

MONTANA DEPARTMENT OF TRANSPORTATION



Development of Strategic Enterprise
Architecture Design and Implementation
Plan

TASK 2
SYNTHESIS OF ENTERPRISE ARCHITECTURE BEST
PRACTICES

JANUARY 2016

TABLE OF CONTENTS

1	Introduction.....	1
2	An Introduction to Enterprise Architecture (EA) Concepts.....	2
3	Enterprise Architecture Best Practices.....	6
	3.1 California.....	6
	3.2 Colorado.....	7
	3.3 Hawaii.....	10
	3.4 Kansas.....	11
	3.5 Michigan.....	16
	3.6 New Jersey.....	18
	3.7 North Carolina.....	19
	3.8 Ohio.....	24
	3.8.1 <i>Applications Architecture</i>	25
	3.8.2 <i>Data Architecture</i>	26
	3.8.3 <i>Technical Architecture</i>	27
	3.9 Texas.....	29
	3.10 Virginia.....	32
4	Concluding Comments.....	35
5	Works Cited.....	36

LIST OF FIGURES

Figure 1: Enterprise Architecture Interfaces (CEAF 2.0, p.46).....	7
Figure 2: Colorado’s “As-Is” and/or Pre-2008 State.....	8
Figure 3: Colorado’s “To-Be” State.....	9
Figure 4: Colorado’s Enterprise Architecture Processes.....	10
Figure 5: KDOT’s Overall Architecture.....	12
Figure 6: Types of Work Products Produced During KDOT’s Enterprise Architecture Design.....	13
Figure 7: KDOT’s High-Level Data Model.....	14
Figure 8: KDOT’s Data Integration with Partners.....	15
Figure 9: Business Architecture Deliverable from the State of Michigan’s Enterprise Architecture Project....	17
Figure 10: New Jersey OIT Architecture Stack.....	18
Figure 11: NCDOT’s Continuous Process Improvement of IT Work Processes Maturity Model.....	21
Figure 12: NCDOT’s Enterprise Architecture Drivers.....	22
Figure 13: NCDOT Enterprise Architecture Common Themes Supporting Strategy.....	22
Figure 14: NCDOT Information Technology Division Organization Chart.....	24
Figure 15: Ohio Enterprise Architecture “To-Be”.....	28
Figure 16: TxDOT Modernization EA Focus.....	31
Figure 17: Generalized TxDOT IT Organization.....	32
Figure 18: VITA Enterprise Architecture Model.....	33
Figure 19: VITA ETA Relationship to the Enterprise Architecture.....	34

ENTERPRISE ARCHITECTURE BEST PRACTICES

1 INTRODUCTION

The Montana Department of Transportation requested (via RFP 15-3109T) a consultant develop a Strategic Enterprise Architecture (EA) Design and Implementation Plan for the Montana Department of Transportation (MDT), structured around one of the leading EA frameworks and customized to best address the MDT environment (Montana Department of Transportation 2015). One of the intermediate deliverables on this project was an assessment of EA Best Practices, which is the purpose of this report.

An Enterprise Architecture (EA) is a strategic technology plan that aligns with the strategic plan of the agency; integrates the technology needs of the agency; and leverages data, systems, technology infrastructure, and knowledge of staff members to implement technology systems to support the efficient delivery of the programs, operations, and services of an organization, such as MDT.

Typically, all of the nuances of an Enterprise Architecture are not fully understood by those in the enterprise; this includes IT staff as well as those in the business units. However, the overall importance of technology is generally understood in varying degrees by most in the enterprise. Most recognize that *“Technology will have a greater impact on transportation in the next 50 years than it has in the past 50.”* (Rahn 2013)

The sections in this report introduce EA concepts, the role EA needs to play in the ongoing success of the organization, and concludes with an overview of EA Best Practices in the public sector, with a focus on state agencies and specifically transportation agencies where appropriate.

2 AN INTRODUCTION TO ENTERPRISE ARCHITECTURE (EA) CONCEPTS

Every enterprise, or organization, has a structure or architecture. This structure or architecture achieves the goals and objectives of the enterprise with varying levels of success. For organizations that have existed for more than 30 years, this structure, or architecture, has typically been the result of organic growth rather than the result of deliberate process. Without a synoptic view of their Enterprise Architecture, most organizations or enterprises are marred by duplications in each of the following areas:

- Roles;
- Platforms;
- Data; and
- Business applications.

As a result, the business side of the enterprise typically perceives things like:

- The high cost of Information Technology (IT);
- The inflexibility of IT; and
- IT's inability to react quickly to changing business needs.

On the other hand, IT perceives the same situation as:

- The enterprise lacks formal business processes;
- Lacks clarity in its formal business requirements; and
- IT is saddled with an inherited and obsolete technology base with a barely comprehensible architecture.

In short, many organizations face similar issues in that they have grown organically into complex systems, similar to complex jigsaw puzzles after many years of patching and point-based solutions that ultimately integrate poorly. This is a highly problematic scenario in an increasingly complex and quickly changing world.

These are some of the motivations for developing an Enterprise Architecture (EA). An EA is a strategic technology plan that aligns with the strategic business plan of the enterprise/organization. This plan integrates the technology needs of the enterprise and leverages its data, systems, technology infrastructure, and the knowledge of staff members to implement technology systems to support the efficient delivery of the programs, operations, and services.

It is important to recognize that EA is a process and not an end state. That is, when done properly, an EA is something that will move from a program state to a business as usual activity. The delivery of an EA is both iterative and cyclic, converging towards the changing target state

of the organization/enterprise. In short, it is the ongoing process of delivering the target state of the enterprise.

The term “Enterprise Architecture” was first used in an IBM journal article in 1987 by John A. Zachman (Zachman 1987). Zachman’s work, later extended in 1992, continues to be the archetypal EA framework. As initially defined in this journal article, Enterprise Architecture addresses two (2) very important issues:

- System complexity resulting in more and more money being spent on information technology systems; and the
- Poor business alignment between information technology and business objectives, resulting in it becoming increasingly difficult to keep these expensive systems aligned with business needs. (Zachman 1987)

Enterprise Architecture (EA) seeks to address the issues of *system complexity* and *poor business alignment* by providing an overall blueprint to guide technology portfolio investment decisions. The EA approach:

- Establishes the organizational mission;
- Identifies the information necessary to perform the organization’s mission;
- Identifies the technologies necessary to perform the organization’s mission; and
- Provides the transitional processes for implementing required technologies (The Chief Information Officers Council 1999).

The typical enterprise today is now so complex that it is impossible to remember or be aware of everything unless it has been documented or written down. Once documented, if you want to change it, you begin with what has been documented (i.e., the “architecture”), which provides the baseline for managing change. One of the benefits of the Zachman Framework is that it presents a straightforward classification scheme for representing the enterprise and the perspectives of the enterprise.

Not surprising, Zachman also notes that most enterprises “have a large inventory of ‘current systems’, built out-of-context, not integrated, not supporting the Enterprise, that are too costly to replace”. These are commonly known as “legacy” systems, which Zachman calls an “albatross” or a penalty to be paid for sins of the past. (Marks 2002, p.102)

EA is the specific description and documentation of the current and desired relationships, or states, among the enterprise’s operations and management processes and information technology. As such, EA describes the “As-Is”, or current state, and the “To-Be”, or future state, and includes the rules, standards, and systems life-cycle information to optimize and operate the environment the organization desires. Key to being successful is having the underlying strategy in place that enables the enterprise to both support its current state and act on transitioning to its desired future state. This transition plan must include:

- Capital planning and investment control processes to guide technology investment decisions;

- EA planning processes; and
- Systems life-cycle management methodologies. (Fri, USAF Summer 2007)

Few organizations have been built with a Business Architecture Blueprint. Most have solely allowed IT to build the Enterprise Architecture on their own, which in some respects is not unlike allowing IT to run the business. What has been clearly missing in the process are business processes and business involvement in the construction of the organization's Enterprise Architecture. This is also especially difficult to accomplish by any state agency given the administration changes that occur on a frequent and regular basis, as there is a tendency to abandon much of the prior administration's thinking and planning as new administrations come into place. Rather than losing ground each time an administration change takes place, an EA framework, and its supporting processes, should be designed and implemented in a manner designed to survive administration changes for the long-term benefit of the agency and the citizens it serves.

In the nearly 30 years since Zachman first introduced Enterprise Architecture, multiple EA frameworks have been specified with varying objectives in mind. Not all of these frameworks have survived. Today, some of the better known EA frameworks include Zachman's, TOGAF (The Open Group Architecture Framework), the US government's Federal (FEA) and departmental levels (TEAF for Treasury, etc.), and DoDAF for the US Defense framework. DoDAF and FEA are both elaborate and unfortunately somewhat specialized frameworks.

These various frameworks have been compared and analyzed numerous times. However, in one comparison of EA Frameworks, TOGAF scored better overall when compared to the Zachman EA Framework using the following comparison criteria: Completeness, reference model and practice guidance, maturity, business focus, governance guidance, vendor neutrality, information availability, time to value, etc. (Sessions 2007)

TOGAF has roots in the Defense framework and provides a high-level approach to design typically modeled at four (4) levels:

- Business Architecture, which defines the functional structure of the enterprise in terms of its business processes and organization and associated business information needs;
- Applications Architecture, a subset of information systems architecture, which delineates the capabilities of specific applications used to support business functions and how these various applications work together or integrate to support enterprise-wide information requirements;
- Data Architecture, a second subset of information systems architecture, which establishes data standards for all enterprise information systems to support integration and information sharing between these systems; and
- Technology Architecture, which describes the technical infrastructure and specific hardware and the software technologies that are required to support the various business applications.

In short, EA is a management engineering discipline that can guide the path toward transformation and provide the tools for management of change. Regardless of the industry an

MDT—EA BEST PRACTICES REPORT

organization is in, EA provides a solution to the problems mentioned in this overview of EA. If organizations are to become more agile and more effective leveraging their technology investments and managing their own processes, an Enterprise Blueprint needs to be developed. This Enterprise Blueprint must be documented and known. EA is the enterprise picture, the shared vision, or the blueprint by which business and IT address their concerns using a common vocabulary.

An EA design and planning is similar to a state transportation agency designing, planning, and maintaining its transportation infrastructure; only the assets are different. That is, there are strong parallels between Enterprise Architecture planning and design and transportation planning and design: In a state transportation planning agency, planners design the infrastructure in the face of many unknowns, such as future transportation technologies, external regulations, changing work, living, changing commuting patterns, etc. IT planning occurs in a similar fashion also with many unknowns, such as future technologies, obsoleted technologies, externally defined regulations and restrictions, changing business requirements, an uncertain work force, etc. With the right level of planning, both will be able to produce results that remain viable for many years, each making their respective contributions.

3 ENTERPRISE ARCHITECTURE BEST PRACTICES

This section provides an overview of best practices in the public sector, paying attention to state transportation agencies whenever possible.

The management of Information Technology within each state is a function of how Information Technology (IT) is organized within the state. Each state has its own unique nuances with respect to managing their IT governance frameworks. That is, state government enterprise IT governance frameworks are organized in a broad spectrum ranging from highly centralized to loosely federated models. The State CIO's Office in each state have varying degrees of authority, control, responsibility, and oversight over the conduct of IT for their state's agencies. This obviously can have an impact on the agency in terms of how Enterprise Architecture is both viewed and treated within the state. For the states described below, we have attempted to provide a profile of the state model followed, noting when it is centralized, loosely federated, or some form of hybrid to assist understanding of what is happening within the state.

