

Ontology-driven Decision Support in Dynamic Supply-Chains

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The Tyranny of Choice

(Barry Schwartz, 2004)

Conventional wisdom

More choices make people happier, create greater opportunities for business.

Reality

People can be paralyzed by too many options. Online markets can lead to a combinatorial explosion of possibilities.

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Decision Support for Users

Traditional view

- There are many vendors and tools that promise to help build decision support systems.
- Most provide simple signals to make choices.

Smart Business Network view

- Organizations and people can buy and sell online.
- Many choices and opportunities are available.
- .. but choosing requires complex knowledge and requires support for complex decision making.

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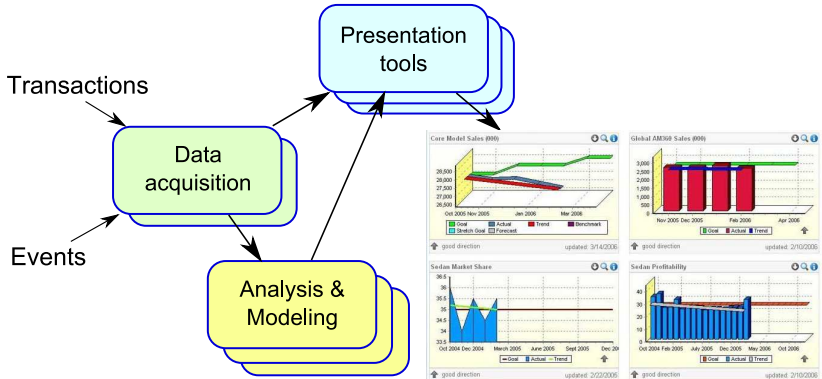
A New Vision for Smart Business Networks

Requires infrastructure changes:

- Everything has an IP address!
- Standardization
- Demand side management (bottom-up instead top-down)
- Economic incentives
- Automated trading markets
- Self-organization
- Advanced user interfaces (Economic Dashboards)

Elements of Decision Support

Decision support depends on information and analysis



Flexible and Personalized Decision Support

Economic Dashboards

Desiderata

- Appropriate separation of concerns.
- Concepts have well-defined meaning in business context.
- User-defined abstractions.
- Transparency.
- Easy to experiment and test.
- Ability to play out hypothetical scenarios.
- Scalability.
- Robustness, reliability, availability, etc.

A New Approach to Services

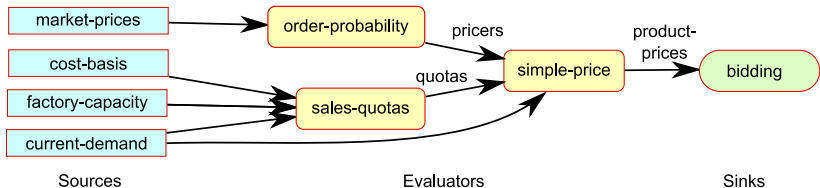
Evaluator Services

- Small single-purpose analysis modules that can be composed into dataflow networks by connecting inputs to compatible outputs.
- Each evaluator has inputs, parameters, process, output, constraints.
- Evaluators refer to each other by name rather than direct reference.
- Evaluator names are configurable, either through XML configuration files, or through a user interface.

Example: Sales Evaluators

Basic idea

- 1 Determine quantity Q_X of product X to sell
- 2 Set a price Φ_X such that when offered on all demand D_X for X , moves Q_X units in expectation.
- 3 etc.



