Top Geo-Information and Geo-Technology Priorities in China - A Comparison with the European Situation

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Acknowledge to Professors Deren Li and Huadong Guo

8 October, 2014
OUTLINE

• Introduction

• Development of Geoinformation Technology and Industry in China

• Sino-EU Cooperation
Urbanization as the New Engine of China’s Economic Development in next 20 Years

However, the new government needs to solve several critical problems which were generated from very fast economic development in last 20 years:

• Environmental pollution
• Social justice
• Natural resource management
This national program requested
• Change of the management tradition
• Re-structure the professional teams
• Upgrade the technologies in surveying and mapping

Strategic Move – the second milestone for NBSM
### National Geo-Survey’s impact to the existing system

<table>
<thead>
<tr>
<th>Basic Geo-Information</th>
<th>Thematical Geo-Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land ownership</td>
<td>Flood Area Population</td>
</tr>
<tr>
<td>transportation</td>
<td>Distribution</td>
</tr>
<tr>
<td>Water system</td>
<td>Land cover</td>
</tr>
<tr>
<td>Boundary</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Control Points</td>
<td>Atmosphere</td>
</tr>
<tr>
<td>Elevation</td>
<td>Soil</td>
</tr>
<tr>
<td>Aerial Image</td>
<td></td>
</tr>
</tbody>
</table>

#### 1st step: Inventory

#### 2nd step: Dynamic monitoring

**Challenges in monitoring**

The environmental change in time
Chen Shupeng
Fellows of CAS, IEAS, and TWAS.

Big Data, Big Map.

The changes of Mapping Technologies:
- Map data acquisition
- Map data management
- Map data analysis
- Map data representation
- Map applications
The Map Stories of Richest Person in China
阿里巴巴为何必须收购高德？

腾讯科技 作者 力辰 2014年02月11日08:24

[导读]通过地图业务扩充阿里巴巴在移动互联网领域的军火库，应对其他巨头的挑战。
腾讯在亚洲股市
Industry Chain of Map Navigation in China

http://b2b.toocle.com/detail-6118256.html
National Strategies

Focus development schemes:

- High Resolution remote sensing
- Xihe positioning network
- From geo-data management to geo-processing model management
GLOBAL DATA GENERATION (2014)

- USA 32%
- West Europe 19%
- China 13%
- India 4%
- Other countries 32%

In 2020, China is expected to generate 21% of global data.
1. Four Earth Observation satellite series in China

