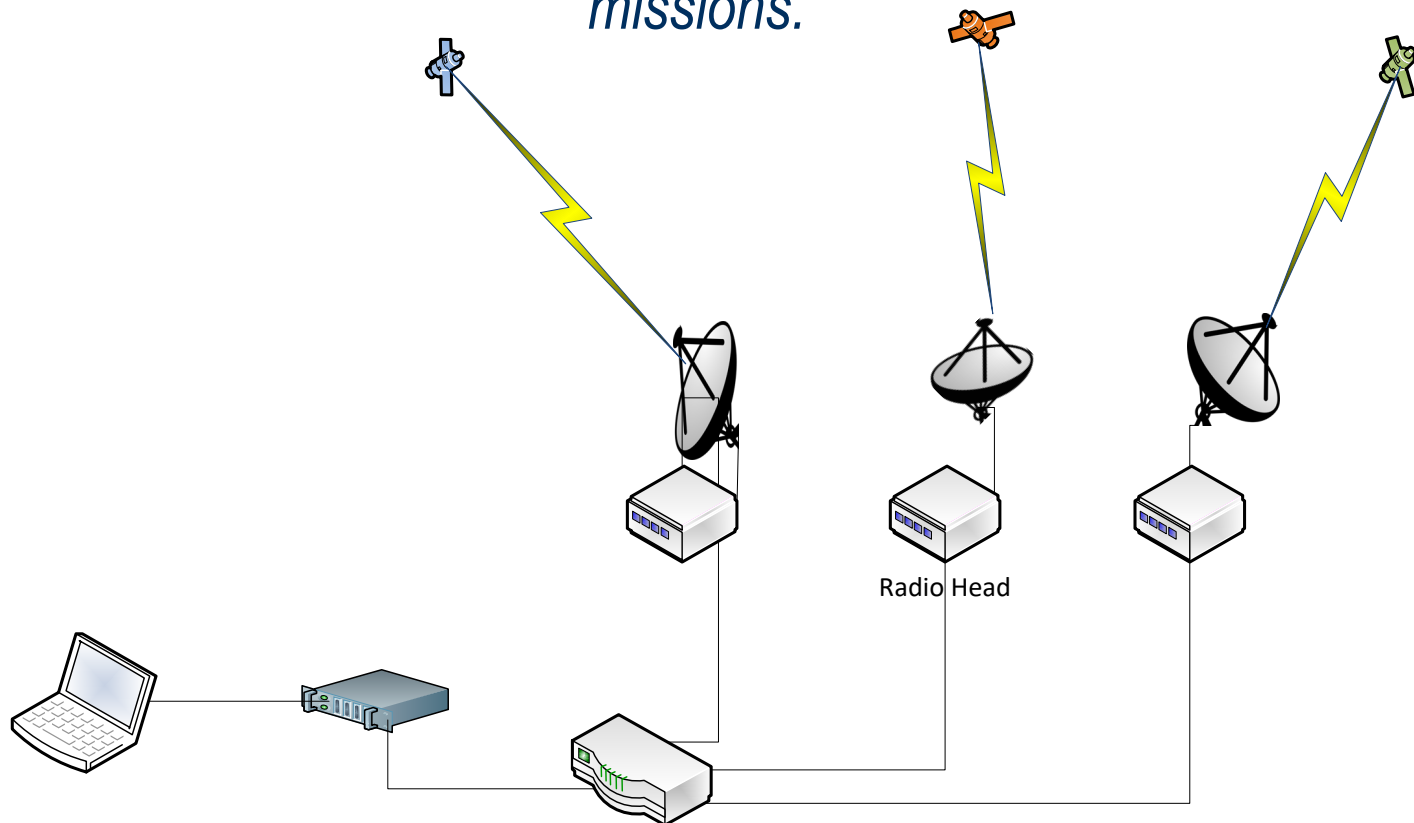


***Mission Adaptable Software Define Radio (MASDR)  
Ground Station  
to the WInnComm 2018***

Howen Fernando  
SSC Pacific  
November 14, 2018

# MASDR Vision

*The MASDR Ground Station shall deliver an optimized SWaP-C ground systems solution that is highly mobile, reconfigurable, and easily integrated into existing satellite systems to support both new and current space missions.*



