Interorganizational System Standards Development in Vertical Industries

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A b s t r a c t

Interorganizational information system (IOS) standards development in industrial groups is proving to be an extremely productive and effective endeavour. With countless stakeholders, varying opinions and firms that are more accustomed to competition than cooperation, many industrial groups have leveraged the use of a non-profit, voluntary-consensus, standards development consortium to act as a separate entity and lead agent towards industry-wide standardization initiatives. We employ common empirical data collection techniques (management interviews, observations in consortia work groups, meeting minutes, consortia charters and others) and provide a comparative analysis of the consortia and the IOS standards development process across nine such industries. The results are summarized and a formal IOS Standards Development Cycle is introduced based on a synthesized understanding from across the industries. The IOS Standards Development Cycle in industrial groups is found to include the following steps: (1) Choreography and Modularity, (2) Reach Consensus and Prioritize, (3) Standardize and Document, (4) Review and Test (5) Implement and Deploy and (6) Certification and Compliance. We define, provide illustrations and highlight effective practices found in each step. Comparisons are made to other development processes and a discussion is provided regarding the value and role of private consortia in IOS standards development.

Keywords: vertical standards consortia, interorganizational system standards development

INTRODUCTION

Vertically orientated standards development consortia are rapidly making their mark in the ICT standards setting landscape. Employing a minimalist approach towards the standards setting process *(develop a little, test a little)*, they can quickly respond to technological innovations, market dynamics and changing world events. Utilizing a not-for-profit, voluntary-consensus and vendor-neutral approach, they are experiencing sharp increases in membership levels and achieving highly productive standards output. HR-XML, for example, is a standards consortium in the human resource industry. They were established in 1998 and have a growing membership of over 150 firms. They have developed and published 33 IOS specification sets. Similarly RosettaNet, a standards consortium in the high technology industry, has formed a membership of over 500 firms and published nearly 110 IOS specification sets. Similar initiatives have been launched across a variety of industrial groups including eMSA in the Marine Industry, STAR in Automotive Retail, papiNet in the Paper industry and many others.

In addition to this growing momentum, researchers have

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recommended a closer examination of vertical standards development consortia from a variety of perspectives. Teo *et al.*'s (2003) study of financial EDI (FEDI) found that the *participation in* and *use of* a professional industry focused sanctioning body was a significant determinant towards FEDI adoption intention. They encourage future studies to examine the different roles of these bodies in the context of 'standards-setting, information dissemination, resource aggregation, and arbitration (2003: 41). Choudhury recommends future lines of inquiry to include cross-industry analysis and a closer examination into the role of intermediary organizations (1997). Rai *et al.* (1996) recommend the study of alliances and their role in new standards setting procedures and their impact on an industrial group's evolution. David and Greenstein (1990) recommend closer examination of the micro-institutional arrangements of voluntary standards organizations and a comparison of what features of standards writing committees help solve problems. Other studies have (or anticipated) similar findings and recommendations (Grover 1993, Nelson *et al.* 2002, Premkumar and Ramamurthy 1995).

Despite these recommendations, few studies have closely examined the development process utilized by vertical standards consortia. Key questions remain regarding the value of these organizations and how firms might benefit from strategic initiatives of this type. Where does a vertical standards consortium fit in the IOS standards setting hierarchy? Why do industrial groups choose to collaborate and develop industry-wide business process initiatives? What is the IOS standards development process used by these organizations? Are there effective practices and lessons learned from early adopter industries that can be shared with industrial groups just beginning the development process? Using a grounded empirical approach based on observations in work groups, interviews with consortia management, member firms, and users, and reviews of meeting minutes and other consortia publications, this paper critically analyses the IOS standards development process of nine relatively distinct industrial groups. By synthesizing the findings across the industries, a common IOS Standards Development Cycle emerges. Each of the steps is defined with illustrations. The contributions of this line of inquiry are valuable. In addition to responding to research recommendations from prior studies, this is one of the first known studies to formally document the development cycle used in standardizing cross-company business processes in industry verticals. The diverse range of industrial groups represented enhances the reliability and generalizability of our findings. Practitioners will further benefit from the effective practices and lessons learned from early adopter industries, while researchers will further benefit from the positioning of vertical standards consortia, advancing the discussion regarding concerns of this form of standards development and numerous recommendations for future research.

The paper is organized as follows. First we provide background information and a brief illustration of a vertical standards development consortium. We then describe the research setting and present results of a comparative analysis of the consortia participating in this study, including an examination of the key factors leading industrial groups to develop business process standards. Next we outline and define the IOS standards development cycle. A discussion section follows that summarizes our findings, responds to concerns expressed regarding this form of standards development and provides recommendations for future research in this emerging field.

VERTICAL STANDARDS DEVELOPMENT CONSORTIA BACKGROUND

Interorganizational system (IOS) standards hierarchy

To briefly distinguish between the tiers of organizations influencing IOS standards, the International Organization for Standardization (ISO) and other higher order accredited standards development organizations (SDOs) will generally have a top-down or *structuralist* approach with standards development (Libicki 2002). Structuralist-based SDOs develop comprehensive sets of standards in hopes of encompassing current and future endeavours. The Internet Engineering Task Force (IETF) develops bit-orientated standards for the Internet. The World Wide Web Consortium (W3C) develops syntactic standards (that ride atop of the IETF's standards) for the World Wide Web (HTML, XML, etc.). Recent technological innovations such as eXtensible Markup Language (XML), Simple Object Access Protocols (SOAP), Web Services Description Language (WSDL), Universal Description Discovery and Integration (UDDI), and other application programming interfaces (APIs) permit the tight integration of interorganizational business process standards with information technology, and are generally considered the key components of web-services (Hagel and Brown 2001; Koch 2003). Couple this with the rapid diffusion of the Internet and the emerging ubiquitous connectivity and an interoperability infrastructure has evolved that can have profound benefits to industrial groups.

With this backdrop, we consider the role of an industry-based (vertical) standards development consortium. Many industrial groups have opted to utilize a vertical standards consortium for the development of their cross-company business process standards such as RosettaNet in the semi-conductor industry, papiNet in the paper industry, CIDX in the chemical industry, PIDX from the petroleum industry and many others.

