Panel Discussion

Towards the Future of Geomatics Science – Its Global Impacts

Wuhan University
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19th-20th Nov. 2018, Deqing, China

Definition of Geomatics (ISO,1996)

- "Geomatics is a field of activity which, using a systematic approach, integrates all the means used to acquire and manage spatial data required as part of scientific, administrative, legal and technical operations involved in the process of production and management of spatial information. These activities include, but are not limited to, cartography, control surveying, digital mapping, geodesy, geographic information systems, hydrography, land information management, land surveying, mining surveying, photogrammetry and remote sensing."
- "Geomatics is the modern scientific term referring to the integrated approach of measurement, analysis, management and display of spatial data."

New definition of Geomatics in big data era

- Geomatics in big data era is a multiple discipline science and technology which, using a systematic approach, integrates all the means for spatio-temporal data acquisition, information extraction, networked management, knowledge discovering, spatial sensing and cognition, as well as intelligent location based services of any physical objects and human activities around the earth and its environment.

The future of Geomatics

1. Full automation;
2. Real time services;
3. From earth observation to human observation.

Unmanned aerial vehicle "TianHuo" (Independent Research and Development)

"TianHuo"

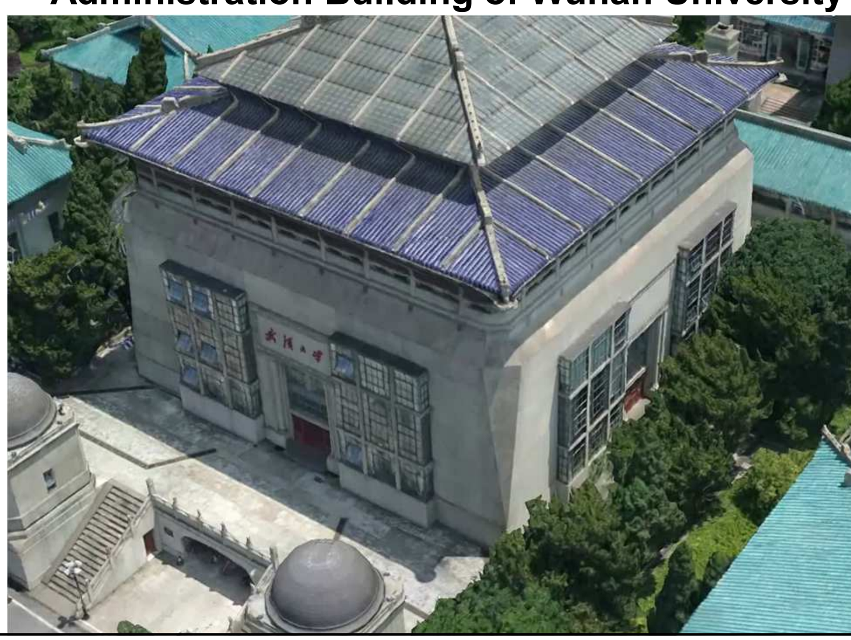
TianHuo + Pisces tilt camera

- **Flight time : 45 min**
- **Operation range : 0.6~0.8 km^2**
- **Ground pixel resolution : 1-3cm**
- **Maximum altitude : 4000 m**
- **Remote control distance : 10km**

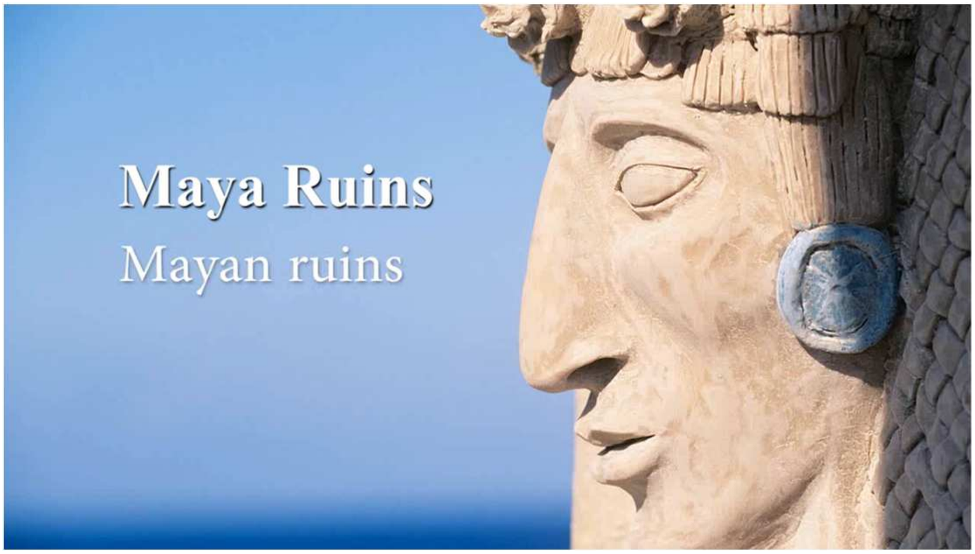
Flight master (control UAV):

- Specially designed for surveying and mapping
- Simplify hand flying operation, intelligent

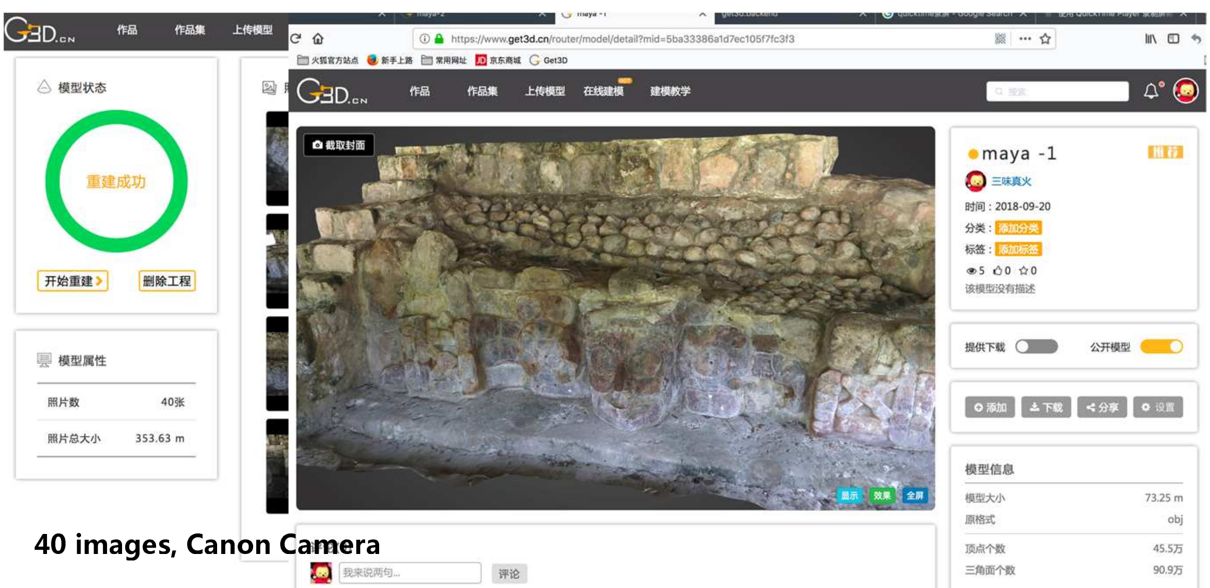
Three Dimensional Automatic Modeling of Administration Building of Wuhan University



