

What GPS really costs and implications for the development of a lunar satellite navigation system.
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Introduction: There is significant worldwide interest in developing a satellite navigation system for the Moon [1]. The European Space Agency Moonlight initiative has proposed creating a partial lunar satellite navigation system starting in 2025, with a full system slated to be operational by 2035. In September 2021, NASA published a draft of its LunaNet Interoperability Standards, designed to ensure that satellite navigation signals from different commercial providers are interoperable.

Both of these initiatives face a daunting fact - building and maintaining a satellite navigation systems is expensive. How expensive? For fiscal year 2022 the United States of America's Presidential budget requested 1.8 billion United States Dollars (USD) for the Department of Defense Global Positioning System (GPS) program [2].

Methods/Discussion: Given the unlikelihood that any government agency will invest a similar amount in a lunar navigation system, what tradeoffs will be necessary? To answer this question, we will discuss what the USD 1.8 billion funds in the GPS system. We will examine options for reducing some of those costs via less expensive technologies (particularly clocks and smallsats), and minimizing the ground control segment that is often overlooked in discussions of satellite navigation system costs. We will conclude by outlining the tradeoffs between cost, reliability, availability, accuracy, and time to first navigation solution that changes to the existing model will likely entail. This will give prospective lunar explorers an idea of how a lunar satellite navigation system may differ from GPS, and how this will impact lunar surface operations.

References: [1] Schönfeldt M. et al. (2020) "Across the Lunar Landscape – Exploration with GNSS Technology." Inside GNSS, 02 October 2020, <https://insidegnss.com/across-the-lunar-landscape-exploration-with-gnss-technology/>. [2] National Coordination Office for Space-Based Positioning, Navigation, and Timing (2022) "Fiscal Year 2022 Program Funding." GPS.gov, 02 March 2022, <https://www.gps.gov/policy/funding/2022/#dod-approps>.