

UHF GEN 2 RFID

# LLRP—Reader Control Simplified



## Industry Mobilizes behind Standards to Facilitate RFID Adoption

**In April 2007, EPCglobal announced ratification** of the Low-Level Reader Protocol (LLRP) standard, a specification for the network interface between the reader and its controller. Having already standardized the tag and reader radio frequency (RF) air interface protocol with UHF Gen 2, this specification was the practical, logical next step in facilitating the adoption of RFID. Impinj recognizes the importance of both standardization and collaboration with other companies as a vehicle for moving RFID toward more widespread adoption. So, similar to the UHF Gen 2 air protocol standard definition, Impinj assumed a leadership role, dedicating important internal resources who worked closely with other companies to both define the standard and work toward open source programming support. What is LLRP and why is it important?

### LLRP Standardizes Client-to-Reader Interface

The device operating an RFID reader can vary from a software application to middleware running on server hardware to programmable logic controllers (see Figure 1). And while the ultimate end business application these clients support may differ, the primary function of the interface

*(Continued inside)*

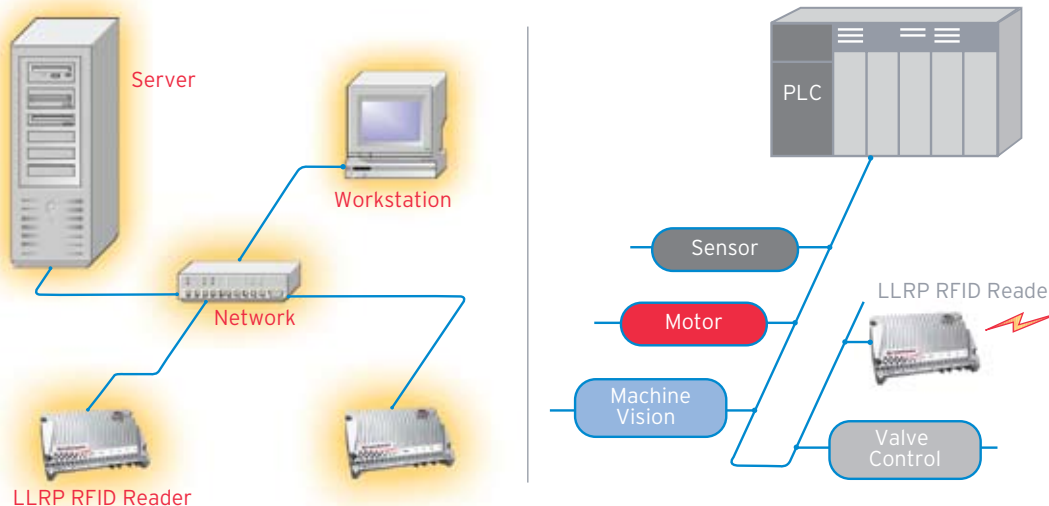


Figure 1: RFID Control Sources Vary

between control device and reader remains the same: that of commanding the reader to inventory tags and otherwise access them.

Readers that pass EPCglobal's Gen 2 interoperability test should work seamlessly at the tag and reader interface. However, the interface at the network or controlling side could be radically different. Consequently, committing to a particular system may end up being more of a marriage to proprietary technology than originally intended. With proprietary control software in place, the cost and time associated with changing to alternative readers or controlling software could be prohibitive, to say nothing of defeating the plug and play strategy critical to technology innovation and wide-spread technology adoption. LLRP, by removing the task of writing numerous proprietary protocol interfaces that all support the same functionality, lets controlling application software vendors focus on customer-visible features that impact RFID ROI.

A standard network interface yields many advantages. At the front of a system deployment, it enables a standard test application to use when comparing readers. A standard interface means the tools used to evaluate reader performance are the same for all candidates—apples to apples comparison rather than the compromised apples to oranges model available today. Using a common interface, users benefit from a much more accurate picture of specific reader performance, and thereby make better buying decisions.

In architecting robust application platforms that interface to a multitude of proprietary protocols, vendors have been forced to expose “common denominator” functionality that presents only the basics of each reader. By providing a consistent client programming model for controlling applications, LLRP enables these applications to expose a richer set of features across unique reader platforms. Rather than making readers a commodity item, LLRP increases reader differentiation, because reader performance as seen through the controlling software will be more apparent and easier to compare.

