

# Analytics, Cloud Still Dominant, but More Looms on IT Horizon

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In partnership with  
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## IBM survey identifies latest trends

A new survey of thousands of IBM experts puts analytics, cloud, and mobile at the top of the IT trend list worldwide, reinforcing the company's leadership and investment in these critical areas.

Analytics remains atop of the ranking for the fourth straight year, as companies continue to seek more and better insight from their data. Cloud and mobile, too, remain firmly near the top, reflecting both continued demand for cost-saving hosted infrastructures and a growing reliance on devices that help users conduct business while on the move.

But lists of trends are interesting for more than just what sits at the top. What emerging topics have the IT experts excited?

Last year, the IBM survey team elevated digital transformation, intelligent automation, and wearable computing to the list. Now, for 2015, they have added cognitive business, new software models, and the IT infrastructure of tomorrow.

The annual IBM Academy of Technology survey represents the collective opinion of thousands of IBM experts around the world, from executives to developers to field engineers, each informed by their own networks of social, customer, and industry contacts. In addition to assessing today's IT landscape, the survey also seeks to identify the societal and business factors that will drive the new technology of tomorrow.

IBM uses the survey to help guide its intellectual investments and solution designs. But results provide a timely snapshot for anyone interested in where most IT spending and new business opportunity are likely to occur in the next 12 - 24 months.

### Highlights

- ▶ The IBM Academy of Technology has released the results of its latest internal survey of top IT trends or themes.
- ▶ The list confirms the industry's ongoing focus on analytics, cloud, and mobile, but points to some new, emerging trends that are worth watching, too.
- ▶ Among the IT themes on the horizon, per the survey, are wearable computing, digital transformation, tomorrow's IT infrastructures, and cognitive business.
- ▶ Survey respondents also stated which societal factors they think will influence future IT trends, listing privacy, security, and terrorism, sustainability, and more.
- ▶ The survey helps guide IBM in adopting new solution designs and gives others a broad-based view of anticipated IT focus areas in 2015 and beyond.

### The survey says...

Here are today's top technology trends, or themes, from the most recent Academy of Technology surveys.

1. Analytics
2. Cloud computing
3. Mobile computing
4. Security and privacy
5. User experience
6. Information management and storage
7. Systems of engagement

#### Emerging:

- ▶ Intelligent automation
- ▶ Digital transformation
- ▶ Wearable computing
- ▶ Cognitive business
- ▶ New software models
- ▶ IT infrastructures of tomorrow

Looking at today's list tells only half the story, however, When discussing trends, just as important is watching how a list changes, or does not change, over time.

The top of each year's Academy of Technology list represents an absolute ranking of IT trends in terms of industry focus, IT spending, and other factors. So the highest-scoring trends are hard to overtake, as shown in Figure 1, which indicates that the first four themes (analytics, cloud computing, mobile computing, and security and privacy) have landed at the top of the list consistently since the survey began.

In addition, each annual ranking concludes with three themes that the survey team considers to be the trends of tomorrow. They might not finish 8th, 9th, and 10th in IT spending, but each of these emerging trends is already shaping the industry. In fact, some of them have evolved to gain regular spots on the list (such as digital transformation) or have been merged into larger trends (see Figure 1). For example, the Internet of Things appeared on the first list in 2012, but now it is considered part of intelligent automation. Information management, too, is as important as ever, but it is now grouped into the larger trend of analytics.

## Top technology themes

So which technologies and trends have the industry talking, according to the survey? Here's the list, from "A" to "Z" (or in this case, "W").

## Analytics

Analytics is not a new trend. But the perception of data as a kind of untapped *natural resource* that can be monetized, like gold or petroleum, is new. And there are no current signs that this trend will abate. It is said that by 2020, there will be up to four times more bits of digital data than all the grains of sand on Earth.

Analytics plays an increasingly critical role in transforming raw data into usable information. When done well, it delivers actionable insights and uncovers previously unseen opportunities for value creation by optimizing current processes or adapting new ones. And when done pervasively, analytics promotes the emergence of enterprise-wide *systems of insight* that can inform decision making at all levels of the organization. In fact, many of the IBM experts surveyed predict that these new systems of insight will change how companies think, making analytics part of *every* job role and eventually transforming day-to-day operations in the same way enterprise resource planning systems revolutionized them in the late 1990s.

