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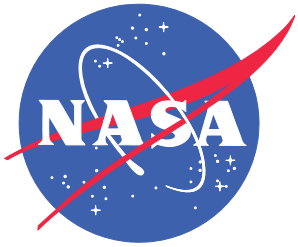

Thermal Performance Data Services (TPDS)

Richard T. French
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Michael J. Wright
Ames Research Center, Moffett Field, California

July 2013

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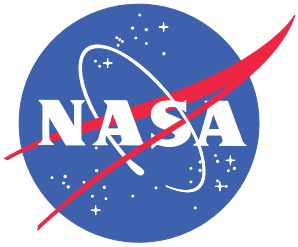

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Acknowledgments

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Thermal Performance Data Services (TPDS)

May 30, 2013

Report Approval and Revision History

NOTE: This document was approved at the May 30, 2013, NRB. This document was submitted to the NESC Director on June 7, 2013, for configuration control.

Approved:	*Original Signature on File*	*6/11/13*
	NESC Director	Date

Version	Description of Revision	Office of Primary Responsibility	Effective Date
1.0	Initial Release	Dr. David M. Schuster, NASA Technical Fellow for Aerosciences, LaRC	5/30/13

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Technical Assessment Report

1.0 Notification and Authorization

The need for the Thermal Performance Database (TPDB) was identified during the Constellation Program Crew Exploration Vehicle (CEV) thermal protection system (TPS) advanced development project. The motivation for this activity stemmed from the lack of a central database for thermal performance test results (arc jet testing) and analyses, which are required to make critical design decisions. Data from previous and current flight projects requiring TPS development have been difficult to obtain, and thermal performance testing and analysis costs are high and represent a significant Agency investment. The data, even for a single test, can reside in multiple locations; analysts and stakeholders expend an inappropriate level of effort collecting data and validating the data set. Much of the data are manually entered into individual spreadsheets that must be merged to provide inputs for an analysis, in part because no standard reporting across the Agency has been developed. Decision makers subsequently find it difficult to draw conclusions and make ultimate use of the testing and analysis. Historical data are also difficult to find and validate properly. This was particularly evident in the run-up to system down select, which was to make the critical decision between TPS materials for the CEV.

The assessment plan was approved by the NASA Engineering and Safety Center (NESC) Review Board (NRB) on November 19, 2009. Dr. Michael Wright of Ames Research Center (ARC) was appointed assessment lead, and Mr. Richard French of the Jet Propulsion Laboratory (JPL) was appointed deputy lead. Follow-on assessment plans were approved on September 23, 2010, and September 29, 2011.

The key stakeholders are NASA missions and Programs, and members of the TPS community, including test facility personnel, principal investigators, and thermal analysts. The database was designed, developed, and tested in conjunction with these key stakeholders.

Note that the project was renamed in March of 2012 from the TPDB to Thermal Performance Data Services (TPDS).

2.0 Signature Page

Submitted by:

Team Signature Page on File - 6/25/13

Dr. Michael J. Wright Date

Significant Contributors:

Mr. Richard T. French Date

Mr. Myron R. Grover Date

Signatories declare the findings, observations, and NESC recommendations compiled in the report are factually based from data extracted from program/project documents, contractor reports, and open literature, and/or generated from independently conducted tests, analyses, and inspections.

3.0 Team List

Name	Discipline	Organization
Core Team		
David Schuster	NESC Lead	LaRC
Michael Wright	Technical Lead	ARC
Richard French	Technical Deputy Lead	JPL
Linda Anderson	MTSO Program Analyst	LaRC
Faranak Davoodi	Software	JPL
Alex Eiser	Software	ARC
Michael Gangl	Software	JPL
Myron (Rob) Grover	Systems Engineering Lead	JPL
David Hash	Chief, Aerothermodynamics Branch	ARC
Thomas Huang	Software Lead	JPL
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Matt Sharpe	Human Computer Interface Design	ARC
Irene Tollinger	Human Computer Interface Design Lead	ARC
Administrative Support		
Linda Burgess	Planning and Control Analyst	LaRC/AMA
Jonay Campbell	Technical Writer	LaRC/NG

3.1 Acknowledgements

Early development of the database and proposal support was provided the CEV TPS advanced development project. Substantial support was provided by the Thermophysics Facilities Branch at ARC, which oversees the Arc Jet Complex (AJC). The success of the TPDS project would not have been possible without the invaluable contributions of key stakeholders on the design of the database. Of most significance are the contributions of Imelda Terrazas-Salinas, ARC AJC test engineering group lead, and her team of test engineers, including Enrique Carballo and Frank Hui. Also making major contributions at ARC are key stakeholders Jose Santos, Cesar Acosta, and Jeff Mach. David Hash provided constant advocacy and project management at ARC. Other contributors include thermal performance community principal investigators and analysts.

4.0 Executive Summary

Historically, thermal performance testing and analyses have been carried out by a number of test facilities dispersed across the country. As a result, test results and data products have been dispersed in location and even dispersed among individuals at a given location. This situation has led to a challenge within the thermal performance community to locate and utilize thermal performance data, both to better inform and enable test planning and to provide key supporting data for technical decision makers. From this circumstance was born the realization of the need for a thermal performance database and central repository for the thermal performance community.

Initiated as a NASA Engineering and Safety Center (NESC) assessment in 2009, the Thermal Performance Database (TPDB) was a response to the need for a centralized thermal performance data archive. The assessment was renamed Thermal Performance Data Services (TPDS) in 2012; the undertaking has had two fronts of activity: the development of a repository software application and the collection of historical thermal performance data sets from dispersed sources within the thermal performance community. The software application is a data processing and archiving engine supported by a Web-based user interface and has undergone a number of development cycles (software builds) since the initiation of the project. An initial operational build has been delivered to the TPDS operations team for an initial deployment to a limited user community at the Ames Research Center (ARC) Arc Jet Complex (AJC). Historical data collection efforts have focused primarily on the collection of data sets from the Constellation Program Crew Exploration Vehicle (CEV) project (now the Multiple-Purpose Crew Vehicle Program) and the Mars Science Laboratory (MSL) project, including data sets from ARC, the Johnson Space Center (JSC) Atmospheric Reentry Materials and Structures Evaluation Facility (ARMSEF), and the Arnold Engineering Development Center. A nearly complete collection for those two thermal performance test campaigns is archived, although only partially ingested into the tool.

The software application has a number of features designed for easy data ingestion and retrieval and application system administration. These features include a data browser, a test package upload interface, data product viewing pages, and a shopping cart and test data download tool. Administrative features include data administration, allowing an administrator to list, modify, and delete data within the system, and comprehensive security tools to implement user access control and secure data type designations.

Historical data collection efforts have been focused on CEV and MSL data sets and include data packages from the ARC AJC test facility and associated data packages from test principal investigators (PIs). Data sets have been collected, and the majority await ingestion into TPDS following initial deployment and data format modifications.

Among the significant findings identified by the TPDS team during development are the widely varying data formats among historical data sets, which made the software design challenging. Because of this, focus of the development effort was narrowed to only those data sets from the ARC AJC as a starting point for TPDS implementation. From this, it was concluded that

establishing data format standards and specifications for future testing is important, and much of the final efforts were directed at this aim. Another significant finding is the importance of involving the thermal performance community in the design of TPDS; this was successfully executed, particularly during the final year of the project.

This assessment has delivered a foundational tool on which additional features should be built to increase efficiency, expand the protection of critical Agency investments, and provide new discipline-advancing work opportunities. The ARC-specific application should be extended to the ARMSEF, and a concerted effort to expand the user base in the entry community should be undertaken. Additionally, a focused historical data collection, curation, and ingestion campaign should be funded to better leverage the existing tool, achieve the full intent of the initial proposal, and protect against the loss of critical Agency investments. Finally, the scope of TPDS should be expanded beyond arc jet testing to include radiant thermal testing and other material properties testing critical to thermal performance material and system development.

Future development is now underway, with significant involvement of the thermal performance community, managed and supported directly by the ARC AJC.

5.0 Assessment Plan

The original assessment plan, approved on November 19, 2009, was to deliver an operational database by the end of fiscal year 2011, accessible to all participating NASA Centers and industry partners with proper security and permissions, operated and maintained at both the ARC AJC and the JSC ARMSEF. The second major task was the collection, reformatting, and input of historical data (priority to the CEV Thermal Protection System (TPS) project and MSL data sets, proceeding to other projects at level of effort).

Two primary alterations of the original assessment plan were implemented.

The first was a continual reshaping of the scope of the software functions and capabilities to stay within the allocated resources. The initial software requirements were to:

- Collect and store data related to thermal performance (e.g., arc jet, radiant, solar, laser) testing, including test results, calibration records, test article configurations, facility operating parameters, and analysis results.
- Accept data from test facilities, test engineers, test PIs, thermal analysts, and computational fluid dynamics (CFD) analysts.
- Search for and report on holdings based on user-specified criteria.
- Extract specified data for general analysis purposes such as thermal analysis, CFD, data traceability, and margins assessment.

Significant systems engineering was completed to architect and better develop the requirements to deliver on these high-level goals. An architecture was laid out and development begun to achieve all of the requirements. However, to field a tool within the schedule and resources provided, the scope of the first operational system was scaled back to serve the primary test facility and test data archiving needs. As a result, most of the downstream analysis activities, including CFD and thermal analysis, were not implemented as features of the current database.

The second major alteration was the focus on historical data collection. The estimate for planning and resources to collect, curate, and archive the Agency's thermal performance test results was seriously underestimated. The decision was made to focus on the two most relevant (and recent) programs for the Agency's near- and mid-term priorities and limit the data ingestion to the MSL and CEV test campaigns. Furthermore, while significant data were collected and stored, only a subset of the data, in particular from the heater columns that continue to produce the most data, was formally added to the database.

While many elements of the vision for thermal performance data management were not achieved, the assessment laid a strong foundation for continued progress toward that vision and, more importantly, resulted in an operational tool that is actively protecting the Agency's critical investments, increasing the efficiency of the test operations, and supporting discipline-advancing work, which were the underlying goals of the assessment.

6.0 Problem Description and Background

The motivation for this assessment stemmed from the lack of a central database for thermal performance test results and analyses from previous and current flight projects requiring TPS development. Loss of significant NASA investments in thermal performance materials testing were risked due to the lack of a central repository for data generated from test and analysis activities at test facilities dispersed around the country. Thermal performance data sets are key to maintaining and advancing TPSs for NASA's current and future space exploration strategies. Data sets classified in this category include data sets that reach back to the beginning of the space age, given the unique nature of thermal protection technology development.

As a solution to dispersed and unarchived data sets, the concept of the TPDS was created to provide a centralized repository for thermal performance data. The scope of the repository was envisioned to include all data sets from current and past thermal performance testing, with a focused historical data collection program to gather data sets from past Programs, projects, and test campaigns. Additionally, the database was to become an integral element in future testing, serving as a tool for test planning, test data processing and delivery, test data archiving, and associated test analyses collection. Furthermore, the critical analysis tasks that follow thermal performance testing were to be critical elements of the database. After a given test, the heating environment is often simulated using CFD, which feeds inputs into thermal analysis to simulate the material response to aeroheating. Analysts retrieve the critical inputs from the database and then upload the results to form the metadata for follow-on analysis. Understanding the analytic and test processes that can empower decision makers to better direct material and TPS technology development was a focus of the early development.

The initial scope of the development of the database was limited to focus on the needs and uses of the ARC AJC. This served as a good initial scope for the development of the database, and most of the project achievements documented in this report focus on the initial version of the database.

6.1 Requirements Definition

At the beginning of the TPDS assessment, an extensive set of 106 requirements was generated to provide the technical specification for the database. Spanning data handling, data retrieval, security/user access, and administrative functions, the requirements were used to assess tool options for the database and led to the selection of the object-oriented data technology (OODT) platform as the foundation for TPDS. The OODT software was developed by the Jet Propulsion Laboratory (JPL) and subsequently released into the open-source community.

The initial version of the database that was delivered after a 3-year assessment period met 58 percent of the initial 106 requirements. Given the reduction in scope that the project underwent over the course of its life, this is considered a successful implementation. Requirements specifying search/query functionality, data display functionality, and mathematical post-processing of data were deferred to later development efforts. This is the result of a

carefully considered reduction in scope that occurred as the details of the development were better understood with time.

6.2 System Design and Development Activities

The power, utility, and promise of the TPDS system stems from centralizing present and past thermal performance data sets. This presented the greatest challenge in designing and developing TPDS. The wide range of data sources dispersed in time and location necessitates a system that is able to handle widely varying data formats. The original intent for the system was a highly flexible, intelligent data-handling service. However, as the project progressed, developing a highly flexible system capable of handling widely varying and sometimes undefined data formats presented a development challenge not sufficiently bounded to successfully move toward an initial robust system. Therefore, a concerted effort was made, with the aid of the stakeholders, to standardize the data formats for data products expected for the TPDS initial deployment. This is addressed in Section 6.3.

Other development activities included:

- Conduct meetings with ARC AJC test engineers to document and understand test facility processes and data flow.
- Develop a comprehensive data model to capture the expected data products and metadata.
- Develop the TPDS system architecture to provide a robust system with the flexibility to evolve with TPDS future development.
- Conduct a security summit to document stakeholder security needs from the thermal performance community.
- Conduct periodic system tests to receive stakeholder inputs during interaction with the database.

6.3 Establishing Data Format Control

As a basis for a robust system, a significant effort was undertaken in conjunction with the ARC AJC test facility personnel to standardize data formats for test facility data packages, which were the primary data set for the initial deployment of the database. Interface control documents (ICDs) were developed for two data sets: the Interaction Heating Facility (IHF) [ref. 1] and the Aerodynamic Heating Facility (AHF) [ref. 2]. These documents are shown in Figure 6.3-1. The documents provided guidance to software developers in the implementation of the system design and established the basis for future ICDs as the breadth of data that can be handled by the database continues to expand.

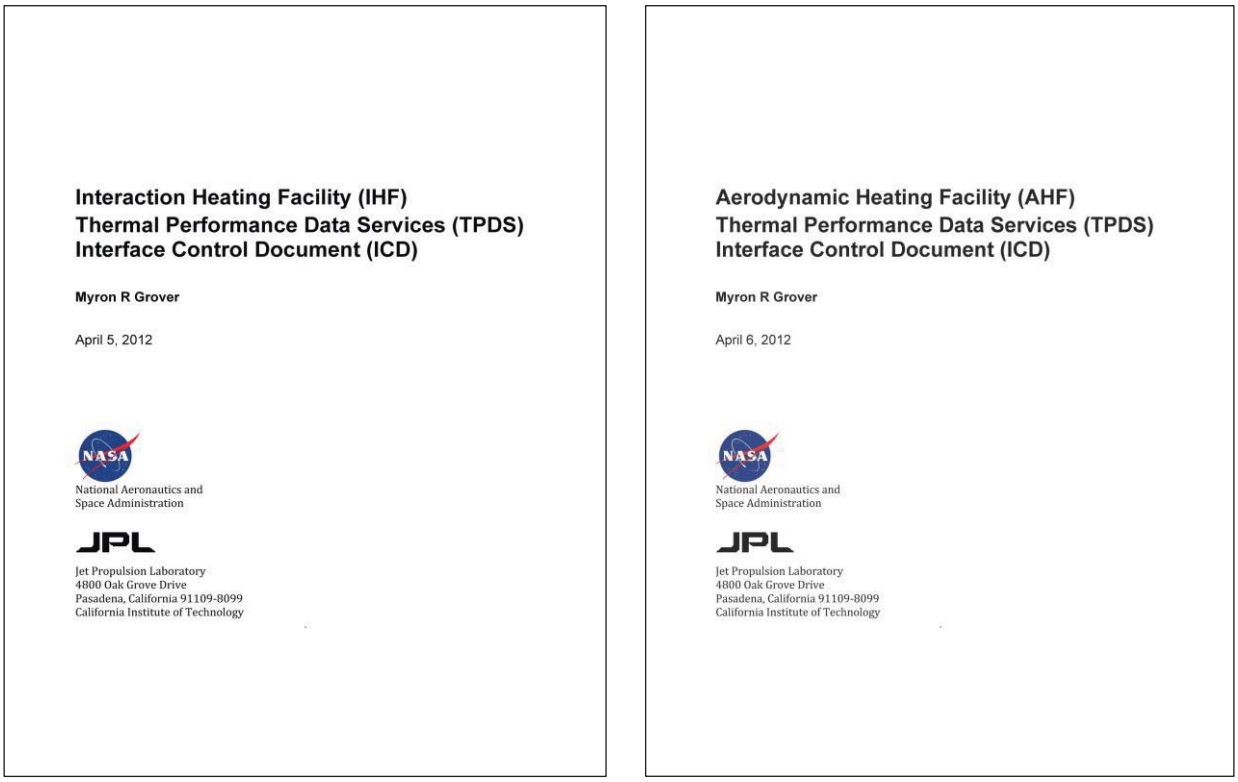


Figure 6.3-1. TPDS ICDs

6.4 Hardware Architecture

The TPDS hardware is hosted in a data center at the NASA Advanced Supercomputing (NAS) Center at ARC. The data server hardware layout is shown in Figure 6.4-1 and consists of:

- A TPDS production server consisting of two Intel® Xeon® X5670 2.93 GHz processors, 36 GB of DDR3 RAM, and 16 TB of disk storage running CentOS 5.6.
- A TPDS development server consisting of two Intel® Xeon® X5670 2.93 GHz processors, 18 GB of DDR3 RAM, and 8 TB of disk storage running CentOS 5.6.
- Complete data backup provided by the NAS facility.

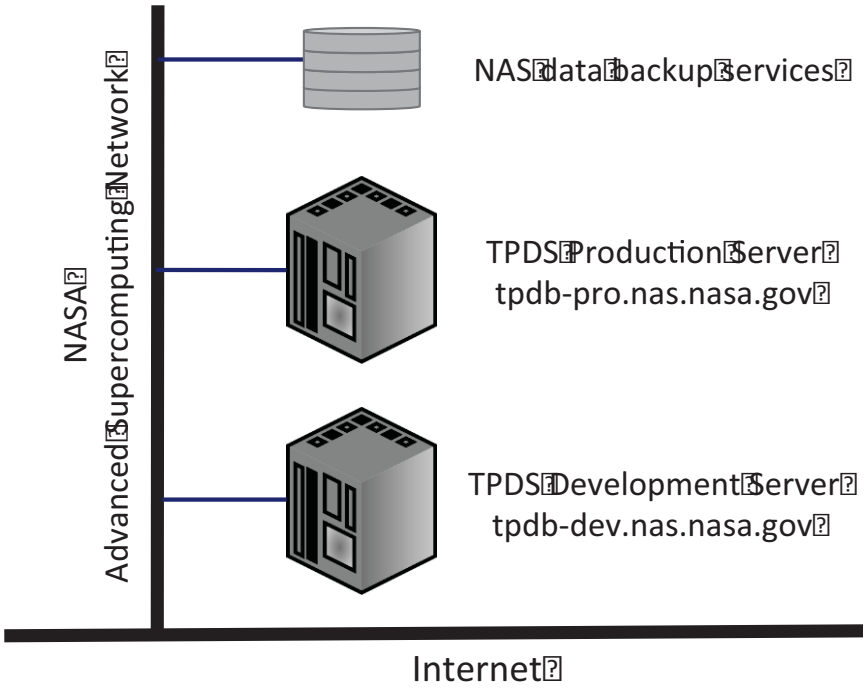


Figure 6.4-1. TPDS Hardware Layout

The servers and associated disk storage were sized to provide enough computing power and data capacity for at least the first 5 years of operational service. Because data storage backup is provided by the NAS facility, no additional TPDS hardware was required. The system is firewalled behind the NAS network. External access, which is discussed in more detail in later sections of this report, is granted through the NASA Account Manager System (NAMS).

6.5 Software Architecture

The TPDS software architectural design must function to achieve data crawling, data extraction, data recognition, and data archiving, with an easy-to-use Web interface. To achieve these goals, the software is architected as shown in Figure 6.5-1. This architecture provides robustness and security while allowing flexibility to evolve over time as the database matures.

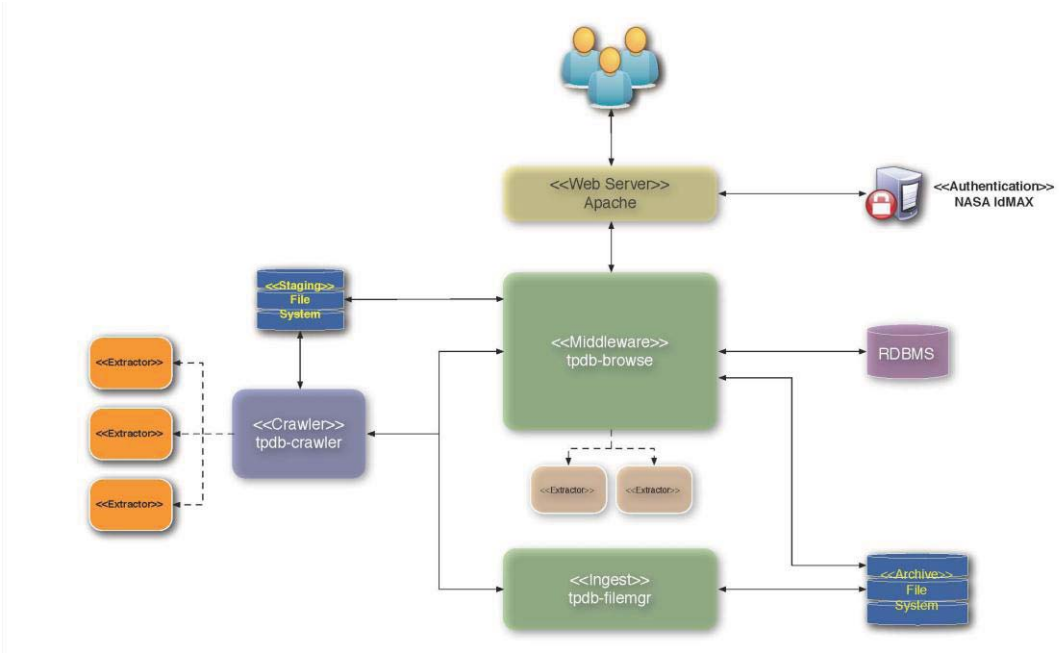


Figure 6.5-1. TPDS Software Architecture

At the front end of the architecture are the data extractors that transform tabular metadata and binary artifacts, such as images and videos, into extensible markup language records describing test run number, condition, insertion instruments used, and linkages between artifacts. The extractor is a pure Java™ standalone application.

