

# Agent Technologies

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Discussion Paper

*A Draft White Paper by:*

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Capgemini

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## ***Agent Technologies Discussion Paper***

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Agent Technologies Discussion Paper

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*Boundaryless Information Flow™  
achieved through global interoperability  
in a secure, reliable, and timely manner*

## **Executive Summary**

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We all know that the Internet has changed everything. It has led us into a new and different direction, initially with the web itself and latterly into Service Oriented Architecture. Now we have to re-examine our thinking in terms of how to make such solutions work – and especially how to make them scale.

Today, the biggest challenge for any enterprise is to be adaptive; and to create systems that can continuously change and be improved without downtime. While tremendous gains have been made over the last thirty years, today's applications are not as flexible as promised. Technology has become the limiting factor in executing a business strategy, and we need to find new tools and techniques that allow us to bring technology's capabilities in line with business demands.

Over thirty years, agent technology has come a long way, and today it provides us with a sophisticated suite of tools and techniques that promise to be capable of managing – in real time – the complexities of modern business processes. The fact is that business exceptions are no longer exceptional; they are simply alternative ways of achieving a goal. Not having Boundaryless Information Flow™, where systems interoperate (i.e., they easily exchange information and use that information to improve operations) is causing organizations real pain.

You are invited to join us as we focus on agent technology's application in the field as part of core enterprise solutions. The rewards look very promising.

## Introduction

This White Paper discusses the nature and scope of future activities of The Open Group related to agent technologies. Therefore, it:

- Examines the problem of scalable computing
- Explains how agent technologies can provide a solution
- Describes the kind of forum needed to facilitate the solution
- Concludes that such a forum should be created within The Open Group

### Why bother to change right now?

The role of the Internet in connecting systems at a number and scale that seem unimaginable – outside anything known before – has already led us into a new and different direction, initially with the web itself and latterly into Service Oriented Architecture (SOA). Given these and other fundamental shifts in the way people who add devices are choosing – and wish – to do business, it is not surprising that we have to re-examine our thinking in terms of how to make such solutions work; to look at cost and reliability at a technology level and business purpose level. Just as there is an acknowledgement of outgrowing ERP procedures, so there must be an acknowledgement of how to achieve a similar scalability in results; but in a new medium.

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*Technology has become the limiting factor in executing a business strategy, and we need to find new tools and techniques that allow us bring technology's capabilities in line with business demands*

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## The Problem: Scaleable Computing

Today, the biggest challenge for the enterprise is to be adaptive: to create systems that can continuously change and be improved without downtime. The history of enterprise software has seen a steady progression after the first few hesitant steps, with each generation providing more capable solutions than the previous. Enterprise applications are available to automate almost every aspect of a business – enterprise resource planning (ERP), customer relationship management (CRM), supply chain management (SCM), materials resource planning (MRP), and operational management suites are available from multiple vendors.

While tremendous gains have been made over the last 30 years, today's applications are not as flexible as promised. Technology has become the limiting factor in executing a business strategy, and we need to find new tools and techniques that allow us bring technology's capabilities in line with business demands. The current wave of service-based approaches provides a partial answer, simplifying incremental development and re-use to provide a generation of IT solutions more flexible and agile than previous generations.

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*These changes create new challenges, and a significant one is scale*

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The more granular approach to IT provided by service-orientation enables the erosion of the walls between departments, and organizations, as business processes extend beyond the enterprise to include suppliers, partners, channels, and employees in the field. This boundaryless environment brings new challenges, creating a wealth of opportunities that the current enterprise technology stack does not allow us to exploit. These opportunities reside in the exception-rich, non-linear processes responsible for business exception management and resolution, or the optimization of these processes, which remain firmly the responsibility of employees and the extended teams within which they function. Delivering the flexibility desired requires us to address this unsupported functionality.

These changes create new challenges, and a significant one is scale. The creation of a boundaryless information environment will necessitate rethinking the possibilities to isolate and define in advance all the combinations of interactions that can occur. The impracticality of the task, let alone the number of rules required, suggests the need to consider alternative technology approaches.

Our inability to leverage the opportunities created by the boundaryless environment is creating real organizational pain today<sup>1</sup>:

- \$Millions in lost opportunities
- \$Billions spent to make systems interoperate or to recover from mistakes

This also includes a significant human cost, in terms of lives lost as hospitals, emergency and disaster systems, critical infrastructure, air traffic control, etc. operate below their full potential.

