Module-4

Sensing the Augmented, Pattern-Rich External World

by
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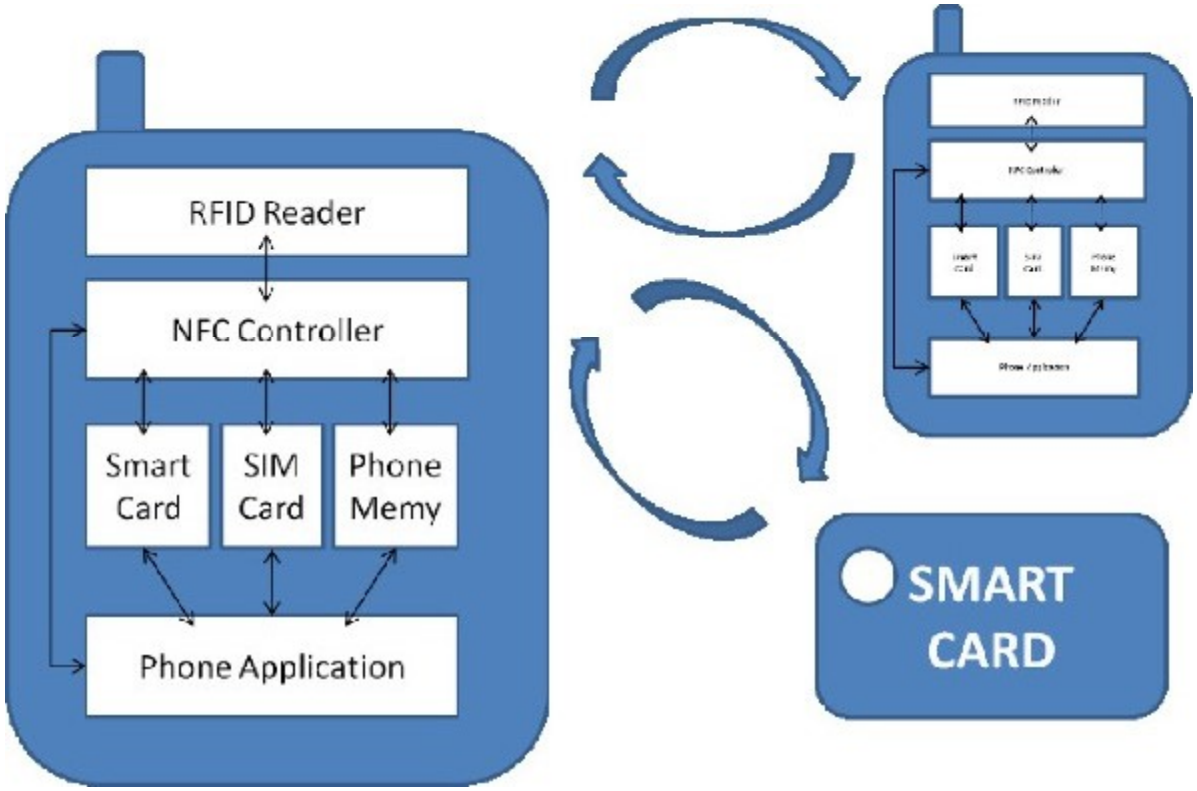
Topics

- RFID, Near field communication (NFC),
- Inventory Tracking System using NFC,
- Camera Activity,
- Barcode Reader,
- Image-Processing using AOA,
- Android Clapper and Media Recorder

RFID, Near field communication (NFC)

- *Near field communication (NFC): the technology that enables the* electronic devices to communicates within close range of your device and read data from these objects.
- Similarly when two NFC-enabled Android devices meet, they can use NFC to submit data peer-to-peer. The inclusion of NFC on Android devices enables developers to create *low friction interactions.*

