Secure RFID for Trusting Devices and Data

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Legacy of RF, RFID, and Security

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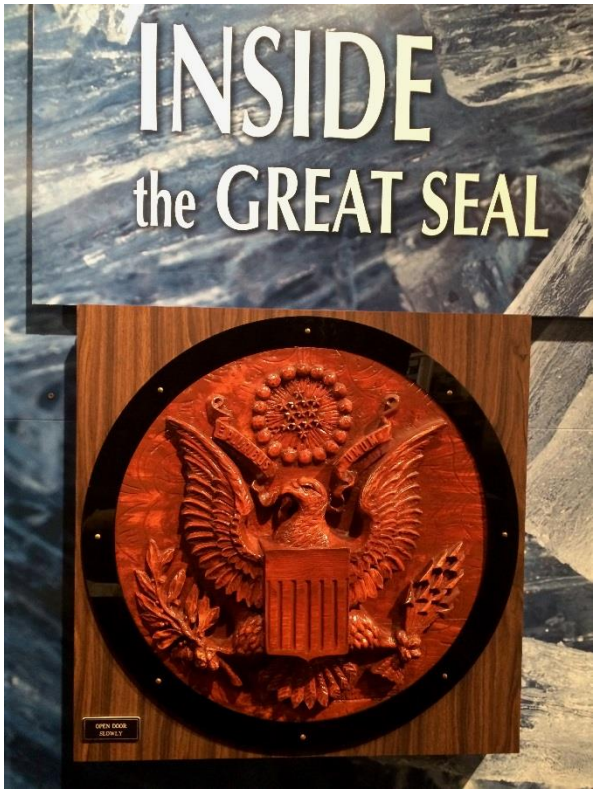
- RF is a shared medium and needs security
- Basis of RFID technology is backscatter modulation and is not a source of RF energy; makes information from RFID intrinsically more difficult to detect



Presentation Outline

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- Context and Background
  - Focus
  - Deterrence mechanisms
- Incursions and Problems
  - Privacy
  - Cloning
- Deterrence and Solutions
  - Standards
  - Protocols
  - Key management

Secure RFID for Trusting Devices and Data

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- **Trust**
  - Derives from “True”, as in "real, genuine, not counterfeit" from 14th century
  - Derives from trees, as in "firm, solid, steadfast” from Proto Indo-European
- **Secure**
  - Private to prevent unauthorized reading or writing of data
  - Secure to prevent unauthorized listening
  - Authentic to ensure the data is valid
- **Cryptographic Secure UHF RFID**
  - Cryptography has well established mechanisms for “Secure” and “Trust”
  - High performance UHF (distance and speed) has previously limited implementation of cryptography in UHF RFID
  - *Focus of presentation is Cryptographic Secure UHF RFID*

UHF RFID Mechanisms for Deterrence

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- **Unique Tag Identifier (TID)**
  - Unique TID in tag is a read-only serial number programmed by IC manufacturers
  - Offers basic protection that tag is unique, but…
  - No defenses against emulators
  - No defenses against IC manufacturers with writeable TID
  - Privacy issue since unique TID is NIST PII
- **Password Protection**
  - Uses Access password to read Kill password, but..
  - 32bit password space is small
  - Limits speed performance with several reader/tag packets
  - Eavesdropping on “secret” cover code from tag isn’t difficult, and XOR for hiding password is easily reversed
- **Secure RFID**
  - Uses established and accepted cryptographic algorithms to implement security

