Enterprise Architecture Professional Journal

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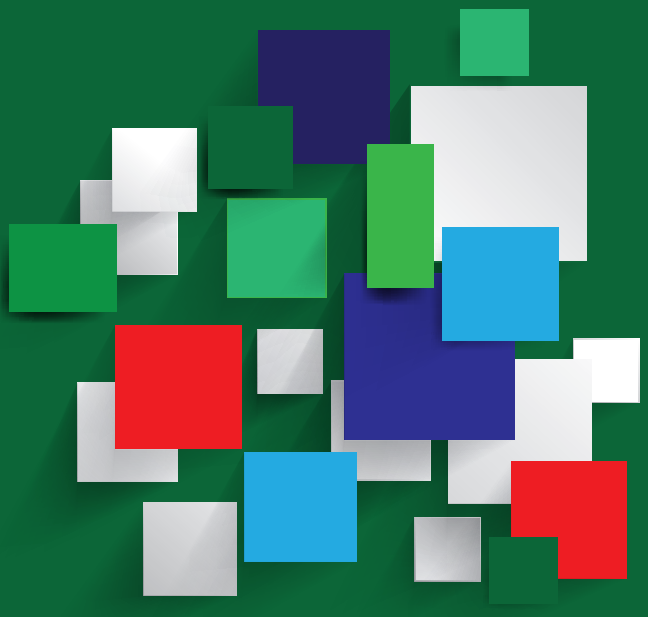

Volume 1 April 2013

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ENTERPRISE ARCHITECTURE PROFESSIONAL JOURNAL

VOLUME 1

APRIL 2013

For Business and Technology Insights: Case Studies and Articles on Enterprise Transformation

FROM THE EDITOR

Welcome to the second issue of the **Enterprise Architecture Professional Journal**, a monthly journal dedicated to practicing and aspiring enterprise architects. As per the inaugural issue, this one leverages a lot of the outstanding work done at the University of Denver (DU) in its mandatory Enterprise Architecture course for all students in its graduate-level Information and Communications Technology track. All five of the case studies in this issue leverage TOGAF® 9. Newer students in the DU are being asked to up the ante a bit due to the stellar work of predecessors in the course, as we add in the requirement to address architecture principles and reference models starting in the Summer Quarter of 2013. In short, the maturity of work on TOGAF is advancing and EA is being advanced as a result. In this issue alone, TOGAF is applied in the medical, utilities/government, oil and gas exploration, financial services, and non-profit sectors. Below are some highlights.

In "Medical Center Operational Systems Data Integration", Elizabeth Peacock describes a medical center initiative to integrate its isolated financial and clinical information systems. Analytical Applications opportunities for intelligent data connection are enabled through Business Intelligence with access to Online Analytical Processing tools. Integrated data stores allow for simplified standards compliance with enhanced security. These solutions fulfill stakeholders' needs for improved enterprise interoperability and usability while opening the door to expansive new opportunities in the hospital's future.

In his "Proposal for Implementing an Enterprise Geographic Information System for Public Works and Utilities Infrastructure Data to be Utilized by Multiple Organizations", Rob Burnes explains that his Enterprise Geographic Information System (EGIS) approach would connect and unify spatial information among the local and county government organizations that would provide an interconnection that does not currently exist. The overall goal would be to have an interconnected public works and utilities infrastructure data network. The benefits should be observed in planning, emergency response, customer service, and regulatory coordination, just to name a few.

In "Enterprise Architecture Steps Forward: Solutions Proposal for K3RI", Kas Osterbuhr introduces K3RI, a small oil and gas exploration company with a well-defined corporate vision but poor execution for achieving that vision. He relays how Enterprise architecture (EA) provides a toolset that can create a virtual "lattice" of growth for K3R, where capabilities can be better architected to achieve business goals.

In "Organization-Specific Enterprise Architecture Analysis of a Major Financial Services Sector Systems Provider", Robert Wood Specifically, an anonymous financial services organization in the context of the TOGAF framework and recommends specific solutions from an organization-specific perspective. While many important architectural elements are already available to ABC, the ultimate success of its articulated corporate strategies ties closely to the success of its EA efforts to address and remediate identified architectural issues.

Finally, in "Organization-Specific Enterprise Architecture for Rotary International", Stephanie Livsey applies EA analysis to Rotary International, a non-profit organization with more than 34,000 local clubs in cities all around the globe. She makes recommendations on how EA could help the organization to standardize global processes, procedures, and reporting. Such a related transformation would offer the

capabilities and structure necessary to enhance administrative procedures, foster communication among clubs at all levels, and allow for better allocation of resources.

Please subscribe at http://eapj.org, let your friends and colleagues know about this great resource, and let us have your feedback on this material, and contribute your own case studies for consideration by our Executive Board of Editors. Also, if you would like to be considered to join our editorial group, please contact selse@eapj.org. Although we are a young organization, we have a treasure trove of material lined up for publication already and will be including increasingly sophisticated case studies, results of interviews with technology leaders, reviews of the latest EA-related publications, and opinion pieces, as well as tips on all kinds of EA frameworks and approaches. Our initial emphasis is on TOGAF*, but that will change rapidly. This publication is about advancing EA and we think that every organization doing EA needs to be conversant in multiple frameworks for enabling better decision making, just as they do in the vast array of technology building blocks available for business transformation.

Steve Else, Ph.D.

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ELIZABETH PEACOCK: MEDICAL CENTER OPERATIONAL SYSTEMS DATA INTEGRATION

EXECUTIVE SUMMARY

In this enterprise architecture solutions report, a medical center initiative to integrate its isolated financial and clinical information systems is described. Focused senior management commitment is needed to coordinate stakeholder cooperation. Systems integration interoperability opens up opportunities for intelligent enterprise knowledge-sharing and improved standards compliance process.

Key stakeholder support is engaged through issues education and participation in business scenario workshops. A Coherency Management program to secure community cooperation and collaboration is engaged, followed by senior management stepping into the roles of chief communicators and consultants. TOGAF ADM is chosen as the enterprise architecture (EA) framework, complemented by the III-RM reference model to support the requirements of medical center intranet communication.

Systems integration centers on dynamic data warehousing applications with Enterprise Information Integration (EII) data preparation and interactive metadata. Analytical Applications opportunities for intelligent data connection are enabled through Business Intelligence with access to Online Analytical Processing tools. Integrated data stores allow for simplified standards compliance with enhanced security. These solutions fulfill stakeholders' needs for improved enterprise interoperability and usability while opening the door to expansive new opportunities in the hospital's future.

GENERAL BACKGROUND

Institutional scope. The medical center is an integrated academic health facility with a $2 billion budget, including $145 million in federal research funding. The hospital's mission centers on education, patient care, and community outreach, with a strategic vision to rank among the top academic medical centers in the northeastern United States (University of Rochester 2008, University of Rochester Medical Center 2011b).

Financial data systems management. High national ratings require information technology excellence. Five years ago, the medical center in-vested in an enterprise-wide financial data management system (i.e., GE *FlowCast*). *FlowCast* provides basic patient information with financial specifics (e.g., ID, insurance coverage, admission/discharge status, and unit, as well as real-time census information).

Electronic medical records. Intended to run as a parallel platform, a new electronic medical records (EMR) system was officially rolled out at the medical center in March 2011. The federal-government mandated system contains information relevant to provision of patient care. The medical center chose *eRecord*'s single point-of-access comprehensive EMR to optimize data integration and standardization within the platform. Institutional agility is supported, while departments continue to operate with locally responsive flexibility. (Epic Systems Corporation 2011, University of Rochester 2008, University of Rochester Medical Center 2011a).

Stakeholder requirements supporting local autonomy. Stakeholder groups have various functional needs of the hospital's two major operational systems. Financial managers need access to data relevant (and often particular) to their processes. Managers and other staff users review administrative operational data in near real-time (e.g., as workflow views), and require the capability to edit source systems. Both systems offer operational and master data with some overlap, but they maintain essential database and access autonomy. Each system has its own demanding process of data entry and editing that requires specialized knowledge to engage (University of Rochester 2008).

Stakeholder requirements supporting interoperability. Interdepartmental teams (e.g., financial case management, insurance verification, and social work) use both financial and clinical information. Senior managers need a smooth, integrated interface for views related to ongoing and timely decision-making. Whether reviewing relevant information directly from the database source or derivations of business intelligence processes, all of these stakeholders must have confidence that the data being presented originates from the source of record and is current.

Need for greater operational integration. Balanced against the medical center's mission and strategic vision, stakeholder requirements favor connecting the two systems with service-oriented components through a redesigned architecture that *contains a basic infrastructure for integration*. Loosely coupled, services are interchangeable to serve a variety of needs. While the project's scope is cross-enterprise, flexibility for lines of business to use their own internal data remains an option (Godinez et al. 2010).

Functional integration orientation. Currently, there is no functional service connection between *FlowCast* and *eRecord*. An Enterprise Service Bus (ESB) messaging model is in place, originally designed with the intention to integrate the medical center's research infrastructure. The ESB might also serve as a foundation for more extensive enterprise-wide integration in the future (University of Rochester 2008).

Purpose of the study. This project analyzes the issues raised and makes recommendations for action. Throughout the study, TOGAF framework perspectives, terminology, and methodology are applied in order to arrive at solutions. A plan to approach implementation of a redesigned architecture is provided.

Note. The parallel systems (i.e., FlowCast and eRecord) are referenced throughout this paper as lines of business (LOBs). The use of this phrase, defined as critical computer application systems vital to running an enterprise, is intended to highlight the systems' contrasting, yet parallel, functionality (SearchCIO.com 2000).

IDENTIFICATION OF MAJOR ARCHITECTURE ISSUES

Key Stakeholder Support

- The hospital lacks adequate administrative support to coordinate autonomous line-of-business cooperation across the organization.

Knowledge-Sharing

- Lines of business within the hospital have inadequate access to a full range of beneficial enterprise intelligence.

Systems Integration

- Due to constraints imposed by vendor contract agreements, hospital information technology (IT) systems maintain their own databases and proprietary implementations that impede enterprise interoperability.

Standards Compliance

- Workflow mandated to meet industry-standard compliance is inefficient, involving levels of security and reliability risk because it is spread across multiple systems.

Framework Process

- The frameworks that were chosen to facilitate the design and governance of existing side-by-side enterprise systems are unsuitable as an architectural approach to their integration.

ANALYSIS OF MAJOR ARCHITECTURE ISSUES

KEY STAKEHOLDER SUPPORT

Business case. Senior management has coordinated major decision-making around the transformative *FlowCast* and *eRecord* architecture efforts over the last five years as an overarching priority. The systems are presently fulfilling operational goals. The separate LOB systems, fulfilling basically complementary functions, are currently considered by middle management to meet intermediate-term goals adequately. The hospital's concerted efforts to generate enthusiasm for the new IT initiatives have generally been successful, as stakeholders have experienced benefits through the systems' usability, availability, and interoperability.

The new systems provide standardizing infrastructures that serve as precedents for next-generation enterprise initiatives. The full support of key stakeholders is needed, however, to inspire organizational vision toward an enhanced architecture that features system integration. In particular, senior management involvement in planning and implementation is recognized as having a primary correlation to a new architecture's chances of success (Ross et al. 2006).

Baseline. At present, when major enterprise initiatives are being considered, the enterprise communications and public relations departments produce videos available over the intranet with promotional messages from hospital senior management such as the CEO, CIO, or CMO (Chief Medical Officer). The intranet homepage changes daily with inspiration messages, news, and policy updates. Through these venues, key stakeholders are able to communicate the value of architectural requirements such as interoperability at the enterprise level, but with limited effectiveness. The impersonal aspect of cross-enterprise communications doesn't reach broadly into domain-specific operational concerns.

Target. A formalized shared methodology is needed to inspire change. When more of the enterprise stakeholder community is engaged in problem analysis and collaborative solutions modeling, the way can be paved for the EA team to effectively bring them together around a shared vision.

Gap analysis. TOGAF ADM methodology from Preliminary Phase to Business Architecture serves to familiarize key stakeholders with the business process foundations of the proposal. With this knowledge, senior management moves forward with approval of the project (Harrison 2009).

A lightweight front-line approach such as *Coherency Management* (CM) works to build on established hospital communication venues. Architects are provided access to a facilitation framework that helps coordinate communication and collaboration between stakeholders. To augment the task of engaging, educating, and inspiring stakeholders, as well as serving to communicate feedback to senior management, techniques to model various business processes help facilitators eliminate "semantic mismatch" ambiguity that might exist across lines of business. Mismatch often happens between IT and physician leadership in their communications about medical center goals (Axelrod 2011, Gryning et al. 2010, Open Group 2009).

Diverse specialization, distribution of work locations, and departmental silos within hospital IT operations present challenges to communication.

CM promotes mutual awareness of the efforts (in some cases, the existence) of business units such as these across enterprise domain-specific operations, with the aim of creating trust and interest. Once a more personal foundation is established, greater levels of cooperation generally result. The EA effort can then proceed on a stronger footing, with senior management assuming the role of top-level consultants and communicators (Gryning et al. 2010).

EA framework. While Phase B business architecture is enabled through the proposed dialog and feedback, CM might allow greater transparency of hospital operations and viewpoints to inform the implementation of Phase A. Stakeholders are identified, and their concerns and objectives clarified. Definition of business principles and goals is validated. Performance metrics (e.g., improved profitability or progress in coveted national rankings) might be defined. A vision is articulated, and with the success of the outreach effort, management commitment is reinforced (Open Group 2009).

KNOWLEDGE-SHARING

Business case. Even though collaborative opportunities for intelligence sharing and innovation are central to the operational success of a major research-based medical center, LOB processes in the hospital have evolved in relative isolation to one another. Exacerbated by the autonomous function of their LOB information systems, the separate entities are often unaware of potential points of overlapping connection. As a consequence, knowledge-sharing accessible to key stakeholders that might yield collaborative insight and innovation isn't being leveraged to fullest organizational advantage.

Analytical business intelligence represents a paradigm shift in business process. Critical information is delivered with minimal intervention. Hospitals that make best use of enterprise business intelligence exhibit significant improvement in key performance criteria. Higher patient satisfaction scores and reduction in staff overtime are positively correlated with knowledge sharing. Successful initiatives often see a reduction in adverse events per patient as well as unplanned readmissions, metrics that have a direct effect on national rankings tied to funding (Biere 2003, Hatch and Lock 2008).

Baseline. The medical center is currently fairly well positioned for a basic level of academic knowledge sharing through its dedicated research database and related services. Inpatient and Ambulatory EMR form a virtual suite of services connected to the research records databases (distributed both inside and

outside the enterprise) as well as to services accessible through an investigator portal (University of Rochester 2008).

There is little physical connectivity or logical interoperability, however, between the hospital's operational systems. The current information systems architecture connects general/patient accounting and Clinical Information Systems/electronic medical records (EMR) with their respective databases only. The only exception is a one-way feed that allows sharing of a limited range of basic patient information (University of Rochester 2008).

All three tiers of the enterprise system (i.e., client, server, and database) are connected, directly or indirectly, by the Enterprise Service Bus (ESB) messaging service (University of Rochester 2008).

Target. The hospital's disparate IT systems are brought together and enhanced through EIA Reference Architecture (EIARA) Data Warehousing and Identity Analytics Capability. Integrated business analysis reporting and discovery mining are enabled to make intelligent data connections vital to the medical center's reputation as a research facility. Equally important to competitive standing as a major hospital system are administrative operations informed by Business Intelligence (BI). New BI capabilities include formal patient/asset tracking procedures and real-time patient flow updating for improvement of patient care, as well as integration of clinical and patient record data with financial billing/claims systems data (see *Systems Integration,* pg. 11). EIARA's Search and Query Presentation Services are responsible for users' client-side capabilities (Godinez et al. 2010, Hatch and Lock 2008).

Gap analysis. In order to realize these beneficial enhancements to operational and research IT capability, the EIARA EII Component plays a critical basic role. EII extends a number of services that prepare information to be integrated for purposes of analysis by discovering information; ensuring high-quality data through extraction, cleaning, and harmonization; transforming heterogeneous data/information into a "single version of the truth"; and loading the processed data into a data warehouse. Interfaces provide a unified view of business and extend agile and reusable transformation services, making BI accessible to applications, business process, and portals (Godinez et al. 2010).

The Analytical Applications Component provides a finer level of functionality to support business intelligence optimization and performance. Operational Intelligence Services provide responsive event-driven analytics on demand. Exploration and Analysis Services extend core functionality for Online Analytical Processing (OLAP) (i.e., processing multidimensional analytical queries), trend analysis and descriptive statistics critical to medical center enterprise decision-making. Data Warehouse Services act as foundation applications of BI services, and Cubing Services provide views for data retrieved from relational databases (Godinez et al. 2010, Wikipedia 2011c).

At the EIARA operating pattern level, Near-Real-Time Business Intelligence captures operational data on demand and transforms it for data warehouse storage. An Extract-Transform-Load (ETL) process splits the data into parallel subsets across processors, scaling for the volume needed to serve the hospital enterprise 24/7 (Godinez et al. 2010).

EA framework. All requirements are driven by business process as defined and clarified in Phase B. As part of Phase A, key performance indicators related to business intelligence might include metrics balancing availability of insightful information across domains, with graduated query complexity against percent availability.

Following principles inherent to the Phase C process, application architecture knowledge-sharing capability is described in this EA as EIARA high-level, platform-independent categories. Outputs for this phase include Target Application Architecture mapped to relevant data architecture views (Harrison 2009).

SYSTEMS INTEGRATION

Business case. The two referenced systems (i.e., *eRecord* and *Flowcast*) are healthcare-industry standards in their respective areas of information management. Each extends their own proprietary vendor contract implementation and support agreements. Line-of-business data is maintained in separate databases. Application functionality is hidden behind simplified interfaces that render them essentially as black boxes.

System interoperability is thus constrained, with undesirable consequences for stakeholders across the enterprise without ready access to the data and information they need for operational performance. The information technology staff is unable to customize functionality at the interface level, precluding a viable revenue source for the organization. End users requiring a comprehensive information view of the patient/customer for capture or update are required to consolidate the information across several applications; these are accessed simultaneously or in sequence, with compromised efficiency.

Without IT architecture to make appropriately integrated information available, these conditions risk the hospital's ability to deliver high-quality service in a competitive timeframe. The bottom line is that health insurance companies approve payments based on improvement of financial and clinical performance metrics directly correlated to systems integration (Hatch and Lock 2008).

Baseline. The systems integration issue focuses on the particular application and data architectures involved in setting up the necessary physical connectivity and logical interoperability between the hospital's large-vendor operational systems for patient care (i.e., *eRecord*) and financial management (i.e., *FlowCast*). This issue is intrinsic to the development of knowledge-sharing capabilities. The two issues' baseline architectures are therefore the same.

Target. The goal is IT architecture that makes appropriately integrated information available to work with vendor-provided black box functionality. Primary applications driving this functionality fall into the high-level categories of metadata management and EII capability.

Gap Analysis. Building on the ESB messaging backbone already in place in the hospital's IT architecture (see *Appendix E*), The EIARA Connective and Interoperability Services Component incorporates Enterprise Application Integration (EAI) as a middleware model. Systems are allowed to communicate through separated application and integration logic organized around business data and process. Standardized interfaces are used, providing near real-time response. Through services contained in this component, operational systems are given access to analytical applications (see *Knowledge-Sharing,* pg. 7) as well as metadata management critical to integration. For example, in patients' online EMR charts, physicians are able to access a trends view of key diagnostic and treatment indicators across the patient's entire medical history (Godinez et al. 2010, Wikipedia 2011b).

According to institutional and stakeholder information requirements, successful integration mandates versatile solutions. Data to be consumed must remain in place (i.e., large-vendor separate databases and well-established access systems) with enabled source updating. Views to aggregated/integrated

information must be provided in near real-time to preserve optimal data currency. For example, financial case management submits Medicaid applications for inpatients as a service. Follow-up to the application process requires *FlowCast* access to patients' financial information, along with diagnostic information from *eRecord*, both ideally available in near real-time (Godinez et al. 2010).

On the operational level, the EIARA Data Integration and Aggregation Runtime Pattern describes the versatility needed to transparently manage the huge volume and diversity of data residing across the hospital's two major LOBs when brought together in the data warehouse. Extracts from the individual data sources are aggregated and normalized using integration logic, with results appearing as one unified virtual data source. The powerful underlying foundations of this pattern's processes of active integration are examined next: EII data preparation and metadata management (Godinez et al. 2010).

EII has been described in terms of its beneficial relationship to Analytical Applications (see *Knowledge-Sharing,* pg. 7). The EIARA component's functionality has broad relevance to operational data integration as well.

Metadata plays a significant role in EII, beginning in the initial discovery stage in which the individual databases are analyzed for relationships and checked for integrity and accuracy. Business metadata communicate business rules, models, procedures, and performance management while providing contextual information (e.g., medical terminology used); technical metadata indicate data location and access details. Both are stored in a centralized metadata repository serving as an essential resource throughout the integration process (Godinez et al. 2010).

EII Profile Capabilities map data relationships across systems and integrate metadata with other processes into the metadata repository. Cleanse Capabilities quantify data quality in business terms. Requirements are standardized for individual data elements, with performance reporting to metadata for analysis. Finally, Transformation Capabilities manage aggregations with conversion of reference data to assure consistency across systems (Godinez et al. 2010).

Behind the scenes, the Metadata Management Component enables exchange and communication between systems using diverse data formats such as *eRecord* and *FlowCast*. Metadata facilitate collaboration between the systems' roles and tasks by actively documenting their relational and transactional backgrounds. End-to-End Metadata Management serves process optimization across the hospital enterprise by promoting standardization. Through its diverse palette of services, and to the extent that the hospital uses it wisely and creatively, metadata serve the function of an effective librarian for the enterprise. The purposes of integration are furthered by initiating and maintaining a complex network of metadata relationships (Godinez et al. 2010).

EA framework. Phase C encourages an abundance of views, viewpoints, and other artifacts to inform the design and understanding of IT systems architecture as related to business process. Modeling tools have the potential to go further, producing a rich associative metadata context as code-behind to applications and data structures (Axelrod 2011, Band 2011).

STANDARDS COMPLIANCE

Business case. The enterprise mandates compliance with Diagnosis-Related Group (DRG), an industry-wide standard that ranks hospitals using data related to diagnoses, procedures, and demographics with controls for complications or comorbidities (Wikipedia 2011a). Results must be delivered in near real-

time because they track and update current patient status. Compliance involves a complex operational workflow processed inefficiently in stages across the two systems (i.e., *eRecord* and *FlowCast*). These proprietary systems must be adapted to provide the appropriate units of workflow, and there may be functionality gaps between them.

Many risks are introduced with this process. Security is implemented through each system, creating two points of entry where one would be ideal. Multiple data-processing locations create possibilities for redundancy, compliance standard anomalies, and inaccuracy.

The most consequential productivity impact concerns Medicare re-imbursement. The hospital is paid per DRG "product" (i.e., related to each patient's diagnostic category) administered – considered to have a positive correlation with use of hospital resources. Inaccuracy in the compliance process manipulating these DRG numbers creates enormous risk to the hospital's bottom line (Wikipedia 2011a).

IT architecture to support integrated data aggregation with centralized security is needed for a more effective approach to standards compliance.

Baseline. Lack of integrated baseline applications and data architectures causes segmented workflow process in respect to DRG compliance. This unfortunate consequence fails to meet the needs of stakeholders and the interests of the enterprise as a whole.

Target. Data architecture to support effective EII capabilities addresses data quality before optimized data warehouse storage. Users access DRG process through standardized interfaces featuring simple single-point-of entry enhanced security.

Gap analysis. Comprehensive ETL data cleanup, enhancement, restructuring and summarizing are built into compliance EII capabilities, processes that constitute the data architecture's most resource-intensive services. Data quality issues are addressed as part of the data warehouse integration process (see *Appendix C*) (Brooks 2009, Godinez et al. 2010).

Serving the principles of Dynamic Data Warehousing, transformation can occur anywhere within the medical center's IT architecture as long as its processes are managed and governed. The end result is a unified view delivered to the user that actually represents a complex pool of data resources and services (Lahanas 2010).

Client-side presentation is included within the scope of EIARA's Presentation Services component. Database middleware connects warehouse servers to end-user client workstations. Hub servers interpret metadata in order to access data across multiple database servers for optimized speed and currency (Brooks 2009, Godinez et al. 2010).

EA framework. DRG process integration engages major data management principles central to Phase C Data Architecture. A clear understanding of how the data is used to meet compliance standards influences plans for functional design of data warehouse layers to optimize storage, transport, and reporting. Incorporating the most aggressive security standards, the chosen data architecture is capable of handling the complex mix of data transformations required by applications implementing multiple compliance stages (Brooks 2009, Harrison 2009).

FRAMEWORK PROCESS

Business case. The vision and business architecture behind the new electronic records system are motivated by a strategic vision that establishes patient service as a priority. The medical center's commitment to standardized data and practices is central to its process, inspiring deployment of single-point-of-entry access to clinical information systems. Integration of as many stand-alone *clinical* systems as possible is prioritized as part of the *eRecord* EA effort (University of Rochester 2008).

In the process, the University's Information Technology Strategic Plan has deemed the "back-office" applications, including patient accounting's *FlowCast*, to be supported well enough without further integration with other systems (2008). In the five years since the Plan was released, however, stakeholder requirements have thrown this evaluation into question.

Real-time data views integrating patients' clinical and financial information (e.g., related to financial counseling, case management, or social work) are required in the course of common hospital operations, and ad hoc mitigations initiated by end users or developers are time-consuming and costly. The need for intermediary processes violates the nonfunctional system requirements of interoperability, usability, maintainability, availability, security, and reusability. Without a structured enterprise architectural process to address this critical area of dysfunction, stakeholders' unmet needs for integrated information perpetuate the current misalignment of business process with IT architecture.

Baseline. In spite of the short period that has elapsed since the introduction of electronic medical records in March, there is strong evidence supporting the need for integration of *eRecord* patient information with existing *FlowCast* financial management functionality. Currently, no formalized EA is in process.

Target. In order to fully support and automate the hospital's core capability of interoperable integration, the enterprise architecture initiative demonstrates value by making the two existing platforms' delivery cheaper, faster, and more likely to succeed. Communication and understanding between stakeholders are facilitated, avoiding duplication of effort (Ross et al. 2006, Godinez et al. 2010, Tamm et al. 2011).

An enterprise-wide integration EA initiative moves the hospital's existing Information Architecture (IA) toward a more fully actualized EIARA model. In the process, business context is applied to a common language and solution-design foundation with support for metadata-enabled and analytical intelligence opportunities (Godinez et al. 2010).

Gap Analysis. At the highest level, enterprise maturity models are studied and the hospital's goals assessed. Stakeholder consensus on the need for evolution from basic information interaction (i.e., EIA's Developing stage) to an information-enabled stage of business innovation (i.e., Optimizing) is negotiated and objectives clarified (Godinez et al. 2010).

Human factors analysis to identify knowledge, information, and data requirements comes next in the form of architectural visioning. Business scenario workshops are held, with questions asked and key performance indicators surveyed to determine the need for systems integration (e.g., "What percentage of production time do users spend looking for the information they need?" or "Which stakeholders – or systems – are most affected?") (Godinez et al. 2010, Harrison 2009, Smith 2008)

Phases to develop and align architectures (i.e., business, information systems, and technology) proceed with framework guidance from the ADM. Information technology architecture is designed within the

constructs of the EIARA to include (from high- to low-level): components – comprised of capabilities – mapped to conceptual operating models (Godinez et al. 2010, Open Group 2009).

SOLUTIONS

KEY STAKEHOLDER SUPPORT

Recommendations. Education of key administrative staff regarding enterprise needs for LOB integration is an essential first step to securing their support. Participation in business scenarios to define outcomes and actors, and ADM Preliminary Phase process agreement regarding scope, principles, and governance of the project, follow. The areas of concern are explored to the point of Phase A architectural vision and Phase B business process relationship definition (Harrison 2009).

Coherency Management (described in *Analysis of Major Architecture Issues*) establishes communication and collaboration with the wider stakeholder community. With a full range of input and feedback, the EA effort can proceed on a stronger footing, with senior management assuming the role of top-level communicators and consultants (Gryning et al. 2010).

Alternative considered. Thompson describes her Stakeholder Analysis and Planning technique used to solicit stakeholder consent. There is peripheral overlap with the ADM process as far as emphasis on stakeholder education, enterprise communication, and participation in framing goals, but the design is anecdotal in format with little formal structure. Although it entails a greater commitment of time and resources, the recommended combination of TOGAF and Coherency Management as an approach provides frameworks that provide a clear focus on relevant business process, principles, and the enterprise environment (Harrison 2009, Thompson 2011).

KNOWLEDGE-SHARING

Recommendations. To meet requirements for metadata-informed business intelligence with EII support as described in *Analysis of Major Architecture Issues*, *MediSolv* provides Analytical Applications OLAP support to integrate clinical and financial data. The Metadata Coalition (MDC) *Open Information Model* (an open-source metadata management repository) is recommended for metadata management. MDC is broadly based on UML, SQL, and XML and is technology-independent, designed to facilitate sharing and reuse in various database and data warehouse domains. *Speedminer* software extracts data from the hospital information system to incorporate tools such as KPIs and dashboards that are accessed by users via web browser (MediSolv Healthcare Business Intelligence 2010, Singh 2011, Subrahmanya et al. 2010).

