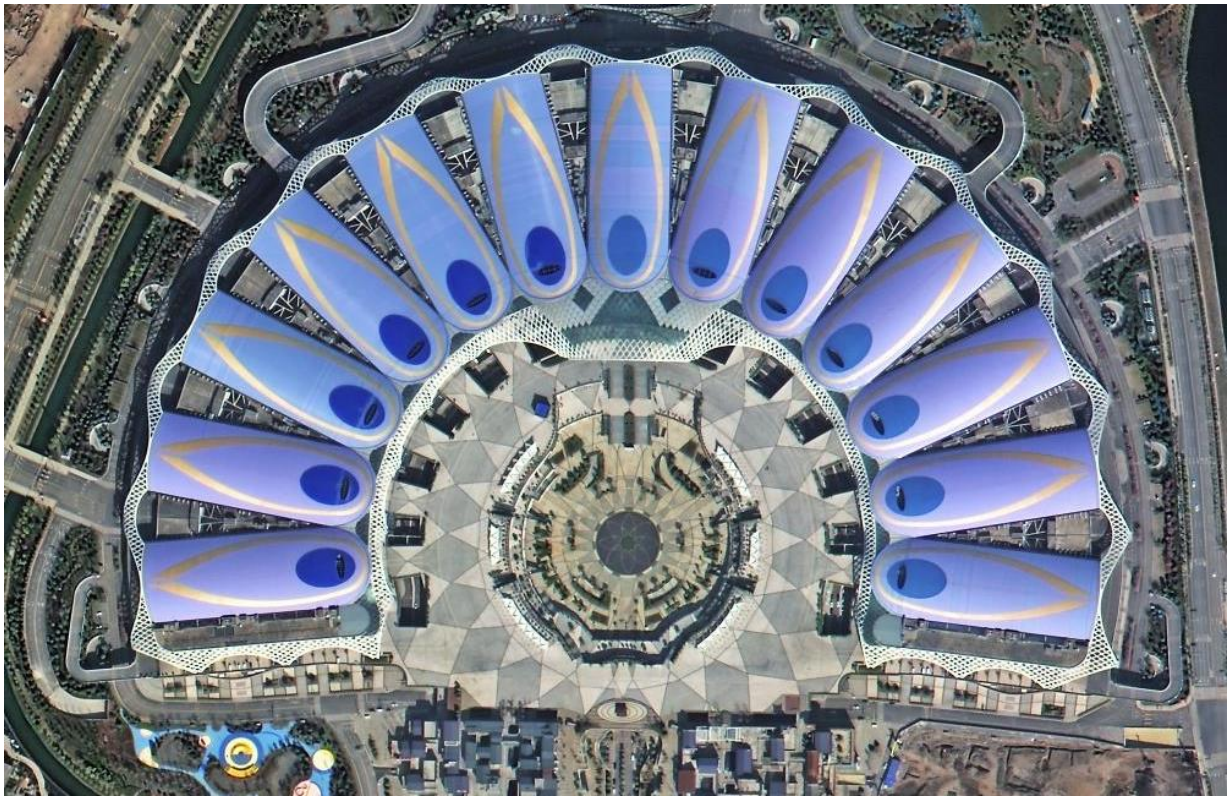
HEAD

AEROSPACE GROUP

2020

Superview 1-02, Madrid Airport, Spain



Superview 1-03, 50cm GSD, Yunnan, China, 2018

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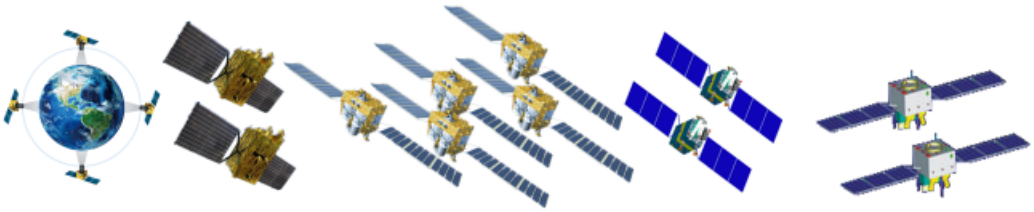
SATELLITE ASSESTS

HEAD Aerospace (HEAD) commercializes data collected by a series of 17 on-orbit Chinese Earth observation satellites including

