Aerospace Industry Guidelines for Implementing Interoperability Standards for Engineering Data

Version 1.0

February 12 , 2009

Developed By:
Engineering Data Interoperability Working Group
Aerospace Industries Association, Inc.

History Page

Date	Version	Change	Reason
2-12-2009	1.0	Initial Release	

1 Executive Overview 1
1.1 The Challenge 1
1.2 Solution 3
1.3 Purpose for this Guideline 4
1.4 Target Audience 5
1.5 When to Use 6
1.6 Benefits of Interoperability 6
2 Engineering Data Interoperability Basics 7
2.1 What is Engineering Data Interoperability? 7
2.2 Background 7
2.3 Risk and Risk Mitigation Opportunities 8
2.4 General Approach 9
2.5 Lessons Learned from DOD/Industry Interoperability projects 10
3 Concepts of Operation 11
4 Examine State of Enterprise for Existing Standards-based Capability 13
4.1 Analyze existing internal business processes and related industry practices for standards based data interchanges and capabilities 13
4.2 Analyze any existing standards based data export capability for applicability 14
4.3 Design a data exchange business process 15
4.4 Identify Application(s) used to support the business process 15
4.5 Identify source data of information to be used in the business process 16
4.6 Identify systems, standards, and infrastructure used to support the data exchange process 16
4.7 Design business process data exchange architecture 17
4.8 Create a business process Design Substantiation Report 17
5 Develop Business case (options) 18
5.1 Prepare a cost analysis of the Design Substantiation Report 18
5.1.1 Reuse existing applications 18
5.1.2 Acquire new applications 19
5.1.3 Develop custom application 19
5.2 Quantifying benefits of proposed solution 20
5.2.1 Engineering 20
5.2.2 Operations 20
5.2.3 Service 21
5.3 Develop a Business Case Proposal 22
5.4 Get Executive Approve of the Business Case Proposal 22
6 Develop Exchange Methods for required Data Exchanges and verify Systems Quality 24
6.1 Define Requirements for a DEX 25
6.2 Design and Implement DEX-based Exchange Systems 26
6.3 Verify Quality of Source Systems 27
6.3.1 Identify discernable Quality values for comparison – Geometry and Non-Geometry 27
6.3.2 Define Test Cases 28
6.3.3 Capture in Application 28
6.3.4 Create Neutral File 28
6.3.5 Extract Discernable Values from Native Data 28
6.3.6 Extract Discernable Values of Neutral File 28
6.3.7 Compare 28
6.3.8 Quality Assessment 28
6.3.9 Plan Corrective Action for Conversion System 28
6.3.10 Source System Translator Verified 28
6.4 Verify Quality of Receiving Systems 29
6.4.1 Extract Discernable Values of Neutral File 29
6.4.2 Transform to Application Specific File 29
6.4.3 Extract Discernable Values of Application Specific File 29
6.4.4 Compare 29
6.4.5 Quality Assessment 29

6.4.6 Plan Corrective Action 30
6.4.7 Receiving System Translator Verified 30
7 Perform Data Exchanges and verify Data Quality 30
7.1 Convert to Neutral 30
7.2 Extract Discernable Data from Neutral Data 30
7.3 Extract Discernable Data from Native Data 31
7.4 Compare 31
7.5 Quality Assessment 31
7.6 Plan and implement Corrective Action on source data 31
7.7 Transfer neutral file 31
7.8 Receive neutral file 31
7.9 Extract Neutral Discernable Data 32
7.10 Convert to target Native 32
7.11 Extract discernable data from target Native format 32
7.12 Compare 32
7.13 Quality Assessment 32
7.14 Determine Cause of the Error and Plan Resolution 32
7.15 Use converted native data 32
8 A. Appendix – Use Cases 33
8.1 Example Use Case - Engineering Bill of Material 33
8.2 Example Use Case - 3D Data / CAD GEOMETRY 33
9 Appendix B Key Terminology 33
10 Appendix C. External References: 34

Table of Figures

Figure 1-1, Current state of the Industry from the perspective of the stakeholders
Figure 1-2, Using disparate software across supplier tiers
Figure 1-3, Comparison of OS, hardware, IT, and product lifecycles
Figure 1-4, Desired standards–based information backbone
Figure 1-5, Business Activity Connection Model with areas of focus

Figure 2-1, Process map for delivering business solutions

Figure 3-1, Implementing data exchange based on standards

Figure 4-1, Standards based data exchange process model
Figure 4-2, Using existing standards-based capability

Figure 5-1, Develop a business case

Figure 6-1, Develop exchange methods
Figure 6-2, Define a DEX
Figure 6-3, Design and Implement a DEX-based exchange system
Figure 6-4, Verify source data quality
Figure 6-5, Verify recipient data quality

Figure 7-1, Outgoing exchange and quality process
Figure 7-2, Incoming exchange and quality process

1 Executive overview

1.1 The challenge

The variety of engineering tools used to support design, procurement, manufacturing, and support of aerospace products has never been greater. From company to company, tools and processes range from manual capture in 2D drawings to sophisticated 3D models that are tightly integrated with other enterprise systems. The challenge is further compounded by the growing need to provide engineering information for support extending beyond the life span of individual applications.

This heterogeneity has created both technical and business challenges. Data integrity across the applications and systems that author and consume engineering data is problematic. Point-to-point integration between systems is often so complex and costly that organizations opt for manual data re-entry when faced with program budget and schedule constraints. This decision has a lasting impact on information quality, supplier management, manufacturing integration, and in-service support.

From a business perspective, budget and schedule constraints often dictate a concise solution for the tool and process subset in use for the program duration. Near-term program priorities are in conflict with the need for investment in a holistic solution that can be reused by downstream processes and systems, and that can be leveraged by future programs. Again, the long-term impact is significant from a cost and risk perspective.

Leading software vendors currently have little incentive to develop and support a generic interoperability capability that is comprehensive with respect to all engineering data exchange requirements. The use of proprietary data models and exchange tools foster vendor “lock-in”, assuring vendors of a long-term relationship with consumers of their products.

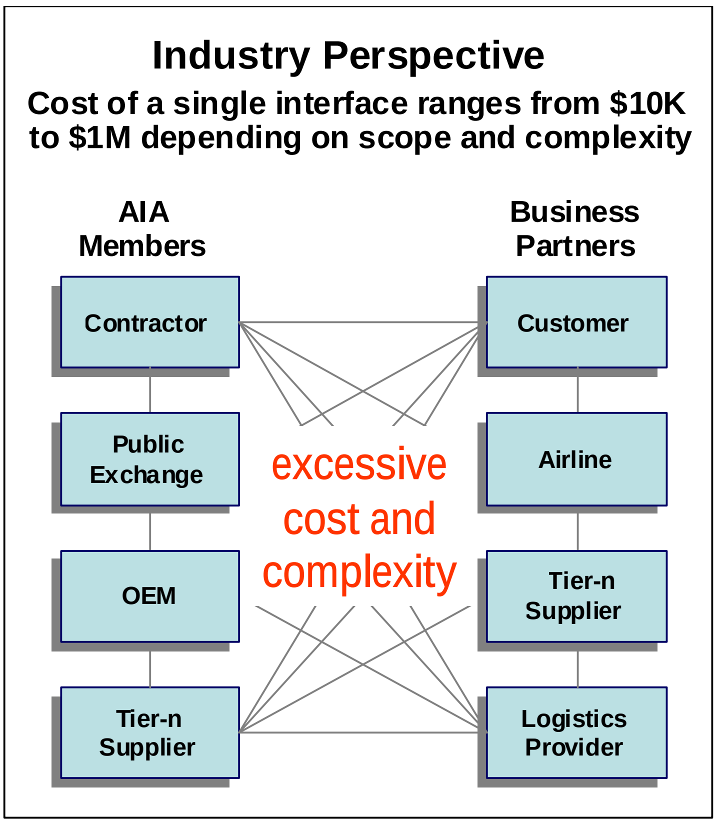


Figure 1-1, Current state of the industry from the perspective of the stakeholders

The result of this environment is that companies are often forced to communicate with each other through multiple proprietary vendor-specific software applications as shown in Figure 1-1. Suppliers must purchase and be trained in applications that are prescribed by their prime contractors or their customers, as shown in Figure 1-2. As a result, they often run multiple software applications and versions to be able to deal with multiple prime contractors or customers. This situation gets amplified as we move down the supply chain towards Tier-n suppliers.

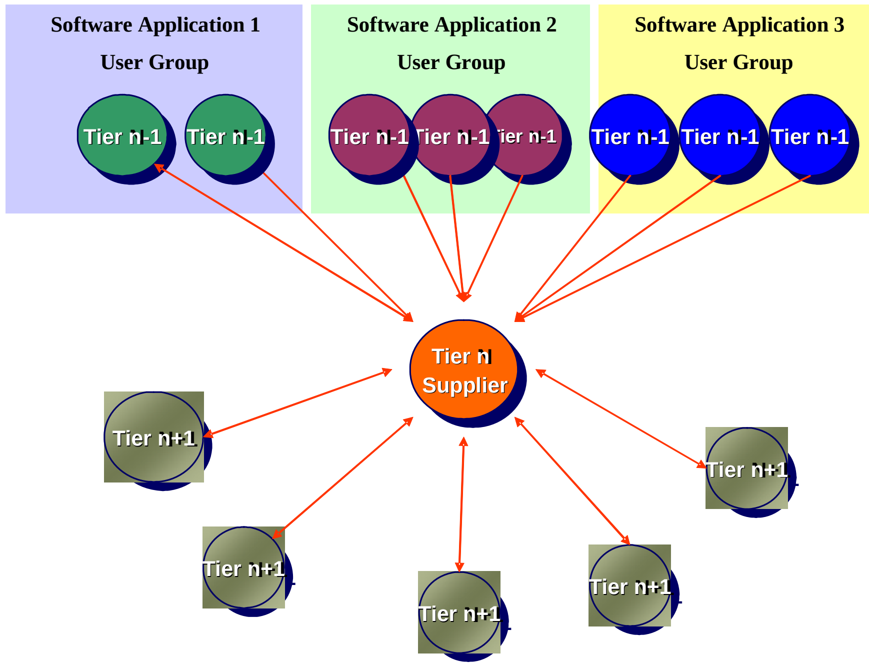


Figure 1-2, Using disparate software across supplier tiers

A primary concern for all aerospace companies is the management of Type Design data, especially as they migrate to 3D Model-Based Design (3D MBD) where the master information source is a 3D model with all the necessary attributes for manufacture and support. While 3D MBD offers tremendous potential benefit for design cost reduction, the elimination of 2D drawings introduces new technical challenges for meeting Type Design data consistency and longevity requirements. Proprietary vendor-specific software and data is inherently life-limited. Long-term storage is no guarantee that the tools will exist to access the data, 20-50 years into the future, as is shown in Figure 1-3.

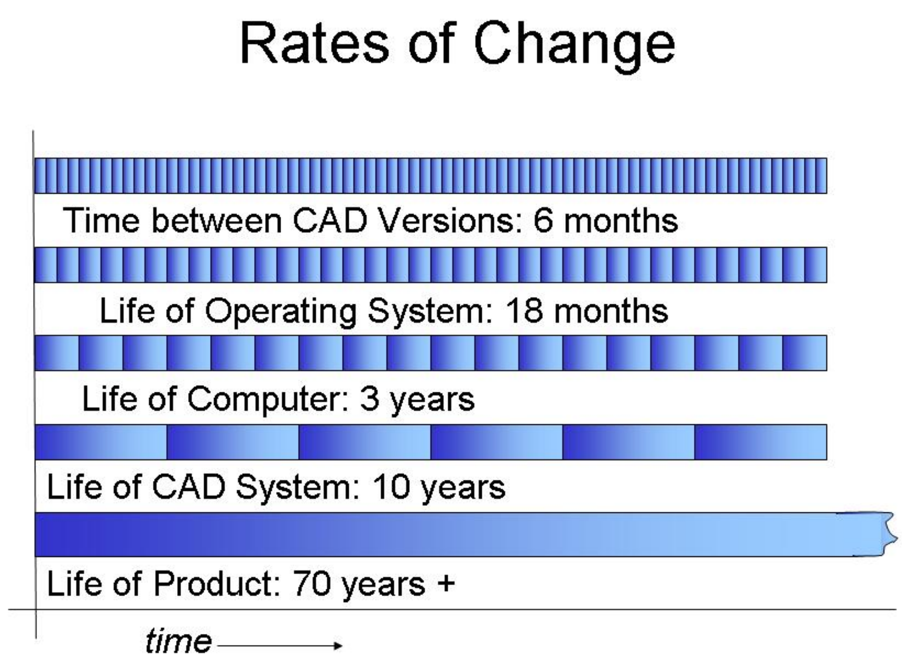


Figure 1-3, Comparison of OS, hardware, IT, and product lifecycles

The requirement for long-term retention of Type Design data can be supported by the use of a neutral, open, human-readable format such as that provided by a standards-based data exchange tool. The format addresses the limited-life issues incurred through use of proprietary tools by providing a way to preserve core design information independent of the vendor-specific authoring tool. Data can be extracted and maintained in the standard format, ready to be imported and consumed by any supporting application as needed. Extraction to the neutral format also provides the means for validation of data consistency independently from the authoring application, over time and across application versions.