Alternative considered. Microsoft Excel is widely used throughout the hospital by users creating ad hoc business intelligence spreadsheets for common operational decisions. Retaining these systems as alternatives to business intelligence is considered because of their current ubiquity; their uncontrolled shared quality, however, severely compromises data quality and consistency. In a heavily regulated industry such as healthcare, the overall risk involved is unacceptable (Quinn 2007).

SYSTEMS INTEGRATION

Recommendations. Service-based architecture provides the interconnection required to achieve enterprise interoperability through systems integration. TOGAF's Integrated Information Infrastructure

Reference Model (III-RM) serves as a high-level planning reference. The III-RM provides a taxonomy describing the necessary components to align data, applications, and technology related to integration (Harrison 2009).

Starting from the ESB messaging service connecting the whole of the hospital IT infrastructure, an enterprise data warehouse is connected simultaneously to financial databases and the EMR database suite. The warehouse communicates with Research EMR components as well. Business intelligence applications are accessed by the aggregated warehouse data through OLAP tools. For full component descriptions, see *Analysis of Major Architecture Issues* (University of Rochester 2008).

Alternative considered. Event Stream Processor (ESP) is a scalable, responsive alternative to data warehouse data aggregation using ETL. With a query language similar to SQL, ESP analyzes streams of events as changes occur in real time.

The large volume of data generated and consumed by the hospital enterprise makes scalability an attractive option. Real-time processing presents data currency advantages. Lack of ability to create historical views is the ESP solution's critical drawback, however. An expensive framework for capturing and retrieving data is necessary, which would not be feasible for the amount of data being processed in a hospital environment (Drobi 2008).

STANDARDS COMPLIANCE

Recommendations. EII provides comprehensive cleanup, enhancement, restructuring, and summarizing of ETL data (see *Analysis of Major Architecture Issues*). In frequent incremental extracts, dynamic centralized data warehousing applications combine financial and clinical data from the two databases (as well as other hospital sources). The aggregated data serve as source material for reporting, business intelligence, or analysis.

If large queries or complex operations are run against the data, a shadow server is used to avoid placing excessive load on the data warehouse (DW).

To extend functionality, commercial-off-the-shelf (COTS) products are available that create tailored ETL programs. Custom applications providing integrative capability between the two systems (and filling gaps in functionality of either one) are also developed in-house. As the architecture matures, vendor updates to the primary systems might be developed to replace these agile ad hoc solutions (Brooks 2009).

Alternatives considered. A unified interface presented to the user that sits on top of heterogeneous systems would be ideal. A single security implementation might be presented. This solution isn't feasible, however, as the primary systems are vendor-owned, and interfaces on top of their products are not supported.

After the centralized DW functionality is well established, an option is being considered that might improve system extensibility in the future. The DW might be upgraded from a single data-storage facility to a two-tiered capability: a central DW extending to multiple decentralized data marts. Similar to the central DW, each satellite takes care of its own data aggregation and integrative capabilities for its location to provide "one-stop-shopping" (Brooks 2009).

Recommendations. The particular requirements of operational systems integration mandate a dedicated architectural initiative. TOGAF's ADM, with support from its Enterprise Continuum, provides a comprehensive framework with structured methodology. Business process is aligned with IT, while stakeholder participation is actively engaged.

Information systems and technological capabilities to be included in the new architecture are chosen with reference to TOGAF's III-RM Common Systems Architecture. The III-RM helps facilitate alignment with the requirements of the medical center's primary communication venue, its intranet web portal.

Alternative considered. The Zachman Framework provides a rudimentary architecture framework as well as a taxonomy for artifacts (similar to the TOGAF Technical Reference Model). These features serve as a strong foundation for EA in that they reference business process and requirements. TOGAF and the ADM provide more in the way of a method-ology to collect, analyze, and manage information in a prescriptive context useful to multiple domains and viewpoints (Wikipedia 2011d).

ROADMAP

TWO-YEAR PLAN

(Each phase four months)

Phase 1

- Conduct business scenarios for key stakeholders
- Develop ADM Phase A vision
- Obtain high-level management approval for project
- Complete Phase B

Phase 2

- Conduct Coherency Management project
- Complete ADM Phase C-E

Phase 3

- Negotiate ADM Phase G Governance
- Complete Coherency Management project
- Senior management begins ongoing communication/consultation role
- Negotiate contracts with BI software providers
- Develop DW application
- Develop standards compliance application
- Buy COTS standards compliance (optional)
- Develop EII, OLAP capability
- Develop Business metadata
- Plan metadata management processes

- Plan III-RM Network Services
- Consult with security (regarding integration)

Phase 4

- Plan ADM Phase F Migration
- Begin population of TOGAF Enterprise Repositories
- Continue standards compliance application development
- Develop technical metadata

Phase 5

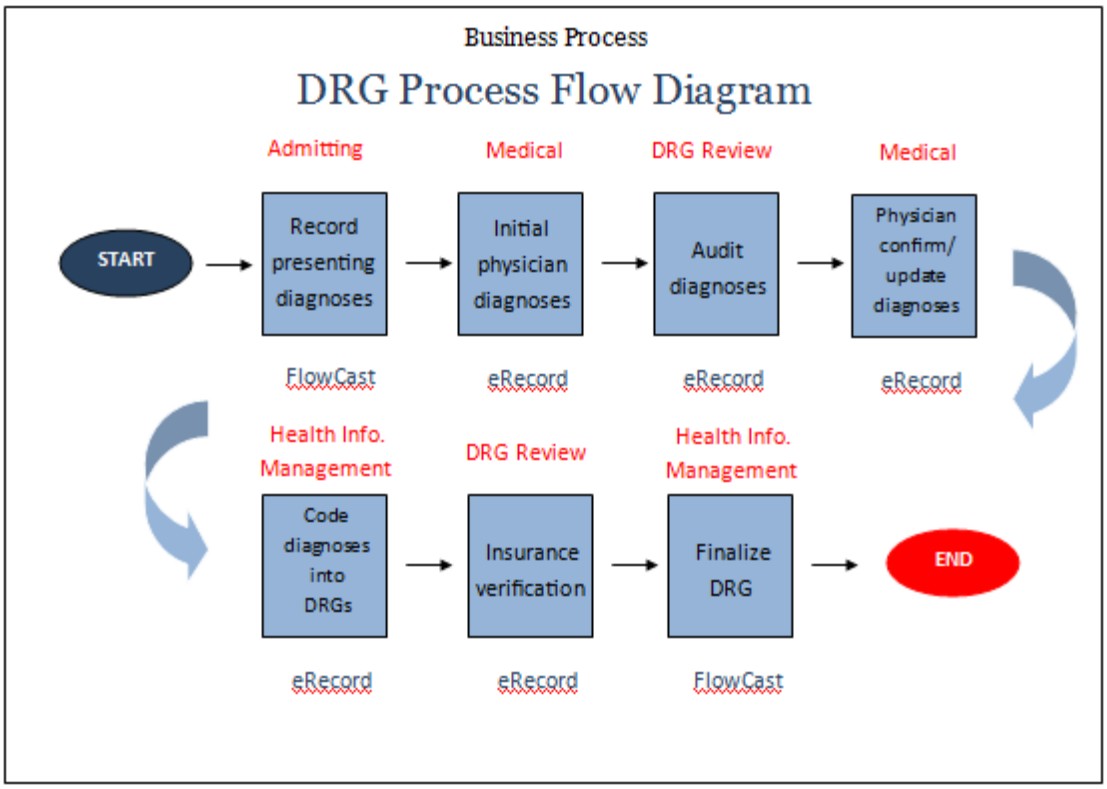
- Continue population of TOGAF Enterprise Repositories
- Test application/network/hardware
- Develop metadata management
- Design user interface applications (integration-related)

Phase 6

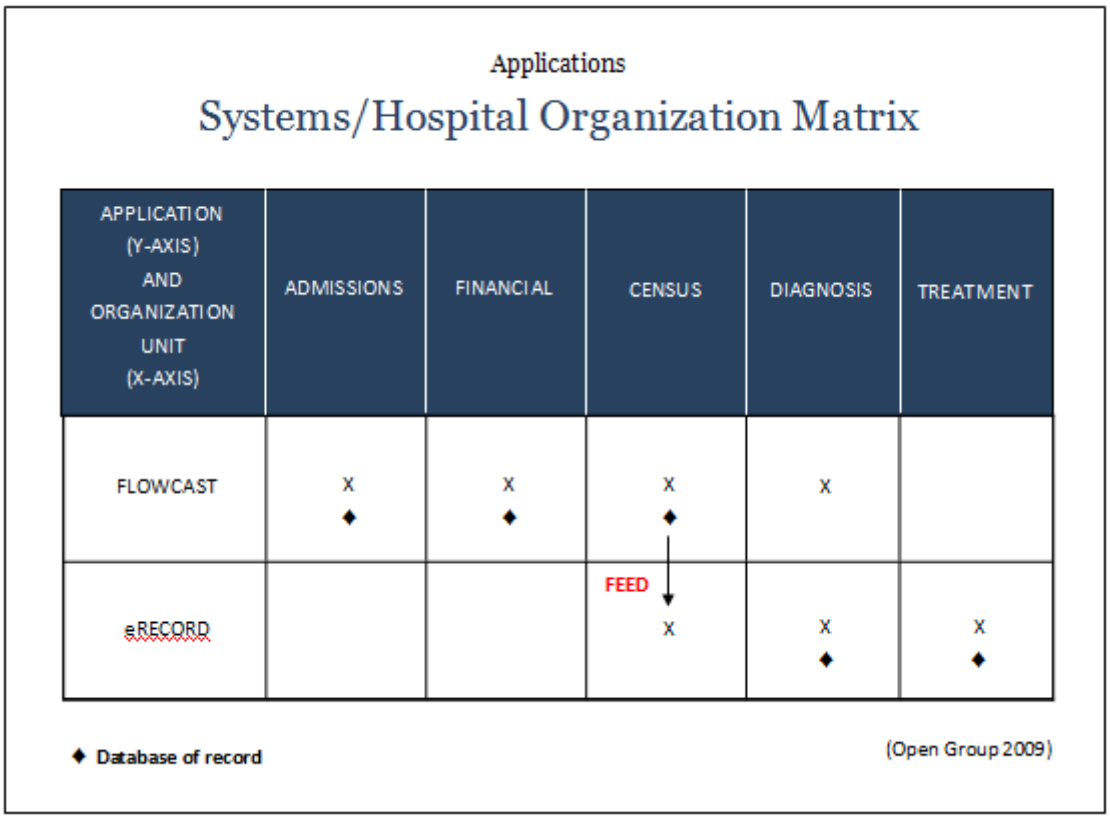
- Implement ADM Phase F Migration Plan (data transfer)
- Implement ADM Phase H Change Management
- Continue population of TOGAF Enterprise Repositories
- Complete application/network/hardware testing
- Re-evaluate two-tier DW upgrade plan

APPENDICES

APPENDIX A



(Open Group 2009)



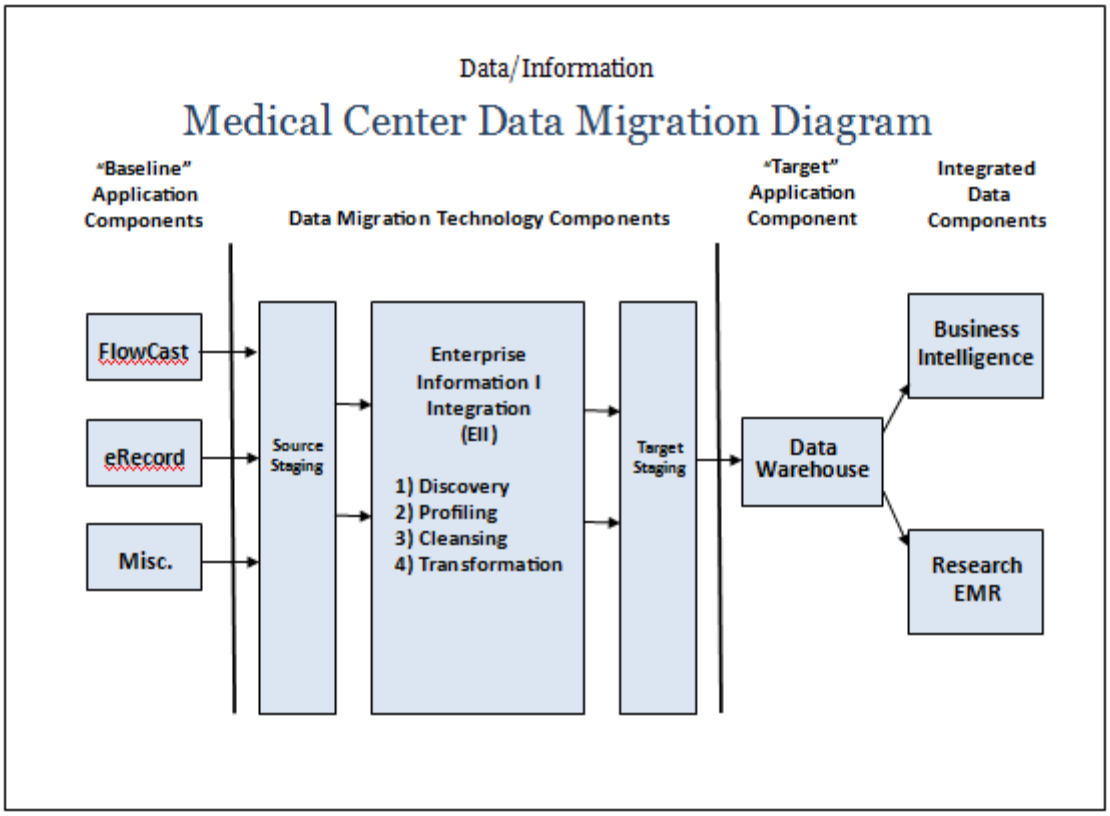
Applications

Systems/Hospital Organization Matrix

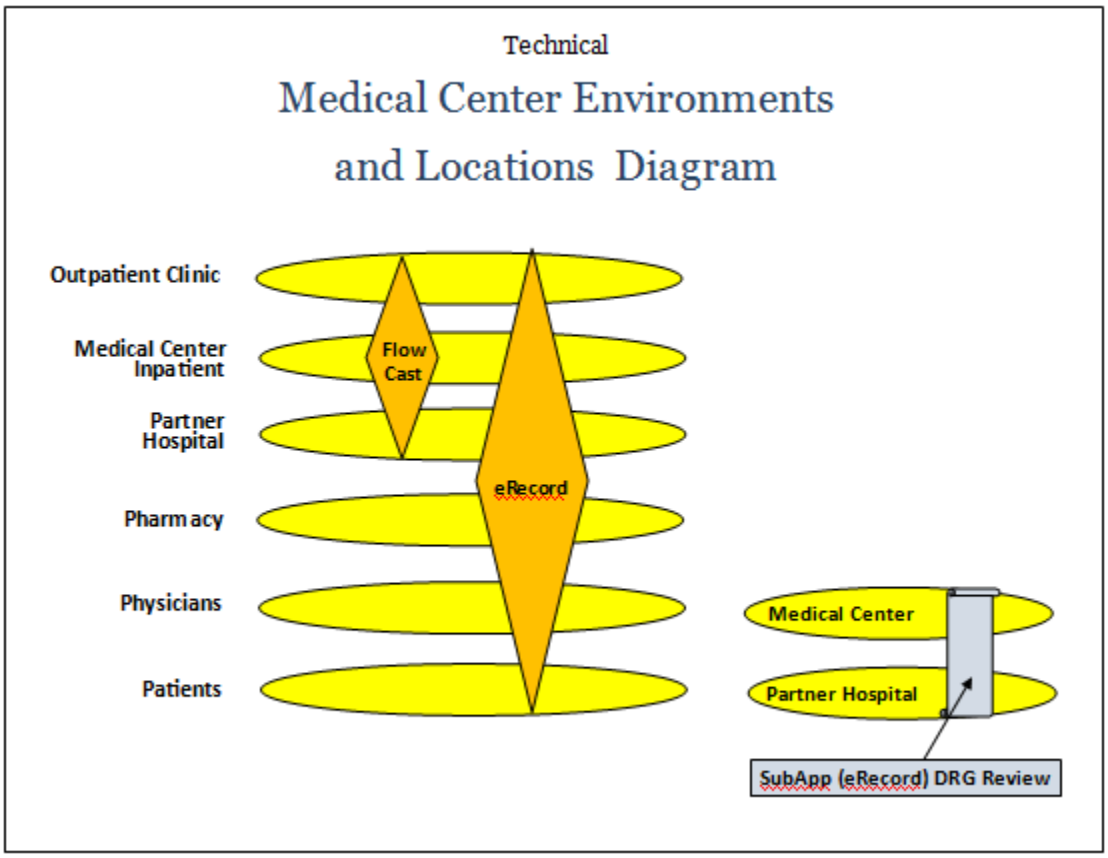
APPLICATION (Y-AXIS) AND ORGANIZATION UNIT (X-AXIS)	ADMISSIONS	FINANCIAL	CENSUS	DIAGNOSIS	TREATMENT
FLOWCAST	X ♦	X ♦	X ♦	X	
eRECORD			FEED ↓ X	X ♦	X ♦

♦ Database of record

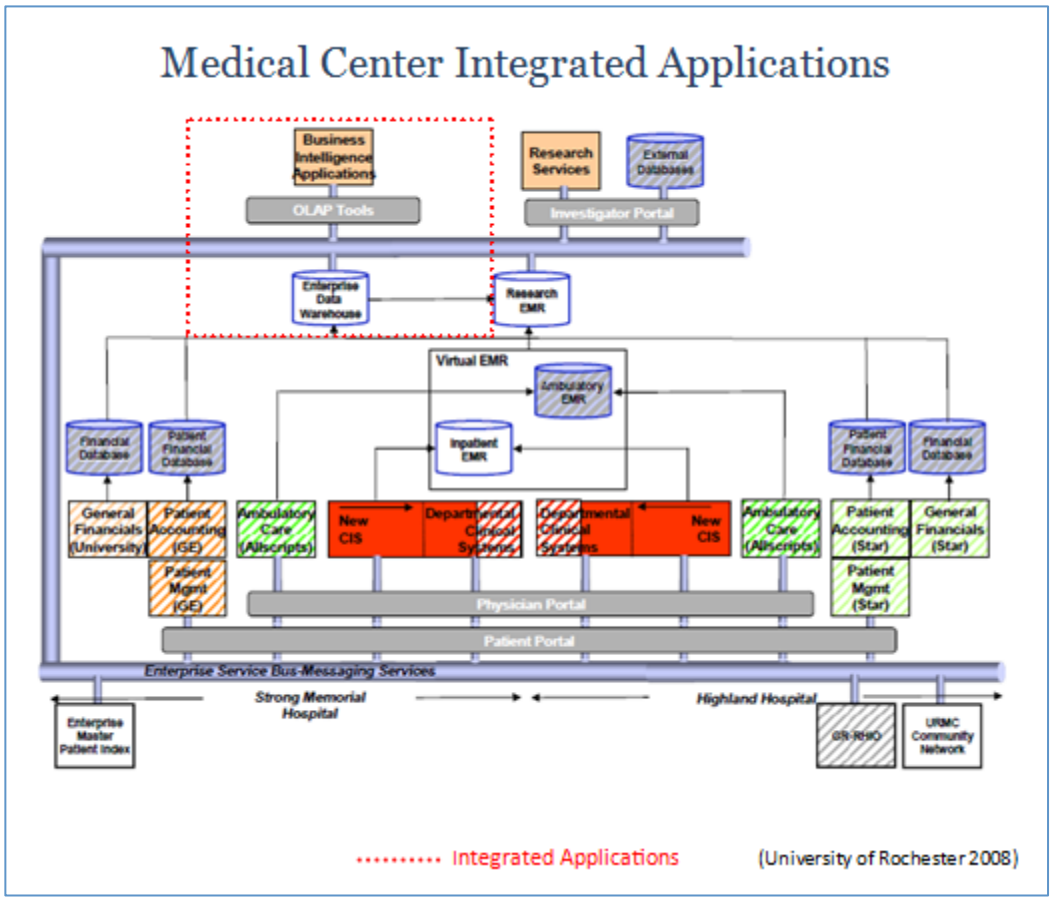
(Open Group 2009)



(Open Group 2009)



(Open Group 2009)


Medical Center Integrated Applications
Business Intelligence Applications
OLAP Tools
Research Services
External Databases
Investigator Portal
Enterprise Data Warehouse
Research EMR
Virtual EMR
Ambulatory EMR
Inpatient EMR
Financial Database
Patient Financial Database
General Financials (University)
Patient Accounting (GE)
Patient Mgmt (GE)
Ambulatory Care (Allscripts)
New CIS
Departmental Clinical Systems
Physician Portal
Patient Portal
Enterprise Service Bus-Messaging Services
Strong Memorial Hospital
Highland Hospital
Enterprise Master Patient Index
GS-RHIO
URMC Community Network
Patient Accounting (Star)
General Financials (Star)
Patient Mgmt (Star)
Integrated Applications
(University of Rochester 2008)

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AUTHOR'S BIO

Elizabeth Peacock is currently working as a programmer/analyst with Frontier Communications in Rochester, NY. She designs and implements intranet applications for corporate systems. She enjoys making the user experience as multi-faceted and enriching as it is functional.

Earning a graduate degree in Web Design/Software Development, Elizabeth attended one of Dr. Else's Enterprise Architecture courses as part of her graduate coursework. The knowledge gained has informed her understanding of the ways a large corporation works, allowing for a more involved participation and creative perspective.

ROB BURNES: PROPOSAL FOR IMPLEMENTING AN ENTERPRISE GEOGRAPHIC INFORMATION SYSTEM FOR PUBLIC WORKS AND UTILITIES INFRASTRUCTURE DATA TO BE UTILIZED BY MULTIPLE ORGANIZATIONS.

EXECUTIVE SUMMARY

The economic climate of recent years has been especially harsh on local governments. Revenues have shrunk drastically and there have been a variety of ways to try to balance the budgets. Large-scale layoffs, re-organizations, and efficiency programs have been undertaken to try to "right-size" government for the current climate.

With the emphasis on increasing efficiencies and decreasing costs new partnerships need to be explored. I am proposing that County establish and implement an Enterprise GIS (EGIS) that will incorporate public works and utilities infrastructure data (e.g. pipes, roads, bridges, etc.) from all local municipalities and provide standardized systems and processes. An EGIS of this nature would connect and unify spatial information among the local and county government organizations that would provide an interconnection that does not currently exist. The overall goal of implementing this system is to have an interconnected public works and utilities infrastructure data network. The benefits should be observed in planning, emergency response, customer service, and regulatory coordination, just to name a few.

The main issues preventing the organizations from operating in an optimal way are the current cultural climate, siloed data, lack of process and platform standardization, and lack of governances and controls. Each problem discussed is done so individually, but the overall recommendation for the proposed system is to undertake an enterprise architecture initiative to address the issues and provide a framework for future expansion of objectives.

BACKGROUND

The Pinellas County government is a county level government in the state of Florida. This organization serves nearly one million residents/customers and operates on an annual budget of approximately 1.5 billion dollars. The goal of this organization is to provide a host of services including but not limited to emergency response, public works (e.g. water, roads, and bridges), permitting, and law enforcement. There are 24 municipalities within the borders of the county and they operate in much the same manner as the county organization. As with most government organizations in recent years, these organizations have seen shrinking revenues (property taxes, tourism based taxes) that required large-scale reorganization and reductions in personnel and service levels. Now that the organizations have stabilized the focus is on how to optimize services at current expenditure and staffing levels.

A vast majority of the organizations currently operate in a diversification-operating model as both integration and standardization are low. A generalized core diagram of the organizations encompassed in this project can be found in the Appendix section of this paper. Within each organization all units deal with the same customer base each unit is so diversified there is little cross commonality. Across the

organizations individual units operate autonomously and processes are controlled, except HR and financial, at the unit level. This model works best for the organization on a whole as goals and critical needs vary across the organization.

While current work is underway to establish an EGIS within the county organization little attention has been paid to creating an EGIS that can be utilized by municipalities contained within the County. I am proposing that County establish and implement an EGIS that will incorporate public works and utilities infrastructure data (e.g. pipes, roads, bridges, etc.) from all local municipalities and provide standardized systems and processes. An EGIS of this nature would connect and unify spatial information among the local and county government organizations that would provide an interconnection that does not currently exist. The overall goal of implementing this system is to have an interconnected public works and utilities infrastructure data network. The benefits should be observed in planning, emergency response, customer service, and regulatory coordination, just to name a few.

The benefits for implementing a multi-organizational Enterprise Geographic System for public works and utilities infrastructure data are numerous and apparent. For our organization we would see a decrease in emergency response times, overall costs, and manpower hours. Furthermore, on a technological front little design is needed, as this system will build upon the EGIS system currently under development, and only minor additions to infrastructure and processes would need to be implemented.

IDENTIFICATION OF MAJOR ARCHITECTURAL ISSUES

- ***Change Culture-*** Little communication currently exists between units and each unit has evolved their operating procedures to that which meets their immediate unit needs.
- ***Siloed Data-*** Data is extremely fragmented and it is seldom available to units outside of the authoring unit. Much of the data is repetitive and sometimes contradictory.
- ***Lack of Uniform Processes and Platforms-*** Currently there are multiple processes and platforms that operated across all of the units. There is little uniformity of the processes and platforms that create issues related to usability and analysis of data.
- ***Lack of Governances and Controls-*** The current lack of rules and regulations provide for an atmosphere where there is little congruency and often the same data is housed in multiple formats.

ANALYSIS OF MAJOR ARCHITECTURAL ISSUES

Issue 1: Change Culture

BUSINESS CASE. It has been well established that with implementing a well-planned Enterprise Architecture many organizations see increases in overall business efficiency, increased strategic planning benefits, and increased customer satisfaction (Shang and Seddon 2002, 289-290). However, a system is only as good as those who utilize and manage it. So it is important when implementing an EA project to ensure that not only are the critical business needs met but the organization, or in this case organizations, must understand and enact a system that relies on working within the EA framework (Godinez et. al. 2010).

In recent years many local governments have seen a decrease in their revenue base that has necessitated these organizations to take measures to offset these loses. The main measures taken by the organizations in this proposal were employee reductions, re-organization, and evaluations of procedures and processes. This has caused a great upheaval within the organizations and has emphasized the need for continuity in procedures and processes, especially when it relates to utility infrastructure.

The current atmosphere of these organizations is highly fractured and has little documentation of their processes and procedures. Each unit, defined in this paper as departments of member organizations, currently operates under their own processes, systems, and goals. In order for the proposed EA system, as with any EA system, to work there must be a culture change throughout all of the affected units (Fui-Hoon Nah, Lee-Shang Lau, and Kuang 2001, 293). The new culture must include buy in from all employees to a single EA approach and system, well-defined strategic objectives, and defined controls and governances. Developing this new culture will lay the groundwork for fully implementing a successful EA and completing our objectives.

BASE ARCHITECTURE. Each organization and in many cases units (e.g. utilities, public works, environmental compliance) within a specific organization operate utilizing their own set of processes and software. To further complicate matters these groups operate with little to no coordination between other organizations. Currently these organizations form inter-organizational committees to address issues on a regional scale. However, these groups seldom work together outside of these committees and operate independently of one another.

Employees tend to operate with concerns on a unit level and have tendencies to act as if they have ownership of the data. To further confound issues many of them are long-term employees that have important information stored in their brains and resist entering the data into a database of any form. Both of these issues make it difficult for other employees within their organization and in others to gather the information they need in a timely manner. This atmosphere creates a culture that is extremely fragmented and one where the operational goals are not clear throughout the organization.

TARGET ARCHITECTURE. The target for the units is to have them all act in a cohesive and cooperative manner. One where individual units act as custodians of the data (e.g. house, edit, QA) but the data are now available through an EA that allows for anyone within the system to view. The employees would understand benefits of the strategic goals and better understand the importance of implementing a system of procedures and processes. The biggest asset will be to have buy-in from the leadership and management with that support then permeating throughout the units.

One of the greatest assets a system like this will provide is the ability for units to utilize data from other units to fulfill regulatory requirements and respond to emergency infrastructure repairs. This will require cooperation among units and employees will gain a greater understanding of what other units are doing. The benefits derived from utilizing this propose enterprise architecture for these two purposes should be immediate and this should encourage buy-in from employees.

In order for an enterprise architecture system implementation to be successful it is important essential to get all units to be on the same page. Collaboration is important in order to ensure that all information is being utilized and the overall system goals are achieved.

One of the biggest hurdles that exist is not technical in nature, as most of the infrastructure and processes will be developed in a previous phase, but rather it is getting buy in from all of the municipalities to make this work. However, the benefits to all parties involved should make this an easy sell, so to speak, to all potential partners. For large municipalities this would provide both efficiency and cost saving benefits, while smaller municipalities would benefit from coordination and technological advancements that may not be possible for them alone.

GAP ANALYSIS. The current culture in place in units is counterproductive to that of a successful enterprise architecture system. Nearly all units have created their own culture with little regard of how it affects other units within and outside of their organization. This type of climate can bring the best architectures down and the shift in culture needs to come from the top and work its way down.

Addressing the culture of the units that will encompass this project is of great importance because a misaligned culture can crash even the best of frameworks (Abdinnour-Helm, Lengnick-Hall, and Lengnick-Hall 2003, 263). Management needs to ensure that the need for cooperation and cohesiveness is emphasized at all levels of the involved units. A program that allows for shadowing of someone from another unit should be implemented between all of the units involved in the EGIS implementation. This type of program builds relationships across units and further instills the need for cohesive processes and procedures.

