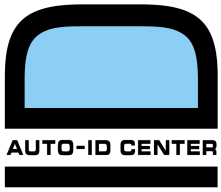
Published June 1, 2002. Distribution restricted to Sponsors until September 1, 2002.



TECHNICAL REPORT

Auto-ID Center Field Trial: Phase I Summary

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ABSTRACT

The Auto-ID Center Field Trial was conceived as a test to evaluate the capabilities and practical feasibility of the Networked Physical World system designed by the Auto-ID Center in real world supply chain applications. A prototype of the Networked Physical World system has been implemented by the Auto-ID Center. The key components of this technology are the Electronic Product Code (EPC), the Object Name Service (ONS), the Savant, the Physical Markup Language (PML), and the cheap Radio Frequency Identification (RFID) tag. The combination of these components provides a new method of uniquely identifying physical objects and storing and retrieving information about these objects. The goal of the Field Trial is to determine if the Auto-ID Center's Networked Physical World system is able to locate any one item, case, or pallet anywhere and at anytime in the supply chain to include: manufacturing facilities, manufacturing distribution centers, retailer distribution centers, retail stores, consumer homes and ultimately disposal/recycling centers. This report summarizes the execution, the learnings, and the results from the first phase (Phase I) of the Field Trial.

TECHNICAL REPORT

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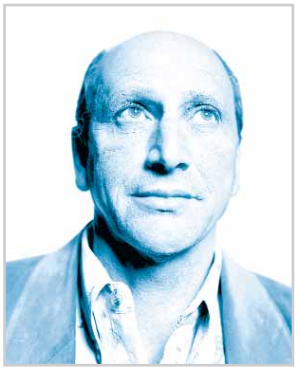
Biography



by Silvio Albano
Program Manager

Silvio, was employed by The Gillette Company for the past 34 years and is now on loan to the Auto-ID Center. With a Mechanical Engineering degree from Northeastern University, he has worked on design and specifications of automation and packaging equipment, various managerial assignments in production, plant facilities engineering and package engineering. He also served as R&D Program Manager for the Stationery Products Group and had responsibility for identifying, evaluating and implementing new products for manufacturing in the Far East and Europe. Silvio joined the Auto-ID Center in Cambridge MA, in March 2001 as Field Trial Program Manager.

by Daniel W. Engels
Associate Director

Daniel W. Engels received his B.S. from the University at Buffalo, his M.S. from the University of California, Berkeley, and his Ph.D. from the Massachusetts Institute of Technology all in Electrical Engineering and Computer Science. His master's thesis is in the area of computer-aided design for electronic systems, and his doctoral thesis is in the field of theoretical computer science. Dr. Engels joined the Auto-ID Center after obtaining his doctoral degree where he leads the day-to-day research activities of the Center. Dr. Engels' research interests include scheduling theory and applications, real-time system design, distributed and mobile computing, and computer-aided design for embedded systems.

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Contents

1. EXECUTIVE SUMMARY

The Auto-ID Center Field Trial has been designed to evaluate the Auto-ID Center's Networked Physical World system and its reference implementation technology in real world supply chain applications. The Field Trial has been divided into three phases with the divisions corresponding roughly to the types of items being tagged. Each phase has unique objectives and requirements.

The first phase of the Field Trial (Phase I) began 1 October 2001 and ended 1 February 2002. Phase I involved the tagging of pallets only. Two commercially available RFID tags are affixed to every pallet, with the tags placed on opposing corners of the pallets. The objective of Phase I was to evaluate the effectiveness of the EPC, ONS, and Savant designs and implementations within a real-world supply chain.

Each RFID tag is written with a unique EPC, and the two EPCs corresponding to the same pallet are recorded in a database. Reading either of the two associated EPCs identifies the pallet. RFID readers are installed in portal configurations at multiple locations within the supply chain to read tags as they either enter or exit a particular location. A single Savant is installed at each location, and a top-level Savant is installed at MIT. The global ONS is installed at a single location, MIT.

A 97% item identification accuracy was achieved during Phase I, while only a 78% tag identification accuracy was achieved.

Phase I shows that the Auto-ID Center system components (EPC, ONS, and Savant) work as designed. Phase I also shows that affixing multiple tags to an item increases its chance for identification provided that the EPCs on the tags corresponding to that item are known in advance. Phase I also shows that portal installations alone are not sufficient to guarantee 100% item identification with today's technology.

2. FIELD TRIAL OVERVIEW

2.1. Charter

The Auto-ID Center Board of Overseers at the February 2001 meeting decided it was prudent to test the effectiveness of the Auto-ID Center's technology in a real-life supply chain environment. A Field Trial Action Group was formed to execute the test, and a charter was adopted by the Board of Overseers to govern the execution and implementation of the Field Trial. The complete charter is reproduced in Appendix A.

The first Field Trial Action Group meeting was held in Cambridge, MA, on March 12, 2001.

2.2. Objectives

Several objectives were established to begin the implementation of the Field Trial. These objectives are categorized along the following four broad classes:

1. Field Trial Objectives.
2. Team Objectives.
3. Field Trial Implementation Objectives.
4. Phase I Objectives.

1. Field Trial Objectives

The Field Trial Charter Objectives were modified to reflect timing and a phased implementation approach adopted in the implementation objectives. The modifications are summarized in the following two points.

- Pilot the current Auto-ID Center system developments and create awareness with consumers, retailers, manufacturers and technology producers as to the power of the system.
- Conduct Phase I of the Field Trial by October 2001, followed by Phase II in February 2002 and Phase III in the 4th quarter of 2002.

2. Team Objectives

The agreed team objectives are summarized as follows:

- Work as a cohesive unit to plan, organize and implement a Field Trial for the Auto-ID Center.
- Establish lines of communications and assign responsibilities.
- Formulate goals and objectives for implementation of the Field Trial.
- Unify team to work together in generating and sharing information and ideas.
- The team will operate under the guidelines of the Auto-ID Center Field Trial Charter published by the Board of Overseers.

