



The battle of the blue laser DVDs: The significance of corporate strategy in standards battles

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ABSTRACT

Markets and industries that require their products to interconnect or utilize important complements are becoming increasingly common. From communication networks to social web sites, network effects have shown themselves to be powerful forces. However, the same feedback effects that make these industries so interesting also makes them difficult to study as often, without an accepted standard, the industry never germinates and grows. This paper takes and refines an existing model for competition in these types of industries and applies it to the recently concluded contest between Sony's Blu-ray and Toshiba's HD-DVD in blue laser DVDs.

Analysis of this standards battle suggests some interesting findings. First, in this case corporate strategy provided a decisive advantage to the Blu-ray alliance led by Sony. Sony appears to have "won" the battle in the U.S. by exploiting a superior corporate strategy to not only provide complementary products as called for by the traditional model (e.g. Hill, 1997) but also by utilizing its technology as a component in an ancillary product, its Playstation 3. Second, a heuristic is proposed for considering indirect network effects to complement "Metcalfe's Law" for direct network effects. Finally, Sony paid a high a price to "win" this standards battle.

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1. Introduction

Standards are interface protocols that create a single network of compatible users (Shapiro and Varian, 1999). Standards serve to reduce transaction and switching costs, as well as facilitate the development of complementary products by allowing a division of labor between suppliers of a core product and its complementary products (David and Greenstein, 1990; Kindleberger, 1983; Besen and Farrell, 1994). What makes these markets so interesting is network effects—a product's utility for a consumer today is contingent on what future consumers will do (see Shy, 2011 for review). These network effects, coupled with switching costs, can tip the competition to a single winning standard, e.g. VHS over Beta in video cassette recorders (Cusumano et al., 1992). While very interesting, study of standards battles is difficult because they are relatively rare, either potential battles are resolved via negotiations before market entry or the products simply never get introduced. Furthermore, each battle provides exactly one example for study (e.g. Lint and Pennings, 2003).

Abbreviations: HD, high definition also refers to a specific format of blue laser DVD players; PS3, Playstation 3

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This paper examines the recently concluded battle between Sony (Blu-ray) and Toshiba (HD-DVD) for the next generation of DVD players. Section 2 discusses an overview of models for competition in these industries. This is followed by a description of the products and the competitive moves that were made in the U.S. market in Sections 3 and 4. Section 5 applies the actions and competitive maneuvers of the firms against an expanded model of competition in these industries.

2. Theoretical overview: standards and firm strategy

Since they can be controlled by a single firm that may in turn accrue proprietary rents from them standards are strategically important (Hill, 1997; Katz and Shapiro, 1985; Morris and Ferguson, 1993). Microsoft is frequently touted as the ultimate example of this strategy, though other examples, Nintendo and Sony in video games and Dolby in audio technology are also common (Shapiro and Varian, 1999). Similar situations, driven by network effects, have started to surface in the area of services, such as financial payments (Paypal) and personal networking, with Microsoft being willing to invest \$240 million for 5% of personal networking site, Facebook, a stake worth an estimated \$4.2 billion today (Guth et al., 2007; WSJ, 2011). Of course, these effects are nothing new, the telephone, electric utility, and early railroad industries exhibited similar effects.

As the network of users increases greater utility for consumers from these effects manifests itself in two ways. First, direct utility – the benefit derived from the interoperability of products between users (e.g. fax machines) – grows. Second, indirect utility arises from a greater array and range of complementary products, such as software, that become more plentiful, see Fig. 1 (Katz and Shapiro, 1985).

Unfortunately, the strength of network effects is hard to measure. The direct effect is frequently modeled using some modification of “Metcalfe’s Law”—the potential value of a network is proportional to the square of its users, e.g. n^2 or $n(n-1)/2$ where n is the number of nodes (Shapiro and Varian, 1999, p. 184). This of course is not a law, but a heuristic to help practitioners and scholars think about and model these industries. While there has been considerable attention paid to Metcalfe’s Law, a similar heuristic for indirect effects has not arisen. A suggested heuristic that this paper explores in examining this industry is—the lower the cost of the core product relative to the cost of each complement, the lower the network effects in that industry. So an industry where core products cost \$1000 and complements are \$100 (10:1) would exhibit lower network effects than an industry where complements were only \$10 (100:1). Therefore, the higher the core to complement cost ratio, the higher the indirect network effects.

Because of network effects, if switching costs are present, it is possible that the “best” technology on a traditional price/performance metric does not gain broad market acceptance, e.g. the QWERTY keyboard prevailed over “better” rivals (David, 1985). This has become especially important for considering the effects of technological change on markets and industries. Hill (1997) modeled market demand and installed base in these markets as a function of availability of complements and their product utility, which are further reinforced through feedback effects (see Fig. 1 for feedback effects, Fig. 2 in Section 5 takes Hill’s model as its foundation). As more customers adopt a product, that product’s value increases to past, present, and future customers. This feedback effect is what causes some markets to “tip” to only one version being available, e.g. VHS format VCRs. Needless to say, much attention has been given on how firms can exploit these industries via tactics such as penetration pricing, subsidies to complement producers, product preannouncements, and the direct provision of complements (Besen and Farrell, 1994).

Of course, not all, or even most, standards battles result in a “tipped” market. Some industries remain split, e.g. video game players (Subramanian et al., 2011). Occasionally, this split is along regional lines, such as with different television formats in USA (NSTC) and Europe (PAL). Sometimes, industries manage to reconcile multiple standards, such as DVD recording formats, or 33, 45, or 78 RPM prerecorded vinyl disks (i.e. records) via adapters or versatile core products. Finally, some industries fail to gain broad consumer acceptance, such as quadrasonic sound (Postrel, 1990) or Mini-Disk.