LLRP will provide a common knowledge base to leverage during deployment of RFID systems. Like other standard network protocols, network sniffer and protocol analyzers are emerging to provide detailed information about the communications between reader and client.

Finally, at the backend of a deployment, people installing an RFID system will require a reader to perform certain tasks particular to their usage model. If the network interface is standard, they won't have to learn multiple systems, they will only need LLRP proficiency.

## LLRP is the Right Standard, Right Now

Other standards have been proposed for the controller-to-reader network interface, so why has LLRP won out? In part, it's because previous approaches did not go quite far enough to accommodate the needs of both reader and application software providers—needs that included the ability to better leverage the competitive advantages of their respective products. So, in creating this new standard, the EPCglobal Reader Operations working group—a consortium of end users, reader vendors, and application software vendors—included in LLRP a rich set of vendor extension points that allow vendors the flexibility to innovate and differentiate their products, yet still operate within the standardized network framework. And with clearly defined extension points, the controlling software can more easily expose extensions unique to particular products. End-users could also propose extensions for features specific to their enterprise.

LLRP's ability to poll the readers on the network for their particular capabilities (which may vary by vendor) is yet another reason for acceptance. By allowing the readers to respond with their individual characteristics, the client software can be written so as to maintain common core functionality, yet still take advantage of extensions where available.

LLRP is also modular with respect to air-protocol. LLRP allows basic configuration and operations independent of air protocol, supporting simple configuration of readers without any knowledge of air protocol specifics. In LLRP 1.0.1, EPCglobal has developed a parameter set to control the full functionality of Gen 2 readers. For protocol specific operation, LLRP's Gen 2 parameter set provides simple access to Gen 2 inventory-support functionality such a read, write, lock, and kill, as well as simple methods to select the Gen 2 link parameters. And as the UHF Gen 2 specification evolves, LLRP is easily extended to provide support for future enhancements.

## LLRP Improves RFID System Performance

LLRP specifies a binary protocol over TCP/IP. It is an asymmetric protocol where a client implementation of LLRP (application software) speaks to a reader implementation of LLRP, with reader- or client-initiated connections.

One key advantage for LLRP is that it does not rely on real-time interaction between the application software and the reader, yet the readers can still be commanded to perform all of the Gen 2 time-critical functions. The reader application software can pass operational rules to the reader in non-real time, and then trigger those rules

to activate in real time. This declarative method of operation allows for the reader to achieve peak performance without any constraints caused by the network or host latency.

For applications such as pharmaceutical lines where functions are time-critical, this more autonomous procedure facilitates uninterrupted line operation. The reader can operate without a real-time control interface from the host. Alternatively, for applications such as a dock door in an isolated area where accommodating a controlling computer is not feasible, the ability to remotely control the reader operation via common network connections brings about cost savings and security advantages.

## LLRP Overview

The LLRP protocol was designed to provide maximum performance flexibility. A typical LLRP sequence between an application software client and a reader involves the following processes:

- > client polling the reader for its capabilities (see Table 1)

Table 1: Obtaining Reader Capabilities

General Device Capabilities	LLRP Capabilities	Example Regulatory Capabilities
<ul style="list-style-type: none"> <li>&gt; Number of antennas</li> <li>&gt; Number of general purpose input (GPI) ports</li> <li>&gt; Number of general purpose output (GPO) ports</li> <li>&gt; Device manufacturer</li> <li>&gt; Model number</li> <li>&gt; Firmware version</li> <li>&gt; Supported Air Protocols</li> <li>&gt; Receive sensitivity table</li> </ul>	<ul style="list-style-type: none"> <li>&gt; RF survey supported</li> <li>&gt; Number of Reader Operation Specifications supported</li> <li>&gt; Number of Access Specifications supported</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Regulatory region supported</li> <li>&gt; Transmit power table</li> <li>&gt; Transmit frequency table</li> <li>&gt; RF mode table</li> </ul>

- > setting the reader configuration
- > sending reader operation commands. These commands are called Reader Operation Specifications (ROSpecs) and they contain a list of sequential inventory operation commands called Antenna Inventory Specifications (AISpec)
- > sending the reader Access specifications (AccessSpec), or commands that tell the reader which data access operations (both read and write) to perform on tags
- > obtaining reports back from the reader

You can think of Reader Operation Specifications as a collection of inventory settings and commands that the Client software provides to the reader, along with instructions on when to start and stop those operations. START operations may be triggered immediately, by setting a periodic timer, by sending an absolute start time, by direct instruction from the Client software, or by GPI designated for that function. Operation commands sent to a reader may have durations bounded by STOP triggers that can be time-based, host command-based, or GPI control-based. A Reader Operation Specification is independent of air protocol.