This study's intent is to examine the role of vertical standards consortia and (more specifically) their role in developing IOS *business process (semantic) standards* that are integrated with the technology outlined above. Vertical standard consortia are depicted as *minimalist* towards their standards development activities. Minimalist approaches develop standards in small subsets (*develop a little, test a little*) and only after there is a sufficient and demonstrated need for the standard by the targeted user group(s).

Vertical standards development consortium illustration

The following is a brief illustration of a typical vertical standards consortium from the paper industry. papiNet is a consortium of organizations formed by the global paper supply chain established to develop, maintain and support global electronic business standards between firms in the forest and paper products industry. Member organizations in papiNet include paper manufacturers, printers, publishers, technology providers, universities and non-profit industry interest groups. papiNet's interorganizational system (IOS) standards are based on an open standards code made freely available to the public and are platform independent and vendor neutral. Participation in the papiNet consortium is voluntary and the IOS standards development process is consensus driven. papiNet's IOS standards are narrowly defined around common cross-company business processes shared between trading partners (e.g., goods receipt, credit debit note, shipping). Development of papiNet's standards was initially based on EDI standards used in the industry. These standards were then modified and expanded upon to enable transmission via Internet-based IOS, thus avoiding the more costly solutions of value-added networks, EDI and proprietary systems. papiNet was started in Europe in 1999 and then combined with similar initiatives in North America in 2001. Despite its youth, papiNet has been productive. As of first quarter 2005, papiNet had developed and launched 36 messaging standards, six book manufacturing standards and 80 firms from the industrial group are users of papiNet's IOS standards. Choudhury refers to these types of standards as *public goods* in the formation of *electronic dyads* in his study of strategic choices in inter-organizational system's development. On the Swanson scale, this group of technologies can be considered *Type III (combined)* innovations that are centred around core work processes, tightly integrated with the cross-company business processes throughout the supply chain and able to be extended to the firm's basic business products and services (Swanson 1994).

Vertical standards development consortium coordination and management

Members of a vertical standards consortium's management team are in a precarious position. They must accommodate firms at varying levels of diffusion, while relentlessly being their industry's leader in the standardization efforts. They must be look beyond their own industrial group for consistency and new technological developments, while also looking above their industry to higher order SDOs for compliance and certification. These activities are in addition to their day-to-day tasks of managing conflicts, reaching consensus, establishing priorities and promoting uptake throughout the entire industrial group.

Managing this development process across an industrial group is a challenge. By reviewing recent literature regarding effective alliance coordination and management techniques, we can then identify important attributes to consider when documenting the IOS standards development process. For example, in the governance area, maintaining a long-term focus, the use of neutral third parties to overcome partner dominance, structured partner evaluation procedures and carefully planned exit strategies for terminating the alliance were found as key factors effecting success (Rai *et al.* 1996). In the management practices area, trust, conflict resolution tactics, senior management support, the ability to meet performance expectations, joint problem solving and clarity of goals were found to be effective techniques (David and Greenstein 1990; Monczka *et al.* 1998; Whipple and Frankel 2000). In the standards writing and architecture area, interdependence, compatibility, information quality, information sharing, decision-making structures, delegation of authority and responsibility and the existence of a formal supplier/commodity alliance selection process were found as important attributes of success (David and Greenstein 1990; Monczka *et al.* 1998). All of these factors are important attributes to consider when evaluating a vertical standards consortium's ability to manage the IOS standards development process throughout their industrial group.

VERTICAL STANDARDS CONSORTIA COMPARATIVE ANALYSIS

Research setting and method

The selection criteria used to identify the consortia included in the comparative analysis are as follows. First, consortia were identified that made standards submissions to the *XML.org registry*. Launched in 1999 by OASIS, the *XML.org Registry* is used since it acts as a portal for industries to submit IOS standards in order to minimize overlap and duplication of efforts. Up to

March 2005, this portal had registered IOS standards across 45 industries and received 16,700 page views from over 4,400 visitors per day. If an individual firm made a submission to the registry (as opposed to a consortium), then attempts were made to identify the corresponding standards consortium for the firm's industry group. Second, this candidate list was reduced for duplication, consortia no longer in existence and consortia with a horizontal focus (as opposed to a vertical *industrial-group* focus). Third, inquiries were made to the consortia candidate list to learn of their willingness to participate in a study concerning their standards development process and coordination procedures. A consortium was removed from the candidate list if they declined the offer or failed to respond to inquiries after three attempts. If more than one consortium was identified from an industrial group, then the most dominant consortium was chosen (based on membership size and completed specification sets). Of the 252 standard submissions to *XML.org Registry*, 23 distinct consortia were identified that fit our sampling profile. Inquiries were made to each and eight non-responses and three rejections were received. Consistent with the paper's intentions, three non-dominant consortia were dropped to concentrate on the most prevailing consortia from nine distinct industrial groups. The final list of organizations included in the review are the following vertical standards development consortia; papiNet from the paper industry, RosettaNet from the semi-conductor industry, HR-XML from the human resources industry, Open Geospatial Consortium (OGC) from the geo-spatial industry, Petroleum Industry Data Exchange (PIDX) from the petroleum industry, Chemical Industry Data Exchange (CIDX) from the chemical industry, Schools Interoperability Framework (SIF) from K-12 education, Marine eBusiness Standards Association (eMSA) from marine industry, and Standards in Automotive Retail (STAR) from the automotive retail segment (See Appendix A).

