

A Semantic Web Architecture for Advocate Agents to Determine Preferences and Facilitate Decision Making

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International Conference on Electronic Commerce, Innsbruck, Austria

Thursday, August 21st 2008

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Overview

- Advocate Agent Objectives
- Business Intelligence Dashboard Example
- Business Architecture Overview
- Technical Architecture Overview
- Architecture Details
- Related Work
- Conclusion and Future Work



Advocate Agent Objectives

Research, develop, and use highly personalized software agents that:

- Complement the cognitive limitations of the human mind
- Facilitate the decision making process
- Reduce information overload
- Increase productivity (reduce cost, improve ROI through increased work efficiency and shorter decision time)
- Increase solution quality (product or service)
- Increase customer and end-user satisfaction!



Motivating Example: Business Intelligence Dashboard

De virtuele veiling

Veiling Partijen Beeld Diversen Help

9999

VBA klok 1

Veilgroep C 507
Fa. de Vries en Zn.
Product 8 0

VBA klok 3

Veilgroep G 300
Fa. Groen en Co.
Product 7 0

VBA klok 1

Aanvoerder
Fa. de Vries en Zn. Aanv. Nr. 36171 Partijnr. 4390

Produkt Product 8 Zelfk. N MPS Stw. 6 Ap.stw. 10

Ronde Munt
Plaatnr. 5406 Subnr.
Eenheden 0 APE 4
Min. Af 2

Kwaliteitsopmerking Kwal Pos.keuropmerking

Berichten

Tijd	Afzender	Bericht
13:54	VBA klok 10	Bekijk al het moois in de vitrine op http://ec
13:54	VBA klok 11	Bekijk al het moois in de vitrine op http://ec

Overzicht aankopen

Bestand

Koper	Sub	Produktnaam	Aanvoerdernaam

Video van VBA klok 1

antal
5
17
10
11
6
7
5
7
10
15
15
20

Komende partijen

Klok	Aanvoerder	Produktnaam	Eenh	STW	EPW	APE	S1	S2	S3	S4	Opmerking 1	Opmerking 2
VBA klok 1	K.A. Zwartjes	Product 7	20	4	5	8	12	81				
VBA klok 1	Onder den Hove	Product 3	168	12	14	2	90	95			Enkel gesprongen	
VBA klok 1	Wempe Sierproducten	Product 10	273	13	21	7	31	43				
VBA klok 1	H.J. de Bruin	Product 6	69	3	23	10	37					
VBA klok 1	Onder den Hove	Product 1	11	1	11	6	11	46			Enkel ongelijk van rijpte	
VBA klok 1	J. Plant	Product 7	336	14	24	2	62				Enkele watervlekken	
VBA klok 1	K.A. Zwartjes	Product 8	13	1	13	9	18		60	51	Enkele watervlekken	

Business Intelligence Dashboards

Drill-down capabilities →

	Strategic BI	Tactical BI	Operational BI
Business Focus	Achieve long-term organizational goals	Conduct short-term analysis to achieve strategic goals	Manage daily operations, integrate BI with operational systems
Primary users	Executives, analysts	Executives, analysts, Line-of-business managers	Line-of-business managers, other goal-oriented, action-taking operational users and systems
Timeframe	Months to years	Day(s) to weeks to months	Intra-day
Data	Historical metrics	Historical metrics	Right-time metrics



But wouldn't it be nice if we could...

- **Get a dynamic view of information** relating to different user roles and give rapid feedback regarding performance on specific goal-oriented tasks.
- **Have non-intrusive user interfaces** that facilitate strategic, tactical and operational decision making processes.
- **Present views** of historical business and newly gained knowledge **using drill-down capabilities.**
- **Give users explicit feedback** to evaluate the quality of the findings and suggestions.



