VA HEALTH CARE Defining EXCELLENCE in the 21st Century

Linked VISTA

A Metadata-Centric Approach to VA Master Data Management

February 24, 2015
Pacific Joint Information Technology Center
Maui, HI

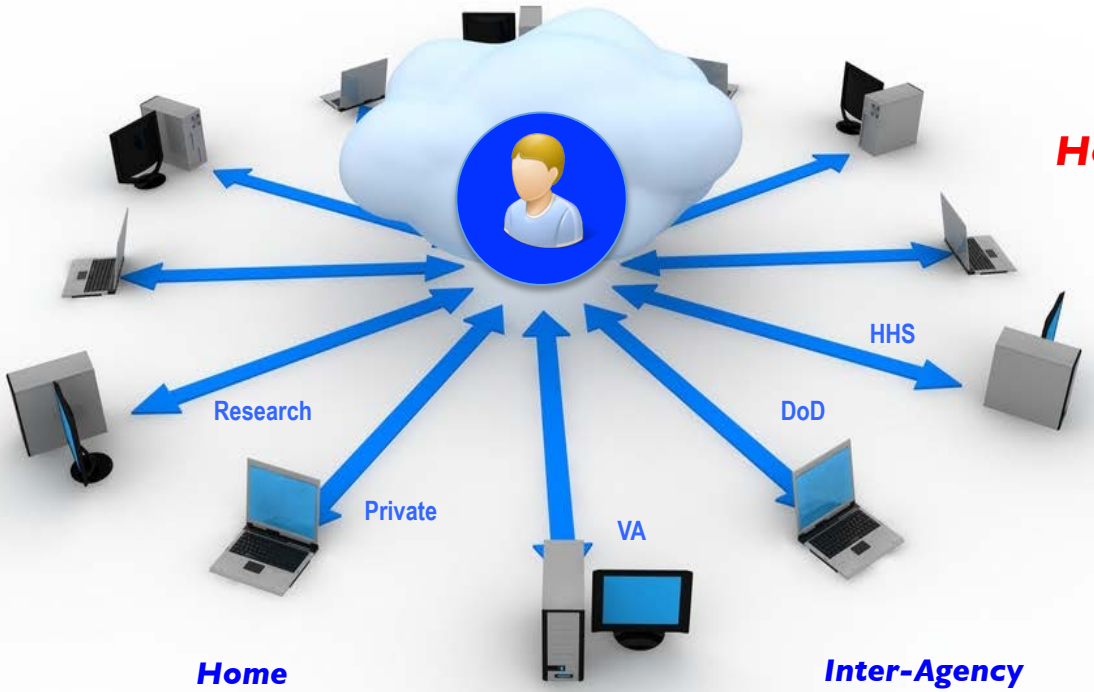
Rafael Richards MD MS

VHA Office of Informatics and Analytics
U.S. Department of Veterans Affairs

Vision: Linked VISTA

A Linked Data Approach to Patient-Centric Care

One Patient.
All Data.
Secure.
Accessible.
Integrated.
Web-scale.

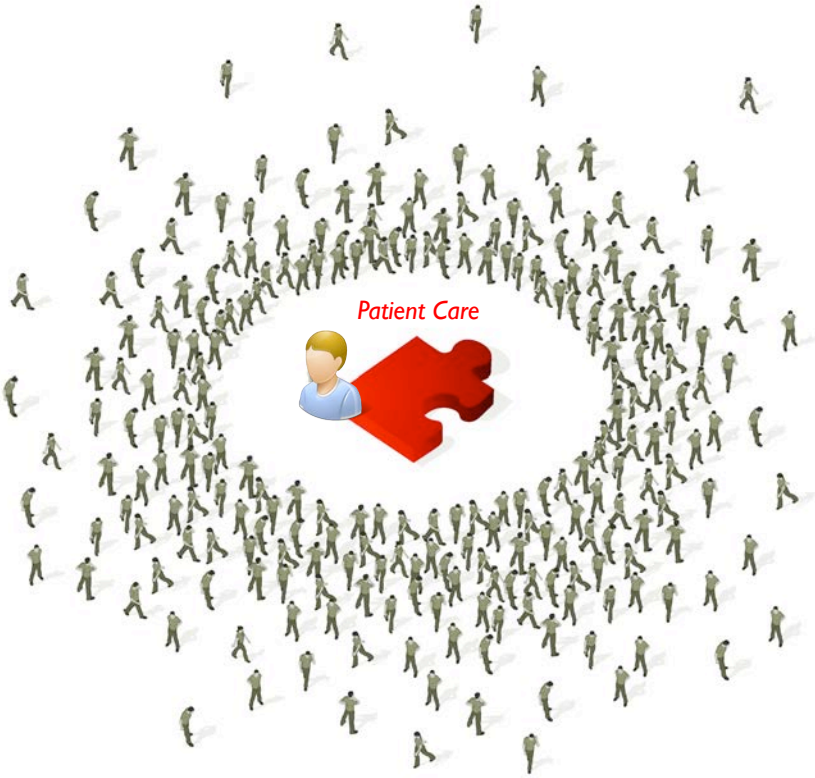


How do we get here?

Collaboration

Required to solve real world problems

VA



DoD

Common goals

Common vision

PJITC

Pacific Joint Information Technology Center (PJITC)

Mission:

"To rapidly research, test, and develop medical solutions and products, through pilots or prototypes that provide mission critical value and actionable information to the Department of Defense, including the Services and the Department of Veterans Affairs.

"…Supporting the MHS' medical readiness requirements and IT modernization needs across the continuum of care through ***rapid prototyping and advanced concept development****".*

About PJITC:

Pacific JITC provides research and development activities with the goal of improving quality of services primarily within the federal healthcare sector. The Pacific JITC offers a full suite of services that support systems research, prototyping, development, and testing. The goal of every project within the PJITC is to efficiently develop and transition value added services and solutions to the customer's organization.

This is primarily accomplished by leveraging PJITC's Integrated Test and Evaluation Center (ITEC), the first DoD/VA integrated lab where critical systems are virtualized. The ITEC provides an agile computing environment that supports military health and interagency research, development, testing, and evaluation missions.

PJITC: DoD-VA Collaboration Areas

Common data management needs:

Future-proofing federal health data
Enterprise view of patient data across all systems
Enterprise shared data model across systems
Inter-agency shared data models

Common data management technology:

Systems derived from DHCP
*DBMS remains identical across all systems**

Intermediate-range goals:

DoD: data migration (DHMSM)
VA: master data management (OneVA)

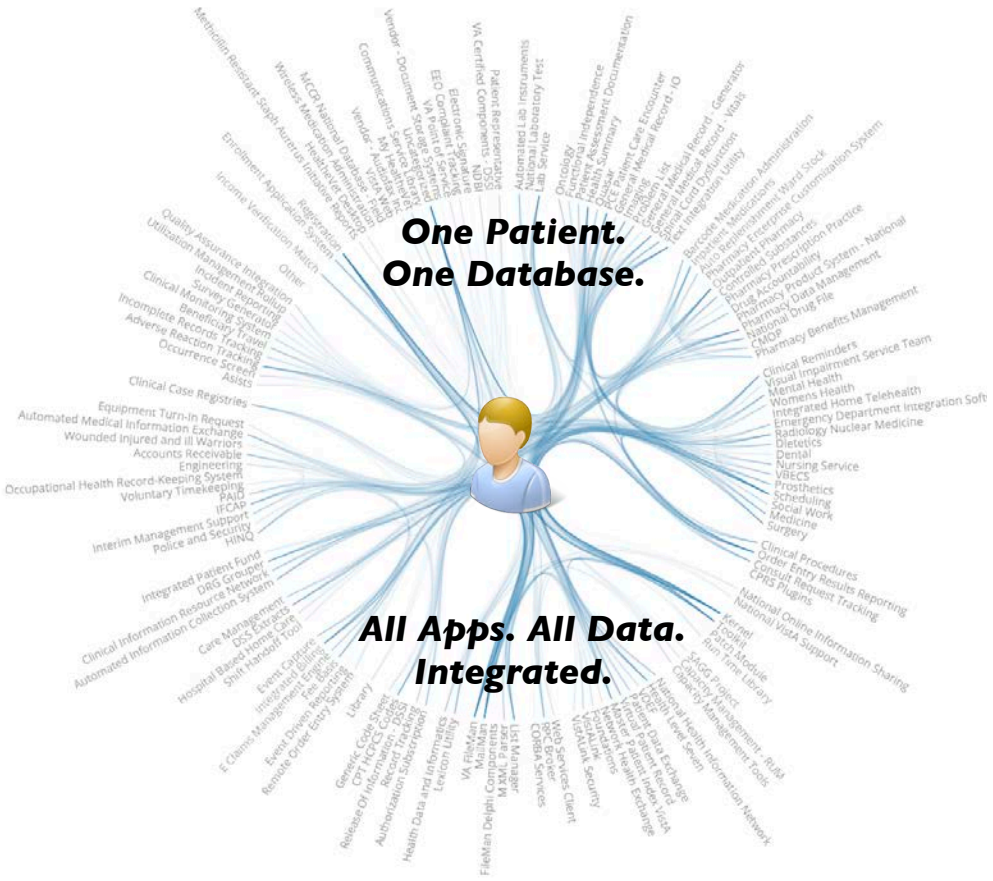
There are over 230 DHCP-based systems deployed throughout VA and DoD as of 2015. While all have been locally modified at the application layer over the years, they remain ***identical in design and function at the database management layer.*** Therefore, the largest lever arm that exists to collaboratively manage, modernize, standardize, or migrate the data between VA and DoD systems is through this common, core database management layer. This will be discussed in the context of the VA VISTA systems in this review, but is applicable equally to all DoD CHCS systems.

VISTA Overview

- *VISTA Architecture: Single-integrated EHR*
- *VA Enterprise: One Patient. Many VISTAs*
- *Problem: Isolated VISTAs. Fragmented data.*
- *Approach: Linked VISTAs.*
- *Vision: OneVA.*

VISTA Architecture: Single-integrated EHR

A Patient-Centric Single integrated EHR



Patient-centric Health Record

The data architecture of VISTA consists of over 160 modules for clinical care integrated within a single common multidimensional data engine (MDE).

In VISTA, both business logic (Applications) and data (Database) are managed within the multidimensional data engine. This provides the tight integration of applications to data, and to a single common integrated database.

The integration between VISTA applications (outer ring) and shared data (inner circle) is visualized, showing the shared data flow between applications.

VA Enterprise: Many VISTAs

1200 VA healthcare facilities throughout the US
Supported by 130 VISTA systems

Care coordination for patients within VA requires integration of patient data across all 130 VISTA systems.

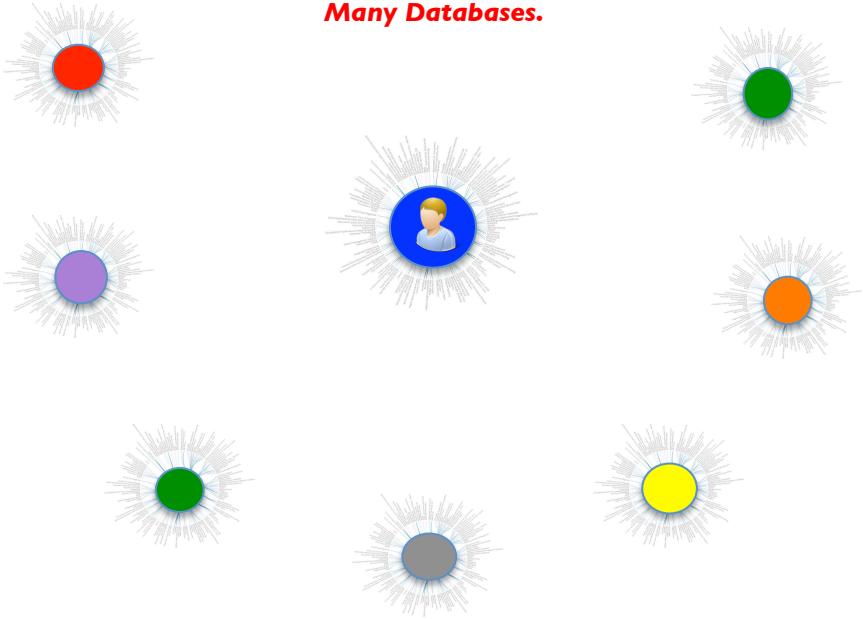
Problem Statement

VA is comprised of 130 unique VISTAs.
This fragments patient data and care.

