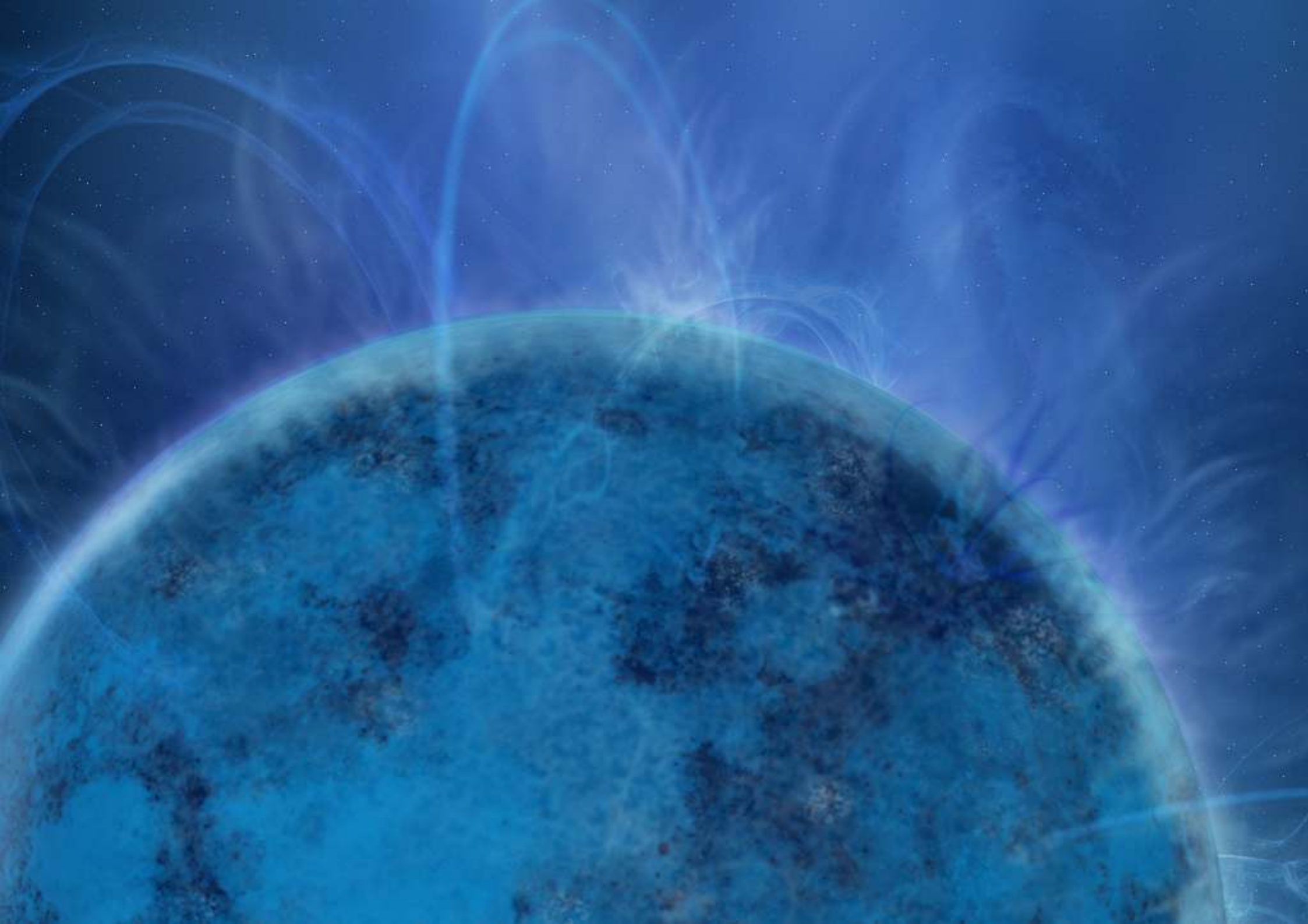
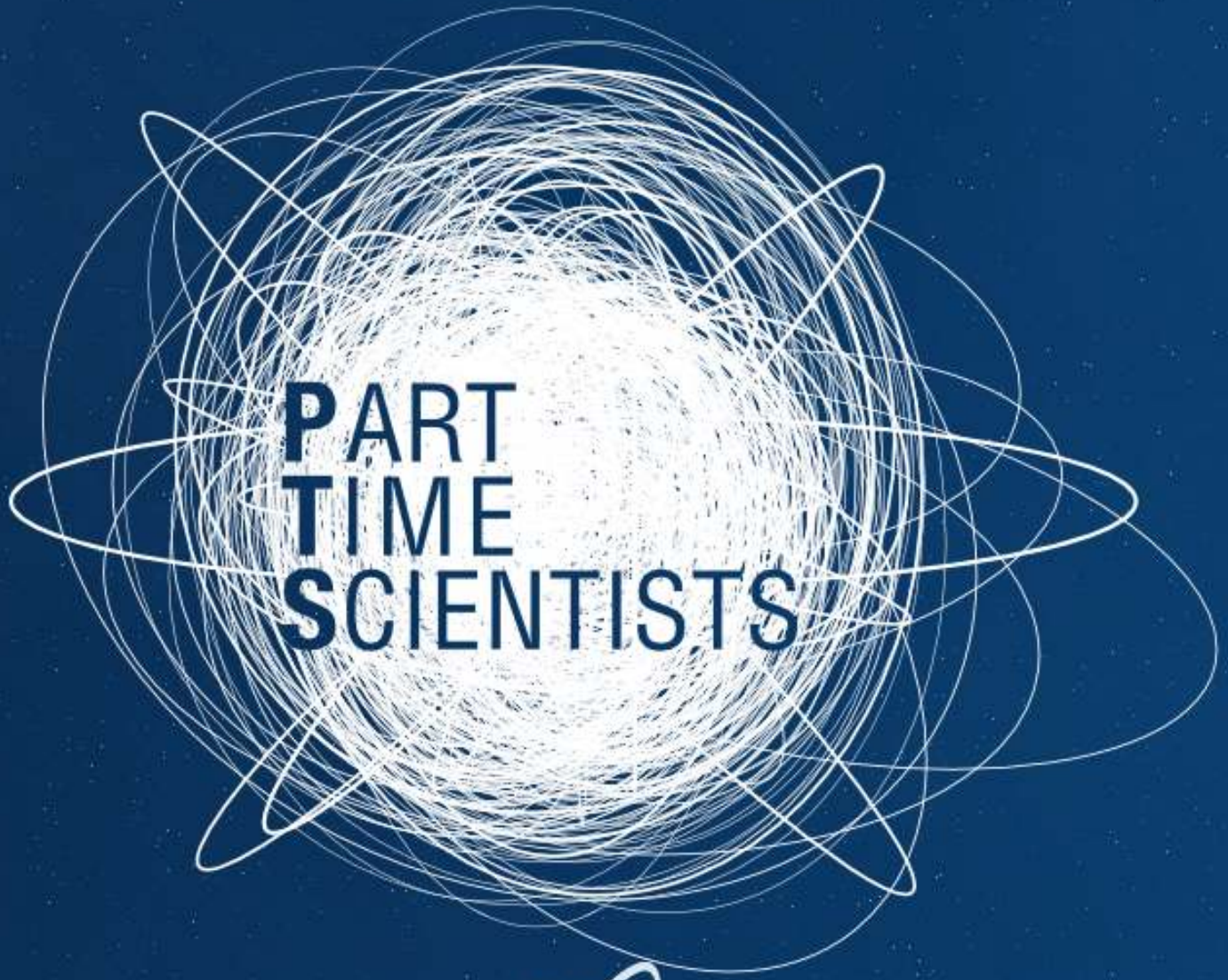




Google LUNAR X PRIZE


XPRIZE
Revolution through
Comptetition

Spirit of St.Louis

The New York Times.

LINDBERGH DOES IT! TO PARIS IN 33½ HOURS; FLIES 1,000 MILES THROUGH SNOW AND SLEET; CHEERING FRENCH CARRY HIM OFF FIELD

COULD HAVE GONE 500 MILES FARTHER

Gasoline for at Least That Much More; Flew at Times From 10 Feet to 10,000 Feet Above Water.

CROWD ROARS THUNDEROUS WELCOME

Breaks Through Lines of Soldiers and Police and Surging to Plane Lifts Weary Flier from His Cockpit

LEVINE ABANDONING BELLANCA FLIGHT

LINDBERGH TRIUMPH THRILLS COOLIDGE

ANSARI

PRIZE

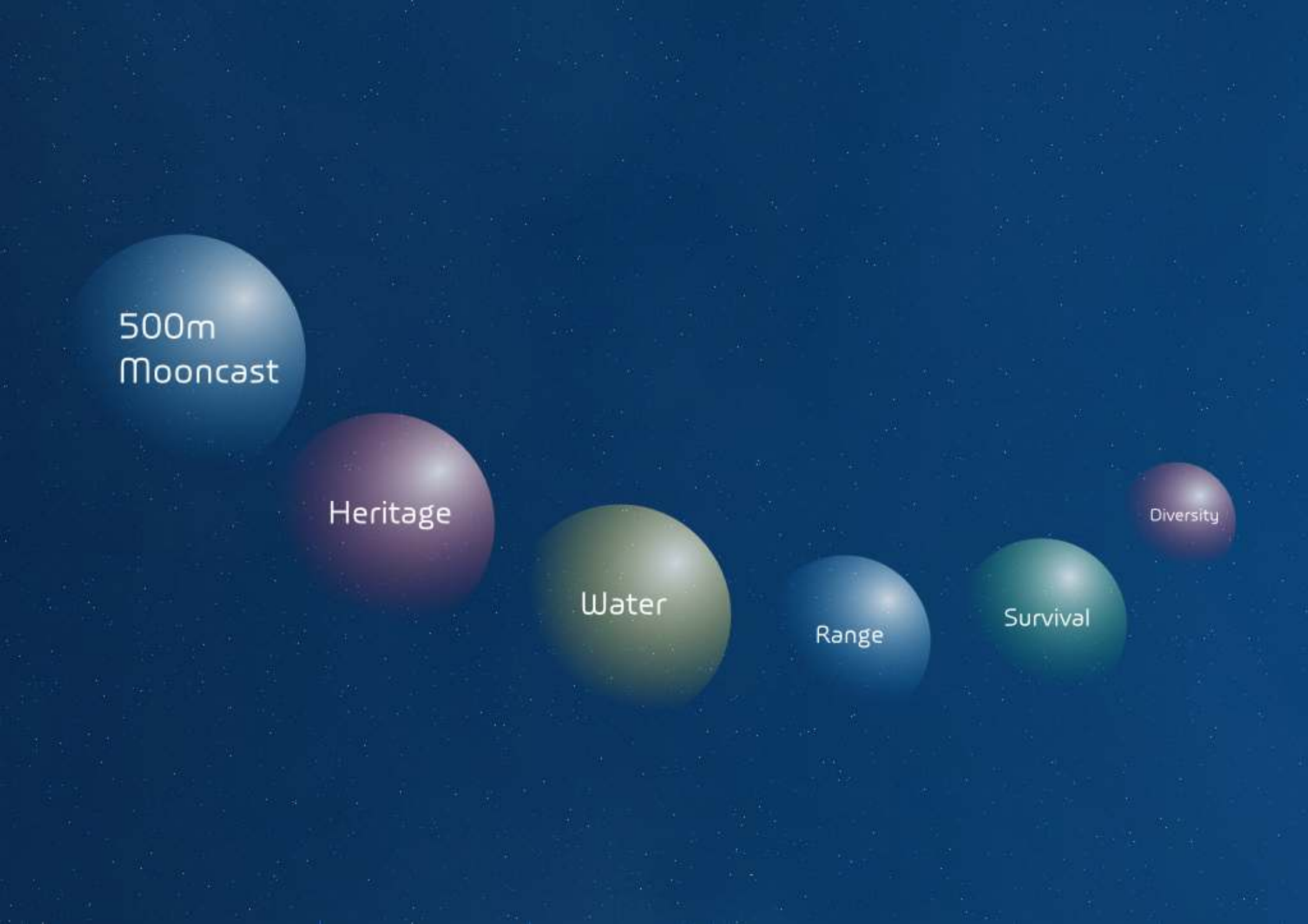
SpaceShipOne

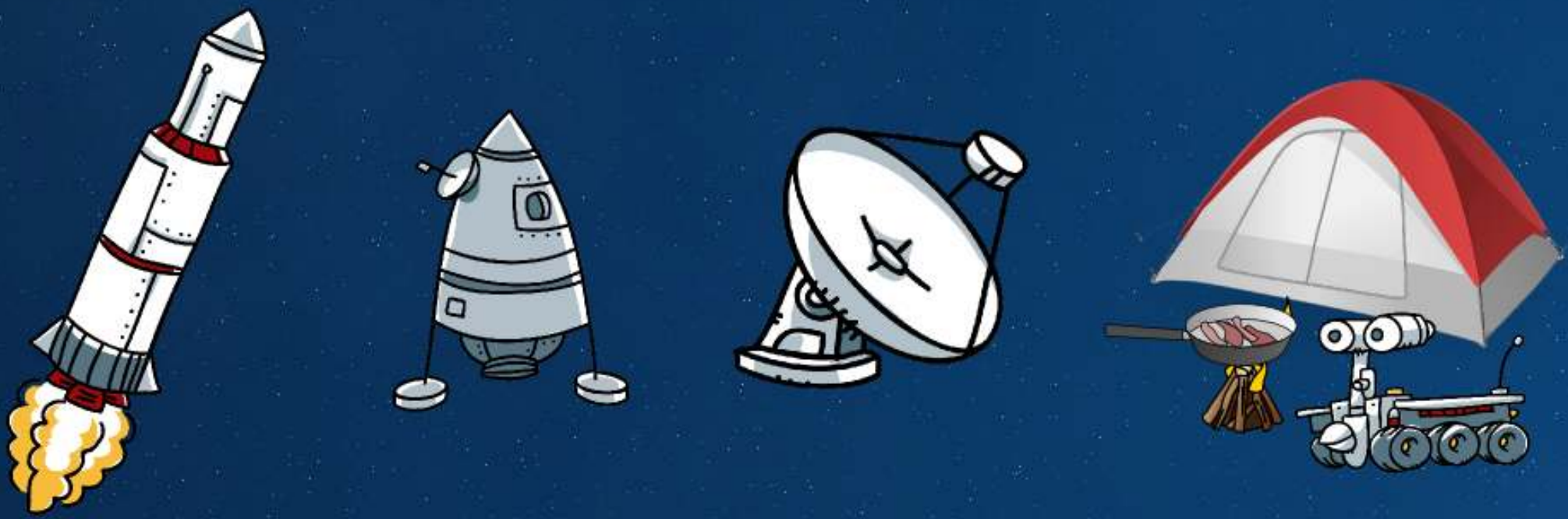
The First Non-Government Manned Spacecraft

