The Globalization of Space

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A quick introduction to satellites

About 1000 satellites currently operating
Some in low orbit skimming just outside the atmosphere, mostly going from pole to pole

Some In 'geostationary orbit' in a ring high above the equator
Communications

Earth Imaging

Signals intelligence

Navigation (GPS)

Science (e.g. astronomy)

Human spaceflight
The Growth of Space Junk
Space Junk - mass in metric tons
Satellite Tonnage (excluding human spaceflight)

2010s

3-yr total 700 t robotic, 1000 t 6 x Shuttle + ISS/PRC
We still think of space the way it was in the 1960s

Here, the TIROS weather satellite is assembled by a US manufacturer – in this case, RCA in East Windsor, NJ
Another US company, Douglas Aircraft, builds the Thor Delta rocket.

The satellite is delivered to its owner, the US civil space agency NASA, who also buy the rocket.

Here is TIROS 2 on top of the rocket before the nose cone is added.
Here, the NASA Delta launches TIROS 2 into space from a launch site on US territory – in this case, Cape Canaveral, FL.
And the satellite operates in orbit under the ownership of NASA, using a NASA mission control center in Greenbelt, MD.
1962 – Ariel 1, a UK owned, US built satellite with UK instrumentation

(1964's Ariel 2 carried the first – and AFAIK so far only – Cambridge satellite experiment, for radio astronomy)

Later in 1962: Canada's Alouette 1 Canadian built and owned
1965:
The first French satellite launch from the Algerian desert

France becomes the third country with orbital launch capability after the USSR and the USA
But it's not like that any more!

South Korea's Koreasat-5 satellite takes shape in the Thales Alenia factory in Cannes, in the south of France.
In the Ukraine, the Yuzhnoe company builds the Zenit-2S rocket.
In Korolev, near Moscow, the Rocket Space Corporation “Energiya” builds the Blok DM-SL upper stage rocket.
At Sea Launch home port in Long Beach, California, the satellite and Zenit rocket are loaded on the Norwegian-built floating launch platform.

The platform then sails out in the Pacific to the Equator – in international waters.
The Zenit rocket puts the Koreasat-5 in orbit where it is operated via the mission control center in S Korea with support from engineers in France.

The rocket launch is carried out by Energia Logistics (US), a US subsidiary of RSC Energiya. The launch is sold to the satellite owner by Sea Launch AG of Bern.

I count this as a US launch!
Today the space launch market has many more players. In 2012 China had as many orbital launch attempts as the US. 12 countries plus ESA/Arianespace have launched satellites; Brazil has also tried but failed. North and South Korea are the latest members of the club.
If we look at the 68 parent countries of satellite OWNERS, the pie chart doesn't cut it
Neither does this set of histograms really...

Instead, let's pick out the main players and lump the rest per continent
The commercialization of space
In the era of government space programs, commercial enterprises were involved early on as manufacturers (contractors).

In the USA, the early-lab built Explorer and Vanguard satellites from JPL and the Naval Research Laboratory were soon followed in 1959 by satellites built by Lockheed (CIA CORONA) and TRW (NASA/USAF Able Probes). RCA, McDonnell, General Electric and Ball Brothers soon followed.

The space rockets, like their military ballistic missile siblings, also moved from the Army-Huntsville and Navy-NRL workshops to the factories of Chrysler (REDSTONE), Martin (VANGUARD), Douglas (Thor) and Lockheed (Agena).

In the Soviet Union, the Design Bureaus of Korolev, Yangel and Chelomey acted in some ways like the independent corporations they would later become.

When Europe and Japan arrived on the space scene, bolstering their respective aerospace industrial concerns was a priority. But for the most part the projects were initiated by and funded by governments - true “commercial space” came later.
1962-1963

Telstar 1 and 2 – AT&T funded the first commercial communications satellites and paid NASA to launch them.
Telstar was not followed up – the next commercial satellite system had to wait for geostationary satellites to be mature.

In 1972 the Canadian company Telesat was established as a commercial enterprise by the Canadian government. The `Anik' system was the first of a rush of first-generation commercial communications satellites built by Hughes and RCA.
1974: Western Union's Westar
1975: RCA Globcom's Satcom
1976: Comsat General's Marisat and Comstar
1976: Perumtel of Indonesia's Palapa
In the 1980s government civilian orbital launches by NASA and ESA were replaced by commercial launch services by McDonnell Douglas (now Boeing), General Dynamics (now Lockheed Martin) and Arianespace.