Deterrence and Value of Incursion

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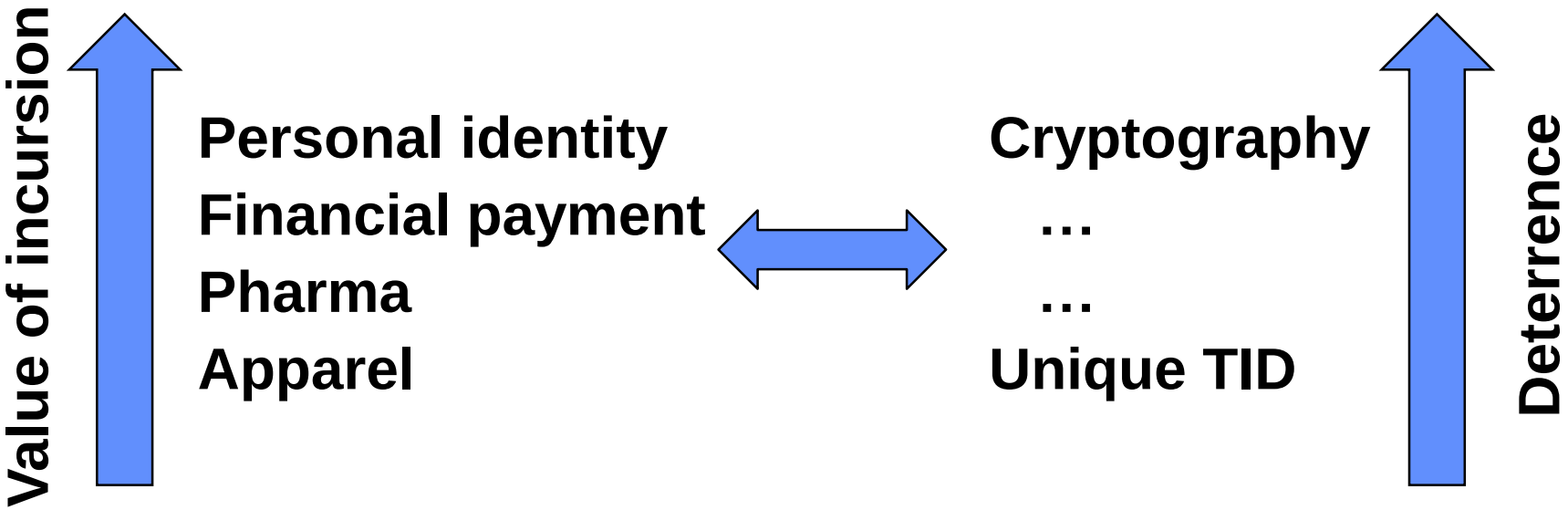
- **Deterrence should exceed value of incursion**



Incursions and Problems
(White hat hacking)

HF RFID Mass Transit Tracking

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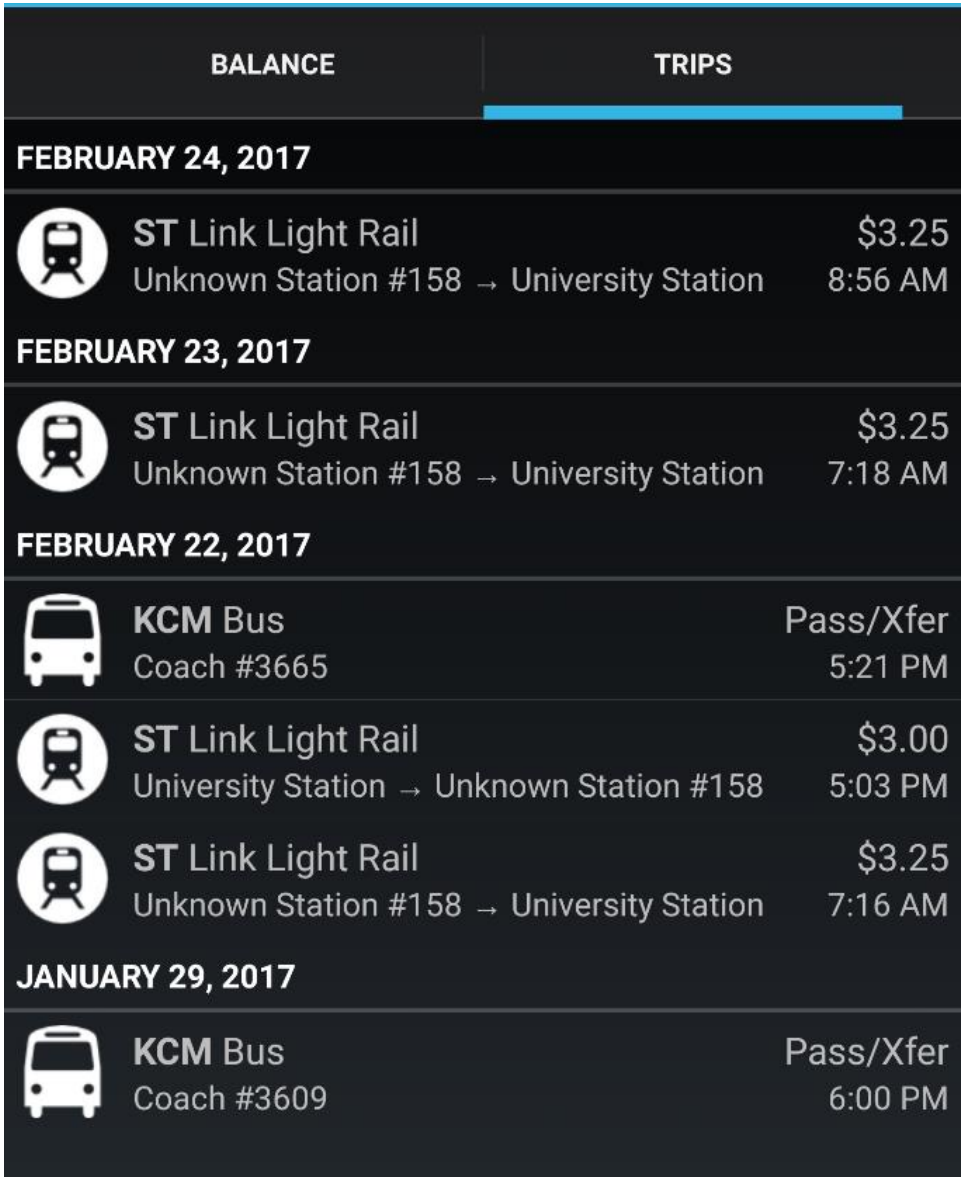

