Chinese Industry Practice for Space Capacity Building

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1. Approach of Industry Engagement

Generally, the industrial resources can be summarized as:

- management,
- technology,
- engineering, and
- applicable ground supporting infrastructure.

Methods for sharing resources above include,

- seminars,
- space education,
- technical **training oriented engineering**, for more qualified engineers
- collaboration for flight missions (satellite development, launching campaign, in-orbit support),
- space data sharing for an effective application,
- **grounded facility building**. To Qualify before flights, to build confidence!

Grounded facility building should be prioritized for emerging space nations.

1. Approach of Industry Engagement (Continued)

The reason for prioritizing building ground facility is to ensure the space activities are fully supported by industrial resource.

Advantage of Industrial Facilities

- Effective engineering organization
- Concentration of resource (technology, human resource, etc.)
- R&D oriented marketing
- Promotion of product & service
- Benefit to social progress

Space Activities

01 Launching

02 Space segment

03 Ground segment

04 Deep space exploration

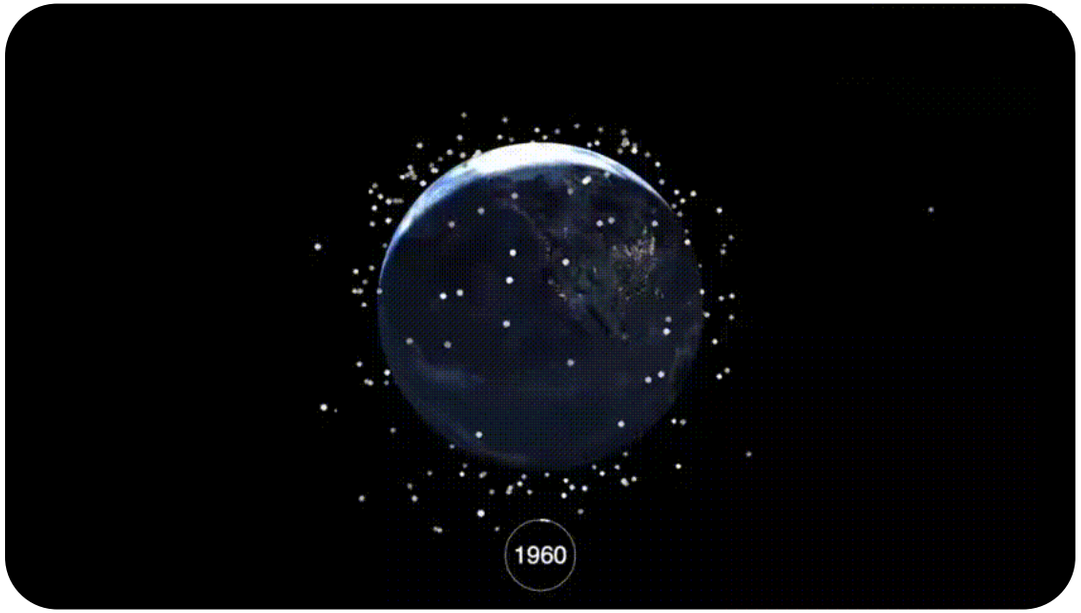
05 Space science and environment

1. Approach of Industry Engagement (Continued)

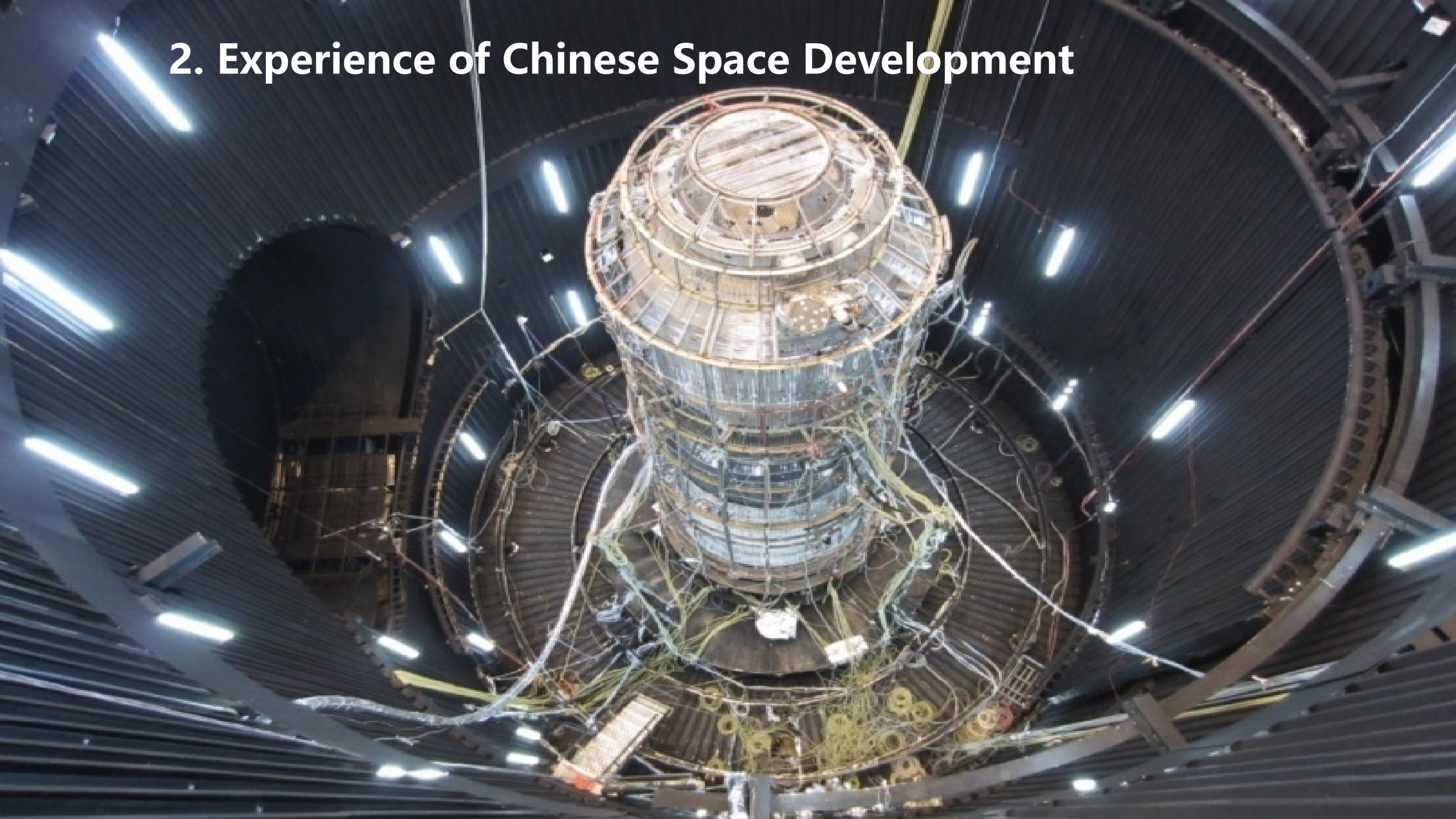
The industry engagement for space capacity building should follow relevant sustainable policy, national and/or international,

In consideration of the change of the outer space environment since 1958, the first manned satellite delivered to orbit,

both the **cooperation on space activities** and the **sharing of ground resources** are considered to be valuable approaches.



2. Experience of Chinese Space Development



2. Experience of Chinese Space Development

2.1 General Requirement for Nation to Develop its Space Industry

01 National space strategy & policy

02 Availability of science & technology

03 Design & Manufacturing Capacity

04 Return to its strategy

2. Experience of Chinese Space Development (Continued)

2.2 Milestones of Chinese Space Industry

China's first satellite

DFH-1

- Scientific Satellite
- Recoverable Satellite
- Telecommunication Satellite
- Remote Sensing Satellite

Total:5 satellites

FY-1

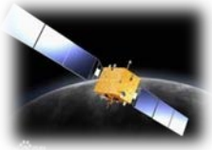
- Scientific Satellite
- Telecommunication Satellite
- Remote Sensing Satellite
- Spaceship

