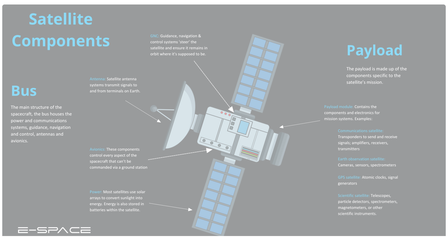
What are the components of a satellite?

Alex Miller 5 minutes
Technology



According to the Union of Concerned Scientists, as of January 1, 2023, there are 6,718 satellites in orbit around the Earth. Artificial satellites, which are objects people have built and launched into orbit using rockets, come in all shapes and sizes and orbit the planet in a variety of different altitudes, but most have some basic elements in common.

So what is an artificial satellite, exactly? Here's a look at what they're typically comprised of:

The bus

The bus is the main structure of the spacecraft, and it houses the power and propulsion systems as well as the communications system and, typically, the payload (see below). The bus also contains the hardware and software for controlling the spacecraft and the electronic systems — or avionics.

It's worth diving a little deeper into these components:

- **Power system:** All satellites need power to operate, almost always from solar panels that draw energy from the sun, batteries or some combination of the two. For propulsion, satellites typically use some form of chemical propellant for thrusters, but in recent years we're seeing more electric satellites, which use electrostatic, electromagnetic or electrothermal power to accelerate propellants to generate thrust. There are also satellites that use xenon gas for ion propulsion — and a variety of others detailed in this NASA info sheet.
  For most of its power needs while in orbit, satellites use solar energy, which is why we often associate the look of a satellite as a box in the middle of traditionally two long solar panels.
- **Guidance Navigation & Control (GNC):** GNC is a specific field of engineering and expertise focused on "steering" the satellite. That includes station keeping to ensure the spacecraft gets to where it's supposed to be in space (and stays there) using a variety of sensors, algorithms and control mechanisms. Another function of GNC is pointing and adjustments for perturbation on the satellite. These can be a result of solar pressure or drag pressure from the atmosphere that must be addressed and compensated for.
- **Antenna:** Another "must-have" for satellites is an antenna for the transmission of data. That can be everything from GNC commands and power instructions to the data uploads and downloads specific to the satellite's mission. The larger the antenna, the more data it can transmit, which is why, for example, we see very large antennas on broadband satellites that need to stream video content down to Earth.
- **Avionics:** Satellites live and die by their ability to power themselves, and spacecraft avionics is all about managing that electricity to keep things going. Avionics control every aspect of the spacecraft that can't be commanded via a ground station. The on-board computer, an integral part of the avionics, is running the primary flight software which automates most of the functionality of a satellite, like running GNC control algorithms for station keeping and sensor measurement acquisition and processing.

The bus can be custom-made by the satellite operator — such as what E-Space is doing — but it's often purchased from a supplier like Boeing or Airbus — companies with long histories of making large spacecraft. The growing popularity of smaller satellites has spurred a great many manufacturers of these — from tiny CubeSats and other smaller spacecraft buses.

Payload

The payload is made up of specific equipment or components designed to perform a specific function or carry out a specific mission, such as collecting and transmitting data, conducting scientific experiments or providing communication services. These payloads can include cameras, sensors, antennas, transponders or any other hardware necessary to fulfill the satellite's intended purpose.

The payload for an Earth observation satellite, for example, would be hardware and software for cameras or other sensors. An internet satellite's payload might contain a number of transmitters and receivers as well as large antennas. The payload on a military satellite might include components for surveillance, reconnaissance and targeting, while space-based telescopes like the Hubble and the James Webb have the observation equipment as well as other scientific instruments.

Payloads for other scientific satellites could include things like multispectral imagers, infrared or UV sensors and others that help create detailed maps of the Earth's surface — or point toward space for gaining greater understanding of the solar system and universe.

Global Positioning Systems (GPS) are another well-known class of satellite whose payloads include radio transmitters and receivers that allow them to communicate with ground stations. Those signals are what's used to determine the location of the GPS receiver (e.g., your smartphone) on the Earth's surface.

Yet another familiar class of satellites are those operated by TV providers beaming shows to a dish on the outside of your house. Like broadband satellites, these are often large, powerful spacecraft in high Earth orbit. But since they're only sending signals down and not both ways as an internet satellite needs to do, the payload is a bit simpler.

The E-Space bus and payload

Our upcoming global satellite constellation will feature some trailblazing technology to enable hyper-scaled deployments of Internet of Things (IoT) solutions and services. The payload of an E-Space satellite will have some special properties that allow it to deliver that service — so unique that no "off-the-shelf" bus from another company would be suitable. To reach our goal, E-Space aligned itself as a vertically integrated company, with both our bus and payload being created almost entirely by us.

Our satellites are also being designed with sustainability in mind, so rather than create massive buses and payloads that could one day contribute to the growing space debris problem in LEO, E-Space satellites will be resilient enough to withstand a collisional cascading event while also designed to avoid one.

Learn more about sustainability and E-Space satellites.

All of that means that, when it comes to the traditional payload and bus systems we're used to seeing in satellite design, E-Space's will be quite different.

Alex Miller

Alex Miller leads editorial at E-Space. Based in Denver, he's a longtime journalist who's been involved with the satellite industry for over a decade.

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