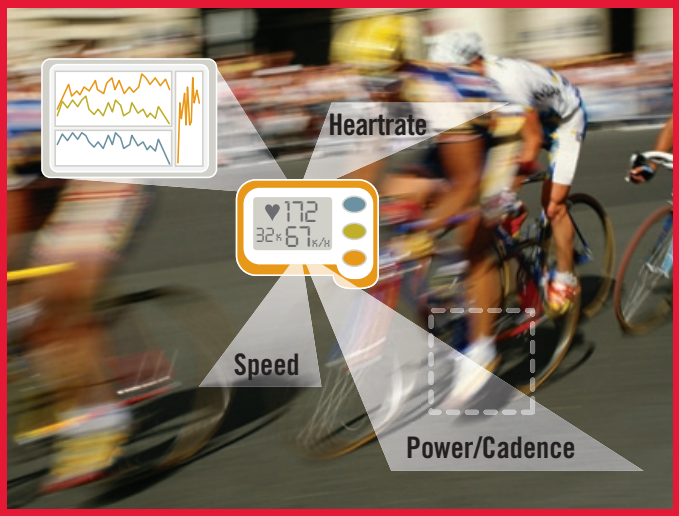
Convergence

Creating and Capturing Value for the Enterprise



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Boston University Institute for Leading in a Dynamic Economy

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ENVISIONING new ways to compete and win

EXPLORING new theories to guide practice

EXAMINING new logics of value creation and capture

Intelligence at the Edge

Strategic Experimentation

The Connected Home

Winning in the Network Era

Platform Economics

Real Options

Relationship Networks

Architectural Control Points

Visualization

Sensory Networks

Expressive Data Models

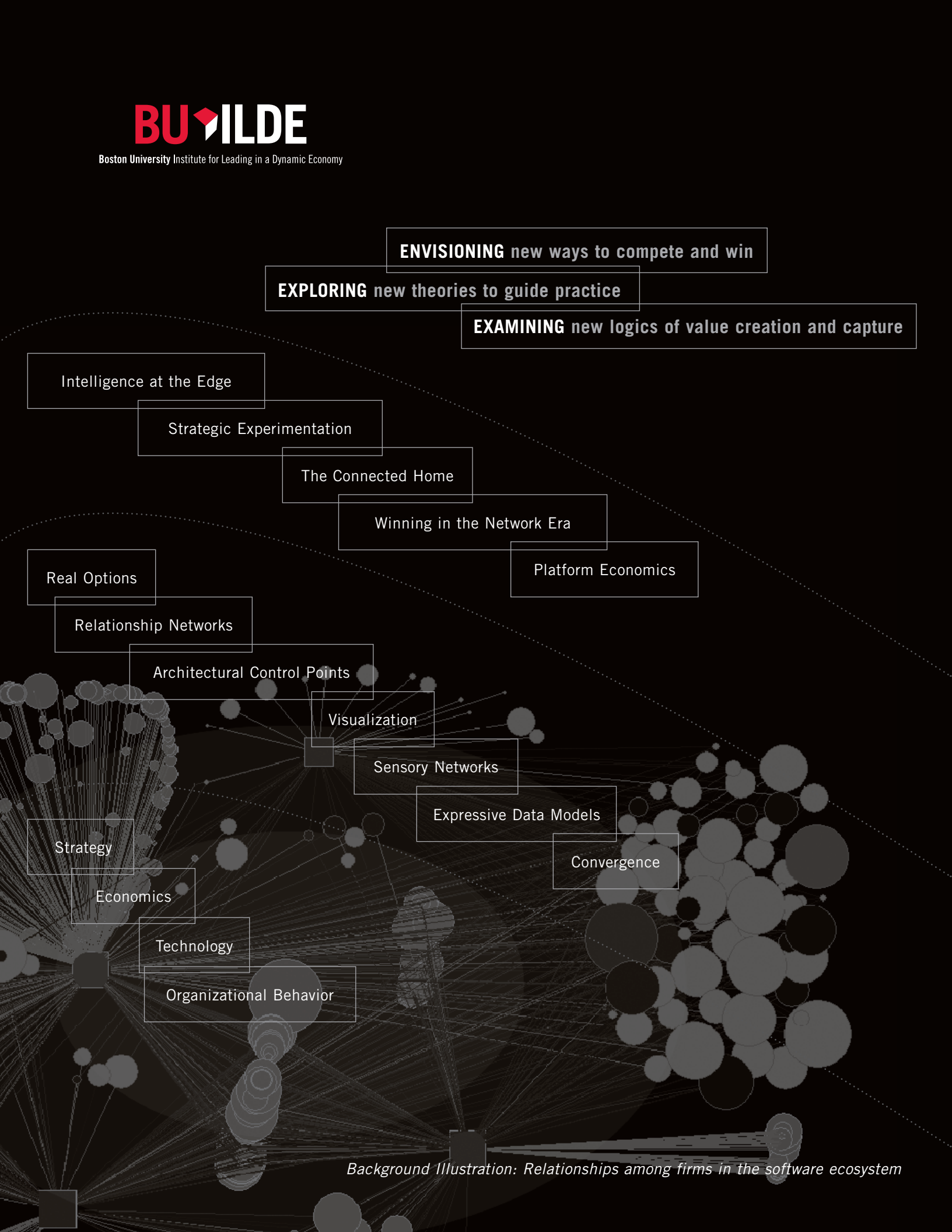
Convergence

Strategy

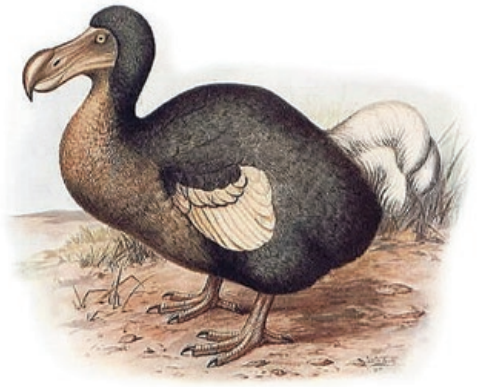
Economics

Technology

Organizational Behavior



Background Illustration: Relationships among firms in the software ecosystem



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Flightless in Times of Trouble

The Dodo Bird was first discovered on the small island of Mauritius in the Indian Ocean in 1507. When Portuguese sailors arrived on the island, they were fascinated by the bird's docility and curiosity. In fact, they mistook the bird's curious nature for stupidity and named the bird, "Dodo," the Portuguese word for "simpleton". The Dodo Bird, like most of the animals living on Mauritius, had never been exposed to any type of predator and was unaware that the Portuguese sailors posed any threat to its life.