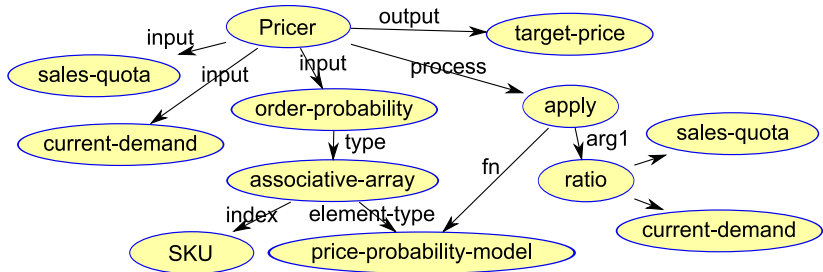
Service Composition

A pipe-and-filter model

- Restrict services to dataflow components that can be composed into directed graphs.
- Abstractions can be composed from subgraphs.
- Add rich semantic descriptions to components.
- Process annotations to ensure that composed graphs have consistent semantic descriptions.
- Assist user in finding and understanding data.
- Assist user in composing graph modifications.

Service Semantics

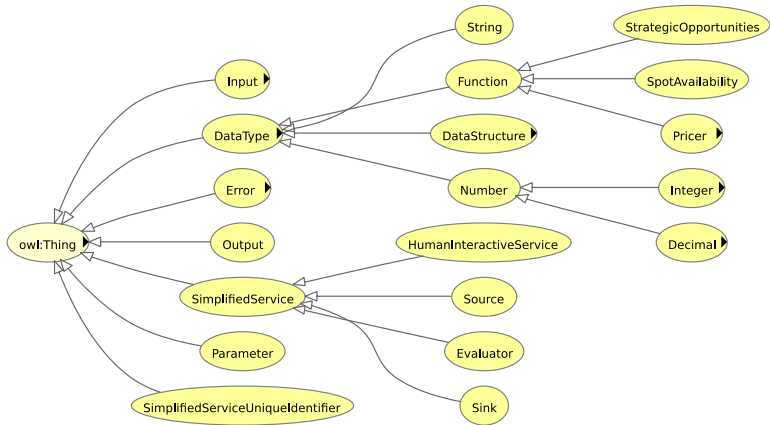
- Dataflow restriction simplifies annotation.
- Connection from component A to component B is possible if output of A can be mapped to an input of B.
- Semantic mappings propagate from input to output of B.



Semantic Interoperability

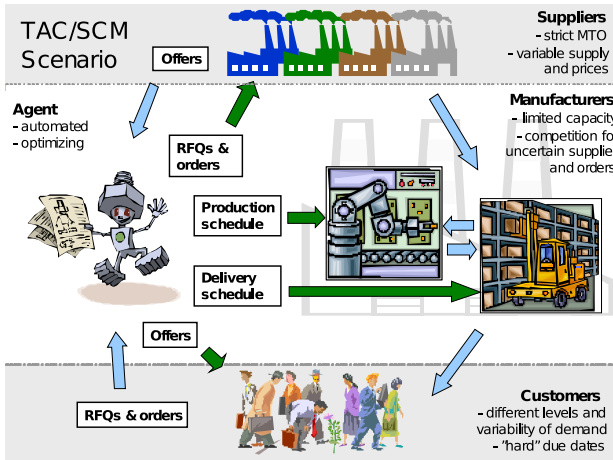
Tools created for the Semantic Web can be used to specify the format, content, and business meaning of the data and of the transformations that are performed by the services.

General MinneTAC Top-level Ontology



TAC SCM

Overview – Dynamic Business Network Testbed



TAC SCM

Why a simulated testbed?

Enabling research

- The problem is too complex for a game-theory solution.
- It's hard to do experiments with real organizations.
- Evaluation is needed to validate solutions.

The "Game"

- An abstraction of a simple three-tier supply chain (Dell).
- Balance between real-world complexity & ease of analysis.
- Data can be collected and analyzed, experiments can be repeated.

