Forecasting the Unit Cost of RFID Tags

by Richard Moscatiello, March 27, 2003, updated July 9, 2003

A major stumbling stone in the path of RFID market growth has been the question of RFID tag per-unit cost. Potential end-users balk at the uncertainty of current and near future pricing, and there is a lingering perception that per-unit tag costs will not be going down anytime soon. However, that perception is yesterday's news. In fact, over the last three years tag prices have fallen dramatically.

The steep drop in tag fabrication costs suggests a trend toward future reductions. The following cost forecast arose from a customer request to assess the cost of tags five years and ten years in the future. The customer needed the forecast to make a case to his upper management that the RFID program in his company was an endeavor that would provide a return on investment, rather than being a costly boondoggle. That is a case that every RFID Integration vendor must make. But how?

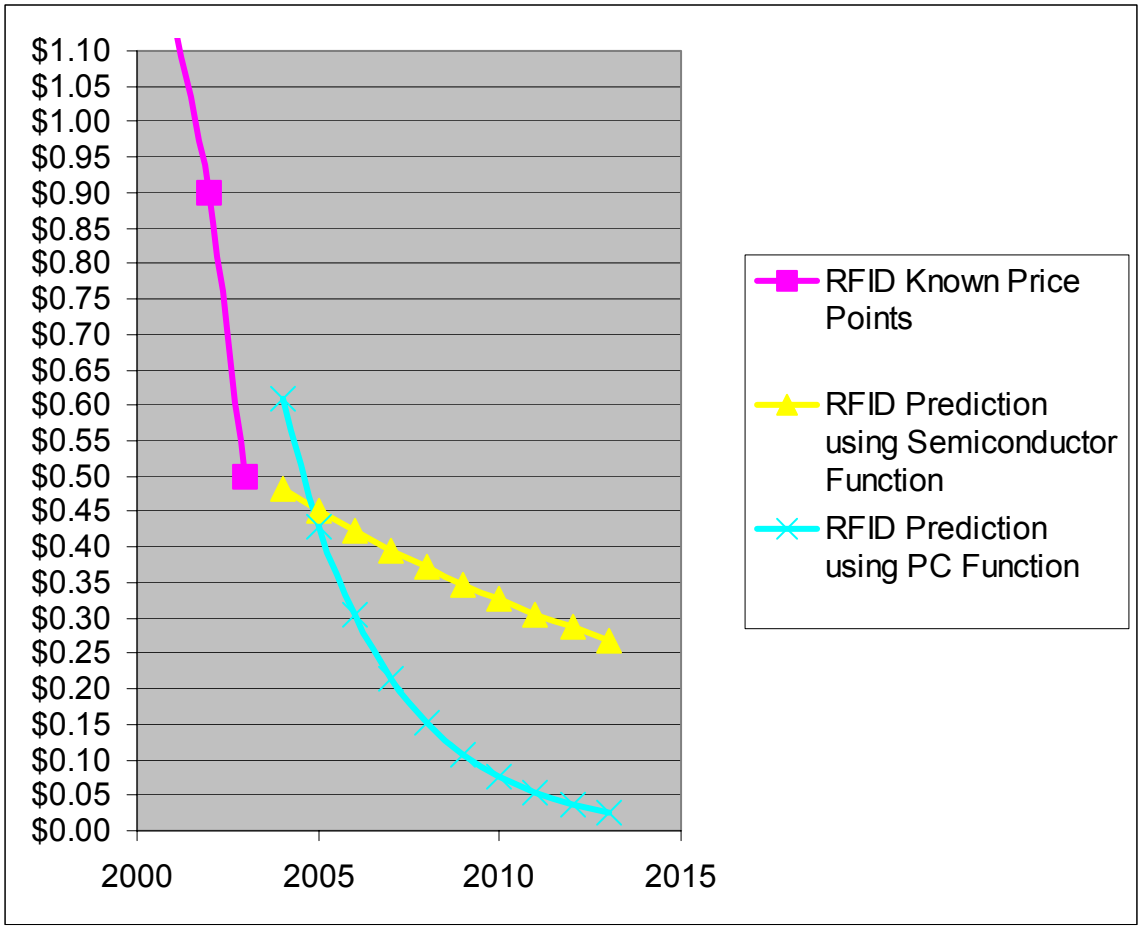
To begin with, establishing an historical Producer Price Index (PPI) for RFID tags is very difficult because tag prices have been, as they say, "all over the map" depending on the type of tag, manufacturer, distributor, economies of scale, and erratic demand. Presently, even unreliable data sets are scarce. Fortunately I'd had some experience over the last few years outsourcing tag fabrication, so I had some apples-to-apples numbers. The baseline item for the forecast is a 915 MHz Read/Write RFID tag that is similar to Auto-ID's Class 2 format, that uses pick-and-place process to position the RFID chip which is soldered to a simple half-wave dipole antenna laminated to a kapton substrate. Outsourced fabrication for that item in 2001 was $1.15 per unit in quantities over 100,000. In 2002 the same tag dropped to $.90 per unit. This year, furthermore, product costs for that type of tag have dropped to the point where it can be offered to a customer by the integrator for under 50 cents per unit, with the largest cost driver being the IC chip. Based on a tag fabrication run of 500,000, the customer's cost per tag would be as follows:

Substrate with antenna	.05
RFID Chip (915Mhz)	.26
converter costs	.06
Overhead and margin	.10
Total Unit Cost	0.47

Incidentally, a recent study by Bear Stearns confirms that price point. The authors say, "[w]e estimate that current production volumes yield a price point of about $0.45, including raw materials and associated manufacturing costs."[1]

Starting with those three price points and reasoning that the PPI for the RFID market would parallel historical pricing patterns in the semiconductor and personal computer industries, then the latter could serve as a model for an RFID tag price forecast. Our data set was the Producer Price Index (PPI) for PCs and semiconductors for the period 1978 to 1998 available from the US Department of Labor. We indexed the PPI using 1978 as a reference year (i.e. 1978 PPI = 100). We then used spreadsheet software to fit a function to the data, and then superimposed the function onto the three known price points in the RFID. This provided some basis for comparison as to what a similar tag would cost in the future. What the forecast suggested was that in 2005 the cost per tag would fall between 43 cents and 45 cents, and in 2010 the cost would be between 8 cents and 33 cents.

Year	Index	RFID Known Price Points	RFID Prediction using Semiconductor Function	RFID Prediction using PC Function
2001	-2	$1.15		
2002	-1	$0.90		
2003	0	$0.50		
2004	1		$0.48	$0.61
2005	2		$0.45	$0.43
2006	3		$0.42	$0.30
2007	4		$0.40	$0.21
2008	5		$0.37	$0.15
2009	6		$0.35	$0.11
2010	7		$0.33	$0.08
2011	8		$0.31	$0.05
2012	9		$0.29	$0.04



By way of comparison, a recent forecast by IDTECHEX suggests a per-unit cost of 16 cents in 2005 and a 2010 cost of 7 cents for chip-based RFID tags,[2] a much more optimistic estimate.

Year	Total Annual RFID Revenues	Ratio of Hardware to Services	Ratio of Chip Based to Chipless	Total Annual RFID Tag Shipments	Total Revenue From Chip Based RFID
2005	**$4 Billion**	**60% hardware; 40% services**	**80% chip-based; 20% chipless**	**12 billion tags**	**$3.2 Billion**
2010	**$10 Billion**	**50% hardware; 50% services**	**70% chip-based; 30% chipless ***	**50 billion tags**	**$7 Billion**

**** Assumes introduction of plastic film and silicon film transistor circuits to replace portion of chip-based business***

Table by Raghu Das, ©2002 IDTECHEX

The author acknowledges that the forecast methodology used leaves out much in the way of detailed analysis, but there are no historical data sets for the emerging RFID industry. Indeed author Clayton Christensen, discussing the growth characteristics of disruptive technologies (RFID is one), points out that it's near impossible to analyze nascent markets. He explains how the associated risk uncertainty tends to thwart investment in new technologies :

> "Companies whose investment processes demand quantification of market sizes and financial returns before they enter a market get paralyzed or make serious mistakes when faced with disruptive technologies. They demand market data when none exists and make judgments based upon financial projections when neither revenues or costs can, in fact, be known." [3]

The paradox is that increased demand for RFID will lower price points, but that very demand is impacted by the uncertainty vis-à-vis costs, which manifests itself as a risk outlook that holds back investment in the RFID sector. However, what the cost forecasting exercise does reveal is that although there is a swath of uncertainty, which the end-users consider as risk, RFID tag costs are resolving into a predictable range of cost expectations that lowers end-user risk, bringing the decision to invest in RFID systems closer.

