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Console Industry

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Technological Leapfrogging: LESSONS FROM THE U.S. VIDEO GAME CONSOLE INDUSTRY

Melissa A. Schilling

In industries characterized by strong network externality effects, the value a good offers to customers is a direct and positive function of how many other users there are of the same good.¹ The classic examples of markets demonstrating network externality effects are those involving physical networks, such as railroads or telecommunications. However, network externalities can also arise in markets that do not have physical networks. For example, a user's benefit from using a good may increase with the number of users of the same good when compatibility is important, such as the compatibility of video tapes with VCRs or the compatibility of documents developed with a particular software program. A large installed base may extend the range of the user's network, increase the value of the user's training in the particular technology, and attract more developers of complementary technologies, thus increasing the number of options available to the user.² Therefore, other things being equal, the customer prefers a technology with a large installed base.

In such industries, technology standards can become locked in as the dominant design through the self-reinforcing effects of installed base and complementary goods.³ Such a position can be very powerful—and profitable—for the sponsoring firm(s). Since the value of the good is closely tied to the size of the installed base and the availability of complementary goods, new entrants are at a severe disadvantage. Even though other products may appear technologically superior, they can yield less overall value to customers because of the network externality effects. Eventually, however, a new technological generation that offers a radical improvement in technological functionality may render the standard obsolete and may eliminate the advantage of the existing installed base and complementary goods.⁴ Because of this, radical innovation may be a new entrant's most fruitful avenue for breaking into an industry dominated by an entrenched standard. However, it is also apparent from observing many

industries that even major technological advancements often fail to break the current standard, prompting the following questions: When will radical innovations succeed in displacing an incumbent standard? What characteristics must the new entrant possess and what strategies must it deploy to maximize its chances for success? What can a sponsor of the incumbent standard do to protect its position?

The article develops a multidimensional framework for assessing the value components of technologies in network externalities industries by examining three generations of competition in the U.S. video game console industry, each of which demonstrate successful and unsuccessful technological leapfrogging of an entrenched incumbent.

The U.S. Video Game Industry

The very first home video game system was the Odyssey, introduced in 1972.⁵ The product was commercially produced and sold by Magnavox. It was based on technology developed in 1966 for military simulations by Ralph Baer and Sanders Associates, a military electronics consulting firm. At a price of \$100, over 100,000 units of the game system were sold.⁶ However, the Odyssey came to an end rather quickly with the rise of a game system that would prove to be much more successful and establish home video game systems as an important and viable industry: Atari's "Pong."

Pong, the Beginning of an Era

In 1972, Nolan Bushnell founded Atari and introduced "Pong," a ping-pong-like game that was played on a user's television set with the aid of the Atari console. In its first year, "Pong" earned over \$1 million in revenues. "Pong," and over sixty similar knock-offs, soon flooded the market. The creation of large-scale integrated circuits enabled the systems to be fast and yet produced inexpensively. "Pong" dominated the market until Atari's 1977 introduction of the Atari Video Computer System (VCS, later renamed the 2600), which would lead the second generation of video games.⁷ The VCS/2600 utilized a microprocessor, and could play multiple games. The console sold for \$200, with games selling for between \$20 and \$40. Atari sold over \$5 billion worth of 2600 systems and products by 1983. The height of this generation saw yearly sales of \$3 billion in the United States alone.⁸ However, the 1976 acquisition of Atari by Warner Communications had also turned the company's focus more to developing personal computers. The next few years saw a variety of Atari computer introductions, but none would prove to be big money makers for Atari. While Atari's attention was diverted towards computers, Coleco entered the market and introduced the Coleco Vision video game system in 1982. The Coleco Vision was very successful, and in 1983 Coleco Vision games outsold Atari games.

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In the mid-1980s, profits for video game makers began to decline; many feared that video games had reached market saturation. Compounding this, the rapid proliferation of unauthorized games (games produced for a console without authorization of that console's producer) led to a market glut of games of dubious quality, and many unhappy retailers with video game inventories they were unable to move. By 1985, many industry observers were declaring the video game industry dead. Much to everyone's surprise, however, two new entrants from Japan entered the U.S. video game market: Nintendo, with its 8-bit Nintendo Entertainment System (NES) introduced in 1985, and Sega, which launched its 8-bit Master System in the U.S. in 1986 (Sega had previously introduced an 8-bit system dubbed SG-1000 in Japan in 1983).⁹ Though Sega's Master System appeared to be technologically superior, Nintendo spent much more on advertising and development of quality games and characters, and had more game titles available than Sega. The Master System went on to sell two million units and at times held an 11% market share. The NES sold over one million units in the first year, sold 19 million units by 1990, and could be found in more than a third of the households in America and Japan.¹⁰ Nintendo's "Super Mario Brothers 3" grossed over \$500 million in America in 1989, selling seven million copies in the U.S. and four million in Japan.¹¹

In 1987, Atari released its last 8-bit system, the Atari XE Game System, but the product was unable to compete with the power and graphics in the systems made by Nintendo and Sega. Furthermore, Atari only spent roughly \$300,000 promoting its system, while Sega and Nintendo each spent \$15 million promoting their systems. Finding itself unable to compete, Atari sued Nintendo in 1988 for monopolistic practices (the court sided with Nintendo).¹² In the same year, Coleco filed Chapter 11.

Thus from 1985 to 1989, Nintendo held a near monopoly of the U.S. video game industry. The company sold its consoles for a price very close to production costs, while earning the bulk of its profits from games. Nintendo both made games for its system in-house and licensed third-party developers to produce games through very strict licensing policies that limited the number of titles a developer could produce each year, required the developer to preorder a minimum number of cartridges from Nintendo (which had its own contract manufacturers produce the games), and restricted the developers from making similar games for other consoles. Nintendo also restricted the volume and pricing of consoles sold through distributors, ensuring that no single distributor acquired significant bargaining power.¹³ Nintendo's restrictive policies were very profitable, however, they also caused the company to be sanctioned by the Federal Trade Commission, and they alienated distributors and developers, potentially leaving the company more vulnerable to a competitor.

The 16-bit Video Game Industry

In September of 1989, Sega introduced the 16-bit Genesis to the U.S. video game market. The Genesis offered dramatic performance enhancement over 8-bit systems. Further, Sega leveraged its popular arcade games to the

TABLE 1. Competitive Summary, 16-bit Video Games in the U.S.

