TECHNOLOGY RADAR

Tracking technology trends that will change the future of the industry. Fostering innovation

DECEMBER 2014

Globe picture from NASA Earth Observatory

CISCO TECHNOLOGY RADAR

Preface

We are releasing this first edition of the Cisco Technology Radar Trends at a time when Disruptive Technology Transitions – such as the Internet of Everything (IoE) and Cloud Computing – are becoming mainstream.

The report highlights the technology trends that we believe will impact the IT industry and the business at large over the next 18 to 24 months.

Each trend includes insights from Cisco's executives, venture capital, academic research, or intellectual property analysis. The report also outlines the technological, social, and business changes that each trend can bring.

For the last 30 years, Cisco has been at the edge of the technology frontier, consistently embracing new technologies and turning them into high-value products and services for our customers and partners.

An important pillar of our success is our technology foresight activity, namely the Cisco Technology Radar.

The radar is a structured framework to identify, select, assess, and disseminate information on new technological developments and trends. It relies on input from sources across Cisco and outside of Cisco.

The radar fosters analytical and hypothetical thinking about the future, paving the way for faster technology sourcing. By enabling early technology identification, it shapes and aligns our innovation strategy.

Today, we are pleased to share our vision of what the future of IT looks like. We hope it will ease the industrywide adoption of emerging technology transitions.

We welcome your feedback on the Cisco Technology Radar Trends. We also wish to thank the many executives and technical leaders who helped make this report possible.

Stephan Monterde,
Director Corporate Development,
Cisco Systems

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About the Technology Radar

Envisioning the Future of IT Sets the Stage for Disruptive Change

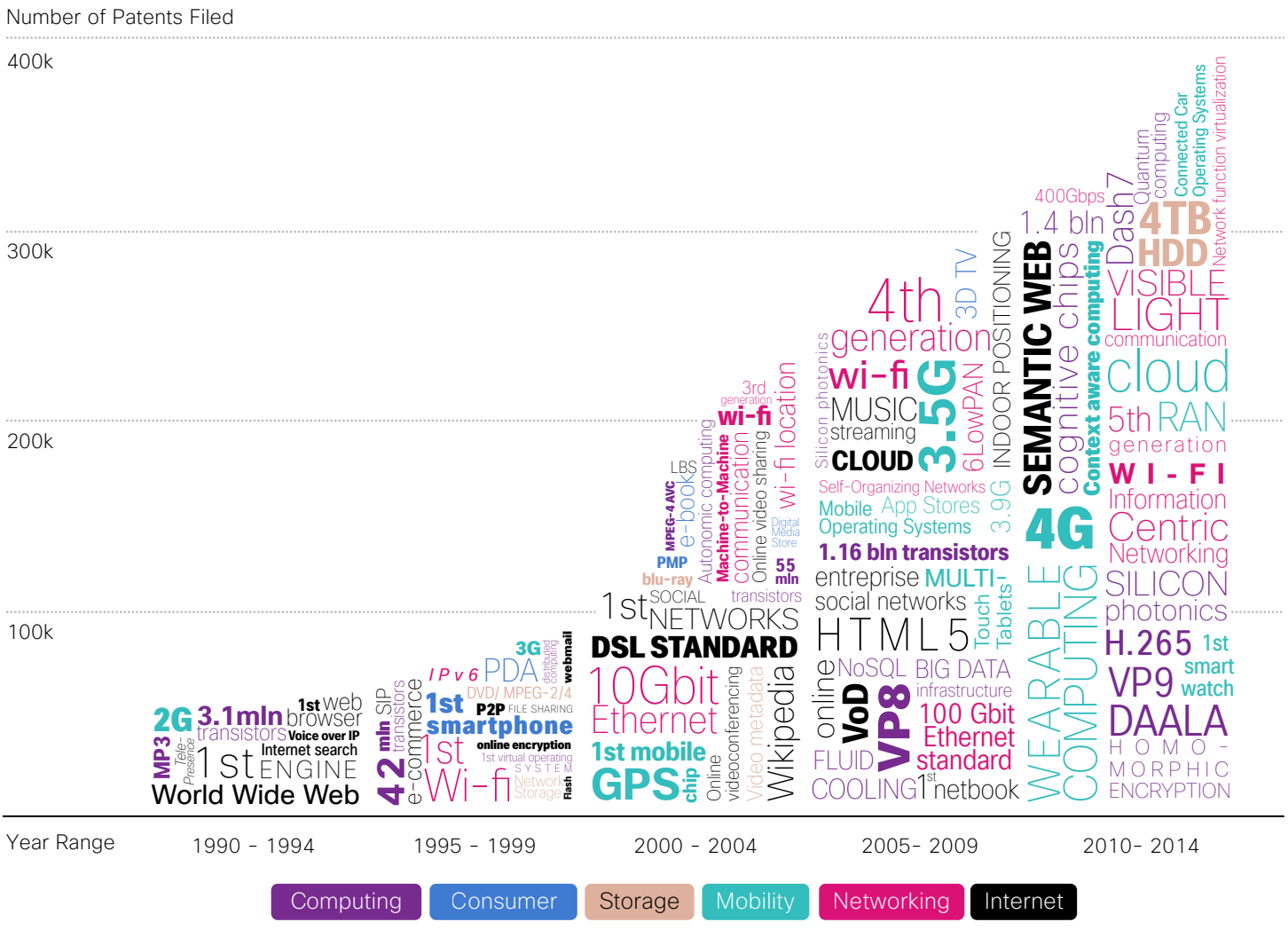
IT has taken on a pervasive role in the world economy, fostering innovation at an incredible pace. Because of this, it is hugely important to predict where the IT industry is heading in the near and long term.

Innovation is Accelerating in IT

Megatrends and transitions are occurring in months rather than years. From mobility and video to cloud and network programmability, there is no end in sight.

The implications of this are amazing. Faster rates of new product introduction. Increasing product complexity. And a highly volatile technology landscape, where disruption occurs more easily.

Timeline of New Technologies Introduction and Inventive Activity in the ICT Industry.



Note: The information is merely a general characterization for illustrative purposes

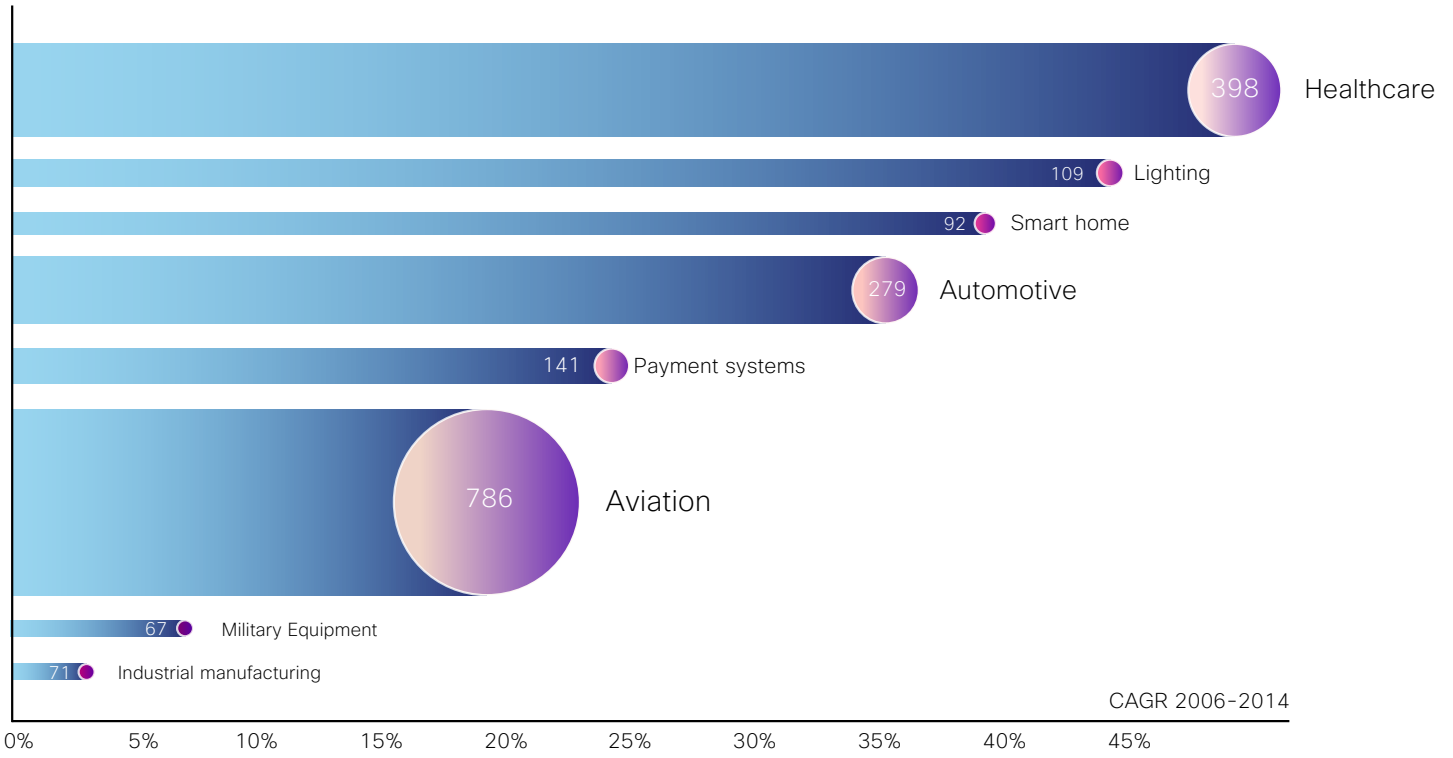
IT Innovation is Expanding Other Industries' Technological Frontiers

Innovation within the industry is a pivotal source of growth. IT innovation is overflowing into distant domains, expanding other sectors' technological frontiers.

Consider, for example, Internet protocols like IPv6. Since its introduction, IPv6 has accelerated innovation across a wide range of industries, including the medical sector with e-health and the automotive industry with connected cars.

IPv6 is Spilling Over into Distant Domains.

This graph displays non-IT industries building on IPv6-related inventions.



5% CAGR 2006-2014

Bar length: growth rate at which these industries have been exploiting IPv6-related inventions recently.

200 inventions

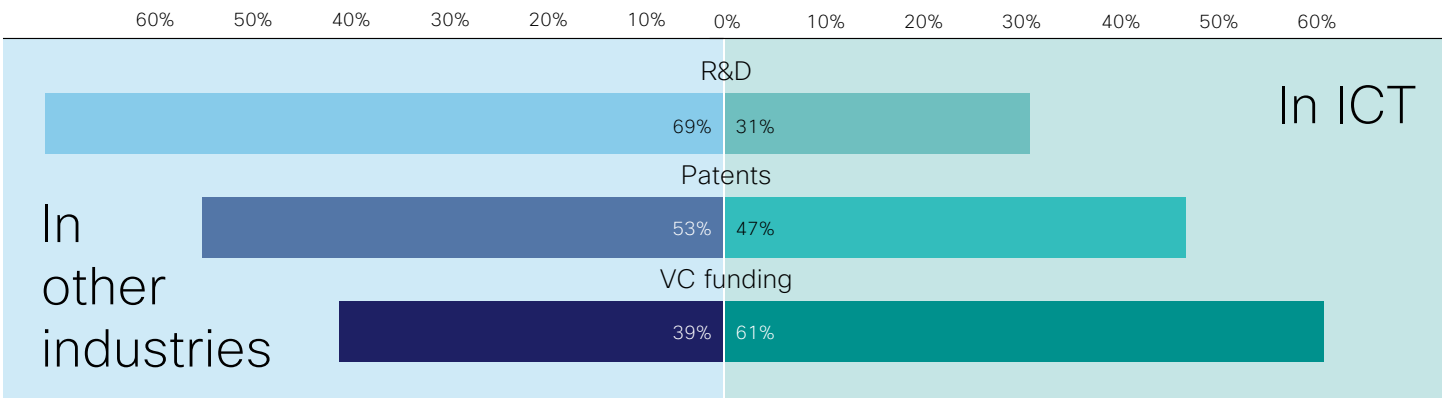
Bubble size: relative use of IPv6-related inventions in the industry.

Crucial Enabling Factors Speeding Up Innovation in IT

Many factors contribute to this sustained progression and widening impact, including:

- **Increased research and development (R&D) spending**: the information and communications technology (ICT) industry invested $139 billion in 2013 and is the largest private-sector R&D investor in the United States. This investment translates yearly into thousands of patents filed with the U.S. Patent and Trademark Office (USPTO).
- **Access to venture capital funding**: this has allowed for the creation of new ventures and sustained the development of small startups. Venture capitalists have invested considerable funding in the ICT industry, ranging from software to mobility. And, more recently, to the Internet of Things (IoT).
- **Talent development**: since the year 2000, the top 250 ICT companies have employed 4 percent of the entire business sector in the United States. The industry consistently attracts and feeds new talent.

ICT Share of Total Research & Developement Spending, Patent Filings and Venture Capital Funding in 2013.



Data sources: Cisco Corporate Technology Group, BRI, CBInsights, Thomson Innovation

Cisco Technology Radar Envisions The Future of IT

To continue advancing the technological frontier, and encouraging global economic growth, we need a comprehensive vision of where the IT industry is heading.

Cisco Technology Radar meets this need. It is the foundation of Cisco internal and external innovation strategy.

The Corporate Technology Group coordinates the radar for the Cisco Chief Technology and Strategy Office. The program builds on Cisco employees' passion for technology combined with data-driven inputs from the latest trends in academic research, patenting activity, and venture capital funding.