Situated far from the mainland, the sailors had limited food resources. The docile Dodo Birds, weighing up to 50 pounds, were soon found to be good sources of food and sport. Since their small wings did not allow them to fly, the sailors could easily approach and then attack the Dodos with clubs.

Within a few decades, the Dodo population on the island had significantly decreased. What's more, dogs, pigs, monkeys and rats introduced by man, also preyed upon the helpless Dodos. Together, these human and animal predators ultimately led to the Dodo Bird's extinction.

External shock (to a previously stable ecosystem) is to blame for the ultimate demise of the Dodo, less than 200 years after it was first discovered. Because the Dodo Bird never had any natural predators, it lived a peaceful and sustainable life on Mauritius, finding no use for its wings. Years of inactivity rendered the Dodo flightless and therefore defenseless against predators when they eventually arrived.[1]

[1]A reference from *The Ancestor's Tale*, Richard Dawkins, Houghton Mifflin Company, 2004

Acknowledgements
This work was supported by Global Mobility Insights and Innovations (GMII). We thank Emily W. Groves and Tara Venkatraman for creative and editorial help; and Stef van Aarle, Scott Forbes, John Henderson, Lihui Lin, and Sandip Mukerjee for valuable comments and suggestions. The point of view and all remaining errors, however, are our own.

LEARNING FROM THE TRAGEDY OF THE DODO BIRD

The tragedy of the Dodo Bird shows that time carries the unexpected. From dinosaurs to the giant ground sloth, natural history is filled with examples of species that did not evolve as fast as their environment changed. What if the Dodo Bird had regained the ability to fly? Better yet, what if it could have developed the aquatic capability of a seal? These abilities may have saved the Dodo from extinction. Species' extinction shows that for all its power, evolution is myopic and lacks the flexibility to change quickly.

Modern organizations evolve like species in nature. But unlike natural species, organizations can innovate and respond to external shocks—faster and with greater foresight. Now more than ever, innovations in communications technology are changing the environment in which organizations compete. These innovations present organizations with new challenges but also provide them with new opportunities. How can organizations evolve successfully while handling their own predators—their "sailors with clubs?"

We argue that winning organizations must understand the end user. Technologies make many things possible, but if they are not in demand, they may never become adopted or even noticed. Technologies can also create production efficiencies and ensuing cost savings, but earning a fair return on large upfront investments requires that firms change the way work is organized around technologies. These multiple layers of change are best understood through the perspective of what is impacted—the organization, person, or entity that derives value from it. For our end user story, we have chosen the Tour de France as a vehicle to showcase the many layers of change and hint at the organizational possibilities.

We follow with a discussion on the "so what" of communications technology change. Historically, communications systems (e.g., telephony, television) have been rigid, forming linear chains of content, channel, and device. Conversely, today's communications systems are inherently flexible, allowing for a mix and match relationship between components. This flexibility provides an opportunity for the convergence of established communications systems and the creation of new services. Watching television on a mobile phone and making voice calls over the Internet are only the start of what is to come. End users are now positioned to leverage this capability to create flexibility for the organization, the employee, and the customer.

Lastly, we propose a method for driving strategy in the face of uncertainty. In today's rapidly developing, technologically-connected world, organizations have the power to shape the future and adapt to their changing environments. In order to survive, organizations must build new relationships with outside players, be in a position to observe the revelation of information, and be armed with a rich set of choices from which to select the appropriate response. However, in many instances the future choices themselves are far from known. In other words, much of the value comes from an ability to gain proprietary learning from strategic experimentation.

Technology presents today's organizations with valuable opportunities and difficult challenges in the face of tremendous uncertainty. So as not to follow in the steps of the Dodo Bird and be flightless before predators, today's organizations must evolve flexibly and intelligently or face extinction.

In cycle sports, the Tour de France is the top event, requiring both individual and team achievement to master harsh terrain over great distances in remote locations. Over time, these ideals have remained constant, while everything else has changed in response to technological innovations. More recently, innovations in communications technology are changing the way the race is run, followed by reporters, and watched by fans.

CONVERGENCE AND THE TOUR DE FRANCE

While recovering from losing a breach of copywrite lawsuit to his rival, Henri Desgrange founded the Tour de France in 1903 with the intention of increasing sales of *L'Auto* newspaper. Promoted as the greatest cycling trial in the entire world, the race immediately created a unique and captivating atmosphere. It was a new and exciting event that drew people from everywhere to watch professional cyclists use their incredible athletic abilities, drive, and passion in a competitive struggle. The race was an immediate hit, and fueled a dramatic increase in *L'Auto* subscriptions from 20,000 to 130,000.

Having kept current on the race by reading *L'Auto* newspaper, thousands of people gathered at the finish of the final stage to watch Maurice Garin win the first Tour de France in 1903. Using rudimentary single speed cycling machinery, 60 riders covered 2,500 kilometers of flat terrain at an average speed of 26 kilometers per hour. By contrast in 2004, highly evolved communications technologies enabled millions of people in several countries to watch Lance Armstrong win the 101st race. Aided by cycling machinery developed with space age technologies, 300 riders covered a distance of 3,400 kilometers (including several difficult mountain stages) at an average speed of 40 kilometers per hour. From its origin to current day fame, the Tour de France has grown into an event of incredible magnitude, and has brilliantly evolved with and adapted to change.

Innovation has been a big part of the Tour since its origin in 1903. Shortly after the surprisingly successful first race, organizers were creating new technologies to enhance cycling machinery and new business models to increase the scope of race exhibition. In the 1930s, major innovations included the standardization of an advanced derailleur system, which allowed cyclists to change gears without removing their wheels. In the same time period, tour organizers introduced the highly popular publicity caravan, which continues to delight race fans today. Recent improvements in communications technologies have dramatically accelerated the evolution of how the race is organized and run, how teams compete, and how digital content for end user consumption is created and delivered. Today's more converged networks enable real time, end-to-end media coverage of the Tour de France, and allow end users anywhere to enjoy the event while stationary or mobile, in numerous content formats, over several different access networks, using a multitude of devices.