<table>
<thead>
<tr>
<th>Satellite Type</th>
<th>Satellite</th>
<th>Payload</th>
<th>Spectral ranges</th>
<th>Spatial resolution (m)</th>
<th>Swath width (km)</th>
<th>Revisit rate (d)</th>
<th>Launch time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infrared Scanner</td>
<td>SWIR/IRR/IR</td>
<td>VIS/NIR/IR</td>
<td>78/156</td>
<td>120</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CBERS-1-01 /02B</td>
<td>High-Resolution Camera</td>
<td>VIS/NIR/IR</td>
<td>20/258</td>
<td>113/890</td>
<td>26/5</td>
<td>29.10.2007</td>
</tr>
<tr>
<td></td>
<td>ZY-3-01</td>
<td>CCD</td>
<td>VIS/NIR/IR</td>
<td>2.36</td>
<td>52</td>
<td>59/5</td>
<td>09.01.2012</td>
</tr>
<tr>
<td></td>
<td>Forward/Back-looking Camera</td>
<td>VIS/NIR/IR</td>
<td>VIS/NIR/IR</td>
<td>3.5</td>
<td>52</td>
<td>59/5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HJ1-1A</td>
<td>CCD/Hyperspectral Imager</td>
<td>VIS/NIR/IR</td>
<td>30/100</td>
<td>700/50</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HJ1-1B</td>
<td>Infrared Multispectral Camera</td>
<td>VIS/NIR/IR</td>
<td>30</td>
<td>700</td>
<td>4</td>
<td>06.09.2008</td>
</tr>
<tr>
<td></td>
<td>HJ-1C</td>
<td>Synthetic Aperture Radar</td>
<td>-</td>
<td>5 (single look) * 20 (4 looks)</td>
<td>40-strip mode/100 scan mode</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Environment Series</strong></td>
<td>FY-1A/B</td>
<td>MVISR</td>
<td>VIS/NIR/TIR</td>
<td>1100/4000</td>
<td>2860</td>
<td>-</td>
<td>06.09.1988/03.09.1990</td>
</tr>
<tr>
<td></td>
<td>FY-1C/D</td>
<td>MVISR</td>
<td>VIS/IR</td>
<td>1100/4000</td>
<td>3100</td>
<td>12</td>
<td>10.05.1999/15.05.2002</td>
</tr>
<tr>
<td></td>
<td>HEPD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Meteorological Series</strong></td>
<td>FY-2A/B/C</td>
<td>VISSR</td>
<td>VIS/IR</td>
<td>1250/5000/5760</td>
<td>-</td>
<td>30/25.5</td>
<td>10.06.1997/25.06.2000/</td>
</tr>
<tr>
<td></td>
<td>IRAS/VISSR/MERSI</td>
<td>VIS/IR</td>
<td>VIS/IR</td>
<td>17/km/1100/250-1000</td>
<td>2800</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MWTS</td>
<td>EHF/U-band</td>
<td>EHF/U-band</td>
<td>15/km/50-75km</td>
<td>2700</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MVRI</td>
<td>X/Ku/Ka/W-band</td>
<td>X/Ku/Ka/W-band</td>
<td>15-85km</td>
<td>1400</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ERM/SIM</td>
<td>UV/VIS/IR</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SBUS/TOU</td>
<td>UV</td>
<td>200km/50km</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Space Environment Monitor</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Ocean Series</strong></td>
<td>HY-1A/B</td>
<td>COCTS/CZI</td>
<td>VIS/IR/TIR</td>
<td>1100/250</td>
<td>1600/3000/500</td>
<td>3/1/7</td>
<td>15.05.2002/11.04.2007</td>
</tr>
<tr>
<td></td>
<td>HY-2</td>
<td>Radar Altimeter</td>
<td>C/Ku-band</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>16.08.2011</td>
</tr>
<tr>
<td></td>
<td>Microwave Scatterometer</td>
<td>Ku-band</td>
<td>-</td>
<td>1350/1700</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SMR/CMR</td>
<td>C/X/Ka-band</td>
<td>-</td>
<td>1600</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Note: VIS: Visible; SWIR: Short-wave Infrared; IR: Infrared; NIR: Near Infrared; TIR: Thermal Infrared; EHF: Extremely High Frequency; UV: Ultraviolet; WFI: Wide Field Imager;IRMSS: Infrared Multispectral Scanner; MVISR: Multichannel Visible and IR Scanning Radiometer; HEPD: High Energy Particle Detector; VISSR: Visible and Infrared Spin Scan Radiometer; IRAS: Infrared Atmospheric Sounder; MERIS: Medium Resolution Spectral Imager; MWTS: Microwave Temperature Sounder; ERM: Earth Radiation Measurement; SBUS: Solar Backscattering UV Radiometer; TOU: Total Ozone Unit; COCTS: Chinese Ocean Color and Temperature Scanner; CZI: Coastal Zone Imager; SMR: Scanning Microwave Radiometer; CMR: Calibrated Microwave Radiometer.
Earth observation satellites in China

- Meteorological Satellite
  - Polar Orbit FY-1 A,B,C,D, FY-3A,3B 6
  - Geo-stationary FY-2A,2B,2C,,22E 5
- Marine Satellite HY-1A,1B, HY 2A 3
- Resource Satellite (CBERS 01,02A,B,;ZY-2a,b c; RS1-11) 17
- Communication Satellite 11
- Navigation Satellite Beidou 15
- Return Land Satellites 17
- Scientific experiment Satellites 18
- Spacecraft SZ –1,2,3,4,5,6,7,8,9 9
- HJ satellites A ,B,C 3
- Mapping Satellite ZY3，High Resolution GF-1 2
• Space-Air-Ground integrated earth observation network (SAGIEON) is not only the most promising high-tech area, but also a fundamental infrastructure closely related to national security and economic/social development. (LI Deren, 2012)

http://www.cheos.org.cn/n380385/n380480/c390685/content.html
Space-Air-Ground Integrated Observation Network (973 Project) (LI Deren, 2012)
The Multi-source, Multi-scale and Multi-temporal Spatial Data Model with the Global Seamless grid

