VA HEALTH CARE Defining EXCELLENCE in the 21st Century

Linked VISTA

A Web-Standards Approach To Patient-Centric Care

Rafael Richards MD MS

Physician Informaticist
VA Collaborations Group
Office of Informatics and Analytics
Department of Veterans Affairs

Pacific JITC ITEC Lab
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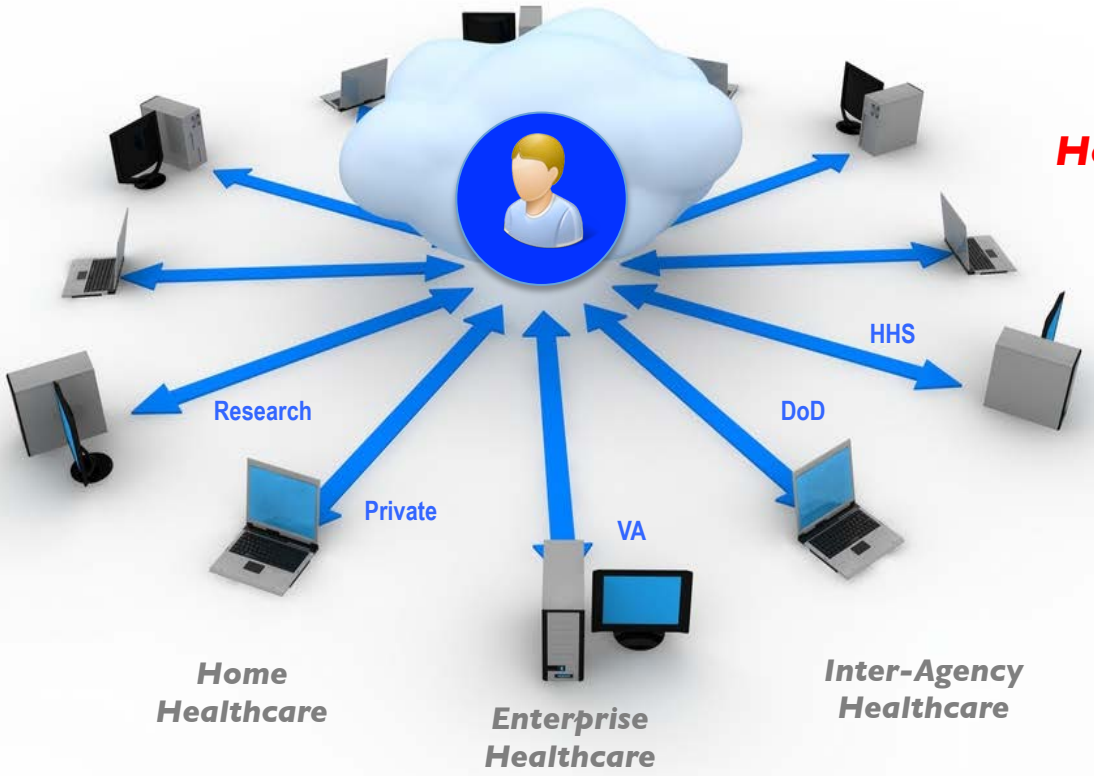
Vision: Linked VISTA

A Web-Standards Approach to Patient-Centric Care

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



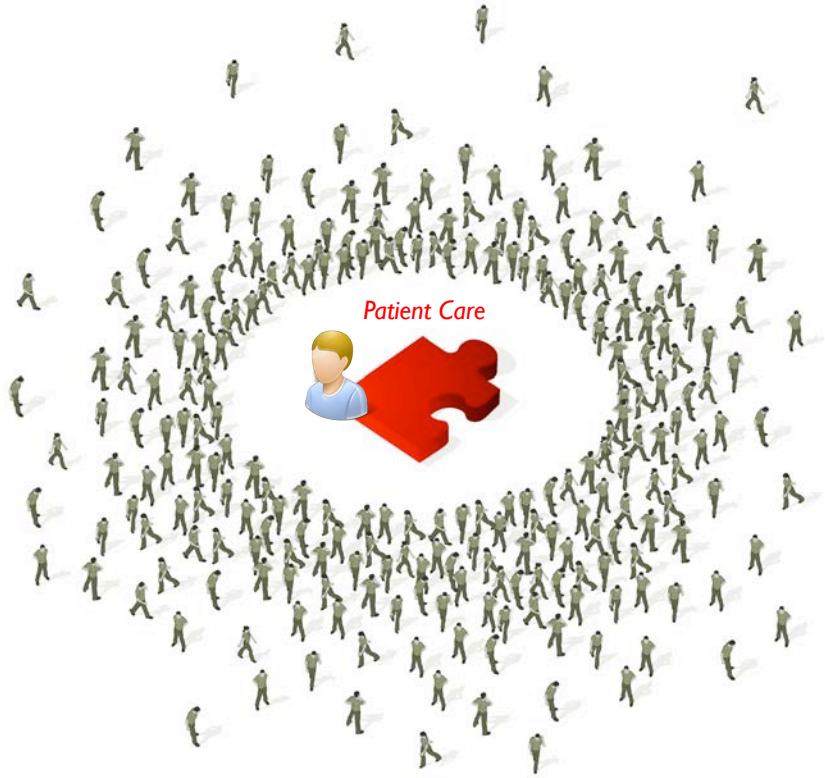
How do we get here?

Collaboration

Required to solve real world problems

Collaborations Team

VA



DoD

PJITC Team

Common goals
Common vision

VISTA Overview

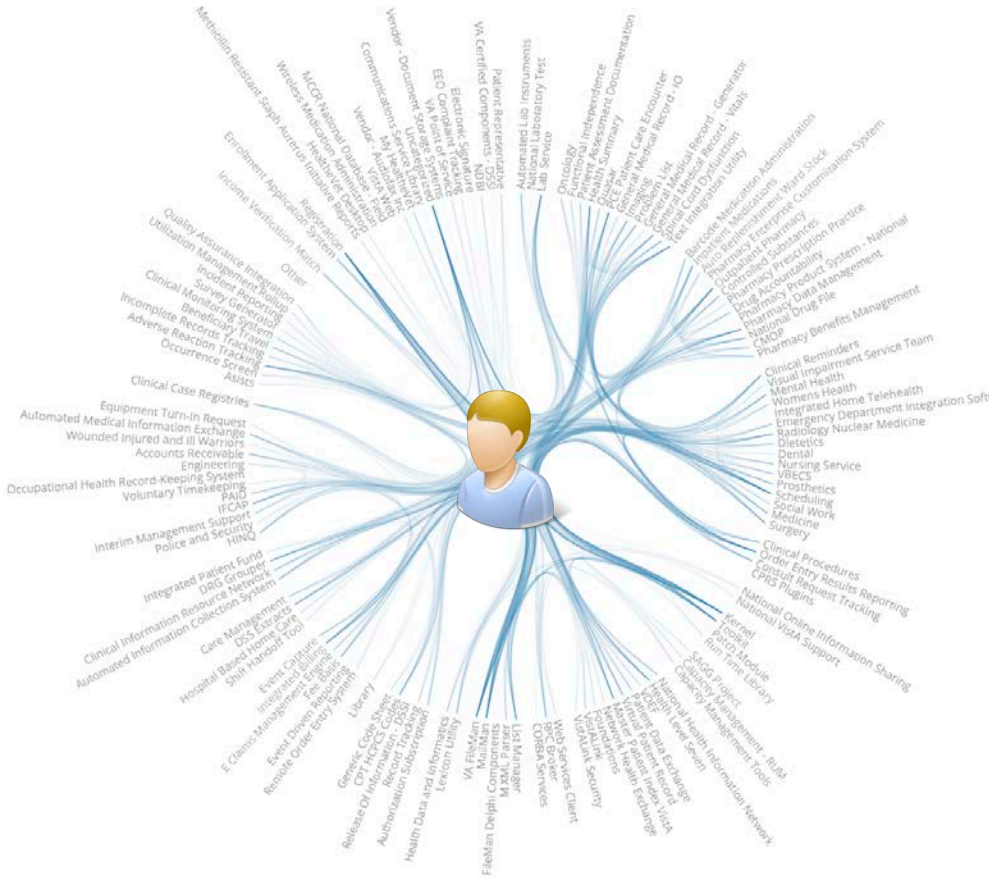
- *VISTA Architecture: Single-integrated EHR*
- *VA Enterprise: One Patient. Many VISTAs*
- *Problem: 130 Unique VISTAs.*
- *Problem: Isolated patient data.*
- *Approach: Linked VISTAs.*
- *Vision: OneVA.*

VISTA Architecture: Single-integrated EHR

A Patient-Centric Single integrated EHR

One Patient.
One Database.

