

Emerging Technology Trends— Finding the Next Big Thing

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Organizations and individuals around the world spend billions of dollars each year providing and using information technology. New capabilities, standards, and products appear every day. Many involve incompatible or even competing specifications and interfaces. Remember VHS versus Betamax? How about Blu-ray versus HD DVD? Which technology is the right choice for you or your organization? Working with ACUTA, researchers at Murray State University (MSU) collected and analyzed scientific, academic, industry, and popular data in order to predict technology trends. The target timeframe for the predictions was two to five years.

If this were an easy task, readily approachable with a standard scientific method, making IT investments would be much simpler. There have been many famous technology forecast blunders, such as Tom Watson, chairman of IBM, stating in 1943, “I think there is a market for maybe five computers,” and Bill Gates, Microsoft, in 1981 saying, “640K ought to be enough for everyone.” The predictions that follow are personal opinion about the most important technology trends for the next two to five years (your results may vary).

Methodology

Before describing what was done, it is important to stress what the methodology was not. This project was not a formal, highly funded modeling or simulation-based effort such as would typically be done by government, military, or investment/market researchers. In this case, a variety of relatively informal approaches was used to collect and assess information to forecast the most important emerging technology trends based on a fairly rigorous review of available information, including forecasts made by industry sources, such as Gartner Inc.¹

A basic but essential analytical assumption was that the more often a technology term appeared in literature, on the Web, or in a conversation, the more likely it was to be a viable and important technology trend. As an example, the concept of cloud computing appeared in one or two articles in technology publications more than five years ago. One or two years later, it might have been in 10 articles per year. Currently, the phrase *cloud computing* probably appears in 100 articles per week. This kind of progression is a clear indicator of emerging importance. The trick is to identify the emerging trends early and know which are important.

The three student research assistants—Josh Stump, Stefan Bischoff, and Jeffrey Kaleta—were challenged with proposing and developing their own innovative approaches to supporting, improving, or refuting the author’s predictions. Each student designed and implemented an approach that took the lead researcher’s input and generated some level of confirmation or rejection of the predictions.

In addition to my own literature review, about 75 students in MSU computer science and networking classes were asked to nominate and vote on proposals for “the next big thing” in IT. Their opinions are factored into the predictions that follow.

Technology Trend Predictions

The fifteen items listed are the top new technologies, approaches, standards, or issues identified by the project. They are listed in their relative order of importance based on either their expected impact or how quickly they will become a current hot topic.

1. Cloud computing and its variations. Cloud computing is the concept of computing and IT resources being positioned in the Internet or an intranet “cloud,” rather than owned and oper-

ated locally. This topic cannot be discussed without an introduction of the many variations, such as private clouds, public clouds, hybrid clouds, open cloud, cloud storage, agile infrastructure, and real-time infrastructure.

2. Virtualization. Running multiple iterations of one or more operating systems on or from a single powerful computing platform is the modern, popular definition of virtualization. Multiple virtualization systems, software, and approaches exist, and many organizations are moving quickly to virtualize their computing environments.

3. Mobile computing. Mobile computing is the use of mobile and handheld devices as the primary computing platform of choice. Mobile devices combine communications and computing power in a single device, and whether we use a cellular network, WiFi, or Bluetooth, many more of us are staying connected to the world through mobile computing. Mobile computing is also how advertisers and cyber criminals want to connect with us!

4. Social networks and their application. Social networking, and all the related interaction, advertisement, gaming, and cybercrime, appears to be the killer app of the Internet age. Everyone, from preteens to 80-year-old seniors, is staying involved with friends, family, and communities through social networks.

5. Wireless networks. End users expect wireless access to the Internet from everywhere, and IT providers are working hard to deliver it. This includes the family of IEEE 802.11 WiFi standards, 802.16 WiMAX, and the emerging Long Term Evolution (LTE) standard.

6. Collaborative computing and collaboration tools. Like a trip down memory lane back to the days of Lotus Notes,² many product developers, service providers, and endusers are again talking about the importance of collaborative effort now supported by mobile computing and communications platforms.

7. Green IT. Green IT is providing and using computing and communications with a focus on being environmentally friendly. With rising energy and environmental costs, Green IT is (and always has been) a smart business move.

8. Computer games and online gaming. Game play on computers, game consoles, and the Internet now rivals industry profits from movies/motion pictures.³ Even the simplest, single-player games on the market today usually require Internet connectivity for license verification and sale of extra content before a game can be played. This is an important topic for both the time and network bandwidth consumed. It is also an emerging venue for cybercrime.

9. Context-aware computing. Context-aware computing is a concept that combines many of our top 15 topics. The primary idea is that our mobile computing devices will know our location, our interests, our typical activities, and the current time and will automatically prompt us about opportunities or issues in a timely and context-aware manner. Imagine walking down the street and having your cell phone remind you it is lunch time, offering directions to a local restaurant, and offering a discount coupon for your favorite meal at the restaurant.

10. E-health records. Mandated by a variety of national and local laws and regulations, our medical records are being digitized and made available for collaborative medical efforts via networks. Along with the opportunity for portability and collaboration come requirements to ensure security, accuracy, and privacy.

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11. eDiscovery. The more that official documentation and records go digital, the more likely it is that these e-records will be required by courts. eDiscovery is the formal retrieval and presentation of electronic records, such as text messages and e-mail, for use by the legal system.

12. Cybercrime. All of our computing and communications topics include an increased exposure to cybercrime. Crooks go where the money is, and today money and opportunity are online and mobile.

13. Mobile ad hoc networks (MANETs). A topic long researched by the military, MANET is coming to commercial products. Rather than rely on dedicated wireless access points and other dedicated networking devices, end-user mobile devices will interact and cooperate to extend communications services out to remote users.