Total: 16 satellites

Spaceship-1

Total: 49 satellites

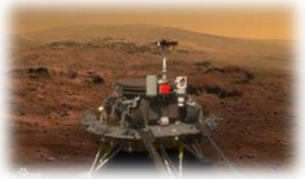
Spaceship-5



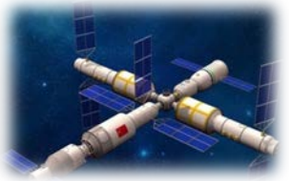
Luner-1 Navi-1

- Spaceship
- Navigation Satellite
- Lunar Exploration Satellites

Total: 125+ satellites



MARS



Space Station

Luner-3/5

Navi-2

- Mars Exploration Satellites
- Space Station

Minzuyuan Space Park

Delivered in 1960

Main Facilities: KM2 space environment simulator

Huairou Space Park

Delivered in 1968

Main Facilities: KM3/KM4 space environment simulator

Beijing Space City

Delivered in 1997
Capacity: over 20 satellites/year
Main Facilities: KM6/KM7A space environment simulator, 400kN Vibration Test System

Delivered in 1999
Capacity : 8~10 manned spacecraft /year

Delivered in 2001
Capacity: 10~12 small satellites/ year

Delivered in 2009
Capacity: 6~8 satellites/year
Main Facilities: KM7 space environment simulator, 350kN Vibration Test System

Tianjin Space Park

Delivered in 2015
Capacity:
Main Facilities: KM8 space environment simulator, 1400kN Vibration Test System, 4000m^3 Acoustic Test System

1960 1970 1980 1990 2000 2010

2. Experience of Chinese Space Development (Continued)

2.2 Milestones of Chinese Space Industry (Continued)

Chinese experience in the past over 60 years shows how its space capacity progresses rapidly along with the growth of grounded facilities. The following equipment were delivered 2015 for Chinese Space Station, to be launched by 2020:

1,200kN vibration test system

Main Specifications:

- Table dimension: vertical: ϕ3.8m, horizontal: 4.4m×4.4m
- Sine rated excitation force: vertical 1,200KN, horizontal 700KN
- Frequency range: 2～100Hz
- Control: 40 input channels

4,000 m³ acoustic test system

Main Specifications:

- Size: 14.5m(L)×11.5m(W)×24m(H)
- Spectrum capacity: ≥150dB, OASPL: ≥156dB
- Frequency scope (central frequency of octave): 31.5Hz～8000Hz
- Control method: 1/3 octave and octave

KM8 space environment simulator

Main Specifications:

- Size: 17m in diameter, 32m in height
- Shroud Temperature: 100K
- Non-load Ultimate Pressure： below10^{-6}Pa
- Data Acquisition Channel： 3500
- Infrared Heat Flux Channel: 1600

2. Experience of Chinese Space Development (Continued)

2.3 Major Constraints for Developing Countries

The major constraints for developing countries to start their space programs are,

- Economic difficulty
- Underdeveloped space science & technology
- Ineffective support from industry

Therefore, to solve the constraints above, the developing countries will benefit from

- Space education, training & technology transfer,
- Selecting the suitable scale for space infrastructure development,
- The opening & sharing of international space facility.

Equipment transition in 1960s

Classroom in 1970s

Machining in 1980s

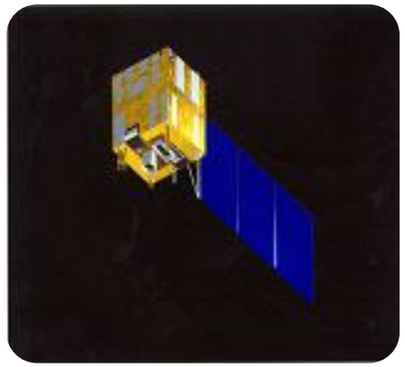
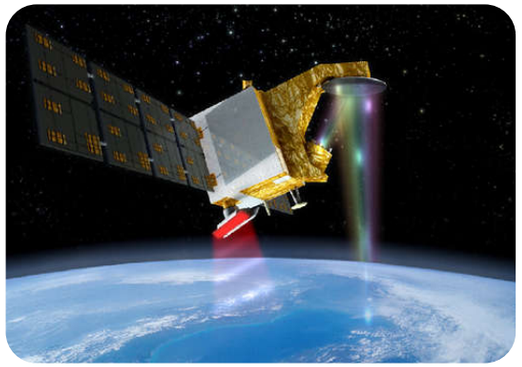
3. Activities for International Space Capacity Building

For international activities, China has collaborated on numerous projects involving flight missions, building ground facilities and technical trainings.