Data collection methods include structured interviews and formal correspondence with each of the consortia during the fourth quarter of 2003 and the first quarter of 2004. Typical participants during interviews included the consortium's president, lead architect and an individual responsible for standards adoption and outreach. Direct observation techniques were also employed by attending standards development sessions and reviewing minutes from prior development sessions. Other data sources included reviewing consortia organizational charters, by-laws and comprehensive reviews of IOS specification sets (standards). Although one to three researchers attended each of the data collection sessions, one principal researcher consistently participated in all data collection efforts. Follow-up enquiries and data collection (primarily through consortium websites) were conducted during the second quarter of 2005 to update key figures and track progression of key milestones along the IOS Standards Development Cycle.[1]

Key differences in vertical standards consortia

An initial analysis of Appendix A reveals that the nine vertical standards consortia differ according to membership size, the year of inception and the various industrial groups each represents. Their public ownership/partnership structure model tends to vary as well. HR-XML, CIDX and OGC operating as stand alone entities, while others are closely aligned (or formally merged) with more established organizations (RosettaNet with the UCC, papiNet with IdeaAlliance, PIDX with American Petroleum Institute). Another key difference is the consortium's intent to balance between vertical and horizontal focused standards. Organizations such as STAR, SIF and eMSA focus on IOS standards development for specific segments in their vertical industrial group (automotive retail, K-12 education and marine vessel construction, respectively). In contrast, HR-XML develops interoperability standards that, although aimed at firms within the human resources industry then may also be used in human resource functions (horizontally) across industrial groups. Similarly RosettaNet develops standards across several technology-orientated sectors including semi-conductor, electronic components and high technology. Another significant difference is the penetration levels of the IOS standards within their targeted industrial groups. Although membership size and completed IOS standards are two good indicators of this, many consortia are unable to provide specific data regarding usage rates of their standards. Since their standards are freely available to the public (via download from a website), several have yet to establish formal tracking mechanisms to precisely monitor deployment levels. An exception to this is RosettaNet, which publicly announced in May 2003 that they reached critical mass in the high technology sector.

Key similarities in vertical standards consortia

Despite these differences, many more similarities exist when comparing the consortia included in the study. These include their non-profit status, vertical (industrial group) orientation, and the provision of standards freely to the public. In fact, when comparing common traits among the consortia, they are consistent with David and Shurmers' set of shared principles in formal SDOs (voluntarism, consensus, due process, fairness and transparency) (1996: 793). Participation in the consortia is voluntary, decision-making is consensus driven (primarily based on voting rights associated with membership type) and the consortia management and work groups strictly adhere to their charter, by-laws and guidelines that are made available to the general public. Furthermore, the vertical standards consortia are vendor neutral and platform independent. There are also similarities associated with membership and fee structures. Most consortia offer discounted fees for universities, non-profit research centres, governmental institutions and individuals. Most permit draft versions of their standards to be available for public comment from their website. (One notable exception to this is RosettaNet.) All of the consortia offer a variety of membership levels (with increasing annual fees) that permit members to have greater levels of influence in the standards organization. For example, OGC offers a variety of annual membership levels ranging from university associate members ($300), technical committee membership ($10,000), up to principal committee membership ($50,000). University associate members are granted non-voting membership in the technical committee including the ability to participate in working groups (WG), special interest groups (SIG) and have access to all written and electronic communication functions of the consortium. Technical committee members participate and vote in the OGC technical committees and may submit responses to consortium requests. Principal members participate and vote in both the OGC technical committee and the OGC planning committee, and are offered priority in chairing technical committee SIGs and WGs. This membership hierarchy, along with the ascending fee structure and scope of influence is typical among the consortia analysed in this study (especially with the more established organizations such as RosettaNet, HR-XML, CIDX and OGC). Other consortia offer fee variations depending on the firm's size (SIF, eMSA, PIDX) or country of origin (papiNet 2005; RosettaNet 2005).

Why industry-wide standardization?

A more profound finding, however, are the significant drivers behind industrial groups choosing to develop industry-wide business process standards in the first place. That is, why did the industrial groups choose to standardize cross-company business processes? Three key drivers emerged from the study including technological innovations, an underlying need for industry wide collaboration and the value of a vertical standards consortium. First, the underlying technology was routinely noted as the simplest and most straightforward driver. As previously discussed, with the rapid diffusion of the Internet, a plethora of technological innovations (XML, SOAP, WSDL and others) and the technology standards developed by higher order SDOs; the technology side is simple, compared to the daunting task of standardizing cross company business processes (common terminology, forms, definitions, etc.). Second, although the particular need varied with each industrial group, an additional driver towards standardization is the industrial group's need to for interoperability. Representatives from the human resources industry, for example, discussed the voluminous piles of federal, state and local governmental regulations recently passed covering diverse areas such as payroll tax collections, personnel reporting, hiring quota reporting, background checking, pensions, 401k plans and so on. Many firms are no longer able to keep abreast of the human resource related legislative and reporting requirements and have outsourced the function to speciality firms. Representatives in the Geo Spatial industry discussed the urgent and growing demands in homeland security and the virtual islands of data repositories (located throughout the world in a variety of mixed formats) that are required by scientists and geologists for research collaboration and interoperability. Similarly, representatives in the semi-conductor industry discussed the more than 30 years of relentless product performance increase pressures, product price reduction pressures and the incredible rise in chip manufacturing cost. Simply put, firms in the semi-conductor industry need to collaborate and interoperate in order to survive. Although the motivation for business process standardization within each industry varied, the common thread is the industrial group's underlying need for interoperability. Third, the vertical standards consortium business model is valuable to the industrial group. Participants in the study indicated that the most important value points of a vertical standards consortium include the pooling of research and development expenditures, time savings on renegotiating IOS standards with each new trading partner, the consortium's management acting as an independent intermediary to manage the development process, resolve disputes and keep abreast of best practices, the lessons learned and technological advancements. In fact, the vast majority of participants indicated that higher-order SDOs would have little reason to approach their particular industrial group's domain space. That is, the private consortia model not only provided value, but the participants felt a sense of duty to develop business process standards for their industrial group since higher-order SDOs would have little reason to assume the responsibility.

