CUBE & SMALL SATELLITES

TOO SMALL IN SIZE,

TOO BIG IN SPACE

Hedef Koç Consultancy

Cem BİLSEL

HISTORY

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- 1999 – The first CubeSat concept was developed by professors from California Polytechnic State University and Stanford University to provide students with an affordable, hands-on experience in space exploration.

- 2003 – First CubeSat launch.
- 2009 – First CubeSat of Turkey (**ITUpSat-1**) launch.
- To date, more than 550 CubeSats have been launched into space by around 50 countries.

TYPE OF SATELLITES

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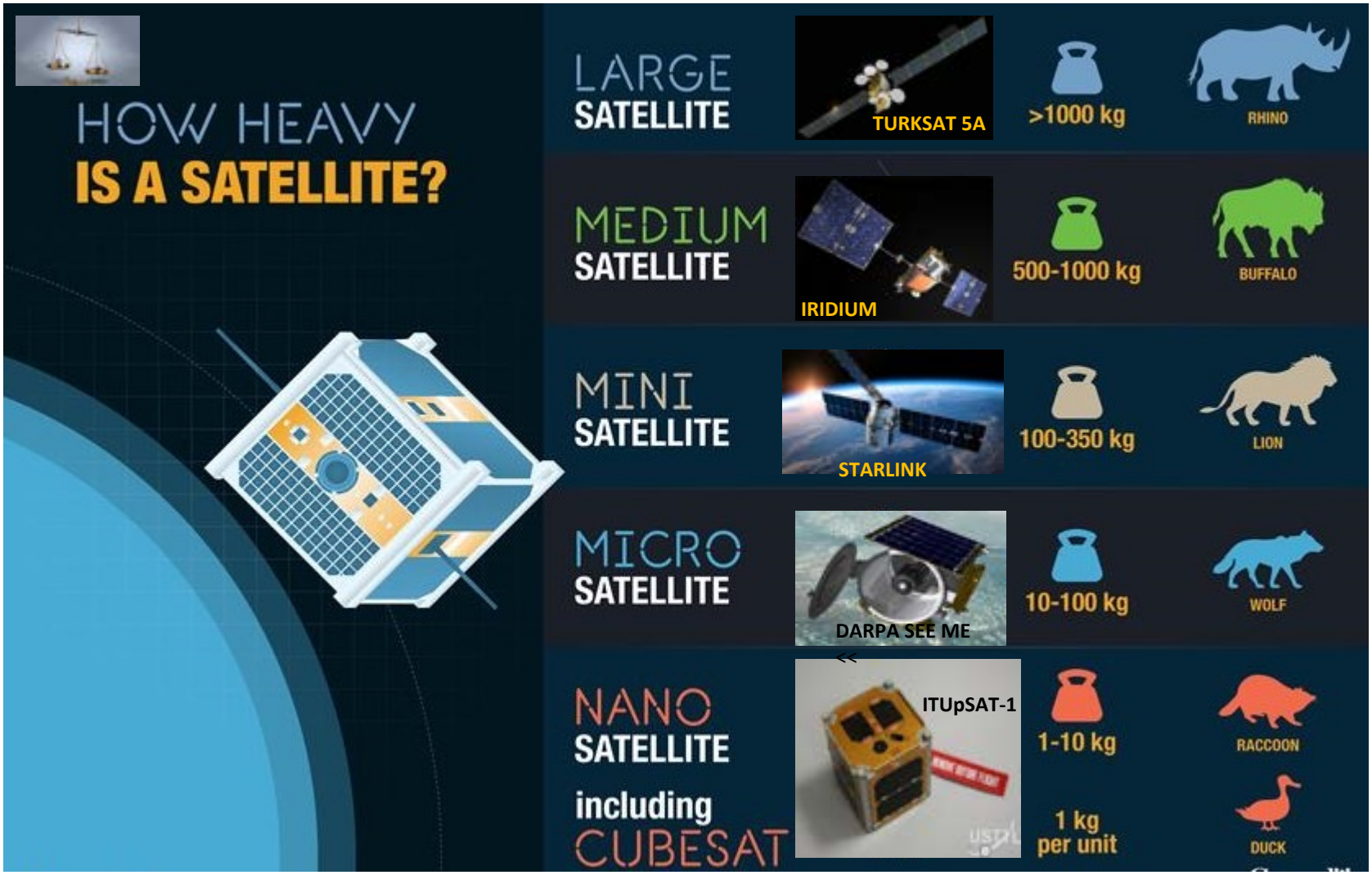

