



## Siemens Uses Artificial Intelligence and CCR and DSS Toolkit 2008 to Speed Mail Delivery

### Overview

**Country or Region:** United States

**Industry:** Manufacturing

#### Customer Profile

Siemens Energy & Automation helps customers in the industrial, manufacturing and construction sectors improve productivity by providing them with complete electrical, engineering and automation solutions.

#### Business Situation

Siemens needed to support concurrent processing in the new Delivery Point Resolver address lookup engine it was creating for use by the United States Postal Service.

#### Solution

Siemens is using the Concurrency and Coordination Runtime (CRR) in the Microsoft® CCR and DSS Toolkit 2008 to gain the multi-threaded processing power it needs for Delivery Point Resolver.

#### Benefits

- CCR support for AI agents
- Split-second performance with CCR
- Industrial-strength code
- CCR ease of integration

“Using the Concurrency and Coordination Runtime, the transaction rates of our AI agents greatly exceeded our expectations.”

Hamid Saleemizadeh, Director of Engineering, Reading & Coding, Siemens Infrastructure Logistics

Anyone who has ever puzzled over sloppy handwriting or had to guess at an incomplete address can appreciate the split-second decisions required of automated mail-handling equipment used by post offices around the world. Siemens Energy & Automation, Inc. Infrastructure Logistics division is a leader in creating the artificial intelligence (AI) agents and supporting hardware for analyzing and correcting addresses. While creating Delivery Point Resolver, its newest product for correcting unclear, incomplete or incorrect address information, Siemens needed a way to support multi-threaded processing to enhance the speed and accuracy of its AI agents. The Concurrency and Coordination Runtime (CCR) in the Microsoft® CCR and DSS Toolkit 2008 provided Siemens with the technology it needed to easily coordinate concurrent thread processing by its AI agents—enhancing performance.

## Situation

The United States Postal Service (USPS) each year delivers more than 206 billion pieces of mail. The scale of this delivery challenge staggers the imagination: Place one year's worth of mail end to end, and it would stretch from the Earth to the moon and back more than 100 times. When you figure that almost all of this mail gets to where it's going without a hitch in a matter of days, it's even more remarkable.

Behind the scenes is some remarkable automated equipment that sorts the mail at a rate of a thousand pieces per minute. Much of this equipment is supplied to the USPS by Siemens, the world's largest provider of mail automation equipment. To get a sense of the importance of automation to the USPS, consider the journey of a letter that you drop off in a mailbox. Along with mail from other nearby mailboxes, branches and collection points, it is brought to the nearest main post office, where the mail is processed by equipment that correctly orients each piece of mail for further automated processing.

The next step passes each piece of mail through an optical character reading (OCR) system that automatically locates and reads all primary and ancillary address elements and verifies their correctness by matching and correlating the information against a database of more than 140 million known addresses in the United States.

The system also recognizes addressing errors and makes corrections to elements such as a misspelled street name or city name, wrong street direction (north, east, etc.) or even a wrong ZIP code. Once all address elements are confirmed to the highest possible level of accuracy (usually in excess of 99 percent), the automated recognition equipment sprays each mail piece with a unique barcode. These barcodes can then be used by all subsequent automated mail processing equipment nationwide to automatically sort the mail pieces into bins of mail going to the same area and to schedule flights or trucks for delivery. When mail arrives at the destination post office, Siemens' automated sequencing systems sort and group the mail pieces to correspond to the actual delivery route sequence of mail carriers at a rate of 40,000 to 60,000 pieces an hour, thereby saving thousands of valuable manual hours.

While it is easy to imagine a precisely printed piece of mail such as your monthly bill from a utility or credit card company passing through the system, a challenge arises when it comes to hand-addressed envelopes. Difficulties here can range from poor penmanship and hurried scrawls, to a 5-year-old addressing a card to grandparents using a crayon, to a multilingual person using another language for part or all of the address.

Still more problems can be introduced when a sender makes a mistake by writing the wrong street address, spelling the city incorrectly, using the wrong ZIP code, calling

Sortation – A Siemens sortation system keeps the mail flowing.



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an avenue a street or making any of numerous other kinds of mistakes.

The postal automation engineers at Siemens build sophisticated mail-sorting equipment—referred to as sortation systems—that are capable of recognizing thousands of address patterns, letters and handwriting styles. Siemens sortation systems can also “read” many languages, ranging from Latin letters to Chinese ideograms and Arabic characters. And it can do this at speeds of nearly 17 mail pieces per second.