(LI Deren, 2012)
## Triple Linear Array CCD Sensor Parameters

<table>
<thead>
<tr>
<th>Sensor Parameter</th>
<th>Triple linear Array Camera</th>
<th>Multi-spectral Camera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral Range</td>
<td>0.5~0.8um</td>
<td>Blue: 0.45-0.52um</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green: 0.52-0.59um</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red: 0.63-0.69um</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Near Infrared: 0.77-0.89um</td>
</tr>
<tr>
<td>GSD</td>
<td>Nadir: 2.1m</td>
<td>5.8m</td>
</tr>
<tr>
<td></td>
<td>Forward &amp; Backward: 3.5m</td>
<td></td>
</tr>
<tr>
<td>Focus Length</td>
<td>1700mm</td>
<td>1750mm</td>
</tr>
<tr>
<td>bit number of quantization</td>
<td>10bit</td>
<td>10bit</td>
</tr>
<tr>
<td>Pixel size</td>
<td>Nadir: 24576PixelX7um;</td>
<td>9216Pixel X 20um</td>
</tr>
<tr>
<td></td>
<td>Forward &amp; Backward:16384Pixel X10um</td>
<td></td>
</tr>
<tr>
<td>Static MTF</td>
<td>Better than 0.2</td>
<td>Better than 0.2</td>
</tr>
<tr>
<td>Swath</td>
<td>52km</td>
<td>52km</td>
</tr>
<tr>
<td>Field of View</td>
<td>6 Degree</td>
<td>6 Degree</td>
</tr>
</tbody>
</table>
The First Triple Linear Array CCD images from ZY-3

Forward 3.5m  Nadir  Backward
Dalian Harbor fusion image of panchromatic and multi spectral image 2.1m
Munich airport, Germany
panchromatic image 2.1m
fusion image of panchromatic and multi spectral image 2.1m
Valid Data Coverage for China

Area: 7,500,000km²
Scene: 10,148
Valid Data Coverage - Global

Area: 30,000,000km²
Scene: 33,327
ZY3 Image -棕榈岛- Isle of Palms
ZY3 Image - 埃及 - Egypt
## Comparison with other Satellites

<table>
<thead>
<tr>
<th>Items</th>
<th>French SPOT5</th>
<th>Japan ALOS</th>
<th>India IRS-P5</th>
<th>Thailand THE OS</th>
<th>China ZY3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>2.5/5/10m</td>
<td>2.5m</td>
<td>2.5m</td>
<td>2m</td>
<td>Nadir 2.1m Forward &amp; Backward 3.5m</td>
</tr>
<tr>
<td>Base-altitude ratio</td>
<td>0.82</td>
<td>1.0</td>
<td>0.62</td>
<td>0.5-0.8</td>
<td>0.89</td>
</tr>
<tr>
<td>grey quantitative value</td>
<td>8bit</td>
<td>8bit</td>
<td>10bit</td>
<td>8bit</td>
<td>10bit</td>
</tr>
<tr>
<td>Accuracy without GCP</td>
<td>15m</td>
<td>200m</td>
<td>80m</td>
<td>200m</td>
<td>Better than 15m</td>
</tr>
<tr>
<td>Accuracy with GCP</td>
<td>5-10m</td>
<td>3-5m</td>
<td>5m</td>
<td>3-5m</td>
<td>2-5m</td>
</tr>
</tbody>
</table>
The first stage: 3 satellites
2 optical (HJ-1A/1B) + 1 SAR (HJ-1C)

The second stage: 8 satellites
4 optical + 4 SAR
Monitoring Using HJ-1A/B in Australia in 2009
**HJ-1C: First Chinese civilian SAR satellite**

