KNEXUS RESEARCH CORPORATION

DRIVER OF INNOVATION THROUGH INTELLIGENT SYSTEMS RESEARCH

WWW.KNEXUSRESEARCH.COM

AN OVERVIEW

Knexus Research Corp. specializes in artificial intelligence (AI), cognitive science, machine learning, and data science research and applications. We work from our **high-tech and professionally managed lab** located in Maryland to rapidly develop, evaluate and showcase advanced technology concepts for autonomous agents and decision support systems.

We deliver professional services both to the US Government and the commercial sector. Our **clients** are providers of state-of-the-art decision support, autonomous, and training systems. They trust Knexus to reliably and cost-effectively reduce technological risks and to give them a sustained competitive advantage with transformative systems and products.

Our **vision** is to create modular, testable, reliable, safe, and affordable communicative autonomous and decision support systems for US national defense and commercial applications.

Our **mission** is to deliver software solutions that measurably outperform the state-of-the-art in decision support effectiveness, efficiency and autonomy levels.

OUR TEAM

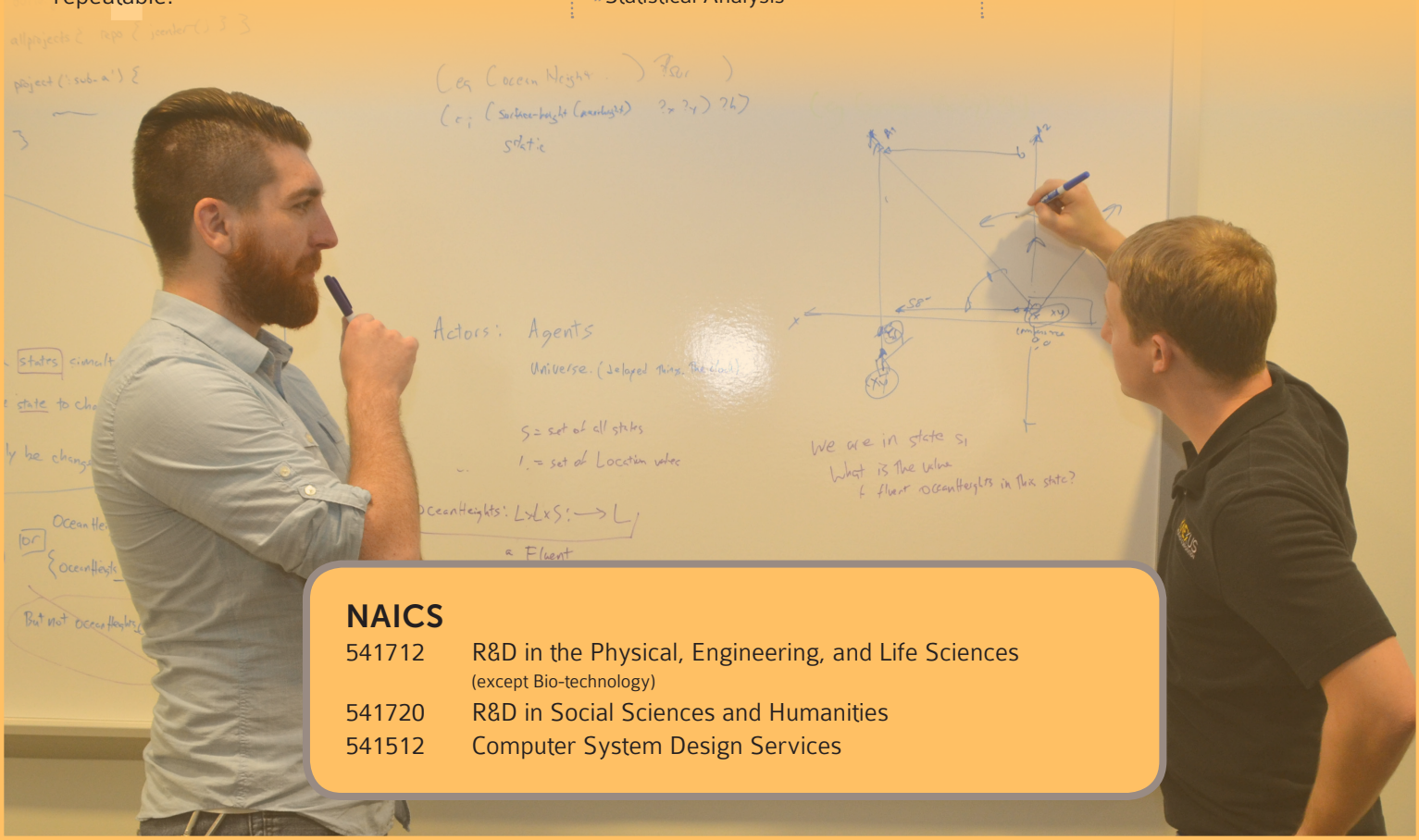
Knexus was founded in 2006 by Dr. Kalyan Gupta, a seasoned AI and information technology (IT) researcher with a track record of invention, Research and Development (R&D) project and product management. He is the Knexus President with demonstrated and exemplary ability to transition innovative technologies into software products and solutions.