A key challenge in the analytics space is not only to generate new insights but also to filter them so the right insights are delivered to the right person or group at the moment they are most valuable. Individuals have shown an insatiable demand to interact with the companies they do business with, in personal and unique ways, and this will continue to drive both the growth of data being collected and the analytic technologies we use to dig into it.

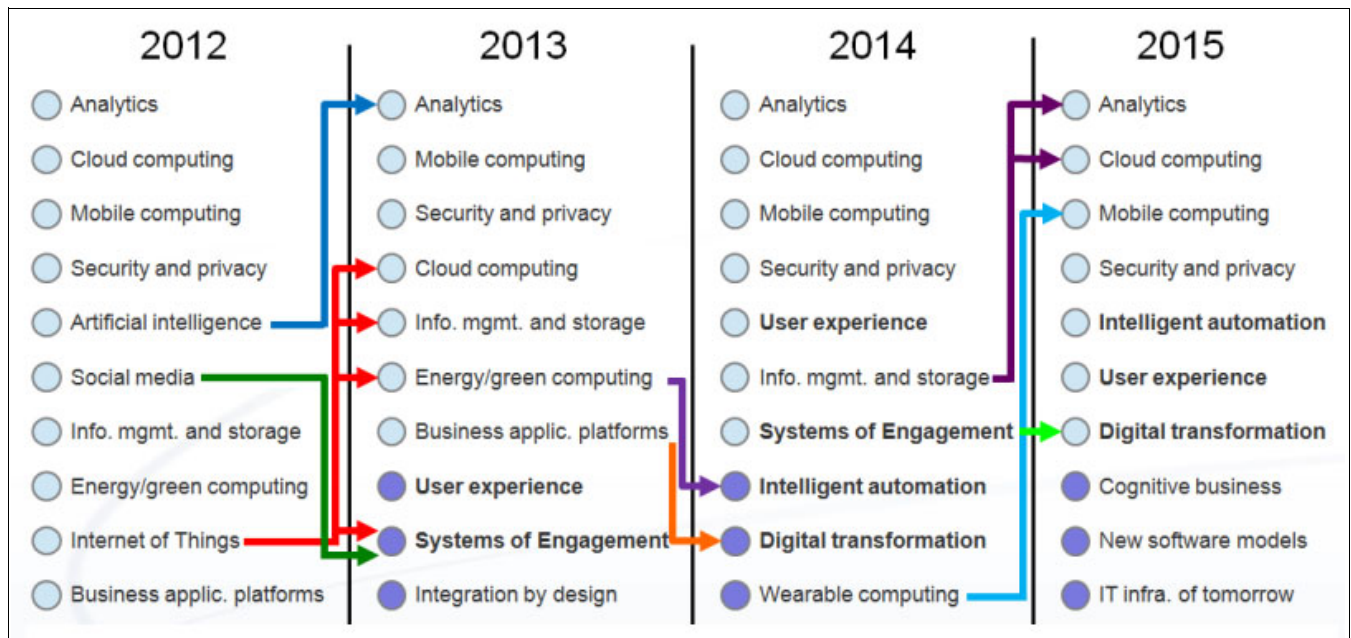


Figure 1 Evolution of top technology trends, 2012-2015, based on IBM Academy of Technology survey

And as companies and governments grow more dependent on the insights that emerge from advanced analytics on big data, there will be expanded demand for people with the skills to understand the different types of data that can be captured and the range of analytic technologies that can be used to interpret it. One expected challenge, then, is to train these data scientists as rapidly as possible and then apply their expertise where it is most needed.

## Cloud computing

Thanks to its economic and technical efficiencies, cloud is emerging as a *preferred* means of acquiring or expanding computing infrastructure.

Advances in deployment automation and economies of scale give distinct commercial advantages to businesses employing cloud technologies. Analysts predict that fully one-third of all personal digital content (photos, videos, text files, and so on) will reside in cloud-based environments by 2016, and 80% of new applications will be distributed or deployed through the cloud. The agility and business flexibility of cloud-based environments makes them a natural choice for new applications.