NFC enabled mobile devices



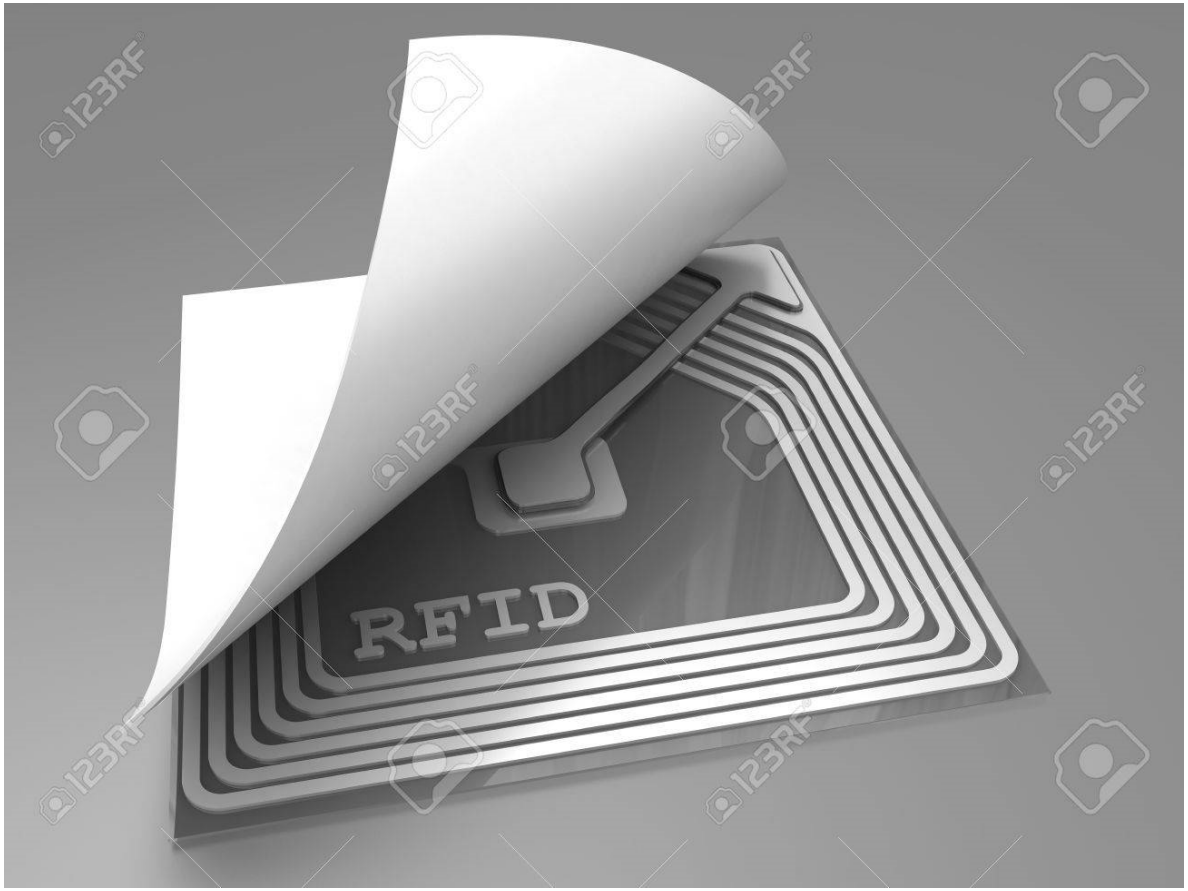
Contactless Technologies

- Two *contactless technologies*
- Outlines the advantages and disadvantages of NFC with Android
- Tools and code needed to build a small NFC-enabled system with the Android SDK
- The future of NFC on Android

WHAT IS RFID?

- Radio frequency identification tags come in many form, such as cards and key fobs.
- *RFID sticker while* shopping at malls and other electronic goods.
- They are usually 2.5 cm square white stickers attached to almost all the products on the shelves.

RFID sticker



https://www.youtube.com/watch?v=Ukfpq71BoMo

RFID Sticker

- Rectangular coil of metal strips much like that shown in diagram these coils are the *antennas that "listen" for radio frequency.*
- *Within the coils are other larger metal blocks;* the circuit layouts vary, but these metal blocks are very small integrated circuits (IC) made of silicon.
- These ICs can store small amounts of manufacturer defined identification data and the logic to allow the tag to transmit data back to the RFID reader via the antenna.