1.2 The solution

The standards community has been at work for decades in an effort to address the issues with data exchange, with varying degrees of success. Based on their research and analysis, AIA's Engineering Data Interoperability Group (EDIG) believes that certain of these standards have reached a sufficient level of maturity to be feasibly and cost-effectively implemented. Companies investing in data exchange capabilities based on interoperability standards will realize both technical and business benefits.

From a business perspective, companies will benefit from reduced investment in piecemeal integration projects. The corresponding increase in data quality, based on data transfer versus data re-creation, will lower the cost resulting from rework. Ultimately, companies should see a significant reduction in application integration costs, as downstream processes and successive programs reuse the existing interoperability framework.

From a technical perspective, the standards-based approach can greatly simplify integration complexity, by largely eliminating the need to develop and maintain point-to-point integration solutions. The simpler integration model will make it feasible to add new applications as demands arise for new capabilities. The time required to deploy new applications and processes that are integrated with existing capabilities will be greatly reduced.

These benefits are predicated on several factors. The standards used must be comprehensive enough to support a complete business scenario, such as engineering design. They must be robust enough that they can support exchange between a wide variety of data models and applications. They must be feasible to implement, and the implementation itself should follow certain established patterns to derive maximum benefit. Perhaps most importantly, the implementation must be sponsored and supported at the executive level. This is critical to obtain the significant up-front investment and commitment that is required, and to ensure that the implementation will be prioritized and sustained beyond the scope of a single project or program.

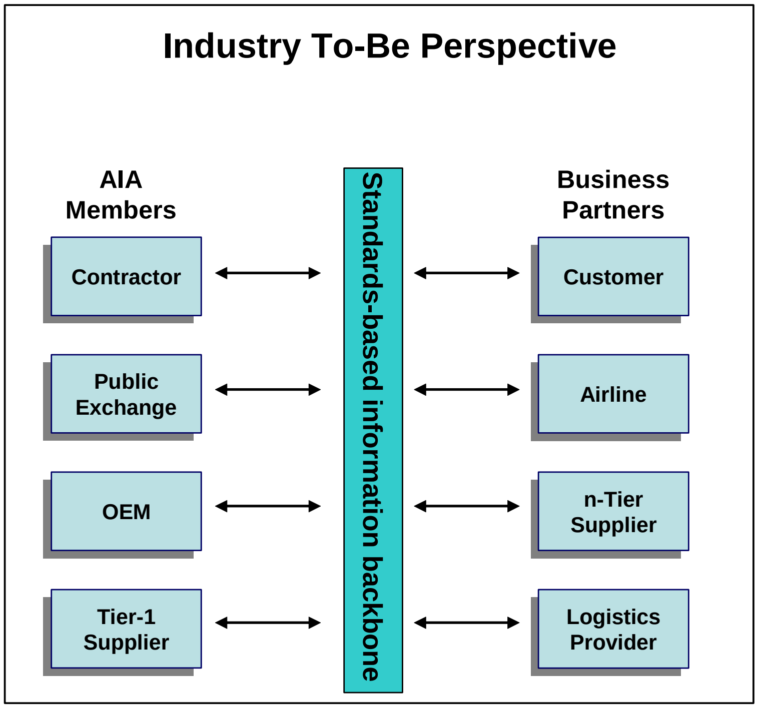


Figure 1-4, Desired standards–based information backbone

The desired state of the industry is shown in Figure 1-4. The intent of using a standards-based information backbone is to enable the transition from a collection of disparate supply chains to a cohesive Supply Network. Multiple partners in the supply chain can now communicate engineering data with each other through one common standards-based interoperability layer.

The use of such a backbone also facilitates the long-term retention of information independent from its source system.

1.3 The purpose of these guidelines

The purpose of this document is to provide strategic and tactical guidance for the adoption by industry of a common standard-based information backbone. This will enable interoperability for product definition data across the aerospace industry and throughout the product life cycle. It is for use by acquirers and suppliers at all tiers in support of engineering data interoperability.

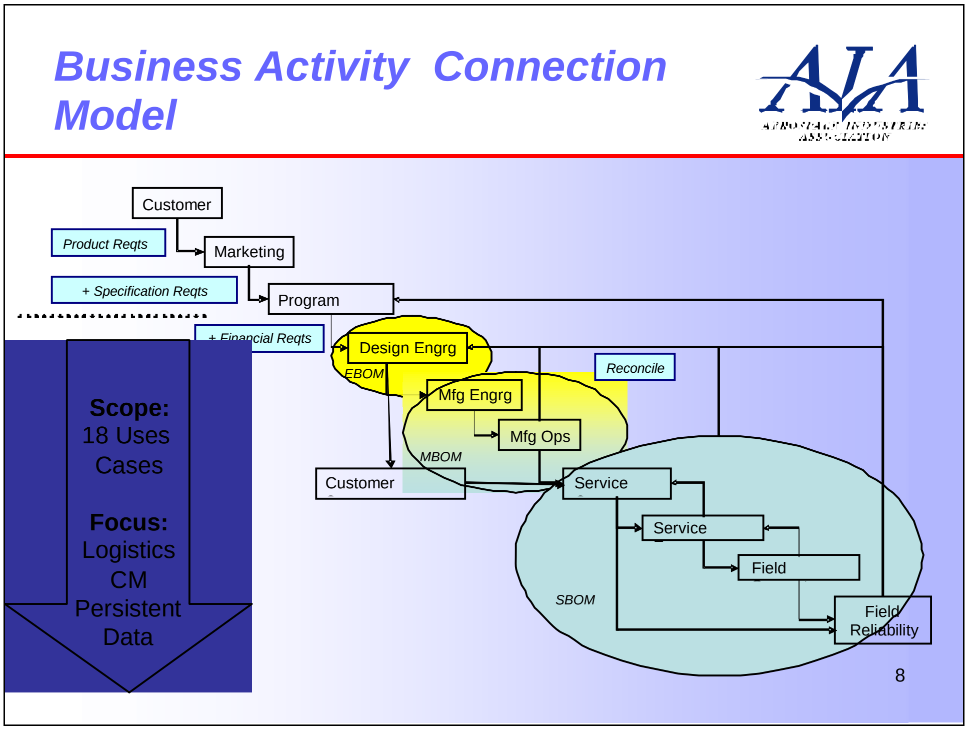


Figure 1-5, Business Activity Connection Model with areas of focus

The eventual scope of this document is the exchange of data throughout the life cycle of the product. To start the focus is on design and manufacturing, recognizing that these are the foundation for supporting data exchanges throughout the life cycle of the product. The current version of these guidelines addresses the yellow-shaded areas of the Business Activity Connection Model, as shown in Figure 1-5. It represents design engineering, manufacturing engineering and manufacturing operations, and includes the creation and maintenance of specific bills of materials (BOMs) for individual products. The blue-shaded areas that are shown before and after the yellow-shaded areas will be addressed in the future.

The general principles and processes outlined in these guidelines are applicable to any engineering data interoperability solution. Two specific use cases and solutions are identified in Appendix A, and will be expanded as necessary to cover evolving business priorities.

1.4 The target audience

The use of a common backbone creates advantages for all stakeholders throughout the supply chain, from design and production to consumption and operation.

OEMs and Prime Contractors
Adopting standards-based data exchanges to create interoperability of engineering data reduces the cost, risk, complexity and increases the speed of working with suppliers and partners at any level.

Suppliers
Suppliers include all levels throughout the supply chain, from Tier-1 to Tier-n. One advantage for each supplier is that they have the capability through standards-based data exchanges to support their higher-tier customers, the prime manufacturers and end-user “owner/operators.” Another advantage is that they can accumulate data from lower tiers without investing in multiple applications.

Application Vendors
Application vendors who provide the tools for design activity can conform to an industry-accepted

standard, which allows them to provide consistent data constructs with standard requirements, and to have confidence investing in tool development.

Customers
Customers can include both the top-tier prime manufacturer and the end–user of the products produced in the supply chain. The advantage to the customer is apparent by their ability to use a common data format from multiple suppliers.

1.5 When to use

Implementation of standards-based engineering data exchanges should be considered for new information exchange environments or when considering changes and enhancements to existing environments.

1.6 Achieving the benefits of interoperability

These benefits are predicated on several factors. The standards used must be comprehensive enough to support a complete business scenario, such as engineering design. They must be robust enough that they can support exchange between a wide variety of data models and applications. They must be feasible to implement, and the implementation itself should follow certain established patterns to derive maximum benefit. Perhaps most importantly, the implementation must be sponsored and supported at the executive level. This is critical to obtain the significant up-front investment and commitment that is required, and to ensure that the implementation will be prioritized and sustained beyond the scope of a single project or program.

The increasing dependence on electronic data introduces a new challenge for all aerospace companies: the long-term retention of essential business information throughout the product life cycle, with specific emphasis on the original design data. This is further complicated as companies begin to transition from the traditional 2D form of data to the more sophisticated 3D form of data. Although the 3D-model-based design process offers potential cost benefits from the reduction of design life cycles costs, the elimination of 2D drawings introduces new technical challenges for meeting industry specific data longevity requirements. 3D-model-based processes require the use of proprietary vendor-specific software applications to access and view the 3D data. Software applications often have product life cycles that are shorter than the product life cycle of the products being designed. Long-term storage of the design data in a vendor specific proprietary format is no guarantee that the data will be accessible once the applications used to view the data are no longer available in the commercial marketplace.

The requirement for long-term retention of data varies by industry. The commercial aviation industry has a regulatory requirement to retain the original design data for 50 years or more. This requirement can be found in Order 8110.4, which is available at www.faa.gov. The defense industry has an incentive to retain data for the life of a deployed weapon system. The B-52 bomber and the C-130 transport are great examples of weapon systems that have been in use by the DOD for greater lengths of time that any specific software application life cycle (1955 and 1956, respectively). In other industries the requirements for product liability requires the retention of data for the life of the product plus 7 to 10 years depending on industry.

The long-term retention of electronic data can be supported by the use of a neutral, open, human-readable format such as that provided by a standards-based data exchange tool. The standard-open-neutral format addresses this application life limit. Data can be extracted, validated, and maintained in the standards format, ready to be imported, validated, and consumed by any selected application at any future time that access to the data is required.

The factors cited above formed the basis for the research and analysis activities undertaken by the EDIG. These activities are summarized in the Sections following.

2 Engineering data interoperability basics

2.1 What is engineering data interoperability?

Engineering data interoperability is the ability to reuse data in diverse systems by use of data translation and transfer. The data can be 3D (solid models), 2D (drawings), or text, but the goal is to allow transfer of engineering information among prime contractors, suppliers, vendors, and customers in a way that adds value to the product development life cycle. Some characteristics of effective data interoperability are:

- Data is created once, then is translated and transferred to other systems in the supply chain.
- Data translation is standards-based for uniformity, predictability, and reduced risk.
- Data integrity is preserved: accuracy, consistency, and completeness across systems.
- Companies use their best practices and tools – no need for investment in multiple applications.

The scope of interoperability discussed in this document is limited to the design and manufacturing engineering portions of the product lifecycle, since the key engineering data exchanges occur in these areas. Once standards and procedures are in place for these areas, interoperability analysis should be continued in other areas of the lifecycle such as requirements management and service support.

2.2 Background

Aerospace engineering programs are becoming increasingly collaborative, with multiple companies involved with various aspects of a given program. Systems integration is a key role for prime contractors in particular, since they must combine engineering data from partners, suppliers, and vendors into a product that meets the customer's requirements. Efficient data sharing among these companies is vital to meet aggressive program deadlines.

Companies must invest resources wisely to be competitive in the aerospace environment. A critical requirement is that companies be able to use their best practices and tools regardless of which other companies they are teamed with on a given program. Effective data interoperability allows companies to operate efficiently without requiring an investment in multiple systems to satisfy various teaming arrangements.

Given the number of companies involved in aerospace engineering programs and the varying mix of teaming relationships that occur, there is a need for common standards for data exchanges across the industry. Regeneration of engineering data and ad hoc data exchange agreements lead to errors and inefficiency that can limit or prevent pursuit of more advanced aerospace technology and products. The Standards community has been working for decades to solve data exchange issues, and has developed a number of standards, which could be useful in the aerospace industry.

The AIA Engineering Data Interoperability Group (EDIG) was formed as an aerospace industry-wide team to develop plans for the adoption of common standards. An early project for the EDIG was a survey of member companies to understand their efforts, successes, and challenges in developing data interoperability, and gauge their interest in a common standards-based data exchange capability. A subgroup within the EDIG also performed a comparative analysis of the leading data exchange standards from ISO and GEIA, evaluating them for scope and depth of coverage against certain product engineering lifecycle scenarios.