Much of the middle and backend of TPDS is founded on OODT. Following the action of the extractor, data products are crawled and organized by the TPDB crawler, which is an implementation using the OODT crawler framework. The crawler implements the IHF and AHF ICD rules on data packaging and naming, invokes built-in or external metadata extractors, and submits data files to the OODT file manager for archive. The TPDB-browse element is the middleware of the system and is the brains of the TPDS system for security, metadata capturing and coordination, significant event trapping, and file downloads. The middleware is implemented with the open-source Grails Web framework, which is built with the open-source Groovy dynamic scripting language that runs on the Java™ virtual machine. Grails provides the industry standard model-view-control architecture. *Model* is the business logic integrated with a backend relational database. *Control* handles all user requests and Web-service interfaces. *View* implements the Web user interface. The TPDB-browse middleware communicates with Oracle® MySQL™, a relational database management system to manage the organization of the data within TPDS.

A data model of the IHF/AHF data sets was completed (shown in Appendix A). The ARC AJC test facilities (IHF/AHF) deliver data as a test series. Each test series is a multi-gigabyte artifact. A test series contains multiple test runs. A test run contains multiple test conditions. A test condition contains multiple insertions. There are media artifacts, such as videos and photos, for

test series and test runs. The TDPS system is designed to intelligently link artifacts to the test series/run/condition/insertion by detecting file naming conventions, physical location of the artifact (i.e., the folder where it was found), and metadata within the data files (see Figure 6.5-2).

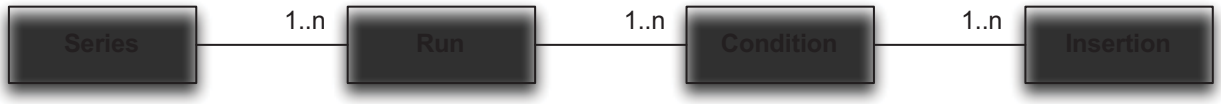


Figure 6.5-2. Top-Level Facility Artifacts Schema

6.5.1 Test Series Schema

The test series provides a top-level grouping of a collection of data artifacts. There are also media and engineering artifacts (see Figure 6.5-3). Data artifacts can be registered to a test series in any random order, which makes TPDS a dynamic data system.

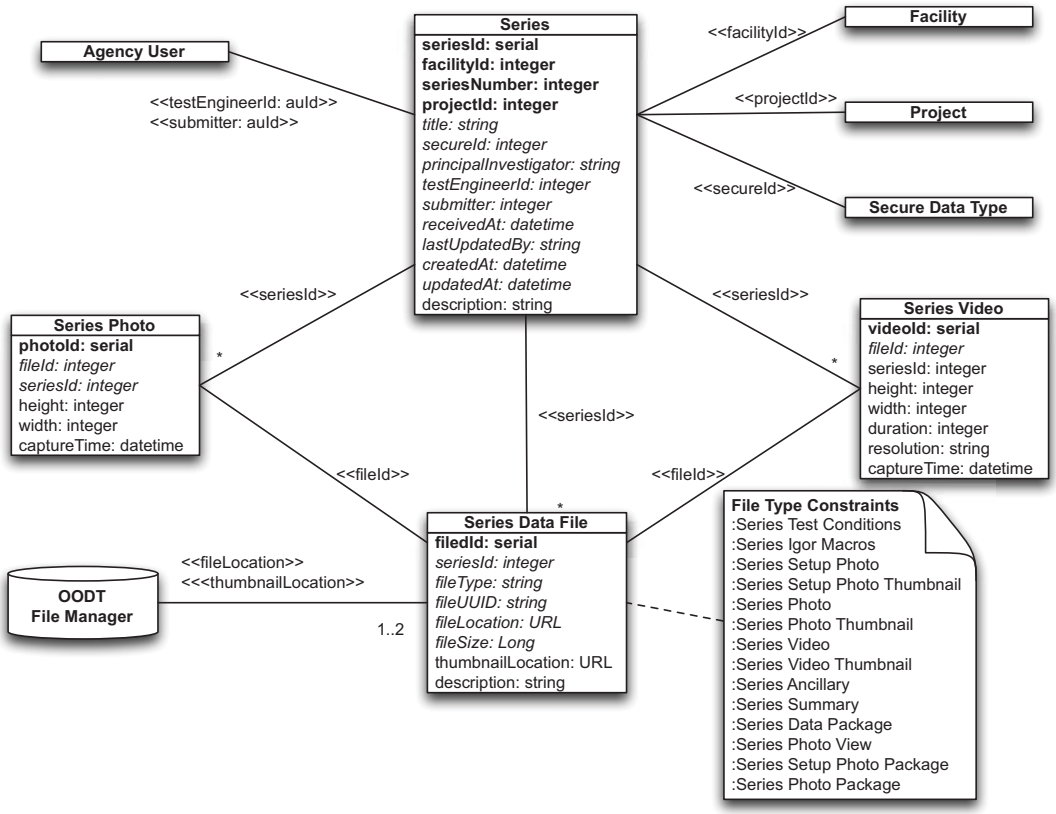


Figure 6.5-3. Test Series Schema

6.5.2 Test Run Schema

There are one or more test runs for a given test series. Like a test series, a test run contains media and engineering artifacts (see Figure 6.5-4). The artifacts can be registered to a test run in any random order. This makes the system flexible and allows for future post-ingestion registration of additional artifacts.

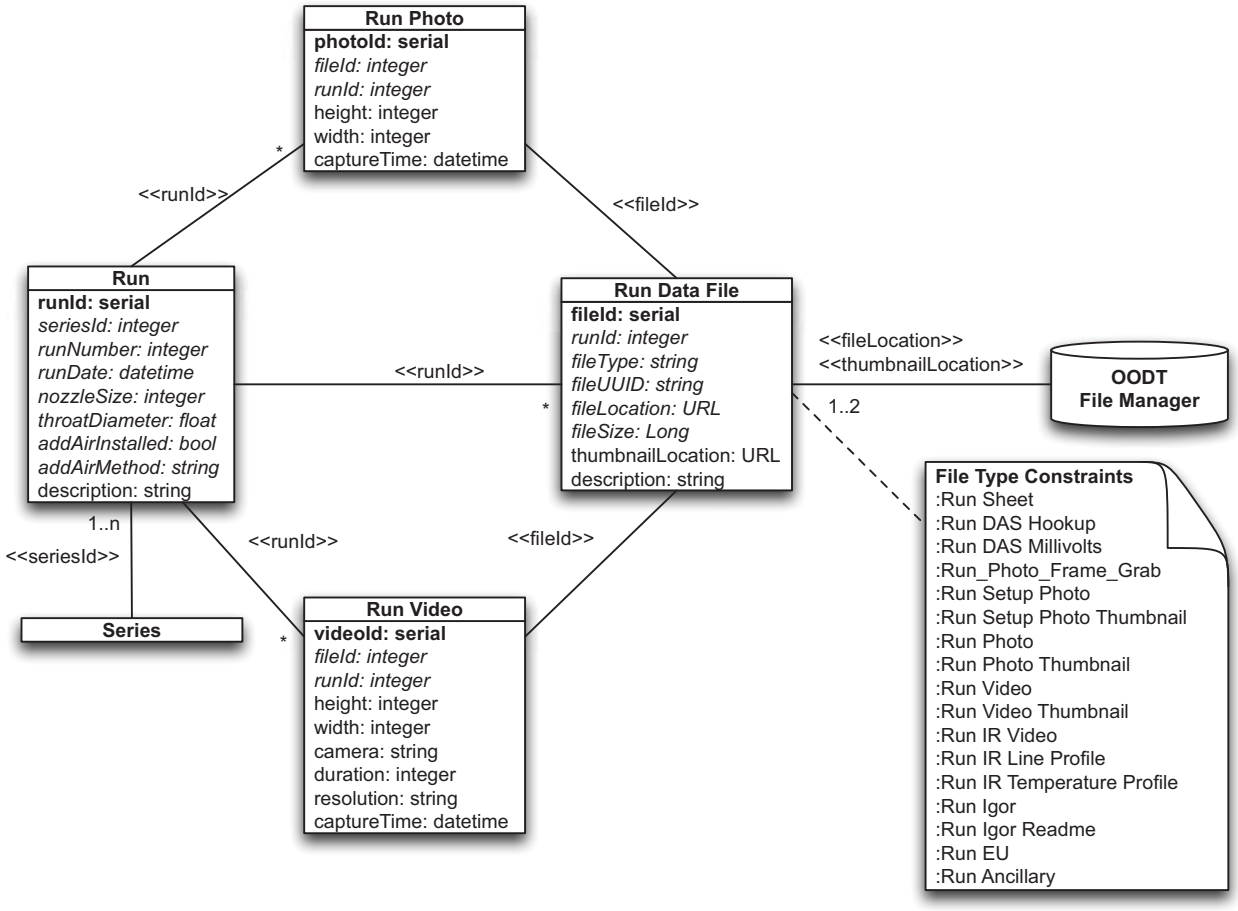


Figure 6.5-4. Test Run Schema

6.5.3 Test Condition and Insertion Schema

Each test run can contain one or more test conditions, and each test condition can contain one or more insertions (see Figure 6.5-5).

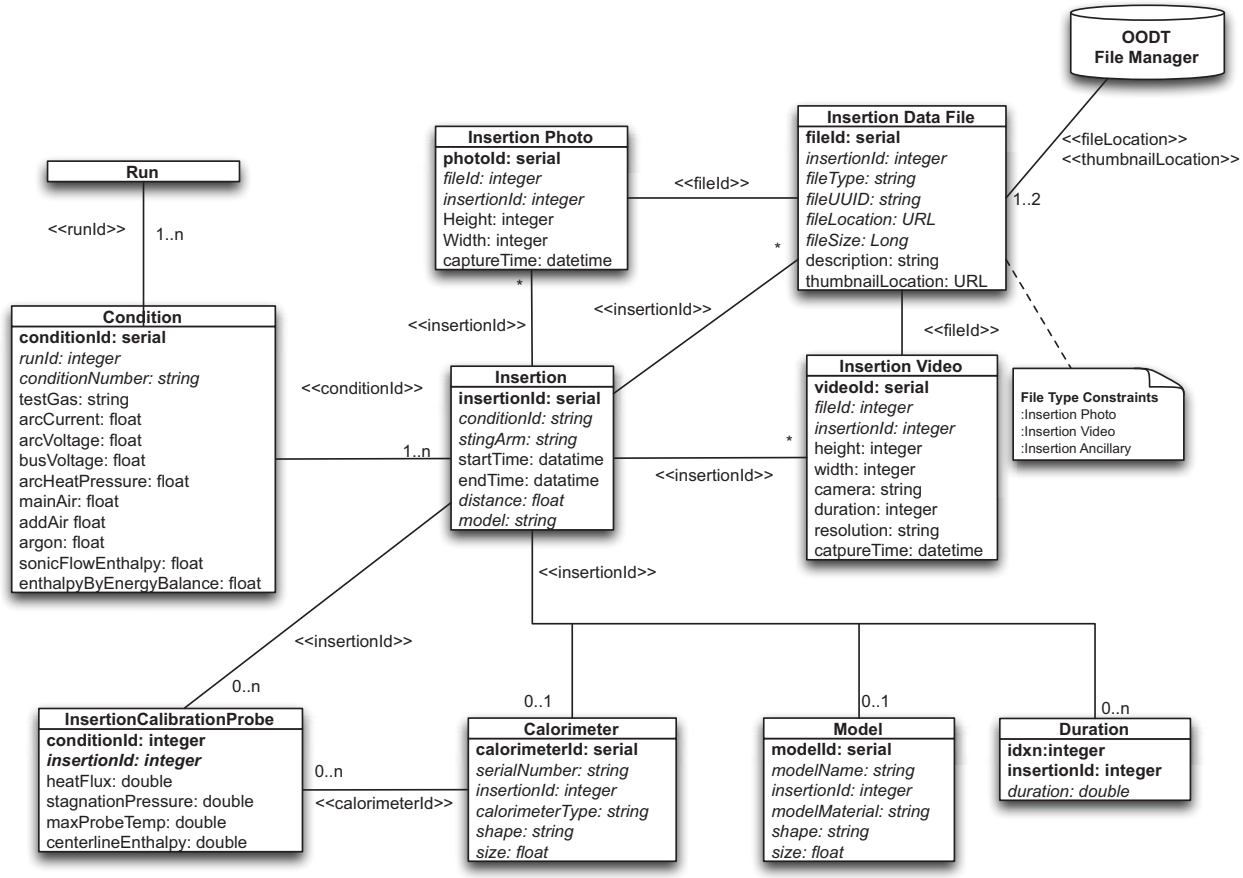


Figure 6.5-5. Test Condition and Insertion Schema

6.5.4 Security Schema

Security is important for the TPDS because the system contains International Traffic in Arms Regulation (ITAR) data and supports multiple project artifacts. The system must also provide administrative tools for the TPDS administrator to manage users of the system. The schema below provides a flexible linking between artifacts, access roles, and users (see Figure 6.5-6). TPDS is designed to use NASA IdMAX authentication service, which provides secure access and communication to TPDS. A more detailed security presentation presented at a security meeting with the TPDS application community is presented in Appendix B.

Access Role
Provides abstraction for access groups
Example groups
CEVRead
CEVFacility
Capabilities attribute is a bit-oriented mask value
NO_CAPABILITY = 0
READ = 1
GET = 2
CREATE = 4
UPDATE = 8
UPLOAD = 16
DELETE = 32

Secure Data Type
Core representation of secure data product type.

Agency User
User will be authenticated by NASA IDMax. This class defines any special user privileges. Privileges set here will override all data product access capabilities. If no special privilege given, then each access will be evaluated according to the user + data product access role relation
Special User Privileges Constants
NO_CAPABILITY = 0
READ_ALL = 1
WRITE_ALL = 2
ADMIN = 3

Secure Data Type Role
The join between Access Role and Data Product to define many-to-many relation to define associate access roles to each data product

Agency User Role
The join between Access Role and Agency User to define many-to-many relation to define access roles for each user

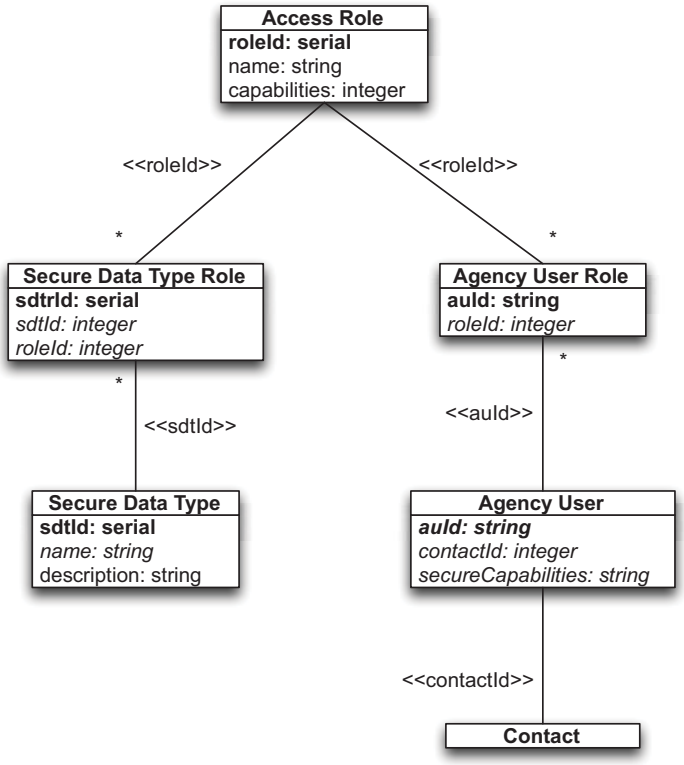


Figure 6.5-6. Security Schema

7.0 Testing and Development

A regular process of software development and testing was used throughout the life cycle of the TPDS project. Table 7.0-1 lists the major builds and the dates they were completed and provides a brief description of the builds. For each of the builds, an internal quality assurance (QA) test program was used at the completion of the builds to confirm functionality and identify and resolve any bugs in the system.

Table 7.0-1. TPDS Build History

Build Number	Date	Description
0.0	March 2011	An initial prototype build custom-designed for the needs of the 4th Air Force (AF)/Sandia National Laboratories (SNL)/NASA Ablation Workshop.
1.0	June 2011	First prototype build with metadata extractors and data archiving.
1.1	August 2011	A prototype build with metadata extractors, data archiving, and user interface. Build 1.1 was used in System Test 1 (ST1), the first software development test with user community.
2.0	March 2012	Lessons learned from ST1 were fed into Build 2.0, resulting in significant improvements in system robustness and user interface usability. Build 2.0 was used in the System Test 2 (ST2).
3.0	May 2012	Results from ST2 fed into the final build, Build 3.0. In addition to IHF, Build 3.0 added capability to handle data from the ARC AHF facility. Build 3.0 was delivered to ARC on May 22, 2012, for eventual operational deployment.

For the later software builds, in addition to QA testing, ST1 and ST2 were conducted on site at the ARC AJC to exercise the database with key stakeholders to further identify programming bugs, receive user feedback, and ensure the system was being developed to meet the needs of the thermal performance community. Figure 7.0-1 shows a TPDS test conductor aiding a PI test subject during ST1. The results of ST2 aided in generating the final build, Build 3.0. Build 3.0 was delivered to the Human-Computer Interface (HCI) team at ARC in May 2012, and responsibility for TPDS operations and continued development was transferred from JPL to ARC personnel in June 2012. The ARC HCI team built a strong relationship with the AJC team during the JPL-led development. Not only did they take on the operational management and maintenance of TPDS but also continued the final development of Build 3.0. Build 3.0 was deployed for use by the test facility in March 2013.

Figure 7.0-1. ST1 PI Exercising TPDS

7.1 Applications Feature

The following sections highlight some of the TPDS main features.

7.1.1 Entry Page

Visitors to the TPDS are routed through NASA's IdMAX authentication process. Access is granted only to approved users. Once authenticated, users are taken to the TPDS entry page shown in Figure 7.1-1. The entry page contains links to the data browser via the Browse link and to the administration features via the Admin link.

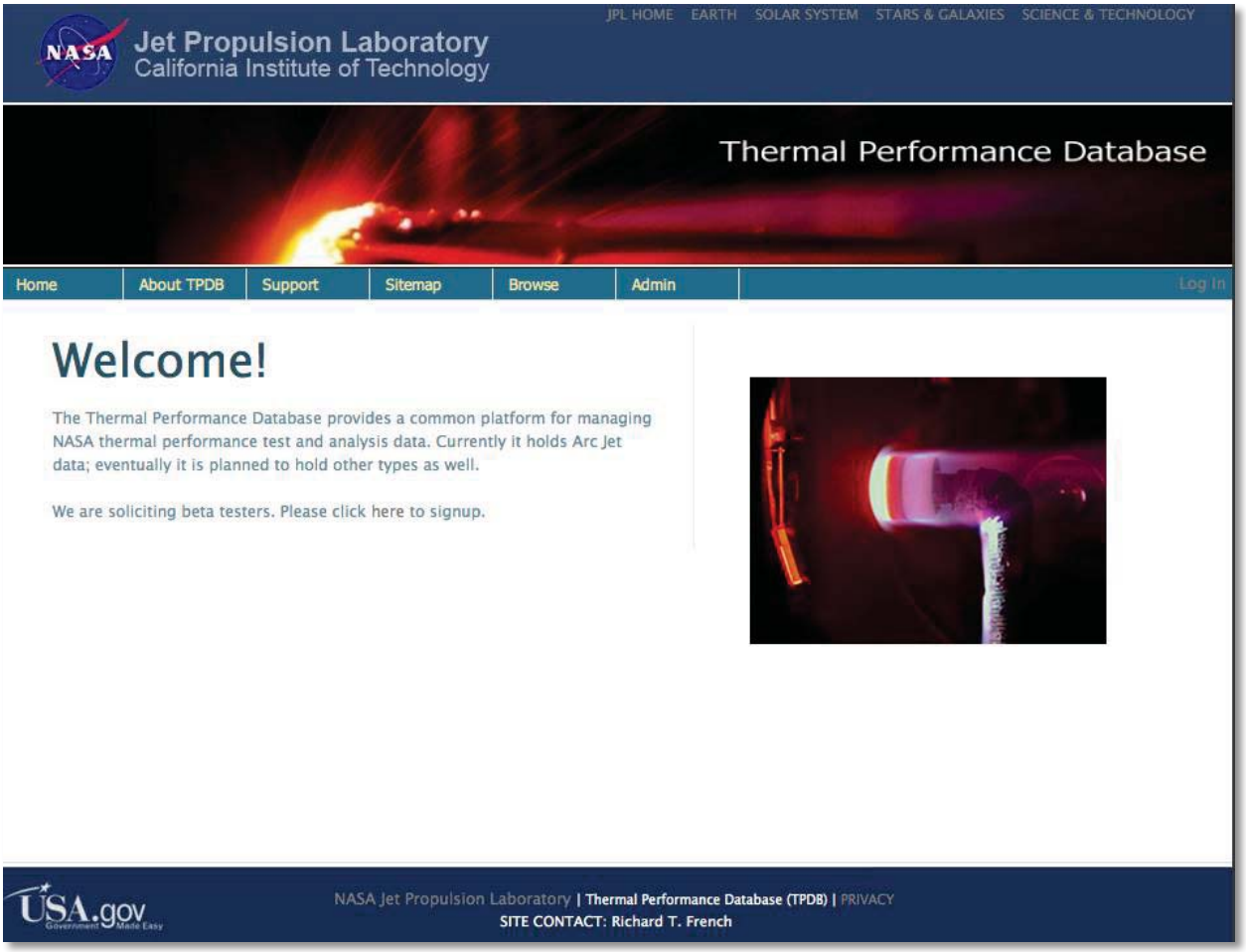


Figure 7.1-1. TPDS Entry Page

7.1.2 Browse Page

The browse page is the central feature of TPDS. It provides access to test facility data sets by test facility or project. The data can be sorted by project, test series, test run, facility, contact, instruments, test conditions, and run sheets. The data product listing, shown in Figure 7.1-2, can be used to drill down into a test series data package to access specific data products within a test series, including test plans, data files, test photos, and test videos.