CUBESAT SUBSYSTEMS

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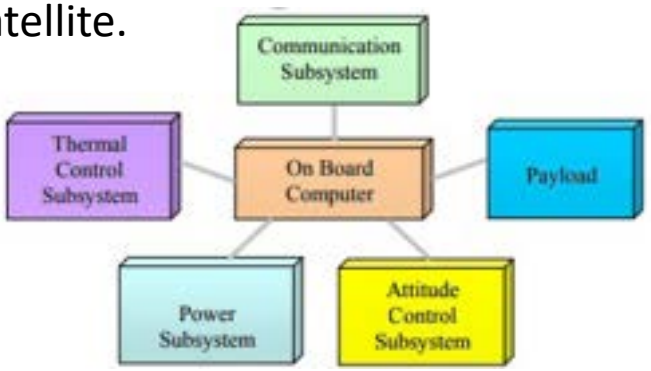
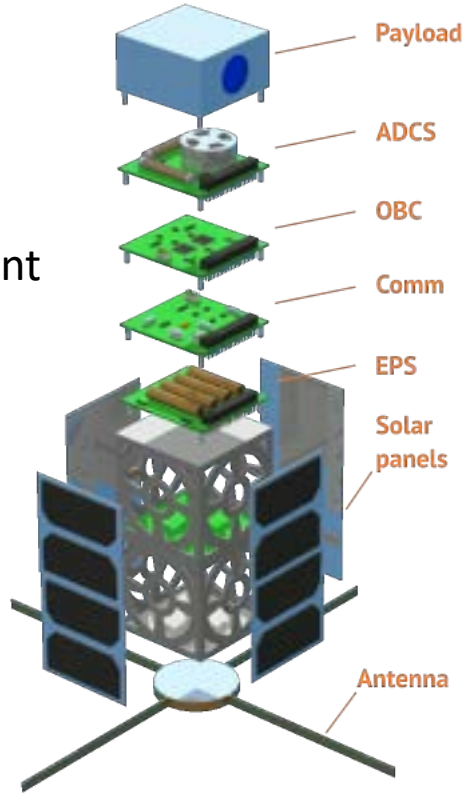
Things CubeSats have in common:

Just like any satellite, CubeSats are custom built to the specific requirements of their mission and have at least **three things in common**:

- **Communication Subsystem** which sends and receives information to and from Earth.
- **Power Subsytem:** solar panels, batteries and power management unit.
- **On-Board Computer**: brain of the cubesat, controlling the operations of the satellite.





- The main cubic structure is made of aluminum and serves to hold these subsystems along with others such as Payload including cameras, sensors etc.
- Thermal Control Subsystem and/or Attitude Control Subsystem can also be added for the sake of required mission, incurring additional cost.

CUBESAT MISSIONS

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Type of Mission	Description
Technology Demonstration 	The harsh environment of space is the ultimate test bed. CubeSats can help test new instruments or materials and validate their readiness to be integrated into a more complex space mission.
Science 	CubeSats can carry small science instruments to conduct an experiment or take measurements from space.
Educational Projects 	CubeSats can provide students with a unique hands-on experience in developing space missions from design, to launch and operations.
Commercial 	CubeSats can be used for commercial applications, like providing telecommunications services or capturing Earth observation images.

