

# In Pursuit of the One True Software Resources Data Reporting (SRDR) Database

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## Abstract

For many years, Software Resources Data Reports, collected by the Defense Cost and Resource Center (DCARC) on Major Defense Acquisition Programs (MDAPs), have been widely acknowledged as an important source of software sizing, effort, cost, and schedule data to support estimating. However, using SRDRs presents a number of data collection, normalization, and analysis challenges, which would in large part be obviated by a single robust relational database. The authors set out to build just such a database, and this paper describes their journey, pitfalls encountered along the way, and success in bringing to fruition a living artifact that can be of tremendous utility to the defense software estimating community.

SRDRs contain a wealth of data and metadata, and various attempts have been made by such luminaries in the field as Dr. Wilson Rosa and Mr. Mike Popp to excerpt and summarize the "good" data from SRDRs and make them available to the community. Such summaries typically involve subjective interpretations of the raw data, and by their nature are snapshots in time and may not distinguish between final data and those for which updates are expected.

The primary goal of this project was to develop an Access database, which would both store the raw source data in its original form at an atomic level, exactly as submitted by WBS element and reporting event, and allow evaluations, interpretations, and annotations of the data, including appropriate pairing of Initial and Final reports; mapping of SLOC to standard categories for the purposes of determining ESLOC; normalization of software activities to a standard set of activities; and storage of previous assessments, such as those of the aforementioned experts. The database design not only provides flexible queries for quick, reliable access to the desired data to support analysis, it also incorporates the DCARC record of submitted and expected SRDRs in order to track missing past data and anticipate future data.

The database is structured by Service, Program, Contract, Organization, CSDR Plan, and Reporting Event, and is flexible enough to include non-SRDR data. Perhaps its most innovative feature is the implementation of "movable" entities, wherein quantities such as Requirements, Effort, and SLOC, and qualities such as Language, Application Type, and Development Process can be reported at multiple levels and "rolled up" appropriately using a sophisticated set of queries. These movable entities enable the database to easily accommodate future changes made to the suggested format or reporting requirement found in the SRDR Data Item Description (DID).

This work was sponsored by the Office of the Deputy Assistant Secretary of the Army for Cost and Economics, and represents a continuation of the effort that produced the ICEAA 2013 Best Paper in the IT track, "ODASA-CE Software Growth Research." A key motivation of the database is to be able to provide real-time updates to both that Software Growth Model and ODASA-CE's Software Estimating Workbook. We are also collaborating with the SRDR Working Group on continual improvements to the database and how best to make it available to the broader community.



## Outline

- Where we are: Multiple data sources, each with their own limitations
  - Defense Cost and Resource Center (DCARC) SRDRs
  - Popp/Rosa data and evaluations
  - Difficulty in mapping between DCARC data and Popp/Rosa data and evaluations
- Where we are going: Single Relational Database
- How we are getting there:
  - Database overview
  - Challenges
  - Future goals
- How far we have gotten: Stats on database population



3

## Where we are...

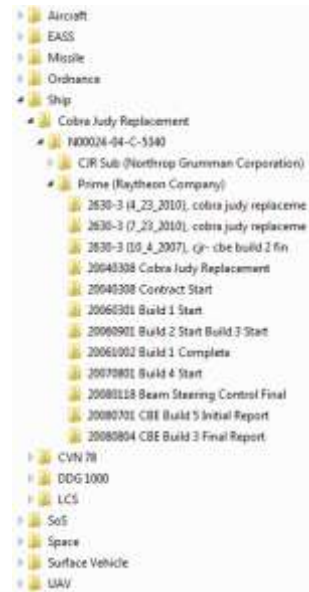
- DCARC: Defense Automated Cost Information Management System (DACIMS) provides a central *repository*, but is not a *database*
  - Authoritative source
  - Non-normalized (not “analysis ready”)
  - Inconsistent content and format of reports
    - Abandonment of DD 2630
    - Evolving Data Item Description (DID)
  - Not easily searchable/retrievable
- Popp/Rosa Database:
  - Mike Popp (NAVAIR/Omnitec) has done a yeoman’s job of compiling SRDR data as a shareable Flat File (spreadsheet)
  - Further annotated by Dr. Wilson Rosa (then-AFCAA)
  - Non-authoritative source
  - Normalized (analysis ready, maybe?)
- Difficulty in mapping between sources



4

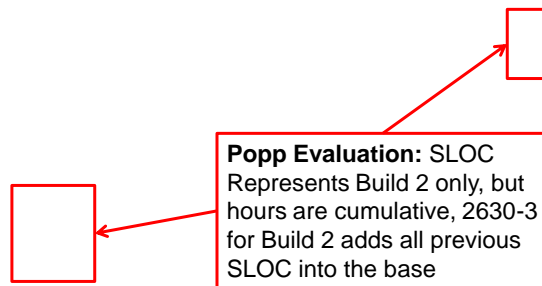
## DACIMS is a Repository

- SRDRs are stored in a file structure tantamount to the one seen on the right
- Manually have to retrieve SRDRs one at a time
- No convenient way to search/filter SRDRs based on data needs