Problem: Isolated VISTA

VISTA Silos

One Patient.
Many Databases.



Many VISTAs.
Many Models.
Fragmented Data.

While each VA VISTA system is individually highly integrated, each system has its own distinct data model (shown as different color).

Different data models creates data silos – fragmenting patient data and fragmenting patient care.

Approach: Linked VISTA

Exposing VistA's Data Model securely as a Web-standard model enables web-scale integration.

Web-standard Integration requires:

Common Data Model.
Data Security.
Data Services.

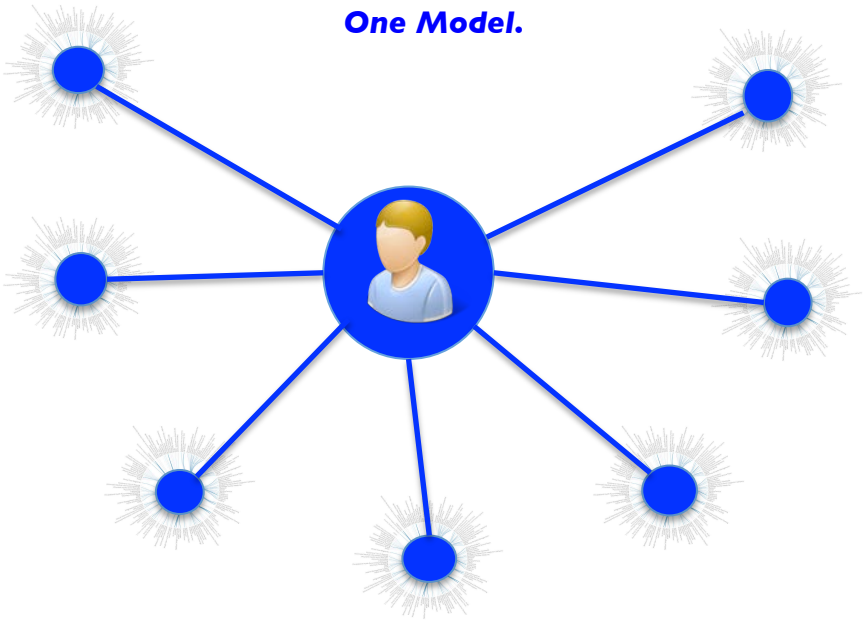
A model-centric approach to VISTA data modernization would provide comprehensive granular, metadata driven access and security to all data.

This would allow publishing, linking, and exchanging, with patient-centric security, granular data with internal and external systems with international Web standards.

Approach: Linked VISTA

Linked VISTA

One Patient.
One Model.



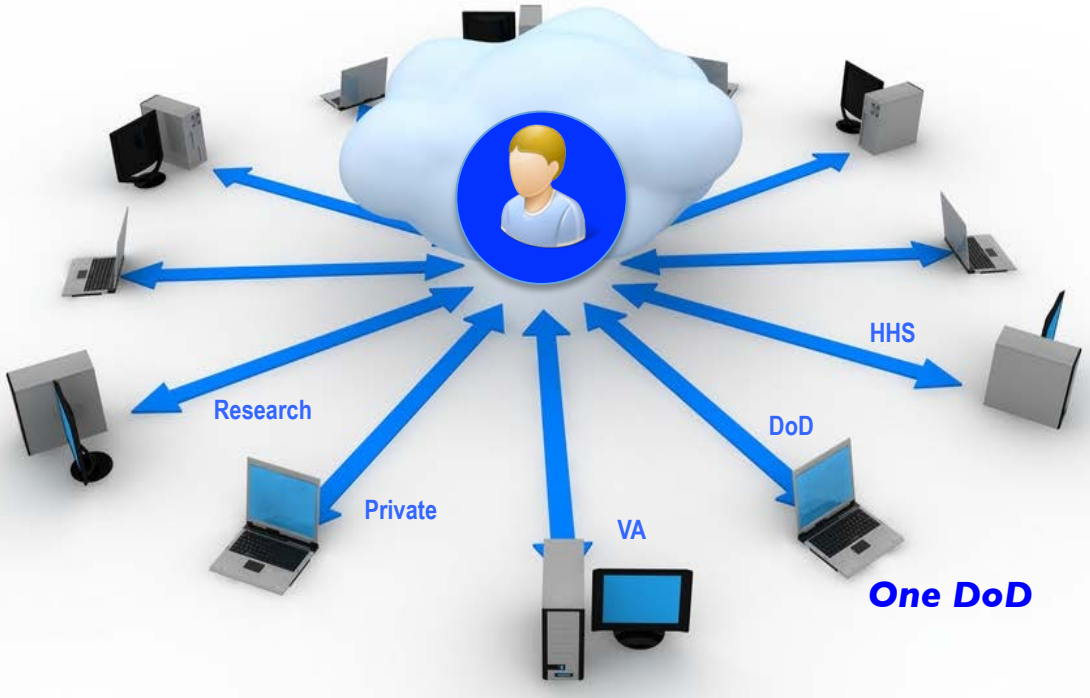
Many VISTAs.
One Model.
Integrated Data.

Exposure and cross-linkage of VISTA's local models to a common VISTA model provides an integrated view of all patient data from all VISTA systems.

OneVA

Vision: ***Linked VISTA***

Web-standards approach to provide Patient-Centric Collaborative Care

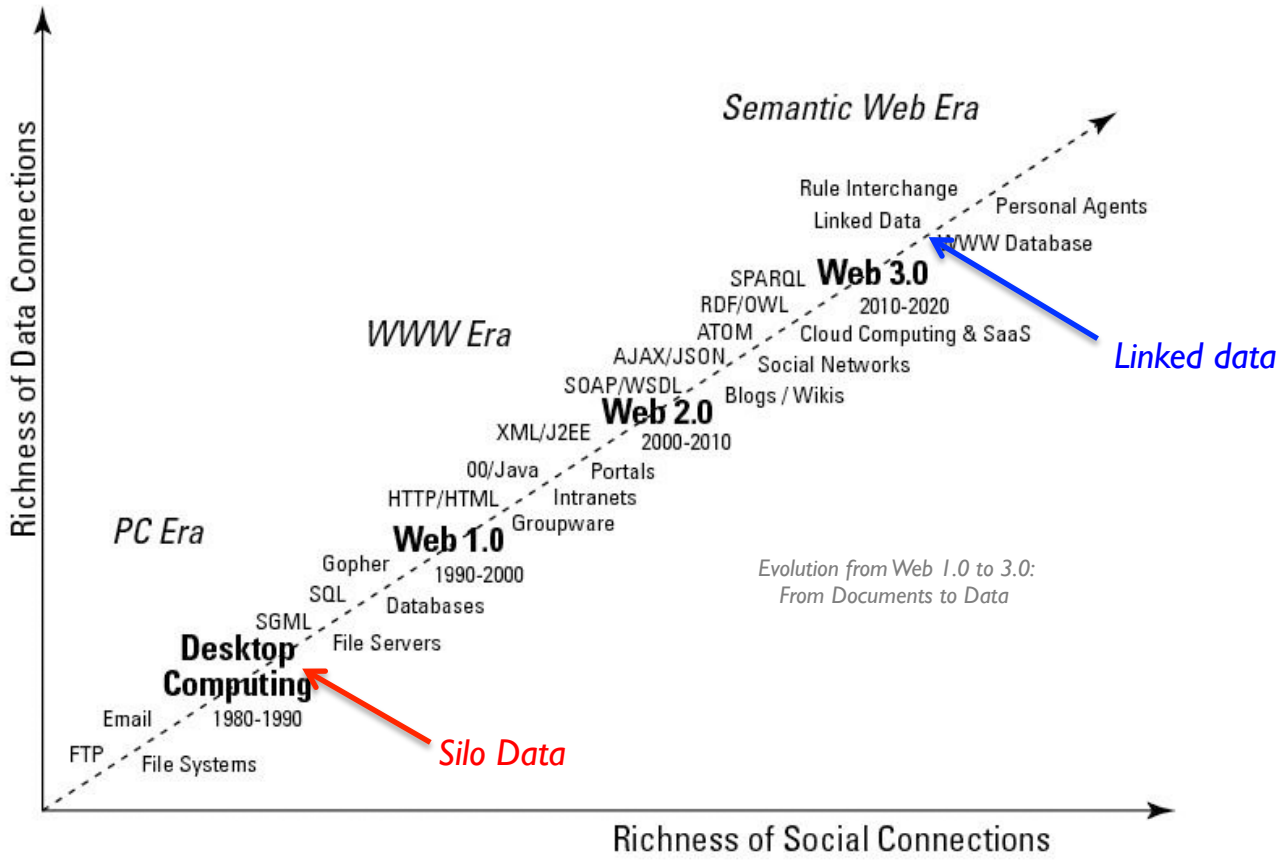


One Patient.
One Model.
Integrated.
Web-scale.

Linked Data

- *Evolution of Computing: Increased connectivity*
- *What is it Linked Data?*
- *What problems does it solve?*
- *Who uses Linked Data?*
- *Health Data: Many diverse models*
- *Linked Data: Accommodates model diversity*
- *Health Data: PCAST Recommendation*

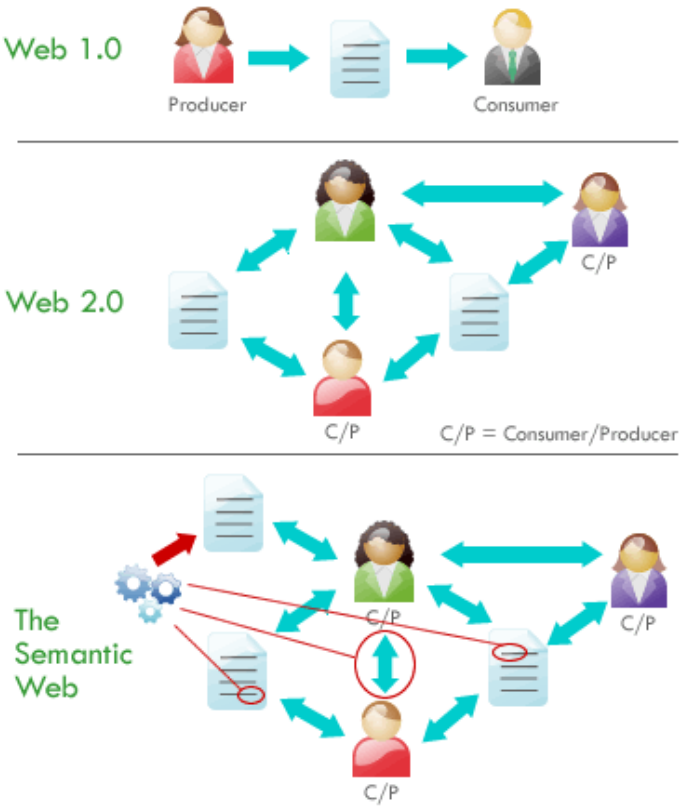
Evolution of Data management: Increased Connectivity



DHCP was officially launched in 1982 and is the foundation of all VA VISTA and DoD CHCS systems.
This was in the early PC Era, before the age of inter-networked data ("the internet"), when databases were isolated inside institutional systems (Silo Data: red arrow). Note that the TCP/IP internet protocol had not even been invented at that time. To bring any VISTA system into today's WWW Era, allowing data to be linked to all VISTA systems within VA enterprise (or to any CHCS system in DoD), VISTA needs be web data-standards capable. This would transform VISTA to a WWW Database that could manage Linked Data (blue arrow).

http://en.wikipedia.org/wiki/History_of_the_Internet
http://paanchiweb.blogspot.com/2012/12/getting-essence-of-semantic-web.html

Evolution of the Web: ***From Documents to Data***



Web 1.0: Document Web (HTML)
Linked Documents
Read-only web (**humans** only)

