# The Next Big Thing on the Software Horizon

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Proceedings
and
Executive Review

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## Executive Summary

On December 2, 2002, the Silicon Valley World Internet Center convened a Think Tank Session to glean what could be the next breakthroughs on the software horizon. The participants -- senior software developers, scientists, and business developers -- were challenged to focus on those factors, including any discontinuous technologies, which would shape what they all came to call the "Next Big Thing" for software by the year 2007.

Whatever emerges as the Next Big Thing on the software horizon, the participants agreed that it has to improve how businesses are run and increase productivity. The Next Big Things in Internet technologies will emanate from complex systems interacting dynamically on various devices through bridged, ubiquitous connectivity media. And, very likely, all the technologies necessary to compile the Next Big Thing are already developed, waiting in the wings for someone to put the pieces of the puzzle together to solve a gaping business or social need.

*Whatever emerges as the Next Big Thing on the software horizon, participants agreed that it has to improve how businesses are run and increase productivity.*

Participants decided upon the following as probable areas for the development of the Next Big Thing on the software horizon. Through a combination of heated discussion and ranking exercises, they eventually focused their attention on the first three of this list, as the most likely to breakthrough onto the software horizon by 2007. The other top choices areas are listed here and discussed in detail in the full proceedings:

- Multi-player Gaming
- Autonomics
- Always-on, Always-connected World
- Security
- Complexity
- Interoperability and Data Management
- Bio Medial Industry
- Transforming the Enterprise
- Mass Customization, Rapid Application Development, and Collective Intelligence
- Nano-technology

This invitation-only session convened 22 experts in the software arena for an interactive exchange of knowledge. Participating companies or individuals included:

- Combex, Inc.
- Creative Science Systems, Inc.
- Dejima, Inc.
- Eou.com
- Fujitsu Software Corporation
- Garage Technology Ventures
- Hesley Associates
- Hewlett-Packard Laboratories
- LANDesk Software, Inc.
- MLDesign Technologies
- Osprey Ventures
- Rod Heisterberg Associates
- SAP Labs
- SCS Lab, Inc.
- SRI – Computer Science Lab
- Mr. Neal Goldstein
- Dr. Barney Pell

For a copy of the full proceedings, please see the Silicon Valley World Internet Center's Website at: http://www.worldinternetcenter.com/Publications/proceedings.html.

## Executive Review

The top choices for the Next Big Thing on the software horizon are briefly presented here, with key influencing factors. Please see the full proceedings for a detailed discussion of each proposed area.

## The Next Big Thing: Multi-Player Gaming and Collaborama©

Today, 23 million people consider themselves part of an on-line community and participate at least once a week in some on-line community or game. Collaborama©, a company ideas developed by one of the Session's break-out groups, would be based on multi-player gaming systems to create a global collaborative forum for solving world problems.

### Proposed "Next Big Thing"

- A distributed collaborative environment that could harness scalable groups to work, play and collaborate to solve problems.

### Influencing Factors

- Nano-technology
- Secure networking
- Development of the technology to allow the virtualization layer on which the game is played
- Further employment of peer-to-peer networks to facilitate the network
- Critical infrastructure to facilitate the always-on, always-connected requirement
- Huge global user base for games and on-line communities

## The Next Big Thing: Autonomics

Autonomics can reduce the cost of operations by providing a system that self-configures, self-optimizes, self-heals and self-protects. Other motivating factors for autonomic systems include the elimination of human error, the reduction of staff size and, related, the ability to manage heterogeneous systems with a staff with a single skill set.

### Proposed "Next Big Thing"

- Systems that self-configure, self-optimize, self-heal and self-protect.

### Influencing Factors

- Reduces operations and maintenances costs.
- IBM is pushing autonomic computing.
- The starting technology already exists.

## The Next Big Thing: Always-On, Always-Connected World

In an always-on, always-connected world there is complete interoperability between wired and wireless connectivity and among devices.

### Proposed "Next Big Things"

- Supply-chain applications where an order is placed with a sales representative and is distributed along the supply chain, with a shipping date returned to the sales representative within 30 seconds
- The wireless phone is connected wirelessly outside a building, then switches automatically to the wired system inside the building as one enters
- Uninterrupted connectivity between one's phone and one's desktop computer
- Self managing manufacturing plants with machinery that looks after itself and signals maintenance needs
- A path of trust, directed from a root, among the connected parties to ensure security

### Influencing Factors

- Connectivity that is fast, integrated and unified, providing wired and wireless universal access
- Key-centered and path-dependent naming, both of which are fully de-centralized from dependence on DNS or route-name servers
- Bridges between Wi-Fi, wireless and broadband
- Ubiquitous connectivity
- The whole network stack, with the BlueTooth in the chips, all packaged together on single chips in embedded devices

## The Next Big Thing: Security

Inter-related issues of security and privacy stood out as the greatest obstacles to be overcome before the Next Big Thing on the software horizon emerges. The Internet begs for authorities that promote shared computation by guaranteeing the authentication of users and the security of data. Security must be built-in to the basic infrastructure under the broadband, and the DNS needs to be fixed at the networking level. When the security is in place, always-on, pervasive computing will take off, as will more sophisticated Web Services and a plethora of changes in the way we use the Internet.