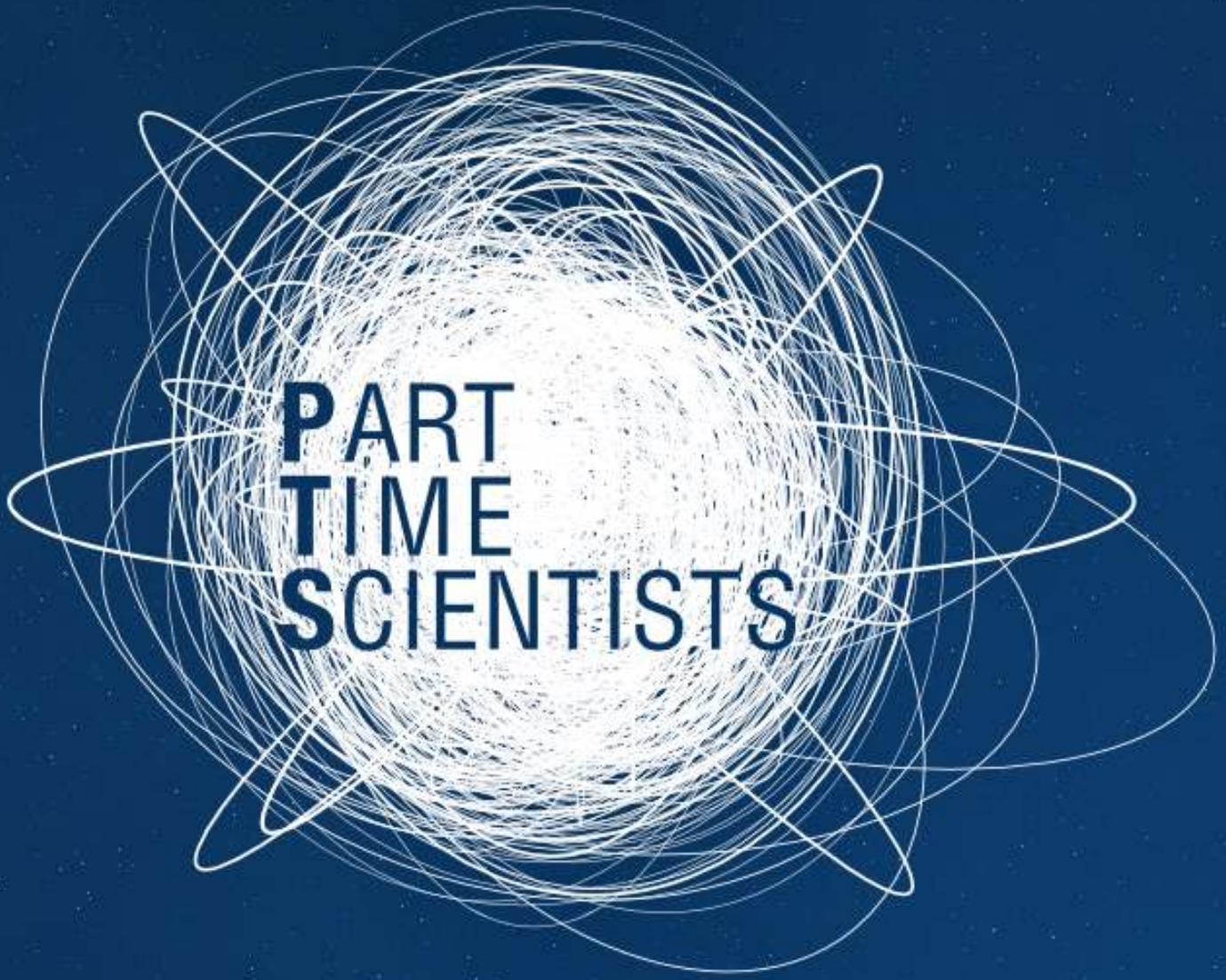
Google LUNAR XPRIZE

21 Teams

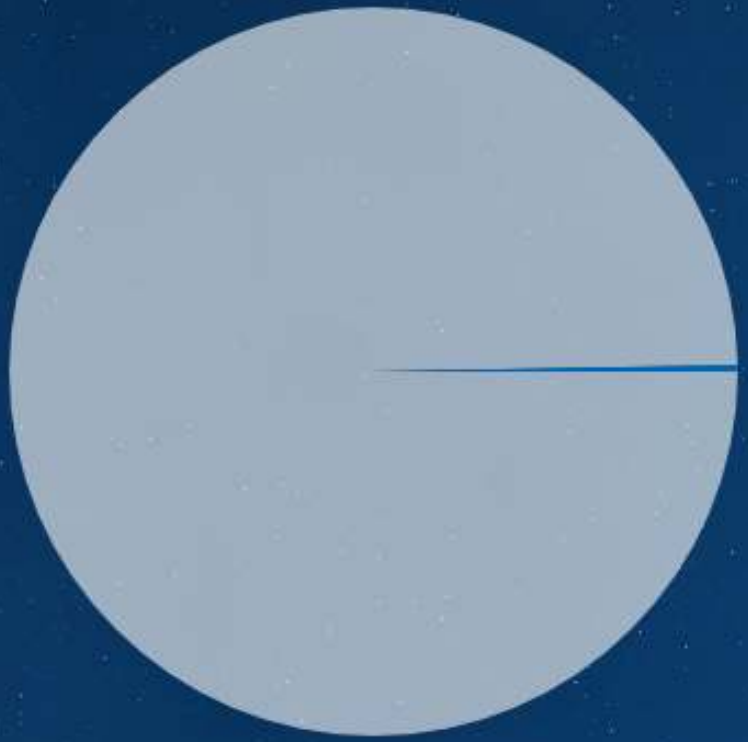
12 Nations


500m
Mooncast
Heritage
Water
Range
Survival
Diversity

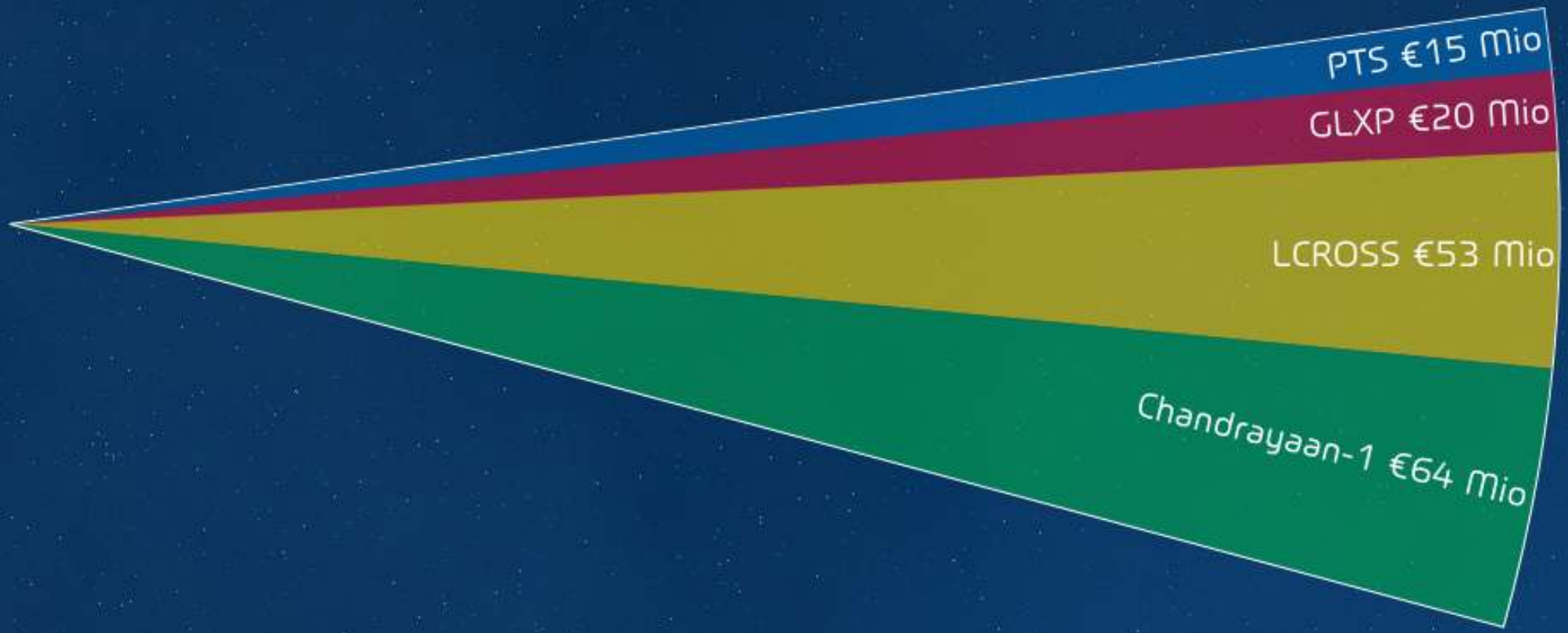



PART
TIME
SCIENTISTS

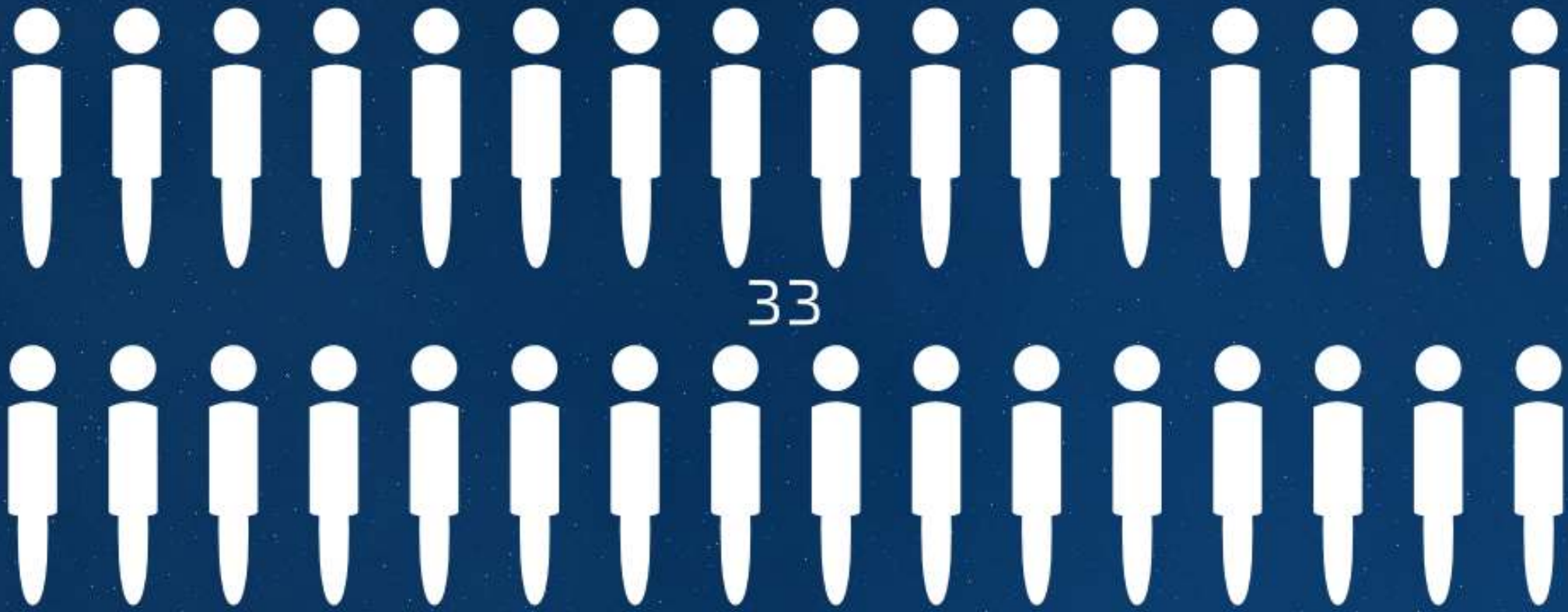

NASA



€ 90.870.000.000


PTS €15 Mio
GLXP €20 Mio
LCROSS €53 Mio
Chandrayaan-1 €64 Mio

No Rocket
existing Technology
Low Budget
Innovation
No Time
Cow


33

Engineers

Aerospace Professionals


Students

Broadcast Engineers

Retired Military

Economists

IT- Professionals

Technical Programmers

Retired Apollo Staff

Partners

You


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 04.10.1957 Sputnik (USSR)


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

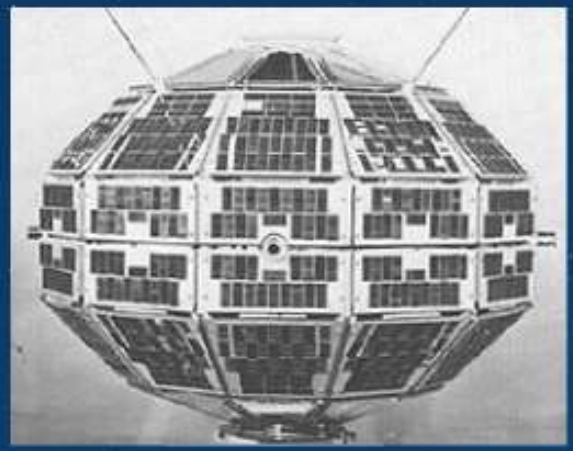
- 13.09.1959 Luna 2 (USSR) Impact

57 60 65 70 75 80 85 90 95 00 05 10 15

- 13.09.1959 Luna 2 (USSR) Impact
- 04.10.1959 Luna 3 (USSR) Pictures

57 60 65 70 75 80 85 90 95 00 05 10 15

- 13.09.1959 Luna 2 (USSR) Impact
- 04.10.1959 Luna 3 (USSR) Pictures
- 04.10.1962 Alouette (Canada) Ionosphere



57 60 65 70 75 80 85 90 95 00 05 10 15

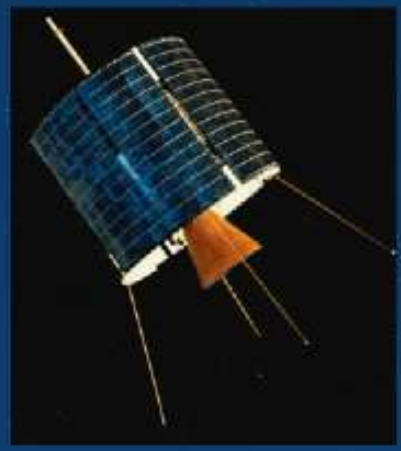
- 13.09.1959 Luna 2 (USSR) Impact
- 04.10.1959 Luna 3 (USSR) Pictures
- 04.10.1962 Alouette (Canada) Ionosphere
- 04.10.1963 X-15 (USA) reusable

- 13.09.1959 Luna 2 (USSR) Impact
- 04.10.1959 Luna 3 (USSR) Pictures
- 04.10.1962 Alouette (Canada) Ionosphere
- 04.10.1963 X-15 (USA) reusable


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 06.04.1965 Intelsat (Corp) Company



57 60 65 70 75 80 85 90 95 00 05 10 15

- 06.04.1965 Intelsat (Corp) Company
- 14.07.1965 Mariner (USA) Flyby

57 60 65 70 75 80 85 90 95 00 05 10 15

- 06.04.1965 Intelsat (Corp) Company
- 14.07.1965 Mariner (USA) Flyby
- 02.06.1966 Surveyor 1 (USA) Moonlanding

57 60 65 70 75 80 85 90 95 00 05 10 15

- 06.04.1965 Intelsat (Corp) Company
- 14.07.1965 Mariner (USA) Flyby
- 02.06.1966 Surveyor 1 (USA) Moonlanding
- 30.10.1967 Cosmos 186 (USSR) docking

57 60 65 70 75 80 85 90 95 00 05 10 15

- 06.04.1965 Intelsat (Corp) Company
- 14.07.1965 Mariner (USA) Flyby
- 02.06.1966 Surveyor 1 (USA) Moonlanding
- 30.10.1967 Cosmos 186 (USSR) docking
- 21.12.1968 Apollo 8 (USA) Orbit

57 60 65 70 75 80 85 90 95 00 05 10 15

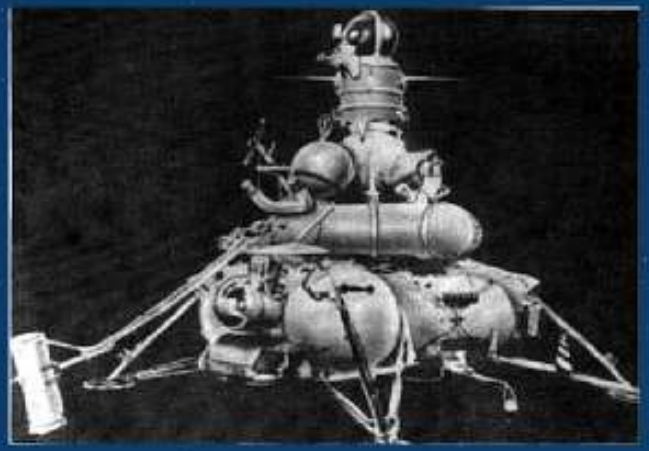
- 06.04.1965 Intelsat (Corp) Company
- 14.07.1965 Mariner (USA) Flyby
- 02.06.1966 Surveyor 1 (USA) Moonlanding
- 30.10.1967 Cosmos 186 (USSR) docking
- 21.12.1968 Apollo 8 (USA) Orbit
- 21.06.1969 Apollo 11 (USA)

- 06.04.1965 Intelsat (Corp) Company
- 14.07.1965 Mariner (USA) Flyby
- 02.06.1966 Surveyor 1 (USA) Moonlanding
- 30.10.1967 Cosmos 186 (USSR) docking
- 21.12.1968 Apollo 8 (USA) Orbit
- 21.06.1969 Apollo 11 (USA)


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 24.09.1970 Luna 16 (USSR) Sample

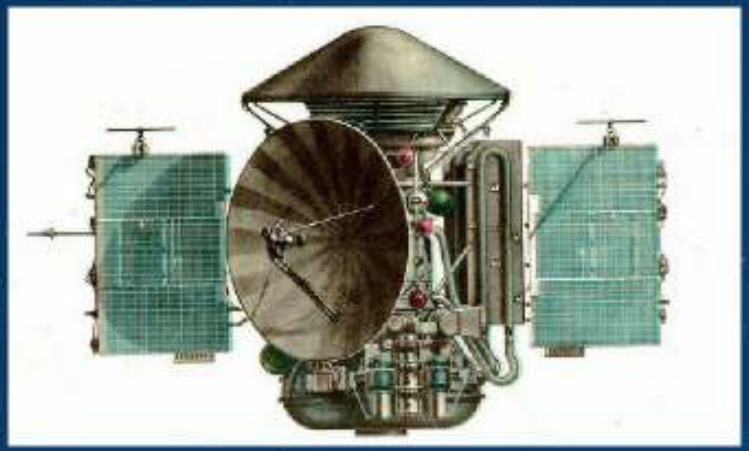


57 60 65 70 75 80 85 90 95 00 05 10 15

- 24.09.1970 Luna 16 (USSR) Sample
- 23.11.1970 Lunokhod 1 (USSR) Rover

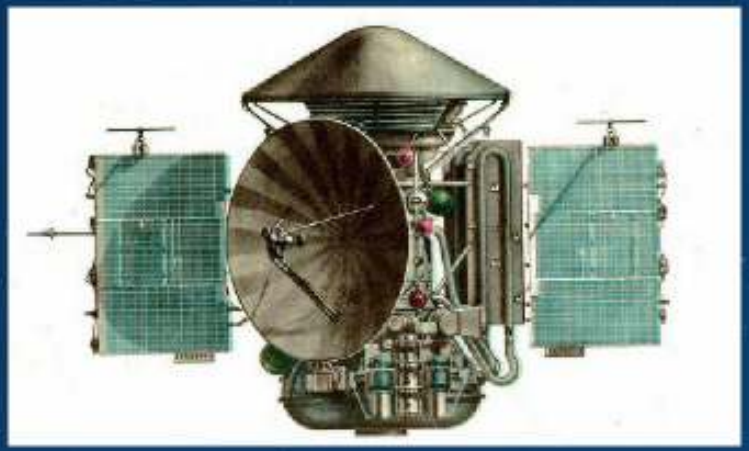
57 60 65 70 75 80 85 90 95 00 05 10 15

- 24.09.1970 Luna 16 (USSR) Sample
- 23.11.1970 Lunokhod 1 (USSR) Rover
- 27.11.971 Mars 2 (USSR) Impact



57 60 65 70 75 80 85 90 95 00 05 10 15

- 24.09.1970 Luna 16 (USSR) Sample
- 23.11.1970 Lunokhod 1 (USSR) Rover
- 27.11.971 Mars 2 (USSR) Impact
- 02.12.1971 Mars 3 (USSR) Lander



57 60 65 70 75 80 85 90 95 00 05 10 15

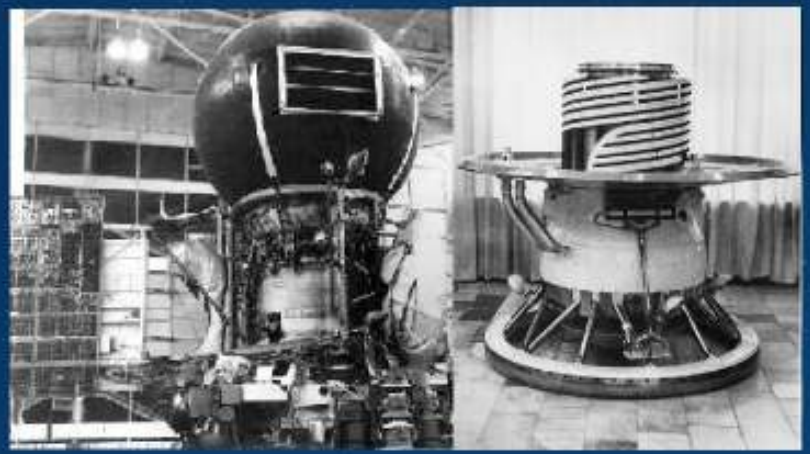
- 24.09.1970 Luna 16 (USSR) Sample
- 23.11.1970 Lunokhod 1 (USSR) Rover
- 27.11.971 Mars 2 (USSR) Impact
- 02.12.1971 Mars 3 (USSR) Lander
- 23.04.1972 Salyut 1 (USSR) Station

- 24.09.1970 Luna 16 (USSR) Sample
- 23.11.1970 Lunokhod 1 (USSR) Rover
- 27.11.971 Mars 2 (USSR) Impact
- 02.12.1971 Mars 3 (USSR) Lander
- 23.04.1972 Salyut 1 (USSR) Station


