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Defense Health Agency

2014 Defense Health Information Technology Symposium

RDF, Hadoop and Real-Time CDS:

Practical Applications Supporting PTSD Management

DHA Vision

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"A joint, integrated, premier system of health, supporting those who serve in the defense of our country."

Learning Objectives

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- Recognize the advantages of RDF for exposing, aggregating, normalizing, and enriching clinical data
- Understand how NoSQL data stores deliver cost-effective, massively scalable storage capacity
- Learn how several reasoning technologies (rules, predictive models, optimization algorithms, etc.) might be orchestrated to provide real-time Clinical Decision Support
- Understand how both enterprise and local reporting might be supported by modern analytics platforms, e.g. Hadoop
- Identify generalized opportunities for applying these technologies to improve clinical care, optimize resources, etc.

Agenda

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- TAPS (Transition Application Plan Support) Project Overview
- What is RDF (Resource Description Framework)?
- What are cloud, scale-out databases?
- What is Hadoop?
- Illustrations of practical enterprise value
  - Post-Traumatic Stress Disorder (PTSD) identification: TAPS Cohort Service
  - PTSD care: Resource & Capacity Management

TAPS Overview

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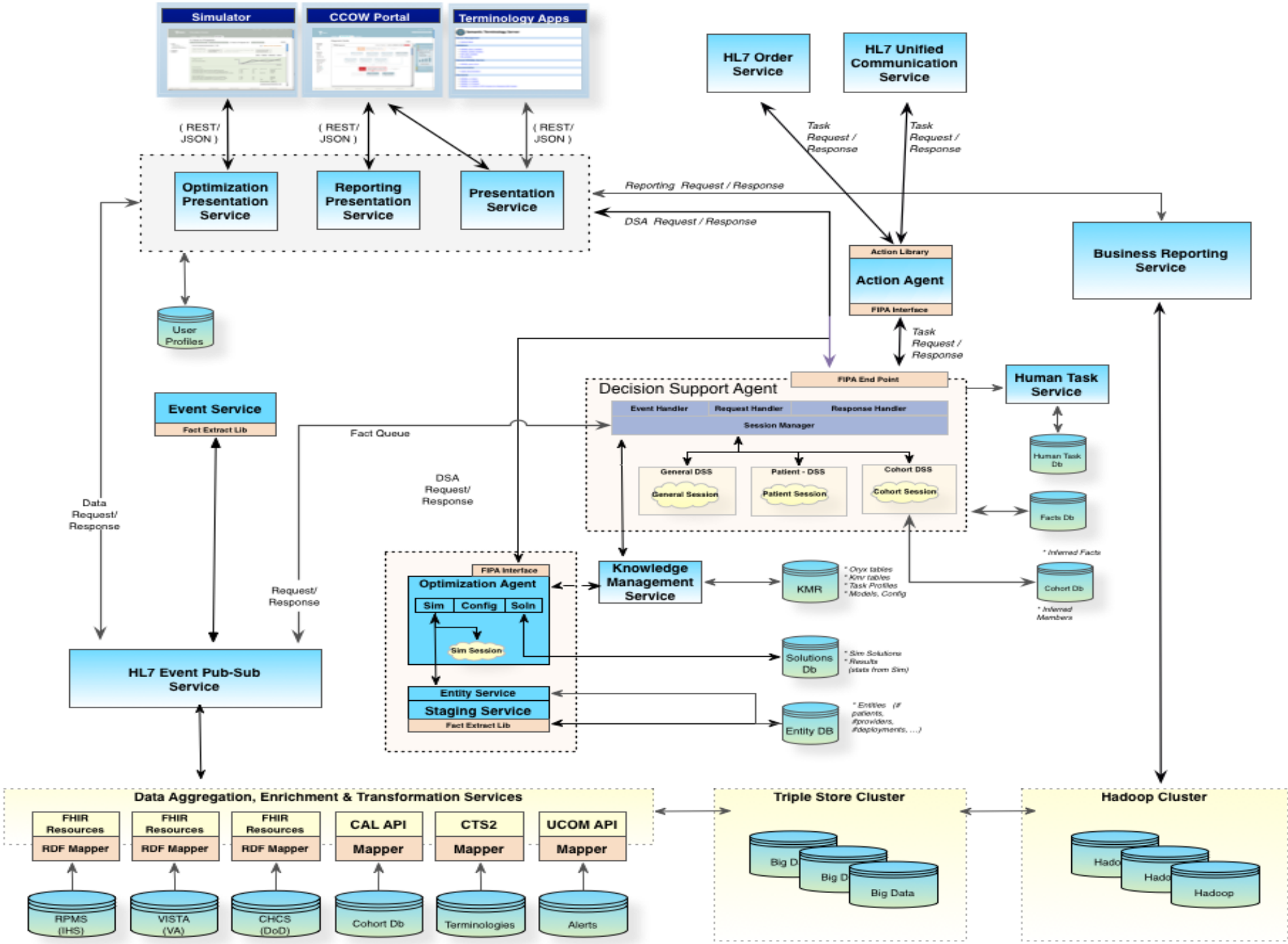
- TAPS Pacific Joint Information Technology Center (PJITC) project
  - Integrating legacy data/functionality into Service Oriented Architecture (SOA) environment
  - Exposing institutional / business process knowledge
  - Consuming federated data: storage and analysis technologies
  - Enterprise value: Clinical Decision Support (CDS), reporting, resource optimization