Skimming Electronic Toll Tags

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Skimming tags at highway ramp

Skimming tags at parking lot

Skimming Tags in Parking Lot

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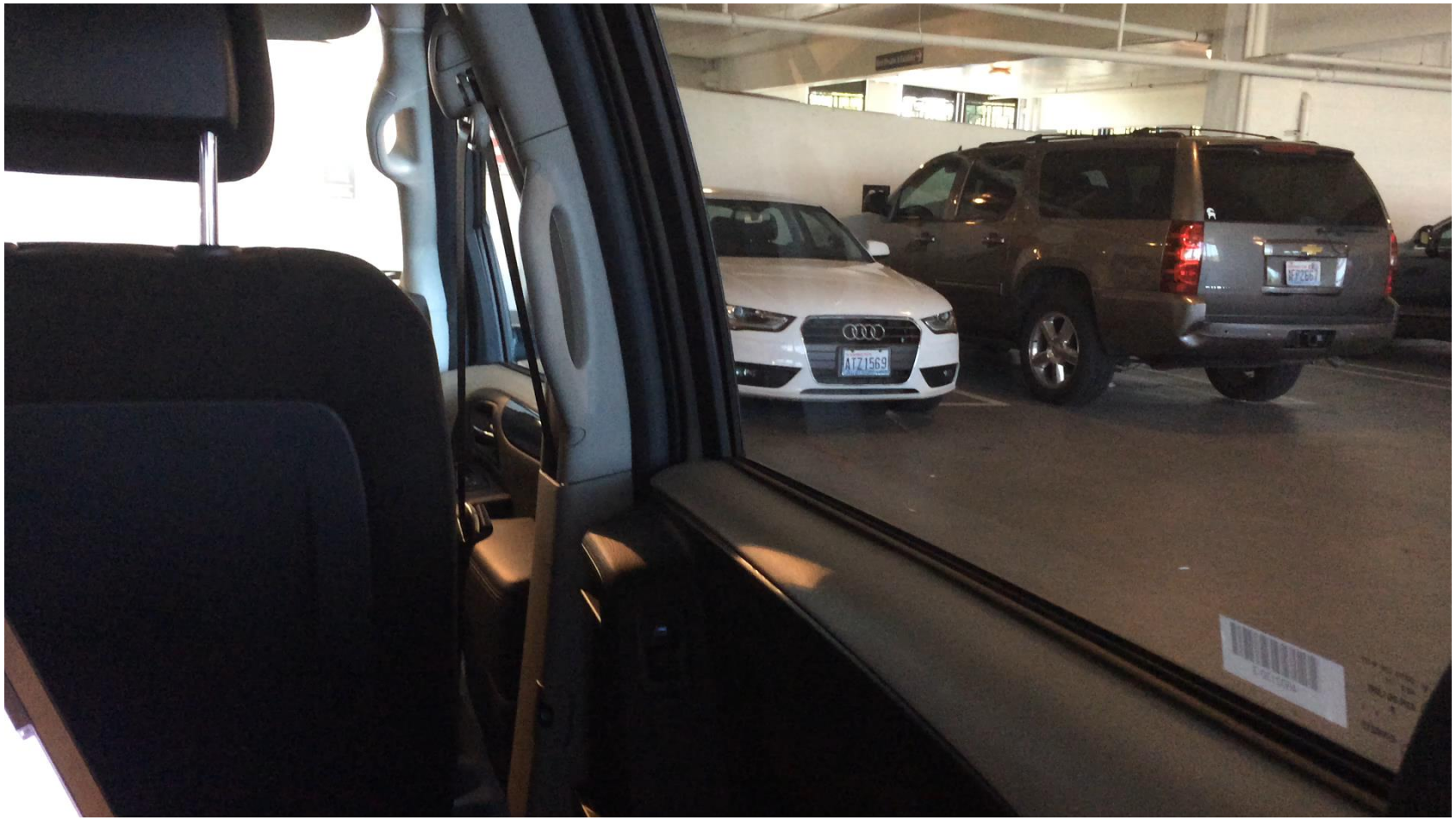