TECHNOLOGY RADAR TRENDS

Securing the Internet of Things

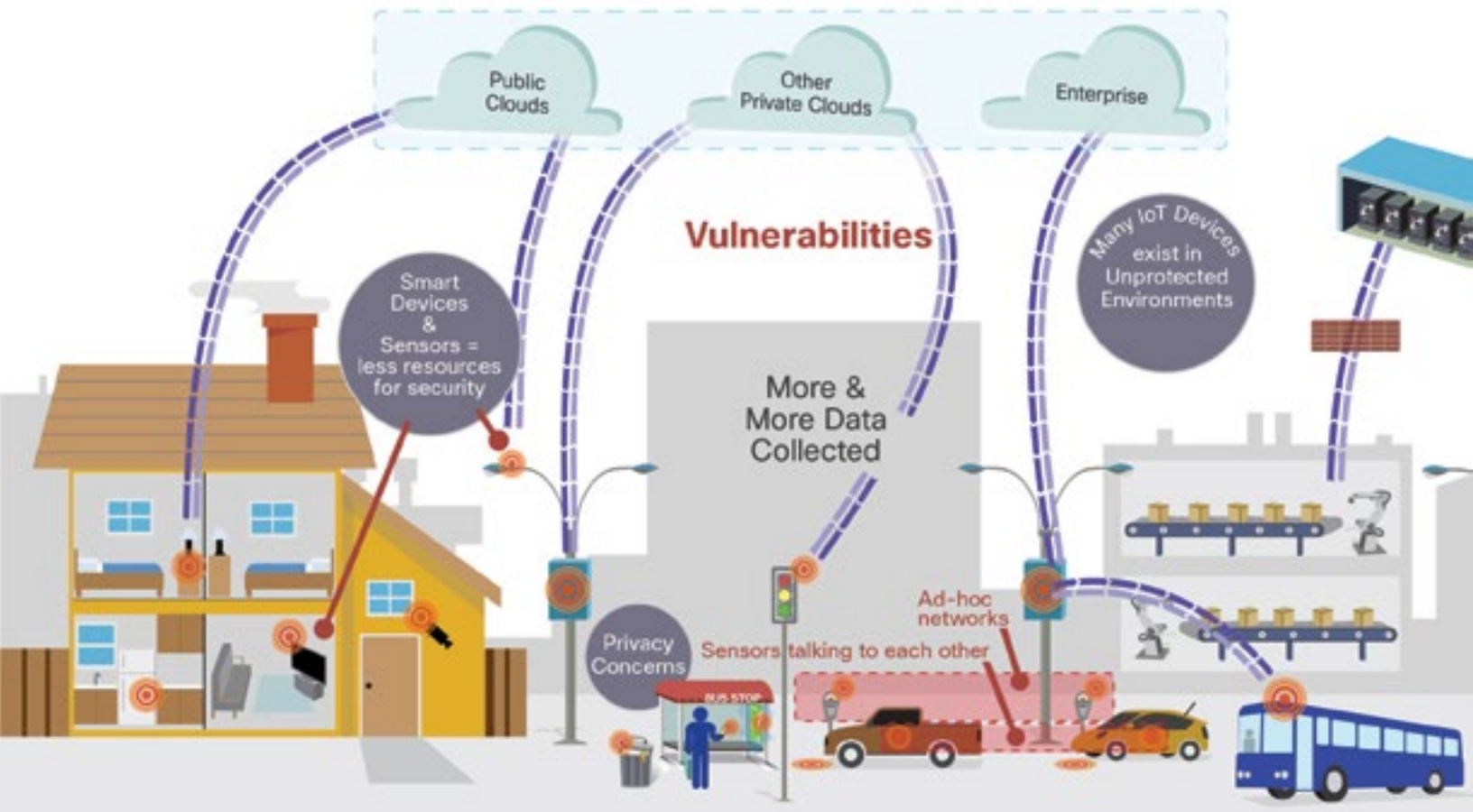
Securely integrating the cyber and physical worlds

More things are being connected to address a growing range of business needs. By 2020, more than 50 billion things will connect to the Internet—seven times our human population. Examples are wearable health and performance monitors, connected vehicles, smart grids, connected oil rigs, and connected manufacturing.

This Internet of Things (IoT) will revolutionize the way we work, live, play, and learn.

Inadequate security will be a critical barrier to large-scale deployment of IoT systems and to broad customer adoption of IoT applications. Simply extending existing IT security architectures to IoT will not be sufficient. The IoT world requires new security approaches, creating fertile ground for innovative and disruptive thinking and solutions.

Many connected things in the future will have highly constrained resources that cannot be easily or cost-effectively upgraded. But they will still need protection over a very long lifespan. This increases the importance of cloud-based security services—with resource-efficient, thing-to-cloud interactions.



The cyber-physical connection

With the growth of IoT, we are shifting toward a cyber-physical paradigm. This model closely integrates computing and communication with the connected things. It includes the ability to control their operations. In such systems, many security vulnerabilities and threats come from the interactions between the domains. An approach to holistically integrate security vulnerability analysis and protection in both domains becomes increasingly necessary.

There is growing demand to secure the rapidly multiplying number of connected, and often mobile, things. In contrast to today's networks, where secure assets are typically inside firewalls and protected with access control devices, many things in the IoT arena will operate in unprotected or highly vulnerable environments. Examples include vehicles, sensors, and medical devices used in homes and embedded on patients.

Protecting such things poses additional challenges beyond enterprise networks

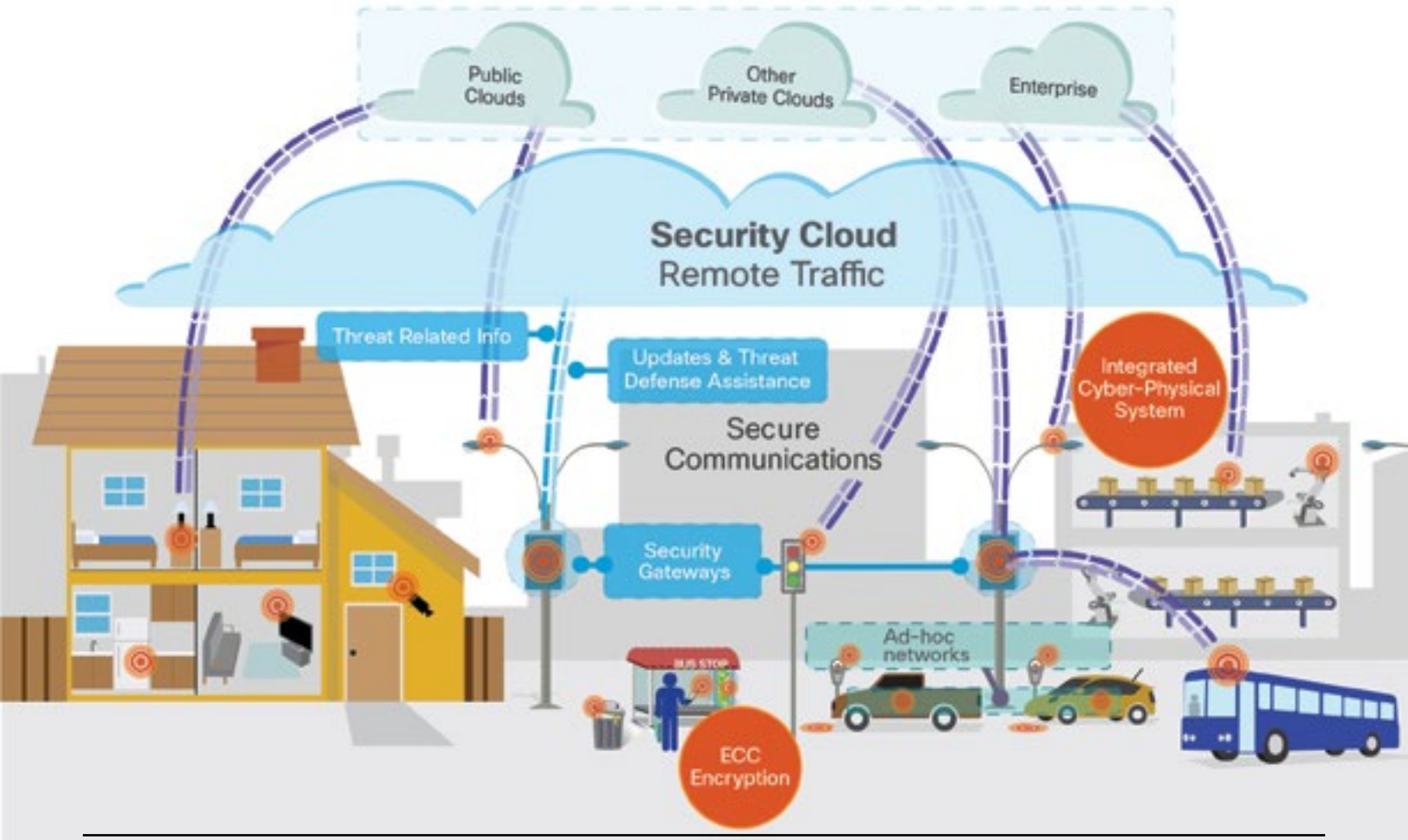
Building a foundation for new possibilities

We expect privacy concerns to continue to rise. As we interconnect more things, governments and enterprises will collect a rapidly growing amount of data about consumers, including their medical records, vehicle driving patterns, and application usage statistics.

Higher scalability will be a critical requirement for IoT security solutions. For example, there are currently more than 250 million registered vehicles in the United States. This requires securing billions of electronic control units.

Building a powerful foundation for a new world of possibilities also requires an ecosystem of partners—all working toward the same goal.

One step toward that goal was the recent Cisco IoT Security Grand Challenge, where we invited startups, entrepreneurs, and universities to submit their best ideas for addressing security challenges.



TREND INSIGHTS

Disruptive security thinking cuts across ecosystem, regions

It is very exciting to see data confirm that the industry is coming together to resolve the security challenges surrounding IoT. This includes a global ecosystem covering key innovative areas to make IoT happen.

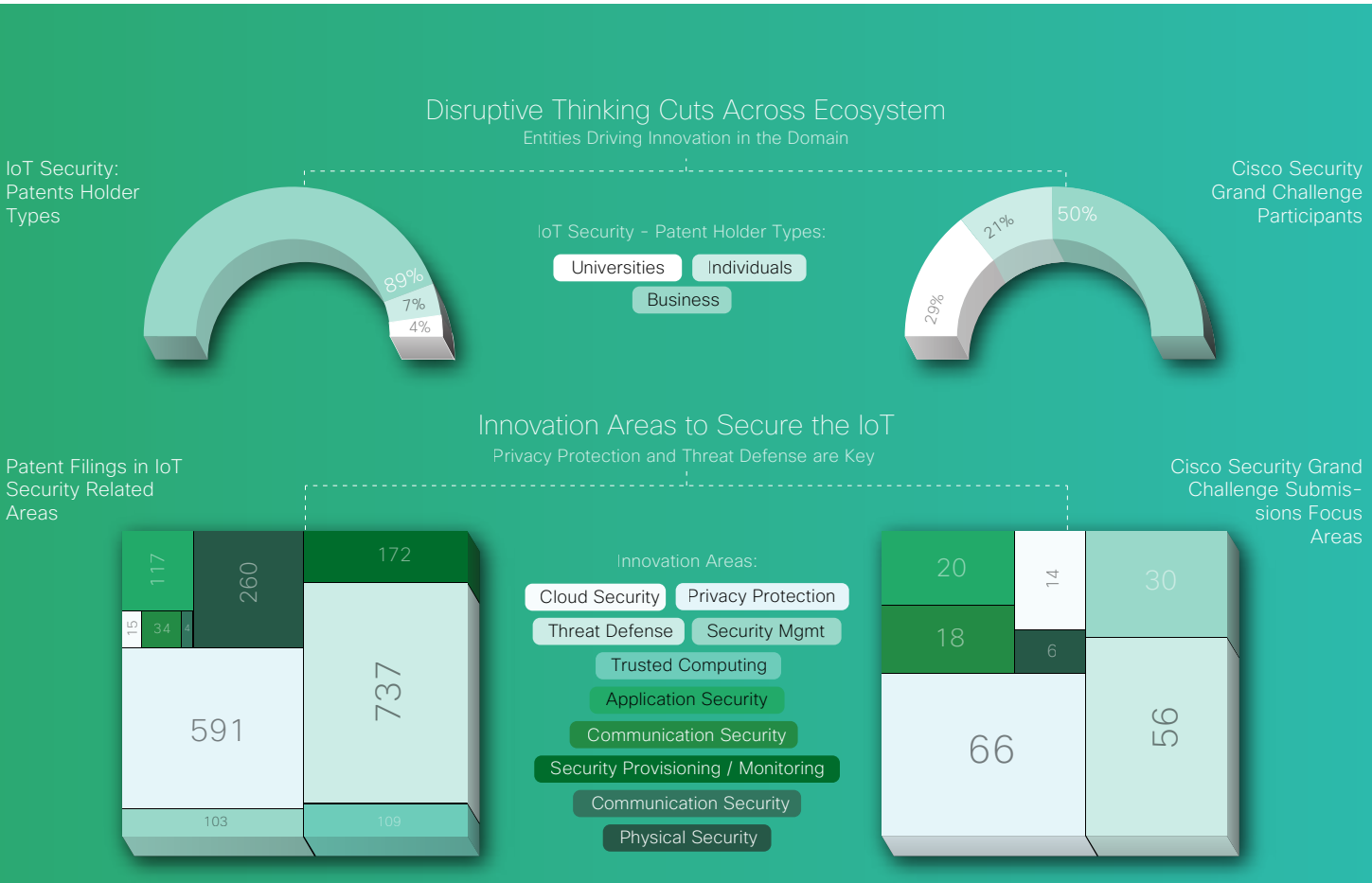
While large companies and startups lead the innovation effort, the world of academia—and even individual inventors — also play an important role. The Cisco IoT Security Grand Challenge highlights this trend:

- **29 percent** of submissions came from universities and public institutions
- **21 percent** came from individuals

Academia and individual inventors currently hold 11 percent of all IoT security-related patents.

Although security remains the bottleneck for IoT, innovation is beginning to occur everywhere. Privacy protection and threat defense are important inventive areas. And patent filings in application, cyber-physical, and cloud security are doubling.

North America and Europe will continue to be the hotspots for innovation. In the areas of cyber-physical security, privacy protection, and application security, however, innovation is occurring on a global scale—from Asia Pacific to Latin America and the Arab States.



Growth of Encrypted Network Traffic

The dash to fill the gaps

What happens after we type an email and press “send?” Many think their computer securely sends the email to the intended recipient. Truth is, for most of us, our email goes over the Internet completely unencrypted.

Even more startling is that while there are close to one billion websites, only about 10 percent of the traffic to and from them is encrypted. This is an important realization—and demonstrates a huge potential for growth in encrypted network traffic.

And the industry is taking notice.

Facebook, Twitter, and Google introduce encryption

In 2011, Facebook announced it would offer many of its services over encrypted web sessions by default. A proof-of-concept hacking tool called Firesheep, which allows users to snoop Facebook traffic and impersonate users on open Wi-Fi networks, prompted the company's decision. Twitter and Google followed Facebook.

Awareness about the value of encryption began to grow in 2013, when the topic of government surveillance really started to hit the headlines. Discussions continue today about the appropriate safeguards and limits needed to serve both national security objectives and the needs of global commerce.

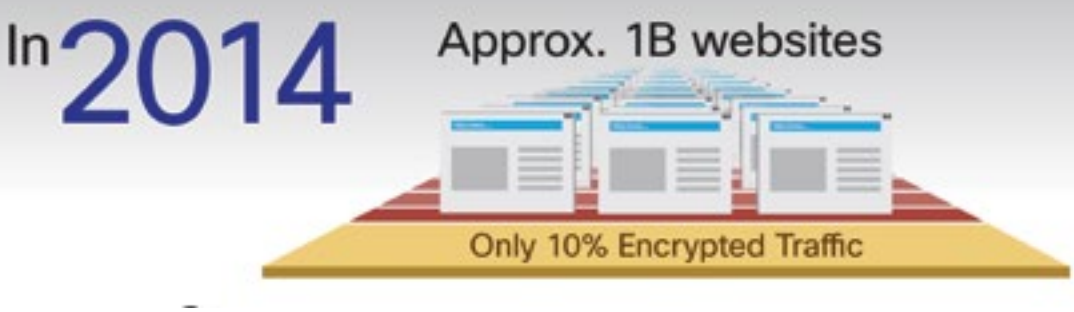
The result? We can expect to see hyper-growth in encrypted network traffic.