# Approach



Ettus E310 SDR



# Project Team

- ▼ **SSC Pacific – Hawaii, Pacific C4ISR (SSC Pac)**
  - Lead project management and support project development
- ▼ **Hawaii Space Flight Laboratory (HSFL) – U. of Hawaii Manoa**
  - Support project development
- ▼ **Naval Postgraduate School (NPS)**
  - Provide technical guidance and support MC3 Ground Station integration
- ▼ **Joint Tactical Network Center (JTNC)**
  - Provide SCA 4.1 technical guidance and support
- ▼ **SSC Pacific – San Diego (SSC Pac)**
  - Project consultation and development as needed

# Accomplishments

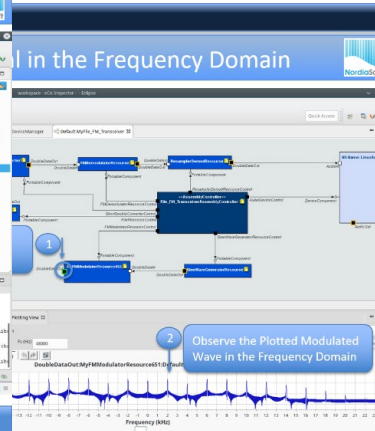
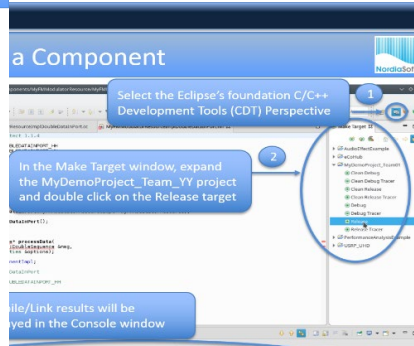
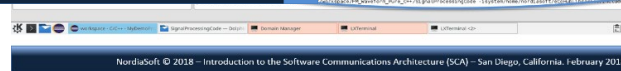
## Completed NORDIAsoft eCo Software Training

Development Team (HSFL and SSC Pacific) attended a four-day NordiaSoft Training Workshop (2/20 – 2/23) to learn how to utilize new software tools for waveform development.



Introduction to the Software  
Communication  
Architecture (SCA)  
Hands-On Sessions

San Diego, California. Feb 2018



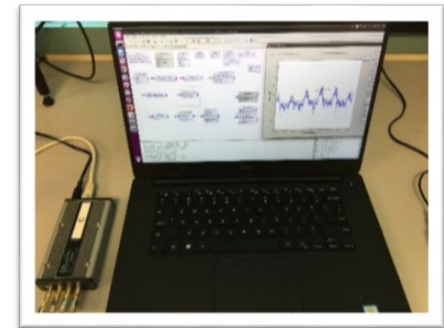
# Highlights - Verified E310 Compatibility with MC3 Ground Station

- **Findings:** Observed receive frequency offset by NPS operators during satellite passes with E310.
- **Troubleshooting:**
  - Characterize frequency reference difference between USRP 2922 vs. E310. Measured offset as high as 36.5 kHz delta.



Image courtesy of Hawaii Space Flight Laboratory

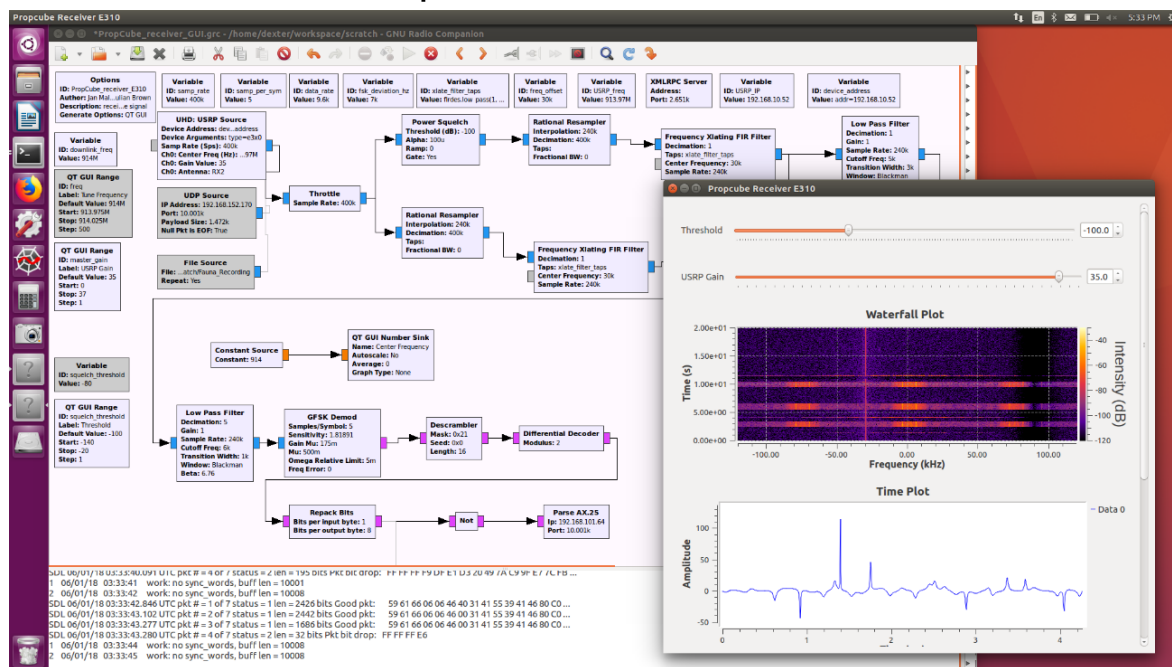
Tx SDR	Rx SDR	Successful Packet Reception Frequency range
E310-B	E310-A	913.972 MHz +/-1.5 kHz
E310-B	NI-USRP 2922	913.9725 MHz +/-1.5 kHz
E310-B	NI-USRP 2922 (w/ 10MHz Sig Gen Ref)	913.9355 MHz +/-1.0kHz
E310-B	NI-USRP 2922 (w/ 10MHz MC3 Ref)	913.97225 MHz +/-1.25kHz