Enhanced Economic Dashboard: Humans and Agents Working in Concert

A mixed-initiative Economic Dashboard can mediate goal-oriented human and software agent interactions that empower people to:

- **Monitor** critical business processes and activities using metrics of business performance.
- **Analyze** and explore relevant and timely information from various sources at different levels of detail.
- **Manage** people and processes to improve decisions, optimize performance, and effectively guide the organization.
- **Communicate** bi-directionally with **Advocate Agents**
... So that better, more informed actions can be taken!



Holistic User Modeling

- Advocate Agents work in a collaborative manner with users to accomplish their goals.
 - To work effectively and efficiently with a human user, agents must learn the human user's interests, habits and preferences (as well as those of the user's communities).
 - In the flower example, recommendations can be given as to what to buy (product-brokering) and from whom to buy (merchant-brokering), based on customer criteria.



Preferences are Critical

- Key factor in effectively facilitating the decision making process
- People have different preferences for different **roles** with respect to specific **tasks**.
 - Preferences indexed by user-task-role
 - Roles and tasks can be members of concept hierarchies
 - A person (user) performs tasks to meet goals/objectives “wearing specific hats” (roles); This suggests a need to relate facts and actions that support goal/objective satisfaction to a ternary user-task-role relationship.
- Inherently a multi-disciplinary topic of interest to business scientists, computer scientists, economists, operations researchers, mathematicians, etc.

