PhoneSat Program Overview

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Demonstration Objectives

- Increase on-orbit processor capability by a factor of 10-100
- Decrease cost by a factor of 10-1000
- Free up cubesat volume for additional payload through avionics miniaturization
- Demonstrate COTS approaches to all subsytems (ie, power, RCS, comms)

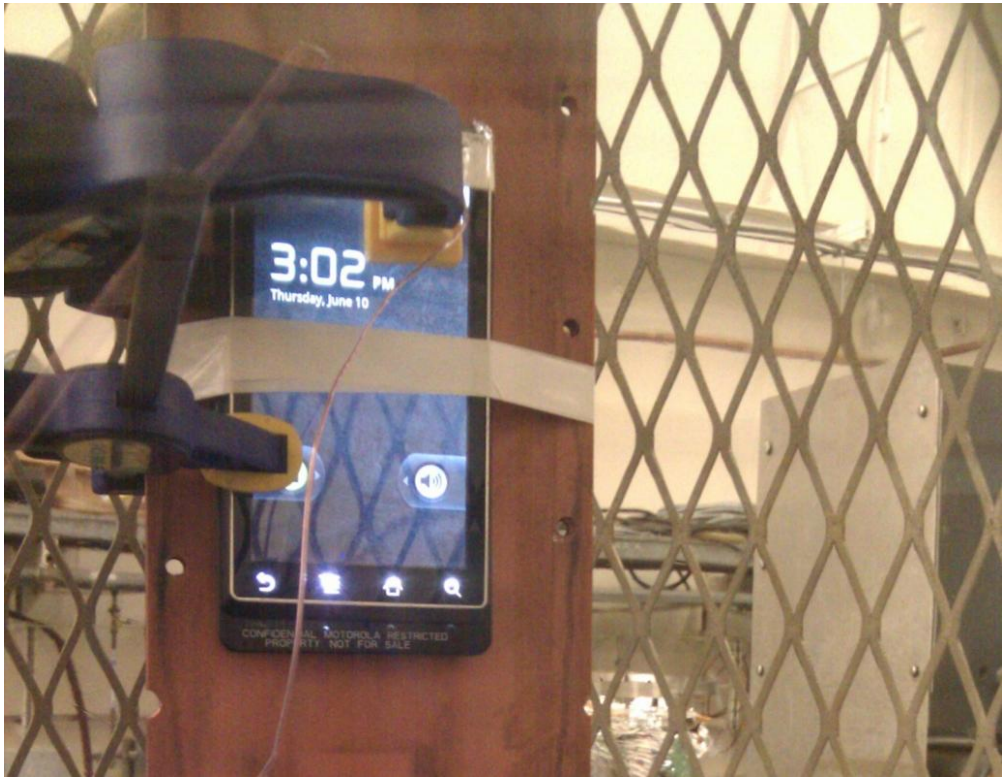
➔Produce high-capability spacecraft for $1-10k (exc. LV)