Automatic 3D construction of Maya Ruins using non-metric Camera



Maya Statue Modeling using get3d.cn



40 images, Canon Camera

Modeling using Mobile Phone (Huawei)

Collected using Huawei Mobile Phone, 11 images to create model

Three Dimensional Automatic Modeling from Outdoor to Indoor

Automatic image search: automatic search for target from remote sensing images

How to search arbitrary target automatically from big image database (such as Google Maps and Sky maps) , achieve ：

- **Fast**
- **Accurate**
- **Directly on the Internet without the need to enter addresses**

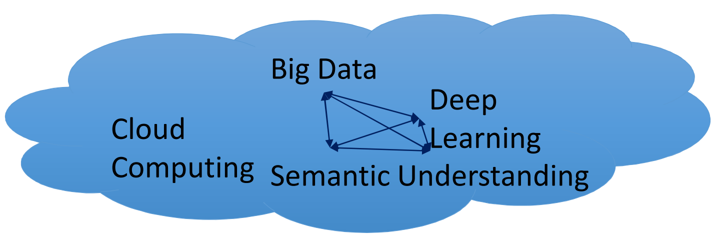


Image Retrieval on Large-Scale Tiled RS Image Database

A deep learning based high performance online search engine

- 10 million tiled remote sensing images
- Deep learning based content extraction and semantic modeling
- Second response time
- Search by keywords, semantic and example

Object Level

Land Cover Level

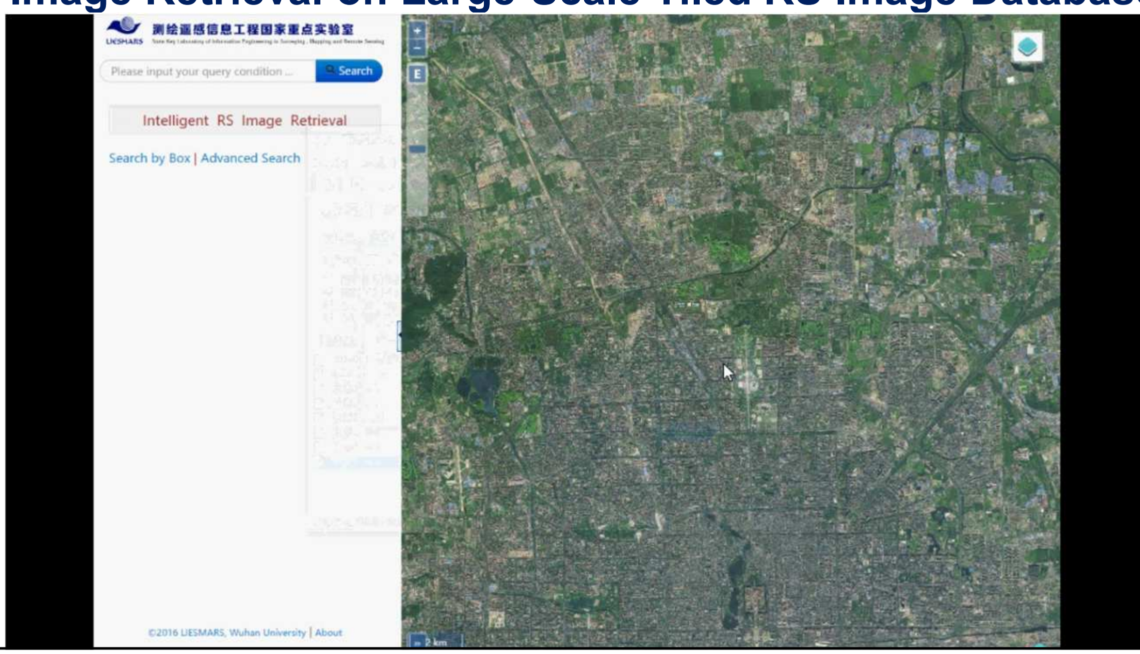
Scene Level

- Ship
- Airplane
- Playground
- ....

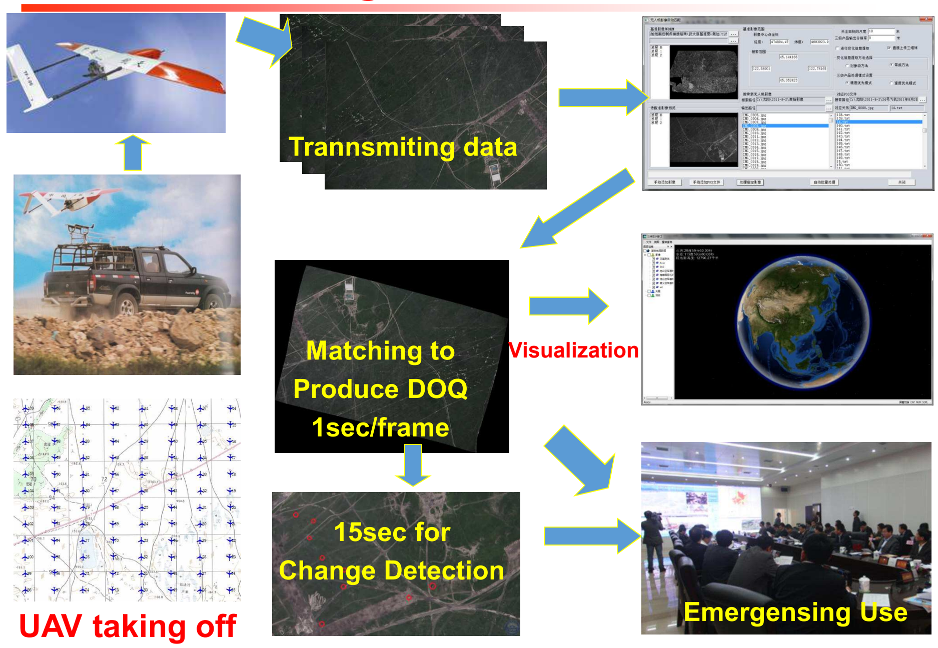
- Farmland
- Fishpond
- Villa area
- ....