### Proposed "Next Big Things"

- Technology that would ensure that secure data access be independent of the transport mechanisms.
- A class of applications that will provide attributes such as being connected when one expects to be connected and disconnected when one expects to be disconnected.
- Ubiquitous and universally acceptable delegation of authority.

### Influencing Factors

- Naming and addressing will be crucial.
- Secure data access must be independent of the transport mechanisms.
- Security must be built-in to the basic infrastructure under the broadband.
- The DNS needs to be fixed at the networking level

## The Next Big Thing: Complexity

Today software is talking to software through software. As a result, software is becoming very specialized in its applications. Large systems are being disaggregated into smaller, specialized systems. These pieces of software must be able to interact to form a whole. And the whole needs to be very simple at the keyboard.

### Proposed "Next Big Things"

- Network processors need to be made part of the net work, so that they have some shared state. The net work becomes a parallel computer, not just a bunch of computers talking.
- A complex system comprised of complex systems.
- A meta construction above the complexity to manage the system as a whole.

### Influencing Factors

- As business tries to do tasks that are increasingly complex with computers and IT, new ways need to be devised to handle that complexity.
- Software is no longer run on a single machine, but in a very complex system that is part of an even larger complex system.
- Software must talk to, not only the next processor, but also to the processor further on down the system.

## The Next Big Thing: Interoperability and Data Management*

Real sharing, not just of data but of computation. The Center's Web site contains a series of Summaries of in-depth Working Group Discussions on Interoperability of machines and applications at http://www.worldinternetcenter.com/Publications/proceedings.html.

### Proposed "Next Big Thing"

- Technologies that protect the machine from the process and the process from the machine.

### Influencing Factors

- If designers could get 80 percent of the solution and systems, human beings would be able to map processes together very quickly, economically and in a dynamic manner.
- To accommodate machines that do not interoperate, designers need to make it easy for new things to enter the system.

## The Next Big Thing: Bio-Medical Industry

The bio-medical industry is software limited at this time. Deriving information from data to determine the susceptibility of individuals currently takes weeks. The chemistry can be done quickly, but the information extraction from the data is laboriously time consuming.

### Proposed "Next Big Thing"

- An on-line bio-analyzer providing real-time analytics

### Influencing Factors

- Health Insurance Privacy and Portability Act (HIPPA)
- The health care system in the United States is collapsing under its own weight

**The Silicon Valley World Internet Center has published on its Web site a series of Summaries on dynamic information integration. Please refer to these for a discussion of data, system and machine interoperability. See http://www.worldinternetcenter.com/Publications/proceedings.html.*

## The Next Big Thing: Transforming the Enterprise

The enterprise exists the way it does, with most functions under the same "roof," (campus, corporation, firewall), because it has been the most economically feasible way to organize the necessary tasks of the enterprise. With the advent of certain types of always-on, real-time, connected, extensible and self-configuring networks, the real costs of performing business functions externally versus internally change.

### Proposed "Next Big Thing"

- The technology that allows businesses to outsource real business processes less expensively than to maintain all these functions under one roof.

### Influencing Factors

- The advent of certain types of always-on, real-time, connected, extensible and self-configuring networks.

## The Next Big Thing: Mass Customization and Rapid Application Development

Mass customization and rapid application development of software could lead to Web Services creating a collective intelligence of its own. Companies can effectively customize and integrate off-the-shelf components, tied in by real-time integration.

### Proposed "Next Big Things"

- Tools that help people rapidly pull together resources that are out on the Internet and, using distributed teams, aggregate and create very customized applications for business needs.
- An unknown, unpredictable collective intelligence created from diverse pieces of software comm unicating with one another and interacting in ways unpredicted by the program writers

### Influencing Factors

- Open sourcing of software applications on the Web, in combination with outsourcing of tasks across the firm
- Emergent Properties -- The outcome of diverse pieces of software combining in new ways and talking to each other.

## The Next Big Thing: Nano-Technology

Nano-technology is the ability to create materials from building blocks the size of viruses. Storage density is growing faster than we can figure out how to use it. This capacity for memory will greatly enhance the capabilities of Personal Digital Assistants (PDAs). With this unlimited memory, PDAs will become context-aware devices that sense other devices in your space.

### Proposed "Next Big Things"

- PDAs that are know everything going on in the room through communications with other PDAs.
- Eye glasses that tell me what your name is and when your wife's birthday is.
- Smart tags that tell everything about a product and where it has been.

### Influencing Factors

- Unlimited memory in devices.
- Never throw any data away.
- Privacy and security issues.

## Introduction

On December 2, 2002, the Silicon Valley World Internet Center convened a Think Tank Session to glean what could be the next breakthroughs on the software horizon. The participants --senior software developers, scientists, and business developers--were challenged to focus on which factors, including any discontinuous technologies, would shape what they all came to call the "Next Big Thing" for software by the year 2007.

