

How NASA Built an Expertise-Matching Service Using Knowledge Graphs



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How NASA Built an Expertise-Matching Service Using Knowledge Graphs



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“

Knowledge is every company's most valuable asset, but it remains hard to grasp at the same time, because it is scattered across different systems and human minds...”

Deloitte

Creating a talent marketplace allows you to move away from the unstructured database.



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Speakers



Greg Ladd

VP, North America Enterprise Sales,
Stardog



Andrew Schain

Data Integration Lead, Human Space
Flight (retired), NASA

Agenda

- **The Need for Expertise Matching**
- **Key Challenges**
- **Consequences if Overlooked**
- **Optimizing the Organization for Success**
- **The NASA Use Case**
- **Q&A**

Why the Need for Expertise Matching?



“Knowledge, however, is **not just data thrown into a database**. It is a complex, dynamic model that puts every piece of information into a larger frame, builds a world around it and **reveals its connections and meaning in a specific context.**”

Deloitte

Key Challenges

- Employee profile information typically is stored in disparate databases across the enterprise.
- HR professionals need to run several discrete queries to find what they are looking for
- Rolodex culture is time consuming and can return no results — and is impossible to scale

Consequences if Overlooked

- Resources wasted on time-consuming searches
- Mismatch between employee and project, resulting in:
 - Lost productivity when work does not get done
 - Wasted resources when unnecessary headcount is hired
 - Turnover when employees' skills are not used
- Degradation of institutional knowledge

Consequences if Overlooked

- Money wasted developing and maintaining employee profiles
- Lack of trust in results of ad-hoc queries
- Increased operational, regulatory and revenue risk
- Degradation of institutional knowledge

Optimizing the Organization for Success with Stardog

Our Enterprise Knowledge Graph helps you make better decisions with data.

We help our customers and partners:

- Build innovative new products
- Create efficient, data-driven operations
- Unlock access to data

Headquartered
Washington, DC

50++
Global Customers

Venture-backed
With \$20M in funding

Trusted by global leaders with their toughest data challenges



Morgan Stanley



D | DOW JONES



BNY MELLON



BOSCH

ELSEVIER



QIMR Berghofer
Medical Research Institute

SIEMENS



Boehringer
Ingelheim

NOKIA

SPRINGER NATURE

Schneider
Electric

Optimizing the Organization for Success with Stardog

- Quickly respond to changing economic conditions
- Move talent to the areas of the business that need it most
- Optimize your talent allocation at scale in a time of remote and globally distributed work
- Help your employees develop new skills
- Reduce the need for third-party consultants
- Preserve the high-value legacy of institutional knowledge across the organization

Helping NASA's missions to the Moon and Mars



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**It started with a public
challenge.**



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The Problem

How do you
Identify Expertise?

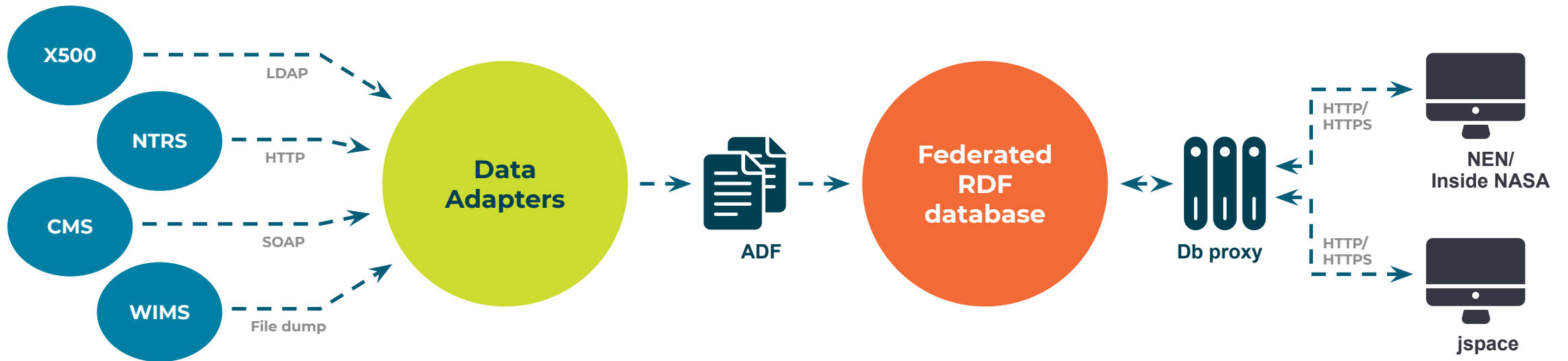
- **Instructions from NASA's Chief Engineer:**
 - Purchase an "Expertise Location" system to support strategy planning and new projects
- **Implementation questions:**
 - Who is going to fill out forms? How to ensure honesty?
 - Are there authoritative data sources that can be leveraged?
 - How will information be kept up to date?
- **Assertion:**
 - NASA has all the information needed and a single-purpose application not required

