NOAA's NPOESS Data Exploitation Project: Re-usable Tools and Services

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1. INTRODUCTION

The NPOESS Data Exploitation (NDE) Project is building a near-real time data processing and distribution system to provide operational civilian users with observations from the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and its risk-reduction forerunner, NASA's NPOESS Preparatory Project (NPP). The NDE Project has diverse user requirements for atmospheric, oceanographic, and land surface data products with strict operational timeliness. The NDE system design meets these user requirements by employing a Service Oriented Architecture (SOA) in which data ingest, product generation and tailoring tools, and distribution functions are presented as internal service components. This approach reduces redundancy and provides scalability and high availability for mission critical operations, while maintaining flexibility to meet future requirements for products, data processing, and distribution. In addition, the NDE Project has worked with stakeholders to promote and adopt widely used scientific data formats consistent with the interoperability objectives for the Global Earth Observation System of Systems (GEOSS). This paper reviews the design of the NDE system and the progress made toward its implementation.

2. NPOESS Overview

The NPOESS Program, operated by the Integrated Program Office, was established to develop, acquire, and deploy a system of operational environmental satellites and sensors that would merge the separate NOAA Polar Operational Environmental Satellites (POES) and Defense Meteorological Satellite Program (DMSP) into a single platform serving both the civilian and military user communities. In addition, NPOESS was designed to provide continuity for the data sets established by NASA's EOS satellite series. The key features of NPOESS operations are depicted in Figure 1. There is a single space segment, consisting of one or more spacecraft, each bearing a variety of sensors designed to satisfy the consolidated data requirements of NASA, NOAA, and the DoD. The initial risk-reduction implementation will be the NASA-operated NPP mission.

The Command, Control and Communications Segment (C3S) provides capability to send instructions to the spacecraft and to receive observations from the sensors via radio frequency (RF) links. For the NPP mission all C3S service will be accomplished through a single ground station located at Svalbard in Norway. Later a globally distributed series of receptors designated SafetyNet will be deployed, reducing the time between observation and data receipt for processing dramatically and facilitating near-real time application of polar satellite data.

From the C3S, sensor data will be delivered as Application Packets (APs) to central processing sites designated as the Interface Data Processing Segment (IDPS). One IDPS implementation at the National Satellite Operations Facility (NSOF) under NESDIS will serve the civilian user communities for both the NPP and NPOESS eras. Another IDPS will be operated by the Air Force Weather Agency (AFWA) will provide data to DOD users for NPP and NPOESS. Two more IDPS facilities to supply the US Navy operational centers are planned for the NPOESS era. Each IDPS site will receive the APs and process them into Sensor Data Records (SDRs) and Environmental Data Records (EDRs), using common algorithms and ancillary data as necessary to deliver common global data products in the Hierarchical Data Format 5 (HDF5) at each of the four operational centers.