All Apps. All Data. Integrated.



Patient-centric Health Record

This figure depicts the data architecture of VISTA, which 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 (MDE) which 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.

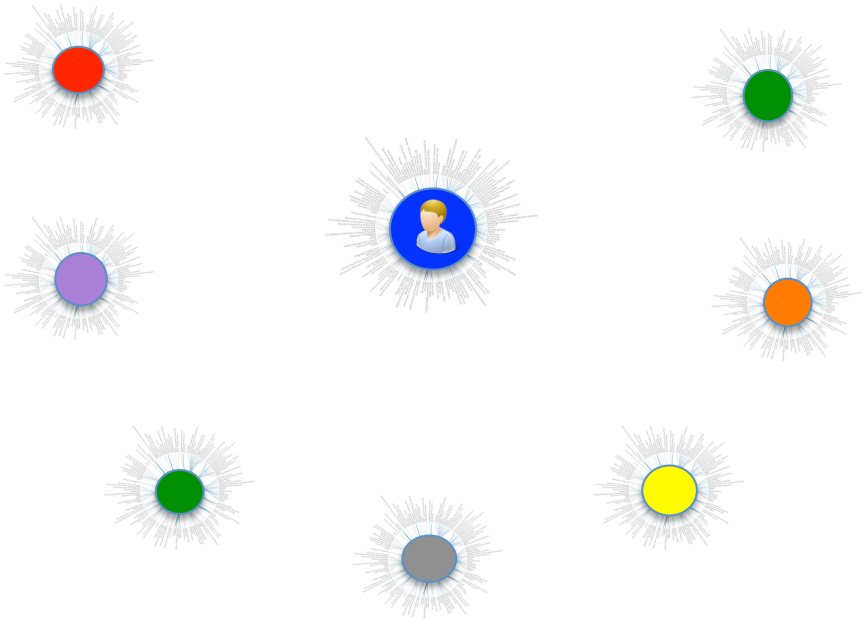
Problem Statement

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

Problem: VISTA Silos. Isolated Patient Data.

VISTA Silos

One Patient.
Many Databases.
Isolated.



Many VISTAs.
Many Models.
All Different.

While each of the VistA instances are internally highly integrated (Intra-VistA), each VistA has its own distinct data model (different color circles).

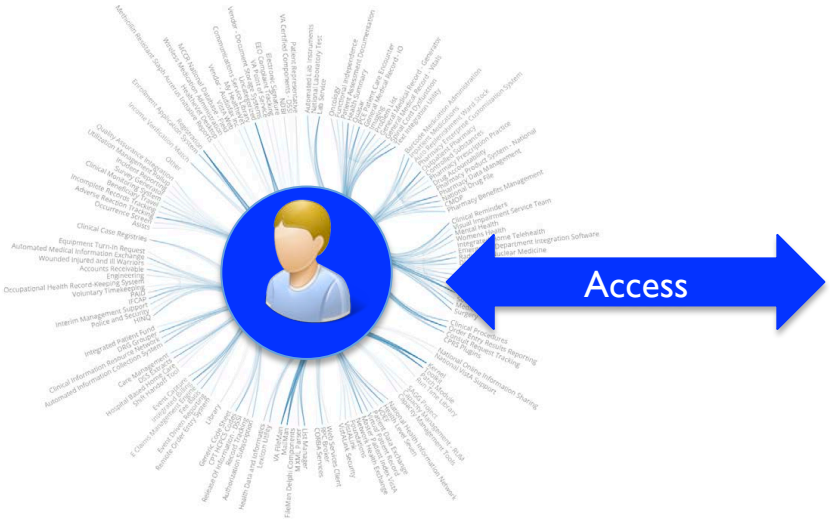
Different data models makes it difficult to integrate patient data between VISTAs.

Care of patients in VA requires integration of patient data across all 130 VISTA systems. However, these are all data silos, isolating patient data.

Approach: Linked VISTAs

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

One Patient.
One Model.
All Data.



Web-standard Integration requires:

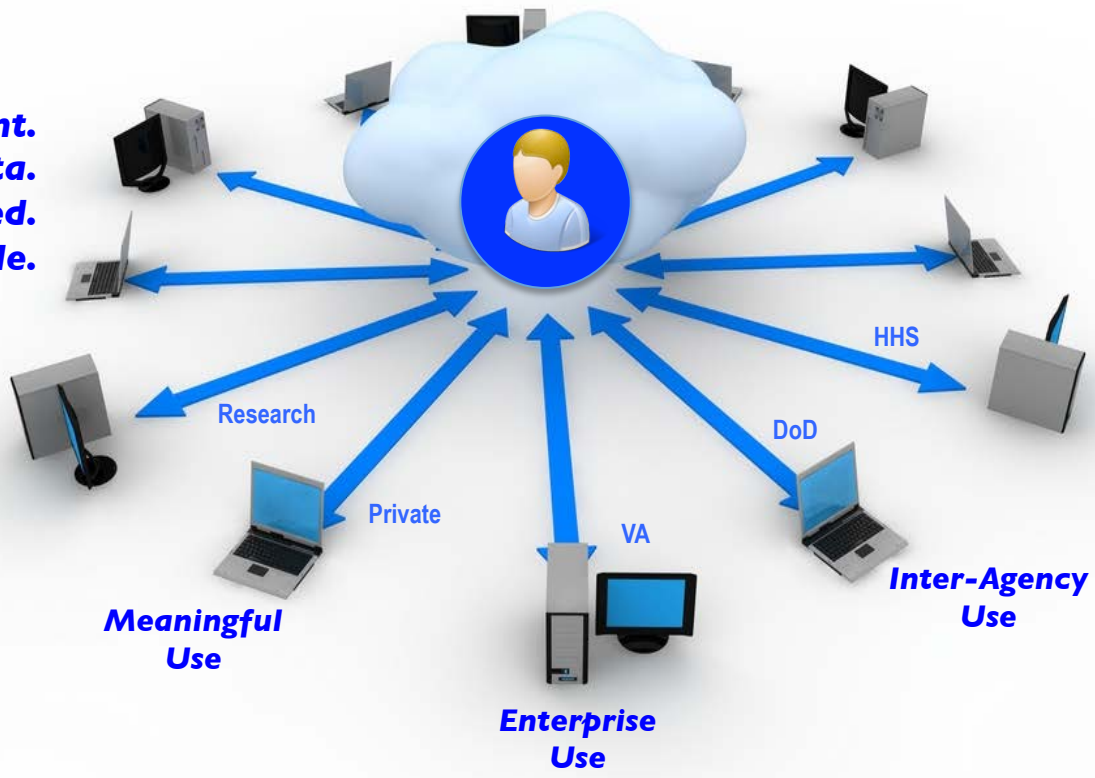
Enterprise Data Model.
Data Security.
Data Services.

A model-centric approach to VISTA data modernization provides full, granular, metadata driven access to all data. This would be capable of publishing, linking, and exchanging, with patient-centric security, granular data with external systems using international web standards.