- NPS to develop MC3 recording capability to capture the receive signal of a real-time Propcube satellite pass. (in process)
- Use Propcube recording to perform bench level troubleshooting and find root cause.

# Highlights - Developed reconfigurable SDR via SCA4.1 implementation of waveform

- Leveraged GNU Radio models to support SCA software development.



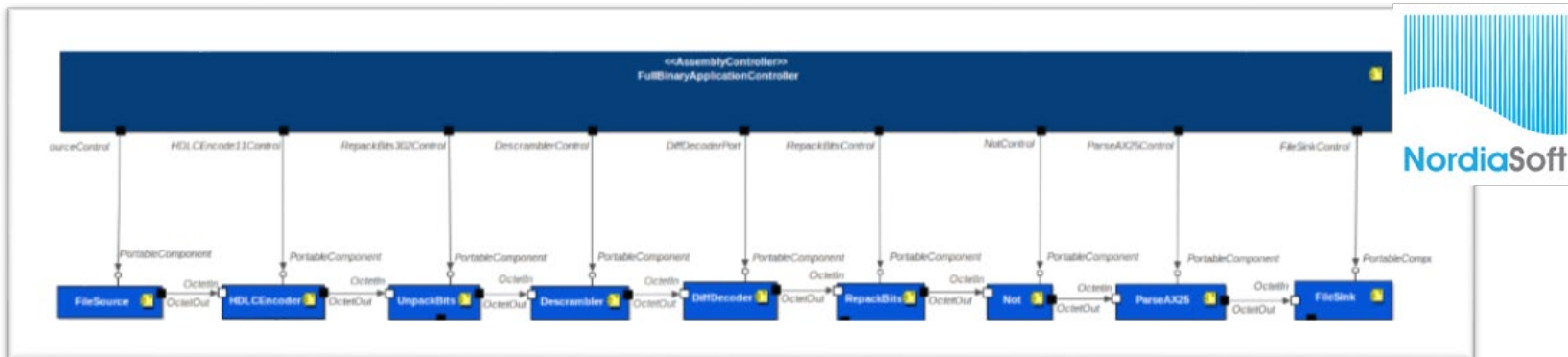
**Figure. GNURadio PropCube receiver flowgraph using NPS FlatSat recording**

# Accomplishments

- ▼ 1. Successfully performed Hardware-In-Loop testing using E310 and PropCube GnuRadio Flowgraphs
- ▼ 2. Decoded packets with Ettus E310 during PropCube satellite passes
  - Used MC3 ground station and E310 SDR to successfully receive PropCube transmissions during live satellite passes.
- ▼ 3. Verified partial PropCube SCA 4.1 waveform using NordiaSoft's eCoSuite
  - Successfully created several digital processing SCA components and validated functionality using PropCube data packets.



