GS1 EPCglobal US

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August 13, 2009

Angie Leith
U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery (5306P)
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Dear Angie:

Pleased find attached the final report of Project PURE filed to fulfill the requirements of the EPA grant awarded to GS1 EPCglobal US.

The report was written by Elliot E. Maxwell of eMaxwell & Associates and Lygeia Ricciardi of Clear Voice Consulting based upon the work of the Project PURE participants listed in Appendix A of the report. The group included representatives of companies involved in the supply chain for computers ranging from manufacturers and retailers to reusers, recyclers and waste disposers. It also included academic experts and environmental authorities from both the state and federal level.

The group found that there were substantial potential benefits from the use of RFID in the end of life processes, but that there still exists obstacles, including possible requirements for RFID tag deactivation at the point of sale in the interest of privacy protection. The most important short term benefits could be achieved by incorporating a marker on tags applied to computers for supply chain purposes, indicating that the item to which the tag is attached requires special handling; special handling requirements might be imposed for a number of reasons including the presence of hazardous materials or the need for special security requirements.

Under separate cover we will be filing our financial report on funds received and expended. We may also file a supplementary appendix based on the work being conducted by the GS1 End Of Life Industry Action Group. This group consists of experts from around the world who are examining possible end of life requirements for standards on RFID tags to be used in the supply chain.

We appreciate the confidence you placed in GS1EPCglobal US by awarding us this grant. We look forward to working with you in the future on the important task of reducing e-waste.

Sincerely,

Elizabeth Board

Elizabeth Board
Executive Director, Public Policy
GS1 EPCglobal

Project PURE Final Report
June 2009

Background

Project PURE (Promoting Understanding of RFID and the Environment) was launched in January 2007. Project PURE is an initiative supported by the Environmental Protection Agency (EPA) to study how the infrastructure of RFID tags and readers being developed and deployed to improve supply chain management might be used to support post-sale "end of life" (EOL) recovery activities. According to EPA estimates, only 18% of consumer electronics are recycled. Because of the importance of e-waste, the project has focused on computers and how RFID could improve the efficiency of reuse, recycling, and materials aggregation, as well as minimize the amount of materials that are used.

Project PURE was funded through the Office of Solid Waste and Emergency Response's "innovation" grant program, designed to encourage creative ways of addressing environmental challenges. The grant was awarded to EPCglobal, a neutral, not-for-profit standards organization responsible for standardizing Electronic Product Code (EPC) and RFID technology so it can be used in the global supply chain. The project includes representatives from major stages in the lifecycle of computing devices including manufacturing (Hewlett Packard), distribution and sale (Wal-Mart), reuse/refurbishment (PCRR Rebuilders and Recyclers) and recycling/materials aggregation/disposal (We Recycle! and SIMS) as well as a leading RFID chip manufacturer (UPM Raflatac). An environmental scientist from Georgia Tech and representatives from the EPA and the Minnesota Pollution Control Agency (Minnesota State's environmental agency), participated as observers. Elliot Maxwell of eMaxwell and Associates and Lygeia Ricciardi of Clear Voice Consulting, served as consultants/facilitators for the project. (For a full list of participants by name and organization, see Appendix A.)

Over the course of the project, participants met by phone and in person to better understand the requirements and processes used by various parts of the supply chain. This included both post sale activities involving reuse, recycling, refurbishing, materials aggregation, and disposal, and the identification of the most salient challenges associated with using RFID to support product end of life (EOL) recovery activities. Participants also interacted with outside experts who are working on related issues at industry conferences such as eScrap and other industry functions. As EPCglobal is part of the international organization that oversees the global barcode organization, representatives of Project PURE were able to have access to related commercial and academic work in Japan, Korea, and elsewhere, and to engage directly with experts from around the world. This report summarizes Project PURE's findings and accomplishments, and identifies potential future activities.

How RFID works in the Computer Supply Chain

The RFID tags used in the computer supply chain under examination by Project PURE are each encoded with a unique serialized number (EPC). The tag is used to identify the item, product or asset to which it is attached as it moves through the supply chain. When a tag receives a signal from an RFID "reader," the tag is powered up and emits a unique identifier—and any other data embedded in the tag—which is then captured by the reader. The reader, which is connected to a network, then passes data via the network to the operator's business management software application, such as an inventory application or a retail store operational system.

