HOW MANY STANDARDS IN A LAPTOP?
(AND OTHER EMPIRICAL QUESTIONS)

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ABSTRACT

An empirical study which identifies 251 technical interoperability standards implemented in a modern laptop computer, and estimates that the total number of standards relevant to such a device is much higher. Of the identified standards, the authors find that 44% were developed by consortia, 36% by formal standards development organizations, and 20% by single companies. The intellectual property rights policies associated with 197 of the standards are assessed: 75% were developed under “RAND” terms, 22% under “royalty free” terms, and 3% utilize a patent pool. The authors make certain observations based on their findings, and identify promising areas for future research.

Keywords— standards, SDOs, consortia, intellectual property rights (IPR), RAND, royalty free

1. OVERVIEW

Our effort began with some simple questions: how many standards are embodied in a modern laptop computer? How many of these standards are developed by formal standards development organizations and how many by consortia? What type of intellectual property rights policies – e.g. “RAND” or “royalty-free” – apply to each of these standards?

Answering these seemingly-simple questions proved dauntingly complex. Nonetheless, subject to the limitations and qualifications described in this paper, we were able to reach the following conclusions:

- We identified 251 interoperability standards that are embodied or directly utilized in a modern laptop computer. We focused only on standards that facilitate technical interoperability, and did not count quality, safety, performance, measurement, environmental, accessibility, design process, manufacturing process or electromagnetic compatibility standards. Further, our count of interoperability standards is not comprehensive: we have become aware of significant omissions. Accordingly, we believe our count sets only a floor: a modern laptop embodies or utilizes at least 251 interoperability standards, but the actual number is certainly much higher (the authors would be unsurprised by a total number of 500 or more). Including other types of relevant standards, such as environmental or safety standards, in addition to interoperability standards would further raise the count dramatically.

- Of the 251 standards we identified, 112 (44%) were developed by consortia, 90 (36%) by formal standards development organizations, and 49 (20%) by individual companies (see Figure 1).

- We were able to allocate 197 of the 251 standards into one of three broad intellectual property model categories: RAND, RF or patent pool (we lacked sufficient information to categorize the remaining 54 standards). Of the 197 we categorized, 148 (75%) were RAND, 43 (22%) were RF, and 6 (3%) utilized a patent pool (see Figure 2).

In order to meaningfully assess our data it is imperative that readers understand our terminology and our methodology. These are described in Section 2, below. Section 3 highlights some limitations of our approach, and identifies some gaps in our research. Section 4 explores some preliminary observations and conclusions based on our data. Section 5 identifies opportunities for further research. Finally, the appendix contains a table listing the particular standards we identified and the values we assigned to each.

2. TERMINOLOGY AND METHODOLOGY

We began by examining the specifications of various current-generation laptop computers produced by different manufacturers, and developing a vision of a composite, hypothetical laptop that drew from the features of each. We also gave ourselves some flexibility to include a few features that are widely expected to be included in laptops in the imminent future (e.g. hi-definition wireless display capabilities).

Next, we created a set of broad categories – display, graphics, sound, storage, BIOS, input device, processor, power, file system, networking, wireless, I/O ports, memory, software, codecs, content protection, security and “other” – and sought relevant standards. Using a variety of methods, including interviews with experts and extensive primary research, we identified standards in each category.
that would be embodied in or directly utilized by our hypothetical laptop computer.

For our purposes, “standards” included not just standards developed by formal standards development organizations like ISO, but also industry specifications developed by consortia like PCI-SIG. We also encountered a number of specifications intentionally promulgated by a single company for broader industry adoption, and we counted these as “standards” as well. We limited our count of company-promulgated standards to those that a company intentionally and specifically made available for adoption as an industry specification; we did not include proprietary technologies that have significant market share but that are not otherwise intentionally made available for industry adoption.

As noted in the introduction, we focused only on standards that facilitate technical interoperability, and did not count quality, safety, performance, measurement, environmental, accessibility, design process, manufacturing process or electromagnetic compatibility standards.

