Transforming BP Processes
Using
Sensory Networks

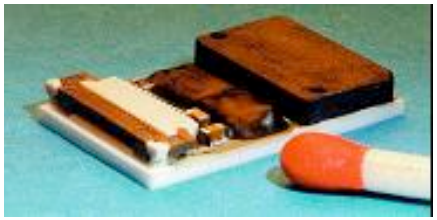
August, 2003

Three Technologies Intersect

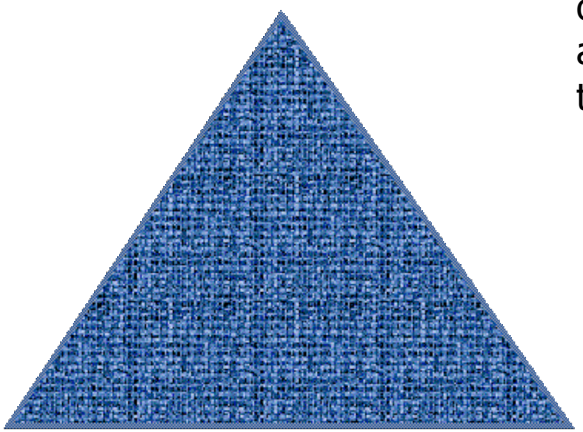
Sensors: Once large and expensive, sensors are now tending to tiny sizes, near disposable cost levels, with a vast range of measurement capabilities allowing you to "know things at a distance."

Smarter, Smaller Sensors

Computing: Computing power is becoming small and inexpensive enough to add to almost any object, bringing new management capabilities and applications into the realm of the possible.



Pervasive Computing



Wireless: Spans a host of technologies including Bluetooth and WI-FI networks, low earth orbit satellites (LEO) and GPRS, all with increased impact thanks to the internet.

Ubiquitous Wireless

Wireless, Sensors and Computing—the Building Blocks of Sensory Networks

RFID Tags & Motes are Key Solutions

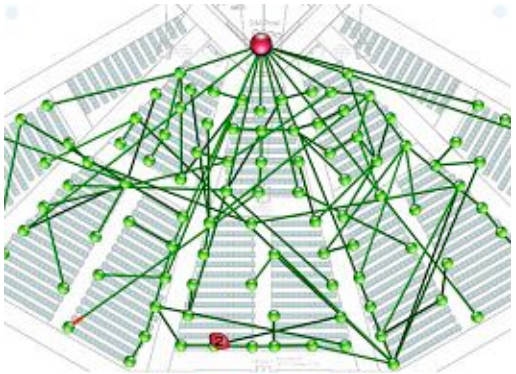
Smaller, cheaper RFID Tags

RFID tags: RFID tags on boxes, pallets, machinery or railroad cars carry unique identification and information that can be used for a wide variety of applications ranging from logistics and asset management to retail operations and HSSE.

Motes & Smart Dust

Self-configuring Sensor Networks

Motes: Also known as "smart dust," motes are small sensors with built-in power, memory and communications ability, that can gather a vast amount of sensory input and communicate it over a self configuring wireless network.



A network of miniscule, remote sensor chips gather, process and communicate data for applications as varied as catching defects in manufacturing to tracking patient movement in a hospital room.

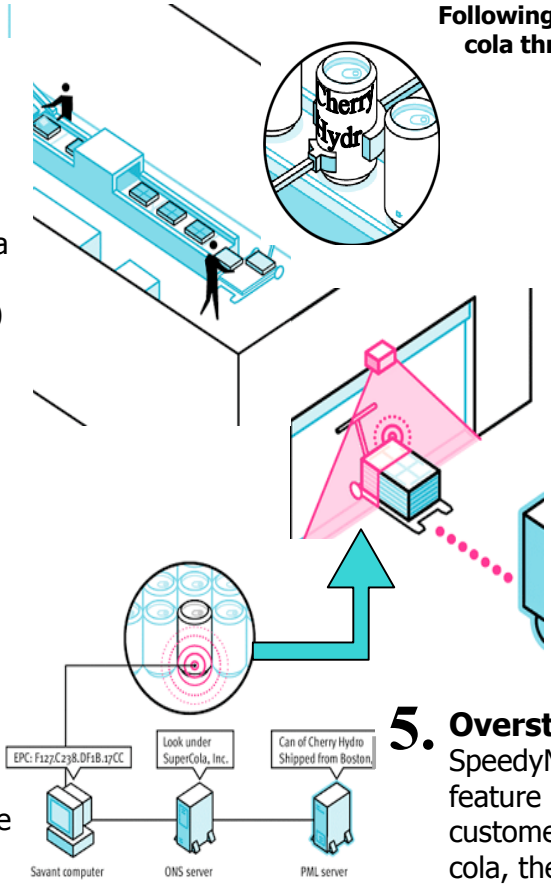
A Supply Chain Example of RFID

Following a can of "Cherry Hydro" cola through the supply chain

1.