The biggest technical challenges lie in transforming established IT organizations into cloud service providers and for companies that want to use cloud to find the best delivery model for their needs: public (available to any entity that wants to pay to use it), private (provisioned for the exclusive use of a single entity), or hybrid (a public-private combination).

## Mobile computing

As the number of new smartphone shipments approaches 1 billion per year, the battle for dominance between iOS and Android devices will continue. Yet regardless of which device, if any, emerges as a clear leader, a 2013 IBM study<sup>1</sup> found that corporate executives expect to continue expanding their investments in the mobile space. Of those surveyed for the study, 84% of CIOs considered mobile solutions vital to their efforts to get closer to their consumers, and 94% of CMOs ranked mobile apps as critical components of their future digital marketing plans.

The introduction of the IBM MobileFirst™ platform and related products reflects the company's belief that the

smartphone should be the first choice for new applications, not an afterthought. So-called Millennials are both a vast consumer audience and the newest generation of business creators, and they expect to use their smartphones for practically every chore they face.

In addition, an interesting concept is developing where analytics and cloud intersect with mobile. We call it the Individual Enterprise (see Figure 2).

When organizations first started migrating to technical platforms years ago, it was typically done in response to specific, situational needs. As data storage improved, so-called systems of records emerged to support ongoing functional needs. And social media and advanced analytics soon helped organizations become more insightful. But everything was still done on an organization-wide basis. However, today's mobile platforms support even the most advanced business applications, making it possible for companies to put all their new insight into the hands of employees in the field. They can now conduct company business from anywhere, at any time, making each employee, in effect, an individual enterprise.

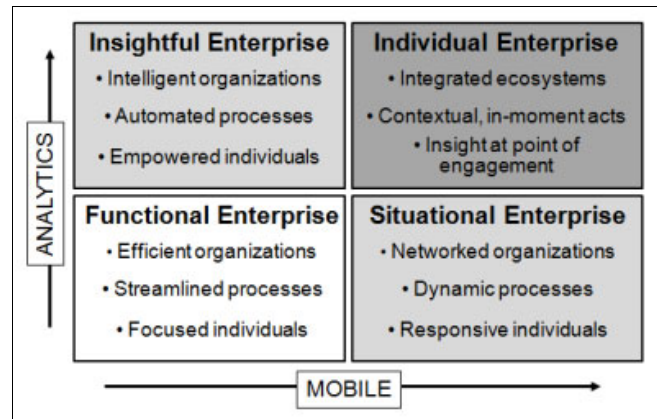


Figure 2 The Individual Enterprise<sup>2</sup>

## Security and privacy

Thanks in part to ongoing revelations about possible government monitoring of personal communications, the security and privacy trend retains its high spot on the list of technology trends. Security has been and remains a major concern for all business systems, and balancing the risks of data breaches against the costs of securing IT services is a constantly changing equation.

<sup>1</sup> Exploring the inner circle: Insights from the Global C-suite Study. <http://www-935.ibm.com/services/us/en/c-suite/csuitestudy2013/>

<sup>2</sup> Adapted from *The Individual Enterprise: How mobility redefines business*. <http://www-935.ibm.com/services/us/gbs/thoughtleadership/individualenterprise/>

As consumer dependence on cloud- and mobile-based services increases, the associated security risks also increase. The 2012 IBM Global Technology Outlook<sup>3</sup>, in its chapter on resilient business and services, highlighted a wide range of issues and opportunities across society. And an IBM Academy of Technology Point-of-View document about security<sup>4</sup> discussed the wider spectrum of security risks that organizations need to address. It noted that today's security paradigm is changing. Firewalls that defend the system perimeter are no longer sufficient. Defenses must be erected at multiple points, even at the level of individual applications.

Interestingly, during the last several years, a more individual-centric view of IT has emerged as people are being asked to provide more and more personal data, and are growing more willing to share it in business contexts. This introduces another level of data to defend and makes the security scenario even more complex. In addition to their traditional role in protecting sensitive corporate data, IT security personnel must now address personal data privacy concerns also.

## User experience

Solution designers have so greatly improved the user experience in consumer applications that it is generating an expectation of similar services in the workplace. So, IT spending on business interfaces will increase. Yet complex business processes and the frequent need to preserve existing systems put constraints on the business user experience. The challenge, for IT companies, is to identify the best practices for innovation in this area.