In the days leading up to stage 16 of the 2004 tour, thousands of cycling fans assembled along the 15.5-kilometer mountain stage route which ascends 1,860 meters through 21 hairpin turns to the town of L'Alpe D'Huez. Armed with the latest mobile devices, they captured the event in many formats while soaking up the festive party atmosphere. Voice communications, text messages, email, and photos from the mountainside were easily sent over the Internet to friends and family from cellular voice and data networks. Digital TV subscribers in several countries were able to control how they enjoyed the event in new ways. Enhanced digital video set top boxes allowed subscribers to stop, pause, rewind or fast forward live high-resolution digital broadcasts that arrived at homes over the air, cable or broad-

To adequately support the high demand for digital content,

highly evolved and flexible networks have emerged.

band IP networks. Newly available home media products allowed subscribers to "place shift" in real time. The Tour de France broadcast was able to instantly and seamlessly move anywhere around the house through a local wireless network while complete control over the digital set top box and the enhanced viewing experience was maintained. Some products support place shifting to remote locations with available broadband Internet access services like the airport or a hotel. The home video device is accessed and controlled through the Internet. Live or recorded video content is then redirected back through a home broadband Internet connection to a PC or even a cell phone.

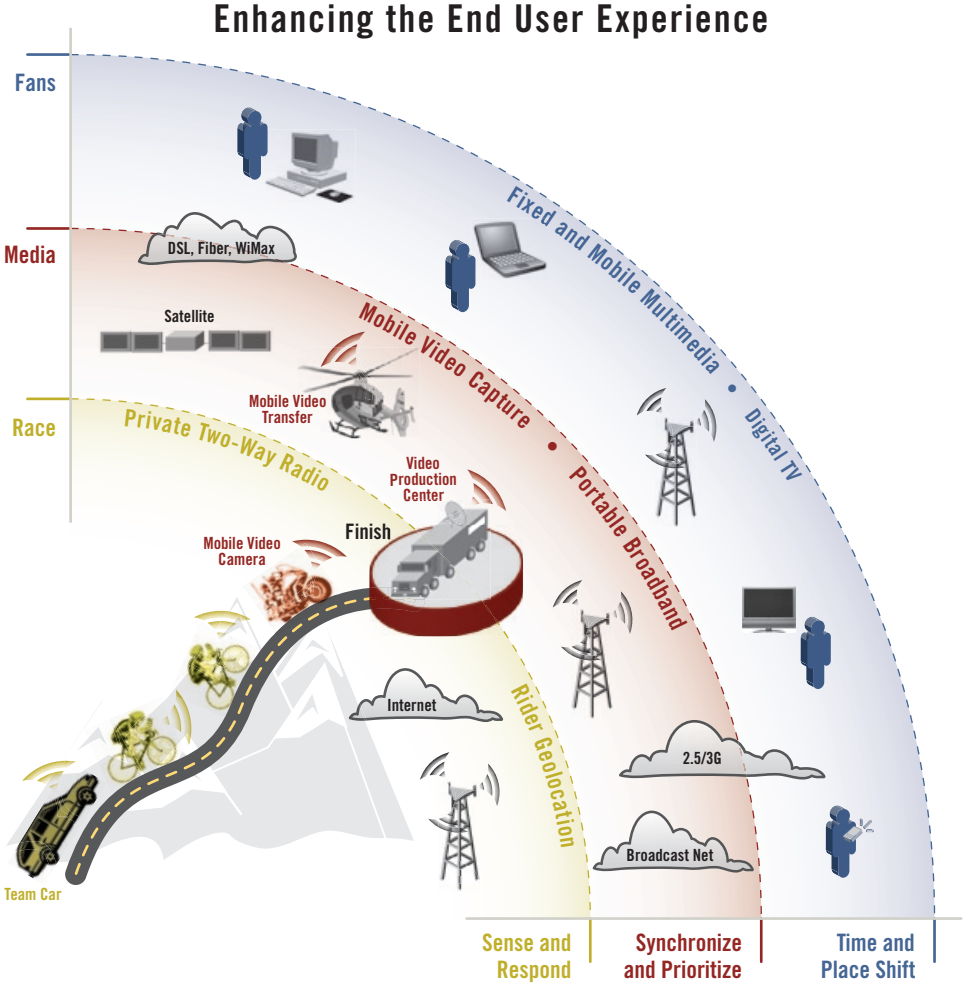
For members of the media and other mobile professionals working the Tour de France, a Wi-Fi enabled notebook computer, instant messaging, collaborative online white boarding and file editing, and voice over Internet Protocol (IP) are becoming vital to keeping a competitive edge. These components combined with more pervasive availability of broadband Internet access allow the office to become mobile. Broadband IP services allow stories, digital photos, video or other types of data to find their destination with greater speed, but there is more to it. User controlled combinations of IP applications that run seamlessly on different device types over a variety of wireline and wireless networks enable mobile professionals to find and collaborate with co-workers in real time. The collaborations are now richer in content, and less restrictive. One to one, one to many, and many to many communication sessions are possible, and multiple applications can be used within the same communications session. As a result, better stories are created faster, and fewer deadlines are missed.

To adequately support the high demand for digital content, highly evolved and flexible networks have emerged. During the night before the L'Alpe D'Huez stage, a new kind of broadband wireless network known as WiMax was easily moved to the finish area, installed, configured and put into service. On race day, this remote town in the French Alps hosted a leading edge portable wireless network that seamlessly connected race organizers, participants, media and corporate sponsors to the Internet at speeds up to 14 times faster than the average Digital Subscriber Line (DSL) or cable service. With the help of WiMax, enormous quantities of email, data files, graphics, video, and voice communications traveled over a broadband IP network that didn't exist twenty-four hours earlier. The network was available for only as long as it was needed, and then moved to the next race location for a repeat performance.

To capture and deliver a live television broadcast, another incredibly flexible network has been created for the tour. From motorcycles that operate amongst the racers, videographers get high quality digital video using specialized cameras from the focal point of the action, which is then wirelessly sent to a low flying helicopter. Because the helicopter has a high point of view and mobility, it can stay within line of sight of a mobile broadcast production center set up at the finish line, allowing it to relay the live video signal. The production center then mixes the video stream with graphics and audio before seventy-five local cable and satellite TV providers in 170 countries pick up the broadcast, insert advertisements, and send it out to their viewers. In a growing number of locations around the world, the broadcast can be delivered to homes over an IP broadband network.

