POSIX – Inside: A case study

Jim Isaak
School of Business; Southern New Hampshire University
E-mail: POSIX@JimIsaak.com

Abstract

The POSIX (UNIX) standards activities, from /usr/group and IEEE through ISO WG15 and X/Open reflect one of the major success and failure stories in the standards process. This paper provides a case study of the POSIX effort from 1983 through the turn of the century. Key events and turning points in the activity are identified along with their apparent impact on the overall activities. The ultimate benefit from this evaluation is lessons learned that can be applied to future standards activities.

1. Introduction

The advent of microprocessors circa 1980 created an opportunity for new computer vendors, but they required applications software. To establish the critical mass needed to attract application suppliers required an environment that supported portability between systems. This required a common operating system (OS) interface. AT&T's UNIX was a candidate OS portable across these diverse processors. Emerging vendors, and others building on microprocessor technology turned towards collaborative standardization to address this objective[1]. This vendor and processor independence was an essential objective for "Open Systems" standards. The POSIX (Portable Operating System Interface) effort focused on this as the foundation for portable applications. POISIX is credited with increasing the market for UNIX systems by 30% [18] – an economic impact approaching 100 billion dollars[2]. A summary timeline is provided in Table 1

What were the factors that contributed to this significant impact, and what factors constrained even greater impact? How might future standards activities (and advocates) avoid the pitfalls, and take advantage of this experience? This paper looks back at the twenty years of the POSIX/Open systems processes, and in particular the points of success and failure from which we can identify lessons for future standardization.

2. 1983 – In the Beginning

A series of factors created the environment that would bring the world's largest and smallest computer vendors together in the POSIX operating system standards effort:

a) The emergence of microprocessors, most notably the Motorola 68000, which had the capacity to host a full UNIX implementation.
b) The release of the UNIX operating system for commercial licensing by AT&T
c) The implementation of U.C. Berkeley's BSD UNIX 4.x, and it's distribution in the educational community
d) The emergence from a research community (Usenix) of a commercially oriented user community (/usr/group).
e) The emergence of a handful of independently developed, UNIX "look alike" systems
f) Applications implementation companies looking beyond the Apple II and IBM PC class personal computers for a larger, scalable platform.
g) The formation of companies combining various combinations of these things to build general purpose computing platforms.

All of these factors came into play in the early 1980's. At the same time IBM was just introducing the first Intel 8088/Microsoft DOS "PC", and Apple was bringing forward widowing (with Lisa, based on concepts from Xerox PARC), another group of companies was combining 68000 processor technology with UNIX like systems. In 1981, /usr/group initiated a "standards" activity of individuals interested in defining the common core of UNIX so applications software could be portable between the major (AT&T UNIX vs. BSD) implementations. In 1983, a project proposal (P1003) was submitted to IEEE for an operating system interface standard based on UNIX[3]. The initiator of that work, Dennis Allison at Stanford, was not able to continue that work and it was expected to be withdrawn in 1984.

Key point #1: the driving forces behind UNIX standardization were individuals (at least on paper) in the /usr/group activity; many with a view towards applications portability rather than defending a specific implementation.

Heinz Lyklama was the champion of the /usr/group work and chair of that committee. Jim Isaak[4] was a member of

[1] AT&T's lack of strategic concern for UNIX in the early 1980's provided an opportunity for open (any interested person) standardization to be initiated and driven by others.

[2] This apparently large amount is in the same ballpark as Bill Gates individual net worth over this time frame. Both resulted from addressing the need for operating systems for applications portability.

[3] This initial project was not initiated with AT&T involvement. Also, at the time UNIX was not a strategic asset of AT&T.

[4] I cannot speak for other's motivations, but my employer, Charles River Data Systems, was developing a UNIX compatible operating system and wanted the "credibility" of claming conformance. As chairperson I was able to get significant visibility for both CRDS and POSIX in part because

that committee, and also agreed to chair the IEEE P1003 activity after discussion with Dr. Steve Sherman of University of Nevada who was the IEEE Sponsor chair. The basic agreement of all involved was to have the participants select which venue they wished to use, IEEE or /usr/group and the groups would merge under that banner. The decision was taken in Nov. 1983 at the University of Nevada meeting of /usr/group to use the IEEE route to standardization. A significant factor in this decision was the IEEE focus on "individual" membership representation in the process which paralleled the model being used by /usr/group (in contrast with "corporate membership" in X3, and "national body" membership in ISO.)

The group focused on the applications program interface with the intent to avoid any dependence on implementation characteristics. Given the makeup of the group, some building on minicomputers (Digital VAX), others on 68000's, and some on Intel 286 or other platforms, and using BSD, ATT, or independently developed source code, this was the clear common ground.

> Key point #2: Driving forces for this work were applications developers (not users), and system developers. For this community, portability and interoperability was a "source code" issue (they had access to source code) not an issue of "binary compatibility". The concept of binary portability would be antithical for this community since most had their favorite hardware/operating system platforms to promote.[5]

Significant events in this time frame included: a decision to re-organize the traditional UNIX manual format from an alphabetical listing to a functional listing (all file system operations together, etc.) This re-write was accomplished by Jim McGinness, a BSD advocate inside Digital Equipment[6]. Note that major vendors were 'lurking' in the process (IBM, DEC, HP, Unisys, Burroughs, Cray) but without any explicit endorsements of the effort. Often the participants were individuals with strong UNIX interest, potentially with no corporate mandate, and at times not involved in the 'mainstream' product areas of their corporations. Some of these vendors had identified the need to develop microprocessor based product lines, or at least new generation product lines, that would not be compatible with their established base, and UNIX was at least a research topic for this application. A less forward looking decision by the working group was to not re-write the interface descriptions in object oriented format – there is a good beer or two to be drawn in the contemplation of what impact that might have had on subsequent standards and systems.

