RFID: Research Update

Milind Tavshikar, MIT Sloan Fellow

Value Chain Dynamics Working Group
Semi-Annual Meeting
May 24, 2006
Cambridge, MA

# Value Chain Dynamics with relationship to RFID

- Information Processing Loop for business: Capture, Manage, Analyze, Access and Act
- RFID represents a significant development in the "Capture" area
- Yesterday: Capture is done offline and entered into systems via data feeds in a batch mode
- Today: Capture needs to be realtime increasing the efficiency of the information processing loop.
- Established industry structures are being challenged
- RFID is a capable of being a disruptive Innovation

- Traditional
  - Mainframes
  - Less IT Driven
  - SCM:Weeks
  - Megabytes

- Internet
  - Distributed Computing
  - Network Driven
  - SCM:Days
  - Terrabytes

- Real-Time
  - Edge Computing
  - Event Driven
  - SCM:Near Realtime
  - Exabytes

X1. Infrastructure Basics

- RFID tag gets into reading device's electromagnetic field
- Tag receives the signal which energizes the passive tag
- Tag transmits the data stored in the IC in return
- Reader passes the information to the host system
- Host system can be connected into the Internet or company's ERP system
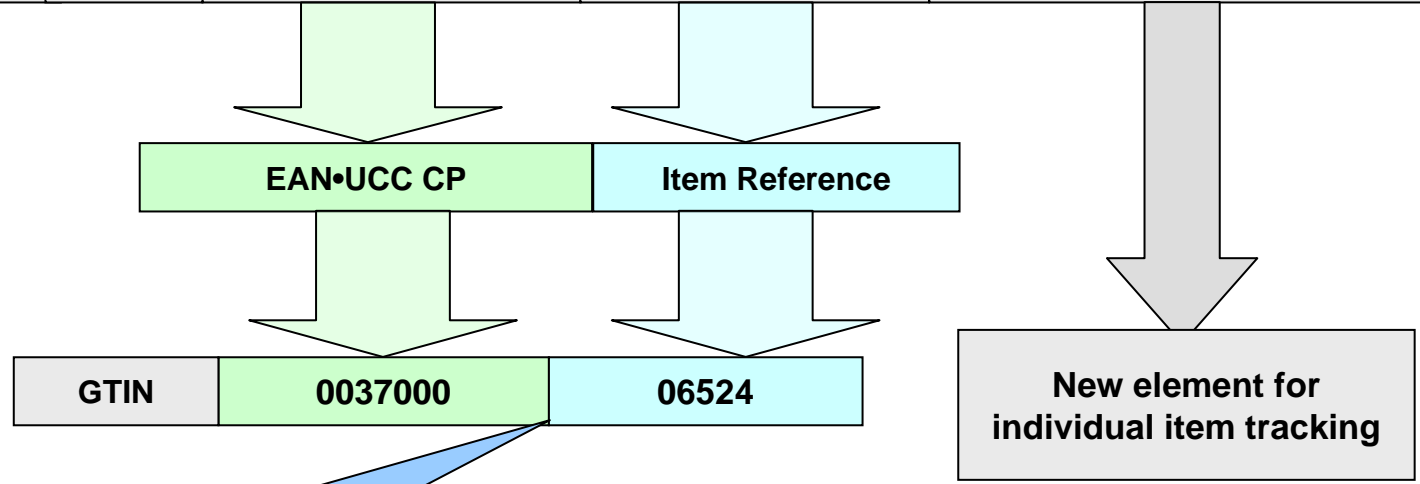- Reader can also pass information to the tag which can be re-written or deactivated

Host system

Gate reader

RS-232

Tag
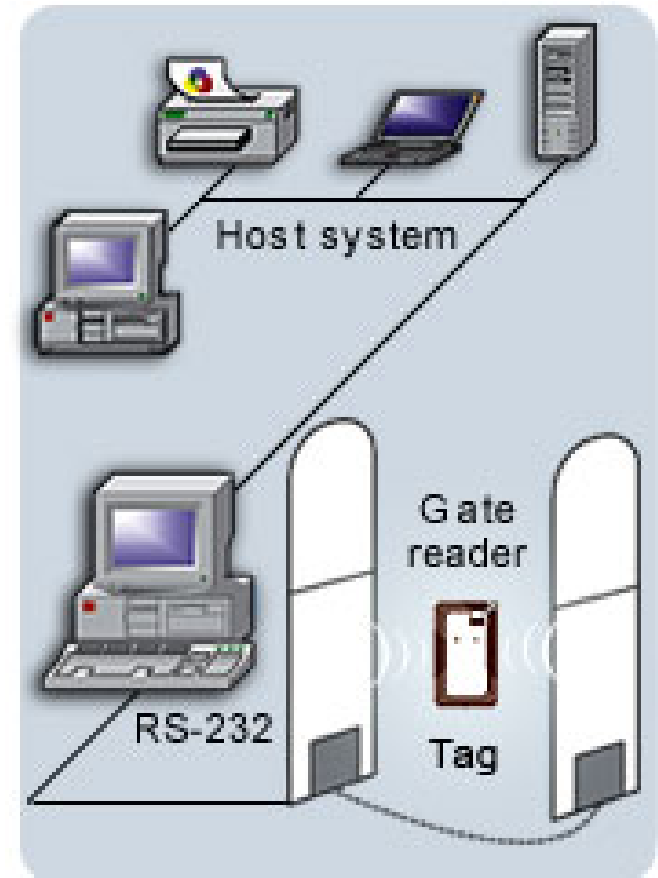
X1. What is **R**adio **F**requency **ID**entification?
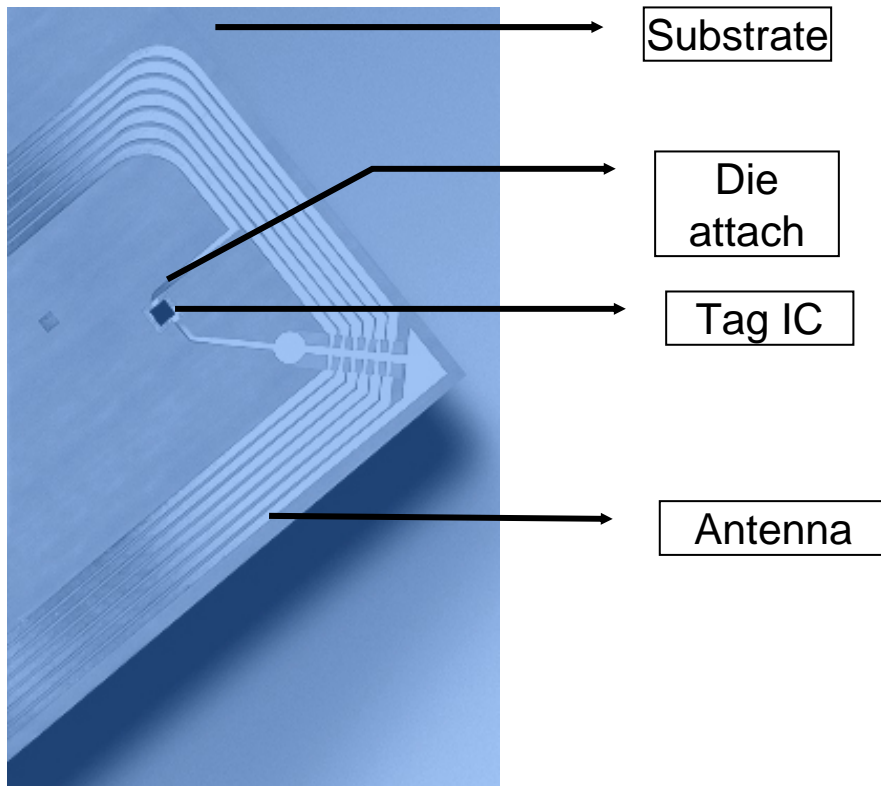
Substrate	• No requirement for line-of-sight
Die attach	• Dynamic information carrier (read/write)
Tag IC	• High memory capacity if needed
	• Anti-collision (many tags can be read at the same time)
Antenna	• Robust and reliable
	• Performs in rugged, harsh environment
	• Cheaper in long term
	• No human intervention
	• Reader virtually maintenance free

RFID

EPC Tag Specification

Element	Header	Type	EPC Manager	Object Class	Serial Number
Bits	8	4	27	17	40
$Value_{10}$	001	00	0-134,217,727	0-131,071	0-1,099,511,627,775

	EAN•UCC CP	Item Reference	

GTIN	0037000	06524	New element for individual item tracking

Gillette Mach 3, 5 Blade Pack

268 million companies can each categorize 16 million different products and each product category may contain over 687 billion individual items !!

RFID

More on Tags?

