The
Evolving
Internet

**DRIVING FORCES,
UNCERTAINTIES, and
FOUR SCENARIOS TO 2025**

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TABLE OF CONTENTS

FOREWORD

This report is a collaborative effort between Cisco, the global leader in Internet architecture, and Global Business Network (GBN), the world's foremost scenario consultancy.

It is offered as a contribution to ongoing discussions and efforts to harness the huge potential of Internet and IP networks to drive economic and human development around the world. This is of particular relevance to emerging-market countries where the relatively low level of Internet use today reveals a wide opportunity gap in terms of economic productivity and social inclusion.

We hope that our discussion of key driving forces and uncertainties affecting the Internet's evolution and the scenarios that we've developed to illustrate how these factors may unfold by 2025 will be a useful source of insight for even the casual reader. But we had two primary audiences in mind for this report. One is business and technology leaders who are actually constructing the Internet as vendors, suppliers, service providers, device manufacturers, and application developers. The other is a broader group of stakeholders, especially policymakers who are shaping the rules of engagement that affect the Internet in order to best serve their constituents.

The measure of a successful set of scenarios is twofold: by getting us to imagine different paths that the future may take, they help us to be better prepared for long-term contingencies; by identifying key indicators, and amplifying signals of change, they help us ensure that our decisions along the way are flexible enough to accommodate change. With this report, we have attempted to meet these objectives in ways that are far-sighted and provocative on the one hand, and practical and action-oriented on the other. We hope these scenarios will inspire broader conversations and wiser choices so that broadband and the Internet realize their potential to enhance global prosperity and well-being.

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INTRODUCTION

It's 2025. Imagine that the Internet has underpinned a new wave of global prosperity. It is now as central to the lives and opportunities of people in the outskirts of Mexico City and rural Sri Lanka as it is to people in Tokyo, New York, and London. Myriad new applications cater to most of the world's population and to businesses of all sizes and shapes.

Or maybe not.

Maybe the Internet has become a victim of its own success, with the explosion of Internet products and services now a source of frustration as much as satisfaction and networks overburdened and unreliable in many parts of the world. Or maybe the Internet has hit a wall, so plagued by hackers and cyber attacks that it's given rise to a new digital divide between those with access to expensive security measures in gated Internet enclaves and those who tread warily across the free but dangerous Internet. Or maybe prolonged economic stagnation and protectionist policies have drastically dampened demand for new devices and eroded people's willingness to pay for applications and services.

All of these worlds are plausible. All of them could happen. Are you prepared?

Today, in 2010, the Internet is already an integral part of existence in many parts of the world. It's easy to forget the incomparably large strides that the Internet has made since the first email messages were sent over the ARPAnet in 1970, and the massive changes it has triggered in how we live and work. Yet despite its explosive growth, especially in the last 15 years, the Internet is still in its youth, maybe even its infancy: only one-third of the world's population has ever "surfed" online (almost 5 billion people haven't) and fewer than one-fifth of those who use the Internet do so regularly.

Just as the architects of the ARPAnet never anticipated the Internet of today, it's equally hard for us to predict the Internet's evolution—its future and its impact. That billions more people are poised to come online in the emerging economies seems certain. Yet much remains uncertain: from who will have access, how, when, and at what price to the Internet's role as an engine for innovation and the creation of commercial, social, and human value. As users, industry players, and policymakers, the interplay of decisions that we make today and in the near future will determine the evolution of the Internet and the shape it takes by 2025, in both intended and unintended ways.

Hence the need for scenarios—a set of divergent stories about the future—to help us explore and prepare for possible futures of the Internet. To make sure that our scenarios are both relevant and logically related, we've organized this inquiry around two related questions:

What forces will shape the Internet between now and 2025?

How might the use of the Internet and IP networks (particularly with regard to emerging countries) evolve?

INTRODUCTION

For purposes of this report, we look at the Internet broadly, from both the mechanical and value creation perspectives. Technically, the Internet can be thought of as a mesh of digital impressions, storage systems, fiber, radio frequencies, transmissions, switches, screens, and terminals. But it is the complex array of relationships across technologies, applications, players, and policies that defines the Internet as a creator of economic and social value.
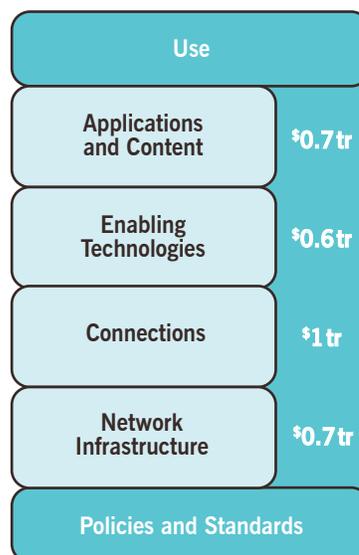
At its base are policies and standards that shape Internet build out, interoperability, and security. The next tier, network infrastructure or backbone, comprises the cables, switches, routers, and towers that are the essential transmission grid for all Internet traffic. Next there are the connections—the on-ramps through which individual and enterprise users plug in—and the enabling technologies like individual PCs, PDAs, phones, and IP networks that allow users to tap the Net. Layered on top of that is content: streaming media, data, peer-to-peer (P2P) communications, games, voice communications using Internet protocol (VOIP), and text, including e-mail. Finally there is usage, the ever-changing ways in which both individuals and enterprises chose to consume Internet content.

The four middle tiers of the stack (applications and content, enabling technologies, connections, and network infrastructure) generate about US$3 trillion in annual revenue, more than two-thirds of which comes from advanced markets today. This includes (under applications and content) the margin attributable to the Internet from "e-commerce," the enormous and rapidly expanding volume of purchases and services delivered over the Internet, from book sales to tax preparation. The volume of e-commerce is estimated at US$8 trillion annually, but we estimate the margin attributable to the Internet as a retail channel to be roughly on the order of US$0.5 trillion. Therefore, the grand total for Internet-related revenue adds up to roughly US$3 trillion—and counting.

In contrast to this transaction-based value, the Internet's social value remains immeasurable. But we do know it is creating a whole new world of opportunity—transforming human interactions while at the same time challenging many existing social and political structures. Although this is not the primary focus of our report, it is an inevitable and powerful force for change.

FRAMING THE $3 TRILLION INTERNET

Use	
Applications and Content	$0.7 tr
Enabling Technologies	$0.6 tr
Connections	$1 tr
Network Infrastructure	$0.7 tr
Policies and Standards	

Making sense of these possibilities calls for scenarios—stories of the future that are intentionally diverse and stretch our thinking to accommodate both the expected and the unimaginable. By visualizing a broad range of potential futures rather than making specific predictions or following narrow forecasts, scenarios help to surface new opportunities and new risks and to explore plausible outcomes that could be game-changing.

Our process involved the following components:

- We began with a broad review of open source and proprietary research and projections (see Appendix 1 for a description of the range of topics explored). This was followed by interviews with experts and leading thinkers from within and outside Cisco, including members of GBN's Network, to identify the drivers of change that might fundamentally alter the Internet's future. Those interviewed were diverse in terms of perspective, location, and expertise.

- Through our research we identified a set of premises that provided a foundation for all the scenarios. We then prioritized the change drivers according to those that were most uncertain and most important in shaping the path of the Internet in the next 15 years (see Appendix 2 for a full list). These drivers were condensed into three axes of uncertainty, which became the scaffolding for framing possible scenarios.

- Finally we selected, from the range of plausible scenarios, four scenarios to develop in depth. We chose these for two reasons: first, they challenged our assumptions, individually and collectively, about what might transpire; second, they suggested business and policy implications that were meaningfully different. The scenarios were then tested and refined with a range of subject matter and scenario authorities.

FIVE PREMISES
FOR THE FUTURE

The future of the Internet will be driven, at least in part, by many dynamics that can already be seen today. Hence, we believe that there are features about its evolution that we can count on with confidence. Below, we offer five premises about the future of the Internet, drawn from our research, interviews, and analysis. These themes appear repeatedly in the scenarios, leading to quite different implications when combined with other possible developments that are more speculative in nature.

BY 2025:

1 Most growth in the Internet-related market will have occurred outside of today's high income, or "advanced," economies.

2 Global governance of the Internet will remain substantially unchanged.

3 "Digital natives" will relate to the Internet in markedly different ways than earlier generations.

4 Today's keyboard will not be the primary interface with the Internet.

5 Consumers will pay for Internet connectivity in a much wider range of ways.

Each premise is described in greater detail below.

1 Growth in the global economy and middle class will occur primarily outside today's "advanced market" countries. Transactions for Internet-related products and services will increasingly take place in countries that we now characterize as "emerging."

A major shift in global market structure will result from three factors that have compounding and accelerating effects. The first will be economic growth: the differential between GDP growth in advanced and emerging countries overall will be significant and persistent—in excess of 3 percent per year. Second, the pattern of growth in many of these emerging countries will result in rapid expansion of their middle classes—both in numbers and in purchasing power. Third, Internet usage and, fast on its heels, broadband connections will grow quickly in emerging countries, but will reach a plateau soon in the advanced countries, characterized by slower growth and aging populations.

The impact of these three factors is represented by a metric we call the "Internet economy," which approximates purchasing power in the hands of Internet users. Advanced market countries accounted for about 85 percent of the Internet economy in 2005; their share is estimated to have fallen to 70 percent in 2010. Our premise is that emerging countries will account for more than half of the Internet economy by 2025, reflecting their extremely rapid economic

growth, compounded by the desire to "catch up" in Internet use. This will be true not just in places like China or Brazil, but in a wide range of countries small and large.

Yet the dramatic shift in the composition of the Internet economy is just a quantitative proxy for an even greater qualitative impact. This will be caused by the dynamics triggered as the potential of networks to improve productivity reaches virgin enterprise territories and as consumers of content from everywhere are located everywhere. Although Internet traffic will continue to be heavier in advanced markets with higher per capita levels of expenditure in and around the Internet, the dynamics and global composition of the market will be dramatically changed by emerging countries.

While our scenarios incorporate variations on this premise, especially in terms of differential growth rates between advanced and emerging economies, they all have in common a profound shift in the global geography of the Internet economy.

2 Governance of the Internet will remain substantially the same. It will retain the loose structure that has characterized it all along, despite pressures for greater control that will arise from occasional Internet disruptions, including malicious ones.

Willful disruption and illicit use of the Internet—electronic fraud, theft, and deception—will be as common in the future as they have been in the recent past. Brown-outs and black-outs will happen as a result of sabotage, vandalism, terrorism—or system malfunctions. These breakdowns will elicit sporadic and sometimes loud calls for enhanced international control of the Internet.

There will also be forceful arguments against any such attempts on the grounds that they are likely to do more harm than good. But the absence of any viable global governance formula or persuasive alternative in terms of institutional structure will keep the set of rules currently governing the Internet fundamentally unchanged between now and 2025.

The evolution of the Internet in the past 40 years has underscored the notion that it is in the network's nature to evolve organically and configure freely as opposed to being determined by strict, static designs. This will remain a powerful assertion going forward, leading governments to focus their efforts on preventive measures affecting the use of the Internet in their sovereign territories and possibly producing disparities not unlike those observed in financial regulation.

The bodies that have so far been involved in proposing and promoting Internet standards will remain a feature of the landscape, but they will not acquire a more formal mandate than they have today. In large measure this premise reflects the lack of alternatives and the hurdles that would impede progress toward anything more binding on the international level.

3 "Digital natives"—who have been raised on the Internet since the late 1990s—will relate to the Internet in markedly different ways than do most of today's adults.

Members of these web-savvy "Net generations" will tend to view the Internet as an extender of their own cognitive capabilities and as a portal to virtual experience. (Whether this also leads to a significant shift in brain function, as some studies suggest, is beyond our purview here.) They will interact with the Internet as part of the ambient environment in which they live; indeed,

FIVE PREMISES FOR THE FUTURE

the Internet is likely to become much more deeply embedded, even invisible. The notion of "connecting" could disappear almost entirely.

These digital natives will be less inclined to distinguish between suggestions made to them virtually by Internet peers and suggestions made by peers with whom they have had face-to-face contact. They will also be more likely to respond comfortably when the Internet asks them unsolicited questions or invades their privacy. But most importantly, digital natives will think about the Internet as a general service platform, like conversation or thinking—part of what makes us who we are and something we just do.