### **A problem statement**

Despite recent advances, key differentiating activities remain firmly in the domain of employees and the extended teams within which they function. The current technology stack has succeeded in removing a great deal of make-work from our employees' day-to-day lives, but automating the complex, trial-and-error processes that we rely on them for is beyond the capabilities of our existing technology stack. Manual intervention continues to be a reality in many situations where there is a need to translate policy and make assessments.

This is the root cause of the challenge in front of us, as retaining people in the transaction streams has a number of immediate effects:

- The potential for human error
- Inconsistent decision-making

<sup>1</sup> Responses to a survey conducted at a conference of The Open Group.

- Delays in responding or executing
- High cost of compliance audit
- Limitations on managing scale and complexity

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*We tend to find a solution that works for us, rather than the best possible solution*

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As people, we are very flexible decision-makers, capable of finding creative solutions in uncertain environments, but we do have limitations. Our relatively slow “thinking speed” (compared to computers) and the low number of options we can consider at once (typically somewhere between four and six) restricts us to creating solutions that are just acceptable in the local context. We tend to find a solution that works for us, rather than the best possible solution.

Human involvement – the requirement to put employees inside transaction streams – is the new limiting factor. Our limited capacity to process data and consider options prevents us from capitalizing on the opportunities unlocked by the boundaryless environment.

Service Oriented Architecture (SOA) has enabled us to deliver a consistent level of automation across the business and drive down costs. It hasn't provided us with the tools to attack more complex problems, to automate the business exception resolution, and complex decision-making that we currently rely on people for.

If we want to deliver the step change promised, then we need to remove employees from operational roles within the transaction stream, where simple human limitations are holding us back. We need to automate these key differentiating activities. Automation allows us to apply the much greater scale of information technology – its ability to consider vastly more options, rules, and interactions, and look across the boundaryless environment – to create globally optimal solutions. Employees move from an operational role, to a supervisory and optimization role where they can leverage their creativity to enrich these differentiating activities and create a competitive advantage.

This is beyond the capability of conventional technologies. The programming languages, development approaches, and rules and business process engines we currently use in the enterprise are mature products with well-understood limitations. Human flexibility is part of our ability to tolerate conflicting goals and rules while working toward a solution. For example, work to capture and automate government legislation<sup>2</sup> with rules engines quickly found contradictions (otherwise known as loopholes) in the legislation's business rules.

<sup>2</sup> Serot & Kowalski's work on the British Nationality Act in the early 1980s, available at: <http://doi.acm.org/10.1145/5689.5920>.

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*New development efforts must move up the business value chain and deliver solutions to the exception-rich business problems previously beyond IT's reach*

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While the government was sure of the legislation's intended effect, conflicts and inconsistencies within the act meant that no one, not even the people responsible for drafting the act, could be sure of the actual effect. However, government found the act workable as the people responsible for interpreting it were perfectly capable of working through the contradictions and inconsistencies as they sought solutions that met the legislation's original intent. Aside from theoretical arguments, the simple fact that they haven't been used to support these differentiating activities can be seen as evidence that that is beyond their capabilities.

The current technology stack places us at the leading edge of the step change; however, delivering the change will require something new.

New development efforts must move up the business value chain and deliver solutions to the exception-rich business problems previously beyond IT's reach.

### **A revolution in concepts**

As we all stand at the forefront of IT, we can look behind us at over 40 years' software development. Over this time, IT has progressively matured as it delivers more and more capabilities to the business. IT has, in fact, completely revolutionized the way we do business, with the modern business environment having little resemblance to the environment Spencer Tracy was used to in the film *The Desk Set*<sup>3</sup> back in the fifties.

Our viewpoint also provides us with a clear view of the next information revolution, which is already well underway. Web 2.0 and social computing are turning IT on its head as we start to focus on supporting the poorly structured but information-rich deliberations, interactions, collaborations, and negotiations that exist between people. The next revolution is not appearing where information scientists, information executives, and the information industry in general are looking. It is not a revolution in technology, machinery, techniques, software, or speed. It is a revolution in *concepts*.

The maturation of the IT industry has allowed us to take for granted the functionality provided by today's generation of applications, freeing us to focus on understanding and supporting the creative processes behind human deliberation and interaction. This does not require a new generation of technology, but a re-interpretation of existing technologies. Wikis, blogs, and RSS all represent low-tech approaches to supporting people as they work together, repackaging old ideas like hypertext to suit the new purpose. Delivering on the promise of the boundaryless environment requires us to use the same approach to supporting, capturing, automating, and optimizing these same human deliberations and interactions in a business context.