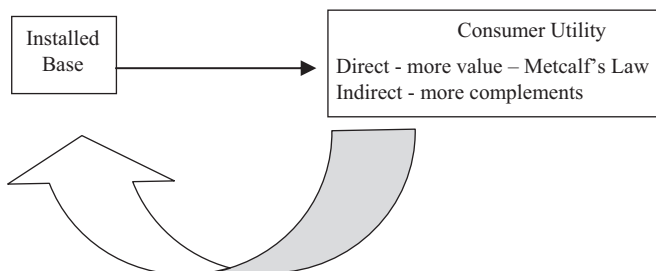


Fig. 1. Basic feedback model.

3. Setting the stage: the Innovation of the blue laser DVD

Since blue light has a shorter wavelength, a blue laser beam (405 nm) is narrower than a red one (650 nm). This enables the creation of higher capacity Digital Video Disks (DVD)—hereafter referred to as blue laser DVDs (blue DVD). Consortia formed around two rival blue DVD standards. One was led by Toshiba, the primary sponsor of the earlier Super Density DVD standard, which pushed for an evolutionary format called HD-DVD (HD). The other, broader, consortium was led by Sony and supported Blu-ray. Table 1 presents some summary information about the dueling formats.

As can be seen from Table 1, the new technology offered many advantages over the existing DVD format. Capacity was expanded from DVD’s 4.4 GB to 15 or 25 GB per side. This capacity increase was key because it allowed for video resolution of 1920×1080 – the resolution of high definition television sets – for a full length motion picture. Initially, only blue DVD players were introduced to the market. This was similar to DVD’s trajectory where players appeared first while recordable DVD systems followed.

4. The battle of the blue laser DVDs in the United States

While Sony introduced an early version of Blu-ray in the Japanese market as a \$4000 player/recorder in March of 2004, demand was weak and there was little support for content other than Sony Pictures, which owned Columbia Pictures as well as Metro-Goldwyn-Mayer. The real battle would start when the players were released in the large United States market. This section reviews the battle of the blue DVDs to its conclusion in March of 2008 broken out by common tactics that are used when competing in these industries (e.g. Besen and Farrell, 1994).

4.1. Tactic: product preannouncements

Since customer perceptions of what future customers will do is so important, both sides engaged in significant preannouncements in an effort to garner movie studio support and encourage consumers to purchase their version of the player, or at least, discourage customers from purchasing a rival player. Toshiba struck first in November 2004 announcing non-exclusive agreements with three major studios, Paramount, Universal, and Warner Bros., to release HD movies for Christmas 2005 (McBride and Dvorak, 2004). However, Sony quickly struck back, allying with Disney and Fox to support Blu-ray (McBride, 2005). When coupled with Sony’s in house support, this evened the count to three movie studios for each standard. However, in October of 2005, spurred by Sony’s announcement that it would use a Blu-ray DVD in its forthcoming PlayStation 3 (PS3), Paramount announced that it would support Blu-ray as well as HD-DVD (McBride, 2005).

This shift by Paramount was partially prompted by Toshiba acknowledging that its players would be delayed until March of 2006. In the U.S., the fourth calendar quarter, due to Christmas, accounts for a disproportionate amount of consumer sales. Therefore, this delay cost HD most of its chance to build its installed base before Blu-ray arrived.

Despite a last ditch effort to unify the standards between April and August of 2005 a full-blown consumer standards battle broke out on 17 April 2006 when Toshiba shipped 10,000 to 15,000 of its HD-A1 HD DVD players priced at \$499 (Garrett, 2006). However, HD’s head start was short as Samsung introduced the first Blu-ray DVD player, the BD-1000, on 25 June 2006, priced at \$999. Sony’s player appeared later that year in December. Ironically, Blu-ray disks were available as early as 23 May 2006.

Table 1
Feature summary for Blu-ray and HD-DVD formats.

Feature	Blu-ray	HD DVD (HD)	DVD
Storage capacity per side (GB)	25	15	4.37
Manufacturing process	New	Existing	N/A
Cover layer (mm)	.1	.6	.6
Transfer rates (Mb/s)	36	19	1.3 ^a
Major early sponsors	Sony, Dell, Hitachi, Hewlett-Packard, Matsushita, Pioneer, Philips, Samsung, MGM, and Walt Disney	Toshiba, NEC, Paramount, Universal, Warner Bros.	IBM brokered compromise between Philips/Sony and Toshiba

^a 1.3 was the initial transfer rate, this was increased over time.

4.2. Tactics: penetration pricing

Low prices are an obvious advantage for building installed base. This was probably HD's biggest advantage as prices for its players were generally from \$100 to \$200 less than Blu-ray. HD players cost less throughout the format battle, \$299 was the list price for Toshiba's least expensive player while Blu-ray players listed for at least \$400 (Associated Press, 2008). During some special promotions HD players were sold for at little as \$99, though \$199 was a more common promotional price (Associated Press, 2008).

However, the Blu-ray camp responded to this challenge by exploiting Sony's PS3. Introduced in November 2006 at \$599, in October 2007 Sony announced a dramatic price cut on the PS3 in the US market to \$399. While still expensive, this price reduction again made the PS3 look attractive in comparison to standalone blue DVD players as well as the Xbox 360 (\$279) with the HD DVD add on (\$179 or \$458 total). Since video game makers have a long history of subsidizing their players to facilitate the purchase of high margin games, Sony was using the penetration pricing tactic very aggressively hoping to cash in on both video game and DVD license fees in the future.

