
# U.S. Policy on Celestial Time Standardization

June 26, 2024

International Committee on GNSS Intercessional

Vienna, Austria

Presented by: Cheryl Gramling, NASA

# Topic

The US Executive Office of the President, Office of Science and Technology Policy (OSTP) released a Policy on Celestial Time Standardization, in April 2024.

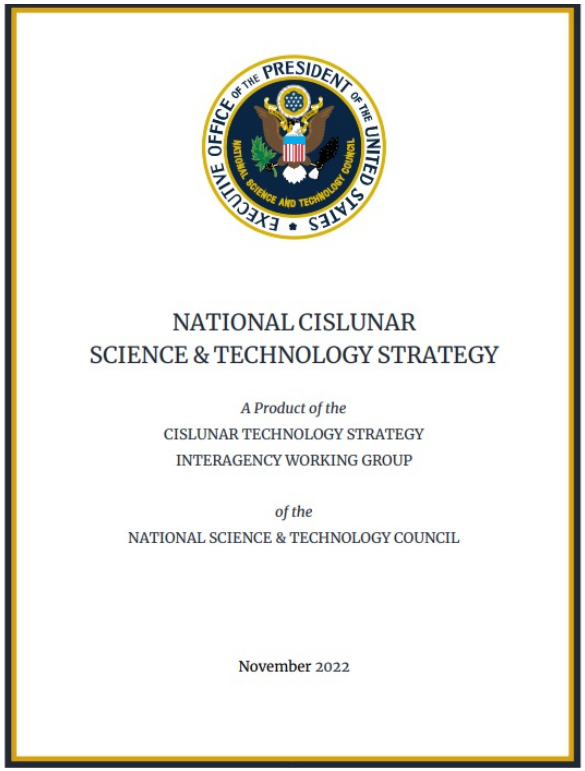
This presentation gives an overview of that policy.

# Context for OSTP's Memo on Celestial Time (1/2)

The U.S. National Cislunar Strategy, as defined by the White House Office of Science and Technology Policy (OSTP) in November 2022, identified Objective 4:

> *Implement cislunar communications and position, navigation, and timing capabilities with scalable and interoperable approaches.*

NASA assigned to lead this objective.



NATIONAL CISLUNAR
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*A Product of the*
CISLUNAR TECHNOLOGY STRATEGY
INTERAGENCY WORKING GROUP

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NATIONAL SCIENCE & TECHNOLOGY COUNCIL

November 2022

# Context for OSTP's Memo on Celestial Time (2/2)

**Standardized time is necessary to achieve Objective 4:**

**Relativity couples time with gravity fields and relative velocities; clocks "tick" at different rates depending on where they are located and how quickly they are moving.**

**Knowledge of time in distant operating regimes is fundamental to scientific discovery, economic development, and international collaboration.**

**Time standardization is a necessary foundation to enable interoperability across international partners for safe navigation.**