Whatever emerges as the Next Big Thing on the software horizon, the participants agreed that it has to help run businesses better and with more productivity. The Next Big Things in Internet technologies will emanate from complex systems interacting dynamically on various devices through bridged, ubiquitous connectivity media. And, very likely, all the technologies necessary to compile the Next Big Thing are already developed, waiting in the wings for someone to put the pieces of the puzzle together to solve a gaping business or social need.

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- Rod Heisterberg Associates
- SAP Labs
- SCS Lab, Inc.
- SRI – Computer Science Lab
- Mr. Neal Goldstein
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Questions addressed at this Think Tank Session included:

- What major forces are at play in the world and in our daily lives that will affect the development of the "Next Big Thing" in software?
- What will be the "Next Big Thing" in software in 2007?
- How will the "Next Big Thing" change how we do business or lead our lives?
- What discontinuous technologies will emanate from the software arena that will affect this NBT; and which will come from outside of the software arena?

## The "Next Big Thing"

In the search for new products and markets, businesses generally have two avenues down which they can travel.

- They can incrementally develop and improve existing products along the natural continuum of development; and/or
- They can search for products, systems and innovations that do NOT result from the normal continuum of existing products.

These innovative and often revolutionary technologies, concepts and products are called discontinuous technologies and are usually blockbusters that change the way people think and relate to one another and to the world. They include the wheel, the telephone and email, and they generally contribute more market share and revenues to businesses than do strategies of continually improving products.

Participants of the Think Tank Session called the phenomenon of a breakthrough application or change in the way software helps us conduct our business or our daily lives "The Next Big Thing." But how discontinuous is the

next big thing, really? Although discontinuous technologies seem to appear on the scene out of nowhere, participants agreed that the elements that need to come together to form the environment, social construct or critical mass that allows the emergence of the The Next Big Thing may have been waiting in the wings for decades. "For things to happen overnight," quipped one participant, "takes about 30 years." Email is based on the Internet, which existed in academic and scientific circles for more than 20 years before the emergence of the personal computer and pervasive computer use. These two factors made email practical, desirable and, eventually, a necessity, to many of our business and family lives. Similarly, cylinders existed in the world for eons before someone's need became so extreme that they thought to slice one up into wheels. So, the The Next Big Thing can be nothing more than someone thinking of a radically new way to use something which already exists.

Participants at the Think Tank Session discussed dozens of technologies, applications and socio-economic factors that they believed would influence the emergence of the The Next Big Thing in software. These ranged from ubiquitous broadband connectivity to key-centered naming to universal environmental responsibility. Participants grouped these ideas into three major areas from which breakout sessions were developed. From these sessions the group developed scenarios that assumed certain technological advances in the next 5 years and from which the The Next Big Thing would result. These included the creation of a global collaborative forum for solving world problems called "Collaborama©," the development of autonomic computer systems that diagnose, repair and operate themselves, and the unfolding of always-on, always-connected ubiquitous computing.

The following reviews the top ideas generated by the participants for what could be The Next Big Things by 2007. Individual ideas and the factors considered to support these proposed NBTs are listed in the appendices.

## Multi-Player Gaming, Stack and Collaborama©

One participant mentioned that his company is developing a "stack" to describe how reliable, always-on connectivity will work. The stack consists of nano-technology, secure networking, the virtualization layer, peer-to-peer and then critical infrastructure. The critical infrastructure means that access to critical systems is always on, always runs and always gives the right permissions to the right people. "So if the director of emergency planning is on vacation in Rome," he elaborated, "and an earthquake hits in San Francisco, that person, using only his cell phone, can walk into a room, get access to a computer, and have the right permissions to interact with the right people at the right time. As soon as the emergency passes, those permissions go away." According to this model, the infrastructure is in place, resilient to attack and resilient to failures because of the robustness of all the layers underneath. "Multi-player gaming is what we are using to simulate the environment and test it in the absence of an emergency," he concluded.

*These innovative and often revolutionary technologies, concepts and products are called discontinuous technologies and are usually blockbusters that change the way people think and relate to one another and to the world.*

Today, 23 million people consider themselves part of an on-line community and participate at least once a week in some on-line community or game. Collaborama©, a company ideas developed by one of the Session's break-out groups, would be based on multi-player gaming systems to create a global collaborative forum for solving world problems. Participants heard that the number of people world-wide participating in single games is staggering. Games are currently being played with as many as 3 million users.

Collaborama© would use multi-player gaming systems to bring together a virtual congress of people over some period of time with a common interest. Collaborama© would harness the power of game-like communities to solve problems such as those associated with oil spills, declining drinkable-water resources and terrorism. The goal would be to stimulate individuals, world-wide, to collaborate in ways they are not doing today to solve global problems. Collaborama© would be a distributed collaborative environment that could harness scalable groups to work, play and collaborate to solve problems.

Knowledge representation and knowledge management would be one of the key outcomes of Collaborama©. Like games, Collaborama© would need a moderator and some way of synthesizing knowledge out of the process to create a work product. Rules are also necessary, and, as a benevolent dictator sets the rules of the game and drives the direction, so would a designated rule-maker guide the work of Collaborama©. Also like games, Collaborama© would need a set of common tools. A role-based mechanism would be employed to set up processes and rules.