Web 2.0: Social Web
Linked People
Read-write web (**humans** only)

Web 3.0: Semantic Web (RDF)
Linked Data
Read-write web (**machine processable**)

http://tomgruber.org/writing/CollectiveKnowledgeSystems.htm

Linked Data: ***What is it?***

The World Wide Web (W3C) Standard for semantic information integration

HTML (hypertext markup language)
For **humans** to exchange information

enables → **Linked Documents** (Document Web)

RDF (resource description framework)
For **computers** to exchange information

enables → **Linked Data** (Semantic Web)

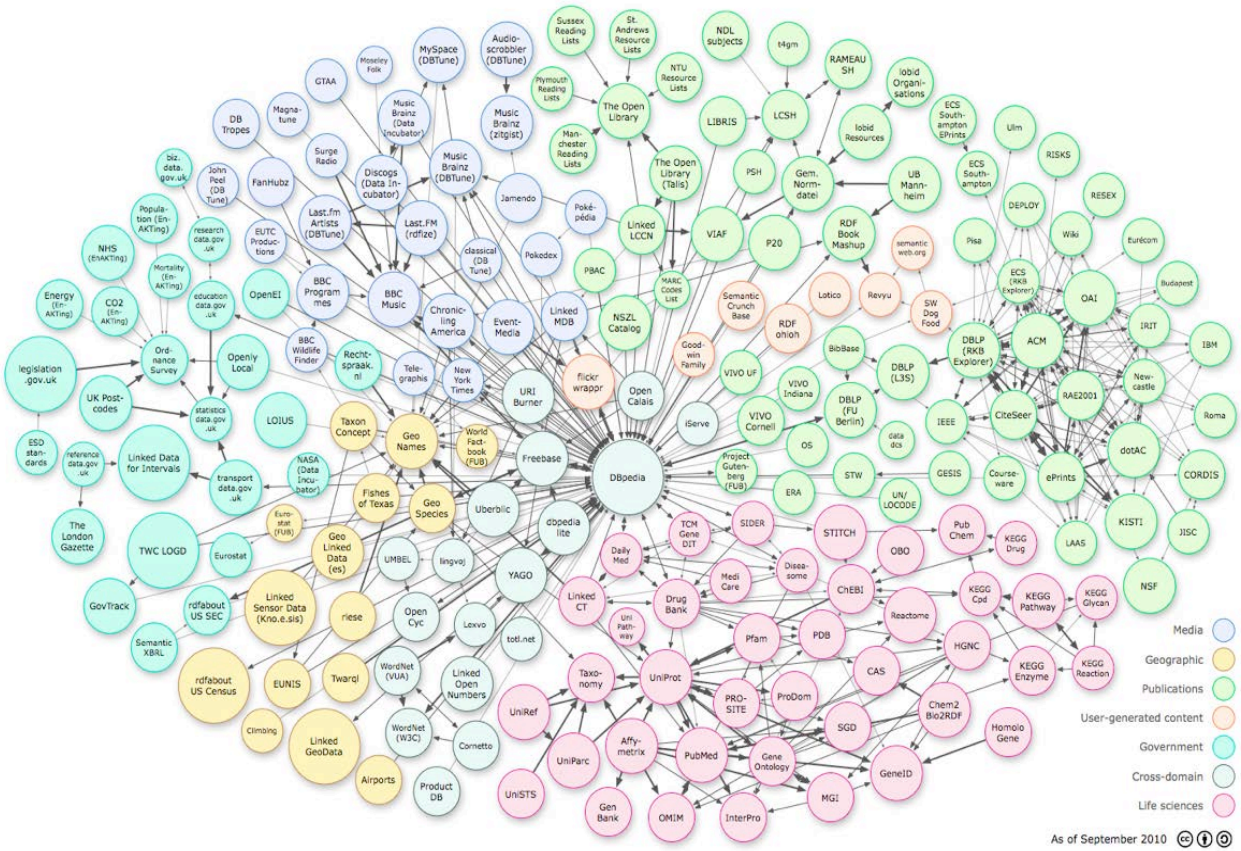
"The Semantic Web [Linked Data] provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries."

Tim Berners-Lee, MIT Professor and Inventor of the World Wide Web

As a W3C standard this supports Internet-scale data integration.

Linked Data: What does it enable?

Web-scale semantic integration of data



Linked Data

This figure shows the Linked Open Data (LOD) cloud, which semantically links hundreds of Linked Data sources including Media, Geographic, Government, and Life Sciences databases.

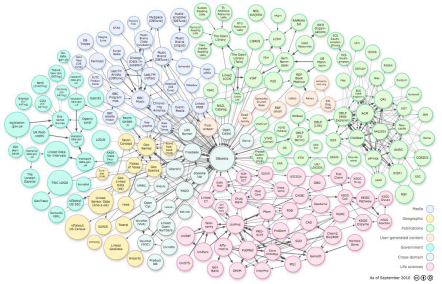
Each circle represents one data source or database. These are semantically linked to other data sources, creating a single virtual federated internet-scale database.

At the center of is DBPedia, the Linked Data version of Wikipedia, which is semantically linked to hundreds of data sources.

Linked Data: ***Who Uses It?***

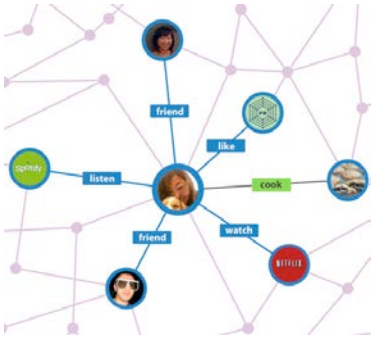
The Linked Data approach to ***Internet-scale semantic data integration*** *is used by the worlds largest organizations such as Google, LinkedIn, Facebook, and IBM Watson.*

Wikipedia (knowledge graph)



IBM Watson (knowledge graph)

LinkedIn (professional graph)



Facebook (social graph)

Google Search (knowledge graph)

Health Data: ***Thousands of diverse models***

The need for Federal Health sector interoperability is not limited to the hundreds of systems within the VA and DoD. Over forty percent of all veterans receive care in the Private sector. Therefore, a more general solution is required that can link to the many more systems in the private sector.

The landscape of healthcare information systems is that of thousands of competing models. Every EHR in the US has its own model. Each of the four thousand Meaningful Use Certified products has its own model. Each instance of each EHR, even *from the same vendor or federal agency,* has its own unique model.

The problem is not just in the number and complexity of models, but that each of these models is rapidly, continuously, and independently changing in response to the rapid growth of healthcare knowledge, drugs, devices, treatments, regulations, and guidelines.

Healthcare cannot fit into a static or "one-size-fits-all" model. There are simply too many models for this to be feasible, and doing so would stifle model innovation and evolution – which is required to keep pace with the changes in medicine.

We need a universal exchange language that is model-flexible. This would allow the thousands of models to peacefully co-exist, while still evolving in their respective knowledge domains, and allow them to be incrementally reconciled in a free, open "model marketplace". The PCAST Report recommended such a "Universal Exchange Language for Healthcare". ***Linked Data fulfills these requirements.***

Linked Data: ***Accommodates diverse models***

A distinguishing feature of Linked Data that makes it an ideal healthcare exchange language is that it is ***model-flexible***:

1. Allows multiple, diverse models to be used concurrently:

- Semantically interlinked
- Complimentarily, non-exclusive
- Both standard models and many specialized models

2. Enables both model standardization and innovation

- These are not mutually exclusive goals
- Allows simultaneous use of legacy (diverse) operational models while overlaying with a single (standardized) model for enterprise use and external exchange.

Currently there are thousands of unique specialized models in healthcare. Within VA and DoD alone there are hundreds of different systems, each with their own data model. Each of these models needs to independently evolve (innovation), while simultaneously resolving to a common enterprise model (standardization). This may appear a mutually exclusive goal, unless there is flexibility in the model to accommodate both standardization and evolution. This requires an adaptive data model.

Health Data: ***PCAST Recommendations***


REPORT TO THE PRESIDENT
REALIZING THE FULL POTENTIAL OF
HEALTH INFORMATION TECHNOLOGY
TO IMPROVE HEALTHCARE
FOR AMERICANS:
THE PATH FORWARD

Executive Office of the President
President's Council of Advisors
on Science and Technology

"The best way to manage and store data for advanced data analytical techniques is to break data down into the smallest individual pieces that make sense to exchange or aggregate. These individual pieces are called "tagged data elements," because each unit of data is accompanied by a mandatory "*meta data tag*" that describes the attributes, provenance, and required security protections of the data.

The indexing and retrieval of metadata tagged data, across large numbers of geographically diverse locations, is an established, highly developed, technology—the basis of web search engines, for example".

- ***The Presidential Council of Advisors recommends a metadata-driven approach to interoperability.***
- ***Linked Data is the World Wide Web Consortium standard for metadata.***

http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-health-it-report.pdf

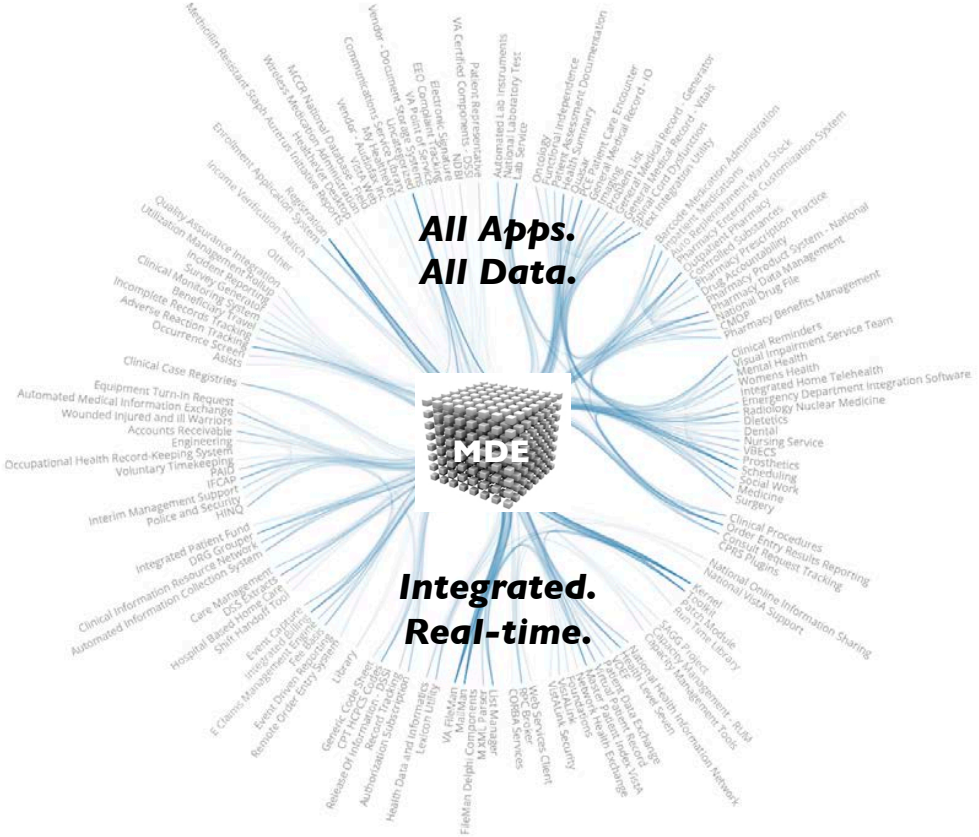
VISTA Data Model (VDM)

A Path to VISTA Data Management:

- VISTA's Database
- VISTA's Data Model
- VISTA's Data Model Exposed
- Benefits of Leveraging VISTA's Data Model:
  - Master Metadata Management
  - Centralized Knowledge Management
  - Master Data Definition
  - Patient-Centric Security Model
  - Separating Business logic from Data
  - Query Access

Review: VISTA's Database

The foundation of VISTA is a high performance Multidimensional Data-integrated Application Engine in which all data and all applications are fully integrated in real-time with each other and to one single authoritative data source.



VISTA's integrated application data engine. *All 160+ applications are integrated with their data and logic inside the multidimensional data engine (MDE). This keeps transactional patient data and logic highly integrated for real-time use within one single data store.*

VA uses the same healthcare industry-standard data engine that nearly 50% of hospitals in the US currently use as their core EHR database.