Cloning of Electronic Toll Tag

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Financial Transaction with Cloned Tag

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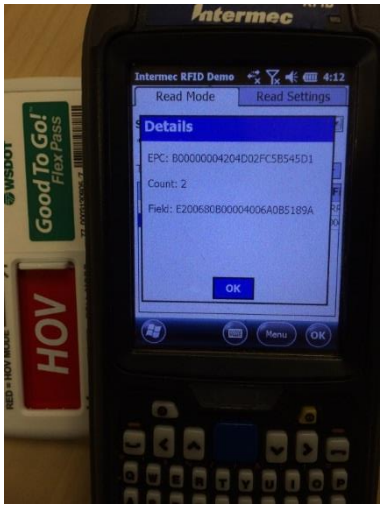
- **Authentic EPC/TID tag data duplicated into clone tag (tag emulator)**
- **Use clone to pay for toll**



Tag Mode	Tag contents			Pass ID			
				Prefix		Account	
	Bank 1 (UII/EPC)	Bank 2 (TID)	Bar code	Dec	Hex	Decimal	Hex
Toll	B00000001204D02FC5B50DB8	E200680B00004006A0B5884F	77 0003130805 7	77	4D	003130805	02FC5B5
HOV	B00000004204D02FC5B545D1	E200680B00004006A0B5189A	77 0003130805 7	77	4D	003130805	02FC5B5

Transaction	Posted Date	Pass ID	Lic[illegible]	Location	Lane	Directio	Amount
11/13/2015 14:58:53	11/13/2015 16:04:58	77-00031 30805		SR 520 Bridge East	520E-520EB-01	East	-$3.10

Deterrence and Solutions (Standards and Protocols)

