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Managing network effects in high-tech markets

Jean-Philippe Bonardi and Rodolphe Durand

Executive Summary

Many high-tech markets are characterized by network effects: situations where consumers make their decisions not simply based on the core product, but also on the quality and availability of its complements. These network effects enable the creation of a technological standard, which can lead to a strong competitive position for the core-product manufacturer. There is no guarantee, however, that this position can be sustained over time. Managers must therefore focus on further developments of the core product. We argue here that the best way to stimulate further developments is to reposition the core product in order to strengthen network effects. A three-phase framework can determine how to make an investment in the future generation of a product for which complements are crucial. First, we provide a matrix to evaluate whether the existing technology presents some untapped potential in terms of network effects; second, we analyze how to reposition the core product; third, we suggest some accompanying measures to manage this repositioning efficiently.

Background and Importance of Network Effects

Audio tapes, VCRs, audio CDs, video games, computers, handheld computers, DVDs, Internet service providers: for end-consumers, the usefulness of these technologies depends highly on complements such as music tapes, movie cassettes, music CDs, games, software, etc. Creating a competitive advantage in these markets, therefore, will come both from the core product itself (for instance, computer hardware) and from the availability and quality of its complements (for instance, computer software). A great selection of high-quality complements boosted Sony's market share to more than 70 per cent in the video game market with PlayStation. Conversely, a shortage of these complements virtually led Sega, one of Sony's key competitors, out of the market. Because complements are so important for core-product sales, managers must look at these two dimensions simultaneously, both when they prepare their business plan with a view to investing in a technology of this kind and when they manage the product on a day-to-day basis.

Recent literature in economics and management has certainly recognized this point and offers important suggestions for the development and management of the core-product technology.[1] Systems that require both a core product and complements have been identified in this literature as being characterized by network effects.[2] Such effects occur when the value that a consumer receives from a product is affected by whether other consumers are using the same product (i.e., the consumers become members of the same network).[3] For core products that work with complements, the consumer value of the products is influenced by the availability, amount, and quality of the complementary products or services. The user of a product is affected directly, by the number of other consumers having adopted this product, and indirectly, if too few consumers have chosen the same product, leading to complements not being provided with consistency and quality, or perhaps not being available at all.[4]

Consequently, a stable base of consumers using the same core product is key to success in these competitive markets. Network effects often lead to technological standards prevailing in an industry, thereby locking other products or technologies out of the market.[5] Imposing a technological standard can generate strong positions with high market shares and can develop a competitive advantage.[6] Well-known examples include Matsushita's VHS

video technology to the detriment of Sony's Betamax,[7] MS Word and WordPerfect word-processing software triggering the lock-out of MicroPro WordStar, Philips' Compact Cassette over 8-track cartridges,[8] and Philips/Pioneer's laser disc versus VHD and RCA's Selecta Vision.[9] Existing research in economics and management supports the ability of network effects to strengthen the competitive positions of core technologies that depend on the success of their complements.

A critical question has been largely ignored: what are the key dimensions that managers need to consider when they plan for the next generation of a core-product technology? Consider the DVD as an example. It was crucial for DVD manufacturers to ensure that movie companies would invest in producing DVDs, in order for consumers to value and buy the core technology: the DVD player. The success of the DVD technology, however, did not mean that the competitive game and the need for strategic planning were at an end. Companies had to decide where to go with the next generation of the technology. Different choices in terms of future investments could, in fact, be observed. In 1998, Circuit City introduced a new technology, the DIVX, which was a pay-per-view alternative to the DVD. The DIVX was connected to a central system through a modem, and users simply called in to rent a movie. By the end of 1998, the installed base of DVD players was about 1.32 million against 160,000 for the DIVX. In May 1999, there were 3,317 titles available in the DVD format and only 471 for DIVX. Circuit City stopped producing DIVX systems in June 1999.

Conversely, other companies seem to have been much more successful with further investments in DVD technology. Two groups of companies have developed a DVD burner standard that will allow consumers to create a video-disk and show it in their living rooms. One group, led by Hewlett-Packard and Philips, promotes the DVD-RW technology. Toshiba, Panasonic, and Pioneer support the rival DVD + RW standard. The DVD burner technology, unlike the DIVX example, is already a great success in the United States.

Why did the DIVX investment fail, yet the DVD burner is likely to be a success? Is there a systematic way to analyze this type of investment in the future generation of a core product/technology? In this article, we propose a three-phase framework that managers can use to answer these questions. As indicated in Figure 1, the first phase evaluates the potential of a technology in terms of network effects and determines whether the benefits derived from complements can be increased. A tool called the network-effects matrix ranks a technology on two dimensions: the transferability of its complements, which considerably increases the diffusion of core products; and the dependence of the core product's technology on its complements, which indicates how the value is shared between the core product's producers and complements' developers.

Once the core product's untapped potential has been evaluated, the second phase of our framework looks at how to reposition it. Investment in future developments of the underlying technology can cause a product to progress to a more favorable position in the matrix. We also explain why some moves within the matrix, such as the one triggered by the investment in the DIVX technology, might, in fact, be mistakes.

Finally, the third phase of our framework suggests some accompanying decisions that should be put in place in order to efficiently manage the move from one part of the matrix to another. These strategic decisions are mainly focused on three dimensions: the compatibility of the core product's technology with existing and competing technologies; the price of the core product/technology relative to the price of the complements; and some potential vertical integration of complements' developments for the core-product manufacturers. To conclude, we comment on some additional factors that may nonetheless hamper the repositioning.