During the discussion, one participant suggested that the biggest leveraging technology that can help scale collaboration and make it more effective is argument visualization. With this technique one could give arguments that are taking place visualization. Someone can then come to the argument or discussion and have a sense of the different positions. Then he or she could orient him or herself in the discussion or argument. Another questioned why, if all the technology is here, Collaborama© does not already exist. The answer was: scale. "It starts to scale in certain directions," explained one Collaborama© designer, "and we do not always know why some directions (e.g., gaming) succeed and others fail. I think by 2007, from a social point of view, this will be much better understood, and we will be able to harness collaborative groups in a new way. The tools are still scattered."

*Solving the cost component through autonomics, by having a system that self-configures, self-optimizes, self-heals and self-protects, is a cost driver that can reduce that 4- to 5-times figure.*

## Autonomics

One participant noted that with any major application that a company either purchases or builds, the cost of operation will be 4 to 5 times higher than the cost of acquisition. Solving the cost component through autonomics, by having a system that self-configures, self-optimizes, self-heals and self-protects, is a cost driver that can reduce that 4- to 5-times figure. Other motivating factors for autonomic systems include the elimination of human error, the reduction of staff size and, related, the ability to manage heterogeneous systems with a staff with a single skill set.

According to the autonomics breakout session members, an autonomic computer complex could maintain itself to some degree and automatically optimize its operation. New equipment and applications could be configured and integrated automatically, and it could make load-shift and security determinations. "It could do a lot of the work that human beings do right now," concluded one participant. Accordingly, the group projected that autonomic computing will so greatly reduce workforces currently required for operating computer complexes that they anticipated socio-cultural conflict issues, especially in Europe, as large numbers of employees are displaced by autonomic systems.

The fact that IBM is pushing autonomic computing is also a driving factor for the technology. But, according to the group, autonomic computing is not just about technology or a single product, but a philosophy for the autonomic integration of every product IBM builds. "For

IBM," said one participant, "autonomic computing is not just a product, but a concept built into everything they do going forward. Whenever you build anything you keep this in mind, so that the cost of maintaining and monitoring is low." One participant volunteered that IBM's big push to allow LINUX to run native on the mainframe was to prepare for autonomic computing. The group projected that autonomic computing could be the next big thing for IBM from the perspective of growing their business.

As was heard so many times throughout the day, one breakout session member commented, "The important thing about this is that the starting technology already exists." Current prototypes include IBM's Websphere and Sun's N1 for Solaris. The new technologies will be those required to make the systems dynamic.

Although there are no completely autonomic products available at this time, the group projected that by 2003, at least some initial installations should be in place and testing begun. "With IBM's name behind it," opined one participant, "things should happen quickly, as opposed to if a start-up in Silicon Valley were putting the idea forth." The group felt that by 2007, the technology will be mature, widely deployed and generally recognized as a best practice.

## Always-On, Always-Connected World

"Remember when we were not always connected?" asked one participant. "Remember when you had to wait to connect? That is the world we are imagining." Always on and always connected computing was a scenario developed by one of the breakout groups at the session as a potential Next Big Thing. They imagined a world where, not only are people always on and always connected, but there is complete interoperability between wired and wireless connectivity and among devices. This would allow, for instance, connectivity between one's phone and one's desktop computer for the phone to search, remotely, the desktop for a needed telephone number. It would also allow the wireless phone to be connected wirelessly outside a building, then switch automatically to the wired system inside the building as one entered.

For businesses, the group envisioned supply-chain applications where an order is placed with a sales representative and is distributed along the supply chain, with a shipping date returned to the sales representative within 30 seconds. Businesses could also give some partners specific access, while other, more trusted, entities had universal access. Always on, always connected means that data mining could be done among all partners' machines and data bases. It was also suggested that, for the insurance industry, always on, always connected would provide an infrastructure that would allow large re-insurance deals by bringing in diverse and appropriate partners. In manufacturing, an always on, always connected world would mean that manufacturing plants could be self managing, with machinery that could look after itself and signal maintenance needs. The whole area of infrastructure management service could be automated, much like autonomic computing.

Computing-on-demand relies on a notion of connectivity that is fast, integrated and unified, providing wired and wireless universal access. According to the group, and consistent with the findings of the day, many of the elements to provide always-on, always-connected communications access are already here, such as application routing and session management. Naming is crucial. The group emphasized both key-centered and path-dependent naming, both of which are fully de-centralized from dependence on DNS or route-name servers, which, they said, could be taken out. With DNS, names are paths. But always on, always connected requires a network that is no longer a hierarchy. In this newly envisioned system the same kind of path still traverses in a network, but is a directed path from the root. The root of the naming system is the point at which you begin. This system also reflects the trust relationships.

One participant explained it this way. "So if my wife's

lover asks me if he can borrow my car, I'll probably say 'No.' But if he asks her, she asks me for the keys, and he is driving around town in my Honda. And as odd as that sounds, that is what you want. The names reflect the path of trust among the parties."

The connectivity infrastructure to support an always-on, always-connected world requires bridges between Wi-Fi, wireless and broadband. And it assumes ubiquitous connectivity. "I need to be reachable on my cell phone in buildings where there may not be connectivity," explained one breakout session member. "I walk into a building and my cell phone is automatically talking along the Wi-Fi or the broadband net. The whole network stack, with the BlueTooth in the chips, is all packaged together on single chips in embedded devices. That is what will allow all the devices to talk to one another."