3.1 CALIFORNIA

The California State Chief Information Officer (CIO) heads the California Department of Technology and the state follows a Hybrid/Federated Model for IT Governance. The California Department of Technology provides leadership for the state's information technology programs and works collaboratively with information technology leaders throughout state government. The California Department of Technology envisions itself as a strategic planner and architect for the state's information technology programs and a leader in formulating and advancing that program's vision. (California Department of Technology, Enterprise Architecture 2015)

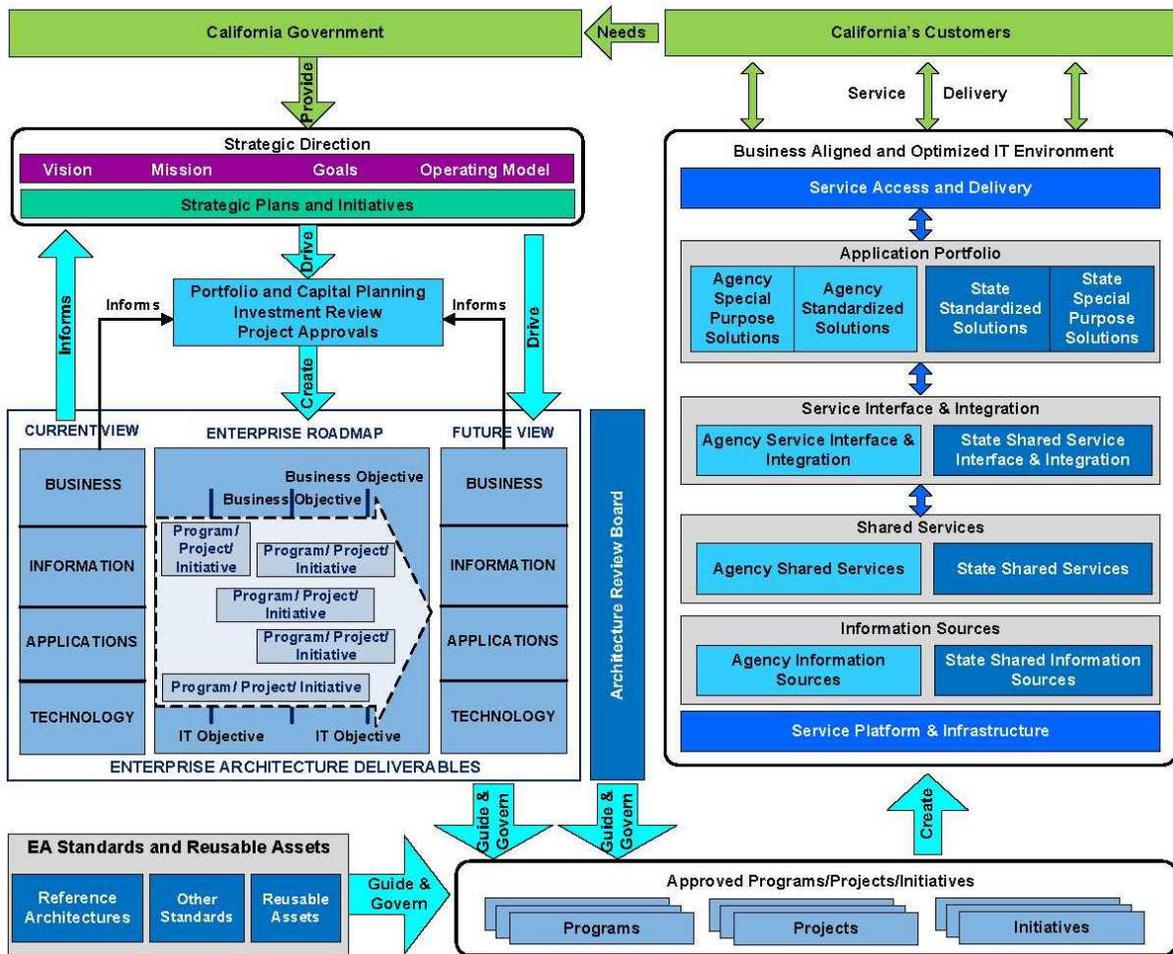
The state follows the Federal Chief Information Officers Council definition of enterprise architecture, as referenced in the Common Approach to Federal Enterprise Architecture: *"Enterprise Architecture means a strategic information asset base, which defines the mission; the information necessary to perform the mission, the technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to changing mission needs; and includes a baseline architecture, a target architecture, and a sequencing plan."* (The Common Approach to Federal Enterprise Architecture 2012, p. 45)

The California Department of Technology has published the California Enterprise Architecture Framework, Version 2.0 (CEAF 2.0) which provides guidance for the development and use of comparable enterprise architectures within and across state agencies. CEAF 2.0 is an Enterprise Architecture framework designed by California to guide development and use of comparable Enterprise Architectures within and across the various state agencies to enable mission success with lower total cost of ownership (TCO), faster delivery times, and reduced duplication. It also promotes cross-agency initiatives (CAIs) for shared development of common business processes, business and technical services, and shared platforms. CEAF 2.0 contains the four (4) familiar Enterprise Architecture Domains noted in the TOGAF framework (i.e., Business Architecture,

Information Architecture, Application Architecture, and Technology Architecture). (California Department of Technology, California Enterprise Architecture Framework 2013)

Figure 1 from California’s CEAF 2.0 illustrates how the state views Enterprise Architecture fitting into the overall organization and its key interfaces with other processes such as strategic planning, portfolio and capital planning, investment management, and project management. (California Department of Technology, California Enterprise Architecture Framework 2013, p. 38)

Figure 1: Enterprise Architecture Interfaces (CEAF 2.0, p.46)



(California Department of Technology, California Enterprise Architecture Framework 2013, p. 38)

3.2 COLORADO

Information Technology in the state operates in a consolidated model. In 2007, the Colorado governor announced a multi-year consolidation plan, folding the state’s decentralized IT operations into the Governor’s Office of Information Technology (GOIT).

The 2007 plan called for centralized information technology management, purchasing, spending, and planning also called for a statewide enterprise structure to replace the current agency-by-agency model. In June 2007, OIT engaged in a number of studies and assessments in collaboration with executive branch agencies to review the state of IT in Colorado, statewide IT procurement practices, and how Colorado and other states delivered IT services. This resulted in the Colorado Consolidation Plan (C2P), a roadmap for moving state government from a decentralized into a singular statewide enterprise organization. (Colorado GOIT Our History n.d.)

As a part of Colorado GOIT, the Colorado Office of Enterprise Architecture (OEA) manages Colorado’s OIT’s Enterprise Architecture and Data Management (EADM) programs, and is authorized to set statewide technology standards and processes. OEA has published a roadmap (or direction-setting “compass”) entitled The Compass: Enterprise Architecture 2011 – 2014. Enterprise Architecture is approached at the state level, and Figure 2 illustrates how Colorado depicts their pre-consolidation and to some extent their “As-Is” state, clearly depicting IT application system silos. Figure 3 illustrates Colorado’s vision for their “To-Be” state. (Colorado OIT Standards - The Compass - Enterprise Architecture 2011-2014 2012)

The Colorado Consolidation Plan (C2P) describes their Adaptive Enterprise Architecture and expresses these as a combination of the following viewpoints:

- Business Architecture;
- Information Architecture;
- Services/Reuse Architecture;
- Technology Architecture; and
- Solution Architecture. (C2P: The Colorado Consolidation Plan 2008)

Figure 2: Colorado’s “As-Is” and/or Pre-2008 State

Dept A EDO	Dept B EDO	Dept C EDO
Dept CIO	Dept CIO	Dept CIO
LoB SW/PM/BA	LoB SW/PM/BA	LoB SW/PM/BA
GIS	GIS	GIS
Enterprise SW	Enterprise SW	Enterprise SW
Cyber Security	Cyber Security	Cyber Security
DBA/Sys Admin	DBA/Sys Admin	DBA/Sys Admin
Data Center	Data Center	Data Center
Server/Storage	Server/Storage	Server/Storage
Help Desk	Help Desk	Help Desk
Desktop	Desktop	Desktop
Network	Network	Network
HR/Finance	HR/Finance	HR/Finance
Lic/Contracts	Lic/Contracts	Lic/Contracts
IT Purchasing	IT Purchasing	IT Purchasing

(Colorado OIT Standards - The Compass - Enterprise Architecture 2011-2014 2012, p. 8)

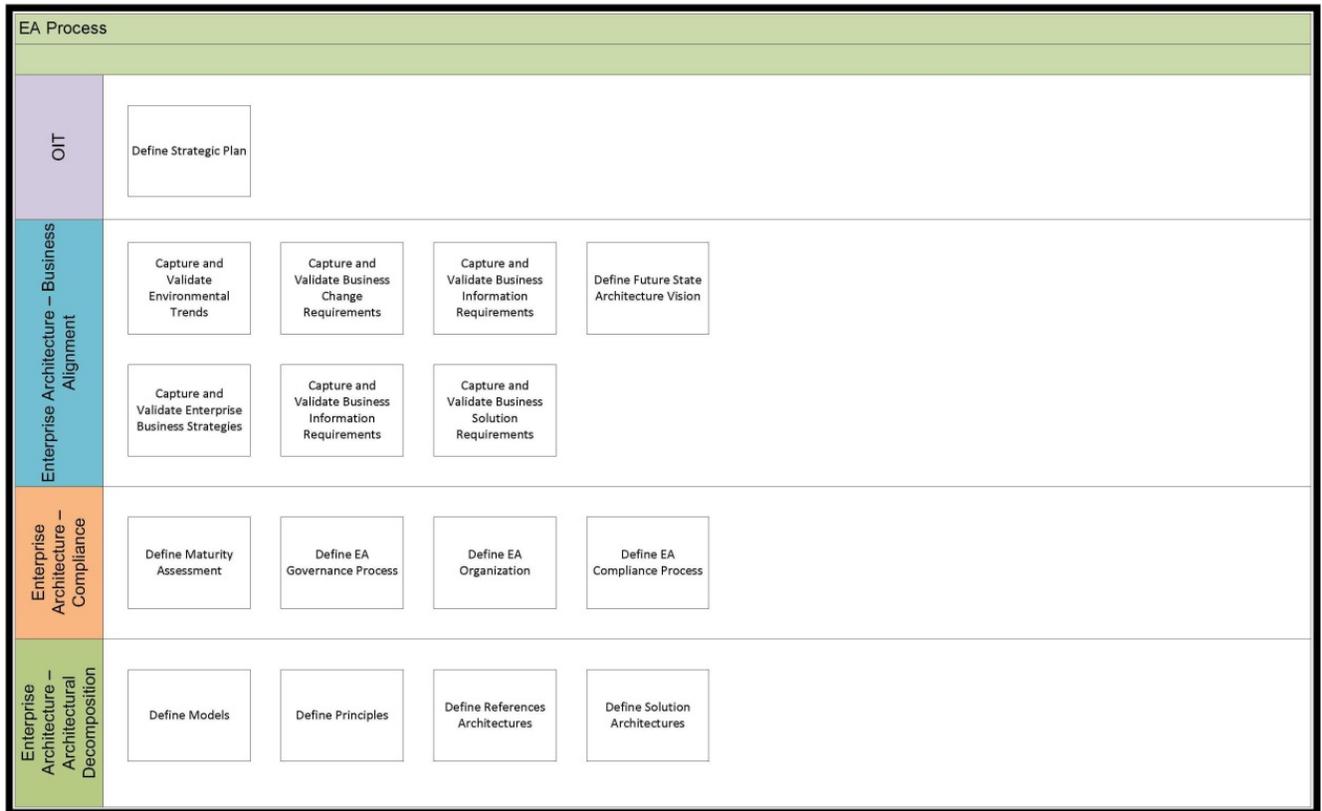
Figure 3: Colorado’s “To-Be” State

(Colorado OIT Standards - The Compass - Enterprise Architecture 2011-2014 2012, p. 9)

The enterprise architectural process depicted in Figure 4 illustrates the mapping of business strategy to the overall architectural process, providing the basis of making all decisions related to the enterprise. Key considerations in this area include:

- Strategic requirements for the state;
- Strategic requirements of enterprise IT;
- Business requirements;
- Requirements for migrating the business from its current state to future state; and
- Metrics for measuring the fulfillment of requirements and the traceability to core business requirements. (C2P: The Colorado Consolidation Plan 2008, p. 133)

Figure 4: Colorado’s Enterprise Architecture Processes



(C2P: The Colorado Consolidation Plan 2008, p. 134)

3.3 HAWAII

In 2010, Hawaii formally established a full-time State CIO position in the Office of Information Management & Technology (OIMT) along with an IT Steering Committee to assist the State CIO in developing state’s standards and policies. The State CIO, OIMT, and the state agencies reviewed best practices and developed the Business & Information Technology/Information Resource Management (IT/IRM) Transformation Plan to guide the work of the state toward achieving a vision and framework enabling the state to translate strategic objectives into actionable projects that will deliver value to the state. Their State Strategic Planning Framework contains four elements:

- Business & IT/IRM Strategic Plan—establishes the goals, objectives, and performance metrics for the transformation from both a business and a technology perspective;
- Enterprise Architecture (EA)—a model of the business processes, information and data, technology infrastructure, and solutions (systems) used by the state to accomplish its mission. The EA comprises as “As-Is” model, a “To-Be” model, as well as the transition and sequencing plan for moving from the former state to the latter state;
- Business & IT/IRM Projects—where plans are implemented, investments are made, systems and infrastructure are designed, developed, and deployed, and new technology replaces old; and

- Management Oversight/Governance—monitors costs, schedules, risks, performance, scope, and strategic alignment of transformation activities to ensure highest priorities are achieved with quality solutions. (State of Hawaii OITS What We Do n.d.)