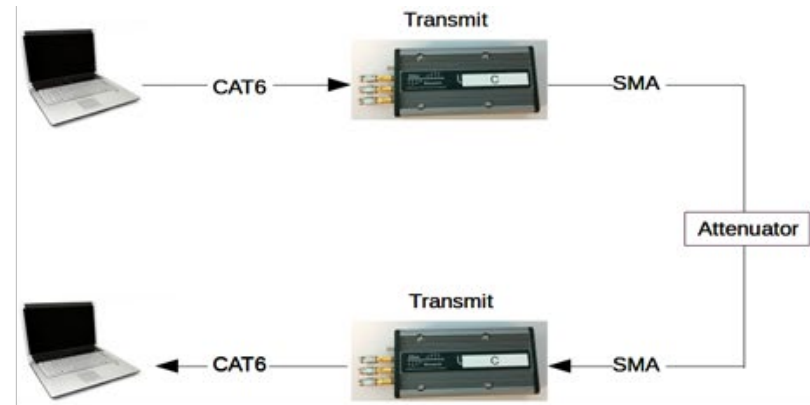
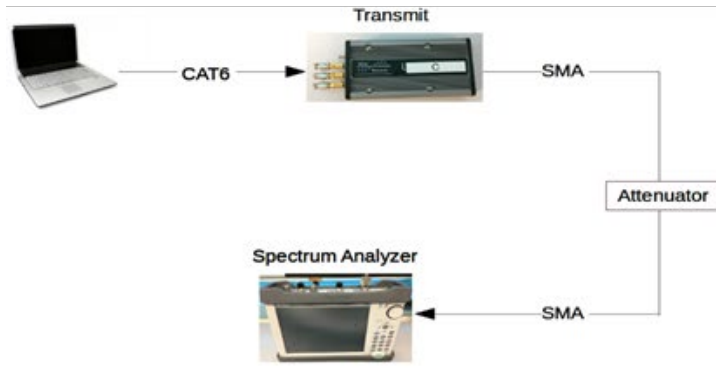
MC3 Ground Station Rack at HSFL  
with MASDR E310 SDR





# Highlights - Developed reconfigurable SDR via SCA4.1 implementation of waveform

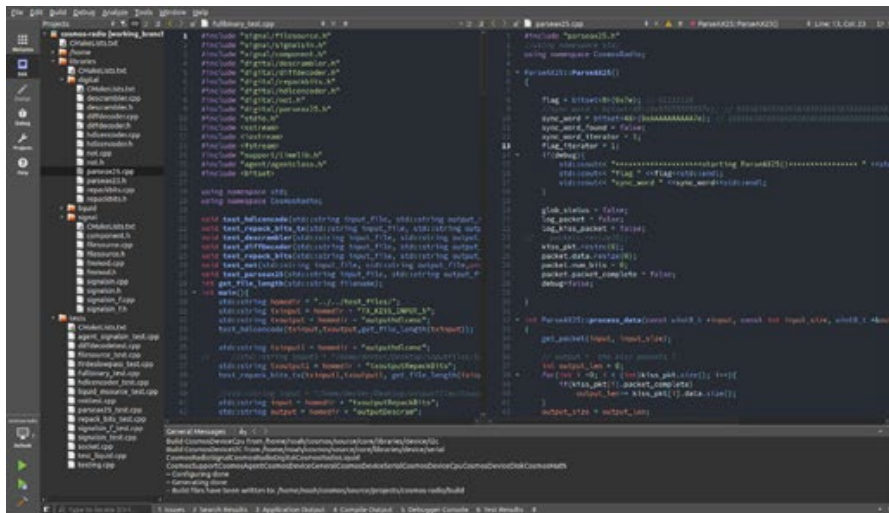
- Validated GNURadio models with hardware-in-the-loop testing.



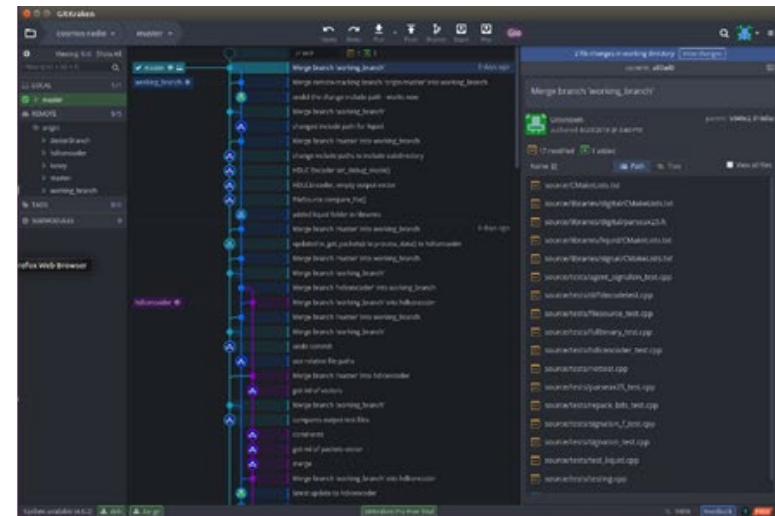
# Highlights - Developed reconfigurable SDR via SCA4.1 implementation of waveform