- Wharf
- Overpass
- Parking lots
- ....

Image Retrieval on Large-Scale Tiled RS Image Database

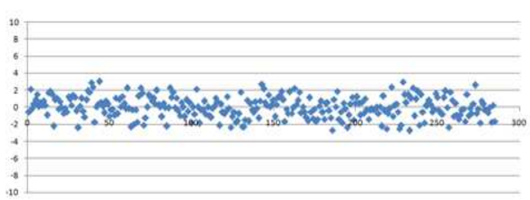


Automatic Change Detection for UAV Data



Automatic Block Adjustment without GCP for super large area with ZY-3 Data

--- Automatic block adjustment of ZY-3 data (8810x3 scenes, 40TB);
--- 3 million connection points are automatically selected from the 2 billion matched points by using the gross error detection method ;
--- Automatic generation Of DOQ（2x2m） and DSM(5x5), which can meet the requirements of 1:50,000 topographic mapping.



Result after System Error Compensation and Gross Error Elimination (5 Meters)

- Data Volume: 40TB
- 60 Computation Nodes
- GPU+CPU
- Completed in 10 days

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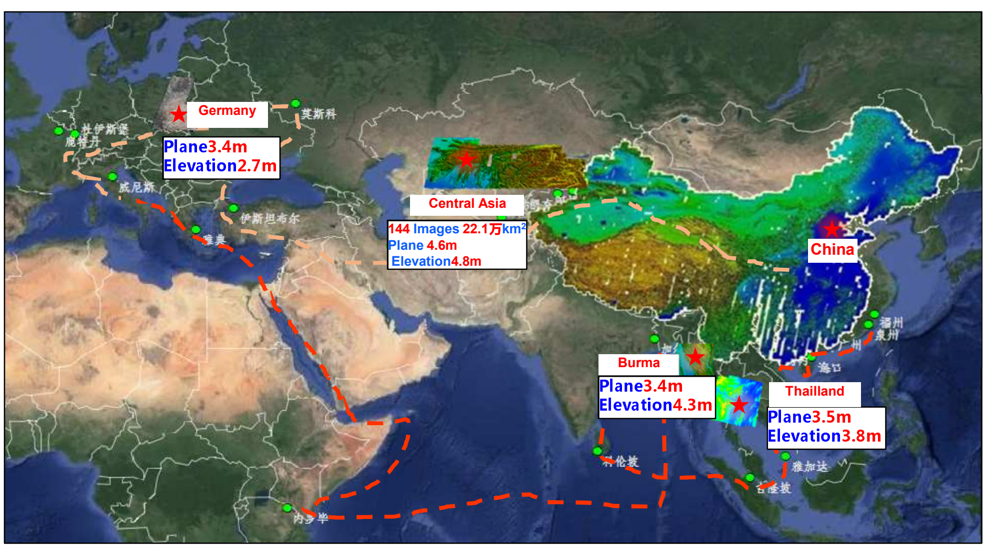
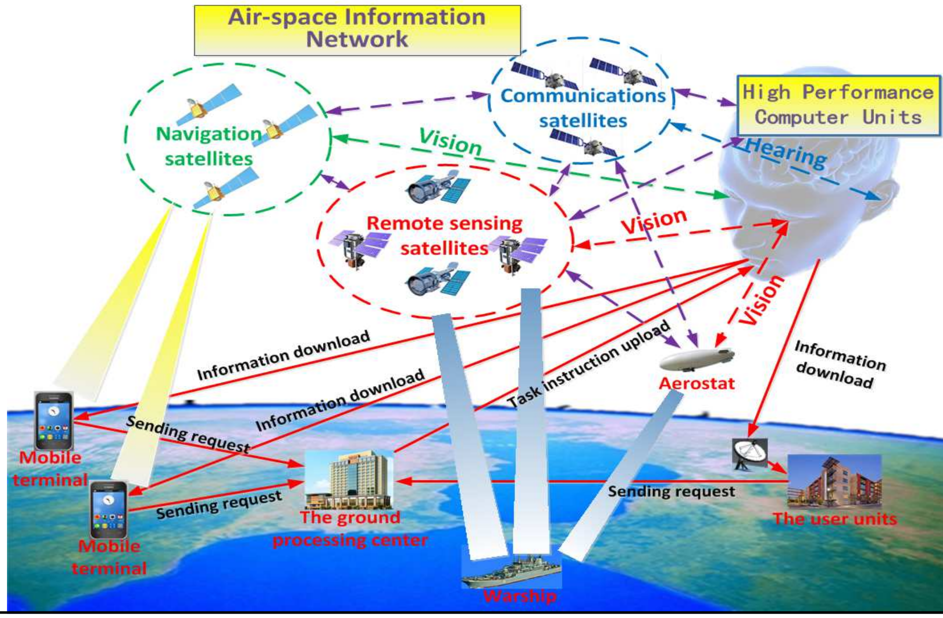
DOM/DSM Automatic Production of the Whole China

2mDOM **5mDSM**

ZY-3 Images are used for “Global Automatic Mapping Major Projects”: Central Asia, Thailand, Burma and Germany



Concept Map of EOB



Concept of EOB

- The human brain obtains information of the surrounding environment by visual, auditory and other functions. Then the information is transmitted to the left and right hemispheres using the neurons. The left and right hemispheres analyze the surrounding environment information, thus guiding people's behavior.
- EOB can achieve on-board sensing, cognition and transmitting the right data, information and knowledge to the end user in real time .