As they reach the labor force, these digital natives will accelerate the trend among enterprises of all sizes toward relying on networks as the multi-dimensional platform for business. One question that remains in the scenarios is the extent to which there will be significant lags in the emergence of these digital natives across the world: how large a minority of young people raised alongside the Internet will be required to trigger a Net generation effect, especially in countries with lagging adoption rates? The sequencing of Net generations emerging in countries that today have low Internet penetration will have a significant impact; the relative size of those in the overall population will also matter and compound the effect of demographic differences across the world.

4 Today's QWERTY keyboard—and the language and interface hurdles it represents—will no longer be the primary means of relating to the Internet as new technologies transform that relationship.

The QWERTY keyboard is a relic of another era. Its logic (minimizing jams in the hammer arms of mechanical typewriters for English language typists) became obsolete long before the start of the twenty-first century. Yet English-language computer keyboards still feature QWERTY and nothing else.

The keyboard, however, is about to be overthrown by a combination of voice recognition, bio-sensing, gestural interfaces, touch-screen versatility, and other technologies that will allow us to input data and commands without keys. The keyboard will fade away gradually as the people who learned to type on it age.

One major consequence of this change will be an explosion in the number of people who can use the Internet, as well as in the types of things they can do with it. A post-QWERTY world is a future in which we don't have to put something else down in order to pick the Internet up. The Internet will be a constant parallel processor—without QWERTY's implicit Western bias.

5 Consumers will pay (or not) for Internet connectivity in a much wider range of ways, both direct and indirect, compared to today's predominant flat-price subscriptions.

As high-bandwidth applications explode, the need to allocate available network capacity efficiently across time and users will be a major issue. The spread of wireless connectivity will also open up many new pricing models for network access, such as easily bundling connectivity and services. Capacity management considerations will force a major reshuffling among pricing models (indeed, similar thinking by service providers is already quite advanced). For the Internet, price elasticities have not yet played the role that they have assumed in virtually every other market. Available bandwidth or network capacity will have to be allocated more efficiently—and pricing is a well-proven tool for that.

Rapid proliferation of new tolling and monetization schemes will also respond to increasingly fine consumer segments appearing across geographies, age groups, genders, and personal desires. Pricing preferences—and highly differentiated competitive offers—will appear around the full range of transaction variables: bundling, a la carte, as you go, off peak, tiered, introductory, balloon, pay for quality, pay for mobility, billing cycles, publicly supported pricing, terms and conditions, guaranteed, banded, bulk, specialty, and so on.

Almost everything that can be variably priced will be. One-size-fits-all bandwidth options will be the exception rather than the norm. Current flat-price plans will seem quaint in retrospect. The presumption that content delivery and connectivity should be considered as separate value propositions will also be subject to experimentation.

We see the demise of one-price-fits-all, usage-impervious pricing for connectivity as a given, but the extent of technical progress on the wireless front and the nature of capacity constraints in the network (sporadic or sustained, widespread or spotty, policy-driven or spontaneous) will have major implications for how this plays out.
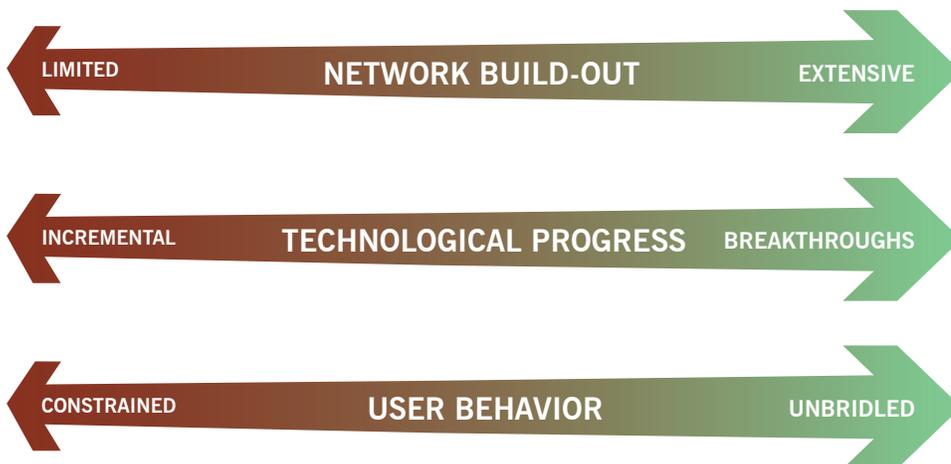
AXES OF UNCERTAINTY

These five premises for the future of the Internet provide a foundation of relative predictability but still leave ample room for uncertainty. From our research and interviews we identified 14 critical drivers of change that span a variety of economic, social, policy, and technology dimensions. These drivers are also highly uncertain, suggesting a range of possible outcomes that could play a major role in the evolution of the Internet through 2025. Exploring the possible impact of these change drivers (listed and explained in Appendix 2) was a key step in the development of our scenarios.

This breadth of coverage is important to our purpose, yet playing with too many uncertainties and scenarios can be overwhelming.

In order to offer a reasonable range of plausible and provocative alternative futures for the Internet in 2025, we synthesized the 14 critical uncertainties into three axes. This allowed us to construct a scaffolding to explore a number of possible scenarios:

- Will broadband network build-out be extensive as a result of the combined effect of private and public investment, or more limited?

- Will technological progress be characterized more by breakthroughs or mostly represent incremental advances?

- Will user behavior (including the appetite for ever-richer Internet applications) be unbridled or more constrained?

THREE AXES OF UNCERTAINTY

LIMITED ← NETWORK BUILD-OUT → EXTENSIVE

INCREMENTAL ← TECHNOLOGICAL PROGRESS → BREAKTHROUGHS

CONSTRAINED ← USER BEHAVIOR → UNBRIDLED

NETWORK BUILD-OUT

What will the global broadband network—its breadth and capacity—look like in 2025?

This axis of uncertainty focuses on key characteristics of the global network, including carrying capacity, speed, and other quality factors. How these characteristics differ around the world will significantly influence what the Internet will look like in 2025—and how much of its promise of productivity, economic growth, social inclusion, and enjoyment will have been realized.

The interplay of government policies and private investment decisions will be a major factor in determining how this axis of uncertainty plays out in time and space. Choices made by governments, national and local alike, will have a direct and indirect effect on network build-out and on the spread of wireless options. Direct actions might include public investment in backbone or gap-filling networks, spectrum allocation, and aggressive action to ensure that other types of infrastructure are available to be shared by fiber deployment or wireless transmitters. Indirectly, governments will influence network build-out through policies that affect the incentives for network operators to invest in expansion and improvements to both fixed and wireless networks.

Decisions that seem unrelated or tangential to the objective of network build-out could have major effects on private investment decisions. Some of these policy, regulatory, and licensing decisions will also influence the mix and relative bargaining power of various stakeholders and create opportunities for, or barriers to, competition between entrants and incumbents, wired and wireless, and short-term and long-term objectives. Approaches to policy and regulation will be forced to evolve with technology and Internet use—but how quickly? To what extent might more dynamic, far-sighted licensing approaches overcome the historical inertia? How much "regulatory competition" will take place across countries and will it result in the convergence or divergence of approaches?

Responses by market actors will also vary. How will investors and network operators react to the shifting policy and regulatory landscape? Will differences in market accountability and in the time horizons for investment payoff lead to different private investment decisions in response to the same government action?

TECHNOLOGICAL PROGRESS

Will there be widespread technology breakthroughs or will progress be more modest and incremental?

This axis addresses the range of new options created by the evolution of the Internet. While failing to invest in R&D guarantees that there will be no technological progress, there is an asymmetry, as R&D investment does not ensure technological breakthroughs. This axis reflects the large element of unpredictability (even randomness) associated with efforts to develop new technologies. The adoption rate of new technologies is also not easily predictable. National objectives,

such as the protection of domestic champions or the creation of information and communication technology (ICT) clusters, can also have an effect (often negative, at least in the short term) on the speed of technology adoption.

Advanced uses of technology have a role to play and breakthroughs that affect business-relevant functionalities could have a major impact. But given the masses of potential Internet users waiting in the global wings, functionality is not the only consideration: affordability will also be decisive. Technological progress that reduces costs (as experienced over the last two decades in connection with computer processing power and storage capacity) could have dramatic effects on the shape of the Internet in 2025. Will technology innovation result in rapid, steady declines in the costs of Internet-related hardware, including smart phones, netpads, and new connection devices?

Other areas of uncertainty—and opportunity— for technological progress include network capacity, wireless capabilities, and security protection. Will new security technologies emerge to better protect against both unintended and willful Internet disruptions? How will storage, compression, and miniaturization technologies evolve and interact to expand quality and reduce bandwidth needs at the same time? How about interoperability?

Finally, wireless is an area where technological progress, or the lack thereof, would have a critical influence. Will wireless technology evolve rapidly enough to ensure reliable high-speed quality, thereby offering a real alternative to fixed (fiber) networks for conveying rich content and other demanding applications?

USER BEHAVIOR

How will enterprises and individuals relate to the Internet and how will their preferences evolve?

This axis of uncertainty is about the choices that users—both individuals and businesses—will make and that will, in turn, shape overall demand for Internet access, devices, applications, and content. Tradeoffs and sensitivities center on price elasticity, ease of use, security concerns, and convergence or divergence in demand patterns across regions and user segments.

Global economic prosperity, GDP growth, and income distribution trends across and within countries will be major factors in translating broader preferences into actual choices—and effective demand. The economy will remain an important backdrop, against which many of the choices will be influenced by perceptions of need and by the evolution of preferences—including generational differences.

How current users in high-income countries (where Internet traffic is now growing at exponential rates) respond to evolving options and with what kind of price elasticity will also have a major effect. But how the masses of new Internet users react to their new experience with different business and consumer preferences will be equally important. Will the bare-all tendencies found in much current social networking, for
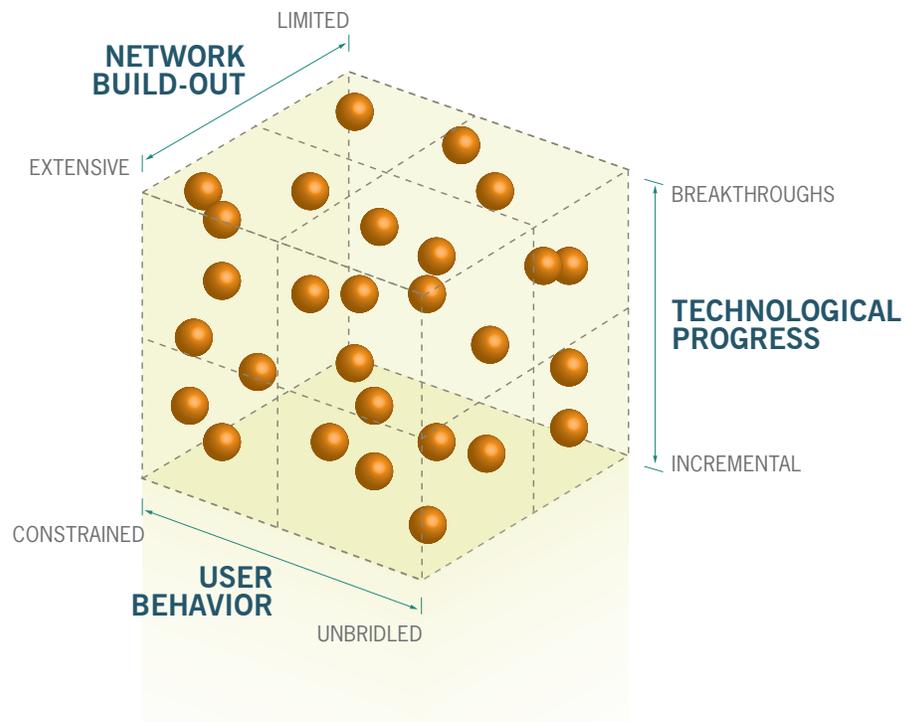
example, emerge among the next 1 billion users? How about among the billion after that? Critical conclusions will be drawn by opinion leaders about the overall security of the Internet as a mechanism for trade, value creation, and information exchange. How different will those conclusions be in Mexico, Russia, Turkey, and Indonesia, or across states in India?

To what extent will users trade off handsets for embedded access portals: on automobile dashboards, on home walls, or in articles of clothing? Will we experience a pendulum swing away from digital experiences (driven by tech fatigue or cultural discomfort with virtual life),

or will increasingly rich, multi-sense offers keep expanding the global appetite for virtual experiences? How will Internet use evolve among corporate IT departments and small- and medium-size businesses—and where? How will the Net generations change their approach to the Internet over time, and how activist will they be regarding government and corporate policies that affect their Internet use?