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 22.10.1975 Venera 9 (USSR) Landing



57 60 65 70 75 80 85 90 95 00 05 10 15

- 22.10.1975 Venera 9 (USSR) Landing
- 26.01.1978 Explorer57 (USA/ESA/UK) Ultraviolet

- 22.10.1975 Venera 9 (USSR) Landing
- 26.01.1978 Explorer57 (USA/ESA/UK) Ultraviolet


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 12.04.1981 STS-1/Columbia (USA) Reusable

57 60 65 70 75 80 85 90 95 00 05 10 15

- 12.04.1981 STS-1/Columbia (USA) Reusable
- 01.03.1982 Venera 13 (USSR) Venus

- 12.04.1981 STS-1/Columbia (USA) Reusable
- 01.03.1982 Venera 13 (USSR) Venus


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 19.02.1989 MIR (USSR) Space Station

- 19.02.1989 MIR (USSR) Space Station


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 24.04.1990 Hubble (USA) Telescope

- 24.04.1990 Hubble (USA) Telescope


57
60
65
70
75
80
85
90
95
00
05
10
15

57 60 65 70 75 80 85 90 95 00 05 10 15

- 26.04.01 Dennis Tito (Private) Tourist

57 60 65 70 75 80 85 90 95 00 05 10 15

- 26.04.01 Dennis Tito (Private) Tourist
- 15.10.03 Shenzhou 5 (China) New

57 60 65 70 75 80 85 90 95 00 05 10 15

- 26.04.01 Dennis Tito (Private) Tourist
- 15.10.03 Shenzhou 5 (China) New
- 21.06.2004 SpaceShipOne (Private)

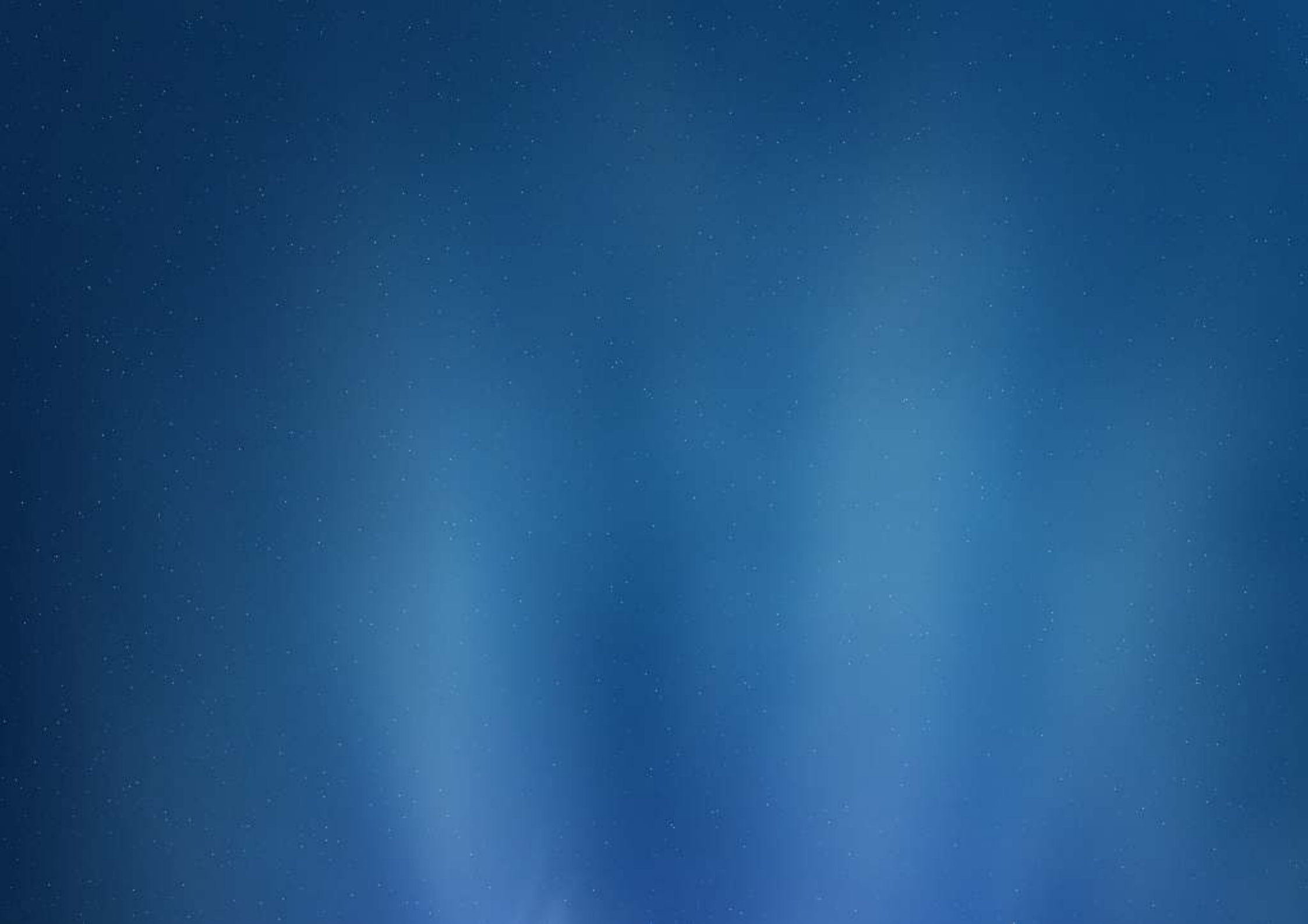
- 26.04.01 Dennis Tito (Private) Tourist
- 15.10.03 Shenzhou 5 (China) New
- 21.06.2004 SpaceShipOne (Private)

