An Introduction to Semantic Modeling for Logistical Systems

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Several Types of Webs

- The Web of Information
  - HTML and the World Wide Web
- The Web of Things
  - Linking physical objects together using Auto-ID
- The Web of Abstractions
  - Building a network of mathematical models
  - Link models together
  - Link data to models
  - Computer languages & protocols to create a free flow of models in a network (Internet or Intranet)

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The Future…

Supply chains that sense and respond to the physical world.

This requires an **Intelligent Infrastructure** for management, control, and automation.

The initial base of the infrastructure is the Electronic Product Code (EPC).

A serial number does not adequately describe an abstraction like a model.

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Semantic Modeling - The Goal

- Communication of models between computers to create **interoperability**
- Run **distributed** models across the Internet
- Increased model **sharing** and **re-use** of model elements
- Increase the **productivity** of modeling
  - Reduce trial & error
  - Improve mathematical intuition
  - Reduce dependence on literature search
- Redefine the **link** between models and data…and data to data
- Share models across **domains**

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An Extension of Auto-ID: Implications for Logistics Practitioners

- Logistics depends on the flow of data for effective management.
- Auto-ID and other technologies will increase the flow of data.
- Practitioners will need models to interpret data streams

  Inventory, transportation, warehousing, customer service, purchasing…

Basic Questions

What are the relationships between models?

How are models connected?

In the future, the definition of a model and the sharing of models though a network will become as important as the model itself.

Meaning arises by the way one model is connected or related to other models

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Early Work in the Field

- GEOFFRION, A.M. **1987**. "An Introduction to Structured Modeling." *Management Science* 33:5.
- GEOFFRION, A.M. **1989**. "The Formal Aspects of Structural Modeling." *Operations Research* 37:1.
- MUHANNA, W.A. and R.A. PICK. **1994**. "Meta-modeling Concepts and Tools for Model Management: A Systems Approach." *Management Science* 40:9.

Recent Conceptual Work

- BROCK, D.L. **2000**. "Intelligent Infrastructure – A Method for Networking Physical Objects," *MIT Smart World Conference*.

- BROCK, D.L. **2003**. "The Data Project – Technologies, Infrastructure and Standards for Distributed Interoperable Modeling and Simulation," *MIT Data Project Workshop*, September.

Recent Applied Work

- GAZMURI, P and MATURANA, S. **2001**. "Developing and Implementing a Production Planning DSS for CTI Using Structured Modeling." *Interfaces* 31:4.

Proposed System - **M**

- David Brock, Chief Architect
- Initial Design – a System of Languages and Protocols

  Data Modeling Language (DML), semantic for describing modular, interoperable model components.

  Data Modeling Protocol (DMP), semantic that describes the communication between the computing machines that host models

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Proposed System – M (continued)

- Initial Design – a System of Languages and Protocols

  Automated Control Language (ACL), specification for describing decision-making elements (outputs).

  Automated Control Protocol (ACP), helps decision-making elements locate one another, even though the individual models may exist in different host systems and organizations.

