RAIN RFID and the Internet of Things: Industry Snapshot and Security Needs

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The accompanying presentation offers a glimpse of the continued development of the UHF RFID industry. Increasingly referred to as RAIN RFID after the foundation of the *RAdio IdentificatioN* (RAIN) *Industry Alliance* [4], this technology[1] will be an integral part of the *Internet of Things (IoT)*.

In addition to the deployments we see today, the tiny constrained devices encountered in RAIN RFID will be increasingly deployed in applications that exchange medical, location, personal, and sensor information. As these developments take hold, cryptographic security will take an increasingly prominent role.

To fully realize the potential of both RAIN RFID and the Internet of Things, therefore, a range of efficient security primitives may be essential. The NIST initiative on lightweight cryptography is therefore particularly welcome and this presentation aims to provide industry input to that process.

[1] The views in this presentation are those of the author. They might not necessarily reflect the views of other members of the RAIN RFID Alliance.

Background

The *Ultra-High Frequency (UHF)* RFID chip is a remarkable piece of engineering. Small and cheap enough to be attached to billions of objects and requiring no on-board power supply, RFID tags that contain these chips can be reliably read at long range[2]. Figure 1 helps illustrate the size of previous-generation chips and deployed systems can read hundreds of tags per second with close to 100% reliability.

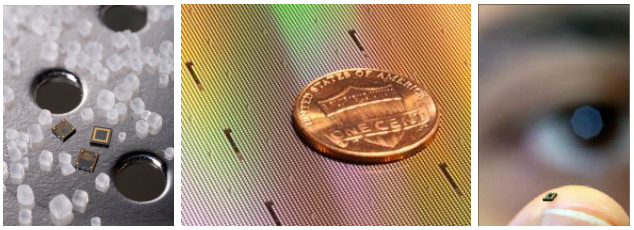

Fig. 1. Previous generations of passive UHF RFID chips on a salt cellar, a silicon wafer, and a finger-tip.

The final deployed tags vary widely in performance and form factor; Figure 2 shows some different inlay designs prior to integration into a label or tag. The suitability of a final tag to a given application will depend on the chip feature set and it's cost, it's read-range, and the time required to complete the necessary task. Unfortunately, the inherent tension between these three attributes poses a significant challenge to both implementation and business development.

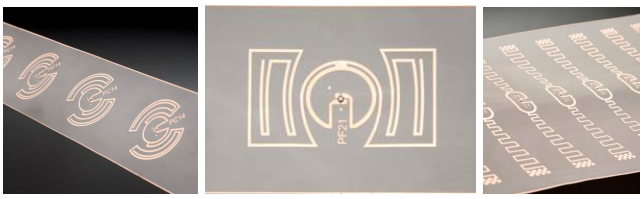

Fig. 2. UHF RFID inlays sporting different antenna designs prior to integration into a tag. The chip can just be seen as the dot at the center of each antenna.

The general public might not be aware, but there are billions of RAIN RFID tags in use today. Previously the preserve of supply-chain logistics, this particular form of RFID is experiencing significant deployment in retail where it provides exceptional granularity to product inventory and new in-store experiences for

[2] In contrast to HF RFID that is found in NFC applications.

customers [3, 7]. At the same time there are initiatives to increase the tagging of aircraft [5] and auto [8, 13] parts as well as deployments in healthcare for pharmaceuticals, equipment, and personnel [11, 12, 14, 10, 15]. Consumer-facing deployments are expanding; beyond long-established race timing there are TV game shows, ice-cream parlors, vending machines, and consumer electronic products that all use the technology. There are even deployments in earth orbit [9].

There are now numerous markets where the technology is proven and established. Deployments are spreading quickly and there is a strong link with the much discussed *Internet of Things* (IoT); a broad term that encompasses many devices and applications[3].

Certainly there is more to the IoT than RAIN RFID. However, accelerating adoption means that RAIN RFID will be an important part of the IoT and, in absolute numbers, the passive UHF tag will be by far the most deployed device. RAIN RFID provides the cheapest way to connect any object to the Internet and not only is each chip uniquely identifiable but each chip can be encoded with information describing the item to which it is attached. In the years to come RAIN RFID will convey vast quantities of information from inanimate objects to global information systems.

Obviously not all this information is "equal". Most information transmitted today has little or no value outside the immediate application. However, some may be significant at a business or personal level and, as the range of applications broadens, we should anticipate increasing demands to protect information from eavesdropping, malicious corruption, or both. Further, irrespective of the information exchanged, a physical world filled with tagged and connected objects is quite unlike anything we have ever experienced and security technologies can help society manage some of the implications. These issues have long been recognized by chip and tag manufacturers. The underlying communication protocol [1, 2] requires that all compliant tags support a *Kill* mechanism and several RAIN RFID chips on the market provide switchable public/private profiles or long-/short-range modes for privacy. The goal of the accompanying presentation, therefore, is to highlight some of the trends and pressures in the RAIN RFID market and to provide support to initiatives that work in tandem with, and further extend, the security techniques already deployed.

Presentation

The accompanying presentation provides an update to a presentation and paper provided at the last NIST workshop on lightweight cryptography [6]. The presentation covers the following topics:

- The state of the RAIN RFID industry and current applications
- The standardization landscape and some trends

[3] The term "Internet of Things" is attributed to Kevin Ashton, a pioneering contributor to the *Auto-ID Center*. The Auto-ID Center was one of the early drivers of UHF RFID adoption.

– Implementation challenges, performance trade-offs, and security
– Mapping industry needs to the NIST lightweight cryptography initiative

As deployments evolve and the technology moves into more applications, cryptographic security will become increasingly important. Looked at from the perspective of the RAIN RFID industry, efficient alternatives to some of the NIST currently-standardized algorithms could be massively beneficial.

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