New Mexico HHS 2020

MITA Technical Management Strategy

(TMS)

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1 ABOUT THIS DOCUMENT

The HHS 2020 MITA Technical Management Strategy (TMS) document is intended to demonstrate how New Mexico's selected Enterprise Architecture addresses the mandatory considerations listed in the CMS publication "MITA Technical Management Strategy 3.0 Part III Chapter 2". The considerations have been grouped into 3 categories:

- 9 Principles
- 8 Goals
- 29 Objectives

The TMS follows the EA organization into Business, Data, and Technology domains. This document first describes the approach to governance applied to work products produced in each of the three domains. Governance elements are sub-divided into Standards, adherence to Requirements, and Traceability of work products across the SDLC disciplines of the HHS 2020 enterprise. This document then transitions to strategy discussions applicable to Business, and Data domains. Since the Technology domain is comprised of Software and Infrastructure portions, each receives a separate set of strategy considerations.

The document makes use of both structured and free-form diagrams to convey various topics. Proficiency with Unified Modeling Language in general and with Static Structure diagrams is assumed of the reader. SDLC discipline metamodel diagrams found in the governance section use class elements (rectangle shape with compartments for attributes and operations hidden) to represent concepts. Concepts are related through a combination of stereotyped dependencies and directed associations. Conceptual Solution Architecture diagrams use component elements with implemented Interfaces and dependencies. Related components may be grouped into component packages.

Appendix B contains a listing of all TMS considerations mapped to relevant document sections. It serves as a coverage checklist, ensuring that every salient point has been adequately covered in the document's narrative.

1.1 RELATIONSHIPS TO OTHER DOCUMENTS

This MITA TMS document is influenced by and, in-turn, influences numerous other HHS 2020 documents. The table below lists the most significant cross-document dependencies.

Table 1: MITA TMS Relationships to Other HHS 2020 Documents

Document	Relationship to MITA TMS
MITA State Self-Assessment (SS-A)	The current SS-A to-be vision is at a very high level to comply with MITA level 4. As NM continues to further define the to-be vision in the MITA SS-A, the TMS and updated MITA SS-A will be used to confirm alignment to MITA Maturity level 4.
MITA Concept of Operations (ConOps)	The ConOps details how NM will own, operate and benefit from the HHS 2020 EA. The TMS provides an end-to-end SDLC perspective tying together the HHS 2020 design and run-time capabilities.
Reference Technical Architecture (RTA)	The RTA details design-time governance applied to the Software Architecture elements and documents the HHS 2020 EA solution architecture approach aligned with the TMS vision.
Technical Standards	Technical standards document catalogues technical standards applicable to all aspects of Information and Technical Architecture elements envisioned in this document.

2 GOVERNANCE

Every aspect of the HHS 2020 enterprise architecture must converge on the singular strategic goal of creating a person-centric service ecosystem for the State of New Mexico. The purpose of governance is to provide standards, guidelines, checklists, auditing and quality assurance mechanisms applicable to every enterprise architecture activity and work product, including Business Architecture, Information Architecture and Technical Architecture.

The HHS 2020 lays out an architecture for a modular enterprise that can be applied repeatedly to new functionalities as they become available, both within the NM Medicaid enterprise but also within the larger NM health and human services enterprise.

Governance considers every phase of solution development from envisioning the future-state business processes, to design and implementation of new solutions, to solution operation in production, to accommodation of ongoing changes and enhancements. The HHS 2020 EA strives to make governance elements understandable, practical and applicable to ensure their adoption by all HHS 2020 stakeholders.

2.1 STANDARDS-BASED

NM HSD's adherence to standards aligns with the State's philosophy of buying and configuring COTS products, rather than building custom solutions. Standards compliance ensures interoperability. Adherence to standards increases solution modularity, allowing for a best-of-breed mix of implementation options owned by the State and brought in from BPO modules (e.g. Financial Services, Quality Assurance, Benefit Management Services).

2.1.1 Government and Regulatory

The following table lists applicable government and regulatory standards and ways in which they affect the HHS 2020 enterprise architecture.

Table 2: Government and Regulatory Standards

Standard	Relationship to HHS 2020
MECT	The latest CMS-approved version of the Medicaid Enterprise Certification Toolkit was used to ensure the HHS 2020 EA and RA follow the applicable guidelines and standards as set forth in the MECT checklist SRC's.
Health-IT.gov HIE	The Health Information Exchange (HIE) has a high-level set of initiatives that provide electronic health information exchange networks to enable providers and patients to securely share a patient's vital medical information electronically, thereby improving the quality and cost of care.
FICAM	Federal Identity, Credential and Access Management is the Federal adaptation of ICAM and is quite useful in raising the bar of expectations and interoperability between federal and State agencies in managing users' Identities, credentials and accesses.
Clinger-Cohen Act	Enterprise Architecture became a recognized strategic and management best practice of the federal government with the passage of the Clinger-Cohen Act in 1996.
Federal Information Security Management Act (FISMA) of 2002	Requirements for all federal agencies to develop, document and implement agency-wide information security programs.

2.1.2 Visual Modeling

The HHS 2020 EA adopts a model-driven architecture approach linking together visual depictions of Business, Data and Technical Architecture elements.

The EA's visual modeling standards are listed in the following table.

Table 3: Visual Modeling Standards for Architectural Domains

Domain	Domain Element	Modeling Notation	Modeling Artifact	Tool
Business Architecture	Business Process	BPMN	Business Process Model	Oracle BPM Studio
Information Architecture	Conceptual Data Model	UML with data modeling extension exportable to ERD via XMI	Conceptual Data Model	Sparx Enterprise Architect (EA)
Information Architecture	Logical Data Model	UML with data modeling extension exportable to ERD via XMI	Logical Data Model	Sparx EA
Information Architecture	Physical Data Model	UML with data modeling extension exportable to ERD via XMI	Physical Data Model	Sparx EA
Information Architecture	Data Warehouse and Data Mart Models	Entity Relationship	DW/DM Design Model	Computer Associates (CA) ERwin
Technical Architecture	Infrastructure Architecture	Infrastructure Modeling Notation	Infrastructure Architecture	MS Visio
Technical Architecture	Software Architecture	UML	Reference Technical Architecture	Sparx EA
Technical Architecture	Software Architecture	UML	Requirement Realization	Sparx EA
Technical Architecture	Software Architecture	BPEL	Orchestration Design	Oracle BPM Studio

2.1.3 Enterprise Architecture

The Enterprise Architecture standards are listed in the following table.

Table 4: Enterprise Architecture Standards

Standard	Relationship to HHS 2020
DoDAF	The U.S. Department of Defense has a widely-used, strongly enforced architecture framework. Version 2.02 was published in 2010 and was used as a checklist for HHS 2020 since it is an advanced, practical architectural framework and favors shared information standards.
National Institute of Standards and Technology (NIST)	The National Institute of Standards and Technology (NIST) created and published the Federal Enterprise Architecture Model in the late 1980's. It was then promoted in September 1999 by the Federal CIO Council as the Federal Enterprise Architecture Framework (FEAF). It has been a foundational architectural standard for federal agencies (including CMS) that were developing enterprise architectures for systems that operated across agency boundaries. NIST also has a Cloud Computing Reference Architecture. Published in September 2011, it presents thoughts and guidance on standards for leveraging cloud computing in federal systems.
NHSIA	www.acf.hhs.gov Published by the Administration for Children and Families (ACF) in 2012, the National Human Services Interoperability Architecture (NHSIA) provides an enterprise architecture framework for the ACF to guide development of systems that work together across organizational silos and boundaries to accomplish ACF mission and goals. Its goals and objectives are very similar to CMS goals and contain common drivers to those of HHS 2020 including Interoperability across organizational and system boundaries, "no wrong door" for clients, and improved data sharing and other similarities.
TOGAF	The Open Group created their architecture framework in the early 1990's and released the first TOGAF in the mid 1990's. It is the most complete EA framework, but many criticize it as too complex and difficult to apply. Many organizations have adopted and adapted it to their organization; therefore, no two are the same. Some organizations complain that it is lacking how-to recommendations. The HHS 2020 EA will follow the CMS MITA architecture. MITA is easier to navigate and apply than TOGAF and is much more practical in its implementation.
The Zachman Framework	First defined back in the 1980's by John Zachman, the current framework is an ontology for enterprise architecture. It defines six dimensions of architectural specifications/interrogatives (who, what, when, where, why and how) and five levels of abstraction (from the most conceptual "owners" view to the most detailed "implementation" view). This is the most rigorous of all architectural frameworks but is not a methodology. Like TOGAF and others, it has never been fully implemented.

Standard	Relationship to HHS 2020
NASCIO	The National Association of State Chief Information Officers is an active organization of State CIOs and industry leaders that advance the state of data management, architecture and governance for State CIOs. They have several operating committees that align with HHS 2020 efforts (https://www.nascio.org/Committees), including: • data management Working Group • Enterprise Architecture and Governance Committee • Cybersecurity Committee • Privacy and Data Protection Working Group
Capability Maturity Model Integration (CMMI) Maturity Level 4 for Development (Product and Process Quality Assurance (PPQA))	Organizational process maturity framework.

2.1.4 Business Architecture

The following table lists standards applicable to HHS 2020 Business Architecture definition

Table 5: Business Architecture Standards

Standard	Relationship to HHS 2020
MITA 3.0	CMS Medicaid Information Technology Architecture (MITA), version 3.0. It presents the concepts, principles, contents, deliverables and expectations of CMS-compliant systems. MITA 3.0 is the basis of the HHS 2020 EA.
Seven Conditions and Standards	The Seven Conditions and Standards for Advanced Funding were incorporated into HHS 2020 EA.
MITA Maturity Model	The MITA Maturity Model was consulted in constructing HHS 2020 EA.
SAMHSA BA-MITA	The Substance Abuse and Mental Health Services Administration (SAMHSA) worked with CMS to create the Behavioral Health (BH) BH-MITA project, which was compared to HHS 2020 to ensure consistency and mapping between HHS 2020 assets and SAMHSA guidelines (for non-MMIS organizations)

Standard	Relationship to HHS 2020
Business Process Modeling Notation (BPMN)	Governs Business process definitions within business architecture domain.
Eriksson-Penker Extensions	UML extensions for modeling of business architecture elements such as rules, goals, constraints, resources, etc.

2.1.5 Information Architecture

The following table lists standards applicable to the HHS 2020 Information Architecture definition.

Table 6: Information Architecture Standards

Standard	Relationship to HHS 2020
National Information Exchange Model (NIEM)	For elements not found in FHIM and FHIR, canonical model element naming for HHS 2020 data entities and attributes.
Federal Health Information Model (FHIM)	For elements not found in NIEM and FHIR, canonical model element naming for HHS 2020 data entities and attributes.
Fast Healthcare Interoperability Resources (FHIR)	For elements not found in NIEM and FHIM, canonical model element naming for HHS 2020 data entities and attributes.
ASC X12	See entry for Accredited Standards Committee in Table 8, below.
XML Metadata Interchange (XMI)	Custom-defined canonical data model element naming standards to ensure understanding and interoperability with external systems.

2.1.6 Technical Architecture

Technical Architecture elements are governed by a combination of standards applicable to Infrastructure Architecture and Software Architecture sub-domains.

The following table lists the EA Infrastructure standards.

Table 7: Infrastructure Architecture Standards

Standard	Relationship to HHS 2020
Minimum Acceptable Risk Standards for Exchanges (MARS-E) 2.0	MARS-E control families applicable to hardware and software infrastructure, as well as physical access controls.
IRS Publication 1075	Tax Information Security Guidelines for Federal, State and Local Agencies
International Organization for Standardization (ISO) 9001:2015	Quality Management.
Information Technology Infrastructure Library (ITIL) V3	Infrastructure and Operations framework.
FedRAMP (Federal Risk and Authorization Program)	Security for access of cloud-based computing environments.
Federal Information Processing Standards (FIPS) 140-2	Hardware architecture-applicable provisions for use of cryptographic modules.
IEEE 802 family	Local and Metropolitan Area networking standards.

The following table lists the EA Software standards.

Table 8: Software Architecture Standards

Standard	Relationship to HHS 2020
IEEE Std. 730- 1998.	Standards for Software Quality Assurance Plan.
Section 508 Amendment to the Rehabilitation Act of 1973	Information Technology Accessibility to individuals with disabilities.
Web Service Dynamic Discovery (WS-Discovery)	Service programmatic interface documentation for discovery and client technology specific proxy generation purposes.
Universal Description Discovery and Integration (UDDI)	Published service listing.

Standard	Relationship to HHS 2020
Hypertext Transfer Protocol (HTTP)	Primary means for service endpoint invocation and information exchanges using SOAP and ReST protocols.
Transport Layer Security (TLS)	Formerly known as Secure Socket Layer (SSL) used to create secure HTTP (HTTPS) communication channels ensuring in-transit data privacy and integrity.
Simple Object Access Protocol (SOAP)	A protocol for HTTP-based service invocation with information exchanged in XML format.
Extensible Markup Language (XML)	Request and response information encoding for SOAP exchanges.
Representational State Transfer (REST)	A protocol restricting endpoint invocations with HTTP verbs (e.g. GET, POST) exchanging information in JSON encoding format.
Java Script Object Notation (JSON)	Information encoding format for REST-based communications offering smaller bandwidth footprint compared to XML.
Business Process Execution Language (BPEL)	Configuration of both long-running (e.g. end-to-end business process) and short-running (e.g. service implementation using Enterprise Application Integration (EAI) adapters) orchestrations.
JSR 362 (aka Portlet Specification 3.0)	Standard for information exchanges across portlets within the web UI layer of HHS 2020 Enterprise.
Web Services for Remote Portlets (WSRP v2.0)	Standard for consumption of portlet output as presentation layer services across HHS 2020 and BPO module web applications.
Accredited Standards Committee (ASC)	In 1979 the ASC formed the X12 Committee, which defined the electronic data interchange (EDI) standards for business-to-business eCommerce at the national and international level. It is useful in that numerous X12 transactions must flow into and out of the HHS 2020 ecosystem.
Federal Information Processing Standards (FIPS) 140-2	Software architecture-applicable provisions for use of cryptographic modules.
Coding Accuracy Support System (CASS™)	Enables the United States Postal Service (USPS) to evaluate the accuracy of software that corrects and matches street addresses.
Java Message Service (JMS) 2.0a	A standard for message-oriented middleware implemented on Java platform.

Standard	Relationship to HHS 2020
SSH File Transfer Protocol, aka Secure File Transfer Protocol (SFTP) v.6	Network protocol for file access, transfer and management over any reliable data stream.

2.1.7 Standards Body Participation

The HHS 2020 enterprise participates in various standards bodies. Participation includes HSD leadership membership in the National Association of State Chief Information Officers (NASCIO), an active organization of state CIOs and industry leaders that advance the state of data management, architecture and governance for state CIOs. NASCIO has several operating committees that align with HHS 2020, including a data management Working Group, an Enterprise Architecture and Governance Committee, a Cybersecurity Committee and a Privacy and Data Protection Working Group. To shape the upcoming MITA releases and to impart New Mexico's experience, New Mexico HSD maintains a seat on the MITA Advisory Board with regular event participation and collateral contribution.

Whenever applicable industry standards fall short of the prescribed minimum model quality levels, NM invokes reactive standards body participation mechanisms. For example, the HHS 2020 canonical data model is based on three major data modeling standards:

- National Information Exchange Model (NIEM)
- Federal Health Information Model (FHIM)
- Fast Healthcare Interoperability Resources (FHIR)

Should modelled entities fall outside of the specialized standards, the HHS 2020 EA applies XML Metadata Interchange (XMI) standards to all adopted canonical model elements.

HHS 2020 data governance requires continual measurement of the reference data model quality. A higher degree of adherence to elements defined as part of specialized standards (NIEM, FHIM and FHIR), as opposed to inventing new concepts and naming them in accordance with XMI, is a sign of model quality. Spot checks are performed on newly-defined model elements by doing deeper investigative dives into the specialized models to be sufficiently certain that an existing, applicable element has not been overlooked.

HHS 2020 data governance defines a threshold for a maximum number or proportion of permitted new (not specialized standards-based) data elements as well as makes provisions to impart changes when existing standards fail to support NM's preference for avoidance of custom element definitions. Under these circumstances, the project engages appropriate standards bodies or model custodians (like the NIEM Program Management Office or J P Systems, Inc. for FHIM) in order to improve published standards and to bring the number of custom-defined canonical elements at or below the desired thresholds. As

with any other standards updates, stakeholders within NM's Medicaid Enterprise benefit from the project's efforts.

2.2 REQUIREMENT-CENTRIC, TRACEABLE SOLUTION

Every decision made in the HHS 2020 technical architecture must be based on corresponding requirements in order to be justifiable. Strong traceability among all EA elements is essential in demonstrating the solution's grounding in requirements.

In order to catalogue and visualize traceability relationships amongst various SDLC elements, the HHS 2020 EA adopted concept metamodels covering requirements management, solution architecture and design, and test management disciplines.

2.2.1 Requirements Management Metamodel

The requirements management discipline is a combination of activities and artifacts residing primarily in the Business Architecture domain and spanning traceable elements of Business Architecture and System Requirements.

The diagram below illustrates the Requirements Management metamodel of HHS 2020 EA.

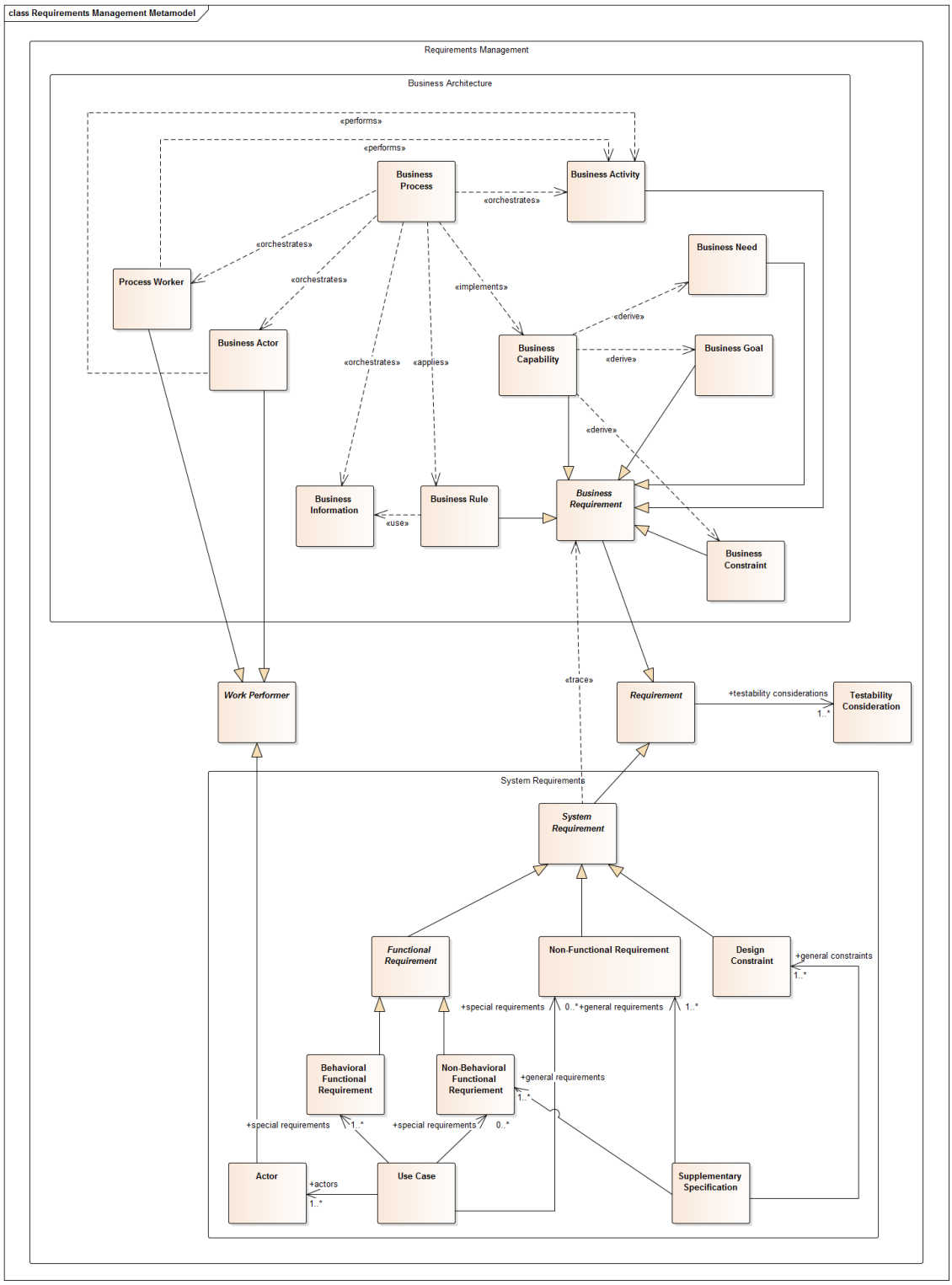

Figure 1: Requirements Management Metamodel

The following table contains explanations for each of the requirements metamodel elements' purpose and relationships to other elements.