4.3. Tactics: provision of complements

In this case there are some clear complements. The first is a high definition television set (HDTV). Without an HDTV the improvements of a blue DVD cannot be seen over a basic DVD. However, HDTVs as complements are neutral to both sides as no TV has a built in preference for one format over the other (due to their possession of a standardized HDMI interface). A second complement was the need for facilities to actually produce the disks with prerecorded content. This was one of HD's advantages over Blu-ray as it could use the existing technology available at the 299 DVD pressing plants located around the world (dvdforum.org). However, if this gave any cost advantages to HD it did not dramatically affect customers—the price of HD disks averaged \$32.90 in 2006 and \$37.51 in 2007, versus \$34.35 and 38.34 for Blu-ray (Samsung Corporation, 2008). Finally, the most important complement was the provision of prerecorded content for consumers to play on their players. Both sides courted the major motion picture studios to release content in their format. Table 2 shows the results of Sony's and Toshiba's wooing of the studios by giving the number of releases by month for each standard. As can be seen in the table, Blu-ray rapidly made up for lost time and surpassed HD in number of titles offered in February of 2007 (191 versus 180). Blu-ray maintained this advantage throughout the battle, though never by an order of magnitude (e.g. 2:1) advantage.

Of course, what may also be important is not only the number of titles available on each format but some indication of their quality. Two additional data points are provided in Table 2, average ratings for each title by fans of the Internet Movie Database and, when applicable, the title's nominal U.S. box office

total. While neither of these quality measures is perfect, they offer some insight into the quality of titles that were being released. However, once again, neither side had a pronounced advantage in either quality as measured by IMDB ratings or box office figures, though HD did possess a small advantage in each.

Of special interest is the role that Sony's own internal movie studio played. A breakout of some relevant data is given in Table 3 regarding Sony's movie studio. As can be seen, while not a leader in the release of Blu-ray DVDs, Sony's contribution was not trivial. What may be especially decisive is not just the count of 95 titles, including 14 "blockbuster" movies that Sony released, but rather that these titles would provide a source of stability for the Blu-ray camp while almost certainly remaining unavailable for HD players (see also Table 4).

4.4. Battle of the blue DVDs—installed base

Given the importance of feedback effects, building installed base is vital. Early sales were slow for both formats. Sales of standalone players totaled about 120,000 HD and 25,000 Blu-ray players in the first few months of release.

However, things changed dramatically on 17 November 2006 when Sony's PS3 went on sale. Of course, Toshiba had not been blind to the potential of the PS3. It had partnered with Microsoft to sell an HD add on kit for the Xbox 360. However, by the end of 2006 the role of the PS 3 was making itself felt – while 150,000 HD add on kits had been sold for Microsoft's Xbox 360 – about 400,000 PS3s had been sold (McBride, 2007a). Since it could also play video games, Sony's advantage with the PS3 was that it featured considerably more utility than a standalone player. Of course, the addition of the Blu-ray drive substantially increased the cost of the PS3. Still, largely driven by the PS3, overall sales numbers for blue DVD players compared favorably with first year sales totals for DVD players (349,000 units) in the U.S. for 1997 (Internet 1).

The role of the PS3 introduction was also widely felt by the studios. Before the PS3 went on sale, HD movies were outselling Blu-ray—578,000 HD to 367,000 Blu-ray (Arnold, 2007). However, afterwards Blu-ray dramatically reversed this advantage outselling HD 832,530 to 359,300 in the first quarter of 2007 (Arnold, 2007). This advantage continued through 2007, with Blu-ray titles consistently outselling HD titles about 2:1 in the U.S. market.

Possibly in response to this momentum, the U.S. video rental chain Blockbuster, noting that in its 250 stores that carried both formats 70% of the rentals were for Blu-ray disks, announced in July 2007 that it would no longer stock HD titles for rental (Associated Press, 2007b). This was a major development in the standards battle that harked back to the frustrations of video stores in stocking both VHS and Betamax video tapes. Some blogs, such as ZD Net's Robin Harris (Internet 2), cited Blockbuster's decision as evidence that this standards battle was a win for Blu-ray.

Table 2
Monthly summary of motion picture titles released by platform.

Month	HD DVD				Blu-ray			
	Number	Cumulative	IMBd avg.	US box avg.	Number	Cumulative	IMBd avg.	US box avg.
April-06	6	6	7.35	\$81.45	0	0	–	\$–
May-06	15	21	7.14	\$84.19	0	0	–	\$–
June-06	11	32	6.78	\$61.22	13	13	6.93	\$78.78
July-06	13	45	6.12	\$67.60	6	19	5.46	\$39.50
August-06	13	58	7.02	\$66.27	12	31	6.88	\$45.63
September-06	20	78	6.70	\$85.99	23	54	6.68	\$76.42
October-06	22	100	7.16	\$81.70	30	84	6.43	\$55.52
November-06	26	126	6.92	\$110.17	29	113	6.21	\$83.76
December-06	22	148	6.90	\$50.03	20	133	6.79	\$63.35
January-07	17	165	6.20	\$69.03	30	163	6.29	\$54.54
February-07	15	180	8.05	\$46.55	28	191	6.84	\$48.55
March-07	4	184	7.60	\$103.57	15	206	7.10	\$84.60
April-07	14	198	6.97	\$52.03	18	224	7.21	\$67.52
May-07	26	224	6.93	\$49.69	24	248	6.51	\$84.35
June-07	31	255	6.65	\$49.05	20	268	6.17	\$54.28
July-07	28	283	6.71	\$55.10	17	285	6.83	\$57.65
August-07	12	295	6.92	\$91.35	13	298	6.44	\$41.57
September-07	26	321	6.80	\$50.23	27	325	6.67	\$42.77
October-07	25	346	7.13	\$53.16	53	378	7.08	\$60.19
November-07	17	363	6.68	\$88.50	36	414	7.10	\$83.83
December-07	27	390	7.44	115.12	29	443	7.12	\$163.76
Averages			6.94	69.84			6.04	61.26

Table 3
Sony studio's DVD releases by month with their corresponding percentage for all releases.

