Kosmiczne (nie)bezpieczeństwo

Łukasz Dzwoniarek

Co się zmieniło?


S-IV


MISSION CONTROL CENTER
CAPCOM
BOOSTER

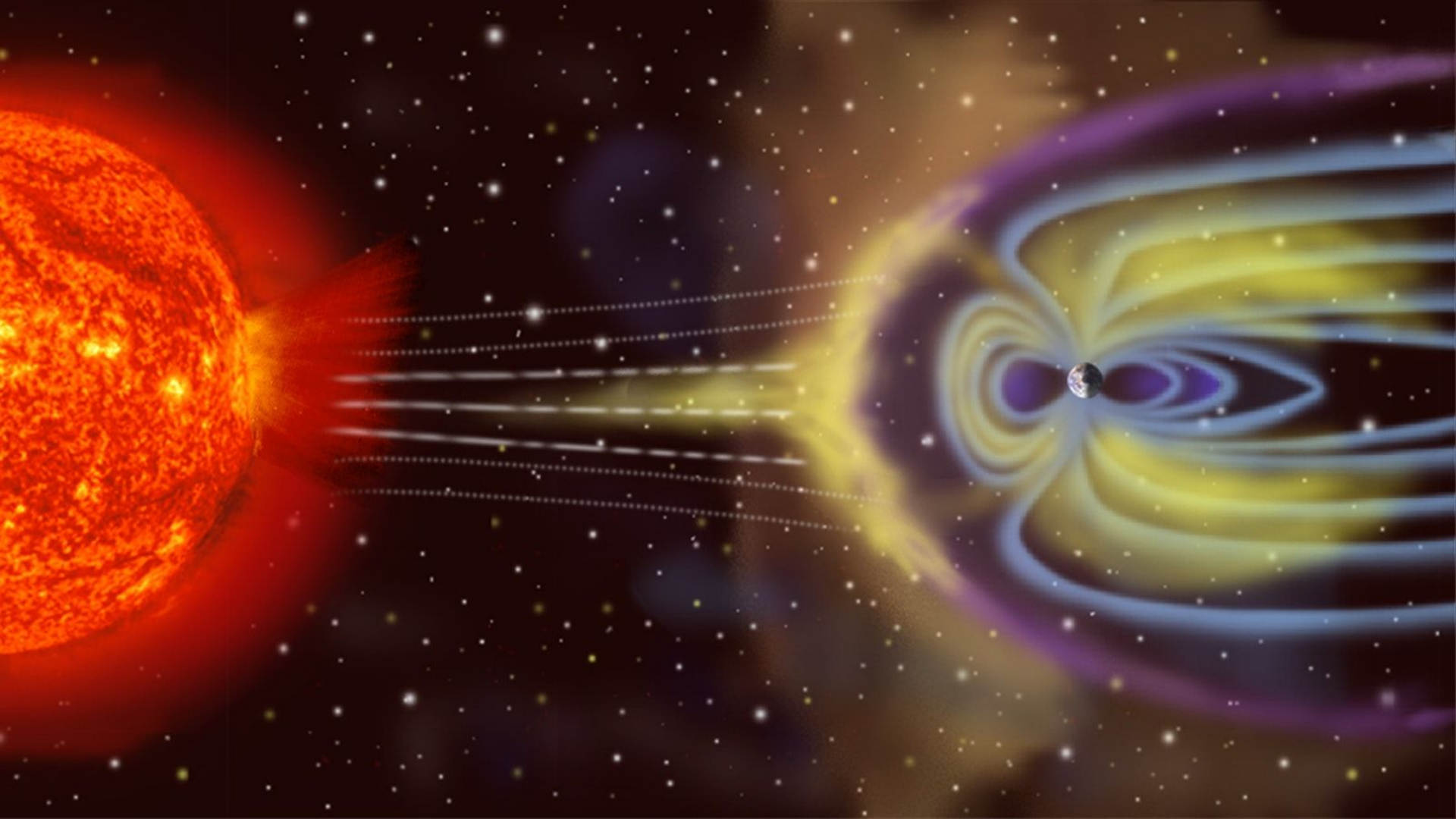
<- 180 mln $

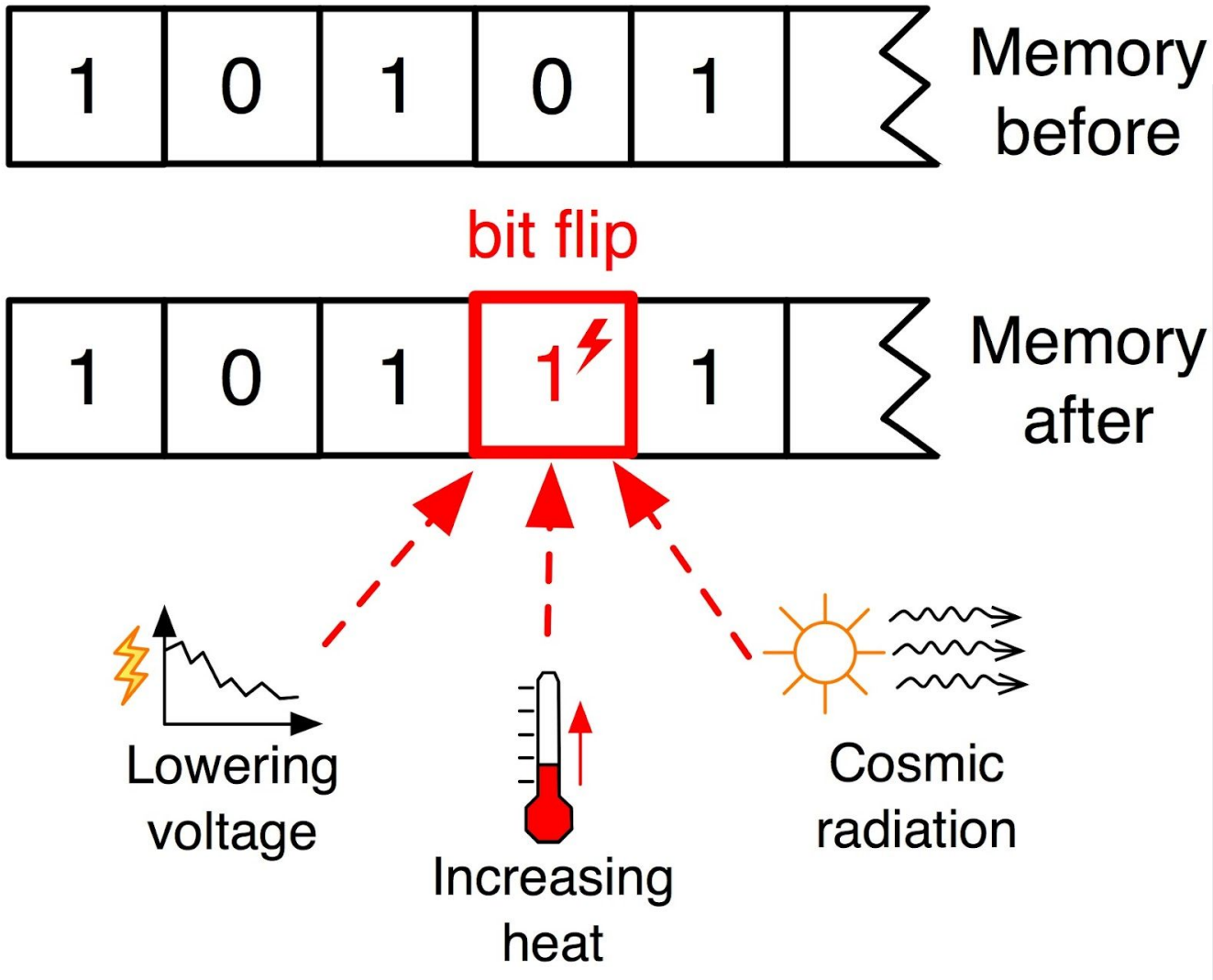
20 ton
ładunku

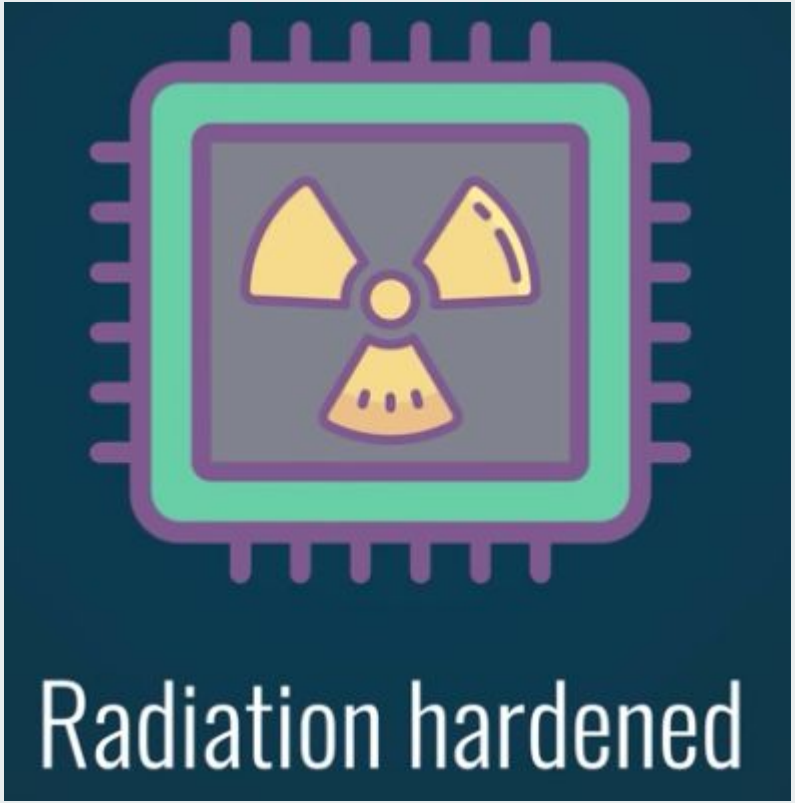
60 mln $ ->


STRATOLAUNCH
SYSTEMS

Komputery pokładowe




1 0 1 0 1
Memory before
bit flip
1 0 1 1 1
Memory after
Lowering voltage
Increasing heat
Cosmic radiation