Competitors	Sega Genesis	NEC TurboGrafx-16	Nintendo SNES
Introduction Date	September, 1989	Fall, 1989	September, 1991
Price	Initially \$190, reduced to \$150	Initially \$200, reduced to \$99	Initially \$200, reduced to \$150
Technological Functionality	Cartridge-based, and CD add-on in 1992 16 bit 7.6 MHz clock speed 128K RAM	Cartridge-based with CD add-on 16 bit 3.6 MHz clock speed 8K RAM	Cartridge-based 16 bit 3.6 MHz clock speed 128K RAM
Backward Compatibility?	Yes—with 8-bit Master System	Not Applicable	No
Developers	Internal and External 200 in-house developers 1500 freelance developers by 1993	External Only	Internal and External 65 licensees by end of 1991
Game Titles	20 by December 1989 130 by September 1991 320 by January 1993	12 by December 1989 80 by end of 1991	25 titles by end of 1991 130 by January 1993

Data compiled from: company press releases; company annual reports; A. Brandenberger, "Power Play (A): Nintendo in 8-Bit Video Games," Harvard Business School Case #9-795-167, 1995a; A. Brandenberger, "Power Play (B): Sega in 16-Bit Video Games," Harvard Business School Case #9-795-103, 1995b; A. Brandenberger, "Power Play (C): 3DO in 32-Bit Video Games," Harvard Business School Case #9-795-104, 1995c; S. Gallagher, "Innovation and Competition in Standard-Based Industries: A Historical Analysis of the U.S. Home Video Game Market," *IEEE Transactions on Engineering Management*, 49/1 (2001): 67-82; *Market Share Reporter* years 1990-2000; and www.videogames.com.

Genesis, and made it backward compatible with its 8-bit Master System games. There were twenty Genesis game titles on offer by December 1989. NEC also introduced a 16-bit system, the TurboGrafx-16, in the fall of 1989, and had twelve game titles on offer by December 1989. Though Nintendo had its own 16-bit system in the works, it delayed introducing it to the U.S., fearing that it would cannibalize its 8-bit system sales.

By the end of 1989, Sega had already sold 600,000 consoles in the U.S. and NEC had sold 200,000. In 1990 and 1991, both Sega and NEC added game titles to their lists, bringing their totals to 130 and 80 respectively. By the end of 1991, Sega had sold two million consoles in the U.S. and NEC had sold one million. Unlike Sega, which produced a major portion of its games in-house, NEC relied completely on external games developers, who found the system to have only a small technological advantage over 8-bit systems.¹⁴ Developers began to abandon the NEC platform, and NEC exited the market in 1991. Nintendo finally introduced its own 16-bit Super Nintendo Entertainment System (SNES) in 1991, but it was too late to quell Sega's momentum. In 1992, Nintendo controlled 80% of the video game market based on combined 8-bit and 16-bit sales, but in 1994 and 1995, Sega was the market leader (see Table 1 for a competitive summary of the 16-bit systems).

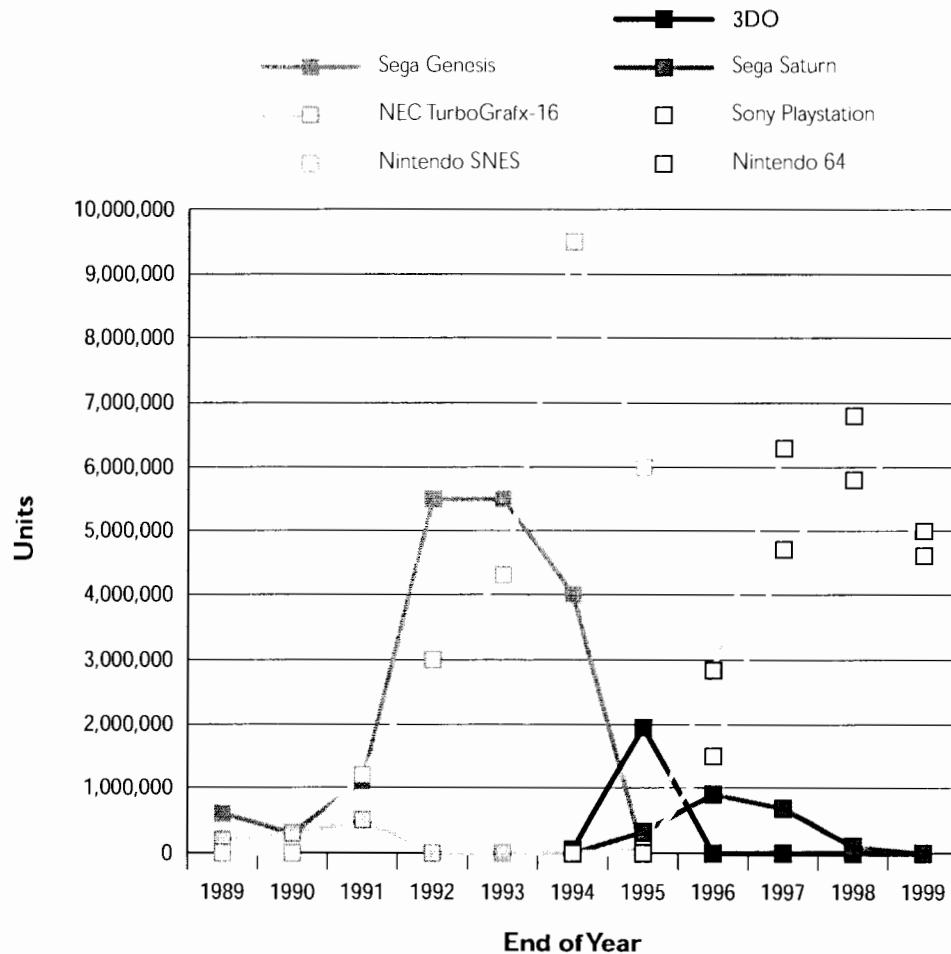
Like Nintendo, Sega made little profit on the consoles, and focused instead on increasing unit sales to drive game sales and software developer royalties. Sega, however, used less restrictive licensing arrangements than Nintendo, and consequently was able to rapidly lure a large number of developers to make Sega game titles. Further, though Nintendo could have chosen to make its 16-bit system backward compatible, thus linking the value consumers possessed in their 8-bit game libraries to the new system, Nintendo chose to make the system incompatible with the 8-bit games. By the end of 1991, the SNES had 25 game titles compared to the 130 available for Genesis. Nintendo had given Sega two years of installed base lead on a system that offered a significant technological advantage, and then entered the market at a ground zero position with respect to the availability of complementary goods. The consequence of Nintendo's late move is aptly captured in the following quote from a review of video game players published in *Fortune*: "To tell the truth, Nintendo just isn't cool anymore. This one is 16 bits, so it's better than the original Nintendo. But the company only made it to compete with Sega, and most kids already have that. So they don't need Super Nintendo, unless they're jerks and have to have everything. That's just idiotic."¹⁵ Over time sales of the Nintendo SNES accelerated, and it would ultimately prove to be one of the more successful game systems ever introduced, but Nintendo's near monopoly position had been broken; Sega had successfully technologically leapfrogged Nintendo (see Figure 1).

32/64-bit Systems

The late 1980s and early 1990s also attracted a number of other competitors to the video game market. In 1989, Philips announced its 32-bit Compact Disc Interactive (CD-i), an interactive multimedia compact disc system that would serve as a game player, teaching tool, and music system. However, the CD-i was very complex, requiring a 30-minute demonstration. Furthermore, it was expensive—initially introduced at \$799 and later reduced to a below-cost \$500 (more than twice the cost of Nintendo or Sega systems).¹⁶ Its role was very unclear to American consumers. While the product was actually much more than a video-game machine, customers compared the product to the popular Nintendo and Sega systems, and were dismayed by its price and complexity. Making matters worse, Philips was reluctant to disclose the technical specifications of the machine, greatly limiting the software development for the system. In 1996, Philips CD-i was still around, but had less than a 2% market share.¹⁷ Philips soon indicated that it would no longer push the CD-i in the U.S.