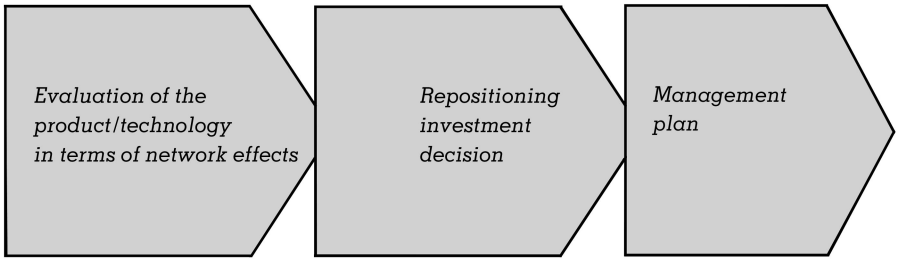

FIGURE 1
Repositioning a Product: A Three-Phase Approach

A THREE-PHASE MANAGERIAL FRAMEWORK

Phase 1: Evaluating the core product: Where are you in terms of network effects?

Network effects are a key competitive factor in markets where, for end-users, the value of the core product strongly depends on the availability and quality of complements. This availability can occur if consumers can purchase many different complements and if consumers can lend these complements to each other. Regarding future investments, managers operating in these markets must ask themselves two questions: How can we strengthen network effects to make our product a standard in the future? Do we want to increase or decrease our dependency on complements?

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Markets in which technology plays an important role are also markets where potential competition is strong. Even if a company has developed a technological standard, the new generation of this technology might disrupt its strong competitive position.[10] Potential competition is therefore as important as existing competition for managers in these high-tech industries.[11]

The answer to the second question, whether to increase or decrease dependency on complements, is related to a core-product manufacturer's willingness to depend on complements. Do managers want to increase dependency on complements or do they want to decrease this dependency? Increasing a product's dependency on complements might be tempting since customers value the combination of the core product and its variety of complements. One risk for core products makers, however, is a loss of bargaining power as most of the standard-related profits may be transferred to complements developers.[12] An example of this situation is the computer hardware manufacturer that may reap significantly smaller benefits from the PC standard compared to those pulled in by components developers such as Microsoft.[13]

This discussion leads to the distinction between two key dimensions in order to evaluate the potential of a product in terms of network effects: the transferability of its complements and its dependency on complements.

Complements Transferability

How can managers increase the attractiveness of their offerings through rapid acceptance in customer networks? As we have already mentioned, network effects are highly dependent on the nature of the networks to which customers are connected. Recent research has shown that the benefit of belonging to a network is essentially derived through the diffusion of local information and through potential contacts among the end-users.[14] In other words, there are situations in which the network becomes an exchange network, which is not easily controlled by manufacturers and complement producers. End-users exchange complements, resulting in two effects. First, the users get a clear idea of how big the network around them actually is, and second, they can derive greater value from the core product itself independently of the core product's manufacturer. The degree of exchange of complements between members of customer networks is what we call complements transferability.

Sharing a video game with a sibling or copying a CD for a friend exemplifies this basic idea. In India and China, Microsoft has relied on this dimension. In order to impose Windows as a standard in these countries, Microsoft chose not to put up a fight against the widespread copying of this software. Conversely, in some cases, network effects are reduced by a low transferability of complements. This is the case for credit-card systems, in which the services provided to a credit-card user cannot be easily transferred to anyone else. In the same way, an enforced regulation banning users from copying computer software will lead to reduced transferability of that software.

The Dependence of the Core Product on Complements

A core-product dependency on complements speaks to the question raised above: How much should the new generation of a technology be dependent on its complements? Research in economics has shown how this dependence can be important in determining competitive outcomes in markets with network effects.[15] In the VCR market, for instance, it has been argued that although network effects related to complements were important factors, another crucial factor was related to the core product's technology itself.[16]

As an example, there were two videotaping formats: Beta, supported by Sony, and VHS, developed by Matsushita. Sony management believed the paramount concern to the consumer would be transportability of the cassette, so they produced a

paperback-sized cassette even though this limited recording time to one hour. Matsushita management believed that consumers would be more concerned with the capacity of the tape, so they opted for a large cassette that allowed a two-hour recording time, making the taping of a complete movie or sports event possible. Sony's head start gave Beta the entire market for several years. But within two years of VHS's introduction, thanks to its longer playing time, VHS had surpassed Beta and soon after came to dominate the market.

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In this example, the core technology played an important role, which influenced consumer choices. When the core product functions without the use of a large variety of complements, then network effects might still occur, but their role will be reduced by the intrinsic characteristics of the core product or technology. A VCR has some value by itself since it allows users to record TV programs and is therefore not totally dependent on its complements. On the other hand, a basic DVD player has no stand-alone value and is therefore totally dependent on the quality and availability of complements. Network effects will therefore be a more important strategic factor for DVD manufacturers than for VCR manufacturers.

The Network-Effects Matrix: A Tool to Evaluate a Core Product's Potential

Combining these two dimensions yields the network-effects matrix depicted in Figure 2. We have given specific names to each quadrant: the rolling stone, the inflating bubble, the expanding fire, and the snowball.

The Snowball—Where Network Effects Are the Highest

A snowball uses the snow around it, attracts other elements on its way, and cannot be stopped. For snowball-product systems, because network effects are so strong, the likelihood of creating monopoly positions is the highest. In terms of network effects, the untapped potential of a technology is the lowest, and therefore this is the part of the matrix towards which repositioning of technologies will converge. The core product depends heavily on highly transferable complements. In the