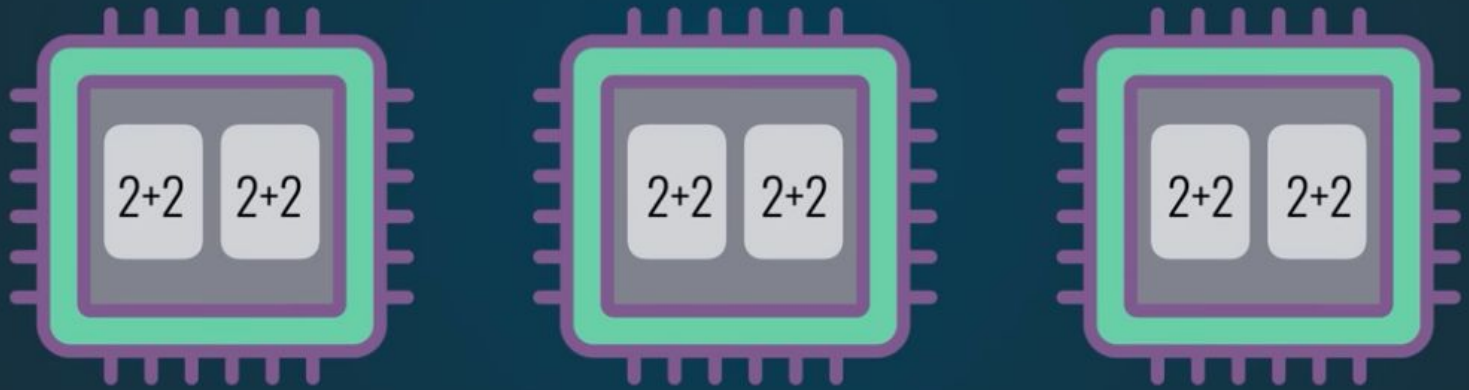

Radiation hardened

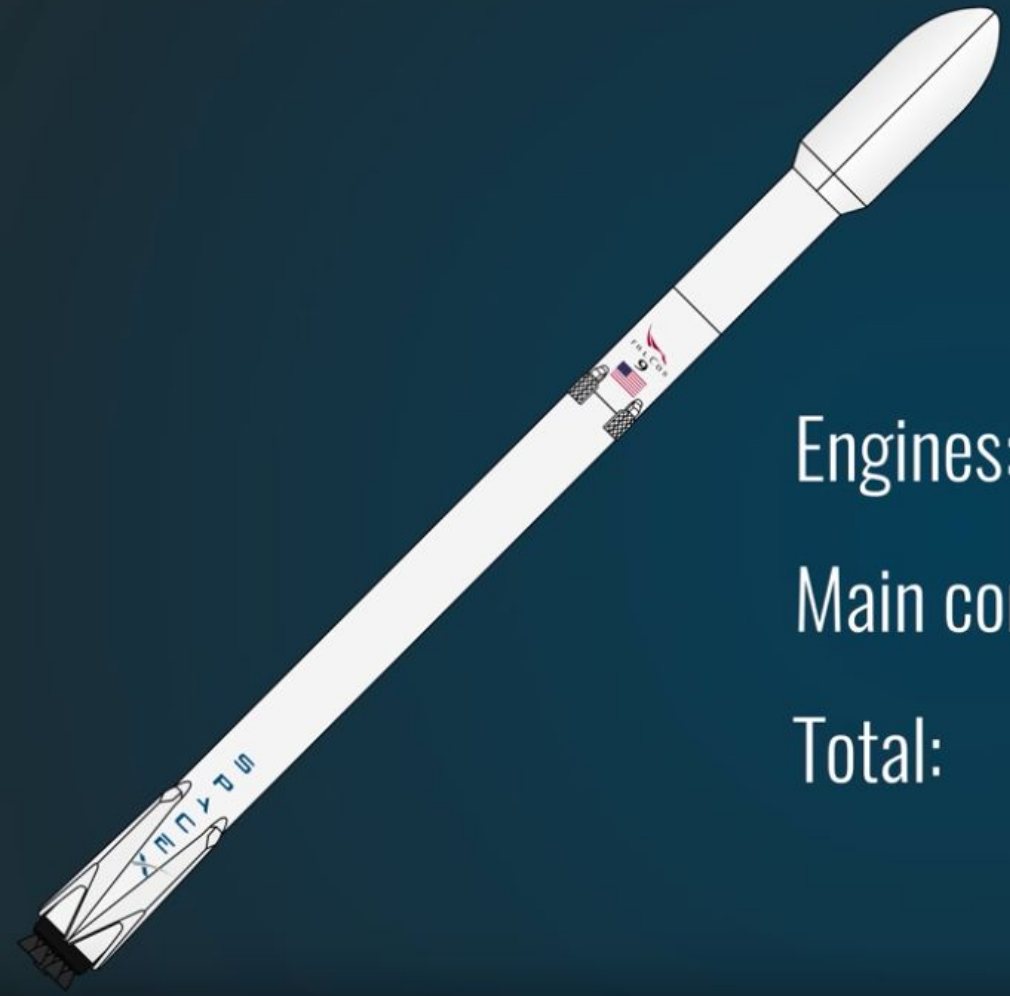
Ariane 5 Flight 501

June 4, 1996

- French rocket reuses code from Ariane 4
- 5's faster engines triggers bug in arithmetic routine in flight computer
- Convert 64-bit FP to 16-bit signed int