Intelligent Detection and Location Architecture for Time - sensitive Target

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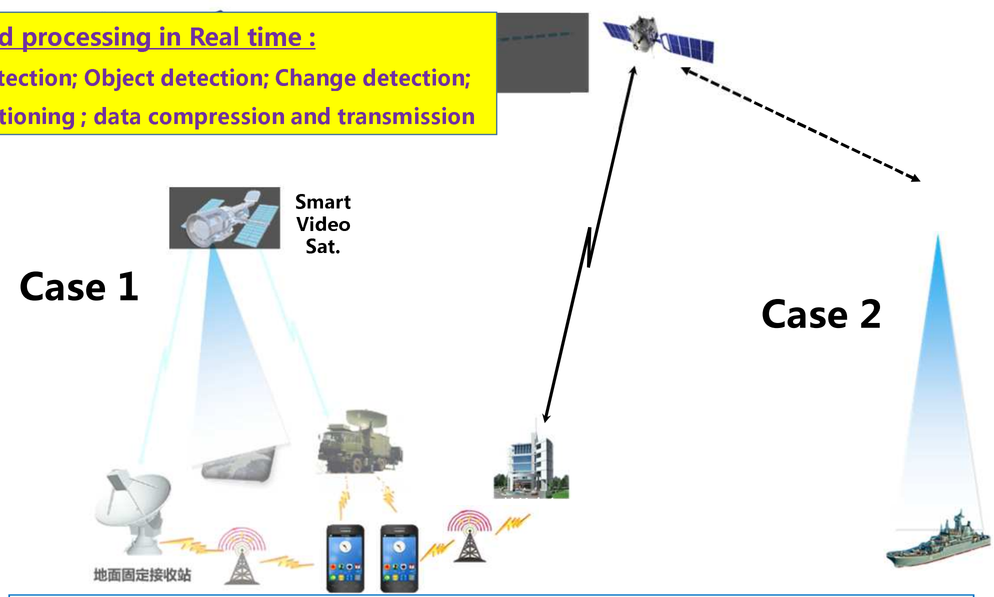
Real time RS to your Smartphone

On board processing in Real time :

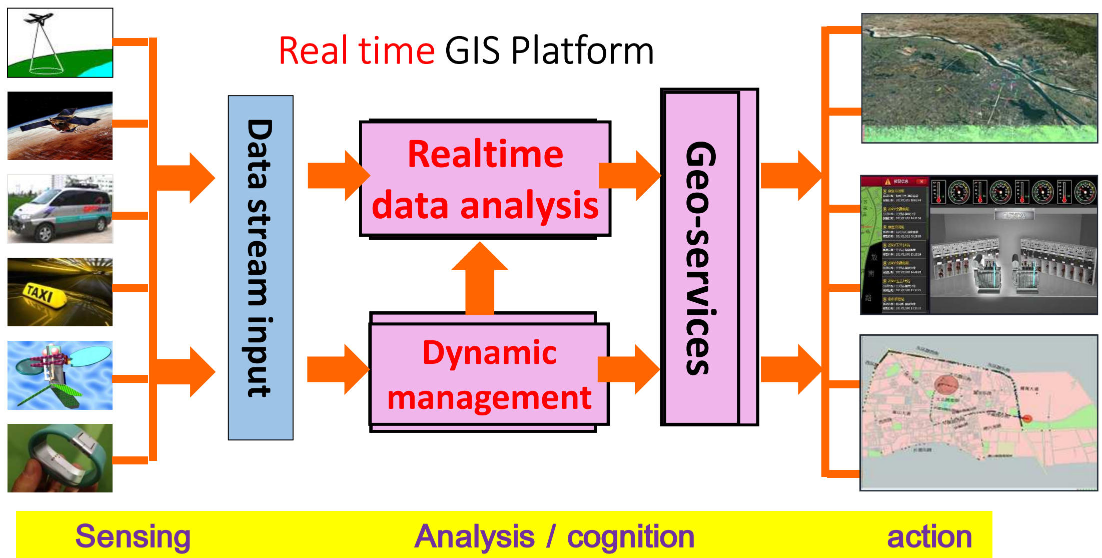
Cloud detection; Object detection; Change detection;