## Popp/Rosa Database

- Popp and Rosa database provides much needed evaluation of SRDRs stored in DACIMS



## Popp/Rosa Database

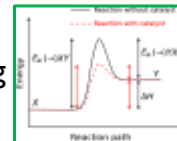
- Mapping Difficulty
  - Popp/Rosa Database does not include CSDR Plan numbers
  - Contractor names often differ between sources
  - Contract names sometimes differ between sources
- Lack of Validation/Verification
  - Simple check to make sure data was correctly transferred from original source to database
  - Are normalization techniques those desired by the end user?



7

## Where We Are Going...


- Motivation: One Software (SW) Database to support multiple...
  - Models (SW Estimating Workbook, Growth Model, etc.)
  - Analyses (estimates, studies, etc.)
  - Organizations (ODASA-CE, OSD CAPE, et al.)
- The time is ripe for a more sophisticated tool to support better coordination
  - ODASA-CE actively participating in SRDR Working Group led by Ms. Ranae Woods (AFCAA TD)
- It takes some “**activation energy**” to get over the hump
  - Address both Functionality and Content (and interactions)
  - Balance capability and complexity within limited resources



8


## SRDRWG Vision

- “One OSD-hosted, central, user-friendly, authoritative, real-time software cost database and tool”
  - Ms. Ranae Woods AFCAA, Chair  
Aviation CIPT, May 2014
  - OSD-hosted = integrated with CADE
  - Central = configuration-controlled, mutually accessible annotations
  - User-friendly = queries from relational database, producing “analysis-ready” results
  - Authoritative = “community-approved” data traceable back to original submissions
  - Real-time = up to date with latest submissions
- Consistent with OSD CAPE vision for CSDR overhaul

9

## Having Our Cake...

- Unified Software Database is for:
  - The ODASA-CE Client, built with their data (Army) and models in mind, but the Community\* can leverage both the functionality and content of the database (e.g., OSD CAPE for CADE)
  - The Community, built with a broad (and ever-broadening) perspective, and ODASA-CE can directly benefit from their involvement
- Unified Software Database is:
  - A database proper, to store, relate, and annotate primary source information
  - A data analysis tool, primarily via automated queries to extract and export data in the desired format
- Unified Software Database contains:
  - SRDR data, the official DoD software data source
  - Non-SRDR data, as collected by ODASA-CE/Technomics
- Unified Software Database is:
  - Backward-looking, capturing legacy data in various formats and annotations thereof
  - Forward-looking, enabling improved data collection in the future



\* Software Cost Community, Cost Community, Software Community

10

## Unified SW Database Vision

- A single *relational* Access database that contains:
  - Raw source data (fully traceable)
  - Data at the level at which it is reported (WBS element, “atomic level”)
  - Both “initial” and “final” instances of a reporting event
  - DCARC CSDR Plan information for reporting events that are still missing or expected in the future
  - Assumptions and context about the data that facilitate analysis (e.g., Pairing ID)
  - Evaluations of the quality of the data (e.g., knowing that counting rules are not provided in the data dictionary)
- New database provides the ability to:
  - Quickly query data at both the lowest level and summary-levels in order to track progress in obtaining missing data
  - Use the level of data most appropriate for the analysis (e.g., contract vs. plan vs. event)
  - Tag and store “Roll-ups” of data
  - Tag and store Initial/Final pairings of data points
  - Interface with and “feed” multiple workbooks that serve different analytic purposes (without touching or modifying the original data)
  - “Save” queries and dashboards that allow analyst to quickly access often-used sets of data