SPACEX
DRAGON

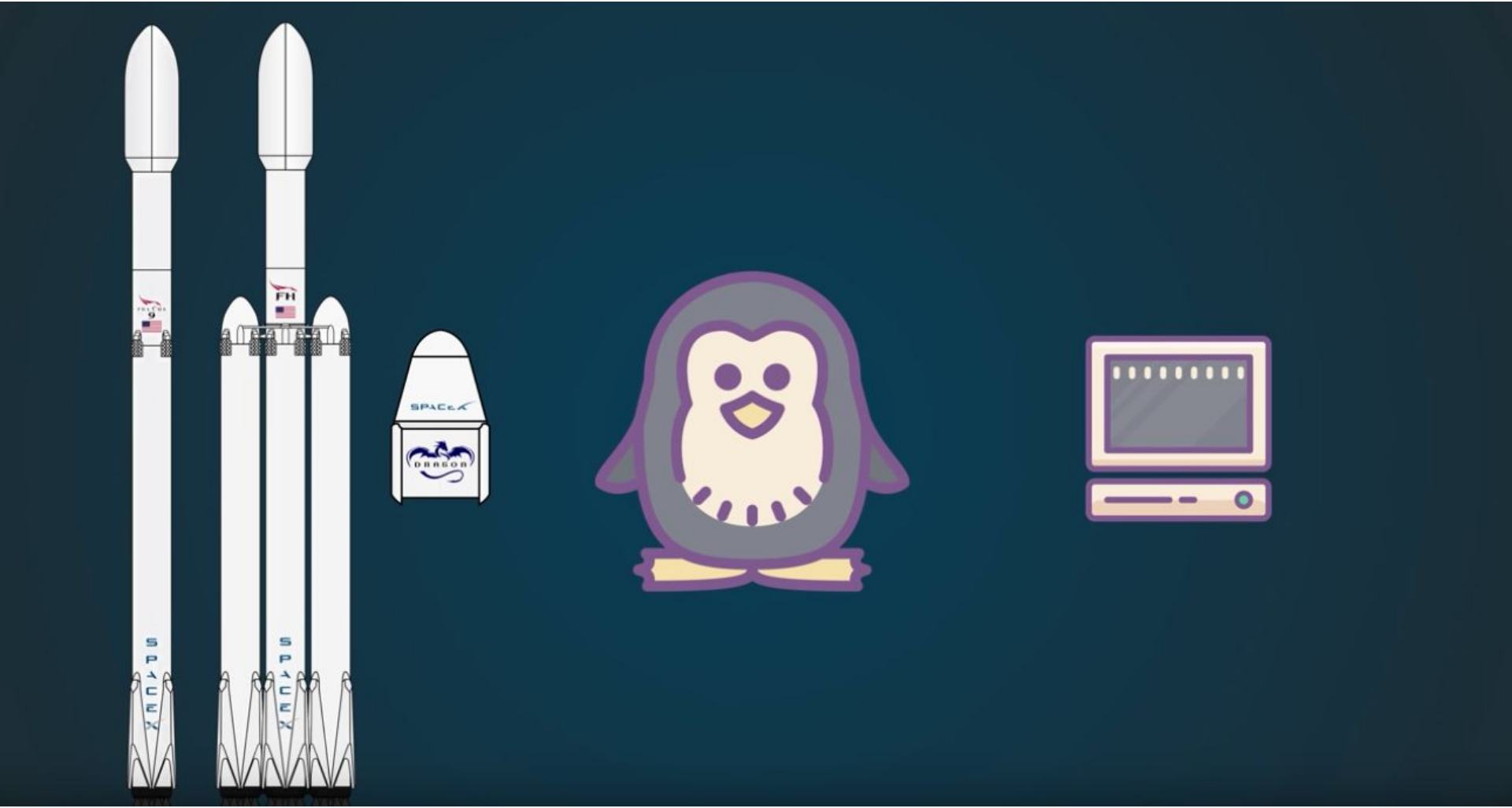

2+2
2+2
2+2
2+2
2+2
2+2



Engines: 9 x 3 = 27

Main computer: 1 x 3 = 3

Total: **30**


FALCON 9
FH
SPACEX
DRAGON
SPACEX
SPACEX

SpaceX

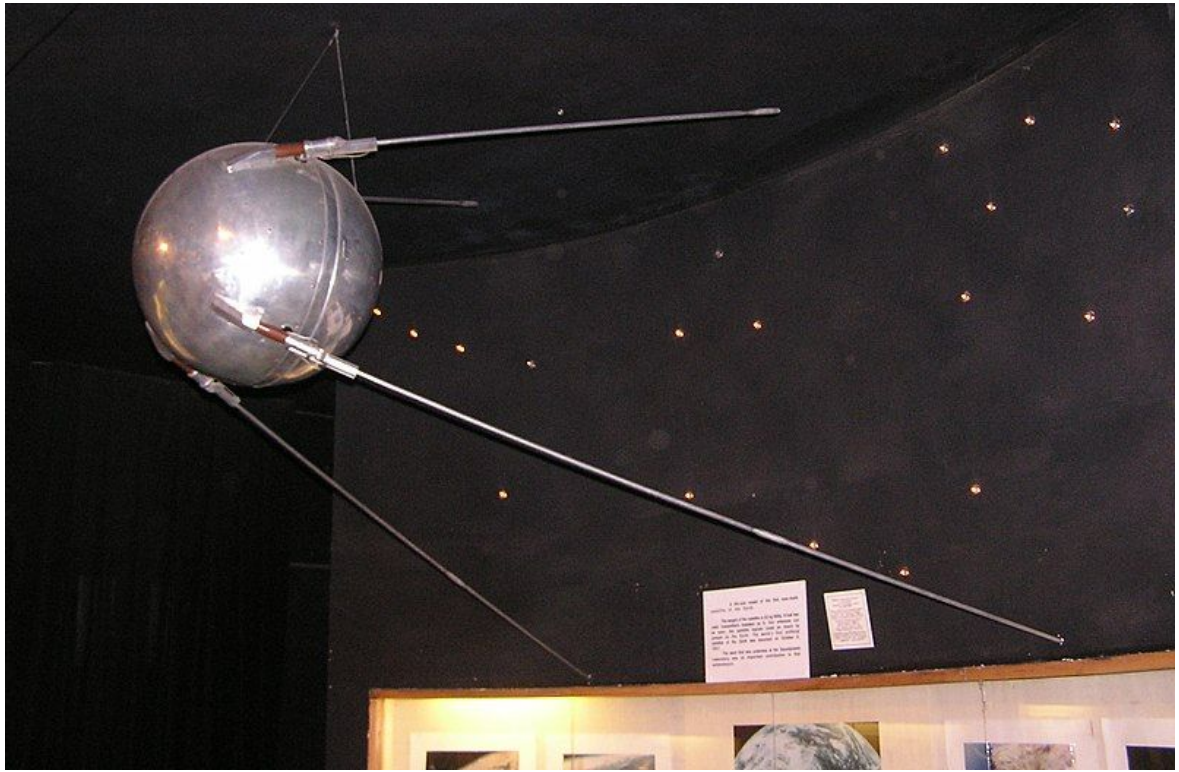
The Flight Software team is about 35 people. *We write all the code for Falcon 9, Grasshopper, and Dragon applications; and do the core platform work, also on those vehicles; we also write simulation software; test the flight code; write the communications and analysis software, deployed in our ground stations. We also work in Mission Control to support active missions.*

The Ground Software team is about 9 people. *We primarily code in* ***LabVIEW****. We develop the GUIs used in Mission and Launch control, for engineers and operators to monitor vehicle telemetry and command the rocket, spacecraft, and pad support equipment. We are pushing high bandwidth data around a highly distributed system and implementing complex user interfaces with strict requirements to ensure operators can control and evaluate spacecraft in a timely manner.*