In the 1985 timeframe real users started to take a stronger interest in the UNIX world. In the data communications world GM and Boeing were driving for OSI adoption via the "MAP-TOP" initiative [See Table 2]. One of these user interests was the U.S. Government, with the National Bureau of Standards (NBS, now NIST), and Helen Wood their Assistant Director for IT Standards. In the summer of 1985 NIST put out a call for UNIX Testing, creating a clear message to industry that government procurement guidelines could be expected. Helen was also a lead delegate to ISO/IEC JTC1[7]/SC22 (recently formed) and set the stage for the formation of SC22/WG15.

Finally, the X/Open group (initially called 'BISON' for founders: Bull, ICL, Siemens, Olivetti and Nixdorf) was formed in Europe to promote AT&T UNIX as a European common ground to counter the domination of that market by US manufacturers. Table 3 outlines the major groups hosting UNIX standards activities.

3. 1986 – Trial use (herding cats)

The decision to create a Trial Use standard rather than full use was based on the perception that we could gain consensus faster with that approach, and also use the visibility of that work to bring in a broader community. IEEE's approval process does not have any lesser hurdle for "trial use" standards, and the ballot on that document generated well over 90% approval. Originally published as "IEEEIX", the name was rapidly changed to "POSIX" after a recommendation from Richard Stallman. (POSIX: Portable Operating System Interface, plus "X" for UNIX.)

With the Nov. 1985 ballot completed, the activity started to spawn additional groups to focus on other areas of systems standardization. Hal Jespersen[8] and Don Cragun initiated the P1003.2 Shell and Tools working group. The NBS interest was formalized with the creation of P1003.3

CRDS was a small company without the PR guardians that try to manage messages to the press.

[5] Ken Bowles had introduced UCSD Pascal in this time frame with it's "psudo code" environment that would provide for a level of "binary portability:" for applications across diverse architectures. This concept did not 'catch' in the IT community until Sun introduced Java, and more recently Microsoft's ".Net". Realistically, performance of the 1980 and even 1990 microprocessors was not sufficient to support the additional level of overhead, and "just-in-time" compilation techniques did not exist.

[6] Digital was schizophrenic with respect to UNIX – a strong VMS camp opposed any other operating system; the AT&T sales team (a major Digital customer) supported System V; and BSD on VAX with virtual memory support was the favorite of the university/research community. In very real terms the 1983 UNIX market was Digital's to lose, a mission accomplished. Digital was acquired by Compaq in 1999, and that merged into HP in 2002, with most standards activities eliminated in that series of events.

[7] JTC1 was the merger of IT standards from IEC and ISO TC97 created in this same time frame.

[8] Hal worked for Amdal, at the time, then Unisoft, his own company and finally moved on to Sun Microsystems. Don worked for Microport systems, then Sun Microsystems. [It is informative to note both the level of corporate involvement, and also the tendency of individuals to remain active in the POSIX Standards community while changing employers. At times this was voiced explicitly to Jim Isaak that individuals were looking for a job where they could remain with the standards community, and would change employers to accomplish that.]

for Test Methods, bringing in Roger Martin[9]. Donn Terry[10] and Jim Isaak co-chaired the ongoing P1003.1 group focusing on the system API.[11]

> Key point #3: Government intention created a significant level of industry interest. NIST was well aware of this, using the POSIX testing, and eventually the FIPS process to bring industry along into a standard operating systems procurement process. General Motors and Boeing interest in POSIX and OSI were also influential. However, vendors viewed the government as being more likely to engage in "policy based" procurement than private industry.

The proliferation of POSIX groups did not stop with test methods. P1003.4 focused on real time[12] interfaces (inherited from /usr/group), with Susan Corwin (Intel) as chair. P1003.5 focused on the Ada programming language with the US Army[13] (Terry Fong), followed later by Jim Longers of Unisys. P1003.6 took a focus on Security with leadership from Jeanne Bacash (AT&T) and then Dennis Steinhauer (NIST) and Ron Elliot (IBM). This litany of names is significant, the level of 'organizational' engagement in the work became evident though their willingness to take leadership roles. Note that corporations might have different strategies for supporting individuals in leadership roles. Some may have a strong interest in promoting the work, others in directing it in a specific direction, or others in holding it up to minimize possible conflict with their business strategies. UniForum carried forward complementary work on Internationalization (I18n as it was known.) This work and the test methods, along with the security work did much to inform the main line API and Shell & Tools work of defects in the form of ambiguity, security flaws and globalization/localization needs. Table 4 outlines the list of standards activities in the Portable Applications Standards Committee (PASC) over the years.