Vision: Linked VISTA

Web-standards approach to provide Patient-Centric Collaborative Care

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

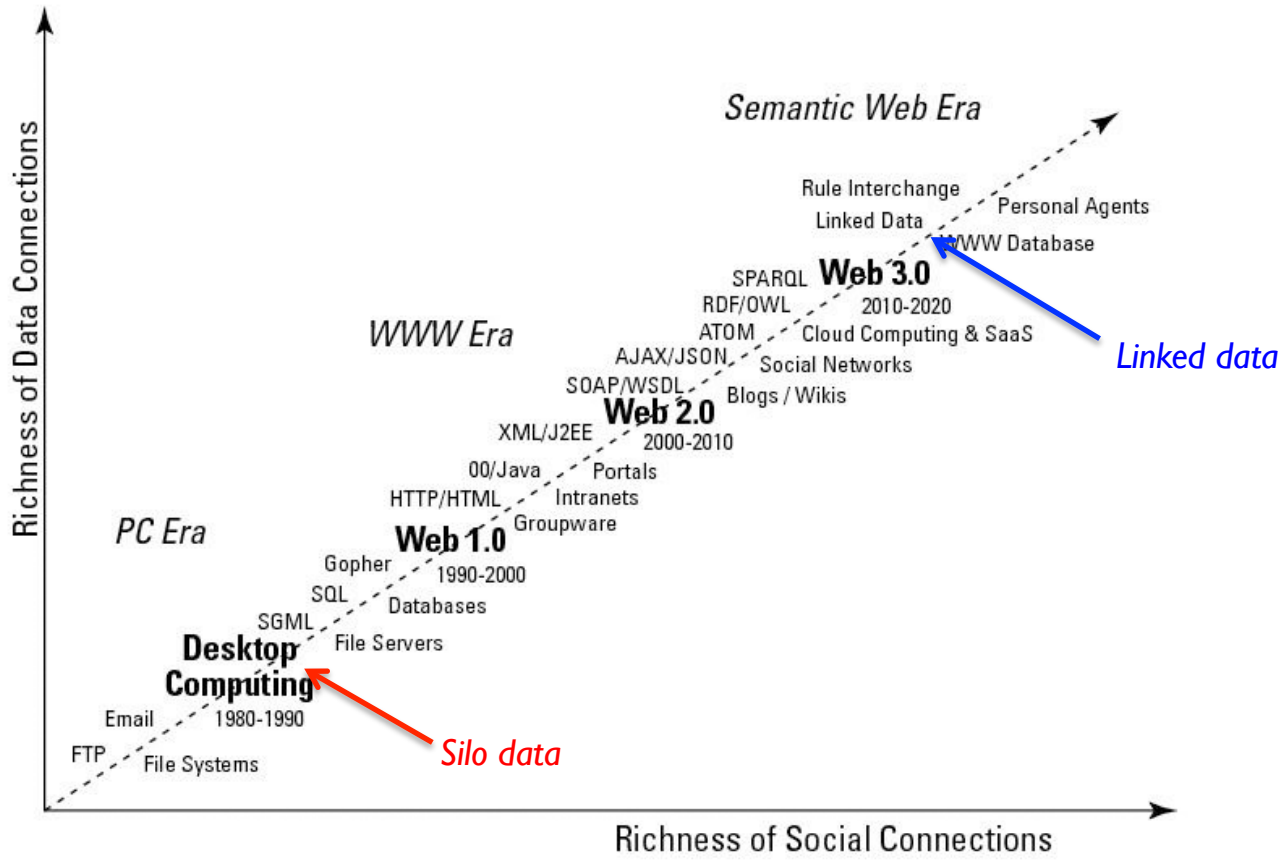


OneVA

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*

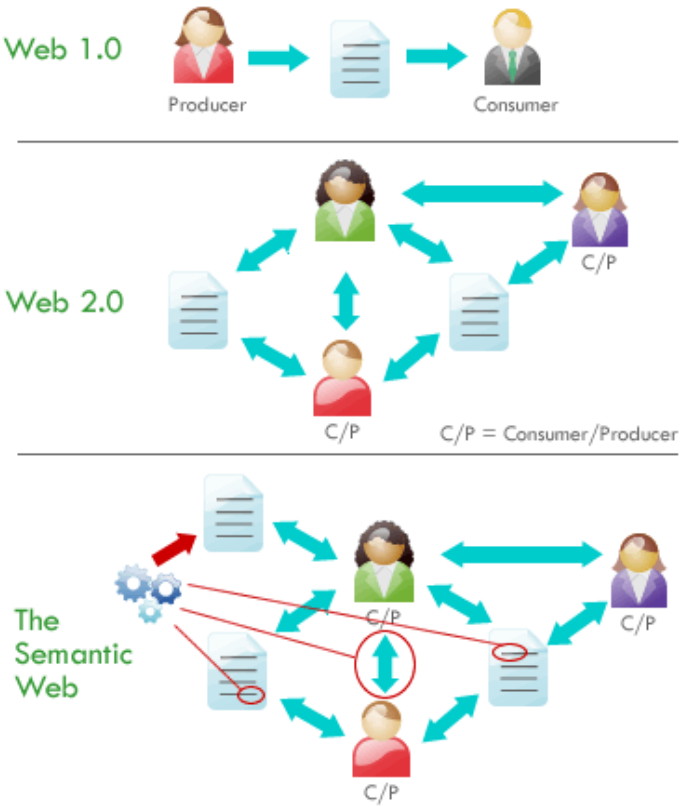
Evolution of Computing: Increased Connectivity



VISTA (originally DHCP) was officially launched in 1982. This is long before the age of inter-networked data ("the internet"), when databases were isolated inside institutional intranet silos (red arrow). Note that the TCP/IP internet protocol had not even been invented at that time. To bring VistA into today's Web Era, and allow VISTA data to be linked to all VISTA systems within VA enterprise, and to any other external Internet-connected systems, 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)

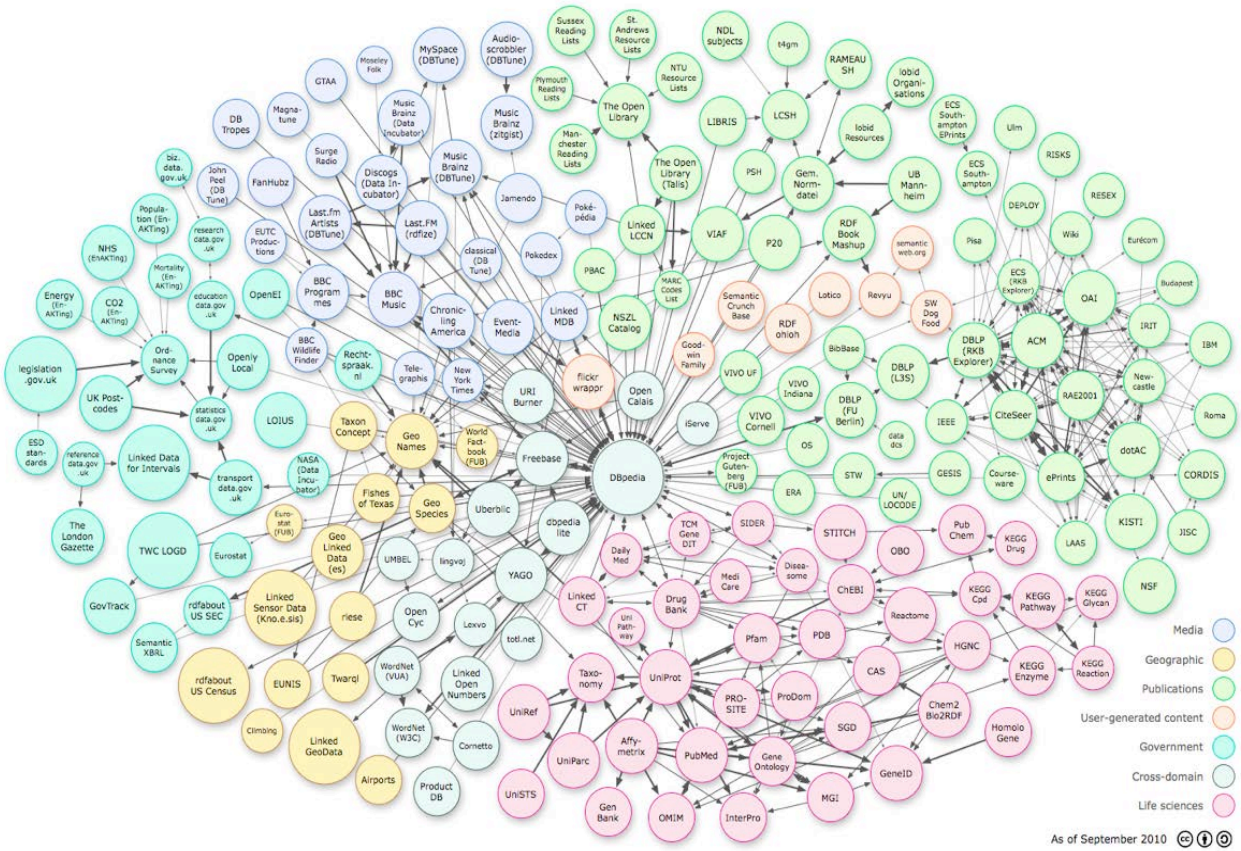
"The Semantic Web [Linked Data] provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries."