According to the group, other requirements include system meta-data standards (but no breakthrough technology requirements), trust, authentication and access, and possible smart contracts leading to jurisdiction-free law. The trusted device is probably the PDA. And fine-grain access control to information and to the resources will be necessary. According to the group, these technologies already exist.

## Security

As has been the case with every Think Tank Session, Working Group and Seminar the Center has produced in the last two years, the inter-related issues of security and privacy stood out as the greatest obstacles to be overcome. This group, as have others, agreed that bandwidth issues will be easily conquered in relatively short order. Access will be pervasive. And everything from cars to houses will become "smart" and connected through the Internet as chips become smaller through the use of nano-technology. But problems related to security and privacy loom over the industry.

The Internet begs for authorities that promote shared computation by guaranteeing the authentication of users and the security of data. This group heard that security must be built-in to the basic infrastructure under the broadband, and the DNS needs to be fixed at the networking level. One participant suggested that the underlying discontinuous technology is one that would ensure that secure data access be independent of the transport mechanisms. Another participant suggested that the Next Big Thing will be a class of applications that will provide attributes such as being connected when one expects to be connected and disconnected when one expects to be disconnected. This could be accomplished through the proper interoperation of BlueTooth and Wi-Fi (wireless fidelity) so that one is never out of range, and by the employment of IPv6 for security and naming.

According to participants, there is plenty of processing out there and ways to hook processes up, such as Web Services. But none of it is going to be adopted unless there is some way that it is ubiquitous and universally acceptable for delegation of authority. "If I am going to talk to an agent," said one participant, "and it is going to talk to another agent, and that agent is ultimately going to talk to my bank account, I want to make sure that there is a way to prove that all of this was a result of my initial intention."

Naming and addressing are also crucial. "If we cannot name things properly;" said another participant, "if names do not have temporal and spatial integrity, we cannot secure them and we cannot address them." The group concurred that the expectations of large numbers of people for such qualitative changes will drive their creation and adoption. When the security is in place, always-on, pervasive computing will take off, as will more sophisticated Web Services and a plethora of changes in the way we use the Internet.

Another perspective on security was offered by a par-

ticipant who suggested that one of the discontinuous changes is going to be how we categorize functionality. The traditional models for security, for instance, should merge and become redefined. Things such as firewalls, will be replaced by security being extant within every one of the software components. The old categorization is going to change and become part of a dis-aggregation that will take place as systems become more complex.

## Complexity

The group felt that software is adapting to the dramatic changes in hardware, while it is responding to social, cultural and political changes. Software does not exist in and of itself, but within a context. It is part of a much larger environment than ever before and is more complex than in the past. "That larger environment," said one participant, "will have a great influence on where software is going."

Today software is talking to software through software. As a result, software is becoming very specialized in its applications. Large systems are being disaggregated into smaller, specialized systems. These pieces of software must be able to interact to form a whole. And the whole needs to be very simple at the keyboard. "So what we want to do," opined one participant, "is move the complexity from the brain into the system."

Complexity at the networking level is another knot that is looking for a Next Big Thing to unravel it. As business tries to do tasks that are increasingly complex with computers and IT, new ways need to be devised to handle that complexity. The group heard that this problem currently is not being handled very well. Single, centralized software packages, are either executed on a large computer or are put into a multi-processor computer, which creates problems with multi-tiered-software operating systems. Software is no longer run on a single machine, but in a very complex system that is part of an even larger complex system. Under these conditions, software must talk to, not only the next processor, but also to the processor further on down the system.

One participant proposed that architectures are currently based on the fact that the network processor is part of the computer. He argued that the network processors need to be made part of the network, so that they have some shared state. "When we do that," he said, "the network will be able to do magical things because it becomes a parallel computer, not just a bunch of computers talking. I think that is one of the opportunities for really changing the way we think about the network." A Next Big Thing?

The group agreed that complexity will remain, but it needs to be well organized, it must be hidden from the user, and it requires a meta construction above it to manage the complexity and the system as a whole. Finally, we need to look at the basic networking architecture and imagine new structures for it.

"Whatever the Next Big Thing is going to be," concluded one participant, "it is going to be a complex system comprised of complex systems. We are going to integrate a lot of existing hardware, software and existing solutions, so that whatever it is, it is not going to be a stand-alone piece that is going to revolutionize the world. It is going to be something that integrates a lot of stuff that is either there, is on the way there, or is on the way out, and it is going to be a complex, almost dynamic system."

## Interoperability

To allow real sharing, not just of data but of computation, will require protecting the machine from the process and, eventually, the process from the machine. One participant posed the question whether, in the next five years, it is truly realizable to have such consistent semantic argumentation that two machines could autonomously agree on something and really do something productive. He suggested that if designers could get 80 percent of the solution and systems, then human beings would be able to map processes together very

quickly, economically and in a dynamic manner. "We get to the degree of dynamic data sharing that could actually deal with human processes and cultures today," he suggested, "and leave the last 20 percent for the next generation." Another participant proposed that as soon as one decides that it is acceptable if two automated systems cannot work together you are at your 80 percent. To accommodate machines that do not interoperate, designers need to make it easy for new things to enter the system. Wrappers make it relatively easy to allow participation in the system, albeit at a very unsophisticated level. Wrappers do not, at this point, involve mapping semantics between systems.