This same multidimensional data engine is also used as the real-time transaction engine of the world's five largest banks, the largest Wall Street trading systems, and over half a million ATMs in North America.

Review: VISTA's Data Model (VDM)

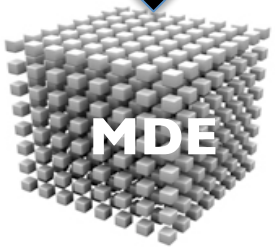
All real-time transactional operations in VISTA take place within the the multidimensional data engine (MDE). To provide consistent structure and model for the data, a data dictionary driven hierarchical data storage system is overlaid on top of the MDE. All VISTA applications read and write data to this hierarchical store using a file manager called Fileman.

File Manager

Hierarchical Graph Store

This layer provides the data structures, data models, and data management for VISTA. Fileman is the DBMS for this hierarchical store.

Apps Data

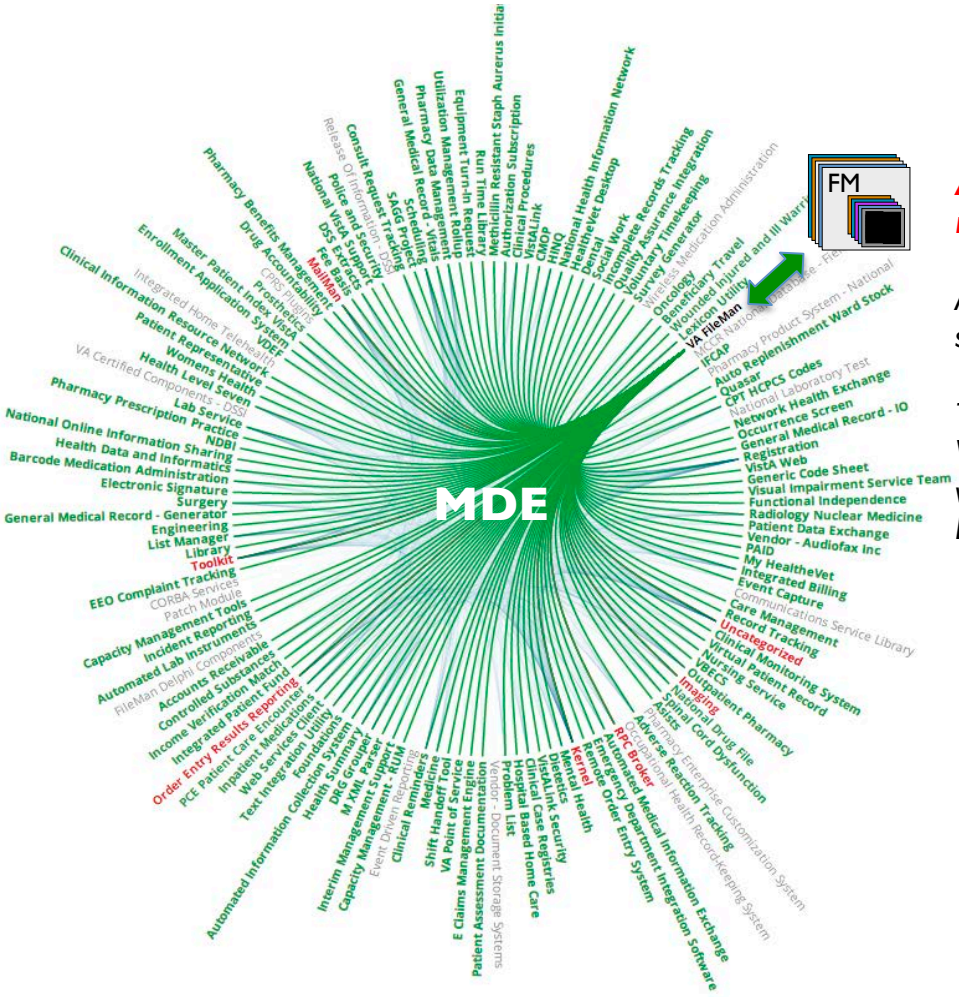


Multidimensional Data Engine

This is the data-structure flexible transactional core of VISTA. This core is a healthcare industry-standard for nearly 50% of the hospitals in the US. This is also used as the real-time transactions engine of the world's five largest banks, the largest Wall Street trading systems, and over half a million ATMs in North America.

Review: VISTA's Data Model (VDM)

All VISTA applications read and write data to VISTA's data engine through the NoSQL hierarchical data manager, Fileman (FM). Unlike many NoSQL databases, VISTA's database is not schema-less, but schema-driven. VISTA's schema is self-documenting through data dictionaries in Fileman. *Surprisingly, this fact has not yet been leveraged to expose and modernize the data model.*



All VISTA data is organized through its data model, managed by Fileman.

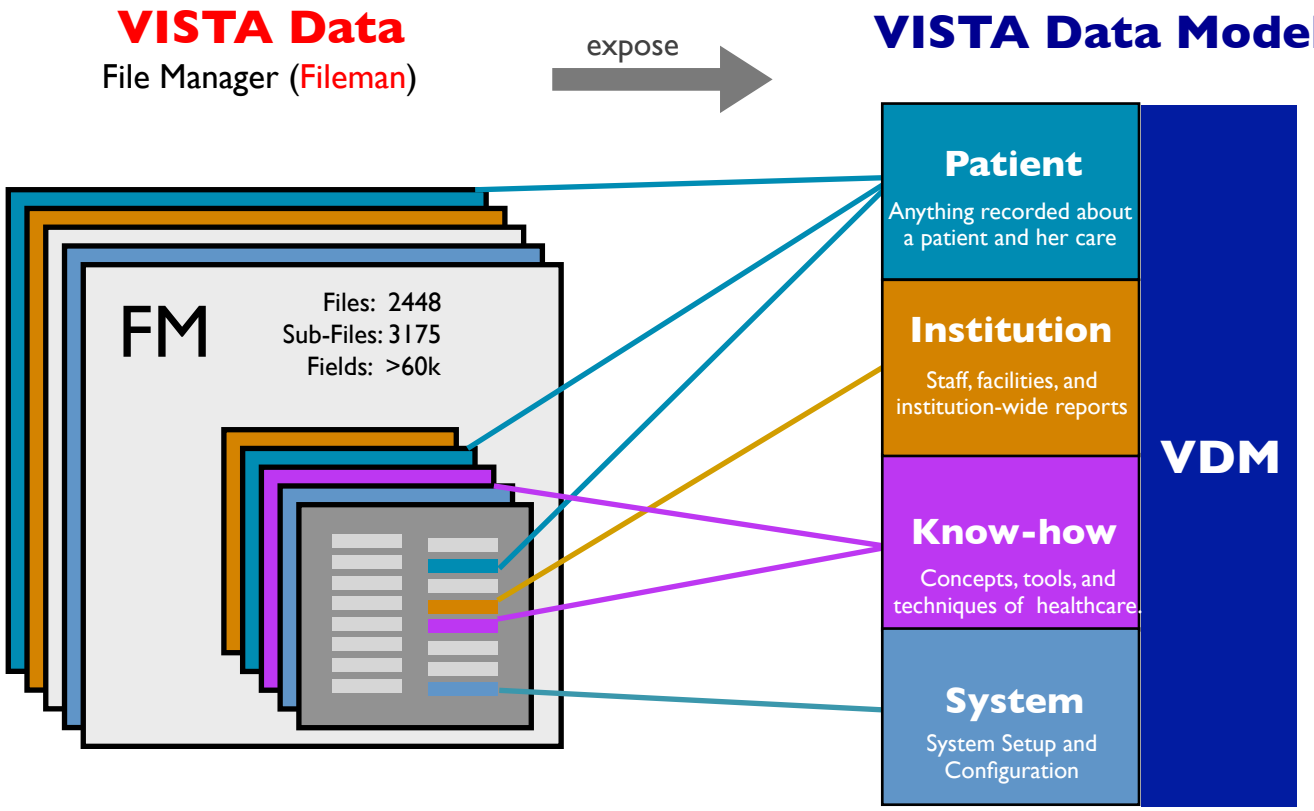
All VistA applications use Fileman to access, structure, and query all data in VistA.

The green lines represent the data flow of all VISTA application to Fileman for all read and write operations to the Multidimensional Data Engine (MDE).

Reference: code.osehra.org/vivian

VDM: Expose and Leverage the Model

The first stage of data modernization is to expose and leverage VISTA's real, live operational data model. Since this is just metadata, there is no patient data involved. Unlike many NoSQL databases which are schema-less, VISTA's NoSQL database model is self-documenting through Fileman. This allows us to render this in a standard definition format. In this new web-standard medium, data can be sorted, tagged, searched, and organized by data categories such as by patient, institution, know-how, or system information.



Access: Thousands of RPCs, API's, HL7
Model: Unknown

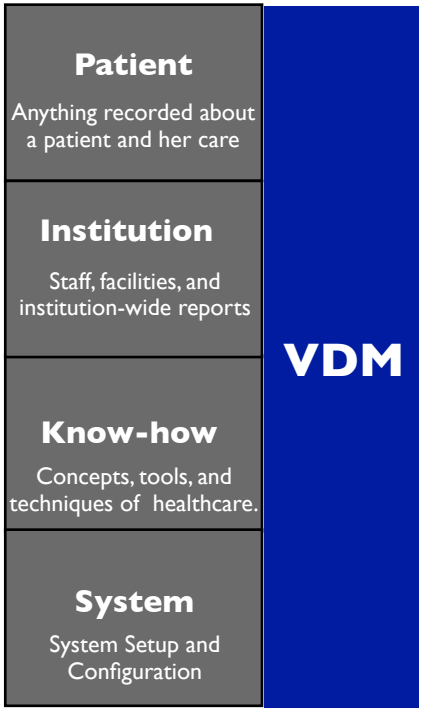
Access: Single query access
Model: Consistent, Transparent

VDM: Master Data Management

A benefit of a VISTA data model allows one to manage data logically across all VISTA application boundaries independent of the source of the data. This lets one manage data with much flexibility, including logically partitioning and managing the data using metadata tagged categories (such as Patient, Institution, Know-how, and Systems information).

- ***One may logically partition data by any class of data***, such as Patient data, Institution data, re-usable Know-how, and System configuration data.
- ***One may extract and move <u>all</u> patient data from system to system with one operation***, making system configuration migration and patient record movement far more efficient.
- ***One may apply security metadata or protocols to any of these logical classes*** of data. For example a patient-centric security model for patient data, and thus enforce patient-centric controls on information exchanged.

VISTA Data Model



Benefits:

Patient Data Management
Extract and manage patient data with patient-specific security and metadata, allowing patient-centric controls on data access and exchange.

Institutional Data Management:
Institution specific data can be exchangeable and centrally manageable

Knowledge Management:
Common medical concepts, standards, and know-how may be identified and managed as a clearly defined class of VISTA data.

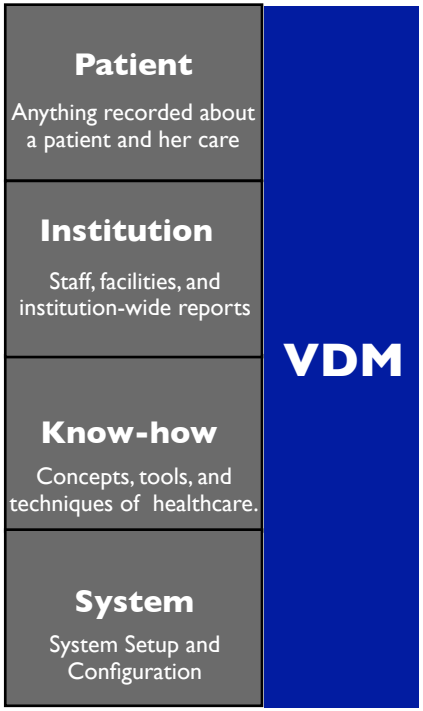
System Management:
The entire configuration of a system can be identified, extracted, and transported, and inserted from system to system

VDM: Patient-Centric Data Security

An exposed VISTA data model allows one to tag and partition certain classes of data separately from all other data in VistA. Specifically, this allows one to granularly partition any and all Patient data from all other kinds of data in VistA. This provides true, direct, "on the metal" security on patient data itself.