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.

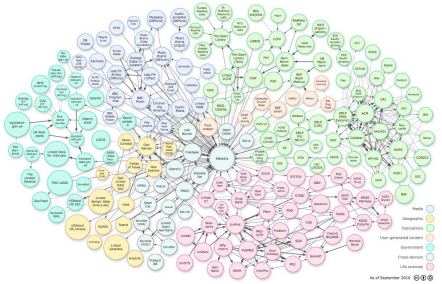
Each circle represents one data source or database. These are semantically linked to other data sources, creating a single virtual federated internet-scale database.

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

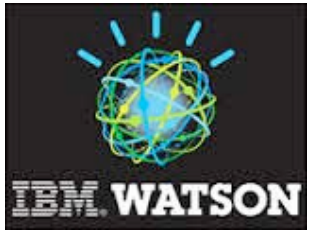
Linked Data: ***Who Uses It?***

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)

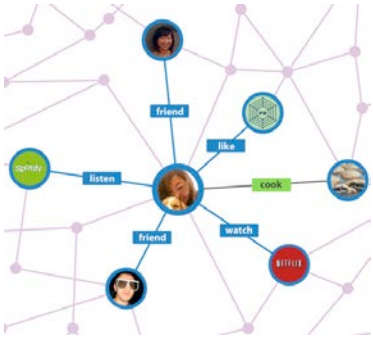


IBM Watson (knowledge graph)



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 a flexible data model.

Health Data: ***PCAST Recommendations***

"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".

PCAST recommends and describes precisely Linked Data

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

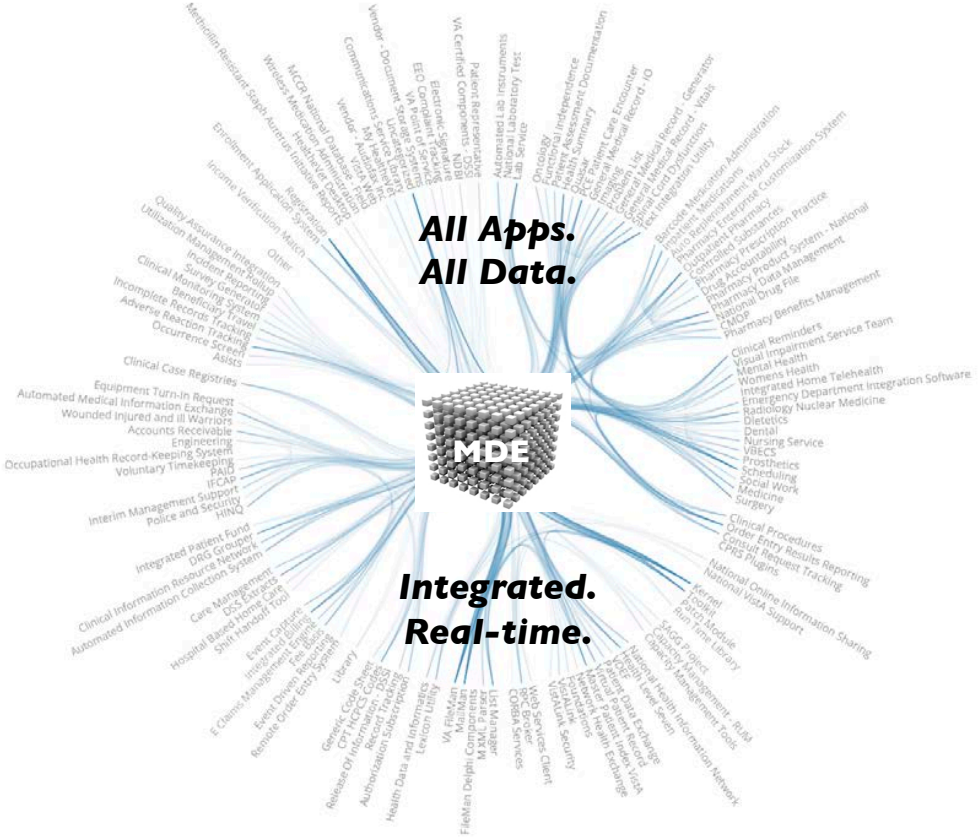
VISTA Enterprise Model

A Path to VISTA Data Management:

- Review: VISTA's Database
- Review: VISTA's Data Model (VDM)
- How: Exposing and Leveraging VDM
- Benefits of VDM:
  - 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.

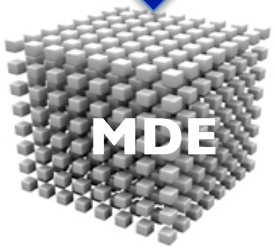
Review: VISTA's Data Model (VDM)

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

Data Model

Hierarchical Graph Store

This layer provides the data structures, data models, and data management for VISTA.