THE IOS STANDARDS DEVELOPMENT CYCLE

The most revealing similarity emerging from the consortia comparative analysis is a consistant methodology used across the industries in the development of IOS cross-company business process standards. To supplement the effort of identifying an IOS standards development methodology, we can build on findings from prior studies. For example, the development process for a voluntary standards-writing committee is outlined below (David and Greenstein 1990). In general, the process includes the following steps: (a) begin with a reference model (for example OSI or ISD); (b) develop an item and services and document into a standard protocol; (c) allow user groups to review and provide feedback; (d) develop complementary products and conduct conformance testing; and (e) certification. The context of this process differs from standards development in vertical consortia in three material respects. First, it focuses on IT products (as opposed to processes). Second, it is based on the development of anticipatory standards that are prior to a product's release (as opposed to the *minimalist* approach). Third, it assumes the existence of competing standards (as opposed to the *consensus driven, bottoms-up* approach inherent in vertical standards consortia). Although the context differs, it does provide a useful starting point for documenting a standard setting process that is conducted on a voluntary basis from a wide-ranging group of stakeholders (firms, individuals, vendors and other industry representatives). In addition, Choudhury (1997) outlined two strategic choices that must be made in the IOS development process: (a) *what kind* of IOS to develop (electronic monopolies, electronic dyads or multilateral IOS); and (b) *how to develop* an IOS (competitively or cooperatively). In our context, the consortia included in this study closely resemble *cooperative arrangements* in the formation of *electronic dyad public good standards* that are made freely available to the public. Choudhury's work helps us frame standards development in an IOS context, but it does not provide a formal methodology used in the entire IOS standards development process. Futhermore, *The Cyclic Stage Model of Standardization* was introduced by Kai Jakobs (2002). This model helps us identify key actors and their roles, as well as documenting the steps occurring within the analysis and technical stages of standardization projects. The model however, is geared more towards the development of technology standards (as opposed to business process standards) and does not capture important steps towards the beginning and end of the IOS standards development methodology.

Thus, we have established the following parameters for documenting the IOS standards development process. First, we will reflect the technology innovations inherent in modern-day IOS solutions. Second, we conduct the analysis by synthesizing development procedures used across the consortia participating in the study, while also highlighting effective practices found in the consortia management and coordination techniques. Third, we leveraged existing consortium-based, voluntary standards development procedures as our starting point, but made adjustments to reflect the *business process*, *minimalist, consensus driven* approach inherent in vertical standards consortia.

The IOS Standards Development Cycle works as follows: (1) Choreograph business data flows and modularize these flows into cross-company business processes that need to occur between partners; (2) Reach consensus and prioritize which of these business processes will be documented and standardized and agree on the associated timing of these efforts; (3) Standardize and document the common business fields, terms and definitions, including the development of document type definitions (DTD), XML Schema Definitions (XSD), sample XML messages and ISO compliance checks. The standards output from step 3 can be referred to as IOS specification sets; (4) Permit stakeholders to conduct testing and provide reviews and feedback of draft specification sets; (5) Implement the IOS standards and provide extensive implementation support materials and 'networks' for end-users. Also develop adoption, deployment and outreach programs; and (6) Develop compliance programs to insure the proper implementation of IOS standards and certify successful implementations on an end-to-end basis (See Figure 1)

Step 1 – Choreography and modularity

The first step in the development process is to choreograph industry-wide high-level process flows and decompose key cross-company business processes into manageable units. It is important to include all stakeholders (potential user groups, vendors, developers) and representatives from critical points in the supply chain and distribution channels to maintain an industry-wide perspective. Consortia utilize a variety of sources for this initial effort including industry action groups, research centres, prior industry-wide initiatives as well as similar schemas from different industries. Towards this end, Appendix B identifies some of the higher-level process flows for the nine consortia included in the study. Although consortia will vary the particular vernacular used to describe them (e.g., broad curriculums, collections, business clusters), for purposes of this paper we refer to them has *high-level process flows.* Appendix B also provides examples (and the count) of the lower-level 'modularized' business processes. RosettaNet, for example, has identified seven global business process clusters (*Partner Product and Service Review, Product Information, Order Management, Inventory Management, Marketing Information Management, Service and Support* and *Manufacturing*). Within each cluster RosettaNet has defined business process segments. The *Product Information* cluster, for example, has four business segments *Preparation for Distribution, Product Change Notification, Product Design Information* and *Collaborative Design and Engineering.* Finally, each segment is then further broken into *Partner Interface Processes* (PIPs ®) which contain the lowest common data elements, business documents and process choreography. The *Preparation for Distribution* segment, for example, includes thirteen

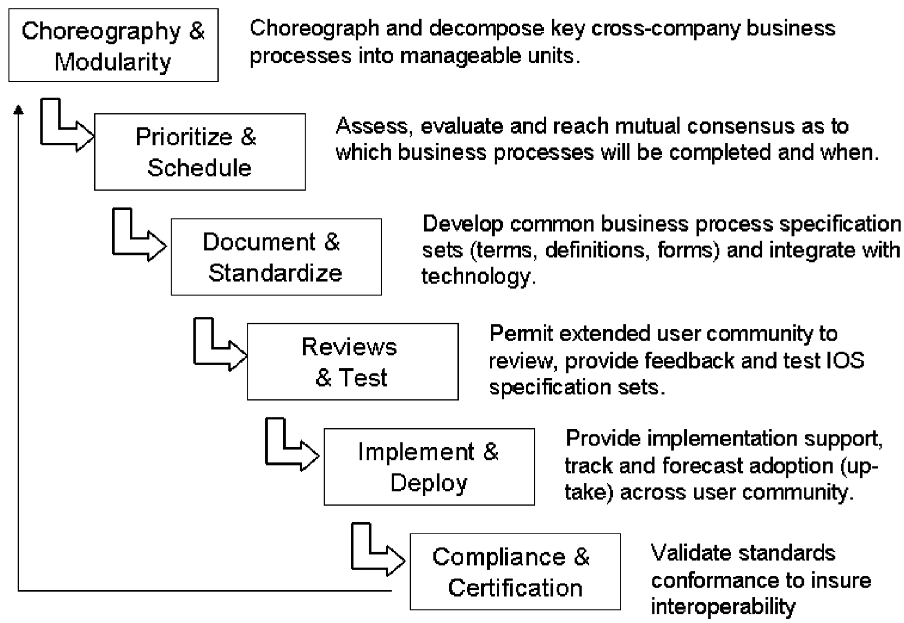

Figure 1. IOS standards development cycle

PIPs ® ranging from *Distribute New Product Information* to *Distribute Material Composition Information*. Similarly, CIDX has choreographed eight broad categories of data flows for the chemical industrial group (*Customer, Catalogue and RFQ, Purchase Order, Logistics, Financials, Forecasting, Exchange Interactions* and *Product Information*). CIDX then decomposed these broad categories into distinct inter-organizational business processes. For example *Catalogue* and *RFQ* has three identifiable cross-company business processes (*Customer Specific Catalogue Update, Product Catalogue Update,* and *Request for Quote*). Similarly, other consortia, such as OGC, SIF and the petroleum industry's Public Petroleum Data Model (PPDM), maintain an overarching data model to supplement the management of their industry-level business processes and data flows. This practice was found particularly effective in a work group setting by permitting developers and users to immediately classify and arrange new terms, new business forms or revisional work. Surprisingly, this choreography and modularization step is one of the least controversial areas in the IOS Standards Development Cycle. With little exception, members of the consortia management teams indicated the relative ease and minimal disagreements associated with conducting and maintaining this step.

