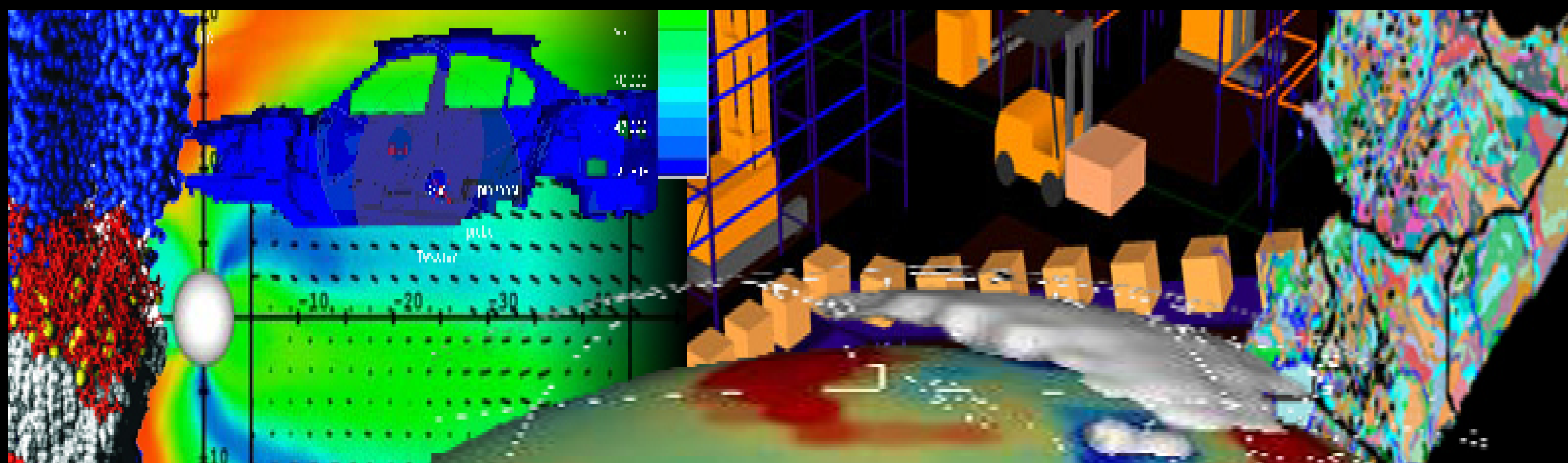

INSTITVTE OF TECHNOLOGY

The Data-Driven Economy

Applications of the M Language in Agriculture



Edmund W. Schuster and Stuart J. Allen
The Data Center Program
Laboratory for Manufacturing and Productivity
Massachusetts Institute of Technology

WHAT WE WILL DISCUSS TODAY

1. A brief **case study** of quantitative risk modeling in agriculture
2. A list of **applications** and projects programmed for the future
3. The **M Language** and **Web Machines**
4. Questions

THE MIT DATA CENTER WEB SITE

datacenter.mit.edu

CASE STUDY - THE GRAPE HARVEST AT WELCH'S

Allen, S.J. and E.W. Schuster, "Controlling the Risk for an Agricultural Harvest," *Manufacturing & Service Operations Management* 6:3 (2004): pp 225 – 236.

Allen, S.J. and E.W. Schuster, "Managing the Risk for the Grape Harvest at Welch's," *Production and Inventory Management Journal* 41:3. (2000): pp 31 – 36.

Schuster, E.W. and S.J. Allen, "Raw Material Management at Welch's," *Interfaces* 28:5 (1998): pp. 13 - 24.

