

Agent Applications

Boi Faltings

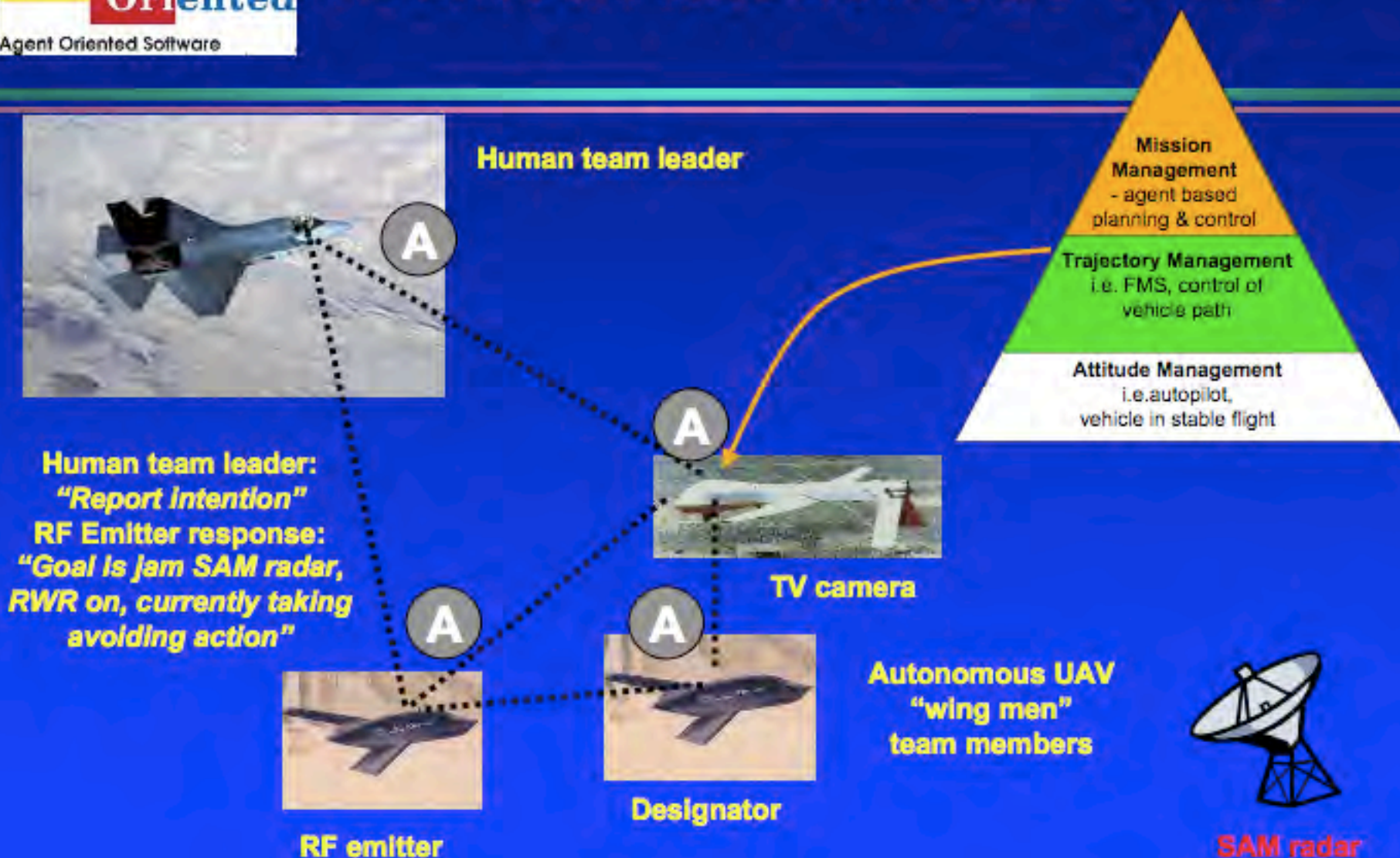
Value Propositions

- Autonomous agents: reactivity
 - Personal agents, ambient intelligence
- Agent-oriented software: structure
 - Simulation, control; shop-floor, etc.
- Self-interested agents: mediation
 - e-commerce, decision-making, etc.

Autonomous agents

- Agents that work for their users
- Reactive/deliberative architecture
- Act/react in environment

Teamed Autonomous UAVs



Games and Entertainment

- Computer Games:
 - Ex: Creatures from GameWare: Simulated environments with synthetic agents that a user can interact with in real-time.
- Entertainment:
 - Ex: Battle Scenes of the Lord of the Rings use the Massive Agent System
 - Each character has its own independent behavior.

