Euclid-NexusLIMS: A Customizable Data Management Software for Microscopists with Cloud Computing Outlook

Ao Liu[1*], Weinan Si[1], June Lau[2], Joshua Taillon[2], Roberto Reis[3] and Laura Bartolo[4]

[1.] Euclid Techlabs, LLC, Bolingbrook, IL, United States.
[2.] National Institute of Standards and Technology, District of Columbia, United States.
[3.] Northwestern University, NU*ANCE*, Evanston, IL, United States.
[4.] Center for Hierarchical Materials Design, Evanston, IL, United States.
* Corresponding author: a.liu@euclidtechlabs.com

The ever-expanding size of electron microscope (EM) data in a single experimental session renders most proprietary software inefficient at managing data. Over the past few years many open-source EM analysis packages have been developed. However, they have not yet been consolidated into an open-source software framework capable of using data on a central server commonly available at a local computing facility or on the cloud computing platforms. Particularly, the Findability, Accessibility, Interoperability, and Reuse (FAIR) principles of digital assets require a convenient platform for users to share and manage data on. An open-source data framework for storing raw data and metadata, hosting databases, and providing a platform for data processing and visualization is highly desirable.

We have developed an open-source, infrastructure-independent data management software framework, named by Euclid-NexusLIMS, customized from the original NexusLIMS [1] version developed by our NIST collaborators. Euclid-NexusLIMS and NexusLIMS are designed to archive, register, record, visualize and process experimental data. NexusLIMS-Euclid was generalized with specific features and can be conveniently deployed on a local server of any EM facility independent of the infrastructure. It has two versions that support not only a local central server, but also most major cloud computing platforms like Google Cloud Platform (GCP), such that the data activities and workloads are hosted and handled by the scalable cloud resources.

The Euclid-NexusLIMS framework contains three major components that are all customizable based on the facility that they need to be implemented at. The *Logger-GUI* is a miniature Python-based app that is installed on the microscope computer and connected to a network storage device, which supports Windows as old as XP, OSX, and Linux. The *Logger-GUI* records experimental session information and integrates the user information on the scheduler or calendar with the session info. The *backend* is a service program that is constantly running on a server, which interprets microscopic data files generated in each experimental session and summarizes the data into a metadata file for rendering in the next step. The *frontend*, which is currently built with a customized version of the NIST CDCS webserver framework, is hosted by the server to provide secure, open and convenient access to the experiment files, and metadata.

The Euclid-NexusLIMS-local is a local version of Euclid-NexusLIMS that runs with a local area network that does not require public WWW network access. The communication is done among microscopes and servers that are in the same facility network, and the *frontend* is only visible to the internal IPs. The flowchart of the Euclid-NexusLIMS-local version is shown in Fig. 1. The Euclid-NexusLIMS-cloud is a cloud version that can be hosted by all major platforms, such as the GCP, Amazon AWS and Microsoft Azure. The cloud version enables cloud storage, database operations and

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one can easily add cloud data analysis to the framework. The flowchart of the Euclid-NexusLIMS-cloud version is shown in Fig. 2.

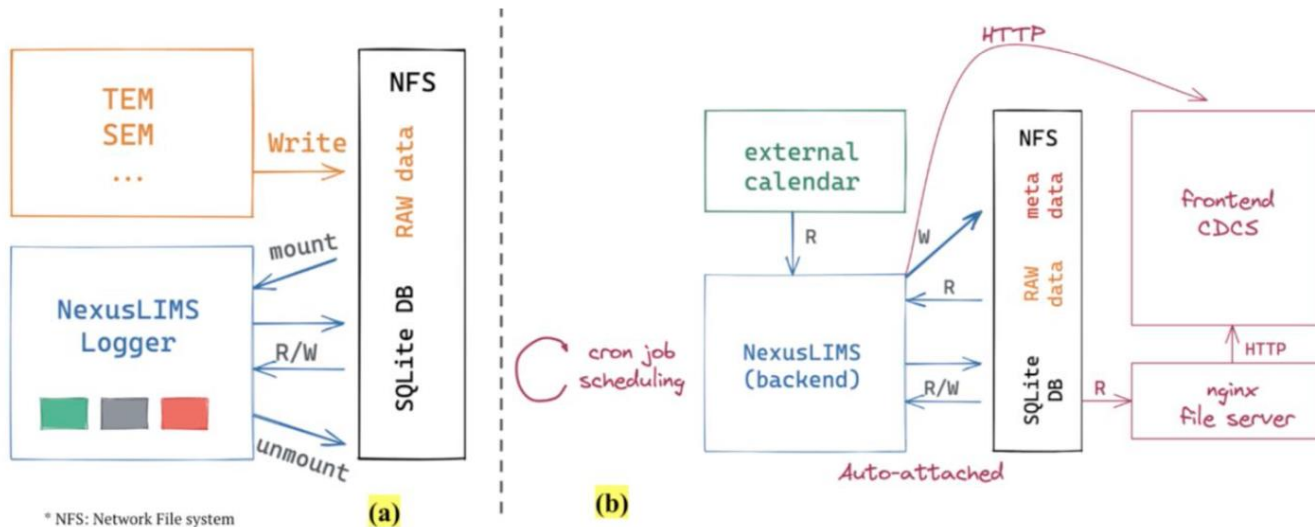We are working with NU*ANCE* and ChiMAD to deploy a customized installation of Euclid-NexusLIMS-local now.