During the past ten years, Knexus has grown into a team of 16 full-time scientists and engineers who hold advanced degrees in computer and information science, business, and engineering. Knexus members thrive on the challenge of methodically deconstructing a complex and difficult problem, developing AI algorithms and solutions, putting them together into systems that advance the state-of-the-art, and running them through the rigors of application test and evaluation.

Their innovations range from figuring out how to make virtual game bots that learn to win by watching their opponents' moves, to deciphering the cognitive underpinnings of how we understand spatial descriptions and using that knowledge to develop naturalistic command and control for autonomous robots.

OUR CAPABILITIES

	EXPERTISE	DELIVERABLES
BASIC & APPLIED RESEARCH **We apply rigorous research methods** to advance subfields of AI, cognitive science, machine learning & data science. Our research is the basis of our innovation & transformative products.	»Automated Planning »Spatio-temporal Cognition »Human-robot Trust »Intent Recognition »Privacy Preserving Analytics	»Algorithm Specifications »Knowledge Representations »Research Publications »Patents
SYSTEMS & SOFTWARE ENGINEERING **We take theories from the lab to the field.** We employ industry best practices to architect stand alone and integrated systems & modules ready for demonstration, testing, & deployment.	»Autonomy & Cognitive Architectures »Interactive Mission Management »Natural Command & Control »Threat Detection »Service Oriented & Dist. Systems	»Advanced System Prototypes »Application Scripting Languages »Application Software & APIs »Application Knowledge Bases
SIMULATIONS & TESTBED DEVELOPMENT **We cost-effectively reduce the technical risks** of our algorithms and systems by developing reusable simulation frameworks & testbeds.	»Test Frameworks & Architectures »Test Generation & Case Sampling	»Application Specific Simulators »Simulation Models »Agent & Autonomy Testbeds
PERFORMANCE STUDIES & EVALUATIONS **We provide confidence & reliability in our product performance** through broad coverage, fair, and rigorous test & evaluation that is repeatable.	»Experimental Design »Human Subject Studies »Crowd-sourcing »Statistical Analysis	»Test Data »Study Findings & Comparative Performance Reports



NAICS

541712	R&D in the Physical, Engineering, and Life Sciences (except Bio-technology)
541720	R&D in Social Sciences and Humanities
541512	Computer System Design Services

WHY CHOOSE KNEXUS?