11

## Unified SW Database Strengths


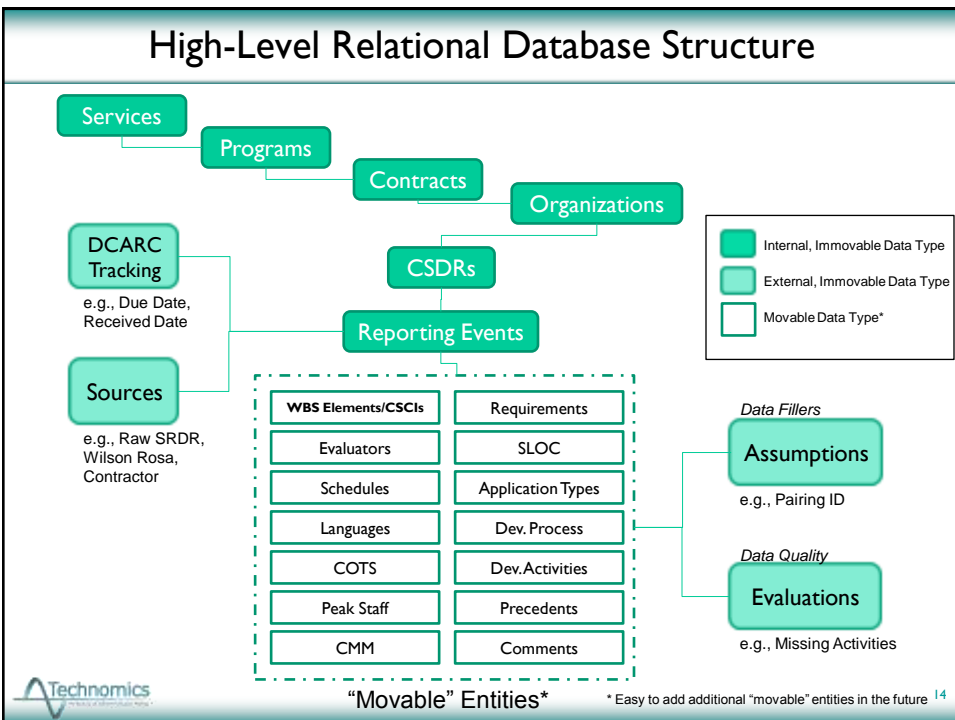
- Preserve atomic raw un-normalized SRDR data
- Relational database
  - Data integrity, flexible queries, etc.
- Enables “crowd-sourcing” community-best version of SRDR database (under aegis of CADE?)
  - Quality assessments, annotations, etc.
- More efficient data ingest
  - XML → DCARC → SWDB
  - Accommodates DID changes, known and unknown
- More rigorous access control and DB exports
  - Full-context versions where NDAs exist
  - Anonymized version (only valuable if you trust the source)



12

## How We Are Getting There...

- Maintain trace to original data
  - Raw = exactly as submitted (unadulterated)
  - Atomic = at the lowest level submitted
  - Un-normalized = neither mapped, nor rolled up, nor summarized (e.g., ESLOC)
- Provide direct link to source files
- Use “moveable entities” to accommodate reporting at various levels and in non-standard categories


13


## Access Database

Over 50 tables make up the complete relational database in Access. Below is a small sample.

The diagram illustrates a relational database structure for software types. A central table, 'Software Types', is linked to numerous other tables. These include tables for software types (e.g., Software Types 1-50), software descriptions (e.g., Software Description), software reports (e.g., Software Reports), software development (e.g., Software Development), software testing (e.g., Software Testing), software deployment (e.g., Software Deployment), software maintenance (e.g., Software Maintenance), software support (e.g., Software Support), software training (e.g., Software Training), software documentation (e.g., Software Documentation), software security (e.g., Software Security), software compliance (e.g., Software Compliance), software risk management (e.g., Software Risk Management), software quality management (e.g., Software Quality Management), software configuration management (e.g., Software Configuration Management), software change management (e.g., Software Change Management), software version control (e.g., Software Version Control), software backup and recovery (e.g., Software Backup and Recovery), software disaster recovery (e.g., Software Disaster Recovery), software business continuity (e.g., Software Business Continuity), software incident response (e.g., Software Incident Response), software forensic analysis (e.g., Software Forensic Analysis), software digital forensics (e.g., Software Digital Forensics), software network forensics (e.g., Software Network Forensics), software mobile forensics (e.g., Software Mobile Forensics), software cloud forensics (e.g., Software Cloud Forensics), software IoT forensics (e.g., Software IoT Forensics), software AI forensics (e.g., Software AI Forensics), software AR forensics (e.g., Software AR Forensics), software VR forensics (e.g., Software VR Forensics), software MR forensics (e.g., Software MR Forensics), software XR forensics (e.g., Software XR Forensics), software mixed reality forensics (e.g., Software Mixed Reality Forensics), software extended reality forensics (e.g., Software Extended Reality Forensics), software virtual reality forensics (e.g., Software Virtual Reality Forensics), software augmented reality forensics (e.g., Software Augmented Reality Forensics), software mixed reality forensics (e.g., Software Mixed Reality Forensics), software extended reality forensics (e.g., Software Extended Reality Forensics), software virtual reality forensics (e.g., Software Virtual Reality Forensics), software augmented reality forensics (e.g., Software Augmented Reality Forensics).

