4.3

NWS ENTERPRISE ARCHITECTURE

Bobby Jones*, Chief IT Architect
Barry West, Chief Information Officer

NOAA's National Weather Service

1 INTRODUCTION

In 1996, Congress required Federal Agency Chief Information Officers (CIO) to develop, maintain, and facilitate integrated systems architectures with the passage of the Clinger-Cohen Act. Additionally, Office of Management and Budget (OMB) issued guidance that requires agency information systems investments to be consistent with Federal, Agency, and bureau architectures. Enterprise Architectures (EA) are "blueprints" for systematically and completely defining an organization's current (baseline) or desired (target) environment. EAs are essential for evolving information systems and developing new systems that optimize their mission value. This is accomplished in logical or business terms (e.g., mission, business functions, information flows, and systems environments) and technical terms (e.g., software, hardware, communications), and includes a sequencing plan for transitioning from the baseline environment to the target environment.

If defined, maintained, and implemented effectively, these institutional blueprints assist in optimizing the interdependencies and interrelationships among an organization's business operations and the underlying IT that support operations. The experience of the OMB and the General Accounting Office (GAO) has shown that without a complete and enforced EA, federal agencies run the risk of buying and building systems that are duplicative, incompatible, and unnecessarily costly to maintain and interface.

The purpose of this article is to discuss the National Weather Service's (NWS) approach to establishing and maintaining an effective EA. It begins by defining EA and describes the benefits of having an EA. Next, the methodology the NWS is using to establish and maintain its EA is described. Finally, the article goes into detail describing the current state of the NWS' EA.

2 WHAT IS ENTERPRISE ARCHITECTURE?

An Enterprise Architecture (EA) is a comprehensive blueprint that aligns an organization's business processes with its Information Technology (IT) strategy. It is documented using multiple architectural models or views that show how the current and future needs of an organization will be met. The key components of the EA are:

- Accurate representation of the business environment, strategy and critical success factors
- Comprehensive documentation of business units and key processes
- Views of the systems and data that support these processes
- A set of technology standards that define what technologies and products are approved to be used within an organization, complemented by prescriptive enterprise-wide guidelines on how to best apply these technology standards in creating business applications.

The Federal CIO Council defines EA as "a strategic information asset base, which defines the business mission, the information necessary to perform the mission, the technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to the changing mission needs." (CIO Council, 1999)

An Enterprise Architecture (EA) includes a baseline architecture, a target architecture, and a transition plan for moving from the baseline to the target. The target architecture components may be justified using business cases developed by the Enterprise Architecture team. EA is documented using the following architectural concepts:

Business architecture - addresses the business mission, strategy, lines of business, organization structure, business process models, business functions, etc.

Information architecture - defines what information needs to be made available to accomplish the mission, to whom, and how.

Data architecture - establishes a framework for maintenance, access and use of the data of the enterprise. The data should meet the standards of the business unit and the other levels of the EA. The creation of a data dictionary and associated naming conventions is an important part of the data architecture.

Application architecture - focuses on the application portfolio required to support the business mission and information needs of the organization. At the next level of detail, it addresses the common business components and business services that can be leveraged by multiple applications.

Technology architecture - defines the technology services needed to support the application portfolio of the business. It also documents the software, hardware, and network product standards.

3 BENEFITS OF ENTERPRISE ARCHITECTURE

An EA provides senior management with an increased understanding of the information technology (IT) as it relates to the strategic planning and to the capital planning and investment process. It provides a consistent approach for defining and communicating the components needed to cost and plan IT programs. It is based on the business requirements derived from the priority initiatives as well as systems engineering design best practices. Such an approach will enable the NWS to 1) leverage IT investments and avoid unnecessary duplication of infrastructure and major components, 2) link business processes through shared, yet sufficiently protected information systems, and 3) leverage disparate business processes, services and external activities.

An effective EA will provide the NWS with the ability to:

- Capture facts about the mission, functions, and business foundation in an understandable manner to promote better planning and decision making;
- Improve communication among the business organizations and IT organizations within the enterprise through a standardized vocabulary;
- Provide architectural views that help communicate the complexity of large systems and facilitate management of extensive, complex environments;
- Focus on the strategic use of emerging technologies to better manage the enterprise's information and consistently insert those technologies into the enterprise;
- Improve consistency, accuracy, timeliness, integrity, quality, availability, access and sharing of IT-managed information across the enterprise;
- Support the CPIC processes by providing a tool for assessment of benefits, impacts, and capital investment measurements and supporting analyses of alternatives, risks, and tradeoffs;
- Expedite integration of legacy, migration, and new systems; and
- Enables the sharing of reusable components and interoperability among programs, systems and applications.