Geo-positioning ; data compression and transmission

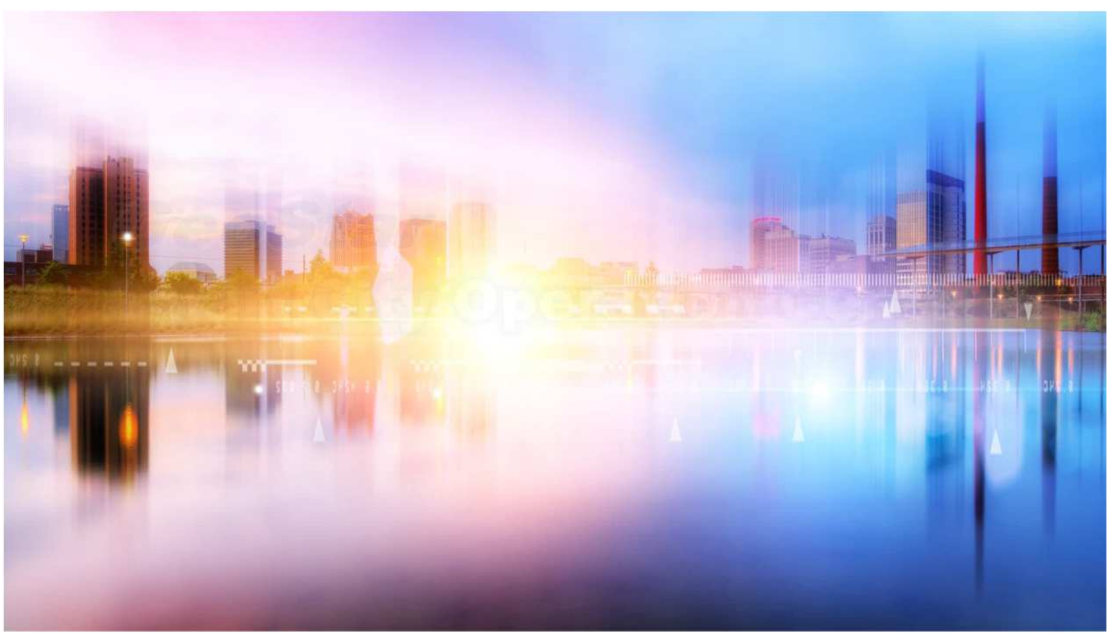


Service time: ~few seconds

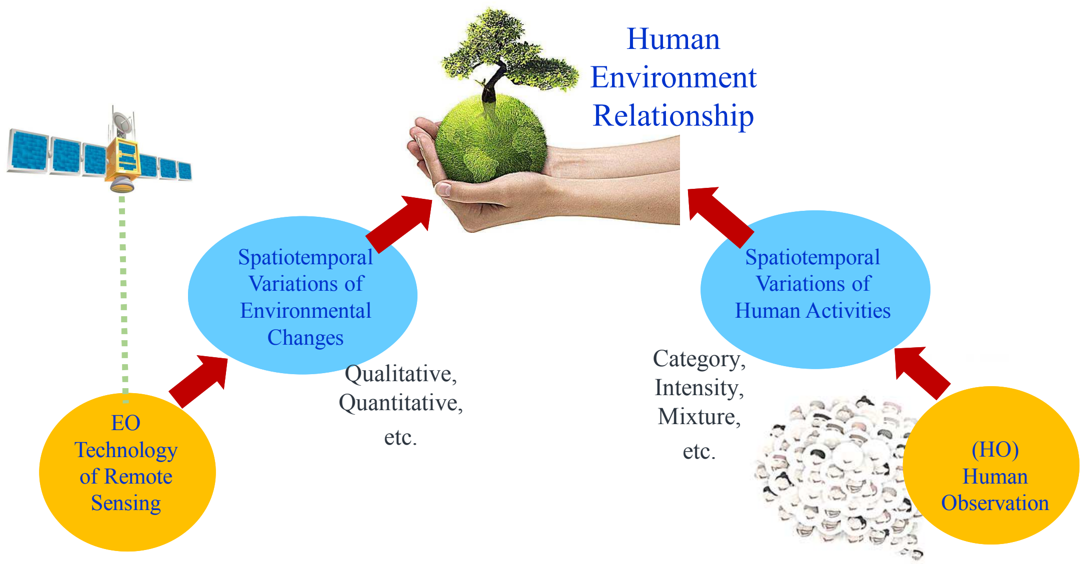
Real time GIS（GeoSmarter）



Smart city operation Brain

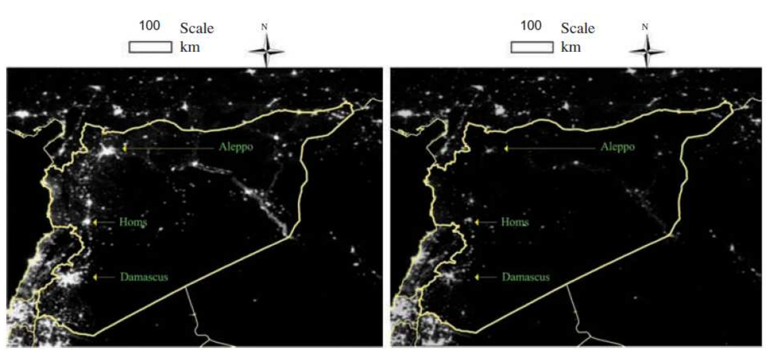


From Earth Observation to Human Observation



Evaluating the Syrian Civil War using the night-time light RS

- We use the DMSP/OLS monthly product to show the night-time light in Syria. From these images, most of previously lighted areas have fallen to darkness

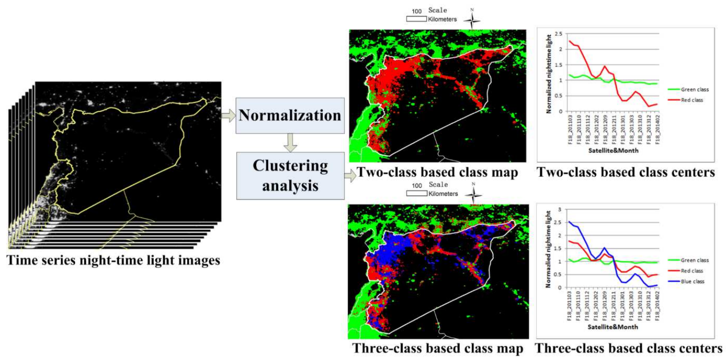


Night-time light in March, 2011 Night-time light in February, 2014

LIESMARS

Evaluating the Syrian Civil War

- By using clustering analysis on normalized multi-temporal night-time light images, the spatiotemporal pattern of the night-time light is revealed
- ✓ The two-class map shows two different night-time light variation patterns with the international border as the pattern border; The three-class map shows a similar pattern



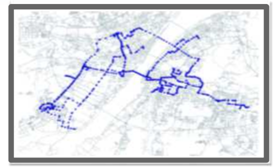
Evaluating the Syrian Civil War

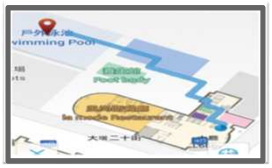
Al Jazeera report on our research
阿拉伯半岛电视台引用本团队研究成果