At the heart of a sortation system is an address lookup software engine that applies artificial intelligence (AI) to determine which potential address is the one the sender intended. Address lookup engines need to be certified compliant with two USPS standards—the Coding Accuracy Support System (CASS) and the Multiline Accuracy Support System (MASS). As Siemens prepared to design and develop its next-generation address lookup engine, it needed to identify a solution that would support multi-threaded computation for its AI expert agents, to enhance accuracy as well as the speed of processing each piece of mail.

### Solution

Researchers at the Infrastructure Logistics division of Siemens Energy & Automation are using the Concurrency and Coordination Runtime (CCR) feature of the Microsoft CCR and DSS Toolkit 2008 to gain the multi-threaded processing power they need for their next-generation CASS/MASS address lookup engine, called Delivery Point Resolver.

The CCR and DSS Toolkit 2008 delivers a set of Microsoft .NET Framework and Microsoft Compact Framework class libraries and tools that enable developers to better deal with the inherent complexities in creating loosely coupled concurrent and distributed applications. The Toolkit is designed to help

developers take advantage of the CCR and Decentralized Software Services (DSS) originally released as part of Microsoft Robotics Developer Studio.

CCR offers developers an easy way to create and coordinate loosely coupled, data-driven applications. After it was introduced by the Microsoft Robotics Group, CCR proved popular in the field because it makes it easier to write programs that handle asynchronous input from multiple robotics sensors and output to motors and actuators. CCR answers the need of service-oriented applications to manage asynchronous operations, deal with concurrency, take advantage of parallel hardware and deal with processes that cannot be completed. It enables developers to create solutions based on loosely coupled processes that can be developed independently and to make minimal assumptions about their runtime environment and other components.

The automatic load balancing across CPU cores that CCR provides helps meet the huge computational demands of Siemens' Delivery Point Resolver and efficiently handles multi-threading. After Siemens equipment scans each envelope, OCR technology captures the address information for Delivery Point Resolver to use in verifying the address elements. In cases where the address is unclear, incomplete or incorrect, Siemens' AI technology is used to resolve ambiguities and determine where the piece should be sent.

“If a piece of mail is addressed to ‘123 Main,’ our Delivery Point Resolver needs to determine if that should have been Main Street or Main Avenue,” says Hamid Salemizadeh, Director of Engineering, Reading & Coding at Siemens Infrastructure Logistics. “If the address was handwritten, the system may need to decide if the ‘1’ was actually a poorly written ‘9.’ The system also must determine if the person addressing the



High Speed – Siemens-developed technology is capable of capturing all significant information on up to 60,000 letters per hour.

envelope incorrectly wrote *Main* Street when it should have been *Mann* Street. We need to also be able to correct for patron errors such as using the wrong ZIP code, not specifying a state, misspelling the city name or a host of other errors.”

“Our R&D showed that the best way to resolve mistakes in addresses was by creating a collection of AI agents, each with its own area of expertise,” says David Hudspeth, Software Engineer at Siemens Infrastructure Logistics. “We have each expert agent throwing suggestions up on a figurative ‘blackboard’ for the other agents to consider.”

Hudspeth describes the AI agents almost as if he is talking about professors from different disciplines pooling their knowledge. “Each time an agent tosses information onto the blackboard, it may provide the missing key for another agent approaching the problem from a different viewpoint.”

While tossing ideas up on a blackboard might seem like a leisurely activity in the real world, the AI agents need to generate each suggestion, toss it up on the blackboard and decide on the best solution—all within less than one-tenth of a second. The split-second processing is required because the same lookup and address verification is performed

on every piece of mail, so that the correct address can be encoded on the barcode that guides the mail the rest of the way through the delivery process.

“We require great speed from the Blackboard Framework we’ve created for our Delivery Point Resolver,” says Saleemizadeh. “But just as important, we require painstaking accuracy.”

Development work on the AI and supporting software for Delivery Point Resolver is done using Microsoft Visual Studio® 2008 and the Microsoft .NET Framework. Saleemizadeh notes, “We create our solutions using the Microsoft Application Platform because this gives us a powerful, intuitive development environment and an integrated set of servers and applications.”

## Benefits

The Concurrency and Coordination Runtime in the Microsoft CCR and DSS Toolkit gave Siemens developers the technology they needed to support the AI agents of their Delivery Point Resolver address lookup engine. Siemens found that CCR provided the split-second performance required for Delivery Point Resolver. The company also found that CCR was highly scalable and easy to integrate into the existing product code.

### CCR Support for AI Agents

After the Siemens researchers designed their Blackboard Framework solution for Delivery Point Resolver, they went in search of technology that would support the concurrent efforts of their AI agents.

“To implement our agent-based technology, which is an evolved form of artificial intelligence, we began searching for existing agent-based framework solutions,” says Saleemizadeh. “Unfortunately, we could not find any products on the market. We found some interesting work going on at two

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universities, but they were prototypes and not commercial products. And we needed something that was exceedingly fast.”