THE SCENARIO FRAMEWORK

Using the "axes of uncertainty" as the basic scaffolding, we created a scenario "cube" to visually depict the full range of possible future states, or scenarios, suggested by permutations of network build-out, technology progress, and user behaviors.

LIMITED

NETWORK BUILD-OUT

EXTENSIVE

BREAKTHROUGHS

TECHNOLOGICAL PROGRESS

INCREMENTAL

CONSTRAINED

USER BEHAVIOR

UNBRIDLED

The future could turn out to be anywhere in the notional playing field represented by the intersection of the three axes. Among the many combinations of outcomes, we chose four to develop into scenarios. The choice of scenarios was not driven by how probable we felt the scenarios were, but by our attempt to provide a set of novel and divergent—yet plausible—stories of the Internet in 2025. In each scenario all three axes play a role, although their relative importance to the trajectory and outcome varies. The four scenarios are:

FLUID FRONTIERS: This is a world in which the Internet becomes pervasive and centrifugal. Technology continues to make connectivity and devices more and more affordable (in spite of limited investment in network build-out) while global entrepreneurship—and fierce competition—ensure that the wide range of needs and demands from across the world are met quickly and from equally diverse setups and locations.

INSECURE GROWTH: This is a world in which users—individuals and business alike—are scared away from intensive reliance on the Internet. Relentless cyber attacks driven by wide-ranging motivations defy the preventive capabilities of governments and international bodies. Secure alternatives emerge but they are expensive.

SHORT OF THE PROMISE: This is a frugal world in which prolonged economic stagnation in many countries takes its toll on the spread of the Internet. Technology offers no compensating surprises and protectionist policy responses to economic weakness make matters worse—both in economic terms and with regard to network technology adoption.

BURSTING AT THE SEAMS: This is a world in which the Internet becomes a victim of its own success. Demand for IP-based services is boundless but capacity constraints and occasional bottlenecks create a gap between the expectations and reality of Internet use. Meanwhile, international technology standards don't come to pass, in part because of a global backlash against decades of U.S. technology dominance.

INSECURE GROWTH
CONSTRAINED USE*
TECHNOLOGY BREAKTHROUGHS*
EXTENSIVE NETWORKS

FLUID FRONTIERS
UNBRIDLED USE*
TECHNOLOGY BREAKTHROUGHS*
LIMITED NETWORKS

BURSTING AT THE SEAMS
UNBRIDLED USE*
INCREMENTAL TECHNOLOGY
LIMITED NETWORKS*

SHORT OF THE PROMISE
CONSTRAINED USE*
INCREMENTAL TECHNOLOGY
EXTENSIVE NETWORKS*

* Indicates most critical determinants
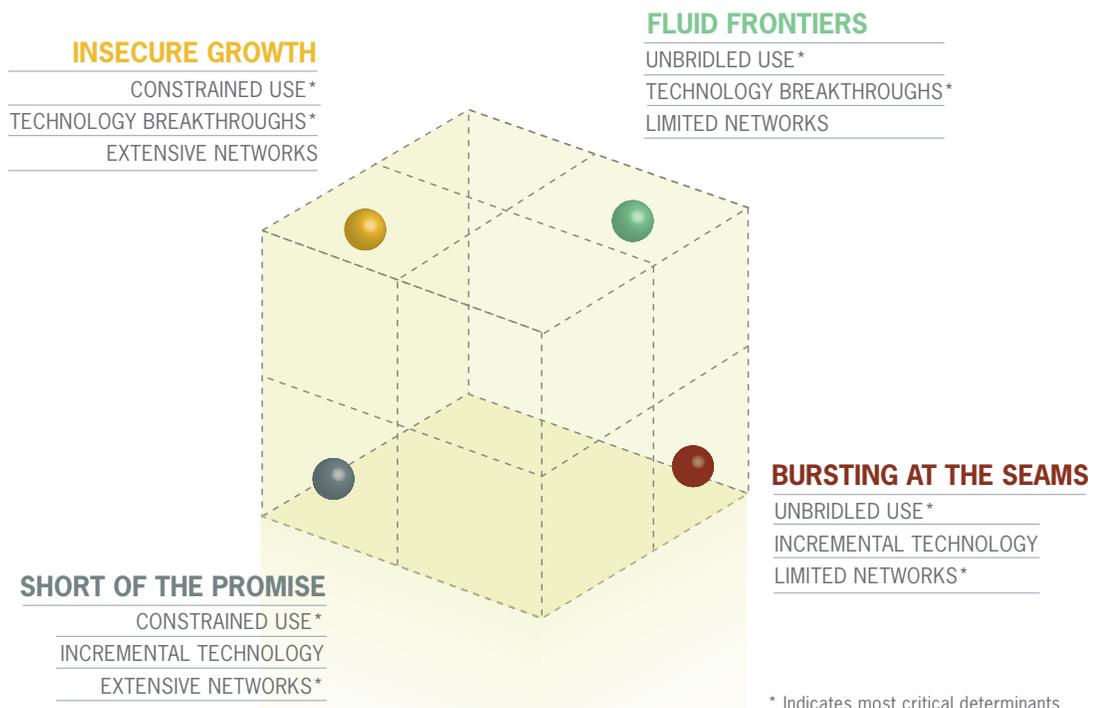
In the next section we bring each of these scenarios to life.

FLUID FRONTIERS

In this world the Internet becomes pervasive and centrifugal. Technology continues to make connectivity and devices more and more affordable while global entrepreneurship—and fierce competition—ensure that the wide range of needs and demands from across the world are met quickly and from equally diverse set-ups and locations.
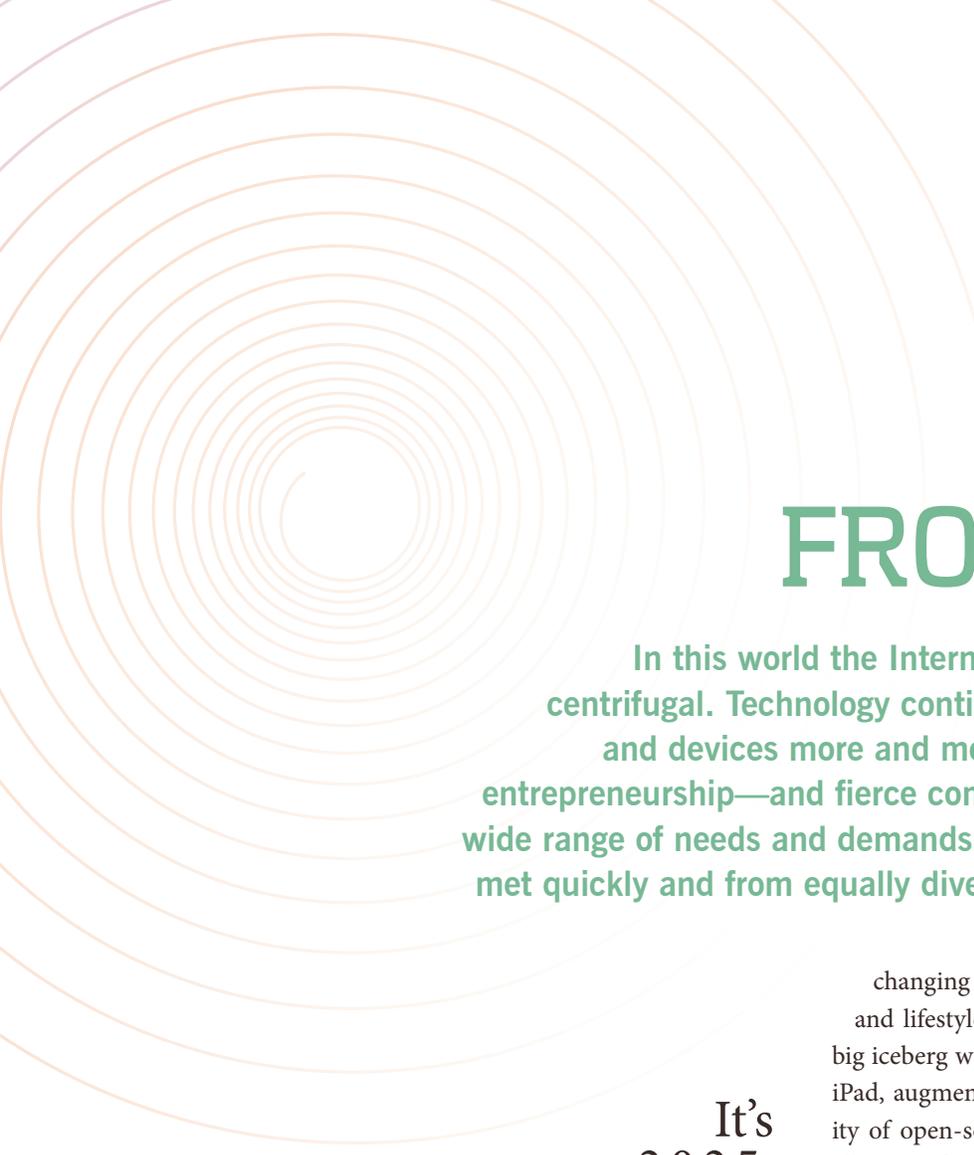
It's 2025, and the Internet is ubiquitous, extending its power and impact far and wide. It's being used by 5.5 billion people now, 3.5 of them since 2010, meaning that more than two-thirds of the world's population has newly experienced the Internet. The exponential growth in Internet traffic was fueled by both an explosion of cloud services on the business side and a mounting appetite for video and high bandwidth applications among individual users. The resulting waves of productivity proved transformative for the economic and social development of countless countries, creating millions of knowledge-based jobs.

On a more personal level, connectivity allowed people to discover and act on new affinities that cross old boundaries of geography and culture, changing the structure of human interactions and lifestyles in the process. The early tip of a big iceberg was the arrival of e-books and Apple's iPad, augmented by the availability and popularity of open-source software and applications for all sorts of new devices. Pricing innovations also spread with a vengeance, with providers offering "menus" to individuals and businesses that feature a startling number of offers and combinations.

While investment in network build-out remained relatively modest (in many countries, mixed regulatory signals discouraged private investment at various points in time), technological progress was breathtaking. Wireless technology generated a frenzy of development in hot zones (no longer "spots") around the world. The mobile Internet is now a pervasive reality and the range of connectivity options and combinations has expanded everywhere. The downside to this booming development, however, is that public investment in networks is more difficult to justify.

Dramatic increases in data transmission efficiency enabled traffic to grow at unexpectedly high rates. Yet computing power, storage, bandwidth, and devices all experienced radical downward price movements, if not in absolute terms then certainly as measured by functionality per dollar. The geography of innovation—technological and managerial— also shifted markedly. Today some innovation still comes from traditional places like Silicon Valley, but most is erupting at dizzying speeds in places like Bogota, Cairo, Mumbai, Perth, and Zhanjiang. Breakthroughs in compression, screen, or interface technology seem to happen overnight.

Much of this innovation and growth is being driven by "digital natives" (those under 35 in 2025), who have taken the workforce by storm, bringing with them the expectations and skills to accelerate the use of technology. Already pioneers in adopting technology for socializing and fun, they are now turning their Internet acumen into a new wave of productivity and creativity. While the generation gap is noticeable in many of the established advanced economies, it is especially significant in the newly prosperous ones that were labeled "emerging" back in 2010 but now constitute almost a quarter of the global economy. Fortunately these digital natives are also enthusiastic about easing their "elders" into this brave new world as they embed technology into the daily fabric of life in ways we would have considered awkward, invasive, or both not so long ago.

This generational boost also helped leapfrog such technology applications as distance education and remote healthcare, which struggled to achieve critical mass earlier despite their com-

pelling promise. The arrival of young, Net-savvy teachers and nurses made the difference, however, eroding divides and increasing efficiency. Widespread adoption of these services also paved the way for more advanced technologies that use multi-dimensional imaging, robotics, asynchronous interactions with experts, and rich media that can be adapted in a variety of contexts.

Given such pervasive access to high-quality communications, education, healthcare, and interactive entertainment, it is finally possible to live and work anywhere. Otherwise remote areas are now more attractive, partially reversing the trend

> **Some innovation still comes from traditional places, but most is erupting at dizzying speeds in places like Bogota, Cairo, Perth, and Zhanjiang.**

toward urbanization and the sprawl of megacities. But cities of all sizes are increasingly appealing, intensely connected, and reenergized by national and local "green and clean" policies. New technologies—and the global dissemination of best practices and promising experiments via the Internet—helped make the integration of sustainability and economic growth not just idealistic but realistic. This benefitted every part of the planet and especially the Global South.