4 NWS APPROACH TO ENTERPRISE ARCHITECTURE DEVELOPMENT

The NWS began its EA development in 1998 with the development of a seven volume static capture of the business, information, application, technology infrastructure views of the enterprise. This document attempted to show the relationships among the various architectural views, it lacked a visual or graphical means to trace through the various levels of data. It was also difficult to maintain since it was not automatically linked. Eventually, the documented EA aged and was unusable to support capital planning activities.

In 2002, the NWS researched and selected an EA tool and repository to graphically show the relationship among the NWS strategic plan, mission, and business processes, the Enterprise Architecture, and the capital IT investment planning and decision making process. The NWS selected the Metis Business Modeling Application by Computas, Inc.

The NWS CIO chartered an EA working group which is led by the NWS' Chief IT Architect and comprised of representatives of each NWS Office and Region. Also, the team is augmented by prime contractor Systems Plus, Inc. and subcontractor SRA International, Inc.

4.1 The Federal Enterprise Architecture Framework

There are a number of Enterprise Architecture frameworks available. The NWS EA is based on the NIST Enterprise Architecture Framework (NIST Special Publication 500-167) and the Federal Enterprise Architecture Framework (FEAF), and is consistent with the Department of Commerce (DOC) and National Oceanic and Atmospheric Administration (NOAA) EAs. Figure 1 depicts the FEAF which partitions a given architecture into business, data, applications, and technology architecture layers.

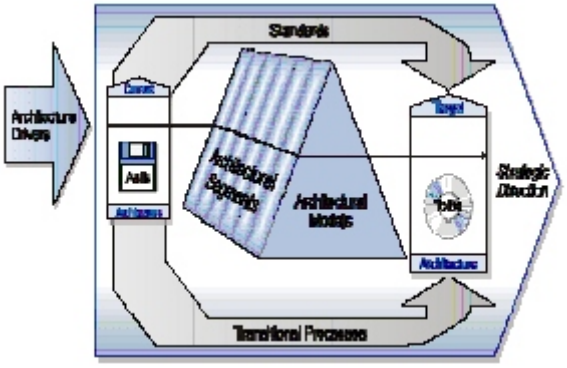

Figure 1. Federal Enterprise Architecture Framework

The eight components of the Federal Enterprise Architecture are as follows:

- *Architecture Drivers* - external stimuli that cause the Federal Enterprise Architecture to change.
- *Current (As-Is) Architecture* - the current state of the enterprise.
- *Target (To-Be) Architecture* - the target state for the enterprise within the context of the strategic direction.
- *Architectural Models* - provide the documentation and the basis for managing and implementing changes in the Federal Enterprise.
- *Architectural Segments* - subsets or smaller enterprises within the total Federal Enterprise.
- *Standards* - standards (some of which may be made mandatory), voluntary guidelines, and best practices, all of which focus on promoting interoperability.
- *Transitional Processes* - processes that apply the changes from the current architecture to the target architecture, in compliance with architecture standards (such as various decision making or governance procedures, budgeting, engineering change control, etc.).
- *Strategic Direction* - ensures that changes are consistent with the overall Federal direction.

4.2 NWS Roadmap to Implementation

The Roadmap to complete implementation of the NWS EA consists of the following steps:

- Load and validate the existing architecture into the Metis application, linking the business, information, data, application and technology layers of the architecture.
- Develop a target architecture which also links the business, information, data, application and technology layers.
- Perform a gap analysis to identify the areas where NWS must invest to achieve the target architecture and link these needs to the NOAA and NWS Strategic Plans and NWS IT Strategic Plan NWS IT investment portfolio.
- Develop a migration plan for achieving the target architecture.

The NWS CIO plans to roll out the complete EA in fiscal year 2004. The EA working group is populating and validating the current view of the NWS EA into the Metis application. Also, an effort has been initiated to define the target architecture view.

5 THE NWS ENTERPRISE ARCHITECTURE

The NWS used the Metis Modeling Application to develop the NWS EA. The first view available to users of the NWS EA is a Navigation Screen, Figure 2, which aids the user in navigating to the major components of the model.