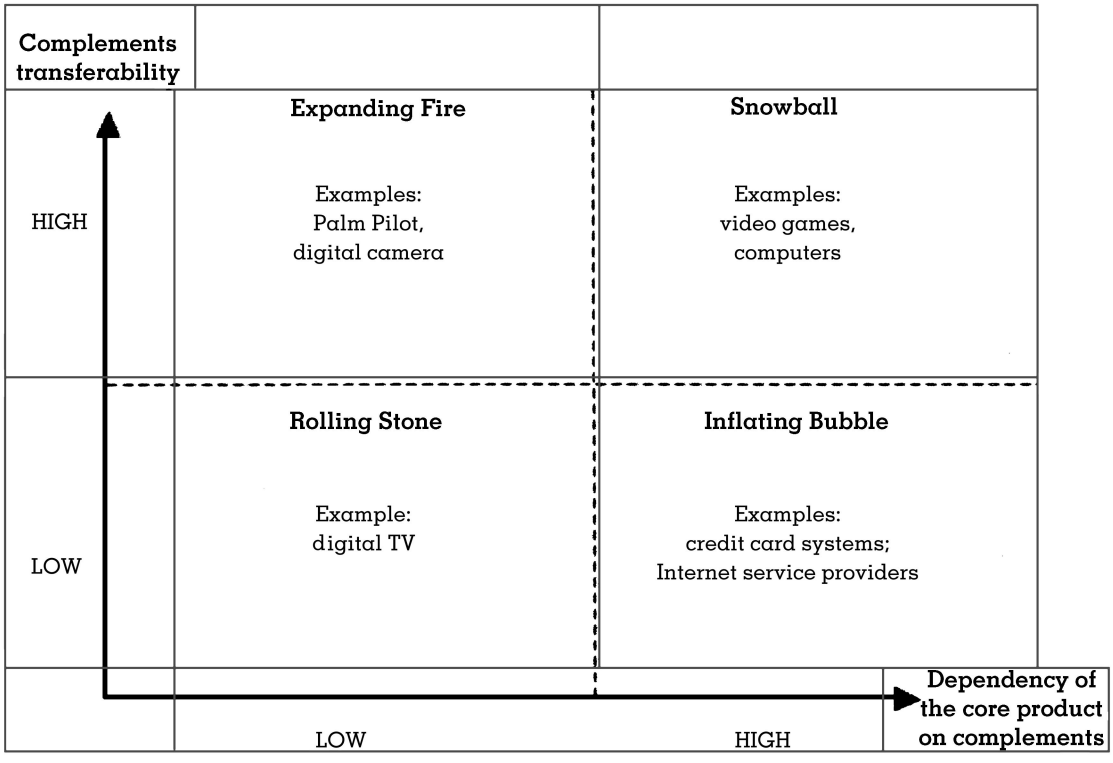


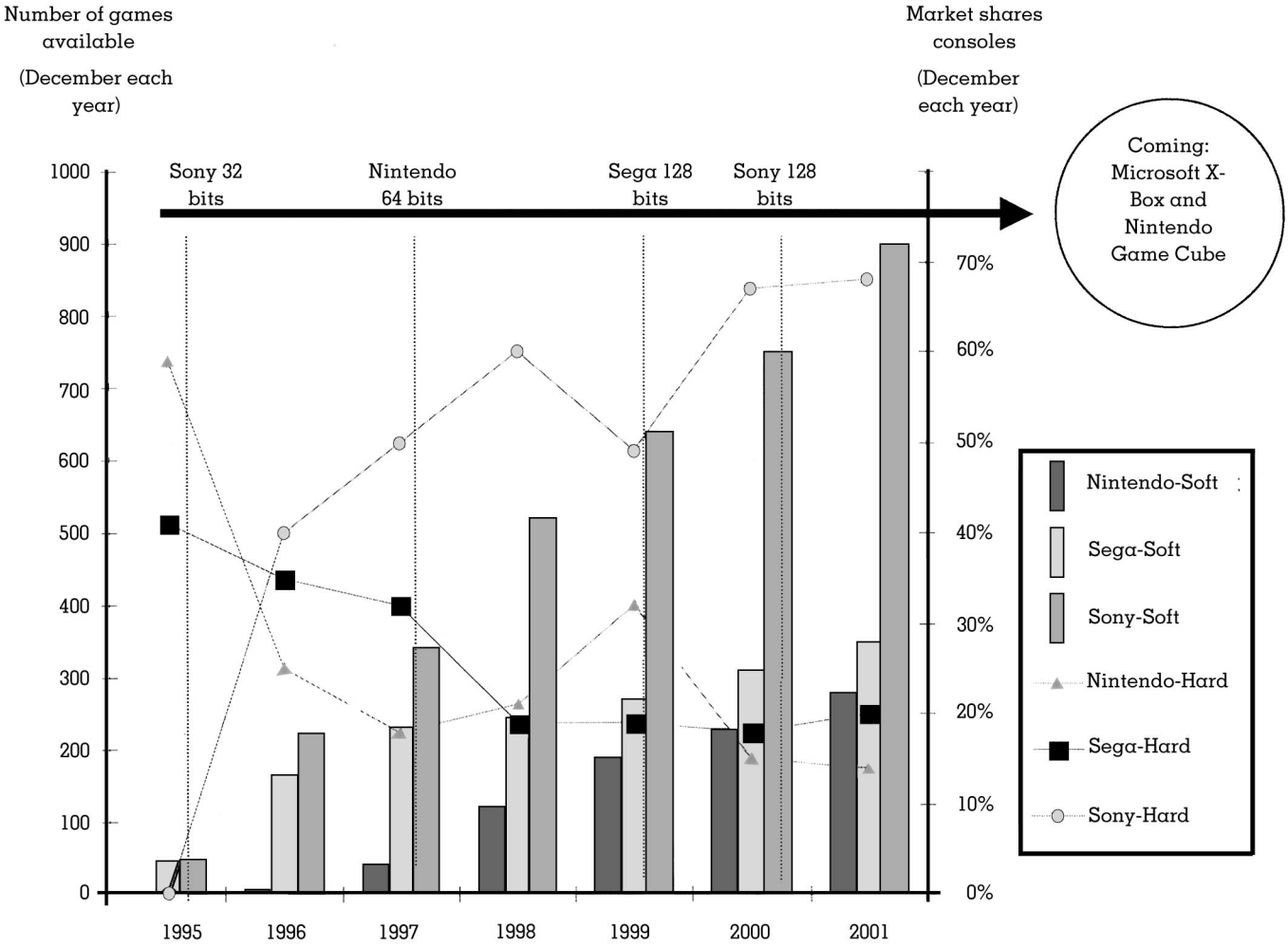
FIGURE 2
Evaluating the Potential of a Technology in Terms of Network Effects: The Network-Effects Matrix

video-game industry, for instance, for each generation of hardware, the competition led to a quasi-monopoly position. The first to profit from this strong competitive position was Atari in the 1970s, then Nintendo in the 1980s, and finally Sony in the second half of the 1990s. Strong network effects have also assured Nintendo a dominant position in the sub-market of portable video games,[17] with its leading product, Game Boy.