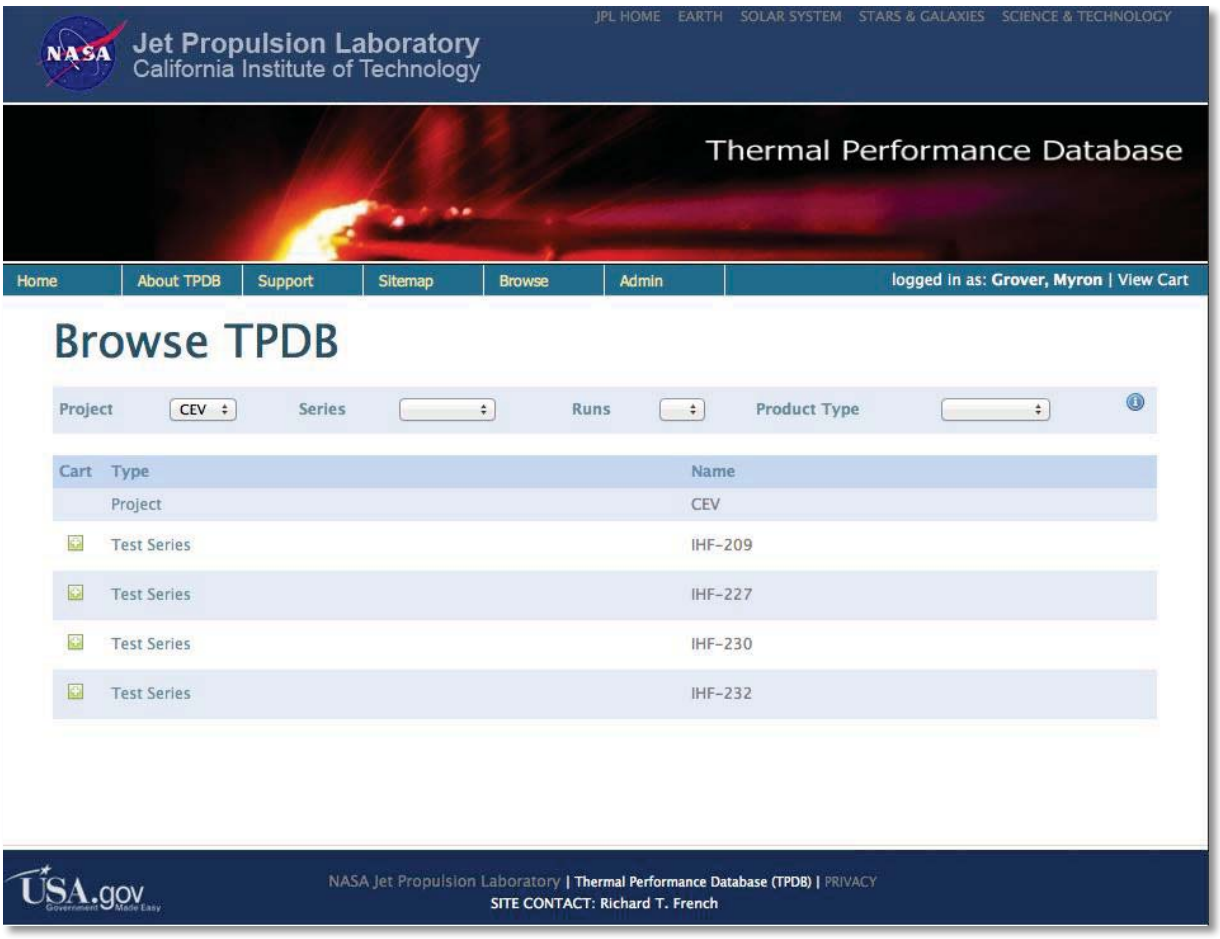


Figure 7.1-2. TPDS Browse Page

7.1.3 Test Series and Test Run Page

Accessed through the browse page or the administration page (discussed later), a test series page contains detailed attributes of the test series, such as project, PI, and test engineer, and links to test series photos, data files, and test runs. The test-run links allow access to test-run pages that contain detailed attributes of a test run, such as test series, run number, run date, and nozzle size, as well as links to each test condition, run photos, and run videos. A sample test series page, with links to test runs expanded, is shown in Figure 7.1-3.

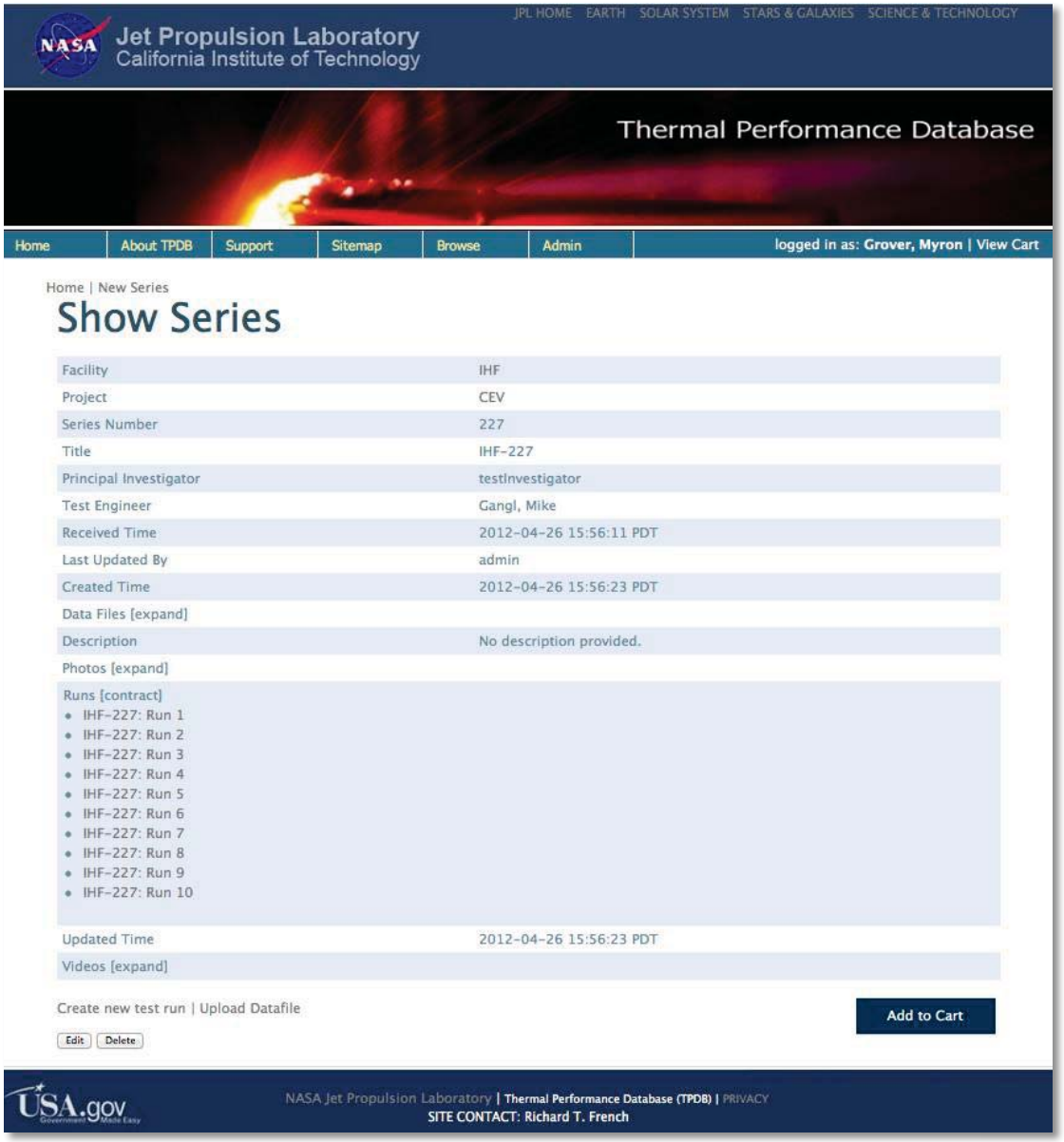


Figure 7.1-3. Show Test Series Page

7.1.4 Shopping Cart Feature

For ease of selecting and downloading data products, TPDS has a shopping cart feature that can be loaded with data products by a user (see Figure 7.1-4). When the user is finished browsing or searching the database, the user can "check out" and download the contents of the shopping cart. If there is more than one item in the shopping cart, the items are packaged in a zip archive, and an email message with a download link is sent to the user when the package is ready.

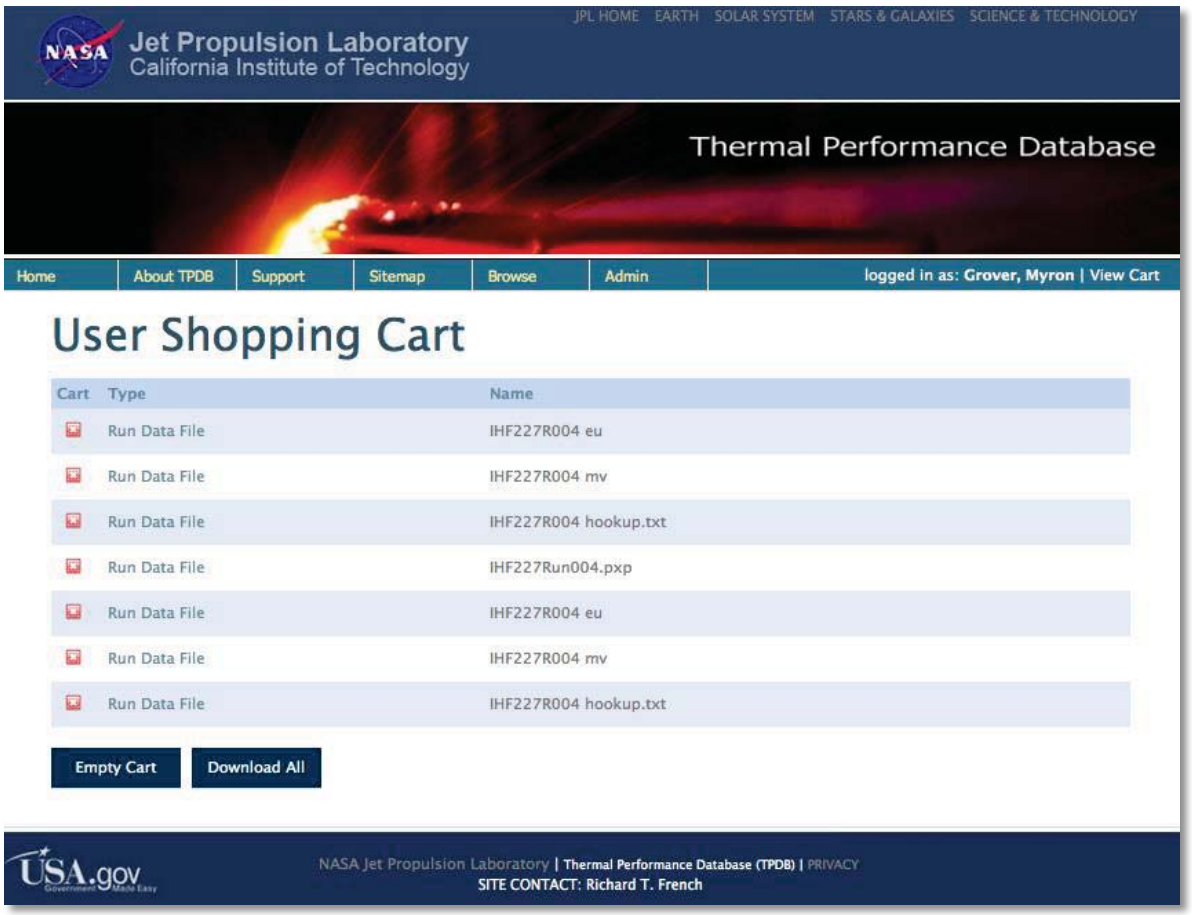


Figure 7.1-4. TPDS Shopping Cart Feature for Data Product Download

7.1.5 Test Package Upload

Test series data packages are uploaded following the completion of a test series test report, either by a test engineer or by a qualified intern assistant. Figure 7.1-5 shows the data package upload interface.

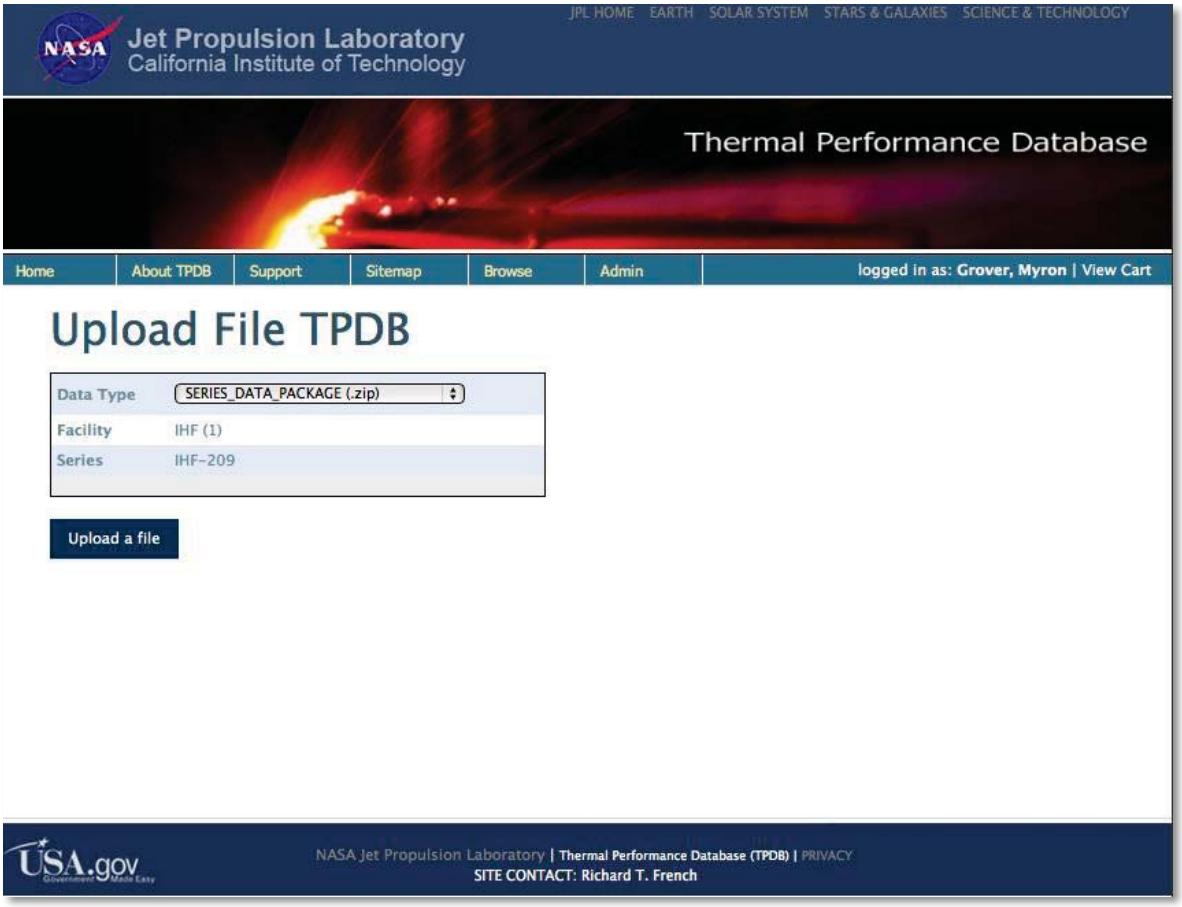


Figure 7.1-5. Data Package Upload Interface

7.1.6 Administrative Features

The TPDS has an administrative page, as shown in Figure 7.1-6. Only users with administrator privileges can access the administrative page; the administrative page provides links to the tools required by a TPDS system administrator. From the administrative page, an administrator can create new facilities, projects, users, custom user roles, and secure data types. The administrator can list users, access roles, and secure data types. Also provided are product administration tools to allow the administrator to list all classes of data products and edit or modify these as needed. The administrative tools allow the administrator to execute the security system presented in the next section.

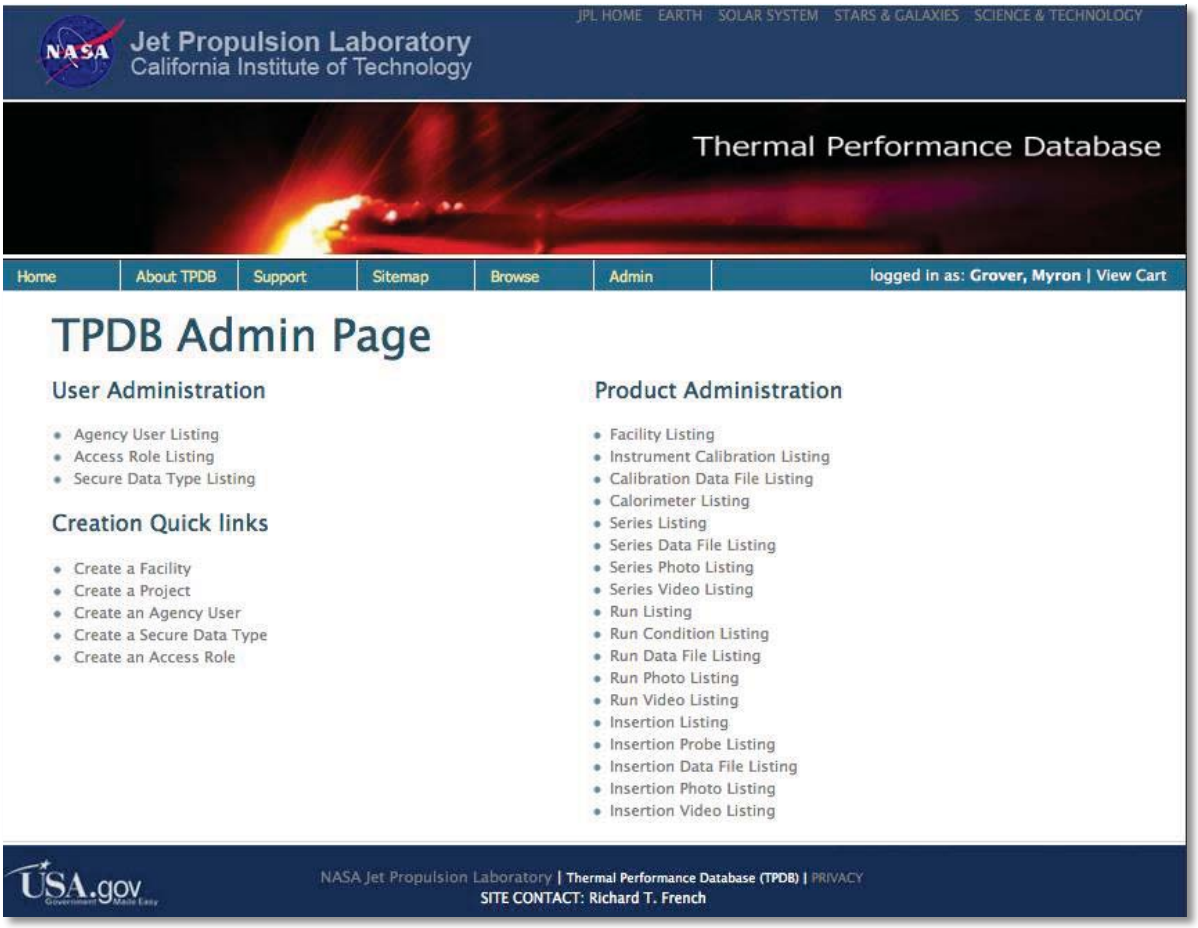


Figure 7.1-6. TPDS Administration Page

7.2 System Security

The TPDB hardware is physically secured in the access-controlled NAS facility at ARC, which is physically maintained and monitored by the facility. All system hardware administrative services are provided by the facility.