In 1986/7, AT&T started to roll out their System V Interface Definitions (SVID) and test suites. This created a tension between the "private" specifications of AT&T -- SVID and ownership of the UNIX trademark -- and the question of what the reference specification should be. A U.S. Air Force procurement (AFCAC 251) for an SVID based system was challenged by Digital (who was a supplier of BSD in their main line product, Ultrix). While the challenge was not successful it became clear that the stakes were becoming significant and the government procurement process would benefit from adoption of procurement guidelines. NIST set the stage for a Federal Information Processing Standard (FIPS)[7], hoping to target it on a 1988 "Full Use" version of the standard. (At this point the "Trial Use" status became more of a problem.)

In Europe the X/Open group started to formalize their organization, with Digital Equipment joining as the first "US headquartered" company to join[14]. Note the orientation of this group towards the AT&T implementation, and Digital towards the BSD version. X/Open was able to obtain concurrence from AT&T to build their specifications on SVID, and proceeded ahead with that publication. X/Open used a high annual fee, along with concurrence of the current members as a means maintain an exclusive membership, forming a 'major vendor only' fraternity[15]. With the introduction of the 3B2 computer systems from AT&T, they also joined X/Open (as did HP, Sun and IBM).

The user community was taking a stronger interest and getting concerned over the apparent divergence of the major vendors with one camp moving ahead with SVID another with BSD while playing in the POSIX game. Compromise was sought in two areas: identification of differences between SVID and POSIX, and elimination of duplication between the X3 C language committee and the POSIX API. The final resolution was to eliminate as many SVID deviations as possible from POSIX, and then introduce "options" that would permit SVID or BSD conformance (some options being mutually exclusive.) The resolution with the C language activity was much cleaner; the IEEE relinquished all areas of overlap based on the principle that the C language would be more broadly implemented than POSIX.

> Key Point #4: The introduction of "options" resolved a schism in industry, but formalized divergence within the standard. This frustrated users.

4. 1988 – Full Use

The approval of the full use version of POSIX corresponded with FIPS 151, creating a solid U.S. Government alignment with the standard. The FIPS 'selected' from the POSIX options, reducing the viable range of variations. Harmonization activities within the

[9] Roger worked for NBS/NIST until they withdrew from standards leadership, and moved to Sun Microsystems.

[10] Donn was with HP. He moved to Softway Systems; which was developing a POSIX environment subsystem for NT and was later acquired by Microsoft Corp.

[11] Jim Isaak worked for Charles River Data Systems (68000/Unix Compatible OS supplier), and moved to Digital Equipment in 1987, continuing as chair of the POSIX work in both IEEE and ISO.

[12] While UNIX was not known for it's real time capabilities, the interest in this grew out of both process control communities and the Department of Defense. The Joint Fighter project community evaluated various alternatives and selected the POSIX.4 activities as their target for implementation.

[13] One constraint with military officers is that they often have a rotation of duty every two years that precludes their continuing involvement.

[14] Jim Isaak was one of Digital's first representatives to X/Open, and participated in the incorporation of that organization on it's first Board of Directors.

[15] A four hour, 6 course lunch at the Henry the VI pavilion near Paris, or a few days in a villa in Tuscany were a sharp contrast in meeting venues and style between the X/Open Board and the IEEE's "yet another Marriott Buffet" operating models. Most of the X/Open Board members had titles like "director" or "Vice President", and tended to be from marketing, not technical organizations, and to my recollection, all were male.

WG15 group resulted in concurrent progression to draft international standard status. The model adopted at that level called for resolution of any significant international objections by means of a rapid amendment to the IEEE documents. IEEE also made arrangements to provide for the publishing of the documents (having selected an A4 page size for the IEEE version as well.) This version also contained conformance clauses that defined both "system" conformance and "application" conformance.

Three major challenges facing the POSIX movement started to emerge. First, an API specification, even in combination with the C language standard was not sufficiently rich to establish a viable operating environment for complex applications software. Second, the Macintosh, fledgling Microsoft Windows and the X Windows system pointed to the value of a windowing based environment. Third, the limitations of source code portability started to emerge: applications vendors did not want to implement, test and support software on an unbounded set of platforms.

In this time frame Sun and AT&T announced a partnership which raised significant concerns among other players on how the next set of reference interfaces might be manipulated to specific corporate advantage (or disadvantage.) HP and Digital initiated a counter movement, the Open Software Foundation (OSF)[16]. OSF sought to address the evident concerns of the user and applications community by both endorsing a specific suite of standards (or profile as they were becoming known, a concept evolved out of the OSI world), including Motif for windowing; and also collaborating on engineering a specific implementation that would eliminate options and divergences in the code base. It is important to realize here that this is still not 'binary compatibility'; incompatible processing platforms would host the OSF implementation.

To address the window environment for applications Sun started to promote "Open Look", a higher level set of "widgets" based on the X-Windows system. Digital and HP joined forces with their related work, and proposed the "Motif" graphical user interface (GUI) environment. Corporations started to take sides, splitting the X/Open community (vendor based) and the POSIX community (individuals, but with strong vendor alignment). These "GUI Wars" strained the good will of participants, resulting in some meetings that relied more on Roberts Rules than consensus[17]. [2] The user community, applications development community and government folks all communicated a strong desire to have the two camps come together on a single windowing interface.

