



Migrating Passive RFID Solutions into Mainstream Healthcare Use:

Practicality, Affordability, and Powerful Performance Deliver an Advantage

Dr. William Howden
Chief Revenue Officer



ACCE gratefully acknowledges the sponsorship of this webinar by



ABOUT THE MODERATOR



Angelina Chiaracane-Guthrie, MS, CHTM

Department of Veterans Affairs

Biomedical Engineer

Member, Education Committee

Angelina is a Biomedical Engineer with the Department of Veterans Affairs of Tampa, Florida. She is responsible for the implementation of specialized equipment and complex capital projects. Previously Angelina worked for Kaiser Permanente in Northern California, serving as a Clinical Systems Engineer responsible for the Respiratory Care and Cardiovascular Services portfolios in the Region, and has prior experience as a Clinical Technology Manager developing standardization practices and documentation for service delivery.

Angelina received her Bachelor's Degree in Bioengineering from Florida Gulf Coast University, and received her Master's Degree in Clinical Engineering from the University of Connecticut.

MEETING LOGISTICS

- All attendees please have your microphones muted during the presentation.
- Submit questions to the panelists via the “Zoom Q&A” feature (not chat) at any time.
- If there is any urgent issue, please use the “chat” feature to communicate with the panelists.
- We will try to ask Ty, Skip, and Jon to answer questions not addressed during the webinar and distribute them to participants via email or post them to the ACCE website.
- Please remember to complete the webinar evaluation after attending. A link will be provided at the end.

ABOUT THE SPEAKER



Dr. William J. Howden ('Bill')

Chief Revenue Officer

Pycube, Inc.

Bill Howden is an engineering-centric executive, who serves as Pycube's CRO. He is responsible for Marketing, Sales, and the Coordination of Business Strategy at Pycube, and also contributes to the technical team.

Dr. Howden previously worked in Telecommunications for 33 years, designing, producing, deploying, and supporting Satellite and Telecom equipment and systems. He served in Engineering, Project Leadership, and Executive Management, with a long-term role as the VP/GM over a Fortune 500 Global Services Division.

After telecom, Bill pursued his passion for making 'Big Data' usable to Small & Medium Enterprises (SMEs), emphasizing Technology Adoption.

Dr. Howden holds a BSc in Electrical/Electronic Engineering, an MSc in Systems Engineering, and a Doctorate in Business with a focus on Data Analytics and Technology Adoption.

SESSION DESCRIPTION

Join us for an insightful and engaging presentation that delves into the fascinating world of Ultra High Frequency (UHF) Passive Radio Frequency Identification (RFID) technology. This presentation will provide an in-depth overview of UHF Passive RFID, illustrating its capabilities and exploring its numerous applications for healthcare.

Key takeaways from this presentation include:

- **Understanding the Fundamentals** – of UHF Passive RFID technology, including its operating principles, frequency range, and key components.
- **Gaining Insights into the Technology and Market Evolution** – of UHF Passive RFID
- **Discovering the Benefits** – of UHF Passive RFID, such as extended read range, improved data transfer rates, and low power consumption.
- **Exploring Various Applications** – of UHF Passive RFID in healthcare services and hospital/clinic operations.
- **Learning about Best Practices and Successful Case Studies** – leveraging UHF Passive RFID solutions to optimize business processes and enhance operational efficiency.

Whether you're a technology enthusiast, industry professional, or simply curious about the possibilities of UHF Passive RFID technology, this presentation will equip you to better understand and harness the power of wireless connectivity. Don't miss this opportunity to stay informed and get inspired by the potential of UHF Passive RFID.

DISCUSSION AGENDA

Introduction to Pycube

- *Who are we? Where did we come from? What is it we do?*

Overview of RFID

- *Origins*
- *Types of RFID Systems*
- *How it Works*

Challenges & Solutions in Healthcare Space

Features, Benefits, & Applications of Typical Systems

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OVERVIEW OF PYCUBE - BACKGROUND

- Founded in 2012 as an IT/Consulting Firm... Currently ~ 70 people
- Initial focus was creating affordable healthcare apps for individual practices
- Expanded to 'digitization'... Digitizing indexing, and hyperlinking legacy docs
- Became involved in fast-replenishment warehousing, accelerated by COVID
- Developed proprietary warehousing tools and systems to drive down costs
- Those tools evolved into our aktivu® and SyncSens® based customer solutions

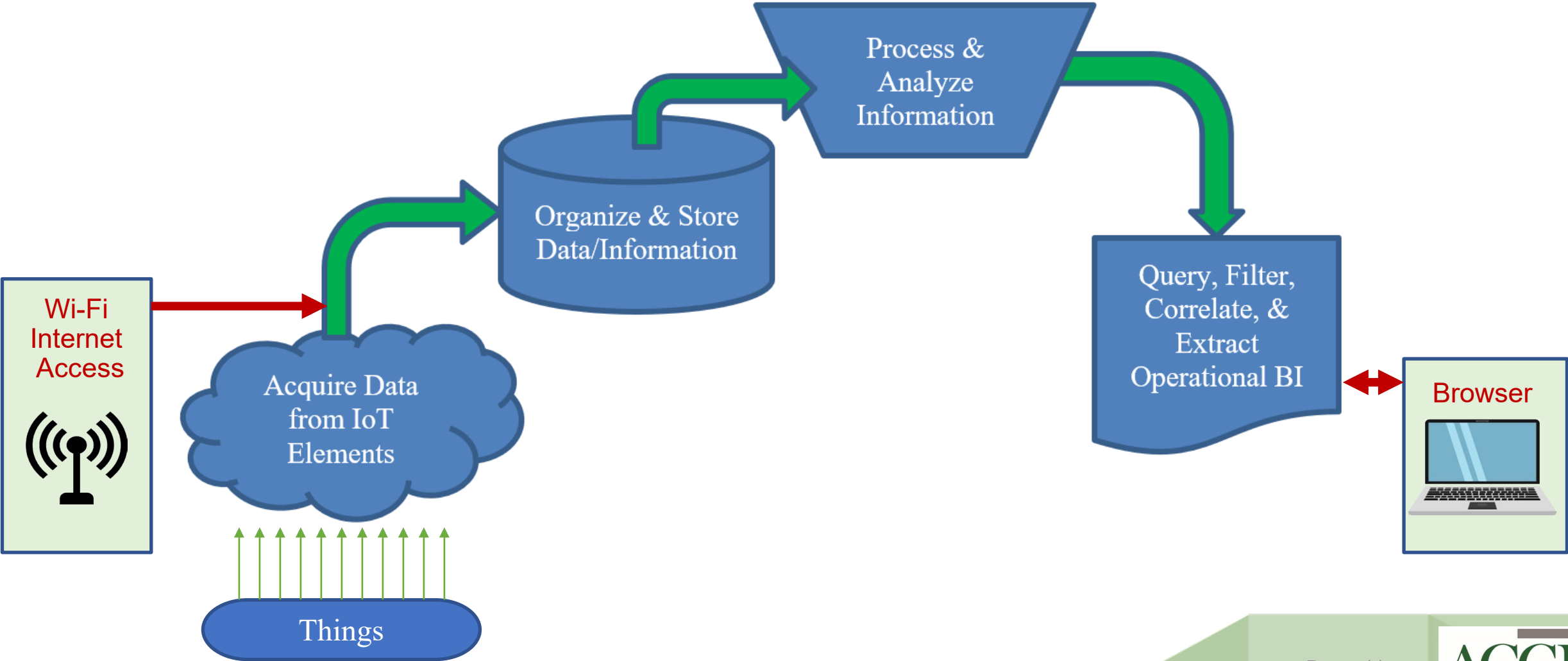
We are an emerging provider of workflow digitization & automation solutions

OVERVIEW OF PYCUBE - MISSION

- Develop, implement, and support innovative technology solutions.
- Specialize in Digital Transformation, Process Automation, and the use of RFID/IoT sensor data to create and visualize Business Intelligence.
- Enable our customers to...
 - *Improve Operating Performance (...efficiency, speed of results, patient care time...)*
 - *Reduce Chaos (... and cognitive overload, employee burnout, turnover...)*
 - *Lower their OpEx (... and in some cases CapEx).*

We are an emerging provider of workflow digitization & automation solutions

OVERSIMPLIFICATION – TYPICAL PYCUBE SOLUTION



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WHAT IS RFID?

