



Computer Vision, Imaging, and machine Intelligence, CVI²-SnT, University of Luxembourg

Carl Shneider



Space 2. 

The New Investment Frontier

Computer Vision, Imaging, and machine Intelligence, CVI²-SnT, University of Luxembourg

Carl Shneider



LUXEMBOURG
INSTITUTE OF SCIENCE
AND TECHNOLOGY



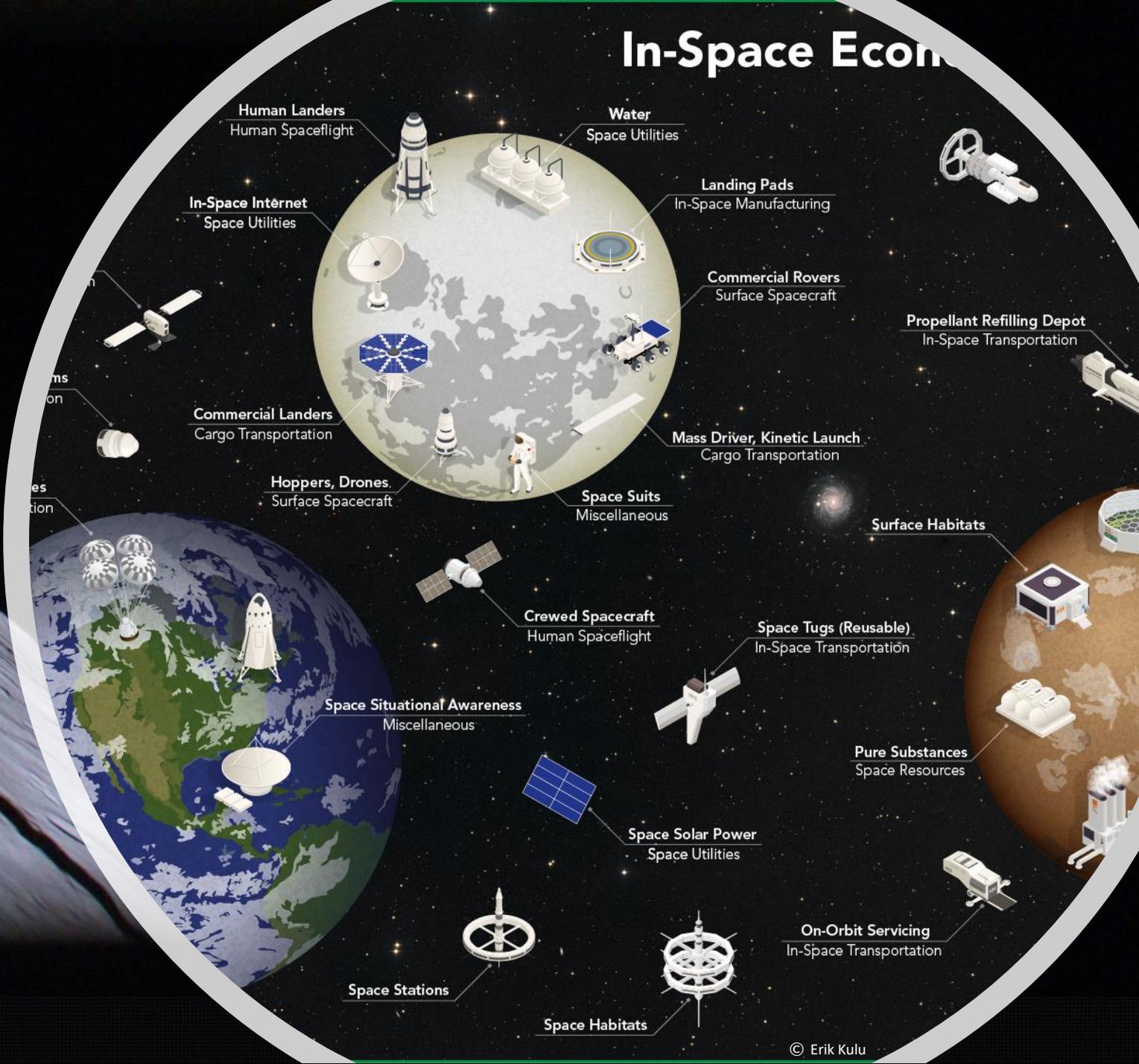
Space 2. 

The New Investment Frontier

Computer Vision, Imaging, and machine Intelligence, CVI²-SnT, University of Luxembourg

Carl Shneider

In-Space Economy



Human Landers
Human Spaceflight

Water
Space Utilities

Landing Pads
In-Space Manufacturing

Commercial Rovers
Surface Spacecraft

Propellant Refilling Depot
In-Space Transportation

Mass Driver, Kinetic Launch
Cargo Transportation

Space Suits
Miscellaneous

Surface Habitats

Space Tugs (Reusable)
In-Space Transportation

Pure Substances
Space Resources

On-Orbit Servicing
In-Space Transportation

Space Habitats

Space Stations

Space Solar Power
Space Utilities

Space Situational Awareness
Miscellaneous

Crewed Spacecraft
Human Spaceflight

Commercial Landers
Cargo Transportation

Hoppers, Drones
Surface Spacecraft

In-Space Internet
Space Utilities

In-Space Economy



In-Space Economy Classification:

- 1) Human Spaceflight
 - Crewed Spaceships & Shuttles
 - Human Landers
- 2) Cargo Transportation & Landers
 - Robotic Landers (Moon, Mars)
 - Re-Entry Capsules (Earth, Mars)
 - Cargo Resupply
 - Reusable Satellites
- 3) Surface Spacecraft
 - Crew Rovers
 - Robotic Rovers
 - Drones, Hoppers
- 4) Space Stations & Habitats
- 5) Surface Habitats & Structures
- 6) In-Space Manufacturing (ISM)
 - In-Space Production
 - Space Food, Space Agriculture
 - Microgravity Manufacturing
 - Additive Manufacturing
 - In-Space Assembly, Construction, etc.
- 7) Space Resources
 - ISRU (In-Situ Resource Utilization)
 - Pure Substances (Ice, Oxygen, Metals)
 - Space, Lunar & Asteroid Mining
 - Prospecting, Processing, Recycling
- 8) Space Utilities
 - Energy, Power-Beaming
 - In-Space Internet, Data Relay
 - Navigation
 - Water, Propellant
- 9) In-Space Transportation
 - Space Tugs, Space Trucks
 - Orbital Transfer Vehicles (OTV)
 - On-Orbit Servicing, Maintenance
 - Propellant Reload Stations (Depots)
 - Active Debris Removal
 - In-Orbit Inspection
 - Space Mobility, Space Logistics
- 10) Miscellaneous
 - Microgravity Services
 - In-Orbit Computing, Storage
 - Space-Flown Items
 - Space Suits & Garments
 - Commercial Astronauts
 - Space Entertainment & Advertising
 - Space Traffic Management
 - Space Tourism Support, etc.

