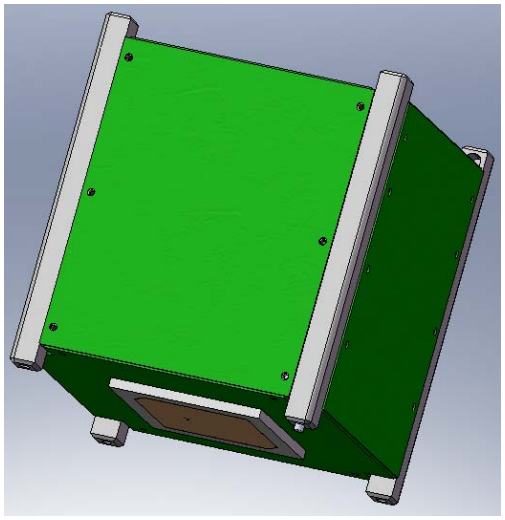
A Miniaturized Communication System for Cubesats

AstroDev

Kevin Brown and Tyler Burba
www.astrodev.com

The 1U Mission: The Problem

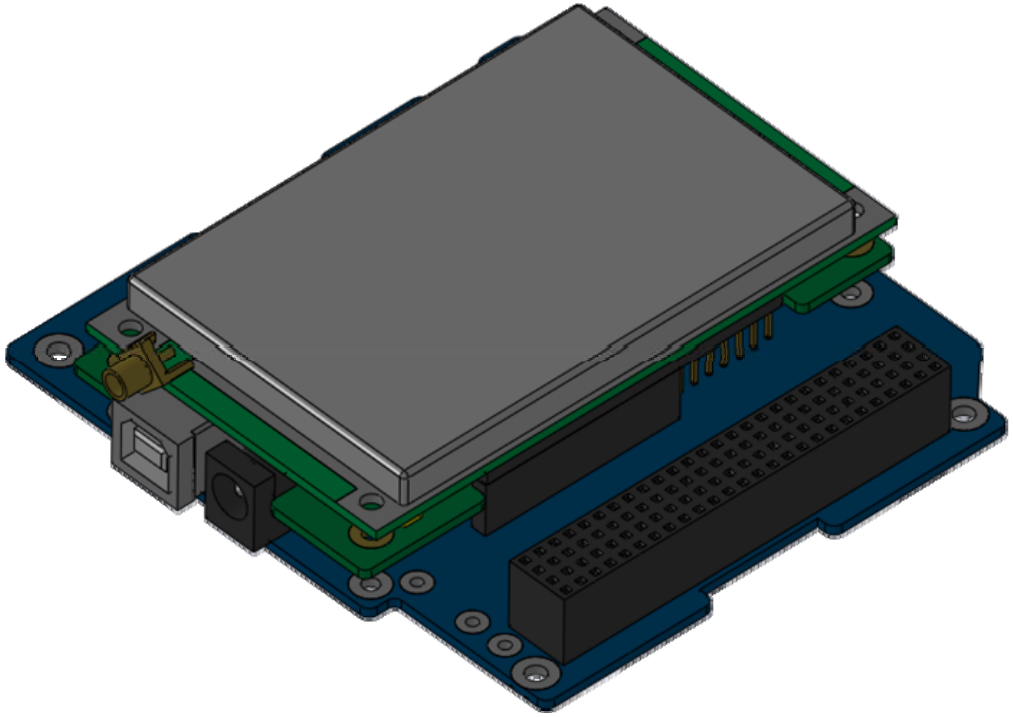


A 1U mission can not sacrifice volume and mass to accommodate large subsystems.

The 1U Mission: Example

- Pumpkin CubeSat Kit

*Can you integrate your **entire** UHF communications subsystem into the same volume as a MHX2400?*



http://www.cubesatkit.com/

The Radios: Method

- **Move to radios which can be highly integrated onto PCB and existing subsystems.**
- **Use modern electronics manufacturing**
- **Integrate RF cables into radio connect at antenna**