RFID = Radio Frequency Identification

What it Does - RFID uses radio waves to identify people or objects. A device 'reads' information contained in a wireless device or "tag" from a distance without making physical contact or requiring a line of sight.

Information within and/or about the tag can provide...

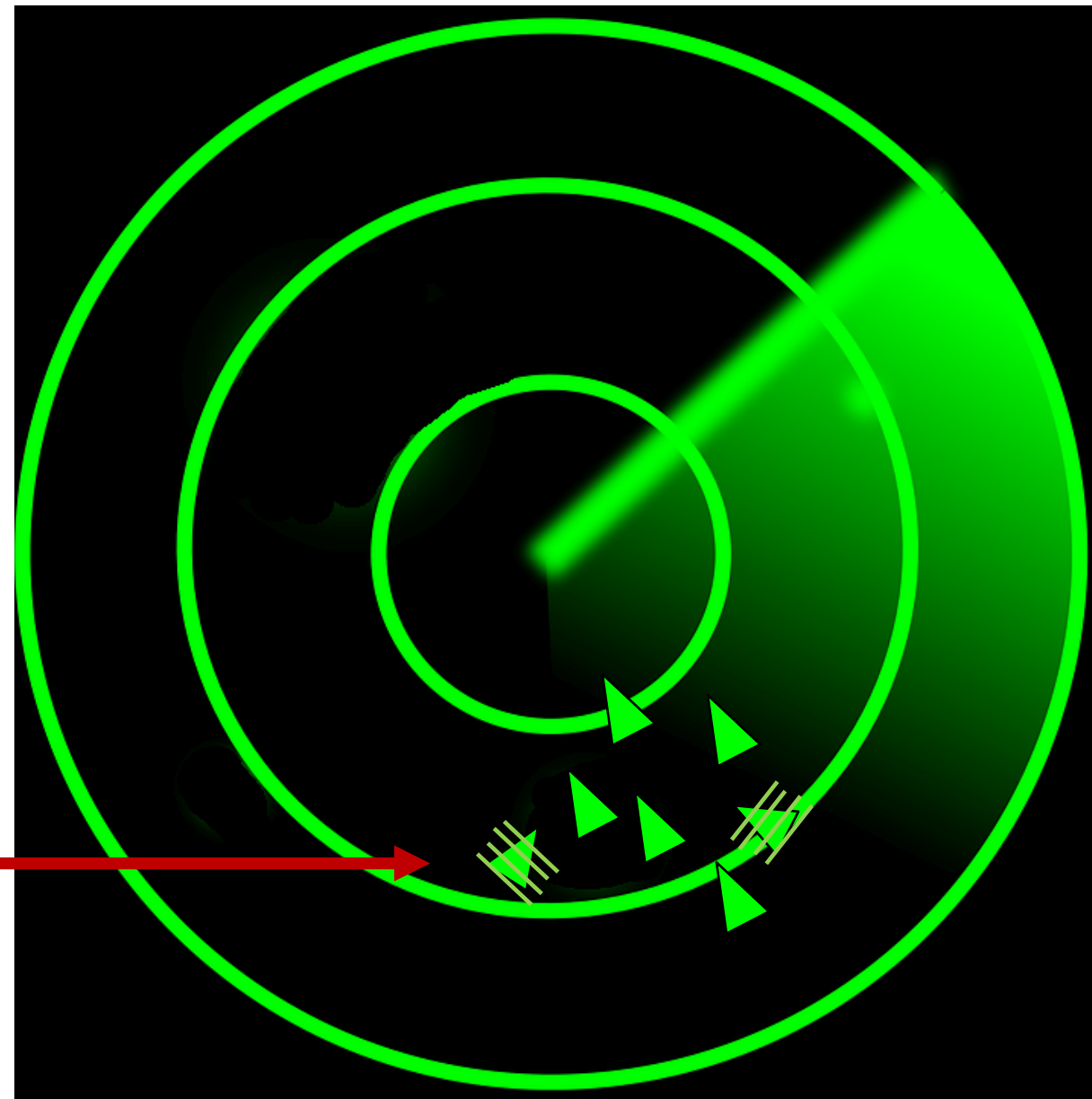
- **Identification** – Of the article associated with the tag
- **Location** – Of the article associated with the tag
- **Reported or Derived Measures** – Motion, Direction, Speed, etc...
- **& More** – In some cases, tags can report parametric info (temp, pressure...)

ORIGINS OF RFID - WWII

Technology Foundations – Radio & Radar

Earliest Origins – Late 1930's

- **The Problem:** All WWII forces were using radar to detect airborne aircraft. However, they could not differentiate between friendly and enemy planes
- **The Solution:** Britain developed the Identification Friend or Foe (IFF) system, fitting each British plane with a device that altered reflected Radar Signals identifying the aircraft as friendly.



EVOLUTION OF RFID

1940s – Harry Stockman publishes "Communication by Means of Reflected Power."

1950s – Heavy R&D for aircraft and transponder systems.

1960s – First commercial application emerged...

- ***EAS (Electronic Article Surveillance) is a 1-bit tag for retail (presence or absence).***

1970s – First modern RFID... 12-bit remote energized, passive backscatter w/memory

- ***Toll Collection, Early Entry Card Systems, Animal Tracking, Factory Automation***

1980s – Commercial Expansion... US & Europe Transportation Systems

1990s – Standards emerge to allow RFID to become more commonplace

2000s – Major Technological Advancements (Cheap Internet Connectivity, HW, SW)

- ***GaAs RF Receivers in Antennas increase distance, reduce size, and multiply RF power efficiency***
- ***Wi-Fi and Cloud Computing eliminate the need for big infrastructure (LANs, Processors, Servers...)***
- ***IC/ASIC Miniaturization enables sensitive pinhead-size chips and small tags***

PRIMARY AND SECONDARY **TYPES** OF RFID

Transponder Types

- **Active System** – Battery-powered tags, transmit an ID beacon to fixed infrastructure receivers, thru ethernet, to local processors, which triangulate to determine location. (Often colloquially called 'RTLS')
 - ✓ *Tradeoffs—Longer Range, but High Cost, Large Infrastructure, High Maintenance*
- **Passive System** – Transmitter-based power is beamed to a passive tag that 'wakes' and disturbs a reflection of the transmitted signal, with ID. Proximity, location reference tags, phase-array antennas, and/or triangulation all can determine location. (Both system types can be 'RTLS')
 - ✓ *Tradeoffs—Short and Mid Range, but Low Cost, Small or Zero Infrastructure, Low Maintenance*

Field/Range

- **Far Field** – RF antenna coupling, $>1 \text{ RF } \lambda$ (Assets, Inventory, Vehicles, People...)
- **Near Field** – Magnetic field coupling, $<1 \text{ RF } \lambda$ (POS, Entry Cards)
- **Low Power Near Field** – Magnetic field coupling, within an inch (Credit Card Readers)