Step 2 – Prioritize and schedule

Once the high-level business processes have been choreographed and decomposed, the second step in the IOS Standards Development Cycle is to prioritize and schedule the standardization initiatives. This step involves assessing, evaluating and reaching mutual consensus as to which business processes will be standardized and when. This is a highly consensus driven with discussion and debate from all stakeholders. Strict voting rights are enforced and traditionally assigned to the type of firm membership and/ or their association with the consortium. Many consortia conduct planning studies, insertion projects and feasibility analysis to determine pilot programmes. Low hanging fruit areas are identified based on anticipated development effort, the underlying business need, consistency of business process flows (and terminology) across the industry, the potential return on investment (ROI) to individual firms, the potential network effects (direct and indirect) for the industry and the likelihood of uptake by the user community.

Conflicting interest can run high during this step and become quite complex. A good illustration of this is taken from the electronics industry. Representatives from a small electronic components manufacturer and a large distributor were assigned to a work group responsible for standardizing a *credit authorization due to antiquated inventory* modularized business process. The large distributor represented 85% of the small manufacturers sales, while the large distributor purchased less than 5% of its inventory from the small manufacturer. Both representatives estimated that the implementation of the IOS standards would provide the distributor with several million dollars in cost savings per year (and likewise reduce the small manufacturer's sales by the same amount) just between their two companies. Ironically, the project lead rotation list (as maintained by the consortium) required the small manufacturer representative to assume the lead role in developing the standards for this particular 'modularized' business process. Knowing full well (in advance) that implementation of the IOS standard would likely cost him his job, the small manufacturer representative went on to lead the standardization effort with the highest quality and delivered the specification sets according to schedule. In interviews with the small manufacturer's representative during the midst of this, he admirably maintained an industry level perspective and kept the higher goal in mind of 'eliminating non-value added expense from the supply-chain' for the overall 'betterment of the industry'. (As a side note, despite the representative's valiant work, he was furloughed within three months and had not returned to the company.) Again, conflicting interests are prevalent in the vertical standards space and this type of scenario is not unusual. It is essential for the consortium's management team to maintain their industry-wide perspective, remain neutral and keep the higher goal in mind.

Most consortia have conferences once a quarter to take votes, re-scope, re-prioritize and re-schedule projects and workloads. A recurring point emphasized during management interviews indicated that this level of *flexibility* and *ability* to quickly adjust priorities of the consortia and work teams is essential to their success. It permits the consortium to rapidly respond to changes in technology, market conditions and other world events. It reaches to the core of what differentiates a vertical standards consortium (bottom-up, minimalists, market responsive) versus that of higher order SDOs (top-down, structuralists).

The output from this step is generally two-fold. First, an *overall project plan* is developed identifying the priority and approximate timing of which high-level business process flows will be standardized. Second, a *detailed project plan* is developed identifying the priority and timing of which low level modularized business processes will be standardized, including target completion dates and resource requirements (human, capital, equipment, facilities and other). Both plans are routinely updated and disseminated to the membership and extended industrial group. The consortia included in this study have a relatively small number of direct full-time staff (typically ranging from 10 to 30 personnel). Thus representatives from member firms conduct the bulk of actual standards development work. These 'employee-on-loan' programmes are a common technique among vertical standards consortia. Interestingly, many higher priority business processes chosen are also similar to business processes in other industrial groups. For example, Request for Quote and Purchase Orders are business processes that have already been standardized (or are in the process of being standardized) by several consortia. These business processes with similarities on a cross industry basis are opportunities for higher-order SDOs (or for vertical consortia) to assume leadership positions and seek horizontal-based solutions.

Step 3 – Standardize and document

Once the high level process flows have been choreographed and broken down into manageable business process units (step 1) and the consortium's priorities have been evaluated, voted on and scheduled (step 2), the next step is to develop the business process standards and integrate these standards with the recent technological innovations (XML, WSDL, SOAP and other APIs). A completed specification set coming out of step 3 will typically include choreographed business process models and data flows, terminology, definitions, XML Schema (XSD), DTD, sample XML messages, version history and other referent examples. See Appendix B for additional examples of specification set contents.

Step 3 can be a laborious and time-consuming step lasting from weeks to months. Due to this effort, most consortia utilize special work groups (sub-committees) that are dedicated towards completing the task. OGC for example has 35 work groups ranging from an *earth observation, sensor web enablement,* to *coordinate reference system* work groups. CIDX is broken into two business units (Chem eStandards and Cybersecurity). Chem eStandards has a steering committee and advisory committee in addition to their 18 working teams ranging from *Order to Cash, Logistics* and *Supply Chain*. See Appendix B for additional examples of consortia committee structures for the consortia participating in this study. Appropriate and structured project management skills are essential during this step. The work groups will be responsible to identify, define and document the common business terms and forms associated with the 'modularized' cross-company business process. Effective practices include developing and enforcing procedures to evaluate progress, perform validity checks with ISO guidelines and provide periodic status reports to the extended membership and user groups. eMSA, for example, strictly follows the STEP (Standard for the Exchange of Product Model Data) structure as published by ISO's sub-committee 4 (Industrial Data) of technical committee 184 (Industrial Automation Systems and Integration). CIDX validates that XSDs are in compliance with ISO related guidelines (e.g., ISO 8601 is a format for structuring date and time elements, ISO 639-1 is the two-character language code and ISO 639-2/T is the three-character code). Most consortia maintain a data dictionary for the entire industrial group (as opposed to a single firm). The business process choreography will, to a large extent, be collectively based on industry norms, contractual agreements, governmental requirements and emerging trends. Work groups must have the authority to make decisions, standards development milestones must be established and adhered to and communication channels must be opened to key industry stakeholders and top management.

