

DRAFT STATEMENT OF WORK

**SECTION 0 - INTRODUCTION**

***Purpose***

This draft Statement of Work (SOW) serves: (i) to identify the Mandatory Requirements (MRs) and Target Requirements (TRs) of this RFP; and (ii) as a template for the Offeror to use / insert its proposed research and development (R&D) work to advance its Next-Generation High Performance Computing Networking (NG-HPCN). As mentioned in the Proposal Evaluation & Proposal Preparation Instructions (PEPPI), Offeror will insert its proposed R&D work in a Work Segment / subsegment approach consistent with the following Sections 1 to N. Offeror will include the resulting document as part of its Technical Proposal.

***References***

Lawrence Livermore National Security, LLC (LLNS) at Lawrence Livermore National Laboratory (LLNL), Triad National Security, LLC at Los Alamos National Laboratory (LANL), and National Technology and Engineering Solutions of Sandia, LLC (Sandia) at Sandia National Laboratories (SNL) are collectively referred to as either “Tri-Laboratory”, “Tri-Laboratories”, or “Tri-Labs”.

***Requirement Category Descriptions / Definitions***

This draft SOW includes multiple requirement category descriptions. Each requirement category is identified and defined as follows.

MRs are features / elements, components, performance characteristics, or other properties that are essential to LLNS’ requirements, and an Offeror must satisfactorily propose all MRs in order to have its proposal considered responsive.

TRs are features / elements, components, performance characteristics, or other properties that are important to LLNS, but which will not result in a nonresponsive determination if omitted from a proposal. TRs add value to a proposal.

MRs, TRs, and additional features / elements proposed by the selected Offeror, and of value to LLNS, will be included in a final negotiated SOW incorporated within the resulting subcontract.

***Mandatory Requirements***

1. **High-Level Description of Next-Generation High Performance Computing Network Solution (MR)**

The Offeror shall provide a detailed high-level overview of its next-generation HPC network (NG-HPCN) technology describing the characteristics and expected enhancements for improving the performance of MPI-based DOE/NNSA HPC applications.

1. **Collaboration and Co-design on Network Enhancements and Optimizations for DOE/NNSA Workloads (MR)**

The Offeror shall describe the strategy for collaboration and co-design with DOE/NNSA subject matter experts on the next-generation HPC network. The strategy shall focus on improving DOE/NNSA application performance for capability (single application using full system), capacity (many simultaneous simulations), and strong scaling (fixed simulation size) workloads. These workloads shall be HPC physics-based simulations, but shall also contain elements of artificial intelligence, machine learning, and data analytics.

1. **Next-Generation High Performance Computing Network Solution Timeframe (MR)**

The Offeror shall address and explain how its proposed research and development (R&D) activities (under the contemplated award resulting from this RFP) will enable its NG-HPCN technology to impact the HPC marketplace and system deployments within the 2024 timeframe.

1. **NG-HPCN Source (MR)**

LLNS intends to make award only to an Offeror that is the direct owner of the NG-HPCN technology, and not to a third-party intermediary / reseller. Therefore, the Offeror shall affirm it is the direct owner of the NG-HPCN technology, and that the Offeror is not acting as a third-party intermediary / reseller.

***Target Requirements***

1. **Network Simulation Capabilities (TR)**

The Offeror will describe its ability to simulate the next-generation networks advanced features and performance capabilities on various combinations of traffic pattens and network topologies of 50K or more network endpoints. The Structural Simulation Toolkit (SST) and/or access to vendor proprietary system is preferred. The Offeror will also describe its ability and plan to utilize network simulation capabilities in co-design collaborations with DOE/NNSA subject matter experts.

1. **Advanced Network Routing, Quality of Service, and Congestion Control (TR)**

The Offeror will describe how the advanced network features (routing, congestion control, QoS, etc.) will enable optimized application(s) throughput for the capability, capacity, and strong scaling simulation categories. The Offeror will describe how the advanced network features impact MPI point-to-point, one-sided, and collective performance, including best, average, and tail latencies, multi-job/multi-traffic network congestion, and other applicable performance limiters. The Offeror will provide specific quantitative improvements targets of performance benefits measured relative to not using the advanced network features.

1. **Network Scalability and Topologies (TR)**

The Offeror will describe NG-HPCN features and all supported network topologies that allow scalable performance to 50K or more network endpoints. The Offeror will provide quantitative justification for how performance will scale up to 50K or more network endpoints. Further describe Offeror’s support for port splitting on switch and multiple interface profiles for single NIC (for example, 4x100 Gb/s lanes split to dual 2x100 Gb/s lanes).

1. **Next-generation High Performance Computing Network NIC Interface (TR)**

The Offeror will describe the NIC to processor interface, support for nodes with multiple processor, support for stripping data over multiple NICs per node, and any NIC to processor coherence. In addition, describe any offload, accelerator, specialized/general compute features or programmability features of the NIC or network switches.

1. **Node Message Injection Rate (TR)**

The Offeror’s NG-HPCN will be capable of supporting 400 Gb/s (or more) per node with one or multiple NICs. Fewer, higher performance NICs is preferred. The Offeror will describe the minimum message size needed to achieve 90% of peak bandwidth. The NG-HPCN will achieve a message injection rate of 400 million/sec or more for 8-byte messages.