Issue 2: Siloed Data

BUSINESS CASE. Currently there is no way to get key data (e.g. spatial infrastructure, maintenance records, etc.) from different systems and locations. This lack of cohesion causes increases in response times to infrastructure emergencies, increases man-hours to meet regulatory requirements, and decreases cross-jurisdictional cooperation. All of this leads to straining of the already reduced resources and reductions in overall business efficiencies. For instance many times a person may live in the edge of one jurisdiction but have public works and utility infrastructure that is managed by another jurisdiction. This potentially causes both customer service and emergency response issues.

Many of the units collect the same master data and none of it is shared across units. This causes time wasting redundancies that affect both the customer and the employee. In the proposed system these people would only have to give their information once, thus saving time and making things run more efficiently. It is also safe to infer that this would improve customer satisfaction, which despite public opinion a primary goal of government customer service.

An Enterprise Architecture should increase efficiencies, create cohesions where previously absent, and align all of the units toward one goal (Shang and Seddon 2002, 289-290). In this case one of the biggest goals is to make the data available to all of the cooperating partners. The best operating model for this project is the Federated Metadata operation pattern. Since the data in my project comes from multiple organizations and they would want to maintain some form of ownership of the data on their own system, this operational pattern is ideal. The data can be retrieved by any entity when needed, but still managed locally by the owning entity. I believe utilizing this operating pattern is a smart strategy because it provides a solid foundation on how to handle the availability and performance of remote data retrieval.

BASE ARCHITECTURE. Each unit operates with autonomy and utilizes its own processes and procedures. To further complicate matters you are potentially housing infrastructure data from over two dozen

organizations that currently operate in separate systems. With the current system is sometimes tough to identify ownership of infrastructure, thus delaying repair. Further, customers sometimes get the run around as to whom they need to contact for maintenance and/or repair. The fractured nature of the data leads to many problems that affect all of the units in a variety of ways.

An example of how a system like this causes inefficiencies and the potential for redundancies recently occurred in a meeting I was participating. We were discussing data collection utilizing Light Detection and Ranging (LIDAR) and an employee in a small unit starts discussing their 3-year-old data. All other units were utilizing 6-year-old data. Even worse the unit that had the new data did not know how to utilize it and had done virtually nothing with it. Had proper procedures and processes been in place not only would all of the units that need this data for essential functions have access but the "owner" unit would have had the resources to leverage the data to its fullest.

TARGET ARCHITECTURE. Aslan and McLeod in 1999 outlined generalized methods of how to successfully integrate loosely linked remote systems of data. While complicated there are many methods by which to successfully implement a federated metadata operating system for data sharing. One of the biggest decisions in this operating pattern is how to integrate remote and local data; and one way to do so is to create a common platform for data exchange (Aslan and McLeod 1999, 120).

For the system proposed here it will be best to only utilize the needed portion of remote databases and utilize a system that utilizes platform "bridges" (Appendix-Business Use Diagram). The key is to make sure that all data is available for any employee in the system no matter their unit. Each unit will continue to utilize and manage their own data but now they will have the ability to see the full extent of their infrastructure and its connectivity to infrastructure in other jurisdictions.

GAP ANALYSIS. The gap in this case consists of un-connected data and systems that are isolated between units. Currently there are no systems in place allow for data sharing and coordination. In order for the organizations to succeed in implementing and operating the enterprise architecture system they must determine the best ways to unify the data and make it available to all units.

Issue 3: Lack of Uniform Processes and Platforms

BUSINESS CASE. For the most part, each unit operates with unique processes and in some cases unique platforms. None of the infrastructure data is connected to an Enterprise database and thus it is not available to all parties in a timely manner. The benefits are numerous for integrating processes and platforms, they include reduction in IT costs, reducing potential system downtime, and increase in overall business efficiencies (Ross 2003, 7).

The largest benefits from developing and implementing a system of this nature would be the increased efficiency during emergency responses to infrastructure issues (utility, roads, etc.). Through data and process integration personnel will be able to utilize extremely accurate models to make the most informed decision. For example, since both potable and storm water systems are interconnected throughout the County and Municipalities it is important to have a model that shows complete connectivity. If a water main break occurs having the this view will allow decision makers to best re-route or restrict flow so as to affect the least amount of customers. Also, rapidly identifying responsibility for the asset will reduce lag time in terms of repair. All of these factors increase customer satisfaction while simultaneously saving time and money for the organizations. This is a great example of where the role of technology makes the local government organizations more efficient and effective.

Joan Miller discusses how she views this as an important role for technology in public sector organizations (Yourdon 2011, Ch 14:9).

In order for an Enterprise Architecture to be successful it is imperative that they have a standardized set of processes and platforms (Hjort-Madsen 2006, 3). Even in a system were the data will be stored in remote locations it is important that the processes and platforms be as standardized as possible to ensure ease of data transfer and analysis. By doing this IT costs should be reduced, data operations should be streamlined, and overall work efficiencies are increased.

BASE ARCHITECTURE. Currently each unit operates under its own processes and platforms. These processes and platforms do not currently interact with other units in the system. This issue is very similar to the issue of siloed data in Issue #2 in that each unit works autonomously and there is little to no cooperation across units. One unit does not know the functions of another and this leads to further issues of redundancy and segregation.

There are several cases where multiple platforms are being used within the same unit. Pinellas County for instance utilizes two platforms for infrastructure asset management. This creates several issues including high IT costs, redundancies, and increased risk for error. The biggest issues that concerns this group is the possibility of data being lost or service requests being ignored.

The way the current system is set-up much time is wasted maintaining and utilizing multiple platforms and processes that are independent of units. This issue seems to relate to issues 1 and 2 in that the isolation created by multiple processes and platforms drives the culture and siloed data problems.

TARGET ARCHITECTURE. Each unit needs to evaluate their processes and platforms and work with all the other units to see where standardizations could occur. Many of the units should be able to simplify these elements and find enough commonalities that the implementation of standards should be relatively easy. The processes should mainly be able to be standardized because nearly all of the units have the same operational elements and requirements.

Even though the units in this system would be from multiple organizations there are several factors favorable to standardizing processes and platforms. Each unit has similar goals, regulations, and requirements. This should lead to easy buy-in and implementation of standardizations. Further, the spatial technology platform, ESRI, should be easily standardized as it is the industry leader in providing these services and all units should easily see the benefits.

GAP ANALYSIS. First and foremost, the units must identify all processes and platforms and then analyze what elements are essential. They should also analyze what processes and platform can interact and thus have existing relationships that may aid in implementation. Overall, it is not what is missing from the units but rather what "noise" can be removed from the system without creating issues related to operation. The better each unit can simplify and standardize processes and platforms the better the whole system will operate.

Issue 4: Lack of Governances and Controls.

BUSINESS CASE. As this is such a complex system incorporating multiple organizations and remote data it is imperative that there are strong governances to ensure that everything is conducted properly. In order for a system of complexity to succeed it must have well defined rules that give direction to

procedures and follow the strategic goals of the units. The focus should be on ensuring that overall goals and strategies of the system are being followed rather than trying to set up and intricate system of rules and regulations.

The employees must ensure that they utilizing the proper rules and procedures. There must be internal control measures in place to ensure that workflows are staying in line with system objectives (Nasser 2013, 35). These rules and regulations will not only ensure that current data and processes fall in line but there is a framework for the future.

BASE ARCHITECTURE. Currently there are no controls or governances that outline uniform objectives and/or goals. Each unit acts in its own self-interests without much concern for the whole. This causes many issues, not the least of which is a reduction in business efficiencies. An example of this is what type of data one unit collects versus another. The units need to collect the same data and in the same format as everyone else or you may have issues when conducting analysis. That is where having set governances that outline data requirements come into play, if the units have to follow the same format then they will not encounter issues of this nature.

TARGET ARCHITECTURE. The target architecture would be one that incorporates controls and governances that will help to ensure that the organizations goals and objectives are being maintained. The rules and regulations should be well defined and all employees should be well versed in them. The employees would then be responsible for following these rules and ensuring correctness of the data.

From a permitting and regulatory requirements viewpoint, implementing controls and governances will reduce time and costs related to managing and tracking. Under current conditions it may take several months and numerous people to acquire all of the necessary data needed to complete a regulatory report. By implementing the proposed system the process could be streamlined to several hours, if not minutes.

GAP ANALYSIS. The current structures of the units in their current form do not have any rules or guidelines by which to operate. Their efforts currently focus on their immediate unit needs with little thought towards the larger organizational picture. The future guidelines to be put in place should ensure that employees are always working toward the system goals and objectives.

RECOMMENDED SOLUTIONS

Issue 1: Change Culture

RECOMMENDED SOLUTION. While it is tough to implement a cultural change within an organization, it is imperative to the success of the architecture to do so. The key to successful implementation of change is to be patient and take baby steps. Organizational change does not occur overnight; it usually takes time and much support from the top down. In Enterprise Architecture as Strategy: Creating A Foundation for Business Execution the authors discuss how important getting the entire organization to work as a cohesive unit is to the success of an Enterprise Architecture (Ross, Weill, and Robertson 2006).

Many of the organizations that would be included in this system have already undergone organizational change in recent years. This may help to kick start the culture change process as not all units have a strong history to lean on. One specific way to help foster better understanding of other units' daily duties is to conduct periodic cross training or shadowing. Pinellas County has started to implement

"jetting" which is where employees from one unit spend a day or two shadowing an employee from another unit. This programs has shown several benefits, like furthering understanding, standardizing of processes, and better overall cohesion.

ALTERNATIVES. Culture changes within an organization are difficult to implement and cannot be forced. The most important thing to start the process is to make sure upper level management fall in line and support the initiative. If this does not occur then an alternative method is to hire new employees to fulfill those roles. This could also trickle down to all employee levels during the change process. While this may provide an immediate change in culture from the new employees, there are several negatives including training costs and lowered morale.

Issue 2: Siloed Data

RECOMMENDED SOLUTION. The solution I recommend for the problem of siloed data is to implement a federated metadata-operating pattern. This will help to make all of the needed data available for all units while addressing data ownership needs. A system of this nature will help to fill all of the data gaps by showing all of it in one platform. One of the biggest selling points for all the organizations is that the data will still reside within their infrastructure. They will have administrator privileges to be able to manipulate and QA the data. While at the same time they will have access to previously unavailable data that will enable to better understand the workings of their systems.

There are several key areas where implementing a system such as this would be beneficial to all of the units within the system. First and foremost, there would be a decrease in response time during an infrastructure emergency. Another benefit would be to aid in large scale planning in that maintenance and repair could be coordinated by multiple organizations. In broad terms this merging of information would reduce both cost and man hours required to track permitting and regulatory requirements.

ALTERNATIVES. Another route the units could take to address this issue is to implement a Master Data Management system. This would centralize the data into a single managed system. This would aid in reducing redundancies and provide a complete model for everyone to work off of. This would also help to reinforce the cohesion and cooperation among the units as the data will be centralized and standardized.

However, there are some negatives to this type of system. As there are multiple organizations in this project the need for maintaining one's own data in the sense of steward and editor is of great importance. This type of system would probably be very unpopular as it would seem that one entity would own and control all of the data, even data that is not necessarily their own. Another issue is that editing lag times would be increased as there may be several levels in order to update data.

Issue 3: Lack of Uniform Processes and Platforms

*RECOMMENDED SOLUTION***.** Most units currently work utilizing their own processes and platforms. This will need to be addressed to help ensure a successful enterprise system. Each unit will need to analyze their current processes and platforms and then a group of stakeholders will need to review the analysis to determine where redundancies occur, processes can be simplified and standardized, and which platforms will work best across all organizations. Putting a system in place where there are standardized processes and formats will be beneficial to the units in that it will reduce research time, increase cooperation and sharing, and increase overall efficiencies.

An added bonus that may help this project is that ongoing project that Pinellas County is undertaking to create an organizational wide EGIS system. Incorporating this project as a phase of the larger EGIS effort would provide a several benefits. This would allow the project to set up a structure for setting a strong foundation and build a consensus on how to standardize processes. This timeframe would allow for the maturation of the enterprise architecture in a step-by-step manner that would not disrupt everyday services and ensure that all stakeholder needs are addressed. It is important for success of the enterprise architecture maturation to make sure all steps are addressed and none are skipped (Ross, Weill, and Robertson 2006).

Regulatory requirements may provide a mechanism for standardization of processes and platforms. This is due to the fact that all of the organizations have the same reporting requirements. By determining the best practice methods for processes and platforms it should be easy to convince the other stakeholders to buy into the standardization.

ALTERNATIVES. There is really no other alternative than to standardize and simplify the processes and platforms, if you are going to implement and enterprise system. They could choose to ignore the issues and go about business as usual but the current structure does not provide a good foundation for which to build an enterprise system. The system would be to bogged down by all of the individual processes and possibly incompatible platforms.

Issue 4: Lack of Governances and Controls.

RECOMMENDED SOLUTION. To address this issue it will be necessary for a system of internal governances and control measures to be implemented. This will be somewhat complicated by the scale of the project, but can be mitigated through thorough planning. The goal of this should be to provide guidance and structures that will aid in leveraging the system to its fullest while not bogging down day-to-day operations.

This system could be implemented as an additional phase of the ongoing EGIS system currently under development and many of the rules and regulations could be utilized in this system. The County will maintain the infrastructure (e.g. servers, support) and manage both the enterprise license agreement with the software developer and inter-local agreements with the participating municipalities. This type of arrangement is not unique between the county organization and the municipalities within its borders. There are several current examples where inter-local cooperation is being utilized to coordinate programs and processes.

The biggest needs would be to make sure that all of the units, across all organizations, core business needs are addressed when developing and utilizing internal controls and governances. Remote-connectivity and security are big issues that will need to have much governance and control. Furthermore, implementing a type of system as proposed would fit into the organizations operating model as we are just trying to standardize and integrate needed processes at the unit level while not changing the any larger methodologies that would affect the entire organization.

Once the internal controls and governances have been implemented this should allow the units to move forward with implementing the goals of the enterprise system. Having rules and controls is an essential element to implementing a successful enterprise (Nasser 2013, 43). Another benefit is that integrating new data organizations in the future will be much easier with set regulations and controls in place.

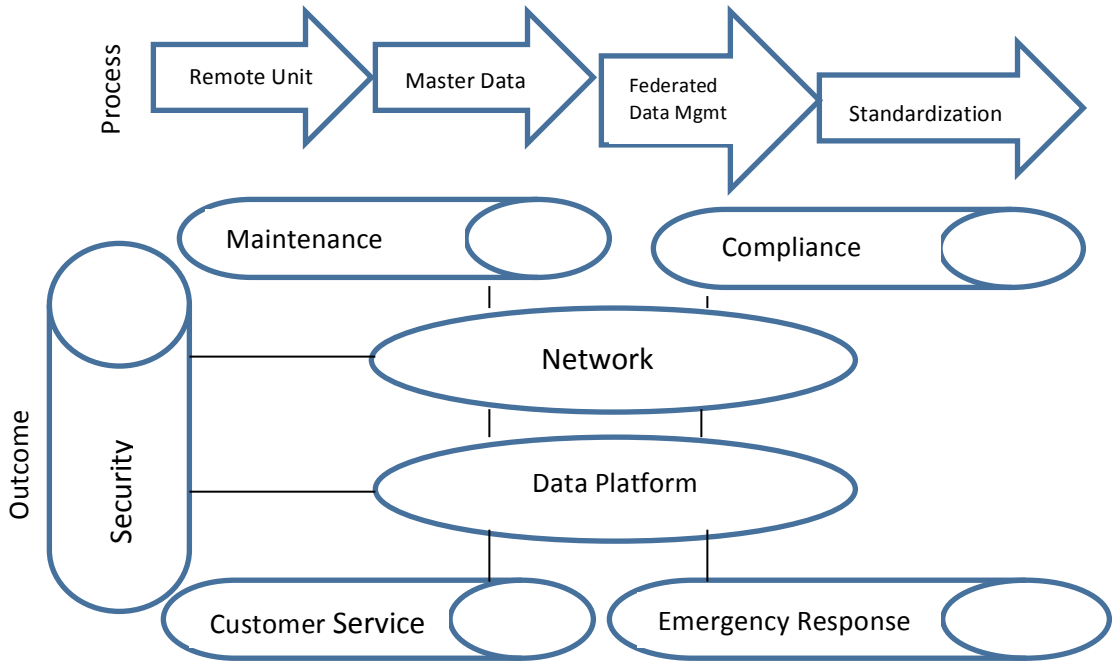
ALTERNATIVES. There are few other options for implementing governances and controls. One way to do this would be to do manual controls and governances. As there are multiple organizations involved this system a committee to oversee this would be a viable option. The drawbacks are that this would be a very time consuming strategy and there would be few checks in place to ensure no data falls through the cracks. This method would drain valuable resources for both day-to-day operations and for maintaining and maturing the enterprise system.

ROADMAP

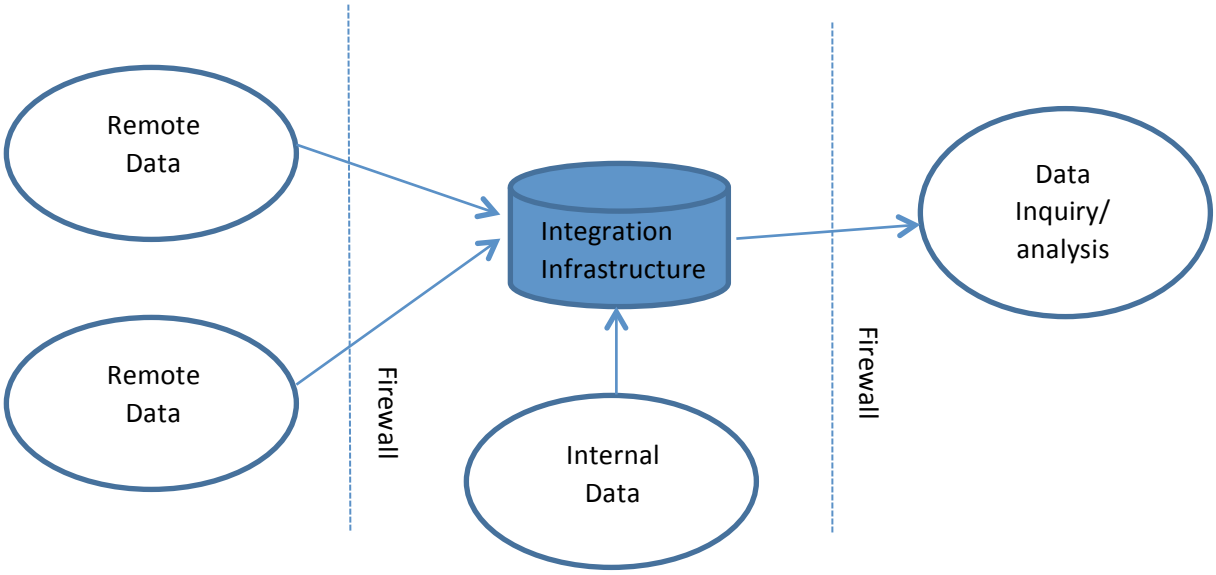
Phase	Overview of Phase Objectives
Phase 1: TOGAF ADM Preliminary Phase and Phase A Timeframe: Ten Months	1) Kick-off meeting with all stakeholders to create and outline the EA objectives, scope, and obtain commitments from all stakeholders. 2) Review current organizational structures, frameworks and architectural tools. 3) Define and establish the organizational model and operating pattern. 4) Address the need for culture change and develop recommendations for change. 5) Determine governance and control structure 6) Create formal outline that defines EA project.
Phase 2: TOGAF ADM Phase B Timeframe: Five Months	1) Develop base architecture, target architecture, and identify gaps that exist between the two for all of the organizations involved in the system. 2) Develop and agree upon core strategic objectives 3) Define the business architecture, and all of the necessary environments (e.g. processes, strategies, organization, etc.) 4) Continue the organizational cultural changes started in Phase 1.
Phase 3: TOGAF ADM Phases C and D Timeframe: Six Months	1) Determine the location of all the data that will be utilized in the system. 2) Determine the software used and if any relationships between them occur. 3) Develop a roadmap by analyzing architecture gaps. 4) Make decisions on which software and hardware to utilize in the proposed architecture. 5) Integrate governance structure and internal controls into the proposed architecture. 6) Continue cultural change initiative from Phase 1.

Phase 4: TOGAF ADM Phases E and F Timeframe: Eight Months	1) Build implementation roadmap based on gap analyses. 2) Decide on approach for each component of the project. 3) Assess project priority hierarchy and determine if any dependencies between projects occur. 4) Take one project at a time approach. 5) Finalize Architectural Roadmap 6) Perform needed analysis (cost/benefit, risk, etc.) on each proposed project. 7) Continue organizational change initiative in Phase 1.
Phase 5: TOGAF ADM Phase G Timeframe: Four Months	1) Make sure that governance and internal controls are being implemented across units. 2) Ensure all employees are aligned behind common vision and goals. 3) Ensure all day-to-day business activities are being managed to avoid disruption of services. 4) Ensure conformity of all units to the target architecture.
Phase 4: TOGAF ADM Phase H Timeframe: Twelve Months	1) Assess performance of architecture and make recommendations for the future of the system. 2) Continue monitoring system performance.

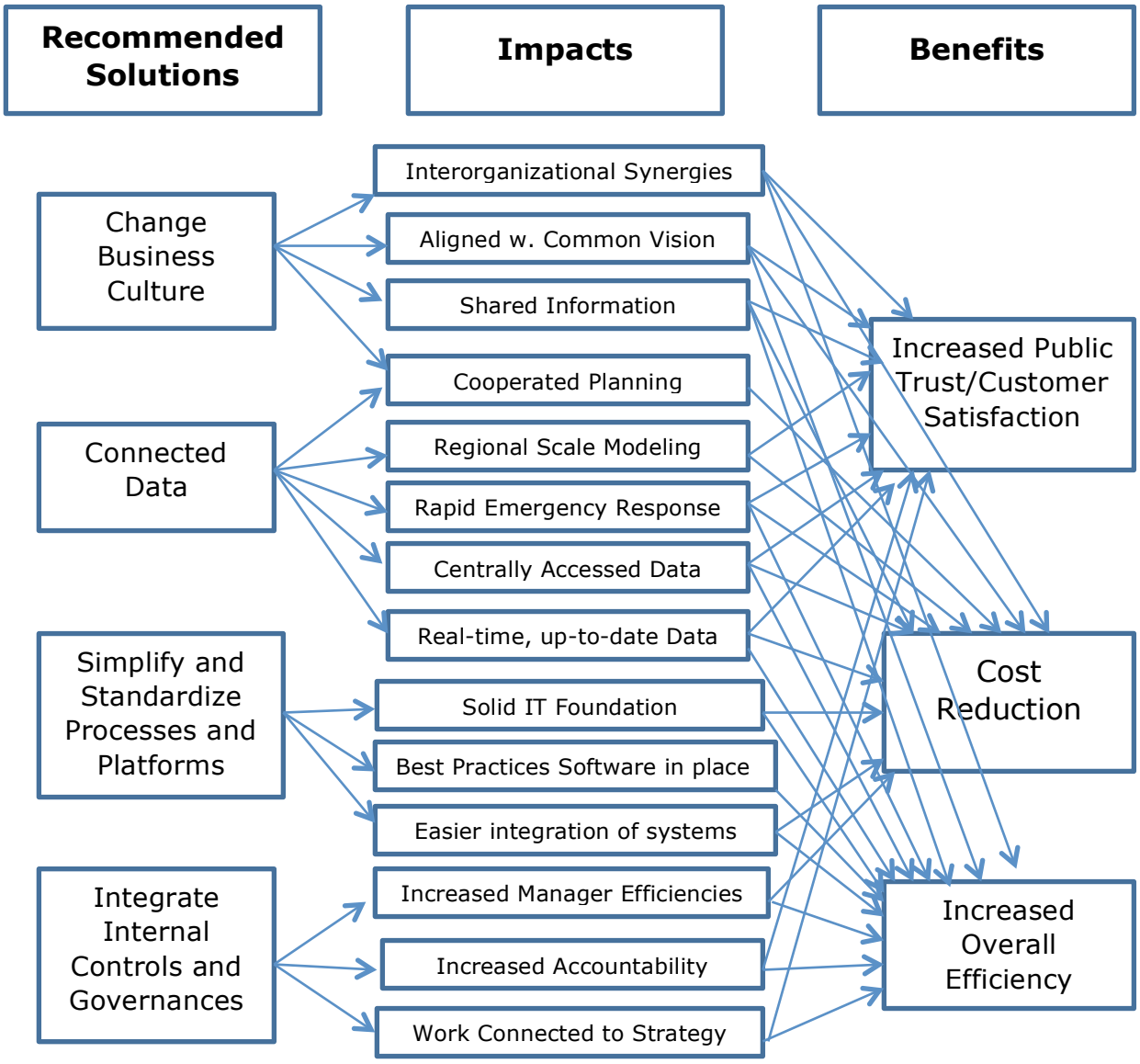
Organizations Core Diagram



Business Use Case Diagram



Benefits Diagram



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AUTHOR'S BIO

Robert Burnes is an environmental specialist for Pinellas County, Florida. His work focuses on aquatic habitat monitoring, analysis, and restoration in both freshwater and saltwater ecosystems. He has been working in this position for nearly three years and has been involved in numerous restoration projects and has provided analysis to multiple agencies and organizations. Rob received a Bachelor of Science in Wildlife Conservation and Ecology and a Masters of Science in Fisheries and Aquatic Sciences from the University of Florida. He is currently working towards a Masters in Information and Communication Technology with a concentration in GIS from the University of Denver.

KAS OSTERBUHR: ENTERPRISE ARCHITECTURE STEPS FORWARD: SOLUTIONS PROPOSAL FOR K3RI

1.0 EXECUTIVE SUMMARY

K3RI is a small oil and gas exploration company with a well-defined corporate vision but poor execution for achieving that vision. Enterprise architecture (EA) is a toolset that can create a virtual "lattice" of growth for K3RI…where capabilities are engineered to achieve business goals. The Open Group's TOGAF model is leveraged to cultivate several technical capabilities that have emerged as core requirements to an overall EA program: network connectivity, data management and security, collaboration, and cloud computing.

A high-level roadmap is constructed to guide the company through the next phases of deployment. A more granular (detailed) plan needs to be developed before actually building any of the recommended infrastructure, but the findings here should be sufficient to commit funding and time resources to the project. This work is one of several iterations of the architecture program that will be repeated over the life of the company – technology will change over time as will the core values and business goals.

Despite the fact that EA has been traditionally recognized as a tool suited only to large enterprises, this work has proven the approach to be a useful paradigm for potential improvement of business functionality even in very small companies.

2.0 BUSINESS AND PROJECT OVERVIEW

This section defines intent and high-level goals; briefly describes the K3 Resources Inc. (K3RI) business strategy; and exposes the basic operational workflow of the company to give context to the remainder of the paper. Information concerning K3RI is based on my personal involvement as a part owner of the company.

2.1 PROJECT INTENT.

In the recent proposal submitted February 6, the case was made for adopting an Enterprise Architecture (EA) solution to address several operational issues at K3 Resources Inc. (K3RI). This paper is an extension of that work and thus begins the developmental stage of actually building an architecture for the company. Enterprise architecture is a widely used problem solving approach that allows companies to integrate information systems, technology, security, governance, and other business operations into a unified and well-aligned whole (Ross, Weill, and Robertson 2006, 47-49).

Starting with an analysis of deficiencies in the existing systems (i.e. the "as-is"), an architecture for the target "to-be" systems will be described. Loosely using TOGAF (The Open Group Architecture Framework) as a reference tool, the target design will be conceptualized and then streamlined as much as possible to make implementation manageable in light of K3RI's limited resource pool. Simplifications of the complex TOGAF architecture approach will honor the *potential* for rapid growth in the future of the company.

The practicality of this work can be generalized to define what might be considered an "EA for small business". Enterprise solutions are typically constructed for companies that have an element of scale, but for a small company, EA is a daunting undertaking – evidenced by the nearly 800 pages of the TOGAF 9M document. As Sessions points out (2006), a failing EA "can be a huge *counterproductive drain* on precious organizational resources."

The goal of this project is to innovate and develop reusable information technology (IT) **capabilities** that the company can continue to capitalize in the future. A "capability" **enables** the company with a valuable tool that can be universally applied whereas a "solution" is only a temporary relief or answer to a specific problem (Ross, Weil, and Robertson 2006, 9&44).

2.2 BUSINESS OVERVIEW.

K3RI is a Kansas small business established in 1974 which has maintained a persistent interest in the exploration of oil and gas resources (O&G) in various geographic areas. While initially more diversified in scope (including product design, manufacturing and other efforts), recent changes have focused company resources almost entirely in the energy sector with emphasis on O&G exploration and production. Technology plays a significant role in business operations both in daily transactional routines and in the preparation of maps and data utilized in valuation of potential property acquisitions.