Step 4 – Review and test

Upon completion of the initial specification set from the work group (step 3), all of the consortia in this study provide a review and testing period of the draft standards. In fact, many consortia may have just as many draft 'in-review' standards as they do approved standards. OGC, for example, had 12 specification sets in review as of this writing. At one point in 2003, RosettaNet had 52 specification sets under review. Regardless of the volume, consortia managers and users emphasized the importance of permitting the extended user community an opportunity to review, provide feedback and test draft specification sets. Effective practices include offering lengthy review and testing periods including interoperability labs, open publication of test results and adherence to formal versioning procedures. In addition, consortia utilize their quarterly conferences and/ or user conferences to provide lessons learned, report out of testing results and standards development status reports from working groups. See Appendix B for additional illustrations of effective testing and review practices from the consortia in this study.

Potential user firms, research centres, technology vendors and other stakeholders will often volunteer for testing and parallel processing. OGC has established a formal request for quote (RFQ) program (available to members and the general public) for interoperability testing and web-service test bed services. eMSA provides formal translator testing procedures with clues for appropriate testing techniques, sample data sets and test cases. RosettaNet provides similar testing services, however, they limit the availability to review and provide feedback of draft standards to formal RosettaNet member firms. RosettaNet announced in October 2004 the outsourcing of many of their testing services. papiNet, on the other hand, offered a completely open two-month review period for their 2.3v standards and permitted reviewers to provide online feedback via their website.

Step 5 – Implement and deploy

Once the specification sets have been fully reviewed and tested, most consortia will provide extensive implementation and adoption support programmes. For example, all of the consortia in this study have assigned project champions for leading adoption initiatives across the industrial group. Several have recently launched programmes for tracking, promoting and forecasting the adoption (up-take) of standards across their user community and beyond. See Appendix B for additional illustrations of effective deployment and implementation support practices from the consortia in this study. Many creative techniques have been undertaken by consortia to provide implementation and adoption assistance programmes. It begins with the fact that all of the consortia in this study provide their standards freely available to the public. Additional assistance includes white papers, cases studies and formal implementation support networks for user firms. papiNet, for example, has special *implementation* groups (SIG's) structured along lines of their standard's major categories: *Carton Board, Fine Paper Group, Label Stock Group, Packaging/ Containerboard, Publication Papers Group, Pulp Global, Recovered Paper Group, WoodX (Wood Products) European , and XBITS (Book Publishing)*. Most consortia also provide informal 'support networks' that track key personnel with implementation experience, lessons learned, best practices and other implementation guidelines. One often-overlooked fact regarding deployments is the lack of formal tracking mechanisms. Since consortia make their standards freely available (typically via downloads from a website), they often lack precise knowledge of the extent of adoption and which companies are users of their standards. The majority of consortia in this study have just recently begun requiring users to register prior to downloading specification sets. Although this does help with the problem, consortia are still unable to track which firms actually implemented the standards or track deployment if the standards were obtained through alternative sources. This makes managing the deployment process challenging and significantly reduces their ability to understand adoption and deployment determinants. As a result, many consortia have launched formal certification programmes as discussed below.

Step 6 – Compliance and certification

The final step in the IOS standards development process is compliance and certification. The typical intent of these programs is to establish formal procedures regarding *certifiable* implementations (according to consortia specified guidelines) and to protect the consortium's trademark name and usage. Other consortia initiate their compliance and certification program to track usage, adoption and deployment levels of their standards. Although late in coming, most of the consortia in this study now provide some form of certification and compliance programs. (See Appendix B for more details (some programs are fully operational, while others have been partially launched and still others are draft (in development).) The majority were launched as recently as late 2003 or during 2004. The reason for the delay is likely due to the controversies surrounding certification programs. The consortia stamp of approval is important in industrial groups. It provides instant recognition by the entire industry regarding the firm's successful compliance with the consortium's standards. For example, RosettaNet has launched three compliance programs that include process compliance (for members that have successfully implemented their PIP© standards), product compliance (for vendors that have integrated their IOS standards in their products) and testing compliance (for successful testing results through their eBusiness Ready partner). HR-XML and OGC offer similar compliance and certification testing programs. Many firms view the certification programs, however, as an infringement on their privacy. They often feel forced to reveal future strategies or other competitive contractual information that they otherwise would not. Some firms fear that requiring certification may send false or misleading signals to the user and vendor community, especially when considering that the consortium is intended to be a *non-profit, vendor neutral* and with a *voluntary-consensus* style.

VERTICAL STANDARDS CONSORTIA CONCERNS AND RESEARCH RECOMMENDATIONS

This study examined an emerging phenomenon occurring across many industrial groups with their use of a non-profit, industry-based, voluntary-consensus consortium acting as a separate entity and lead agent towards industry-wide IOS standardization initiatives. A comparative analysis of nine such consortia was conducted and the key differences and similarities were identified. The key drivers towards standardizing industry wide cross-company business process were identified and include the underlying need for interoperability, the technology and the value proposition of a vertical standards development consortium. The IOS standards development process was defined, documented and illustrations of effective practices were provided for each step.