Hawaii’s EA methodology was tailored from the federal government’s Federal Enterprise Architecture (FEA) and Federal Segment Architecture Methodology (FSAM) and influenced by Gartner (such as the Common Requirements Vision and the Conceptual Architecture Principles). These Federal models were simplified, to make adjustments for simpler terminology, architecture layers and deliverables, and methodology steps. These models were also streamlined to provide a more incremental and iterative approach to EA development to balance speed of accomplishment and realization of benefits in investment decision-making from the EA models and artifacts. (State of Hawaii OITS 4.0 Enterprise Architecture Methodology n.d.)

3.4 KANSAS

The state CIO resides in the Kansas Information Technology Office (KITO), which supports the statutory responsibilities of the executive, judicial, and legislative branch Chief Information Technology Officers (CITOs) and the Chief Information Technology Architect (CITA). IT Governance in Kansas follows a Federated/Hybrid model.

Since the late 1990’s, KITO includes the Enterprise Project Management Office (EPMO) and provides oversight to information technology reviewing and making recommendations for policies, guidelines, and best practices for information technology projects throughout Kansas state government. It provides consultation on major IT projects throughout Kansas government in the areas of project plan development; specification development, review, and approvals; project reporting; and project closeouts. (State University of New York 2009)

Figure 5 through Figure 8 illustrate several examples of information systems architecture work products from work completed 2003-2005 at the Kansas Department of Transportation (KDOT).¹

- Figure 5 depicts KDOT’s overall architecture;
- Figure 6 shows the types of work products produced during their Enterprise Architecture design;
- Figure 7 shows KDOT’s high-level data model; and
- Figure 8 depicts KDOT’s data integration with partners.

¹ All KDOT diagrams are from the presentation “Enterprise Architecture at The State of Kansas and the Kansas Department of Transportation” by Bill Rothman, January 2005.

Figure 5: KDOT's Overall Architecture

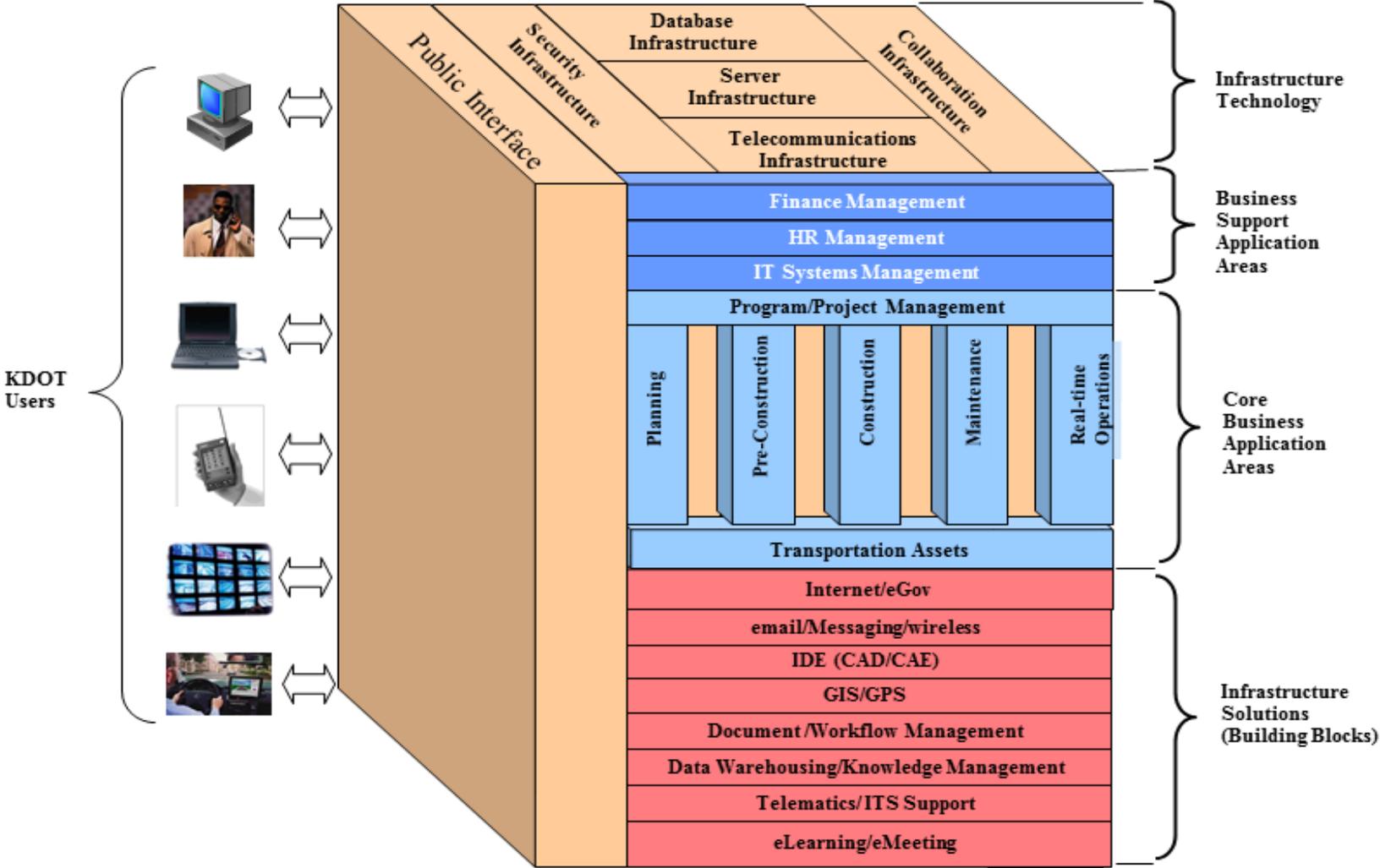


Figure 6: Types of Work Products Produced During KDOT's Enterprise Architecture Design