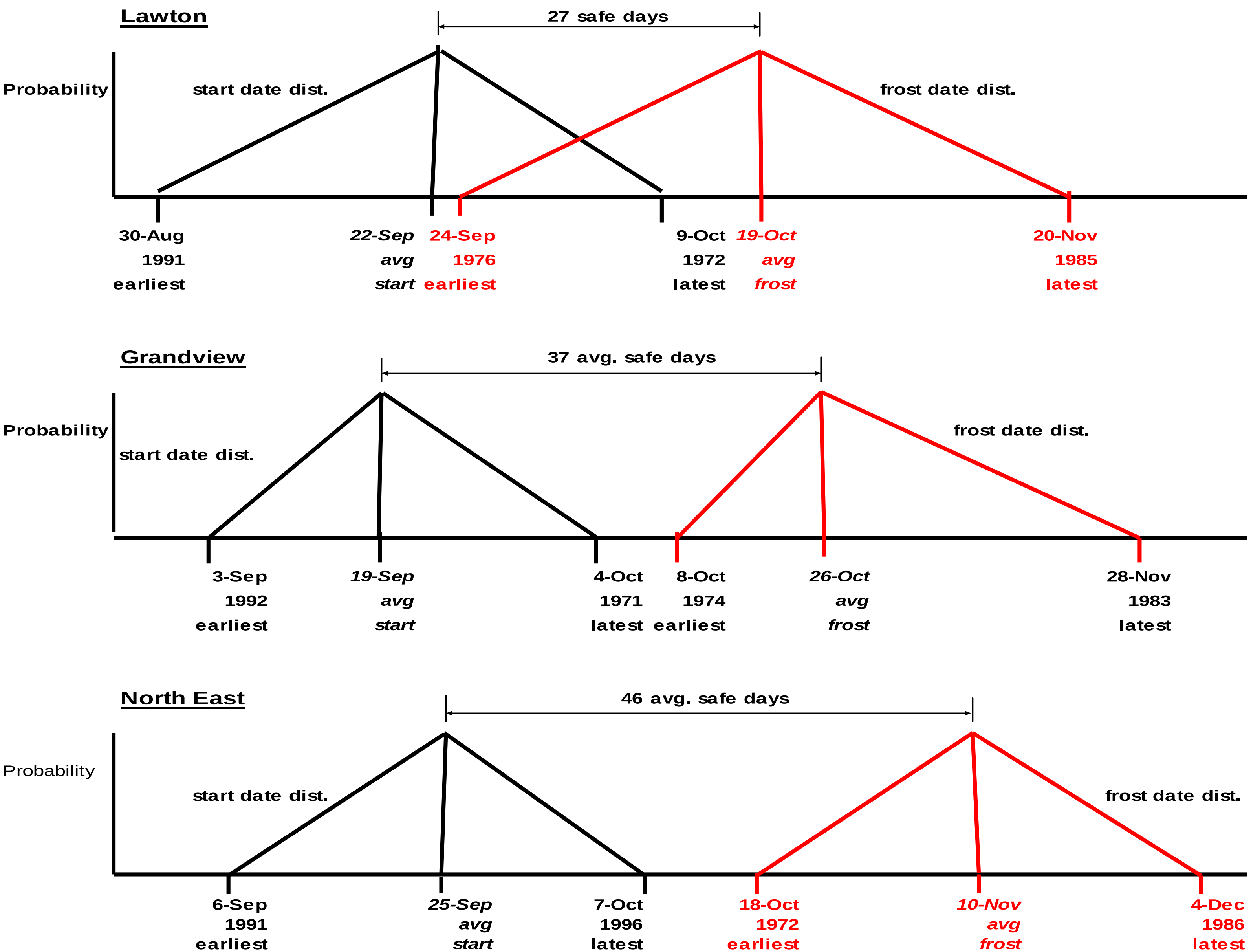
PURPOSE OF THE "HARVEST MODEL"

- Balance the growers desire to harvest all grapes before a hard frost verses capital expenditures required for maximum through-put rate.
- Historically, Welch's used a fixed-length of harvest to plan the though-put rate.
- The fixed-length of harvest method did not consider the risk of a hard freeze or uncertain start dates

DEFINITION OF “POLICY”

- Take 100% of the crop, 85% of the time
- Implies a harvest rate (R) required to meet the policy
- By defining a “statistical” policy for receiving grapes we can make trade-offs between harvest capacity and investment in equipment
- We calculated a “loss function” and found the 85% policy to be optimal

Qualitative Comparison of Start Dates and First 28 Degree Day
With Estimated Triangular Distributions



Comments (a

Lawton has
occurring

Six times du
Lawton h

Comments (a

The West ha
occurring

Over a 50%
in Octobe

Comments (a

North East l
in October

Largest am

DATA REQUIRED FOR THE HARVEST MODEL

- Harvest Size - we use the average of the LRP for Concord, for each growing area
- Historical analysis shows the harvest size to be normally distributed

DATA (continued)