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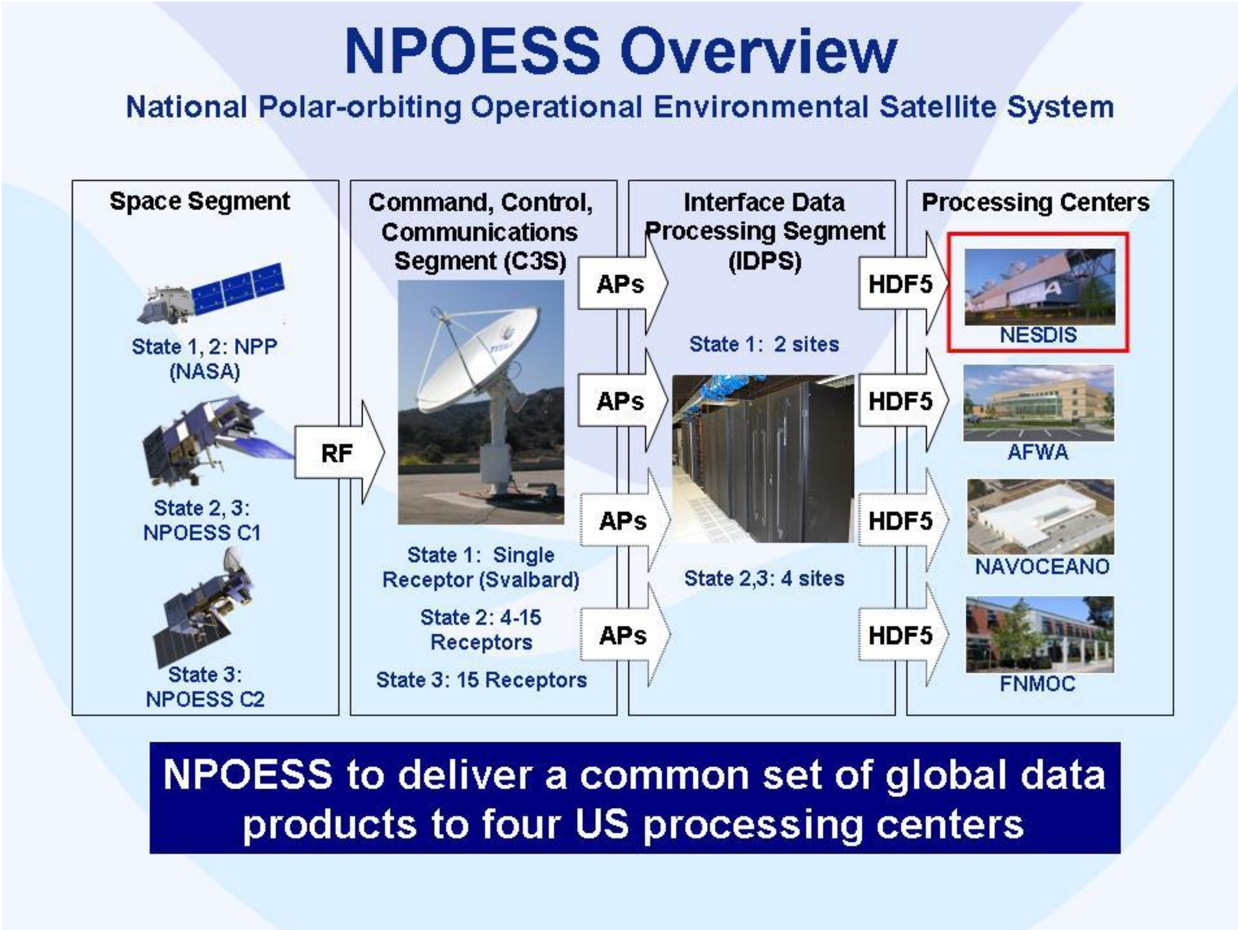

Figure 1: Schematic overview of the NPOESS space, communications, and processing segments, and the flow of a common set of data products from a single suite of on-orbit sensors to multiple operational centers.

3. NPOESS Data Exploitation (NDE)

NOAA's NPOESS Data Exploitation provides the sole link between NPP and NPOESS and the civilian real-time data user communities. To serve these users NDE must:

- Disseminate NPOESS Data Records to end users in the native HDF5 format
- Generate and disseminate tailored NPOESS Data Records (in alternative formats, views, projections, aggregations, subsets, etc.)
- Generate and disseminate NOAA-unique products (enhanced environmental products constructed from NPOESS Data Records, which use advanced science algorithms to meet mission requirements unique to NOAA)
- Deliver NOAA-unique products, product processing elements, and associated metadata to the NOAA Long-Term Archive
- Provide services to customers, including a Help Desk, NDE product training, product enhancement, and implementation support across NOAA
- Develop a sustainable system that meets its customer needs
- Provide software for NPOESS Data Record format conversion and other data manipulations

This paper describes the tools and services that will be used to process and disseminate NPP and NPOESS data effectively. The data products themselves are described in a companion paper [1].

3.1 *NDE Enterprise Approach*

To reduce the time, cost, and risks associated with the development of the NDE system, an enterprise approach has been adopted, based on using standardization as much as possible.