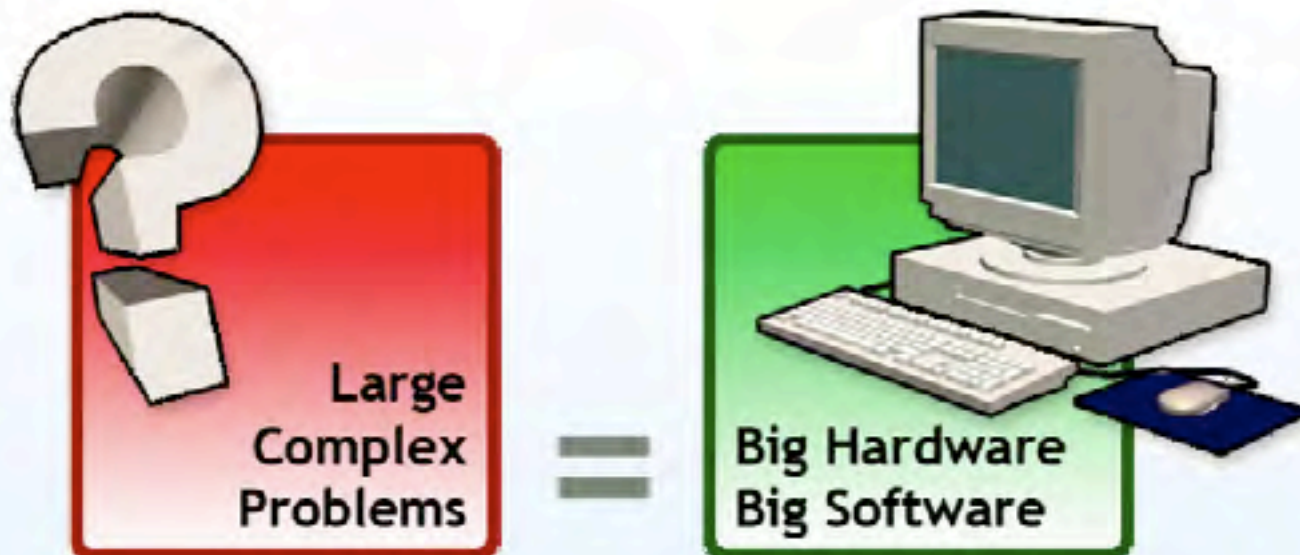
www.massivesoftware.com



Agent-oriented software

- Software that models many interacting processes becomes very complex
- Agents simplify structure:
 - Reduce cost
 - Easier to maintain

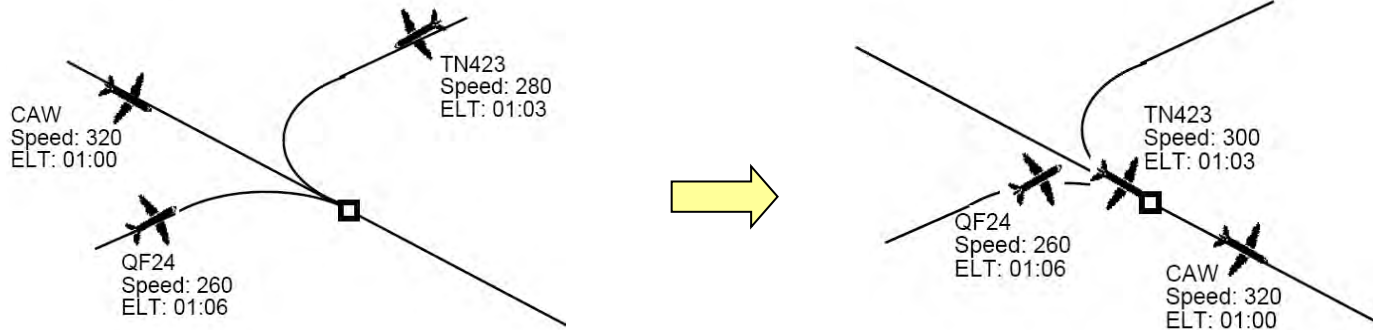
The Old Equation...



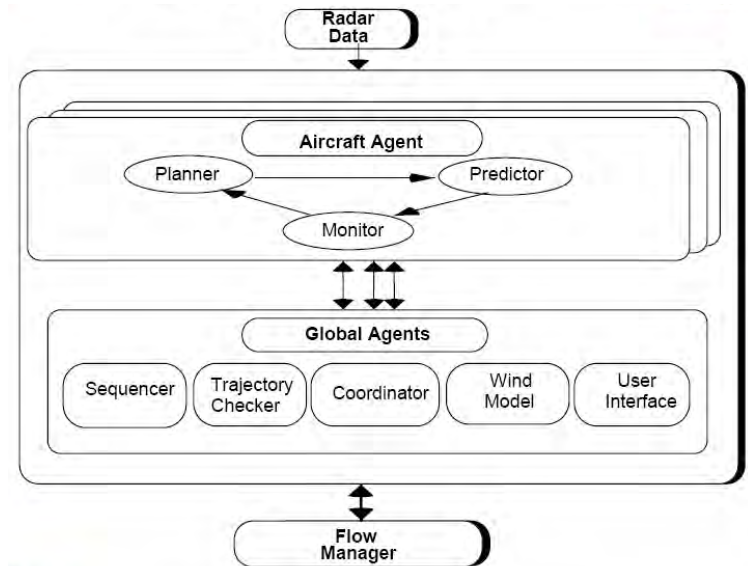
The New Equation...

