

RTLS Performance Considerations in SAW Based RFID Systems

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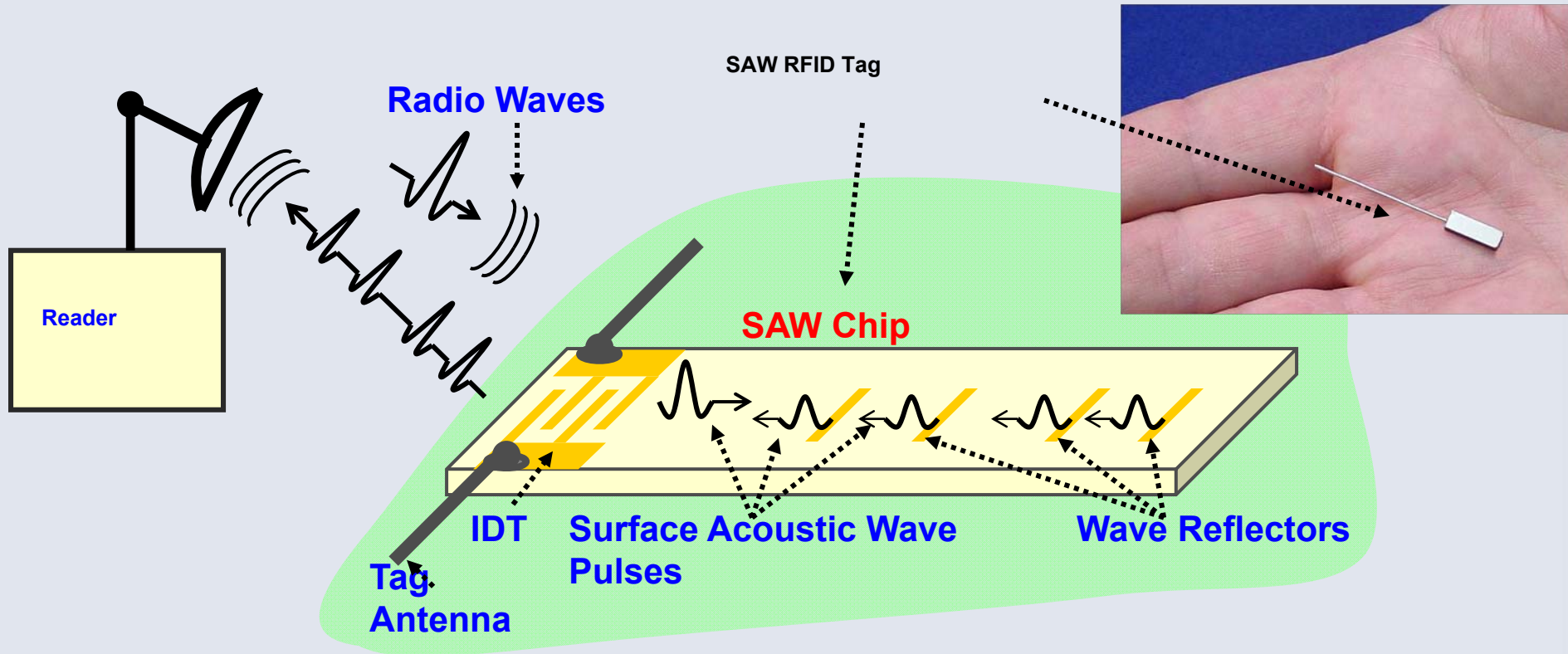
April 14, 2010



Outline

- Basic SAW RFID System Operation
- Characteristics of SAW RFID systems that have potential application for RTLS
- Monostatic systems – RTLS example
- Monostatic systems with beam steering
- Multiple reader RTLS
- Summary

Passive SAW Based RFID



- **SAW Tag Requires No DC Power**
 - **Range is Determined by Round Trip Delay**
 - **Received Signal Must Exceed Noise Floor**
- © RFSAW, 2010