We identified the developer/promoter of each standard as either (a) a formal standards development organization or “SDO,” (b) a consortium, or (c) an individual company. For this step we utilized the taxonomy suggested by the IPO Standards Setting Committee in their 2009 “Standards Primer” document. [1] We counted as SDOS: (a) the “Big I” international standards organizations (ITU, ISO, IEC), (b) the “Little I” international organizations (IEEE, ASTM), (c) government-sanctioned regional bodies such as ETSI, (d) government-sanctioned national bodies, such as BSI, and (e) organizations sanctioned or accredited by a national body, such as all of the ANSI-accredited organizations (e.g., JEDEC, TIA). All other group-focused specification-development efforts were classified as “Consortia.” The consortia category contains a wide variety of different groups, ranging from formal organizations like the W3C to very informal open source development efforts. We called specifications created by single commercial entity “Company” standards.

Assessing the intellectual property rights (IPR) policies associated with each standard proved difficult. Many IPR policies were extraordinarily complex. Further, IPR policies for some organizations were not publicly available, leaving us to rely on second-hand accounts or draw inferences. Noting some risk of oversimplification or error, we allocated each standard to one of four broad categories:

- **RAND.** This category included standards that were developed under RAND or F/RAND terms – (fair,) reasonable and non-discriminatory patent license commitments, without precluding the option of patent owners collecting patent royalties for essential patent claims. If a SDO or Consortia permitted a RAND option, even if it contemplated other options as well, we included it in the RAND category. We note that the fact that an IPR policy permits collection of royalties does not mean that parties in fact collect royalties.

- **RF.** This category included standards that were created under terms that prohibit the participating companies or individuals from collecting patent royalties for essential patent claims (usually subject to important limitations). For our purposes, IPR models such as “RF-RAND” (royalty-free RAND) and “RAND-Zero” (RAND with zero royalties) fall into this category. We also included standards with IPR policies that rely on promises not to assert essential patent claims here. Note that our designation of a standard as RF does not mean that the standard is in fact royalty free to implement, as entities not bound by the IPR policy could assert patents, for example.

- **Patent pool.** The term “patent pool” is sometimes defined in a way that would sweep in virtually any RAND or RF IPR policy, but for our purposes we adopted a narrow definition. We focused on the scenario where a specification is made available subject to execution of a license agreement, and that license agreement conveys a license to patents pooled by multiple parties. The DVD specifications provide an example.

- **NA (“not available”).** In 54 of our 251 cases we simply could not determine the intellectual property policy associated with a particular standard. Figure 2 below includes only the 197 bodies that we were able to categorize.

We should emphasize that our taxonomy glosses over a great deal of complexity, including the key issue of whether the RAND or RF promise extends from participants in the standards development process to all implementers or only to those implementers that join the relevant consortia or SDO. For our categorization purposes, either approach sufficed: e.g., if a group required that participants promise to license on RAND terms only to members of that group, with no other license obligation, we counted that group as RAND.

### 3. LIMITATIONS AND GAPS

Our hypothetical/composite laptop approach potentially allows some ambiguity or duplication. For example, we include file systems standards for both Linux and Windows computers, even though in many cases they would not co-exist in a single machine. Likewise, we include wireless display standards that might be competitive rather than co-existing. Focusing on a single, specific “real world” machine would have mitigated this risk. However, our composite approach enabled us to avoid singling out a specific vendor, and enabled us to anticipate soon-to-be implemented standards.
A related point: while our primary focus was on standards that would be fully implemented in our hypothetical laptop, we also included some standards that would be directly used by our hypothetical machine, but that are not necessarily fully implemented on the client side (e.g., basic Internet standards like IPv4, DNS or TCP). This involved some judgment calls and line drawing. Similarly, we included standards related to some basic software applications (e.g., OpenXML), but tried to avoid expanding too far “up the stack” into the software application world.

Another issue: our data are imperfect. The authors bring legal expertise to the table rather than deep technical expertise. Understanding each of our various technical focus areas – display, graphics, sound, storage, BIOS, input device, processor, power, file system, networking, wireless, I/O ports, memory, software, codecs, content protection, security – sufficiently to assess the relevant standards in each area proved challenging. We suspect there are errors of both under-inclusion and over-inclusion in some of our focus areas. Further, we have realized that our focus areas may have been too narrow. For example, battery technologies, biometrics, camera hardware, solid state drives and docking systems standards are currently underrepresented in our list. We will continue to refine and improve the quality of our data set. However, we do not believe that this refinement will dramatically change our observations or conclusions.