- Ground sampling resolution (GSD) ranging from 0.5m to 30m optical data
- Submeter optical data with Daily Revisit Globally
- Optical (panchromatic, multispectral & hyperspectral)
- C-band radar at 1m GSD

Strategic partner of 18 Chinese Civilian EO Satellites

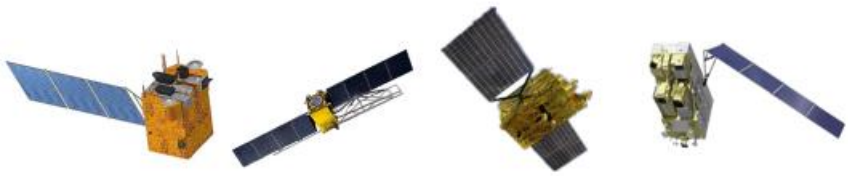
OPERATIONAL ON-ORBIT AIS, OPTICAL, RADAR, VIDEO DATA



	Optical VHR		Optical MR		
Satellite	Superview -01,02,03,04	GaoFen-2 GaoFen-7	GF-1a b c d GF-6	ZiYuan (ZY)-3 01/02	HuanJing (HJ)-1A/1B
Launch	2016 & 2018	2014,2019	2013, 2018	2012, 2016	2008
Altitude	530 km	631 km	645 km	509 km	650 km
Orbit	SSO	SSO	SSO	SSO	SSO
Resolution	0.5m PAN, 2m MS	0.8m, 3.2m	2m, 8m	2.1m, 5.8m	30m, 100m
Swath	12 km	45 km	60 km	51 km	700km, 50km
Revisit	Daily	5 days	Daily	5 days	4 days

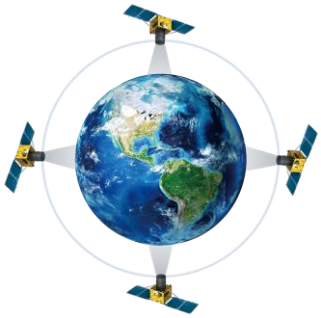
Strategic partner of 18 Chinese Civilian EO Satellites

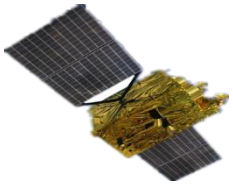
OPERATIONAL ON-ORBIT AIS, OPTICAL, RADAR, VIDEO DATA



	Optical MR	C-Band SAR	Optic GEO	Hyperspectral
Satellite	CBERS 4	GaoFen-3	GeoFen-4	GaoFen - 5
Launch	2014	2016	2015	2018
Altitude	778 km	775 km	36 000 km	705 km
Orbit	SSO	SSO	GEO	SSO
Resolution	5m, 20m, 40m	1m, 3m, 10m	50 m	6 payloads
Swath	60-120km	10 - 650 km	400 km	60 km
Revisit	3 days	1.5 / 3 days	Real time	4 days

Vigh High Resolution (VHR) Satellites (<1m)

SuperView Constellation	
SuperView-1a and 1b is launched on 26 December 2016. Superview - 1c/1d was launched on 08 Jan 2018. These are **four identical satellites.** It operates at an altitude of 530 km and provides imagery with 0.5 m Panchromatic and 2 m multispectral resolution. It has 4 multispectral bands (blue/green/red/near infrared) and one Panchromatic band. The swath width is 12 km and the descending node time is 10:30 am. It possesses high agility and runs with multiple collection modes. Its multi-imaging mode can satisfy different imaging requirements. (Examples: nadir imaging, scroll imaging, continuous strip, multi-band stitching, three-dimensional imaging)	
Orbit	Altitude: 530 km
	Type: Sun-synchronous
	Period: 97 minutes
Design life	8 years
Mass	560 kg
Sensor bands	Panchromatic: 450-890 nm
	4 Multispectral: Blue: 450-520 nm; Green: 520-590 nm; Red: 630-690 nm; Near-IR: 770-890 nm
Spatial Resolution	PAN: 0.5 m
	MS: 2 m
Dynamic range	11 bits
Swath width	12 km
Onboard storage	2.0 TB
Revisit time	Daily with 4 satellites
Positioning accuracy	Better than 20 m
Data transmission	2 * 450 Mbps
Daily Capacity	700,000 km²

