SMART COMMUNICATION SATELLITE (SCS) PROJECT OVERVIEW

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OUTLINE

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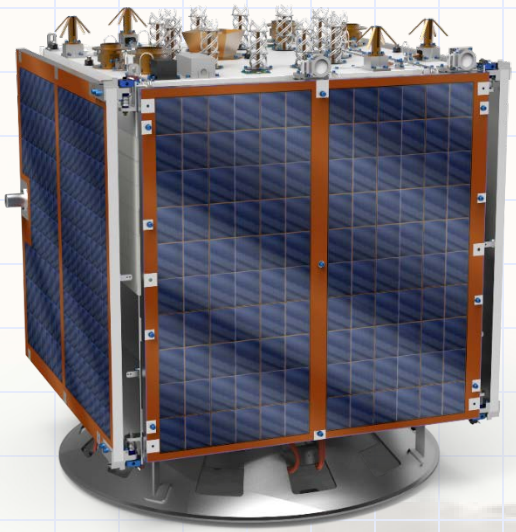
- **System Scheme**
- **Technical Challenges**
- **Flight Results**
- **Future**

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.



1 Overview

Engineering design of **initial prototype**

Jan. 2013

Production, assembly and experiment of **structural thermal testing satellite**

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**

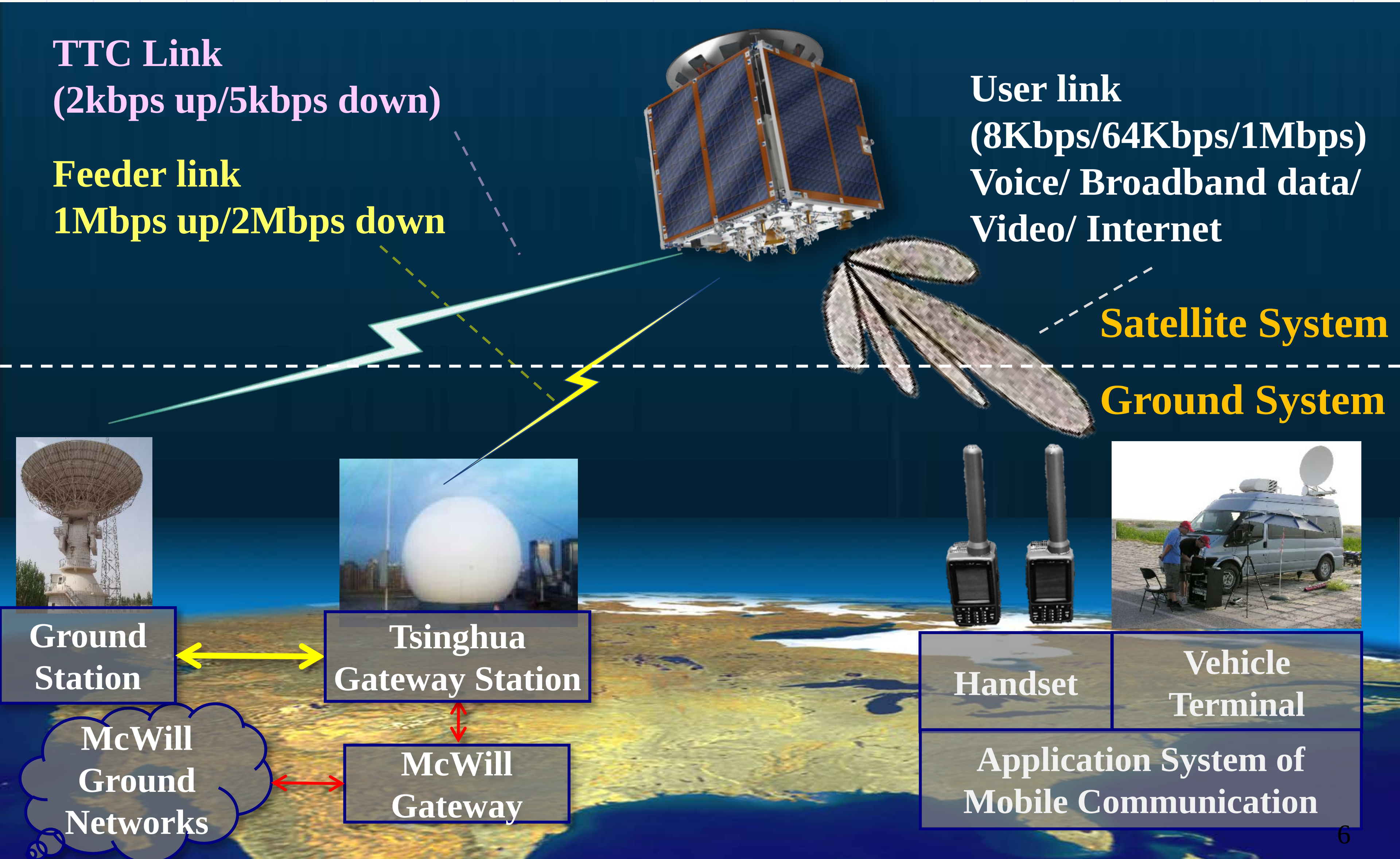
Jan. 2014 ~ Jul. 2014

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

2 System Scheme



2 System Scheme

Smart Communication Satellite	
Platform	**Payload**