PROS & CONS OF USING CUBESATS

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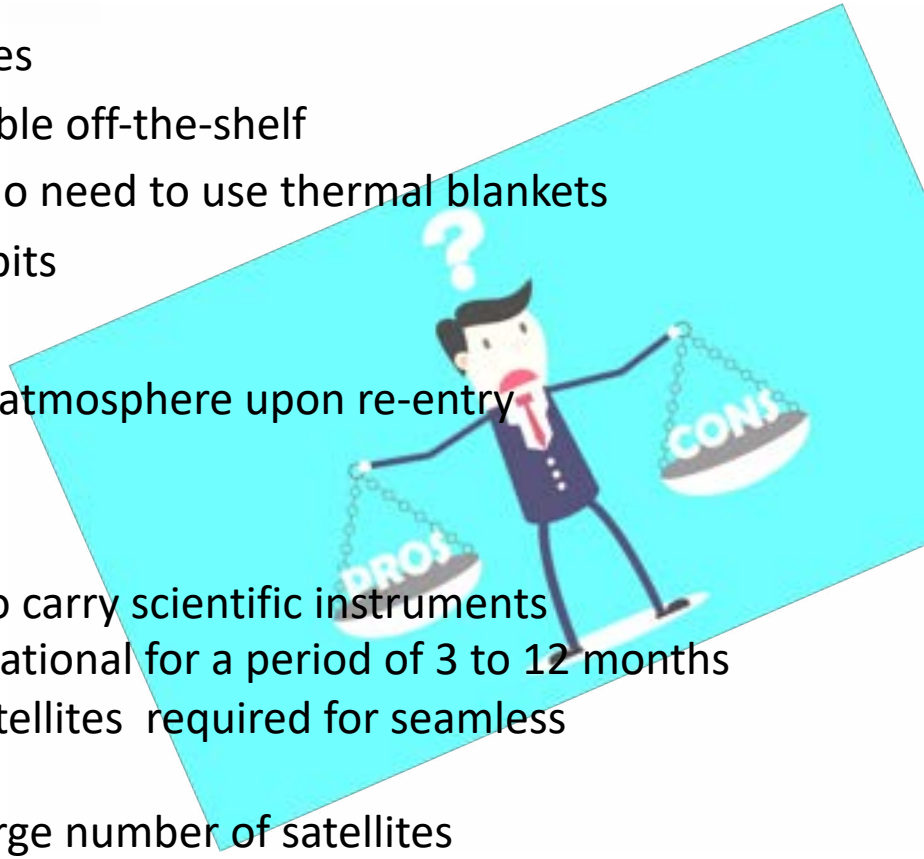
- **Fast**: can be built less than two years
- **Cost**: far less expensive than large satellites
- **Technology**: simple, standard parts available off-the-shelf
- **Design**: simple design for short mission; no need to use thermal blankets
- **Latency:** very low compared to other orbits
- **Free space loss:** very low
- **Space debris**: none – they burn up in the atmosphere upon re-entry



- **Scope**: limited due to reduced capacity to carry scientific instruments
- **Mission duration**: most of them are operational for a period of 3 to 12 months
- **Number of satellites:** large number of satellites required for seamless communication
- **Operations:** more troublesome due to large number of satellites
- **Control:** They have little or no propulsion, so you can't control where they go.
- **Launch failure:** Failed launches are more common compared to traditional satellites.

WHY SIZE MATTERS

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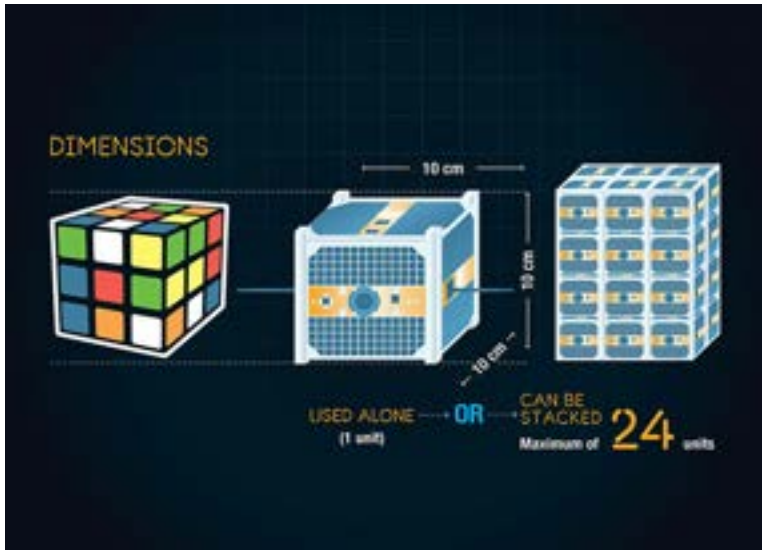
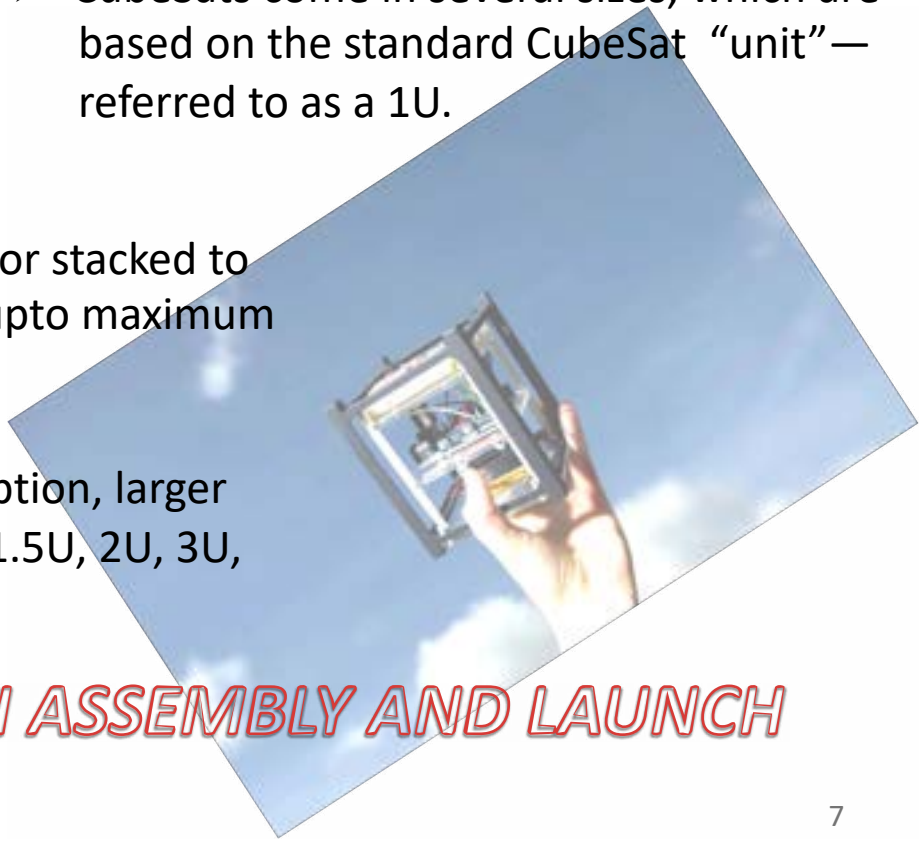