By tracking the tags, RFID system operators can follow tagged products as they move through the supply chain on a continuous, real-time basis. Tags can be attached to logistical items such as pallets and cartons, to product packaging, or to an individual item itself. Tags are now being attached to cases, each of which contains a single computer. In the future they may be applied directly to individual computers or to subcomponents. Tags might also be embedded in a subcomponent as part of a process integral to the functioning of the computer.

Benefits Identified

To determine whether the RFID infrastructure being put into place in the computer supply chain by manufacturers and retailers might be used by end of life organizations to reduce e-waste, Project PURE participants examined the potential benefits of doing so for manufacturers, retailers, and end of life recovery participants.

Benefits to manufacturers and retailers of extending RFID use through EOL include:

- Increased efficiency of refurbishing and recycling management and compliance, leading to lower costs for manufacturers that are increasingly being asked to take responsibility for their products throughout the product's life-cycle;
- Improved information about EOL processes, allowing more realistic recycling targets to be set;
- Increased availability of product life-cycle information and item history;
- Facilitation of recycling incentives, rebates, coupons, and trade-ins;
- More efficient product returns and restocking, (which also benefits consumers);
- Improved warranty handling, including detection of warranty fraud, (which also benefits consumers); and
- Better after-sale servicing including improved understanding of when and how the item was serviced, and what functions were performed (which also benefits consumers).

The extent to which these benefits are realized depends in part on the amount of information available (whether on an RFID tag directly or via a database). Costs will also vary depending on the requirements necessary to make the information available. More

complex benefits are not likely to emerge in the short term, but they may emerge in the longer term depending on costs and the evolution and pervasiveness of item-level tagging.

These benefits build on the benefits to manufactures and retailers that have led them to adopt RFID to improve supply chain management for items up to the point of sale. These include better inventory management, reduced ordering of out of stock items, decreased product re-ordering and unnecessary transport of goods, improved "special handling" of products, including those that may contain hazardous materials or require enhanced data security, and stronger protections against counterfeiting.

Benefits to EOL participants of having access to data on RFID tags include:

- Improved inventory control for goods that enter their facilities;
- More efficient product sorting/management and handling;
- Increased access to information about product materials, such as whether the item contains recycled materials;
- Assistance in determining the presence of valuable materials in the item;
- Assistance in tracking weight;
- Improved loss prevention as a product moves through the EOL processes;
- Improved detection of illegal diversion or disposal;
- Improved audit capabilities, including where and when disposed;
- Facilitation of electronic markets and fulfillment for parts and materials;
- Easier and less costly regulatory reporting/reporting for clients;
- Minimized risks and improved efficiencies associated with products that require "special handling," such as hazardous materials, items requiring enhanced data security, or precious metals, as well as recommended treatments for them; and
- Improved management of materials transport

It is important to note that different types of EOL participants have different processes and requirements and thus use data in different ways. For example, while most are concerned with the identification of materials that may present hazards to their employees or the environment, refurbishers and resusers also seek information that will help them to reconstruct equipment effectively, while recyclers and materials aggregators are more interested in assessing the monetary value of materials on their own.

While EOL participants identified types of information that might be useful to them if it were to be included on RFID tags or accessible in databases that could be reached using the tags, the group agreed that a high proportion of the potential benefits could be realized by extending access to information that manufacturers were already planning to include on the tags for their own use. Such information includes basic data about product make and model number, from which other useful information could be derived without having access to the manufacturers' or retailers' databases.

For example, knowing the make and model number of a computer, an EOL participant could find out whether a laptop contains potentially hazardous materials as well as their

location, speeding up the sorting process that is now often done by hand. Similarly using make and model number, an EOL participant could assess the value of a computer's component parts. That information could be made available by manufacturers to their supply chain partners, including EOL recovery operations. Other (non-partner) EOL participants could have access to outside databases built to correlate with make and model number, although this would be somewhat less efficient than having direct access to the databases being used by manufacturers, retailers and their partners. Using just the data that is already available (or will soon be available) on the tags, rather than adding new data requirements for the tags or affixing new tags to items when they enter into the EOL processes, would streamline the overall process and minimize costs.