The Radios: Operations

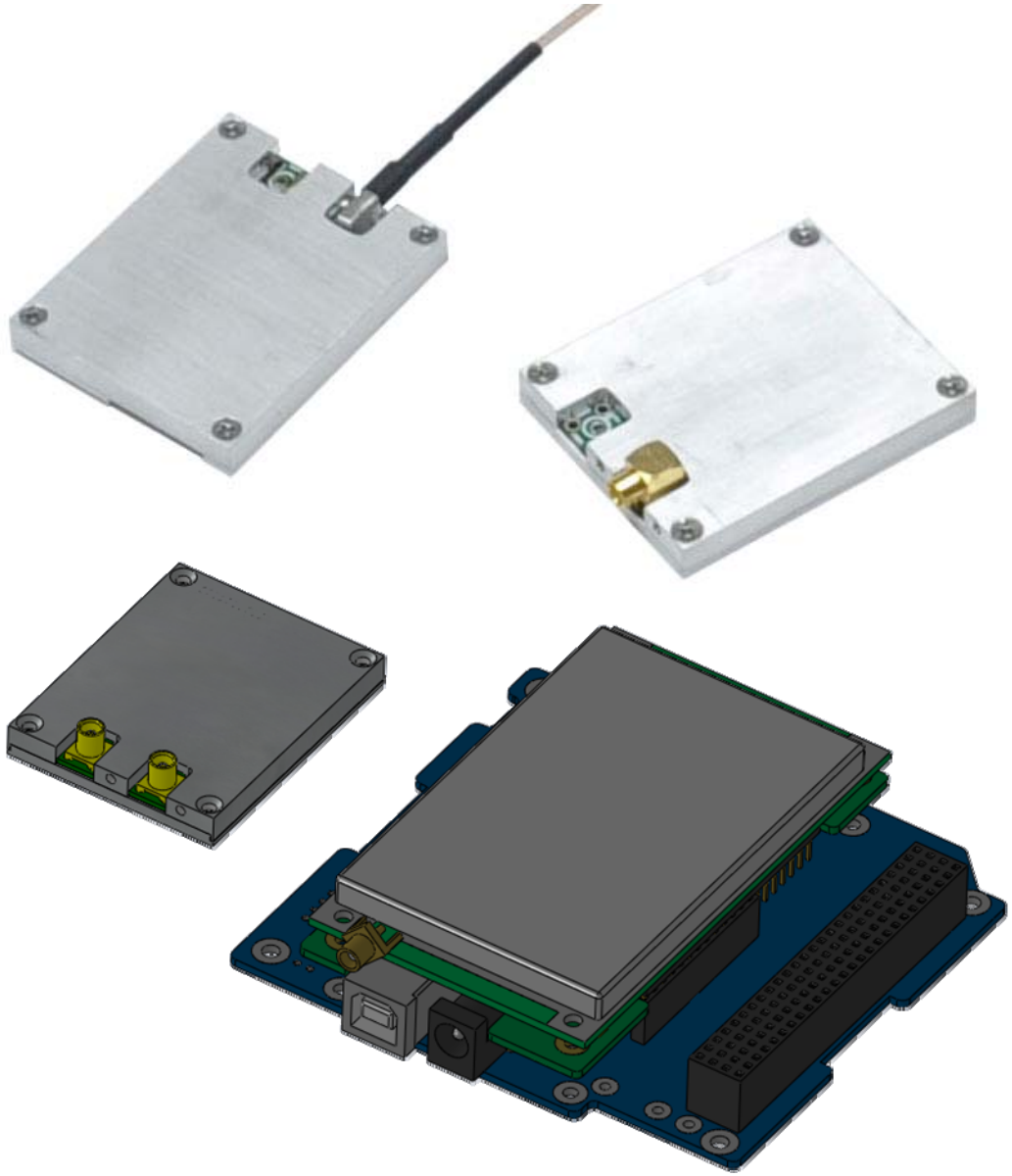
- **Beacon**
  - **Satellite tracking, health and status, spacecraft reset**
- **VHF/UHF High Reliability Access**
  - **Command and Data**
- **L Band Secondary Up/Downlink**
  - **Data**

The Radios: Capabilities

- **HAM Compliant or Other**
  - ***AX.25 (GFSK)***
  - ***802.11 (DBPSK)***
- **Power Levels**
  - ***27 to 33 dBm***
- **Data Rates**
  - ***1.2 to 38.4 kbps (low bands)***
  - ***115.2 kbps and greater (high bands)***

The Radios: New in 2010/11

- **CII Radio**
  - ***40 x 50 x 6 mm***
  - ***VHF/UHF/L***
  - ***< 200 kbps***
  - ***< 36 dBm***
  - ***Full Duplex***
  - ***CLP Plug***



  - ***USD $5000***

The Radios: New in 2010/11

- **Ne-2 Beacon**
  - ***15 x 25 x 3 mm***
  - ***UHF***
  - ***< 38.4 kbps***
  - ***< 33 dBm***