Electron & FPGA

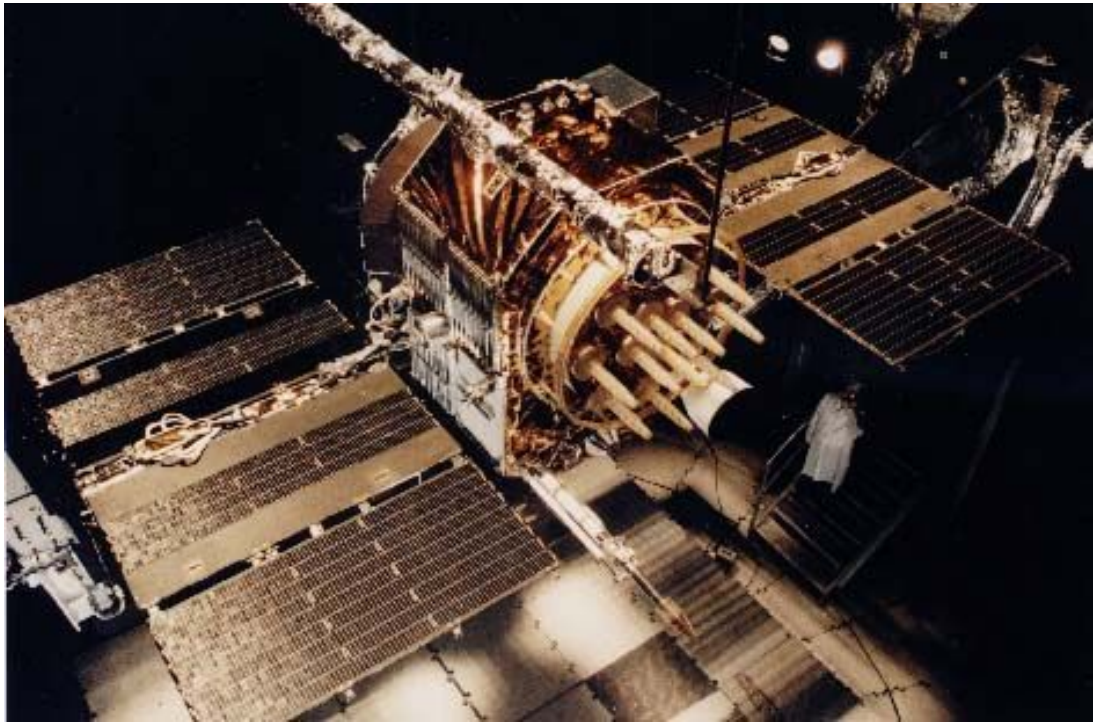
Sputnik 1

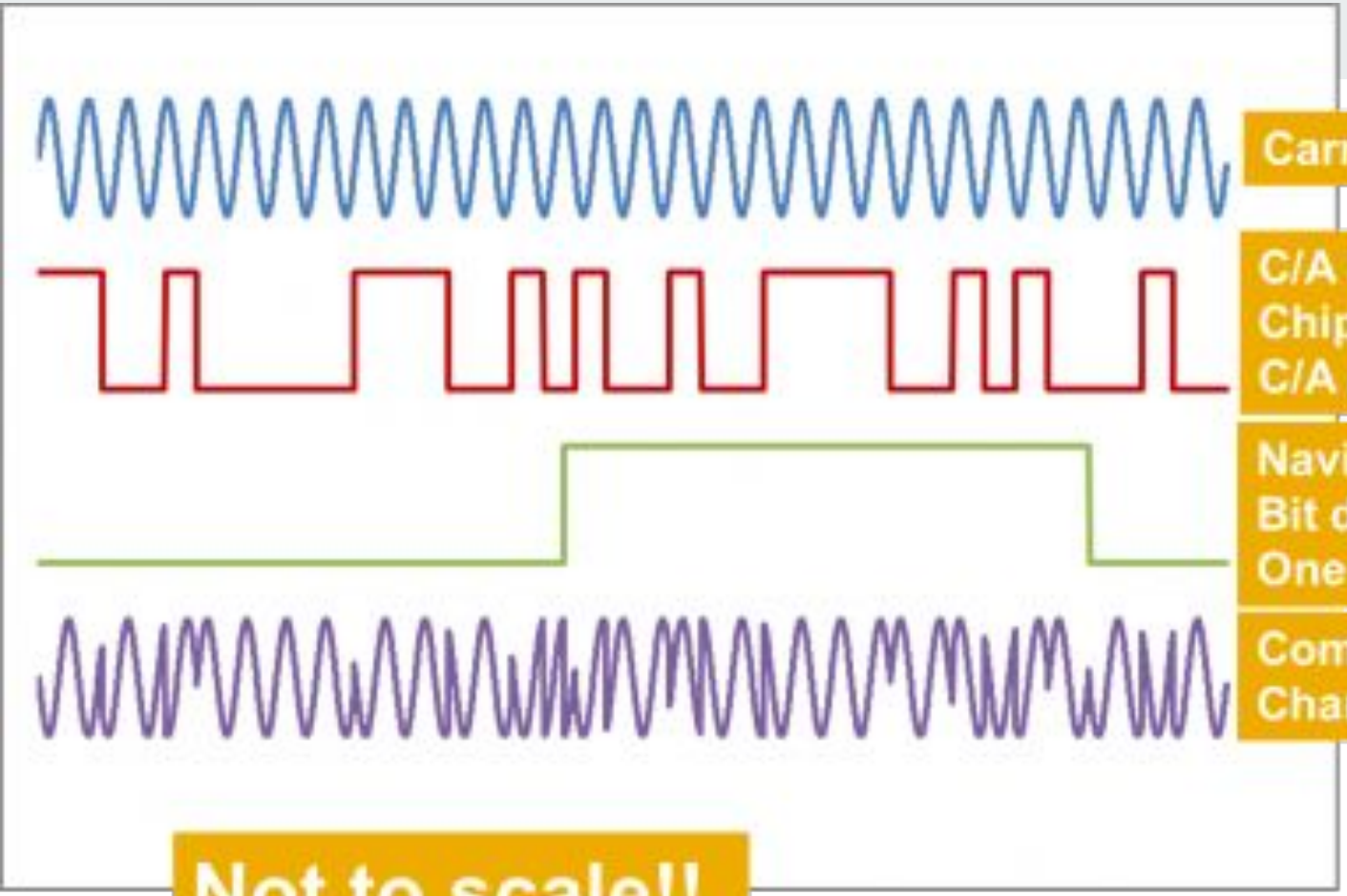
- 1957
- 1 satelita



GPS

- globalny system nawigacyjny
- 1995
- 24 satelity





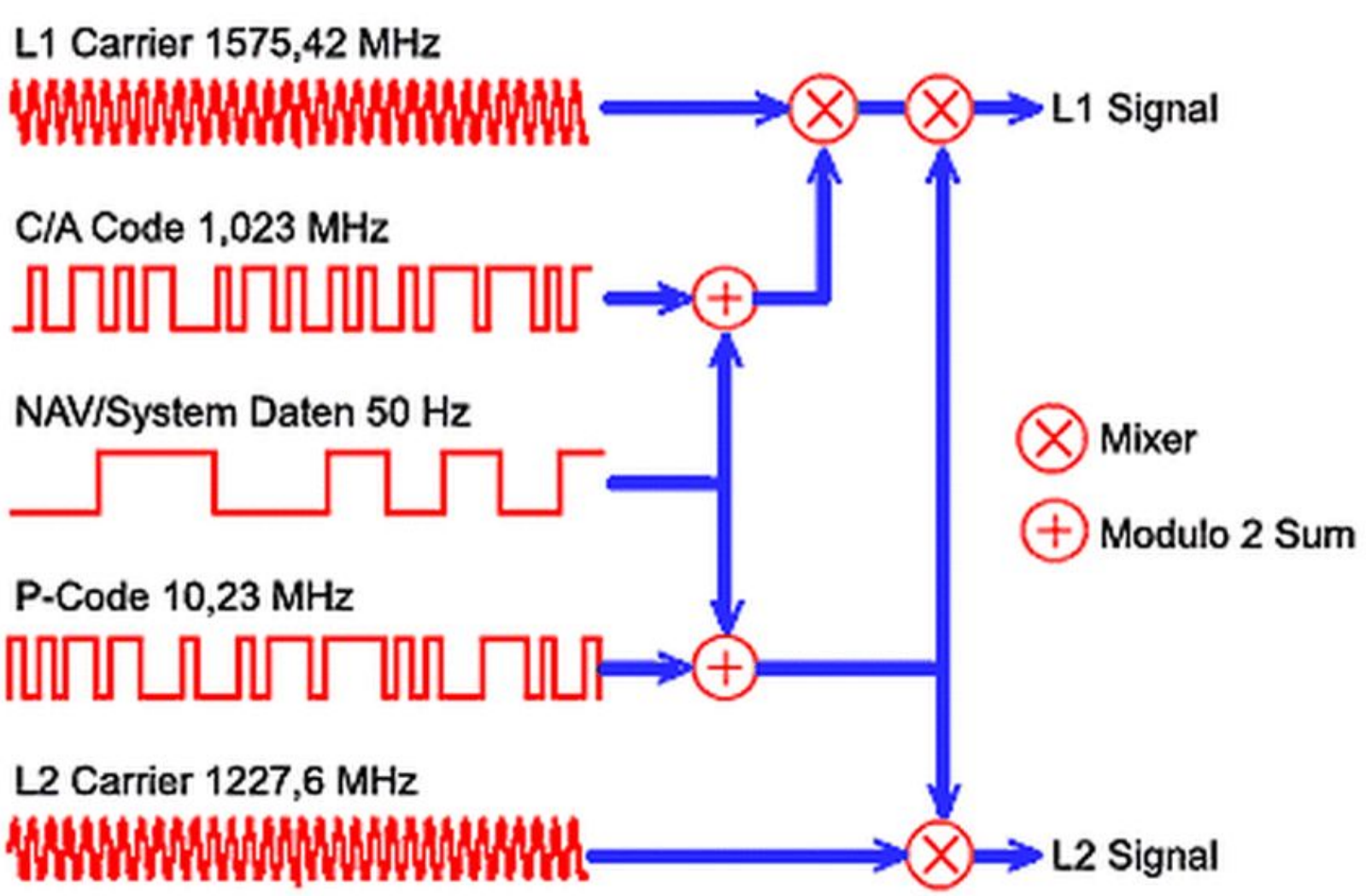
Carrier L1: 1575.42 MHz

C/A PRN : 1.023 MHz
Chip duration : ~ 1 µs
C/A period: 1023 chips

Navigation Info: 50 Hz
Bit duration: 20 ms
One bit: 20 full PRN

Composition
Change of phase

Not to scale!!


L1 Carrier 1575,42 MHz
L1 Signal
C/A Code 1,023 MHz
NAV/System Daten 50 Hz
Mixer
Modulo 2 Sum
P-Code 10,23 MHz
L2 Carrier 1227,6 MHz
L2 Signal

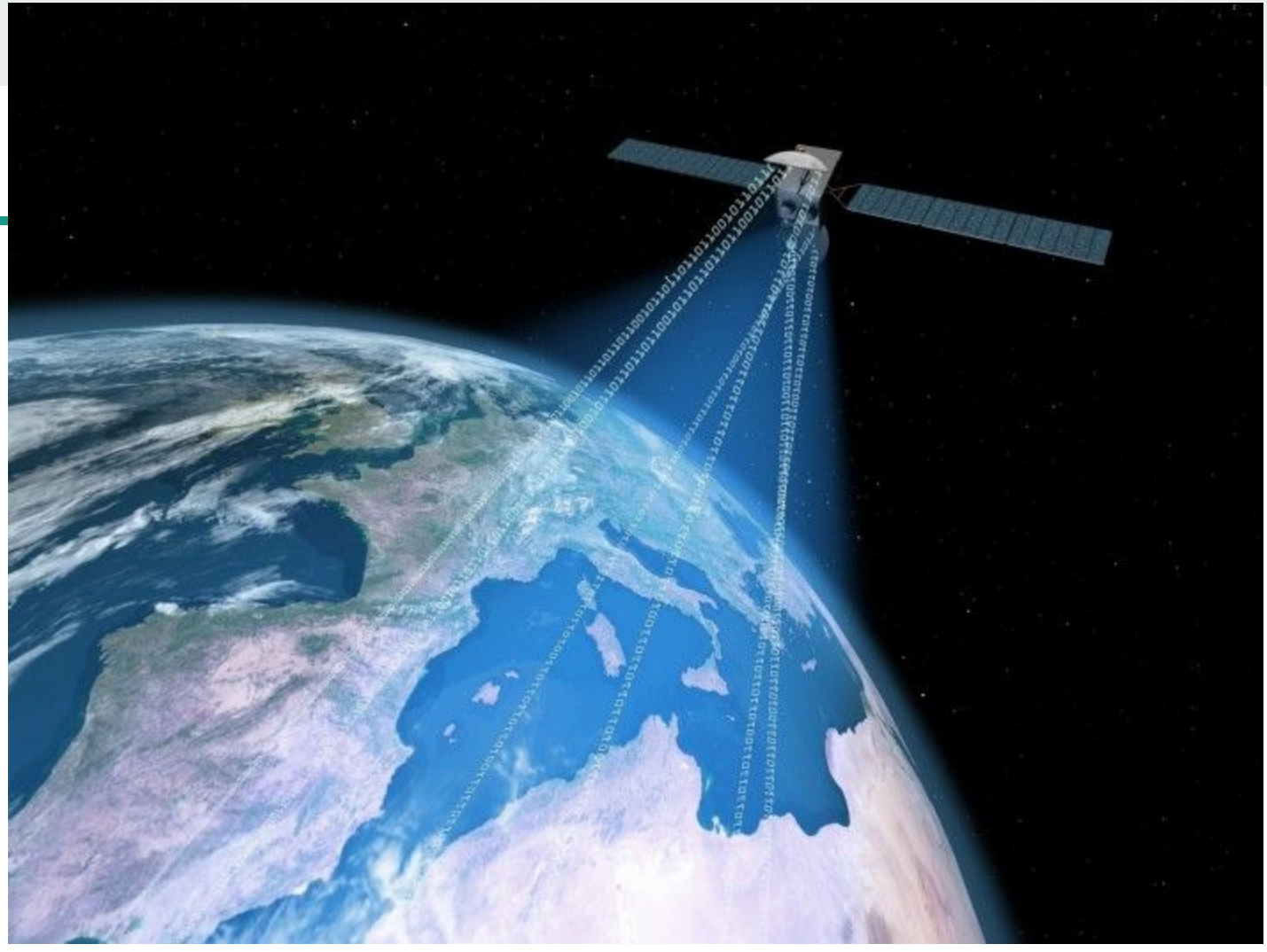
GALILEO

Quasi-Zenith Satellite System
QZSS
みちびき

北斗卫星导航系统
BeiDou Navigation Satellite System

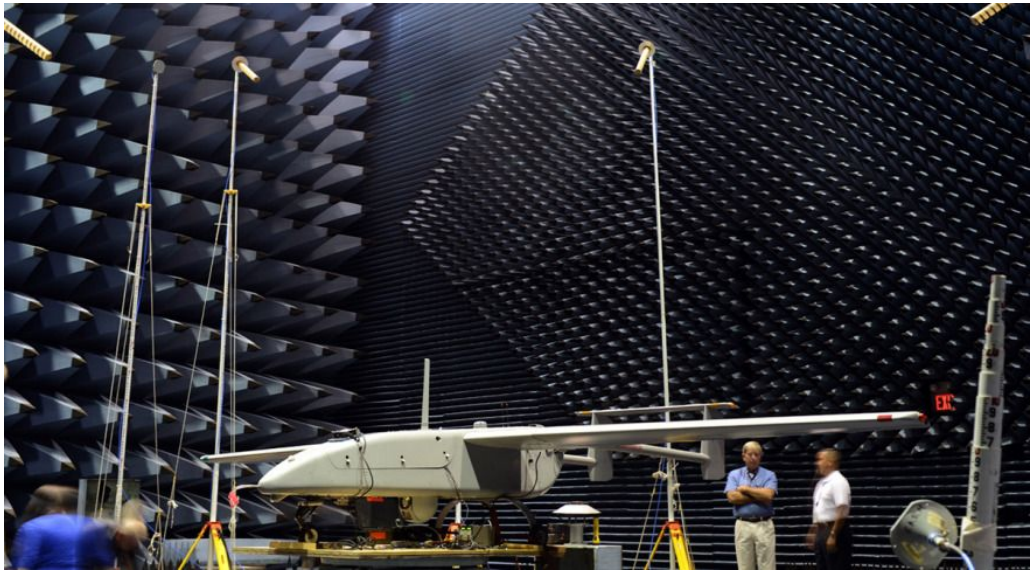
IRNSS
INDIA'S OWN GPS

Military Vehicle-Mounted GPS Jammers



Counter GPS Jamming Devices

US Navy conducted a test in which it mounted a small antenna system on a unmanned aerial vehicle and subjected it to heavy interference.