RFID WITHIN THE RADIO FREQUENCY SPECTRUM

Frequency Band Typical Frequency	LF 125-134 kHz	HF 13.56 MHz	UHF (Low) 902-928 MHz	UHF (High) 2.45 & 5.8 GHz
Read Range	0.5~2m	<1m	>3m	Passive ~3m; Active ~15m
Cost	Relatively Expensive	Less Expensive	Least Expensive	Very Expensive
Penetration of Materials	Excellent	Better	Poor	Can be Good
Affected by Water?	No	To Some Extent	Yes	Highly
Power Source	Passive (Inductive)	Passive (Inductive)	Passive (Propagation)	Passive and Active
Data Rate	Slower (<1kb/s)	Moderate (~25kb/s)	Faster (~30kb/s)	Fast (up to 100kb/s)
Reading Multiple Tags	Poor	Good	Very Good	Great
Common Applications	Access control; Animal ID; Inventory Mgmt; Vehicle Immobilizers; POS	Smart Cards; Access & Security; Item level tracking; Passports; Library Books;	Logistics; Case/pallet tracking; baggage handling	Railroad car monitoring; automated toll collection
Health Care Applications	Medical wristbands; Access control; Inventory control;	Pharma; Access & Security; Item level tracking; Inventory transactions	RTLS; Asset Tracking; Infant/patient monitoring; sensors	RTLS, Nurse call stations; Utility monitoring

PASSIVE RFID – CONCEPT OF OPERATION

Generating a Reflected Signal... Consider:

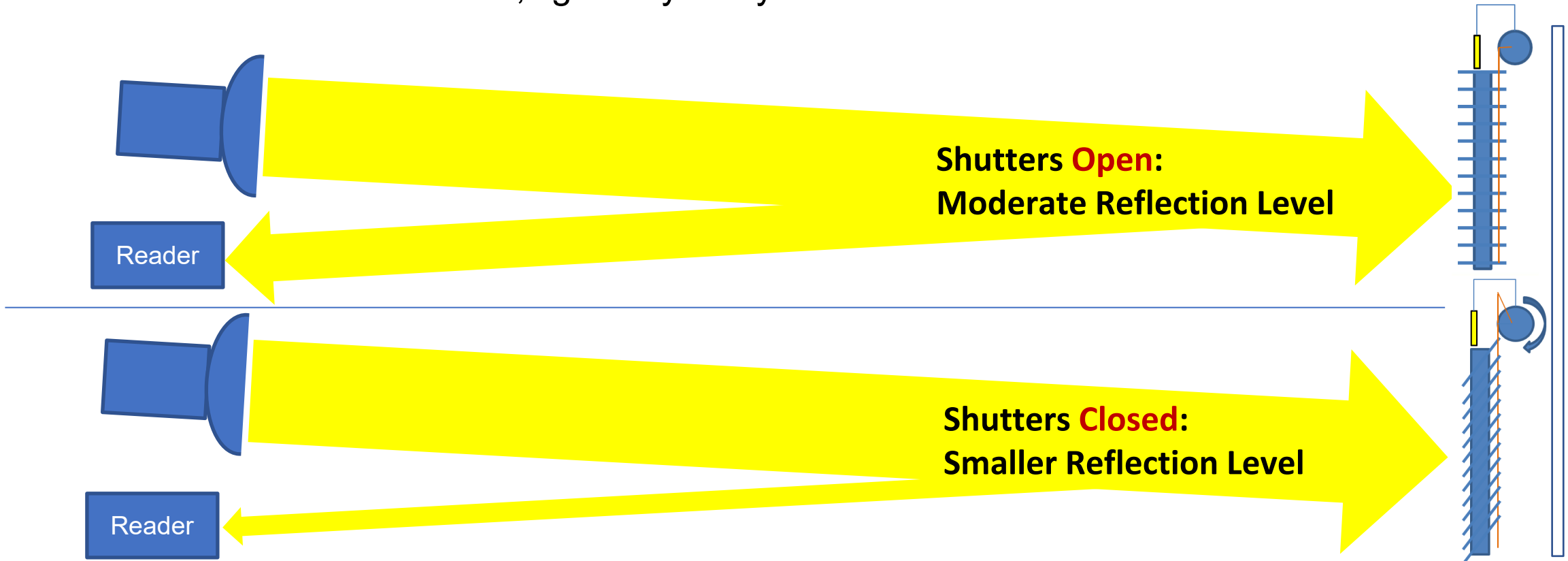
- A spotlight aimed at a white wall, with movable black shutters in front,
- Connected to a Photocell which harvests power from the light,
- And closes/reopens the shutters in a specific pattern/sequence using a motor.



PASSIVE RFID – CONCEPT OF OPERATION

Varying (Modulating) The Reflected Signal... When:

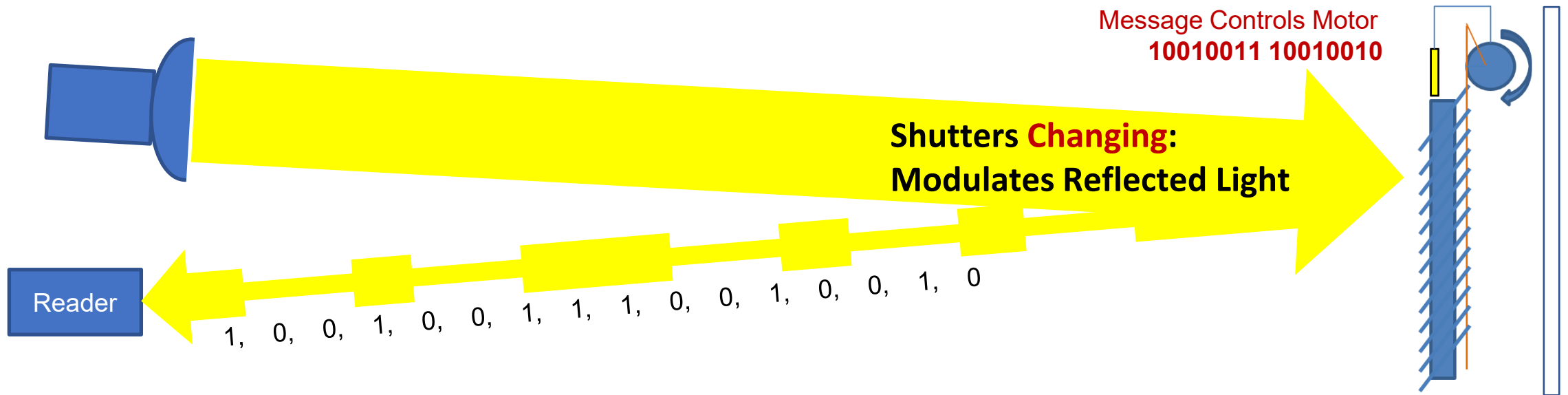
- The shutters are **OPEN**, light passes through the shutters, and reflects off the white wall.
- The shutters are **CLOSED**, light only dimly reflects off the black shutters.