When Salemizadeh asked a contact at Microsoft about agent-based solutions, he learned about CCR as a building block. As soon as Salemizadeh and Hudspeth tried CCR with their product, they knew they had found just what they needed.

“We dropped the CCR code into our application, and within a few hours we were able to establish the basic mechanics and flow for our AI agents to work with the Blackboard Framework,” says Hudspeth. “We immediately found that the Concurrency and Coordination Runtime was powerful and very easy to work with.”

The multiple concurrent processing threads supported by CCR represent a big advance over single-threaded processing systems. Single-threaded processing can be compared to going through the aisles of a supermarket with one cart and one shopping list. With concurrent processing, a number of carts can be sent out at the same time, each with its own list.

“With the Concurrency and Coordination Runtime, scaling is simple,” says Hudspeth. “The trend in hardware is to provide more and more processing cores. We can take advantage of that additional computational power by launching more agents that can work together to solve problems. Because CCR takes care of all the behind-the-scenes state control and other coordination duties, we can scale up to take advantage of new processors without having to change our code.”

Salemizadeh adds, “The CCR’s built-in scalability across many processors will enable us to easily enhance the Delivery Point Resolver architecture based on the Swarm Theory in artificial intelligence.”

#### **Split-Second Performance with CCR**

The team was impressed with how fast the CCR-supported AI agents were able to work.

“Even running on our development computers, which aren’t nearly as powerful as what we use for deployment, the performance was amazing,” says Hudspeth. “We’re seeing 150,000 Blackboard transactions a second. And for each one of those Blackboard transactions, there are several CCR events going on behind the scenes. So we were impressed that the CCR-powered AI agents were able to perform so well even on a relatively slow computer.”

Salemizadeh agrees: “Using the Concurrency and Coordination Runtime, the transaction rates of our AI agents greatly exceeded our expectations.”

#### **Highly Scalable Code**

Salemizadeh and Hudspeth were pleasantly surprised by how solid the CCR code was. After determining that CCR indeed provided the concurrency and coordination solution they needed for their AI agents, the team assumed they would have to essentially rewrite the code in order to make it scale to their demanding product needs. But subsequent testing found that the code was highly scalable and could meet their needs.

“We deal in milliseconds and microseconds, and there are not very many commercial products that we can take off the shelf and integrate into our product that can meet our demanding performance criteria,” Salemizadeh says. “Our experience has shown us that if we really want something to work, we have to create it—or heavily customize it—ourselves. So it was a very pleasant surprise when we examined CCR and found out that it already had an ideal framework for synchronizing our AI agents and managing the communication between

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For more information about Siemens Energy & Automation products and services, visit [www.sea.siemens.com](http://www.sea.siemens.com).

them. We had allotted project time for rewriting the code and found that the CCR library was already set to go and would scale to our demanding production needs.”

### CCR Ease of Integration

The Concurrency and Coordination Runtime library has proven so easy to integrate into Delivery Point Resolver that developers can all but forget it's there. Hudspeth and one other developer work with CCR, while the other developers benefit from its work in the background.

“Our developers can concentrate on creating the algorithms guiding their AI agents, without having to worry about coordinating locks and preserving states and performing the other traffic management that in the absence of CCR would be required to do this work,” says Hudspeth.

With the existing CCR so easy to work with and so powerful, the Siemens team looks forward to how the technology will grow in the future.

“We like the fact that Microsoft has a team of software engineers dedicated to basically developing and maintaining and enhancing the CCR technology that we use to support our Blackboard Framework,” says Saleemizadeh. “With CCR, Microsoft is developing, maintaining and enhancing an extremely important building block that goes into our product, and that is why I view Microsoft as our partner.”

## Microsoft CCR and DSS Toolkit 2008

The Microsoft CCR and DSS Toolkit 2008 delivers a set of Microsoft .NET Framework and Microsoft Compact Framework class libraries and tools that enable early-adopting developers to better deal with the inherent complexities in creating loosely coupled concurrent and distributed applications. The Toolkit is designed to help developers take advantage of the Concurrency and Coordination Runtime (CCR) and Decentralized Software Services (DSS) originally released as part of Microsoft Robotics Developer Studio.

To learn more about the CCR and DSS Toolkit 2008, visit [www.microsoft.com/ccrdss](http://www.microsoft.com/ccrdss).

### Software and Services

- Microsoft CCR and DSS Toolkit 2008
- Microsoft Visual Studio 2008
- Technologies
  - Microsoft .NET Framework 3.5

### Hardware

- Intel-based server computers with multi-core processors