4. OBSERVATIONS

The focus of this stage of our effort has been primarily on collecting empirical data rather than interpreting it. However, a set of fairly obvious conclusions are immediately apparent:

• The critical role of standards in ICT. The fact that a modern laptop computer implements or relies on over 250 (and probably closer to 500, we estimate) interoperability standards is remarkable. While certainly no one doubted the importance of standards to the information and communications technology (ICT) industry in the absence of this data, quantifying the volume of standards embodied in a common ICT device is striking. We believe that as technological convergence continues, and ICT devices increasing include elements from the computing, telephony and consumer electronics sectors, the number of relevant standards will only increase.

• The importance of consortia for ICT standards development. Of the 251 standards we identified, only about one-third were developed by formal SDOs. Consortia developed 44%, and single companies developed 20% (see Figure 1). We suspect the dominant role played by the private sector in at least this aspect of ICT standardization will come as a surprise to some policymakers and other standardization stakeholders.

5. NEXT STEPS AND CONCLUSION

As noted in Section 3 above, a key next step for us is to expand our data set and refine our data. We welcome constructive input and will happily make our spreadsheets available to interested parties.
While we utilized a single RAND category, we have noted that in the ICT environment there seems to be two broad subcategories of RAND standards: those for which the de facto reality seems to be a RF environment, and those for which there are active royalty-collection efforts. We believe that it would be interesting to attempt to count the number of standards in each subcategory.

Another promising focus area for additional empirical analysis is an assessment of consortia. For our purposes consortia occupied a single category, but in fact we saw a bewildering variety of approaches among consortia in the course of our research. Identifying different types of consortia, and analyzing the implementation of standards produced by different types, strikes us as a fascinating research question.

Additionally, assessing each of our identified standards against various criteria of “openness,” along the lines of Per Anderson’s recent study [2], could prove quite interesting. Our working theory is that the development and distribution processes associated with a significant percentage of the successfully-implemented standards we identified would not meet typical definitions of openness, transparency or consensus decision-making. If true, this would be an interesting data point to bring into, e.g., current policy debates over “good practices” for consortia, such as the current BSI PAS 98 effort. Further, it would be interesting to consider whether the empirical data could demonstrate either a positive or negative correlation between the “openness” of a standards development effort and its effectiveness as measured by widespread implementation of that standard in the commercial marketplace.

* * *

The academic literature on standardization often bemoans the dearth of empirical analysis of standards. Our hope is that the analysis documented in this paper helps to fill this gap, and enables policymakers, academics, commercial stakeholders and others to better understand ICT standards and industry specifications.

REFERENCES

[1] IPO Standards Setting Committee, Standards Primer: An Overview of Standards Setting Bodies and Patent-Related Issues that Arise in the Context of Standards Setting Activities, 2009 IPO Articles & Reps., Pats. Sec. No. 16 (10/09/2009). Available to IPO members via http://ipo.org; excerpts publicly available at <http://standardslaw.org/seminar/class-2/excerpts-from-ipo-standards-primer/>.

[2] Per Anderson, Evaluation of Ten Standard Setting Organizations With Regard to Open Standards, IDC Study commissioned by the Danish National IT and Telecom Agency, January 2008. Available at <http://www.itst.dk/it-arkitektur-og-standarder/standardisering/abne-standarder/baggrundsrapporter/Evaluation%20of%20Ten%20Standard%20Setting%20Organizations.pdf>.
# APPENDIX:

## LIST OF STANDARDS/SPECIFICATIONS

| Name of standard/specification | Developer | Developer type | IP type |
|---------------------------------|-----------|----------------|--------|
| .NET                            | Microsoft | COMPANY        | NA     |
| 16x9 Notebook Panel ver. 1a     | VESA      | CONSORTIA      | RAND   |
| 3GP                             | 3GPP      | SDO            | RAND   |
| 8P6C/"RJ-45" IEC 60603          | IEC       | SDO            | RAND   |
| AC'97 v2.3                      | Intel     | COMPANY        | NA     |
| ACS-2 [ATA/ATAPI Command Set 2] | T13 INCITS| SDO            | RAND   |
| Advanced Configuration and Power Interface Spec 3.0 | ACPI | CONSORTIA | RAND |
| Advanced eXpress I/O Module [AXIOM] | ATI | COMPANY | NA |
| AES (U.S. FIPS PUB 197)         | NIST      | SDO            | NA     |
| AGP                             | Intel     | COMPANY        | NA     |
| AIFF                            | Apple     | COMPANY        | NA     |
| ALC889                          | RealTek   | COMPANY        | NA     |
| Allegro 4.9.19                  | open source project | CONSORTIA | RF |
| ANSI INCITS 207-1991[R2007]     | ANSI      | SDO            | RAND   |
| ANSI INCITS 346-2001[R2006]     | ANSI      | SDO            | RAND   |
| ANSI INCITS 407-2005            | ANSI      | SDO            | RAND   |
| ANSI INCITS 417-2006            | ANSI      | SDO            | RAND   |
| ACPI                            | Intel     | COMPANY        | NA     |
| ASF                             | Microsoft | COMPANY        | NA     |
| Atom                            | IETF      | CONSORTIA      | RAND   |
| AVI                             | Microsoft | COMPANY        | NA     |
| Bluetooth spec.                 | Bluetooth Sig | CONSORTIA | RF |
| Blu-ray Disc Read-Only Format ver. 1 | Blu-ray Disc Association | CONSORTIA | POOL |
| Blu-ray Disc Recordable Format ver. 1 | Blu-ray Disc Association | CONSORTIA | POOL |
| Blu-ray Disc Rewritable Format ver. 1 | Blu-ray Disc Association | CONSORTIA | POOL |
| C                               | ANSI/ISO  | SDO            | RAND   |
| C++ (ISO/IEC 14882:2003)        | ISO/IEC   | SDO            | RAND   |
| CD audio (“Red book”) - IEC 60908 | IEC | SDO | RAND |
| CDROM                           | ISO/IEC   | SDO            | RAND   |
| CIM [Common Information Model] 2.250 | DMTF | CONSORTIA | RAND |
| Cinepak                         | SuperMac Technologies | COMPANY | NA |
| COLLADA 1.5                     | Khronos   | CONSORTIA      | RF     |
| Compact Flash                   | Compact Flash Ass. | CONSORTIA | RAND |
| CSS (Cascading Style Sheet)     | W3C       | CONSORTIA      | RF     |
| CSS (Content Scrambling System) | DVD Forum | CONSORTIA | NA |
| DDR3                            | JEDEC     | SDO            | RAND   |
| Dirac                           | BBC Research | COMPANY | RF |
| Direct Drive Monitor [DDM] v1   | VESA      | CONSORTIA      | RAND   |
| Direct3D 11                     | Microsoft | COMPANY        | NA     |
| DirectCompute API               | Microsoft | COMPANY        | NA     |

