One NASA Cost Engineering Database (ONCE)

2015 NASA Cost Symposium

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SAIC: Mike Blandford and Julie McAfee

Overview

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- **ONCE and CADRE Background**
  - Brief overview
  - 2014 Symposium, release of “ONCE 2.0”
- **By the Numbers**
  - CADRe Dashboard
  - Download Dashboard
  - User Dashboard
  - Model Downloads
  - Numbers Summary
- **Enhancements**
  - Home Screen Dashboard
  - Inflation
  - Summary Tables
  - Help & Instructional Resources
  - CADRe Developer Workshop feedback status
- **Quality Assurance Activities**
  - Background
  - Goals
  - Summary
  - Completeness Metrics
  - Upload process improvement
  - QA reports & process
  - Targeted improvement activities

The “Plan”

- *This brief is designed to be a primer*
- *Invite everyone to attend the ONCE demo later with more content*

Note: All numbers shown current as 06 Aug

Last Time…at 2014 Symposium

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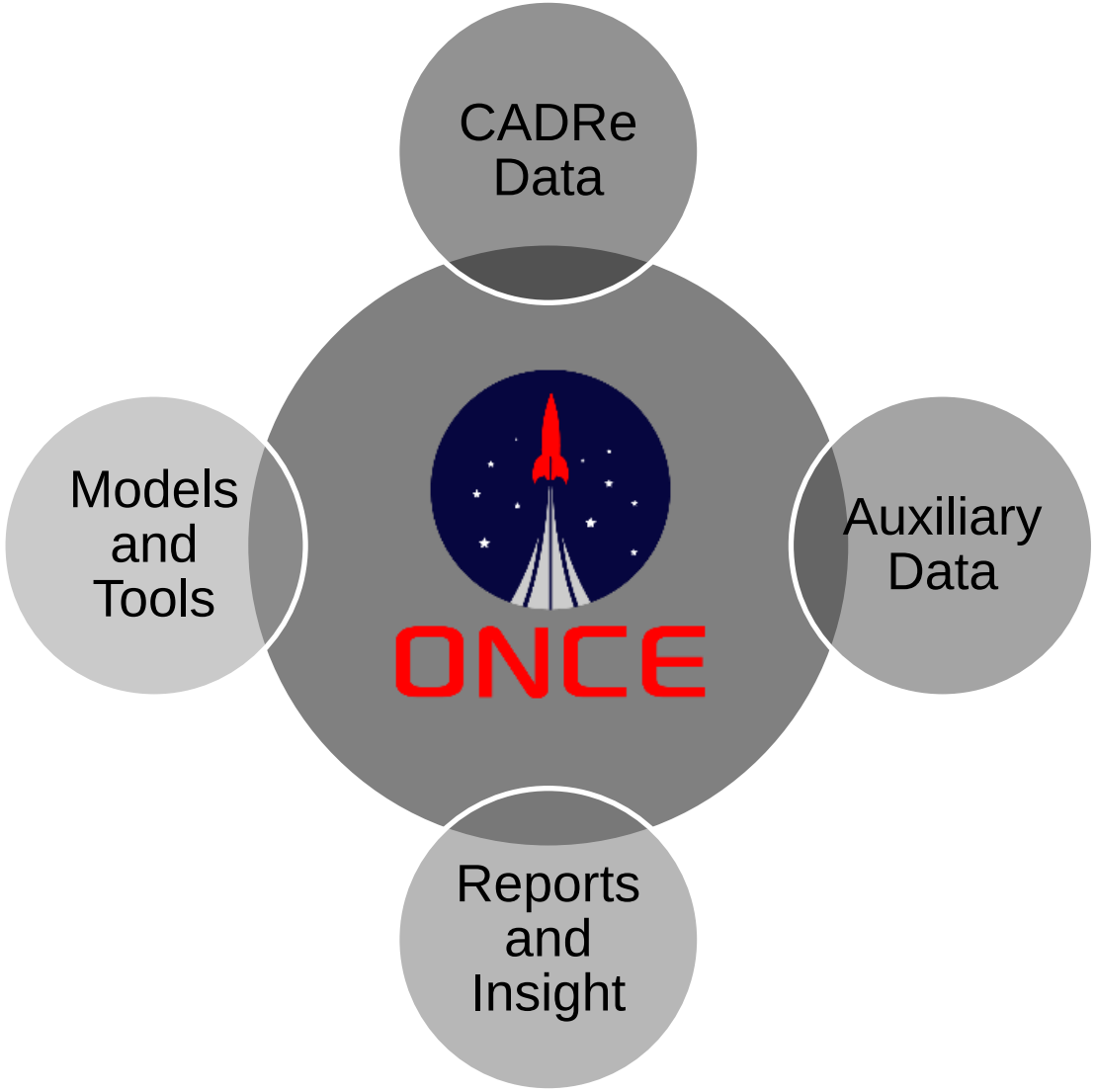

- ONCE 2.0 is significant improvement and puts the database at the center of CAD's efforts to build and improve the NASA community.
- ONCE is now the center of CAD's efforts to empower analysts and improve cost estimating at NASA by providing access to:

- **CADRe Data**
  - Active filtering for custom user reports
  - CADRe Library
- **Auxiliary Data**
  - Normalized datasets
- **Reports and Insight**
  - Dynamic graphical & tabular reports
  - Structured database reporting
- **Models and Tools**
  - Model Portal sharing access across community

Since then…we've been working!

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- **ONCE improvements resulting from 2014 Symposium demo**
  - Interface created that visualizes the ONCE standard WBS
    - Located under Resources Menu
  - Developed metrics on QA reports
    - New dashboards that document percent of completeness
  - Select all mission event's instruments when "Instrument n" is selected on standard WBS
  - Created a Symposium Library
    - 2006 – 2014 presentations currently available
  - Additional Libraries added
    - Inflation Indices, Decision Memos, CADRe Templates, MS Project Files
  - Models added to ONCE Model Portal
    - ACEIT, DOCTOR, PRICE, SMART

ONCE

By the Numbers

CADRe Dashboard

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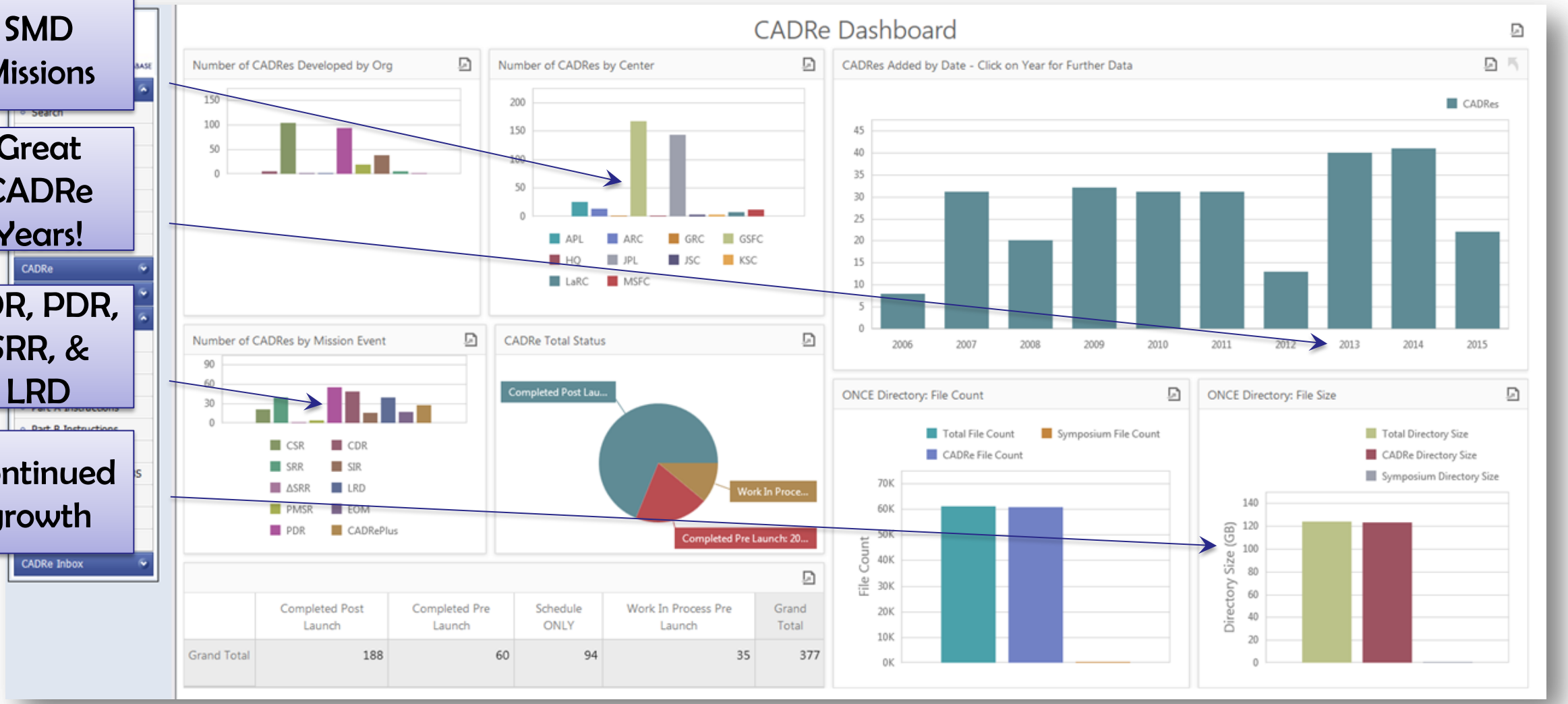
SMD Missions

Great CADRe Years!

CDR, PDR, SRR, & LRD

Continued growth



User Dashboard

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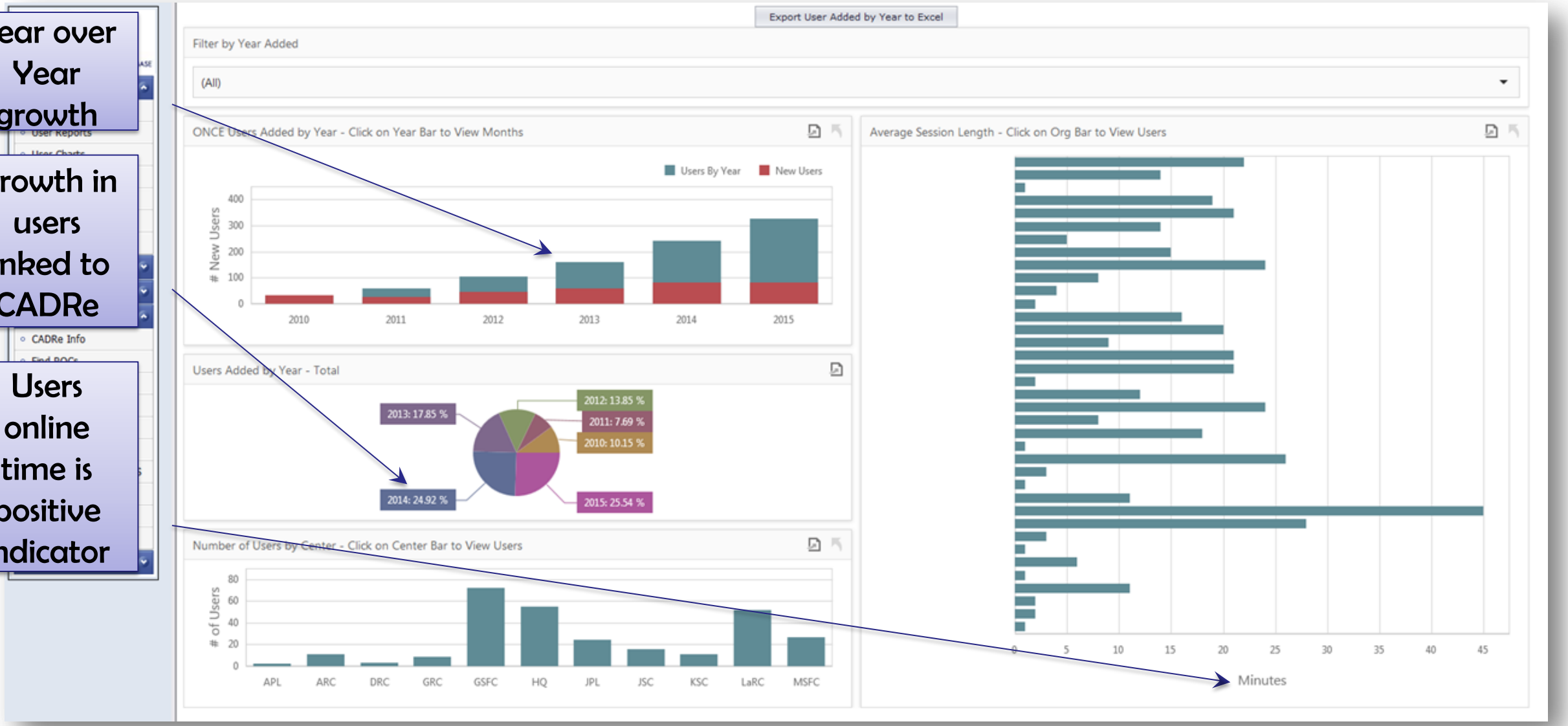
Year over Year growth

Growth in users linked to CADRe

Users online time is positive indicator



Downloads Dashboard

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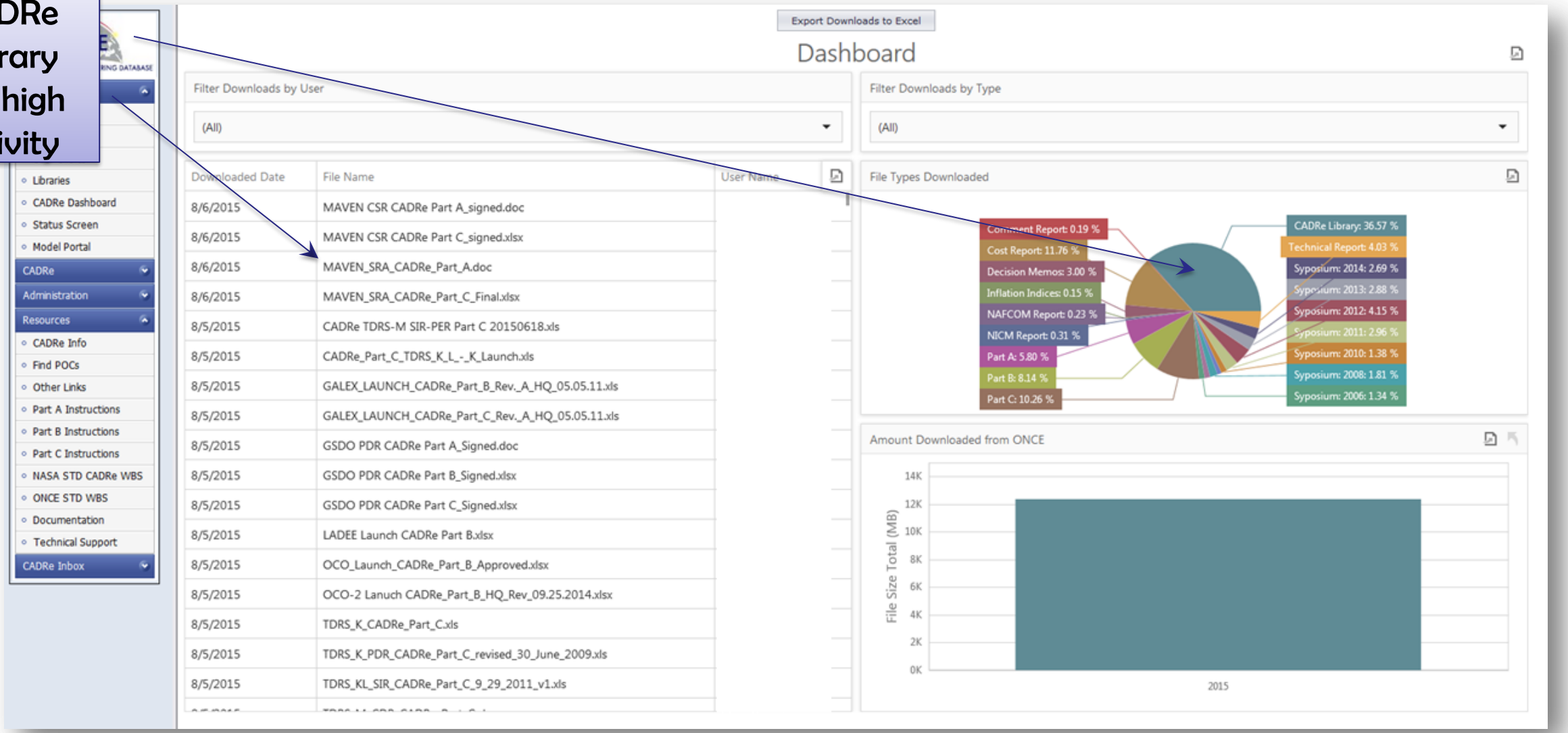
CADRe Library has high activity



