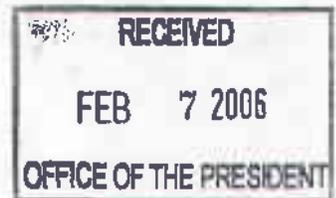




State of Arizona
Department of Education



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Tom Horne
Superintendent of
Public Instruction

February 03, 2006

Richard Stavneak, Director
Joint Legislative Budget Committee
1716 West Adams
Phoenix, Arizona 85007

Dear Mr. Stavneak:

As required by the footnote in the fiscal year 2006 appropriations report (p. 135), the Arizona Department of Education (ADE) is pleased to submit the enclosed report.

The footnote directs the ADE to use a portion of the monies appropriated for planning and preliminary design of the department's agency information factory to be used to hire an independent information technology consultant. In accordance with this directive, the ADE has produced a report written by the independent consultant evaluating the department's agency information factory plan.

As a courtesy, the ADE is also sending copies of the report to the Governor, Senate President, Speaker of the House, the Office of Strategic Planning and Budgeting, the House and Senate Appropriations Chairmen, the Auditor General, and the Government Information Technology Agency. Additional copies are available to the public.

Should you have any questions, please direct them to either Janice McGoldrick, ADE CIO, at 602-542-1111, or to me at 602-364-1541. We look forward to discussion.

Sincerely,

Ruth Solomon
Associate Superintendent
Education Policy

Attachment



STATÉRA

TECHNOLOGY MEET BUSINESS

DOCUMENT PURPOSE

To provide a summary of findings and recommendations for the Arizona Department of Education regarding the Arizona Education Information Factory Data Warehousing Initiative

PREPARED BY

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Strategic Principal
Statéra

January 25th, 2006

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Executive Summary

Introduction

Superintendent Horne and the Arizona Department of Education (ADE) have made a steadfast commitment to persist the vision, leadership and resources necessary to continue the development and operational maturation of the evolving IDEAL (Integrated Data to Enhance Arizona's Learning) portal. A primary objective of IDEAL is to provide a single point of access to the educational data, resources, and services required to assist in supplying quality education for every Arizona student and ultimately increasing student learning.

In support of IDEAL and the associated initiatives targeted at raising the measurable achievement levels of all Arizona students, ADE has specified requirements for the processes and technologies necessary to provide data-driven decision support system (DSS) capabilities. These processes, and their underlying technologies, are intended to enable educational stakeholders associated with governmental entities, educational districts, schools, the community at large, and higher education institutions the ability to transition the traditionally disparate rich educational data stores into usable and credible information with evolving knowledge.

As a result, the requirement for the creation of an ADE consolidated data repository quickly surfaced. This repository will effectively and efficiently support the requirements associated with DSS and data supported knowledge creation. The envisioned information-management solution will provide analytical and informational processing to all providers and consumers of state and local level educational data. The resultant plan has the data repository taking the form of an ADE sponsored and managed data warehouse which is named the Arizona Education Information Factory (AEIF). Ultimately, the AEIF's intent is to provide a credible coalesced view of all existing and future disparate ADE/locally owned and managed data sources developed and operated with a high "coefficient of effectiveness" (the relationship between dollars spent and quality education).



Statera Company Background

Founded in Denver, Colorado in 2001, Statera is a consulting firm employing over 125 staff members and is resolute in solving technical and organizational challenges through integrating an organization's vision with the right technology, strategy and resources. Since expanding into the Phoenix, Arizona and Seattle, Washington's markets, Statera has remained focused on long-term solutions and relationships. It also uses a comprehensive, disciplined approach to deliver practical business tools through effective custom development, business integration, knowledge management, and portal technologies.

Strategic alliances with leading technology providers help ensure that Statera is able to offer clients a full range of technology solutions. To that end, Statera is a premier Microsoft Partner in the Western Region and possesses numerous Gold Certified Partner credentials and frequently works jointly with Microsoft and Microsoft Consulting Services in the delivery of technology solutions.

With respect to direct data warehousing experience, Statera has worked with numerous organizations helping them turn data into actionable and valuable information. These organizations include both private and public sector entities ranging in size from small business to large, multi-nationals. Statera has also been chosen by Microsoft to assist on a number of internal Data Warehousing initiatives, including the construction of a pilot Scorecard for Steve Ballmer. Statera is also working with the Business Scorecard Manager (BSM) Product Group within Microsoft in the publishing of several White Papers on "Best Practices" with the new BI tools. Statera also manages the Phoenix SQL Server User Group. Statera's proven consultants and BI solutions are designed to gather critical data with minimal cost and effort and deliver this data to appropriate parties across the enterprise. Statera provides the insight needed to optimize performance and make strategic decisions with confidence.

Finally, Statera is a Latin word meaning "balance" which is a founding principle for the company - a balance of not only business and technology, but between manual effort and automation, between people and processes, between employees and employer, between customers and partners and between work and family.

Additional information can be found at www.statera.com.



Engagement Scope

The evaluation process has been structured to assess ADE's AEIF plan and associated preparedness for the plan's successful execution. This has been accomplished through examination of critical factors that are conventionally requisite for a successful data warehouse supported DSS implementation.

The review of each critical element assures that core decisions and elements of design are fundamentally sound and based upon best practices. This engagement has included an assessment of ADE's readiness by examining key fundamental critical success factors that maximize the probability of a successful AEIF implementation. These factors include:

- **ADE's AEIF Vision:** A review of ADE's short and long term vision, with the proposed rollout and implementation plan. A significant component of this review is to align and compare Arizona's consolidated data warehousing vision with those warehousing initiatives in parallel developmental and/or operational modes in other states.
- **AEIF Data Sources:** Analysis of existing and future ADE's transactional data sources with an enterprise prospective, including the various extract-transformation-load (ETL) strategies associated with the AEIF data suppliers, are required to generate a holistic view of AEIF source information. As a result of AEIF's creation of technical dependencies across traditionally siloed application teams and databases, each data feed and its unique transport, cleansing, normalization and/or aggregation requirements necessitates integration of new enterprise design and communication methodologies.
- **AEIF User/Information Consumer Communities:** Continued creation and support for targeted user out reach programs, with the resulting categorization of the individual and groups of AEIF information consumers, is a key element to delivering a data warehouse with maximum utility. Ultimately, the AEIF architecture and deployment must feature the native agility and performance excellence standards to support each individual AEIF user the ability to choose their data and select the form of delivery.
- **ADE Cultural and Organizational Influences:** A successful data warehouse implementation requires cultural components that facilitate and sustain a trusting collaborative relationship between all users/information consumers and the supporting IT team. To that end, there is a fundamental requirement for a documented agency wide clear data warehousing strategic vision, with the requisite leadership commitment. This lends tactical guidance on how to obtain,



disseminate, manage and utilize the rich ADE managed data assets. The varied AEIF stakeholders associated roles and resources, internal to and external to IT, require clear definition and dedicated bandwidth to achieve a successful AEIF implementation, deployment and operation.

- **ADE Information Technology (IT) Operational and Management Processes:** Repeatable documented processes integrated into ADE's application development, change and configuration management, quality assurance (QA) testing practices, operations management and project management processes are requisite for a successful AEIF implementation.
- **Data Security Practices:** Identification and classification of assets needing protection will be performed to provide a focus on the appropriate security risks. Areas of concentration include data assets, existing applications, network infrastructure servers and appliances, secure transport methodologies, security patch management, and monitoring.
- **AEIF Technical Strategy:** Leveraging existing technological assets is a key strategic element when constructing and managing the AEIF data warehouse. As business requirements are defined and scalability requirements are understood, an assessment of existing technological investments and ADE resident technological core competencies are required. If gaps are identified between the defined requirements and the functionality provided by ADE's existing technological assets, a cost, time, effort and training evaluation of potential one-off tools purchases becomes critical.
- **AEIF Information Consumer and Technologist's Training:** Beyond incorporating the best toolsets, architecture and implementation strategies, training of both the IT staff and data consumers on AEIF information utilization opportunities and best practices, including how to incorporate the rich tools and warehoused information into each stakeholder's day-to-day processes is critical to AEIF's success. Training of the selected toolsets, information definition and utility, standards for data use, transport/communications methodologies and available canned reports/query libraries are a partial subset of the curriculum standards required for consistent and quality knowledge transfer.
- **User and Technologist's Communications:** Formalized communications processes require analysis, planning, preparation, and implementation strategies to successfully disseminate AEIF critical information to all concerned parties. The common forms may include state wide advisory boards (both technical and functional), portals, user groups, intra-ADE cross discipline task forces, leadership task forces, newsletters, conferences, targeted email groups, etc.