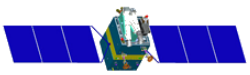
GaoFen-2 (GF-2)	
Launched on 19 August 2014, GF-2 is equipped with 2 PAN/MS cameras, capable of collecting images with resolution of 0.80 m (nadir) in Panchromatic and 3.24 m (nadir) in the multispectral bands on a swath of 45 km. GF-2 is a follow-on mission of the GF-1technology demonstration mission, a series of high-resolution optical Earth observation satellites of CNSA (China National Space Administration), Beijing, China. GF-2 is part of the CHEOS (China High Resolution Earth Observation System) family with the objective to provide high accuracy geographical mapping, land and resource surveying, environment change monitoring, near real-time observation for disaster prevention and mitigation, as well as for agriculture and forest estimation. 	
Weight	2000 kg
Orbit	Altitude: 631 km
	Type: Sun-synchronous
	Period: 97 minutes
Life	Design life: 5-8 years
Sensor bands	Panchromatic: 450-900 nm
	4 multispectral: Blue: 450-520 nm Green: 520-590 nm Red: 630-690 nm Near-IR: 770-890 nm
Spatial resolution	PAN (nadir): 0.80 m
	MS (nadir): 3.24 m
Dynamic range	10 bits
Swath width	45 km
Onboard storage	3.75 TB
Revisit time	Within 5 days

GaoFen-7 (GF-7)	
GF-7 was successfully launched on 03 Nov 2019. It is an optical stereo mapping satellite. It will make breakthroughs in high-resolution stereo mapping image data acquisition, high-resolution stereo mapping, high-precision satellite remote sensing and remote sensing statistical survey in urban and rural construction. Through stereo mapping, products such as stereoscopic images and digital elevation models of the target area can be obtained. 	
Weight	2400 kg
Orbit	Altitude：500km
	Type：sun-synchronous
	Period：97 minutes
Spatial resolution	PAN (nadir): 0.64 m PAN (front): 0.8 m
	MS: 2.6 m 4 multispectral: Blue: 450-520 nm Green: 520-590 nm Red: 630-690 nm Near-IR: 770-890 nm
Swath width	20 km
Revisit	59 days
Spatial range	P：0.45-0.90 B1:0.45-0.52 B2：0.52-0.59 B3:063-0.69 B4:0.77-0.8
Onboard storage	4TB

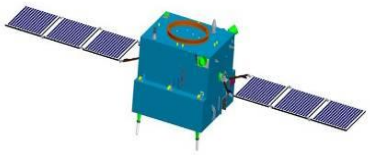
Medium Resolution (MR) Satellites

GaoFen-1 (GF-1)		
The first GF-1 was launched in April 2013, three identical GF-1 satellites as follow up missions were launched in 2018, which strengthen significant the data collection capacity at 2m resolution data. GF-1 is equipped with two 2 m Panchromatic and 8 m multispectral cameras (PMC), and 4 wide field imagers (WFI) with 16 m MS medium-resolution and a combined swath of 830 km. The complete camera set of PMC and WFI (6 cameras) may observe simultaneously, or each camera set (PMC or WFI) may observe separately. The revisit frequency of the spacecraft is ≤4 days and the observation range of the mission covers a region from 80ºN to80ºS. It mainly applies in land resource investigation, mineral resource management, atmospheric and water environment quality monitoring, and natural disaster emergency response and monitoring. GF is the abbreviation for 'GAO FEN' - meaning 'high-resolution'. 		
Orbit	Altitude: 645 km	
	Type: Sun-synchronous	
	Period: 97 minutes	
Life	Design life: 5-8 years	
Sensor bands	**2 * PMC**	**4 * WFI**
	PAN: 450-900 nm	4 multispectral: Blue: 450-520 nm Green: 520-590 nm Red: 630-690 nm Near-IR: 770-890 nm
	4 multispectral: Blue: 450-520 nm Green: 520-590 nm Red: 630-690 nm Near-IR: 770-890 nm	
Spatial resolution	PAN (nadir): 2 m	MS (nadir): 8 m, 16m
Dynamic range	10 bits	
Swath width	60 km with 2 cams (nadir)	830 km with 4 cams (nadir)
Onboard storage	3.75 TB	
Revisit time	4 days	
Geolocation accuracy	50 m without GCP	