Model Downloads (2015)

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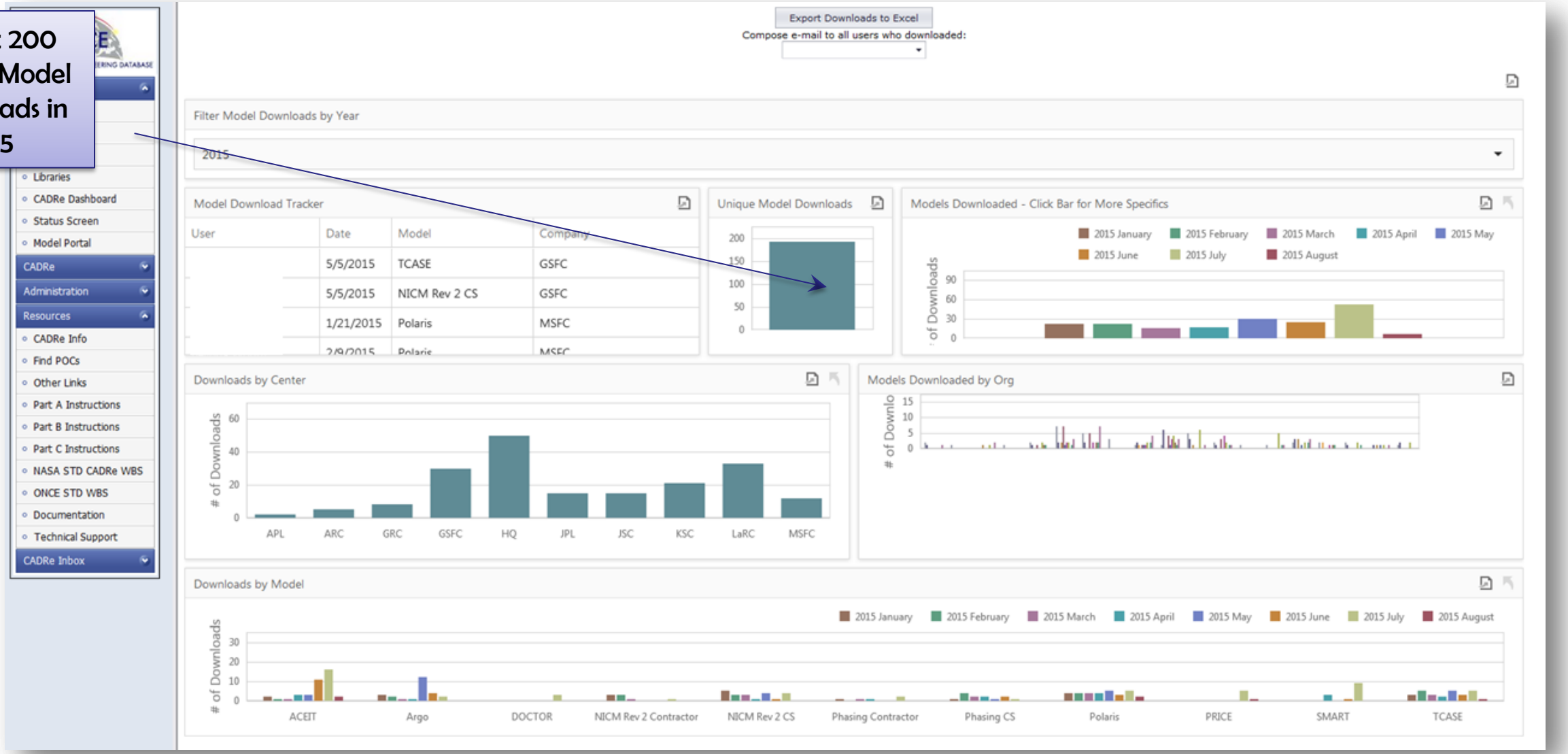
Almost 200 Unique Model Downloads in 2015



Total Model Downloads

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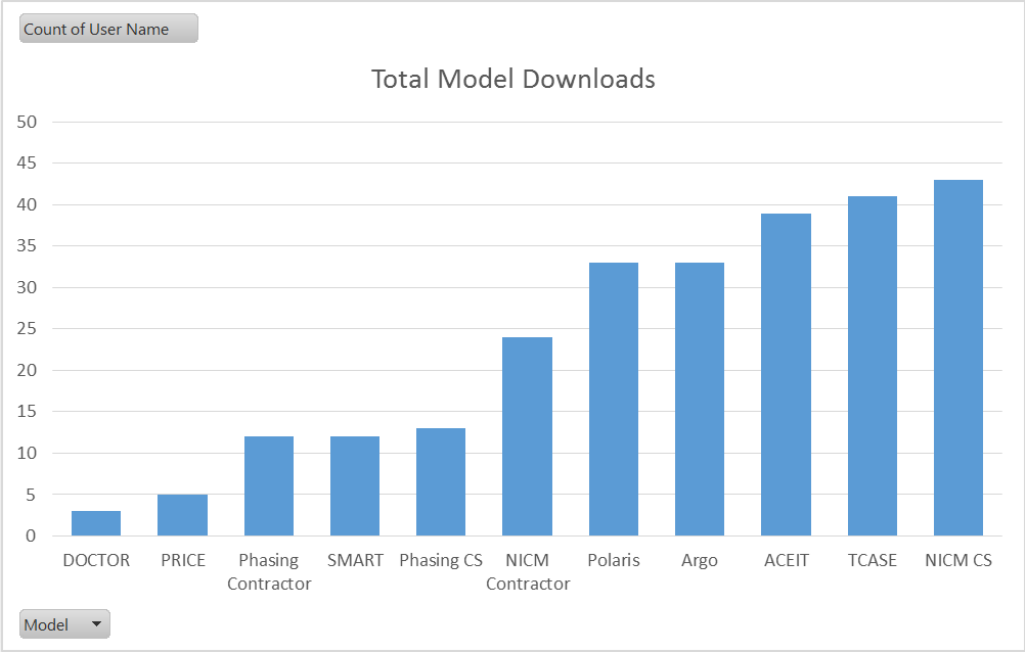
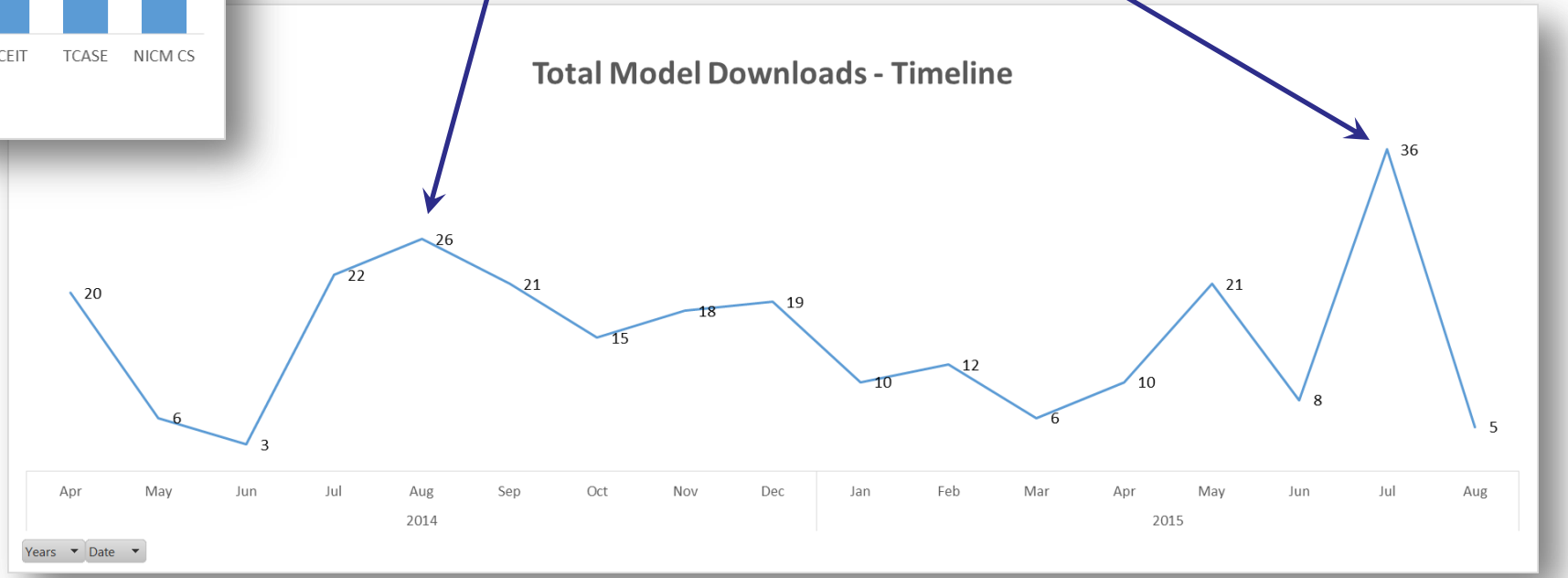


- **362 Total Model Downloads**
- **Updates to the Model Portal drive download spikes**

Model Portal Updates



- **NICM model is widely used (43)**
- **TCASE has become very popular**

Top Downloads

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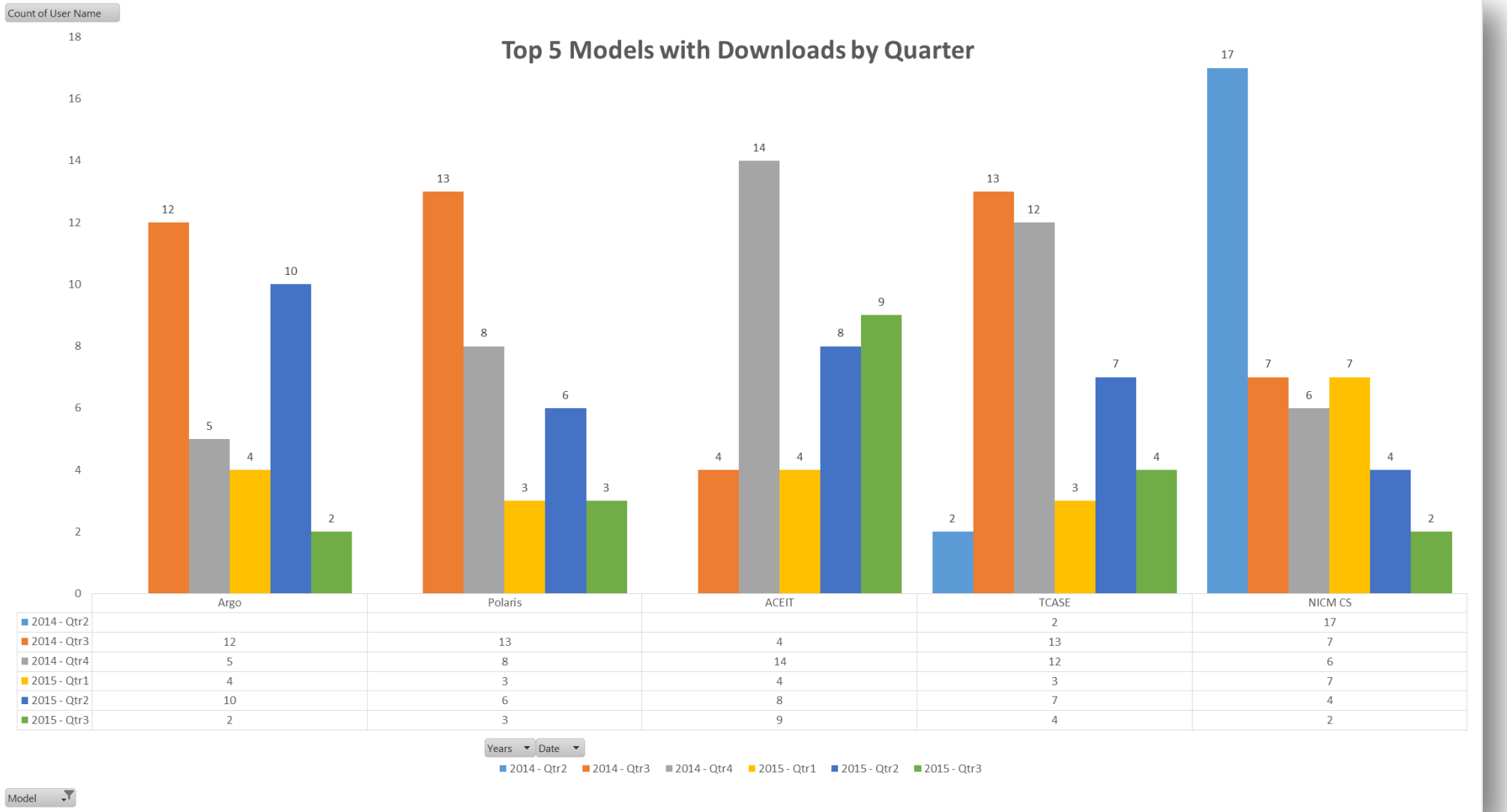
- NICM — 43
- TCASE — 41
- ACEIT — 39
- Polaris — 33
- Argo - 33



	Argo	Polaris	ACEIT	TCASE	NICM CS
2014 - Qtr2				2	17
2014 - Qtr3	12	13	4	13	7
2014 - Qtr4	5	8	14	12	6
2015 - Qtr1	4	3	4	3	7
2015 - Qtr2	10	6	8	7	4
2015 - Qtr3	2	3	9	4	2