Other companies also introduced 32-bit systems, including Turbo Technologies' Duo, and 3DO's Interactive Multiplayer, but the cost of the systems (\$600-700) was prohibitive. Turbo Tech's Duo was very short lived and received little attention. 3DO's system, on the other hand, received considerable attention. 3DO was founded in October 1993 by Trip Hawkins, formerly of Electronic Arts, which made a number of games for the Sega Genesis console. Though 3DO had signed agreements with an extremely large number of developers (750 by July of 1994), most of those development agreements did not result in actual

FIGURE 1. U.S. Sales of 16-bit and 32/64-bit Video Game Consoles



Data compiled from: R. Scally, "Next-Generation Platforms Engage in Shelf-War Games," *Discount Store News*, 36/7 (1996): 45; J. Rigdon, "Game Over: 3DO Intends to Exit Hardware Business," *Wall Street Journal Europe*, 14/161 (1996): 4; A. Kasten, "Off-Computer: CD-ROM and the Game Machines," *E Media Professional* (March 1997), pp. 66-68; A. Brandenberger, "Power Play (A): Nintendo in 8-Bit Video Games," Harvard Business School Case #9-795-167, 1995a; A. Brandenberger, "Power Play (B): Sega in 16-Bit Video Games," Harvard Business School Case #9-795-103, 1995b; A. Brandenberger, "Power Play (C): 3DO in 32-Bit Video Games," Harvard Business School Case #9-795-104, 1995c; S. Gallagher, "Innovation and Competition in Standard-Based Industries: A Historical Analysis of the U.S. Home Video Game Market," *IEEE Transactions on Engineering Management*, 49/1 (2001): 67-82; *Market Share Reporter* years 1990-2000; and www.videogames.com.

game titles. The system had five game titles at launch, and forty by July 1994. Furthermore, 3DO's unique strategy of licensing out all game and hardware production made it next to impossible to achieve the low console prices of Sega and Nintendo by subsidizing console production with game royalties. 3DO's hardware producers (Matsushita and Panasonic) did not sell games and were consequently unwilling to sell the consoles without a margin. 3DO tried to rectify this problem by establishing a "Market Development Fund" whereby a

hard-core gamers. The system was based on a 64-bit RISC CPU with a clock speed of 93.75MHz. While there were only two software titles available at the console's release (one being Super Mario), the game units were sold out within weeks of their release. Though Nintendo's 64-bit system gained rapid consumer acceptance, neither Nintendo nor Sega were able to reclaim dominance over the video game industry. Though several new entrants (and one returning entrant, Atari) had tried to break into the video game industry through technological leapfrogging, only Sony had the successful combination of a product with a technological advantage, strategies and resources that enabled it to rapidly build installed base and availability of complementary goods, and a reputation that signaled the market that this was a fight it could win (see Table 2 for a competitive summary of the 32/64-bit systems).

An Unfolding Battle: 128-bit Systems

In September of 1999, Sega launched its 128-bit Dreamcast console, a \$199 gaming system that enabled narrow-band (56Kbps) access to the Internet. Prior to the Dreamcast's release, Sega was suffering from its lowest market share in years at 12%. The Dreamcast was the first 128-bit system to market, and 514,000 units were sold in the first two weeks, and achieving an installed base of 5 million by October of 2000. Sega's success turned out to be short lived, however. In March of 2000, Sony launched its 128-bit Playstation 2 (PS2) in Japan, and introduced the system to the U.S. in October of the same year. Despite price cuts on the Dreamcast, and a promotion rebate that would make the console essentially free (in exchange for a two-year contract for Sega's SegaNet Internet service) the Dreamcast was crushed in the holiday sales season.

In early 2001, Sega announced that it would cease making consoles and transform itself into a third-party developer of games for other consoles. Developer support for the system had been lackluster, and Sega's losses had been mounting in the battles against Sony's Playstation and PS2 and against the Nintendo 64. After having come close to bankruptcy, it was ready to give up the fight for the console market and focus on the more lucrative game production. Notably, it signed a deal to produce games for Microsoft's entry into the video game console business—the Xbox (Sega's Dreamcast system had been based on Microsoft's Windows CE operating system).²⁴

Sony's PS2 was an unprecedented success. During the opening sales weekend of March 4, 2000, Playstation2 sales reached about one million units, a figure that eclipsed by ten times the amount of original Playstation units sold during the three-day release period in 1994. Demand for the new unit was so high that on the opening day of pre-orders on Sony's web site, over 100,000 hits in one minute were received, and Sony was forced to briefly shut the web site down. The chip used in the system was the result of a \$1.2 billion joint venture between Sony and Toshiba, and offered a significant technological advantage over previous systems. Furthermore, the PS2 was backward compatible, enabling gamers to play their Playstation games on the console until they amassed new game libraries.²⁵

TABLE 2. Competitive Summary, 32/64-bit Video Games in the U.S.

Competitors	Philips CD-I	3DO	Atari Jaguar
Introduction	October 1991	October 1993	Fall 1993
Price	Initially \$1000, reduced to \$499 \$299 budget model	Initially \$700, reduced to \$500, reduced to \$299	Initially \$249
Technological Functionality	CD-ROM-based 32 bit 16-26 MHz clock speed NA RAM	CD-ROM (600M content) 32 bit 12.5 MHz clock speed 3M RAM	Cartridge-based, with \$200 CD-ROM add on 64 bit (equivalent to 32 bit) 13.3 MHz clock 2MB RAM
Backward Compatibility?	Not Applicable	Not Applicable	Unknown
Developers	External only	300 external developers by March, 1994; 750 by July, 1994	Internal and external
Game Titles	Emphasized educational and reference titles	5 at launch, 40 titles by July 1994, 220 by October, 1995	5 by May, 1994; 30 by October 1995

(continued on next page)

At the time of the Playstation2 release, Nintendo had just postponed the launch of its new 128-bit system, the GameCube (code named Dolphin), to a release date in the first half of 2001. The GameCube was a joint venture with Matsushita, one of Sony's main rivals, and IBM. The console promised a faster processor than that of the PS2, but its graphics capabilities would be similar. Unlike the PS2, however, the GameCube did not offer backward compatibility with N64 games. The GameCube was also targeted towards a younger market (8-18 year olds) than Sony's 16-24 year old demographic. The real threat to Sony's Playstation2 came in the form of a new entrant to the video console industry: Microsoft's Xbox.