University Projects with Major Potential

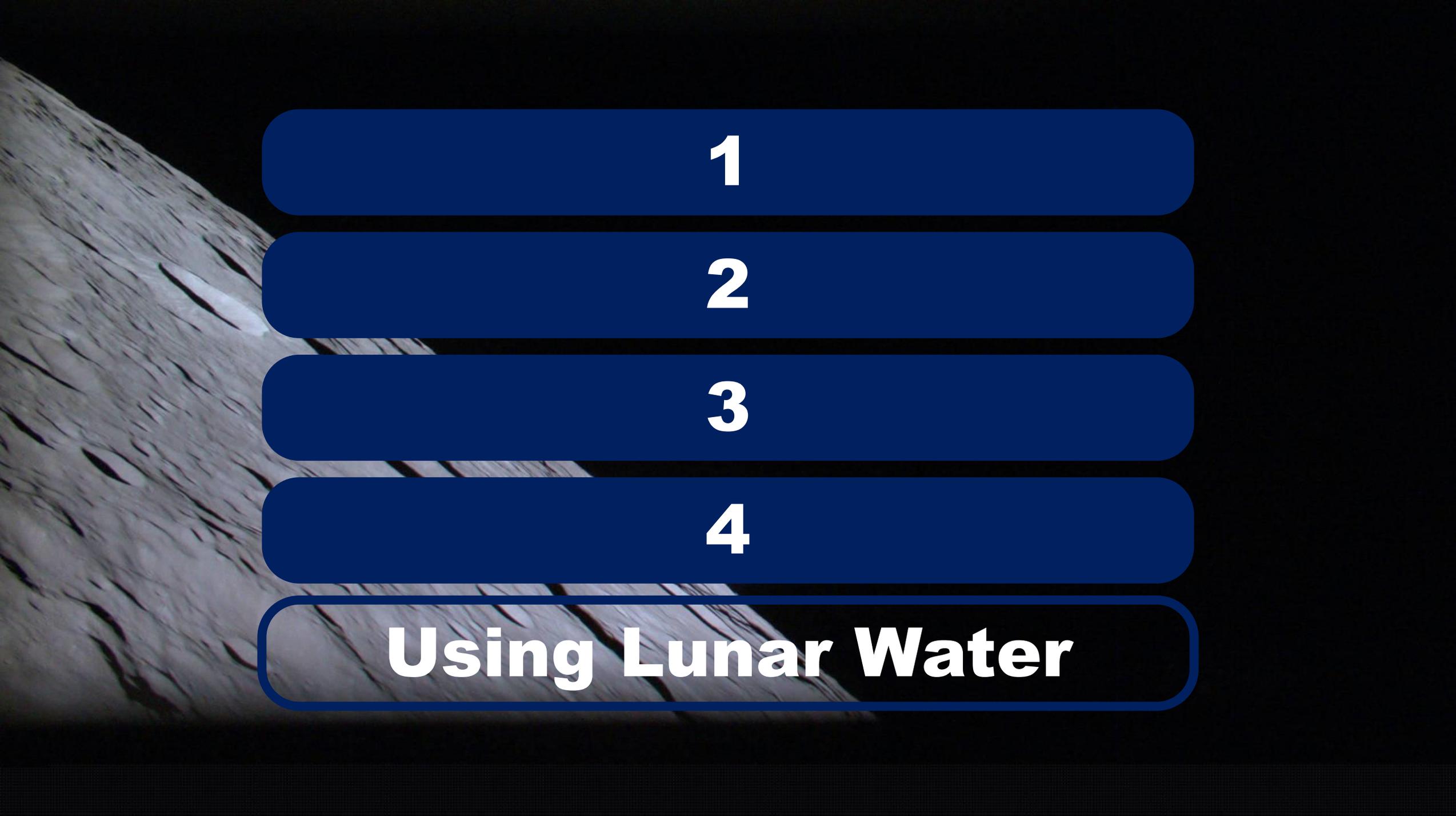
1

2

3

4

5

A close-up photograph of a tree trunk with a blue circular overlay containing a list of numbers. The tree trunk is on the left side of the image, showing its natural texture and grain. The blue overlay is on the right side, containing a list of numbers from 1 to 4, with the text 'Using Lunar Water' at the bottom.

1

2

3

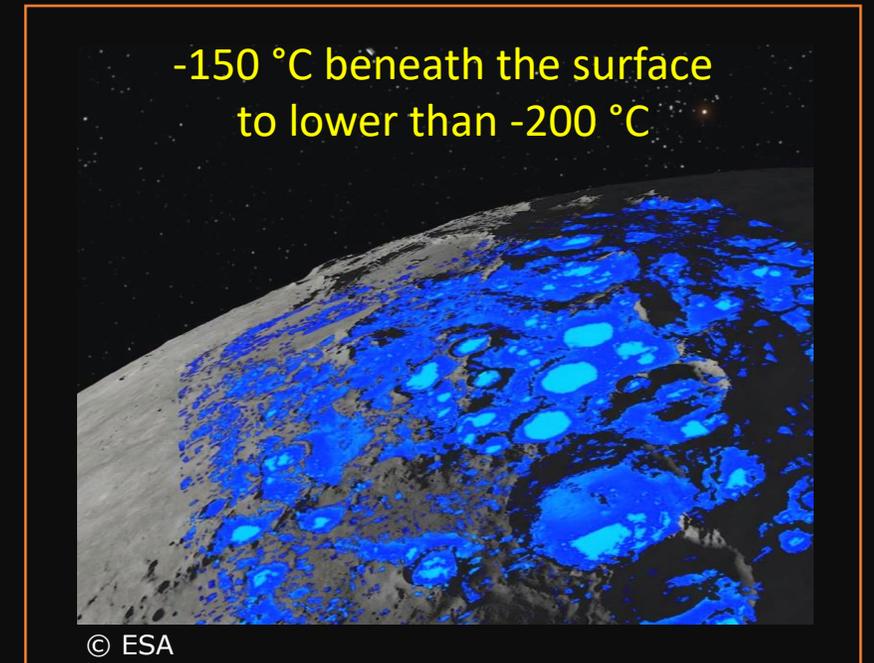
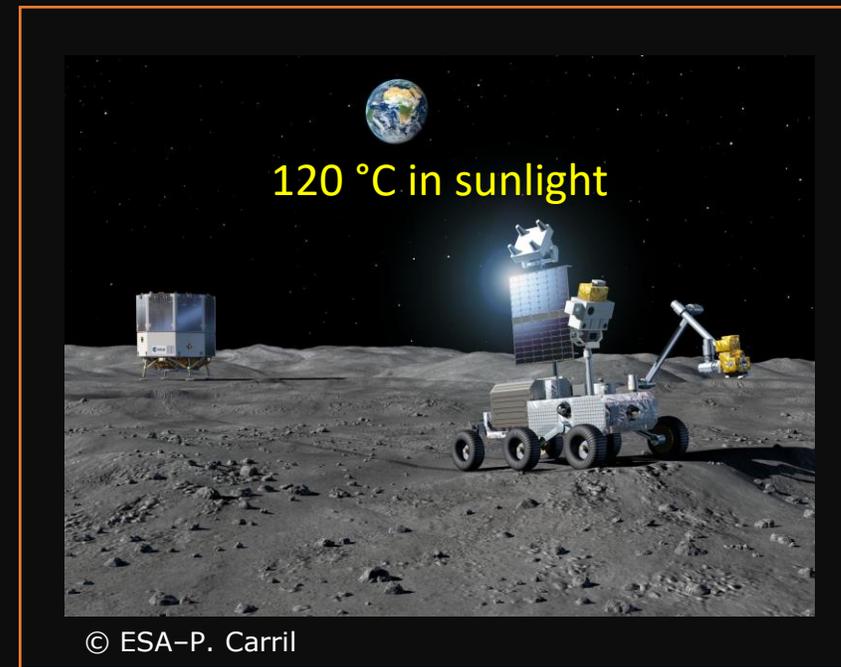
4

Using Lunar Water



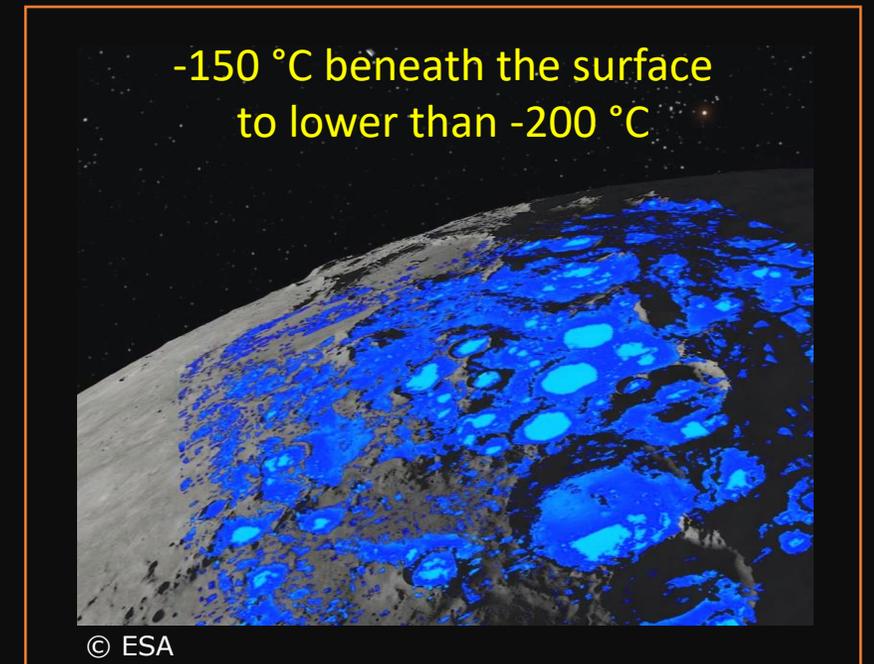
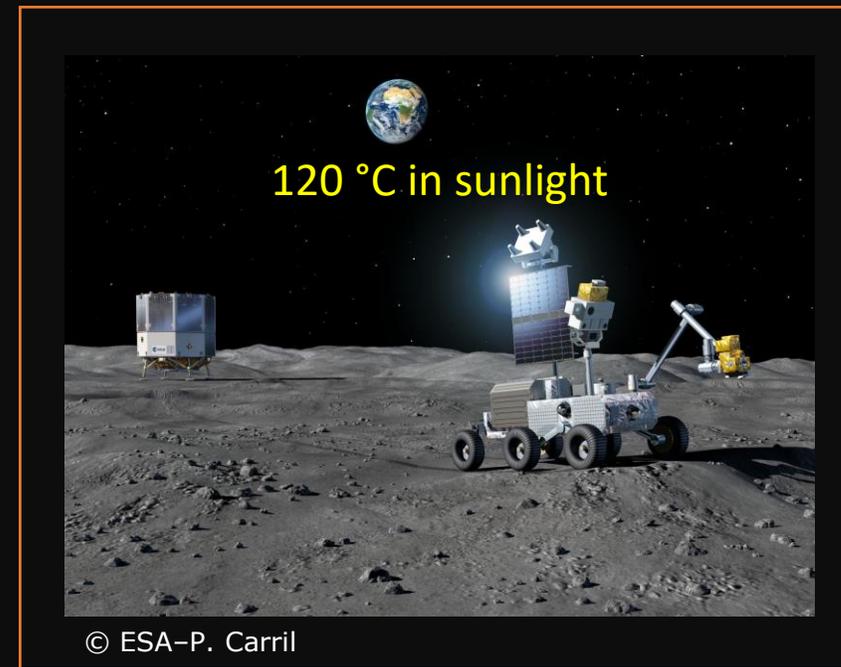
Lunar Water

