Gen 2—The Tough Questions, Part 1

One of the architects of EPCglobal's Generation 2 standard addresses end users' concerns regarding Gen 2-based tags and readers.

Aug. 15—The cofounder and chairman of Impinj, a fabless semiconductor company that makes RFID chips, inlays and readers, Chris Diorio was one of the chief architects of the EPCglobal Gen 2 specification. As cochair of the Hardware Action Group that developed the spec, and project coeditor of the corresponding ISO spec, 18000-6 Type C, Diorio is uniquely positioned to answer some of the questions end users may have as they consider deploying the new technology.

What part, if any, of existing Gen 1 systems will users be able to retain when they transition to Gen 2?

Users will be able to use existing RFID readers, or interrogators, that have been upgraded with Gen 2 firmware, but they probably will not be able to use the dense-reader capability; in most (if not all) cases, support for dense-reader mode will require hardware changes. Many interrogator vendors, though, are planning hardware upgrades to support dense-reader mode, so there will be a migration path.

Users will also retain a good deal of their knowledge base—what works, what doesn't work, how to apply tags, how to read tags, how to use the middleware that filters tag data, and so on. But it's important to note that Gen 2 has considerably more functionality than Gen 1, which is fairly simple in comparison. The mindset behind Gen 1 was for it to be a replacement for bar codes. In Gen 1 systems, you can read a tag just like you would a bar code. In Gen 2, though, you also have bidirectional communication; not only can you read a tag, but you can also turn around and lock it, kill it or write new data to it. And that increased level of tag-reader communication will require a big change in the interrogator and network software model.

How will Gen 1 and Gen 2 systems coexist during what might be a lengthy and potentially bumpy transition period?

First of all, I don't necessarily see it as a very lengthy transition period. The fact is, in many respects, Gen 1 systems were used as pilots for end users to obtain practical experience with RFID; most users were waiting on the availability of Gen 2 for their full-scale deployments. Now that Gen 2 products are available, the transition will be rapid. One exception might be airports, several of which are using Class 0 and Class 0+ systems in their bag-tagging operations and may continue to do so, even as Gen 2 matures. In a closed environment such as an airport, those protocols are apparently adequate. But for the most part, the market is moving rapidly to Gen 2; tags and readers are available now, with new vendors coming online quickly. Most interrogators can now read Class 1, Class 0, *and* Gen 2. Some of them can read Class 1, Class 2, Gen 2, ISO 18000-6 A and ISO 18000-6 B—you've got readers now that can read everything. There will be a short-term performance penalty associated with multiprotocol readers, though, because if there are Class 0, Class 1 and Gen 2 tags in the same tag population, readers will have to cycle through the different protocols in order to read them all; they can't just talk to all tags at once. But that will go away once everybody adopts on Gen 2 exclusively, which might even happen as early as first quarter 2006.

In terms of cost, will Gen 2 tags ever be able to compete with Gen 1 offerings?

Undoubtedly. Gen 2 volumes will greatly exceed those of Gen 1 in the very near future, and as we all know, in this industry, volume drives costs down. With multiple vendors entering the market—and more of them coming online—competitive pressures will also drive costs down. So both large volumes and competitive pressures will eventually conspire to make Gen 2 products very cost-competitive. In fact, it's anticipated that Gen 2 will be the most cost-competitive segment of the RFID industry. It was designed to be so.

Will writing Gen 2 tags be any easier, faster or more reliable than writing Gen 1 tags?

Theoretically, Gen 2 shouldn't necessarily be any faster, because the speed at which you can write is a function primarily of memory technology, not the protocol. In practice, however, the vendors delivering Gen 2 tags have memory technology that is faster and more capable than that deployed in Gen 1 tags, so users will see a big difference in Gen 2 products relative to Gen 1.

I should add that there's nothing in Gen 2 that puts a hard specification on write speed (with the exception of a 20 ms tag write-response window), so vendors should purchase tags that provide the write speed they need. That said, the Gen 2 protocol does require some mechanisms to ensure reliable memory writing. For example, when a reader writes a tag, the tag must reply with a confirmation that it's done; it backscatters a "done" signal that, in effect, says, "I have written the memory, and I have done it successfully." That was not used, generally, in Gen 1 systems. In the case of our Monza tags, we go a step further and have the memory check itself as it's being written, which makes writing even more reliable; they don't say "done" until they really are done.

I'll also add that writing in Gen 2 versus Gen 1 is more secure. Gen 2 has a way to mask writes, via cover coding, which offers significantly improved protection from potential snoopers—a feature that was not available in Gen 1 systems.

It seems inevitable that tag makers will field lower-cost, reduced-functionality tags for targeted applications that might require some level of Gen 2 compatibility, but not necessarily total compliance. How will this muddy the waters in the proliferation of Gen 2?

First and foremost, EPCglobal will be certifying that Gen 2 tags implement all parts of the Gen 2 spec. As we've just discussed, readers have to implement all Gen 2 commands, but they don't have to implement all Gen 2 modes (dense-reader and maximum throughput modes). Unlike an interrogator, a tag must implement all parts of the Gen 2 spec, and that includes dense-reader mode, backscatter at the highest data rates—everything. With the exception of several commands that allow some extended functionality but are not required to implement the protocol, the tag has no option—it must do it all—and EPCglobal will be testing tags to ensure that they do, indeed, "do it all."

To get EPCglobal certification, tags will have to demonstrate that they meet the entire Gen 2 spec. As such, it's not possible to come out with a "reduced functionality" Gen 2 tag and receive EPCglobal certification. End users, therefore, should be looking for EPCglobal certification as a stamp of approval; they shouldn't accept anything less. And the certification plan is very rigorous; it will weed out those tags that are not truly Gen 2-compliant. That said, different tags will exhibit different performance characteristics. Just like the interrogators, some tags will have better noise immunity, some will have better interference rejection and some will have faster write rates or greater range. Some will have less frequency sensitivity and will operate well in both North America and Europe. Some tags will have high frequency sensitivity and be able to operate only over a narrow frequency range. Some will implement *access* and *kill* passwords; others will not. Depending on the environment, many of these things may prove to be both price and performance differentiators. Again, though, meeting all mandatory aspects of the Gen 2 spec is required.

The bottom line is that users will have to be careful when choosing tags that meet their particular set of requirements. They may have to do some benchmarking and run some comparison pilots. If they do, they'll see that two tags from two different vendors will exhibit very different read and write ranges, because they will have different levels of power consumption. It's also likely they'll have other performance differences. For example, one may have been designed with too low a clock frequency, which will degrade the tag's ability to differentiate between data 1s and data 0s, in which case the tag may drop commands in noisy environments. A better-designed tag may use a higher clock frequency and work better in the same environments.

The orientation sensitivity of the tag should also be taken into account. If you were to point a tag directly at the antenna, it would work fine. But if the tag's azimuth angle to the reader were to rotate 90 degrees, or if there were a change in elevation relative to the reader, you'd want to know how those conditions would impact performance. A world where the tag was always pointed at the antenna would be a nice one, but we all know that's not always the case.

So it comes down to two primary issues: EPCglobal certification and performance. All end users should buy certified tags. But beyond that, the more educated our customers are, the better off we'll be as an industry. We understand that users will demand RFID solutions that work, and the solution providers are going to have to deliver. But if end users base decisions on price alone, then getting to that working system may be greatly jeopardized. Of course, working systems have to meet cost targets, but working right is fundamental. Meeting cost targets and not working is not an option.

In Part 2 of this article, the author will address six additional questions.

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