DATA CENTER

Make sense of your data

David Brock, Founder and Director
Data Center
Massachusetts Institute of Technology
40% to 60% annual data increase
What are you going to do with all your Data?
DATA CENTER

Make sense of your data
EXAMPLE - LOGISTICS
MODELS
MODELS

Model
MODELS
DRIVERS

- XML
- HTML
- EPC
- HTTP
- TCP/IP
- SOAP

Inside the Future: Tracking Moore's Law

U.S. Census Bureau

National Digital Forecast Database

Low Temperature (F) Ending Tue Jul 06 2004 03 PM EDT

© Regents 2004
The more complex the network, the more you need standards.
VISION

Mission

- Make sense of your data

Task

- Create the standards and systems for interoperable data and modeling
How do we synchronize data?
XML!
PROBLEM

<CallsPerDay>
2575
</CallsPerDay>
PROBLEM

“CallsPerDay”?
That’s not even a word
<CompanyData>
  <Company_Name>
    Fidelity Employer Services Company
  </Company_Name>
  <Location>
    Merrimack
  </Location>
  <CallData>
    <Record_Date>
      Tue Aug 11, 2004
    </Record_Date>
    <Calls_Per_Day>
      2575
    </Calls_Per_Day>
  </CallData>
</CompanyData>
MORE PROBLEMS

<CompanyData>
  <CompanyName>
    Fidelity Employer Services Company
  </CompanyName>
  <Location>
    Merrimack
  </Location>
  <CallData>
    <RecordDate>
      Tue Aug 11, 2004
    </RecordDate>
    <CallsPerDay>
      2575
    </CallsPerDay>
  </CallData>
</CompanyData>

<CorporateRecords>
  <Company>
    Fidelity Employer Services Company
  </Company>
  <Records Data="Tue Aug 11, 2004">
    <Calls Units="PerDay">
      2575
    </Calls>
  </Records>
</CorporateRecords>
MORE PROBLEMS

<CallsPerDay>
  2575
</CallsPerDay>

<Calls Units="PerDay">
  2575
</Calls>

<Calls>
  <Units>
    "PerDay"
  </Units>
  <Value>
    2575
  </Value>
</Calls>

“CamelCase”
Attributes
Elements
Standards!
a proposal ...
- Dictionary
- Grammar
Dictionary
call  n.
1. A loud cry, a shout.
2. The characteristic cry of an animal.
3. A telephone communication or connection.
4. Need or occasion.
Call (n.)
a telephone connection.

She reported several anonymous calls.
He placed a phone call to London.
He heard the phone ringing, but didn't want to take the call.
Syn. phone_call.1, telephone_call.1

Ant. 

Type of. telephone.2, telephony.1

Types. conference_call.1, long-distance_call.1

Part of. 

Parts.
Data Type. one number element.

Data Description. A telephone number.

Data Example. “1-800-444-7856”

Attributes. party.5, duration.1, telephone_number.1
Demonstration
DICTIONARY DEVELOPMENT

• Web accessible
• Web editable
• Web community
• Staged approval
  • Proposal – Universal accessible and editable
  • Draft – Universal accessible and limited editable
  • Pre-approval – Universal accessible and limited comments
  • Recommendation – Universal accessible
Grammar
purchase_order.1

item.1

ID.3

quantity.1

price.1

description.1

customer.1

name.2

credit_card.1

name.1

“Bill Buckram”

2938 8488 4001 5439; Jun 2007
1. **Noun phrases** – root words plus modifiers
2. **Key-value pairs** – tax forms, medical records, receipts, etc.
3. **Tables** – enumerations, tables, spreadsheets
AuthorizedPricingInformation

authorized.1_pricing.1_information.1

CurrentAccountBalance

current.1_account.2_balance.6

UnitPrice

unit.1_price.2

PaymentMethod

payment.2_method.2
<customer_receipt>

  <merchant>Core Communications</merchant>
  <date>14-Sep-2005 09:25:35 PM</date>
  <invoice_number>47189</invoice_number>
  <amount2>$9.95</amount2>
  <first_name>John</first_name>
  <last_name>Smith</last_name>
  <phone>978-224-9981</phone>

