The Compass: Enterprise Architecture 2011 - 2014

Enabling Technology Solutions Efficiently, Effectively, and Elegantly

V.3.0- 04/16/2012

Document Control

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10/24/2011	Sherri Hammons	1.0	Initial creation
01/30/2012	Jill Elggren/ Lauren Plunkett	2.0	Communication Team Revisions
04/16/2012	Lauren Plunkett	3.0	Added Document Management and Revision Request Process and Form

Modification

The Compass: Enterprise Architecture 2011-2014 Technology Roadmap is a living document that will be reviewed on a quarterly basis and updated as necessary. The goal of having a living document is to obtain feedback from our agency partners and other functional area teams within the organization in an ongoing and collaborative way. A Revision Request Process and Form has been developed to enable a simple and uniform way for our stakeholders to provide their comments and change requests. The process and form may be found at the CTO's website under the button titled "Tech Roadmap".

The Chief Technology Officer (CTO) is the author primary author of The Compass: Enterprise Architecture 2011-2014 Technology Roadmap. The CTO Enterprise Architecture (EA) Team will support the CTO in making quarterly updates, vetting revision requests, and are responsible for maintaining soft and hard copies of this document.

Duration

The Compass: Enterprise Architecture 2011-2014 Technology Roadmap is effective from date of publish and may be modified or extended to support the long-term goals and objectives of the Office of the Chief Technology Officer (CTO). The CTO is responsible for transitioning responsibility of this document in the event of a personnel change.
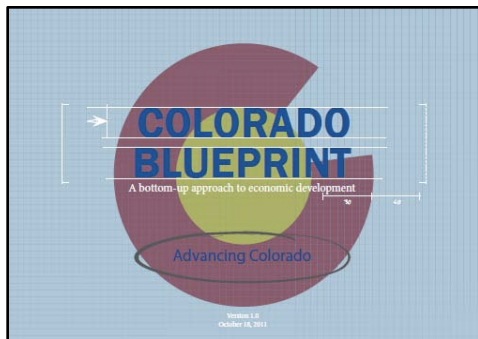
The Compass: Enterprise Architecture 2011 - 2014

Enabling Technology Solutions Efficiently, Effectively, and Elegantly

Executive Summary

The definition of a compass usually makes reference to direction, often using a magnetic needle pointing toward the north or south pole. However, synonyms related to the word as defined by Webster offer a different meaning: accomplish, achieve, execute. The Office of Enterprise Architecture and the Chief Technology Officer (CTO) is tasked with providing both: direction to the enterprise as it relates to technology, as well as setting a path to execution.

The driving forces behind the goals we will accomplish over the next few years are the Colorado Blueprint and the Governor's Office of Information Technology FY12 Playbook. Each of these sets forth the overall direction and accomplishments for Colorado, with former being a comprehensive and collaborative approach to economic development through six core objectives including cultivating innovation and technology, and the latter setting the overall direction for the Governor's Office of Information Technology.
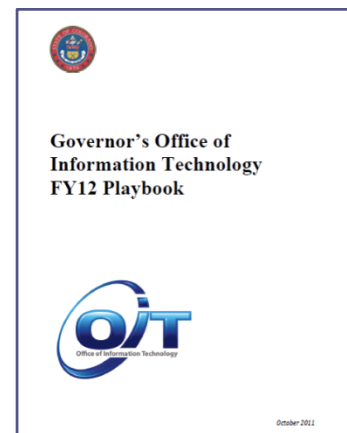
The Playbook sets priorities around Customer Service, People, Innovation, Service Excellence, Trusted Partnerships and Information Security. The Blueprint's six core objectives are Build a Business-friendly Environment, Retain, Grow and Recruit Companies, Increase Access to Capital, Create and Market a Stronger Colorado Brand, Educate and Train the Workforce of the Future, and Cultivate Innovation and Technology. Technology plays a key role in each of them, from delivering the right services to the right people to ensuring their information is secured, yet available, to attracting Tech Industry companies to headquarter in Colorado and create jobs, and improve communications technologies infrastructure, including broadband, as a foundation of local and regional economic development and innovation .

Technology innovation is taking place at lightning speed, giving businesses and government advantages to decrease time to market by leveraging solutions such as cloud technologies. The incredible adoption rate of mobile technologies gives the government more opportunities to connect remotely with citizens and offer our workforce better accessibility to applications and data – anytime, anywhere.

The Enterprise Architecture compass will set the direction for future technical solutions that will ensure that the public services available to the citizens of Colorado are met efficiently, effectively and elegantly.

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Enterprise Architecture in the State of Colorado

The Chief Technology Office's mission it to directly advise and inform the state's Chief Information Officer (CIO) on all strategic and tactical matters as they relate to the technical direction and roadmap for the state's technology solutions and ensure all information technology (IT) services are working efficiently, effectively and elegantly together. The Chief Information Officer has set three execution paths: Plan, Build, Run.
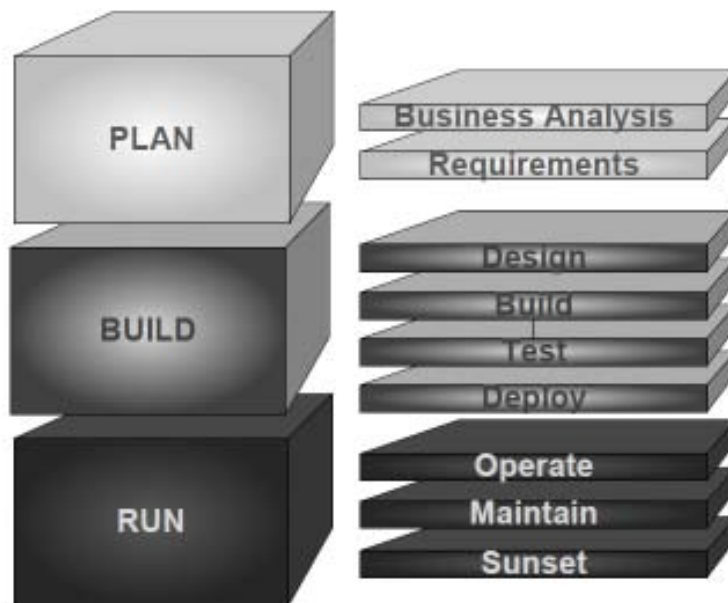
When architecting for the state enterprise, it is important to understand the type of operating model according to two dimensions: business process standardization and integration.[*] This will guide the principles needed to create the most efficient solutions.

OPERATING MODELS

There are generally four types of operating models, which align around the degree of standardization and integration of delivering goods and services to customers.

1. Diversification (low standardization, low integration)

2. Coordination (low standardization, high integration)

3. Replication (high standardization, low integration)

4. Unification (high standardization, high integration)

Standardizing business processes increases efficiency and predictability across the enterprise, while integration, through data sharing, increases efficiency, coordination and transparency. High degrees of standardization can limit innovation, however, and integration requires standard definitions and formats for data shared across business units.

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[*]This discussion of operating models is based on Enterprise Architecture as Strategy; Ross, Jeanne, Weill, Peter and Robertson, David. Harvard Business Press. 2006.

The four general operating models are shown below with their business characteristics.

	Low	High
High — Business Process Integration	**Coordination** • Organic: Stream of product innovations easily made available to existing customers using existing integrated channels; for government, this means business units have differing business processes, but an enterprise architecture for those areas in common. • Acquisition: Must integrate the data.	**Unification** • Organic: leverage economies of scale by introducing existing products/services in new markets; grow product line incrementally • Acquisition: must rip and replace infrastructure
Low	**Diversification** • Organic: small business units may feed core business; company grows through business unit growth. For government, this means little to no integration between agencies. • Acquisition: unlimited opportunities, but little integration exists to ensure success.	**Replication** • Organic: replicate best practices in new markets; innovations extended globally • Acquisition: can acquire to expand market reach; must rip and replace

Business Process Standardization

Colorado currently operates under the *Diversification* model, but wishes to move to the *Coordination* model, with shared citizen data to deliver services, but differing business processes and mandates. The State desires to move from the current silos to one of greater agility and modularity at the same time improving efficiency and reducing operating costs.