2.3 OPERATIONAL CONTEXT.

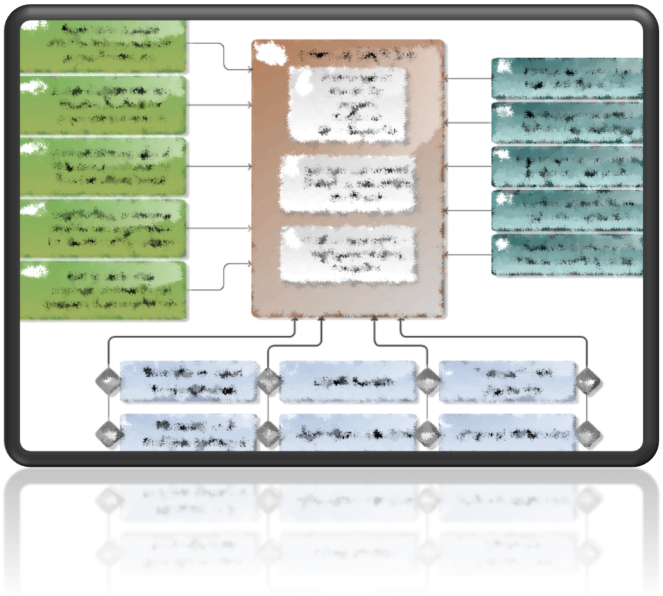
Based in a single office, K3RI's operations generally include fieldwork in areas within 100 miles but potentially as far as Texas, Wyoming, and western Colorado. If a highly profitable oil and gas (O&G) property is established in a remote location, significant resources are consumed for remote management. Such dispersion may require establishing permanent satellite offices with hired full-time contractors handling daily operations.

Figure 1 – A typical field location showing a pumping unit and surface plumbing used to deliver gas or oil to the sales pipeline. Digital instrumentation can be used to relay operational data to a remote monitoring workstation.

The work process begins by collecting scientific data about a particular piece of land. Geologists then analyze data, looking for patterns from nearby pre-existing well bores or in newly acquired sub-surface data (magnetic, seismic, etc.). Ideally, the interpretation will yield a prospective drill location called a "well spot". In an alternate scenario, another party may proffer an already functioning oil or gas operation for sale. In that case, the same background work will be conducted but the focus will be on how the existing wells can be improved.

When background work has been completed, a presentation package is assembled and at this point is called a "play". The play will be discussed with potential investors to determine their interest in backing further development. In some cases where the play is of substantially reduced scope and cost, K3RI may fund the project internally. Any play will almost certainly have a multitude of stakeholders, as this is the nature of the O&G industry. The first stakeholder is the landowner, who always receives a portion of the production profits as well as some compensation for destruction of property – even if the wells are never successful. Other stakeholders are those who may fund the project directly or provide services in trade for a fractional return.

The approach to enterprise architecture herein is aimed at guiding operational processes at K3RI. With a strong foundation of capabilities, projects will progress more effectively from beginning to end. Ultimately, the EA must compliment the business model and increase profitability. The K3RI business core diagram is contained in Appendix A for reference.



See Appendix A for a full diagram of the K3RI operational model.

3.0 ISSUES FOR THE "AS-IS" OPERATIONS

K3RI is operating currently operating with no Enterprise Architecture (EA), this makes it difficult to assess the status quo of the architecture. Several issues, listed below, deserve a majority of the focus for a new EA program. Because K3RI is a small business, treatment of these issues needs special care to avoid diverting too many resources from normal operations. Following are five key areas of improvement where EA will make a positive difference in the strategic position of K3RI relative to their competitors:

A. *Networking infrastructure* lacks effective deployment on a local scale (Local Area Networks, LAN) and is virtually non-existent at the large scale in the central office (Wide Area Networks, WAN/internet).

B. *Workplace collaboration* is poor – the company needs to adopt a clear policy of rich communications (multimedia, desktop sharing, etc.) and build a technology capability to support that policy.

C. *Hardware deployment* (e.g. workstations) is ad-hoc and not easily scalable, with no standby or rapid replacement contingency in place.

D. *Poor implementation of security and data backup* means that systems are vulnerable to attack or catastrophic loss during disaster events.

E. *Master data management is not utilized* to maintain data integrity and utility, making it difficult to discern a corporate-level "single version of the truth".

4.0 IMPLEMENTATION ANALYSIS (ARCHITECTURE)

This section of the paper will detail the architecture issues that exist in K3RI currently as well as a target "ideal" architecture that the company should attain. Section 5 will then describe technology solutions specific to those architectures. An architecture is supervisory guidance for understanding how to build a complex solution, it is used to "scope and plan incremental delivery of solutions in the context of a roadmap" (Godinez et al. 2010, 24). Solutions are the implementation building blocks of these architectures and typically represent some type of technology or other packaged functionality that caters to business needs (The Open Group 2008, 499-500 and 531-532).

Many of the architectural issues are interconnected and do not exist in isolation. For example, the lack of network connectivity leads to reduced collaboration in the workplace. The absence of a guiding overall "IT Engagement Policy" leads to localized hardware and software solutions that isolate each office location and exacerbate management problems when troubles arise in these systems. This is precisely the reason for addressing the K3RI problem space from an architectural standpoint – the architecture will guide overall deployment of technology and business strategy. Iterative refinement of the architecture ensures business goals remain the priority goal of any architectural implementation – as such, this document is obviously one of many that will help K3RI along a path of success.

4.1 LACK OF NETWORK INFRASTRUCTURE

See Appendix A for a full-size diagram of the Network Target Architecture

4.1.1 Network Status Quo. Within each local office, K3RI demonstrates limited utilization of network connectivity. Ethernet (or wireless) infrastructure has only recently been deployed, but with very little success. File and printer sharing is very cumbersome within the local offices. Worse, the K3RI main office is crippled by a physical location issue, which has made broadband internet largely inaccessible until very recently.

It is no stretch to say that connectivity between offices is trivial at best. Currently, email attachments are the primary means of information exchange. This leads to many additional issues such as revision control, security, and governance.

4.1.2 Network Business Case. Most would agree from personal experience that connectivity has changed business (emails, websites, etc.). Brown et al. (2011, 61-63) remark on the need for networking and point out that beyond sharing data, networking allows sharing of technology resources (printers and other devices) as well as *enhanced* communication. Brown also notes, "Communication links between a company and its suppliers or customers have been successfully used to give the company a strategic advantage."

As the full disclosure of issues continues to unfold within this paper, it will become more obvious that lack of network infrastructure is crippling the company's ability to function in many ways. A network architecture is nearly fundamental to all other aspects of the enterprise. Messerschmitt succinctly articulated the implications of connectivity when he stated, "the global internet liberates many activities from geographical constraints" (2000, 18).

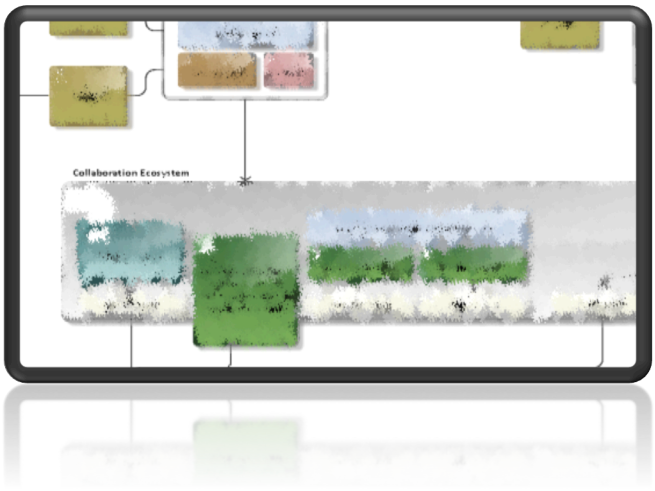
A 1993 interview of Paul Saffo, a fellow at the "Institute for the Future", underscores the way our world has evolved in the years since. At the time, Saffo noted the atrocity that was the "internet" was still growing at a very fast pace despite a clumsy interface. He also remarked how the computer was already transforming from "*processing* to *accessing"*…a profound prediction of today's technology ecosystem in which internet access is essential to getting work done (Wylie 1993). Saffo also mentions that companies will only survive if they are flexible and that they will need to "adapt to new technology very quickly." Unfortunately, with respect to K3RI's adoption of networking technology, there has been insufficient adaptation.

4.1.3 Network Target Architecture. Within each office, a wired Ethernet backbone will serve as the physical layer of local area network connectivity. In addition to wired Ethernet, wireless routers will be installed to allow connectivity with employee laptops, mobile devices and other wireless-enabled hardware.

An ultra-high bandwidth wide area network connection is necessary to route traffic between offices in different geographic locations. A software layer at each access point will handle encryption of sensitive data and firewall the access to restrict unwanted traffic either in or out of the system. The combined local and wide components of connectivity ensure that any device can be accessed from anywhere. For example, an employee with a tablet or smartphone could, in theory, connect to a workstation at the office or even a computing cluster on the cloud platform.

4.1.4 Network Deployment Issues. Connecting the main office to wide-area-networks (i.e. "internet") is one of the primary obstacles due to a large cost incurred for physically connecting to a network within range of the business property boundaries. A significant issue is reliance on internet service providers (ISP) for the wide area connectivity between office locations. Potential alternatives to public ISP are dedicated wire or microwave transmission links, although these options can be very costly.

4.2 LACK OF UNIFIED WORKSPACE AND ENVIRONMENT



See Appendix A for a full-size diagram of the Collaboration Target Architecture

4.2.1 Collaboration Status Quo. Collaboration deficiency at K3RI is a manifestation of network connectivity and poor IT implementation – each of which is a problem large enough to be treated on its own. However, there is a specific need to address the employee workspace and environment from the standpoint of how to exploit collaboration tools. K3RI, even though it consists of only four primary members, is "dispersed" to three separate office locations. It has become exceeding difficult to maintain an environment of real-time knowledge. Most decisions and notifications are executed by email exchange interspersed with telephone calls. Business meetings where all four members are present occur twice annually, incur significant travel, and consume a significant amount of time.

4.2.2 Collaboration Business Case. Schrum and Benson prepared an insightful article on the evolution of group communications and collaboration. Though written 10 years ago, their work forecasts the importance of communications and "the way in which the technologies help maintain our humanity while they streamline our work" (2002, 490). Not all communication technology is to be used without restraint. For example, the authors point out that there is a point of diminishing return with email, as it can take up to five minutes to process a single message (2002, 488). They suggest instant messaging as an alternative to email, which can leverage the dynamic communication negotiations of "live" interaction.

The ultimate interpersonal collaboration tool is telepresence – a "near face-to-face experience" that has proven itself very effective for communication (Heck 2009). Coupled with tools such as remote screen sharing and digital whiteboards, it is conceivable to coalesce multiple geographically dispersed office locations into a unified workspace. Heck (2009) notes that telepresence allows users to "immediately pick up on all-important visual cues – such as how someone reacts to an offer."

An insightful collaboration case study comes from Stripling (2011), who writes about two individuals who are each managing academic institutions over dispersed geographic areas. The use of email, messaging, voice over IP (i.e. "Skype"), and other technologies in both cases has enabled these individuals to effectively collaborate and manage facilities when their physical presence is not possible.

These and many other case studies are proving that network connectivity coupled with good collaboration tools can bridge the distance between workplace and worker.

4.2.3 Collaboration Target Architecture. The driving force of the collaboration architecture is to make individuals in separate workspaces feel as though they are working in within the same office. The technologies forming the core collaboration environment are: email, instant messaging, voice conferencing, desktop screen sharing, video conferencing, real-time sharing folders (synchronized FTP or similar), remote desktop, and digital white boarding. Network connectivity is a base layer required to deploy all of these applications. A security layer is also necessary to prevent unintentional disclosure of information. In the desired form, these tools are readily accessible to individuals regardless of their location (home, office, or travel).

4.2.4 Collaboration Deployment Issues. One potential drawback is that the company could become technologically dependent with no recourse to turn back to previous operational patterns (Schrum and Benson 2002, 489). Cultural issues may also be a stumbling point – individuals could be reluctant to share images of their computer screen and might potentially exhibit unnatural behavior when using video conferencing tools. Probably the most important issues are security and the ability to access an adequate network connection. When network connectivity drops, so would the majority of collaboration tools. Some of the more expensive collaboration tools are built on proprietary networks and could be isolated from the company's internet connection.

4.3 AD HOC COMPUTING PLATFORM

4.3.1 Computing Status Quo. There are currently seven prototype computer systems in three office locations, each built and maintained by the local user. These computers are operating on Windows XP, Windows Vista/7, Ubuntu and Mac OS/X. This diversity presents a challenge in terms of maintenance and interoperability. If a workstation fails, there is an urgent need to correct the failure and no alternative in place while the repair is executed. Regrettably, this type of hardware ecosystem has manifested problems in the past ranging from nuisance "glitches" to complete operational shutdown.

The existing hardware solution is adequate only for meeting current needs and does not adequately address the potential for growth. In particular, data intake with a large project could easily outpace the capacity to store data. Raw computing power, needed to solve large-scale numerical problems, is also limited by the current hardware configurations with no architecture plan in place to build scalable systems.

4.3.2 Computing Business Case. The case for standardizing the workstation hardware is easily made based on personal experience of the author. When problems arise, there is significant time expended getting "up to speed" with the individual system to interpret the context of the issue. If all hardware is built to a standard configuration, time spent troubleshooting or upgrading can be diminished significantly. To help with this particular aspect of the infrastructure, both the network and collaboration architectures will enable remote login to the affected systems for in-situ analysis and repair.

Beyond the scope of local workstation issues lies the "cloud-computing platform."[1] One of the primary advantages of utilizing a public cloud infrastructure is that resources can be easily scaled up or down in capacity. This means that K3RI would have the ability to provision hardware on an as-needed basis. Despite increased capabilities, scalable virtual infrastructure can still be up to 40% cheaper than building on-premise hardware on both a maintenance and cost basis (Shroff 2010, 65-66). With economics that match or beat on-site deployment, cloud computing is quickly becoming a commodity – much like electricity evolved from private generation to public persistence.

The economics of cloud computing typically favor larger deployments than needed at K3RI. However, it is important for *architecture capability* development for K3RI to migrate to this usage model because, while it may not be cheaper, it also does not incur a significant cost penalty. This means that K3RI can begin integrating cloud services into operations in *anticipation* of growth phases. Notably, services like AWS do not typically involve long-term contracts, so it would always be possible to drop the service.[2]

4.3.3 Computing Target Architecture. The ideal computing platform for K3RI comprises: 1) standardized workstations built according to a "recipe", 2) in-house scalable storage platform such as a rack mount RAID[3] array, and 3) standard practices and procedures for deployment of need-based cloud computing hardware. Over time, dependence on local hardware will likely diminish as the capabilities of cloud platforms increase and the ability to transfer data over networks improves. This trend could potentially eliminate the need for local workstations, leaving only a user interface (keyboard/ monitor/ mouse) connected to a network backbone such as the internet or a private dedicated line to the remote infrastructure.[4]

A critical aspect of the computing architecture is the ability to remotely access, diagnose, and repair user workstations. This capability is reliant on good network infrastructure as well as policy and procedure. Because users will typically want to customize their systems, the architecture must allow a means to isolate core functionality from user-adjustable functionality on a per-workstation basis. Lastly, data backup policy and the availability of a standby workstation will ensure continuity in the event of a hardware failure.

4.3.4 Computing Deployment Issues. Individual personality and preferences could pose culture barriers to adopting a new workstation design. More specifically, operating system changes can be traumatic

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[1] The definition of "cloud computing" is, ironically, a bit cloudy. It typically references hardware or application platforms that are hosted in remote facilities. However, there are also "private clouds", which are clusters of resources pooled into a single repository. The most popular context of the term "cloud" is in reference to large pools of IT resources that are accessible over the internet.

[2] To further explore the economics of AWS in particular, visit http://aws.amazon.com/economics/ to use Amazon's spreadsheet calculators.

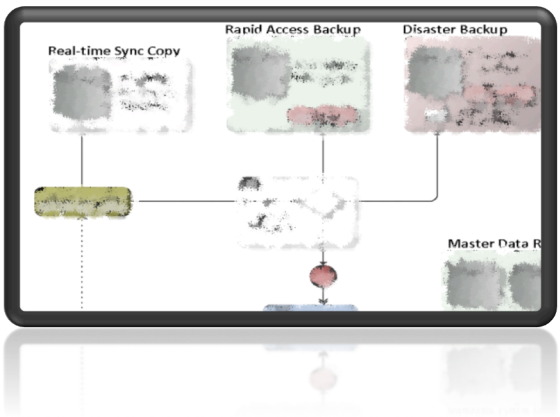
[3] Redundant Array of Inexpensive Disks. RAID is a scalable, fault-tolerant, high-availability storage method.

[4] Amazon, for example, offers "AWS Direct Connect". This reduces bandwidth expenses and improves throughput but is currently only available at a few locations. Read more at: http://aws.amazon.com/directconnect/

when a user is accustomed to a particular workflow. Another issue is that reliance on the remote cloud infrastructure implies the presence of network connectivity, which could leave the business stranded in the event of an outage.

One unfortunate side effect of the proposed hardware standardization is that there is less diversity in the systems deployed and less capability to work around specific issues on a case-by-case basis. For example, if the need arises to write custom code on a 32-bit machine and the entire infrastructure has been standardized to 64-bit, there is little recourse. Similarly, if an operating system suddenly experiences a security issue or defect, the trouble would be systemic throughout the entire K3RI infrastructure – this would not be the case with a large diversity of systems.

4.4 LACK OF DATA SECURITY AND BACKUP



See Appendix A for a full-size diagram of the Master Data Target Architecture

4.4.1 Security/Backup Status Quo. K3RI has no established formal procedures for backing up data in the event of a disaster. Only one office location leverages a fire-safe backup policy but this leaves two other office locations vulnerable to "disaster". Even worse, those same two offices have no means to automate routine daily, weekly, or even monthly backup. This leaves the systems vulnerable to catastrophic loss in the (plausible) case of hard drive failure.

Security "policy" has not been implemented, leaving the company vulnerable to data leakage through potential breaches or attacks. For example, the computer system used for financial accounting is disconnected from the local network to prevent "infection" but relies on a USB flash drive to exchange data with other computers in the office. USB flash drives are one of the most vulnerable security points (especially on a Windows OS workstation) and are commonly used in socially engineered system infiltrations (Tetmeyer and Saiedian 2010, 45).

4.4.2 Security/Backup Business Case. The case for implementing security and data backup procedures is easily made by openly discussing the value of data and information. It is clear that loss of data or compromised security represents some level of financial loss. The magnitude of loss could range from minimal to "full", depending on the type of failure. K3RI relies on data intelligence to find value where others may fail – data and any derived metadata are obviously of extremely high importance to the company. Loosing this data is bad enough, having the data fall into the hands of a competitor could equate to catastrophic loss.

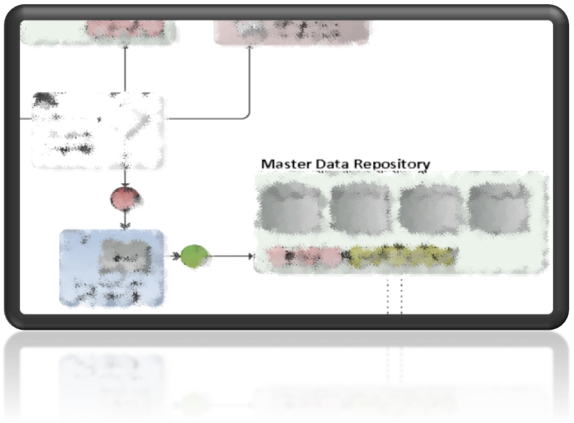
The recent onslaught of hacking (or "cracking") activity from the group *Anonymous* has brought light to the possible disclosure of company "secrets". In one instance, the group hacked the webservers and Google email accounts of the law firm Puckett and Faraj (Neil 2012). Anonymous released several private emails, tampered with the website, and essentially brought the digital infrastructure of Puckett and Faraj to a literal standstill. The case emphasizes the vulnerability of most companies to a genuine security threat. It also underscores the importance of understanding security systems when K3RI relies upon a third party, for example using Yahoo Small Business for email and web hosting.

4.4.3 Security/Backup Target Architecture. Physical security at each office location should comply with best practices for prevention of theft. Robust *digital* security is pointless if a determined individual can breach the office premises and gain possession of a hard drive with several terabytes of proprietary data or sensitive communications. As a secondary measure against theft, hardware level encryption can be used to thwart all but the most determined efforts to retrieve data from stolen media. Other key components of digital security are the use of encryption for email attachments, file servers, and other types of network activity. Firewalls and anti-malware implementations are required. User training on security practices is important to ensure that files are not sent to an unintended or insecure location. Even the most well-intentioned executive can expose the company to loss through seemingly trivial actions; education is vital to prevention.

Even though data theft is a significant threat, the most obvious degradation or loss of data comes from hardware failure or catastrophic disaster. To mitigate these types of failures, local backup servers will be configured to automatically mirror data on a scheduled basis (daily, weekly, monthly). Backup copies of data will be periodically archived to some type of removable high-capacity data module that can be stored in a fire-safe location (hard drives, optical disks, magnetic tape). Backing up data to remote infrastructure (i.e. cloud computing platform) is a very reliable way of making data available and error proof, but unfortunately has security implications that require encryption techniques.

4.4.4 Data Security Deployment Barriers. Security and data backup must become a "silent component" of the enterprise architecture so that users are not impeded nor inconvenienced by these functionalities. Education and awareness about the threat of data loss (due to security or disaster) is one of the primary goals to keeping culture focused on protecting data. Education should be cleverly incorporated into daily operations so it does not "inconvenience" the users.

4.5 NO MASTER DATA MANAGEMENT (MDM)



See Appendix A for a full-size diagram of the Master Data Target Architecture

4.5.1 MDM Status Quo. One of the core business processes at K3RI lies in the interpretation of data. This data could be satellite images, magnetic

surveys, or any other type of measurement or observation. K3RI has possession of approximately 15 TB (terabytes) of raw data (digital and analog) that has been meticulously collected from free sources, purchased through vendors, or gathered by fieldwork. Unfortunately, this data is not contained in a central repository nor is it managed effectively. When projects use data, they typically do so by creating a duplicate copy for local access. This makes revision control troublesome and tracking of information becomes almost impossible. Furthermore, project leaders have diminished understanding and confidence of the data – thus limiting the value of information extracted.

4.5.2 MDM Business Case. Master data management is a blend of data integration and standardization that merges enterprise data into a single system of record. One researcher notes that "the real goal of master data management is to create a structure for information management that lets the business effectively and efficiently use this information for business value" (Ollinger 2006). According to Ollinger, having "clean" data in the enterprise is the only way to get the "full return on investments". McKnight reinforces the importance of master data, encouraging companies to "adopt best practices, provide new functionality, and do some things right that weren't done before" (2008).

Data is important – many case studies point to the benefit of reliable and accessible storage systems. Most authors seem to reflect the same common theme – *data enables innovation*. According to Hutchinson (2011), "the ability to store and manipulate increasingly voluminous data actually drives serious innovation." Hutchinson remarks "companies like Google wouldn't exist without huge amounts of storage." Manyika et al. (2011) feel that storage is just as essential as having human resources and hard assets and that "economic activity, innovation, and growth simply couldn't take place without data." These philosophies apply to the foundation of K3RI's business model, as data is integral to making a project profitable.

4.5.3 MDM Target Architecture. Leveraging cloud-based scalable infrastructure and high-bandwidth networks is an enabling base layer to master data management, as is a robust security architecture. To manage data effectively, K3RI needs to first establish a hardware platform that can be trusted to keep a safe copy of the digital files that represent "master data". Also required are ancillary capabilities such as file-naming conventions, organizational methods, encryption standards, and metadata management.[5] Local hardware can be built to high levels of fault tolerance for backing up data without access to a wide area network, but ultimately some type of off-site duplication is a necessity for true disaster resistance.

The master data architecture at K3RI is not only a physical implementation, but also centers around the people who can give a hierarchy and meaning to the data. Most importantly, the users must alter their work strategy so that they rely on access to a central repository rather than a local copy that can be modified to suit their own needs. Local modifications should be kept in the master data repository as an ancillary modifier to the original data. Governance will be a key constraint for the MDM system and may represent an equally resource-intensive parallel effort to MDM deployment (Godinez et al. 2010, 311). With a working central repository, K3RI has a foundational data architecture that allows future work to benefit from the knowledge and wisdom learned in earlier projects.

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[5] In the context of Enterprise Architecture, metadata is often treated as separate from master data. Metadata is the "data about data". To reduce complexity in this initial iteration of architecture at K3RI, metadata is treated as a component to the overall data management architecture.

4.5.4 MDM Deployment Issues. Working from a common database requires complex permissions settings (to prevent accidental overwrite or delete). It also hinges upon network access to the location of the master data repository; with dispersed offices, this implies reliance on internet connectivity. Furthermore, because data can be transmitted over public infrastructure, encryption of sensitive information is essential. Fortunately, deployment of MDM is never "big-bang" – but it requires a high level of maturity and may be one of the more difficult aspects of the EA program to successfully implement (Godinez et al. 2010, 310).

5.0 SOLUTIONS PROPOSAL

In this section, four major solution areas are presented which overlap and address the previously defined architecture issues. They are 1) network infrastructure, 2) computing hardware, 3) data management and security, and 4) collaboration tools. K3RI does not have sufficient resources to dedicate a team for deploying solutions, nor enough capital to make large investments in change. Primarily for these reasons, the solutions here are selected on the criteria that they can be implemented in a stepwise manner (NOT as a "big bang") and at reasonable acquisition and maintenance cost.

5.1 BUILDING NETWORK CAPABILITY

Solving the immediate local area network (LAN) deficiency is a relatively straightforward project primarily involving the installation of Ethernet cables and routers, hubs, or switches to connect the various elements of the network. "Gigabit" Ethernet (1GbE) hardware is a commodity item which is readily available at low cost. With theoretical transfer speeds of 1 billion bits per second (equivalent to 125 Megabytes per second), GbE is an adequate match for most systems. For example, a very fast hard drive in today's market will sustain ~150 Megabytes per second, making GbE a nearly one-to-one match.

It is worth noting that 10-Gigabit Ethernet (10GbE) equipment is available. Due to the K3RI's reliance on data as core functionality, planning an upgrade path to 10GbE should be considered. Fortunately, 10GbE carries up to 55 meters over basic Category 6 cables (the same Cat 6 cables can be used with the 1GbE network infrastructure). The 10GbE specification is also backwards compatible, meaning that systems can be upgraded incrementally in the future. Transferring large data, as in the case of uploading to a cloud-computing platform such as Amazon Web Services (AWS), can present calendar time obstacles, as revealed in *Figure 2*. Fortunately, AWS allows users to ship data on hard drives as an alternative to transferring over network. For large repositories of static data, this content delivery mechanism can significantly ease the burden on local hardware.

Available Internet Connection	Theoretical Min. Number of Days to Transfer 1TB at 80% Network Utilization	When to Consider AWS Import/Export?
T1 (1.544Mbps)	82 days	100GB or more
10Mbps	13 days	600GB or more
T3 (44.736Mbps)	3 days	2TB or more
100Mbps	1 to 2 days	5TB or more
1000Mbps	Less than 1 day	60TB or more

Figure 2 – The AWS platform offers gives clients the option to ship physical disks for data ingestion to the infrastructure. Shown here is a table that suggests the break-even points for network upload versus physically shipping a disk. Typical consumer-grade internet connectivity is approximately 20 to 50 Mbps (equivalent to "T3" in the table).

Wide area connectivity (WAN), using the global Internet, is essential to link office locations. For the short term, the most logical option is to contract through a local internet service provider (ISP). Connection speeds up to 50 Mbps are typically available to consumers. At 50 Mbps, one gigabyte of data can be downloaded in approximately three minutes – this scales to approximately one half terabyte per day. When communication overhead is included, efficiency can easily drop to half in real-world situations. Worse, upload speeds are often an order of magnitude lower than download – or approximately 25 minutes per gigabyte. This underscores the advantage of hosting data remotely on a cloud system such as Amazon Web Services.

5.1.1 Networking Options. Moving to the next step in WAN connectivity involves deployment over private dedicated lines (either physical or wireless). For example, Comcast has a dedicated "Ethernet internet" offering that can scale to 10GbE point-to-point for upload AND download (symmetrical).[6] While the cost of private connections is currently cost prohibitive, it is critical to know and explore these options as the company continues to grow. Another possibility to improve bandwidth and guard against failure is to invest in network aggregator equipment that can distribute traffic over multiple incoming/outgoing connections (Goodman 2010). Gigamon is one of the commercial vendors in network aggregation and flow monitoring equipment and represents a growth platform for K3RI in the future.[7]

5.2 BUILDING A HARDWARE PLATFORM CAPABILITY

The two primary aspects of the hardware capability are 1) standardized workstations with known configurations and 2) access to scalable infrastructure locally or on public cloud platforms such as Amazon Web Services.

The standardized workstation is a rather trivial matter in comparison with the overall EA project. Because a majority of the software tools used at K3RI are written for the Windows OS, it makes most sense to deploy using Windows on the workstations. The file servers and background infrastructure can be built using open source Ubuntu – a "flavor" of Linux that is widely adopted and very well supported. Using open source OS where possible decreases software licensing costs. Ubuntu is, in the author's experience, a more stable computing platform and more suited for server hardware than the Windows OS. Furthermore, a new long-term support (LTS) version of Ubuntu is now available with maintenance assured through 2017.[8]

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[6] http://business.comcast.com/enterprise/services/Data

[7] http://www.gigamon.com/about-gigamon-traffic-visibility-fabric

[8] https://wiki.ubuntu.com/LTS Version 12, shipping mid-2012, will be supported for the next 5 years.

Figure 3 – Typical rack mount hardware. At left, a large rack (standing approximately 7 feet tall) easily accommodates numerous modular units, as seen at right. The modules can be oriented towards dense storage or dense computing, or both. Rack shown is approximately $1,000 and individual modules carry a ~20% premium over standard workstation hardware.