Power	Mobile Communication
Tt&C	Feeder Link
House-keeping	Beidou Position
Attitude Determination and Control	Spectrum Scanning
Structure	
Thermal	

Item	Technical Indication
Mass	131Kg
Size	720mm×660 mm×760mm, Φ902mm×760mm
Launch interface	Φ660mm separation ring
Orbit	SSO, altitude 800Km, Local time of descending node: 6:30 a.m.
Attitude Control	3-axis stabilization attitude
Power	Platform: 55W; Communication Payload: 200W(Peak)
Communication	S-band / C-band
Launch	4^{th}, Sep. 2014

2 System Scheme

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);

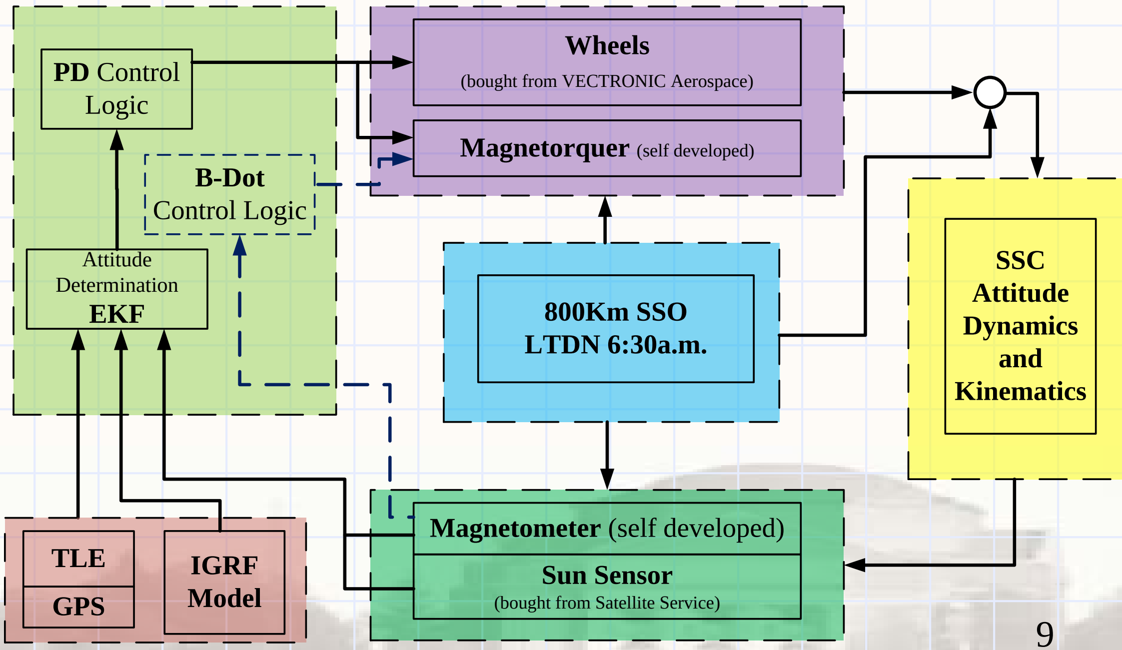
Thermal Scheme

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

2 System Scheme

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);
- IGRF-11 Geomagnetic model