3. Field Trial Implementation Objectives

Given the complexity of the supply chain, the availability of new technology and the limited funds available for the test, a plan was required that would allow for the implementation of a Field Trial to be adopted in a gradual manner. The implementation objective was developed to include a three phase approach. The plan would meet the objective of early adoption (October 2001) in a field trial of the Auto-ID Center's developed technology by using existing RFID hardware and minimize spending by beginning at the pallet level. The approach allowed for gradual building of the infrastructure from pallet to case and eventually escalating to units level reads using newly developed low cost technology (tags/readers).

Table 1

FIELD TRIAL PHASE TIMINGS AND IMPLEMENTATION OBJECTIVES		
OCTOBER 2001	Phase I	– Minimize number of SKUs. – Eliminate (if possible) DCs. – Minimize number of stores (1 or 2). – Minimize number of participating sponsors. – Use existing hardware technology. – Auto-ID developed software (ONS, Savant). – Restrain to pallets only.
FEBRUARY 2002	Phase II	– Increase number of SKUs. – Increase number of stores. – Add distribution center. – Increase number of sponsors. – Use existing hardware technology. – Auto-ID developed software (ONS, Savant). – Reduce restraint to pallets and case quantity.
4TH QUARTER 2002	Phase III	– Increase number of SKUs. – Increase number of sponsors. – Use new low cost technology (tags/readers). – Auto-ID developed software (ONS, Savant). – Eliminate restraints to the unit, case and pallet level.

4. Phase I Objectives
Specific objectives were set for Phase I of the field trial. These objectives are summarized below.

- Evaluate the effectiveness of the Auto-ID Center's EPC, ONS, and Savant technology.
- Understand the performance of existing RFID hardware (tags/readers).
- Obtain Funding.
- Select town, sponsors, retailer, and distribution centers for installation within the Field Trial.

2.3. Expectations

Sponsors participating in the Field Trial conveyed many expectations pertaining to how Auto-ID Center technology could affect and improve their manufacturing process, distribution supply chains, and mode of operation within the retail stores. However, given the nature and design of Phase I which was limited to tagging pallets only with portal readers only, expectations of Phase I were refined and identified as:

1. Evaluation of effectiveness of Auto-ID Center system technology (EPC, ONS, and Savant).
2. Evaluation of existing reader/tag technology.
3. Begin to gather data for Business Case support.
4. Generate enthusiasm with all trade groups, manufacturers, retailers, and distributors by creating. awareness of the Auto-ID Center through a public relations campaign about the Field Trial.
5. Drive the development and publication of open standards.
6. Publish results of all available data to include:
    - Read rates
    - Failure mode rates
    - Item Identification rates
    - Multiple reading operations (anti collision).

2.4. Membership

Membership in the Field Trial is open to all Auto-ID sponsors who want to actively participate in the test. Membership will also allow sponsors to be part of the decision process for selection of technology to be used in the test or just participate at team meetings and obtain information prior to open disclosure to the general public and non Field Trial participating sponsors. All members are voting members and are consulted and participate in all decisions regarding the execution of the Field Trial.

At the start of Phase I not all sponsors elected to be members of the Field Trial. Membership for Phase I included:

End User Sponsors
CHEP International, International Paper, Johnson & Johnson, Philip Morris Group (Kraft), Procter and Gamble Company, The Coca-Cola Company, The Gillette Company, Uniform Code Council, Unilever, Wal-Mart Stores, Inc., Westvaco, Yeun Foong Yu Paper Mfg.

Technology Sponsors
Alien Technology, Checkpoint, Invensys Control, MARKEM Corp., NCR, Philips Semiconductors, Rafsec, Savi Technologies, Sensormatic, SAP Labs Inc., Sun Microsystems

The Uniform Code Council, Inc. (UCC) can contribute its vast experience in the implementation of the UPC code, and it was deemed that their knowledge would be essential to the success of the Field Trial implementation. They are the only non-paying non-voting member of the Field Trial Team.

2.5. Financial

The Field Trial Charter specified that the implementation of a real world supply chain test would be supported and governed by the Auto-ID Center Board of Overseers but not financially funded by the Center. Incremental funds would need to be solicited from Auto-ID Center sponsors wanting to participate in the Field Trial.

Preliminary Field Trial cost estimates showed that at least $1.5 million dollars would be needed to support the Field Trial through three phases. Phase I was estimated at $350,000. The team agreed on the following:

- Funds would be raised for the entire test (all three phases).
- The Field Trial Program Manager is responsible for financial control.
- Monthly statements are to be published to all team members.
- Funds would be pro-rated by sponsor Auto-ID Center level of membership as detailed below.

Table 2

AUTO-ID MEMBERSHIP FEE	AUTO-ID FIELD TRIAL FEE
$300,000 Sponsorship	$87,000
$150,000 Sponsorship	$44,000
$100,000 Sponsorship	$30,000
$50,000 Sponsorship	$15,000

3. FIELD TRIAL IMPLEMENTATION

3.1. Trial Concept

Trial Location
Several locations/towns were evaluated by a sub committee as possible sites for the Field Trial retail location, including Tulsa, Oklahoma, Chicago Illinois, Atlanta, Georgia and Seabrook, New Hampshire. None of the sites fit all the requirements as specified in the Charter. The team recommended and adopted Tulsa to be the first test city for the Auto-ID Center Field Trial.

Implementation Scheme
Given the complexity of the Field Trial, the limited availability of existing hardware (tags/readers), and the constrained start date of October 1, 2001, a test implementation concept was adopted by the team that would allow for starting with a simple supply chain (factory to retail) and limit initial shipments to one SKU.

With this concept there would be one manufacturer's factory, one SKU at the pallet level only, and one retail store. Manufacturer's and retailer's distribution centers were not in the test for the initial start. Figure 1 depicts the Field Trial implementation scheme for October 2001. This implementation scheme corresponds to the supply chain depicted in Figure 2.

Figure 1: Field Trial Phase I implementation scheme on 1 October 2001.