VISTA Data Model

- *The most important class of data to apply security is the Patient data category. This will allow very granular patient-centric security on the data itself.*
- *Current VISTA security is based on actions one can take using a legacy menu system - which has no relationship to the data.*
- *With a data-centric security model, we can specify not just what type of data ("Mental Health Record"…) but whose data ("For patient X").*
- *This is much more specific and secure than the prior VistA security model.*



Patient-centric security model

Extract and manage patient data with patient-specific security and metadata, allowing patient-centric controls on data access and exchange.

This is compatible with security notions in Meaningful use Data Exchange: it can suppress even data that exists if there is no access permission.

It is essential to improve precision in data security to permit access to VISTA data securely. Otherwise one will have to reverse-engineer 3300 legacy RPCs and their one-off use of Kernel's menu options for each payload.

A patient-centric security model is much more appropriate, flexible, and secure as a foundation for patient data security than the current VistA security model. The current VistA security model provides security only indirectly, through legacy controls of a menu system for a legacy roll and scroll terminal interface – which has nothing to do with the type of data at all (!).

VDM: Analytics Driving Interoperability

Comprehensive exposure and analytics of the VISTA Data Model will drive enhanced data use and interoperability as well as a major improvement in the structure of the database itself. To address these and other areas, focused reports could be generated from the model including:

Report	Activity	
Inconsistencies between VistA data models	Drive dictionary and code fixes in various centers so that every center is running the same consistent model	→ **Enterprise Data Model**
Isolate centrally and locally managed "know-how"	Enables the next generation of enterprise knowledge services that seamlessly synchronize VistAs and other applications	→ Centralized Knowledge Management
Under-definition in the model	Too many ill-defined string values and not enough nuance ("zip code", "telephone number") can be defined, and provided additional metadata ("home", "work", "mobile") leading to a plan for incremental dictionary improvement	→ **Enterprise Data Definition**
Key logic performed within FileMan	The barrier between the data store and business logic will be laid bare. This report will encourage the movement of certain types of logic into FileMan and out of less maintainable procedural code.	→ Clean separation of business logic from data
Overlooked but highly valuable types of patient data (Some of this may have been hard-set by the application logic, and overlooked by Fileman or DD)	Improve VistA Data mining (for CDW etc.) and interoperability (more comprehensive electronic patient records). Without a complete model, how do you know what you're leaving behind?	→ Clinical Research → **Interoperability**
VistA model/ FHIR comparison (key types)	Show how a direct from VistA transformation can remove the need for redundant intermediate, hard to maintain procedural code	→ Accelerate Data Exchange
Isolate patient from other types of data	Enable patient-data access control rather than the crude option/API security now in VistA	→ **Patient-centric Security Model**

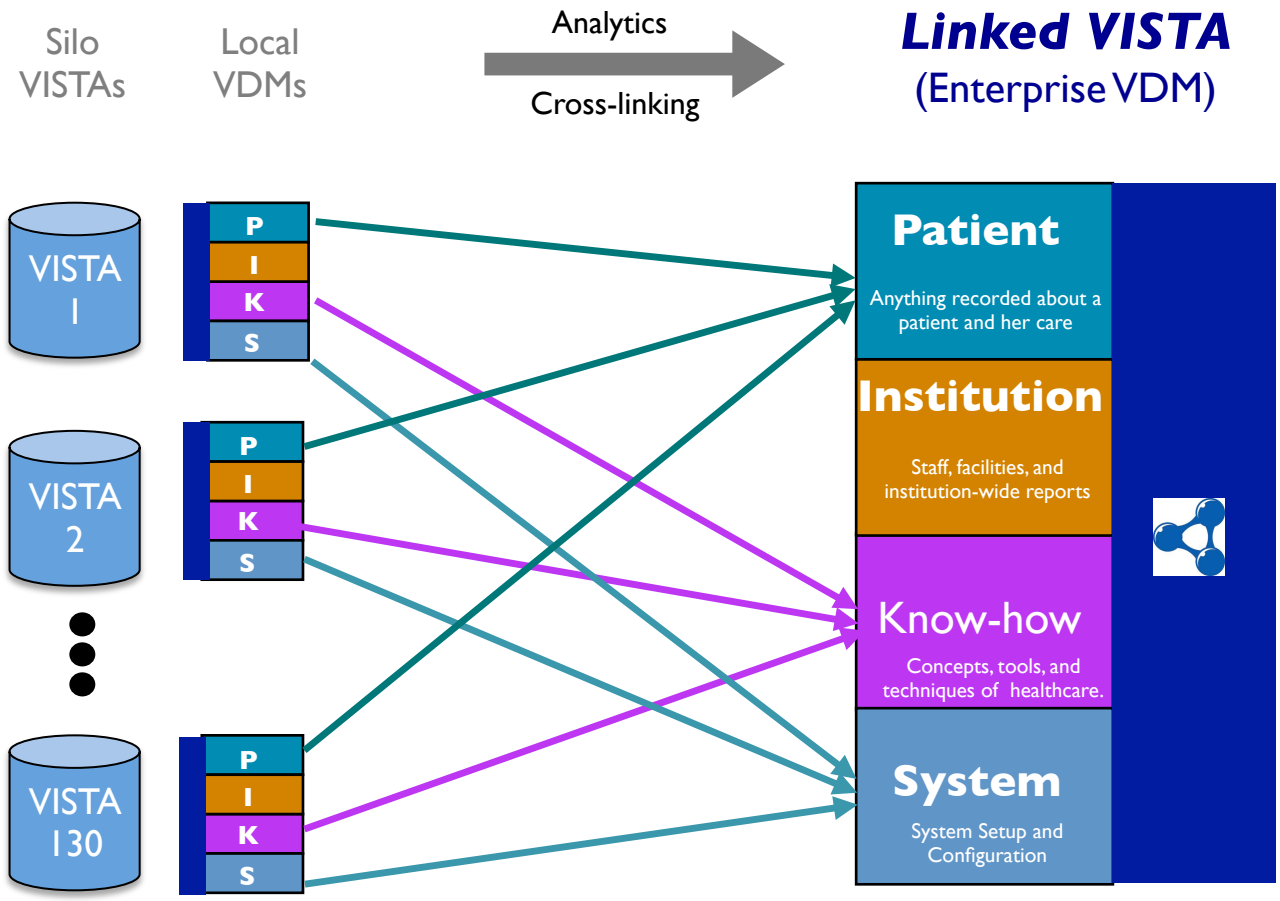
Linked VISTA

Features

- *Enterprise Cross-linked VISTA Model*
- *Comprehensive Data Access*
- *Web-standard representation language*
- *Web-scale semantic integration*
- *Knowledge Discovery*
- *Native terminology integration*

Linked VISTA: The Enterprise Cross-Linked VISTA Data Model

Exposing VistA's Data Model (VDM) and applying analytics allows one to cross-link all local VDMs to an enterprise VISTA data model (Linked VDM), providing the capability for Enterprise query and Enterprise data management. This leverages the capability of Linked Data to create a cross-VISTA (enterprise) data model.



Patient Data Management
Extract and manage patient data with patient-specific security and metadata, allowing patient-centric controls on data access and exchange.

Institutional Data Management:
Institution specific data can be exchangeable and centrally manageable

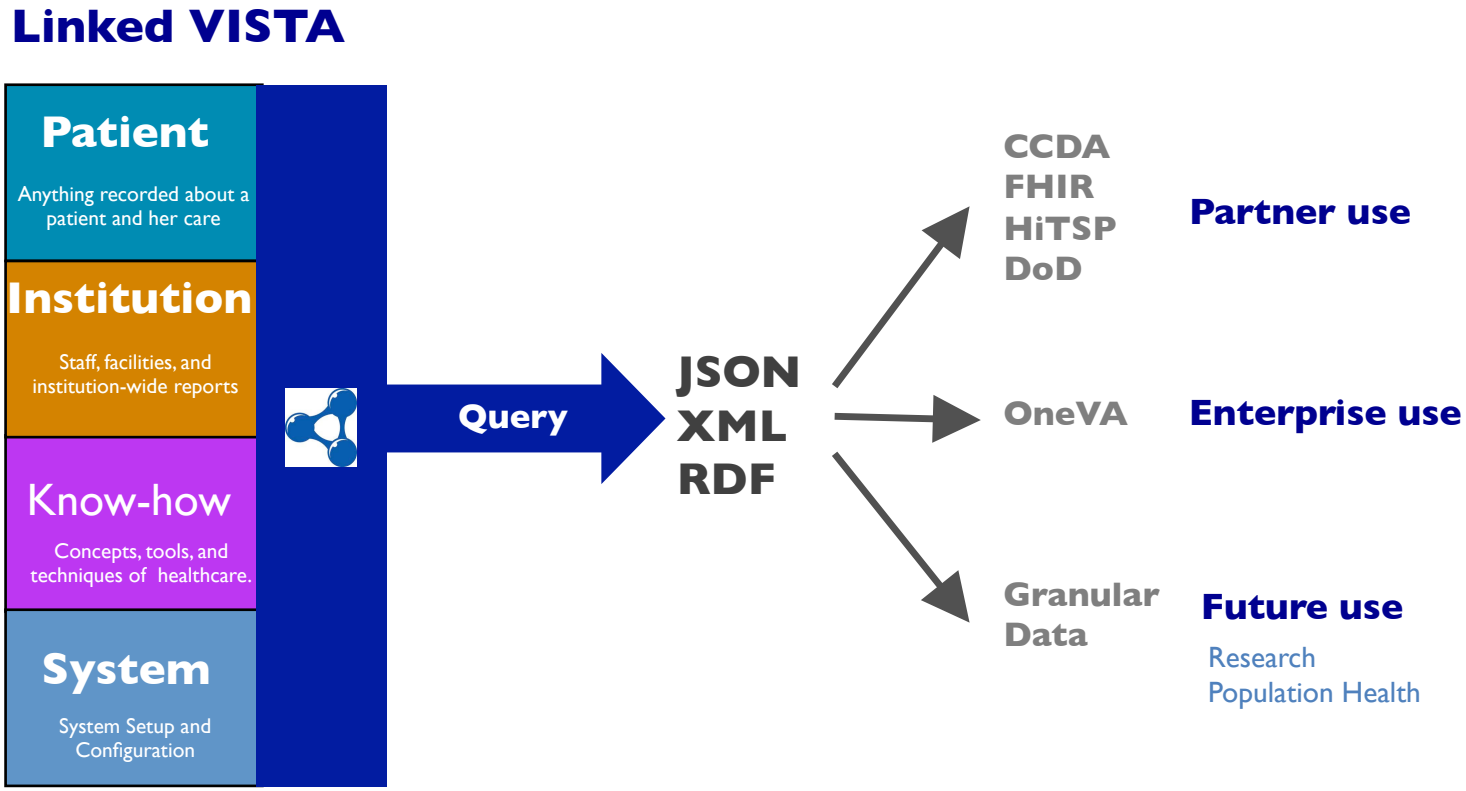
Knowledge Management:
Common medical concepts, standards, and know-how may be identified and managed as a clearly defined class of VISTA data.