Besides user workstations, building scalable storage locally is also beneficial. Local storage is best handled with a rack mount (or equivalent) disk array built in a RAID[9] configuration to ensure high availability. While storage on public cloud platforms is potentially infinitely scalable, having immediate access to data is also important because it isolates K3RI from the possibility of operational failure during network outages. Furthermore, current storage pricing is cost prohibitive for extremely large data collections, with vendors charging from $100 to $150 per static terabyte-month.

For massively scalable on-demand computing, the economics do generally favor public cloud hardware. This is primarily because of the high initial investment required to build a stand-alone workstation or server module. There are numerous cloud providers including Amazon, AT&T, and Microsoft. Amazon Web Services (AWS) has a very broad spectrum of offerings including relational database engines, storage and web hosting, data analytics, and cluster computing capabilities. AWS is a logical first choice for public cloud computing at K3RI.[10]

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[9] Redundant Array of Inexpensive Disks – RAID 6 arrays sacrifice two of the member hard drives for redundancy. An array of 10 disks would have collective capacity of 8 drives and would tolerate complete failure of two drives while still keeping the storage system online. RAID alone is NOT adequate for backup, but does keep systems online while disks are replaced.

[10] A potential "do it yourself" computing cluster could be built using the open source specification on http://www.opencompute.org This website highlights the server design used at Facebook and is purportedly an energy efficient low cost means to building server hardware. Furthermore, Ubuntu

A first step to incorporating cloud infrastructure at K3RI is to mirror a portion of the commonly used static data to an AWS-based storage server. Because a large majority of the static data has been gleaned from public portals, there is minimal sensitivity to theft or disclosure. Where necessary, an encryption layer can be added so that any information on remote hardware is useless without proper credentials. Firewall rules can be enforced on the AWS platform to restrict traffic to specific IP addresses, adding another layer of protection. With data hosted on AWS hardware, all three office locations would have access 24 hours a day with very high download bandwidth (whereas serving the data from a K3RI office location would require an expensive network connection to serve data faster than ~10 to 20 Mbps).

K3RI can also deploy fully functional workstations on the AWS infrastructure. A workstation on AWS could be used remotely by any employee with internet access. Synchronous access by more than one person may be a trouble spot, but this can be handled with clear communication until the company grows and a solution is developed. A potential use scenario would be to instantiate a remote workstation for each project, this AWS "instance" would then become the focal point of interaction for all work done on the project.

5.2.1 Software Licensing in the Cloud. As noted in their whitepaper, Amazon discovered that vendor-licensing agreements were never intended to work in the cloud-computing ecosystem. Some software uses hardware identification as a means of authorization; this mode of licensing thus becomes an issue on virtualized hardware typical of the AWS platform. Luckily, Amazon noted in their study that vendors were willing to work out licensing issues on a case-by-case basis (Amazon 2010).[11]

5.3 DATA SECURITY AND MANAGEMENT CAPABILITY

All storage devices throughout the K3RI enterprise should be configured with encryption at either the file level or hardware level. The only devices that do not need encryption are operating system drives that are known not to contain sensitive data. One popular open-source solution for on-the-fly encryption is TrueCrypt, available at the truecrypt.org website. TrueCrypt has a relatively good record of accomplishment and, most importantly, encrypts ALL files on a hard disk and protects the files with boot-level password authentication. TrueCrypt could be installed on remote computing platforms as well, as the software is capable of encrypting in situ over a functional operating system.

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offers a private cloud service where technicians would come on premises and assist K3RI in building a computing cluster.

[11] For further insight, refer to http://blogs.computerworld.com/19761/software_licensing_drags_innovation

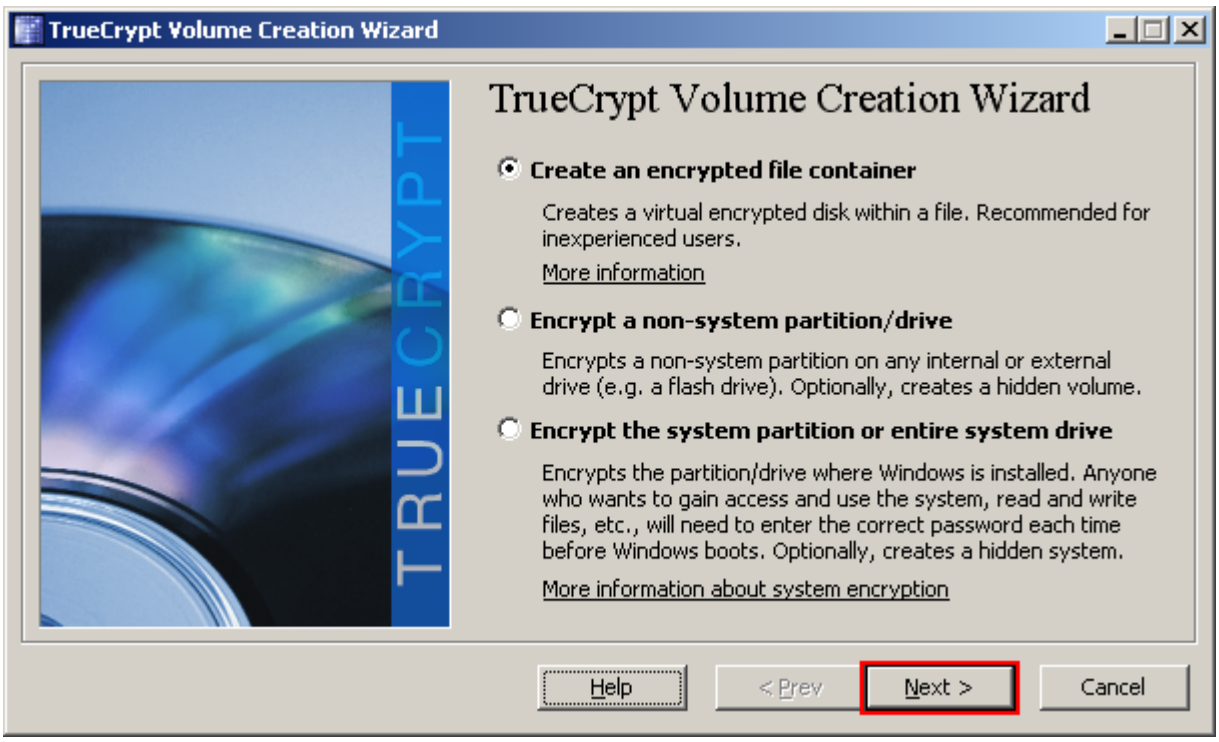

Figure 4 – Representative screen capture from the TrueCrypt program showing the creation wizard. Encryption can deploy on an entire disk, a partition, or at the file level.

An exception to encryption can (and should) be made for backup media, which can be retained in a physically secure location – for example a bank safe-deposit box or equivalently secure on-premise container. Maintaining backup copies on bare drives without encryption is desirable because in the event of total disaster, including loss of password files or access keys, information can be extracted using commodity hardware.

For encryption of email attachments containing sensitive data or casual file-level encryption, software such as PKZip is an adequate solution. PKZip is a well-known standard in the industry. The company even has solution scenarios focused on the enterprise as well as cloud computing, making it a viable stand-in for Truecrypt.[12]

While secure data is important, longevity is probably a more important immediate goal. It is clear from review of literature that building low-failure storage systems is a significant undertaking. Locally, a RAID (redundant array of inexpensive disks) system can ensure high availability but presents detectable risk as a long-term fail-safe architecture (Hafner et al. 2008). For robust data backup, an automatic scheduler should copy data to several locations, including a disaster proof container (e.g. fire safe) or an offsite location.

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[12] Read more on PKWare cloud: http://www.pkware.com/data-security-compression-solutions/cloud-solution

Live synchronizing tools such as SugarSync or DropBox have already proven themselves in the daily workflow at one K3RI office location. Live synchronization mirrors files in near real-time to an offsite location and across multiple devices. Unfortunately these tools are not suitable for large volumes of data (exceeding one terabyte), but they are very effective for active working directories and unstructured file sharing.[13]

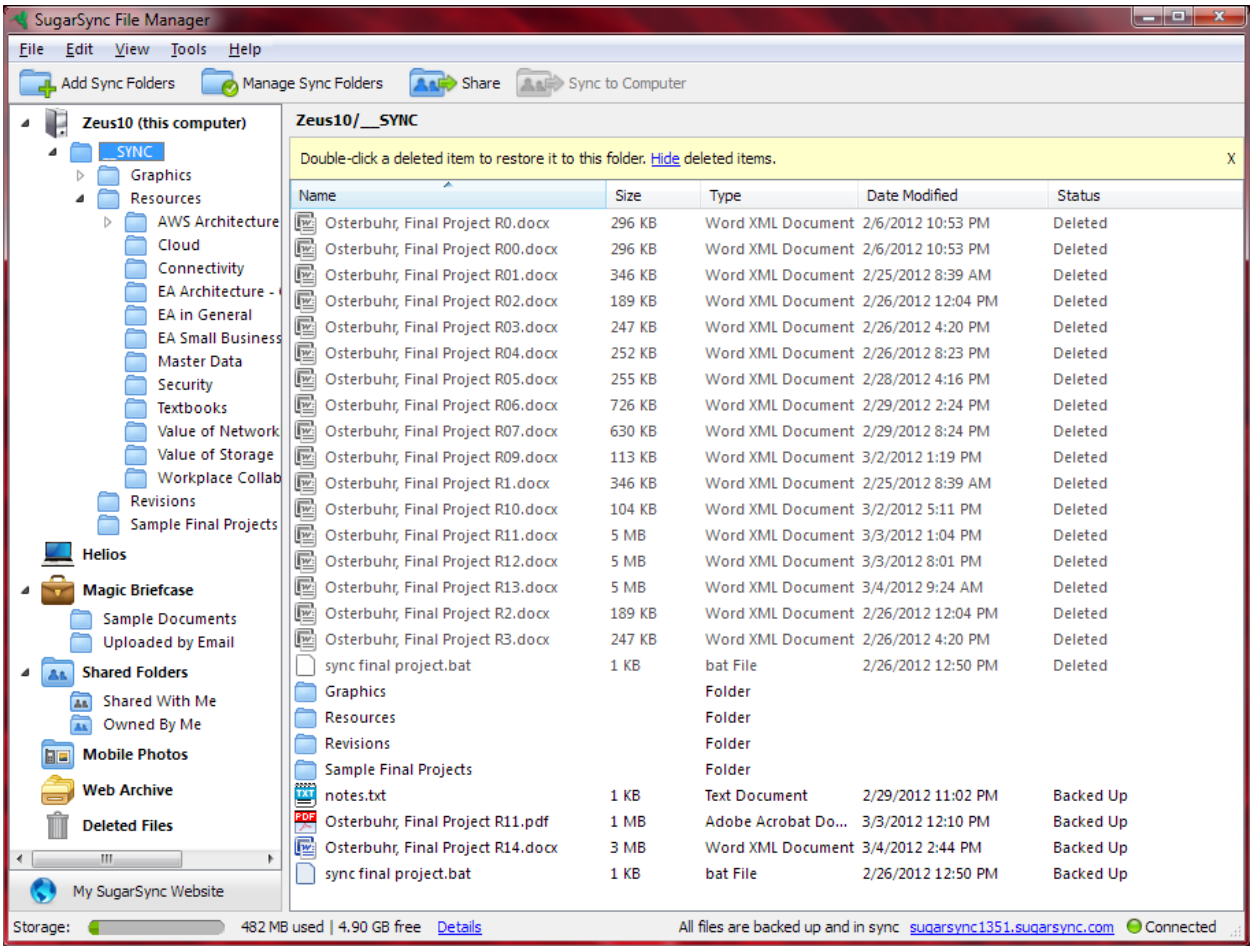


Figure 5 – A screen capture of the SugarSync dashboard showing how the author exploited the live synchronization feature as well as the versioning that is built-in to the SugarSync application. Multiple users can connect to the same synchronized workspace.

The most reliable form of backup currently available is Amazon AWS storage. In their whitepaper covering AWS storage options, Baron and Schneider present several use cases where cloud storage has proven to be a robust solution both for massive repositories and for high volumes of daily transaction data. The authors note that AWS advertises their storage service as "eleven nines," or 99.999999999%

[13] See http://www.sugarsync.com and http://www.dropbox.com for more information. SugarSync and DropBox are excellent tools for synchronizing folders across systems, but they do not offer fine control of permissions, nor do they adequately handle transactional issues such as simultaneous updates. Both are available in a premium business-class offering with up to 1TB of capacity.

error proof (2010, 9). Even the AWS "reduced durability" storage option (a less expensive alternative) is 99.99% durable – which is still *400 times more reliable* than a typical hard disk drive (2010, 10). Given this level of reliability and the ability to encrypt data, K3RI's best data storage option is to eventually move data to the AWS infrastructure.

5.4 ENSURING COLLABORATION CAPABILITY

Collaboration capabilities are largely enabled by a strong infrastructure of network connectivity (section 5.1), a robust hardware platform (section 5.2) and effective data management (section 5.3). These layers of capability are the foundation of working together; they enable users to have consistent access to data, a predictable working environment, and the confidence to share information over long distances.

Several off-the-shelf software tools will provide a foundation for the initial collaboration environment. These low-cost or free applications are:

- FileZilla and SmartFTP (security-enabled file transfer);
- http://join.me Screen sharing utility that functions over HTTP, includes phone conferencing;
- Windows Remote Desktop (built-in Windows functionality) or TightVNC, an open source remote desktop tool;
- SugarSync and DropBox file synchronization tools;

The next step in collaboration could include migrating to a tool such as Microsoft SharePoint, a comprehensive package offering many plug-in features such as database sharing, dashboards, document sharing, and more.[14] Because of the licensing costs, this step in collaboration architecture will be postponed until K3RI outgrows the less expensive options.

There are also high-end collaboration tools on the market, which are largely unreachable due to high costs. For example, one of the best-in-class systems is HP Halo Telepresence and can cost upwards of $250,000 per site installation.[15] The system also leverages proprietary network infrastructure. It is unlikely that K3RI would need this level or quality of collaboration for quite some time, in which case the technology will have evolved significantly.

[14] For a quick overview of SharePoint, view http://www.youtube.com/watch?v=AOQo_b22Zlw

[15] A video overview of how HP Halo has enabled collaboration on large projects, view the following YouTube video: http://www.youtube.com/watch?v=k79FEyon9XI

Figure 6 – A representative installation of the HP Halo system illustrating a typical meeting configuration.

6.0 DEPLOYMENT ROADMAP

K3RI Architecture roughly follows the TOGAF Architecture Development Method (*Figure 7*). The ADM is a *cycle* meant to iterate throughout the life of the company to ensure architecture and solutions meet business requirements. Two critical phases of the ADM have been skipped in this paper: governance and change management. Both steps will come into focus after the initial solutions are deployed. If the ADM cycle is followed to completion, K3RI will find itself at the "vision" stage frequently and thus will have the opportunity to adapt to new technologies and business goals.

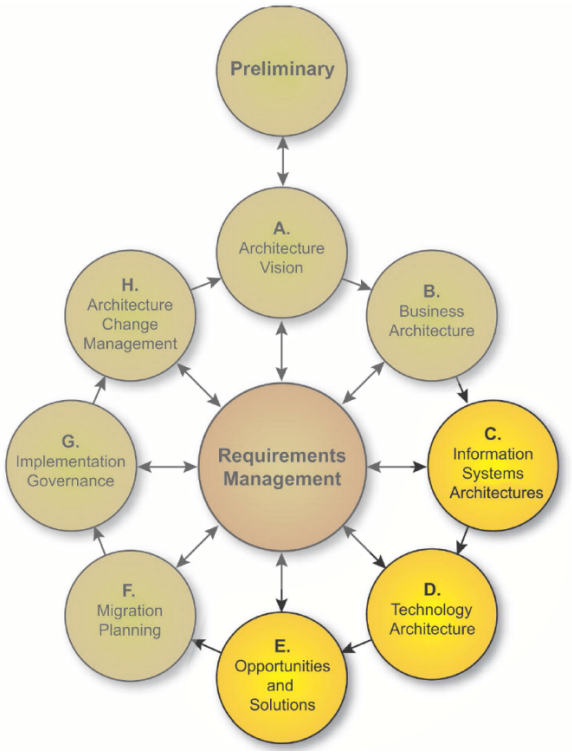


Figure 7 – The TOGAF Architecture Development Method (ADM) comprises nine steps in an iterative cycle, note step H reconnects to step A. This paper emphasizes steps C, D, and E.

The four solutions described in Section 5.0 will be deployed stepwise. Prior to implementing any of the solutions, it will be necessary to revisit the preliminary TOGAF phase by securing the support of stakeholders (collectively, the four owners of K3RI) as well as the resource commitments necessary to steward the project through initial phases. This loop is representative of the "Architecture Context Iteration" referred to in the TOGAF (The Open Group 2008, 216).

For each of the solutions, a more granular roll-out plan will be created that allows the company to methodically ease into the deployment, representative of TOGAF phase F, "Migration Planning" (see *Figure 7*). To guide the construction of a more detailed rollout, the roadmap presented in *Figure 8* shows key phases and sequencing in the solution development.

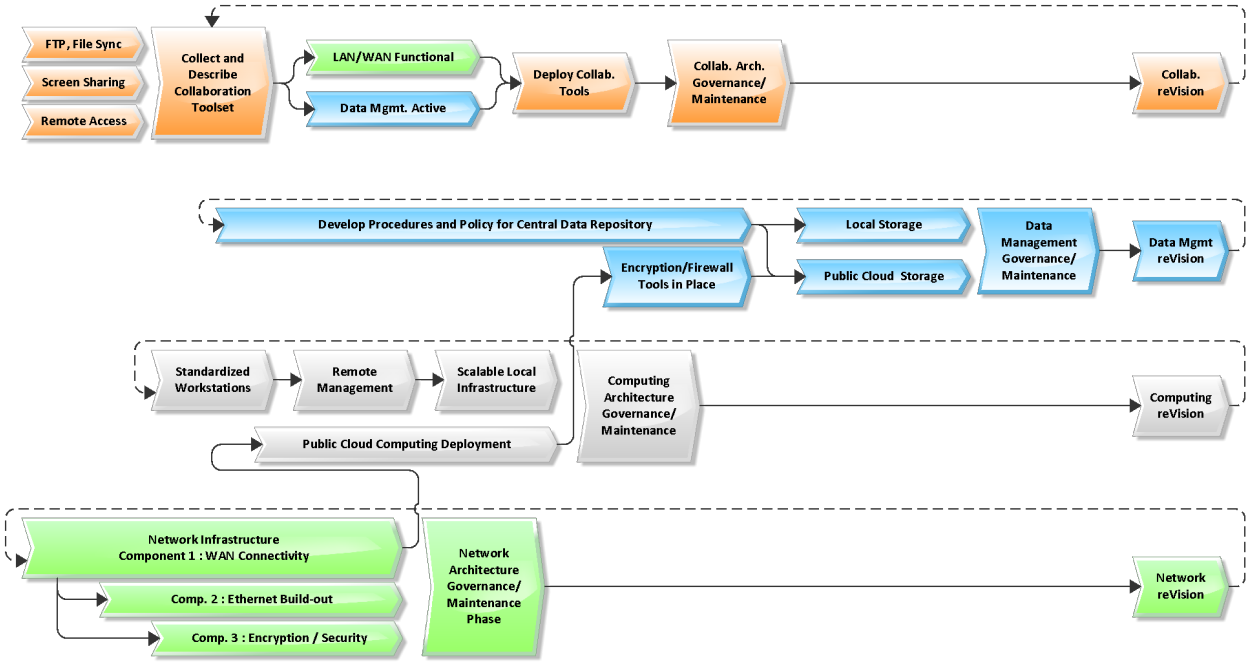


Figure 8 – A deployment roadmap showing the key components, phases and sequencing of the solutions presented in Section 5. Time scale depicted from left to right is on the order of eight to ten months. This figure is duplicated in larger size in Appendix A

7.0 CONCLUSIONS

Launching an enterprise architecture (EA) program is a daunting task in any company, particularly when the company is small and acting with limited resources. By leveraging the development framework contained in TOGAF, K3RI's business case can be adapted to an architecture program despite the apparent complexity. It is clear from this initial development phase that EA will be most successful with a balance of planning and deployment to create an iterative cycle of improvement over the course of business growth.

Several key capabilities emerged with successive generalization of the architectural issues at K3RI. The capabilities identified as critical to the entire foundation of execution are: connectivity, data management and security, collaboration, and cloud computing. The core issues at K3RI seem to follow a pattern of dependence on at least one of these critical capabilities.

While not comprehensive, the findings and research conducted herein have contributed to a framework from which stakeholders at K3RI can confidently proceed with allocation of resources and build-out of technology capabilities. A recommended course of action moving forward is to secure funding and begin infrastructure development using the deployment roadmap as a guide.

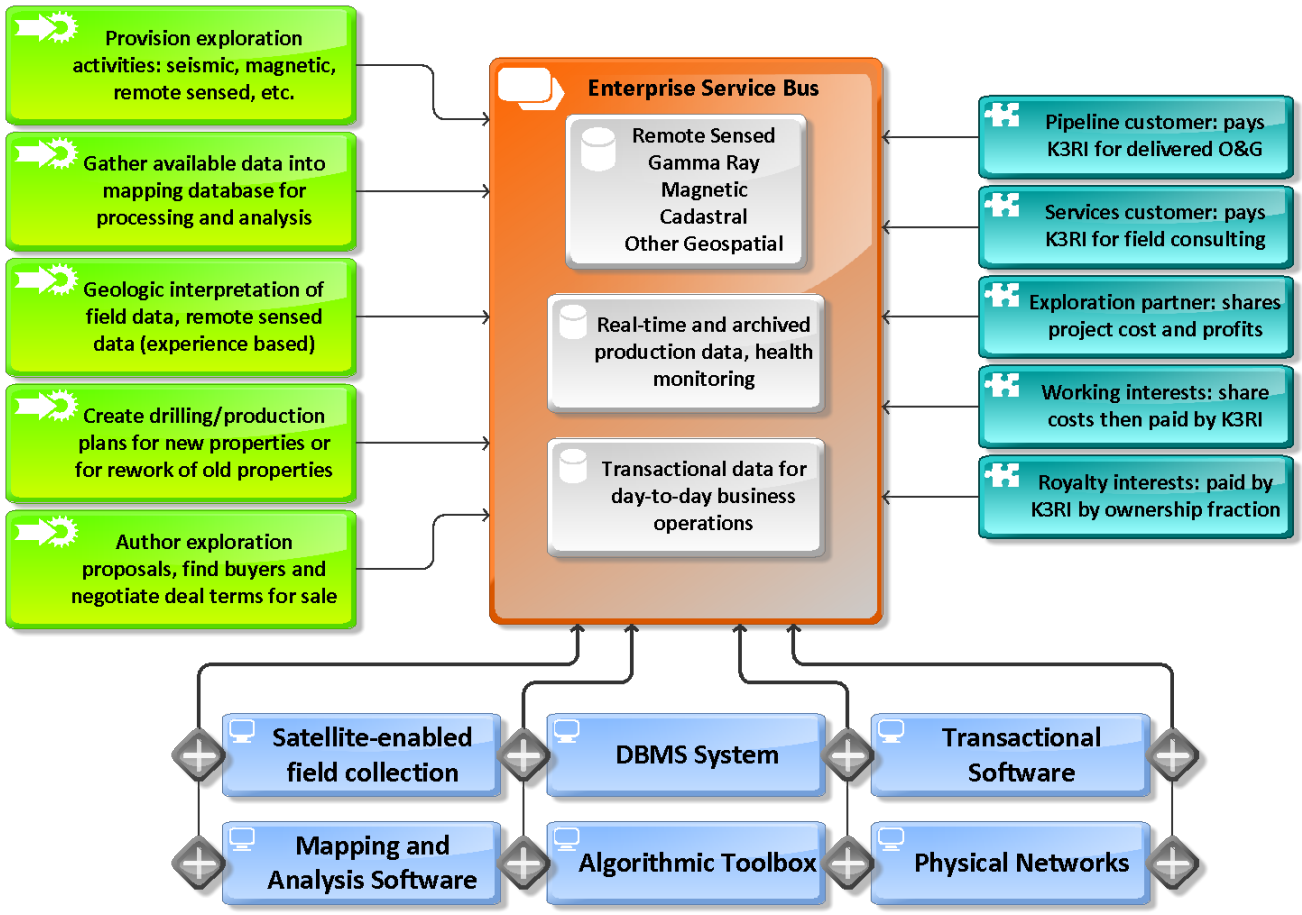
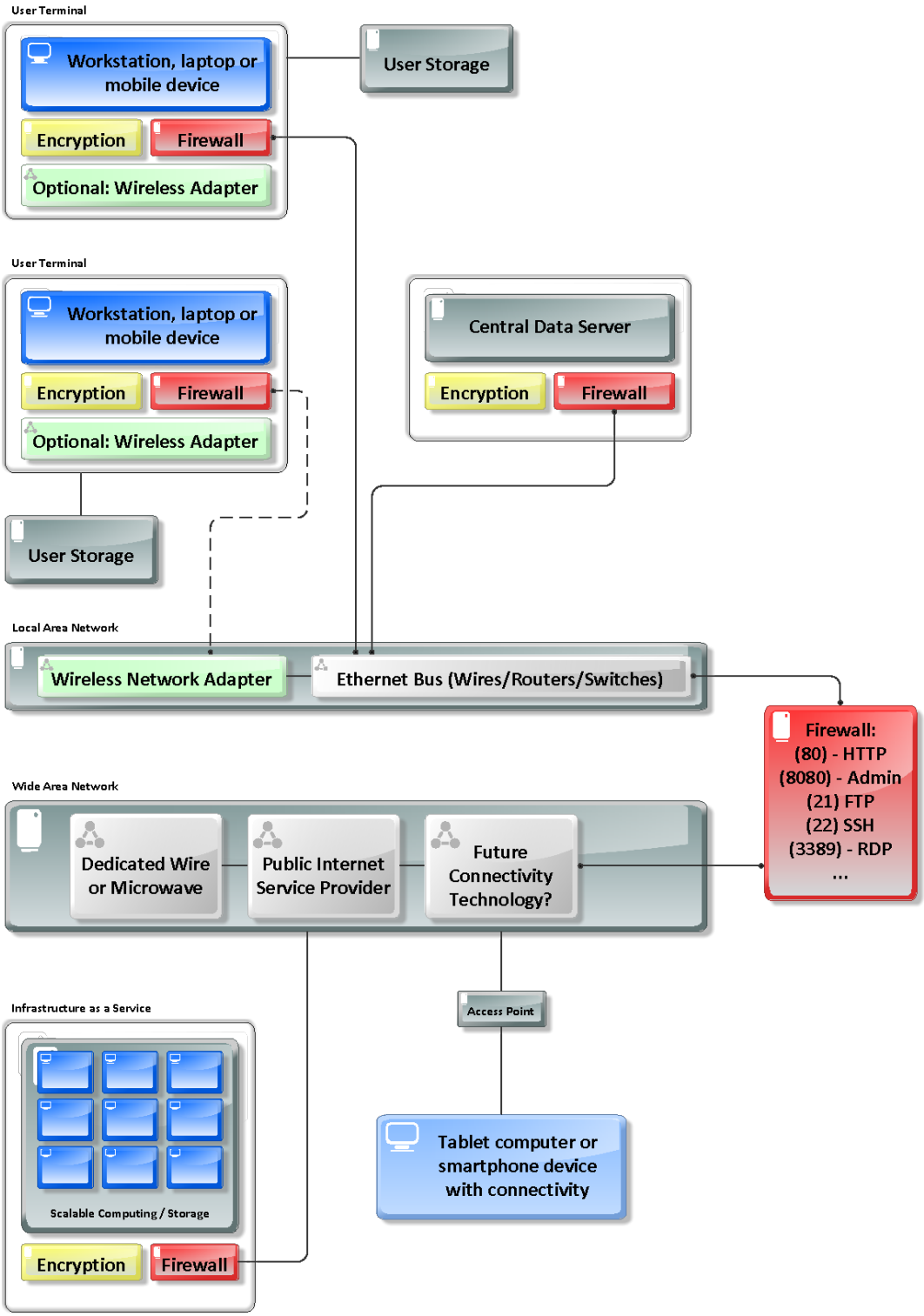


Figure 9 – Diagram of the overall K3RI business core shows a centralized "service bus" that ties together workflow (at left, green), customers and partners (at right, teal), technology systems (bottom, blue), and a centralized data repository (center, orange).