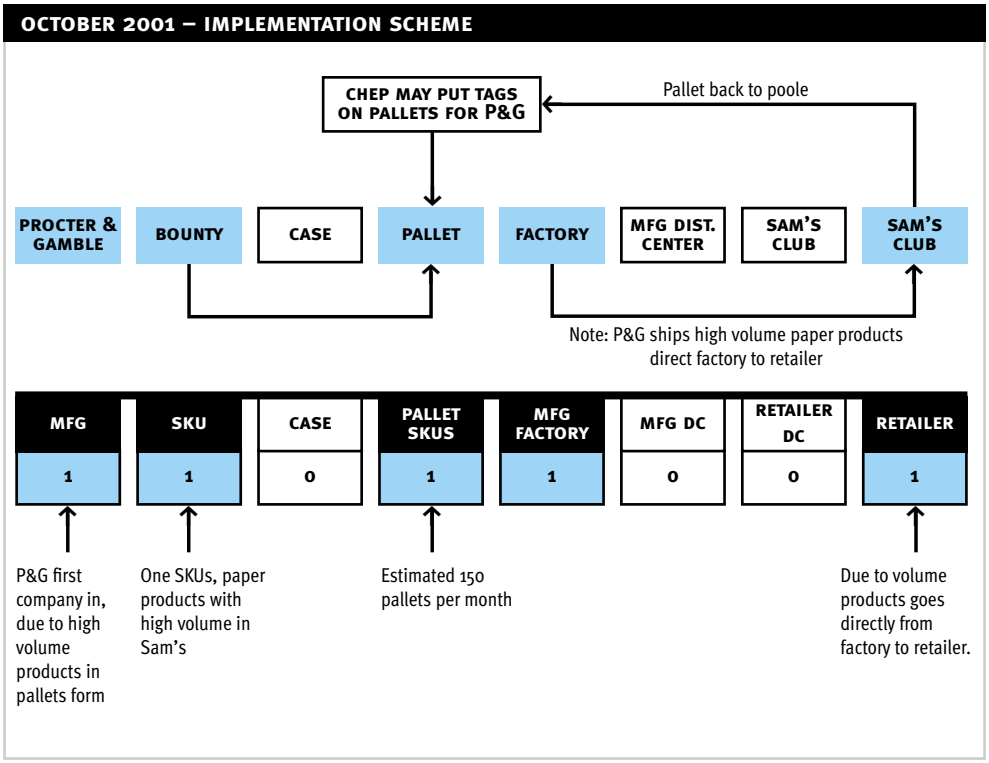
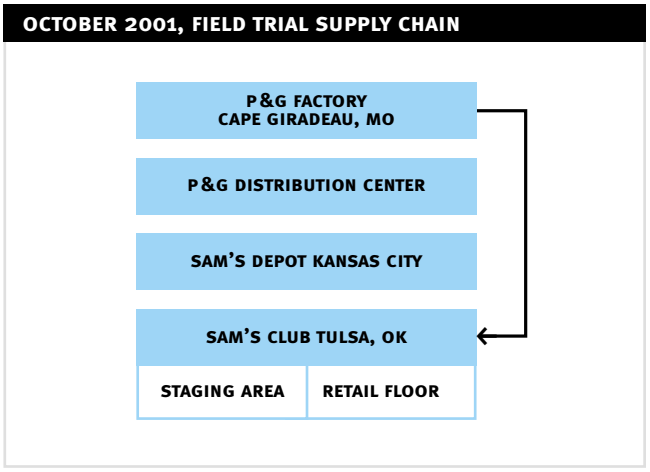


Figure 2 best describes the supply chain implemented for the October 2001 start date.

Figure 2: Field Trial Phase I supply chain flow on 1 October 2001.



From its humble beginnings, the test would grow in size through Phase I by increasing to three end user sponsors, adding two more SKUs, two manufacturer's distribution centers, and one retailer distribution center. By the November/December timeframe the Field Trial would take on the structure depicted in Figure 3. The new and expanded supply chain flows as per Figure 4.

Figure 3: Field Trial Phase I final implementation scheme.

Procter & Gamble Factory: Cape Girardeau, Mo
Sam's Club: Tulsa, Kansas City
Gillette Mfg DC: Chicago, Il
Unilever Mfg DC: Baltimore

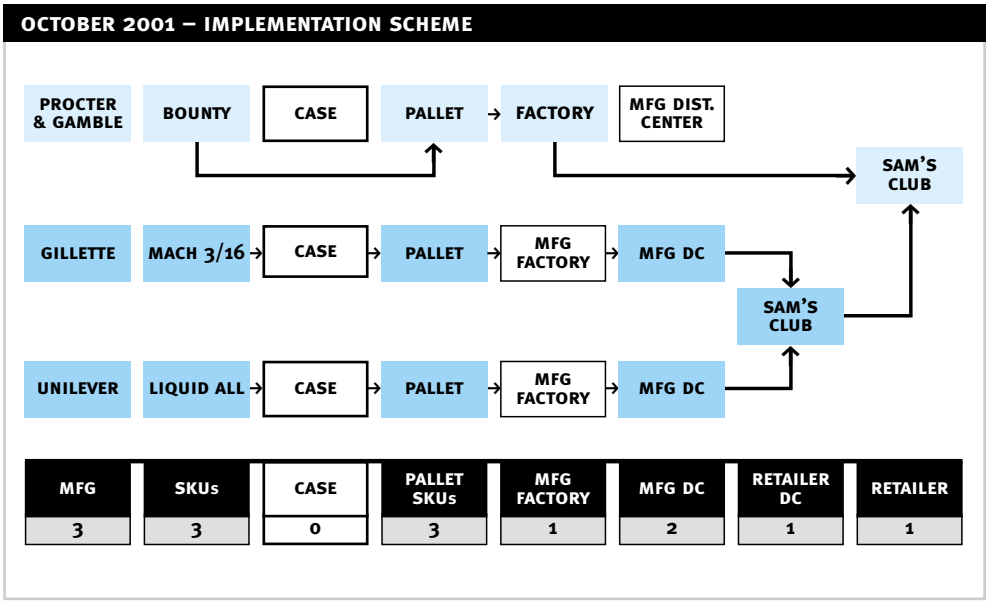
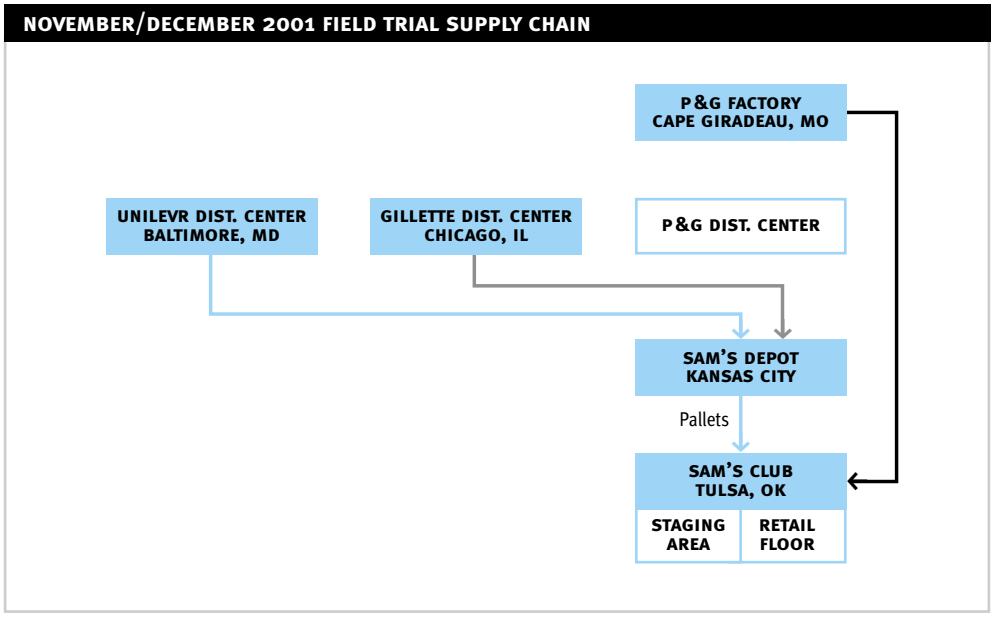