Figure 3 illustrates how Sony built its leadership for PlayStation on a new console (core product, right vertical axis) and also on an increasing number of games (complements, left vertical axis), which made the device increasingly attractive for consumers, to the point where PlayStation became the dominant product in the market. Nintendo tried to re-enter the market in late 1997 with the Nintendo 64, and Sega followed in 1999 with the Dreamcast, but neither product was able to challenge Sony's strong competitive position, which was assured by network effects.

The Rolling Stone—Weak Network Effects

The rolling stone gathers no moss. In this part of the matrix, network effects are the lowest. In terms of network effects, this is where the untapped potential of a technology is the highest. When feasible, repositioning a rolling-stone technology in other parts of the matrix will potentially generate a much stronger competitive position for core-product manufacturers. In the case of a rolling stone, even if there are some network effects, the core product is feebly dependent on the complements. The transferability of complements is low, meaning that consumers cannot lend, trade, or rent them to anyone else. A rolling stone is worthy on its own and does not need complements. A good example



Source: Figure constructed using data provided by NPD Group Inc. *www.npd.com.*

FIGURE 3
Market Shares in Core Products (Consoles) and Number of Complements (Games) in the Video-Game Industry (1995–2000)[29]

of a rolling stone is digital TV.[18] When consumers buy digital TVs, and high-definition televisions in particular (HDTV), they also expect a certain amount of digital programming of a quality associated with their purchase. Digital TV will offer the best picture quality and a movie theater-like widescreen appearance but will also potentially suffer from limited programming specifically designed for this technology. Broadcasters such as ABC, NBC, or CBS, cable operators such as Time-Warner or TCI, or digital broadcast satellite companies such as DirectTV and USSB will develop specific digital programs only if the demand from end-consumers is high enough.

However, it is also clear that the network effect for a rolling stone is only one of many factors that consumers will consider, along with price, quality, brand, design, and reliability, and that the digital TV is only weakly dependent on complementary programming. In the same way, these complementary services cannot easily be transferred to anybody else and therefore do not create any further value or interest for an additional customer. Therefore, a network effect exists, but it is only one strategic factor among others (and in this example is arguably less important than others).

The Inflating Bubble—Some Network Effects Limited by Low Transferability of Complements

Once created, the bubble inflates using air, and once light enough, the bubble floats up. It uses only air to grow and fly; it doesn't use other bubbles. In this quadrant, the core product (the bubble) is highly dependent on the availability and the quality of the complements (the air). Network effects are part of the competitive game but are not major influences, since the complements are not easily transferable. Internet service providers (ISPs) rely on the bubble effect. When consumers decide to subscribe to an ISP such as AOL, they would like for others to invest in the same service in order to be sure that this ISP will provide the best content and growth. It is not the ISP itself that is at stake here, but rather the content that it can provide.

Other consumers subscribing to the same ISP contribute to the quality of content in three ways. First, their subscription provides direct cash to the ISP and allows it to acquire proprietary contents or to create contents itself. Second, their subscription increases the installed base of customers, allowing the ISP to collect advertising fees from companies that are willing to advertise on the Internet. Last, a large installed base of subscribers makes an ISP more attractive for content developers, who will be tempted to use this ISP as a priority outlet for their new content. A huge installed base of subscribers, such as the more than 10 million people subscribing to T-Online in Europe or to AOL in the United States, fosters a competitive advantage to create and obtain innovative content and, therefore, attracts new customers.

In the context of a bubble, core-product manufacturers are, in fact, trapped. On the one hand, network effects are such an important competitive factor that these firms have to be focused on making them happen. To do so, they have to find ways to create as many complements as possible in a short period of time. Developing all the complements themselves is not really possible in this context, so core-product manufacturers will have to rely heavily on complements developers. This makes the bubble quadrant difficult for core-product manufacturers; complements developers are in a very strong position and can extract a large part of the profits. In the case of Internet service providers, many have tried to offer their core product free of charge in order to finance the development and acquisition of new complementary programs through advertising revenues. This strategy made it more difficult to make any money out of this business model.

The Expanding Fire

A fire can expand rapidly and is highly dependent on the characteristics of its environment. Its expansion is characterized by the method used to create the fire and the many external forces that feed its flames. For propagating fire-product systems, network effects play an important role. The higher the transferability of complementary products, the more rapid the growth of consumers using the same core product. However, the impact of network effects is limited by the low dependency of the core product on complements. One example is the handheld computer industry (Palm Pilot, Psion, Visor, Ipaq, etc.), where consumers can and often do use the core product without buying additional software. Only basic software that is generally sold with the handheld computer, such as the agenda and address book, is used by the vast majority of customers. Existing consumers who support the development of additional software are not a critical factor for consumers who choose this product. The quality of the hardware technology itself is a prevailing dimension.

In that sense, Palm's managers made it clear that they did not want to pack too many features into their machine or give consumers the opportunity to request too many features. Instead, Palm

preferred to focus on a few functions that were the most important for users (organizer, address book), resulting in the Palm Pilot's almost instant success. Conversely, PDAs that were available earlier were all failing. Initially, Palm did not pin its strategy on network effects but instead concentrated its attention on the core-product technology. After the market ignited, a growing number of developers created additional software exclusively for the Palm Pilot, a move that led to the product's rapid growth. These software programs could be downloaded from the Internet and were easily transferable. Palm made this rate of transferability even higher by creating the beaming function that allowed two Palm Pilot users to instantaneously and easily exchange software. This transferability played a role in creating a network of people using the Palm, thereby increasing the value of the device for potential buyers. This, in turn, boosted the product's network effects and supported the Palm's overall success.

Summary of Phase 1

The network-effects matrix allows managers to evaluate where their core product stands in terms of both network effects and potential for future investment. Network effects are high in the snowball situation. They are quite strong in the case of the fire, not as strong in the case of the bubble, and insignificant in the case of the rolling stone. In terms of management, however, what is really important is not the static analysis of where a technology stands in the matrix, but rather how a manager can reposition a technology to generate a stronger competitive position.

