Food Security and Safety: Opportunities within the Advanced Technology Sector of Industry
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Background: IBM Research - 3000 Researchers in 8 labs, 14 years of Patent Leadership
Food Security and Safety: Opportunities within the Advanced Technology Sector of Industry

Abstract

§ Are there some specific opportunities within the Advanced Technology sector of Industry that can speed development of solutions in Food Safety and Security? This is the question to be addressed in this session.
Food Security and Safety: Opportunities within the Advanced Technology Sector of Industry

Specific Opportunities

1. Supply chain management
2. Advanced analytics
3. IT infrastructure
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1. Supply chain management
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Advanced supply chains allow the ability to track and trace entities through a multi-enterprise supply chain. Supply chains for food present unique challenges:

- Complex networks of trading partners, including global sourcing
- Heterogeneous technological capabilities
- Non-homogeneous data
- Non-digital, incomplete, or unreliable data
- Disparate data sources
- Benefits not gained by trading partners who incur costs
- Difficult governance
Learning from other industries can help speed solutions for food safety and security. These are a few examples of traceability projects for public and private sector clients across many different industries.

**DISTRIBUTION**
- Retailer Metro AG - RFID system for tracking consumer products from production through transport & warehousing to sale and customer service

**GOVERNMENT**
- Japan - Waste Disposal Traceability Pilot
- Government of Thailand - RFID pilot on Shrimp Traceability

**AUTOMOTIVE**
- Honda - Infrastructure for Data/Process Integration including Traceability
- Japan - Automotive Parts Traceability prototype

**AGRICULTURE**
- Maple Leaf Foods - DNA traceability pilot for pork
- Major beef farm & processor in US Midwest - RFID system for farm to fork traceability to meet new state regulations and create a premium brand positioning

**PHARMACEUTICAL**
- Japanese Ministry of Internal Affairs and Communications - Pharmaceutical Traceability
Gaining full compliance to a voluntary end-to-end traceability system depends on identifying the benefits for each participant in the Supply Chain.

### Food Continuum/Supply Chain

<table>
<thead>
<tr>
<th>Farm Input/Supplier</th>
<th>Producer/Grower</th>
<th>Processor</th>
<th>Distributor</th>
<th>Retailer</th>
<th>Customer</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased productivity/supply chain optimization</td>
<td>• Increased farm efficiency</td>
<td>• Increased service offerings to clients</td>
<td>• Increased productivity</td>
<td>• Increased confidence in food supply</td>
<td></td>
<td>• Improved public safety</td>
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<tr>
<td>• Improved inventory</td>
<td>• Individual animal/product value-added information from processor</td>
<td>• More detailed understanding of input and throughput by client</td>
<td>• Improved inventory</td>
<td>• Increased competitiveness</td>
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<td>• Increased competitiveness</td>
</tr>
<tr>
<td>• Improved shipping/receiving accuracy</td>
<td>• Increased yields – business analytics from feed, pesticides, processor</td>
<td>• Increased quality control</td>
<td>• Improved shipping/receiving accuracy</td>
<td>• International trade</td>
<td></td>
<td>• Risk mitigation</td>
</tr>
<tr>
<td>• Demand visibility and forecasting</td>
<td>• Increased and secure access to global markets</td>
<td>• Risk mitigation and reduced liability</td>
<td>• Demand visibility and forecasting</td>
<td>• Risk mitigation and reduced liability</td>
<td></td>
<td>• Reduced compensation</td>
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<tr>
<td>• Refined client behaviour information</td>
<td>• Risk mitigation and reduced liability</td>
<td></td>
<td>• Decreased diversion expenses</td>
<td></td>
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<tr>
<td>• More efficient marketing</td>
<td></td>
<td></td>
<td>• Risk mitigation and reduced liability</td>
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### Infrastructure

- Interoperable
- Globally compliant
- Flexible/scaleable

### Secure Transportation/Secure Trade Lanes

### Sector/Commodity Specific Business Processes

### Technological Infrastructure & Common Business Processes
Various technologies exist, e.g. sensors and actuators for data capture. Enabling efficient and effective food safety and security solutions is still a logistical challenge.

Animal verification via RFID tagging

Barcode based near real time animal movement data capture

GPS based real time animal movement data capture

Digital Pens and Workplace Forms used in traditionally low tech environments
A track and trace system that supports food safety and security must capture, structure and integrate data on product a) movements, b) attribute changes, and c) processing activities from across and within the supply chain.

**Example:** Beef - Each company maintains its own product information and record of transactions, making that information available on a permission basis to stakeholders.

- Fertilizers
- Antibiotics
- Ingredients
- Packaging
- Ingredients
- Logistics

Corn Farmer → Cattle Rancher → Beef Processor → CP Manufacturer → Distribution Center → Grocery Store/Restaurant

**Track and trace products and risks within the four walls to isolate and prevent issues.**

**Virtual Traceability System**

Rapid communication of essential data facilitated through open-standard software and adoption of industry ID standards.

Data security maintained via encryption, restricted password access, etc...

Secure, standards-based queries enabled.
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Opportunities for data analytic technologies in food safety and security solutions

§ **Data Mining**
- The process of extracting hidden patterns from data
- Increasingly important tool as the volume of data increases

§ **Predictive Modeling**
- The process of trying to best predict the probability of an outcome

§ **Risk Analysis**
- The process of identifying and assessing factors that jeopardize the success of a goal

§ **Statistical Analysis and Forecasting**
- The mathematical science of collection, analysis, interpretation, explanation, and presentation of data, and estimating unknown quantities

What conditions existed prior to a food safety event?