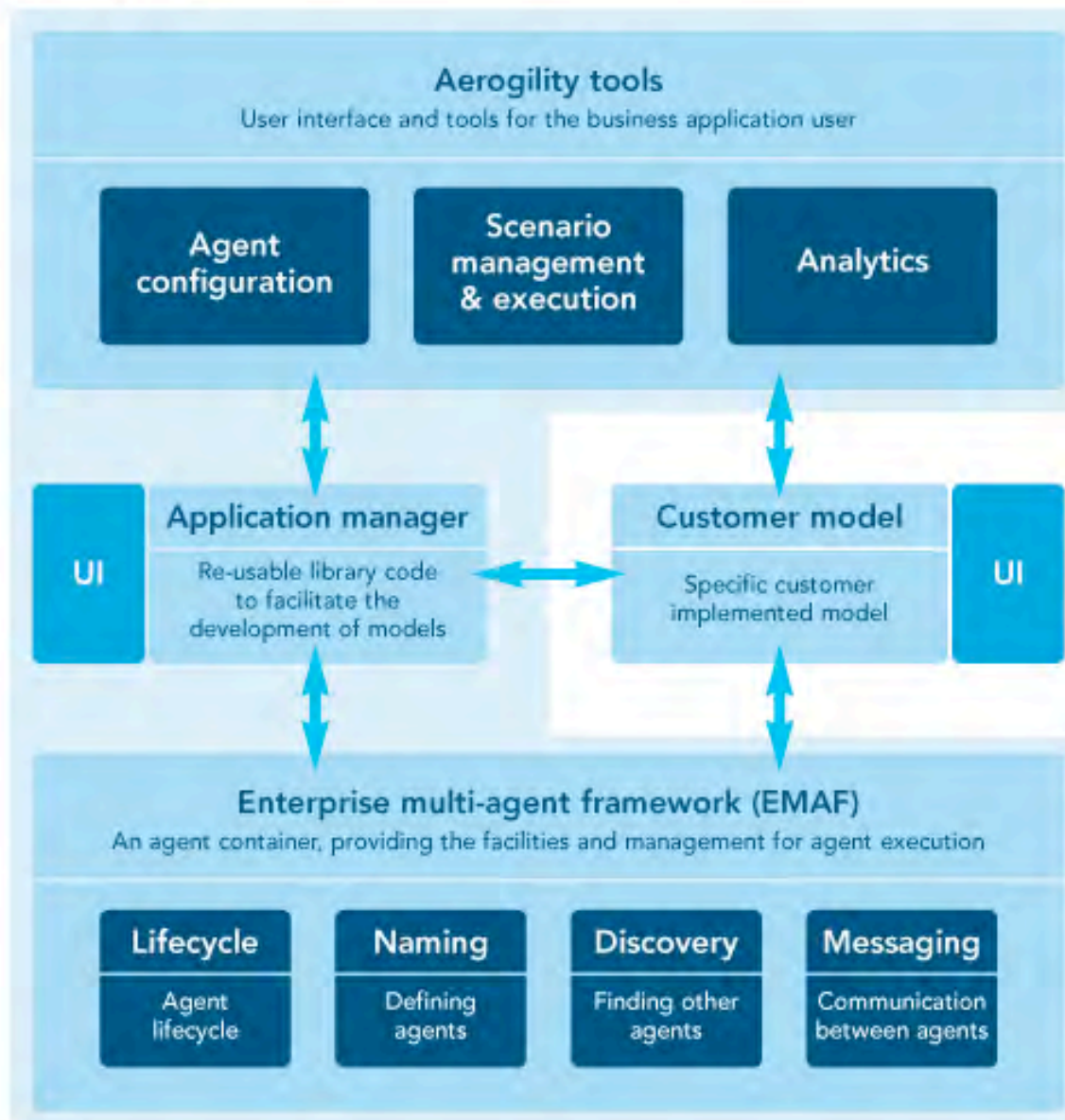


Air Traffic Management



- Optimal Aircraft Sequencing using Intelligent Scheduling (OASIS)
- Assigns landing times 20 to 45 min. before arrival time.
- Continuous monitors aircrafts until they land at an airport
- Based on BDI-agents
- Used at Sydney airport