Figures 1 and 2 below represent the state of IT in Colorado prior to the legislatively mandated consolidation in 2008. The delivery of IT in Colorado has moved from a fully decentralized model to a consolidated model where enterprise services are managed within OIT and their support of state agencies is managed through a customer service management defined by service level agreements between the departments and OIT. However, business processes will remain independent, except in areas where an enterprise strategy makes sense. (See Figure 3) The to-be state focuses on enterprise information solutions and technology, leaving business process to the specific agencies. (See Figure 4)
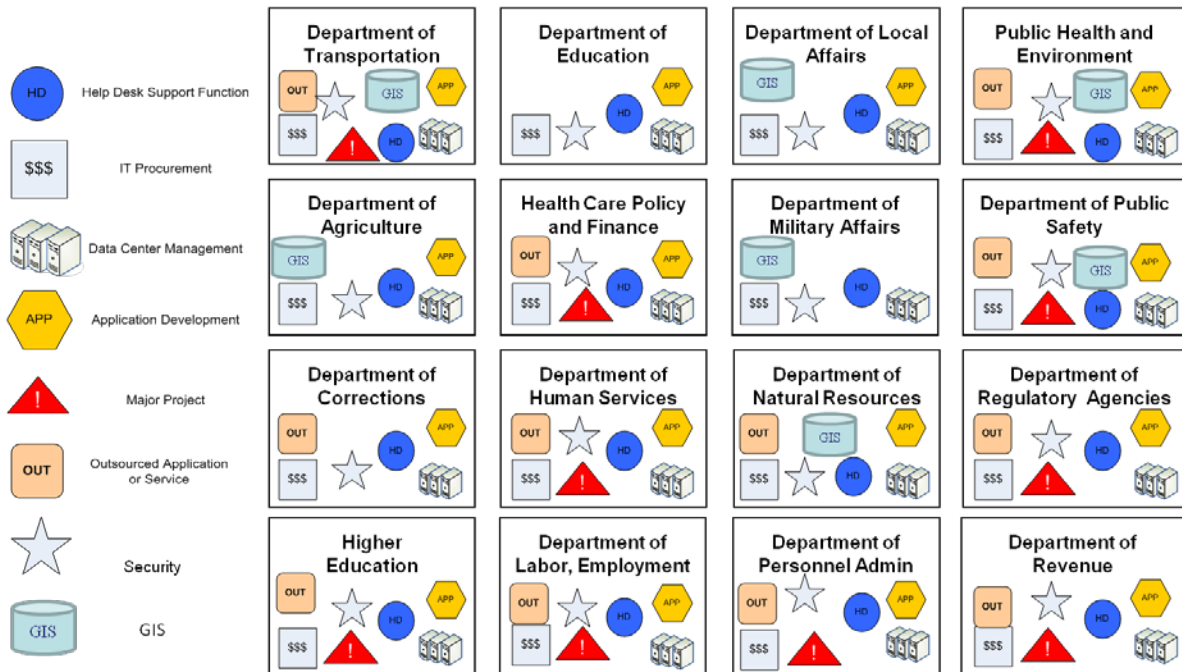
Figure 1: IT Model Prior to July 2008

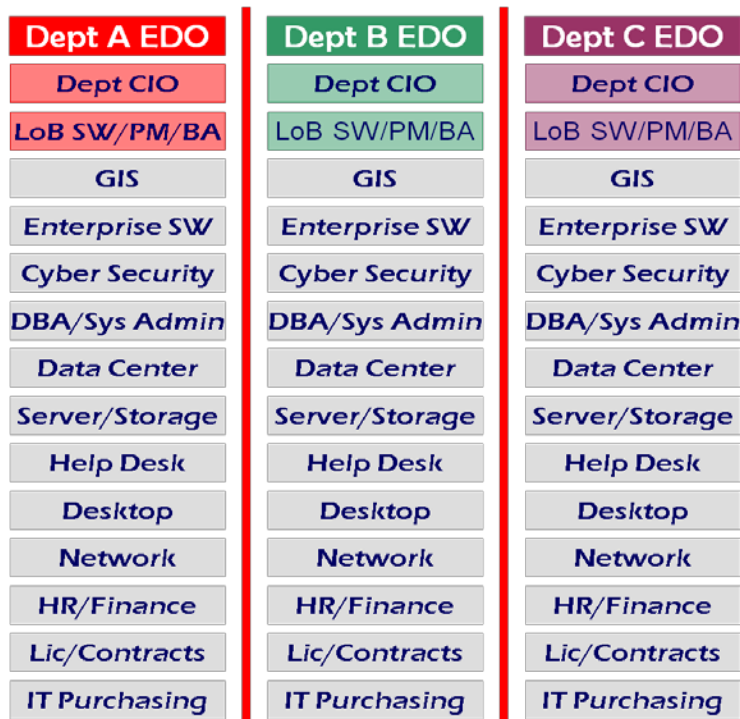## IT Organization before Consolidation

Figure 2: Another View of the IT Model Prior to July 2008

Current IT State
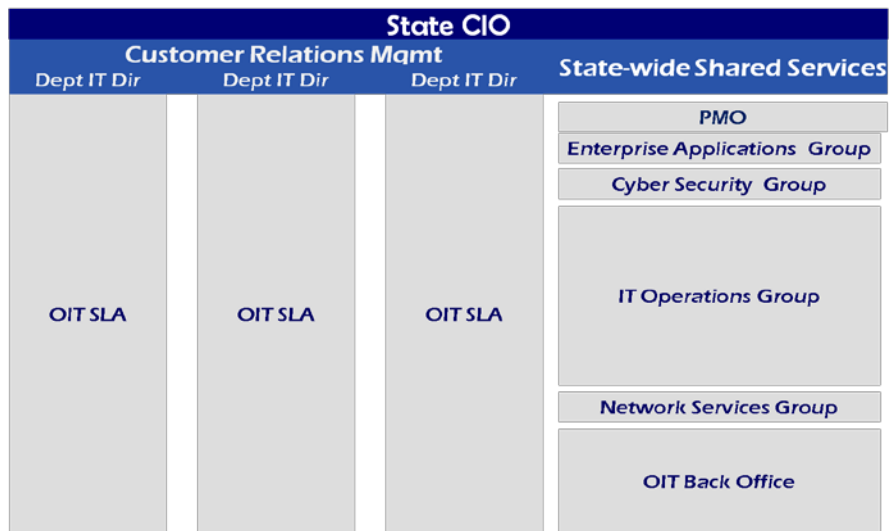
Figure 3

To Be State– Consolidated Enterprise Architecture

Figure 4

Enterprise Architecture Principles

The Enterprise Architecture (EA) in Figure 4 above adheres to the following Architectural Principles:

- Business requirements drive the technical solutions
- Just in time technology - no more, no less
- Simplicity over complexity
- Data is a statewide asset
- Technology should maximize benefit for the entire enterprise
- Common use applications are preferred over departmental applications
- Enterprise operations are maintained in spite of system interruptions
- Data is defined consistently and a common vocabulary is used across the enterprise
- Data is never compromised
- Ease of use for applications – no training required
- Use standards wherever they exist
- Design solutions for reuse, both within and without state boundaries (Create once, use many times)
- Data value increases with use and availability

EA Goals

- ➢ Align to the Administration's Priorities and Focus Areas, the Colorado Blueprint and OIT's Strategy and FY12 Playbook
- ➢ Improve information availability and interoperability
- ➢ Reduce costs and redundancy
- ➢ Increase agility, efficiency and long term sustainability
- ➢ Reduce business, operational and security risk
- ➢ Continuously improve

Like a compass, technology changes with each turn. This Enterprise Architecture will be continuously improved.

Enterprise Architecture Frameworks

Enterprise Architecture Frameworks provide the building blocks necessary to create agile, secure and reusable solutions and OIT has adopted the Federal Enterprise Architecture. Each discipline within the

EA framework provides a unique focus: Business, Information, Solution and Technology. Together, these solutions provide foundational support for the entire enterprise. (See Figure 5)

Business ← **Business** processes and activities

Information ← **Information** to be shared with protocols, processes and supporting platforms

Solution ← **Application Solutions** their design and and standards

Technology ← **Technology** lifecycles and other hardware and software standards and protocols
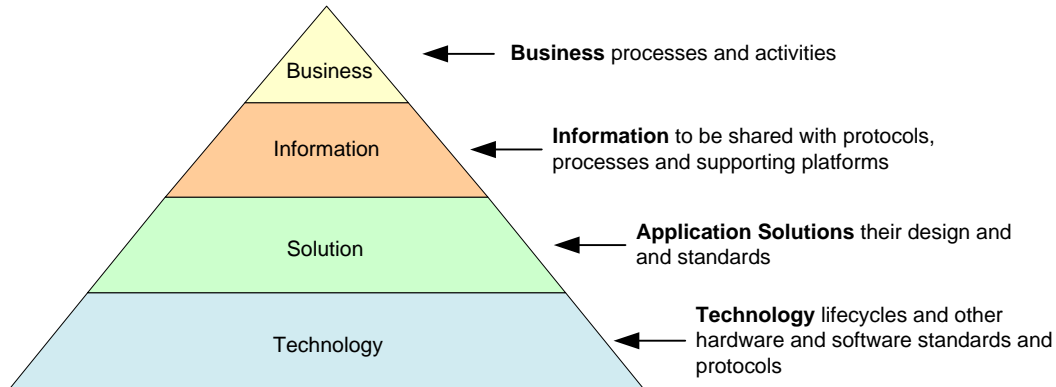
Figure 5

As the state relies increasingly on mobility, an objective of the Enterprise Architecture of the future is to give access to Any One via Any Platformto Any Service with proper credentials. (See Figure 6)

Figure 6

Business Architecture

Overview

The primary goal of the enterprise architecture is identification and refinement of enterprise processes. It provides thedirection for the rest of the frameworks. As such it provides the state focus around limited technology resources as it pertains to the enterprise. The business architecture defines optimal and common enterprise processes across the various agencies within the state and works with the business to ensure adoption. Business processes specific to one agency fall outside the realm of the enterprise architecture, based on the Coordination operating model. The enterprise business processes undergoing the most change should be the primary focus areas as they present the greatest opportunity for restructuring to be compatible with an enterprise business architecture.