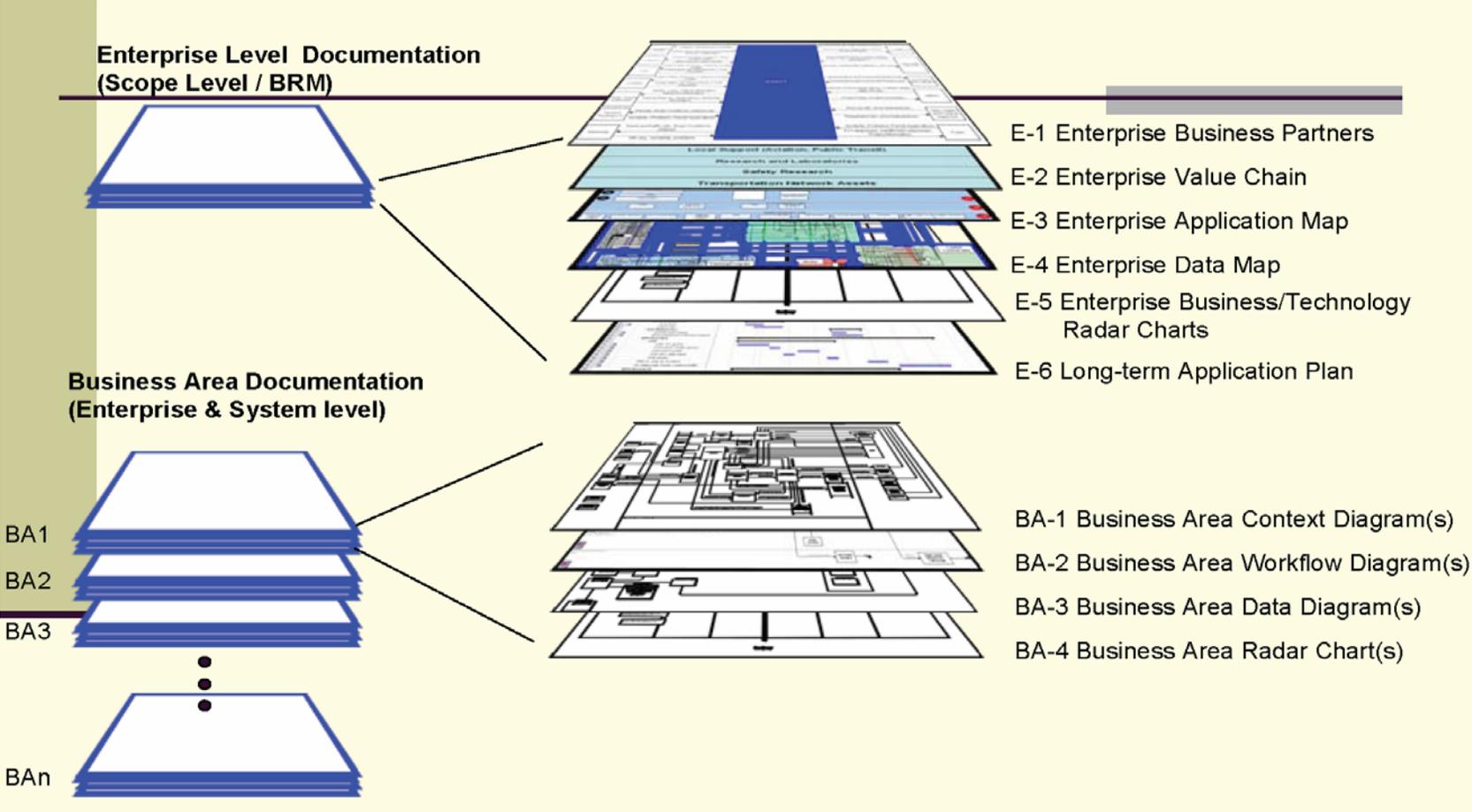


Figure 7: KDOT’s High-Level Data Model

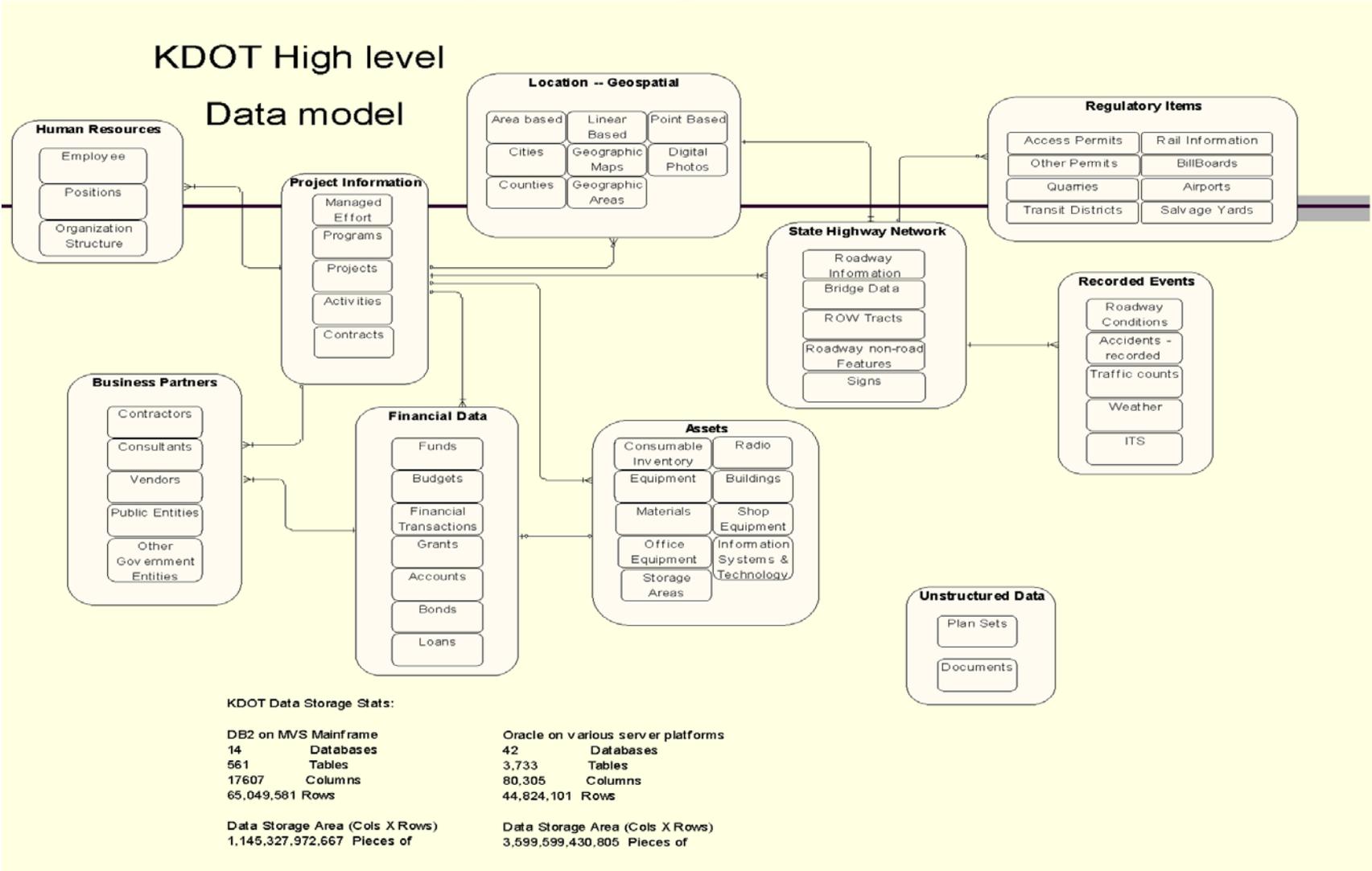
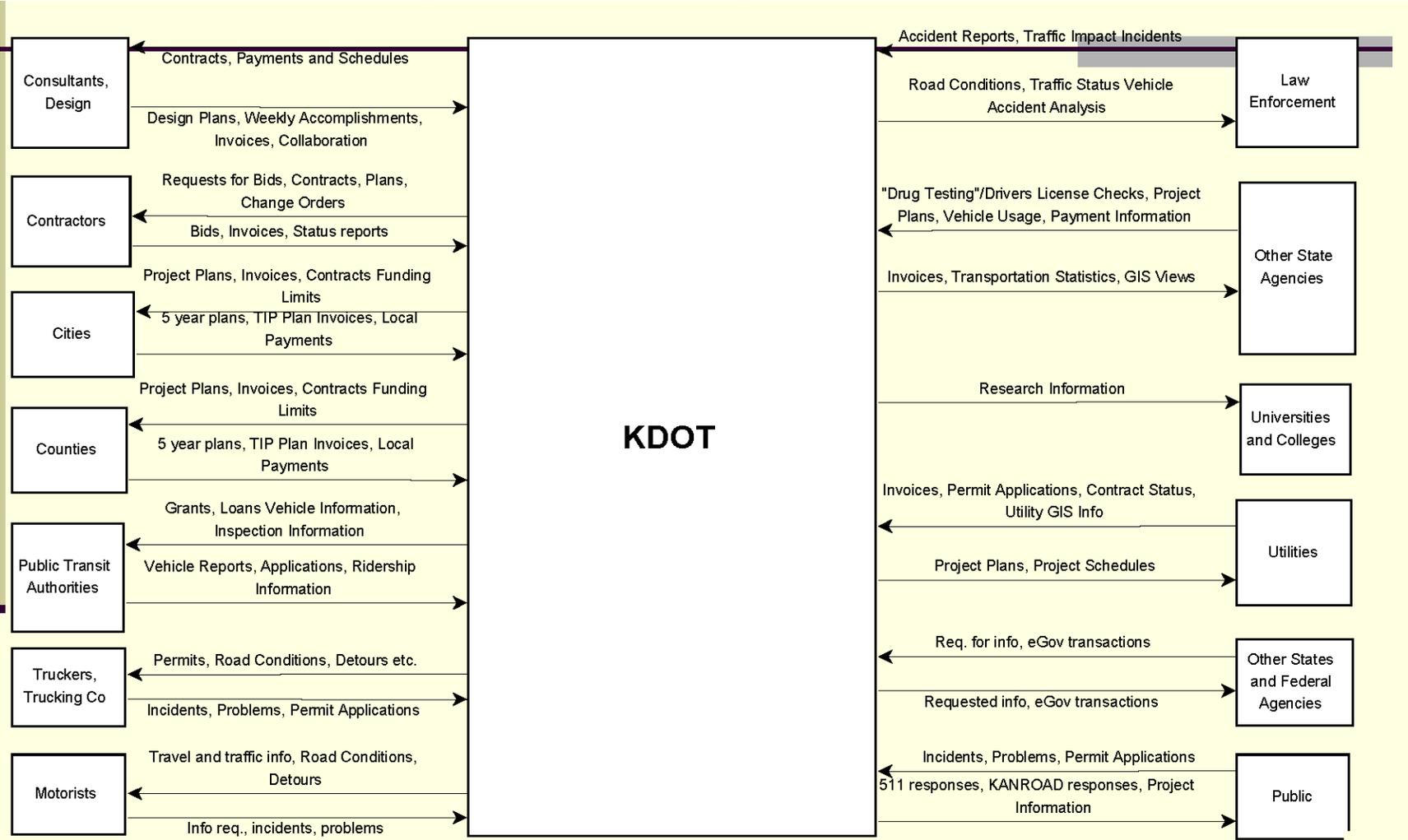


Figure 8: KDOT’s Data Integration with Partners



3.5 MICHIGAN

IT Governance in Michigan follows a centralized model. In 2001, by governor executive order, the Department of Information Technology (DIT) was established with the intent of creating a unified and cost-effective approach for managing IT among executive branch agencies.²

DIT was organized into the following five (5) subdivisions:

- Bureau of Agency Services—Liaison between DIT and the individual agencies responsible for ensuring delivery of agreed upon services working across all agencies to identify common technology needs to leverage resources;
- Office of Employee and Financial Services—Responsible for oversight of the department's Human Resource functions, facilities management, and budget and financial management;
- Bureau of Infrastructure Services—Responsible for maintaining and supporting the state's information technology infrastructure accountable for desktop services, field services, data center services, telecom & network management, and technical services;
- Office of Security—Responsible for identifying, managing, and mitigating security risks and vulnerabilities within Michigan state government computing resources and charged with disaster recovery planning, risk management, security awareness and training, assisting state agencies with their security issues, and enforcement of state security policies and procedures;
- Office of Strategic Policy—Assures, through policies, standards, and research, the consistent, efficient, and effective delivery of information technology services. (State University of New York 2009)

Figure 9 illustrates a business architecture deliverable from the State of Michigan's Enterprise Architecture project (Michigan 2007). In this example, the State of Michigan has mapped business drivers within its Public Service Architecture to specific application systems and technology architecture initiatives. Note that Michigan has utilized the nomenclature Public Services Architecture for the business architecture layer since the State of Michigan views their state's mission as being one of providing services to the public as opposed to the more traditional definition of a business.

² DIT was subsequently renamed the Michigan Department of Technology, Management, and Budget (DTMB).

Figure 9: Business Architecture Deliverable from the State of Michigan’s Enterprise Architecture Project

 Goal Area: The Economy 		
Business Drivers and Outcomes	Sample of Strategic Information Technology Projects	Supporting Enterprise Architecture Strategies Initiatives
<p>Sustain and Create Business Investment and Jobs in Michigan:</p> <ul style="list-style-type: none"> • Retain and strengthen Michigan’s existing manufacturing, agriculture and tourism base by creating new jobs. • Facilitate employment by making it easier for employers and employees to find each other. • Make the regulatory process easier to navigate for Michigan businesses. • Make State Government a good partner with businesses in Michigan 	<p>On-line Business Startup Wizard An online web service has been established to fast track the application processes for tax identification numbers and business startup tasks, shortening the startup process by 6 weeks.</p> <p>MiTAPS Online permitting system used to facilitate the application and approval processes. This system will be extended to support as many permitting processes as possible to make Michigan a better place to do business.</p> <p>eProcurement A project in process intended to improve the way the State of Michigan procures goods and services, making better use of tax revenues and facilitating the processes for doing business with the State of Michigan.</p> <p>Michigan Talent Bank A web portal focused on talent retention in Michigan by allowing employers to post jobs and to review resumes posted by Michigan job seekers.</p> <p>Family Automated Screening Tool (FAST) An electronic screening tool used to identify barriers to employment for families in need. It is intended to help people become successful members of Michigan’s workforce.</p>	<p>Identity Management The State of Michigan will be making more resources available to businesses, and some of these resources will require strict controls around secure information such as tax data.</p> <p>Service Oriented Architecture Supporting the secure exchange of data is one of the critical functions that MDIT must fulfill moving forward. As these needs increase, and timeframes shorten, a successful SOA strategy will play a vital role in meeting the data needs of business functions supported by the State of Michigan.</p> <p>Hosting and Data Center Consolidation Just as businesses are expanding their hardware and data center capabilities to meet emerging technology needs, the State of Michigan must continue to provide the expanded data center services needed to help government services keep pace with an ever changing economy.</p>

3.6 NEW JERSEY

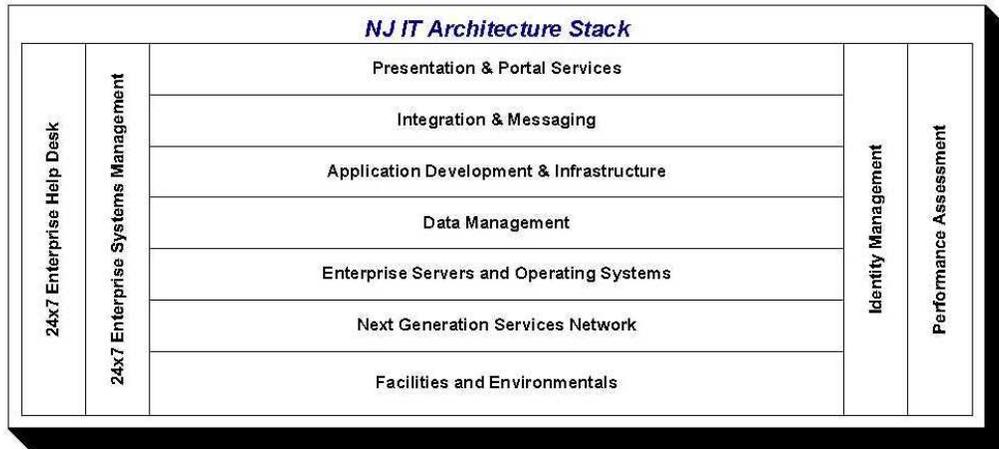
The New Jersey Office of Information Technology (OIT) is the central state IT organization that oversees the technology infrastructure for the executive branch. The state follows a Federated/Hybrid model for IT Governance. In 2007, the state adopted a governance model that facilitates three (3) layers of accountability, the

- Technology Governing Board (technology professionals from the public and private sector responsible for establishing overall direction, standards and priorities), the
- Interim Project Review Board (reports into the Governing Board and charged with reviewing, approving and monitoring large-scale IT projects), and
- Affinity Groups (there are five (5) Affinity Groups comprised of two or more agencies with common processes and interests: Administrative Services; Business and Community; Health and Social Services; Public Safety; and Workforce Enhancement). (New Jersey OITS Overview n.d.)

The New Jersey Department of Transportation is a member of the Business and Community Affinity Group. (New Jersey OITS Organizational Structure n.d.)

In the New Jersey OIT Shared IT Architecture publication, they define their current architecture using the architecture stack depicted in Figure 10, and note that the state has undertaken an Enterprise Architecture program to focus on the Business, Information and Technology needs of the state at an enterprise level. The program (according to this publication) is helping them achieve success in the government-to-business domain to promote their Governor’s initiatives to stimulate economic growth. This cross-agency cooperative effort is intended to be a model for growing their enterprise and satisfying requirements in other domains. (New Jersey Shared IT Architecture 2014)

Figure 10: New Jersey OIT Architecture Stack



(New Jersey Shared IT Architecture 2014, p. 2)

3.7 NORTH CAROLINA

IT Governance in North Carolina followed a Federated/Hybrid model until mid-2015, at which time the state legislature created the North Carolina Department of Information Technology (DIT), thereby consolidating IT under the State CIO. At the time this paper was finalized, it is unclear how quickly the state will change to the new model, as things have been mostly “business as usual”. Therefore, much of what follows focuses on what existed prior to this announcement; that is, the reader should realize significant changes are likely in the next couple of years. It is also worth pointing out that a new State CIO was appointed in December 2015.

The state CIO resides in the Department of Information Technology (DIT), or what was formally known as the Office of Information Technology (OITS). DIT/OITS already provides much of the IT infrastructure used by the state’s agencies, local governments, and educational institutions, which includes mainframe and server hosting, email, network and video services, telecommunications, and various enterprise shared services.

