Capacity Building of GNSS Education in China and its enlightenment

Prof. Guifei Jing

Institute of BeiDou Belt and Road, Beihang University, China
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PART ONE

Degree Program
Chinese GNSS education and training began in the 1980s. With the large-scale expansion of GPS services in the world.

Construction of BeiDou system stimulated applications together with education and training.

Disciplines, research facilities, talent and industrial chain of BDS/GNSS have been rapidly upgraded and developed in China.

GNSS Education and training is mainly provided by three parties:

- Universities are mainly responsible for degree education and training activities.
  - More than 30 universities have relevant postgraduate teaching and training.
- Research institutes focus on training activities that related to technological innovation.
- Enterprises' training activities mainly rely on related products and market activities.
Example: GNSS Education in Beihang University

- **BD-IETC of CSNO**
  - 2012

- **APSCO-ETC in China**
  - 2013

- **RCSSTEAP (China)**
  - 2014

- **The Regional Centre for Space Science and Technology Education in Asia and the Pacific (China) (Affiliated to the United Nations)**

- **BeiDou Belt & Road School**
  - 2017

**GNSS Education Platforms**
The BeiDou System has been developing in line with the “three-step” and the thinking of “from regional to global, and from active to passive”, and forms a development path as region-highlighted, world-oriented, with its own features.

**BeiDou System Development Plan**

- **The 1st Step:**
  1994 ~ 2000, provide regional active services

- **The 2nd Step:**
  2004 ~ 2012, provide regional passive services

- **The 3rd Step:**
  2013 ~ 2020, provide global passive services
PNT1m Emerged business in China

1994~

Car navigation

2012~

Pedestrian navigation

Indoor navigation

GNSS: Global Navigation Satellite System
PNT: Positioning, Navigation, Timing

LBS
Industry Chain

PNT1m Provider

Information Provider

Terminals

Service provider

applications

Courtesy Shichuang
Pilot project: Autonomous Agri-Machinery

- Information management
- Control
- Management of tractors
- Internet+
- Big data

NRTK
GNSS
SBAS
WAAS/EGNOS/MSAS

Telematics
NTRIP
Hydraulic Valve

Radio Base
UHF 410-470 MHz
UHF 223-235 MHz

IRON 1
ISO 11783/J1939

MC1/MC2
RTC/ROX

Net20
010C

Section/ VR Control

Video

Courtesy Guo Xinping
Sharing bicycles

More than 3M in big city like Beijing, Wuhan, etc
Mobile PNT1m & Insurance
Location-based service/Location service

Request more than 100b times per day
Algorithm and Chipset - MPNT

Maybe “terminal=chipset” then

Courtesy Guo Xinping
Degree Program in Beihang

- Beihang University has initiated the Master program on Space Technology Applications (MASTA) since 2006
- Improved together with evolution of BDS/GNSS applications in China

- Global Navigation Satellite Systems
- Remote Sensing and GIS
- Satellite Communications
- Micro-satellite Technology
- Space Law and Policy

The program are designed for improving space education of developing countries.
# Degree Program

Study period is divided into two phases

<table>
<thead>
<tr>
<th>Phase I: Course Study (9 months at Beihang University) (Leading to Course Completion Certificate of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulation of an Individual Training Plan</td>
</tr>
<tr>
<td>Module I - Common Platform Courses</td>
</tr>
<tr>
<td>Module II - Major courses, Academic Lectures, Professional Visits</td>
</tr>
<tr>
<td>Module III - Team Pilot Project or Practical Courses</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase II: Thesis Research (12 months in China or home country) (Leading to Master’s Degree in Engineering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature Survey and Thesis Proposal</td>
</tr>
<tr>
<td>Midterm Assessment</td>
</tr>
<tr>
<td>Academic Activities</td>
</tr>
<tr>
<td>Thesis Defense</td>
</tr>
</tbody>
</table>