User access control is accomplished via the NAMS. Any potential user of TPDS must first obtain a NASA Agency account and then request TPDS access via NAMS, as shown in Figure 7.2-1. Once the request is in the NAMS system, a project point of contact (POC) representing the project whose data will be accessed must authorize the establishment of the account. Once authorized, the TPDS administrator will set up the initial account. Following the establishment of the account, the project POC can use administrative privileges to modify data access for the role of the new user.

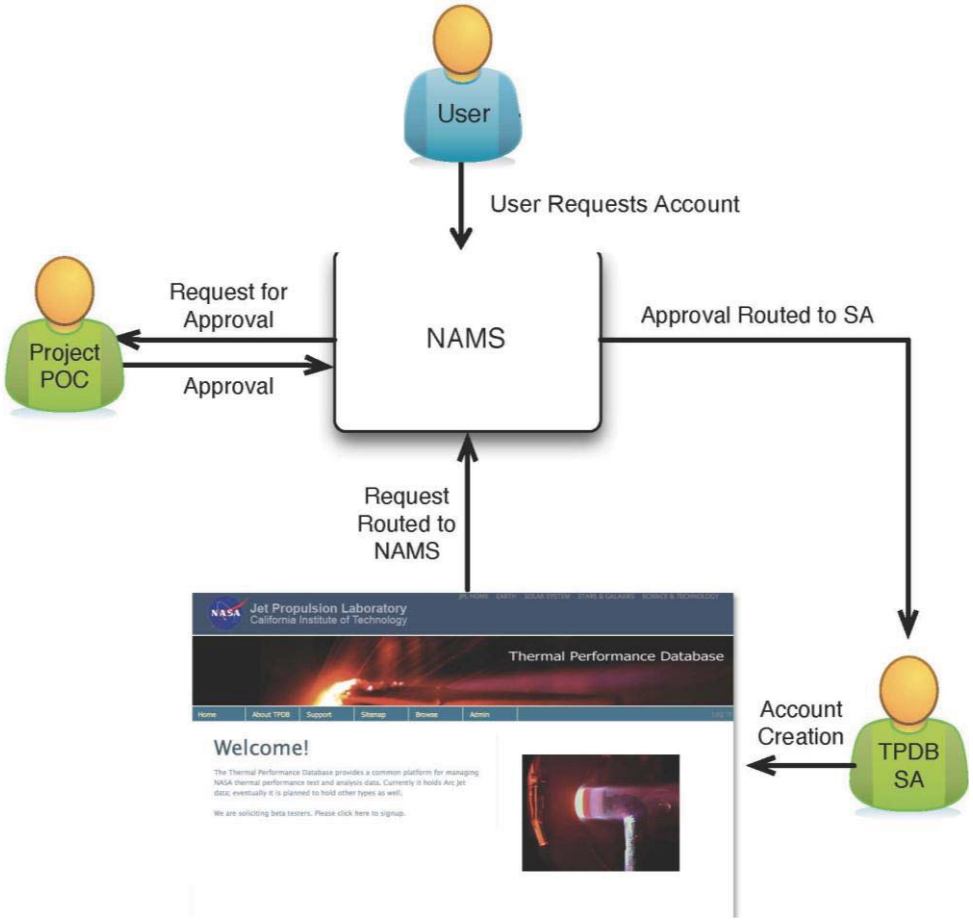


Figure 7.2-1. TPDS Account Request Process

The TPDS administrative tools allow the designation of secure data types for all data within the database. The TPDS administrator and project POC can create custom data types and designate user roles that have access to that data type. This implementation allows the database to contain data products from multiple projects, institutions, and companies, while controlling access to data sets based on user project affiliation and role within the project. Figure 7.2-2 shows the secure data type listing page. Figure 7.2-3 shows TPDS data types that have global access and restricted access, with restricted access being set by project affiliation and user role. While browsing data within the database, users can see only the data to which they have access. There is no ability for a user to see other data products that exist within the database outside the data that are accessible to that user.

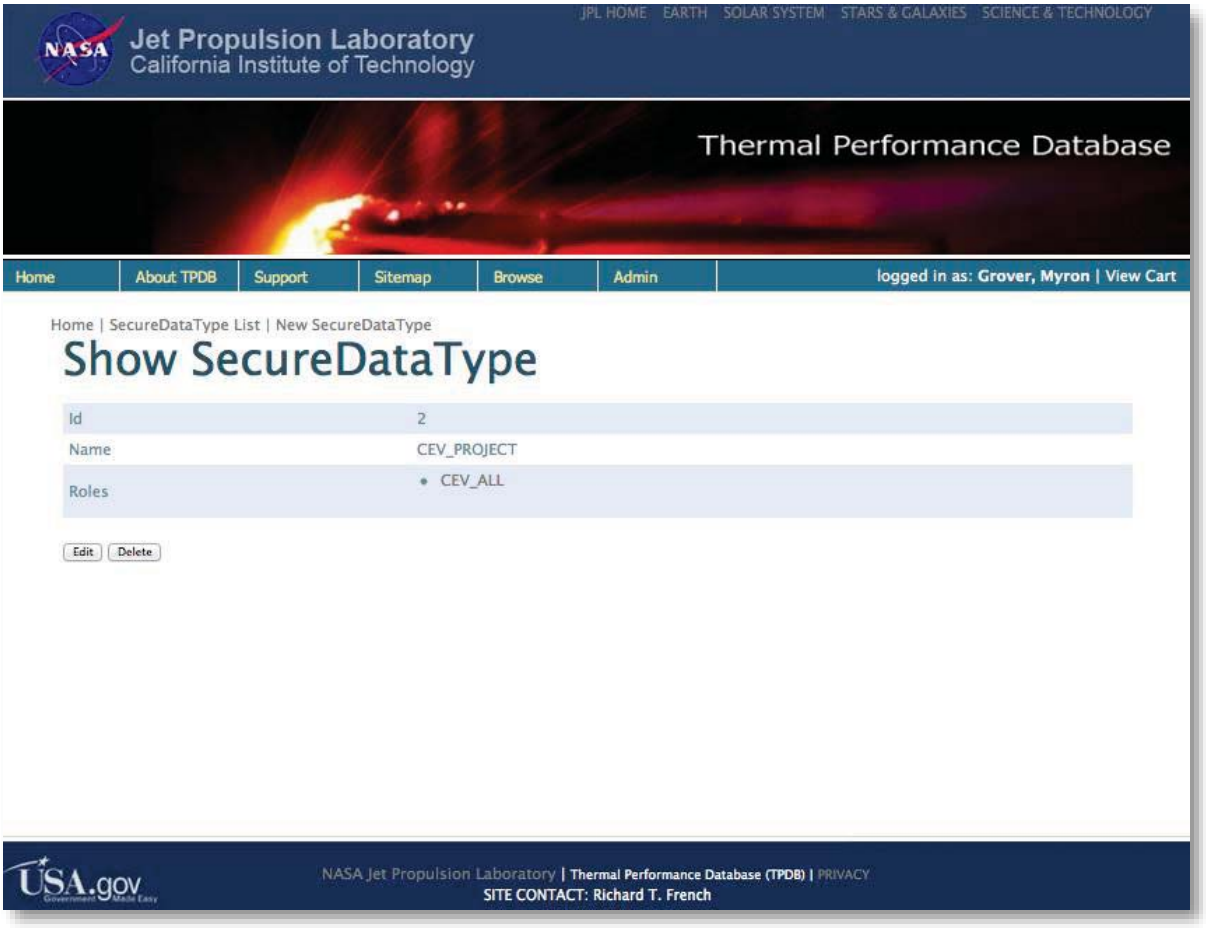


Figure 7.2-2. Secure Data Type Listing

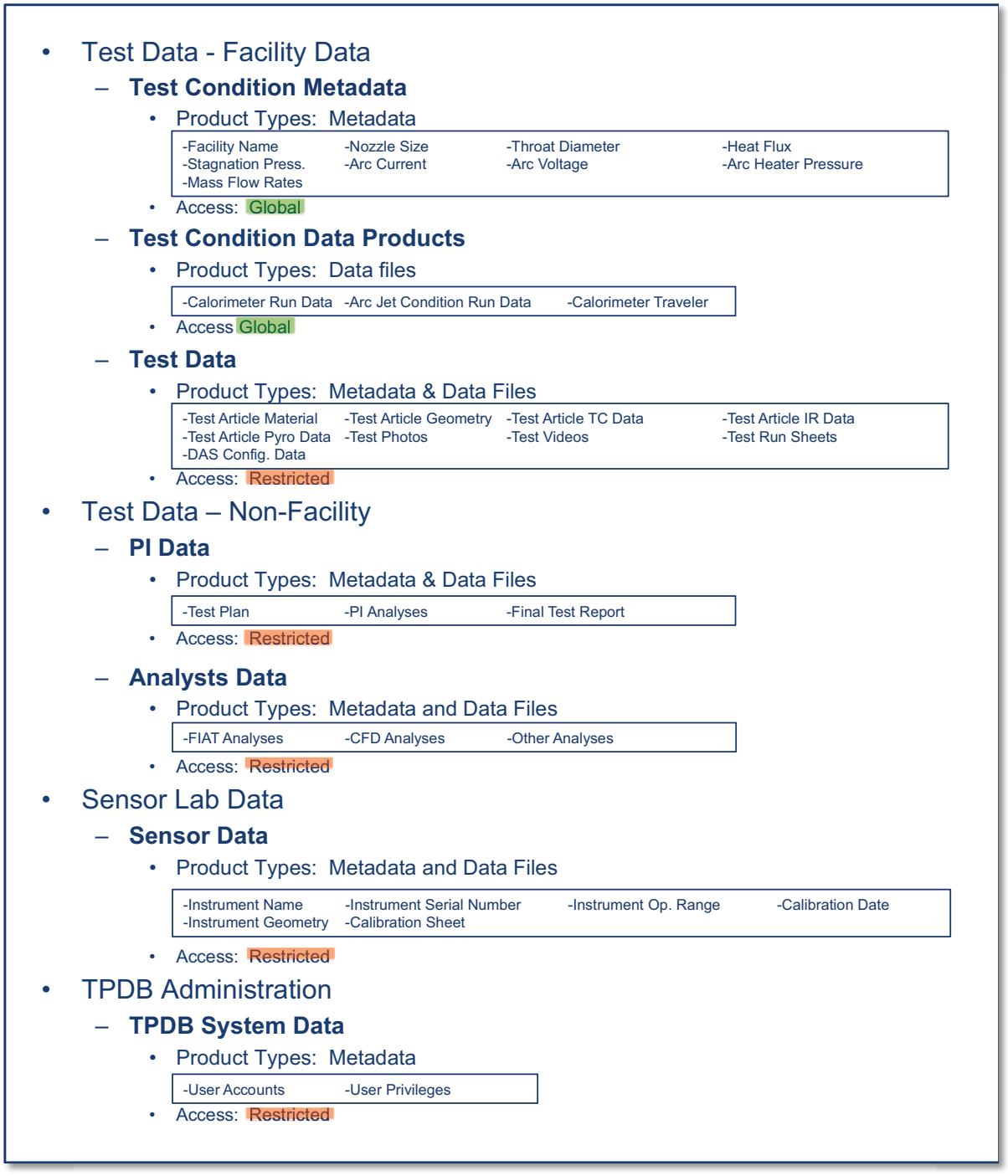


Figure 7.2-3. TPDS Global and Restricted Data Types

Strict compliance to restrictions on foreign national access to ITAR-restricted data is also achieved through the use of secure data type designations. TPDS users designated as foreign

national users will have an ITAR access data mask applied to their privileges. TPDS will work with the ARC Entry Systems and Technology Division management to identify ITAR-sensitive data products; foreign nationals will not be able to access these data products based on the ITAR-tagged secure data type designation.

The initial deployment of TPDS will be available to a limited user set within the ARC AJC test facility, requiring a limited implementation of the security system. However, Build 3.0 contains all of the necessary features to implement a full security system for a broad user community, including the implementation of ITAR access restrictions.

7.3 Operational Status

TPDS Build 3.0 was delivered to ARC on May 22, 2012, and was deployed on the TPDS development server for assessment by the ARC HCI team, which has assumed ownership of the database and now has responsibility for quality control. The ARC HCI team completed a technical assessment of the delivered database as part of the responsibility handoff. Building on their experience with database and human-system interaction development and having developed a working relationship with the AJC team, the ARC HCI team picked up the development and completed the operational database. The operational deployment of TPDS for only the ARC AJC test personnel was completed in March 2013.

7.4 Interaction with the Thermal Performance Community

The TPDS team interacted with the thermal performance community throughout the life cycle of the assessment. Interactions with the thermal performance community were critical to the success of the development of the database and key to providing a tool that is useful and that facilitates the processes employed by the community. Interactions took the following forms:

- Meetings and consultations with the test facility staff and PIs at the ARC AJC test facility, to understand test facility processes and needs.
- ST1 and ST2, to provide an opportunity for the thermal performance community to interact with development versions of the database and provide input on its function and form. The briefing package for ST2 is included as Appendix C.
- A security summit with the ARC thermal performance community to provide an overview of the security implementation plan and receive inputs on how the plan should be tailored to community member needs.
- A TPDS poster at the International Planetary Probe Workshop 7 in 2010, to reach out and interact with the international planetary exploration community.
- A TPDS presentation, poster, and custom implementation of the database at the 4th AF/SNL/NASA Ablation Workshop, in 2011, to inform the thermal performance community regarding the potential of the database.
- A TPDS poster at the International Planetary Probe Workshop 9, in 2012, to reach out to and update the international planetary exploration community on TPDS progress.

7.5 Transfer of System to Sponsor

During the course of this assessment, an agreement was reached with the HCI team at ARC to take responsibility for TPDS operations, maintenance, and long-term development. To aid in a seamless handoff, the HCI team began working with the TPDS team a year before the planned transfer, allowing the HCI team to become educated on the system architecture, technical implementation, and customer processes prior to the transfer of responsibility. The TPDS system was transferred to the HCI team on May 22, 2012, allowing approximately 1 month of overlapping responsibility with the TPDS development team. The HCI team formally took full responsibility for TPDS on June 28, 2012, which concluded the development efforts of the NESC-funded TPDS development team. The HCI is continuing development under ARC AJC funding and direction.

8.0 Findings, Observations, and NESC Recommendations

8.1 Findings

The following findings were identified by the TPDS team based on their experience with this task:

F-1. Existing thermal performance data sets are widely dispersed at test facilities; with PIs at NASA, private industry, and universities; and with data analysts, making them a challenge to collect.

F-2. Historical data sets vary in format, and as such it is difficult to design a robust, reliable system that can interpret and ingest varying or unknown formats.

F-3. Standardization of data packaging and data formats is key to establishing a bounded, tractable development challenge.

F-4. Older historical data sets will require significant manual reformatting to prepare them for ingestion into TPDS.

F-5. Integration of customers into the development process is important to developing a system with high value and utility for the target user community.

F-6. A foundational TPDS tool has been developed based on a subset of MSL and CEV data. The existing Agency reservoir for such data is quite large, and the utility of the tool relies on the continued integration of these data in the TPDS.

8.2 Observations

The TPDS team noted the following observations that could have an impact on future archival initiatives:

O-1. There is a clear need for a central data repository for the thermal performance community, and the initial implementation of the TPDS illustrates the promise and utility of such a system.

O-2. Customer enthusiasm grows with capability and maturity of the system, and it is important to foster this enthusiasm to maintain project momentum.

8.3 NESC Recommendations

The following NESC recommendations were identified:

R-1. Continue the historical data collection efforts begun during the initial years of the TPDS project, emphasizing data sets outside the ARC AJC, before these data are lost. ***(F-1)***

R-2. As the TPDS system matures, continue to work the standardization of data packaging and formatting, and expand the data sets to include radiant thermal testing. ***(F-2, F-3)***

R-3. A focused historical data collection, curation, and ingestion campaign should be funded to better leverage the existing tool, achieve the full intent of the initial proposal, and protect against the loss of critical Agency investments. ***(F-4, F-6)***

R-4. In future development work, provide greater integration of TPDS development with ARC AJC test facility process development and ongoing test facility upgrade planning. ***(F-5)***

R-5. Extend TPDS capabilities to include CFD support tools, in particular to augment test data sets with analytically anchored flow properties such as enthalpy and composition. ***(F-5)***

R-6. Extend TPDS capabilities to include material thermal modeling support tools, in particular for augmenting test data sets with analytic predictions of bond line temperature and material response for eventual efficient comparison with test results. ***(F-5)***

R-7. The scope of the TPDS should be expanded beyond arc jet testing to include radiant thermal testing and other material properties testing critical to thermal protection material and system development. ***(F-6)***

R-8. The TPDS should be marketed to the thermal performance community to increase the user base and encourage additional developments, particularly integration into the ARMSEF data management processes. ***(F-6)***

9.0 Alternate Viewpoint

There were no alternate viewpoints identified during the course of this assessment by the NESC team or the NRB quorum.

10.0 Other Deliverables

No unique hardware, software, or data packages, outside those contained in this report, were disseminated to other parties outside this assessment.

11.0 Lessons Learned

No applicable lessons learned were identified for entry into the NASA Lessons Learned Information System (LLIS) as a result of this assessment.

12.0 Recommendations for NASA Standards and Specifications

No recommendations for NASA standards and specifications were identified as a result of this assessment.

13.0 Definition of Terms

Corrective Actions	Changes to design processes, work instructions, workmanship practices, training, inspections, tests, procedures, specifications, drawings, tools, equipment, facilities, resources, or material that result in preventing, minimizing, or limiting the potential for recurrence of a problem.
Finding	A relevant factual conclusion and/or issue that is within the assessment scope and that the team has rigorously based on data from their independent analyses, tests, inspections, and/or reviews of technical documentation.
Lessons Learned	Knowledge, understanding, or conclusive insight gained by experience that may benefit other current or future NASA programs and projects. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure.
Observation	A noteworthy fact, issue, and/or risk, which may not be directly within the assessment scope, but could generate a separate issue or concern if not addressed. Alternatively, an observation can be a positive acknowledgement of a Center/Program/Project/Organization's operational structure, tools, and/or support provided.
Problem	The subject of the independent technical assessment.
Proximate Cause	The event(s) that occurred, including any condition(s) that existed immediately before the undesired outcome, directly resulted in its

	occurrence and, if eliminated or modified, would have prevented the undesired outcome.
Recommendation	A proposed measurable stakeholder action directly supported by specific Finding(s) and/or Observation(s) that will correct or mitigate an identified issue or risk.
Root Cause	One of multiple factors (events, conditions, or organizational factors) that contributed to or created the proximate cause and subsequent undesired outcome and, if eliminated or modified, would have prevented the undesired outcome. Typically, multiple root causes contribute to an undesired outcome.
Supporting Narrative	A paragraph, or section, in an NESC final report that provides the detailed explanation of a succinctly worded finding or observation. For example, the logical deduction that led to a finding or observation; descriptions of assumptions, exceptions, clarifications, and boundary conditions. Avoid squeezing all of this information into a finding or observation

14.0 Acronyms List

AF	Air Force
AHF	Aerodynamic Heating Facility
AJC	Arc Jet Complex
ARC	Ames Research Center
ARMSEF	Atmospheric Reentry Materials and Structures Evaluation Facility
CEV	Crew Exploration Vehicle
CFD	Computational Fluid Dynamics
HCI	Human Computer Interface
ICD	Interface Control Documents
IHF	Interaction Heating Facility
ITAR	International Traffic in Arms Regulation
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
LaRC	Langley Research Center
MSL	Mars Science Laboratory
NAMS	NASA Account Manager System
NAS	NASA Advanced Supercomputing
NESC	NASA Engineering and Safety Center
NRB	NESC Review Board
OODT	Object-oriented Data Technology
PI	Principal Investigator
POC	Point of Contact
QA	Quality Assurance

SNL	Sandia National Laboratories
ST1	System Test 1
ST2	System Test 2
TPDB	Thermal Performance Database
TPDS	Thermal Performance Data Services
TPS	Thermal Protection System

15.0 References

1. Grover, M., "Interaction Heating Facility (IHF) Thermal Performance Data Services (TPDS) Interface Control Document (ICD)," National Aeronautics and Space Administration Jet Propulsion Laboratory IHF-TPDB ICD, April 5, 2012.
2. Grover, M., "Aerodynamic Heating Facility (AHF) Thermal Performance Data Services (TPDS) Interface Control Document (ICD)," National Aeronautics and Space Administration Jet Propulsion Laboratory AHF-TPDB ICD, April 6, 2012.