*Figure 10 (below) –Target network infrastructure for K3RI. The principle is to have local **and** wide area connectivity between workstations, mobile devices and the "cloud" computing infrastructure. Encryption for sensitive data and firewall configuration is central to security.*



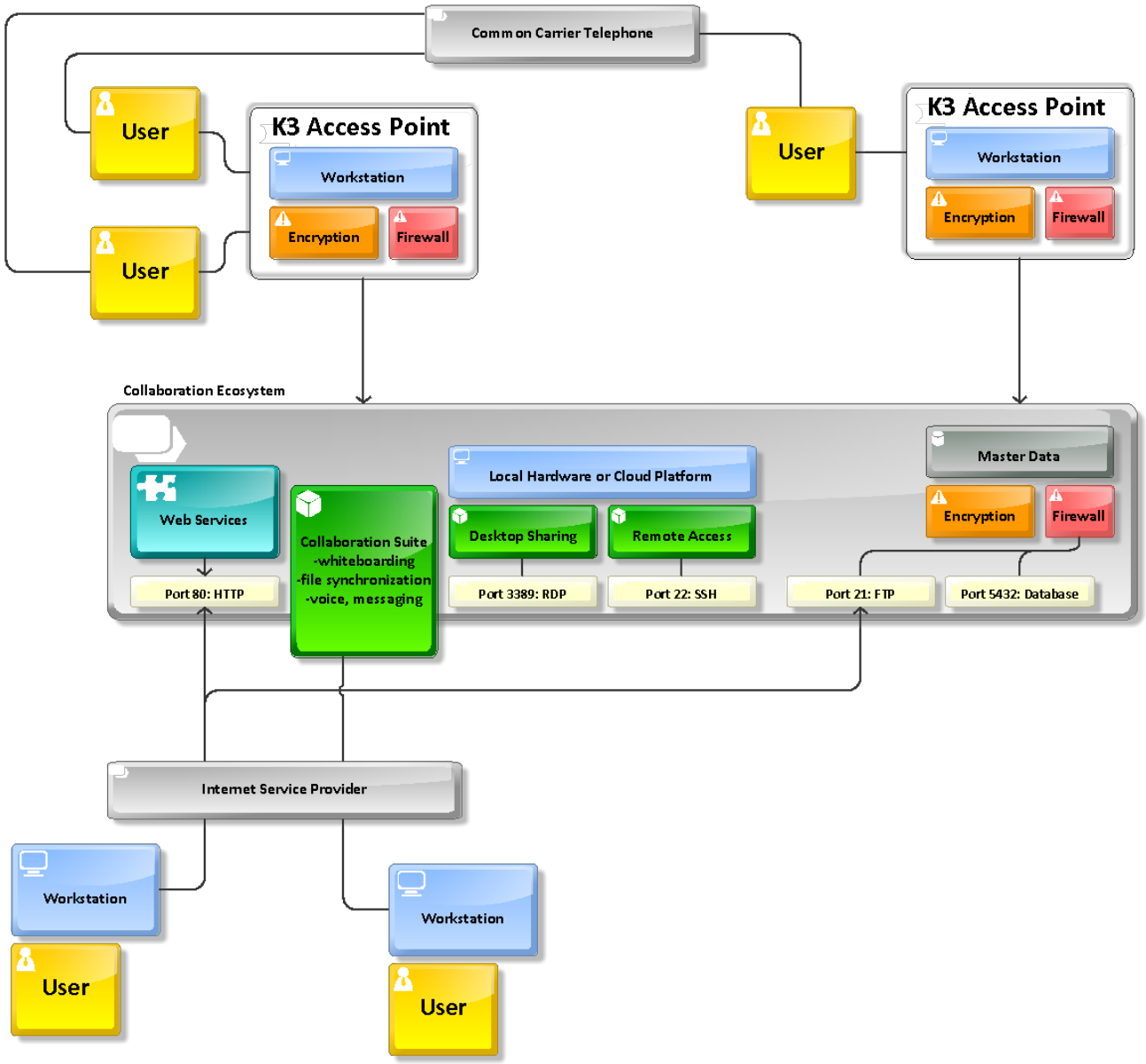


Figure 11 – The K3RI collaboration ecosystem centers around a toolset comprising standard internet protocols (HTTP, FTP, RDP, others) and leverages component applications such as screen sharing and data services. Access points use encryption and firewall policy to restrict access to sensitive areas of the infrastructure.

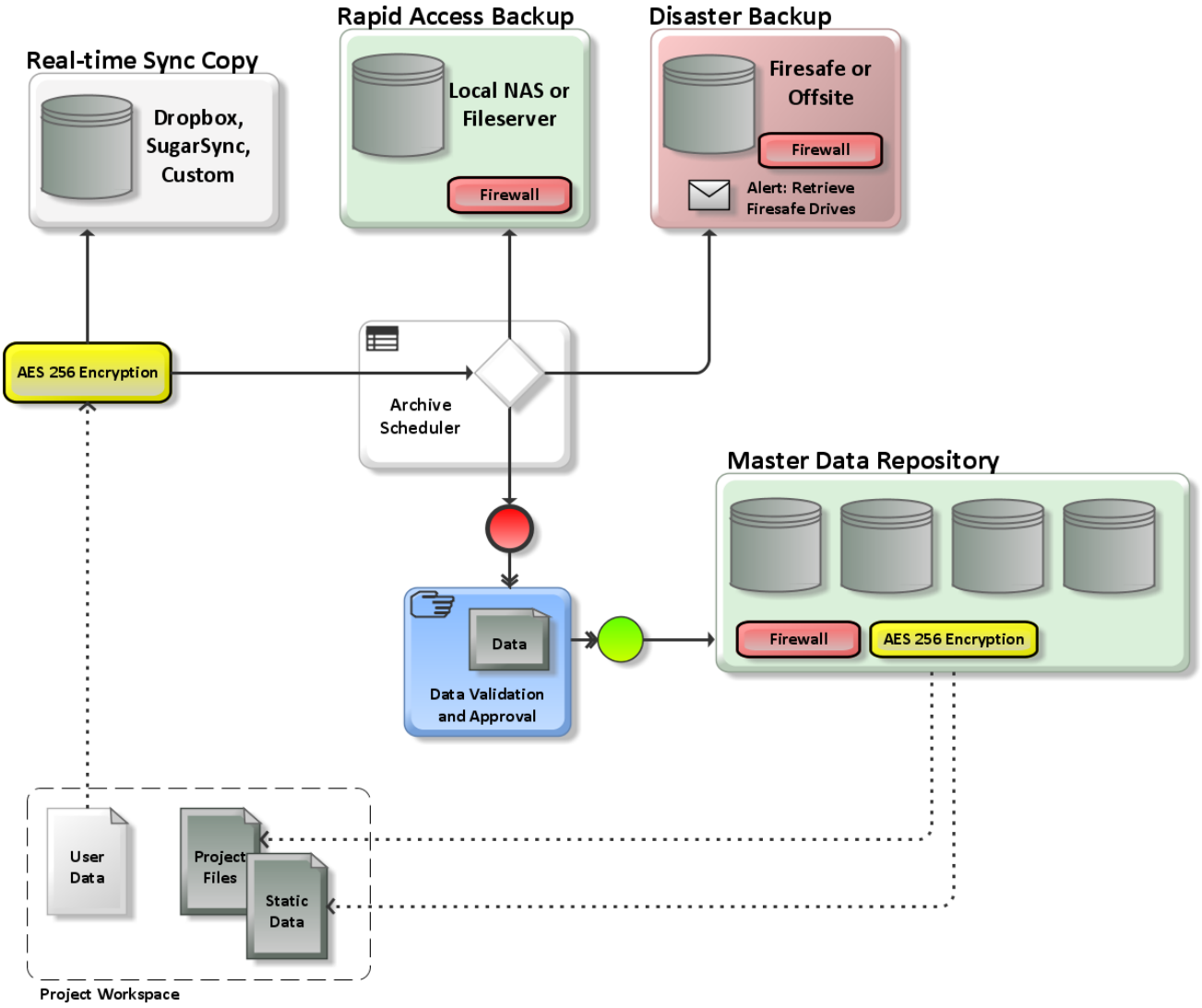
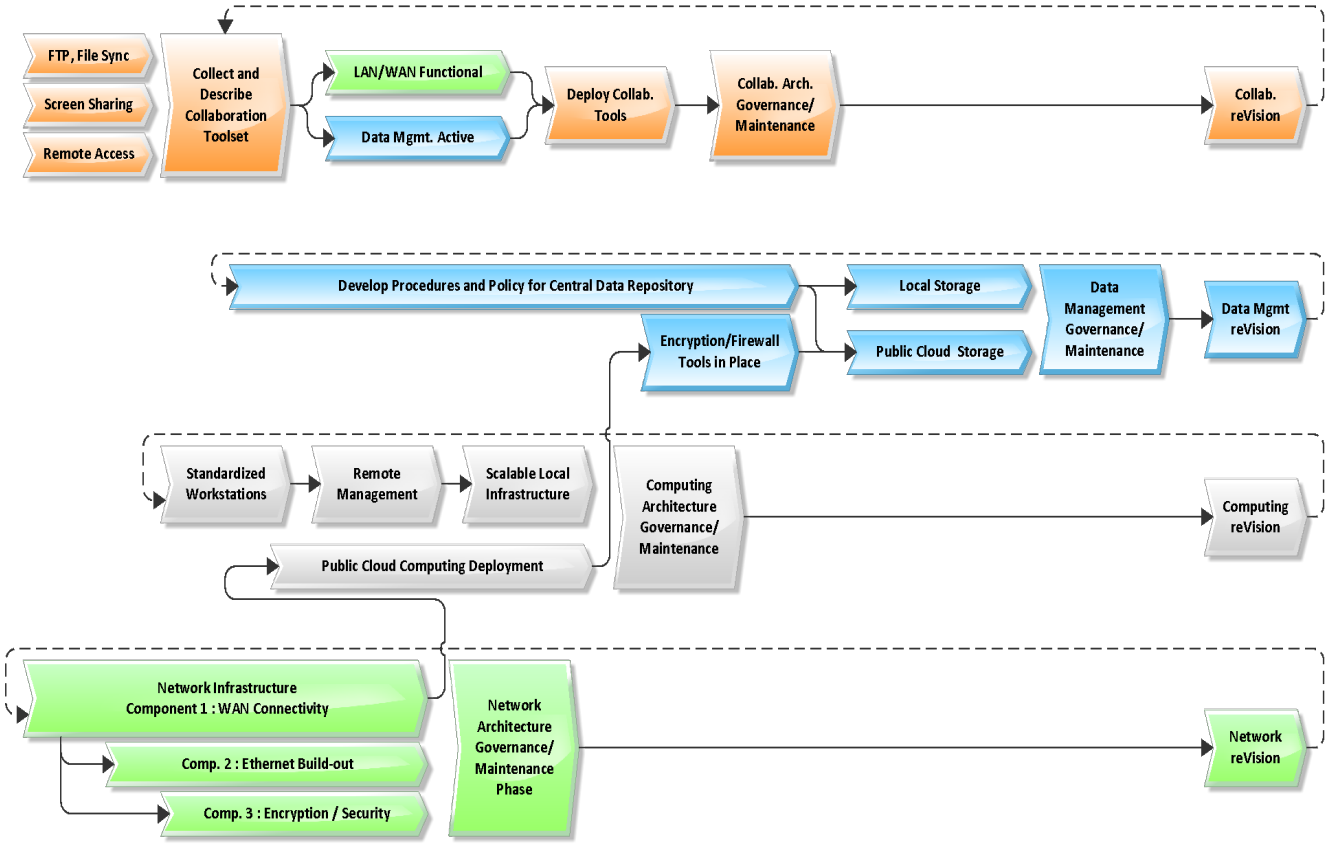


Figure 12 –The flow of data starts when a user generates or collects data. The files are immediately synchronized on a variety of backup systems and sent to a validation queue where they are approved and sent to the master data repository. On any given project, the user will likely access many files from the repository to add content to the workspace.

Figure 13 (below) – (Duplicate of Figure 8) Implementation Roadmap shows features and flow of collaboration, data storage and security, hardware, and networking architectures. Timescale represented is approximately 8 to 10 months.



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AUTHOR'S BIO

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ROBERT WOOD: ORGANIZATION-SPECIFIC ENTERPRISE ARCHITECTURE ANALYSIS OF A MAJOR FINANCIAL SERVICES SECTOR SYSTEMS PROVIDER

EXECUTIVE SUMMARY

ABC Systems (ABC), a system provider to the financial services sector since 1968, has embarked on significant organizational change in recent years as market conditions have changed and new corporate strategies have been articulated.

While ABC has started the process of change in a number of areas, adherence to Enterprise Architecture (EA) principles can help the organization to achieve its goals more efficiently and cost-effectively. Acquisitions, involvement in new industries and new lines of business, and the challenges of maximizing current investments will keep ABC busy for the foreseeable future.

This paper endeavors to define the environment in which ABC operates, identify specific architectural challenges presented to the company, and provide recommendations for effectively and efficiently overcoming those architectural challenges.

Specifically, this paper looks at ABC in the context of the TOGAF framework and specific solutions are recommended from an organization-specific perspective. While many important architectural elements are available to ABC, the ultimate success of its articulated corporate strategies ties closely to the success of its EA efforts to address and remediate identified architectural issues.

GENERAL BACKGROUND OF PROJECT TOPIC

ABC is a major system provider to transfer agents in the financial services sector. Their core offering is a system that is used for shareholder accounting by many Fortune 100 mutual fund companies. ABC has been in business since 1968 and profitable for most of that time. However, recent trends in account management, due to the success of large brokerage houses like Charles Schwab, have significantly reduced revenues from their core offering. ABC's response to this market shift has been to enact a corporate strategy that includes the addition of several lines-of-business, optimizing IT resources, and reducing costs where possible.

ABC has made a number of acquisitions over the last few years. These acquisitions have resulted in a complex landscape with varied stakeholders. This structure is detailed in the stakeholder map matrix in Appendix C.

In addition to providing the shareholder accounting system for several Fortune 100 mutual fund companies, ABC now also provides software solutions for mutual fund compliance testing and oversight as well as printing services for mutual fund transfer agents. Mutual fund servicing functions now offered include fund accounting, transfer agency, legal, compliance, and sales in the open-end, closed-end and ETF markets. Adding to the complexity and thanks to recent acquisitions, ABC now provides system solutions to the healthcare industry.

Over the years, ABC has made significant investments in IT infrastructure to support its flagship product offering. Two world-class data centers are in operation and managed by ABC and used to provide IT services and recovery capabilities to the parent company and subsidiaries.

Acquisitions made in recent years have created significant challenges in terms of integration and optimization of IT resources. Several of the acquired companies had contracts with third party data center providers and owned significant amounts of hardware that differed from the ABC corporate standard. Where possible, services provided by acquired companies to employees were relocated to existing ABC platforms in ABC data centers and acquired hardware was retired or redeployed. Where this was not possible, acquired hardware was relocated to ABC data centers and maintained there through its useful life. Also, most of the newly acquired business units were given access to centralized SAN resources for storage therefore allowing them to leverage existing data replication processes for disaster recovery purposes.

Because ABC endeavors to provide world-class IT infrastructure resources to its associates, acquired business units have been given access to resources via redundant data lines. These redundant lines are provided by multiple telecommunications providers. Providing business units with robust access to the corporate data centers is meant to keep hardware needs at remote offices to a minimum.

ABC's centralized resources are intended to address the final strategic item; cost reduction. With IT resources centralized, remote offices should require minimal personnel for desktop support and have limited power and cooling needs. The result should be that people and technology costs are kept to a minimum.

Because these strategic goals should feed the bottom-line when realized, the TOGAF framework and related ADM tools should be leveraged to make them achievable. The goal of this paper is to identify the specific architectural issues that must be addressed and provide recommendations for solving them.

MAJOR ARCHITECTURE ISSUES

- *Organizational* – As the sources of data have increased over time, seamless access to that data is required for both internal and external stakeholders.
- *Data* – Internal stakeholders need access to multiple pools of data on multiple platforms for multiple lines of business while external stakeholders need access to more limited amounts of data but also across multiple lines of business.
- *Information and Knowledge* – Centralized data, especially data about clients, is needed by multiple groups to facilitate new business and service existing clients.
- *Information Technology* – Central, replicated SAN resources are required by business units to ensure uninterrupted access to corporate data.
- *Business Process* – Digitization of business processes is needed and access to related documentation is required across the organization, including clarification of the relationships between key groups.
- *Controls/Metrics* – Proper controls and related metrics are vital to understanding the health of the IT operation and planning for actionable improvements.

ANALYSIS OF PROJECT TOPIC AND MAJOR ARCHITECTURAL ISSUES

The following section details the major architectural issues that need to be addressed by ABC. These issues are considered in the context of the TOGAF framework, and specifically from an organization-specific architecture viewpoint, with a goal of recommending appropriate solutions. “Focusing strongly on the to-be situation…” (Rik Bos, 2012) and planning solutions accordingly will help ABC to achieve its strategic goals.

ORGANIZATIONAL ARCHITECTURE

Organizational architecture is a key consideration at ABC. Providing seamless access to data for both internal and external stakeholders has been identified as a critical need and it is important that ABC understand the related issues and potential solutions.

Internal users have the most substantial need for data access. The data needed by this group can be categorized into three data pools. The first is that data needed by all associates across the enterprise. The second is that data needed by operational personnel. The third is that data needed by non-operational personnel including those working in sales and client relationship management functions.

External stakeholders have more limited data access needs. However, appropriate client access is a priority because data must be properly sanitized, secured, and logically presented. There is little tolerance for disrupted or incomplete data access from this group.

Associates across the enterprise need access to data from core internal systems including human resources systems and corporate accounting systems. PeopleSoft’s HR module is used at ABC to provide access to human resources data including benefits information, paid-time-off information, and employee management information. Corporate accounting data, including expense-reporting detail, is provided by PeopleSoft’s Financials module. Both systems need to be more easily accessible. Existing interfaces to this data require third party software to function and a significant number of help desk tickets are generated in their support.

Operational personnel need access to internal line-of-business applications for processing as well as related internal web-reporting systems. While many of the web-reporting systems can easily be made available internally over HTTP, many of the line-of-business applications require thick clients that cannot easily be delivered remotely from the data center as currently deployed. This is an area that should be addressed to achieve the desired centralization of IT resources and related cost savings.

Non-operational associates need access to internal data for multiple purposes. Sales associates need a centrally available data repository for tracking sales prospects. Client relationship management associates need a similar repository that can be used to track communications with existing clients.

External stakeholders have broader but more straightforward data access requirements. Because ABC provides a variety of services to various clients, external users need a secure, readily accessible interface by which they can obtain all data relevant to them. For many external users this interface will need to interact with two or more pools of data that live in operationally distinct and non-integrated systems.

Because "…simplicity…promises clarity, speed and flexibility…" (Nash, 2012), this "single pane of glass" view should provide clients with an optimized experience and leave them with a comfort-level that their data is securely stored and managed in a single location. Further, creating a solution that presents data from "…the viewpoint of the customer…" (Mamaghani, Madani, & Sharifi, 2012) will provide ABC a higher level of technological credibility with clients.

DATA ARCHITECTURE

Data architecture issues are also present at ABC. Internal stakeholders need access to multiple pools of data on multiple platforms for multiple lines of business. External stakeholders need access to more limited amounts of data but also across multiple lines of business**.**

Much of the data architecture challenge relates to standardizing and streamlining access to critical systems. Much of the needs of internal users relate to operational tasks. Many of those tasks are themselves related such that "…change in one particular function or rule can result in various modifications on other rules that fall under the same category or set". (Thirumaran, 2012) The result is that a great deal of data in the enterprise can be consolidated if the underlying systems are made to act on central pools of data.

A good example of the inter-relationship of data comes from the mutual fund processing world. Every day that the stock market trades, transfer agency personnel process trades for individual shareholders. Fund accounting personnel, who need access to this shareholder data, must also pull in data from third party pricing vendors and fund administration expense systems to calculate the net asset value for the underlying mutual funds. Once this has been completed, Compliance personnel must review NAV calculations and determine both if calculations are correct and if fund groups have traded in accordance with SEC and IRS rules. Fund administration personnel must then compile the data from all groups and provide periodic expense reports and financial statements to the legal group. The legal group then reviews the associated data and provides approval for its publication. Finally, the marketing group takes the data and sends it to external stakeholders in print or electronic format.

As currently implemented, data lives in multiple locations. Further, existing levels of integration between systems is not sufficient resulting in duplication of data. In extreme cases, manual re-entry of already reviewed data is required. ABC needs to find a way to achieve a "…convergence between computer and communication technologies…" (Zuppo, 2012) so that data flows efficiently through the operation.

INFORMATION AND KNOWLEDGE ARCHITECTURE

Information and knowledge architecture issues also exist at ABC. Centralized data, especially data about clients, is needed by the sales and client relationship management functions.

Because no formal CRM system has been implemented, too much time is spent by sales staff tracking leads and determining next steps in the sales process. Many sales associates track leads using spreadsheets. Some have built small databases using Microsoft Access, but there is currently no central repository for sales data. Further complicating the issue is that several of the business units are pursuing the same clients for slightly different purposes. Lack of a CRM system leads to the occasional embarrassment of two different business units reaching out to the same sales leads.

Client relationship management has been identified by senior management of ABC as a critical function. However, lack of a formal system to address this has led to angst with some clients. The simple perception that business units within ABC are not communicating can lead to client dissatisfaction and ultimately client attrition. Unfortunately for ABC, some clients have provided feedback to this effect.

INFORMATION TECHNOLOGY ARCHITECTURE

Information technology architecture is another important architectural issue at ABC. Central storage and the related benefits of data replication between data centers have been identified as a critical goal.

ABC has spent a great deal of resources getting redundant, world-class data centers up and running. An important component of the established configuration is that a storage area network (SAN) has been established such that all data in the primary data center is replicated at 15-minute intervals to the secondary data center. Also, investments have been made in so-called "Big Data" platforms including an enterprise-wide offering that provides centralized access to disparate data for market research purposes.

The challenge that ABC now faces relates largely to the number and variety of businesses acquired over the last few years. To fully leverage investments in SAN technologies at the data centers as well as big data capabilities, the majority of stored data must reside in the corporate data centers. ABC has stated that it wishes to achieve data integration between business units and in the process "…solve the issues of bulk data movement, replication, synchronization, transformation, data quality and data services…" (Hansen, 2012) While important strategically, tactically completing data migrations and providing the appropriate connections for big data is challenging. The result is that many acquired systems still live in remote offices.

BUSINESS PROCESS ARCHITECTURE

ABC must also address business process architecture issues to realize its strategic goals. Digitization of business processes is needed and access to related documentation is required across the enterprise. Graphical documentation tools should play a part in capturing this information and providing visual aids for those who own business processes at all levels.

The breadth of business processes at ABC is significant, especially given recent acquisitions. As such it is important that the company fully understand internal processes such as HR and corporate accounting that spread across the enterprise, internal operational processes that are specific to the various lines of business, and business processes that involve interaction with clients. Appendix A provides a graphical view of ABC's core system diagram and attempts to depict the complex relationships at play within the company.

Documenting internal processes that span the enterprise is important and will help ensure that employees are serviced efficiently thereby reducing the risks associated with unhappy employees. ABC must understand and clearly communicate how it will interact with its employees, the ways in which employee activities will be monitored, and proper methods of handling exceptions to stated policies. From a corporate standpoint ABC must understand how expenses are tracked and controlled, the ways in which corporate data is compiled and communicated to corporate stakeholders, and the controls in

place to ensure compliance with regulations and reduce associated regulatory risk. The documentation in this area needs to be addressed and is a recognized shortcoming for ABC.

Proper documentation and digitization of internal operational processes at the business unit level will increase the efficiency of operations, reduce the risk of operational errors, and provide clients assurance that their data is being properly handled and secured. For ABC, unfortunately, this documentation and digitization is lagging resulting in error rates higher than are acceptable to senior management.

Because business is ultimately about the clients, proper documentation and digitization of business processes related to clients is imperative. Not only will this standardize interactions with clients and therefore improve client satisfaction, it will also improve the security posture of the organization related to the client data that it handles and stores. "External electronic integration allows firms to connect with business partners". (Nazir & Pinsonneault, 2012) As with other documentation, ABC needs to improve this area of documentation and solidify and digitize the related business processes.

CONTROLS AND METRICS ARCHITECTURE

Controls and metrics architecture is a final area that must be addressed by ABC. Due to the fact that ABC operates in both the financial services and healthcare industries, proper controls and tracking of metrics is critical. It is also important that ABC quantify the value of its IT operation using metrics since "…like any investment there is a need to justify IT expenditure through demonstrating value." (Wilkin, 2012) Regulations including HIIPA, GLBA, SOX, and PCI-DSS are also daily concerns and it is important that ABC have the appropriate controls and metrics to allow them to stay in compliance with these regulations. As such, incident handling and response procedures, metrics related to IT operations, and audit procedures as related to regulatory agencies must be clearly defined.

Incidents are a fact of doing business. Properly responding to those incidents can be the difference between a minor issue and one that threatens the ongoing health of the company. As such, business processes for handling standard incidents must be spelled out and communicated regularly. ABC systems needs to improve in this area to both reduce risk to the organization and to provide greater assurance to clients that ABC can handle situations as they arise.

Metrics allow IT managers to gauge the health of operations. Understanding the frequency and duration of downtime in the IT operation, tracking error rates and trends, and capturing feedback from stakeholders are good ways of understanding the current state and making improvements for the future state. This is especially important because "…poor strategies in managing one or more [IT] factors can lead to a failure [emphasizing that] IT and business models have become virtually inseparable." (Wilkin, 2012) As with other areas, ABC needs to establish more formal metrics and manage them effectively ongoing.

Audits both allow businesses to validate that they are doing what they need to be doing and to provide clients a mechanism by which they can verify that their vendors are doing things the right way. Effectively navigating audits is critical to businesses as missteps in the audit process can lead to client angst and regulatory penalty. Ultimately, ABC needs to ensure that "…corporate IT systems [comply] with predefined policies, procedures, standards, guidelines, specifications, or legislation". (Rik Bos, 2012) Though ABC regularly undergoes audits from various agencies, a better-documented audit process is needed.

FRAMEWORK CONSIDERATIONS

TOGAF's ADM provides a useful structure for planning architectural solutions. Defining the overall architectural vision and documenting the business architecture and related information systems and technology architectures establishes a clear picture of the organizational landscape. Considering the enterprise through this framework enables effective planning as opportunities and solutions are identified, governance established, and change management processes socialized. Further, TOGAF's ADM framework provides access to a rich collection of artifacts and buildings blocks that can be used to memorialize the current state and plan for the future state.

This section outlined the major architectural issues that need to be addressed by ABC. Considered from an organization-specific architecture viewpoint, the goal has been to make clear the issues and provide context for the recommendations that will be made in the following section of this paper.

RECOMMENDED SOLUTIONS AND HIGH-LEVEL ROAD MAP

Regarding organizational architecture, there are several ways that ABC can address identified issues. Solutions need to be designed to address the needs of both internal and external stakeholders. Further, tools from the TOGAF ADM framework should be incorporated to enforce recommended architectural changes.

As identified previously, all internal users need seamless access to HR and corporate accounting systems. The ERP system currently in place to provide that access is PeopleSoft. On the HR side the solution is PeopleSoft HR and on the corporate accounting side the solution is PeopleSoft Financials. While both products can be delivered via web interface, the current iteration requires an outdated version of a third-party browser plug-in, Java, which is both insecure and often unstable.

Because ABC is such a large client for PeopleSoft, the recommendation here is to work with PeopleSoft to either remove the Java requirement for this application or, at a minimum, upgrade it to use the latest Java version. Doing so will greatly reduce the burden caused by supporting an older version of Java and reduce the inherent risks of leveraging a vulnerable plug-in in the production environment. While ABC could look to switch to a different ERP vendor to work around this issue, such a move would be costly and take significant time to complete.

Regarding line-of-business applications, much of the current challenge relates to the lack of standardization in providing access to these systems. Some applications are hosted in the data center and accessed remotely using Terminal Services, some are accessed remotely using Citrix, and others are hosted locally at business unit locations. This causes headaches for support staff and increases cost because of the additional support required.

The recommendation here is that the company mandate that all line-of-business applications be hosted at the central data center and that business units leverage Citrix to access the applications. While this will take some effort up front, the long-term benefit will be greater security and recoverability for the systems, reduced support costs to the business units, and better reliability of the systems for end users. An alternative, selecting line-of-business applications that are offered in a SaaS model, is not practical given the current investments in existing solutions.

Regarding the needs of non-operational associates, the recommendation is to license SalesForce.com. This cloud solution will address the needs of both the sales and client relationship management groups by providing a central repository for both sales lead and client data. IT support costs will be eliminated and security of data can be ensured contractually. Service can also be guaranteed contractually with service-level agreements. This solution is more practical than attempting to implement a CRM system internally as it can be achieved more quickly and with less up-front cost.

As for external system users, the recommendation is to create an optimized portal that can provide users a sanitized view into all of their pools of data provided by ABC. The portal should be Internet-facing, leverage SSL encryption for data-in-motion security, and be monitored continuously for security. While this data could also be delivered using methods such as SFTP, a web portal provides ABC an opportunity to display its technological capabilities and improve client satisfaction.

Identified data architecture issues can be addressed by buying or building appropriate interfaces for line-of-business systems. As such, the recommendation for ABC is that they evaluate interactions between systems and identify areas of integration. This will allow them to determine the most cost-effective solution. Further, because so much operational data is passed between business units, reducing manual processing and eliminating duplication of operational data must be a priority for ABC. While manual processes could be maintained and optimized to some degree, eliminating data redundancy and digitizing data moves will reduce errors and the costs related to those errors.

SalesForce.com is the recommended solution to address identified information and knowledge architecture issues. This system not only makes the data easily accessible for end users, it can also serve as a central repository for both sales leads data and data on existing clients. Because this is a cloud solution, staff members from all business units can easily retrieve and update data. Further, data duplication is reduced as users access it centrally. While it is feasible to license and support a system in the ABC data center to provide CRM functionality to the sales department and client relationship management group, SalesForce.com is easily implemented, industry-tested, and secure.