Adding Identity to Products & Cases

RFID tags on each cola can contain a radio antenna and a unique Electronic Product Code (EPC) stored in a microchip, allowing the cans to be identified, counted and tracked. Cases and palettes are also tagged.



2.

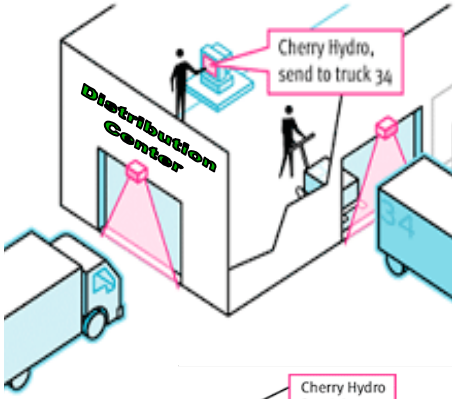
Reading Tags

As the palettes of cola leave the manufacturer, an RFID reader hits the smart tags with radio waves, powering them. The tags "wake up" and start broadcasting their individual EPCs.

3.

Efficiency in Distribution

At the distribution center, there's no need to open packages and examine their contents. RFID readers identify the cargo and the cola is quickly routed to the appropriate truck.



4.

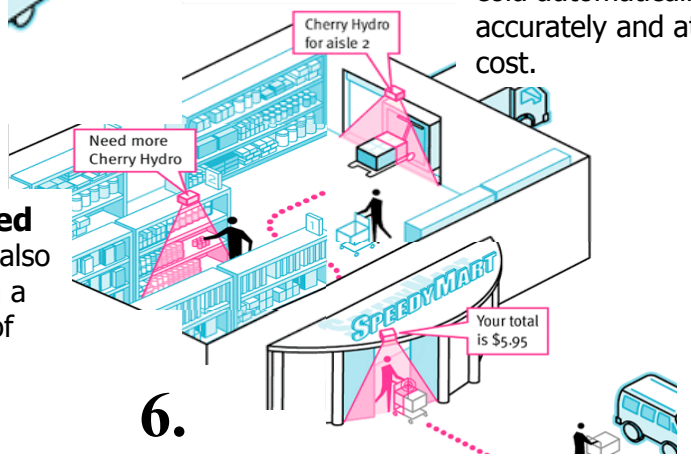
Efficiency in Inventory

As soon as the cola arrives, SpeedyMart's retail systems are automatically updated to include every can of cola automatically, accurately and at low cost.

5.

Overstocking Eliminated

SpeedyMart's retail shelves also feature readers. Now, when a customer grabs a six-pack of cola, the shelf will route a message to SpeedyMart's automated replenishment systems - which will order more. The need to maintain costly "safety volumes" of cola in remote warehouses is eliminated.



6.

Consumer Convenience Rather than wait in line for a cashier, customers simply walk out the door with their purchases. A reader built into the door recognizes the items by their individual EPCs; a swipe of the credit card and customers are on their way.

Source: Auto ID Center

Sensory Networks Gaining Momentum

Wal-Mart is focused on using RFID technology to improve its supply chain operations. It will require its top 100 suppliers to tag pallets and cases by January 2005.

Gillette has purchased half a billion RFID tags for its shaving products supply chain to address problems of:

- **Incomplete orders shipped/received**
- **Errors in data entry on receipt of sale**
- **Misplaced product due to lack of stock visibility**
- **Theft/diversion**
- **Inefficient stock replenishment/reordering**

METRO Group
Future Store Initiative

The Metro Group is testing a number of advanced technologies at one of their stores in Germany. They are using RFID tags at every level from supply chain operations to the item level to shopper location tracking for advantages in warehousing, theft control, shelf availability, quality assurance, labor reduction, marketing innovation and more.

