THE DATA EXPLOITATION (DEX) PLATFORM

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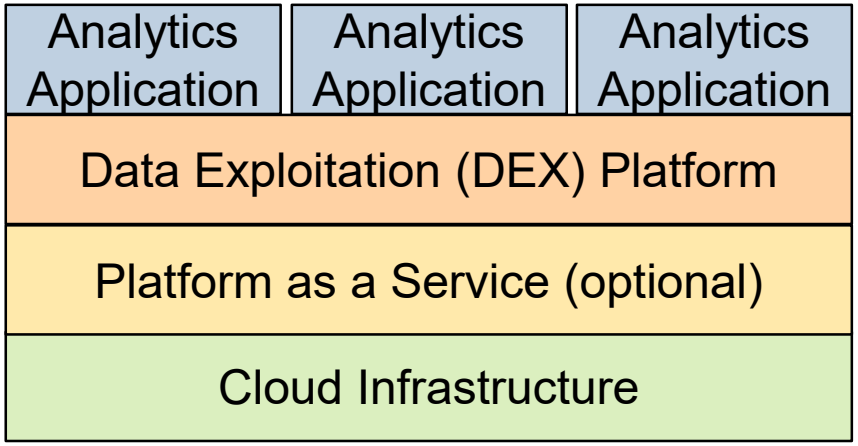
4/8/2019

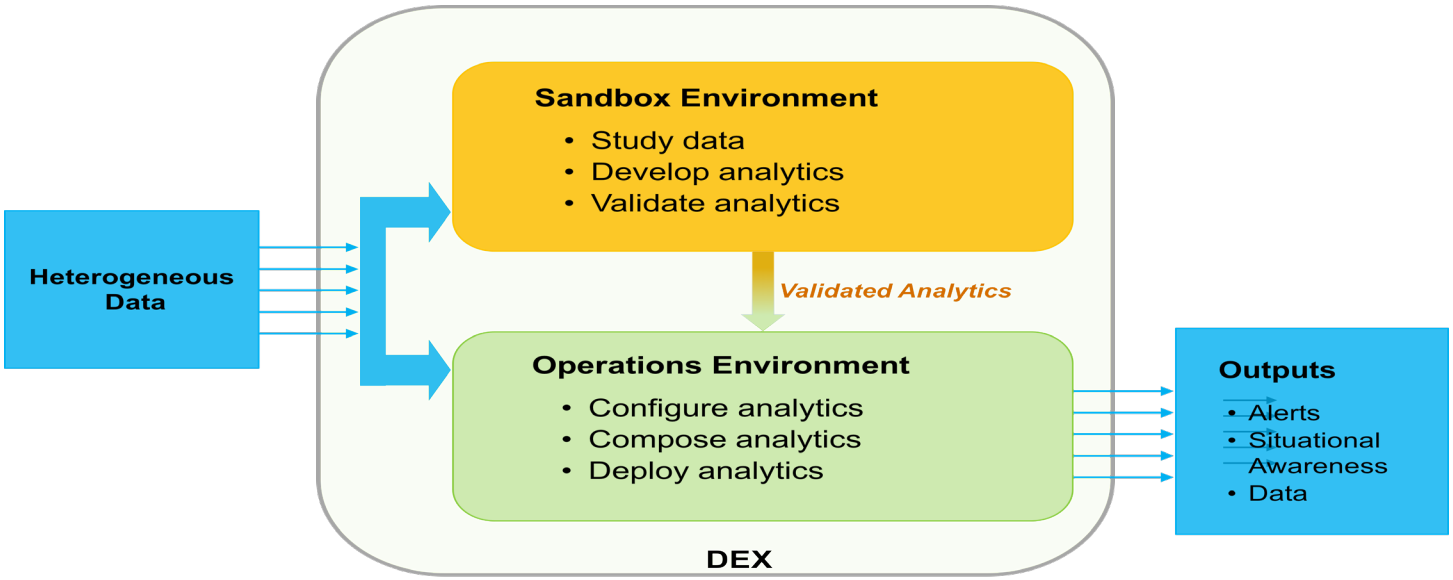
The Data EXploitation (DEX) Project

- The Data EXploitation (DEX) Project is part of Enterprise Ground
  - *Enterprise Ground: Will provide shared cloud infrastructure, enterprise services and common user interfaces for SMC space systems*
- DEX is a **Reference Architecture** and **prototype implementation** for a data exploitation platform that is:
  - *Evolvable*
  - *Responsive*
  - *Cloud-based*
- DEX enables the exploitation of available and relevant data sources to identify abnormal behaviors in real-time
- The DEX data analytics platform provides a software layer between data analytics applications and the underlying cloud infrastructure to manage the applications