Simulation Applications

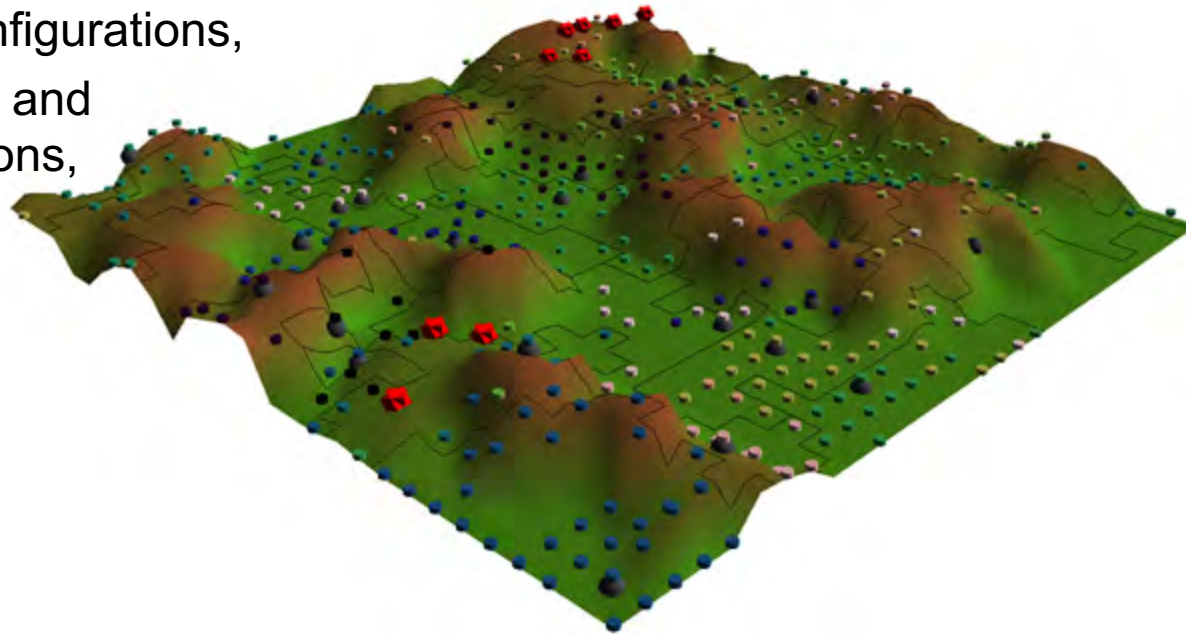
- Multiagent simulations offer strong models for representing real-world environments
- Differ from traditional kinds of simulation (e.g. with differential equations) in that the simulated entities are modeled in terms of agents with strategies
- Allows mixing software with human agents
- Three broad application areas:
 - Social structures and institutions:
 - *Ex: marketplace simulation where agents represent consumers of products*
 - Physical systems:
 - *Ex: Traffic systems (Tunnel of Glion), biological populations*
 - Software systems:
 - *Ex: Traffics in telecommunication networks*

Agent-Based Simulation

- GeoSim, an agent-based simulation framework of geopolitical processes

Prof. Cederman, International Conflict Research, ETHZ – www.icr.ethz.ch

- Explores complex issues in world politics:
 - influence of polarity configurations,
 - evolution of democracy and nationalist transformations,
 - reconstruction of war-size and state-size distributions.



Holonic Manufacturing Systems (HMS)

"Holonics"

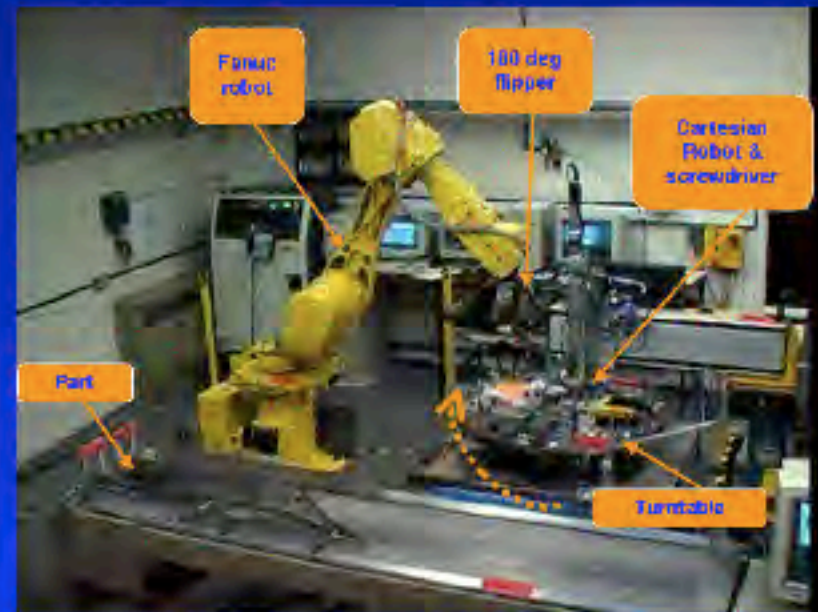
- A **Holon** is the combination of a physical process and an intelligent agent
- Holonic manufacturing systems are autonomous and co-operative

Holons can be in teams

- A team of holons can be a group of machines, each with a role

Orders are pro-active - Order Holons

- Negotiate with resources to "make themselves"
- Novel view, inverts conventional concept of a static "order"



Institute of Manufacturing, Cambridge University

- assembly cell control using a JACK Team implementation
- combine holons with radio-based part identification - the future of manufacturing...

