RFIDIOts!!!

Hacking RFID Without A Soldering Iron

(or a Patent Attorney)

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http://trifinite.org

http://rfidiot.org

FIRST TC, 2008

Prague, Czec Republic

Who Am I?

- The Bunker non-exec
- Co-Publisher APACHE-SSL
- DEFCON 'goon'
- Open Source developer / researcher
  - Bluetooth
  - RFID
  - Full Disclosure / White Hat!
- Freelance research / training / lecturing

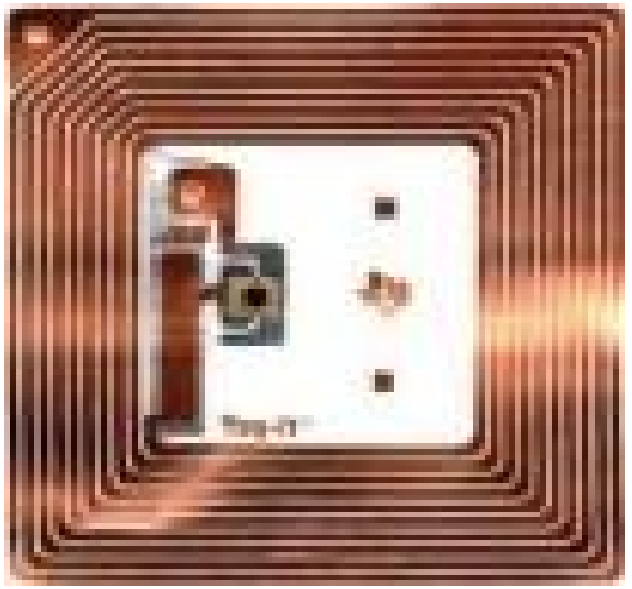
What do I do?


LEATHERMAN® WAVE®


non-medical • in-home care
Comfort Keepers®
Your Phone Number Here

What is RFID?

- Radio Frequency IDentification
  - Radio Frequency or Magnetically Coupled chip
    - Chip is passive
    - Energy from reader activates the chip

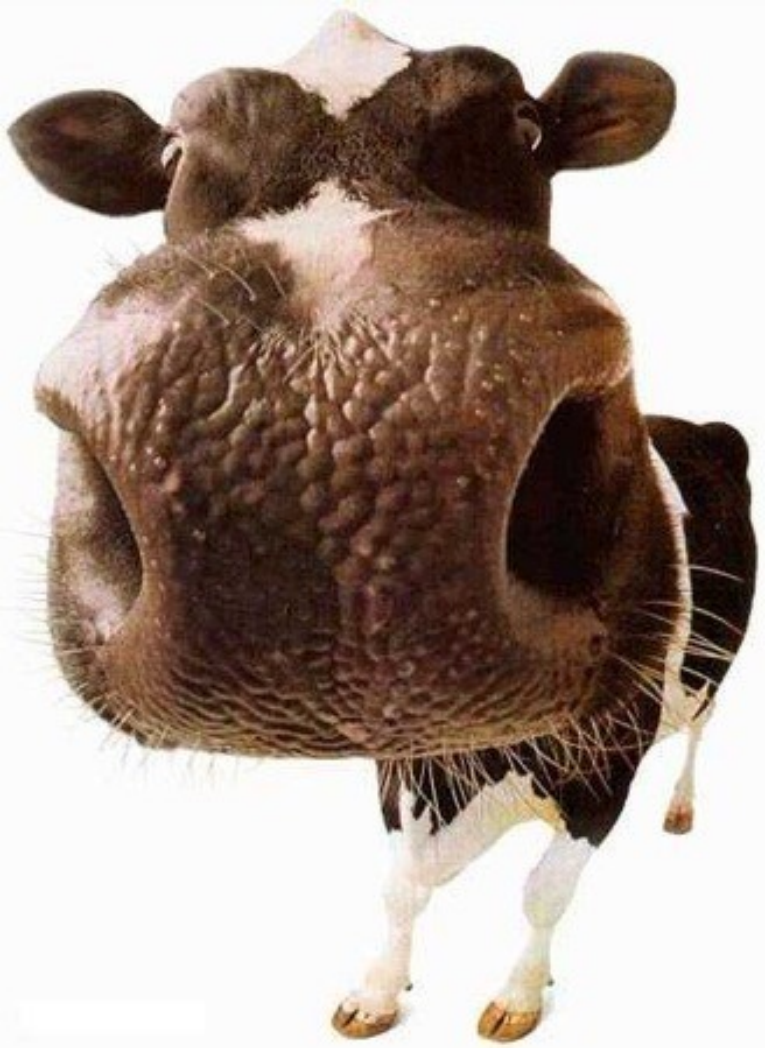


'Dumb' vs 'Smart'

- Dumb: Simple ID/Data only
  - Door Entry Systems
    - e.g. HID

- Smart: Smartcards
  - Payment Cards
    - e.g. London Transport Oyster
  - Biometrics
    - Passports

'Dumb' RFID – Moo am I?