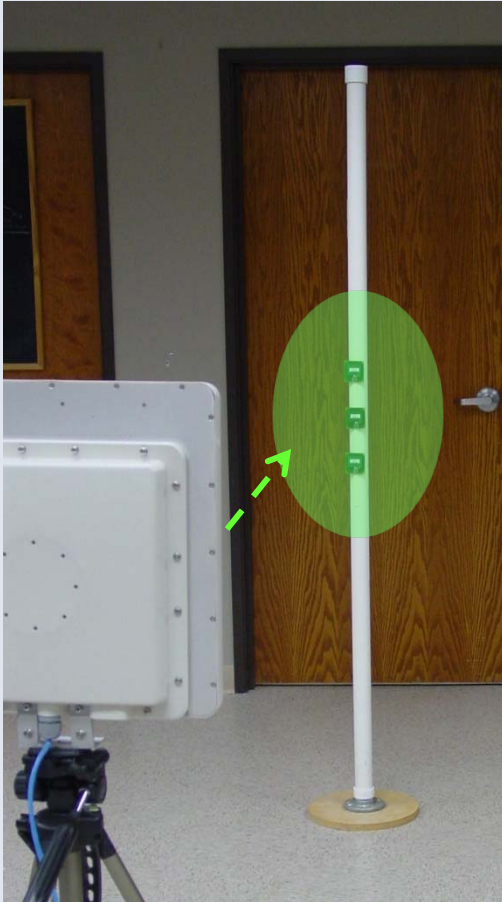
SAW RFID System



Characteristics Useful for RTLS

- Tag reading process requires:
 - Tag distance be determined
 - Tag temperature be determined
- Managing interference in multiple reader configuration is straight forward
- Synergy often exists between antenna configurations for anti collision and RTLS
- Reader power can be very low
- Distance resolution ~ 0.5 ft.
- Distance accuracy ~2 ft. without individual tag calibration

Mono Static Systems



- Single reader with single antenna
- Location capability set by antenna directivity and tag distance
- Simple arrangements can be useful in many applications

Animal Health RTLS Example

- Objective: Identify animals that are potentially ill by verifying feeding habits
- Animal health is a major concern in feedlots and food supply chains
- Monostatic SAW RFID system used for trial
- Tagged animals consisted of 3 beef calves on central Texas ranch