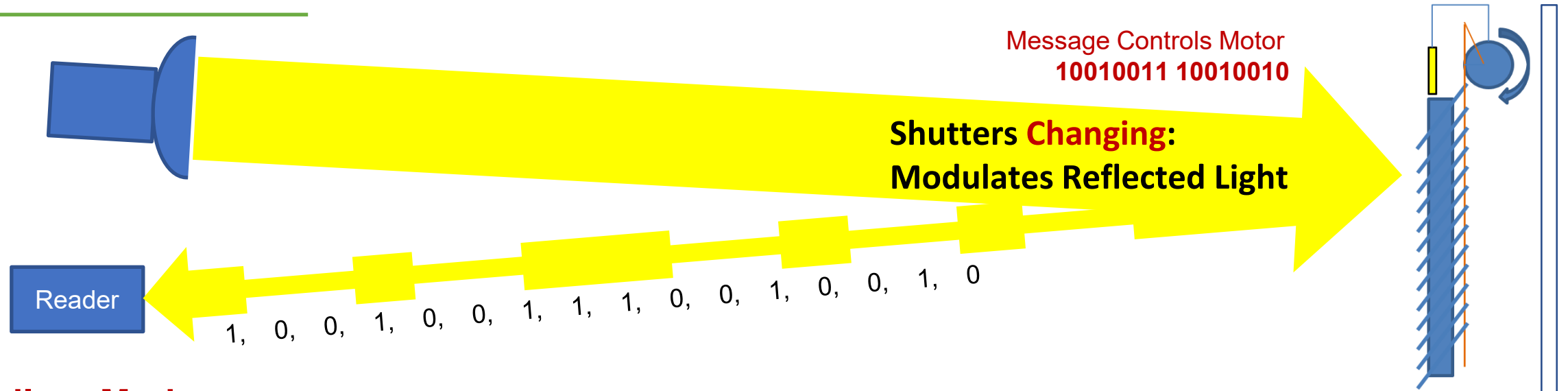
PASSIVE RFID – CONCEPT OF OPERATION

Embedding a Message in the Reflected Signal... When:

- The shutters OPEN (1) and CLOSE (0) in a particular sequence (corresponding to message)
- The light level changes (is 'modulated') with that sequence.
- The reflected light is encoded with the message, which can be detected.



PASSIVE RFID – FAILURE & SUCCESS MODES



Failure Modes

- **Forward Fail:** The light is not bright enough nor close enough to activate the 'motor'
- **Backward Fail:** The reflected light is not bright nor close enough to be read by the reader

Success Modes

- The forward light activates the motor, and the message is developed, modulating the light
- The modulated light is received by the reader, and decoded into a simple identity
- The software solution (Savant) performs recognition, location, and analytic info for use.

How RFID Works – SOLUTION COMPONENTS

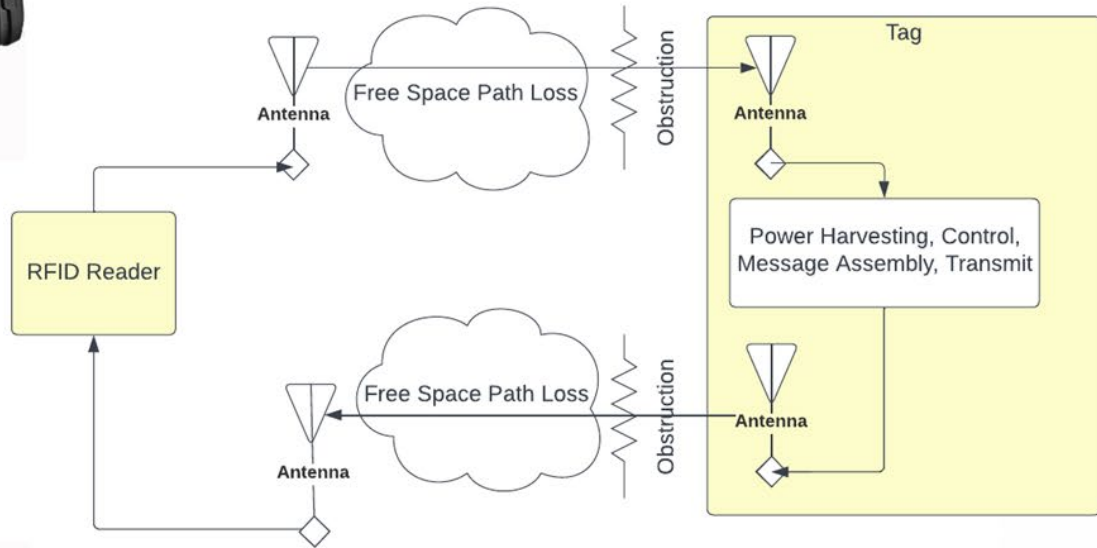
- Transmitter:** Sends a signal which is a 'pure tone' (consider as the 'light bulb')
- Antenna:** Generally, aims the signal in one direction (converts light to a spotlight)
- Tag:** Acts upon the pure tone, and 'disturbs' (modulates it) with the message
- Reader:** Receives the reflected signal, and decodes the modulated message
- Savant:** The software which evaluates the data, and produces usable results

Note: More components exist for complex systems, but these are the basics.

How RFID Works – A SIMPLIFIED ‘CIRCUIT’



Outbound = Higher Power, Pure Signal



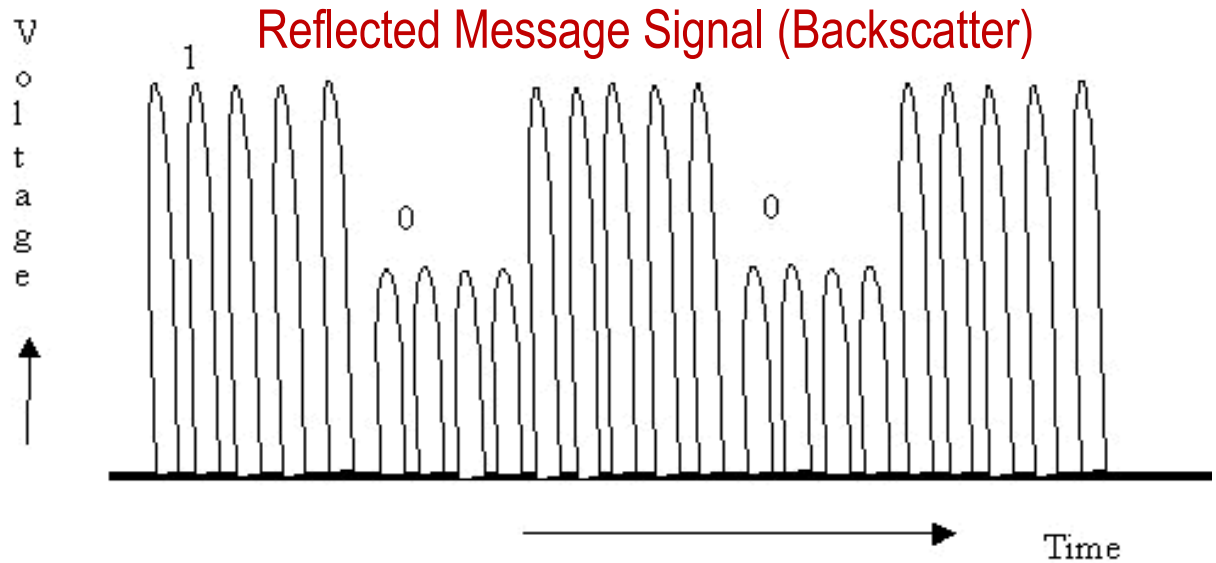
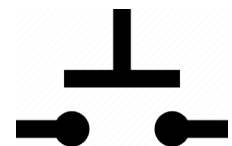
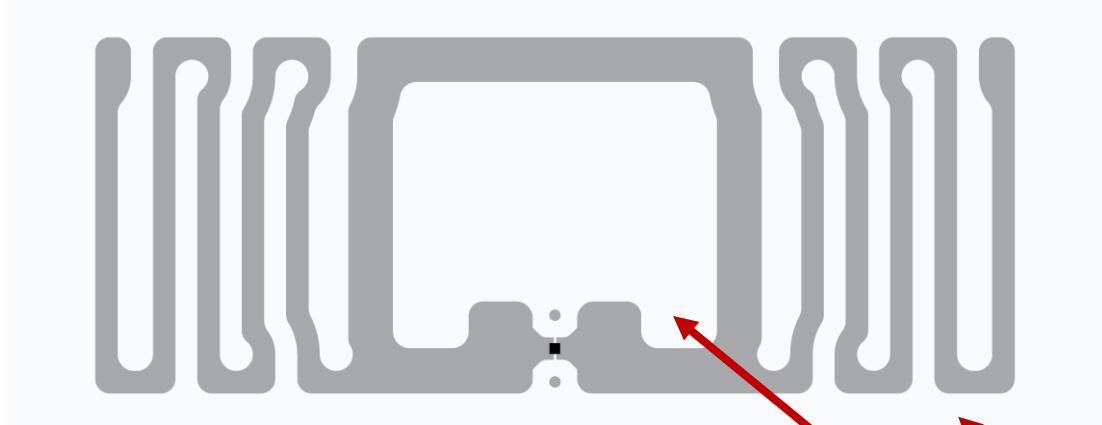
Reflected = Tiny power ‘Disturbed’ Signal



