

TECHNOLOGY *for* SOLUTIONS

TECHNOLOGY *for* PEOPLE

Alternatives to Bar Coding: RFID and RTLS

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Speaker Background

- Currently employed by FHT, Inc, a subsidiary of Baxa Corporation, as Chief Pharmacy Officer and Chief Technology Officer.
- Previously employed by Baxa Corporation as their Director of Technical Support.
- Past Chairman of the American Society of Health-Systems Pharmacists (ASHP) Section on Pharmacy Informatics and Technology (SOPIT).



Conflict of Interest Statement

- I have no conflicts of interest, real or apparent, related to this subject.
- I am the immediate past-chairman of the ASHP Section on Pharmacy Informatics and Technology; opinions expressed are my own, and not the policy or position of the American Society of Health System Pharmacists.



What we are going to cover

- Why consider alternatives to bar coding?
- What is RFID and how does it work?
- How could RFID affect BCMA as a practice?
- Is RFID practical?
- What is RTLS and how does it relate to RFID?
- Why use RTLS in healthcare?
- What would medication administration look like with RTLS applications?
- Overall comparison



What's good about bar coding?

- Inexpensive
- Lots of competition in the hardware and software marketplace = low cost
- Technology is mature
 - Most scanners autodiscriminate a wide variety of symbologies
 - Setup is therefore simple
 - Where configuration is required it can be scanned in
 - Hardware is generally interchangeable



Scan Stand Mode

When a unit is in Scan Stand mode, it remains idle as long as it sees the Scan Stand symbol. (See *Scan Stand Symbol* that follows.) When a different code is presented, the imager is triggered to read the new code.

Note: The imager automatically adjusts the illumination LEDs to the lowest light level possible to maintain a good lock on the Scan Stand symbol. When a symbol is presented, the imager's light levels adjust to the saved setting (see LED Power Level on page 4-9). This mode requires at least 50 lux of ambient light to operate correctly.



Scan Stand Symbol

When a unit is in Scan Stand mode, the LEDs shine at the Scan Stand symbol on the base of the stand which tells it to remain idle. When the Scan Stand symbol is covered, the imager turns the LEDs on at the configured power level (Default High) and attempts to find and decode bar codes in its field of view.



Presentation Mode

Note: This mode requires at least 50 lux of ambient light to operate correctly.

Scanning the bar code below programs the imager to work in Presentation Mode. Presentation Mode uses ambient light to detect bar codes. The LEDs are off until a bar code is presented to the imager, then the LEDs turn on automatically to "read" the code. If the light level in the room is not high enough, Presentation Mode may not work properly.



What's good about bar coding?

continued...

- Current technologies can produce large amounts of data in a single scan – reference data sets not necessarily required.
- Lots of data standards in place
 - GS1
 - HIBCC
- Has stopped errors
 - Brigham & Womens' reports
 - 3% wrong product selection in pharmacy



Bar code contains full HL7 I.V. description of about 100 characters.



So what's wrong with it?

- Requires human compliance – what doesn't get scanned isn't known
- Requires line-of sight – may require disturbing/moving patient to get a scan
- Scanner cannot tell the difference between scanning 10 items and scanning the same item 10 times (this may change with proposed barcode serialization from FDA).
- Fatigue – scanning a large number of items



So what's wrong with it?

Continued...