When developing a business case for an RFID system it is important to consider the tag-to-system ratio as a function of future system costs and ROI. The rule of thumb is that the greater the number of items to be tagged the lower the per-unit cost that the infrastructure contributes to each tagged item (i.e. basic economies of scale). For example, I recently installed a system for the Port Authority of NY/NJ for managing high-end tool use. This was a small project that was under $10K. The tags were less than 10% of the total costs, but there were only 250 tags for that site.

To give a second example, I designed a system plan to tag the Army Reserve's approximately 250,000 weapons distributed in 1100 nationwide armories. In that system the Reserve's investment in RFID tags represented less than 5% of the total system price in the first three years of deployment.

The third example benchmarks a much larger project. While at Marconi InfoChain I managed a project to tag and track cargo pallets for CHEP. That project was to be implemented in two phases. In the first phase, 1 million tags represented approx 50% of total price, and in the second phase 6 million tags represented approx. 70% of program price, even though the unit tag cost decreased by 7%. Furthermore after the first two phases, hardware and integration costs fall off dramatically and the primary expense is the tags. For very large systems the tag costs approach or exceed 90% of system costs. A very rough fitted line plot for the above ratios suggests the following percentages for increasing orders of magnitude.

Number of Tags	Approximate Ratio of Tag Cost to Total System Cost
1,000	**19%**
10,000	**25%**
100,000	**32%**
1 million	**46%**
10 million	**85%**
100 million	**92%**
1 billion	**97%**

In the quest for increased demand, RFID vendors and system integrators must keep in mind that although the end-user often focuses on the price of an individual tag, the upfront infrastructure and ongoing service costs incurred to implement an RFID system are just as important. Suppliers and integrators are tempted to gloss over those costs to make systems seem more affordable. At least in the first few years of operation, upfront costs will represent an incremental increase of the cost to tag each item. **The proper approach for vendors and integrators is to include all relevant costs in the RFID system proposal and contrast those costs against a quantifiable dollar benefit to the end-user in the form of a business case.** For example, in the case of PANYNJ cited above, what is important is not the fact that per-unit cost for the system was "$10K divided by 250 units = $40 per unit." What is important is that, since tool checkout and check-in is now automated, there is no requirement to hire a union man just to barcode-scan tools, and the system frees up the supervisor's time. So, that little system is much more valuable than its $10K cost due to 1) savings of approx. $40K in annual salary, 2) savings in higher productivity of the supervisor, 3) more productive tool users, 4) reduced losses (easy to establish last user of the tool and prevention of theft), and 5) visibility of which tools are in highest demand for procurement planning.

Yet recent experience with the pace of the information revolution should make it no surprise if reductions in cost coupled with increases in capability (Moore's Law) reveal current forecasts to be overly shy. According to a recent industry study "silicon chips currently represent 60-80% of the total RFID tag cost [and] reducing chip cost is the primary area of focus" in the industry.[4] Already, a California firm has created a revolutionary breakthrough in RFID chip yield and continuous flow tag manufacture that reduces the chip cost factor from 60-80% down to 10-20%, while at the same time making it possible to produce tags at a rate several orders of magnitude faster than possible with previous manufacturing technologies. In sufficient quantities, tags produced using these new processes can be offered for 5 cents per unit. Associated hardware, such as interrogators and antennae, are also seeing significant reductions in cost. Yet, industry analysts frequently refer to the AUTO-ID Center's benchmark of a $0.05 RFID tag as an Arthurian holy grail. The emerging truth is that the 5 cent tag is no myth. Instead, it is a contemporary reality.

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[1] Edward M. Wolfe, Philip Alling, Harry D. Schwefel, and Scott D. Brown, *Track(ing) to the Future: The Impending RFID-Based Inventory Revolution,* (Bear Stearns Equity Research, June 2003)

[2] Das, Raghu, *Emerging Chip-Based RFID Technologies, Excerpts from Presentation at 2002 Source Tagging Council Meeting*, ©IDTechEx, www.idtechex.com

[3] Christensen, Clayton M. , *The Innovator's Dilemma* (Boston, Harvard Business School Press, 1997) page xxi

[4] Das, Raghu, *Emerging Chip-Based RFID Technologies, Excerpts from Presentation at 2002 Source Tagging Council Meeting*, ©IDTechEx, www.idtechex.com

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Bio:

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