  - ***Highly Integratable***

  - ***Intern: Tyler Burba***

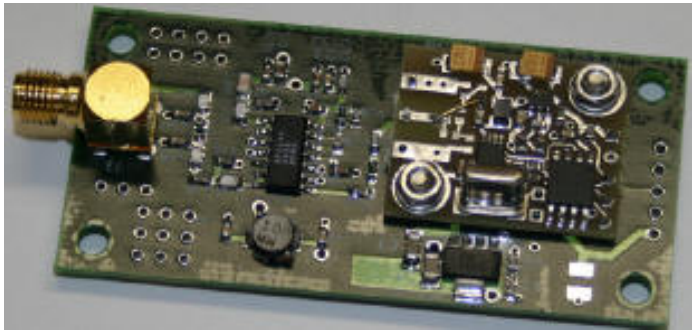
Beacon Design Goals

To create a remotely reconfigurable UHF beacon that can change:

- protocol
- frequency
- power

with no physical access required

Current Beacons Available

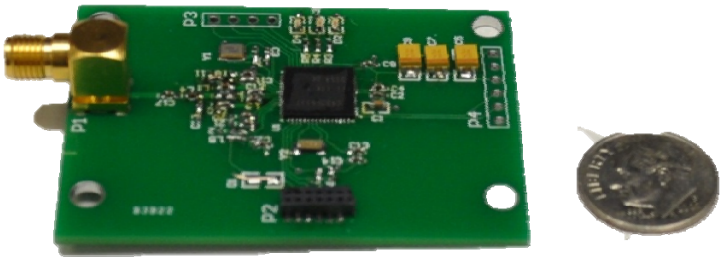


- Stensat Radio Beacon
  - 430MHz to 440MHz
  - 1 watt max
  - 3.1 inches x 1.75 inches
  - Data Rates: 1200 baud AFSK and 9600 baud FSK
- ISIS
  - 400MHz to 450MHz
  - 300mW PEP, 150mW average
  - 3.5 inches x 3.7inches
  - 1200-4800 baud

- Next generation will continue to shrink in size

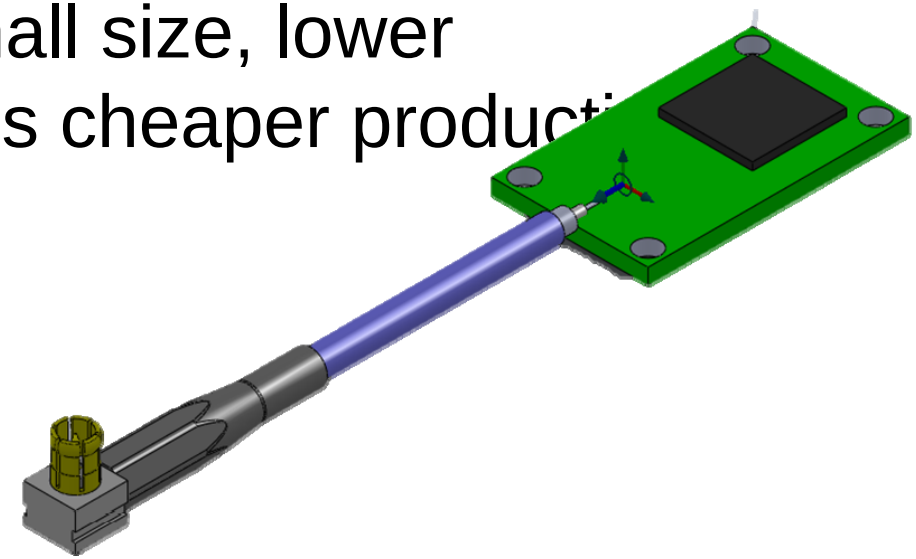
Concept for Design

- By using modern SoC a smaller, more capable beacon can be created that has numerous advantages over traditional beacons, while meeting the design goals
- A SoC brings tightly coupled RF, processor, and flash



Advantages

- A SoC:
  - Allows transmit power, frequency and protocol to be changed at any time
  - No dependence on C&DH processor for reconfiguration
  - Single SoC allows small size, lower component count, thus cheaper producti cost