## ▼ Used eCo Suite IDE

- Created external source code libraries for C++ Implementation
- Utilized QTCreator and GitKraken software tools for testing and team development



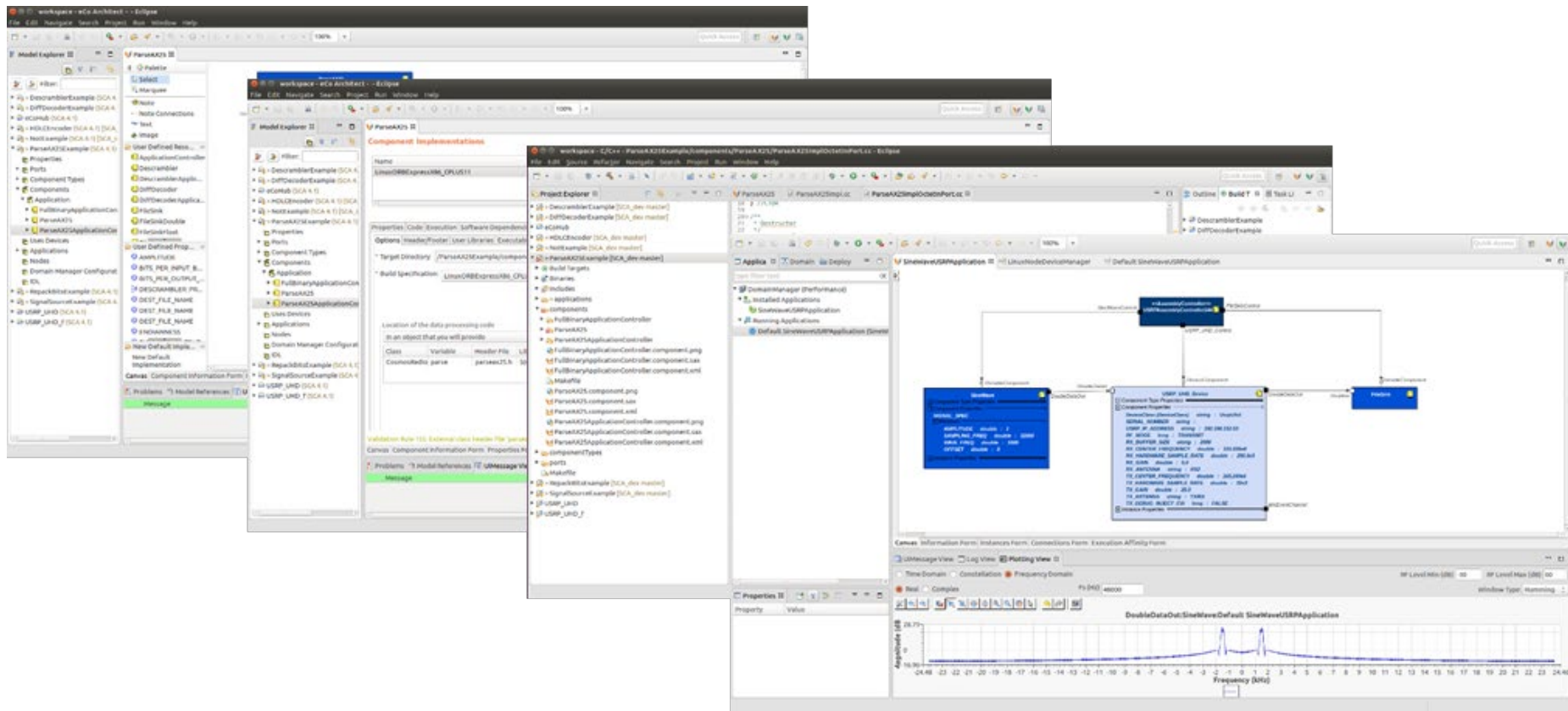
QTCreator



GitKraken

# Highlights - Developed reconfigurable SDR via SCA4.1 implementation of waveform

## ▼ Used NordiaSoft eCo Suite IDE



# Future Goals

- Complete SCA 4.1 implementation of PropCube Waveform (November 2018)
- SCA 4.1 implementation of HiakaSat (December 2018)
- Integrate MC3 Ground Station Management System and SDR running SCA 4.1 implemented waveforms.
- Test waveform application portability on National Instruments N300 SDR
- Operational Demonstration
- Transition technology to ProCube and HiakaSat users
- Acquire transition sponsorship