Animal Tagging RTLS Example



Animal Tagging RTLS Example



SAW Tag on Cattle Ear Tag

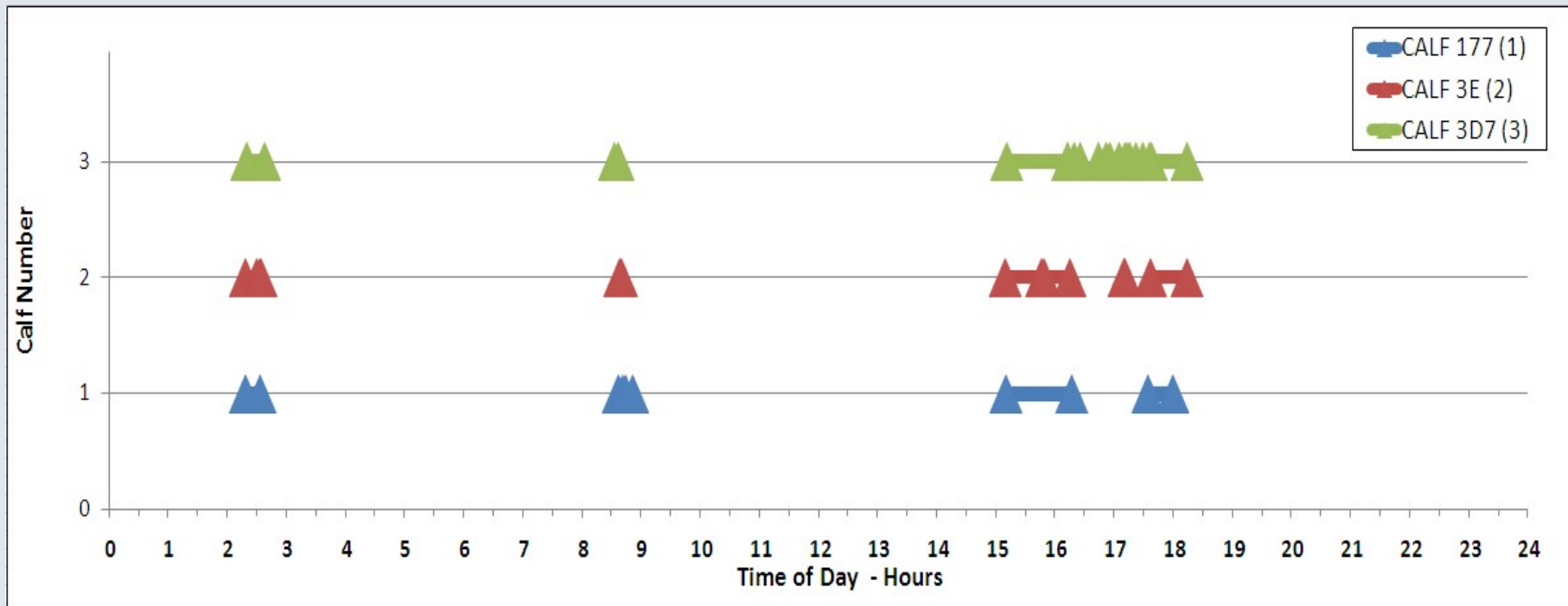


3 Calves at Feed Bunk



24 Hour Calf Tracking Data

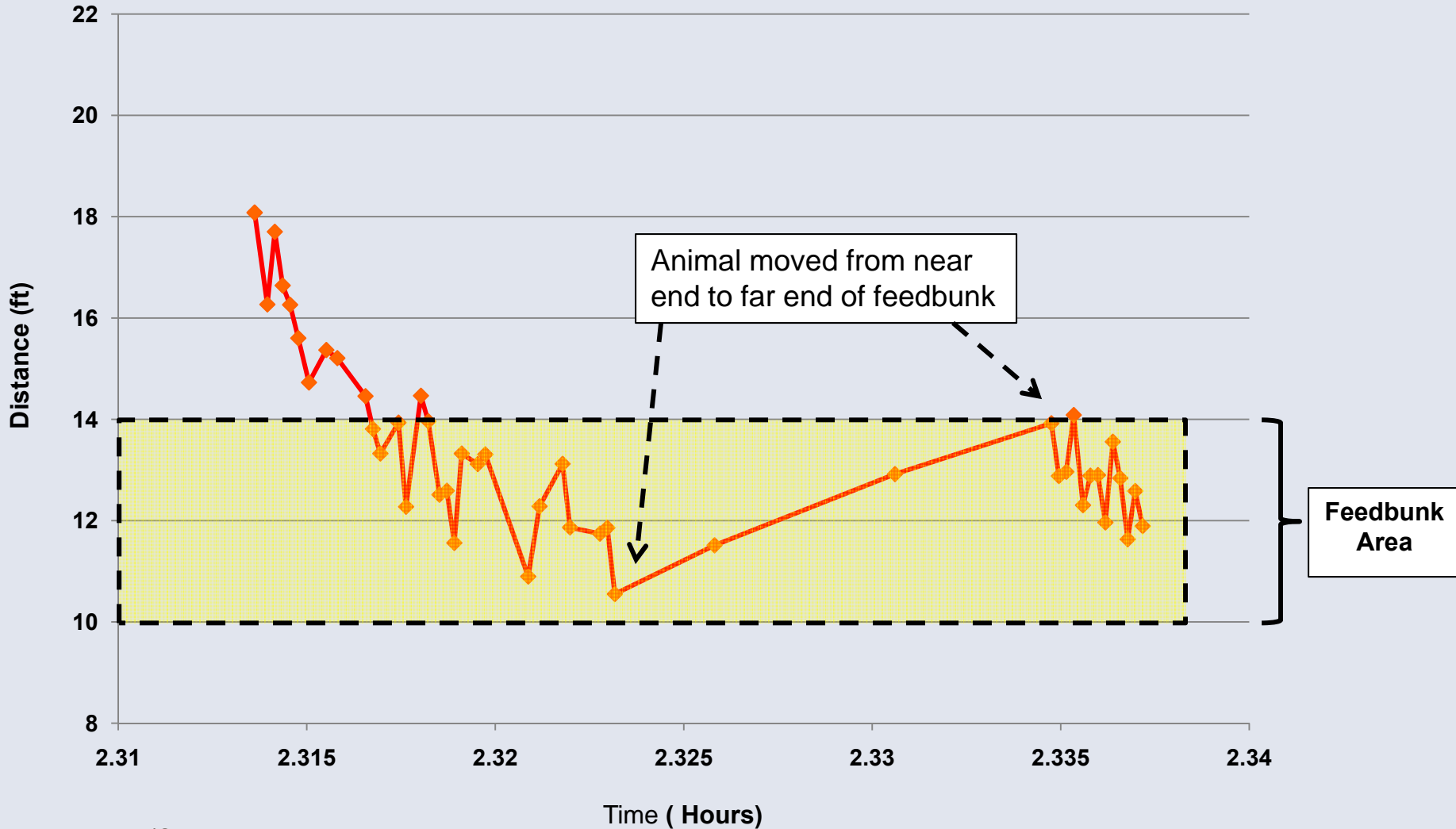
January 30, 2010



Reader Log for Single Tag

HexTag Number	Date and Time	RT Delay (nsec)	Temperature (Deg C)
02000000003E	2010-01-30T08:18:49.024Z	36.2	-0.24
02000000003E	2010-01-30T08:18:50.246Z	32.5	0.41
02000000003E	2010-01-30T08:18:50.957Z	35.4	0.14