- **Vendor Relationship Management:** Quality managed vendor relationships are essential to a successful AEIF deployment and ongoing operational viability. Meeting the goals surrounding performance and proactive technical management.
- **AEIF Documentation and Artifacts:** Artifact creation standards and processes documenting critical build and operational factors are requisite to a successful AEIF implementation.



Summary of Findings

This engagement – the examination of several critical factors key to a successful AEIF deployment – has been completed. Findings surrounding the ADE’s methodologies for addressing these factors and their associated requirements are covered in detail in subsequent sections of this report. This section summarizes these findings.

1. The ADE AEIF vision provides ample direction to the development and deployment of Arizona’s educational data warehousing initiative. The vision successfully embraces requirements for all education information stakeholders and provides the foundation to maximize the probability of AEIF’s success. The next steps have the IT leadership team formulating a strategic road map detailing how to lead the ADE technology group in translating the agency wide vision into a series of tactical elements that will maximize the probability of a successful AEIF deployment.

With that being said, the ability for ADE to translate that vision into a successful AEIF deployment will be challenging. Prior to an ADE AEIF deployment, it is requisite that the entire ADE executive management team provide clear agency wide direction, empowerment and leadership to converge ADE’s traditionally siloed view of application development and data management into an IT managed centralized set of policies, procedures and repeatable practices (PPP). As a result of past MIS challenges, the lack of individual ADE section’s confidence in ADE IT’s ability to deliver technological solutions has fostered a climate handicapping agency wide vertical and horizontal communications.

In addressing these challenges, ADE is in its infancy. The recent leadership change in IT began the process of rebuilding inter/intra ADE IT partnerships. Recently, a superintendent sponsored assembly brought agency wide technology stakeholders together to discuss defining a collaborative framework for the management, securitization, transmission, and usage of ADE managed data.

Out of that meeting, an ADE IT sponsored and facilitated committee, comprised of key section technology stakeholders, will meet regularly to review formulation of a framework for the coalesced educational data repository. Those meetings are providing agency sections with the opportunity to contribute to the development of ADE enterprise data management PPPs. The group as a whole has already adopted a consensual understanding surrounding the need for a centralized IT managed data repository. A fundamental understanding was reached concerning the challenges surrounding the disparately managed ADE education data resources of the past. An understanding that those practices



have historically resulted in creating agency wide painful experiences and the consolidated data view is requisite to the agencies future success.

Within ADE IT, a course of action has begun leading towards the creation of agency wide enterprise data management policies PPPs. This team is accountable for development of data access standards and will contribute to the agency data management group by producing the resultant PPPs. Even though the IT team and any associated processes are in their infancy, rewards of the focused group were realized in initiatives completed December, 2005 and January, 2006. The evidence is seen in measurable increases in SAIS's successful transaction processing load capabilities per unit time. Additional evidence resides in increased administrative data management practices focused on higher data repository availability.

In like manner, parallel efforts have been taken to establish an ADE agency configuration management (CM) team. Ultimately, a portion of the CM team's charter will be to focus upon system design and development PPPs.

These preliminary initiatives, associated with the acknowledgement that ADE has had significant challenges associated with building and operating ADE enterprise technical solutions, are good initial steps in maturing the ADE technology environment. But follow-up is the key. If progress is not realized quickly and/or these data consolidation efforts lose ADE executive management sponsorship, focus, direction and/or empowerment for IT leadership to continue their focus on managing technological initiatives through best practices, the ability for ADE to successfully develop and deploy AEIF is at serious risk.

2. ADE has the native talent, capability, and drive to effectively build and operate a large scale educational data warehousing initiative. The challenge is not the quality of ADE IT's native talent, but ADE IT's resource bandwidth. To intelligently carve out the requisite resources dedicated to assure AEIF's successful deployment, ADE IT requires additional resources, both staffing and capital. This will augment their existing breadth of technical capabilities. Under the current leadership, with the aforementioned dedicated ADE executive team support, ADE IT is capable of managing existing resource demands and managing the processes surrounding successful growth and a successful rollout of AEIF.
3. Initial analysis has been completed to understand and stratify education data consumers. Documentation of their fundamental requirements, coupled with the knowledge of the types of questions that will be asked of the AEIF retained information, lays



a framework for user requirements documentation. The processes surrounding the collection of these data consumer requirements have been in place and evolving over time. As AEIF evolves, these processes are intended to expand collection of requirements from all Arizona educational data interested parties. As importantly, these processes are providing the foundation for selection of optimal reporting and data mining tool sets.

4. Analysis is underway to understand the ADE managed data sources (i.e. SAIS, SDER, SFS, R&E data, AIMS Data, etc.) for AEIF and to document the requirements associated with coalescing, normalizing and cleansing this source information. Significant progress has been realized in reaching this understanding through the completion of linking some of the ADE disparate data sources in support of the ASIP data requirements. Additional analysis is required to understand and document the non-ADE managed data sources (i.e. district SMS systems). As previously mentioned, the challenges associated with the decentralized nature of AEIF's data collection requirements and the LEA's self-selected data systems are being acknowledged and addressed in the AEIF implementation strategy.
5. The desired technology set utilized in developing and managing AEIF is industry "best practice" standard, with the inherent flexibility to adapt to changing requirements. The selected Microsoft technology stack marries the ability to leverage existing ADE native technical skills with the dynamic nature of the data consumer's requirements. The chosen technologies also provide a supported technological roadmap for ADE technical professional development and strategic/tactical planning.
6. ADE IT has begun the process of reviewing the security practices utilized in securitizing ADE's technical environment and their rich data stores. This includes a focused review of transmission securitization.

As a result of some former technological decisions, security holes currently exist in public and private facing applications that may expose ADE managed information to compromise. Some of these holes have been closed. But the process of securing ADE's technological environment, applications and data is also in its infancy. The IT leadership team's focus is upon deriving manageable policies, procedures and repeatable IT security practices (PPP). Several meetings have been completed to assist in providing a dedicated focus on the practice of wrapping security contexted metadata around each data element and an associated formalized data classification/ identification process. ADE IT's security commitment is also demonstrated through other meetings



concluded to establish the requisite PPPs surrounding securitization of all technological assets managed by ADE.

7. ADE has completed an extensive review of their IT development and operations management practices and acknowledges past issues in lack of process and focus. As a result of that review operational viability, and the processes and controls required to realize that goal, have been identified as a significant element of ADE IT's mission. Because AEIF's success is dependent upon stable applications, data repositories and infrastructure, these PPP's must be designed and implemented as part of the AEIF deployment plan. Strategies are currently in place to mature the organizational processes and intensify the focus upon repeatable processes and operational viability.
8. On-going due diligence processes are continuing so that ADE may work closely with other states to learn from their experiences and share common challenges and opportunities. ADE has recognized that there are "lessons learned" and best practice opportunities through strategic partnerships and dialogues with other states. Even though there are some efforts for national standards, ADE is cognizant of the fact that varying states have varying requirements and must relate other states' experiences to Arizona's specific requirements.
9. Opportunities and challenges resulting from legislative and legal stipulations have been recognized and are being addressed by working with the Arizona Attorney General's office and legislators.
10. Adequate documentation and artifacts are being designed to provide support for training, knowledge transfer, process control and monitoring/measurability of key processing indicators (kpi).
11. ADE's vendors and customers are now being included as strategic partners in ADE's journey towards a successful AEIF deployment. This has enhanced and fortified those relationships and the communications practices between them.

As a result of this examination of ADE IT's capabilities, their past challenges/successes and the recent strides ADE has made in addressing some of their key issues in deploying enterprise solutions, I am convinced that ADE is in a favorable position to sponsor, develop and operate AEIF. ADE's matured focus on repeatable processes, operations, self-examination, leadership, staff development, relationship management, user involvement and technical excellence places ADE in an excellent position to build upon recent accomplishments and construct a state-of-the-art education data warehouse.