</customer_receipt>
<customer_receipt>
  <merchant>Core Communications</merchant>
  <date>14-Sep-2005 09:25:35 PM</date>
  <invoice_number>47189</invoice_number>
  <amount2>$9.95</amount2>
  <first_name>John</first_name>
  <last_name>Smith</last_name>
  <phone>978-224-9981</phone>
</customer_receipt>
### Tables

<table>
<thead>
<tr>
<th>Name</th>
<th>County</th>
<th>DateOfLicensure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edward Taylor</td>
<td>United Kingdom</td>
<td>3/5/1968</td>
</tr>
</tbody>
</table>

### EMS_Agencies_Table

<table>
<thead>
<tr>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong>: Dixie County EMS</td>
</tr>
<tr>
<td><strong>County</strong>: Dixie</td>
</tr>
<tr>
<td><strong>DateOfLicensure</strong>: 2/1/2002</td>
</tr>
</tbody>
</table>

```xml
<Agency>
  <Name>Dixie County EMS</Name>
  <County>Dixie</County>
  <DateOfLicensure>2/1/2002</DateOfLicensure>
</Agency>
</EMS_Agencies_Table>
```
<table>
  <tag1>data</tag1>
  . . .
  <heading>data</heading>
  . . .
  <row>
    <column>data</column>
    . . .
  </row>
</table>
WEB SERVICE INTEGRATION

XML Schema A
Database 1

Conflict

XML Schema B
Database 2
WEB SERVICE INTEGRATION
Demonstration
Proposed Deliverables
‘M’ Browser

- Standard browser-based (IE6, FF1)
- Client-side, JavaScript ‘M’ Parser
- Asynchronous JavaScript and XML (Ajax)
- ‘M’ names and patterns for XSLT/JavaScript
- Dynamic Scalar Vector Graphics (dSVG - IE6, FF2)
  - Client-side charting
  - Interactive charts and graphs
DEVELOPMENT – ‘M’ Data Feeds
NOAA NDBC

Raw Data Feed

YYYY MM DD hh mm WD WSPD GST WVHT DPD APD MWD BARO ATMP WTMP DEWP VIS PTDY TIDE
2005 07 11 17 50 MM MM MM 1.2 5 MM MM 1011.8 16.2 13.8 13.6 MM -0.7 MM

‘M’ XML Web Service

<timestamp.1>
   2005-07-11T17:50
</timestamp.1>
<wave.5_height.2>
   1.2
   <unit.5>foot.11</unit.5>
</wave.5_height.2>
DEVELOPMENT – ‘M’ Models
DATA CENTER VISION

MODELS
- Business rules (Biz rules)
- Business Intelligence (BI)
- Data Mining
- Analytics

XML / SOAP

Access / Conversion

Data
EXAMPLE – SHELF LIFE

Current Type 3 Tag w/Temp Sensor

Next Generation Application Specific Integrated Circuit (ASIC)

350 Micron NanoBlock™ chips
EXAMPLE – SHELF LIFE
EXAMPLE – SHELF LIFE
EXAMPLE – SHELF LIFE

\[
\frac{\partial Q}{\partial t} = -k_1 e^{-\frac{E_a}{R_g T(t)}} Q^n
\]

Variables

- \( E_a \) Activation energy
- \( k_1 \) Arrhenius constant
- \( n \) Order of the reaction
- \( T \) Temperature
- \( Q \) Quality
- \( t \) Time
EXAMPLE – SHELF LIFE

![Graph showing the relationship between temperature (Kelvin) and expiration date (days)]
EXAMPLE – SHELF LIFE

**Food Quality**

- **Name:** Food Quality
- **Description:** Food Quality based Arrhenius
- **Developer:** Natick Army Laboratories
- **ID:** EPC: 010300908808BF60000000AA
- **Comp:** $0.25 per month
- **Type:** Analytic
- **Rate:** 1 to 10,000 sec
- **Algorithm:**

**Activation Energy**

- **Name:** Activation Energy
- **Symbol:** $E_a$
- **Access:** Read
- **ID:** EPC: 010300908808BF6000000102
- **Class:** Scalar
- **Type:** Float
- **Unit:** $m=2 \ kg=1 \ s^{-2} \ u^{-1}$
- **Default:** 25000.0