The bottom line is inescapable: technology in general and the Internet in particular, have delivered. From Maputo to Milwaukee to Mumbai, the

FLUID FRONTIERS

Internet has become a fact of life, not just a nice to have. More and more machines, computational devices, sensors, and humans—altogether numbering in the trillions—are now embedded components of the World Wide Web. In the past decade, we moved beyond having a conscious relationship with the processes, wires, and screens that we rely on; it's hard, even irrelevant, to say when one stops and the other begins. Whether it's the carpet that alerts medical services when an elderly person falls in her home or the automotive system that adjusts your route based on traffic, weather patterns, and food preferences, we now take for granted the depth, breadth, and consequences of connectivity with everything and everyone. No wonder this is such a high adrenaline world, percolating with the buzz that comes from being always on, always sensing, always interacting, and always changing.

This is also an exhilarating—and unsettling—world in which to do business. Players proliferate, rise and fall, and constantly iterate the value proposition around the Internet. New technologies, new access models, and new pricing schemes—concerning both content and bandwidth—dominate the weekly industry headlines. The development pipeline is full of toys, consoles, sensors, interfaces, and tablets intended to make someone's transition online seamless. Yet many of the most touted innovations are the product of unusual alliances, partnerships, and licensing agreements, rather than traditional R&D. To succeed, one eye must always stay focused on the core—cost, efficiency, and sustainability metrics matter as much as ever—with another scanning the horizon for signs of imminent disruption and fleeting opportunities. Even the most agile competitors struggle constantly to stay ahead of the emerging and morphing competition.

Looking ahead, there is no question that IP networks will continue to play a big role in national, city, and enterprise competitiveness as well as personal experiences and lifestyles. But in many parts of the world capacity limitations are beginning to loom large. The question of how to finance the higher quality, extensive networks that this densely connected, rich-bandwidth world needs does not have an obvious answer. Public-private partnerships for network build-out are the exception rather than the rule and few governments have found the courage to prioritize public network investments. Can the forces of technological progress that enabled the Internet's explosive growth from 2010 through 2025 be counted on to continue doing so indefinitely, or will a major new policy approach be required?

Life in the unfolding world of FLUID FRONTIERS
Meet Diedra, Mieko, and Slava.

There is no way **DEIDRA** is going to miss her favorite game show, "Date the Globe." Especially not this latest real-time episode, in which a bachelorette from Reykjavik is posing really clever questions (instantly translated) to single men in Mumbai, Cape Town, Cairo, and a remote research station in Antarctica, in an attempt to find her true love. Deidra started watching the program on her 3D Flex Screen (located on the back of her backpack) while she was on the bus from work. Now she's home and she's starving, but she can't miss discovering who the bachelorette picks! So Deidra "beams" the show onto the side of her fridge, which she can view clearly from her high-speed stove (her pasta water only takes six seconds to boil). Everyone can send real-time comments to the bachelorette and to the bachelors, so Deidra taps a 3D button hanging in the air and says the Cairo contestant's name. "Hey, tell her you love her eyes!" Three seconds later, he does. Will it work? Deidra takes a final bite of pasta, and waits for the bachelorette's choice. "I just know it's Cairo man," she cries, her fingers crossed.

MIEKO, a 39-year-old professor at Tulane University in New Orleans, stands in front of her computer's 3D scanner in her underwear, hits "record," and slowly turns around in a circle. Shuffling back over to her keyboard, she hits "send." Almost instantly, a voice with a Thai accent fills her living room. "Those came through perfectly. Stand by for us to project your 3D dressing room so that we can get started." Within seconds, she's in a virtual dressing room with a three-fold mirror. "Stand on the green dot you see on your floor, and here comes your first style—the cocktail dress that you loved." Suddenly, Mieko is "wearing" the most stunning red dress she's ever seen, custom-sized just for her. The deep V neckline is as flattering as she'd hoped, and the sequins add just the sparkle she wants for the upcoming banquet. This dress—this look—was why she was determined to "try on" the styles of this particular Thai designer. "Mieko, you look amazing. But let's try the dress in blue. Just a gut feeling," says the voice. Suddenly, her virtual dress switches to a deep cobalt. "Oh my God!" Mieko whispers. "Gaston won't be able to take his eyes off of me!"

SLAVA, a 46-year-old Internet executive from Ukraine, loosens his tie, his workday now done. Of course, the end-of-day commute doesn't take long, given that the business meeting he just wrapped up took place via video-conferencing technology set up in his home office. Technically, Slava works for a firm based in New York City. But thanks to incredible advances in videoconferencing, he can work almost seamlessly—as well as he could if physically in New York—from his new home in Tumbes, Peru. Plus, this Peruvian coastal town has become a major center for solar-powered server farms—and who better to oversee his company's share of those servers than a man who loves swimming in these gorgeous Peruvian waters? "Slava, can you take a quick client videocall? Something about that new deal with the micro-server firm in Odessa?" he hears through his ever-present (in fact, embedded) ear piece. "Uh, sure," he says, tightening his tie. The beach can wait. "OK, he says. "Put them through."
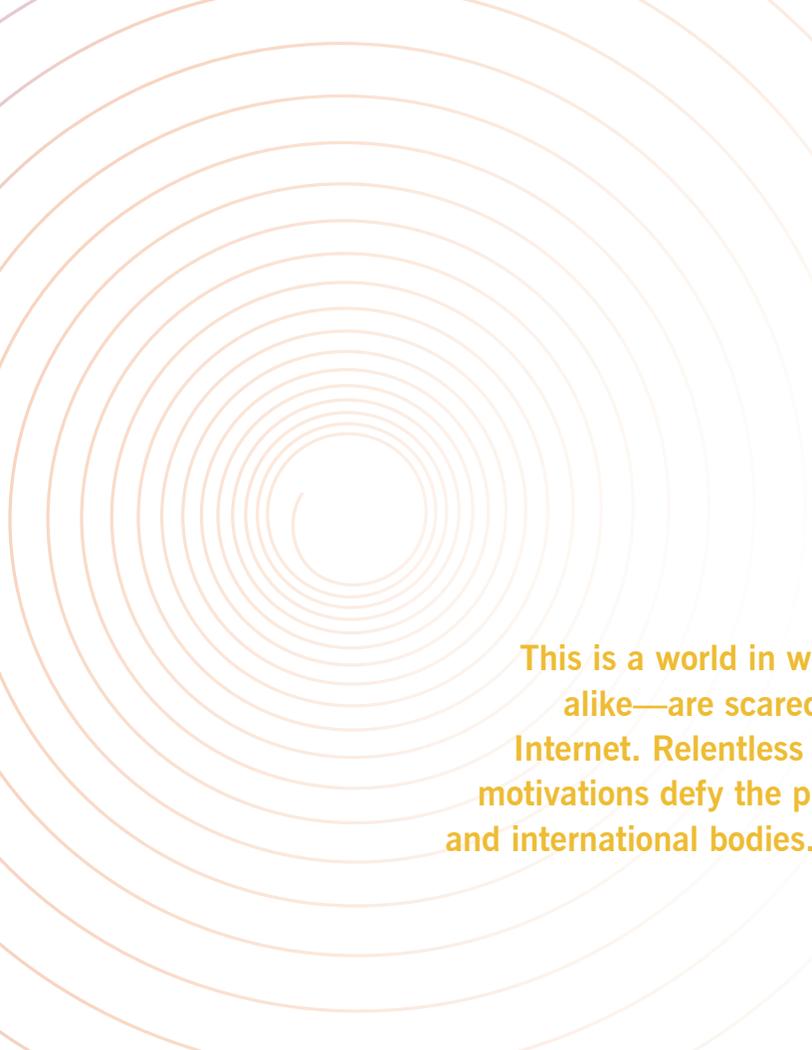
INSECURE GROWTH

This is a world in which users—individuals and business alike—are scared away from intensive reliance on the Internet. Relentless cyber attacks driven by wide-ranging motivations defy the preventive capabilities of governments and international bodies. Secure alternatives emerge but they are discriminating and expensive.

It's 2025, and the dream of the Internet as the great transformer is in shambles. The promise of a ubiquitous virtual platform through which an ever more globalized world would collaborate and think differently, and through which all kinds of new businesses would change our lives in unimaginable ways, simply failed to materialize. In fact, it's hard to look back on the 2010s and not blush. How trusting we were. And, in some ways, how foolish.

Even 10 years ago, in 2015, the dream was already tarnishing. Security breaches and data swipes were becoming more frequent and their consequences more serious. Yet network build-out continued its march around the world, reaching even the remotest of places where few thought they'd ever see a computer, let alone high-speed access

to the "information superhighway." Wireless, of course, was a big part of that story. And so much investment! Network infrastructure came to be seen as a key ingredient of national competitiveness. Countries as different as Peru, Turkey, and Vietnam all launched programs combining public funding and incentives for private investment to ensure that networks extended the reach of broadband across geographies and social segments—fast.

And yet our focus on the upside of connectivity made it possible to miss something big. As the world went about busily managing more and more of its finances, relationships, and business online, everyone just assumed that the platform was fundamentally secure in some capital-S kind of way. Sure, the Internet was home to its share of scams, viruses, and stolen identities, but these seemed more annoying than dangerous. Plus, weren't there organizations and initiatives dedicated to policing all that? (Hundreds of them, as it turned out—but often poorly coordinated and sometimes at cross purposes.)

Even so, how were we to know that the security wall between our everyday Internet use and the nefariousness on the other side was as thin as the spyware on any given laptop or PDA? There we all were, typing and texting, forwarding personal documents, accessing YouTube clips, plugging addresses and credit cards numbers into online forms, making payments on our mobile phones, and thinking that our anti-virus software or our IT department fortifications were sufficient. We didn't realize that if we were to put our ears right up against those firewalls, we'd hear the shuffling of thousands of vandals, fraudsters, and cyber-terrorists just inches away.

In retrospect, the highly publicized attack on Google in 2010—and, equally alarming, Google's intimation that it wasn't sure if it could block attacks from happening in the future—should have made the holes in the firewall more visible. But it wasn't until reported incidents of mega-hacks became commonplace—and seemingly unstoppable—that we fully realized our predicament. Advising users to "install patches to operating systems" or "avoid clicking bad links" was like telling someone to duck against a hailstorm of bullets. The complexity and cleverness of these attacks far exceeded the tools available to combat them. In 2015, an issue of *The Economist* asked on its cover: "Who Is Foolish Enough to Trust the Internet?"

So we all woke up—and rather abruptly—from our shared dream of an Internet that was fundamentally "good." We didn't give up on the Internet entirely; we just adopted a much more wary and circumspect approach. Young, intrepid "internauts" adapted by self-editing what they revealed on social networking sites. Many other Internet users limited their online activities to the websites and businesses of known brands—particularly those that had redefined themselves around safety ratings and standards and touted their big investments in security, encryption, and fraud control. Impulsive Internet shopping was now a thing of the past.

Safety was not cheap, and users flocked to expensive private networks and online "gated communities" that promised bolstered security (even if they didn't deliver). For those who couldn't afford such services, the only alternative was to be super-vigilant and limit online time and activities. For many, once-common practices like downloading software updates and iPhone apps or trading stocks through the open Internet were deemed too dangerous.

> **Combating cyber-terror and cyber-crime has become a continuous, high-cost, low-return endeavor, much like the old war on drugs.**

The retreat of wary consumers from the Internet (or, at least, their new usage patterns) froze many IP-based initiatives that had been in the works and shook up all kinds of enterprises. In the IT industry, well-established software providers saw their market positions strengthen while upstart brands and service providers struggled. Meanwhile, the world of e-commerce was turned on its head. Many companies that had redirected their marketing strategies online swung back toward more traditional approaches. Alliances of strong

brands anchored by "bricks and mortar" and secure technology found their footing once again. Some banks chose to rebuild their street-front branches while others invested in super-secure networks (and access procedures) hoping to keep Internet banking alive, at least for high-value clients. Similarly, "cloud service providers" developed new ways to be both fail-safe and connected, but this made the cloud prohibitively costly for many smaller businesses.

All this did not, however, keep malicious hacking and illicit Internet activities from proliferating. It did contain their impact—but at considerable cost. Even now, in 2025, it's clear that cyber attacks can't be stopped—not outright and maybe not ever. Policing the virtual world is harder than policing the physical world. Combating cyber-terror and cyber-crime has become a continuous, high-cost, low-return endeavor, much like the old war on drugs.