Configuration Management:
The entire configuration of a system can be identified, extracted, and transported, and inserted from system to system

Linked VISTA: ***Comprehensive Access***

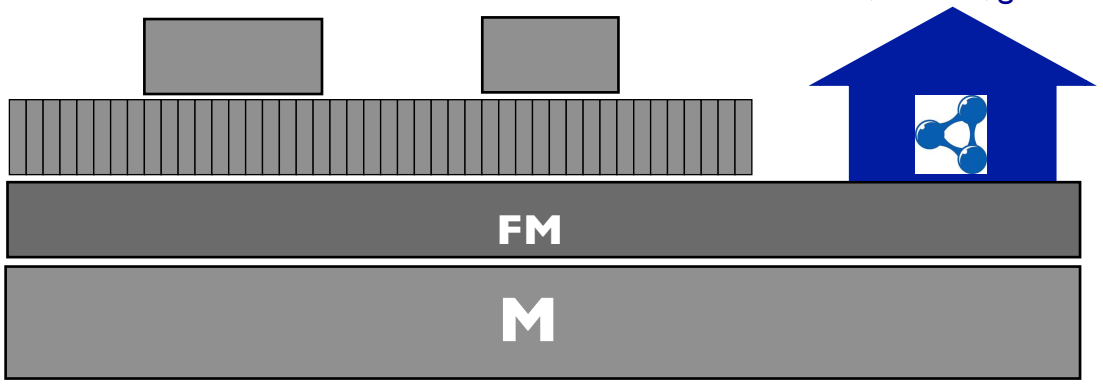
One benefit of creating a cross-VISTA enterprise data model (Linked VISTA) is that it can be queried against any VISTA for any data with with one web-standard query.

This would allow any authorized system to securely and directly query authoritative VISTA data in real-time with one standard query language. The output of these queries will be in all modern web-standard forms to maximize secondary use.



Linked VISTA: Comprehensive Access

	CPRS	JLV	Linked VISTA
View	Delphi	HTML	HTML
Controller	Delphi	java	Web service
Model	Undefined	MDWS	**Full VISTA Model**
Format	Ad-hoc	Ad-hoc	XML JSON RDF
Method	RPC	RPC	Query
VISTA Data	Fixed slices	Fixed slices	Full, flexible, granular

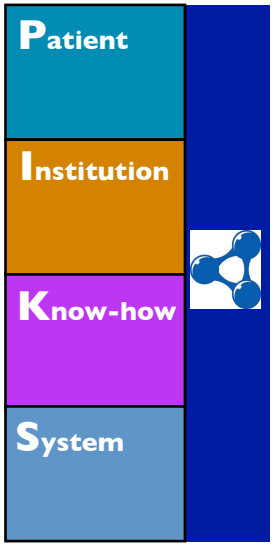


VISTA Data Model (VDM) can access all data spanning 160+ applications with full granularity because the fully exposed VISTA Data model bridges all applications. No legacy APIs, HL7, RPCs, or MUMPS. Just VISTA data. All of it. Real-time.

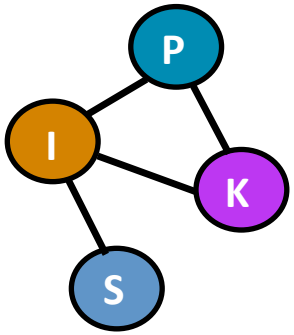
Linked VISTA: ***Web-standard Representation***

Use of web-standard representation maximizes data re-use, meshing, and re-mixing with the maximum number of other sources of data for research and patient care.

Linked VistA



published



Same As

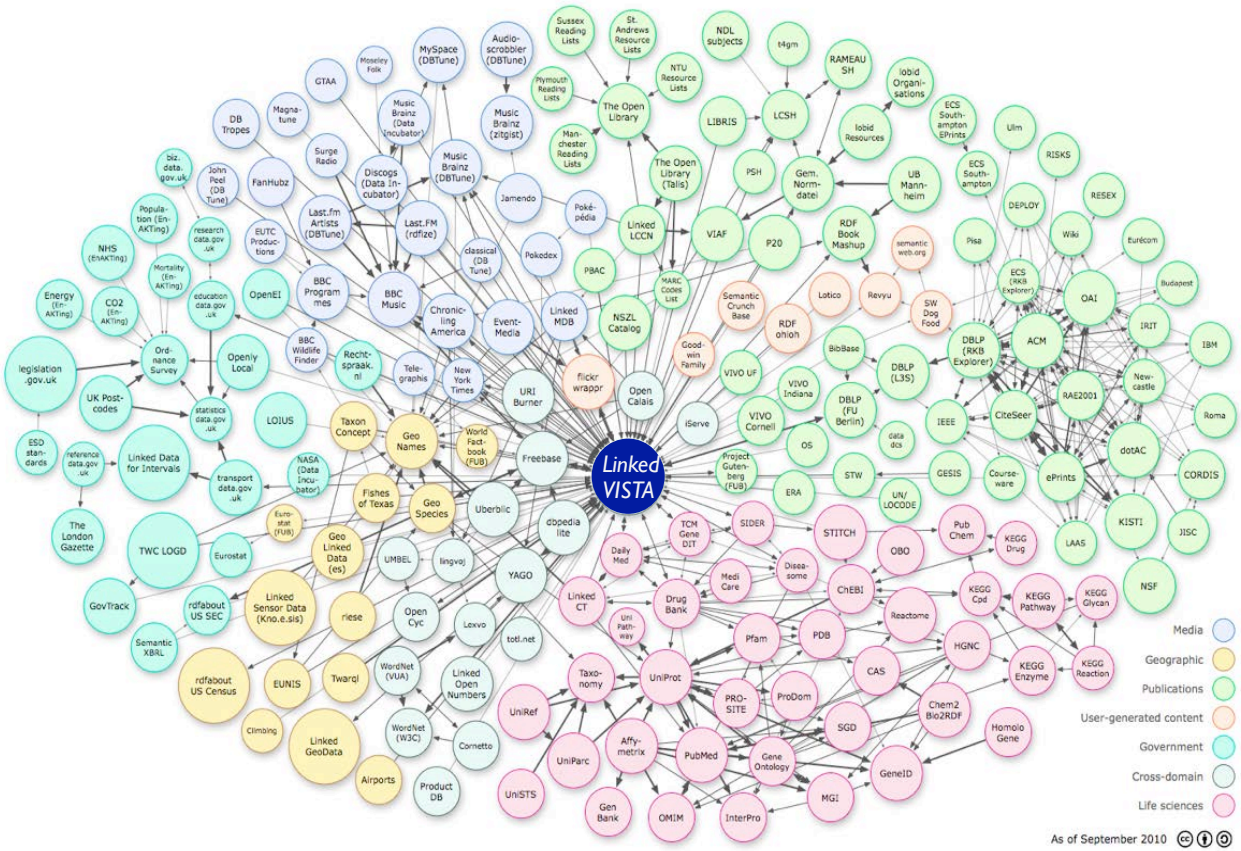
=

Linked Data

Granular
Data-atomic
Meta-data tagged
URI-based
Model-based
Linkable
Web Standard

Linked VISTA: Internet-scale semantic integration

Representing VistA data in a Linked Data form supports real-time semantic integration with thousands of other other linked sources.



Linked VistA

VistA Data - represented in standard Linked Data form - can be interlinked with any and all other Linked Data sources.

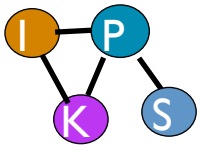
This will enable *meshing, enrichment, and augmentation of patient data with all other sources, providing a comprehensive view of all patient data from all locations, clinics, hospitals, or the home.*

Data sources also include patient-generated, mobile device, TeleHealth, and any other Internet-enabled device data (Internet of Things).

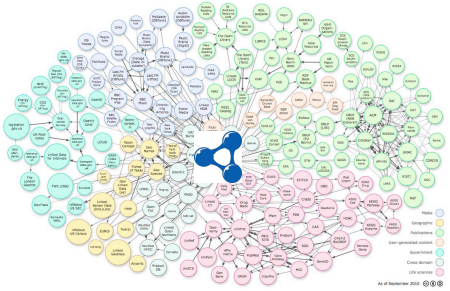
Linked VISTA: ***New Knowledge Discovery***

Linked VISTA can participate in federated queries over unlimited number of other Linked Data sources, enabling meshing, enrichment, and ultimately, new knowledge discovery.

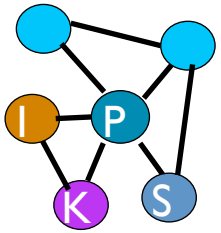
Linked VistA (VistA Model) **+** **Linked Data** (Thousands of sources) **=** **New Knowledge**



+



=



Because data in the VistA Data Model can be represented just like any other Linked Data resources, *one can mesh VistA data directly with unlimited sources of internal or external, public or private life sciences, and other scientific or healthcare related data sources.* This leads to discovery of new relationships between different sources of data - and new knowledge.

Linked VistA: Native integration to terminology

One can merge VistA data directly with any terminology published in Linked Data form.

Linked Data (RDF) + **Linked Terms** (RDF) = **Data-Terms integrated**

All current major healthcare terminologies including SNOMED, ICD-10, ICD-11, LOINC, RxNORM, and over 350 other terminologies (ontologies) at Bioportal.org are represented as RDF.

VA-DoD Use cases

Applications of Linked Data / RDF

- *Mandate: Future-proof data access*
- *DoD: Already operates RDF database*
- *VA: Already approves RDF as model*
- *VA-FHIR*
- *VA-DOD (current)*
- *VA-DOD (future)*
- *Linked VA-DoD: RDF databases are capable*
- *An Achievable Vision*
- *Recommendations*
- *Links!*

Mandate: ***Future-proof Data Access is Required***

Both VA and DoD currently have patient data that is over 35 years old in their core operational health IT systems. This legacy data must be not only universally available today, but available an ***for the lifetime of all patients*** in a form that is computable within each agency, and between both agencies.

Both agencies need to future-proof current and legacy data to meet these Congressional mandates. *This requires* adopting a shared, modern, *model-neutral, internationally recognized, internet-scale standard* for data representation and interoperability.

Linked Data provides such a PCAST-recommended standard.

Mandate: ***Future-proof Data Access is Required***

An Inter-Agency Linked Data strategy would provide:

- ***Defense Health Agency (DHA) a transition strategy for CHCS data*** from all DHA systems to a common model, allowing uniform, standardized data migration in support of **DHMSM**.

- ***Veterans Health Agency (VHA) an enterprise data model for VistA data*** from all VA systems, providing a single view of patient data in support of **OneVA**.

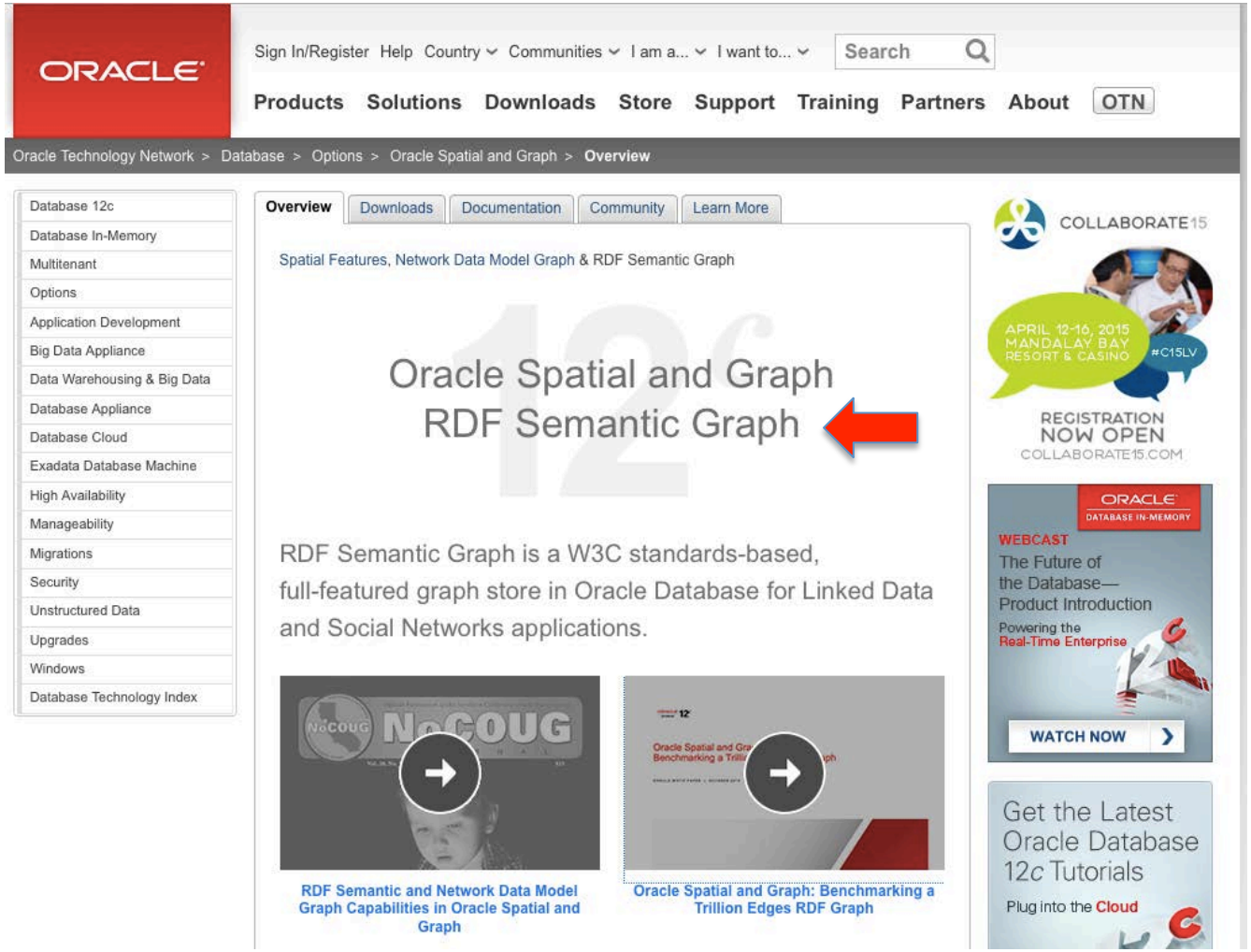
- ***VHA and DHA a future-looking interoperability strategy*** *which will support the* ***continuous change of OneVA and DHMSM systems*** *as all these evolve and change over time.*

Note: DoD has taken the lead in transforming CHCS data to Linked Data at the PJITC lab in the TAPS I project.