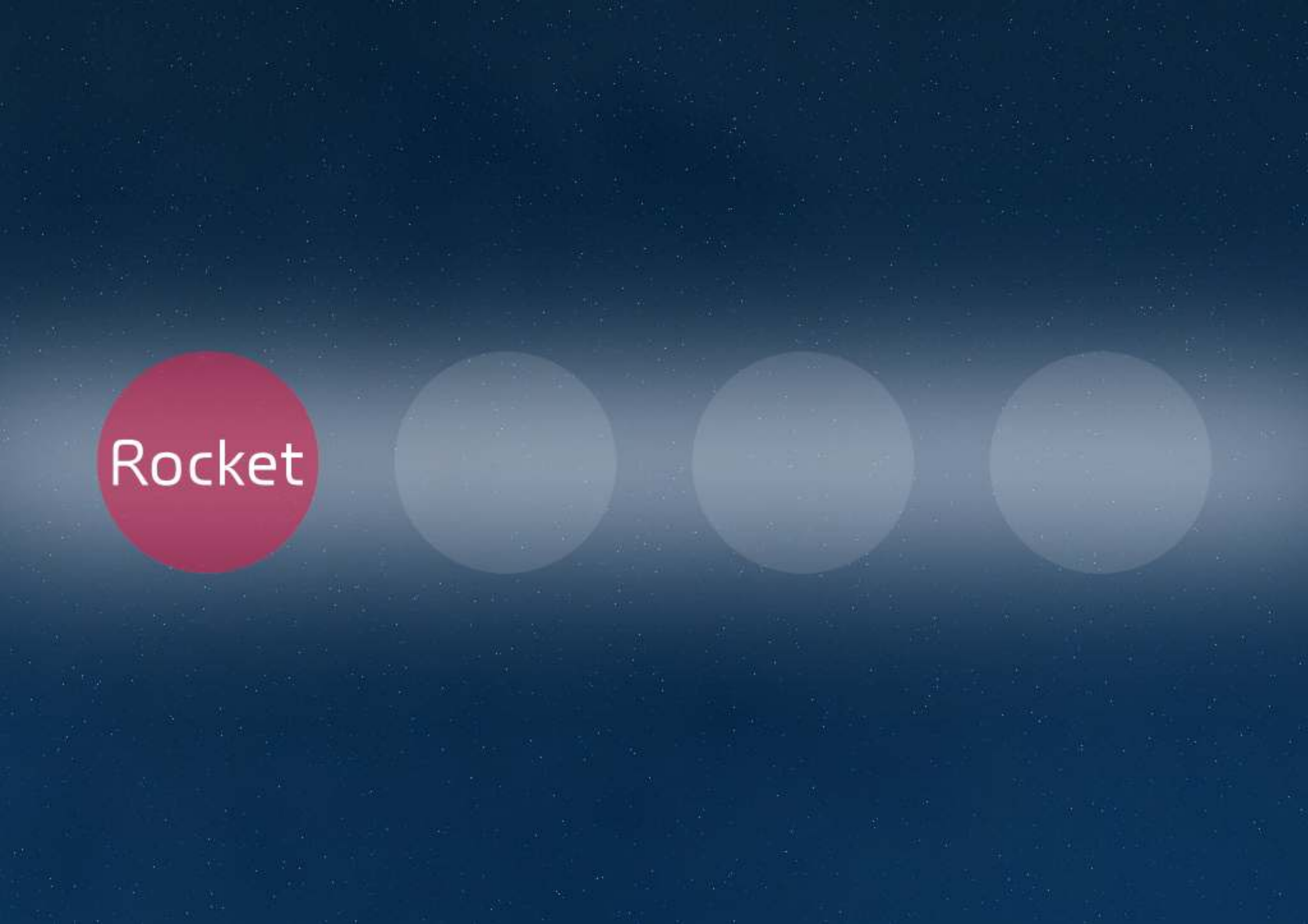

57
60
65
70
75
80
85
90
95
00
05
10
15

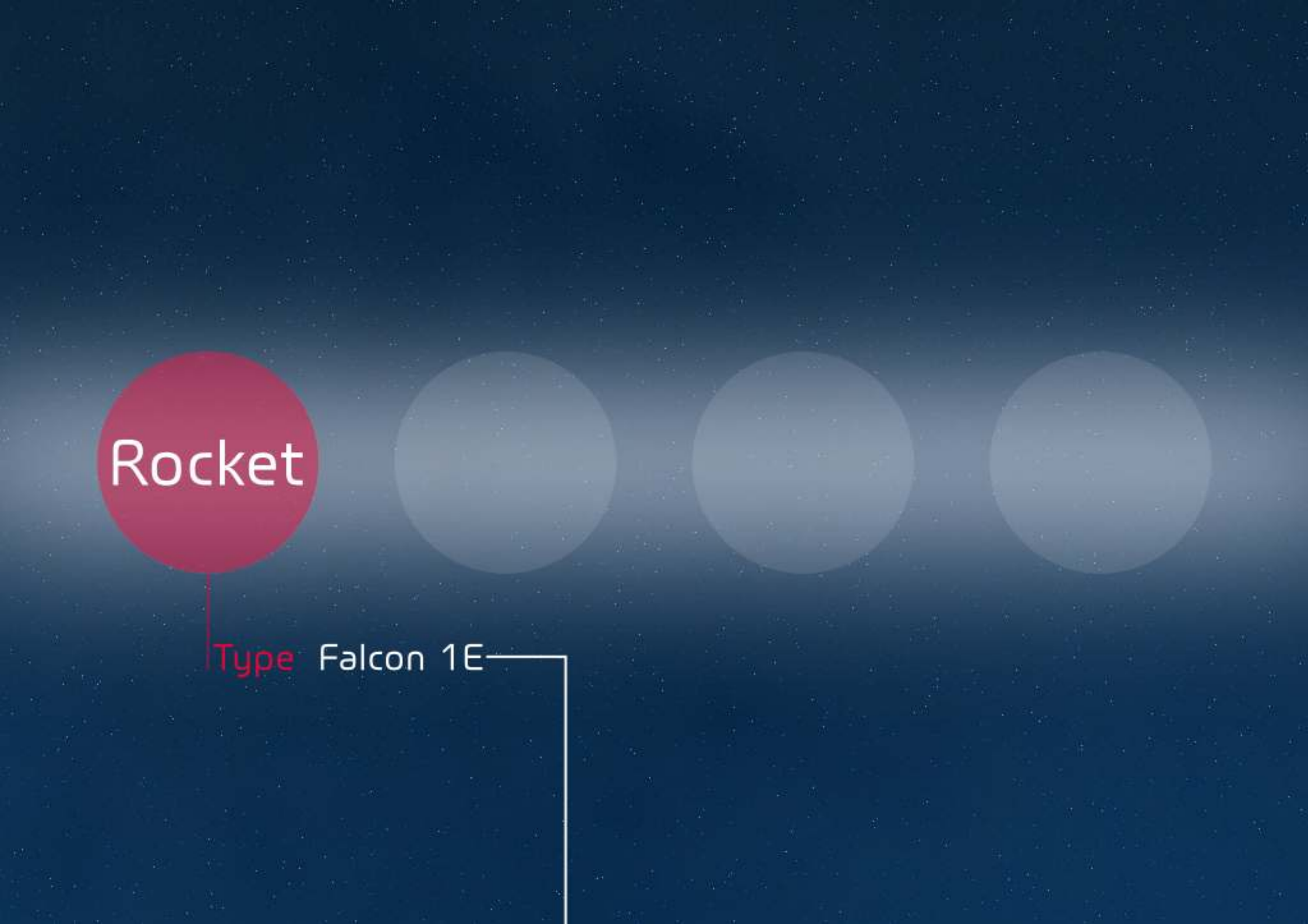
57 60 65 70 75 80 85 90 95 00 05 10 15

- 14.01.2005 Cassini-Huygens (USA/ESA/ASI) Titan

- 14.01.2005 Cassini-Huygens (USA/ESA/ASI) Titan




Rocket


Rocket
Type Falcon 1E

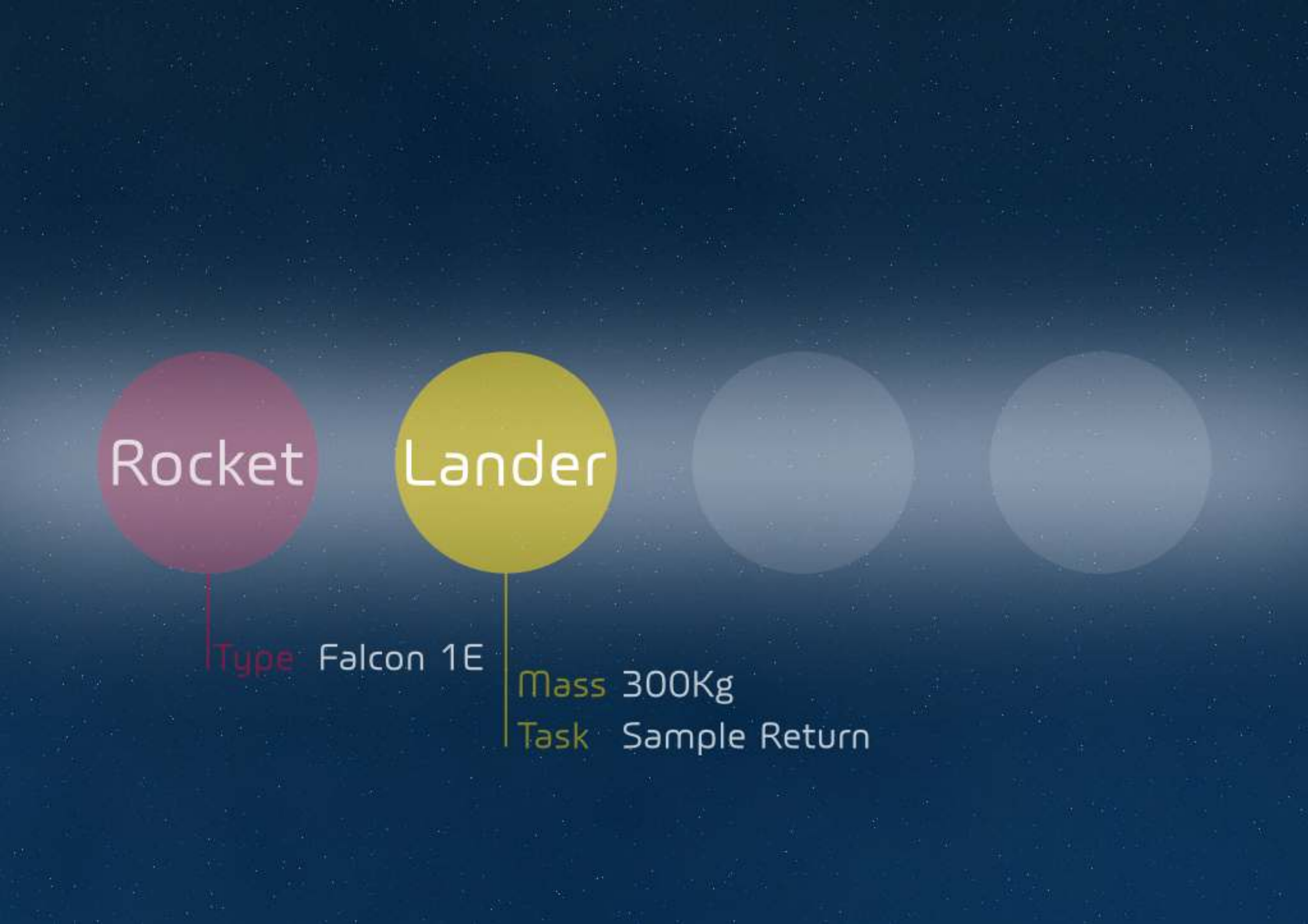
Falcon 1E RazakSAT

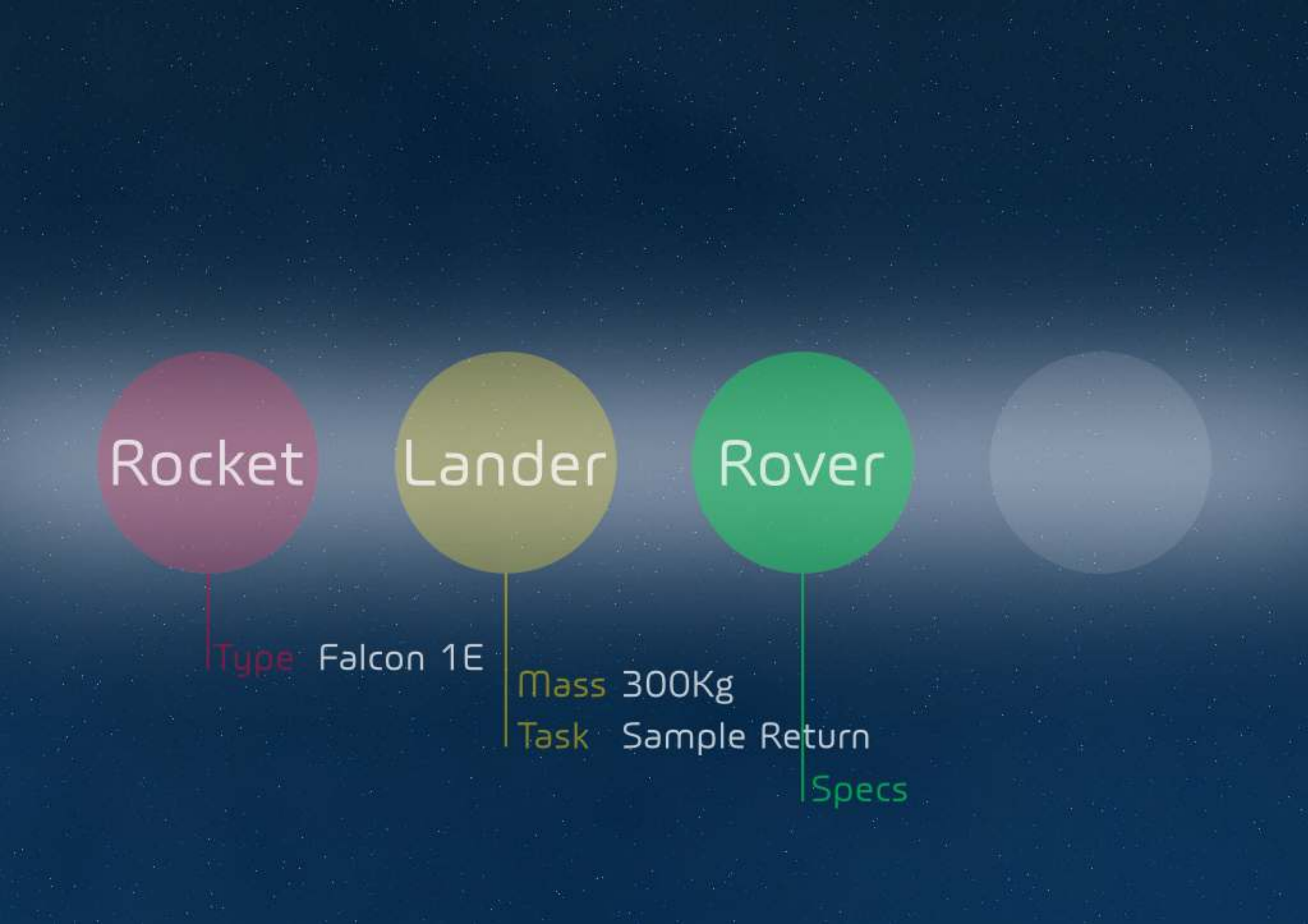
Modified Falcon 1E

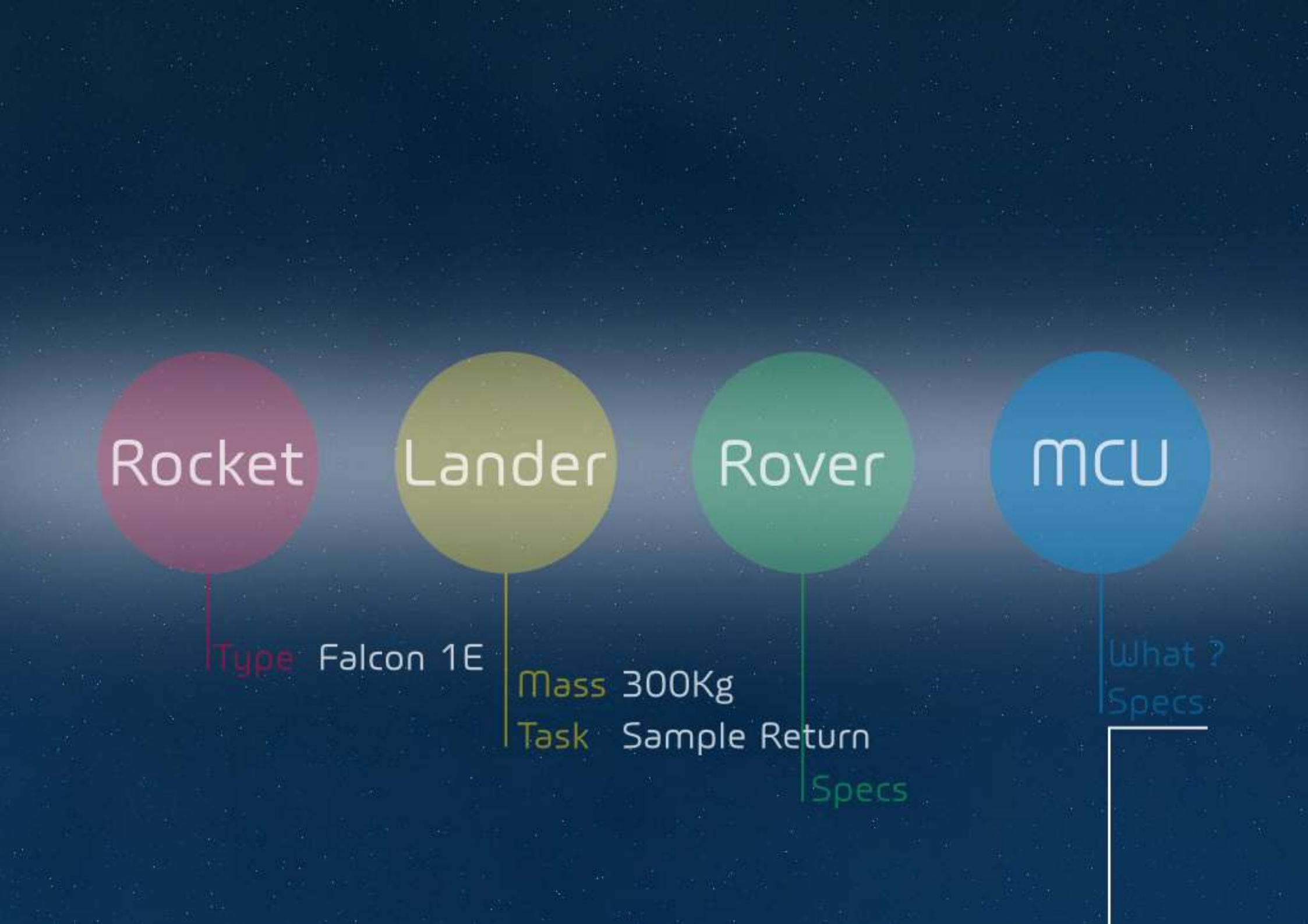
<10.000$ / kg Orbit

1010kg mass to LEO

80% Fuel


Rocket
Lander
Type Falcon 1E
Mass 300Kg
Task Sample Return


Rocket
Lander
Rover
Type Falcon 1E
Mass 300Kg
Task Sample Return
Specs


Rocket
Lander
Rover
MCU
Type Falcon 1E
Mass 300Kg
Task Sample Return
Specs
What ?
Specs

FPGA

Xilinx Virtex 4/5 Series FPGA

Full Analog/Digital control

Fully HiRel certified Components

I/O

Standardized Protocols

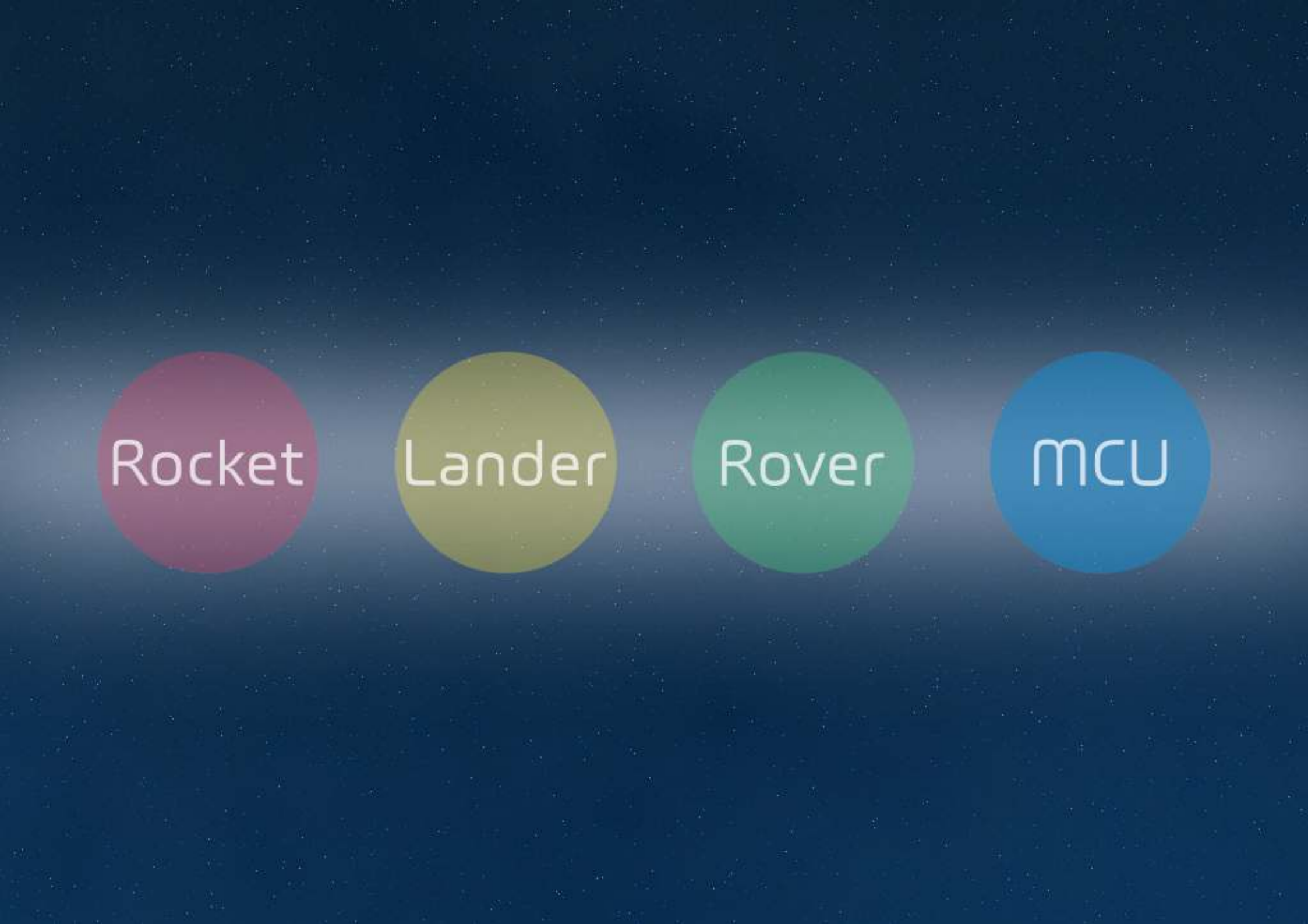
Ethernet for Falcon 1E control BUS

Gigabit Ethernet as Interconnect / Ethernet BUS

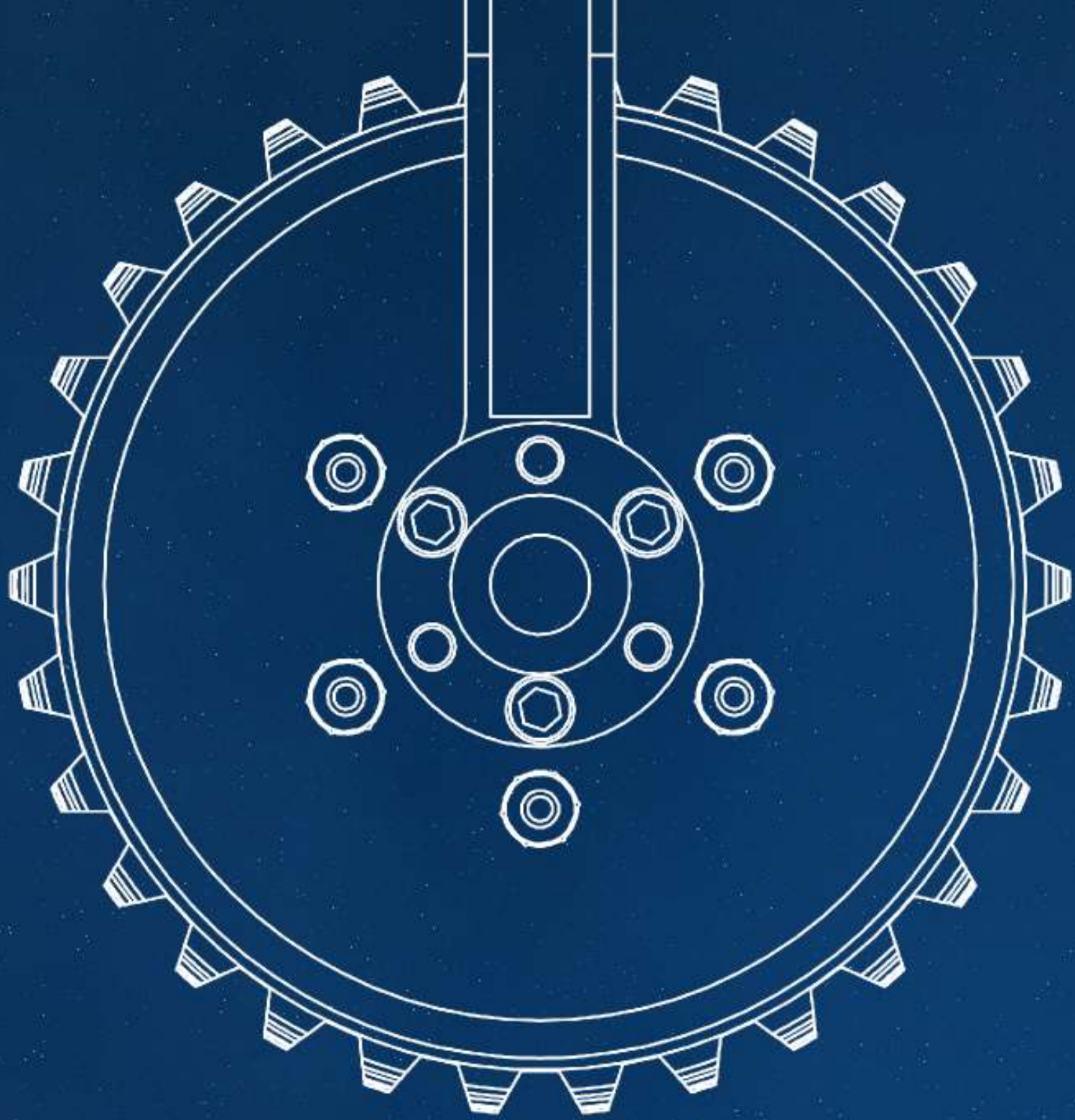
Storage

Persistent HiRel Datastorage

Customized ECC Algorithms for both Flash and RAM


Rocket
Lander
Rover
MCU


maxon motor
EAGLE
SolidWorks
SolidLine AG
Schneider
KREUZNACH
mindmeister
XILINX
O'REILLY
PART
TIME
SCIENTISTS



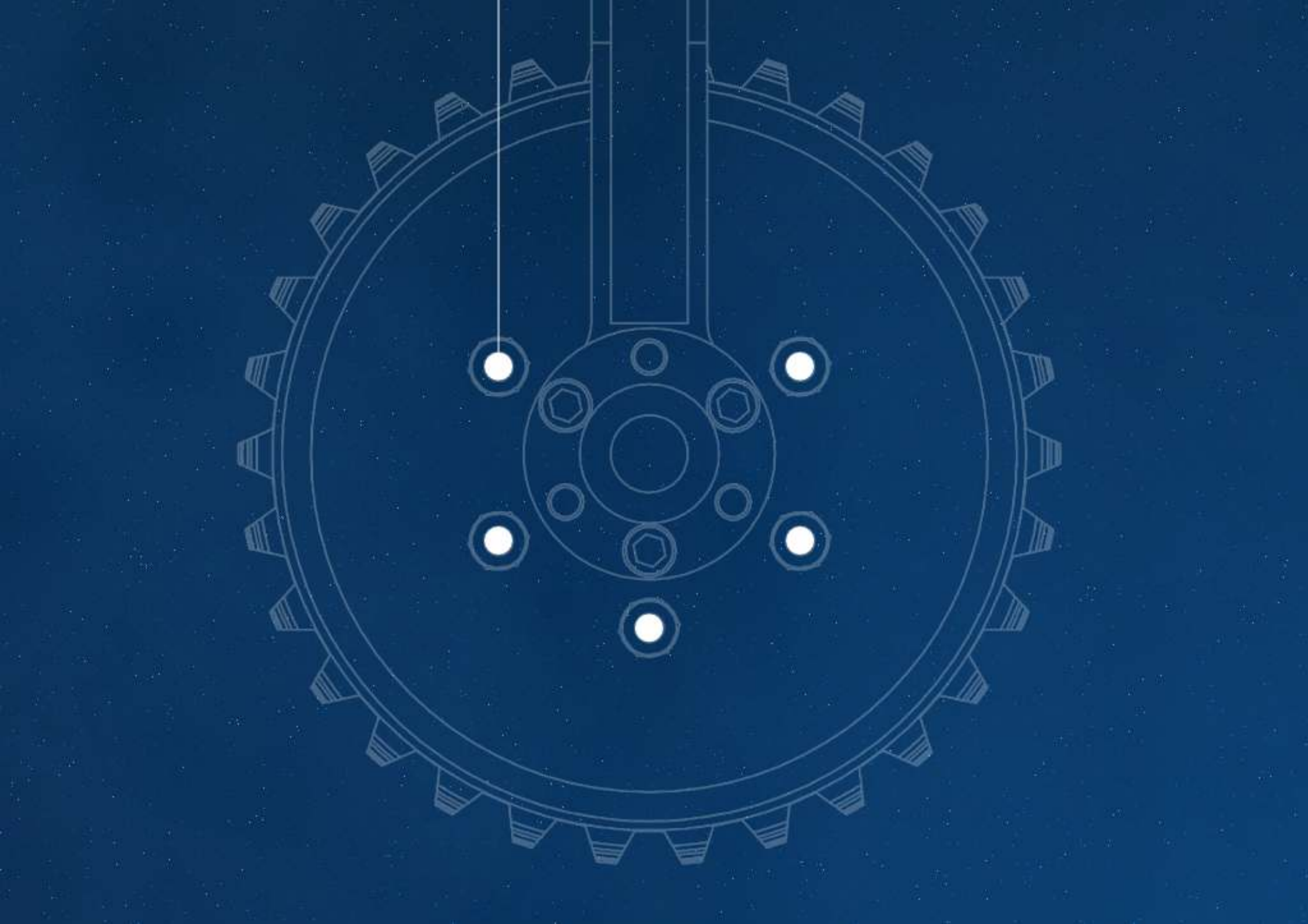
Requirements

Concept

Asimov Jr.