Requirements

Starts with User Stories

- **Jorge** is responsible for staffing a new NASA project which requires a programmer with zero gravity materials science experience and willingness to work in California
- **Lucinda** is putting together a Tiger Team for which Bob, a flight engineer on STS-51L, would be a good fit; but since he's retired she needs to find someone who worked with him instead.
- **Jeff** is a new thermal engineer at JSC and wants to use the same testing methods that were used on the Mars Rover. He needs to find people who worked on this project and see have experience with the Space Shuttle.

Building the System



Data is spread across different data services and geographically – dispersed data centers with different policies for access.

“POPS” - Creating an Ontology

NASA Center ➡ People who worked at the same space center

Building ➡ People who worked in the same building

Office ➡ People who worked for the same organization and had an office close to one another

Your job category ➡ People who were aeronautics engineers and worked in the same department

Project ➡ If you worked on the same project and had the same skills was higher probability than if you worked in the same office

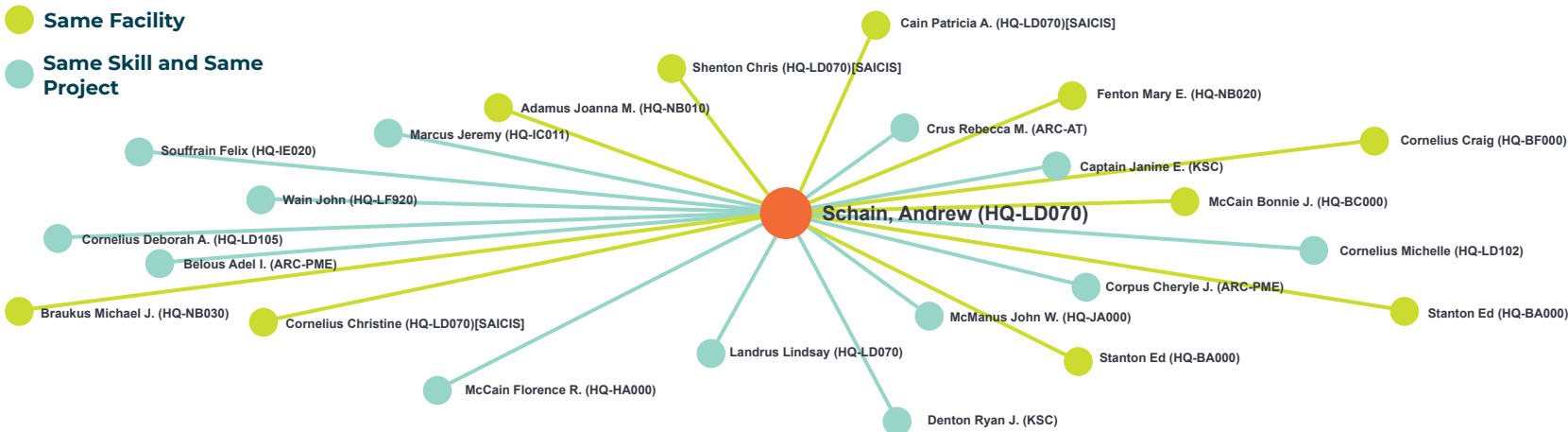


Recognizing Existing Human Processes

- Like many organizations, NASA is a rolodex culture where managers turn to people they know for recommendations.
- With POPS, combining Directory, Time & Attendance, Competency, and Publication systems wasn't enough; we needed to show likely human relationships.
- We added annotation to help document query results but also to help “lay bread crumbs” for the next customer.

