A Multi-Agent System for Coordinating International Shipping

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The Border Trade Facilitation System

I  Background: The Border Trade Environment  (What’s the problem?)

II  Motivation for a Multi-agent Architecture  (Why use agents?)

III Standard Agent Framework  (How do our agents work?)

IV  Agent Tasks & Collaboration  (What do our border trade agents do?)

V  Conclusions and Lessons Learned  (What did we learn?)
I. Background: The Border Crossing Environment
The Maquiladora Shipping Process

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ARRIVES (INFOx, POEx, t1) => ARRIVES (CONT, POEx, t2) => t2 > t1

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II. Motivation for A Multi-agent Architecture
Stakeholder Survey

Automated Documentation (80)

System Integration (80)

Shipment Tracking (60)

Information Security (60)

Process Improvements (40)
System Attributes

Distributed System

Decentralized Decision Making

Specialized Knowledge & Expertise

Proprietary Data & Knowledge

Collaborative Enterprise

USG & Commercial Security
Allocation of Agents

Problem is naturally partitioned according to commercial entity and government regulator

Agents are allocated to generic tasks:
- Elicitation
- Mediation
- Delegation
- Negotiation
- Monitoring

Agents are allocated to capture business processes
III. Standard Agent Framework
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An instance of standard agent on "A" invokes the ACTIVATE method on the public proxy for Agency "B". The RMI semantics are: at-most-once; asynchronous.

The public proxy delegates the message to the Access Control Proxy for Agency "B".

( from standard agent proxy )
The Dispatching Agent processes the request: Sends MAKE message to class and then ACTIVATE to instance.

The Access Control Proxy validates the message. If valid, it delegates the message to the Dispatching Agent.

The response is an ACTIVATE message sent to a private proxy of the invoking agent. The proxy delegates directly to the invoking agent object.

The Shipper Agent is created and activated with a stimulus of “shipper-101”.

The response is an ACTIVATE message sent to a private proxy of the invoking agent. The proxy delegates directly to the invoking agent object.

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IV. Agent Tasks & Collaboration
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Elicitation

Objectives:
1. Reduce data entry errors
2. Allow case-based presentation
3. Increase referential integrity
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## Iniciar un Nuevo Pedimento de Exportación

**Pedimento Consolidado?**  ☐  **Sí**

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| Peso: | 201 kg |
| País comprador: | 68 |
| País de Origen: | N3 |

| Facturas: | (1) T07478 |
| Fechas: | 27/5/97 |
| Forma de Facturación: | F.O.B. |
Mediation

Objectives:
1. Eliminate duplicate data entry
2. Ontological leveling
3. Enforce referential integrity
Delegation

Objectives:
1. Delegate goal to other agent
2. Monitor goal satisfaction
3. Contingency action on failure
Negotiation

Objectives:
1. Settle on document fields
2. Provide authentication
3. Provide non-repudiation

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Objectives:
1. Notify agents/people of status
2. Monitor transaction progress
3. Monitor physical state
4. Coordinate contingency actions
V. Conclusions & Lessons Learned
Lessons Learned

Industrial-grade multi-agent systems require

1. Sophisticated object-oriented substrate
2. High quality software engineering process
3. Knowledge engineering methodology
4. Extensive and expensive requirements analysis
5. Agent development framework
Conclusions

1. Agent-oriented system development is superior to client-server

2. Major barriers to agent-based E-commerce system deployment are cultural

3. Legacy data is a pernicious problem

4. Agent theory and technology are mature enough for successful application to large-scale E-commerce systems