The survey respondents ranked data interoperability as a high priority with a potential for significant business improvement. Most respondents also reported struggling or failing to implement a standards-based data exchange system so far. Change management was noted as the greatest challenge; complexity of systems in use and large variability in data were also cited as obstacles. These results show the need for a guideline to help companies develop capability for standards-based data exchange.

2.3 Risk and risk mitigation opportunities

There is a natural cycle of buy-implement-support-buy that companies and government agencies seem to follow when deciding to use software applications to help improve employee productivity, comply with contracts, or win new business.

The premise behind this discussion is a series of events that usually transpire in the life cycle of product development where interoperability standards are not considered in the selection or implementation of electronic business systems.

The first event is the acquisition of a new electronic tool or application to aid in the design, manufacture, delivery, operation, or support of commercial or governmental products and services. Typically these decisions are based on the ability of an application(s) to satisfy a set or subset of business needs or business process requirements in a particular functional area and then on the factor of cost. Often the only significant determining factor in this selection process is costs. Interoperability is rarely if ever included in this decision making process.

The second event in this sequence is the bridging of a capabilities gap between the as-provided condition of the application from the application provider and the complete set of business process needs. This usually involves the creation of specialized software coding or customization of the application(s) to perform business functions it was not specifically designed to do. Depending on the business need these customizations can be very extensive and very expensive. The logical extension of this customization philosophy is the point-to-point integration or threading of these standard and customized applications together to form a larger chain of highly specialized electronic business processes.

The third is the eventual application upgrade of one or more applications for new or improved functionality and/or system performance. This requires significant investment in testing, debugging, re-coding and can involve further application customization.

Fourth is the obsolescence of the physical infrastructure such as networks, bandwidths, servers, workstations and media storage devices. The ever-increasing pace of technology has exacerbated this problem ever faster in recent years.

Fifth is the loss of application support from application retirement, application provider mergers or acquisition and/or the application provider announcing a cessation of doing business. Often businesses have contract clauses with application providers that escrow the base software code to protect themselves from this possibility.

The sixth and final event in this cycle is the loss of access to data from obsolete software, obsolete hardware and the lack of data interoperability standards. At this point data must be translated, validated, and stored in new applications or simply re-mastered and, depending on the industry, re-approved. If interoperability standards are still absent the cycle begins over again.

There are significant business risks to any business or government entity associated with not adopting data interoperability standards. These business risks manifest themselves in multiple use cases some of which are detailed here. This is not an exhaustive list.

1. Data loss due to application obsolescence.
2. Business process stagnation due to application obsolescence
3. Liability of incorrect manufacture from inconsistent non validated translated data
4. Intellectual property loss due to application obsolescence and the associated data loss
5. Hardware obsolescence

6. Operational and support costs associated with obsolete applications

Risk mitigation:
1. Implement standards based interoperability thinking in the business analysis and decision-making described above.
2. Develop a data succession plan and an application obsolescence plan
3. Do an exhaustive analysis and evaluation of application functionalities from competing application providers prior to acquisition.
4. Choose an application ecosystem and stick with it
5. Avoid any and all application customizations
6. Change or reinvent business processes to accept default application functionality
7. Be careful not to take on too much too fast – implement in gradual steps
8. Stick to a pre-defined plan and avoid scope creep

2.4 General approach

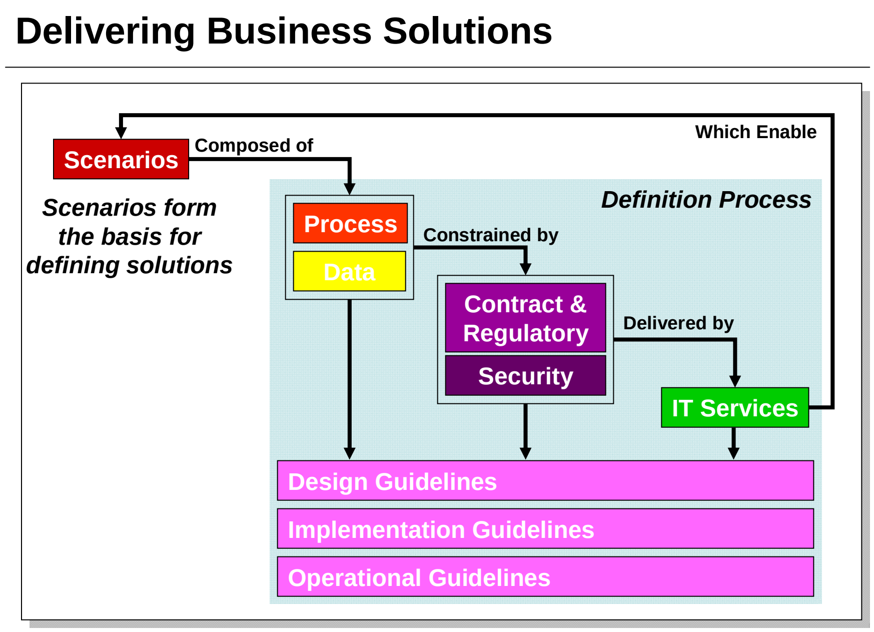


Figure 2-1, Process map for delivering business solutions

The EDIG used an approach pioneered by the AIA across all its eBusiness activities, to ensure consistency and alignment with other industry solutions. The methodology is based on the identification of individual business scenarios in sufficient detail to allow business subject matter experts to agree on the key stakeholders, processes, transactions, event sequences and information flows, in business terms. The scenarios typically include information on controls, decision points and criteria, and performance requirements. There is no attempt to constrain the number of scenarios that can be developed.

These scenarios are used as the basis for identifying candidate eBusiness components that need to be agreed to deliver interoperable business solutions, recognizing that in many cases, the same components can be used to support multiple scenarios. Some tailoring may be necessary.

The general process calls for the key processes and data flows to be extracted from the scenario, and any specific regulatory, commercial or legal constraints identified. The set of necessary IT services to support the process may be identified, and guidelines developed to emphasize the business and technical issues that will arise at the time of designing, implementing and operating the solution. The process is illustrated in Fig 2-1.

This document brings together the guidance necessary to design build and operate any standards-based interoperability solutions for engineering information, as well as containing specific advice on a range of related scenarios that depend on engineering data interoperability.

2.5 Lessons learned from DOD/industry interoperability projects

There have been a few examples in the media recently that illustrate the hidden costs that can surface when interoperability is not considered as a key element of an application architecture or implementation.

A European aircraft manufacturer announced an additional 5 billion euro cost increase in a product launch from design flaws due to lack of interoperability between different CAD systems.

In the March 1999 NIST study of the interoperability cost analysis of the US automotive supply chain estimated that imperfect interoperability imposes a $1 billion annual cost on the members of the US automotive supply chain.

Respondents to a 2008 mold design and manufacturing industry survey were asked if customer unique CAD requirements added significantly to their cost of doing business. Of those responding, more than a quarter estimated that those requirements add 20 percent or more to the cost of doing business.

3 Concepts of operation

Companies wishing to adopt standards based data exchanges should follow an overall process similar to figure 3-1.

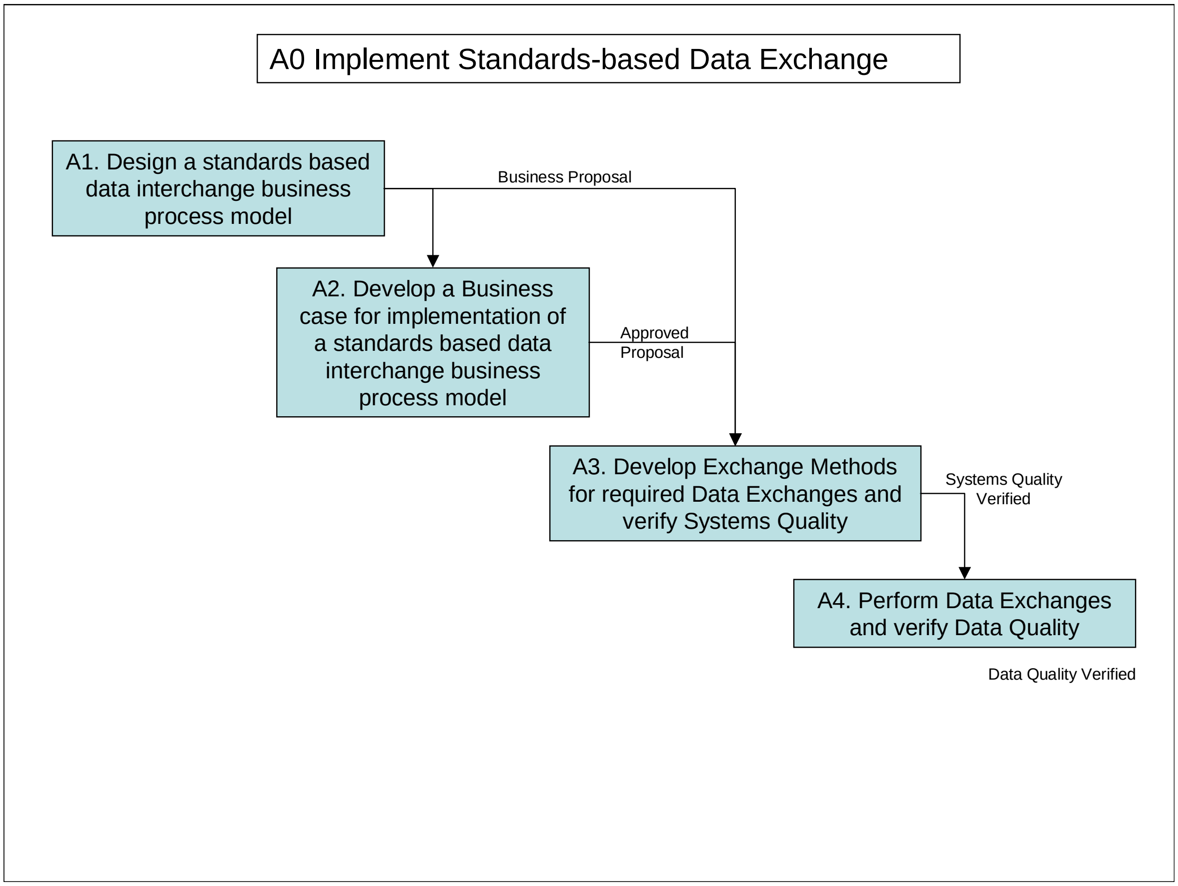


Figure 3-1, Implementing data exchange based on standards

One of the first steps is to examine the capability of the existing applications or systems that already exist within their enterprise to produce PLCS or other STEP standard based data export. Once this existing internal capability is understood, then the company needs to examine if the data to be exchanged is managed by the existing applications that already produce the required data export capability. If not, then the first step to be designed is the migration of the data to be exchanged from the application it is currently managed by to an application within the enterprise that has the standards based data export capability. This process alone may fulfill the requirements to adopt a standards based data exchange. The absence of an existing standards based interoperability capability within the enterprise will demand the development of requirements and the evaluation of new applications that will provide this capability, and the migration of any exchange data to this new application. Organizations that are large enough to commit adequate resources may opt to develop these capabilities themselves by developing business use case specific interchanges or Data Exchange Specifications (DEXs) in conjunction with applications that currently exist within their environments. Companies adopting this approach should consider soliciting outside expertise in the form of consulting services or collaboration with other organizations to do so.

This purpose of this phase of the implementation is an information collection and data exchange conceptual design phase with the intention of producing a specific exchange design substantiation report. The report should contain a diagram of the proposed exchange process complete with business process before and after templates, quantitative substantiating improvement data relative to labor and materials, gap analysis, and specifics relating to the statement of the problem being addressed and the proposed resolution. This report will used to determine the cost benefits and Return On Investment, if one exists, in implementing a standards based data exchange.

The financial justifications for the adoption of interoperability standards for data exchange can derived by reducing or eliminating the cost burden associated with the lack of interoperability, by reallocating newly available resources from a proposed increase in productivity to other more value added tasks, by the leveraging the standards based interoperability capability to acquire new business or enter into new markets, or a combination of all three.

The business case should be aligned with an adopted corporate strategy and/or provide a sound financial justification. The resulting analysis should identify and quantify the cost benefit for the proposed solution from a well-defined business process design substantiation report complete with realizable metrics, and an acceptable internal rate of return to substantiate the financial investment. A financial governance model or project financial quality monitoring system should be implemented to manage and report back project based earned value metrics. This will prevent the resource expenditures from outpacing the realization of the exchange capabilities and provide a governance model to mitigate the risk to the project. Finally, depending on the size of the project or implementation, a management reserve should be included and budgeted for to retain the capability to react to unforeseen changes in the project scope or duration.

Upon determination of adequate standards-based capabilities or approval to develop the capabilities, proceed to fill exchange capabilities gaps and verify systems quality. At this stage the commonality of reference data is determined.

Testing is performed based on standard test cases to validate the exchanges will work to the satisfaction of your quality limits.

Having verified the quality of the data exchange system, you can perform the data exchanges with operational data and verify quality of the data exchange.

