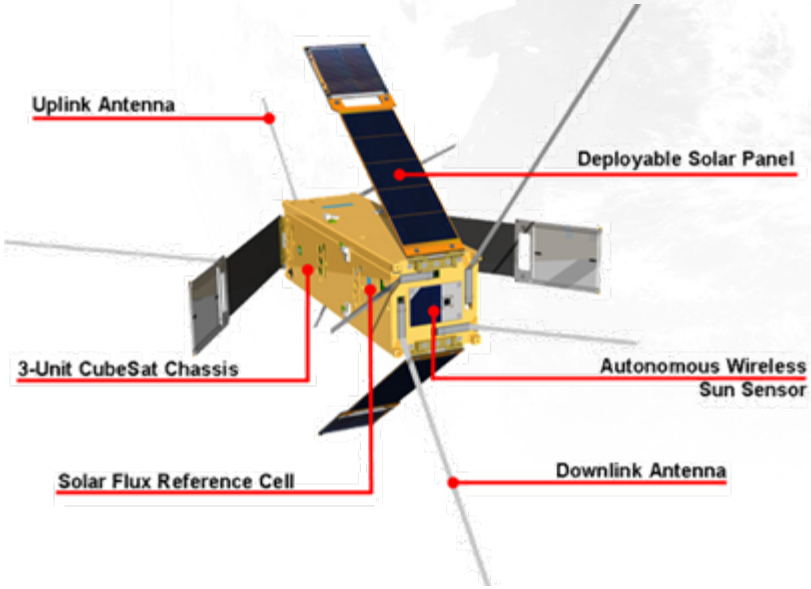


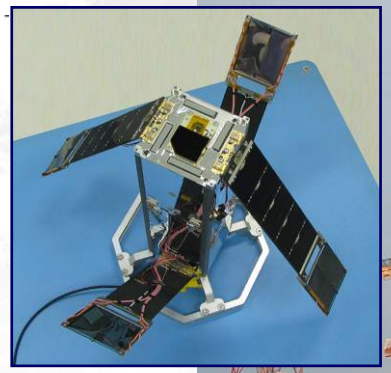
Outline

- Company history
- Company overview
- Milestones of the past year
- Current activities
- What does the future hold … ?

November 2004 - Delfi-C3 Starts

- 4th Dutch Satellite after ANS, IRAS and SloshSat
- 1st Dutch university satellite to be actually launched in to orbit (28 April 2008)
- Project largely run by students
- Industry payloads





April 2005 – the idea was born

Why start a space company?

"The way to make a small fortune in space is to start with a big fortune.

Space is a good place to lose a lot of money real fast."

John Pike
American Federation of Scientists

January 6, 2006 – ISIS founded

Young Entrepreneur Ruimtevaart

Delftse branie brengt doorbraak in markt voor kleine satellieten

March 2006 – Office at YES!Delft Incubator

At the time: 18 m2 for 5 engineers (founders)

May 2008 – New office at Rotterdamseweg 380

At the time: about 200 m2 for ~10 engineers (incl. management)

July 2009 – initiated two daughter companies

Name: Innovative Space Logistics BV

Goals: All-in Launch Services for Small, Auxiliary Payloads

Name: Innovative Data Services BV

Goals: Full Service Applications with nanosatellites

July 2010 – New office with more lab space

About 400 m2 for ~20 engineers (excl. management)

Company Overview

- Spin-off of Delfi-C3 nanosatellite project of TU Delft
- Founded January 06, 2006
- Office locations:
  - Delft, near Delft University of Technology Campus
  - Noordwijk, in the European Space Incubator at ESTEC
- Current team: 20+ engineers, plus management, support
- Fully owned by the management team:

Jeroen Rotteveel
Managing Director

Abe Bonnema
Marketing Director

Wouter Jan Ubbels
Technical Director

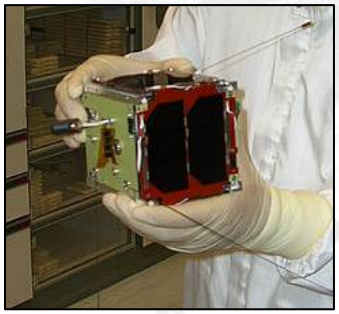
Eddie van Breukelen
Financial Director

Company Structure

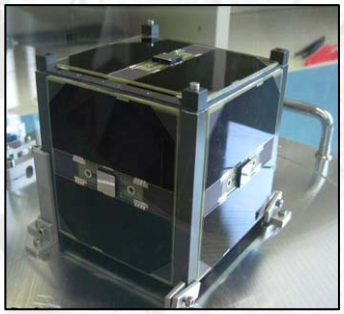
- Separate ‘business units’ for:
  - Missions, Platforms, Custom systems
  - Off-the-shelf systems from CubeSat system developers
  - Small Satellite Launch Services
  - Nanosatellite Applications

Milestones over the past year

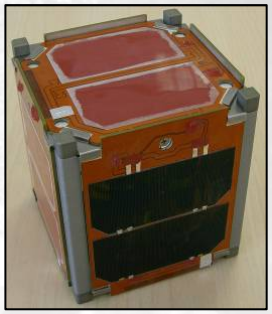
- Successful launch campaign (ISILaunch01)



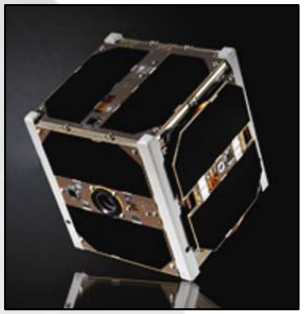
UWE-2



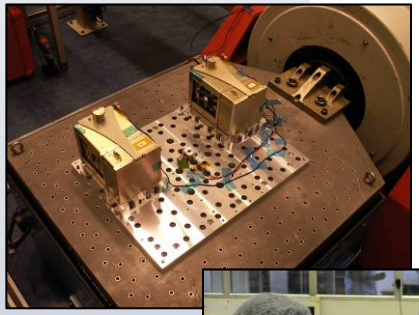
BEESAT

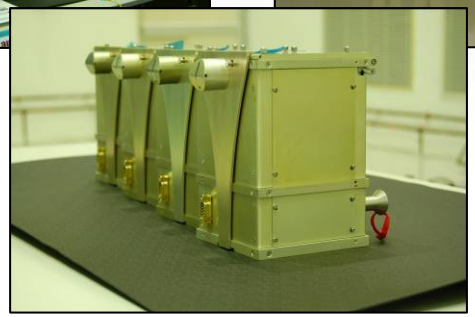


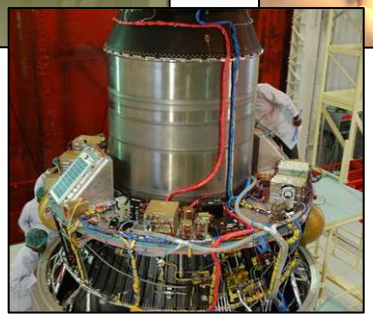
ITUpSAT1



SwissCube





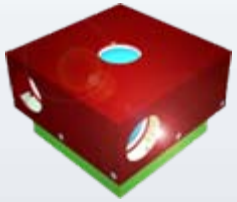


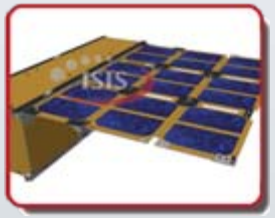
Milestones over the past year

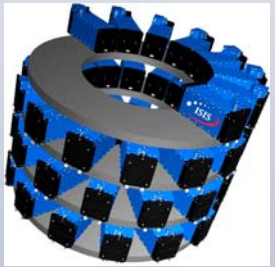
- involvement in ESA's nanosatellite research projects
- OTS-products successfully demonstrated in orbit (e.g. Antenna system on STUDSat)