Figure 4: Field Trial Phase 1 final supply chain flow.



3.2. Participating Sponsors (End Users)

Four end user manufacturer sponsors and one end user retail sponsor were selected to have facilities and products participate in Phase I. The four manufacturer sponsors are: Chep, Proctor & Gamble, Gillette, and Unilever. The retail sponsor is Wal-Mart, utilizing its Sam's Club store in Tulsa, Oklahoma. The five companies and their participation in Phase I are described below.

Table 3

END USER SPONSOR	PRODUCT	
Chep	**Wooden Pallets**	Use of Chep pallets in the field trial was governed by the fact that Chep already supplied pallets to P&G and Unilever but was also manufacturing pallets with pre installed 915MHz RFID tags that could store an EPC. These criteria made Chep pallets a natural fit for use in the early adoption of the Field Trial.
Procter & Gamble	**Bounty Paper Towels**	Bounty Paper Towel is one of the highest moving products through the Sam's store. The high volume was beneficial to Phase I of the Field Trial in two respects: 1. Truck loads of Bounty towels leave the P&G Factory and go directly to the Sam's store, bypassing two distribution centers, and 2. High volumes generated sufficient information for early understanding and evaluation of the Auto-ID Center's system.
Gillette	**Mach 3, 16 Pack**	High visibility of Mach 3 blades made for a good fit into the early adoption in Phase I. This included the addition of Gillette's DC along with the need to include Sam's DC in Kansas City.
Unilever	**Liquid All Detergent Soap**	High volume of Liquid All detergent soap was beneficial to the test as it added a new DC in Baltimore MD along with introducing a liquid product to the test.
Wal-Mart Stores	None	

At the beginning of the Field Trial there was only one retail sponsor, Wal-Mart. For the test to get some meaningful information at the pallet level there was a need for a product that would have high pallet volume through a retail store. Within the Wal-Mart chain sizable pallet movement for one individual product could only be realized in one of their Sam's Clubs. With the selection of Tulsa, Oklahoma as the test-city, Sam's Club in the city became the first store to be utilized in Phase I.

3.3. Technology

The time constraint of October 1, 2001 as the start date for Phase I of the Field Trial dictated that existing hardware (tags and readers) be used in the initial system implementation. Several technologies were therefore evaluated for frequency, application and availability.