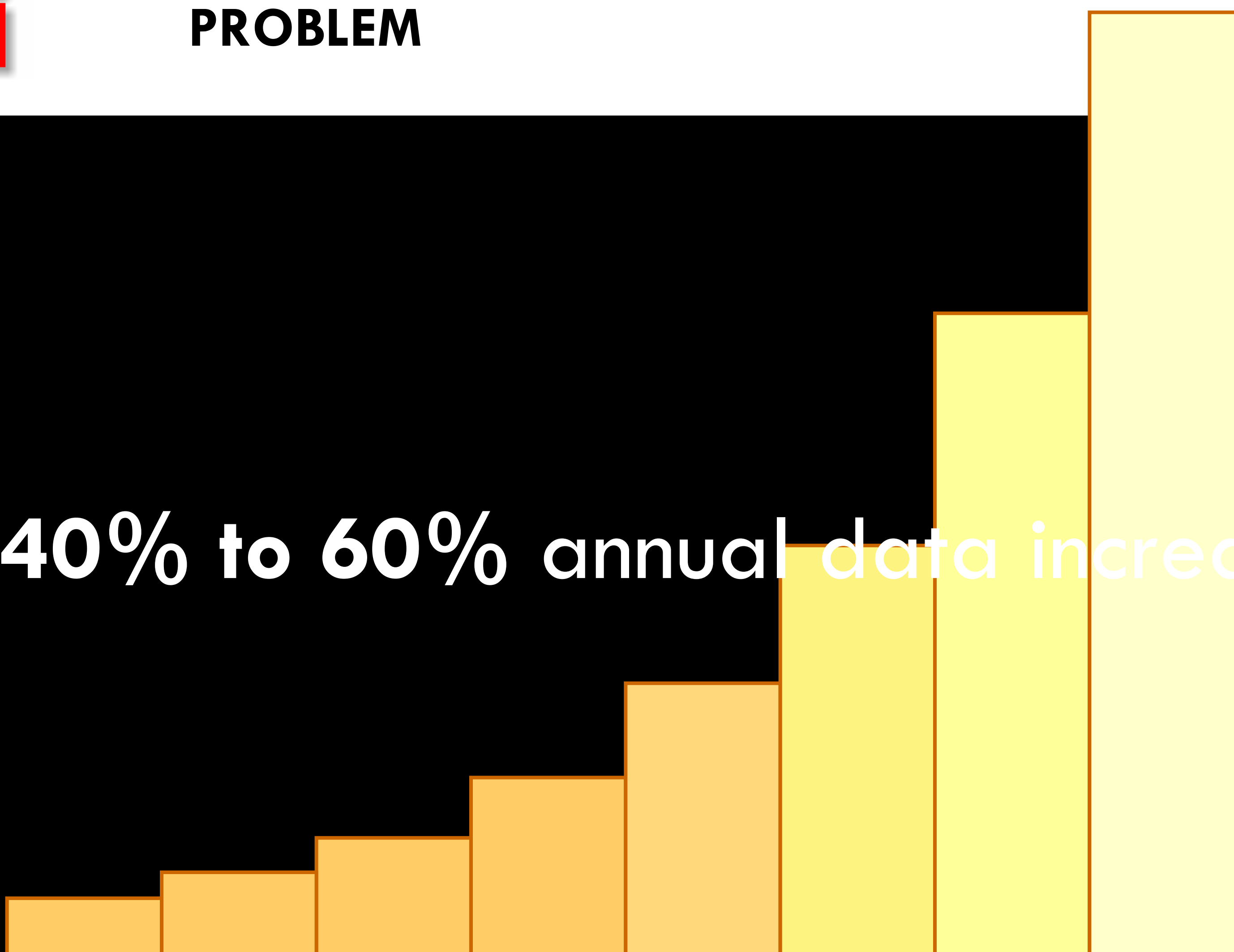
- We use the “start date” and “end date” provided by National Co-op to calculate the length of season, L
- We assume the distribution of the season length to be normal (based on observations of histograms)
- L is not correlated with harvest size, H.
  - .14 correlation with significance of 53%.
- ONLY DATA AVAILABLE – POINT ESTIMATE OF TEMPERATURE
- TEMPERATURE SENSORS

There are only several certainties in the world,

"death, taxes, and integration."

Professor Grosof
MIT Sloan School of Management

PROBLEM



40% to 60% annual data increase

From *Forbes*

PROBLEM

What are you going to do with all your Data?

BREAK-THROUGH

- **"An Introduction to Semantic Modeling for Logistical Systems,"** D.L. Brock, E.W. Schuster, S.J. Allen and P. Kar, J. *of Business Logistics (2004)*.

- Winner of the 2004 **E. Grosvenor Plowman Award** given by the Council of Logistics Management for best contribution to the study of logistics.

M – THE BIG PICTURE

- Sensors

  "the number of deployed sensors will dwarf the number of personal computers by a thousand fold in 2010"

  Ferguson, Glover, Sanjay Mathur and Baiju Shah (2005), "Evolving From Information to Insight," *Sloan Management Review* 46:2, p. 52.