Class V tags
**Readers. Can power other Class I, II and III tags;
Communicate with Classes IV and V.**

**Class IV tags:
Active tags with
broad-band peer-to-peer communication**

**Class III tags:
semi-passive RFID tags**

**Class II tags:
passive tags with additional
functionality**

**Class 0/Class I:
read-only passive tags**
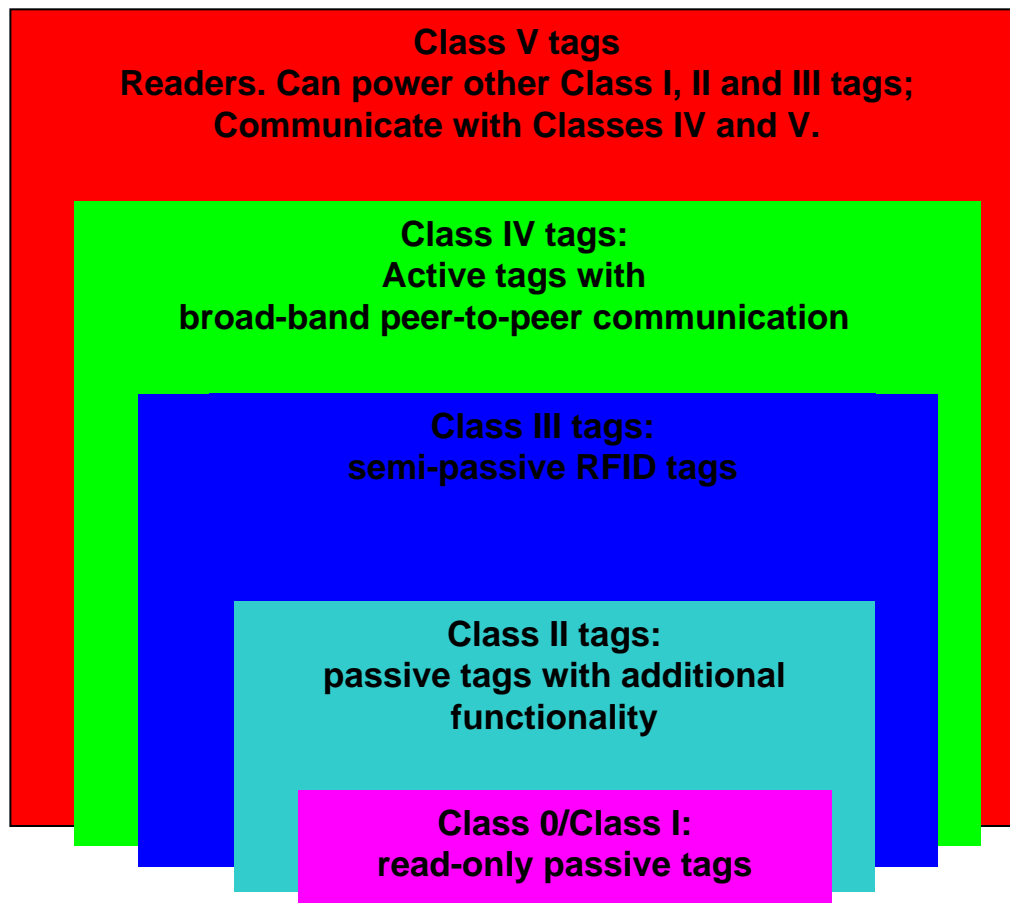
- Tags can be attached to almost anything:
  - pallets or cases of product
  - vehicles
  - company assets or personnel
  - items such as apparel, luggage, laundry
  - people, livestock, or pets
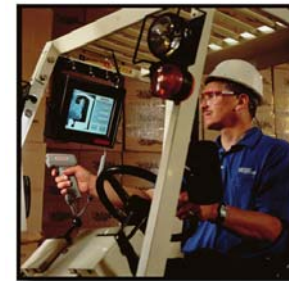 - high value electronics such
    as computers, TVs, camcorders

Active Tags Vs Passive Tags

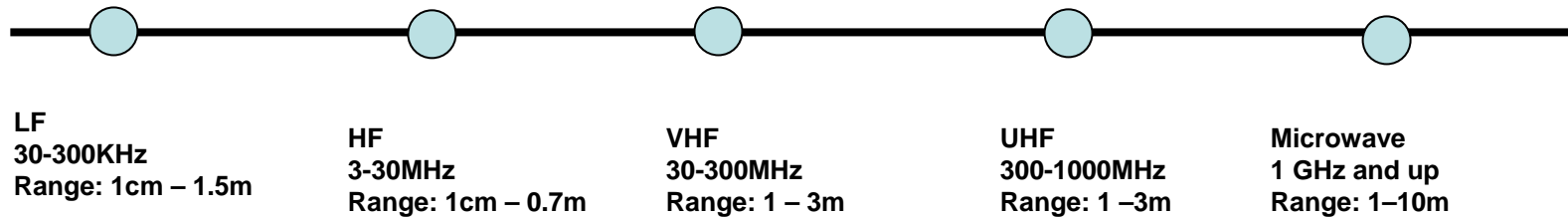|	Passive	Active
Feature	Identity	Store, Update, Authenticate, Securely Transmit
Cost	10c – 100c	$3 - $30
Range	Smaller	Larger
Memory Capacity	Smaller	Longer
Power Source	Radio Waves	Battery, Others
Applications	Retail	Animal Tagging, Shipping
Life	Unlimited – until killed	Limited by battery

More on Readers?

- Readers (interrogators) can be at a fixed point such as
    - Entrance/exit
    - Point of sale
    - Warehouse

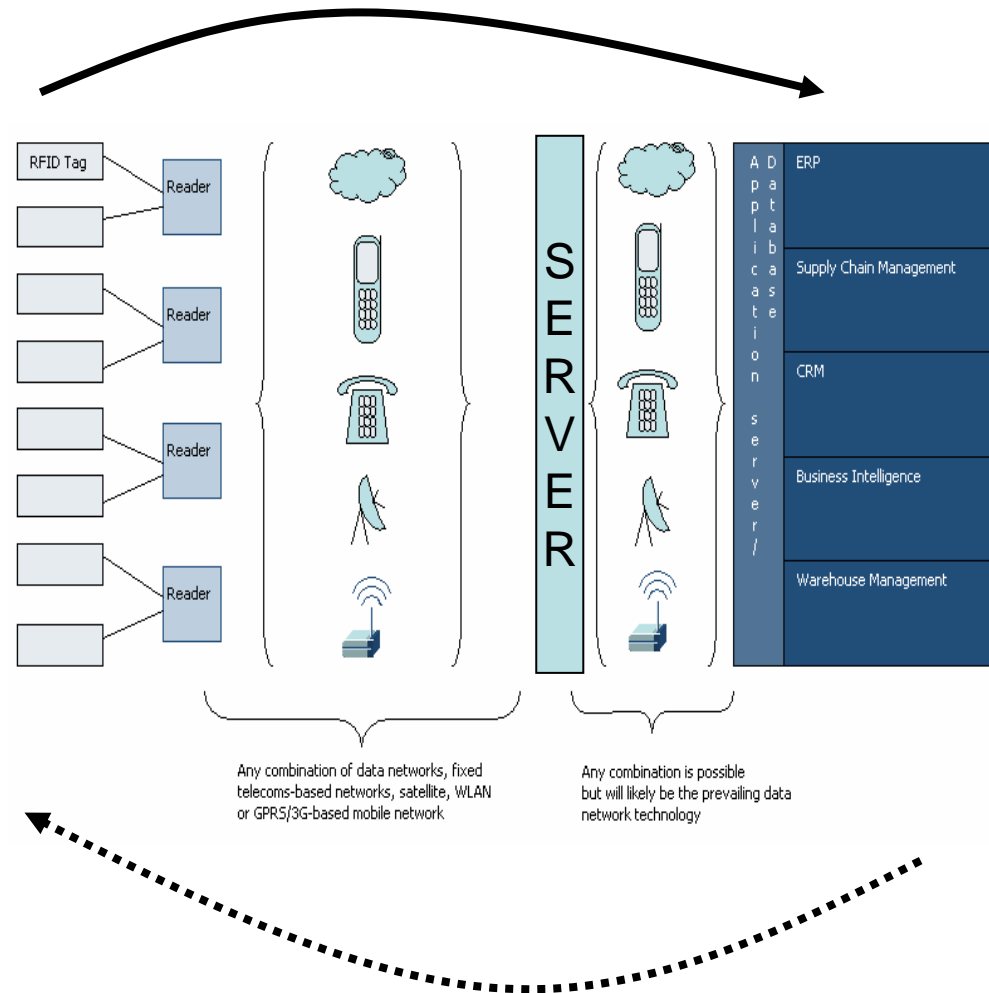- Readers can also be mobile -- tethered, hand-held, or wireless

Frequencies

LF
30-300KHz
Range: 1cm – 1.5m

HF
3-30MHz
Range: 1cm – 0.7m

VHF
30-300MHz
Range: 1 – 3m

UHF
300-1000MHz
Range: 1 –3m

Microwave
1 GHz and up
Range: 1–10m

- Triggers
  - Distance
  - Cost
  - Physics of Reflection and Interference
  - Data Capacity
  - Data Rate

- Triggers..
  - Regulations
  - Supply Chain Partners
  - Security
  - Directionality
  - International Availability

Core: Communication from a Carrier Perspective

- Tags and Readers at the end users premises
- Data transmitted back to the server and processed
- Relevant Data sent to back office systems
- Data may flow back to the tag!

RFID Tag

Reader

Reader

Reader

Reader

SERVER

ERP

Supply Chain Management

CRM

Business Intelligence

Warehouse Management

Any combination of data networks, fixed telecoms-based networks, satellite, WLAN or GPRS/3G-based mobile network

Any combination is possible but will likely be the prevailing data network technology

Trigger Dynamics and the Gear Teeth Model

- Triggers cause changes in business models (micro level) and industry value chains (macro level)
- Triggers include
  - Technology
  - Regulation
  - Customer preferences
  - Business strategy
  - Business cycles
  - Industry structure
  - Capital markets
- Triggers influence each other

Trigger Dynamics and the Gear Teeth Model

It begins with Technology Dynamics
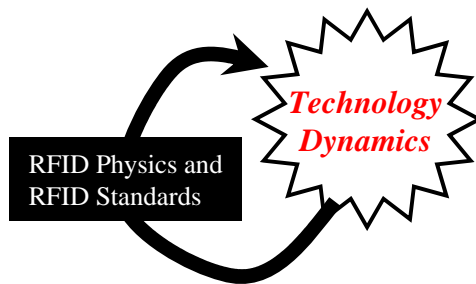
RF Technology used since World War II for data communication over radio waves

1999: MIT AutoID Labs created to further the concept of 'The Internet of Things" using RFID and Sensor Networks

2003:Transfers responsibility to EPC Global for further development of standards.