02000000003E	2010-01-30T08:18:51.703Z	33.2	0.05
02000000003E	2010-01-30T08:18:52.415Z	32.5	0.18

RTLS Animal Tracking Data for Animal 3E



Scanning Fan Beam Reader





Last Data Decoded, Queue: 0
Saturday, November 21, 2009 16:52:19.694

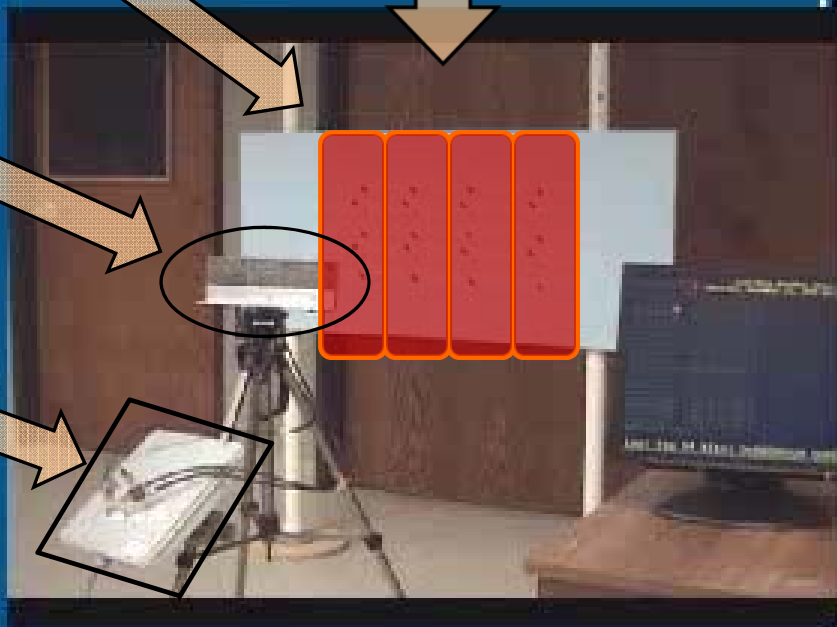
0x020000000027A 3.2ft 22.9°C (30) 18
 0x020000000018F 3.1ft 23.0°C (24) 18
 0x0200000000250 3.2ft 22.9°C (24) 25
 0x0200000000087 3.0ft 22.7°C (27) 19
 0x020000000009D 3.0ft 22.5°C (26) 18
 0x0200000000156 3.0ft 22.5°C (26) 18
 0x020000000000C 3.9ft 24.4°C (21) 9
 0x0200000000185 3.5ft 22.0°C (28) 9
 0x0200000000237 3.5ft 22.5°C (29) 11
 0x0200000000221 3.1ft 20.8°C (29) 9
 0x0200000000187 3.5ft 22.4°C (27) 14
 0x02000000002E5 3.4ft 22.0°C (25) 8
 0x0200000000075 3.6ft 23.0°C (25) 8
 0x0200000000111 3.8ft 23.1°C (25) 8
 0x020000000020D 2.6ft 23.4°C (25) 8
 0x0200000000236 3.1ft 23.0°C (24) 12
 0x02000000000FB 3.1ft 23.0°C (27) 7
 0x0200000000000 3.0ft 22.9°C (24) 7
 0x02000000000A1 3.0ft 22.9°C (25) 7