- Interoperable Data
  - Something like Adobe Acrobat

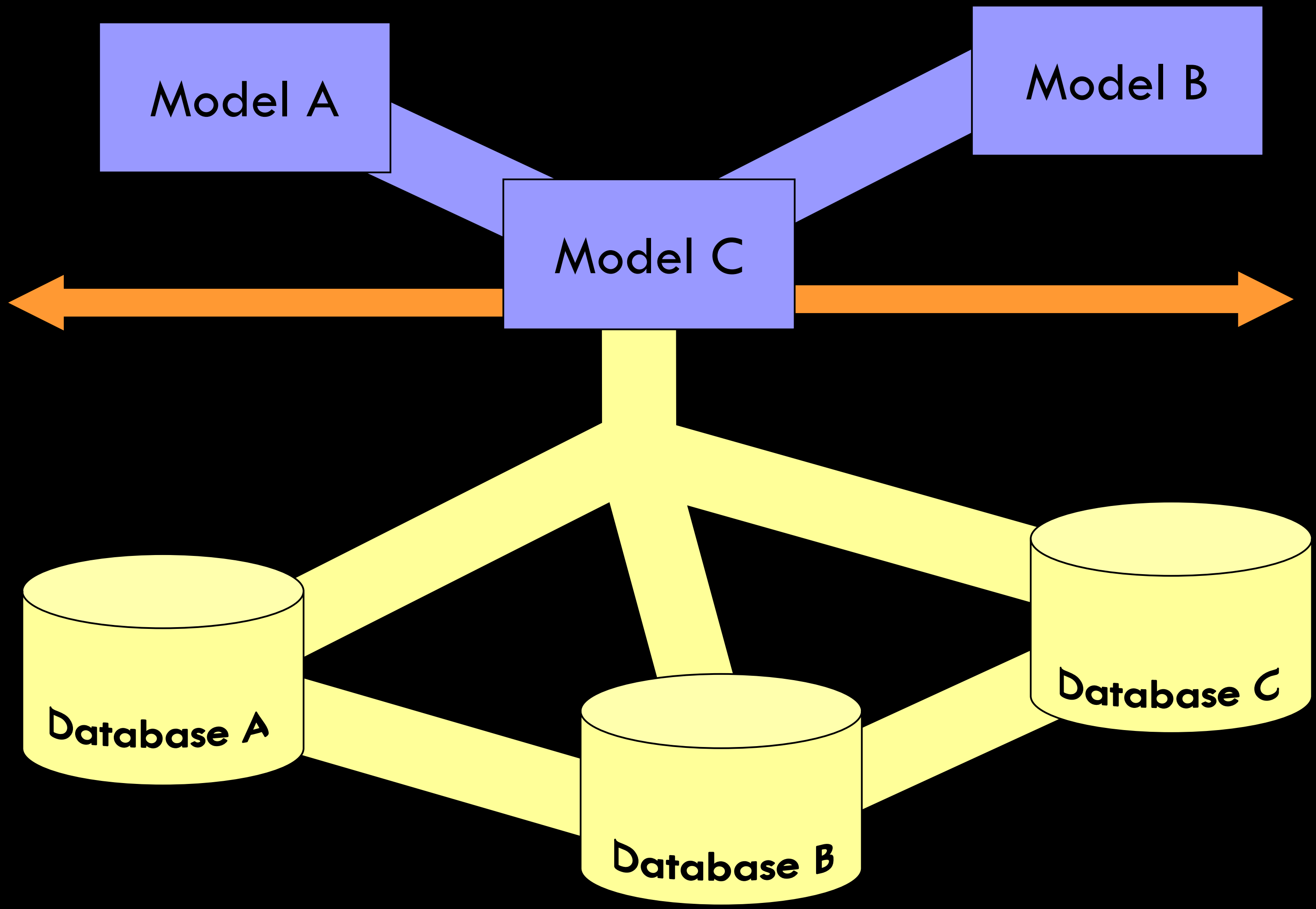
- A Network of Models
  - Capture 50 years of modeling, link everything together
  - Something like eBay
  - The future of ERP…Packaged Software?
  - SAP and DEC, **Analog Devices**

M – THE BIG PICTURE (COMPUTER SCIENCE)

- An open system
- M works with existing data
- The language is designed to be used with existing standards, including the W3C
- Achieve communication when target is un-known
- Address the "many-to-many" problem
- A way to deal with semantics that is different from previous Artificial Intelligence approaches

We want to become the “Henry Ford of Math Modeling”