Microsoft had previously produced PC-based computer games (such as Flight Simulator and the Age of Empires series) and operated an online gaming service (Microsoft Gaming Zone) that enabled multi-player games, and thus had some familiarity with the industry. However, it had neither the arcade experience of Sega or Nintendo nor the consumer electronics experience of Sony. The Xbox seemed a strange fit with Microsoft's product portfolio and competencies, which had historically focused almost exclusively on packaged and licensed computer software. However, both Sega's Dreamcast and Sony's Playstation2 had added the ability to access the internet, making video game consoles increasingly a threat to the personal computer industry. If video consoles became a primary portal for accessing the Internet, they could undermine the founda-

TABLE 2. Competitive Summary, 32/64-bit Video Games in the U.S. (continued)

Competitors	Sega Saturn	Sony Playstation	Nintendo 64
Introduction	May 1995	September 1995	September 1996
Price	Initially \$399, reduced to \$199	Initially \$299, reduced to \$199	Initially \$199
Technological Functionality	CD-ROM-based 32 bit 28.6 MHz clock 2MB RAM	CD-ROM-based 32 bit 34 MHz clock speed 16MB RAM	Cartridge-based 64 Bit 93.75MHz clock 36MB RAM
Backward Compatibility?	No	Not Applicable	No
Developers	Internal and external	Internal and external	Internal and external
Game Titles	4-8 games at launch	50 by end of 1995; 800 by end 2000	2 at launch; 6 by end of 1996

Note: Data compiled from: company press releases; company annual reports; A. Brandenberger, "Power Play (A): Nintendo in 8-Bit Video Games," Harvard Business School Case #9-795-167, 1995a; A. Brandenberger, "Power Play (B): Sega in 16-Bit Video Games," Harvard Business School Case #9-795-103, 1995b; A. Brandenberger, "Power Play (C): 3DO in 32-Bit Video Games," Harvard Business School Case #9-795-104, 1995c; S. Gallagher, "Innovation and Competition in Standard-Based Industries: A Historical Analysis of the U.S. Home Video Game Market," *IEEE Transactions on Engineering Management*, 49/1 (2001): 67-82; *Market Share Reporter* years 1990-2000; and www.videogames.com.

tion of Microsoft's empire. This possibility was strengthened by the fact that nearly 25% of PC households surveyed indicated that the primary use of the PC was for playing games.²⁶

Microsoft launched the Xbox in November of 2001. The Xbox targeted the 18- to 34-year-old male, positioning it directly against the PS2 rather than the Nintendo GameCube. By the time the Xbox hit the market, Playstation2 already had a significant lead in installed base and availability of games (there were more than 300 PS2 game titles available at the end of 2001), but Microsoft was counting on the technological advantages offered by the Xbox to tip consumer preferences. The Xbox operating system ran on a 733 MHz microprocessor from Intel, which was more than twice as fast as the processors used in any other game console on the market—including the Toshiba 300 MHz microprocessor supplied in the Playstation2. The Xbox had 64 megabytes of memory and a data rate of 400 megabits per second per pin with 6.4 GB per second bandwidth, enabling more information to be processed faster. The Xbox memory chip would give game developers nearly twice the memory offered in other game consoles. The Xbox also offered a 10 gigabyte hard drive, enabling gamers to save a virtually unlimited number of games. Customers also did not

have to trade off technological advantages against price: the Xbox launched at a retail price of \$299, significantly less than its production costs (it is estimated that Microsoft loses between \$100 and \$125 per unit).²⁷

To rapidly deploy the console and build installed base, it leveraged its existing relationships with distributors that carried its software, though it was now forced to seek much greater penetration into distributors such as Toys “R” Us, Babbage’s, and Circuit City. Microsoft also faced the challenge of cultivating a radically different brand image in the game console market than the one that it had achieved in the software market, and to make much greater use of marketing channels such as television advertising and gaming magazines. To that end, Microsoft budgeted \$500 million to be spent over 18 months to market the Xbox—more than any other marketing campaign in the company’s history.²⁸ Microsoft’s biggest brand disadvantage was its lack of a big hit game that carried the sales of the console (e.g., “Mario” for Nintendo, and “Gran Turismo” for PS2).

To ensure that there would be wide availability of complementary goods, Microsoft both utilized in-house development and aggressively pursued licensing arrangements with third-party developers. By 2001, Microsoft was well established as a leader in developing PC games (“Age of Empires,” for example, was the fourth best selling PC game in 2000), and planned to produce 30-40% of games in-house (similar to Sony’s percentages). To attract developers, Microsoft gave away \$10,000 game development kits and funded focus research groups for games.²⁹ Furthermore, because Microsoft used its DirectX technology in the Xbox, it would be very easy for existing PC game developers to transition to the console.

Both the Xbox and Nintendo’s GameCube were launched in November of 2001 (in time for the extremely important Christmas season) and sold briskly. By the year’s end, it was estimated that 1.3 million GameCube units had been sold, and 1.5 million Xbox units had been sold.³⁰ However, both of the new consoles were outrun by PS2, of which approximately 2 million units were sold during the month of December, bringing its worldwide installed base to over 20 million units.³¹ PS One (a modified version of the original Playstation) was also selling well at its \$99 price tag.³² The Playstation2 continued to outsell the Xbox and Gamecube in 2002. By September 30, 2002, estimates put both Xbox and Gamecube sales at just under seven million units worldwide, and Playstation2 unit sales at over 40 million worldwide.³³ Furthermore, the number-one best selling video games in 2001 and 2002, “Grand Theft Auto III,” and its sequel, “Grand Theft Auto: Vice City,” were available only on the Playstation2 platform (see Table 3 for a competitive summary of the 128-bit systems).³⁴

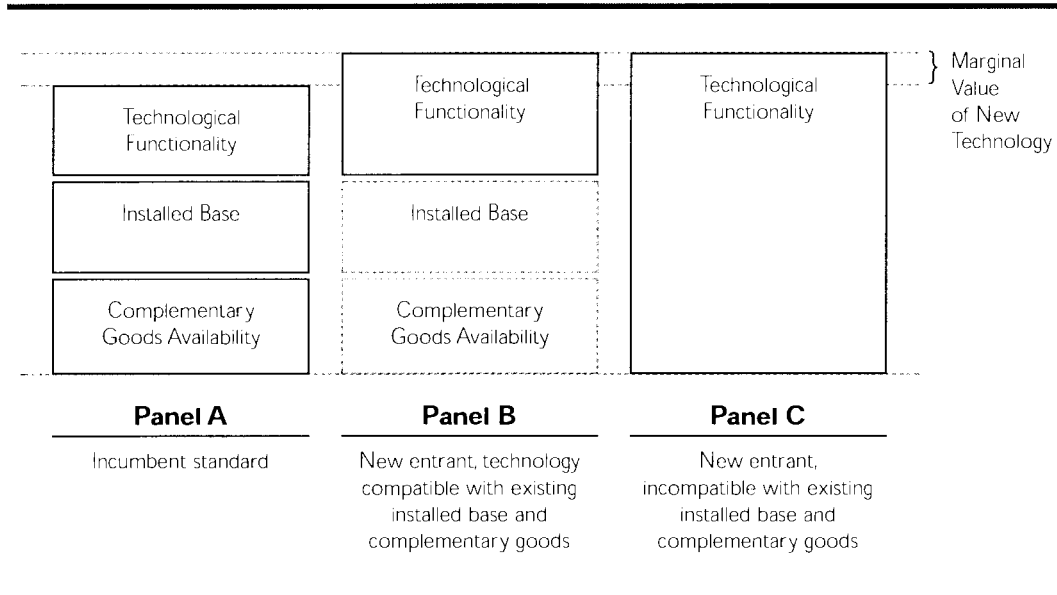
TABLE 3. The Current Battle: 128-bit Video Games in the U.S.