Clearing Away Clutter to See Data Clearly

NASA Center (Source: LDAP)	Project (Source: WIMS)	Competency Sub-Category (Source: CMS)	Competency Category (Source: CMS)	Person (Source: LDAP)
ARC	Center G&A – B&TD – Available for New W	Business Operations Competency Suite	Business Knowledge Domain	McManus, John W. (HQ-JA000)
DFRF	Corporate Labor	Computer Sci & Info Technology Competen	Engineering & Technology Knowledge	Schain, Andrew (HQ-LD070)
GRC	ESMD-HSR&T-Human Systems Integration	Engineering of Systems Competency Suite	Leadership & Management Knowledge Do	
HQ	Education HQ Labor	Financial of Systems Competency Suite		
JSC	Exploration Mission Directorate	Institutional Operations \$ Support Compete		
KSC	Function to Another Center	Management Competency Suite		
LARC	ISS – ISS Launch and Mission Objectives	Mission Operations Competency Suite		
SSR		Professional Development Competency Sui		
		Workforce Operations & Support Competen		



Polyarchical query browser allowed for easy searches without the use of SPARQL

Not so much blazing a trail of new data, rather clearing clutter away so you can see the data you more clearly

POPS: The Results

- Efficient expertise location at half the initial investment and significantly lower operational costs
- UI for navigating trusted data sources without disruption to source system policies or operations
- Mind blowing customer response



Infrastructure for Information Integration

- POPS: Not an expertise locator but is an **infrastructure for information integration**
- Federate query and browse through data **leveraging trusted sources and existing data relationships**
- Applicable to **hundreds of integration problems** at NASA



What was Next? Business Impact Analysis

- BIANCA - a system for analyzing assets within a datacenter.
- Built reusing infrastructure from expertise matching system.
 - A completely different UI conforming with the actual human experience
- Integrated existing monitoring systems, not just traditional databases.





BIANCA

- Business Impact Analysis for Networked Computer Assets (BIANCA) is a web application for browsing and quarrying information about NASA HQ, including business impact analysis data. It contains information about Applications, Servers, Network Services, Networks, and Change Requests. [LINK TO BIANCA](#)

BIANCA

Home Apps Servers Networks Services CR BIA Persons Help

Sign in

- Report Builder
- Current Apps
- Orphaned Apps
- App & Machine Types
- Bust-A-Node (BAN)
- About BIANCA

Log in to BIANCA

This is a contractor operated website on a U.S. Government computer. This website is for the use of AUTHORIZED users only. By accessing this website you are consenting to system monitoring. UNAUTHORIZED use of, or access to this website may subject you to disciplinary action and criminal prosecution. If you are not authorized to access this website, disconnect now.

Enter a username and password

Username:

Passcode (PIN+Tokencode):

Log In

To request a BIANCA account complete a NAMS request.

[Home](#) | [Help](#) | [Give the developers feedback](#). | This is BIANCA <Release 1.5 (Sung Gyro), Date: 11 December 2009>.

And Now: Back to the Moon and on to Mars

The screenshot displays the STARDOG web application interface, which is used for managing and visualizing complex systems data. The interface is divided into several sections:

- Top Navigation:** Includes tabs for "Tools", "Help", "NASA Owner: Ian Maddox - Website Maintainer: Gregory Coluni", and a "Perspective" dropdown set to "SLS Function".
- Left Panel:** Contains a search bar and a list of "ESD Requirement [ESD Cradle] (11)" items, including "ESD_R-11: Lift Capability", "ESD_R-12: Payload Fairings", "ESD_R-13: Orbital Insertion Accuracy", "ESD_R-14: Alternate Means of Delivering Crew To/From ISS", "ESD_R-15: Launch Rate", "ESD_R-16: Loss of Crew", "ESD_R-20: Audio and Motion Imagery", "ESD_R-22: Secondary Payloads on SLS", "ESD_R-25: SLS TLI Capability", "ESD_R-26: Block 1B and Block 2B Co-Manifest Payload Volume", and "ESD_R-28: Cislunar Element Delivery".
- Center Panel:** Displays a network diagram with nodes representing various SLS components and functions, connected by lines indicating dependencies. Nodes include "ESD_R-11: Lift Capability", "ESD_R-13: Orbital Insertion Accuracy", "DMM-VM-0001: Marshall Aerospace Vehicle Representation in C (MAVERIC)", "R.V.M. 3.1.1.10: Mission Management Function", "VMSPEC.DC.001", "R.SLS.0009: Autonomous Operation", "DVO.SLS.0009.T.1: Autonomous GN&C Operations SIL Test", "DVO.SLS.0009.T.2: Autonomous M&FM Operations SIL Test", "DVO.SLS.0009.T.3: Autonomous GN&C Operations SIL Test", "DVO.SLS.0027.2.1.3121.T.3: Attitude Control SIL Testing", "DVO.SLS.0027.2.1.A.2: GN&C Performance Assessment", "DVO.SLS.0041.V.1: Flight Software Validation of Records", "I.MPCV.SLS.3121: SLS Performs Attitude Control of Integrated Vehicle", "I.MPCV.SLS.3121: VR to I.MPCV-SLS.3121", "R.F.C.2100-SC: Send Core Stage TVC Yaw Commands", "I.I.SPE.003.23: SPE Provide Attitude Control of Integrated Vehicle", and "R.SLS.0027.2.1.A.2: GN&C Performance Assessment".
- Right Panel:** Shows a list of "SLS Requirement [SLS Cradle] (12)" items, including "IR.ICD.CS.E.1594: Fluids Criteria", "IR.ICD.CS.E.1595: Fluids Criteria", "R.F.C.1420-SC: Maintain LH2 Tank Ullage Pressure", "R.F.C.1421-SC: De-energize GH2 Valves When No Valid LH2 Tank Pressure Is Available", "R.F.C.1430-SC: Maintain LO2 Tank Ullage Pressure", "R.F.C.1431-SC: De-energize GO2 Valves When No Valid LO2 Tank Pressure Is Available", "R.SLS.0009: Autonomous Operation", "R.SLS.0027.2.7: SLS-ICD-039-01", "R.SLS.0041: Flight Software", "R.SLS.0061: Flight Software for Block 1B", "SLS-GSDO.CL-2020: LH2 Pre-Press", and "SLS-GSDO.CL-4020: LO2 Pre-Press".
- Bottom Panel:** Contains a "Query" section with a table of results.

Type	ID	Description	Status
SLS Function	1.1.4	1.1.4: Pressurize Core Stage Propellants This function describes the ALS commands to control pressure in both Core Stage LH2 Tank and Core Stage LOX tank (at slightly different times), to prepare for launch, as well as switchover of fluid for pressurization once engines have started. Prior to engine start, the tanks are pressurized using helium, supplied from GHe tanks and replenished from GSDO. As the engines start, warm gas is fed back to the tanks for that pressurization. Fluid switchover is done outside of software control, but once it switches to engine gases, the Flight Software controls the tank pressure.	APPROVED
Mission Phase	Pad and Launch Operations	Pad and Launch Operations	DRAFT
ESD Function	C-142	SLS Fueling and Propellant Conditioning - GS	DQA
	C-171	Countdown and Launch	DQA
HEO Requirements	ESD-R-11	Lift Capability	BASELINED
	ESD-R-13	Orbital Insertion Accuracy	BASELINED
SLS Requirements	IR.ICD.CS.E.1594	Fluids Criteria	
	IR.ICD.CS.E.1595	Fluids Criteria	



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A photograph of the Space Shuttle Columbia on the Mobile Launcher Platform being moved by the Crawler-Transporter at the Kennedy Space Center. The shuttle is white with orange and black stripes. The crawler is a large, yellow, lattice-structured vehicle. The background is a sunset sky with orange and blue clouds.

An Awakening

The data and data relationship already exist but are locked in all kinds of places; they just needed to be tied to associated data

Customers saw that using combinations of interconnected data they already had was powerful in new and unexpected ways, it enriched the sources

The quality of the data increased

The clutter was cleared



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Q&A.



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Thank you.



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