Active and Passive RFID

- Many types of RFID tags exist, with the major categories being *active or passive, or a combination of* the two.
- Active RFID tags have built-in batteries and have the advantage of being able to receive and transmit from a much longer distance (up to 10 meters or more) than passive tags.
- Passive tags, as you might have already guessed, do not have an on-board power supply and are limited to only a few feet at most.
- https://www.youtube.com/watch?v=1lIdtOTp03A

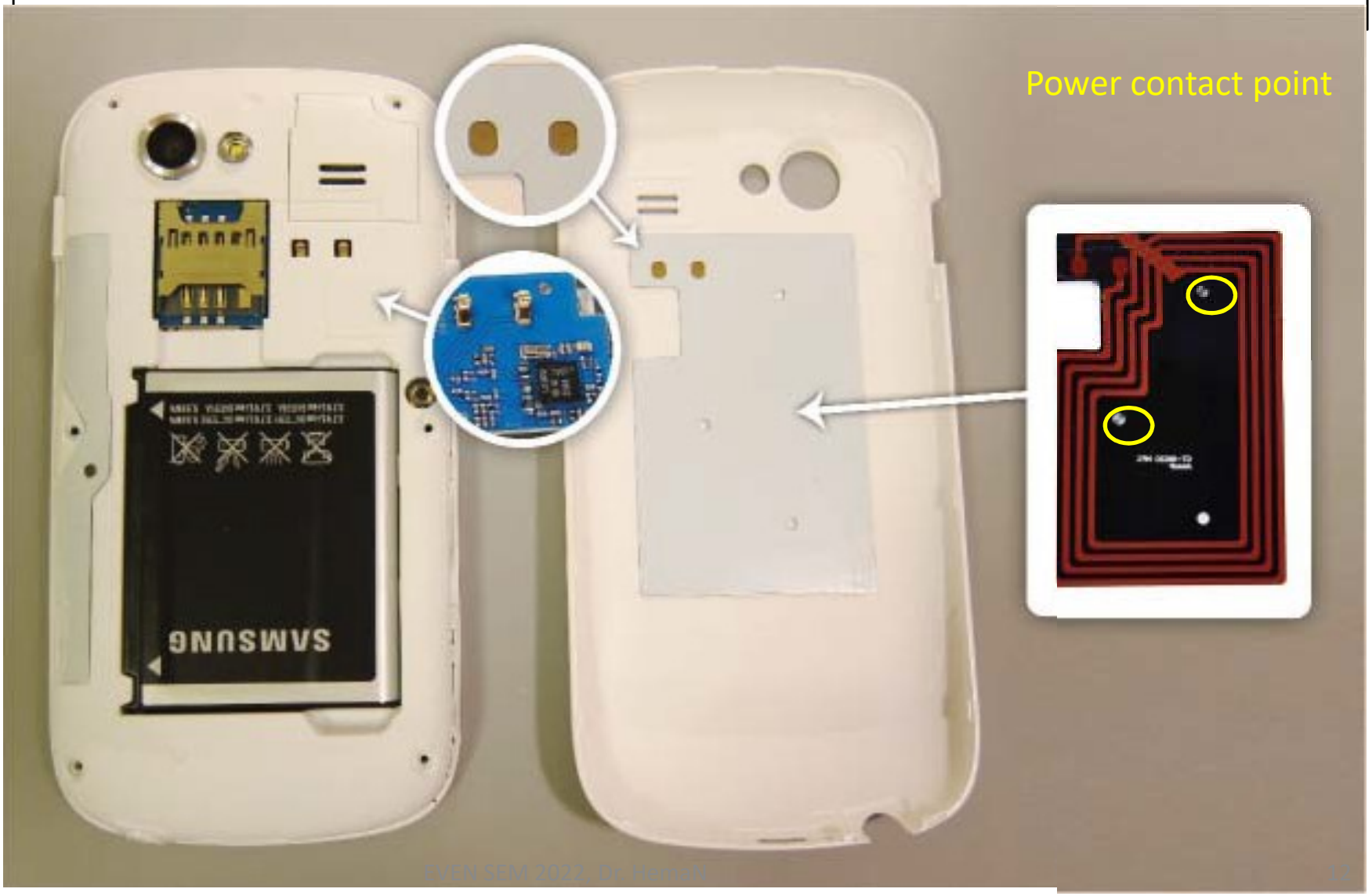
Benefits of Passive tags

- The benefits of passive tags mean that they can be cheaper, smaller, and can remain readable as long as the circuit remains in good condition (that is, not cut or severely bent).
- Without on-board power, passive RFID tags get activated when they are “interrogated” by an RFID reader or scanner.