The OSF was both divisive and ultimately decisive in bringing together the diverging windowing approaches. IBM joined just prior to announcement, with the caveat that their operating system kernel be used as the core technology. Others from the X/Open community joined as well. The users who had viewed the BSD/SVID compromise as a frustration now faced an OSF/Sun-ATT supplier split with the same concerns. Applications vendors found little solace in the hope that they might find the world reduced to two operating system bases on however-many processors.

X/Open sought a 'common ground' role and considered the promotion of a set of "binary platform' interfaces. Essentially the selection of a group of specific processors and API profiles which would be used to define a limited number of binary targets. In theory an applications supplier could provide a single product with multiple binary images, one for each in the set they choose to support. A UK initiative called "ANDF" (Architecture Neutral Distribution Format) to define an intermediate code that could be targeted by all vendors was proposed (but fell by the wayside over time.)[18]

These divisions and battle lines emerged five years after the standardization efforts started, and concurrent with the establishment of major user demand (US Government FIPS, GM, Boeing, et al.) Vendors had identified user interest in this "open systems" concept, but not really embraced the level of interoperability that the users sought. The IEEE and /usr/group models of individual participation were strongly influenced by the employer's who were paying their way. However, it is significant that the individual relationships built up over the prior years often formed substantial ties that spanned vendor differences. It started to become evident that individuals were changing employers, but not standards involvement (as indicated in a number of the footnotes.) The 20 or so cumulative weeks the individuals had spent together (morning, noon and night), building trust and reciprocity, often establishing closer ties than those in the shifting cubicle and management contexts of their jobs [9].

[16] Jim Isaak was also part of the initial meetings in which the creation of OSF was initiated.

[17] While Cargill suggests the PASC activity was dominated by this level of formality, I strongly disagree. The relatively rare situations where Roberts Rules were invoked reflected significant, and mostly "corporate interest" divergence. The vast majority of decisions were taken "without objection." The vendor consortia route avoids this by initially limiting participation to concurring vendors, X/Open and OSF being examples of this "consensus by exclusion" process.

[18] This is the second major step towards true portability, from UCSD Pascal and followed by Java and .NET.

> Key Point #5: Individuals establish relationships in the standards process. This is true in corporate sponsored work, but more readily assured with individual membership activities (since you can change companies and retain your involvement). The interpersonal influence on standards is generally undervalued, particularly by those who have not experienced the environment. Much of this parallels the development of "Social Capital", as outlined in Robert Putnum's "Bowling Alone"[16].

Chairs of the 1003 committees held a vote on the Sponsor Executive Committee (which I chaired). This body became the focal point for areas of vendor dissention. Part of the challenge of managing that group, particularly in bringing new members to the table, was identifying a reasonable balance between various camps while assuring we had significant vendors at the table. A simple example was the appointment of administrative roles to engage targeted players: we had Dale Harris from IBM as logistics chair, at a time when IBM did not hold another seat.

5. 1990 – The Great Divide

The April 1990 (Snowbird) meeting was the peak of POSIX's independence. Vendors realized that new committees were being formed to address niche markets and that these could be rolled into specifications users might blindly require. A motion was made that basically sought to curtail the potentially unbounded expansion of 1003 projects. It established criteria for new projects, and formalized concepts such as "existing practice" which had previously been considerations, but not constraints[19].

The "GUI" war (Motif/Open-Look) reflected many of these elements. At the time of Jespersen's coverage [11] of this, the war were barely over but he does raise many of the key points. I suggest this was a battle of three parties, not two: the Motif camp, the Open Look camp, and the users. The strategy in the Motif camp was to advocate for multiple standards: define them and let the market choose. In reality there were users who asked for that option and implied they would select Motif. The apparent strategy of the Open Look camp (recall my employer was on the Motif side so I do not have first hand insight into the alternate strategy) was to delay standardization, often citing the concern of "premature" standardization or "existing practice." It was my perception that the intent was to develop greater market share (on both sides) so the final standard would be an endorsement of the winner. Note that the user (and applications developer) communities strongly urged the vendors to deliver a single target environment. At the beginning of this battle, Windows was not a viable competitor in either terms of maturity, or the capability of the PC platforms on which it ran; by 1995 this picture was changing, and UNIX vendors started to get a glimpse of the real competition. Even a small percentage of the hundreds of millions of Windowing PC's sold after 1990 would have expanded the UNIX market significantly. This could only have happened if POSIX systems had captured the high end windowing applications before the WinTel systems caught up.

Also in this time frame two additional 'criteria' were established for 1003 projects: Test Methods, and Language Independent Specifications (LIS). NIST was the driving force behind testing. They were funding POSIX validation suites and chairing the system interface test methods work (P1003.3). The test method work was surfacing ambiguities that formed an essential 'quality assurance' value for the work, as well as providing users with a level of confidence in conformance.

The language independence was driven more by academic interests involved in the ISO JTC1/SC22/WG15 work. In part this was a compromise in response to a "competing" effort in ISO (Open Distributed Processing, ODP); as well as some a level of concern about Japanese activities on the Systems Software Interface (SSI) which sought to span the full gambit of interfaces needed for applications (POSIX, windowing, but also database, etc.). Intellectually these approaches made much sense. But they ran counter to the "existing practice" mantra that the IEEE groups had adopted, and the pragmatic concerns of vendors who were funding a significant expense in both standards participation and the effort to implement these in products. At the April 1990 meeting we tried to estimate the overall annual cost, our initial estimate of $15, million a year was doubled by Dale Harris of IBM who indicated they were expending that much alone. A few years later in the process, these requirements were abandoned, but not before a systems interface document was established in this form, and an effort at a more formal "Z" specification was attempted.