<table>
<thead>
<tr>
<th>Item</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Launch date</td>
<td>19 Nov, 2012</td>
</tr>
<tr>
<td>Lifetime</td>
<td>3 years</td>
</tr>
<tr>
<td>Orbit height</td>
<td>~500 km</td>
</tr>
<tr>
<td>Microwave band (Polarization)</td>
<td>S-band (VV)</td>
</tr>
<tr>
<td>Radar frequency (wavelength)</td>
<td>3.2 GHz (9.37 cm)</td>
</tr>
<tr>
<td>Radiometric resolution</td>
<td>3 dB</td>
</tr>
<tr>
<td>Spatial resolution</td>
<td>5 m (Stripmap), 20 m (ScanSAR)</td>
</tr>
<tr>
<td>Imaging swath</td>
<td>40 km (Stripmap), 100 km (ScanSAR)</td>
</tr>
<tr>
<td>Incidence angle</td>
<td>25 ~ 47°</td>
</tr>
<tr>
<td>Repeat cycle</td>
<td>31 days</td>
</tr>
</tbody>
</table>
HJ-1C coverage Asia until 10 May, 2013

≥ 30000 scenes
Applications of FY-03

Global radioactive anomalies in shortwave and longwave derived from ERM/FY-3 in an El Niño year (2010) and La Niña year (2011) (Yang et al., 2012)
Oceanic Satellites-HY series

**HY-1 Satellite**

To detect the marine environmental parameters of China Seas
- chlorophyll concentration
- suspended sediment concentration
- dissolved organic matter, pollutants
- sea surface temperature

<table>
<thead>
<tr>
<th>Orbit type</th>
<th>Near Circular and near sun-synchronous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equator crossing time</td>
<td>8:53-10:10am (descending node)</td>
</tr>
<tr>
<td>Altitude</td>
<td>798km</td>
</tr>
<tr>
<td>Inclination</td>
<td>98.8 deg</td>
</tr>
<tr>
<td>Period</td>
<td>100.8 minute</td>
</tr>
<tr>
<td>Repeat observation period</td>
<td>3 days for COCTS, 7 days for CCD</td>
</tr>
<tr>
<td>Mass</td>
<td>367kg</td>
</tr>
<tr>
<td>Payload</td>
<td>COCTS and CCD</td>
</tr>
<tr>
<td>Attitude control</td>
<td>3 axis stabilized</td>
</tr>
<tr>
<td>Downlink frequency</td>
<td>X-band</td>
</tr>
<tr>
<td>Design life</td>
<td>2 years</td>
</tr>
<tr>
<td>Memory recorder on board</td>
<td>80Mbyte (can record 18 minute COCTS data)</td>
</tr>
</tbody>
</table>

- **10-band Chinese Ocean Color and Temperature Scanner (COCTS)**, 8VNIR, 2TIR, 1.1km
- **4-band CCD** – 0.42-0.89µm, 250m
- **Launched on 15th May, 2002**
HY-2 Satellite

To globally observe dynamic ocean environment parameters

Four microwave instruments onboard

- The HY-2 satellite altimeter provides sea surface height, significant wave height and sea surface wind
- The HY-2 scatterometer provides SSW fields.
- Also, it can provide sea surface temperature, water vapor and liquid water content

Launched on 16th August, 2011
Products of HY-2
Scientific Experiment Satellite for CO₂ Monitoring

- “Scientific Experiment Satellite for Global CO₂ monitoring Monitoring and Application Demonstration” launched by the National High-Tech Development Program

- Payload of the satellite:
  - High spectra of CO₂ detector/multichannel cloud
  - Aerosol detector

It is China’s first satellite for global CO₂ monitoring, and scheduled for launch in 2014.

(MOST-863)
Electromagnetic & Earthquake Satellite

Electromagnetic & earthquake satellite used for monitoring electromagnetic field changes to forecast the earthquake.

- Small satellite platform;
- 3 weight magnetic monitor and 3 weight electronic monitor;
- Electron feature monitor and proton feature monitor;
- GPS monitor in ionization;
- Launch in 2013
2. BeiDou Navigation Satellite System

- BeiDou Navigation Satellite System is China’s global navigation satellite system which has been developed independently.
- **Target**: maintain independence and keep the initiative in our own hands, keep open, compatible, stable and reliable on technology, offer global service, thereby accelerating the foundation of navigation satellite industrial chain, consummating the sustaining extending and guaranteeing system, expanding the range of application in the country's economic and social sector.