20 SAW Tags in Four Columns, 5 Tags per Column

Three Element Antenna Array

GST Reader with Beam Forming & Switching

Scanning Fan Beam

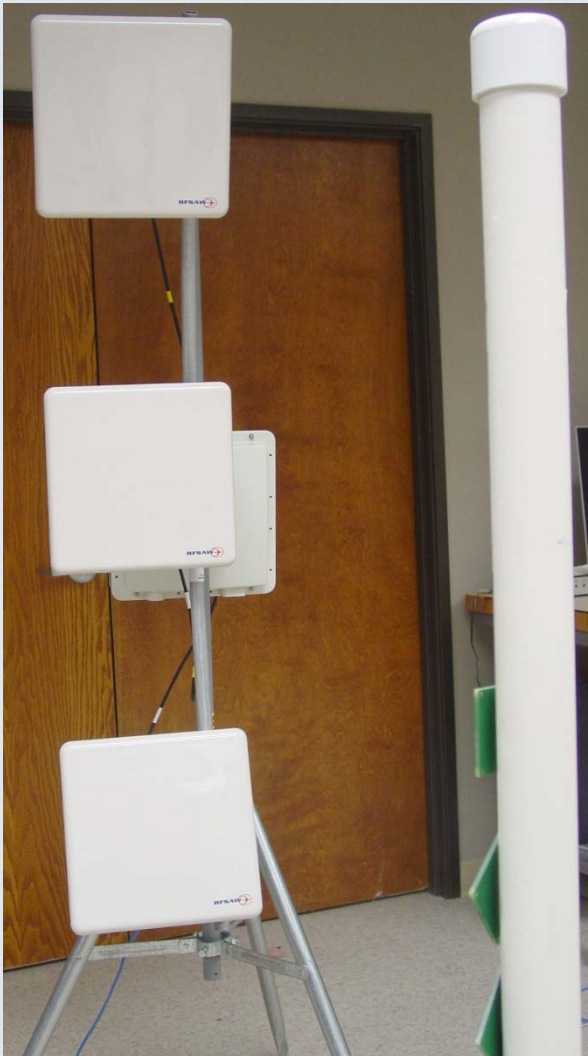


Distinct: 19 Total: 218

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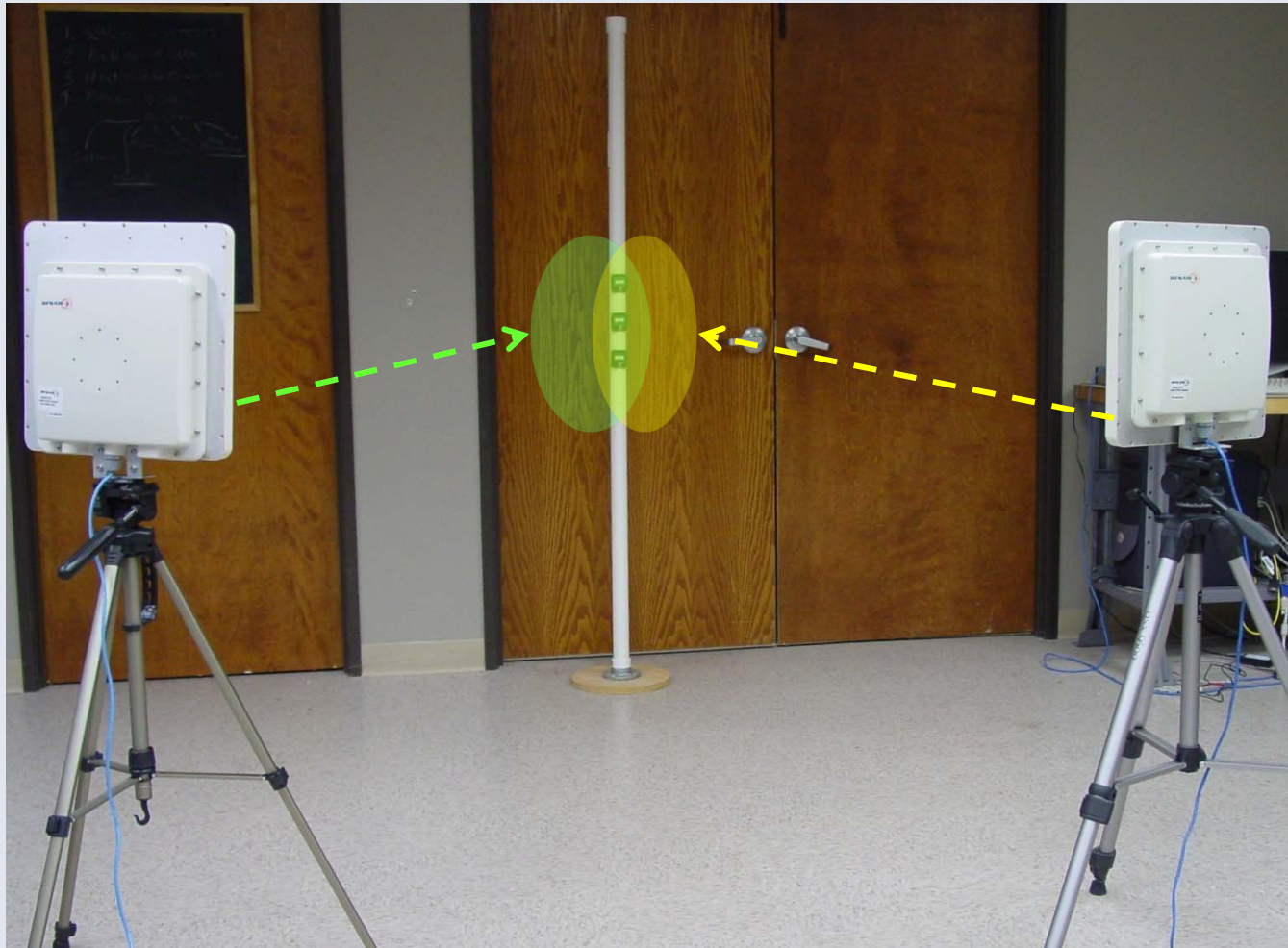
Last Tag 64 Bits: 0x000000200 0000027A