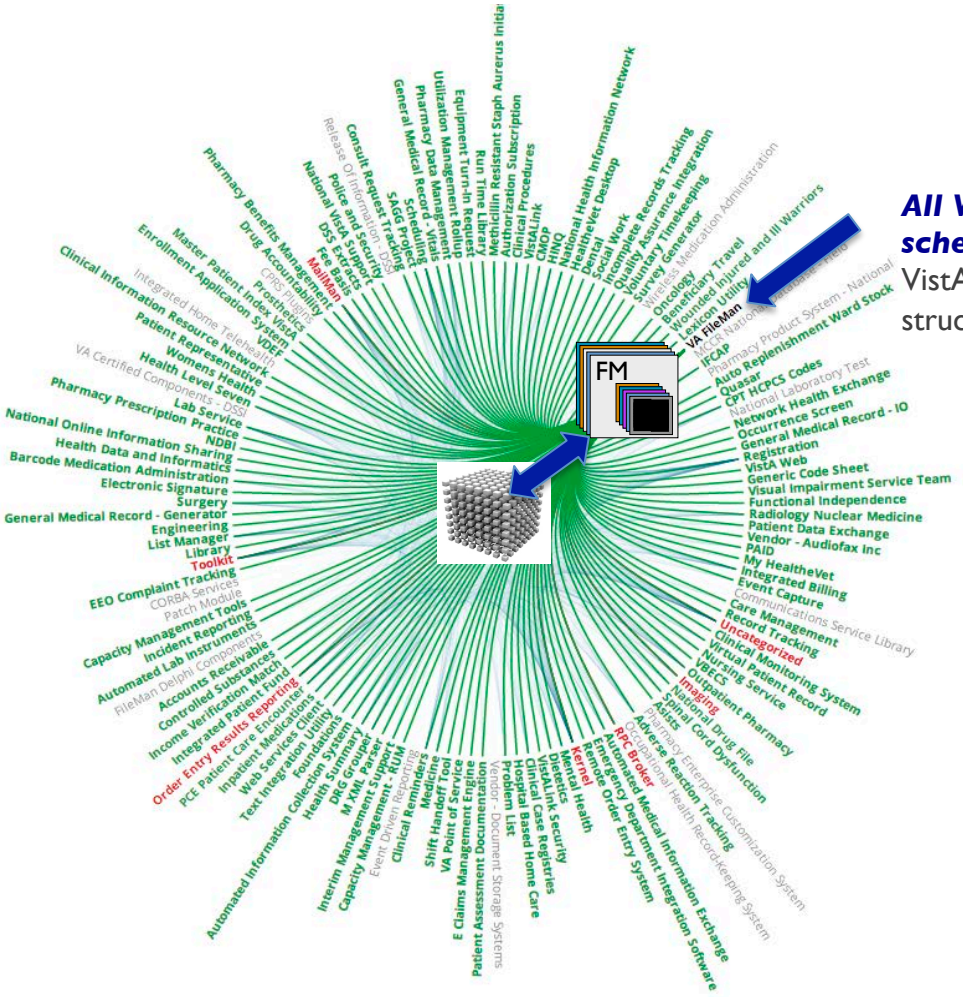
Apps Data

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-graph 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 Fileman. *Surprisingly, this fact has not yet been leveraged to expose and modernize the data model.*

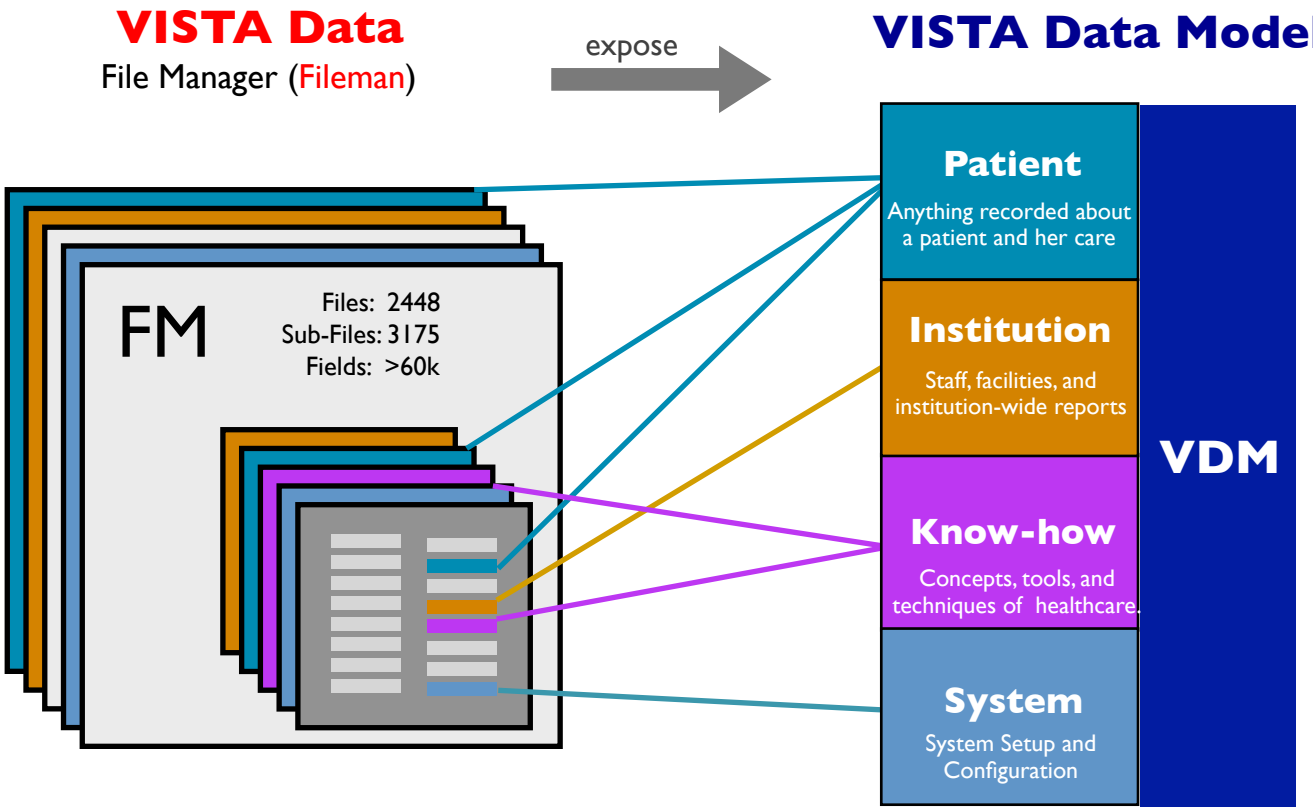


All VISTA data flows through its data scheme, managed by Fileman. All VistA applications use Fileman to access, structure, and query all data in VistA.

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. Fortunately VISTA's database 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

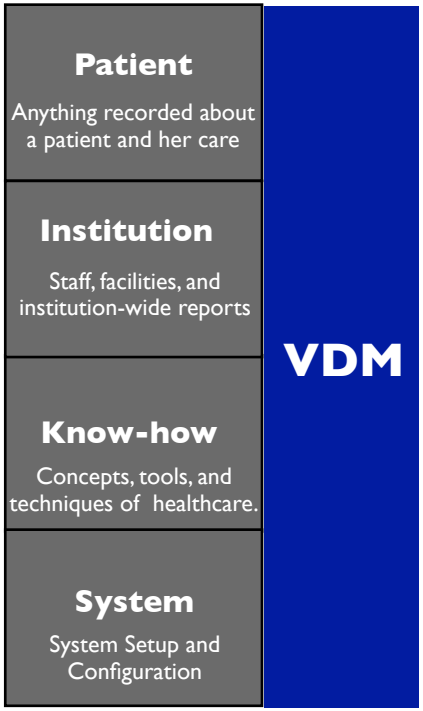
Access: Single query access
Model: Consistent, Transparent

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.

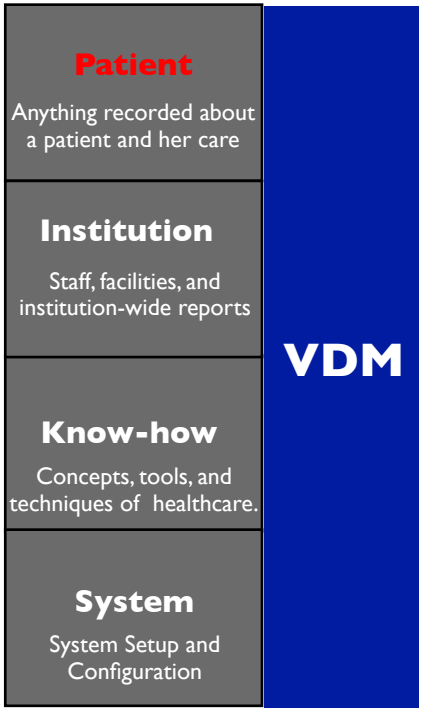
System Management:
The entire configuration of a system can be identified, extracted, and transported, and inserted from system to system

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.*
- *Right now we have only "type based security" at best.*
- *With the new 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**