- **We offer the best value** for your most challenging autonomy and decision support R&D requirements.
- **We have a unique institutional DNA** that consistently produces award winning research and products:
  - **Shared core values:** Each member shares our values of empathy, integrity, dependability, excellence, perseverance, and collective intelligence.
  - **Professional talent management:** Our leadership nurtures, empowers, and rewards AI, machine learning, and data scientists and engineers for long-term research and product development.
  - **Institutionalized best-practices:** Our team adheres to carefully-established standards for program, customer, and quality and risk management.
- **We are an 8(a) certified small business.**

CLIENTS & SPONSORS

- Information Technology Division (ITD) Naval Research Laboratory (NRL), Washington DC
  - Code 5510 (Navy Center for Applied Research in Artificial Intelligence - NCARAI)
  - Code 5501 (Office of the Associate Superintendent of ITD)
- Office of the Secretary of Defense (OSD)
- The Office of Naval Research (ONR)
  - Division 341 (Human and Bio Engineered Systems)
  - Division 311 (Image Analysis and Understanding Program)
  - Division 321 (Ocean Sensing and Systems Applications Division)
- Harris Corporation
- Tapestry Solutions Inc. a Boeing Company

FACILITIES

MARYLAND (PRINCIPAL OFFICE)

4020 Sq ft
174 Waterfront Street, Suite 310
National Harbor, MD 20745

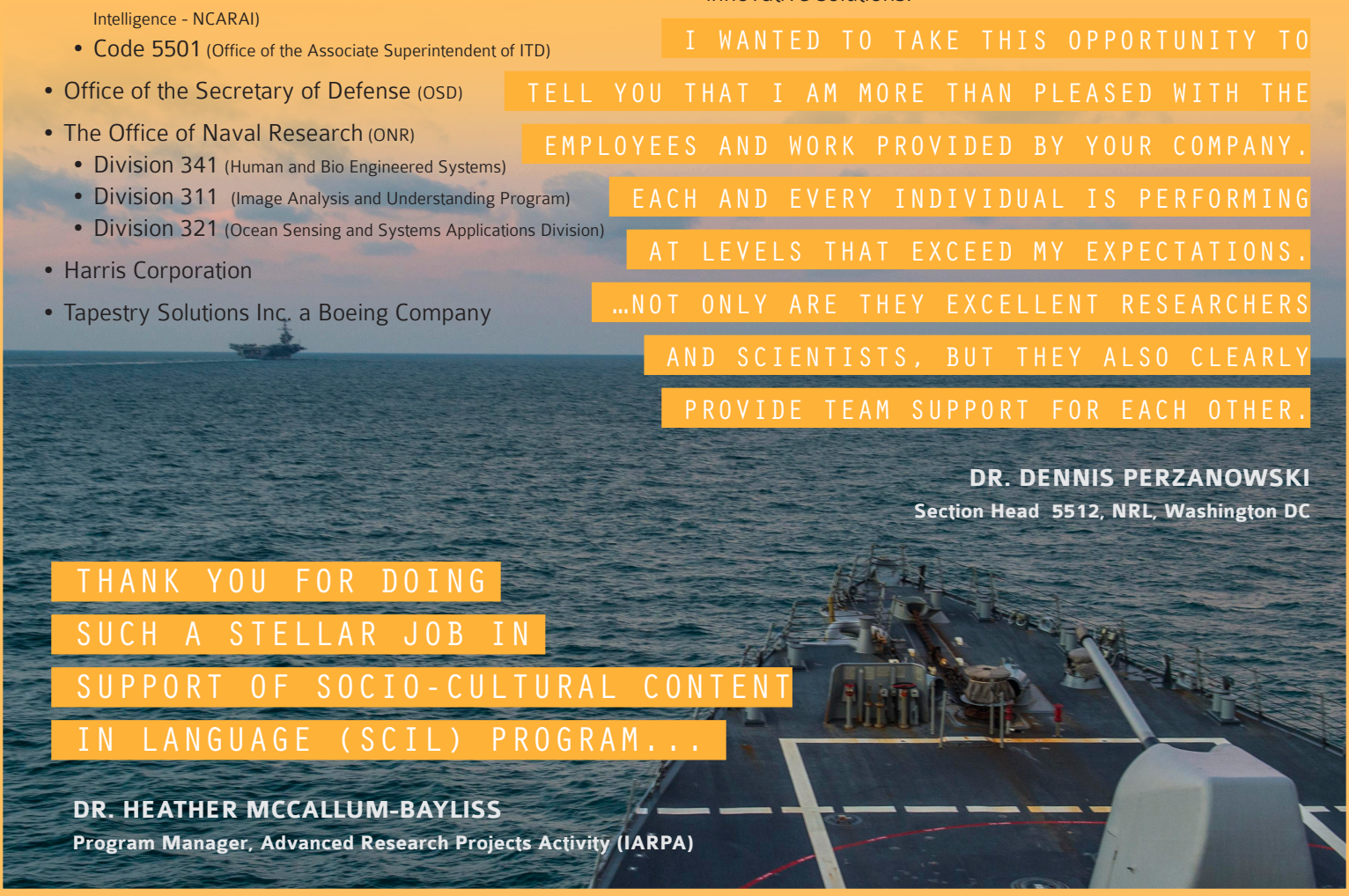
VIRGINIA (REGISTERED OFFICE)

