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EPC® Radio-Frequency Identity Generation-2 UHF RFID Standard

An interview with Claude Tételin of GS1 on the important updates to this foundational standard



Question 1: Firstly, thank you for joining us, Claude. You are a world-renowned personality in the RFID community, much appreciated for your knowledge, willingness to help and, perhaps most importantly, clarity on esoteric topics. Today, we want to get into GS1's recent update to one of your main RFID standards, the standard commonly known as Gen2v2 or now Gen2v3. Can you please give us an overview of this standard? What does it cover?

Answer: Version 3 of GS1's "EPC® Radio-Frequency Identity Generation-2 UHF RFID Standard", also known as Gen2v3, is what we call an Air Interface Protocol. The first release was published by GS1/EPCglobal back in 2004. The standard describes the communication between passive RFID readers and tags operating in the Ultra High Frequency (UHF) frequency range. It defines both the physical and logical layers. The physical layer is to define the operational frequencies, modulation schemes, timings and waveforms to be used for Reader-to-Tag (forward link) and Tag-to-Reader (reverse link) communications. The logical layer is to define the Tag memory, Tag states, state transitions and flags. It also defines all the Reader's commands and Tag's responses that will help selecting, inventorying and accessing the Tags. Some of these commands are mandatory (Tags and Readers must

support them), other are optional. The standard also describes how to manage sensor and crypto tags.

Question 2: Given that we have this key standard for UHF RFID from GS1, some people are not clear on what “RAIN RFID” is. How does RAIN RFID relate to this standard?

Answer: “RAIN” is essentially a brand name, a marketing name for UHF passive RFID technology. Like any other technology such as WiFi, Bluetooth or NFC, it must rely on global and open standards to provide the service for which it was designed. For RAIN, it means connecting everyday items to business processes and even the internet to enable businesses and consumers to identify, locate, authenticate and engage each of these items. One of these standards is, of course, the Air Interface Protocol, Gen2v3. It is a fundamental standard but it’s not the only one. To operate properly, RAIN must also rely on other standards which, for example, describe the way valuable and relevant data can be encoded in RAIN Tags or define the way Readers can be managed and connected to the network. So, it's easy to see why, rather than listing all these standards, it's better to use “RAIN”.

Question 3: Okay, onto the main reason for this interview. For years, we had “Gen2v2,” i.e., version 2 of this standard. A lot of Marketing materials even utilized this term (and still do today). Whether people knew it or not, your common bread-and-butter RAIN RFID solutions were based on Gen2v2. So why did GS1 update this standard? What are the key updates and why are they important?

Answer: The second version of GS1’s “EPC® Radio-Frequency Identity Generation-2 UHF RFID Standard”, Gen2v2, was released something like 10 years ago to address issues like tag authentication, privacy protection and file management. It is such an old, stable and widely implemented version that most of the “marketing” material refers to Gen2v2. But when you look at the “basic” commands for Tag selection, inventory and access, they have not been modified and are quite the ones that were defined 20 years ago when the technology was not that widely used. Today, we see more and more RAIN applications and the number of Readers and Tags is growing exponentially. This is good news, but this is not without creating new challenges. As an example, do you think that it is worth capturing more than a thousand of Tags if you realize that only some of them are relevant for your application? Obviously, no. That’s one of the reasons why, 3 years ago, GS1 has decided to update Gen2v2. With the support from users and solution providers communities, GS1 decided to work on these 4 main challenges:

1. **Tag selection and inventory:** this is to help focusing on tags of interest based on efficient and easy-to-implement filtering criteria. With the new Gen2v3 QueryX and QueryY commands, you will be able to only select and inventory tags that carry a specific identifier or tags that support a specific feature or even tags that carry a value (e.g., a date) that is greater or lower than a targeted value.
2. **Reading of additional data:** the unique identifier (EPC or UII) a Tag must carry is not always sufficient to address the business need. People sometime want to encode additional data in the tag. This can be achieved by using the new GS1 EPC schemes that are described in the GS1 Tag Data Standard, but this can also be achieved by using the dedicated User Memory bank of a tag. Unfortunately, reading data from User Memory is a guessing game if you don't know exactly what has been encoded. So Gen2v3 is proposing a new command that instructs the tag to only backscatter the data that has been encoded. Nothing more, nothing less.
3. **Inventory reliability:** in a very crowded environment, you can have up to 25% of the tag population that is not correctly energized by the reader. This means that the reader will fail to completely capture those tags and consequently, the throughput can drastically be reduced. Gen2v3 proposes a new waveform called "field adjustment" that prevents those "fringe" tags to participate to the inventory.
4. **Passive sensor tags and crypto tags:** are more and more widely used. Gen2v3 now supports passive (snapshot and tripwire) sensor tags. Gen2v3 also simplifies the implementation of crypto tags making the next generation of those tags more affordable.

More information about all these new features can be found in the RAIN Alliance website.

Question 4: What is the difference between this standard and the other RFID standard from GS1 that I hear a lot about, "Tag Data Standard?"

A: As explained previously, even if fundamental, implementing the RAIN technology is not only about the Air Interface Protocol. Data encoding, as well as reader management and connection to the network are of great importance. GS1, as a global, not-for-profit, Standards Development Organization, proposes standards that cover all of these aspects. To name only two of them, GS1 Tag Data Standard (TDS) is about encoding GS1 identifiers in RFID tags using the EPC (Electronic Product Code) syntax. One of the most widely used EPC schemes is the well-known SGTIN-96 but there are many more. It also describes how to encode additional GS1 data in

the User Memory bank using the Packed Object compaction rules. The other one is the GS1 Low Level Reader Protocol (LLRP) that specifies an interface between RFID readers and clients. The interface protocol is called low-level because it provides full control of RFID air interface protocol operation timing and access to all the parameters of each Gen2vX command.

Question 5: And for our bonus question, what is the difference between this standard and ISO/IEC 18000-63?

Answer: Based on a clear and well recognized standard management process and IP policy, GS1 is developing a huge number of global standards to help many different sectors to identify, capture, share and use data. From day one, GS1 also set up partnerships with other Standards Development Organization (SDOs) like ISO. That's why many of the GS1 standards have been adopted as ISO standards. The Gen2 standard is not an exception. Gen2v2 has an ISO equivalent standard that is ISO/IEC 18000-63:2021. This standard is developed and maintained by the ISO/IEC JTC 1/SC 31 committee. In addition to all the Gen2v2 features, ISO/IEC 18000-63:2021 provides additional features, like the battery assisted passive tag, simple or full function sensors tags that are not relevant for GS1 applications. Now that Gen2v3 has been published, the ISO/IEC 18000-63 is under revision to support the new Gen2v3 features.

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The RAIN Alliance special session at the IEEE RFID event is scheduled for the morning of Thursday, 24 April 2025. A unique opportunity to share, discuss, and witness research results in all areas of RFID technologies and their applications.

RFID Blog Library

1. **Case Study: BlueTrace Reels in Compliance, Efficiency: BlueTrace**, a leader in inventory management and compliance software for seafood processors, distributors, and producers, faced a challenge familiar to many businesses serving the food industry: maintaining peak operational efficiency while ensuring regulatory compliance. The company needed a reliable and efficient solution for printing millions of tags and labels annually for its global customer base, while delivering real-time inventory communications. TSC Auto ID provided the answer.
2. Case Study: Weyco Steps Up to the Retail Challenge: Weyco, a leading distributor of men's footwear, faced a daunting task: printing millions of labels annually for a global customer base while maintaining peak efficiency and compliance. The solution? TSC Auto ID.
3. 7 Reasons Why On-Metal RFID Tags Can Be Ideal For Asset Tracking: On-metal RFID tags are game-changers, offering unparalleled performance and

versatility in even the most challenging environments. Whether you're managing a bustling repair facility, a high-tech IT department, or a rugged industrial factory, here are 7 reasons why on-metal RFID tags can serve you well for tagging difficult-to-read items.

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