Geo-computation with GNSS Tracking Data

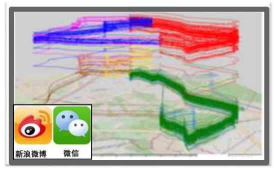

Mobile phone


Video


Taxi

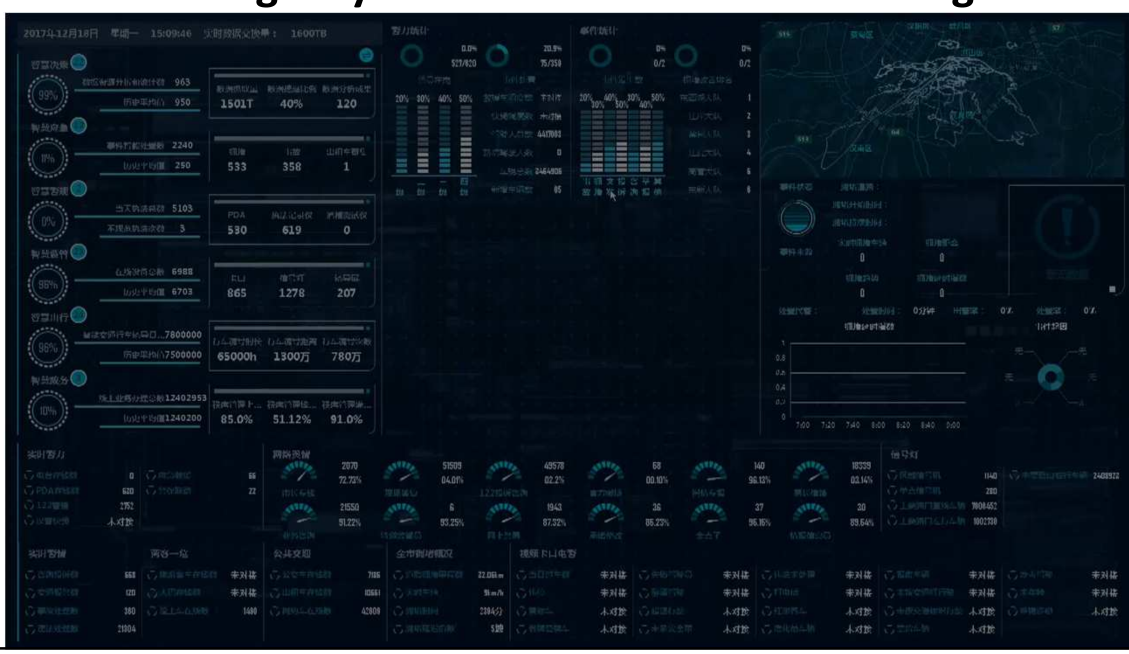

Indoor Location


Bus and subway card data


New Media Check in Data

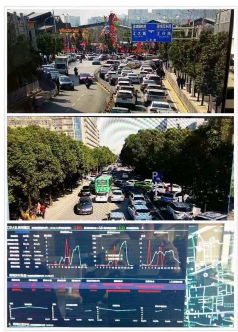
City's Travel Track Big Data

Smart Emergency Brain of Wuhan Traffic Management



Smart Emergency Brain of Wuhan Traffic Management

- In 2017, in the national ranking of traffic congestion, the system improved Wuhan from 23 to 53.
- In Oct. 2017, using "7 quick model", the system minimized traffic congestion accident handling time from 7 minutes to 90 seconds.
- On 11th Dec. 2017, Keqiang Li, the Prime Minister of P. R. China, spoke highly of the system after watching its operation.



Conclusion

1. The ubiquitous space-air-ground sensors will produce unprecedented big spatio-temporal data;

2. Facing the situation of **"mass data, less information , lack of knowledge"**, the integration of big geospatial data, cloud computing and AI techniques should be very important;

3. The integration of earth observation and human observation is helpful to answer the human-nature relation.

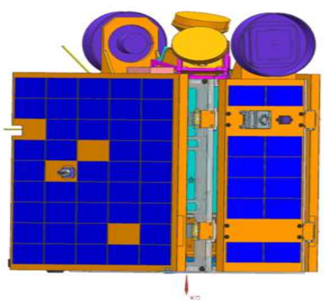
Thank You!

Satellite LJ-1 Series PNTRC

Wuhan University launches the Satellite LJ-01 to verify PNTRC thought

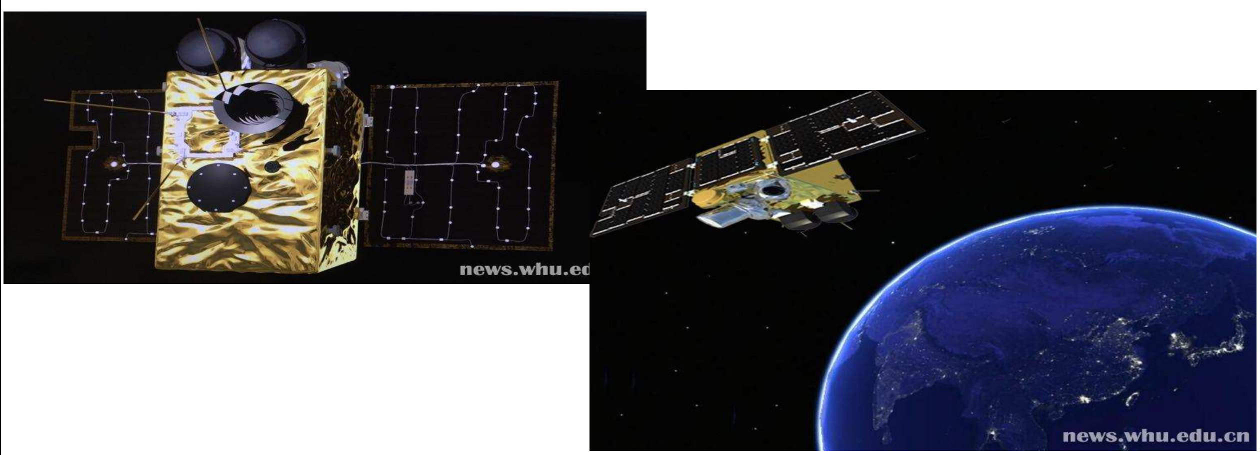
- **Satellite LJ-1A**
  - ✓ **The first professional night light remote sensing satellite in China has a pioneering significance for the development of China's luminous remote sensing satellite and the application of remote sensing in the social and economic fields.**
  - ✓ **The LEOS-based navigation enhancement , the first test in the world. The test results are of great significance to the follow-up construction of the Beidou System in China. It is possible to lay aside the need for building global stations in foundation reinforcement.**
- **Satellite LJ-1B**
  - ✓ **Multi-angle radar remote sensing , the first test in the world. The test results are of great significance to the development of radar satellite and radar mapping in China.**
  - ✓ **Video radar remote sensing , the first test in the world. The test results are of great significance to the application and innovation of moving target detection and tracking.**
- **Satellite LJ-1C**
  - ✓ **sensor to shooter , the first test in China. The test results are of great significance to the consumption level application . LJ-1C will send the real time 0.5 resolution video image directly to the end user's Smartphone.**

Main technical parameters of Satellite LJ-1A



Track Type: sun synchronous orbit
Orbit Height : 645 km
Ground Pixel Resolution: 130m@650km(sub-satellite point)
Imaging Spectrum: 480nm~800nm
Ground Bandwidth: 250km×250km@650km
Imaging Mode: night light mode + day light mode
Maneuverability: elevation axis > 0.9° /s
Three Axis Attitude Stability: batter than 0.1° s
Attitude Determination Accuracy: batter than 0.05°
Total Satellite Mass: 22kg
On Orbit Envelope Size : 520mm×870mm×390mm
Measurement and Control: UHF measurement and control system , distinct transmission mode
Data Transmission: X band, 50Mbps
Design Life: 6 months