- Animal ID
- Hotel Keys
- Car Immobilisers
- Ski Passes
- Goods Labels
- Luggage Handling
- Vending
- Human Implants

Please return this card after check-out

Bitte Karte bei Abreise zurückgeben

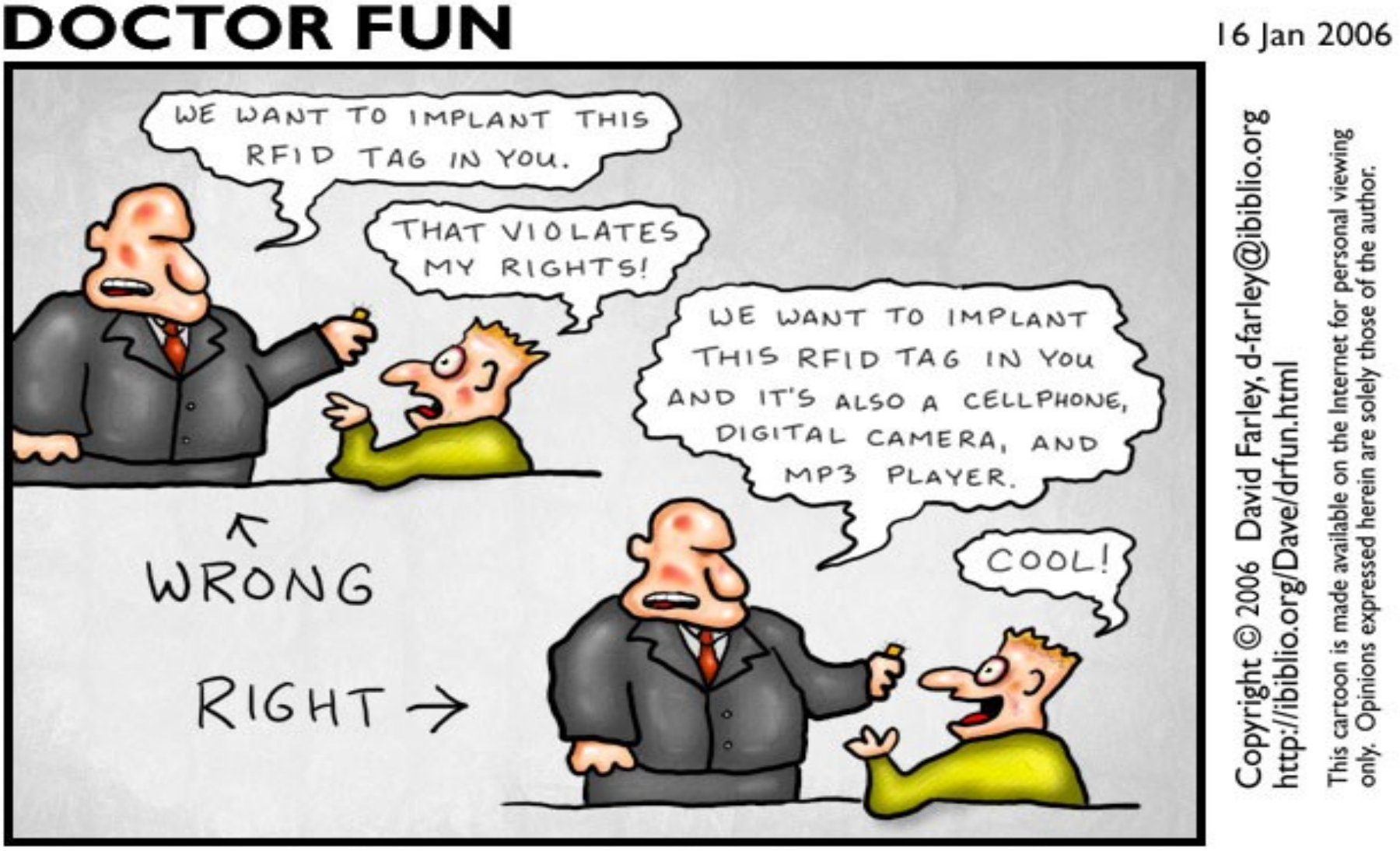
Hold the key card in front
of the sensor area until
LED-light appears.
Then open the door.