Sony	Titles	Percentage of monthly total releases accounted for by Sony
June-06	6	46
July-06	2	33
August-06	4	33
September-06	4	17
October-06	3	10
November-06	2	7
December-06	4	20
January-07	4	13
February-07	5	18
March-07	8	53
April-07	3	17
May-07	7	29
June-07	8	40
July-07	5	29
August-07	7	54
September-07	7	26
October-07	10	19
November-07	4	11
December-07	5	17
Total	98	22

However, HD was not done yet and Blu-ray's momentum was dealt a setback in August 2007 when Paramount and Dreamworks announced an exclusive shift to HD DVDs. This resulted in 32 Paramount titles being removed from Blue-ray production (Internet 3). There were reports that Toshiba paid \$150 million to the two studios for the exclusive deal. However, regardless of any side payments, and all movie studios received some subsidy from hardware makers for new movie releases on their format via advertising support, this deal provided some hope for the HD side (Dvorak et al., 2004).

This left the market largely in flux. Sony's CEO Howard Stringer, declared the battle between the two standards a "stalemate" (Associated Press, 2007a). While the contest appeared stalled out, Blu-ray, largely on the strength of PS3 sales, retained its advantage. Nielsen Video Scan reported that through 2 December 2007 Blu-ray disks had a 65% market share in 2007

Table 4
Movie data by studio, including blockbusters (> \$100 million US box).

Studio	Blu-ray titles	HD titles	Blockbusters
Buena Vista (Disney)	54	0	13
Sony	98	0	15
FOX	46	0	15
Lionsgate	32	0	3
Paramount	30 ^a	40	10 ^a
Universal	0	140	31
Warner Bros.	104	125	26 ^b

^a Paramount had ceased releasing Blu-ray titles, but had 9 of its 10 blockbusters on Blu-ray.

^b Only 23 of Warner's 26 blockbusters were available on Blu-ray.

and a 62% share of all blue DVD disks sold since the start of the standards war (see Internet 4).

However, in an interesting twist, it appeared that the blue DVD market was almost as important to the movie studios themselves as to the hardware makers. DVD sales had become an important revenue stream for the studios and DVD sales were down about 5% in 2007 (McBride, 2008). Specifically citing its desire to resolve the confusion in the market driven by the standards battle, Warner Bros. announced on 4 January 2008 that starting in June they would switch from being format neutral to supporting Blu-ray only (McBride et al., 2008). Side payments of up to \$400 million were rumored, but the key issue seemed to be that studios had become especially dependent on DVD sales and were looking to cash in on blue DVDs before they were replaced by something else, e.g. downloadable movies. The war was over.

5. Blue laser DVDs—applying and extending a model of standards battles

Hill (1997) presented the essential elements of competition in standard based industries. However, there are other elements that enter the model both directly and indirectly. Fig. 2 presents an expanded model including several strategic elements that are present in the battle between the two standards. This section

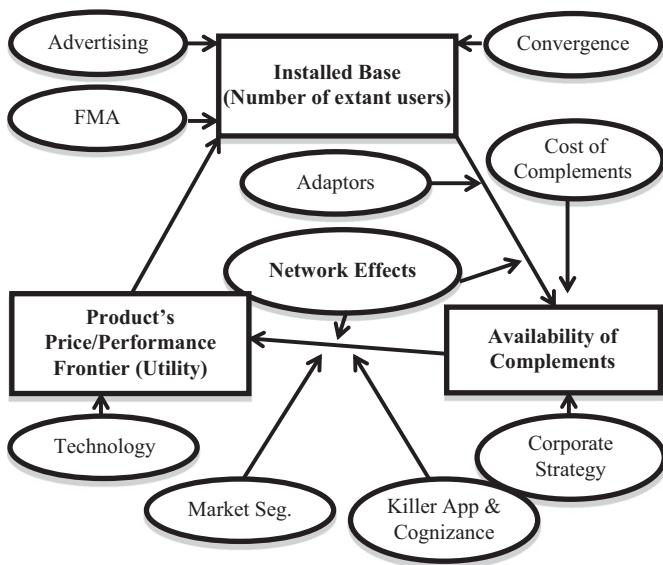


Fig. 2. Expanded model of competition in SBI (drawn from Hill, 1997).

examines each of the key relationships and discusses how the competitors in the blue laser DVD industry maneuvered. Since they permeate the entire model, issues surrounding network effects are discussed first.

5.1. Variable or dynamic network effects

Since they influence consumer utility, network effects are especially important moderators of the relationship between installed base and the availability of complements and the link between complements and utility. However, one area that may not have been taken sufficiently into account for models of competition in these industries is how network effects vary. They may be stronger when products are directly linked, e.g. telephones and electrical systems, than when only complements are needed. Agent based network models have been developed using simulations to explore some of these situations (e.g. Garcia, 2005). However, some core products have a use that is independent of its complements, for example a VCR can record TV broadcasts even if no preformatted shows are available. Furthermore, network effects can also change over time. For example, early on the choice of a PC was driven by the availability of software. Then, as computers became networked together, the operating system became a more important driver of consumer choice. However, with the rise of the Internet which operating system a computer uses now matters less, as they can all access the Internet. How important were the network effects in this market?