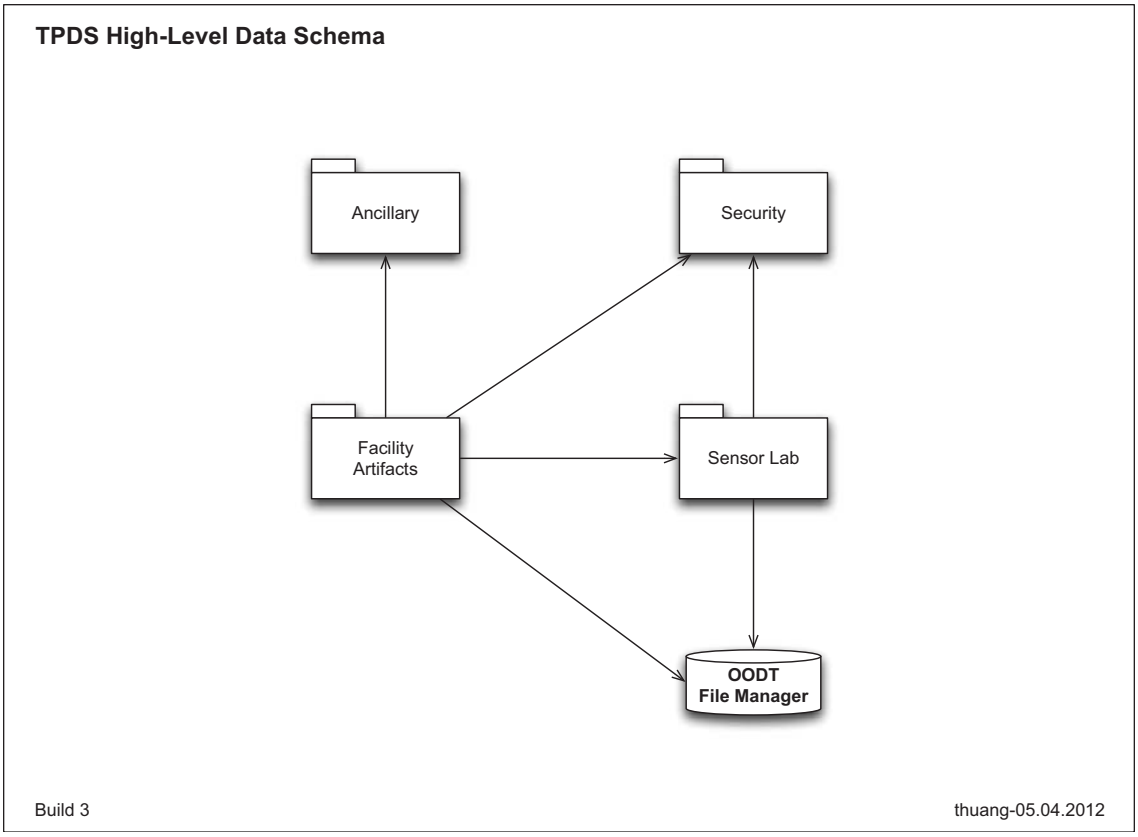
16.0 Appendices

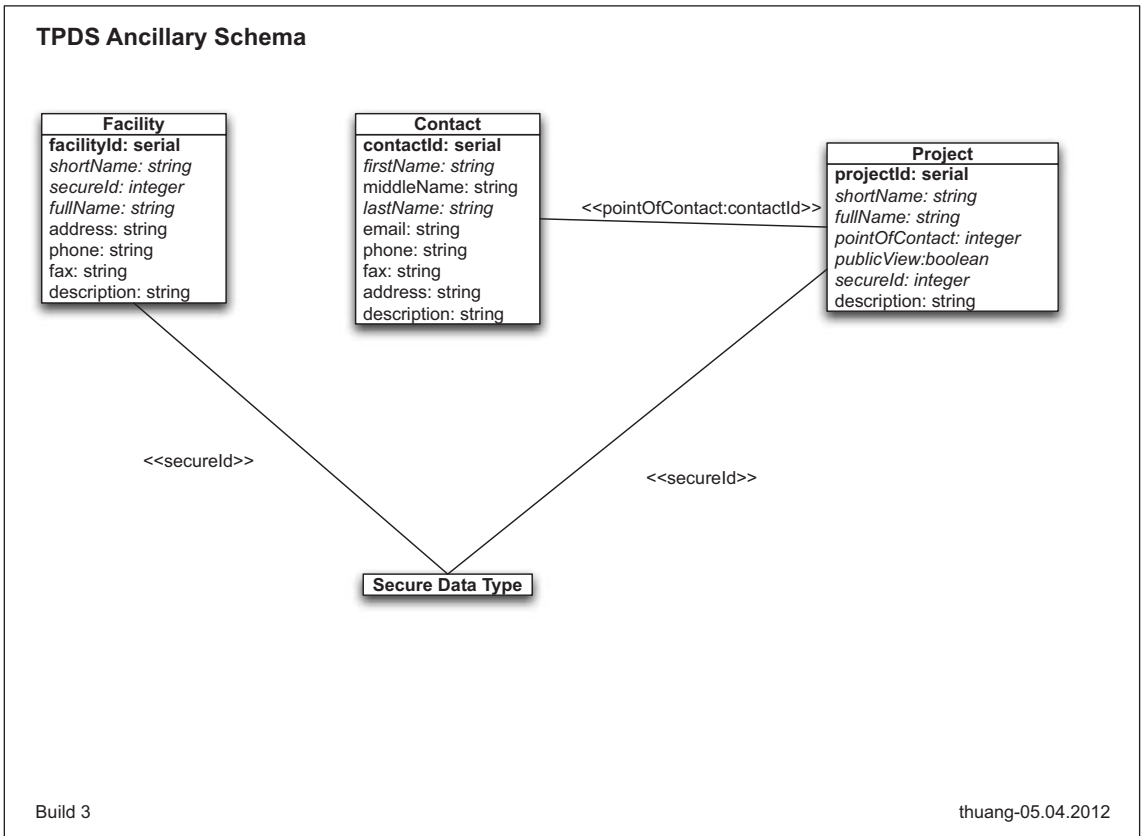
Appendix A. TPDS Build 3.0 Data Model

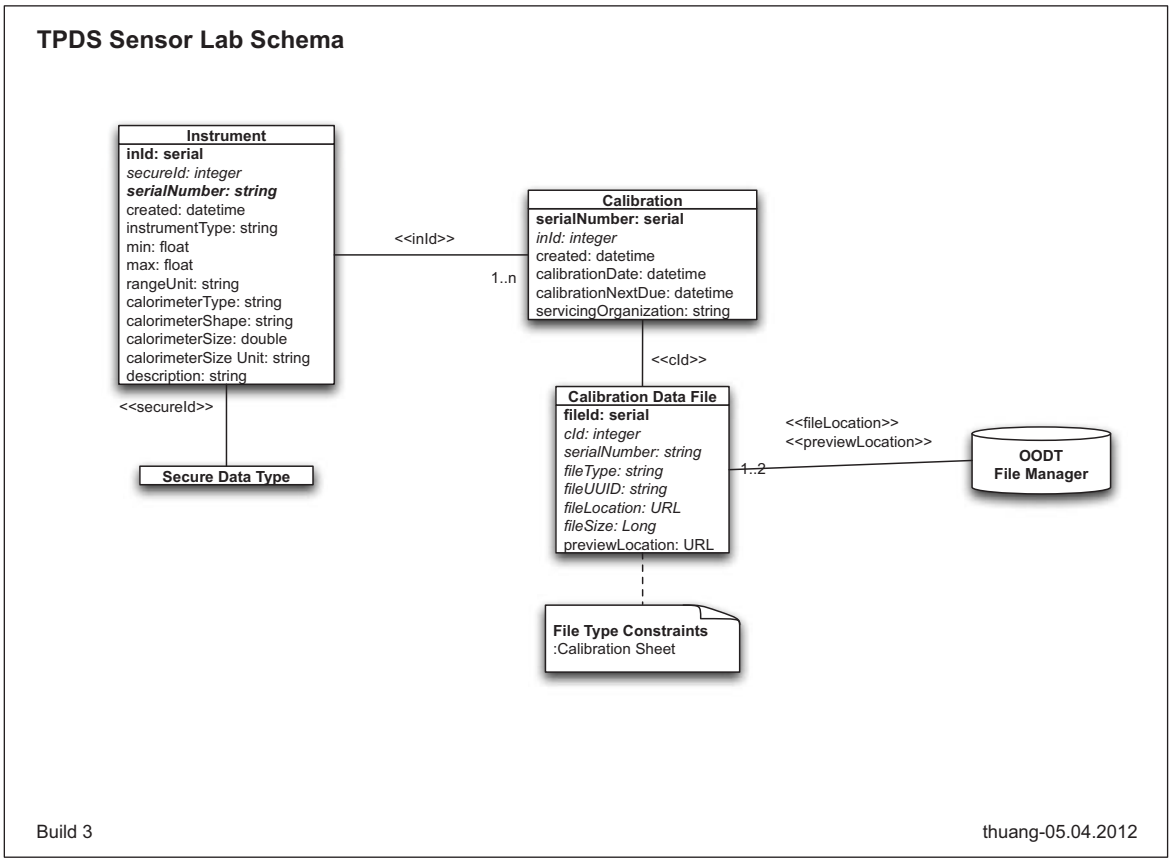
Appendix B. Security Summit Briefing

Appendix C. Build 2.0 Briefing Package for System Test 2

Appendix A. TPDS Build 3.0 Data Model




TPDS Ancillary Schema
Facility
facilityId: serial
shortName: string
secureId: integer
fullName: string
address: string
phone: string
fax: string
description: string
Contact
contactId: serial
firstName: string
middleName: string
lastName: string
email: string
phone: string
fax: string
address: string
description: string
<<pointOfContact:contactId>>
Project
projectId: serial
shortName: string
fullName: string
pointOfContact: integer
publicView:boolean
secureId: integer
description: string
<<secureId>>
<<secureId>>
Secure Data Type
Build 3
thuang-05.04.2012


TPDS Sensor Lab Schema
Instrument
inId: serial
secureId: integer
serialNumber: string
created: datetime
instrumentType: string
min: float
max: float
rangeUnit: string
calorimeterType: string
calorimeterShape: string
calorimeterSize: double
calorimeterSize Unit: string
description: string
<<inId>>
1..n
Calibration
serialNumber: serial
inId: integer
created: datetime
calibrationDate: datetime
calibrationNextDue: datetime
servicingOrganization: string
<<cId>>
<<secureId>>
Secure Data Type
Calibration Data File
fileId: serial
cId: integer
serialNumber: string
fileType: string
fileUUID: string
fileLocation: URL
fileSize: Long
previewLocation: URL
1..2
<<fileLocation>>
<<previewLocation>>
OODT
File Manager
File Type Constraints
:Calibration Sheet
Build 3
thuang-05.04.2012

TPDS Security Schema

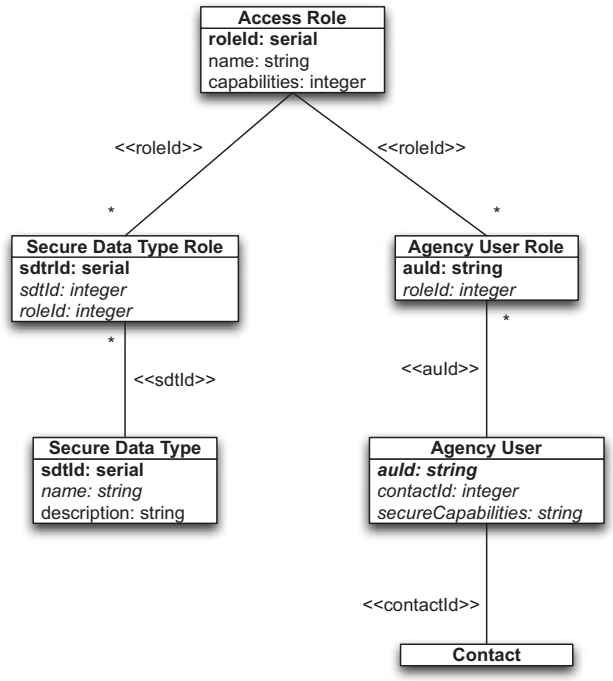
Access Role
- Provides abstraction for access groups
- Example groups
  - CEVRead
  - CEVFacility
- Capabilities attribute is a bit-oriented mask value
  - NO_CAPABILITY = 0
  - READ = 1
  - GET = 2
  - CREATE = 4
  - UPDATE = 8
  - UPLOAD = 16
  - DELETE = 32

Secure Data Type
- Core representation of secure data product type.

Agency User
- User will be authenticated by NASA IDMax. This class defines any special user privileges. Privileges set here will override all data product access capabilities. If no special privilege given, then each access will be evaluated according to the user + data product access role relation
- Special User Privileges Constants
  - NO_CAPABILITY = 0
  - READ_ALL = 1
  - WRITE_ALL = 2
  - ADMIN = 3

Secure Data Type Role
- The join between Access Role and Data Product to define many-to-many relation to define associate access roles to each data product

Agency User Role
- The join between Access Role and Agency User to define many-to-many relation to define access roles for each user



Build 3

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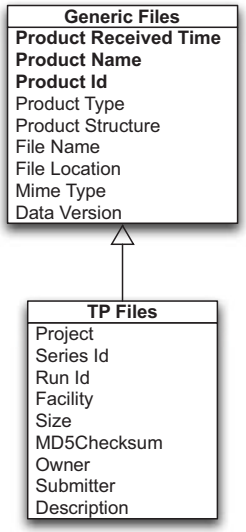
TPDS OODT_FM Schema