Table 9: Requirements Management Metamodel Element Catalogue

Element Group	Metamodel Element	Description
Foundational	Requirement	An abstract concept representing a statement of capability that is clear and concise, complete, non-conflicting with and distinct from other requirements, as well as achievable, traceable and testable. Requirements contain the pure "what" of the capability, and not the "how" of its accomplishment. A requirement is associated to at least 1 testability consideration.
Foundational	Testability Consideration	Testability consideration is a description of a mechanism by which a requirement will be verified for implementation correctness
Foundational	Work Performer	An abstract concept representing humans, systems, organizations and departments, both internal and external to the HHS 2020 enterprise, that exercises functionalities within the enterprise.
Business Architecture	Business Requirement	A business requirement is an abstract sub-type of system requirements. The specification for a business requirement must be expressed in non-technological (business) terms only.
Business Architecture	Business Process	Each of the 80 business processes defined under MITA 3.0 in standard form with New Mexico State-specific variations, plus any additional processes unique to the State of New Mexico. A business process is an implementation of a business capability that orchestrates interactions among business actors and process workers performing business activities, while manipulating business information subject to applied business rules.
Business Architecture	Business Capability	A business capability is a concrete sub-type of a business requirement derived from a combination of business needs, business goals and business constraints.
Business Architecture	Business Actor	A business actor is a concrete sub-type of a work performer representing an individual or an organization external to the HHS 2020 enterprise that interacts with the enterprise via business processes.
Business Architecture	Process Worker	A process worker is a concrete sub-type of a work performer, representing an individual or a system internal to HHS 2020 enterprise, participating in business process execution.

Element Group	Metamodel Element	Description
Business Architecture	Business Activity	A business activity is a concrete sub-type of a business requirement that represents functionalities performed by process workers and business actors as part of a business process.
Business Architecture	Business Information	Business Information is a noun or a concept of business vocabulary (e.g. Claim, Payment, etc.) that flows through business processes and serves as a Fact for application of business rules. Business Information items are documented in plain English text format and give rise to, but are not as formal as, Conceptual Data Model elements.
Business Architecture	Business Rule	A Business rule is a concrete sub-type of a business requirement comprised of a logical expression in the form “if <condition>, then <outcome>”. business rules govern the direction of business processes at decision points by using business Information items as facts against which conditions are checked.
Business Architecture	Business Need	Business need is a concrete sub-type of business requirement that specifies pain point or area of improvement to be addressed by HHS 2020 solutions.
Business Architecture	Business Goal	Business goal is a concrete sub-type of business Requirement representing quantitative, measurable, success criteria for business improvement.
Business Architecture	Business Constraint	A business constraint is a concrete sub-type of business requirement that stipulates a prescribed mechanism for accomplishing or preventing a business capability, e.g. regulatory constraints.
System Requirements	System Requirement	An abstract sub-type of requirement that is expressed in technical (non-business) terms.
System Requirements	Design Constraint	A concrete sub-type of system requirement that stipulates a prescribed implementation approach (e.g. uses of certain approved COTS technologies).
System Requirements	Non-Functional Requirement	A concrete sub-type of system requirement applicable to the aspects of system operation (e.g. performance, scalability, reliability, etc.) and not the functionality carried out by the system.
System Requirements	Functional Requirement	An abstract sub-type of system requirement describing what the system is supposed to do.

Element Group	Metamodel Element	Description
System Requirements	Behavioral Functional Requirement	A concrete sub-type of functional requirement that is best expressed as an interaction dialogue between the user and the system.
System Requirements	Non-Behavioral Functional Requirement	A concrete sub-type of functional requirement that is best expressed not as an interaction dialogue between the user and the system (e.g. "the system shall encrypt data in transit using a 256-bit asymmetric key").
System Requirements	Use Case	A use case is an aggregate of specific behavioral functional requirements structured into its flows, potentially coupled with specific nonfunctional and non-behavioral functional requirements with limited applicability scope. Use cases are associated to actors involved in the runtime execution of system functionalities.
System Requirements	Actor	A concrete sub-type of work performer representing an individual, system or passage of time that triggers and/or participates in use case execution.
System Requirements	Supplementary Specification	A container of all globally applicable non-behavioral functional requirements and non-functional requirements as well as design constraints.

2.2.2 Solution Architecture and Design Metamodel

Solution Architecture and Design discipline is a combination of activities and artifacts residing in a combination of Data and Technical Architecture domains.

The diagram below illustrates the Solution Architecture and Design metamodel of HHS 2020 EA.

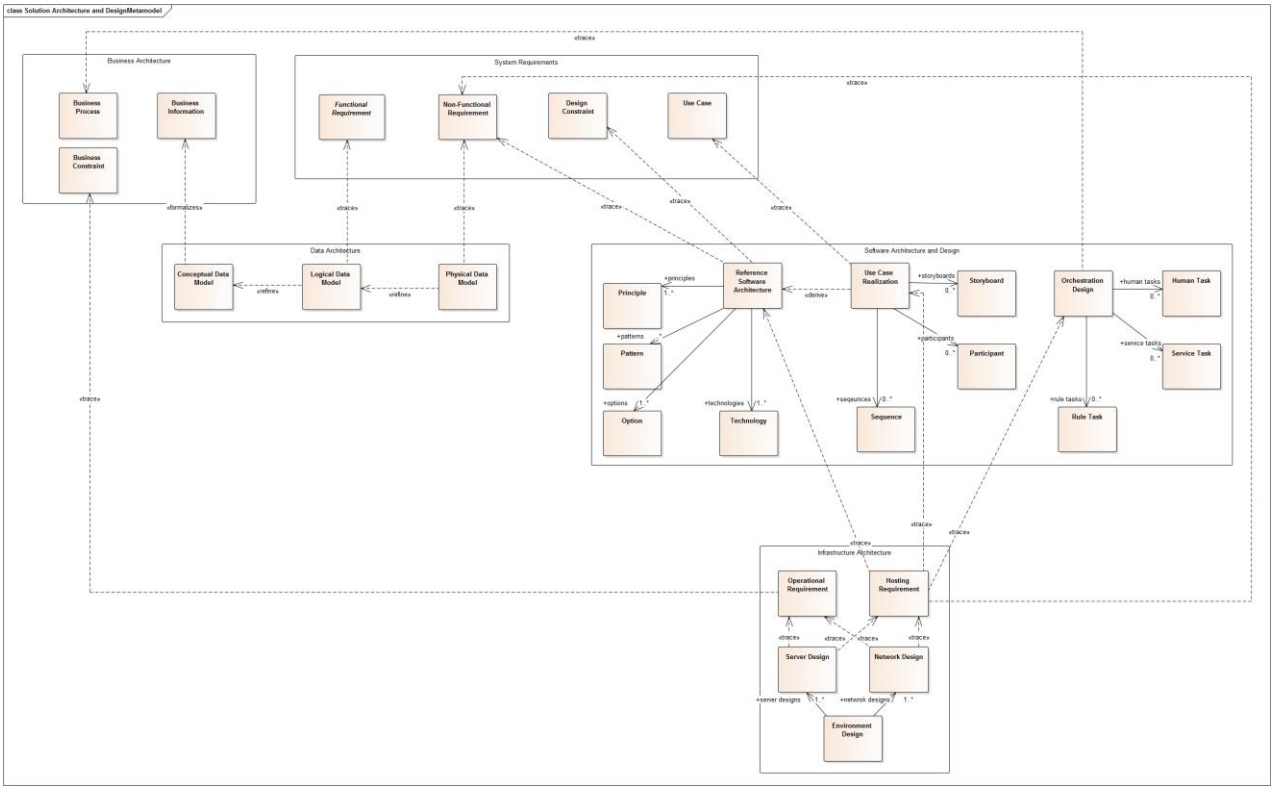

Figure 2: Solution Architecture and Design Metamodel

The following table contains explanations for each of the Solution Architecture and Design metamodel elements' purpose and relationships to other elements.

Table 10: Solution Architecture and Design Metamodel Element Catalogue

Element Group	Metamodel Element	Description
Information Architecture	Conceptual Data Model	A formalization of text-based descriptions of business information items into visually modeled entities, attributes and relationships.
Information Architecture	Logical Data Model (LDM)	A refinement of the Conceptual Data Model traceable to corresponding functional requirements. The LDM includes additional design elements of referential integrity (e.g. keys and constraints) as well as better-structured attribute data-typing.
Information Architecture	Physical Data Model (PDM)	A refinement of Logical Data Model traceable to non-functional requirements. The PDM includes additional design elements of indexing, storage partitioning, etc., intended to serve as a blueprint for database instantiation in the targeted environment.

Element Group	Metamodel Element	Description
Software Architecture and Design	Reference Software Architecture	The Reference Software Architecture serves dual purposes. First, it's a catalogue of approved patterns and technology selections that address key shared functional and global non-functional requirements (to which all Reference Software Architecture decisions are traced). Second, it provides prescriptive guidance to solution designers tasked with specific functional requirement implementations through a combination of design principles and options ranked by degree of adherence to enterprise preferences, whenever applicable.
Software Architecture and Design	Principle	A principle is a governing approach to architectural decisions resulting in favorable solution traits (e.g. loose coupling, modularity, favoring declarative vs. imperative implementations).
Software Architecture and Design	Pattern	A proven architectural method to addressing a class of problems and requirements (e.g. architectural layering, service orientation).
Software Architecture and Design	Option	A choice of a design approach to a specific class of problems ranked in terms of attractiveness of the resulting solution based on the PADU framework. - Preferred: Fully adhere to specified standards - Acceptable: Adhere to the optimal set of standards, but generally result in more effort to implement than ideally desired - Discouraged: Initial shortcuts are only permitted if accompanied by a future mitigation plan - Unacceptable: Violating key architectural tenets to the point of impermissible under any circumstances, regardless of any future correctional remedies
Software Architecture and Design	Technology	Purchased COTS offering to be used as foundation for functionality implementation (e.g. operating system, business rule engine, database engine, enterprise application integration platform).

Element Group	Metamodel Element	Description
Software Architecture and Design	Use Case Realization	Use case realizations are traceable to use cases whose requirements serve as inputs into solution function designs. Use case realizations refine the foundational principles found in the Reference Software Architecture to achieve optimal, standards-compliant solution designs. In the spirit of SDLC agility, HHS 2020 permits solution designers substantial leeway in the formality of use case realizations. Only the non-obvious, complicated, fundamental, important design elements will be documented. Storyboards are the most likely vehicle to elicit UI-related software designs. Static structure depictions of participating components or classes (depending on design granularity) may be presented to show scope of a technical solution. Participants may be put into sequences of message calls demonstrating their interaction to fulfill specified requirements.
Software Architecture and Design	Storyboard	A storyboard is a visual depiction of a user interface via wireframes, in various states of interaction, intended to shape UI layer solution design.
Software Architecture and Design	Participant	Programmatic interfaces and classes (or components for less granular designs) with their attributes, operations and inter-relationships (generalizations, implementations, dependencies, associations, etc.)
Software Architecture and Design	Sequence	Interactions of use case realization participants with messages exchanged in the course of requirements implementation.
Software Architecture and Design	Orchestration Design	Orchestration design is a combination of human, service and rule tasks traceable to the requirements contained in a business process.
Software Architecture and Design	Human Task	A Human task is an orchestrate-able business process element involving human interaction with a user interface (e.g. a web page, text message, email exchange, etc.).
Software Architecture and Design	Service Task	A Service task is an orchestrate-able interaction with a business service (e.g. check claims status).
Software Architecture and Design	Rule Task	Rule task is an invocation of one or more business rules to be applied to the process data in order to arrive at a decision (e.g. if payment status is disputed and payment is past due by more than 2 weeks, escalate to account manager).

Element Group	Metamodel Element	Description
Infrastructure Architecture	Environment Design	Environment design is a combination of server and network design for a given computing environment instance (e.g. development, production, disaster recovery).
Infrastructure Architecture	Server Design	Server design is physical hardware, software and virtualization specification for a server computing node (e.g. web server, app server, database server).
Infrastructure Architecture	Network Design	Network design is network partitioning, addressing schemes, security mechanisms, etc., within and across environments.
Infrastructure Architecture	Operational Requirement	An operational requirement is a requirement arising from business constraints (e.g. MARS-E security controls) and configuration change management requirements for hosted software and integrated hardware components (e.g. changes to network configuration, access control lists, etc.).
Infrastructure Architecture	Hosting Requirement	Requirement for placement of COTS software and configured/built solution components into various computing nodes within an environment.

2.2.3 Test Management

The HHS 2020 initiative adheres to the CMS Testing Framework V1.1 and marries that with the V-Model of Testing (below). HHS 2020 benefits from following the guidance and standards of CMS as well as the rigor of V-Model Testing that standardizes tasks for the module contractors participating in the HHS 2020 effort. Figure 3 below provides a visual representation of the V-Model of Testing.

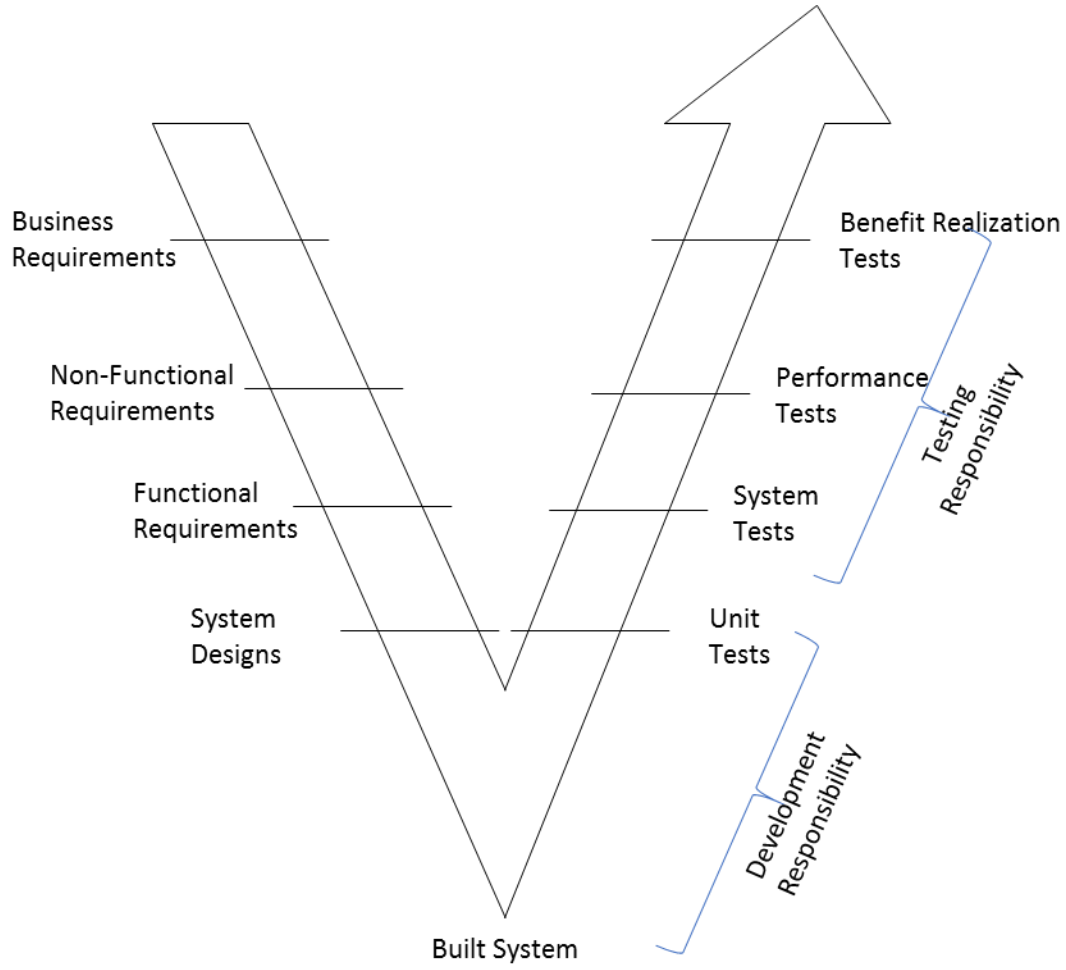

Figure 3: HHS 2020 V-Model of Testing

The SDLC lifecycle can be thought of as the 2 sides of the letter V where the left side represents the journey to create the solution, and the right side represents various levels of tests to verify the solution's quality and adherence to stipulated requirements. The highest level of requirements contributing to a solution come from the Business Architecture. They are followed by the Non-Functional Requirements for the system (performance, scalability, reliability, redundancy, etc.) since such requirements are expressed as simple, "bullet point" statements and are easy to elicit and document. System functional requirement elicitation, analysis and documentation is a much lengthier task with a considerably larger number of work products. Solution requirements get reflected in system designs, which in turn materialize as executable solution elements or the "built" system. This completes the left-hand side SDLC activities, enabling the testing (right side) activities to commence.

Testing activities occur at the granularity of the solution elements corresponding to the left- side elements. The most granular tests corresponding to system designs are unit tests. Unit test design,

execution and failure resolution are the responsibilities of solution implementors. Tests of lower granularity are the responsibility of test management professionals outside of the implementation teams. The first non-developer testing is done to demonstrate coverage of the functional requirements in the solution and is known as system testing. With functional implementations in place and verified, the solution is tested against the non-functional requirements; most critically: performance and scalability-related requirements. The highest level of testing demonstrates that the complete solution, with all its functional and non-functional aspects, meets the needs stipulated in the Business Architecture and allows the HHS 2020 enterprise to realize all the benefits envisioned at the highest levels of business requirements.

The diagram below illustrates the test management metamodel of the HHS 2020 EA.

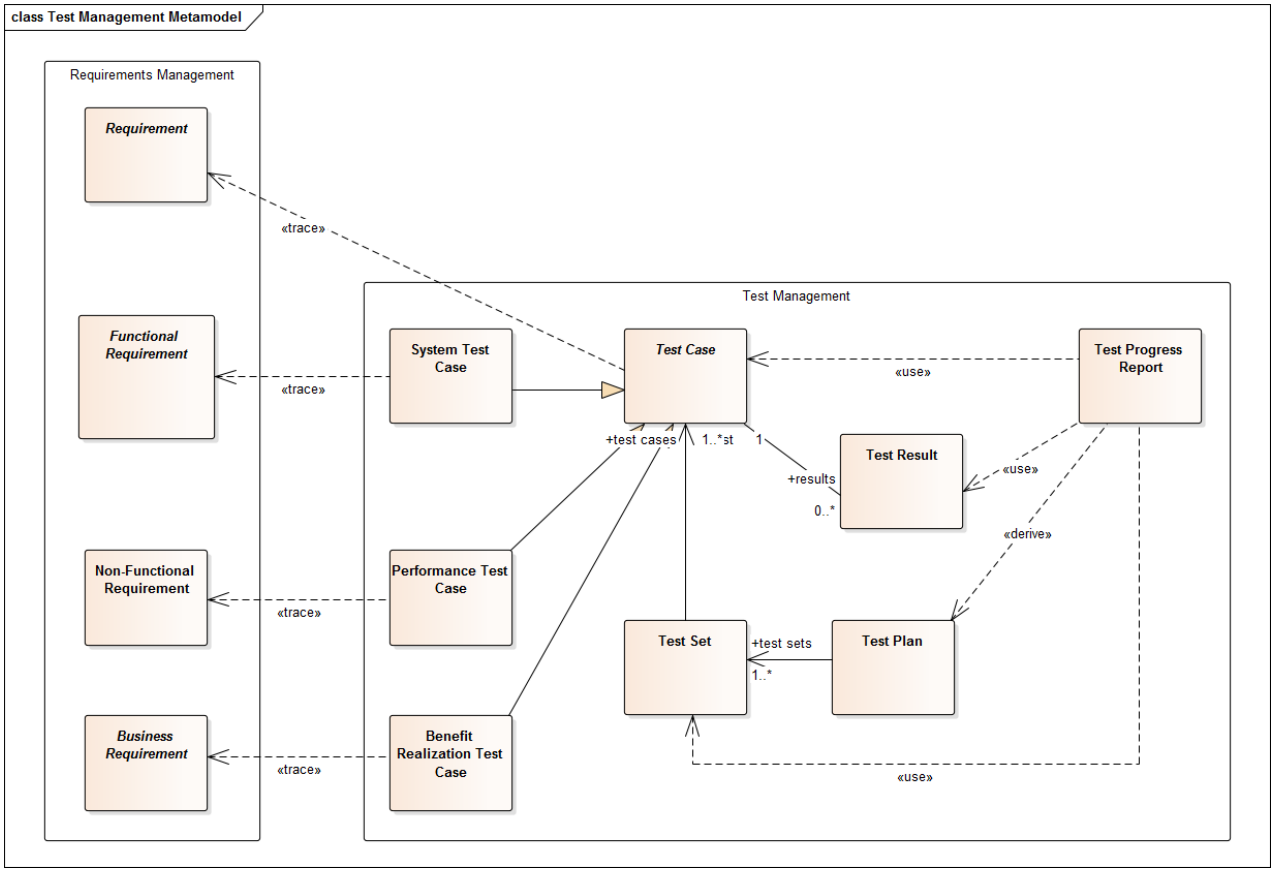

Figure 4: Test Management Metamodel

The following table contains explanations for each of the test management metamodel elements' purpose and their relationships to other elements.