Within each Reader Operation Specification are a number of Antenna Inventory Specifications (AISpec) to instruct the reader on antenna settings and particulars about inventory operation, such as when to stop the inventory, or which antennas to use. The reader executes the AISpecs in order. Within the AISpec are Inventory Parameter specifications, which can be used to describe detailed RF and air-protocol specific configurations.

Gen 2 and other air protocols allow the reader to perform operations as tags are inventoried. In LLRP, the reader accesses individual tags via Access Specifications—commands instructing the reader to access a particular tag based on tag selection criteria (filter the tag). LLRP allows the tag selection criteria to be configurable by tag data pattern, antenna, or a specified Reader Operation Specification (which could trigger based on a particular time, for example). See Figure 2.

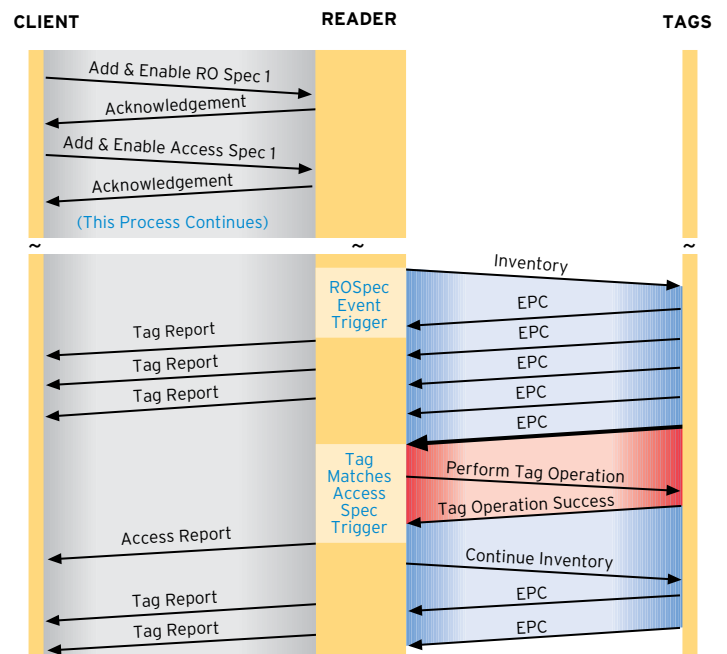


Figure 2: LLRP Command Sequencing

## LLRP Extensions from Impinj Enhance the Performance

Current Impinj reader functionality exceeds the standards proposed by the LLRP standards body. (For the standards description, see <http://www.epcglobalinc.org/standards>. In order to maintain features already in place, Impinj Octane™ 3.0, the RFID firmware running on the Speedway reader, offers differentiating features, already available but which are not part of the standard LLRP specification, via LLRP extensions. In the Octane 3.0 version, for example, available Impinj LLRP extensions will mirror the Mach1 API protocol operations that offer sub-regulatory region specification, fixed frequency lists, and frequency avoidance lists in those regions where frequency hopping is permitted. Other Speedway reader features such as simplified inventory search modes that Impinj has optimized for particular RF environments, control of antenna duty cycle, and the ability to report on tag direction information for each tag will also be provided via extensions. Future releases of Octane firmware will support all Mach1 functionality now present in the Speedway reader. However, as LLRP will be the primary reader control interface going forward, any new capability will only be available through LLRP.

## Impinj Leading the Effort to Create an Open Source LLRP Toolkit

While a standard network interface is an important development, not everyone wants to learn a binary protocol. Therefore Impinj is leading the effort to create an open source programming toolkit for LLRP.

The toolkit information can be found at [www.llrp.org](http://www.llrp.org).

## Impinj Supports LLRP Adoption

Impinj has been, and continues to be, a strong proponent of standards creation, and LLRP is no exception. As a leader in creating RFID technology solutions, Impinj recognizes the importance of standards in facilitating widespread adoption of technology. And because this standard enables technology innovation and differentiation via extensions, the performance and product differentiators the industry has come to expect from Impinj are present in the Octane 3.0 version of our Speedway reader firmware.