Creating a positive business user experience requires understanding the how, where, and why of a typical user's activities. Approaches to design at IBM have evolved over time, yet the fundamental aspects of involving the user at every stage of development and collecting user data and feedback remain central.

## Information management and storage

The amount of digital data being collected is increasing rapidly and the drive to collect even more data is driving innovation in information management and storage. Already, advances in hardware are making it

more affordable than ever to store and use enormous volumes of information. And that's a good thing, because even the simplest consumer transactions can now generate enormous amounts of data, both from the transactions themselves and the company's analysis of them.

Yet while collecting and storing data is cheaper than ever, optimizing information storage to enable faster and more effective analysis remains a big IT focus area. In a consumer scenario, for example, true insight requires analysis of the full context of a particular interaction, and collecting, storing, and interpreting every aspect of every transaction poses significant technical challenges.

In addition, the emerging perception of data as a tradable entity creates its own set of challenges for information managers. New policies will need to be developed for data sharing, data masking, data privacy, and even the overall ethics of data usage. Many companies are now hiring Chief Data Officers like they appointed Chief Technical Officers two decades ago.

## Systems of engagement

The term *systems of engagement*, first introduced by organizational theorist Geoffrey Moore, represents the thinking that IT systems should interact like people, and that focus should be placed on communication and collaboration to help employees be more productive, more efficient, and more consumer-oriented.<sup>5</sup> In a systems of engagement world, systems are more decentralized, incorporate technologies that encourage peer-to-peer interactions, and often use the cloud to provide tools to enable that interaction.

These systems are distinct from, yet complement, *systems of records*, the traditional systems applications that handle business transactions and store enterprise records. Compared to systems of records, which are not expected to be a primary focus of IT investment in the coming years, systems of engagement will grow in importance as companies seek new ways to offer value to consumers.

Systems of engagement are also at the heart of many new applications for front-office digitization, another top technology trend (see below). Designers are relying on such systems to provide a unified user experience for both employees and customers.

<sup>3</sup> *Global Technology Outlook 2012*.

[http://www.research.ibm.com/files/pdfs/gto\\_booklet\\_executive\\_review\\_march\\_12.pdf](http://www.research.ibm.com/files/pdfs/gto_booklet_executive_review_march_12.pdf)

<sup>4</sup> *A Sweeping Approach to Security*,

<http://www.redbooks.ibm.com/redpapers/pdfs/redp4944.pdf>

<sup>5</sup> *Systems of Engagement and the Future of Enterprise IT: A Sea Change in Enterprise IT*.

<http://www.aiim.org/futurehistory>

## Additional, emerging themes

Looking into the future, the respondents to the 2014 and 2015 Academy of Technology surveys placed these new themes on the list of trends to watch.

### Intelligent automation

Thanks to advances in pattern matching and cognitive computing, a new class of automated systems is emerging to take greater advantage of the ongoing miniaturization of sensors, actuators, and remote computing devices. Whether the goal is to intelligently heat your home or accelerate complex tasks on assembly lines, this new era of intelligent automation systems will disrupt established industry value chains.

Adding to this trend is the growing Internet of Things, which enables constant monitoring of automated systems to achieve greater control and optimization. The so-called *connected vehicle* (which includes the concept of self-driving cars) is an excellent example of what is possible with this technology.

Organizations need to better understand the scale and trajectory of this new IT segment and seek to identify new business opportunities within it. And as these projects move beyond the pilot stage, additional barriers must be overcome, including the need for industry standards defining how, for example, one driverless car will communicate to another driverless car moving beside it on the highway.

### Digital transformation

In his book *The Curve*, Nicholas Lovell states that anything that can be digitized has a tendency to eventually become cheaper, possibly even free of cost. We have seen this trend with books, compact discs, and videos.

With the advent of 3D printing and the business process as a service (BPaaS) model, the impact of digitization will transform many industries. In fact, digital transformation is fueling the maker culture in which engineers and entrepreneurs seek to apply existing or emerging technologies in unexpected ways.

Advances in this realm will occur rapidly and might not be linear. Improved cognitive computing capabilities, for example, have potential to enable rapid innovation and step function-level improvements in digitization.

