SIRIUS software for ECP

# The goals of your project and its current status

Our long-term vision is to create a sustainable and extensible multi-tier storage system and I/O framework. Our goal is to reduce the time that solution scientists spend in moving, storing, and processing data. To that end we are performing research to

SIRIUS will support

* List the items

SIRIUS is being created by scientist at ORNL, SNL, Rutgers, UCSC, and Brown University. We also have outside participation from scientist at GT, and Stony Brook.

# Do you release your software as open source?

We will release services and methods for SIRIUS under the completely free BSD license. This license is even more permissive than LGPL. The software will be openly available on GitHub:

# Do you have DOE/NNSA users of your software?

Fusion Pixie3D, XGC1, GTC, and etc.

# Have facilities, vendors, or ISVs picked up your software?

SIRIUS is under development and the public release will be available at DOE Leadership Computing Facilities, and NERSC.

# What is the support model for your software?

The initial releases of SIRIUS will be primarily supported by the core SIRIUS team. After the completion of the project, the support will transition to user assistance groups at various computing facilities, who the SIRIUS team will train and interact with on a regular basis. Eventually SIRIUS will be developed and maintained on Github by the open source and user communities.

# Are there any applications in particular that the outcomes of your project are targeting?

This project targets all Exascale applications which generate large amounts of analysis data.

# The specific ties to identified requirements of the applications, other software components?

SIRIUS is driven by the fact that many DOE applications generate large amounts of analysis data that need to be prioritized/reduced/mapped to storage hierarchy efficiently.

# Your plan for ensuring that the developed software technologies be mature enough to be part of the software stack on exascale systems expected to be selected in 2019 and installed in 2023?

To ensure that SIRIUS will be ready for exascale software stack, we will identify and resolve major research challenges in the next 3 years, and leverage ECP as well as other future projects (e.g., SciDAC, LCF), and work closely with applications to harden the software.

# What do you feel are the key challenges posed and opportunities offered by exascale systems for your specific area?

Exascale system will feature large capacity of memory including HBM, NVRAM as well as GPU memory. With these new memory technologies, application can generate even larger amount of data that need to be stored and analyzed efficiently. This offers challenges and opportunities for new data management techniques that can prioritize and map data to storage hierarchy.

# What is the R&D that you would like to carry out within the ECP?

There are plenty of *research* topics where we still need to find out what is the best way to deal with the big data challenges on extreme scale systems:

* *Data Refactoring:* We must reduce the amount of data while retain most of the *information* written to permanent storage. Our approach is to use mathematical and statistical techniques for this and we need to work closely with applications to find the appropriate methods for their data, analysis requirements and data lifecycle management. Also, our idea is to optimize read access to most frequently used data by refactoring data for multiple levels of storage.
* *Data Lifecycle Management:* When we say data, we mean not just the dataset output of an application but also the knowledge gained from it, and the codes and processing workflows and visualizations applied to it to gain that knowledge. We want to *morph* data as it moves to different systems and transforms itself from data to knowledge. We will apply *learning techniques* to pre-fetch, pre-calculate data from semantically described intentions. Also, better data reduction techniques will be needed because of the size of the data.

# What research remains for your project’s outcomes to benefit key DOE applications?

The success of SIRIUS project will benefit key DOE applications. There are still a few possible research directions that can be further pursed in order to better serve applications, such as usability, more intuitive programming models.

# How would the proposed activities build on the research you have been carrying out with ASCR Research funding?

SIRIUS will build upon key capabilities that were/have been funded by ASCR.

* + Include ADIOS, DataSpaces, Sirocco and DAOS

SIRIUS will further build upon these successes and further integration and advance data storage and analysis capabilities.

# What are the proposed activities that you believe would contribute to the ECP?

# Your roadmap/timeline for maturing the software technologies and deploying them on exascale platforms, with a few intermediate milestones or decision points (forks in the roadmap). The timeline is of particular importance in selecting what the ECP will include in the development plans.

For this project, we divide up our tasks by making the following distinctions

* API: creating new APIS for I/O for the Sirius SSIO project.
* Metadata: naming and discovery of the metadata on the multi-tier storage system.
* QoS: Predictable performance, performance isolation, performance optimization.
* Refactoring: Techniques to re-order, reduce, and bin data into different levels of importance.
* Storage: The management of the persistent resources.

**2016**

* [API] SIRIUS APIs that are capable of communicating user intentions to SIRIUS.
* [STORAGE] example storage mechanism capable of storing and retrieving "objects".
* [METADATA] metadata support for basic refactoring information.
* [REFACTOR] simple refactoring functionality (e.g., precision-based refactoring and multi-resolution refactoring).
* [STORAGE] Multiple simultaneous direct tier access from a single API, exploring Sirocco and Ceph
* [QoS - optimization] Extension to data format and metadata service to evaluate, store and query utility of data blocks based on frequency of access.

**2017**

* [METADATA] Metadata support for custom metadata that includes refactoring code, to regenerate data, along with file/pile (index/search) tradeoffs, along with8 support for resiient copies
* [STORAGE] Data migration for performance based on request, along with support of the querying for I/O performance estimates based on data locality.

[QoS] Expanded description of data utility to guide tradeoffs between performance and accuracy.

* [METADATA] metadata support for resilience copies
* [STORAGE] data placement based on training
* [API/METADATA/STORAGE] bounded search time prototype

**2018**

# Highlight your activities that would help DOE exascale apps achieve ECP performance, efficiency and resilience performance goals on 2023 hardware and system architectures