Manufacturing applications

- Industry 4.0
- See DaimlerChrysler presentation...



Smart Manufacturing

Use of robotics and software control to adapt manufacturing processes

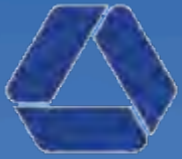
Whitestein AMC

Automated Machine Control

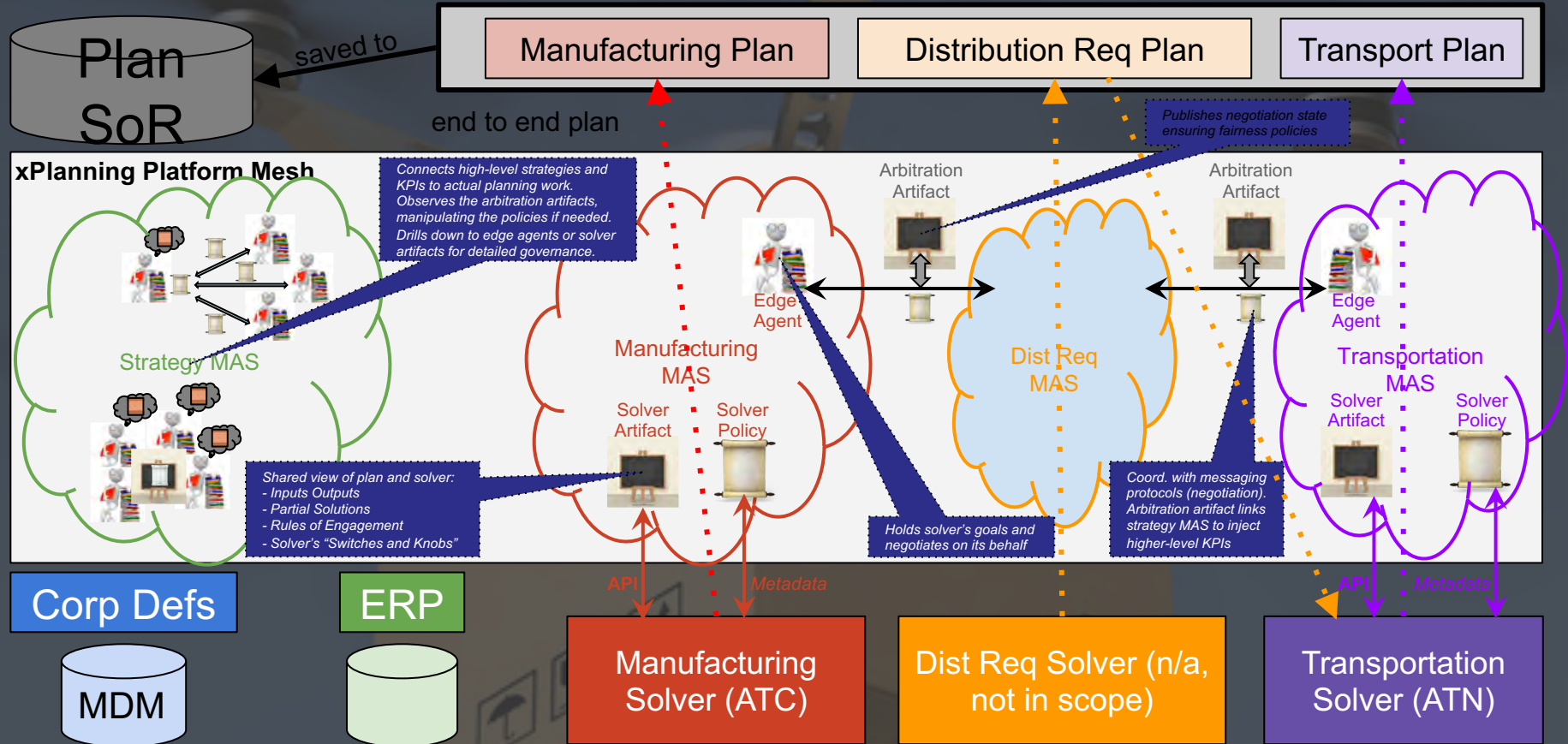
Software agents coordinate modular soldering machine