BUSINESS ARCHITECTURE EXAMPLE

Problem Statement

OIT realizes the workforce needs to be more mobile to access information and processes anytime, anywhere.

Proposed Solution

OIT is defining the standards and Acceptable Use policies to bring mobility to our workforce. Ensuring the workforce has secure access to resources when they need it is imperative in today's world.

Current Drivers

There are numerous business drivers, across the state enterprise as well as within various agencies, that require information sharing and integration between business processesnot in place today. Identifying the common processes or points of integration between these processes allows the design of information systems to support such sharing. Some of the business initiatives include:

- Education Initiatives – Statewide Longitudinal Data System, Early Childhood

- Healthcare Reform and State Initiatives – Health Insurance Exchange, Health Information Exchange

- Innovation offerings for state workforce and citizens, such as collaboration, ERP and Human Resource Management

In addition to these specific business drivers, the Colorado Blueprint places an emphasis on innovation through the use of technology. Such innovations that enable more elegant, efficient and effective government will require a concomitant change in business architecture.

Future State

The business architecture drives initiatives around business enablement, interoperability and data sharing, which are key to improvethe effectiveness and efficiency of state government and to achieve proper and successful outcomes. While the operating model for the state will remain Coordination, as described above, and many of the business processes will remain autonomous within the business, the business processes and requirements for all initiatives will make use of the architectural frameworks. This will ensure long term sustainability and interoperability.

There are several key areas that are candidates for enterprise consolidation.

- **BusinessEnablement Tools** – Offer innovative and new technologies to agencies for projects and solutions that may or may not need an enterprise perspective. OIT's Chief Financial Officer (CFO) is responsible for the IT Storefront for all IT-related procurements including hardware, software, maintenance, and services for all Executive Branch agencies. The IT Storefront is the life cycle management process for all IT services. The CTO's office will supply the list of approved hardware and software, based on standards and policies, which will feed the IT Storefront.

- **Mobility for State Workforce –** Ensure the workforce access to their applications and information anytime, anywhere via any device.

- **Portfolio Management –** Streamline enterprise offerings to reduce cost and improve interoperability.

- **Community engagement and citizen participation (eGov) –** Offer multiple ways for citizens to engage with government entities. Create new ways for citizens to interact with each other.

The Business Architecture Framework can be found in Appendix A.

Information Architecture

Overview

Information is the essential component for interoperability and decision-making in the State of Colorado. This framework focuses on standardization of and governance around data and is often the start to innovative ideas and exchanges.

INFORMATION ARCHITECTURE EXAMPLE

Problem Statement

There are several areas within the state that require data sharing and governance. Two in particular need to implement a data governance group: Statewide Longitudinal Data System (SLDS) and Early Childhood Leadership Commission (ECLC).

Solution

The Colorado Information Marketplace (CIM) is a governance and publishing framework for information sharing and exchanges within the state. It is being used as a guide to assist both SLDS and ECLC.

Current Drivers

Mostof the information architecture business drivers relate to information sharing across jurisdictional and agency boundaries, including federal, state, local, non-profit and for-profit businesses. To date, most of the sharing has been point to point between agencies and entities leading to inefficient information sharing and a lack of comprehensive organizational knowledge regarding data availability, access and use constraints. Without the proper infrastructure, information will continue to be siloed and therefore will not be discoverable nor used to its maximum value. In addition, lessons learned and work developed through information exchanges are not always reused for future initiatives.

Business drivers for an information framework include:

- Statewide Longitudinal Data System

- Health Insurance Exchange

- Healthcare Information Exchange

- Public Safety and Homeland Security

- Economic Development

Future State

An information framework will create reusable processes and standards to ensure security and privacy around state data, while facilitating data exchange, transparency and reuse where appropriate. It will also provide a foundation for data governance to communicate utility, appropriate uses and quality of data.

Key areas of the information framework include:

- **Colorado Information Marketplace (CIM)** – The state has developed a set of data governance procedures and an infrastructure to facilitate cross boundary sharing, rules based access and authorization, and discovery of state data assets.

- **MasterData Management** – Enabling identity resolution for all citizens and businesses.

- **EnterpriseBusiness Intelligence—**Applying BI tools for expanded analytics and accountability of government operations.

The Information Architecture Framework can be found in Appendix B.

Solution Architecture

Overview

The Solution Architecture framework creates standards around systems and application design, ensuring the technical solution is aligned with the Business and Information Architectures. The solution architecture creates macro views of solutions, such as a generic, scalable architecture, that has been field tested and can be reused.

SOLUTION ARCHITECTURE EXAMPLE

ProblemStatement

The Colorado Benefits Management System (CBMS) desires to build out an environment that will give the system elasticity during peak enrollment times.

Architectural Solution

CBMS can take advantage of the Cloud Strategy, utilizing a private cloud to ensure availability and scalability during peak enrollment times.

Current Drivers

Few solutionstandards exist today resulting in a non-standard environment that isa challenge to maintain. In addition, many systems are not interoperable. Providing frameworks for the enterprise will accelerate the design process, since reusable components can be pulled from the shelf and reused. These components may also be combined to create new innovative business solutions. They consist of reusable patterns and build upon the technology standards developed in the Technology Architecture.

Examples of current initiatives for new solutions include:

- COFRS replacement
- CBMS rearchitecture
- State Level Registry (SLR)

These systems must be interoperable, so future initiatives may take advantage of their information and processes.

Future State

The future state solution framework will emphasize reusability and reducing custom "one off" solutions. This will enhance the sustainability of information technologies in the state and increase the agility in implementing new solutions. It will consist of:

- **COTS (Commercial Off-The-Shelf Solutions)**– Readily available, commodity, well - supported products and services that conform to OIT standards and principles, which can be consumed by state agencies and their departments.

- **Web Solutions** – Solutions will conform to Service Oriented Architecture (SOA)/Software as a Service (SaaS) based architectures allowing fundamental interoperability and facilitating scale-out strategies to become standard.

- **Mobility Solutions** – Technology will be embraced which enhances the productivity of employees across the state by enabling secure, continuous connectivity to data, applications and services from remote locations and across dynamic environments.

- **Cloud and "as a Service" solutions**– "Turn-key" solutions that allow expenses to be scaled as it relates to usage, governed by clear SLA's, and have been vetted according to OIT standards and principles.

- **Standardized Architectures** – Modeling and design patterns will be provided to inform and guide all agencies and departments in their design and development endeavors.

- **Identity Management / Single Sign On** – Identity management is standardized and pervasive, allowing cohesive, seamless, user-context access, authentication, and authorization to applications and network resources.

The Solution Architecture Framework can be found in Appendix C.

Technology Architecture

Overview

The Technology Architecture provides developers and engineers the toolkit to provide the foundation for all IT initiatives. This framework outlines the software and hardware lifecycles, as well as the standards for all hardware and software initiatives. While the Solution Architecture gives a macro view of an application or solution, the Technology Architecture provides a micro view of technical standards.

TECHNOLOGY ARCHITECTURE EXAMPLE

Problem Statement

The state currently has a very limited set of standards around hardware and software. Agencies wishing to make these types of purchases must go through a cumbersome process.

Architectural Solution

OIT will set standards and post these on the IT Storefront, so buyers can place immediate orders without having to go through a lengthy procurement process.

Current Drivers

Similar to the Solutions Architecture, few standards exist in the enterprise today. Best practices can help guide developers and engineers to create sustainable and reusable systems and components in order to become more agile and create an open environment where information and processes can be easily shared and reused and security/privacy has been vetted. The Technology Architecture is the foundation for all the other frameworks and will drive initiatives such as the IT Storefront.