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*We need to create a new generation of IT that will allow our solution to scale*

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<sup>3</sup> Refer to [www.imdb.com/title/tt0050307/](http://www.imdb.com/title/tt0050307/).



### **The vision**

Today, the sort of deliberations and interactions people are responsible for are seen as exceptional. Business exceptions are something we need to treat differently from the exception-free process flow. However, these business exceptions can represent a disproportionate amount of a company's competitive advantage. How we deal with a stock-out or select a trading partner has a much greater impact on the top line than how efficient our invoicing and collections process is.

We need to create a new generation of IT where business exceptions are no longer exceptional, where they are simply alternate ways of achieving the same goal, and where the concepts our employees use to deliberate are refined in software, removing people from the transaction stream. This allows our solution to scale, leveraging the increased capabilities of software to consider more options and look further across the boundaryless environment in search of an optimal solution. Employees move from operational to supervisory roles, where they monitor the transaction stream and use their creativity to search for improvements that might provide a competitive advantage. The interactions between employees as they work together in teams need to be refined in new protocols and orchestrations capturing the high-value interactions within an organization. And, finally, we need to look to creating electronic markets where organizations can gather to form alliances and build virtual partnerships.

## **Agent Technology: A Possible Solution**

### **The role of agent technologies**

Agent technology has a long history going back over 30 years to Carl Hewitt's work on actors as autonomous primitives for distributed computation. The technology has come a long way since then, and today it provides us with a sophisticated suite of tools and techniques that promise to be capable of managing – in real time – the complexities of modern business processes.

Problems are decomposed into a set of software agents, each with its own goals, strategies, and intentions. Solutions are then constructed by organizing agents into teams capable of cooperating and negotiating to achieve a set of common goals. The anthropomorphic view of software the technology provides allows us to leverage ideas from economics and complex systems theory to create applications that exhibit the richness and capability of systems seen in the natural world.

Agent technology has proven itself as a powerful tool, enabling the development of more flexible, adaptive, and sophisticated applications than are possible with other approaches. Companies that have been involved with agent technology believe that: “agent technology is the foundation of

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*We must focus on the technology's application in the field*

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*Agent technology results in increased speed and accuracy, delivering an immediate benefit to the business*

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adaptive systems” (Navi Radjou, Forrester); however, successful proof-of-concepts or prototypes have faced difficulties when moved to production.

Widespread adoption has been frustrated by the technology's inability to break away from its roots in research and find a place in the standard enterprise toolkit. Efforts to integrate conventional and agent technology stacks have failed, as either the conventional or agent technology is compromised and neither the agent technologist nor enterprise developer is satisfied with the result. Agent technology is still seen as something apart from more conventional enterprise technology stacks – complex to use and difficult to manage once deployed.

### **A different approach**

As agent technology is well-served with forums focused on standardizing the technology, we want to take a different approach and focus on the technology's application in the field as part of core enterprise solutions. Rather than develop a standardized agent platform, we want to integrate the technology with existing trends in the enterprise software market and leverage it in the development of key data-center solutions within the enterprise.

The recent emergence of SOA has provided the IT community with its first cross-platform enterprise software stack. SOA and the development of composite applications represent a consolidation of existing enterprise functionality. Previously, users were required to mediate between applications via their swivel-chair, manually copying data between and synchronizing these applications. Composite applications directly address this problem by providing them with a single consolidated view into both enterprise functionality and data. Users are provided with the correct data, at the right time, and presented in the most appropriate fashion to facilitate the business decision they need to make at that moment (“Should I cross-sell?”, “How do I resolve this lost shipment?”, “Is this credit card transaction fraudulent?”).

While this is a big step forward for enterprise software, a more cynical view is to see composite applications as simply solving problems created by previous technologies. Composite applications simplify operations by eliminating the negative aspects of more conventional silo approaches, allowing users to focus on the job at hand. However, a composite application doesn't enable the creation of more advanced business logic, as the tools and techniques SOA provides are a repackaging of existing technologies. Human employees are still the most effective means of supporting the sort of complex, trial-and-error, non-linear decisions required to support business exception management and process automation. If a decision or process is too complex for a Java implementation, then it will also be too complex for BPEL or a rules engine.