Definitions and Abbreviations:

AD	Active Directory
ADE	Arizona Department of Education
AED	Rijndael AES standard
AEIF	Arizona Education Information Factory
AES	Advanced Encryption Standard
AG	Arizona's Attorney Generals Office
AIMS	Arizona's Instrument of Measure Standards
ASIP	Arizona School Improvement Plan
AYP	Adequate Yearly Progress
BI	Business Intelligence
CC	Change Control
CCB	Change Control Board
CCP	Change Control Processes
CI	Configuration Items
CIO	Chief Information Officer
CM	Configuration Management
CMDB	Configuration Management Database
CPI	Certified Personnel Interface
CPU	Central Processing Unit
CTO	Chief Technology Officer
CTO	Chief Technology Officer
CTT	Core Technical Team
DAC	Data Advisory Councils
DBA	Database Administrator, Analyst and/or Architect
DBM	Database Management Group
DBMS	Database Management System
DOE	Federal Department of Education
DSL	Definitive Software Library
DSS	Decision Support Systems
DTS	SQL Server 2000 Data Transformation Services
DW	Data Warehousing
ELL	English Language Learner
ELT	Extract, Load and Transform
ETL	Extract, Transform and Load
FERPA	Family Educational Rights & Privacy Act
FRB	Failure Review Board
IDEAL	Integrated Data to Enhance Arizona's Learning
IT	Information Technology
ITIL	Information Technology Infrastructure Library
KPI	Key Processing Indicators
LDAP	Lightweight Directory Access Protocol
LEA	Local Educational Agencies
Longitudinal Data	Information for a student, school, LEA, etc. collected repetitively over time.



MDX	Multi-dimensional Expression Language
MIS	Management Information Services
MOF	Microsoft Operations Framework
MOM	Microsoft Operations Manager
NCES	National Center for Educational Statistics
NCLB	No Child Left Behind
OLAP	On-line Analytical Processing
OLTP	On-line Transactional Processing
P&P	Policies and Procedures
PBDMI	Performance Based Data Management Initiative
PMO	Project Management Office
POC	Proof of Concept
PPP	Policies, Procedures and Repeatable Practices
QA	Quality Assurance
ROI	Return On Investment
SAIS	Student Accountability Information System
SDER	Student District Employee Report
SDLC	Software Development Life Cycle
SFS	Student Financial System
SIF	Schools Interoperability Framework
SIS	Student Information System
SLA	Service Level Agreements
SLB	Service Level Baselines
SLO	Service Level Objectives
SMF	Service Management Functions
SMS	Student Management System
SPED	Special Education
SSIS	SQL Server Integration Services
SSL	Secured Socket Layer
SSN	Social Security Number



AEIF Critical Success Factors Analysis

ADE's AEIF Vision:

The envisioned ADE data warehouse is the next step in the implementation of ADE's long-range enterprise strategy surrounding state educational data management. The act of successfully creating, deploying and operating AEIF should facilitate the requirements for improved analysis capabilities surrounding educational data, with the ultimate goal of increasing student achievement.

The AEIF vision and implementation strategy provides the ability for educational stakeholders to examine school and program effectiveness, to identify educational best practices, to meet certain state and federal reporting mandates, to set effective statewide educational policies, and, through utilization of OLAP data-driven decision support systems (DSS), to make the best educational decisions. The vision is to continue building upon the existing understanding of the educational stakeholders' business needs, user needs, and data needs to link aggregated student data with teacher data and, ultimately, the class data. This will result in the managed collection of state level longitudinal data to enable Arizona educational stakeholders to follow student's progress over time.

The concept of longitudinal student data will link student enrollment, demographics, program participation, test scores, course rigor index, course completion, and graduation information. The AEIF vision builds upon ADE's Student Accountability Information's (SAIS) existing ability to assign unique student IDs and enable Arizona's educators, policymakers, and researchers to:

- Trace, monitor and measure the educational progress, challenges and opportunities of tested and untested students from preK-12 through higher education systems.
- Track and measure students' performance in tested content areas on statewide assessments, year to year, for the life of the students. The AEIF will track the performance of students for the periods in which they participate in the Arizona public school system.
- Track LEA academic performance in providing success with student learning through tested content areas, based on its students' assessment scores, year to year, for the life of the students.
- Track and measure English Language Learner (ELL) students' performance throughout their entire Arizona educational experience.
- Identify key relationships and dependencies like the relationship between early education and achievement with regard to later student success.
- Build upon the existing capabilities surrounding student level ADE graduation and dropout analysis.



- Monitor and measure student level enrollment, demographic and program participation statistics.
- Identify and monitor untested students for academic growth and to assure no student “falls through the cracks”.
- Analyze the effects of state educational policies.
- Measure student mobility, associated test scores and course completion.
- Refine credibility of student socioeconomic data.
- Create level multi-variant comparisons horizontally and vertically across educational institutions and time.
- Implement a process of data auditability with respect to data integrity, utility, operational viability, quality, validity and reliability.
- Identify highly performing LEAs as benchmarking schools.
- Identify performance gaps and use AEIF information to narrow and close the documented gaps.

An additional element of the consolidated AEIF vision builds upon existing ADE teacher certification processes by providing AEIF with a unique certified teacher identification number. In future phases of AEIF, these existing capabilities will enable the warehoused information to retain data that joins certified teachers to students and curriculum. ADE is currently allocating resources and executing on plans to provide for incorporation of non-certified, charter and private school teachers to the ADE teacher data collection efforts and ultimately available to AEIF data consumers.

As a result of that vision, the initial elements of a roadmap have been compiled to provide Arizona’s educational stakeholders the information necessary to make informed educational decisions. The roadmap stipulates that operationally viable, predicable credibility and high availability/reliability are foundational tenets of a successful AEIF implementation. The roadmap acknowledges the data warehouse is not one single entity, but an integrated platform of applications and data repositories that are comprehensive, secure, personalized and collaborative in nature and implemented with a keen eye on an efficient return on investment (ROI) to the Arizona taxpaying community.

The roadmap acknowledges the fact that the AEIF data warehouse exists to serve its users. Fundamentally, user acceptance is the ultimate measure of its success. The educational data warehouse exists to enhance the ability for Arizona to deliver a quality educational experience to all children by providing vital insights through data that accurately models the past, current and future state of Arizona’s educational experience. But the delivery of a great user experience must be accomplished without compromising or interfering with the supporting on-line transactional processing (OLTP) systems such as ADE’s SAIS. AEIF is being implemented as a central repository of consistent data and that will have the ability to efficiently and accurately answer complex queries. The vision includes the requirement that the provided data accessing toolsets will be available to the AEIF user community and will make available a variety of powerful analytical tools.



When designing the AEIF data warehouse vision implementation plan, ADE incorporated a strategy that starts with analyzing the data workflow and process from the “beginning and end”, and then worked toward the middle. This means that ADE has recognized that a successful data warehousing implementation strategy requires a fundamental understanding of the range of questions that are to be answered by the data retained in the data warehouse (the end) and a fundamental understanding of the sources of the data supplying AEIF information (the beginning). As a result, ADE is generating a gap analysis between available credible AEIF data sources and the data required to accurately and efficiently respond to the documented questions.

In addition, the plan also stipulates that the AEIF logical data model must be based upon on-line analytical processing (OLAP) dimensional modeling. That AEIF contains historical data generating repeatable detailed and summarized result sets and reports, and the processes associated with extracting, transforming and loading (ETL) or extracting, loading and transforming (ELT data integration) data into AEIF assures data credibility, consistency, normalcy and balance. Denormalization of OLTP data through the transformation process is key to maximizing performance and data utility.

Beyond quantifying the aforementioned foundational tenants, in practice, the ADE AEIF strategy provides direction for the process of stratifying the user/consumer community. The user stratification process is enabling ADE to select data structures and toolsets that address the distinctive requirements of each AEIF stakeholder’s classification. These high level user/consumer’s classifications include analytical information users, information explorers and information consumers.





As the above graphic illustrates the largest segment of AEIF users, identified as information consumers (i.e. the ADE Information Technology (IT) Group), have requirements for standardized cached reports that are repetitive in nature and have little "what if" capabilities or requirements. Information consumers have requirements for data record sets that may have little strategic value but significant operational value that provides assistance in supporting informed day-to-day decision processing. The plan is to provide Microsoft SQL Server querying tools, SQL Server agent and scheduling tools, and Microsoft's Reporting Services to all user stratifications.