What the DEX Platform Provides

- Supports **integration of new and legacy analytics applications**
- Can **evolve** readily with emergent technologies and products
- **Stores and streams heterogeneous data** from EGS resources
- Extracts information by running configurable, **general-purpose and domain-specific analytics**
- Supports delivery of **actionable, real-time information** for satellite operations
- Provides **intuitive user interfaces** that allow users to:
  - ***Configure and deploy analytics workflows*** *easily*
  - ***Respond quickly to real-time events*** *by changing the situational, regional, or global analytics workflows running on the DEX platform*



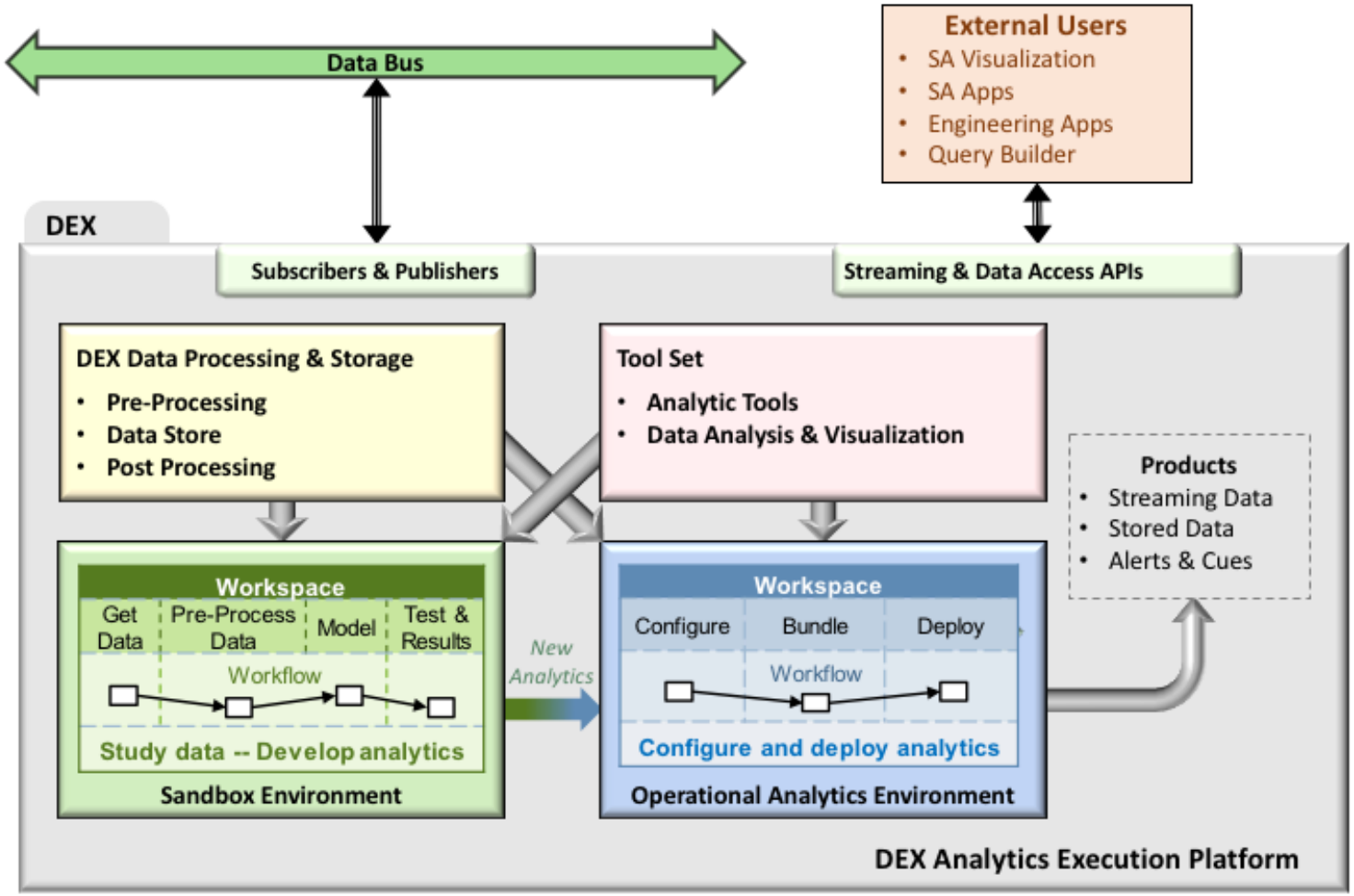
DEX Platform Design Principles

- ***Provide Higher Levels of Abstraction for Operators and App Developers***
  - *Hide the complexity of the underlying cloud infrastructure*
  - *For operators: Intuitive DEX User Interface to configure and deploy analytics workflows*