Numbers Summary

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- **Total CADRe = 378**
  - 2015 = +22, 2014 = +41, 2013 = +40
- **Total Project = 110**
  - 56 PDR, 49 CDR, 40 SRR, and 40 LRD
- **Total User = 325**
  - 2015 = +94, 2014 = +81, 2013 = +53
- **Total Size = 60k documents and 120GB**
  - CADRe Library and Symposium Library most popular
- **Total Model Downloads = 362**
  - 2015 = 191
  - Top 5 Models are: NICM, TCASE, ACEIT, Argo, and Polaris

ONCE

Enhancements

New Home Screen

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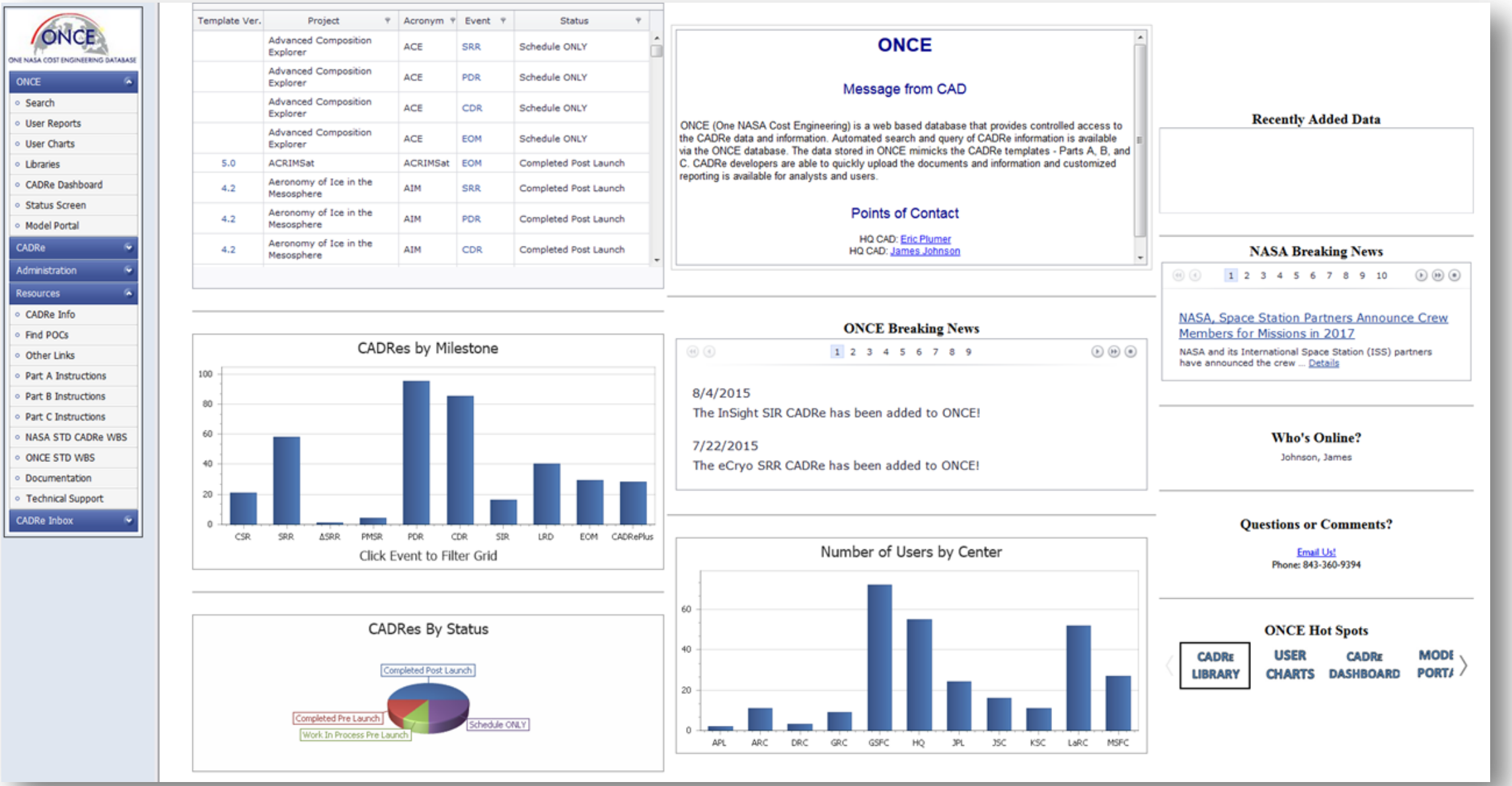

Document Search & Retrieval

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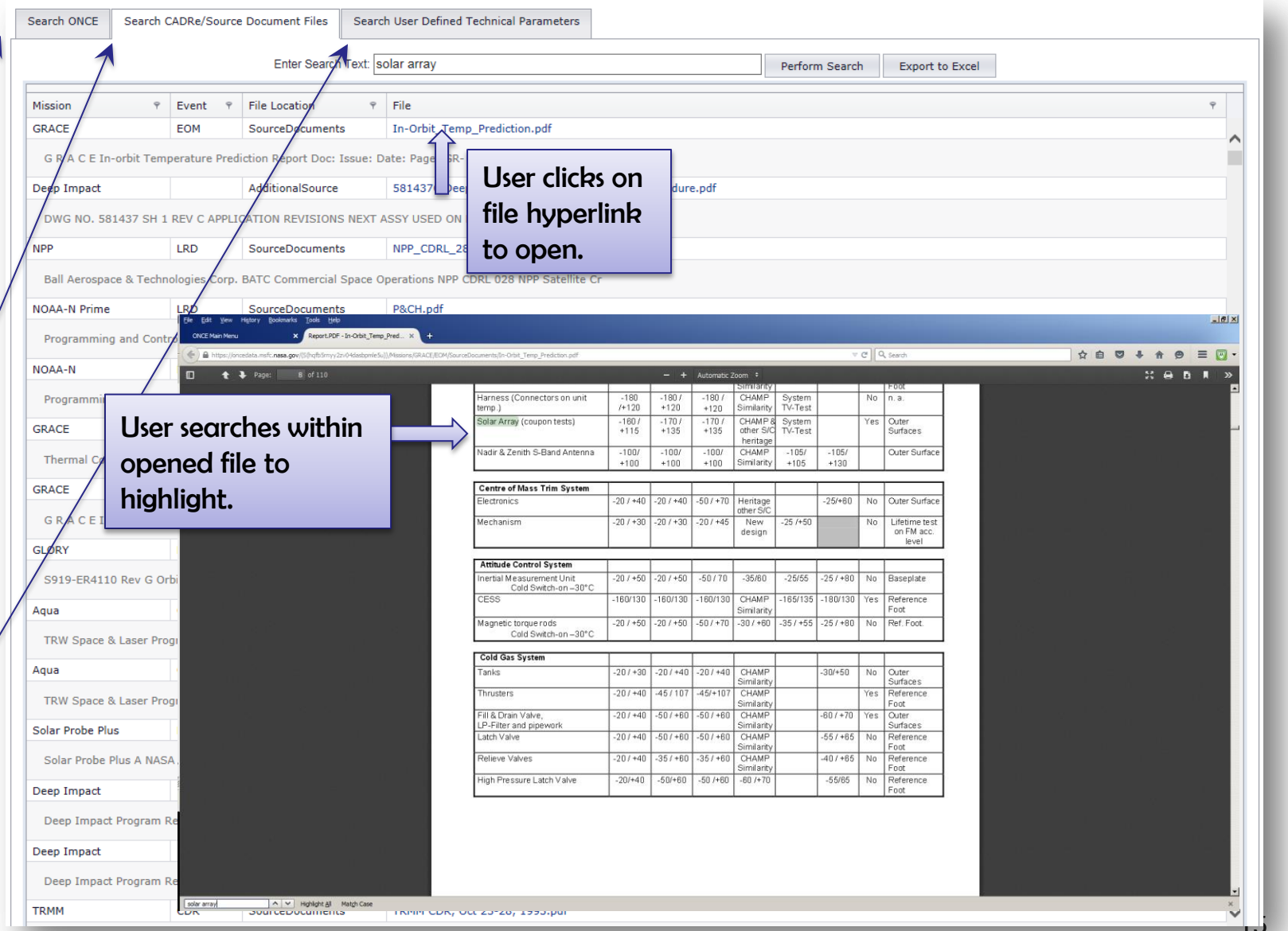
Search ONCE:
Search data incorporated into the ONCE database.

Search CADRe/Source Document Files:
Full text search of over 60,000 files --123 GB--stored in CADRe Library.

User Defined Search:
Provides ability to search user defined technical parameters.



New Summary Tables

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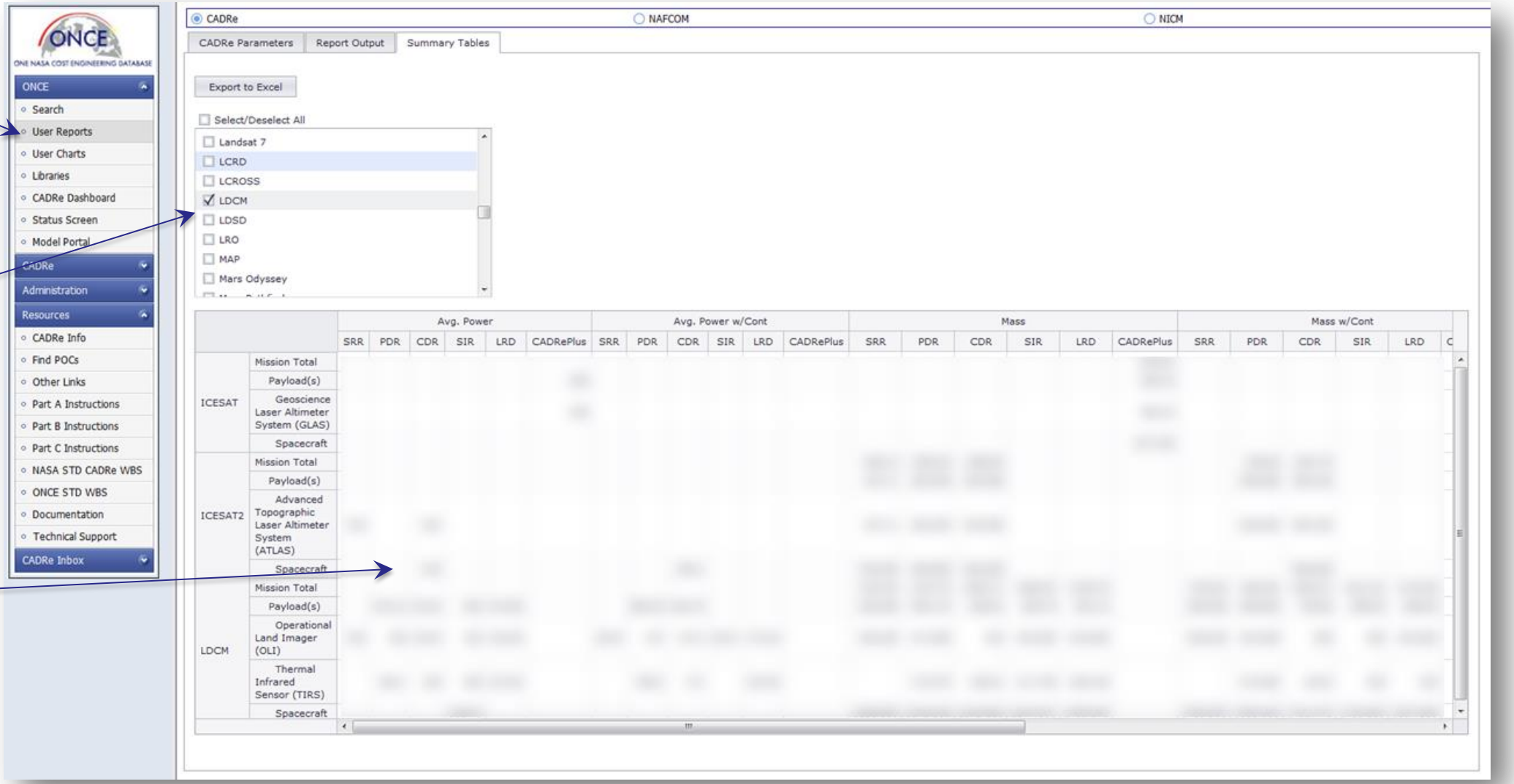
Summary Tables now available

Mission Selector

Clean dataset for Mission Total, Instrument, and SC



New Inflation Capability

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Inflation Radio Button

- **Inflation handling capability has been incorporated into the ONCE interface**
  - Users can now choose to output their report costs in standard Base Year dollars (e.g. BY2012$)
  - The legacy Real Year dollars will continue to be an option for reported costs so as to not lose traceability to historical CADRe phased costs.
  - The 2014 NASA New Start Inflation Index was integrated into the ONCE database to calculate inflation.
- **A radio button has been added to the phased cost output grid to allow users to switch their output between Real Year and Base Year (2012$)**
- **A base year of 2012 was selected to parallel with the year dollar outputs from the other datasets in the ONCE database (NICM and NAFCOM)**

- The base year for cost element was derived by:
  - Determining the real year for the cost element
  - Determining the correct inflation factor from the 2014 NASA New Start Inflation Index (NNSI)
    - Note on NNSI: The NNSI is intended to estimate new efforts and for normalizing historical cost from prior missions. It is suggested that NNSI should not be used to estimate NASA CS personnel costs. Future ONCE capabilities will include the ability to apply other indices to specific cost elements.
  - Inflating/deflating the cost element to 2012 dollars using the derived inflation factor.

Updated Resources - Overview

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ONCE Resources received major updates

Documentation has many new additions

ONCE
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- ONCE
  - Search
  - User Reports
  - User Charts
  - Libraries
  - CADRe Dashboard
  - Status Screen
  - Model Portal
- CADRe
- Administration
- Resources
  - CADRe Info
  - Find POCs
  - Other Links
  - Part A Instructions
  - Part B Instructions
  - Part C Instructions
  - NASA STD CADRe WBS
  - ONCE STD WBS
  - Documentation
  - Technical Support
- CADRe Inbox

CADRe and ONCE DATABASE OVERVIEW

CADRe (Cost Analysis Data Requirement)

The CADRe is a formal project document that describes the programmatic, technical, and life-cycle cost and cost/schedule risk information of a project. It is a 3 part document that describes a NASA project at each milestone, and provides historical record of cost, schedule, and technical project attributes so that estimators can better estimate future analogous projects. A 2005 initiative, the CADRe is NASA's unique response to the need to improve cost and schedule estimates during the formulation process, providing a common description of a project at a given point in time.

HISTORY OF CADRe

Over the past 15 years, NASA has been criticized for its inability to provide credible cost and schedule estimates for its space projects. In 1992, the Government Accountability Office (GAO) reported that NASA space projects sustained a 62 percent average growth rate over their initial cost estimates. Through a number of programmatic changes over the years, the Agency was able to reduce project cost growth rate to 30 percent. This was a good improvement, but the GAO still considered a 30 percent growth rate to be unacceptable.