### Wearable computing

Trend-spotting is a sport at the annual Consumer Electronics Show in Las Vegas, the world's biggest consumer-technical trade show. The 2014 and 2015 events saw an explosion of wearable technologies, or wearables, from smart eyeglasses to wrist-mounted personal health monitors. Every major consumer technology manufacturer at the shows said it is experimenting with wearable products.

Many of the latest concepts play on the human desire to live long and healthy lives. They aim to make the idea of a *metricated* or *datified* self a reality, and to make a healthy lifestyle easier to maintain. These new personal appliances will also likely be sources for yet more volumes of big data, and, when combined with new cognitive computing tools, might provide even more opportunities for today's entrepreneurs.

As with advances in data storage, the trend toward wearable computing also raises new privacy and data ethics considerations. For example, companies that manufacture health monitors and store the collected data in the cloud must consider the implications of holding and securing so much potentially sensitive personal health information.

### Cognitive business

Cognitive computing refers to computing methods that are neither linear nor deterministic, but rather learn and interact with people in order to extend natural human function. A 2015 study from the IBM Institute for Business Value identified three main capabilities of cognitive systems:<sup>6</sup>

- ▶ They use evidence-based reasoning
- ▶ They seek to find new insights and connections from within vast amounts of information
- ▶ They change the way humans and systems interact

Many IT (and even some non-IT) companies are investing in cognitive computing; the cognitive approach is contributing to advances in other, more traditional IT areas. One pressing need is to understand how cognitive computing can evolve into cognitive business. How can cognitive computing drive innovation and make measurable gains in business performance and customer satisfaction? How can these methods be integrated into current business-related IT operations? How will we decide when cognitive approaches make more sense than traditional analytics?

<sup>6</sup> *Your cognitive future: How next-gen computing changes the way we live and work.*  
<http://www-935.ibm.com/services/us/gbs/thoughtleadership/cognitivefuture/>

## New software models

The ways in which software is produced and consumed are dramatically changing.

Instead of traditional front-ends, IT teams now focus on building new apps (and redesigning existing ones) for smartphones, tablets, and other mobile devices. And in place of traditional back-ends are new sets of API services and micro-services built for easy integration into cloud infrastructures.

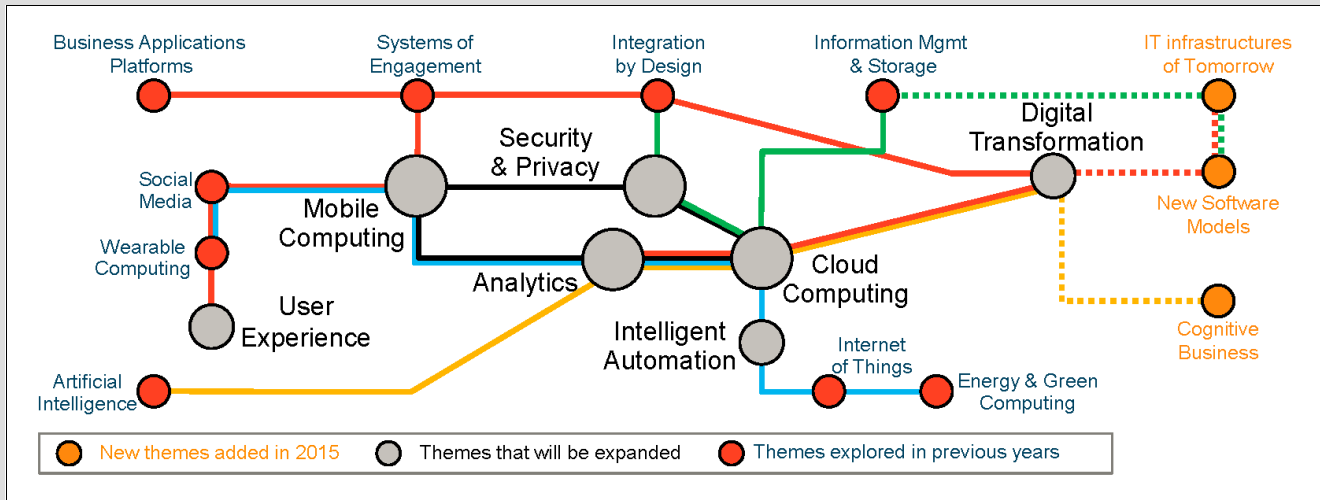
This new service orientation is commonly known as the API Economy and is one of the main drivers of today's ongoing digital transformation. In coming years, the critical way of thinking will be for IT companies to both recognize things are changing and to understand the expected trajectory of the changes.