14. Software-defined radios (SDRs). Another topic long researched by the military, SDR could revolutionize communications interfaces and interoperability. Rather than a communica-

tions device having a limited, hardwired capability to communicate on certain frequencies with certain protocols, SDR would permit a single device to communicate in a much broader range of formats and protocols by switching between software components.

15. Solid-state memory and storage. The era of rotating-disc-based mass storage is rapidly coming to a close. The solid-state technology that makes USB thumb drives possible and affordable is becoming less expensive and denser and will soon replace the much less reliable disc-based storage that we have used for six decades.

Summary of Recommendations

Each of these topics is likely to have some importance for every ACUTA member. While all the data collection, analysis, and reporting done within this project has been done with ACUTA members in mind, the following paragraphs summarize advice and forecasts specifically for the ACUTA membership.

Wireless access everywhere, with full Internet access to and from handheld and larger devices, will be expected as the mini-

Students and Supporting Projects

This ACUTA project served as a wonderful opportunity to spawn and motivate student-designed and -executed research. While their projects warrant publication of academic papers on their efforts, it is also appropriate to mention them here.

Josh Stump is an MSU undergraduate computer science major. To support this project, he created a series of automated online search programs that, with a single mouse click, would execute multiple complex searches of the Internet for the technology terms that this research produced. Josh's program used advanced features of Google's search engine to indicate how popular a particular term was with regard to how many "hits" it produced. Since the Google search engine does not encourage automated searches, development of these programs required coordination with Google and some complex programming approaches.

Stefan Bischoff and Jeffrey Kaleta were MSU graduate information system students who both recently completed their degrees. Stefan took the initial technology terms the research produced and created a database that stored the terms and their synonyms, as well as the relationships between terms that were identified over time. Stefan also produced the

complex multiline search terms that were used in our automated Google searches.

A search for *cloud computing* provides a powerful example of the importance of doing a proper search of the Internet. Searching for *cloud computing* (without quote marks) results in over 20 million hits—most of which are not useful items. Simply adding quote marks and searching for "*cloud computing*" still produces over 10 million hits. A properly formatted search string that includes synonyms and excludes certain unrelated words reduces the results to 950 hits, which are almost all useful information.

Jeff Kaleta created a relational database of the technology terms and sources that were produced by the project and then developed data-mining routines that examined the information to extract relationships between the terms. An example of a relationship between technology terms that his data mining produced is the link between context-aware applications and mobile computing. A publication that had an article on context-aware computing on a particular date was very likely to have an article on mobile computing in the same edition, and both terms were likely to appear in both articles. Jeff's research also included the development of relationship models that allow forecasting on the rise or decline in popularity of the terms.

mum standard by users. If your campus and service providers do not offer this, you will be at a competitive disadvantage. WiFi variants will continue to get better and cheaper but probably will still not provide the long-range coverage you would like in the next five years. WiMAX (IEEE 802.16) has finally become a viable longer-range wireless option in terms of product availability; but if you go this route now, you may be buying into as dead a standard as Betamax tapes. The emerging LTE wireless standard may kill WiMAX before it is widely adopted.

Your wireless coverage will soon need to support more complex and bandwidth-intensive applications. Wireless access to social networking, context-aware applications, mobile gaming, and electronic wallet capabilities will be expected on every campus within five years.

While expanding your wireless networks, also expect to adopt IPv6 to some extent during the next five years. Most of the IT equipment you buy today is IPv6 ready, and some of your campus IT systems may already be using it, whether or not you are aware of it. You will not be able to acquire significant blocks of IPv4 addresses after 2010.

It won't be common soon, but perhaps by the end of the next five years, your users' mobile devices may be able to help you with your wireless coverage problems. Mobile ad hoc networking (MANET) has been researched and tested for many years, but device manufacturers may soon routinely include this capability in their mobile devices. If you allow it, users' devices that are out of direct range of your wireless access points could be assisted by other users who are within range, facilitating the relay of the distant users' data to and from your wireless access points.

Enhanced computing and network environments will be expected from your users, while your budgets will remain flat—or even go down. Some of the latest technology trends can support doing more with less. Cloud computing, virtualization, green IT, and solid-state memory and storage are all technology trends that have the potential to save you money while enhancing capabilities.

Cybercrime may be one of the most important issues of the 21st century. Although users will demand unlimited wireless access and complex mobile computing and communications capabilities, they will also expect safety, security, and privacy. The criminals of the world know that there is money to be made on the Internet and through your wireless networks.

If you fail to provide safety, security, and privacy in your IT environment, your networks and computers can become crime scenes subject to eDiscovery that can cost you millions of dollars and damage your reputation. Your IT environment and security/privacy requirements will become more complex because of steady progress on e-health records. The government is requiring, and

users are beginning to expect, their medical records to be digital, mobile, and available everywhere, while never having their security and privacy violated.

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Where's Your Focus for the Future, Apogee?

We've seen many technologies rise and fall on campus over the past decade. Traditional phones, for example, are now dead, and nonmobile VoIP is simply a non-starter for college students today. Over the long run, we also see traditional cable TV going the way of the landlines. From our perspective, the future of residential technology will be centered around bandwidth and mobility.

Considering the rising call for pervasive wireless coverage and increasing bandwidth consumption, all of our partners are now being transitioned to the most robust 802.11n wireless standard to meet the scale of present and future student demand. One of the unique things we are doing in this area is enabling multicast video to run over the wireless network. We are also working on bridging student cellular use with the campus network. We've experimented with everything from small femtocells to full-scale carrier towers. Our primary focus is on innovation that will tie student use of mobile and cellular technology to the campus network in ways that are both meaningful to the university from a cost-value perspective and attractive to students who want to take advantage of the latest technology without sacrificing mobility.