| Name of standard/specification | Developer | Developer type | IP type |
|---------------------------------|-----------|----------------|--------|
| Display Identification Data [DisplayID Structure v1.1] | VESA | CONSORTIA | RAND |
| Display Port Panel Connector    | VESA      | CONSORTIA      | RAND   |
| Display Subsystem Power Management | VESA | CONSORTIA | RAND |
| DisplayPort Interoperability Guideline v1.1 | VESA | CONSORTIA | RAND |
| DLNA                            | Digital Living Network Alliance | CONSORTIA | RAND |
| DMI2 [Direct Media Interface]   | Intel     | COMPANY        | NA     |
| DNS                             | IETF      | CONSORTIA      | RAND   |
| DOM                             | W3C       | CONSORTIA      | RF     |
| DVB-H/EN 302 304                | DVB/ETSI  | SDO            | RAND   |
| DVD Multi                       | DVD Forum | CONSORTIA | POOL |
| DVI                             | DDWG      | CONSORTIA      | RAND   |
| DVI 1.0 Spec                    | Digital Display Working Group | CONSORTIA | NA |
| ECMA 262 3rd edition            | ECMA      | CONSORTIA      | RAND   |
| ECMA C#                         | ECMA      | CONSORTIA      | RAND   |
| ECMA CLR                        | ECMA      | CONSORTIA      | RAND   |
| ECMA-378                        | ECMA      | SDO            | RAND   |
| ECMA-384                        | ECMA      | SDO            | RAND   |
| EDD-4 [Enhanced Disk Drive - 4] | T13 INCITS | SDO | RAND |
| EHCI                            | Intel     | COMPANY        | NA     |
| Embedded DisplayPort Standard (eDP) | VESA | CONSORTIA | RAND |
| Ethernet [802.3]                | IEEE      | SDO            | RAND   |
| EXT4                            | open source | CONSORTIA | RF |
| Fat16                           | ECMA      | SDO            | RAND   |
| Fat32                           | Microsoft | COMPANY        | NA     |
| Firewire/1394                   | IEEE      | SDO            | RAND   |
| Flash (FLV, F4V)                | Adobe     | COMPANY        | NA     |
| FMOD                            | Firelight Technologies | COMPANY | NA |
| FTP                             | IETF      | CONSORTIA      | RAND   |
| Guideline for transmission and control for DVD-video/audio through IEEE1394 Bus | DVD Forum | CONSORTIA | POOL |
| Guideline for Transmission and Control for DVD-video/audio through Most Bus | DVD Forum | CONSORTIA | POOL |
| H.263                           | ITU-T     | SDO            | RAND   |
| H.264                           | ITU-T/ISO/IEC | SDO | RAND |
| HDCP                            | DCP       | COMPANY        | NA     |
| HDMI                            | HDMI      | CONSORTIA      | RAND   |
| HFS                             | Apple     | COMPANY        | NA     |
| Standard Name                                      | Organization | Company | Year |
|---------------------------------------------------|--------------|---------|------|
| HFS+                                              | Apple        | COMPANY | NA   |
| HTML5                                             | W3C          | CONSORTIA | RF   |
| HTTP                                              | W3C          | CONSORTIA | RF   |
| HTTPS                                             | W3C          | CONSORTIA | RF   |
| HuffYUV                                            | Rudiak-Gould | COMPANY | NA   |
| IEC 60320                                         | IEC          | SDO     | RAND |
| IEC 60958 type II (S/PIF)                         | IEC          | SDO     | RAND |
| IEEE std. 1212.1-1993                              | IEEE         | SDO     | RAND |
| IEEE std. 1680.1-2009                              | IEEE         | SDO     | RAND |
| IETF RFC 5545 iCalendar                            | IETF         | CONSORTIA | RAND |
| IMAP                                               | IETF         | CONSORTIA | RAND |
| INCITS 370-2004/1510(D): ATA Host Adapter Standards| T13 INCITS  | SDO     | RAND |
| INCITS 437-2008                                    | ISO          | SDO     | RAND |
| INCITS 452-2008/1699: AT Attachment 8 ATA/ATAPI Command Set | T13 INCITS  | SDO     | RAND |
| Intel 64 architecture x2APIC Spec                  | Intel        | COMPANY | NA   |
| Intel AHCI                                         | Intel        | COMPANY | NA   |
| Intel High Definition Audio                        | Intel        | COMPANY | NA   |
| Intel Platform Innovation Framework for UEFI       | Intel        | COMPANY | RAND |
| IPSEC                                             | IETF         | CONSORTIA | RAND |
| IPv4                                               | IETF         | CONSORTIA | RAND |
| ISO 8601 is dates and time                         | ISO/IEC      | SDO     | RAND |
| ISO 9241-300-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-302-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-303-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-304-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-305-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-306-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-307-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-400-2007                                   | ISO          | SDO     | RAND |