The evolution of the Internet has provided an increased ability to rapidly create new web browser based applications that can be easily accessed from a variety of networks and user devices. From one new application, end users are given the opportunity to get a customized virtual view of the race that before would have been too costly to attempt. For the first time in 2004, satellite tracking data (EGNOS and GPS), which can pinpoint the location and speed of each rider to within one meter, is placed within a 3D visualization of the L'Alpe D'Huez race stage and uploaded to

Enhancing the End User Experience



the Internet, allowing a perfectly precise real-time picture of the race. The application is made available to consumers and race participants, and can be used as part of a TV broadcast. Other rapidly emerging applications allow race participants to benefit from advanced training and analysis tools. Riders are fitted with sensors that send biometric data back to the team car, a mobile command center that follows closely behind the racers. A race team manager's ability to easily access constantly updated telemetry and biometric data provides the competitive edge necessary to make winning decisions.

So what's next? The rapid evolution of technology is constantly removing barriers to the creation of new, more converged, and valuable services over IP networks. In addition, the standardization of network architectures provides a pathway for the integration of disparate network technologies, and supports seamless roaming scenarios for simultaneous voice and data (multimedia) services across networks and devices. A standard that is gaining significant momentum in both wireline and wireless communities is the IP Multimedia Subsystem (IMS), which presents a unifying architectural model. In its simplest form, a network architecture based on IMS creates a reusable platform upon which high quality multimedia services for consumers and enterprises can be quickly created, deployed, and either expanded or decommissioned at low cost. This eliminates the need for expensive and often redundant vertical "silo" architectures that are dedicated to a single service, and accelerates the evolution of services targeted more closely to a variety of end user needs.

As technologies continue to evolve, end users everywhere will be able to more easily and seamlessly engage in IP voice communication sessions with one or several others while everyone views a video clip, picture, or other type of media. There will be no restriction on where anyone is geographically, what type of network they are on, or what device they are using. The user will no longer have to consider or manage these aspects. In addition, users will be able to simultaneously engage in several communications sessions at once, and they will be delivered with quality of service and security levels equal to or better than those we expect today. As demonstrated by the modern day coverage and consumption of the Tour de France, "sharing the moment" or "getting the job done" will present endless possibilities.

Modern communications systems are more flexible, providing better choices for the end user and new opportunities for ecosystem players. Each component of the system (content, channel, and device) is now free to evolve independently in a mix and match relationship, allowing for greater innovation, convergence of existing communications systems, emergence of a virtual core network, and endless opportunities (and challenges) for the enterprise.

THE ROAD FROM TRIPLES

As demonstrated by media coverage of the Tour de France, technology is most effective when it is "mixed and matched," that is to say, when different types of technology are combined to instill a variety of capabilities in one system. This inherent flexibility created through technological innovation affects the way services are consumed by the end user—disrupting the status quo and providing opportunities for supply and demand side players.

Flexibility in communications systems allows for access to a broad range of services at variable levels of quality and at different price points (a wider array of quality-price tradeoffs). For the end user, these quality-price tradeoffs mean better choices. The mobile phone is one example of this flexibility in communications systems. To simply make voice calls, a mobile phone and traditional service is relatively inexpensive. However, if we want to make voice calls, access e-mail, take photos, and track location, the quality of the services and the price will vary dramatically based on our needs. The decision to pay a premium for flexibility is a good indication that there is more value in the convergent device than the sum of its parts. For service providers, this means an opportunity for price-discrimination based offerings. An example is the notion of priority services, where important calls or e-mails are routed with higher quality of service—at a higher price.

Flexibility, however, rarely delivers an immediate return on investment. As seen in the evolution of the Tour de France over time, capturing value from flexibility often requires follow-up investments in changing work practices and organization. The greater investment is often accompanied by an increase in expected value, and an increase in uncertainty. A good example of how flexibility can generate increasing value over time is in the insurance industry, where a convergent device allows a claims agent to take photos at the scene of an automobile accident and transmit them in real-time back to the branch office. The technology alone improves efficiency, but only a change in workflow and the re-allocation of decision rights allow the agent to settle the claim on the spot and reduce liability for the firm.

Historically, communications systems are inflexible. The electric telegraph is widely recognized as the first of these systems, easily displacing the horse-and-rider as the preferred means of sending a message. Similar to many of today's systems, the telegraph is comprised of specialized devices to send and receive encoded messages and a mesh of wire to connect the end points (a link or channel). The telegraph's content is simply the encoded message. The devices and links, however, serve no functional value without the other. So extreme is the compatibility between devices and links that each component or the larger system can be referred to by the same name. For example, telegraph is a term that can be applied to the sending or receiving device, the transport link, or the message itself. We call this rigid type of communications system a *triple*, where the system is optimized for a specific application and lacks the flexibility to perform multiple applications.

This lack of flexibility reflects technology limitations and cost constraints at the time of construction. For example, telephony offers one application (voice), at one quality of service (very high), and at one price point (minutes of use). To provide this level of service, telephony has always relied on circuit switching to form a reliable and direct connection between two parties. The flexibility to do more than voice communication (such as offering broadcast radio) would have been prohibitively expensive.

TO MIX-AND-MATCH

There are few triples, but they tend to be dominant with a long lifespan. One of the largest, measured by number of end points, is telephony. Others operate in a broadcast model, such as television and radio, delivering rich content from a single source, mostly for entertainment, advertising, and news. Triples create value by generating network effects, where the value to each user increases with the addition of each new user (more people to interact with or the availability of richer and more diverse content). These network effects are responsible, at least in part, for why many historical triples are still around today.

The evolution of triples, however, is not without innovation and change. For example, telephony has been extended to include fax and multiple generations of wireless voice services. But the innovation was bounded by compatibility requirements and slowed by the need for coordination across components, illustrating that advances in network technology are of no value without the corresponding advances in handsets. The answering machine is another example of an innovation that grew out of telephony. Trivial by today's standards, the answering machine makes use of the device and the content without the real-time need for the channel. A person could review recorded messages at a convenient time, and later—from a convenient place. This was the start of "time-shifting," a design principle driven by the end user and common to all communications systems.

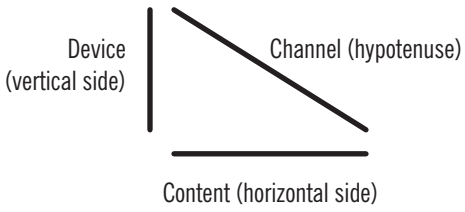
Computing networks have always been different—from triples and from each other. Heterogeneous computing networks grew organically inside corporations, universities, and government agencies. Sharing information across these organizations requires an internetworking solution—the Internet, designed for connecting a group of physical networks into a single larger network. The Internet uses an overlay solution to deliver reliable end-to-end transport over a diverse number of physical network types. The encapsulation of these physical networks allows the Internet to continuously exploit advances and diversity in communications technology, becoming more powerful without the pain of transition.