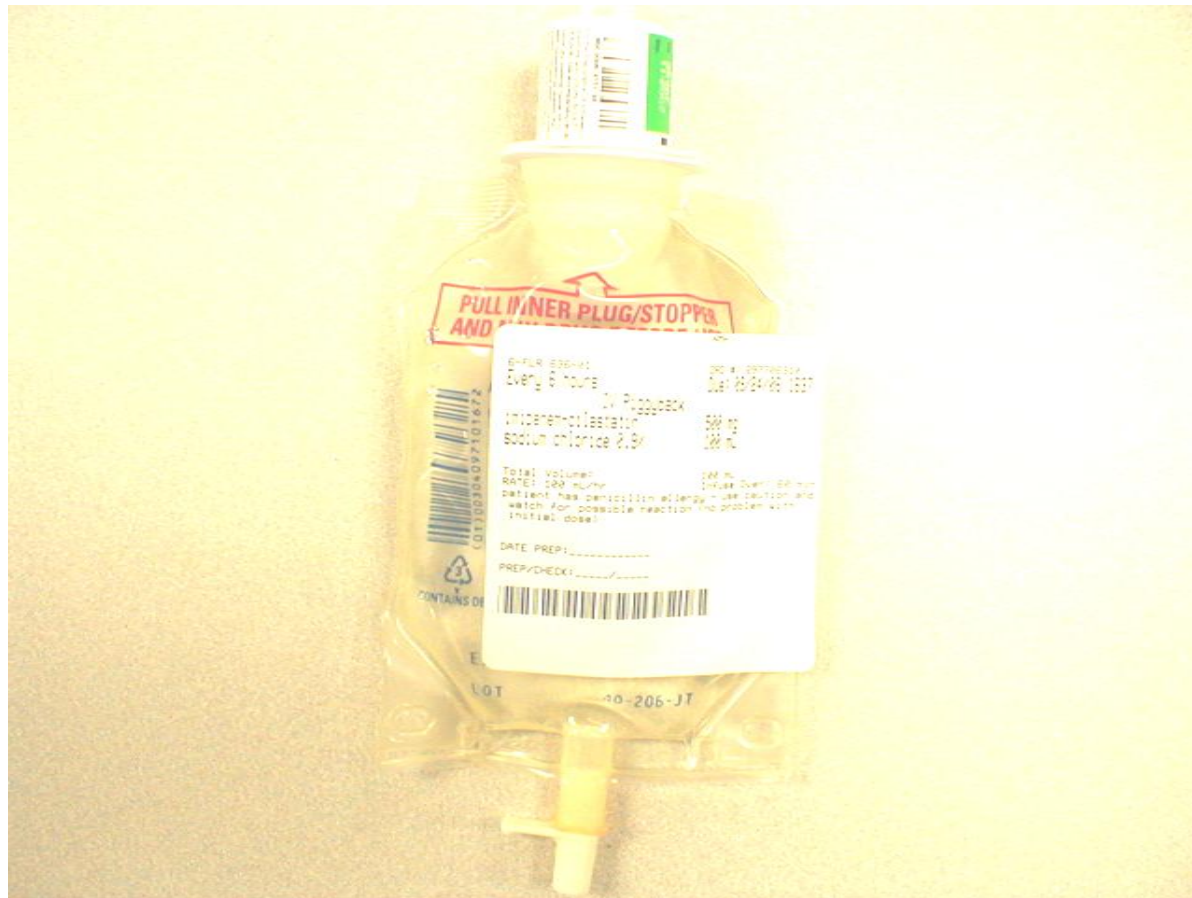
- Relies on print quality – damage to the printed surface can result in unreadable codes.
- Data is fixed at the time of printing; there is no way to accumulate more data on the way.
- Scanning on irregular surfaces is difficult
- Scanning on certain container types is difficult (e.g. IV bags)
- Can't tell if you scanned it already
- Which bar code do I use?



So what's wrong with it?

Continued...