Trigger Dynamics and the Gear Teeth Model

RFID Technology drives Supply Chain Management Dynamics

Technology Shift → **SCM Strategy Dynamics**

Investment in RFID

Technology Dynamics

RFID Physics and RFID Standards
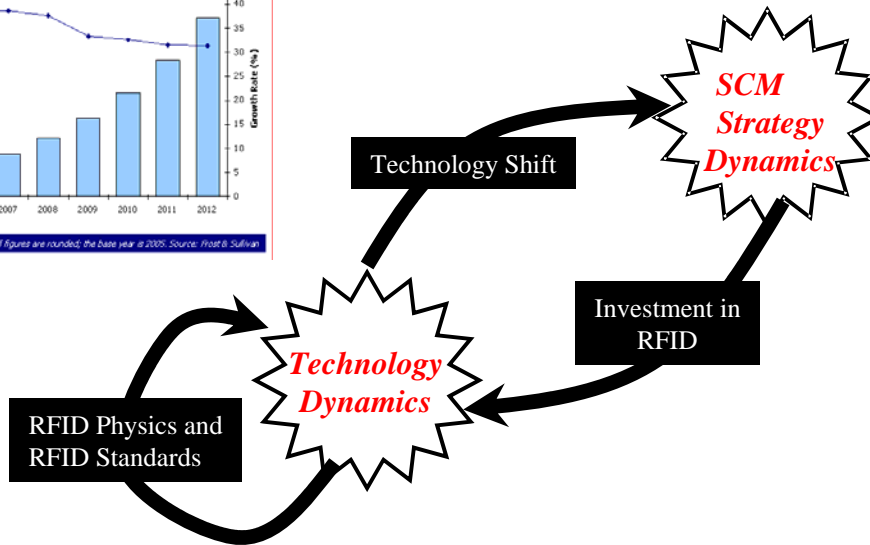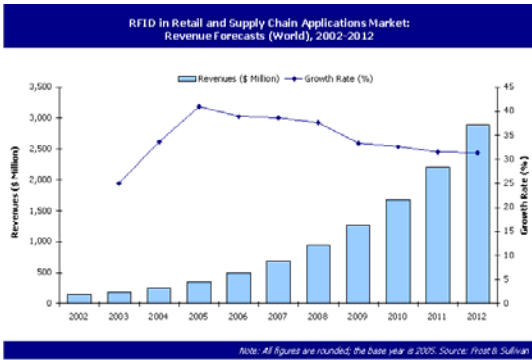
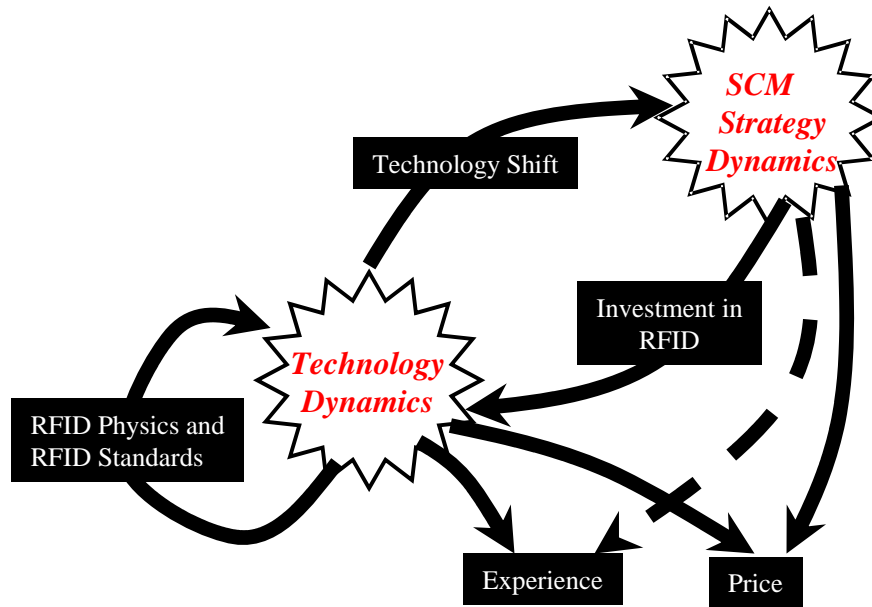Supply Chain Management chosen as the 'Low hanging fruit"

RFID to deliver near real-time visibility

RFID enabled supply chain = Collaborative scenario

CAGR of 25% over 2005-2012

Trigger Dynamics and the Gear Teeth Model

Technology and SCM Strategy shape Price and Experience

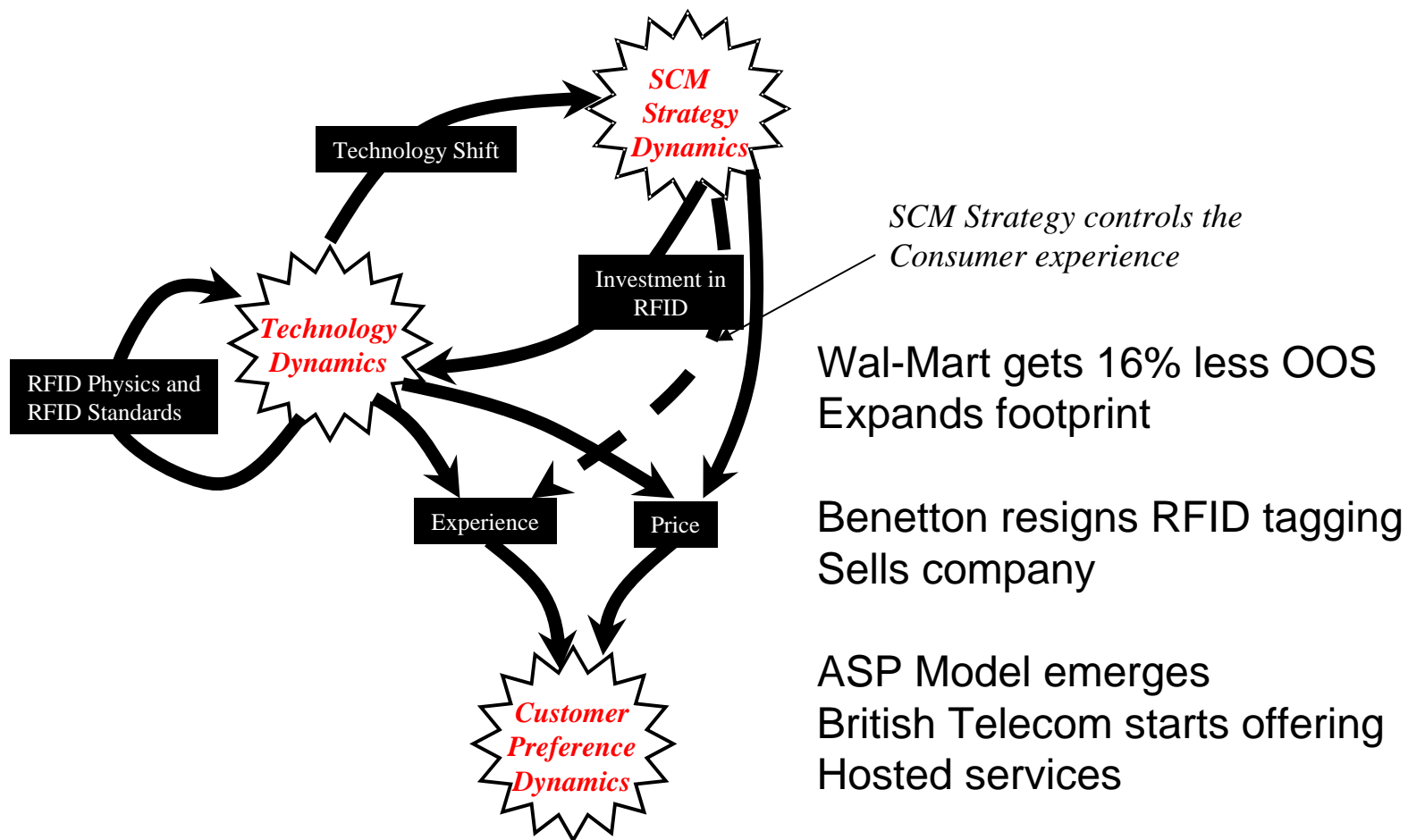2003: Wal-Mart issues Mandate
2004: DoD issues Mandate