- A CubeSat is a square-shaped miniature satellite (10 cm × 10 cm × 10 cm—roughly the size of a Rubik's cube), weighing about 1 kg.
- CubeSats come in several sizes, which are based on the standard CubeSat "unit"—referred to as a 1U.
- A CubeSat can be used alone (1 unit) or stacked to suit the needs of a specific mission (upto maximum 24 units).
- In the years since the CubeSat's inception, larger sizes have become popular, such as 1.5U, 2U, 3U, 6U and 12U.



COST ASSOCIATED WITH ASSEMBLY AND LAUNCH

USAGE AREAS OF CUBESATS

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- Border surveillance
- Agriculture observation
- Environment changes monitoring
- Flood risk management
- City planning
- Intelligence
- Wideband internet services
- Mobile communications
- IoT
- Deep space aplications (e.g. spectral measurements of asteroids' surfaces)

ORBITAL PROPERTIES OF SATELLITES

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	GEO (36,000km)	MEO (5,000-20,000km)	LEO (500-1,200km)
Altitude latency[1]	High	Low	Very low
Earth coverage	Very large	Large	Small
Satellites required	Three	Six	Hundreds
Data gateways	Few fixed	Regional flexible	Local numerous
Antenna speed	Stationary	1-hour slow tracking	10-minute fast tracking
Advantages	High throughput (HTS) technologies enable basic broadband internet applications	Proven low latency comparable to terrestrial networks, offers fibre-equivalent performance	Claims support for high-frequency trading, virtual gaming, and high-performance computing applications
	Fewer satellites over very large fixed geographical areas	Simple equatorial orbit covers 96% of global population	Smaller, lower power satellites batch-launched more cheaply than GEO
Disadvantages	High altitude and distant ground networking impacts latency-sensitive applications	Dual tracking antennas required to maintain continuous connectivity	Very complex tracking and ground network, plus complete constellation must be in place before service starts
	Signal power losses require larger satellites and antennas	Inclined plane orbits needed to cover high latitudes	Unproven business model, risky technology, and space debris risk