In June 1991, a community of users referred to as "SOS" had their CEO's send letters to their suppliers outlining the kind of open systems environment they expected to have available. Needless to say, when Ken Olsen (then CEO of Digital) gets ten identical letters from CEO's of fortune 500 companies that indicate a preference for a given computing environment it does get corporate attention. This environment paralleled the "OSF" suite, the suite of standards identified in 1003.0, the X/Open Open System Environment documents, etc. A question asked cynically at the time (not to those CEO's as far as I know) is "that's nice, but if I sell it for 20% less will you abandon your request for conformance?" There is every indication that this question was answered in the affirmative as those companies abandon their standards based ideals for PC's

[19] Specific criteria included: Existing industry experience, base document, realistic scope, expecting a comparable level of acceptance, integration plan, demonstrable interest in moving work forward, within the scope of PASC, appropriate timeframe (considering impact on meeting management, etc.), provide addendum for inclusion in P1003.0 document.

that sold for less, purchased directly by individual departments. Table 2 outlines major user organizations, ad hoc and formal, formed to drive vendors towards viable open systems.

6. 1993:Winning the Battle- Losing the War

The GUI war came to an abrupt end when SunSoft President, Ed Zander, announced to his troops that they would support Motif and join OSF. [1] Ed was probably painfully aware that the battle had only lead to user alienation, and perhaps could see the specter of Microsoft on the horizon as well. By this time the two standards strategy had been initiated using the ultimate reality that there is more than one standards forum in the world. Failing to get the PASC SEC to accept projects in this area, the Motif folks (quickly followed by the Open Look folks) went to the Computer Society Standards Coordinating Committee[20] and had projects approved. One project lost in this battle was an effort from Sun's Lin Brown on "drivability". Lin was looking at the human factors value of consistency in GUI interfaces and was advocating this as a bridge between Motif and Open Look. Ironically, if Lin's effort had completed with the appropriate adoption it would have provided a basis for ease-of-use spanning UN*X [21], Mac and Windows systems.

The P1003.0 project, "Open Systems Environment" reflected the need for a more comprehensive suite of capabilities than just the operating system. Al Hankinson of NIST co-chaired this with Kevin Lewis of Digital. The focus was on both the question of what "defines" an open system environment, and then a guide for users on how to describe it. This group worked for some time on a definition, which continues to show up beyond the POSIX arena. The group also tried to develop a "model", following after the "OSI" concept (and influenced in part by the Japanese SSI effort.) Perhaps a major value of this effort was to provide a forum for dialog among representatives of major user organizations[22].

7. Changing of the guard: post 1995

A gradual decline in PASC participation became evident as vendors consolidated and X/Open started to become the forum for the limited technical evolution of the standards [19]. PASC retained an ongoing role in complementary work: threads, the Ada and Fortran bindings and even the language independent specification. New projects were denied the "1003" and "POSIX" designations, and in general were discouraged by the 'overhead' that the PASC SEC had adopted. The language independent and test methods restrictions were eventually rescinded. NIST abandon its role in IT standards rather abruptly with a change of management. This affected both leadership involvement in PASC, but also the perception (and perhaps reality) of US Government commitment to open systems. The new government mantra was "commercial off the shelf" (COS) an euphemism for WinTel systems in many cases. DoD remained the strongest user or government voice in PASC. While DoD was an advocate of COS, they also recognized that mission critical systems, secure systems, and other objectives were better suited to the POSIX environments.

The "Layered" POSIX implementations emerged in this timeframe as well. Digital announced "Open VMS" with a POSIX conforming implementation. IBM provided a similar capability in MVS, and even Microsoft delivered a level of POSIX conformance with NT. The interpretation process for POSIX (formal requests to determine what the standard required) was triggered in this last case when NIST (before its retreat from the field) tried to find out if a "single user" was a legitimate implementation. This was based on the NT system where no support was provided for multiple user id's. As a result, validation tests (run by NIST at the time) were not able to verify if some of the interfaces that returned user id's were conforming. The PASC interpretations process evaluated the standard and determined that it did not require support for multiple user ids, providing NT with its certification, albeit an instantiation of a "wierdnix" model[23]. Quite telling was the response of the PASC (and X/Open) groups in this case. Rather than "fix" this with a revision to the standard, which would have been easy, they declined to make that change..

Lowell Johnson of Unisys took over as chair of PASC in 1995. Collaboration between PASC and X/Open led to an agreement that the POSIX component of X/Open would be developed via a joint, and eventually X/Open hosted forum. The elements of POSIX that were not in X/Open's environment were left in POSIX, but with limited support. The one exception in part was the DoD support for real time related extensions that they targeted for mission critical applications. For example, the Joint Strike Airframe project adopted POSIX with real time as the development environment and the Air Force ran proof of concept evaluations to verify that this would meet their needs.

As POSIX based products were maturing, vendors moved from "no additions" to "no substantive changes" to "we don't want to even change the documentation" constraints on the evolution of the work. Clearly this put a

[20] In 1997 Jim Isaak became the Computer Society VP for Standards, under which this forum operated.