Build 3

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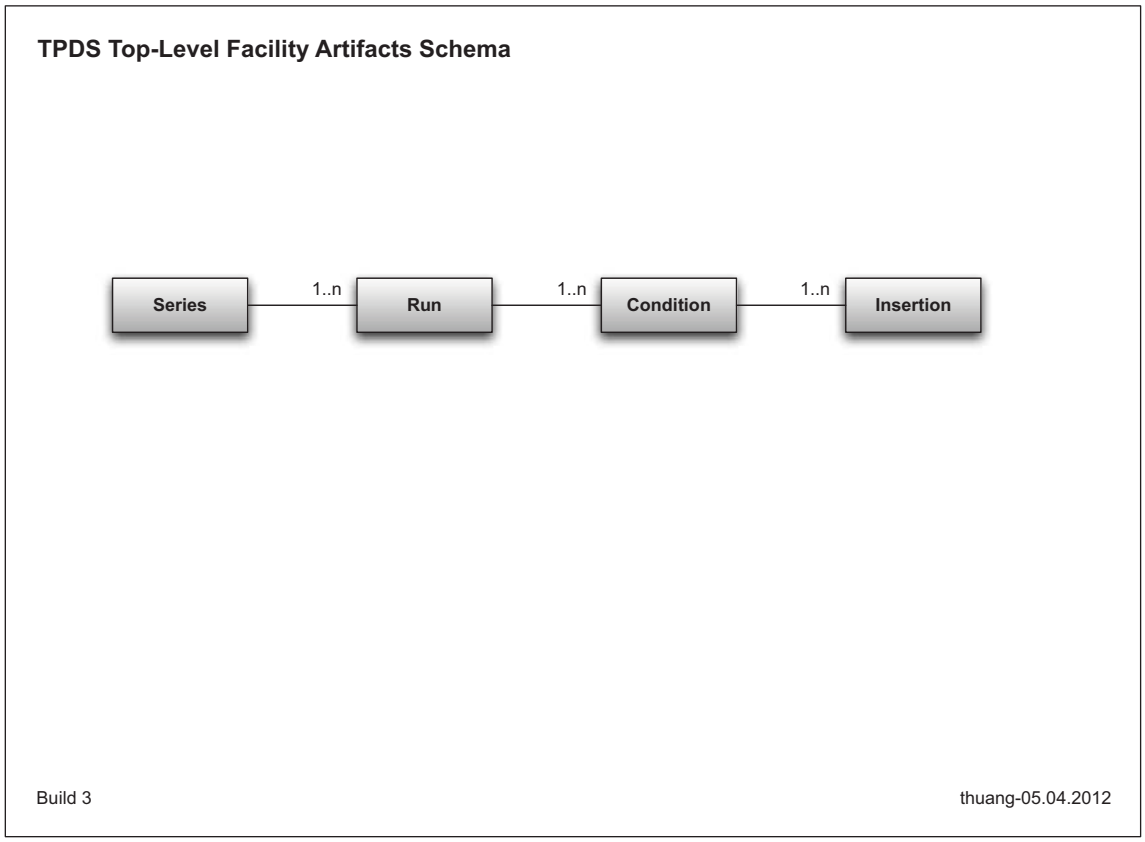
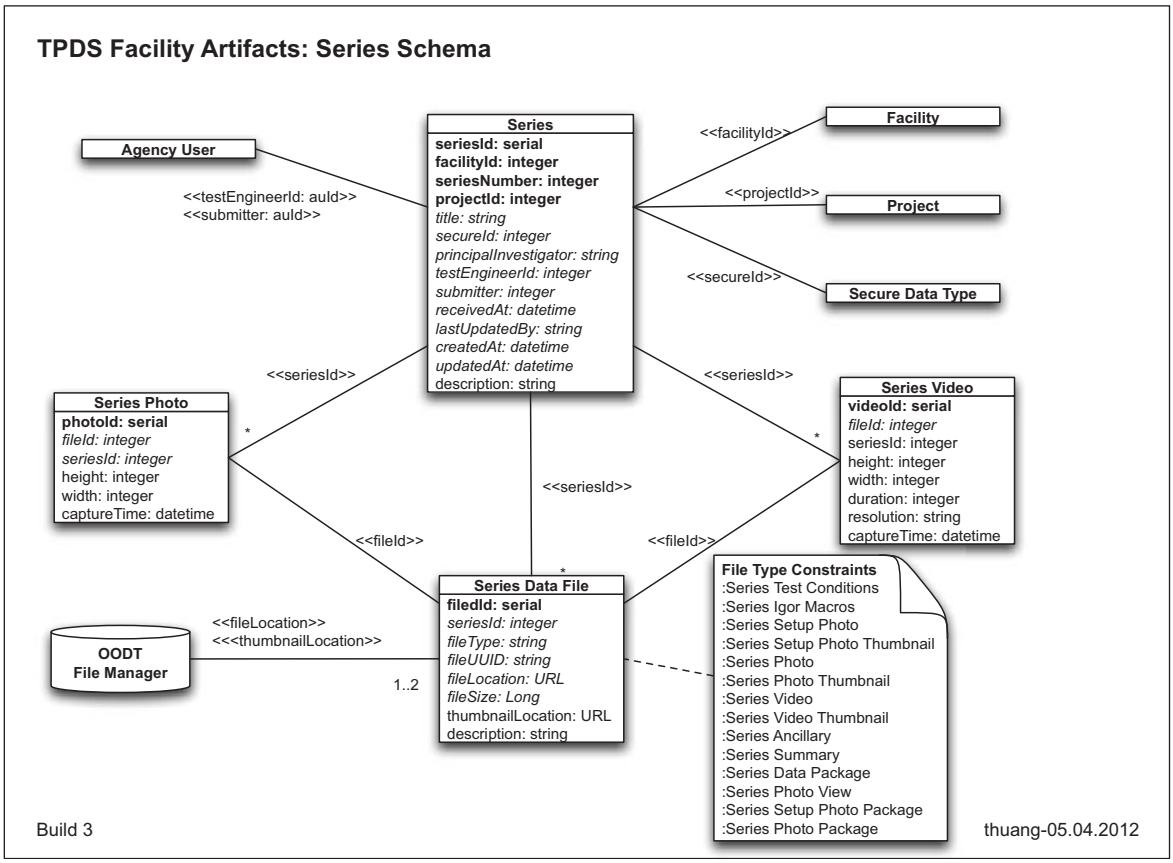
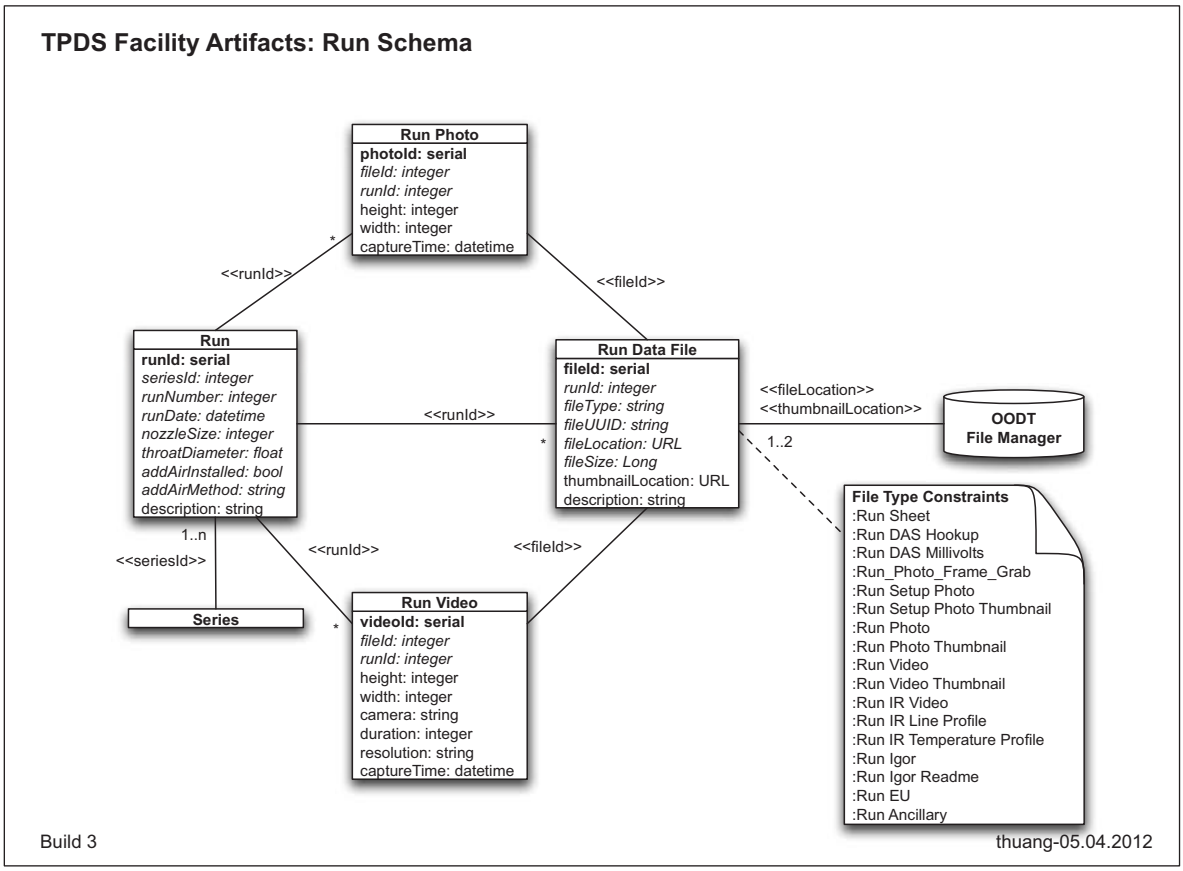
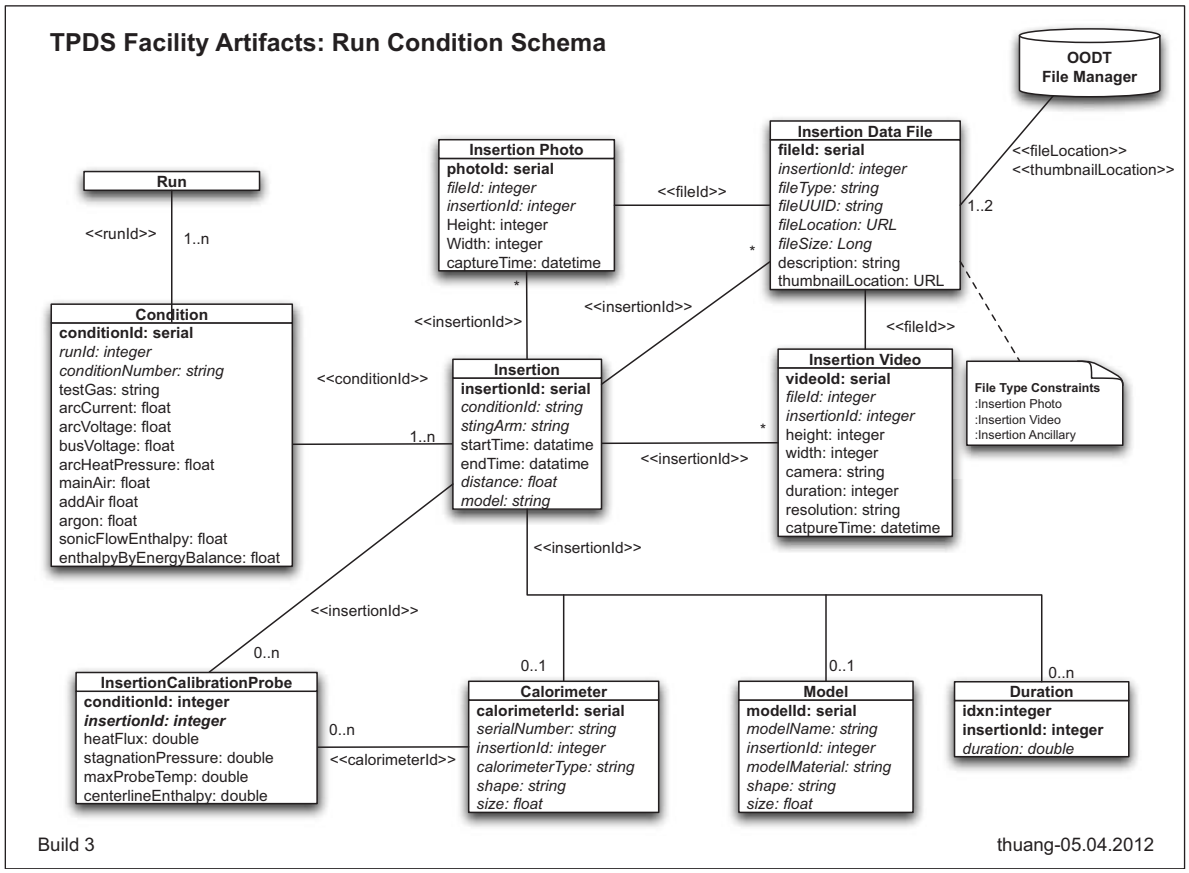
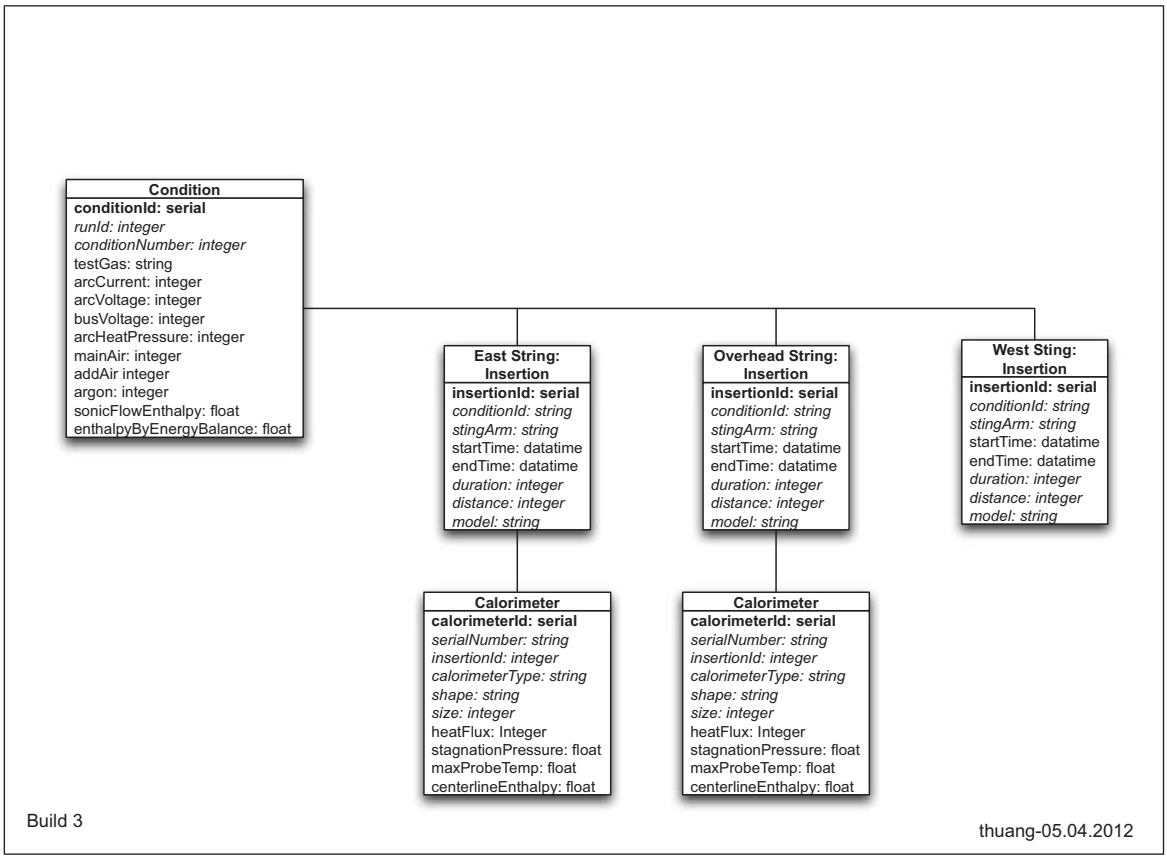
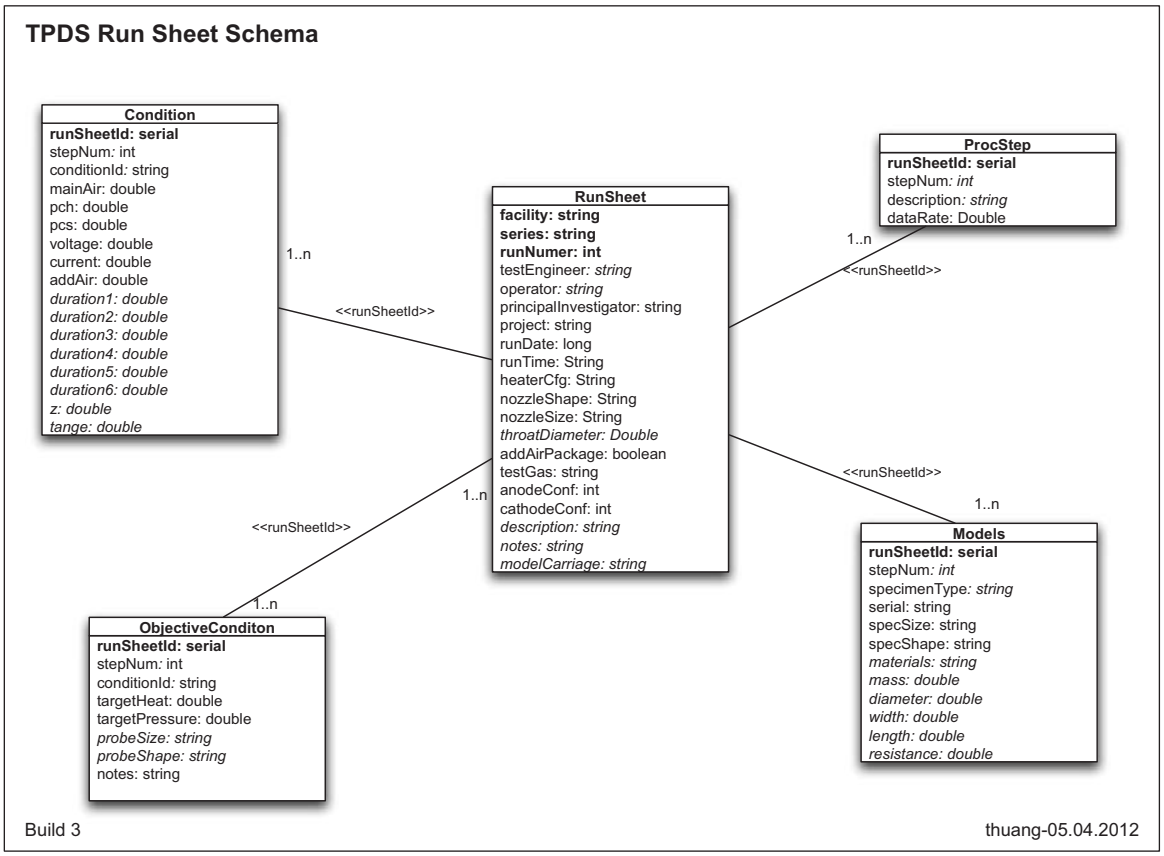

TPDS Top-Level Facility Artifacts Schema
Series
1..n
Run
1..n
Condition
1..n
Insertion
Build 3
thuang-05.04.2012


TPDS Facility Artifacts: Series Schema
Agency User
<<testEngineerId: auId>>
<<submitter: auId>>
Series
seriesId: serial
facilityId: integer
seriesNumber: integer
projectId: integer
title: string
secureId: integer
principalInvestigator: string
testEngineerId: integer
submitter: integer
receivedAt: datetime
lastUpdatedBy: string
createdAt: datetime
updatedAt: datetime
description: string
<<facilityId>>
Facility
<<projectId>>
Project
<<secureId>>
Secure Data Type
<<seriesId>>
<<seriesId>>
Series Photo
photoId: serial
fileId: integer
seriesId: integer
height: integer
width: integer
captureTime: datetime
Series Video
videoId: serial
fileId: integer
seriesId: integer
height: integer
width: integer
duration: integer
resolution: string
captureTime: datetime
<<seriesId>>
<<fileId>>
<<fileId>>
Series Data File
filedId: serial
seriesId: integer
fileType: string
fileUUID: string
fileLocation: URL
fileSize: Long
thumbnailLocation: URL
description: string
<<fileLocation>>
<<<thumbnailLocation>>
OODT
File Manager
1..2
File Type Constraints
:Series Test Conditions
:Series Igor Macros
:Series Setup Photo
:Series Setup Photo Thumbnail
:Series Photo
:Series Photo Thumbnail
:Series Video
:Series Video Thumbnail
:Series Ancillary
:Series Summary
:Series Data Package
:Series Photo View
:Series Setup Photo Package
:Series Photo Package
Build 3
thuang-05.04.2012

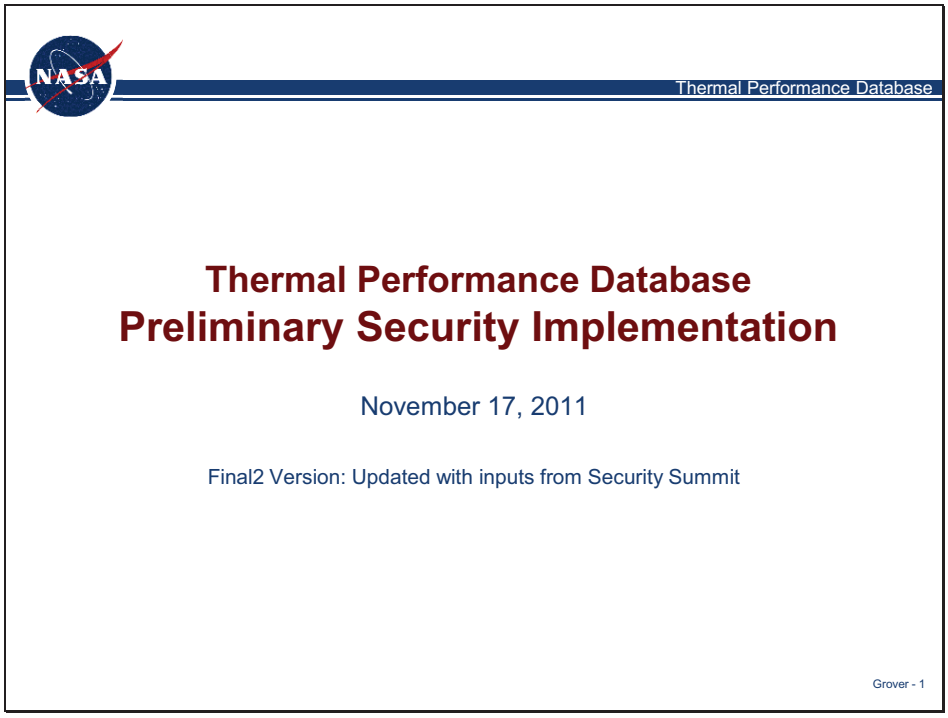

TPDS Facility Artifacts: Run Schema
Run Photo
photoId: serial
fileId: integer
runId: integer
height: integer
width: integer
captureTime: datetime
<<runId>>
<<fileId>>
Run
runId: serial
seriesId: integer
runNumber: integer
runDate: datetime
nozzleSize: integer
throatDiameter: float
addAirInstalled: bool
addAirMethod: string
description: string
Run Data File
fileId: serial
runId: integer
fileType: string
fileUUID: string
fileLocation: URL
fileSize: Long
thumbnailLocation: URL
description: string
<<runId>>
<<fileLocation>>
<<thumbnailLocation>>
OODT
File Manager
1..2
1..n
<<seriesId>>
Series
<<runId>>
<<fileId>>
Run Video
videoId: serial
fileId: integer
runId: integer
height: integer
width: integer
camera: string
duration: integer
resolution: string
captureTime: datetime
File Type Constraints
:Run Sheet
:Run DAS Hookup
:Run DAS Millivolts
:Run_Photo_Frame_Grab
:Run Setup Photo
:Run Setup Photo Thumbnail
:Run Photo
:Run Photo Thumbnail
:Run Video
:Run Video Thumbnail
:Run IR Video
:Run IR Line Profile
:Run IR Temperature Profile
:Run Igor
:Run Igor Readme
:Run EU
:Run Ancillary
Build 3
thuang-05.04.2012

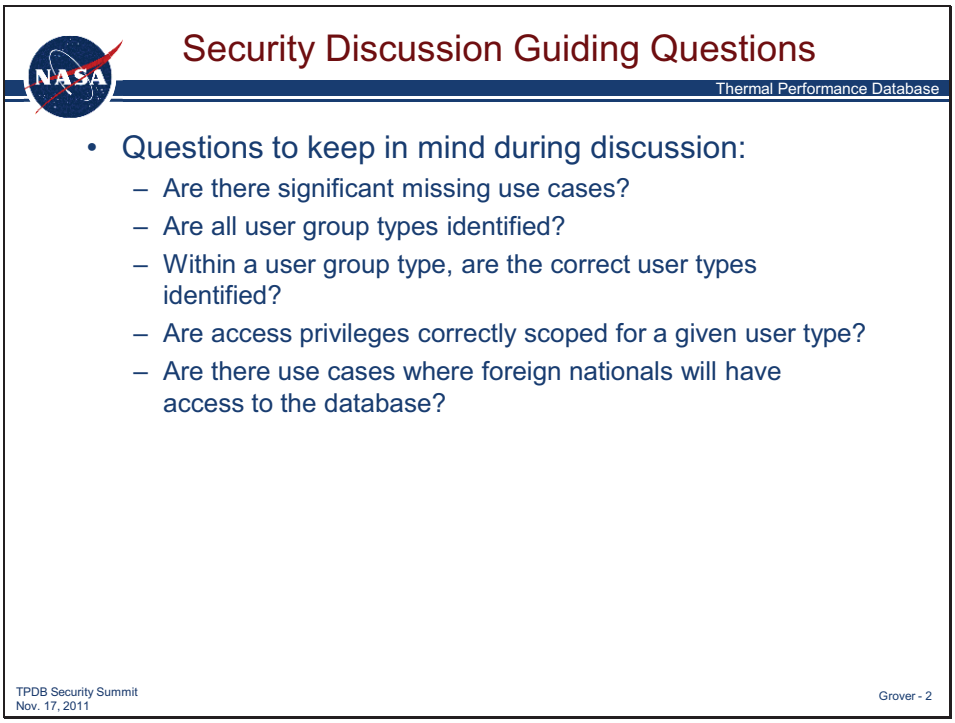

TPDS Facility Artifacts: Run Condition Schema
OODT File Manager
Run
<<runId>>
1..n
Condition
conditionId: serial
runId: integer
conditionNumber: string
testGas: string
arcCurrent: float
arcVoltage: float
busVoltage: float
arcHeatPressure: float
mainAir: float
addAir float
argon: float
sonicFlowEnthalpy: float
enthalpyByEnergyBalance: float
Insertion Photo
photoId: serial
fileId: integer
insertionId: integer
Height: integer
Width: integer
captureTime: datetime
<<fileId>>
Insertion Data File
fileId: serial
insertionId: integer
fileType: string
fileUUID: string
fileLocation: URL
fileSize: Long
description: string
thumbnailLocation: URL
<<fileLocation>>
<<thumbnailLocation>>
1..2
<<insertionId>>
<<insertionId>>
<<fileId>>
<<conditionId>>
Insertion
insertionId: serial
conditionId: string
stingArm: string
startTime: datatime
endTime: datatime
distance: float
model: string
1..n
<<insertionId>>
Insertion Video
videoId: serial
fileId: integer
insertionId: integer
height: integer
width: integer
camera: string
duration: integer
resolution: string
catpureTime: datetime
File Type Constraints
:Insertion Photo
:Insertion Video
:Insertion Ancillary
<<insertionId>>
<<insertionId>>
0..n
0..1
0..1
0..n
InsertionCalibrationProbe
conditionId: integer
insertionId: integer
heatFlux: double
stagnationPressure: double
maxProbeTemp: double
centerlineEnthalpy: double
0..n
<<calorimeterId>>
Calorimeter
calorimeterId: serial
serialNumber: string
insertionId: integer
calorimeterType: string
shape: string
size: float
Model
modelId: serial
modelName: string
insertionId: integer
modelMaterial: string
shape: string
size: float
Duration
idxn:integer
insertionId: integer
duration: double
Build 3
thuang-05.04.2012


Condition
conditionId: serial
runId: integer
conditionNumber: integer
testGas: string
arcCurrent: integer
arcVoltage: integer
busVoltage: integer
arcHeatPressure: integer
mainAir: integer
addAir integer
argon: integer
sonicFlowEnthalpy: float
enthalpyByEnergyBalance: float
East String: Insertion
insertionId: serial
conditionId: string
stingArm: string
startTime: datatime
endTime: datatime
duration: integer
distance: integer
model: string
Overhead String: Insertion
insertionId: serial
conditionId: string
stingArm: string
startTime: datatime
endTime: datatime
duration: integer
distance: integer
model: string
West Sting: Insertion
insertionId: serial
conditionId: string
stingArm: string
startTime: datatime
endTime: datatime
duration: integer
distance: integer
model: string
Calorimeter
calorimeterId: serial
serialNumber: string
insertionId: integer
calorimeterType: string
shape: string
size: integer
heatFlux: Integer
stagnationPressure: float
maxProbeTemp: float
centerlineEnthalpy: float
Calorimeter
calorimeterId: serial
serialNumber: string
insertionId: integer
calorimeterType: string
shape: string
size: integer
heatFlux: Integer
stagnationPressure: float
maxProbeTemp: float
centerlineEnthalpy: float
Build 3
thuang-05.04.2012