Through the training programs involved we found it is highly effective to **combine** the education & training with **engineering projects**, for instance, organizing training workshop in conjunction with satellite development projects.

3. Activities for International Space Capacity Building (Continued)

3.1 Flight Missions


- China-Brazil Earth Resource Satellite (delivered to orbit individually in 1999, 2003, 2007, 2011, 2014)
- China-France Oceanography Satellite (to be launched 2018)
- Nigeria Communications Satellite (delivered to orbit 2007)
- PakSat-1R Communications Satellite (delivered to orbit 2011)
- Bolivia-1 Communications Satellite (delivered to orbit 2013)
- Laos-1 Communications Satellite (delivered to orbit 2015)
- Belarus-1 Communications Satellite (delivered to orbit 2016)
- Algeria-1 Communications Satellite (delivered to orbit 2017)
- Venezuela Satellites (delivered to orbit individually in 2008, 2012, 2017)

3. Activities for International Space Capacity Building (Continued)

3.2 Space Education and Technical Training

Series No.	Contents of the training	Numbers of trainees	Countries	Date
1	China-ASEAN spacecraft basic courses training	25	10 countries from ASEAN	1997
2	China-ASEAN spacecraft engineering training	28	10 countries from ASEAN	2000
3	China-Asian pacific spacecraft techniques training	54	10 countries from ASEAN & Middle East	2002
4	China-ASEAN remote sensing spacecraft technology training	23	10 countries from ASEAN	2004
5	China-ASEAN spacecraft project management training	30	10 countries from ASEAN	2004
6	China-Asian pacific spacecraft technology & spacecraft project management training	21	11 countries from ASEAN & America	2005
7	China-Nigeria spacecraft professional training	50	Nigeria	2005
8	Spacecraft diploma education and spacecraft professional training	90	South America	2007
9	Pakistan-1R KHTT training	61	Pakistan	2009
10	Satellite manufacturing training	52	South America	2012
11	Satellite Application technology training	42	South America	2012
12	Satellite AIT training	60	South America	2013
13	Egyptian satellite AIT training	20	Egypt	2017

3. Activities for International Space Capacity Building (Continued)

3.2 Space Education and Technical Training (Continued)

Pakistan

PAK-1R Satellite Program, education and training included,

- System Design Technology
- System AIT Technology
- Know-How-Technology-Transfer by theoretical and on-site operation
- Numbers of trainees: 61
- Duration: March, 2009 to July, 2011

3. Activities for International Space Capacity Building (Continued)

3.3 Satellite Manufacturing Capacity

- Delivery of GVU-600 Thermal Vacuum Chamber (Φ8m, 10m(L),2011) for ISS Russia to support its space programs.
- Delivery of TVC-BZ1200 Thermal Vacuum Chamber (Φ1.5m, 2m(L), 2017) for SUPARCO Pakistan to support its on-board equipment test.

3. Activities for International Space Capacity Building (Continued)

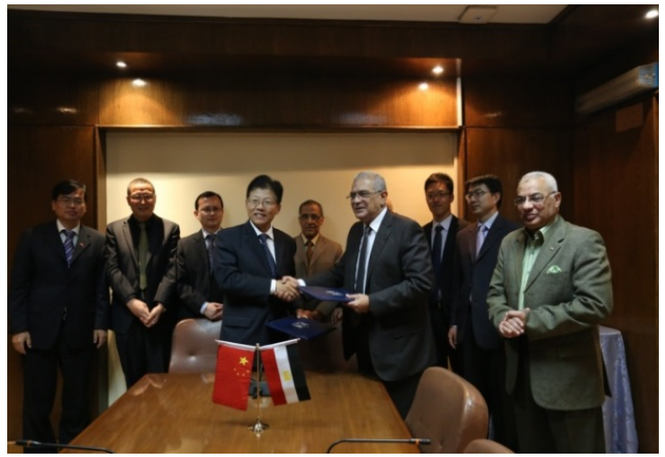
3.3 Satellite Manufacturing Capacity (Continued)

- Egyptian Satellite Assembly Integration and Test Center

The Egyptian Satellite Assembly, integration and Test Center is a key Infrastructure to support Egyptian space program. With its establishment in space city, New Cairo, 2019, Egypt will possess internationally advanced facilities and the capacity to develop two 600 kg-level satellites in parallel.