These components are elaborated in the next four sections of the guideline.

4 Examine state of enterprise for existing standards-based capability

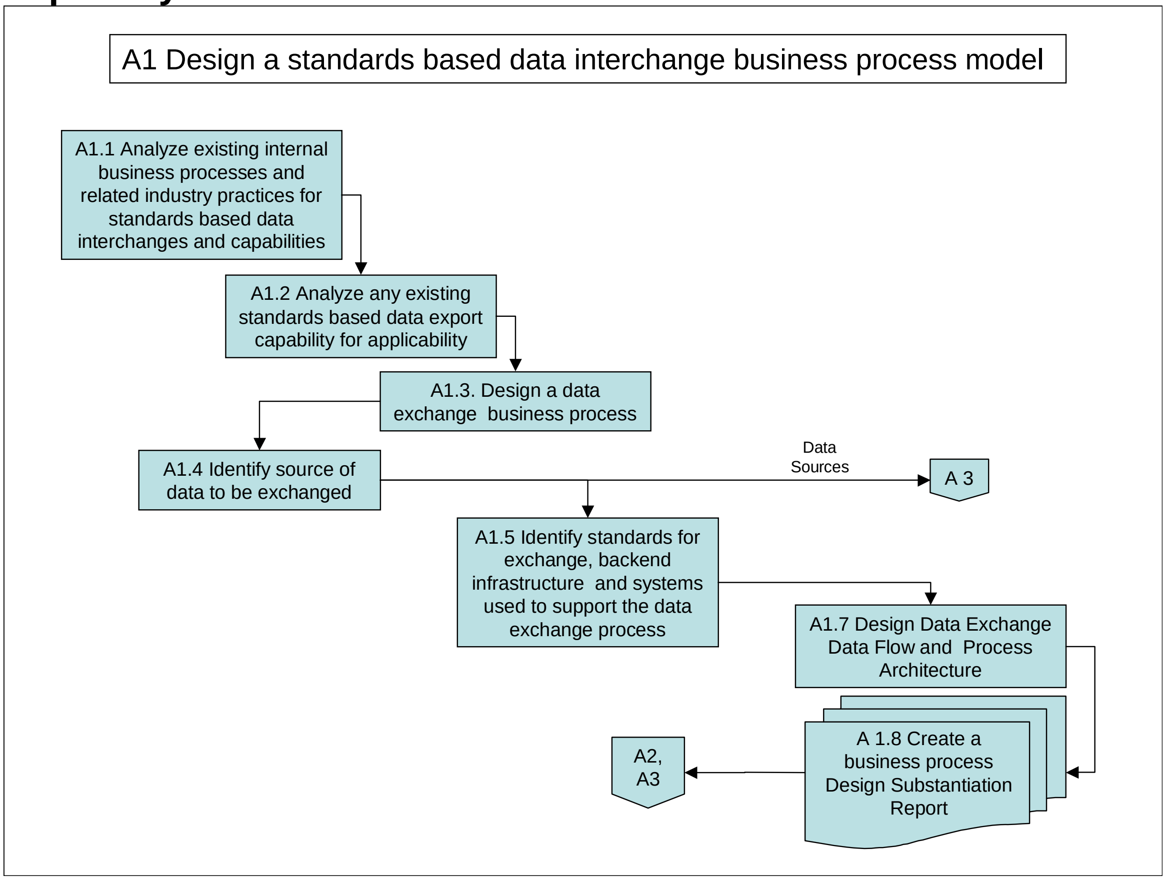


Figure 4-1, Standards based data exchange process model

4.1 Analyze existing internal business processes and related industry practices for standards based data interchanges and capabilities

The initial step of the process to implement a standards based exchange is to internally survey the company to determine if any standards based data exchange capability already exits. This can be accomplished by simply creating a list of all the applications that a company is currently using and determine what standards export capabilities these applications already support. There may be underutilized standards based capabilities within existing applications. Another useful exercise is an evaluation of what standards are commonplace within the industry that the company competes in. A survey of competing companies or suppliers and/or partners may provide valuable insight into the nature of data exchanges that may or may not be prevalent within an industry or market segment. Once these two capabilities are determined a gap or comparative analysis on the companies' existing standards based exchange capabilities within the existing applications and within the competitive market sector can be performed.

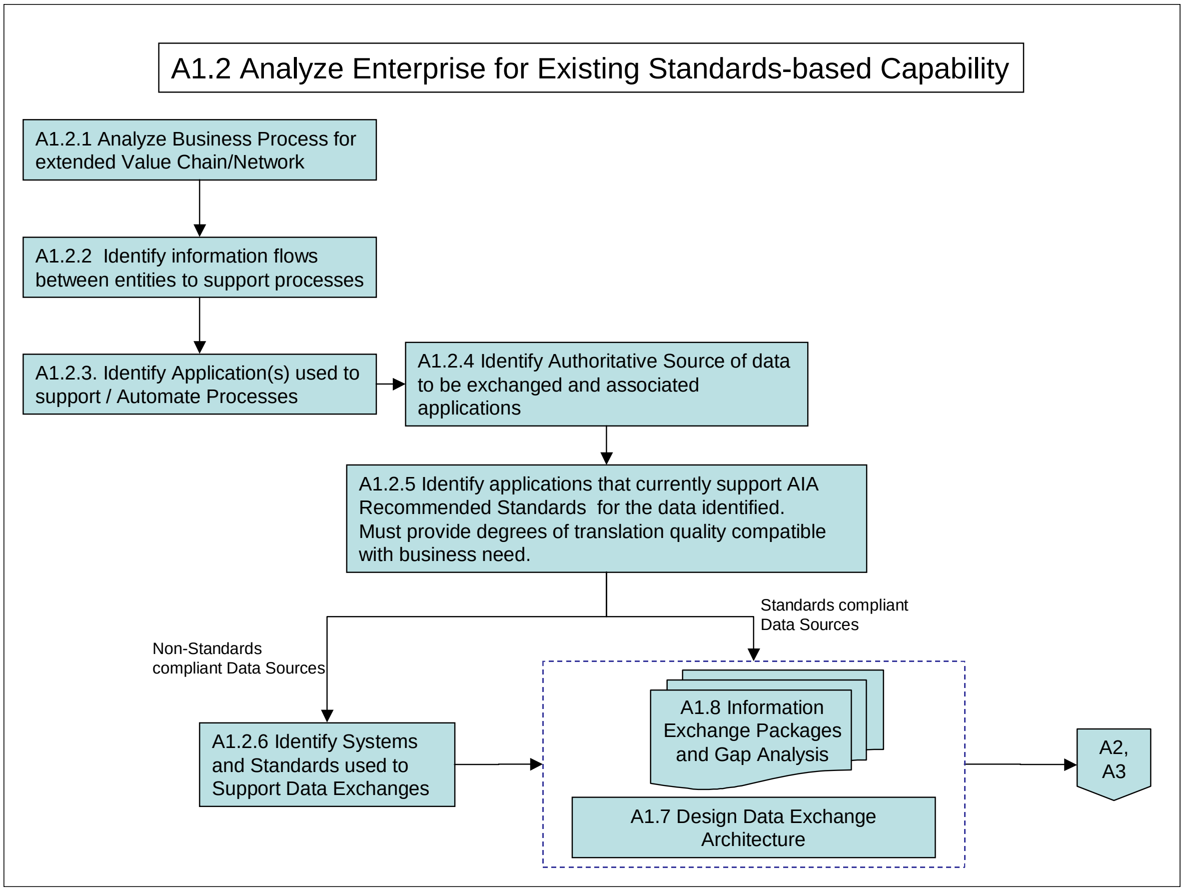


Figure 4-2, Using existing standards-based capability

4.2 Analyze any existing standards based data export capability for applicability

The next step is to analyze any applications currently used or owned by the business that already have a standards based export capability for applicability in the envisioned data exchange scenario being considered. It should be considered whether these applications are already being used in the area or section of the business where exchange capabilities are required. Are these applications being used in an existing data exchange process, and if so, to what degree of effectiveness? Do these applications fully support any ongoing data exchange business processes they are being used for? Is there a gap or room for improvement?

Consideration should also be given to the position of the applications within the overall applications' life cycle, in order to evaluate the capability to support data exchange for the period required. Are any of these applications on the verge of technological obsolescence or are they already obsolete? Are these applications currently implemented at a revision level that is supported by the application provider? What is the support plan from the application provider? What is the underlying application technology?

In addition any application prerequisites for hardware support, operating system requirements, and dependent applications and at what specific revision levels need be addressed. What are the required operating system specifications and or hardware requirements? Are they changing, and what does the business already own? What other applications are required such as database and or hardware drivers and at what revision levels? Are they changing? Do the companies that provide them also support them? What is the support condition of these required capabilities in the market place?

Lastly but not least the financial health and technical support capabilities of the application or hardware provider should be assessed. Although events such as mergers and acquisitions that are so commonplace in the software industry cannot be accurately predicted, the overall financial position and health of the application provider should be sufficient to warrant any continued investment in them. If the application provider does have sufficient financial means to continue supporting and developing the applications currently being used for standards based data exchanges then an understanding of the application developer's strategic vision, if any, should be sought and included in the assessment.

4.3 Design a data exchange business process

The next requirement is to determine the business need and the area of the business impacted by the implementation of standards based data exchanges. This may be part of a corporate growth plan or attempt at reducing overhead costs or an effort aimed at improving labor efficiency and / or productivity. The specific business process and the data to be exchanged that is ultimately desirable should be well defined and understood.

A suggested approach may be to ask the business to identify their ideal data exchange scenario for the identified business need? In other words, if there were no restrictions on technology or resources what would the perfect data exchange scenario look like? This gives the business the opportunity to creatively think long term about the final objectives and goals without being burdened by the short-term requirements and budget and schedule limitations, and may open opportunities for more radical and effective strategies.

An understanding of the existing and proposed state of the business processes is also required. An analysis should be performed to identify the specific business areas that are going to be affected, which business processes need to be altered, what business processes need to be designed and what the pre and post state of the business looks like. A before and after business process diagram should be developed to document the changes being proposed. There may be desirable positive changes within the affected business area that have a corresponding negative effect on other areas of the business. The affected (positive or negative) organizations may or may not be prepared for the disrupting nature of a transition in business processes. Any positive impact on specific areas of the business must have an overall positive impact on the entire business larger than any corresponding negative effect on other areas. The net to the business must remain a positive change. Metrics such as labor hours, head count, job functions, processes and frequencies and degree of automation should be collected and quantified for both states of the business.

Additionally, the scope and duration of the business process should be considered. Is this exchange a specific contractual requirement? Is this part of a development project? Is this a permanent change in capability or is it just for the duration of a contract or project? Does this process have an end date or a time in the future when it will no longer be required? What is the effect of ending the process if a process end date is determined? Who are all the parties at each end of the exchange? Are there multiple senders or recipients?

4.4 Identify application(s) used to support the business process

In section 4.1 and 4.2 a gap analysis was performed on the existing capabilities of the current applications that reside within a company to produce standards based data exchange exports along with a survey of the related market segment as to what applications or standards already exist within the applicable industry of interest. If this analysis highlighted a deficiency in existing capabilities then an acquisition of a new application or an in house capabilities development activity should be considered. A requirements matrix should be documented specifically identifying the business process requirements, the data requirements, and the standards based export capability requirements and costs. This requirements matrix can be used to evaluate a number of new applications or in house development projects to determine which is best suited for the specific exchange scenario being considered at an affordable price.

Companies should first look at the applications being used within their market segment or alternate approaches that have been undertaken and determine to what degree of success prior to the consideration of other non industry common approaches. Metrics to be considered also include growth capability, application support and frequency of update, hardware dependencies, licensing, and application provider financial stability.

4.5 Identify source data of information to be used in the business process

The nature, quality and reliability of the source of the data are critical to understand before designing successful standards based data exchanges. Some of the factors that need to be determined can include the form of the data, i.e. is the data in 2D or 3D format, is all the data in electronic format, is there attribute or textual data, is a data reformat required?

The original authoring master source of the data needs to be uniquely identified. The identification of the master data and which is copied or "slave" data is important as copies of data risk being changed, modified or be out of synchronization with the master data. Is any data copied from another source? Is the data being refreshed and if so at what frequency and according to what business logic or rules? Any existing relationships that exist within the data will be important to understand. Examples of these relationships can include parent / child relationships, links, mapping, and any other data dependencies.

The location is also of importance. What data is stored where and managed by which application? Is data stored on line or off line? What is the required access to the data? What is the security measures surrounding the data? Are there any company, governmental or national security restrictions on access? Is the data for the exchange process stored in the same location and format as other data that is not in scope? Must the data be separated, translated, or transformed?

The quality and quantity of the data are metrics of interest to the exchange process. An analysis of the source data should be performed to determine minimum and maximum data size limits, median data size requirements, and expectations on data exchange throughput or capacity. Data should be analyzed for quality metrics such as free from corruption, homogenous formatting, and frequency of update.