Secure UHF RFID Standards in 2015

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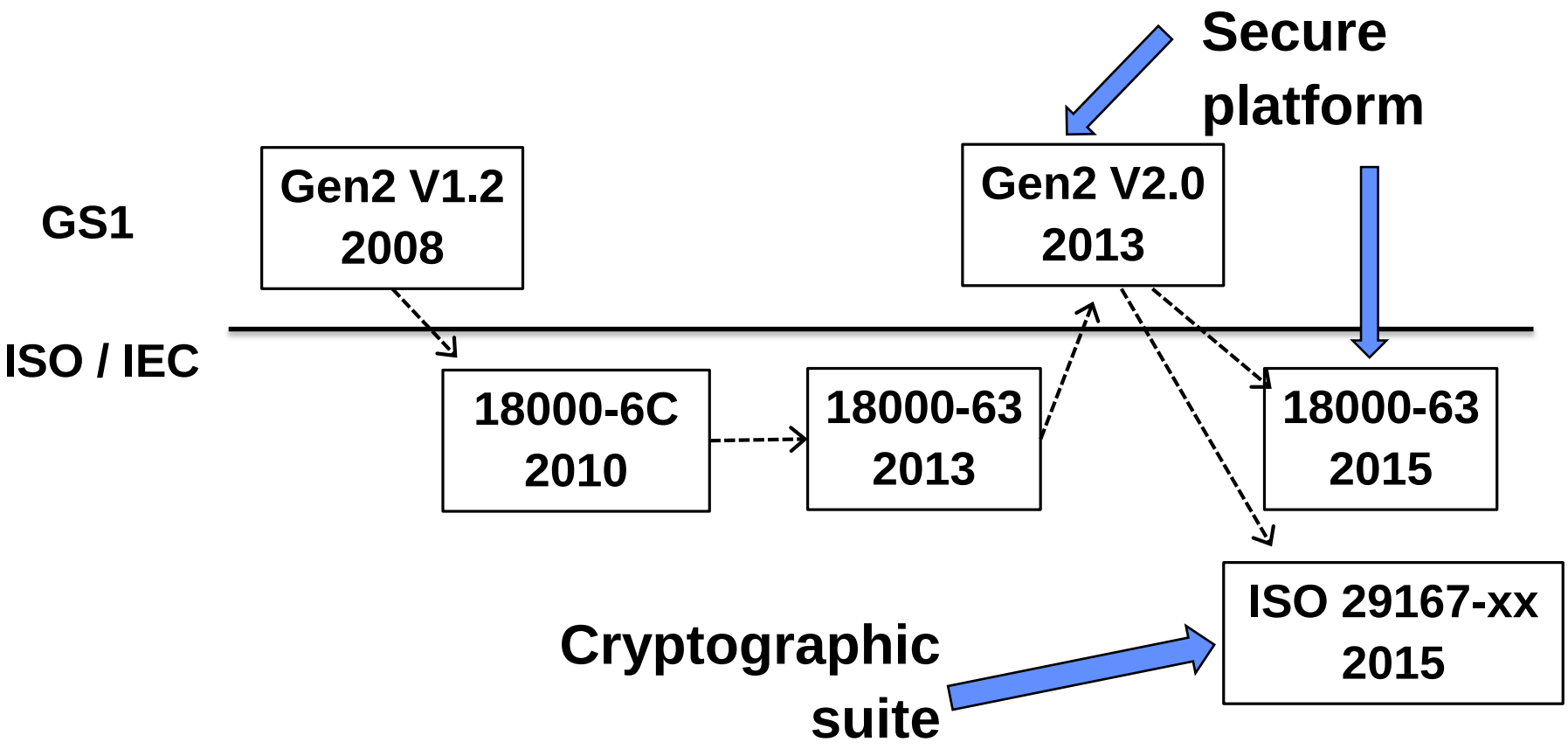
- Platform for cryptographic suites in 2013 and 2015
- First cryptographic suite in 2015
- Secure UHF RFID needs 18000-63 *and* 29167



Security Commands in ISO 18000-63 / Gen2v2

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Gen2v2 / ISO 18000-63 commands	Common use	Required	Optional
Untraceable	Hiding serialized public tag data	✗	✓
Authenticate	Secure reading and writing of data, usually for ≤128bits of memory	✗	✓
ReadBuffer	Recovery from crypto data errors	✗	✓
Challenge	Parallel processing of cryptographic operation saves time; 25% for two tags, and 50% for three tags	✗	✓
AuthComm	Authenticated transactions >128bits of data with stream cypher	✗	✓
SecureComm	Encrypted transactions for >128bits of data with stream cypher [1] *Authcomm can also encrypt data*	✗	✓ [1]
KeyUpdate	Secure update of keys in-the-field [2] *Authenticate write could update key*	✗	✓ [2]