Based on identified patterns, predict the probability of a future food safety event

Make decisions on risk mitigation.
For example, product recall prior to a food safety event

Support impact analysis by forecasting demand under different hazard scenarios
Risk models appear to be particularly relevant for food safety and security solutions

- **Statistical and machine learning models**, used to discover key risk indicators and characterize likelihood and impact of risks based on historical data;

- **Simulation models**, which are (usually) data-driven representations of a system facilitated by sampling from specified probability distributions.

- **Stochastic optimization models**, where at least one of the variables involves uncertainty, and is assumed to follow a particular probability distribution.

Why “advanced data analytics” is a technology to consider in food safety and security solutions?

§ Methods deal with **large volumes of data** and address computational complexity

§ **Unstructured data** may be leveraged for improving predictive accuracy and insights

§ Approaches consider **missing data** and **uncertainty**

§ Even more powerful when combined with **visualization** tools

§ Advanced data analytics are the key for moving food safety and security from **reactive** to **preventative**

http://manyeyes.alphaworks.ibm.com/manyeyes/
In system design for safety, the highest priorities are assigned to hazard prevention. Advanced data analytics help to move in this direction.

**Hazard Elimination**

Complete elimination of the possibility for future hazard events.

**Hazard Reduction**

Minimize the probability of future hazard events occurring.

**Hazard Control**

A hazard event has occurred. Mitigate the effects.

**Damage Minimization**

A hazard event has occurred. Minimize the damage.

Advanced data analytic methods take large volumes of data from various sources, including from traceability solutions, to enable prediction and avoidance.

* Traceability enables improved reaction given a food safety hazard has occurred

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Since the constituent database systems often must remain autonomous, a federated database system is an alternative to the (sometimes daunting) task of merging together several disparate databases.
Data to Smart Decisions

Data arises from many sources (instrumentation, automation, on-line communities). Managing and preparing the data for use is a necessary first step in data-driven decision making.

The volume of digital data is exploding
§80% of new data growth is unstructured
§Data and metadata quality varies
§Better approaches to finding relevant data are critical

Gather Data

Tenfold Growth in Five Years!

DVD, RFID, Digital TV, MP3 players, Digital cameras, Camera phones, VoIP, Medical imaging, Laptops, Datacenter applications, Games, Satellite images, GPS, ATMs, Scanners, Sensors, Digital radio, DLP projectors, Telematics, Peer-to-peer, Email, Instant messaging, Videoconferencing, CAD/CAM, Toys, Industrial machines, Security systems, Appliances

Data cleansing
Searching
Feature extraction
Semantic linking and extraction
Stream processing
Crowd computing

The number of semantically tagged documents and data sets is growing dramatically, improving data gathering capabilities.
Cloud Computing is a model of shared network-delivered services, both public and private, in which the user sees only the service, and need not worry about the implementation or infrastructure.

- Standard Internet technologies
- Consumable web-delivered services requiring no installation, minimal setup
- Important roles for both public and private clouds
- Rapid provisioning
- Service layers separated by clean APIs, enabling composition
- Flexible pricing
- Built on radically scalable, manageable, virtualized IT resources
- Elastic scaling
- Advanced virtualization

People Services
Business Services
Application Services
Platform Services
Infrastructure Services
Other recommendations to speed development of food safety and security solutions

1. Form real G-U-I teams to study the problem, identify gaps, and prioritize solution development approaches
   - Combine domain experts with technology, commercial and regulation expertise
   - Take a "system" view that recognizes multi-perspective, multi-objective aspects

2. Find ways to propose / contribute toward the economic stimulus packages
   - Mainly, financial stabilization, but includes spending in 2 other key areas

3. Take advantage of existing experiences w/ G-U-I relationships, e.g.
   - Joint research programs
   - Programs for interns and summer students
   - Research mentorship
   - Workshops, various outreach

4. Learn from other industries
   - Retail, Government, Automotive, Agriculture, Pharmaceutical, …
Example: Value of IBM’s FOAK Program

- Links Research strategic initiatives to real client challenges
  - Validate market requirements
  - Test market readiness
- Accelerate delivery of new technologies to the market
  - Enhance core technologies
  - Create new offerings
  - Enable On Demand Innovation Services (ODIS) engagements
- Provide headlights into emerging market opportunities
  - Uncover new markets and growth opportunities
- Gain valuable experience and thought leadership
  - Skills and knowledge transfer
- Facilitate solution sales
  - Proof points for reuse
- Create mindshare
  - References and differentiation
Economic Stimulus: Government Spending Prioritized in Three Key Areas

<table>
<thead>
<tr>
<th>Program</th>
<th>Focus</th>
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| Financial stabilization and reform | Loan management  
Risk assessment and management |
| Government stimulus          | Regulatory systems  
Troubled assets  
Social safety net systems  
Intelligent transportation  
Shared services  
Customs, ports, borders |
| Cross sector stimulus        | Infrastructure  
Smart grid  
e-health  
Schools modernization  
Broadband  
New energy sources  
Sustainability  
Industry change  
Research |