Table 11: Test Management Metamodel Element Catalogue

Metamodel Element	Description
Test Set	A combination of test cases covering a group of related requirements.
Test Case	An abstract concept traced to a corresponding requirement, describing test conditions, data, and success criteria. The element is abstract because the nature and structure of the contained information changes with the type of test that is performed and is delegated to the concrete derivatives. While initially a test case is not associated to any test results, as testing is performed and results are generated, the cardinality of case to result increases.
Test Result	An outcome from the performance of a single test case.
System Test Case	A concrete sub-type of test case traced to a functional requirement.
Performance Test Case	A concrete sub-type of test case traced to a non-functional requirement.
Benefit Realization Test Case	A concrete sub-type of test case traced to a business requirement.
Test Plan	An ordered listing of all test sets ensuring holistic requirement coverage.
Test Progress Report	A regularly executed report derived from test plan scheduling information, listing status of test sets, test cases based on available test results.

2.2.4 Traceability through SDLC tools

The HHS 2020 initiative will follow CMS guidance on how traceability should be undertaken. HHS 2020 will leverage enterprise tools for the project requirements traceability matrix (RTM) and fully trace requirements through the SDLC to the solution elements that satisfy the MECT checklist. See Table 11, below.

Table 12: Requirement Traceability Tools

Company	Product	Purpose in EA
Microsoft Corporation	SharePoint	Artifact repository for all RTM artifacts

Company	Product	Purpose in EA
TaskTop	TaskTop	Enterprise Integration tool connecting tools within requirements management; test management; defect management and engineering management. This tool enables models and rules to be applied to work iem types (WIT) in each of the tools and apply rules and real time synchronization between the systems.
Atlassian	Jira	This tool functipons as the project engineering system to track, trace and plan development activities. TaskTop is leveraged to synchronize information that is linked between the systems.
Xpand-it	Xray Add-on for Jira	A test management solution for requirement verification, defect management and traceability. .
Xpand-it	Xporter Add-on for Jira	This tool is used to move information from the engineering system into CMS Templates in the artifact system both for traceability and reporting.
JAMA Software	JAMA	JAMA is the project requirements repository. It is the central component of the project RTM. TaskTop connects JAMA's requirements functions to Jira for development as well as traceability.
Adaptavist ScriptRunner	ScriptRunner Add-on for Jira	Used to author scripts for Jira.

3 BUSINESS ARCHITECTURE STRATEGY

For New Mexico HSD, the journey towards a more person-centric enterprise starts with the definition of a Business Architecture that links processes, information, stakeholders, systems and rules in an effort to provide optimal service to NM stakeholders.

3.1 ARCHITECTURE SCOPED BY MITA

MITA business process catalogue bounds the functional scope of Business Architecture with a set of proven, structured and well-documented interactions. HHS 2020 EA will include a holistic depiction of all standard business processes and variations necessitated by uniqueness of New Mexico Medicaid Enterprise. The processes will be modeled in an industry-standard notation (BPMN) that is universally understandable and shareable within State of New Mexico's departments, as well as with other states looking to leverage proven MMISR Business Architecture collaterals. New Mexico HSD business stakeholders have taken charge in systematic identification, cataloguing, documentation of Business Information items that flow through business processes. The resulting definitions are technology-independent, understandable and subject to reuse across business processes as needed.

Business information items serve a foundational role for solution data modeling with strong traceability maintained among Business Information items and Conceptual, Logical and Physical data model elements. HHS 2020 Business Architecture takes the approach of externalizing the logic controlling business process flow execution into Business Rules. In the spirit of keeping Enterprise Architecture assets understandable and reusable, HHS 2020 EA is using the latest COTS BRE technologies from Oracle, enabling Business ability to define rules in plain English language. Related rules are combined into rule sets that are checked for consistency, redundancy and any coverage gaps, equipping the Business Rules authors with sufficient degree of confidence in the quality and usefulness of our Business rules.

3.2 NO WRONG DOOR

With HHS 2020 solution in place, the State will serve each constituent through the channel of his/her preference, with consistent information, data quality and ubiquitous security through our no-wrong-door multichannel strategy. To maintain continuity of user experience with available legacy touchpoints, HHS 2020 will initially offer web and interactive voice response (IVR) self-service channels. However, due to the socioeconomic background of our target constituents and the complex nature of initial interactions to bring potential benefit recipients into the system and offer them an optimal combination of assistance offerings, in-office, in-person field office visits and calls to full-service contact center will remain as the most interaction-rich channel for the foreseeable future.

Whether in self or full-service model, the State's goal is to bring all the pertinent, up-to-date, high quality information to users, making each interaction as positive and productive as possible, minimizing the number of subsequent touchpoints. The State's aims to maximize initiation, execution and tracking of various business processes through uses of advanced computer technologies. It is expected that the process, data and rule elements of Business Architecture, along with all related requirements, will be implemented in the technology layers of HHS 2020 Enterprise, vastly reducing the amount of manual tracking, coordination and escalation that has been the historical norm.

The State will pursue a mobile-first approach to our self-service channels. The ubiquity of mobile devices in use by our constituent population, coupled with the limited financial resources to make larger form-factor devices and internet access available for regular use, necessitate mobile optimization for all constituent-facing web and mobile application entry points. The Business foresees not only rendering user experience that is optimized for the host device form-factors, but also enhancing the experience based on the interaction context and considering state of the user's participation in various business processes that are currently underway. We are striving not for just a responsive experience, but for a truly adaptive one.

State will explore new self-service channel opportunities such as SMS text-based applications and visual IVR. With ubiquity of text messaging available to users in all socioeconomic strata and widespread acceptance of texting technologies, HHS 2020 Enterprise can capitalize on this low-cost communication channel. It can be used not only for traditional message-based campaigning e.g. enrollment and seasonal vaccination reminders, but also to implement stakeholder information exchanges as part of ongoing business processes e.g. questionnaires, field office appointment scheduling, etc.

Visual IVR is a customer service technology gaining quick traction in the world of commercial healthcare that shows great promise in government service applications.

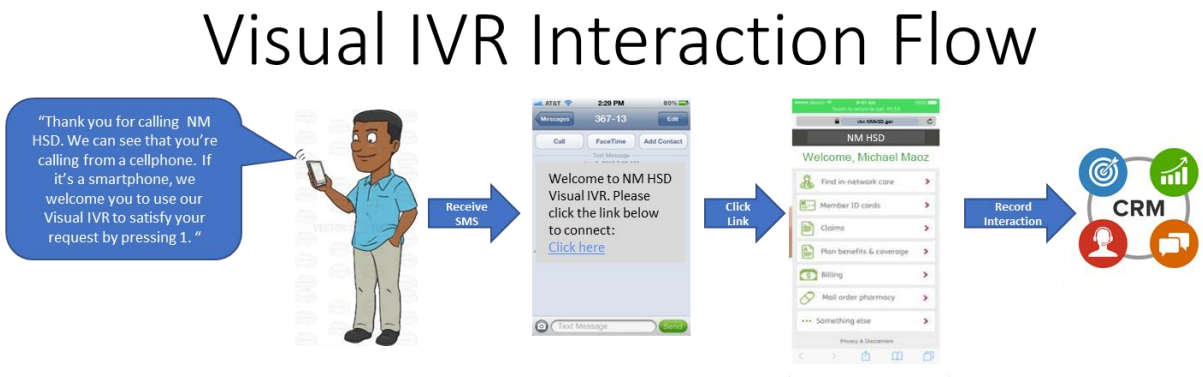

Figure 5: Visual IVR interaction flow illustration

Visual IVR interactions start with a call from the user's mobile device to a regular voice response system, followed by an opportunity to switch from the IVR menu interactions to a small-format web site. The web

site provides a better experience than the telephony-only options by providing the user tailored screens and workflows. Should the user's inquiries fail to get answered in visual IVR self-service mode, his/her place in the full-service queue will be maintained and all interaction details will become available to the customer service representative to complete the full-service portion of the call.

Fundamental to NM's ability to provide a useful and compelling digital experience is the end user's ability to customize and maintain their preference for communication channels, styles, media, etc.

3.3 STAKEHOLDER-DIRECTED, STATE-CONTROLLED INFORMATION

Given the strategic goal of changing the population behaviors towards healthier alternatives and providing integrated, value-based models of care, it is essential for constituents to know the extent of relevant information maintained by the State. To meet these goals, the State envisions a robust, end user preference management mechanism that the user can access via self-service or via a traditional encounter with the contact center. The preference management service will allow stakeholders to fine-tune his/her communication and information sharing preferences.

Given the highly personal and sensitive nature of constituent information held in the HHS 2020 systems, the State is adopting strict security and privacy standards to prevent unauthorized system access or information disclosure. The user's ability to access functionality and to view data will be based on a combination of application role membership, applicable information sharing preferences and the user's relationship to the information (e.g. a State employee who is normally authorized to review claims will be prevented from accessing claims for his/her family members as such access would constitute conflict of interest).

3.4 DATA-DRIVEN ENTERPRISE

Access to timely, pertinent and high-quality data is essential to decision-making by HHS 2020 stakeholders. Business Architecture stipulates strict data quality requirements, including information accuracy, timeliness, absence of data duplication and effective information aggregation.

Access to transactional data will be required for one-off review and decision purposes. Transactional information will be included as part of various application screens and operational reports. Aggregated and summarized data lacking individual transactional details will be used for managerial reporting purposes offered for internal and external consumption. The State envisions operating a Reporting Universe sub-system enabling business users to query the enterprise for new combinations of summarized data concepts without involving technical resources that have been historically needed for creation of every report. An even higher level of data aggregation will enable strategic what-if analysis as

well as proactive identification of trends pertinent to business operations, finance, care management and emerging current and future focus areas for the enterprise.

Having satisfied the stakeholders' data access and reporting needs, the HHS 2020 EA will offer additional data-driven event origination and processing capabilities whereby discovered trends will lead to business process improvements and opportunities to offer innovative public assistance administration and health care approaches. New Mexico HSD understands that its area of historical competency in health care administrative data (defined under the HIPAA EDI standard) is insufficient for creation of a 360-degree view of a constituent, complete with insightful and actionable information to enable optimal care. Other necessary data streams will be incorporated under the HHS 2020 vision. To enable outcomes-based care and reimbursement models the state will invest in clinical data repositories (HL7 standard) that can be used to link provided care with diagnosable outcomes.

3.5 COLLABORATION AND REUSE

The HHS 2020 EA provides an opportunity for integration among legacy and newly-deployed systems where data is shared and business processes span across traditional organizational boundaries. Such an approach breaks down artificial boundaries between systems, geography and funding inherent to Title XIX programs. Although the starting scope of implemented functionalities are Medicaid-centric, departments outside of NM Medicaid are enabled from the outset to share in the benefits afforded to the State by the new enterprise. Conversely, as other NM departments join the HHS 2020 ecosystem and make their data and processes open for collaboration, new opportunities to serve constituents will emerge.

Decisions can be made concerning housing, child-support, income, employment, transportation and even correctional and other data sources not typically associated with the core business of health care but revealing valuable data points about the social determinants of health. For example, correctional data can be used to plan the transition of inmates from prison to public health care, vocational training and housing assistance, or; changes in housing status of chronically ill members would trigger proactive interventions to keep them from falling off treatment regimens, etc. New Mexico's embrace of mandatory managed care for recipients places the burden of constructing and operating the care ecosystem with contracted MCOs.

3.6 MOVING FROM TRANSACTIONAL TO VALUE-BASED RELATIONSHIPS

The realm of evidence-based care, value-based reimbursements and other innovative approaches changes the historical pay-per-transaction paradigm to a pay-for-performance framework. The State's goal is to equip its care partners (MCOs, providers) with information-based insights, predictive analytics and tooling to better manage risk and to maximize rewards for demonstrated, proven performance. New Mexico plans to erect a partner ecosystem in which the State does the heavy-lifting in setting up the

complex information exchange for its partners to leverage in the movement towards value and outcomes-based care.

HHS 2020 takes the concepts of risk-sharing and value-based relationships beyond its health care partners to management of relationships with business process outsourcing (BPO) partners responsible for operation of financial services, quality assurance, data services, etc. This approach contrasts with the historical transactional contracts maintained with monolithic Medicaid system vendors tasked with day-to-day processing and not incentivized for any improvement opportunities or innovative thinking.

4 INFORMATION ARCHITECTURE STRATEGY

HHS 2020 Enterprise Information Architecture (EIA) supports the following 8 major objectives:

1. To provide a 360-degree view of all entities in all constituent categories (Client, Employee, Provider, MCO, etc.) in support of the Data-Driven Enterprise vision outlined in the Business Architecture Strategy
2. To provide report data for
    a. Regulatory, mandated reports (CMS-64, etc.)
    b. Pre-canned operational and analytical reports
    c. Ad hoc reporting and self-service business analytics
3. To enable predictive analytics and artificial intelligence-based hidden data pattern identification
4. To act as a backend for Enterprise Data-as-a-Service (EDAS) functionality
5. To maintain Enterprise data mastering of "golden" records for non-transactional entities
6. To support legacy system decommissioning and data migration to future systems
7. To provide Enterprise-wide Metadata Management, including data element definitions, provenance, survivorship rules etc.
8. To deliver the IA capabilities through joint efforts among State's own technical resources, System Integration Contractor (Turning Point Global Solutions), Data Services Contractor (IBM Watson Health) and numerous future BPO partners

4.1 ENTERPRISE INFORMATION ARCHITECTURE VISION

The proposed HHS 2020 EIA approach capable of achieving all of the major stated objectives is based on the modern Big Data Factory architecture pattern.

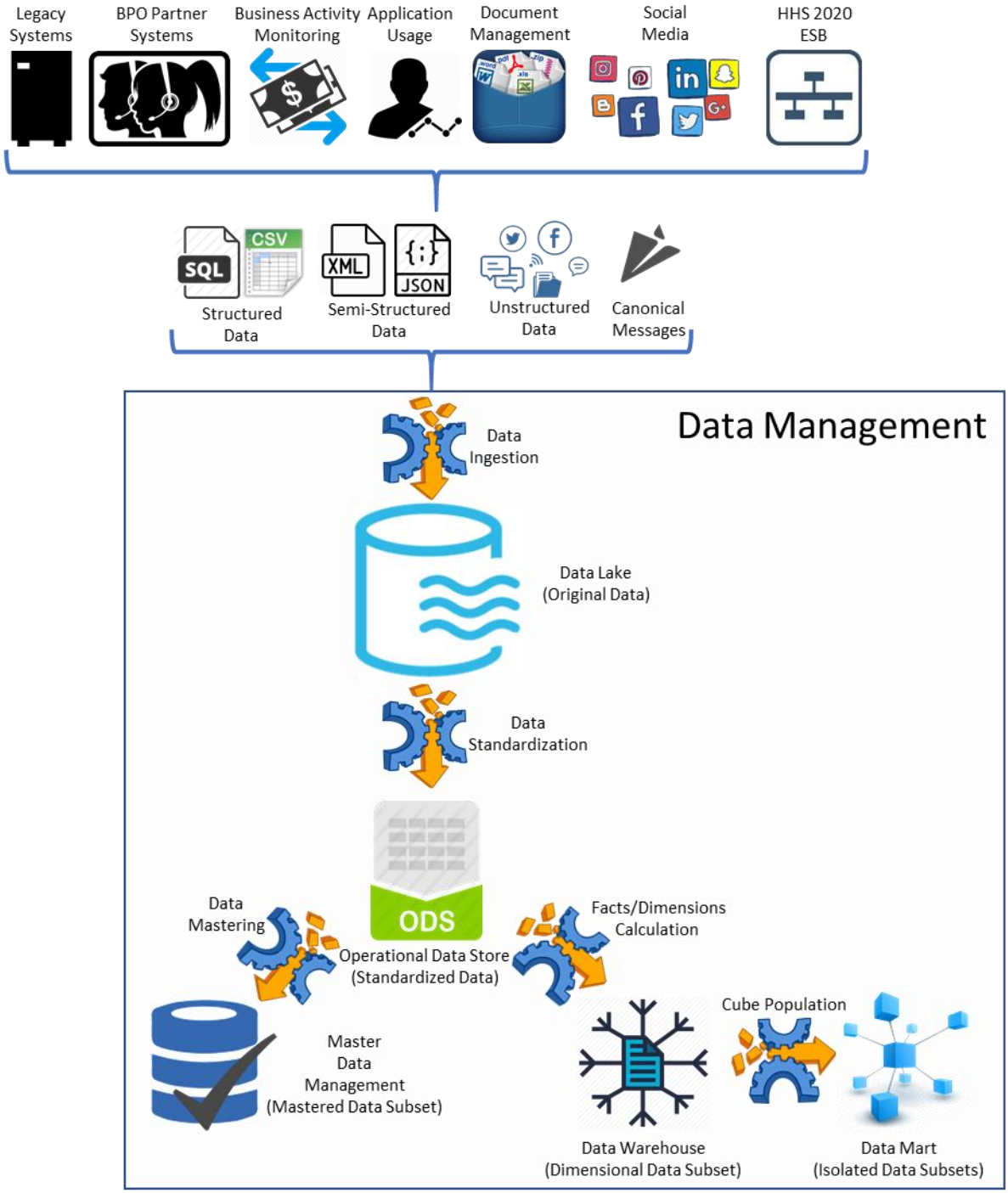

Figure 6: HHS 2020 Data Factory

Data Types and Sources

The HHS 2020 Data Factory will routinely ingest data from a variety of sources. Data of interest falls into four categories:

- Structured – strongly structured and consistent data extracts from application back-ends (e.g. SQL exports, delimited files)
- Semi-structured – data with applied schema but no guaranteed consistency (e.g. XML and JSON-encoded files)
- Unstructured – data in formatted document files, free-form text, images, etc.
- Canonical Messages – information exchanged amongst HHS 2020 services. Although messages follow XML encoding (like semi-structured data) their content is consistent with applicable rules, making them more akin to structured data.

The likely data sources of each of the above categories are:

- Legacy systems primarily supplying batch extracts of structured data with a possibility of messages sent from applications that have been enhanced with SOA capabilities for HHS 2020 ecosystem participation
- BPO module systems will deliver a mix of structured data extracts and canonical messages
- Metadata about execution of business process orchestrations and application usage of HHS 2020 presentation layer components will be delivered as a combination of structured data extracts and semi-structured files
- Documents residing in the enterprise document management system, digital content assets deployed via the Liferay digital experience platform and social media content and metadata for interactions of interest to NM HSD will be represented as unstructured data
- HHS 2020 data back-end will subscribe to certain canonical messages from the ESB that are deemed applicable to enterprise data management capabilities

Data Ingestion and Data Lake

All data entering the data management boundary will be stored within a data lake. The data lake will preserve all incoming data and metadata details and make them available for subsequent refinement as an input into the artificial intelligence sub-system for machine-driven pattern analysis. The data lake will be built in COTS technology from MarkLogic.

Data Standardization and Operational Data Store

The transactional sub-set of raw data will be transformed into an operational data store. In the steady state, the HHS 2020 enterprise will contain transactional data at stipulated quality levels (e.g. error rates

and extent of duplication below maximums permitted under HSD data governance quality standards), reducing the need for quality improvement within the ODS. The primary enhancements performed during ODS loads will be directed at data standardization into the HHS 2020 canonical model for schema and reference values. ODS contents will feed into operational reports and will be available for export as bulk data extracts for consumption by interested external parties. The ODS will be built from a MarkLogic NoSQL database.

Data Warehouse

A sub-set of transactional data in the ODS will be transformed into fact and dimension tables of the data warehouse (DW). The DW will serve as a primary source of information for analytical reports and for data science research. DW contents will be available for consumption by external parties. The DW will be implemented by IBM Watson Health, the MMISR Data Services module contractor.

Data Mart

While the DW serves as a dimensional aggregator for enterprise-wide data analysis and consumption, the data mart (DM) will segregate data into analytical cubes to serve narrow needs (e.g. line-of-business, departmental, etc.). The DM will support analytical reporting and data science needs by pre-running queries against DW contents, making complex, high-value data retrieval extremely fast and efficient. The DM will be implemented by IBM Watson Health.

4.1.1 Master Data Management

Complex enterprises like NM HSD contain numerous systems that manage portions of large business entities spanning multiple business processes. For example, information about provider entities is spread across contracting, credentialing, claims, compliance and other systems. The goal of a master data management solution is to consolidate, standardize and keep up to date various portions of an entity record in a single referenceable source. The HHS 2020 MDM sub-system will be built on the MarkLogic NoSQL platform.