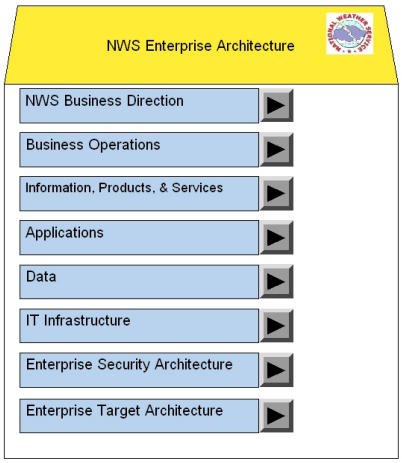

Figure 2. NWS EA Navigation Screen

Figure 3 depicts the major components of the NWSEnterprise Architecture model, the Federal Enterprise Architecture (FEA), the NWS Current/Target Enterprise Architecture, and the NWS Enterprise Security Architecture.

5.1 Federal Enterprise Architecture

The Federal Enterprise Architecture (FEA) component of the NWS model defines the five OMB reference models and guidance. The five reference models are the Business Reference Model (BRM), Performance Reference Model (PRM), Service Component Reference Model (SRM), Technical Reference Model (TRM), and the Data Reference Model (DRM). As of this writing, OMB has released all reference models with the exception of the Data Reference Model. In addition to the reference models, OMB guidance is contained in this component and includes OMB Circular A-11 Budget Guidance for IT Investments. In accordance with OMB guidance for implementing an Enterprise Architecture, the EA must adhere to the five reference models.

Figures 4 through 8 depict the representation of the five reference models in the NWS EA model. These views are mapped to the Current and Target Architecture component of the NWS model.