Beam Steering with Butler Matrix



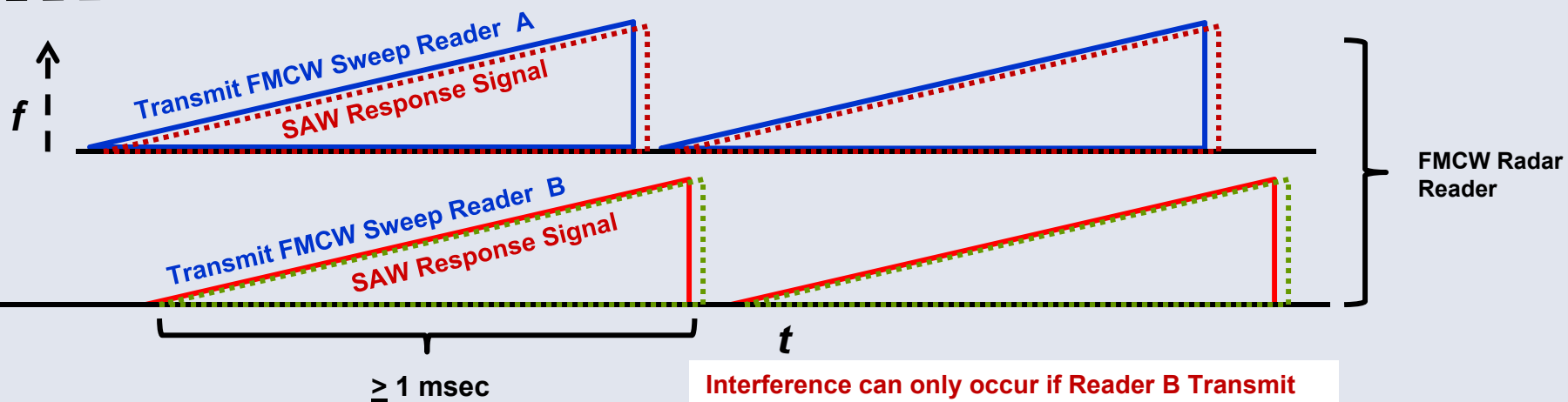
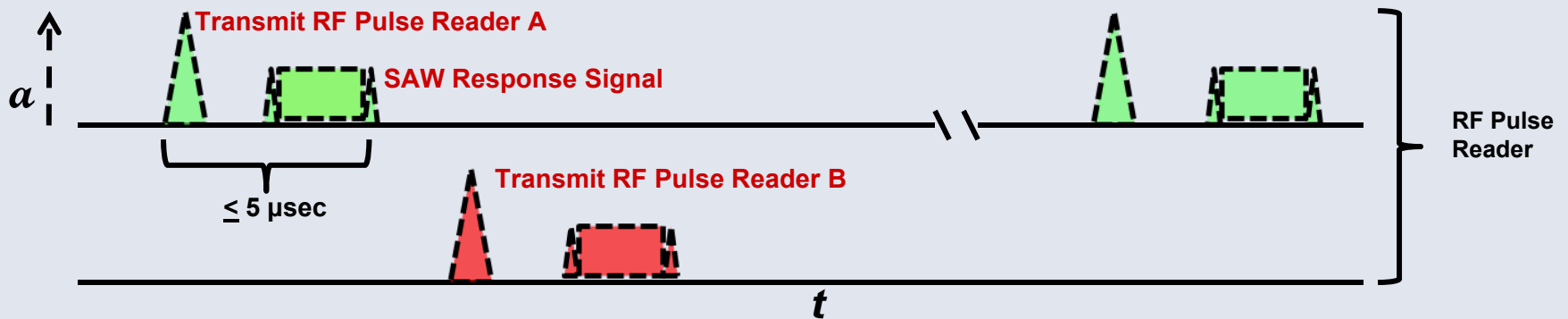
- Larger antenna for beam steering at longer tag distance.
- Produces multiple patterns in elevation plane.
- Single reader with switching and beam forming RF matrix for pattern control

Multiple readers RTLS



Multiple SAW Reader Interference

Interference can only occur if Reader B Transmit Pulse occurs during Reader A Response



Interference can only occur if Reader B Transmit Sweep start is $\leq 5 \mu\text{sec}$ from Reader A sweep start

Summary

- Distance measuring capability of SAW based RFID is very useful for RTLS.
- Distance reading resolution and accuracy are sufficient for many applications
- Temperature measurement is an important adjunct in some applications
- SAW Based RFID has significant potential for RTLS