  - *For application developers: Simple mechanisms to integrate apps into DEX platform*
- ***Minimalist Approach***
  - *Incorporate new technologies only as needed by DEX stakeholders*
  - *Utilize mature, "best of breed" open source components*
  - *Utilize DevOps (Development and Operations) tools for rapid and continuous development, integration and deployment of new capabilities*
- ***Responsive to Changes in the Operational Environment***
  - *DEX UI allows users to compose and deploy analytics workflows quickly in response to alerts or events*
  - *Sandbox supports rapid development, evaluation and integration of new applications*
- ***Avoid Vendor Lock-In***
  - *DEX's modular design utilizes open source components, well-defined APIs, and industry-standard cloud container management tools*
  - *DEX platform can be deployed on any commercial or private cloud that supports Docker containers and Kubernetes container management*

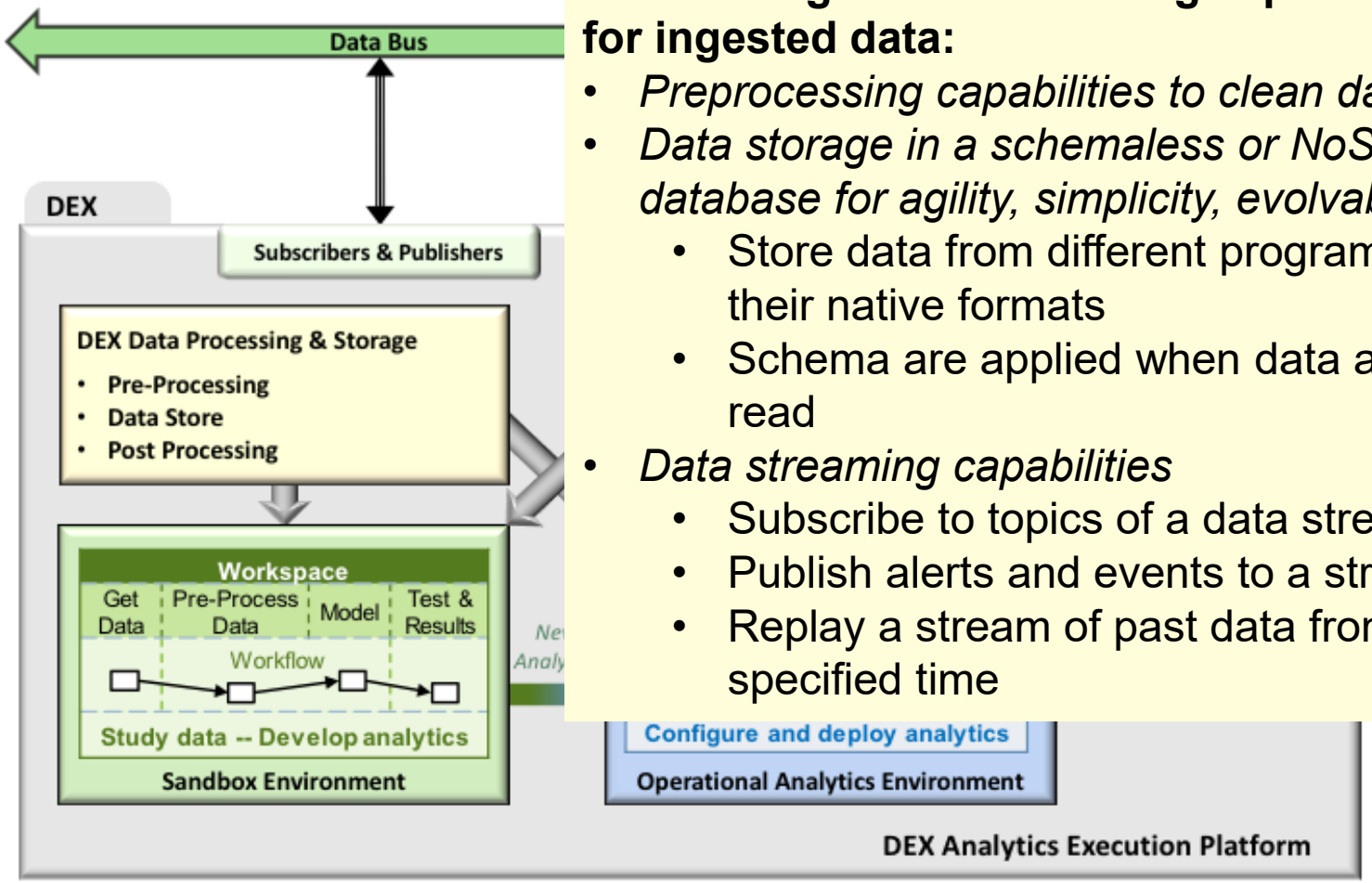
DEX Platform Supports a Range of Use Cases for Space Operations Data

