Fusion of Disruptive Technologies: Lessons from the Skype Case

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In this paper, we study the effects of integration of one or more disruptive innovations and ask if the resultant (new) innovation can have a dramatic impact on new and existing markets, and the resultant technology paradigm. We describe the evolution and dynamics of this process using Skype as a case in point. Skype successfully fused peer-to-peer computing (P2P) techniques and voice-over-Internet-protocol (VoIP) to create a new standard and operating model. We discuss whether such integration of disruptive technologies may lead to a ''marriage of equals'' or whether it leads to dominance by a single technology – and if so, in what circumstances.
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Introduction

Previous research in technology management has addressed the issue of disruptive innovation as it relates to a single technology. One novel question which can now be considered is the potential impact of a merger or integration of two or more disruptive technologies and their resultant pattern of innovation. In this paper, we use the case of Skype to examine what happens when two or more disruptive technologies combine to offer a potentially new value proposition.

Skype, a European-based startup, had launched a host of services by fusing VoIP (voice over internet protocol) and P2P (peer-to-peer) computing. It sought to offer a challenging alternative to existing voice communication solutions. While each of these technologies (VoIP and P2P) was inherently new and potentially disruptive, a unique combination of the two as offered by Skype promised to radically change the telecommunications landscape. Using the disruptive innovation literature as a theoretical background, we develop a framework that examines the potential impact of a merger of multiple disruptive technologies.

Background

Over the past decade, the telecommunications industry has witnessed rapid changes in the way people and organizations communicate. Many of these changes sprang from the explosive growth of the Internet and from IP (Internet Protocol) based applications. The Internet became a truly ubiquitous means of communication, and this is reflected in the amount of data exchanged and commerce transacted over this medium. Today, the total amount of packet-based network traffic surpasses traditional voice network traffic. Interestingly, even on the packet based network, the amount of bandwidth taken up by Internet surfing is much lower than that taken up by various file sharing services like BitTorrent (which uses P2P technology, a feature described later in this paper). In the wake of these technology advancements, it became clear to entrepreneurs that voice

traffic and services would be one of the next major applications to take full advantage of IP. This expectation was based on the impact of a new set of technologies generally referred to as Voice over IP (VoIP) and IP telephony. VoIP had the potential of creating many unique capabilities for carriers and customers who depended on IP or other packet-based networks. In parallel, innovations in the area of peer-to-peer computing meant that data could be efficiently distributed over a vast network with little or no centralized control.

Disruptive Innovations

The role of disruptive innovations in creating new market value has been an important area of study in technology management (Christensen, 1997; Hamel, 2000, Tushman & Anderson, 1986). These disruptive technologies and innovations often create new market value in unexpected ways, both independently and through combination with existing standards and protocols (Bower & Christensen, 1995; Christensen, 1997; Hamel, 2000, Tushman & Anderson, 1986, Tushman & Nadler, 1986; Ahuja & Lampert, 2001). While sustaining technologies serve the needs of most customers, and are improved along the trajectory valued by mainstream customers, disruptive technologies take on a different trajectory as they diffuse in the marketplace. Typically, such technologies are often cheaper and inferior in performance, yet they involve features that may provide competitive advantage in the future. As Paap and Katz (2004) point out, the disruption in the term ''disruptive technologies'' is the effect some technology based innovations appear to have on markets affected by technology-based innovation. However, we argue that disruptive innovation need not necessarily be inferior in quality. Although not as common as the bottom-up variety, top-down disruptive innovation aimed at high-end (and least price-sensitive) customers can actually outperform existing products and will sell for a premium price rather than at a discount [1]. In addition, technological convergence is yet another example of how disruptive innovations can occur, but in this case, it is the combination of incremental innovations that becomes disruptive (Hacklin et al., 2004). Before the notion of technological convergence as a precursor to disruption, technology fusion was described as being nonlinear, complimentary, cooperative, and market revolutionizing (Kodama, 1992). On the other hand, Markides (1998) and Hamel (2000) acknowledged the existence of disruptive opportunities not only in the process of the evolution of technologies, but also in the evolution of business models. Using the above perspective, we find that both VoIP as well as the peer-to-peer mode of distribution represent disruptive phenomena. In addition, they thrive in a networked environment where the growth patterns can be extremely rapid depending on initial acceptance of such solutions.

The Rise of VoIP and P2P: Two Distinct Disruptive Technologies

The Rise of VoIP

VoIP was developed as an IP based application in order to provide convenient communication between users using a variety of device types. VoIP essentially referred to the delivery of voice communications over an IP network, specifically the traffic management mechanism but not necessarily the layered applications or services. IP telephony is described as the basic voice communication services delivered using IP network, and enabling asynchronous and real-time voice communications. In the user environment, examples of IP telephony included dial tone, voice messaging, call management, caller ID and other functions considered common or traditional telephony features. Examples in the carrier domain included feature management and billing/performance measurement. The underlying technology also enabled another category of integrated voice applications (advanced communication applications) that would be delivered to users over an IP network. These applications would have been impossible, or prohibitively expensive, for implementation in a traditional telecommunications environment (e.g. TDM). Examples of these applications would include presence-awareness phone features, find-me-follow-me services integrated with collaboration tools such as calendar/scheduling programs, screen-pop provisioning beyond the call center environment, and similar applications. A number of these applications could also be custom-built to deliver advanced location based services to users in a context-specific and time-sensitive fashion (Rao and Minakakis, 2002). Given these various application types and potential revenue streams derived from them, there were a host of VoIP providers operating in the marketplace. As an illustrative example, we describe the key players in the US market at the time of Skype's launch (see Table 1).

As can be seen from the exhibit, the competitive landscape was diversified, with firms approaching the same market through very different routes. Typical competitors included cable companies, traditional telcos, a number of pure-play VoIP firms, and other challengers like IM (instant messaging) platforms and SIP (Session Initiation Protocol) phones. Typically, the cable companies and telcos offered VoIP services as an additional service offering to their existing portfolio of audio, video, and content programming. On the other side, the major drawback considering VoIP service included reliability of the calls and vulnerability to security threats:

''Administrators may mistakenly assume that since digitized voice travels in packets, they can simply plug VoIP components into their already-secured networks and remain secure...'' [2]

– Security Report by the National Institute for Standards and Technology.