‘The Math’

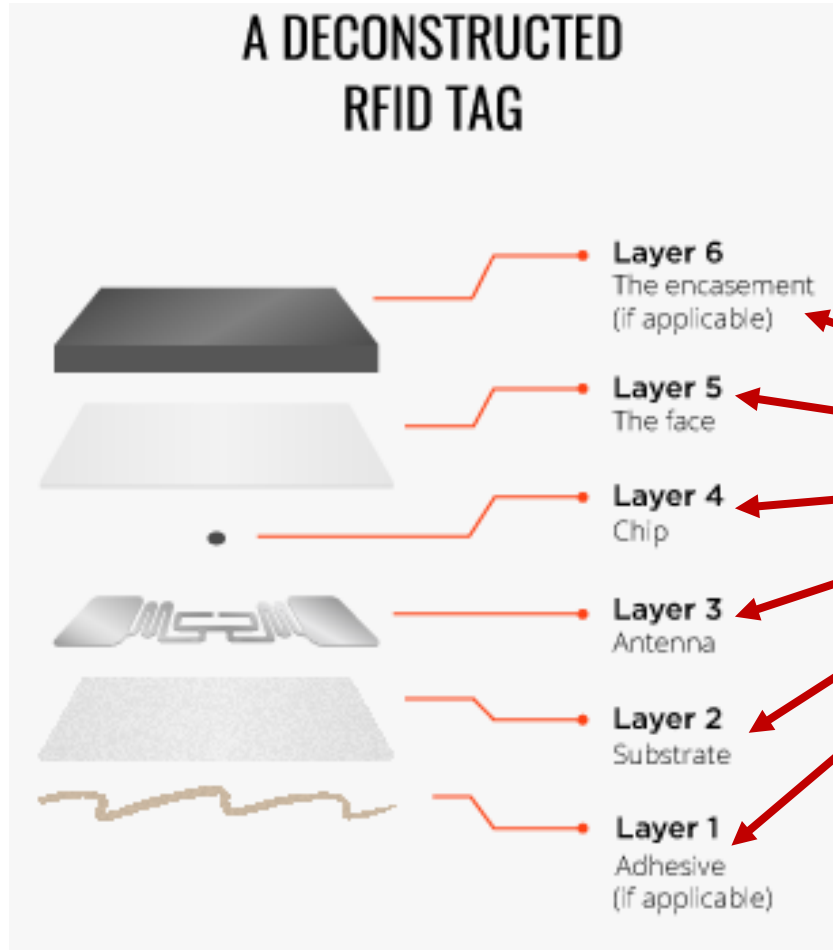
Step	Gain/Loss	Actual Value
Transmitter Emits	+30dBm	1 Watt
Antenna Gain	+3dB	(2x)
Effective Directional Output	+33dBm	2 Watts
Loss Out Thru Free Space	-45dB	x/31,600
Loss for Tag Conversion	-8dB	x/6.3
Energy at the Tag/Chip	-20dBm	1/100 th of a Watt
Loss Back Thru Free Space	-45dB	x/31,600
Antenna Gain	+3dB	(2x)
Energy at Receiver	-62dBm	~0.63 millionth W
Minimum Threshold	-71dBm	~0.079 millionth W
Margin	+9dB	8x Min

How RFID Works – A PASSIVE RFID TAG



- Antenna elements receive signal and harvests a small amount of RF energy from the transmitter
- Unit momentarily stores harvested energy, and 'wakes' control chip
- Chip methodically shorts out the antenna, causing disturbed reflection, sending an encoded 'message'

How RFID Works – GEOMETRY OF AN RFID TAG



Often called an 'Inlay'

Encasement
Front Cover
IC Chip
Antenna
Substrate
Adhesive

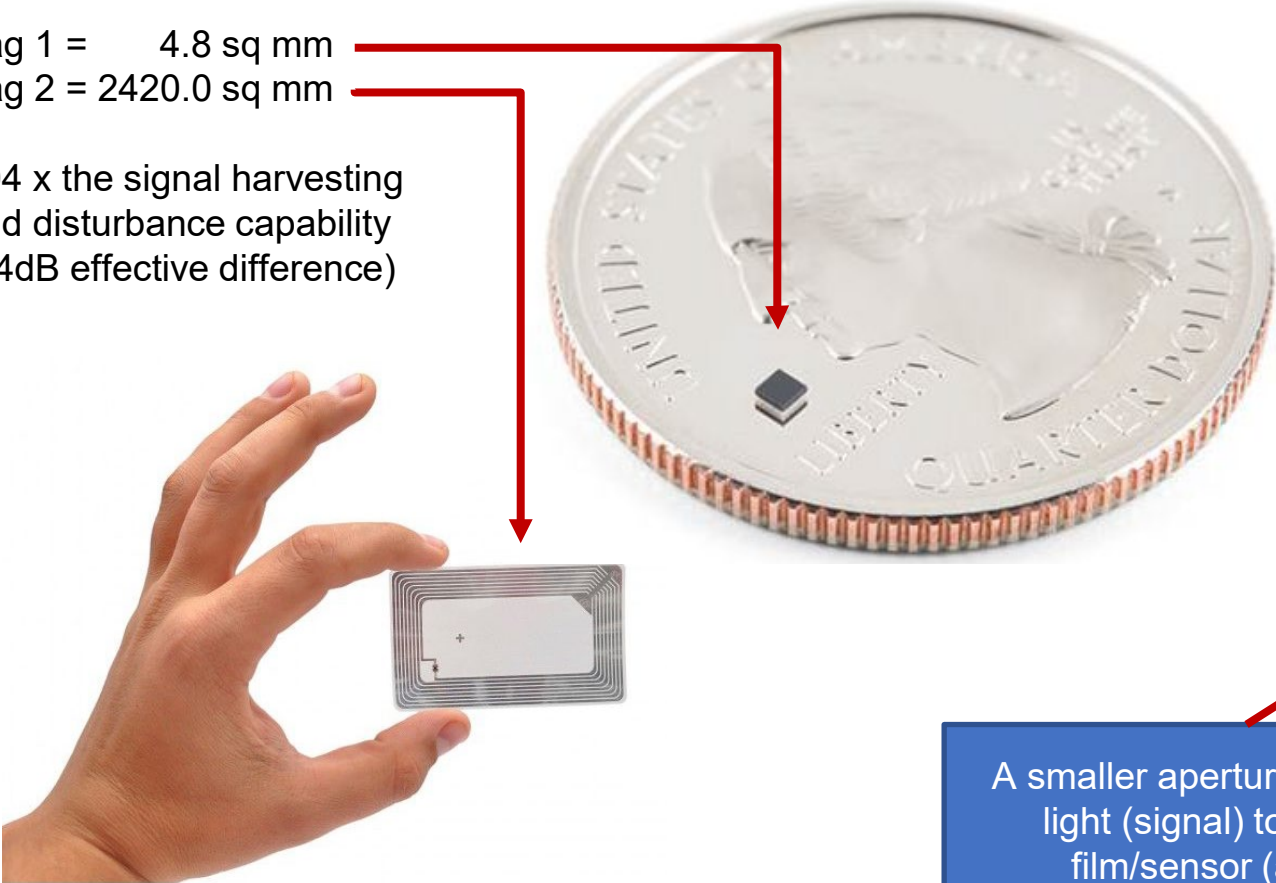
- Protects Tag From Damage (optional)
- Normal Cover in Pycube Use
- Controls Energy Harvest, Messaging
- Receive Signals & Creates Disturbance
- The Platform to Hold the Assembly
- Secures Tag to Unit (if used)