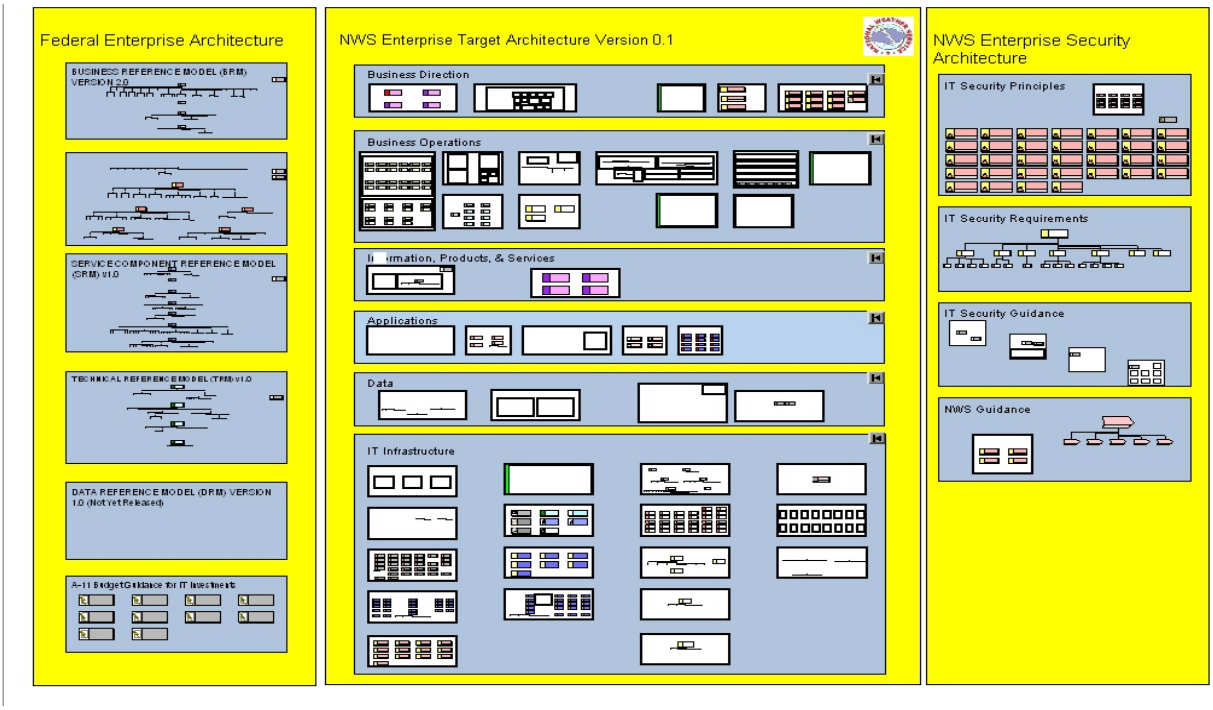

Figure 3. NWS Enterprise Architecture Model

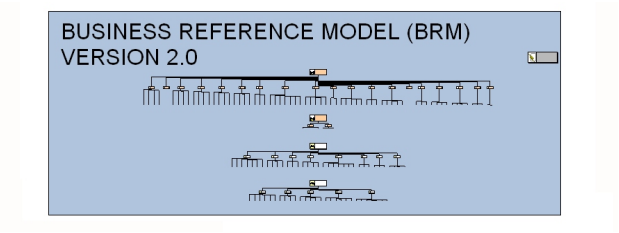

Figure 4. Business Reference Model

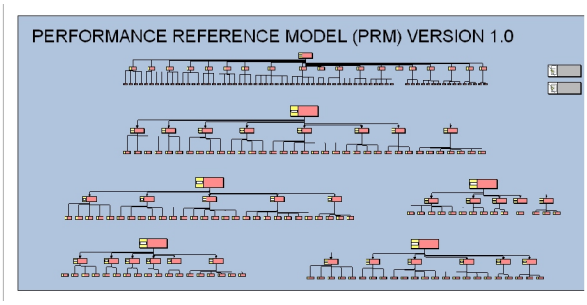

Figure 5. Performance Reference Model

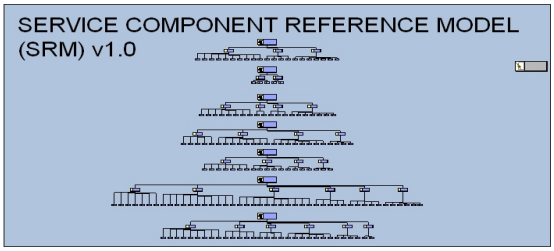

Figure 6. Service Component Reference Model

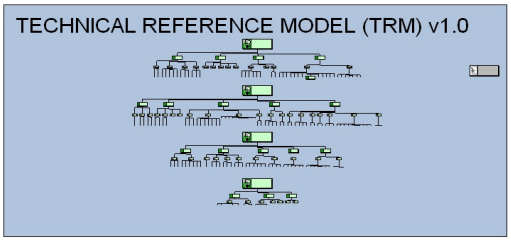

Figure 7. Technical Reference Model

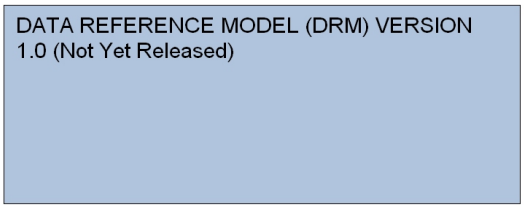

Figure 8. Data Reference Model

Figure 9 depicts the view of the Federal Enterprise Architecture A-11 Budget Guidance For IT Investments.

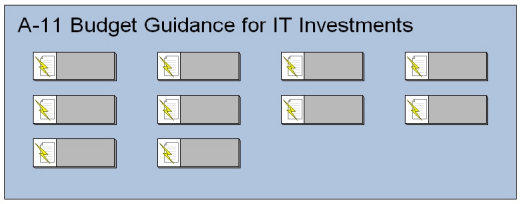

Figure 9. A-11 Budget Guidance

5.2 The NWS Current/Target Enterprise Architecture

The center panel of Figure 3 depicts the NWS Target EA view which was built using the NIST Enterprise Architecture Framework and the Federal Enterprise Architecture Framework. It describes the NWS Business Direction, Business Operation, Information, Products and Services, Applications, Data, and the IT Infrastructure. The NWS Enterprise Architecture component toggles between the Current and Target EA views. Structurally the two views are the same with the target architecture identifying the "to be" state of the architecture layers.

5.2.1 Business Architecture

The NWS EA Business Architecture consists of a business direction view and a business operations view. The NWS' Business Direction describes the NWS business strategy, objectives and purpose, as well as how our strategies address the principles of EA. In addition, we can tailor this EA model to provide answers to specific questions that managers would need on a frequent basis.

The Business Operations view of the architecture contains:

- NWS IT investments - the current and future investments defined in the NWS Budget submissions.
- Business processes- which is divided into Mission Services, such as issuing forecasts and warnings, Mission Support services, such as training and logistics, Management and Administrative Services, such as budget and human resources,

and Lines of Business, such as the public and fire weather service areas.