In 2004 the GAO came out with harsh report on NASA titled "Lack of Disciplined Cost Estimating Processes Undermines NASA Ability to Manage Their Flight Projects". The GAO made a number of recommendations to NASA such as developing a document to fully describe a project and including the actual costs of the project so that estimators could use such data to better estimate similar future projects. Agency project managers (PMs) have historically estimated the cost of their projects using a bottom up method; otherwise known as "grass-roots estimating". The result is that these estimates are highly optimistic and don't tend to include all potential risks. To combat this tendency, the GAO recommended using actual historical costs and building a repository of cost and technical data for use in preparing cost estimates.

In response, the Agency, agreed (in line with the GAO recommendations) that all major space projects would develop what is now known as a Cost Analysis Data Requirement (CADRe), which contains the cost, technical and programmatic history of the various space projects. This document would serve as a formal means to capture and archive cost, technical and programmatic data for use in estimating future NASA projects. Over the course of several months unique templates for each part of the CADRe (A, B, C) were developed to standardize the development of the document across all of NASA's flight projects. Shortly afterwards the CADRe document was formally established in 7120.5C which was a new policy and direction to implement CADRe across all of NASA. The CADRe requirement continued in the release of 7120.5D and 7120.5E. With the framework in place, CAD began implementing CADRe on current mission as well as preparing CADRe for many historical flagship missions.

CADRE PURPOSE

The CADRe program satisfies a foundational cost-estimating need, which is to provide historical cost data that is vital to performing estimates for future missions. The CADRe provides information to support an Independent Cost Estimate (ICE) as well as actual cost and technical information so that estimators can do a better job of projecting the cost and schedule of future analogous projects. This way important data is captured across all major flight projects at NASA including major instruments that fly on foreign partner spacecraft.

CADRE OWNERSHIP

The CADRe is a project owed document and is signed by the project manager; therefore, it does not include any independent assessments or evaluations, or opinions about the project. It simply records the known configuration at the specific milestone. HQ/CAD provides the necessary funding and support to prepare the document on behalf of the project using existing project documentation prepared during the milestone review process. In the few cases where a CADRe is prepared for a previously launched mission, CAD will make the determination if there is enough data, and if so CAD will prepare a single Launch or End of Mission (EOM) CADRe. These CADRes are also very useful for historical benchmarking and understanding cost, schedule, and technical trends over time.

CADRE STRUCTURE

Composed of three parts, the CADRe captures detailed programmatic, technical, and cost data in a standardized format. The document is prepared six times during the life cycle of a project at major milestones (SRR, PDR, CDR, SIR, Launch, End of Mission).

The three parts of a CADRe are as follows:
PART A Describes a NASA project at each milestone (SRR, PDR, CDR, SIR, launch and End of Mission), and describes significant changes that have occurred. This section includes essential subsystem descriptions, block diagrams, heritage assumptions needed for cost analysis purposes. The templates for robotic or human space flight missions can be found at: http://www.nasa.gov/offices/ooe/CAD.html

PART B Contains standardized templates to capture key technical parameters that are considered to drive cost such as mass, power, data rates, and software metrics in an Excel Workbook. The formats of this template follow standard NASA terminology such as Current Best Estimates (CBE) and CBE Plus Contingency. (See http://www.nasa.gov/offices/ooe/CAD.html)

PART C Captures the NASA project's cost estimate and actual life-cycle costs within the project's WBS and a NASA Cost Estimating Work Breakdown Structures (WBS) in an Excel Workbook. This section also captures the project schedule, risks, and ground rules and assumptions. (See http://www.nasa.gov/offices/ooe/CAD.html)

The source documents that make up a CADRe include all the various documentation that the project is already producing. The CADRe is always written using existing project documents, and CAD does not force the project to produce any unique documentation to produce the CADRe. This is one of the key aspects of CADRe that makes it a one-stop source of data. As can be seen in the figure below Part A includes documents such as the Project Plan and Milestone briefing charts, Part B uses the project mass and power reports, and Part C uses the project's cost estimates, schedules and cost reports. See the figure below for many of the key documents used.

New Resources - Documentation

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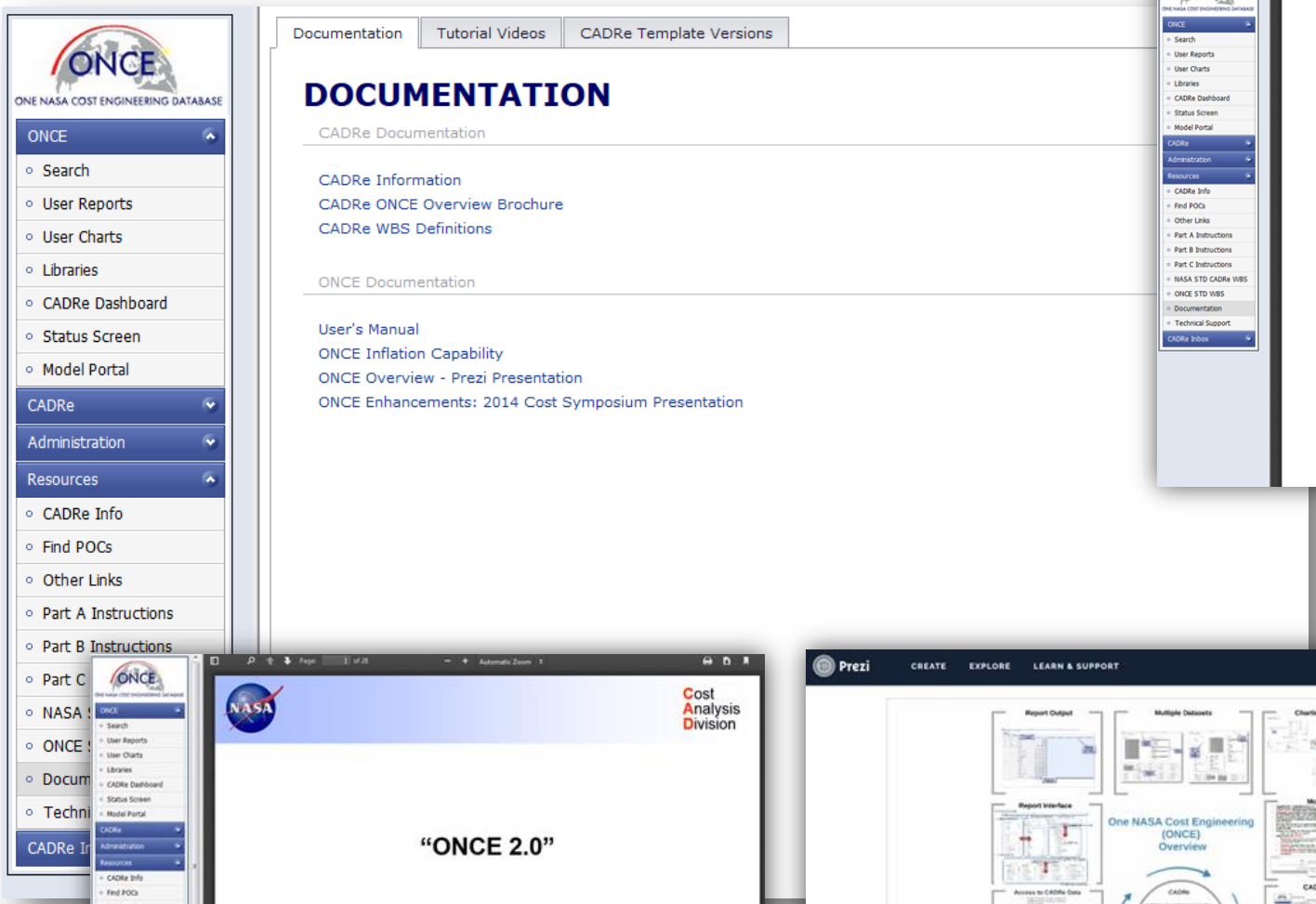

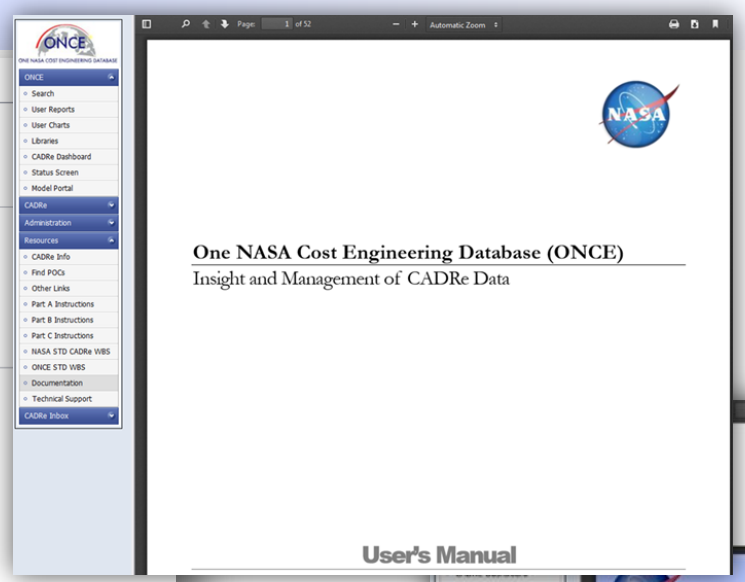

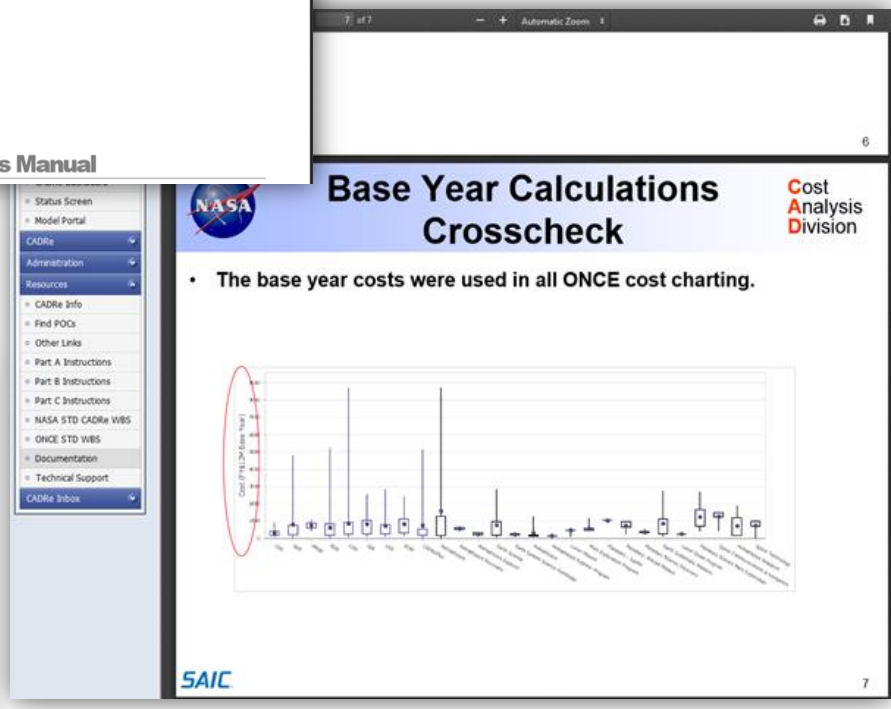

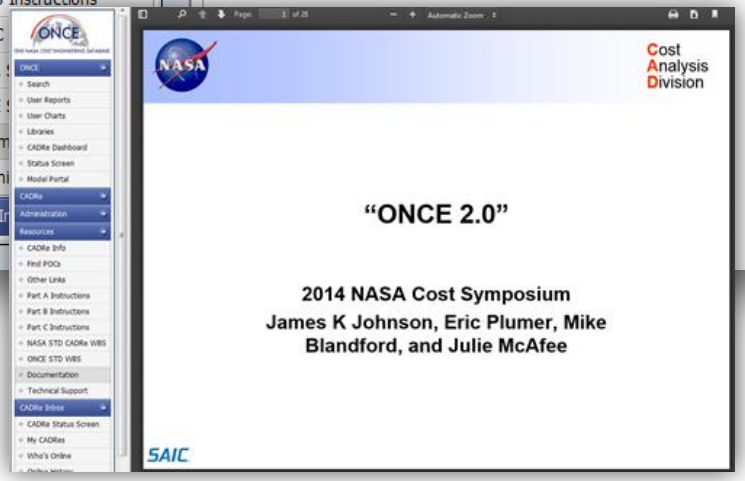

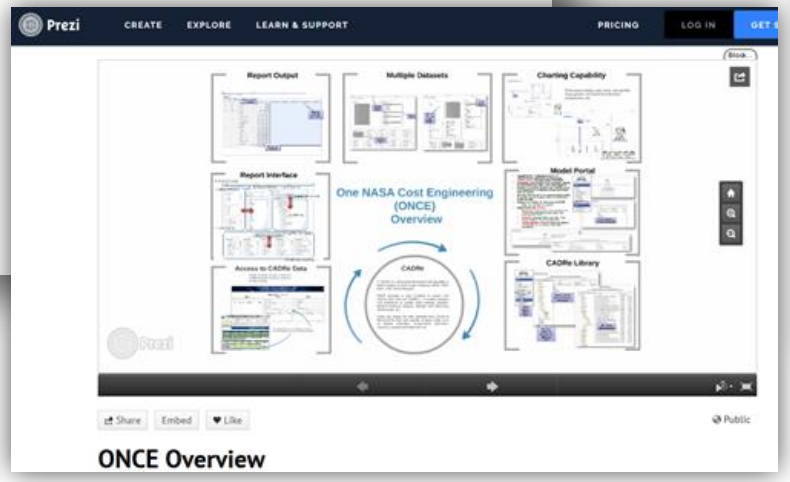

New Resources – Tutorial Videos

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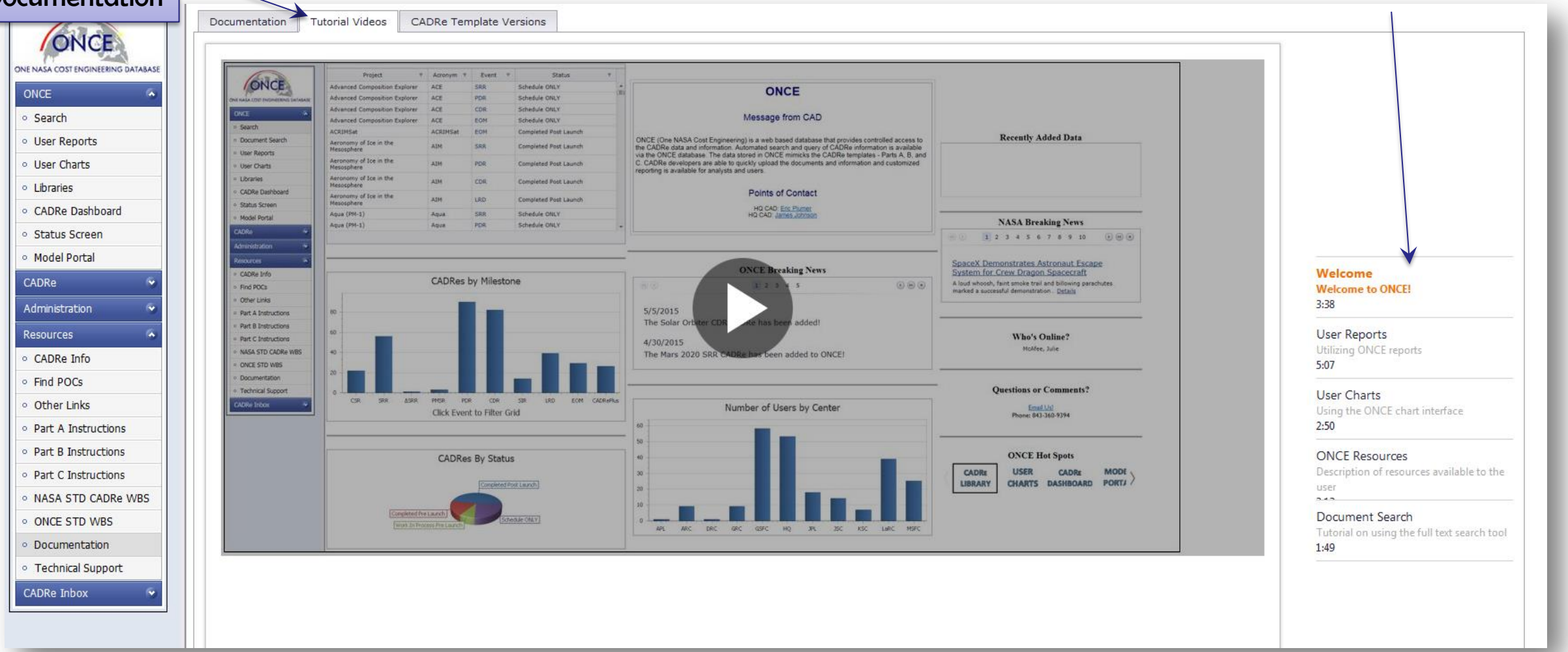
Tutorial Videos tab under Documentation