There was a silver lining, though. With connectivity levels and Internet familiarity quite high in many countries, the Internet has become less of a medium for economic activity or high-tech interaction and more of an environment for community activity, cultural and artistic sharing, and political activism. The "back to basics" proponents of this less mercenary Internet are delighted by the shift, which holds little appeal for malicious intruders. Still, the Internet could have been and done much more, if only it could have been secure.

There were other bright spots. Print media—including newspapers—didn't die as predicted. TV has experienced a renaissance of sorts, with limited interactivity that mimics the Internet but is nowhere near as risky. And all that rapid-cycle innovation in products and services that once flooded the marketplace has been largely replaced by quality-assured innovation. In fact, a lot of the frenetic pacing of life in the early 2010s—facilitated by our addiction to connected devices, ubiquitous access, and instant gratification—has slowed down. The placement of products and services on the Internet is now measured in years, not months.

Still, there are many enclaves where sophisticated use of secure networks does provide major benefits because the scale of revenues is large enough to bear the associated costs. Many of the applications thriving in these enclaves could easily be expanded to much wider markets. There is hope that new security technologies will make that possible (undoubtedly resulting in the emergence of the new IT giant of the 2030s). But for the time being, so much insecurity is gravely hindering the Internet's growth and potential.

Life in the unfolding world of INSECURE GROWTH
Meet Alvaro, Ludmila, and Deepak.

ALVARO, a 29-year-old dentist in Sao Paulo, enters the Rapid Security Pod attached to his local Banco Itaú branch and steadies himself for the barrage of BICs (biological identity checks) that will be run on him in the next 46 seconds. First comes the iris recognition scan, then a finger prick to confirm his blood type. "This is a lot to go through just to use my ATM card," Alvaro mutters. But then he remembers how awful it was to have his bank account hacked—12 times. Plus, going through BICs wasn't all bad, thinks Alvaro, as a sultry woman's voice fills the soundproof pod, posing to him a series of "random" questions designed to elicit the right syllabic fodder for voice recognition. "I love that woman," Alvaro whispers, a bit embarrassed that he's dreaming—not for the first time—of dating a disembodied voice. His BICs confirmed, an inner door opens. Alvaro whips out his ATM card and gets to his banking.

LUDMILA, a 23-year-old computer programmer in Moscow, stares down at her fingers. Possibly criminal fingers. After graduating with honors from university, and winning awards for her thesis on "Deflecting Service Attacks from the Asian Triad: Three Approaches," Ludmila had desperately wanted to join ROPF, Russia's online police force. But during the initial training, she quickly realized that ROPF's methods—and its cops— were not nearly fast and smart enough to catch the cybercriminals who were fast turning the Internet into their own dark playground. Plus, she had bills to pay and parents to support, and it would be so easy to join any of the dozens of hacking networks that keep trying to woo her—including the Triad. "Maybe I'll just check out the dark side for a little while," she thinks, as she opens a blank email and types in "recruiting@triad.net."

DEEPAK, the 56-year-old owner of a top Indian Internet security firm, hits the "end call" button on his mobile phone and lets out a sigh. This wasn't the first pleading call he'd received today, and he was sure it wouldn't be the last. After Friday's epic hack attack, in which the identities of 1 million Indian citizens were swiped, everyone and his uncle began to call Deepak, begging him to let them inside the protective walls of WebBarb, the high-end, ultra-secure gated online community that he manages. Indian millionaires paid dearly for the protection afforded by WebBarb. Yet his friends and family want in for free. Deepak feels badly that the only people he can help are the very rich—but not that badly. The kind of protection afforded by WebBarb costs big money to provide. Let his cousin's uncle in for free, when there's a waiting list of people willing to pay handsomely to join WebBarb? No way!

SHORT OF THE PROMISE

This is a frugal world in which prolonged economic stagnation in many countries takes its toll on the spread of the Internet. Technology offers no compensating breakthroughs and protectionist policy responses to economic weakness make matters worse—both in economic terms and with regard to network technology adoption.

It's 2025, and the news on the Internet front isn't good, particularly considering the potential that was envisioned back in 2010. It could be worse, of course: the number of Internet users has doubled (to 4 billion people) and is far more distributed than it was 15 years ago. The big disappointment, though, is that many of those "traveling" the Internet today are doing so with only basic functionality. Sure, the super broadband Internet of full-immersion gaming, streaming 3D, and split-screen functionality exists—but only a few people in very few places can indulge in it. Across the globe, the Internet just hasn't advanced in the whiz-bang way that the extrapolation of trends from the late 2000s would have predicted. Not even close.

The early 2010s seemed full of promise, as a mounting body of data showed an undeniable connection between high-speed broadband and economic growth. This persuaded many governments across the world to include broadband in their stimulus programs. Various combinations of public funding and incentives for private investment significantly expanded broadband networks and improved the quality of connections. While the pressure of fiscal deficits soon constrained the more ambitious programs, considerable progress was made in expanding the reach and capacity of broadband networks.

The biggest surprise: these ambitious investments in broadband have resulted in overcapacity. Of course, given the sustained economic pummeling that the world has taken over most of the last decade, the more modest evolution of the Internet isn't exactly surprising. When economic recovery failed to consolidate after a promising bounce in 2010 and 2011, economic malaise spread globally. Cautious consumers and hobbled banks in

the West dragged everyone down, and income growth in emerging markets was set back by years. Nobody was unaffected by this second wave—and no one escaped the lean times that followed, particularly in countries without robust institutions. Financial dynamics changed dramatically, and individuals and corporations alike had to work to rebalance their debt loads even as they watched the value of their assets diminish. Fiscal deficits also demolished any chance of further stimulus packages in most advanced markets.

Consumers worldwide refrained from spending their money, if they were lucky enough to be earning an income. Sparse cash and competing priorities meant that most global citizens—even those inching into the middle class—were forced to make tough spending choices. High unemployment rates and aging populations produced increasingly large social carrying costs that no one seemed prepared for—least of all the mega-cities that swelled with new arrivals. Against this backdrop, indulgences like 3D-HD home entertainment systems seemed beyond excessive—and the subject of scorn—except for small up-market segments in high-income countries.

What did all of this mean for patterns of Internet use? Plenty. The nearly 2 billion new Internet users who came online in the 2010s turned out to be surprisingly low-revenue business opportunities. They were careful consumers of online offers and sought bargains at every corner: on devices, on service packages, and on content offers. They also used e-commerce sparingly and weren't fond of bells and whistles, exhibiting a preference for Internet essentials like VOIP, e-mail, and modest P2P applications.

Lower-cost providers got creative, finding inventive ways to segment markets and cater to frugal users through off-peak pricing, limited-quality connections, and other offers. Business models that depended on teasers to sell premium packages were severely squeezed as consumers flocked to free offerings and resisted upgrades. Advantage tipped to local service providers and technology companies that could offer right-size or bite-size deals and packages.

Most new and existing users seemed more focused on basic functionality and service than on high-end entertainment or virtual immersive experi-

> **The people who came online during the 2010s turned out to be surprisingly low-revenue business opportunities…and sought bargains at every corner.**

ences. Screens, speakers, and ever more interactive and ubiquitous interfaces weren't everyone's idea of a good time. As a consequence, many of the newly connected cultural and ethnic groups never got addicted to the Internet and even showed a tolerance for government controls over content.

A similarly Spartan attitude affected business: enterprises flipped their focus on profits into an obsession with cost management. Overall pressure on the bottom line also had big implications for R&D expenditures, dampening the emergence of new technologies and tangling them in lengthy development cycles. Flash-in-the-pan innovations were tabled in favor of ones that improved dura-

bility. High-end design continued to speak to the small and shrinking elite consumer niche, but the overall attractiveness of that space was limited by the ferocity of the competition and the modest prospects for growth. Optimization, standardization, streamlining, and focus became boardroom buzzwords. Platform interoperability became more important than ever: switching costs are now the nemesis of hardware manufacturers seeking to introduce next-generation technologies.

Relentless economic and social pressure turned many governments protectionist, and not just in terms of trade. Sheltering national companies, including Internet and other technology service providers, from challenges by foreign competitors was a high priority. The rhetoric revealed a deep-seated backlash against excessive dependence on the leading hardware and software companies (mostly American and European) that had long supported Internet use. Of course, not all countries possessed credible technology firms that could deliver

the required alternatives. In those instances, tough partnership agreements based on technology transfer were negotiated. National ownership requirements for companies in virtually all ICT-related areas also increased with varied results: in some cases leading to inferior network performance, in others delayed adoption of readily available technologies.

Now, in 2025, there is still near universal recognition of the potential of broadband as basic infrastructure and yet there is much unrealized potential and growing divides between the digital haves and have nots. Efforts to expand the breadth and depth of connectivity continue to be trumped in many countries by immediate government concerns related to employment and social safety nets, and by the trade offs faced by many people around the world, between, for instance, investing in smart communication devices and the need to satisfy more basic needs. If and when that will change is anyone's guess. Meanwhile predictions of lasting economic recovery keep proving to be wrong.

Life in the unfolding world of SHORT OF THE PROMISE
Meet Anjali, Norman, and Radu.

ANJALI, a 42-year-old Bangladeshi shop owner, rips open the big box she's just received and whistles. Inside are dozens of old smart phones—discards from the West and Japan—that have been refurbished and reloaded with more basic software and interfaces by ReeFur, a top Indian technology recycling company. She picks up an ex-iPhone—the little apple now buried beneath a ReeFur sticker—and turns it on. What was once an app-filled screen is now a vision of simplicity: one small square icon for Internet access, another for phone calls. Nothing extraneous or flashy. Just the essentials and a couple of extras—which, in fact, is all her customers will pay for. "These phones will fly off my shelves," says Anjali, already calculating her next order.

This sucks," says **NORMAN**, a 51-year-old product rep manning a table at the 2020 Houston Consumer Electronics Fair. Looking around, he wonders if the misery and boredom written on the faces of the other product reps mirrors his own. Norman has set up his display of next-generation handheld holographic videogame modules so beautifully—really, it's the most becoming display job of his career. But the only people here to appreciate it are the other reps. There are barely any customers—then again, there are barely any buyers at all anymore of the kinds of whiz-bang stuff his company is still trying to sell—with less and less success. Consumers just aren't mesmerized by features and gadgets that are expensive and pricey, the way they used to be. "No one even wants the free samples," mutters Norman. He glances over at the Bluefang rep running the next booth, who is filing her nails. "Yep," says Norman. "This sucks."

RADU, the 29-year-old Romanian founder of a small and innovative ISP, stands before his staff, buzzing with excitement. His company, Micuta Faina ("tiny meal"), has just been named the most innovative company in Eastern Europe. Its core offering: Internet service payment plans to match the customer's budget—even day by day—rather than monthly subscription. "We saw an opportunity that bigger companies—particularly big Western companies—have flat-out missed," says Radu. Cost-crunched consumers are trimming their spending as much as possible. So the idea of paying per day as/when you can afford it—forget all those unused hours!—had broad appeal. As a result, the very customers that the big players continue to dismiss as low-revenue opportunities—are the very ones who have now turned Micuta Faina into a huge success. "If these other companies had listened to their consumers, this could have been their idea," says Radu, raising a glass. "Here's to the low revs!"
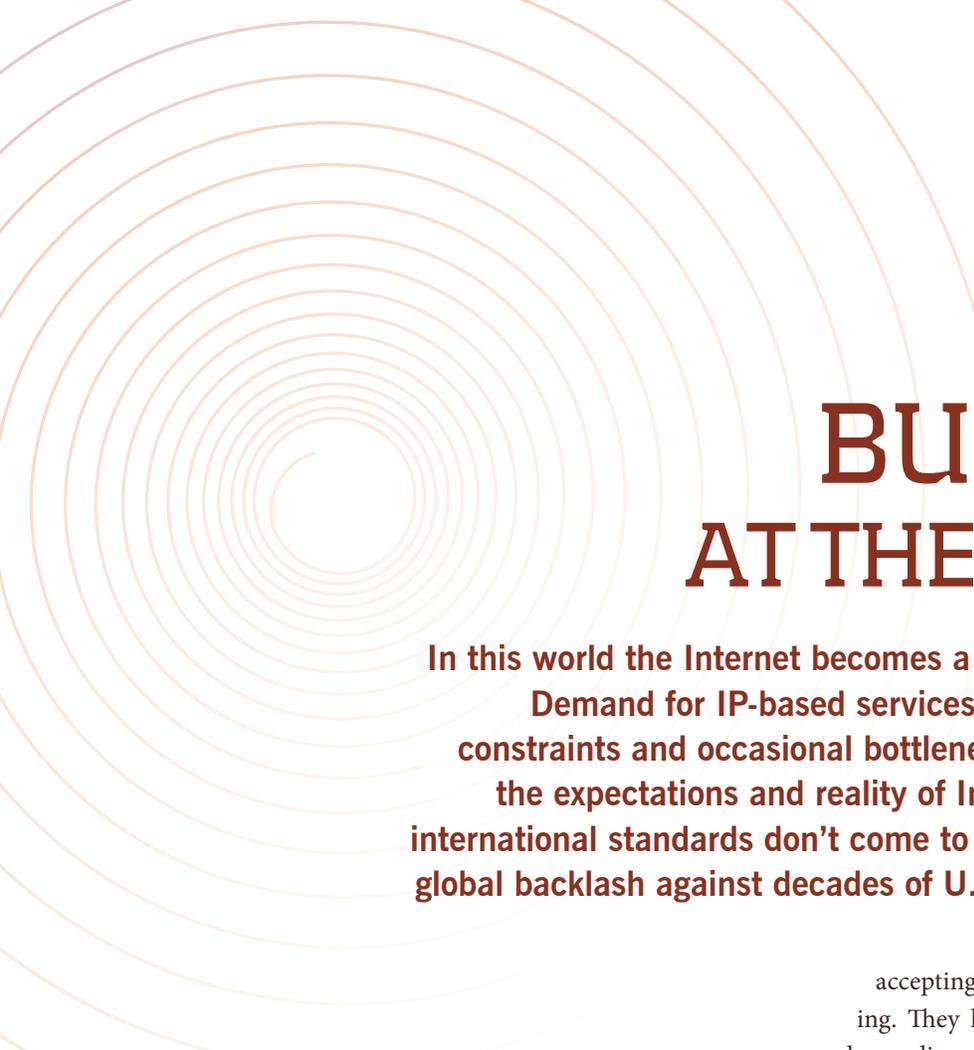
BURSTING
AT THE SEAMS