2 System Scheme

Software Satellite

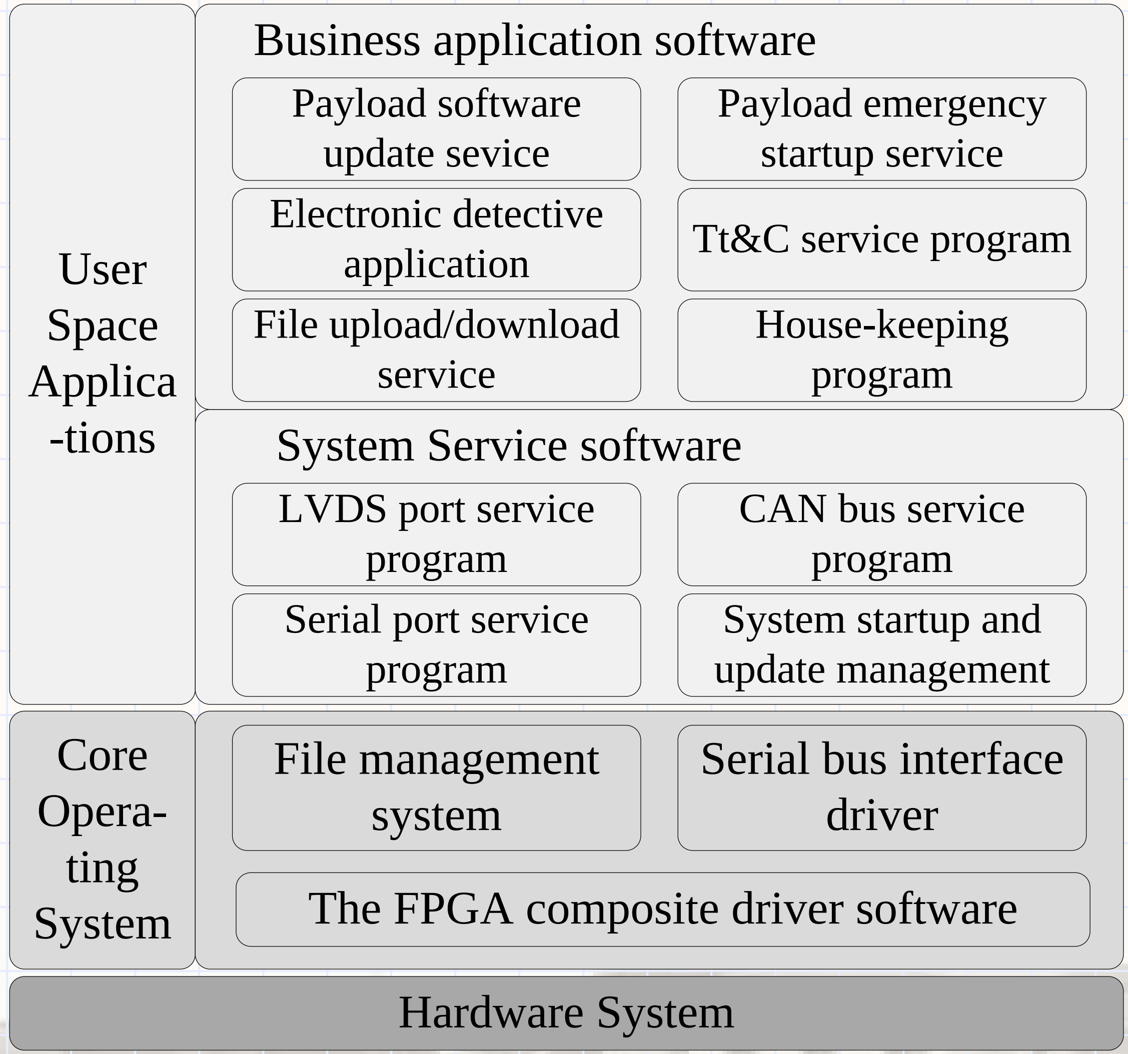
Core processor:

- **ARM9-based industrial-strength** integrated chip

Operation System:

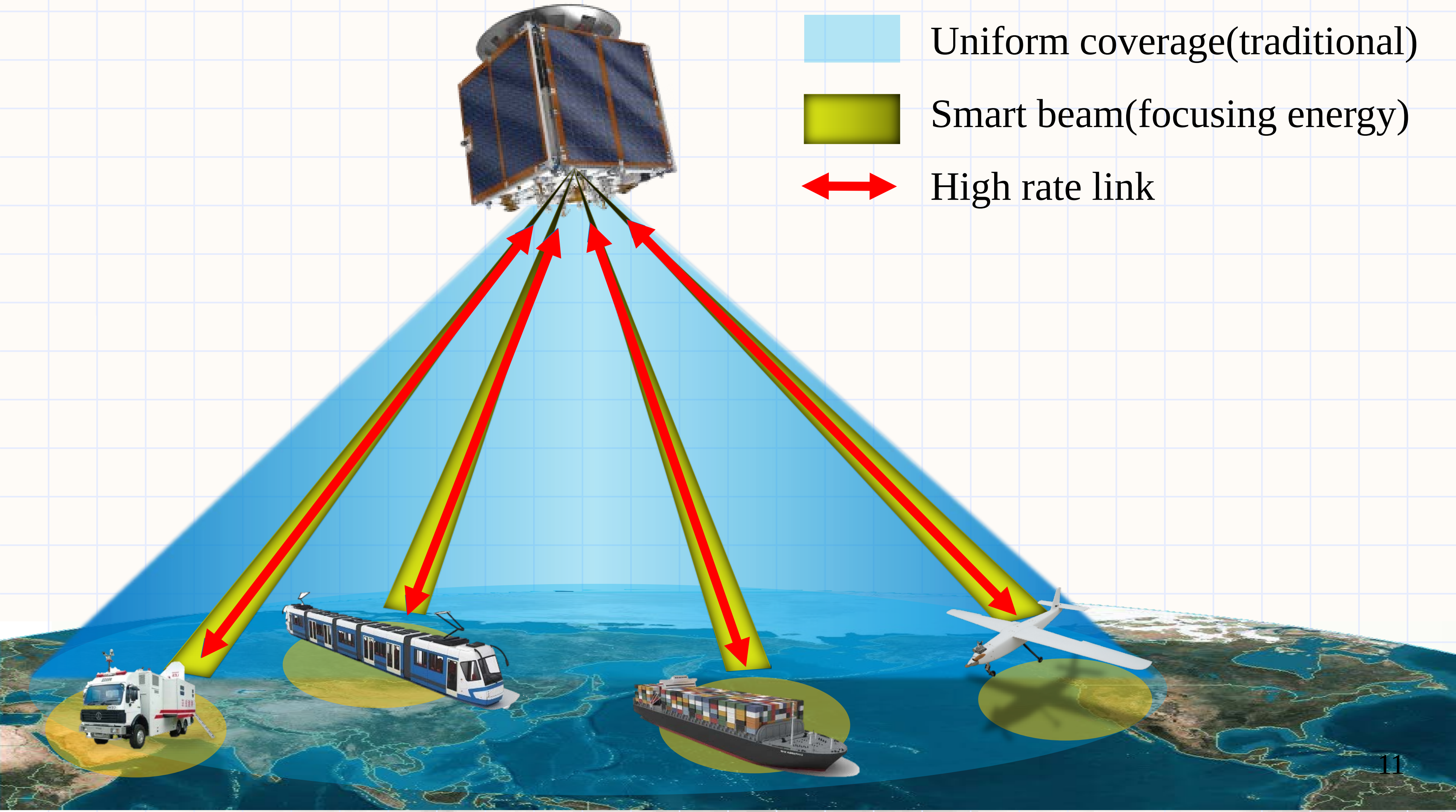
- **Embedded Linux**

  (cut and reconstructed for space use)



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**.