Schlüssel-Karte direkt vor
den Sensor-Bereich halten
bis LED-Licht die Freigabe
signalisiert. Dann Türe öffnen.

Key Cards:

www.messerschmitt.com

Selling the idea of Human Implants



Human Implants

- Military
  - Access Control
- Mental Patients
  - Tracking
- Beach Bars
  - Digital Wallets

Unique ID!!!

- Cannot be cloned
- Cannot be cloned
- Cannot be cloned
- Cannot be cloned
- Cannot be cloned
- Cannot be cloned
- Cannot be cloned

Unique ID?

- DIY Cloning Units
  - http://cq.cx/vchdiy.pl

Spot the original?

Unique ID?

- DIY Cloning Units
  - http://cq.cx/vchdiy.pl

Spot the original?

- Industry Defence:

Unique ID?

- DIY Cloning Units
  - http://cq.cx/vchdiy.pl

Spot the original?

- Industry Defence:

“These 'clones' do not have the same form factor and are therefore not true clones”

2nd Line of Defence

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- Security by Patent Attorney?

2nd Line of Defence

- Security by Patent Attorney?
  - HID vs IOActive

2nd Line of Defence

- Security by Patent Attorney?
  - HID vs IOActive
    - “HID Responds to Staged Proximity Card Cloning”
      - http://www.hidcorp.com/page.php?page_id=147
    - “IOActive Provides Clarification on HID Dispute”
      - http://www.ioactive.com/pressreleases.html

Unique ID?

- Readers cannot 'see' so form factor irrelevant

Unique ID?

=

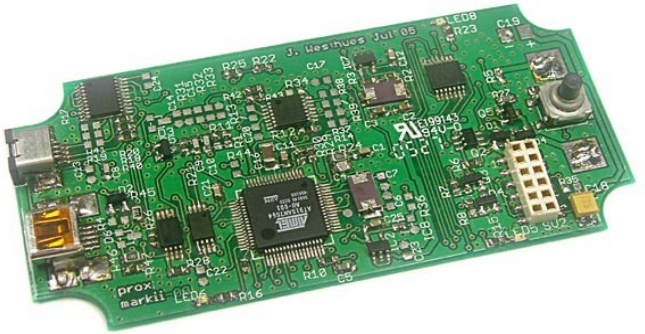
- Readers cannot 'see' so form factor irrelevant