For the past decade, OITS has had an Enterprise Project Management Office (EPMO), which monitors all state technology projects over a legislatively specified dollar threshold. The EPMO conducts audits of all ongoing IT projects for the agencies, with gated approvals intended to keep agencies from moving forward on projects until project milestone or gate approval is received.

The OITS website contains numerous publications, which defines the state’s Statewide Architecture Framework. These publications appear under headings of:

- Principles, Practices, and Standards (Application, Collaboration, Data, Enterprise Management, Network, Platform, Security, and System Integration); and
- Implementation Guidelines (Application Domain Implementation Guidelines, Data Domain Implementation Guidelines, Enterprise Management Domain Implementation Guidelines, Groupware Domain Implementation Guidelines, Network Domain Implementation Guidelines, Platform Domain Implementation Guidelines, Security Domain Implementation Guidelines, and Systems Integration Domain Implementation Guidelines). (Office of Information Technology Services (OITS) n.d.)

In effect, OITS defined the technology standards and technology landscapes in which the agencies deliver technology. Until the recent consolidation of IT in the state, this left Enterprise Architecture efforts to the agencies, as long as what they did conformed to the overall state policies and guidelines.

The North Carolina Department of Transportation (NCDOT) Information Technology Division has a sizable staff of IT professionals (over 500 state employees and contractors) and is therefore able to dedicate a staff of approximately 20 state employees and contractors to Enterprise Architecture. To help understand the size of this agency, NCDOT spent \$120,245,281 in the year ending June 30, 2015 on Information Technology, with \$23.6 million of that amount in mainframe charges paid to NC OITS. (North Carolina Office of State Budget & Management 2015)

In the NCDOT 2014-2016 IT Strategic Plan, NCDOT defines their Enterprise Architecture Framework Initiative, as well as a Service Oriented Architecture (SOA) Initiative as programs within their Enterprise Architecture Group, which are both currently underway. Their strategic plan describes the drafting of an Enterprise Business Architecture (EBA). The plan also notes a focus on:

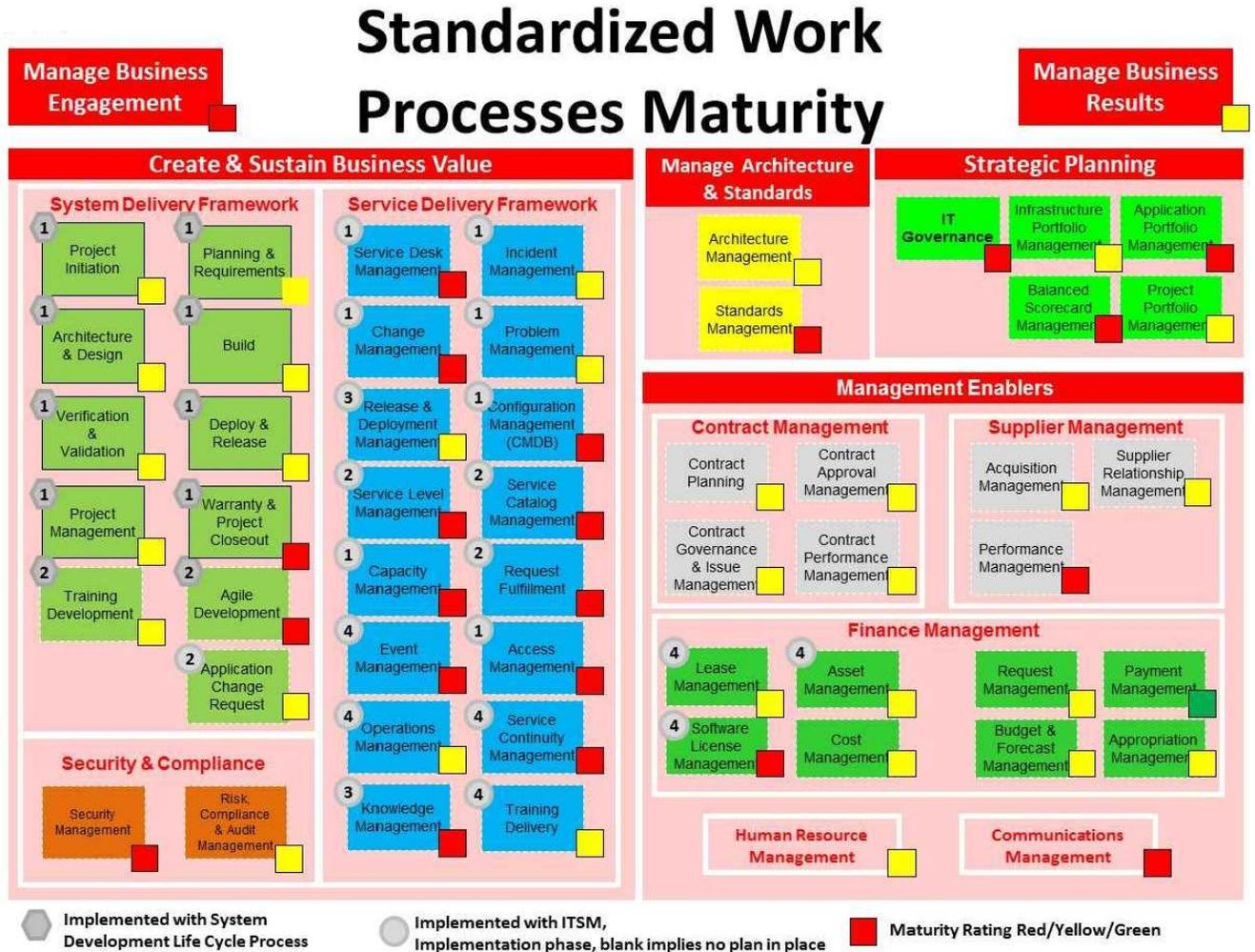
- Incorporating solution architects into project teams to assist in design and delivery of new technologies aligned with the Enterprise Architecture; and
- Defining an approach for introducing the Service Oriented Architecture (SOA) pattern noted earlier. (North Carolina Department of Transportation IT 2014)

The NCDOT IT Division justified their SOA Initiative with agency senior leadership by stating they would:

- Improve their speed to deliver technology; and
- Increase their ability to take advantage of reusable components.

Figure 11 (from the 2014-2016 NCDOT Information Technology Plan) illustrates the agency's program of continuous process improvement within IT. NCDOT IT will continue to build upon its use of Information Technology Infrastructure Library (ITIL) (research on ITIL began in 2004 and was formalized as an initiative in 2007-2008) and Systems Development Lifecycle (SDLC) best practices to continue improving existing software development and service delivery processes. Each of the initiatives shown in Figure 11 are intended to continue to improve quality, reduce development risk, and improve customer service; the figure provides an overview of the SDLC and IT Service Management (ITSM) processes targeted for improvement and contains NCDOT IT's internal assessment of their process maturity for each of the SDLC and ITIL processes. As such, it highlights self-identified areas for improvement, as well as those areas in which the NCDOT IT Division believes it is performing well (North Carolina Department of Transportation IT 2014).

Figure 11: NCDOT’s Continuous Process Improvement of IT Work Processes Maturity Model



(North Carolina Department of Transportation IT 2014, p. 36)

Figure 12 (below) illustrates the Enterprise Architecture drivers identified for the agency, which would be applicable to most organizations.

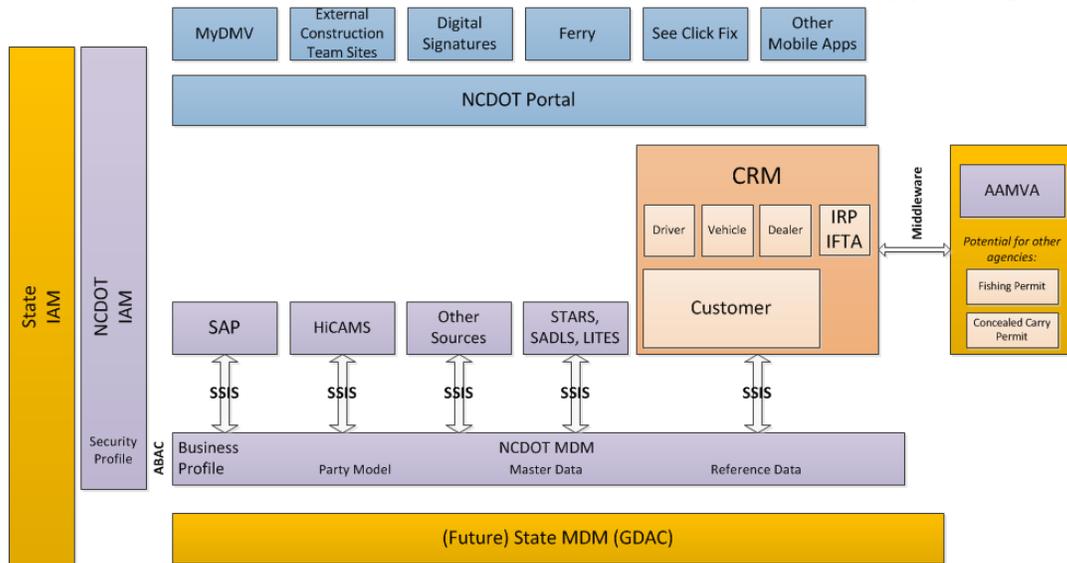
Figure 12: NCDOT’s Enterprise Architecture Drivers
NCDOT Enterprise Architecture Drivers

Driver	Guiding Thought
Reusability	Solutions shall be designed to maximize the sharing of resources such as network, computing, components, storage and data.
Adaptability	Solutions shall be designed to achieve simplicity, flexibility and modularity catering to changes in requirements, procedures, processes, and organization.
Standards Based	Solutions shall be designed to maximize interoperability through the use of open standards and management of technical diversity.
Maximum Information Utility	Solutions shall be designed to streamline the flow and use of information (data) in support of business processes and decisions.
Enhanced Performance	Solutions shall be designed with sufficient scalability, capacity and functionality.
Legal Compliance	Solutions shall be designed to comply with all relevant laws and regulations.
Balanced Security	Solutions shall be designed to achieve the proper balance between acceptable risk and usability.

(NCDOT Enterprise Architecture Manager 2015)

Figure 13 illustrates a high-level overview of the applications in the NCDOT Enterprise Architecture, and the figure shown below is an adaptation from an internal presentation to the agency’s senior leadership on the NCDOT Enterprise Architecture Common Themes supporting the agency’s business strategy.

Figure 13: NCDOT Enterprise Architecture Common Themes Supporting Strategy



Themes: Data Management, Customer Relationship Management, Agility, Mobility, Cloud Computing

(NCDOT Enterprise Architecture Manager 2015)

NCDOT went live with SAP (ERP) in 2003 (shown above in Figure 13). This implementation was initiated and completed as a NCDOT-only effort. This project was initiated and managed by NCDOT Finance, to replace an end-of-technical-life finance system. Once the ERP System was implemented in 2003, responsibility for managing and upgrading the system was turned over to the NCDOT IT Division.