Table 1   Major U.S. VoIP Service Providers

Company	Location	Details of VoIP Offering(s)
Cable companies		
Time Warner Cable	Stamford, Conn.	This subsidiary of Time Warner launched VoIP service in Maine in 2003 and is planning a nationwide rollout this year. It's rumored to be an IPO candidate as a way for parent Time Warner to buy out 18% investor Comcast.
Cox Communications	Atlanta	Cox offered VoIP in one cable market, Roanoke, Va. The company also provided digital phone service—including traditional circuit-switching technology—in other markets, where it pays phone companies to carry some calls. Cox customers paid between $9.99 and $15.89 a month for their first line.
Cablevision Systems	Bethpage, N.Y.	Cablevision offered "Optimum Voice" VoIP service to high-speed Internet customers for unlimited calling in the U.S. and Canada at $34.95 a month. Its target market included its one million-plus cable-modem customers; the product launched in September 2003.
Telcos (Voice Carriers)		
AT&T	Bedminster, N.J.	Ma Bell announced business and residential VoIP services in major cities in 2004, with rollout in "select metropolitan markets" during the first quarter of 2005. VOIP was seen as a defensive move. Began offering the CallVantage plan in March, 2004.
Verizon	New York City	The largest telco in the US planned to build the nation's biggest "converged network," which includes VoIP. It started with the Verizon VoiceWing broadband telephony service for $29.95/month.
Pure play VoIP Firms		
Net2Phone	Newark	A VoIP pioneer, it was focused on selling wholesale VOIP service to cable companies (although it generated its revenues by selling phone cards at convenience, for example).
Vonage	Edison, N.J.	The biggest independent, Vonage offered national VoIP service. Monthly rates ranged from $15 to $35, and the service worked with any cable modem or DSL connection. Announced IPO plans in February 2006.
8 × 8	Santa Clara, Calif.	A former chip company, 8 × 8 began offering its "Packet8" VoIP service nationwide in 2002. For $19.95, plus a $29.95 activation fee, customers get unlimited local and long-distance calling in the U.S. and Canada.

P2P Redefines Digital Distribution

In parallel to the trend of using internet telephony for transmitting voice signals, another major development was enabling the rapid transfer of data packets using peer-to-peer networking, a paradigmatic shift over the client-server computing model. This peer-to-peer mechanism was formally defined as the action of mutually exchanging information and services directly between the producer and the consumer to achieve purposeful results[3]. A more precise understanding for the technology was provided by the P2P Research Group, IETF/IRTF[4]:

"Peer-to-Peer (P2P) is a way of structuring distributed applications such that the individual nodes have symmetric roles. Rather than being divided into clients and servers each with distinct roles, in P2P applications a node may act as both a client and a server."

While P2P was not necessarily a technological leap in the sense of a new manufacturing or functional innovation, it represented a fundamental paradigmatic and philosophical shift in the way data was distributed and content accessed over a networked platform such as the Internet. P2P could be viewed as a *decentralized paradigm of networking with distributed usage of resources*, such as bandwidth, memory, processing and computing power. No particular clients and servers were present as in the traditional form of networking, but all nodes could act both as clients and servers at the same time. P2P systems could be designed using various topologies, starting from centralized P2P systems like Napster, decentralized systems like Gnutella, hybrid like Fast Track/KaZaA, and structured P2P systems like Chord[5]. Several interesting applications based on P2P technology had been launched with varying degrees of success (see Table 2).

Integration of Disruptive Technologies: The Case of Skype

While the exercise of plotting the trajectories of VoIP and P2P along an individual timeline is in itself an interesting project, we believe that the more interesting question lies at the level of merger of the two technologies. Prior literature has not examined this angle of disruptive innovations due to a persistent

Table 2 P2P Application Types and Examples[a]

Application Type	Examples
P2P file swapping (sharing)	Napster, FreeNet, Gnutella, KaZaA, eDonkey, Morpheus, Grokster, EZPeer, Kuro
P2P communication	NetNews (NNTP), Instant Messaging (IM), Skype
P2P lookup services and applications	IRIS, Chord/CFS, Tapestry/OceanStore, Pastry/PAST, CAN, HP2P
P2P overlay networking	BGP, RON, PDF, Detour, LRR
P2P multimedia streaming	CoopNet, Zigzag, Narada, P2Cast, Streamlla
Proxies and Content Distribution Networks	Squid, Akamai, DigitIsland
Overlay Testbed	PlanetLab, NetBed/EmuLab
Distributed data processing and science content sharing	Quarknet, SDSS, Neptune, SETI, Folding, Fightaids
P2P gaming	Many multiplayer online games and several ongoing hybrid projects

[a]*Source*: Chun-Hsin Wu, "*Differentiated Admission for Peer-to-Peer Systems*," Academia Sinica – Taiwan, April 20, 2004; Ivyes Poppe, "*The Peer 2 Peer Internet*," PowerPoint Presentation, May 13, 2004. Networld & Interop, Las Vegas, NV.

lack of qualified examples and the difficulty in employing an appropriate framework of analysis. In order to examine this interesting question, we turn to the case of Skype, which represents a unique and novel merger of two disruptive technologies. Using a case-based analysis of Skype's technological underpinnings and its approach to the marketplace derived from Rao and Angelov (2005), we describe how Skype has successfully fused two distinct disruptive technologies to deliver its unique brand of service offerings. In essence, we refer to case studies using Yin's "technical" definition (Yin, 1994):

"A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used."

Yin (1994) argues that a "how" and "why" question about a contemporary set of events is the proper research strategy when the investigator has little or no control over behavioral events. We believe that the research question of our interest, analyzing how and why disruptive technologies integrate, required studying cases, and Skype is the choice we made. In addition, Eisenhardt (1989) identifies case-studies as a highly appropriate research approach in investigating new topic areas or when a fresh perspective is needed. According to Eisenhardt, the resultant theory (built from the case-study) is often novel, testable, and empirically valid. Even though there are several methodological problems raised by the study of a single case (Lee, 1989), Lee describes the scientific method of case studies and proposes responses to the problems involved in the study of a single case (the case of Skype fits into Lee's single case category). More specifically, Lee (1989) focuses on the issues of making controlled observations and deductions, while allowing for replicability and generalizability. In analyzing the integration of disruptive technologies, our paper utilizes Skype as a case in point, and as such it can be evaluated using the previously

mentioned literature related to the case-study based research.