How RFID Works – PASSIVE TAG SIZES (APERTURE)

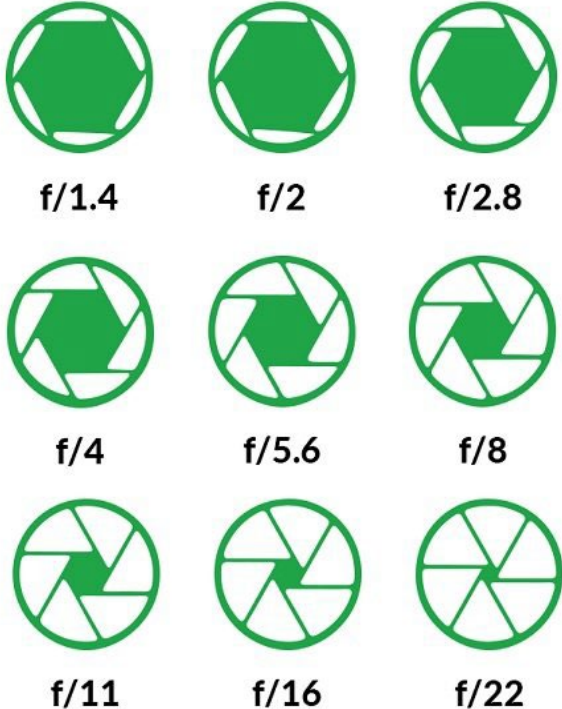
Size and Area Effectiveness is known as 'Aperture'

Tag 1 = 4.8 sq mm
Tag 2 = 2420.0 sq mm

504 x the signal harvesting and disturbance capability (54dB effective difference)

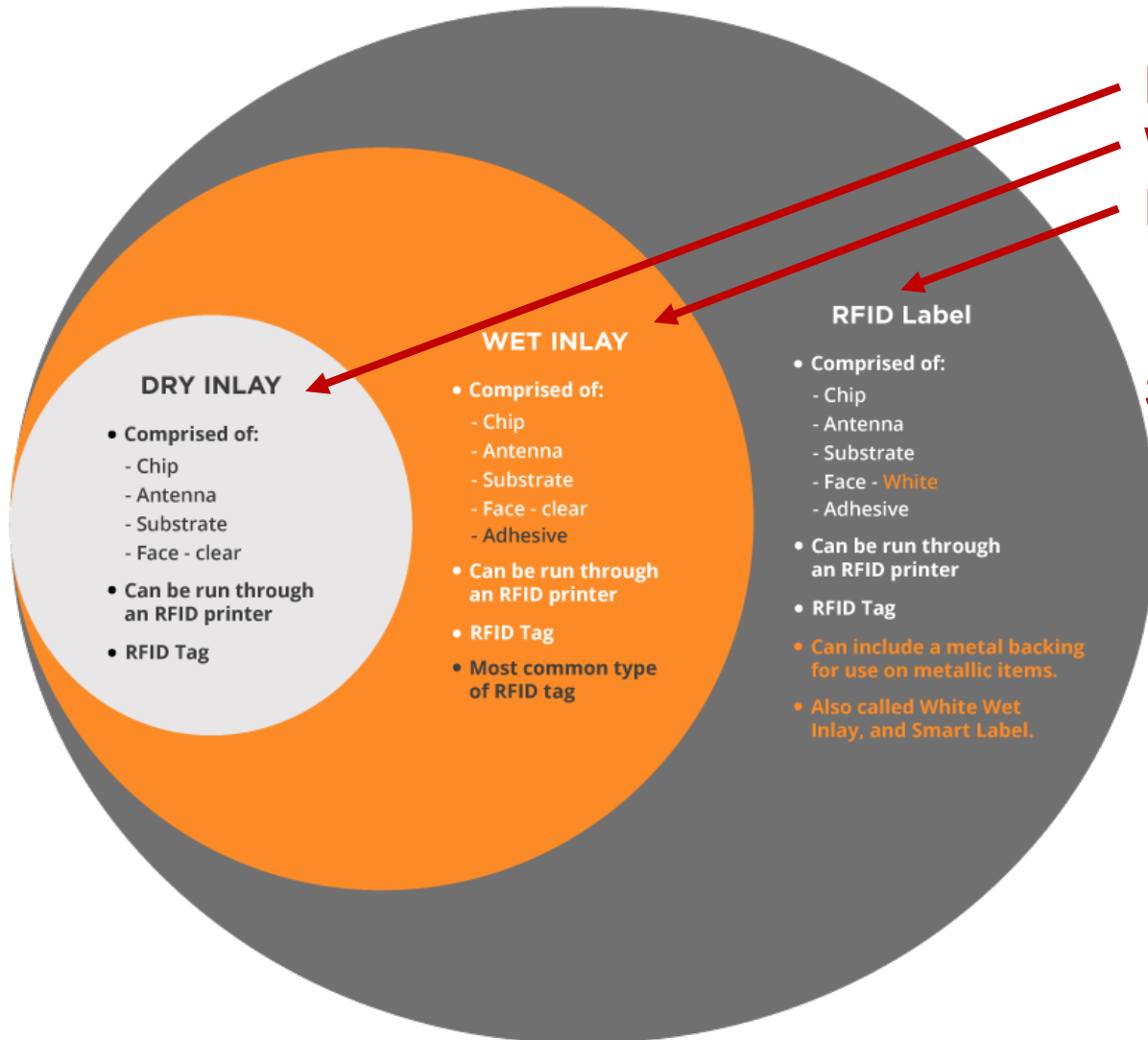


Borrowing a Concept from Photography
APERTURE SIZE



A smaller aperture causes less light (signal) to reach the film/sensor (antenna)

How RFID Works – TYPES OF RFID TAGS



- Dry Inlay** – Full assembly, but no adhesive
- Wet Inlay** – Full assembly, with adhesive
- RFID Label** – White face for visible printing (Possibly for a barcode or QR)
- Special** – Backing to allow use on metal or encasement to be used on cloth

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- ➔ **Challenges & Solutions in Healthcare Space**
Features, Benefits, & Applications of Typical Systems

CHALLENGES FOR SMALL/RURAL HOSPITAL SOLUTIONS

Access to Technology

- **Solution Scale** – The scale of tech solutions has (until now) not been optimal
- **Geographical Distance** – Availability of local tech providers has been limited

Financial Constraints

- **Initial Cost** – CapEx Budget cannot handle an expensive solution
- **Recurring Cost** – OpEx Budget cannot absorb high monthly expenses

Workforce Limitations

- **Capabilities** – Highly complex solutions need/exceed IT capability or capacity
- **Operational Resources** – Implementing any new initiative consumes resources

BUSINESS AIM FOR SMALL/RURAL HOSPITAL SOLUTIONS

Provide Access to Technology

- **Scalable Solution** – Ability to size correctly; start small; grow as needed
- **Geographical Distance** – 1 person OnSite to actualize; others OnLine to support

Deal with Financial Constraints

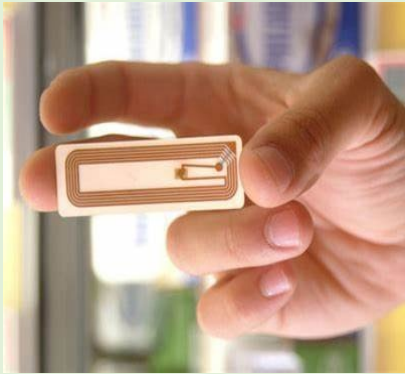
- **Initial Cost** – Provide a subscription solution with very low initial cost
- **Recurring Cost** – Tailor subscription solution to have low recurring cost
- **Value** – Incorporate multiple features into one solution for greater customer benefit