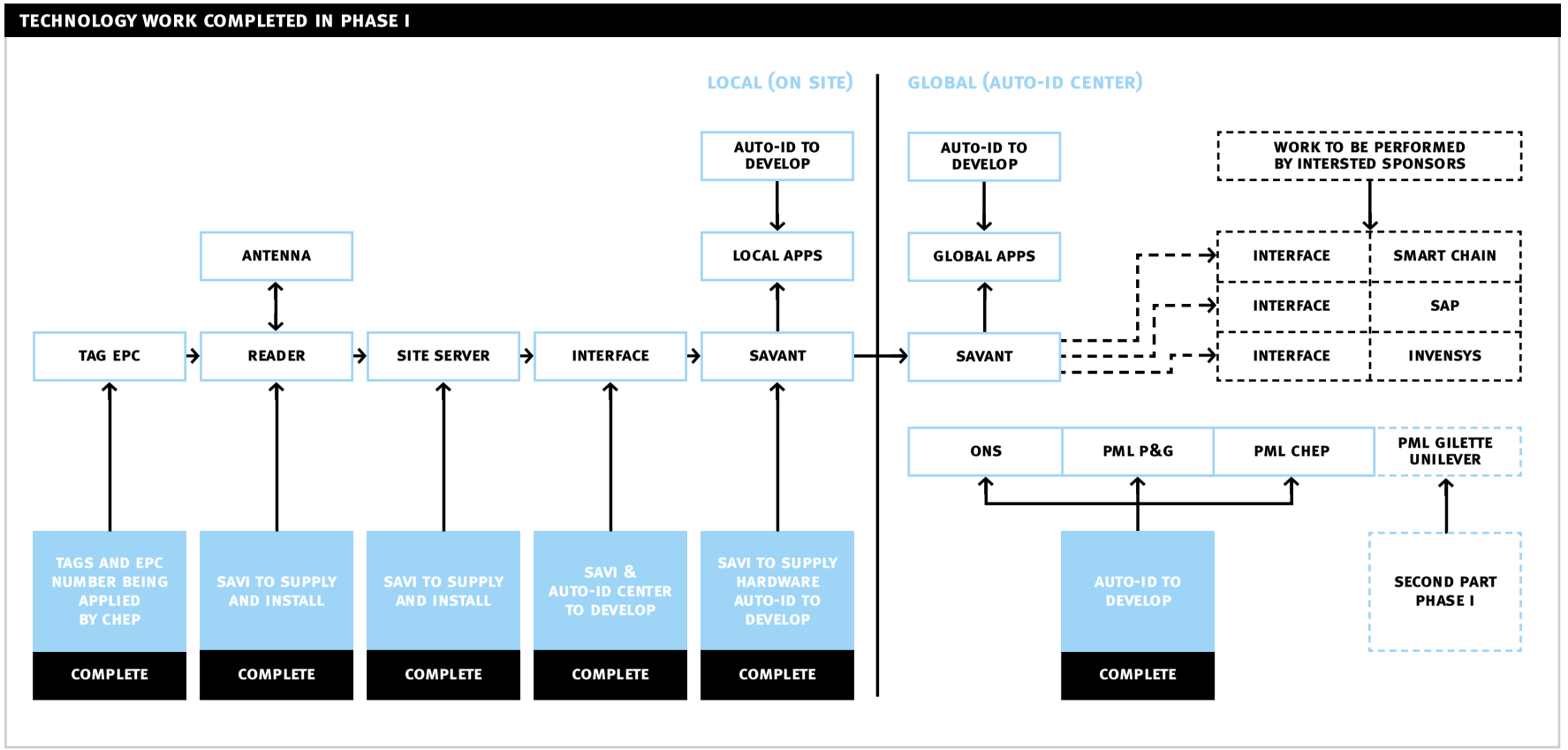
Table 4

FREQUENCY	PLUSES	MINUSES
915MHZ	– Longer range – Better for pallet read – Auto-ID spec range for low cost tags	– Not as effective on liquids and metals – No Auto-ID sponsor
13.56MHZ	– Several sponsors available – Better for Liquids and Metal	– Shorter range
APPLICATIONS	**PLUSES**	**MINUSES**
PORTAL	– Reads pallets going though portal (in/out) – No need to shock mount – Solid wire long term	– Need to distinguish product in and out versus product nearby – Many doors need wiring for – 100% read assurance
FORKLIFT	– Smaller number of trucks to be wired – Close proximity to pallet – Confirmation at fork lift cap – Speed and distance not an issue	– System can only be used at DC or Warehouse – Too many truck and hand carts at retailer
AVAILABILITY	**PLUSES**	**MINUSES**
SAVI PORTAL	– Available Today – Portal application – 915MHz technology	– Must be integrated with Auto-ID system
IP FORKLIFT	– Forklift application – 13.56MHz and 915MHz technology	– Must be integrated with Auto-ID system – Under development

Upon review of all the technical information available the team decided to adopt the Savi proposal. International Paper's forklift application would be deferred to Phase II.

The diagram in Figure 5 depicts the technology work completed in Phase I. Development was divided into two sections, on site work at the local manufacturer or distribution center and work conducted at the Auto-ID Center.

Figur 5: Field Trial Phase I completed technology work and installation details.



3.4. Installation Details

The following table details the installation locations and installed systems within Phase I of the Field Trial.

Table 5

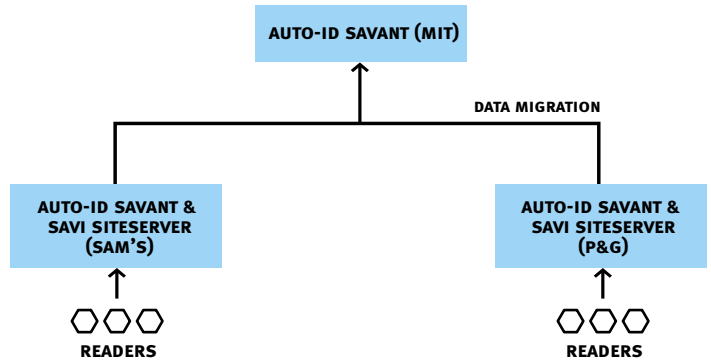
LOCATION	INSTALLATION DETAILS	
Procter & Gamble Cape Girardeau, MO Factory	1 exit door	Portal installation Dial up modem 2 – 915MHz reader 2 circular polarized antennas, one on each side of portal Savi Site Server Savant
Sam's Club Tulsa, OK Retail Store	5 entry doors 1 exit door	Portal installation Dial up modem 1 – 915MHz reader per door 2 circular polarized antennas on one side of door. One on top of the other Savi Site Server Savant
Sam's Club Kansas City, MO Distribution Center	2 Exit doors	Portal installation Dial up modem 2 – 915MHz reader 2 circular polarized antennas one on each side of door Savi Site Server Savant
Gillette Romeoville, Distribution Center	1 exit door	Portal installation Dial up modem 2 – 915MHz reader 2 – circular polarized antennas, one side of door Savi Site Server Savant
Unilever Baltimore, Distribution Center	1 exit door	Portal installation Dial up modem 2 – 915MHz reader 2 – circular polarized antennas Oatsystem Site Server Savant
MIT Cambridge, MA Laboratory	Desk hook up	Top level Savant Global ONS

Figure 6 depicts a typical network set up. Local readers communicate with a local Savant and Savi SiteServer, which in turn communicates with the Auto-ID Center (global) Savant located at MIT.

The Savi SiteServer receivers the EPC number from readers. The SiteServer sends these readings to the Savant in real time using their CDATP protocol. The Savant processes this data and logs the data into Site data base. Application tasks scheduled on the Savant monitor the data and take appropriate actions.

Figure 6

PHASE I SAVANT HIERARCHY



Note
Chep pallets were used for the Unilever and P&G facilities. Chep pallets were pre fabricated with 915MHz RFID tags as part of the pallet, buried under a plastic leader board at two opposite corners Gillette pallets were equipped with 915MHz RFID tags hand applied at the distribution center at two opposite corners.