Skype: An Integration of VoIP and P2P

Skype represents one of the first and most successful efforts at fusing together two distinctly different technological breakthroughs. The founders of Skype had introduced a P2P based VoIP software that would provide audio quality equivalent to conventional phone lines. This P2P technology could take various forms that differed in their functionality and feature offerings, such as instant messaging and communication tools, file sharing utilities, and distributed computing. In the case of Skype, all these features were integrated in an attempt to provide impeccable quality of the voice service, along with various possibilities of value-added packages at the lowest cost possible. While Kodama (1992) differentiates between a breakthrough and a fusion approach to technology strategy, Skype is clearly a representative of a fusion strategy involving two breakthrough technologies. In addition, Skype's fusion process follows Kodama's three basic principles of: (1) demand articulation, (2) information collection and dissemination incorporating active receivers, and (3) reciprocal and substantial industry relations. According to the founders of Skype, a true P2P system would have all network nodes joined together to dynamically participate in traffic routing, processing and bandwidth intensive tasks that would have otherwise been handled by central servers. Skype thus successfully leveraged all available resources in the network and had no infrastructure implementation and maintenance costs.

Technical Characteristics of Skype

In order to deliver its "state-of-the-art" IP-based telephony, Skype employed several techniques[6]:

(a) IP addresses – No end-user configuration of gateways and firewalls was required, thus avoiding

one of the major issues with the existing VoIP service providers.

(b) A global and decentralized user directory – in order to deliver high quality telephony with the lowest possible cost, a third generation of P2P technology (3G P2P), or Global Index (GI) was necessary for development and represented yet another paradigm shift in the notion of scalable networks. The GI technology represented a multi-tiered network where all supernodes communicate in such a way that every node in the network has full knowledge of all available users and resources with minimal latency.

(c) Intelligent routing – Skype used the most effective paths possible to intelligently route encrypted calls. It kept multiple connection paths open and dynamically chose the one that was best suited at the time. This increased the call quality throughput by reducing the latency.

(d) Security – Skype employed special encryption technology (256 bit AES) to protect all calls and instant messages for unrivaled privacy.

(e) Simple user-interface – Skype designed a very simple and intuitive to use interface, requiring no special technical skill-set, to enable quick adoption among various consumer segments.

Skype initially offered only PC-to-PC calling, combining the features of both IM and VoIP. The Skype-Out service, enabling connectivity to the POTS (Plain Old Telephone Service), was added later on, as it happened with the SkypeIn service, enabling connectivity from the POTS. The hardware requirements to use Skype were 400-MHz CPU, 128 MB of RAM and 10 MB of hard drive space, microphone, sound card, and speakers/headphones. A broadband Internet connection was required to ensure superior voice and service quality.

Skype: Service Offerings and Expansion

The VoIP industry could be segmented into three main categories (Research and Markets, 2003). The first category was represented by the technology providers, offering solutions for wholesale carriers and enterprises, supplying endpoints (IP-phones and soft phones), communication servers, application servers, switches, routers, signaling points and gateways. This segment included companies such as 3Com, Cisco, Lucent, Siemens, Nortel Networks, and many others. The service providers like Net2Phone, 8 × 8, Dialpad, Iscom, Vonage, Talking-Nets, Skype, ICQ and others, formed the second segment. The offerings of this segment included PC-to-PC, PC-to-Phone, hosted flat-free, calling cards and number portability services for both enterprises and consumer customers. Wholesale Carriers represented the third segment. The companies in this segment, such as iBasis, ITXC, Genuity and others, offered network services to service providers.

Given this multiplicity of offerings and vendors, Skype tried to differentiate its offering immediately in order to provide a more distinctive appeal to users. It made available free downloadable software from its website, which enabled customers to sign up and use the service almost immediately. The free nature of the initial service along with the superb voice quality of the service made Skype stand out from the rest of the IP telephony providers. In addition, interoperability with popular industry standards such as Microsoft's Windows OS and Linux OS ensured a wider adoption. In order to exploit the ever-increasing proliferation of Wi-Fi enabled devices, Skype developed a Pocket PC version of its software, which essentially enabled calls to be placed through the Skype account from a PDA. Skype's co-founder, Niklas Zennström, provided an analogy to the introduction of the e-mail and the fax technology. In the same way that e-mail did not replace the traditional fax service, Skype (or IP telephony in that context) would not replace the traditional PSTN. This did not mean, however, that Skype was not going to try to approach the PSTN market. Through the launch of the SkypeOut service (and later on the SkypeIn service), the company attempted to integrate its VoIP offering with the old PSTN by extending its services and allowing connection to users not having Skype. Through a SkypeOut account, a customer could call a traditional phone line (landline or mobile) at a competitively low (local) rate. In addition, by introducing the new SkypeIn service, Skype users were able to obtain up to 10 different telephone numbers, which made them accessible to the conventional PSTN users. The obtained telephone numbers could be local numbers from different countries in the world. Capitalizing on the Internet as the global distribution medium, Skype offered its product for distribution in fifteen languages allowing immediate penetration to over 165 countries. In addition, Skype partnered with Plantronics and Siemens AG to launch branded headsets and accessories. These strategic partnerships had a long-term objective of enabling seamless customer transition from traditional services to their VoIP product. Plantronics was a proven headset manufacturer, particularly popular with the Internet customer base, while Siemens AG produced high quality telephone equipment and computer hardware. Targeting the market niche, Skype's position in the IP telephony was based on innovation and personalization of the services.

"Voice is just the beginning. Once you are in the IP environment you bring in video and data, it's all about who can create the best application … it's about interactive media." [7]

– John Arnold, VoIP program leader for Frost & Sullivan Inc.

The advertising and promotion strategy used by Skype was simple and effective. It used strong "word-of-mouse" networks to build up a critical mass of users. It was the classic example of viral

promotion. Once a user had the software, he/she wanted friends and relatives to have it as well. Consequently, in just one week of availability, 60,000 people had downloaded the free Skype software. The most essential advantages of the P2P business model for Skype were the immense scalability options, easy and cost effective marketing, and efficient retailing and distribution through partnerships. The fact that there was no special infrastructure to support the promotion, customer recruiting process, and the distribution channels, gave Skype a strong competitive advantage over the rest of the VoIP service providers. In essence, the combination of viral marketing and free PC-to-PC telephony promoted Skype into a customer-friendly company, and did a better job at gaining market popularity than expensive marketing and advertising campaigns, similar to those employed by Vonage[8]. In this context, Skype exhibited the somewhat hidden characteristic of ''disruptiveness''. It changed the traditional marketing and business model by letting the customer dictate the pace, and even though it lacked the sophistication and depth of a well developed marketing campaign, it got the message across better, cheaper, more effectively, and on target. In addition, if the incumbents tried to imitate this approach, they were doomed to fail because their business model was based on traditional revenue generating processes, and their customers lacked the enthusiasm and incentives to virally promote their products. With Skype, they feel part of the marketing team, and there are no hidden fees or cheap advertising tricks to lure them into using a technology they do not need or want.