Competitors	Sony Playstation2	Microsoft Xbox	Nintendo GameCube
Introduction	March 2000	November 2001	November 2001
Price	\$299	\$299	\$199
Technological Functionality	CD/DVD-based 128 bit 300 MHz clock speed 38 MB RAM Broadband Compatible	CD/DVD-based 128 bit 733 MHz clock speed 64 MB RAM Broadband Compatible	Mini-Disc-based 128 bit 485 MHz clock speed 40MB RAM
Backward Compatibility?	Yes	Not applicable	No
Developers	Internal and External; 40% of games produced in-house	Internal and External; 40% of games produced in-house	Internal and External; 80% of games produced in-house
Game Titles	About 300 by December, 2001; 483 by March, 2002; 1582 by December 2002 (334 specific to PS2, 1248 for PS1 but playable on PS2)	About 40 by December 2001; 205 in March, 2002; 215 by December 2002.	About 20 by December, 2001; 117 in March, 2002; 306 by December 2002.

Strategies for Successful Leapfrogging

Multiple Dimensions of Value

The value to consumers of technologies characterized by network externality effects can be divided into (at least) three primary components: technological functionality, size of the installed base, and availability of complementary goods (see Figure 2, panel a). Thus for a new entrant to successfully enter, it must find a way to yield more total value than that yielded by the incumbent technology. A new technology might be successful by making it compatible with the existing installed base and complementary goods while offering a marginal advantage in technological functionality (see Figure 2, panel b). Alternatively, if the new entrant is unable (or unwilling) to make its technology compatible with the existing standard, it may compete on technological functionality advantage alone, but this functionality advantage must offer so much value to the customer that it exceeds the combination of functionality, installed base, and complementary goods value offered by the incumbent technology standard (see Figure 2, panel c). This is why even technologies that offer a significant functionality advantage over previous offering may not, in fact, offer additional value over the incumbent standard. It is also evident that for an incompatible new technology to compete on technological functionality alone, the technological advantage it offers must be so large that it eclipses the installed base and the complementary goods value offered by the existing standard.

FIGURE 2. Components of Value

It is important to note also that when customers are comparing the value of a new technology to an existing technology, they are weighing a combination of objective information (e.g., actual technological functionality, actual information on installed base or complementary goods), subjective information (e.g., perceived technological advantage, and perceived installed base or complementary goods), and expectations for the future (e.g., anticipated technological advantage, anticipated installed base and complementary goods). Thus each of the primary value components described above also has corresponding perceived or anticipated value components (see Figure 3). In Figure 3, panel a, the perceived and expected value components map proportionately to their corresponding actual components. However, as depicted in panel b, this need not be the case. For instance, perceived installed base may greatly exceed actual installed base, as depicted in panel b, or customers may expect that a technology will eventually have a much larger installed base than competitors and thus the value accrued from the technology's installed base is expected to grow much larger than it is currently. Each of these instances was demonstrated in the U.S. video game industry.

Creating a Technological Gap

As noted, new technologies must typically offer a functionality advantage over the existing standard, and this advantage must be particularly large if the technology is incompatible with the existing installed base or complementary goods. For this reason, often only radical innovations are capable of overthrowing an entrenched standard.³⁵ The functionality advantage offered by the technology must be readily apparent to customers, and firms may have to invest in customer education to facilitate consumer appreciation of the new technology's

games or experience to leverage. By the time Nintendo introduced its own 16-bit system, it had already lost its dominant position. Furthermore, Nintendo did not offer any upgrade incentive to lure its existing 8-bit users to the 16-bit platform. Consequently, when 8-bit users were ready to buy a 16-bit system, there was little reason for them to stay with Nintendo (this was exacerbated by Nintendo's decision to not make its 16-bit systems compatible with its 8-bit games). Nintendo spent heavily in advertising and fought fiercely to regain market share. By 1994, it appeared that the tide was again tipping towards Nintendo's favor, but by this point Sega was already transitioning to its new 32-bit system, the Sega Saturn (see Figure 1).

Similarly, both Sony and Microsoft entered the market with products that offered dramatic technological advantages. When Sony first introduced its 32-bit Playstation, Sega already had its own 32-bit system, and several other competitors (e.g., Atari, 3DO, and Philips) had beaten both Sega and Sony to market with 32-bit systems. The Playstation, however, had a much faster clock speed (34 MHz to Sega's 28.6 MHz, Jaguar's 13.3 MHz, and 3DO's 12.5 MHz) and more than five times the RAM of any other existing 32-bit competitor. Further, unlike the other new entrants, only Sony combined the technological advantage of its system with a set of complementary strategies and resources that enabled it to wrest control of the video game industry from Sega and Nintendo. Similarly, Microsoft's Xbox would be relatively late to the 128-bit generation, but it would arrive with a clock speed of 733 MHz (more than twice that of Playstation2), and 64 MB of RAM (compared to 38 MB in the Playstation2).

Building Installed Base and Availability of Complementary Goods

There are a number of strategies a new entrant can employ to increase the value its technology offers in the form of actual installed base and complementary goods. The new entrant can tap the value of the existing installed base and complementary goods through making the new technology compatible with the incumbent standard. It can offer the product at an aggressive discount to encourage adoption and use alliances to rapidly deploy the technology and encourage development of complementary goods. It can also sponsor the third-party production of complementary goods or produce them in-house to ensure that a wide range of complements are available. It can also work to reduce customer resistance to adopting the new technology by lowering customer switching costs. Incumbents, in turn, have a number of strategies they can use to protect their installed base and complementary goods advantages. First, they can attempt to prevent a new entrant's technology from being made compatible with the existing installed base and complementary goods. The incumbent can use attractive and/or powerful licensing and distribution policies to tie existing complementary goods providers and distributors closely to the current standard, and create switching costs for customers. The incumbent can also make new generations of its own standard backward compatible. Backward compatibility allows the incumbent to leverage its advantage in installed base and complementary goods across generations.

Compatibility with Existing Hardware and Software

Customers considering adoption of a new technology typically face switching costs in the form of investment in their current system, investment in complementary goods and other peripherals, familiarity with use of the system, and possible forfeiture of compatibility with others using the incumbent system. When possible, one of the fastest ways to ensure the new technology yields the value of a large installed base and availability of complementary goods is to make it compatible with the existing standard and complementary goods. A firm that is able to introduce a new technology that is compatible with existing complementary goods dramatically lowers the customer's switching costs.

