# Phase I Project Summary

**Firm: Intelligent Automation, Inc.**
**Contract Number: NNX11CE03P**
**Project Title: Security-Enhanced Autonomous Network Management for Space Networking**

**Identification and Significance of Innovation:** (Limit 200 words or 2,000 characters whichever is less)

NASA's Space Communications and Navigation (SCaN) program is integrating its three current agency networks: Space Network (SN), Deep Space Network (DSN), and Near Earth Network (NEN). This effort raises several issues for the network management in the future integrated space networks. First, an integrated network management function, which uses common standards and implementations, is needed to serve as the interface for all SCaN network customers. Second, satellite operations currently use a highly manual approach. The research and development of autonomous operations has been conducted recently but is still at early stage. Third, due to different characteristics of space networks, security management mechanisms and other network management functions that are widely adopted in the traditional networks are not fully suitable to space networks. To address these issues, we propose an innovative Security-Enhanced Autonomous Network Management (SEANM) scheme for reliable communication in space networking, which allows the system to adaptively reconfigure its network elements based upon awareness of network conditions, policies, and mission requirements.

**Technical Objectives and Work Plan:** (Limit 200 words or 2,000 characters whichever is less)

The overall objective of the project is to develop a Security-Enhanced Autonomous Network Management (SEANM) system for effective and autonomous network management in space networking, to enable smart network elements to make decisions based upon awareness of local network conditions through the cross-layer information sharing mechanisms. In Phase I, we will investigate the performance of the proposed SEANM scheme, which will form a solid technical foundation for the follow-on Phase II and III programs. The design and implementation of SEANM will be accomplished by conducting research and simulations in Phase I. We will conduct detailed analysis of the scheme, perform initial prototype design, and demonstrate its effectiveness. In Phase II, we will refine the algorithms and architecture, and develop a system prototype. Specific Phase I objectives include:

Objective 1: Refine the SEANM requirements and modify Phase I objectives if necessary.
Objective 2: Refine the SEANM architecture.
Objective 3: Investigate cross-layer information sharing and cross-layer interactions
Objective 4: Customize the cross-layer reconfiguration mechanism
Objective 5: Investigate and design security solutions in space networking
Objective 6: Evaluate the performance in terms of accuracy, scalability, reliability, and bandwidth-efficiency.

**Technical Accomplishments:** (Limit 200 words or 2,000 characters whichever is less)

In our Phase I efforts, we focused on developing a reliable and efficient autonomous network management system for space networking through an efficient cross-layer negotiation approach. First, we designed an integrated cross-layer information sharing architecture to expedite information exchange between different network layers and necessary inter-layer interactions. Second, we studied the necessary information to be shared, the possible information sharing mechanisms, and the ways to integrate with our cross-layer information sharing architecture. Third, we designed a flexible User Interface to display the information in the monitored space network(s) to help users (i.e., network operators) to better understand the problem and the performance of our solutions. Fourth, we designed a robust security scheme to fight against dynamic network topology and disrupted infrastructure service. Finally, we implemented a set of test scenarios on hardware testbed to demonstrate the feasibilities of the proposed SEANM approach.

**NASA Application(s):** (Limit 100 words or 1,000 characters whichever is less)

The proposed autonomous network management solution has tremendous applications potential to largely reduce the operation costs while maintain or even enhance the reliability for the NASA missions. Due to the heterogeneous nature of network assets and the lack of autonomy, the developed solution can be applied to the NASA's efforts on the integration of its current agency networks. The potential customers of our solution include robotic and human missions at locations ranging from the near Earth (e.g., EO-1, ISS) to deep space (e.g., Mars exploration).

**Non-NASA Commercial Application(s):** (Limit 200 words or 2,000 characters whichever is less)

The proposed solution has potential in dynamic military applications. Given the GIG vision, such heterogeneous and dynamic wireless networks will be common. Therefore an autonomous network management is necessary. The proposed architecture, algorithms, and the developed simulation tool can be applied to various military networks for major programs like Airborne Networks Program, Joint Strike Fighter (JSF) program, Joint Tactical Radio System (JTRS), Future Combat System (FCS), etc.

The commercial drive for reliable communication is also increasing due to the increasing popularity of wireless network technologies. The potential commercial applications include satellite communications, wireless ad hoc networks and vehicle networks. The size of the market is quite large and may grow rapidly with the demand for network reliability and availability. We expect that the aggregate market size will be similar to or larger than that of NASA and military applications.

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