GaoFen-6 (GF-6)	
GF-6 satellite was successfully launched on June 2, 2018. It is the first optical remote sensing satellite in China to set the red-edge spectrum. It also has high-efficiency imaging capability combined with high-resolution and wide-format coverage. Equipped with a high-resolution camera (2m full color / 8m multi-spectrum) and a wide-format camera (16m multi-spectrum). GF-6 achieves single-camera large field of view imaging based on GF-1 with 4 supplementary spectral bands were added. The performance indicators were further improved with a high-altitude satellite network was operated.	
Orbit	Altitude: 634 km
	Type: Sun-synchronous
	Period: 97 minutes
Life	Design life: 5-8 years
High-resolution camera	
Spatial resolution	PAN (nadir): 2 m, MS (nadir) : 8m
Spectral bands:	**PAN:** 450-900 nm **4 multispectral:** Blue: 450-520 nm Green: 520-590 nm Red: 630-690 nm Near-IR: 770-890 nm
Swath width	90 km
Revisit time	4 days
Wide-format camera	
Spatial resolution	MS : 16 m
Spectral bands:	**Multispectral:** Blue: 450-520 nm Green: 520-590 nm Red: 630-690 nm Near-IR: 770-890 nm Red-edge band 1: 450-520 nm Red-edge band 2: 520-590 nm
Swath width	850 km
Revisit time	4 days

ZiYuan-3 01/02 (ZY-3 01/02)	
ZY-3-01 was the first civil high-resolution stereoscopic Earth mapping satellite of launched in January 2012 and ZY-3-02 was launched in 2016, making a stereo constellation. Both carries three high-resolution Panchromatic cameras and an infrared multispectral scanner (IRMSS). The cameras are positioned at the front-viewing, vertical-viewing and rear-viewing positions. These cameras can image the Earth from different perspectives at the same time, allowing precise determination of the exact locations of different area of interest, very adaptable for large scale maps. The payloads provide high-resolution infrared and stereoscopic images dedicated for resource mapping, environmental surveying, disaster monitoring, city planning and national security needs. The overall objective is to compile a database for the production of 1:50000 and larger scale maps and to provide data for resource mapping, environmental surveying, disaster monitoring, city planning and national security needs. 	
Orbit	Altitude: 509 km
	Type: Sun-synchronous
	Period: 97 minutes
Life	Design life: 5 years
Sensor bands	Panchromatic: 500-800 nm
	4 Multispectral: Blue: 450-520 nm Green: 520-590 nm Red: 630-690 nm Near-IR: 770-890 nm
Spatial Resolution	Vertical viewing: 2.1 m
	Front/Rear Viewing: 3.5 m (ZY-3 01), 2.5 m (ZY-3 02)
	MS cam: 5.8 m
Dynamic range	10 bits
Swath width	Vertical viewing cam: 51 km
	Front/Rear viewing cam: 52 km; MS cam: 51 km
Onboard storage	3.75 TB
Revisit time	5 days

HaiYang -HY 1C/2B



HaiYang (HY) measn Ocean, which is designed for maritime and oceanographic applications.

HY-1C satellite is Chinese third satellite of HY series, launched on September 7, 2018 in Taiyuan satellite launch center. HY-1C has 5 payloads, including ocean water color scanner, coastal imager, ultraviolet imager, onboard calibration spectrometer and automatic identification system, which generate more than 40 standard products and applications every day. Through on-orbit test validation, its performance is good, and have great potential for application. Ocean water color scanner is used to detect ocean water color elements and sea surface temperature field. It contains ten channels including visible light, near-infrared and thermal infrared.

HY-2 B satellite is Chinese second satellite of HY series, and the second marine service satellite in China's civilian space infrastructure plan. It was successfully launched by a long March 4b carrier rocket at 6:47 am on October 25, 2018 from the Taiyuan satellite launch center. The satellite will further enhance China's capability of ocean remote sensing observation, which is of great significance to improving disaster prevention and reduction, carrying out marine scientific research, and solving global changes common to mankind.