Heavy investment by largeCos
• Texas Instruments
• Motorola
• Hitachi
• IBM
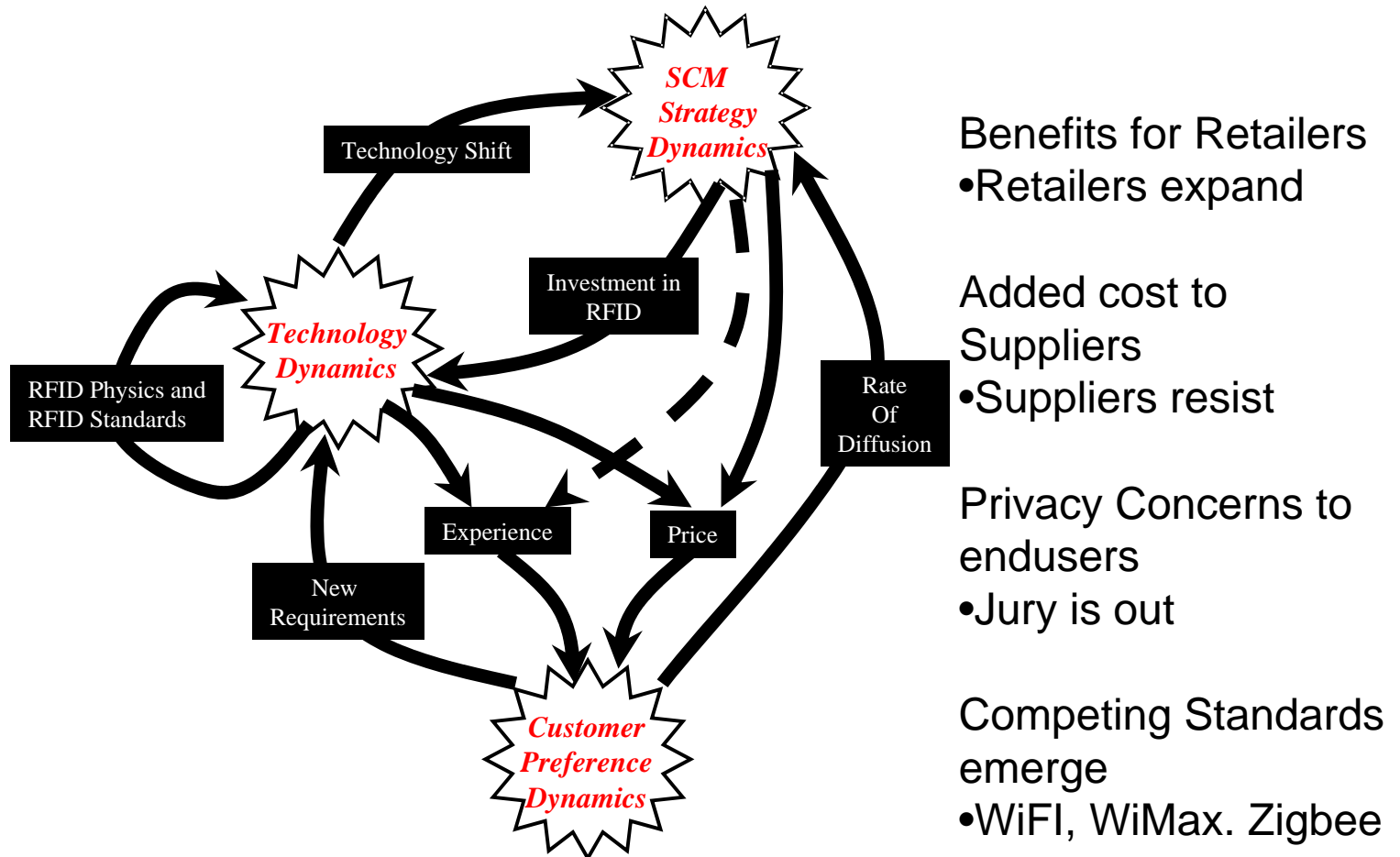NewCos Like
• Alien, Symbol, OAT

Price points of 5cents desired

Trigger Dynamics and the Gear Teeth Model

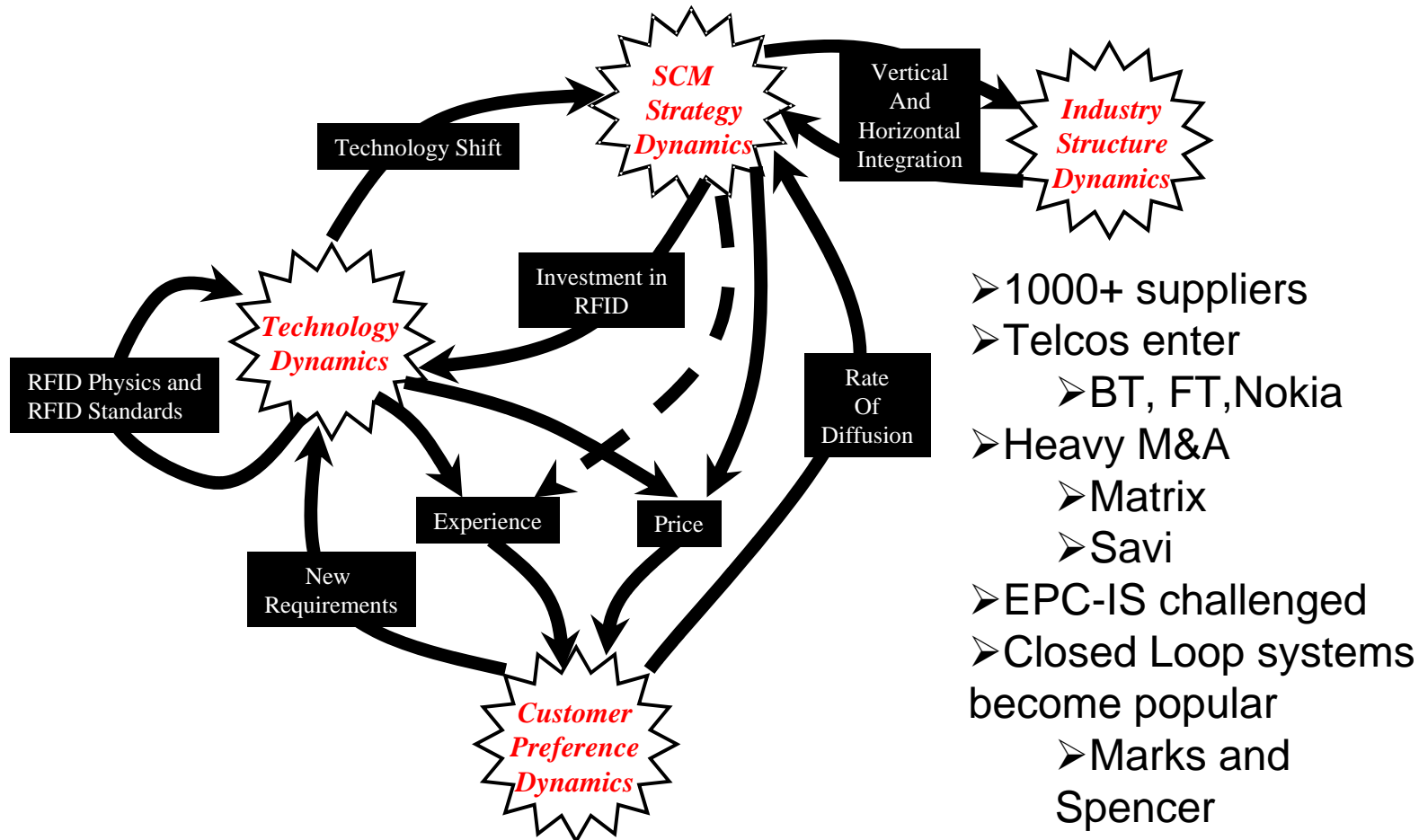Price and Experience shape Consumer Preferences

SCM Strategy Dynamics

Technology Shift

SCM Strategy controls the Consumer experience

Investment in RFID

Technology Dynamics

RFID Physics and RFID Standards

Experience

Price

Customer Preference Dynamics

Wal-Mart gets 16% less OOS
Expands footprint

Benetton resigns RFID tagging
Sells company

ASP Model emerges
British Telecom starts offering
Hosted services

Trigger Dynamics and the Gear Teeth Model

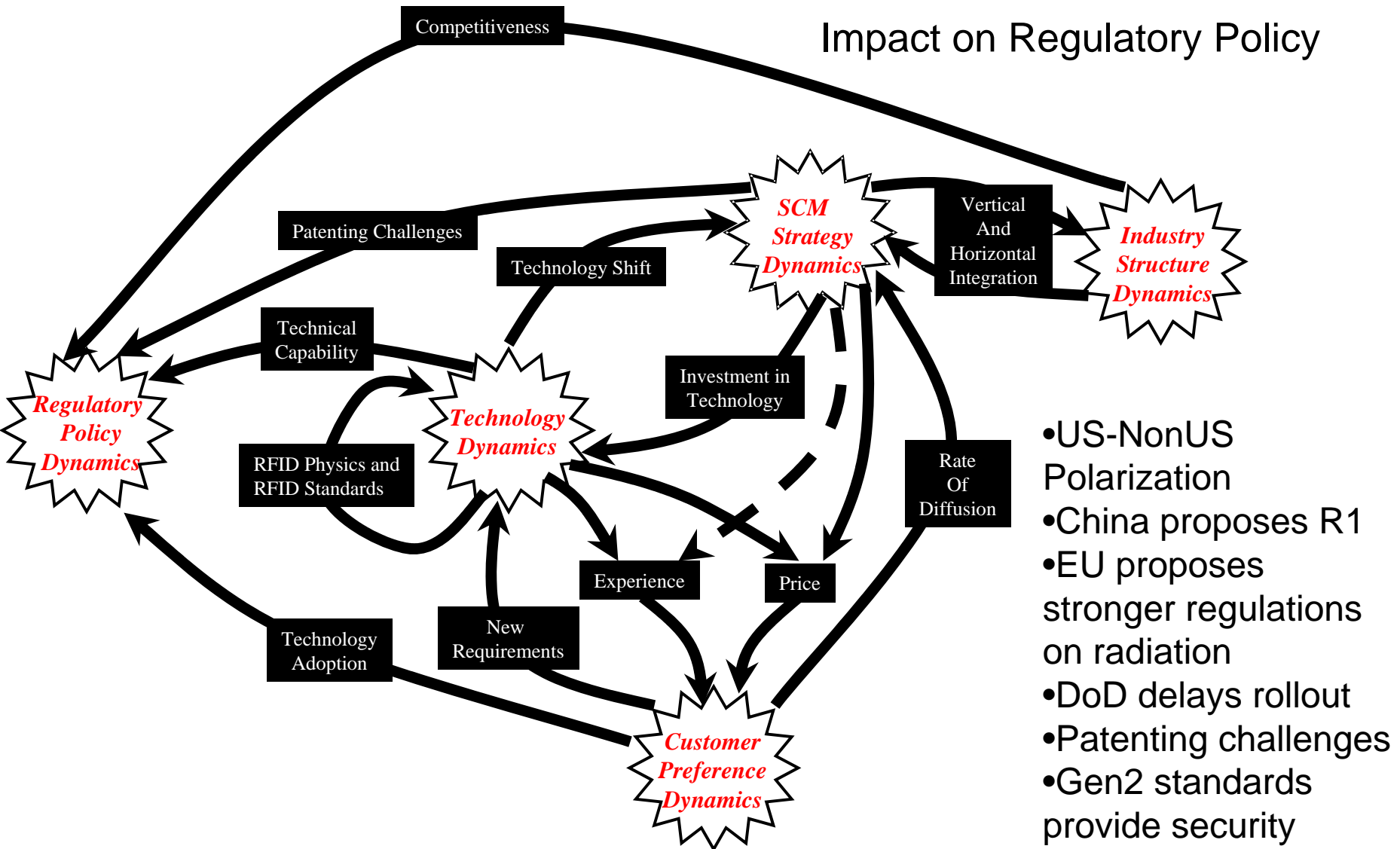Consumer Preferences churn Technology and Corporate Strategy Dynamics