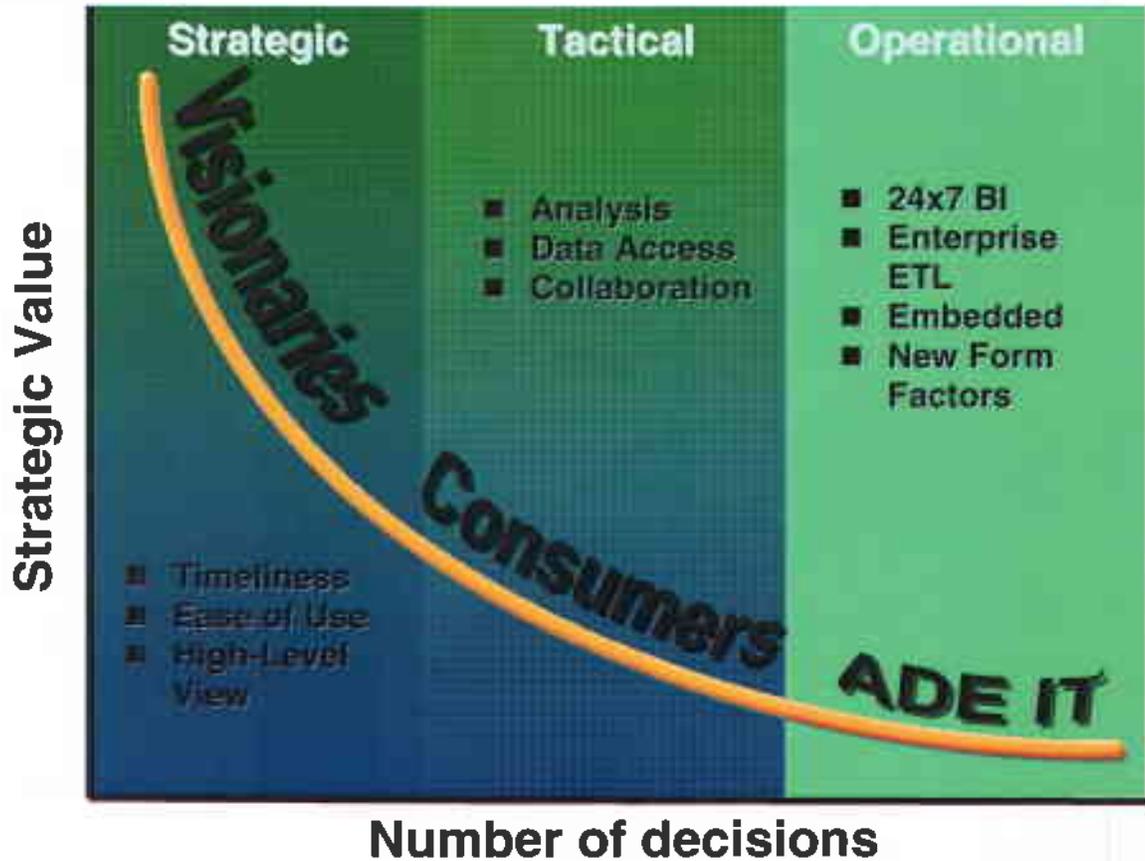
The next segment of AEIF users, characterized as information explorers (i.e. ADE school finance, local education agencies (LEAs) or their student management systems (SMS)), have requirements for information downloads and parameterized reporting capabilities. Information explorers have a more balanced set of requirements between strategic and decision making data extract requirements. The ability to submit real time requests for reports/views/data downloads designed with and by the ADE staff and stakeholder groups would provide assistance in improving student learning by enabling a broad spectrum of educational analysis. Planned examples include the ability to examine school and program effectiveness, to identify promising educational practices, to meet federal and state reporting mandates, to set effective statewide educational policies, and to make the correct, most informed educational decisions for teachers and students alike. To realize those goals the AEIF vision incorporates input from the LEA Data Advisory Councils (DAC), most recently referred to as the Chief Technology Officers Advisory Group (CTO), with respect to the type of data, the form of data and the toolsets desired to maximize the value of the AEIF initiatives to the LEA user community. The AEIF vision has information explorers using reporting solutions similar to Microsoft's Reporting Services or customized data querying/management tools to garner the user desired information.

The final high level segment of AEIF users, Analysts (i.e. researchers, legislators, educational power users) require the toolsets and access to the AEIF information necessary to evaluate the complex "what if" scenarios. These users will be vested in presenting complex questions through ad-hoc queries and leverage the longitudinal reporting capabilities integrated into future versions of AEIF. The analyst's results may not produce a large volume of decision making findings, but will necessarily have significant strategic value. The capabilities associated with these types of users may vary between sophisticated multidimensional expression language (MDX) developers to experienced business intelligence (BI) tool users.

Each user group may have their data "marted" to minimize the potential impact of any one user or process on the entire AEIF user community. In this context, the act of creating a data mart warehoused information is characterized as the processes associated with exporting, at a predetermined refresh rate, a specific user or user groups data into a unique logical and/or physical data mart designed to address their unique data requirements. As



the following graphic depicts, the relationship between the strategic and decision making requirements of AEIF users are correlated to their user classification.



Concurrently, beyond the user stratification process, the ADE AEIF vision provides analysis of all new and existing AEIF data sources. Each data source is being evaluated to determine:

- Its specific collection requirements, processes, methodologies and technologies.
- Its relative credibility and actions for remedy.
- Its transformation requirements with associated data type, normalization, and aggregation requirements.
- Its refresh rates and latency requirements.
- It's joining requirements (uniquely keyed, composite multi-keyed or fuzzy logic).
- It's mapping into the AEIF data dictionary.
- Its metadata requirements for dimensional and fact translation.
- Its ability to snapshot import or incrementally update through repeatable processes.

As the AEIF data sources are quantified, the coalescing processes result in the merging, cleansing, normalization and transformation of the source data to eliminate redundancy and to provide a unified trusted credible data source. Unlike the existing disparate sources of data, the data warehouse will provide the data and tools needed to organize the retained information, add utility to the information and have the native flexibility to glean knowledge from its use.

When translating the AEIF vision into actionable tactical elements, ADE has created an AEIF proof-of-concept (POC), a microcosm of AEIF, to demonstrate that many of the previously disparate educational data repositories managed by ADE can be joined and coalesced into a credible unified data source. The resultant unified data source, AEIF version 1, has already provided value by supplying the information necessary to support the "Integrated Data to Enhance Arizona's Learning" (IDEAL) on-line Arizona School Improvement Plan (ASIP) processes. This microcosm has successfully demonstrated that AEIF is feasible and has joined student demographic data with student achievement data. As the AEIF proof-of-concept is finalized and the pilot program is deployed, each stage of the AEIF roll-out plan is being envisioned and quantified.

Building upon the POC, the AEIF phase one vision is to deploy functionality that exposes and manages aggregated student information (membership, demographics, special needs, and funding data) coalesced with associated student achievement data (AIMS Results). The successful interrelationship of these data groupings is scalable to linking future educational data groupings and dimensions. Subsequently, phase two will provide teacher and curriculum schedule data mapped into AEIF and made available to the specifically authorized users.

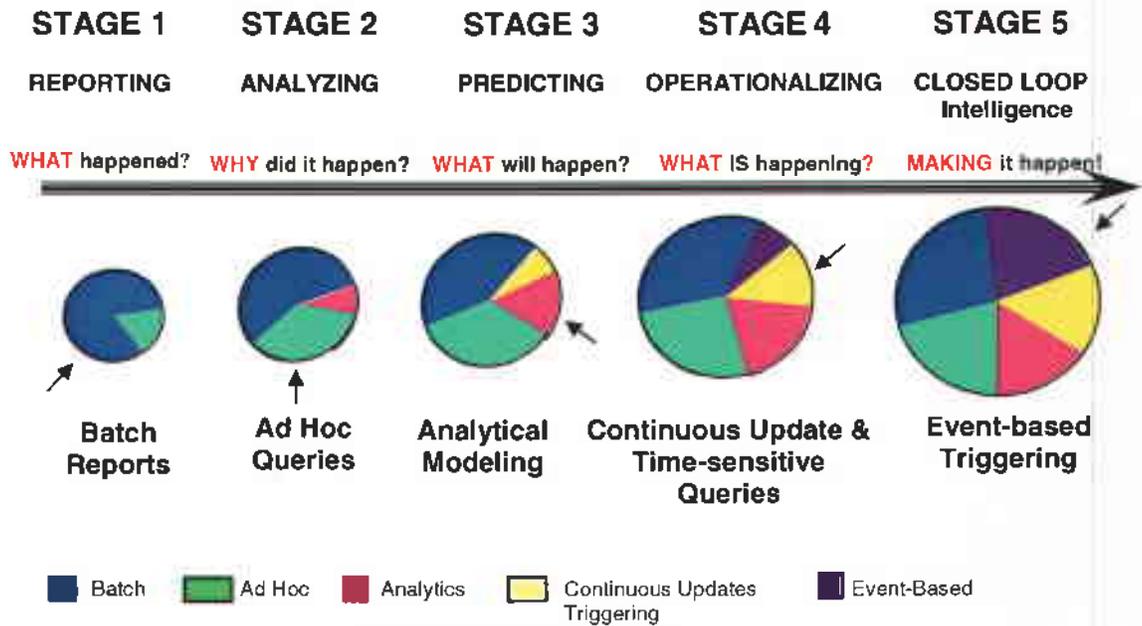
Within each phase, the functionality roll-out will follow prescribed stages of maturity and utility. As the following graphic illustrates, each AEIF phase will be rolled out to the various user classifications in a managed order commencing with:

- Static reporting answering the "What happened?" questions.
- Analyzing answering the "Why did it happen?" questions.
- Predicting answering the "What will happen?" questions.
- Operationalizing answering the "What is happening?" questions.
- Closed loop intelligence users which responds to questions targeted at asking "how to make it happen?"