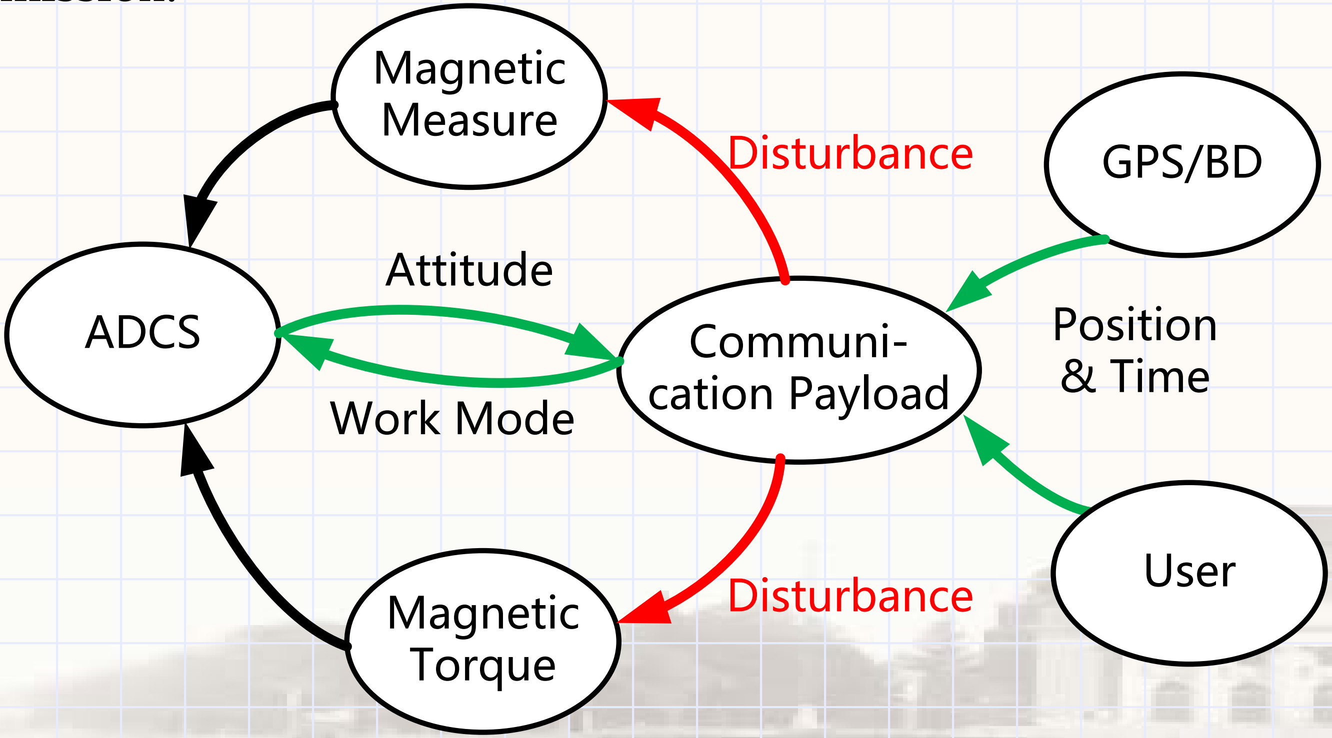
Due to the small space of the satellite, **a 6-ampere time-varying current** for the payload to work normally would cause a **dynamic magnetic measuring error of thousands of nanotesla (**up to 50% of the ratio between interference and valid measurement value**).**

- 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

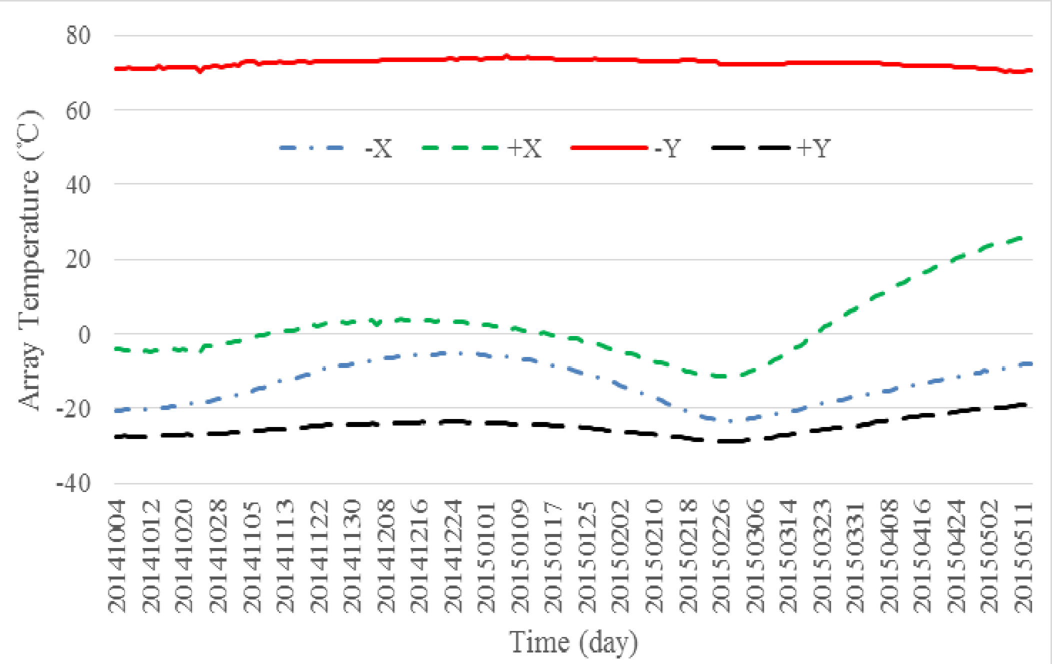
- The actual accuracy of attitude angles are better than ±1.5° ;
- No prominent angle drifting during the communication experiments;
- Handsets accessed the Internet and transmitted data;
- Vehicle terminals achieved the Internet accessing and high-speed data transmission.

