BROADBAND 2030:

The networked future

Broadband
Center of Excellence
Resources for a Broadband World

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The future, brought to you by broadband

Thirty years ago the Internet was an R&D project that connected a few thousand Ph.D.-level researchers at an average of about 500 bits per second per person, each in a fixed location limited to universities in the U.S. and Europe. That's a total network capacity of about 1 million bits per second.

Today, that capacity has grown to 2 million megabits per second for close to 1 billion people, a majority of them now connected to mobile broadband networks. The total network capacity has grown to petabits (that is 10^{15} bits per second). To put that in common terms, that's about the same information rate equivalent to transferring 15,000 full length high definition movies per second. Not bad. It reflects a factor of 1 billion in 30 years, an exponential growth rate doubling each year.

Now for the fun part. Let's assume that growth rate will continue. The number of people won't double each year (we hope), but the number of connected devices will increase by a factor of 1 million to 10^{15} (peta) devices — producing a forthcoming "big bang" of connectedness that will inspire huge improvements in broadband network performance. Each device will be connected at a speed of 1 gigabit per second. The devices will be connected wirelessly, and at some point it won't matter where they are: anywhere on the surface of the earth or in the sky or under the sea or in space within the orbit of the moon. The total network capacity will be 10^{24} bits per second—a yottabit per second, or the equivalent to transferring 15 thousand-billion full length high definition movies per second. Yowza!

In this emerging world, the possibilities start to expand dramatically as we move toward a world a reality where a full range of business services, government services and personalized services are made possible by applying intelligent, automated software over broadband networks.

For one thing, forget tablets and smartphones. The broadband device of the future could just as well be part of your outfit for the day: a hat, let's say. Place it on your head and you're connected to an immersive virtual reality world, thanks to brain research that will have shown engineers how to wirelessly connect directly into our visual, spatial and olfactory sensory nerve centers at 1 billion bits per second. Think of where you want to go and you'll be transported there, virtually. Entrepreneurs can attend a business meeting on the moon with their professional colleagues to discuss the challenges of colonizing Mars with the raw materials available on the moon. A surgeon in Boston can perform a delicate procedure on a patient's heart in Los Angeles. Engineers will collaborate on world-changing projects such as fusion-based clean energy. Students from hundreds of countries can come together on the same day to learn from one another thanks to simultaneous language translation driven automatically by broadband's toolkit. Infants will effectively grow up in a world without boundaries. And we will all enjoy entertainment and art no matter where we are. You'll simply need your ultra-broadband connected-hat. ultra broadband-connected hat. Pretty cool, yes?

This is where thinking about the future of broadband starts to get fun. Rather than look to existing applications and practices and marveling about how next-generation networks will affect them, why not theorize about an entirely new range of possibilities?

Adopting this wider lens lets us escape the relatively narrow trappings of the voice-video-data heritage. Much of what today's multi-megabit broadband networks do is to make familiar Internet applications work better than they did in the dial-up era. That's an improvement, but it's not a revolution.

Better ways
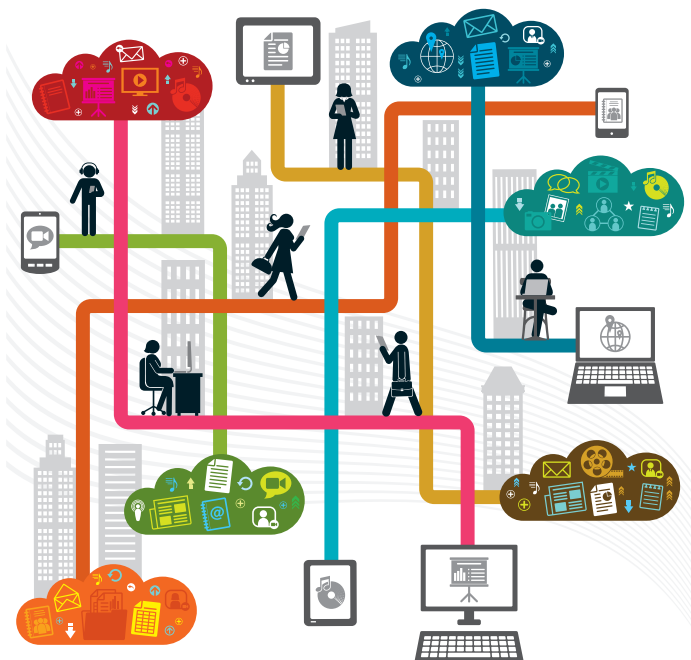
A more telling way to express the possibilities of broadband is to look at ahead-of-their time companies like Amazon, which exemplifies a transformational embrace of connectivity, automation and intelligent software that is achievable through broadband. Amazon has transformed an industrial-age business — the selling of physical, printed books — into an integrated goods delivery platform. It has done so by integrating a suite of fully automated, broadband-connected services that together create a nearly friction-free, highly efficient commerce environment. Broadband touches nearly everything Amazon does, from ingesting and distributing enormous amounts of data at server farms to integrating knowledge about customer habits with price and merchandise information. Amazon has coupled software tools with broadband to collapse and flatten its internal organization in a way that hints at how networked collaboration can improve economic performance in a hybrid industrial-information age.