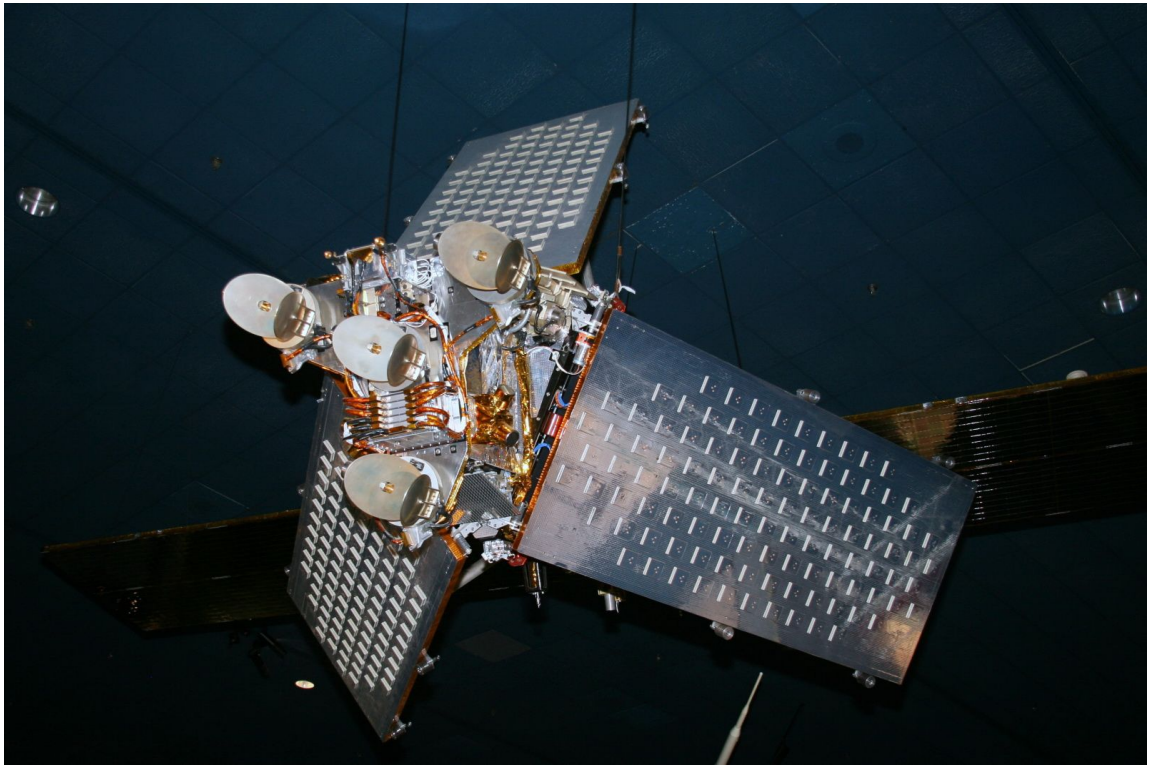


Eutelsat and new anti-jamming capability

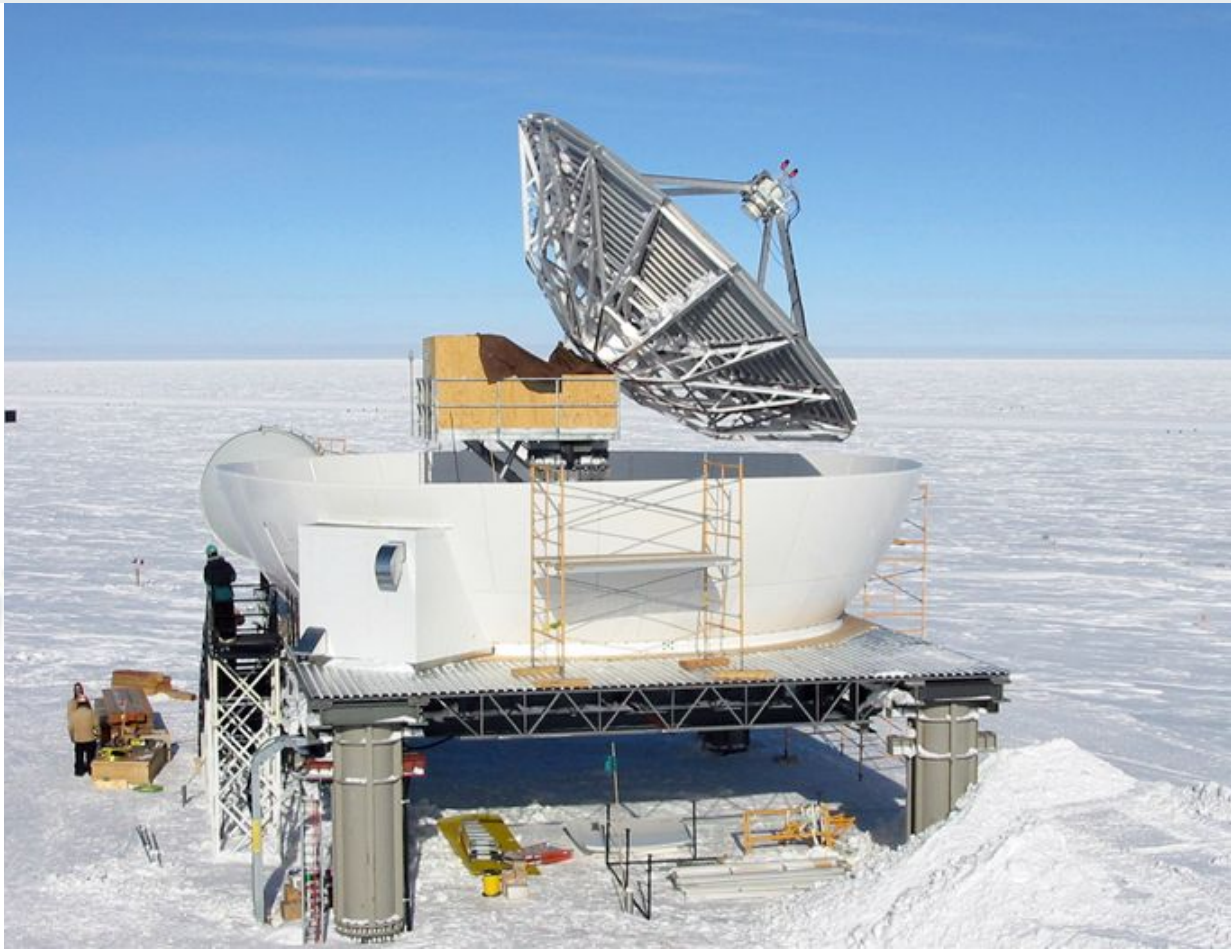
Eutelsat is placing an experimental anti-jamming capability on one of its upcoming satellites, like the recently launched Eutelsat 21B telecommunications satellite, to be stationed over the Middle East.

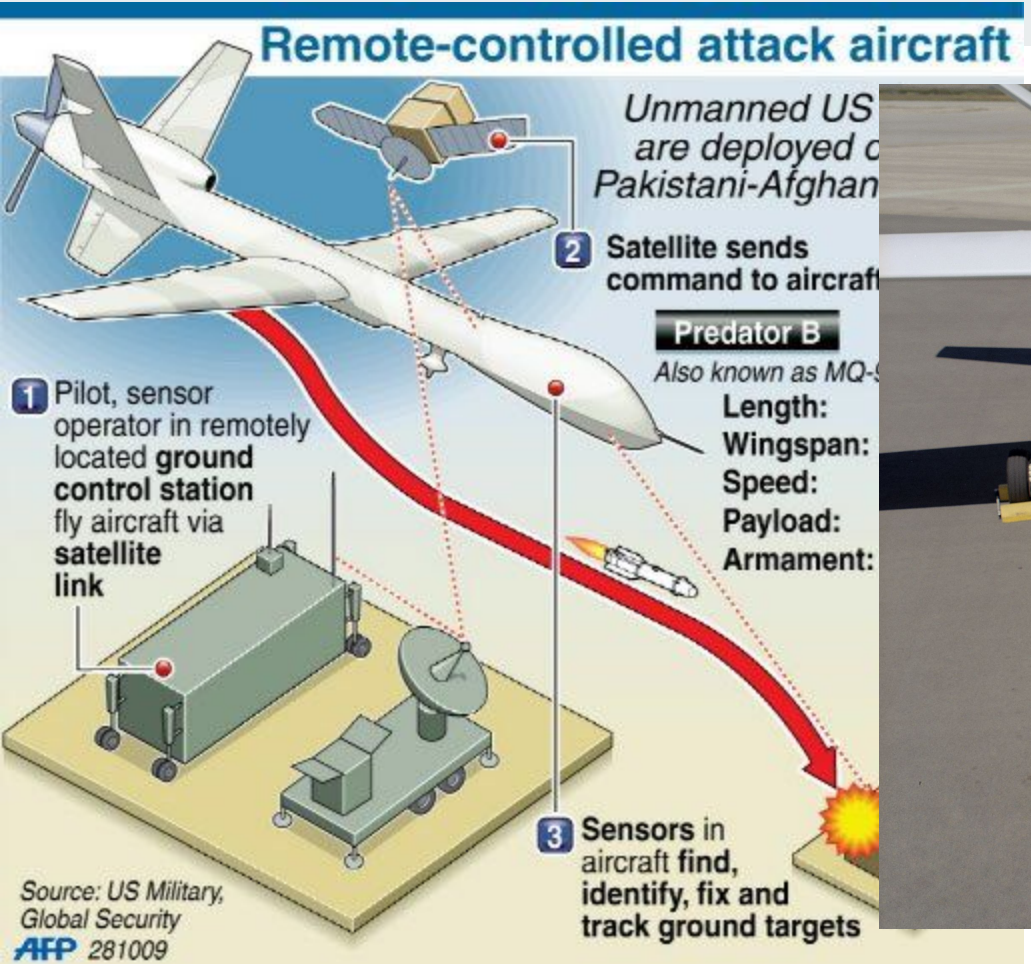
Iridium

- globalny system telekomunikacyjny
- 1998
- 66 satelitów




IRIDIUM
MOTOROLA
Anywhere to Everywhere




Remote-controlled attack aircraft
Unmanned US
are deployed
Pakistani-Afghan
2 Satellite sends command to aircraft
Predator B
Also known as MQ-
Length:
Wingspan:
Speed:
Payload:
Armament:
1 Pilot, sensor operator in remotely located ground control station fly aircraft via satellite link
3 Sensors in aircraft find, identify, fix and track ground targets
Source: US Military, Global Security
AFP 281009

THE WALL STREET JOURNAL.

Austin Bomb Suspect Dead After Blowing Himself Up

Trump's Stormy History: The Seven-Year Battle Between the President and ...