Working of Passive tags

- Power generator by wrapping magnetic wire around a magnet and connecting it to a light bulb.
- When you spin the wires around the magnet at high speed, it causes electrons to become excited and activate the light bulb.
- This electricity is created through a process called *electromagnetic induction.*
- The radio waves generated by the RFID scanner are enough to cause the coils of the RFID tag to oscillate, which can be converted to energy.
- https://www.youtube.com/watch?v=4QSFcPKRJcY

Antenna of Nexus S phone NFC reader



Samsung Galaxy Nexus has the antenna built into the battery

NFC controller (part number PN65N)

- Manufacturing company is NXP Semiconductors.
- NFC soldered onto a PCB with the rest of the internal phone components.
- Most RFID tags only store a 40-bit unique identifier such as 0x12345678AB.
- When a scanner activates an RFID tag, the tag transmits this unique ID and the middleware of the scanner interprets it.

NFC software alert System

- Inventory system or, in the case of mall security systems, to trigger an alarm to indicate that you're carrying around a product whose tag was not deactivated.
- The read time of an RFID scanner to its tag can happen in less than 100 milliseconds!

NFC/RFID

- NFC tags share the same basic technology as that of retail RFID stickers in that they are passive and are meant for short-range scanning, specifically at a frequency of 13.56MHz.
- The biggest comparisons to make between NFC and the wider spectrum of RFID tags is that NFC, as its name would imply, is meant for very short range scanning of 1–4 cm.
- NFC tags are advertised to be scanable at up to a distance of 10 cm, but that would only occur under perfect conditions.
- Another large difference between RFID and NFC is the size of the data transaction.
  - RFID tags contain a 40-bit unique identifier and are read-only.
  - a small NFC tag can store 48 bytes of data, average around 144 bytes, and go up to 8 kilobytes (8,152 bytes) for larger tags.
- Its data can also be rewritten by any reader if the tag is not write-protected.
- https://www.youtube.com/watch?v=7atphSqrvAc

The NDEF Data Format

- NFC standards are regulated by various bodies including
  - the International Organization for Standardization (ISO),
  - International Electrotechnical Commission (IEC),
  - European Telecommunications Standards Institute (ETSI), and
  - ECMA (the European association for standardizing information and communication systems)
  - NFC Forum

NFC Forum

- As defined by the NFC Forum, the standard data format for NFC-compliant devices and tags is a lightweight binary message format named *NFC Data Exchange Format, or NDEF for short.*
- *This* data format is comprised of an encompassing *NDEF message container that can contain one or* more NDEF records.

NDEF record

- An *NDEF record carries application data (commonly referred to as the **payload**) and additional* meta data to help NFC applications quickly parse the payload during a data transaction.
- Alongside the payload, each NDEF record must define **meta data** values for the payload, such as **type** and **length**. An additional identifier URI is optional

Android NFC APIs for Inventory Tracking System

- **Payload length: An unsigned integer indicating the size of the payload measured in octets.**
- **Payload type: An arbitrary type as declared by the developer for its specific application**, Ex: NFC *Smart Poster,* NFC *Signature*
- **Payload identifier: An optional and arbitrary URI-based value set by the developer.**

How and Where to Buy NFC Tags

- How much data do you want to store on it?
- Do you want to be able to write-protect it? And
- what environment will the NFC tag be deployed to?

NDEF-compatible NFC Tags

TABLE 11-1: Compatible, Commercially Available NFC Tags

NFC FORUM TYPE	POPULAR PRODUCTS OF THIS TYPE	OPERATIONS SPECIFICATIONS	REWRITE CAPABILITIES	AVAILABLE MEMORY	COMMUNICATION SPEED	PRICE RANGE (PRICE PER UNIT)
1	Broadcom Topaz	ISO 14443A	User rewritable; can be marked as read-only by user	96 bytes, expandable to 2KB	106kbit/s	Low (~$1-2 USD)
2	MIFARE UltraLight	ISO 14443A	User rewritable; can be marked as read-only by user	48 bytes, 144 bytes is common, expandable to 2KB	106kbit/s	Low (~$1-2 USD)
3	Sony FeliCa	JIS X 6319-4	Manufacture preconfigured to be read-only or re-writable.	variable, theoretical 1MB	212kbit/s or 424kbit/s	High (~$8-10 USD or higher)
4	NXP DESFire, NXP SmartFX	ISO 14443A, ISO 14443B	Manufacture preconfigured to be read-only or rewritable.	4KB for DESFire, up to 32KB for SmartFX	Up to 424kbit/s	Medium-High (~$3-4 USD)

Storage Size versus Price versus Security Trade-off

- Consider a scenario in which you want to share a picture.
- Attempting to encode even a very small JPEG thumbnail photo would cause your storage requirements to skyrocket to 3000 bytes, which would increase the costs of the NFC sticker.
- Instead, it would be better to embed a link to an online resource that the Android application would then download after scanning the NFC tag.