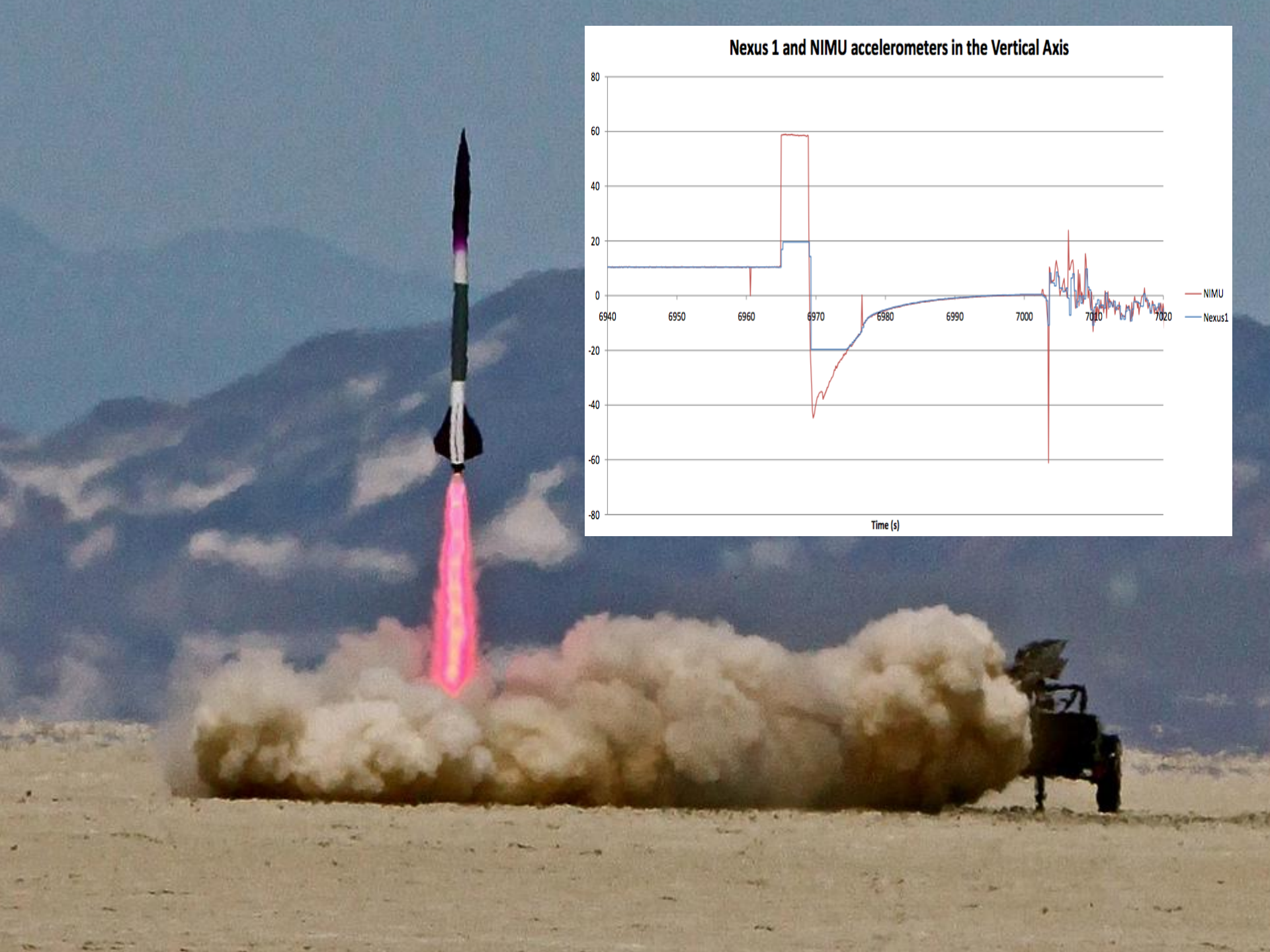
Series of Missions to Demonstrate Capability

0. Demonstrate feasibility of phones as flight devices through sounding rockets (completed)
1. PhoneSat 1: Demonstrate on-orbit operation of a phone as a flight processor
2. PhoneSat 2: Demonstrate a high-capability cubesat with solar power and attitude control
3. PhoneSat 3: Undertake one scientific or technical mission:
   - Heliophysics
   - Earth Observation
   - Many-to-many cubesat communication and networking
   - others

Space Qualification Testing

1. Thermal-Vac testing to 10-5 Torr, -35C to +40C
2. Suborbital Rocket Testing to 10,000m readiness
3. Launch vibe and shock to NASA GEVS standards
4. Series of balloon flights for system level qualification (30km)




Nexus 1 and NIMU accelerometers in the Vertical Axis
80
60
40
20
0
-20
-40
-60
-80
6940
6950
6960
6970
6980
6990
7000
7010
7020
Time (s)
NIMU
Nexus1