## IT infrastructures of tomorrow

Both traditional enterprises and those borne of the Internet are today demanding essentially limitless resources in all dimensions (data, workload and bandwidth) and are turning to virtualized solutions, whether partial or complete, to supply those resources. This complexity is driving a new breed of middleware and infrastructure, including in data centers.

Virtualization technologies are improving, but the growing demand will require a new generation of IT infrastructure, particularly for the explosion of IT capabilities at the edge of traditional computing. A new generation of intelligent networks, for example, will not only generate great volumes of data but will also issue billions of individual requests for services and decisions from central systems and data centers. So this shifting infrastructure will be a trend to watch, along with the how future data centers are shaped by the demands of public and hybrid clouds.

## Top IT trends: A different perspective



The Academy of Technology survey is an iterative, yearly process. But a simple top-to-bottom list can't show the relationships between the trends or how advances in one technology can influence others.

Just as a subway or train map can help acquaint a visitor to a new city and its neighborhoods, a similar diagram (see above) can illustrate how the top IT trends have changed since the survey began in 2012.

The figure reveals the relationships among the trends and reflects how IT priorities have changed over the short history of the survey. In addition, some trends are logically grouped into *exploration trajectories* that link related trends and reveal where new opportunities can arise in the future.

The **black** lines connect the critical areas of cloud, analytics, mobile, and security. The other lines indicate these trends:

- ▶ **Red line:** Trends tied to changing business models and user behaviors as a result of digital transformation.
- ▶ **Yellow line:** Trends related to increasing capabilities in artificial intelligence and analytics, which often accelerate those related to digital transformation (see where the red and yellow lines intersect).
- ▶ **Blue line:** Trends linking the digital and physical worlds, such as the growing Internet of Things and proliferation of *on-the-edge* computing capabilities.
- ▶ **Green line:** Trends related to the transformation of IT itself to support the new, digitally transformed world.



## Shaping the future

In addition to assessing today's major technological trends, the Academy of Technology survey also attempts to define the current societal and business challenges with the greatest potential to change how technology is used, whether by expanding use of existing technologies or by driving creation of new ones.

These societal factors shape the trends discussed in this document even as they are shaped by them. For example, issues related to privacy and security have rapidly moved to the top of the list of challenges, in part, due to the ongoing technological trend in which companies collect more and more personal data about consumers. In turn, those public fears about privacy and security are driving new advances in data protection.

Figure 3 presents the list of current societal challenges, as measured by the internal IBM survey. Although the concepts have remained relatively steady over the years, changing societal priorities have led to some movement within the list. The fact that privacy/security and digital data sit near the top of the latest list indicates that this year's priorities are focused on the management and protection of data.

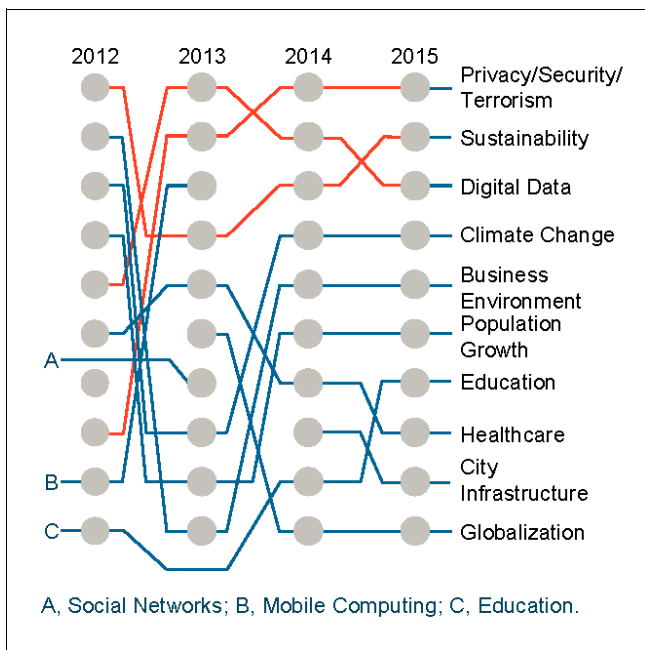


Figure 3 Recent evolution of societal challenges affecting IT

Here, per the global IBM survey, are the societal factors with the greatest potential to drive future IT trends:

- ▶ **Privacy/Security/Terrorism:** Understanding why this trend sits atop the list is not difficult. Massive thefts of credit card data from major retailers have consumers on edge. Reports that governments might be monitoring private communications are heightening concern over security and data privacy. And there is growing fear that cyber-terrorists could launch destructive attacks aimed at bringing down major companies or municipal power grids.
- ▶ **Sustainability:** In 2012, a study found that an astounding 2.6 trillion of pounds of garbage was generated worldwide in a year, equal to the weight of about 100,000 Eiffel Towers. Gathering data on the usage of critical resources will identify opportunities for technology-related optimization and transformation.
- ▶ **Digital Data:** This might not seem like a challenge at first glance. But with massive volumes of digital data already stored and 50% annual compounded growth predicted for the foreseeable future, fears are emerging that important data might be overlooked or that increasing amounts of incorrect data might overwhelm the analytical models that are used.
- ▶ **Climate Change:** Various data sources show a warming of the Earth's climate since the 1950s. Greenhouse gases are seen by many as the primary driver of climate change, so movements are started to substantially reduce them. Data analysis is playing a critical role in developing these plans.
- ▶ **Business Environment:** The business environment or the context in which business is conducted influences how companies operate and innovate. Political conditions and technological maturity might present region-specific challenges. But there is one universally recognized driver of business change: a willingness to innovate and exchange information and knowledge.
- ▶ **Population growth:** The world population has risen rapidly since the industrial revolution enabled greater food production and distribution, and increasingly, this population is centered in urban areas. One result is increased stress on city infrastructures, which in turn is creating demand for the kinds of technological solutions that IBM calls Smarter Cities®.
- ▶ **Education:** Many experts predict that the school of the future will learn about each of its students over time and, through the course of their education, adapt each student's educational program to help

the students master skills that match their personal goals. The rapid digitization of educational institutions, combined with advances in cognitive computing, will allow unprecedented instrumentation of the learning process.

- ▶ **Healthcare:** With people living longer and new medical advances being announced every day, healthcare spending continues to increase as a percentage of Gross Domestic Product (GDP). The healthcare industry is one where advances in cognitive computing are likely to have the greatest impact.
- ▶ **City Infrastructure:** As mentioned previously, rising populations are putting increased stress on city infrastructures. But transforming a city infrastructure is a long-term program requiring significant funding, at a time when city budgets are under pressure. So one challenge is to find innovative ways to optimize the use of existing facilities.
- ▶ **Globalization:** The interdependency of local and global markets, a so-called virtuous cycle, has long been a key driver of economic growth. Recent financial crises have slowed economic growth and contributed to an increasing isolationism, even protectionism, in some regions. So there is a looming challenge in again finding the proper balance between open and isolated trade policies and between shared and protected innovation.

Each of these societal challenges is unique, although several of them are interconnected. And whether individually or collectively, they are expected to drive the top technology trends for years to come.

## Resources for more information

For more information about the concepts highlighted in the paper, see the following resources:

- ▶ **Analytics:** As analytics capabilities extend beyond traditional business intelligence systems, leading organizations are working with IBM to analyze data in new and varied ways to distance themselves from the competition.
  - IBM Analytics:  
<http://www.ibm.com/analytics/us/en/>
  - IBM Smarter Workforce:  
<http://www-03.ibm.com/software/products/en/category/SW333>