Multiple new videos



Resources – CADRe Template Versions

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CADRe Template Version History

Template Version # displayed with Project CADRe

Template Version #, Name, and Description

ONCE
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- ONCE
  - Search
  - User Reports
  - User Charts
  - Libraries
  - CADRe Dashboard
  - Status Screen
  - Model Portal
- CADRe
- Administration
- Resources
  - CADRe Info
  - Find POCs
  - Other Links
  - Part A Instructions
  - Part B Instructions
  - Part C Instructions
  - NASA STD CADRe WBS
  - ONCE STD WBS
  - Documentation
  - Technical Support
- CADRe Inbox

Documentation | Tutorial Videos | CADRe Template Versions

Export to Excel

Template #	Version Name	Version Description
1.0	Version 1.0: 3/10/06	Part A- First Baselined Template Part B- First Baselined Template Part C- First Baselined Template
2.0	Version 2.0: 12/06/06	Part A- Introduces a CADRe Plus section that attempts to document all cost, technical, schedule, and programmatic changes that occurred from SRR to LRD Part B- New instructions for completing CADRE, added FFRDC section in FTE/WYE table, Report AS OF dates added, Re-engineered MOS/GSD tables, Removed LV System Parms and LV Stage parms. Part C-Improved the Instructions. Added Basis of Estimate Sheet, and Detailed Element WBS Costs
3.0	Version 3.0: 3/26/07	Part A- Added Program/Project History Table, Added Milestone Event on cover, Added Sig Event Cost log, Workforce Analysis Log. Part B- Updated Instructions for completing a CADRe, Added Support Contractor and Prime WYE tables. Part C- Provided Level 2 WBS breakout for Project WBS and LCCE sheet with Corp G&A and CMO, Added early schedule data sheet.
4.0	Version 4.0: 4/29/08	Part A- Adjusted CADRe Plus instructions for Section A.5. Part B- Added Additional CADRe Plus Template. Part C- Improved Instructions, Added Cost Assumptions Tab which has 2 sections-Ground Rules and Basis of Estimate.
4.1	Version 4.1: 12/1/08	Part A- Added Project Logo instruction, Added Milestone Data and Revision Date, Added Table of Contents & Table of Figures, Added SBU Footnote. Part B- Added MOS to System Level Parms, Re-Organized MOS/GDS table. Part C- Added Risk Assessment Sheet - but no structure.
4.2	Version 4.2: 10/01/09	Part A- No Change to Part A. Part B- Improved Cell Definitions (Thermal, Power), Broke out Separate MOS and GDS sections in the MOS/GDS tab. Part C- No Change.
5.0	Version 5.0: 3/10/11	Part A- No Change to Part A. Part B- Added pull down menus, added Instrument Builder Name, Added breakout of Physical and Logical SLOC in SW sheet. Part C- Added Directions to include source sheets, Added new schedule table to Schedule Tab, Added Risk Tab prompts for 5X5s, JCL results, and Risk lists.
6.01	Version 6.01: 4/20/15 – UNDER DEVELOPMENT	Part A- Added List of Tables (separate from list of Figures), Re-ordered A.1.2. System Overview & Launch, Added Internal vs External changes in Section A.5. Part B- Moved Milestone Schedule to Schedule Tab, Moved Key Tech Parms to System Level Param, Added additional units as provided by Developers, Added Check Sum formulas.

ONCE

Enhancements – CADRe Developer Workshop Status

Summary

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- **CADRe Developers Workshop held on 27-28 May 2015 at JPL in Pasadena, CA**
  - 32 attendees including phone participants
  - Topic focus on: ONCE updates, CADRe upload, TDM missions, Part B template revisions, Data Completeness metrics, Collecting schedule data, and Collecting risk data
- **Notes with full Action Item Listing sent on 2 June 2015 Date**
  - General Actions, CADRe Template Actions, and ONCE Actions
- **ONCE Action Items**
  - 15 of 21 Action Items marked Complete
- **Part B Action Item for CADRe Developers**
  - All teams have submitted their feedback, thank you!
- **Part B Template Revision**
  - HQ CAD is revising Part B template and will provide draft back to CADRe Developers for revisions and comment at later date

ONCE

Quality Assurance Activities

Quality Assurance Activities - Background

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- **ONCE contains the data from CADRes in a SQL DB (database)**
  - Primarily from Part B (Technical) and Part C (Cost)
- **Quality Assurance activities refer to the CADRe data stored in the DB**
  - Easy to say, hard to put your finger on:
    - CADRe has evolved over time (template changes, quality improvements, etc.)
    - Database has evolved over time (version upgrades, schema improvements, etc.)
    - CADRe is technically a Project document
      - Current design is as a “Flight Recorder”; quality is therefore a pass-thru
      - When Projects data products are healthy, CADRe quality is high and vice-versa
- **Prior research and feedback has indicated QA activities have value**
  - Reduce time spent formatting, structuring, and cleaning up datasets for analysis
  - Increase the completeness to provide more data points for queries
- **Put simply, QA activities involve:**
  - Improving the underlying CADRe data quality (focused on Part B and Part C)
  - Improving the structure and functions of the ONCE DB
  - Analyzing the DB and CADRe to develop metrics
- **Efforts have been underway perpetually and increased since Summer 2014**
  - Next slides provide metrics, achievements, and selected screenshots

Quality Assurance - Goals

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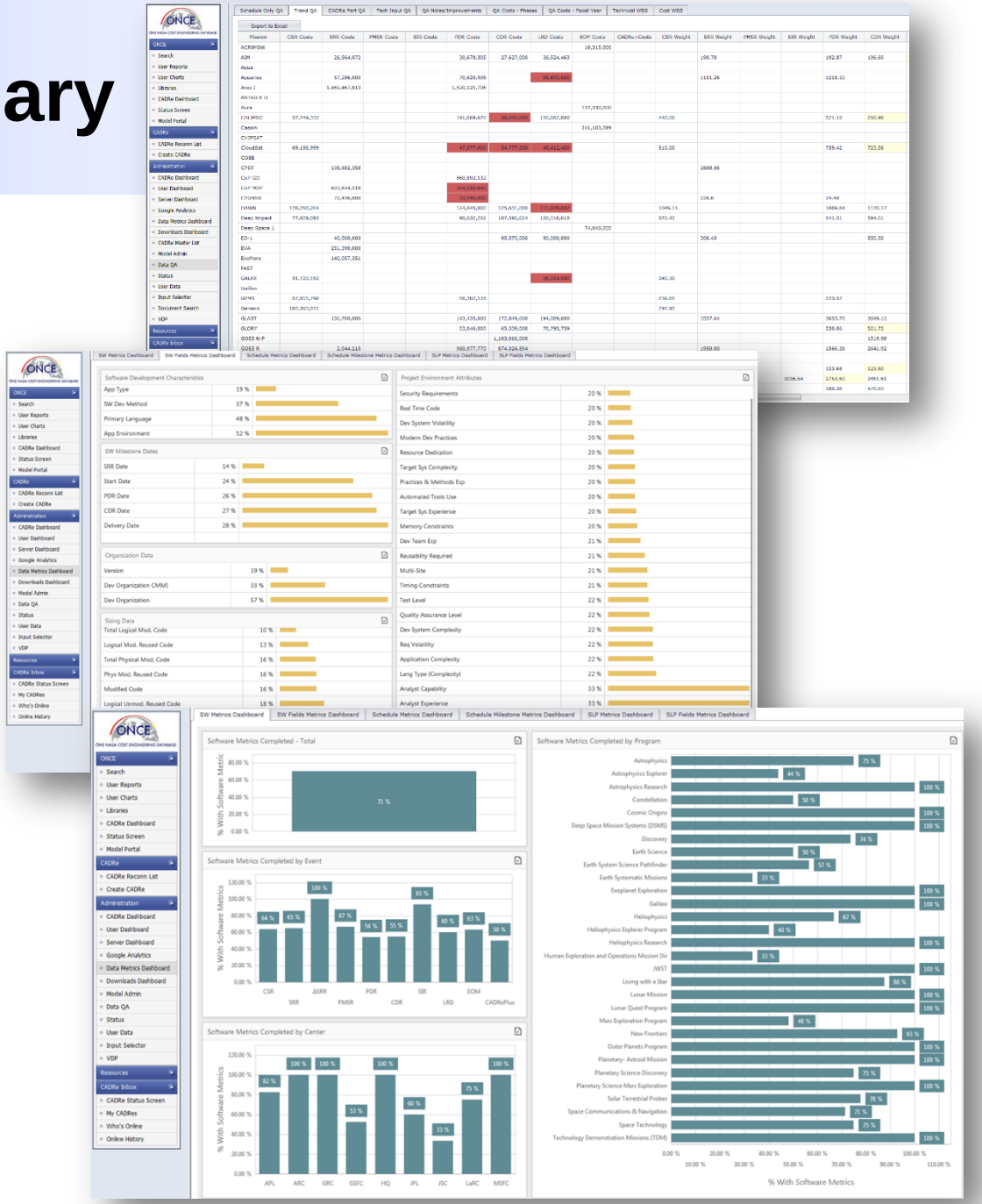
- **Establishing and analyzing data quality metrics will have a large impact on the entire estimation & analysis community**
  - More than 300 users today, at 10 centers, representing more than 30 orgs
- **Goal #1**
  - Establish meaningful data quality metrics that leverage automation and advanced database analysis techniques.
    - **"Build Good and Smart Data Quality Metrics."**
- **Goal #2**
  - Use the data quality metrics to identify specific areas of the database that can be improved which will yield the largest total impact.
    - **"Use Metrics to Identify the Biggest Bang for the Buck."**
- **Goal #3**
  - Continually measure and perform trend analysis on the data quality metrics to inform future decisions on CADRe data collection and ONCE database management.
    - **"Utilize Metrics to Perform Trend Analysis Over Time."**
- **Goal #4**
  - Maintain the credibility and integrity of the CADRe data stored in ONCE by documenting any revisions that occur as a part of quality control / quality assurance activities.
    - **"Ensure the Integrity of CADRe and ONCE with Good Documentation."**

QA Achievements - Summary

- **9 Data Completeness Dashboards**
  - Software (3), Schedule (3), System Level Parameters (3)
- **9 Quality Assurance Dashboards and Tools**
  - Schedule Only QA, Data Trends, CADRe Part, Tech Input QA, QA Notes/Improvements, QA Costs by Phase , QA Costs by FY, Technical WBS, and Cost WBS
- **25 Closed QA Activities Completed**
  - 12 Open, QA Activities are fed by dashboards and tools, and tracked for closure
- **NICM vs CADRe QA Completed**
  - Documentation, live reporting, delta analysis, etc.
- **15 out of 21 QA Action Items from 2015 CADRe Developer Workshop complete**
  - Status report sent to CADRe Developer community



Data Completeness Dashboard – Type 1

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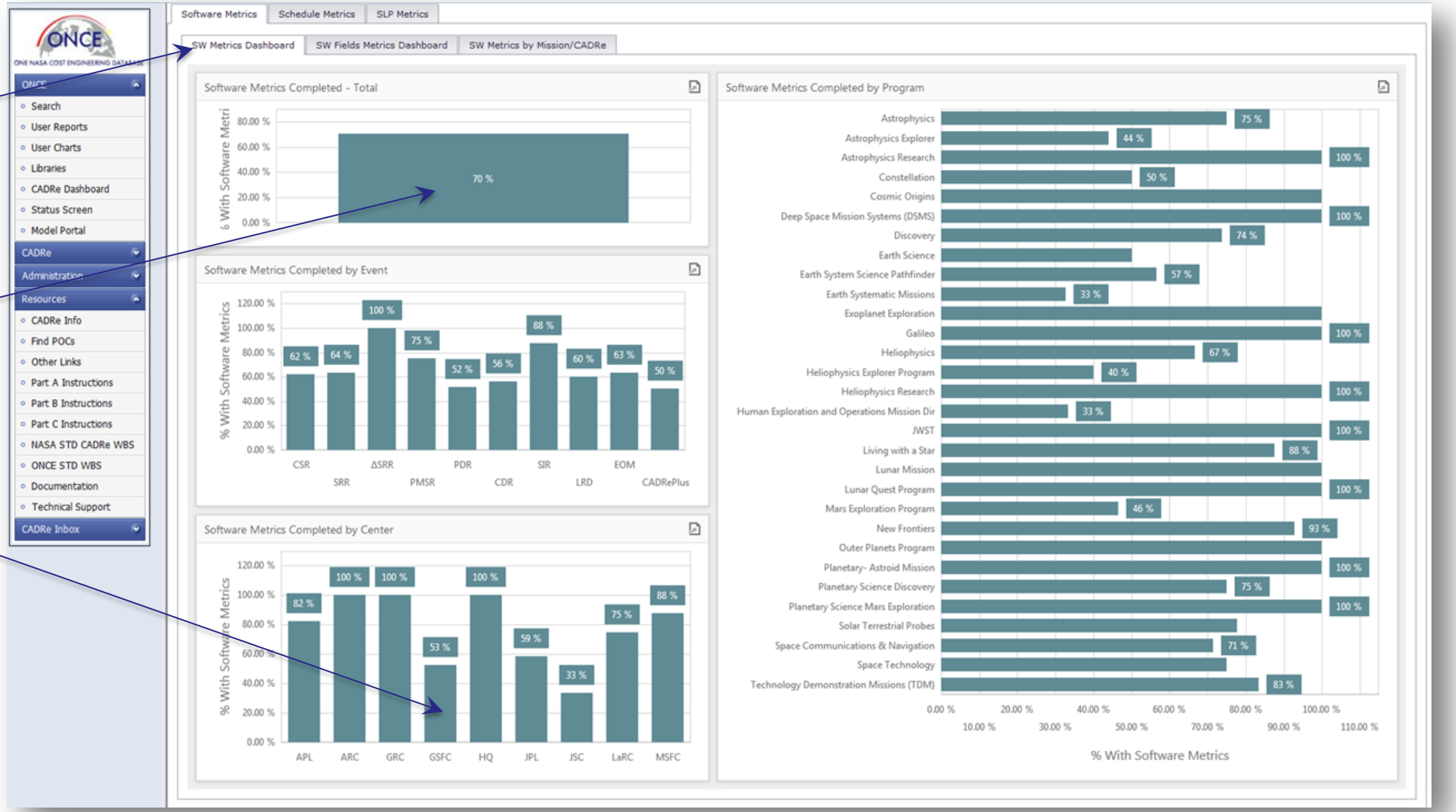
Type 1 provides high level overview metrics