- NWS Governance - the process by which NWS makes decisions regarding and manages changes to the EA.
- Organization chart and Organizational component locations.
- Requirements- IT requirements which are levied on the NWS EA, such as the E-Government Act of 2002 and the Clinger Cohen Act of 1996.
- Users and Stakeholders - captures all NWS customers and partners.

There are plans to include in the Business Operations view of this layer a description of the Capital Planning process, Technical Support, and Key individuals. Figure 10 depicts the Target Enterprise Architecture Business Architecture.

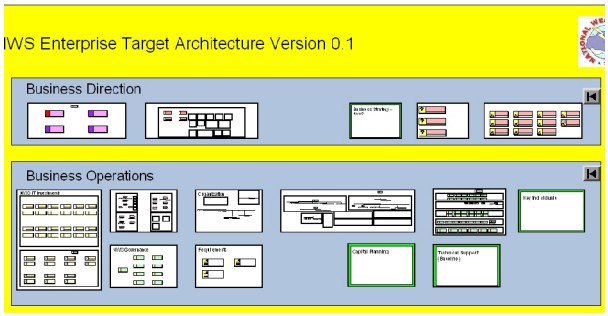

Figure 10. NWS Business Architecture

5.2.2 Data and Information Architectures

The Data Architecture contains all the input and output information related to mission service, non-mission applications, and definitions of all data used to create NWS' service products. All databases in the NWS will be defined in the EA as well. The Information Architecture includes the products and services that are in the NWS EA and incorporate the routine and severe weather products, such as a zone forecast or tornado warnings, respectively. Information captured in the EA ranges from science to administrative information. Figure 11 shows the Data and Information Architectures in the NWS Enterprise Target Architecture.

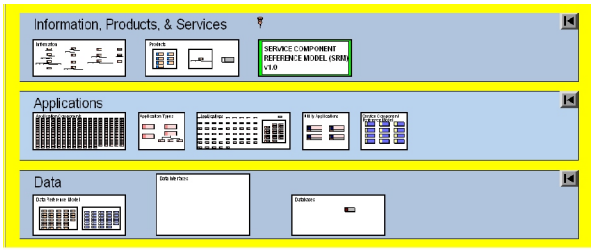

Figure 11. NWS Data and Application Architectures

5.2.3 Application Architecture

The Application Architecture defines application types and identifies applications used in the NWS. Applications are further decomposed to their components and there are linkages which trace from the applications to their components. The Application Architecture is depicted in Figure 11.

5.2.4 IT Infrastructure Architecture

The IT Infrastructure view describes the technology contained in the NWS' enterprise (see figure 12). Generally, this is the view that many people imagine when the Enterprise Architecture topic is raised. This view captures:

- computer languages
- networks
- hardware
- operating systems
- commercial software
- database management systems
- computing systems
- programs/projects
- interconnecting devices
- telecommunications
- technical standards and policies.

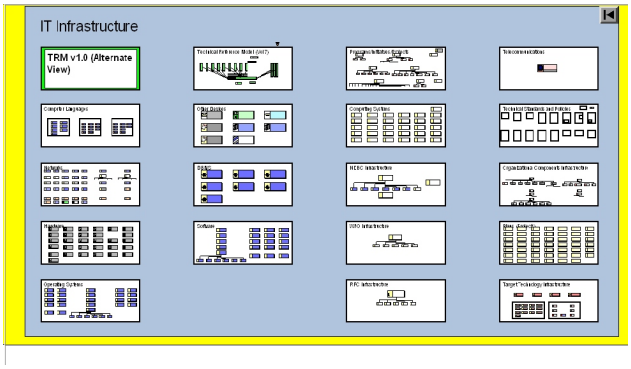

Figure 12. NWS Infrastructure Architecture

5.3 NWS Enterprise Security Architecture

The NWS Enterprise Security Architecture describes how NWS' security program is implemented across the enterprise. The IT Security Principles component lists the guidance which NWS applies to its IT security program. This guidance is drawn from security practices contained in the draft pamphlet "Engineering Principles for IT Security, Recommendation of the National Institute of Standards and Technology". The IT Security Requirements component identifies specific requirements for data integrity, data confidentiality, protection against denial of service, accountability, security management, security policy and security planning. The IT Security Guidance component consists of National Guidance such as the Federal IT Security Management Act (FISMA) and Federal Information Processing Standards (FIPS), Department of Commerce (DOC) and NOAA Guidance, including DOC IT Security Program Policy and Minimum Implementation Standards, and the DOC Password Policy and NOAA Guidance in the form of the NOAA IT Security Manual. The NWS Security Policy will also be included in this model and will include references to policies from each NWS Region. Figure 13 Depicts the Security Architecture.