A common data handling system (DHS) will be used to manage and move data within NDE, without regard to the sensor of origin for a given data granule, or the particular environmental data “product line” involved. Likewise, a common tailoring software toolset is being developed to perform aggregation, spatial, temporal, and spectral filtering, re-formatting and map projections. Standard tools and methods are being used for system and product development, based on standardized component technologies including programming languages, databases, and configuration management tools.

3.2 *NDE Service Oriented Architecture*

Each NPP or NPOESS spacecraft will generate some 4 TB of data daily, far surpassing the data volumes of current operational polar satellite systems. Nominal NDE data retention is 96 hours, while the IDPS retention (for data recovery support is 24 hours). To meet the data processing workload imposed by such large data volumes, NDE will rely on a service-oriented architecture, in which common functions are invoked as services, as illustrated in Figure 2. Data pushed from the IDPS will land on NDE’s Storage Area Network (SAN). The Ingest service will detect, check, and register incoming data. The registry will be compared to Production Rules, so that when requisite files are present, a trigger message is issued to invoke the Product Generation Service (PGS). Narrow arrows in Figure 2 indicate the transmission of messages, while broad arrows represent data flows. One objective within the NDE system is to minimize the movement of large volumes of data, unless doing so increases the performance within the PGS enough to offset the overhead associated with moving the data.
Modular algorithms running as components of the PGS will generate the NUPs and perform the product tailoring for all product lines.

Customer Services include the registration of users authorized to receive NDE data products in near real time, and order management for users’ product subscriptions. The Distribution service provides supporting notification to subscribers, for example, when products have been successfully generated, and ensures that the products are available for distribution via the specified protocol for each subscription.

Not shown in Figure 2 is the System Monitoring and Control service, which encompasses all of the other services. This service will automatically monitor logs and reports, and control the other sub-processes through a central repository maintained as a Relational Database Management System.

3.3 *NDE Interoperability*

To facilitate sharing of data and tools for manipulating data among product development teams, product area leads, researchers and operational end users, NDE will adhere to NOAA recommendations for data formatting conventions [2]. For GIS applications, NDE will support GeoTIFF. For the Numerical Weather Prediction (NWP) community, NDE will provide key data records in the BUFR and GRIB2 formats to ensure continuity of the beneficial impact of polar satellite data to operational forecasting.

To support research and analysis, NDE plans to archive some of the NOAA Unique Products (as determined by management review). These NUPS will be put in netCDF4 format with the Climate and Forecasting (CF) conventions, or HDF5 as required. The NDE Tailoring Tools and associated documentation will be made available to users through the archive as well. NOAA CLASS provides the IT infrastructure for the long term archive of NPP and NPOESS data and metadata, and NDE tools.