70% of all CADRe has some value in Software area

53% of all GSFC CADRe has some value in Software area



Data Completeness Dashboard – Type 2

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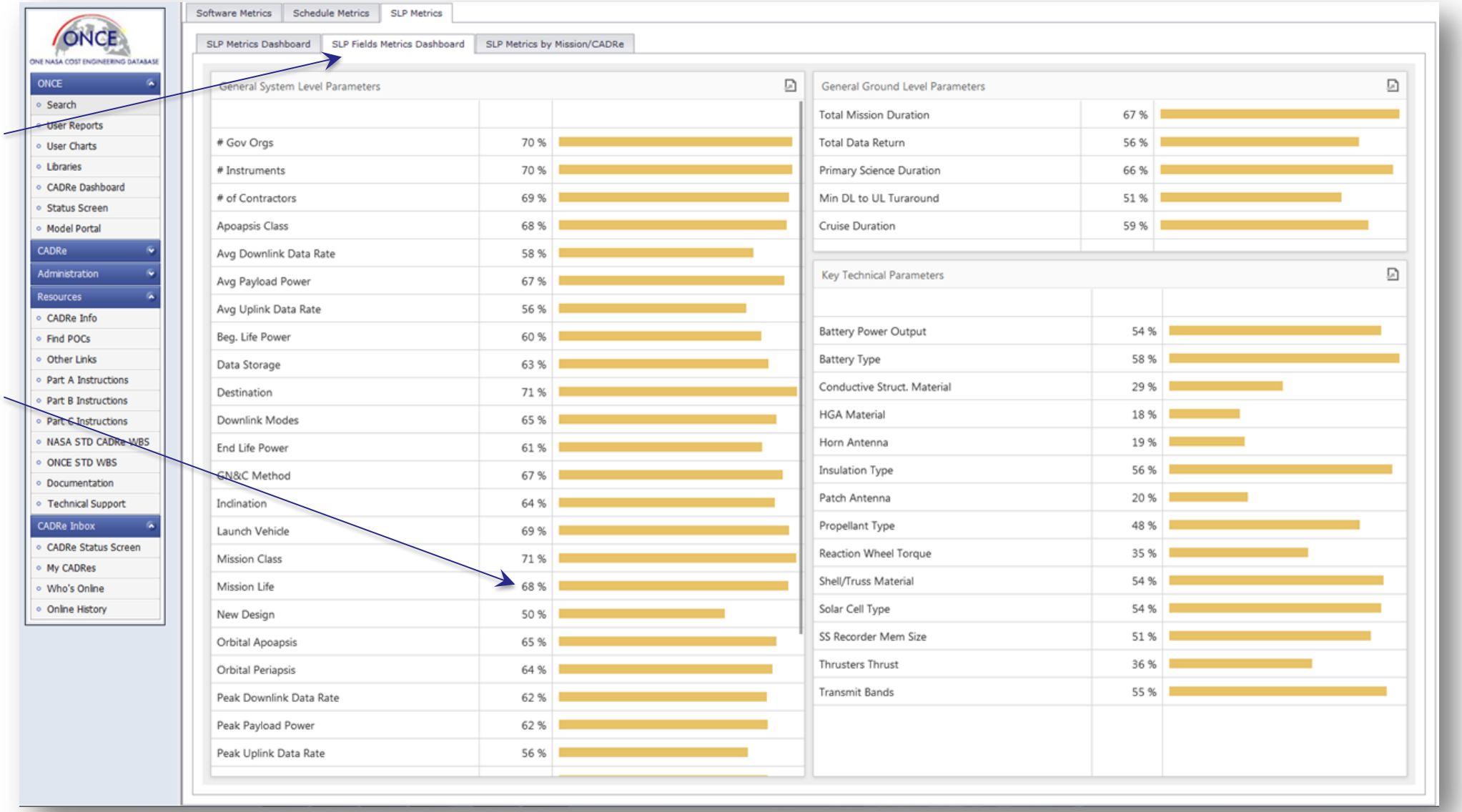
Type 2 provides specific parameter metrics

68% of all CADRe has value for Mission Life in System Level Parameters (SLP)



Data Completeness Dashboard – Type 3

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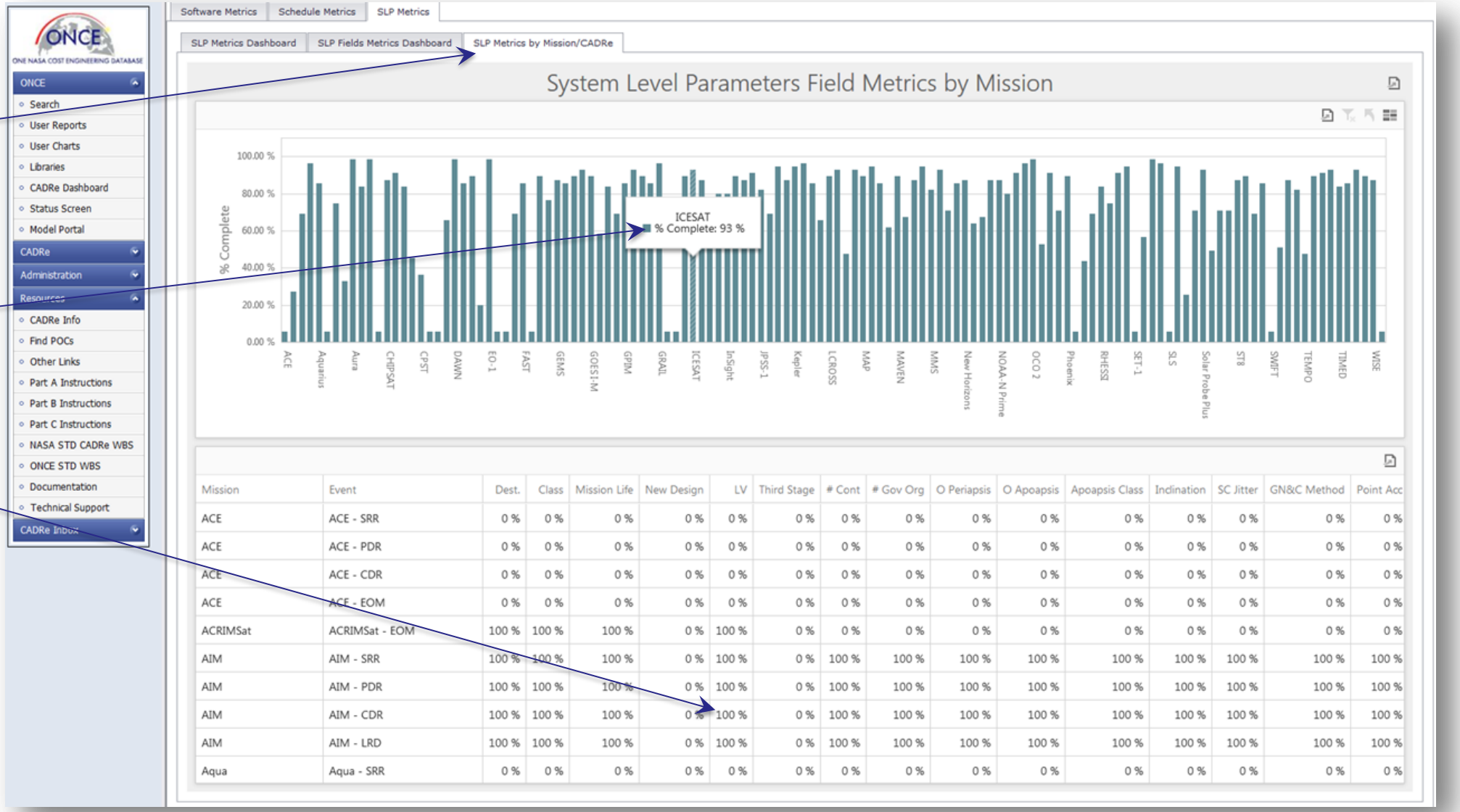
Type 3 provides specific metrics by Mission and CADRe

ICESAT CADRes sum to 93% complete

Completeness detail per CADRe per Mission



Mission	Event	Dest.	Class	Mission Life	New Design	LV	Third Stage	# Cont	# Gov Org	O Periapsis	O Apoapsis	Apoapsis Class	Inclination	SC Jitter	GN&C Method	Point Acc
ACE	ACE - SRR	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
ACE	ACE - PDR	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
ACE	ACE - CDR	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
ACE	ACE - EOM	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
ACRIMSat	ACRIMSat - EOM	100 %	100 %	100 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
AIM	AIM - SRR	100 %	100 %	100 %	0 %	100 %	0 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
AIM	AIM - PDR	100 %	100 %	100 %	0 %	100 %	0 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
AIM	AIM - CDR	100 %	100 %	100 %	0 %	100 %	0 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
AIM	AIM - LRD	100 %	100 %	100 %	0 %	100 %	0 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Aqua	Aqua - SRR	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %

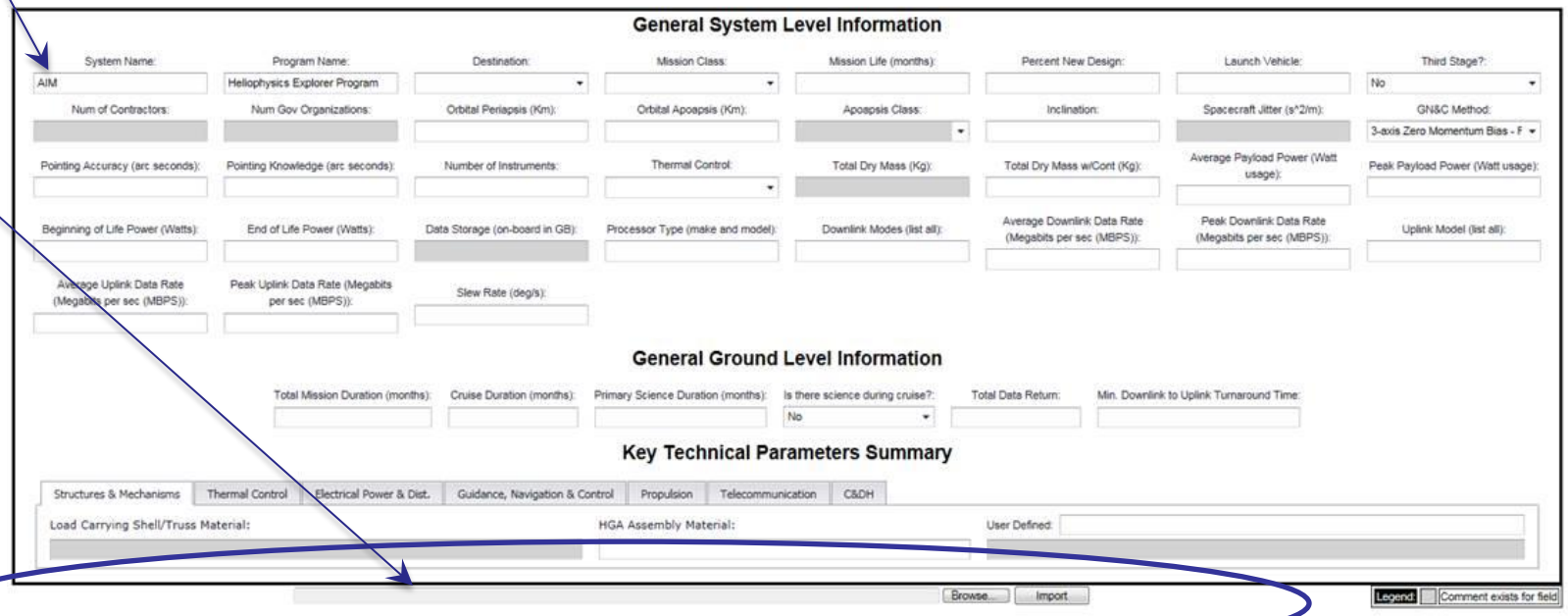
Upload Process Improvement

Cost
Analysis
Division

Values automatically imported

CADRe Part B File Upload

- **Approximately 50% of the CADRe entry process is automated.**
  - CADRe System Level Parameters Automation
    - All inputs populated in a few seconds.
    - Screen is updated with values allowing for sanity check before saving to database (e.g. removing units or “N/A” entries).



Upload Process Improvement

Cost
Analysis
Division

- **Metrics were established to measure the time for new automated entry vs. old manual entry**
  - **Test case produced a 67% increase in productivity with new upload process and automation**
    - **Less time to complete, more throughput**
  - **The test case took 10 hours total to manually enter the CADRe**
    - **5 of those 10 hours are now automated.**
    - **New upload process only takes 1 hour to enter the same information**
    - **That 1 hour includes the time to upload, enter all the comments, and double check all values**

Conclusion

Cost
Analysis
Division

- **Good work continues on ONCE from 2014**
  – 110 missions, 300+ CADRe's, and 120GB of files available

- **Major enhancements include:**
  – Inflation capability
  – Search and retrieval
  – Completeness Dashboards
  – New Home Screen…and many more!