TPDS Run Sheet Schema
Condition
runSheetId: serial
stepNum: int
conditionId: string
mainAir: double
pch: double
pcs: double
voltage: double
current: double
addAir: double
duration1: double
duration2: double
duration3: double
duration4: double
duration5: double
duration6: double
z: double
tange: double
RunSheet
facility: string
series: string
runNumer: int
testEngineer: string
operator: string
principalInvestigator: string
project: string
runDate: long
runTime: String
heaterCfg: String
nozzleShape: String
nozzleSize: String
throatDiameter: Double
addAirPackage: boolean
testGas: string
anodeConf: int
cathodeConf: int
description: string
notes: string
modelCarriage: string
ProcStep
runSheetId: serial
stepNum: int
description: string
dataRate: Double
Models
runSheetId: serial
stepNum: int
specimenType: string
serial: string
specSize: string
specShape: string
materials: string
mass: double
diameter: double
width: double
length: double
resistance: double
ObjectiveConditon
runSheetId: serial
stepNum: int
conditionId: string
targetHeat: double
targetPressure: double
probeSize: string
probeShape: string
notes: string
1..n
<<runSheetId>>
Build 3
thuang-05.04.2012

Appendix B. Security Summit Briefing





General Security Approach

Thermal Performance Database

- Global Access Content
  - Test Conditions
    - All condition data will be globally available (anonymously, without test series or project association)
      - Arc jet conditions, measured heat flux, measured stagnation pressure, calorimeter info, etc.
- Restricted Content
  - Project Proprietary Test Results
    - Model response data, photo & video data, test plans, test results, etc
  - ITAR
    - Any data that is designated ITAR

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High Level Use Cases

Thermal Performance Database

- At a high level, users groups are identified as
  - Test Facility
  - Sensor Lab
  - Projects
  - Database Administration
- Use cases binned into the following actions:
  - Creates
  - Updates
  - Browse & Searches
  - Uploads
  - Downloads

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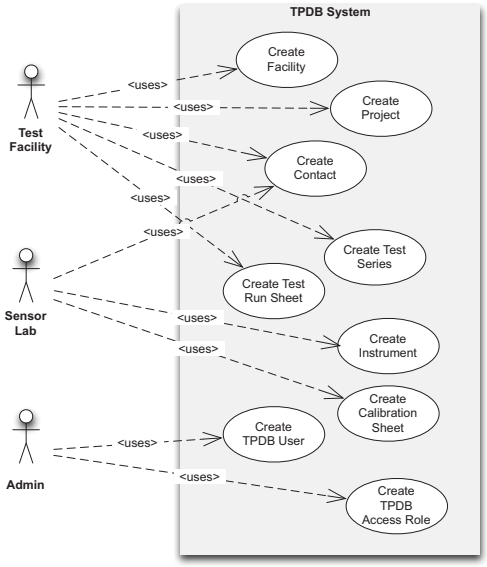
Use Cases (1/5): Creates

Thermal Performance Database



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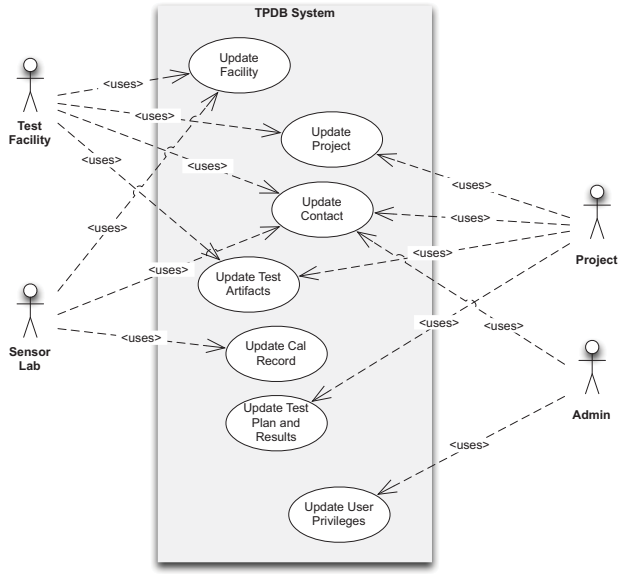
Use Cases (2/5): Updates

Thermal Performance Database



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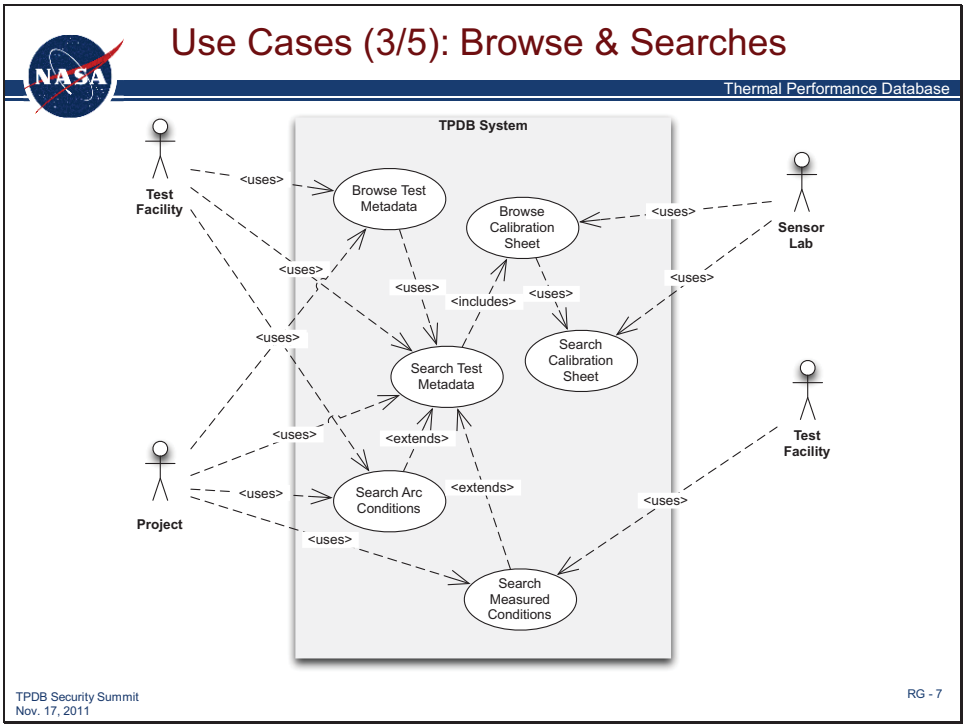
Use Cases (3/5): Browse & Searches
Thermal Performance Database
TPDB System
Test Facility
Sensor Lab
Project
Test Facility
Browse Test Metadata
Browse Calibration Sheet
Search Test Metadata
Search Calibration Sheet
Search Arc Conditions
Search Measured Conditions
<uses>
<includes>
<extends>
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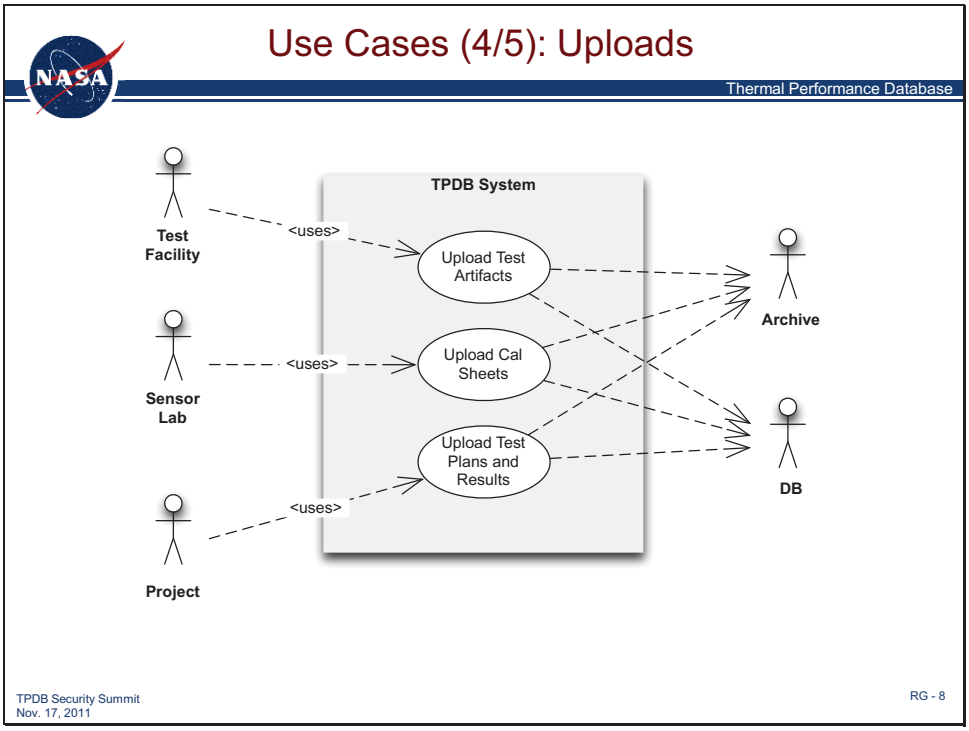
Use Cases (4/5): Uploads
Thermal Performance Database
TPDB System
Test Facility
Sensor Lab
Project
Archive
DB
Upload Test Artifacts
Upload Cal Sheets
Upload Test Plans and Results
<uses>
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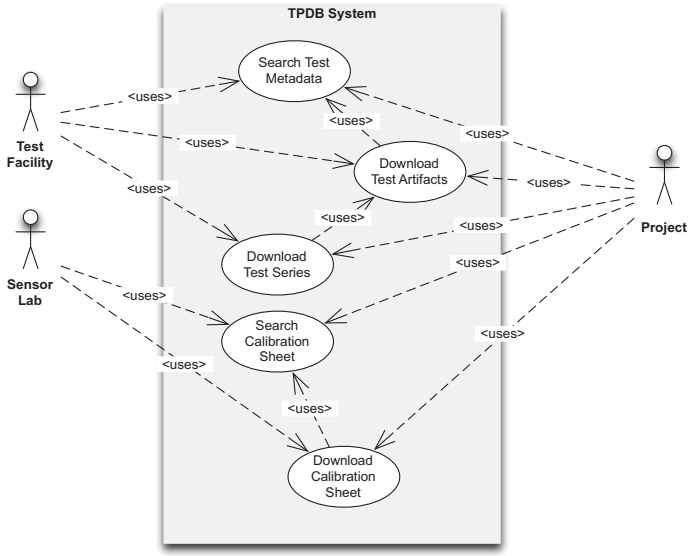
Use Cases (5/5): Download

Thermal Performance Database



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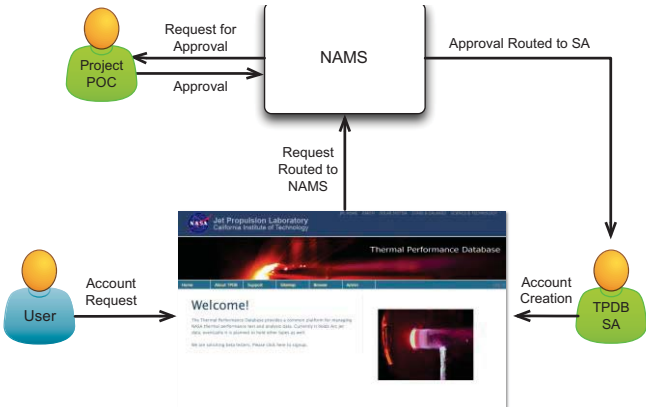
Account Request Process

Thermal Performance Database

- Accounts requested via the TPDB web interface, and uses NAMS for approval from Project POC and TPDB administrator



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Project Creation Process

Thermal Performance Database

- Project POC requests the creation of a project via the TPDB web interface
- Once created, in addition to default user types, the project POC defines custom user types and defines all user type access privileges if desired different from defaults

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TPDB Group Types

Thermal Performance Database

- The following are identified user group types for the database

Project
A project requiring use of TPDB for testing planning, test execution, and archiving of data. Includes projects affiliated with NASA, industry and academia.

Test Facility
A thermal performance test facility that is a test data source for TPDB.

Sensor Lab
Sensor lab providing calibration models and sensors.

General
The default user group for general users without a project or test facility affiliation.

TPDB Admin
Personnel supporting the operation, maintenance and development of the database.

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User Types - Project

Thermal Performance Database

- The following are identified user types for the user group type *Project*

Principal Investigator
Principal Investigator for a test series and primary lead for an investigations. Responsible for test planning and final analyses and test results.

Analyst
A project affiliated thermal performance analyst responsible for test affiliated thermal performance modeling and analyses.

Contractor
A project affiliated contractor nominally a project industry partner.

General
A user with general affiliation with a project

Custom
A customer user type whose name and access privileges can be specified by the project.

Project POC
A project point of contact responsible for granting user access to project data, and with project administrative responsibilities

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User Types - Test Facility

Thermal Performance Database

- The following are identified user types for the user group type *Test Facility*

Test Engineer
Test engineer for a test series. Responsible for test series data delivery to the database.

Photo Tech
Photo/Video technician responsible for test facility photo and video data products.

General
A user with general affiliation with a test facility.

Custom
A customer user type whose name and access privileges can be specified by the test facility.

Facility POC
A facility point of contact responsible for granting user access to project data, and with project administrative abilities

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User Types – Sensor Lab

Thermal Performance Database

- The following are identified user types for the user group type *Sensor Lab*

Sensor Lab Tec
Responsible for maintaining Sensor Lab instrument data in the database including calibration records.

Custom
A customer user type whose name and access privileges can be specified by the sensor lab.

Sensor Lab POC
Responsible for maintaining Sensor Lab instrument data in the database including calibration records, as well as acting as POC for the Sensor Lab.

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User Types – General

Thermal Performance Database

- The following is the identified user types for the user group type *General*

General
A user with access to the database but with no specific affiliation.

Super General
A user with access to the database with no specific affiliation, but with read-all access. An example is facility management.

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User Types - TPDB Admin

Thermal Performance Database

- The following are identified user types for the user group type *TPDB Admin*

TPDB SA

Overall database administrator responsible for account creation, database operations and database maintenance

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Database Data Classes

Thermal Performance Database

- Test Data - Facility Data
  - **Test Condition Metadata**
    - Product Types: Metadata

-Facility Name	-Nozzle Size	-Throat Diameter	-Heat Flux
-Stagnation Press.	-Arc Current	-Arc Voltage	-Arc Heater Pressure
-Mass Flow Rates			

    - Access: Global
  - **Test Condition Data Products**
    - Product Types: Data files

-Calorimeter Run Data	-Arc Jet Condition Run Data	-Calorimeter Traveler

    - Access Global
  - **Test Data**
    - Product Types: Metadata & Data Files

-Test Article Material	-Test Article Geometry	-Test Article TC Data	-Test Article IR Data
-Test Article Pyro Data	-Test Photos	-Test Videos	-Test Run Sheets
-DAS Config. Data			

    - Access: Restricted
- Test Data – Non-Facility
  - **PI Data**
    - Product Types: Metadata & Data Files

-Test Plan	-PI Analyses	-Final Test Report

    - Access: Restricted

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Database Data Classes (cont.)

Thermal Performance Database

- Test Data – Non-Facility (cont)
  - **Analysts Data**
    - Product Types: Metadata and Data Files

      -FIAT Analyses -CFD Analyses -Other Analyses
    - Access: Restricted
- Sensor Lab Data
  - **Sensor Data**
    - Product Types: Metadata and Data Files

      -Instrument Name -Instrument Serial Number -Instrument Op. Range -Calibration Date
      -Instrument Geometry -Calibration Sheet
    - Access: Restricted
- TPDB Administration
  - **TPDB System Data**
    - Product Types: Metadata

      -User Accounts -User Privileges
    - Access: Restricted

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Access Privilege Definitions

Thermal Performance Database

- The following is the set of possible access privileges available via the TPDB security system
  - **Read**
    - Ability to retrieve and display metadata or a data product
  - **Write – Create**
    - Ability to create a new data product, including data product ingestion and the input of metadata
  - **Write – Update**
    - Ability to update metadata fields of an existing data product
  - **Write – Replace**
    - Ability to replace an existing data product, including metadata
  - **Delete**
    - Ability to delete a data product
  - **Download**
    - Ability to download a data product

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User Privileges - Project

Thermal Performance Database

- User privileges for *Project* user types
  - Privileges shown are proposed defaults – customization optional

Global Access
Restricted Access

Users			PROJECT DATA						SENSOR LAB		TPDB ADMIN
			TEST DATA PRODUCTS IN FACILITY				TEST DATA PRODUCTS IN NON-FACILITY		SENSOR LAB DATA PRODUCTS		SYSTEM PRODUCTS
Group	Role	ACCESS	Test Conditions Calorimeter & arc jet metadata	Test Conditions Calorimeter & arc jet data products	Test Data Model Data, Thermal Response, etc	Test Data Photo/Video Data	PI Data	Analyses/CFD Data	Instrument Data	Calibration Sheets	Account Settings, Etc
PROJECT	PI	Read	X	X	X	X	X	X	X	X	
		Write & Create					X	X			
		Write & Update					X	X			
		Write & Replace					X	X			
		Delete					X	X			
		Download	X	X	X	X	X	X	X	X	
	Analyst	Read	X	X	X	X	X	X	X	X	
		Write & Create						X			
		Write & Update						X			
		Write & Replace						X			
		Delete						X			
		Download	X	X	X	X	X	X	X	X	
	Contractor	Read	X	X	X	X	X	X			
		Write & Create									
		Write & Update									
		Write & Replace									
		Delete									
		Download	X	X	X	X	X	X			
	General	Read	X	X	X	X	X	X	X	X	
		Write & Create									
		Write & Update									
		Write & Replace									
		Delete									
		Download	X	X	X	X	X	X	X	X	
	Custom	Read									
		Write & Create									
		Write & Update									
		Write & Replace									
		Delete									
		Download									
	Admin POC	Read	X	X	X	X	X	X	X	X	
		Write & Create	X	X	X	X	X	X			
		Write & Update	X	X	X	X	X	X			
		Write & Replace	X	X	X	X	X	X			
		Delete	X	X	X	X	X	X			
		Download	X	X	X	X	X	X	X	X	

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User Privileges – Test Facility

Thermal Performance Database

- User privileges for *Test Facility* user types
  - Privileges shown are proposed defaults – customization optional

Global Access
Restricted Access

Users			PROJECT DATA						SENSOR LAB		TPDB ADMIN
			TEST DATA PRODUCTS IN FACILITY				TEST DATA PRODUCTS IN NON-FACILITY		SENSOR LAB DATA PRODUCTS		SYSTEM PRODUCTS
Group	Role	ACCESS	Test Conditions Calorimeter & arc jet metadata	Test Conditions Calorimeter & arc jet data products	Test Data Model Data, Thermal Response, etc	Test Data Photo/Video Data	PI Data	Analyses/CFD Data	Instrument Data	Calibration Sheets	Account Settings, Etc
TEST FACILITY	Test Engr	Read	X	X	X	X	X	X	X	X	
		Write & Create	X	X	X	X					
		Write & Update	X	X	X	X					
		Write & Replace	X	X	X	X					
		Delete	X	X	X	X					
		Download	X	X	X	X	X	X	X	X	
	Photo/Tech	Read	X	X	X	X	X	X	X	X	
		Write & Create				X					
		Write & Update				X					
		Write & Replace				X					
		Delete				X					
		Download	X	X	X	X	X	X	X	X	
	General	Read	X	X	X	X	X	X	X	X	
		Write & Create									
		Write & Update									
		Write & Replace				X					
		Delete									
		Download	X	X	X	X	X	X	X	X	
	Custom	Read									
		Write & Create									
		Write & Update									
		Write & Replace									
		Delete									
		Download									
	Admin POC	Read	X	X	X	X	X	X	X	X	
		Write & Create	X	X	X	X	X	X			
		Write & Update	X	X	X	X	X	X			
		Write & Replace	X	X	X	X	X	X			
		Delete	X	X	X	X	X	X			
		Download	X	X	X	X	X	X	X	X	

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User Privileges – Sensor Lab

Thermal Performance Database

- User privileges for *Sensor Lab* user types
  - Privileges shown are proposed defaults – customization optional

Global Access
Restricted Access

Users			PROJECT DATA						SENSOR LAB		TPDB ADMIN
			TEST DATA PRODUCTS IN FACILITY				TEST DATA PRODUCTS IN NON-FACILITY		SENSOR LAB DATA PRODUCTS		SYSTEM PRODUCTS
Group	Role	ACCESS	Test Conditions (Calorimeter & Circuit metadata	Test Conditions Calorimeter & Circuit data products	Test Data Model Data, Thermal Response, etc	Test Data Photo/Video Data	PI Data	Analyses/CFD Data	Instrument Data	Calibration Sheets	Account Settings, Etc
SENSOR LAB	Sensor Lab Tech	Read	x	x					x	x	
		Write Create							x	x	
		Write Update							x	x	
		Write Replace							x	x	
		Delete							x	x	
		Download	x	x					x	x	
	Custom	Read									
		Write Create									
		Write Update									
		Write Replace									
		Delete									
		Download									
	Admin POC	Read	x	x					x	x	
		Write Create							x	x	
		Write Update							x	x	
		Write Replace							x	x	
		Delete							x	x	
		Download	x	x					x	x	

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User Privileges – TPDB General & Admin

Thermal Performance Database

- User privileges for *Sensor Lab* user types
  - Privileges shown are proposed defaults – customization optional

Global Access
Restricted Access

Users			PROJECT DATA						SENSOR LAB		TPDB ADMIN
			TEST DATA PRODUCTS IN FACILITY				TEST DATA PRODUCTS IN NON-FACILITY		SENSOR LAB DATA PRODUCTS		SYSTEM PRODUCTS
Group	Role	ACCESS	Test Conditions (Calorimeter & Circuit metadata	Test Conditions Calorimeter & Circuit data products	Test Data Model Data, Thermal Response, etc	Test Data Photo/Video Data	PI Data	Analyses/CFD Data	Instrument Data	Calibration Sheets	Account Settings, Etc
GENERAL	General	Read	x	x							
		Write Create									
		Write Update									
		Write Replace									
		Delete									
		Download	x	x							
	Super General	Read	x	x	x	x	x	x	x	x	
		Write Create									
		Write Update									
		Write Replace									
		Delete									
		Download	x	x	x	x	x	x	x	x	
TPDB ADMIN	System Admin	Read	x	x	x	x	x	x	x	x	x
		Write Create	x	x	x	x	x	x	x	x	x
		Write Update	x	x	x	x	x	x	x	x	x
		Write Replace	x	x	x	x	x	x	x	x	x
		Delete	x	x	x	x	x	x	x	x	x
		Download	x	x	x	x	x	x	x	x	x

Foreign National Restriction

Thermal Performance Database

- Propose ITAR content will be restricted to foreign nationals via an ITAR access mask
  - Work with community to identify database products that are inherently ITAR as a standard
  - Establish ITAR mask from identified products
  - In addition to set user types privileges, mask is applied to data access privileges to further restrict access
  - Capability to designate ITAR data to individual data products would be required
- TPDB will work with TS division management to identify ITAR sensitive data products
- What are inputs from the user community?