New Internet protocols

Standards bodies, including the Internet Engineering Task Force (IETF), are creating new protocols to thwart cyber criminals and the surveillance capabilities of security agencies. The goal is to keep cyberspace open and free.

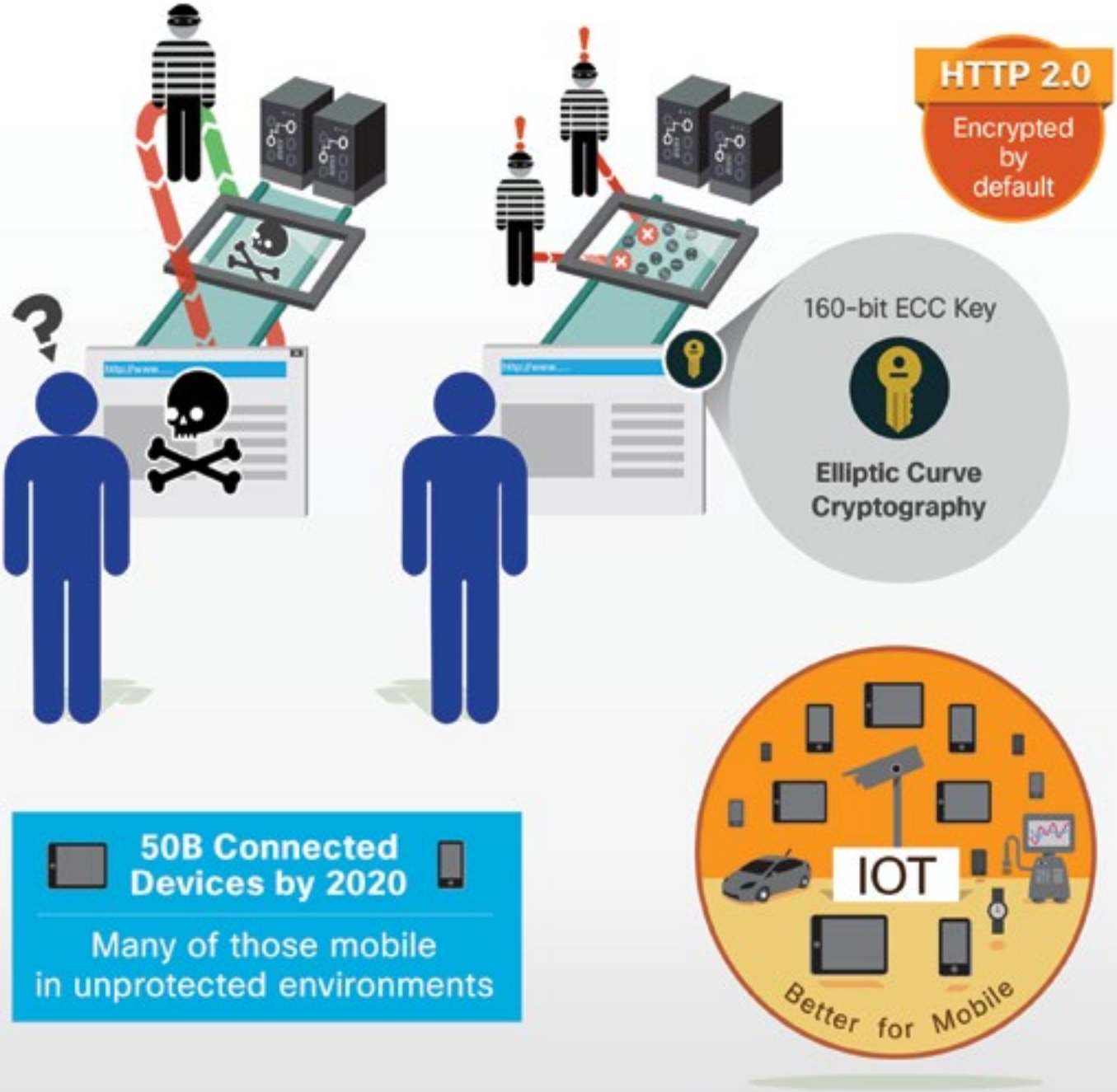
One IETF protocol under way is HTTP 2.0, with encryption capability by default. This will optimize web traffic performance and is an overhaul of HTTP—the foundation of the World Wide Web.

But encryption goes far beyond common email or even websites. With the proliferation of the Internet of Everything (IoE), the attack surface is growing dramatically. Unlike enterprise IT assets, which operate within a secured perimeter, many IoE assets operate in unprotected and highly vulnerable environments. Encryption is critical for protecting these systems’ confidentiality.



Next-generation encryption

In this context, next-generation encryption efforts based on Elliptic Curve Cryptography (ECC) are promising. They provide the same level of encryption strength with shorter keys. The benefit is lower CPU consumption and low memory usage, two essential requirements for mobile devices such as sensors, actuators, controllers, and microcomputers, and the Internet of Things (IoT).



TREND INSIGHTS

Technology advances to secure network traffic – global cybersecurity dialogue needed

What we are seeing confirms that now is the time for the world to come together on cybersecurity.

The technical community is actively creating solutions to secure network traffic. Patent filings show a compound annual growth rate (CAGR) of 12.3 percent from 2009 to 2013. The innovation boost, together with other factors, has led to an upsurge in encrypted network traffic. In the same period, the number of secured servers worldwide grew at a CAGR of 9.2 percent. This is a positive sign of advancement.

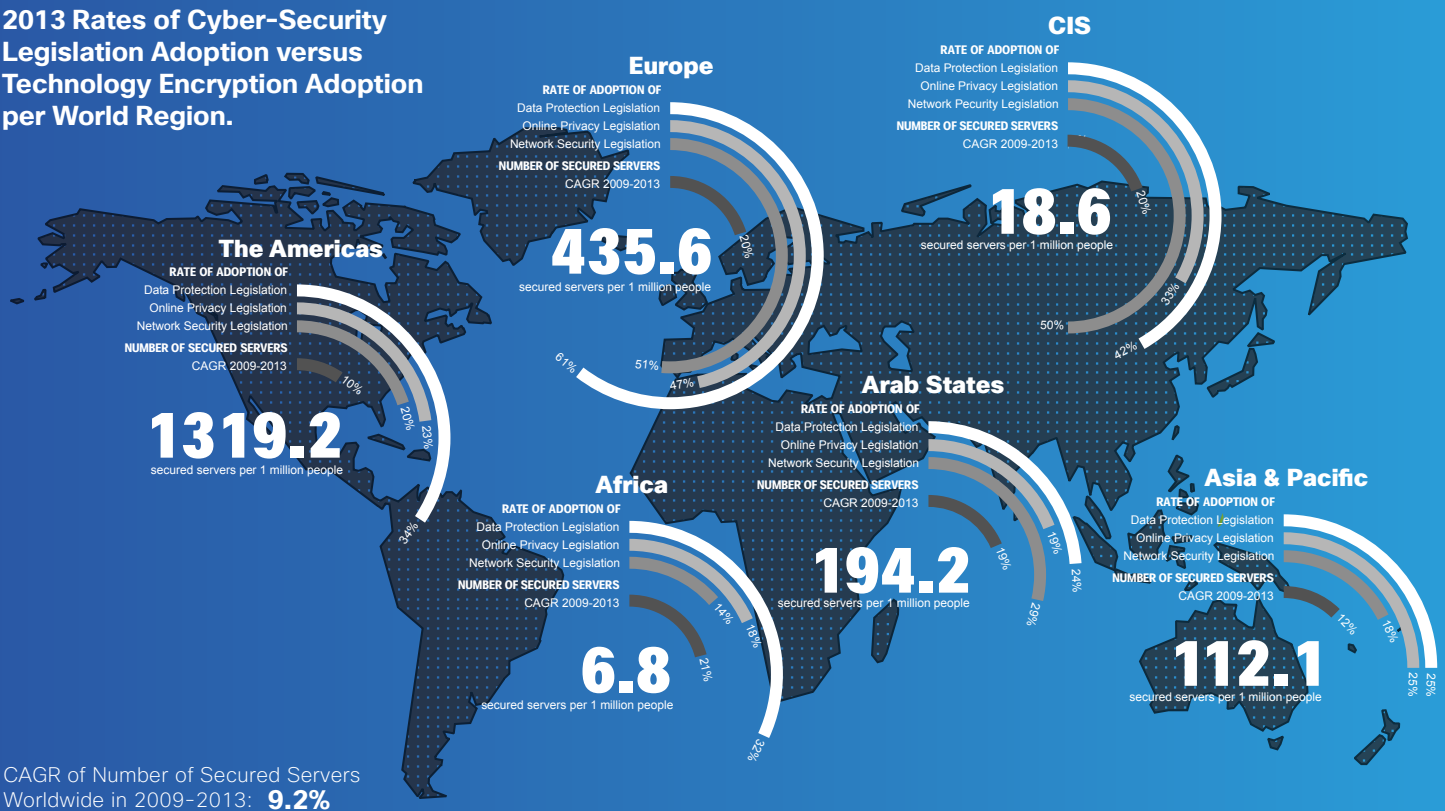
Encryption and information privacy are not converging into common practices, however. People, industries, and regions around the world confront the issue of cybersecurity in different ways.

Ultimately, this varied approach could raise barriers to the free flow of information online. And the economic consequences could be severe: by 2016, the Internet economy in G-20 nations is expected to account for 5.3 percent of Gross Domestic Product.

A global dialogue among all stakeholders, including governments, society, and the private sector, can help create agreement on how to secure the Internet economy. In the meantime, with the progress the IETF and other standards bodies are making, the future looks promising.

Encryption is Growing Across the World Regions at Different Speeds.

2013 Rates of Cyber-Security Legislation Adoption versus Technology Encryption Adoption per World Region.



CAGR of Number of Secured Servers Worldwide in 2009-2013: **9.2%**

Network Simplification

Using an architectural approach to strengthen systems

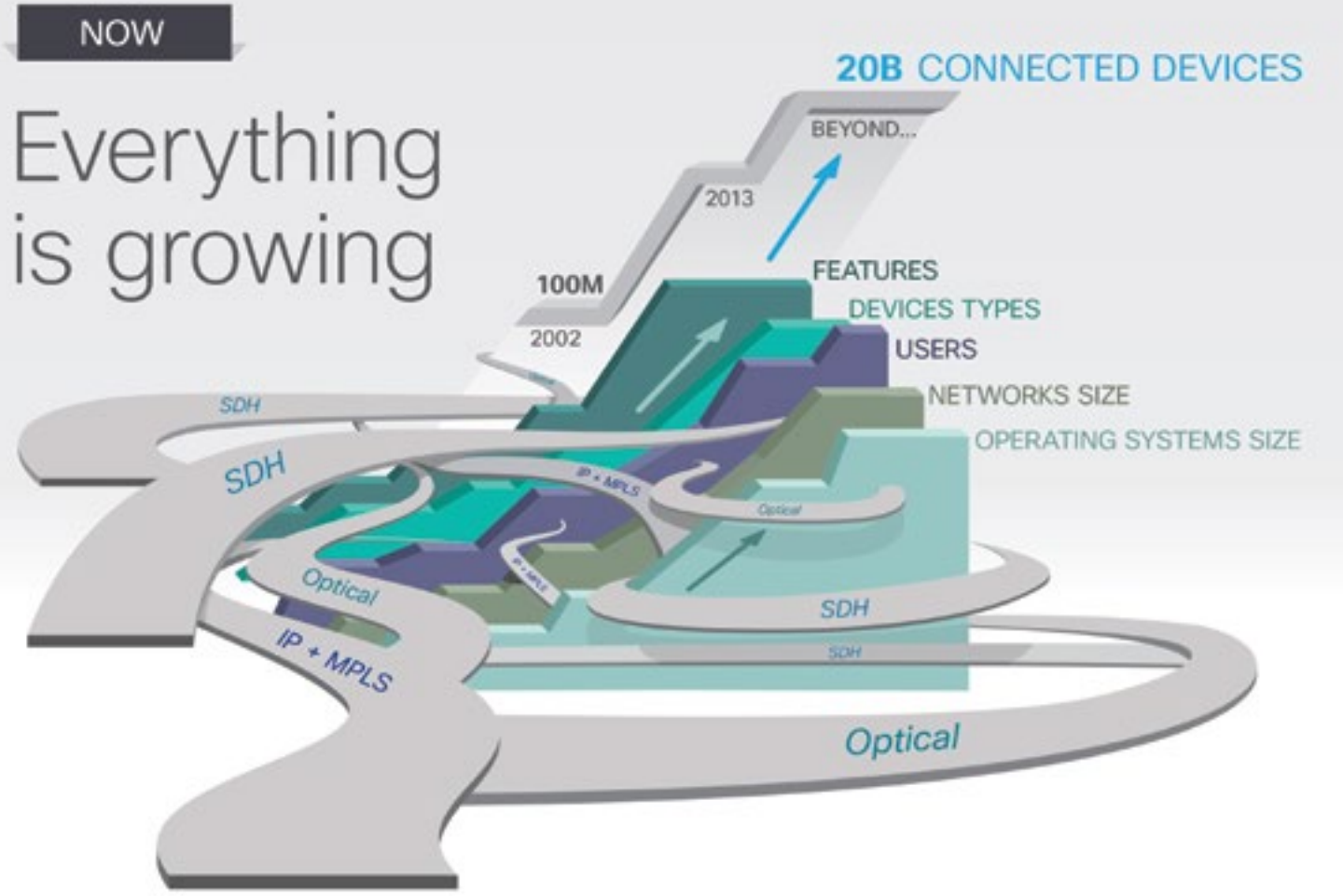
Ever revisit a city after many years only to discover a new maze of freeways? Or, perhaps, a trio of traffic lights in a town that only needed a stop sign before? Changes to transportation routes are common as communities grow and traffic increases. The same is true for the Internet.

We have reached the point where network simplification is critical. And it is not because something is broken. It is a natural evolution of the Internet's success. The Internet of Everything (IoE)—where people, processes, data, and things come online—is advancing this trend.

In fact, network simplification will make the promises of IoE possible. And it will lead to less downtime, better customer care, and the delivery of entirely new services.

Can existing systems meet growing demands?

This trend is set to continue for the immediate future as IoE increases device types (for example, low-powered sensors) and connection models (such as mesh networking).



Without simplification, systems will become fragile and prone to operating errors. Businesses will find it difficult to adopt new services or create new processes. Their revenues could decline.

While a clear definition of network complexity for an overall network architecture does not yet exist, the Network Complexity Research Group is working to provide one.

Regardless of the definition, we do not expect a single technology to bring simplicity and solve productivity problems. Instead, an architectural approach is the answer.