As noted, one of the ways the incumbent standard bearer may protect its installed base and complementary goods advantages is to prevent them from being compatible with those of future entrants. Most competitors in the U.S. video game industry (with the exception of Atari) have been fairly successful at this strategy. Nintendo, for example, uses a security chip to ensure that only licensed Nintendo games may be played in their consoles, and only Nintendo consoles may be used to play Nintendo games. Nintendo's licensing arrangements during the 8-bit era also stipulated that developers were forbidden to develop comparable games for competing platforms. However, increasing competition over game developers (and pressure from the Federal Trade Commission) drove Nintendo to loosen its licensing policies in later generations.

In other industries, entrants offering a new technology platform have often been more successful in ensuring compatibility with the installed base or complementary goods of the incumbent standard. For instance, Sony and Philips new audio format, Super Audio CD, is a high density multi-channel audio format based on a revolutionary "scalable" bitstream technology known as Direct Stream Digital. However, the new Super Audio CD systems will include a feature that enables them to play standard CDs and, by including a CD audio layer in addition to the high density layer on recorded Super Audio CDs, most of the new discs will be playable on standard CD systems. Thus customers may transition to the new technology gradually, and they may do so without feeling compelled to replace their existing music libraries.

A particularly powerful defensive strategy on the part of the incumbent is to combine continuous innovation with backward compatibility. The incumbent that both innovates to prevent a competitor from creating technological gap and utilizes backward compatibility so that its new platform or models are compatible with previous generations of complementary goods can leverage the existing value yielded by a large range of complementary goods to its new platforms. While such a strategy may cause the firm to forfeit some of the sales of complementary goods for the new platform (at least initially), it can also effectively link the generations through time and can be a very successful way of transitioning customers through product generations while preventing competitors from having a window to enter the market. Microsoft has utilized this strategy deftly with Windows—though the operating system is regularly updated, each successive generation provides backward compatibility with most of the major software

applications developed for previous generations. Thus customers can upgrade without having to replace their entire libraries of software applications. By contrast, when Nintendo introduced its 16-bit system (and later its 64-bit system) it prevented the system from being compatible with 8-bit Nintendo game systems (which existed in tremendous range), believing that it would be more profitable to require customers to purchase new games. This is understandable given that the consoles were sold at cost and profits were made through game sales. However, it also meant that the Nintendo forfeited a significant potential source of advantage over Sega. In contrast, Sega made its 16-bit Genesis compatible with its 8-bit Master System games though this may not have proven terribly persuasive to customers given the limited success of the Master System. More significantly, Sony made its Playstation2 console backward compatible with Playstation games, thereby not only ensuring that there was a tremendous existing library of compatible games at its launch, but also providing a significant incentive to Playstation owners that were considering upgrading to a 128-bit system to choose the Playstation2, as opposed to Sega's Dreamcast or waiting for the Xbox or Gamecube.

Aggressive Discounting

Part of the firm's aggressive promotion strategy may also be to offer the product at a greatly discounted price (or free, as in the case of the web browser wars) in order to rapidly deploy its product.³⁶ In network externality industries, firms may initially offer products at or below cost in order to rapidly deploy the product, with the hope of recouping profits through later sales on either the core technology or complementary goods once the standard is established. In the video game industry this has proven to be a very important strategy. Nintendo, Sega, Sony, and Microsoft have each employed a strategy of selling consoles at a price very close to (or below) production costs while profiting from subsequent game sales and licensing royalties (see Tables 1, 2, and 3). The systems offered by Philips and 3DO, by contrast, were both introduced at price points that were more than triple the price of 16-bit systems, and twice the launch prices of 32-bit systems ultimately introduced by Sega and Sony.

Alliances and Attractive Licensing Policies

Firms introducing a new technology standard can use strategic alliances with manufacturers of complementary goods and with distributors to more rapidly deploy the technology.³⁷ Through alliances with manufacturers of complementary goods, the firm may be able to negotiate joint promotion of the new technology with other goods or a strategic bundling relationship whereby the new technology is bundled with another good that already has a wider market presence. Manufacturers of complementary goods may be particularly likely to engage in such joint promotion if they believe that they will be able to extract a larger portion of the combined value of the bundle than they are under their current situation with the existing standard.

Firms can also use strategic alliances with distributors to rapidly deploy their goods. For instance, by providing a distributor a stake in the success of the new standard, the firm may be able to persuade the distributor to carry and promote the new technology much more aggressively than they would otherwise. Firms that already have relationships with distributors for other goods are already at an advantage in pursuing this strategy; firms without such relationships may need to cultivate them or even consider forward vertical integration to ensure that their product is widely available.

Lack of distribution may have contributed significantly to the failure of the Sega Saturn to gain an installed base. Sega had limited distribution for its Saturn launch, which may have slowed the building of its installed base both directly (because customers had limited access to the product) and indirectly (because distributors that were initially denied product may have been reluctant to promote the product after the limitations were lifted). Nintendo, by contrast, had unlimited distribution for its Nintendo 64 launch, and Sony not only had unlimited distribution, but had extensive experience with negotiating with retailing giants such as Wal-Mart for its consumer electronics products. Consequently, Sony Playstation had better distribution on its first day of business than the Sega Saturn, despite Sega's decade of experience in the market.³⁸

The incumbent, in turn, must go to great lengths to retain its existing relationships with complementary goods and with distributors, and it must ensure that its licensing and pricing policies are attractive. An incumbent controlling an entrenched standard can have tremendous power in an industry. It is the beneficiary of the market's tendency to produce a natural monopoly, and it has the opportunity to exploit this monopoly power by extracting greater rents from customers and the other industry players such as complementary goods providers and distributors. However, an incumbent that wields this power too forcefully may find that its customers, complementary goods providers and distributors are more willing to support a potential entrant's technology, even if the new technology poses switching costs or some risk of failure. An entrenched incumbent may attempt to thwart such a possibility by locking complementary goods providers and distributors into long-term exclusivity contracts. However, such a position can be difficult to sustain. A strategy with a greater probability of success is to nurture the relationships with customers, complementary goods providers, and distributors by not tapping the full monopoly power available to the incumbent. This translates into charging more reasonable prices than could be extracted from consumers and enabling complementary goods providers and distributors to retain more of the profit (or bear less of the risk) than their relative bargaining power demands. The U.S. video game industry provides several examples of the importance of this strategy.

When Nintendo controlled approximately 85% of the 8-bit video game market, its licensing policies with game producers ensured that Nintendo reaped most of the profits while the game producers bore most of the risk. Game producers were only permitted to produce a maximum of five titles for Nintendo, encouraging them to sink heavy research and development funds and market

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research into only a few titles. Once titles were approved by Nintendo, the game producers were required to give the design to Nintendo who would have its own contract manufacturers produce the game cartridges. The game producers were then required to purchase a minimum order of 10,000 of the cartridges from Nintendo, thus ensuring that the games producers bore all the investment risk for the games. On top of the payment for the minimum order of cartridges, games producers were also required to pay royalties to Nintendo for each game copy actually sold. Thus Nintendo's policies ensured that it received the lion's share of the profits of third-party games while bearing almost none of the risk. Games producers continued to make games for the Nintendo system while Nintendo held a near monopoly position, but upon Sega's introduction of its 16-bit Genesis, accompanied by more attractive licensing policies, many developers flocked to the new system. Nintendo was subsequently forced to loosen its licensing restrictions in order to compete for third-party developer support.