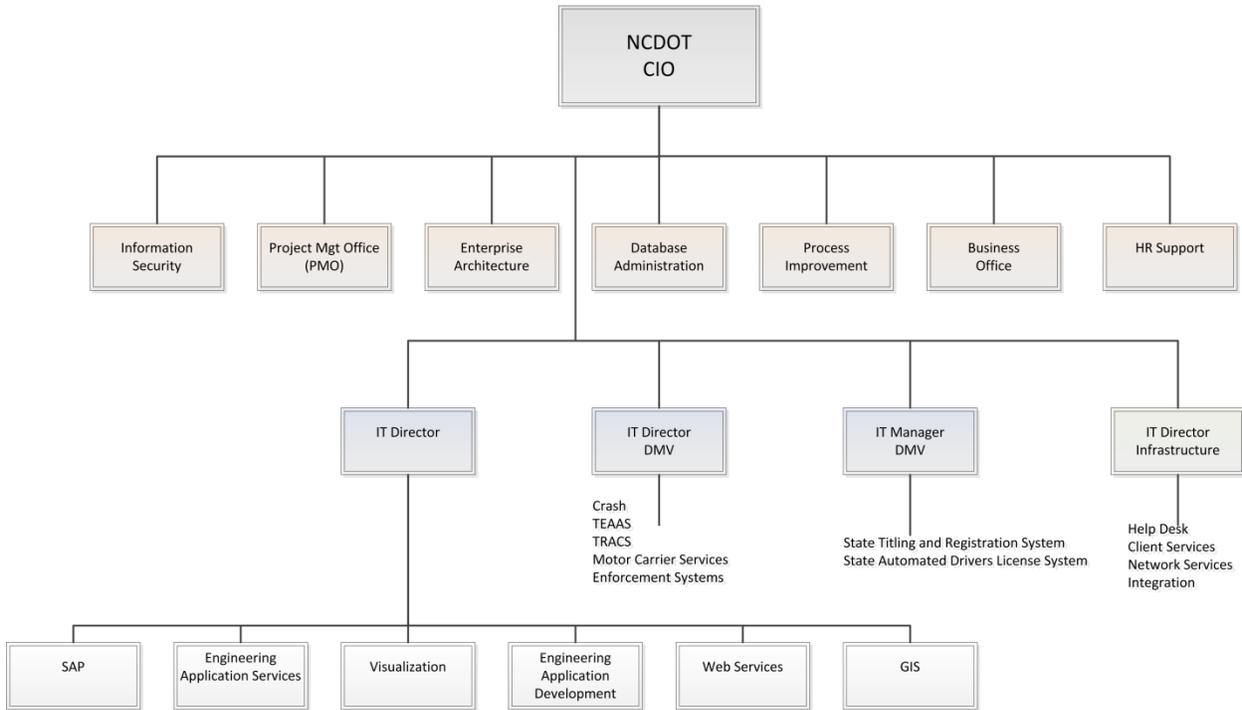
After the SAP implementation for finance, the NCDOT IT Division implemented SAP's Project Systems (PS), or project management modules, for managing both construction projects as well as for project management of internal NCDOT Information Technology Projects. The result is a tight integration of construction projects with financial systems. The implementation of Business Warehouse (BW) and the analytics modules of SAP followed shortly afterwards.

During the initial ERP Project, NCDOT acquired SAP HR/Payroll modules and licenses. After the implementations noted above, NCDOT wanted to implement SAP HR/Payroll, to replace an end-of-technical-life Payroll System written in Assembler. However, the state decided to implement SAP HR/Payroll statewide, and NCDOT was tasked to participate in the state project, ultimately replacing 23 independent payroll systems across the state with a single HR/Payroll system. Since that time, the state has attempted to procure funding for a statewide implementation of SAP Financials. To date, this has not occurred.

The NCDOT IT Division implemented a Project Management Office (PMO) in 2003 to provide project management standards, direction, staffing, support, training, and education to the IT staff. The state later implemented the EPMO in 2004, described earlier. As a result, the NCDOT IT PMO increased its original mission to become an interface between the State CIO's EPMO and the NCDOT IT staff. The state EPMO implemented comprehensive project reporting requirements and gated approval processes that the NCDOT IT PMO became experts in navigating, providing assistance to the NCDOT IT staff who were not always familiar with the processes. All application software development is under the authority of the NCDOT CIO, including GIS, which was placed under the NCDOT IT CIO in 2003 (staff of approximately 67).

The December 2015 NCDOT IT reorganization, see Figure 14 (below), shows the NCDOT IT PMO still reporting to the NCDOT CIO. However, it would be logical to expect at some point the NCDOT IT PMO would eventually merge with the state EPMO to perform statewide PMO-related activities. Furthermore, it would be logical to assume that the Enterprise Architecture group within NCDOT would eventually become a part of a statewide architecture group within NCDIT.

Figure 14: NCDOT Information Technology Division Organization Chart



3.8 OHIO

The Department of Administrative Services (DAS), Office of Information Technology (OIT) delivers statewide information technology and telecommunication services to state government agencies, boards, and commissions in addition to policy and standards development, lifecycle investment planning and privacy and security management. (Ohio Office of Information Technology n.d.)

Ohio Department of Transportation (ODOT) Information Technology has established an internal Program Management Office (PMO), with 5-6 Project Managers. The PMO works with other DoIT groups, ODOT districts, and divisions to deliver ODOT information technology projects supporting the vision of ODOT’s business plan and strategic initiatives.

The state of Ohio selected Oracle® PeopleSoft as the state’s ERP solution, referred to as the Ohio Administrative Knowledge System (OAKS). This ERP software system integrates central government business functions, including human resources, procurement, budgeting, accounting and asset management. ODOT has become a participant in the state’s ERP solution, as described in more detail below.

With respect to Enterprise Architecture, ODOT initiated a strategic Enterprise Architecture design effort in 2012. At the time of starting their enterprise architecture project, ODOT had a number of technology systems not developed in a comprehensive fashion or under one strategic vision. A number of systems were old and not well supported due to the age of the software or a lack of staff familiar with the systems. Some systems had been developed for individual offices

or districts and not designed to integrate within an overall architecture. Limited data integration resulted in some information being entered into multiple systems across different business units.

The project consisted of two phases:

- Phase I: Baseline Enterprise Architecture, consisting of a best practices synthesis and review of ODOT's As-Is technology environment; and
- Phase II: Develop Enterprise Architecture Strategic Plan, including the development and validation of an ODOT Enterprise Architecture; an implementation plan for the recommended architecture; recommendations for a technology governance model; and an organizational change management strategy to support implementation of ODOT's proposed enterprise architecture.

A summary of the project findings and recommendations by architecture layer is outlined below:

3.8.1 APPLICATIONS ARCHITECTURE

The enterprise architecture project team concluded that various core systems, including ODOT's legacy agency specific financial management system and its program and project management system, are at end-of-life and should be replaced as soon as possible. Recent deployments of industry leading systems have been, and are being, implemented with limited interaction and integration; the State of Ohio's OAKS system (based on an Oracle® PeopleSoft platform) can form the basis of an enterprise resource planning (ERP) solution for ODOT. The research team's recommendations for the applications architecture layer included:

- Implementing OAKS Plus ERP, an enhanced version of the State of Ohio's PeopleSoft ERP system with additional modules and extensions as required to meet ODOT business requirements. This proposed implementation project will:
 - Replace Appropriations Accounting (ODOT's primary financial management system) and various other ODOT-specific accounting and financial management applications; and
 - Improve timeliness of access to human resource data for use in other ODOT systems and retire to the extent possible ODOT agency specific human resource applications.
- Continuing ODOT's recent direction of adopting industry leading off-the-shelf software solutions versus custom developing applications to the extent possible, which includes:
 - Completing implementation of EIMS/AgileAssets, InspectTech SMS, Deighton dTIMS, and initiating follow-on projects to further expand and enhance the utilization of these products;
 - Implementing planned Roadway Information Management System utilizing the ESRI Roads and Highways platform and tightly integrating application with EIMS/AgileAssets, Deighton dTIMS, and InspectTech SMS; and

- Implementing planning and analytical components needed to have a fully functional bridge management system through an off-the-shelf-solution such as AASHTOWare™ PONTIS.
- Designing and implementing a new Capital Program Management System (CPMS) to replace its current program and project management system known as Ellis and support management of ODOT's overall capital program, which is tightly integrated with the OAKS Plus ERP environment. Requirements for this application should be developed in parallel with OAKS Plus ERP and ODOT should then evaluate various solution options for meeting these requirements, leveraging existing technologies used by ODOT or other State agencies where possible.
- Implementing a Capital Project Delivery System to manage execution of individual capital projects, which is tightly integrated with both the new CPMS and OAKS Plus ERP, utilizing a combination of one or more off-the-shelf solutions to meet the requirements for an upgraded and enhanced consultant contract selection system, and providing document management, project scheduling, and team collaboration capabilities.
- Designing and implementing an enterprise-wide asset management system, which provides a common enterprise view of all major assets on the ODOT network. Existing products such as Deighton dTIMS and EIMS/AgileAssets should be evaluated to meet the requirements of this functionality.
- Implementing in the longer term a cross-asset trade-off solution as an extension of the enterprise-wide asset management system; when the product offerings available for this purpose in the marketplace become more mature and the business policies and supporting business processes that drive cross-asset trade-off decision making are developed.

ODOT has currently implementing the OAKS Plus ERP recommendations. ODOT developed detailed requirements for the OAKS Plus ERP project (now renamed as the OAKSenterprise project) and as of December 2015 is finalizing the selection of a systems integrator.

3.8.2 DATA ARCHITECTURE

The project recommended the implementation of a Data Warehouse with Business Intelligence (BI) capabilities allowing a wide range of users to access the data to perform business analytics to facilitate improved decision-making.

For this architecture layer, the research team recommended that ODOT implement an industry leading BI environment and integrate this environment with OAKS Plus ERP and other core ODOT applications. The new BI toolset should provide end-user reporting and query tools, online analytical processing tools to support multi-dimensional analysis, management dashboards and other graphical presentation tools, data mining tools, and performance management and measurement tools.

3.8.3 TECHNICAL ARCHITECTURE

The project concluded that three significant issues are likely to impact ODOT technical architecture in the very near future, namely the ODOT mainframe reaching an end-of-life status and two state-wide IT initiatives which are intended to move more infrastructure management and common services to statewide platforms and management. Recommendations for the technical architecture layer included:

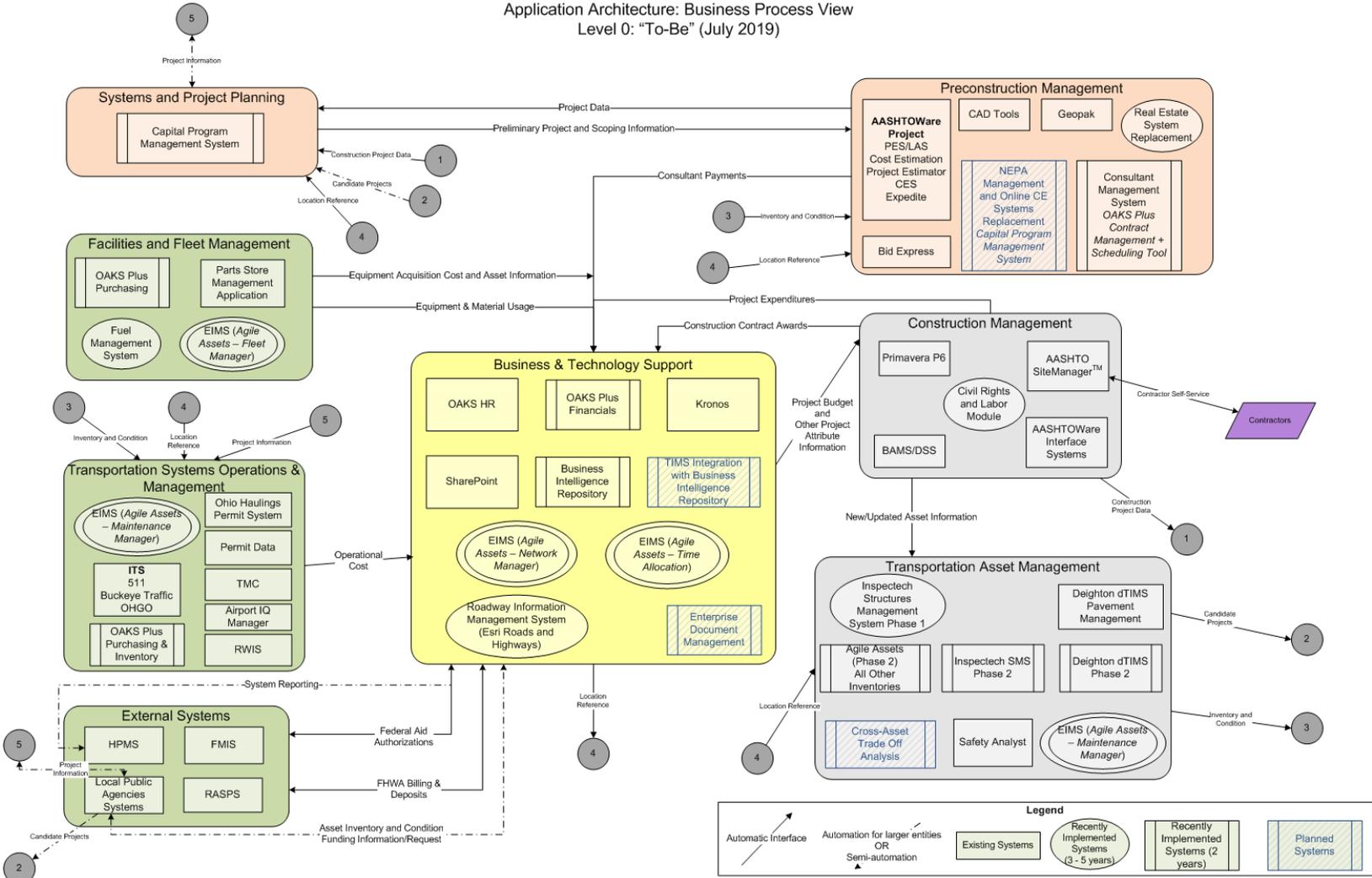
- Transitioning responsibility for managing most technology infrastructure to the State of Ohio’s Office of Information Technology through the State’s IT Optimization project;
- Establishing a mainframe replacement project to migrate all remaining applications off the mainframe, which are not included in the scope of the OAKS Plus ERP project or another ongoing project, to allow for de-commissioning of the ODOT mainframe environment;
- Defining requirements to evaluate, select, and deploy an enterprise document management system, and integrate this new system with OAKS Plus ERP, CPMS, and other core ODOT applications; and
- Implementing additional partner self-service capabilities across business units and management systems.