| ISO 9241-400-2007                                   | ISO/IEC      | SDO     | RAND |
| ISO 9241-410-2008                                   | ISO          | SDO     | RAND |
| ISO 9241-410-2008                                   | ISO/IEC      | SDO     | RAND |
| ISO/IEC 1064 is Unicode (and utf-8, utf-16)        | ISO/IEC      | SDO     | RAND |
| ISO/IEC 11002:2008                                 | ISO          | SDO     | RAND |
| ISO/IEC 11989:2010                                 | ISO          | SDO     | RAND |
| ISO/IEC 13170:2009                                 | ISO          | SDO     | RAND |
| ISO/IEC 14772-2:2004                               | ISO          | SDO     | RAND |
| ISO/IEC 14776-150:2004                             | ISO          | SDO     | RAND |
| ISO/IEC 15412:1999                                 | ISO          | SDO     | RAND |
| ISO/IEC 15948:2004                                 | ISO          | SDO     | RAND |
| ISO/IEC 19774:2006                                 | ISO          | SDO     | RAND |
| ISO/IEC 19775-1:2008                               | ISO          | SDO     | RAND |
| ISO/IEC 19775-2:2004                               | ISO          | SDO     | RAND |
| ISO/IEC 19776-1:2008                               | ISO          | SDO     | RAND |
| ISO/IEC 19776-2:2008                               | ISO          | SDO     | RAND |
| ISO/IEC 19776-3:2007                               | ISO          | SDO     | RAND |
| ISO/IEC 19777-1:2006                               | ISO          | SDO     | RAND |
| ISO/IEC 19777-2:2006                               | ISO          | SDO     | RAND |
| ISO/IEC 24739-1:2009                               | ISO          | SDO     | RAND |
| ISO/IEC 24739-2:2009                               | ISO          | SDO     | RAND |
| ISO/IEC 24739-3:2009                               | ISO          | SDO     | RAND |
| ISO/IEC 24757:2008                                 | ISO          | SDO     | RAND |
| ISO/IEC 26300:2006 Open Document Format            | ISO/IEC      | SDO     | RAND |
| ISO/IEC 29121:2009                                 | ISO          | SDO     | RAND |
| ISO/IEC 29171:2009                                 | ISO          | SDO     | RAND |
| ISO/IEC 29171:2009 [iVDR spec]                     | ISO          | SDO     | RAND |
| ISO/IEC 29500 Office Open XML                       | ISO/IEC      | SDO     | RAND |
| ISO/IEC 9995-1:2009                                | ISO          | SDO     | RAND |
| ISO/IEC 9995-2:2009                                | ISO          | SDO     | RAND |
| ISO/IEC 9995-3:2002                                | ISO          | SDO     | RAND |
| ISO/IEC 9995-4:2009                                | ISO          | SDO     | RAND |
| ISO/IEC 9995-5:2009                                | ISO          | SDO     | RAND |
| ISO/IEC 9995-7:2009                                | ISO          | SDO     | RAND |
| ISO/IEC 9995-8:2009                                | ISO          | SDO     | RAND |
| ISO/IEC TR 24784-2009                              | ISO          | SDO     | RAND |
| ISO/IEC TR29106:2007                               | ISO/IEC      | SDO     | RAND |
| ISO 32000-1:2008                                   | ISO          | SDO     | RAND |
| JCP JSR 270 Java SE 6                              | Java         | Community Process | RAND |
| Magsafe                                           | Apple        | COMPANY | NA   |
| MATHML                                            | W3C          | CONSORTIA | RF   |
| Matroska                                          | open source  | project  | CONSORTIA | RF   |
| MD5 (RFC 1321)                                    | IETF         | CONSORTIA | RAND |
| Micro SD                                          | SD Association | CONSOR   | RAND |
| MIDI                                              | MIDI Manufacturer s Ass'n | CONSOR   | NA   |
| MIME                                              | IETF         | CONSORTIA | RAND |
| Mini Displayport                                   | VESA         | CONSOR   | RAND |
| MINI-DVI                                          | Apple        | COMPANY | NA   |
| MiniSD                                            | SD Association | CONSOR   | RAND |
| MJPEG (RFC 2435)                                   | IETF         | CONSORTIA | RAND |
| MMS                                               | Open Mobile Alliance | CONSOR   | RAND |
| Monitor Control Command Set [MCCS] Standard v2.2  | VESA         | CONSOR   | RAND |
| MP3 (MPEG-1 Layer 3)                              | ISO/IEC      | SDO     | RAND |
| MP4 (ISO/IEC 14496-14:2003)                        | ISO/IEC      | SDO     | RAND |
| MPEG-2                                            | ISO/IEC      | SDO     | RAND |
| MPEG-2 (ISO/IEC 13818)                             | ISO/IEC      | SDO     | RAND |
| MPEG-4 Part 2 (ISO/IEC 14496-2)                    | ISO/IEC      | SDO     | RAND |
| MSFT Silverlight                                   | Microsoft    | COMPANY | NA   |
| MXF                                               | SMPTE        | CONSOR   | NA   |
| MXM Graphic Module Software Spec 3.0 revision 1.1  | MXM Group/SIG | CONSOR   | RAND |
| MXM Graphics Module Mobile PCI Express Module Electromechanical Spec version 3.0 rev 1.1 | MXM Group/SIG | CONSOR   | RAND |