A big advantage of the unified entity views provided through MDM is the ability to continually improve data quality and to relate entities to each other in order to enable key processing capabilities. Poor data quality of constituents' address information has historically been a source of unnecessary physical mailing expenditures, where hundreds of thousands of pieces of mailed correspondence are routinely returned as undeliverable. Address standardization capabilities via the MDM solution, coupled with USPS address verification and credit agency address checks, will lead to substantial increases in physical mailing efficiency and cost reductions.

The MDM subsystem will power identity-based access authorization functions in scenarios where access to requested information is dependent on a user's membership and application roles. For example, a State employee who is normally authorized to review claims will be prevented from accessing claims for his/her family members as such access would constitute a conflict of interest.

4.1.2 Reporting and Outbound Data Extracts

Information residing in the data management layer will be fed to various reports and file extracts.

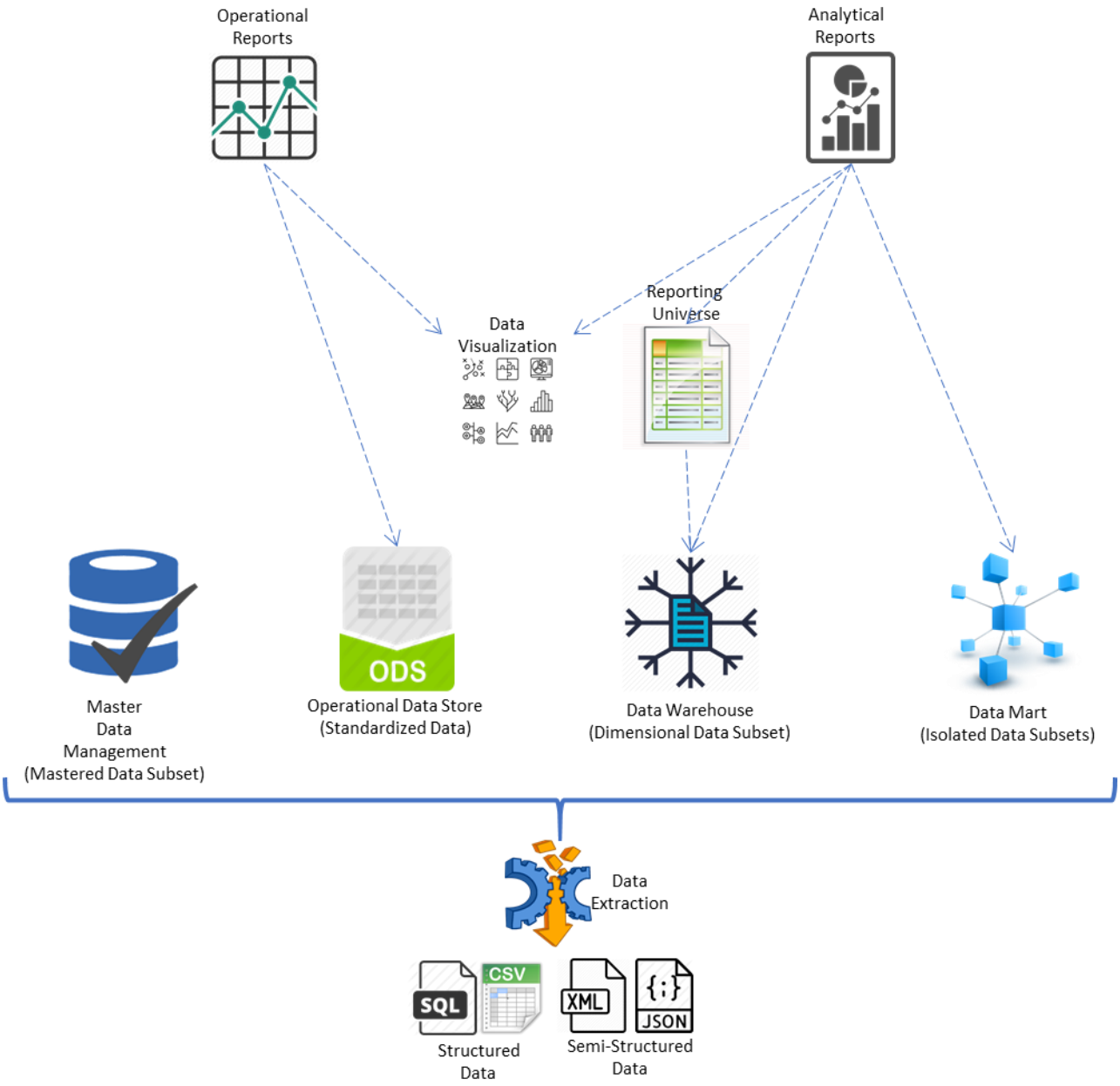

Figure 7: Reports and Outbound File Extracts

Reporting

The ODS, DW and DM will collectively satisfy all of HHS 2020's reporting requirements.

Pre-canned operational reports requiring transactional data will query the ODS. Analytical reports will be generated out of the DW and DM. At present HSD produces over 1,200 pre-canned reports and data extracts for reporting purposes. The goal of the HHS 2020 EA is to reduce the number of such full-service reports to the minimum required to maintain operational capabilities and regulatory compliance. All others will be moved into the realm of self-service data analysis by qualified users. These users will have access to a reporting universe that makes all reportable elements and relationships available for easy selection and ad hoc report inclusion.

IBM Cognos will be used for pre-canned report management and will support ad hoc reporting and data analysis. All reports can be enhanced with advanced data visualization capabilities afforded by Tableau software.

Data Extracts

Information contained in the MDM, ODS, DW and DM sub-systems will be made available for consumption by external interested parties (e.g. researchers, MCOs, regulators, etc.) in file-based extracts. The HHS 2020 EA will support structured and semi-structured formats. The available data elements will originate for the canonical data model. Values to all reference items will come from canonical reference lists of the EA.

4.1.3 Data Science and Artificial Intelligence Support

The HHS 2020 data management layer will enable the enterprise to gather insights from the stored information that will lead to significant improvements in NM HSD operations and customer service.

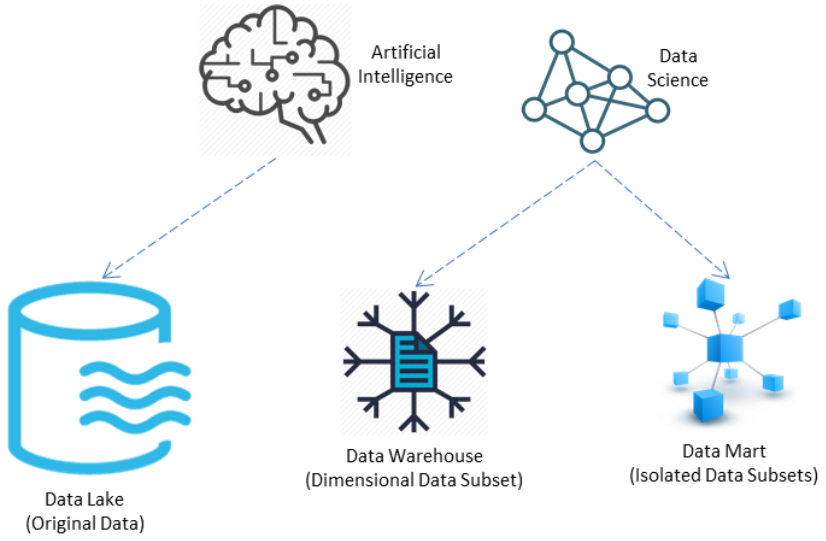

Figure 8: Data Science and AI Capabilities

Human-Powered Data Science

Human users are best capable of querying and analyzing structured data. Analysts, economists, strategists and other similarly skilled personnel will rely on data science tools like Python and R programming languages to explore the DW and DM sub-systems. Their findings will be made available to stakeholders and decision-makers as discovered (i.e., not via automated measures) and will play a role in shaping HSD's offerings and operations.

Artificial Intelligence

The IBM Watson AI platform will assist with pattern matching and insight discovery while considering the complete spectrum of available data. The HHS 2020 AI sub-system will mine the data lake contents. AI findings and recommendations will be initially and primarily used on a one-off basis to shape HSD's offerings and operations. However, as the levels of confidence in the AI's capabilities increase, the sub-system will publish its findings automatically into the HHS 2020 ESB in order to trigger decisions and processes.

4.1.4 Data Services

A number of components in the data management layer will act as services accessible via the HHS 2020 ESB. These data services will communicate using canonical messages as well as by subscribing to and publishing events as required. Figure 9, below, depicts the candidate data service components and their relationships to the ESB.

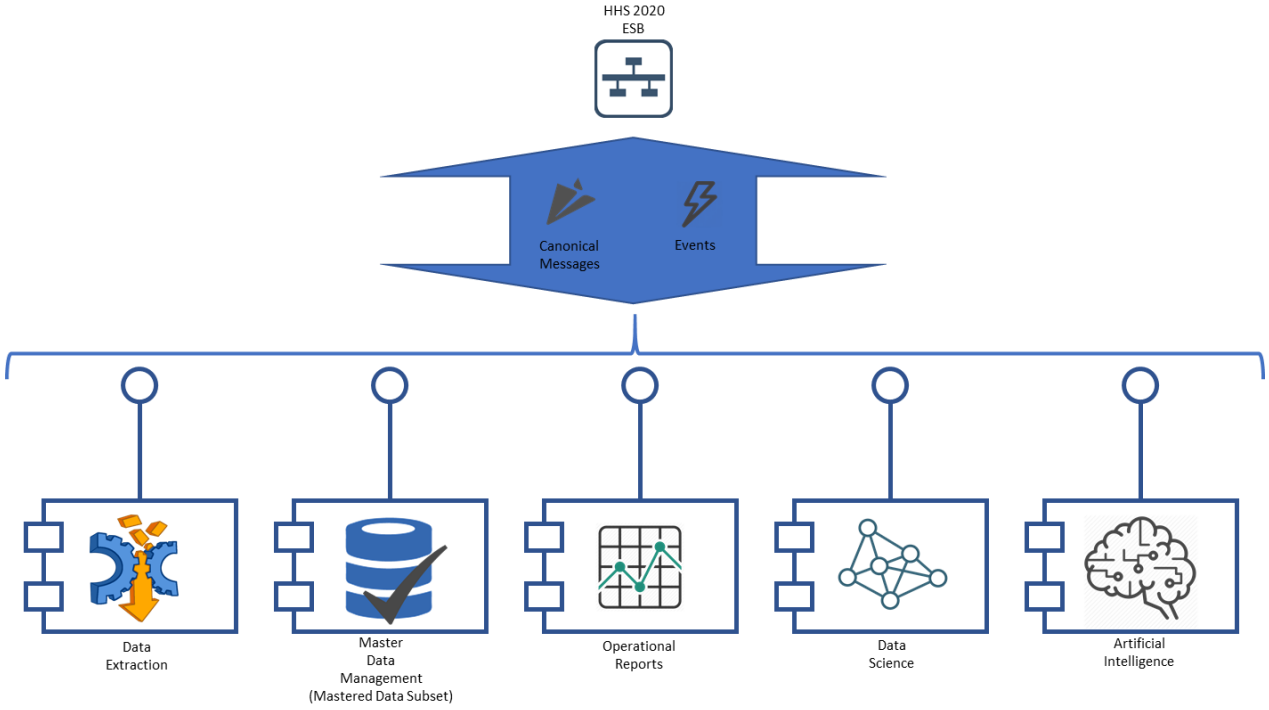

Figure 9: data management Services

Data Extraction Services

Data Extraction Services (DES) components encapsulate the ETL functionality of the HHS 2020 EA. When invoked, DES will perform asynchronous extraction, encoding, and presentation of data in the form of files. Data extraction will occur during optimal times and using optimal methods based on the context of each incoming request. DES may implement call-back and event-based notification design patterns to inform callers of file creation completion so that consumers can proceed with desired file access.

MDM Services

The MDM will present mastered data as a service. In addition to providing access to a golden copy of each mastered entity, the MDM may render information about concept inter-relationships. For example, an entity service will connect related individuals, organizations, family units, etc., so that users can make use of these relationships while implementing business functions (e.g. to prevent authorized data access by entities in unpermitted relationships with subject entities). MDM services will be invoked through request/response patterns and may publish events to subscribers interested in changes to particular mastered data categories or record instances.

Operational Reporting Services

Operational and other pre-canned report invocation and dissemination can be invoked programmatically via operational reporting services (ORS). On-demand pre-canned report execution will occur during

optimal times using optimal methods based on the context of each incoming request. ORS may implement request/response, call-back, and event-based notification design patterns to inform users of file creation completion.

Data Science Services

Data science service interfaces will be invoked by client processes and applications to request analyst involvement in identified situations of interest to the enterprise. Services would have a request/response pattern with no expectation of any results entering the system and influencing operations automatically. The findings will be made available to stakeholders and decision-makers on a one-off basis.

4.1.5 Legacy Data Migration

The HHS 2020 System Migration Repository (SMR) will play a central role in data conversion from legacy systems to new modules. The SMR will ultimately exercise the same portions of the data management layer as ongoing operations, but in separate regions/instances that HSD will keep active during data migration activities.

Figure 10 shows how data will be extracted from source/legacy systems, transformed, cleansed, converted to a new schema, and loaded into tables that enforce and validate NM HDS data governance policies for data quality management.

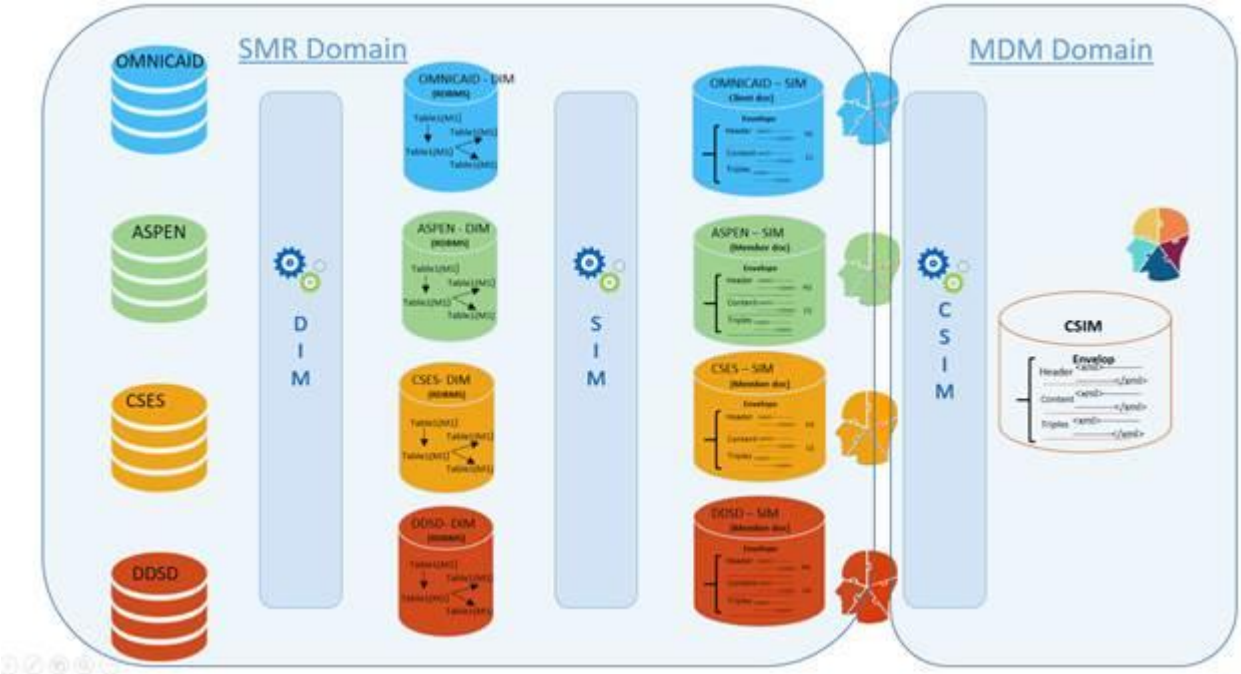

Figure 10: SMR Design

The processing will occur within and through the SMR. The purpose of the SMR is to create a reusable infrastructure with repeatable policies, processes and data quality management (DQM) best practices for all systems that will integrate with MMISR assets.

Figure 11 below illustrates the SMR-enabled data migration process.

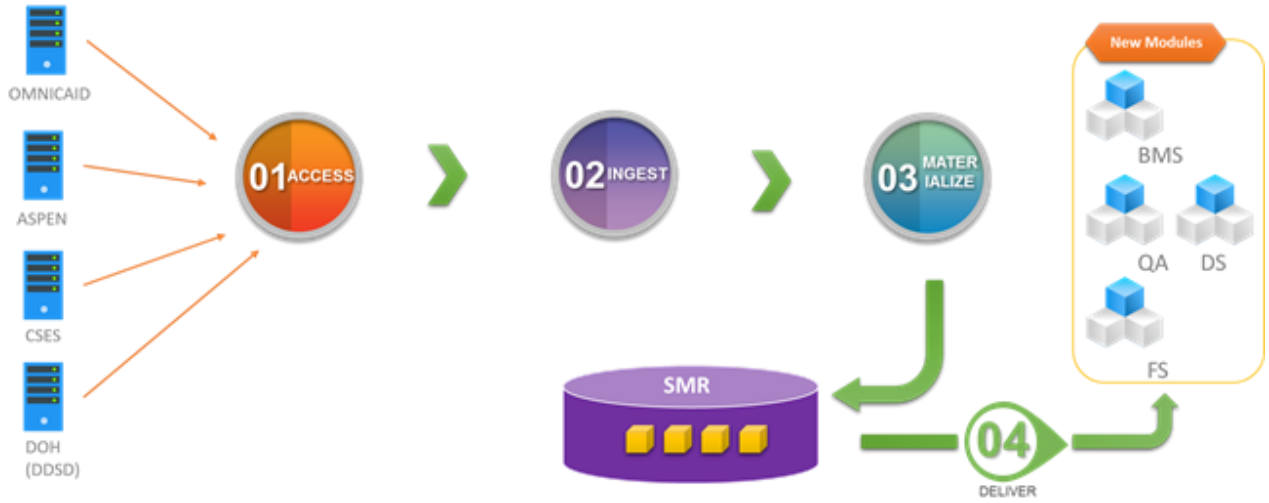

Figure 11: Pre-Go-live Data Integration Steps

Migration of a given legacy system to a new BPO operation would proceed as follows:

1. A copy of the legacy system's data in complete raw form will be obtained.
2. The complete raw legacy data set will be placed into a data lake repository.
3. The raw data will be converted into canonical format with standardized reference values, followed by enhancement of data quality through de-duplication.
4. The canonical, standardized and de-duplicated data will be placed in the SMR NoSQL database.
5. The NoSQL database contents will be made available for ingestion by the new BPO module systems.

The SMR is not meant to supply operational, transactional data to the MMISR systems in real time. It is only meant to perform bulk loads of source data into MMISR systems. All transactional data, once the system/module is live, will be populated by transactions flowing through the integration platform.

The SMR is a reusable platform that includes ETL tooling, DQM tooling, databases, data modeling, and data dictionary tools. It is also a main asset used by the NM HHS Data Governance Council for publishing policies on shared data, shared schemas, data models, data security, and other data sharing/reuse topics.

Stringent data quality processes, including master and reference data management, are intended to ensure that data quality in the HHS 2020 ecosystem post go-live will remain consistent with the quality of data obtained during initial loads of canonical data via the SMR.

4.1.6 Operational Data Store

HHS 2020 Operational Data Store or ODS will be implemented as an XML document-based repository with structure very similar to that of the SMR. Like the SMR, ODS will contain transactional data obtained from source systems that has been standardized into canonical format. However, it will be loaded through mechanisms very different from the SMR's and will satisfy a distinctly different set of functional needs.

While SMR will be loaded with information from legacy systems in the process of decommissioning and migration to new solutions (like BPO partner systems), ODS will be always up to date with all information relevant to HHS 2020 enterprise operations. SMR process will receive its inputs in a form of extracted data files, most likely in delimited format. ODS will take in XML-formatted, canonical data, which under normal operating conditions will be collected from applicable messages traversing the ESB.

ODS will support 4 primary sets of functionalities. The first is to serve as a data backend for Canonical Data Access services for users who do not need absolutely real-time transactional data from the source systems. Such "day-old" data will satisfy the vast majority of information requests in our envisioned future state and do so with upmost performance and extremely low implementation costs compared to live system access.

The second role of the ODS is to act as a transactional information repository that can be queried for Operational Reporting needs. Typical operational reports may include staff utilization, service wait times by interaction channel etc. Our reporting solution has a choice of accessing the ODS either via the XML route of XQuery statements or via a SQL emulator interface provided by MarkLogic for older style reporting solutions.