In Section 2 the heuristic – *the lower the cost of the core product relative to cost of each complement, the lower the network effects in that industry* – was introduced. This heuristic is driven by applying an economic and “killer application” lens to these markets (Cringely, 1992). A killer application is a complementary product that is so desirable that it compels the purchase of the core product as well. For example, Lotus 1-2-3 is often credited with being the “killer app” for the early PC industry. So, if the price of a core product is relatively low in comparison to a highly desirable complementary one it is relatively easier to buy both. For example, consider video games. Early on the cost of the players (core product) is usually high, several hundred dollars, while the costs of games (complements) usually hovers around \$30–50. Over time the price of players drops precipitously, it is not uncommon for them to reach \$99 toward the end of their generation. Under those circumstances the role of network effects has dropped. Why? If there is a

game a consumer wants on one platform and another game they want on another, it is relatively inexpensive for them to simply acquire both games and both platforms. This would be much less likely if the core product costs were higher. This also ties well to the idea of switching costs, which are simply driven by the cost of the core product coupled with any intangible learning effects that would be incurred with the alternative technology.

This insight explains a lot of the behavior we see in standard based markets, especially if they tip to one standard or not. For example, razors are a market where standards are important, Gillette has patented the interface between its razors and their blades, so has Schick. However, there is no tipping in the wet shave market because the ratio of the cost of the core and complementary products is so low, even below one, as companies subsidize razor sales to facilitate the sale of blades, i.e. it would be easy for you to have each company’s razor and simply buy whichever company’s blades were cheaper. This is also the case, though the ratio is greater than one, in the video game industry where rival standards are usually able to duke it out over the course of a product generation without the market tipping to one standard.

For blue DVDs, network effects manifested themselves via the necessity of prerecorded disks for the players to use. Using the heuristic of measuring network effects described earlier, their role was rapidly diminishing during the battle as the price of the players dropped, from \$500 to \$200 or even less for some HD players, while the cost of prerecorded disks remained about the same at about \$30. So, if both types of players are inexpensive, it is relatively easy for consumers to buy one of each. This will result in a lower likelihood of tipping barring some strategic maneuvering by firms, which did happen here. Interestingly, this same phenomena will also potentially lower the returns to having the standard adopted as it may be easy to include both regular and blue DVDs in the same package.

5.2. Utility—installed base

One of the biggest challenges in evaluating competition in standard based industries is the “chicken and egg problem” of which aspect of the product – hardware (core) or software (complement) – actually motivates the purchase. This results in (at least) two different models of consumer adoption. One model, the complement search model, has consumers buying the core product and then seeking complements for it. This is the tacit model used when discussions center around the “price point” for “mass market” consumer adoption—usually about \$199 for consumer electronic products in the United States. This contrasts with the “killer app” model of consumer adoption that states that consumers will buy core products when a complement emerges that is so desirable it justifies not only its purchase price but the cost of the core product as well (Cringely, 1992). Which model applies is especially important because in this case each standard and its resultant strategic maneuvering was grounded in very different advantages. By attempting to exploit lower prices for its core products, HD DVD seems to have aimed for the complement search model, i.e. they hoped consumers would buy an HD player and then start to look for content. Blu-ray tailored its strategy more toward a killer app model, by focusing considerable attention on movie studios, such as Disney, that had highly coveted movies in their library.

Under normal circumstances which model is correct would not matter. After all, a traditional economics approach starting at the core product’s price/performance frontier, or utility, is usually driven by a product’s embodied technology. Normally this would be the primary driver of a consumer’s purchase of a product. “Leapfrogging” an existing product and introducing a technologically superior one, i.e. one further out on the price/performance frontier, is a

common competitive weapon in a standards battle (Schilling, 2003). In a way, blue DVDs were a way for Sony and Toshiba to leap frog the existing DVD standard that was widely adopted. A key issue for consumers was if the higher performance of the blue DVD players was sufficiently high enough to justify their higher price. This is not a given because many consumers appeared (and still appear) quite satisfied with their “standard definition” (480p) DVD players or DVD players that can “upconvert” standard DVDs to near HD levels (720p). If this is the case, it would hamper the HD DVD strategy – those consumers seeking a new DVD player will simply buy a standard definition player – while those aficionados willing to pay a premium for a blue DVD player will seek the most content and be enticed by Blu-ray’s superior movie library. The irony is that Blu-ray’s movie library was never dramatically larger than HD’s, reaching 443 to 390 in December 2007.

5.3. Installed base—complements

Installed base is simply the number of users that exist for a core product—in this case the blue DVD player. First mover advantage and marketing, especially advertising, directly influence the number of users of a product. The earlier a product is on the market, the longer it has to potentially build its installed base. Similarly, the more a product is promoted, the more adopters it is likely to have. Clearly Toshiba missed any significant first mover opportunities by missing the fourth quarter of 2005. Was there anything else they could have done?

An important way firms can strategically maneuver in these industries and mitigate the effect their rivals’ installed base has on their product and increase the availability of complements is to develop a more robust core product. Some makers of blue laser DVDs, notably Samsung, developed players that could use either HD or Blu-ray disks. Similarly, dual format products were how the earlier DVD recorder standards battle (dash – versus plus +) was resolved. Of course, dual format players are considerably more expensive than single format ones, and this would have undercut Toshiba’s cost advantage.