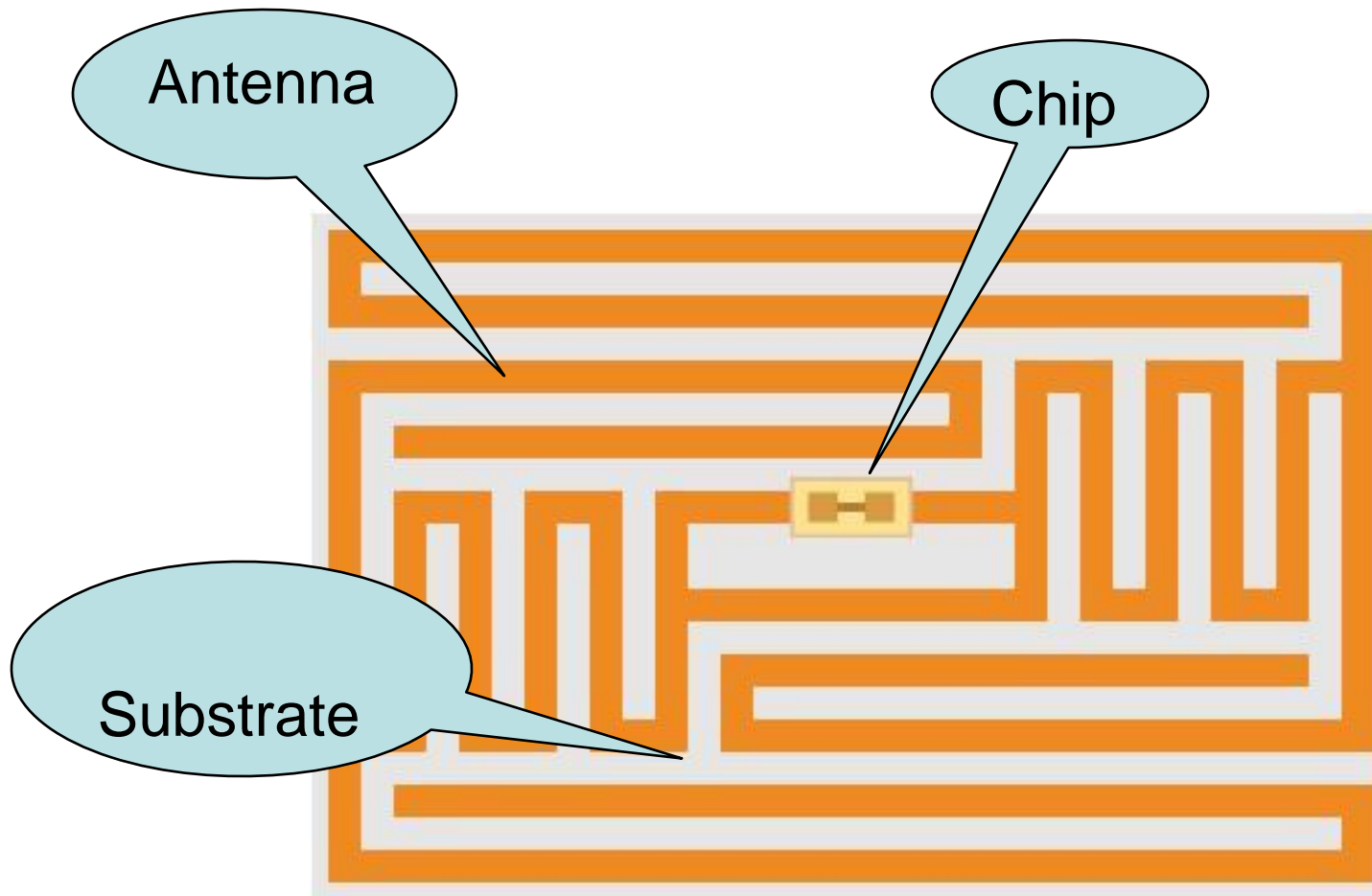
- Which bar code do I use?



What is RFID

- Radio Frequency Identification
- Passive –
 - Chip plus antenna
 - Substrate for carrying the chip and antenna
 - Transponder (scanner) activates chip with a radio signal that causes it to reply with its data contents
 - Each chip has a globally unique identifier – a license plate
 - Chip may store data, get information written to it.
- Active –
 - Tag has a power source, continually signals its presence
 - Scanner just needs to listen for transmissions from chips





At minimum, every chip has a unique ID – a license plate

Some can store kilobytes of data



The License Plate

- Promoted by EPC (www.EPC.org) looking for widespread adoption that will drive tag price down to \$0.05
- 96-bit tag –
 - Provides 79,228,162,514,264,337,593,543,950,336 unique combinations
 - That's enough unique “license plates” to provide a unique identifier for 6,000 doses/day at 10,000 hospitals for over 3×10^{19} years!
- Other tags use serial numbers encoded with 25 to 36 bits plus data storage representing between 33 million and 68 trillion unique identifiers.