Simulator
CCOW Portal
Terminology Apps
HL7 Order Service
HL7 Unified Communication Service
(REST/ JSON)
(REST/ JSON)
(REST/ JSON)
Task Request / Response
Task Request / Response
Optimization Presentation Service
Reporting Presentation Service
Presentation Service
Reporting Request / Response
DSA Request / Response
Action Library
Action Agent
FIPA Interface
Business Reporting Service
User Profiles
Task Request / Response
FIPA End Point
Decision Support Agent
Human Task Service
Event Service
Fact Extract Lib
Event Handler
Request Handler
Response Handler
Session Manager
Fact Queue
General DSS
General Session
Patient - DSS
Patient Session
Cohort DSS
Cohort Session
Human Task Db
Facts Db
DSA Request/ Response
Data Request/ Response
FIPA Interface
Optimization Agent
Sim
Config
Soln
Sim Session
Knowledge Management Service
KMR
* Onyx tables
* Kmr tables
* Task Profiles
* Models, Config
* Inferred Facts
Cohort Db
* Inferred Members
Request/ Response
HL7 Event Pub-Sub Service
Solutions Db
* Sim Solutions
* Results (stats from Sim)
Entity Service
Staging Service
Fact Extract Lib
Entity DB
* Entities (# patients, #providers, #deployments, ...)
Data Aggregation, Enrichment & Transformation Services
FHIR Resources
RDF Mapper
FHIR Resources
RDF Mapper
FHIR Resources
RDF Mapper
CAL API
Mapper
CTS2
Mapper
UCOM API
Mapper
RPMS (IHS)
VISTA (VA)
CHCS (DoD)
Cohort Db
Terminologies
Alerts
Triple Store Cluster
Big D
Big D
Big Data
Hadoop Cluster
Hado
Hado
Hadoop

TAPS Outcomes

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- CHCS transition / decommissioning approach
- Light weight, extensible, standards-based data federation
- Powerful data transformation services - structure & semantics
- "Big Data" scale warehousing, analytics, and reporting
- Real-time clinical decision support services providing: rules, predictive models, optimization/planning algorithms, etc.

What is RDF?

- RDF stands for "Resource Description Framework"
- Is a framework for describing resources on the web
  - Data model, query language, etc.
- Designed to be read /understood by computers, not people
- RDF is a World Wide Web Consortium (W3C) Standard

Why RDF?

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- Semantics, not syntax
- Self describing
- Schema promiscuous
  - Multiple data models peacefully co-exist
  - Unlike schema-centric languages, e.g. XML
- Facilitates data exposure
- Integrate patient/enterprise data from existing legacy and future federated sources
- Allows for rapid development and cost savings through reuse of legacy data stores and business rules

What is a NoSQL Database?

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- Not based on a relational data model - don't use standard SQL
- Tend to be designed to run on a Cluster
- Don't have a fixed schema
- Take "liberties" with ACID (Atomicity, Consistency, Integrity, Durability)
- Basic classification based on data model:
  - Column: Accumulo, Cassandra, HBase
  - Document: Couchbase, MarkLogic, MongoDB
  - Key-value: Dynamo, Project Voldemort, Redis, Riak
  - Graph: Allegro, Neo4J, OrientDB, Virtuoso

Why NoSQL Databases?

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- Massively scalable and provide superior performance
- Easily support large volumes of structured, semi-structured, and unstructured data
- Low latency
- Ability to grow on demand
- An easier programming model
- Extremely cost-effective

What is Hadoop?