However, what probably hurt Toshiba the most was the march Sony stole on them enabled by digital convergence. Digital data can be transformed and presented in many different forms facilitating a consolidation of traditional media formats. This gives rise to another opportunity to build installed base by finding alternative uses for the core product. In an interesting contrast to prior standards battles, because of digital convergence, important avenues existed for blue DVDs beyond just playing movies. DVD had become an important medium for both personal computers and home video game consoles and both of these platforms would be important outlets for blue DVD drives. Sony announced it would include Blu-ray drives in many of its PCs. Toshiba countered by announcing that starting in 2008 it would include HD drives in its popular laptops as well as arranging a deal with Microsoft for an HD add on for the Xbox 360.

However, these efforts were dwarfed by Sony’s PS3. Between November 2006 and December 2007 Sony sold more PS3s than Blu-ray or HD standalone players—it was the primary blue DVD player sold! The role of a product that used the core product as a *component* playing such a decisive role in a standards battle is unusual. The PS3 built in some core product utility for adopters of Blu-ray. Even if Sony lost the standards battle, consumers who had bought a PS3 would still be able to use it for video games. However, as discussed later, Sony’s strategy was expensive.

5.4. Complements—utility

Two key strategic weapons firms have in effecting complement availability is to influence their cost, e.g. subsidize them, and via their

corporate strategy. Historically, many firms endeavor to make the cost of providing complementary products low, for example, video game firms provide tool kits to facilitate the development of games for their platforms. Naturally, firms may also seek to produce complementary products themselves. This can be a key aspect of their strategy, either to profit on the sale of the complements, for example, Gillette sells razors cheap while blades are relatively expensive, or to simply facilitate the adoption of their core technology, as Apple historically ran its iTunes store at about a break even level to facilitate iPod sales.

In the case of blue DVD players, both sides used these strategies. Since the devices were only players, the critical complement was preformatted content on disks they could read. As noted earlier, both sides paid side payments to movie studios in the form of marketing support to encourage releases on their format of disks. Both Sony and Toshiba made personal computers and HDTVs. However, Sony also had an extensive movie library as well as a video game unit. This gave Sony a large potential advantage in the provision of complements. It released its movies only for Blu-ray. While this does not guarantee success, for example Sony’s release of Sony Music titles did not result in wide adoption of Mini-Disk, it was effective in efforts to facilitate the adoption of Blu-ray as long as movie profits were not larger than player profits. While not as far reaching as Sony’s corporate strategy the HD group responded by engaging in side payments to movie studios and strategic alliances with computer makers and Microsoft’s Xbox unit.

Earlier, the killer application model of consumer adoption was discussed. During their battle, neither format benefited from a “must have” movie that was only available in one format or the other. Since both formats were backwards compatible, a consumer could always play the standard definition DVD of that movie in their player. Perhaps the closest thing to a “killer app” in this case would be “blockbuster” (US box office sales > \$100 million) movies. However, as Table 4 shows, while Blu-ray, largely thanks to the Disney Corporation, had a clear advantage in the number of blockbuster movies available for it, this did not appear to have been decisive, though it does probably explain Blu-ray’s ongoing lead in disk sales.

Another important issue in the provision of complements is the potential for diminishing marginal returns to them. Once a certain number of complements are available, it may not matter how many more one platform has over the other. For example, most personal computer users use Microsoft Office, as long as that package is available for their computer then they do not care which one they use. However, to the extent that the market is composed of movie fans, many of whom have extensive collections of movies, a bigger catalog of titles may help. This is referred to as “cognizance” in Fig. 2 but does not appear to have been decisive in this case.

Another important moderator on the relationship between increased complements and consumer utility is market segmentation or regionalism. Market segmentation occurs when a subset of the market can be clearly identified and served independently of the larger market, e.g. Macintosh OS X and Windows for personal computers. As long as the needs of this sub-market can be adequately served, the core product will not suffer from relatively fewer complements. For example, despite accounting for a small portion of the personal computer market, Macintosh OS X retains considerable appeal for those in the publishing, music, and graphical art fields. Similarly, Facebook overcame Myspace in social networking by initially focusing on college students. There can also be splits across regions, as has occurred with cellular phones (CDMA in the US, GSM in Europe) and televisions (NSTC in US, PAL and SECAM in Europe). The original DVD format essentially mandated regionalism via region coding

on disks as a way to facilitate copy protection. For blue DVDs, HD DVD had no region coding, while Blu-ray had three regions though most disks released to date have not utilized this feature, greatly reducing the chances that different countries would adopt different blue laser DVD standards (Sheng, 2007).

6. The end of the battle

Good theory should aid prediction as well as explanation. However, Toshiba’s resignation in early 2008 makes speculation on the outcome of this battle pointless. Still, it may be helpful to see if the expanded model can be used to explain the different outcomes that could have occurred. This is summarized in Table 5.

Table 6 gives the best available public estimates of the number of players sold in the U.S. as of year end 2007 (Grover and Edwards, 2007). The PS3 clearly stands out. While not achieved without cost, using a video game system, which offers considerable standalone utility, to help build installed base appears to have been decisive. Unfortunately for HD DVD, Microsoft reportedly never considered using an HD drive in all of its Xbox360 video game systems (McBride et al., 2008).

Table 7 gives the best available public estimates of disk sales as of year end 2007 in units (Seitz, 2008) and dollar value (Veiga, 2008). Again, motivated by the large base of PS3 units, the Blu-ray camp was able to engender greater disk sales in total, though not per player sold, than the HD DVD format.

The corporate strategy success of Sony in using the PS3 to drive Blu-ray installed base paid off with Warner’s shift in 2008 to become an exclusive Blu-ray studio supporter. This sealed Blu-ray’s victory in the U.S. market. Given that Warner possesses the largest U.S. movie library and had released 125 titles on HD most observers believed this was decisive. The move was so stunning that the HD DVD consortium canceled their scheduled press conference at the Consumer Electronics Show and publicly admitted that this was a “setback” (McBride et al., 2008). Warner’s motivation, a stated desire to end the standards battle, rather than assertions of technical superiority or side payments, was also a major blow to the continued fortunes of the HD camp. Making matters worse, it appears that Universal’s agreement with HD expired at the end of 2007 and Paramount was looking for an “escape clause” from its August 2007 exclusive agreement with HD.