The License Plate

continued...

- The “license plate number” comes built into the chip
- Presumes there is some way of assigning the chip to a particular entity (perhaps in a label)
- Presumes there is some mechanism by which the scanning system can read the “license plate” and query a database to learn what it represents.
- HOWEVER, a tag with additional data capacity could carry a description of the tagged item in addition to the “license plate”
- But the license plate effectively prevents scanning the same item multiple times.



Multiple Frequencies

- **Low Frequency** – less than 135 KHz – provides limited read distance (0.33 m), requires very little power, and good penetration of metal and water-containing objects.
- **High Frequency** – 13.65 MHz – read range up to 1 m, better data throughput, and good around metals
- **Ultra High Frequency** – 860 – 960 MHz – read range is in 10s of feet, faster data transfer, but require more power.
- **Microwave** – 2.45 GHz - expensive



Different frequencies have different performances

	<i>13.56MHz</i>	<i>915MHz</i>	<i>2.45GHZ</i>
Range (write typically 50% of read) depending on transponder, antenna size, number of antennas	.25 to .5 m	3 to 5 m	.5 to 1.m
Human Body Effects	Detuned by tissue	Blocked by tissue	Blocked by tissue
Regulatory	Worldwide OK except Japan	No Europe, U.S. OK	Europe OK, U.S. OK

http://www.databrokers.net/rfid_overview.html

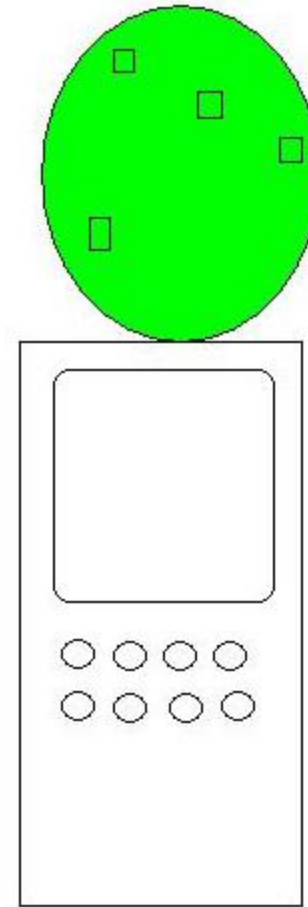
Tags and scanners must be matched to frequency –

A tag designed for short-range reading cannot be read by a long-range reader



Reading is different

- Line of sight not required
- May be able to read around corners
- Creates a sensing bubble and reads everything in the bubble
- Size of the bubble depends on frequency and power of signal
- Typically can read and identify 30-60 items per second
- Very hard to “aim” it at just one item



Other considerations

- Signal strength varies inversely with distance
 - Inverse square law ($1/d^2$)
 - Environmental interference (metals, water) can make distance degradation as much as $1/d^4$
- Data throughput also varies with distance and power
 - 13.65 MHz can vary between 2 MBPS at short range and 75 KBPS at the extent of its range
 - That is more than a 25-fold difference in data speed
 - Compare to a bar code scanner that normally runs at serial speeds of 9.6 to 115 KBPS



Cost

- Chips are now down to approximately \$0.10 (in quantity)
- Antennas and substrates (e.g. labels) at cost, probably \$0.20 per tag is a reasonable estimate for a license plate
- Data capacity adds more...
- Still not price-competitive with bar coding



How would BCMA be different?