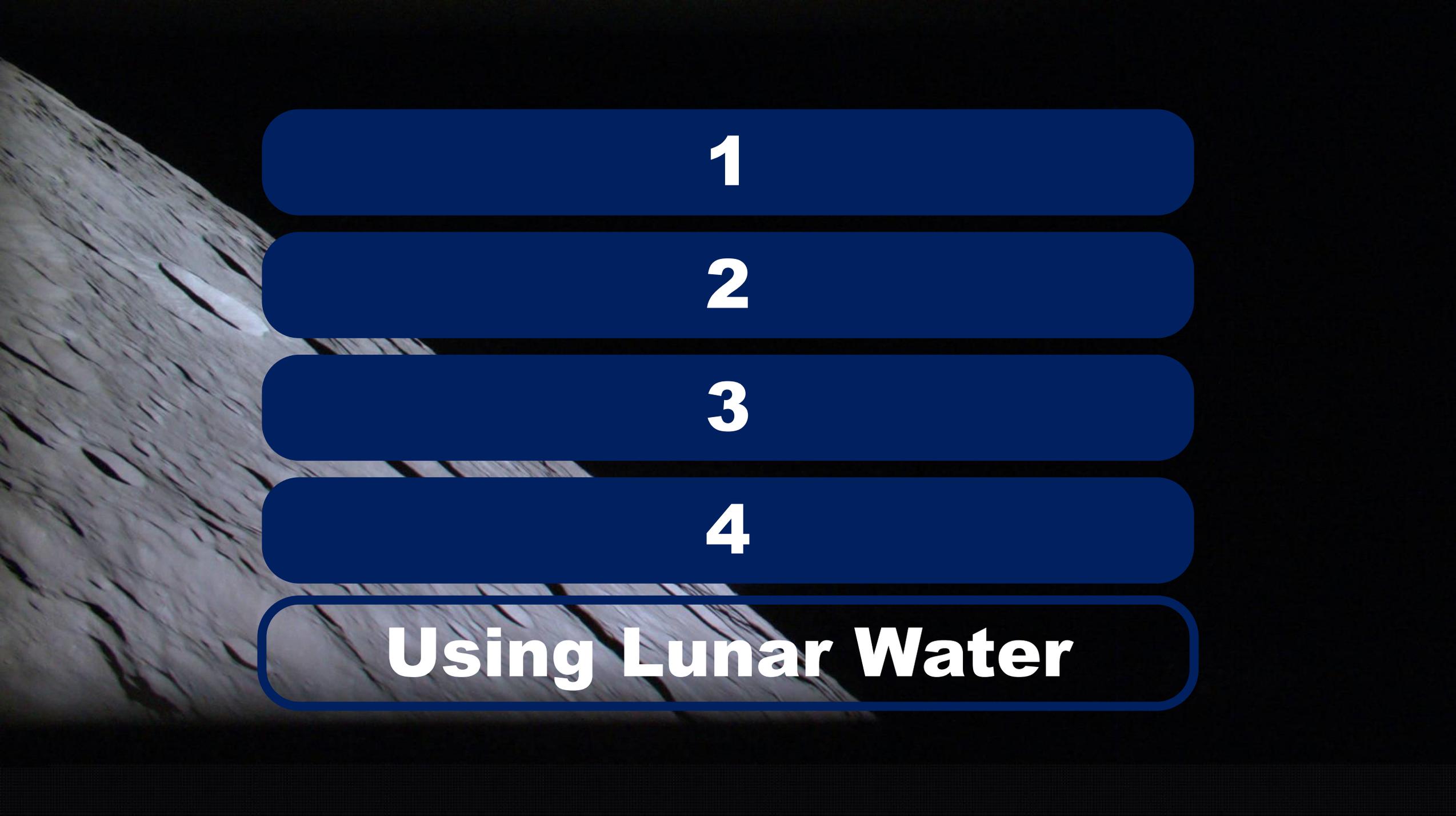
- Support sustained presence on moon and Mars
 - Drinking, growing crops
 - Life support and rocket fuel (Water, Hydrogen, Oxygen)
- Tasks of prospecting, extraction, storage, and distribution
- How much water at a location and what type of water (e.g., deuterium)
 - Lunar poles may hold hundreds of billions of kilograms of water ice
 - Permanently shadowed regions (PSRs)
 - Water in glassy beads from meteorite impacts
 - Micro cold traps



Lunar Water

- Hydrogen + iron-oxide -> water followed by electrolysis
- Microwaves + condensation plate
- Central processing plant or processing aboard rover
 - Energy plant: can also improve farming capabilities in harsh environments
- Small and light module
 - Drill, a vaporizer, and an analyzer
 - 60x30x30cm
 - 10kg or 15kg
 - Water map of the moon



A close-up photograph of a tree trunk with a blue circular overlay containing a list of numbers. The tree trunk is on the left side of the image, showing its natural texture and grain. The blue overlay is on the right side, containing a list of numbers from 1 to 4, with the text 'Using Lunar Water' at the bottom.