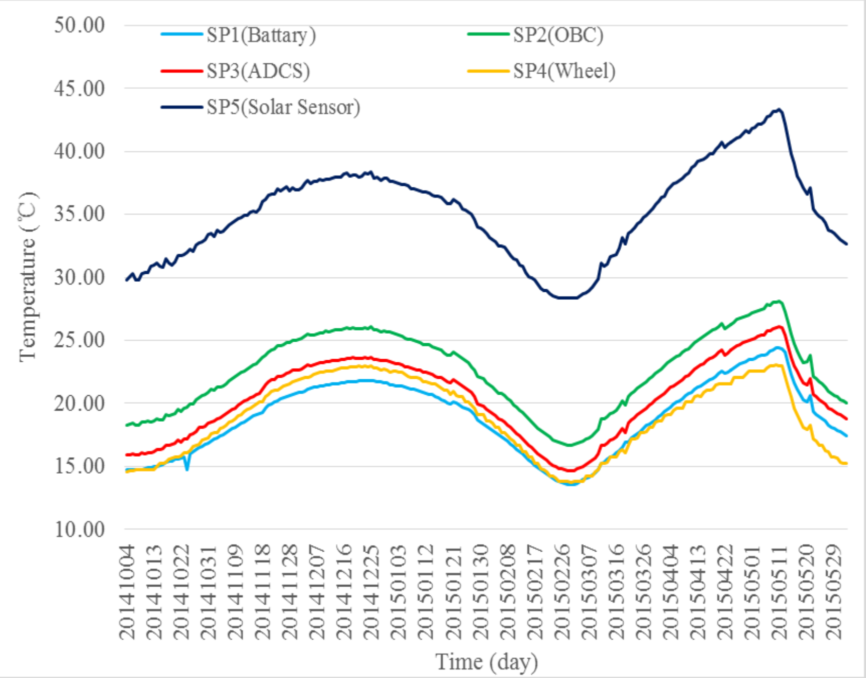


4 Flight Results

On-orbit Temperature

Internal circuit : 15 to 30 ° C (due to the drift of beta angle);
Battery:15 to 25 ° C.
Solar sensor: 30 to 54° C.
The telemetry data matches well with Thermal Desktop simulation.