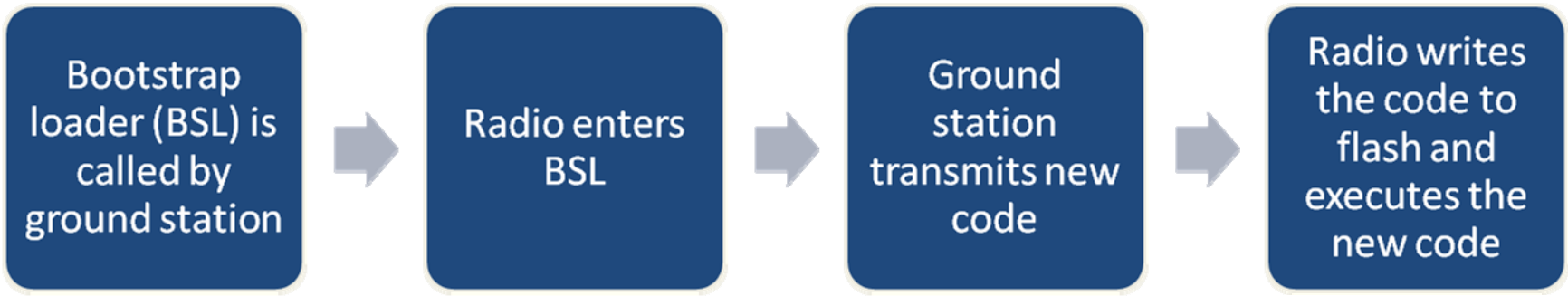
User Advantages

- Reprogrammable thru RF
  - No physical access required
  - Post integration reconfiguration
  - On orbit reconfiguration
  - Allows final integration into satellite before IARU frequency allocation is complete, etc.

Capabilities

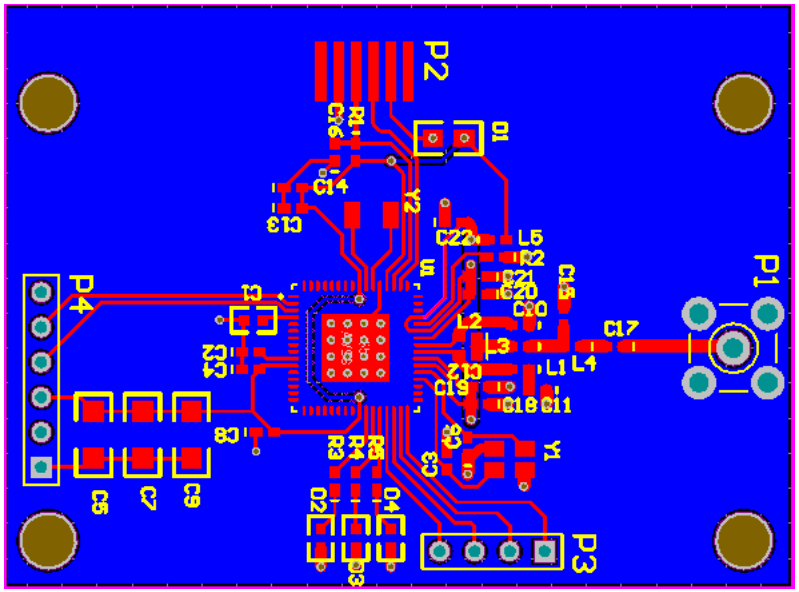
- UHF - 390MHz to 460MHz
- 3.0V-4.0V up to 1.0Amp
- 1W max output expected
- Data rate effectively limited by link budget and licensing, hardware range from .6kBaud to 500kBaud
- Small- approx. 1in x .75in
- Currently supports GFSK, FSK

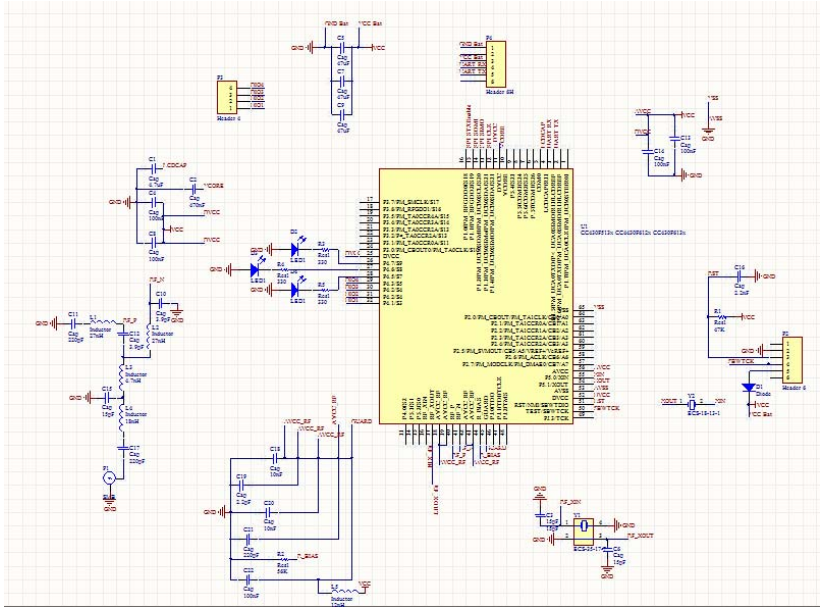
RF Update Process



Status

- Have populated prototype PCBs and software development is in progress





Conclusions

- A complete UHF communications solution can fit within a MHX2400 volume
- Requires no electrical changes to host system in example CubeSat Kit
- Users can replace low efficiency, low performance, and difficult software with easy to use, high efficiency and acceptable performance