## Data Management

Software is currently under development that allows a user to get data from a number of relational and unstructured sources on the Web based on a single query and then push the information back to the user in one format. Finding the data is just the tip of the iceberg. It needs to be put into the right context, interpreted and information extracted from all sources of data. "The big delta is not finding the data," said one participant. "It is translating it into something that is meaningful." The goal is to automate some of the decision-making. Another participant suggested that this type of temporal analysis of databases is outside of the five-year window imposed on this Session. The group concurred that this ability for software to analyze information on the Web and turn it into information that can be used for decision-making could, indeed, be a strong candidate for the Next Big Thing.

## Bio-Medical Industry

The group discussed that the bio-medical industry is software limited at this time. It takes weeks to derive information from data to determine the susceptibility of individuals because of either pre-existing, inherited characteristics or environmental matters. The chemistry can be done quickly, but the information extraction from the data is laboriously time consuming. One participant felt that the opportunity exists right now to provide a Google-like solution for the bio-medical industry. "The industry is screaming for a solution," he claimed. "The demand would be overwhelming." An on-line bio-analyzer could be the Next Big Thing for the bio-medical industry. This would mean real-time analytics.

One participant proposed that the health care system in the United States is collapsing under its own weight. He questioned how the government will respond and what software will be necessary to meet that response. Another noted that the Health Insurance Privacy and Portability Act (HIPPA), which places new privacy and access requirements on patient information, will affect software development in the health-care industry.

## Transforming the Enterprise

What impact will new capabilities -- brought about by advanced, and, perhaps, discontinuous Internet technology -- have on the fundamental structure of the enterprise?

Participants posited an enterprise exists the way it does, with most functions under the same "roof," (campus, corporation, firewall), because it has been the most economically feasible way to organize necessary task. With the advent of certain types of always-on, real-time, connected, extensible and self-configuring networks (candidates for our list of discontinuous technologies), the real costs of performing business functions change. Several participants' companies are looking for business models that makes it possible to break up their large companies into component parts, creating fundamental changes in the structure of the enterprise. These changes are made possible because the technology allows businesses to outsource real business processes less expensively than to maintain all these functions under one roof.

## Mass Customization, Rapid Application Development and Collective Intelligence

A conversation that began with discussion of the mass customization of software ended with the ominous prospect that Web Services may create a collective intelligence of its own. Open sourcing of software applications on the Web, in combination with outsourcing of tasks across the firm, could drive down the cost of creating custom software. Companies can effectively customize and integrate off-the-shelf components, tied in by real-time integration. A middleware opportunity then exists for the creation of tools that will help people rapidly pull together resources that are out on the Internet and, using distributed teams, aggregate and create very customized applications for business needs. This is rapid application development. "The old idea of rapid application development," said one participant, "is, 'Let us quickly create something from nothing.' The new idea is, 'Let us quickly assemble the massive wealth of stuff out there down to our needs.'"

*. . .emergent properties are a real danger that needs strong security and delegation measures to control. "I can delegate, with limits, on things I know I can do,but I cannot control how they gather authorities together from other sources."*

Another participant coined the term "emergent properties" to describe what could happen when enough of these pieces talk to each other. "Will they do something that no one ever thought of doing when each of those components was written?" he asked the group. "This could happen without our interference." While the group agreed that the emergence of unknown properties is a real possibility, they disagreed as to whether the aggregate results of software pieces coming together and producing unpredictable results is an advantage or a disadvantage. One participant argued that emergent properties are a real danger that needs, again, strong security and delegation measures, to control. "I can delegate, with limits, on things I know I can do," opined another, "but I cannot control how they gather authorities together from other sources. The way ants show collective intelligence, but individually they do not, our Web Services may show collective intelligence, even though the individual components could not do any of those tasks." Collective intelligence among software applications. Could this be the Next Big Thing? It may be unavoidable.

## Nano-technology

According to Business Week On-Line, Spring, 2002, nano-technology is the ability to create materials from building blocks the size of viruses. Participants posited that a possible Next Big Thing is that nano-technology will provide unlimited memory to devices. One participant suggested that in the not-to-distant future, we will never have to throw any data away. "Storage density is going up faster than we can figure out how to use it," he said. This capacity for memory will greatly enhance the capabilities of Personal Digital Assistants (PDAs). With this unlimited memory, PDAs will become context-aware devices that sense other devices in your space. "My PDA will know every other PDA that is in the room," he added.

While the group attributed great technological advances to the implementation of nano-technology one participant questioned whether we are really going to see its application in improved connectivity and device-to-device communication in the next five years, because the privacy issues are so huge. "Do I want you to know that I just purchased a package of cigarettes? I don't think so," he opined.