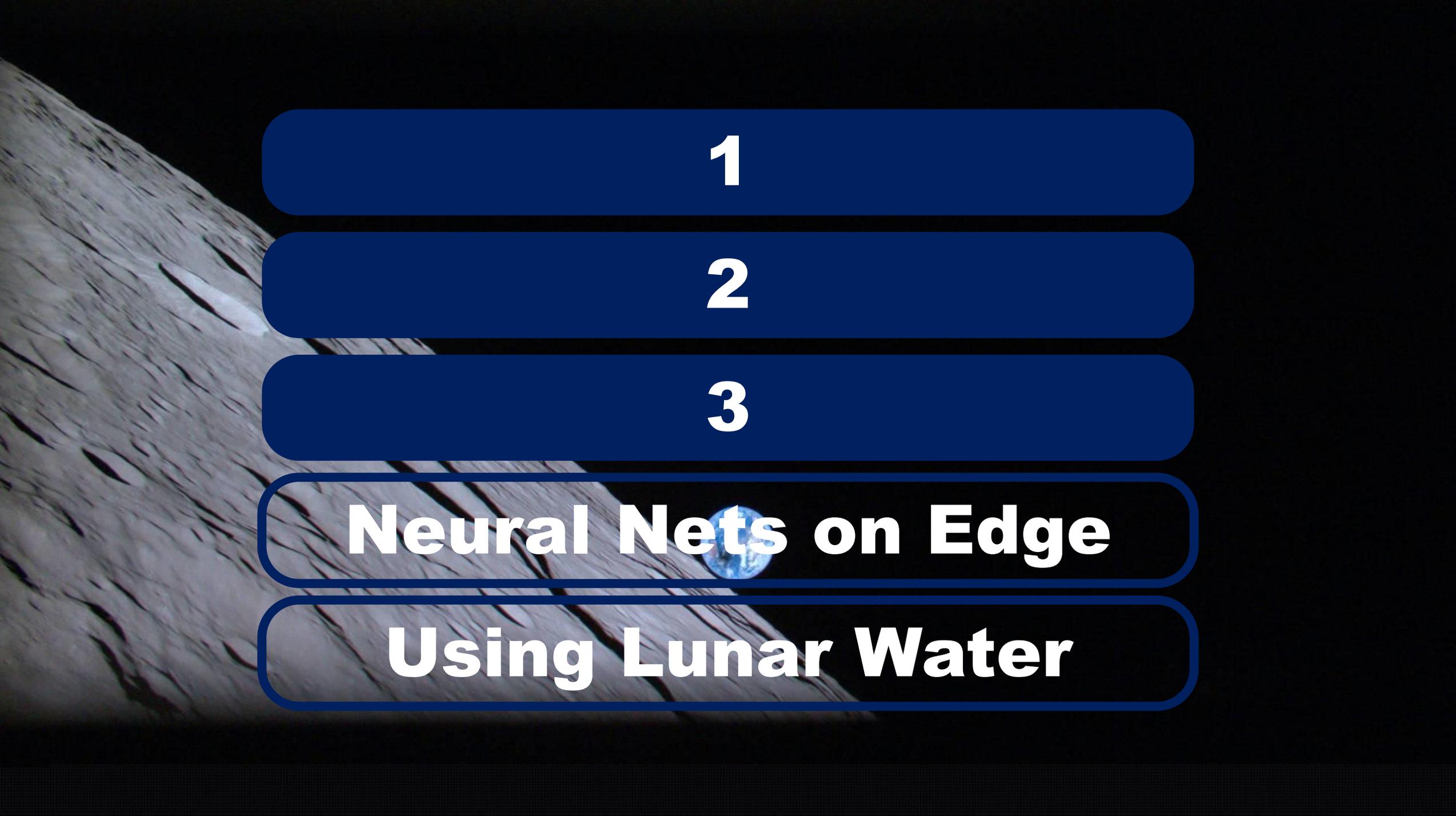
1

2

3

4

Using Lunar Water



1

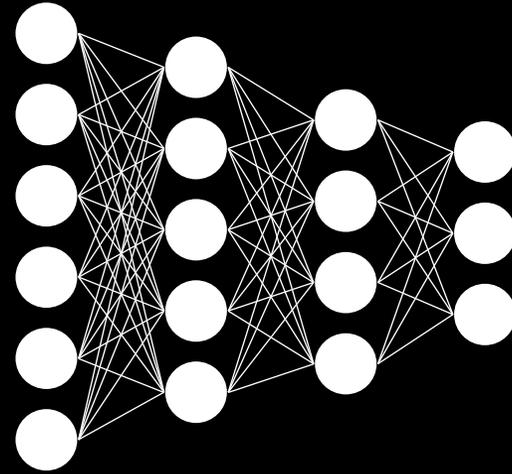
2

3

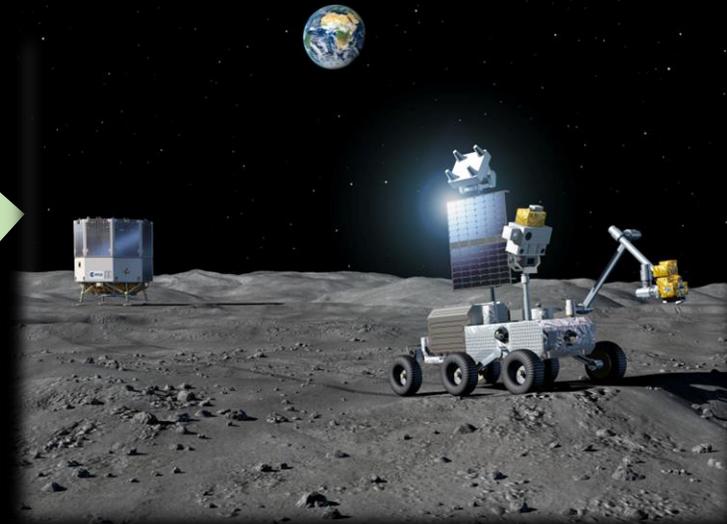
Neural Nets on Edge

Using Lunar Water

Compression of Deep Neural Networks on Edge Devices

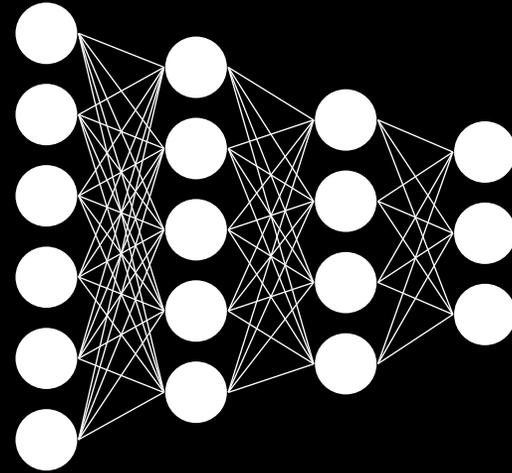


Large neural network



Onboard Device

Compression of Deep Neural Networks on Edge Devices

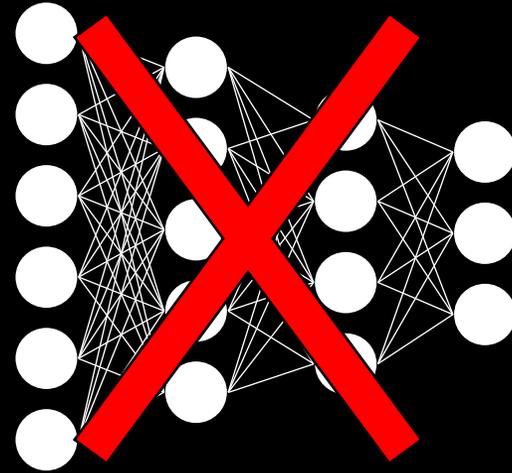


Large neural network



Edge Device

Compression of Deep Neural Networks on Edge Devices

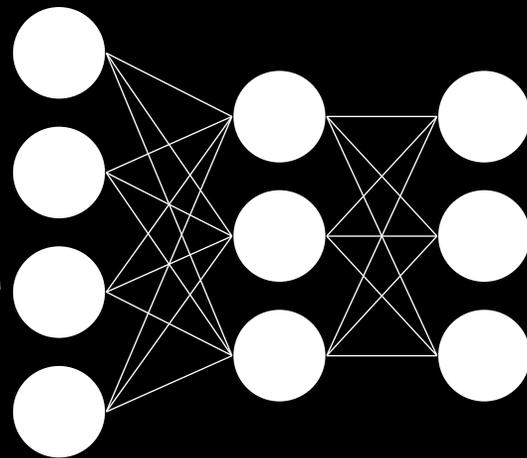


Large neural network



Edge Device

Compression of Deep Neural Networks on Edge Devices

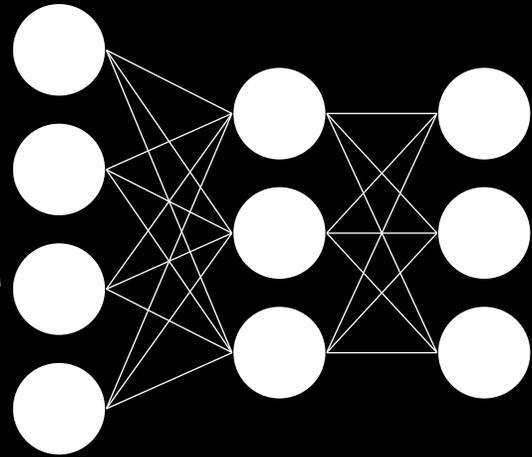


Small neural network



Edge Device

Compression of Deep Neural Networks on Edge Devices

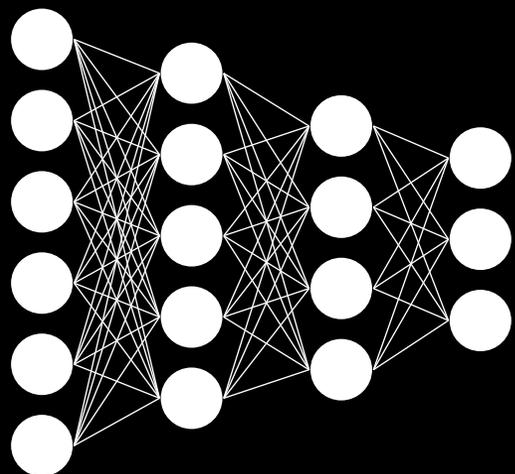


Small neural network



Edge Device

Compression of Deep Neural Networks on Edge Devices

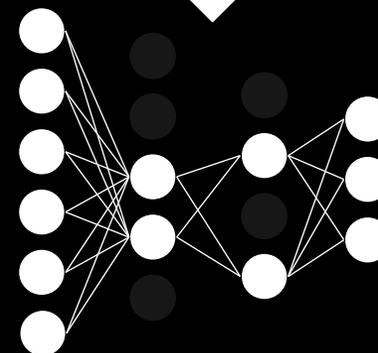
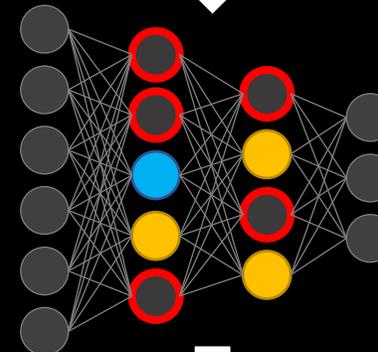
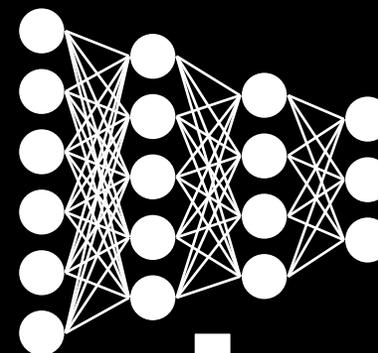