Machine adapts as modules are inserted or removed while in operation



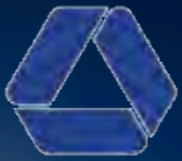


MAS Interactions for End-to-end Planning



Logistics applications

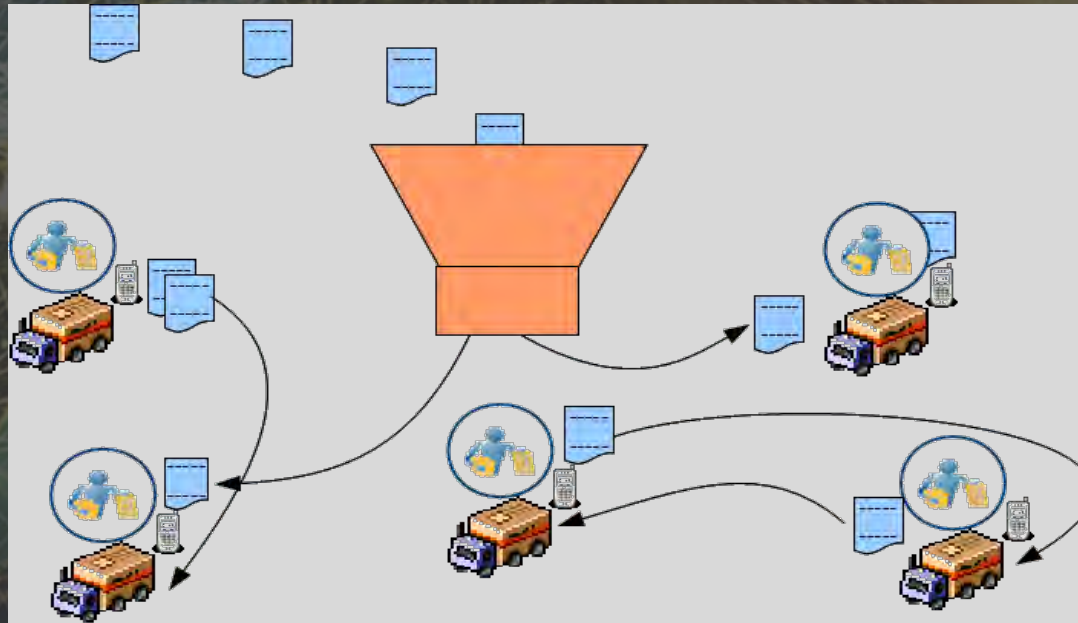
- Demand changes dynamically.
- Unforeseen problems: breakdowns, etc.
- Complex interdependencies with many participants.
- => difficult to handle in a centralized and static plan.

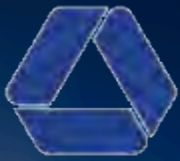


Adaptive Transportation Networks

Agent-based real-time optimization

Optimization problem space is automatically partitioned, distributed across a population of goal-directed agents and solved in real-time using multiple concurrent auctions





Adaptive Transportation Networks

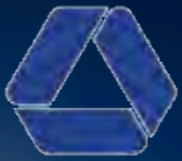
Whitestein product for optimizing freight transportation routing

Problem definition:

1. Improve ability to dispatch orders on real-time basis;
2. Provide pan-European visibility over dispatch operations

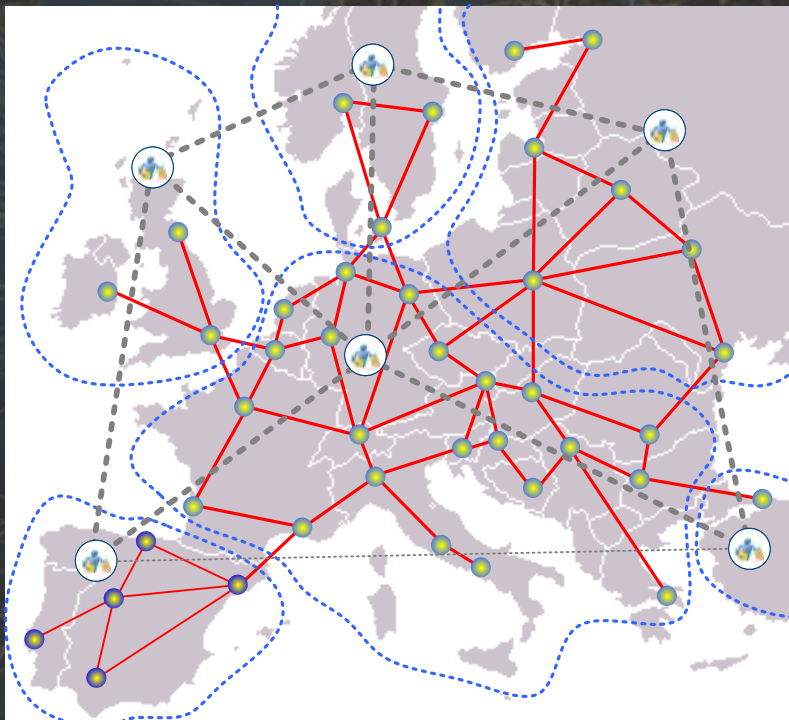
Product requirements:

1. Decision support for human dispatchers;
2. Higher utilization of multimodal transportation capacities;
3. Multiple Pick up and Delivery Problem with Time Windows;
4. Continuously produce feasible schedules in real-time;
5. Order exchange via combinatorial auctions;
6. Automated handling of plan deviations;
7. Real-time data feeds