Imagine how a similar transformation might impact thousands of global companies and millions of individual entrepreneurs who will be able to conduct commerce at a fraction of current costs thanks to the adoption of smart tools and automation. When the independent plumbing contractor shows up at your doorstep knowing in advance what pipe is leaking, what parts he needs to fix it and which of your preferred accounts to bill electronically, we'll know broadband has truly arrived.

Next ingredient: software

But that's not going to happen without a concerted effort by software developers who hold the keys to making broadband integration accessible, secure and foolproof for organizations of all types and sizes.

Cable and telco providers have invested mightily in creating user-friendly, powerful and robust delivery platforms that scale to serve massive amounts of customers. Wireless network operators have revolutionized our world by introducing the concept of connected mobility to the lives of billions of people.

Now, a similarly vigorous effort should be directed toward devising intelligent and rigorously tested software solutions associated with broadband-enabled nanotechnology, biotech and information technology. Software is the glue that tightly couples these technologies with broadband to produce breathtaking advancements in health care, education, business and governance that will touch every connected citizen in the world.

It's a grand ambition, but recent developments points to our ability to achieve it. The type of seamless, automated, integrated experiences Amazon has demonstrated in post-industrial retailing can be associated with almost any element of life. This is how we will advance and grow a global economy in the post-industrial era: with a combination of intelligent networks and software that allows anyone, from the solo entrepreneur to the large corporation, from the municipal mayor to a national government, to leverage the power of sophisticated software applications enabled by broadband.

There are examples already emerging everywhere. In agriculture, farmers can now apply software and broadband-connected devices to maintain watch of growing conditions, market prices, inventory yields and other critical information with newfound efficiency. This sort of nanotechnology application is emblematic of the emerging Internet of Things revolution that will infuse the world with new knowledge thanks to findings reported by billions of miniature devices connected to broadband.

In biotechnology, the broadband-plus-software pairing will provoke enormous advancements by enabling simple, easy and inexpensive monitoring of indicators like blood pressure, heart rate and neural activity that used to require time-consuming and expensive in-person visits with physicians and caretakers.

Broadband also has enormous influence in academic research. Believe it or not, academic and industry researchers who specialize in research subjects such as gene sequencing still commonly overnight computer disks to one another because they're unable to move massive amounts of information over available access networks. The combination of advanced software and multi-gigabit networks will change that, enabling real-time Big Data analysis and collaboration that inspires scientific breakthroughs.

Business and commerce are poised for revolution as well. Consider just one category: e-commerce. Many providers have taken advantage of broadband capabilities to present merchandise in more attractive ways using multimedia tools. That's terrific. But what if instead of changing the color of the shirt displayed on a shopping site's web page, you could render a holographic 3D model of how you would look wearing it? And even touch it to feel the fabric? Samsung's Advanced Institute of Technology is among those working to deliver vibrational feedback in response to touch so that users can feel and interact with 3D objects — an endeavor that has almost limitless implications across the spectrum of business, government and personalized broadband services.

A final indicator has to do with the most important application of all: human interaction. Today we marvel that we can see the image of a friend or family member on a screen while we talk live over the Internet. But we're only skirting the surface of more immersive "presence" applications that have the potential to redefine the way people participate in relationships, communicate with one another, and create or maintain friendships in communities large and small, anywhere in the world.

The academic and writer Susan Crawford is among those who believe advanced broadband networks hold the key to technology breakthroughs that can help restore notions of belonging and even self-esteem that early-stage social media applications have struggled to produce. "We're getting closer to full-bandwidth communications. That's presence. That's the killer app," Crawford said in a June 2013 speech at a conference organized by US Ignite, a gigabit network advocacy group. "We may be able to figure out how to make authentic friendship possible over high-capacity networks. That's what's next. Presence; visual literacy; a new form of relating."