Some drivers include:

- Remove redundant technology from the environment

- Remove upgrade dependencies by migrating to cloud offerings

- Improve hardware utilization through consolidation and cloud offerings

- Increase interoperability and remove flat file dependencies

 Future State

All initiatives can benefit from best practices and standard policies. The CTO's office will continuously review, update and improve standards and policies and post them on the OIT website.

The future state will include standards around the following:

- **Software Development Life Cycle** – Standards and processes around software builds and deployments are critical in preventing business disruption.

- **Technology and Infrastructure Lifecycle Strategy** – Ensuring *End of Life* plans and upgrades will keep the state's infrastructure running efficiently.

- **Information Lifecycle**–Timely and accurate information is critical to the success of the state.

- **Application Design and Coding Standards** – Design and coding standards will ensure applications stay modern and updated.

- **Collaboration and Business Process Tools**–Enabling the business with proper toolsets is crucial for business efficiency and effectiveness.

- **Mobility Tools and Devices** – Standard device sets and tools can increase the workforce mobility.

- **Enterprise Management** – Enterprise management, such as project management, will enable us to better manage larger projects, as well as gain efficiencies through ongoing learnings.

- **Platform** – Standards around platforms can increase our efficiency and effectiveness by gaining economies of scale around training and support.

- **Security** – Working with the Chief Information Security Officer (CISO), these standards will provide a framework to use for procurement, as well as development and maintenance.

- **Applications**– Standards for applications, software languages, middleware, web services and the like give the state a foundation on which to work.

The Technology Architecture Framework can be found in Appendix D.

Implementing the Frameworks

OIT Playbook

The OIT Playbook will outline timeframes and deliverables per quarter for this Roadmap.

Resources and Governance

Government Data Advisory Board

The Government Data Advisory Board was created through HB 09-1285 to provide recommendations to the state Chief Information Officer around the ongoing development, maintenance and implementation of interdepartmental data protocols. The recommendations from this board will be key in providing a true information architecture for the State of Colorado.

Information and reporting can be found here:

http://www.colorado.gov/cs/Satellite/OIT-EADG/CBON/1251579896288

Technology Review Board

The Chief Technology Officer's office will create an Technology Review Board (TRB) with the express purpose of reviewing and advising on all aspects of the Enterprise Architecture. The TRB will be responsible for:

- Advise on the efficacy of the Roadmap

- Review new standards and technologies

- Advise on revisions of the standards and technologies

- Set new standards and technologies

Members will include OIT employees from the following functional areas:

- CISO or designee

- CTO or designee

- Agency Services as appointed by Director of Agency Services

- Service Operations as appointed by Director of Service Operations

- Other members as necessary

Chief Technology Officer Advisory Council

The CTO will create an advisory council of members external to government, to provide a private sector viewpoint for the Enterprise Architecture, advise on areas for public/private collaboration and inform the CTO on innovations within the marketplace that may be of interest to the state.

The council creation product may be found [here](#).

Standards Process

The Government Data Advisory Board and the Technology Architecture Review Board will advise the CTO's office of standards that should be adopted by OIT. These will be [documented](#) as adoption occurs and will be reviewed quarterly.

The policy for standard adoption will be based on the following:

- Comprehensive in its application – No duplication of processes, costs, workloads, or required environments (not to include DR/scalability)

- Use open standards and conforms to accepted best practices to ensure scalability and interoperability/integration into broader roadmap scope

- Clearly defined product roadmap

- Clearly defined product support and service level agreements

- Sustainable product community/financially viable entity (commodity or best-of-breed preferred)

The CTO's office will also drive Best Practices teams throughout OIT to discuss and disseminate best practices for various engineering disciplines. Disciplines such as Database Administrators, Network Administrators, Software Engineers, Quality Assurance and such will lead decision-making and best practices for their own organizations.

Gates and Gatekeepers

The [Technology Architecture](#) defines the Software Development Lifecycle and the Technology and Infrastructure Lifecycle Standards. These two frameworks include mandatory gates, with associated gatekeepers, charged with reviewing new solutions at two key areas: post requirements/pre build, and pre-deployment. Specific projects will identify the actual gatekeepers, but gates will be required for those projects large enough or with broad enough reach to require these gates. Three offices, Chief Technology

Officer, Chief Information Security Officer, and Procurement will be required to approve the gates before projects can continue to ensure adoption of standards and security policies. This ensures the adoption of standards and technologies and opens communication between teams within OIT. Anomalies and exceptions can be documented and may become a standard. (See Figure 7)
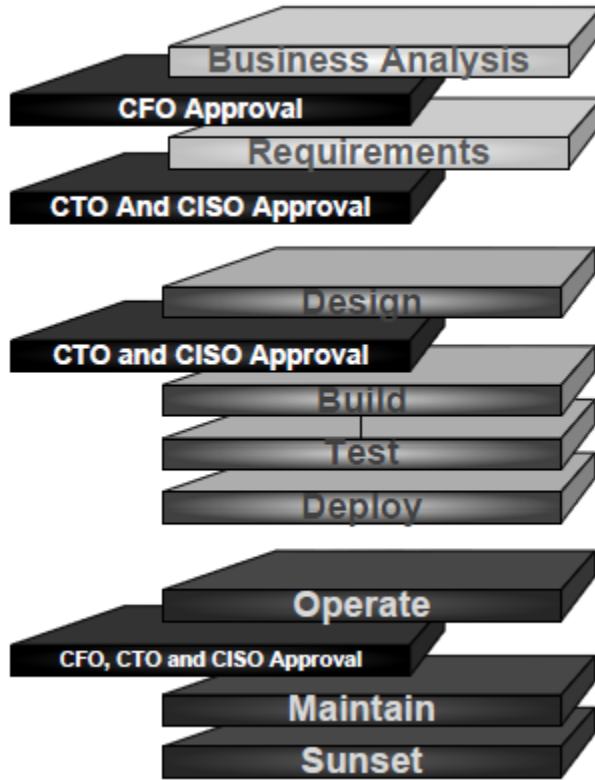
Gates and Gatekeepers

Business Analysis
CFO Approval
Requirements
CTO And CISO Approval
Design
CTO and CISO Approval
Build
Test
Deploy
Operate
CFO, CTO and CISO Approval
Maintain
Sunset

Figure 7

Appendix A

Business Architecture Framework
The following key strategies will be the primary focus for the Enterprise Business Architecture.

Business Enablement Toolkit

As Is
Currently, the state workforce makes decisions regarding business enablement tools on their own or in a process that can best be described as cumbersome. (See Figure 8)
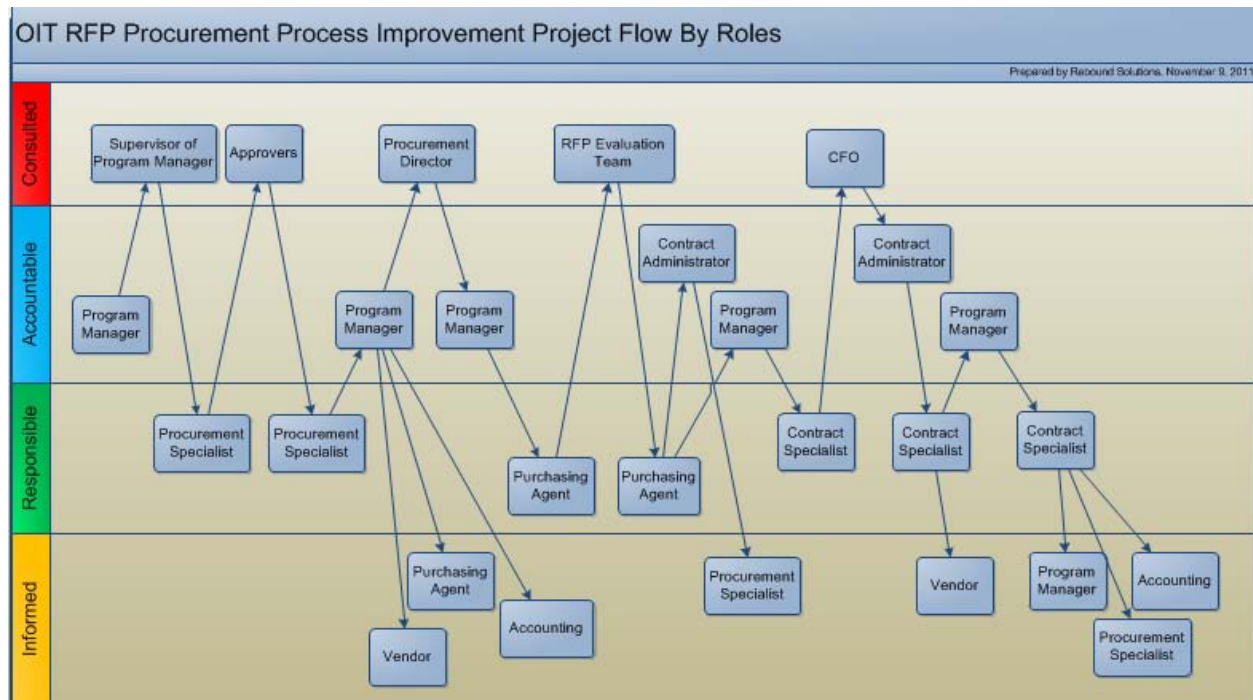
** Reused from IT Storefront analysis