4.6 Identify systems, standards, and infrastructure used to support the data exchange process

A key element of the data exchange process is the final selection of the standards to use, the definition of the information systems infrastructure backbone and the applications needed to do the actual transfer of data between the entities identified in the business process design.

The selected standards should be aligned with the specific characteristics of the data being exchanged and the industry or technology of interest. For example, different collections of engineering data have different STEP standards or Application Protocols (AP's) designed for specific data exchanges targeted at specific business needs.

Key considerations for the information systems infrastructure backbone include local area networks (LANS), wide area networks (WANS), network data transfer bandwidths, network storage devices and storage capacities, application servers and server process capabilities, file transfer protocol (ftp) applications, network and user security requirements and firewall restrictions. The identification of the use of these resources as required by the data exchange process should include the evaluation of these capabilities to the satisfaction of the resulting business process. The business will also need resources that are proficient in the installation and maintenance of these underlying systems. If these capabilities are not already available within the business then the business may consider acquiring them through direct employment or consulting, or through an outsourcing exercise.

4.7 Design business process data exchange architecture

Once the steps outlined in 4.1 through 4.6 are completed, a business process applications connectivity chart and an infrastructure architecture diagram need be completed. These documents should address the requirements from the business area that the data exchange is being designed for. The applications connectivity chart should thread together the applications used throughout the data exchange process starting with the source data location and concluding with the destination data repository. The infrastructure architecture diagram should identify all the applications and hardware devices connected together to demonstrate the flow of data throughout the process. These two documents need to clearly and concisely communicate the overall business process, the applications needed, the flow of data, and the hardware infrastructure required for a successful standards based data exchange process. Each capability identified on these documents that is not an existing capability of the business needs to be highlighted in order to identify those that need to be developed or acquired. All risks to the exchange process should be identified and evaluated. Available options and risk mitigation plans should also be included.

4.8 Create a business process design substantiation report

The final step in this series of exercises is to prepare a design substantiation report detailing the activities undertaken and the results achieved from the activities performed in steps 4.1 through 4.7 above. The report should be structured in such a manner and include enough detail for the evaluation in a business case analysis that will result in a positive return on investment.

The report should include an executive summary of the objectives or problem statement(s) and the identification of the solutions, the resulting capabilities, the reuse of existing capabilities, and the requirements to acquire and / or develop any missing capabilities to bridge any identified capabilities gap. The business process diagram, the applications connectivity chart and the infrastructure architecture diagram should be referred to and included as attachments.

5 Develop business case (options)

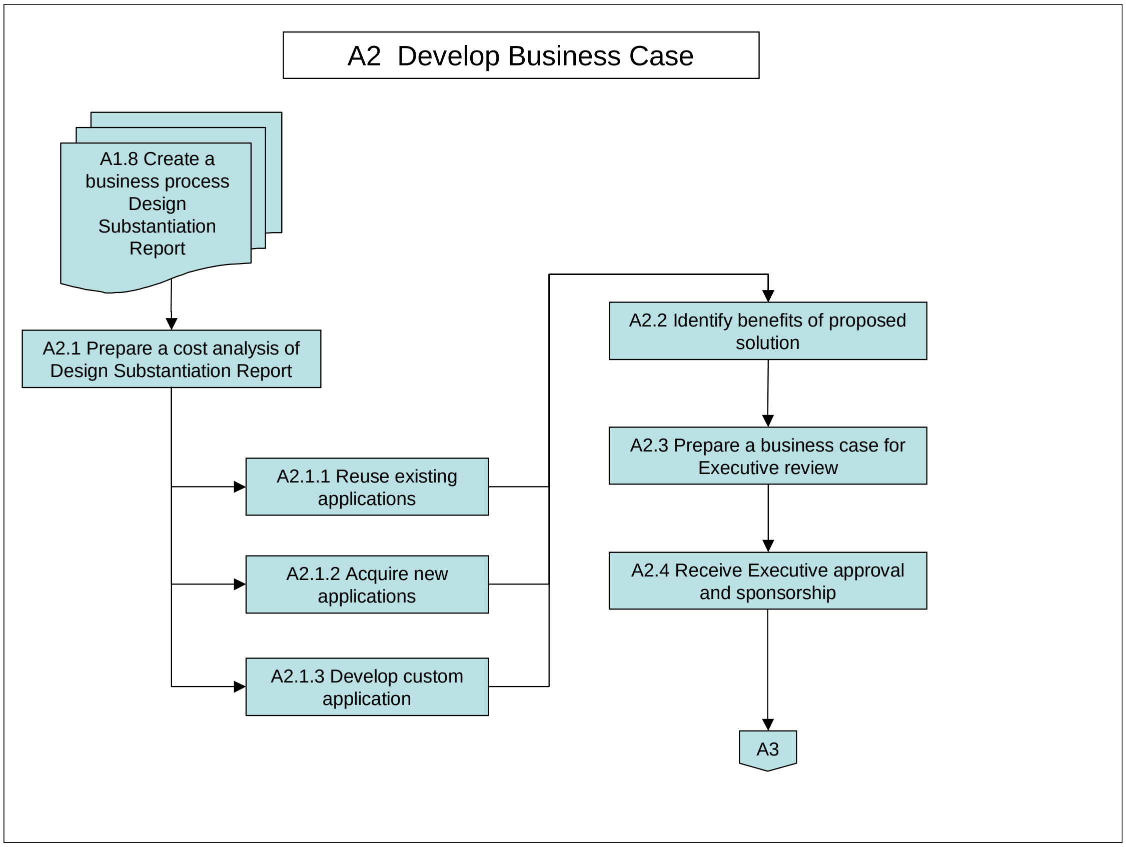


Figure 5-1, Develop a business case

5.1 Prepare a cost analysis of the design substantiation report

The costs determination process is comprised of a detailed analysis of the costs for each required task identified in the design substantiation report to determine the labor and / or materials required for each approach or combination of approaches outlined. An initial approach to the costs analysis would be a very high level review of the design substantiation report to determine if the approach presented is reasonable or "makes sense" and is at a very high level financially feasible within the resource constraints imposed by the business environment, and is aligned with a corporate goal or business objective. An alternate approach can be a detailed costs determination to be included with a substantiating benefits proposition to present to executive management for project or program approval. The three approaches outlined here are not intended to be a complete or exhaustive list of cost sources. These approaches are designed to be an outline of cost sources and a list of items to be considered during the cost analysis process.

5.1.1 Reuse existing applications

The costs associated with the reuse of existing applications from within a business can be calculated by quantifying any the following:

1. Labor required for migrating, authoring or re-mastering of any data that is going to be exchanged from a non-standards export producing application to a standards export producing one. This could be from a legacy data migration project or from a new development program. The labor costs can be a combination of internal direct labor and external contract or consulting labor.

2. Labor to define and document new business strategies and process models associated with the activities defines in (1). These skills are typically from a higher-level expertise and therefore are higher in costs than the labor to perform the activities in (1). This task can involve business process analysts and require advanced computer and IT expertise.
3. Labor to provide the minimum required training of the users in the new business and data exchange processes.
4. Labor and materials to develop the training materials and train a group of classroom trainers and / or subject matter support experts. This can be referred to as the “train the trainer” exercise.
5. Labor for program and project management resources.
6. Rents for any temporary or permanent office space or equipment.
7. Labor and materials required for any changes in IT infrastructure such as rewiring offices with network access and phone connections and / or printing and faxing capabilities.
8. Labor required for performing any application upgrades, which includes user testing and application deployment.
9. Costs associated with any travel and incidentals. This can include travel to the application provider for an evaluation or to other companies to do an evaluation of the success of any application to provide the required standards based export.
10. Management reserve dollars to mitigate any risks and unknowns in the technology development and deployment.

5.1.2 Acquire new applications

The costs associated with the acquisition of new applications can be calculated by quantifying any the following:

1. Labor required to prepare a requirements matrix for the evaluation of new applications and to perform the actual evaluation and analysis and results report.
2. Costs for application licenses and application support for the period of performance of the business case. This is often referred to as PLC (purchase license cost) and ALC (annual license costs).
3. Labor and materials for IT infrastructure improvements associated with any new application if the current infrastructure does not support it. Examples include license and application servers and license serving applications, data base applications, and other low-level application infrastructure prerequisites. If the period of performance of the business case is longer than the life cycle of any components of the IT infrastructure then the costs of any required upgrades to the IT infrastructure need to be added to the business case.
4. Labor to perform the classic IT functions to deploy any new applications such as application procurement, desktop install package building, application server builds or upgrades, application testing, application integrations, application modifications, application installation and computer and user desktop support. If the period of performance of the business case is longer than the application provider average revision release period then any upgrade or upgrade(s) costs need to be added to the business case.
5. Any documented costs from the activities analyzed in section 5.1.1.

5.1.3 Develop custom application

Selecting the option to develop a custom built application to generate standards based exports for a data exchange is essentially an internal IT research and development project. This method is a practical approach for non-geometric data in the form of attributes. The recommended standard is ISO 10303-239, commonly known as STEP AP239, or PLCS. Companies considering this option should also consider acquiring outside resource or consulting services that specialize in the application of this business process technology, or collaborating with other organizations that are deploying the standard.

The costs associated with this approach can come from these sources:

1. Labor for analysis and design of the PLCS DEX development activities. Companies should consider a combination of internal and external labor to accomplish this deliverable.

2. Labor for specification development and approval.
3. Labor for application development and software coding.
4. Any documented costs from the activities analyzed in section 5.1.1 and 5.1.2.

This approach should be carefully monitored to make sure resources do not get expended without delivering on the capabilities the resources were planned for. The design substantiation report that includes this option should also include a detailed software development plan with firm deliverables of capability and periodic project milestone reviews. The management reserve costs should be higher for this option than for option 5.1.1 or 5.1.2 to mitigate the risks inherent in a software development project. Finally, a financial spend tracking procedure should be implemented to report out on earned value.

5.2 Quantifying benefits of proposed solution

One of the most difficult things to determine in a standards based data exchange implementation is the benefit to the business in terms of defined quantifiable metrics. The business case justifying benefits must be realizable in budget terms and not simply of cost avoidance in nature to receive the Executive management support that is critical for project or program approval. These are often referred to as hard benefits rather than soft benefits to the organizations responsible for financing an implementation. There can be many different approaches to quantifying the benefits to a business to achieving standards based data exchanges. The approach detailed here is an analysis of the business at an organizational or departmental level and list various proposed sources of savings within each.

5.2.1 Engineering

This is often the initial focus of the source of benefits because this is typically the organization that has the highest change in business process as a result of a new or improved process for exchanging data. Although there are achievable benefits from within the engineering organization, they may not be enough to produce a justifiable return on investment if they are the only defined benefits.

The engineering organization should improve its overall organizational efficiency as a result of the exchange of timely and accurate standards based data. The quality and speed of the decision making process within engineering will increase as the quality and the frequency of the data being exchanged is increased. This increase in processing efficiency and resulting throughput will either produce a higher quality delivered data product in the same time period or the same quality product in a shorter time period. If engineering is spending any time correcting or re-mastering or validating exchanged data that is not included in a standards based data exchange then this activity can be either reduced or eliminated altogether. The engineering labor can become overall more productive as a result of the implementation of the new standards based data exchange processes. The final data package product that is released to operations by engineering should ultimately be of a higher quality or achieved at a lower cost. This can be accounted for as a percentage of engineering labor budgets.

A subset of engineering labor may be a data management organization or function within the overall engineering budgetary umbrella organization. If a data management group does exist that performs non-standards based data exchanges then the level of such activity of this organization can also be reduced or eliminated by implementing a standards based data exchange.

Engineering labor is an attractive source of a business case cost reduction as engineering labor is most often accounted for as an operating overhead expense; therefore any quantifiable reduction in engineering labor produces a commensurate reduction in overhead operating costs.

5.2.2 Operations

The benefits to operations is mainly attributed to the increased quality of the design and design data delivered by engineering as a result of improved or faster design integration due to the timely and accurate exchange of standards based data. The operations total build cycle can be reduced because operations will have fewer discrepant build issues to deal with due to the improved integration during the design cycle. This will reduce the operations build learning curve as the design stabilizes sooner as the design variations flatten sooner and operations becomes more repetitive sooner, thus requiring lower build cycle costs earlier in the build process life cycle. This increase in operations efficiency can again be accounted for a percentage of operation labor budgets.

The increase in productivity of the touch labor of operations can be accounted for as an overall cost reduction to the project or program operations budget or can be applied to increase the throughput of operations at the same cost point at or reduced cost levels relative to the known cost levels prior to the introduction of a standards based data exchange.

In many corporations or companies the purchasing department or another operations department is responsible for the process of data exchanges to the part manufacturing supply base. This is often associated with purchasing organization because the purchasing organizations are the ones who officially authorize expenditures for product and services via a company purchase order. This is the official financial commitment of resources process. The supply base manufacturing the product or providing the services are financially responsible for the terms and conditions placed on them via the purchase order. If the purchasing or other subordinate department is performing a non-standards based *ad hoc* data exchange to the supply based then this activity again can be either reduced or eliminated. This can also be accounted for as a percentage of operations budget.