Connecting everything — including cars

We often think of broadband connectivity as a conduit to two types of devices — homebound machines like computers or appliances and mobile marvels like tablets and smartphones. But in the emerging networked ecosystem, everything will be connected. And that includes another place where we spend much of our time — in vehicles.

Within 10 to 15 years, your car will be part of your connected personalized broadband world. Connected vehicles will enable safer operating, better fuel efficiency and more pleasant traveling environment for passengers with potential for these technologies to improve several aspects of existing transportation systems.

The broadband-meets-vehicle ecosystem comprises three distinct types of connectivity: intra-vehicle, vehicle-to-vehicle and vehicle to infrastructure vehicle-to-infrastructure. Among its possibilities:

1) Providing standardized interfaces for intra-vehicle applications promises to reduce the weight of the cabling harness and provide a high-performance high-reliability communications infrastructure that will connect life-critical systems such as braking and steering along with information distribution and presentation systems such as dashboard indicators, heads up displays and infotainment systems.
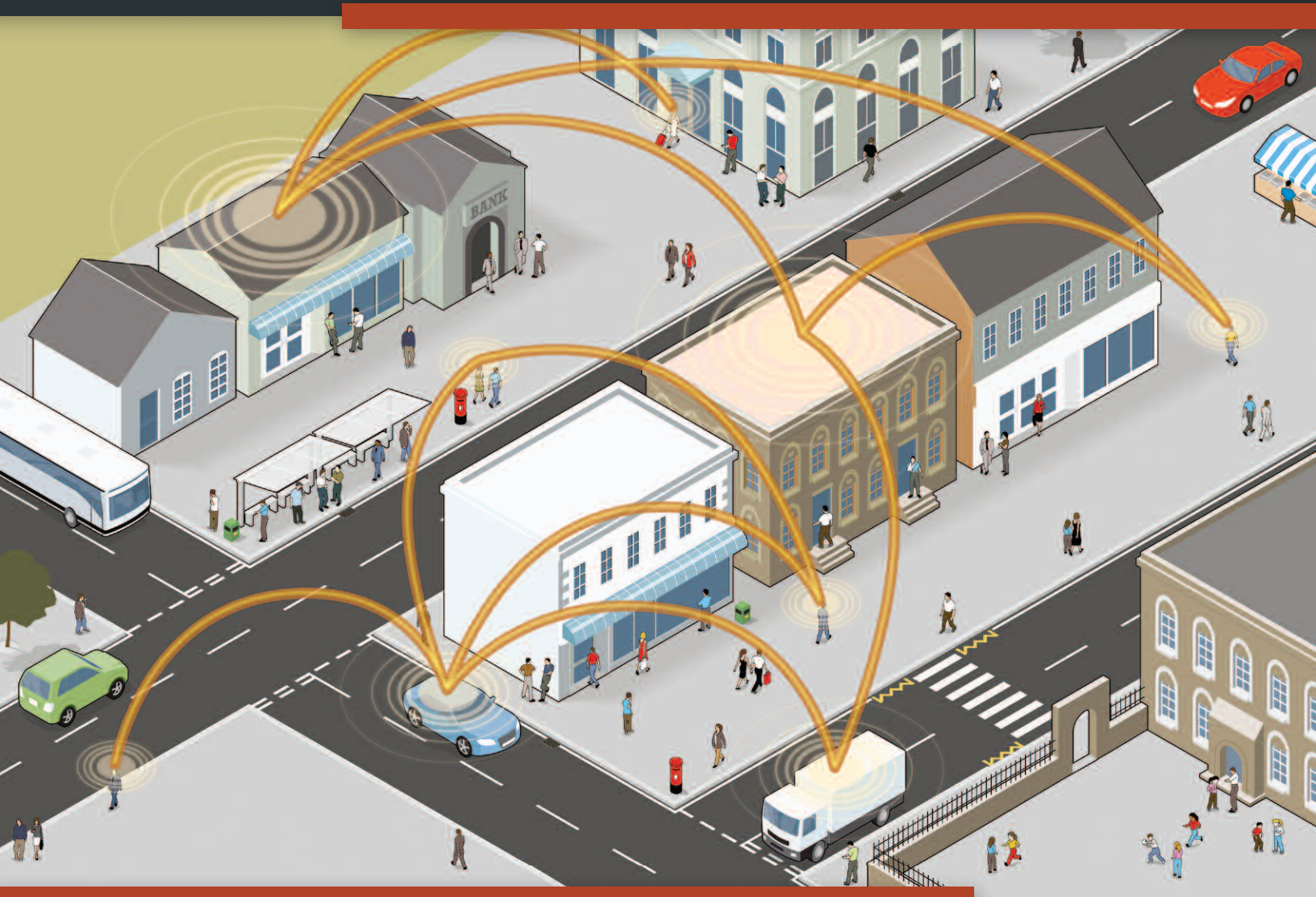
2) Providing standardized interfaces for vehicle-to-vehicle communications will help realize the vision of Dedicated Short Range Communications (DSRC) applications that will help reduce collisions, improve road safety, and enable fuel savings by more efficient operation of single vehicles as well as vehicle "platoons."