1. **Next-Generation HPC Network Hardware Offloads (TR)**

The Offeror will describe hardware capabilities to accelerate network operations (e.g., switch-based collectives, tag matching, or other operations) in the NIC and/or switch of the proposed NG-HPCN. The Offeror will provide performance targets for operations with and without acceleration.

1. **Advanced MPI Features for Next-Generation HPC Network (TR)**

The Offeror will describe how planned hardware capabilities enhance MPI performance for the MPI 4.0 specification or later. For example, to improve the performance of MPI point-to-point, one-sided, synchronous/asynchronous collective operations, MPI tag matching, and other MPI offloads.

1. **Support for Multiple Component Suppliers (TR)**

The Offeror will describe the ability of its NG-HPCN to support multiple processor manufacturers, processor/accelerator types (e.g., CPUs, GPUs, FPGAs, and others), and various processor instruction sets (x86, ARM, RISCV, and other). The Offeror will describe specific capabilities and support for discrete and integrated accelerators, for example, support for triggered operations and accelerator-initiated communications.

1. **Support for Multiple System Integrators (TR)**

The Offeror’s NG-HPCN will affirm their commercial product offering that will be offered for sale by multiple system integrators and original equipment manufacturers (OEMs).

1. **High Performance Networking Software Architecture (TR)**

The Offeror will describe NG-HPCN software model for device drivers, network configuration, network monitoring, network fabric management, network error counters, network resilence features, network performance counters, low-level network communication library/API, NG-HPCN support for application middleware such as MPI, PGAS programming models, Lustre, NVMe over fabrics, TCP/IP, and any support for additional upper layer protocols.

1. **Advanced Network** **Security (TR)**

The Offeror will describe the network security features of the NG-HPCN, including, but not be limited to, secure fabric setup, secure fabric control, secure fabric/subnet management, secure fabric diagnostics, secure and trusted firmware/BIOS for NIC and/or switch, support for SELinux, support for virtual LAN (VLAN), and support for single root I/O virtualization (SR-IOV). The security features should have minimal to no impact on overall network performance.

1. **Data Center Resource Integration (TR)**

The Offerors will describe the ability of the NG-HPCN to integrate into data center level resources (storage/SAN, edge computing, etc.) that utilize Ethernet, InfiniBand, or other network protocols.

**SECTION 1 – WORK SEGMENT 1**

***Purpose***

This section identifies Offeror’s proposed Work Segment 1 scope for *Offeror will insert its proposed work segment title*. Work Segment 1 will develop HSN technology necessary for and related to *Offeror will insert its proposed corresponding high level work / task description*.

***Milestone 1.1 –*** *Offeror will insert proposed milestone title*

In support of Work Segment 1, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone 1.1 to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

***Milestone 1.2 –*** *Offeror will insert proposed milestone title*

In support of Work Segment 1, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone 1.2 to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

***Milestone 1.N –*** *Offeror will insert proposed milestone title*

In support of Work Segment 1, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone 1.N to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

**SECTION 2 – WORK SEGMENT 2**

***Purpose***

This section identifies Offeror’s proposed Work Segment 2 scope for *Offeror will insert its proposed work segment title*. Work Segment 2 will develop HSN technology necessary for and related to *Offeror will insert its proposed corresponding high level work / task description*.

***Milestone 2.1 –*** *Offeror will insert proposed milestone title*

In support of Work Segment 2, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone 2.1 to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

***Milestone 2.2 –*** *Offeror will insert proposed milestone title*

In support of Work Segment 2, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone 2.2 to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

***Milestone 2.N –*** *Offeror will insert proposed milestone title*

In support of Work Segment 2, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone 2.N to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

**SECTION N – WORK SEGMENT N**

***Purpose***

This section identifies Offeror’s proposed Work Segment N scope for *Offeror will insert its proposed work segment title*. Work Segment 2 will develop HSN technology necessary for and related to *Offeror will insert its proposed corresponding high level work / task description*.

***Milestone N.1 –*** *Offeror will insert proposed milestone title*

In support of Work Segment N, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone N.1 to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

***Milestone N.2 –*** *Offeror will insert proposed milestone title*

In support of Work Segment N, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone N.2 to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

***Milestone N.N –*** *Offeror will insert proposed milestone title*

In support of Work Segment N, Offeror shall complete the following work / tasks and deliver the following deliverable items.

*Offeror will insert its proposed work / tasks and corresponding deliverable item(s) (i.e., reports, etc)*

This milestone is complete after the work / tasks and deliverable items are considered acceptable to LLNS reasonable satisfaction.

Offeror proposes this Milestone N.N to offer work and deliverables consistent with the RFP’s following MRs and / or TRs.

*Offeror will insert the applicable MRs and or TRs and explain how the proposed work / tasks correlate with the applicable MRs and TRs*

**SECTION N+1 – MILESTONE SCHEDULE**

Milestone due dates are identified in the Subcontract.

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