| Package Name                        | Developer       | Licensing Model | Notes                          |
|-----------------------------------|-----------------|-----------------|--------------------------------|
| Net2Display Remoting Standard (N2D) | VESA            | CONSORTIA       | RAND                           |
| NTP (time synchronization)         | IETF            | CONSORTIA       | RAND                           |
| OGG                               | Xiph.Org Foundation | RF              |                                 |
| OpenAL                            | Creative Technology | RF              |                                 |
| OpenCL                            | Khronos         | CONSORTIA       | RF                             |
| OpenGL 4.0 Compatibility Profile Specification | Khronos | CONSORTIA   | RF                             |
| OpenGL 4.0 Core Profile Specification | Khronos | CONSORTIA   | RF                             |
| OpenGL ES                         | Khronos         | CONSORTIA       | RF                             |
| OpenGL SC 1.0                      | Khronos         | CONSORTIA       | RF                             |
| OpenGL Shading Language 4.0.0.7 Specification | Khronos | CONSORTIA   | RF                             |
| OpenKode                          | Khronos         | CONSORTIA       | RF                             |
| OpenMAX                           | Khronos         | CONSORTIA       | RF                             |
| OpenML                            | Khronos         | CONSORTIA       | RF                             |
| OpenSL/ES                         | Khronos Group   | CONSORTIA       | RF                             |
| OpenVG                            | Khronos         | CONSORTIA       | RF                             |
| OpenWF                            | Khronos         | CONSORTIA       | RF                             |
| PCI Express Base Specification 2.0 [x8,x16] | PCI-SIG   | CONSORTIA       | RAND                          |
| PCI Local bus Spec 3.0             | PCI-SIG         | CONSORTIA       | RAND                          |
| PCI Local Bus Specification 3.0    | PCI-SIG         | CONSORTIA       | RAND                          |
| PCMCIA/PC Card                     | USB-IF          | CONSORTIA       | RF                             |
| PGA-989 socket                     | Intel           | COMPANY         | NA                            |
| PGP (RFC-4880)                     | IETF            | CONSORTIA       | RAND                          |
| PNG                               | W3C             | CONSORTIA       | RF                             |
| POP                               | IETF            | CONSORTIA       | RAND                          |
| Quicktime                         | Apple           | COMPANY         | NA                            |
| RealVideo 3.4                      | RealNetworks    | COMPANY         | NA                            |
| RJ-11 (TIA-968-A)                 | TIA             | SDO             | RAND                          |
| RSS                               | Various         | CONSORTIA       | NA                            |
| RSVP                              | IETF            | CONSORTIA       | RAND                          |
| RTMP                              | Adobe           | COMPANY         | RF                             |
| RTP                               | IETF            | CONSORTIA       | RAND                          |
| RTSP                              | IETF            | CONSORTIA       | RAND                          |
| S/MIME                            | IETF            | CONSORTIA       | RAND                          |
| SATA                              | Serial ATA      | CONSORTIA       | RAND                          |
| SD                                | SD Association  | CONSORTIA       | RAND                          |
| SDL 1.3                           | open source project | RF              |                                 |
| SDP                               | IETF            | CONSORTIA       | RAND                          |
| SDRAM                             | JEDEC           | SDO             | RAND                          |
| SHA-1 (FIPS PUB 180)              | NIST            | SDO             | NA                            |
| SIP                               | IETF            | CONSORTIA       | RAND                          |
| SmartMedia                        | Toshiba         | COMPANY         | NA                            |
| SMTP                              | IETF            | CONSORTIA       | RAND                          |
| SOAP                              | W3C             | CONSORTIA       | RF                             |
| SODIMM                            | JEDEC           | SDO             | RAND                          |

**Notes:**
- **CONSORTIA** indicates a standardization organization.
- **RAND** indicates an informal or industry-wide agreement.
- **RF** indicates a patented technology or open-source software.
- **SDO** indicates a standards development organization.
- **COMPANY** indicates a proprietary technology.
- **NA** indicates information not available.