In addition, the ODOT EA project recommended a new technology governance structure and a new technology investment process for ODOT. ODOT established this new Technology Council in late 2014, which consists of cross-functional representatives from the middle and senior management ranks. ODOT also designed and implemented a new technology investment process which is more tightly linked to business objectives. This new process has been utilized by the Technology Council to prepare the annual technology work plan for FY 2016 and it is currently in the process of preparing the FY 2017 work plan.

The Ohio Department of Transportation (ODOT) Enterprise Architecture (EA) Assessment Project produced the “To Be” Architecture depicted in Figure 15. (eVision Partners, Inc. 2014)

Figure 15: Ohio Enterprise Architecture “To-Be”

Ohio Department of Transportation Enterprise Architecture Study
 Application Architecture: Business Process View
 Level 0: “To-Be” (July 2019)



SOURCE: (eVision Partners, Inc. 2014)

3.9 TEXAS

The state of Texas follows a Hybrid/Federated Model for IT Governance. The State CIO is the Executive Director of the Texas Department of Information Resources (TxDIR), which provides information technology oversight and services. Data Center Services (DCS) is a program overseen by the Texas Department of Information Resource (TxDIR), which provides mainframe, server, network, data center, and print/mail services for Texas state agencies in an effort to reduce costs and reduce IT operations focus within the respective state agencies. The state's data centers utilize a multi-vendor model, allowing state agencies to access data center computing as a managed service, consolidated into two (2) data centers.

TxDIR provides a high-level planning policy and standards setting role for state agencies to provide consistency in technology across the state agencies. TxDIR provides state leadership with information on technology issues relevant to state agencies, working with these agencies to assess needs and measure the impact of industry developments providing vision, guidance, and oversight on technology.

Each state agency is required by Texas law to appoint an Information Resources Manager (IRM) designate. The agency IRM must report to the Executive Director (or functional equivalent) of the state agency. The IRM is responsible for information technology reporting and expected to ensure the agency remains compliant with information resources regulations and policies. For reporting, TxDIR utilizes two (2) tools, the IRDR and the IR-CAP:

- The Information Resources Deployment Review (IRDR) is a self-assessment tool to document an agency's technology strengths and weaknesses. The Information Resources Deployment Review (IRDR) is a standardized survey designed to:
 - Measures an agency's progress against the State Strategic Plan (SSP);
 - Confirms agency compliance with the state's Information Resource (IR) related statutes, rules, and standards; and
 - Examines how each IR deployment has supported the agency's mission, goals, and objectives. (IRDR & IR-CAP n.d.)
- If an agency's IRDR survey demonstrates the agency is non-compliant in any area, TxDIR notifies requires the agency to complete and submit an Information Resources Corrective Action Plan (IR-CAP). (IRDR & IR-CAP n.d.)

TxDIR established the Texas Project Delivery Framework for major, large-scale IT projects, and provides templates designed to capture all required information to improve the probability agency projects stay on track with measurable outcomes. Various steps and templates in the Project Delivery Framework require approval from the Quality Assurance Team (QAT). The Quality Assurance Team (QAT) includes membership from three (3) state agencies: the Legislative Budget Board (LBB), State Auditor's Office (SAO), and TxDIR. TxDIR also provides a PM Lite framework for projects that do not require the full weight of the TxDIR Delivery Framework.

The Texas QAT:

- Approves projects before the expenditure of any appropriated funds, based on an analysis of the project, project plans, and project risks;
- Reports the status of Major Information Resources Projects (MIRPs) to state leadership;
- Determines the frequency of monitoring (monthly or quarterly), based on the project;
- Performs approvals of contract amendments, if any contract amendment exceeds 10 percent of the original contract amount during the project;
- Requests detailed project information, framework deliverable updates, audits, or assistance as necessary; and the
- QAT publishes a summary annual report in December, to highlight lessons learned over the year, to provide agencies with information to anticipate common pitfalls that consistently cause missed deadlines and project overruns.

In March 2011, TxDOT created the "TxDOT Modernization" initiative at the direction of the Texas Transportation Commission by establishing the TxDOT Modernization Leadership Team (MLT), made up of district engineers and division, office and region directors. This initiative had roots in an audit initiated by the Texas Transportation Commission (Commission), in response to a recommendation from the Legislature during the agency's 2009 Sunset Review. The audit was completed and delivered in May 2010. The MLT completed their committee assignment in 2012 and transitioned the modernization efforts to TxDOT Administration, supported by the Operational Excellence Office, created largely for this purpose.

TxDOT's Modernization efforts address multiple business objectives, however, the three (3) key initiatives related to technology include:

- Establish New IT Organizational Structure—Document IT roles and responsibilities to eliminate redundancy and increase accountability in support of TxDOT IT customers and develop the appropriate organizational structure. IT functions were reorganized into two divisions and three offices, all reporting to the TxDOT Chief Information Officer;
- Improve IT Operations and Development Policies and Processes—Improve IT processes and procedures to increase IT effectiveness and efficiencies in support of TxDOT employees; and
- Improve IT Governance Processes—Improve information technology governance, planning, and architectural processes to increase effectiveness and strategic focus in support of internal and external stakeholders. (Texas Department of Transportation 2012) (TxDOT Modernization Projects 2012)

Figure 16 (below) outlines the TxDOT's Modernization effort with respect to EA:

Figure 16: TxDOT Modernization EA Focus

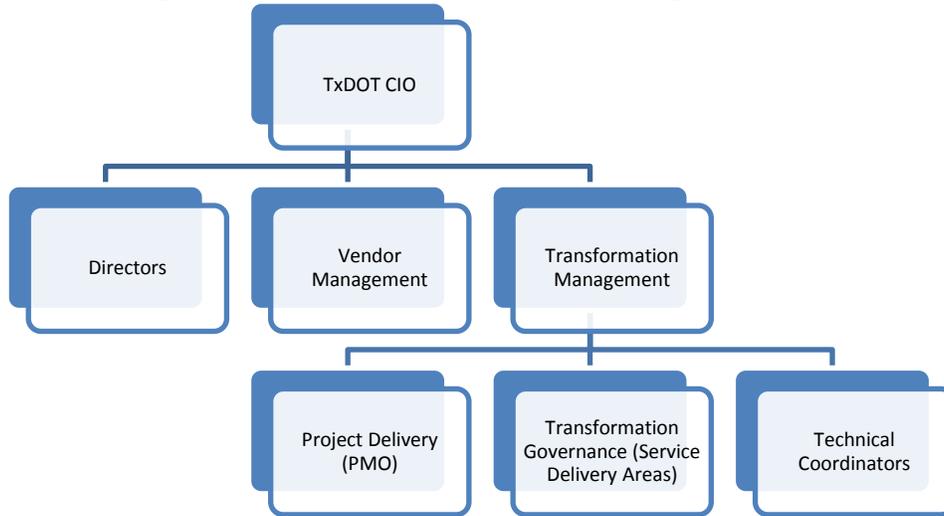
EA is a component of an enterprise-wide business change initiative

Objectives	Scope
<ul style="list-style-type: none"> • Develop a technology strategy tied to TxDOT mission, vision, and goals • Redefine information technology governance • Define an enterprise technology vision for TxDOT <ul style="list-style-type: none"> • Documentation of current architecture • Target vision and conceptual architecture • Gap assessment • Flexible plan to bridge gaps 	<ul style="list-style-type: none"> • Prepare EA design • Develop IT planning process • Prioritize current IT work load • Determine IT resource capacity model • Establish IT PMO • Develop governance strategy • Establish Enterprise Architecture function • Set up single entry point for IT work requests

TxDOT reorganized and centralized their IT staff under the CIO in 2012, as described above. As another step in TxDOT’s Modernization initiative, in 2013 it outsourced IT maintenance and support for its Applications to a private sector firm in a five-year deal worth \$190 million, affecting over 350 TxDOT IT state employees who were offered a minimum of six (6) months of employment with the private sector company. (The Texas Tribune 2013) The outsourcing reduced headcount of TxDOT IT staff into the 20’s range. The TxDOT CIO reports directly to the Deputy Executive Director of the agency, and the current TxDOT organization chart shows a dotted line connecting the CIO to the Chief Strategy and Innovation Officer, who also reports directly to the Deputy Executive Director.

After stabilizing the new IT outsourcing arrangement, TxDOT IT refocused efforts on transformation management, including IT Governance and Project Delivery, which increased IT staff to approximately 65. Figure 17 (below) illustrates a generalized outline of the TxDOT IT Organization. There are IT Directors assigned to business units, resources dedicated to the management of the outsourced vendor, and resources dedicated to the oversight and management of projects (PMO), IT Governance, Enterprise Architecture, and so forth under the general heading of Transformation Management. The outsourced vendor handles standard operations and maintenance of legacy applications, while new development projects are bid via RFP and managed out of the PMO. The PMO is required to manage projects in compliance with the Texas Project Delivery Framework (per TxDIR) as described earlier.

Figure 17: Generalized TxDOT IT Organization



The state of Texas implemented Oracle® PeopleSoft as the state’s ERP solution (under a program named ProjectONE/CAPPS, where CAPPS stands for Centralized Accounting and Payroll/Personnel System). Agencies may be either Central or Hub Agencies. Hub Agencies are typically the larger and more complex agencies, and receive their own copy of the CAPPS Financials and CAPPS HR/Payroll baseline applications to implement on their own infrastructure. The key distinction is that CAPPS Hub agencies bear their own costs for transition, deployment and ongoing maintenance and support. TxDOT is participating in the state ERP project as a Hub Agency for both CAPPS Financials and CAPPS HR/Payroll. (The CAPPS Program Model n.d.)

3.10 VIRGINIA

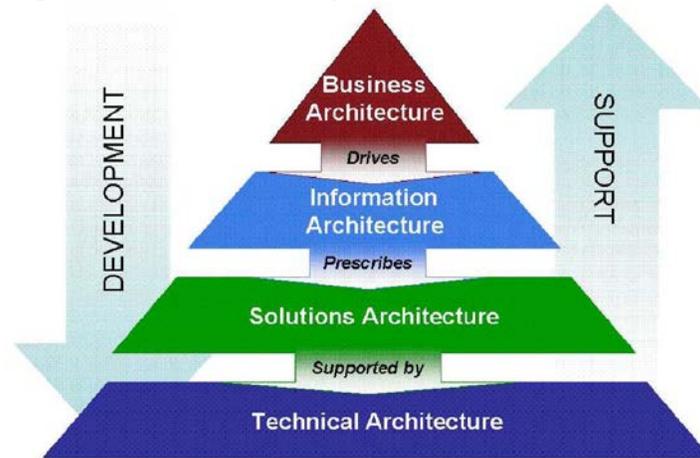
In 2003, the Commonwealth of Virginia Information Technology Transformation Initiative made Virginia a centralized IT Governance model. Highly decentralized prior to 2003, Virginia consolidated IT services and employees into a single agency called the Virginia Information Technologies Agency (VITA). The creation of VITA eliminated three (3) state agencies and independent IT divisions within 94 Executive branch agencies when consolidated into VITA. (2003 NASCIO Recognition Awards Program 2003)

VITA defines Enterprise Architecture (EA) as providing a strategic planning framework that relates and aligns information technology with the business functions that it supports. Enterprise Architecture for the state is described as a collaborative effort undertaken to assure value is gained from their information technology investments. The VITA EA website notes, *"EA does not start with technology. It starts with a strategic framework based in the business of our government and the vision and goals of our leadership. The effective use of information technology must be an integral part of how we conduct our business in state government."* (VITA Enterprise Architecture - Overview of EA n.d.)