For the end user, the complexity and ugliness of the Internet are hidden, making it appear as another triple. It has the World Wide Web and e-mail as content, a personal computer as a device, and a link in the middle. Furthermore, it is interactive and generates new value with each new user. These observations, as important as they are, miss a fundamental point. The Internet is not like the "rigid triples" of the past; it has more flexibility. Computers, links and web pages are certainly compatible with the Internet, but so are many other devices and forms of content. They have a mix and match relationship, as shown by the rise of electronic music distribution, Voice over Internet Protocol, and many other new or adapted services.

With the Internet as a model, modern communications systems are now more flexible. The removal of extreme compatibility requirements resulted in a mix and match possibility for each component of the chain. This means that many types of devices (e.g., phone, computer, game console, television) can be used to access many forms of content (e.g., music, film, photography, world wide web, messages, orders, customer profiles, prices) over many types of channels (e.g., fiber, 3G, Wi-Fi, cable). For example, watching television programming on a mobile phone over a wireless network is now a viable service. (See Illustration: Communications Systems Path to Flexibility)

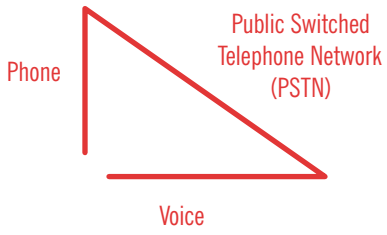
Communications Systems Path to Flexibility

From a functional perspective, a communications system is comprised of three complementary components: content that is created or consumed by the end user; a device for presentation, analysis, or capture of information (by human or machine); and, a channel for connectivity and management of the system.

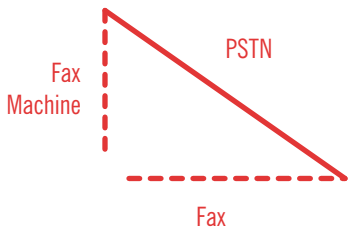


Historically, the components are linked to form a linear chain, collapsing space and time for a specific function. This type of system can be referred to as a triple, often controlled by one or few companies in an industry.

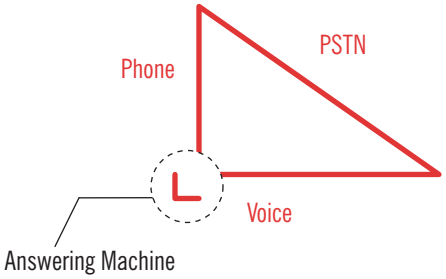
Telephony (red)



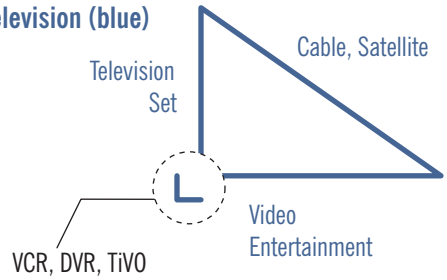
The channel can be leveraged for the creation of new systems, but flexibility is limited by the physical capabilities of the channel.



A linkage between device and content provides functionality without a real-time link with the channel. This is the start of time-shifting within the domain of communications systems.

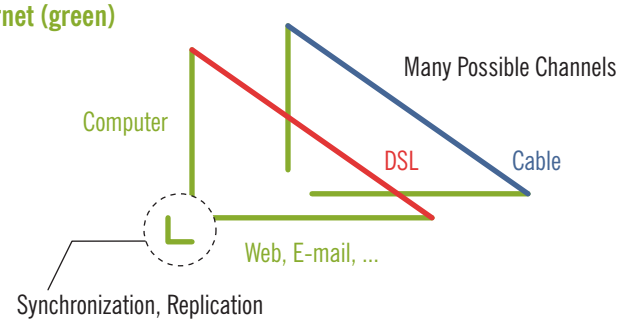


Television (blue)

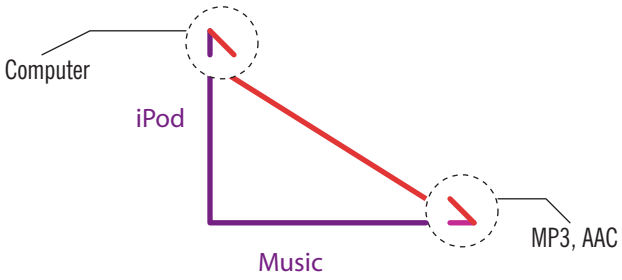


Triples are subject to innovation drag, bounded by compatibility requirements across components and slowed by the need for coordination across organizations. The end-to-end model of the Internet lessens the compatibility requirement, allowing for a more flexible relationship between components.

Internet (green)

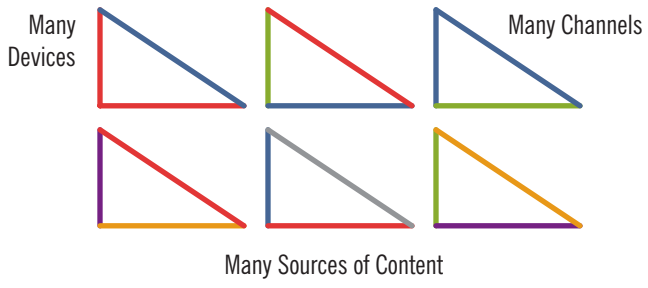


Increased flexibility creates new possibilities for the interconnection of content, device, and channel. This flexibility also sets the stage for the migration of existing services (convergence).



A mix and match environment is more flexible, providing better choices for end users and new opportunities for ecosystem players, while allowing players and technologies from other "industries" to cross their traditional boundaries.