There are also benefits that can be realized by the part manufacturing supply base. The use of a standards based data exchange to and from the part manufacturing supply base negates any requirement for a parts supplier to re-master or re-author any data that is received from an OEM or sub tier supplier in a non-standard or application proprietary format. It also negates any requirements for the supply base to acquire, install, and revision manage multiple applications that are dictated to them by higher tier suppliers or by OEM's. The part manufacturing supply base just needs a single compliant standards based data exchange capable application. The imposed overhead burden that these multiple unique applications running at multiple revision levels as a percentage of operating costs in the part manufacturing community can be significant. Other areas of benefits to the parts supply base can be derived from the higher quality data package being delivered by Engineering in electronic format. A more complete standards based technical data package will result in fewer part manufacturing errors and therefore fewer scrapped or reworked parts. In addition fewer errors in part manufacturing will also result in better schedule performance with fewer late deliveries and supplier overtime costs or company expedite fees to meet schedule. The purchasing or contracts organization of a company implementing a standard based data exchange process with an external parts manufacturing supply base, knowing that there are benefits achievable within the supply base, can negotiate for favorable costing or pricing and bring some of the achievable benefits back in house to add to the overall business case benefits.

5.2.3 Service

The service organization may be perhaps the largest source of potential benefits of a standards based data exchange process. If the proposed new or revised data exchange process is intended for a product already in service, then these benefits are immediately available. The benefits may be in the form of increased support capabilities for products in service, which will result in lower support labor costs, or increases in support business capabilities and revenue. Other benefits may be reductions in labor costs to locate, fine and analyze service related data to perform service unit support repair or upgrade procedures.

The recent emphasis on the service of fielded products as a new market for OEM's makes this an especially significant business capability. Companies that have entered into a factory owned unit, pay by the hour type of business model may require a standards based data exchange process to reduce the liability of the long-term service contract when the duration of such a contract exceeds the life cycle of an application. The standards based data can be exchanged through chronologically sequential applications during a product support life cycle through the standards based data exchange. In addition, the receipt of accurate and timely reliability data of fielded units through a standards based data exchange process can further reduce the service liability by allowing OEM's to cost out and make product improvements to increase the reliability any low MTBF components that increase service costs.

5.3 Develop a business case proposal

The process of developing a business case is comprised of determining the costs of the implementation of a standards based data exchange process and subtracting it from the benefits over a predetermined period of performance. Some of the enterprise level benefits that need to be determined are how to capitalize on productivity gains in labor and lower materials costs and whether to reinvest these benefits back into the business or return the value directly back to the investors. Some strategic weighting can be put on intangible metrics such as critical business value or competitive advantage.

The final business case should include an executive level presentation stating the original objectives and summarizing the return on investment. The business case should also contain a schedule or timeline and a summary of cash flow year over year with a predetermined financial break-even point. In addition, an analysis of risks and a risk mitigation plan should be prepared with a commensurate percentage of the implementation budget held in a management reserve position.

- Determine relevant cost metrics and a period of performance to use in the preparation of a business case analysis. Examples are internal engineering and operations labor rates either burdened or unburdened, acceptable internal rate of return on investment, cost of material, excess inventory, total costs of hardware and software, and one year, five year, or ten year time frames. A specific metric may be of particular importance to the business at the time such as head count reduction or acquisition of new business. It is important to understand the cost drivers of a business to better predict positive business case impact. For instance what percentage of the business is labor and what percentage is material, and which commands a larger percentage of the overall business budgets.
- Sum up all costs from section 5.1
- Calculate benefits from section 5.2 Prepare a new budget baseline for a change in labor budgets or change in material budgets or a combination of both.
- Calculate the value of reinvestment of productivity gains back into the business or the savings in terms of head count reductions. Head count reductions may be obtained by eliminating open requisitions for new hires or by allowing attrition to reduce the employee population gradually. Direct head count reduction may increase outplacement services costs while employee reassignment may increase employee-retraining budgets. Employee retraining costs may be recoverable by state or federal programs designed to fund such activities.
- Special weighting factors of specific intangible metrics may be applied to the overall business case. This may be the strategic business value of the capability to collaborate with industry business partners, or a long-term strategy of budget reductions of the Information Technology or Engineering departments.
- Consideration should be given to the impact of any applicable governmental regulations such as tax laws or financial reporting requirements.
- Subtract total cost from total benefits over the predetermined period of performance of the business case. Prepare a comparison of the pre business case cash flow with the post business case cash flow. Identify the specific budgets and budget line items affected and detail the change in specific budgets required to achieve any identified business case benefits.

5.4 Obtain executive approval of the business case proposal

The final step in the business case development for the implementation of a standards based data exchange process is the executive approval of the business case and the introduction of the implementation program or project. It is critical to have executive level sponsorship of the project to make and support the decisions required in organizational and budget reallocations.

The final business case presented to executive management should include the identification of the implementation champions and the immediate budgetary requirements to support the transitional actions. A project plan complete with a work breakdown structure and time charging tracking mechanism and a benefits tracking vehicle should be established. A schedule or frequency of milestone activity or management updates should be proposed. This management update should include critical decision points to advance to subsequent steps of an implementation and include the go or no go criteria to advance or cancel the project.

6 Develop exchange methods for required data exchanges and verify systems quality

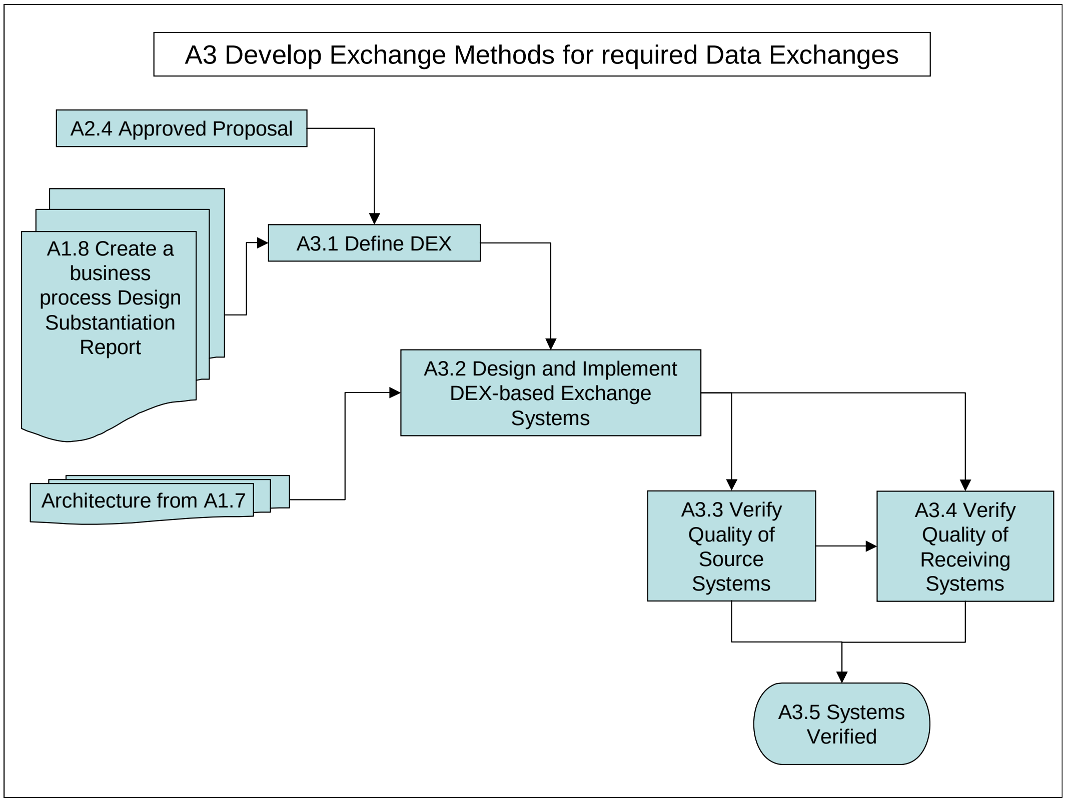
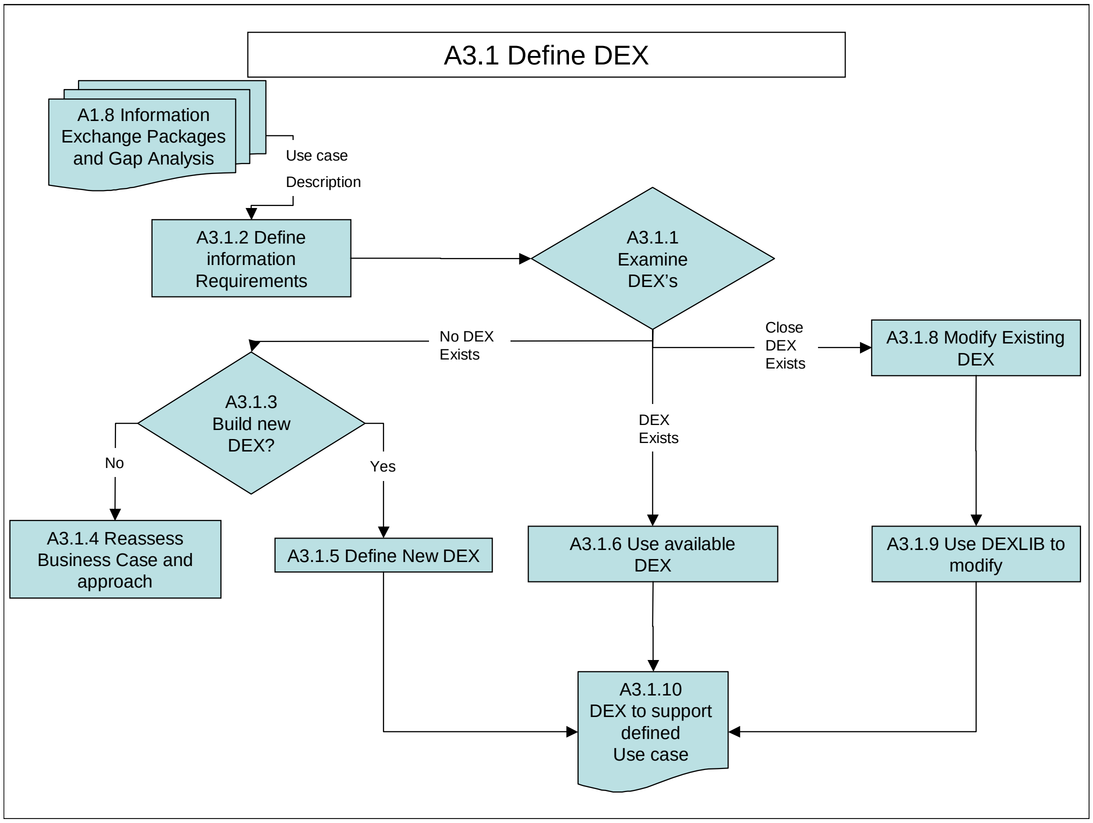


Figure 6-1, Develop exchange methods

Once a standards based data exchange is approved, current capabilities are known, and gaps are identified then the methods for data exchange must be developed. ISO 10303-239 (PLCS) has a comprehensive information model and the use of a Data Exchange Specification (DEX) is used to create subsets of the model for particular exchange needs.

Once a suitable DEX is defined, then a DEX-based exchange system can be designed and tested.



6.1 Define requirements for a DEX

Figure 6-2, Define a DEX

Uses cases can be used to obtain more detail on the requirements from the information exchange package and gap analysis. Existing DEXs can be examined for fit with business requirements. There are two possible outcomes of that examination.

1) An existing DEX may provide full or partial coverage of requirements
2) No DEX may (yet) be available that fulfills the exchange requirements

For information on DEXs, http://www.plcs-resources.org/

If a DEX is found that meets or exceeds requirements, then it can be used directly.

If a DEX has partial coverage, then the exchange requirements could be scoped down to make it suitable. Alternatively, the DEX could be extended. Consider the business value and justification when extending a DEX.

To extend a DEX you examine available templates for the ones that provide the missing coverage to enhance the DEX for your business requirements. Consider working with a company or a consortium with the specialized skills to develop DEXs. This can reduce risk and improve delivery timeline. These companies and consortiums may also promote the extensions to OASIS so that they are implemented into the original DEX for long-term support and public sharing.

If no DEX is available, there is the possibility that a suitable one is being developed. Work with the OASIS PLCS Technical Committee to determine if this is the case and to achieve a level of collaboration.

As a last resort, a new DEX can be developed. Again, it should be done under the auspices of OASIS to gain the advantages of collaboration in both development and testing.