Storage Size versus Price versus Security Trade-off

- Type 1 and Type 2 tags are very similar, however the least expensive and most widely available NFC chips are the NFC Forum Type 2 tags sold under the MIFARE UltraLights brand owned by NXP Semiconductors.
- A shortened URL might consume 23 bytes, a plaintext sentence containing “The quick brown fox jumps over the lazy dog” uses 51 bytes, and a custom MIME type to deep-link to content within an app might use around 100 bytes.

Write Protection

- some tags are more appropriate for prototyping or controlled environments because their data can be rewritten using any NFC reader/writer, including those found on mobile phones.
- MIFARE Classics can be write-protected only by the manufacturer.

Form Factor

- Another consideration to keep in mind when purchasing NFC stickers is the surface that you will be sticking them onto.
- Paper, fabric, wood, plastic, and other non-conductive materials shouldn’t cause any problems, but take care if you are applying to metal surfaces.
- Because metal is conductive, you should look for “metal isolated” tags that are thicker than regular stickers.

Form Factor

- For extra environmental protection of your NFC stickers, buy “outdoor” or “laundry” type tags that are water-resistant or waterproof.
- If you don’t want to use stickers, plastic-encased NFC tags in mthe form factor of contactless credit cards and key fobs are also an alternative.

General Advantages and Disadvantages of NFC

- https://www.youtube.com/watch?v=Gbv2BIi9i58
- Low Power and Proximity Based
  - Turning on NFC scanning for your device is described in the “Enabling NFC in the Settings” section later and, once enabled, your device can be left to scan for tags whenever the screen is on with very little power draw on the battery.

Low Power and Proximity Based

- The advantage of NFC tags over barcodes or QR codes (aka 3-D barcodes) is that you don’t need line of sight.

Small, Short Data Bursts

- Although NFC-enabled devices such as the Nexus S do enable peer-to-peer transactions, NFC is not to be used for verbose communications between two devices.
- The NFC standard currently supports data rates of 106kbit/s, 212kbit/s , and 424kbit/s, which is fine for data transactions below 4KB. Bluetooth is a mid-range wireless technology that works within a 10-meter range and transfers data at a rate of 2.1Mbps.
- However, Bluetooth requires a pairing process that can be quite cumbersome, so it makes sense to use NFC to help quickly authenticate the pairing process and then hand it off to Bluetooth to continue the communications.

Singular Scanning

- If you are attempting to scan multiple items at once, you should be aware that only one NFC tag can be reliably scanned at a time;
- and considering the distance limitations of fewer than 10 cm or less, it’s unlikely the scannable space would allow for more than one item at atime

Security

- The short range of the NFC chip is its biggest security feature.
- NFC chips must be held within centimeters of the reader, making it harder for “sniffers” to find out if you are carrying an NFC-enabled device.
- The data on an NFC tag can also be encrypted before writing to it using your own encryption schema, such as using MD5 or AES, and
- certain tags can be made read-only by the user or the manufacturer.

Card Emulation

- *Card emulation is the capability of an NFC chip on a mobile device to act like a contactless smartcard,* such as a PayPass™ or payWave™ credit card, when presented at retail store terminals.
- Google Wallet uses the Secure Element, however, it is important to note that Google has reserved not to open up any public APIs to emulate cards on Android phones.
- https://www.youtube.com/watch?v=iuvyN4iZiP8

Android-specific Advantage: Intents

- The Android intent filter system is a huge advantage to building low-friction interactions with NFC.
- You don’t need to be redirected to a URL like a QR code might.
- The detection of an NFC tag can deep-link into an app already installed on your phone or redirect you to Google Play to download the app.

Required Hardware

- The biggest disadvantage that NFC has in the Android ecosystem is the availability of phones and tablets that have built-in NFC readers at the moment.
- Android devices that can currently read and write NFC tags include: the Google Nexus line of phones

NFC app Development

- https://www.youtube.com/watch?v=n-8Aq3tp5lE