Information technology architecture issues can be addressed by fully leveraging the corporate investments in SAN technologies. Because the ABC SAN networks have been configured to replicate from the primary data center to the backup data center, all data stored in the SAN environment is protected and secure. ABC should prioritize the migration of business unit data to data center SAN devices and work to achieve as high a level of standardization as possible. While workarounds could be implemented that would allow for operational data to be housed outside of the central data centers, the costs of maintaining a separate recovery strategy for exception situations are impractical.

Technologies needed to address identified business process architecture issues are largely in place. The recommendation for ABC is for it to leverage Microsoft SharePoint to capture and manage business process documentation across the board. This product will allow users to establish the interfaces that they find most conducive to maintaining and communicating business process information. Further, this data can be made available to clients if SharePoint is deployed to support external access. While this data could be stored in network file shares, SharePoint provides structure and gives users the ability to customize the ways in which data is presented to stakeholders.

Controls and metrics architecture issues can be addressed incrementally. A good first step for ABC is to document and socialize a formal incident response process. This should include step-by-step procedures

for handling multiple incident scenarios. Microsoft SharePoint can be the repository for this information and access provided accordingly.

ABC also needs to identify and publish useful IT operational metrics. These should include metrics detailing the levels of confidentiality, availability, and integrity of data housed in ABC's systems. Further, this data should be made available in dashboard format to upper management. Once again, Microsoft SharePoint will work nicely for this effort.

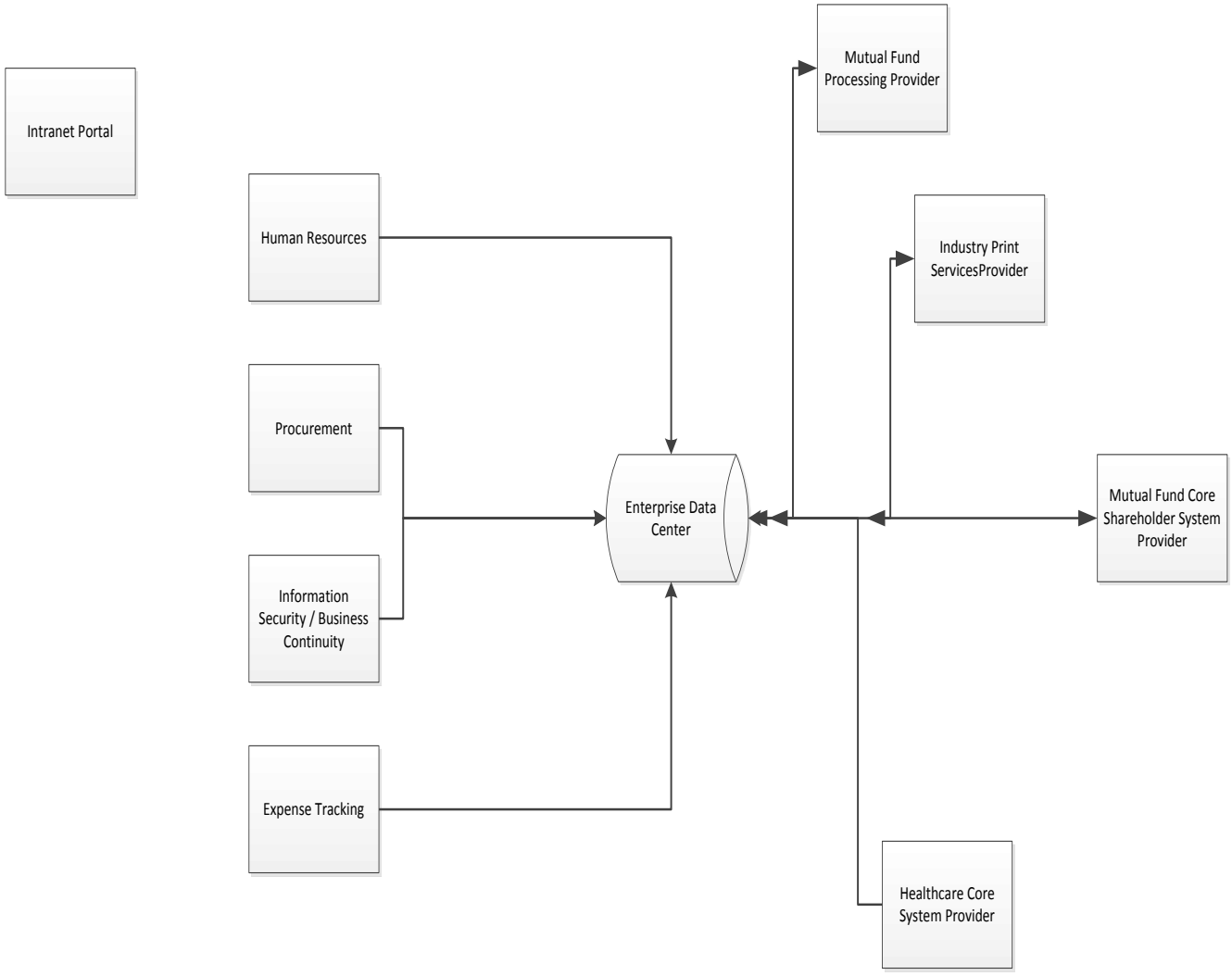
A final recommendation for ABC relates to audit planning and documentation. ABC should leverage Microsoft Visio to memorialize audit processes. This documentation should be stored in SharePoint and made available to both internal and external stakeholders as needed.

ROAD MAP – PRIORITY OF ITEMS

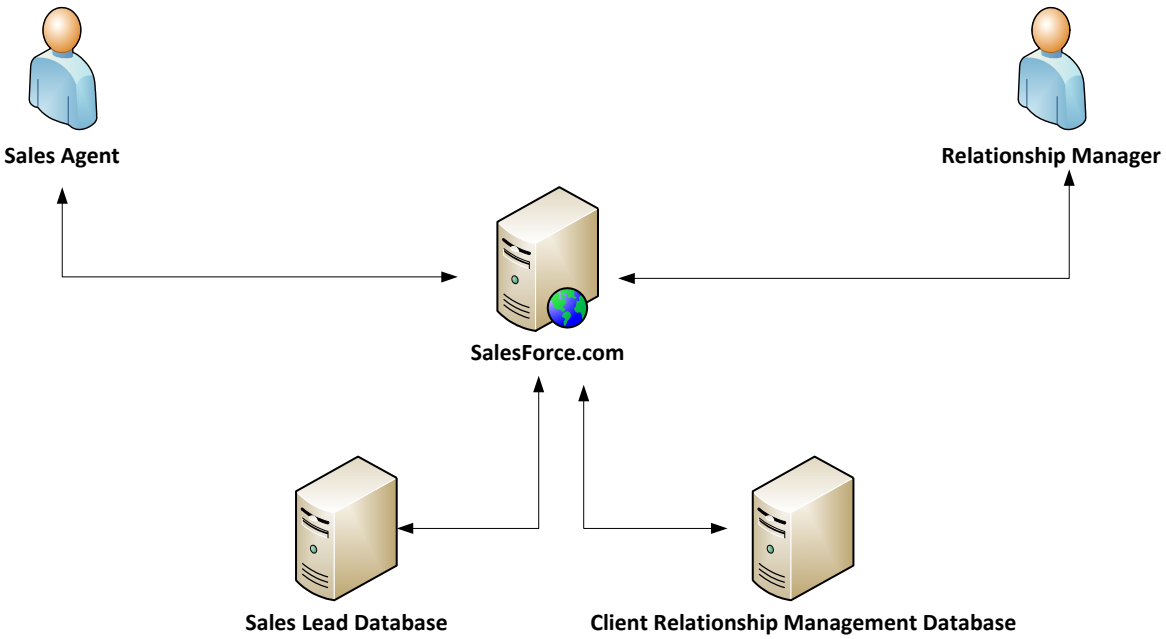
Architectural Issue	Recommended Solution	Priority
Organizational Architecture / Data Architecture / Information and Knowledge Architecture	Implement SalesForce.com.	1
Organizational Architecture	Work with PeopleSoft to remove Java requirement.	2
Organizational Architecture	Mandate the use of Citrix for line-of-business applications.	3
Organizational Architecture	Build an Internet-facing, web-based client portal.	4
Data Architecture	Identify data interface gaps and build appropriate interfaces.	5
Information Technology Architecture	Enforce use of SAN for all business units.	6
Business Process Architecture / Controls and Metrics Architecture	Deploy Microsoft SharePoint in conjunction with Microsoft Visio.	7
Controls and Metrics Architecture	Established IT Operational metrics.	8
Controls and Metrics Architecture	Formalize Incident Response Procedures.	9

APPENDICES

APPENDIX A – ABC SYSTEMS CORE DIAGRAM



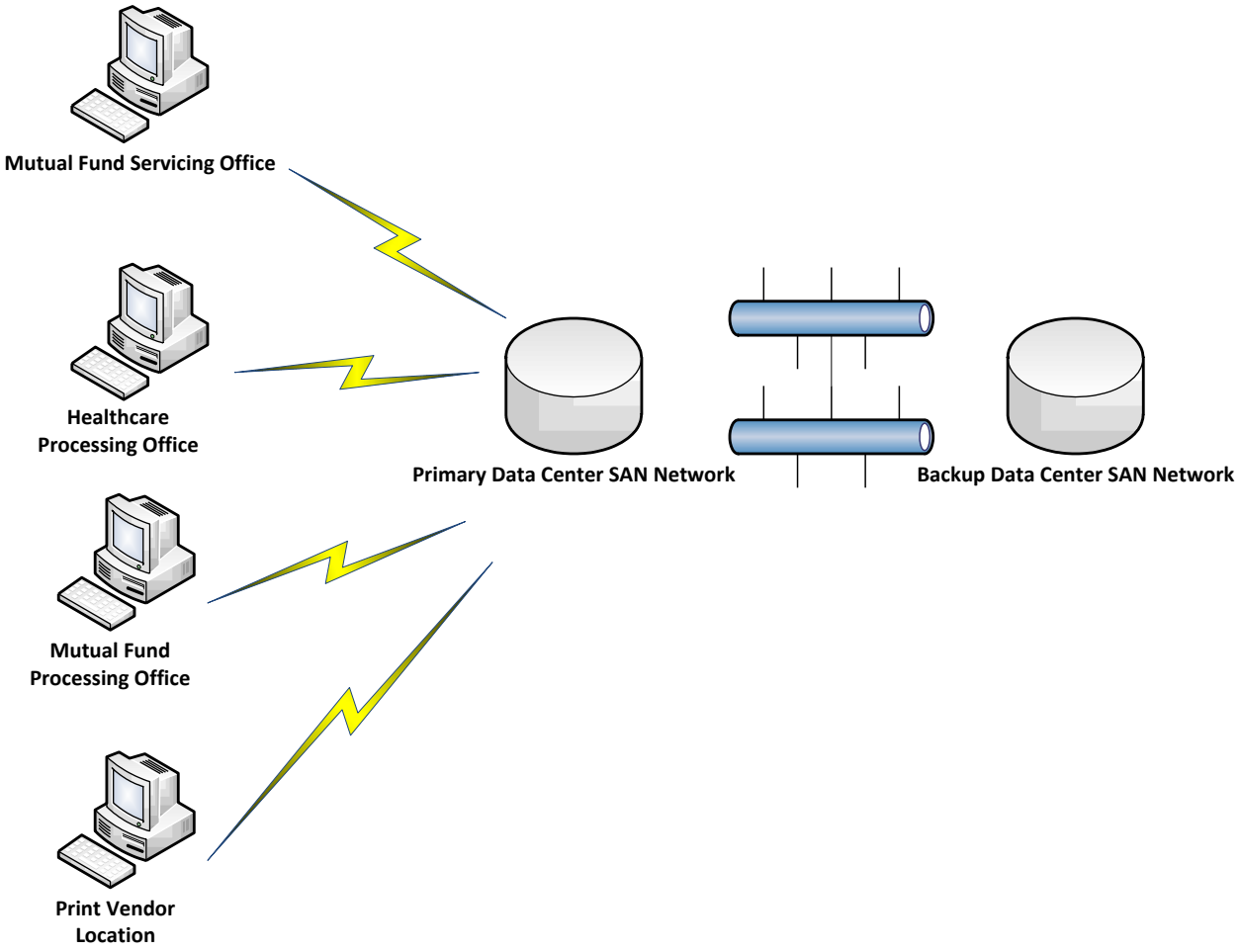
APPENDIX B – SALESFORCE.COM USE CASE DIAGRAM



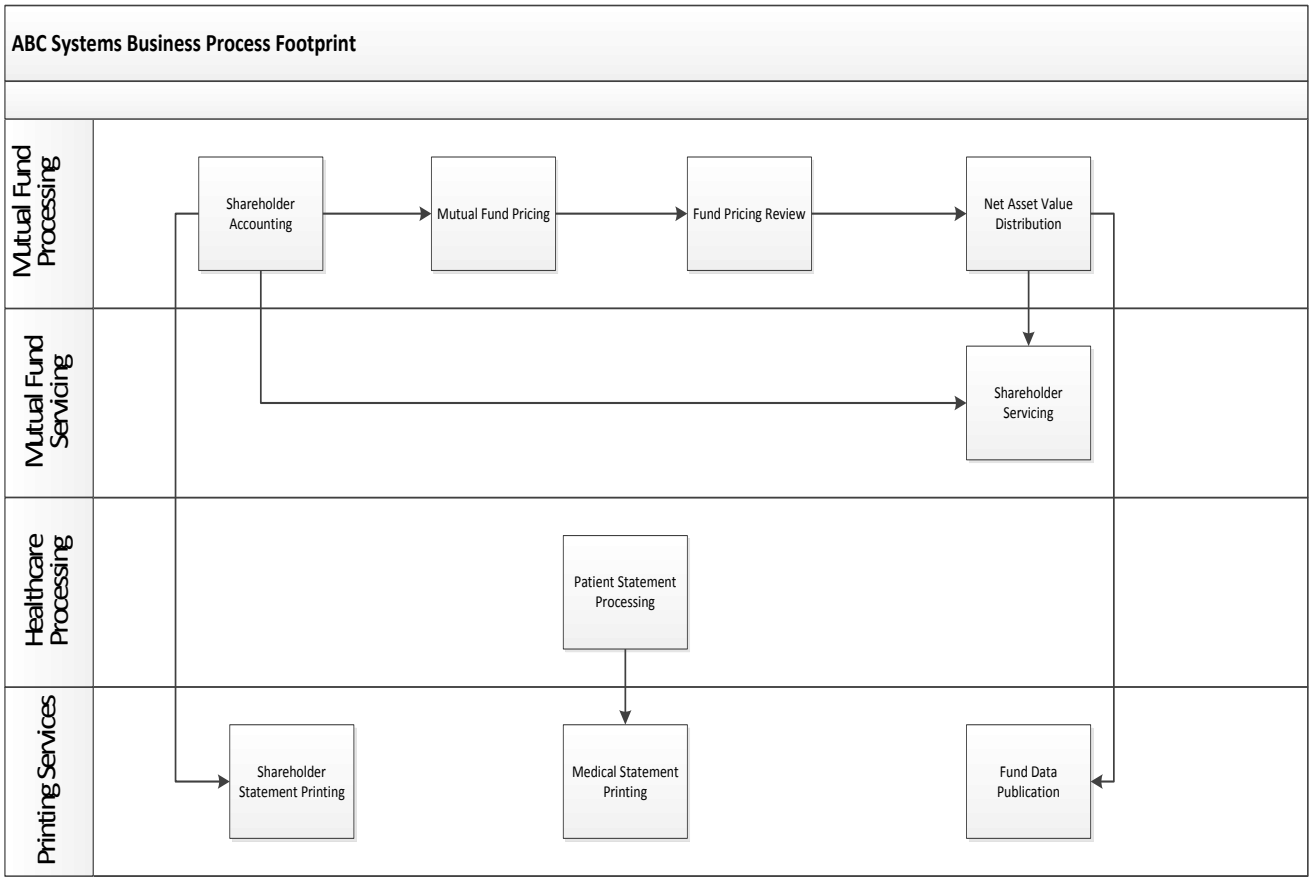
APPENDIX C – SHAREHOLDER MAP MATRIX

Stakeholder	Involvement	Class	Relevant Artifacts
Executive	This group is most interested in tracking the health of the organization. They set the goals and objectives for the organization and closely monitor the relationship between IT and the business.	Keep informed.	Dashboard-level reports.
Internal Systems Users	Employees across the enterprise use PeopleSoft HR for HR functions.	Keep satisfied.	Reports and notifications.
Line of Business Application Users	This is the operational staff responsible for daily processing across a range of complex applications.	Keep satisfied.	Reports and web interfaces.
Corporate Accounting System Users	This group leverages PeopleSoft Financials for expense tracking and reporting.	Keep satisfied.	System documentation.
Client	Clients are primarily interested in accessing their data via secure, external-facing web applications.	Keep satisfied.	Reports.

APPENDIX D –SAN NETWORK DIAGRAM



APPENDIX E – BUSINESS FOOTPRINT DIAGRAM



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STEPHANIE LIVSEY: ORGANIZATION-SPECIFIC ENTERPRISE ARCHITECTURE FOR ROTARY INTERNATIONAL

EXECUTIVE SUMMARY

Rotary International is a non-profit organization that has more than 1.2 million members in local clubs around the world. From Tajikistan to Thailand and Canada to Australia, member clubs within the organization join together for a unified mission of service above self. Members are dedicated to improving the lives of people in their local communities and around the globe. However, many clubs operate in silos. A lack of information systems that facilitate communication among worldwide clubs and centralized data and information perpetuates many clubs, especially those in developing countries, to be left in a silo.

A need exists for better communication and information systems that will enhance data collection and storage among clubs to allow seamless sharing of data among its members. Clubs have a wealth of information to gain from being able to communicate with other clubs and analyze where they stand in regards to other clubs. Making information accessible at the lowest club level facilitates the sharing of ideas and joint, international projects at the club level.

By designing an Enterprise Architecture that can overcome language barriers, find solutions to make data accessible at all levels, standardize data collection for uniform reporting, and account for disparities in available technology throughout various regions, Rotary International can prepare its stage for future growth and tighter integration and seamlessness among its member clubs.

BACKGROUND AND ISSUES

COMMUNICATING ACROSS AN INTERNATIONAL ORGANIZATION

With more than 34,000 local clubs in cities all around the globe, Rotary International is a worldwide non-profit organization dedicated to the idea of service above self. Rotarians volunteer their time, money, and available resources to help their local communities and join together for organization-wide projects, such as the eradication of Polio around the world. Managing an organization that has 1.2 million members who speak different languages; have various cultures, beliefs, and social norms; and are scattered across the world has its challenges (Rotary International). But, an Enterprise Architecture designed to standardize global processes, procedures, and reporting would offer the capabilities and structure necessary to enhance administrative procedures, foster communication among clubs at all levels, and allow for better allocation of resources.

Current reporting methods. Local clubs within Rotary International are responsible for reporting key pieces of information to the overall organization: new members, dropped members, attendance, club activity, and performance. This data must be frequently communicated to the next level within the chain of command as the events occur. Rotary clubs around the globe utilize various ways in which to report data and often, the same information is reported multiple times through the chain of command,

increasing the chances of human error when the final information is eventually recorded at the highest level (see Appendix C, System Context Diagram).

Other methods and processes. As part of an international organization, local Rotary clubs around the world follow similar procedures and governing rules to run their local organizations. Clubs are responsible for recruiting new members; encouraged to communicate with other clubs to develop joint, international projects; and instructed to accomplish both service projects and fundraising activities for the campaigns that support Rotary International initiatives. For many club projects and functions, Rotary International provides the guidelines and rules for each instance of a Rotary International project to function the same, everywhere around the globe.

Individual clubs are entrusted to follow the rules and guidelines, but tools for better communication among clubs worldwide are lacking. Also, the processes for executing and establishing some of the official initiatives are archaic with no way to utilize technology for streamlining the process of things like setting up club projects.

PROBLEMS FACING THE ORGANIZATION

The size of Rotary International alone creates various hurdles and challenges that the organization must tackle to improve its overall processes, move forward in completing its mission, continue setting new goals, and following a strategic vision that will make the foundation stronger and able to continue thriving. Although challenges can be many in an international organization, four distinct issues must be addressed in defining a new Enterprise Architecture at the highest level.

Potential issue: language barriers. Language barriers pose unique problems in developing an Enterprise Architecture. The design must take into consideration systems and infrastructure that will be compatible across multiple languages and all efforts must be taken to remove any possible confusion among systems, processes, and data that might stem from opposing cultural norms among the countries involved.

Potential issue: varying levels of technology. An organization that has many units located in different parts of the world, including under-developed and emerging countries, faces distinct challenges when creating an architecture that can account for a disparity in available technology across regions. Capturing data from the lowest level will require unique solutions that are customizable for the various scenarios that could present themselves.

Potential issue: non-uniform reporting methods. A database is only as good as the information that is entered into it. Developing an architecture that is to be used by an international organization that consists of individual clubs, which speak different languages and have varying levels of available technology, will require unique solutions to enable consistent and uniform data capture.

Potential issue: inaccessible data. Individual units that make up the larger organization serve to benefit from being able to access shared, critical information for analysis and growth. However, an organization that is geographically spread across continents and cultures must address the issue when developing an architecture that will allow the individual units to enter the same data that other units are entering and also allow them to seamlessly retrieve data entered by other units, regardless of location, language, or culture.

BUILDING A FOUNDATION FOR EXECUTION

Before embarking on an Enterprise Architecture project for an international organization, a strong foundation must first be in place in order to set the stage for building a successful architecture.

Current state of the foundation. Rotary International has good practices and processes in place for common tasks and operations that are a part of day-to-day business for a Rotary club. Manuals, guidelines, and documentation can be found in abundance online and in most clubs as Rotary International consistently sends hard-copy materials to club board members. However, few processes are actually digitized. Processing paperwork adds additional costs and requires more time from personnel to process through multiple channels and the command structure. With much data still being captured and stored in hard-copy form, sharing the data becomes difficult and proliferates the behavior of clubs functioning in silos.

Desired state of the foundation. In order for the foundation for execution to be strong enough from which the Enterprise Architecture can be built, Rotary International must define an operating model. In doing so, Rotary International can focus on the concepts and solutions that will allow them to share information easily and quickly, reduce the number of redundant tasks, and be able to support the global spread of its member clubs.

IMPLEMENTING A SOLUTION-ORIENTED ENTERPRISE ARCHITECTURE

Global Organization Calls for Organizational-Specific Architecture

"According to Thomas Friedman, the world is flat! Businesses are strategizing and operating on a global playing field" (Baltzan et al.). This is even truer for an organization like Rotary International. Global-scale projects, such as eradicating Polio from the world, and a leadership board consisting of members from different countries, make Rotary International a truly global organization. For Rotary International, the world is flat.

A global organization, however, demands a careful, well-planned infrastructure, strong vision, and technology to enable operations on such a large scale. An Enterprise Architecture can lead to streamlined processes, more accurate data, timely reporting, greater in-depth analysis of programs and operations, and increased communication among all levels of the organization. Implementing an architecture that is specific to the organization and accounts for the unique circumstances and problems that are presented in an international organization will help the organization to continue growing and enhance its ability to take on global-scale projects that improve the lives of people around the world.

Starting with the foundation. Before Rotary International can embark on a full-scale Enterprise Architecture project, identifying an operating model to guide business decisions and future growth is a critical starting point. Its current state of being proliferates the behavior of individual clubs operating in silos; little to no information is shared among clubs for analysis and reporting methods often require redundant actions that open the data up for an increased risk of human error when recording the information.

Adopting a unification operating model. Rotary International exhibits a clear need for adopting a unification-operating model. The organizations customers, both Rotarians themselves and the individual

people they help through service projects, are both local and global. The business processes – such as adding new members, reporting attendance, requesting matched funds for grants and projects – are integrated on a global scale. The processes are the same from club to club and depend upon the support of the overall organization. Individual clubs serve as business units within the organization and all serve the same Rotary International mission; they function similarly across the board, but have individual characteristics that make each club unique. A centrally mandated database is required for tracking statistics on members around the globe, from individual giving records to dates entered into Rotary International, a single database must be utilized to track and analyze membership and club information.

By choosing the appropriate operating model, companies gain a clear direction for development and overall support of the company strategy (Ross, Weil and Robertson). Starting with a clear operating model and building a strong foundation for execution will give Rotary International the understanding and clear definition of business process integration and standardization from which to develop a successful Enterprise Architecture that will help the organization to continue to grow and thrive (see Appendix A, Rotary International Foundation for Execution).

Greater flexibility with service oriented architecture. Rotary International has member clubs in countries all over the globe. From Pakistan to China and Egypt to Wales, an organization that has to meet the challenges of language barriers, disparity in technology among its business units, and geographic distance requires a solution that is flexible and adaptable for growth and change. A service-oriented architecture, loosely coupled, allows for interoperability that can provide benefits to an organization on a global scale. According to Papazoglou and Heuvel, service-oriented architectures eliminates barriers and facilitates the changing needs of businesses:

> *An SOA is designed to allow developers to overcome many distributed enterprise computing challenges...while allowing multiple platforms and protocols and leveraging numerous access devices and legacy systems [1]. The driving goal of SOA is to eliminate these barriers so that applications integrate and run seamlessly. In this way an SOA can deliver the flexibility and agility that business users require, defining coarse-grained services, which may be aggregated and reused to facilitate ongoing and changing needs of business, as the key building blocks of enterprises.*

Rotary International began as a single club with only four members and a mission of service above self in 1905 (Rotary International). In just over 100 years, Rotary International is now a global organization with a strong mission and growing membership base. An organization that has adapted and changed with technology, growth, and taken on a global presence must focus on being flexible enough to have the ability to continue keeping up with changes. From processes, mission and vision to infrastructure, technology and information systems, a growing organization must change and adapt as growth occurs, economic changes take place, and technology advances.

ADDRESSING POTENTIAL ISSUES AND FOLLOWING A TOGAF APPROACH

Implementing an Enterprise Architecture is a lengthy task that is best done by following a proven method for architecture development. By following an iterative approach, as outlined in the TOGAF framework, Rotary International can build an architecture that identifies and addresses the possible issue areas, strengthens and improves the strong foundation and operating model, and helps the organization to streamline processes and bring together business vision, mission, goals and infrastructure and technology. Using the TOGAF framework, Rotary International will have four broad phases of implementation to build the Enterprise Architecture:

Phase 1: Vision, requirements, and management. Beginning with the Preliminary Phase, Rotary International will define the principles and describe the initiation activities of building and implementing an architecture. Moving into the Architecture Vision, Rotary International must thoroughly define, articulate and understand exactly where the vision lies for the architecture (see Appendix B, Core Diagram).

An Enterprise Architecture for Rotary International will address the key issue areas. The problem of inaccessible data can be addressed at the requirements level and Rotary International must define whether a single database will be used or whether a network of linked databases can be implemented to create a single repository of shared data and information that member clubs will be able to access and utilize for analysis, data entry, and record keeping. Defining what the database requirement is will allow Rotary International to further plan how the information can be made accessible. This is the phase where Rotary International can also decide whether an implementation of a Web interface as part of the service-oriented architecture will be the best solution to enable direct data entry, more accurate information, streamline day-to-day tasks that are not currently automated and enhance communication among members.

Phase 2: Identifying the architectures. After understanding the larger concepts and vision of how the architecture will be defined, Rotary International can move into the more in-depth discussions on each of the architectures and how they will be implemented. The Business Architecture, Information Systems Architecture and Technology Architecture are the big three architectures that will comprise the overall Enterprise Architecture program and must be clearly defined in this stage and continue to be refined as the process continues.

Rotary International's Business Architecture will discuss the overall business fundamentals and how the business meets its goals. For Rotary, International this must consider the population of its clubs and individual members, the geographic locations of each, and the processes and operations for how business is conducted (from new member inductions to joint, international club projects).

The Information Systems Architecture of Rotary International must look at the various solutions and services that will allow Rotary International to communicate better among clubs, allow direct reporting, improve data capture, and what methods are available for regions where technology is behind the general curve (see appendix D, Information Systems Architecture Future View). The data and types of data must be considered along with all possible applications that will meet the needs. This is where Rotary International will want to identify how language barrier issues can be handled and whether specific software and reporting methods can help eliminate the issue. Rotary International must also decide what solutions are available to improve data capture and ensure that there are uniform reporting

methods in place. Identifying what systems are required to meet the originally defined vision, requirements and goals of the Enterprise Architecture will then allow Rotary International to move into identifying what changes and improvements need to be made to the infrastructure.

The Technology Architecture is the third key architecture that Rotary International must analyze in planning. Once the systems and functionality are identified for what will allow Rotary International to accomplish its requirements and goals, the technology architects can look at what must be done to the infrastructure and what technology is available to meet the needs (see Appendix E, Technology Architecture Future View). A critical discussion piece of the Technology Architecture for Rotary International will be how the disparity of technology among clubs will be handled. Unique solutions that link the lowest level of technology to the overall systems must be considered and identified to ensure that the goal of better data capture can be met, along with the overall visions and strategy.

Phase 3: Solutions for the architectures. "In an attempt to bring some order to the sea of information chaos, many enterprises are turning to a Service Oriented Architecture approach to integration." (Patrick). Rotary International serves to benefit the most from a loosely coupled service-oriented architecture. One of the critical requirements for the overall Enterprise Architecture of Rotary International is the ability to share and capture accurate data. Pushing the function of data entry down to the lowest level of each individual club will prevent occurrences of things like the same information being reported by multiple people along a chain of command.