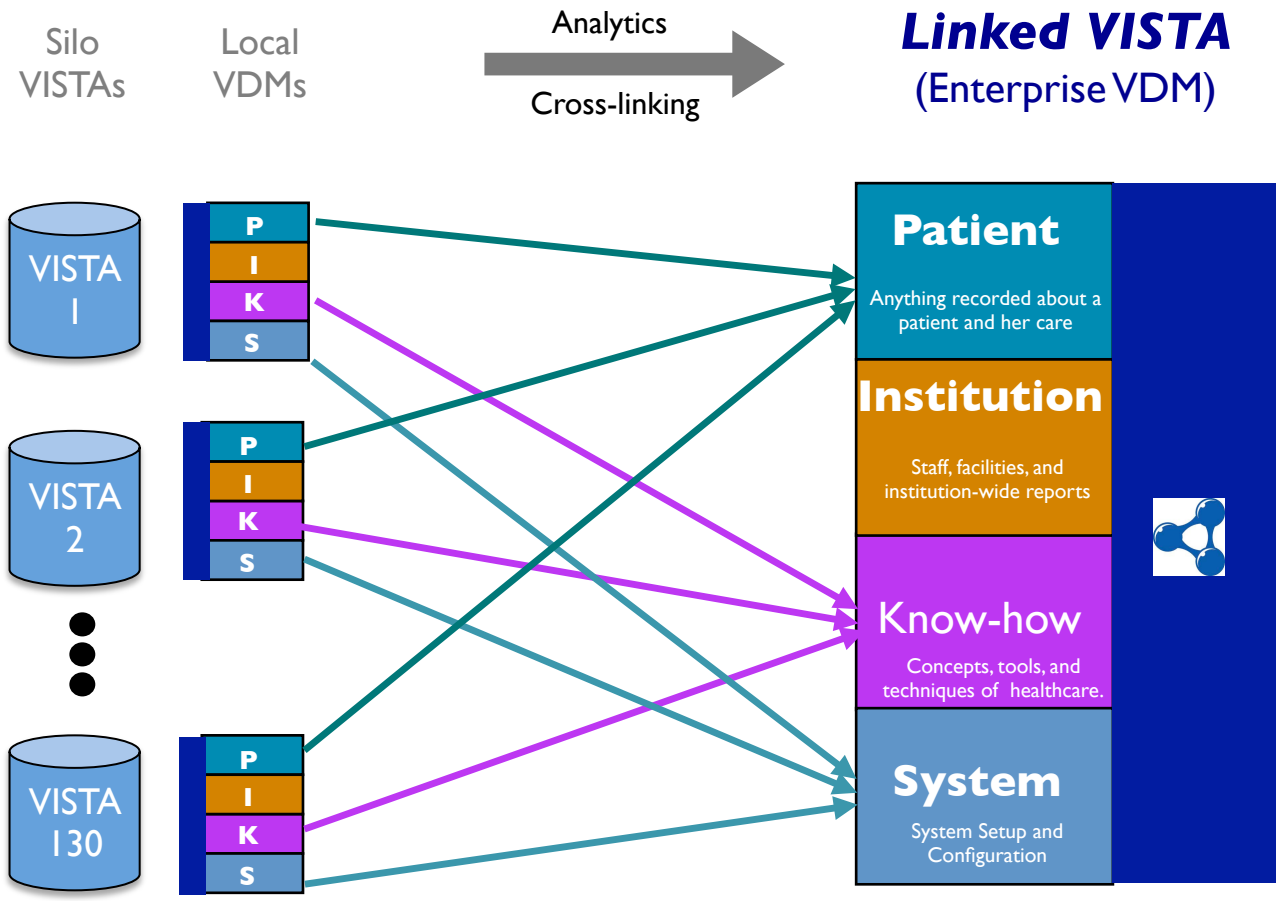
Linked VISTA

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.



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

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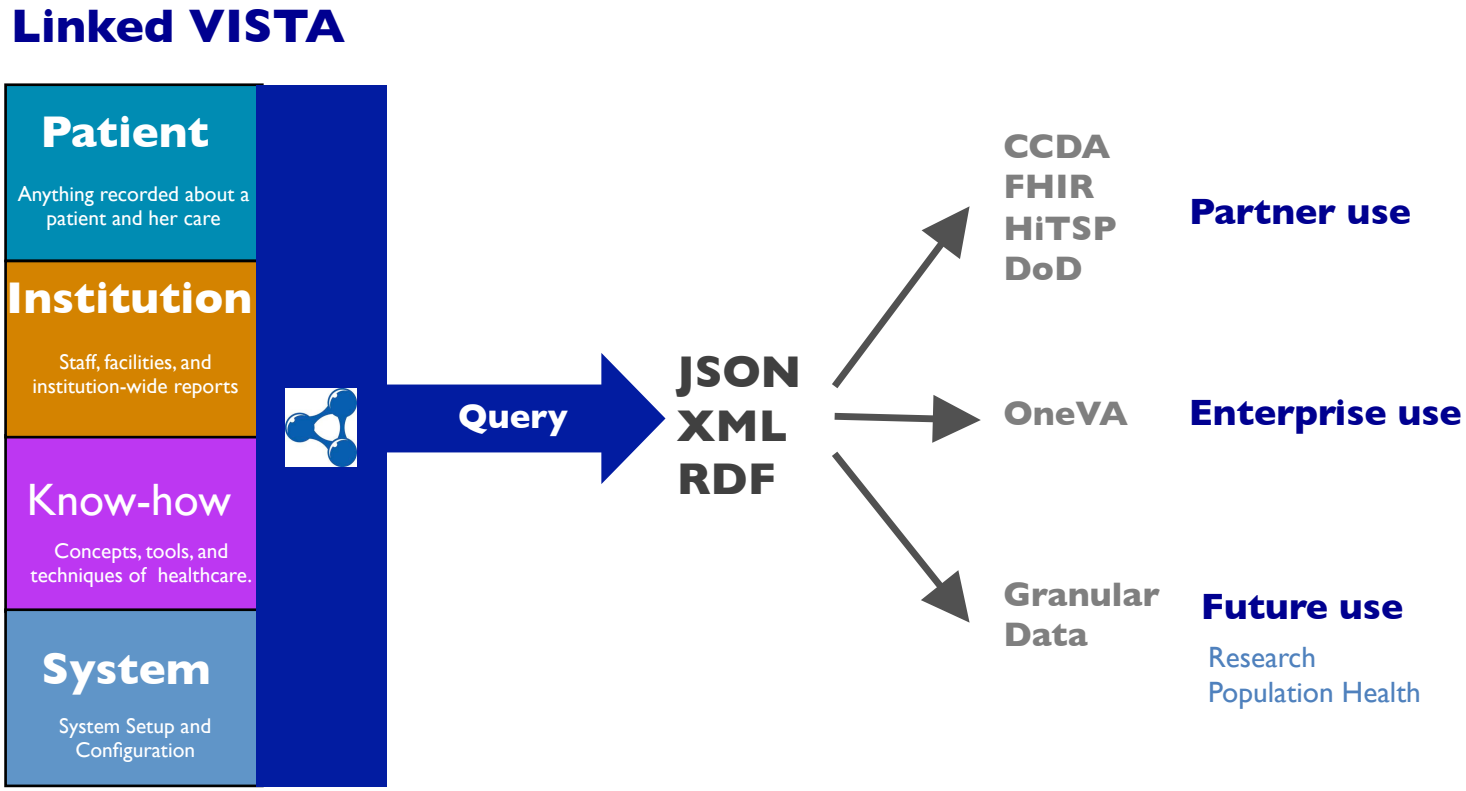
Configuration Management:
The entire configuration of a system can be identified, extracted, and transported, and inserted from system to system

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.

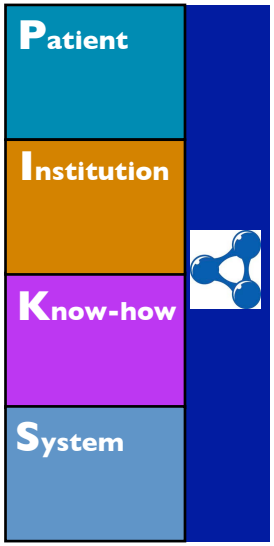
This would allow any authorized system to securely and directly query authoritative VISTA data in real-time with one standard query language. The output of these queries will be in all modern web-standard forms to maximize secondary use.



