



The Power of Agent-Based Systems

THE NEXT MAJOR ADVANCEMENT IN NETWORK COMPUTING ARCHITECTURES

Cougaaar Software applications are built upon a powerful architecture concept called distributed intelligent agents. Distributed agent technology represents the next generation application paradigm beyond object-oriented technology. While it is built on an object-oriented language, the design is pervasively process-centric rather than data-centric. Business information systems are intended to manage the intersection of information and processes and to meet goals of being more agile, aware and flexible. When enterprise applications are process-oriented and are enhanced with cognitive features, a component-based approach and rich collaboration capabilities, as is the case with intelligent agent systems, these goals can be achieved quickly and cost effectively.

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Executive Overview

To be successful in today's technological climate, it is imperative that business processes be efficient, timely, and accurate. However, in the modern enterprise, business operations are in a constant state of flux evolving from one form to another in fluid and often unpredictable ways. The major problem for the modern enterprise is how to become more aware, agile and flexible.

More flexible and advanced than basic peer-to-peer or object-oriented computing, agent-based systems represent the next major advancement in network computing architectures. With intelligent agents, we can build larger and more complex systems than are possible with conventional architectures.

The key benefits of agent technology come in three areas –

- **Dynamic Planning** – The ability to develop distributed workflows using rules and domain knowledge that is appropriate to the current situation. This benefit allows enterprises to create more accurate and appropriate plans and to react more quickly and appropriately when conditions change.
- **Business Process Adaptation/Evolution** – The ability to allow significant business changes to be implemented quickly and dynamically by actual users who can easily manage adjustments to the business rules or policies—without engaging consultants to significantly alter their systems. This benefit allows enterprises to be agile and adaptive as conditions change, thus saving valuable costs in process re-engineering.
- **Collaborative Execution** – The ability to easily share information and coordinate changes with your partners, suppliers and customers.

Applications that use only object-oriented technology usually fail to achieve the business goals of being agile and flexible because all processes are hard-coded in the applications. Customizing business processes tends to be the most costly component of enterprise systems because of this shortfall. When enterprise applications are process-oriented and are enhanced with cognitive features, a component-based approach and rich collaboration capabilities, as is the case with intelligent agent systems, these goals can be achieved quickly and cost effectively.

Complexity of Today's Business Operations

In business today, the only constant is change. Operations are in a constant state of flux, evolving from one form to another in fluid and often unpredictable ways. Businesses struggle to ride the wave of change and evolve their structures, processes and products accordingly.

Unfortunately, most of the existing core business systems upon which companies rely cannot adapt easily or quickly to changes in the organization or in business rules. In addition, businesses are producing and are being inundated with massive amounts of data that is increasingly unmanageable, and, therefore, increasingly less meaningful.

The major problem for the modern enterprise is how to become more aware, agile and flexible. To meet these challenges, the modern enterprise needs the ability to:

- Develop detailed plans that address all facets of a dynamic environment
- Monitor those plans against a vast amount of potentially uncertain data
- Determine when and how to modify those plans dynamically

Why Don't Current Systems Hold Up?

Business information systems are intended to manage the intersection of information and processes and to meet the goals of being more agile, aware and flexible. Applications that use only object-oriented technology usually fail to be agile and flexible because all the processes are hard-coded in the applications. Customizing business processes tends to be the most costly component of enterprise systems because of this shortfall. Current business systems typically provide limited support for both planning and execution and virtually no support for execution monitoring and dynamic re-planning.

Luckily, an innovative technology based on intelligent agents has arisen that enables secure, dynamic collaboration over complex business processes and deals with massive amounts of information to levels of accuracy, timeliness and quality never possible before.

The Power of Cougaar

Cougaar, the Cognitive Agent Architecture, is a powerful new large-scale distributed, intelligent agent technology that models human decision-making and business process management in software. Cougaar was developed during the pursuit of the technology for creating a global command and control capability for DoD logistics under DARPA's Advanced Logistics Project.

The Cougaar infrastructure was used to build and demonstrate large scale planning systems with intelligent agents collaborating over scores of machines at geographically distributed locations. These efforts resulted in the capability to develop near-optimal solutions to complex problems that were otherwise unsolvable by humans in similar timeframes. The scope of the demonstrations included effectively managing millions of activities from hundreds of organizations while collectively controlling tens of thousands of resources.