Figure 8

To Be
Enabling the business by leveraging existing tools and adding new technologies and innovations will place the State in a position of better serving our customers and increasing productivity. Solutions whose data and processes encompass multiple agencies and services will require vetting by OIT for an enterprise solution. However, many business productivity tools do not span across the enterprise and can be leveraged without requiring any OIT resources. A menu of these tools will be made available through the IT Storefront website for departments and customers to utilize as needed. OIT will continue to research new tools and innovations and provide them on the website for access similar to the federal government GSA site, apps.gov. (See Figure 9 below) A certification process will be required that includes the offices of the CTO, CISO and Procurement.

Figure 9

The policy used to declare a particular application available for use (either purchase or free) without

intervention from OIT is under construction.

The IT Storefront will contain all the applications and resources available and outline whether OIT must be involved in the acquisition and detailed instructions on how to apply for business enablement tools and resources.

Areas to be considered around business enablement include emerging technologies and innovations around Communication, Collaboration, Community, Crowd Sourcing, Social Media, and Information Availability. The CTO's office has initiated a series of Tech Forums to provide training and demonstrations on best practices and new or emerging technologies. The Tech Forums are intended to seek out innovative solutions that are thought-provoking and forward-lookingwith topics aimed at showcasing strategic solutions using existing and emerging technologies that align with business needs and may deliver long-term value to the state and its citizens. These may serve the Business Enablement Toolkit by bringing about new applications and resources that may be vetted and potentially approved through the certification process to be added to the Storefront for use across the enterprise.

Mobility for State Workforce

Virtualize

As Is
Today's environment utilizes standard 'grey box' laptop and desktops within the enterprise. Deploying thousands of laptops, ensuring the operating systems and processes are up to date, and maintaining the equipment, creates a tremendous supportburden.Due to the disparities in the end-user operating environments, the Service Desk cannotalways centrally troubleshoot a problem and it may take desktop

support personnel multiple trips to the problem computer in order to get the work completed. Further, upgrading systems usually requires manual intervention.

Some workforce employees rarely use an office and are required to be in the field to perform work. Others could have the option to work from home (during inclementweather, employee perk, etc.), but may not have the equipment necessary to perform their work, thus driving up costs of non-productivity.

To Be

The state workforce should have access to their processes and information from a multitude of devices. In the current technology environment, the state could benefit from reduced costs and gain productivity by virtualizing the environments for much of the workforce. The state will adopt a policy of virtualization and will standardize around the following:

- Job functions to be virtualized

    Identify jobs that require it as initial step

- Standards for desktop virtualization

    Virtualization Provider

    Operating System(s), memory and CPU standards

    Storage in the cloud adoption

    Software as a Service (SaaS) adoption

    Platform as a Service (PaaS) adoption

For more information, please refer to the [Cloud Strategy Roadmap](#) found here.

Mobilize

As Is

Some members of the state workforce are issued government devices which should be used exclusively for state work. However, nothing prevents an employee from using their own personal device to check email and download sensitive documents via webmail. In the event of equipment loss, there is the possibility that sensitive data may be stolen. The device may or may not allow for remote wiping.

In addition, use of non-government issued devices may not be adhering to statewide security standards, such as data encryption and access control. The state workforce who do use state issue devices often have their own device. They are thus inconvenienced with having to maintain two sets of phones, two tablets, etc.

Additionally, the state has considerable cost around supplying devices and has issued approximately 7,000 BlackBerries, iPhones, iPads and other devices.

To Be

The state recognizes the need for both state issued devices as well as allowing some users to 'Bring Your Own Device', not only as a convenience to the workforce, but to save costs for the state. Devices in this context mean smartphones and tablets, not laptops. The CTO's office will work with the CIO and the State to define an Acceptable Use Policy, which will include a Bring Your Own Device (BYOD) strategy.

Portfolio Management

The Statewide Inventory Management initiative is under way and the results will be used to form a baseline for portfolio management, as well as portfolio risk assessment. Once gathered, like solutions will be consolidated across multiple state agencies to improve Total Cost of Ownership.

Based on the data gathered, systems identified during the assessment will be classified by the Enterprise Architecture group for potential consolidation and cost savings.

In general, Enterprise Portfolio Management candidates for change will consist of the following::

Two or more agencies using the same applications / solutions should be consolidated if they meet the following criteria:

- High usage **

- Consolidation will result in smaller footprint (cost savings, workforce savings)

- The applications / solutions are not End of Life

Two or more agencies using outdated (End of Life) applications / solutions with high usage should be replaced with technologies that meet the standards defined within this document

Agencies using proprietary applications / solutions that require maintenance and upgrades with high usage should be placed on a replacement schedule for COTS as appropriate

Critical systems must be replaced or refactored due to technical debt based on the risk assessment using the standards set within this document

Sunsetting strategy for existing solutions that are End of Life, but without high usage or required by law or regulation. (See Figure 10)

*** High usage is defined as either many users (100+) or high workforce requirements for maintenance and upgrades.*
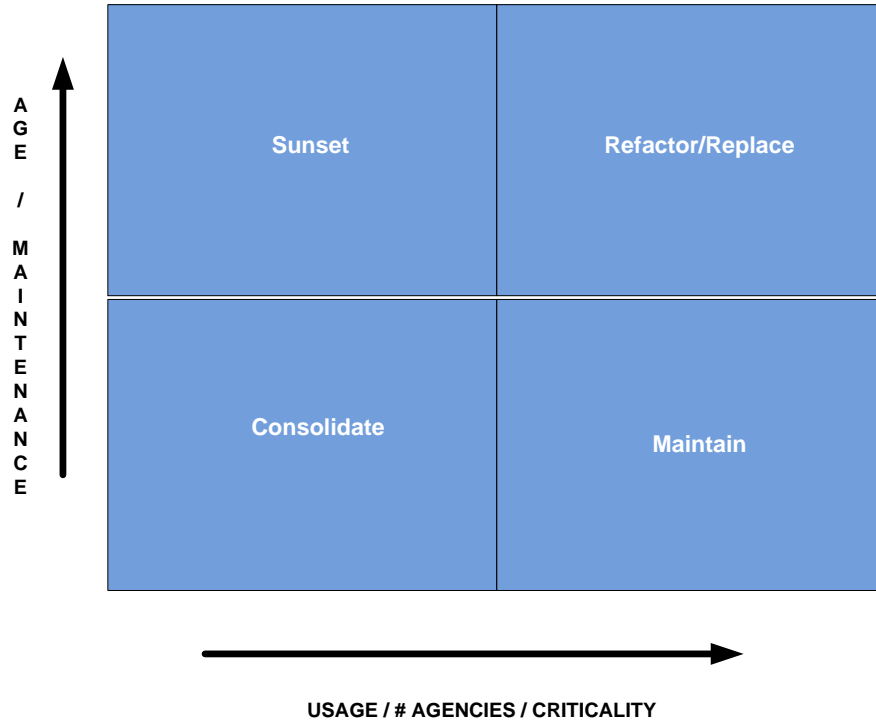
Figure 10

Appendix B

Information Architecture Framework

Colorado Information Marketplace (CIM)

This framework defines data sharing and information exchange policies and procedures and can be found [here](#).

Master Data Management

Currently underway is the SLDS Link project which will provide the initial implementation of a Master Data Management solution within Colorado. The chosen provider will become the de facto standard for the state around Identity Resolution. More information will be posted on the OIT EA website (www.colorado.gov/oit/ea) as it becomes available.

Business Intelligence

Appendix C

Solution Architecture Framework

COTS (Commercial Off-The-Shelf Solutions)

The state mandates the use of COTS whenever possible. All of the following questions must be answered 'No' in order to deviate from the standard.

Do COTS solutions exist for the business problem?

    Review Request for Proposal section for more information on evaluations

    Functional substitution exists for features not available

Are the solutions within budget?

Can the COTS solution be customized using configuration to meet future business requirements without customization (i.e. modularity and add ons are available or could be)?