- Move to a new building:
  - Clean room 80m2
  - Operations room and Ground Station
  - doubled our lab space
  - building up end-to-end in-house environmental test facility line

Current Activities



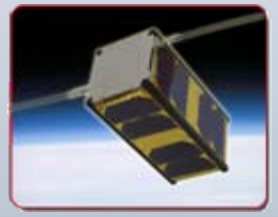




- Ongoing Product Developments:
  - Communication Systems (UHF, VHF, S-Band)
  - ISIPOD Deployer systems in various form factors (e.g. 6-Pack)
  - Test & Ground Support Equipment Kits
- Ongoing CubeSat R&D Projects:
  - Track & Trace payloads (with Dutch partners)
  - Miniaturized Star trackers (with TNO)
  - Deployable Solar Arrays (with Dutch Space)
  - Cool Gas microPropulsion Module (with TNO / Bradford)
  - Modular Payload Deck Elements (with Stork/Fokker/Mecon)

Current Activities

Delfi-n3Xt



- Ongoing Missions & Platforms:
  - Triton-1 Tech Demo Mission (with SystematIC / NLR)
  - Triton-2 AIS Demo Mission (with ClydeSpace / GomSpace)
  - FUNcube Platform and MAIV (for AMSAT UK)
  - De-Orbit Sail Demo Mission (EU project with SSC, DLR, ASTRIUM, Universities in Greece, Turkey, South Africa)
  - Delfi-n3Xt (Payload Partner of TU Delft)
  - 2U environmental monitoring mission (undisclosed customer)

Current Activities

- Ongoing Studies / Involvement in Programs
  - IDS / CubeSat SAT-AIS constellation (in house)
  - QB50 (VKI)
  - OLFAR (TU Delft, UTwente, ASTRON, SME's)

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Solution:

Cell phone cell density and radio feeds to locate congested areas

Additional Requirements:

- Cellular phones, GSM Antenna stations
- Car Radios, traffic information broadcasts

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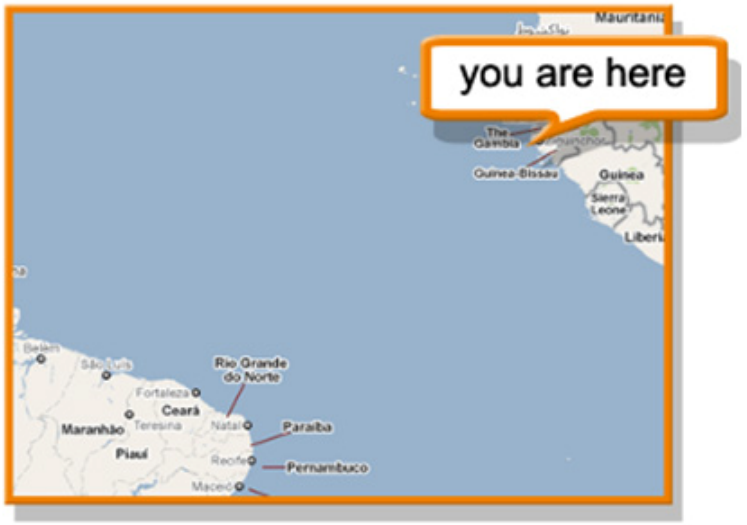

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Solution:

IMO mandated transponder system improves local information needs for safety

Additional Requirements:

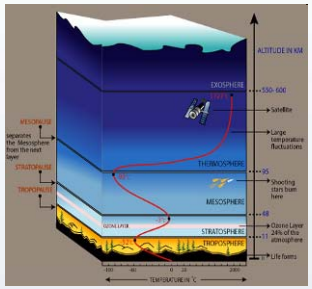
- AIS transponders on ships (since 2007)
- Reception stations (coastal and in space)

Implementation

- Space Segment
  - S-AIS Receivers
  - 16 Spacecraft
  - Launch into 4 orbits
- Ground Segment
  - 4 Ground Stations
  - 1 Operations Center
  - 1 Data Center
  - Distribution channels