Of particular importance are Cougaar's innovative abilities to manage information across global networks, allow fine-grained coordination of complex enterprise processes and provide workflows that address both physical and information activity streams. As part of a total architectural solution, the Cougaar infrastructure easily integrates with legacy and contemporary business systems at both the data and process level.

The Benefits of Agent Technology

More flexible and advanced than basic peer-to-peer computing, agent-based systems represent the next major advancement in network computing architectures. With intelligent agents, we can build larger and more complex systems than are possible with conventional architectures. These advanced systems leverage the strengths of object-oriented, peer-to-peer and service oriented architectures while providing a process-centric design paradigm. The key benefits of agent technology come in three areas –

- **Dynamic Planning** – The ability to develop distributed workflows using rules and domain knowledge that is appropriate to the current situation. This benefit allows enterprises to create more accurate and appropriate plans and to react more quickly and appropriately when conditions change.
- **Business Process Adaptation/Evolution** – The ability to allow significant business changes to be implemented quickly and dynamically by actual users who can easily manage adjustments to the business rules or policies—without engaging consultants to significantly alter their systems. This benefit allows enterprises to be agile and adaptive as conditions change, thus saving valuable costs in process re-engineering.
- **Collaborative Execution** – The ability to easily share information and coordinate changes with your partners, suppliers and customers.

Dynamic Planning

Dynamic Planning is the ability to develop plans in the form of distributed workflows using business rules and domain knowledge appropriate to the situation. As situations change, or execution of a plan does not progress as anticipated, the system must be able to dynamically re-plan the areas affected by the change or deficiency.

Unlike static or periodic planning, dynamic planning must account for the current situation and emerging trends as well as consider the flow of time in business decisions. Users must be able to adjust rules or change policies quickly and easily. These adjustments then dynamically influence the plans that are generated and triggers alerts and/or re-planning as required against current, unexecuted conditions.

Advantages of this advanced capability include:

- More accurate, timely and appropriate planning
- Instant reaction when problems arise and development of mitigation plans in seconds
- Easy adjustments to system behaviors by users – not programmers – in response to changing conditions
- Continuous status monitoring, assessing and alerting across the distributed plans
- Less time and money lost to production and supply chain delays ‘between’ planning cycles

Business Process Adaptation/Evolution

One of the major problems with ERP and SCM systems today is that the business processes are very rigid. When a company decides it needs a different process, vast amounts of time and money from teams of consultants are required to ‘bolt on’ changes to the system. The result of this, beyond the time and expense, is that enterprises lose the ability to be agile and adaptive as market conditions change. This rigid evolution strategy can lead to significant lost revenue and real limitations in process options. And, the biggest names in enterprise systems are major culprits of this painful evolution strategy.

With Cougaar technology, the following benefits can be realized:

- Significant business changes can be implemented dynamically by end-user adjustments to the business rules or policies. While high-level policies guide the emergent behavior across business processes, rule engines in each agent allow a large degree of flexibility over known domain processes.
- Processes can be evolved while in operation by dynamically loading or unloading domain modules (PlugIns). Using the Cougaar Open APIs, Open Standard design and architecture, these modules can be developed in-house or easily purchased from any of a number of application domain process providers.

- Businesses can assemble their enterprise processes using the best of breed interfaces while leveraging the seamless interoperability support provided by the underlying agent architecture.
- Vast amounts of time and money can be saved since hiring teams of consultants is no longer a requirement, and users can easily adjust business rules and workflow themselves.

Collaborative Execution

In the area of Collaborative Execution, the main benefits of agent technology arise from the ability to coordinate changes with your partners, suppliers and customers. In addition to collaboratively building and maintaining plans, you can work together to find effective solutions when problems arise. It is not always the organization with the problem that is best suited to provide the solution. Working as a team, an extended enterprise can achieve efficiencies never before possible, thus providing real value to everyone involved.

Other supply chain research has suggested that eliminating friction is one of the main benefits of execution time collaboration. An important component of eliminating friction is being able to compare execution status against plans and demand forecasts to determine if processes are proceeding as expected. This planning vs. actual analysis, when supported by dynamic re-planning, can be used to identify and address emerging trends quickly.