Revenue Models

The long-term goal of Skype was to provide fee-based services on the top of its basic plan. The premium services offered to specific customer groups were designed as a major form of revenue for the company. Constantly adding value for their users, Skype was planning to build high customer loyalty while building the critical mass needed to support the company's growth. SkypePlus, the premium service offered by Skype, included Voicemail, mapping of DID (Direct-Inbound-Dialing), ad banner, and other value added services. Considering the large customer base, Skype planned to include special third-party advertisements and e-commerce features to increase the revenue possibilities[9].

Two new services, SkypeOut and SkypeIn were developed to complete the service offering and add value to the existing customers. It was very clear that SkypeOut, a connection to the regular PSTN, could serve as a viable revenue generator[9]. It provided low-cost international calls and had attained popularity among its users. Mr. Zennstrom, the co-founder of Skype, revealed that about 5 percent of Skype members used SkypeOut or SkypeIn[8]. Another form of revenue for Skype surfaced from its partnership with Plantronics and Siemens AG. Skype opened an online

''Skype Store'' offering desktop and wireless Plantronics headsets that were compatible with the Skype software. It also offered the Siemens Internet telephone, the Gigaset M34 USB PC Adapter as part of their product portfolio. As part of Skype's plans to become a platform for a new form of seamless communication (free telephony), the company teamed with Motorola to develop products including headsets and mobile devices for Skype users[10]. Another possible revenue model for Skype was leveraging the licensing of the Skype API to third-party developers and carriers. As the popularity of Skype and VoIP grew, along with the improvements in reliability and security, licensing its software for handheld devices and phones could prove to be an extremely lucrative business for Skype[11]. This model could substantially increase Skype's presence in the telephony market and promote the company into a key player on the market. One such example was a small Cambridge based start-up, iSkoot, which uses Skype technology to make cell phone calls[12]. As far as business customers were considered, Skype estimated that 30 percent of its 40 million users (as of July, 2005) were corporate[13]. In addition, most of them were small and medium-sized businesses using Skype to save money and add functionality to their conference calls. This segment of the market could also be a substantial revenue generator since it was willing to pay premiums for value-added services while experiencing significant savings by not paying for the telephony itself. It is interesting to notice that there was a growing agreement in identifying corporate VoIP users as the key to complete VoIP prominence[14]. In essence, analysts showed that return-on-investment (ROI) of VoIP involves multifaceted costs and savings[15], but improved productivity (as in the case of unified messaging) and new services were probably as important as direct ROI[16]. Therefore, as a long-term strategic goal, it was important for Skype to attract as many corporate customers as possible and build an image known both for innovation and reliability. Through this variety of ways, Skype was attempting to create a new-market winning strategy.

EBay and Skype: A Promise for Revolutionizing E-commerce

While analysts were trying to determine Skype's possible long-term impact on the telecommunication industry[17], the company announced that it had agreed to be taken over by eBay Inc., the leading online auction-house[18]. This acquisition ignited a host of different opinions about the real value of Skype as a company and about the nebulous business plans of eBay (concerning its new acquisition) in the future[19]. One of the reasons for these reactions was the price eBay agreed to pay for Skype. The online-auction giant would acquire all of the outstanding shares of the privately-held Skype for a total upfront consideration of approximately $2.6 billion; $1.3 billion of which was in cash and the rest in eBay's stock[20]. In addition, there was a performance-based

earn-out as big as $1.5 billion, if Skype reached certain performance goals by 2009. Even though there were many experts who believed Skype could be a Google-sized opportunity [17] (one of them being Kevin Werbach, legal studies and business ethics professor at Wharton Business School), most of them agreed that a takeover of the company had potential, but it would be definitely a surprise for them (considering the difference in culture between Skype and major telecom and media companies). And while companies like Yahoo, Microsoft, Google, and News Corp. were rumored to have a vested interest in buying Skype [21]; eBay was the company that actually did the acquisition.

Even though eBay announced that it was not going to transform itself into a phone company [22], it did emphasize the importance of communications as being at the heart of e-commerce and community, thus considering Skype as the road towards creating extraordinarily powerful environment for business on the Net [23]. In some way, the partnership between eBay and Skype could turn out to be another type of potentially disruptive opportunity. Skype could now count on eBay to support its brand and image (along with its financial needs). This could prove extremely favorable for Skype, especially in times when the VoIP community believed in corporate customers to be the key towards global telecommunications convergence, and whilst Skype was being attacked for its reliability, quality and security promises [24]. As a business opportunity, Skype could increase the velocity of trade on eBay, add a voice bargaining option to its large customers, and introducing ''pay-per-call'' advertising with the potential of generating significant revenue. As far as Skype's future was considered, PayPal (an eBay owned company) could provide simple, secure, and reliable billing and accounting, exactly what Skype needed for its corporate customers [23]. In addition, eBay's strategy left Skype highly independent as a brand and as a business, something large telecom and media companies would have rarely done [18].

The acquisition of Skype has definitely shed a different light on the previously acclaimed disruptive character of the company. However, the fact that Skype was bought by eBay, not Microsoft or News Corp., left room for additional opportunities for technology and business fusion, and thus for a host of new ''potentially'' disruptive technological and business models. If today we are interested in the impact of the fusion between VoIP and P2P, future research could delineate the possibilities of combining P2P and online auctions or advertising.

Disruptive Innovation: Antecedents and Consequences

Disruptive technologies like VoIP and P2P can often represent a new value proposition in the way prod-

ucts and services are delivered. The antecedents of disruptive technologies are varied. Once they are introduced in the marketplace, they can take multiple paths to market dominance or their eventual demise. Prior research confirms how such innovations can often find new uses in untapped areas and also recombine with other standards and protocols (Tushman & Nadler, 1986; Ahuja & Lampert, 2001). In addition, when they combine in such meaningful ways, the net result can have a dramatic market impact, as we see in the case of Skype.

Why are VoIP and P2P Disruptive?

