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Introduction: Lunar exploration and human long term sustainment present many challenges identified by the LSIC community. One of these challenges is working in extreme environments and operational access to locations on the Moon. This abstract briefly introduces the context of navigation. Then, it discusses how certain technologies developed for Earth use can be the basis for the Lunar environment.

Extreme Access: How to enable humans and robotic systems to efficiently access, navigate, and explore various lunar surface and subsurface areas with minimal infrastructure?

The extreme Lunar environment offers challenges in positioning (PNT) and wayfinding for both people and robotic systems. The following elements impact positioning:

- No localisation infrastructure
- Lack of magnetic field
- Craters
- Volcanic features, lava tubes
- Areas of high and low (shadow) Illumination

Several projects are being designed for beacon-based navigation. Creating a specific Lunar GPS is a solution far down the line. The LuGRE project plans to use the GPS signals from earth-orbiting satellites for Lunar-based positioning. The ESA LCNS looks at a comprehensive system of satellites and beacons for PNT. Positioning based on radio antennas similar to cell phone positioning or relying on long-range beacons like LORA and Ultra Wide Band are also considered. The Moon has a nearby horizon which adds to the challenge.
Lidar is also being investigated as positioning technology. Part of the research is to understand the impact of dust on these sensors.
As these systems take shape, there will be a period of human and robotic presence preceding such positioning systems. However, even with such systems in place, positioning faces the same challenges as Earth GPS when moving in tunnels, in deep canyons or craters, etc.
In light of this, it makes operational sense to have a reliable, lightweight PNT solution that, in the short term, can operate autonomously and which can gradually add the features of GPS or beacon PNT capabilities in the mid to long term.

Earth Shyn: Shyn is a wearable Epic Blue solution for seamless positioning in GNSS and GNSS-denied environments. Shyn takes a novel Artificial Intelligence based-approach to positioning. Shyn exploits IMU (inertial measurement) data to ensure continuous positioning using a known location as a starting point. Shyn can also rely on beacons and GPS to determine starting points or intermediate reference points. https://vimeo.com/502116641

Lunar Shyn: Epic Blue proposes to exploit PNT technologies already developed and validated on Earth and apply them to the Lunar environment and missions. With this concept, the astronaut suit has a Shyn-like device embedded. As astronauts leave the base or other reference locations (e.g. the position of a rover), Shyn is given an initial position fix and starts tracking its wearer's movements. Shyn incorporates different movement models, including scope usage of ladders, ascents and descents, fall/impact detection and alerting. In a pre-Lunar GNSS stage, positioning and heading are based on Shyn inertial and any signals from prepositioned beacons. As more initiatives for Lunar GNSS come to fruition, Shyn evolves to a recipient of those signals, effectively becoming an advanced 'GNSS tracker', similar to its role on Earth. Several use cases can be covered with this concept:

Use Case 1 - Lunar Caves & Tunnels
Use Case 2 - Astronaut Operations
Use Case 3 - Human-Machine Collaboration
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Earth to Lunar: Transposing the technology from Earth application to the Lunar environment requires a stepwise experimental and validation multi-layered approach. Next to roadmap evolutions the following are key experiments to have:

- Device Environmental Suitability
- Device Component Suitability
- AI Model Suitability