300 Sq ft
9120 Beachway Lane,
Springfield, VA 22153

Security Clearance: Secret

Accounting: DCAA Certified

Computing Infrastructure: Both our locations have fiber optic connections (75 Mbps) to the Internet. Our computing infrastructure includes 4 quad core servers with 32 GB RAM and terabytes of storage along with our ability to use cloud services and two general purpose GPUs for image processing research. We have redundant and failsafe operations that are backed up multiple times daily across locations and on the cloud. Our scientists and engineers use powerful laptops with office productivity, open source software development environments and scientific software packages to develop innovative solutions.



ACCOMPLISHMENTS

71,000+ HOURS OF PROFESSIONAL SERVICES DELIVERED

We have delivered over 71,000 hours of outstanding professional services to the NRL, performed Small Business Innovation Research (SBIR) for the office of ONR and the OSD with a record of 100% graduation from Phase I to Phase II, and provided consulting services to private companies like Tapestry Solutions Inc.

APPLIED & EVALUATED AI ALGORITHMS FOR DOD

We have applied AI algorithms and evaluated their benefits on a wide range of DoD systems and problems, such as:

- Using relational classification techniques, we exploited contextual information to improve the ability to categorize vessels and activities in maritime surveillance video.
- We demonstrated that adaptive agents representing Tactical Air Operation Commanders (TAO) could adequately plan courses of action despite an adversarial environment.
- For United States Transportation Command (USTRANSCOM), using our algorithm for information brokering and automatic database schema linking, we helped our client, Tapestry Solutions Inc., demonstrate a potential savings of 1 FTE of schema mapping effort.
- For IARPA, we integrated state-of-the-art question answering algorithms from 3 performer teams into a next generation Intelligent Question Answering (INQA) system for Intelligence Analysts which was demonstrated to the US Congress.

AWARD-WINNING RESEARCH

We have pioneered the research on many of AI topics, published 74 articles in leading journals (such as Journal of Machine Learning Research, and Journal of Information Technology and Web Engineering) and peer reviewed conferences (e.g., IJCAI, AAAI & ICCBR). We have received three Best Paper Awards. We received the Best Overall AI Video award in the AAAI on AI in 2009.

SCIENCE & TECHNOLOGY

- 74 Peer Reviewed Publications
- 3 Best Paper Awards (ICCBR-2014, FLAIRS-08,09)
- Best AAAI Video Overall 2009
- Patents: 2 Awarded, 2 Pending, 1 Disclosure

RESEARCH SOFTWARE & TOOLS

- Six Application servers, three generators, four testbeds, three APIs, three annotation tools and two scripting languages

SOFTWARE PRODUCTS

- Closed Source
  - eBotworks
  - AIMS (deployed at NRL ITD)
  - APrCoTS (deployed at NRL NCARAI)
- Open Source
  - SHOP2-PPDL+, Hierarchical Planning for Continuous Domains
  - A categorical to speech grammar translator