SCM Strategy Dynamics

Technology Shift

Investment in RFID

Technology Dynamics

RFID Physics and RFID Standards

Rate Of Diffusion

Experience

Price

New Requirements

Customer Preference Dynamics

Benefits for Retailers
•Retailers expand

Added cost to Suppliers
•Suppliers resist

Privacy Concerns to endusers
•Jury is out

Competing Standards emerge
•WiFI, WiMax. Zigbee

Trigger Dynamics and the Gear Teeth Model

Corporate Strategy determines the Industry Structure

- 1000+ suppliers
- Telcos enter
  - BT, FT,Nokia
- Heavy M&A
  - Matrix
  - Savi
- EPC-IS challenged
- Closed Loop systems become popular
  - Marks and Spencer

Diagram labels: SCM Strategy Dynamics, Technology Shift, Vertical And Horizontal Integration, Industry Structure Dynamics, Investment in RFID, Technology Dynamics, RFID Physics and RFID Standards, Rate Of Diffusion, Experience, Price, New Requirements, Customer Preference Dynamics

Trigger Dynamics and the Gear Teeth Model

Impact on Regulatory Policy

Competitiveness
Patenting Challenges
Technology Shift
SCM Strategy Dynamics
Vertical And Horizontal Integration
Industry Structure Dynamics
Technical Capability
Technology Dynamics
Investment in Technology
Regulatory Policy Dynamics
RFID Physics and RFID Standards
Rate Of Diffusion
Experience
Price
Technology Adoption
New Requirements
Customer Preference Dynamics

- US-NonUS Polarization
- China proposes R1
- EU proposes stronger regulations on radiation
- DoD delays rollout
- Patenting challenges
- Gen2 standards provide security

RFID

Trigger Dynamics and the Gear Teeth Model

Regulate Corporations and Consumer Behavior

High cost of Gen2
Back to HF?
More Features = High Cost
More Safety = High Cost
More Complexity = High Cost

Trigger Dynamics and the Gear Teeth Model

Business Cycle and Capital Market Dynamics
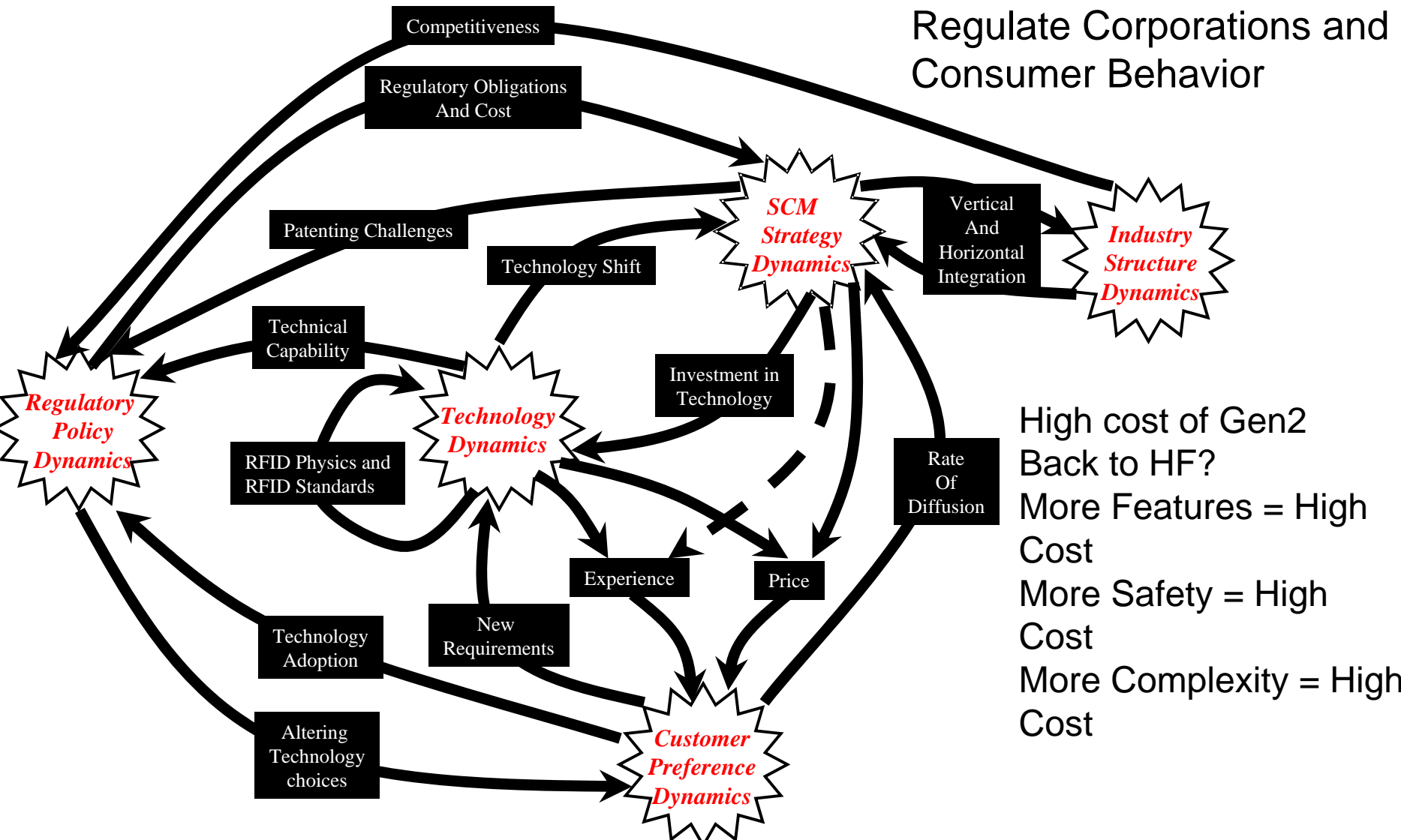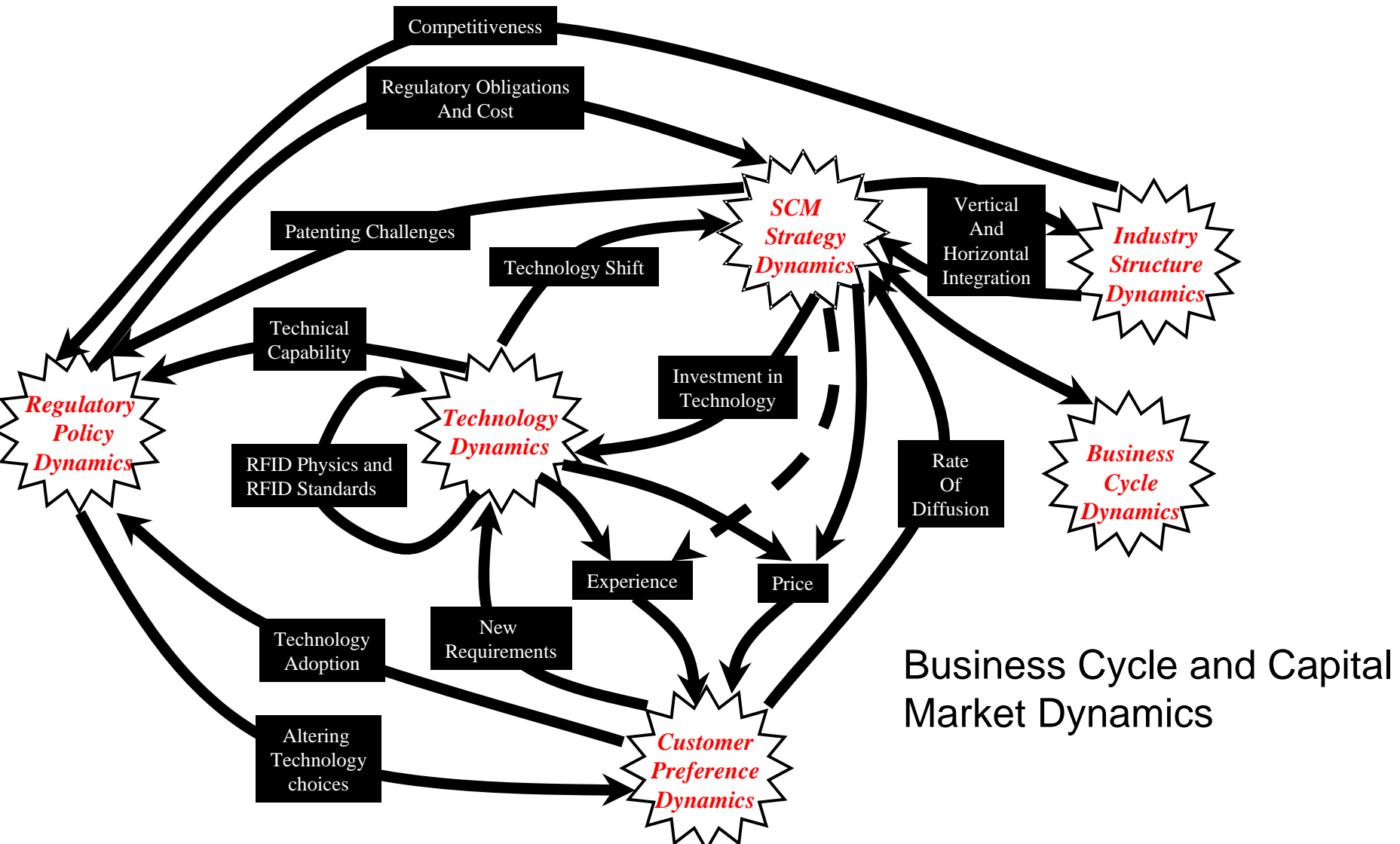
Analysis
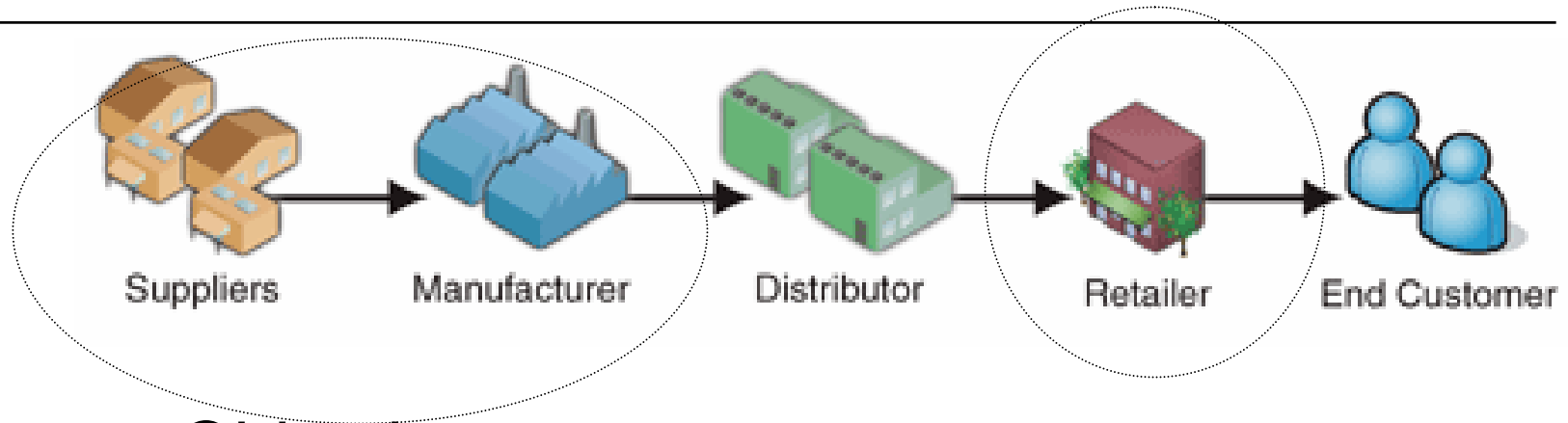
- Objective:
  – Analyze the Value Chain Dynamics (RFID) in the Retail Supply Chain
  – Make observations on Needs, Solution Scenarios, Challenges and ROI for each component
  – Attempt to model the above using System Dynamics Modeling