The 3rd major role of the ODS is to provide bulk data to the downstream analytical repositories for initial population of the dimensional models in the Data Warehouse and eventually of data cubes in the Data Mart. Extracts will be created using MarkLogic ETL toolkit and delivered to consumers via a Secure File Transfer solution from Oracle. Outside of initial large-scale Data Warehouse loads requiring on-demand extract file production and transfer, the regular downstream updates will be requested from Enterprise Canonical Entity Access services with output format specified as XML files. No matter how obtained (one-time bulk extracts or regular service generated), the files will be identical in structure and only vary in the amount of contained data.

The 4th and final ODS role is to provide records for Data Mastering purposes to be incorporated into the MDM solution. For a deeper look into our Data Mastering approach, please see the corresponding section.

4.1.7 Metadata Management

HHS 2020 will contain a unified Metadata Repository and a Metadata Management process that will provide a single-point-of-entry to definitions of all information terms, attributes, origins, transformations etc. Figure 12 below provides an overview of the metadata management architecture.

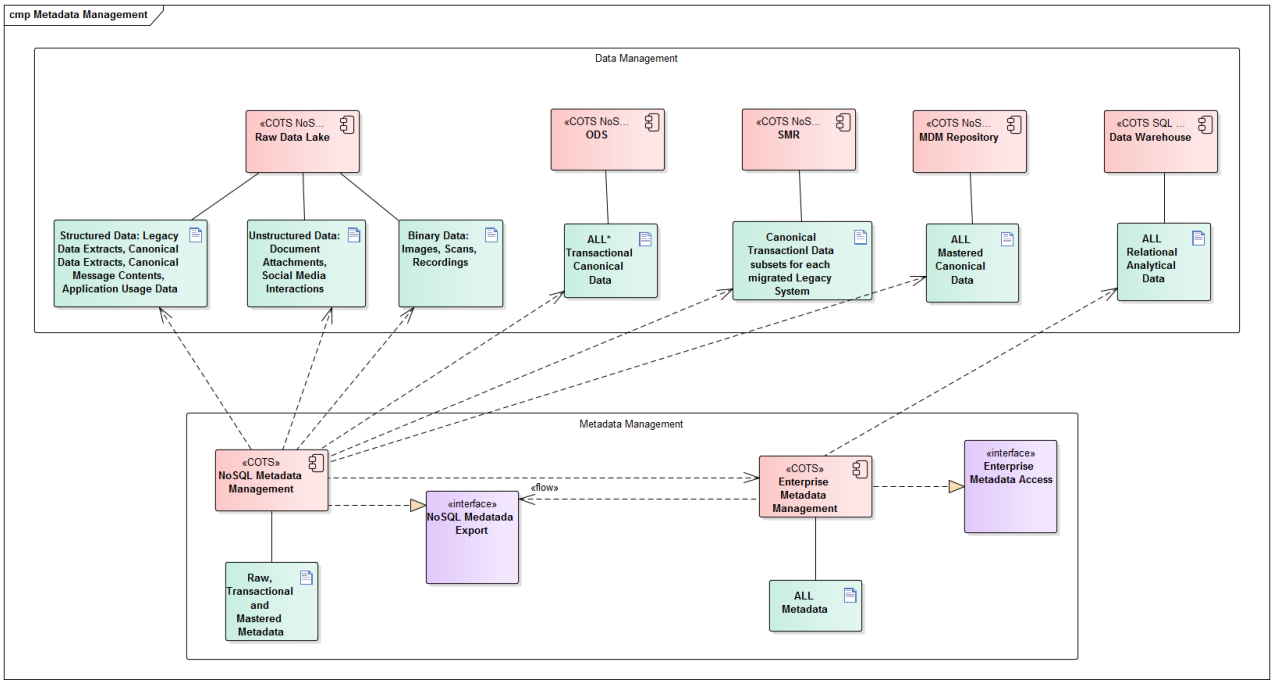

Figure 12: Metadata Management Architecture

Operationally we will maintain two metadata repositories:

Metadata definitions of entities and attributes housed in the MarkLogic NoSQL sub-system will be maintained in the associated tool from the same vendor.

IBM InfoSphere Information Governance Catalog (IGC) will house the unified, enterprise Metadata Management solution. It will have direct awareness of all data constructs in the Data Warehouse sub-system. To complete the enterprise-wide view, metadata extracts from MarkLogic will be made available for ingestion by the IGC, which will occur with necessary frequency to maintain the Enterprise Catalogue in sync with latest NoSQL database definition changes.

5 SOFTWARE ARCHITECTURE STRATEGY

HSD's approach to software architecture results in a modular, loosely coupled, layered, secure and declarative solution built on proven COTS technologies.

5.1 COTS TECHNOLOGY PERSPECTIVE

To offer maximum flexibility to various HHS 2020 ecosystem participants while deploying best possible solutions to meet the State's needs, the HHS 2020 EA is pursuing a technology-independent architectural approach to all specialized and shared sub-systems. By following standards for technological interoperability, service orientation and componentization HSD intends to bring together optimal solutions sourced from contracted vendors regardless of their respective implementation approaches. Such an enterprise architecture allows for eventual vendor changes and additions with minimal technological and operational disruption. Additional benefits arise from the ability to replicate a proven solution approach to other departments of NM State government as well as to other States' Medicaid agencies, thus furthering a consistent, nation-wide Medicaid ecosystem.

At present time the key Commercial-off-the-shelf (COTS) technologies operating within the boundaries of the HHS 2020 ecosystem hosted by the State are listed in Table 13.

Table 13: HHS 2020 Internally hosted COTS technologies

Technology	Purpose
Microsoft Active Directory	1. Certificate services supporting internal Public Key Infrastructure (PKI) 2. State employee enterprise group membership 3. State employee authentication through user ID and password combination 4. Active Directory Federation Services (ADFS)
Oracle Identity and Access Management (IdAM) platform	1. Multi-factor authentication for all HHS 2020 users, including State employees, BPO employees, providers, constituents and system/service accounts 2. Application role-based authorization for all authenticated users applied to all publicly accessible and private URLs (web pages, service endpoints, process orchestration end points)

Technology	Purpose
Oracle Fusion Middleware suite	1. Long-running business process configuration, orchestration and monitoring 2. Service publishing, discovery and run-time invocation 3. Service end-point hosting and message routing 4. Enterprise rule management and enforcement 5. Service implementations using EAI adapters and short running orchestrations
Liferay Digital Experience Platform	1. Unified presentation layer web-based portals supporting all HHS 2020 stakeholders 2. Digital content management
MarkLogic NoSQL Database	1. Bi-directional ETL file-based data supporting both legacy system migration onto HHS 2020 platform and ongoing file-based integration with external systems 2. Metadata management 3. Master data management 4. Raw data lake 5. NoSQL database engine
Hyland OnBase	Enterprise document management
Hyland ContentComposer	Correspondence management
Experian Correct Address	US and Canadian postal address validation and formatting

At this time, the MMISR effort has established contracts for two modules, the System Integrator and Data Services module contractors. Following is a list of COTS software that the Data Services contractor will use.

Table 14: HHS 2020 Externally hosted COTS technologies

Partner	Technology	Purpose
Data Services	IBM Cognos Analytics	1. Pre-canned report management 2. Ad hoc report management
Data Services	Tableau	1. Data visualization

Partner	Technology	Purpose
		2. Geo-spatial data analysis
Data Services	Python programing language	Statistical analysis programing
Data Services	R programming language	Statistical analysis programing
Data Services	IBM Watson	Question-answering artificial intelligence engine

5.2 SOFTWARE ARCHITECTURE VISION

In accordance with HHS 2020 EA standards all software-related architecture views are modeled using unified modeling language (UML) v.2.4.1.

HHS 2020 adopts a layered software architecture approach depicted in Figure 13 below.

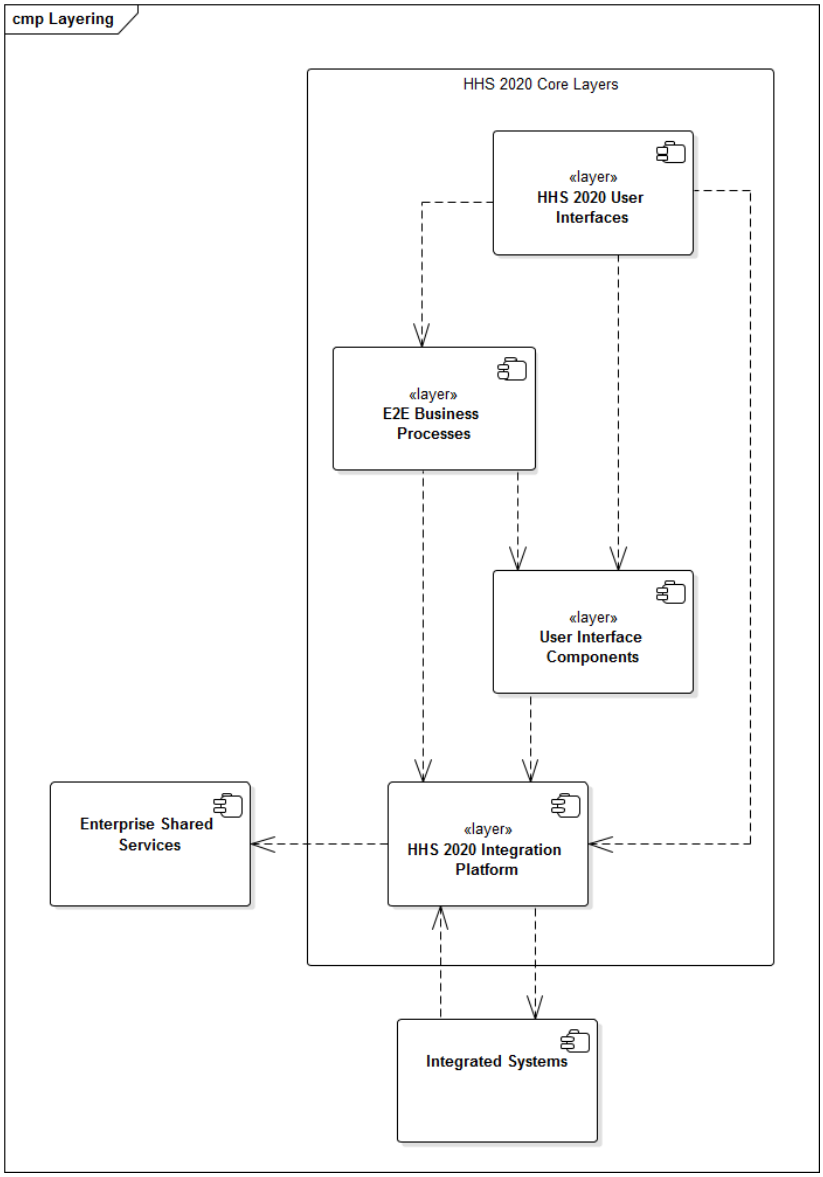

Figure 13: HHS 2020 Software Architecture Layers

The top-most layer contains all user interfaces packaged as internal and external-facing web and mobile applications. User Interface layer depends exposes entry points into Business Processes layer and applications are comprised of components found in the Reusable UI layer. Applications make use of various services provided by the Integration Platform layer.

End-to-End Business Processes layer houses BPEL implementations of long-running orchestrations that combine human tasks (consumed as UI Component layer elements) with service and rule tasks found in the Integration Platform layer.

Reusable UI components, like complete UI applications make rely on various services exposed by the Integration Platform layer.

Integration Platform layer exposes to the enterprise functionalities of COTS components purchased as Enterprise Shared Services as well as providing connectivity and information exchange among various integrated systems operated by both the State as well contracted BPO partners.

Figure 14 shows groupings of components packages comprising both the HHS 2020 enterprise and the external systems. SOA integrations are shown as associations decorated with descriptive stereotypes. Only most significant packages are included, with all package-to-package dependencies omitted for clarity.

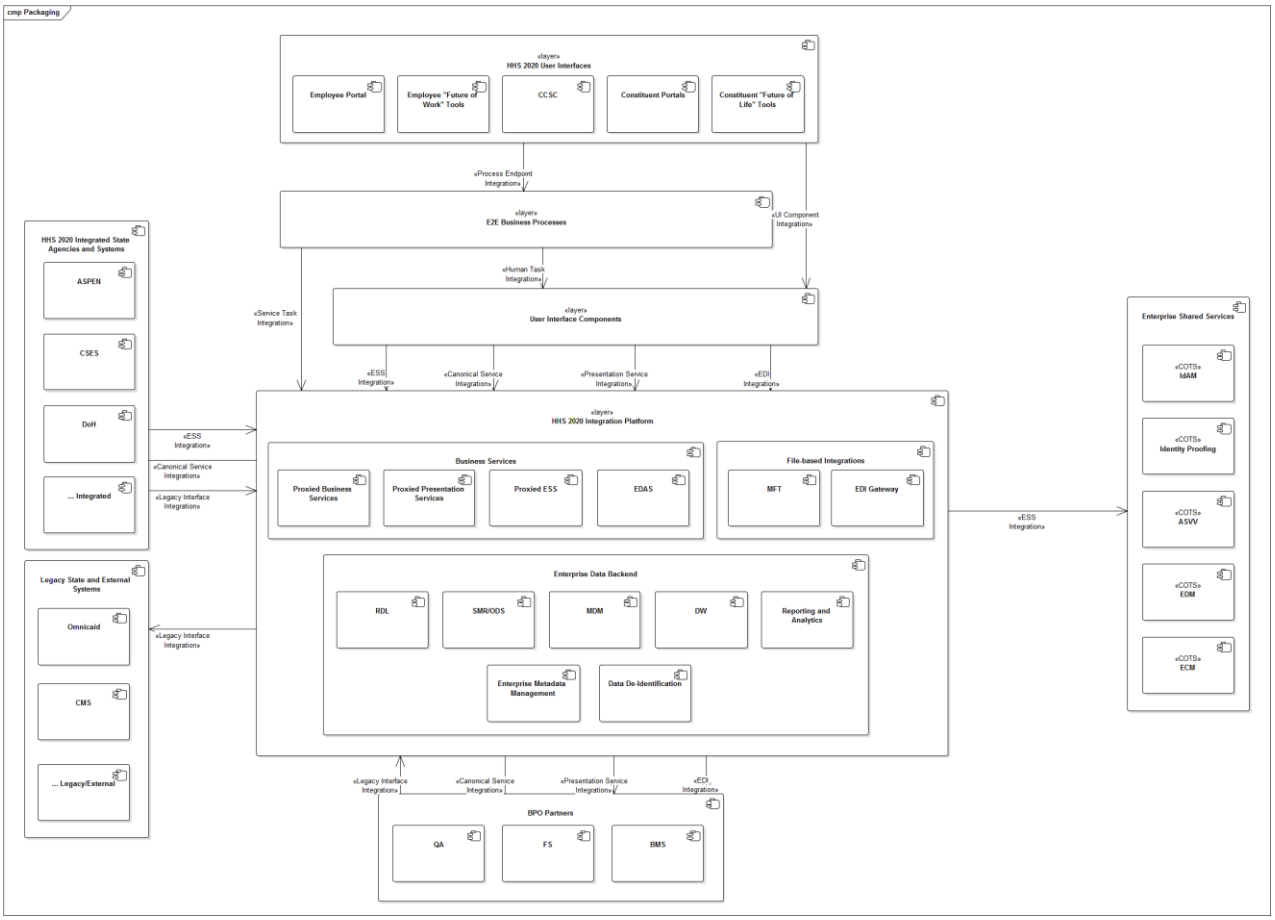

Figure 14: MMSIR Conceptual Software Architecture

Security

All requests for functionality and data contained within the HHS 2020 enterprise pass through the security system. It is comprised of purchased COTS components and configured to meet HHS 2020 requirements

for user authentication, role-based access authorization, cryptographic public key infrastructure management and single sign-on.

HHS 2020 User Interfaces aka Unified Public Interface or UPI

The UPI includes user interaction channels for the public, including a Unified Portal (for all external and internal web interfaces and applications), mobile and social media access (for incorporating mobile devices/interfaces and tying into social media outlets), and a Consolidated Customer Service Center (CCSC)/Call Center Interface.

Integration Platform (IP)

The sole responsibility of the MMISR System Integrator contractor, this is the central mechanism for integrating all backend systems, all interfaces to external systems, and users via the Unified Public Interface. The IP layer contains three distinct sub-groupings of functionality.

Business Services includes an ESB and other service-oriented architecture enablers like COTS EAI adapters to be used in service implementations, business process management components for process definition and execution, a business rules engine to assist in rule-based business processing and context-based message routing through the ESB, and API Management for service discovery and invocation by the UPI layer clients. All systems, subsystems, modules and services will integrate using SOA principles of decoupled services exchanging messages through a common integration platform, briefly listed below:

- Services will be autonomous and decoupled from other services.
- Services will be discoverable through the IP.
- Services will be composable.
- Services will interoperate via sending/receiving asynchronous messages.
- Services and messages will be built to be reusable.
- Services will be stateless and idempotent, as much as possible.
- Services will communicate via asynchronous messages.
- Services will hide their implementation details from other services.

All services will be registered in the API Manager services catalog, which will enforce any policies regarding knowledge of and access to those services. All shared schemas which comprise messages will also be registered in the IP, which will enforce data integrity and DQM where required. Message requests and responses will be managed by the Integration Platform, which will enforce common security protocols to ensure that access to the IP and integrity of messages is secure.

File-based Integrations allow for EDI transaction handling and all other ongoing file-based data exchanges in standard (e.g. HL7) and custom formats with HHS 2020 legacy and external systems.

Enterprise Data Backend contains all software capabilities supporting Enterprise Information Architecture.

HHS 2020 Enterprise Applications
This is a grouping for all new BPO module applications, services and legacy systems integrated into HHS 2020 enterprise.

Enterprise Shared Services
This logical group consists of one or more master data management (MDM) instances (for managing master indices for members/consumers, providers, and potentially others), shared reference data, a shared document Management solution (for all scanning, storing, imaging, creating and managing all documents), a shared address standardization service, and a set of shared auditing/logging services.

BPO Partners
BPO module contractors are grouped together in this package. Their offerings consist of decoupled, stand-alone applications licensed/implemented through procurements of the MMISR program:

- the Quality Assurance system
- the Benefit Management Services system
- the Financial Services system

Each of these systems will rely on Service, Data and Interface integration tooling exposed by the IP.

Integrated State Agencies and Systems
This is a grouping of all State-operated solutions that will be brought up to compliance with HHS 2020 service integration principles.

Legacy State and External Systems
This an architectural grouping of systems with two different provenances. The first are State operated legacy and the second are externally operated (e.g. other States, Federal, partner etc.). The similarity of the two families is that their constituents are not compliant with HHS 2020 service architecture and integrations remain at the level of legacy interfaces.

5.3 SERVICE ORIENTATION

Pervasive Service Orientation is the single most important architectural feature of HHS 2020 ecosystem. Access to all functions contained in various applications as well as to all information in the enterprise will occur through services.

Figure 15 provides a high-level overview of our targeted level of service enablement. There is a lot of information presented in the model[1], so a narrative description is in order and follows below.

[1] The services overview diagram uses a "lollypop" Interface modeling notation in order to avoid clutter of Dependency lines that would connect classifier-shaped Interfaces with Components that consume them. Each of the interfaces exposed by source or back-end systems (a "lollypop") has a corresponding consumed interface symbol (a rounded 2-pronged "fork") attached to an integration layer component tasked with exposing a corresponding HHS 2020 service from the ESB.