Gaining Momentum

Scottish & Newcastle

Scottish Courage adopted RFID tags to improve supply chain operations. They have eliminated $6-8 million annually in new beer keg purchases, improved keg cycle time by 4 days (about 10%) and resolved several quality issues through traceability.

Port Authority

To date, 64 Port Authorities and trade entities around the globe have joined Smart & Secure Tradelanes, using sensory network technology to keep cargo safe from terrorism. Smart tags not only alert authorities to any tampering, but also trace its movement, who packed it and what is contained inside, speeding up the supply line as well as improving safety and security for all.

U.S. Department of Defense

The US DoD created the world's largest supply chain visibility network using active RFID and GPS. It operates in 40 countries with nodes at airports, seaports, rail stations and more. It tracks 280,000 container movements and their contents saving the DoD millions in supply chain and logistics costs.

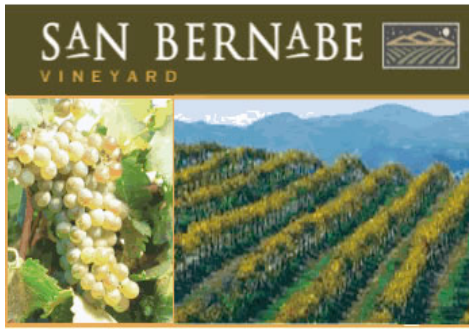
Gaining Momentum

The US Military is improving quality and efficiency of site maintenance and repairs in the field by tagging spare parts and maintainable assets. The tags identify the parts and retain a maintenance history, while handheld devices allow checking of parts availability and replenishment.

PITO, the Police Information Technology Organisation, is making innovative use of wireless and sensory technologies, focusing on crime and crisis management in the UK. Stolen car rates dropped 50% as a result of deploying sensory technologies coupled with existing video cameras.

The Auto-ID Center at MIT is a unique partnership between global companies and leading research universities to create a new infrastructure that enables the unique identification of scanned objects anywhere in the world. Electronic Product Codes (EPCs) allow tagged items to be traced, enabling companies such as founding member Proctor & Gamble to reduce retail theft, counterfeiting and develop superior supply chains.

Motes Proving Their Value



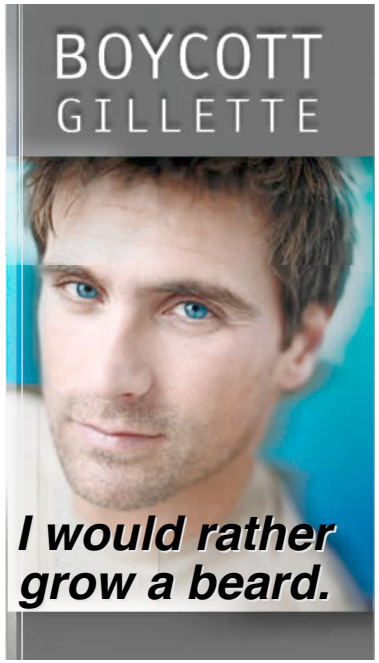
Frost is a major problem for vineyards. The San Bernabe Vineyard in California improved their frost control process by deploying 13 motes to measure temperatures in distinct areas of their 12,640-acre property. When temperatures fall to a certain level, sprinklers are activated in appropriate areas before the onset of frost to prevent damage to the grapes. Previously, people with handheld thermometers were deployed to the fields, taking longer and costing more to accomplish this task.

Intel is testing use of sensory networks using mote technology as real time diagnostic tools in fabrication plants for improved vibration monitoring, allowing more effective scheduling of maintenance.

The University of California, Berkley, has demonstrated how mote networks can assess structural damage from earthquakes, making eventual re-entry of large buildings quicker, less expensive and more effective. They showed how 100 motes could be installed in an afternoon with sensors collecting vibration data and measuring how building elements moved relative to each other revealing the degree of damage at each location after mock-earthquakes.

Privacy is a big issue

Fear of "Big Brother" type spying has spawned a consumer backlash against tagging. A consumer group, CASPIAN, launched boycotts of Benetton and Gillette to protest their plans to implement RFID tagging in retail products.



Only the tagging of *consumer* products is drawing fire. Tagging at pallette or carton level is not considered threatening.

What are the BP opportunities?