In-House or Sponsored Production of Complementary Goods

If the new entrant is unable to secure production of complementary goods through alliances or other incentives, it may be in its best interest to produce complementary goods itself or sponsor their production in another firm. There are a number of ways that a firm can sponsor the production of complementary goods. It might offer purchase guarantees for a specified quantity and price. It might provide the initial capital outlay or in other ways bear the investment risk of establishing production. It may even opt to pay for all (or a portion) of production costs.

Nintendo, Sega, Sony, and Microsoft all had in-house game production in addition to aggressive licensing policies. NEC, 3DO, and Philips, by contrast had no in-house games production, and the strict reliance on external developer support proved dire.

Reducing Resistance

The entrant can reduce both the real and perceived risk of adopting the system by offering guarantees. When there is uncertainty about whether a new technology will succeed in toppling the existing standard, customers, distributors, and complementary goods producers, face great risk in supporting the new technology. Should the technology fail to gather the necessary momentum, customers may find that they have borne switching costs only to end up with a technology that is incompatible with that used by other buyers, that lacks complementary goods, and that is not further developed over time. Similarly, distributors might end up with inventories of products that cannot be sold, and that have a rapidly eroding value. Complementary goods producers may find that they have forfeited both their production cost investment and the value of their time and effort devoted to developing complementary goods for a technology with little future.

By offering full money-back guarantees to customers (or distributors), the firm creates an option for the customer to reverse their switching costs (at least

that portion accounted for by the purchase price of the product platform) should the technology not be successful. Thus while the customer still faces switching costs to adopt the new technology, their risk of loss of the switching cost investment is reduced. A similar argument for complementary goods producers was already made: the firm can guarantee particular quantities of goods to be purchased or provide the capital for production itself, thus bearing the bulk of the risk of producing complementary goods for the technology. The complementary goods producer may still have forfeited time or effort in producing goods that may not have a long-term market, but the direct costs will be less at risk. An excellent example of this was the original Nintendo NES system. After the crash of the video game industry in 1984/1985, distributors were understandably reluctant to stock new consoles and games. As a result, Nintendo introduced its 8-bit system to the U.S. by selling it on a consignment basis. Retailers thus bore little risk in distributing the good because unsold units could be returned to Nintendo, and the video game industry was reborn.

By contrast, once a firm's technology is entrenched as the standard, it is in its best interest to build customer switching costs. As already mentioned, the incumbent can encourage upgrading to the incumbent's newest platform, both increasing switching costs and reducing the likelihood of a new entrant achieving a significant technological gap. However, another more subtle way of increasing customer switching costs is through the provision of peripheral add-on devices specific to the platform. For instance, a competitor that can induce video game customers to buy additional joysticks, 3D headsets, or other accessories can ratchet the customer's investment in the platform to higher levels and increase their resistance to an incompatible system offered by a potential competitor. This indicates that peripheral devices play more strategic importance than simply providing additional revenue streams—they are ties that further bind the customer to the platform. This, in turn, implies that the incumbent may wish to invest more in development of such accessories than standard NPV analysis of the projected revenue streams from the devices would indicate.

Shaping Perceptions and Expectations through Signaling

Another key element in the battle to overthrow an existing standard is signaling: the sponsor of the new technology may be able to influence the perceived installed base and availability of complementary goods through advertising, vaporware, and press releases extolling forecasted sales. Sponsors can also shape expectations about the future of the technology by signaling the market (including distributors, end users, manufacturers of complementary goods, and perhaps even other potential contenders for the new standard) that this is a battle it intends to win and is capable of winning. The firm's reputation in prior markets may create a signal about its likelihood of success. Firms may also use credible commitments such as major fixed capital investments and guarantees to convince stakeholders that the firm has what it takes to challenge the incumbent(s).

Advertising and Vaporware

A firm that aggressively promotes its products can increase both its actual installed base and its perceived installed base. Even products that have relatively small installed bases can obtain relatively large “mindshares” through heavy advertising (thus Microsoft’s \$500 million marketing budget for the Xbox). Since perceived installed base may drive subsequent adoptions, a large perceived installed base can lead to a large actual installed base. Such a tactic underlies the use of “vaporware”—pre-advertising products that are not actually on the market yet, and may not even exist—by many software vendors. By building the impression among customers that a product is ubiquitous, firms can prompt rapid adoption of the product when it actually becomes available.³⁹ Vaporware may also buy a firm valuable time in bringing its product to market. If other vendors beat the firm to market and the firm fears that customers may select a dominant design before its offering is introduced, it can use vaporware to attempt to persuade customers to delay purchase until the firm’s product is on offer.

The Nintendo 64 provides an excellent example. In an effort to forestall consumer purchases of 32-bit systems, Nintendo began aggressively promoting its development of a 64-bit system (originally named Project Reality) in 1994, though the product would not actually reach the market until September 1996. The project underwent so many delays that some industry observers dubbed it “Project Unreality.”⁴⁰ Another interesting vaporware example was Nintendo’s –re-writeable 64M disk drive. Though the product was much hyped, it was never actually introduced.

The major video game producers also go to great lengths to manage impressions of their installed base and market share, often to the point of exaggeration or deception. For example, at the end of 1991, Nintendo claimed it had sold two million units of the SNES to the U.S. market, while Sega disagreed, arguing that Nintendo had sold one million units at most. Nintendo also forecast that it would sell an additional six million units by the end of 1992 (actual installed base of SNES systems in the U.S. reached just over four million units in 1992). By May of 1992, Nintendo was claiming a 60% share of the 16-bit market, and Sega was claiming a 63% share.⁴¹ Similar tactics were deployed in the battle for the 32/64-bit market. For example, in October 1995, Sony announced to the press that it already had pre-sold 100,000 consoles in the U.S., to which Mike Ribero, Sega’s executive vice president for marketing and sales countered that Sony’s figures were deceptive, arguing that many preorders would never materialize into actual purchases.⁴²

Reputation

When a new entrant is poised to challenge an entrenched dominant design, its reputation for both technological and commercial competence will critically influence the market’s expectation about its likelihood of success. Customers, distributors, and complementary goods producers, will use the firm’s track record for technological innovation as an indicator of the new product’s

functionality and value. The firm's degree of prior commercial success acts as an indicator of the firm's ability to build and manage the necessary support network around the new technology (distribution, advertising, alliances) to create the necessary momentum in the installed-base/complementary-goods cycle.