These considerations equate to the following value propositions:

- Maintaining accurate and appropriate (and minimal) inventories
- Ensuring production processes have the right material at the right time
- Avoiding interruptions, delays and errors in production processes
- Reducing friction in the process from engineering to production procurement
- Completing Plan vs. Actual analysis to address deviating trends before they become significant problems
- Increasing supply chain velocity and reducing time to market
- Gaining competitive advantage while increasing customer loyalty / retention
- Reducing costs of materials and of managing operating processes

Application of Intelligent Agents

The Cougaar technology allows you to build intelligent applications that can:

- Recognize and accept high level tasking
- Determine appropriate processes and activities
- Allocate the appropriate resources to complete the tasking
- Continuously monitor and assess progress towards achieving the initial tasking

Just as different humans can do different jobs based on their training and experience, different agents do different jobs based on functional business processes with which they are configured. Also like humans, agents can communicate with each other as well as with other systems, databases and applications through “interface” business process modules. Unlike humans, agents never get tired, don’t make mistakes, can pay attention to every detail in massive amounts of information and work at computer speeds.

Read on for detailed descriptions of how this agent-based technology provides its amazing technical benefits to the enterprise.

Key Features of Intelligent Agents

At first glance, most people see little difference between the distributed agent approach and more conventional approaches – like client-server, web-portals and the old central server approach. As one would expect, many of the features IT managers have come to expect in a software solution are present:

- Web-based or browser accessible
- Process control through some form of workflow engine
- User-defined ‘rule’ parameters
- Collaboration support - authorized members of other organizations can access your data
- Highly automated – can run standard transactions without human intervention
- Rich planning support

Like most other solutions, agents support all these features; but, agents are better in two ways. The first is that many of those 'standard features' are supported in unique and powerful ways. Second, agents offer several powerful features the other architectures cannot – at least not in a manner that is clean, efficient and natural to the operation of the enterprise. Let’s explore some of these key features in more detail.

Agent as Web Server

The Approach: Agent solutions by definition are distributed across a wide global network allowing easily scalable and autonomous components to be accessed through the Internet. With an agent-based approach, each agent is itself a Web server. It can gather, fuse and present operational data to other agents, systems, and users on demand or proactively.

A collection of agents collaboratively shares a plan, which means parts of the plan are maintained in each agent, and there are links between the agents where tasking, dependencies and constraints are present. In addition to showing the current plan and situation in a web-browser form, the architecture seamlessly manages the redirection of the browser from agent to agent as interrogation traverses one of the tasks or other links between agents.

The Value: The organization does not rely on a central database or central server. The work can be distributed easily among all the organizations of the enterprise and its partners and traversed as required. Further, maintaining information at the location of the process owner ensures that the latest and most accurate information is used at all times.

Process Control with Dynamic Workflows

The Problem: Most systems use either static workflows or parameterized workflows that are based on templates. While this is powerful and usually effective, it lacks the agility to deal with changing environments and unexpected situations.

The Solution: Agents plan dynamically, which means they use their cognitive processes to build the workflow as needed – based on their specific understanding of the unique situation, rules, preferences, constraints, operational status, resource availability, organizational policies and the effectiveness of previous decisions in similar situations. All this is considered in an instant, and a dynamic workflow is generated that is most appropriate for the situation.

The Value: The more complete your understanding of the situation and the more specific your plans against that situation, the more appropriate and effective your execution becomes. This means fewer mistakes, higher efficiency and productivity, lower costs and more accuracy in your plans and execution - all of which results in a smoother supply chain.

User-defined Rule Parameters

The Problem: When operating over standard best practices and well-defined, rigid process workflows, identifying the parameters that influence those processes is fairly straightforward. Through custom interfaces, users can define their rule settings, which in essence set one or more parameters and ensure the settings are consistent with other current settings and related processes. While this approach is typical, it generally limits the ability to allow users to change rules dynamically. Further, it is completely insufficient when users are faced with new situations or market conditions in which the rigid 'best practices' are no longer appropriate or effective.

The Solution: With agent technology, not only can you define user rules, but also preferences, constraints, policies and priorities. The rules you define tailor the pieces of the business process, and literally influence the construction of the process pieces into a business workflow. The business rules support complex situational conditions as well as simple value ranges and empower the user to capture more of the automated reasoning and exception processing in the system.

The Value: Agents can use the combination of rules, preferences, constraints, policies and priorities—in conjunction with the situational analysis—to build unique plans that are specifically suited to the situation. This results in more accurate plans that have a higher probability of achieving objectives with fewer problems, lower cost, and increased throughput.