PhoneSat 1: Requirements

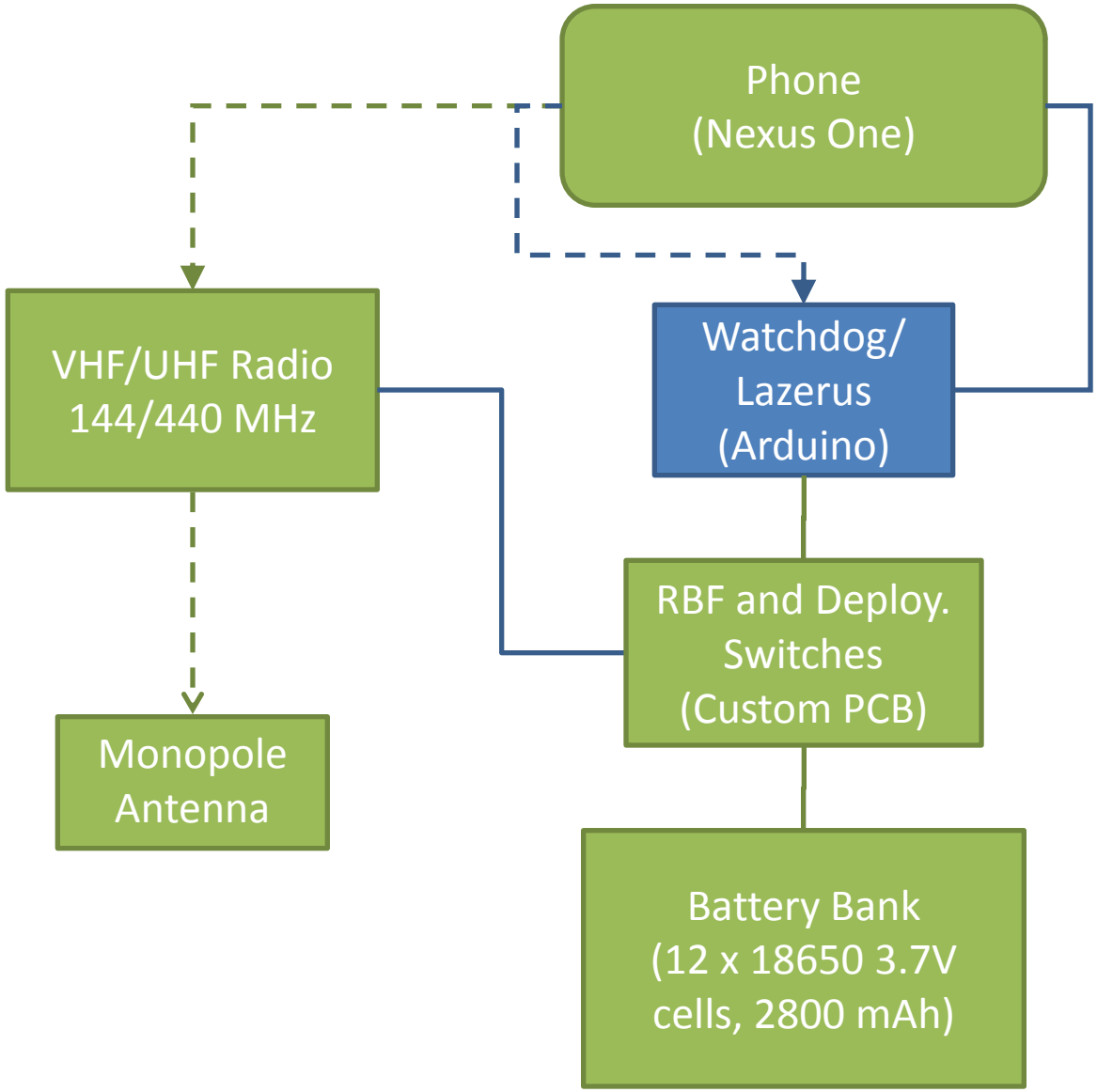
1. Work for > 1 orbit
2. Send minimum health data and 1 image taken by the phone to the ground
3. Parts cost << $10,000, leading towards $1,000 unit cost
4. Schedule < 3 months from ATP to flight readiness

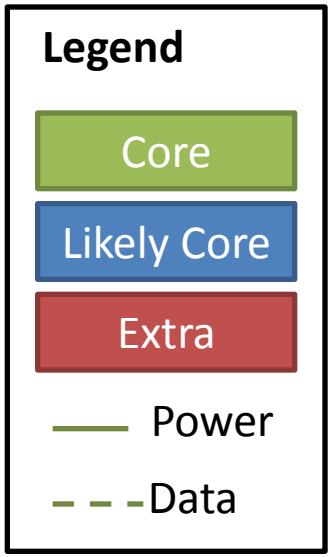
PhoneSat 1: Mission Parameters

- Mission Risk Class: NPR 7120.8 / Tech Demo
- Architecture: Cubesat structure + Phone
- Open source hardware and software
- Initiation Date: Aug 2010
- Launch Date: 2011
- Ops Duration: 1 week
- LV Class: Secondary Cubesat (to LEO)

PhoneSat 1: System Architecture

Spacecraft 1.0
Concept A
- With UHF radio
- & Hardware battery override
- & Watchdog/Lazerus





PhoneSat 1: Prototype generations

0.1: “flat sat” demo of core system integration and notional telemetry sent over a bluetooth radio connection

0.2: demonstration of preliminary packaging in a cubesat form factor and notional software operation (via bluetooth radio)

0.3: flat sat demo of flight radio and notional telemetry schema

0.4: full packaging of phone, power and radio, and nominal operation from release to first signal transmission

0.5: full power operation including watchdog and lazerus functions

0.6: full antenna integration and deployment

0.9: Engineering model/test article (Current phase)

1.0: Fight Vehicle

PhoneSat 1.0

PhoneSat 1: Major Challenges Addressed

- Software:
  - Exposing and writing to the hidden serial port
  - Persistent flight executive kernel with robust fault tolerance
- Hardware
  - Power interface (restarting the phone, launch activation timer)
  - FM Radio beacon interface and telemetry output
  - Mechanical and structural design

Conclusions

- Goal: Produce high-capability spacecraft for <$1k (exc. LV)
- Why? Myriad of uses to aid the agency (science, exploration, education & outreach)
- Concept: series of missions building capability
- Progress to date:
  - Tested Phone in thermal-vac, shock/vibe, balloon launch & suborbital launch
  - Built PhoneSat v. 1.0
- Next steps: **find launch, find ground station**