Phase 2: Repositioning the Core Product: Where Do You Go Next?

Once a manager has evaluated the core product/technology and positioned it in one of the four quadrants of the matrix, the next phase is to decide whether and how to reposition it in order to generate stronger network effects. Ideally, all core products should target the snowball quadrant. However, this is not always feasible. We now consider repositioning decisions for each quadrant.

Moving from the Rolling Stone: Best Choice = The Expanding Fire

The network-effects matrix shows that it is the rolling-stone quadrant where network effects are the lowest. Therefore, repositioning can be very interesting in terms of generating stronger competitive positions for core-products manufacturers. However, a quick shift toward making the product highly dependent on complements could be both difficult and risky. Instead of ending up as a snowball, the core product might in fact become a bubble, which is, as explained before, not a desirable situation. The best strategy is to reposition a rolling stone as an expanding fire.

An example of a strategy that involves changing a rolling stone into an expanding fire would be that of wireless phones. They generate some network effects to the extent that they generally come with software to which certain other software can be added. However, this kind of product remains a rolling-stone system because the core-product design and technology are what really drive consumer purchases. The core product is not highly dependent on the complements, and the complements themselves are not easy to transfer, nor is their transfer of interest to other customers.

However, the recent attempt by several cell phone manufacturers to transform their core product into a Palm Pilot or into a camera changes the characteristics of the product system. Complementary software can now be added to the cell phone, which can enable it to function as an efficient calendar or address book. This software can also provide access to the Internet and can be exchanged with other consumers. Taking pictures and exchanging images reinforce network effects, since consumers have an interest in seeing more complements developed for their device. The primary purpose of the cell phone remains its function as a telephone. The dependency of the core product on the complements stays rather low; however, there is now a real network effect related to these complements. Clearly, transforming a rolling stone into a fire can succeed only if the core product evolves with the new possibilities of the complements. In other words, cell phones must evolve to accommodate the handheld computer and/or camera characteristics. Manufacturers need to find a way to keep cell phones as light and compact as possible, while providing a screen that allows the user to easily read a calendar, visualize pictures, play games, and access the Internet. This is the key challenge for cell phone manufacturers who have invested in the complements option.

Moving Out of the Bubble: Best Choice = The Snowball

Earlier, we explained why competing with a bubble technology is a difficult situation for core-product manufacturers since they face the complement providers' high negotiation power. Trying to reposition a bubble into another part of the matrix

is therefore a priority when managers consider further investment decisions. A straightforward approach is to try to transform a bubble into a snowball. An example can be found in the Internet service-provider market. One problem for ISPs lies in the fact that their services cannot be exchanged or transferred to other customers. A method that ISPs have used to create network effects based on their content has been to create chat rooms. Individual consumers are drawn to subscribe to the ISP or portal that has already attracted their own circle of family and friends. Hence, free chat rooms have become a strategic factor in the competition between ISPs and portals. In this case, the complements are free, easily found, easily distributed, and they are always fresh and new. Developing exchanges and interactions among consumers helps to reduce the complement developers' power relative to that of the core-product's manufacturer. Additional revenues stem from the repositioning of a bubble into a snowball that can make the repositioning a win-win game for suppliers of both core products and complements.

Manufacturers need to find a way to keep cell phones as light and compact as possible, while providing a screen that allows the user to easily read a calendar, visualize pictures, play games, and access the Internet.

Transforming an Expanding Fire into a Snowball

The ideal move in the network-effects matrix is to transform an expanding fire into a snowball. This transformation implies a development of complements and the acceptance of an increased dependence of the core product from the complement developers. In the area of handheld computers, Microsoft has tried to change the rules of the game using network effects. Whereas Palm owned about 75 per cent of the handheld computer market until the year 2000, Windows CE devices seem poised to take over Palm's place as the market leader. How can this be explained? The current success of handheld computers based on the Windows CE device comes from the fact that Microsoft, Toshiba, and Compaq have all been able to transfer the competition of this product system from an expanding fire to a snowball. Now, users of handheld devices are willing to spend more to get additional software besides the usual calendar and address book. Palm finds itself at a disadvantage because the hardware, as well as the variety and quality of the software, is valued by the consumer. This is what consumers are looking for.

Also, accessibility to a variety of Microsoft software programs, which are directly compatible with the programs that most consumers use on their home and office desktops, makes the Windows CE device the more obvious choice. Palm does not have the weapons to fight back in this new market, where the management of network effects has become fundamental. In this case, the offering of exchangeable complements into a network of customers transforms an expanding fire into a snowball. The allocation of profit has been changed, since complements developers benefit more from a snowball positioning than from a fire positioning. The returns are shared by the core product's supplier (Toshiba or Compaq) and the complements' supplier (Microsoft).

Make the Snowball Roll Faster

Where managers have been able to position their core product as a snowball right away, no significant repositioning is necessary. Returns can still be increased, however, especially by increasing the transferability of the complements. It is often possible to make the snowball roll even faster. The strategic move by Sony in the video games market, with its PlayStation 2 and the Internet link that it provides, is an example of a company trying to bootstrap itself to increase the intensity of the snowball. One way for companies to compete in snowball cases is to increase the network effects associated with the complements. The key here could be to make their components easily replicable (which is not necessarily in the interest of the complement developers) and to accomplish this by using the Internet. The attempt by Sony to make PlayStation 2 usable for games on the Internet is an example of this tactic. Players can exchange and play games with their friends or neighbors, as well as with many others (for example, AOL users) on the Internet. The network effect related to the complements is therefore enhanced, and video-game devices such as PlayStation 2 score higher on the snowball logic. In this case, the core product's manufacturer must be aware that its control of the network moves away from direct control (as in retail stores) to control that is indirect or even virtual in nature (as with the use of the Internet). Value appropriation—and consequently sharing this value—is made difficult and should be cautiously evaluated before intending a further bootstrapping of the snowball positioning.