VHA: RDF is an approved technical reference model

http://www.va.gov/TRM/StandardPage.asp?tid=6405#

DHA: Operates a Linked Data-capable database



http://www.oracle.com/technetwork/database/options/spatialandgraph/overview/rdfsemantic-graph-1902016.html

Linked VHA-DHA: ***RDF Databases are capable***

ORACLE DATABASE 12c

Oracle Spatial and Graph: Benchmarking a Trillion Edges RDF Graph

ORACLE WHITE PAPER | OCTOBER 2014

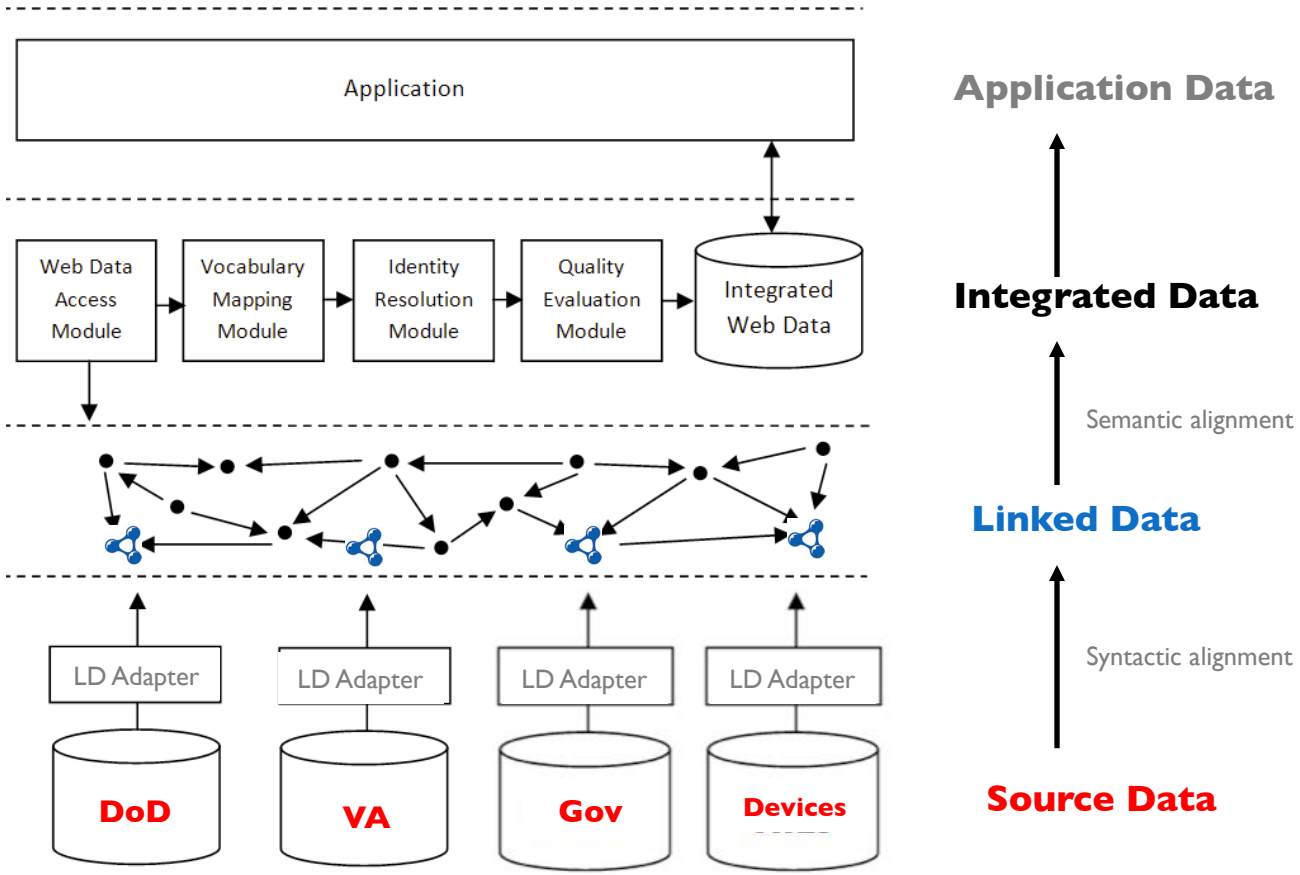
One trillion is a really big number. What could you store with one trillion facts?

- 1000 tweets for every one of the 1 Billion Twitter users.
- 770 facts about every one of the 1.3 Billion Facebook users.
- 10 facts from 107 Billion sensors, located somewhere on the planet.
- 400 metabolic readings for each of the 2.5 Billion heart beats over an average human life time.
- 12 facts about every one of the 86 Billion neurons in the human brain.
- 5 facts about every one of the 200 Billion stars in the Milky Way Galaxy.
- 7 facts about every one of the 150 Billion galaxies in the universe.
- 6,350 facts about each of the 158 Million books in the Library of Congress, the largest in the world.
- 10 facts about each of the 107 Billion people who ever lived

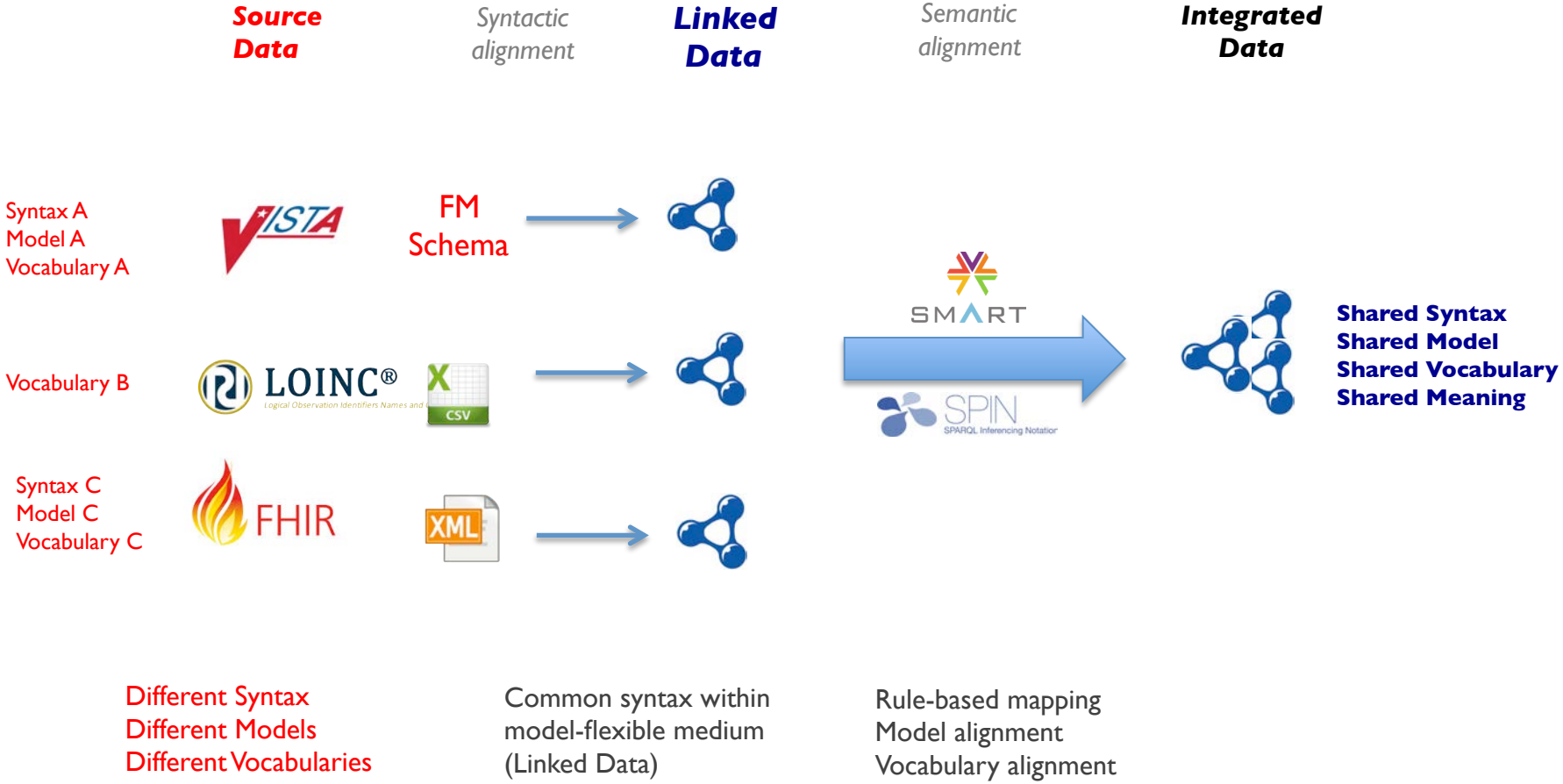
58,823 facts for each of the 17 million combined VA and DoD patients
3134 facts for each of the 319 million citizens in the USA

http://download.oracle.com/otndocs/tech/semantic_web/pdf/OracleSpatialGraph_RDFgraph_1_trillion_Benchmark.pdf