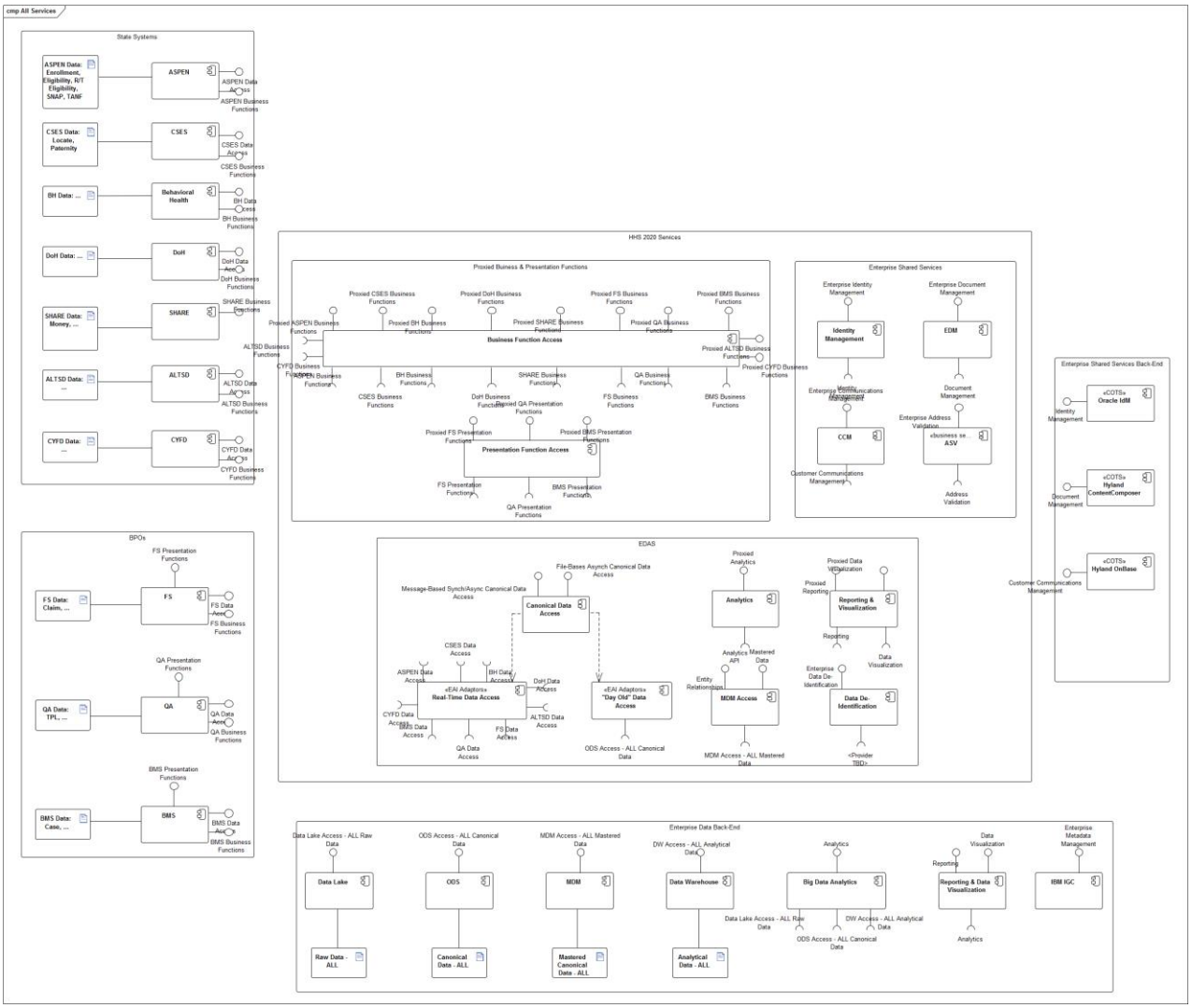

Figure 15: Services Overview

The system boundary marked HHS 2020 Services contains all SOA entry points accessible to consumers. The general pattern is to connect corresponding service "back-ends" to ESB-hosted contracts implemented via off-the-shelf Enterprise Application Integration (EAI) adaptors which are orchestrated to interact with the underlying back-end systems.

ESB-mediated service invocation is at the core of the HHS 2020 SOA. All service consumers that are aware of service interfaces (e.g. the HHS 2020 UP supporting human stakeholders or outside systems requesting data from HHS 2020 enterprise) will request the ESB to invoke the appropriate service endpoints rather than having any direct end-point knowledge. Figure 16 illustrates the role of ESB in our SOA design.

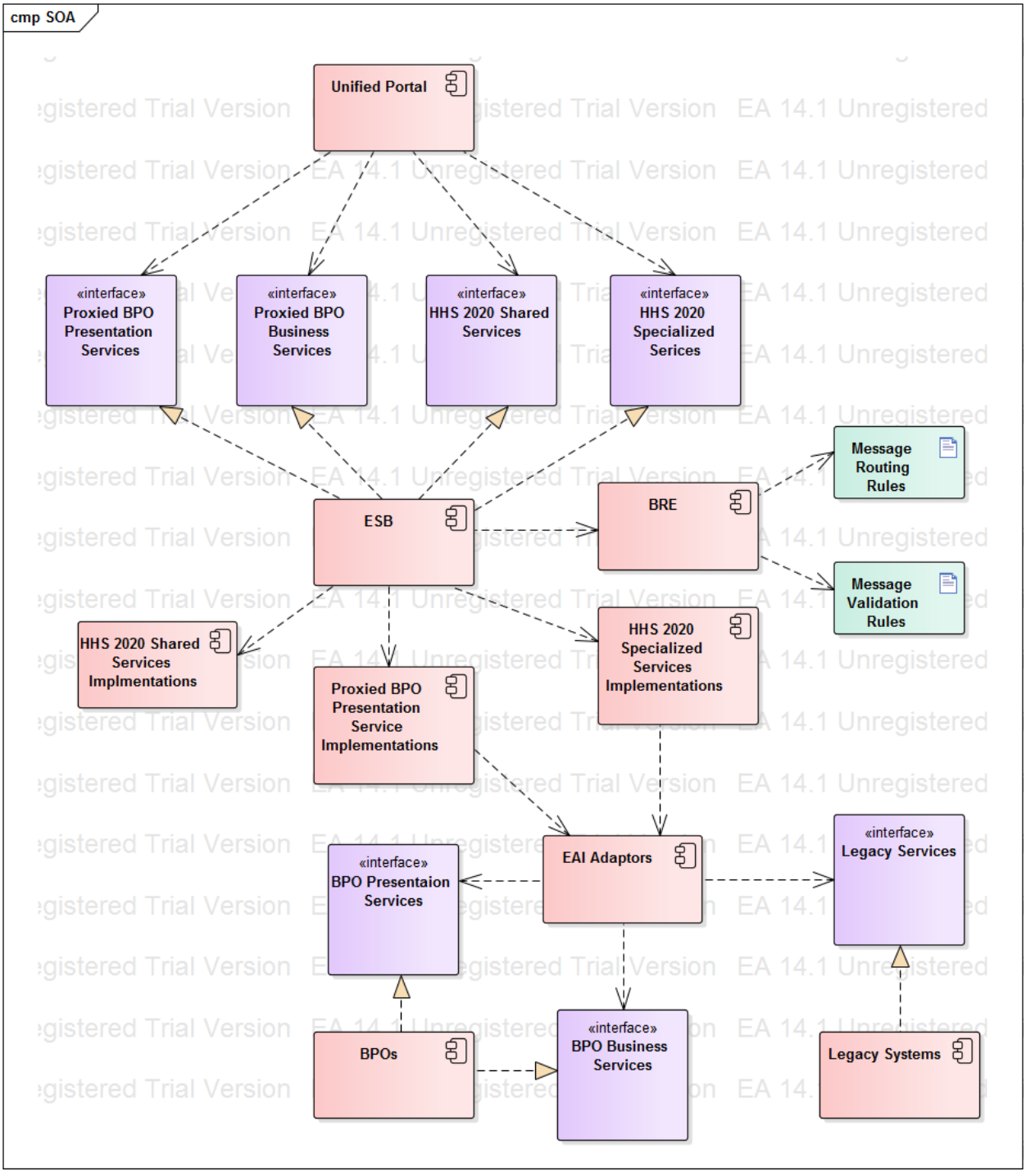

Figure 16: Details on the SOA-Based Design of the MMISR Integration Platform

Consumers will communicate with services via messages routed to the appropriate end points by the ESB. Messages will adhere to shared/canonical schemas and validation for both schema and content. Context-based routing will occur with assistance from a BRE enforcing appropriate sets of message validation and routing business rules. The ESB will provide encoding (XML, JSON) and protocol (HTTP, JMS) translations to handle messages serving clients of varying technological capabilities and needs. The ESB will enforce role-based authorization for service access and will carry out necessary logging of service interactions for auditing purposes.

5.3.1 Business Functions

The integrated back-end category is comprised of State-owned systems colloquially referred to as Legacy and the newly contracted offering from our Business Process Outsourcing Partners (or BPOs). Conceptually each Legacy and BPO system (e.g. ASPEN for Medicaid Eligibility Management) provides access to the underlying data (e.g. Real-time eligibility, SNAP and TANF in case of ASPEN) in “native” format and to business functions that can be performed on the underlying data (e.g. get TANF Eligibility for Client).

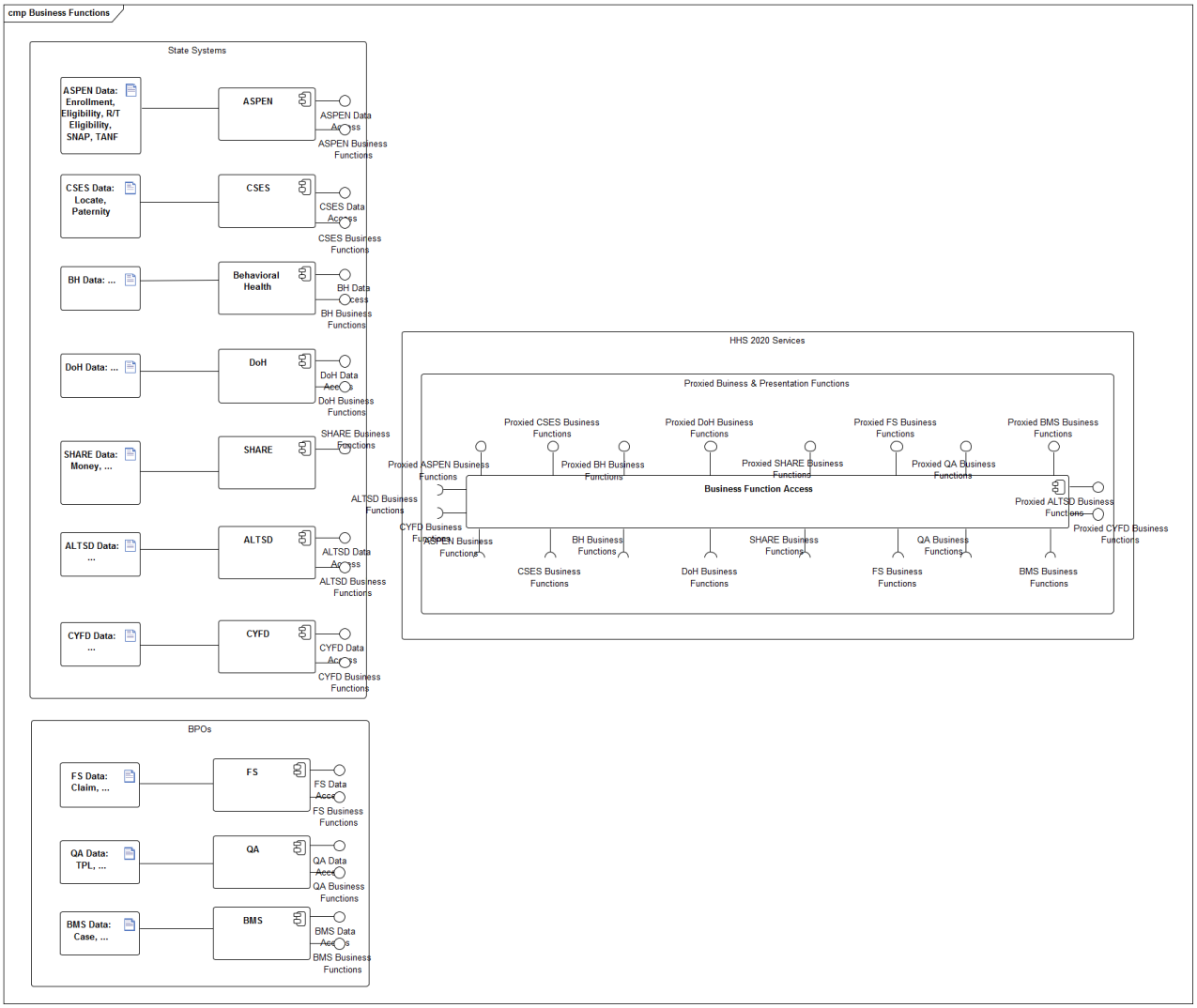

Figure 17: Business Function Components

While newer systems, like the BPOs, expose data and functionality endpoints as SOA services, older systems may have to be queried via less SOA "friendly" integration technologies like direct calls to underlying databases using ODBC or JDBC programming, language-specific Application Programming Interfaces (e.g. Java native libraries), message queuing and even screen scraping if required. Regardless of the available end-point technologies, HHS 2020 proxied business services will be constructed out of available EAI adaptors orchestrated by BPEL engine to perform necessary backend operations. This method is consistent with MITA preference for purchasing and configuring COTS technologies as opposed to custom solution development.

Decoupling the back-end locations from any potential clients is not the only function of the Proxied business services. All ESB-brokered communications are subjected to consistent set of Enterprise security policies including authentication, coarse- and fine-grained authorization, and data protection through encryption. Proxied service implementations standardize “native” information available in the back-end systems into HHS 2020 canonical message format, ensuring adherence to standards and overall interoperability amongst all service consumers and providers.

5.3.2 Presentation Services

While HHS 2020 users are accessing presentation layer components through the Unified Portal, it may be necessary to bring into view significant portions of user interfaces exposed by our BPO partners. For example, a Claims Manager State employee may need to review complex claim decisions made by the Financial Services partner. Our architecture does not permit for un-mediated access to any processing endpoint, such as screens in external applications. For this reason, we would not employ any screen framing techniques to make external UI available within HHS 2020 portal pages.

In anticipation of a need for UI-level functionality reuse, HHS 2020 EA has mandated that all BPO systems must adhere to an interoperability standard that allows us to treat external screens as services that publish both the data and the presentation mark-up. The selected standard is known as Web Services for Remote Portlets version 2.0 (or WSRP 2.0).

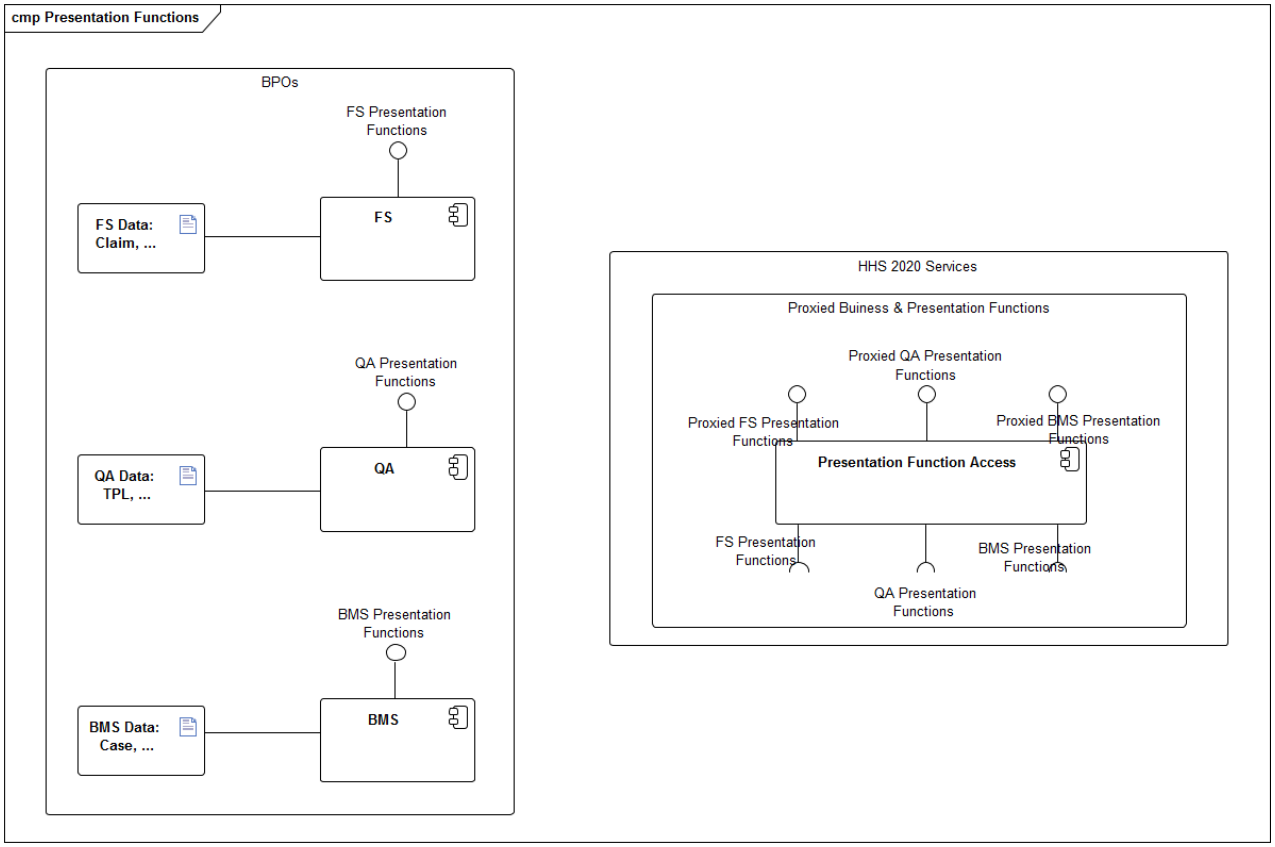

Figure 18: Presentation Service Components

Figure 18 above illustrates the relationship among presentation services available from our BPO partners and the ESB-deployed proxies used by clients within HHS 2020 ecosystem.

5.3.3 Shared Services

Shared services "front" functionalities of COTS applications running either on premises or hosted externally. What is common to all of such applications is that they all implement shared behavioral (e.g. client communication management, document management, etc.) and non-behavioral (e.g. identity access management, address standardization) functional requirements and are intended for broad reuse across business entities. Figure 19 illustrates the 6 shared service areas under current consideration by HHS 2020.

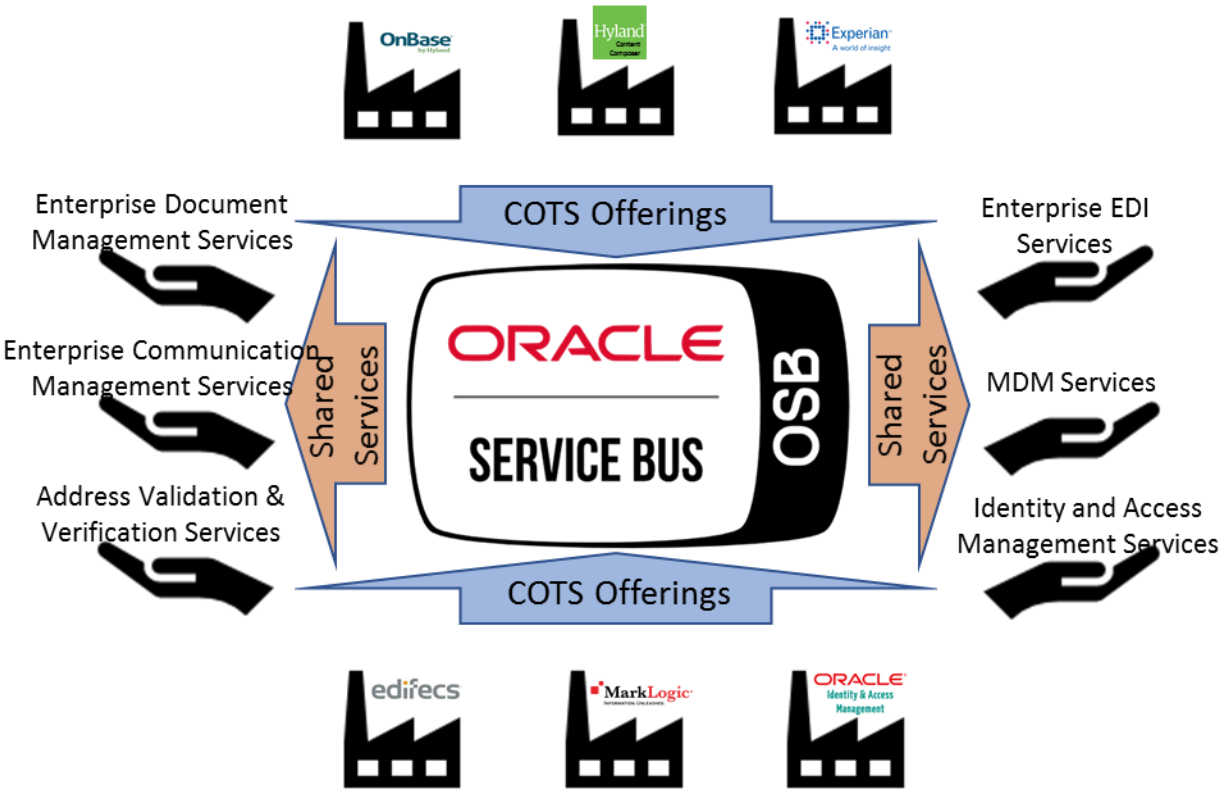

Figure 19: COTS applications fronted by Shared Services

Table 15 below outlines technologies underpinning each of the 6 Shared Services and the intended uses in the enterprise.

Table 15: Enterprise Shared Services Summary

Service	COTS Back-End[2]	Uses
Enterprise Document Management (EDM)	OnBase by Hyland	• Enterprise document template authoring and approval workflows • Document creation
Enterprise Communications Management (ECM)	Hyland ContentComposer	• Stakeholder Communication Preference Management • Multi-channel stockholder outreach

[2] The technologies listed may change depending on the ongoing evaluation and contracting efforts. However, this should have no effect on the functionalities offered by corresponding Services.