Bad Moves: Snowball and Bubble Comparisons

We have stressed earlier that the snowball is the quadrant where network effects are the most beneficial. As such, the snowball quadrant is the most attractive position to be in, while it is difficult to operate in the bubble quadrant. However, whereas not all core products should be first repositioned directly to the snowball area (e.g., rolling stones), repositioning a technology towards the bubble quadrant is very likely to be a mistake. To go back to the example presented in the introduction of the article, this is exactly why the DIVX technology failed. In trying to compete against the DVD system, Circuit City introduced the DIVX as a pay-per-view alternative to the DVD. The DIVX system increased the dependency of the core product on complements, since users did not own movies and therefore had no use of the system without additional connections to get new movies. This mechanism was a way to increase the indirect network effect and potentially to accelerate the adoption of DIVX systems. The DVD was in the fire cell. However, DIVX also reduced the transferability of the movies, thereby making the whole process more private and pushing DIVX significantly closer to a bubble situation than to a snowball. The indirect network effect was finally much lower in the case of DIVX than it was for the DVD.

Figure 4 summarizes the repositioning that should be made from each quadrant, as well as which repositioning should be avoided.

Phase 3: Action Plans to Reposition a Core Product

The key concern for managers who are considering further investment in a technology is determining how to move from a lower quadrant to a higher one. We also suggest that this investment should be accompanied by moves in several strategic dimensions. Various researchers have stressed the importance of several variables to operate in markets with network effects.[19] We will here consider how these variables can be managed in the context of repositioning a core product/technology. These variables are:

- *The compatibility of the core product with others:* A firm may decide to compete with its competitors, each with its own incompatible standard. This move would increase the reward if the company's product becomes the dominant design, but it also bears a high risk. Alternatively, a core-product manufacturer may decide to render its technology compatible, in which case the firm must decide whether to share the development costs and the benefits or to rely only on its own resources.[20]
- *The pricing of the core product compared to the pricing of the complements:* Core-product producers have both significant fixed costs of the core product and variable costs related to the complements. The problem of pricing arises from the attempt to recover the fixed development costs of the core product from the variable revenues of the complements.[21]
- *The vertical integration of the complement development:* The higher the network effect, the more the complements will contribute to the full value of the system. Therefore, a firm must decide whether or not to produce and distribute the corresponding complements.[22]

	Best repositioning	Next best repositioning	Bad repositioning
Rolling Stone	Expanding Fire	-	Bubble
Inflating Bubble	Snowball	Expanding Fire	-
Expanding Fire	Snowball	-	Bubble
Snowball	Reinforce Snowball characteristics	-	Anywhere except Snowball

FIGURE 4
Where Do You Move from Where You Are?

Phase 2 of our framework has identified the two main directions in which to reposition a technology. A product can be repositioned either as an expanding fire (as in the case of a rolling-stone or potentially a bubble technology), or as a snowball (as in the case of a bubble or an expanding fire technology). We therefore look at these two dimensions and what it takes to reposition a technology toward each of them.

Moving Toward an Expanding Fire

In repositioning a technology as an expanding fire, creating a leading edge on the core product is the main objective. To succeed in gaining this position, manufacturers should first keep their core product non-compatible with others. Manufacturing firms should invest heavily in a non-compatible technology, as stressed by Shapiro and Varian.[23] Second, to move toward an expanding fire, the price of the core product itself is highly significant. Firms in the market must maintain relatively high prices for their core product since they cannot count on revenues from complementary products, and they need to make money as soon as possible to finance further technological developments of their core product. Third, because of the inability to control complement revenues and the specialization of the core product, it is not critical for a manufacturer to serve as a complement developer. Rather, it is more important to aim at being attractive for external developers. Creating alliances with outside developers and ensuring that these outside developers have enough incentives to develop new complements are crucial to successfully transform a technology into an expanding fire.[24]

Moving Toward a Snowball

A snowball is characterized by a deep interrelationship between the core product and the available complements. To reposition a technology and transform it into a snowball, manufacturers may be tempted to use a non-compatible standard strategy to rapidly gain a decisive advantage over the other available standards. More than in any of the other quadrants, the first-mover advantage plays a critical role here.

Second, in order to make the repositioning toward a snowball work, it is necessary to think about the pricing of the core technology. Low prices on the core product are generally necessary to stimulate adoption. However, prices of complements must also be low in order to encourage sharing among the consumers and to allow recovery of the fixed cost through mass sales in the long run. Therefore, in this particular repositioning, linking the core product with its complements is an efficient technique that is used to boost adoption of the new technology. A firm must develop the largest installed base of core products, keeping in mind that the local network effects lie mainly in the quality of complements. Because such firms have significant fixed and development costs, they may be forced to give way to a *waiting game*,[25] an incentive to price the core product very low to get market share first and recoup the investment later.[26]

One efficient way to cope with this price-structure problem is to invest in complement development. This way, a firm can play a strategy based on the full cost structure (core product + complements). In-house development of complements allows for the bundling of the core product with the complements at the moment of the sale, and it allows for control of the price structure. Core products can be sold bundled with recent complements and priced at a discount to the sum of the individual prices. Economic theory shows that with tie-in sales, the price of complements is much higher than without tie-in sales, but the price of the core product is much lower. The price structure is independent of, and in some cases less than, a core product's marginal production cost.[27] In the video games market, Nintendo, Sega, and Sony all used this tactic to favor the development of network effects.

Third, it is absolutely necessary to guarantee a wide variety of top-quality complements. This typically requires building, developing, and controlling core competencies in complements development. Failing to offer complements can result in a lock-out of the core-product technology. In the video-games market, for instance, Atari never succeeded in entering the Nintendo-dominated market of the 1980s because of a lack of available software and a lack of in-house capabilities to create new software. Preventing this scenario is key to successfully transforming a technology into a snowball.

It is absolutely necessary to guarantee a wide variety of top-quality complements.