Weight	365 kg
Orbit	Altitude: 798 km
	Type: Sun-synchronous
	Period: 97 minutes
Design life	8 years
Coastal imager	4 Multispectral: Blue: 450-520 nm; Green: 520-590 nm; Red: 630-690 nm; Near-IR: 770-890 nm
Ocean Water color Scanner	Panchromatic: 450-890 nm
	Near-Infrared
	Thermal Infrared
Spatial resolution	1.1 km (Ocean Water color Scanner) 50m (Coastal Imager)
Swath width	2900 km (Ocean Water color Scanner) 950 km (Coastal Imager)
Revisit time	Video: Daily with the constellation PAN + MS: Twice a day with the constellation

HuanJing-1A/1B (HJ-1A/1B)		
Launched on 6 September 2008, HJ-1A is an optical satellite with a multispectral (MS) camera and a hyper spectral (HIS) camera. HJ-1B is also an optical satellite with a multispectral camera and a IRMSS（Infrared multispectral）camera on board. Its overall objective is to establish an operational Earth observing system for disaster monitoring and mitigation and to improve the efficiency of disaster mitigation and relief. And it mainly applies in the fields such as environmental monitoring and prediction, solid waste monitoring, disaster monitoring and prediction. HJ is the abbreviation for “Huan Jing” – meaning “environment”. 		
HuanJing-1A (HJ-1A)		
Orbit	Altitude: 650 km	
	Type: Sun-synchronous 10:30 am	
	Period: 97 minutes	
Mass	470 kg	
Sensor bands	**MS**	**HIS**
	4 multispectral: Blue: 430-520 nm Green: 520-600 nm Red: 630-690 nm NIR: 760-900nm	115 bands:450-950 nm
Resolution	30 m	100 m
Swath width	700 km	50 km
Dynamic range	10 bits	
HuanJing-1B (HJ-1B)		
Orbit	Altitude: 650 km	
	Type: Sun-synchronous 10:30 am	
	Period: 97 minutes	
Mass	470 kg	
Sensor bands	**MS**	**IRMSS**
	4 multispectral: Blue: 430-520 nm Green: 520-600 nm Red: 630-690 nm NIR: 760-900 nm	4 bands NIR: 750-1100 nm SWIR1:1550-1750 nm SWIR2: 3500-3900 nm TIR: 105000-125000 nm
Spatial resolution	30 m	150 m
Swath width	700 km	700 km
Dynamic range	10 bits	
Revisit time	4 days	

CBERS 4		
Launched on 07 December 2014, CBER 4 is an evolution of CBERS-1 and -2. Four cameras will be present in the payload module, with improved geometrical and radiometric performance: ▪ Multi-spectral Camera-MUXCAM ▪ PanMux Camera-PANMUX ▪ Scanning Medium Resolution Scanner-IRSCAM ▪ Wide Field Imaging Camera-WFICAM ▪ Data Collection System payload		
Orbit	Altitude: 778 km	
	Type: Sun-synchronous	
Life	Design life: 5-8 years	
PanMUX	GSD: 5 (Pan), 10 m (MS) Swath : 60 km Revisit : 52 days, Revisit the same place within 3 days	0.51-0.73 (Pan) 0.52-0.59 (green) 0.63-0.69 (red) 0.77-0.89 (NIR)
MUXCam	GSD : 20m Swath: 120 km Revisit: 26 days	0.45-0.52 (blue) 0.52-0.59 (green) 0.63-0.69 (red) 0.77-0.89 (NIR)
IRS	GSD: 40 / (80 m TIR) Swath: 120 km Revisit: 26 days	0.77-0.89 (NIR) 1.55-1.75 (SWIR) 2.08-2.35 (SWIR) 10.4-12.5 (TIR)
Data quantisation (bit)	8	10 bits
Data rate (Mbit/s)	MUXCam : 68 PanMUX: 68 (Pan), 100 (MS) IRS : 17	830 km with 4 cams (nadir)