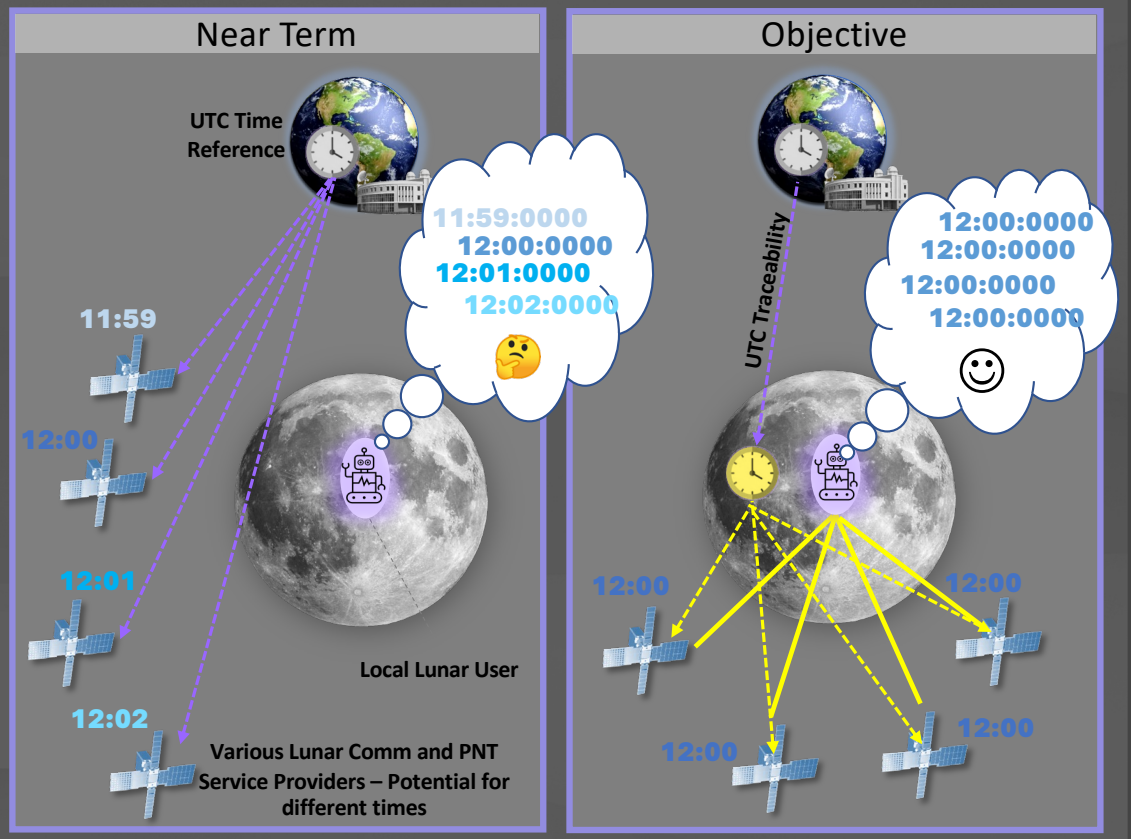
**Lunar science and in-situ operational applications therefore require an associated in-situ realization of a lunar time scale.**

**Establishment of in-situ clock suite and distribution of Coordinated Lunar Time (LTC), traceable to UTC, necessary to meet long term needs.**

***International agreements necessary to define the approach for realizing LTC.***

# Coordinated Lunar Time as Proposed by OSTP in April 2024

- Define a new time scale reference: Coordinated Lunar Time (LTC) – that is directly traceable to UTC;
- Create LTC based on the SI second as measured at the Moon that is the same for all lunar users;
- Provide users in cislunar space a time standard defined in the same gravity environment in which they are operating;
- Enables assets to synchronize with an accuracy to support precision PNT and science;
- Just as Terrestrial Time is realized through an ensemble of atomic clocks on Earth for UTC, an ensemble of clocks on the Moon could realize LTC for Lunar Time.

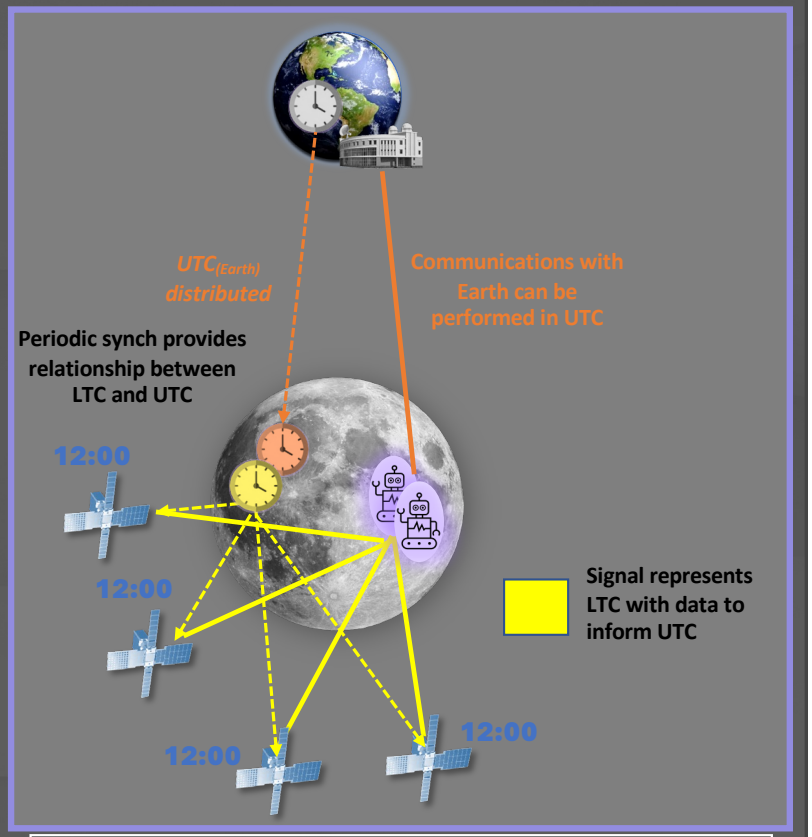



Lunar time synchronized relative to lunar users facilitates safety of navigation and precision science