Large neural network

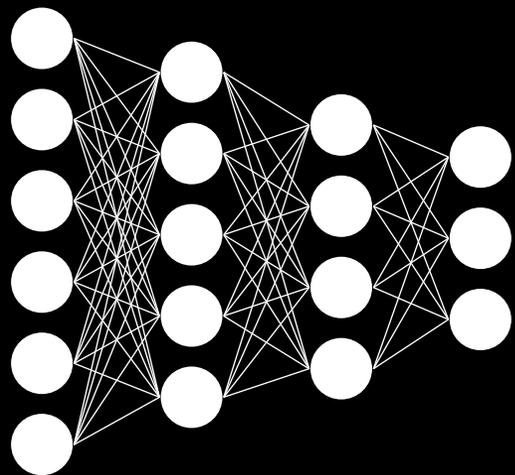


Edge Device

Pruning



Compression of Deep Neural Networks on Edge Devices

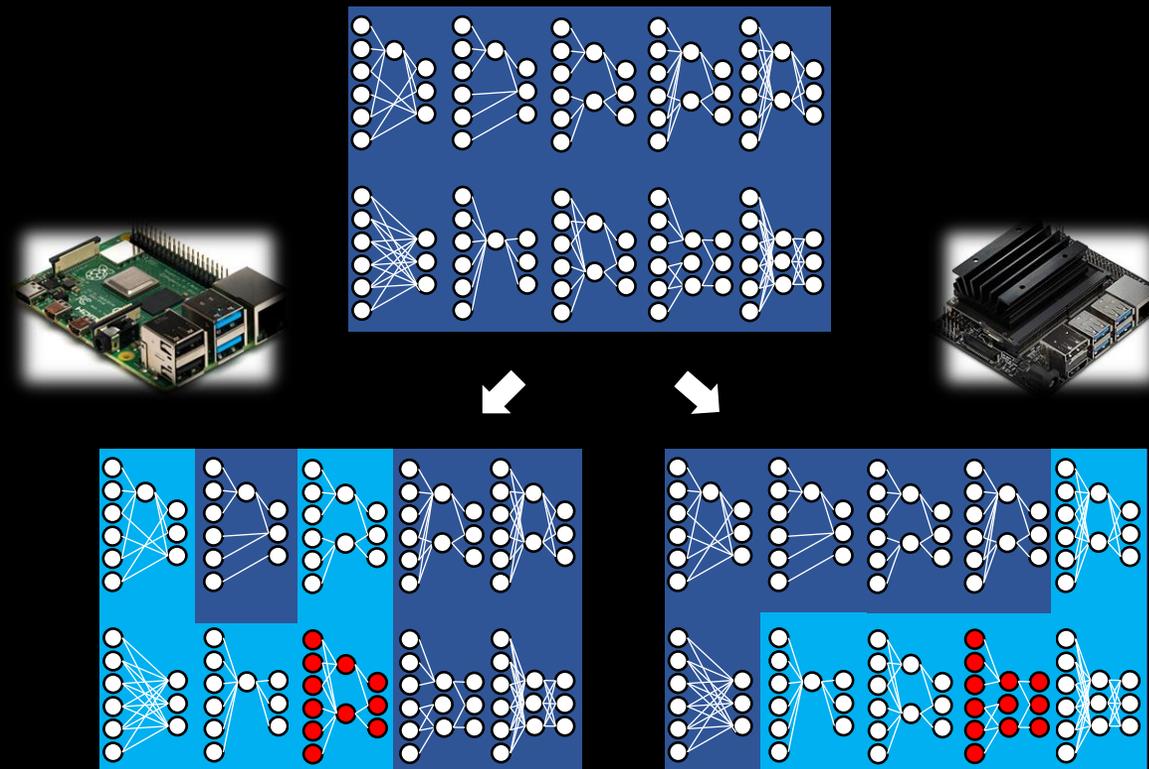


Large neural network

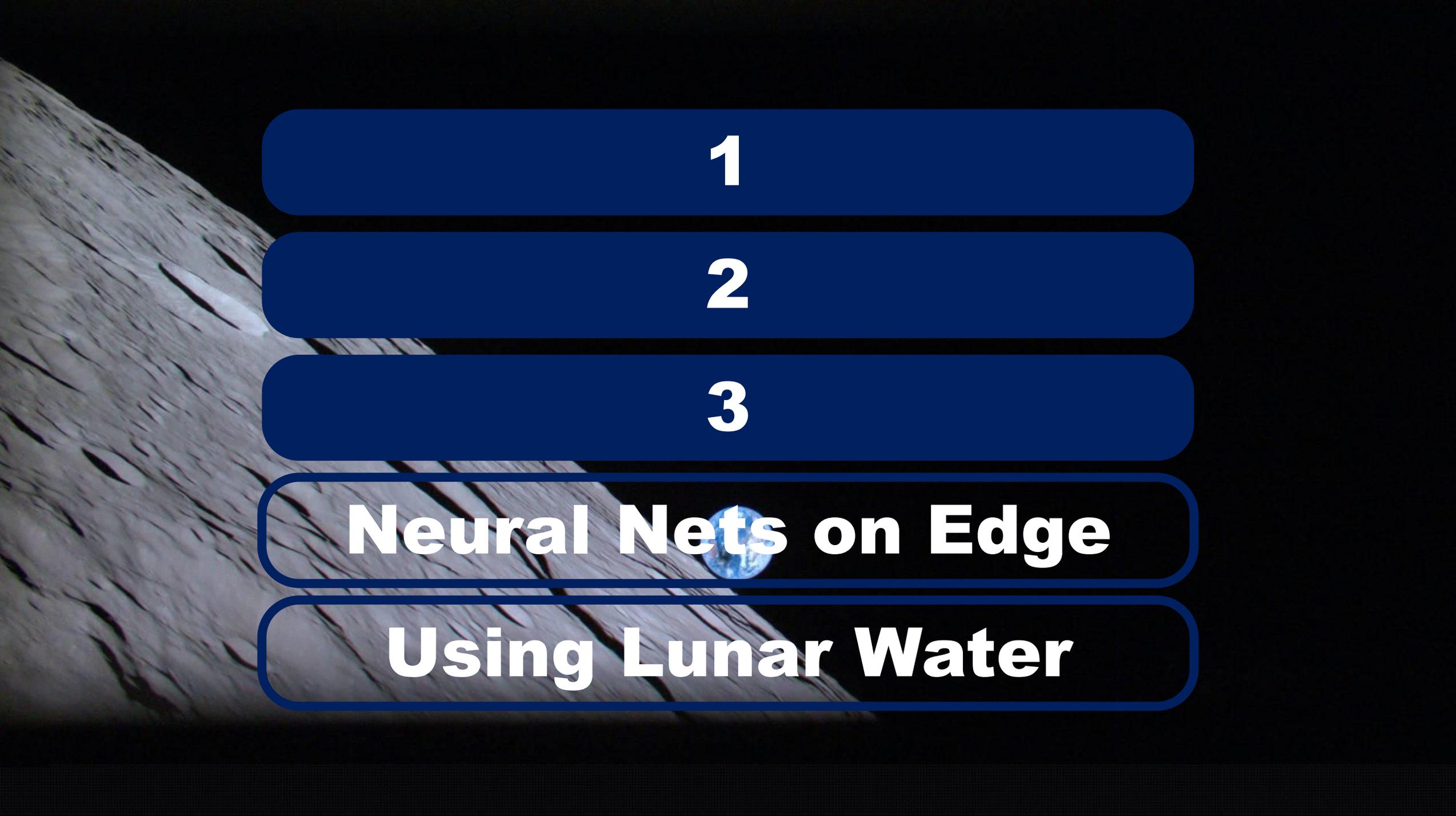


Edge Device

Neural Architecture Search (NAS)