3.5. Pilot Test Facility

All technology must be tested prior to installation within a facility. Wal-Mart made a pilot test facility available for technology evaluation and testing. The test facility is located in Rogers, Arkansas, and it is used to test and to debug all technologies and potential technologies that may be used in the Field Trial.

The test facility is open to all sponsors participating in the Field Trial. End user sponsors may wish to test tag location, arrangement, and performance on their products. Technology sponsors may wish to test their technology performance on multiple products.

All technologies must be tested within the pilot facility prior to installation within the Field Trial

3.6. Phase I Costs

Cost for Phase I, totaled $399,136.

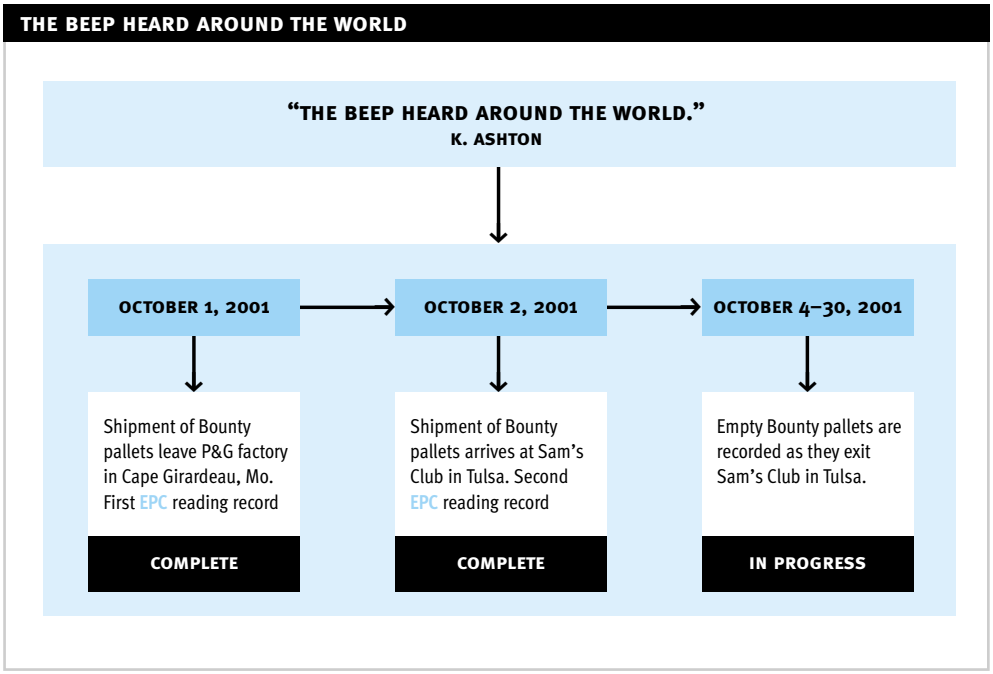
Money was spent for readers, tags, Savant, installation, software development and system maintenance.

$116,000 of the money spent for software development was a one time payment which will benefit Phases 2 and 3

4. PHASE I FIELD TRIAL SUMMARY

4.1. Timings

Figure 7: History made



On October 1, 2001 the first shipment of bounty Paper Towels consisting of 26 pallets left the Procter & Gamble factory in Cape Girardeau, Missouri in route to Sam's Club in Tulsa, Oklahoma. The next day the product arrived in Tulsa and readings were recorded at Sam's Club through the entry door.

Figure 8: D. Engels and S. Albano witnessing first EPC recorded reading October 1, 2001.

Figure 9: Proctor & Gamble factory, Cape Girardeau, MO, October 1, 2001. First shipment of EPC coded product leaving factory.

4.2. Results

As of October 1, 2001 all participating sponsors to the Field Trial were issued an

- **URL**
- **Username**
- **Password**

This information is confidential and is not published in this report.

With this information sponsors were able to access the raw data from the Field Trial via the Internet. Real life data on pallet movement in Phase I was displayed in the following format:

CAPTURED DATA TYPES IN PHASE I

LOCATION	READER NUMBER	EPC NUMBER	MANUFACTURER	PRODUCT	ICON	DATE/TIME
Cape Girardeau	FF03	####	Chep	Pallet		10/1/01 – 10:30

An example of the captured data display is shown in Figure 10.

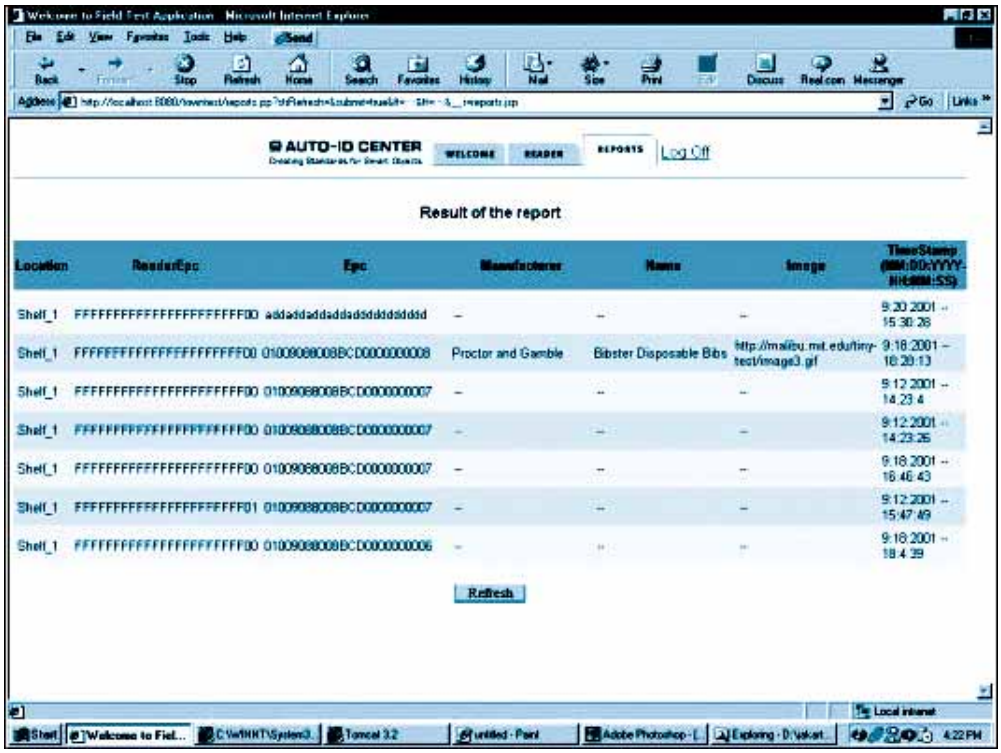


Figure 10: Screen display of generated data in Phase I.