VISION



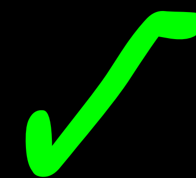
SOLUTION

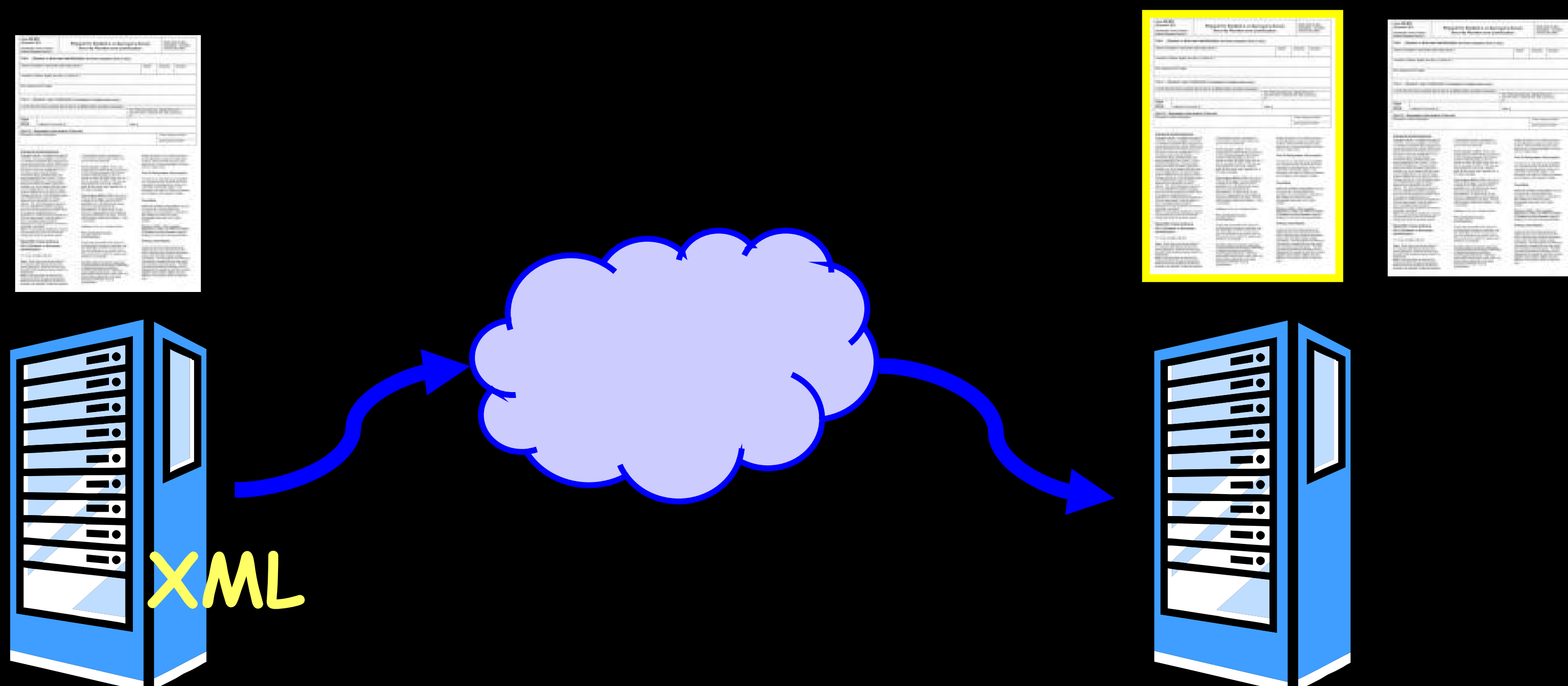
XML

Must agree on vocabulary and syntax

XML

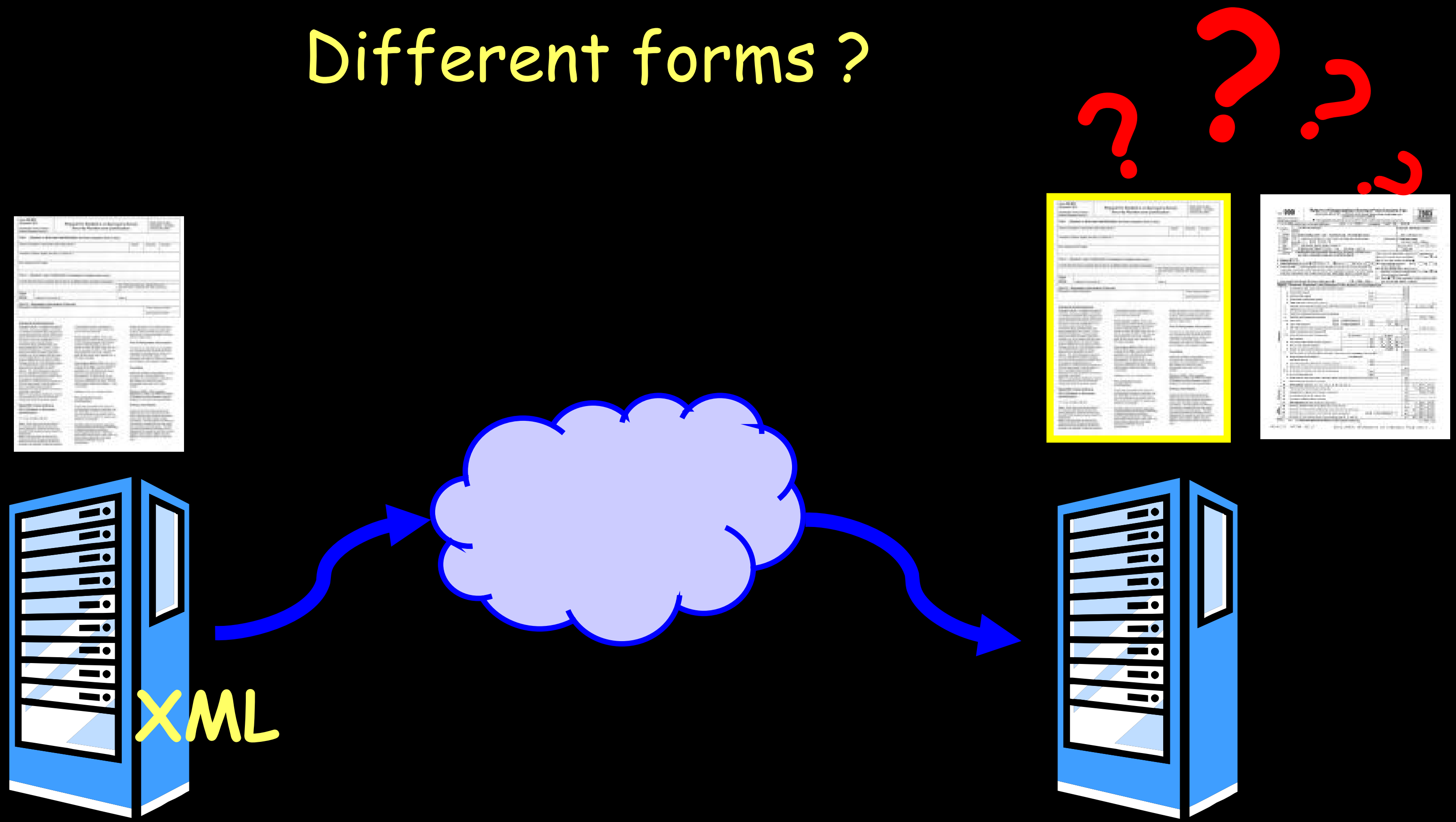
XML is like a form.