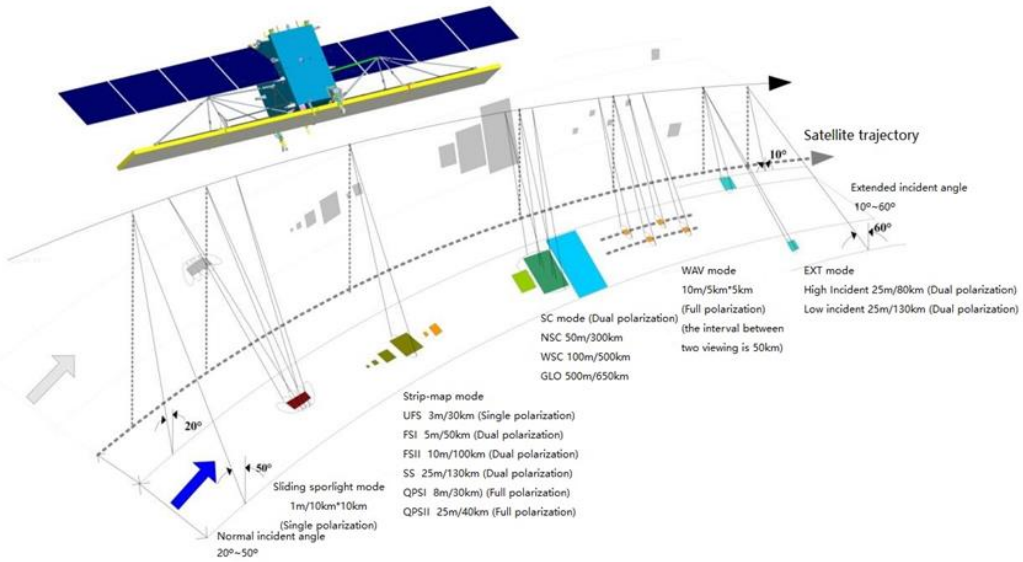
Radar Satellite

GaoFen-3 (GF-3)

Launched on august 2016,GF-3 has 12 imaging modes with the highest resolution of 1 meter in C bands which makes it the world's maximum imaging model of SAR satellite. GF-3 is following on mission of GF-1 and GF-2 technology demonstration mission, a series of high-resolution Earth observation satellites of CNSA (China National Space Administration), Beijing, China. GF-3 is part of the CHEOS (China High Resolution Earth Observation System) family. GF-3 can monitor the global ocean and terrestrial information under any weather conditions and at any time of the day, providing marine management, disaster risk forecasting, water resources assessment and management, disaster weather and climate change forecasting and other applications.

No.	Image mode		Resolution (meters)			Swath (km)		Number of look[4]	Polarization
			Nominal	Azimuth	Range[1]	Nominal	Range		
1	SL [2]		1	1.0-1.5	0.9-2.5	10*10	≥10*10	1*1	Selectable among: HH VV HV VH
2	UFS		3	3	2.5-5	30	≥30	1*1	Selectable among: HH VV HV VH
3	FSI		5	5	4-6	50	≥50	1*1	Selectable among group of (HH HV) (VV VH)
4	FSII		10	10	8-12	100	95-110	1*1	Selectable among group of (HH HV) (VV VH)
5	SS		25	25	15*30	130	95-150	1*2	Selectable among group of (HH HV) (VV VH)
6	NSC		50	50-60	30-60	300	≥300	2*3	Selectable among group of (HH HV) (VV VH)
7	WSC		100	100	50-110	500	≥500	2*4	Selectable among group of (HH HV) (VV VH)
8	QPSI		8	8	6-9	30	20-35	1*1	Full
9	QPSII		25	25	15-30	40	35-50	3*2	Full
10	WAV [3]		10	10	8-12	5*5	≥5*5	4*2	Full
11	GLO		500	500	350-700	650	≥650	4*2	Selectable among group of (HH HV) (VV VH)
12	EXT	High Incident	25	25	15-30	130	120-150	3*2	Selectable among group of (HH HV) (VV VH)

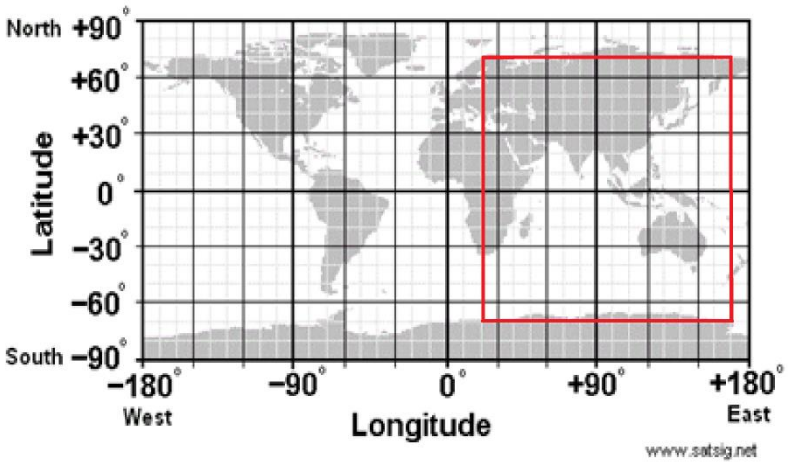
		Low incident	25	25	20-30	80	70-90	3*2	Selectable among group of (HH HV) (VV VH)
Dynamic range			8 bits						
BAQ compress			8:3 or 8:4						
Incidence angle range(look range)			20°-50° (Nominal) 10°-20° or 50°-60° (Extended)						
Revisit			3 days (single side-looking) Less than 1.5 days (double side-looking with 10m resolution and 100km swath)						
Note (1)			Ground resolution						
Note (2)			Shooting phase is 10 seconds, and the resolution for both range and azimuth are 10 km.						
Note (3)			The interval between two viewing is 50KM, the resolution for both range and azimuth are 5km.						
Note (4)			Number of look is range*Azimuth						