Despite their growing momentum in vertical standards consortia, prior studies have expressed concerns about this form of standards development. For example, Hawkins (1999) expressed concerns regarding the ability of private consortia to quickly develop lock-in costs for new adopters and then subsequently permit consortia member's to exploit this with revenue maximizing products and services. Based on our study, consortia members rarely (if ever) raised the topic of additional revenue possibilities due to the IOS process standards. The overwhelming majority of benefits accruing to member firms are in the form of business process cost reductions, pooled R&D expenses, time savings of re-negotiating standards with new trading partners and numerous qualitative benefits (enhanced employee morale, firm image, etc.). The crux of the difference between Hawkins' concern and our study's context is likely to be due to the emphasis of technology product orientated standards versus IOS process standards. Furthermore, David and Shurmer(1996) suggested that the profit driven ventures of private consortia could ultimately lead to the omission of public interest safeguards (such as ready access to committee deliberations and public circulation of draft recommendations). Evidence of this could not be found since the consortia are all non-profit entities with high degrees of transparency (publicly available meeting minutes, consortia charters, and freely available draft standards and final standards). Furthermore, David and Shurmer (1996) indicated that obvious inefficiencies in private sector consortia included high start-up costs and duplication of efforts by rival groups. Based on our study, evidence of competition between vertical standards consortia *within* an industry group could not be found. In fact, it is quite to the contrary. For example, three consortia in the petroleum industry include PIDX, Public Petroleum Data Model (PPDM) and Petrotechnical Open Standards Consortium (POSC). The consortia management from each consistently (and complimentarily) articulated the workspace of the other and where each fits in the IOS standards development effort for the entire industrial group (which, in this industry, varies along segments of the supply chain). Similar findings were found in electronics (RosettaNet and EIDX) and education (SIF and IMS). This concern however, is valid with respect to consortia from *different* industries (especially when the industrial groups share common touch-points in their supply chains). Evidence of disputes and 'turf battles' were readily available in these situations. Future studies could investigate these situations and examine dispute resolution techniques, mitigating circumstances and provide illustrations of successful solutions.

We did find evidence supporting other concerns raised in prior studies and they provide rich areas for future research. For example, the longevity of vertical standards consortia and their ability to maintain, support and update IOS standards on a long-term basis has been questioned (Hawkins 1999). This is a valid concern as several vertical standards consortia lost momentum and ceased operations. Although most consortia incorporate exit strategies directly into their organizational charter to plan for such events, it does not address the larger issue of what are the factors leading to the sustainability of vertical standards consortia as an ongoing concern. Our study has postulated three of these factors (underlying need of the industrial group, technological innovations, the consortium's value proposition), but we did not examine these factors in the context of a failed vertical standards consortium. This represents a future research area using perhaps a longitudinal design from inception to dissolution of the consortium. In addition, concerns regarding private consortia transparency and public safeguards are beginning to emerge (David and Shurmer 1996). That is, the consortia included in our study have been in existence for approximately seven years (on average). With their success (in membership, standards publications and deployment levels), subtle signs are becoming evident of losing their transparency.

For example, several consortia are beginning to strictly limit invited (non-member) guests at conferences, RosettaNet is not permitting draft specifications to be available for review and comment from non-members, and most consortia are now requiring online registration *and a justification* from non-members prior to downloading their standards. Although these are small and subtle changes, they do begin to validate David's transparency and public safeguard concerns. Future studies could examine these transparency encroachment factors and their impact on public safeguards in vertical standards development consortia. Furthermore, close examination is needed regarding the concern of leveraging vertically developed IOS standards on a horizontal (cross-industry) basis (David and Shurmer 1996). Indeed, evidence from our study suggests that end-user groups are struggling with this horizontal convergence issue since it often delays adoption and deployment decisions. Future studies could examine how vertical consortia can overcome these conflicts for the betterment of both industrial groups.

Although attempts were made to minimize the limitations in the study, some do remain. First, most of the vertical consortia included in the study were recently formed (within the prior 5 to 10 years). Future research should compare our findings to those of more established industry-based consortia (such as Acord from insurance industry). Ideally, the more established organizations should have a significant advantage over their younger counterparts since they have had several years (if not decades) of using (or in some cases standardizing) common business terms, definitions and forms. Similarly, comparisons should be made to higher order SDOs such as OASIS and the IETF. Although these SDOs utilize a structuralist approach, identification of their development processes and effective techniques would provide keen insights that transcend multiple levels in the IOS standards setting hierarchy.

Note

1. A subsequent study was conducted with 102 user (or potential user) firms from these consortia encompassing 4,072 implementations of IOS standards. The subsequent study's intent was to examine adoption and diffusion determinants of IOS standards in industry groups and is the subject of a forthcoming paper by the authors. Although none of the quantitative results from the subsequent study are included in this paper, several end-user perspectives and qualitative insights are shared.

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Appendix A

Industry-based standards development consortia

Industry-Based Standards Development Consortia Examples

Vertical Consortia	***HR-XML***	***papiNet***	***OGC***	***PIDX***	***STARS***
Industrial Group	Human Resources	Paper	Geo Spatial	Petroleum & Oil	Automotive
URL	www.hr-xml.org	www.papinet.org	www.opengeospatial.org	www.pidx.org	www.starstandard.org
Profit Orientation/ Partnerships	Non-Profit	Non-profit orientation Partnered with Idealliance.	Non-Profit	API committee one-Business. Non-profit orientation	Non-Profit
Membership Fee Structure	Annual fees based on membership levels. Fees also vary by end-user versus technology vendors.	Annual fees based on membership levels. Fees also vary by geography, technology vendors and industry champions.	Annual fees based on membership types (strategic, principle, technical, academic and governmental)	Annual fees based on firm revenues and membership levels.	Annual fees based on organization type (dealerships, mfrs, vendor) and the # of dealers supported.
Industry Participation	Voluntary	Voluntary	Voluntary	Voluntary	Voluntary
Decision Making	Consensus based on membership voting rights.	Consensus based on membership voting rights.	Consensus based on membership voting rights.	Consensus based on membership voting rights.	Consensus based on membership voting rights.
Standards Availability	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public
Members	150	24	278	27	45
Year Incepted	1999	1999	1994	2002	2001

Industry-Based Standards Development Consortia Examples

Vertical Consortia	***CIDX***	***SIF***	***eMSA***	***RosettaNet***
Industrial Group	Chemical	K-12 Education	Marine	Semi-Conductor Mfr
URL	www.cidx.org	www.sifinfo.org	www.emsa.org	www.rosettanet.org
Profit Orientation/ Partnerships	Non-Profit	Non-Profit	European Marine STEP Association (EMSA). Non-Profit orientation.	Merged with UCC in 2002. Non-profit orientation.
Membership Fee Structure	Annual fees based on firm type and firm revenues.	Annual fees based on firm revenues and membership type.	Annual fees based on membership type and firm size.	Annual fees based on geography, membership levels, and council members.
Industry Participation	Voluntary	Voluntary	Voluntary	Voluntary
Decision Making	Consensus based on membership voting rights.	Consensus based on membership voting rights.	Consensus based on membership voting rights.	Consensus based on membership voting rights.
Standards Availability	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public
Members	70	156	15	500
Year Incepted	2000*	1997	1994	1998