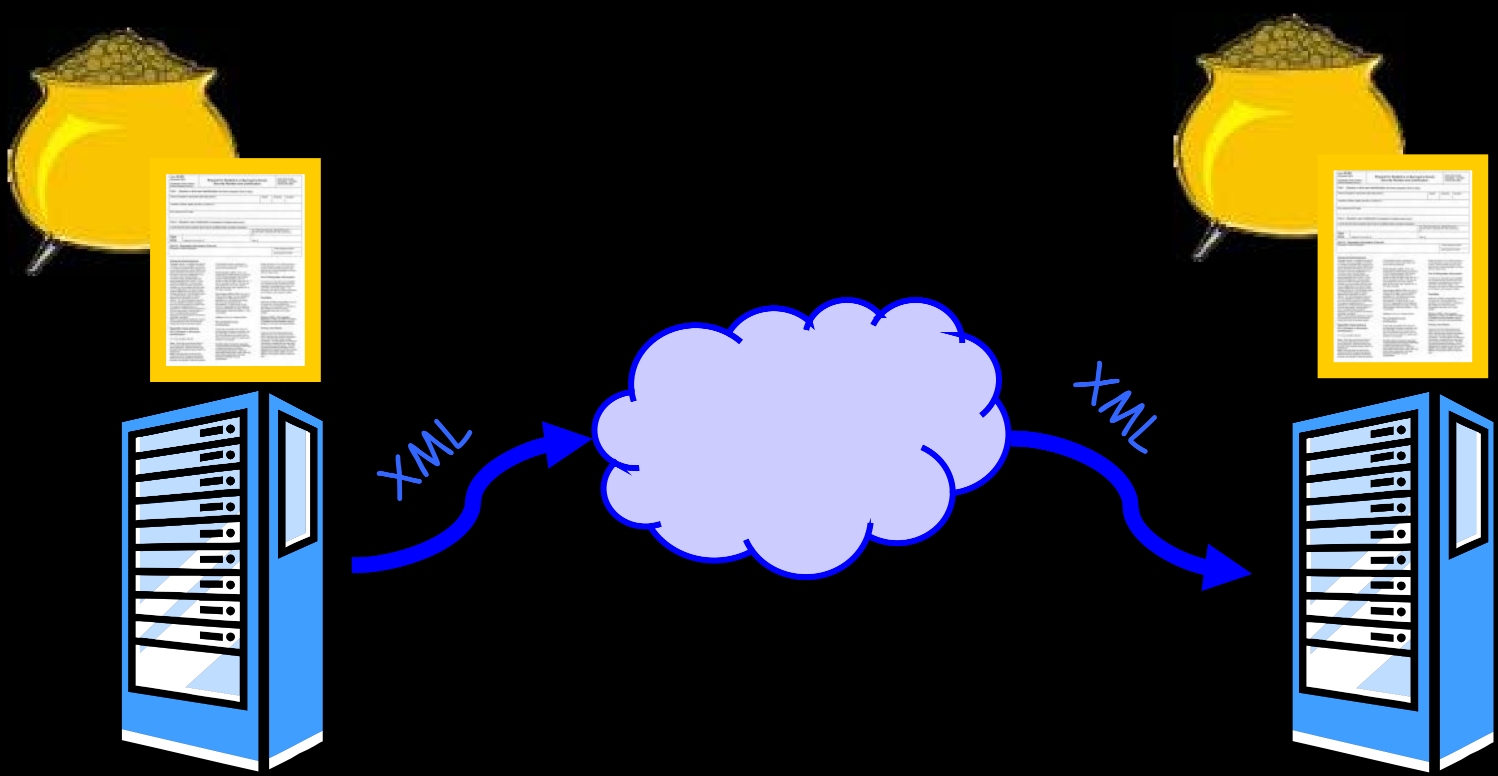
PROBLEM

Different forms ?



STANDARD

Can't we just agree on <u>one</u> form?



STANDARD?

Whose form?

STANDARDS?