Technology


Future



GLXP

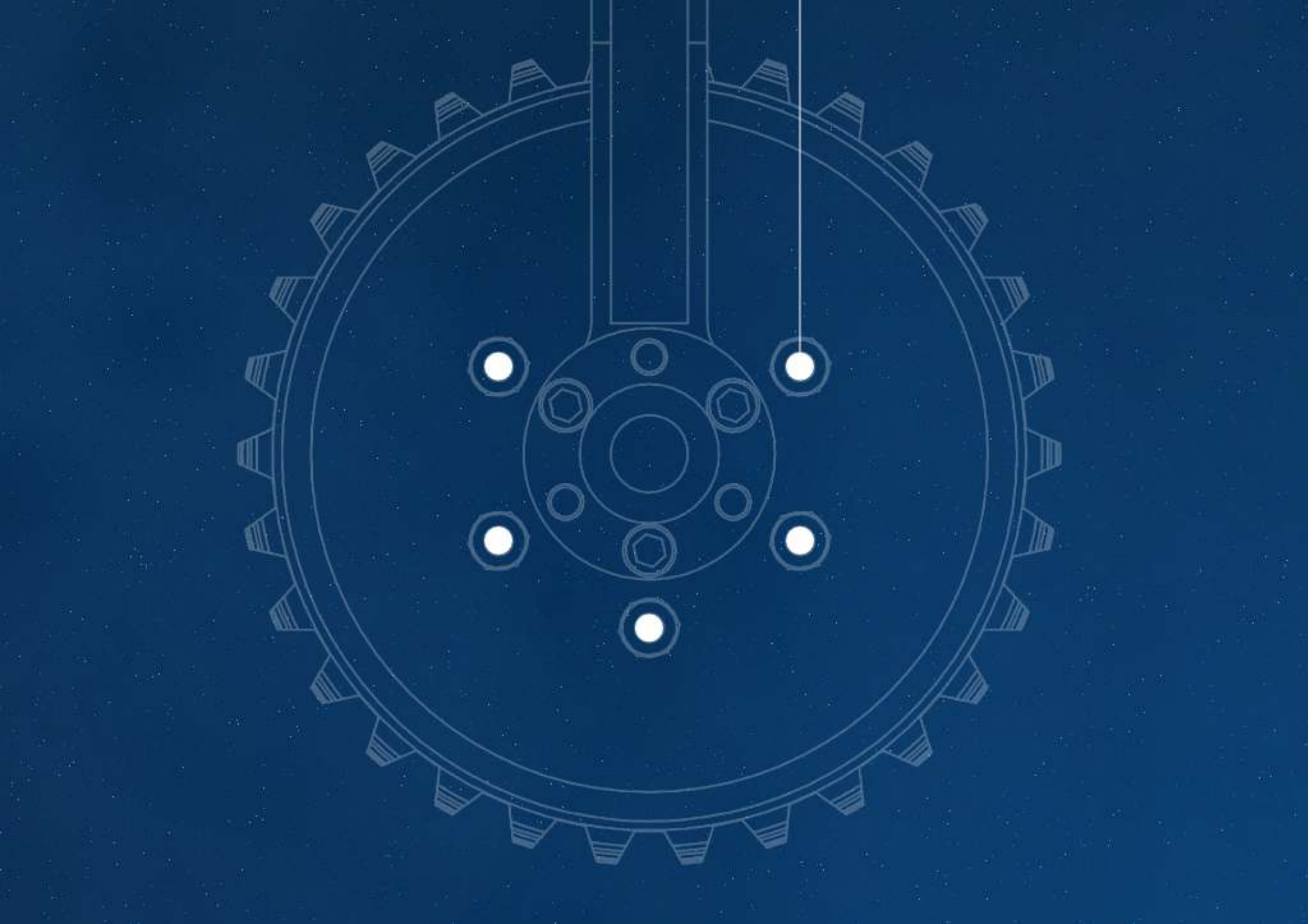
500m
Mooncast

PTS

5000m
Lunar Night

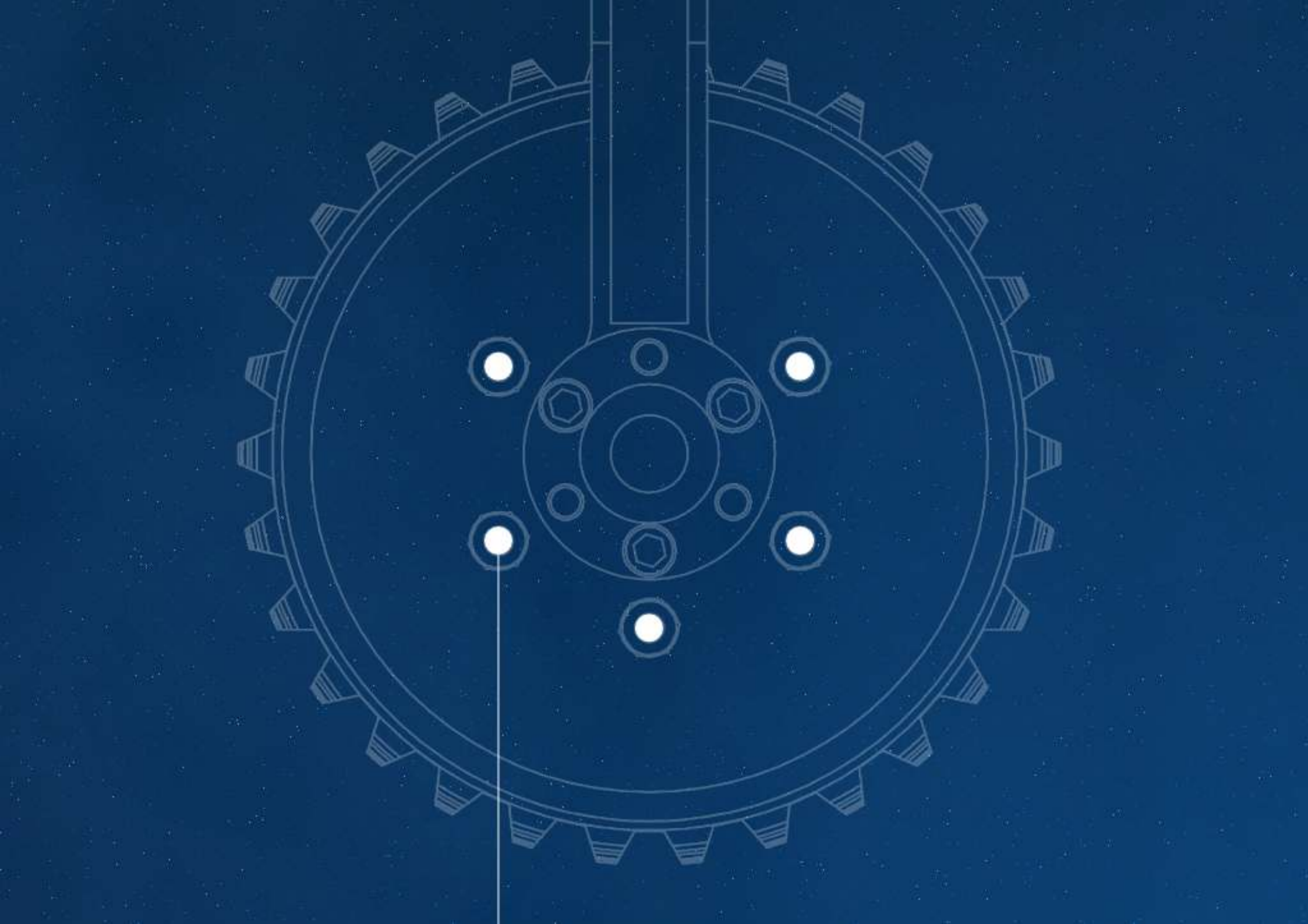
Moon

Temperature
Surface
Regolith

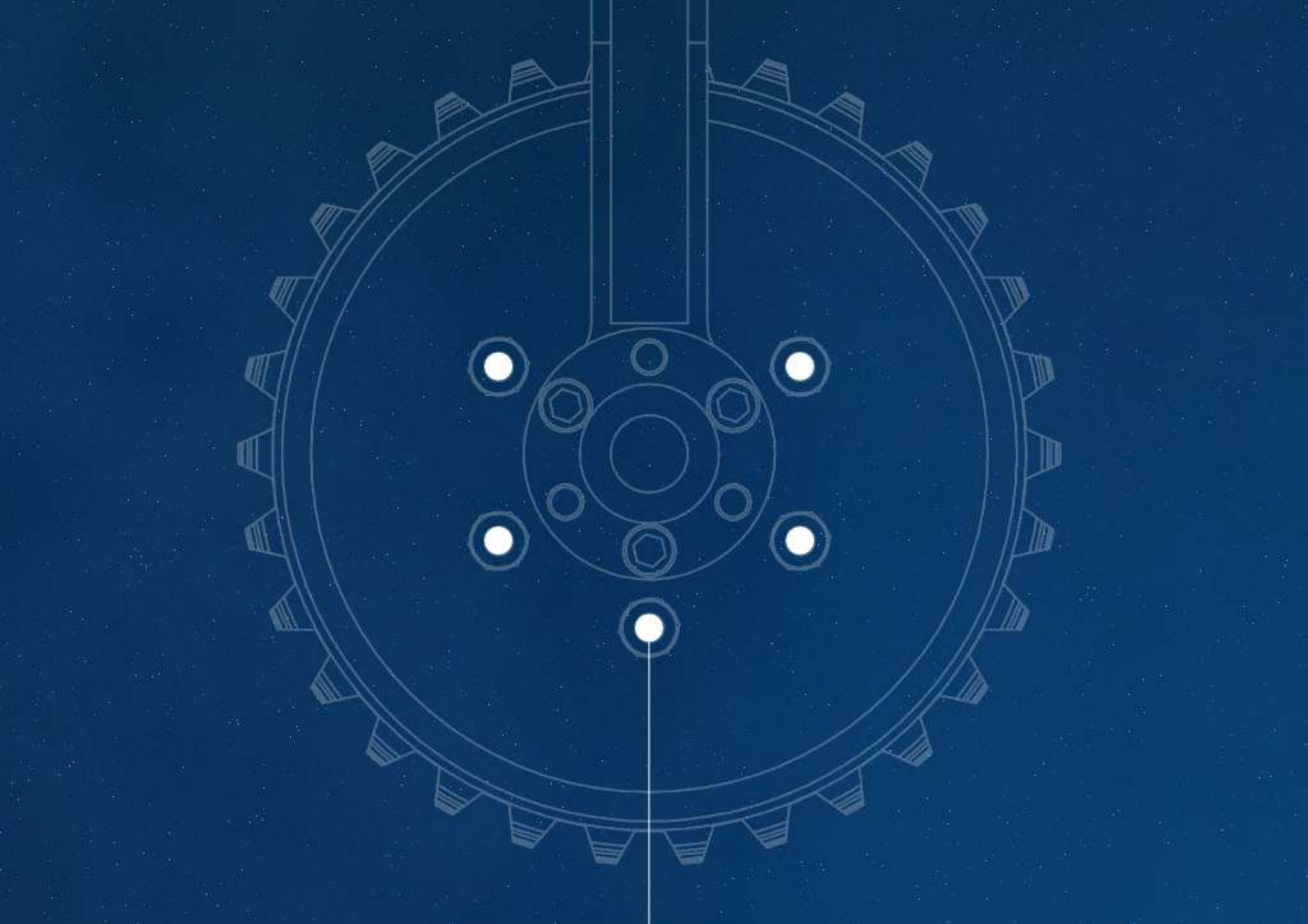


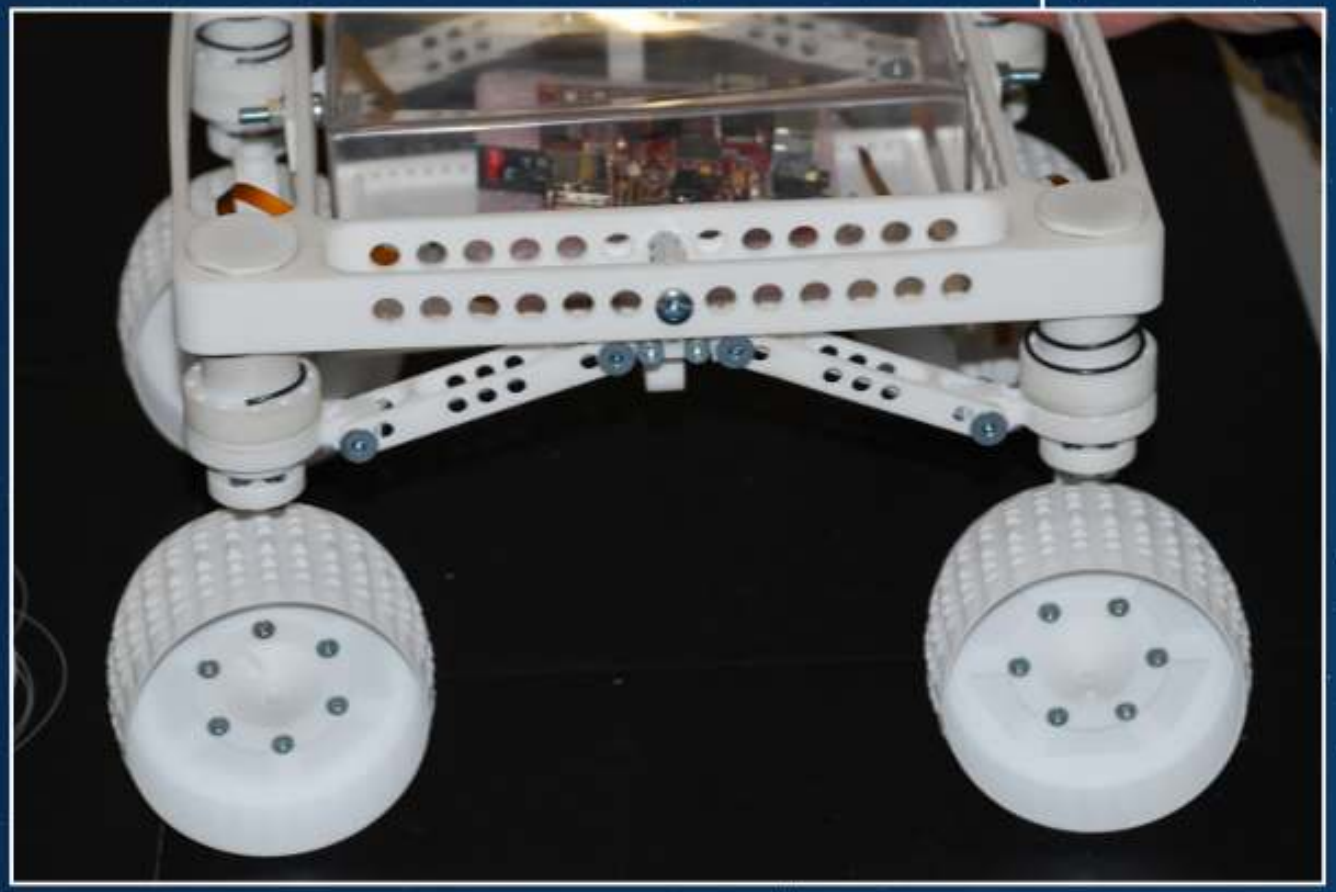
Mass / Components

Mobility	4 Wheels 360°	1000g
Tower	HD Stereo Vision	
	Optics	
	Total	1000g
Control	Main Computing Unit	500g
Energy	Solar Panel with	
	Slot Array Antenna	
	Total	1000g
Reserved	XPF Payload	500g
	Scientific Payload	-
Total	Weight with Interconnections	5Kg