# The Four Features for an LTC

## Any Lunar Time Standard must have:

1. **Traceability** to Coordinated Universal Time (UTC)
2. **Accuracy** sufficient to support precision navigation and science;
3. **Resilience** to loss of contact with Earth;
4. **Scalability** to space environments beyond the Earth-Moon system



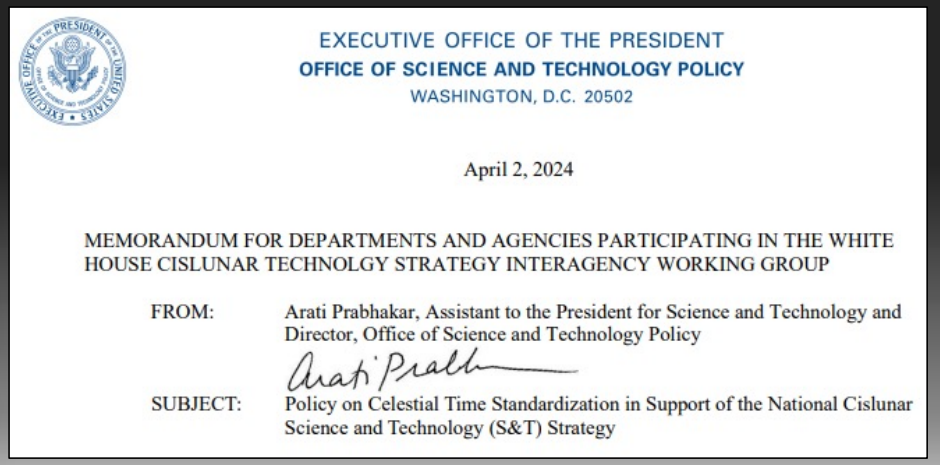

Periodic correlation with Earth allows relationship to UTC (e.g. for Earth comms)

# OSTP Policy Guidance for LTC Development

**“Coordinated Lunar Time (LTC) will act as the established standard to enable Cislunar operations and maintain traceability to UTC.”**

**“NASA, in coordination with the Departments of Commerce, Defense, State, and Transportation, will study, define, and implement a Coordinated Lunar Time (LTC) to support the gradual establishment of lunar infrastructure.”**

- NASA, with support from partnering departments and agencies, will establish the approach to LTC as the international standard *through existing standards bodies*.
- NASA will consider LTC as part of its annual Moon-to-Mars Architecture Concept Review cycle no later than December 31, 2024.
- NASA will provide a finalized strategy to the Executive Office of the President to implement lunar timing standardization no later than December 31, 2026.



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

April 2, 2024

MEMORANDUM FOR DEPARTMENTS AND AGENCIES PARTICIPATING IN THE WHITE HOUSE CISLUNAR TECHNOLGY STRATEGY INTERAGENCY WORKING GROUP

FROM: Arati Prabhakar, Assistant to the President for Science and Technology and Director, Office of Science and Technology Policy

SUBJECT: Policy on Celestial Time Standardization in Support of the National Cislunar Science and Technology (S&T) Strategy

https://www.whitehouse.gov/wp-content/uploads/2024/04/Celestial-Time-Standardization-Policy.pdf


Questions?

# Lunar Time

**Following the GNSS paradigm, lunar PNT services based on Radio Navigation can offer a means to distribute time.**

**Considerations:**

- what accuracy is required for navigation and science precision;
- which geoid should the time scale represent;
- are there aspects to be defined by convention;
- how to evaluate time from the PNT service;
- how to ensure the ability to refer a lunar time scale to UTC;
- ease to achieve consistency among community.

**Understanding of multi-body relativistic effects**

Primary secular drift is ~58.7 microseconds/day from Earth Geocentric Coordinate Time (TCG) to Lunar Coordinate Time (TCL);

Periodic terms introduce additional variability.