4ML	ARML	BiblioML	CIDX	eBIS-XML	HTTP-DRP	MatML	ODRL	PrintTalk	SHOE	UML	XML F
AML	ARML	BCXML	xCIL	ECML	HumanML	MathML	OeBPS	ProductionML	SIF	UBL	XML Key
AML	ASML	BEEP	CLT	eCo	HyTime	MBAM	OFX	PSL	SMML	UCLP	XMLife
AML	ASML	BGML	CNRP	EcoKnow	IML	MISML	OIL	PSI	SMBXML	UDDI	XML MP
AML	ASTM	BHTML	ComicsML	edaXML	ICML	MCF	OIM	QML	SMDL	UDEF	XML News
AML	ATML	BIBLIOML	Covad xLink	EMSA	IDE	MDDL	OLifE	QAML	SDML	UIML	XML RPC
AML	ATML	BIOML	CPL	eosML	IDML	MDSI-XML	OML	QuickData	SMIL	ULF	XML Schema
ABML	ATML	BIPS	CP eXchange	ESML	IDWG	Metarule	ONIX DTD	RBAC	SOAP	UMLS	XML Sign
ABML	ATML	BizCodes	CSS	ETD-ML	IEEE DTD	MFDX	OOPML	RDDI	SODL	UPnP	XML Query
ACML	AWML	BLM XML	CVML	FieldML	IFX	MIX	OPML	RDF	SOX	URI/URL	XML P7C
ACML	AXML	BPML	CWMI	FINML	IMPP	MMLL	OpenMath	RDL	SPML	UXF	XML TP
ACAP	AXML	BRML	CycML	FITS	IMS Global	MML	Office XML	RecipeML	SpeechML	VML	XMLVoc
ACS X12	AXML	BSML	DML	FIXML	InTML	MML	OPML	RELAX	SSML	vCalendar	XML XCI
ADML	AXML	CML	DAML	FLBC	IOTP	MML	OPX	RELAX NG	STML	vCard	XAML
AECM	BML	xCML	DaliML	FLOWML	IRML	MoDL	OSD	REXML	STEP	VCML	XACML
AFML	BML	CaXML	DaqXML	FPML	IXML	MOS	OTA	REPML	STEPML	VHG	XBL
AGML	BML	CaseXML	DAS	FSML	IXRetail	MPML	PML	ResumeXML	SVG	VIML	XSBEL
AHML	BML	xCBL	DASL	GML	JabberXML	MPXML	PML	RETML	SWAP	VISA XML	XBN
AIML	BML	CBML	DCMI	GML	JDF	MRML	PML	RFML	SWMS	VMML	XBRL
AIML	BML	CDA	DOI	GML	JDox	MSAML	PML	RightsLang	SyncML	VocML	XCFF
AIF	BannerML	CDF	DeltaV	GXML	JECMM	MTML	PML	RIXML	TML	VoiceXML	XCES
AL3	BCXML	CDISC	DIG35	GAME	JLife	MTML	PML	RoadmOPS	TML	VRML	Xchart
ANML	BEEP	CELLML	DLML	GBXML	JSML	MusicXML	PML	RosettaNet PIP	TML	WAP	Xdelta
ANNOTEA	BGML	ChessGML	DMML	GDML	JSML	NAML	PML	RSS	TalkML	WDDX	XDF
ANATML	BHTML	ChordML	DocBook	GEML	JScoreML	xNAL	P3P	RuleML	TaxML	WebML	XForms
APML	BIBLIOML	ChordQL	DocScope	GEDML	KBML	NAA Ads	PDML	SML	TDL	WebDAV	XGF
APPML	BIOML	CIM	DoD XML	GEN	LACITO	Navy DTD	PDX	SML	TDML	WellML	XGL
AQL	BIPS	CIML	DPRL	GeoLang	LandXML	NewsML	PEF XML	SML	TEI	WeldingXML	XGMML
APPEL	BizCodes	CIDS	DRI	GIML	LEDES	NML	PetroML	SML	ThML	Wf-XML	XHTML
ARML	BLM XML	CIDX	DSML	GXD	LegalXML	NISO DTB	PGML	SAML	TIM	WIDL	XIOP
ARML	BPML	xCIL	DSD	GXL	Life Data	NITF	PhysicsML	SABLE	TIM	WITSML	XLF
ASML	BRML	CLT	DXS	Hy XM	LitML	NLMXML	PICS	SAE J2008	TMML	WorldOS	XLIFF
ASML	BSML	CNRP	EML	HITIS	LMML	NVML	PMML	SBML	TMX	WSML	XLink
ASTM	BCXML	ComicsML	EML	HR-XML	LogML	OAGIS	PNML	Schemtron	TP	WSIA	XMI
ARML	BEEP	CIM	DLML	HRMML	LogML	OBI	PNML	SDML	TPAML	XML	XMSG
ARML	BGML	CIML	EAD	HTML	LTSC XML	OCF	PNG	SearchDM-XML	TREX	XML Court	XMTP
ASML	BHTML	CIDS	ebXML	HTTPL	MAML	ODF	PrintML	SGML	TxLife	XML EDI	XNS

The Future…

The integration of **marketing science**, **engineering technology**, and **supply chain management**.

Supply chains that sense and respond to the physical world.

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

The **M Language** is an open system that will form the base.

OBJECTIVE

Develop new ways of influencing customer decision-making at the point of sale

Interactive Marketing

Use the M Language as the data aggregator between venders and retailers

In-Store Informational Kiosk

Self-service, interactive, networked terminals in the aisles for:

- *Product information*
- *Comparisons*
- *Targeted marketing*
- *Promotions*

Agricultural Projects

- Integration of weather and pest data
- Managing Risk In Premium Fruit And Vegetable Supply Chains
- The M Language and Agricultural Sensors
- Agricultural Planning Under Demand, Yield, and Harvest Uncertainty: An Application in Tomato Farming
- Risk in Agriculture - A Study of Crop Yield Distributions and Crop Insurance
- The “Three Risk” Model – optimal size of a cooperative
- Application of the Boeing TR System to Agricultural Machinery

datacenter.mit.edu

An Overview of the M Language
http://mitdatacenter.org/MIT-DATACENTER-WH-009.pdf

Capacitated Materials Requirements Planning and its Application in the Process Industries
http://mitdatacenter.org/JBL98v6%20-%201.5%20spacing.pdf