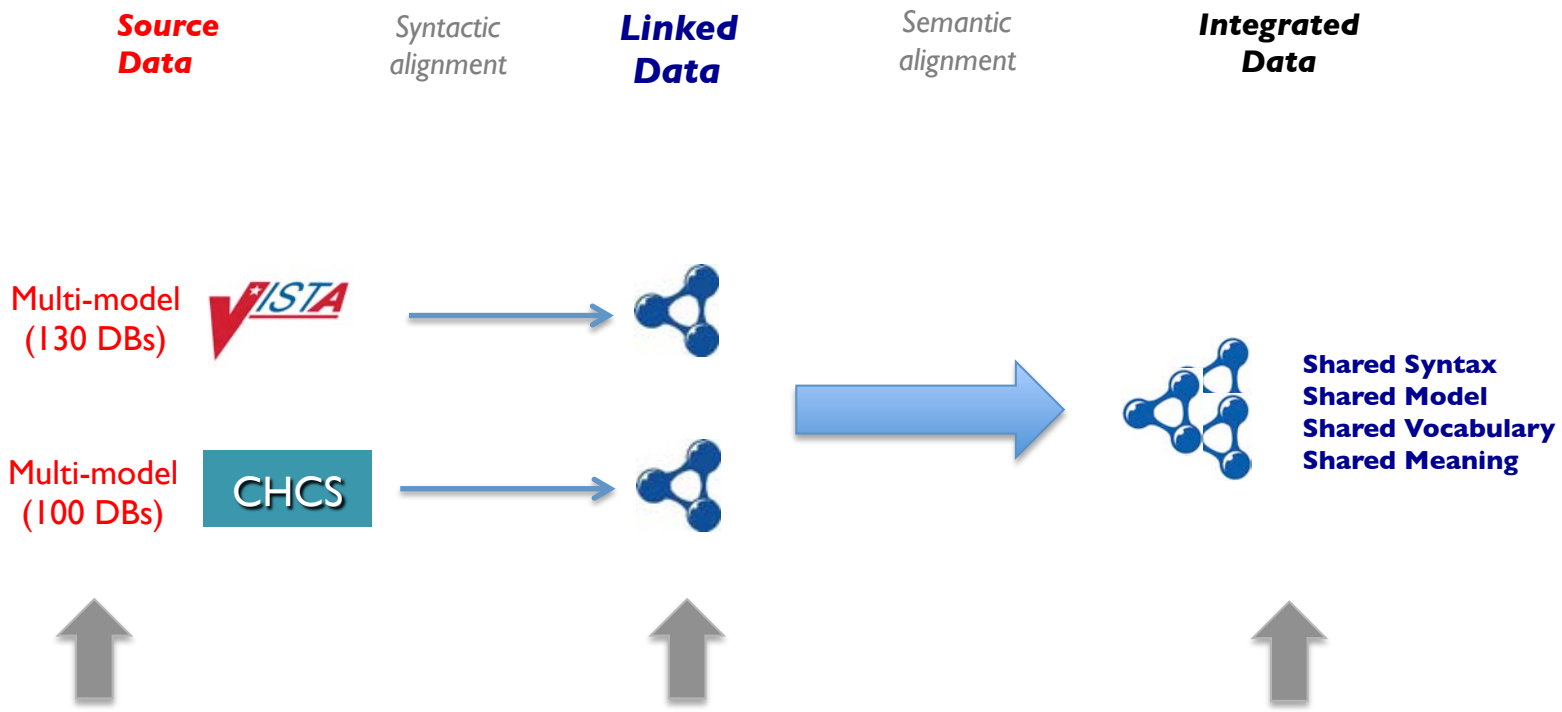
Linked Data Integration: ***Semantic Data Integration***



Linked Data Integration: VA VISTA-FHIR



Linked Data Integration: VHA-DHA (Current)



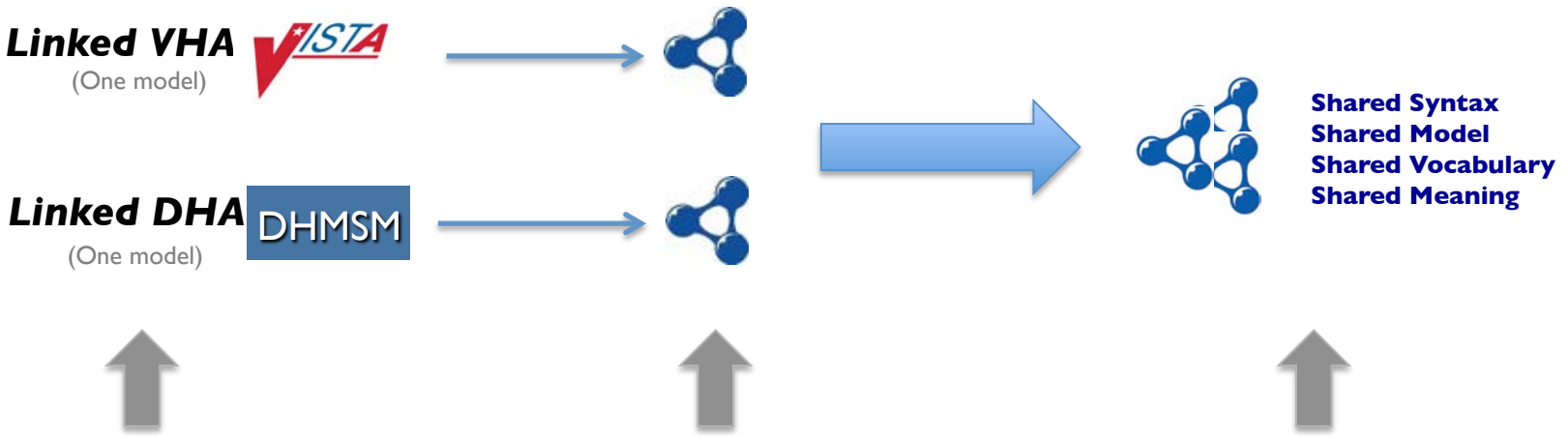
Currently over 230 systems with different data models makes integration challenging within each agency. A common model is required.

DoD is leading the transition of CHCS data to a common integrated Linked Data model at PJITC Lab in TAPS I.

RDF databases are already capable of over one trillion triples – enough to hold nearly 60,000 facts for each of the 17 million combined VA and DoD patient population.

Linked Data Integration: VHA-DHA (Future)

Source Data | *Syntactic alignment* | **Linked Data** | *Semantic alignment* | **Integrated Data**



A common linked model representation within each agency permits integration of all data though one enterprise model, designated as Linked VA and Linked DoD.

Any new system can project their data to Linked Data, allowing both VA and DoD to incorporate data from the latest technologies and systems.

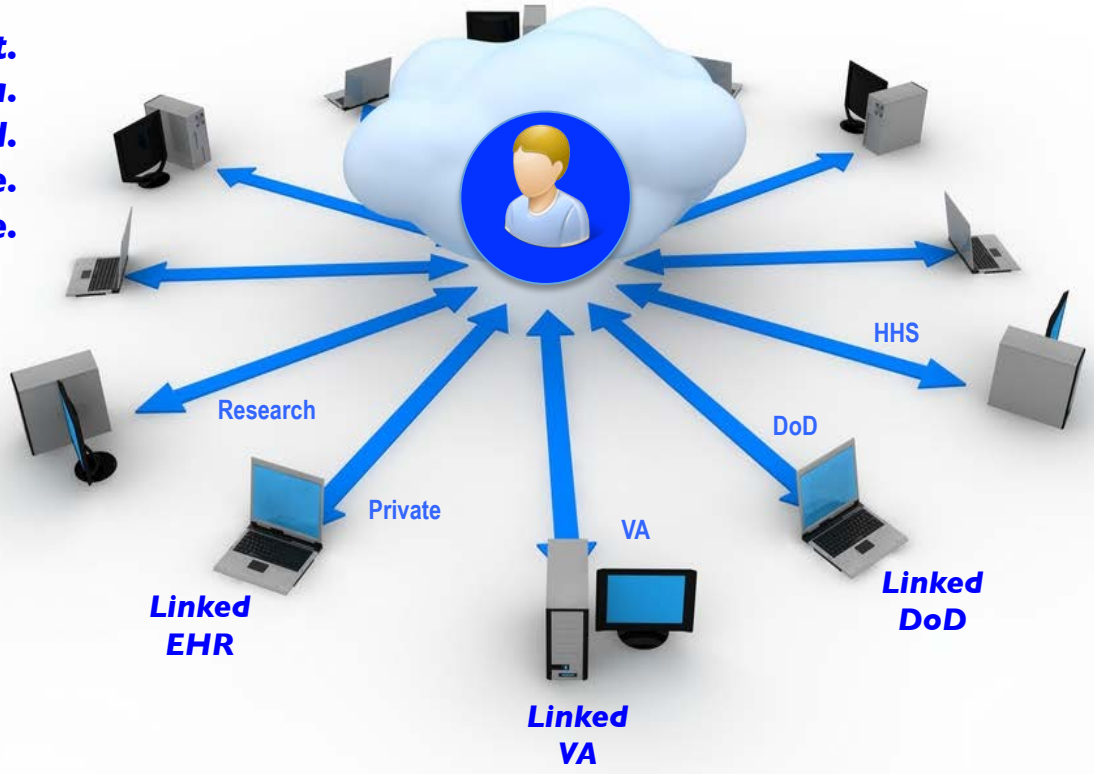
This provides a future-looking strategy for integration.

RDF databases are already capable of over one trillion triples – enough to hold nearly 60,000 facts for each of the 17 million combined VA and DoD patient population.

Linked VISTA: An Achievable Vision

Web-Standard approach to Patient-Centric Collaborative Care

One Patient.
All Data.
Integrated.
Accessible.
Web-scale.



Linked VA
Linked DoD

Reference

Linked Data Summary
Linked Data Links

Linked Data: ***Accommodates both Standards and Innovation***

Information Models:
An apparent conflict between standardization and innovation

Standards: need to remain static in order not to be disruptive for adopters.

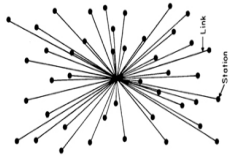
- Static, Brittle
- Centralized
- General (Common Denominator)
- Committee-driven
- Large, "all-or-nothing", disruptive updates

vs.

Innovation: requires continuous evolution of thousands of new information models.

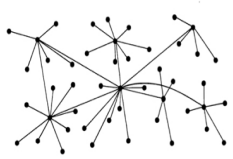
- Adaptive / Evolutionary
- Decentralized
- Highly Specialized, "Best of breed"
- End-user / specialist – driven
- Small, continuous, low-impact updates

What are the options?



Centralized, Model-rigid approach: For exchange of information to occur all models must remain fixed, and data must go through only one central 'broker' model..

Our current approach to healthcare data

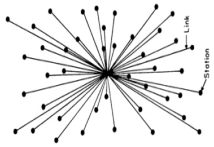


Decentralized, Model-flexible approach: Multiple models peacefully co-exist and evolve, mediated by their ability to freely link to any model at all times. In this approach, all models are free to evolve AND are capable of resolving to a common standard model at all times. *The only current technology that supports this granular data-oriented approach is RDF (Linked Data).*

Linked Data supports <u>both</u> standardization and innovation

http://www.carlsterner.com/research/2009_resilience_and_decentralization.shtml

Data Integration: ***Legacy vs. Linked Approach***



Architectural Issues	**Current Approach**	**Linked Data (RDF)**
Data model characteristics	**Model-rigid.** Only one lowest common denominator model unifies information. Must remain unchanged to orchestrate. **Restrictive expression.**	**Model-flexible.** All data models may independently evolve. **Maximizes expressivity.**
Data model compatibility	**No model diversity permitted** A one-size-fits-all mega-model	**Multiple models peacefully coexist** Data model flexible
Data model evolution	**Costly and difficult to evolve models.** Due to model-rigid architecture.	**Cheaper and easier to evolve models.** Due to model-flexible architecture.
Data access method	Downloading + Aggregating	**Linking + Federating**
Scalability: incremental effort required to add new data sources	**Common model** must be updated	**Individual models** may be independently and incrementally semantically linked.
Primary Function	**Data Syntax and Transport**	**Data Model**
Granularity	**Document-centric** (message-centric)	**Data-centric** (individual data elements)
Semantics	**Weak semantics.** **Extrinsic, separate from the data.** Depends on an external data model.	**Strong semantics.** **Intrinsic, integrated with the data.**

Links: ***Linked Data***

W3C Linked Data Standard
http://www.w3.org/standards/semanticweb/data

W3C Linked Data Platform
http://www.w3.org/TR/ldp/

W3C Semantic Web Healthcare and Life sciences
http://www.w3.org/blog/hcls/

HL7-RDF Healthcare Standards Work Group
http://wiki.hl7.org/index.php?title=RDF_for_Semantic_Interoperability

Semantic Web
http://en.wikipedia.org/wiki/Semantic_Web

Linked Data: Tools (>1000)
http://www.mkbergman.com/sweet-tools

Linked Data: Adaptors (100's)
http://www.w3.org/wiki/ConverterToRdf

Linked Data: Roadmap for Healthcare Interoperability
http://yosemiteproject.org

Linked VISTA: A Semantic EHR

Representation of VistA data as Linked Data creates a ***Semantic EHR*** – one with well-defined meanings derived from a clear data model in RDF. This supports inferencing, reasoning, knowledge discovery, and semantic interoperability. Contrast with today's ***Syntactic EHRs*** focused on data structures.