Applications are possible across the business spectrum

Improve:

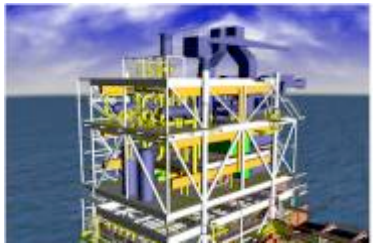
1. **Supply Chain, Logistics and Distribution**
2. **Asset Management & Maintenance**
3. **Retail Operations**
4. **Health, Safety, Security & Environment (HSSE)**

Index of Opportunities at BP

Ref #	Description	BP Business Area of Application
1	Chemicals Rail Car Telematics	US Chemicals Logistics
2	Industrial Site Asset /People Tracking	Hull Chemicals
3	Asset Tagging for Maintenance	Downstream Refining, Toledo
4	Lubricants Supply Chain	Downstream Lubricants
5	LPG Cylinder Tracking	UK Downstream LPG
6	Scaffold Tagging for Safety	UK Downstream Coryton
7	Desktop Computer Security	GBC, Mergers & Acquisitions
8	Remote Solar Panel Monitoring	GP&R, Solar
9	Remote LPG Tank Monitoring	UK Downstream, LPG
10	RFID Tagging of Downhole Inventory	Upstream
11	Asset Tagging for Retail	Downstream Retail
12	RFID Payment System	Downstream Retail
13	Asset Tagging for Operations	SA, Downstream
14	Marine Transaction Security	SA, Downstream
15	Pipeline Monitoring	Upstream, Pipelines
16	Manufacturing of Solar Panels	GP&R, Solar
17	Road Tanker Tracking	US Downstream Logistics

Ref #	Description	BP Business Area of Application
18	Personnel Tracking for Security	Upstream HSE
19	Rhum Construction & Commissioning	Upstream
20	Claire Asset Construction	Upstream
21	Building Monitoring (energy & security)	Facilities
22	Inventory Management	Upstream
23	Rail Yard Management	Chemicals, Decatur
24	Remote Gas Data Logging	GP&R, Holland
25	Remote monitoring of Energy Demand	IST
26	Remote Tank Level Monitoring	Downstream Refining
27	Supply Chain Management	Upstream, N. Sea
28	Ship Engine Vibration Monitoring	Shipping
29	Condition Monitoring-N Slope	Upstream
30	Grangemouth Jetty monitoring	Refining/Chemical
31	Vehicle Tracking (Pakistan)	Upstream
32	Refinery of the Future	Downstream
33	Asset Tracking for Security	Upstream - Russia

High Potential Opportunities at BP



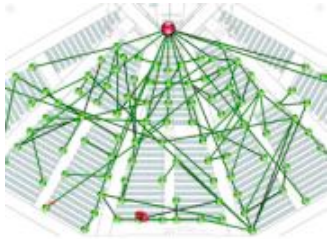
Sensory Networks in Asset Construction

Chemicals Rail Car Telematics

LPG Cylinder Tracking

Lubricants Supply Chain

Sensory Network Applications



Possible Mote Opportunities

Remote LPG Tank Monitoring

Industrial Site Asset/People Tracking

Chemical Rail Car Telematics

Successful trial completed
June 2003

BP can claim industry leadership in this application of Sensory Network computing

Provide end to end real time visibility of the rail car logistics process and the assets within that process

Speed cash flow and reduce costs

- **The ability to identify *when* rail cars are unloaded means earlier invoicing and faster recovery of cars after deliveries**
- **Monitoring product temperatures and environmental conditions minimizes risks, delays and potential incidents**
- **Real time visibility and monitoring of inventory improves order management**
- **Access to on-site statistics reduces manual tracking and car movements**

Next Step: Implement at scale in one BU to confirm the business case

Industrial Site Asset/People Tracking

Hull trial ties into Maintenance Breakthrough initiative

Track people and assets at refineries, chemical plants and other production sites for HSSE and process assurance

- Increase safety by tracking whereabouts of "lone" workers
- Eliminate excessive rental charges caused by losing track of the location of expensive rental equipment
- Increase benefit derived from investment in Wireless LAN

Successful trial of Location Tracking at Hull Chemical facility August 2003

Remote LPG Tank Monitoring

Schedule tank replenishment & logistics automatically by using LEO-connected sensors to monitor customers' LPG tanks

Business Benefits

- Business Process Simplification
- Better Customer Service
- Cost Reduction

- **No phone line, no power line, no drilling, no blind spots**
- **5 year battery**
- **Driver fitted**
- **External web data delivery**

Trial Results

UK LPG sold ***more*** gas with ***less*** truck time on the road, actually reducing the size of its tanker fleet while providing better customer service.