Address Workforce Limitations

- **Capabilities** – Remove complexity from customer environment (make it simple)
- **Operational Resources** – Furnish OnSite and OnLine resources to complete job

EXAMPLE – SIMPLE SOLUTION IN SMALL HEALTHCARE SPACE

Conceptual Workflow:



Apply Tag to Asset

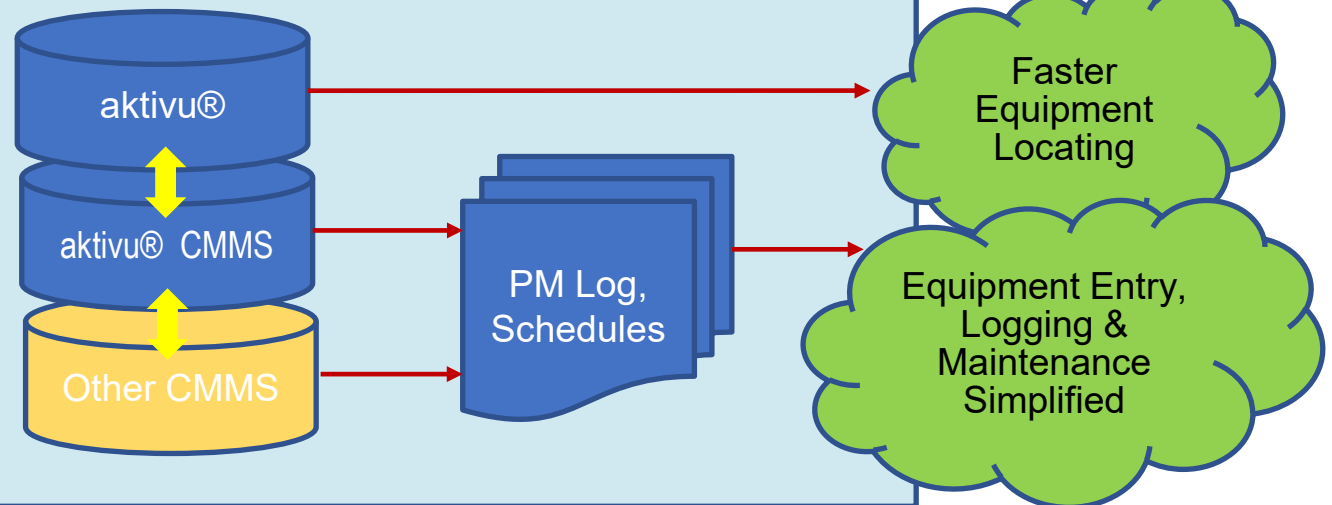
Scan/Enter into System

Deploy Asset

Scan/Locate Asset for Servicing

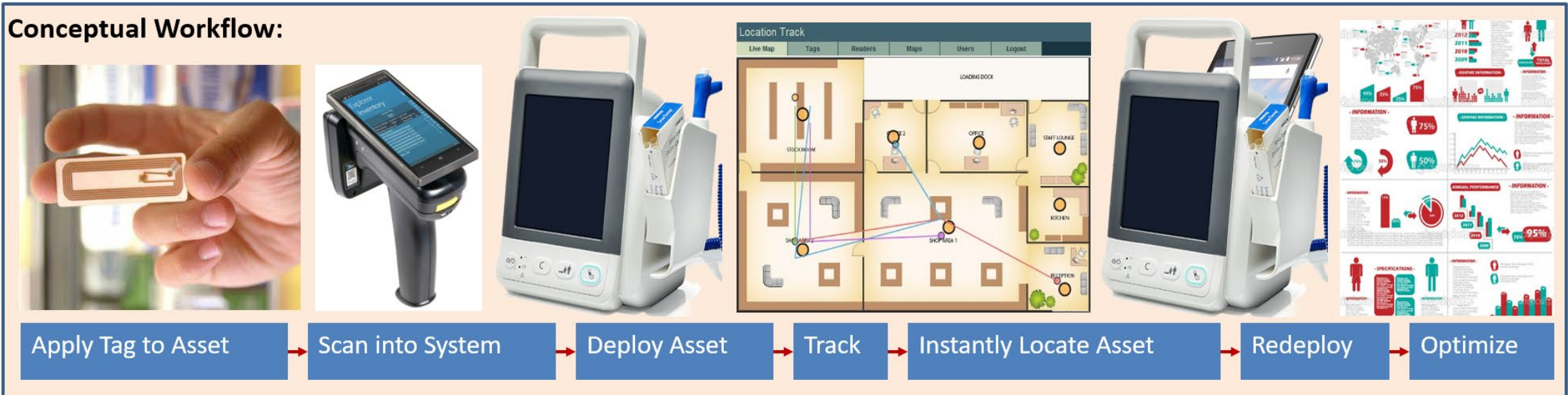
Update Logs

Underlying Technologies:

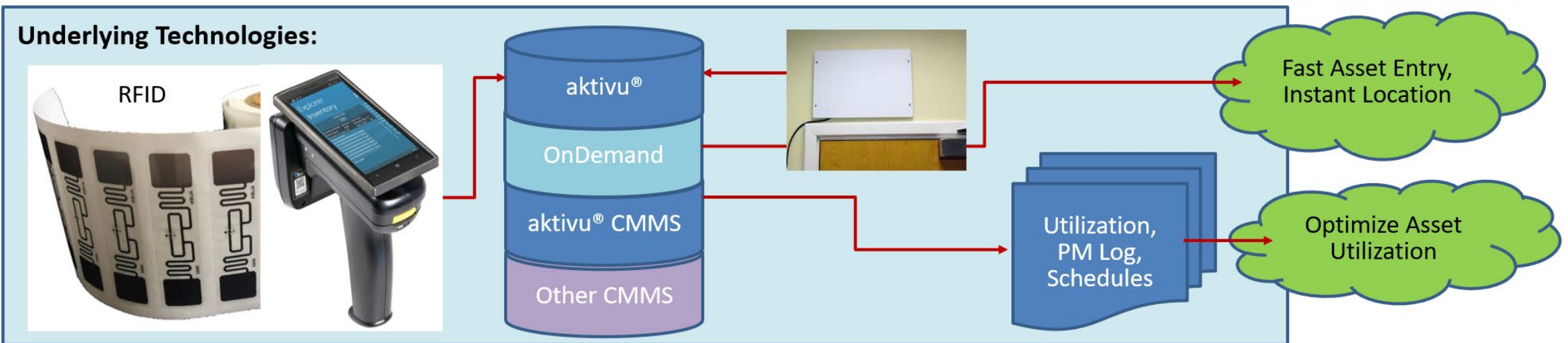


EXAMPLE – LARGER SOLUTION IN MID-SIZE HEALTHCARE SPACE

Conceptual Workflow:



Underlying Technologies:



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FEATURES & BENEFITS - PASSIVE RFID SOLUTION (EZ SERIES)

Zero Fixed Infrastructure – No wiring/cabling or equipment installation expense

Cloud-Based Intelligence – No servers, cost, or maintenance expense

Passive RFID – No tag batteries to replace; No ‘lost articles’ due to dead tag batteries

Broad Scanning Mode – Identify a room full of assets and inventory in seconds.

Narrow Scanning Mode – Find one article in a crowded space of similar articles.

Direct Detection and Promiscuous Detection – Locate a targeted article (asset or inventory) while ‘quietly’ detecting all other room assets/inventory in the background.

Low Cost – Low one-price initial cost to begin, low recurring cost per month/year.