Retailer

- Critical Needs
  - **Including the consumer in the supply chain planning process**
  - Managing product life cycles
  - **Promotional planning**
  - Planning for seasonal products
  - **Determining cost-effective supply channels**
  - **Planning capacities at the store level**
- "Balancing better ROI with better shopping experiences for customers at the point of sale"

Drivers to the Retail Market

- Interest Generated through pilots
- Choices in levels of adoption
- Tag Reuse - Attractive investment option
- Increasing ROI in supply chain over time
- Better Marketing of Technology
- Prevalent Optimism about Technology

Constraints to Adoption in the Retail Market

- Huge Costs in Infrastructure and Implementation (Remember ERP?)
- Patent royalties
- Regulations on Power Use by RF devices
- Internationally usable frequency bands
- Customization Vs Commoditization

Other Challenges

- Data Management
- Privacy Issues
- Physics of 'RFID'
- Lack of global standards.

Deployment Success Factors and ROI

- Management of
  - Hardware, Data, Integration and Process
- ROI
  - Reduction of 7.5% in Labor (Instore + Warehouse)
  - Reduction in OOS of $700,000 per 1B of sales/Yr
- Cost
  - 100,000 per DC and 50,000 per store
  - 35M – 40M for Systems Integration across the organization
- Bottom-line: Viable for > 5B Retailers with immediate ROI.

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Case Study – Wal-Mart

WAL★MART®
ALWAYS LOW PRICES. *Always.*

- Application:
  - Retail, Consumer Goods
- Level of RFID usage:
  - Pallet, Cases, Items
- Benefits sought:
  - Cost Reduction, Theft Prevention, Customer Service, Convenience and Speed of transaction.
- Project Status:
  - Initial Pilot completed, Trials ongoing
- Tags:
  - UHF Gen2 tags
- System:
  - Various Providers.

- Out Of Stock Study for Wal-Mart RFID*
- Scope
  - 12 test stores / 12 control stores, 6 supercenters, 3 division I, 3 neighborhood markets
- Control stores chosen to match test stores
- Stores in Texas and southern Oklahoma
- Scanning
- February 14 to September 12
  - Scanned daily for 210 days (29 Wal-Mart weeks)
  - Scanned most sections of the store (some exceptions)
- Started approximately same time each day and followed the same path

* Done by Univ. of Arkansas

Case Study – Wal-Mart
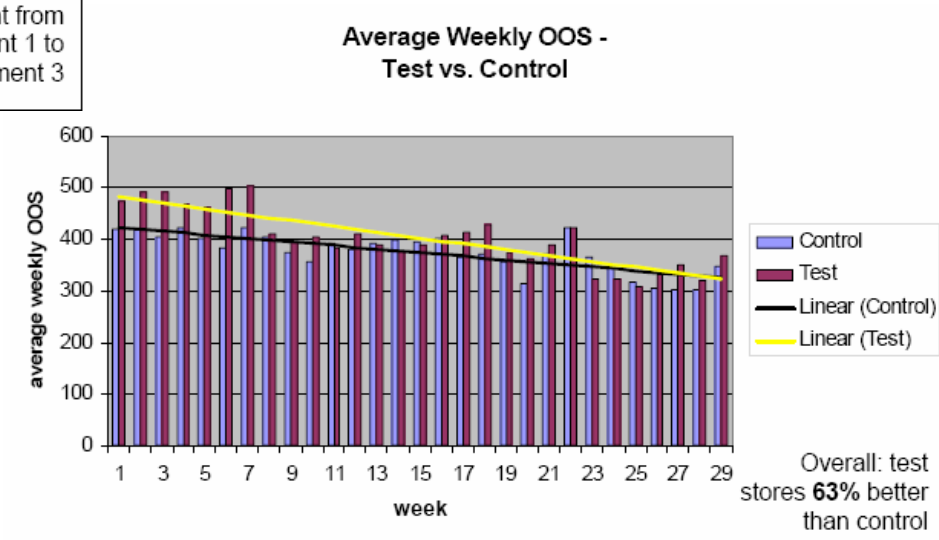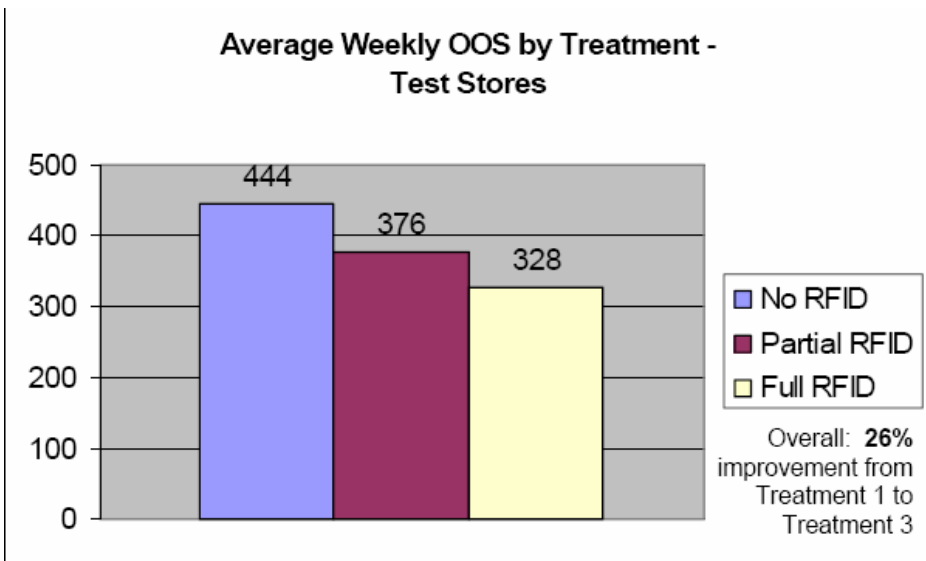
* Done by Univ. of Arkansas

Supplier

- **Critical Needs**
  - Accurate Demand Forecasts (From Stores)
  - Higher order fill rates, increased inventory velocity, faster order processing, shorter lead times
  - Transport Efficiencies (Automated Route Management, Cross Docking)
  - Overcome a Bullwhip effect
  - Manage Recalls and Returns effectively
  - Comply with Regulations
  - Reduce Counterfeiting
- **Better Processes to Reduce costs and increase revenue**