Another participant suggested that the hardware will be here in five years, but the secure software may not. He felt that initially we may be underutilizing the software, but the industry still needs to put thought into the

technology today. A third participant suggested that even though the privacy issues might not be solved in five years, if the hardware and software exist, there may be applications in the B2B space where the privacy issues are less politically sensitive and more associated with trading partners and supply chains.

One participant added that certain kinds of information will not be available due to privacy concerns, but that the technology will move forward by popular demand. "If the technology can associate your name with your face," he said, "and tell me through my eyeglass display who you are and when your wife's birthday is, I think that kind of access to information will be so popular it will override any privacy concerns."

The Smart Tag is also dependent upon the capabilities of nano-technology. The Smart Tag, with virtually unlimited memory, can accomplish a variety of interesting tasks. Participants envisioned a future where Smart Tags are in everything, and everything is known to one another. They said that in a few years, companies will print nano-tags as bar codes are done today. In combination with always-on connectivity and real-time communications, the model will be that one is always connected and, if one is not, it is something one fixes as soon as possible. A Smart Tag could track everywhere that it has ever been and tell everything there is to know about it. "That quart of milk could tell you how old it was, its highest and lowest temperatures, etcetera," said one participant. In this vein, the ability to track a cargo container in its trek across the globe has important implications for security against compromising the contents of that container in the shipping and logistics world.

## Conclusion

Whatever emerges as the Next Big Thing -- whether it be embedded systems, ways to manage complexity, Web Services, the effective sharing of computation, autonomic computing, effective data management, dynamic data bases, always-on collaboration, games, semantics or micro-middleware – the group agreed that the next discontinuous technology in the enterprise software space has to help run businesses better and with more productivity. The Next Big Things in Internet technologies will emanate from complex systems interacting dynamically on various devices through bridged, ubiquitous connectivity media. And, very likely, all the technologies necessary to compile the Next Big Thing are already developed, waiting in the wings for someone to put the pieces of the puzzle together to solve a gaping business or social need.

## Appendix I: The Next Big Thing on the Software Horizon

Participants exchanged ideas about influencing factors in the world, in general, and in the technology space before generating a list of what they considered would be the Next Big Thing on the software horizon by 2007. Please see Appendix II, III, and IV for those influencing factors and technologies.

The top choices and their rankings for the Next Big Thing are listed directly below. The full list follows.

Top Choices for the Most Likely Next Big Thing on the Software Horizon by 2007

Participants voted on which "Next Big Things" they thought most likely to emerge on by 2007. Each asterisk represents a vote from a participant.

**********Collaborama© -- Massive multi-player or useful work collaboration

*********Always-on, real-time dynamically reconfiguring and extensible smart tags

*********Autonomics

- Solving the cost issue of computerization
- Self-configuring
- Self-optimizing
- Self-healing
- Self-protecting

*******Connecting the Islands of data through shared ontologies

******Personal, trainable agents that manage our personal complexity

***Mass Customization: Design and build to order on a massive scale

****Tools for rapid application development through inherent interoperability of software

- Emergent properties of the resulting hybrid software
- Present both dangers and opportunities from the unknown combinations

*Real-time interactivity

*Medical/Bio real-time analysis

*Data Management

*Speech recognition

### Full List of Ideas for the Next Big Thing on the Software Horizon

- Video instant messaging
- Secure personal "life capture"
  - Video, audio and associated services
- Personalization
- Computer enabled artifacts
  - Manufacturing, cars, houses self-management and maintenance
- Massive, multiplayer on-line games
- Games/simulations
- Smart, adaptive software components
  - P2P or agent-based software architectures
- Peer-to-Peer software share-ability for solutions, secure and with graphical display of the networked solution, performance measures and states or parameters to tune
- On-line bio-analysis for DNA-based insight to
  - Disease diagnosis
  - Disease susceptibility
  - Drug discovery and testing
  - Environmental factor correlation based on human/animal DNA and micro-array testing, scanning and analysis
- Improved software-development testing & integration tools
- High assurance
- Computing on demand
- Unstructured data management
- Micro-personal, mini-mainframe-network sharing; not just for data but for knowledge
- Data center automation with reduced complexity
- Protocol stack expanding into data/knowledge stack and expanding the ISO model
- Autonomics
- Understanding semantics

- Self-identifying goods allowing:
  - Real-time inventory
  - Auto purchase/rental
- Large-scale communication/collaboration infrastructure to enable dialog and problem solving for global problems
- Software for a streamlined real estate transaction
- Software that enables real financial transaction security
- Real-time decision support
- Decision process re-engineering
- Real-time customer self-service
- Real-time enterprises/supply chains with Web Services, smart content, collaboration and agents
- Software as a service
- Delegated computing where interactions among software components are not hardwired
  - Increases re-usability, robustness and evolvability of computing
- De-aggregation of software into interacting and interoperating components
- Seamless distributed computing
- Software exists and operates inside a larger system; needs to consider the context within which it operates
- Web Services
- Software for traffic optimization
- Emergent properties from large umbers of Web Services
- Semantic interoperability
- Business logic external to code; pool of methods
- Workable naming scheme
- Formalized semantics; ebSML moving into Minsky frames
- Universality of protocols moving into application conversations
- An always-on, always connected, dynamically re configurable and extensible network if distributed services
- Continuous, multi-channel platform
  - Access from any platform in a coherent way
- Wireless

## Appendix II: Challenges to our Daily Lives

Throughout the Think Tank Session participants were asked to generate ideas around different themes that would serve at the building blocks for their discussion and ultimate foci for the day. Below is the list of what challenges participants felt that face in our daily lives. This list helped focused the participants on what issues could be solved with breakthroughs in software applications.