•Bar code

- Must physically scan each dose
- Must scan patient
- Must scan or otherwise identify caregiver.
- Bar codes on curved or irregular surfaces hard to scan
- May need to move patient to “see” wristband

•RFID

- Single scan identifies caregiver, all present doses, and patient
- Surface of container not an issue
- Patient ID always available
- Administration documented on tag on dose?



Imagine....

- Place doses on a tray near the patient
- Make one scan... the scanner returns:
 - Identity of the patient
 - List of medications present within the scan field
 - Each marked as appropriate/inappropriate, expired or usable, early or late, or incomplete (more needed to satisfy this dose).



RFID Has been documented in Medication Administration

- RFID has been used at Saint Clair Hospital in Pittsburgh, PA
- Am. J Health-Syst Pharm (63) December 15,2006: 2431-2435
- Used only for certain types of drugs (high-cost)
- Used for caregiver and patient identification
 - Simplified patient interaction
 - Eased some manipulations required for marked doses
- Used in combination with BCMA



Are RFID and Bar Coding Mutually Exclusive?

- There are a variety of printers available that will print on labels containing RFID tags
- These printers can also write data to the RFID tag.
- Requires dual-purpose scanners that can scan both bar codes and RFID tags





Other Medication-related Applications

- One Australian research firm has developed an RFID tag with a built-in temperature sensor that can document that a dose has (or has not) stayed within a temperature range.
- Could be used to facilitate medication reuse



How is active different?

- Battery powered – continually shouts out its information
- Can be read/write
- Used in Real Time Locator Systems

	Active RFID	Passive RFID
Power	Battery operated	No internal power
Required Signal Strength	Low	High
Communication Range	Long range (100m+)	Short range (3m)
Data Storage	Large read/write data (128kb)	Small read/write data (128b)
Per Tag Cost	Generally, \$15 to \$100	Generally, \$0.15 to \$5.00
Tag Size	Varies depending on application	"Sticker" to credit card size
Fixed Infrastructure Costs	Lower - cheaper interrogators	Higher - fixed readers
Per Asset Variable Costs	Higher - see tag cost	Lower - see tag cost
Best Area of Use	High volume assets moving within designated areas ("4 walls") in random and dynamic systems	High volume assets moving through fixed choke points in definable, uniform systems
Industries / Applications	Auto dealerships Auto manufacturing Hospitals - asset tracking Construction Mining Laboratories Remote monitoring IT asset management	Supply chain High volume manufacturing Libraries / book stores Pharmaceuticals Passports Electronic tolls Item level tracking

<http://www.atlasrfidsolutions.com/active-vs-passive.asp>



Real-Time Location Systems

- Often use active RFID tags, also Infra-Red, ultrasound
- Networks of sensors throughout the hospital
- Record every time an active tag “shouts” as it moves by
- Tells you when and where a tag (and whatever was attached to it) signaled the receiver
- Multiple receiver triggers permit something like triangulation
- Typical Applications:
 - Patient Location
 - Asset Tracking
 - Caregiver tracking
 - Hands-off computer authentication



Real-Time Location Systems

continued...

- Resolution can reach down to a patient room, unlikely to resolve to one bed vs another
- Typically too expensive to deploy for medication tracking, but could be used to track extremely expensive doses using the network built to track more expensive assets (such as IV pumps).



Real-Time Location Systems

continued...

- If installed for any cost-effective purpose (e.g. asset tracking), then the infrastructure is in place for other uses.
- Consider as component of an automated medication verification system:
 - Acquires location of caregiver when patient is scanned –
Where was the medication actually given? Am I in the correct room?
Is the scanning being done at the bedside?
Tracking actual time spent administering medications?
Big Brother?
 - Is there an IV pump on the floor I can use?
 - Does the patient already have a pump?



Conclusion

- RFID can overcome some of the problems associated with bar codes
 - Need to scan each item separately
 - Human compliance issues
- RFID is unlikely to replace bar codes any time soon
 - Too costly
 - Hard to “aim”
- A cost-effective RFID system could improve compliance and reduce effort and training associated with BCMA