In the world of data warehousing, business intelligence (BI) is defined as a set of technologies and techniques that support decision making. Stages 3, 4, and 5 of the AEIF vision bring business intelligence (BI) capabilities to its users and support many of the data-driven DSS requirements discussed.



AEIF In-Phase Stages of Maturation and Utility



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When reviewing the AEIF vision, a logical step is to evaluate and contrast ADE’s vision with other states’ experiences and approaches to deploying their educational focused data warehousing solutions. The evaluation process included interviewing other state’s educational data warehousing stakeholders and noting their varied approaches, individual requirements, objectives, strategies, challenges, solutions and opportunities. As much as there are many commonalities, the review process revealed significant differences between Arizona’s and the other states’ education related data warehousing requirements and their current level of technological capabilities.

In as much as Arizona’s business and technical objectives parallel those of other states, the AEIF vision aligns well with other state level educational data warehouse initiatives. During the analysis process, the review of Wyoming’s, Vermont’s, Minnesota’s, Oklahoma’s and South Carolina’s plans reinforced the understanding that this type of initiative is critical. All desire a fully implemented statewide educational information system delivering information for regulatory reporting to state and federal agencies and supporting critical decision making by policymakers, educators and members of the public.

The following common elements underscored the realization that state level data warehousing is critical in:



- Gaining a fundamental understanding of the existing state of education.
- Examining school and program effectiveness.
- Meeting federal and state reporting mandates.
- Setting effective statewide educational policies.

Additionally, the subsequent objectives underscored the common vision shared by Arizona and all states researched:

- The desire to create a data warehousing system that is intuitive and readily understandable to every user.
- That State level educational data warehouses need to be responsive to data-driven DSS.
- The data should be consistent, accessible, accurate and credible.
- The data is timely and meets the various requirements surrounding latency and refresh rates.
- The data answers questions relevant to the users.
- The data and performance support informed decision making processes at each level of a child's educational team.

That same review also produced some significant differences in Arizona's educational data warehousing requirements compared to the states included in our analysis. The foundation for the identified requirement's disparities resulted from reviewing the following key factors:

- The fundamental attributes of Arizona's student population.
 - Higher percentages of mobility rates intra and inter district.
 - Higher percentage of ELL students.
- The ETL technologies vary amongst states.
 - Some states are dedicated to the Schools Interoperability Framework (SIF) and others have decided SIF is not a mature enough standard.
 - All states research did profess to have adopted the "zone integration" concept where a consolidated landing zone is created for ETL data interoperability standards across all external AEIF data providers.
- Legislative and legal stipulations
 - An example is Arizona's interpretation of FERPA to prevent ADE from supplying a student's current district with student information created by another district. Currently, based upon initial guidance from the Arizona Attorney General's Office (AG), ADE cannot act as the agent for sharing student data (beyond test scores) from a student's home district to a second district now verifiably owning the student. In responding to this constraint, ADE has requested the AG's Office solicit direction from the Federal Department of Education (DOE) that will empower ADE to act as that agent.



- AEIF Supporting technologies already in Arizona’s production environment.
 - Unique state wide student identification number.
 - Unique state wide certified teacher identification number.
 - Existing SAIS and student management systems (SMS) integrated data import capabilities.
 - Existing student level data export (download) capabilities.
- Sponsoring entity and native associated technical skills.
 - Other state level warehousing initiatives are sponsored and managed by prominent districts who have partnered with the state agency.
 - Other state level sponsoring entities do not have native technicians to build, implement and operate the data warehouse.
 - Other states have chosen to accept the risks associated with third party private vendor dependencies and absorb the variable recurring capital/operating fees associated with building and operating their educational data warehouse.
- The varied types of districts and LEAs that are both suppliers and consumers of AEIF information.
 - States included in our review did not the level of issues associated with the variety of types of districts and schools requiring support from AEIF.
- Past ADE inter-departmental/intra-agency partnership experience.
 - A lack of strong partnership and collaboration between the previous ADE MIS department and other agency departments.
 - A lack of strong partnership and collaboration between the previous ADE MIS department and Arizona school districts, LEAs, other state level agencies, other data stakeholders, etc.

Finally, all of the states researched had similar concerns and challenges in deploying their educational data warehouse solution. All five states have minimal student mobility, but struggle with longitudinal studies and linkages to teacher unique identifiers.

But, ultimately it is about each individual child and providing the requisite tools to empower their educational teams with the knowledge to know what has worked and not worked for each unique student in the past, and what will work and not work for each unique student in the future. As a result, developing the tools that provide that functionality and knowledge is a common theme included in the various vision statements.



AEIF Data Sources:

As noted in the AEIF vision section, a key element of designing, creating, deploying and operating a successful data warehouse is the analysis of existing and future transactional data sources from an enterprise perspective. A coordinated approach to data analysis and collection is essential to making the most effective use of ADE's resources and maximizing AEIF's probability of success. This type of approach will allow for comprehensive, one step data collection. It also provides data auditability and limits the need to expend unnecessary resources to determine the sources of data and their associated statuses.

Data warehouses generally create dependencies across applications and data stores that had traditionally operated in a siloed world. AEIF is no exception. These new dependencies require analysis surrounding the unique transformation requirements and the most efficient data migration strategies to implement when exporting/importing data to AEIF. Factors to be considered are:

- real time data updates and/or bulk loads required?
- sizes of data to be migrated (bandwidth and resource constraints)?
- acceptable latencies?
- the amount of transformations required between the source and AEIF.
- the complexity of extract and load (external data sources vs. internal data sources)?
- the security contexts of data to be extracted?
- the secure transmission requirements?
- the forms of the source data?
- the regulatory and/or legislative contexts of the data (FERPA, etc.)?
- the skill sets and capacities of the staff managing data sources.
- there related information from alternate sources that must be imported synchronously with a specific AEIF data source?
- what data timing issues may be involved (foreign keyed data between parent and child)?
- ETL strategies or are extract, load and transform (ELT) data integration strategies appropriate?

Each data feed and its transport, cleansing, normalization and/or aggregation requirements, necessitates integration of new enterprise design and communication methodologies.

Since ADE has made commitments and significant investments in Microsoft technologies, with the associated skill sets, SQL Server 2000 data transformation services (DTS) and some customized objects have been the traditional toolsets utilized in addressing ETL or ELT requirements. But with the recent release of the long awaited SQL Server 2005, SQL Server Integrated Services (SSIS) and Class Server 3.0 (when possible) provide templated development standards for code based ETL that can be certified



SIF compliant. These products assist ADE in establishing a single-source access point to the numerous and disparate data assets managed by the LEAs including student management systems (SMS) and AEIF. SSIS enables ADE IT to develop the data landing zones providing staging areas for incoming information

AEIF Phase One is being supplied information from existing ADE data repositories providing:

- Student financial system (SFS) providing student enrollment counts from the funding perspective.
- School report cards to ascertain activity types with dropout, attendance, performance, and graduation rates.
- SAIS provides student detail information including enrollments, needs, special programs and demographic information.
- School District Employee Report (SDER) provides teacher (both certified and non-certified excluding charters) information and their assignments as of October.
- AIMS testing information (Dual Purpose Assessment and High School) is provided to the data warehouse team in the form of a CSV download file from ADE research and evaluation, and from a scrubbed SQL Server 2000 data repository that has been imported, transformed and pushed from the data received from McGraw Hill.
- Enterprise system provides entity numbers for LEA's, look up code values, with address/contact person information.
- Certmaster provides LEA employees, employee codes, employee positions, and position codes.
- Research and Evaluation ad-hoc extracts.