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We plan to use a common “*automate, extend, network*” approach to integrating agent technology into a conventional SOA technology stack.<sup>4</sup> This builds on the recent development of SOA and composite applications and their ability to consolidate enterprise functionality and bring user roles into focus.

Once consolidated, we can use agent technology to capture manual exception management processes, leveraging the advantages of automation to move from the locally acceptable solutions generated by employees to locally optimal solutions that automation enables. Automation also results in increased speed and accuracy, delivering an immediate benefit to the business. Employees move from an operational role, where they are integrated into the transaction stream, to a supervisory role where they are responsible for oversight and optimization of key exception management business logic.

Common examples of role-based automation might include fraud detection within a live transaction stream, supply chain exception management, automated local loan approvals, or the automated determination of financial adequacy.

Next we focus on capturing the collaboration and negotiation between distinct roles to create virtual teams, allowing our automated roles to look across its social network to negotiate with its peers in the creation of globally optimal solutions within an enterprise. This builds on the role-based automation from the previous phase, expanding our view beyond that of a single role to include the role's social content—its team.

Where role-based automation allowed us to capture and then optimize the business logic within a role (treating other roles as simple services on the network), a team allows us to consider a group of roles as a whole and capture the negotiations between team members as part of the solution. This allows a role to influence other roles as they reach a decision, simply delegating work or even agreeing for both roles to change their current plans in order to resolve an issue.

Finally, we can network the role-based solutions together and leverage market-based approaches to form automated networks of roles, departments, or even separate companies that dynamically manage resources across the network. This allows us to expand our view of a role's social network beyond the team to support boundaryless business processes. Rather than requiring a single, central planning authority, we can leverage ideas from economics to create flexible markets where roles gather to manage resources.

<sup>4</sup> This approach is discussed in more detail in the article “Moving beyond Composite Applications to the Next Generation of Application Development: Automating Exception-Rich Business Processes”, available at: [www.bijonline.com/index.cfm?section=article&aid=282](http://www.bijonline.com/index.cfm?section=article&aid=282).

## A Forum to Facilitate the Solution

A new forum is needed to facilitate the development of a new generation of tools and techniques capable of capitalizing on the boundaryless environment.

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*We will create a Lloyds of London for agent technologies – an environment where people with problems can meet with people that create solutions to share ideas and work together*

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Our intention is to create a Lloyds of London for agent technology-enabled solutions. Not the modern Lloyds though – our thoughts are more aligned with the original coffee house where people gathered around tables to negotiate insurance deals. As proprietor of the coffee house, The Open Group will provide an environment where the people with problems (from industries such as logistics or finance) can meet with the people who create solutions to problems (consultants and systems integrators), people who support the core business functions in focus (conventional vendors), and people with a deep understanding of the technology (agent technology vendors and research institutes) to solve the problem. Participants can choose to simply share ideas or war stories through to working together to solve specific commercial problems.<sup>5</sup>

Given our goals, we intend to create two general streams of effort within the forum. The first is a community of practitioners interested in working together to find applications for the technology in industry. The second is a formal standardization process to support the integration of agent technology into the appropriate standards. Our intention is to allow developments and discussions from the community of practitioners to drive the direction and development of standards, ensuring that our efforts are focused on those aspects of the technology relevant to the application of agent technology in operational enterprise solutions.

### A community of practitioners

The community of practitioners will encourage a number of conversations (the challenges of integrating agents and SOA, driving technology standards, how to promote agent technology, engagement with other forums, and so on), but the development of repeatable solutions will always be the main focus.

### Standards

Key to the success of the forum is the creation of a body of standards that represents the current best practices for leveraging agent technology within the enterprise context. The body of standards will act as a tool to align the participants' efforts, ensuring that hard-won knowledge is refined in re-usable artifacts, as well as providing platform vendors with a stable target for the development of a new generation of agent technology-enabled platforms.

<sup>5</sup> The commercial arrangements of forum participants who decide to jointly work together in the development of a solution is beyond the scope of the forum.

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Two general streams of standardization are anticipated:

**Analysis and Design:** The integration of agent technology analysis and design techniques with their more conventional brethren. It is anticipated that architecture and modeling standard – such as TOGAF, UML, and MDA – will provide a foundation to leverage elements from agent standards such as Tropos and Agent UML. The resulting methodology will provide practitioners with a tool for understanding, modeling, and communicating agent-enabled solutions.

