UHF RFID Near-Fields... Is that NFC?

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***Abstract*— UHF (Ultra High Frequency) RFID (Radio Frequency Identification) is not confused with NFC (near-field communications, which is HF RFID) but often UHF near-field antennas' read range performance is expected to be similar to NFC. This poster is intended to clarify the concept of near-fields in UHF RFID. The need for near-field signals, its significance in UHF RFID and its practical implications are also explained.**

Keywords—UHF RFID, RFID application, Fixed reader antenna.

I. WHAT ARE UHF RFID NEAR-FIELDS ?

When any reader antenna is energized by an RFID reader, the antenna transmits electromagnetic waves (fields) into the free space. The electromagnetic waves are a combination of electric (E) and magnetic (H) fields that are orthogonal and are in-phase with each other They vary as a function of distance from the transmitting antenna. It is broadly classified as the near-field region and the far-field region. The near-field region is the region next to the antenna. The near-field can further be classified into the reactive near-field and the radiative near-field [1]. Fig.1 shows the three regions and their zone definition based on the longest length of the antenna 'D' and the antenna's operating wavelength 'λ'. Near-field region is reactive when the E-field, and the H-field are 90° out-of-phase with each other. Propagation does not happen in this region. Radiative near-field region is the transitional zone is also known as the 'Fresnel region' that transition from out-of-phase to in-phase fields. The radiation starts to happen in this region, but it is still immature. The radiation pattern of an antenna will vary with respect to distance in this region.

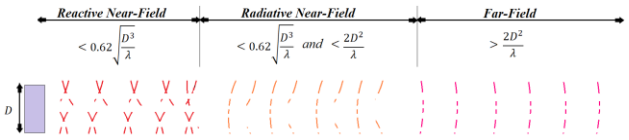

Fig.1 Near-field to Far-field transition

II. IS UHF NEAR-FIELD DIFFERENT FROM NFC ?

Yes, UHF near-fields, also called as RAIN (Radio frequency IdentificatioN) and NFC (Near-Field Communications) are two distinct types of passive RFID systems. RAIN operates in the UHF frequency range (865 – 868 / 902 – 928 MHz) whereas the NFC operates in 13.56 MHZ – same as the High-Frequency RFID. HF RFID and UHF RFID use ISO/IEC 18000-3 and ISO/IEC 18000-6 (or GS1) communication protocols, respectively. HF RFID systems are also governed by two more standards viz., ISO/IEC 15693 and ISO/IEC 14443. The former is being used in the vicinity (read distance is usually 1 to 1.5 metres) and proximity cards (very close range) and the latter is used for identification cards. The proximity HF cards are sometimes referred to as NFC. Table.1 shows the difference between the two types of RFID.

Table I. NFC vs RAIN (UHF RFID) near-fields

	NFC	RAIN Near-field
Similarities	NFC is a type of RFID technology	A UHF RAIN type of RFID technology
	The HF RFID tag must be closer to the HF RFID reader for efficient detection.	The UHF RAIN RFID tag must be closer to the UHF RAIN RFID reader for efficient detection.
	Reduced RF absorption when liquid is present	Reduced RF absorption when liquid is present
Differences	NFC operates in 13.56 MHz frequency	UHF RAIN operates in 865 – 868 MHz or 902 – 928 MHz frequencies
	NFC uses the ISO/IEC 18000-3 or ISO/IEC 15693 or ISO/IEC 14443 protocol	UHF RAIN uses the unified ISO/IEC 18000-6 (GS1) protocol
	Only one tag can be read at a time	Multiple tags (up to 1000 tags per second) can be read at a time
	Slower data transfer	Higher data rate is achieved
	NFC tags are larger in size	RAIN near-field tags are smaller and miniaturized.
	NFC uses inductive coupling between the reader antenna and the tag antenna	RAIN uses both inductive and capacitive coupling
	User memory: up to 1912 byte (Reference: NXP NT3H2211W0FTT)	User memory: 32 to 2048 bits (Reference: NXP Ucode-7) EPC memory: 96 bits

III. WHY DO WE NEED UHF NEAR-FIELDS ?

The concept of near-field and far-field plays a significant role in RAIN RFID applications. RAIN tags can be powered by the far-field electromagnetic fields or by the near-field magnetic fields. The far-field electromagnetic fields get absorbed by liquid assets such as pharmaceutical drugs, shampoos, soaps and so on, while the near-field magnetic fields are not subject to RF absorption [2]. Also, metal assets tend to detune a resonant far-field antenna but not near-field antennas. Thus, there is an increasing need for UHF near-fields.