# Future Goals

## **Integrate SDR into MC3 Ground Station (Mar 2019)**

- **SDR + MC3 Ground Station to support live operations and end-of-year demonstration**
  - Integrate SDR into MC3 UHF transmit and receive chain
  - Identify and procure new hardware and software required for SDR integration.

## **Software Solution for Ground Station Operator (Mar 2019)**

- **Develop End User Interface**
  - Leverage existing software (COSMOS?) to provide interface for SDR control and configuration

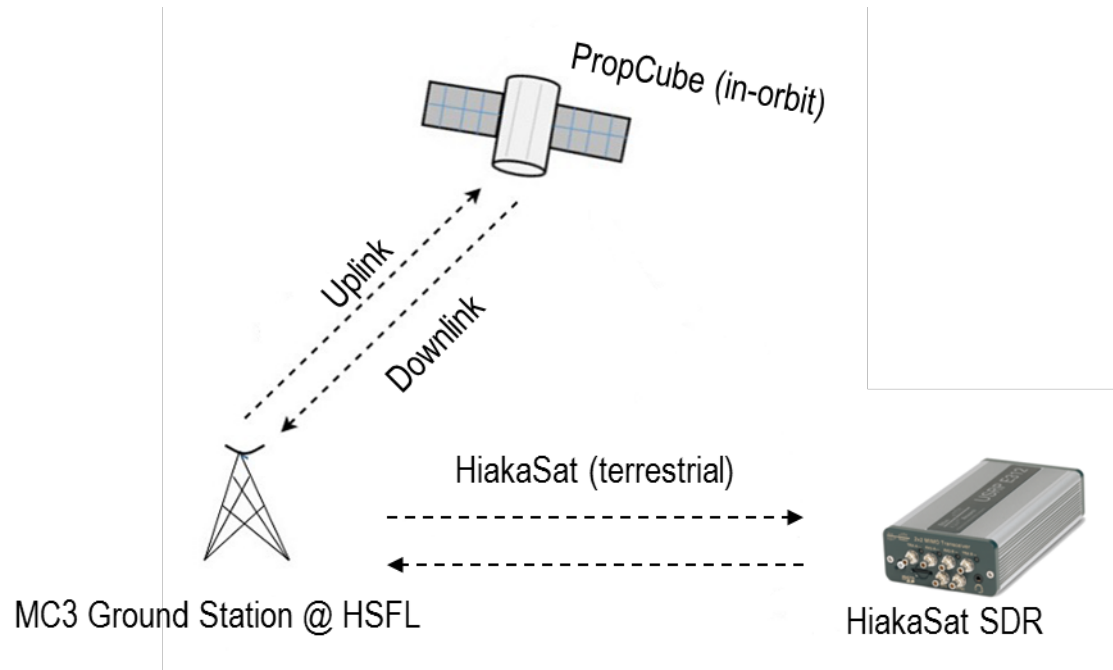
## **Validate Modified MC3 Ground Station functionality (Jul 2019)**

- **Verify SCA waveforms applications using modified MC3**
- **Perform over-the-air testing with PropCube satellites (in-orbit) and HiakaSat radios (terrestrial)**

# Operational Demonstration

## Coordinate Operational Demonstration (Aug 2019)

- **MC3 Ground Station Communications from MC3 using PropCube and HiakaSat waveforms**
  - FY19 end-of-year demonstration will be the transmission and reception of two different waveforms; PropCube and HiakaSat
  - Showcase SCA v4.1 benefits by using two different radio platforms during demo



# Transition Goals

- ▼ Seeking transition partner(s) for MASDR beyond September 2018
- ▼ Determine evolutionary goals from transition sponsor
- ▼ Pursuing project collaboration opportunities through the Responsive Space Capabilities Memorandum of Agreement (RSC MOU) (USA) SAF/IAPC, involving participants from 11 nations

SAF/IAPC: Secretary of the Air Force / International Armaments Cooperation Division