VITA’s Enterprise Architecture Standards (illustrated in Figure 18) defines:

- Enterprise Business Architecture – EBA
- Enterprise Information Architecture – EIA
- Enterprise Solutions Architecture – ESA
- Enterprise Technical Architecture – ETA (VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard 2013, p. 1-1)

Figure 18: VITA Enterprise Architecture Model



(VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard 2013, p. 1-1)

The Enterprise Business Architecture (EBA) documents the business strategy, governance, organization, and business functions of Virginia’s state government identifying the organizations performing those functions. The EBA provides a big picture view of state government from a business perspective defining who they are, what they do, and where they want to go. Their Enterprise Business Model (EBM) of the EBA was developed to define the “what we do” in terms of business functions independent of the organizations that perform those functions. This model was developed and validated through workshops with agency business leaders. Those workshops mapped individual agency business functions to the EBM, creating the Commonwealth’s “As-Is” business architecture for their Executive Branch agencies. (VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard 2013)

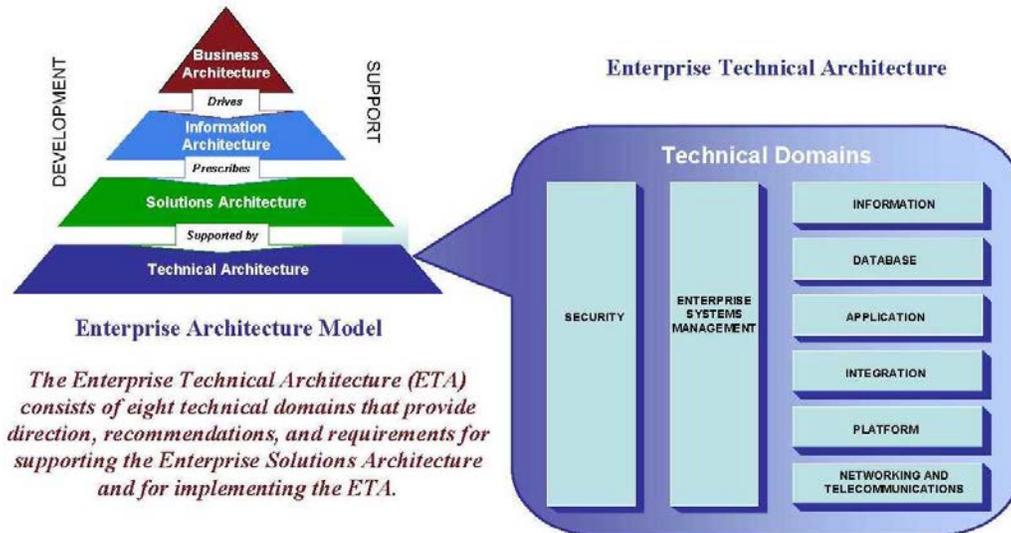
The Enterprise Information Architecture (EIA) provides a common framework for the cost effective sharing of government information across organizations, respecting security, privacy, and appropriate use for this information. It enables agency leaders to manage information as an asset and better serve stakeholders. This also increases their agility to extract value from the information as a strategic asset. (VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard 2013)

The Enterprise Solutions Architecture (ESA) supports the state’s expectations of delivering more services, delivering them better, and at lower cost by presenting a uniform view of solutions to help them achieve this increase in reuse and the reduction of solution complexity. This allows them to take advantage of shared and reusable components, facilitates the sharing and reuse of

data, and makes the best use of the technology infrastructure available. (VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard 2013)

The Enterprise Technical Architecture (ETA) shown in Figure 19 highlights the eight (8) critical technical domains that provide direction, recommendations and requirements for supporting the ESA and implementing the ETA. The ETA guides the development and support of an organization’s information systems and technology infrastructure. (VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard 2013)

Figure 19: VITA ETA Relationship to the Enterprise Architecture



(VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard 2013, p. 5-1)

Each of the eight (8) domains noted describe standards for the respective domain area. For example, the ETA Application Domain provides a formal foundation for development and support platforms, tools, processes, practices and requirements to implement business processes and help them meet business needs. As would be expected, the state’s legacy systems were developed independently over time using different programming languages and tools. Therefore, the ability of those applications to communicate with each other was never a part of the original design requirements, and many of those applications are monolithic or two-tier client/server applications. As such, it defines the tools to assist with code reuse, shared software integration and middleware tools, providing new and different user interface options (such as Web browsers, PDAs (personal digital assistants or smartphones), or IVRs (interactive voice response units)), and N-tier Service-Oriented Architecture (SOA), which aids in code reuse. Each of the other domains provide similar supporting detail. (Commonwealth of Virginia’s EIA Strategy and NIEM Integration Plan 2013)

4 CONCLUDING COMMENTS

It is important to remember that EA is a process and not a one-time effort. There are many moving parts in maintaining this process.

The biggest challenge is most organizations tend to focus more on reactionary or tactical planning than strategic planning. EA is about strategic planning, which can oftentimes be in conflict with short-term tactical thinking. Strategic thinking requires good long-term planning and the execution requires discipline.

One key takeaway from the research, as noted earlier, is that state government administration changes often make sustaining processes such as EA a challenge, as these changes in administration may negatively affect ongoing efforts such as this (and other) work, thus making it necessary to resell the concepts and respective benefits to each new administration. Given that EA provides many benefits, maintaining and having a ready business case at hand will make it easier to argue for sustained EA investment.

The value of an Enterprise Architecture should be clear. Based on some of the best practices presented, it might appear that implementing an Enterprise Architecture initiative is something best accomplished at the state level or by larger state agencies. This, however, would be an inappropriate conclusion. An EA can be right-sized for any enterprise or organization:

- Use a framework and select what is appropriate;
- Right-size or customize a solution appropriate for the organization; and
- Reap the benefits of instilling the strategies outlined.

5 WORKS CITED

- 2003 NASCIO Recognition Awards Program. 2003.
<https://www.google.com/url?sa=t&rcrt=j&q=&esrc=s&source=web&cd=18&cad=rja&uact=8&ved=0CFYQFjAHOApqFQoTCIyOIKOuqccCFY9ckgod8tAALg&url=http%3A%2F%2Fwww.nascio.org%2Fawards%2Fnominations%2F2003Virginia9.doc&ei=rEjOVYyICo-5yQTyoYPwAg&usg=AFQjCNEzm9jEkUIFqYVShf>.
- C2P: *The Colorado Consolidation Plan*. January 24, 2008.
<http://cospl.coalliance.org/fedora/repository/co%3A3142/gov502c762008internet.pdf/>.
- California Department of Technology. *California Enterprise Architecture Framework*. August 1, 2013.
<http://www.cio.ca.gov/ea/docs/California-Enterprise-Architecture-CEAF2-Framework-V2.pdf>.
- . *Enterprise Architecture*. 2015. <http://www.cio.ca.gov/ea/>.
- Colorado GOIT *Our History*. n.d. <http://www.oit.state.co.us/about/history>.
- Colorado OIT Standards - *The Compass - Enterprise Architecture 2011-2014*. April 16, 2012.
<https://docs.google.com/a/state.co.us/viewer?a=v&pid=sites&srcid=c3RhHGGuY28udXN8b2l0LXRlbXBsYXRILWRldnxneDo3ZDg4ZDVmYTU5NTI4OGFm>.
- Commonwealth of Virginia's EIA Strategy and NIEM Integration Plan. July 16, 2013.
<http://www.nascio.org/events/webinars/NASCIO-07162013-Virginia-EIA-NIEM-Integration.pdf>.
- eVision Partners, Inc. "Development of Strategic Enterprise Architecture Design for ODOT." *Development of Strategic Enterprise Architecture Design for ODOT*. January 2014.
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2014/Administration/134756_FR.pdf.
- . "Development of Strategic Enterprise Architecture Design for ODOT." *Development of Strategic Enterprise Architecture Design for ODOT*. January 2014.
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2014/Administration/134756_FR.pdf.
- Fri, USAF, Daniel A. "Enterprise Architecture." *Air Force Journal of Logistics* 31, no. 2 (Summer 2007): 40-46.
- "IRDR & IR-CAP." *Texas Department of Information Resources*. n.d. <http://dir.texas.gov/View-Resources/Pages/Content.aspx?id=29>.
- Marks, Eric A. *Business Darwinism: Evolve or Dissolve: Adaptive Strategies for the Information Age*. John Wiley & Sons, 2002.
- Michigan. *Michigan 2007 EA Strategic Approach*. 2007.
www.michigan.gov/documents/dit/2007_EA_Strategic_Approach_206296_7.pdf.
- Montana Department of Transportation. "Development of Strategic Enterprise Architecture Design and Implementation Plan for MDT." *State of Montana Online Services*. January 22, 2015.
http://svc.mt.gov/gsd/onestop/upload/rfp15-3109t_mdt-enterpirse-architecture-design.docx.
- NCDOT *Enterprise Architecture Manager* (July 2015).
- New Jersey OITS *Organizational Structure*. n.d. <http://www.nj.gov/it/oit/os/>.
- New Jersey OITS *Overview*. n.d. <http://www.nj.gov/it/oit/over/>.
- New Jersey *Shared IT Architecture*. 2014. http://www.state.nj.us/it/ps/Shared_IT_Architecture.pdf.
- North Carolina Department of Transportation IT. *Department of Transportation IT Plan 2014-16*. October 2014.
<http://it.nc.gov/document/department-transportation-it-plan-2014-16>.
- North Carolina Office of State Budget & Management. *North Carolina Information Technology Expenditures Report (Period ending June 30, 2015)*. 2015. http://www.osc.nc.gov/financial/ITReport_06302015.pdf.
- Office of Information Technology Services (OITS). *Statwide Architecture Framework*. n.d.
<http://it.nc.gov/services/it-architecture/statewide-architecture-framework>.
- "Ohio Office of Information Technology." *Ohio DAS*. n.d.
<http://das.ohio.gov/Divisions/InformationTechnology/tabid/79/Default.aspx> (accessed October 25, 2015).

MDT—EA BEST PRACTICES REPORT

- Rahn, Pete K. *State DOT Mission Evolution (Requested by AASHTO)*. April 2013.
<http://downloads.transportation.org/LeadershipForum/State%20DOT%20Mission%20Evolution%20White%20Paper.pdf>.
- Sessions, Roger. *A Comparison of the Top Four Enterprise-Architecture Methodologies*. Microsoft. May 2007.
<https://msdn.microsoft.com/en-us/library/bb466232.aspx>.
- State of Hawaii OITS 4.0 Enterprise Architecture Methodology*. n.d. https://oimt.hawaii.gov/wp-content/uploads/2012/09/Governance_4.0.pdf.
- State of Hawaii OITS What We Do*. n.d. <http://oimt.hawaii.gov/what-we-do/>.
- State University of New York, University at Albany, Center for Technology in Government. *State Profiles*. 2009. http://www.ctg.albany.edu/publications/reports/itgov_profiles?chapter=8&PrintVersion=1.
- Texas Department of Transportation. "TxDOT FTP Site." *TxDOT FTP Site*. December 8, 2012.
https://ftp.dot.state.tx.us/pub/txdot-info/sla/modernization_sunset_121812.pdf.
- "The CAPPS Program Model." *Texas Comptroller of Public Accounts*. n.d.
<http://www.txprojectone.org/project/options/index.php>.
- The Chief Information Officers Council. "Federal Enterprise Architecture Framework, v1.1." *Institute for Enterprise Architecture Developments*. 1999. <http://www.enterprise-architecture.info/Images/Documents/Federal%20EA%20Framework.pdf>.
- The Common Approach to Federal Enterprise Architecture*. May 2, 2012.
https://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/common_approach_to_federal_ea.pdf.
- The Texas Tribune. "TxDOT Outsourcing IT Operations to Private Firm." *The Texas Tribune*. June 4, 2013.
<http://www.texastribune.org/2013/06/04/txdot-announces-plan-outsource-it-plano/>.
- "TxDOT Modernization Projects." *Texas Department of Transportation*. June 29, 2012.
http://www.txdot.gov/about_us/modernization_projects.htm.
- VITA Enterprise Architecture - Overview of EA*. n.d.
<http://www.vita.virginia.gov/oversight/default.aspx?id=349>.
- VITA Information Technology Resource Management (ITRM)-Enterprise Architecture Standard*. February 6, 2013.
http://www.vita.virginia.gov/uploadedFiles/VITA_Main_Public/Library/PSGs/EA_Standard.pdf.
- Zachman, John A. "A framework for information systems architecture." *IBM SYSTEMS JOURNAL*, 1987: 276-292.