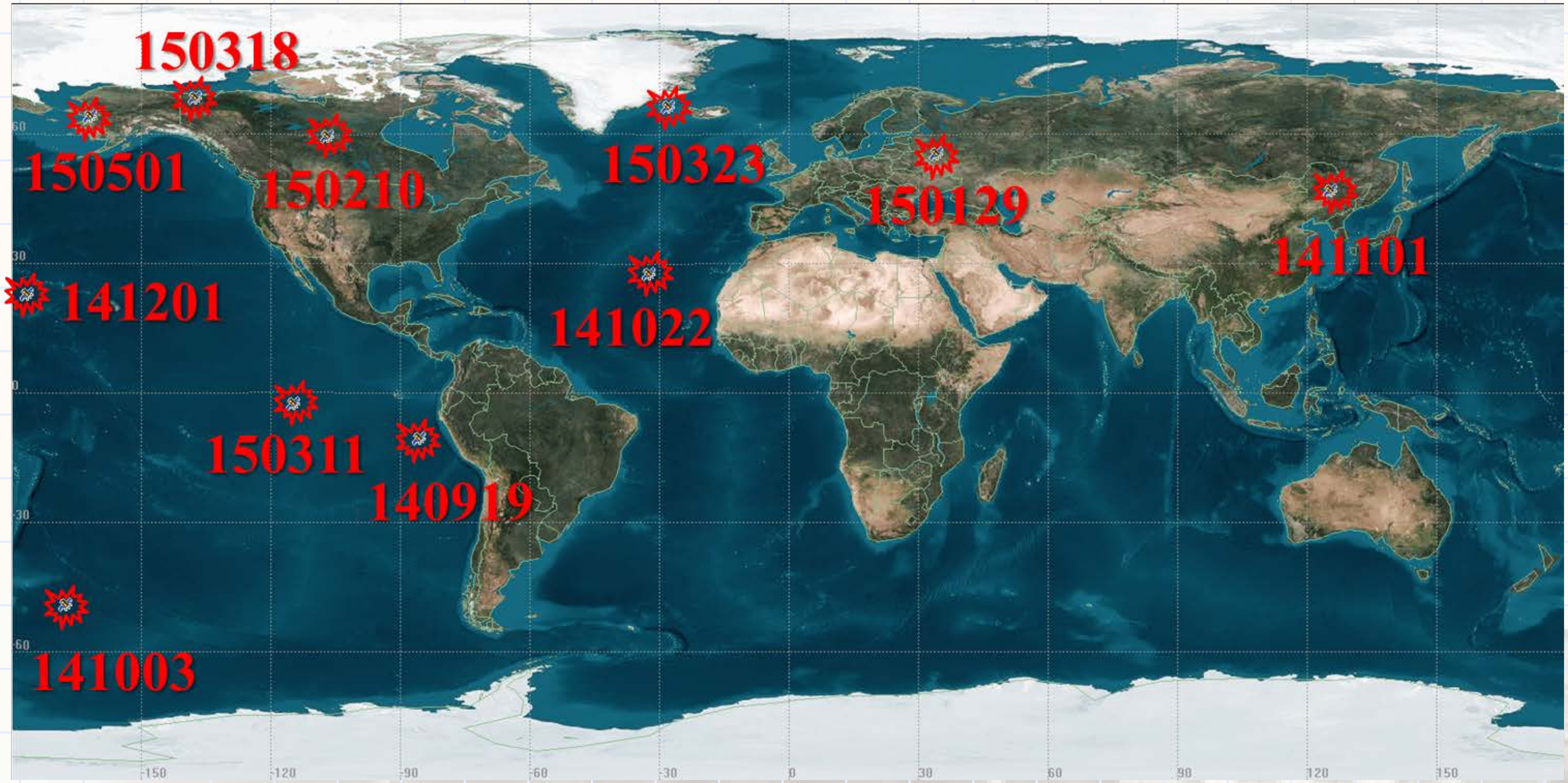


4 Flight Results

SEU Recodes

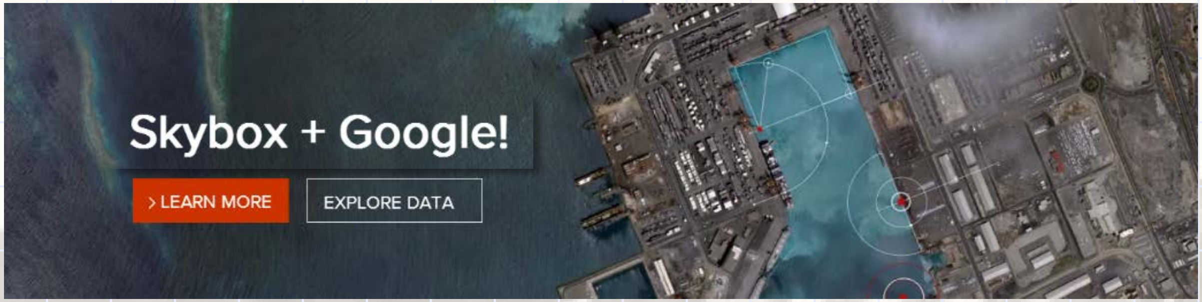
Unprotected SRAM (about 48Kbytes) to monitor the high-energy particle environment on orbit;

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



5 Future

looking to launch about **700 satellites** that each **weigh under 250**.



5 Future

Our Goal:

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

Thanks!

Q&A