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- A distributed file system
- A framework that manages work across nodes in a cluster
- An open-source ecosystem of plugins that extend its core functionality and resembles an operating system
- Benefits:
  - Data Management: Store /process vast quantities of data
  - Data Access: Interact with data in a wide variety of ways
  - Data Governance & Integration: Quickly and easily load data, and manage according to policy.
  - Operations: Provision, secure, manage, monitor and operate Hadoop clusters at scale

Hadoop Technology Family

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Batch	Script	SQL	NoSQL	Stream	Others…
Map Reduce	Pig	Hive Tez HCatalog	Hbase Accumulo	Storm	In-Mem Search

YARN: Data Operating System

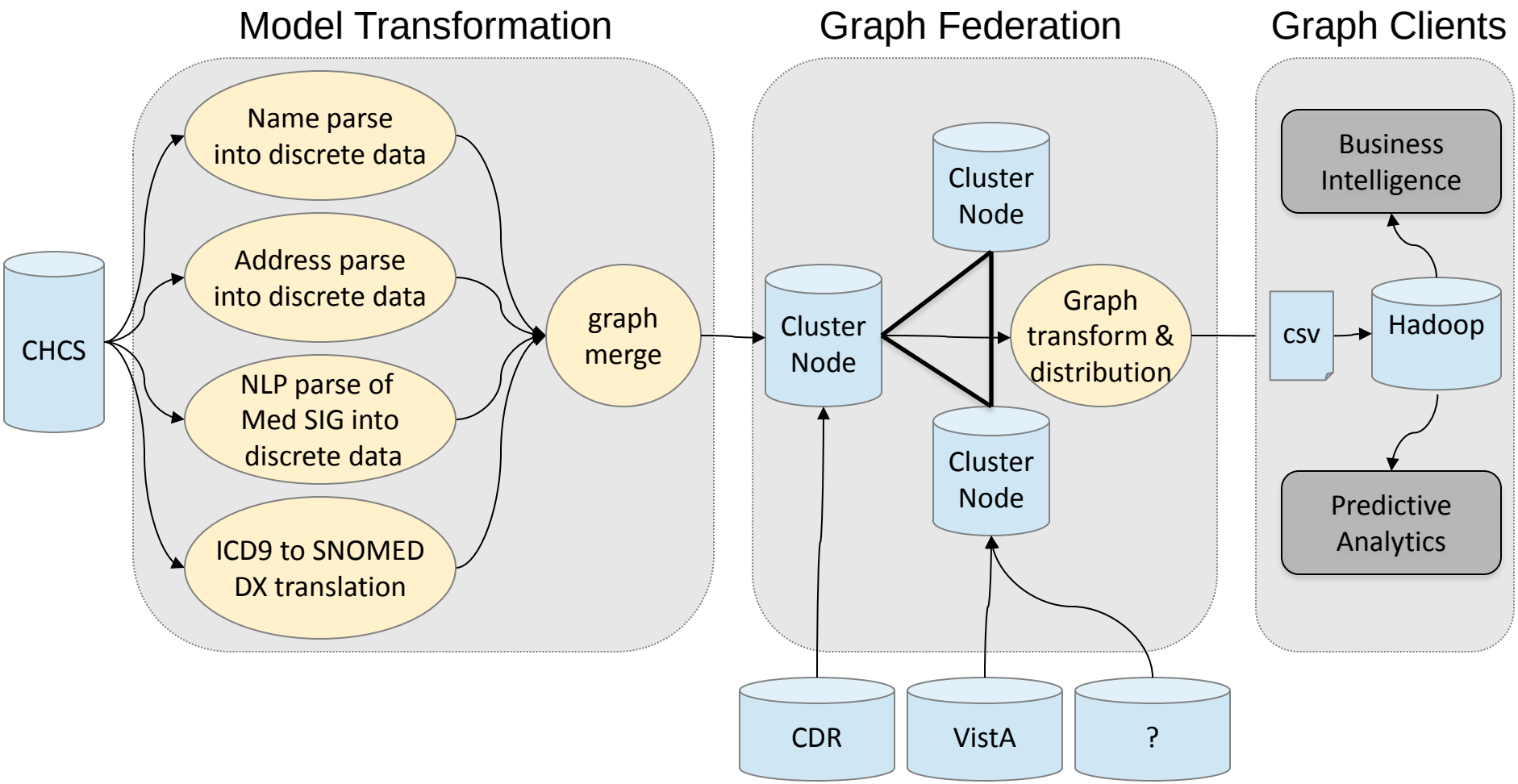
HDFS

Distributed File System

TAPS Cohort Service Combining Them All…..