Expandable/Extendable/Adaptable – to more tags, readers, users, apps, & use cases

APPLICATIONS FOR **PASSIVE RFID SOLUTIONS** IN HEALTHCARE

Small/Rural Hospitals & Clinics

- **Facility Inventory** – Quick physical inventory of all facility assets (desks, chairs, PC's...)
- **Supply Inventory** – Quick assessment of supplies on hand, and get alerts for reordering.
- **Room Readiness** – Quick assessment of equipment and supplies in room to ensure preparedness for the next patient (comparison against par levels).
- **Loss Identification** – Instant determination of missing equipment.
- **Consumption** – Instant determination of supplies consumed.
- **Laundry Loss Prevention** – Reduce TelePack and sensor loss in laundry and/or trash
- **Operational Reports and Analytics** – to support better-informed decision-making.

Hospital Biomed Labs

- **Equipment/Asset Inventory** – Identify movable assets and associate with current locations.
- **Track Asset Movement** – Determine movement and utilization/cleaning cycles.
- **Schedule and Locate Equipment Due for PM/Recall** – Quickly find due assets.
- **Accurately Identify Rental Equipment** – Determine the existence and use of rental equipment.
- **Operational Reports and Analytics** – to support better-informed decision-making.

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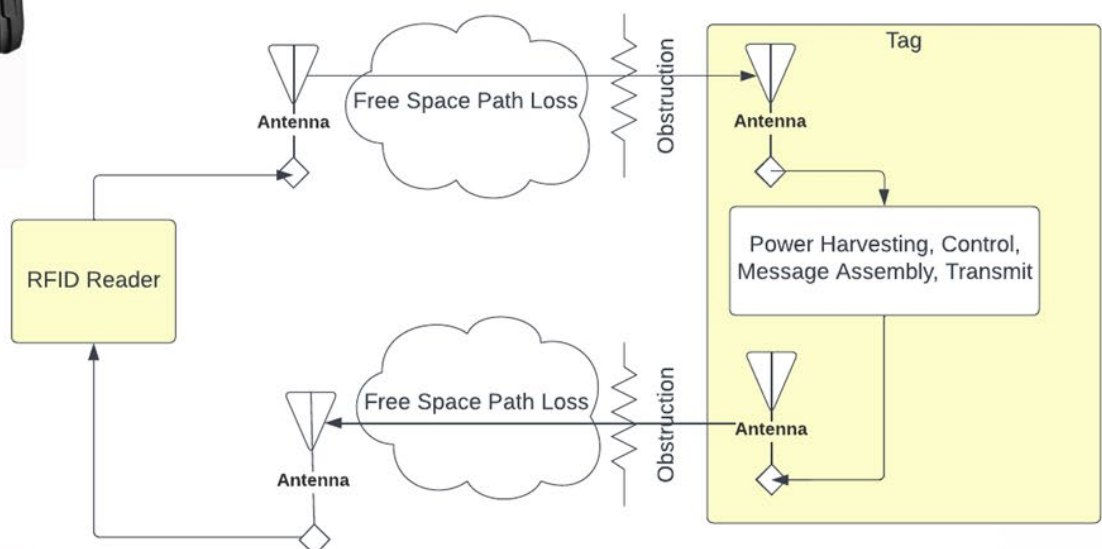
Features, Benefits, & Applications of Typical Systems

 **Bonus – How WELL Does it Work?**

RECALL – THE SIMPLIFIED ‘CIRCUIT’



Outbound = Higher Power, Pure Signal



‘The Math’

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How **WELL** DOES IT WORK?

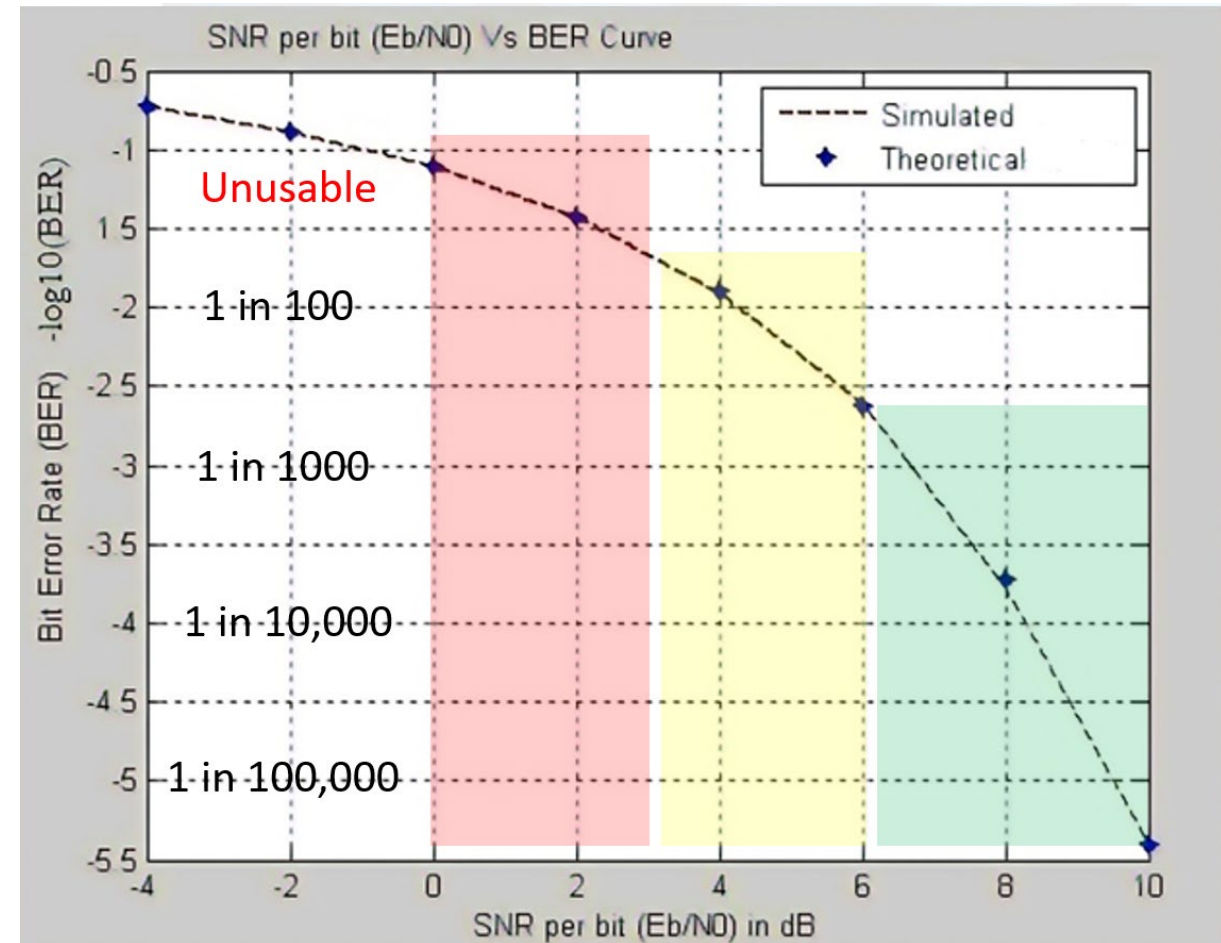
Consider...

Methods of Measuring Success

- ‘**Binary Success**’ (Tag Read or Not Read)
- ‘**Gradient Success**’ (Margin Available)

Success Gradient (Chart)

- **Unusable** – White area below red
- **Minimal** – Red area
- **Ok** – Yellow area
- **Good** – Green



Actual Results in Last 3 Month Field Tests

- **Speed** – 8000+ Previously Tagged Assets located in large PA hospital in ~2 hours
- **Efficacy** – 99%+ Efficacy in large NYC Biomed Engineering Lab Tests
- **Margin** – All tested assets located with Adequate to Good margin