3) Using DSRC to enable vehicle-to-roadway communications that will allow roadway conditions to be communicated to vehicles enabling them to operate more safely as well as detect and avoid other potentially dangerous situations. Of course, all of these capabilities will have to be built on top of hardened communication systems that will be highly reliable and impervious to malicious attacks.

The connected vehicle is another missing piece of ubiquitous connectivity and personalized services we all will experience as networks increasingly reshape the experience of personalized communication.

Sobering side

As I said, it's fun to theorize about the future. But there's a sobering side, too. Although broadband's rise has been impressive, a communications system that many believe is essential to future social and economic welfare is still present in the lives of only a minority of the world's population. According to a September 2013 report from the International Telecommunications Union, roughly 4.4 billion people, or 60 percent of the global population, lack access to the Internet at all. Fewer still have (or can afford) broadband access.

Obstacles: Creating a truly connected global population requires overcoming seven impediments to broadband ubiquity.

If broadband is to achieve the high goals many people believe it can, wider adoption is essential. But that's only one obstacle the world needs to overcome to realize the full potential of this powerful communications tool. At the University of New Hampshire's new Broadband Center of Excellence (UNH BCoE), where I serve as acting Executive Director, we've identified seven impediments to a full realization of broadband as a tool for a global, connected civilization. They are availability, adoption, affordability, performance, utilization, ease of use and service development.

Overcoming these obstacles requires a collaborative interplay among governments and policy-makers, investors and corporations, entrepreneurs and community activists. Among other things, it requires a willingness to experiment with new delivery technologies such as TV White Space, a promising approach that uses fallow broadcasting spectrum to supply wireless broadband connectivity. The UNH BCoE is now engaged in a trial deployment of TVWS to connect underserved New Hampshire communities wirelessly at broadband speeds.

Additionally, we've identified a number of policy and market approaches that can help inspire ideas to overcome broadband's most pressing obstacles, and do so in a time frame that delivers on the promise of the broadband-meets-software revolution.

An early glimpse of this promise is evident today within the university community, where many of the forward-looking services and capabilities of broadband are visible. The University of New Hampshire system has deployed hundreds of advanced services powered by intelligent software applications running over multi-gigabit networks. UNH is a living, working, visitor-friendly showcase representing these new possibilities. Within this advanced environment, UNH BCoE is working to enable a broad cross-section of students, government, researchers, faculty and business organizations to learn how to use broadband and associated software to advance strategic goals and provoke economic growth. We conduct research on broadband technologies and broadband's role in fostering community development while advising practitioners on resources available to leverage broadband capabilities in any location.

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The truth is that in the end, we don't know exactly what a fully integrated, broadband-connected, software-infused world will look like. But there is a broad consensus around the world that broadband is an essential ingredient in the transformation from an industrial economy to something new and different and promising. More than 130 nations, advanced and developing alike, have adopted national broadband plans that seek to gain the fullest advantage of broadband connectivity for their citizens. They believe in broadband's ability to enable positive change across critical social, political, economic and cultural dimensions of life. So do I. If we do it right, broadband can be a key to unlocking new possibilities for reducing poverty, elevating opportunity, improving global understanding and building prosperity across the world. Those are ambitious goals, yes. But in broadband, we're known for making big things happen.

About the author

Dr. Rouzbeh Yassini is CEO of YAS Capital Partners and acting Executive Director of the University of New Hampshire Broadband Center of Excellence. He is widely regarded as the "father of the cable modem," reflecting his pioneering work in cable broadband technology as the founder and CEO of LANCity, and as a prominent contributor to the CableLabs Data over Cable Services Interface Specification (DOCSIS®).

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