[21] The UNIX trademark of AT&T was closely protected and not given over to the POSIX effort. It was transferred via Novell to X/Open, and finally became "implementation independent" via that route. As a result vendors had to call their systems by other names (Ultrix, Xenix, UNOS, Solarus, HPUX, AIX, etc.) The catch phase for these was "UN*X" in a thinly veiled .effort to avoid misusing the trademark.

[22] Others might suggest that getting the marketing folks (the "suits") out of the technical discussions was a benefit.

[23] Wierdnix was a concept developed by Donn Terry after the 1986 standard. He held a contest for the most pathological conforming implementation concepts as a way to identify gaps in the specifications.

cap on changes of the core standards to respond to new requirements. The tsunami of Microsoft Windows swamped much of the low end market, and washed right up into the midrange systems. At the end of the 90's, the traditional vendors were cutting back with major layoffs and cost reductions. Standards activities were cut back in IBM, Digital, HP and NIST. The counter trend was in Sun and Microsoft where experienced standard folks moved in that window of time. In 1998 the Austin Group was formed to coordinate the evolution of the "Single Unix Specification", providing a forum for the individual (POSIX) and Corporate (X/Open) involvement and publishing a single resulting document.

The other significant events impacting the viability of the POSIX work that emerged in this timeframe were viable windows systems from Microsoft, and the Linux open source implementation of POSIX[13]. The failure to deliver windowing[24] with POSIX in the late eighties drove applications suppliers to the single implementation platform (operating system and microprocessor) Microsoft environment. Lower prices brought users to the same target. This triggered a downward spiral in the demand-for and evolution-of POSIX. The 90's were the infancy for Linux with limited commercial visibility. The significant portion of the web server market currently held by Linux reflects advantages that POSIX held over Windows NT in the 90's in terms of multi-tasking, multi-user security concepts and communications interfaces.

8. The Future: Applications Portability, The Holy Grail

The opportunity to meet the POSIX objective of applications portability surfaced again as Sun put forward their Java language. As noted before, real portability needed to address "binary compatibility". Prior attempts -- UCSD Pascal and ANDF -- did not have the requisite processor power. PASC refused to pursue Java standardization without Sun's endorsement. Sun chose a more closely controlled model for promoting that work [6], a methodology that might not match guidelines for "volunteer consensus standards" [12, 14, 15]. Java was un-rivaled for six years until Microsoft brought forward .NET. However Microsoft concurrently introduced .NET and formal standards for the C# language and the .NET common execution environment through ECMA and ISO [4, 5]. At this point it would appear that the .NET environment provides the standards that may be vendor independent, processor independent and provide applications portability at a "binary like" level. At the same time, Linux with its open source methodology and wide use in selected markets is the flagship for the evolution of UNIX based applications portability. Unfortunately there is little interest in using LINUX to drive the evolution of the formal POSIX specifications.

[24] For a simple economic computation – POSIX systems tended to be at the high end of "PC" pricing ($3000+), with a single windowing standard and related applications some share of the one hundred million PC's sold between 1988 and 1995 would have gone to those systems. A one percent share would be in the ten billion dollar revenue arena.

9. Lessons Learned & Conclusions:

The PASC/POSIX experience yields a number of key lessons that can be applied to other projects.

1) Standards (at least voluntary consensus standards) require user demand as well as vendor support. Having a major buyer who is known to 'enforce' their procurement guidelines endorse an area of work is an asset. (The role of government in standards setting/procurement is a matter of ongoing debate, perhaps more in the U.S. than Europe. [3, 10]) User demand, ideally in the form of declared intention and subsequent purchasing, with real market potential is essential to engage and maintain vendor participation and commitment.

2) Industry buyers today will select lower costs over standards conformance, even where conformance might yield long term savings. This suggests that governments who seek the longer term benefits of standardization may need to directly invest in funding the work as well as motivating suppliers through purchasing or regulation.

3) Individual relationships are the core of many standards activities; when membership is individually based it creates opportunities for continuation beyond the commitment that a single employer may be willing to make.

4) Formal standards can be delivered fairly quickly (15 months for the initial POSIX work: "let's go" to "published") it takes resources, and either ignorance or acceptance by vested interests.

5) Aggressively pursued corporate interests (as in the GUI wars) can disrupt progress, discourage participants, and disparage forums. [1] Worse, these can drive away users and significantly reduce the business opportunities for the disparate interests.

6) Repeated standards wars, such as the recurrent clashes between Sun and Digital [1] can undermine opportunities for future beneficial collaboration.

7) Process mandates -- "existing practice", "test methods", "language independence" and even "internationalization" -- are obstacles for rapid progress and response to evolving market needs. Vendors cite these as rationale for creating new consortia.

8) An ongoing commitment to the end result is essential to the evolution of a standards effort. PASC abandon their application portability focus by not pursuing ANDF or Java.