AES Crypto suite ISO 29167-10: 2015 and 2017

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29167-10 Method	Common use	Conformance requirement	In 2015 version	In 2017 version
TAM1	*Authenticate tag* – often combined with public plaintext identification	Mandatory	✓	✓
TAM2	*Secure encrypted read* – authentication of tag with private cyphertext identification	Mandatory	✓	✓ [1]
IAM1/2 or MAM1/2	*Secure change to tag* – modification to tag by authenticated reader	Optional	×	✓
IAM1/3	*Secure encrypted write* – write encrypted data to tag by authenticated reader	Optional	×	✓

[1] Version 2017 adds additional TAM2 format to prevent man-in-the-middle attack that corrupts read data (e.g. private identifier) in the 2015 version.

Example of Encrypting Data

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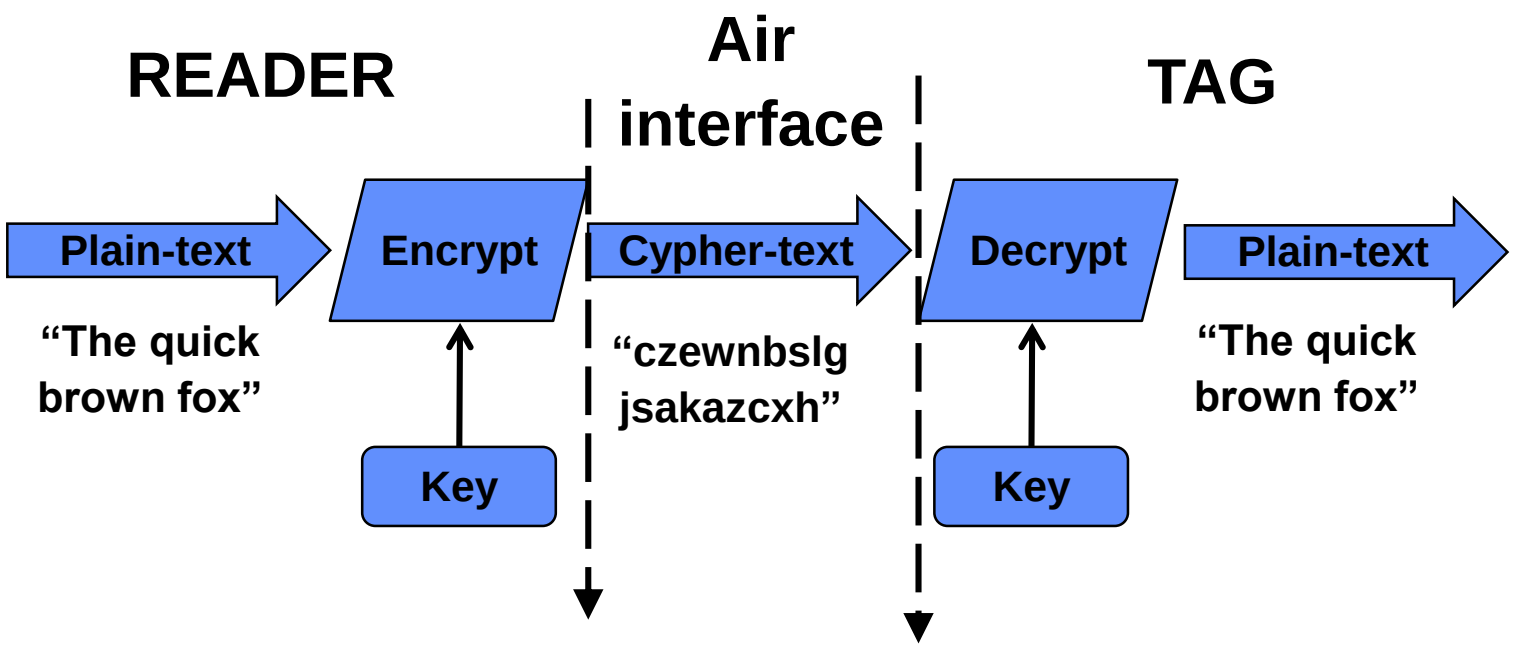
- Reader encrypts plain-text data, sends “cypher-text”, tag receives and decrypts cypher-text
- Plain-text data can be information or a random number “challenge”