When Sega originally entered the market, it had the benefit of having several highly successful arcade games to its credit (both Atari and Nintendo had also been arcade game producers prior to developing home video games). The company thus entered with a reputation for developing exciting games, and this reputation may have facilitated customer acceptance of its 16-bit challenge to Nintendo's 8-bit dominance. By contrast, when Sony entered the video game market, it did not have the arcade background that underscored the other primary competitors. However, it did have a wealth of technological expertise as a consumer electronics manufacturer, and exceptional brand equity in electronic products. Furthermore, Sony had demonstrated its ability to win a format war through its successful introduction of the CD format (with Philips) that supplanted vinyl records and analog cassettes.⁴³

Similarly, reputation is probably Microsoft's greatest strength in the battle for dominance over 128-bit video game systems. Microsoft's near monopoly in the personal computer operating system market was achieved through its unrivaled skill in using network externalities to its advantage. Microsoft had skillfully leveraged its controlling share in the PC operating systems into domination over many categories of the software market, obliterating many would-be competitors in the process. Microsoft's reputation thus sent a strong signal to distributors, developers, and customers that would shape their expectations for its future installed base and availability of complementary goods. Its success was not assured, but it was a powerful force to be reckoned with.

Credible Commitments

A firm can also signal a market its commitment to winning its fight to enter an industry by making substantial investments that would be difficult to reverse. For example, it was well publicized that Sony spent over \$500 million developing the Playstation. It would also manufacture the system itself, as well as establish an in-house games development unit. By contrast, 3DO's cumulative research and development costs at the time of the launch of its multiplayer were less than \$37 million, and the company utilized a strategy whereby all console and game production was performed by third parties. Thus 3DO may not have signaled the market that it had enough confidence in the platform to bear the brunt of the capital risk.

While both incumbent and potential entrant may benefit from shaping perceptions or expectations about installed base and availability of complementary goods through aggressive advertising, reputation, and credible commitments, it is worth noting that the incumbent is typically at a significant advantage in actual installed base and availability of complementary goods. The incumbent may leverage this by aggressively advertising comparative figures

based on actual data, thus defusing any inflated perceptions the potential entrant may have been able to achieve.

Discussion

Though the analysis has thus far been limited to the U.S. video game industry for the sake of brevity and clarity, it should be readily apparent that these concepts should apply equally well to many other industries demonstrating network externalities. For instance, in the personal digital assistants (PDA) industry, Microsoft has several times tried to displace Palm as the market share leader in the U.S. (Palm holds roughly a 75% share in the U.S. PDA operating system market) by offering technologically advanced versions of its product. Palm, however, has vigorously defended its platform by continually offering its own more advanced systems, and ensuring compatibility in applications across versions. Both companies enthusiastically encourage licensing to third-party developers. Globally, this battle is much more complex, as Psion holds a dominant share in PDA operating systems in Europe (and is better positioned than either Microsoft or Palm to transition to "smartphones," wherein PDAs and cell phones will converge) and NTT's DoCoMo holds a near monopoly position in Japan with a PDA that incorporates 2.5 generation (2.5G) telecommunication technology (called "i-mode") and is connected to the internet at all times.⁴⁴

In audio formats, the DVD consortium (including Matsushita, Hitachi, and almost a dozen others) are trying to wrest control over audio formats from Sony and Philips, which developed the currently reigning compact disc (CD) audio format, and as a result have received substantial royalties over the last decade. The consortium has introduced a new, more advanced standard based on technology very closely related to that used for digital video disks. Though Sony and Philips purportedly support the new DVD audio standard promoted by the consortium, they have also developed and introduced their own competing format called SuperAudio disk, as mentioned previously. To ease customer switching costs, Sony and Philips enabled backward compatibility in both the disks and players.⁴⁵ While both formats represent a technological leapfrogging over the existing audio format standard (the technological functionality of the systems are comparable, though Sony and Philips' system is considered to be slightly superior, and is more expensive), they are each positioned differently with respect to capitalizing on the other sources of value in network externalities industries. The consortium's offering is better positioned to enable DVD audio player and DVD video player convergence in the future, which may provide a signal to customers about the future installed base and complementary goods, given the fast growth of DVD video players and recorded material. Sony and Philips' offering, by contrast, is better able to leverage the value customers currently receive from the size of the existing installed base of CD players and the availability of complementary recorded CDs, to their new platform.

Conclusion

Technological leapfrogging requires more than a significant technological advantage; it requires managing a whole system of value components such that the new product can offer value (real, perceived, or anticipated) that significantly exceeds the value offered by the entrenched standard, even when externality sources are taken into account. The cases and framework presented here suggest specific strategies both for the new entrant to successfully leapfrog the entrenched incumbent, and for the incumbent to defend its market position:

New Entrant

- **Create a technological gap** that is significant, and ensure that the technological advantages offered by the new offering are well understood by customers.
- **Build installed base and availability of complementary goods** through strategies such as:
 - making the new technology compatible with the incumbent's installed base and complementary goods,
 - forming alliances with manufacturers of complementary goods and distributors,
 - using attractive licensing and distribution policies to attract third-party developers and distributors,
 - sponsoring production of complementary goods or producing them in-house,
 - using aggressive discounting to promote rapid adoption by consumers, and
 - reducing resistance by offering guarantees to distributors and customers.
- **Shape perceptions and expectations through signaling** through strategies such as:
 - advertising and vaporware to inflate "mindshare" and promote an impression that the installed base is (or very soon will be) very large,
 - leveraging the firm's reputation for success in prior markets to the current market, and
 - using credible commitments to signal the market that this is a battle the entrant intends to win.

Incumbent

- **Prevent the technological gap** by investing in continuous innovation, willingly cannibalizing existing platforms with more advanced platforms, and offering incentives for existing customers to upgrade to the newest platform.

- **Protecting installed base and complementary goods advantages** through such strategies as:
 - preventing compatibility of the existing platform and complementary goods with the offerings of a new entrant,
 - making each generation of the incumbent's platform backward compatible so that installed base and complementary goods advantages from previous generations are leveraged into the new generation,
 - using attractive licensing and distribution policies to ensure that complementary goods providers and distributors are not lured away by the new entrant, and,
 - increasing the switching costs of customers by encouraging them to upgrade to new platforms, and through providing additional services or peripherals that tie the customer to the incumbent's technology.
- **Shape perceptions and expectations through signaling** by investing heavily in advertising that both emphasizes the incumbent's actual installed base and complementary goods advantage, while also building the perceived or expected installed base in the incumbent's future platforms.

The preceding also yields implications for firm characteristics and resources that will benefit a potential entrant. Clearly a reputation for technological expertise, brand image, and a network of existing relationships with complementary goods providers and distributors will improve a new entrant's chances for success. Another characteristic of note is firm size. It is often argued that large firms have greater inertia, or are more conservative, and are thus unlikely to usher radical new innovations into an industry. However, it is precisely such large firms that have the deep pockets required to pay for scientific research, that may have extensive access to and leverage over distributors, and that have the reputation to signal the market that this is a fight they can win.⁴⁶

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43. It is interesting to note that Philips should have also benefited from such reputation effects; however, its product was considerably more expensive and not targeted directly at the games market. Philips also did not have the extensive relationships with software developers and other content providers that Sony had.
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45. J. Palacio, M.A. Schilling, and H. Shiotani, "Shrinking the Standard: Sony Corp. and the MiniDisc," in M. Hitt, D. Ireland, and B. Hoskisson, *Strategic Management: Competitiveness and Globalization* (St. Paul, MN: West Publishing, 2001).
46. Chandy and Tellis, op. cit.