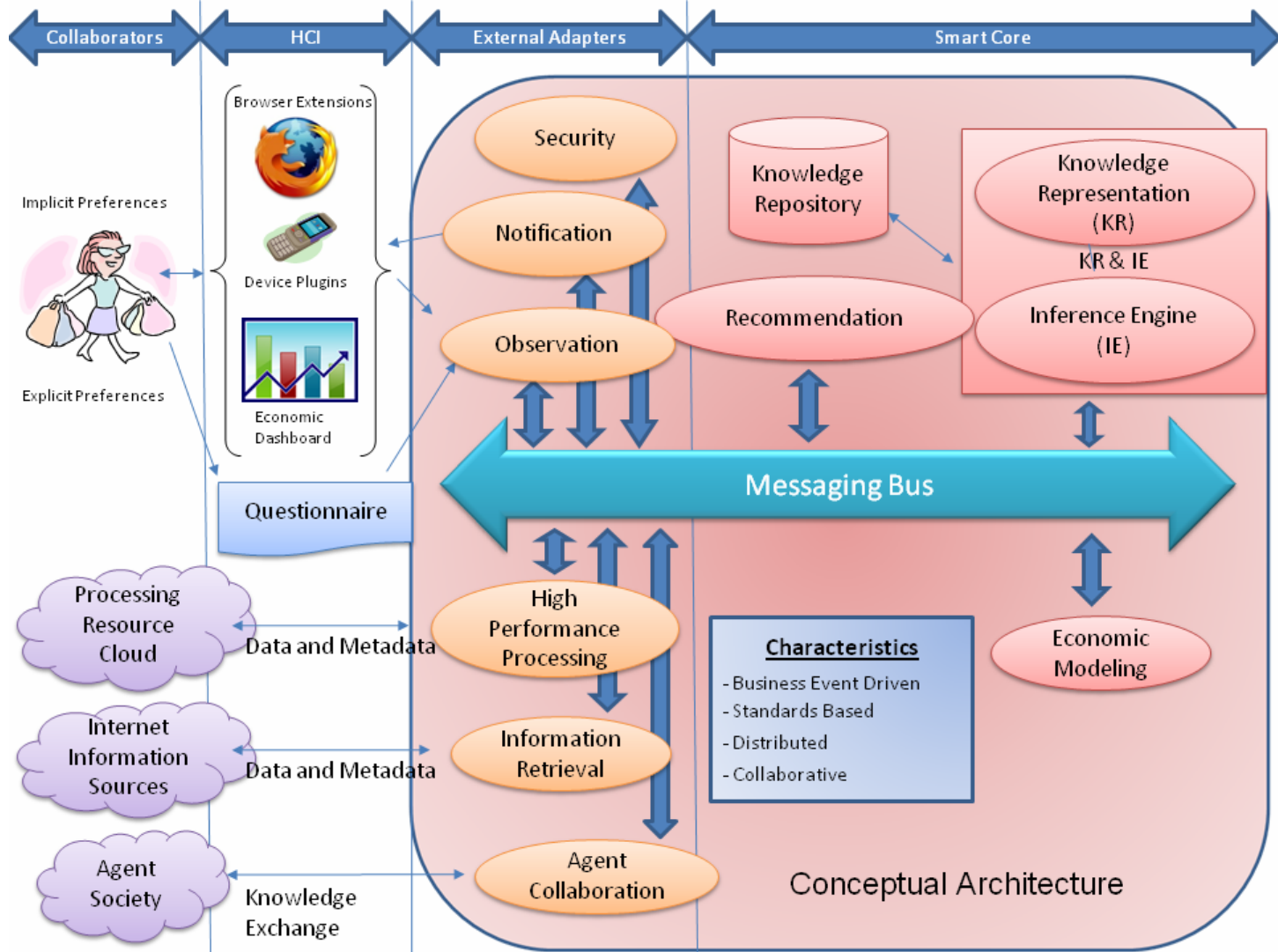


Preference Elicitation

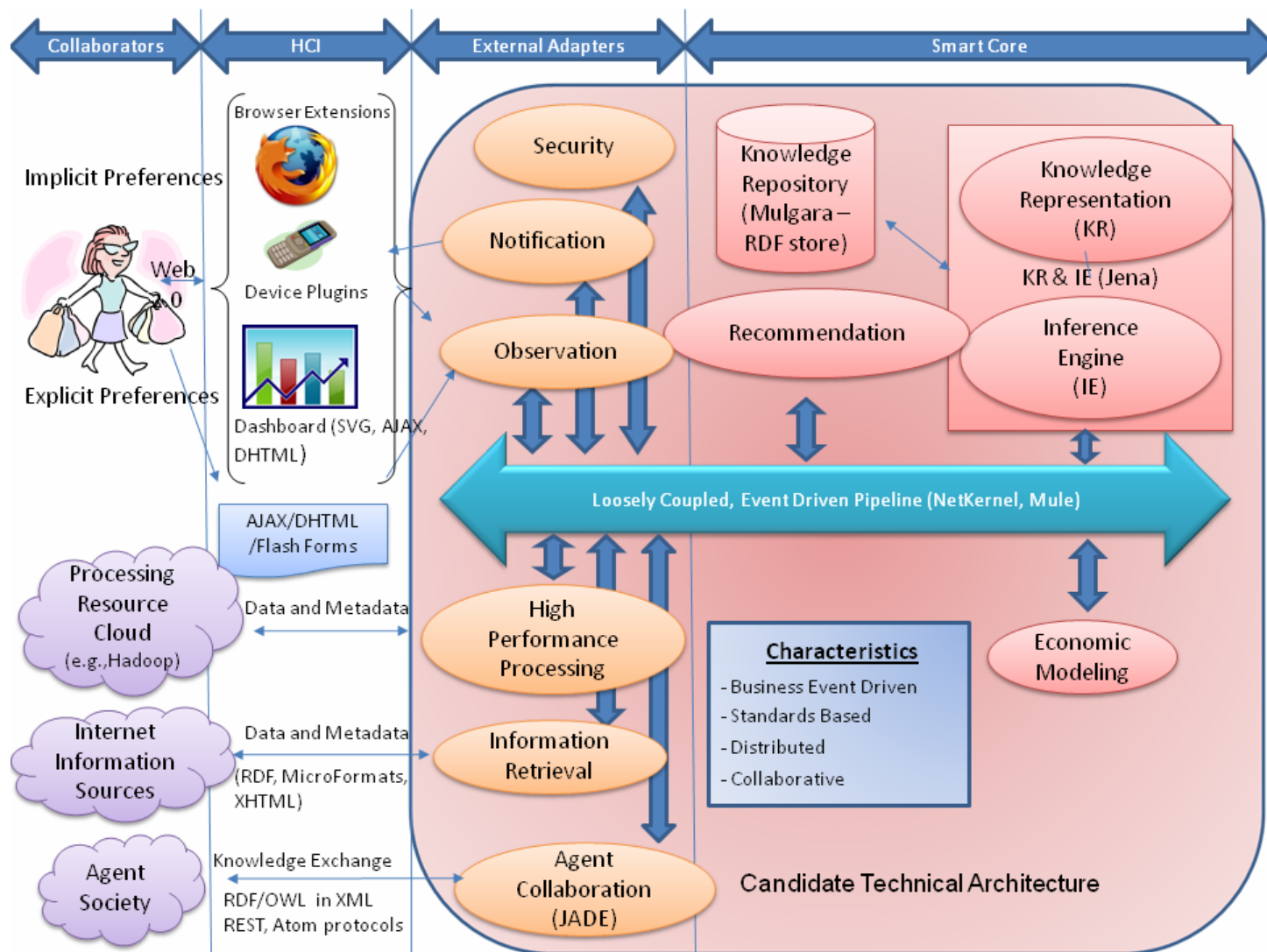
- Explicit
 - Questionnaire
 - Passive: Define roles, areas, objectives, and tasks
 - Active: Role dependant training examples
 - User feedback through economic dashboard, and non-intrusive sidebar in browser window
 - AA Teams – A network of dynamic proxies (AAs') for people
- Implicit
 - User observation through browser extension (Piggy Bank, etc.)
 - Business and Social Networks – static proxies for people
 - Professional (intra company e.g. IBM, [Linkedin](#), Plaxo, etc.)
 - Personal ([Facebook](#), Hi5, Hyves, etc.)