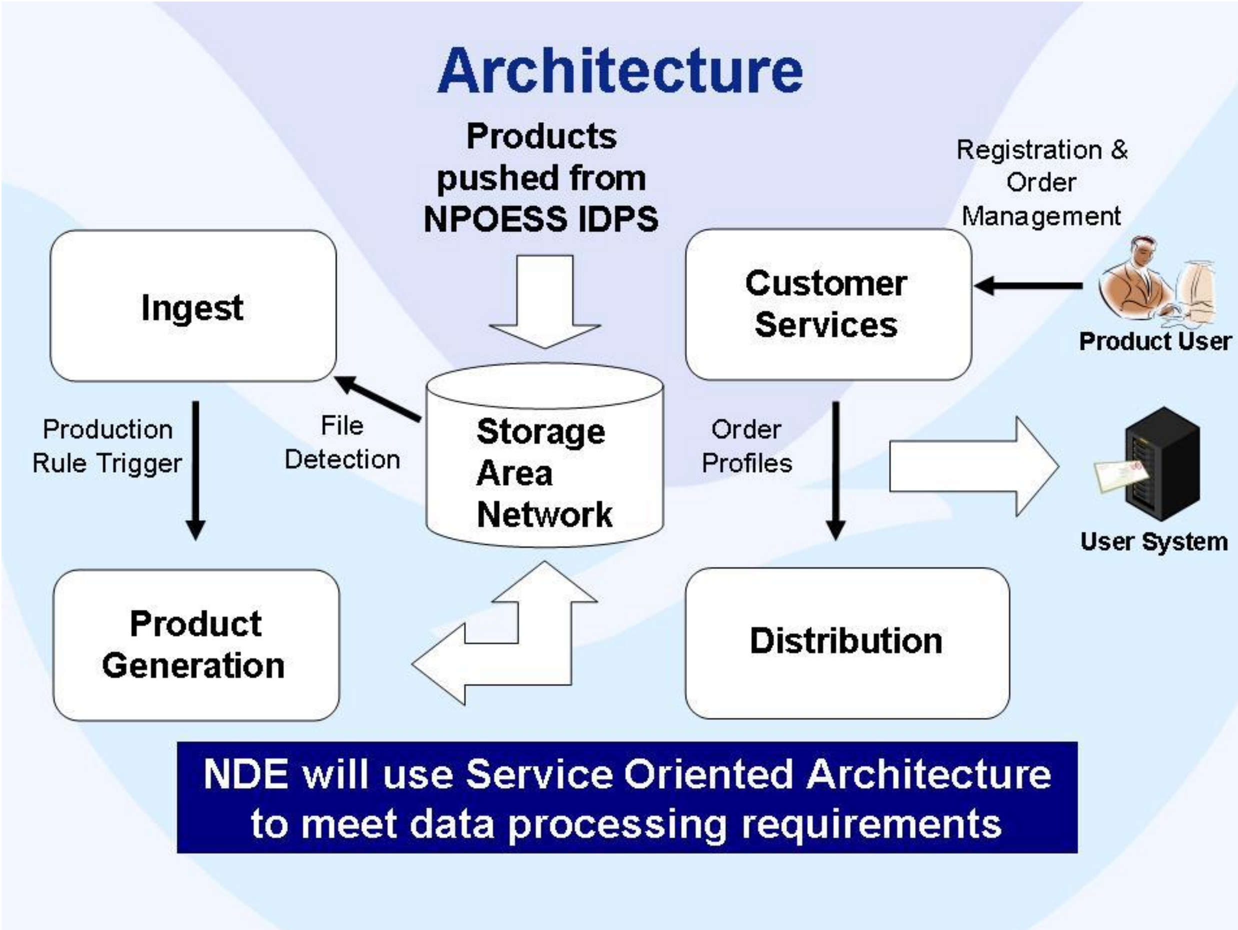

Figure 2: Schematic diagram of NDE Service Oriented Architecture

3.4 *Implementation Schedule*

The development of the NDE software and hardware infrastructure is being performed though a series of subsystem builds, beginning with Ingest and adding Product Generation, Distribution, Customer Services, and finally System Monitoring and Control. The schedule completing each of these builds is shown in Figure 3. NDE has been working to a launch date of January 16, 2011 for NPP, by which time limited distribution capability sufficient to supply high priority data products to key users [for example, sounder radiances to support NOAA's Numerical Weather Prediction (NWP) enterprise] will be in place, and system performance testing of Ingest, Production, and Distribution will be in progress. The Customer Services and System Monitoring capabilities will not be developed, tested, and integrated until after launch. Following implementation and testing of all NDE subsystems supporting NPP, the system will be transferred to operations, and the NDE team will repeat the build cycle in support of NPOESS, incorporating the lessons learned in preparing for NPP.