Master Production Schedule Stability Under Conditions of Finite Capacity
http://mitdatacenter.org/LEC20054-14-05R1.pdf

Improved New Product Forecasting though Visualization of Spatial Diffusion
MIT-DATACENTER-WH-006

Practical Production Scheduling with Capacity Constraints and Dynamic Demand: Family Planning and Disaggregatio
http://datacenter.mit.edu/P&IMJ%201994%20SJA%20EWS.pdf

A Simple Method for the Multi-item, Single-level, Capacitated Scheduling Problem with Set-up Times
http://datacenter.mit.edu/P&IMJ%201997%20SJA%20JM%20EWS.pdf

Capacitated Scheduling of Multiple Products on a Single Processor with Sequence Dependencies
http://datacenter.mit.edu/ditri[1].pdf

A Deterministic Spreadsheet Simulation Model for Production Scheduling in a Lumpy Demand Environment
http://datacenter.mit.edu/P&IMJ%201990%20EWS%20BJF.pdf

GLOBAL RFID
The Value of the EPCglobal Network for Supply Chain Management
http://www.mitdatacenter.org/DATACENTERglobalrfid.htm

Published by Springer Verlag

Controlling the Risk for an Agricultural Harvest
http://mitdatacenter.org/1526-5498-2004-6-3-0225.pdf

Managing the Risk for the Grape Harvest at Welch's
http://datacenter.mit.edu/P&IMJ%202000%20SJA%20EWS.pdf

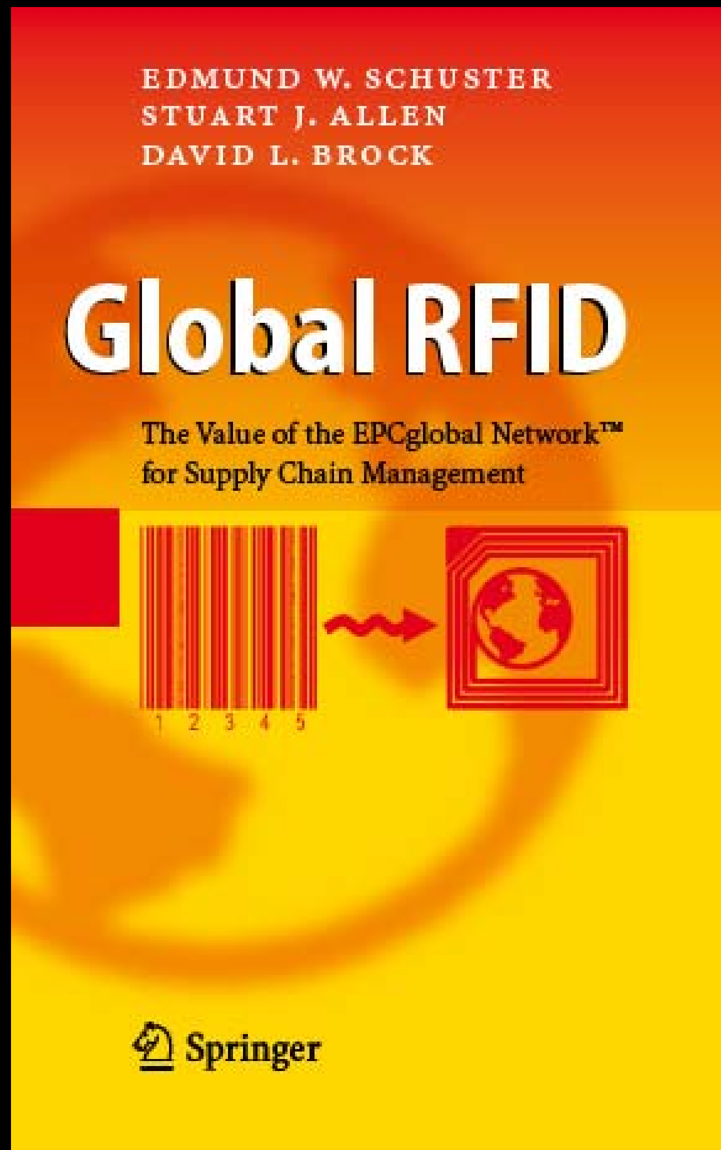
Raw Material Management at Welch's
http://datacenter.mit.edu/Schuster-Allen%201998.pdf

The Impact of e-Commerce on the Japanese Raw Fish Supply Chain
http://datacenter.mit.edu/Watanabe%20-%20Schuster,%20eCommerce,%203-22-03%20(final%20draft).pdf

The Impact of e-Commerce on the Japanese Raw Fish Supply Chain (presentation)
http://datacenter.mit.edu/LEC%202003.pdf

Understanding the Organic Foods Supply Chain: Challenges and Opportunities from Farm Gate to End Consumer
http://datacenter.mit.edu/Agribusiness,%206-7-02.pdf

An Introduction to Semantic Modeling for Logistical Systems
http://www.mitdatacenter.org/BrockSchusterAllenKar.pdf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