Business Architecture Overview



Technical Architecture Overview



Architecture Details - 1

Relational, Web, and Semantic Web Comparison

	Relational	Web	Semantic Web (highest level of automation; designed for intelligent agents)
Designed for	Storing and Joining Tabular Data	Linking Documents	Inference of Distributed Assertions
Metaphor	Tables	Hypertext	Graphs
Search	SQL	Keywords, meta data	SPARQL
Search Engine	Proprietary	Google, Yahoo, Microsoft	Triple Store



Architecture Details - 2

Microformats and RDFa

```
<div class="vcard">
  
  <a class="url fn"
    href="www.ketter.ws">Wolf Ketter</a>
  <div class="org">RSM Erasmus University</div>
  <div class="adr">
    <div class="street-address">
      Burgemeester Oudlaan 50</div>
    <span class="locality">Rotterdam, The
      Netherlands</span>
    <span class="postal-code">3062 PA </span>
  </div>
  <div class="tel">+31-10-4082624</div>
</div>
```



Architecture Details - 3

Representation of User Preferences

- User preferences are represented by RDF triples.
 - For example the following statements might be stored in a user preference triple store:
 - [Wolf] [prefers Rating above] [B1]
 - [Wolf] [prefers Grower] [Flori]



Architecture Details - 4

Representation of Objectives and Behavior

- An Advocate Agent learns of its master's needs via observation (monitoring) or direct questions. Objectives and user behavior are represented by RDF triples.
 - For example, after a user performs several searches for computer hard drives, an agent might make an inference and store the following assertion in its objectives triple store:
 - [Wolf] [needs] [Gold Medal]
 - [Wolf] [needs] [2 Units]