Satellite LJ-1A Diagram

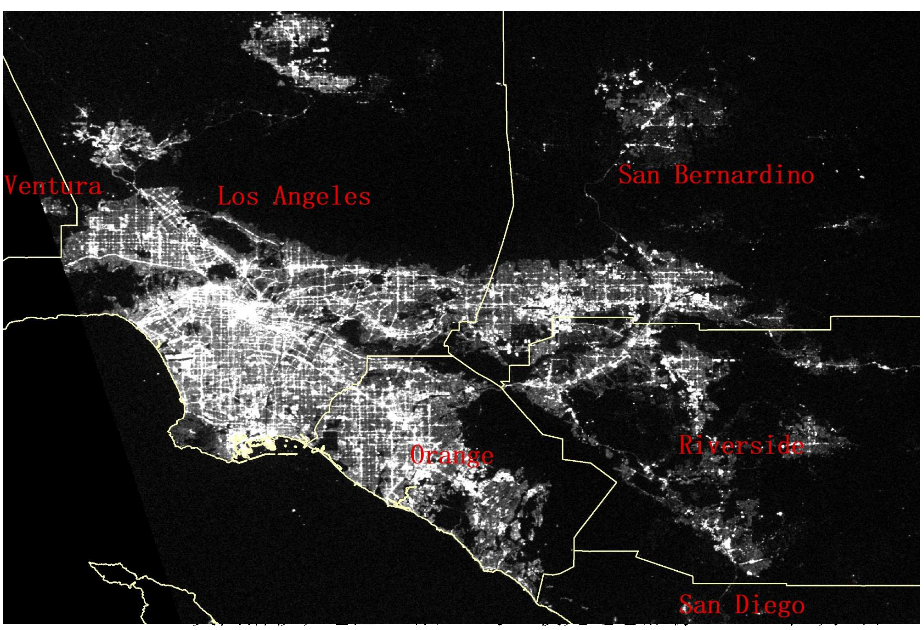


The Real Satellite LJ-1A

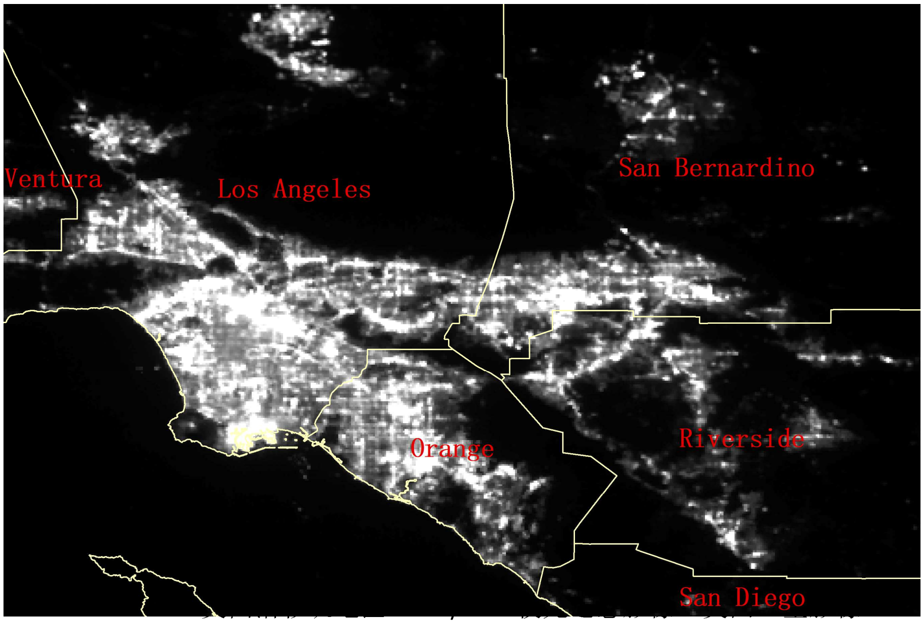
Development of Satellite LJ-1A

Launching of Satellite LJ-1A with CZ-2 Rocket (June 2, 2018)

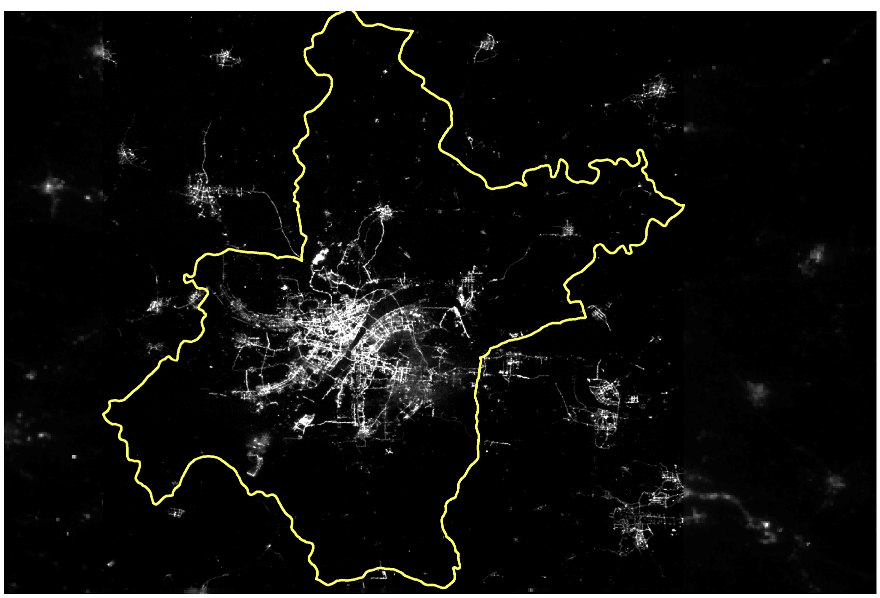
Night time light Image of LJ-1A



Night time light Image of S-NPP/VIIRS



Night time Light Image of Wuhan (LJ-1A)



武汉地区“珞珈一号”夜光遥感影像

Night time Light Image of Wuhan(S-NPP/VIRS)

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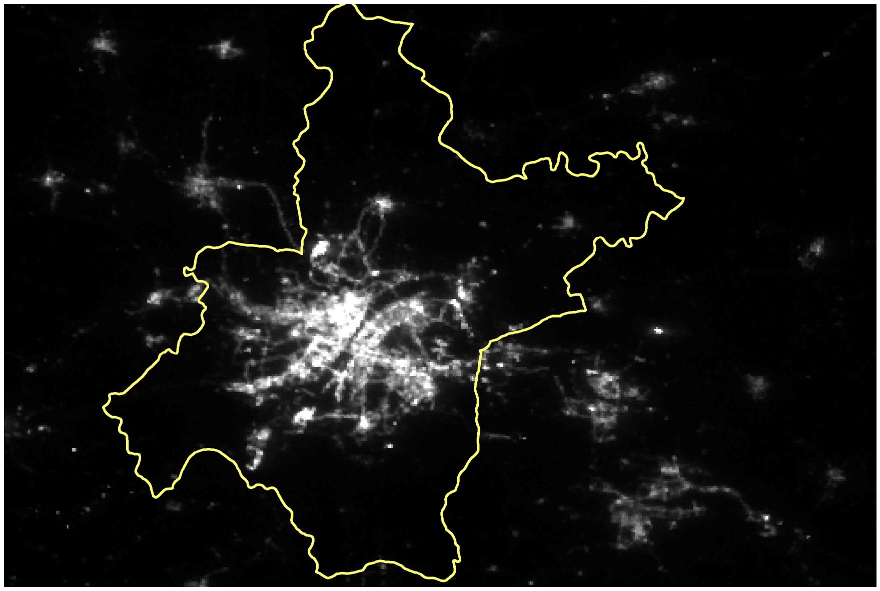
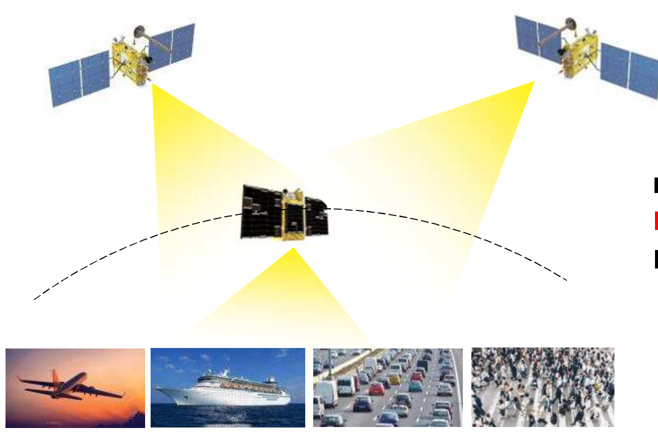