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Security Model

Thermal Performance Database

TPDB Security Schema

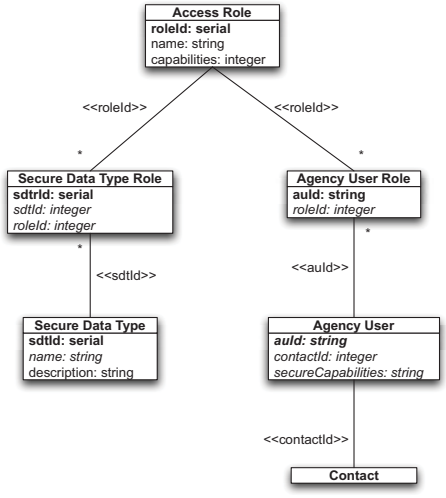
Access Role
Provides abstraction for access groups
Example groups
CEVRead
CEVFacility
Capabilities attribute is a bit-oriented mask value
NO_CAPABILITY = 0
READ = 1
GET = 2
CREATE = 4
UPDATE = 8
UPLOAD = 16
DELETE = 32

Secure Data Type
Core representation of secure data product type.

Agency User
User will be authenticated by NASA IDMax. This class defines any special user privileges. Privileges set here will override all data product access capabilities. If no special privilege given, then each access will be evaluated according to the user + data product access role relation
Special User Privileges Constants
NO_CAPABILITY = 0
READ_ALL = 1
WRITE_ALL = 2
ADMIN = 3

Secure Data Type Role
The join between Access Role and Data Product to define many-to-many relation to define associate access roles to each data product

Agency User Role
The join between Access Role and Agency User to define many-to-many relation to define access roles for each user



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Other Security Summit User Inputs

Thermal Performance Database

- Can access privilege be tied to data maturity? Would like the ability to grant a user type access depending on the maturity of the data: preliminary vs final, etc.
- More likely to grant write access to data and metadata if a history of data versions is retained prior to modification.

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Security Summary Conclusion

Thermal Performance Database

- Participants in the Security Summit express any significant disagreements to user access control architecture
- Returning to the original questions posed up front:
  - Are there significant missing use cases?
    - The Security Summit did not identify any significant missing use cases
  - Are all user group types identified?
    - The Security Summit did not identify any missing user groups
  - Within a user group type, are the correct user types identified?
    - The Security Summit identified two missing user types:
      - Within a project a user type of *Contractor*
      - Within project, test facility and sensor lab, a user type of *Custom* that can be defined and named by the user group
  - Are access privileges correctly scoped for a given user type?
    - The Security Summit identified a few minor modifications to default access privileges
    - User community recommends user access privileges customizable by user groups – adopted by TPDB
  - Are there use cases where foreign nationals will have access to the database?
    - The Security Summit determined that there are potential use cases for foreign nations. TPDB is working with TS division administration to identify ITAR sensitive data products

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Appendix C. Build 2.0 Briefing Package for System Test 2

Thermal Performance Database System

Release 2.0.0

Thomas Huang
March 9, 2012

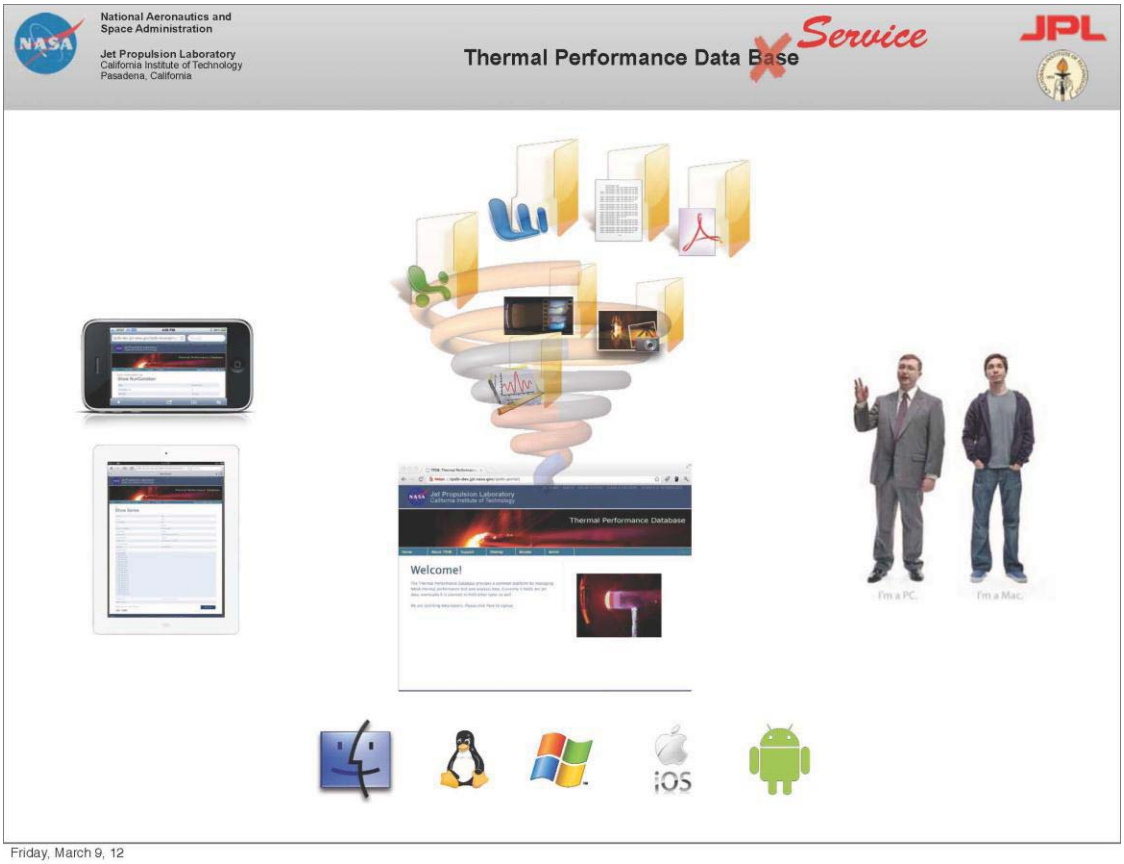
Friday, March 9, 12

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Working Late Last Night...

Friday, March 9, 12


National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California
Thermal Performance Data Base Service
JPL
Thermal Performance Database
Welcome!
iOS
I'm a PC.
I'm a Mac.
Friday, March 9, 12

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IHF Interface Control Document

- Data packaging structure
- Artifact naming convention
- Artifact file formats
- Instrumentation data units
- Metadata documentation
  - Keywords
  - Test Condition
  - Igor Summary
  - Hookup

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Metadata Harvesting

Security

Rich Data Model

System Deployment

Portability

UI

Robustness

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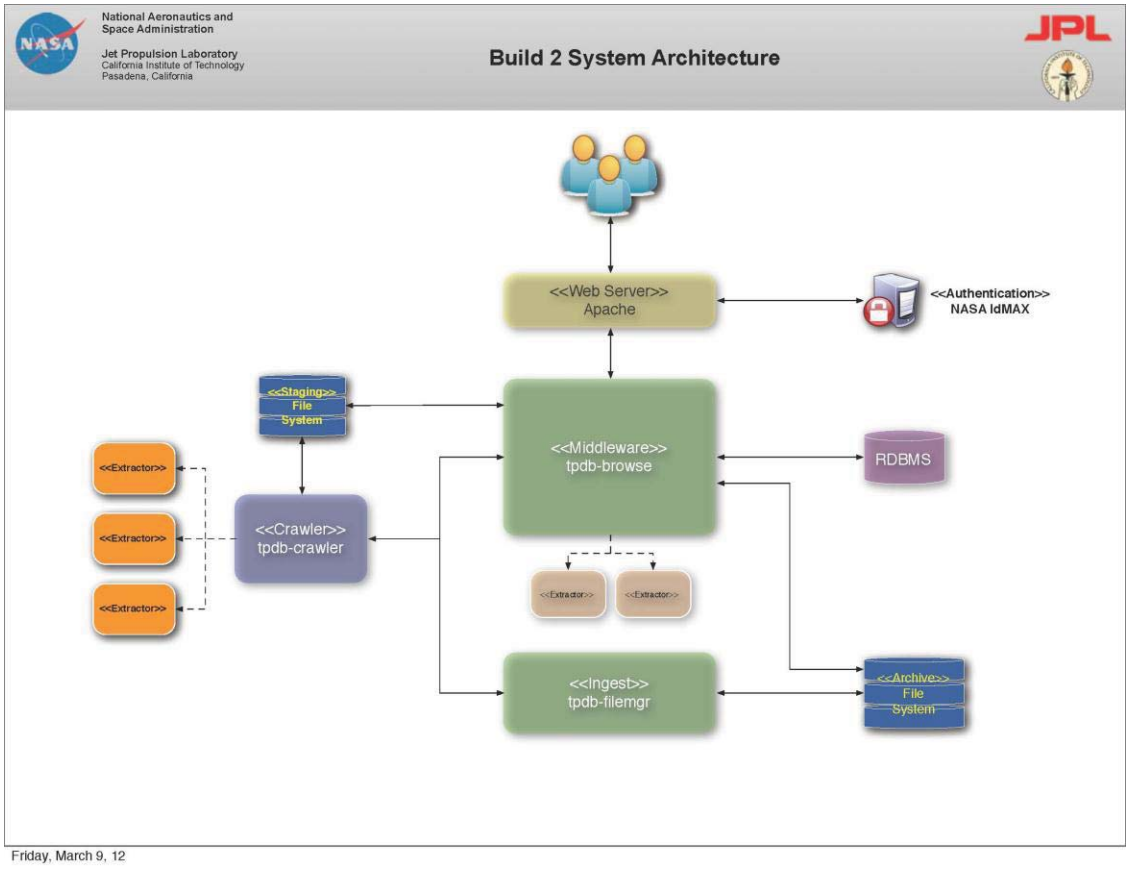
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Build 2 System Architecture
JPL
<<Web Server>>
Apache
<<Authentication>>
NASA IdMAX
<<Staging>>
File
System
<<Middleware>>
tpdb-browse
RDBMS
<<Extractor>>
<<Extractor>>
<<Extractor>>
<<Crawler>>
tpdb-crawler
<<Extractor>>
<<Extractor>>
<<Ingest>>
tpdb-filemgr
<<Archive>>
File
System
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JPL

"Capturing Good Data is like Brewing A Good Cup of Coffee"

-- Thomas Huang

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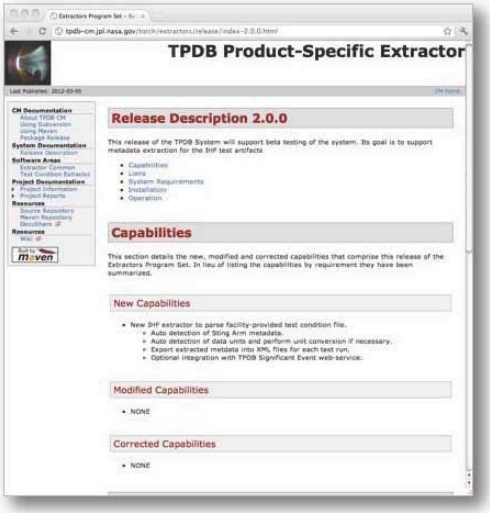
Extractors Program Set



- New IHF Test Condition Extractor
- Transforms tabular metadata into XML records describing
  - Run
  - Condition
  - Insertion
  - Calorimeter
- Standalone Application with optional integration with TPDB Significant Event Service
- Pure Java implementation (i.e. portability)

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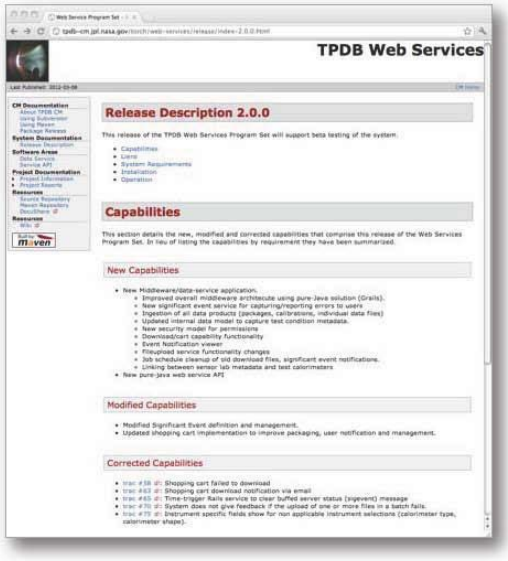
Web Services Program Set



- **Data Service (a.k.a. tpdb-browse)**
  - Middleware built with industry-standard web framework that supports Model-View-Control design pattern
  - The brain of the TPDB System for security, metadata capturing and coordination, significant event, and file downloads
    - **Significant Event** is a web service for trapping and reporting any messages that are published by its clients. Messages can be view on the web page or they can pull by our web service API
- **Service Application Programming Interface (API)**
  - Reusable library for interacting with the Data Service.
    - Metadata submission
    - Significant Event publication

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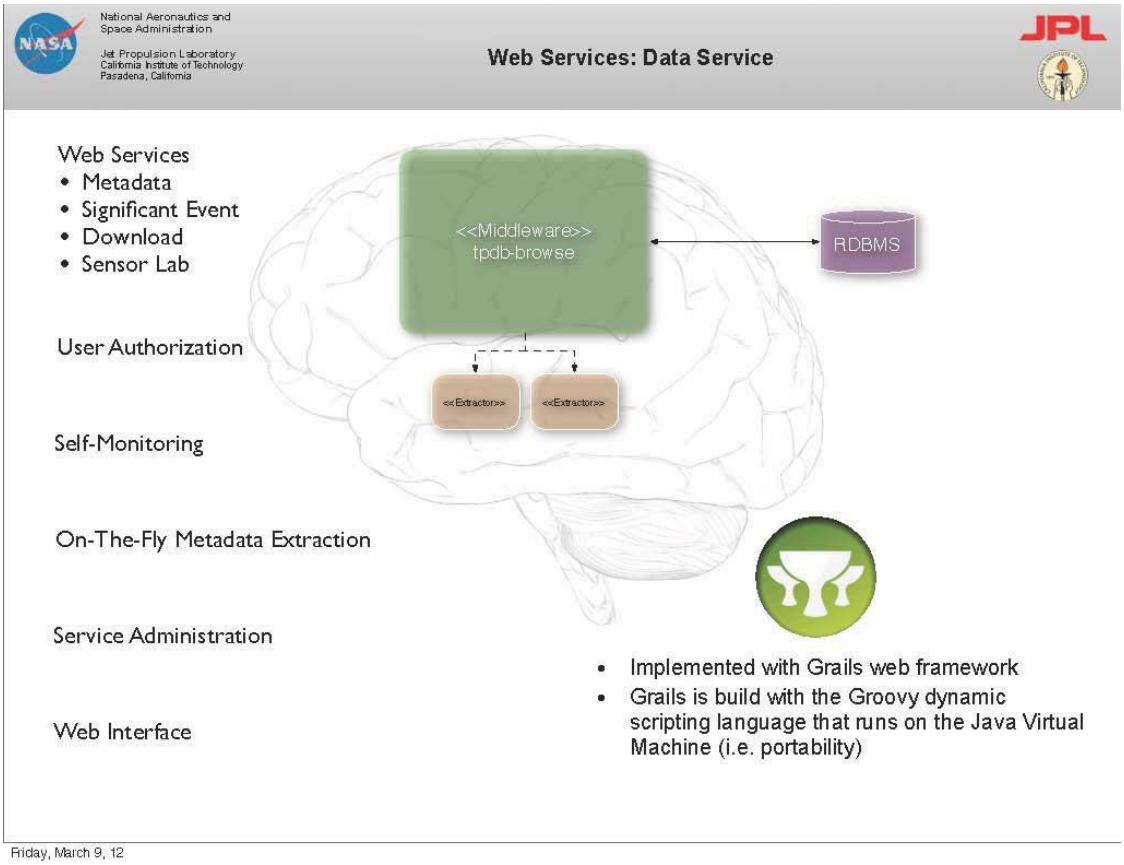
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Web Services: Data Service
Web Services
• Metadata
• Significant Event
• Download
• Sensor Lab
User Authorization
Self-Monitoring
On-The-Fly Metadata Extraction
Service Administration
Web Interface
<<Middleware>>
tpdb-browse
RDBMS
<<Extractor>>
<<Extractor>>
• Implemented with Grails web framework
• Grails is build with the Groovy dynamic scripting language that runs on the Java Virtual Machine (i.e. portability)
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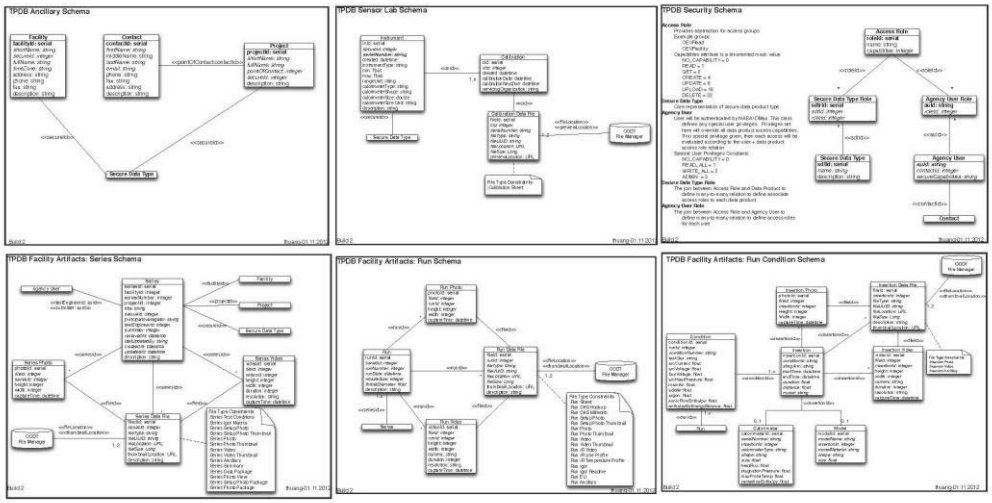
Web Services: Data Service: Data Model



Unified Metadata Data Model

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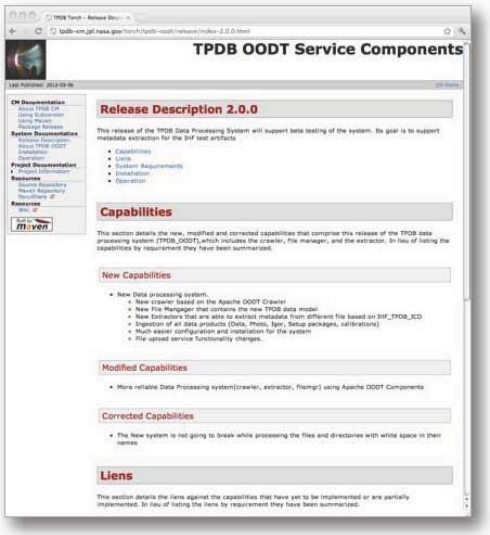
TPDB OODT Program Set



- **Built with the Apache OODT components.**
- **Crawler**
  - Implements the IHF ICD for rules on data packaging and naming conventions
  - Invoke built-in or external metadata extractors
  - Submit data files to the File Manager for Archive
- **File Extractor**
  - Extractors physical file characteristics
- **File Manager**
  - Archives data file
  - Customizable archive file system layout

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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California
TPDB System - Release 2.0.0
JPL
Jet Propulsion Laboratory
California Institute of Technology
Thermal Performance Database
Welcome!
USA.gov
Friday, March 9, 12

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14. ABSTRACT

Initiated as a NASA Engineering and Safety Center (NESC) assessment in 2009, the Thermal Performance Database (TPDB) was a response to the need for a centralized thermal performance data archive. The assessment was renamed Thermal Performance Data Services (TPDS) in 2012; the undertaking has had two fronts of activity: the development of a repository software application and the collection of historical thermal performance data sets from dispersed sources within the thermal performance community. This assessment has delivered a foundational tool on which additional features should be built to increase efficiency, expand the protection of critical Agency investments, and provide new discipline-advancing work opportunities. This report contains the information from the assessment.

15. SUBJECT TERMS
NASA Engineering and Safety Center; Thermal Performance Database; Thermal Performance Data Services; object-oriented data technology; Thermal Protection System

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