Cloning Devices

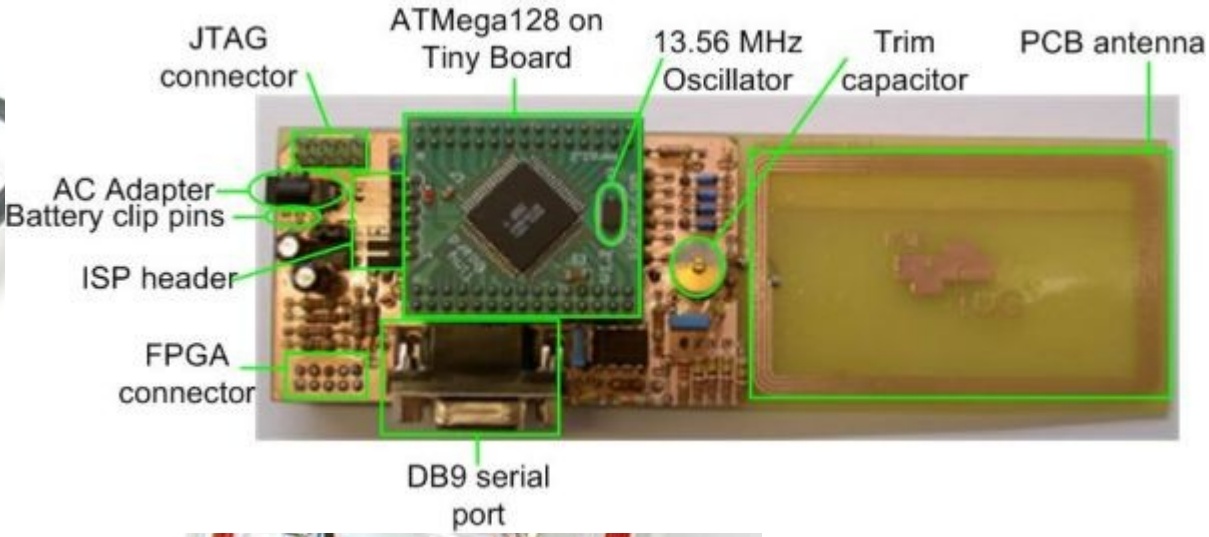
Cloning Devices

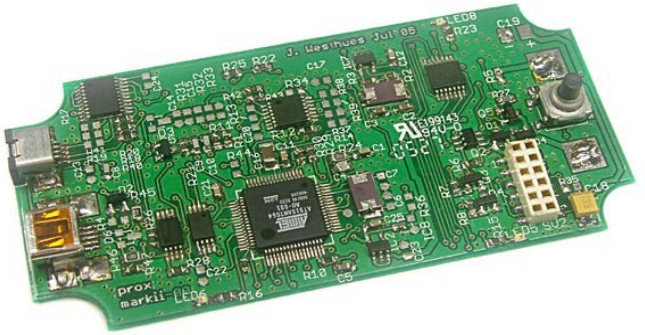
Cloning Devices

Cloning Devices