武汉地区S-NPP/VIIRS夜光遥感影像（美国卫星影像）

LEO Navigation enhancement Principle



- Receiving GNSS Signals
- On board Processing
- Signal transmission to ground

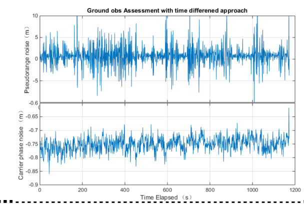
LEO Navigation enhancement Test on LJ-1A

Test results:

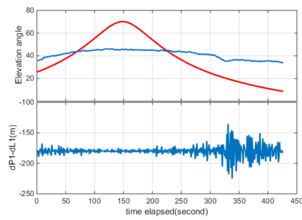
Accuracy of pseudo range 2-3m(1σ),

Accuracy of carrier phase 2-3cm(1σ)

Ground Test

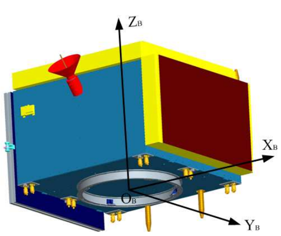


On board Test



Satellite LJ-1B

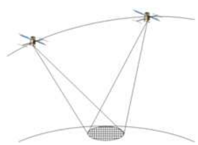
Wuhan University and Beijing Institute of Spacecraft System Engineering(ISSE) have being jointly developed the satellite LJ-1B, a Chinese scientific experiment SAR satellite, which has some new imaging functions, such as multi-angle imaging and video imaging.



Imaging mode	Azimuth resolution (m)	Range resolution (m)	Azimuth width (km)	Range swath (km)	Azimuth scanning angle(°)	Incidence angle (°)
Multi-angle imaging	1	1	1.5	8	-45~45	15
Video imaging	3	3	1.5	8	-15~15	15
Spotlight imaging	0.5	0.5	1.5	5	-	15
Strip imaging	3	3	Dependence on imaging time	8	-	15-25
Star point imaging	2	0.8	7	-	-	0

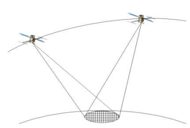
Satellite imaging mode

Multi-angle imaging



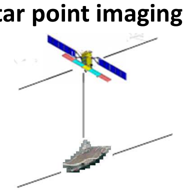
	PRF（Hz）	Width(Km)	Look Angle（deg）	Beam Angle（deg）	Incidence Angle（deg）	Azi. Res.（m）	Range Res.（m）	Band Width（MHz）	Average Power（W）	NEsigma0（dB）	Data Rate（8:3）（Mbps）
Multi-angle imaging	6550.00	8.82	46.9	0.41	51.94	1	0.95	280	452.5	-29.94	719.86

Video imaging



	PRF（Hz）	Width(Km)	Look Angle（deg）	Beam Angle（deg）	Incidence Angle（deg）	Azi. Res.（m）	Range Res.（m）	Band Width（MHz）	Average Power（W）	NEsigma0（dB）	Data Rate（8:3）（Mbps）
Maximum beam position	6600.00	8.82	24.81	0.81	26.91	3.00	1.66	200	456.19	-27.47	1154.06
Minimum beam position	6850.00	7.66	15.00	0.81	16.21	3.00	2.69	200	473.47	-30.62	841.61

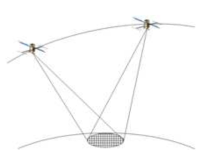
Star point imaging



	PRF（Hz）	Width (Km)	Look Angle（deg）	Beam Angle（deg）	Incidence Angle（deg）	Azi. Res.（m）	Range Res.（m）	Band Width（MHz）	Average Power（W）	NEsigma0（dB）	Data Rate（8:3）（Mbps）
Star point imaging	6550	7.0	0	0.81	0	2.0	0.8	200	452	-27.5	250

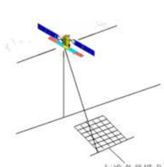
Satellite imaging mode

Spotlight imaging



	PRF（Hz）	Width(Km)	Look Angle（deg）	Beam Angle（deg）	Incidence Angle（deg）	Azi. Res.（m）	Range Res.（m）	Band Width（MHz）	Average Power（W）	NEsigma0（dB）	Data Rate（8:3）（Mbps）
Spotlight inaging	7150.00	5.43	15.31	0.81	16.55	0.5	0.44	900	520	-27.57	2009.14

Strip imaging



	PRF（Hz）	Width (Km)	Look Angle（deg）	Beam Angle（deg）	Incidence Angle（deg）	Azi. Res.（m）	Range Res.（m）	Band Width（MHz）	Average Power（W）	NEsigma0（dB）（beam center）	Data Rate（8:3）（Mbps）
Minimum beam position	6850.00	7.67	15.33	0.81	16.56	3	2.63	200.00	452.31	-27.63	577.10
Central beam position	7150.00	8.19	20.33	0.81	22.00	3	2.67	150.00	463.45	-27.40	541.31
Maximum beam position	7180.00	8.91	25.33	0.81	27.47	3	2.71	120.00	483.50	-27.12	520.06

Schedule of the Satellite LJ-1B

- February 2017: Launching of the project
- June 2017: Further argumentation of the project
- December 2017~June 2019： Development and Production
- September 2019(in plan)： Satellite Launching