- CHCS (Composite Health Care System) & other distributed data sources exposed as RDF
- Data "enriched" by RDF/SPARQL data processing pipeline
- Legacy data mapped to HL7 standard data models (vMR, FHIR) and terminologies
- Stored in clustered Big Data triple store
- Exported to Hadoop cluster for analysis and reporting
- Feed to real-time rule engine employing production rules, predictive modes, classifiers, etc. to identify potential PTSD patients and automatically register them in a Disease Registry

RDF Pipeline



Cohort Management Portal

Cohort Identification Service

Welcome Frank Smith | Log Out | Account | SiteMap | Help

New Identifications | Evaluation Needed | Cohort Members

Cohort | Service | Region | Facility | Predicative Score | Search by first or last name

	Cohort	Last Name	First Name	Service	Region	Facility	Predictive Score
☐	PTSD	An	Ce	Navy	2	Portsmouth	47
☐	PTSD	Ce.	Gi	Army	7	William Beuamont	52
☐	PTSD	Ri.	Ni	Army	11	Madigan	41
☐	PTSD	Sc	Ra	Navy	9	San Diego	87
☐	PTSD	Hu	Non	Air Force	4	Keesler	76
☐	PTSD	Mc	L	Army	3	Eisenhower	81
☐	PTSD	Sa	Ca	Navy	2	Portsmouth	85
☐	PTSD	Sn	Al	Army	7	William Beuamont	73

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First Name: Ce **Last Name:** An **DOB:** May 15, 1969 **Gender:** F **Service:** Navy **Rank:** O6
Address: P.O. Box 604, 7022 Consectetuer Avenue, Carson City, NV, 44789

Classification Schemes Used:
Overall Prediction Score:

Diagnoses | Medications | PCL Scores | Deployments | Alcohol Screenings | Disciplinary Actions

12/29/2013: ICD9-9-CM Diagnosis Code E993.2 - Injury Due To War Operations By; Mortar, AIS Code 116004
12/29/2013: ICD9-9-CM Diagnosis Code 854.0 - Intracranial Injury Of Other And Unspecified Nature Without Mention Of Open Intracranial Wound
01/30/2014: ICD-9-CM: Diagnosis Code 296.2 - Major Depressive Disorder Single Episode

Add To Cohort | Reject | Further Evaluation Needed

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New Identifications | Evaluation Needed | Cohort Members

Cohort | Service | Region | Facility | Status | Search by first or last name

	Cohort	Last Name	First Name	Service	Region	Facility	Status
☐	PTSD	Pu	Em	Army	7	William Beuamont	Tasks Due
☐	PTSD	He	Ve	Marines	9	Camp Pendleton	Up To Date
☐	PTSD	Be	Ra	Air Force	4	Keesler	Tasks Due
☐	PTSD	Fo	Al	Army	3	Eisenhower	Up To Date
☐	Asthma	Ch	An	Air Force	4	Keesler	Tasks Due
☐	Asthma	Mc	T	Army	7	William Beuamont	Tasks Due
☐	Asthma	Ch	Mo	Army	11	Madigan	Up To Date
☐	Asthma	Ri	Ja	Navy	9	San Diego	Tasks Due

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First Name: Ra **Last Name:** Be **DOB:** Jan 19, 1992 **Gender:** M **Service:** Air Force **Rank:** E6
Address: 473-7052 Est, Street, Bangor, ME, 25936 **Overall Prediction Score:**

Email | Alert

Notes
05/29/2014
05/26/2014
05/20/2014
Add

Memo text
This patient expressed feeling significantly anxious during my assessment interview. I sent an email to his primary care physician Dr. Fitzgerald May 26, but have yet to hear back. If we don't get a reply by June 6th, would recommend we assign a case worker to ensure appropriate follow-up. - Karen Brown

Providers
Dr. Richard Fitzgerald - Internal Medicine
Dr. Randy Hutchinson -
Email | Alert

Appointments

Archive | Suspend | Activate

Resource Management & Capacity Planning

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- What resource requirements do a given cohort of PTSD patients require?
- Does the enterprise/local facility/community have sufficient capacity for the anticipated demand?
- What-if scenarios
- Prototypes demonstrate that RDF is viable: enables data federation, data structure/semantic normalization, and data transformation to feed a massive scale-out Hadoop cluster that supports real-time CDS as well as ad hoc reporting and enterprise analytics

QUESTIONS

"Medically Ready Force . . . Ready Medical Force"

Evaluations

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Please complete your evaluations

Contact Information

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This is Your DHA …..

Thank You For All Your Efforts!

"Medically Ready Force . . . Ready Medical Force"