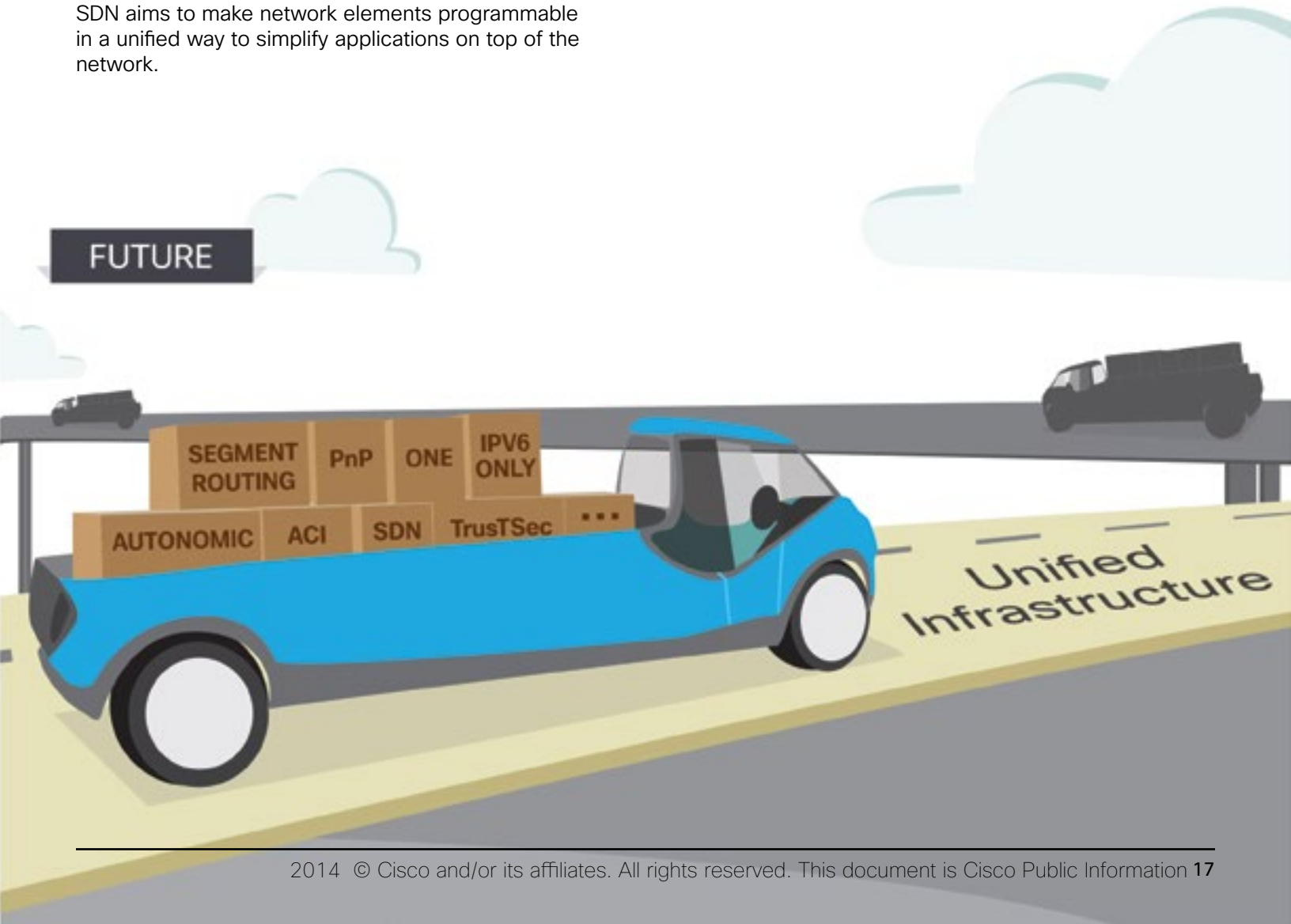
Software-defined and autonomic networking

One of the building blocks for managing network complexity is software-defined networking (SDN). SDN aims to make network elements programmable in a unified way to simplify applications on top of the network.

Another building block is autonomic networking, which reduces complexity by distributing certain functions among network elements. It also removes much of the manual work by allowing network devices to configure, manage, and heal themselves. This creates greater capabilities. One example of this is unmanned vehicles.

Network simplification is a combination of these concepts—and others such as IP and optical, segment routing, and IPv6 deployments—in an architectural approach.

The result will be sustainable network growth to address IoE challenges



TREND INSIGHTS

Network simplification is no easy matter

IoE is bringing everything online. Cisco Visual Networking Index (VNI) predicts 4.5 billion devices will be connected by 2016. Worldwide, machine-to-machine (M2M) traffic will rise six-fold by the same year.

Declining cost of devices and improved infrastructure technologies are two of the reasons for this explosion in devices and traffic. The increasing rate of IPv6 deployment and wireless and wireline networks is also critical for ubiquitous high-speed connectivity. This opens up enormous opportunities for network carriers to create new revenue streams, reusing their existing infrastructure for new industries.

With the exponential growth in connected devices, the network must be simplified. This is especially true for service provider networks, which are becoming more complex to manage.

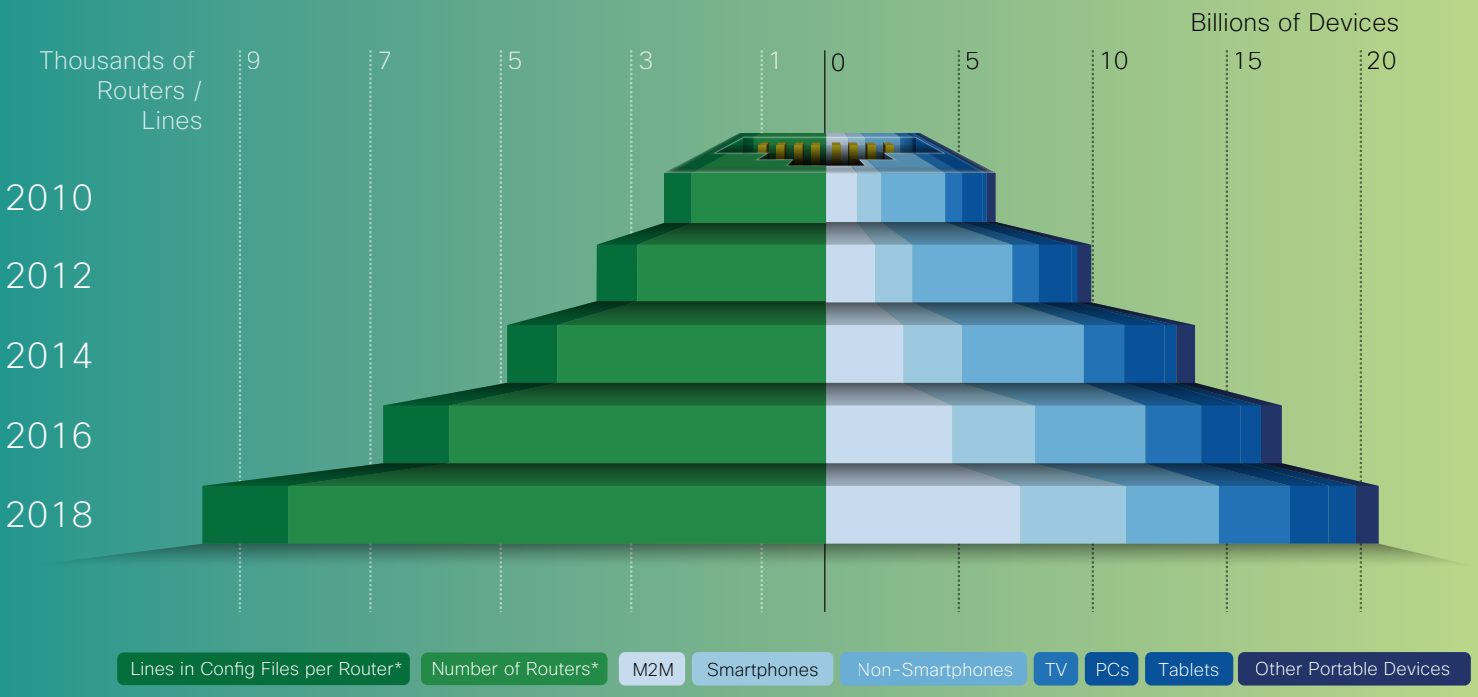
Reducing configuration errors will reduce network outages

To support the varied devices and use cases, we need more sophisticated routers. This is resulting in more complex network configurations, which are responsible for a large fraction of network outages. At the 2010 European IP Networks meeting (RIPE), 97 percent of network operators admitted to having experienced “catastrophic failure.”

We need a new architectural approach that does not damage the network or cause undue hardship on network operators. If done right, we will successfully evolve the Internet, bringing everything online.

Network Simplification is No Easy Matter.

Evolution of the Number of Connected Devices and in the Number of Routers and Lines in their Configuration Files*



* Typical numbers for a tier-2 service provider.

Fog Computing

Collective power enables a new breed of applications and services

It is hard to believe, but the concept of cloud computing dates back to the 1950s, when people used “dumb” terminals to access data housed in enormous mainframe computers.

We have come a long way since then. Connecting through the cloud is now commonplace. And innovators are looking for ways to complement the cloud as the Internet of Everything (IoE) brings everything online over the next few decades.

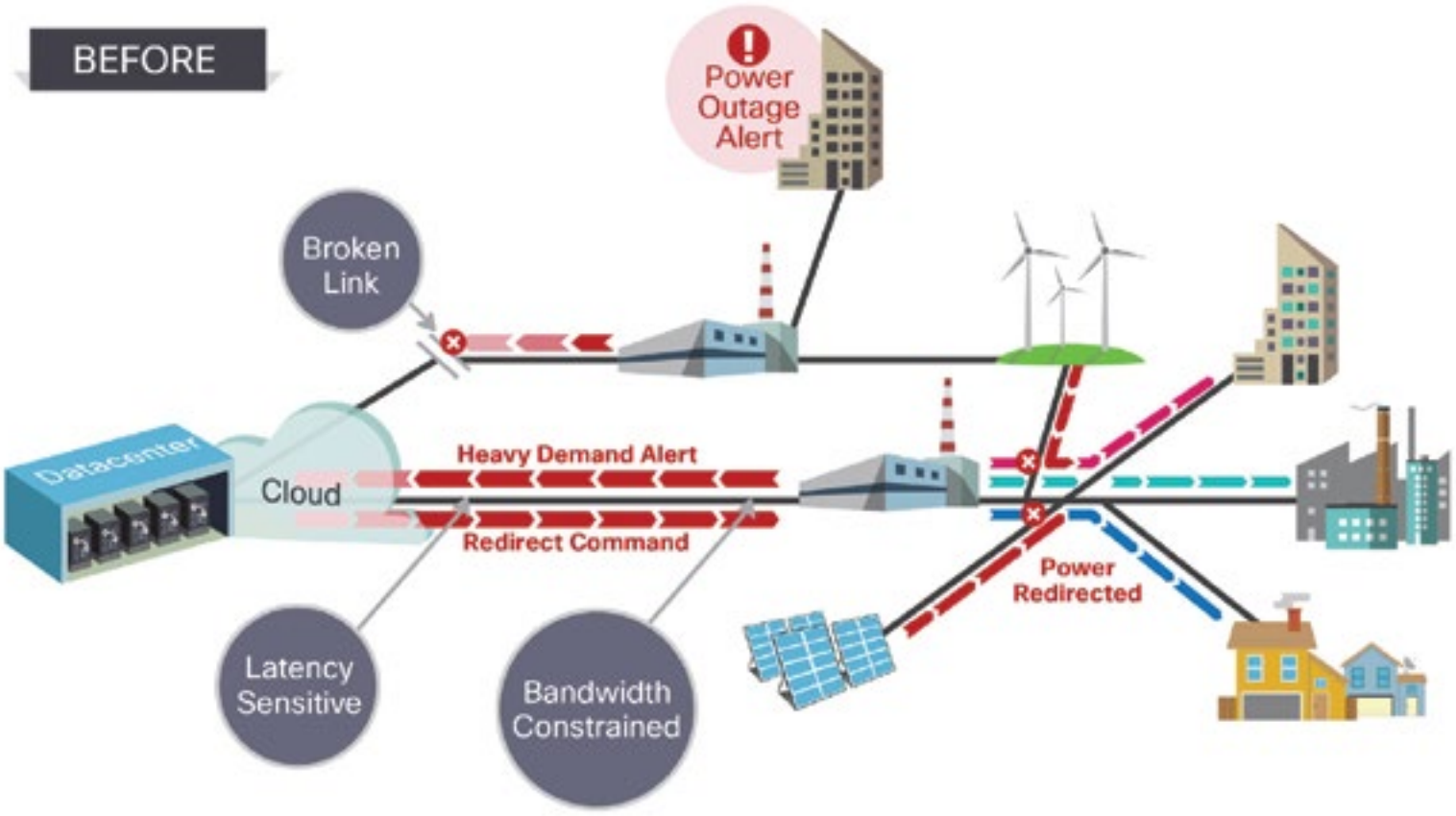
One way to address this is through fog computing, where cloud computing is extended to the edge of the network. This creates a highly virtualized platform that provides compute, storage, and networking services between end devices and traditional cloud computing data centers.

These services are the building blocks of both the cloud and the fog. They are critical for supporting the emerging wave of Internet deployments, which require mobility support and geo-distribution, location awareness, real-time interactions, and low latency. Also important is the ability to support a very large number of nodes in highly heterogeneous environments.

New applications and services

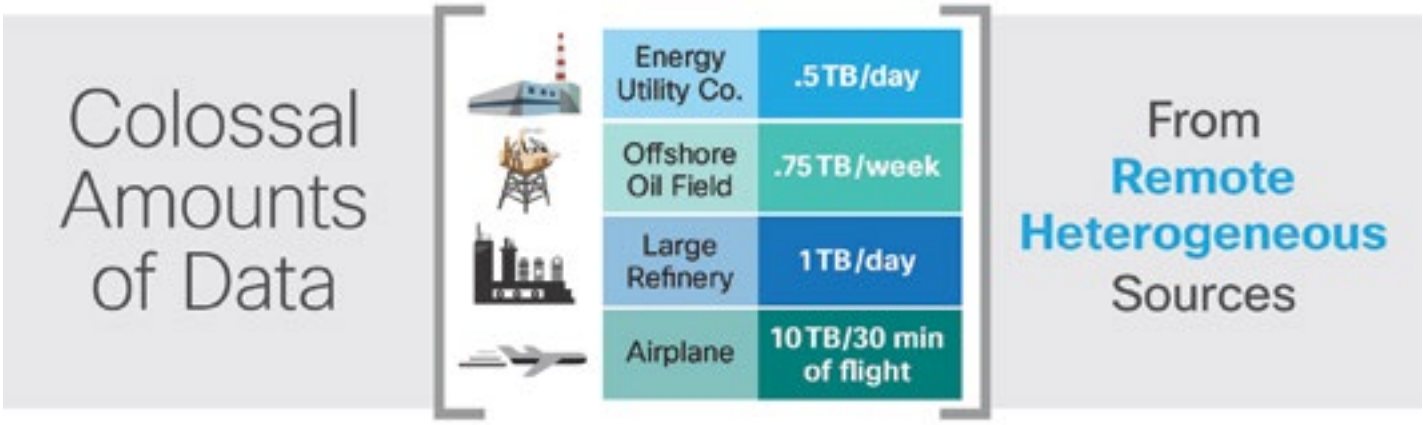
Fog computing can help enable a new breed of aggregated applications and services:

- **Smart energy distribution**: Energy load-balancing applications run on network edge devices that automatically switch to alternative energies, like solar and wind, based on energy demand, availability, and the lowest price.
- **Smart traffic lights**: A video camera senses an ambulance’s flashing lights and automatically controls the traffic signals so the ambulance can pass through.
- **Train maintenance**: Sensors on self-maintaining trains monitor train components. If they detect trouble, they send an automatic alert to the train operator to stop at the next station for emergency maintenance.