Mix-and-Match Networks

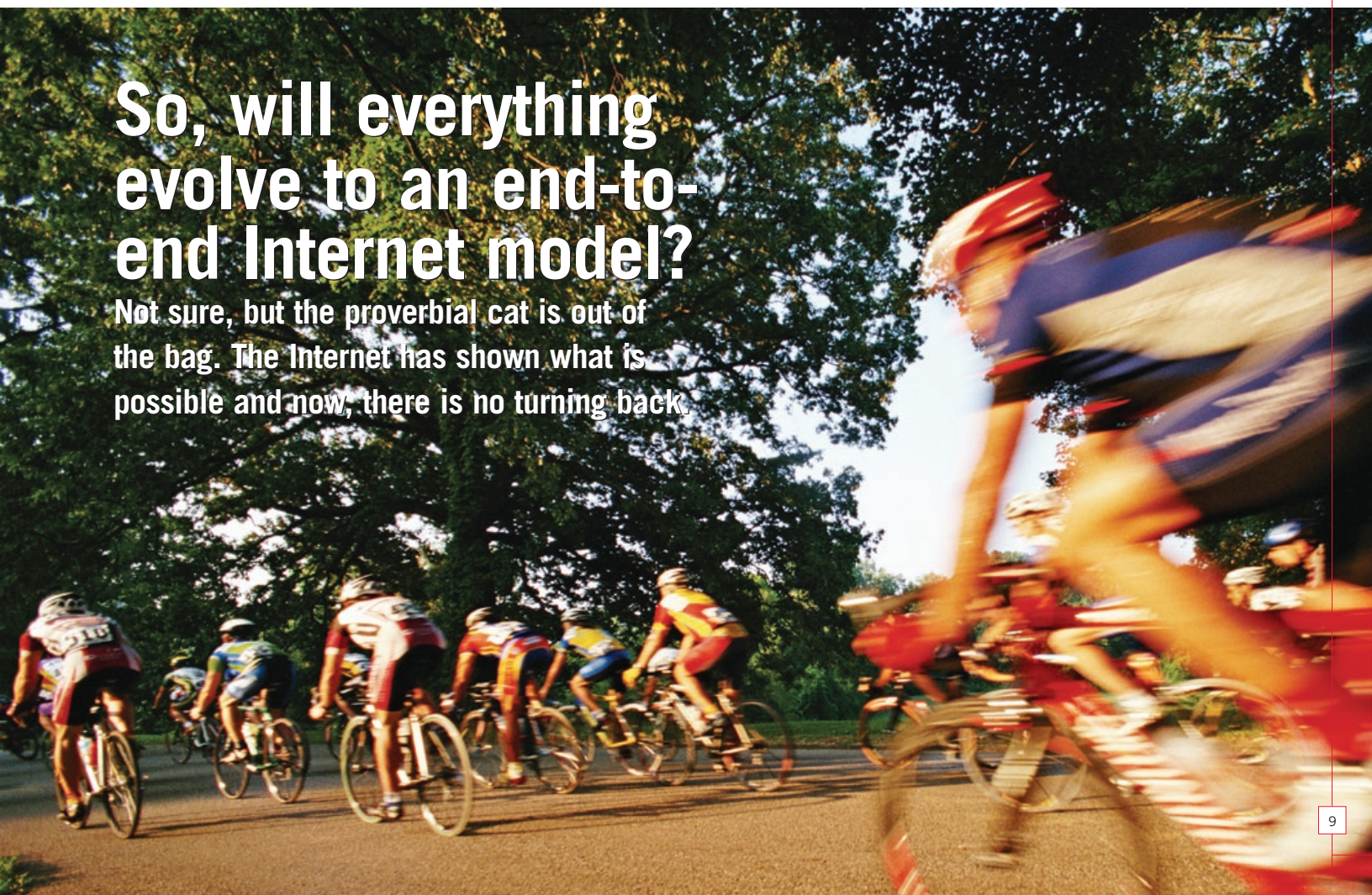


Because of this new flexibility of modern communications systems, each component of the system is now free to evolve independently. From this development, we can draw some initial implications:

First of all, mix and match networks drive innovation. Without the requirement of extreme compatibility, digitization of content is never-ending, becoming more interactive and sophisticated regarding intellectual property. The devices continue to benefit from increasing capability, smaller actual size and cheaper price points. Also, more devices are becoming specialized for specific functions and, at the same time, they are more blended, combining multiple functions. Everything can be connected, including physical goods and environments using sensors and electronic tags. As for channels, we observe that the medium is no longer the message. Multiple network options (especially wireless) are available to provide faster connectivity, broader coverage, and better mobility.

Secondly, mix and match networks allow for the convergence of established communications systems, such as telephony and television. The formation of mix and match networks will not make linear chain systems (rigid triples) obsolete over night. As we have already learned, migration will only take place where there is added value to the end user, in the form of price, service, or functionality. The mix and match model merely allows for convergence, while removing constraints on innovation and scalability. So, will everything evolve to an end-to-end Internet model? Not sure, but the proverbial cat is out of the bag. The Internet has shown what is possible and now, there is no turning back. Convergence will happen from the perspective of the end user. What we still don't know is whether convergence requires a broad physical migration of network assets, or if it just has to emulate one.

Thirdly, mix and match networks drive the emergence of a new role for the core of the network. This role is unlike that of circuit switching in telephony, where assets were distributed based on geographic intensity of end users to manage traffic and reliability. The new, more virtual, core arises out of some old and new questions. Who will manage and prioritize traffic? Who will provide security and privacy assurance? Who will provide convergent services



So, will everything evolve to an end-to-end Internet model?

Not sure, but the proverbial cat is out of the bag. The Internet has shown what is possible and now, there is no turning back.

across physical networks? Who will manage my directory? In our view, the answers point to a new layer of seamless connectivity services (e.g., mediation, synchronization, transaction management, and monitoring) and context-based applications (e.g., location, persona, social network).

Lastly, mix and match networks create challenges and opportunities for enterprises, across all industries. Certainly, this issue is at the heart of strategy for firms in the entertainment and telecommunications industries. But, what about the consumer goods company who can use mobile advertising to build new relationships with consumers—transforming the balance of power between manufacturers and retailers? Or, the news company who can measure content delivery and collect revenue using a micro-payment system? Mix and match networks are transforming independent markets, creating inter-dependent markets, and pumping life into the concept of converged markets. (See Illustration: Convergence and the Impact on Markets)

These observations are ripe for exploration. Innovations in communications technology offer new flexibility to the end user. They can be coupled with advances in process and organization to deliver flexibility for the firm and the ecosystem. Unlocking the potential value, however, requires a systematic approach to learning, which we refer to as strategic experimentation.

Convergence and the Impact on Markets

Independent Markets

circa 1995	*Telephony*	*Internet*	*Television*	.....
Content	Voice	E-mail, WWW, Vertical Apps	Programming, Advertising	
Channel	PSTN (Wired, Wireless)	Packet Data Networks	Cable, Satellite, RF	
Device	Phone (or Mobile)	Computer	Television	

* Linear value chains along industry lines with extreme compatibility across content, device, and channel.

Inter-dependent Markets

circa 2005	*Telephony*	*Internet*	*Television*	*Gaming*	*Automotive*	*Insurance*	.....
Content	Voice	E-mail	Vertical Apps	Programming	Advertising	WWW	Music .....
Channel	PSTN, 3G, DSL Wi-Fi Cable, Satellite *(Extension of Packet Based Networks)*						.....
Device	SmartPhone	Computer	PDA	DVR	Television	Game Console	Camera .....