ADE IT and ADE in general have commenced the processes associated with understanding the opportunities and complexities associated with coalescing these known varied information sources. Undoubtedly as more "questions to be answered" by AEIF are identified, more data sources will be required to respond to these dynamic requirements. ADE IT has laid the preliminary framework, with the required flexibility and agility, to respond to the evolving needs for warehoused data.



AEIF User/ Information Consumer Communities:

As noted in the AEIF vision section, another key element of a successful data warehouse is the stratification and understanding of the AEIF user/consumer community and their associated data requirements. Each user stratum has a unique set of needs that require ADE user out reach programs to gather their requirements.

Over the last two months, ADE has made significant changes to their IT (formally MIS) leadership team and, as importantly, made significant modifications to the approach IT utilizes when interacting with other ADE departments, agencies, LEAs, and the public sector. This collaborative partnering style has already provided benefits in ADE's ability to out reach and listen to AEIF stakeholder's requirements, concerns, opinions and recommendations. With that being said, there are still historical hurdles to overcome in engaging the varied AEIF stakeholders in trusting dialogues. The new leadership team is extremely focused upon overcoming those hurdles and rebuilding trusting partnerships with all AEIF stakeholders.

Tactically, there are daily dialogues with stakeholders working on reestablishing trust and quality partnerships. ADE recognizes that for AEIF to be successful, the users must be empowered to:

- Choose their data. ADE is committed to enabling the AEIF user community to have significant input into the data retained within AEIF.
- Determine the timing requirements of the information. Refresh rates and data latency are key elements of those dialogues.
- Have input into performance SLAs. ADE is also committed to developing the dialogues necessary to level set expectations and understand the user's performance requirements with respect to AEIF.
- Have input in the determination of the functionality that will be provided through the AEIF toolset and, as importantly, what functionality will not be provided.
- Have input in their role in the AEIF project and what is expected of them. Some power users will have a key role in laying the framework for future AEIF initiatives.
- Have result sets from AEIF that are credible and trusted.

Within ADE, meetings occur weekly that assist in empowering the ADE AEIF users with the ability to partner with ADE IT in laying the framework for AEIF's future roadmap. Outside of ADE, Janice McGoldrick (ADE CIO) and her leadership team have made significant efforts to work with technical and business advisory groups. Specifically, Janice has been working with district CTO groups and other LEA consortia to build these partnerships and provide them opportunities to be significant contributors to this process. These types of proactive out reach initiatives are critical to incorporating user involvement in the AEIF deployment process; which also means that these types of initiatives are critical to AEIF's overall success.



ADE Organizational and Cultural Influences:

A successful data warehouse implementation requires cultural components that facilitate and sustain a trusting collaborative relationship between all users/information consumers and the supporting IT team. As previously mentioned, the recent leadership change from ADE MIS to ADE IT has fostered this shared spirit of collaboration and partnership. ADE has recognized that “business as usual” would jeopardize a successful AEIF deployment. As previously mentioned, prior to a successful AEIF deployment, it is requisite that the entire ADE executive management team provides clear agency wide direction, empowerment and leadership to converge ADE’s traditionally siloed view of application development and data management into an IT managed centralized set of PPP’s

With respect to a data warehouse, organizations may be the recipients of a softer benefit, one that is much less tangible than having information for the improvement of better educational decisions. This benefit is that the process of deploying a critical data warehouse solution often facilitates better communications across organizations. ADE is leveraging this opportunity to realize the following benefits:

1. The ADE IT organization that is the centralized infrastructure unit (hardware, software, networking, communications, etc.) works more cooperatively with AEIF users and data consumers.
2. Acknowledgment of an increased focus upon the data management and configuration management disciplines by creating the Enterprise Data Management and Configuration Management Groups.
3. Formation of an IT enterprise committee comprised of multiple technical disciplines and business stakeholders.
4. Business organizations that are drawn together as part of a data warehousing project often gain more appreciation for each other’s missions and challenges.
5. Better communications between development and customers in the organization’s business units.
6. Increased communications across different business units.

In the past, ADE IT’s intra-departmental collaborative successes have been minimal. There is a history of ADE non-MIS sections circumventing ADE MIS to avoid the potential of experiencing anticipated disappointments and handicapping intra departmental communications. These practices have resulted in ADE creating extremely siloed applications that are challenging to reengineer for reuse or cross-application communication requirements.

Since the leadership change at ADE IT, work has been ongoing to reverse the perceptions of the past and foster an environment of trust and co-departmental reliance in developing required applications. It will take time and there are many steps to this process. But for AEIF to be successful, all ADE developed and/or managed applications that may supply data to AEIF



must be designed from an enterprise holistic viewpoint. Coding standards, code atomicity, code reuse, shared components, web services, etc. are opportunities to maximize the ROI of ADE's technological investments, maximize efficiency of code development processes and simplify the support requirements associated with ADE applications. To that end, the formation of the enterprise data committee will be empowered to make effective enterprise wide decisions, both vertically and horizontally across the organization. These processes will bridge the varied application teams and the build/operations focused groups.

In the past, ADE MIS has been organized with resources allocated primarily to building applications, but very few resources were focused on operating applications. There have been little or no resources or processes focused upon service delivery, operations, configuration management or data management. In unison with championing the collaborative spirit, ADE IT has commenced the process of morphing the IT organization to one that has a more balanced focus between build and operations.

Additionally, in the past, even though the previous IT reorganization had allocated resources for a project management office (PMO), it was problematic because the previous IT leadership style did not foster effective delegation methodologies and staff empowerment. That was especially destructive when the PMO staff was directed to create a new department with all of the associated priorities, policies and processes, without the direction to see the directives through.

The updated IT organizational vision is to incorporate an "excellence in operations" mindset when delivering any solution. Historically, members of IT have been rewarded for heroic efforts in reacting to operational issues that negatively affect the user experience. Members of IT are now focused on problem prevention tactics and, when issues do occur, taking the time to complete a root cause analysis, focusing beyond remedying reoccurring symptoms.

Currently ADE has the native talent, capability, and drive to effectively build and operate a large scale educational data warehousing initiative. The issue is not the quality of ADE IT's native talent, but ADE IT's resource bandwidth. To intelligently carve out the requisite resources dedicated to assure AEIF's successful deployment, ADE IT requires additional resources, both staffing and capital. This will augment their existing breadth of technical capabilities. Under the current leadership, ADE IT is fully capable of managing existing resource demands and intelligently managing the processes surrounding successful growth

Building upon the recent philosophical changes, there are short-term plans to continue the operational focus by reallocating resources to focus on IT operations, data management, configuration management and project management. This mindset and its associated practices are critical to insuring a successful AEIF deployment and operation. The new IT



leadership's focus on repeatable processes and an enterprise vision have been key in transitioning AEIF from concept to reality.



ADE IT Management and Operational Processes:

Operations is a big topic, and since in the past, operational viability has not been a priority, this dialog will be strictly limited to some very basic areas that can be improved at the ADE in order to enhance the security, availability, predictability and reliability of the Windows-based systems operating in this environment and the AEIF; basically the "low hanging fruit".

Because ADE has made significant commitments to Microsoft technologies, operational process discussions are focused on solutions provided through Microsoft. Additionally, as a result of the tactical nature of this effort, I limited the scope of operational prescription to three core areas:

- *Change Management* which deals with the disciplined and methodical process or effecting a change to the production environment.
- *Service Monitoring and Control* which deals with proactive monitoring of all production systems.
- *Configuration Management* which deals with the classification and identification of assets along with the formal processes associated with releasing new applications or services into production (note: Configuration Management is a broad topic encompassing numerous disciplines and processes; for the purpose of this effort we'll limit our scope to include only aspects that relate to the release of new applications and the AEIF into the ADE production environment).

Having stable applications and environments makes designing and implementing effective PPP's surrounding these concepts requisite to a successful AEIF deployment. Current focus upon these PPP's is also in its infancy, but ADE IT is dedicated to their success. Several meetings have transpired focusing upon the strategies, tactics and tools required to make these processes part of the "way to do business" for ADE.