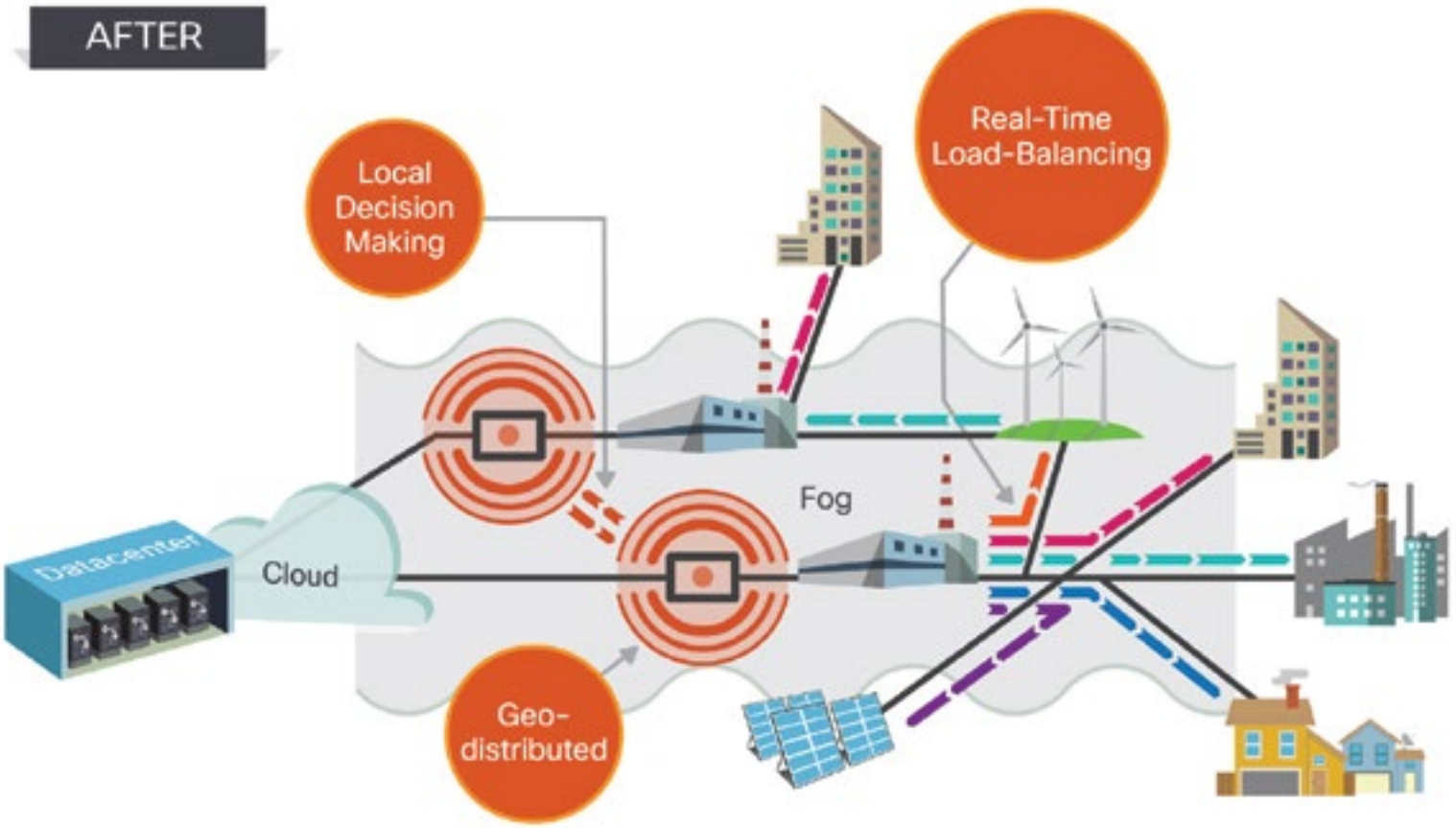
With a fully developed fog computing architecture, customers and solution providers across industries can develop, manage, and run software applications directly on industrial networked devices. This includes hardened routers, switches, and IP video cameras.

never seen before. Possibilities include self-learning, self-organizing, and self-healing applications for massively distributed industrial networks.



This development puts applications closer to where IoE creates actionable data. As a result, it will be much easier to manage the colossal amount of data projected in a hyper-connected world. Adoption of fog computing will also accelerate innovation in ways

Cisco believes that with a collaborative effort across institutions and organizations, we can build tomorrow's networks—and harness the collective power of geographically distributed resources.



TREND INSIGHTS

Fog computing is a large business opportunity

Fog computing is entering an exciting time, where it can positively affect operational costs.

As IoE becomes mainstream, because of the rapid increase of connected devices, two main challenges are emerging.

Reliable communication will not always be possible due to network congestion or simply bad connections. Poor network connections are an issue particularly for short-range wireless devices. It could cost billions to implement geographically distributed wireless networks that allow sensors to send real-time data back to the cloud.

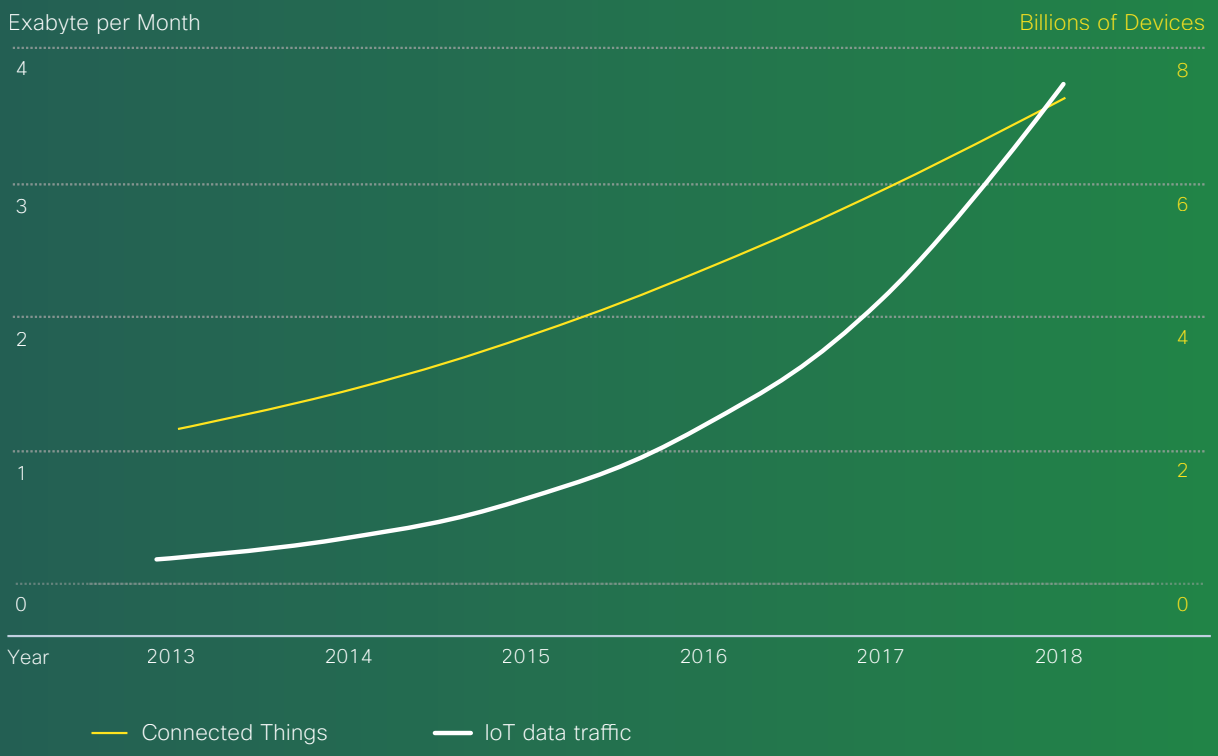
Certain classes of connected devices such as remote health monitoring and emergency services require very low latency. Sending data to the cloud and back to the application can negatively impact the performance of these services.

Fog computing resolves problems related to congestion and latency. It provides compute, storage, and network services at the network edge. It also provides an intelligent platform to manage the distributed and real-time nature of emerging IoE infrastructures.

Developing these services at the edge through fog computing will lead to new business models and opportunities for network operators.

Fog Computing Set to Become Huge Business Opportunity

Number of Connected Devices and Generated IP Traffic



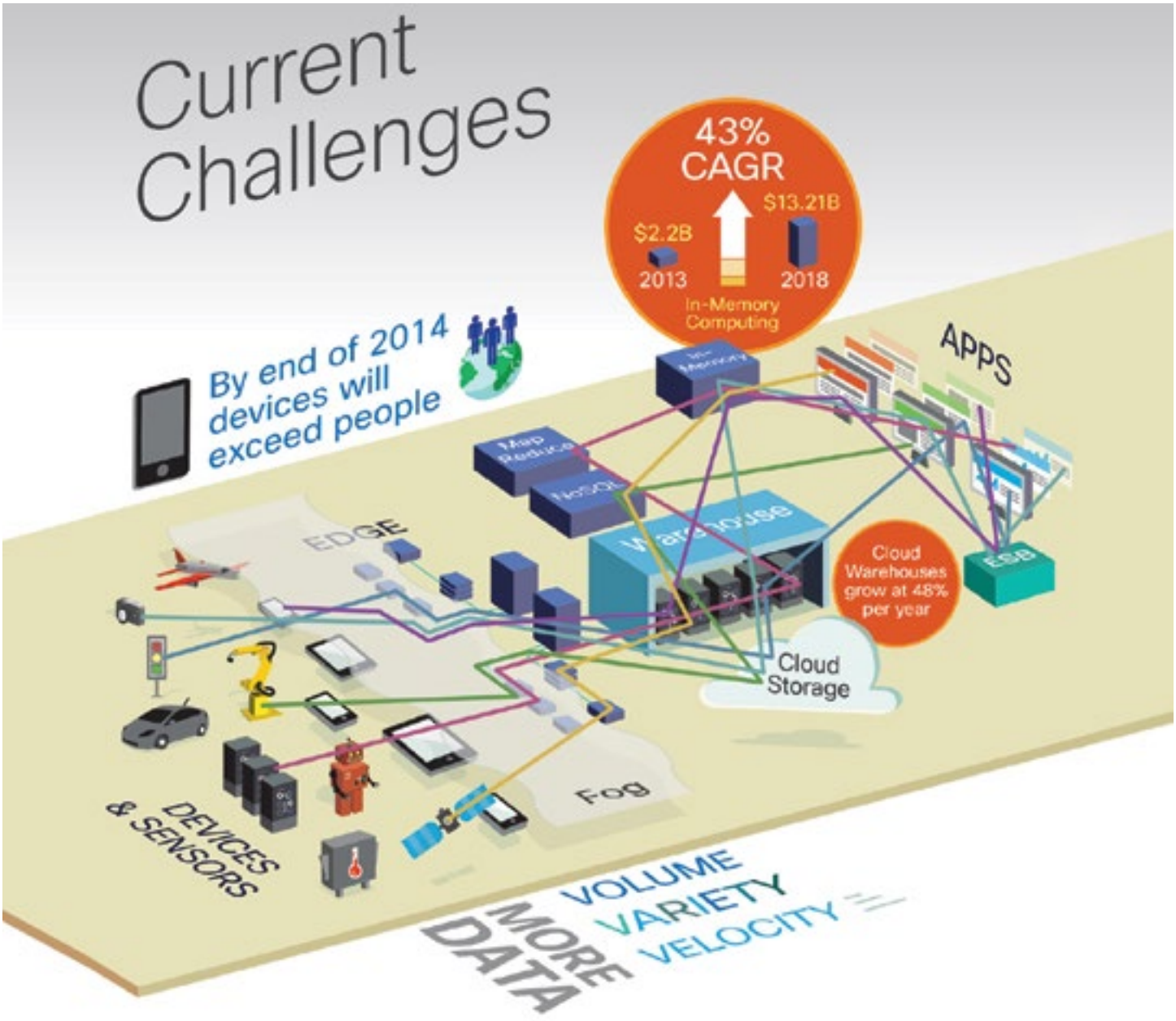
Evolution of Data Management and Data Fabric