In this world the Internet becomes a victim of its own success. Demand for IP-based services is boundless but capacity constraints and occasional bottlenecks create a gap between the expectations and reality of Internet usage. Meanwhile, international standards don't come to pass, in part because of a global backlash against decades of U.S. technology dominance.

It's 2025, and the Internet is hardly the sleek bullet train we anticipated. It's more like a locomotive working at the limit, burdened with an increasingly heavy load and blowing the occasional gasket as it strains to keep pace. The load, of course, consists of users and content—both of which continue to pile on the train and never get off.

Internet users now number more than 5 billion—that's 3 billion-plus more than there were in 2010. Of course, this phenomenon was not unexpected. But it turns out that imagining what it might be like for so many people in so many places to be online and actually experiencing it—the stresses it creates, the pressure on the network—are two entirely different things. In addition, hoards of these new users aren't passive and simply accepting of the status quo. They're challenging. They have remarkably high expectations, demanding options and functions that are way beyond what the prevailing standards, protocols, and infrastructure can deliver. Many hail from developing countries and most of them are young; indeed, the growth in Internet usage since 2010 has been mostly among people under 35 from outside the old high-income economies.

And these users aren't adapting in quite the way we expected either. They are restless and not easily corralled into loyalty. For example, the landscape of social networking sites that existed 15 years ago when Facebook dominated has changed dramatically and now contains hundreds of sites, with much more fluidity between them. Users are also making unexpected tradeoffs: the digital natives who were raised on, and some say by, the Internet have surprised Silicon Valley by eschewing HD and streaming video, opting instead for simpler forms of highly visual communications. The image quality might be mixed, but the price is right and the sense of spontaneity trumps other

characteristics. Also, rather than adopting sophisticated new applications and devices, these young innovators are ingeniously adapting technology already in existence, with one of the more popular ones being "like" the visual, low-cost equivalent of SMS "texting."

In terms of content, the volume of new information being created is astronomically high—all of which has needed to be organized, safeguarded, and stored. By 2020, in the U.S. alone, Internet traffic was 100 times greater than it was in 2010. And much of the rest of the world experienced even more dramatic expansions. Anything, anywhere that can be put online, is. As a result, the platform is now so overflowing with content, coordination signals, and basic communications that it seems fit to burst.

The "cloud" has felt the pinch of this, as network reliability is in doubt and storage capacity still remains cost-effectively based on the client device. Extremely thin devices have evolved too, but they are considered an alternative (and one that comes at a price) rather than the hands-down preferred choice. One of the strongest market plays to emerge in cloud computing has combined cloud services with a dedicated high-quality network. The move by one of the major global hardware manufacturers to acquire a collection of small telcos and turn them into a global niche ISP caught much of the competition in both fields by surprise.

For a company to make money in this environment, it has to be nimble. The management teams that seemed to intuitively grasp the evolving competitive landscape were those that honed their skills in the fast-moving, messy world of emerging markets in the 2010s. What they all had in common was the ability to turn challenges into opportunities and scale rapidly to become global players. Yet "grassroots" business models focused on smaller, specialized, and nontraditional markets also proved key, enabling bold entrants to challenge the incumbent leaders who couldn't adapt quickly enough. Device manufacturers were particularly shaken when demand for sophisticated devices plummeted; many of these new consumers wanted value—not flash and bang.

Meanwhile, the notion that Internet access should be considered a basic human right gained more and wider support. If the Internet was critical to national economic development and the deliv-

> **New users have remarkably high expectations, demanding options and functions that are way beyond what the prevailing standards, protocols, and infrastructure can deliver.**

ery of a whole raft of services like education and healthcare, the advocates argued, then unfettered individual access would only accelerate progress. Plus, the demand for access from individuals all over the world was almost deafening. Civic institutions, NGOs, and influential supranational organizations like the UN were clamoring for it too. By 2018, the "Internet for all" movement seemed unstoppable and basic access began to spread quickly across the globe. Unfortunately, that created quite a paradox: it worsened system congestion to the point that plans to extend basic access to many low-income pockets were backlogged or delayed.

BURSTING AT THE SEAMS

This dilemma was compounded by the modest investments made in network build-out and improvements over the last decade. Incentives for private investment were often eroded by regulations to extend network access and prevent discrimination, without any significant public investment in backbone to compensate. Other policies relevant to the Internet shifted as well. By 2020, many national broadband plans showed overtones of defense technology policy, as happened earlier in the century with energy. In retrospect, of course, this might have been anticipated. Not only did the absolute power of the technology point in this direction, but there was also a significant desire to level the playing field around U.S. technological dominance. The lack of agreement on upgrading the protocol to IPv6 was largely attributed to the geopolitical undertow.

Nevertheless, there were a smattering of small countries where visionary governments tried to combine their nation's quality-of-life appeal with high-speed, high-quality capacity—successfully creating a test market for new

applications and an attractive base for Internet innovators. Elsewhere, large islands of good connectivity were surrounded by vast expanses of overburdened networks with poor reliability, speed, and quality.

Now, in 2025, the question on everyone's mind is, "What happens next?" We are addicted to connectivity and everyone—literally everyone—is counting on it to keep expanding. But the limitations are too obvious to ignore and no one is sure how to climb up to the next plateau. As different players seek to circumvent the constraints of existing networks, and in the absence of new network-enhancing technology breakthroughs, a few post-emerging governments are quietly supporting research on wholesale alternatives to the well-worn Internet protocol. There is rampant speculation on the direction and progress of that research and now rumors are flying that somewhere a new protocol is about to be launched. China and Russia are the odds-on favorites, although a surprising number of less prominent countries are mentioned as well.

Life in the unfolding world of BURSTING AT THE SEAMS
Meet Issa, Anna, and Dzong.

Haraka haraka haina baraka. The old Swahili proverb (haste makes waste) was not meant to apply to the new high-speed connection linking Mkokotoni, a village on the island of Zanzibar, to the outside world. Until today, the village had been known mainly for its tuna and king mackerel fishing and its bustling daily fish market. But today, Mkokotoni would become the first village on Zanzibar to have a live video link to Japanese fish brokers. The fishing cooperative leader, **ISSA**, has made a big deal of the symbolic "flipping of the switch" ceremony (the high-tech version of the symbolic ribbon cutting). After a brief speech, Issa presses the remote and … nothing. He tries again. Nothing. Peter, the representative sent from the South Africa-based service provider, puts down his camera—he was poised to capture the glee they were all expecting—and begins frantically checking and rechecking the connections. Peter has no idea how to tactfully tell the village leader—and all the fisherman clustered behind him—that the system is congested, the ceremony a victim of the increasing burden placed on existing networks with every geographic expansion. "I sooo did not sign up for this," thinks Peter as he puts on a big smile and walks nervously toward Issa and the crowd.

"I've got one!" shouts **ANNA**, a 22-year-old intern at Verbindungen, a Munich-based, all-volunteer organization that scans the country for "discrimination" perpetrated by service providers (the name means "connected"). Anna's find is a perfect example: an ISP operating in Eastern Germany seems to have a pattern of slower packet traffic from non-partner sources and to lower-revenue generating connections. Anna's fellow volunteers let out a whoop, and she beams with pride. She can't wait to tell her dad—one of the biggest supporters of the "Internet for all" movement she knows—that she just found something that could make a real contribution to the campaign. With the Internet so critical to delivering healthcare and education around the world, high-speed access is essential. It must be assured! "Back to work," Anna thinks. "We must do case studies to show activists in other countries what to watch for."

DZONG, a 16-year-old Vietnamese boy, used to feel so bored sitting on a stool for hours on end, watching over his mother's low-traffic souvenir shop in Hanoi's Old Quarter and connected to his friends only through clumsy "texting." When the occasional tourist wandered in to peruse the silk scarves or study a set of chopsticks, Dzong had felt eternally grateful to them for disrupting his stupor. But now he doesn't need the tourists for that. Now he has the Bia Hoi, a new device that connects him to his friends and to the Internet for cheap. Named after the super-inexpensive Vietnamese beer that Dzong's parents still think he doesn't drink—as if!—the Bia Hoi is the brilliant creation of two young Vietnamese entrepreneurs not much older than Dzong. The device can do all sorts of cool stuff, like project media onto any screen and conduct lightning-fast Internet searches. But it's also affordable, primarily because it somehow uses much less bandwidth than the alternatives. Now all of Dzong's friends have Bia Hois, and they spend much of the day sending stuff to one another: film clips, texts, etc. The only thing they can't do is watch media in HD—a high-price function the Bia Hoi doesn't allow. "But who cares?" thinks Dzong, as he starts up another video game on his device, sitting on his stool in the tourist-less shop.

USING THE SCENARIOS AND EXPLORING THEIR IMPLICATIONS

Having developed four scenarios to help us explore alternative, plausible futures for the Internet, we can play with them in a variety of ways. Yet it's important to remember that the value of these scenarios has nothing to do with whether we accurately predict the future 15 years from now (which is unlikely to happen in any case). Scenarios are useful because they help us to see emerging patterns differently, to separate "the signal from the noise" so we can detect big risks or opportunities in advance, and to rehearse ways of managing unforeseen challenges.

PLACING THE SCENARIOS IN PERSPECTIVE

We have already described the differences across our scenarios in terms of their characteristics (the change drivers behind the axes of uncertainty) and in terms of their texture and feel (what it might be like to live and do business in these futures). Before proceeding to sketch out the implications from different angles, however, it is helpful to compare how different the Internet looks in 2025 in each of the scenarios according to two key metrics:

the level of Internet use and the composition of the global Internet economy.