* Increased flexibility offers access to more content in more ways, spurring innovation and the creation of new services.

Converged Markets

circa 2010	*Gaming*	*Advertising*	*Publishing*	*Education*	*Banking*	*Automotive*	*Healthcare*	.....
Content	Digital Content							*Interactive / Multi-Source*
	Context-based Applications							
Channel	Fiber	3G	Cable	Satellite	WiMax	Ultra-Wideband	.....	*Network of Networks*
	Seamless and Secure Communication Services							
Device	Mote	Mobile	Appliance	Computer	Game Console	Camera	.....	*Form / Function Blends*

* Mix-and-Match Networks offer better choices for end users, while providing new opportunities for ecosystem players.

CONVERGENCE COMPELS ENTERPRISE ACTION

Innovations in communications technology present today's organizations with opportunities for building new operating capability and making new markets. The path for creating and capturing value in this environment, however, is marked with uncertainty. To be successful, organizations must act (not wait and see) in partnership with others, with a view towards systematic learning—creating options for the future.

We have argued that convergence greatly enhances an organization's ability to mix and match content, channel, and device combinations. The resulting richness in management choice is gained not only by spawning innovations within each category but also by enabling easy interconnection between components. This increased flexibility, in effect, may be used to enhance operating capability or drive new growth for the firm.

Building new capability is largely an internal function. It requires changing some combination of technology, process, and organization to improve efficiency (lower costs) or enhance the firm's ability to respond to change (greater agility). Even though the firm is in control of this function, building new capability still faces some uncertainty. The sources of uncertainty may include skills availability, relationships with outsourcers, or likelihood that the new capability will do what was intended. If the uncertainty is low, then the project is managed in a traditional way. But, if the uncertainty is high, a traditional project may fail easily, or be viewed as such a failure, being subject or falling victim to many assumptions about what is not yet known.

Complicating things further, the flexibility provided by convergence may also be used to grow new markets, products, and services. Growth is largely an external function, with generous exposure to environmental uncertainty—out of the control of the firm. Among the numerous sources of uncertainty are the paths of technology evolution, the technical feasibility and economic viability of end uses, levels of acceptance by customers, partners, and employees, and industry and market conditions. The value from a growth initiative is derived by exploiting existing capability and by creating real options whose value depends on the revelation of information about the environment. As with financial options, these real options allow their owners to exploit the up-side opportunities arising in the environment by selectively responding after the uncertainty has been resolved.

Whether building new capability or making new markets, organizations face a difficult dilemma: should they wait until the dust settles to make the investments or place big bets now? Waiting may avoid regret if the path turns out differently than predicted but companies may miss out on strategic benefits. On the other hand, placing big bets is risky and inefficient given the profound uncertainty about the scope and pace of evolution.

Our call for action reflects a new approach that we term strategic experimentation. We argue that enterprises should make their investments cautiously with a view towards systematic learning. The intent of systematic learning is to resolve uncertainties over time, as well as fine-tune resource allocations to reflect both internal and external conditions. We also believe that effective strategic experimentation could be carried out by enterprises acting in isolation but that there is significant value to be gained by exploring plausible experiments with other enterprises and providers of key convergent technologies.

It is dysfunctional to treat strategic experimentation as isolated research projects carried out in remote test-beds and research labs apart from current business operations. Strategic experiments are probes to learn, ones that are actively championed by key decision makers who have direct stakes in how these experiments guide their investments.

We believe there are opportunities for strategic experimentation for three distinct actors within an enterprise: the technologist (the CIO or CTO), the operations manager (the COO), and the enterprise leader (the CEO).

CONVERGENCE AS THE CIO CHALLENGE: EFFICIENCY

Convergence at a technical level can deliver valuable opportunities to some organizations and processes. This is simply due to pervasive and seamless connectivity—operating efficiency is possible from the higher speed, wider bandwidth, lower latency, greater coverage, and improved mobility of modern communications networks. For example, a mobile worker may access enterprise applications through Wi-Fi (a local wireless 802.11 network) and Cable or DSL (Digital Subscriber Line) at home; 3G (third generation wireless) on the road; and corporate LAN (Local Area Network) at the office. Increasingly, this flexibility of network access is possible on a global basis.

Experimentation at the technical level aims to develop insights about how the different technologies work together, how the different applications work across the various types of networks that are increasingly converging and how workers use the different devices to access the variety of applications and more. Often, such experiments can be conducted within a small part of the firm (e.g., a geographic area like the USA or Europe, or a particular division or product line), involving the participation of service providers and technology vendors. For example, companies are exploring how well the Blackberry device works across the different global telecommunications networks. Others are experimenting with VoIP (Voice over Internet Protocol) and some others are examining the technical challenges of embracing RFID (Radio Frequency Identification) tags under complex and difficult supply chain operations.

Success in technical trials provides the confidence to embrace the new technology. No substantial changes to the business processes of the firm are required. Failure is less costly and unlikely to disrupt operations. The potential payoff is greater operating efficiency.

CONVERGENCE AS THE COO CHALLENGE: OPERATIONAL EFFECTIVENESS

If we go beyond technical efficiency, the value from convergence is enhanced when enterprises undertake requisite changes to business operations. The overwhelming lesson from the re-engineering efforts in the 1990s is that while technology alone may provide some value, a much greater set of opportunities is opened up when the enterprise is willing to modify its own business processes. Indeed, many of the profound benefits of reengineering were realized when business processes and operations were modified to take advantage of the technological developments in the 1990s.

The technological developments underlying convergence create "context awareness" from sensory indicators and electronic connections with physical goods and operating states. This fact changes the very nature of many business processes. Sensory indicators on location, direction, speed, temperature, light, and vibration provide more accurate and granular data that can help design business operations differently. Satellite-based location services are often used to locate stolen vehicles. Also, GPS antennas on automobiles allow for location-based service and convenience services as in the case of GM OnStar. There are now even intelligent temperature sensors deployed on crates of lettuce from Peru to the US to help minimize spoilage.

Experimentation at the business operations level calls for the design of new business processes that make full use of the converging infrastructure. It is not about superimposition of the different pieces of technology on existing processes but about designing business operations that leverage optimal mix and match networks. It calls for an "outside-in" perspective and for assessing the relative benefits of progressing incrementally versus embracing new logics that take advantage of convergence more completely.