Figure 1. Flowchart of the Euclid-NexusLIMS-local framework. (a) *Logger-local* component, (b) *backend* and *frontend* component.
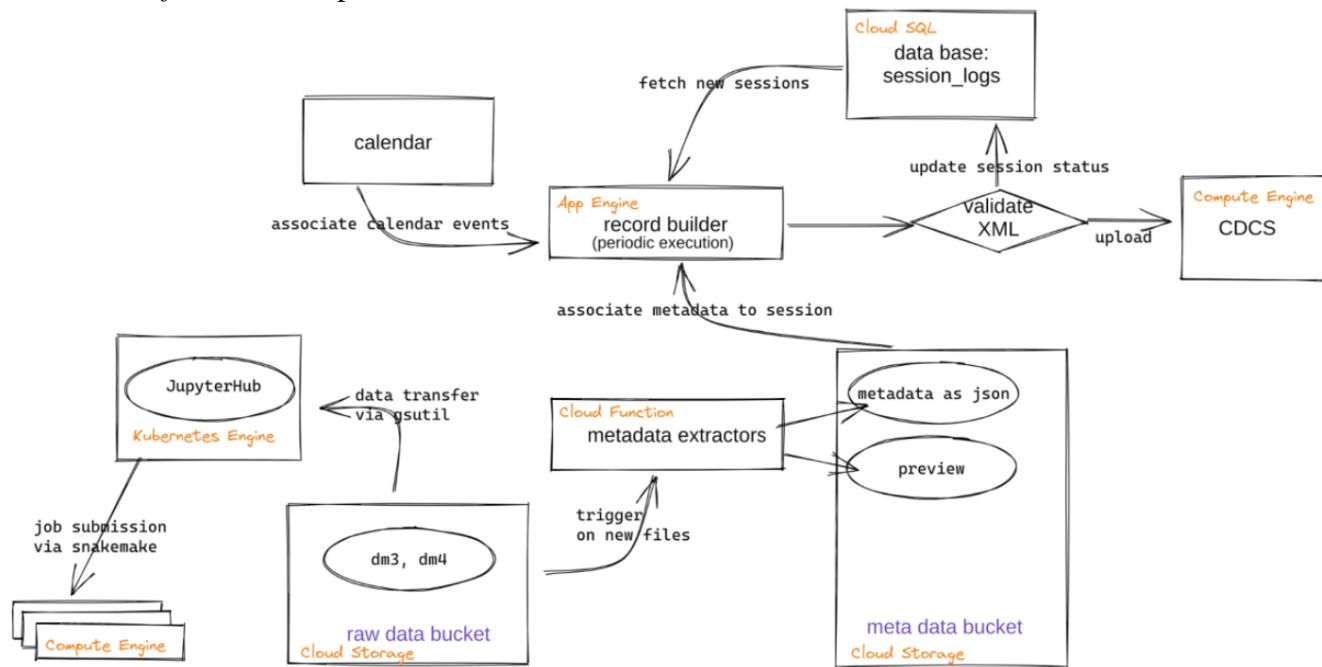

Figure 2. Detailed workflow and GCP engines used in Euclid-NexusLIMS-Cloud.

References:

[1] J. Taillon et al., Microscopy and Microanalysis **25**(S2) (2019). DOI: https://doi.org/10.1017/S1431927619001430