The most voluminous data was obtained from the Proctor & Gamble Bounty paper towel shipments. A summary of captured data from Bounty paper towel shipments is shown in Figure 11.

This data shows that, when the system was working, 78% of all tags passing through an instrumented portal were read, allowing 97% of all pallets to be identified (reading at least one tag affixed to a pallet identifies that pallet).

The tag and pallet identification rates at the Cape Girardeau factory were slightly lower than this average with 65% of all tags and 96% of all pallets being identified. The low tag identification rate is due to pallets being loaded two wide by two high. Consequently, tags located in the interior of the load were read at a very low rate. Zero tag reads during shipments 2 and 3 were due to a power outage that damaged the Savant. Zero tag reads during shipments 12 and 14 were due to product being loaded through a non-instrumented dock door.

The tag and pallet identification rates at the Sam's Club were higher than average with 92% of all tags and 97% of all pallets being identified. The low identification rates during shipment 1 were due to non-optimally arranged reader antenna. The system was tuned to provide significantly better performance beginning with shipment 2. Zero tag reads during shipment 6 were due to the system being turned off by Sam's Club personel. Zero tag reads during shipments 9 through 16 were due to an incorrectly installed network preventing the Savant from communicating with the Savi SiteServer.

Figure 11:
* Do not include fully missed reads

	TOTALS	ADJUSTED TOTALS
Pallet Read Percentage	57.36%	96.75%
Total Actual Pallets	835	490
Total Read Pallets	475	475
Tag Read Percentage	44.48%	78.41%
Total Actual Tags	1646	977
Total Read Tags	724	724

SHIPMENT	LEAVING P&G, CAPE GIRARDEAU						ARRIVING AT SAM'S CLUB, TULSA					
	PALLETS			TAGS			PALLETS			TAGS		
	ACTUAL	READ	%	ACTUAL	READ	%	ACTUAL	READ	%	ACTUAL	READ	%
1	26	25	96.15%	52	32	61.54%	26	22	84.62%	52	34	65.38%
2	39	0	0.00%	59	0	0.00%	30	30	100.00%	59	59	100.00%
3	16	0	0.00%	32	0	0.00%	16	16	100.00%	32	31	96.88%
4	22	22	100.00%	44	32	72.73%	22	22	100.00%	44	40	90.91%
5	25	25	100.00%	50	32	64.00%	25	25	100.00%	50	47	94.00%
6	24	23	95.83%	48	33	68.75%	24	0	0.00%	48	0	0.00%
7	26	25	96.15%	52	34	65.38%	26	26	100.00%	52	51	98.08%
8	31	28	90.32%	62	31	50.00%	31	30	96.77%	62	60	96.77%
9	25	25	100.00%	50	30	60.00%	25	0	0.00%	50	0	0.00%
10	16	16	100.00%	32	21	65.63%	16	0	0.00%	32	0	0.00%
11	35	35	100.00%	70	41	58.57%	35	0	0.00%	70	0	0.00%
12	25	0	0.00%	50	0	0.00%	25	0	0.00%	50	0	0.00%
13	14	11	78.57%	28	22	78.57%	14	0	0.00%	28	0	0.00%
14	28	0	0.00%	56	0	0.00%	28	0	0.00%	56	0	0.00%
15	33	32	96.97%	66	44	66.67%	33	0	0.00%	66	0	0.00%
16	37	37	100.00%	72	50	69.44%	37	0	0.00%	72	0	0.00%
Totals	**422**	**304**	**72.13%**	**823**	**402**	**48.83%**	**413**	**171**	**42.59%**	**823**	**322**	**40.13%**
Adjusted Totals*	**314**	**304**	**96.17%**	**626**	**402**	**65.11%**	**176**	**171**	**97.34%**	**351**	**322**	**91.72%**
Highs	**39**	**37**	**100.00%**	**72**	**50**	**78.57%**	**37**	**30**	**100.00%**	**72**	**60**	**100.00%**
Lows	**14**	**0**	**0.00%**	**28**	**0**	**0.00%**	**14**	**0**	**0.00%**	**28**	**0**	**0.00%**

4.3. Problems and Resolutions

Most problems encountered in Phase I of the Field Trial were hardware related or human error induced. Below is a list of all difficulties and the resolutions implemented.

	PROBLEM	FIX
1	Power outage at one of the facilities caused system to shut down and no readings were recorded.	Installed UPS (uninterruptible power supply) at all locations
2	Frequency interference. At Sam's Club the Auto-ID system interfered with their hand held scanning system.	Software was modified to allow system to time share and not be reading simultaneously.
3	Loading dock process flow. At the P&G facility pallets of Bounty are loaded two wide and two high. Installation was set up to read one wide two high. Therefore system was not able to read far side pallet.	Readers and antennas were installed on both sides of the portal opening
4	DSL line router at one of the facilities did not work well.	Remove DSL line and install dial up line
5	Lost reader. One of the readers stopped working.	Replace reader
6	Lost inoperative tag	Replace tag. Not able to find out why tag was inoperative
7	Lost hard drive (failed)	Replace hard drive
8	Robustness of installation. In several places antennas have been damaged.	Antennas have been replaced. Need to implement more robust installation for the future in Phase II and III.
9	Capture of data was unreliable. DC associate was not able to determine if system was working correctly.	Monitors have been installed at all the facilities. Associate is now able to see if an EPC number has been recorded as anticipated during a transaction through a portal
10	Data as displayed on the internet not user friendly. Data was difficult to interpret and readers captured the same data many times it was redundant.	User-friendly data display had been developed. EPC is number is read many times by the reader but displayed only once on the monitor.
11	Human error. System has been turned off at times, and several times product has gone out the wrong door (no readers) or pallets without tags have been used	Pallets are being marked with large, bright, colorful tags to ease identification along the supply chain
12	Initial installation at Sam's Club proved to be unreliable	System improvements made by relocating and adding antennas at the portals