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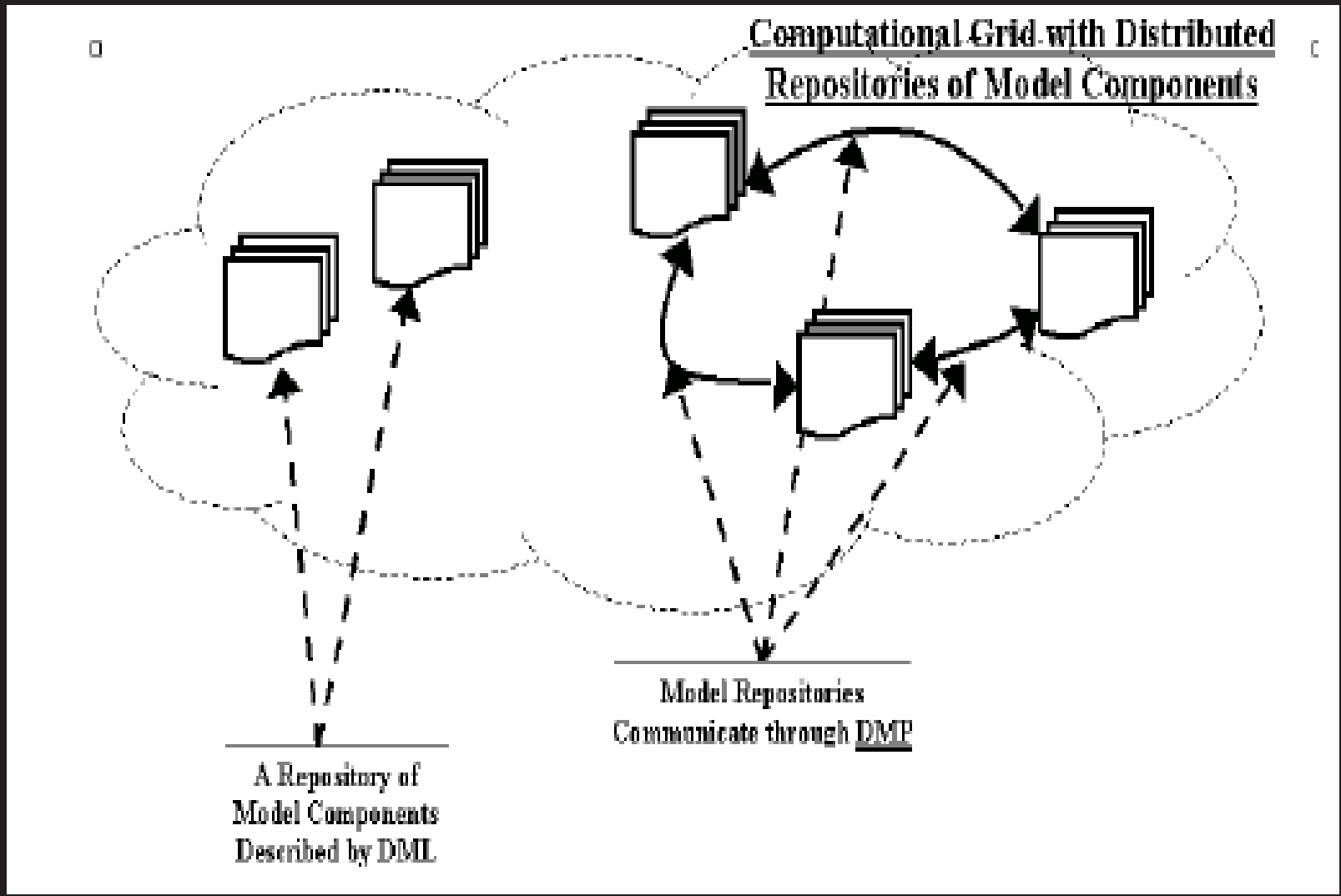