Collaboration Support

The Problem: For most systems, the concept of collaboration is one of sharing fairly static information in primarily human-centered ways. By exporting part of the enterprise system database and creating a collaborative, role-based web portal or EDI and XML messages, information is limited that can be provided to supply chain partners.

The Solution: While the above approach may be a step in the right direction, agents go further in that they can act as proxies to data systems (SCMs, ERPs and others) to support collaboration between enterprises and allow shared decision-making. Supporting the same concepts of limited information exchange, the agents can be tied into each enterprise's planning processes and support coordinated activities with each of the partners – making commitments and decisions only after the partner's agent has confirmed its ability to support that part of the plan or an alternate participant is identified. Now, everyone in the supply chain can be part of the construction of a shared plan as well as share visibility into the execution of that plan.

The Value: This is important because no enterprise operates independently. While Channel Masters can often make the key decisions for the entire chain, building credible, detailed plans requires continuous collaboration on both planning and execution. Agents are a clean, effective way to ensure high confidence collaboration while protecting sensitive enterprise information.

Highly Automated Processes

The Problem: Almost all SCM and ERP solutions provide high degrees of automation on mainstream transactions and activities. Where they tend to fall short is in small-volume, unique transactions and activities because they are too unique to the situation or require task-complex specification.

The Solution: Cougaar agents have a representation of the human cognitive process, which allows them to capture in software the same types of planning, decision making, monitoring and analysis activities that humans use. This cognitive process supports the same kind of

complex reasoning and situation assessment that humans apply to the 'fringe' processes that normal systems cannot support. Using rules, policies and other tailored mechanisms, users can define cognitive processes for the activities they want automated and under what conditions they should be invoked.

The Value: The higher the degree of automation in your planning, execution, monitoring and assessment, the fewer errors result and higher velocity and better overall efficiency occur. Fewer humans are required to support the process, and they can now focus their attention on making critical decisions and developing strategy rather than on routine information processing tasks.

Rich Planning Support

The Problem: Most SCM and ERP systems have some flavor of Advanced Planning System (APS) often utilizing a hierarchical planning approach. Unfortunately, many systems have an APS module that feeds their workflow and, in turn, drives their execution modules while other modules do the execution work and post execution trend analysis. Segmentation typically occurs in the different phases of a particular process rather than by process.

This has several key shortcomings. First, the domain rules and functional knowledge are spread across many different modules, which means required changes must be made in many places. Second, generalizing the processing step by reducing the complexity and using higher levels of abstraction provides answers that are not detailed enough.

To put it in perspective, which is better? (1) To take your car to three different shops, one for tires, one for oil changes and one stereo installation, or (2) Take your car to one shop that specializes in just your make and model car, knowing every last detail about your car. Unfortunately, it is usually less expensive to use approach (1) because each shop deals in volume that can make them price competitive. But, you sacrifice the unique knowledge and needs of your vehicle. What if you could have approach (2) for the same price or better than approach (1)? In that case, you would much prefer to have a specialist for your car perform each of those functions.

It's the same with supply chain software. In the past, it was cost prohibitive to take the functional approach, so general-purpose modules were built and plugged together – never able to get the same level of specialized function that specific planning was capable of.

The Solution: Using Cougaar agents is not only cost effective, but provides more detailed processing and uniform application of domain rules and knowledge, and uses the same cognitive reasoning to support the execution and assessment as to perform the original planning. This provides a tight and effective feedback loop.

The Value: The more specific your processes, the more effective your plans and actions become. By harnessing the power of distributed computing, one agent can be a specialist at a small number of functional processes and be explicitly responsible for all aspects of that process—planning, execution, monitoring, analysis, and reporting. Clean, efficient and effective...custom processes at the mass market price.

Managed Evolution of Enterprise Processes and Process Integration

The Problem: Most traditional SCM solutions require the user to implement a complete, integrated package to replace all or nearly all of their legacy processes. This approach is very costly in both dollars and time-to-solution.

The Solution: Agents are uniquely designed to support the managed evolution of process monitoring and collaboration capabilities. Agents can be used to augment existing enterprise and supply chain management solutions, or they can act as standalone process monitoring and/or management applications. This tractable integration quality allows resource-constrained customers to focus on critical pain points and evolve both the breadth and depth of their solutions consistent with other business objectives.