Do the viable solutions scale to future needs?

In the event a customized solution is required, it must follow the Software Development Lifecycle, the Technical and Infrastructure Lifecycle and the Application Design and Coding Standards found in the Technology Architecture section of this document.

Web / Mobile Solutions

Nearly 25% of the United States' citizens are exclusively mobile users and do not own a PC or laptop. The smartphone and tablet community is growing exponentially, while the desktop and laptop markets are in decline. The state needs to consider mobile solutions as an integral part of its online strategy.

In general, the strategy for web and mobile solutions is the following:

Any form available online should be optimized for mobile (tablet, smartphone)

> *All forms posted online should be available in a mobile format.*

HTML 5

> *Becoming the standard in order to remove native and application store dependencies. Problems with working between browser and native OS's are resolved with HTML 5. It is estimated that in 2016, 2.1 Billion smartphones will have HTML 5 compatible browsers.*

iPhone and Android specific apps until HTML 5 becomes standard in mobile devices

> *Any applications requiring use of smartphone/tablet hardware continue to require specific OS calls and, therefore, must be native for the 2011-2012 timeframe. Therefore, devices interfacing with any hardware on the device (location based services for example) must still be created natively.*

All paper based business process should be migrated to Web / Mobile

> *The cumbersome processing paper based forms and the required data entry should be completely removed from state systems unless there is a legal requirement for paper processing.*

Web and mobile solutions should be interoperable and conform to SOA

> *Any form available online shall have a corresponding Web Service, which will enhance the information sharing across the state.*

Leverage the Colorado Information Marketplace to supply innovative private sector mobile solutions

> *The Colorado Information Marketplace will place non-sensitive data online for public access in order to foster innovations around the state.*

Private sector collaborations will drive the state's mobile strategy

> *The state's slim resources do not allow for a robust mobile development environment. We will instead rely on private sector collaborations to help us drive innovations around web and mobile technologies.*

The infrastructure standards for web and mobile solutions can be found in the Standardized Architectures section below.

Cloud and "as a Service" solutions
The strategy for cloud solutions may be found here.

Geographic Information Systems (GIS)
The strategy for GIS solutions may be found here.

Healthcare Strategy

Standardized Architectures
The standardized architecture outlined below should be used in all new and upgraded solutions. Each layer has its own requirements, but every layer should be loosely coupled with the one above and below it. All functionality within each layer should consist of many discreet and modular components.

All layers except People and Processes should be fully redundant, highly available and self-healing. The CTO and CISO will assist with implementation designs per the gates.

The orange boxes below should reside in their own discreet hardware stacks unless there is a cost or implementation reason that precludes it. (See Figure 11)
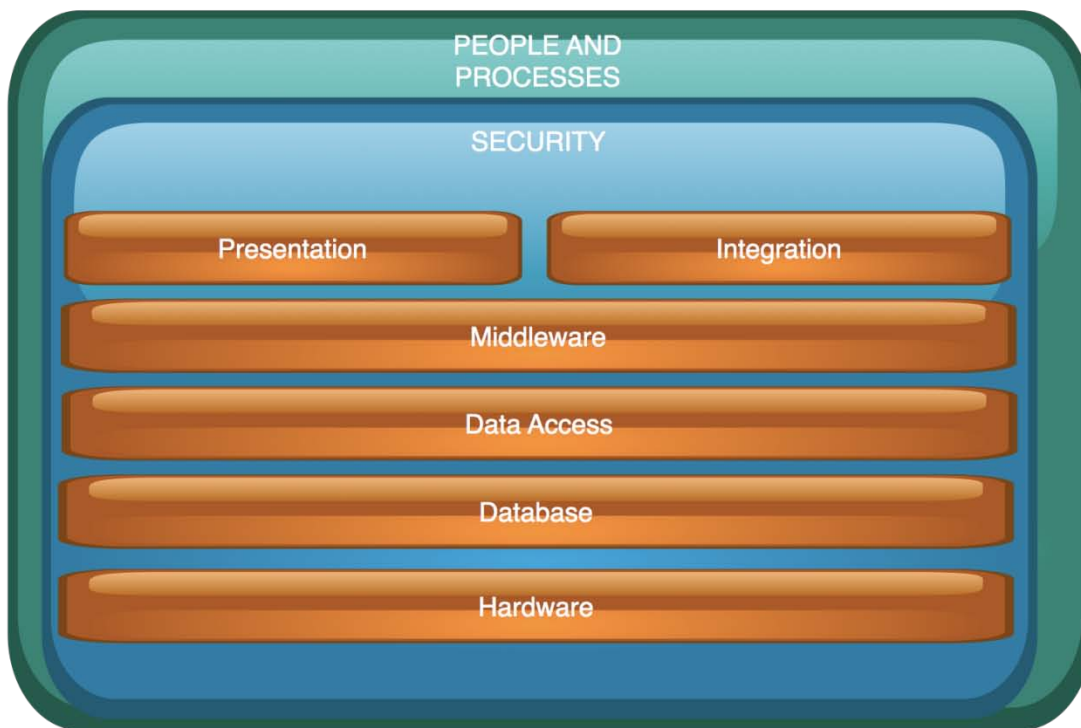
Figure 11

People and Processs

This layer is primarily the responsibility of the business architecture. People define the workflows and business processes for the particular solution.

Security

Please refer to the CISO webpage.

Presentation Layer

The presentation layer should be well-defined with an emphasis on usability and user interface workflow. It should consist of all user interface components and any user interface processes that must occur in the presentation layer. This layer should be light on business logic. Validation of input should be server side as much as possible to reduce redundancy between an integration (i.e. web services) layer and the presentation layer.

The presentation layer should be a thin browser client. Exceptions shall be approved by the CTO's office.

Integration Layer

The integration layer consists of Application Programming Interfaces (API's) that allow another entity to programmatically interact with the system and bypass the presentation layer altogether.

This layer should use industry standards around SOAP, REST, and other integration standards as they become standardized and published.

Middleware
Business logic resides in the middleware layer and should be discreet and modular steps in the workflow process. It should include service interfaces that can be used by both the presentation and integration layers. Additionally, this includes business processes.

Data Access
The database should never be accessed from the business logic, so both layers may be changed without affecting the other. A data access layer is the service interface between the two, ensuring that modifications made in one layer do not adversely affect the other.

Database
The database and associated schema and tables reside in this layer.

Hardware
The hardware layer really supports the other layers. Each layer should have its own redundant stack and the following are guidelines when planning a new solution:

Presentation and Integration layers typically use more memory than disk or CPU.

Middleware typically uses more CPU than memory or disk.

Databases typically peg CPU and memory (i.e. they take over as much as they can) and are normally I/O bound to the disk speed.

Network bandwidth should be considered and we we migrate solutions to cloud offerings could become a bottleneck. Other high bandwidth solutions, such as video, should always consider bandwidth requirements.