- Best Architecture
- Whole Architecture Space
- Architecture Sub-Space



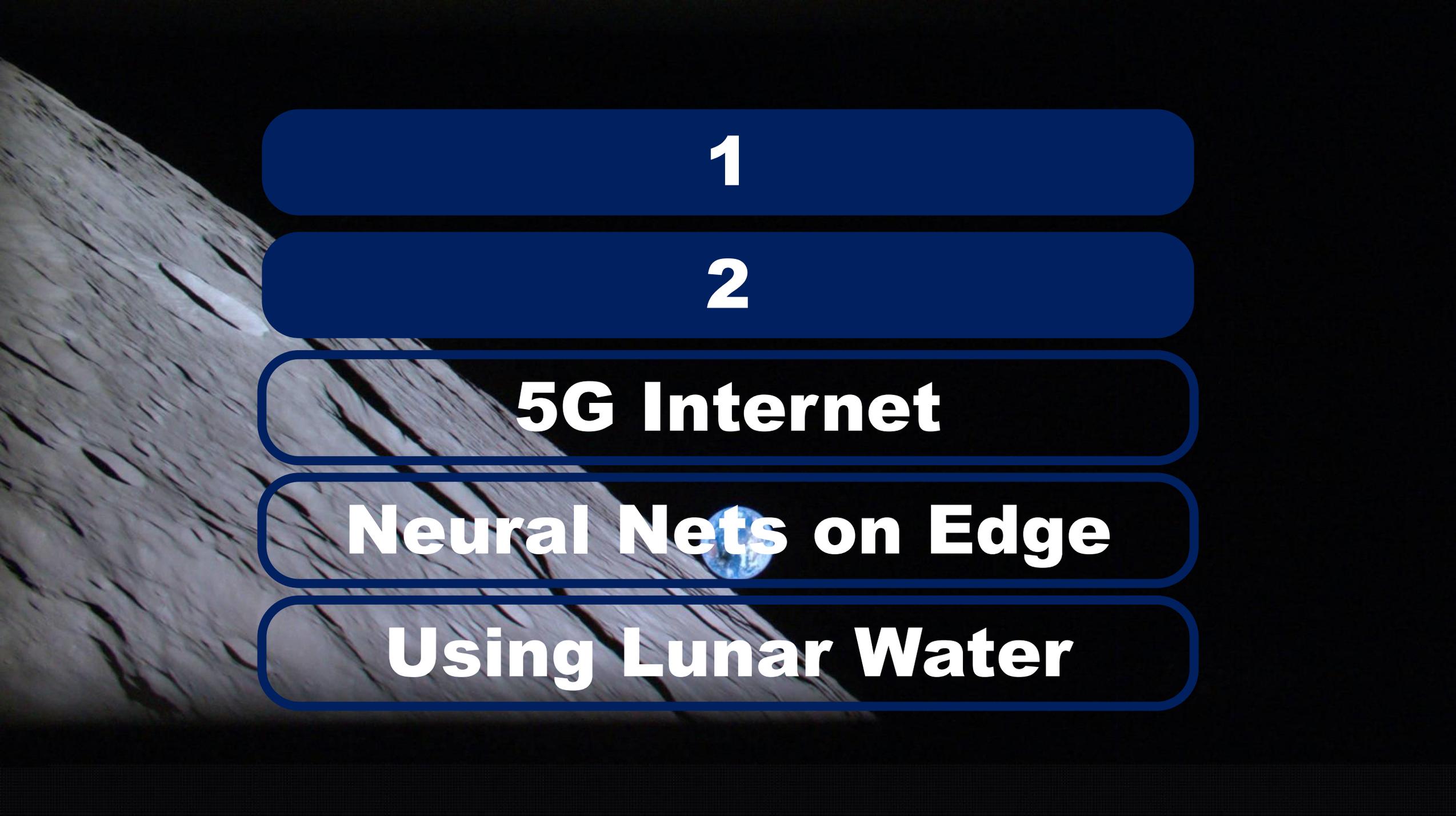
1

2

3

Neural Nets on Edge

Using Lunar Water



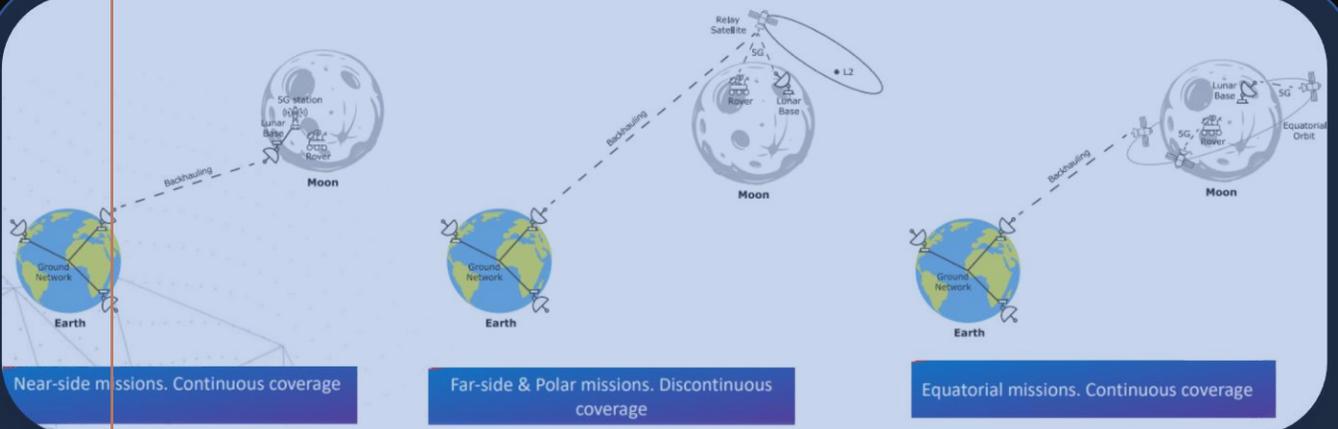
1

2

5G Internet

Neural Nets on Edge

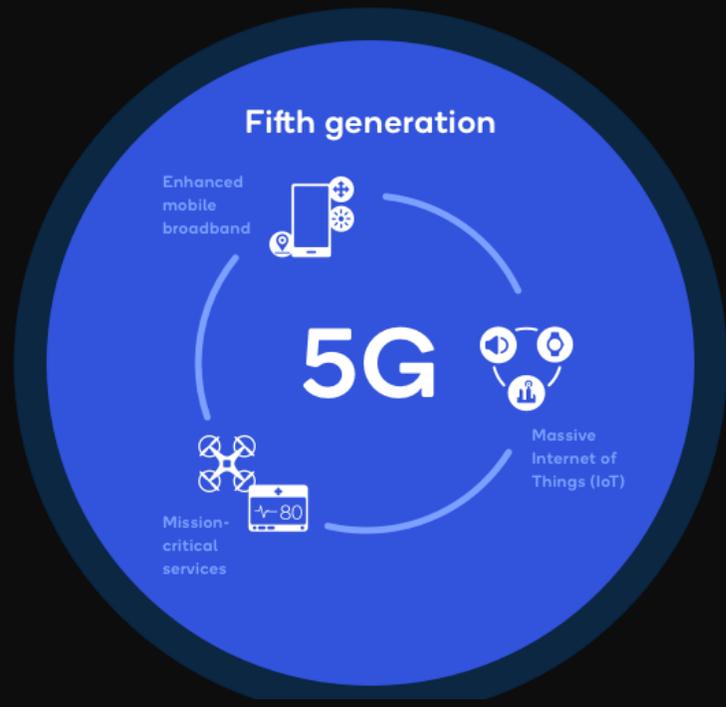
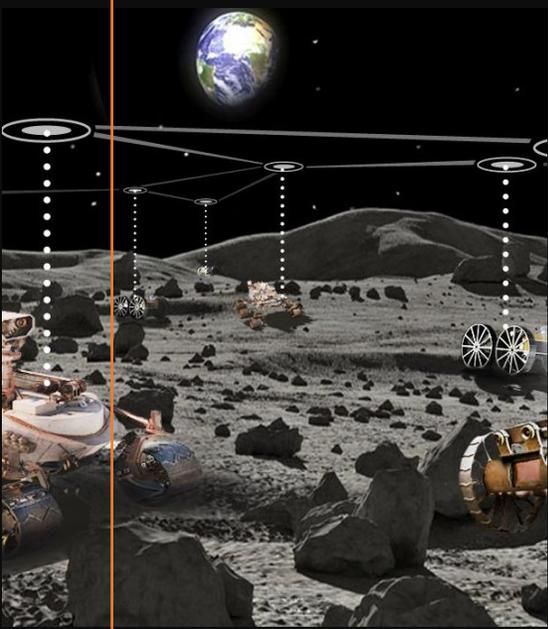
Using Lunar Water

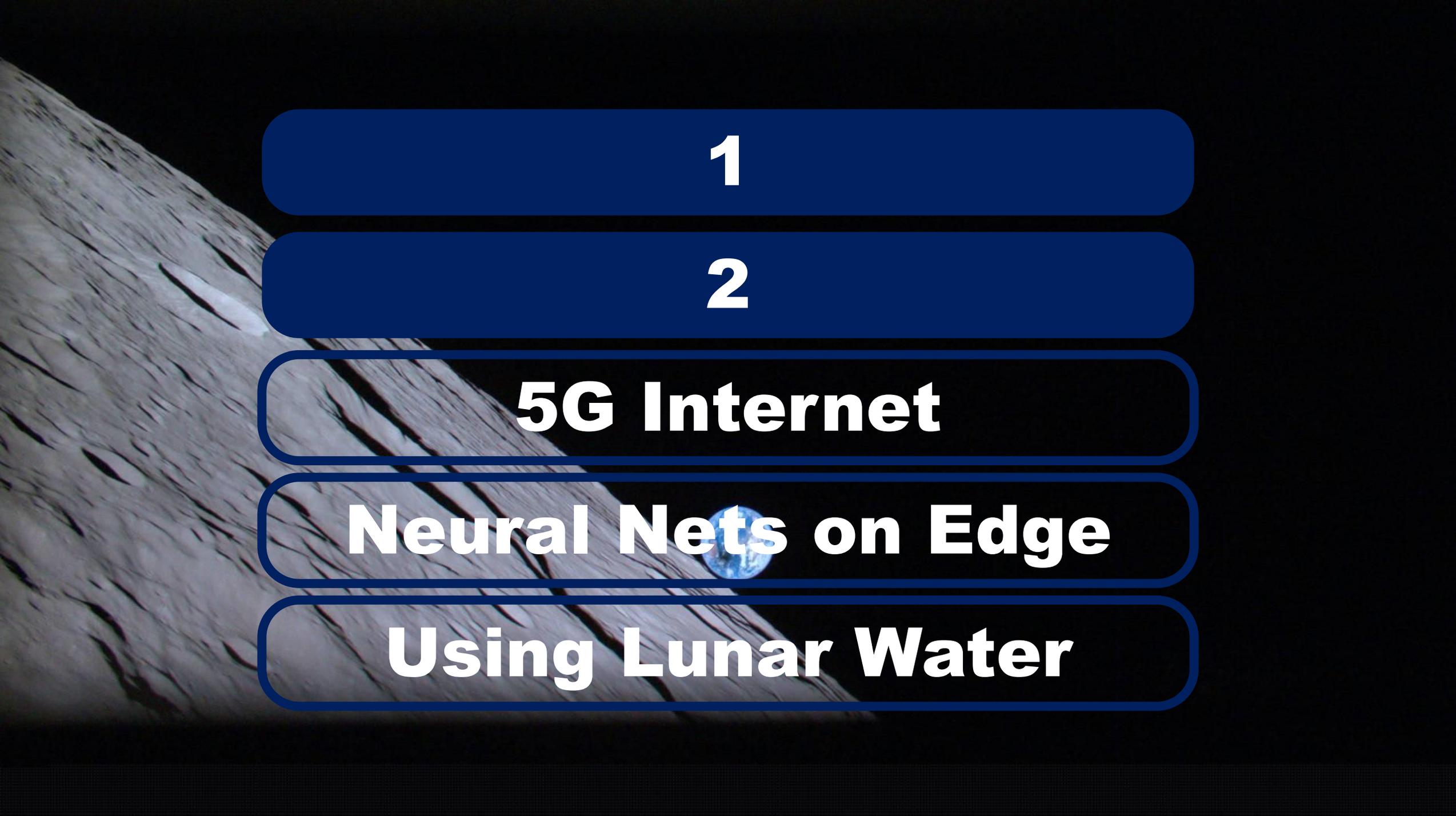


5G Connectivity



- 5G-like capabilities: fast connections, low latencies, and greater bandwidths
- Replace point-to-point with point-to-multipoint connections: crews, robots, and rovers
- Solve the same connectivity challenges on the Moon that we are solving with 5G on Earth
- Interoperability between different systems and devices on the Moon
- Scenarios
 - Direct communication between Earth and a lunar lander,
 - communications via a lunar relay satellite,
 - connectivity of a large number of rovers to a Moon-orbiting satellite constellation