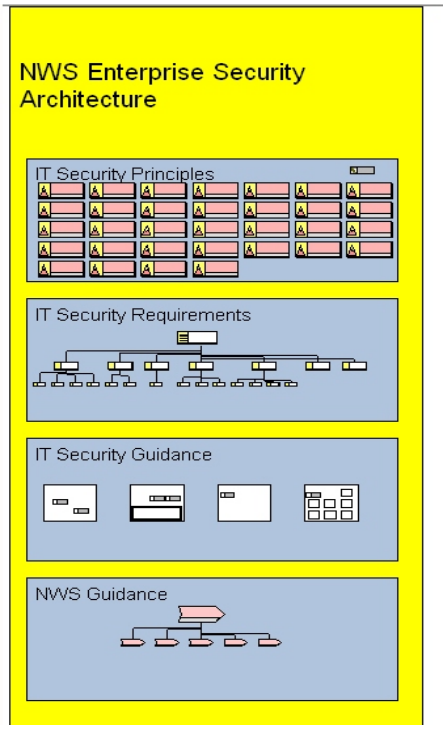

Figure 13. NWS Enterprise Security Architecture

5.4 NWS Enterprise Architecture Relationships

A key process in developing an effective Enterprise Architecture is to define and establish the relationships between the business, data, information, applications, and technology architectures. By using the Metis Modeling Application, the NWS EA model describes the relationships of 1) data entities to the business functions, 2) applications to the business functions, 3) technology platforms to applications and business functions, 4) the Federal Enterprise Architecture (FEA) reference models to the EA model, and 5) the Enterprise Security Architecture to the EA Model.

5.4.1 Relationship of Data Entities to the Business Functions

The EA model can enable users to trace the relationship of data entities to business functions. The working group implemented the relationships by determining which data entities are created, retrieved, updated and deleted by a business function. See Figure14 for an example of how data are mapped to business functions in the NWS EA.

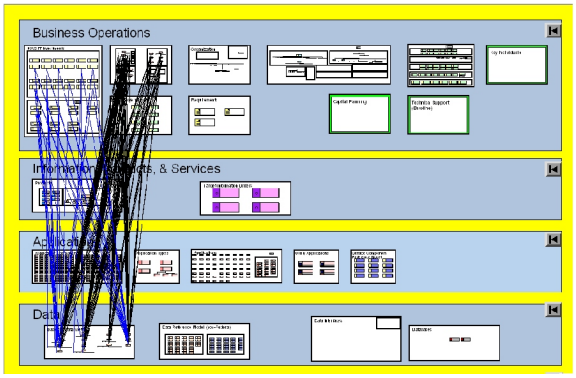

Figure 14. Example of Data to Business Architecture Relationships

5.4.2 Relationship of Applications to Business Functions

The Metis application contains a mapping of Applications to Business Functions supported by the enterprise. See Figure 15 for example of applications to business operations linkage.

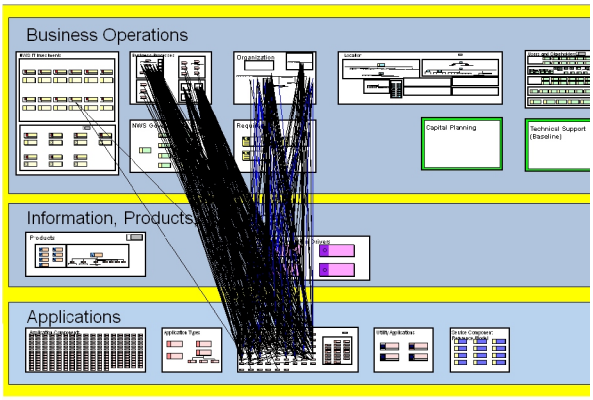

Figure 15. Example of Applications to Business Processes Relationships

5.4.3 Relationship of the Technology Platforms to Applications and Business Functions

NWS business processes and business strategy drive the need for certain technology to accomplish the mission of the organization. There are linkages established within the model that relate technology platforms to the business functions that directly utilize them. In addition, the various aspects of the infrastructure are interrelated. Figure 16 provides a view of the interrelationship of the AWIPS Program with hardware, software, operating systems, and technical standards views being displayed within the model.