- **Quality Assurance activities utilize new capabilities to focus improvements**
  – Dashboards, reports, etc
  – CADRe Developer Workshop produced high quality list of QA activities
  – Targeted improvements will focus efforts on particular Missions, CADRes, or Parameters

- **Invitation to the ONCE Overview**
  – Tuesday 4:00 to 4:30
  – Room 171, Bldg 152

BACKUP

Slides not included in Symposium Brief

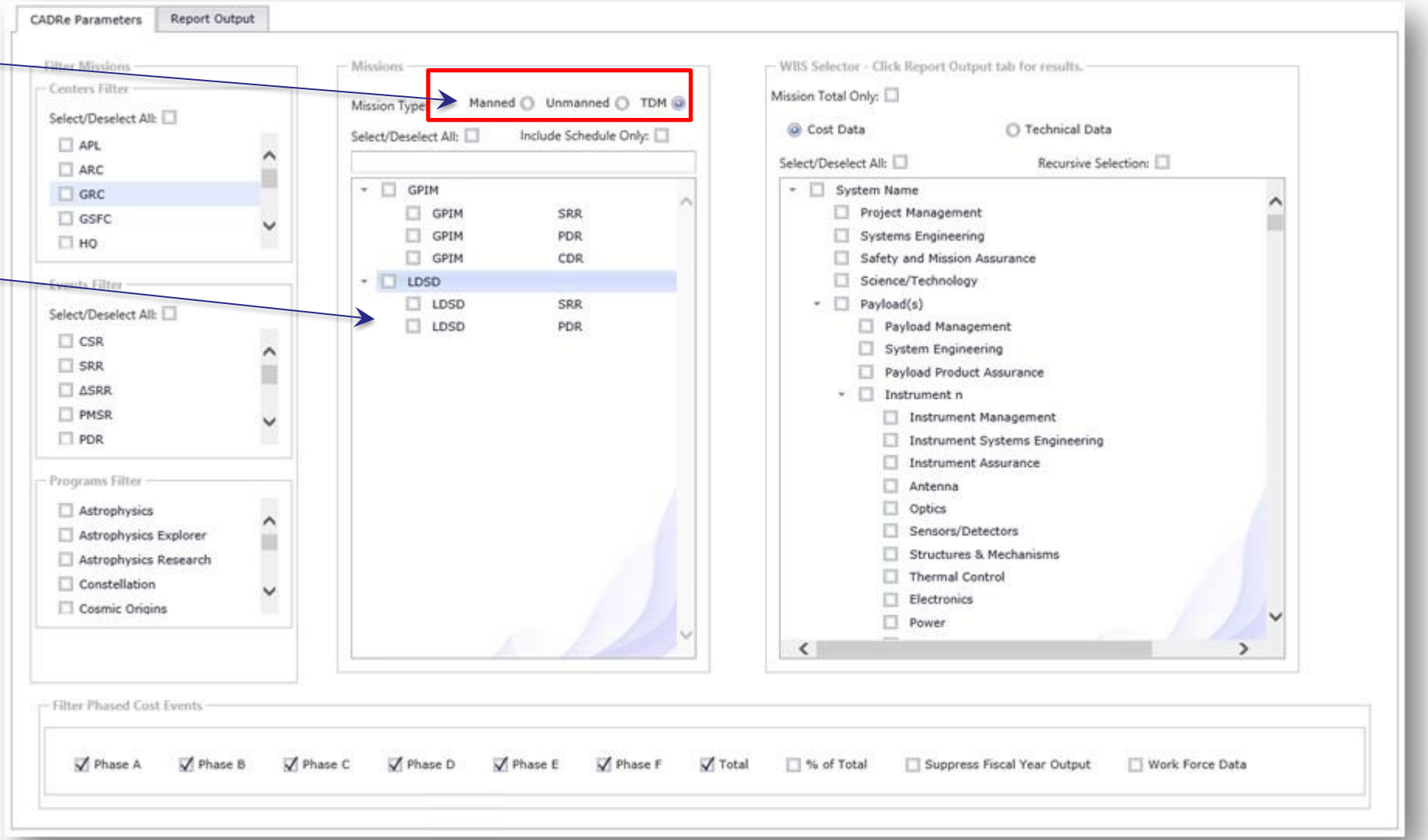
Will be briefed during the ONCE Demo

Segregation of TDMs CADRes

Cost
Analysis
Division

Mission Type Radio Button

Mission List Auto-Populated based on user selection



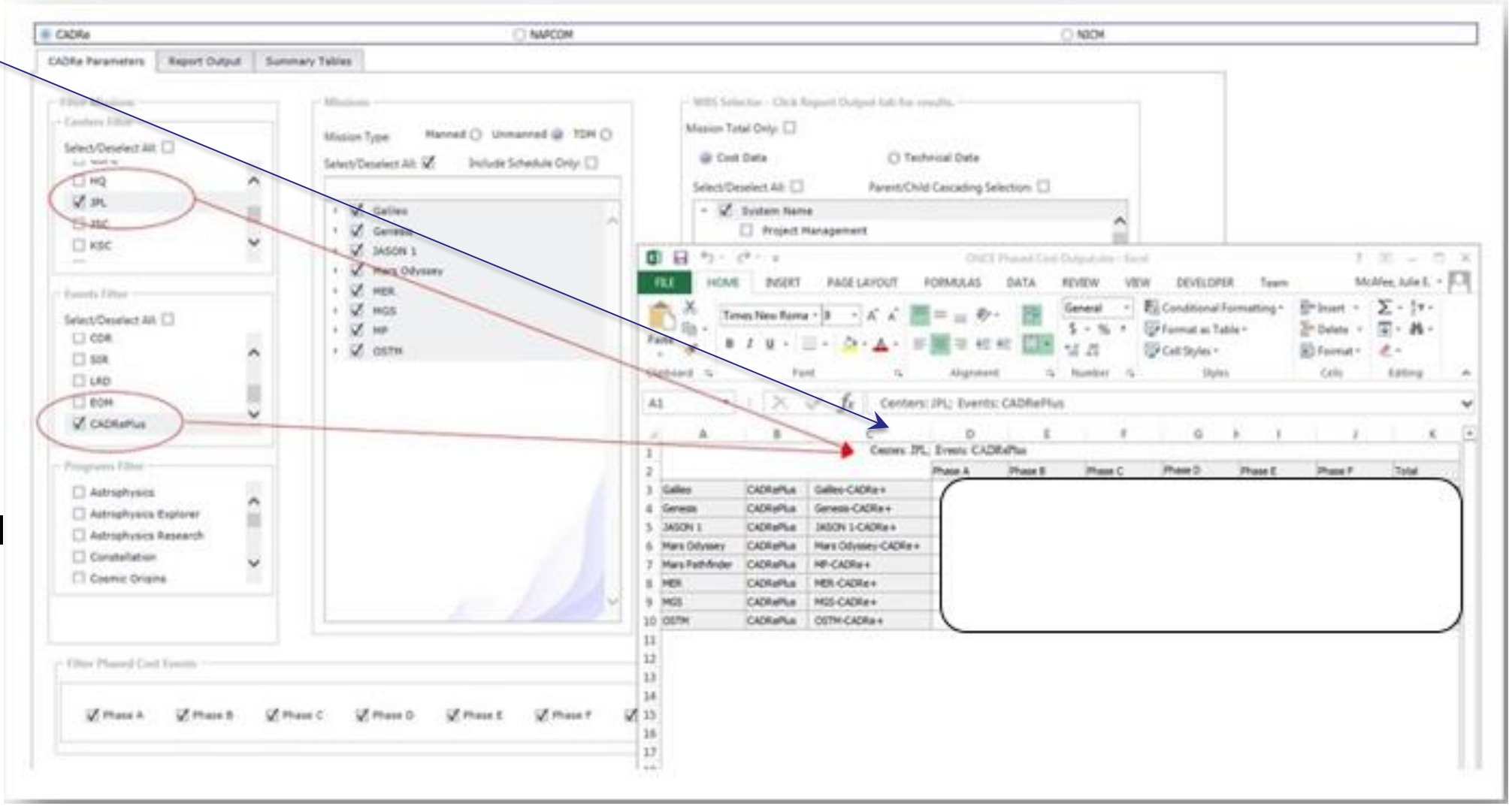
- **TDM CADRe's are different than a "standard" CADRe due to multiple factors**
  - CADRe Workshop feedback

Report Filter Settings

Cost
Analysis
Division

Filters display directly on the report

- **Report "filter settings" now show up in the report output**
- **When you export to Excel the user selected filters are shown**



Report Filter Settings

Cost
Analysis
Division

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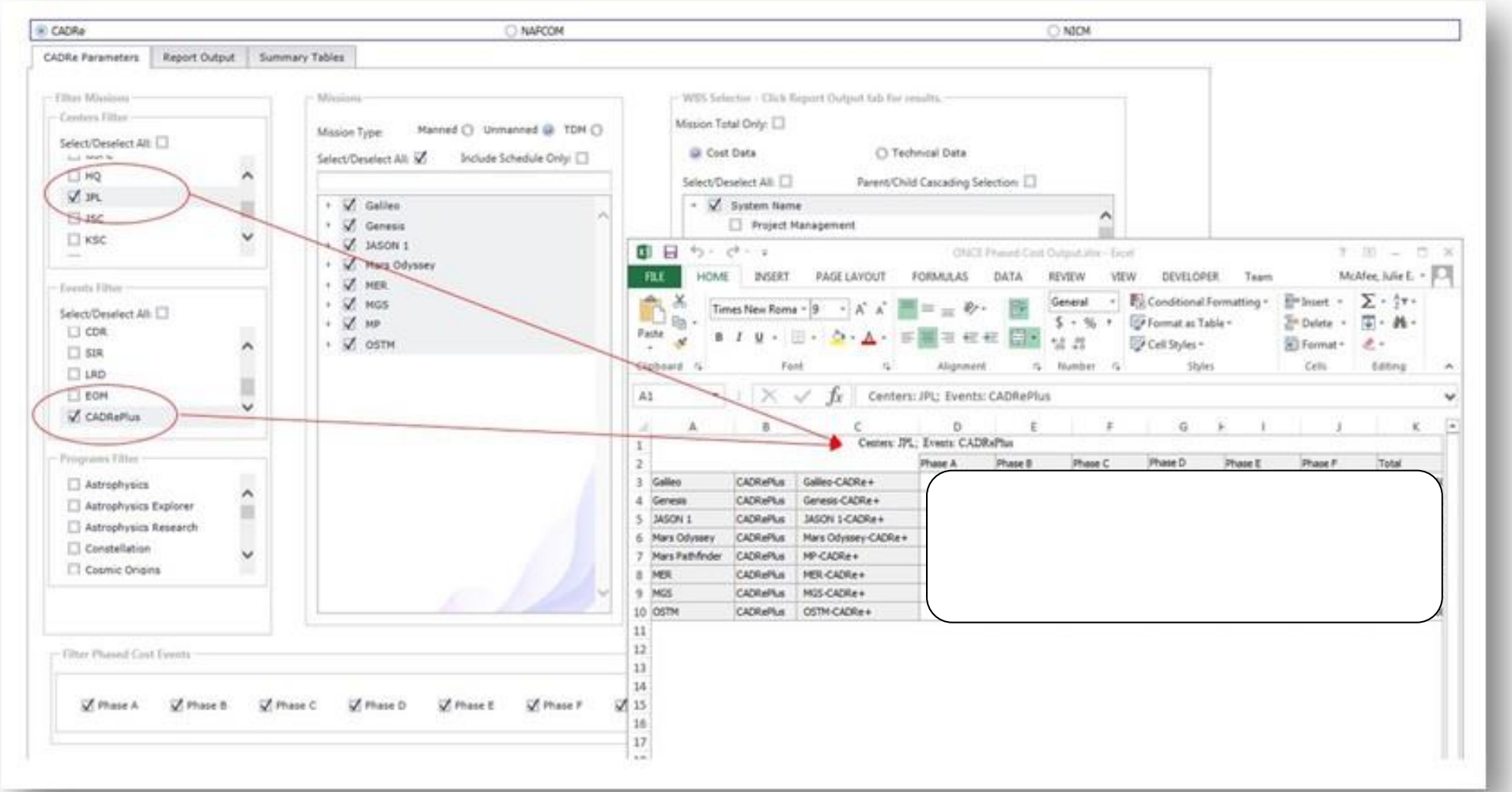


ONCE Workshop Action Item Listing
Page 1

Cost
Analysis
Division

Item #	Title Description	Status
1	Develop interface to display cell and spreadsheet comments in ONCE reports	Complete
2	Change New Design input on Sys Level Params to have drop down of choices	Complete
3	Develop ability for ONCE to handle data ranges in CADRe spreadsheets	In-Progress
4	Change Sys Level Params upload to allow for new template with summary data	In-Progress
5	Review Phase E of each CADRe for Launch Vehicle costs	Complete
6	Partition TDM missions in ONCE so reports are pulled separately	Complete
7	Include flag or notation on costs that were phased by the DB and not by CADRe	Complete
8	Add description of each dataset to ONCE Users Manual	Complete
9	Research methods to determine missing data between CADRe and ONCE	In-Progress
10	Create CADRe Summary Table report across milestones so devs don’t need to update	Complete
11	Document each CADRe version and include in the ONCE Resources section	Complete
12	Notate which CADRe version for each CADRe in DB and include hyperlink to resources	Complete

ONCE Workshop Action Item Listing Page 2

Cost
Analysis
Division

Item #	Title Description	Status
13	Remove repetition of total variables (total cost, total mass) in whole CADRe report	Complete
14	Change CADRe Library modified date to transfer date	Complete
15	Add preference button to user reports for recursive selection of children	Complete
16	Add title to report outputs to delineate filters chosen and make exportable	Complete
17	Double check templates in template library for currency	Complete
18	Research how to handle missions with blank data – consider data completeness	In-Progress
19	Remove Film Camera from Instrument Type field and double check on values	Complete
20	Research including an electronic survey for ONCE to incorporate user feedback	In-Progress
21	Revise CADRe Part B Template per feedback	In-Progress

Data Completeness Dashboard Calculations

Cost
Analysis
Division

- **Type 1: High Level Overview Metrics**
  - Each CADRe is scanned for data existing in *any* of the parameters within the data type (e.g. all software data fields). For example, if the CADRe contains data in at least one of the software fields then it's added to a counter. Once all CADRes are scanned then the counter is divided by the total number of CADRes to get a total completeness percentage. That dataset is then grouped by event, center and program in order to report those metrics.

Data Completeness Dashboard Calculations

Cost
Analysis
Division

- **Type 2: Specific Parameter Metrics**
  - All CADRes are scanned for data existing in *specific* parameters within the data type (e.g. all system level parameter fields). For example, if the design life parameter is populated then it's added to a counter. Once all of the design life parameters have been scanned then the counter is divided by the total number of CADRes to get a total completeness percentage for that parameter. The same calculation is completed for each parameter within the Data Completeness Dashboards.

Data Completeness Dashboard Calculations

Cost
Analysis
Division

- **Type 3: Specific Metrics by Mission and CADRe**
  - Each CADRe is scanned for data existing in *specific* parameters within the data type (e.g. all schedule data fields). For example, if the CADRe's schedule data contains at least one populated field then it's added to a counter. Once all of the schedule parameters have been scanned for the CADRe then the counter is divided by the total number of schedule fields to get a total completeness percentage for schedule data for that CADRe.
  - The completeness percentage for all parameters is then averaged together to obtain a completeness percentage for the mission. For example, assuming a mission has four CADRe milestones and if the ATP date is populated for every milestone then the percentage completeness for the ATP date parameter is 100%. If the PDR date is populated for 1 out of the 4 milestones then the percentage completeness for the PDR date parameter is 25% for that mission. If the ATP and PDR dates were the only two schedule parameters then the percentage completeness for that mission would be 63% (the average of 100% and 25% or likewise 5 out of 8 parameters populated).

