

# SMART COMMUNICATION SATELLITE (SCS) PROJECT OVERVIEW

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2015/8/10



# OUTLINE



- System Scheme
- Technical Challenges
- Flight Results
- ➢ <u>Future</u>



### **1 Overview**

Tsinghua University, cooperated with Beijing Xinwei Telecom Co., has successfully launched a small satellite, which is called Smart Communication Satellite (SCS, NORAD ID: 40136, Int'l Code: 2014-051A), in September 2014, and successfully established hand-set voice communications and broadband data communications via the satellite.

This is the first LEO communication experimental satellite in China.





Engineering design of <u>initial</u> <u>prototype</u>

Jan. 2013

Production, assembly and experiment of <u>structural thermal</u> <u>testing satellite</u>

Production, assembly and experiment of electronic testing satellite

Feb. 2013

#### Oct. 2013

Production, assembly and experiment of engineering prototype

Oct. 2013 ~ Jan.2014

Production, assembly and experiment of flight satellite

Jan. 2014 ~

Jul. 2014



## **1 Overview**

### Important Tests in SCS Development

- Vibration Tests
  - — Sine-scan vibration (3-axis)
  - Radom vibration (3-axis)
  - Characteristics-scan test
- Thermal Vacuum Test
  - 4 of high and low temperature cycles
- Semi-Physics Dynamics Test
  - Single axis air bearing turntable,
  - Geomagnetic field simulator,
  - ADCS circuit,
  - Wheel and Magnetometer.
- Magnetic Calibrate Test
  - Zero drift / Temperature drift/ Linear coefficient / Non-orthogonal error/ Installation angle error/ Constant magnetic field of the satellite/ Dynamic magnetic field of the satellite



TTC Link (2kbps up/5kbps down)

Feeder link 1Mbps up/2Mbps down User link (8Kbps/64Kbps/1Mbps) Voice/ Broadband data/ Video/ Internet

**Satellite System Ground System** 



Ground Station

> McWill Ground Networks

Tsinghua Gateway Station

McWill

Gateway

Handset

Vehicle Terminal

**Application System of Mobile Communication** 

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		1	Item	<b>Technical Indication</b>
Smart Communication Satellite		Mass	131Kg	
Platform	Payload		Size	720mm×660 mm×760mm, Φ902mm×760mm
Power	Mobile Communication		Launch interface	Φ660mm separation ring
Tt&C	Feeder Link		Orbit	SSO, altitude 800Km,
House-keeping	Beidou Position			Local time of descending node: 6:30 a.m.
Attitude	Spectrum		Attitude Control	3-axis stabilization attitude
and Control	Scanning			Platform: 55W;
Structure			Power	Communication Payload: 200W(Peak)
Thermal			Communic ation	S-band / C-band
			Launch	4 <sup>th</sup> , Sep. 2014



#### **Structure Scheme**

- 10 aluminum module boxes, one stacked upon another;
- Firmed by 9 root titanium screws;
- 4 solar cell arrays (±X-axis and ±Y-axis facets);

#### **Thermal Scheme**

- Passive thermal control;
- Heating tapes for battery bars;
- Different properties of coating;
- Anti-packed or wall-sticking installation;



### Attitude Determination and Control System (ADCS)

- The attitude is determined by an external Kalman filter using the measurements of magnetometer and digital sun sensor;
- The actuators contain reaction wheels and three-axis magnetorquer rods, and the two attitude control modes (wheels and magnetorquer) backup each other;
- two lines elements (TLE); Wheels **PD** Control (bought from VECTRONIC Aerospace) IGRF-11 Geomagnetic model Logic Magnetorquer (self developed) **B-Dot** Control Logic SSC Attitude Determination Attitude 800Km SSO EKF **Dynamics** LTDN 6:30a.m. and Kinematics Magnetometer (self developed) TLE **IGRF** Sun Sensor Model (bought from Satellite Service) GPS 9



#### Software Satellite **Business** application software Payload software Payload emergency Core processor: startup service update sevice **ARM9-based** Electronic detective Tt&C service program application User industrial-strength Space File upload/download House-keeping integrated chip service Applica program -tions System Service software LVDS port service CAN bus service **Operation System:** program program **Embedded** Linux Serial port service System startup and update management program (cut and reconstructed Core Serial bus interface File management for space use) Operadriver system ting The FPGA composite driver software System Hardware System



## **3 Technical Challenges**

### **Smart Communication Technology**





## **3 Technical Challenges**

### **Integrated Design and Control**

Various electronic devices (different technical types) within the **limited space of cubic meters**.

Due to the small space of the satellite, a 6-ampere time-varying current for the payload to work normally would cause a dynamic magnetic measuring error of thousands of nanotesla (up to 50% of the ratio between interference and valid measurement value).

- Reflux control approach of satellite electronic system;
- Design method involved information from external systems;
- Multi-level magnetic measurement with correction.



## **4 Flight Results**

### **On-orbit Attitude and Communication**

- The actual accuracy of attitude angles are better than  $\pm 1.5^{\circ}$ ;
- No prominent angle drifting during the communication experiments;
- Handsets accessed the Internet and transmitted data;
- Vehicle terminals achieved the Internet accessing and high-speed data transmission.





## **4 Flight Results**

### **On-orbit Temperature**

Internal circuit : 15 to 30  $^{\circ}$  C (due to the drift of beta angle); Battery:15 to 25  $^{\circ}$  C.

Solar sensor:  $30 \text{ to } 54^{\circ} \text{ C}$ .

The telemetry data matches well with Thermal Desktop simulation.





## **4 Flight Results**

### **SEU Recodes**

Unprotected SRAM (about 48Kbytes) to monitor the high-energy particle environment on orbit;

Analysis: 25 days once VS actual state: 23.55 days once







looking to launch about 700 satellites that each weigh under 250. Elon Musk Selonmusk Following SpaceX is still in the early stages of developing advanced micro-satellites operating in large formations. Announcement in 2 to 3 months.

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Google

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OneWeb

Gateway

> LEARN MORE EXPLORE DATA





### **Our Goal:**

- An affordable Satellite Internet platform
- Innovative information services
  - Global Access;
  - Safety communication;
  - Data collection
  - Navigation augmentation
  - Mobile internet
  - Broadcast

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