**Arrhenius Constant**

- **Name:** Arrhenius Constant
- **Symbol:** $k_1$
- **Access:** Read
- **ID:** EPC: 010200908238760000023877
- **Class:** Scalar
- **Type:** Float
- **Unit:** $s^{-1}$
- **Default:** 0.002

**Temperature**

- **Name:** Temperature
- **Symbol:** $T$
- **Access:** Read
- **ID:** EPC: 010200908238760000023877
- **Class:** Scalar
- **Type:** Float
- **Unit:** $k=1$
- **Default:** 286.0

**Quality**

- **Name:** Quality
- **Symbol:** $Q$
- **Access:** Write
- **ID:** EPC: 010200907ABC8 60000012875
- **Class:** Scalar
- **Type:** Float
- **Unit:** $s^{-1}$
- **Default:** 100.0

**Order of Reaction**

- **Name:** Order of Reaction
- **Symbol:** $n$
- **Access:** Read
- **ID:** EPC: 01020084191000001289731
- **Class:** Scalar
- **Type:** Int
- **Unit:**
- **Default:** 1
### EXAMPLE – SHELF LIFE

<table>
<thead>
<tr>
<th>WKS</th>
<th>080 DEG</th>
<th>100 DEG</th>
<th>120 DEG</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>6.622</td>
<td>6.486</td>
<td>6.243</td>
</tr>
<tr>
<td>02</td>
<td>6.282</td>
<td>6.359</td>
<td>6.026</td>
</tr>
<tr>
<td>04</td>
<td>7.194</td>
<td>6.250</td>
<td>5.972</td>
</tr>
<tr>
<td>06</td>
<td>5.949</td>
<td>6.308</td>
<td>5.077</td>
</tr>
<tr>
<td>08</td>
<td>6.850</td>
<td>6.350</td>
<td>5.175</td>
</tr>
<tr>
<td>10</td>
<td>6.600</td>
<td>6.429</td>
<td>4.286</td>
</tr>
<tr>
<td>12</td>
<td>6.944</td>
<td>6.167</td>
<td>4.472</td>
</tr>
<tr>
<td>16</td>
<td>7.000</td>
<td>6.947</td>
<td>5.316</td>
</tr>
<tr>
<td>20</td>
<td>7.111</td>
<td>6.694</td>
<td>4.361</td>
</tr>
<tr>
<td>24</td>
<td>6.300</td>
<td>6.000</td>
<td>3.667</td>
</tr>
<tr>
<td>28</td>
<td>6.579</td>
<td></td>
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</tr>
<tr>
<td>32</td>
<td>7.189</td>
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<tr>
<td>36</td>
<td>6.694</td>
<td>5.944</td>
<td>3.028</td>
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<tr>
<td>40</td>
<td>6.730</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
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<td></td>
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<tr>
<td>48</td>
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<td>52</td>
<td>6.583</td>
<td>5.944</td>
<td>3.056</td>
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<tr>
<td>65</td>
<td>6.316</td>
<td></td>
<td></td>
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<tr>
<td>78</td>
<td>6.583</td>
<td>5.889</td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>6.842</td>
<td></td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>6.300</td>
<td></td>
<td></td>
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<tr>
<td>130</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>156</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing mean acceptance over weeks](chart.png)
EXAMPLE – SHELF LIFE

T, k_1, \dot{E}_a

\rightarrow Q \rightarrow ? \rightarrow Keep or Toss

T, n, k_1, E_a

\rightarrow \rightarrow \rightarrow PML

\rightarrow T

\rightarrow T

\rightarrow T
EXAMPLE – SHELF LIFE

Class 1
Assessment

ISSUE  INSPECT  DISPOSE
EXAMPLE – SHELF LIFE

- 76 Million cases of foodborne disease
- 325,000 hospitalizations
- 5000 deaths*

- 1.8 Million deaths from foodborne illness worldwide

- 91 Million tons of food disposed
- Transported to landfills
- 26% of food supply*

* United States figures
APPLICATIONS

- M Browser
- M News Feeds
- Inter-lingual M
- Binary M