Anonymous Identification with TAM2

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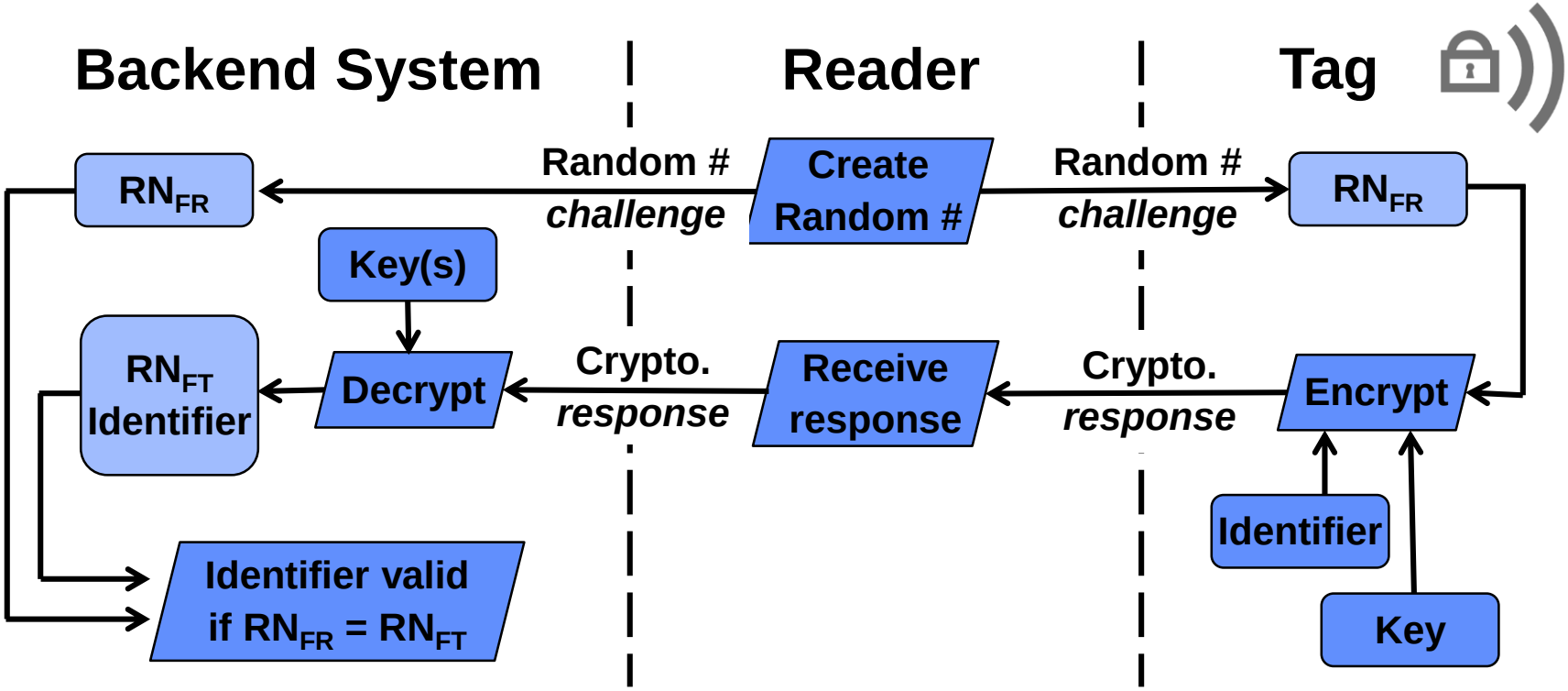
- Tag loaded with Unique Identifier and Key
- Backend system loaded with Key(s)
- Reader functions as intermediate between tag and backend system
- Backend system decrypts tag's cryptographic response to extract and verify identifier