MULTI-ORBITAL SATELLITE SYSTEM

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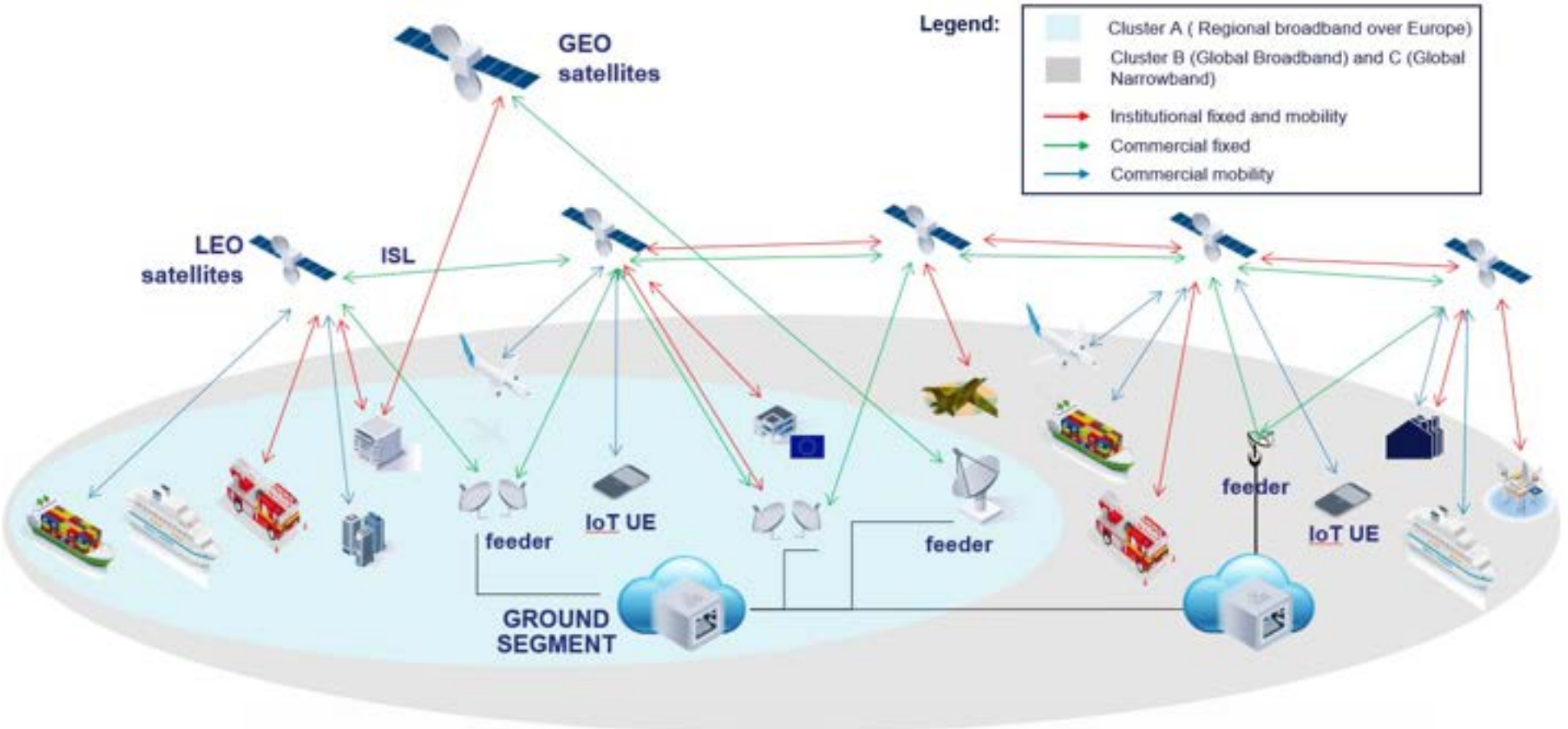

CAN LEO SATELLITES BE A GAME CHANGER?

No orbit is perfect itself → *Multi-orbital satellites*

OUR OBJECTIVES

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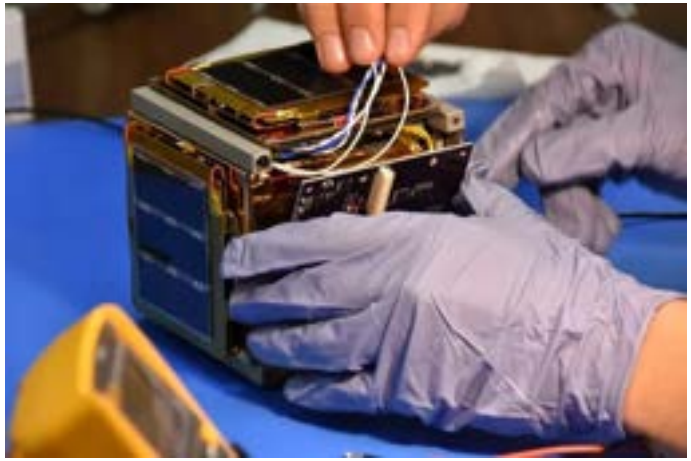
HKC is willing to

- establish a company in Turkey that will design, develop, manufacture, test and bring into service cube and small satellites at different orbits
- partner with companies, universities or research institutes who are interested in benefiting from cube and/or small satellites or planning to manufacture LEO/MEO/GEO cube and/or small satellites
- market cube and/or small satellites to be used for different missions
- support R&D activities to increase local content in design, development, manufacture, test and launch phases of cube and/or small satellites.



Our target is to establish an ecosystem that will bring together the key players in the market, according to their expertises…

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Thank you