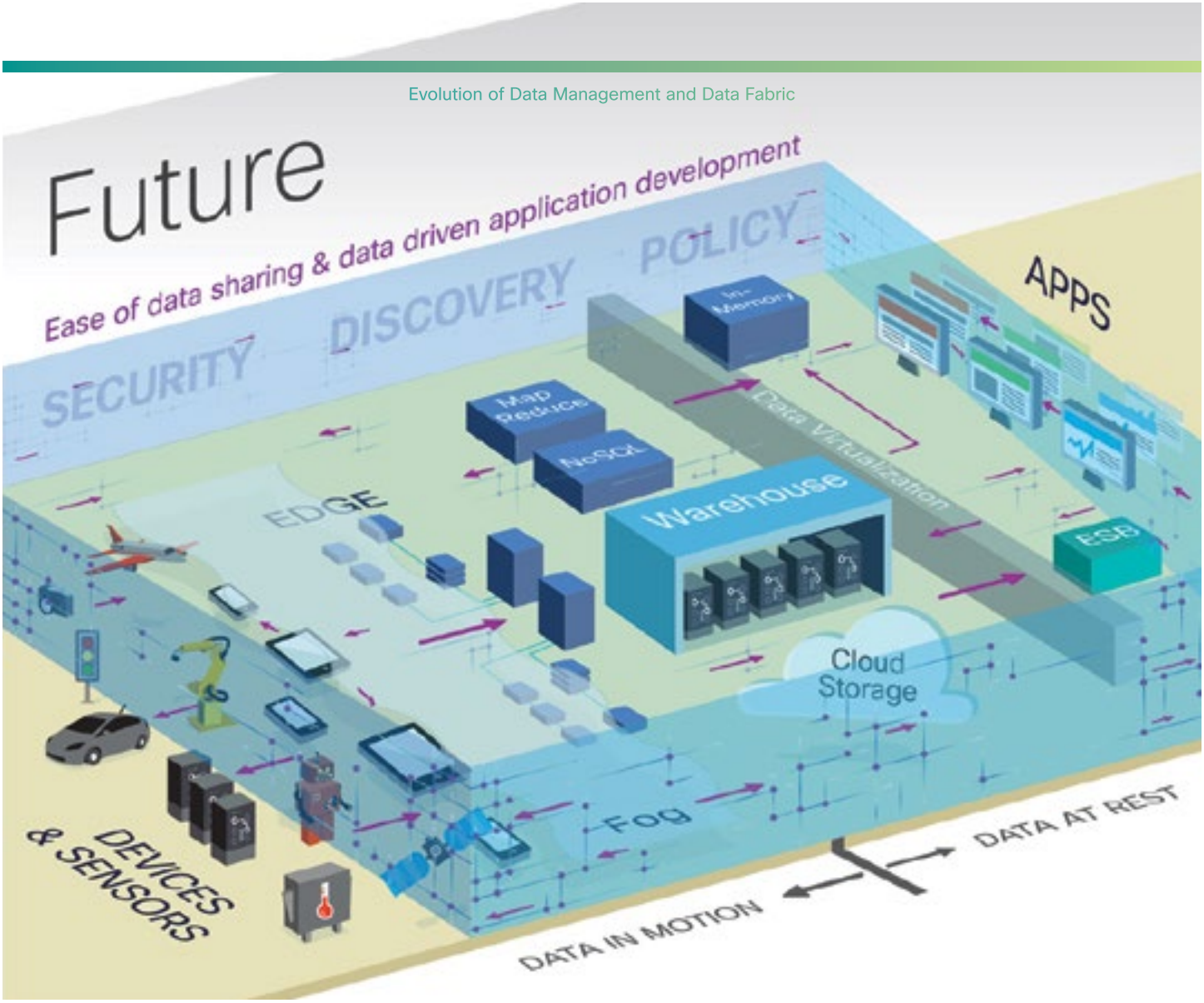
Smart factories are just the beginning

The first three industrial revolutions focused on mechanization, electricity, and IT. The Internet of Things (IoT) in manufacturing environments—where things connect intelligently online—will be the fourth industrial revolution.

Businesses will create global networks to join their resources, including machinery, warehousing systems, and production facilities. And they will dynamically connect their manufacturing capabilities to form smart factories. These factories will provide a global view of the material supply chain, production statistics, maintenance prediction, downtime, safety management, and more.

The benefits of this industrial revolution will be huge. Optimized operations. Removal of inefficiencies. Increased safety. Lower operational costs. More focus on individual customer requirements.





The role of the data fabric

The success of the smart factory will depend on many factors, from analytics and communication protocols to sensors embedded in machines and robots. Most important, however, is a distributed data fabric that provides a platform to share data and dynamically connect data sources, devices, and sensors.

Manufacturing is just one example of how data fabrics will be the next step toward a uniform computing environment. Fabrics will offer a way to simplify data-driven distributed application development across multiple clouds and the network.

This trend will remove established boundaries among the network, cloud, and data centers. The network will become more relevant for the distributed coordination, movement, and storage of data. And we can expect multiple data fabrics managed by several companies and connected through gateways to facilitate data sharing on an even larger scale.

Data management is critical for real-time data streams. Data virtualization, providing a semantic overlay, is an important enabler of the data fabric.

By simplifying data sharing, developers will increase their productivity and focus more of their attention on the core aspects of application and process integration. This includes analytics, mobility, and control—all enablers of IoT.

TREND INSIGHTS

Data fabric is the core of big data

Two technologies dominate the data-fabric-startup landscape: NoSQL database technologies and enterprise big data framework built on Apache Hadoop.

Investments in big data support either these technologies (for example, in-grid memory database systems) or the startups using them (for example, business intelligence, mining analytical, and data visualization software).

The market for Hadoop technology is rapidly consolidating. Three companies have attracted most of the venture capital (VC) funding, including late-stage investments. Major IT players such as Google, Hewlett-Packard, Intel, and Qualcomm have placed their bets on these companies.

No newcomers are expected to enter the segment soon, given the intense competition and the increasing maturity of the technology.

The market for NoSQL databases is still fragmented. Despite the presence of a few major startups receiving a large amount of VC funding, there is still room for new ventures and newcomers. The technology has a wide spectrum of applications and many possibilities for innovative solutions.

At the Core of Big Data, the Data Fabric Startup Landscape is Split Across Two Technology Areas.

Data Farbic Startup Competition Landscape

Startups Mainly Active* in:

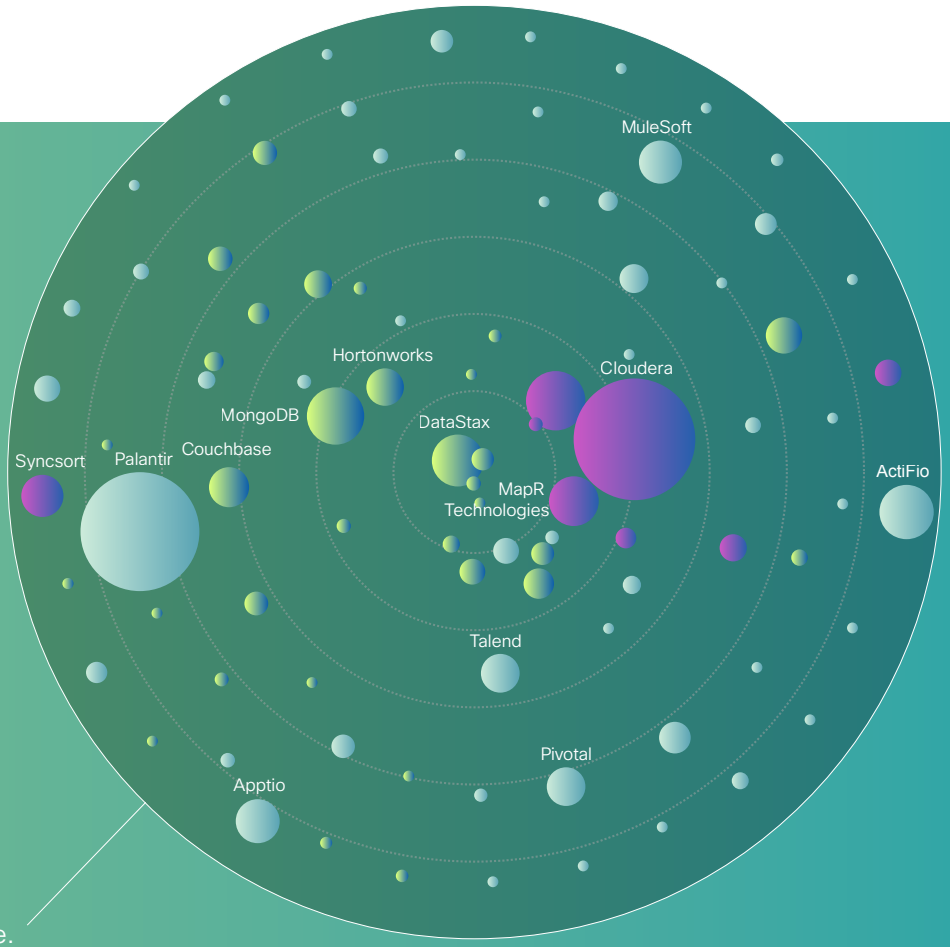
- Hadoop frameworks
- NoSQL databases
- Other big data technologies

* Category based on startup's main business

Total VC Funding Raised:

$200M $100M $20M

Competition Intensity is Lowering toward the Edge of the Landscape.



Real-Time Analytics

Opening the door to new possibilities

We are living in a world of information overload. This data deluge makes it difficult for businesses to get the right information at the right time to make better business decisions.

In fact, traditional data management technologies are not keeping up with today's large volumes of data in motion, which is flowing at an unprecedented speed.

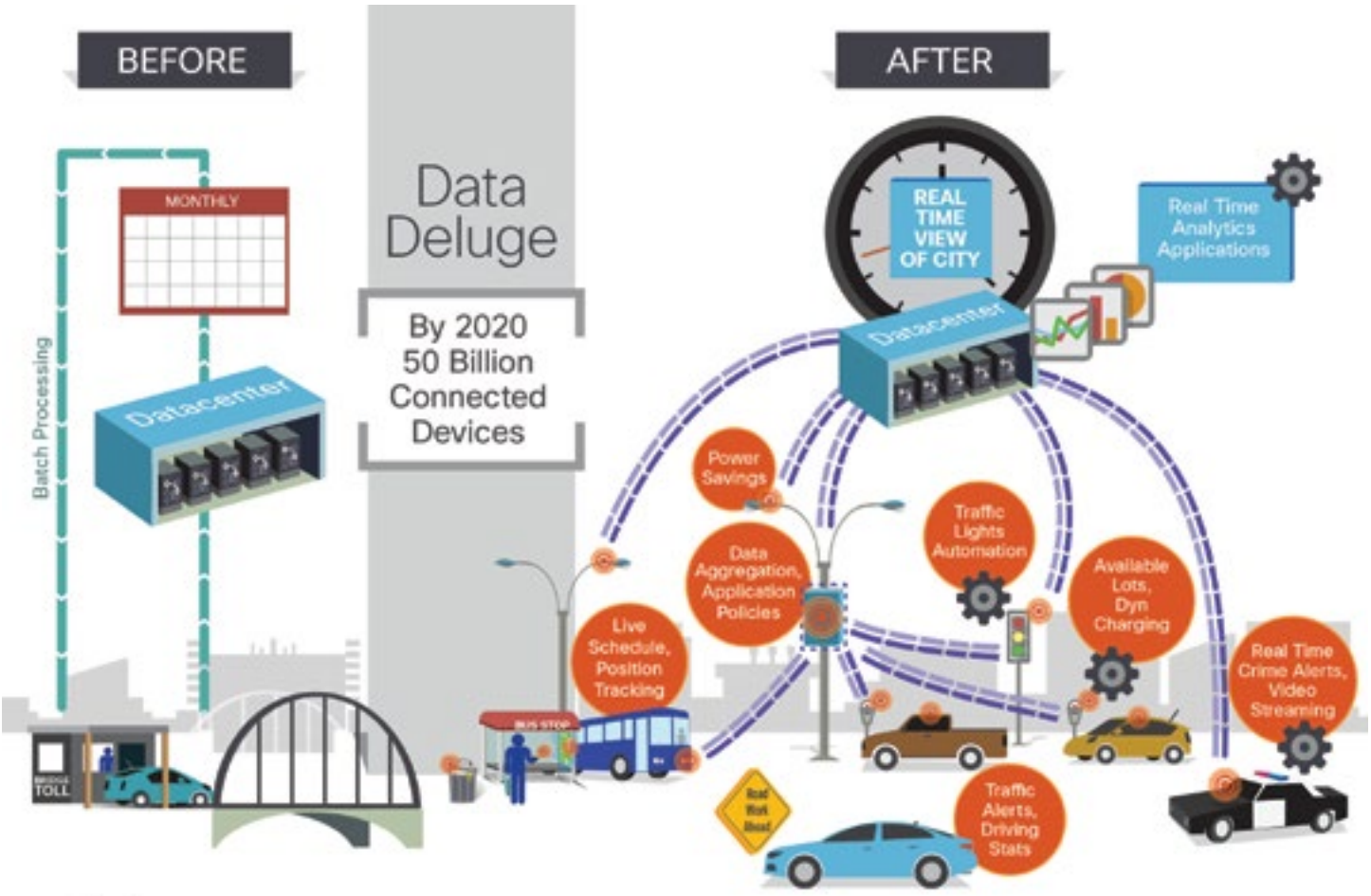
The answer is real-time analytics. This set of technologies processes data or resources within seconds or minutes for analysis, reporting, automation, or business intelligence purposes.

Real-time analytics is a pivotal capability for next-generation networks. Analytics applications can be embedded in networking gear to capture events, monitor performance, detect anomalies, or optimize configurations in real time.

Technologies that provide real-time insight into network traffic will improve operating efficiency and root-cause analysis and fault prediction. They will also support streaming query processing. The result will be continuous monitoring of live data, instantaneous query processing, real-time analysis and action, and efficient use of compute resources.

A multibillion dollar market

The opportunity is huge. In 2012, business intelligence, corporate performance management, and analytics applications and performance management software was worth US$13.1 billion worldwide.



Leading companies (for example, SAP, IBM, Oracle, Cisco, SAS, and Microsoft) believe that real-time capabilities are critical for future analytics, and they are increasingly integrating them into their product portfolios.

As the cost of device memory decreases, in-memory analytics and distributed cache technologies are becoming more and more popular. Typical use cases include financial trade analysis; individual risk-based pricing for insurance; smart transportation; targeted advertising; video surveillance; and fault or anomaly detection in electric grids, telecommunication networks, and production lines.

The possibilities for real-time analytics are vast, in areas such as machine-to-machine technology, smart grids, connected vehicles, and enterprise collaboration.

The real-time analytics umbrella covers a broad range of technologies. Examples include complex event processing engines, streaming databases, massive parallel processing algorithms, in-memory compute grids, high-performance computing hardware, and graphical processing units.

TREND INSIGHTS

Real-time analytics innovation creating fertile ground for new ventures

Since 2004, innovations in the domain of real-time analytics have multiplied. The proof is more than 7000 patented inventions filed so far worldwide—with much of the focus on the development of business intelligence and mining analytical tools.

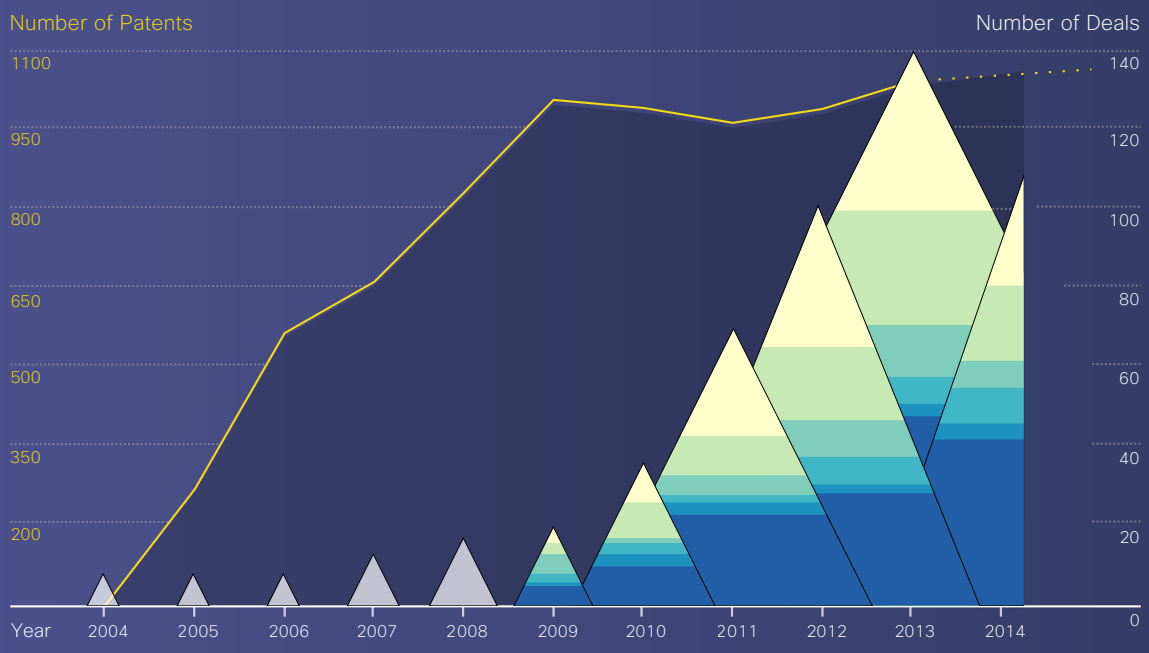
Large companies do not dominate this advance. The majority of total patented inventions originates from small startups.