A service-oriented architecture that can make use of modular systems that can be implemented in different countries around the globe and accept data from various methods will give Rotary International a greater opportunity to ensure that clubs can enter data and information will be as accurate as possible. “Modular design is an approach that subdivides a system into smaller parts (modules) that can be independently created and then used in different systems to drive multiple functionalities” (McDermott and Mudambi). This is a critical phase where Rotary International can choose the systems that will be used, how it can and will be modularized, and to determine how the current information and data can be migrated to new systems.

Phase 4: Executing and continued oversight. Oversight for the implementation of the architecture is essential for each piece of the architecture to be integrated correctly and to ensure that potential trouble spots are identified early and addressed. Although governance of the entire Enterprise Architecture endeavor will remain in place, Implementation Governance must occur side-by-side with specific governance and monitoring of the execution phase. Architecture Change Management is an integral piece of the execution phase, where changes are addressed appropriately. Rotary International will want to stay abreast of technology trends and ensure that new capabilities are included when they will enhance the overall architecture.

ROAD MAP AND KEY MILESTONES.

TIMEFRAME	MILESTONES
Phase 1: Preliminary Phase and Architecture Vision 12 months TOGAF Preliminary Phase, Architecture Vision, Requirements Management	Received feedback from local club level. Established overview of requirements and capabilities of the architecture. Identified current systems, procedures, and documentation and identified how the future vision varies from the current position. Selected and adhering to operating model. Determine the number of databases that will be required and will need to be linked.
Phase 2: The Architectures 12 months TOGAF Business Architecture, Technology Architecture, Information Systems Architecture, Requirements Management	Identify Business Goals and Strategy Identify state of current infrastructure and estimated infrastructure needs. Identify the number of Information Systems required to meet the architecture goals and needs. Identify what parts of the infrastructure and technology can be reused.
Phase 3: Solutions 12 months TOGAF Opportunities and Solutions, Migration Planning, Requirements Management	Identify all software solutions for specific requirements. Identify vendors for products and services.

TIMEFRAME	MILESTONES
Phase 4: Implementation 24 months TOGAF Implementation Governance, Architecture Change Management, Requirements Management	Infrastructure upgraded and new pieces integrated into architecture. Web services installed and tested. Databases designed and linked. Clubs have tested the Web interfaces and modules for data capture. Current information migrated to new systems.

The Business Case

"The emergence of the Internet and the Web offer unprecedented opportunities..." (Nezlek, Jain and Nazareth). A global organization like Rotary International can benefit from the technological advances and services made possible through the Internet. Enabling quick communication, shared data, and streamlined processes through Web services and the Internet allows an organization to operate efficiently. Taking on an Enterprise Architecture program that focuses on service-oriented architecture and Web services will continue to guide Rotary International in a direction of growth and success.

Rotary International's success is exhibited through its growth of four members in 1905 to more than 1.2 million today (Rotary International). Embracing technology allows information to flow easily across borders and cultivate the emergence of new clubs. By developing an Enterprise Architecture with a service-oriented architecture, Rotary International can save time when completing standard business processes, gain greater information technology flexibility, and cut costs (Ashford).

A well defined Enterprise Architecture will not only set Rotary International up for continued growth, but it can also address the issues of language barriers, technology disparities, non-uniform reporting methods, and inaccessible data. Delta Airlines found similar benefits that allowed them to have greater control and accuracy of their data, improvements in data sharing, and integrated various IT infrastructures that allowed them to see substantial improvement in their overall operations when they developed the Delta Nervous System that linked together nine critical databases (Ross, Weil and Robertson). Following a similar course of action by consolidating and linking the required databases for Rotary International's operations will allow them to achieve the same level of integration with uniform data, software that can accommodate language translation, make use of all available technology to allow entry from clubs in emerging economies, and provide the ability to easily share information among the organization.

RECOMMENDATIONS

In order to realize the full benefits of an Enterprise Architecture for Rotary International, I recommend the implementation of a set of linked databases, Web service modules for data entry, and a service-oriented architecture approach. "One of the main motivations behind the adoption of SOA is the need for dynamic applications that can be quickly adapted to changes in business needs and/or regulations." (Ryu et al.).

DATABASE AND SOFTWARE RECOMMENDATIONS

Rotary International's growth during the last 100 years signifies how important it is to be able to adapt and keep up with business needs. Taking examples from what has been successful in the past is also a key factor for architecture success. Following the well-executed implementation of Delta Airline's linked databases, Rotary International can make use of regional databases that can be linked with language software to ensure uniform and cross-compatibility of data. A regional, language-specific database would be recommended to ensure that data entry is correct and not misconstrued from the beginning. "Languages and countries don't necessarily correspond one-to-one. So an architecture may have to concurrently support languages spoken in many countries (e.g., Portuguese), one-to-one language/country pairs (e.g., Japan/Japanese), and languages spoken in a part of a country (e.g., Tagalog)..." (Bloug). Keeping the databases separated by language can help the architect to develop a system of integrating and linking the data in a larger system when the translation occurs.

Despite many countries having a disparity in the technology that is available, I recommend a Web service approach as being the best solution for capturing data. According to Ryu et al.:

> *In service-oriented architectures, everything is a service and everyone is a service provider. Web services...are loosely coupled software components that are published, discovered, and invoked across the Web. As the use of Web service grows, in order to correctly interact with them, it is important to understand the business protocols that provide clients with the information on how to interact with services.*

Utilizing the Internet and services, information can be accessed in a variety of ways and modules can be created and adapted for a customized fit for each unit at the lowest level.

Modularity in Web services interfaces. A custom module that will interface directly with the database could potentially be adapted to allow mobile phone data entry for clubs that are located in countries with emerging markets that do not have full Internet and desktop capabilities but do have mobile Internet access. For all other developed countries, a Web interface module that allows them to enter information directly and also pull reports and compare information from other clubs would improve communication and allow for more accurate and detailed data being entered into the system.

MOVING FORWARD FROM HERE: NEXT STEPS

The first step for Rotary International to embark on an Enterprise Architecture project is to start with building a strong foundation for execution. Selecting an operating model and conforming policies to the model will set the initial stage from which a full architecture can be built. Once the operating model is

chosen, identification of the requirements and features of the architecture will be the critical launching point in getting the Enterprise Architecture project off the ground. There should be buy-in from all levels and communication from all levels about what should be the main functions and key features of the architecture.

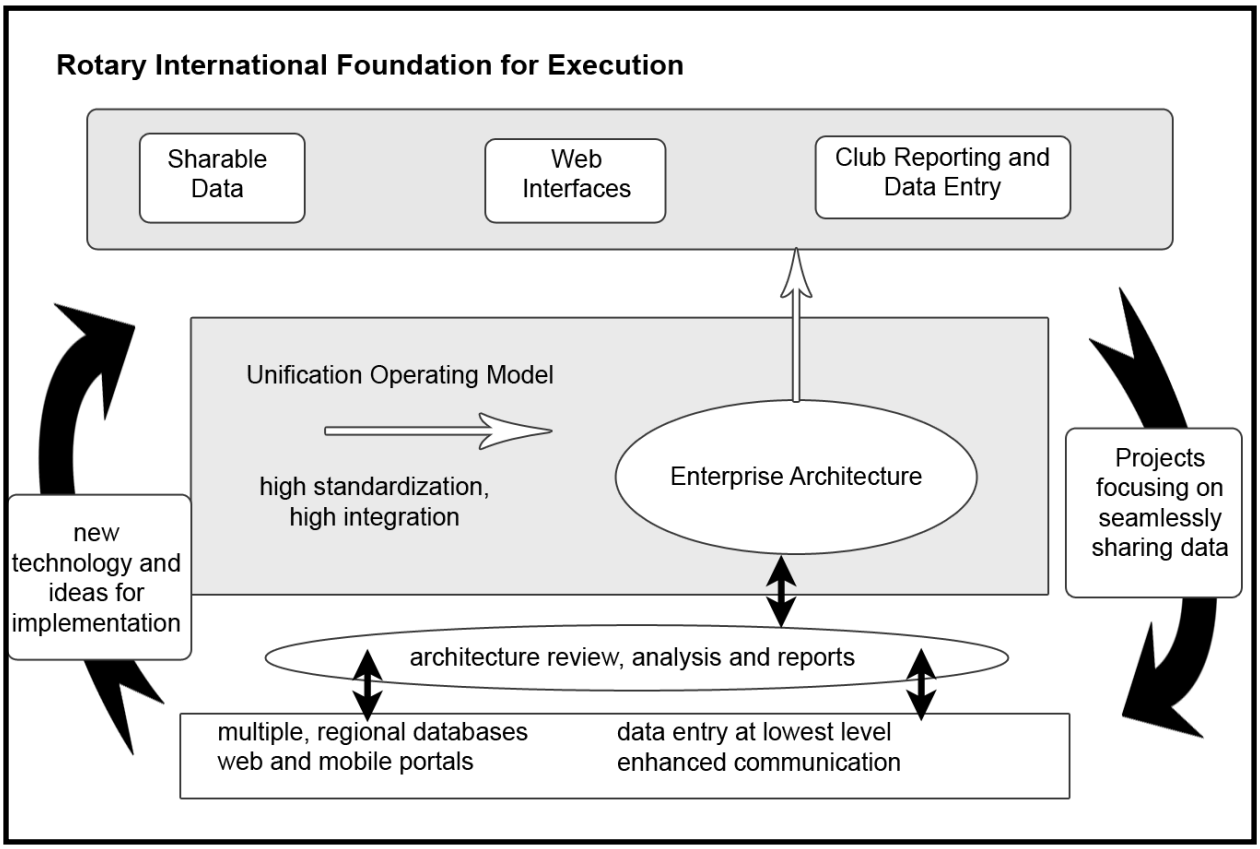
Feedback from various clubs in differing geographic areas should be solicited to find out what needs and requirements exist at the lowest level as well as the higher, overarching needs. Rotary International has clubs in countries all around the world where cultural differences among each are vast. “Cultural business challenges include differences in languages, cultural interests, religions, customs, social attitudes and political philosophies. Global businesses must be sensitive to such cultural differences." (Baltzan et al.). Identifying cultural challenges and looking at the problems in the initial stages will give greater depth and understanding to what the full architecture should encompass to provide benefit and service to all member clubs and improve the captured data, processes, vision and goals of the organization.

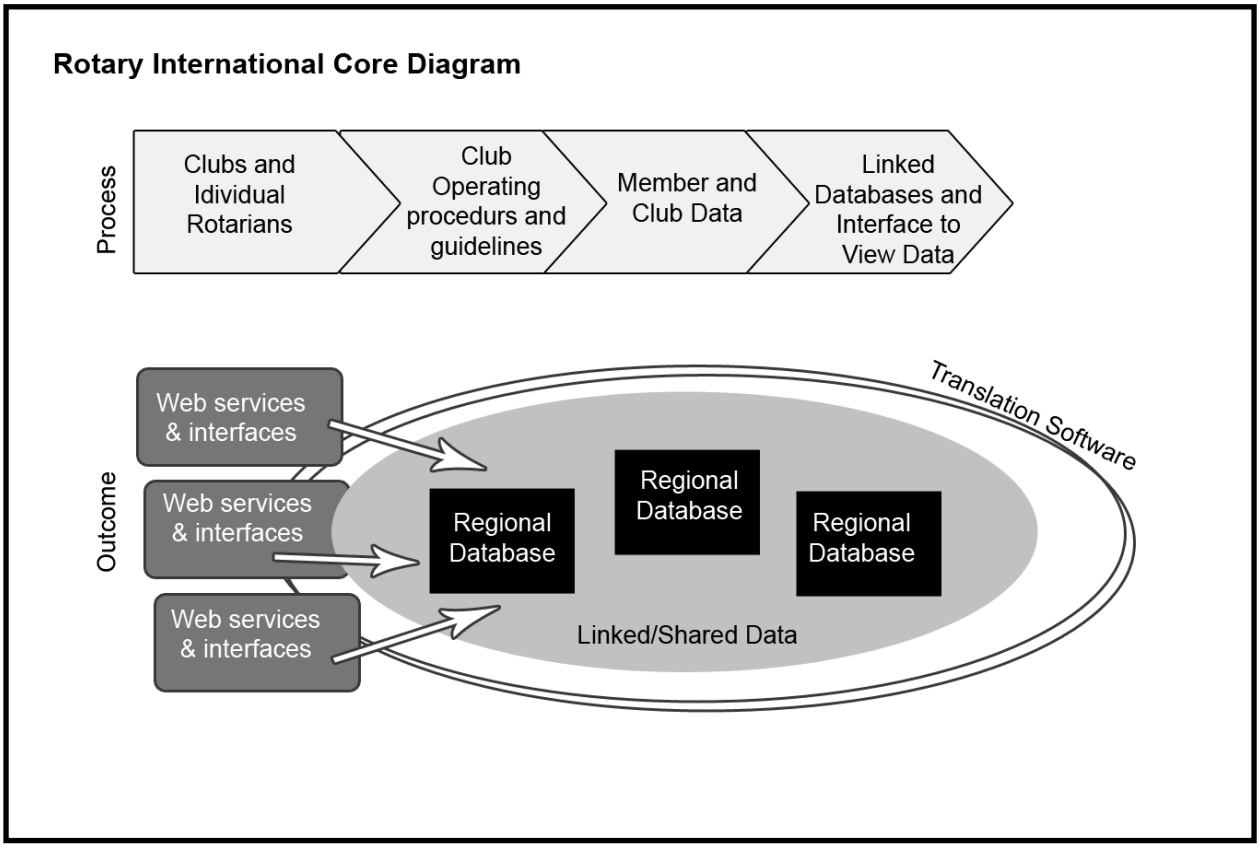
CONCLUSION

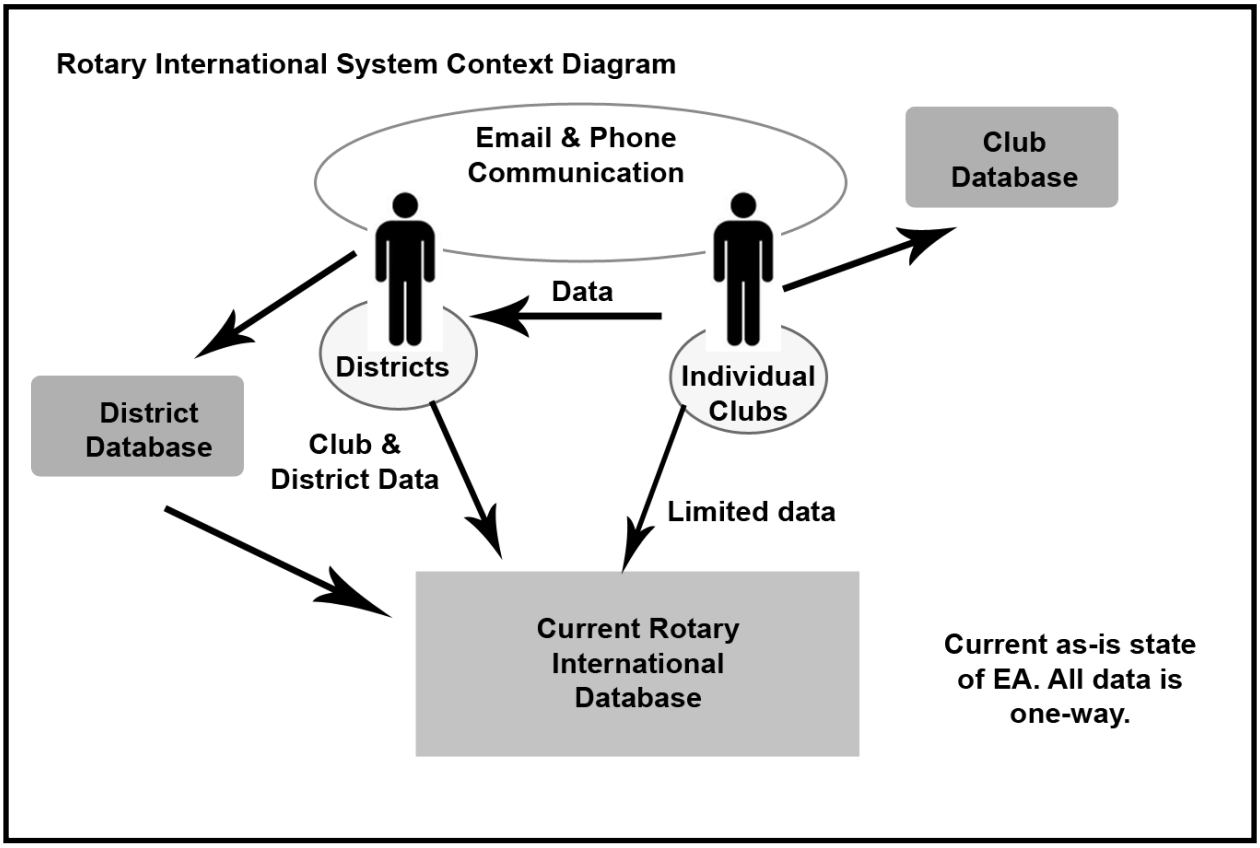
Implementing an Enterprise Architecture across a global organization is a daunting task. However, following proven guidelines to complete the task is an effective and thorough way to ensure successful execution of the architecture along the various stages of development. Although there are multiple possible solutions and frameworks to choose from, following an iterative approach that is outlined in the TOGAF framework is my recommendation for Rotary International to utilize in order to develop an architecture that will address the unique needs and requirements of their organization.

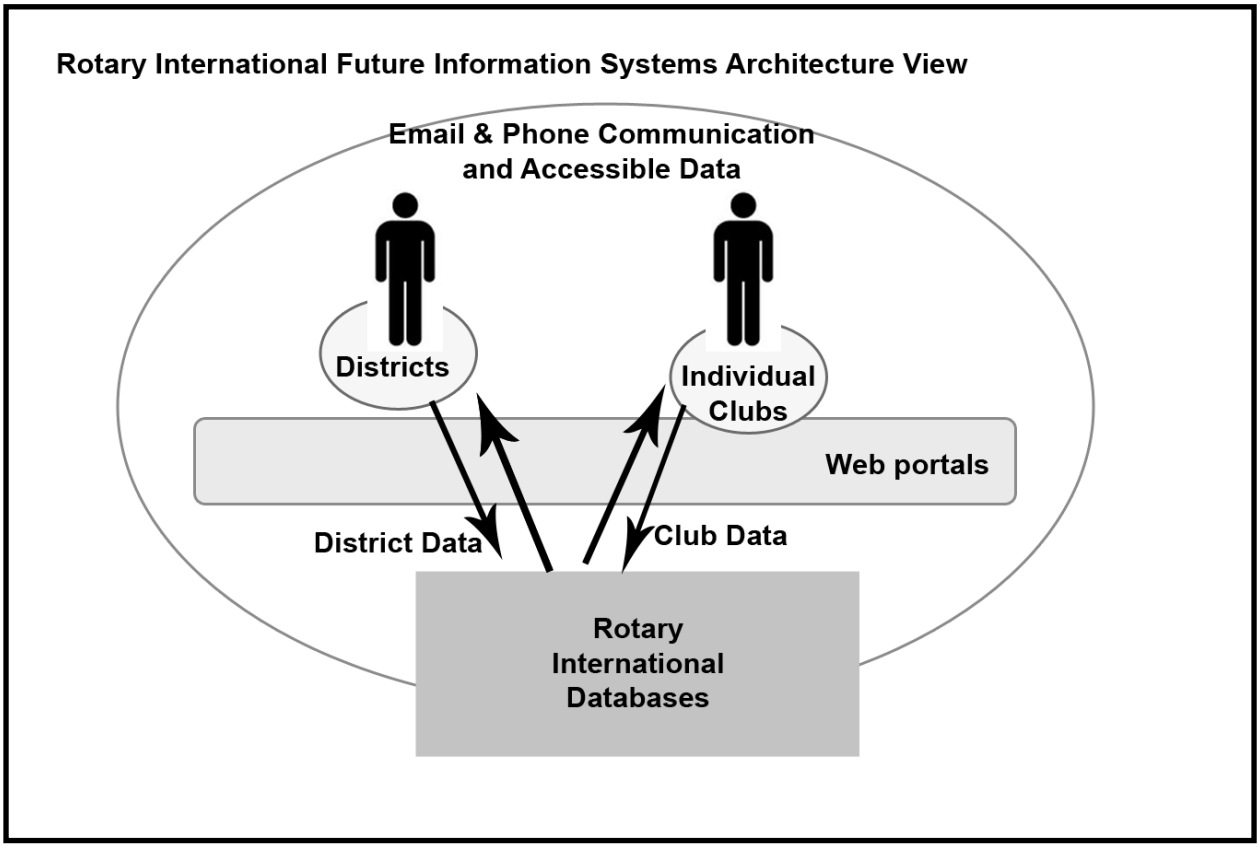
Furthermore, incorporating Web services as part of a service-oriented architecture will give Rotary International the flexibility needed to help account for the varying degrees of technology available to clubs that are located in under-developed and emerging economies. Utilizing software services that can share data in multiple languages, Web services that will allow data capture at all levels, well defined databases that are linked for seamless sharing and retrieval of information, and clear standards for inputting information, Rotary International can realize a higher level of communication among its clubs, produce better analytical results from data, and continue fostering a global community of service above self.

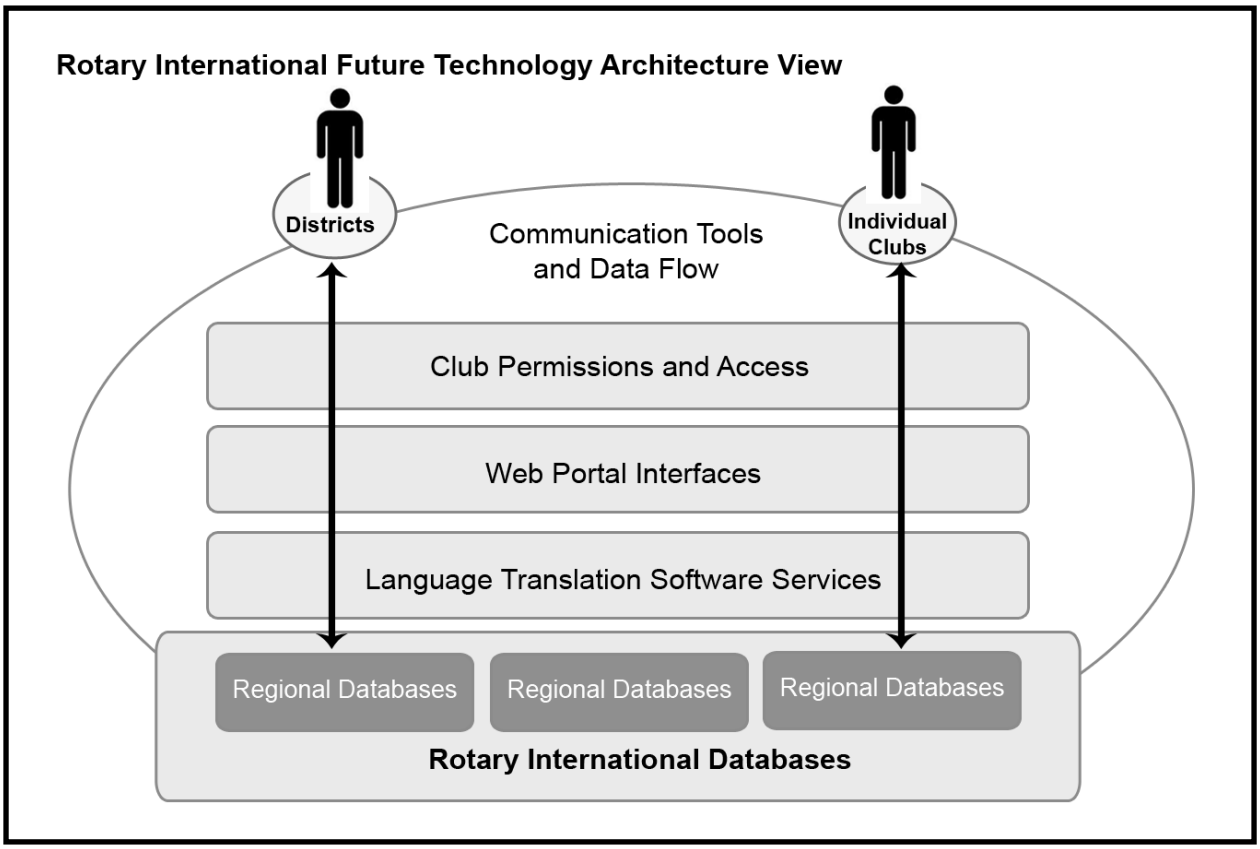
APPENDIX A: ROTARY INTERNATIONAL FOUNDATION FOR EXECUTION




Rotary International Core Diagram
Process
Clubs and Idividual Rotarians
Club Operating procedurs and guidelines
Member and Club Data
Linked Databases and Interface to View Data
Outcome
Web services & interfaces
Web services & interfaces
Web services & interfaces
Translation Software
Regional Database
Regional Database
Regional Database
Linked/Shared Data


Rotary International System Context Diagram
Email & Phone Communication
Club Database
Data
Districts
Individual Clubs
District Database
Club & District Data
Limited data
Current Rotary International Database
Current as-is state of EA. All data is one-way.


Rotary International Future Information Systems Architecture View
Email & Phone Communication and Accessible Data
Districts
Individual Clubs
Web portals
District Data
Club Data
Rotary International Databases


Rotary International Future Technology Architecture View
Districts
Individual Clubs
Communication Tools and Data Flow
Club Permissions and Access
Web Portal Interfaces
Language Translation Software Services
Regional Databases
Regional Databases
Regional Databases
Rotary International Databases

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AUTHOR'S BIO

Stephanie Livsey graduated Magna Cum Laude from Eastern Illinois University in 2003 with a bachelor's degree in journalism, where she also earned a commission in the United States Army. Immediately after graduation, Stephanie completed the Officer Basic Course and was the Honor Graduate, finishing as the top officer in the class. After serving 2.5 years on Active Duty, Stephanie started a local design firm and became involved in graphic design, Information Technology, and web design. She is currently serving as the Webmaster and Director of Community Relations at TMI – The Episcopal School of Texas, a private school located in San Antonio. Stephanie is also involved with Rotary International, serving as her local club's secretary, and is a Paul Harris Fellow. Stephanie is currently pursuing her master's degree in Information and Communications Technology through the University of Denver

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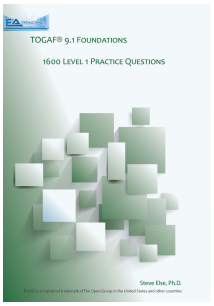

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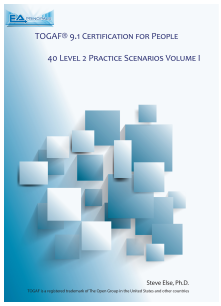

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MEET OUR EXECUTIVE DIRECTOR

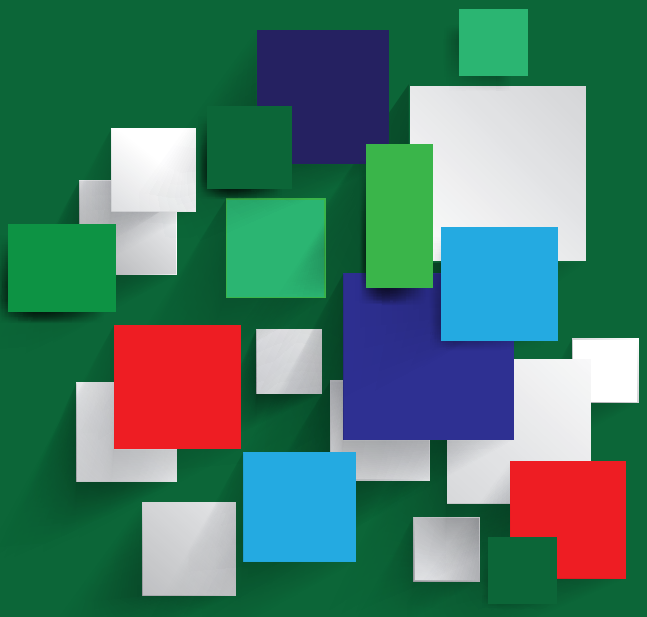
A leading innovator, practitioner/consultant, lecturer, educator, and trainer in Enterprise Architecture (EA) and related topics for nearly two decades, Dr. Steve Else has many roles in the global strategic transformation community. The Founder and CEO of EA Principals, Inc. (EAP) (see http://eaprincipals.com). Steve is one of the leading 10 TOGAF® trainers in the world, having trained about 1750 people himself. He is author of the book, "Organization Theory and Transformation of Large, Complex Organizations."

In addition to running EAP, he has established and leads the Enterprise and Solution Architecture Institute (ESAII) at (see http://esaii.org) , under the Center for Public-Private Enterprise (CPPE) (see http://cppe.org) , which he founded in 1998). ESAII expands his professional outreach globally and will also allow for bringing together experts to mentor students on complex, innovative enterprise solutions approaches (going beyond just the enterprise architecture part of value delivery).

Dr. Else's dedication to the advancement of the EA profession was noted in a recent note to his offices from an EA course conducted in March 2013:

"I loved his passion for the Enterprise Architecture profession. It is people like him who will help advance the skills of many professionals. He was very personable and I loved the antidotes and humor he added to the class. I wish I could have been in the classroom, but he did a great job again making sure the remote students were active and included in the discussion. He has also inspired me to do my part in advancing Enterprise Architecture."

Enterprise Architecture Professional Journal



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