Linked VISTA: ***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



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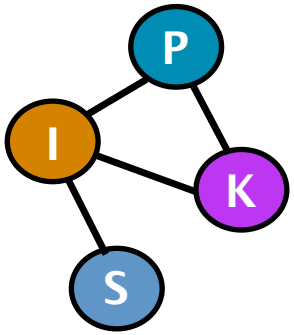

Same As

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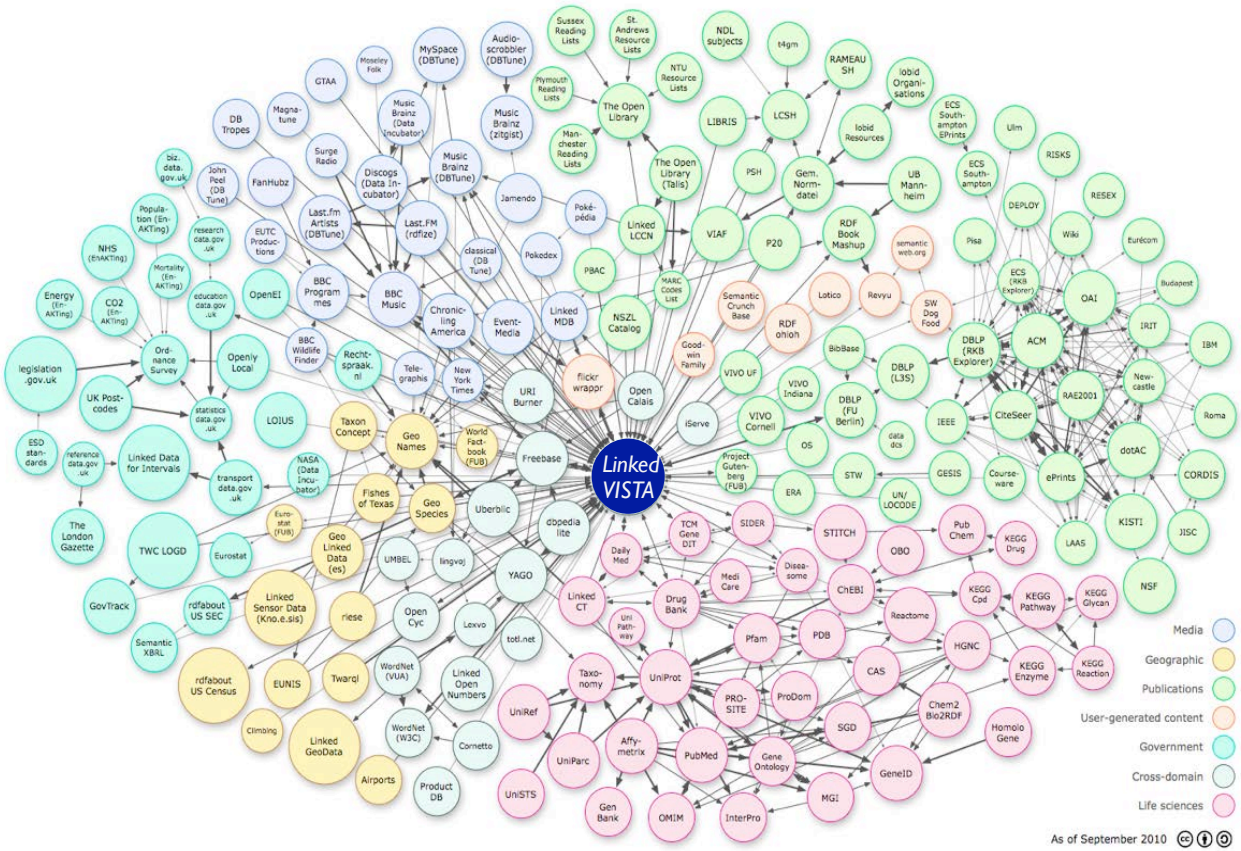
Linked Data

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.

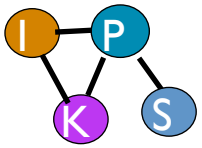
This will enable *meshing, enrichment, and augmentation of patient data with all other sources, providing a comprehensive view of all patient data from all locations, clinics, hospitals, or the home.*

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**



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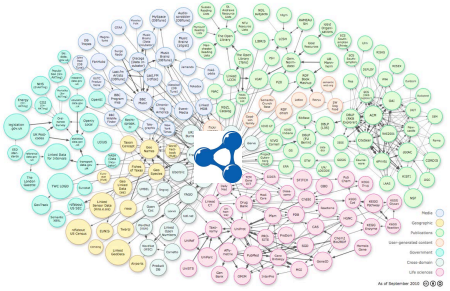

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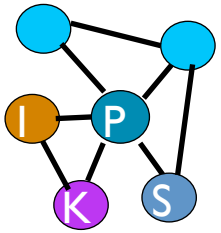


Because data in the VistA Data Model can be represented just like any other Linked Data resources, *one can mesh VistA data directly with unlimited sources of internal or external, public or private life sciences, and other scientific or healthcare related data sources.* This leads to discovery of new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

Data Access and Interoperability

- *Congress: Future-proof access required*
- *VA-FHIR*
- *VA-DOD (current)*
- *VA-DOD (future)*
- *Summary: Recommendations*
- *An Achievable Vision*
- *Links!*

Congress: *Future-proof Data Access is Required*

The Congressional mandate is to make all veteran data available and interoperable for 75 years.

Both VA and DoD currently have patient data that is over 35 years old in their core operational health IT systems. This legacy data will need to be not only be made fully available today, but available an ***additional 40 years*** in a form that is fully standardized, accessible, and integrated within each agency, and between both agencies.

Both agencies will 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 standard.

Congress: *Future-proof Data Access is Required*

An Inter-Agency Linked Data strategy would provide:

- ***DOD a transition strategy for CHCS data*** from all DoD systems to a common model, allowing uniform, standardized data migration in support of **DHMSM**.

- ***VA an enterprise data model for VistA data*** from all VA systems, providing a single view of patient data in support of **OneVA**.

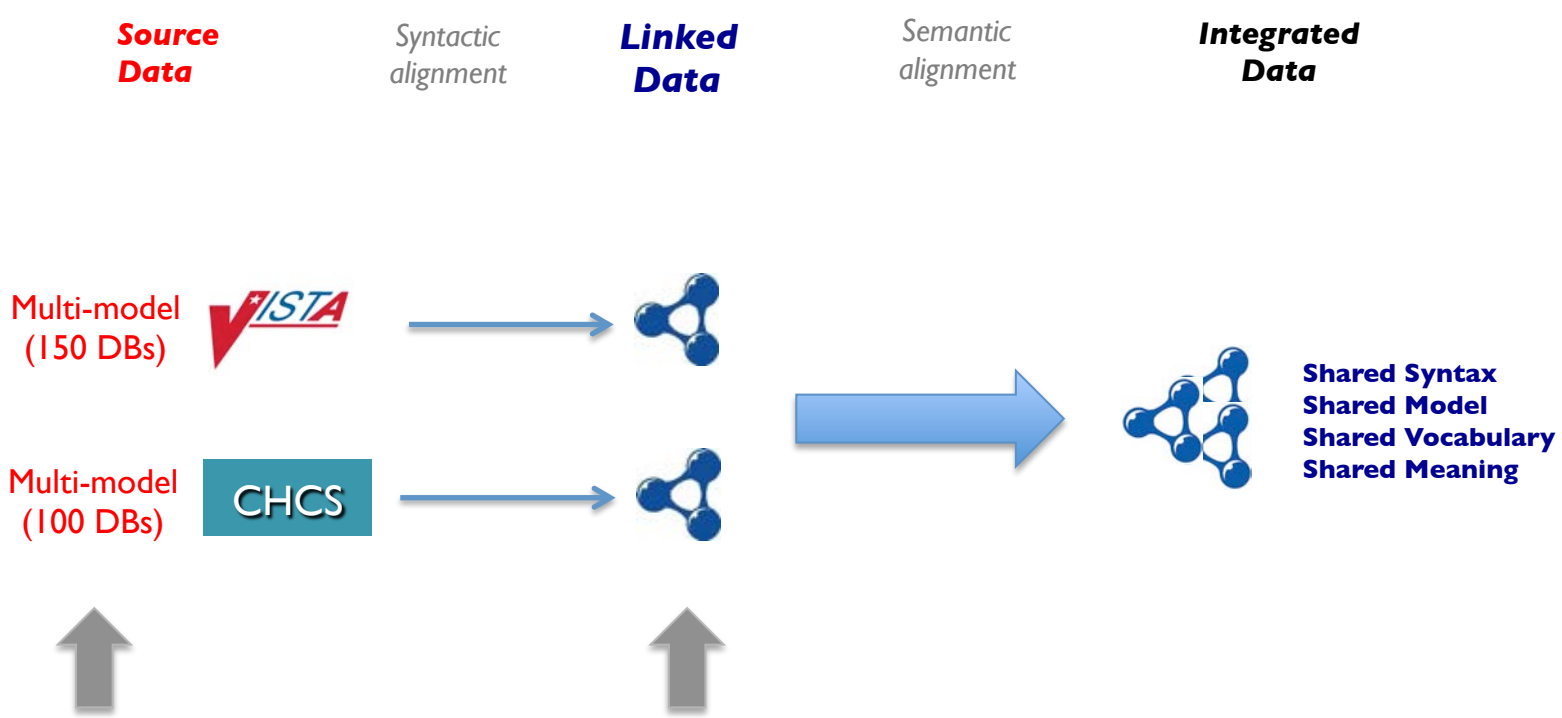
- ***VA and DoD a future-looking interoperability strategy*** *which will support the* ***continuous change of OneVA and DHMSM systems*** *as all these evolve and change over time.*