References:

[1] Cargill, Carl; Section 2: Sun and Standardization Wars ; *StandardsView* Vol. 5, No. 4; Dec. 1997

[2] Cargill, Carl; Evolution and Revolution in Open Systems; *StandardsView* Vol. 2, No.1; Mar. 1994

[3] Dawson, Rhett; Considering a U.S. National Standards Strategy: Building a Framework for Success*; Open Systems Tracking Report* Vol. 8, No. 1; Jan 1999
[4] ECMA 334; C# Language Specification; http://www.ecma-international.org; Dec. 2002; (now also ISO/IEC 23270)
[5] ECMA 335; Common Language Infrastructure (CLI); http://www.ecma-international.org; Dec. 2002; (Now also ISO/IEC 23271)
[6] Egyedi, Teneke M.; Why Java was – not – standardized twice; *Computer Standards & Interfaces* 23; 2001
[7] FIPS 151; Proposed Federal Information Processing Standard for UNIX Operating System Derived Environments*; Federal Register,* Vol. 51, No. 168; Aug. 29, 1986
[8] IEEE and PASC Standards Status Information; http://standards.IEEE.org [general], www.pasc.org [history]
[9] Hurd, John; Isaak, Jim; IT Standardization: The Billion Dollar Strategy; *International Journal of IT Standards and Standardization Research* (JITSR) vol. 3, no 1, Jan - June 2005
[10] Isaak, Jim; The Role of Government in IT Standards*; IEEE Computer*; December 1998; pp 129,132
[11] Jespersen, Hal; POSIX Retrospective; *StandardView* Vol 3, No. 1; Mar 1995; pp 2-
[12] Krechmer, Ken; The Need for Openness in Standards*; IEEE Computer*; June 2001; pp 100-101
[13] Linux International, Linux History; http://www.li.org/linuxhistory.php
[14] OMB Circular A-119; "Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities"'; Feb. 10, 1998 (revised)
[15] Public Law 104-113 (Directs Federal agencies to use technical standards developed by voluntary consensus bodies); National Technology Transfer and Advancement Act; 1995
[16] Putnum, Robert; *Bowling Alone*; Simon & Schuster; 2000
[17] User Alliance for Open Systems; *Overcoming Barrier to Open Systems Information Technology*; Jan 27, 1991
[18] Unter, "The Importance of Standards to HP's Competitive Business Strategy", *ASTM Standardization News*, Dec. 1996
[19] Walli, Stephen; "The POSIX Family of Standards"; *StandardView* Vol. 3, No. 1; Mar 1995; pp 11-17

Table 1: POSIX Timeline

1981 & 1983	/usr/group IEEE initiate individual expert based standards forums for developing a UNIX based operating system API.
1984	This work is consolidated into IEEE, and embraces the concept of "implementation independence" (acknowledging Version 6/7 AT&T UNIX, BSD, and independently developed compatible products.)
1985	IEEE publishes a trial use standard, and NIST takes a formal interest in testing with the intent to create a government procurement guideline.
1988	IEEE generates a Full Use standard NIST delivers the FIPS procurement guideline and test suite, Industry forums emerge for vendor driven standardization and user procurement Vendor divergence on windowing interfaces, the "GUI Wars" delay essential open systems capability for five years.
1990	vendor initiated 'guidelines' established to limit growth of POSIX.
1991	Linux started as POSIX based initiative [Linux International]
1995	VMS, MVS and Windows NT delivered POSIX conforming interfaces.
1998	Austin Group formed to manage evolution of POSIX in collaboration with the Open Group.

Table 2: Open Systems User Consortia Events & Players

Group	Time Frame	Participants
MAP/TOP (OSI networking focused, not OS oriented.)	1985	GM, Boeing, NIST, AB, Honeywell, Gould, ASEA, ACC, Concord Data Systems, DEC, IBM, ATT, HP, Motorola, Intel, Siemens, CRDS
Atlanta 17 and Houston 30 Transformed into the User Alliance for Open Systems, [User Alliance, 1991] [17]	1990	BP, McDonnell Douglas, 3M, Rockwell, GE, Eastman Kodak, John Deere, Merck, NIST, Raytheon, Boeing, DRM, Hughes, Gulf Canada, US Air Force, CAM-I, GM, Conoco, Upjohn, Texaco, ITI, ABB Lummus Crest, Sematech, Perley Technologies, DuPont, Exxon, Amoco, NASA, Transport Canada, Tennessee Eastman, Ford
Dallas Round Table (Hosted by X/Open User Council)	1991	Corporation of Open Systems, European Forum for Open Systems, European Telecommunications Information Services, Federal Open Systems Council, International Government forum for Open Systems, International Public Sector IT, PetroTechnical Open Software Corporation, UniForum US, UniForum Canada, UniForum New Zealand, Uniforum South Africa, Uniforum UK, User Alliance for Open Systems, X/Open User Council
"SOS" Letters to Vendors	June 1991	American Airlines, Du Pont, GM, Kodak, McDonnell Douglas, Merek, Motorola, 3M, Northrop, Unilever

Table 3: UNIX Related Standards/Specifications Organizations

Current Name	Former Name(s)	Founded	Membership & Results	Initial Incentive
Uniforum	/usr/group	1981	Individual experts Initial "UNIX" standardization	Commercial UNIX foci Common Ground: System III and BSD UNIX
PASC: Portable Operating System Standards Committee	TCOS SC: Technical Committee on Operating Systems Standards Committee	1983	"individual expert" 24+ POSIX projects	Formal Standard for /usr/group work (using IEEE Computer Society sponsorship)
The Open Group	X/Open (and "BISON")	1985	Corporate Consortium "X/Open Portability Guide", UNIX trademark	Initially "System V" and "European Mnfg's"
ISO/IEC JTC1/SC22/WG15		1987	International – "National body"	Intl adoption of IEEE POSIX
Open Software Foundation	OSF (The Hamilton Group)	1988	Corporate Consortium (merged into X/Open)	DEC/HP counter to SUN/AT&T initiative and MOTIF GUI advocates
Unix International	(The Archer Group)	1988	AT&T lead response to OSF formation to promote SVID	
The Austin Group		1998	Forum to facilitate PASC, X/Open, WG15 collaboration Generating "the Single UNIX Specification"	