Drivers to the Supplier Market
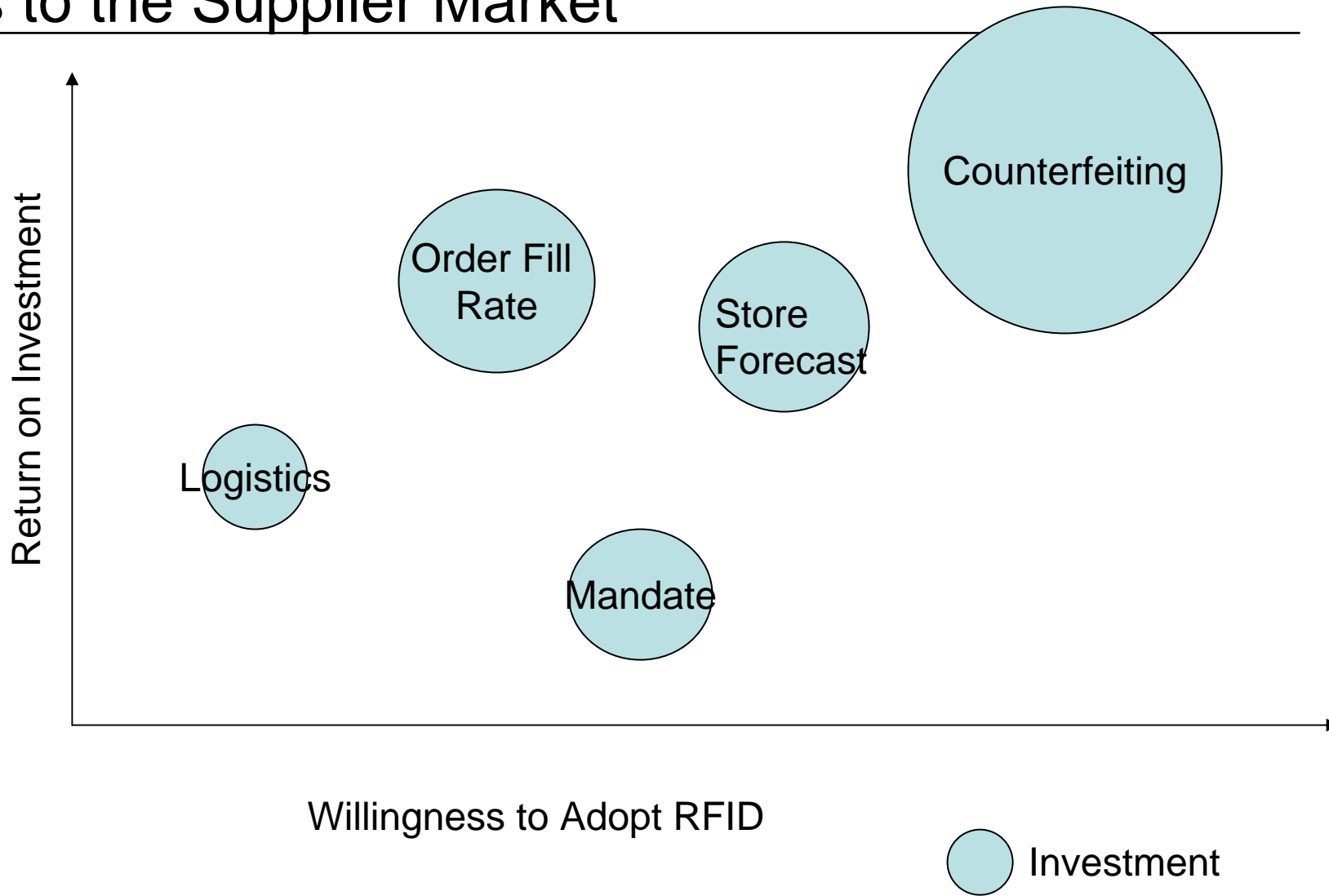
Constraints

- Anything more than slap and ship needs significant more investments

- Item Level Tagging is cost prohibitive for most items in the supply chain

- Lack of collaboration amongst trading partners especially retailers and logistics providers.

- Data Management Capabilities lacking at suppliers end.

- No clear ROI benefits seen yet.

Deployment Success Factors

- Cost of tags to drop
- Critical Mass of retailers to exist
- ROI : Company ships 50 Million Cases to Wal-Mart
  - @ 20C per tag, it takes a $10Million Cost
  - $1 M for additional Infrastructure
- Needs 11M in additional savings to break even
- Great Majority of suppliers find that RFID offers a Poor ROI at this time

Case Study - Gillette

- Application:
  - Retail, Consumer Goods, Razors
- Level of RFID usage:
  - Item Level
- Benefits sought:
  - Anti Counterfeiting
- Project Status:
  - Trials Completed. Implemented with Fusion Product Line in 2006.
- Tags:
  - UHF Gen2 tags
- System:
  - Alien Technologies, OAT systems, SAP, Sun Microsystems
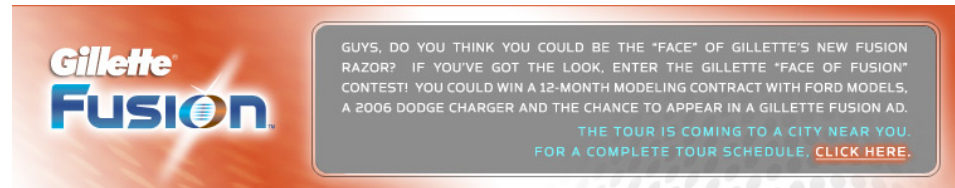
•Worlds most stolen branded product
•Promotions
•Large Theft Rates
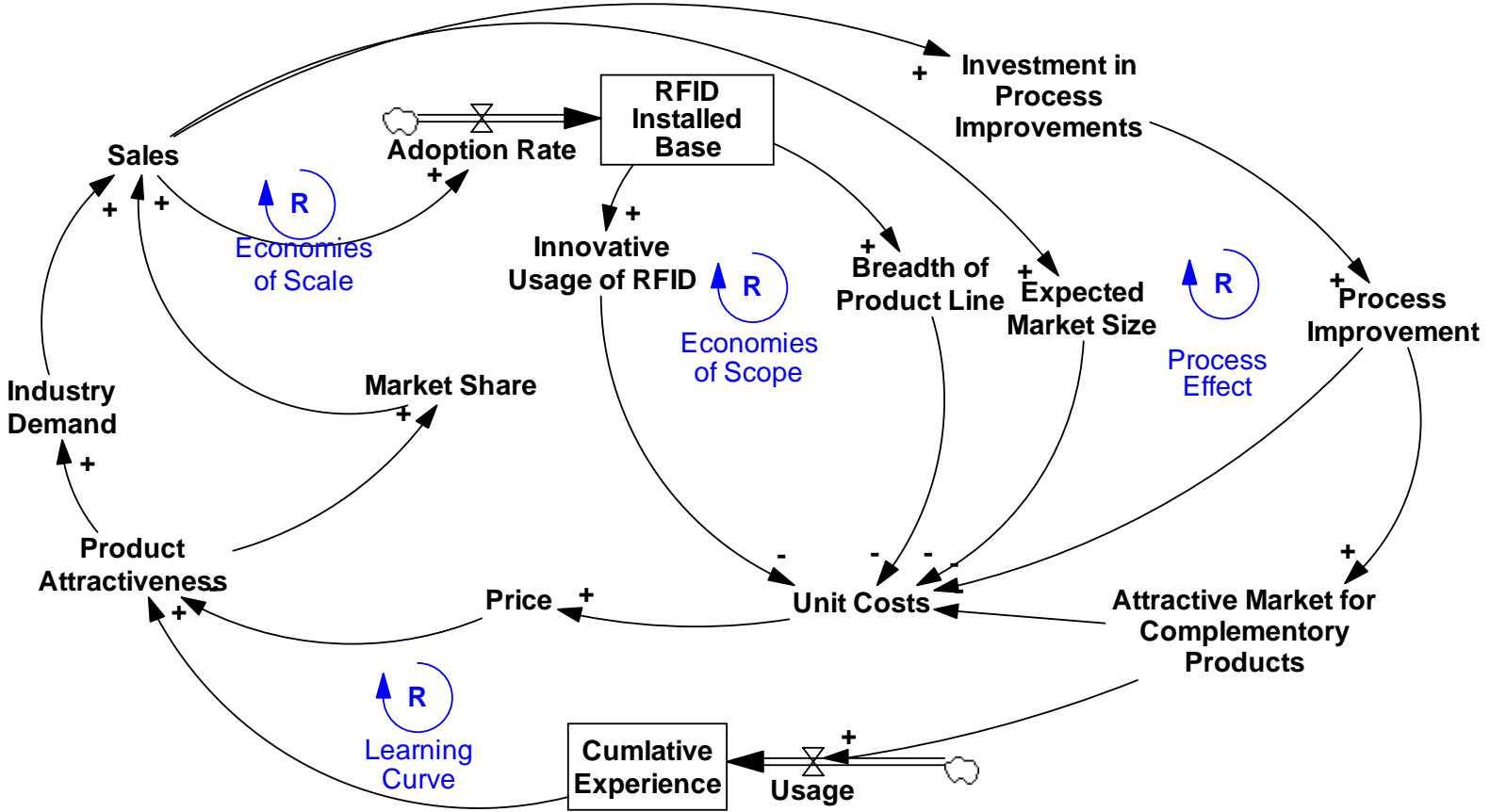•Real Time Stock Details