VoIP and P2P are individually characterized by processes, products, services or business models that offer lower performance along traditional trajectories. In the case of VoIP, the underlying innovation is the use of the Internet to transfer voice data. In the case of P2P, it is the use of a new form of distribution to speed up such data transfers. Following the norms of evolution of disruptive technologies, both VoIP and P2P were individually under-valued by traditional lead customers in their respective markets and were generating lower gross margins, in addition to being perceived as ''low-end'' by industry incumbents (Thomond et al., 2004).

Traditional phone companies did not perceive VoIP to be a serious challenge to their existing monopolies. And while VoIP was becoming more attractive to residential customers, the real opportunity lay in the corporate market. The Internet was at the heart of VoIP and equipment vendors played a major role in supporting the technical infrastructure required for reliable IP-telephony. Since large corporations were ''big spenders'' on IT equipment, their VoIP-oriented strategy directly influenced the growth of VoIP infrastructure [25] provisioning. Acknowledging the changes in the telephony sector, many telecommunication incumbents were entering the high-end (business) VoIP market [26], along with software giants such as Microsoft [27] (primarily interested in corporate videoconferencing) and Google (with Google Talk). On a residential level, while Microsoft did not plan to offer conventional phone service over the Internet [28] (its acquisition of Teleo Inc., a VoIP technology company, was aimed at improving the voice capabilities of Microsoft's IM service), Yahoo announced that it would offer new services that blend its IP technology with the PSTN, providing ''intelligent presence'' for its customers accompanied with voice email and search [26].

Businesses engaged in various forms of distribution (including music, movies, etc.) had only recently begun to perceive the threat posed by P2P distribution mechanisms. The music industry in particular, had been aggressively going after companies like Kazaa and BitTorrent, which enabled such viral distribution. In addition, the revolutionary P2P technol-

ogy had expressed its technical disruptiveness by proving itself to be unbreakable and technically unstoppable (Montemagno, 2005). On another level, P2P seemed to have awakened people's need for ''social sharing'', and started to challenge the conventional marketing and business models.

What made both VoIP and P2P interesting at the individual level was that they each introduced new performance criteria in certain niche market settings. VoIP represented a cheap and alternate method of doing something very traditional – placing a phone call. P2P, in turn, represented a faster and more convenient method of accessing files and content over the Internet. Slowly but surely, each of these two technologies were going mainstream and reaching a wider and perhaps a critical mass of customers. As pointed out by previous research, a period of exploitation and upstream migration upstream toward higher-end customers could eventually redefine the paradigms and value propositions on which existing industries were based (Thomond et al., 2004, Christensen 1997, Christensen and Overdorf 2000). Skype represented a successful fusion of two disruptive technologies. What made this integrated or joint level offering significant was that it represented a discontinuous innovation that could rattle the existing industry structure and create completely new forms of value delivery. There was already some evidence that services like SkypeOut and SkpyeIn were a move in that direction. We describe this phenomenon in the section below.

When Disruptive Technologies Integrate: Evidence from the Skype Case

Why is Skype a Discontinuous Innovation?

Skype represented the fusion of two disruptive technological paradigms (i.e. VoIP and P2P) that had resulted in a discontinuous innovation offering. According to Kodama (1992), technological fusion had the characteristics of nonlinearity, complementarity, and cooperativeness. This is how Skype's technological model integrated the scalability of P2P with the functionality and efficiency of VoIP. At the same time, Skype also fused the underlying P2P philosophy of ''social sharing'' with the cost-effectiveness of VoIP in order to shape its business and marketing model. Typically, discontinuous innovations offered major improvements in performance in the direction that lead-consumers desired, yet were challenged by implementation and adoption issues (Christensen 1997, DeTienne and Koberg, 2002, Thomond et al., 2004). In the case of Skype, the end result was discontinuous because a) Skype offered a revolutionary leap in performance over conventional VoIP, and a leap in functionality over traditional voice calling, and b) there was indication that lead-users of Skype (who are typically more comfortable with making calls over

the Internet) are delighted with the voice quality and service options and are eager adopters. In addition, Skype could be considered a radical technology. Using Dahlin and Behren's (2005) definition of ''technological radicalness'', Skype fulfilled the three necessary criteria of novelty, uniqueness, and adoptability. This definition focused more on the technological impact rather than on market impact.

It was also possible that the VoIP-P2P combination could emerge as the next platform for a new set of continuous or incremental innovations in the future (Clark & Henderson, 1990). The eBay acquisition of Skype could be an introduction into a future lateral technological and business convergence (Hacklin et al., 2004), characterized when mature (known) technologies or businesses (eBay) integrated with technologies (new technologies) or business in their early/growth phase (Skype). When such convergence occurred, the potential for disruption of the traditional technological and business models (related to the mature technology) could be immense. Using the same model of technological convergence (Hacklin et al., 2004), Skype's fusion of P2P and VoIP can be labeled as potential convergence. However, traditional customers of voice services (both corporate and consumer) had not yet fully embraced this new technology and associated services. This was due to a number of factors including low awareness, hesitation in using an online platform for voice calling, and a desire to see a more stable and reliable service quality both online and phone-to-phone. Therefore, it remained to be seen if Skype would dominate the voice market in the conventional sense, and disrupt it irrevocably. In order to do so, it needed the market coverage and traction that were currently the perquisite of the large voice carriers. It was possible that relational arrangements between Skype and such players might ensure a wider dissemination of P2P based VoIP. As pointed out by Lynn, et al. (1996), the case of Skype confirmed that the most consistent feature of a discontinuous technology was the high degree of uncertainty about its future and the potential for interaction between various types of uncertainties (like market, technology, timing, managerial control, etc.). Further, the future actions of competitors and the ongoing trends in industry consolidation could also alter the impact process. For a discontinuous innovation like Skype to be truly disruptive, successful exploitation of its potential was vital, and the result could be a significant transformation of the mainstream market and its value proposition (Thomond and Lettice, 2002). Using Christensen's (1997) understanding of the disruptive technology phenomenon, Skype can be viewed both as a bottom-up and top-down disruption[29]. Its low cost (no infrastructure cost), radical nature, and temporarily lower quality than the traditional PSTN (in this case we consider Skype's requirement of having a PC and a broadband connection as an inferiority to PSTN, for which the same non-requirements represent performance

oversupply) give Skype a bottom-up disruptive appearance, but its new functionality, value-added possibilities, and highly sophisticated users make this company a top-down disruptive technology.