Challenges Identified

Project PURE participants identified a number of challenges that need to be addressed to enable EOL participants to benefit from use of RFID tags. (EOL participants could obviously begin to tag items as they enter their facilities, but being able to use tags already placed on the items for pre-sale supply chain purposes would be much more efficient.) The primary challenges identified include:

- Privacy concerns – There have been proposals to require that tags be deactivated (rendered incapable of responding to readers) at the point of sale in order to protect the privacy of consumers. Deactivation requirements, particularly those that would require consumers to affirmatively request that tags be left active after sale, would eliminate the use and value of tag information to EOL participants contemplated by Project PURE (as well as use of the tags by manufacturers and retailers for other societally-valuable post sale purposes).

- Access to data by EOL users – In order to obtain the maximum possible benefit for EOL participants from the use RFID tags, a number of questions regarding access to data must be resolved such as: Who should be allowed to access data stored on RFID tags or in product databases? What authentication methods, if any, should be used? Should EOL participants without contractual relations with manufacturers or retailers be able to have access and, if so, how should their access be controlled? Manufacturers and retailers might prefer to make tag information available to their existing partners to make them more efficient rather than extending access to information to EOL participants generally. What would the effects of broad availability of information on ties between manufacturers/retailers and their EOL partners be? These questions which implicate relations among the various stakeholders will need to be addressed by relevant stakeholder organizations.

- Data security – At present EPCglobal members establish agreements among themselves about the use of tags as they move through the supply chain and access to data generated by reading the tags. These agreements often have provisions that deal with data security. Allowing access to tag information by

parties that have not entered into such agreements raises data security questions for those parties that maintain the databases that contain information about the item.

- Complexity/fragmentation of the supply chain – Supply chains are long and complex, and often include parties unknown the manufacturer. This makes managing a system of information sharing relatively complex to manage.

- Accuracy of information – Who verifies that information generated by reading a tag is accurate? For example, what if the consumer makes changes to a product or the product is damaged after sale?

- Varying regulatory requirements – Legislation and regulation regarding EOL treatment vary by jurisdiction and present challenges for manufacturers as well as for EOL participants. There are also different regulatory structures and processes for different types of use (e.g. residential vs. business).

- Pace of RFID take up – The use of RFID tags for computers is still relatively new. Estimates are that it will between 5 and10 years before item level tagging, even of high value items, becomes main stream. Unless most items are tagged, there is little incentive for EOL participants to build systems or processes relying upon the presence of tags. The uptake of tagging of pallets and cases is occurring more rapidly than that of item level or subcomponent tagging.

- Lag time for tagged devices to reach EOL firms – It may take as long as 10 years for RFID tags affixed by manufacturers to reach EOL participants, limiting incentives for them to build systems or processes today or in the near future that rely upon the presence of tags.

- Costs and asymmetries of costs and benefits – If additional information fields are added to RFID tags, or if databases need to be expanded to provide additional information about products to EOL participants, who should develop, maintain, and pay for any additional costs?

- Impact of increased refurbishment on sales – Greater levels of reuse may cut into sales of new products and reduce the incentives for computer manufacturers and retailers to participate.

- Competitive positioning – Might actions taken by particular manufacturers or retailers to increase the efficiency of EOL participants place them at a disadvantage relative to their competitors, or will being eco-friendly in this manner be a competitive advantage due to cost reduction or enhanced customer perception?

Primary Accomplishments

Increased Global Coordination and Institutionalization of this Effort
EPCglobal, one of the Project PURE sponsors, is a subsidiary of the international organization that oversees the global barcode organization, GS1. GS1 is the global supply chain standards organization that developed the ubiquitous UPC and EAN bar codes, and is the steward of the modern-day global bar code system, with organizations in 108 countries. Its standards are used by over 20 major industries to conduct efficient global commerce in over 140 nations.

Catalyzed by the efforts of Project PURE, GS1 established an EOL Interest Group in 2008 that is bringing together GS1 members from around the world to examine the potential uses of EPC/RFID tags in the end of life processes for consumer electronics. This group has the responsibility for developing use cases for RFID in end of life processes, and for developing requirements that would be passed on to the appropriate GS1 body for consideration and potentially for inclusion as part of the GS1 RFID standards. Use cases under current discussion include analyses of the use of RFID in collection centers, recycling centers, and disposal centers. As the world's leading standards coordinating body for bar codes and similar technologies, GS1 is an ideal institutional home for such efforts. The End of Life Interest Group will be examining a number of the challenges cited above.