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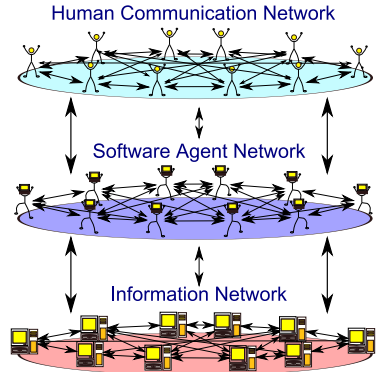
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TAC SCM

Lessons learned

- Businesses don't trust fully autonomous agents.
- Human preferences matter.
- Decision support vs. decision automation.
- Actor vs. network decisions.
- Flexible agent architecture.

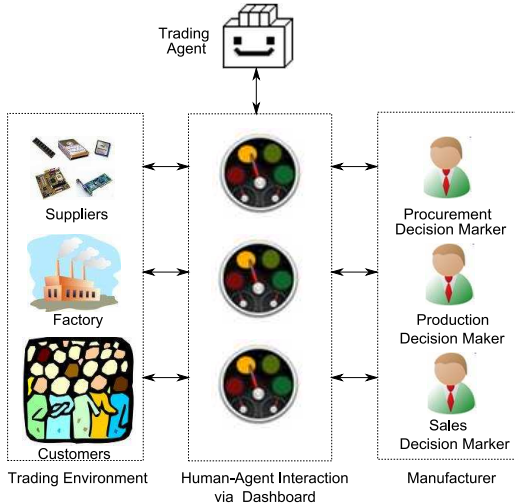


MinneTAC

A highly flexible research tool

- The MinneTAC agent is a general architecture for decision-making agents.
- Modeling and analysis tools (**Evaluators**), along with decision processes, are designed as simple, configurable services, strung together at runtime.
- A typical MinneTAC configuration contains between 60 and 80 of these services.
- There are currently at least 20 different viable versions of MinneTAC.
- MinneTAC has competed successfully in the TAC SCM competition, obtaining 3rd place in the 2009 competition.

Proposed Human-Agent Interaction in TAC SCM



What's needed?

Could a person keep up?

- TAC SCM agents make hundreds of decisions/cycle.
- Some decisions can be simplified, e.g. set prices per product not per RFQ.
- Reduce the problem to just sales or procurement. Let the agent do the rest.

What information & control would a person need?

- Start with the same information the agent uses:
 - Price models
 - Inventory position and projection
 - Demand information
- User controls form and content of information display.

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Human Agent Interaction

Radically rethink user-agent interaction by

- Offering just-in-time information.
- Highly relevant to a unique user and his/her current focus of attention.
- In a non-disruptive, easily accessible, privacy protecting way.

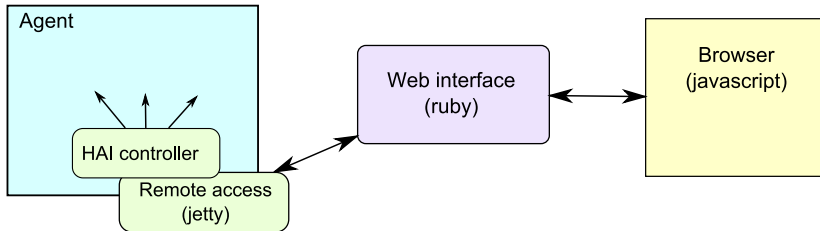
Essential steps

- 1 User preference modeling.
- 2 Decision recommendation.
- 3 Feedback.

Remote GUI

It's important to separate the agent from its GUI

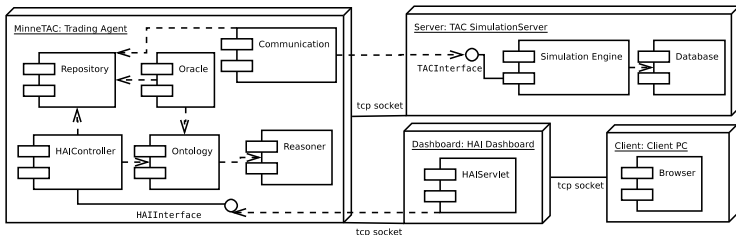
- Separation of agent host from user's screen.
- Support for multiple users.