15

## Database Status

### Software Report Database

#### Database Status Report

Services to include in status report

Army
  Navy
  Air Force  
 Department of Defense
  Missile Defense Agency

These status reported in relation to DACMS Summary Report

Relevant reports in database for DACMS Accepted reports

Future reports expected by DACMS

Total		All	Some	None	
89	Programs	2	30	32	46
122	Contracts	12	45	59	50
228	Plans	30	78	100	60
862	Events	100	221	341	145

#### Navigation

Browse/Query Data

Edit/Enter Data

Evaluate Data

#### View Software Estimating Workbook Data

*A tool for estimating total effort hours and schedule months for a software development effort based on the contractor's initial estimates. To import data from the database into the workbook, simply open a new instance of the workbook, which is located here.*

16



## Searching for SRDRs

### High-Level Search

**Services:**

- Air Force
- Army
- Department of Defense
- Missile Defense Agency
- Navy

Selecting none is the same as selecting all.

**Programs:**

- 3DELRM Three-Dimensional Expeditionary Long-Range Radar
- AEHF Advanced Extremely High Frequency (AEHF) Satellite Program
- AMF JTRC Joint Tactical Radio System Airborne & Maritime/Traced Station
- AMPV Armored Multi-Purpose Vehicle
- ADC-WS Air and Space Operations Center-Weapon System

**Contracts:**

- FA8726-08-C-0008
- TBD
- TBD
- TBD

**CSDR Plan Numbers:**

- D-08-A-C1R1U
- D-08-A-C1-S8
- D-08-A-C1-SNR

**Reporting Events:**

- USASS/AMF JTRC/FA8726-08-C-0008/JTRC AMP Sub (Northrop)
- USASS/AMF JTRC/FA8726-08-C-0008/JTRC AMP Sub (Northrop)
- USASS/AMF JTRC/FA8726-08-C-0008/JTRC AMP Sub (Northrop)
- USASS/AMF JTRC/FA8726-08-C-0008/JTRC AMP Sub (Northrop)
- USASS/AMF JTRC/FA8726-08-C-0008/JTRC AMP Sub (Northrop)

[Go to SRDR View](#)

[Go to Original](#)

17

## Viewing\Entering Data

### SRDR View

Find Record Previous Record Next Record

**SECURITY CLASSIFICATION:** CONFIDENTIAL Fields in all capital letters exist on 2011 SRDR forms. All others are available for legacy forms.

**SOFTWARE RESOURCES DATA REPORTING:** Initial **DEVELOPER REPORT**  
(Set 60 days after contract award and 60 days after start of any mission or build)

**Reporting Event:** Contract Initial Estimate

**Section 3.1** Section 3.2 Section 3.3 Section 3.4 Section 3.5 Other

**Section 3.1 REPORT CONTEXT AND DEVELOPMENT ORGANIZATION**

MAJOR PROGRAM a. NAME: U.S. Army's Brigade Combat Team Modernization (BCTM) Group		b. PHASE/MILESTONE: A (Technology Development)	
REPORTING ORGANIZATION TYPE		a. REPORTING ORGANIZATION: Northrop Grumman Information Systems, Defense Systems Division	
<input type="checkbox"/> PRIME/ASSOCIATE CONTRACTOR <input checked="" type="checkbox"/> DIRECT-REPORTING SUBCONTRACTOR <input type="checkbox"/> GOVERNMENT		201 Electronics Div., Huntsville, AL 35824	
b. DIVISION: Same as Reporting Organization			
APPROVED PLAN NUMBER: A-10-A-C1-S8	CUSTOMER: SAE Systems	CONTRACT TYPE: JFFP	
WRS ELEMENT CODE: 1.B	WRS REPORTING ELEMENT: Ground Combat Vehicle Program		
TYPE ACTION: a. CONTRACT NO.: W56HZV-11-C-0001	c. SOLICITATION NO.: W56HZV-11-R-0001	e. TASK ORDER / DELIVERY ORDER NO.:	
b. LATEST MODIFICATION: 2	d. NAME: U.S. Army's Brigade Combat Team Mod	f. N/A	
PERIOD OF PERFORMANCE		SUBMISSION NUMBER: 6	
a. START DATE: 20130528	APPROPRIATION: <input checked="" type="checkbox"/> RDT&E	RESUBMISSION NUMBER: 0	
b. END DATE: 20131205	<input type="checkbox"/> Procurement	Supersede Number:	
	<input type="checkbox"/> O&M	REPORT AS OF: 20120127	
Revision Data:		DATE PREPARED: 20121001	
NAME (Last, First, Middle Initial):	DEPARTMENT:	TELEPHONE: Fax:	EMAIL ADDRESS:

18

## Queries

Choose the records you would like to see:

Army     Navy     Air Force  
 Department of Defense     Missile Defense Agency

Organizations to include:

- lockhead m-
- AgustaWest
- BAE System
- Bell Aerosp
- Bell Helicop
- Boeing
- CAE Inc
- General Dyr
- General Elec
- Harris
- Hill AFB
- Honeywell
- IBM
- I-2

Total Effort Hours  
Between:  And:

Total Size (Total SLOC)  
Between:  And:

Schedule Months  
Between:  And:

MUST include complete data for:

Effort Hours  
 SLOC


Roll-up Level:  Reporting Event:

ONLY include:

Platform Type:

Commodity Type:

Blank indicates no restriction



19

## SW Data – Accommodating Different Structures

Language is usually a child of the WBS element and code count is reported separately

2. Product and Development Description	Percent of Product
1. Primary Application Type: Guidance & Control	2. 100 %
2. Secondary Application Type	0. %
3. Tertiary Application Type	10. %
4. Fourth Application Type	14. %
5. Primary Language Used: C	10. 100 %
6. Secondary Language Used	0. %

Here code counts is a sub-element (child) of language


Product	Code	Language	Lines	Bytes	Lines	Bytes	Lines	Bytes	Lines	Bytes	Lines	Bytes
Product	100,000	C	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Assembly	20,000											

Effort is usually reported by Activity

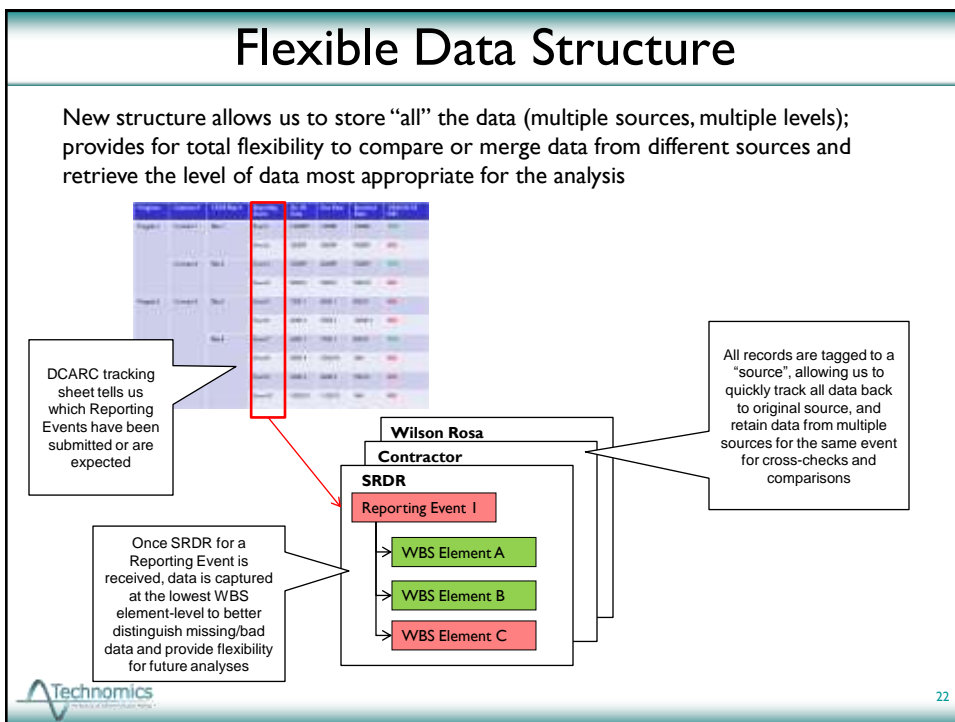
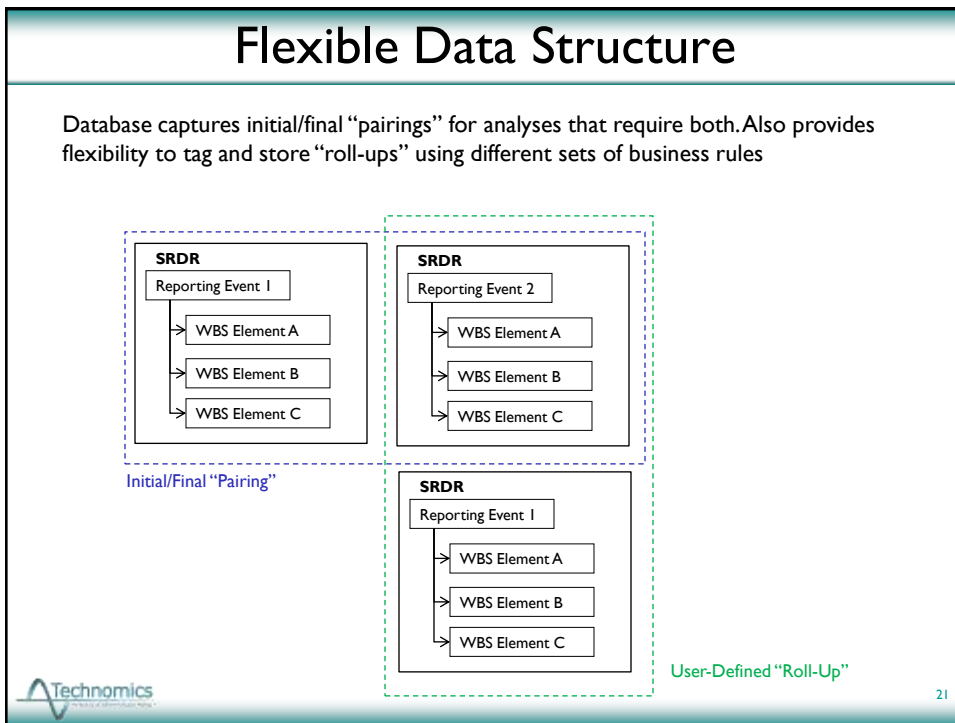
4. Resource and Schedule Reporting	Provide details at least biweekly		
Developers—needs 1 of each and 2, provide Actual (A) and Est (E) for each activity shown. Provide the Actual Total Lines (see 2) for each activity shown.	Start Month	Start Lines	End Month
Development—needs 1 of each and 2, provide Actual (A) and Est (E) for each activity shown. Provide the Actual Total Lines (see 2) for each activity shown. Provide the Actual Total Lines (see 2) for each activity shown. Provide the Actual Total Lines (see 2) for each activity shown.			
Software Requirements Analysis	3/01/2006	8/31/2006	5,000
High Level and Database Code Design	5/15/2006	12/31/2006	3,000