The **level of Internet use** encompasses both its breadth (how widespread the Internet is; what proportion of the global population uses it) and depth (how intensively the Internet is used and how much traffic it carries, defined as the global median of Internet traffic per user). As shown in the figure below, the level of Internet use is highest in *Fluid Frontiers* and lowest in *Short of the Promise.* In *Bursting at the Seams,* Internet use

INTERNET USE ACROSS THE SCENARIOS

FLUID FRONTIERS

BURSTING AT THE SEAMS

INSECURE GROWTH

SHORT OF THE PROMISE

DEPTH

Depth = Internet Traffic
Breadth = Internet Penetration

BREADTH
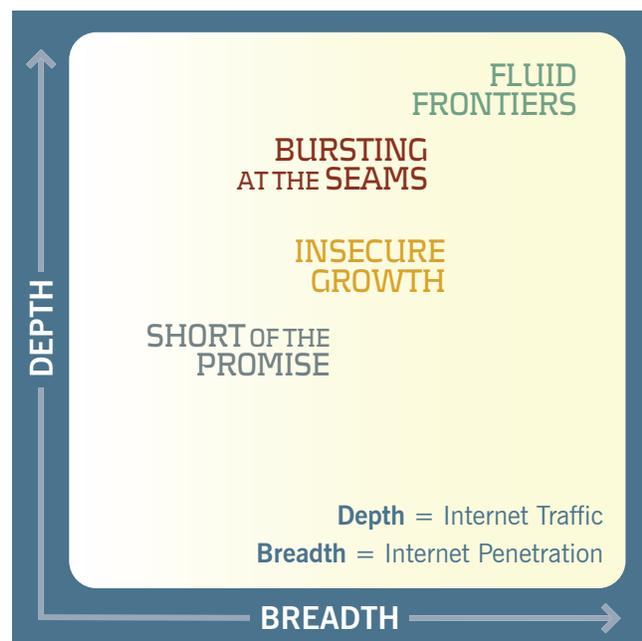
is deep in many areas but somewhat less distributed, while the reverse is true in *Insecure Growth,* due to prevailing concerns about security.

In our first premise about the evolution of the Internet at the beginning of this report, we postulated that emerging countries would represent at least half, and at most three-quarters, of the global Internet economy in 2025. In the Figure to the right, the **composition of the global Internet economy** is depicted relative to each scenario as arrayed in the previous figure. *Short of the Promise* is the world in which the emerging countries do least well, accounting for about half of the global Internet economy in 2025 (up from 30 percent in 2010). In *Fluid Frontiers,* however, the rise of emerging countries continues unabated; by 2025 they represent three-quarters of the global Internet economy and overshadow the old advanced countries in terms of both demand and supply for Internet-related products and services.

EXPLORING IMPLICATIONS ACROSS SCENARIOS

The Internet is a pervasive, complex phenomenon that encompasses many actors and stakeholders. We hope these scenarios, and the underlying discussion of driving forces and uncertainties, will be useful to all of them. But, as noted in the introduction, we have two primary audiences in mind: decision-makers in corporations directly involved in the business of the Internet and national leaders and

INTERNET ECONOMY ACROSS THE SCENARIOS
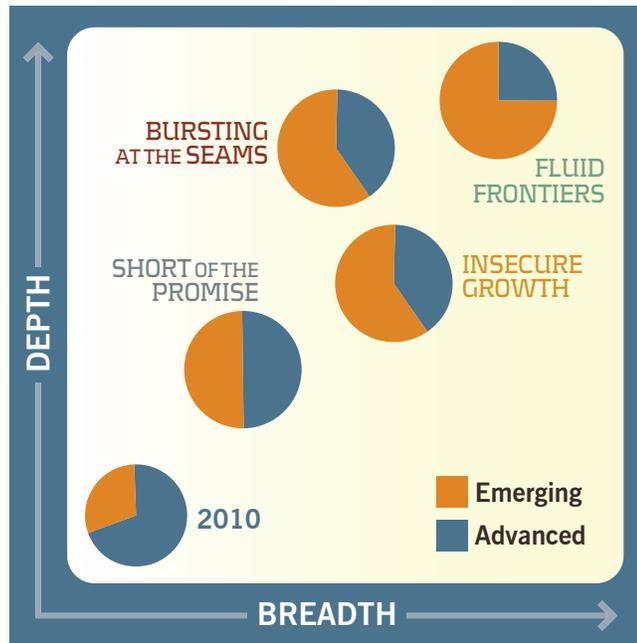
policymakers. Both are, of course, ultimately concerned with their effect on and relationship with all users of the Internet: individuals, enterprises, and institutions.

The primary concerns for each of these audiences, respectively, can be summarized in two questions: what business models will best establish a sustainable, profitable position around the Internet of the future; and what are the policy challenges that need to be addressed—preferably before 2025—in each scenario.

Whether you are a leader in industry or policy, the future is likely to surprise you despite skilled forecasts and data-rich analyses. By using these—or your own—divergent scenarios to rehearse the future, you will be better able to anticipate, respond, and adapt to an uncertain future.

WHAT IS THE BUSINESS MODEL FOR 2025?

This is the question we used to anchor the exploration of implications for Internet industry players.

One way of examining the business model implications of the scenarios is to look at how the dynamics between providers and users might differ in each of them. The framework below is designed as a launching pad for this exploration. On the horizontal dimension we consider the basis on which the providers of the key Internet components interact directly with users (both individual and businesses). On the vertical dimension we provide a simple classification of the types of transaction that characterize the user/provider interaction.

BUSINESS MODELS [*Illustrative*]

Transaction	PROVIDER			
	Devices (PCs, PDAs…)	Connectivity	Software & Services	Content
Buy				
Subscribe				
Pay Per Use				
"Free"				

Working through this framework, we start with a fairly well-established "enclave" (PCs are bought, as is most software). Connectivity, however, is typically by subscription and the drift towards "free" (or, more accurately, indirect payment) is already in play—particularly for content but with some open-source software as well. Yet some of our scenarios will significantly shift this paradigm—vertically toward "free" transactions and horizontally toward bundles of offerings. These types of changes will shape the different business models that are likely to be successful in each of the four worlds that our scenarios portray.

If you are an industry player, consider the following questions:

- What assumptions are you and/or your company implicitly making about the world in 2025? Which scenario comes closest to your assumptions? How will your business model evolve to succeed in that world?

- What happens to your business model in the other scenarios? What are the big challenges or opportunities that might arise?

- What early indicators or signposts should you be tracking so that you know when to revisit or adjust your strategy?

WHAT ARE THE POLICY CHALLENGES BY 2025?

This is the question we propose for policymakers to consider in exploring the scenario implications.

Our framework to address this question starts with three dimensions of desired outcome (across the top) regarding Internet connectivity, which we see as being a basic components of modern life in 2010 and enshrined as a universal right by 2025. The framework also examines the different challenges presented by moving toward these desired outcomes with respect to three key dimensions of Internet connectivity: inclusiveness, security, and quality.

These challenges are worth considering separately at both the international level and the national level. (Addressing the challenges faced by local governments is also relevant and needs to be tackled within their specific national contexts.)

At the national level, the framework offers a way to explore the pending agenda for policymakers with the relevant mandate and accountability. The current situation varies widely but in many countries policy making vis-à-vis the Internet is still in its infancy and more at the policy formulation than the implementation stage. Hence we hope that this approach and the scenarios will help sort through options and implications in a timely manner. Identifying the desirable policy responses to different paths for the future of the Internet might well help clarify the relative advantages of each policy mix option.

POLICY CHALLENGES [*Illustrative*]

SPHERE	OUTCOMES (THREE DIMENSIONS OF INTERNET CONNECTIVITY)		
	Inclusiveness	Security	Quality
International			
National			

At the international level, the challenge framework can help illustrate what a mix of entities and processes—representing governments as well as corporate and global community stakeholders—may have to tackle. In some cases the scenarios may point to the need for an evolution in international coordination (maybe even governance) of the Internet. But in others they could highlight questions that would need to be addressed in a broader context—for example, whether international organizations should be mandated to consider global welfare, including

support for countries that might be lagging behind in Internet access.

Within this context, the questions that policymakers need to ask are similar to those for the industry players:

- What assumptions are you and/or your government/organization implicitly making about the world in 2025? Which scenario comes closest to those assumptions?

- How do you define success and what policies need to be in place to achieve success (and when)? What happens to your policy agenda in the other scenarios? What are the big challenges or opportunities that might arise in each and how might policies have to change to accelerate the positive and mitigate the negative impacts?

- What early indicators should you be tracking so that you know when to review your policies/programs?

Rather than review the implications of the scenarios from every possible angle, what we propose here are two frameworks to help organize the answers to both major questions. The frameworks are offered as tools for exploring the implications and potential strategies and actions that these alternative futures may suggest from the perspectives of different stakeholders.

In the following pages we apply the frameworks to present some of the implications of each scenario—*Fluid Frontiers*, *Insecure Growth, Short of the Promise,* and *Bursting at the Seams*—for both **business models** and **policy challenges**. These implication sketches are only meant to be illustrative and serve as a launching pad for exploring what the specific implications might be for individual industry players, groups of stakeholders, or even countries.

FLUID FRONTIERS

TRANSACTION	PROVIDER			
	Devices (PCs, PDAs…)	Connectivity	Software & Services	Content
Buy	Wide range of options but shift for consumers ↓↓↓		Both consumers and businesses rely largely on cloud and SaaS (Software as a Service) ↓↓↓	
Subscribe		New game for Service Providers as Internet access is bundled with services (and devices?) ↓↓		Premium pockets
Pay Per Use				Cafeteria pockets
"Free"				Norm is "free" (funded by advertising)

(Row label at left: BUSINESS MODELS)

SPHERE	OUTCOMES (THREE DIMENSIONS OF INTERNET CONNECTIVITY)		
	Inclusiveness	Security	Quality
International	• The last 2 billion unconnected people are much harder to reach • Traffic has overwhelmed submarine cables but private investors hesitate to sink money in them	• The global cloud is of critical importance and needs to be secured in a coordinated way	• The greatest divide across countries is the impact of differences in the combination of speed and latency that their prevailing connections offer
National	• Some major countries with low population densities and/or remote populations have not yet found a way to ensure universal connectivity	• Massive data generated by Internet users (including as they move around while connected) has created legal lacunae regarding ownership of information	• Limited recognition of the importance of quality has kept users in many countries from enjoying the benefits of many new applications

(Row label at left: POLICY CHALLENGES)

INSECURE GROWTH

TRANSACTION	PROVIDER			
	Devices (PCs, PDAs…)	Connectivity	Software & Services	Content
Buy	New choices include captive, secure devices	Private and/or gated networks for businesses and top consumers	Emphasis on trustworthy brands	
Subscribe				Premium and safe become the norm
Pay Per Use				
"Free"				Large pockets of "free" (advertising)

(Left axis label: BUSINESS MODELS)

SPHERE	OUTCOMES (THREE DIMENSIONS OF INTERNET CONNECTIVITY)		
	Inclusiveness	Security	Quality
International	• Concerted action to isolate countries that become safe havens for malicious Internet attacks leaves their populations disconnected	• Global cyber-criminals still a step ahead of cyber-Interpol	• Private, secure global networks seen as clubs discriminating against some would-be members, and even serving as geopolitical instruments
National	• Large population segments opting out of the Internet (particularly if they cannot afford expensive, secure networks)	• Focus on responding to citizens' demands for protection while minimizing intrusion; the Internet equivalent of airport security	• Protective measures becoming a severe constraint on quality

(Left axis label: POLICY CHALLENGES)

SHORT OF THE PROMISE

<table>
<tr>
<th rowspan="3">BUSINESS MODELS</th>
<th rowspan="2">TRANSACTION</th>
<th colspan="4">PROVIDER</th>
</tr>
<tr>
<th>Devices
(PCs, PDAs...)</th>
<th>Connectivity</th>
<th>Software &
Services</th>
<th>Content</th>
</tr>
<tr>
<td>Buy</td>
<td>Slow replacement, large secondhand market for devices</td>
<td></td>
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<tr>
<td></td>
<td>Subscribe</td>
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<td colspan="2">Strong price competition; elasticity for both consumer connections and for business cloud services</td>
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<tr>
<td></td>
<td>Pay Per Use</td>
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<td>Low-cost options</td>
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<td>"Free"</td>
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<td>Open-source inroads</td>
<td>Most is "free" (funded by advertising)</td>
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<table>
<tr>
<th rowspan="3">POLICY CHALLENGES</th>
<th rowspan="2">SPHERE</th>
<th colspan="3">OUTCOMES (THREE DIMENSIONS OF INTERNET CONNECTIVITY)</th>
</tr>
<tr>
<th>Inclusiveness</th>
<th>Security</th>
<th>Quality</th>
</tr>
<tr>
<td>International</td>
<td>• Widespread protectionist mood slows spread of technology and defies attempts to breach barrier-lowering treaties</td>
<td>• Cyber-terrorism grows due to prolonged economic slowdown; their safe heavens elude international action</td>
<td>• Limited by the extensive attempts of governments to control content flowing into their countries</td>
</tr>
<tr>
<td>National</td>
<td>• High-functionality devices remain expensive relative to incomes, keeping many countries at low penetration rates for rich Internet use

• Protection of national champions or incumbents also keeps costs high</td>
<td>• Cyber-protection in many countries seen as favoring Internet use by the rich in allocating scarce resources that could go to satisfy more basic needs</td>
<td>• Internal divides as high-quality connections are not widely available nor affordable in many countries</td>
</tr>
</table>