QB50

von Karman Institute for Fluid Dynamics

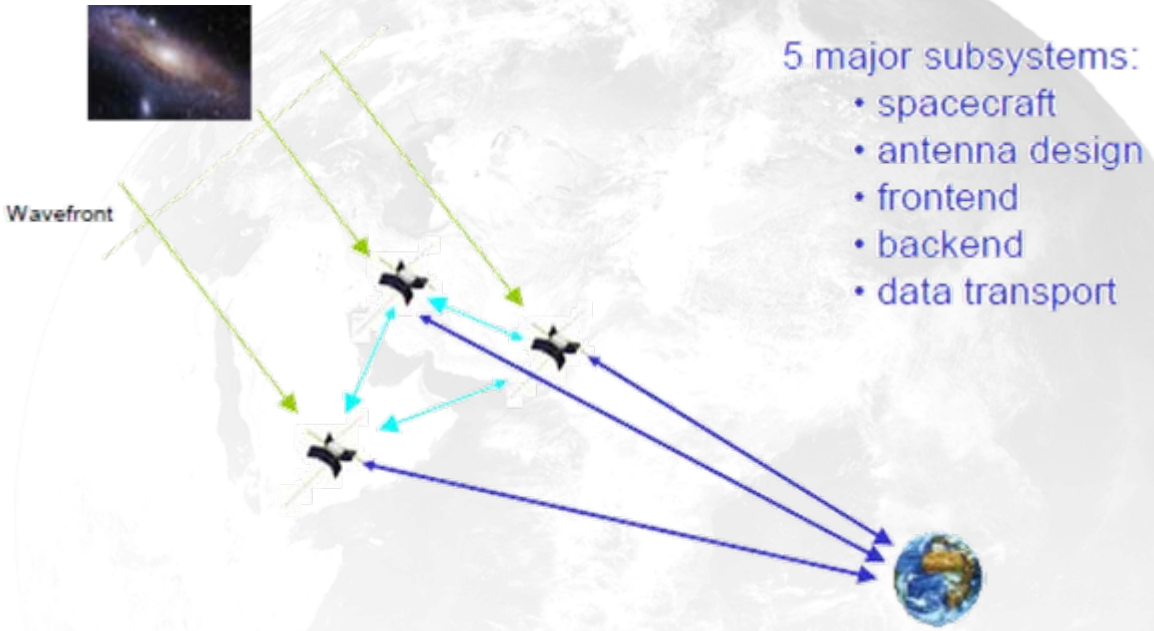


"An international network of *50* double CubeSats for **multi-point**, **in-situ**, **long-duration** measurements in the lower thermosphere and for re-entry research."

- Consortium led by VKI – Von Karman Institute (J. Muylaert)
- Supported by space agencies

- ISIS involved for:
  - Satellite Platform Technical Advice
  - Launch Configuration and Orbit Dynamics Analysis
  - Payload Deck, Deployment System and Integration Support
  - Launch Campaign Support

