Augmented RFID

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RadioFrequency IDentification (RFID) is a technology that has reached a level of maturity that allows it to be widely used in many fields and applications ranging from the simple identification of an article or person, to a more complex application such as the Internet of Things.
From physics point of view RFID is based on the exploitation of backscatter signal generated by passive or active target. The backscatter phenomenon was observed very early in the history of the development of electromagnetism. Indeed, the practical use of backscatter signal was first proposed in the patent of E. Brard published in 1930 [1]. While the contribution of E. Brard is more concerned by circuit vision, other contributions during the 1940s were linked to modern RFID. In particular the landmark paper of H. Stockman [2], who explained the physics behind the operating principle of communication by reflected power, and the development of L.Theremin [3], who developed a passive device that can be used as wireless microphone. This device called the "thing" is certainly the very first passive wireless sensor and is the ancestor of the RFID tag. On the other hand, Radar systems that started to develop during the same decade are among the most relevant and popular techniques exploiting the backscatter signals. With the development of electronic systems and the advent of semiconductor and integration technology in the 1950s it was possible to develop integrated and very compact system similar to modern tag. The most known devices inherited from this period is the Electronic Article Surveillance (EAS), which allowed the first commercial application of RFID [4].
From analysis point of view, the Radar Cross Section (RCS) is the relevant parameter to model the backscatter signal. The RCS measures the ability of a given target to reflect the incident signal either in the same direction of the incident signal (Monostatic RCS) or in another direction (Bistatic RCS) [5]. So, depending on the shape and material composition of the target, the RCS can be frequency dependent. As far as antenna is considered as a target, another RCS contribution must be considered. The later, known as antenna RCS mode, is due to antenna re-radiation. Different targets are considered to define the two families of RFID: Conventional RFID based on loaded antenna as active target and Chipless RFID based on passive target.
Conventional RFID: Modern RFID chips require less than -22dBm to be activated which results in read-range of more than 25 m. Conventional RFID is well standardized and comply with several regulations and norms which favor its implementation in real application worldwide. While the RFID tags are nowadays extensively exploited for identification purposes as each RFID chip receives a 32 bits ID code; the transformation of RFID tags into RFID sensors is intensively investigated allowing the introduction of augmented tags concept which provide new functions. They are able to perform the last few meters of the Internet of Things and Artificial Intelligence.
Chipless RFID: A chipless tag is primarily a target designed to have a predefined electromagnetic signature in the backscatter signal. There are two visions for the predefined signature: time domain coded or frequency domain coded. Time domain coded chipless tags based on Surface Acoustic Wave have been demonstrated with high coding capacity operating in 2.45GHz ISM bands. However, SAW devices are quite expensive and their technology is much more complex than usual printed PCB tags and therefore they are less competitive in the context of low-cost RFID. Frequency domain coded chipless tags are more popular and easier to design, however their capacity is limited to some tens of bits, which is far away from the coding capacity of conventional RFID (32 bits). Another shortcoming of chipless RFID is the absence of solid regulation and lack of commercial reader. Augmented Chipless Tags are also able to provide extra functionalities in particular sensing.
While the very first tag developed is a chipless tag-sensor, nowadays the conventional tags are mature and implemented in real applications, the two families of RFID continue to progress. They are evolving to perform additional duties in particular sensing and localization. The concept of augmented tag is the new frontier for RFID.

References

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