NASA STTR 2020 Phase I Solicitation

T11.03  Distributed Digital Ledger for Aerospace Applications

Lead Center: MSFC

Participating Center(s): ARC, GSFC, LaRC

Technology Area: TA11 Modeling, Simulation, Information Technology and Processing

Scope Description
A Blockchain is a decentralized, online record keeping system, or ledger, maintained by a network of computers that verify and record transactions using established cryptographic techniques. A Blockchain is a data structure that makes it possible to create a consistent, digital ledger of data and share it among a network of independent parties. Blockchain distributed ledger technology may become a key enabler of digital transformation, enabling peer to peer transactions without requiring intermediaries or pre-established trust.

Blockchain was originally developed to support digital currency transactions. Now, application of Blockchain is being explored for other financial services, software security, Internet of Things, parts tracking (supply chain), asset management, smart contracts, identify verification, and much more. NASA is seeking innovative solutions involving Blockchain that would greatly enhance operational efficiency by providing a single, immutable "source of truth", viewable by all authorized parties, and usable by automated reporting and verification systems, for the following two NASA-specific challenges.

Model Based System Engineering (MBSE): A significant challenge in MBSE is knowing that the system model being used is the current (or needed) version, since various aspects evolve through the system development and operations lifecycle. Therefore, because systems are becoming increasingly complex, tracking the vast number of changes that occur needs to be automated and efficient. Blockchain solutions may enable a single, real-time source of truth for system models, to eliminate several sources of error and inefficiency in MBSE.

Distributed space mission management: To accomplish complex space mission and Earth observation objectives, constellations of distributed satellites are often the most cost-effective approach. These constellations share key consolidated resources such as ground stations, a space network, communication networks, onboard processes, etc. A blockchain solution to managing distributed space missions should enable collaboration in a partially trusted environment and increase responsiveness, reliability, and availability of spacecraft and ground resources. The management functions enhance flexibility (e.g., reduce overhead for components to join and leave constellations), and enhance automation (e.g., automate resource outage alerts, facilitate localized replanning, enable a constellation level model-based diagnostics). To accomplish this, proposed solutions must overcome the slow transaction rate, large file sizes, and concurrency issues of some blockchain implementations.

References
Mandl; "Bitcoin, Blockchains and Efficient Distributed Spacecraft Mission Control"

Expected TRL or TRL range at completion of the project: 3 to 5

Desired Deliverables of Phase II

Prototype, Analysis, Research

Description

The desired deliverable is a prototype system that demonstrates a scalable, Blockchain-based solution to one of the NASA challenges described.

State of the Art and Critical Gaps

Almost all successful Blockchain solutions to date are for ledgers for digital currency transactions. Use of Blockchain is being explored in a broad range of areas, but there are no known scalable solutions for the NASA challenges described. Here, scalable means that the solution works efficiently and securely for a large number of transactions and users in a relevant, distributed digital environment.

Relevance / Science Traceability

Blockchain solutions can benefit all NASA Mission Directorates and functional organizations. NASA activities could be dramatically more efficient and lower risk through Blockchain support of more automated creation, execution, and completion verification of important agreements, such as international, supply chain, or data use.