TECH DEMONSTRATIONS

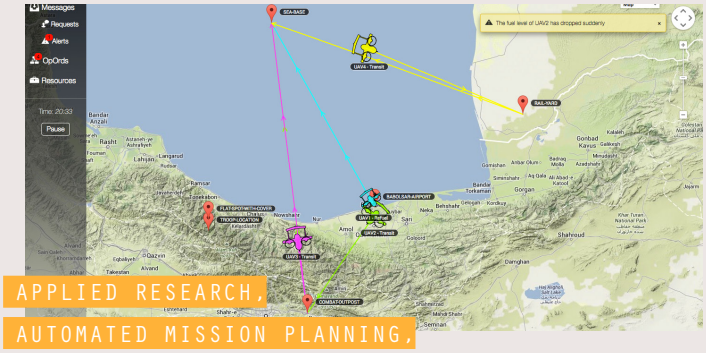
- Office of the Directory of National Intelligence (ODNI) Expo, Capitol Hill, 2008

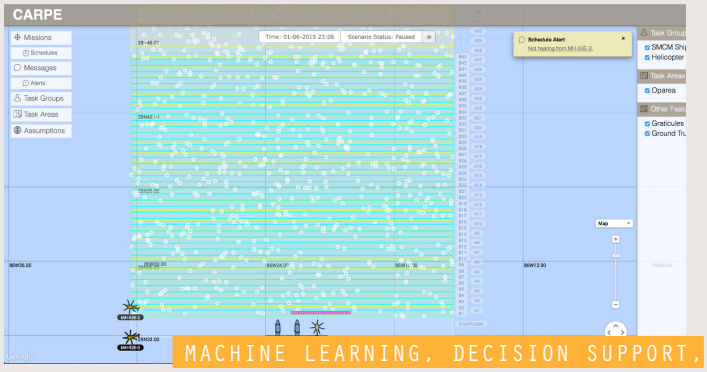
SAMPLE RESEARCH & DEVELOPMENT

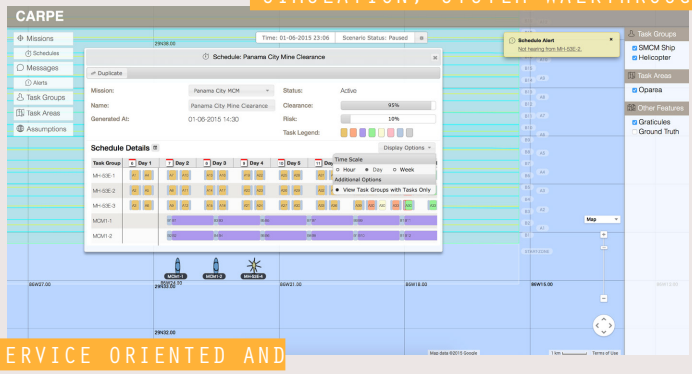
ADAPTIVE PLANNING & SCHEDULING FOR AUTOMATED MISSION MANAGEMENT

Organizations and individuals routinely create plans and schedules to meet a variety of specified objectives. This can be as simple as making a grocery shopping list for a party, through a more complex plan for a wedding, to a very complex operation plan for achieving military objectives. Depending on the scope and size of planning effort, it can be a long and difficult exercise. We asked ourselves, could we automate and streamline this?

A variety of planning, tasking and scheduling algorithms can be used to automate this task to some degree, thereby speeding up the task and reducing human error. We are advancing beyond the state-of-the-art in planning algorithms in terms of the types of planning tasks they can handle, the quality of plans they generate, the speed with which they orperate, and much more. For instance, in two SBIR projects funded by the ONR, we developed techniques for generating valid task orders in response to unmanned aerial vehicle (UAV) mission requests and mine-countermeasures operations in seconds. If performed by a human decision maker, the same work takes somewhere between a few man hours to several days. We also developed innovative techniques to automatically fix the ongoing plans (e.g., retask, reschedule) if the situation in the field was unexpected or the progress in the field was unsatisfactory. We did so with an innovation called minimally disruptive plan repair with event indexed experiences. We implemented algorithms into a robustly engineered planning decision support engine that assists mission planners to plan and manage operations over the web. Another unique innovation we included in the decision engine is its ability to learn and tailor its recommendations based on the schedule choices made by human decision makers. Through wide coverage simulated experiments and with subject matter experts' evaluation, we demonstrated that **our approaches have the potential to significantly reduce time and effort to plan and manage missions.** These algorithms have been selected for Future Naval Capabilities (FNC) program focused on Mine Countermeasures Decision Support.