Change Management

Change Management is but one of the core operational disciplines native to the Microsoft Operations Framework (MOF) Process Model. MOF is Microsoft's disciplined approach to operating and managing a company's IT environment and is founded upon the Information Technology Infrastructure Library (ITIL) model for IT management. The Process Model is a 4-quadrant disciplined approach that targets each critical function of operations, development, support and management, and indicated in the diagram below.



Figure 1: Microsoft Operations Framework Process Model

As the previous diagram illustrates, Change Management falls into the Changing Quadrant of the process flow, and is one of the three Service Management Functions (SMFs) performed in this phase. The information below describes the focus and scope of each function in the Changing Quadrant.

The Change Management SMF is responsible for the process of documenting, assessing the impact of, approving, scheduling, and reviewing changes in an IT environment. A key goal of the change management process is to ensure that all parties affected by a given change are aware of and understand the impact of the impending change. Since AEIF will now make most ADE managed systems heavily interrelated, any changes made in one part of a system may have profound impacts on another. Change management attempts to identify all affected systems and processes before the change is deployed in order to mitigate or eliminate any adverse effects. Typically, the "target" or managed environment is the production environment, but it should also include key development, testing, staging and production environments.

With respect to software change control management, ADE has commenced incorporating the discipline and practices associated with maturing their change control practices (CCP). In summary, ADE has adopted a change control methodology that manages the promotion activities of AEIF components. In summary, the process manages breaks code promotion activities into six steps.

- Daily identify and package new code base to "ready to build" status.
- Create nightly build and complete unit test.
- Complete an integrated functional test.
- Complete a systems/regression test.
- Complete a performance and acceptance test.



- Release to production.

These steps of code promotion provide several opportunities to identify and remedy all levels of defects prior to negatively affecting the user experience. Two boards are established to review defects and determine the significance and remedy action plan. These boards, the failure review board (FRB) comprised of the core technical team (CTT) and the change control board (CCB) with is consists of project management, IT leadership, technical leads and business stakeholders, assist in prioritization of logical groupings of change requests and triaging defects identified in the change control process cycle.

Beyond ADE application software assets, the categories of assets that are placed under change control are broad and include, but are not limited to, hardware, communications equipment, systems software, processes, procedures, roles, responsibilities, and any documentation relevant to the running, support, and maintenance of systems in the managed environment. In other words, any asset that exists in the environment and is necessary for meeting the service level requirements of the solution should be placed under change control. Changes are also rated in their impact and urgency, and ITIL provides an excellent process flow for processing changes of different levels of importance.

The Configuration Management (CM) SMF is responsible for identifying and documenting the components of the environment and the relationships between them. The goal of configuration management is to ensure that the current state is known and that only authorized components, referred to as configuration items (CIs), are used in the IT environment, and that all changes to CIs are recorded and tracked through the component life cycle. The information captured and tracked will depend upon the specific CI, but will often include a description of the CI, the version, constituent components, relationships to other CIs, location/assignment, and current status.

The information contained about the CIs should be held in a single logical data repository, referred to as the configuration management database (CMDB). Whenever possible, this database should be self-maintaining, with automated updates to CI records. CI records are the representation of the CIs in the CMDB, including attributes and relationships. At the enterprise IT level, this repository will often be a relational database with associated support tools, but for smaller organizations a spreadsheet may suffice. In addition, configuration management is responsible for maintaining the definitive software library (DSL), which serves as the repository for all master copies of software deployed in the IT environment.

The recently formed CM team is initially comprised of ADE IT leaders. Their charter is to formalize the PPP's required to successfully execute an integrated CM plan into ADE's native processes. The initial meetings are producing a high level vision statement and have commenced the process of designing formalized PPP's around change management. Even though there is complete



dedication to its success, this mindset is also in its infancy at ADE IT and will evolve to include agency intra-departmental stakeholders.

Configuration management is often confused with asset management. Even though asset management may be an integrated process, it is primarily an accountancy process that is a subset of the overall configuration management process; including depreciation and cost accounting. Asset management systems maintain information on assets above a certain value, their business unit, purchase date, supplier, and location. The relationship to other assets is usually recorded and the information is primarily used to track the whereabouts of equipment.

The focus of the Release Management SMF is to facilitate the introduction of software and hardware releases into managed IT environments and to ensure that all changes are deployed successfully. Typically, this includes the production environment as well as the managed preproduction environments. Release management coordinates and manages all releases and is typically the coordination point between the development release team and the operations groups responsible for deploying the release into production. In combining MSF and MOF in an end-to-end IT life cycle, this is the key point at which MSF-developed projects and solutions integrate fully with the MOF deployment process into a release product.

The oversight role of release management is critical in the successful deployment of complex releases that often involve multiple service providers, operations centers, and user groups. Good resource planning and management are essential to successfully packaging and distributing such releases to customers. Release management takes a holistic view of a change to an IT service and ensures that all aspects of a release are considered together, both technical and non-technical.

Releases should be defined, maintained, and scheduled for each IT service. Most organizations today implement changes on an as-needed basis-or worse, do not implement proactive changes such as service packs at all. The concept of releases and release management allows them to proactively schedule most changes so that high-importance and emergency changes that do not fit the change cycle are the exception, not the rule.

Monitoring

To assure a successful AEIF deployment, greater attention needs to be focused upon operational metrics detail monitoring. As a result of the AEIF creating dependencies throughout ADE's technological organization, monitoring of all technical assets and processes is critical to a successful AEIF operation. Additionally, while monitoring may not immediately be thought of as a security or operational risk, it's critical to every aspect of the operation of the production environment. From the standpoint of monitoring for security and reliability purposes, there are two areas that are applicable:



- Application and database monitoring.
- Core infrastructure monitoring.

This is such a critical factor in maximizing ADE's ability to successfully support an operationally viable data warehouse, the following considerations describe best-practice guidelines and recommendations for proactively monitoring the core infrastructure platforms that touch all architectural systems and applications.

Monitoring the core infrastructure and the services that AEIF relies upon helps maintain consistent directory data and the needed level of service throughout the enterprise. This enables ADE to provide supportable authentication and authorization services for AEIF. ADE can monitor important indicators to discover and resolve minor problems before they develop into potentially lengthy service outages.

As part of this discovery process, it was recognized that previous ADE administrations have already made significant investments in Microsoft Operations Manager 2000 (MOM) to monitor important indicators. As of this time ADE is commencing the MOM implementation plan. Continuing MOM's prioritized managed deployment will provide the necessary consolidation and timely problem resolution to administer all AEIF application and infrastructure components successfully.

Monitoring helps resolve issues in a timely manner, and AEIF users experience the following benefits:

- Improved reliability of productivity of all applications, especially AEIF, that relies upon back-end servers and processes.
- Quicker logon time and more reliable resource usage.
- Decreased help desk support calls.

Monitoring all AEIF components provides administrators with a centralized view of core infrastructure components, applications and data repositories across the enterprise. By monitoring important indicators, administrators can realize the following benefits:

- Predictable performance and the ability to proactively perform key operational maintenance processes.
- Higher customer satisfaction, because issues can be resolved before users notice problems.
- Increased service levels, due to improved reliability and system understanding.
- Greater schedule flexibility and ability to prioritize workload, due to early notification of problems, allowing resolution of issues while they are still a lower priority.
- Increased ability for the system to cope with periodic service outages.



Monitoring Active Directory and the core infrastructure components also assures administrators that:

- All necessary services that support Active Directory are running on each domain controller.
- Data is consistent across all domain controllers and end-to-end replication completes in accordance with ADE's service level agreements.
- Lightweight Directory Access Protocol (LDAP) queries respond quickly.
- Domain controllers do not experience high central processor unit (CPU) usage.
- The central monitoring console collects all events that can adversely affect Active Directory.

Once AEIF is deployed, service level baselines needs to be periodically collected and documented for performance quantification. By setting thresholds to indicate when the baseline boundaries are exceeded, the monitoring solution can generate alerts to inform the administrator of degraded performance and jeopardized service levels. Also, to determine an accurate baseline, monitor and collect data for a time period that is long enough to represent peak and low usage. Monitor for an interval that is long enough to span ADE's password change policy and any month-end or other periodic processing that you perform. Also, collect data when network demands are low to determine this minimal level. Be sure to collect data when the environment is functioning properly. To accurately assess what is acceptable for your environment, remove data caused by network outages or other failures when you establish the baseline. Monitoring key performance indicators (kpis) allows the administrator to ensure adequate performance.