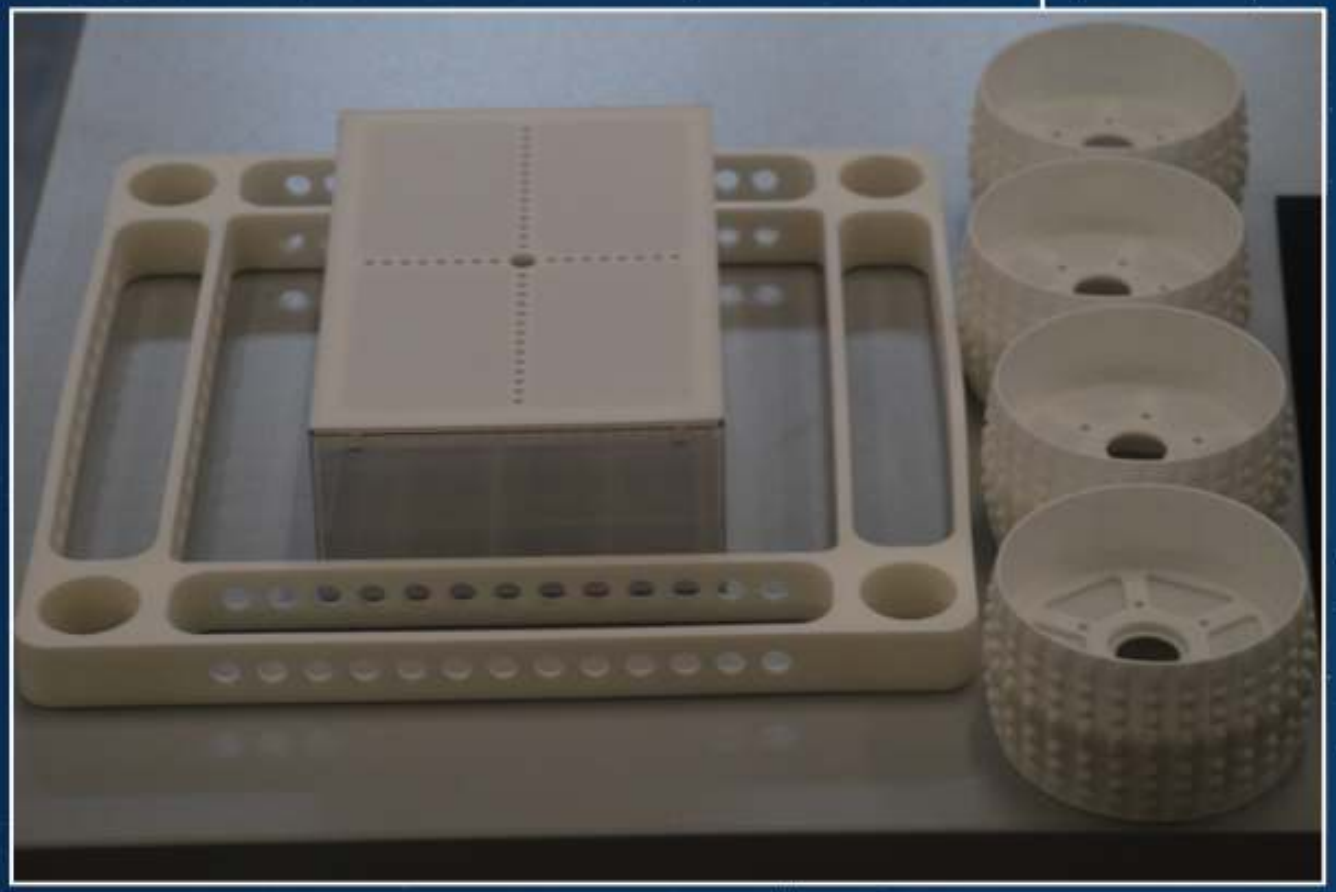


Video

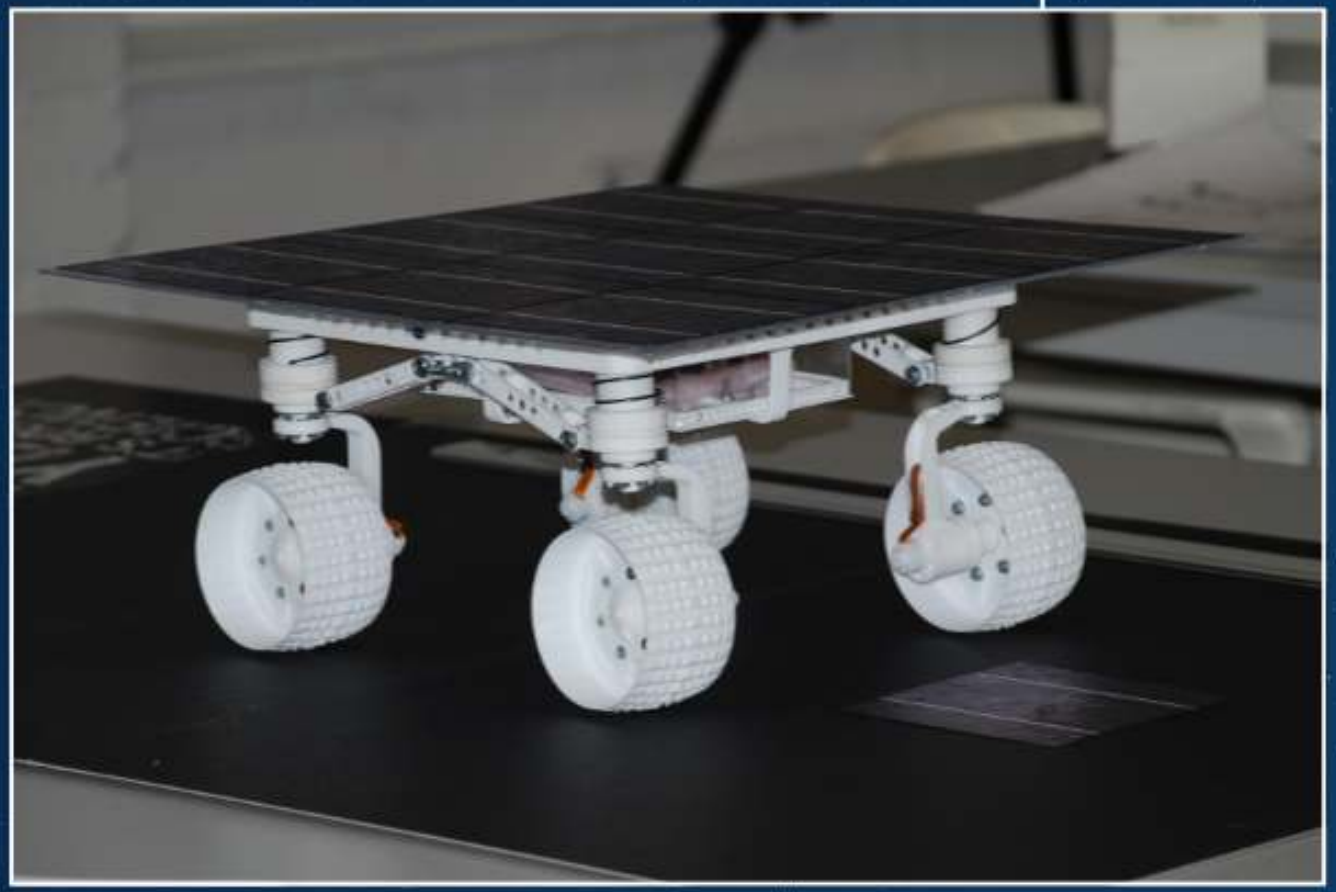




- wheels

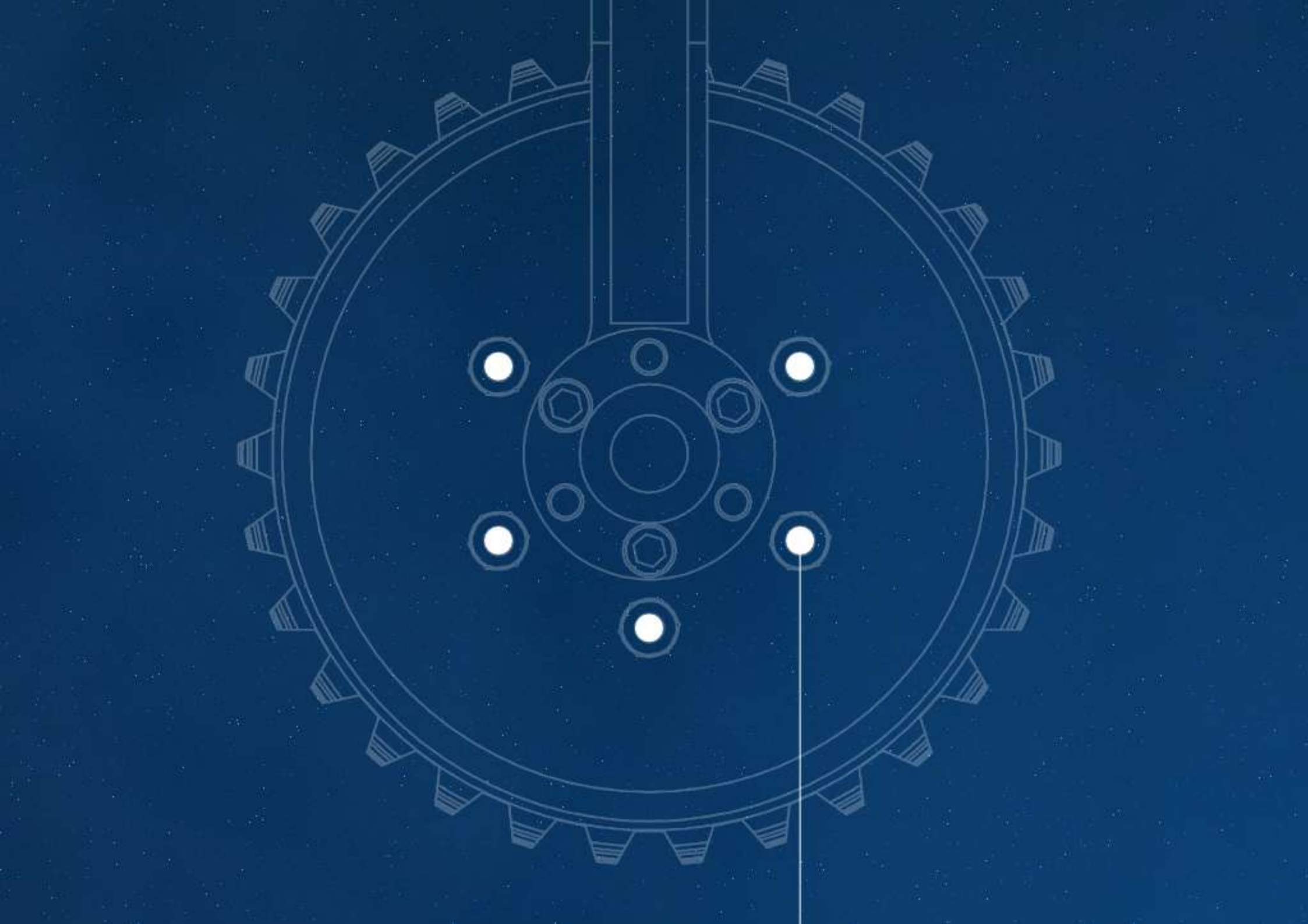


- wheels
- frame



- wheels
- frame
- solar panel

- wheels
- frame
- solar panel
- optics



2010

new materials

new design

check out our new hp, twitter, blog and ...
visit us at our booth after the talk !


Main- Computing- Unit

Requirements

Realtime HD video

Flexible design (IP Cores)

Fully HiRel certified

Goals

Lifetime

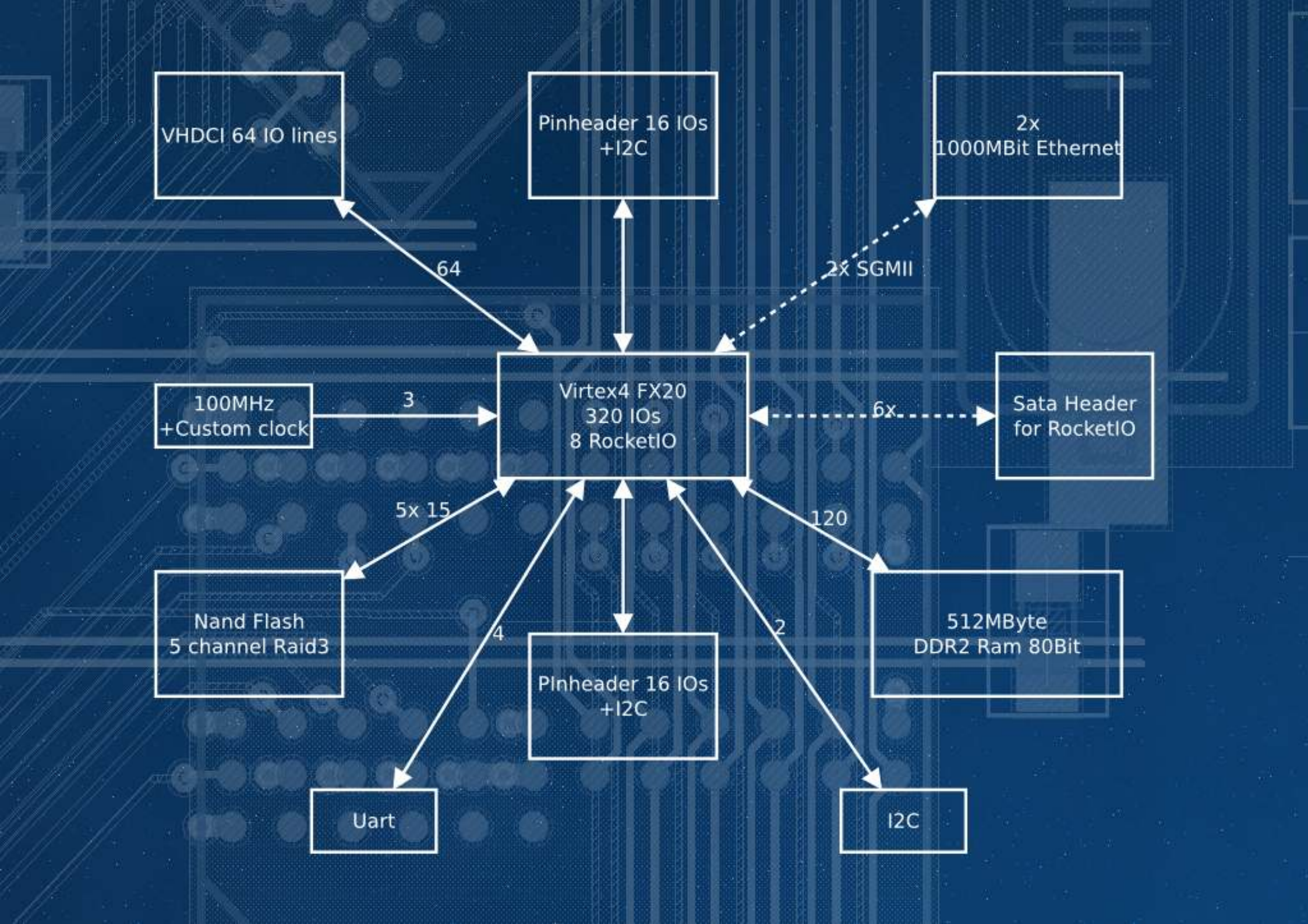
KISS

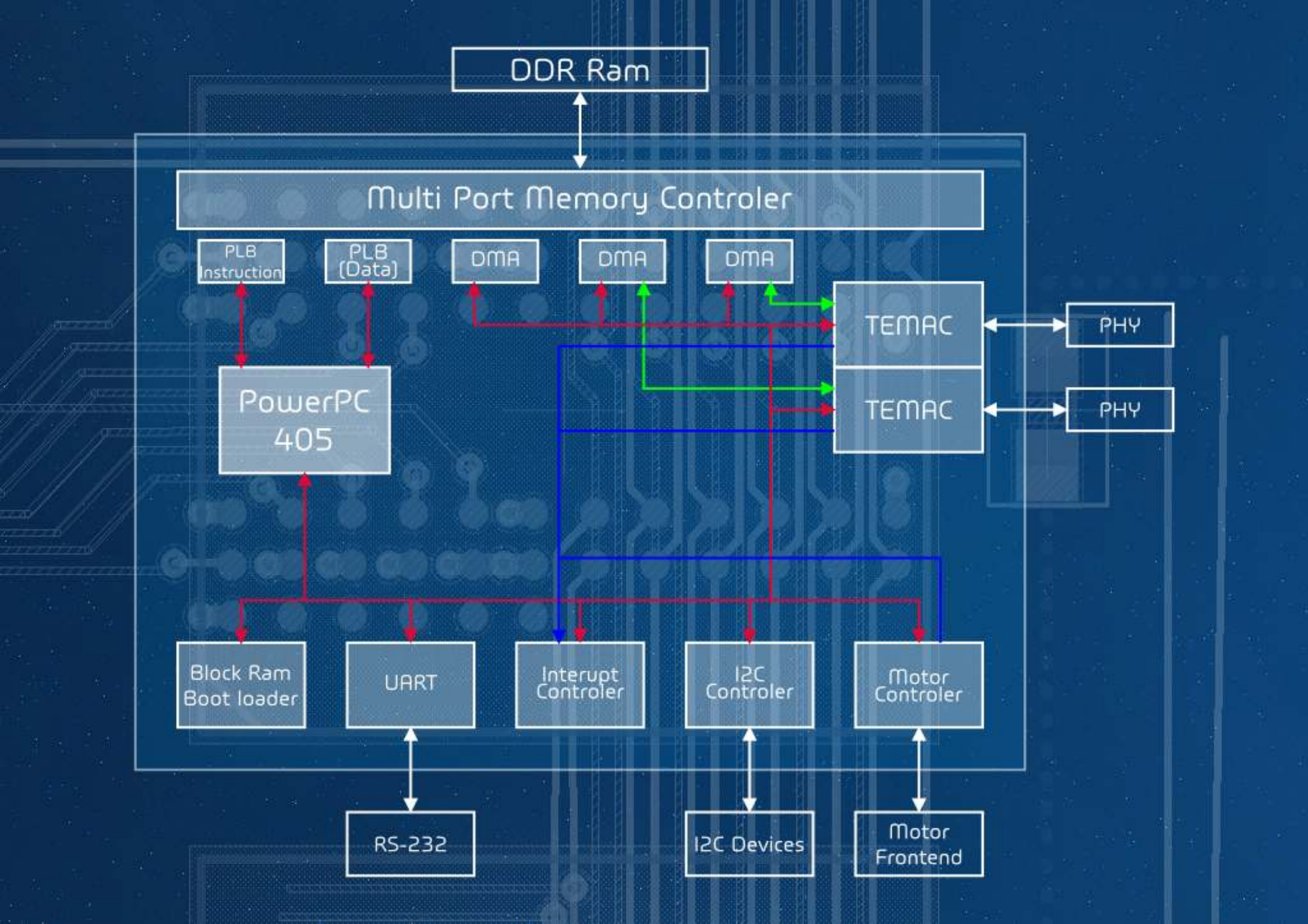
What is HiRel?