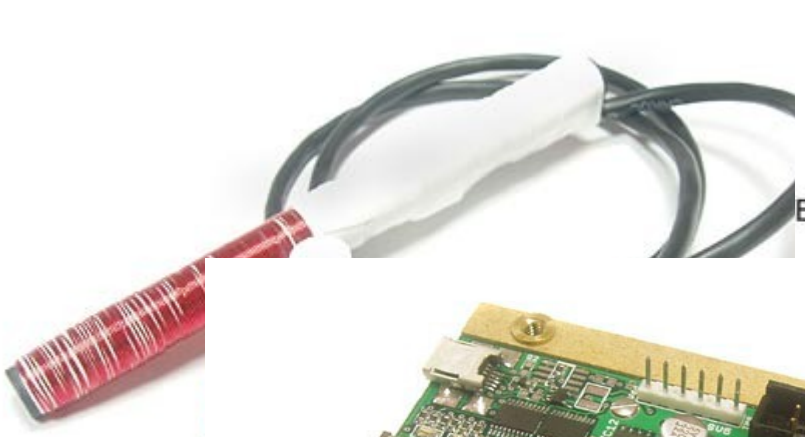


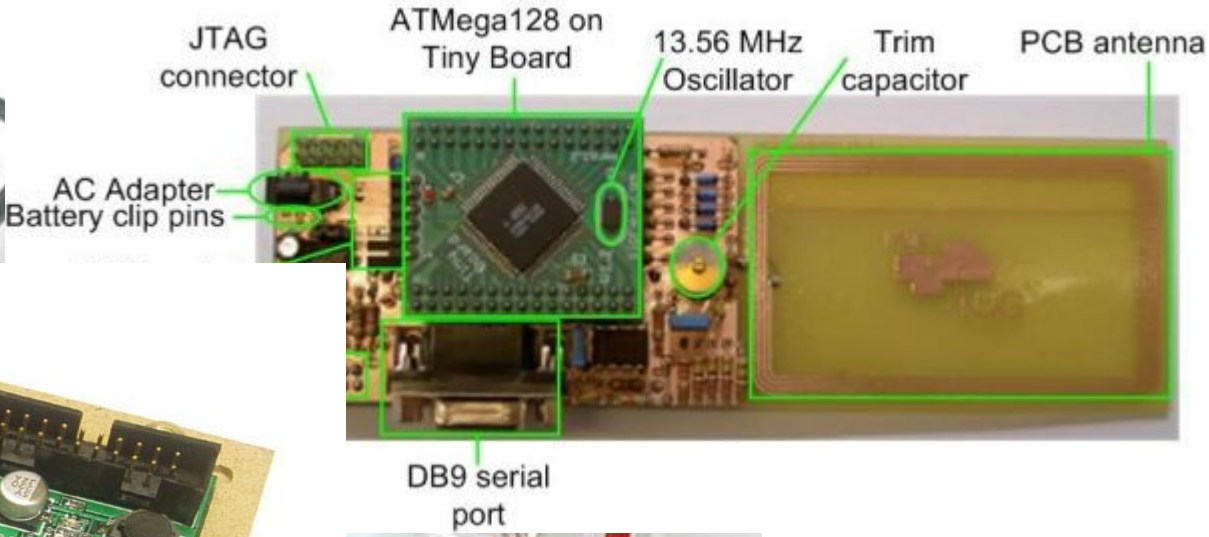
Cloning Devices

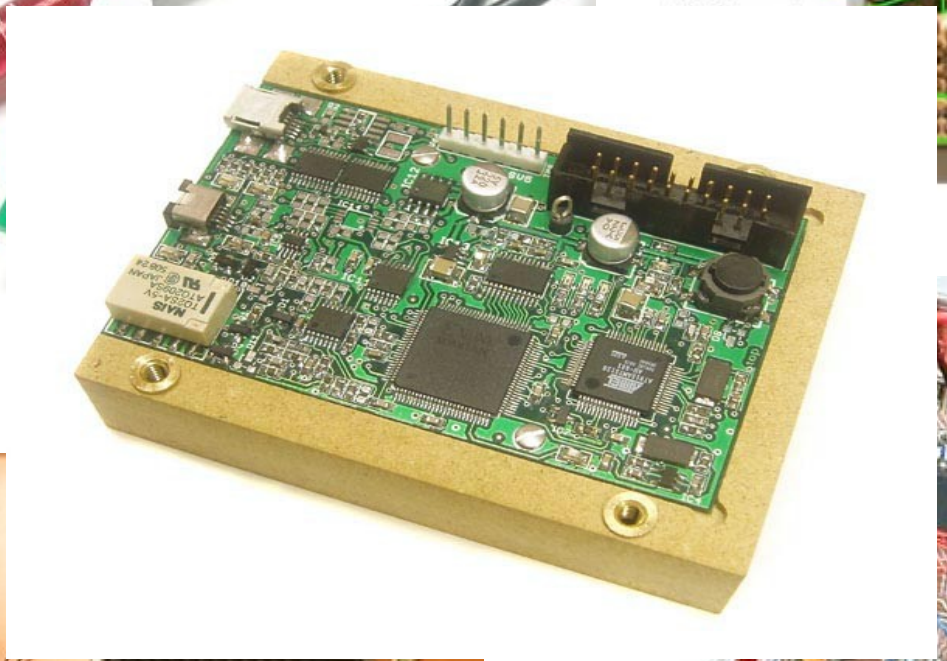


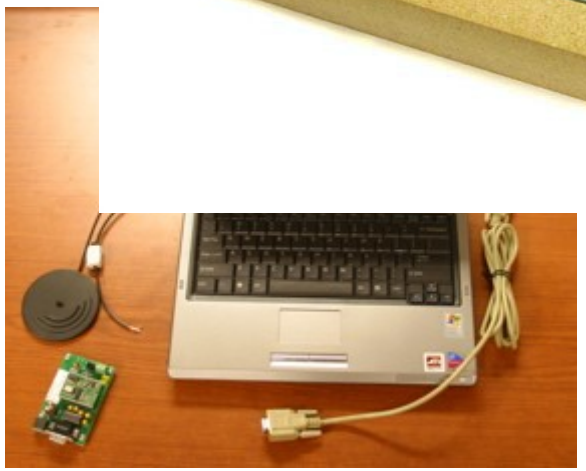