http://www.beidou.gov.cn/
System Description

Space segment
- 5 GEO Satellites
- 30 Non-GEO Satellites

Ground Control Segment
- Master Control Station (MCS)
- Uplink Stations (US)
- Monitoring Stations (MS)

User Segment
- BeiDou user terminals
- Terminals compatible with other GNSS

http://www.oosa.unvienna.org/pdf/icg/2012/icg-7/1.pdf
System Description

Service and Performance

- **Authorized service**
- **Wide area differential service**
- **Open service**
- **Position report service**

**Positioning accuracy** ≤ 10 meters
**Timing accuracy** ≤ 20 ns
**Velocity accuracy** ≤ 0.2 m/s

http://www.oosa.unvienna.org/pdf/icg/2012/icg-7/1.pdf
XIHE System

- XIHE System is the main project supported by earth observation and navigation technology of “863 Project” during “Eleventh-five-year plan”. “XIHE” is the woman who created calendar in fairytale. Using her name to nominate this system means to provide compulsory all space and all period seamless navigation positioning service to the public.


July 4th, 2011: ”Nation’twelfth -five-year plan’s science and technology development scheme “stating “accelerating the researching on navigation and positioning technology, promoting the transformation from science results to product, cultivating new raising industry”

Aug 22nd, 2011: To promote the renovation and industry development of navigation and positioning, technology department released “specialized plan for navigation and positioning during’twelfth -five-year plan” http://www.cenc.org.cn/Portal/files/pic/20130522152355639.pdf
XIHE System

- XIHE System is based on Beidou, Continuously Operating Reference Station (CORS), mobile communication network, broadcast and satellite communication to provide indoor navigation signal and outdoor navigation strengthened signal. Adopting collaborative real-time accuracy positioning technology to resolve the “Last Mile” which connects the positioning signals, location information and personal consumption industry chain and makes a better combination of virtual world and realistic world.

Significance of XIHE System

- XIHE System means we have the capacity of realizing outdoor sub-meter and indoor under 3meter seamless positioning and navigation and the ability of providing online service to billions of people. It also means a transformation from simply used in navigation to a combination of positioning, navigation, time-service, mobile communication and Internet, from outdoor navigation to outdoor and indoor seamless navigation.

Demonstration of XIHE System Application

- XIHE System has built original systems in Beijing, Tianjin, Hubei, Shanghai.

XUNLU Platform

• “XUNLU” mobile Internet product is a pioneered all-round and 3D indoor navigation system based on XIHE, integrated different subjects in indoor GIS, indoor positioning and augment reality. Its appearance makes up the indoor positioning which GPS can not provide and extends its service to indoor.

XUNLU Platform

- “XUNLU” positioning products includes:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Map View</td>
<td>Indoor Map Navigation</td>
</tr>
<tr>
<td>Indoor Map Navigation</td>
<td>Intelligent Key Word Search</td>
</tr>
<tr>
<td>Intelligent Propelling</td>
<td>intelligent propelling function based on scenario</td>
</tr>
<tr>
<td>Software and SDK</td>
<td>Support massive customers visit</td>
</tr>
</tbody>
</table>

- XUNLU Platform includes:
  - XUNLU Platform
The first Chinese Beidou navigation satellite ground reinforced net -- Beidou ground enhancement system of Hubei demonstration project put into trial operation.

Beidou ground based augmentation system in Hubei

- The base station, control system and service system
- Enhanced navigation service ability through the enhance system
- Achieve centimeter level positioning in professional areas and achieve nanoscale positioning in the public areas

- Achieve the positioning precision of plane and elevation were 2cm and 5cm through Beidou tri-frequency real-time precise positioning.
- Positioning precision were 1.5m through Beidou Differential Navigation
Hubei Beidou Precise Positioning Service System

- Initialization time and environmental suitability of Beidou ground enhancement system for precise positioning is superior to enhance system based on GPS, the indicators have reached or better than the current international system level GPS foundation, marking the Chinese Beidou system have the ability to replace the GPS realization of high precision positioning.
3. Virtual Geographic Environments (VGEs): A New Generation of Geographic Analysis Tool

Provide virtual environments that not only correspond to true nature but also in the real world to communicate about geographic phenomena, and further to help understand human behavior taking place in the physical environment.