The Value: Adding new agent applications to the enterprise not only provides new process capabilities but also adds value to existing capabilities through broader execution visibility and process collaboration. This is important because resource constrained enterprises can focus on the critical problem areas in their supply chain management processes without having to suffer the cost and time of wholesale integration associated with monolithic ERP systems.

An Intelligent Agent Technology Company

Managing the problems of dynamic change, agile execution, and flexible business processes are the main challenges that Cougaar Software, Inc. addresses. With our expertise in intelligent systems, it is our vision and technology focus to address these problem areas, which gives us a clear advantage over current systems and provides a unique value proposition to our customers.

Our Solutions

In addition to the core problems identified above, our family of solutions addresses the following issues for mid-to-large-sized enterprises:

- Automatic retrieval, organization, fusion, filtering and propagation of the massive amounts of internal and external information upon which a company must operate to understand its current state, market trends and competition.
- Coordination of activities across various individuals, organizations and companies through automated collaborative planning, partitioned workflows and dynamic relationships. Inherent support for the distributed nature of the enterprise and the virtual corporations in which they participate.
- Intuitive situational pictures for users to understand the state of their part of the enterprise including resources and activities outside the areas upon which they depend.
- Support for embedded and connection-limited devices, which allows the edges of the enterprise – from the manufacturing floor to the mobile worker – to be active participants in the planning and execution of the enterprise activities.
- User-directed sentinels that monitor information and activities and alert the user when a problem condition arises. The alert process can be sent via email, pager, fax or other means. These alerts include notification that not only has a trigger condition been breached, but also includes the situation under which it was breached and a potential recommendation for mitigating the situation.
- The fusion of planning, projection, execution and analysis to adjusting projection assumptions into one fluid system. There is no longer a chasm in time or location of planning vs. execution; both occur simultaneously at all echelons of the enterprise to a level of coordination and synchronization never before achieved.

All of these capabilities serve as a foundation for the agile, aware and flexible enterprise, and, if properly applied, can fundamentally change the nature of how companies do business. This kind of a living, adapting, evolving foundation is what we believe the future holds – the knowledge-enabled enterprise.

Conclusion

Intelligent agent applications enable secure, dynamic collaboration over complex business processes that involve massive amounts of information to levels of accuracy, timeliness and quality no human ever could. Applications that use only object-oriented technology usually fail the goals for agility and flexibility because all processes are hard-coded in the applications. Because of this shortfall, customizing business processes tends to be the most costly component of enterprise systems. When enterprise applications take a process-oriented, component-based approach with an underlying cognitive model and rich collaboration capabilities, flexibility and agility are achieved much more quickly and cost effectively.

Cougaar Software, Inc., one of the leading experts in agent technology and part of the open source Cougaar design team, brings this powerful technology to market in the form of innovative custom business applications and supply chain management solutions. Cougaar Software business applications provide:

- Dynamic, situation-specific planning and scheduling
- Intelligent business process automation
- Continuous execution monitoring and assessment
- Low-cost, high-powered, distributed enterprise computing
- Secure, fine-grained collaboration with customers and enterprise partners
- Ability to evolve for dramatically reduced application life cycle costs

These key benefits can save you valuable time and money while improving the accuracy and efficiency of your custom business processes. The plug-n-play distributed agent framework is the key to providing a managed evolution from loosely connected, distributed processes to fully integrated, collaborative processes that provide execution visibility and control, which all greatly enhance your competitive edge. By focusing on the key pain points first, you can leverage the ROI generated from initial agent solution implementation to fund your continuing evolution with the ultimate objective being...the Knowledge Enabled Enterprise.

In summary, Cougaar Software is uniquely positioned to harness the full power of agent technology to enable the agile, aware and flexible knowledge-enabled enterprise. Is your organization ready?

Contact us today to learn more!

About Cougaar Software, Inc.

Cougaar Software, Inc. (CSI) is a leading provider of intelligent middleware systems for the commercial and military sectors. CSI was created in 2001 to transition a suite of advanced technologies from military research to the commercial market. These technologies represent some of the most advanced reasoning and intelligent automation capabilities in existence, integrated to form a complete system architecture for global military logistics. The CSI team has extended this technology for the domain of RFID, developing a powerful foundation upon which to realize the full value of RFID down to the item level. Scalability, adaptivity, flexibility, and security have been the cornerstone concepts of our approach, bringing our military knowledge and experience to applications that empower enterprises.

Contact us today to schedule a demo of our powerful intelligent architecture and products.

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