BURSTING AT THE SEAMS

TRANSACTION	PROVIDER			
	Devices (PCs, PDAs…)	Connectivity	Software & Services	Content
Buy	Tiered market (from owned, low-cost, souped-up devices to leased, high-end ones)	Business premium pockets		Low-cost options
Subscribe		Extensive price segmentation ↓	Niche consumer and extensive business cloud services ↓	Premium pockets
Pay Per Use				
"Free"			"Free" and open source are pervasive (supported by advertising and/or by volunteers, amateurs, activists)	

(Left side label: BUSINESS MODELS)

SPHERE	OUTCOMES (THREE DIMENSIONS OF INTERNET CONNECTIVITY)		
	Inclusiveness	Security	Quality
International	• Reticence to continue relying on U.S.-based standards and protocols threatens to create multiple, ill-connected systems	• Instances of strong government support for national champions in IT arena create suspicion of their motives and goals	• Massive divide across countries on connection quality results in global traffic disruption
National	• Lack of progress on global standards creates dilemma by limiting expansion in countries with the greater Internet uptake	• Relaxed attitudes toward privacy and information sharing, driven by digital natives, makes it difficult to reach policy consensus	• Insufficient investment in network capacity threatens most countries' Internet use and demands a new public-private bargain

(Left side label: POLICY CHALLENGES)

CONCLUSION

The Internet of the future will be larger and have a greater impact in society than it does today, as the Internet becomes truly global, spreading beyond large cities in emerging countries into villages and rural areas everywhere, and as Net generations move center stage. But the Internet's shape 15 years hence and the path it takes to get there are uncertain and unpredictable. Indeed, the diversity of outcomes across our scenarios highlights how different combinations of change drivers could shape the evolution of the Internet through 2025 in ways that may differ from the implicit assumptions of its key actors today. These differences have important implications for the structure of markets and the emergence of winners and losers across the industry. But the scenarios also unveil insights regarding the Internet's potential to transform social and human value.

The Internet is no longer a world of its own—an autonomous space, separate from the "real" world of bricks and mortar. The process of physical, social, commercial, and even psychological convergence will continue to accelerate under any foreseeable future, with wide-ranging implications. The Internet and TV are not distinct alternatives any more; telephone and IP networks are not parallel universes; public and private transparency and accountability are not really optional. As flexible interfaces erode language barriers, the Internet will become comfortably multilingual. Propositions and applications will spread quickly regardless of cultural origin, evolving to address local preferences while also appealing to virtual groups with affinities not driven by conventional parameters. The range of choices and challenges will keep expanding along with the human and social value that this truly global Internet creates.

The development of the Internet in the last 15 years has been breathtaking. Its next 15 years could be even more fascinating, as it expands in both depth and breadth and as the range of active stakeholders widens. While the potential challenges are enormous, so are the opportunities. We hope that business leaders will use these scenarios to help make their business models and strategies more nimble and adaptive in the face of an uncertain future. Similarly, we hope that policymakers use these scenarios to explore how the potential of the Internet and broadband can be harnessed to serve broader economic and social objectives.

Regardless of how the future unfolds, the Internet will evolve in ways we can only begin to imagine. By allowing ourselves to explore and rehearse divergent and plausible futures for the Internet, not only do we find ourselves more prepared for any future—we can also help shape it for the better.

ACKNOWLEDGEMENTS

APPENDIX 1
INTERVIEWS

Interview Topics

The interviews conducted with leaders and experts within Cisco and with external authorities and visionary thinkers covered a wide range of topics pertaining to the Internet's broader contextual environment, technology and infrastructure, and business models, as shown below.

Policy, Economic and Social Environment

Technology and Infrastructure

Business Models (Supply Demand Interaction)

Content
VOIP
P2P
Streaming
Text
IM
High Definition

Internet Enabled Services
E-commerce
E-finance
Medical records management
Remote care
Remote workers
Applications
Social networking
Open source innovation(?)
Everything as a service
Cloud computing

Monetization
Content
Pricing
Segmentation
Bundling
Indirect vs. direct service
Access models
Advertising
Commodification of core
Telco plays
eTaxation

Network Build-Out and Capacity
Pace
Quality
Breadth
Government investment
Private sector investment
Wired/fixed mobile/pure wireless mix
Bandwidth efficiency technology
Gated internets
Protected cloud "highways

Enabling Technologies
Batteries
Displays
Storage and compression
Encryption
Voice recognition
Virtual reality

Functionalities/cost ratios
Device interoperability
Security protection
Chips

Demographics
Migration
Aging populations
Youth bulges
Urbanization

Economics
Purchasing power of emerging middle classes
Productivity enhancement from IT
Global spending on ICT
Growthpath disparities
Value added by "prosumers"
Illicit trade/fraud

Policies and Governance
Trade protectionism
Sheltering "national ICT champions"
Regionalism
General education
Technical IT training
Net neutrality
Spectrum allocations/licensing approach
IPv6
Internet of things standard

Society
Fluidity of social values
Cultural sovereignty/exchange
Culture clashing
Digital natives
Digital divides
Cyber terror

Cisco Interviews

Within Cisco we interviewed senior executives as well as individuals with deep expertise in areas ranging from markets to technology, in both headquarters and in the field.

Pramod Badjate	Pankaj Gupta
Osvaldo Bianchi	Maxim Kalmykov
Oren Binder	Julian Lighton
Michael Bloom	Mohsen Moazami
Jane Butler	Robert Pepper
Howard Charney	Scott Puopolo
Fernando Gil De Bernabe	Arielle Sumits
Jaak Defour	Stuart Taylor
Bob Friday	Kaan Terzioglu
Tom Goerke	Paul Thienprasit
Kate Griffen	Ted Tsortos

We also took into account the extensive analyses behind Cisco's **Visual Networking Index** and the predictions of Cisco technology futurist David Evans.

INTERVIEWS

Thought Leaders Interviews

To complement the Cisco perspectives, we also engaged an eclectic group of leading global thinkers:

Chris Anderson Editor-in-chief, *Wired* magazine, previously with *The Economist, Science* and *Nature*; author, *The Long Tail* and *Free!*

Stewart Brand Cofounder of GBN, the Long Now Foundation, The WELL, the *Whole Earth Catalog*; author of four books including *Whole Earth Discipline* and *The Media Lab.*

Esther Dyson Venture capitalist; cosmonaut-in-training; emerging technology evangelist and founding publisher/editor, *Release 1.0*; former chair, ICANN; technology columnist and blogger, and author, *Release 2.0.*

Jim Forster Silicon Valley veteran; 20 years and a Distinguished Engineer at Cisco; now engaged in non- and for-profit efforts to extend the Internet globally, including Esoko Networks (Ghana) and ApnaNet (India).

John Hiles Research professor, computer sciences department, U.S. Naval Post Graduate School; development director, "Sim" game on health.

Mimi Ito Cultural anthropologist, Keio University and University of California; researcher on portable technologies and new media, especially among youth; co-author, *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life.*

Eamonn Kelly Monitor partner specializing in mastering uncertainty; former GBN president and strategy director, Scottish Enterprise; author, *Powerful Times: Rising to the Challenge of Our Uncertain World.*

David Post Law professor (intellectual property), Temple University; fellow, the Institute for Information Law and Policy, New York Law School; author, *In Search of Jefferson's Moose—Notes on the State of Cyberspace.*

Peter Schwartz GBN cofounder and Monitor partner; former head of scenario planning, Royal Dutch Shell; author of five books including *The Art of the Long View* and *Inevitable Surprises.*

Steve Weber Political scientist specializing in international and national political economy and security; professor and director, Institute of International Studies, U.C. Berkeley; author, *The Success of Open Source*

We are also grateful to two groups that provided a valuable sounding board at an early stage of our work: experts from the **ICT Policy Unit at the World Bank** and international economists at the **Center for Global Development**.

APPENDIX 2
AXES OF UNCERTAINTY AND DRIVERS OF CHANGE

Axes of Uncertainty

We identified three axes of uncertainty, below, that formed the scaffolding for constructing scenarios on the future of the Internet. These were synthesized from a set of 14 key change drivers that we prioritized based on our research. These drivers are woven through the scenarios in different combinations to create challenging, yet plausible futures.

LIMITED	NETWORK BUILD-OUT	EXTENSIVE

INCREMENTAL	TECHNOLOGICAL PROGRESS	BREAKTHROUGHS

CONSTRAINED	USER BEHAVIOR	UNBRIDLED
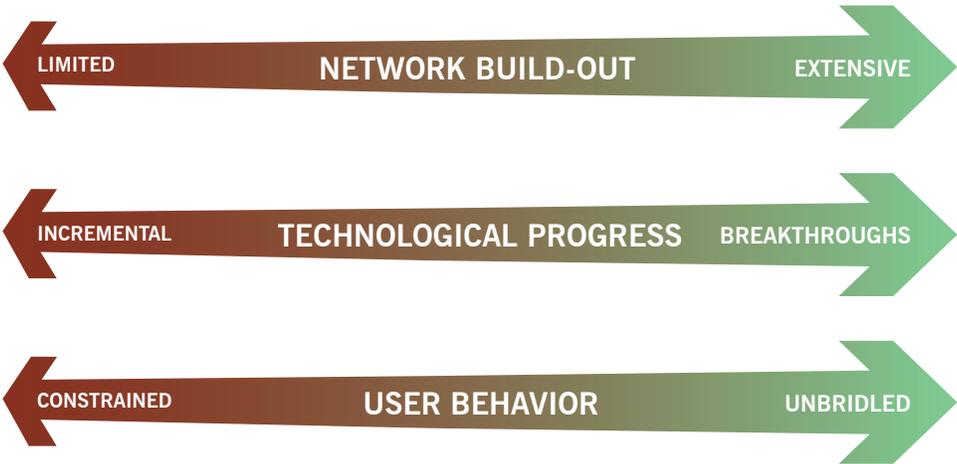
AXES of UNCERTAINTY AND DRIVERS of CHANGE

Drivers of Change

The 14 drivers of change and the range of outcomes we envisage for each are described below. These drivers are grouped under the axis with which they are most closely associated.

NETWORK BUILD-OUT

Laissez Faire	GOVT. (INVESTMENT) ACTIVISM	Broadband as Basic Infrastructure	Are governments likely to actively seed or gap-fill network investments?
Regulate Existing Assets	NETWORK ACCESS	Focus on Entry	Will policies, and the resulting incentives for private investment, focus on access to existing networks or promoting their expansion?
Status Quo	LICENSE/SPECTRUM ALLOCATION	Dynamic Licensing	Will licensing and spectrum allocation evolve into a more dynamic approach?
Widespread	CONTENT CONTROL	Infrequent	How widespread will be government interventions to control content?
Commonplace	PROTECTIONISM/NATIONAL IT CHAMPIONS	Select Instances	Will the protection of national ICT companies from external competition be significant?
Fragmentation	STANDARDS	Harmonization	Will global Internet standards converge and consolidate?

TECHNOLOGICAL PROGRESS

Stagnant or Marginal Drop	PRODUCTION COSTS	Rapid Drop	Will the production costs (and prices) of Internet-related hardware, including smart phones and new connection devices, fall rapidly vis-a-vis purchasing power?
In Very Few Technologies	TECHNOLOGY BREAKTHROUGHS	In all Technologies	Will rapid technology breakthroughs continue to happen across network-related and interface technologies?
Phones and Computers	DEVICE CONNECTIONS	Internet of Things Plus	Will the Internet move significantly beyond relying on handheld devices and computer terminals towards a more massively integrated web of things?

USER BEHAVIOR

Curtail Ubiquitous Connectivity	PRIVACY CHOICES →	**Always on/ Everything Viewable**	Will the trade-offs around privacy be resolved in ways that curtail connectivity?
A Mirage	GENERATIONAL GAPS →	**A Game Changer**	How different will the learning and social behavior of the Net generations turn out to be from older generations?
Spending Slows down	ICT EXPENDITURE (INCL. DEVICES) →	**Growing Percent of Income**	Will consumers keep expanding the portion of disposable income they allocate to ICT (products and services)?
Setbacks	MIGRATION TO CLOUD →	**Full with Few Concerns**	Will services and software keep moving steadily and massively to the cloud?
Price Elastic	RICH CONTENT →	**Exponential Growth**	Will there be continuously rapid demand growth for rich content or will consumption suddenly respond to changes in bandwidth pricing?

CISCO

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