Facebook's Lax Data Policies Led to Cambridge Analytica Crisis

Justi Califo Chall Antia

WAR WITH IRAQ

Insurgents Hack U.S. Drones

$26 Software Is Used to Breach Key Weapons in Iraq; Iranian Backing Suspected

By Siobhan Gorman, Yochi J. Dreazen and August Cole

Updated Dec. 17, 2009 11:59 p.m. ET

WASHINGTON -- Militants in Iraq have used $26 off-the-shelf software to intercept live video feeds from U.S. Predator drones, potentially providing them with information they need to evade or monitor U.S. military operations.

MPEG-2 Private Data

List

L...	K...	UDS	LDS Name	UDS Name	ESD Name	Value
0	-	06 0E 2...		user defined date-time stamp - ...		
0	-	06 0E 2...		byte order		6E 75 6C 6C
0	-	06 0E 2...		time system offset		null
0	-	06 0E 2...		original producer name		null
0	-	06 0E 2...		url string (iso 7 bit)		null
0	-	06 0E 2...		platform designation		null
0	-	06 0E 2...		classification		-
1	-	06 0E 2...		security classification		C
1	-	06 0E 2...		stream id		00
1	-	06 0E 2...		organizational program number		□□+4□□□...
1	-	06 0E 2...		release instructions		null
1	-	06 0E 2...		caveats		null
1	-	06 0E 2...		classification comment		null
0	-	06 0E 2...		u.s. department of defense met...		-
1	2	06 0E 2...	unix time stamp	user defined time stamp - micro...		01.01.1970 ...
1	11	06 0E 2...	image source sensor	image source device	sensor name	1
1	12	06 0E 2...	image coordinate system	image coordinate system	image coord...	0
1	-	06 0E 2...	start date time - utc	start date time - utc		
1	23	06 0E 2...	frame center latitude	frame center latitude	target latitude	31,3566388...
1	24	06 0E 2...	frame center longitude	frame center longitude	target longit...	-110,44166...
1	22	06 0E 2...	target width	target width	target width	159,4109
1	15	06 0E 2...	sensor true altitude	device altitude	sensor altitu...	2507,903
1	13	06 0E 2...	sensor latitude	device latitude	sensor latitu...	31,5507222...
1	14	06 0E 2...	sensor longitude	device longitude	sensor longi...	-110,99983...
1	21	06 0E 2...	slant range	slant range	slant range	1,777161E+...
1	-	06 0E 2...	angle to north	angle to north		173,45
1	-	06 0E 2...	obliquity angle	obliquity angle		-4,61
1	16	06 0E 2...	sensor horizontal field of v...	field of view fovhorizontal	field of view	270
1	-	06 0E 2...		field of view (fov-vertical fp-4)		0
1	5	06 0E 2...	platform heading angle	platform heading angle	uav heading...	0
1	6	06 0E 2...	platform pitch angle	platform pitch angle	uav pitch ins	0
1	7	06 0E 2...	platform roll angle	platform roll angle	uav roll ins	0
1	26	06 0E 2...	corner latitude point 1	corner latitude point 1 decimal d...	sar latitude 4	0
1	27	06 0E 2...	corner longitude point 1	corner longitude point 1 decimal...	sar longitud...	0
1	28	06 0E 2...	corner latitude point 2	corner latitude point 2 decimal d...	sar latitude 1	0
1	29	06 0E 2...	corner longitude point 2	corner longitude point 2 decimal...	sar longitud...	0
1	30	06 0E 2...	corner latitude point 3	corner latitude point 3 decimal d...	sar latitude 2	0
1	31	06 0E 2...	corner longitude point 3	corner longitude point 3 decimal...	sar longitud...	
1	32	06 0E 2...	corner latitude point 4	corner latitude point 4 decimal d...	sar latitude 3	0
1	33	06 0E 2...	corner longitude point 4	corner longitude point 4 decimal...	sar longitud...	0
0	-	06 0E 2...		user defined date-time stamp - ...		
0	-	06 0E 2...		byte order		6E 75 6C 6C
0	-	06 0E 2...		time system offset		null
0	-	06 0E 2...		original producer name		null
0	-	06 0E 2...		url string (iso 7 bit)		null
0	-	06 0E 2...		platform designation		null

MPEG2 Transport Demo

File View Control Preferences Help

HEAVENS ABOVE

Flary Iridium

Początek okresu wyszukiwania: 14:35 środa, 21 marca, 2018
Koniec okresu wyszukiwania: 15:35 środa, 28 marca, 2018

Kliknij na czasie flary, by zobaczyć szczegółowe informacje, w tyr

Czas	Jasność	Wysokość	Azymut	Satelita
mar 21, 19:29:37	-7,2	34°	2° (N)	Iridium 14
mar 22, 19:23:25	-7,3	36°	1° (N)	Iridium 66
mar 23, 19:17:13	-0,4	37°	3° (N)	Iridium 21
mar 24, 04:44:41	-7,0	31°	17° (NNE)	Iridium 82
mar 27, 05:48:11	-0,2	30°	20° (NNE)	Iridium 39
mar 28, 06:04:00	-0,5	35°	22° (NNE)	Iridium 18


idium
EXT
iridium

A REVOLUTION IN SATELLITE MANUFACTURING

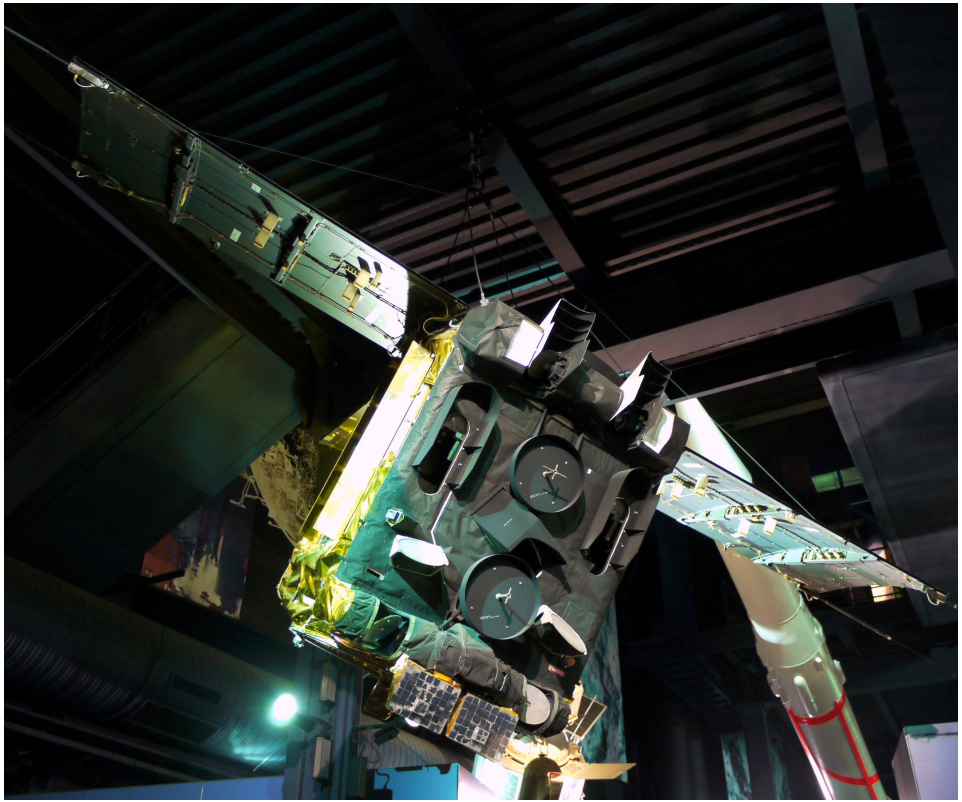
No one has ever built a satellite in one day… we will build several every day!

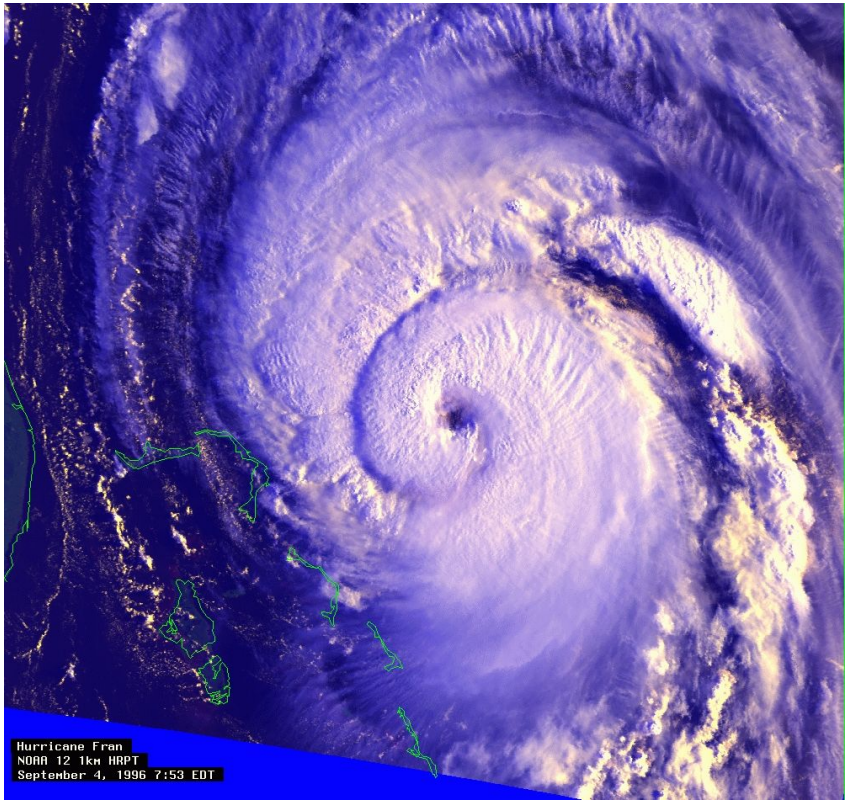
TOTAL COVERAGE

Internet to everyone, everywhere on Earth

GLOBAL LOW EARTH ORBIT CONSTELLATION

Providing high-speed internet connectivity equivalent to terrestrial fiber-optic networks