- **Single Satellite Abnormality Detection**
  - *Analytics identify telemetry measurand values for individual satellites that are anomalous or outside of expected ranges*
  - *Example analytics:*
    - Satellite as a Sensor (SAS) neural network based abnormality detection
    - Exponential Weighted Moving Average (EWMA)
    - Threshold-based abnormality detection
    - Bayesian trend change detection
- **Develop precise profiles of abnormal satellite behavior**
- **Identify ground- and space-based threats**
  - *Geo-Spatial Clustering can identify a group of satellites that are affected in a spatially significant geographical area and thus may be affected by a common cause or threat*
- **Multi-satellite abnormality detection algorithms** can identify common manufacturing defects that occur in multiple satellites
  - *For example, if multiple satellite batteries start to fail before their predicted end of life*

DEX Functional Elements



DEX Functional Elements



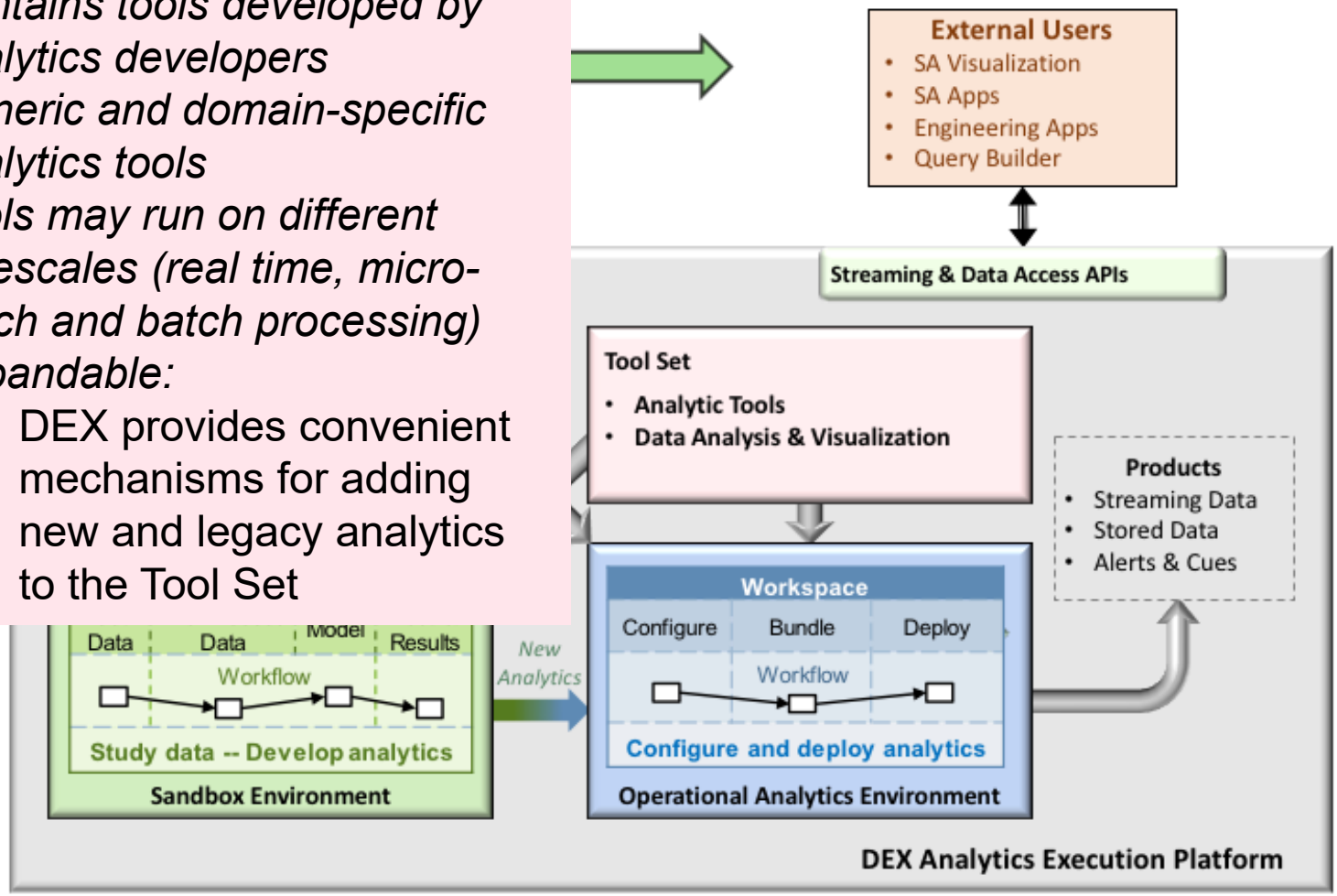
Data Storage and Processing capabilities for ingested data:

- *Preprocessing capabilities to clean data*
- *Data storage in a schemaless or NoSQL database for agility, simplicity, evolvability*
  - Store data from different programs in their native formats
  - Schema are applied when data are read
- *Data streaming capabilities*
  - Subscribe to topics of a data stream
  - Publish alerts and events to a stream
  - Replay a stream of past data from a specified time

DEX Functional Elements

Analytics Tool Set

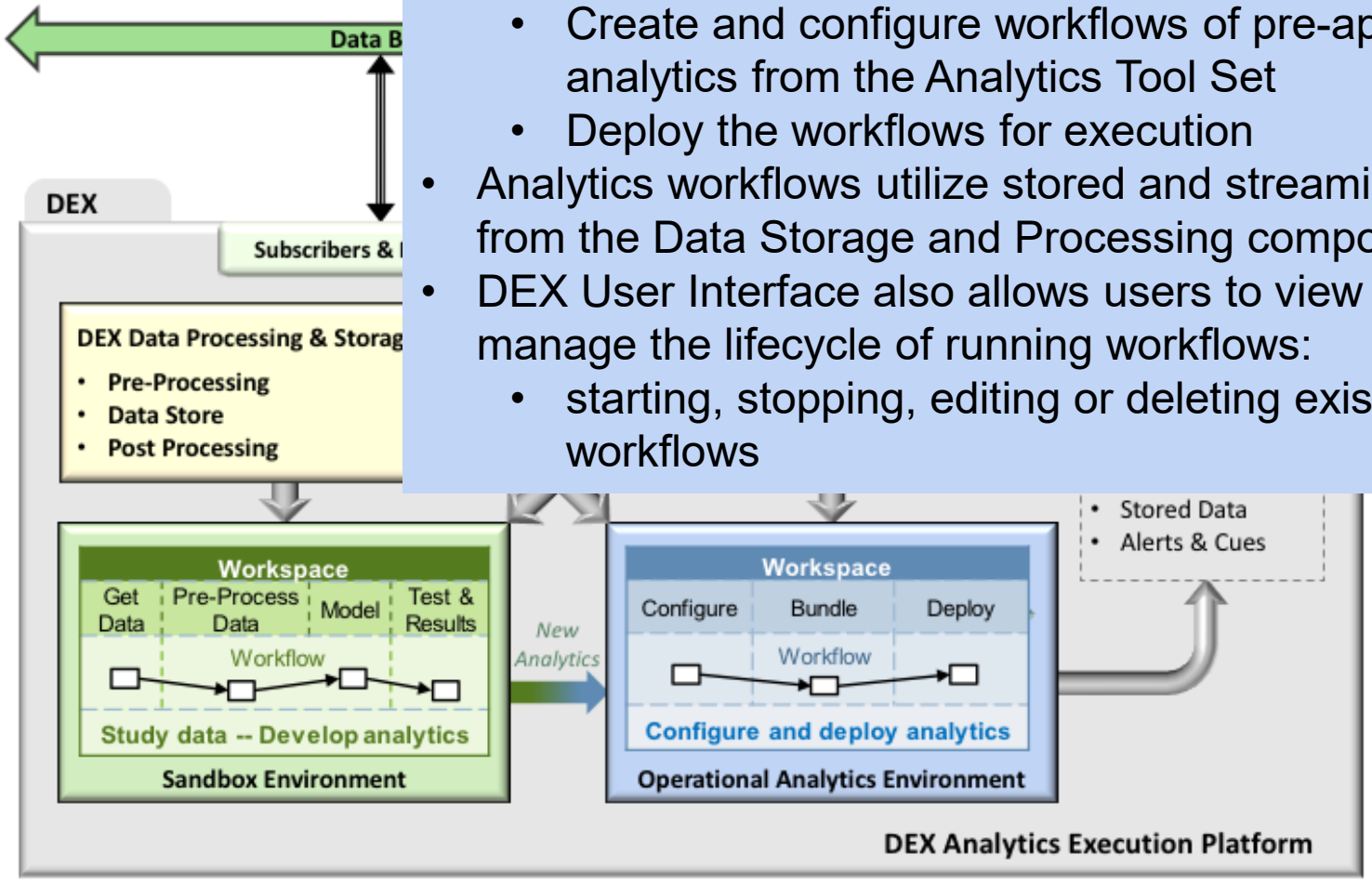
- *Contains tools developed by analytics developers*
- *Generic and domain-specific analytics tools*
- *Tools may run on different timescales (real time, micro-batch and batch processing)*
- *Expandable:*
  - DEX provides convenient mechanisms for adding new and legacy analytics to the Tool Set