	PROBLEM	FIX
12	Tag location on pallet. Gillette applied tags to two corners of a wood pallet. Reliability of reads was unreliable	Problem was fixed by backing the tag with a plastic shield between the wood and the tag.
13	Phone line at Sam's DC was poor quality and contributed to data transfer difficulties	Replaced phone line
14	Sam's Club DC Savant and Site Server were not communicating adequately	Network was configured incorrectly. Savant system had 2 network cards. Network talking to Savi was corrected to wrong card. Took more than 3 months to figure out.
15	Dial up failure due to ISP misbehavior and MIT Webserver inadvertently shutdown	Webserver restarted and ISP erratic behavior subsided.

4.4. Learning and Accomplishments

- Starting October 1, 2001 EPC technology is in play in a Field Trial in a real world setting which has generated excitement and interest about EPC past the academic environment and laboratory demonstration.
- Most important ONS and the Savant work as expected. They are robust and scalable and require no design changes. Beta implementation proving to be very stable.
- 97% item identification has been realized.
- PML language has proven to be the most difficult problem to solve. There is a multitude of way of describing a single object. Must be user driven in its development.
- Automated network management a necessity even for small distributed systems.
- Valuable learning on installation, debug and maintenance costs, which can be used in planning future Phase installations and in the development of a Business Case, has been obtained.

5. CONCLUSIONS AND NEXT STEPS

Phase I objectives have been accomplished. Phase I of the Field Trial proves that the Auto-ID Center's developed technology (EPC, ONS, and Savant) work as designed. The system is robust and scalable. Phase I testing also shows that a portal only approach is not sufficient to guarantee 100% item identification with existing RFID technology. The test also proves that with multiple tags per item there is an improvement in the item identification rate.

The Field Trial will be expanded to Phase II, consisting of case identification and aggregation to pallets using existing technology. Phase II is due to start February 1, 2002.

APPENDIX A

Auto-ID Town Test Project Charter
Agreed February 23, 2001

Purpose

The purpose of the Auto-ID Town Test is to quickly demonstrate the power and potential of the EPC in the real world across the supply system including into the consumer's homes. We envision an "inclusionary" real world pilot to let all interested parties learn about the new infrastructure that is being developed (i.e. EPC code; tag definition; tag-reader interface; communication standards, networking technology and language).

The Town Test goals are to pilot the current MIT developments and to create awareness with consumers, retailers, manufacturers, and technology providers as to the power of the EPC. Creating this awareness is essential to drive cheap chips, agile readers, smart appliances, and exciting new software applications which can add value to the world's consumers and advantage to all adoptors.

The test will expand "organically" over time to include different types of objects, different applications, etc.

Desired Results

1. Prove the MIT developed infrastructure to support the EPC (ONS, pml, EPC) in a town of at least 10,000 residents beginning by 10/2001. We expect there will be at least 2 retailers, or retail formats (1), at least 2 distribution centers, and a representative American populations. Similar tests in Asia and/or Europe may follow at a later date. All stores and DCs should have standard (i.e. typical) IT infrastructure, such as checkouts, in store systems, etc.
2. Begin using the EPC for supply system applications to enable applications in areas such as manufacturing; inventory control; stock loss management; anti-theft protection; automatic replenishment; product authentication; reduced shelf out of stock; efficient checkout; and to interact with smart appliances (washers and microwaves) and provide other valuable consumer benefits.
3. Drive awareness of EPC's potential so that technology providers see the huge market potential (billions of chips) and therefore, they provide cheap chips, agile readers, network infrastructure and software applications to deliver the EPC potential market expansion within 3 years
4. Gain confidence that consumers will be comfortable seeing this technology proliferate especially by addressing and allaying concerns about privacy and safety.

Guidelines

1. Funding for the Town Test will be from sources other that the Auto-ID Center @ MIT. The Town Test project team will identify what funding is required and recommend appropriate ways of obtaining it.
2. We will "lean forward" in funding the Town Test to confirm the EPC infrastructure and begin demonstrating its potential. By "lean forward" we mean be prepared to pay higher than affordable prices for chips, readers, etc in anticipation that these prices would fall to acceptable levels at market expansion.
3. Funding for the Town Test may include the Federal Government, under a keep America competitive platform; from technology providers; from manufacturers; from retailers.
4. We must deliver the key infrastructure components to support EPC in and "inclusionary" manner, which still allows Board sponsors to find competitive advantage.
5. We will start the Town Test with the EPC at the case and pallet level; and within 3 months, follow with the EPC at the consumer unit level. As stated in the "purpose" above, the test will expand organically. Detailed plans for phasing in new products and technologies are the responsibility of the Project Team.

6. We expect the team to live for 2-3 years, or for as long as new applications are developed, demonstrated and analyzed, for their cost/benefit potential. It may be possible to implement some technologies at scale before the test is complete
7. Final decisions about the Test will be made by a consensus among the Auto-ID Center's Board of Overseers. If no consensus is reached, the Executive Director will request a two-thirds majority of votes.

Target success criteria & measures

1. Kick off the Town Test project implementation team will be 3/12/2001
2. The Town Test Project Team provides a timeline of key activities and shares it broadly by 6/01
3. Phase I (case/pallets) of the Town Test will be operational by 10/1/2001
4. Phase II (consumer units) of the town Test will start on 1/1/2002
5. EPC and its related infrastructure components are available for supplier/manufacturer/retailer planning and implementation by 7/01
6. Financial resources to quantify the cost/benefits of the EPC Town Test are in place and monitoring the TBD measures.
7. There will be regular public communications about progress.

Accountability

The Town Test Project leader will report to Kevin Ashton. The Project Team will report to the Auto-ID Center Board of Overseers and provide monthly written project updates.

Team members

Town Test Project Leader: Silvio Albano (on loan from the Gillette Company) plus one member from each sponsor organization.

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