- Tailor-made Curriculum
- Teaching Language: English
## 9-month Course List

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Class Hrs</th>
<th>Credits</th>
<th>Remark</th>
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<tbody>
<tr>
<td></td>
<td><strong>Module I Platform Courses</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PC1-1</td>
<td>Probability and Statistics in Engineering</td>
<td>48</td>
<td>3</td>
<td>Select at least 3 compulsory credits</td>
</tr>
<tr>
<td>PC1-2</td>
<td>Theory of Matrix</td>
<td>48</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC1-3</td>
<td>Numerical Analysis</td>
<td>48</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PC2-1</td>
<td>Matlab Programming</td>
<td>32</td>
<td>2</td>
<td>Compulsory/Optional</td>
</tr>
<tr>
<td>PC3-1</td>
<td>Space Environment, Orbit and Spacecraft Systems</td>
<td>48</td>
<td>3</td>
<td>Compulsory</td>
</tr>
<tr>
<td>PC3-2</td>
<td>Introduction to Space Technology Applications</td>
<td>18</td>
<td>1</td>
<td>Compulsory</td>
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<tr>
<td>PC3-3</td>
<td>International Cooperation in the Peaceful Uses of Outer Space</td>
<td>16</td>
<td>1</td>
<td>Compulsory/Optional</td>
</tr>
<tr>
<td>PC3-4</td>
<td>Introduction on Space Life Science and Astrobiology</td>
<td>18</td>
<td>1</td>
<td>Compulsory/Optional</td>
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<tr>
<td>PC4-1</td>
<td>Introduction to China and Chinese Language</td>
<td>54</td>
<td>3</td>
<td>Compulsory</td>
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<tr>
<td></td>
<td><strong>Module II Major Courses</strong></td>
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<tr>
<td>MC3-1</td>
<td>GNSS Reference System</td>
<td>18</td>
<td>1</td>
<td>Compulsory</td>
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<tr>
<td>MC3-2</td>
<td>Principle of GNSS</td>
<td>32</td>
<td>2</td>
<td>Compulsory</td>
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<td>MC3-3</td>
<td>GNSS Receiver Principles and Design</td>
<td>32</td>
<td>2</td>
<td>Compulsory</td>
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<tr>
<td>MC3-4</td>
<td>GNSS/INS Integration Navigation</td>
<td>32</td>
<td>2</td>
<td>Compulsory</td>
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<td>MC3-5</td>
<td>GNSS Applications</td>
<td>18</td>
<td>1</td>
<td>Compulsory</td>
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<tr>
<td>MC3-6</td>
<td>Satellite Navigation Data Processing</td>
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<td>2</td>
<td>Compulsory</td>
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<tr>
<td>MC3-7</td>
<td>GNSS Experiment</td>
<td>18</td>
<td>1</td>
<td>Compulsory</td>
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<tr>
<td>MC3-8</td>
<td>GNSS New Technologies</td>
<td>18</td>
<td>1</td>
<td>Compulsory</td>
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<tr>
<td></td>
<td><strong>Module III Team Pilot Projects</strong></td>
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<tr>
<td>PPC</td>
<td>Team Pilot Project</td>
<td>12 Weeks</td>
<td>8</td>
<td>Compulsory</td>
</tr>
</tbody>
</table>
GNSS Education in Beihang University

GNSS Textbook & training Materials
imported BDS
GNSS Education at Beihang University

BDS Exhibition Hall  Smart Classroom  Experiment equipment  Courseware/Tools

Experimental teaching conditions
Degree Program

Professional Visits
Industry tour and collaboration
Achievement in GNSS degree program

- Enrolment

<table>
<thead>
<tr>
<th>Program</th>
<th>Year</th>
<th>Number</th>
<th>Countries of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master's</td>
<td>2017</td>
<td>11</td>
<td>Bangladesh, Bolivia, Mongolia, Pakistan, Peru, Thailand, Turkey</td>
</tr>
<tr>
<td>Program</td>
<td>2018</td>
<td>6</td>
<td>Ethiopia, Peru, Turkey, Iran, Pakistan</td>
</tr>
<tr>
<td>Doctoral</td>
<td>2017</td>
<td>11</td>
<td>Algeria, Bangladesh, Iran, Pakistan, Thailand, Turkey, Venezuela</td>
</tr>
<tr>
<td>Program</td>
<td>2018</td>
<td>11</td>
<td>Bangladesh, Indonesia, Iran, Nigeria, Pakistan, Thailand</td>
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</tbody>
</table>
PART TWO