Architecture Details - 5

Representation of Available Products

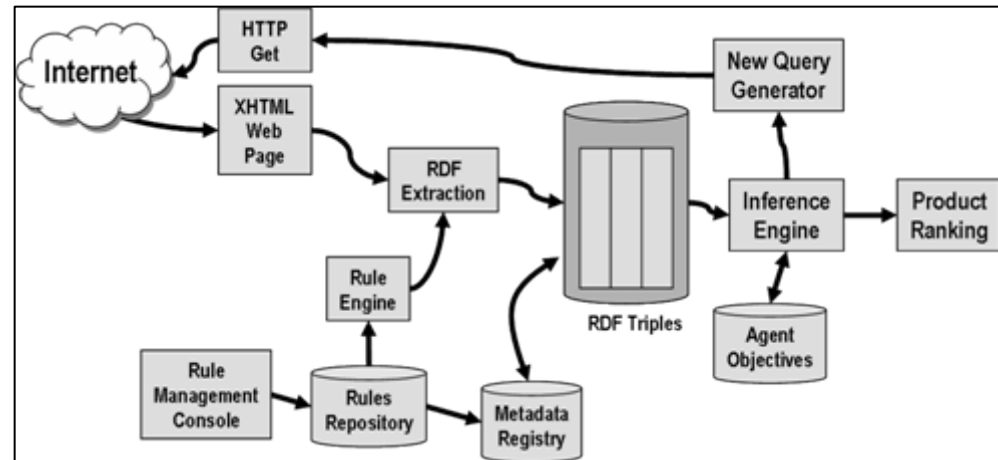
- An agent must then combine the following types of knowledge:
 - User profile and user needs
 - Where products might be purchased
 - How user needs relate to product taxonomies
- Availability and other attributes of products can be represented as RDF triples. For example:
 - [Flori] [has flowers] [roses]
 - [Flori] [has potted plants] [orchids]
 - [Flori Gold Medal] [has Rating above] [B1]
 - [Flori Gold Medal] [isInstanceOfClass] [rose]
 - [Flori Gold Medal] [available] [12 Units]



Architecture Details – 6a

Knowledge and Inference: Reasoning with Preferences

1. A user observation agent creates objectives and saves them in **Agent Objectives DB**.
2. The **Inference Engine** takes objectives to search its **RDF triple store** and construct new queries. It passes queries to **New Query Generator** which converts to **HTTP Get** queries on the Web, to look for product info, recommendations and other metadata.
3. **HTTP Get** requests return well-formed **XHTML Web Pages** that run through **RDF Extraction** and harvesting process.

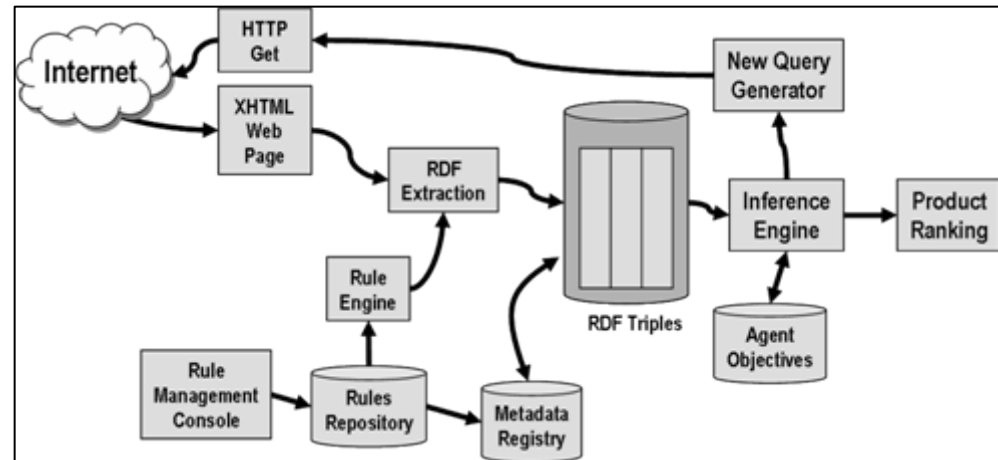


Architecture Details – 6b

Knowledge and Inference

Reasoning with Preferences

4. The RDF extraction process is governed by a **Rule Engine** that determines what RDF statements will be added to the **RDF triple store**.
5. The rules are stored in a **Rule Repository** that is consistent with the semantic bus.
6. Changes to **RDF triple store** may trigger new queries or may change the **Product Rankings** of products.
7. Administrative Users may change rules at any time using a **Rules Management Console** using a set of **Rule Templates** generated by the Advocate Agent system.