Upload Process Improvement

Cost
Analysis
Division

- **A template has been created to automate CADRe entry into ONCE**
  - Goal is to consolidate the CADRe information for easier import into the database
  - Separate tabs for Part B and Part C
    - Mass and technical parameters for the payloads, instruments, Spacecraft, EDL, or Rover are now electronically transferred
  - Data from Excel is then copied directly into ONCE
    - Before copying, review is conducted for verification & validation
  - The ONCE automation interface allows for the WBS structures to be reviewed before saving to database
    - Hierarchy and element type assignments are verified
    - Check units, values, formatting, etc.

Upload Process Improvement

Cost Analysis Division

- **Data from each CADRe tab is consolidated into one WBS structure in the automation template.**

CADRe File

Payload	Assembly Name	Mass CBE (kg)	Mass CBE+Cont (kg)	Average Po (W)
Camera	**Payload Total**			
	Total			
	Antennas			
	Optics			
	Sensors/Detectors			
	Structural & Mechanical			
	Thermal Control			
	Electronics			
	Power			
	Pointing Subsystem			
	Harness, Cabling, etc.			
	C&DH			
	Other			
DHU (Data Handling	Total			
	Antennas			
	Optics			
	Sensors/Detectors			
	Structural & Mechanical			
	Thermal Control			
	Electronics			
	Power			
	Pointing Subsystem			
	Harness, Cabling, etc.			
	C&DH			
	Other			

Project MEL | System Level Parms | **Payload Parms** | Spacecra

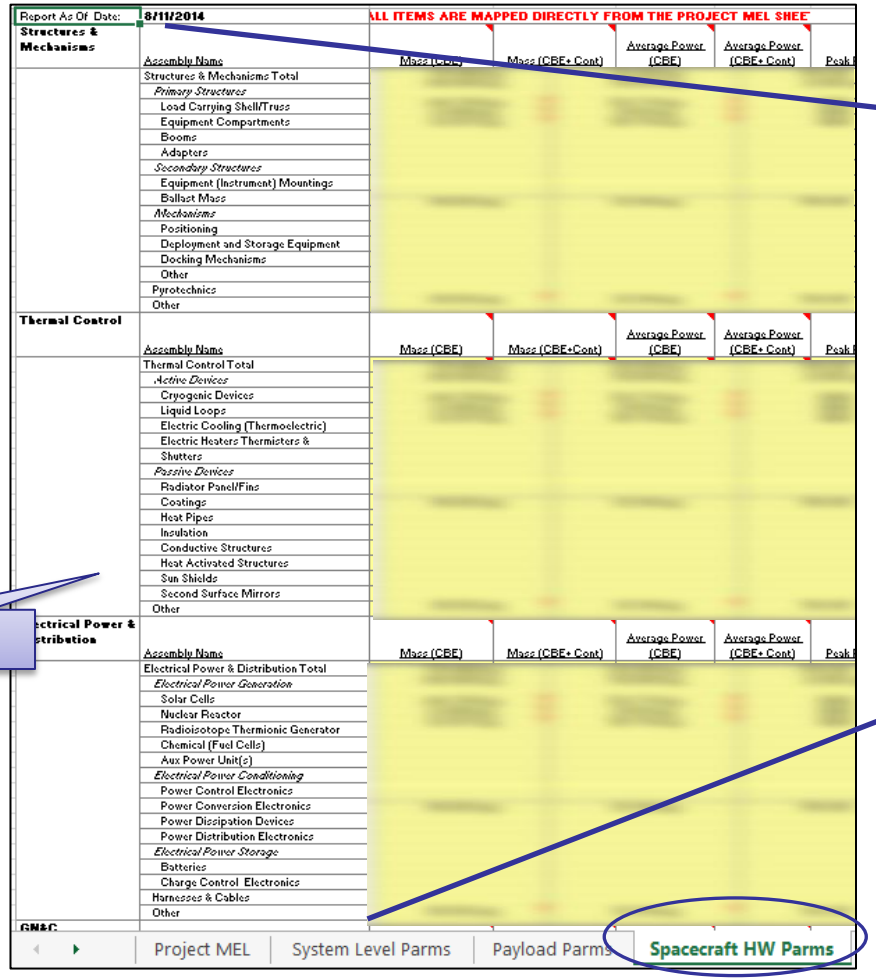
Automation Template

		Mass (CBE)	Mass Cont	Avg Pow\Inst	Avg Pow Cont\Inst M	Peak Pow\Inst MTBF M
4						
5	Tess PDR					
6	Payload(s)					
7	Camera					
8	Optics					
9	Sensors/Detectors					
10	Structural & Mechanical					
11	DHU (Data Handling Unit)					
12	C&DH					
13	Flight System \ Spacecraft					
14	Spacecraft					
15	Structures & Mechanisms Total					
16	*Primary Structures*					
17	Load Carrying Shell/Truss					
18	*Secondary Structures*					
19	Equipment (Instrument) Mountings					
20	Other					
21	Thermal Control Total					
22	Electrical Power & Distribution Total					
23	*Electrical Power Generation*					
24	*Electrical Power Storage*					
25	Batteries					
26	Charge Control Electronics					
27	Harnesses & Cables					
28	Other					
29	GN&C Total					
30	*Attitude Determination*					
31	Sun Sensors					
32	Star Tracker/Sensors					
33	Inertial Reference Unit					
34	*Attitude Control*					
35	Reaction Wheels					
36	Propulsion Total (Dry)					
37	*Tanks*					
38	Propellant Tanks					
39	Plumbing					
40	*Maneuvering Thrusters*					
41	Monopropellant					
42	*Translation Thrusters*					
43	Monopropellant					
44	Other					
45	Communications Subsystem Total					
46	*Antennas*					
47	Omnidirectional					
48	Parabolic					
49	*Waveguides/Routers*					
50	Multicouplers					
51	Waveguide					
52	*Radio Frequency Equipment*					
53	Transmitters					
54	Transponders					
55	Other					
56	C&DH Subsystem Total					
57	Processors					
58	Decoders					
59	Command Units					

Upload Process Improvement

Cost Analysis Division

- **Each WBS element is consolidated into the template.**



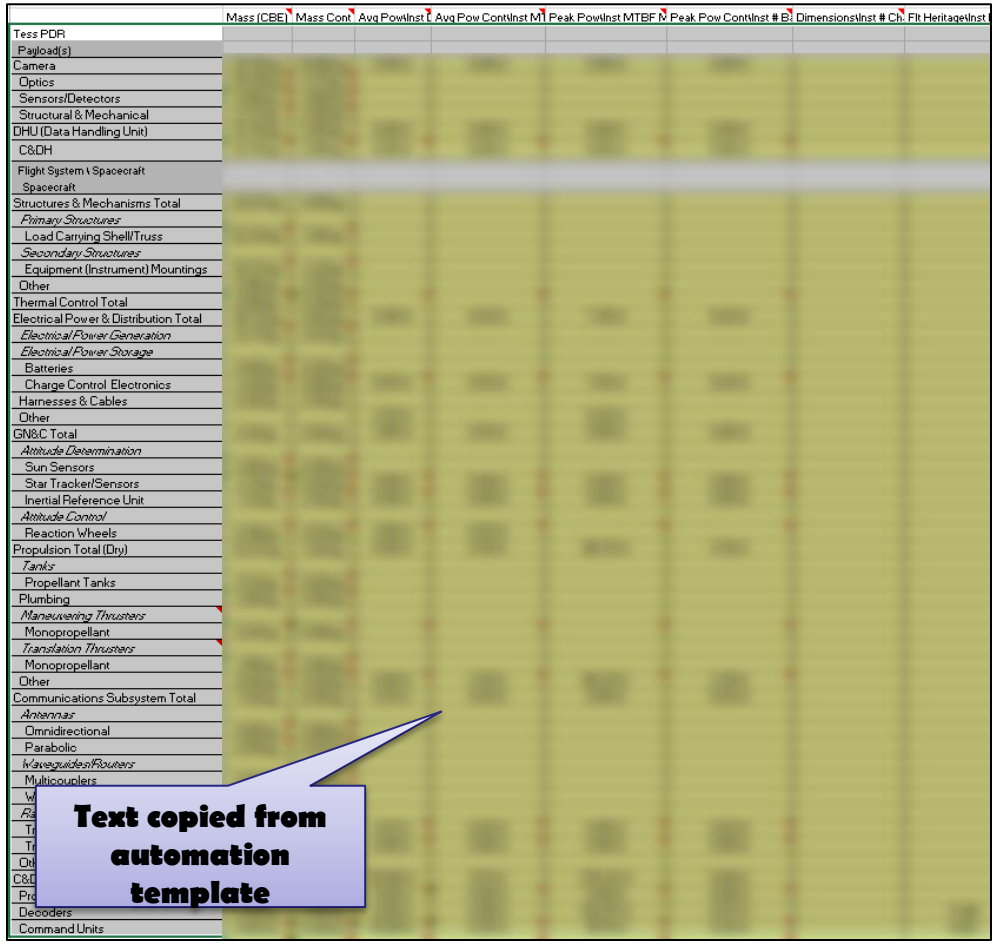
CADRe File

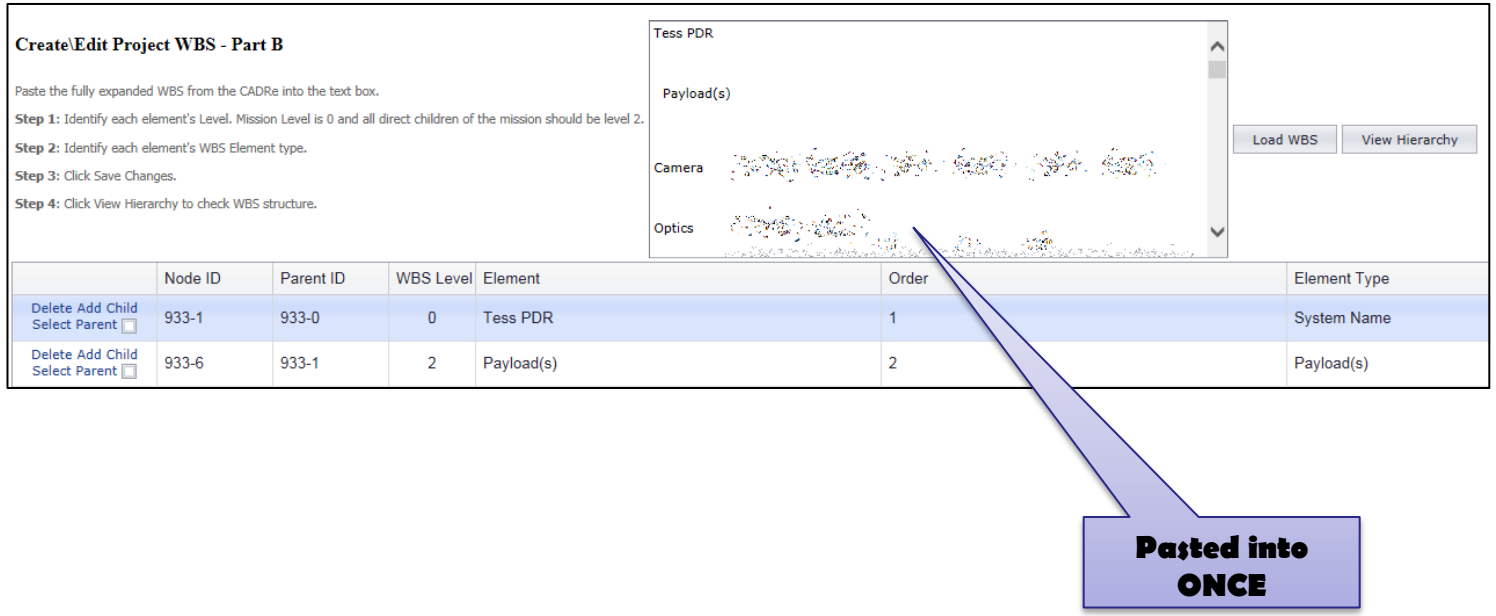
Automation Template

Upload Process Improvement

Cost
Analysis
Division

- **The data is then copied into ONCE after all the data is consolidated within the template.**





Upload Process Improvement

Cost Analysis Division

- **CADRe Entry Automation**
  - WBS Automation
    - Corresponding Part B **technical parameters** are imported as well.
    - Element assignments are performed before saving to the database.

Create\Edit Project WBS - Part C

Paste the fully expanded WBS from the CADRe into the text box.

Step 1: Identify each element's Level. Mission Level is 1 and all direct children of the mission should be level 2.

Step 2: Identify each element's WBS Element type.

Step 3: Click Save Changes.

Step 4: Click View Hierarchy to check WBS structure.

```
SORCE CADRe+
  Project Management
  Systems Engineering
  Science/Technology
  Payload(s)
  Flight System \ Spacecraft
    Spacecraft
  Launch Vehicle/Services
  Mission Operations System (MOS)
    LASP Mission Operations
    CSOC Mission Operations
  Contingency (GSFC)
  Chase Plane (LRC)
```

Load WBS | View Hierarchy

	Node ID	Parent ID	WBS Level	Element	Element Type
Delete Add Child Select Parent	932-1	932-0	1	SORCE CADRe+	System Name
Delete Add Child Select Parent	932-2	932-1	2	Project Management	Project Management
Delete Add Child Select Parent	932-3	932-1	2	Systems Engineering	Systems Engineering
Delete Add Child Select Parent	932-4	932-1	2	Science/Technology	Science/Technology
Delete Add Child Select Parent	932-6	932-1	2	Payload(s)	Payload(s)
Delete Add Child Select Parent	932-26	932-1	2	Flight System \ Spacecraft	Flight System \ Spacecraft
Delete Add Child Select Parent	932-30	932-26	3	Spacecraft	Spacecraft
Delete Add Child Select Parent	932-31	932-1	2	Launch Vehicle/Services	Launch Vehicle/Services
Delete Add Child Select Parent	932-32	932-1	2	Mission Operations System (MOS)	Mission Operations System (MOS)
Delete Add Child Select Parent	932-33	932-32	3	LASP Mission Operations	Mission Operations System (MOS)
Delete Add Child Select Parent	932-34	932-32	3	CSOC Mission Operations	Mission Operations System (MOS)
Delete Add Child Select Parent	932-35	932-1	2	Contingency (GSFC)	Contingency
Delete Add Child Select Parent	932-36	932-1	2	Chase Plane (LRC)	Other Costs (e.g. ONC)

Save changes Cancel changes

WBS Structure and technical parameters pasted from Excel

WBS structure can be altered

Allows for Element Type Assignment

Targeted improvement activities

Cost
Analysis
Division

- **QA activities and capabilities have provided opportunities for targeted improvement**
  - Robotic Flight Software data collection
    - Completeness dashboard indicate that FSW is one of our most challenging areas of data collection
    - Many parameters are left unpopulated including key sizing information such as Logical SLOC
    - Determining which Missions, which CADRes, and which parameters can be improved
    - Goal is to execute a task to improve FSW data completeness and quality
  - Schedule activities and duration(s)
    - Schedule dates in the CADRe are very well populated, but sometimes inconsistent over a project lifecycle
    - Many additional schedule files from Projects include activities and duration(s)
    - Arnold Hill/Schedule Initiative is embracing collection of schedule data, review of existing data, and strategies to improve