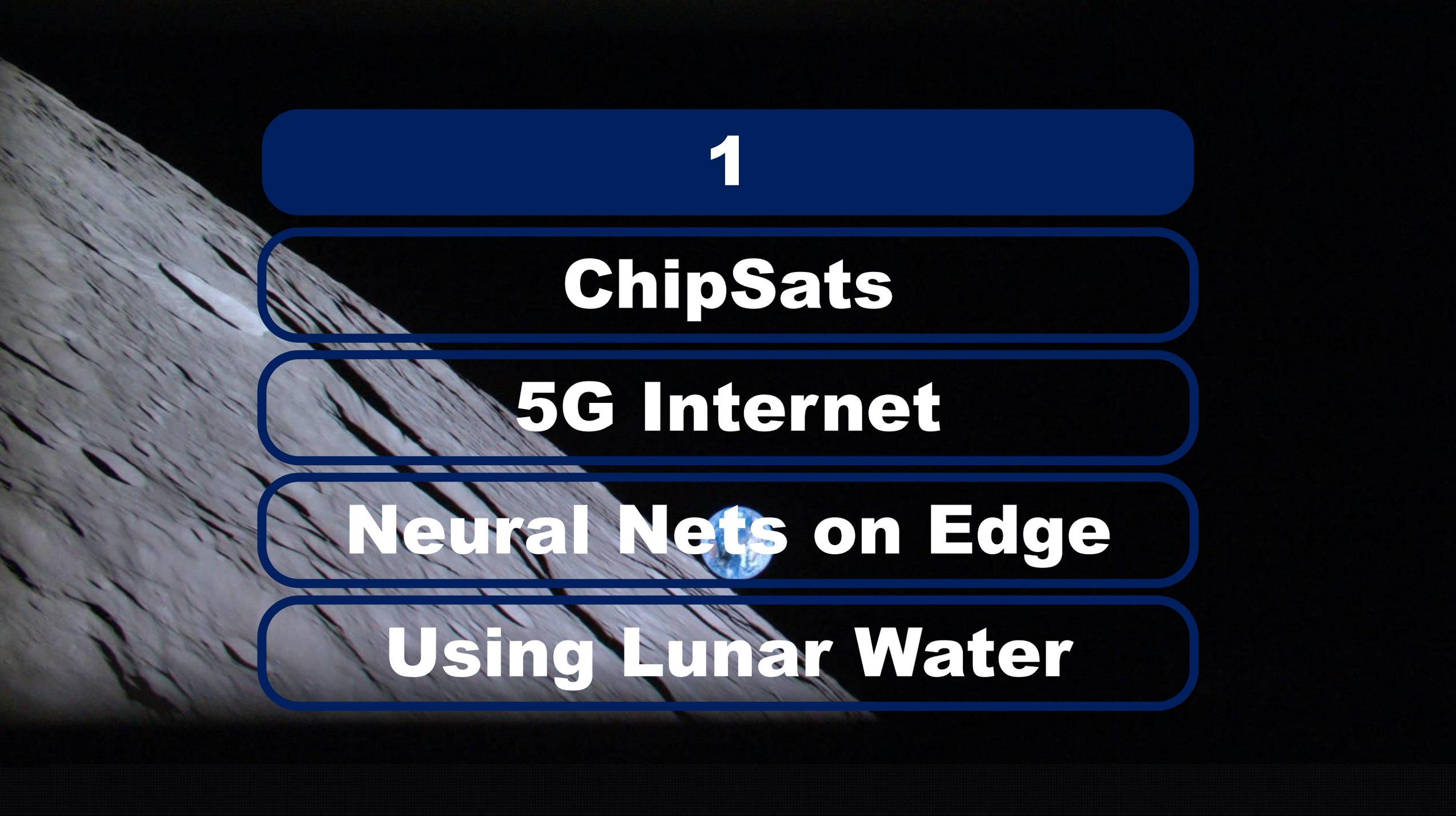
1

2

5G Internet

Neural Nets on Edge

Using Lunar Water



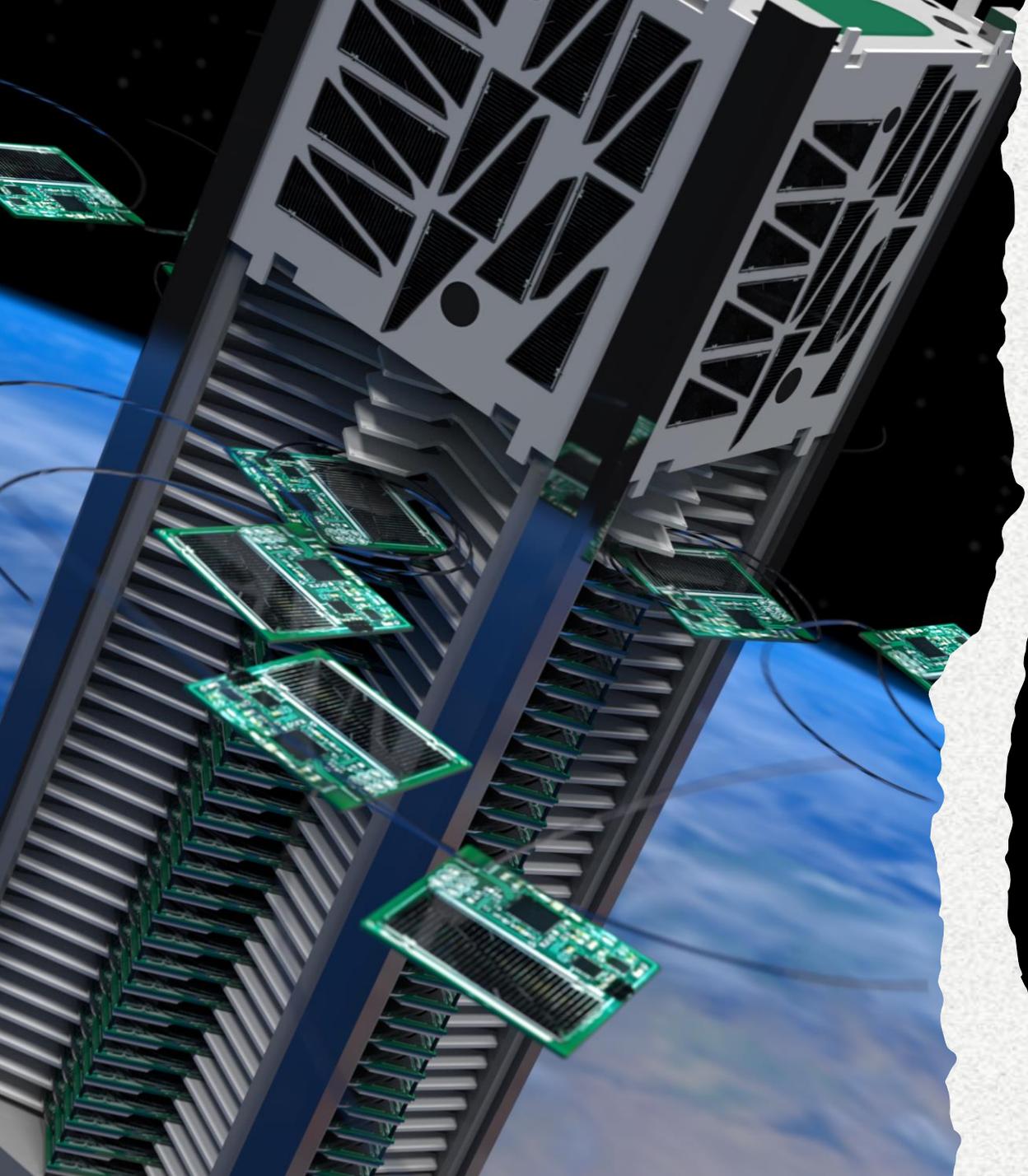
1

ChipSats

5G Internet

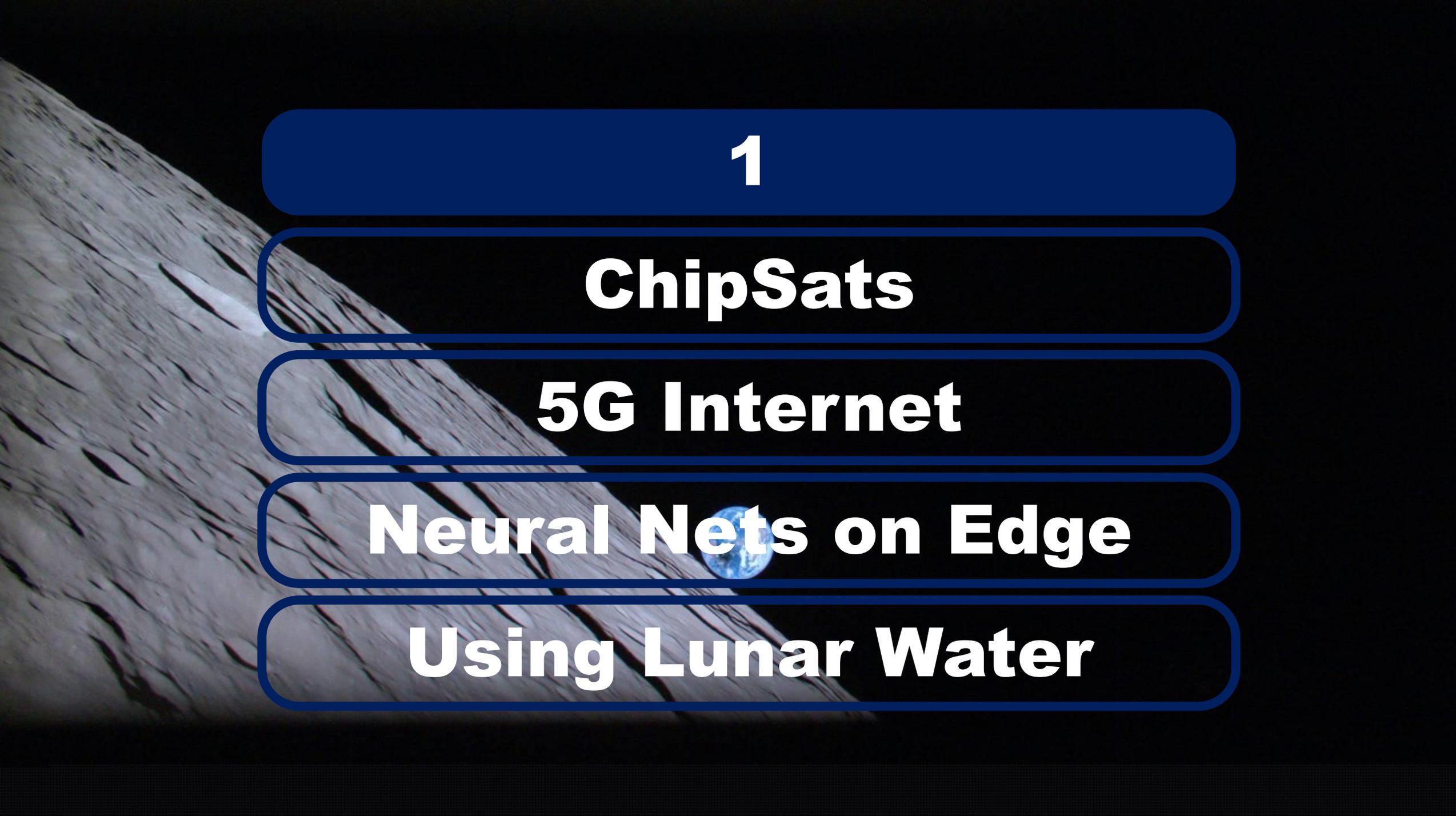
Neural Nets on Edge

Using Lunar Water



ChipSats

- Launched in large numbers (~ 100)
 - Size of credit card
- Rapidly prototype collaborative space systems
 - Swarms
 - Formations
- Quickly test new technologies in space
 - Scientific research
 - Communication
 - Exploration
- **In-space laser** sailing deeper in solar system
 - Photonic Propulsion



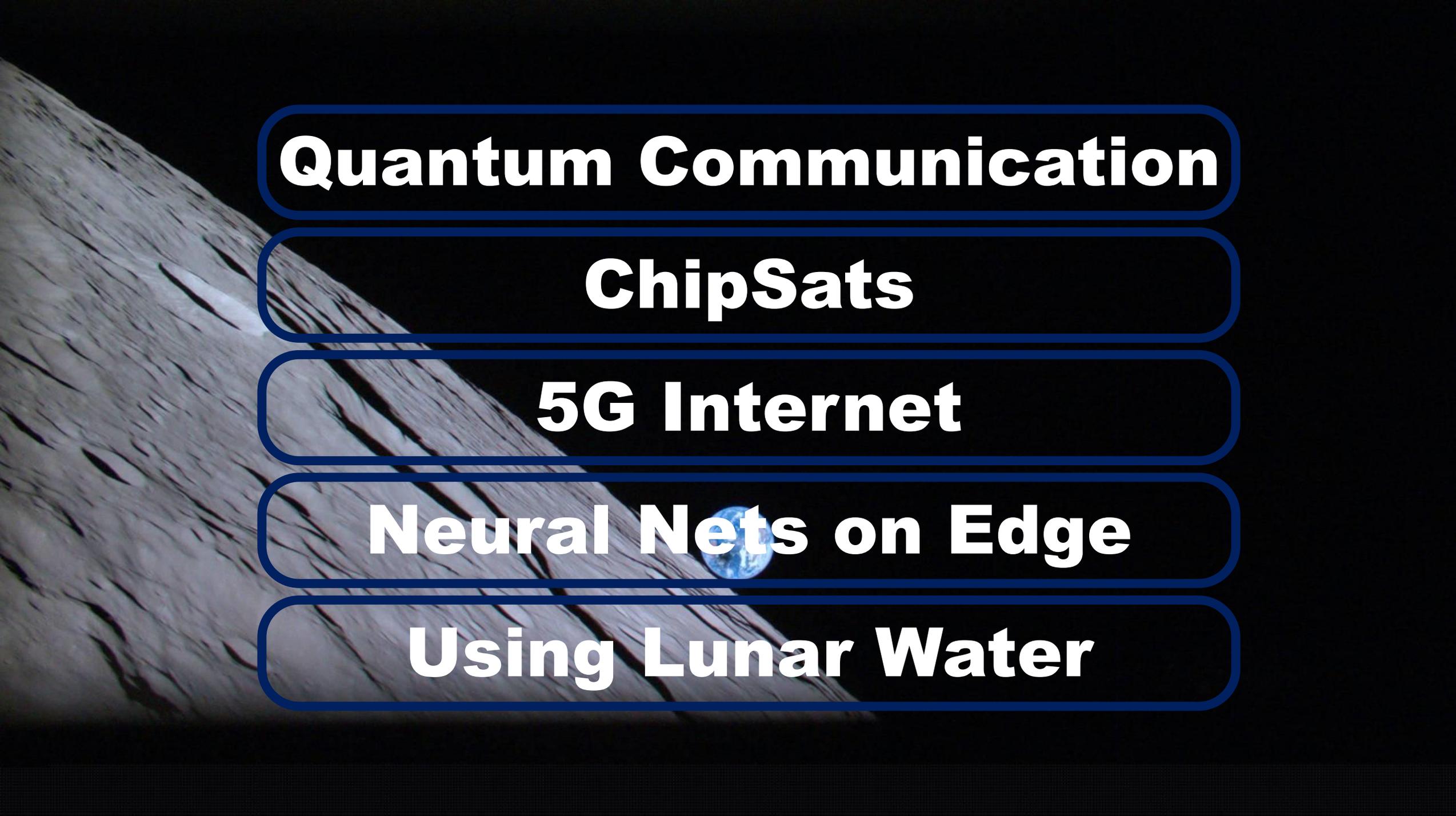
1

ChipSats

5G Internet

Neural Nets on Edge

Using Lunar Water



Quantum Communication

ChipSats

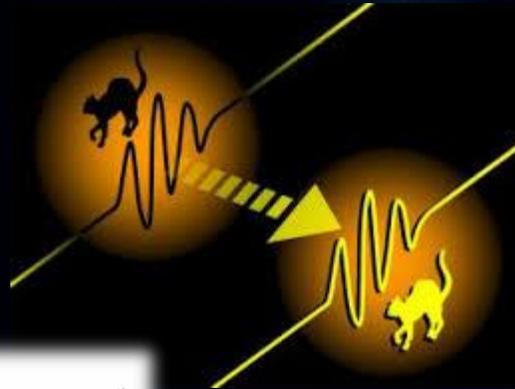
5G Internet

Neural Nets on Edge

Using Lunar Water

Quantum Communication

- binary bit -> quantum bit
- Superposition and Entanglement
 - Entanglement of qubits allows state of entangled particles to match, even over long distances
 - Qubits can't be copied with preservation of superposition -> attempt to intercept qubits is detected
 - Potentially extremely secure
- Earth-to-satellite, satellite-to-satellite
- Advanced optical systems for future quantum networks
 - Quantum memory
 - Frequency converters





Quantum Communication