6.2 Design and implement DEX-based exchange systems

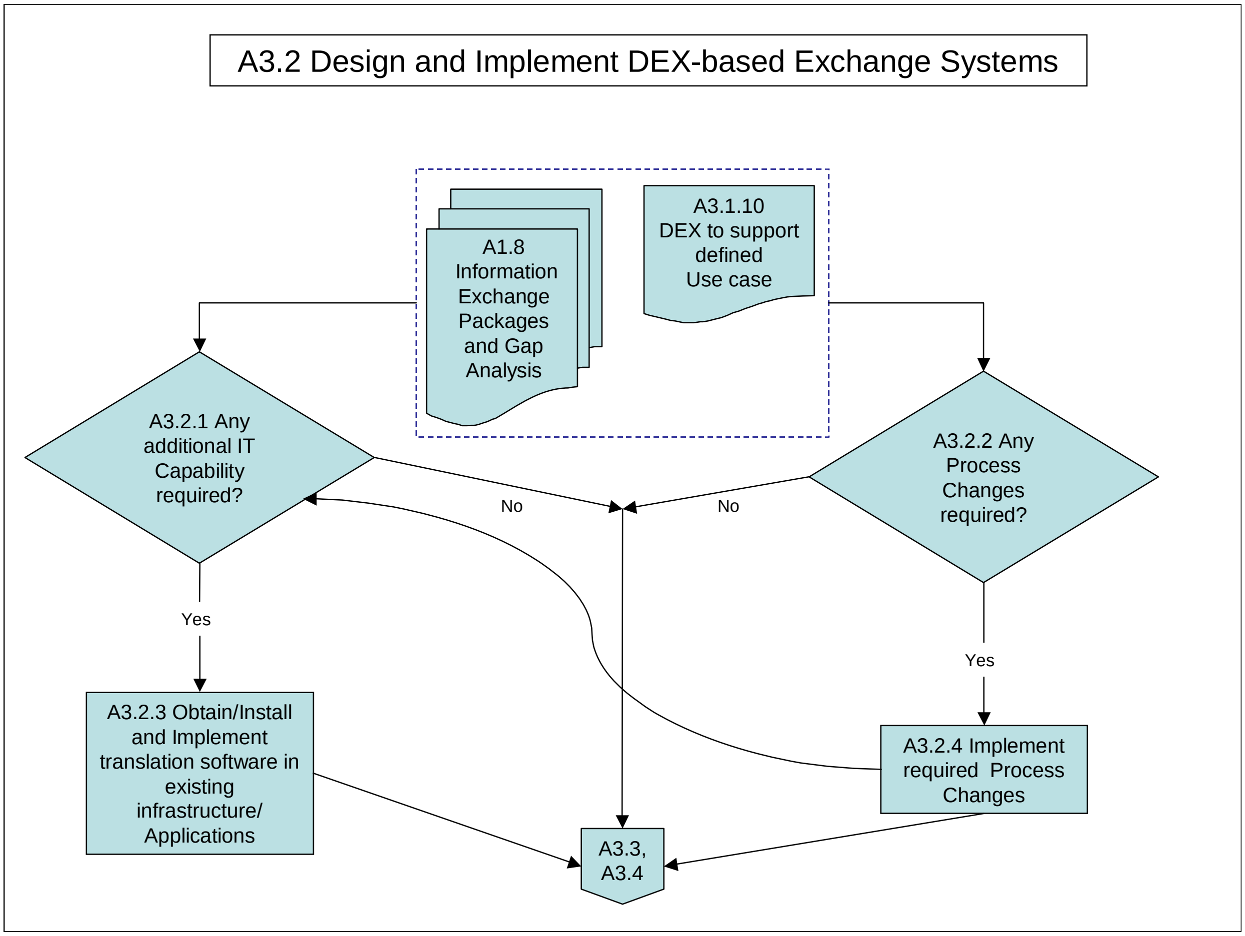


Figure 6-3, Design and Implement a DEX-based exchange system

Once a DEX is defined, there may be implications on the IT infrastructure, the tools, licenses, etc. There may also be an impact to the business processes. If there are significant business process changes, there may also be an impact to the IT systems supporting those processes.

6.3 Verify quality of source systems

After the IT systems and business processes are developed, then the source and receiving data exchange process must be developed and tested. The goal here is to create a prototype of the eventual production system. This section describes the validation process for translating source information to one or more neutral files.

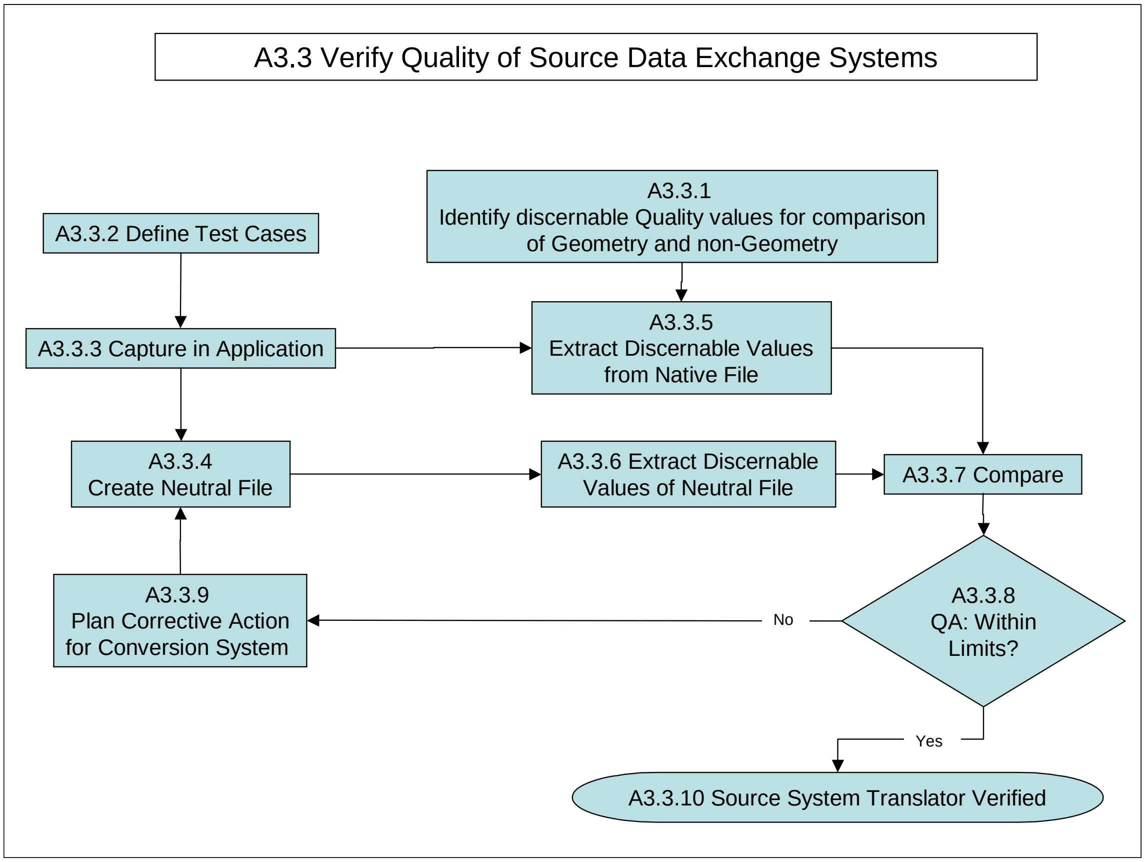


Figure 6-4, Verify source data quality

6.3.1 Identify discernable quality values for comparison – geometry and non-geometry

It is not practical to compare the complete model between the source and target systems. Therefore, the user should pick certain characteristics that are important for quality comparison to ensure the success of the translation, and can be represented in the selected neutral file format. The specific characteristics are dependent on the use-case in question and may vary from one use-case to the other. For geometry, these may include existing standardized validation properties (as defined in AP203 ed2) or any other significant properties. Global testing regime, operated by PDES, Inc. and ProSTEP, for AP203 ed2 has recommended a set of properties to be tested to validate successful exchange.

For non-geometric data, some examples of these significant properties could be the number of parts in an assembly, number of indentations/levels in product structure, number of related documents, presence or absence of key meta-data, etc. Alternatively, the user may choose to conduct a full validation of all properties.

6.3.2 Define test cases

The user should identify one or more representative test cases, which include all the characteristics that the translator is likely to encounter in production use. These cases may be synthetic or based on actual production examples. The user should also investigate the use of reference test cases from standards organizations and implementer's forums.

6.3.3 Capture in application

The user should generate the test data sets based on the identified test cases using the source application. Alternative sources for this test data may include reference data sets from standards organizations and implementer's forums.

6.3.4 Create neutral file

The user should generate the STEP neutral files using the appropriate translator from the source application.

6.3.5 Extract discernable values from native data

The user should extract the identified characteristics of the test cases using the source application.

6.3.6 Extract discernable values of neutral file

The user should extract the identified characteristics of the test cases from the neutral files.

6.3.7 Compare

The user should identify the differences between the results from 6.3.5 and 6.3.6.

6.3.8 Quality assessment

The user should identify whether any differences are outside the acceptable limits of tolerance. The user may choose not to accept any variation in non-geometric properties.

6.3.9 Plan corrective action for conversion system

If any difference is outside the acceptable limit, then the translator in the source application must be modified.

6.3.10 Source system translator verified

If all differences are within acceptable limits, then the source system translator is verified for the test cases and production use may begin.

6.4 Verify quality of receiving systems

This section describes the validation process for translating neutral files to the target system.

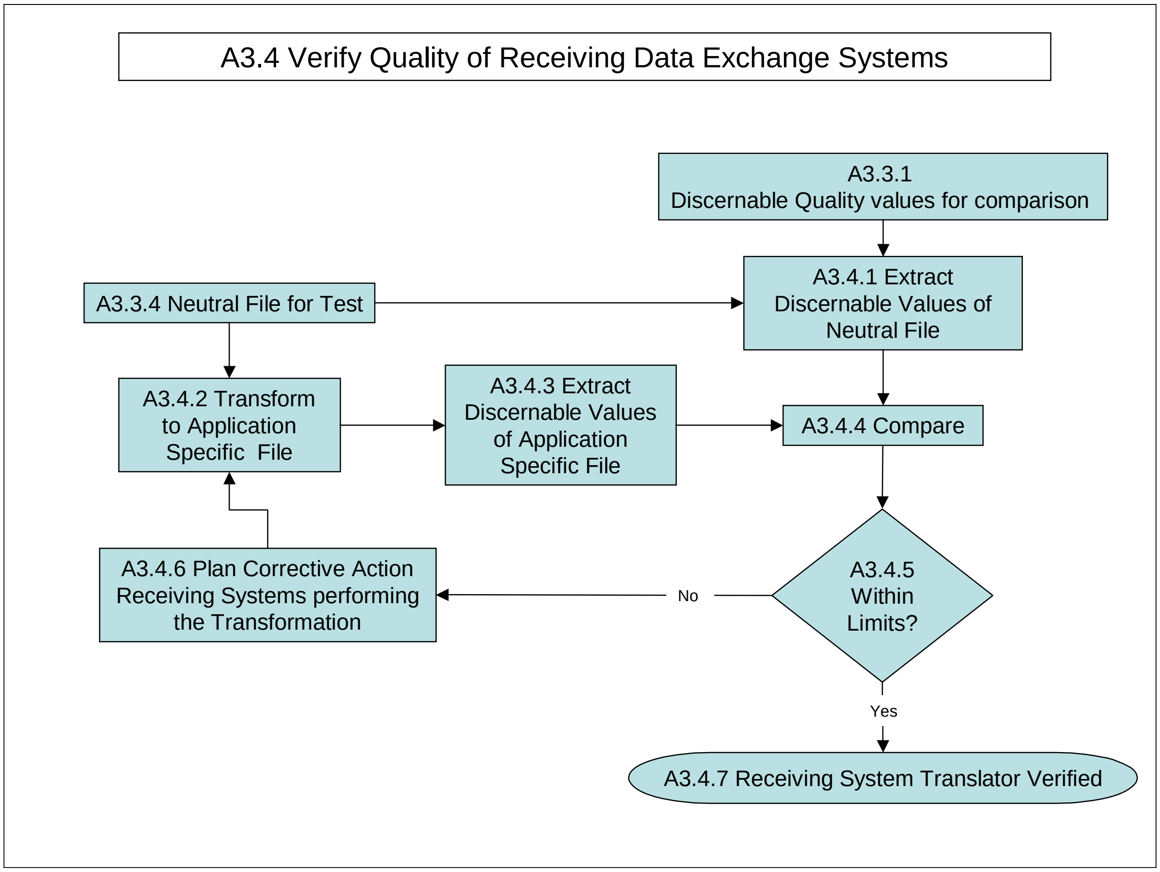


Figure 6-5, Verify recipient data quality

6.4.1 Extract discernable values of neutral file

The user should extract the identified characteristics of the test cases from the neutral files.

6.4.2 Transform to application specific file

The user should import the neutral files into the target application.

6.4.3 Extract discernable values of application specific file

The characteristics of the test cases should be extracted within the target application.

6.4.4 Compare

The user should identify the differences between the results from 6.4.1 and 6.4.3.