Advanced Application - OLFAR

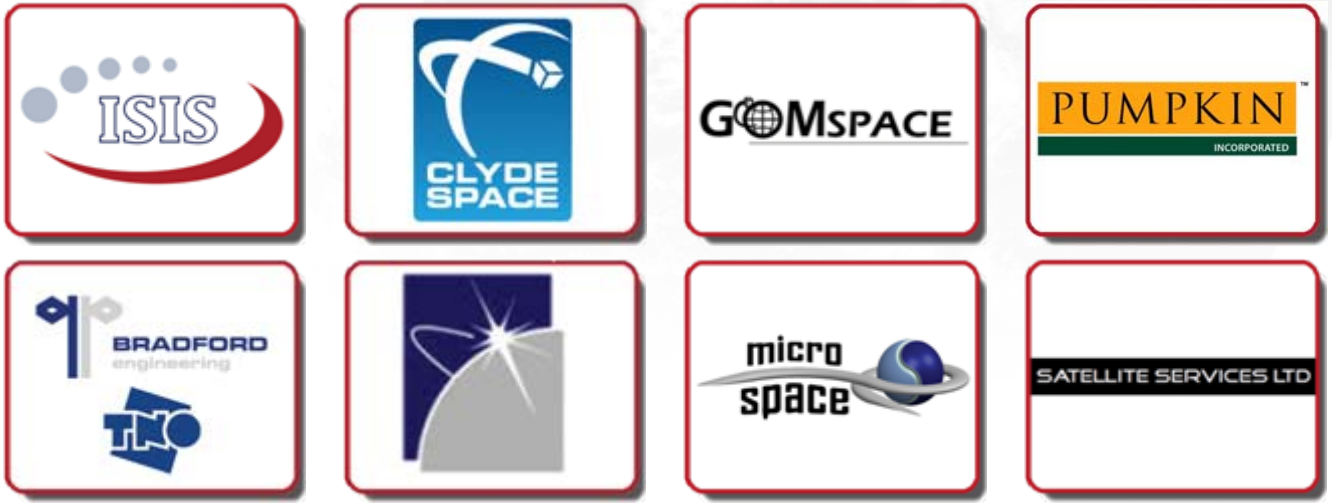


- OLFAR is a new concept of a low frequency radio telescope in space using small satellites.
- Correlation must be done in space.
- Distributed processing with centralized downlink transmission is the preferable option.
- Inter satellite link is the communication challenge.

CubeSatShop.com

- Objectives:
  - One-stop-shop for all your off-the-shelf CubeSat systems
  - Single portal for questions and system comparison
  - Ultimate goal: CubeSat configurator interface

- Partners (new partner/products always welcome)



CubeSatShop.com

- Current range of products already extensive:
  - Structures, mechanisms, deployers
  - Comm systems, antenna systems, ground stations
  - Power systems, batteries, solar panels
  - Attitude control systems, computers, camera
  - Standard kits and support equipment

- Opportunities and Needs:
  - The ‘big gaps’ (examples): GPS, CMGs, DPUs
  - Additional needs: cameras, payload systems, etc.

Some challenges for the future

- Frequencies and downlink of data, operations:
  - Amateur frequencies
    - Need for improved coordination?
    - Re-use / sharing of frequencies?
  - Networks of CubeSats
    - How do you coordinate 25+ Cubes deployed at the same time (e.g. QB50)?
    - Scheduling (TDMA)?
  - Shared ground stations
    - Licensing & regulatory aspects?
    - Training of operation?
    - Data policies?

Some challenges for the future

- Improved Cooperation
  - Develop your strengths, do not re-invent the wheel
  - Regulatory issues and restrictions
    - E.g. ITAR vs non-dependence movement in Europe
    - Licensing
  - IPR issues in cooperation between parties
    - Industry / Industry: competitors vs. partners
    - Industry / Academia: risk your IPR to become public domain
    - Academia / Industry: risk of not being allowed to publish your work
    - Industry / government: risk w.r.t. IPR ownership

Some challenges for the future

- Improve access to space
  - Launches are **not** cheap
    - Launch fees
    - Testing and procedures
    - Campaign cost
  - More often regulations apply
    (e.g. national space laws, NOAA, ITU/FCC)
  - Do not underestimate the level of testing and prove of conformance required by the LSP
  - Take into account end-of-life

Some challenges for the future

- Standardization and modularity
  - CubeSat Standard, universally adopted?
    - Depends very much on the type of deployer used for things like envelope, mass, etc
    - Variations on CubeSats are not very well covered
    - Mostly covers form, fit, mechanical aspects
  - Standardization of internal interfaces:
    - No real solution or consensus (mech, data, power, etc)
    - If you say: “we use our own standard”, it’s not a standard.
    - Commercial CubeSat systems providers struggle with this quite a bit…

Thank you for your attention!

Let’s discuss your needs …

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