Apart from the Space Shuttle, NASA hasn't launched a satellite itself since 1994.
In the 1990s a commercial microgravity market began but didn't really take off – hopes of industrial scale manufacturing in space remain a science fiction dream for now.

German company MBB flew the SPAS experiment on Shuttle missions.

Wake Shield Facility – Shuttle payload.

Foton – Russian recoverable microgravity satellite.
The US govt attempted to create a commercial imaging satellite market for many years

In 1985 operation of Landsat 4 and 5 was turned over to the private company EOSAT – although the govt. retained ownership

The French company SPOT IMAGE was created for commercial sales of the French space agency's imaging satellite SPOT 1
Commercial Earth imaging satellite – ORBIMAGE's Orbview-2/Seastar
Launched 1997
Today commercial imaging satellites are familiar thanks to Google maps!
In the 2010s, commercialization began to extend to human spaceflight. SpaceX's latest Dragon cargo ship reached the Station on Mar 2.
With the globalization of corporations, space commercialization becomes space globalization

SES (Societe Europeene des Satellites)
- Based Luxembourg, 1985 (first satellite 1988)
- Absorbed RCA Americom (New Jersey) 2001
  (Absorbed GTE Spacenet 1994)
- Absorbed GE Capital (Gibraltar) 2001
- Absorbed Nordic Satellite (Stockholm) 2005
- Absorbed New Skies (The Hague) 2006
  (spun off from INTELSAT in 1998)
- Stake in Nahuelsat (Argentina), Quetzsat (Mexico)
- Former stake in Asiasat (Hong Kong) and Star One (Brazil), etc.
The INTERNATIONAL TELECOMMUNICATIONS SATELLITE ORGANIZATION - in the 1960s, an IGO
Now 149 member countries

Operations privatized in 2001
Headquarters in Bermuda until 2009, then Luxembourg
The Democratization of Space
Dec 1961 – the first amateur satellite
Built by radio amateurs in California
Hitched a ride strapped to the side of a spy satellite rocket

OSCAR – Orbiting Satellite Carrying Amateur Radio
Guildford, 1981: the University of Surrey builds amateur radio satellite UoSat-1. It becomes the basis of a series of cheap commercial satellites affordable by developing countries.
Cubesats: 1 kg, 10 cm (2 lb, 4 in for the metric impaired)
Standard kit for universities to make students build sats in engineering courses
Can also make '3U' cuboids 30 x 10 cm
102 Cubesats launched since 2003 by 66 organizations in 20 countries
USA  CalPoly, Stanford, Cornell, Kentucky, UIUC, Arizona, U Louisiana-Lafayette, Berkeley, Montana State, Hawaii, Colorado, Texas-Austin, Michigan, Kansas, USC Los Angeles, Auburn, Utah State, San Jose State, Texas A&M, Aerospace Corp, NRO, Boeing, NASA, Los Alamos
Canada        Toronto
Switzerland   Lausanne, SUPSI
Colombia      U Sergio Arboleda (Bogota)
Germany       Aachen
Denmark       Aalborg, DTU
Spain         Vigo
France        U Montpelier 2
Hungary       Budapest U. Tech.
Italy         Roma-Sapienza, Torino Poly
India         IIT Kanpur
Japan         Tokyo, Tok.Tech,Hokkaido,Fukoka,
Korea         Hankuk AvU,
Norway        NTNU Trondheim
Netherlands   Delft
Poland        Warsaw Poly
Romania       Bucharest
Turkey        Istanbul ITU, Tubitak
UK            Surrey
Vietnam       FPT Univ
Earth orbit is now globalized
Until recently the rest of the solar system was a superpower preserve

MOON:
USSR 1959  USA 1962  Japan 1990  Europe 2003
China 2007  India 2008

VENUS:

MARS:

JUPITER:
US 1973  Europe 1992 (ULS)

SATURN:
US 1979  Europe 2005 (hitching a ride with US)

COMETS:

ASTEROIDS:

MERCURY, URANUS, NEPTUNE: Only USA
The future of space globalization

- Human spaceflight
  
  USSR 1961   USA 1961-62

  As passengers:
  Czech SSR, Poland 1978  W Germany 1983 .... now 37 nations

  With own habitable modules:
  Europe 1983  Japan 2008

  Launching own astronauts:
  China 2003

  Coming soon?
  - India?
Even Cambridge has astronauts:
Mike Foale (BA, PhD Cantab, Queens) - ISS Commander, Expedition 8
Nick Patrick (BA Eng. Cantab, Trinity) - Shuttle astronaut, made 2 flights
David Saint Jacques (PhD Cantab, Corpus) – in training

If you know of any Oxford astronauts, please let me know.