Here effort is reported by language

3. Effort	Language	Lines	Bytes	Lines	Bytes
3. Effort	C	1,000	1,000	1,000	1,000



20



## Tracking Missing Data – What’s the “Universe”?

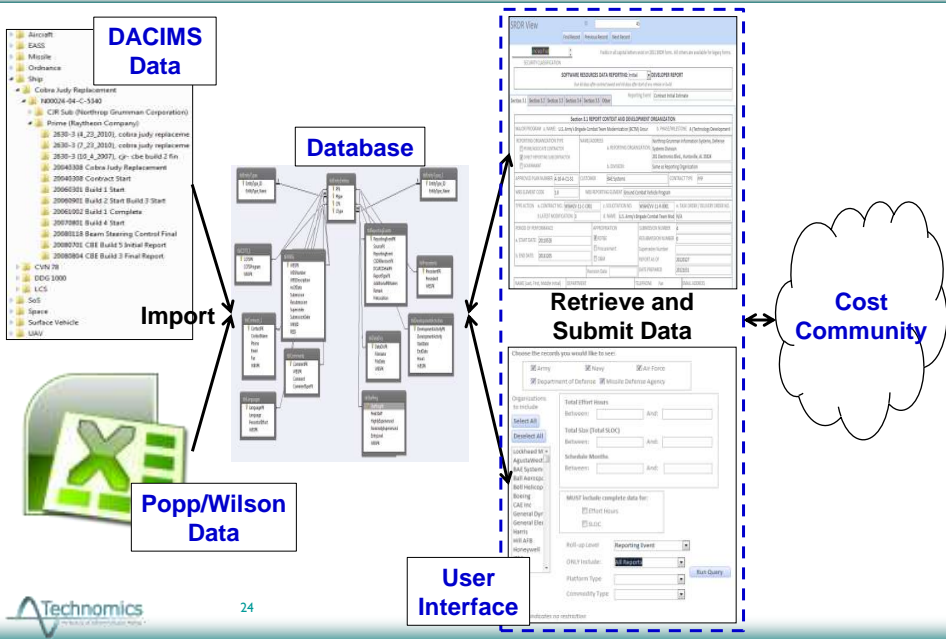
Database incorporates DCARC-provided tracking sheet that contains all delivered and expected SRDRs for programs still active after 2009

Program	Contract #	CSDR Plan #	Reporting Event	As-Of Date	Due Date	Received Date	ODASA-CE DB?
Program 1	Contract 1	Plan 1	Event 1	12/2007	1/2008	1/2008	YES
			Event 2	3/2009	4/2009	4/2009	NO
	Contract 2	Plan 2	Event 3	5/2009	6/2009	7/2009	YES
			Event 4	8/2010	9/2010	9/2010	NO
Program 2	Contract 3	Plan 3	Event 5	7/2011	8/2011	8/2011	NO
			Event 6	8/2012	9/2012	10/2012	NO
		Plan 4	Event 7	6/2011	7/2011	8/2011	YES
	Event 8		9/2014	10/2014	N/A	NO	
	Event 9		5/2012	6/2012	7/2012	NO	
				Event 10	10/2015	11/2015	N/A

Allows us to track our SRDR data against all "possible" data



## How it All Fits Together



## Data Normalization Approach

- Dr. Wilson Rosa and Dr. Brad Clark
  - Inspect Data
    - Context Information
    - Effort Data
    - Schedule Data
    - Project Identifiers
  - Correct Data, Evaluate Quality
  - Normalize Data
    - Adjust SLOC data (physical to Logical, ESLOC)
    - Adjust for Missing Effort Data