Service	COTS Back-End[2]	Uses
Enterprise Address Standardization, Validation and Verification (ASVV)	Experian Correct Address	• Address format validation using USPS standards • Constituent residency verification
Enterprise EDI Management	edifecs	• Trading Partner Management • HIPAA transaction management
Master Data Management (MDM)[3]	MarkLogic	• Entity golden record mastering • Human and Organizational Entity relationships (spousal, parental, employment etc.)
Identity and Access Management (IdAM)	Oracle IDM	• User authentication including multi-factor for external users • Application role membership • Coarse-grained authorization for resource access based on application role membership • Fine-grained authorization for resource access based on usage context

5.3.4 Canonical Data Access Services

All of the Entity data relevant to HHS 2020 future operations and decision-making will be accessible via a set of dedicated Canonical Data Access Services.

[3] MDM services are discussed in more detail as part of Data as a Service section.

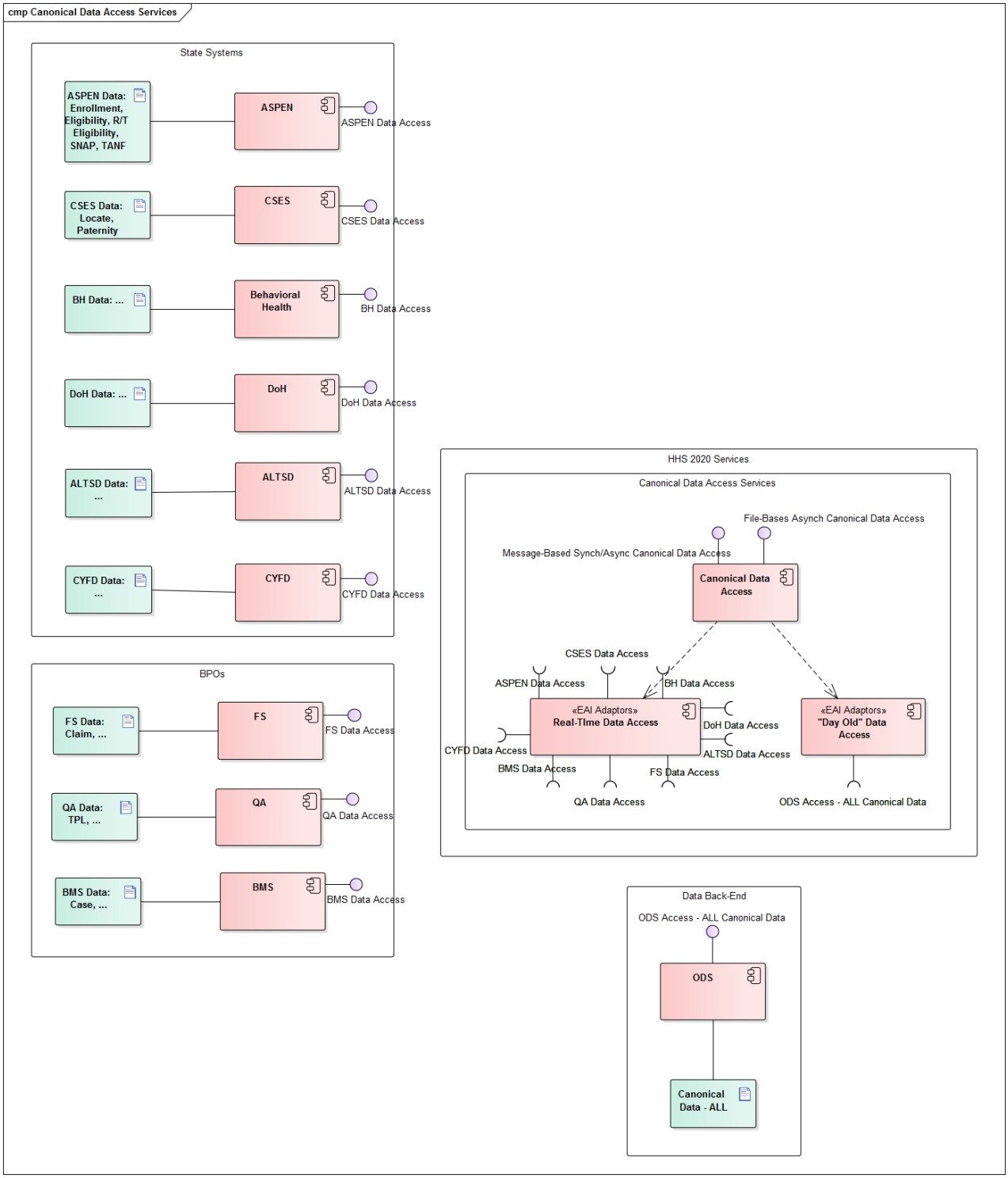

Figure 20: Canonical Data Access Services

Canonical Data Services serve two complementary purposes, one functional and one architectural.

The functional purpose is to give clients access to canonical entity data residing in either the source transactional systems (when clients require absolutely real-time view of information) or to data from the operational data store (when some "staleness" could be tolerated by the consumer). Requested data could be returned in the form of messages traversing the ESB, or in bulk files that are generated once data is collected from the appropriate source back-end. In either scenario the same canonical definitions will be used, and information will be encoded in a modern format of either XML or JSON. Services could be invoked either synchronously or asynchronously in order to satisfy a wider range of client needs and processing capabilities.

The second, architectural purpose is to limit proliferation of entity access services as client needs become more diverse. It is foreseeable that a nearly infinite number of possibilities may exist with respect to requested data granularities (from mobile clients needing very little data to desktop applications requesting large number of entity attributes), response formats (message vs. file) and calling conventions (synchronous vs. asynchronous). In order to avoid creation of a "tailor-made" service implementation for each distinct client's needs, HHS 2020 EA stipulates use of only 7 services that satisfy all possible client requests:

1. Synchronous Message-based Entity Get
2. Asynchronous Message-based Entity Get
3. Asynchronous File-based Entity Get
4. Synchronous Message-based Entity Update
5. Asynchronous Message-based Entity Update
6. Synchronous Message-based Entity Delete
7. Asynchronous Message-based Entity Delete

The following diagram provides a conceptual overview of the proposed service interfaces and key message constructs.

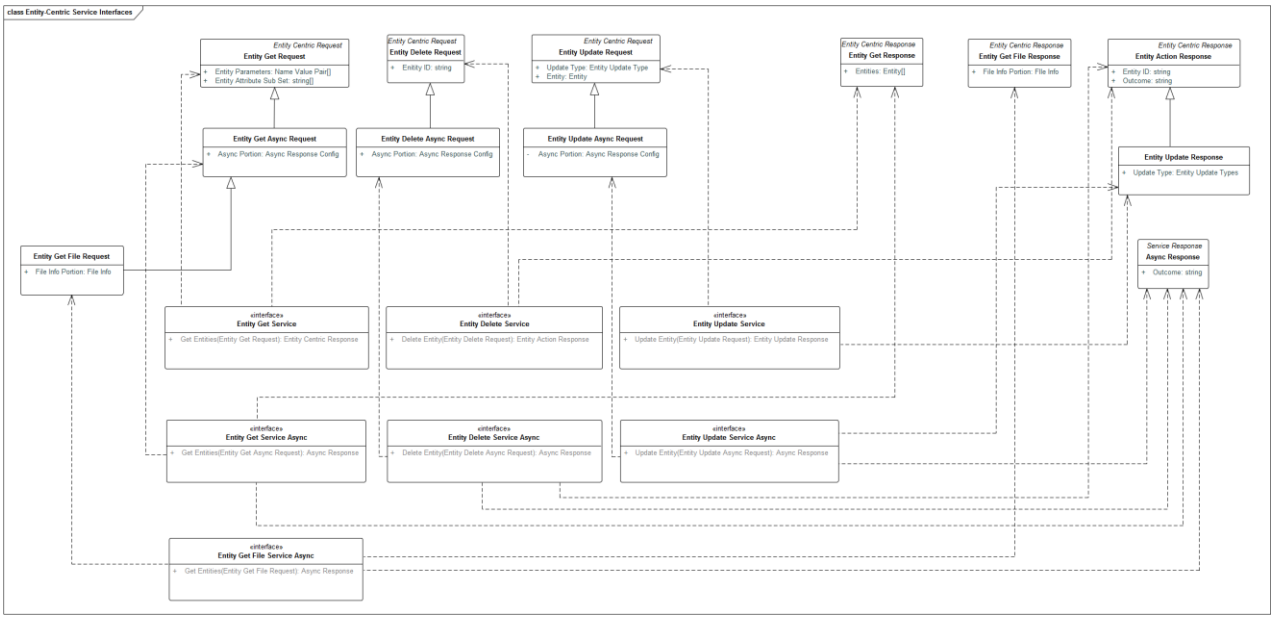

Figure 21: Canonical Data Access Service Interfaces and Key Messages

The architectural mechanism that will enable each service to render just the right amount of requested information is known as Response Schema Injection Pattern. Additional notes on service functionality can be found in the following table.

Table 16: Additional details for Canonical Data Access Service design

Service	Notes
Synchronous entity get	• Satisfies 2 purposes: Entity Search and Entity Get • The service will accept entity get request parameter consisting of selection criteria. Current design shows an array of name-value pairs. This model may be overly simplistic and would require an upgrade to more of a criteria object that can combine complex selection clauses joined by logical expressions AND, OR and matching logic like BEGINS WITH etc. • The second portion of the request is an array of XPath expressions encoded as strings that specify schema elements of the requested entity that needs to be brought back • The service would be invoked synchronously and the client would be blocked until an instance of Entity Get Response is returned

Service	Notes
Asynchronous entity get	• The asynchronous version of entity get service will return immediately an instance of asynchronous response object that provides information to the caller about acceptance (or rejection) of the request. • Asynchronous request is derived from the synchronous request with addition of call-back URL, which the service implementation is going to call once the results have been obtained and properly encoded.
Asynchronous file-based entity get	The file-based version of the entity get service is invoked asynchronously, and rather than eventually calling the client with a message containing the requested entity instances, it generates a file containing requested instances and simply informs the caller about availability of the file
Synchronous entity delete	We decided to disallow bulk deletes of entities, and each delete request must be based on a unique identifier for the entity that is to be deleted. The caller is blocked until a delete response message is sent back.
Asynchronous entity delete	Asynchronous version of delete releases the client immediately and calls back with delete completion on the specified call-back URL
Synchronous entity update	• Like deletes, updates are geared at one entity at a time. The request message must contain the entity that is being updated. A service implementation will examine which attributes are present in the supplied entity object, thus no need for additional XPath attributes explaining what information is present in the request. • We need to investigate further whether we want to support the granularity of update of PATCH, equivalent to a database update statement, or PUT, equivalent of “delete if exists then insert” database statements.
Asynchronous entity update	Asynchronous entity update works in the same fashion as all other asynchronous versions

It must be noted that accessing all canonical transactional data through only 7 services presents complications with both coarse and fine-grained authorization of user requests. Attaching “tradition” URL-based coarse access permissions based on application role membership fails to serve the intended purpose as a single service would be manipulating vastly different entities depending on request parameters. We are therefore likely to strike a middle ground and choose to replicate the 7 canonical services per domain (like Claim, Member, Provider etc.)

5.3.5 Enterprise Data as a Service (DaaS)

Information contained in the HHS 2020 Data Back-end Mastered Data and Analytical Data repositories will be exposed to consumers via a dedicated set of services depicted in the following diagram.

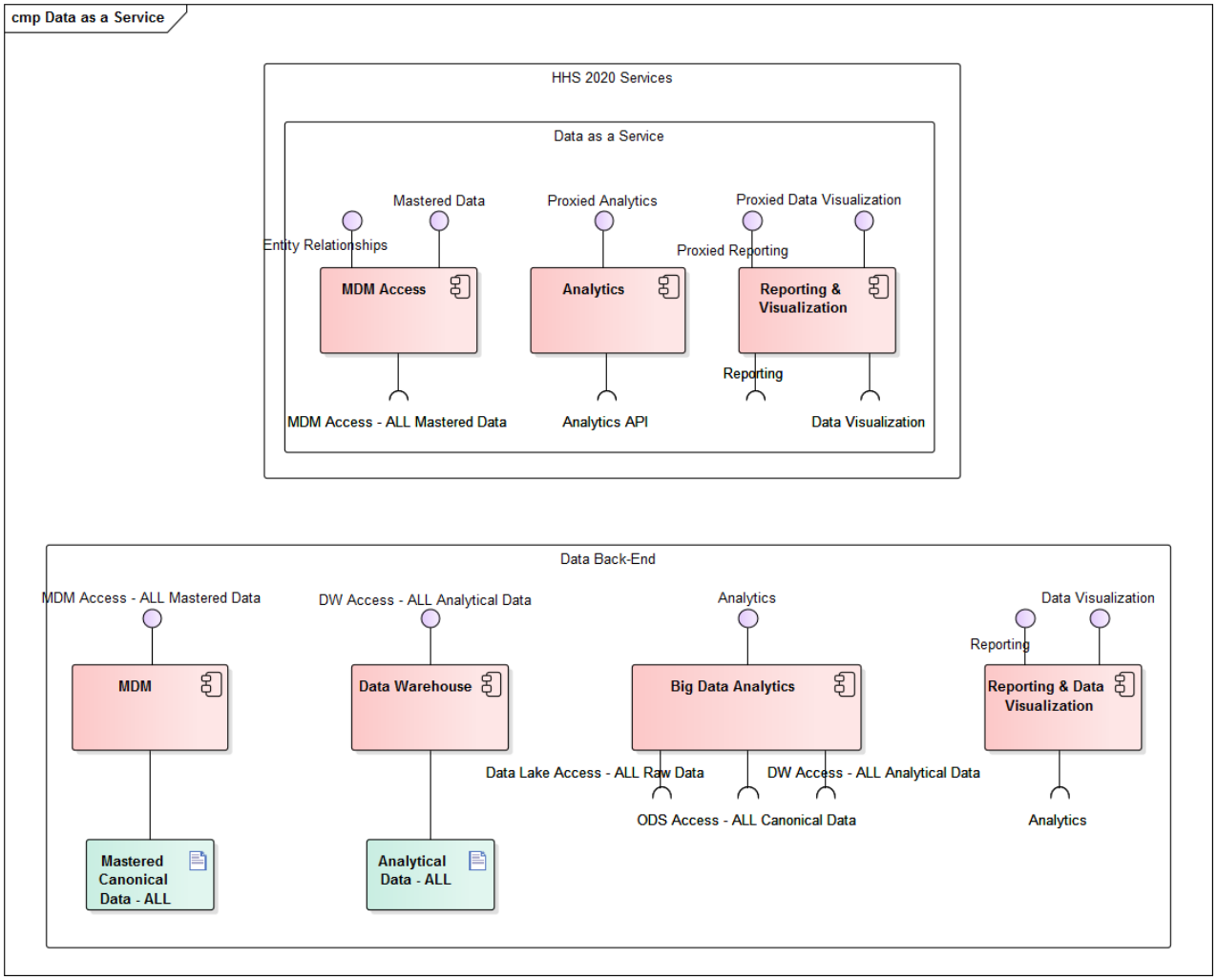

Figure 22: Data as a Service Conceptual Architecture

Since DaaS components are very closely related to the Information Architecture elements, the intended architecture and uses are best discussed in the IA section of this document.

5.4 ADAPTIVE WEB AND THE MULTI-CHANNEL ARCHITECTURE

The HHS 2020 enterprise will serve user needs through a variety of access channels, including:

- Adaptive web applications
- Mobile applications
- SMS applications
- Desktop applications

Adaptive web applications exposed via the UPI will be the initial and the ongoing primary means of self-service interactions of the HHS enterprise and its various human stakeholders.

The UP UI will be the primary means of end user access to HHS 2020 functionality. The web user interface will be based on a COTS portal framework rendering not only a responsive, but also an adaptive user experience. Responsive experience refers to the web application's ability to scale presentation area and UI mechanisms with available screen resolution on the browser host device. Adaptive applications go beyond resolution-based display scaling and include customizations of content and functionality, depending on the usage context. As the system knows more about a user and his/her needs, it will better tailor the user experience. The continuum of context is broad, starting with unauthenticated users browsing sites with content tailored based on the user's geographic location (assuming access to location has been granted), to authenticated users during program enrollment with limited, goal-oriented functionalities, to authenticated, fully enrolled users interacting with most complete sets of UI features.

The preferred mechanism for State employees to interact with functions exposed by both the HHS 2020 services and 3rd party applications is via State-provided, tailored UI components via the internal Unified Portal. These components will have a consistent look and feel and will participate directly in UI process orchestrations, including immediate posting of workflow step outcomes to the process orchestration engine. Such custom-built UIs will rely on underlying services for data acquisition and manipulation. The same UI components can be reused in multiple workflows.

5.5 COMPONENT RE-USE

The HHS 2020 ecosystem will be comprised of reusable, loosely coupled components that can be brought together through an orchestration to achieve both long- and short-running business process capabilities.

Reusability and platform independence of HHS 2020 architecture is achieved through three complementary technical approaches:

1. Design by contract
2. Adherence to standards for technological interoperability
3. Reliance on configuration of proven COTS products rather than custom software solutions

All HHS 2020 functional component design decisions are grounded in corresponding business requirements. All components expose their functionalities though well-defined programmatic interfaces. It is therefore possible to create implementations of the same set of requirements in different ways while hiding all technology-specific implementation details from consumers. This implementation flexibility is applicable to other NM HHS stakeholders that will join and leverage the HHS 2020 ecosystem in future. The HHS 2020 EA will be available for other state Medicaid enterprises to leverage as well.

The possibility of complete implementation transparency vis-à-vis consumption of HHS 2020 components by clients is enabled through adoption of standards for technological interoperability. HHS 2020 services will be discoverable via WS-Discovery (Web Service Dynamic Discovery) and UDDI (Universal Description Discovery and Integration) protocols. Service invocation will occur over an HTTP channel in either SOAP (Simple Object Access Protocol) with XML (Extensible Markup Language) message encoding or via REST (Representative State Transfer) protocol with JSON (Java Script Object Notation) message encoding. Service implementations will be secured using technology-independent identity and principal objects accessible from any client development platform.

The HHS 2020 EA favors use of COTS adapters and orchestrations to implement reusable service functionalities and BPEL orchestrations to enable long-running business process automation. Both types of orchestrations will be assisted by a COTS BRE that houses rule logic outside of functionality implementations. Use of orchestration-based solutions allows for quick modification of service and process capabilities with evolution of business needs. Reliance on open, human-readable and repeatable process and rule configurations enables knowledge sharing among larger Medicaid ecosystem, so that external organizations in need of similar functionalities can have a substantial productivity boost on their solution development efforts.

5.6 SECURITY CONSIDERATIONS

The HHS 2020 EA is governed by a combination of security control requirements found in MARS-E 2.0 and FIPS 140-2 standards intended to prevent unauthorized access to system data and functionalities. Compliance with 18 MARS-E 2.0 security control families is distilled into four separate focus areas of the HHS 2020 enterprise:

- Application security is implemented in software components and covers run-time execution of the following capabilities:
    - Authentication
    - Authorization
    - Encryption
    - Non-repudiation
    - Auditing
- Network and system security covers run-time operation of server nodes and networks providing the following capabilities:
    - Network partitioning
    - Minimization of potential attack surface
    - Access monitoring
    - Auditing
    - DDoS attack detection and response
    - Software intrusion detection and response
- Physical security covers the following aspects:
    - Physical access controls

    - Physical intrusion detection and response
- Configuration management
    - Application security configuration changes
    - Network and system security configuration changes
    - Physical security configuration changes

All human users of HHS 2020 functionalities will be permitted access after successful multifactor authentication. Although all users will have an ID and password combination, representing the "what you know" portion of the authentication mechanism, the system will consider additional factors like trusted device ("what you have") and user's location ("where you are") as part of the authentication scheme for a given usage context (e.g. a State employee accessing an internal web site from a State-issued computer vs. a constituent accessing a public web site form an unknown device).

After successful authentication users will be assigned permissions to access system functionality and data based on application role membership. All user roles will be defined in the identity management solution, the system's "first line of defense" when authorizing system access. Additional entitlement checking will be performed to ensure that the data requested by a user can be rendered based on the user's identity. Such identity-driven entitlement checking will be enabled by the shared entity management service, which will establish relationships among entities, including the family ties of State employee with constituents.

All data traversing the HHS 2020 enterprise will be encrypted both in transit and at rest to an applicable standard of strength using certificate services from Microsoft Active Directory and database encryption via MarkLogic and Oracle. Other at rest encryption needs will be supplied by Vormetric encryption from Thales Security. All web server requests (for web sites, services and business process orchestrations) will be hosted under the Transport Layer Security (TLS) protocol, ensuring appropriate web channel privacy protection. Data in databases and file systems will be encrypted as well using the same cryptographic infrastructure.

Encryption capabilities will be used for an additional purpose of non-repudiation by relying on digital signatures to sign communication content. By supplying a public key with which to decrypt digitally signed content, the sender ensures that the signed communication originated from the device where the corresponding private key can be found.

All access to secure information will be audited. Failed authentication and lack of authorization will be logged and processed via the identity management system. Rogue access attempts will be prevented by denying the originating host system access and triggering investigative and corrective actions by the State IT Security personnel.