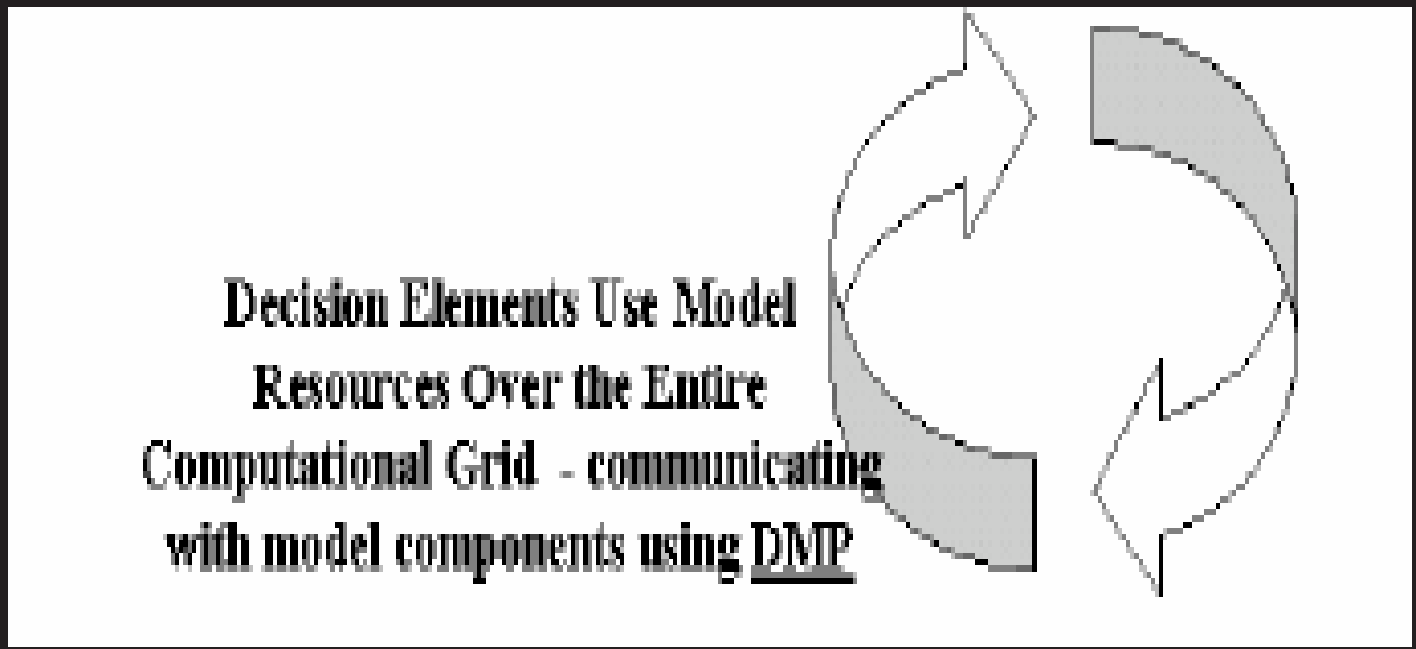
A Visualization of **M**