The baseline that ADE establishes can change over time as new applications, users, hardware, and domain infrastructure are added to the environment, and as the expectations of users change. Over time, the administrator should look for trends and changes that occur, and take actions designed to meet the increased demands on the system and maintain the desired level of service. Such actions might include fine-tuning the software configuration and adding new hardware.

Determining the thresholds when alerts are generated to notify the administrator that the baseline has been exceeded is a delicate balance between providing either too much information or not enough. Operational administrators should periodically adjust these thresholds to meet the service level objectives (SLOs). To adjust these thresholds, first collect and analyze the monitoring data to determine what is acceptable or usual activity for the environment. After good data sample is gathered and consider the service level needs, meaningful thresholds can be set to trigger alerts.

To determine thresholds:



- For each kpi, collect monitoring data and determine the minimum, maximum and average values.
- Analyze the data with respect to your SLOs.
- Adjust thresholds to trigger alerts when indicators cross the parameters for acceptable service levels.

The goal of a comprehensive monitoring solution is to monitor all of the important indicators and provide alerts that are concise, highly relevant, and lead an operator to resolve the problem. Ideally, the monitoring solution alerts operations only when a problem requires action.

In addition to providing increased service availability, the relationship between monitoring and troubleshooting increases ADE's understanding of the root causes of most problems that arise. As ADE's environment becomes more reliable, monitoring alerts more precisely indicate the cause of new problems that arise.

Server Environment Patch/Hotfix Management

Systems, applications and network patch updates for the servers are currently performed manually. Eventually an automated patch management tool should be researched and integrated into the operational maintenance strategy. Until that time server patch management (versus desktop patch management) for AEIF, ADE should implement patch/hotfix change management. Any distributions to the server systems are approved and have an appropriate test, validation and contingency path.

Patch management only works when it is a process deployed across the organization. The consultants create a people and process-based approach for an effective security patch management infrastructure using ADE's selected patch management solution. The solution may be configured in a lab environment to provide ADE's security team a hands-on opportunity to work with the solution for the enterprise.



Data Security Practices:

The security of AEIF authentication/authorization resources, stored sensitive information and data transmissions are critical elements to AEIF's success. All information stored in AEIF will have retained metadata describing each data objects security context. The security context of data will be viewed by evaluating risks associated with possible data compromise. Once that determination is made, data is categorized, partitioned and secured based upon its potential risk. Some of these categories include:

- Personal identity theft (i.e. data that would, if compromised, potentially result in a risk of personal identity theft like social security numbers (SSN), birthdates, etc.)
- Personal privacy theft (i.e. address, telephone, email, etc. information)
- Student privacy theft (demographic information, test scores, grades, special programs participation, etc.)
- Agency sensitive information (i.e. employee rosters, organization, budgets, finance, etc.)

As data is categorized, logical and physical data partitions are created to minimize the associated risks.

With respect to application authentication and authorization, ADE currently utilized its enterprise authentication engine to authenticate most of ADE's public facing applications. But if AEIF were to leverage this asset several upgrades would be required. The most important is to update the current practice of retaining the user name and password in plaintext in the database. Most organizations have discovered that they do not need to actually store a users name and password. Usually the storage of actual password information is only needed if one system needs to act as a proxy application or to forward an actual password in order to gain access to another system.

With respect to AEIF authentication data, a one way hash should be used in lieu of storing user passwords, encrypted or not. Microsoft Windows 2000 and 2003 Server have support for both the MD5 and SHA (Secure Hash Algorithm) included for use in the built in Crypto API. If given a choice, I would recommend utilizing SHA hashes for AEIF and stipulate that passwords would never need to be retrieved from the system. If passwords are forgotten a process would be available to create and email a new password to a verified email account.

If it is determined that passwords must be retained in the AEIF authentication data partition, the password and optionally the user information (or any other high security risk information) will be encrypted using a standardized and government accepted strong encryption algorithm such as the Advanced Encryption Standard (AES). The AES standard was originally known as Rijndael (pronounced rain doll) prior to being accepted as a standard and renamed AED. AES was approved for Government use by the National



AEIF Technical Strategy:

ADE's strategy for providing the AEIF enterprise technical framework leverages ADE's extensive investments in existing technological assets and tools. With ADE IT's native expertise in Microsoft technologies, a key element of their technical strategy is to incorporate and enhance that expertise in deploying AEIF.

Once again, because a successful deployment of any large data warehouse initiative requires a holistic enterprise approach to technical processes and toolsets, ADE IT has commenced the process of analyzing the most recently available tool sets to realize the most effective technical roadmap strategy. Under current assessment is the recently released Microsoft solution set which is intended to provide ADE with the next generation of managed development and deployment process control suites. The toolsets are designed to assist in managing three critical elements of data warehousing management:

Enterprise Data Management

- High availability for enterprise applications
- Key security and performance features
- Focus on self manageability and optimization

Developer Productivity

- Integration with Visual Studio and .NET
- Native XML technology
- Interoperability via Web Services

Business Intelligence

- Integrate and Transform Data
- Analyze, Store and Mine Data
- Report and Interact with Data

The preferred technology stack, illustrated below, provides ADE with the integrated application development and data management toolsets. ADE's choice to utilize these technologies provides integration efficiencies while having the flexibility to support heterogeneous environments. The tools associated with AEIF will require the abilities to work seamlessly with alternate technologies utilized by the varied AEIF data consumers and data suppliers.





AEIF Information Consumer and Technologist's Training:

To assist AEIF stakeholders in realizing the opportunities provided by a well designed and managed AEIF, ADE has recognized the need for and has incorporated plans for ongoing targeted training programs. The proposed training programs are intended to instruct the AEIF user and support community on the strategic, tactical and administrative elements of AEIF.

As stated earlier, deploying the best toolsets, architecture and implementation strategies, cannot by itself provide the robust utility provided by the information retained in AEIF. Training of both the IT staff and data consumers on AEIF information utilization opportunities and best practices, including how to incorporate the rich tools and warehoused information into each stakeholder's day-to-day processes is critical to AEIF's success. Training of the selected toolsets, information definition and utility, standards for data use, transport/communications methodologies and available canned reports/query libraries are a partial subset of the curriculum standards required for consistent and quality knowledge transfer.



User and Technologist's Communications:

ADE is currently designing and implementing formalized AEIF communications processes that utilizes portal technologies (amongst others) to disseminate critical information to all AEIF stakeholders. Opportunities to utilize formalized training sessions, to participation in AEIF stakeholder forums, to broadcast notifications and to sponsor AEIF user conferences are some of the communication methodologies planned to disseminate critical information to all stakeholders. Additionally, utilization of existing portals like IDEAL provide unique opportunities to reach out to all parties. As technological opportunities arise for enhanced communications with AEIF stakeholders, whenever possible, ADE plans to envelope them into their communications strategies.



Vendor Relationship Management:

Quality managed vendor relationships are essential to a successful AEIF deployment and ongoing operational viability. When selecting a strategic vendor partner, ADE evaluates a vendor's:

- Financial stability.
- Support capabilities and processes.
- Reputation in the data warehousing technical and user communities.
- Proximity
- Experience (both technological and educational)
- Product costs (fixed and variable).
- Time in marketplace.
- Support documentation.

Well managed strategic vendor partnerships are key elements in maximizing AEIF's probability of success. These relationships create effective and efficient product procurement and implementation decision processes.



AEIF Documentation and Artifacts:

Artifacts documenting the standards and processes associated with the design, management, development, testing, deployment, and operations of AEIF are requisite to a successful AEIF implementation. The types of artifacts currently being designated include:

- A project charter that defines the AEIF project's scope, objectives, risks, critical success factors and deliverables.
- A project plan.
- An organization chart.
- A Business requirements document.
- A Technical requirements document.
- A Data management strategic document that details data warehouse elements configurations, data refresh requirements, data latency requirements, data archival requirements and data granularity requirements.
- A Technical architectural document,
- User and Technologists Training Materials.
- Project Status Reports.
- A User Interview Question Document.
- A Subject List Document.
- A Source Data Document.
- A Data Dictionary based upon the National Center for Education Statistics (NCES) standards and collaborative analysis with LEAs.
- An Environmental and Policies Document.
- A Technical and Business Roles Definition Document.
- A Technology Acquisition and Rollout Plan Document.

As the AEIF implementation strategy matures, I fully expect the requirement for additional artifact types to surface.