25

## Level I Evaluation

- Purpose: Initial evaluation and “organization” of the data needed to get the data in a more usable form
  - With the tags and user-provided data in the Level I evaluation, the database user can develop initial queries of data that can be used to support estimates and other analyses
- Sample items in Level I:
  - Initial/Final pairing tags
  - Identification (and potential addition) of contract-level and build level roll-ups
  - Data dictionary availability
  - Evaluation of the scope of effort represented in the event



26

## Level I Evaluation: Roll-Up Types

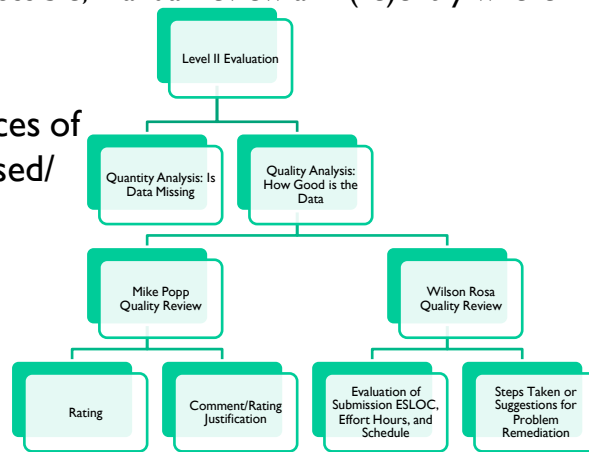
- It is important to clearly define and implement different types of “Roll-Ups” based on data field
  - May require subtle adjustment of database queries
- Summation (distinct)
  - Total SLOC, effort hours, e.g.
- Max/Most Recent (monotonically increasing)
  - Total SLOC
- Max of Max
  - Peak staff, e.g.
- Extremes (Min/Max)
  - Schedule start and end months, e.g.
- Plurality
  - Programming Language, Application Type, e.g.



27

## Data Quality Analysis

- Leverage to maximum extent previous work of Popp, Rosa, et al.
  - Import where possible, manual review and (re)entry where necessary
- Annotations vs. additional instances of data points (revised/corrected)



28

## Level II Evaluation – Vision

- Purpose: To get the data “analysis-ready”\*
- Sample items in Level II:
  - Mapping of SLOC to our ESLOC categories so that ESLOC can be quickly calculated for each data point
  - Mapping of activities to a “standard set of activities” that can be used for effort normalization and cross-data comparisons
  - Evaluation of Wilson Rosa/Mike Popp comments and storage of these assessments in a standard fashion (so they can be quickly used to exclude/include certain data points)
  - Review of Data Dictionary and entry of standard information from the dictionary in our database (examples: code counting logic, definition of each activity)
  - Evaluation and entry of additional “contextual” information that can help with analysis such as Operating Environment and Productivity Type

\*Note: Before Level II Evaluations are completed, database can be used to quickly query for a set of data points that meet initial criteria but some of the activities listed below would still need to be conducted manually before the data could be used to support an estimate or as part of a study like the Growth Study. The Level II Evaluation simply completes these steps beforehand.



29

## How far we have gotten...


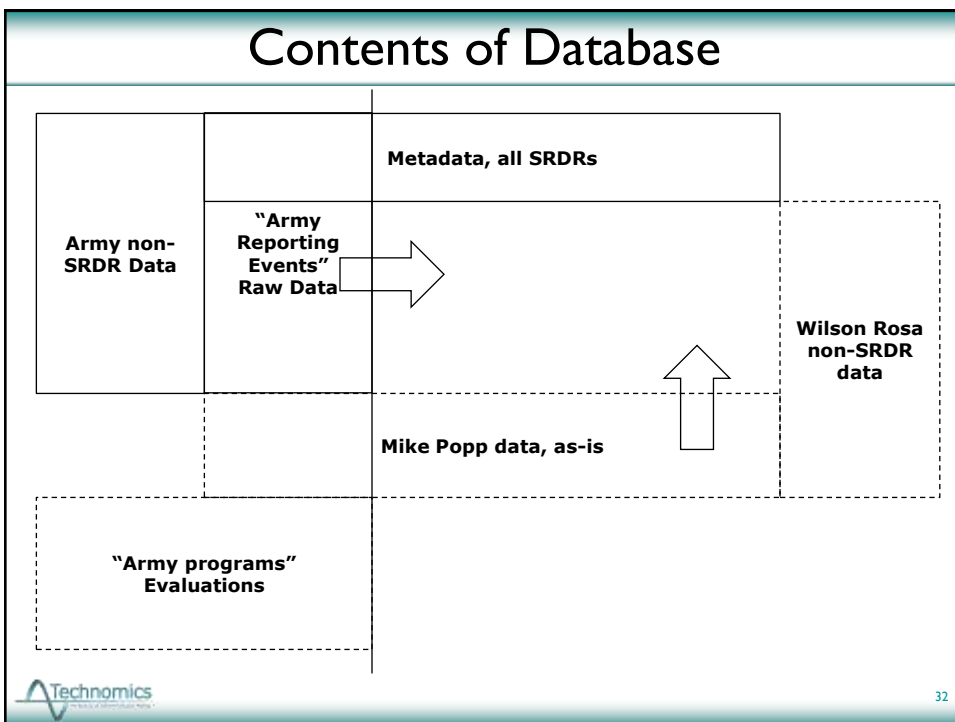
- Multiple iterations with ODASA-CE client
  - Demonstration of incremental capability
- Parallel data entry for Army SRDRs
  - Import of legacy non-SRDR data, All SRDRs metadata
- Version 1.0 incorporates all essential functionality
  - Drill-down
  - Data entry / SRDR view
  - Evaluations (Level I and Level 2)
  - Query
  - Go to Original
- Accompanying User Guide
- Prioritize future enhancements and content updates