**Technology:** The extension of existing standards from the SOA technology stack (such as BPEL and the WS-\* family) to incorporate key elements of agent technology and the creation of agent-technology-enabled solution frameworks, akin to the work underway in the OASIS SOA Reference Model.<sup>6</sup>

### Objectives

The **near-term** objectives are:

- Establish the forum
- Develop the mission statement
- Create critical mass of participants
- Create an Agent Reference Model, defining key concepts and terms
- Collect a list of use-cases and scenarios in each industry, including how they were solved and how they would be solved according to the Agent Reference Model

The **mid-term** objectives are:

- Define an Enterprise Agent Stack Reference Model; one that includes SOA/WC components (Components/services in the Enterprise Agent Stack Reference Model that are not currently served by a standard or *de facto* technology should be identified as potentially the subject of standardization in some form.)
- Pull in applicable external standards
- Leverage solution work from members to create “enabled solution frameworks”
- Work with existing standards bodies to extend their standards in a solution-friendly way

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*If you would like to get involved, please contact Chris Parnell at The Open Group:*  
[c.parnell@opengroup.org](mailto:c.parnell@opengroup.org)

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<sup>6</sup> Ideally we will synchronize with the OASIS SOA Reference Model work.

The **long-term** objectives are:

- Identify the components of a reference platform
- Develop new standards to fill gaps in the platform
- Develop open source reference implementations, where appropriate

## **Conclusions**

We find ourselves rushing toward a tipping point as SOA creates a boundaryless environment that we cannot capitalize on. The challenge of scale, of managing the massive number of options and opportunities the boundaryless environment presents us with, requires us to find new approaches to automation.

IT needs to start moving up the value chain to attack the complex problems currently out of its reach, and which we rely on people for. Doing this will allow us to leverage the capabilities and scale of IT to deliver globally optimal solutions, where people are limited to locally acceptable solutions only.

Agent technology has a strong heritage in delivering sophisticated solutions to complex problems, and can provide the tools that are required. Standards have already been established in a range of forums, but the biggest question still remains: how to successfully leverage the technology in the boundaryless environment.

A new forum that can answer this question should be created within The Open Group.

We should take an “*automate, extend, network*” approach:

- First we will identify the tools and techniques required to capture the human deliberations that are at the heart of a company’s ability to differentiate and establish itself in the market.
- Second we will expand our field of view to encompass the high-value interactions within the organizational team.
- Third, and finally, we will look to market-based approaches that may be leveraged to bring organizations together.

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The forum should have two major components:

- The first is a coffee shop – a community of practitioners where people with problems, solutions, and technology can gather to discuss different approaches and solutions.
- The second is a standardization effort, taking the lessons learnt from the coffee shop and refining them into a form everyone can use.

This is the most pragmatic approach to successfully leveraging agent technology to meet the challenge that the boundaryless enterprise presents.

## About the Author



**Peter Evans-Greenwood** is CTO, Australasia at Capgemini where he provides clients with guidance and support in the development of next-generation IT systems. Over 15 years' experience working at the interface between research, technology, and business has seen him involved in a diverse range of problem domains, from traditional back-office applications (such as finance, billing, logistics, B2B, B2C, and CRM applications), turn-key solutions (including MUARC's advanced driving simulator and air traffic control), through to leveraging emerging technologies to create innovative B2B and voice portal solutions (such as OnStar).

## About Capgemini

Capgemini is a global leader in consulting, technology, outsourcing, and local professional services. They are headquartered in Paris, France and operate in more than 30 countries. It is, above all, a people company with nearly 60,000 people in North America, Europe, and the Asia Pacific region. Management and support roles aside, its employees are grouped into four major disciplines (referred to above), each of which is governed by its specific economic rules, and managed with its own profit. Further information on Capgemini can be found at [www.capgemini.com](http://www.capgemini.com).

## About The Open Group

The Open Group is a vendor-neutral and technology-neutral consortium, whose vision of Boundaryless Information Flow™ will enable access to integrated information within and between enterprises based on open standards and global interoperability. The Open Group works with customers, suppliers, consortia, and other standards bodies. Its role is to capture, understand, and address current and emerging requirements, establish policies, and share best practices; to facilitate interoperability, develop consensus, and evolve and integrate specifications and Open Source technologies; to offer a comprehensive set of services to enhance the operational efficiency of consortia; and to operate the industry's premier certification service, including UNIX® system certification. Further information on The Open Group can be found at [www.opengroup.org](http://www.opengroup.org).