DEX Functional El

Operational Analytics Environment

- *Cloud environment where DEX analytics workflows are executed*
- *DEX User Interface allows users to:*
  - Create and configure workflows of pre-approved analytics from the Analytics Tool Set
  - Deploy the workflows for execution
- Analytics workflows utilize stored and streaming data from the Data Storage and Processing components
- DEX User Interface also allows users to view and manage the lifecycle of running workflows:
  - starting, stopping, editing or deleting existing workflows



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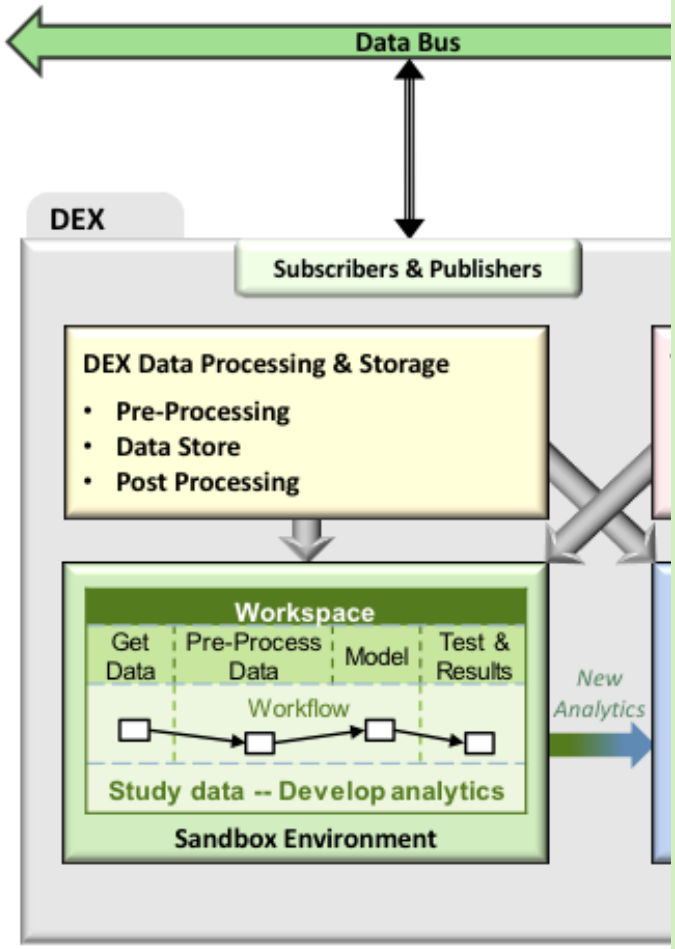
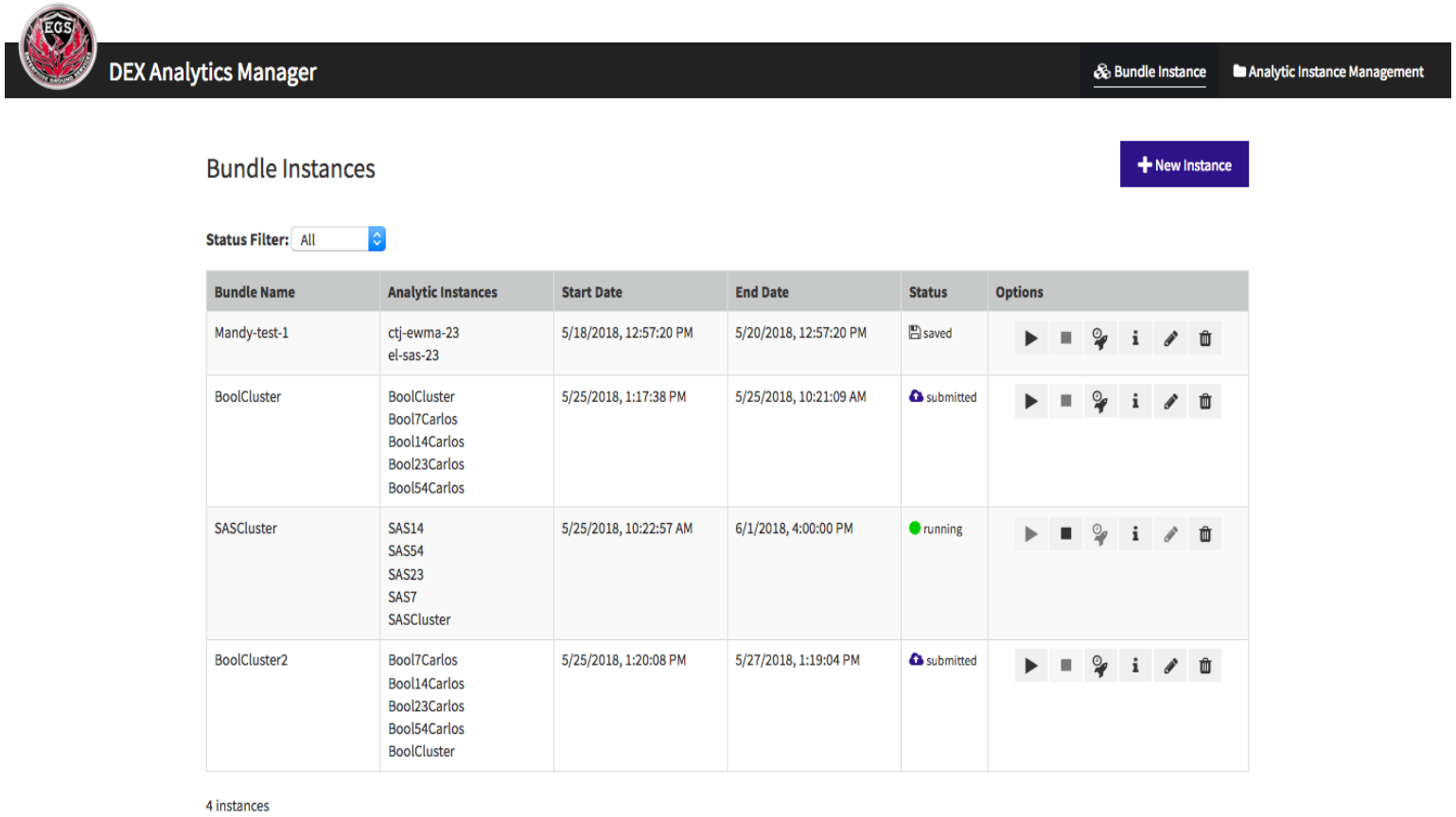