LEARNING TO MAP SCHEMAS AND LINK RECORDS ACROSS DATABASES FOR ORGANIZATIONAL INTEGRATION

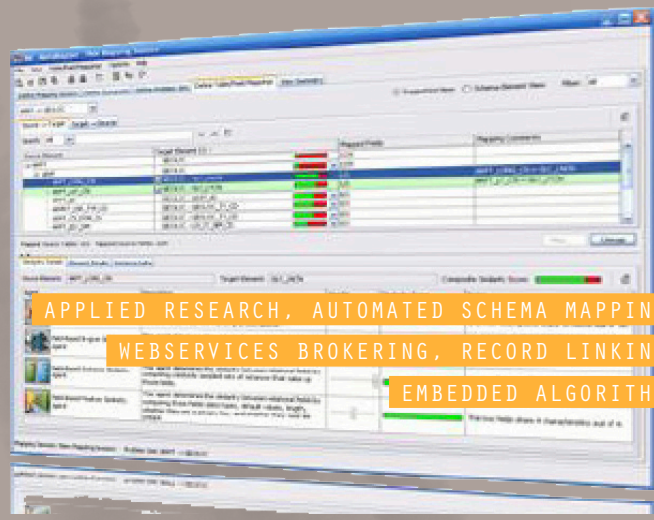
Some government agencies such as USTRANSCOM, National Oceanogarphic and Atmospheric Administration (NOAA) must efficiently and accurately broker data between their vendors and customers. This can be challenging because the requested data may be located in multiple databases or webservices across different organizations each with different schema. Manual approaches to integrating such schemata and records is painfully slow, expensive and fraught with errors and inconsistences. We have investigated approaches to automatically link schemas and broker queries across webservices for both Tapestry Solutions Inc. and NRL. Our patented machine learning techniques which automatically categorize and broker queries across webservices and ag-

LANGUAGE & SCENE UNDERSTANDING FOR AUTONOMY AND COMMAND & CONTROL

Robots and drones already assist us with a variety of chores and with dangerous or repetitive tasks. In the near future, they will be smarter, more trustworthy, safer and intuitive to command and control. For instance, given a vague spoken command such as "Go into the building", how should a robot figure out where exactly in the building should it go and which way it should face, or what should it do once it gets there? How should it respond when asked "Where are you?" Understanding and responding to questions and commands in a reliable manner will require leaps from our understanding to integrated theories about how we perceive and represent situations, understand language, plan and act.

We are addressing these challenges and making seminal AI and machine learning technology contributions in a portfolio of closely-related basic and applied research projects. For instance, in an ONR-funded basic research, we developed a new theory of spatial language understanding that connects perception to action through planning and spatio-temporal reasoning. Our algorithms, building on psycholinguistic theories and novel AI approaches, have resulted in three patents. In a related ONR funded SBIR project, we developed an autonomy simulation and test and evaluation tool called eBotworks and successfully demonstrated an application of our theory to command a mobile robot with voice and text. In collaboration with NRL, we used eBotworks to pioneer and demonstrate theories of operator trust and supported the investigation of autonomous systems software reliability. In yet another thread of related research, we focus on perception, or vision and scene understanding. We developed novel relational learning techniques, which outperform the state-of-the-art in maritime object detection classification. We applied these algorithms with new techniques for behavior and intent recognition to improve maritime surveillance and threat detection.

gregate responses have been published in leading journals. We developed a novel pattern matching algorithm combined with machine learning to perform schema mapping and record linking. These algorithms and semantic matching technology were embedded by CDM in their tool, called IMT, and evaluated at USTRANSCOM. We showed that with IMT TRANSCOM would save over 1 person year and improve the data quality.



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