This development is particularly important, given the global nature of the consumer electronics industry. Workable solutions must reflect the global practices of the industry while preserving some degree of flexibility for local needs. This forum will also help avoid duplication of efforts and help participants learn from developments from around the world.

Members of GS-1 active in the EOL interest group include participants from Japan, Korea, the US, and the EU. The Japanese government is taking active steps to mandate increased recycling and reuse of electronic goods; RFID is being considered as a facilitating technology to accomplish the government's aims. Korean researchers are studying the utility of RFID tags and readers affixed to products when they enter reuse/recycling facilities. Early results are positive, but much more work is needed to determine the costs and benefits of such a course of action.

In addition to seeding and participating in the launch of the GS1 EOL Interest Group, Project PURE has created links among other parallel and related efforts, including another project, called EPEAT, funded by the EPA. The EPEAT project seeks to identify design changes that would improve the sustainability of electronic products. In their surveys, EPEAT has found particularly strong interest in incorporating, as part of the design of electronic products, some means for alerting those who encounter the product that it requires special handling, e.g. contains hazardous materials that must be disposed in a certain way. RFID tags could provide an ideal mechanism to signal the need for special handling of items.

Broadly Publicizing the Case for Including RFID in EOL Processes
In February 2009, a Project PURE participant, Valerie Thomas, a Professor at Georgia Tech, testified on e-waste at a hearing conducted by the U.S. House of Representatives Committee on Science and Technology. She included some of the findings identified in this report as part of her testimony, which may influence funding for academic research centers and teaching on e-waste at universities. Willie Cade, also a participant, also testified at the hearing. Their testimony can be found on the Committee website at http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2348.

Several other participants and observers of Project PURE have also written or spoken about the initiative's work at industry conferences and meetings, including eScrap.

Areas for Future Work

There are numerous opportunities for the GS1 EOL Interest Group and others to further the progress made by Project PURE. Priorities include efforts to define requirements for a "special handling" bit to be added to RFID tags for consumer electronics, and establishing a mechanism whereby EOL participants without contractual relationships to consumer electronics manufacturers or retailers might obtain access to the information about products that would help them increase their efficiency. This will require a model for information handling, and mechanisms for funding and controlling access. The EOL Interest Group will also continue to address the challenges cited above.

In addition, additional work is needed to strengthen the ties between existing Korean and Japanese efforts and those in the US, as well as finding an appropriate partner in Europe.

The concept of using the RFID information infrastructure to improve EOL is not limited to computers and consumer electronics. A broader application of this concept in other areas may speed adoption and achieve greater efficiencies. Related activities include use of RFID for track and trace requirements in pharmaceuticals and use of RFID in food safety monitoring and tracking.

Also, Project PURE's findings and the work of the GS1 group should be shared with policymakers as they consider policies that would restrict or encourage the use of RFID tags post sale, and the development of innovative post sale applications built upon access to RFID tags.

Finally some attention should be given as to whether there are incentives available that might speed deployment of RFID technology and reduce the time period before RFID tags are sufficiently pervasive so as to make them more economically and technically attractive for EOL participants to use to increase their efficiency and effectiveness. As

the use of RFID tags grows, attention will also need to be paid to their disposal in an environmentally friendly way.

Appendix A -- Project PURE Participants

Primary Participants:

- EPCglobal (Elizabeth Board, Allison Fleming, Daniel Romm)
- Georgia Tech (Valerie Thomas)
- Green Electronics Council (Wayne Rifer)
- GS-1 (Audrey Kremer)
- HP (Greg Edds, Renee St Denis)
- PCRR Rebuilders and Recyclers (Willie Cade)
- Sims Recycling (Steve Skurnac)
- UPM Raflatac (Randy Stigall)
- Wal-Mart (Ron Moser)
- We Recycle! Inc. (Gina Chiarella, Dave Smith)

Observers:

- EPA (Angie Leith, Clare Lindsay, Karen Pollard)
- Minnesota Pollution Control Agency (Garth Hickle)

Staff:

- E-Maxwell and Associates (Elliot Maxwell)
- Clear Voice Consulting (Lygeia Ricciardi)