At this point HD was faced with some amazingly difficult strategic choices. Its key advantage of providing a less costly solution than Blu-ray was not worth much when its players would only be able to utilize 25% of movie studio content. Based on the model, there were four potential, and admittedly unlikely, courses for the HD camp. First, HD could have added some key functionality

to the core unit, e.g. recording capacity. This would provide customer utility even in the face of the overwhelming complement disadvantage it faced in prerecorded disks. Second, while the U.S. movie studios were a lost cause, the nature of the movie business often has them selling their international rights to different firms who would not have been bound by the US studios’ agreements with Sony. For example, even some Sony Picture films had been released on HD disks internationally (McBride, 2007b). So a regional “split decision” or market niche outcome was still possible. However, Blu-ray outsold HD by even greater margins in Europe and Japan than it did in the U.S. (McBride, 2008). Third, just as Sony used its PS3 to push its installed base, Toshiba could have used other component based products, e.g. personal computers, to push HD DVD. However, given that this would have increased the price of the products, and the expectation that online distribution was coming soon, this was not a very attractive option. Finally, if the cost of HD-DVD could be reduced to that of standard definition DVD players then HD may have remained viable. For example, Toshiba announced a 50% price cut in its HD DVD player line up, cutting the suggested retail price of its entry level unit to \$149 (Associated Press, 2008). However, this was not a viable choice as basic DVD players were still much less expensive, and there was nothing to prevent Sony from cutting prices as well. Sony did in fact do so, with Blu-ray players reaching an average price of \$221 by November 2009 (Kane and Bustillo, 2009).

Given these poor options, on 19 February 2008 Toshiba officially ended the battle (Kane, 2008a). However, in a surprise, investors greeted the decision with support, sending Toshiba’s stock up over 5% on news that it was ending its support for HD (Kane, 2008b). In August 2009 Toshiba announced it would make

Table 6
Estimated U.S. installed base 2007.

Estimated US installed base—2007	HD DVD	Blu-ray
Standalone players	578,000	370,000
Video games	300,000 (Xbox 360 add-ons)	2,300,000 (PlayStation 3)
Total	878,000	2,670,000

Table 7
Estimated blue laser DVD sales by format, number, and USD value.

Blue DVD sales	HD DVD	Blu-ray
Movie disks sold	2,600,000	4,000,000
Value of disks sold	\$103,000,000	\$169,000,000

Table 5
Outcomes and rationales.

Outcome	Rationale
Single winner—HD Single winner—Blu ray (historical outcome)	<ul style="list-style-type: none"> • Lower costs facilitated consumer adoption model process • Sony had superior corporate strategy—especially the PS3 • “Killer App” model of consumer adoption occurred
Split (parallel)	<ul style="list-style-type: none"> • Network effects not that significant • Studios release DVDs in both formats (as done outside US)
Split (regional) Split (multi-format)	<ul style="list-style-type: none"> • Market segmentation benefits > network effects • Dual format players drop in price very quickly • Studios package both HD and Blu-ray DVDs in same case
Failure	<ul style="list-style-type: none"> • Next technology, e.g. online, arrives before battle resolved

Blu-ray DVD players and use Blu-ray drives in its laptops (WSJ, 2009).

7. Conclusions

So what does the case of Blu-ray versus HD confirm and contradict what we think we know about competition in standards based industries? It confirms quite a bit. Both firms engaged in the proscribed tactics of a standards battle by engaging in product pre-announcements, penetration pricing, and courting complement providers, attesting to the soundness of our basic understanding of competition in these industries. However, other issues arose. Key issues that this battle illustrates are the primacy of corporate strategy, the challenge of turning a standards victory into profitability, and a proposed heuristic for *indirect* network effects.

The most dramatic insight is the role of corporate strategy. Corporate strategy figured very prominently in this duel and suggests some opportunities for refining our understanding of that important strategic dimension. The decisive difference appears to be that Sony won the installed base race using the PS3, a product that derived considerable utility from something other than playing movies. Despite the fact that HD had outsold Blu-ray in stand-alone players, the PS3's relative success convinced movie studios to view Blu-ray as the winning standard. So while movie studios decided the battle, it was video game players who drove it.

Most corporate strategy can be broken down into a variation of sharing resources or creating specific assets. This is clearly shown in Sony's ability to maneuver in comparison to Toshiba. Using a Blu-ray drive as a *component* was clearly an excellent example of sharing resources between its corporate units. While not decisive by itself, its ownership of Sony Pictures insured that at least some specialized assets, i.e. prerecorded movies in Blu-ray format, would be available in quantity. While the number of titles may not have been decisive (22% of Blu-ray's total), Sony Pictures did provide a secure foundation for the Blu-ray camp as the other studios vacillated back and forth between the two standards. In many ways, the apparent victory of Blu-ray in the US is as much a corporate strategy story, enabled by digital convergence, as it is a standards story.

Of course, just as digital convergence gives it can take away. Convergence sets the stage for the greatest threat to Blu-ray, online distribution, and raises the important question, could this be a high profile pyrrhic standards victory? Sony's time to enjoy the fruits of their victory may be short. Online distribution, while still only a small percentage of overall sales, is growing. Interestingly, Blu-ray players that are on the U.S. market today are also capable of displaying online content. So consumers today are not only purchasing a Blu-ray player, but with every purchase, a vehicle for its marginalization.