- Environmental, social and economic sustainability
- Loss of control over objects in our environment
- Bring the poorest 4 billion on the Planet into the economy
- Emotional, religious security threats un-aligned with any national authority
- Ability to adapt to changes in technology
- High-quality display that works in bright sunlight and darkness
- Clear wireless service
- Anti-spam email
- Wireless access to more services that relate to daily life activities
- Information overload, including spam
- Too much information that is not well organized
- Getting the information one needs when and where one needs it
- Managing the huge amounts of data that will be gathered
- Technology complexity and its real usefulness to many people
- Already too connected; more coming!
- Information overload
- Lack of a new paradigm for the next big thing
- Too many meetings
- Operating in the global economy; cross-cultural, functional and integration
- Lightweight, long-life, safe, non-toxic electric battery
- Transportation is a drain on our time
- Traffic congestion

- Dynamic trading partner formation
- Mass customization
- Privacy and security
- Privacy in the face of physical security concerns
- Identity/Privacy; how to log in to services without loosing privacy
- Privacy invasion
- Good online and credit card security
- Globally connected AI-enabled toys such as robots

## Appendix III: Major Forces in the World that could Influence the Development of the "Next Big Thing"

Participants listed major forces they believed would influence the emergence of the Next Big Thing on the software horizon. These are listed below.

- Personalization: Go from Model T Ford to Built-to-Order Goods
- Smart devices everywhere
- RFID smart tags in everything everywhere
- Pervasive sensing devices everywhere
- Instant messaging everywhere
- Ubiquitous P2P internetworking
- Always-on global Internet presence
- Ubiquitous connectivity
- Complexity
- Shift to complex system
- Safety
- Security
- Cyber security
- Privacy
- Government systems for better service in all government departments
- Grid and marriage between OS and middleware
- Shift to multi-processor and grid solutions
- Storage density; with nano-technology, never discard data
- Make computers easy to use
- Disposable, error-free PC
- Cheap memory
- Moore's Law continues
- Operation and expansion of new markets such as China
- China and other nations becoming more computerized
- Terrorism
- Political instability of emerging nations that become major new markets
- Balancing human rights with physical security
- Seamless global communications and trading
- Globalization
- Increasing interconnections between economies and cultures
- Clash of cultures
- The Ongoing and rapidly increasing clash of civilizations
- Large retiring population
- Global teenager
- World economy
- Wealth distribution
- World environment
- Deregulation of communications networks in developed countries

## Appendix IV: Discontinuous Technologies from Outside of the Software Area

Participants noted technologies from outside of the software realm that could be deemed as "discontinuous," or as sparking a significant shift in the way a task or operation is currently handled.

- Semantic Interoperability
  - 5 years out
  - Incorrect documentation for old applications
  - Semantic Web within 5 years
  - Bridging the "Islands" of connectivity
  - Increasingly more abstract syntaxes
    - Designing to a higher level
- Chips
  - Will run into power and heat walls

- Are out-running software
- TCPA/Paladium
- Nano-technology
  - Molecular-based memories
  - Qualitative changes
- Low-cost RFID tags and smart cards
- RFID Technology
  - Presence measuring
  - Privacy issues are huge
    - Higher probability for B2B
    - Few problems with B2B
- Pervasive surveillance
- Standards
  - Minimum of 3 years out
- Basic network infrastructures need to be secure. Once they are, huge changes will take place.
- Secure platform infrastructure
- Alternative energy such as fuel cells
- Early nano-technology
- Nano-technology memories in 5 years
- Nano-technology computers in 10+ years
- Quantum computing
  - Keys -Today
  - Cryptography -Soon
  - Computing -When?
- Interaction technology, such as that for mobile devices
- PDAs
- Collaborative homeland-security threat detection
- 12+-hour battery for notebook computer
- People are becoming more service- and possibility-aware
- Hyper-cars
- Naming
  - Temporal and spatial integrity
- Micro-middleware
- Application of mathematic linguistics to genetics
- Collaborative performance measurement systems
- Collaborative value-chain management
- Always-on mobile wireless Internet
- Broadband wireless
- Broadband
  - IBv6 offers real security
  - BlueTooth brings infrastructure and needs to be secure
- Public/private partnerships forming at city/county level to solve Internet/Broadband accessibility in spite of de-regulated communications
- The government's response to health insurance collapse
- Cure for AIDS and cancer
- Breakthrough for obesity
- Smell and tactile on computers via the Net
- Biotech causes people to live twice as long
- Global teenager
  - Empowered to create, research and live on the Internet via flat-rate charging through schools and opt-in for special needs. Much faster adoption of technology thatn parents and can cross boarders
- A special form of enterprise formation