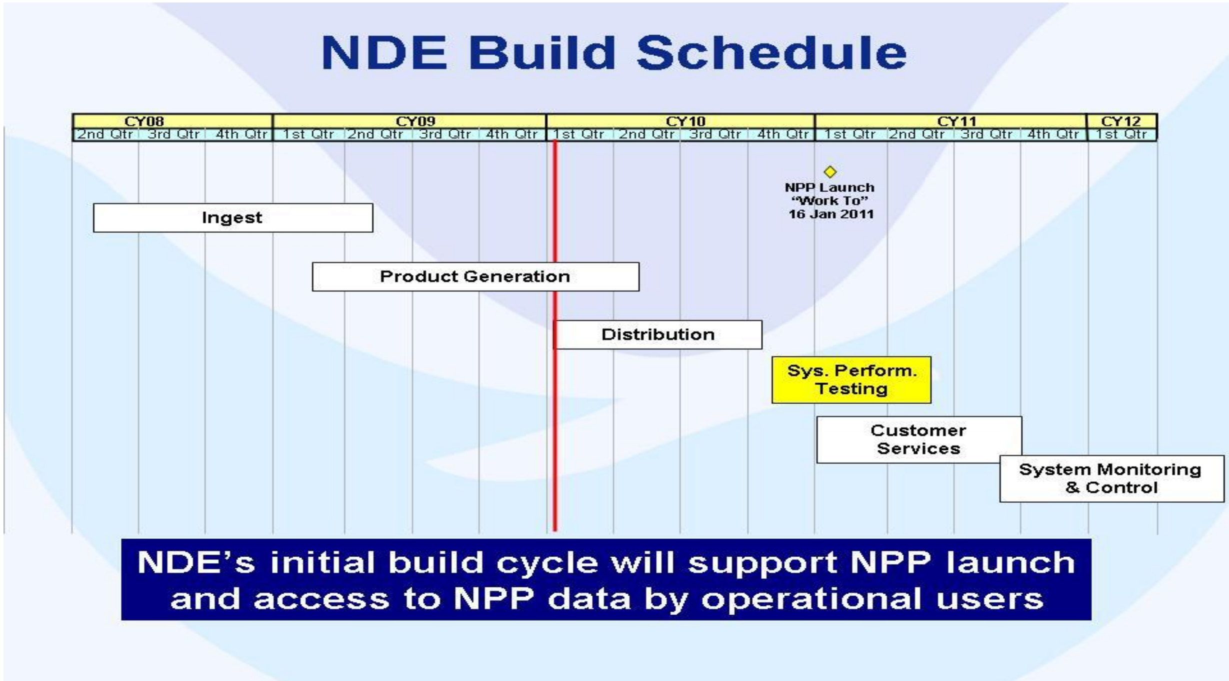

Figure 3: NDE Software Build Schedule to support processing and distribution of NPP data

4. NDE DATA USER INTEGRATION

The advanced sensors developed for NPOESS and NPP will be used to generate a larger number of more varied polar data products than their forerunners. Moreover, many of these products will be of significantly improved precision, accuracy, and resolution (temporal, spatial, and spectral), and with the implementation of SafetyNet, delivered much more rapidly.

These changes indicate new applications and users for NPP and NPOESS data, and significant changes for current polar satellite data users. NDE will form Stakeholder Integration Teams (SITs) within NOAA to help end users prepare to use the enhanced data products and the tools and services provided by NDE. Analysis of end user systems will be performed to identify necessary upgrades, develop test procedures and transition plans, and to identify training needs. The initial NDE Stakeholder Integration Team will support NOAA's operational NWP capability using NPP sounder radiance data, working in collaboration with the Joint Center for Satellite Data assimilation, the Center for Satellite Applications and Research, and the Environmental Modeling Center. Other SITs will support the NOAA CoastWatch community, and users of the Advanced Weather Interactive Processing System (AWIPS).

5. SUMMARY

NDE will provide the sole link between real-time civilian data users and the NPP and NPOESS satellite data. An enterprise approach featuring re-usable tools and services is being used to lower the cost, time, and risk associated with the development the NDE systems. This approach is based on a Service-Oriented Architecture that performs tasks as common services, and which is developed as a series of builds that integrate successive subsystems and services into the system. NDE ingest, product generation, and distribution services will be ready to support delivery of high priority data to key users as soon as possible after NPP launch.

6. REFERENCES

[1] NOAA's Near-Real Time Data Products from NPP and NPOESS, Schott, T., S. Bunin, J. Yoe, J. Silva, and G. Goodrum, *AMS 90th Annual Meeting, Atlanta, GA, January 2010.*

[2]https://www.nosc.noaa.gov/dmc/swg/wiki/index.php?title=Standards_White_Paper.