Impact on the Marketplace

Skype's market potential was considered to be vast, as were the number of determined competitors. Depending on which segment of the market it sought to enter, there were a number of alternate strategies that could be pursued. By entering the IP telephony market, Skype had garnered the attention of other VoIP providers, such as Vonage, Net2Phone, 8x8, DialPad, FreeWorld Dialup and others, and traditional voice carriers such as AT&T, Verizon, Qwest etc. Despite the clear service differentiation of Skype, the fight on both market fronts was inevitable. These two groups represented the key market segments formed by the alternative VoIP service providers, and the traditional voice carriers and MSOs. The battle with the alternative VoIP providers was considered an easy one by the founders of Skype. In this segment, companies like Vonage[30] (41 percent US market share in 2004) that had well-established pricing models suffered from very high infrastructure costs, thus clearly giving Skype an upper hand in the market. To add a new user, Vonage had to spend almost $400 (compared to no cost for Skype). In addition, the pricing model, as opposed to the free basic service, was a major disadvantage in obtaining a critical mass of users. On the other hand, Vonage used telephone adapters and provided regular PSTN connection, while Skype was based on the PC platform and its users were not available outside Skype's network. With the introduction of SkypeIn and SkypeOut services, Skype enabled full connectivity of its users to the PSTN.

The second representative of the VoIP segment, viz. the popular instant messaging (IM) providers (Yahoo, AOL, ICQ, MSN, Netscape and others), had an immense shortcoming in the poor quality of the voice service. Their infrastructure and technology were not designed to support high-quality voice communications since telephony was their secondary service. As with alternative VoIP providers using telephony as a primary service, the IM providers' centralized infrastructure represented additional drawback considering their customer expansion. Another new entrant with a potentially discontinuous trajectory was the SIPphone. Based on the popular Session Initiation Protocol (SIP), SIPphone was a stand-alone appliance easy to use and configure. It represented direct competition to Skype. A major disadvantage was the limited interoperability with non-SIP devices and the traditional PSTN. In the corporate domain, Avaya was the global leader in communication systems, applications and services. Avaya's market share was substantial and based on the reliability, security, customer relationship, and the effectiveness of their offering[31]. In addition,

pure-play VoIP providers like Vonage were offering more enhancements to their services by integrating VoIP calling over wireless broadband networks. Vonage had recently announced the launch of Wi-Fi phone that could make calls over the Internet at homes or at public Wi-Fi hot spots. Vonage subscribers would thus have access to a limited-use cell phone with no extra costs (Davidson, 2004).

Even though Skype declared itself as a second phone alternative to the traditional PSTN it was more than mere competition for the traditional telephony providers.

''In the big picture this is very threatening (to traditional telecom providers) because it works. They've demonstrated that they can make end-to-end phone calls and cut the phone companies out of the equation.''[9]

– Jon Arnold, VoIP program leader for Frost & Sullivan Inc.

The big telcos, forming the second segment of the competition were skeptical of Skype's potential:

''What Skype is doing is like a toy. They will realize they can't scale it, they don't have a brand like the AT&T brand, and they don't have the local footprint, which we have. It's going to be very hard to compete with someone like AT&T.''[32]

– Hossein Eslambolchi, AT&T's CTO and president of AT&T labs.

Despite its dismissal of Skype, AT&T had entered the IP telephony battle. So had other carriers like Verizon, Qwest, Cox, Cablevision, and Time Warner Cable. The competition was intensifying and a low-cost service was a critical tool for attaining competitive advantage. In addition, the traditional telephony carriers were still considering the PSTN as a major business opportunity (their main form of revenue), thus relentlessly trying to ''keep it alive'' as long as possible.

In terms of revenues, despite its sharp growth, Skype had experienced only a modest payoff (according to some analysts[33]). The VoIP company earned $7 million in revenues last year, and it is on track to generate $60 million this year and $200 million in 2006. On the other side, a report by Evalueserve[34] predicted at least 22-26 percent reduction in overall profitability and revenues by 2008 for incumbent telecom operators offering fixed services, and a 5 percent reduction for operators offering mobile services. In the meantime, Skype was supposed to reach between 140–245 million users worldwide. In addition, the report stated that European incumbent telecom operators were at greater risk than their US counterparts, and that VoIP providers could lose up to 90 percent of their revenues unless they change and adjust their business model accordingly. These forecasts can be interpreted as a result of the value-creation potential lying in the convergence process (Nystrom & Hacklin, 2005) of the two disruptive technologies

integrated in Skype's offering (P2P and VoIP). Building a disruptive technology resulted in a disruptive business model. If we consider value as what customers are willing to pay, what happens if they don't have to pay anything? Skype is as close to that value promise as no telecom incumbent has been before. In addition, by using viral marketing, Skype delivers yet another value promise to its customers, thus raising the general expectations in the global communications industry. The technical capabilities of the integrated P2P and VoIP offering are well above what the traditional telecom operators can provide, and the richness of the value added features sets a new standard in the industry. Thus, a total reinvention of the telecommunications business becomes inevitable. On top of it, if we take a company perspective and a network approach in defining value, as something created between actors in exchange relationships (Nystrom & Hacklin, 2005), eBay's acquisition of Skype promises even more staggering value creation possibilities.

Research Propositions

Based on our analysis of some of the key features of Skype's business model and its marketplace position, we propose a set of research propositions for further academic and managerial considerations. These propositions demonstrate the importance of agility and flexibility in meeting challenges posed by recombinant disruptive innovations. Depending on the type of marketplace player (large or small, new or incumbent), the strategic and operational implications can range from nonexistent to the dramatic. We organize our propositions under four key headings.

In a previous section, we discussed how Skype represented a successful integration of two distinctly different disruptive innovations. The key here is to realize that this fusion can create an entire new dynamic and result in a technological and/or marketplace discontinuity. As Internet-based technologies gain more traction and the capacity to integrate diverse innovations based on networked infrastructures gain popularity, we can expect to encounter more examples of such fusion. One related reason for such developments is the fact that internet protocol facilitates modular and plug-and-play approaches to building new service capabilities (such as IPTV [35]). Entrepreneurs will find more opportunities in integrating technologies as diverse as biometrics, nanotechnology, and information technology, to name a few.