MinneTAC architecture with Human Agent Interaction.

HAIController responsibilities:

- Relay data from sources and evaluators to the dashboard.
- Save data modifications to evaluators and sinks.
- Present agent configuration details.
- Persist agent configuration details.



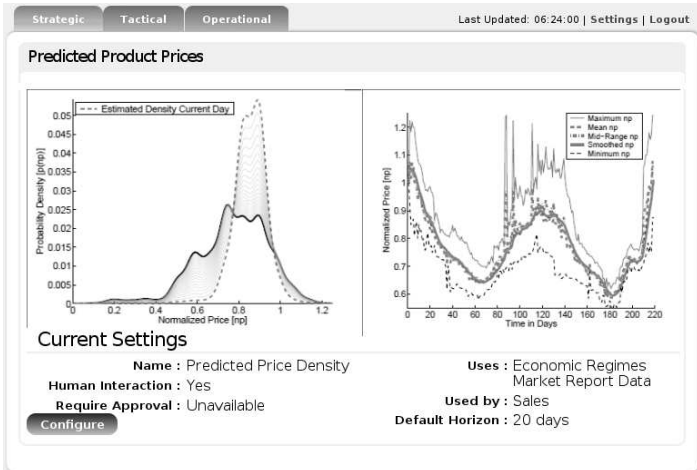
User roles

We find it useful to distinguish among three classes of users and decision makers:

- *Strategic* users
- *Tactical* users
- *Operational* users

Each class needs tools to support their reasoning.

Strategic Dashboard



Tactical Dashboard

Strategic

Tactical

Operational

Last Updated: 06:24:00 | [Settings](#) | [Logout](#)

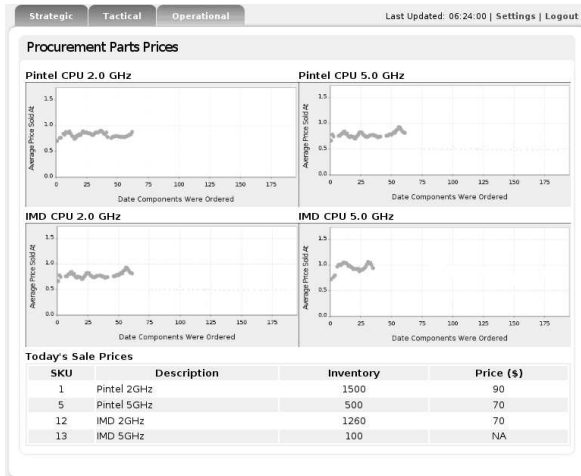
Current Recommended Product Sales Prices

Please approve the recommended prices below.

SKU	Description	Price (\$)
1	Pintel 2GHz, 1Gb Memory, 300 Gb Hard disk	<input type="text" value="1650"/>
2	Pintel 2GHz, 1Gb Memory, 500 Gb Hard disk	<input type="text" value="1750"/>
3	Pintel 2GHz, 2Gb Memory, 300 Gb Hard disk	<input type="text" value="1750"/>
4	Pintel 2GHz, 2Gb Memory, 500 Gb Hard disk	<input type="text" value="1850"/>
5	Pintel 5GHz, 1Gb Memory, 300 Gb Hard disk	<input type="text" value="2150"/>
6	Pintel 5GHz, 1Gb Memory, 500 Gb Hard disk	<input type="text" value="2250"/>
7	Pintel 5GHz, 2Gb Memory, 300 Gb Hard disk	<input type="text" value="2250"/>
8	Pintel 5GHz, 2Gb Memory, 500 Gb Hard disk	<input type="text" value="2350"/>

Approve

Operational Dashboard



Summary

- Highly configurable, transparent decision processes that are described in terms that end users can understand.
- MinneTAC design shows how decision processes can be composed from networks of analysis and modeling tools.
- Teaching tool and research framework.

Questions?