Architecture Details - 7

Security & Privacy

- *Traditional*
 - *Firewalls for perimeter security*
 - *Cryptography for privacy of information*
 - *Central authentication*
 - *E.g. OpenID*
- *Non-traditional*
 - *Social Verification and Trust*
 - *Models the way we trust friends-of-a-friend*
 - *Behavioral Inferences*
 - *Learned modeling of trust and distrust*

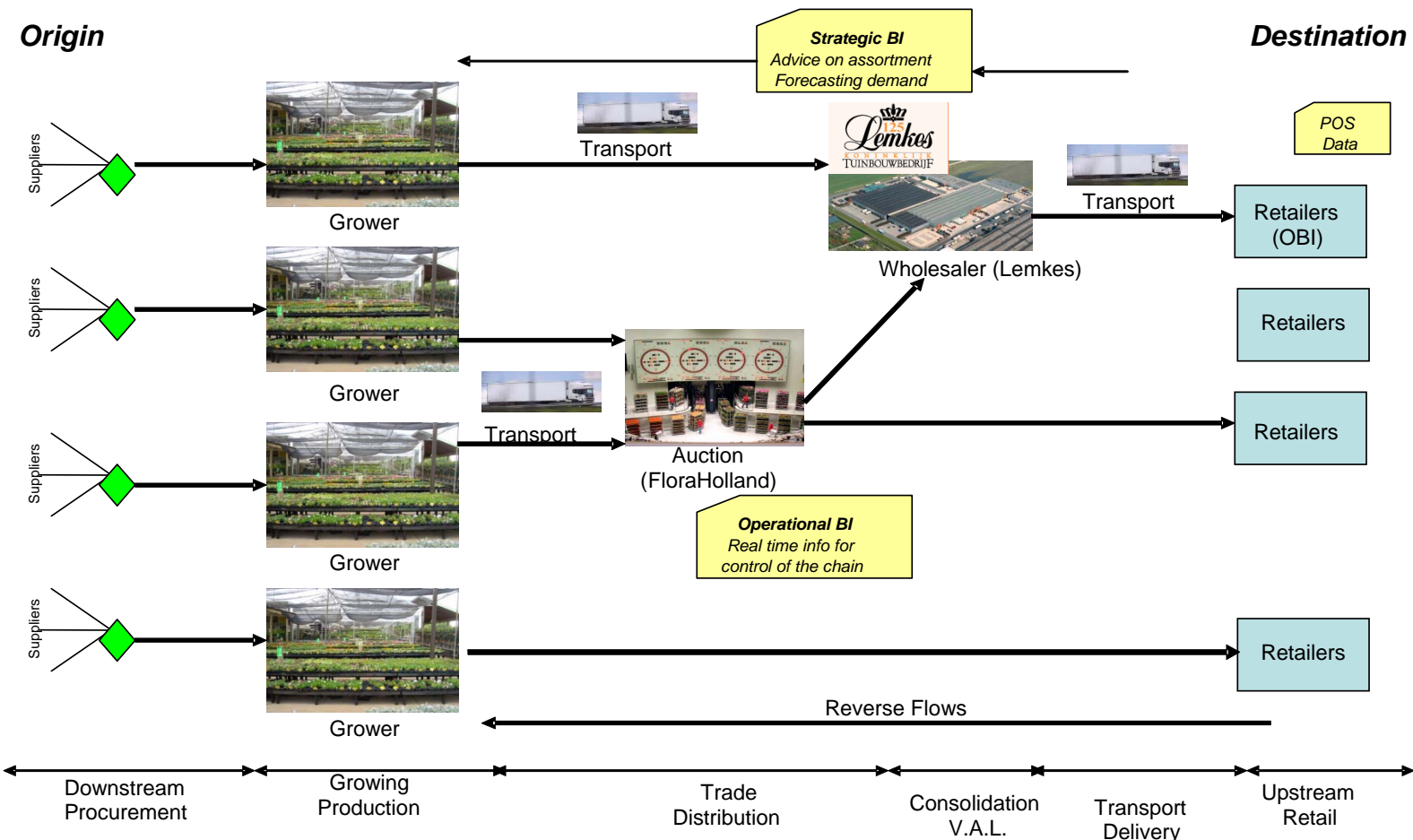


Dutch Flower Auction Network (1)

- Largest in the world + market leader
- Association setup by the growers
- Industry is a huge network
 - Including: breeders, growers, auctions, wholesalers, retailers, and transportation firms for im- and export.
- Import from warmer countries: Israel, Kenya, Zimbabwe etc.
- Export to: Germany, UK, France, USA, etc.
- Two scenarios:
 - Push strategy (supply driven) → clock auction (70%)
 - Pull strategy (demand driven) → mediation (30%)



Dutch Flower Auction Network (2)



Dutch Flower Auction Network (3)



Dutch Flower Auction Network (4)

Information

We are not auctioning flowers but INFORMATION

- Flower type and quality (including pictures & video clip)
- Seller (name, background, reputation)
- Auction clock (price, units)
- Buyer (identification)
- Previous transactions
- Services (logistics, payment, settlement)



Dutch Flower Auction Network (5)

Decision Parameters

1. Price
2. Quality measures
3. Transportation cost
4. Transportation time
5. Upcoming auctions
6. Market condition



Related Work

- *Adomavicius, G. and A. Tuzhilin, An Architecture of e-Butler: A Consumer-centric Online Personalization System. In't Journal of Computational Intelligence and Applications, 2002. 2(3): p. 1-15.*
- *Maes, P., Social interface agents: Acquiring competence by learning from users and other agents. Software Agents—Papers from the 1994 Spring Symposium, Technical Report SS-94-03, Etzioni, O., Ed, 1994a: p. 71-78.*
- *Rhodes, B.J. and P. Maes, Just-in-time information retrieval agents. IBM Systems Journal, 2000. 39(3&4): p. 685-.*
- *Shmueli et. al, Data Mining for Business Intelligence, Wiley, 2007*
- *Shneiderman, B., Direct manipulation: A step beyond programming languages. 1981.*
- *Electric Elves, Tambe et. Al, AI Magazine, 2008*
- *Wayne, E., Performance Dashboards, 2005*
- *Few, S., Information Dashboard Design, 2006*
- *Walsh, T. Representing and Reasoning with Preferences, AI Magazine, 2007*



Conclusion

- Advocate Agents efforts to-date:
 - Definition of business and technical architectures that integrate current technologies and machine learning techniques to support all key aspects of the Advocate Agent vision.
 - Ongoing Implementation of an Advocate Agent core reference application demonstrating key elements of the Advocate Agent architecture



Current & Future Work

- Application areas:
 - Dutch Flower Auctions
 - Financial Services
- Setup a complete architecture framework
- Setup knowledge repository and RDF inference engine
- Supporting browser extensions
- Enhanced Economic Dashboard
- Develop an increasing range of data and text mining, machine learning and personalization elements to support more powerful Advocate Agent applications



More Information and Contacts

- Lots to do... interested in participation?
- Blog: <http://advocate-agents.blogspot.com/>
- Email: wketter@rsm.nl
- Web: www.ketter.ws