IV. How do tags respond to near-fields ?

Liquid assets can be efficiently detected when they are tagged using a near-field tag (see Fig. 2(a)) or a hybrid tag (Fig. 2(b)) that has a dipole-like far-field radiator and a near-field loop. Near-field loop couples with the magnetic fields of the reader antenna and respond to tag queries. Near-field antennas generally have shorter read range (less than 600 mm), and it is governed by the sensitivity of the tag and reader input power.

(a) (b)

Fig.2 (a) Near-field tag (Smartrac Trap NF) and (b) Hybrid tag (Smartrac Miniweb)

V. What is special about a near-field reader antenna ?

Although all the RAIN reader antennas have near-field and far-field region for operation, only a handful of reader antennas has even power distribution on their surface for surface tag detection. A typical patch antenna (dominated by the electric field at the near-field region) has a dead zone at its centre where the voltage is zero. Small-sized tags may not be detected when they are located at the patch antenna's centre. Fig.3 shows the near-field tag surface readability on a Times-7 A5010 far-field antenna. Loop antennas are dominated by the magnetic fields at the near-field region, yet a line of null zone appear where the currents are reversed within the loop. A segmented loop (zero-phase-shift-line loop) can offer uniform magnetic field intensity, and the problem of surface dead zone can be avoided [3]. The segmented loops have low gain and cannot be scaled to different sizes as the design is a function of wavelength. The size of a reader antenna that adopts this segmented loop design is fixed. These reader antennas are coined as the 'Near-Field' antennas due to their uniform surface-magnetic field distribution and less far-field gain. Fig. 4 shows the near-field tag's readability on a Times-7 A1163 True near-field antenna.

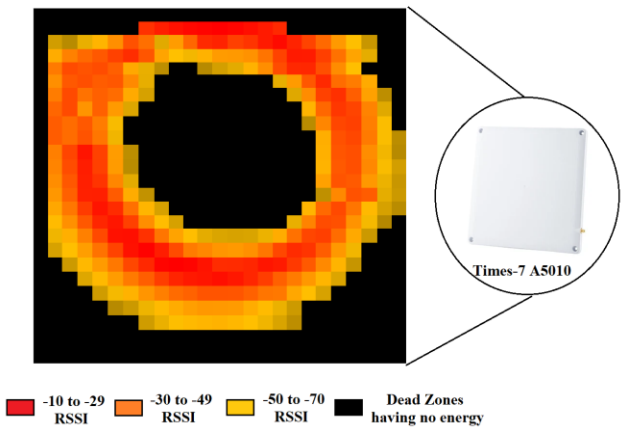

Fig.3 Trap-NF tag's readability on Times-7 A5010 far-field antenna

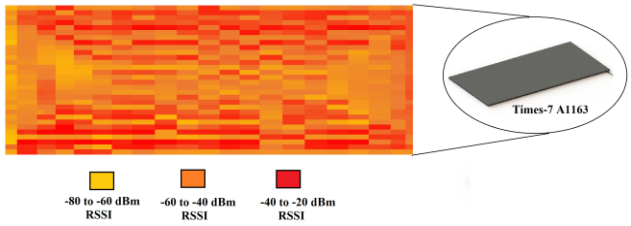

Fig.4 Trap-NF tag's readability on Times-7 A1163 near-field antenna

VI. 10 myths about near-field reader antennas

1. ***They can only read near-field tags:*** No, they can read both near-field and far-field tags.
2. ***Their read range is limited to their surface:*** No, read range is dependent on tags' sensitivity and tag antenna design.
3. ***They cannot read multiple tags at a time:*** NFC cannot but RAIN near-field can.
4. ***They are suitable only for 'tap and go' applications:*** No, RAIN near-fields are suitable for long-distance tag reads too.
5. ***They are low gain far-field antennas:*** No, low gain far-fields have surface dead zones.
6. ***They are always linearly polarized:*** No, polarization is not applicable as it relies on the inductive coupling. However, a dipole-like tag can be more sensitive in one orientation that other.
7. ***They are only magnetic loop antenna types:*** No, there are multiple types of near-field antennas such as leaky strip-lines, travelling-wave antennas, etc.
8. ***They cannot radiate at all:*** It can be an inefficient radiator, operating in the radiating near-field zone.
9. ***They have surface dead zones:*** No, a near-field antenna would not have surface dead zones.
10. ***Their magnetic fields cause electromagnetic interferences*:** No, these are not EMI generated in a transceiver device but are generated by an antenna design.

References

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