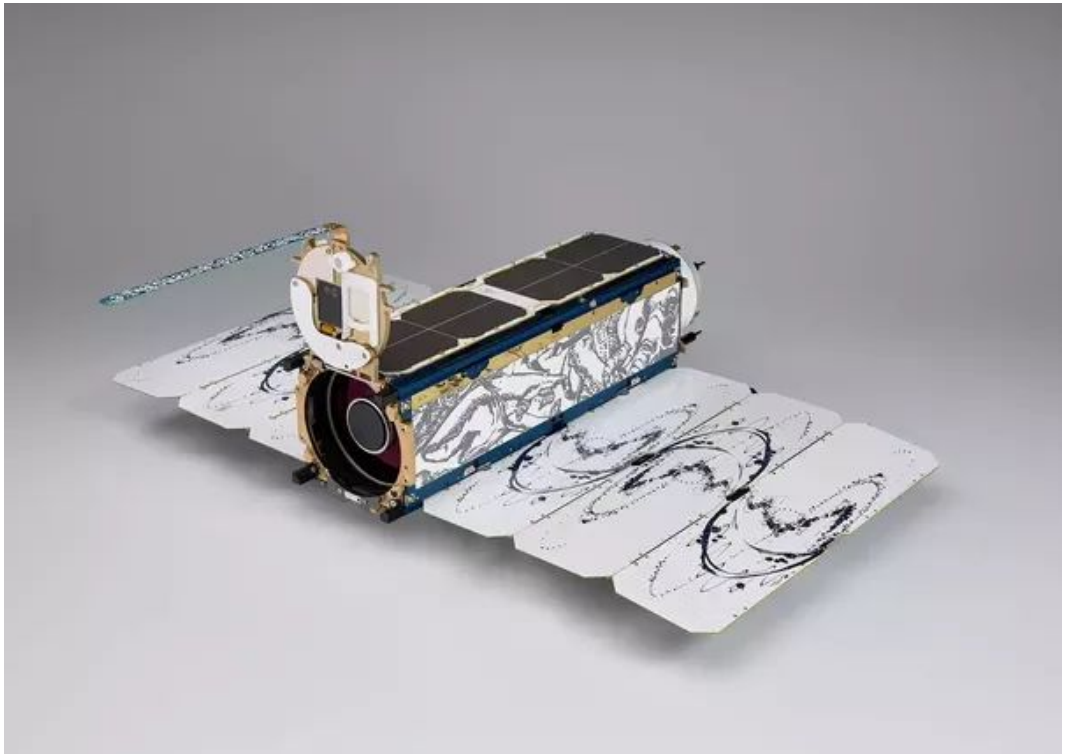


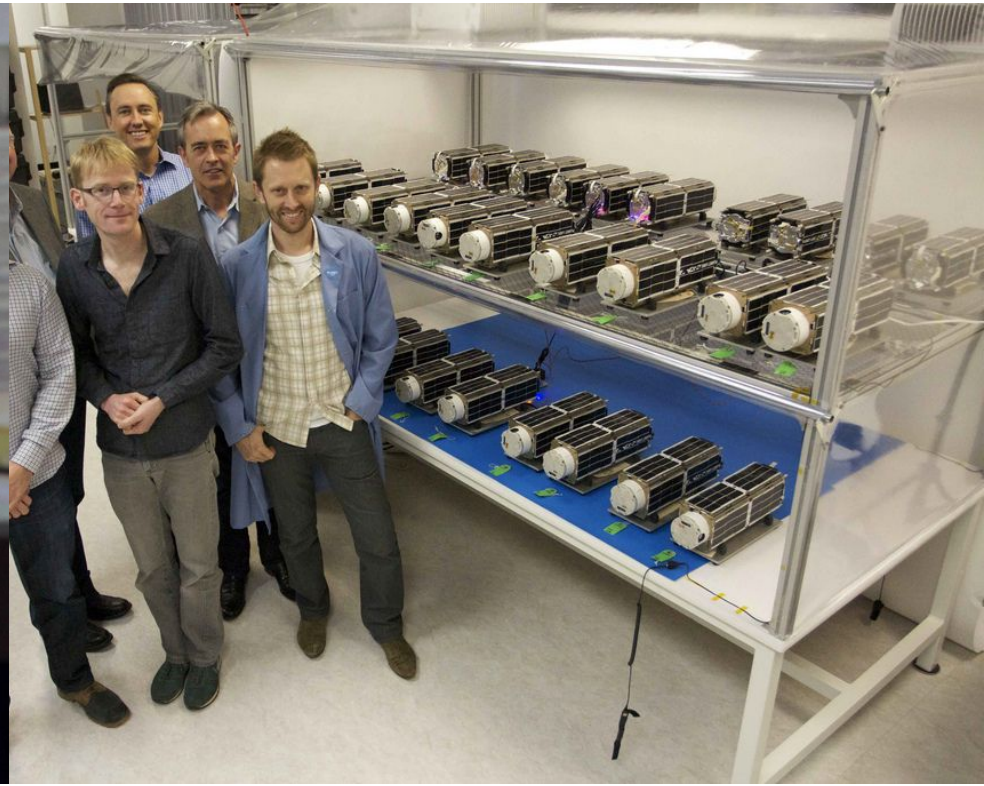

Hurricane Fran
NOAA 12 1km HRPT
September 4, 1996 7:53 EDT

NO

Planet Labs

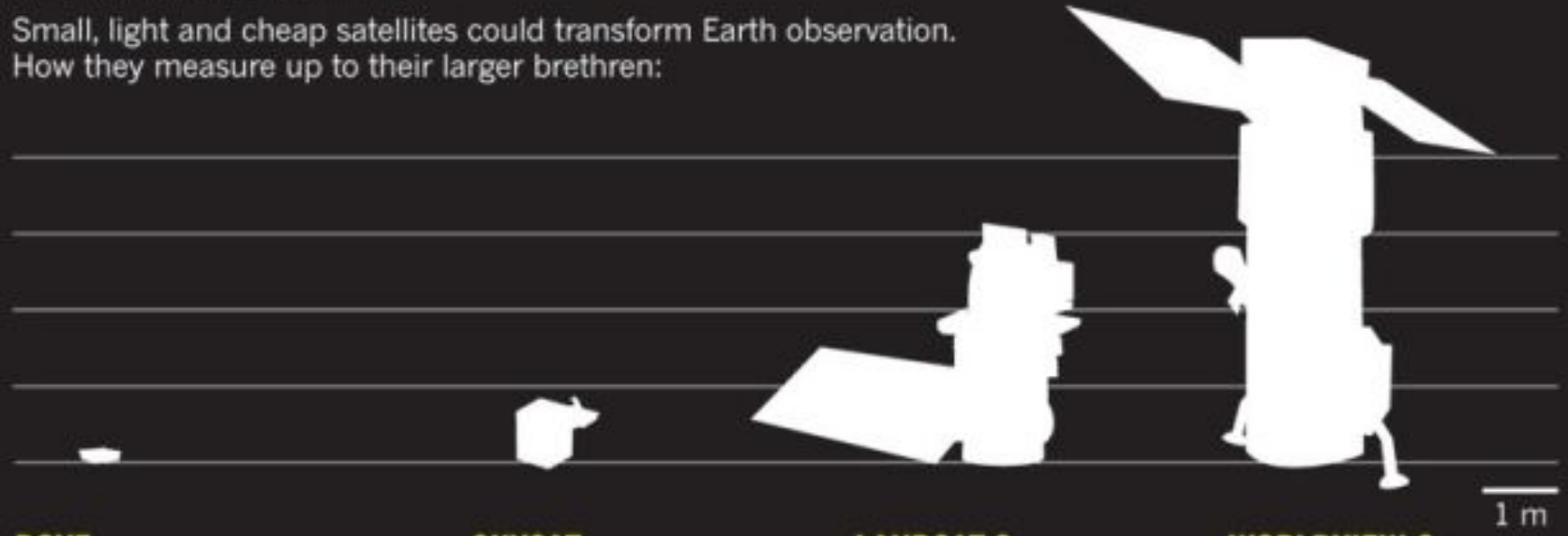
- globalny system obserwacyjny
- 2018
- 175 satelitów
- 88 wystrzelonych w 2017