Past research recognizes two distinct ways by which a disruptive technology could impact an industry. One potential method is to exploit performance oversupplies and attack lead players through a low-end disruption using simplicity and novelty (Christensen, 1997; Charitou & Markides, 2003). Another thesis

points to a strategy of targeting ''non-consumers'' in a particular industry – i.e. those who have historically lacked the skill or money to use their products (Gilbert, 2003; Gilbert & Bower, 2002). Through incremental improvements from this starting position, the pool of non-consumers can be expanded to include consumers of incumbents and eventually existing markets could be entered using this strategy. In the case of Skype, the ''non-consumers'' turn out to be very demanding and sophisticated, and actually represent a unique and perhaps premium niche segment of early adopters. They also perform another valuable function in this context – through their ''word-of-mouth'' recommendation; they increase the pool of customers for Skype's services. In this context, we believe that the traditional notion of ''non-consumers'' being naïve, unsophisticated, or resource-poor needs to be revised. An important way for such innovations to gain traction is by attracting an early set of sophisticated customers, who in turn influence others to consider the newcomers products and services. Combining this feature with the networked power of the Internet means that the entire process can be significantly accelerated, both through firm-centric managerial intervention, and customer-centric adoption and co-creation (Prahalad & Ramaswamy 2003, Iansiti & MacCormack 1996).

Based on the above discussion, we offer the following research proposition:

P1: Recombinant (disruptive) innovations can result in a discontinuous innovation

Given the plurality of visions and strategic goals as described in the previous sections, we envision multiple paths to achieving greater integration of multiple disruptive technologies like VoIP and P2P in this market landscape. Each of these paths also represents strategic postures adopted by players operating in each of the sub-domains. We categorize these approaches based on two axes:

(a) Degree of convergence: This axis represents the degree to which the service package consists of a number of converging elements. In our analysis, this would typically represent a portfolio of service offerings including voice calling, e-mail, instant messaging, video communication, file sharing, etc.

(b) Degree of discontinuity: On this axis we classify the different approaches based on the degree to which the inherent innovation driving the business models are discontinuous, i.e. the extent to which they shift the learning curve due to more attractive performance metrics.

We present a summation of some of these paths in Exhibit 1.

As can be seen in the exhibit, one immediate way of countering the effect of an innovation like Skype is
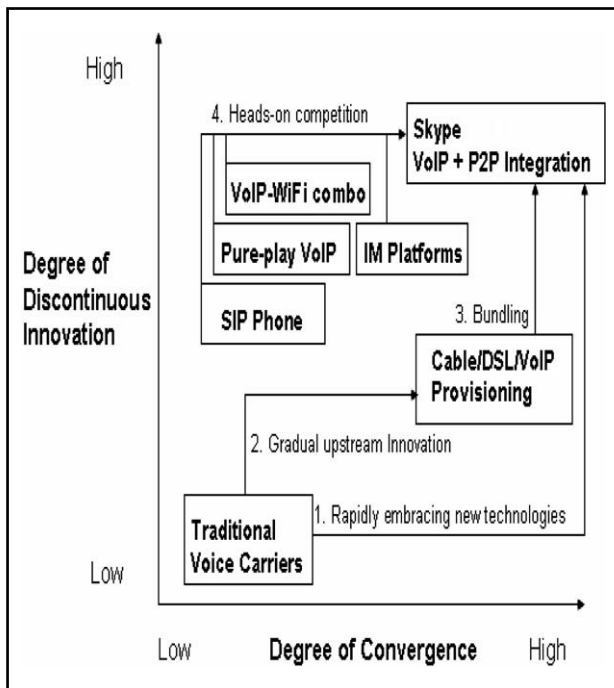
Exhibit 1 Paths towards Integration of Multiple Disruptive Technologies

to rapidly embrace the new technology or set of technologies that enables a drastic improvement in performance metrics and delivers a high-quality and cost-effective solution. This view is most applicable to the industry incumbents, i.e. the traditional voice carriers. However, the voice carriers do not perceive an immediate threat due to certain other advantages they currently enjoy, like a large installed subscriber base, a more grounded and stable technology platform, and certain size and tenure-related advantages. Given the turbulent technological environment they find themselves in, these incumbents need to be extremely flexible and responsive insofar as incorporating new technologies and product introductions (Iansiti, 1995). However, it is likely that dominant firms are likely to adopt more incremental innovations rather than take a radical approach (Utterback, 1994).

The second path consists in gradually adding new service options through a steady migration upstream towards more technological domains and opportunity areas. Some carriers are beginning to see the importance of VoIP, cable, DSL and potentially P2P powered solutions and are making slow but steady strides to shore up their learning and capacity in these areas by taking the second path, which we label this 'gradual upstream innovation' in the Exhibit. There are examples in the literature of such organizations responding successfully to discontinuous innovations despite various structural and organizational limitations (Macher and Richman, 2004).

The third option, and perhaps the safest position to be in the current scenario, is the space occupied by

cable and DSL providers who offer a wider range of bundled services. Since they typically possess a critical media foothold into the homes and offices of end-users, they enjoy a major advantage in either pushing or rejecting new and potentially disruptive technologies (a classic "entrenched" position). This gives them some slack before they figure out whether to operate in relatively new and risky markets. Some of these cable and DSL operators are already offering bundled VoIP services as they seek to price the traditional voice carriers out of the market, and also increase customer switching costs. In addition, they may seek to embrace a medium like Skype in the future either through acquisition or licensing, and thus offer more choice to their customer base. By adopting a skills-acquisition approach that employs recombination of their current capabilities (Kogut and Zander, 1992), these firms can approach new markets and opportunities as those represented by an integration of VoIP and P2P. This is consistent with a portfolio-based strategy of innovation where firms gradually move into different markets by extending existing current technical trajectories (Abernathy and Clark, 1985; Venkatraman and Lee, 2004).

The fourth path that can be also taken by some industry players is to engage in direct head-to-head competition with Skype. In order to do this, they have to possess an equally novel or comparable underlying technology and distribution mechanism, and be willing to aggressively go after new customers. The pure-play VoIP players and SIP Phone providers, VoIP-WiFi combination services providers, and instant messaging platforms are key representatives of this strategic group. They face challenges similar to those faced by Skype, including the challenge of rapidly growing the customer base (by adding both new and current customers of incumbents), uncertain returns on technological investment in the short run, and lack of clarity in market definition and competitive potential. Their high-risk, high-return profiles mean that there could be big winners and significant failures in the group.