Features of facility:

- Clean room
- Shaker
- Thermal vacuum chamber
- EMC chamber
- Optical Lab.



4. Sharing Chinese Industrial Facilities

4.1 Establishment of International Satellite AIT Center

China National Space Administration (CNSA) has been actively exploring an effective cooperative approach with other nations since its involvement in international activities.

In May 2017, CNSA decided to share one of its satellite manufacturing facility with other nations. This shared facility is titled as “Satellite Assembly Integration and Test(AIT) Center, CNSA”, which is one subsidiary of China Academy of Space Technology located in Huairou District Beijing China.

As a shared resource, the Satellite AIT center CNSA shall be applied for:

- Space education & seminars
- Technical training,
- Satellite AIT activities,
- Building ground facilities

Bird-view of satellite AIT center by 2020

4. Sharing Chinese Industrial Facilities (Continued)

4.2 Introduction of Satellite AIT Center, CNSA

This AIT center was originally delivered in 1970s for satellite thermal testing, and so far, the tested programs listed below:

- Chinese first Recoverable Satellite and its follow-ups, 1970s
- Chinese first Meteorology Satellite and its follow-ups, 1980s
- Chinese first Telecommunication Satellite and its follow-ups, 1990s
- China-Brazil Earth Resource Satellite-1/2, 1990-2000
- Chinese Lunar Programs(Rovers for Chang'e-3/5 Mission), 2000-2016
- China-France Oceanography Satellite, 2017

With the upgrade of existing supporting equipment 2017, the current capacity of this satellite AIT center:

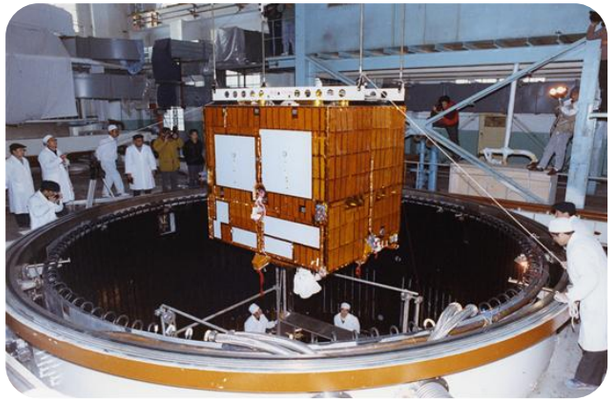
✓ 4-6 satellites (up to 2 tons-level) AIT activities in parallel per year

4. Sharing Chinese Industrial Facilities (Continued)

4.2 Introduction of Satellite AIT Center, CNSA (Continued)

The major facilities to support the satellite AIT activities, space education and trainings are described below,

Thermal vacuum chamber 3.6m(Diameter)*5.5m(Length)



Thermal vacuum chamber 7m(Diameter)*12m(Height)

200kN Shaker for Vibration Test

Satellite AIT Cleanroom (2060 m^2)

Space Education Center
with UN certificate in Asia-Pacific region

International Conference Center

4. Sharing Chinese Industrial Facilities (Continued)

4.3 International Activities in Satellite AIT Center CNSA

1) Space Programs from APSCO

The Asia-Pacific Space Cooperation Organization (APSCO) is involved by countries of Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand, Turkey, Indonesia and Mexico.

System integration and test of satellites from APSCO shall be planned in this satellite AIT center.

4. Sharing Chinese Industrial Facilities (Continued)

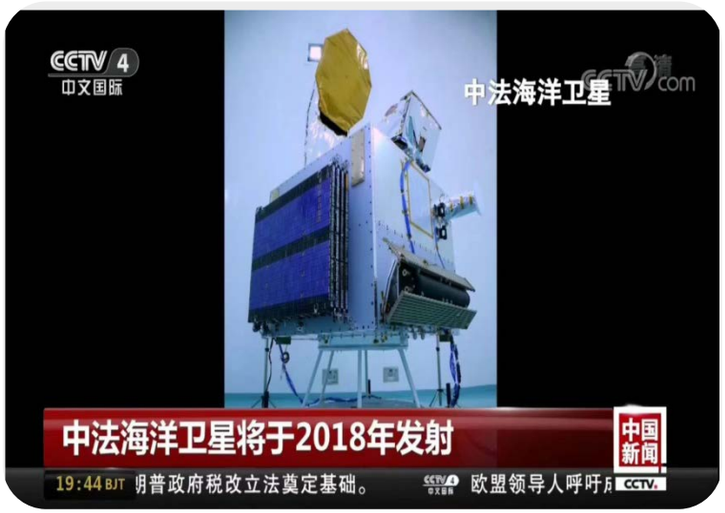
4.3 International Activities in Satellite AIT Center CNSA (Continued)