Web Reference Architecture

Controller

Data/State Mgmt

Security Container/Model

Virtual Machine

Rendering/Media

Client Tier

Communication Services

Design, Development and Governance tools

Standard Technologies And Protocols

Service Invocation Layer

Configuration

Service Container

Core Services

Business Rules / Workflow

Service Tier

Service Provider Interface

Resource Tier

Databases

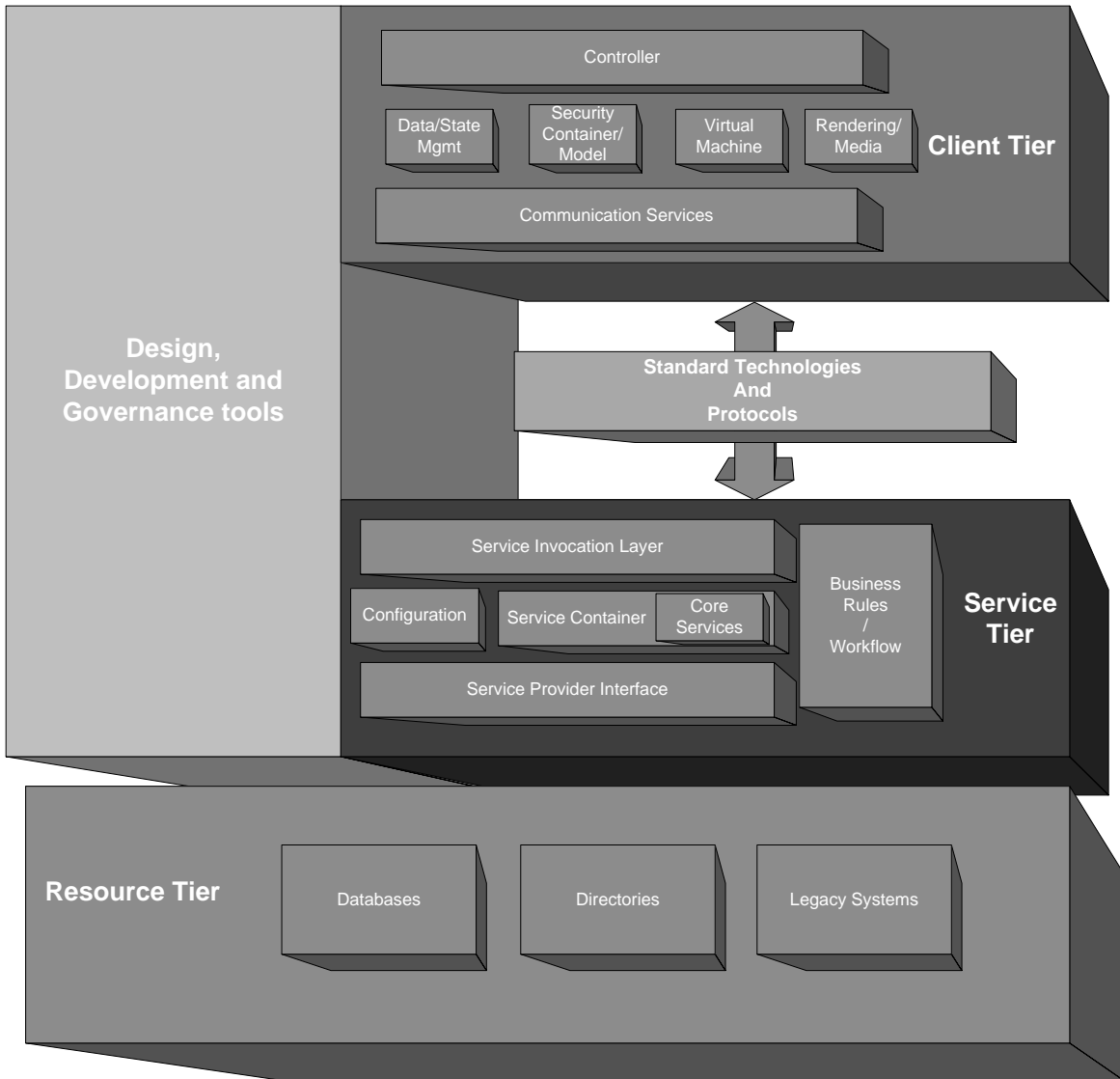Directories

Legacy Systems

Figure 12

Standardized Architecture Diagram
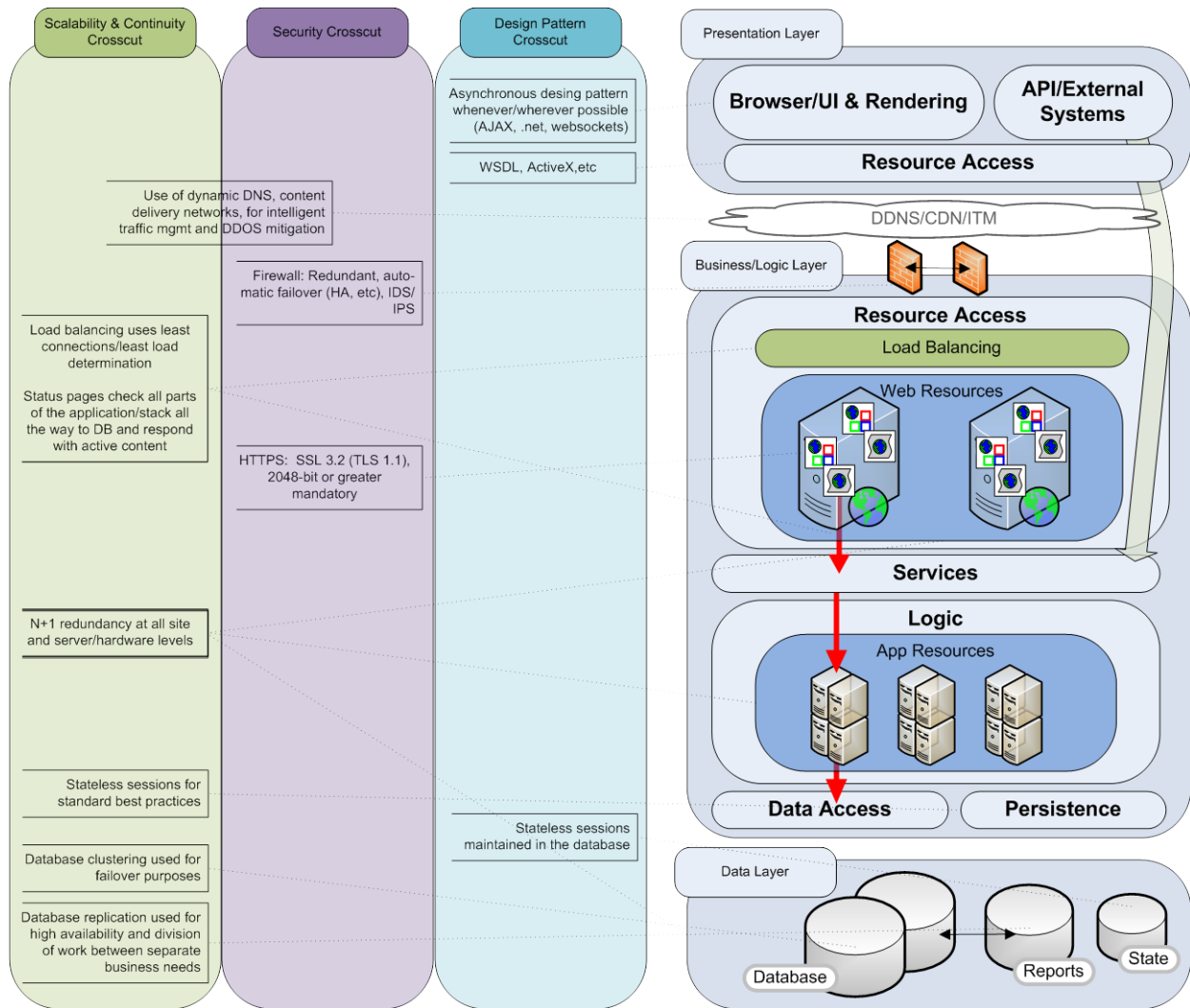

Figure 13

Appendix D

Technology Architecture Framework

Software Development Life Cycle

As Is

Today's state environment relies primarily on the waterfall approach to software development. With large projects, this approach normally results in a 'Big Bang' deliverable that may be years in the making.

Requirements change within the timeframe and the ultimate end product does not meet the present day requirements. A more iterative, agile approach is needed within the state to ensure timely deliverables that meet the demands of the current business process, not the one decided upon months prior.
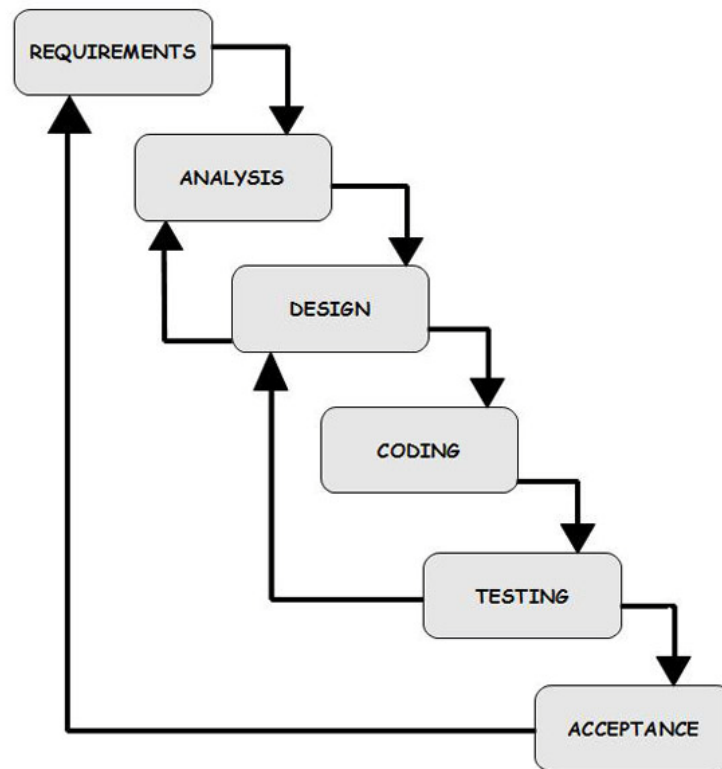
The typical steps in a waterfall process include:

Figure 14

Of note: A waterfall approach might be the best process if the requirements are carved in stone and will not be changing for the duration of the project. While this is rare, it can be an option in this instance.