30

## Data Inventory


- 1007 Total Reporting Events (according to DCARC reports)
  - 863 - Accepted Events
  - 144 - Due in the Future
- We have all 863 accepted events obtained in a bulk download request from DCARC
- Approximately 306 of these 863 have been entered into the database
- Dashboard and Drill-Down functionality in current database support further exploration


31




## Database Population

- Based on client (ODASA-CE) and community (OSD CAPE, SRDRWG) priorities
- Leverage existing resources to maximum extent possible
  - Import Mike Popp spreadsheet, e.g.
- Analyst involvement still crucial
  - At a minimum, validate against original submissions



33

## Comparison: SEI SCAR

	SCAR	Unified SWDB
Sponsor	USD(AT&L)?	ODASA-CE
Developer	Software Engineering Institute (SEI)	Technomics
Data	5 programs (pilot)	18 programs (Army), 58 programs (Total)
Metadata	??	All SRDRs (DCARC import), including Future
Data Entry	Scraper (DD 2630 only)	Import/manual
Platform	Web-based	Microsoft Access
Popp/Rosa	Separate repository?	Direct incorporation/annotation
Database Components	4 Databases, ...	2 Databases, ...

“Software Cost Analysis Repository” webinar, Brad Clark, Jim McCurley, Software Engineering Institute (SEI), July 2, 2013

Disclaimer: Direct insight into SCAR is limited at this time.


34

## The Bigger Picture

- Improve Accessibility and Quality of existing data (Past)
- Improve guidelines for ongoing data collection, i.e., SRDR DID (Present, Pull)
- Improve capture for incoming SRDRs (Present, Push)
- Improve mechanism for data collection on new programs, i.e., XML (Future)



35

## Bibliography

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- “Software Cost Analysis Repository” webinar, Brad Clark, Jim McCurley, Software Engineering Institute (SEI), July 2, 2013
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- “Software Database User Guide,” Office of the Deputy Assistant Secretary of the Army, Cost and Economics (ODASA-CE), March 2014



36

# In Pursuit of the One True Software Resource Data Reporting (SRDR) Database

Backup



## Army SRDR Programs Summary

- Ground Vehicles
  - GCV
  - JLTV
  - PIM
- Missiles and Munitions
  - Excalibur
  - JAGM
  - GMLRS
- Aircraft
  - Apache
  - UH-60M
  - ARH
- Electronics
  - JTRS-GMR
  - WIN-T Increments 2 and 3
  - DCGS-A
  - FBCB2
- System of Systems
  - JLENS
  - IAMD
  - FCS
  - GCSS
  - GFEBS



38

## Army Non-SRDR Programs Summary

- Ground Vehicles
  - EFV
- Missiles and Munitions
  - AIM-9X Block II
  - AARGM
  - SM-6
  - SDB II
- Aircraft
  - B-2 EHF
  - VH-71
  - Super Hornet
  - C-130 AMP
  - Hercules
  - H-1 Upgrades
  - B-2 RMP
  - E-2D AHE
  - F-22
  - KC-46A
  - B-2 DMS
  - CH-53K
  - MH-60R
  - EA-18G
- Electronics
  - NMT
  - JATAS
  - CAC2S
  - G/ATOR
  - MPS
  - NAVY ERP
  - MP RTIP
  - IDECM
  - FAB-T
  - ADS
  - CEC
- UAV
  - VTUAV
  - MQ-4C
- Ships
  - LCS
  - Cobra Judy Replacement
- Space
  - SBIRS HIGH
  - GPS OCX
  - NAVSTAR GPS
  - EPS
  - MUOS