There are thus multiple paths to migrate towards a high-value position even in this crowded marketplace. Increasing levels of convergence and discontinuity can be proving grounds for a new breed of players who offer a range of products and services for communications, connectivity, commerce and entertainment. Following the previous rationale, the second research proposition is as follows:

P2: Alternative paths exist in successful integration of disruptive technologies

Given Skype's differentiated positioning in the VoIP and convergent communications space, traditional voice carriers face a critical decision on how to challenge or incorporate the discontinuous innovation represented by Skype. Several firms in the past have

vanished because of an unwillingness to anticipate and/or embrace ''disruptive innovations''. If traditional voice carriers believe that Skype represented a new and more effective paradigm for delivering services that are core to their business proposition, they will need to rethink their technology and business strategies accordingly. Skype represented a unique case where a combination of two disruptive technologies had created a strong discontinuous innovation space. As previous research has uncovered, the introduction of a technological discontinuity often gives rise to an era of ferment and uncertainty as new and incumbent firms try to introduce new products and processes that aim to capture profits from the emerging technology paradigm (Macher and Richman 2004). Flexibility, responsiveness and dynamism would be critical to entrenched incumbent's success in such turbulent transitions (Iansiti 1995, Thomke and Reinertsen, 1998; Tushman and O'Reilly, 1996). Also, as described in the sub-section above, certain types of diversified incumbents might enjoy more of a leeway in responding to a potentially discontinuous innovation.

Hacklin et al. (2004) argue that in times of drastic changes in the market environment (when disruptive technologies appear) it is crucial for industry incumbents to focus on a resource-based view of the firm activity. On the other side, it is very uncertain for the ''disruptor'' of the marketplace (in this case Skype) whether it will continue its disruptive path, or end up as a trophy in some large incumbent's showcase. What is the likelihood of integrating Skype in an incrementally oriented business company? Nystrom and Hacklin (2005) confirm the theory that technological convergence could represent a special case of disruptive innovation, and eBay's recent acquisition of Skype may turnout to be a perfect case in point. In addition, it is tempting to examine if eBay and Skype can create a new business dynamic following the method of lateral convergence (Hacklin et al., 2004), which occurs when a known, incrementally oriented company converges with a new, disruptive market entrant. This takes us to the third research proposition:

P3: Disruptive innovation can grow to become a sustainable and dominant innovation model after an established and incrementally oriented company acquires a new and disruptive firm

Finally, one cannot discount the role of managerial intervention in shepherding a potentially discontinuous innovation to marketplace success. It is here that Skype enjoyed a strong competitive position. Harnessing their prior experience, exposure and industry connections with the launch of Kazaa, the founders of Skype were determined to make their new company a success. They adopted a number of strategies that play to their position of strength but at a low incremental cost. These included a low-cost viral marketing strategy, the free distribution of initial software, and the rapid buildup of a viable and global customer base. Even though Skype had declared itself as an alternative to the traditional PSTN, it was more than mere competition for the traditional telephony providers.

''In the big picture this is very threatening (to traditional telecom providers) because it works. They've demonstrated that they can make end-to-end phone calls and cut the phone companies out of the equation.'' [9]

– Jon Arnold, VoIP program leader for Frost & Sullivan Inc.

In addition to the successful launch of their initial product, the founders of Skype had also demonstrated agility and quick maneuvering. A spate of new product features had been launched, with the objective of improving customer experience and also reducing dropout rates. In the long run, this would provide the company with a more sustainable competitive advantage. The fact that the peer-to-peer and Internet-based nature of the service allowed for rapid product and service development and rollout was not lost on the management team at Skype. They had clearly identified their core capabilities and were willing to compete and excel based on them (Stalk, Evans and Shulman, 1992).

''By having telephony as a Net application, we can develop new features faster... it takes a long time for traditional telephone companies to develop new switches.'' [9]

– Niklas Zennström.

Even though researchers have suggested numerous reasons why incumbents fall victim to disruptive innovations (Christensen, 1997; Hamel and Prahalad, 1990; Anderson and Tushman, 1991) and explanations of the managerial influence in that process (White, 2004), it is our opinion that managerial vision and intervention is an absolute requirement for a technology, along with its business model, to become disruptive. Similar to our previous deliberations, we consider Skype as a well-suited example of this rationale. In addition, we suggest the following research proposal:

P4: For a discontinuous innovation to become disruptive it has to be spurred by managerial vision and intervention accompanied by engineering creativity and excellence

Conclusions

It is well established in the literature that innovation in the form of new combinations of products, markets, supply sources, and organizations can sometimes lead to the destruction of incumbent firms, industries or technologies (Schumpeter 1943). In

addition to such ''creative destruction'' dynamics, there could also be periods of technological discontinuities where one technology displaces another due to new and fundamental breakthroughs in underlying technologies or delivery paradigms. As Amit & Zott (2001) point out, innovative models that facilitate creative destruction can also relate to exchange mechanisms and transaction architectures, a fact becoming more common as platforms like the Internet emerge as an important backbone network infrastructure on which other applications and services are based. Skype represents a novel case of discontinuous innovation that has arisen out of a tangible combination of two or more disruptive technologies being deployed in the form of novel transaction architecture. As the underlying technology and the associated services it offers becomes more widely accepted and diffused in the marketplace, it is likely that Skype will pose a serious threat to industry incumbents. A critical mass of discriminating and demanding users who are willing to make the switch to a relatively new form of communication will determine the next winners and losers in this area. In the meantime, industry incumbents would do well to learn about the implications of Skype on their own business models. Despite the novelty and attractiveness of Skype's technology and business propositions, forecasting its eventual success or failure is fraught with uncertainty. In addition, such innovations very often serve different markets with different characteristics and which lie at different points in the diffusion process (Linton, 2002).

In this paper, using the case of Skype, we have demonstrated how two or more disruptive technologies in concert can result in a new discontinuous innovation that can create new forms of market value. The resultant innovation can be discontinuous in that it requires shifting to a different technological learning curve, and enhances and even redefines extant performance metrics. Both incumbents and new market entrants can investigate the impact of such an integration of disruptive technologies to determine what impact, if any, it will have on their own business models and future outlook. In particular, we believe that the space of Internet-based and convergence-oriented services will offer a rich diversity of models and approaches by which this phenomenon will further play out.

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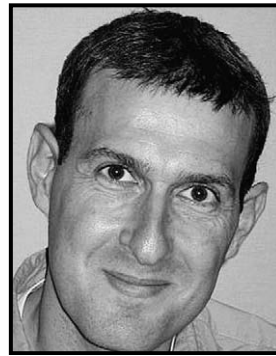
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