GF-3 satellite SAR Imaging Mode and Capability

GEO Satellite
Hyperspectral Satellite
Video Satellites

GaoFen-4 (GF-4)	
The GF-4 was launched on December 28, 2015 from Xichang China, on a CZ-3B/Long March 3 rocket, to a geosynchronous orbit 36,000 kilometers above the Earth. GF-4 satellites constantly stay above a path of Earth, covering a geographic area with longitude 20°E to170°E and latitude 70°N to70°S, providing constant 24 hour surveillance. It has a color image resolution of 50 meters and a thermal imaging resolution of 400 meters (good for applications such as monitoring forest fires). The satellite is part of the dual use China High-Resolution Earth Observation System (CHEOS). And this satellite could also be used for environment change monitoring, for disaster prevention and mitigation, as well as for agriculture and forest estimation. 	
Orbit	Altitude: 36000 km
	Type: geosynchronous
	vertexes position: 105.6°E
Life	Design life: 8 years
Sensor bands	Panchromatic: 450-900 nm
	4 multispectral: Blue: 450-520 nm Green: 520-600 nm Red: 630-690 nm Near-IR: 760-900 nm
	Mid-wave infrared:35000-41000nm
Spatial resolution	PAN (nadir): 50 m
	MS (nadir): 50 m
	Mid-wave infrared:400m
Dynamic range	16 bits
Shooting interval	20 seconds
Swath width	400 km



GaoFen –5 (GF-5)		
Gaofen GF-5 was successfully launched on 09 May 2018. It operates at an altitude of 705 km. GF-5 is one of the most advance high-resolution satellite of the GF series with a hyperspectral payload as one of the six hosted payloads. The satellite launch mass is 2800 kg with an expected life time of eight years. 		
Environment Monitoring Instrument (EMI)	Spectral range	240-315nm 311-403nm 401-550nm 545-710nm
	Spectral resolution	0.3-0.5nm
	Spatial resolution	48km (vertical track)*13km (along track)
Directional Polarization Camera (DPC)	Spectral range	433-453nm 480-500nm (P) 555-575nm 660-680nm (P) 758-768nm 745-785nm 845-885nm (P) 900-920nm
	Subpoint Spatial Resolution	Above 3.5km
Greenhous gases Monitoring Instrument (GMI)	Center Wavelength	0.765µm 1.575µm 1.65µm 2.05µm
	Spectral range	0.759-0.769µm 1.568-1.583µm 1.642-1.658µm 2.043-2.058µm
	Spectral resolution	0.6cm $^{-1}$ 0.27cm $^{-1}$
	Spectral range	750-4100cm (2.4-13.3µm)

Atmospheric Infrared Ultraspectral Sounder (AIUS)	Spectral resolution	0.03cm $^{-1}$
Advanced Hyperspectral Imager (AHSI)	No of bands	320
	Spectral range	0.4-2.5μm
	Spatial resolution	30m
	Swath width	60km
	Spectral resolution	VNIR：5nm SWIR：10nm
Visual and Infrared Multispectral Sensor (VIMS)	Spectral range	0.45-0.52μm 0.52-0.60μm 0.62-0.68μm 0.76-0.86μm 1.55-1.75μm 2.08-2.35μm 3.50-3.90μm 4.85-5.05μm 8.01-8.39μm 8.42-8.83μm 10.3-11.3μm 11.4-12.5μm 12 altogether
	Spatial resolution	20m (0.45-2.35μm) 40m (3.5-12.5μm)
	Swath Width	60km