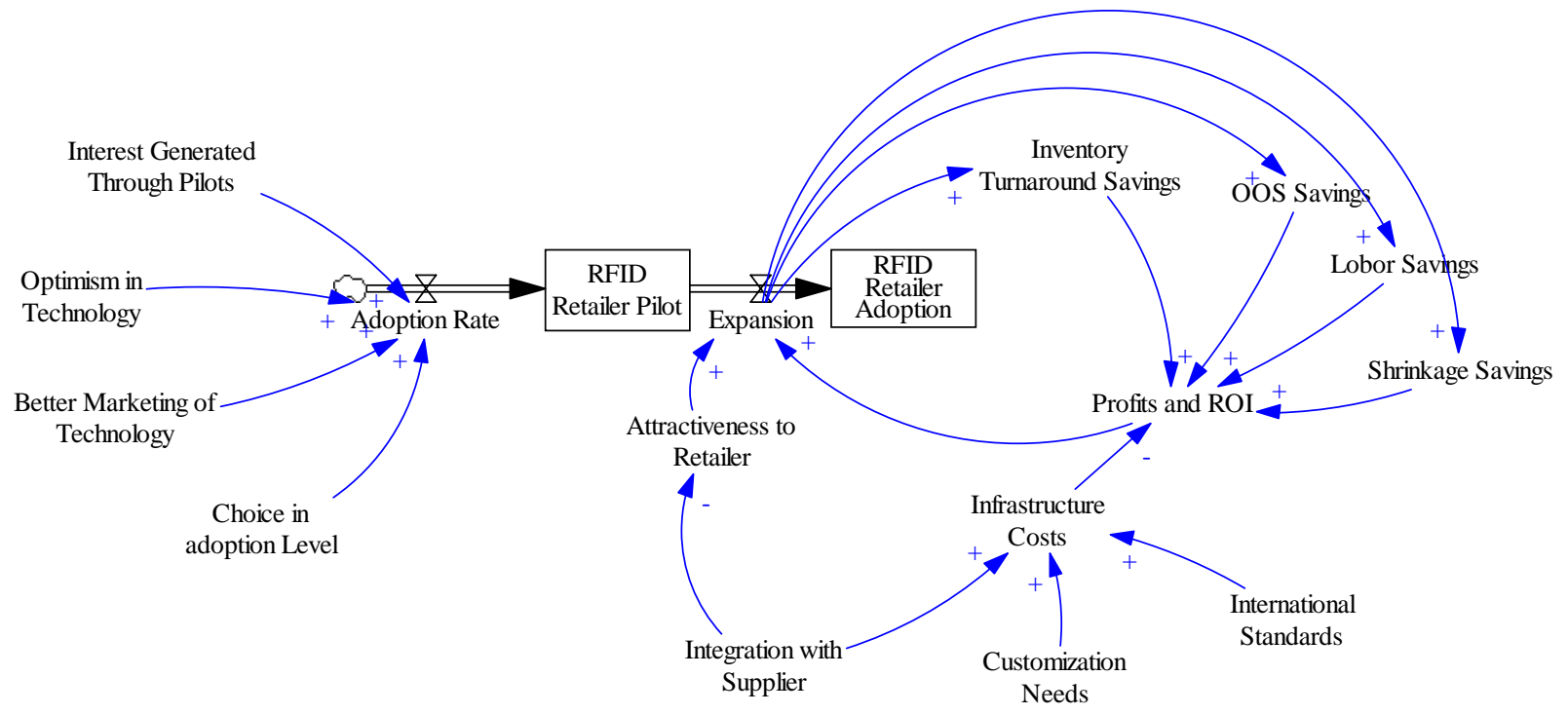## Case Study – Closed Loop

look behind the label

- Application:
  - Retail, Apparel
- Level of RFID usage:
  - Item Level
- Benefits sought:
  - Improved Customer Service, Improved Loyalty, Improved Sales, Less OOS
- Project Status:
  - Trials Completed
- Tags:
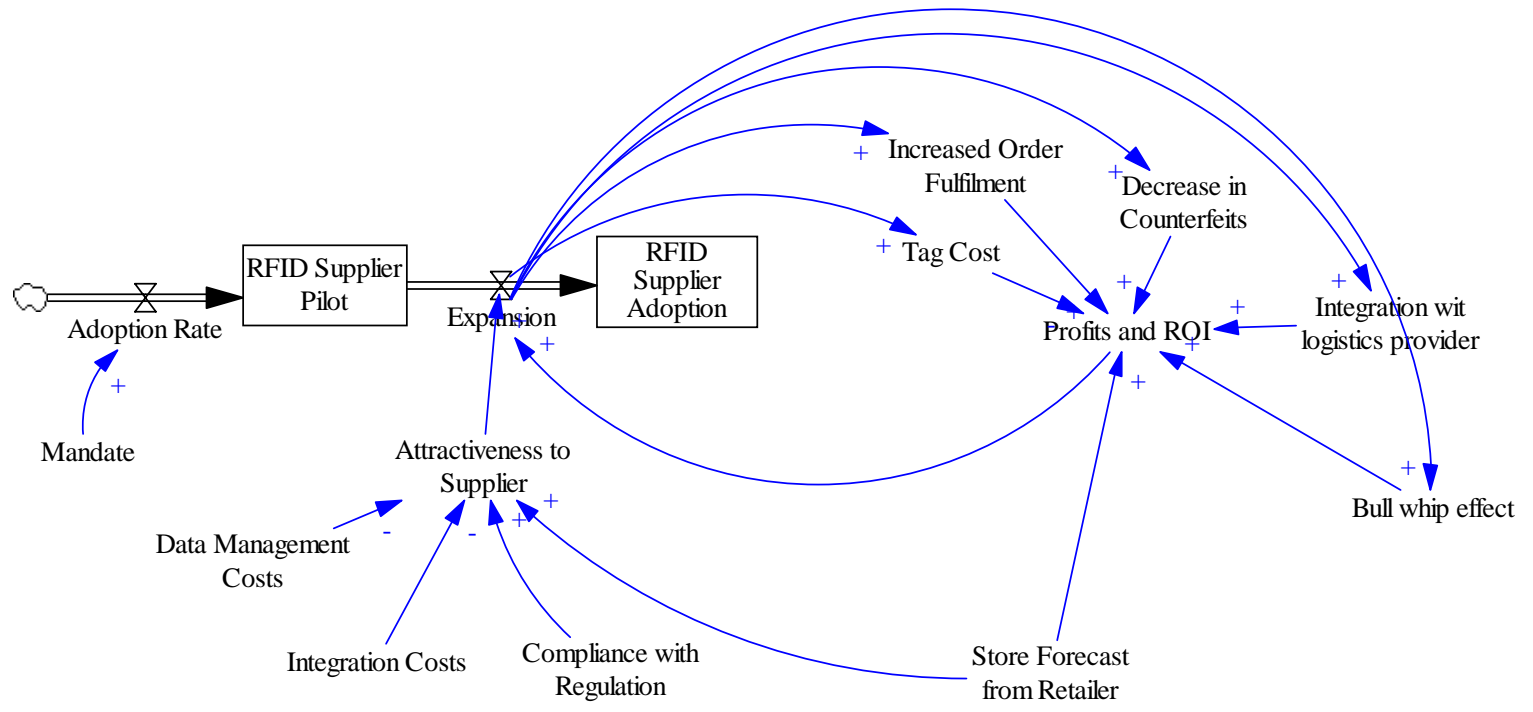 - UHF 868 MHz (Not EPC)
- System:
  - Paxar, Intellident

RFID at a Macro Level

Retailers Perspective

Suppliers Perspective

Summary

- Retailers have proven ROI and are pushing for RFID
  - More than 70% with $5B evaluating RFID
- Suppliers have yet to see a clear ROI and need to eat up all costs
- Complex infrastructure is needed to integrate both parties

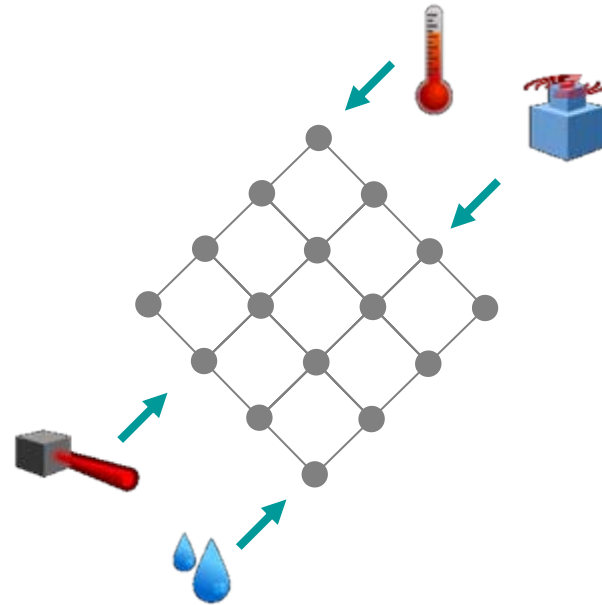# Trend – Towards creating "Thinking Machines"

Internet

Linear Business Processes

Real Time

Web of Business Processes

• **Human Intervention Required**
• **Limited by Submit or Go Button**

• **Triggered by Physical Events in the Real World**
• **Many Starting Points**
• **Automated, Interdependent Processes**
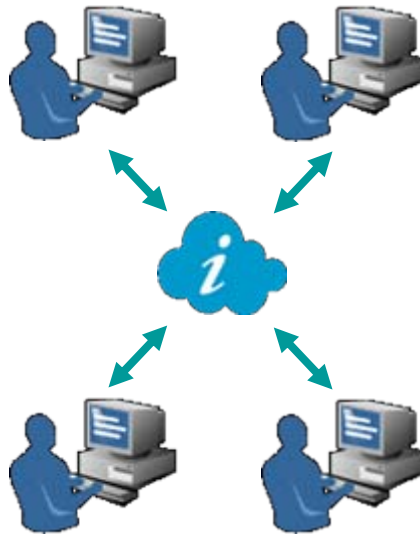
Trend: Towards Real-Time Enterprises

Data Processing

- Weeks
- Batch
- Megabytes
- Punch Cards
- Few People

Internet

(Still Happening)

- Days
- Request/Reply
- Terabytes
- Human
- Many People

Real Time

- Minutes
- Automated
- Exabytes
- Event Driven
- Beyond People

Companies Studied

- Wal-Mart
- Tesco
- Metro
- Tyco
- Intermec
- Texas Instruments
- Bic Corporation
- Pratt and Whitney
- Carrier Corporation
- Sikorsky Helicopters