Appendix B

Vertical standards consortia comparative analysis (part 1)

Vertical Consortia	*HR-XML*	*papiNet*	*OGC*	*PIDX*	*STARS*
Industrial Group	*Human Resources*	*Paper*	*Geo Spatial*	*Petroleum & Oil*	*Automotive*
Choreograph & Modularity	8 broad collections	4 broad collections	16 abstract specs	4 broad collections	24 broad collections
High-Level Process (examples)	Examples Include: - Benefits Enrollment - Payroll - Background Checking	Examples Include: - Recovered Paper - Book Manufacturing - Wood Products	Examples Include: - Spatial Reference - Earth Imagery - Coverage Type	Examples Include: - Pipeline - Downstream - Upstream Acct & Report	Examples Include: - CRM - Credit Processing - Financial
Specification Sets (count)	27	36	14	25	62
Specification Sets (examples)	Examples Include: - Background Checking - Benefits Enrollment - Competencies	Examples Include: - Credit Debit Note - Goods Receipt - Availability	Examples Include: - Imagery Mark Up - Geography Mark Up - Web Map Service	Examples Include: - FieldTicket - FieldTicket Response - Invoice	Examples Include: - Parts Inventory - Delivery Reporting - Financial Statement
Prioritize & Schedule					
Decision Making	Member voting, Work teams, SDO Mgmt	Member voting, Work teams, SDO Mgmt	Member voting, Work teams, SDO Mgmt	Member voting, Work teams, SDO Mgmt	Member voting, Work teams, SDO Mgmt
Updates	Market Responsive, Flexible, Bottoms-up	Market Responsive, Flexible, Bottoms-up	Market Responsive, Flexible, Bottoms-up	Market Responsive, Flexible, Bottoms-up	Market Responsive, Flexible, Bottoms-up
Standardize & Document					
Typical Specification Sets (Content Examples)	Domain issues, supported bus process, content models, version history	Schema, style-sheets, sample XML, data dictionary, message doc	Schemas, filters, APIs, mark-up language, term-inology, definitions.	Schemas, illustrations, bus processes, existing EDI standards & templates	BODs, DTS, XML schemas
Sub-committee Structure (Highlights)	Workgroups, quarterly conferences, employee reps for core development	Central group coordination (bus proc, change control, tech, message task group)	Committees, Work Group, SIGs, Rev Work Group	Committees (General, Exec). Work Groups (classify, message, bus process, dictionary)	Steering Committee and 3 core SIGs (DTS, XML, Infrastructure).
Reviews & Test					
Effective Practices (examples)	Beta results, lessons learned, and quarterly conference "report out"	Draft standards for public comment (fully integrated via web-site)	Test-bed results, interoperability labs, formal testing RFQs, on-line test engines	Draft standards for public review & feedback, electronic balloting	Conference "report out" and lessons learned
Implement & Deploy					
Effective Practices (examples)	Registration required for free specification sets	Deploy tracking (w/ contacts), Online implementation collaboration	"Cook Books" w/ experiences, developer recommendations & lessons learned	Technical bulletins, white papers, discussion forums	Conference "report out" and lessons learned
Compliance & Certification					
Effective Practices (examples)	Product/member certification available to public (via website)	Draft (in development)	CITE Program coordinates programs	Draft (in development)	Info not available

Vertical Standards Consortia Comparative Analysis (part 2)

Vertical Consortia	***CIDX***	***SIF***	***eMSA***	***RosettaNet***
Industrial Group	*Chemical*	*K-12 Education*	*Marine*	*Semi-Conductor Mfr*
Choreograph & Modularity	8 broad data flows	12 broad areas	3 broad areas	7 global business clusters
High-Level Process (examples)	Examples Include: - Customer - Catalog and RFQ - Purchase Order	Examples Include: - Food services - Grade book - Library	Examples Include: - Hull Structures - Hull Form - Machinery	Examples Include: - Partner Product Review - Product Information - Order Management
Specification Sets (count)	54	30	9	110
Specification Sets (examples)	Examples Include: - Qualification Request - Qualification Response - Cust Specific Catalog	Examples Include: - Acknowledge - Receipt - Register	Examples Include: - Hull Structural Design - Society type - Machinery product	Examples Include: - Notification of Failure - Distribute Design Engr Info - Distribute Product Master
Prioritize & Schedule				
Decision Making	Member voting, Work teams, SDO Mgmt	Member voting, Work teams, SDO Mgmt	Member voting, Work teams, SDO Mgmt	Member voting, Work teams, SDO Mgmt
Updates	Market Responsive, Flexible, Bottoms-up	Market Responsive, Flexible, Bottoms-up	Market Responsive, Flexible, Bottoms-up	Market Responsive, Flexible, Bottoms-up
Standardize & Document				
Typical Specification Sets (Content Examples)	Schemas, sample XML messages, data dictionary, bus process guidelines	Schemas, data dictionary, DTD, sample XML messages	STEP (Industrial Auto Systems & Integration), schema, DTD	RNIFv2 covering transport, route & package, security, signals & agreements
Sub-committee Structure (Highlights)	Steering & Advisory Committees with 18 work groups	Directors, Technical Board, Work Groups and Task Forces	Lead committee (founding members) w/ work groups	RSM (Leadership Team, Council, Focus Process Teams)
Reviews & Test				
Effective Practices (examples)	Included in Implementation Accelerator Package	Agent Test Harness	Translator Testing Program	Outsourced testing (eBusiness Ready), Extensive case-study & white-papers via Univ. programs
Implement & Deploy				
Effective Practices (examples)	Implementation Accelerator Package, Dedicated adopt & deploy support team	Readiness toolkits, Discussion forums, vendor registry	Deploy tracking, implementation case studies & support	Implementation support teams, extensive deploy resources (contacts, white papers, research)
Compliance & Certification				
Effective Practices (examples)	Info not available	Compliance programs with users (educators) and vendors (products)	Coordinated via "Implementation Agreement" program	Certification/compliance offered in processes (PIPs), products and testing