Figure 5 summarizes the main points of our approach in Phase 3. However, these are general guidelines and should not be considered independently of other competitive dimensions that may affect the repositioning strategies. Due to space limitations, we cite only the four most common factors that can impact the repositioning strategy.

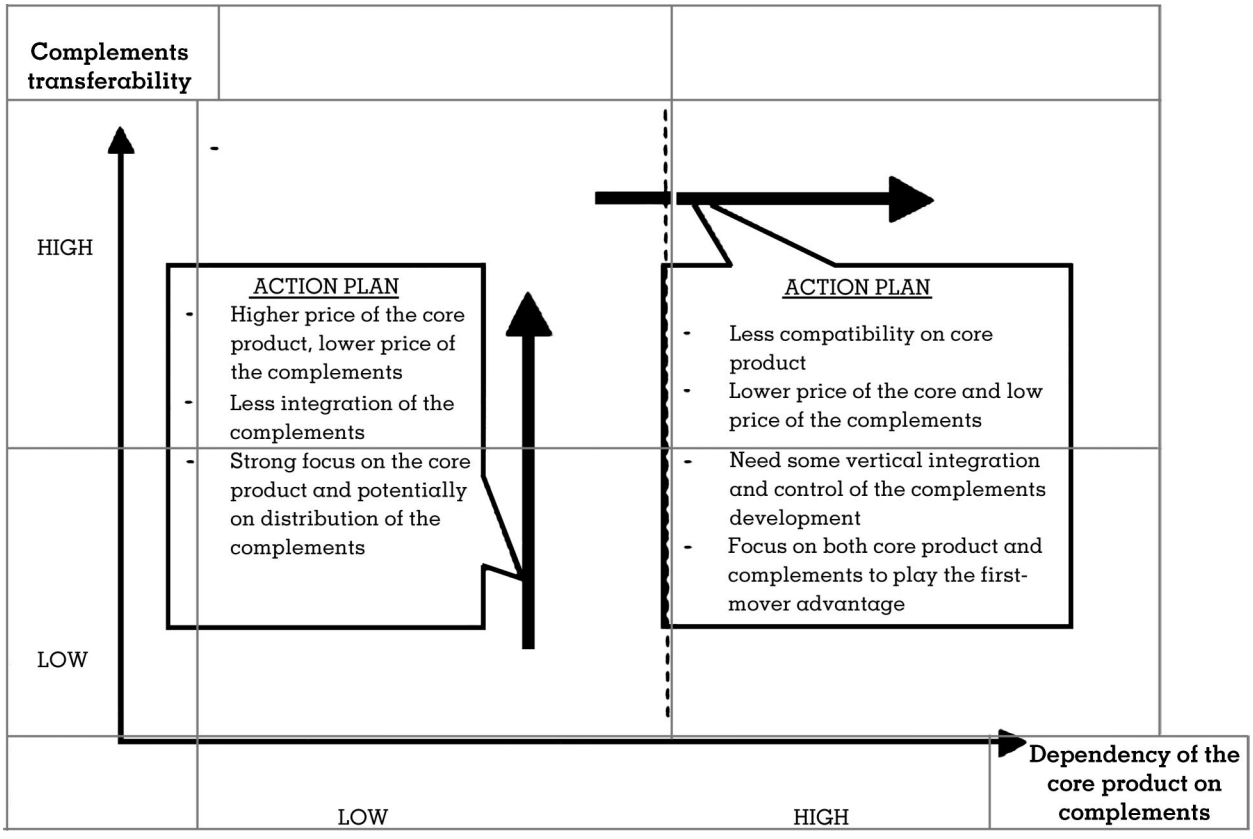


FIGURE 5
Action Plans for Repositioning a Technology in the Matrix

First, the nature of the market plays a role. Depending on the development stage of the industry and the degree of technological obsolescence, the possibility of repositioning is higher or lower. In high-velocity environments, repositioning could be as costly as developing an entirely new technological generation. Second, the competitors' behaviors may influence the available options. In the cases of consortia or cohesive alliances, it is difficult to operate a repositioning alone. Third, the dependence of the core product on complements (in the snowball and bubble quadrants) implies the effects of the industrial structure of the complement producers on the repositioning strategy of the core product. In an emergent industry where start-ups or adolescent firms supply the complements, the ability to maneuver is higher for the core-product manufacturers than when more mature industries are supplying complements. Finally, from an internal perspective, to succeed in a repositioning strategy a firm must possess several strategic capabilities beyond the required technological competencies. Critical success factors include a capacity to absorb knowledge from the surrounding environment, a capacity to enter into alliances, and strong marketing-related resources (such as a recognized brand, a powerful distribution force, and communication mastery).[28]

Action Implications

The perspective highlighted in this article provides at least three new insights to managers of product systems that combine a core product and complements. First, even in markets that tend to create technological standards, competition and rivalry do not come to an end when a standard is in place. Potential competition in these markets is as important as existing competition. Managers need to think about the next generation of a core product–complements system at least as much as they think about the existing one. Whereas most of the existing managerial literature on products combined with complements examines how to create competitive advantage through the standardization process, we show that planning for the next generation of the core product/technology is also critical.

A second related implication results from two concepts: core products do not exploit their full potential right away, and repositioning for next-generation technologies can allow managers to

generate both a stronger competitive advantage and higher profits. Repositioning a technology requires an evaluation of the extent to which its potential is exploited in its current state. Using the network-effects matrix is helpful. The matrix allows managers to determine whether the technology is a rolling stone, a bubble, an expanding fire, or whether it is already a snowball. In the snowball category, network effects are the highest and can generate strong competitive positions for both actors: the core-product manufacturer and the complement developer. In effect, snowball products are based on highly transferable complements, resulting in strong network effects and increased revenues. Snowball products are highly dependent components, creating returns that have to be shared among the players. Our framework also helps to determine how to reposition the various types of technologies in the matrix. We suggest that some repositionings make particular sense (rolling stone towards expanding fire, bubble towards snowball, and expanding fire towards snowball), whereas some others should be avoided (rolling stone towards bubble, expanding fire towards bubble).