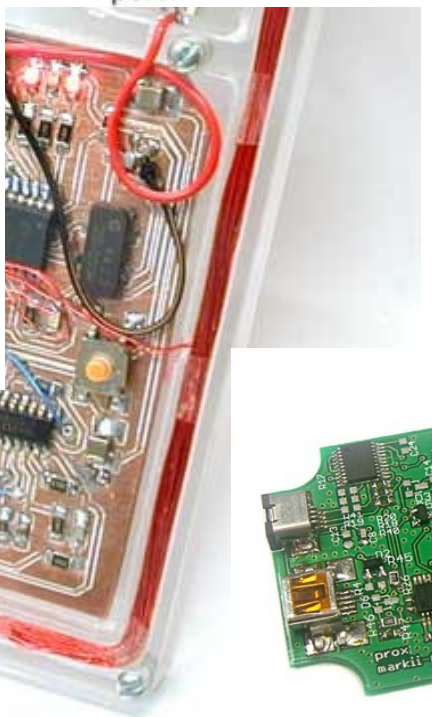
Cloning Devices

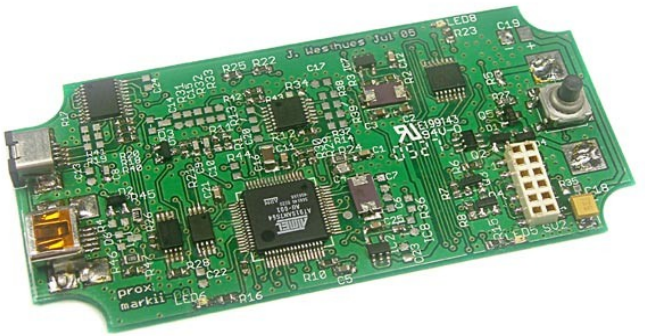




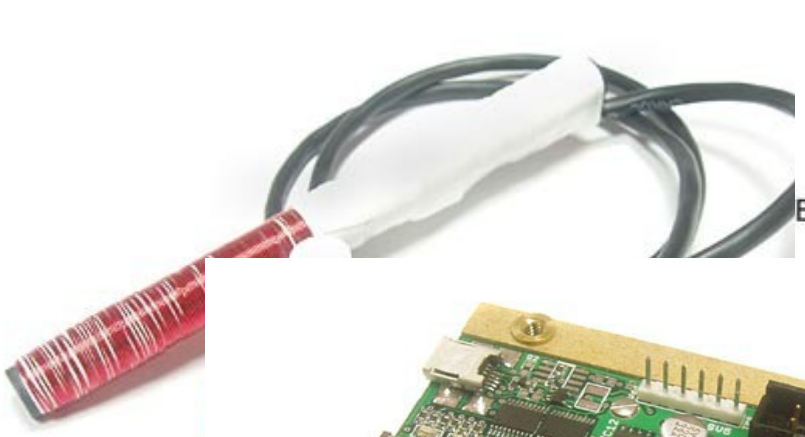


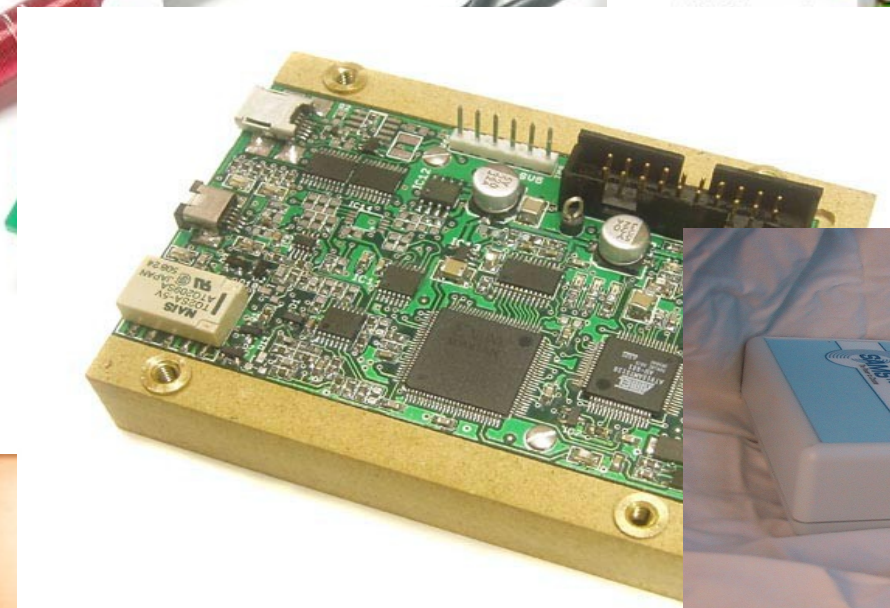