2) CFOSAT

The system integration and testing of China-France Oceanography Satellite (CFOSAT) was performed in Satellite AIT Center CNSA. For CFOSAT, Chinese side contributed the platform and one instrument of payload, French side contributed the payload.

The CFOSAT will be launched 2018, and the space data from CFOSAT will be shared by both sides.

October 2017, the Press Conference jointly organized by CNSA and the French Embassy in China was held in this Satellite AIT center, Total 17 Chinese and French media were invited on site.



4. Sharing Chinese Industrial Facilities (Continued)

4.3 International Activities in Satellite AIT Center CNSA (Continued)

3) Technical Training

Egypt

Satellite AIT Center Program, NARSS

- System AIT training
  - Satellite Assembly & Integration Technology
  - Satellite Dynamic Test Technology
  - Satellite Thermal Test Technology
  - EMC
  - Optical payload
  - Management
- Numbers of trainees: 20
- Duration: November, 2017 to January, 2018

4. Sharing Chinese Industrial Facilities (Continued)

4.4 Access to Share this Infrastructure

All international organizations, space agencies, institutes and industries are invited to use this infrastructure as a sharing platform for supporting space programs, technical trainings and seminars.

Program Registration, Classified by

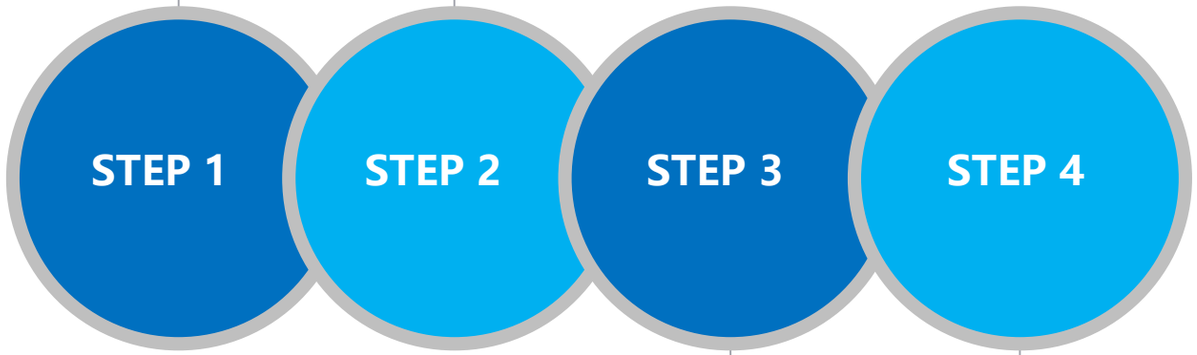
□ Engineering (Duration, Facility)

□ Education/Training/Seminars (Duration, Facility)

Program Acceptance

□ Availability of Engineering Resource

□ Confirmed for education/Training/Seminars



Program Access & Implementation

□ Engineering Processing

□ Education/Training/Seminars performed

Program Completeness

□ Technical Reports from Engineering

□ Certificate Education/Training/Seminars

4. Sharing Chinese Industrial Facilities (Continued)

Access Information

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5. Conclusion

The overall development of the Chinese space capacity, evidenced by its rapid growth, can serve as a reference for other nations.

What we learned through our experience is to make every effort to ensure the effective linkage between the space education, training and the whole process of project development.

When one nation decides to build its space capacity, the applicable ground facility should be established accordingly. The delivered ground facility will play a role to increase its national confidence for space capacity building by concentrating and creating more technical resource.

A sustainable space industry is our future. CNSA has made such an effort to welcome all nations to share its industry resource.

Thanks!