The third insight that this article seeks to provide for executives is that the repositioning decision, even if it is a crucial one, does not work on its own. Some accompanying measures are necessary to implement the repositioning of the core product. We stress the importance of three critical dimensions: the compatibility of the core technology with competing technologies, the price of the core technology related to the price of the complements, and the necessity (or lack of necessity) for core technology manufacturers to achieve some level of vertical integration in the complements markets. Finally, other dimensions also influence the success of a repositioning. It is not appropriate in all circumstances to try to transform a fire into a snowball.

Endnotes

[1] See for instance Besen, S. M., & Saloner, G. 1989. The economics of telecommunication standards. In R. W. Crandall & K. Flamm (Eds.), *Changing the rules: Technological change, international competition and regulation in communication:* 177–220. Washington DC: Brookings Institution; David, P. A., & Steinmuller, W. E. 1994. Economics of compatibility and competition in telecommunication networks. *Information Economics and Policy,* 6(3/4): 217–242.

[2] These network effects can be direct or indirect. Direct effects occur when the value of a product for a consumer directly rises with the number of consumers purchasing the product. Telecommunications is a classic example of direct-network effect, since joining a telephone network becomes more valuable to a given consumer as other consumers join this network. Fax machines operate similarly. See Katz, M-L., & Shapiro, C. 1985. Network externalities, competition, and compatibility. *American Economic Review,* 75(3): 424–440; and Katz, M-L., & Shapiro, C. 1986. Technology adoption in the presence of network externalities. *Journal of Political Economy,* 94(4): 822–841.

[3] Economides, N., & Himmelberg, C. 1995. *Critical mass and network size with application to the US fax market.* Working Paper 95–11, New York University, Leonard N. Stern School of Business.

[4] See Chou, C., & Shy, O. 1990. Network effects without network externalities. *International Journal of Industrial Organization,* 8: 259–270; or Church, J., & Gandal, N. 1992. Network effects, software provision, and standardization. *Journal of Industrial Economics,* 40: 85–104.

[5] See Shapiro, C., & Varian, H. 1999. The art of standard wars. *California Management Review,* 41(2): 8–32. See also Antonelli, C. 1992. The economic theory of information networks. In C. Antonelli (Ed.), *The economics of information networks:* 5–27. New York: Elsevier; David, P. A. 1992. Information network economics: Externalities, innovations and evolution. In C. Antonelli (Ed.), op. cit., 103–106; and Farrell, J., & Saloner, G. 1986. Installed base and compatibility: Innovation, product pre-announcement, and predation. *American Economic Review,* 76(4): 940–955.

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[12] Besen, S. M., & Farrell, J. 1994. Choosing how to compete: Strategies and tactics in standardization. *Journal of Economic Perspectives,* 8(2): 117–131.

[13] Chesbrough, H., & Teece, D. 1996. When is virtual virtuous? Organizing for innovation. *Harvard Business Review.* January–February: 65–73.

[14] See for instance related work such as Shane, S. 2002. Network ties, reputation and the financing of new ventures. *Management Science,* 48(3): 364–381.

[15] On that dimension, see for instance Liebowitz, S. J., & Margolis, S. E. 1990. The fable of the keys. *Journal of Law and Economics,* 33(1): 1–26; and Liebowitz, S. J., & Margolis, S. E. 1994. Network externality: An uncommon tragedy. *Journal of Economic Perspectives,* 8(Spring): 133–150.

[16] On the VCR case, see for instance Klopfenstein, 1989. The diffusion of the VCR in the United States. In Levy, M. R. (Ed.), *The VCR age:* 21–39. Newbury Park, CA: Sage Publications. See also Lardner, J. 1987. *Fast forward: Hollywood, the Japanese, and the onslaught of the VCR.* New York: W. W. Norton.

[17] The portable devices represented almost half the video game market in terms of units sold in 2000.

[18] For an empirical analysis of network effects in the digital TV market, see for instance Gupta, S., Jain, D., & Sawhney, M. 1999. Modeling the evolution of markets with indirect network externalities: An application to digital television. *Marketing Science,* 18(3): 396–416.

[19] For a review, see for instance Quélin, B., et al. 2001. Stan-

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[23] Shapiro, C., & Varian, H. 1999. The art of standard wars. *California Management Review,* 41(2): 8–32.

[24] On this importance of local knowledge and information for network effects, see for instance Shane, S. 2000. Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science,* 11(4): 448–469.

[25] Consumers hesitate to adopt one of the core products until it is clear that there will be a sufficient amount and variety of complementary assets. Similarly, complementary-asset developers hesitate to commit until a sufficient number of consumers have adopted the core product. This creates interdependence between the timing decisions of consumers and complementary-asset developers. See Church, J., & Gandal, N. 1992. Network effects, software provision, and standardization. *Journal of Industrial Economics,* 40: 85–104.

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[28] Lane, P., & Lubatkin, M. 1998. Relative absorptive capacity and interorganizational learning. *Strategic Management Journal,* 19: 461–477.

[29] More current data on the videogames market were unavailable for the authors at the time they wrote this article. It seems however that the launch of the Microsoft X-Box and of the Nintendo Game Cube had an important impact on the market. In June 2002, Sony was reported to have 75 per cent of the U.S. market with its Playstation II, whereas Microsoft and Nintendo each had 12 per cent.

Jean-Philippe Bonardi is assistant professor at the Ivey School of Business, University of Western Ontario. He received his Ph.D. in management from HEC School of Business in Paris, France. His research interests center on technological competition and firms' strategies in regulated and deregulated environments. He has authored and co-authored several articles on these topics in leading journals such as the *Academy of Management Review*. Contact: *jbonardi@ivey.uwo.ca.*

Rodolphe Durand is associate professor of strategy at EM-Lyon, France. His research deals with the conditions of firm performance from a resource and an evolutionary perspective and has been published in *Strategic Management Journal, American Journal of Sociology,* and *Organization Studies* among others. He participates in many executive education programs for companies including Renault-Nissan and groupe Suez. Contact: *RDURAND@em-lyon.com.*