Clearly, there is considerable excitement and energy in this field.

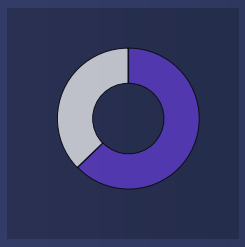
And the market is listening. Venture capital funding is on the rise, with early stage investments driving the wave and running the gamut from game applications to cybersecurity and oil field real-time analytics.

Looking forward, real-time analytics are set to be a game changer for business productivity across industries.

Real-Time Analytics Innovations Paved the Way for New Venture Creations.



Inventive Activity Repartition:



Small Patent Portfolios

Large Patent Portfolios

Number of Investments

Predictive Context

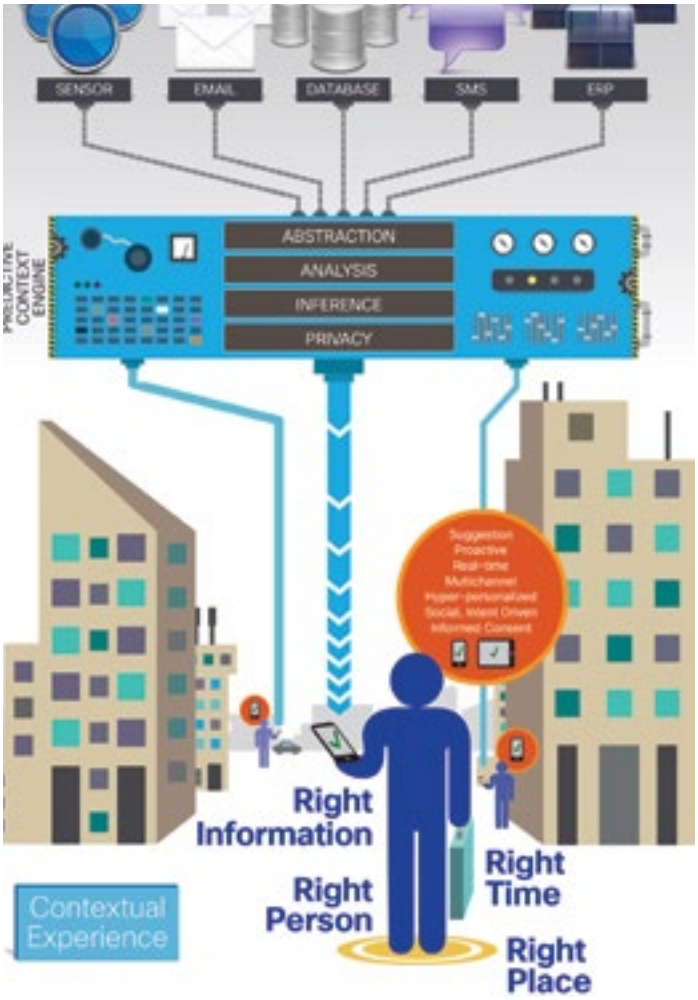
At your service: the right data at the right time

Imagine your next visit to the hardware store. The moment you walk in the door and the store's network identifies your smartphone, it knows you were looking up tile repair earlier in the day.

As you walk the aisles, a video remote assistant pops up on your smartphone offering to help you find the tools you need and walk you through the repair process. The network is so smart it also knows about your previous purchases, and helps you with another project on your to-do list. Finally, it gives you a coupon on the spot to close the deal.

Addressing data overload

Today, we can access data anywhere, at any time, from any device. But the amount of data available is so huge that it has become overwhelming—and not always particularly useful. Predictive context-aware computing, illustrated in our example, addresses this problem. It is also the next evolution of the Internet—the Internet of Everything (IoE).



Predictive context goes beyond anytime, anywhere data. Networks can anticipate what you need and then provide it. This completely transforms the user experience. In this new world, users receive the right data, at the right place, at the right time, and on the right device. Automatically.

The opportunities are almost endless

In the consumer world, we already find instances where information—a nearby restaurant or a product suggestion—is "pushed" to a user.

In the business world, our imagination is the only limit. Increased productivity. More loyal customers. And the financial opportunity is huge. In fact, US$140 billion in new value creation.

From a technology perspective, we need four building blocks to build a predictive context platform on top of a network:

- **The abstraction layer**: Aggregates sources of context
- **Near real-time data analysis**: Detects relevant information
- **The inference engine**: Determines the appropriate action
- **The privacy layer**: Retains user control of the information they choose to share

Location is a key factor in predictive context-aware computing. Businesses can monitor Wi-Fi connected devices and analyze location information in real time. Like our hardware store, they can then offer additional value to their customers.

Predictive context-aware computing can just as easily apply to airline services, connecting ground handlers, real-time flight data, and weather information, to redirect airplanes. Airlines could save billions in fuel costs and flight delays.

The sky is the limit.

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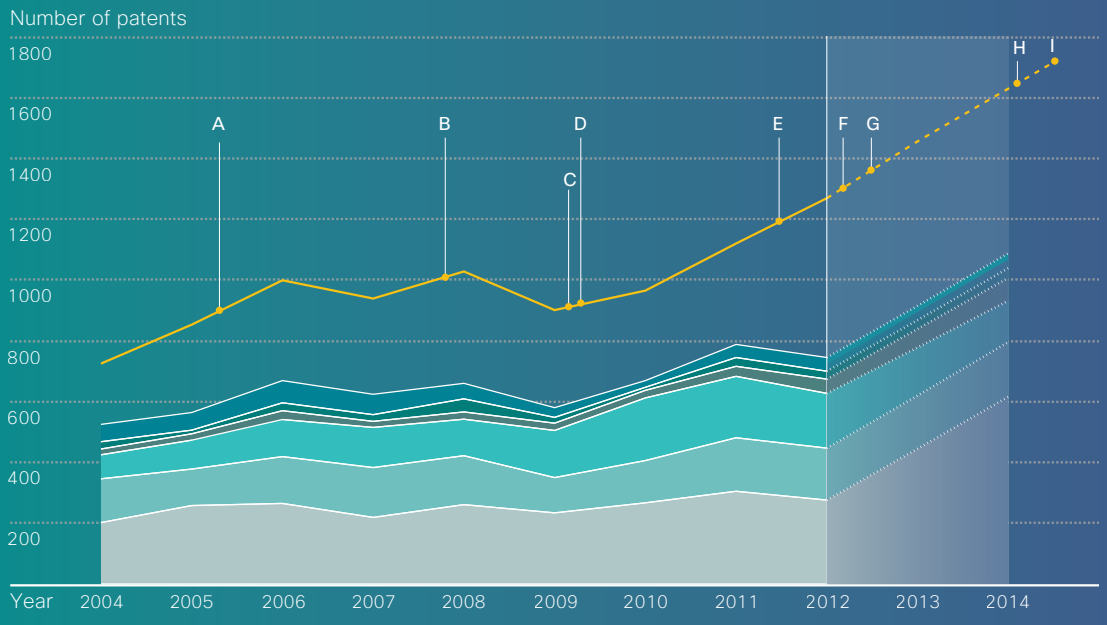
Location and activities analytics fuel predictive context-aware services

Predictive context-aware services are still in the early stages of development, but are gathering momentum very quickly. Real-time analytics innovations, a key technical building block, are fueling these services. Location analytics are a particularly critical component. And we are seeing more focused research on location awareness and activity recognition.

User activity and location are the main sources for context. So it makes sense that most innovations today target transportation and consumer goods, including retail. Energy and utility companies are also prime candidates for predictive context-aware computing. By relying on environmental sensor data, for example, energy utilities can better predict peak demand and organize their supply accordingly. This could help lower energy utility rates. One invention in this area is the smart thermostat.

In the future, we can expect to see context-aware services available across a wide range of industries.

Transportation, Consumer Goods and Retail and Energy are Fueling Innovation.



Events

- **A.** 1st International Workshop on Location and Context-Awareness. (LoCA 2005)
- **B.** Google Maps added "my location" location service that uses nearby WiFi hotspots.
- **C.** Launch of Google Latitude.
- **D.** Nokia testing Indoor Positioning at Kamppi Shopping Center in Helsinki.
- **E.** Apple launched Siri.
- **F.** Samsung launched S Voice, based on Nuance technologies.
- **G.** Launch of Google Now.
- **H.** Microsoft launched Cortana on Windows Phone
- **I.** IBM launched Watson Analytics in Beta

Browser-Based Video and Collaboration

WebRTC to stir development frenzy

Remember 20 years ago, when getting on the web was considered remarkable? Today, we do not even think about it because of the constant flood of innovations. One of the next web advances, Web Real-Time Communication (WebRTC), is just around the corner.

HTML, used for structuring and presenting content on the web, is now in its fifth revision. When HTML5 was introduced in 2004, it spurred a new wave of innovations. WebRTC is the latest evolution of that wave. WebRTC will invite even greater improvements on the web—and have a huge impact on the online communications world.

What is WebRTC?

WebRTC is an open API drafted by the World Wide Web Consortium (W3C) and the Internet Engineering Task Force (IETF). It enables browser-to-browser applications, without plugins, for voice calling, video chat, and peer-to-peer (P2P) communication.

It provides a powerful alternative to other web and mobile development environments such as Adobe Flash and Microsoft Silverlight, as well as other proprietary plugins. And while HTML5 has brought many new capabilities to the web, it is WebRTC that is poised to be the pivotal technology.

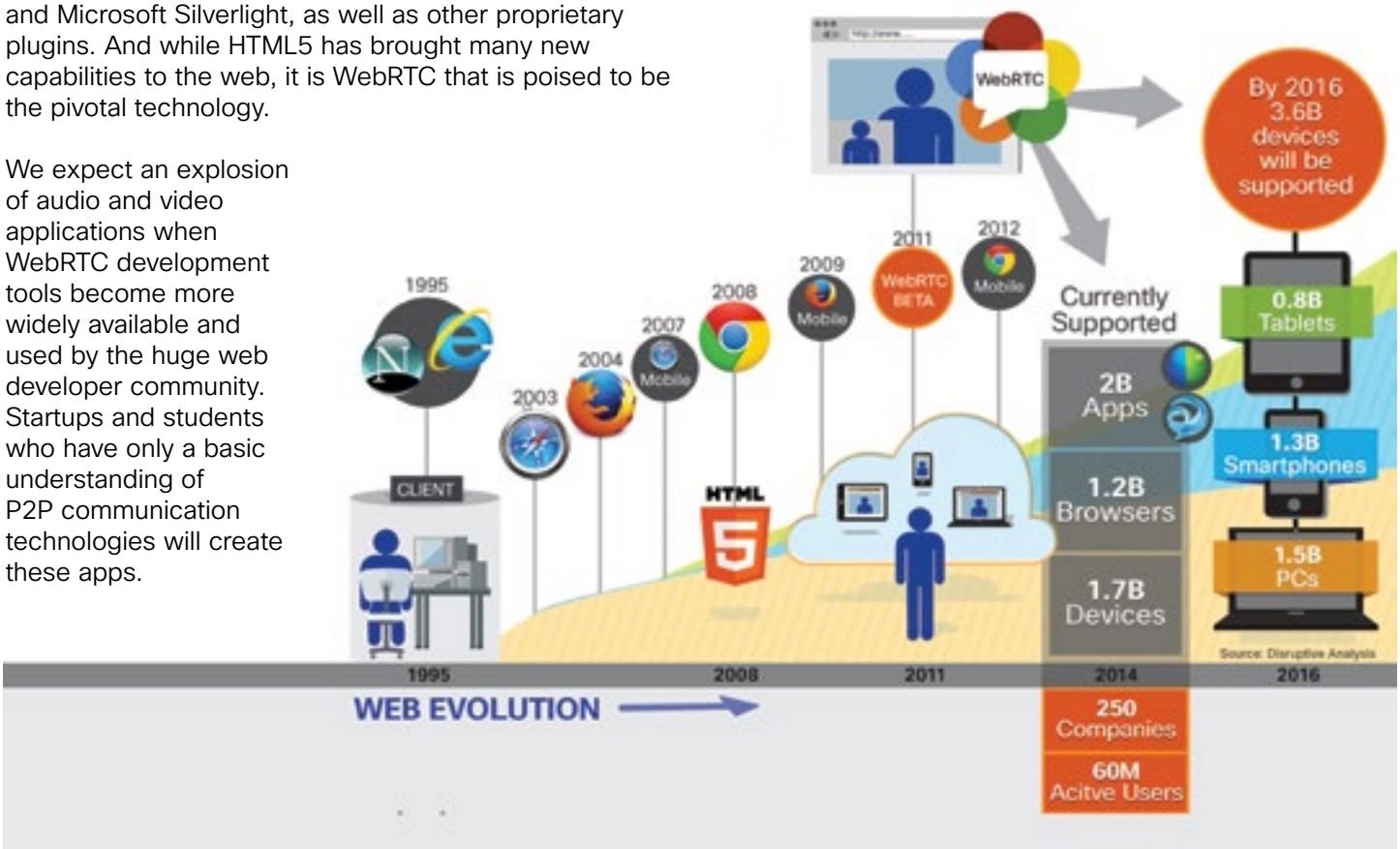
We expect an explosion of audio and video applications when WebRTC development tools become more widely available and used by the huge web developer community. Startups and students who have only a basic understanding of P2P communication technologies will create these apps.

No special software necessary

By integrating real-time communications directly into web browsers, WebRTC opens up a world of possibilities. For example, we will see rich image and video apps directly within our mobile or tablet browsers. We will also be able to share files directly without a software client. And any user will be able to broadcast and share live audio, video, and data – and it will be as simple as opening a web page.

As with previous disruptions, WebRTC will completely change the way we live. Imagine citizen journalists streaming breaking news directly from their phones to news websites. Or colleagues sharing their screens in real time by clicking a button.