- Quantum sensors more sensitive and higher resolution than classical sensors.
- Change detection in:
 - temperature,
 - radiation,
 - acceleration,
 - time,
 - electric or magnetic fields
- Lead to better:
 - navigation systems,
 - radar systems,
 - medical detection techniques
 - high-tech mechanical engineering,
 - semiconductor industries

Luxembourg SpaceBeer!

Public group · 240 members



A purple poster for Partnership Day. At the top left, it features the logos for 'i.li' and 'SNT'. The main text reads 'PARTNERSHIP DAY' in large white letters, followed by 'The Future is Here' in a smaller font. At the bottom, it says 'May 11'. The poster is decorated with various geometric shapes in shades of purple, teal, and white.

A poster for the Summer Space Festival. The top text reads 'WELCOME TO THE SUMMER SPACE FESTIVAL' in large, glowing white letters. Below this, it says 'MAY 5 & 6 2023' and 'NEIMËNSTER LUXEMBOURG'. The background shows a rocket on a launch pad against a dark sky with a horizon line.

A poster for Asteroid Day. The text 'ASTEROID DAY' is written in large, bold letters, with 'ASTEROID' in orange and 'DAY' in white. Below it, it says '30 JUNE'. The background features a view of Earth from space, with a grey asteroid in the foreground.

Upcoming Space Events



CVI²-SnT



Carl Shneider

Space 2. 

The New Investment Frontier