Training Activities
## GNSS Short Term Training

<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
<tr>
<td>2017 International Workshop on BDS Technology &amp; Applications</td>
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<tr>
<td>GNSS and BeiDou System Deep Understanding Training</td>
</tr>
<tr>
<td>CRASTE-LF &amp; RCSSTEAP-China GNSS Workshop and Applications</td>
</tr>
<tr>
<td>BeiDou System Technology and Applications</td>
</tr>
<tr>
<td>The 2nd GNSS Short-term Training of AICTO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Place</th>
<th>Trainee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov.26-Dec.8, 2017</td>
<td>Beihang University, China</td>
<td>23 (Egypt, Gambia, Nigeria, Iraq, Thailand, Indonesia, Sudan, Pakistan, Mongolia, Bangladesh, Bolivia)</td>
</tr>
<tr>
<td>April 11-13, 2018</td>
<td>China-Arab BDS/GNSS Center (AICTO) , Tunisia</td>
<td>38 (Tunisia, Morocco, Egypt)</td>
</tr>
<tr>
<td>April 23-26, 2018</td>
<td>African Regional Centre for Space Science and Technology Education (in French Language), Morocco</td>
<td>Nearly 30 (Morocco, Algeria, Niger, Senegal, Tunisia, Cameroon, Central Africa Republic)</td>
</tr>
<tr>
<td>August, 2018</td>
<td>Naresuan University, Thailand</td>
<td>More than 30 (Thailand)</td>
</tr>
<tr>
<td>Sep. 24-26, 2018</td>
<td>The Friendship Hall, Khartoum, Republic of Sudan</td>
<td>162 (Sudan, Egypt, Zambia, Lebanon)</td>
</tr>
</tbody>
</table>
Training Activities

China-Arab BDS/GNSS Center (AICTO) Opening Ceremony & GNSS and BeiDou System Deep Understanding Training

April 11-13, 2018 & April 1-2, 2019 in Tunisia
Training Activities

CRASTE-LF & RCSSTEAP-China GNSS Workshop

April 23-26, 2018 in Rabat, Morocco

Training event in 2019 was just finished
Training Activities

BeiDou System Technology and Applications

August, 2018 in Thailand
International Exchange

BeiDou Agricultural Applications Seminar

July, 2018 in Laos
Joint Laboratory through training

BDS Constellation

Experiment equipment

Courseware/Tools

Reference station

Receivers
Exchange of personnel after training
R&D with pilot projects after training

- Car navigation
- Location Service
- Floods
- Blizzards
- Construction monitoring: Dam, Mansion, Building
- Disaster Monitoring & Mitigation
Suggestions to do
Together with development of BDS applications emerged in China

Using BDS location labels as coordinate, connecting the Internet and the Internet of Things to a superimposed, computable network, provides the basis for ubiquitous information services.
Urban delicacy management

- Combination of Beidou/5G, the unified access of water, gas, fire, mobile terminals, cameras and other sensing devices at the most basic level of urban facilities
- Building an Inter-things Location Network in a city with billion-level nodes
- Learning the status of components in real time and building information management center
- Urban data exchange and millisecond response, manage the city in real time and provide service for residents
ITLoN for Digital Twin

Sensor network, IOT

Global triangulation and coding
IPv6 location mapping

Municipal Security Service

GBAS
BDS/GNSS
PNT

Sensor
Mobile
Pho ne
Video

Physical
Cyber

GBAS

U, me

.LOB
.COM

LBS

Comprehensive Location Map Center

Internet

带位置的泛在信息
Choose a standard to evaluate the development of Capacity building and take it as a guidance. Besides Education, capacity building should include the other areas, such as:

- Research and development
- Experiment facilities
- Manufacture of HW and SW
- Management
- Quality guarantee
- Policy environment

Capacity Building index need to consider the weighty rate of different factors:

<table>
<thead>
<tr>
<th>No.</th>
<th>Content</th>
<th>Weighty score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Research standards and management</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>Human resources</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>Infrastructure and related equipment</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>Manufacture and Management</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>Finance</td>
<td>150</td>
</tr>
<tr>
<td>6</td>
<td>Quality</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>Policy environment</td>
<td>100</td>
</tr>
<tr>
<td>8</td>
<td>Reputation</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1000</td>
</tr>
</tbody>
</table>
Summary
• BDS/GNSS and Mobile Internet/5G/AI provide innovation in PNT signals and markets, show better business in China

• BDS will provide SIS in global scale in 2020, emerged new space for GNSS R&D, education, training

• We are willing to cooperate with colleagues in areas of education, technology transfer, training
Thanks for your attention!

Dr. JING Guifei
Beihang University, China
Email: guifeijing@buaa.edu.cn