It will be interesting to watch as WebRTC propels a major disruption in the multibillion dollar markets of video conferencing, Internet telephony, and live video streaming.



Cisco is actively contributing to the development of the WebRTC standard and browser code implementation as part of a consortium that includes Mozilla, Google, Opera, Microsoft, Apple Ericsson, and a number of small real-time communications companies.
Already, most major collaboration platforms are using WebRTC to support interactive, instant business-to-consumer communication with voice, high-definition video, and data sharing from public websites and mobile applications.

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Industry is ready to build a WebRTC ecosystem

The WebRTC market has started to consolidate through a growing number of acquisitions. In the past 12 months alone, big mobile operators and enterprise collaboration providers have acquired 14 companies. Most of those deliver development platforms and enterprise collaboration applications.

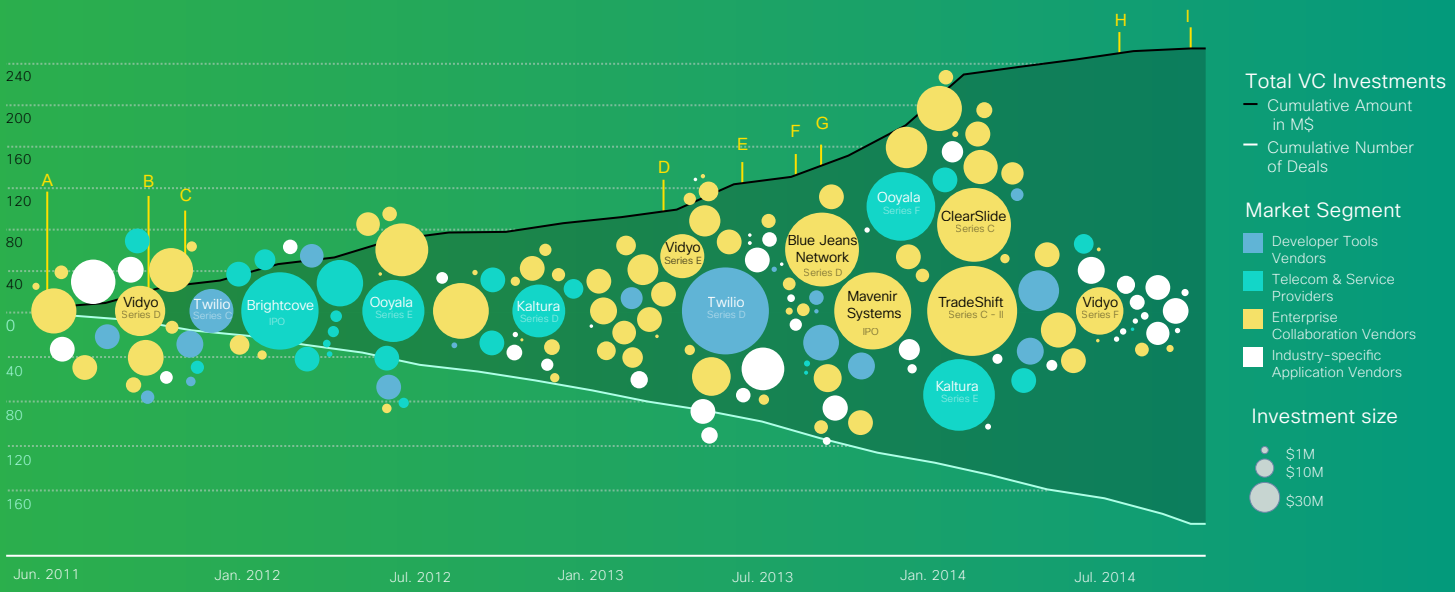
The market is also emerging through early-stage investments in startups developing "voice and video call" services. Most of the investments, however, are less than US$5 million.

We are seeing an interesting shift in terms of market segment from telecom and service providers to enterprise collaboration vendors. This could simply reflect the current trend to make IT more consumer-focused, a shift which is particularly strong in the enterprise collaboration market.

And WebRTC is rapidly expanding beyond simple voice and video calls to more industry-specific applications and services.

All of this movement is occurring at a time when the standard has yet to be finalized. This shows great promise – and strong business opportunities for WebRTC.

VC Investments are Shifting from Telecom & Service Providers to Entreprise Collaboration and Emerging Industry-Specific Application Vendors.



Key milestones about WebRTC standard:

- A. Google open-sources WebRTC framework
- B. W3C releases first Public Working Draft
- C. Chrome 23 adds WebRTC support
- D. Interoperability between Chrome & Firefox
- E. Firefox 22 adds video calls and data channel
- F. Chrome 29 and Firefox 24 supports WebRTC on Android
- G. First W3C Working Draft of WebRTC
- H. First Object RTC - WebRTC 1.1 Public Draft
- I. Firefox Hello free WebRTC service

Dynamic Spectrum Access

Ensuring "radio space" is available into the future

Imagine a highway with one lane—reserved for trucks—that is virtually deserted and another lane clogged with cars that cannot use the open lane. Something similar could happen in the wireless world as global mobile data usage continues to skyrocket.

Fortunately, dynamic spectrum access (DSA) technologies and evolving spectrum regulations are underway. The goal is to open up underused spectrum, exclusively licensed for a single purpose, for shared use with other purposes—in this case, wireless access.

Creating shared spectrum

TV white spaces (TVWS) are spectrum allocated to TV broadcasts that are not in use in a given geographic location. TVWS radios can use white space spectrum for unlicensed wireless access.

Authorized Shared Access (ASA) or Licensed Shared Access (LSA) allow a secondary licensee to use the "shared" spectrum when the primary licensee is not using it.

The U.S. Federal Communications Commission (FCC) has proposed a 3-tier model for shared access in the 3.5-GHz band:

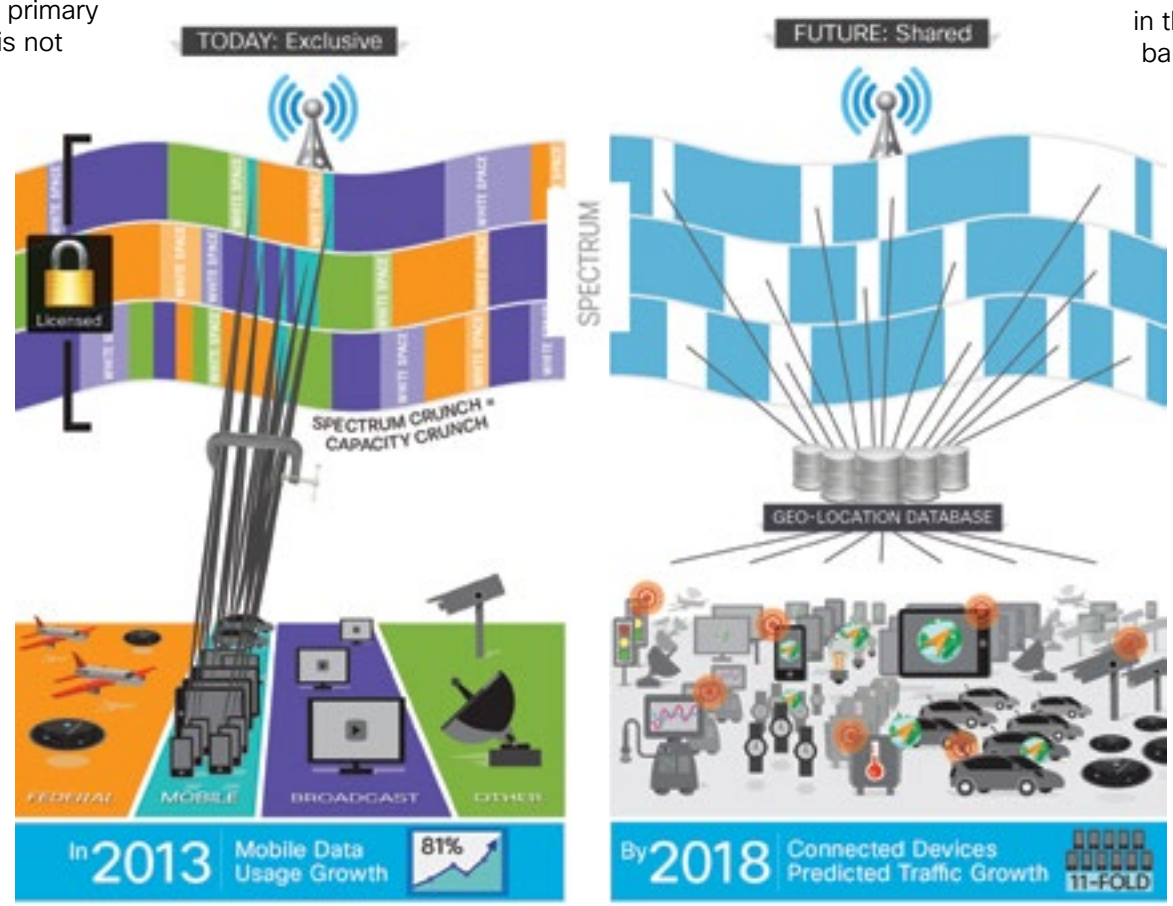
- **Tier 1** for incumbent federal agencies, including military radar users
- **Tier 2** for authorized prioritized access, similar to ASA and LSA
- **Tier 3** for generalized authorized access, similar to unlicensed access

A number of DSA technologies already exist. Others are under exploration.

How spectrum sharing works

Devices that want to use shared spectrum must geo-locate themselves and consult a database to determine what spectrum is available.

The geo-location database manages the spectrum resource allocation based on predefined policies and availability to help ensure there is no impact on the primary licensee. An enhanced version of the geo-location database system – called a Spectrum Access System (SAS)—is the basis for the FCC spectrum-sharing proposal in the 3.5-GHz band.



A second technology is cognitive radio, which senses and monitors the radio environment. This includes knowing the location and policies for self-regulation. Dynamic frequency selection (DFS) and transmit power control (TPC) are cognitive radio techniques that allow co-existence with radar and satellite systems.

Another technology is software-defined radio (SDR), which allows devices to adapt to local radio conditions and use the appropriate radio frequencies.

There is a great need to expand DSA techniques for unlicensed use in the 5-GHz, TVWS, and 3.65-GHz bands. This includes enterprise-class Wi-Fi radios with state-of-the-art intelligence for co-existence and interference mitigation. Standards bodies and regulators are actively working to advance DSA technology and increase shared access.

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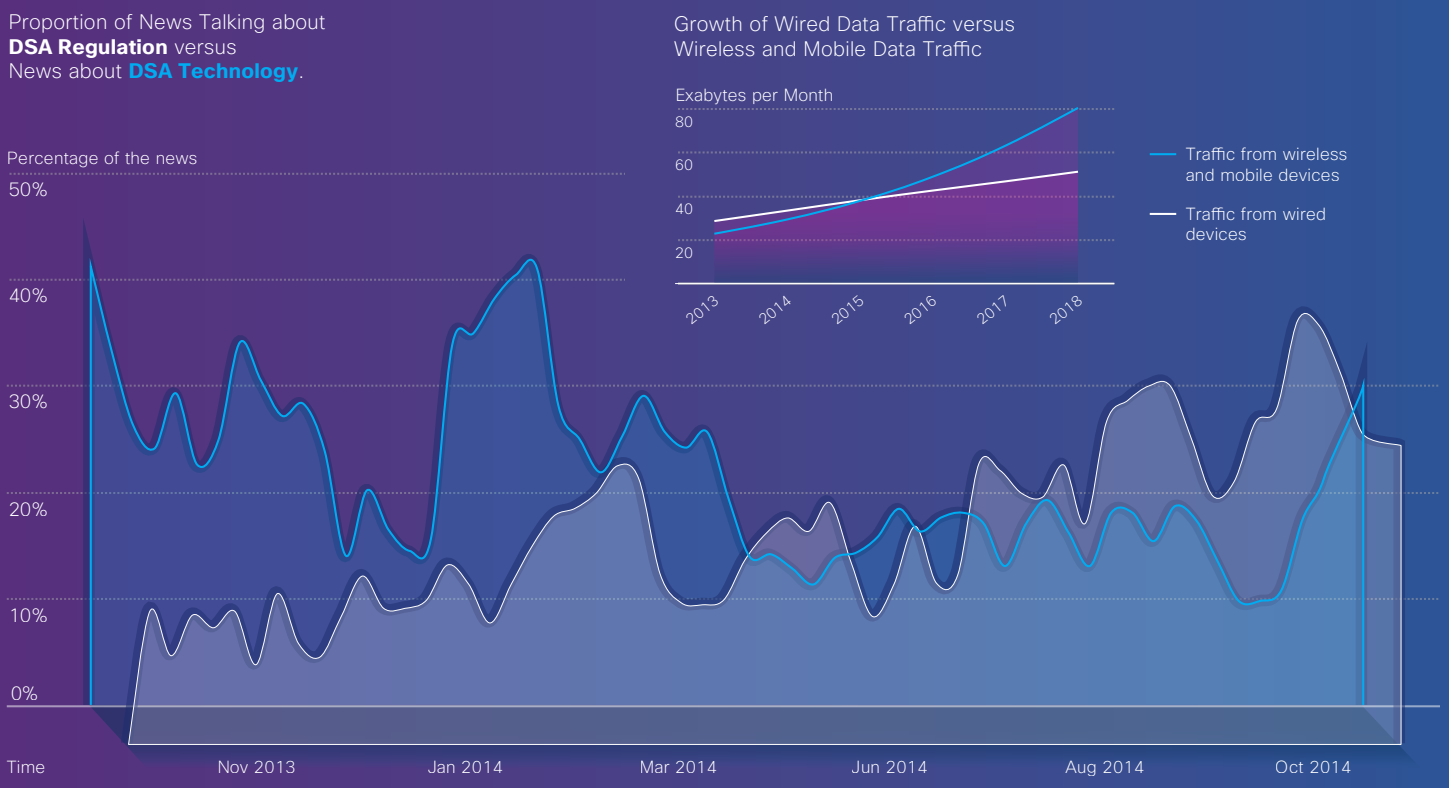
Heated discussion over underused spectrum for new wireless services

DSA is gaining attention. A growing number of academic researchers recognize the importance of sharing underused spectrum licensed for a single purpose. This is widely believed to be the solution to preventing mobile data from colliding and slowing down access.

Since 2008, academia has significantly stepped up its game. Today, four times the number of researchers are looking at the topic of DSA, including how to ensure future radio space availability.

Recent spectrum usage measurements show that available spectrum opportunities are vastly underused. This artificial access limitation occurs while governments work to keep up with mobile technology growth.

DSA is a critical pathway to a shared wireless world and there is growing agreement that this must be corrected. The news media is focusing particular attention on this topic, and has published a growing number of stories about the need for forward-thinking regulations. This, in part, has led the U.S. National Telecommunications and Information Administration (NTIA) to explore new options for the federal government and industry to share spectrum.



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