Was it worth it for Sony? It would be a mistake to assume that just because Sony won that it was profitable. The PS3 was key, but a component cost analysis suggests that the PS3's Blu-ray drive accounted for between \$125 and \$300 of the cost of each PS 3 (Internet 5). A regular DVD drive, such as the Xbox 360 used, would have cost less than \$20. Given Sony sold 1.8 million PS3s in North America in 2007, this would suggest it "paid" a direct subsidy of \$180–\$504 million to build its installed base using the PS3. Perhaps this amount was a bargain when it was rumored to have offered Warner Brothers \$400 million in marketing support in exchange for going Blu-ray exclusive.

However, this is not the only cost the PS3 incurred in order to help Blu-ray. Because of delays in the specifications for Blu-ray, the release of the PS3 was delayed. While the PS3 has become a

success, Microsoft and Nintendo each sold several times as many consoles in 2007 and more in 2008–2010 than Sony did (Internet 6). In contrast to the emerging blue laser DVD market, the video game market is huge—\$20 billion in 2010 (NPD Group, 2011). In comparison, since the end of the standards battle the Blu-ray market has grown to \$2 billion in 2010, but is still a fraction of the basic DVD market at \$8 billion (Worden, 2010). So, while Sony may look forward to increased royalty revenue from Blu-ray, it incurred an opportunity cost in lost game unit royalties.

So the costs of Sony's victory were high. An estimated \$200 million direct cost for putting Blu-ray in the PS3. A rumored \$400 million to Warner in addition to the considerable direct subsidies it paid to the other movie studios, and an unquantifiable loss of video game license revenue due to reduced PS3 sales. While impossible to estimate, the lost video game revenue is especially important because the royalties paid by video game companies are higher than those paid by movie studios for Blu-ray. In a way, the movie studios may have captured the benefits from gaining agreement on a standard through the considerable side payments they received from both Sony and Toshiba. In winding down its HD operations, Toshiba announced losses of ¥160 billion (\$1.64 billion) in attempting to make HD a winning standard (Kane, 2008b). This suggests that future work may be well served to look at the costs of winning a standards battle.

The issue of profits versus acceptance is playing out in standards battles today. For example, in mobile devices Apple's iOS (used on iPhone and iPad) competes with Google's Android. Apple has taken a heavy hand, not licensing out its operating system and demanding a 30% cut of App Store revenue. In contrast, Google provides Android at no charge to handset makers, content to simply have more search revenue and collect a small fee from developers to be in the Android Marketplace. While Apple's vertical integration has to date provided far more profits, Google seems to be winning more acceptance. In 2010 Google's Android OS surpassed iPhone's market share 20% to 14% (Peers, 2011).

Outside of some simulations, there has been little work done on the variability and dynamism of network effects, and even less when the network effects arise indirectly. While the ratio of core to complement cost heuristic employed in this paper is clearly limited, it does not account for intangible factors, diminishing returns, or effects from the library size of complements, there is a lot of potential here. Its key advantage is that it is forward looking, it can help practicing managers gauge the strength of network effects when they are in the midst of a standards battle. The heuristic may be particularly appropriate here because blue DVDs are a consumer product and libraries of earlier generation DVDs did not matter because both players were backwards compatible. While a prior library may influence a consumer's choice to adopt a new technology, in this case they were indifferent. However, this is not always the case, Sony's earlier success with the PS2 was often ascribed to its compatibility with the earlier Playstation. While sunk costs should not matter, consumers can be unpredictable.

The heuristic presented here suggests that the larger the ratio between core and complement costs the greater the network effects. Recently, Inceoglu and Park (2011) modeled a 1% rise in DVD title availability resulting in a .87% rise in DVD player demand, suggesting that focusing on complements was a sound strategy to build installed base for DVDs. While their work was comparing VHS format tapes to DVDs, not two competing standards using similar technology, their results are consistent with the strong network effects the heuristic would predict since the cost of an early DVD player was much greater than DVD movie disks.

So looking forward to the next battle what does the experience here suggest? First, corporate strategy trumps collaborative strategy. Sony was able to integrate Blu-ray more deeply into ancillary markets than Toshiba's consortium was able to. However, this came

at a high price—so this is not a call for ham fist ed vertical integration or diversification efforts. So the second suggestion is to focus on profits not acceptance. This is especially true when your victory may be surpassed by another technology. Finally, the heuristic suggests paying close attention to the cost of the complements as well as the core products. For example, looking forward, in mobile devices this ratio is quite high, many “apps” are even free, suggesting high network effects. Given this, Google might have been better served acquiring an application content company for Android rather than a handset maker.

As with any case study a number of limitations exist. Obviously, this is only one example of a phenomena and future battles will differ. However several aspects of it – need for complements, use of cross subsidies, and the appearance of many common tactics – suggests it is representative of standards battles that make it to market.

In looking forward to future work two issues stand out. First, as discussed, is the price firms pay for winning standards battles, is it worth it? History showed that it was in fact worth it for Matsushita’s VHS, Nintendo’s Nintendo Entertainment System (1985), and Microsoft’s DOS, Windows, and Office, but not for IBM or Hayes (in modems). The record with Blu-ray and subsequent standards battles may be very different. Second, it is possible that early adopters may have very different buying preferences than mass adopters. While early adopters might be motivated using a killer app model, e.g. buy a Blu-ray player so they can watch Disney’s *Pirates of the Caribbean*, the mass market may be more likely to use the consumer adoption model of buying the relatively inexpensive core product and looking for complements later. If this argument turns out to be substantiated, it would seem that Sony won just in time.

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