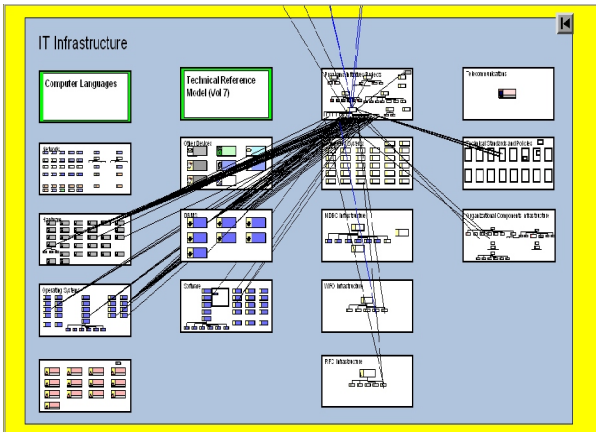

Figure 16. Example of IT Infrastructure Interrelationships

5.4.4 Federal Enterprise Architecture (FEA) Reference Models to the EA Model

To adhere to OMB's Enterprise Architecture requirements, the agency's EA must relate to the components of the Business Reference Model, Performance Reference Model, Service Component Reference Model, Technical Reference Model and Data Reference Model. The NWS EA model reflects these relationships. Figure 17 shows the relationship of the FEA reference models to the NWS' business architecture.

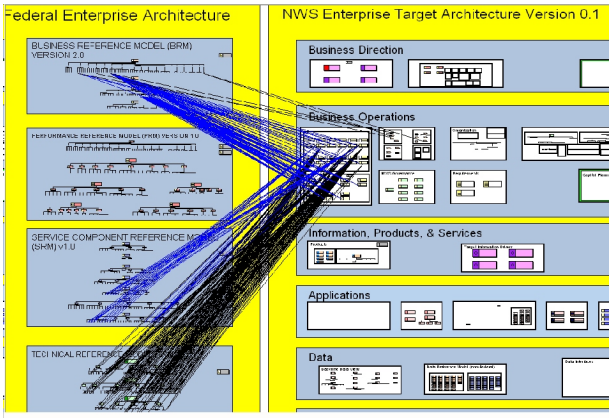

Figure 17. Example of FEA Reference Models Linkage to Business Architecture

5.4.5 Relationship of the Enterprise Security Architecture to the EA

The Enterprise Security Architecture must be prevalent throughout an Enterprise Architecture. The relationships that exist among the four architectures (business, data, application, and technology), and the security domain are described by these relationships. As an example, in Figure 18, the relationships between the IT Security Principles and the NWS EA Principles are illustrated.

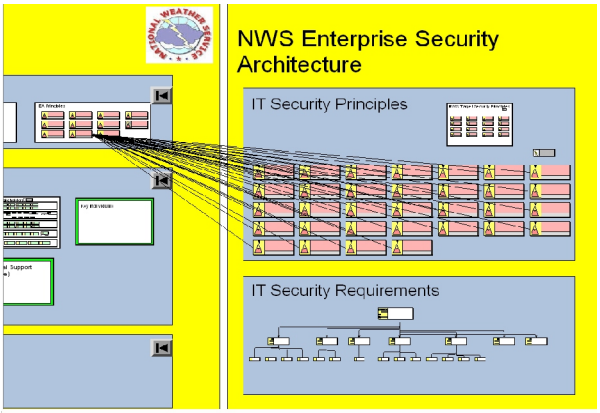

Figure 18, Relationship of NWS EA Principles to IT Security Architecture

6 SUMMARY

When the NWS completes the EA model, it will become a single reference point for addressing critical issues impacting the Enterprise. This model will show how changes will affect the organization from the business processes, administrative procedures, data and technology. It will play a vital part in management decision making and in the capital planning process. Today, the NWS EA is a work in progress, but is projected to be operational by the end of FY04.

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8 ACKNOWLEDGMENTS

Special thanks to:

Barry West, Chief Information Officer, National Weather Service.

Deirdre Jones, Director, Systems Engineering Center, Office of Science and Technology for the National Weather Service (NWS).

Ira Grossman, Chief Information Technology (IT) Architect for the National Oceanic and Atmospheric Administration (NOAA).