Table 4: PASC/POSIX Projects 1983-2000+[8]

PASC Project Number/year	Topic area	Initial Chair/Corporate relation	Results
P1003.0 – 1987 [Also ISO/IEC 14252]	Open Systems Guide	Al Hankinson, NIST Kevin Lewis, Digital	Published 1995
P1003.1 – 1983 [also ISO/IEC 9945-1]	C Language API	Jim Isaak, Charles River Data Systems	Trial Use 1986 Multiple revisions
P1003.2-1986 [Also ISO/IEC 9945-2]	Shell and Tools Environment	Hal Jespersen, Amdahl Don Cragun; Sun[25]	Full Use: 1991 Multiple Revisions
P1003.3 – 1986	Test methods for .1	Roger Martin, NIST	Full Use: 1996 (as 2003.1)
P1003.4 – 1987	Real Time API	Bill Corwin, Intel	Integrated into 1003.1 as 1003.1b [1993]
P1003.5 - 1987 [w/subsequent real time extensions: .5B and .13a]	Ada Bindings	Terry Fong, US Army	Full use 1992
P1003.6 – 1987	Security API	Jeanne Baccash, AT&T	Mirved[26] into P1003.1e and .2c
P1003.7 1989	Administration	Steve Carter, Belcore	Mirved into P1387 (3 parts)
P1003.8 – 1989	Networking API	Dave Dodge, Oracle	Mirved into P1003.1f
P1003.9 – 1989	Fortran Binding	Dan Magenheimer, &	Full Use 1992

[25] Don started his POSIX activities with the very first meeting, then working for MicroPort Systems

[26] "Mirved" is a term suggesting the concept of nuclear missiles with multiple warheads in a single nose cone; the term was introduced as we tried to combine multiple standards projects and groups back into their logical documents. In many cases this consolidated things, in some cases it generated new project numbers.

		John McGrory, HP	
P1003.10 – 1989 ISO/IEC 15287	SuperComputing Profile	Karen Sheaffer, Sandia	Full use 1995
P1003.11 – 1989	Transaction Processing Profile	Elliot Brebner, Unisys	Withdrawn Draft available
P1003.12 – 1990	Network API	Les Wibberley,	Full use 2000
P1003.13 - 1990	Real Time Profile	Susan Corwin, Intel	Full use 1998 Multiple revisions
P1003.14 – 1990	Multiprocessor Profile	Bob Knighten, Encore	withdrawn
P1003.15 - 1990	Batch Services	Karen Sheaffer, Sandia	Full use 1995
P1003.16 - 1991	C Language Bind	Donn Terry, HP	Reverted into .1
P1003.17 - 1991	Directory Services	Robert Spade, Motorola	To 1224.2
P1003.18 - 1991	Traditional UNIX profile	Donn Terry, HP	withdrawn
P1003.19 – 1993	Fortran 90 binding		withdrawn
P1003.20 – 199	Ada real time		Mirved into .5
P1003.21 - 199?	Real Time Comm.	Craig Meyers, SEI/CMU	withdrawm
P1003.22 – 1993	Security Framework	Lynne Ambuel, DoD	Withdrawn
P1003.23 - 1997	OSE Guide	Sandra Swearingen, USAF	1998
P1003.24 - 1996	Ada binding for X/Windows		widhdrawn
P1003.25 - 1998	Fault tolerance	Helmet Roth, DISA	Mirved out of P1003.1h, withdrawn
P1003.25 - 2000	Device API's		
P1201.1 – 1989	Windowing	Sunil Metha, Convergent Technologies	withdrawn
P1201.2 – 1989	GUI Useabilty	Lin Brown, Sun	withdrawn
P1224 - 1991	X400 API	Steve Trus, NIST	Full Use 1993
P1237- 1990	RPC API	Ken Holiday	Moved to X3
P1238.1 - 1990 P1238.2 – 1990 1251 - 1994 1253 - 1994	OSI API FTAM API ACSE LIS ACSC C language	Kester Fong, NIST	Full Use 1994 Full Use Full Use
P1295.1 - 1992 P1295.2 - 1992	MOTIF/GUI Open Look/GUI	John Hurd, Digital Dave Bealby, Sun	Full use 1993 withdrawn
P1372 – 1994	Language Independent API	Jay Meyer, Unisys	Withdrawn
P1387 – 1992	Administration	Martin Kirk, X/Open	1995 (part 2)
P1494	National Profiles	Keld Simonsen	Withdrawn
P2000.1 - 1997	Y2k Terms	Kevin Lewis, Digital	Full Use 1998
P2003.2 – 1990 [Orig. P1003.3.2]	.2 Test methods	Ray Wilkes, Unisys	Full Use: 1996