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OVERVIEW

What will be covered in this session

• Introduction
• NARKISSOS-I
• Project Progress
• Launch & Operation
• What’s Next
• Q&A
INTRODUCTION
INTRODUCTION

We believe...

• ... that space should be accessible to everyone
  – Inexpensively
  – For non-scientists too
  – As a part of daily life

• ... that space systems are best developed in short increments
  – Delivering and launching a working increment every 6 months
  – Test, gather feedback and improve
  – Small (and ‘cheap’) satellite’s are the ideal platform
INTRODUCTION

We believe…

• ... that amateur radio is ideal for experimenting with new radio technology
  – Large and motivated user-base
  – Mistakes are allowed and experimenting is encouraged
  – A lot of experts willing to chip in

• ... it would be cool to integrate space in social media
  – Ideal for reaching a large global audience
  – Introduce ‘real’ space to many people
  – Spark interest & make space part of everyone’s daily life
Our first mission will launch the spaceselfie
NARKISSOS-I
Announcing the pre-launch name of our first satellite!

In Greek mythology, Narcissus (or Narkissos) fell in love with his own reflection after being lured to a pool by Nemesis.

In today’s world, Narcissus would certainly be taking a lot of selfies.

Quite appropriately, we decided to name our first satellite the NARKISSOS-I.

“Enjoying a little ‘me time’, Narcissus?”
NARKISSOS-I
Our first space mission

- LEO
- Based on Interorbital Systems’ TubeSat kit
- Hexadecagonal Tube
- About the size of a smartphone (in length)
- Subsystems
  - Antenna
  - Solar cells
  - Power management
  - Radio
  - Emergency shutdown
  - Microcontroller
  - Camera
  - Projector display
NARKISSOS-I
Our first space mission

- Controller: Arduino Mini 05
- Radio: Radiometrix TR2M + amplifier
- AX.25 (packet 1200)
- Downlink: 437.290 MHz
- 1-in, 1-out (2 separate memory buffers) to increase reliability
- Aim: 1 uplink or 1 downlink per pass
  - Possibility to split files over multiple passes
  - Possibility to fill gaps
- Limited telemetry: battery status and temperature sensor
- No attitude control
NARKISSOS-I

Our first space mission

- All commercial off-the-shelf-components (COTS)
- Adafruit camera + Edmund Optics lens
- Freetronics OLED display
NARKISSOS-I

Our first space mission

• Custom-made satellite projection lens
NARKISSOS-I
Our first space mission
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Our first space mission

• Dimensions & weight
  – Diameter: 3.64 in (92.5 mm)
  – Length: 5.0 in (127 mm)
  – Weight: 0.75 kg (1.65 lb)

• Cost
  – Approx. $18000
  – Excluding launch costs

• Lifetime in orbit
  – 3 weeks to 3 months
  – Complete burn-up when falling back
  – No space debris!
PROJECT PROGRESS
PROJECT PROGRESS

How far out are we?

• Project start (conceptual): October 2013
• Start building the satellite: January 2014
• Frequency coordination with IARU completed on April 27
• Currently (July 2014): Integration testing
• Launch planned for Q4 2014
PROJECT PROGRESS

How far out are we?

Project Status: 3

1. Design & Prototyping
2. Satellite Development
3. Simulations & Testing
4. Front-end Development
5. Launch & Post-launch

0% 20% 40% 60% 80% 100%
LAUNCH & OPERATION
Getting things in the air

• Launch planned for Q4 2014
• Launch provided by Interorbital Systems
• 150 miles off the coast of Califronia
• Together with up to 22 other TubeSats
• NEPTUNE launch vehicle
LAUNCH & OPERATION

Getting things in the air
LAUNCH & OPERATION

Getting things in the air

• Orbit
  – Circular polar orbit
  – Inclination, \( i = 90^\circ \)
  – Declination, \( \delta = 34^\circ \) (120 miles off coast of Long Beach, CA, 34.03° N, 120.39° W)
  – Launch Azimuth, \( Az = 180^\circ \), to be launched in the southern direction
  – \( \cos(i) = \cos(\delta)\sin(Az) \)
  – Altitude 310 km \( \rightarrow a = 6688.14 \text{ km} \)
  – Eccentricity, \( e = 0 \)
  – Mean Angular Motion, \( \omega = 1.154 \times 10^{-3} \text{ rad/s} \)
  – Period, \( P = 1.512 \text{ hrs} \)
  – Velocity, \( V = 7.72 \text{ km/s} \)
  – Total Energy per unit mass, \( \epsilon = -29.78 \text{ km}^2/\text{s}^2 \)
  – Anomaly \( \rightarrow v(\nu) = M = E \)
LAUNCH & OPERATION

Getting things in the air

• As a licensed radio amateur, you can communicate with NARKISSOS-I directly

• NARKISSOS-I will not talk unless talked to (except for beacon)
  – Send start_upload telecommand before starting image upload
  – Send receive_buffer telecommand to start downlink

• We will provide
  – Scripts to encode and decode images
  – Telecommand guide
  – More general information on receiving NARKISSOS-I

• We ask you to inform us after every successful downlink
  – So that we can get the right spaceselfies to the right accounts
  – So that we can clear the outgoing buffer if necessary (also automated)
LAUNCH & OPERATION

Getting things in the air

• As a user, use app or web-interface to upload your selfie
• Will be buffered on a central server
• Ground stations pick top of heap as soon as they can uplink to NARKISSOS-I
• Selfies are converted to a specific HEX format before transmission
• Identification code is appended
• Ground stations receive downlink, extract identification code and convert back to image
• User receives spaceselfie in account
LAUNCH & OPERATION

Getting things in the air

• NARKISSOS-I relies on manual telecommand for uplink and downlink of images (no scheduling)
• Processing received images happens automatically
• Queue and buffer management happens semi-automatically
• Beaconing and downlink of (very limited) telemetry
• No field updates supported in this iteration
WHAT’S NEXT
WHAT’S NEXT

Looking up & ahead

• More iterations of the spaceselfie missions (NARKISSOS)
  – Attitude control (active or passive)
  – Improvements in image quality
  – Faster radio communication (packet 9600 or different protocol)
  – More telemetry
  – GPS
  – More advanced telecommand
  – More memory and more advanced buffering
  – Support for field updates
  – Parallelism, redundancy, ...
  – General improvements based on NARKISSOS-I feedback
  – ...

SPACEBOOTH & NARKISSOS-I
WHAT’S NEXT
Looking up & ahead

• New missions in the pipeline
  – Planetary photography
  – Earth Observation
  – New technologies
  – ...

• All missions focussed on making space accessible to everyone
Q&A

What was that all about??
FREE SMARTPHONE STAND
To snap that ultimate selfie!
Twitter: @Spacebooth_org
Website: www.spacebooth.org

THANK YOU