6.4.5 Quality assessment

The user should identify whether any differences are outside the acceptable limits of tolerance. The user may choose not to accept any variation in non-geometric properties.

6.4.6 Plan corrective action

If any difference is outside the acceptable limit, then the translator in the target application must be modified.

6.4.7 Receiving system translator verified

If all differences are within acceptable limits, then the target system translator is verified for the test cases and production use may begin.

7 Perform data exchanges and verify data quality

This section describes the production process of translating source information to the target system and validating the success of the translation process.

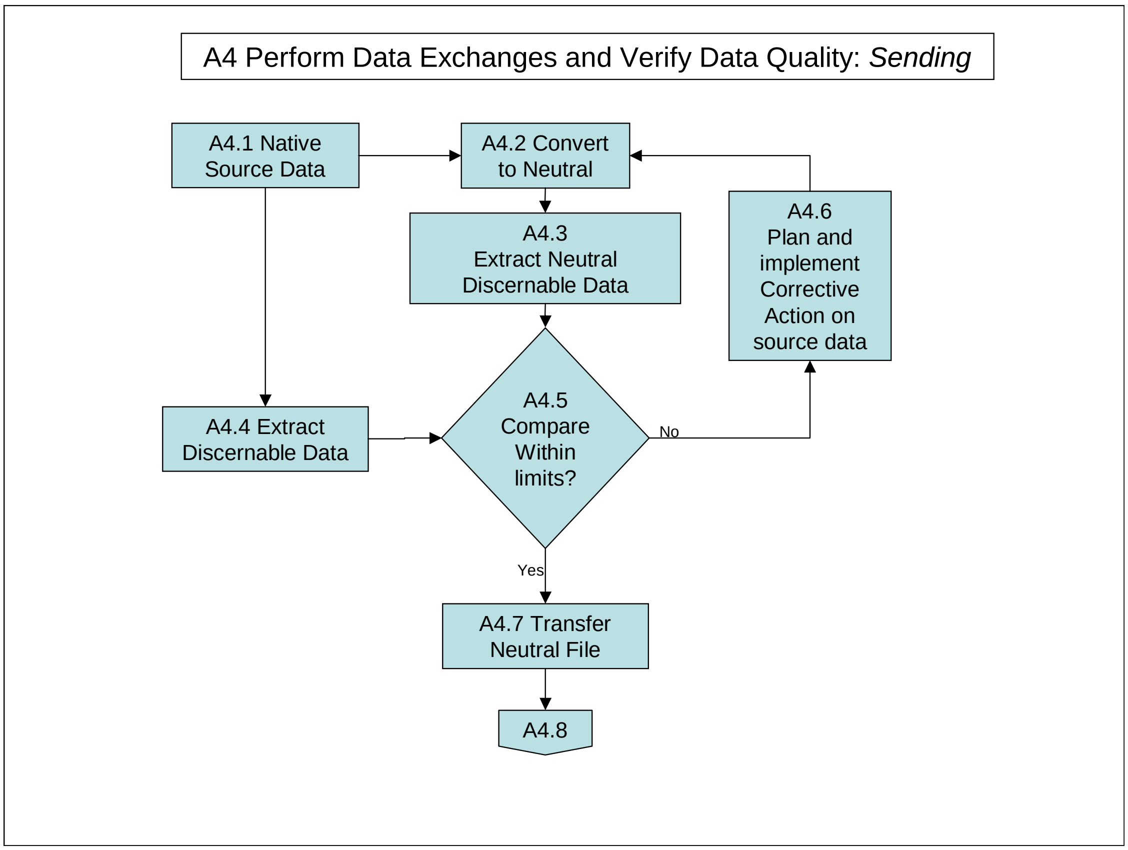


Figure 7-1, Outgoing exchange and quality process

7.1 Convert to neutral

The user should generate the STEP neutral files using the appropriate translator from the source application.

7.2 Extract discernable data from neutral data

The user should extract the identified characteristics from the neutral files. Based on the confidence in the translator, the discernable data may be reduced from that used in the test verification phase.

7.3 Extract discernable data from native data

The user should extract the corresponding identified characteristics using the source application.

7.4 Compare

The user should identify the differences between the results from 7.2 and 7.3.

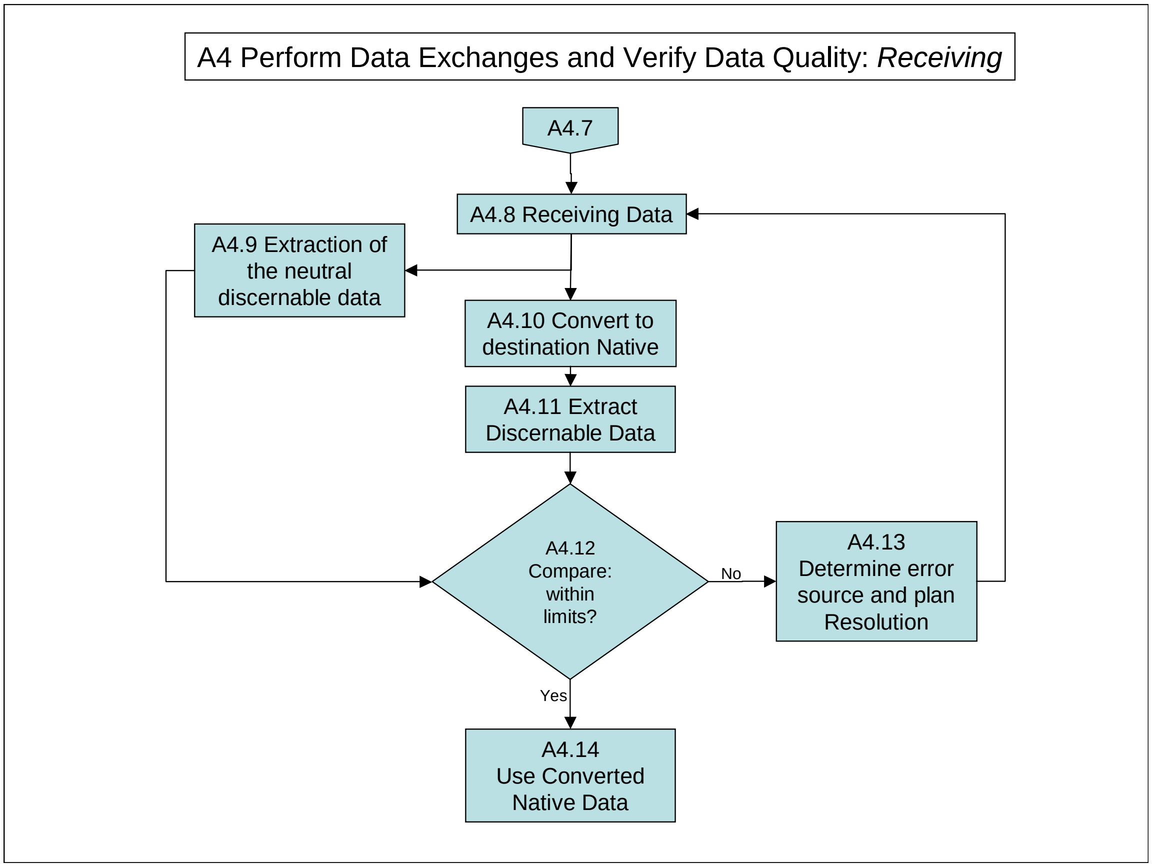
7.5 Quality assessment

The user should identify whether any differences are outside the acceptable limits of tolerance. The user may choose not to accept any variation in non-geometric properties.

7.6 Plan and implement corrective action on source data

If any difference is outside the acceptable limit, then the translator in the source application must be modified.

7.7 Transfer neutral file



If the converted file is within limits, it may be transferred to the target system.

Figure 7-2, Incoming exchange and quality process

7.8 Receive neutral file

If the transfer is successful, the neutral file appears in the environment of the target system.

7.9 Extract neutral discernable data

The same discernable characteristics as those in Step 7.2 should be extracted from the neutral file.

7.10 Convert to target native

The user should import the neutral files into the target application.

7.11 Extract discernable data from target native format

The corresponding discernable characteristics should be extracted within the target application.

7.12 Compare

The user should identify the differences between the results from 7.9 and 7.11.

7.13 Quality assessment

The user should identify whether any differences are outside the acceptable limits of tolerance. The user may choose not to accept any variation in non-geometric properties.

7.14 Determine cause of the error and plan resolution

If any difference is outside the acceptable limit, then the translator in the target application is most likely to be at fault. The problem may also have originated in the source translator.

7.15 Use converted native data

If all differences are within acceptable limits, the converted data may be released for use.

Appendix A. Use Cases for Standards

Example Use Case - Engineering Bill of Material

The transfer of the Engineering Bill of Material (EBOM) from Engineering to Manufacturing is necessary and sufficient to drive many, but not all, business processes. A Bill-of-Material can be thought of as a simplified accounting of the parts needed to assemble a product. This means it can drive procurement (partially), inventory, kitting, etc. Its primary role is to facilitate enterprise resource planning. Design changes are expressed in terms of the EBOM and approvals, including regulatory, are obtained in terms of the EBOM.

The EBOM is not complete without specifications. Specifications drive manufacturing processes (inspection, GD&T, etc.). Modern design processes generally begin with 3D models, from which an EBOM can be derived. Modeling based design eliminates the need for mockups and enable simulations, clearance and fit analyses, automates NC programming and inspections, etc. These are critical to highly engineered product offerings.

The primary use cases for EBOM exchange are:

- Interoperability with enterprise resource planning systems
- Communication of design changes with collaborators, regulatory agencies, suppliers, etc.

Example Use Case - 3D Data / CAD GEOMETRY

CAD data is increasingly being leveraged to communicate engineering content and to automate manufacturing processes. The use of 3-D CAD models have begun to supplant 2-D and textual methods of communicating design requirements between partners but the low level of interoperability is inhibiting effective collaboration. A major inhibitor to lowering costs of labor, automation, and collaboration is the proprietary nature of CAD data. In an ideal design and manufacturing process all reports, visualization, analyses, collaboration, and manufacturing could be simply and uniformly derived from the source design in CAD. At present, each collaboration exchange is driven by contracts spelling out, in detail, the requirements for the exchange; each interface to inspection or tooling equipment is custom built; some suppliers want drawings, while others want models and drawings; and so forth. All these drive up cost (labor to create/manage the data) and risk (configuration complexity and validity).

The result of implementing standards-based interoperability will be to lower both cost and risk to engineering data exchanges.

Appendix B. Key terminology

- **Enterprise** a company and its supply chain, partners, purchased services, and customers
- **Discernable Values** aspects of data that are measurable, essential to the correct form, fit, function
- **Native source** In a data exchange the originating point has the native form of the data
- **Neutral** In a data exchange the neutral form of the data is one that complies with some agreed upon format and using mutually understood semantics
- **STEP** **ST**andard for the **E**xchange of **P**roduct model data. STEP is the title of the international standard ISO 10303. The International standard's objective is to provide a mechanism that is capable of describing product data throughout the life cycle of a product, independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving. Typically STEP can be used to exchange data between CAD, Computer-aided manufacturing,

Computer-aided engineering, Product Data Management/EDM and other CAx systems. STEP is addressing product data from mechanical and electrical design, Geometric dimensioning and tolerancing, analysis and manufacturing, with additional information specific to various industries such as automotive, aerospace, building construction, ship, oil and gas, process plants and others. STEP is developed and maintained by the ISO technical committee TC 184, Technical Industrial automation systems and integration, sub-committee SC4 Industrial data.

- **DEX** Data Exchange Specification. A DEX is a way of dividing up the ISO 10303-239 (PLCS) information model into sections suited for a particular business process. A DEX provides a subset of the PLCS information model and associated reference data and usage guidance. A DEX can be used to contract against or for setting conformance but AP239 implementations do not have to use DEXs. ISO 10303-239 (PLCS) has been published as an ISO standard. The DEXs are initially being standardized by publishing the subset of ISO 10303-239 (PLCS) and associated usage guidance material as OASIS standards. Once they have been used extensively, they may be included as conformance classes of ISO 10303-239.

Appendix C. External references:

- **Aerospace Industry Association:** www.aia-aerospace.org
- **PLCS Resources:** www.plcs-resources.org
- **Current set of DEXs:** http://www.plcs-resources.org/#Data+Exchange+Specifications+%28DEX%29
- **AIA Position Paper on Engineering Data Interoperability:** http://www.aia-aerospace.org/pdf/wp_engineering-data-interoperability.pdf
- **NIST Report on Lifecycle Management Standards:** http://www.mel.nist.gov/msidlibrary/doc/NISTIR_7339.pdf
- **OASIS PLCS TC:** http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=plcs
- **Validation Practices:** http://www.cax-if.org/joint_testing_info.html#recpracs
- **PDES, Inc.:** http://pdesinc.org/
- **ProSTEP:** http://www.prostep.com/
- **CAX-IF:** http://www.cax-if.org/

.