Sandbox Environment

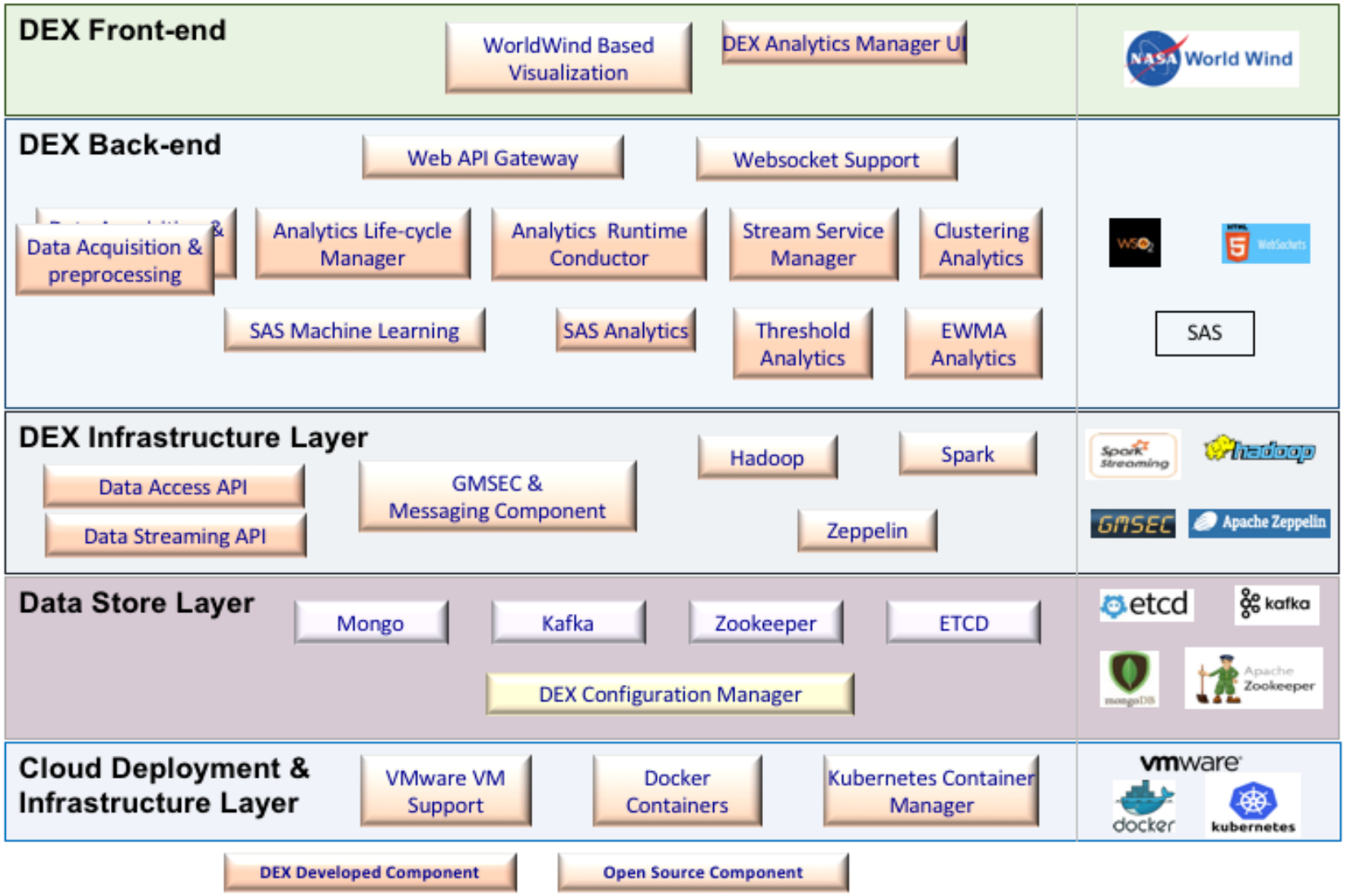
- *DEX Sandbox Environment currently in development*
- *Sandbox enables users to:*
  - Study DEX data sets using existing analytics from the Analytics Toolset
  - When needed, develop and validate new analytics applications or integrate legacy applications
- *Sandbox is isolated from the DEX Operational Analytics Environment*
  - Analyses running in Sandbox will not impact the data or behaviors of operational system
- *Approved analytics applications are:*
  - Added to the Analytics Tool Set
  - Made available to users of the Operational Analytics Environment through the DEX User Interface

Operator-Driven DEX User Interface

- Allows users to configure, compose and deploy analytics workflows easily
- Provides higher level of abstraction to users
- Hides many of the details of the underlying cloud infrastructure
- Provides life cycle management for running analytics workflows (start, stop, etc.)



Layered DEX Architecture and Implementation



Conclusions

- **The Data Exploitation (DEX) Platform is a reference architecture and prototype implementation for an evolvable, responsive, cloud-based data exploitation platform for analysis of space operations data**
  - *Ability to change the operational analytics workflows running on platform on-demand*
  - *Intuitive, operator-driven User Interface for configuring and deploying workflows*
  - *Simple mechanisms for developers to integrate new and legacy applications*
  - *Takes a minimalist approach, incorporating only the capabilities that are needed*
  - *Avoids vendor lock-in using best-of-breed open source components, well-defined APIs*
- With these capabilities, DEX **enables the delivery of timely, accurate, and actionable information** to commanders, operators, analysts, and stakeholders for planning, conducting and assessing space operations
- DEX prototype implementation is mature and stable
  - *Developed over 3 years, deployed in multiple cloud environments*
- The DEX Project is seeking additional industry partners interested in integrating their analytics applications with the DEX platform