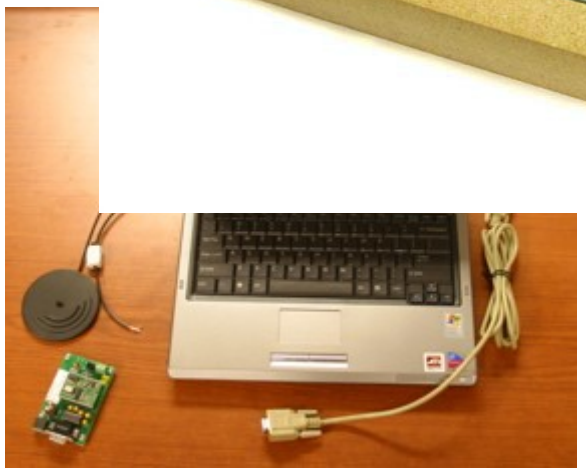


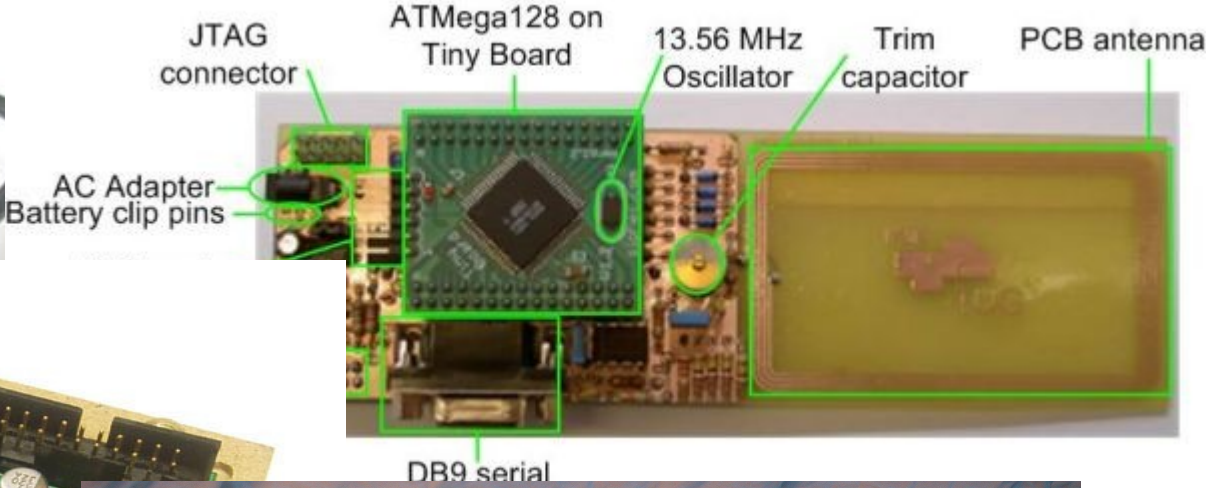


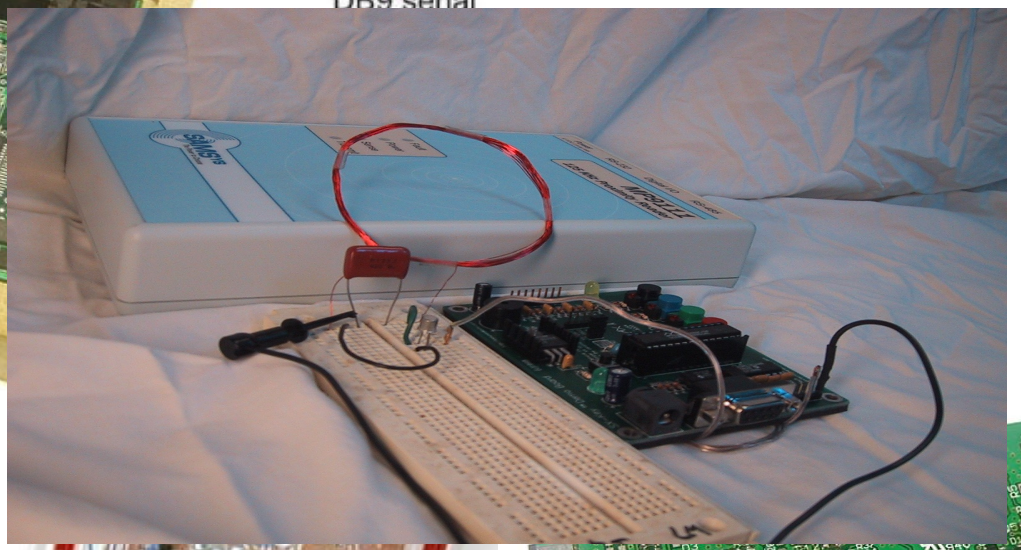
Cloning Devices