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

Linked Data Approach: ***VA-FHIR***

Source Data	*Syntactic alignment*	***Linked Data***	*Semantic alignment*	***Integrated Data***
Syntax A Model A Vocabulary A	VISTA	FM Schema	SMART / SPIN	**Shared Syntax** **Shared Model** **Shared Vocabulary** **Shared Meaning**
Vocabulary B	LOINC®	CSV		
Syntax C Model C Vocabulary C	FHIR	XML		
Different Syntax Different Models Different Vocabularies		Common syntax within model-flexible medium (Linked Data)	Rule-based mapping Model alignment Vocabulary alignment	

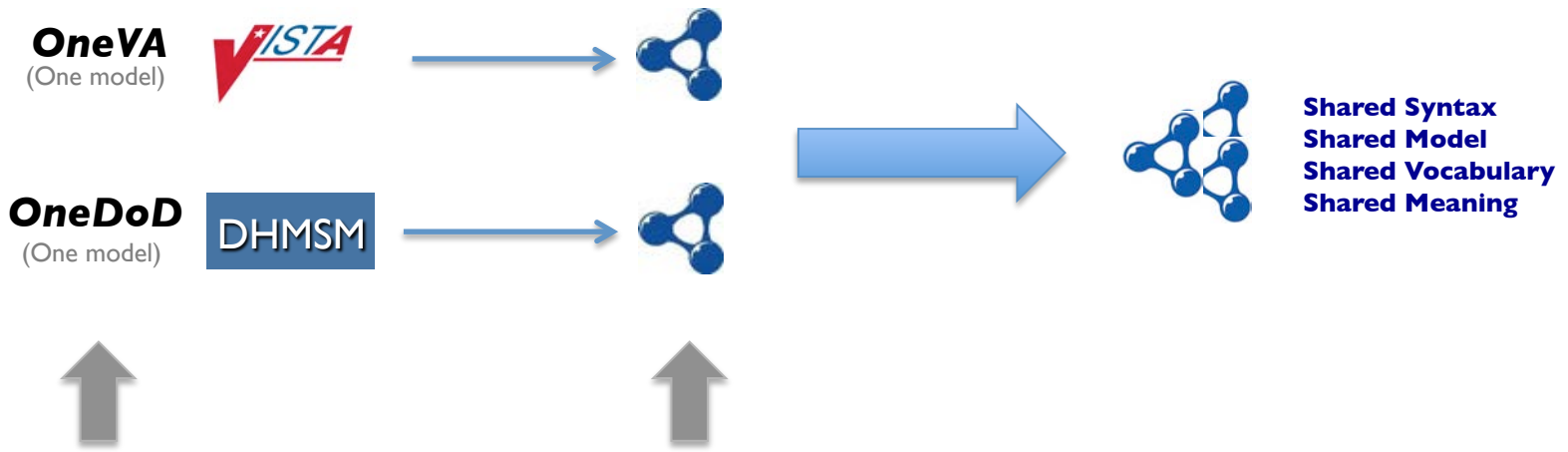
Linked Data Approach: VA-DoD (Current)



Currently over 250 databases (DBs) 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.

Linked Data Approach: ***VA-DoD (Future)***



A common master model representation within each agency permits integration of all data though one enterprise model, designated as OneVA and OneDoD.

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.

Linked VISTA: **Recommendations**

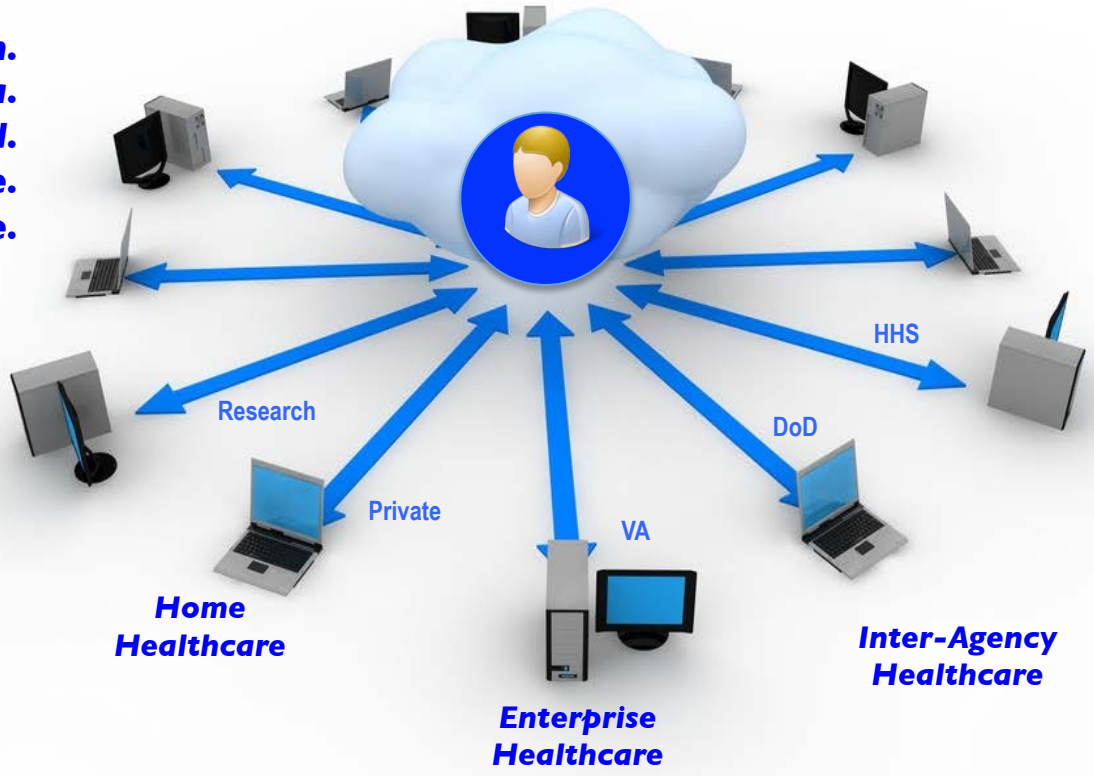
- ***A VistA Enterprise Data Model should be created that links all 130 VistA instances.***
- ***Linked Data/RDF is the best way to do it.***
- ***Linked Data is the best way to link VA and DoD and beyond.***

Linked Data allows data from mixed models to be linked in one "data space", which permits extraction/reduction/presentation for an infinite variety of users.

Linked VistA: ***An Achievable Vision***

Web-Standard approach to Patient-Centric Collaborative Care

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



One VA
One DoD

Links to…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