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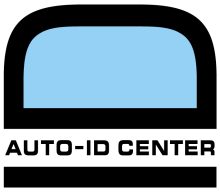

TECHNICAL REPORT

UHF Identity Tag Action Group: Scope and Deliverables

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ABSTRACT

This paper presents the scope of work and the defined deliverables for the Auto-ID Center UHF Identity Tag Action Group. The Auto-ID Center UHF Identity Tag Action Group is charged with developing a reader-tag communication protocol operating in the Ultra High Frequency (UHF) frequency range. The protocol must be designed to operate in the 860MHz–930MHz frequency range and the 2.45GHz ISM (Industrial, Scientific, Medical) band. The protocol must operate as part of an identification procedure for higher functionality tags. Furthermore, the protocol must be targeted to allow for a minimum usable identification rate of 100 tags per second under all regulatory environments allowing RFID operation in the targeted UHF frequency ranges. The overriding constraint placed on the protocol is that it will place a minimum monetary cost burden on the tag and reader implementations. In other words, the protocol must enable the implementation of compliant ultra low-cost tags and low-cost readers that provide usable performance levels.

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Biography

Daniel W. Engels
Director of Protocols

Daniel W. Engels received his B.S. from the University of Buffalo, his M.S. from the University of California, Berkeley, and his Ph.D. from the Massachusetts Institute of Technology all in Electrical Engineering and Computer Science. His master's thesis is in the area of computer-aided design for electronic systems, and his doctoral thesis is in the field of theoretical computer science. Dr. Engels joined the Auto-ID Center after obtaining his doctoral degree where he leads the day-to-day research activities of the Center. Dr. Engels' research interests include scheduling theory and applications, real-time system design, distributed and mobile computing, and computer-aided design for embedded systems.

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1. INTRODUCTION

[1] The UHF Identity Tag Action Group was originally called the Cheap Chip Action Group and has also been referred to as the UHF Cheap Tag Task Force.

The Auto-ID Center formed the UHF Identity Tag Action Group[1] to develop a reader-tag protocol operating in the UHF frequency range that enables the implementation of ultra-low cost protocol compliant tags and low-cost readers. The overriding constraint on the design of the protocol is to minimize the number of gate equivalents required to implement the protocol in silicon. The overall silicon cost budget for implementing the tag functionality is US$0.01 which translates to roughly 0.25 square millimeter silicon area [2][3].

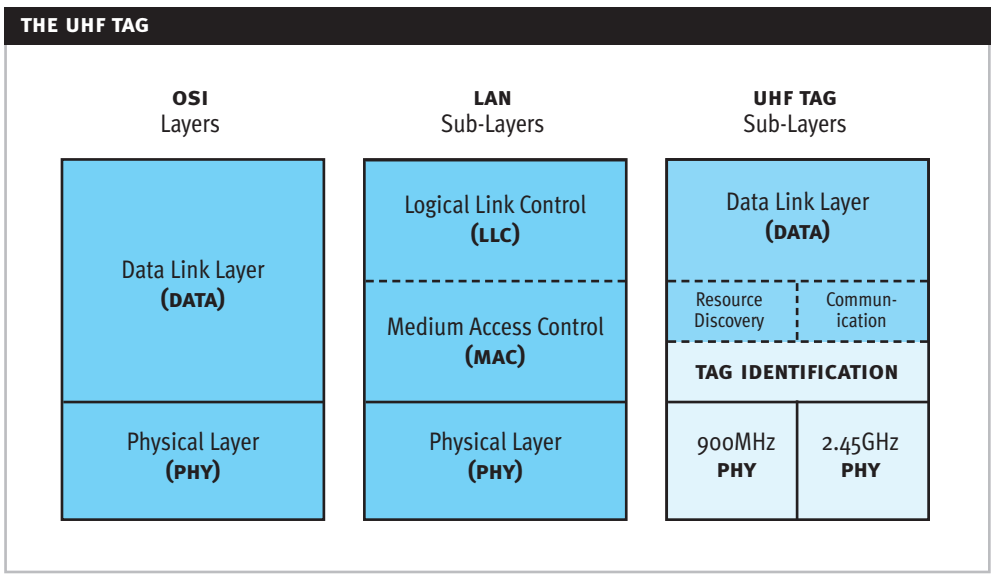
Secondary constraints on the protocol are the ability to store an EPC™ for object identification, the ability to select tags for participation in the identification process based upon their stored EPC™ value, and the ability to issue a `self-destruct`, or `kill` command to permanently disable the communication capabilities of the tag. Performance constraints of 100 unique EPCs™ identified per second and greater than 3 meters communication range are not absolute requirements. Instead, they are a target to ensure that a non-usable solution is not devised. A final constraint on the protocol is its ability to be used as the foundation for higher functionality tags.