6 INFRASTRUCTURE ARCHITECTURE STRATEGY

It is HHS 2020 preferred practice to have each module contractor host their applications in their own data center so that they administer, secure and monitor their own infrastructure and tools. However, since the State reserves the right to bring the application into State's data centers, each vendor's solution must be compatible with State's hosting capabilities and constraints.

Each individual module contractor has leeway on platform choices, although the State will likely restrict platform choices to Linux or Windows and restrict the module contractors to using commodity hardware and storage, COTS container management, virtualization, and best-of-breed system management. It is not anticipated that any modular system will be a mainframe system; rather, the State expects smaller, more agile systems that can scale both vertically and horizontally, depending upon the nature of the application.

The IP and its components, as well as the Unified Portal, will be hosted inside State data centers which are located in Santa Fe (Simms) and Albuquerque (Oso Grande). The primary location is the Simms data center in Santa Fe, with the backup/disaster recovery environment planned for deployment and operation in the Oracle Government Cloud (OGC). Each of the state-run data centers is a Tier 3 data center interconnected with high speed dedicated lines. The IP system and its components will run in a VMware virtualized hyperconverged architecture, such as VxRack. These systems are highly scalable and highly available, with load balancing, software defined storage and networking. Nodes can be either compute-centric or storage-centric, depending on need. The virtual machines, applications, and data in the primary site will be replicated to the backup site in the OGC in a manner that will meet the State's required recovery time objective and recovery point objective.

Each MMISR module will require high-bandwidth, high-throughput internet connectivity for end users. The Simms and Oso Grande data centers can meet these performance requirements by offering secure, continuously available, highly scalable, and self-contained infrastructure. HSD can achieve network connectivity and defense-in-depth security by means of employing a multi-layered approach that includes: network segmentation (DMZ), virtual private network (VPN) connections, firewalls, intrusion detection (IDS) and prevention (IPS) capabilities, secure remote access, and proxy controls. Access to State assets will pass through secure site-to-site IPsec tunnels for dedicated server traffic, while end user traffic will route through proxy servers via F5 load balancers.

6.1 HOSTING OPTIONS

Since different components of MMISR are decoupled, they may be hosted, managed and operated in various physical environments, even in different State, vendor and partner data centers, cloud-based systems, and each with separate security zones.

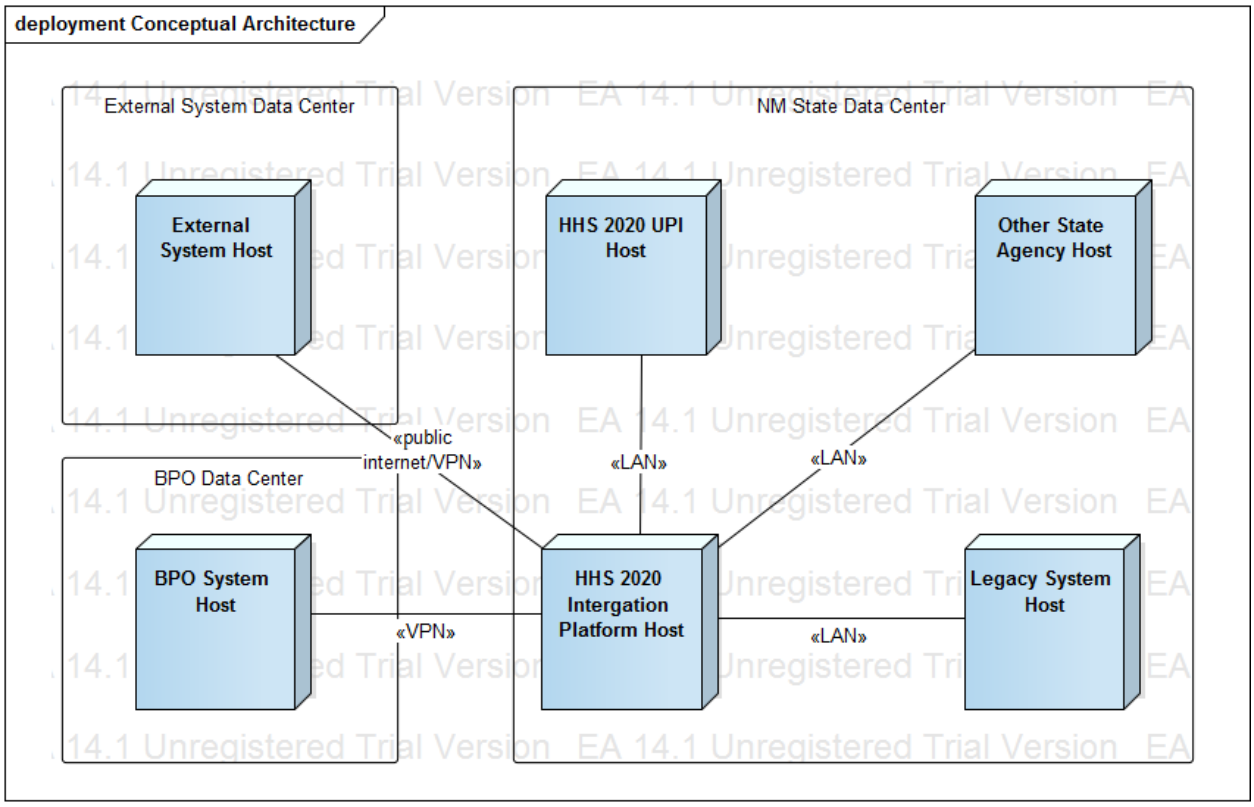

Figure 23: High Level Deployment Architecture of MMISR

MMISR architecture assumes that not all systems, subsystems and services will reside in the same data center. Some systems will be hosted and administered in vendors' data centers and some will run in State of New Mexico data centers. All component systems will integrate and interoperate through a single Integration Platform (IP) that enforces SOA principles, Data Quality Management verification and validation, security, auditing and logging. The IP will support highly reliable and scalable shared services, which will be used by all system assets that are part of MMISR.

Like all other technical decisions, uses of cloud computing within the HHS 2020 ecosystem have been carefully considered in light of business needs and Total Cost of Ownership (TCO) for the resulting solution. NM plans to leverage cloud environments for some systems development and SDLC testing activities and for disaster recovery (DR) purposes. With the HHS 2020 EA maturing over time and

achieving proven results in an on-premise deployment, the State will consider migrating additional elements of the HHS 2020 ecosystem into suitable cloud facilities.

6.2 SECURITY CONSIDERATIONS

To secure the HHS 2020 infrastructure, the network will be segmented to allow minimum access for functionality. This will be done via software defined network microsegmentation with VMware's NSX. All traffic to and between network zones will be logged. The firewall logs are forwarded to Splunk for auditing by the HSD security team. All hosted modules, as well as other state agencies' systems that participate in the HHS 2020 enterprise, will connect to the IP through a VPN. MARS-E controls for servers and network devices will be adhered to. All operating system security patches will be applied on a timely basis.

The Simms data center is a secure facility managed by the New Mexico Department of Information Technology. Entrance is controlled by access card and biometric screening. All racks are locked at all times and the departments that own the racks control access to them.

APPENDIX A: GLOSSARY

Table 17: Glossary of Terms

Acronym	Term	Definition
ACF	Administration for Children and Families	
API	Application Programming Interface	A tightly-coupled interface that a programmer writes which allows other programmers to send data through the interface to a module. Usually these are "Remote Procedure Calls" that tightly couple the hosting system to the client system.
ARB	Architecture Review Board	
Asset	Asset	An asset is any piece of software or hardware that makes up a part of the HHS 2020 EA. Software assets can be designs, drawings, checklists, files and documents.
ATLSD	Aging and Long-Term Services Department	
BA	Business Architecture	The body of work that captures, specifies manages and communicates business area needs, business area divisions of labor, business processes, business functions, business tasks and their interactions with each other, with external systems and with users. This is one of three "realms" of architectural design and specification that are a part of the New Mexico Enterprise Architecture.
BAM	Business Activity Monitoring	
BPM	Business Process Management	
BPO	Business Process Outsourcing	
BRE	Business Rules Engine	
BTC	Business Transformation Council	
CA	Continuously Available	
CIO	Chief Information Officer	
CMS	The Centers for Medicare & Medicaid Services	The federal sponsor of the MMISR project. CMS is responsible for setting the guidelines, regulations, certification requirements, and federal financial participation for state MMISR projects.
COTS	Commercial Off-The-Shelf	
CYFD	Children Youth and Families Department	
DevOps	Development and Operations	An IT practice that creates a tighter relationship between software development and software operations by fostering better collaboration between the builders of applications and those who run and maintain the software artifacts.
DGC	Data Governance Council	

Acronym	Term	Definition
DoD	US Department of Defense	
DOH	New Mexico Department of Health	
Domain	Domain	
EA	Enterprise Architecture	An overarching architectural framework of an enterprise that encompasses rigorous definition of business areas, functions, and processes, shared data, and enabling technologies.
EAF	Enterprise Architecture Framework	
Ecosystem	Ecosystem	
EDI	Electronic Data Interchange	
ESB	Enterprise Service Bus	
ESC	Executive Steering Committee	
FTP	File Transfer Protocol	
HA	Highly Available	
HHS 2020		New Mexico's vision for an ecosystem of Health and Human Services-related programs and supporting systems working cooperatively to improve outcomes for citizens while reducing operational costs for the State by increased use of service sharing and data sharing.
HL7	Health Level-7	
HSD	New Mexico Human Services Department	
IA	Information Architecture	The body of work that captures, specifies, manages and communicates strict definitions of data used within the HHS 2020 ecosystem, including data models, data dictionaries, message schemas, requirements for data quality management and other work products. This is one of three "realms" of architectural design and specification that are a part of the New Mexico Enterprise Architecture.
IP	Integration Platform	
JDBC	Java Database Connectivity	
JMS	Java Messaging Service	
JSON	JavaScript Object Notation	
MDM	Master Data Management	
MITA	Medicaid Information Technology Architecture	
MMIS		
MMISR	MMIS Replacement	
NASCIO	National Association of State Chief Information Officers	
NHSIA	National Human Services Interoperability Architecture	Published by the ACF in 2012, NHSIA provides an EAF in order to guide development of systems that work together across organizational silos and boundaries to accomplish ACF mission and goals.

Acronym	Term	Definition
NIEM	National Information Exchange Model	
Orchestration	Orchestration	
RA	Reference Architecture	A high-level design document that is the basis for myriad implementation projects that will share common architecture, design and implementation patterns.
Resource	Resource	Any asset that may be used by a system, and usually refers to an electronic asset rather than physical documents, files, etc.
SAMHSA	Substance Abuse and Mental Health Services Administration	SAMHSA worked with CMS to create the Behavioral Health (BH) BH-MITA project.
SMR	System Migration Repository	
SOA	Service Oriented Architecture	
SOAP	Simple Object Access Protocol	
SSO	Single Sign On	
TA	Technology Architecture	This body of work describes the kinds of technologies that will exist in the HHS 2020 ecosystem, how they are grouped together and managed, their responsibilities/functional roles, and how they depend upon one another to deliver the capabilities, systems, resources and assets that are the HHS 2020 ecosystem. This is one of three “realms” of architectural design and specification that are a part of the New Mexico Enterprise Architecture.
TMS	Technical Management Strategy	
UX	User Experience	
VPN	Virtual Private Network	
Workflow	Workflow	

APPENDIX B: MITA TECHNICAL STRATEGY CONSIDERATION COVERAGE

The following table provides a cross-reference between MITA Technical Management Strategy Considerations (9 principles, 8 goals and 29 objectives) and sections of this document. The table is used to ensure complete coverage of all considerations through at least one section of the MITA TMS deliverable.

Table 18: MITA Technical Strategy Consideration Coverage

Type	#	Consideration Text	Covered In
Principle	1	**Business driven** – MITA uses technology when it supports a business goal or objective; technology should not exist for technology's sake alone. Technical solutions will map to specific business needs.	Requirement-Centric, Traceable solution, Requirements Management Metamodel, Solution Architecture and Design Metamodel, Traceability through SDLC tools
Principle	2	**Implementation neutral** – States are responsible for selecting their own technology (e.g. Oracle J2EE, Microsoft.NET) to accomplish alignment with the MITA objectives.	COTS Technology Perspective, Software Architecture Vision
Principle	3	**Platform independent** – Stakeholders will develop reusable and platform-independent application software.	Software Architecture Vision, Service Orientation, Component Re-Use
Principle	4	**Adaptable, extensible, and scalable** – States will use SOA-based applications so that they can develop them in a modular fashion to accommodate future expanding business requirements.	Software Architecture Vision, Service Orientation, **Error! Reference source not found.**, Shared Services, **Error! Reference source not found.**, **Error! Reference source not found.**, Component Re-Use

Type	#	Consideration Text	Covered In
Principle	5	**Open technology and standards based** – Stakeholders will leverage the advantages of standardization (e.g. data sharing and interoperability).	Standards-Based, Enterprise Architecture, Business Architecture, Information Architecture, Technical Architecture
Principle	6	**Integrated Security and privacy** – States will maintain security and privacy of information throughout the MITA Framework.	Standards-Based, Government and Regulatory, Software Architecture Vision, Security Considerations, Infrastructure Architecture Strategy
Principle	7	**Interoperability standards** – Stakeholders will establish and follow the MITA SOA design principles to insure seamless functionality between services and other entities.	Standards-Based, Technical Architecture, Service Orientation
Principle	8	**Quality data** – States will design systems to establish the ability to provide the most current data so that they can make business decisions in a timely and accurate manner.	Enterprise Information Architecture Vision, Master Data Management
Principle	9	**Current and proven technology** – Stakeholders will select up-to-date established technology to support current business needs.	COTS Technology Perspective
Goal	1	Apply Cloud Computing concepts where possible and feasible.	Infrastructure Architecture Strategy, Hosting Options
Goal	2	Promote an enterprise view that supports enabling technologies aligned with state business processes and technologies.	Software Architecture Vision, COTS Technology Perspective
Goal	3	Utilize rules engines technologies, where possible, to extend the system configuration abilities to the business community.	Software Architecture Vision, COTS Technology Perspective

Type	#	Consideration Text	Covered In
Goal	4	Provide performance standards for accountability and planning.	Moving from Transactional to Value-Based Relationships
Goal	5	Develop systems that can effectively communicate to achieve common program goals through interoperability and common standards.	Standards-Based, Information Architecture, Technical Architecture, Software Architecture Vision, Service Orientation, **Error! Reference source not found.**
Goal	6	Promote an environment that supports flexibility, adaptability, and rapid response to changes in programs and technology.	Software Architecture Vision, Component Re-Use
Goal	7	Provide data that is timely, accurate, usable, and easily accessible in order to support program analysis and decision-making.	Information Architecture Strategy
Goal	8	Reduce duplication of costs by collecting data already available elsewhere and using that data to administer the program more effectively.	Software Architecture Vision, Shared Services, **Error! Reference source not found.**, Information Architecture Strategy
Objective	1	Break down artificial boundaries between systems, geography, and funding (within the Title XIX program).	Business architecture strategy
Objective	2	Adopt data and industry standards and promote the development of appropriate standards when needed.	Standards-Based, Standards Body Participation

Type	#	Consideration Text	Covered In
Objective	3	Promote the use of data and technical standards to improve the cost effectiveness of IT development. The use of data standards provides better access to data by promoting data consistency and enhanced sharing through common data-access mechanisms.	Standards-Based, Software Architecture Vision
Objective	4	Adhere to technical standards, specifically open standards, to facilitate integration of Commercial Off-the-Shelf (COTS) solutions and the reuse of solutions within and among States, resulting in lower development costs and reduced development risk.	Standards-Based, COTS Technology Perspective
Objective	5	Review national standards for health and data exchange and open standards for technical solutions, using existing national standards whenever possible. When Medicaid-specific standards are necessary, the Centers for Medicare & Medicaid Services (CMS) will support collaboration efforts of industry groups in the submittal of proposed standards to national standards organizations for review and approval.	Standards-Based, Standards Body Participation
Objective	6	Promote reusable software and hardware components and modularity.	Software Architecture Strategy, Software Architecture Vision, Infrastructure Architecture Strategy

Type	#	Consideration Text	Covered In
Objective	7	Develop reusable services to allow a single service to pass eligibility information from a variety of program systems to a mechanized claims processing, information retrieval, or eligibility determination systems.	Service Orientation, Shared Services, **Error! Reference source not found.**, **Error! Reference source not found.**
Objective	8	Differentiate between the processes, data, and technical solutions common to the State Medicaid Enterprise and those unique to individual States.	Architecture Scoped by MITA
Objective	9	Identify common business processes in order to define and reuse common solutions that enable States to share development costs.	Architecture Scoped by MITA, Collaboration and Reuse
Objective	10	Capture and represent state differences between common business processes that accommodate cost-effective solutions for state-specific needs.	Architecture Scoped by MITA, Collaboration and Reuse
Objective	11	Encourage state participation in the development of MITA models and templates to ensure that they represent commonality and differences appropriately. Create a balance between commonality and differences that enable standard mechanisms for interoperability and data exchange. The objective is to maximize the benefit across the State Medicaid Enterprise, while promoting innovation and creativity in local environments.	Standards Body Participation

Type	#	Consideration Text	Covered In
Objective	12	Enable data sharing without requiring extraction and loading of the data to a central location allowing each organization control and ownership of its own data.	Information Architecture Strategy, Service Orientation
Objective	13	Use standard definition formats to map data to standard data elements, where appropriate, and provide the data descriptions when the data elements are nonstandard.	Standards-Based, Information Architecture
Objective	14	Represent security and privacy access rules for each data element in a standard manner.	Information Architecture Strategy, Requirements Management Metamodel
Objective	15	Employ a collection of services to read the data descriptions and security/access rules in order to release information to authorized users for processing.	Stakeholder-Directed, State-Controlled Information, Software Architecture Vision, Security Considerations
Objective	16	Choose to host hubs that identify themselves to others through services and use of standards for the purpose of processing and exchanging data.	Software Architecture Vision, Service Orientation
Objective	17	Provide a beneficiary-centric focus of operations.	Business architecture strategy
Objective	18	Establish access channels, input device transparency, and built-in security and privacy in order to provide beneficiaries with “no wrong door” (i.e., single point) access to Medicaid services.	No Wrong Door, Adaptive Web and the Multi-channel Architecture

Type	#	Consideration Text	Covered In
Objective	19	Improve data quality by using data standards, applying standard performance standards, and relying on the availability of the enhanced data exchange and sharing provided by the hub architecture.	Information Architecture Strategy, Standards-Based, Information Architecture
Objective	20	Use statistical analysis for comparative and normative analyses in order to provide information to improve service to beneficiaries and the resulting health outcomes by more effectively monitoring patient safety and patient care.	Data Science and Artificial Intelligence Support
Objective	21	Enable and support interoperability, integration, and open architectures.	Software Architecture Vision, Service Orientation, Standards-Based, Technical Architecture
Objective	22	Employ services that make it possible to deploy common interoperability (i.e., system-to-system communication) and access (i.e., system-to-person communication).	Software Architecture Vision, Shared Services, **Error! Reference source not found.**
Objective	23	Package common functionality and capabilities with standard, well-defined interfaces (i.e., services), used by new applications, legacy applications, COTS software, or all three, to invoke the functionality.	Service Orientation

Type	#	Consideration Text	Covered In
Objective	24	Provide adaptability and extensibility. An adaptation (i.e., the capability that allows users to change the specifics of processes, data, or technical solutions using configuration files) enables States to customize MITA elements to meet their unique needs. An extension (i.e., the capability that allows users to add functionality and capabilities) enables States to add new functionality to MITA elements in order to meet their needs, while still meeting MITA goals and objectives.	Business architecture strategy, Collaboration and Reuse
Objective	25	Promote secure data exchange. MITA defines and integrates security and privacy capabilities throughout the architecture by identifying access requirements in the business processes, defining them within the data models, and applying them through the MITA technical models.	Standards-Based, Government and Regulatory, Software Architecture Vision, Security Considerations, Infrastructure Architecture Strategy
Objective	26	Promote good practices (e.g. the Capability Maturity Model (CMM), data warehouse).	Standards-Based, Enterprise Architecture
Objective	27	Use an EA framework and methodology that will allow States to align IT solutions with business needs. The MITA TA helps States to identify and then use common solutions to drive their State Medicaid Enterprise to support alignment with the state EA.	Standards-Based, Government and Regulatory, Enterprise Architecture

Type	#	Consideration Text	Covered In
Objective	28	Use the set of MITA Framework common business processes and data standards to make it possible to develop performance standards, measurement techniques, and corresponding utility services.	Business architecture strategy, Architecture Scoped by MITA
Objective	29	Support integration of clinical and administrative data in order to achieve better health outcomes. This allows stakeholders to redirect dollars formerly spent on preventable diseases or on IT maintenance to more pressing business needs.	Business architecture strategy, Data-Driven Enterprise, Moving from Transactional to Value-Based Relationships