Key and Account Management

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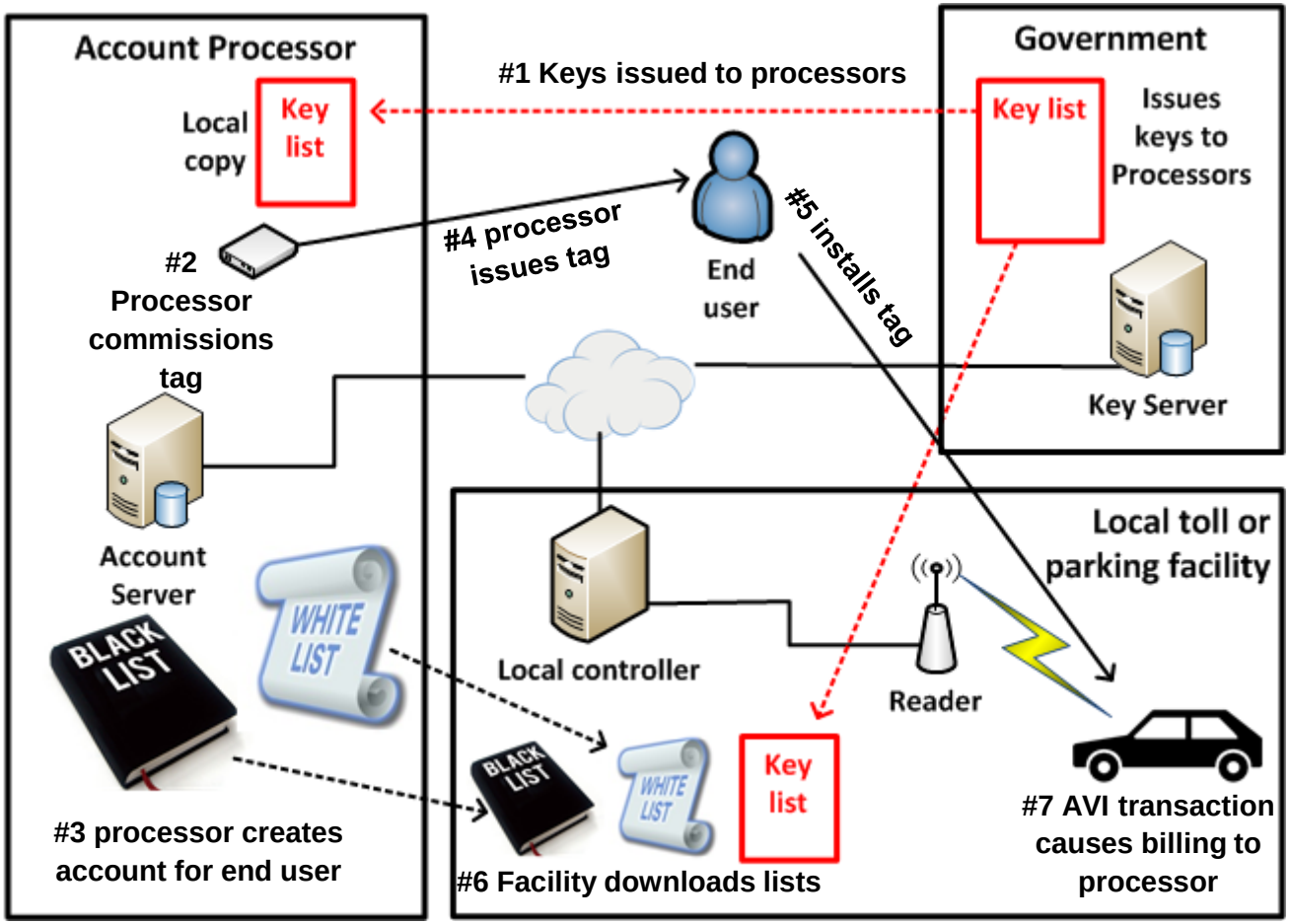

Secure UHF RFID in Vehicle Track Tests

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Conclusions

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- RF and RFID is a shared medium
  → use security when viable
- Security is viable with UHF RFID
  - Standards exist
  - Implementations exist
- Enforce Privacy
  → no unique plain-text identifiers
- Encrypt and Authenticate Data
  → consider talented adversaries

Thank you