Temperature differences of -55° to +125°

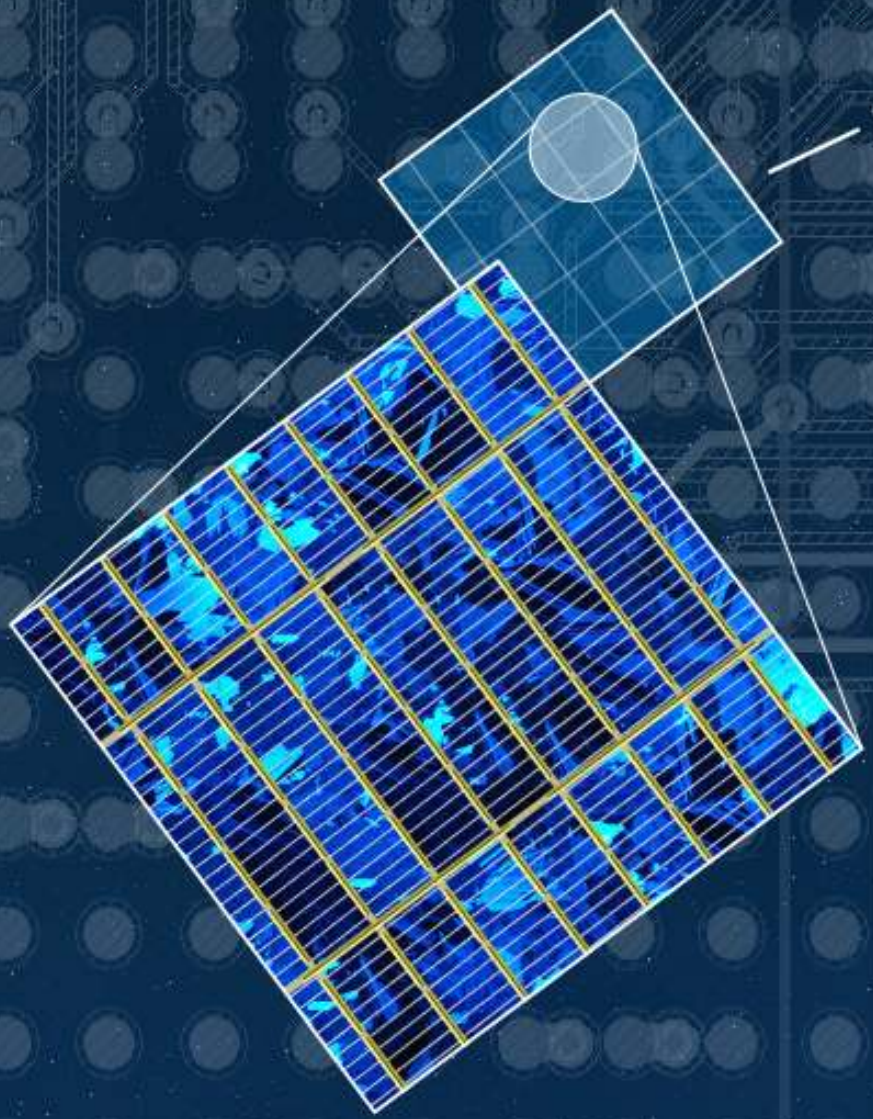
"single event effects"

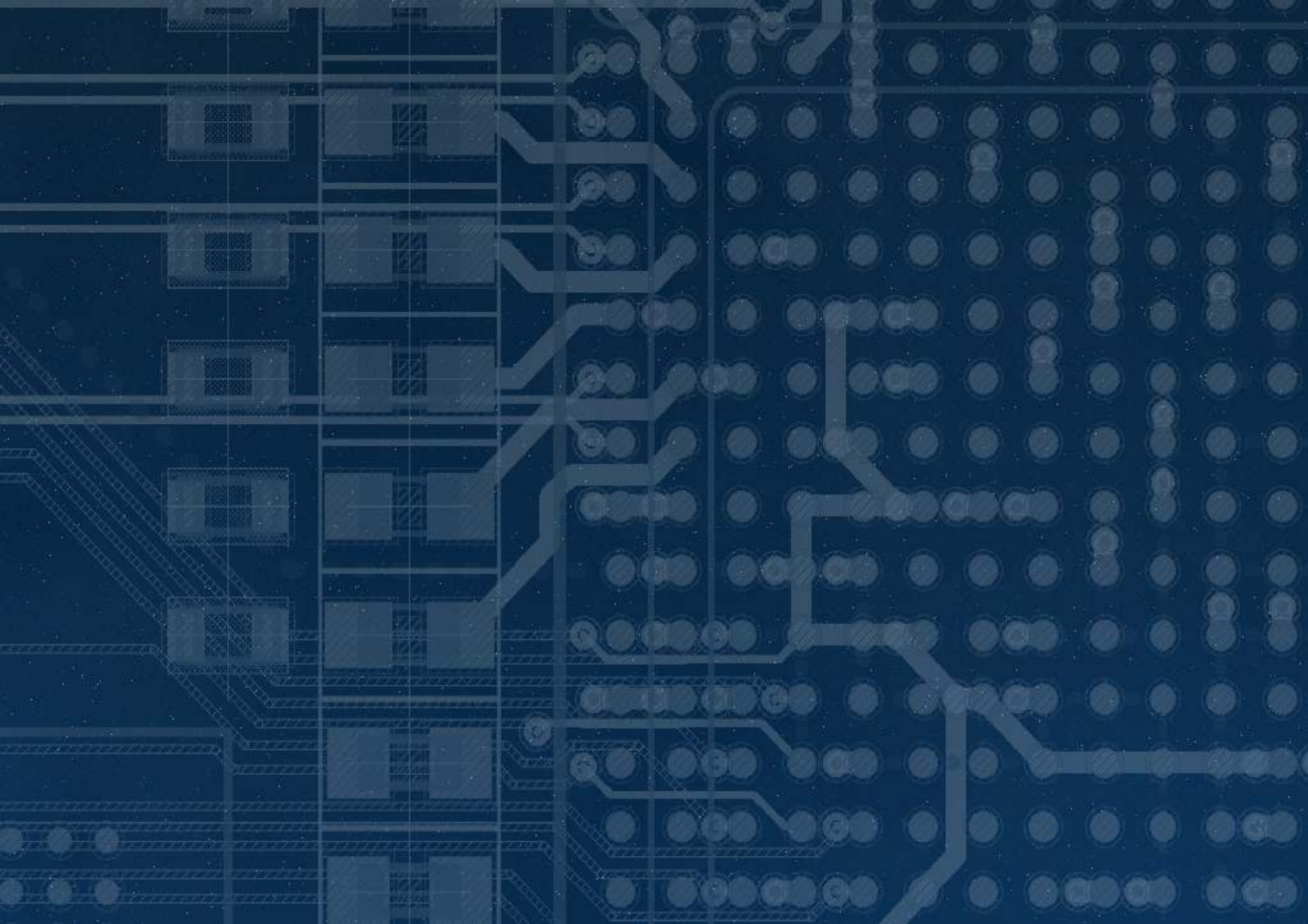
"total ionizing dose"

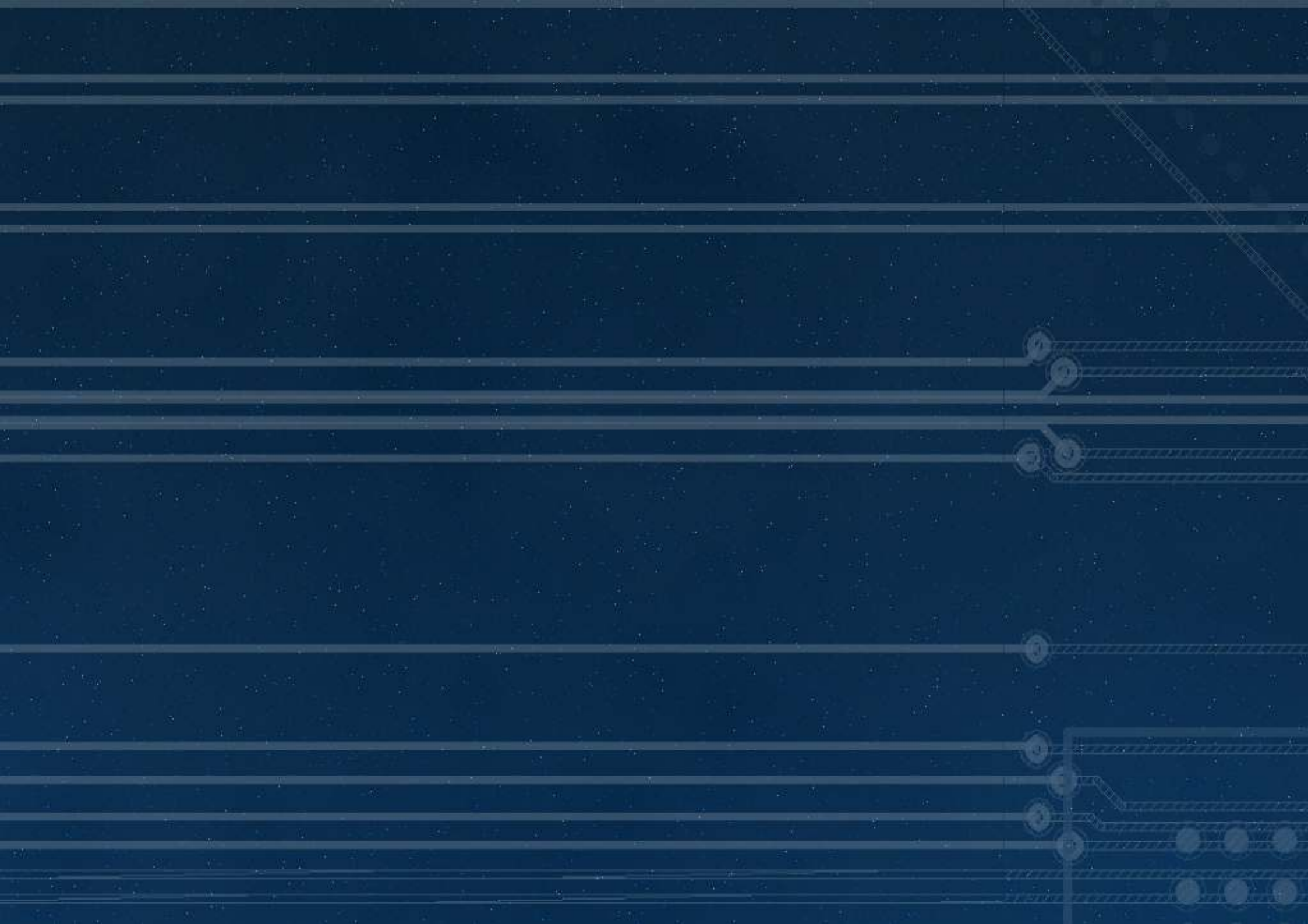

VHDCI 64 IO lines
Pinheader 16 IOs
+I2C
2x
1000MBit Ethernet
64
2x SGMII
100MHz
+Custom clock
3
Virtex4 FX20
320 IOs
8 RocketIO
6x
Sata Header
for RocketIO
5x 15
120
Nand Flash
5 channel Raid3
4
PInheader 16 IOs
+I2C
2
512MByte
DDR2 Ram 80Bit
Uart
I2C


DDR Ram
Multi Port Memory Controler
PLB Instruction
PLB (Data)
DMA
DMA
DMA
TEMAC
TEMAC
PHY
PHY
PowerPC 405
Block Ram Boot loader
UART
Interupt Controler
I2C Controler
Motor Controler
RS-232
I2C Devices
Motor Frontend

slot phased array solar antenna





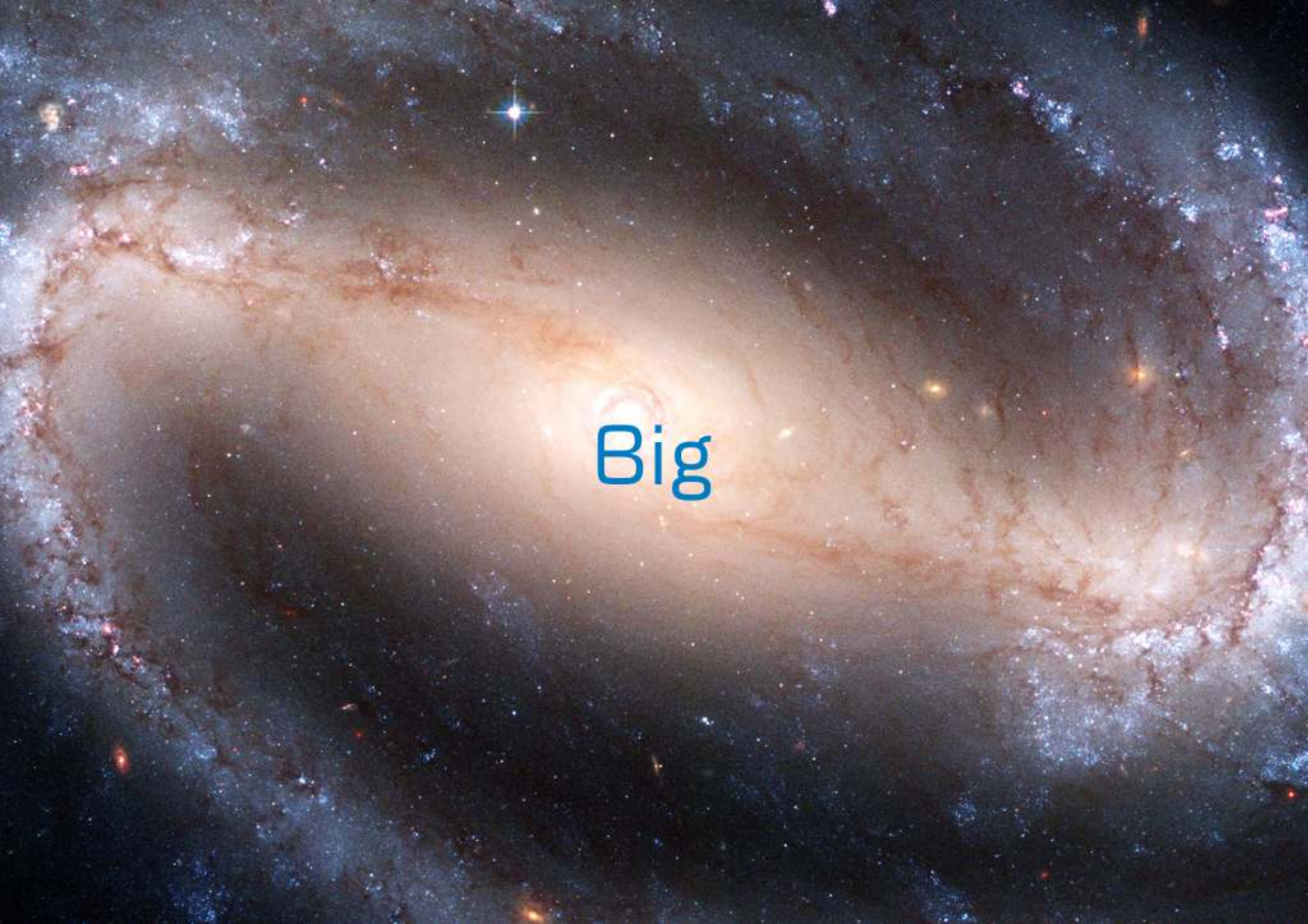


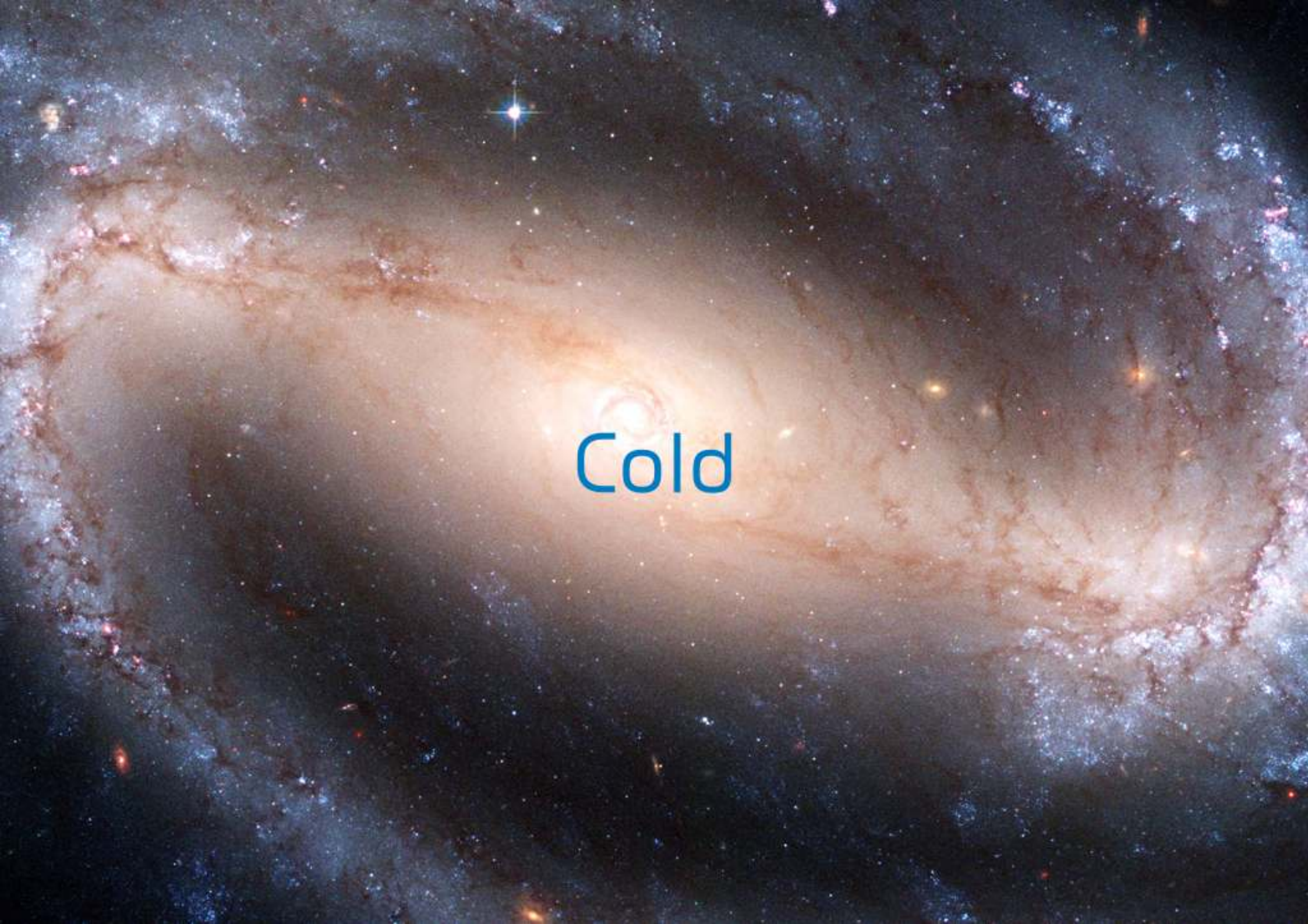
Special Guest appearance

And Now For Something Completely Different

The Problem

Space


Big


Cold


And ...