To expand possibilities for the firm, the focus of experimentation shifts from a technical realm to business operations (technology + organization). The experimentation also examines the requisite changes in management structure, operating processes, reporting relationships, decision rights and performance metrics. Convergence through different configurations of mix and match networks may call for changes in how enterprises manufacture, distribute, and sell their products and services. Experiments now involve more people and processes within the firm and may also involve the way the firm interacts with suppliers, the distribution channel, and even with customers. The potential value-payoffs are high but require organizational changes that are costly to implement. This level of change requires COO sponsorship. When the COO champions the experiments, it signals a potential willingness to explore the broader gamut of how these technological developments are challenging the design of new processes and organizations.

Astute COOs may have a gut feeling that their business operations need to be rethought to take advantage of the technological innovations, but they may be unable to assess the specific courses of action. This uncertainty perpetuates the status quo and inaction at this level. Enterprises reframe the opportunity at the lower level of technical parameters and consequently underachieve their potential. Yet, operating executives who pursue selective strategic experimentation, combining the power of convergence technology with business operations reduce uncertainty and could develop more systematic courses of action.

Strategic Experimentation Guidelines

<table>
<tr><th></th><th>Market A</th><th>Market B</th><th>Market C</th><th>Application Notes</th></tr>
<tr><td>CEO</td><td></td><td></td><td rowspan="3">Objective
Galvanized growth through new products, services, and markets.

Scope
New business models, distributed decision rights, and architectural control points to create and capture new value for the firm.

Actors
A broad coalition of partners across industries.</td><td>Organizations with products and services that can be modified to meet the situation, such as insurance, telecommunications, and entertainment. (on demand services)</td></tr>
<tr><td>COO</td><td></td><td rowspan="2">Objective
Operational flexibility and scalability.

Scope
New value propositions and the restructuring of business processes, supply chains, and channels.

Actors
Core partners involved in the supply of products and services.</td><td>Organizations with operations that are time sensitive, location specific, or depend on state of the good, such as healthcare and consulting (along with supply-chain/logistics intensive industries).</td></tr>
<tr><td>CIO</td><td>Objective
Efficiency and effectiveness of people and processes.

Scope
Technical standards and software applications.

Actors
Key technology providers.</td><td>Organizations with workers that are distributed, mobile, and require a high-level of expertise, such as construction, home services, pharmaceutical sales, and field engineering.</td></tr>
</table>

Today, each market is affected by convergence, but in a different way. Over time, each market will derive more and more business capability from convergence, making it a CEO issue for all.

CONVERGENCE AS THE CEO CHALLENGE: BUSINESS MODEL RE-CREATION

We know that in selective cases, convergence has the potential to render current business models obsolete while creating new models with radically different drivers of profitability. In such cases, fine-tuning current operations through changes in structure and processes is inadequate to capture the potential of new business models. Entertainment is an example of potential transformation unleashed by convergence. The Digital Video Recorder (DVR) has the capability not only to digitally record the popular content on the Internet but also to change the logic of how value is created and shared.

Greater intelligence at the edge of an organization allows decision rights to be allocated differently and across a different set of distributed agents. For example, an intelligent sensor may record the vital signs of a patient, but it may also notify the medical team of a significant change. While it is true that intelligence at the edge distributes decision-making to the far edge of the organization, the largest impact may be on the center—a new role for the core. As opposed to a command and control organization, leaders are no longer burdened with the synchronization of people in the field. Instead, they are able to focus on prioritization of resources and coordination with the broader ecosystem of players. Drivers for intelligence at the edge include more computing power at the edge of the network and the need for intelligent services at the core.

Experiments at this level involve organizational change and other players in the ecosystem. Value comes from top-line growth and value-capture mechanisms. Learnings must include partnership/alliance success factors. Overall, this level of experimentation creates opportunities to make new markets and take share of existing markets, many of which are across traditional industry lines.

Perhaps 99% of all species that ever existed are now extinct. The track record of organizations is not much better. The major difference is that organizations have the power to shape their future, but this power must be exercised. Not with a single broad strike, but with many probes helping to reveal the landscape ahead. This method we term strategic experimentation can also lead to a more agile organization, one that learns to respond in times of uncertainty. Innovations in communications technology are a source of uncertainty for all, but only a few organizations will learn to deliver dynamic response in times of change. Similar to a cycling team competing in the Tour de France, the advantage lies with organizations that embrace technology to enhance future response. The winners will invest wisely, with expectations guided by systematic learning and ecosystem evolution, and be rewarded with a more flexible operating capability and new pathways (options) for growth.

Related Readings

3G Americas, 2004, "IP Multimedia Subsystem (IMS) Overview and Applications".

Amram, Martha and Nalin Kulatilaka, 1999, *Real Options: Managing Strategic Investment in an Uncertain World*, Harvard Business School Press. Also published by Oxford University Press since Summer 2001.

Armstrong, Lance (Foreward), Matt Rendell (Editor), and Nicolas Cheetham (Editor), 2003, *The Official Tour De France: Centennial 1903-2003*, George Weidenfeld & Nicholson, Ltd.

Dawkins, Richard, 2004, *The Ancestor's Tale*, Houghton Mifflin Company.

Kogut, Bruce and Nalin Kulatilaka, 2001, "Capabilities as Real Options", *Organization Science*, Vol. 12, No. 6, pp. 744-758.

Kulatilaka, Nalin and Jim Ciriello, 2004, "The Story of Island Man: It's Not Just the Technology", Boston University Institute for Leading in a Dynamic Economy (BUILDE).

Kulatilaka, Nalin and Jim Ciriello, 2005, "Shaping the Future through Experimentation: Dr. Moulton's Evolving Cone of Possibilities", Boston University Institute for Leading in a Dynamic Economy (BUILDE).

Kulatilaka, Nalin and N. (Venkat) Venkatraman, 2001, "Strategic Options in the Digital Era", *Business Strategy Review* (Spring), Vol. 12, No. 4.

Lin, Chung-Zin, Bill Bushnell, Jim Freeburg, Tod Sizer, Michael Recchione, and Tom Anderson, 2004, "SIP-Based Services Architecture Across Wireless and Wireline Access", *Bell Labs Technical Journal*, 9(3), 5–13, Wiley Periodicals, Inc.

Standage, Tom, 1998, *The Victorian Internet*, Walker and Company.

UMTS Forum, 2002, "IMS Service Vision for 3G Markets", Report No. 20.

Venkatraman, N. (Venkat), 2004, "Waking Up to the Network Era", Boston University Institute for Leading in a Dynamic Economy (BUILDE).