Grid Computing Coordination



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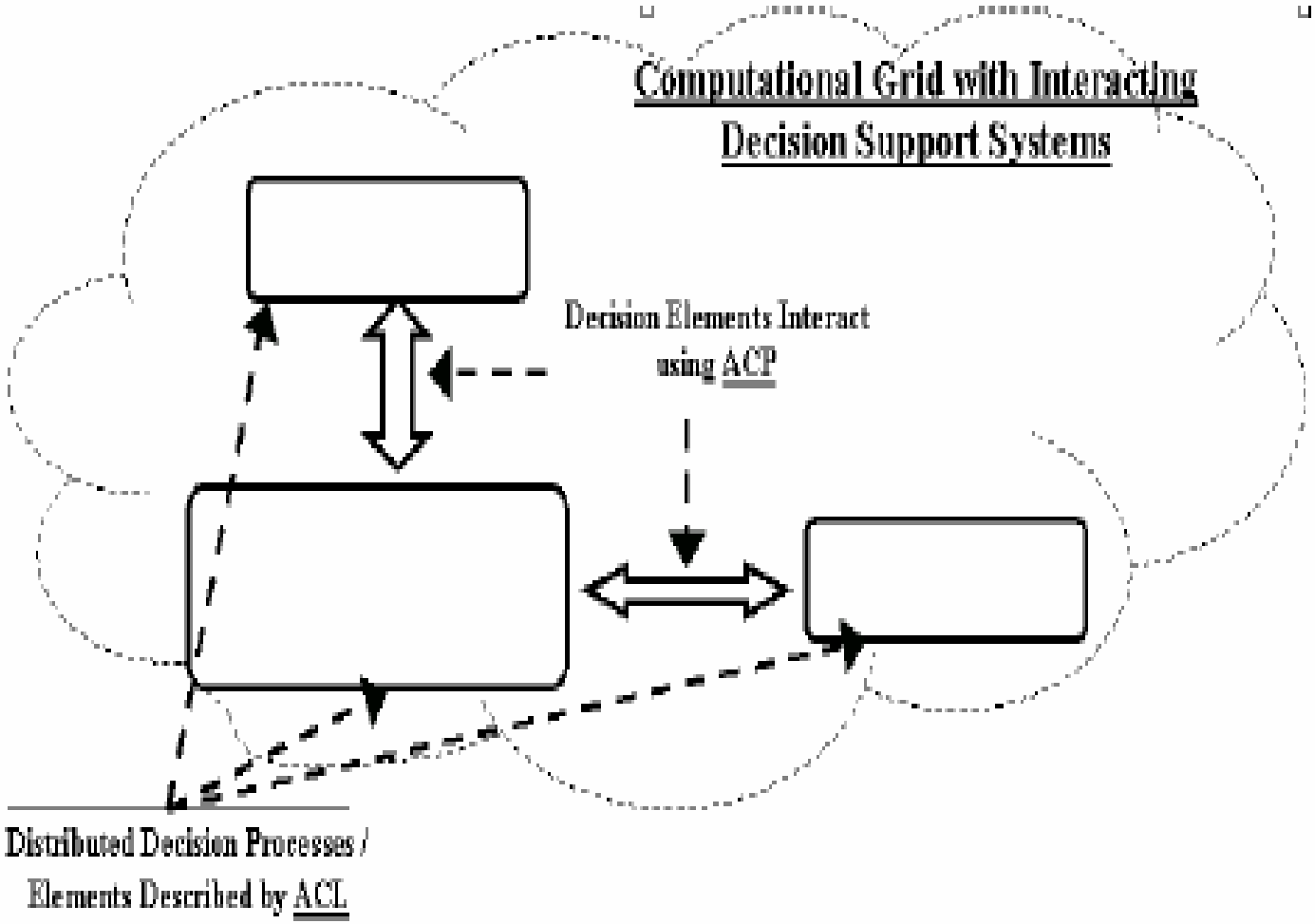

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Data Inputs as a Semantic

Data Input	Model A	Model B	Model C	Model D
D1. Beginning Inventory	X	X	X	X
D2. Forecast Demand (by week)	X	X	X	X
D3. Historical Shipments (by week)	X	X	X	X
D4. Historical Forecast (by week)	X	X	X	X
D5. Hold Time (days)	X			
D6. Queue Time (days)	X			
D7. Service Level (% in stock)	X	X	X	X
D8. Set-up Cost ($/changeover)		X	X	X
D9. Set-up Time (hrs/set-up)			X	X
D10. Holding Cost ($/week)		X	X	X
D11. Capacity Limit (hrs/day)		X	X	X
D12. Family Structure (end items per group)		X		
D13. Overtime Cost ($/hr)			X	X
D14. Sequence Dependent Set-up Cost (From–To table of change-over costs)				X

First Prototypes

- Logistical Systems Including ERP
  - Forecasting, planning, scheduling, and inventory models
- Agricultural Models
  - Harvest risk and planning
- Retail
  - Lot sizing for short life-cycle products
  - Lillian Vernon, Inc.

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First Prototypes (continued)

- More General View of Semantic Modeling

  Method to search and re-use elements of mechanical designs (**automobile industry**)

  Communication between different divisions within a conglomerate (**medical industry**)

  Analyzing news releases (**financial services**)

Next Steps…

- Smart World 2004 – Semantic Modeling
- Meeting date set for Dec. 8, Kresge Auditorium, MIT
- Support from the MIT Industrial Liaison Program
- Speakers representing Intel, IBM, Microsoft, SAP, P&G, J&J and MIT
- Over 60 people registered from industry, special academic rate available
- Establish **The Data Center**
- **This is large project that will take participation from industry and academia**