To Be

The state needs to adopt a lean and agile approach to software engineering, both from internal applications development as well as outsourced projects. While many flavors of agile development exist (Lean, Scrum, XP, Kanban), the primarily strategy remains the same.
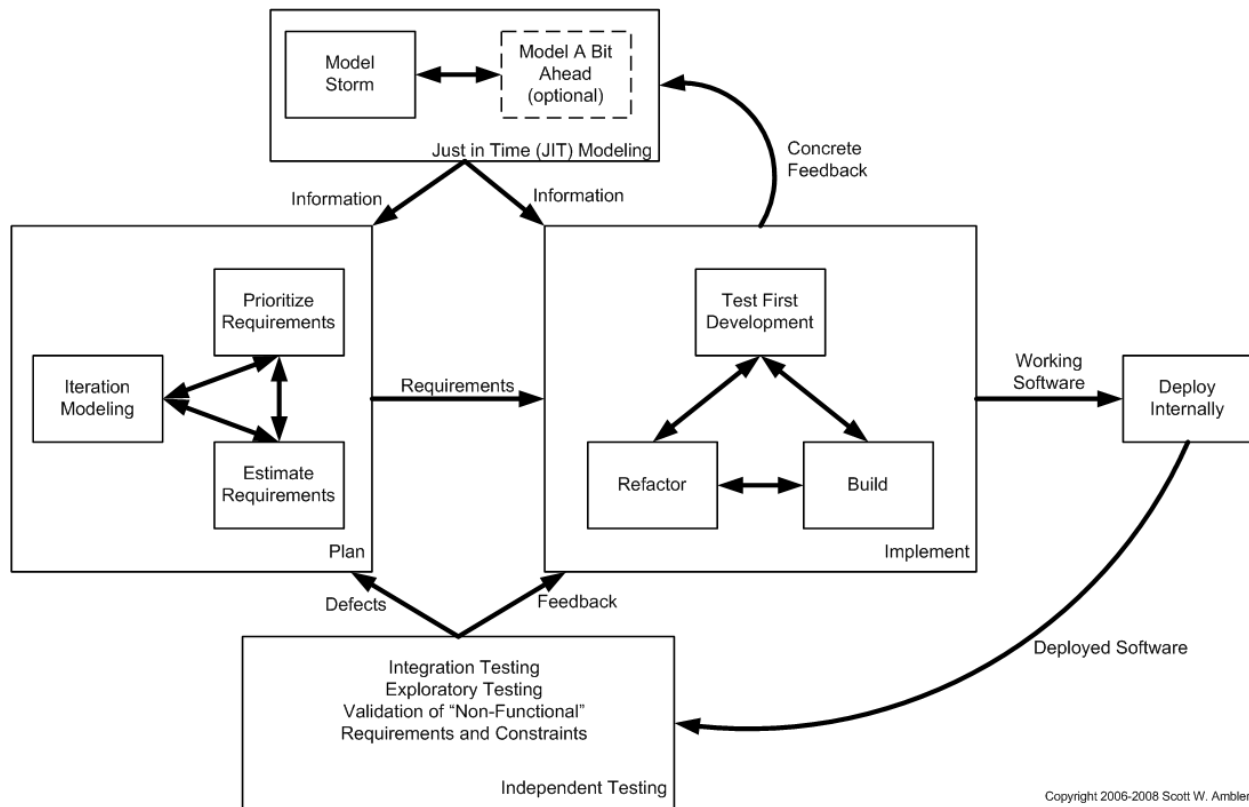
Figure 15

At first glance, lean and agile software processes are very similar to waterfall:

- Understand customer needs

- Formulate Solution Requirements

- Get Work into Development

- Build and Test

- Deliver to Customer

To create a value delivery chain, however, agile and lean processes adopt several pillars (borrowed from [Wikipedia's Lean Integration](#) wiki):

> Waste elimination should be viewed from the customer perspective and all activities that do ncontext, the customer is often an internal sponsor or group within an organization that uses, benefits from, or pays for, the integrated capabilities.
>
> 1. **Continuously improve**
>
>   A data driven cycle of hypothesis-validation-implementation should be used to drive innovation and continuously improve the end-to-end process. Adopting and institutionalizing lessons learned and sustaining integration knowledge are related concepts that assist in the establishment of this principle.
>
> 2. **Empower the Team**
>
>   Creating cross-functional teams and sharing commitments across individuals empower the teams and individuals who have a clear understanding of their roles and the needs of their customers. The team is also provided the support by senior management to innovate and try new ideas without fear of failure.
>
> 3. **Optimize the Whole**
>
>   Adopt a big-picture perspective of the end-to-end process and optimize the whole to maximize the customer value. This may at times require performing individual steps and activities that appear to be sub-optimal when viewed in isolation, but aidin streamlining the end-to-end process.
>
> 4. **Plan for change**
>
>   Application of mass customization techniques like leveraging automated tools, structured processes, and reusable and parameterized integration elements leads to reduction is cost and time in both the build and run stages of the integration life-cycle. Another key technique is a middleware services layer that presents applications with enduring abstractions of data through standardized interfaces allows the underlying data structures to change without necessarily impacting the dependent applications.
>
> 5. **Automate processes**
>
>   Automation of tasks increases the ability to respond to large integration projects as effectively as small changes. In its ultimate form, automation eliminates integration dependencies from the critical implementation path of projects.
>
> 6. **Build quality in**
>
>   Process excellence is emphasized and quality is built in rather than inspected in. A key metric for this principle is **First time through percentage** which is a measure of the number of times an end-to-end process is executed without having to do any rework or repeat any of the steps.

Technology and Infrastructure Lifecycle Standards

May be found [here](#).

Application Design and Coding Standards

May be found [here](#).

Information Lifecycle

May be found [here](#).

Applications and Technology Standards and Policies

May be found [here](#).

Final Thoughts

Technical Debt and the Law of Unintended Consequences

Technical Debt
Technical debt is a metaphor designed by Ward Cunningham who describes the term in this way:

> *"Technical debt includes those internal things that you choose not to do now, but which will impede future development if left undone."*
>
> **Ward Cunningham**

As you continue to build upon a system high in technical debt, it becomes more cumbersome to modify, test, release and support. Older systems are prone to technical debt, since software processes – such as modularity and integration – have made rapid advances in the last year years. Some reasons for technical debt include:

- Scope Creep

- Third Party Estimates

- Change in Team Makeup

- Difficult Estimation Process

- Late Integration

The state maintains millions of lines of software code, some of which is contained in applications decades old. As such, the state has accumulated a high degree of technical debt, which contributes to quality problems, late deliverables and difficult implementations. This debt must be paid down continuously, since it accumulates whenever software is created.

While specifics of decreasing debt are left to the technology projects, in general, the enterprise shall adopt the following standards:

Pay off technical debt immediately

Arguably the toughest to achieve, it is the most effective to pay off before initial release.

Place runtime exceptions in code or create scripts monitoring the network / infrastructure where debt is known to accumulate

When quality problems begin to arise, placing runtime exceptions in the code can give guidance on when the debt must be paid. For example, if a file is not reaching its destination in a known timeframe, placing code to send messages to developers/managers can highlight the technical debt as well as the quantity of the issue.adding technical debt improrefactevery release will improve the code and gain exponential quality improvements over time.

The Law of Unintended Consequences

> *"I got it to work"*
>
> **Unknown engineer**

The Law of Unintended Consequences comes into play whenever an engineer - software, infrastructure or other – is able to coerce an unfunctioning system into a functioning one, but without truly understanding why. Often it happens in a reactive situation (a system is completely down) or simply out of frustration (a newly installed firewall just won't come online). Ignoring standards, best practices and documentation, the engineer tinkers and twists the system until the behavior works correctly. Generally, few other tests are performed before the system is placed back into production.

The Law of Unintended Consequence emerges days, months, years later when the system performs some combination of processes/functions or finds a threshold never before reached and breaks completely or begins to behave erratically. The law's constructs are as follows:

> If the behavior is erratic, the solution resides in an area that is not intuitive, as though there is a ghost in the machine. (For example, a name is modified as it is entered into a database even when the name fields are not touched on a web form.)

> If the system fails completely, it may not be revived at all or take days or weeks to recover. If it does recover, it may show erratic behavior.

Preventing the Law of Unintended Consequences is a simple, two step process:

> **Obey all documentation, best practices and standards set forth by vendors.**
>
> **Never install anything 'fixed' that is not understood or does not make sense.**

"The great thing in the world is not so much where we stand, as in what direction we are moving."
Oliver Wendell Holmes