Empty


400.000 Km
Earth
Moon

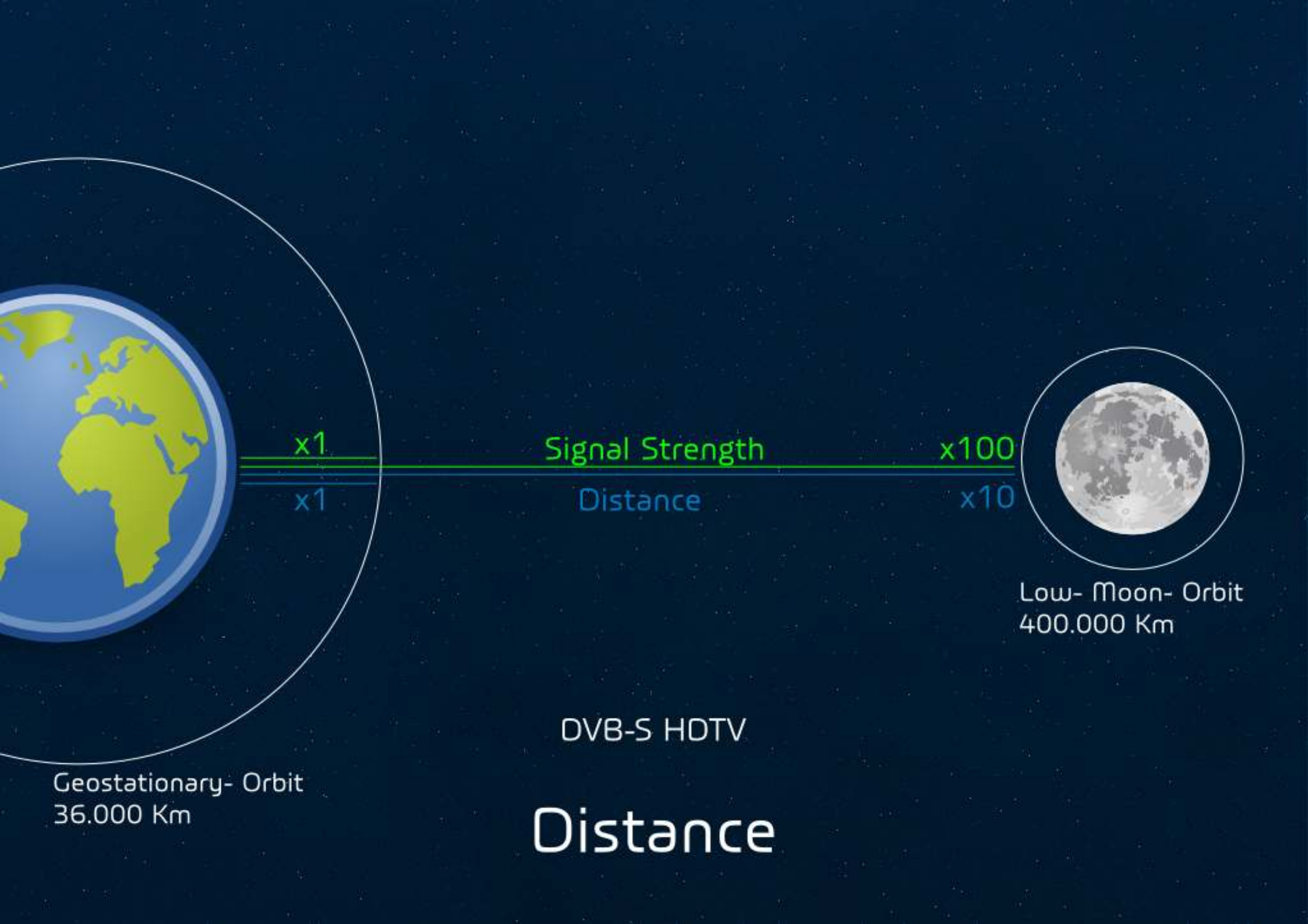

113.649.601 Km
Earth
Mars


16.900.000.000 Km
Earth
Voyager 1

Distance

$$\frac{1}{R^2} = \text{Signal Strength by Distance}$$

Distance


x1
Signal Strength
x100
x1
Distance
x10
Low- Moon- Orbit
400.000 Km
Geostationary- Orbit
36.000 Km
DVB-S HDTV
Distance

Greater distance leads to ...

larger send/recv antennas

larger energy requirements

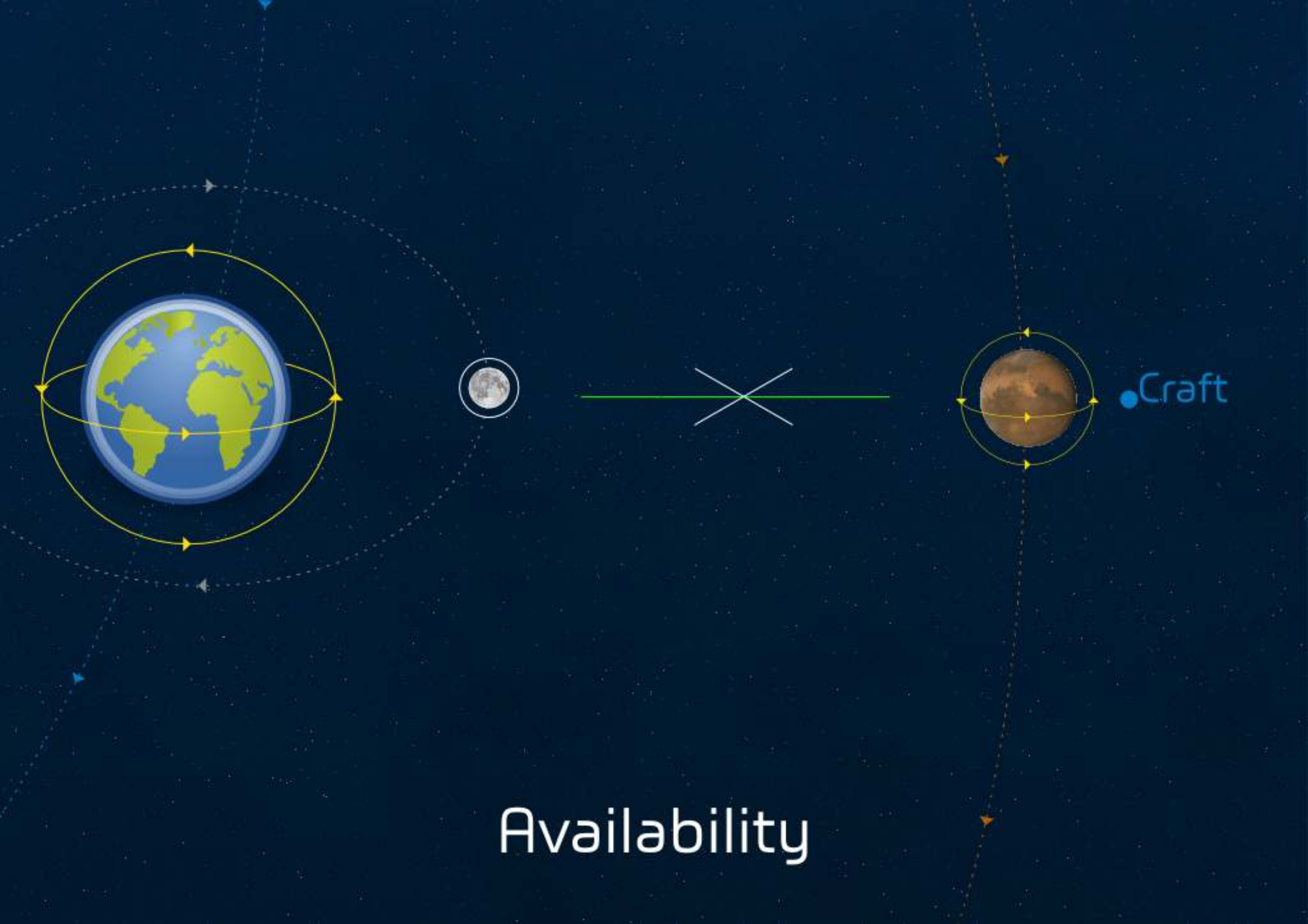
smaller bandwidth

Distance

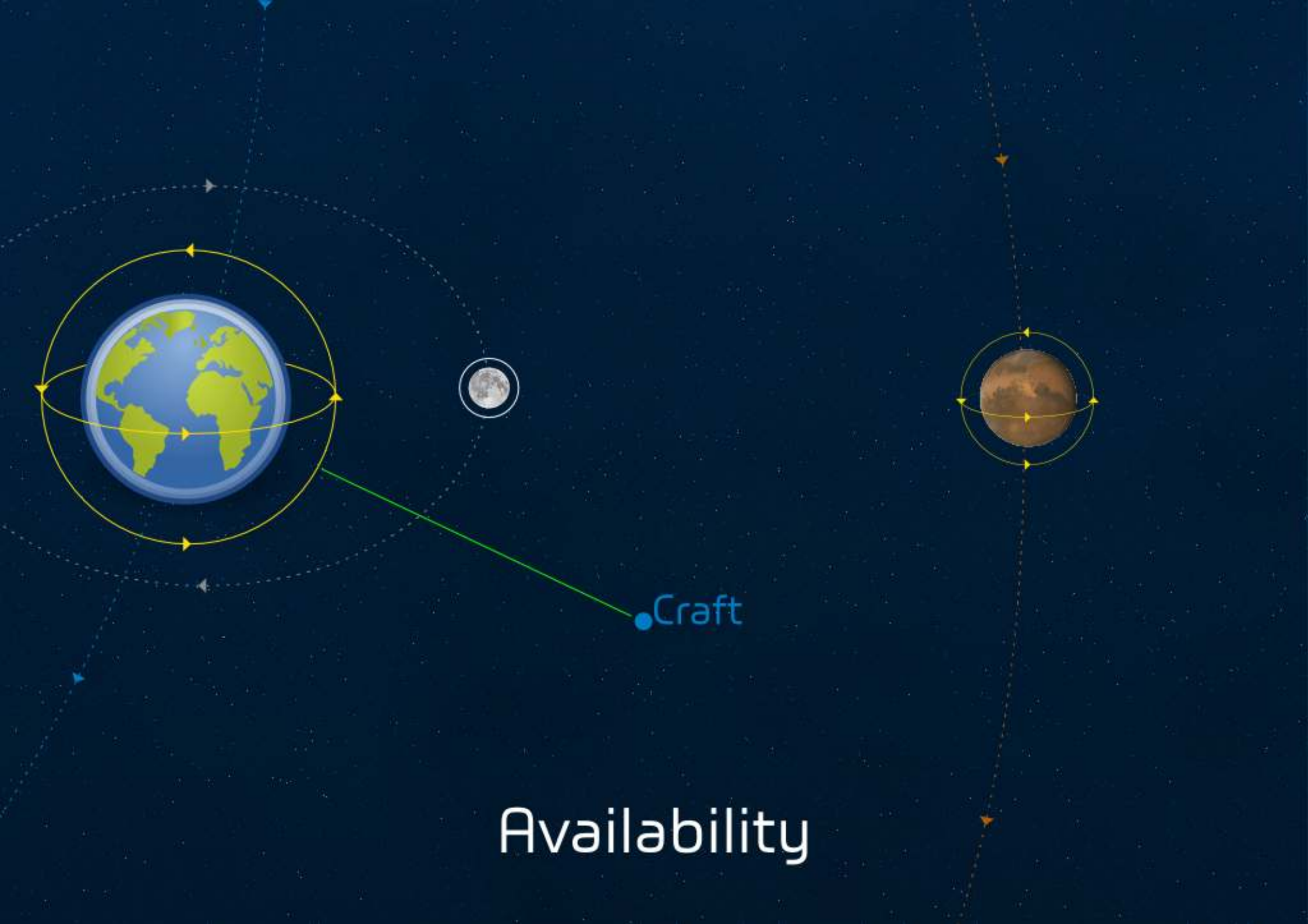
Distance

Availability

The Problem



Availability



Availability


VIEWPORT - MOON
CUBE SAT

Our Solution

Components

— Dish

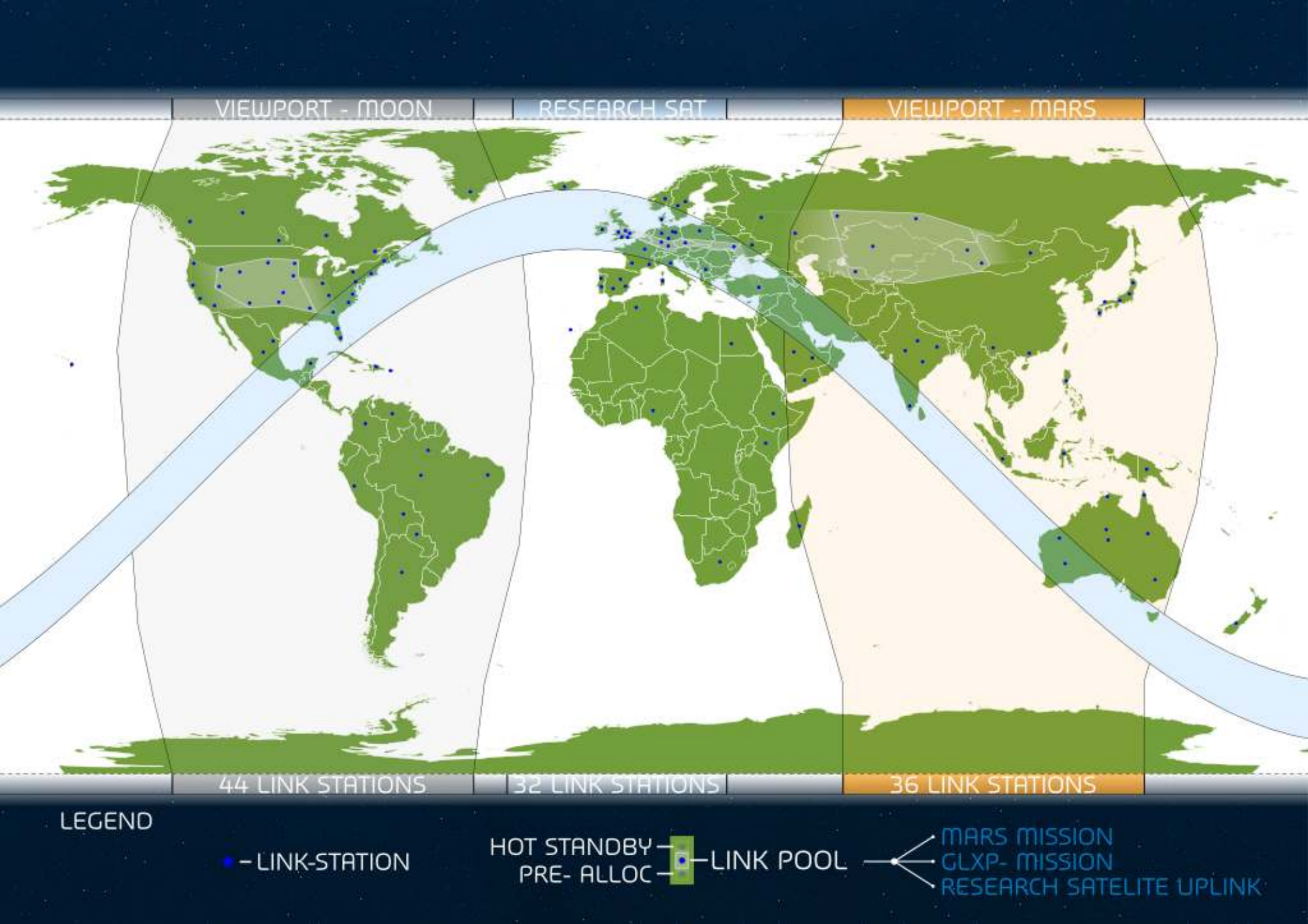
- amateur radio compliant
- minimal modifications needed
- standard dish size

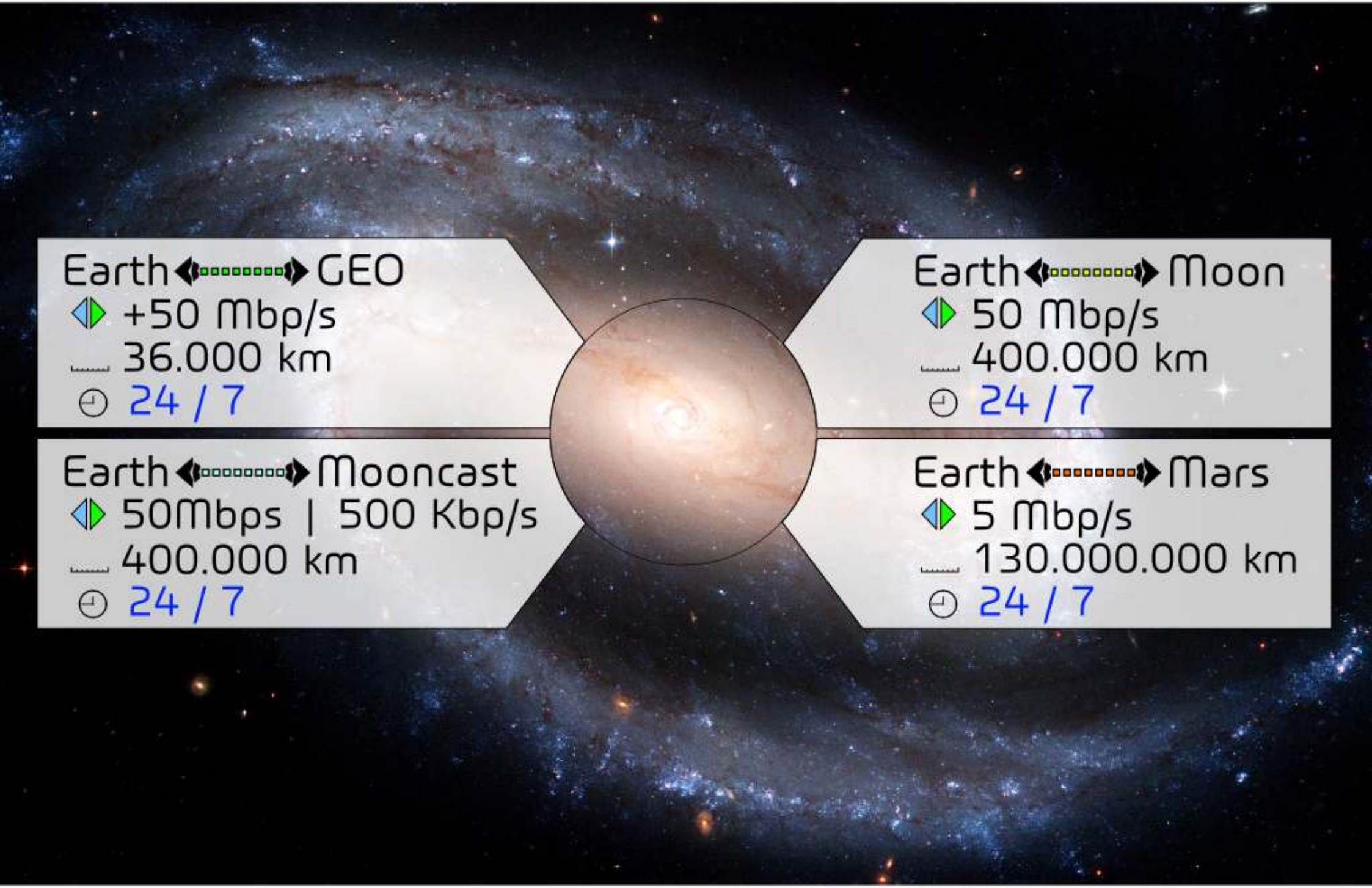
XILINX

— FPGA

- GNU Linux based host system
- IP Core based stream modulation
- Frequency Shifting

Components


VIEWPORT - MOON
RESEARCH SAT
VIEWPORT - MARS
44 LINK STATIONS
32 LINK STATIONS
36 LINK STATIONS
LEGEND
- LINK-STATION
HOT STANDBY
PRE- ALLOC
LINK POOL
MARS MISSION
GLXP- MISSION
RESEARCH SATELITE UPLINK


Earth GEO
+50 Mbp/s
36.000 km
24 / 7
Earth Moon
50 Mbp/s
400.000 km
24 / 7
Earth Mooncast
50Mbps | 500 Kbp/s
400.000 km
24 / 7
Earth Mars
5 Mbp/s
130.000.000 km
24 / 7