Adaptive Transportation Networks

Network of distributed route planning agents



DHL Freight Case

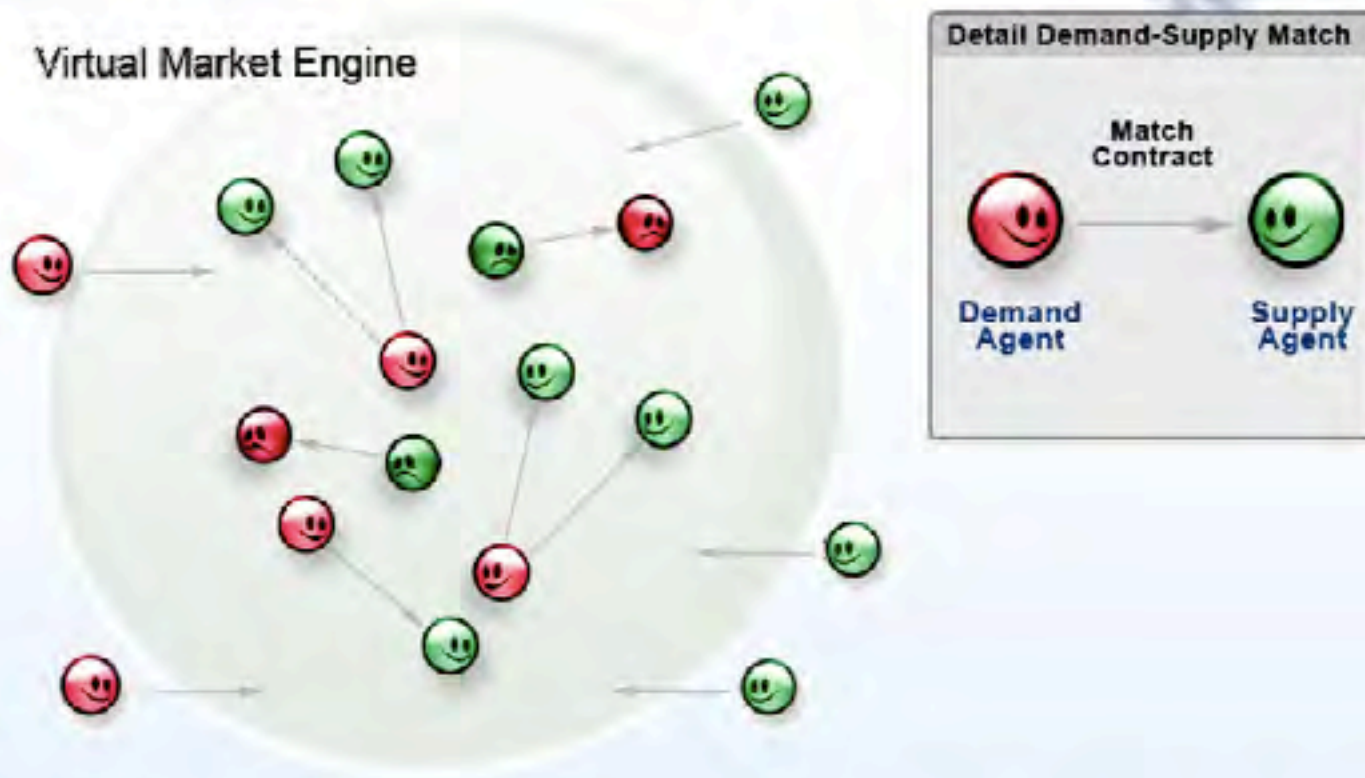
Optimized multimodal allocation of
90,000 orders/day to
35,000 trucks/trains/ships by
300 dispatchers across
24 countries
with every order changing at least once

25-30% ↑ process efficiency
6-7% ↓ transportation costs

Self-interested agents

- Distributed multi-agent systems
- Purpose: mediate interests
- Non-manipulable
- Individually rational
- Efficient (optimization)

Key Technology Features: Demand and Resource Matching



Agents representing individual elements of both demand and supply enter the Virtual Market and trade to meet their objectives. Once a demand agent matches with a supply agent a match contract is created. This contract describes the terms of the agreement. As changes effect demand and supply (such as cancelled orders or unavailable equipment) or as new demand and supply enter the Virtual Market, these contracts can be re-evaluated and broken or kept as is required to meet the level of response needed in the overall network.

Other interesting applications: iBundler

Delegating tasks
in e-procurement

iSOCO Services

RFQ	Quantity	Contract		Numprovider		Weight
		Min	Max	Min	Max	
Req FORT HUB	400.0	0.25	0.75	20	5.0	0.2
Req SHIRT	800.0	1.0	1.0	20	5.0	0.2
Req L.C.A.B.	600.0	0.0	1.0	00	5.0	0.2
Req SHIRT HAT	100.0	1.0	1.0	10	5.0	0.2
Req COIL SPRING	400.0	0.25	1.0	10	5.0	0.2

Load Reset

Buyer RFQ form

Provider's Capabilities

RFQ	Quantity
Req FORT HUB	400
Req SHIRT	800
Req L.C.A.B.	600
Req SHIRT HAT	100
Req COIL SPRING	400