Feeling It in Person, Knowing It beyond Reality.
Five future scenarios:
1. Knowing where everything is;
2. The third spatial dimension for positioning, representation, and wayfinding;
3. The role of Citizen as both GI consumer and producer;
4. Access to prediction of future landscapes;
5. Dynamic information via sensor network.

In summary, dynamic phenomena simulation, multi-dimensional visualization and public participation are the three key points.
To date, there are three primary stages for human understanding the geographic world:

1. acquire the geographic information;
2. study geo-objects (e.g., their shapes, distributions) and their relationships;
3. analyze dynamic geographic processes to explore geographic laws.

Evolution of human understanding the geographic world:

The requirements of acquiring geographic information:
Tools developed with geographic expression and visualization functions (e.g., Maps)

Further requirements of studying geo-objects and their relationships:
Tools developed with geographical expression, geo-data management, and geospatial analysis functions (e.g., former GISystems)

Further requirements for exploring advanced geographic laws:
Tools developed with geographical expression, geo-data management, geospatial analysis, geographical simulation, and human participation functions (e.g., VGEs)
Virtual environments will be a new generation of analysis and research tool. – Science(2007, 317, 472-475)“The Scientific Research Potential of Virtual Worlds”. 

Using virtual world to manage and analysis the real world is an approach worth exploring. –MSRA, 2012.

**Coming to VGEs**

The tendency:

**Virtual manufacturing**

**Virtual design**

**Virtual pharmacy**
Comes to VGES

In geographic filed, on one hand

South–North Water Diversion Project
Three Gorges Dam Project
Poyang lake project
Nuclear power station project

Big Project, Big Data
Needs a geographic analysis method with low-cost and high efficiency

Beidou navigation system
High resolution observation system
Internet of Things
Dynamic earth system needs a comprehensive and collaborative geographic analysis tool
For the public immersed in VGEs and contributing their spatial knowledge

Interactive interfaces

Virtual geographic scenarios

Geo-database
Discrete data
Continuous data
Geographic process model base
Geo-physical model
Spatial behavior model

Two cores

Data component
Modeling and simulation component
Interactive component
Collaborative component

VGE

Integrate
Support
Integrate

Geographic knowledge
Computer technology
Virtual Reality technology
Network technology
Geographical information technology

(LIN Hui et al, 2013)
User case of VGEs

Geographic scenes created for PRD area (chimneys are represented in white color)

Geographic scenes created for CUHK campus

Data prepared and scenarios constructed
User case of VGEs

Chimneys represent point source for pollution
Roads represent line source pollution

Virtual geographic scenarios construction

Geographic process modeling

Geographic process simulation

Modeling and simulation
### User case of VGEs

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<th>For regional scale</th>
<th>Multi-dimensional Expression</th>
<th>Interaction modes</th>
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A VGE example built for air pollution analysis

(LIN Hui et al, 2013)
The Sensor Network Service Framework for Green CUHK Campus
Selected papers will be published in 《Annals of GIS》 and 《Environmental Earth Sciences》
4. The China-EU-ESA Dialogue on Science and Technology Cooperation

- Satellite Navigation
- Earth observation
- Space Science
- Space Research and Technology

ESA-MOST Dragon Cooperation Programme

- ESA, together with the National Remote Sensing Centre of China (NRSCC), an entity under the Ministry of Science and Technology of the P.R. China, have cooperated in the field of Earth observation application development for the last ten years. The cooperation has now taken on a new momentum with the creation of a dedicated three-year Earth Observation exploitation programme called Dragon (2004 to 2007). The programme formally kicked-off in April 2004 with a three day Symposium that was held in Xiamen city in P.R. China.

- The Dragon programme focuses on science and applications development in P.R. China using mainly data from the ERS and Envisat missions.

http://earth.esa.int/dragon/
• **Dragon 1 (2004-2008)**
  – 16 projects, 170 scientists

• **Dragon 2 (2008-2012)**
  – 25 projects, 165 institutes, more than 400 scientists

• **Dragon 3 (2012-2016)**
  – 50 projects, more than 700 scientists
Advanced Training Course in Ocean Remote Sensing of ESA-MOST China Dragon Cooperation (ISEIS, CUHK)
Sino-EU Cooperation is Entering a New Age
Thank you!