- Analytics, A Blueprint for value:  
<http://www-935.ibm.com/services/us/gbs/thoughtleadership/ninelevers/>
- Analytics, The widening divide:  
<http://www-935.ibm.com/services/us/gbs/thoughtleadership/ibv-analytics-widening-divide.html>
- ▶ **Cloud computing:** The 24 of the top 25 Fortune 500 companies use IBM cloud computing. IBM Cloud can help you unlock more value in your business and in the technology you already have.
  - IBM Cloud Computing:  
<http://www.ibm.com/cloud-computing>
  - IBM SmartCloud@:  
<http://www.ibm.com/cloud-computing/social/>
  - *The power of cloud:*  
<https://www.ibm.com/cloud-computing/us/en/assets/power-of-cloud-for-bus-model-innovation.pdf>
- ▶ **Mobile computing:** Build. Protect. Engage. Transform. These four practices will put you on the road to becoming a mobile enterprise.
  - IBM MobileFirst:  
<http://www.ibm.com/mobilefirst/>
  - The “upwardly mobile” enterprise:  
<http://www-935.ibm.com/services/us/gbs/thoughtleadership/upwardly-mobile/>
- ▶ **Security and privacy:** IBM offers a deep enterprise security portfolio that can help you disrupt new threats, deploy security innovations and reduce the cost and complexity of IT security.
  - IBM Security:  
<http://www-03.ibm.com/security/>
  - Data Security and Privacy:  
<http://www-01.ibm.com/software/data/security-privacy/>
  - *Emerging security trends and risks:*  
<http://www-935.ibm.com/services/us/gbs/thoughtleadership/ibv-it-security-trends.html>
  - *Managing threats in the digital age:*  
<http://www-935.ibm.com/services/us/gbs/thoughtleadership/ibv-security-managing-threats.html>

- ▶ **User experience:** IBM Design doesn't only make great products. It painstakingly crafts experiences that delight users and shape the future.
  - IBM Design:
    - <http://www.ibm.com/design/>
  - *Integrated teams: Delivering ninety-day user experience evolution for financial services:*
    - <https://ibm.biz/BdRjep>
- ▶ **Information management and storage:** IBM solutions deliver trusted data throughout your information supply chain and help you analyze that data to gain insights, identify breakdowns, and make better decisions to optimize your business.
  - IBM Information Management Software:
    - <http://www-01.ibm.com/software/data/>
  - IBM System Storage:
    - <http://www-05.ibm.com/ie/systems/storage/>
- ▶ **Systems of engagement:** IBM jStart®, the client engagement team of the IBM Emerging Technology group, is already working with clients to implement systems of engagement that solve real challenges.
  - IBM Systems of Engagement:
    - <http://www-01.ibm.com/software/ebusiness/jstart/systemsofengagement/>
- ▶ **Intelligent automation:** Systems with built-in intelligent automation will help drive the communities of tomorrow, including the IBM vision for Smarter Cities.
  - IBM Smarter Cities:
    - [http://www.ibm.com/smarterplanet/us/en/smarter\\_cities/overview/](http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/)
  - IBM and The Internet of Things:
    - <http://www-01.ibm.com/software/info/internet-of-things/>
- ▶ **Digital transformation:** Businesses today are rethinking what customers value most and are creating new digitized operating models that take advantage of new methods of competitive differentiation.
  - IBM Digital transformation:
    - <http://www-935.ibm.com/services/us/gbs/thoughtleadership/ibv-digital-transformation.html>
- Digital Reinvention: Preparing for a very different tomorrow:
  - <http://www-935.ibm.com/services/us/gbs/thoughtleadership/digitalreinvention/>
- ▶ **Wearable computing:** As companies seek to put more technology into the things we wear, IBM is positioning itself to be at the front of this wave.
  - IBM Systems Journal, Vol 35, Numbers 3 and 4, 1996:
    - <http://www.research.ibm.com/journal/sj/353/sectione/starner.pdf>

## Acknowledgements

This Point-of-View publication includes contributions of many IBM employees.

The authors want to thank the following people for their contributions to the document and for assisting in the analysis of the Academy of Technology survey data:

- ▶ Andrew Penrose, Chief Engineer, IBM SmartCloud for Social Business
- ▶ Feng Xue, Program Manager, ISC Client Quality, ISC Engineering

The authors are also indebted to several colleagues for their helpful input and revisions along the way:

- ▶ Tim Hahn, Distinguished Engineer and Chief Architect, Connected Vehicle
- ▶ Leo Marland, Distinguished Engineer and Solution Design Global CTO
- ▶ Elisabeth Stahl, USA Chief Technical Strategist and Executive IT Specialist

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This document, REDP-5177-00, was created or updated on April 15, 2015.



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