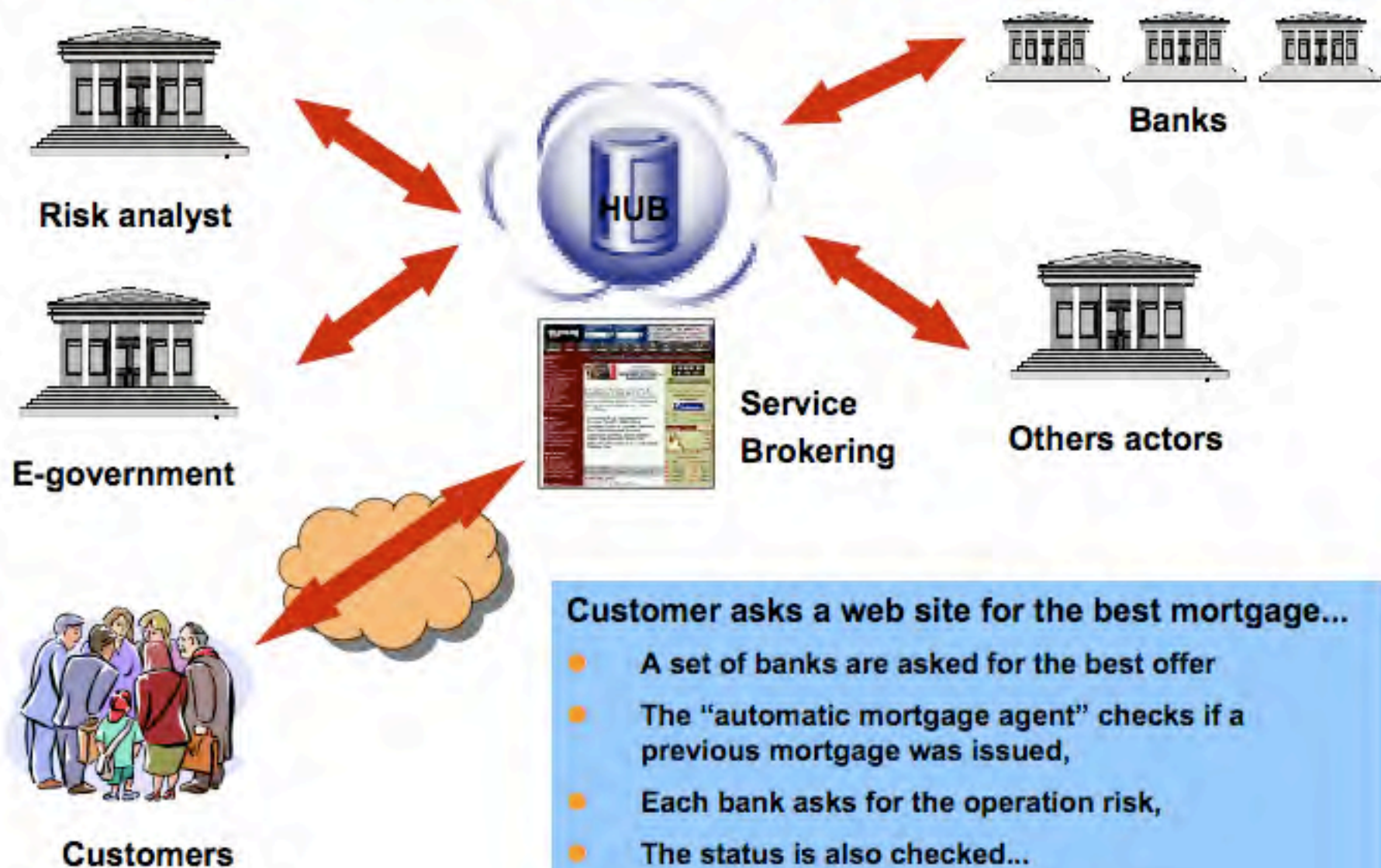
RFQ Item	Capacity provided	Capacity provided	Capacity provided
Req FORT HUB	100	100	100
Req SHIRT	100	100	100
Req L.C.A.B.	1000	1000	1000
Req SHIRT HAT	100	100	100
Req COIL SPRING	100	100	100

Simple Bid Offers

Provider's Single Bids

Provider 1				Provider 2				Provider 3			
RFQ Item	Quantity	Price	Unit	RFQ Item	Quantity	Price	Unit	RFQ Item	Quantity	Price	Unit
Req FORT HUB	400	0.25	0.75	Req SHIRT	800	1.0	1.0	Req L.C.A.B.	600	0.0	1.0
Req SHIRT HAT	100	1.0	1.0	Req COIL SPRING	400	0.25	1.0				

Other interesting applications: Mortgage negotiation



Customer asks a web site for the best mortgage...

- A set of banks are asked for the best offer
- The "automatic mortgage agent" checks if a previous mortgage was issued,
- Each bank asks for the operation risk,
- The status is also checked...

Finally, the best offer is chosen ...