The UHF Identity Tag Action Group has a limited operating scope to limit the distractions of orthogonal and tangentially related issues and well-defined deliverables to maintain the focus of the Group. This document defines the scope of the Group's work and the Group's deliverables.

2. UHF IDENTITY TAG SCOPE OF WORK

The UHF Identity Tag Action Group, or UHF TAG, is charged with developing an identification protocol capable of efficiently and "simultaneously" discovering the EPCs™ stored in multiple tags. The protocol is to operate in the UHF frequency range with the 860MHz–930MHz frequency range (referred to as 900MHz frequency range) and the 2.45GHz ISM (Industrial, Scientific, Medical) band specifically targeted. With respect to the OSI (Open Systems Interconnection) layered communication model [1], the UHF TAG is to develop protocols that operate in the lowest portions of the Data Link Layer (DATA) and the Physical Layer (PHY) as illustrated in Figure 1.

Figure 1: The UHF TAG considers only protocols that operate in the Data Link and Physical Layers.



2.1. Data Link Layer

The Data Link Layer is primarily concerned with the passing of data over the communication medium and the detection, and optional correction, of errors that may occur during the data transmission. Protocols existing at the Data Link Layer provide the functional and procedural means to establish, maintain, and release communication connections.

Local Area Network (LAN) Data Link Layer protocols such as Ethernet and the IEE 802 protocols subdivide the Data Link Layer into Local Link Control (LLC) and Medium Access Control (MAC) sub-layers. The LLC controls the usage of the local link, and the MAC controls access to the link.

For RFID systems, we also subdivide the Data Link Layer into several sub-layers. The lowest sub-layer (the sub-layer closest to the Physical Layer) is the Tag Identification sub-layer. Protocols at the Tag Identification sub-layer control the process of identifying the tags within an RFID reader's communication zone. These protocols are common to all Physical Layer protocols in the UHF frequency range.

Above the Tag Identification sub-layer are the Tag Resource Discovery and Tag Communication sub-layers. These sub-layers may be orthogonal, as illustrated. One sub-layer may be dependent upon the other in a completely layered fashion, or these two sub-layers may be integrated into a single sub-layer. Different protocols may organize these two sub-layers in one of these three fashions.

The final sub-layer in the Data Link Layer for RFID systems is the Reader LLC and MAC sub-layer. This sub-layer controls the reader-to-reader interactions. Algorithms that solve the Reader Collision Problem belong in this sub-layer.

2.2. Physical Layer

The Physical Layer is primarily concerned with the low-level signaling and encoding of symbols between two devices. The properties of the Physical Layer depend upon the medium over which communication occurs as well as any regulations that are imposed upon that medium.

In UHF RFID systems, we are concerned with a wireless medium with a base communication carrier frequency operating in the 860MHz–930MHz frequency range (900Mhz PHY in Figure 1) and in the 2.45GHZ ISM band (2.45GHz PHY in Figure 1). The regulations and allowable Physical Layer properties for these two frequency ranges are very similar in some jurisdictions (such as the United States), but are very different in other jurisdictions (such as Europe).

Additional orthogonal frequency ranges may be added to the Physical Layer; however, the current frequency scope of the Auto-ID Center's UHF Identity Tag Action Group is 900MHz and 2.45GHz. Different Physical Layer protocols may be developed for each of these two frequency ranges.

2.3. UHF TAG Scope

The scope of the UHF Identity TAG are protocols that operate in the 900MHz PHY, 2.45GHz PHY, and the Tag Identity sub-layer of the Data Link Layer.

3. UHF IDENTITY TAG DELIVERABLES

The deliverable of the UHF Identity TAG is a protocol operating in the Tag Identity sub-layer of the Data Link Layer that is used by both the 900MHz PHY and the 2.45GHz PHY.

These protocols form the foundation upon which all higher functionality tags rest.

4. SUMMARY

The Auto-ID Center's UHF Identity Tag Action Group is charged with developing and delivering protocols that enable the efficient identification of RFID tags communicating in the 860MHz–930MHz frequency range and the 2.45GHz ISM band. These protocols operate in the lowest level of the Data Link Layer, the Tag Identity sub-layer, and the Physical Layer. Due to their position within the modular, layered, view of communication, these protocols form the foundation of higher functionality protocols developed for the Auto-ID Center's Networked Physical World, or EPC™, System.

5. REFERENCES

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