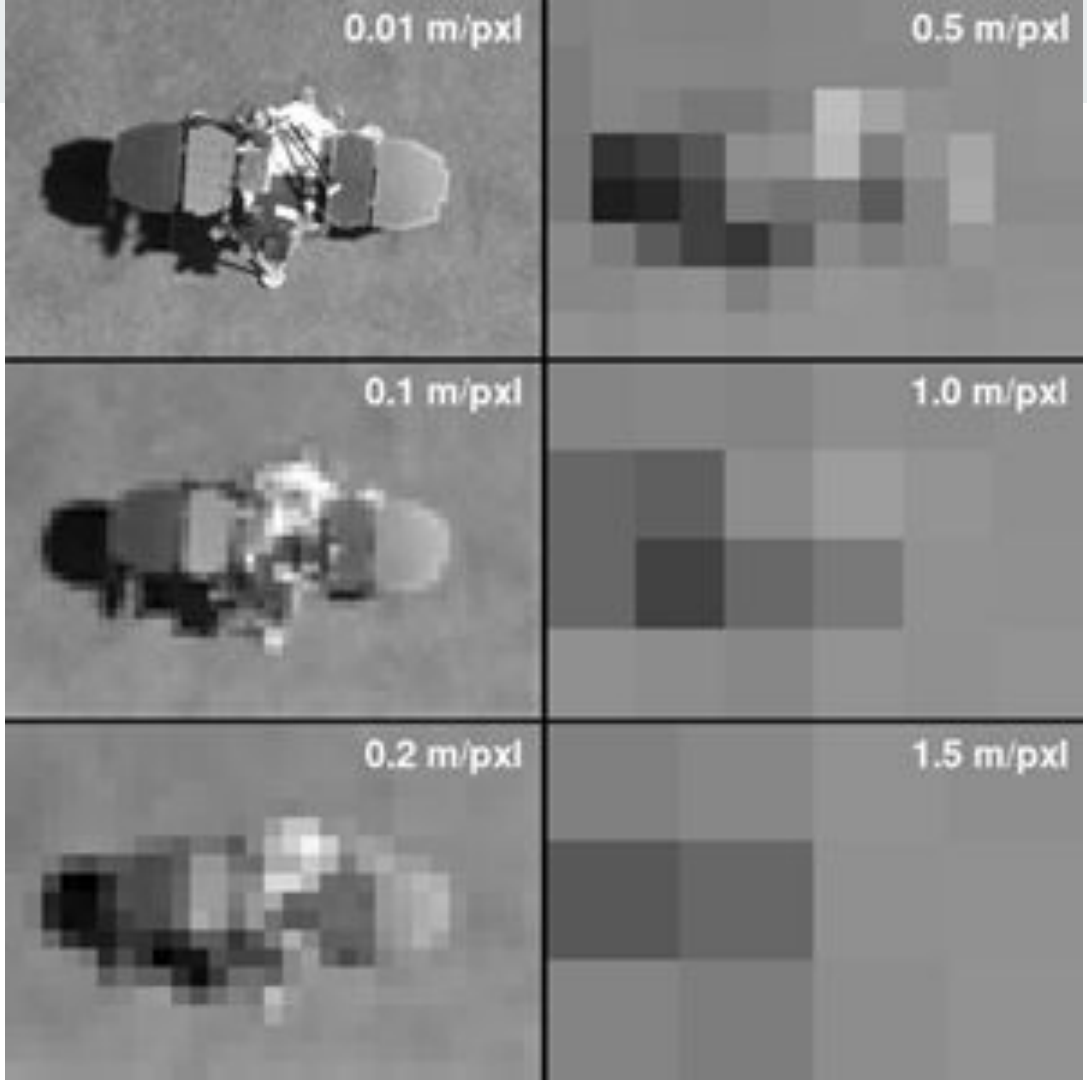
THE SWARM COMETH

Small, light and cheap satellites could transform Earth observation. How they measure up to their larger brethren:



DOVE	SKYSAT	LANDSAT 8	WORLDVIEW-3
Operator: Planet Labs	Skybox Imaging	NASA	DigitalGlobe
Number of satellites*: 32	24	N/A	N/A
Weight: ~5 kg	~100 kg	2,071 kg†	2,800 kg
Instruments: Optical and near-infrared spectral bands	Optical and near-infrared spectral bands	Multiple spectral bands	Multiple spectral bands
Spatial resolution: 3–5 m	~1 m	15–100 m‡	0.3–30 m‡

*When fully operational † Without instruments ‡ Depending on spectral frequency


0.01 m/pxl
0.5 m/pxl
0.1 m/pxl
1.0 m/pxl
0.2 m/pxl
1.5 m/pxl

Zdolność rozdzielcza

Zdolność rozdzielczą teleskopu w sekundach kątowych określa wzór:

$$r = \frac{0{,}26'' \cdot \lambda}{D}$$

gdzie:

λ – długość fali [nm],

D – średnica czynna teleskopu [mm]

A Typical Ground Station

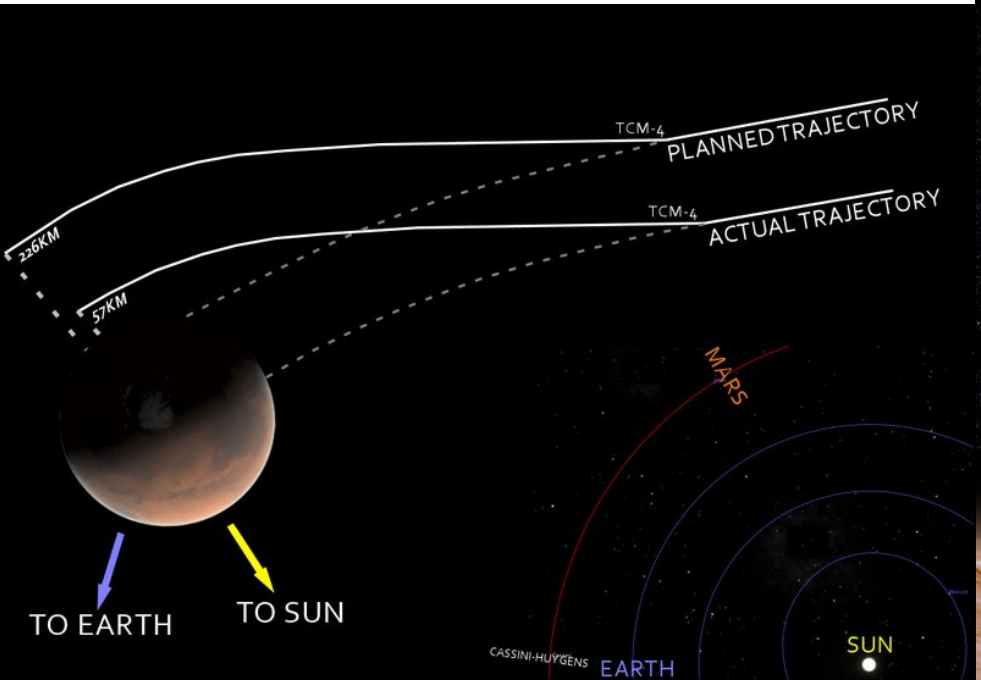
Washington State

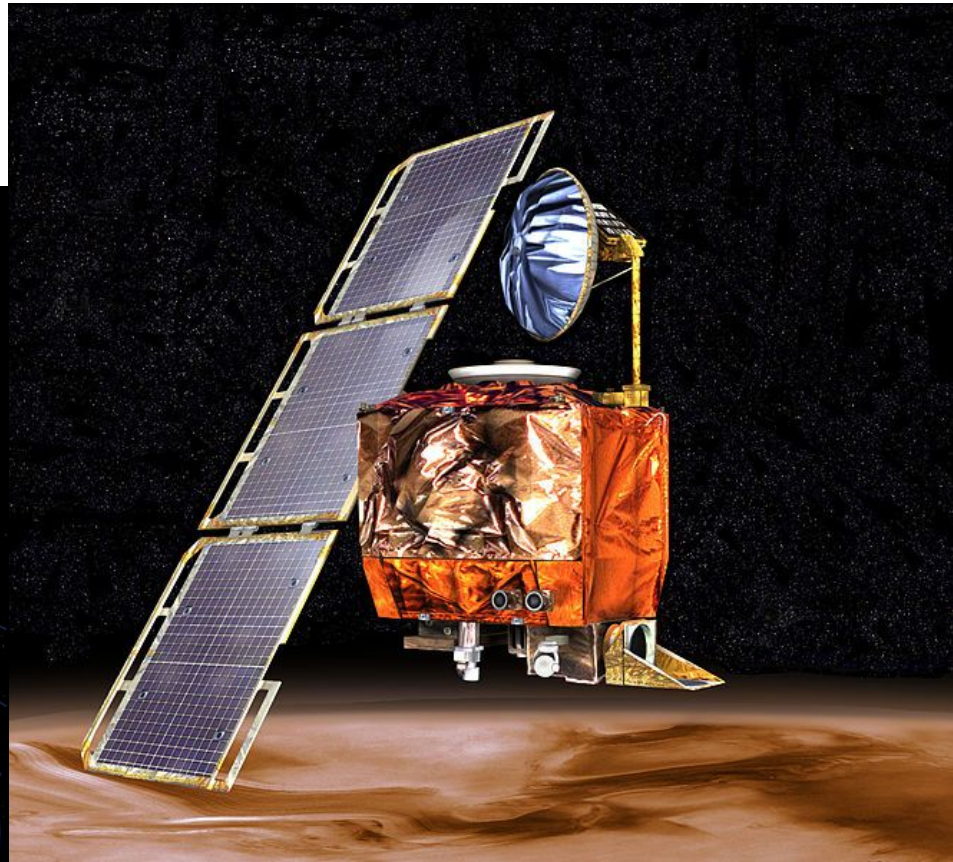
- 5m dish
- Combined S/X feed
- Up to 100 W S-band uplink
- 29 dB/K at X-band
- Integrated UHF feed on other dishes
- Dektec PCI DVB-S2 receiver card

Brewster, Washington

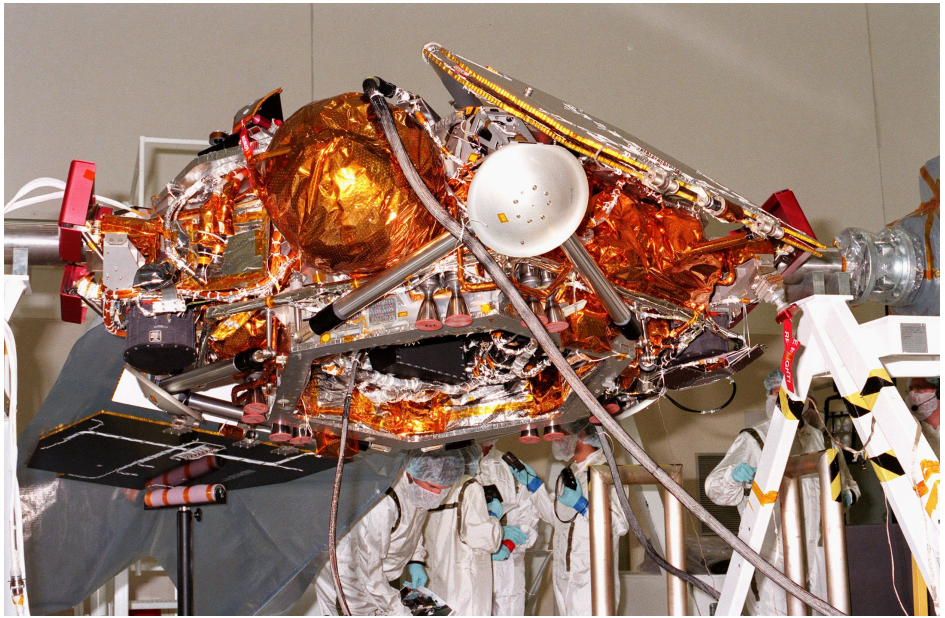
PLANET LABS

Mars Climate Orbiter





Mars Polar Lander



Każdy wie jak ważne są testy

Każdy wie jak ważne są testy

Doświadczenie z kosmicznymi wypadkami pozwalają nam wyciągnąć dodatkowy wniosek.
Przy opracowywaniu systemu nie jest istotne, czy korzystamy ze “sprawdzonych” rozwiązań, tylko na ile jesteśmy w stanie te rozwiązania przetestować.

Czas na pytania

Dziękuje za uwagę