Capital costs were kept very low thanks to negotiating a "managed service" arrangement

LPG developing plan for worldwide rollout starting in Turkey

LPG Cylinder Tracking

Traditional Cylinder

New Cylinder

Features of New Cylinder

- Lighter Weight, Attractive, Safer
- Semi-transparent, to view fill level

Use RFID technology on the new composite cylinder to increase operational efficiency in the LPG business and further enhance its breakthrough innovation

- **Gain significant labor savings while improving inventory control, refill control and maintenance scheduling**
- **Improve marketing information with better understanding of customer usage patterns**
- **Enable unmanned sales and 24-hour availability for customers exchanging bottles**
- **Support potential BP 'Loyalty Program'**
- **Incorporate tags at point of manufacture to reduce implementation cost**

Assessing opportunity to trial cylinder tagging

Lubricants Supply Chain

US: Determine how to meet Wal-Mart's requirements to become RFID-enabled by 2005

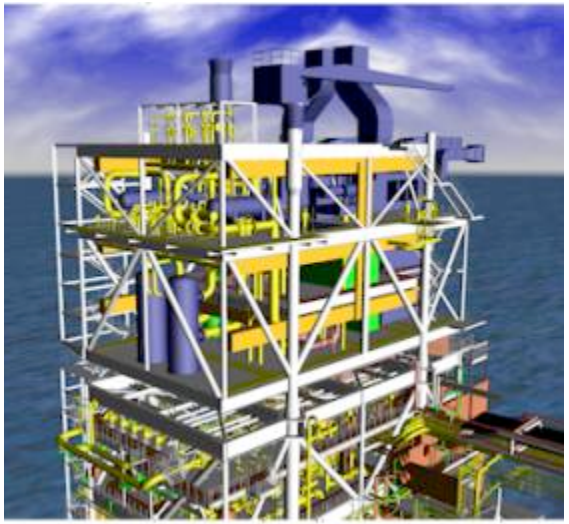
WAL★MART®
ALWAYS LOW PRICES. Always.

Improve end-to-end supply chain visibility by adopting RFID Tags at the pallet and carton level

- Improve container utilization and warehouse processes
- Reduce "shrinkage" and identify distribution issues
- Reduce counterfeiting of products

Conduct a Trial Starting 4Q 2003

Upstream Asset Construction



Being considered by Upstream Rhum project in North Sea, which would be the first module in the world to have RFID included at fabrication rather than a retroactive installation

Design a new production asset that incorporates sensory networks for efficient commissioning as well as future operational efficiencies

- **Tag all major plant items in the Rhum module and install a wireless network infrastructure**
- **Create a more accurate online asset register as the module is built**
- **Reduce commissioning paperwork**
- **Provide Operations with tools to increase efficiency and add value, pushing knowledge to the coalface**
  - **Mobile Maximo**
  - **Info@Site**

Possible Mote Opportunities at BP

Robust, smart sensors without prohibitive wiring costs open up many new possibilities for business benefit

Opportunities include:

- **Building Energy Management – being considered by GPM&S**
- **Pipeline Integrity Monitoring – exploring possibilities in N. America and Scotland**
- **Ship rotating equipment condition monitoring – to improve availability and reduce maintenance effort**
- **Crude Furnace Fouling detection, in conjunction with the "Refinery of the Future" initiative and Grangemouth**
- **Tank Farm monitoring – Texas City site**

We are working with business segments and leading practitioners in this field like

- Dust Inc

- Intel

- Motorola/SAP

- Ember

to identify problems and innovative solutions.

CTO Role in Sensory Network: To Help *Business* Initiatives Succeed

CTO can help BP businesses drive innovative sensory network solutions to challenging problems and opportunities

We bring you:

- Wide ecosystem of suppliers, research firms, industry forums, venture capital firms, university think tanks and external business contacts to draw upon
- Knowledge and experience of activities across the breadth of BP segments and functions
- Vast technical knowledge and expertise
- Technology Trials to separate hype from reality, laying foundation for sound solutions

Institute for the Future
FORRESTER
Gartner insight for the connected world
Working Council for CIOs
Boston University
KPCB Kleiner Perkins Caufield & Byers
Carnegie Mellon
MIT
AUTO-ID CENTER Identify Any Object Anywhere Automatically
Savi Technology
DUST Inc.
ZigBee Alliance