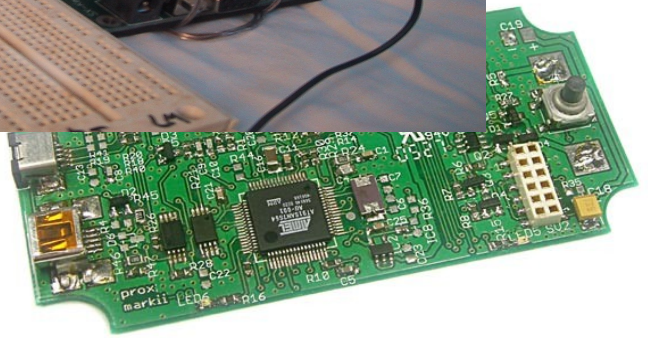




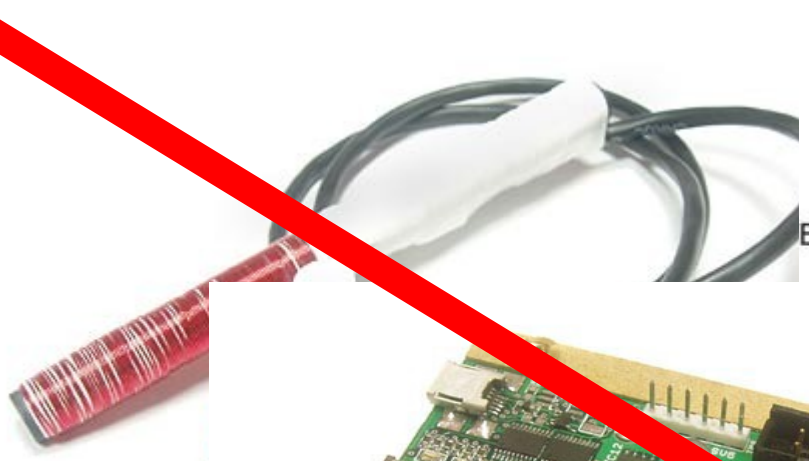


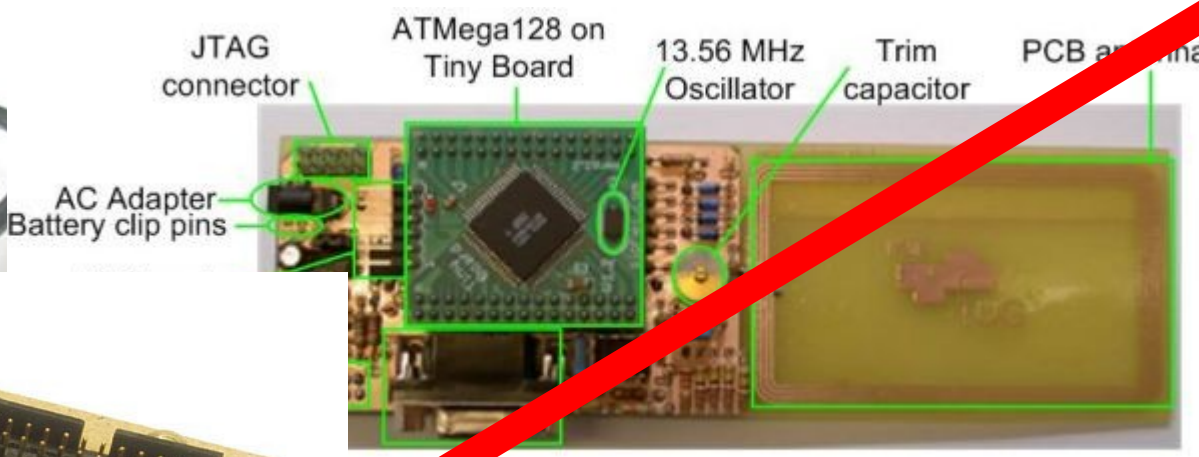


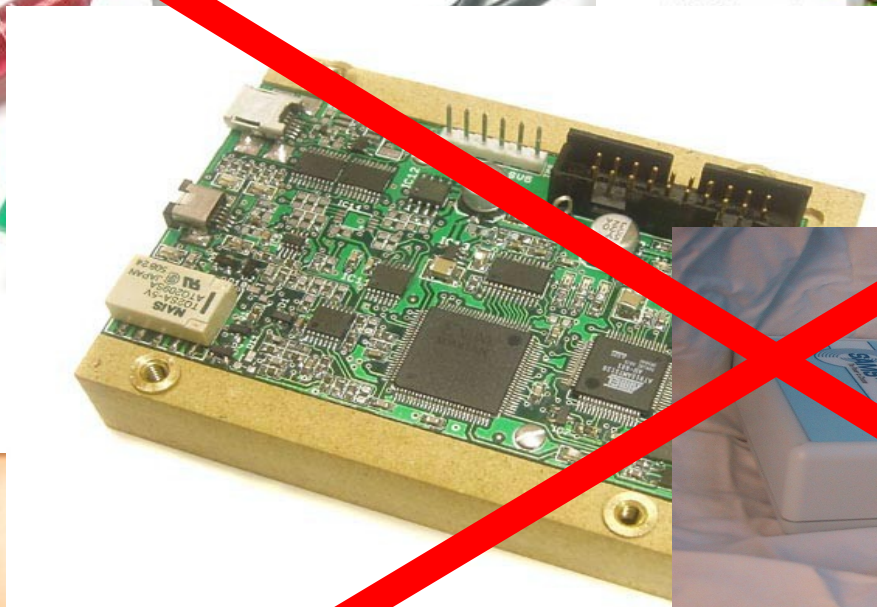


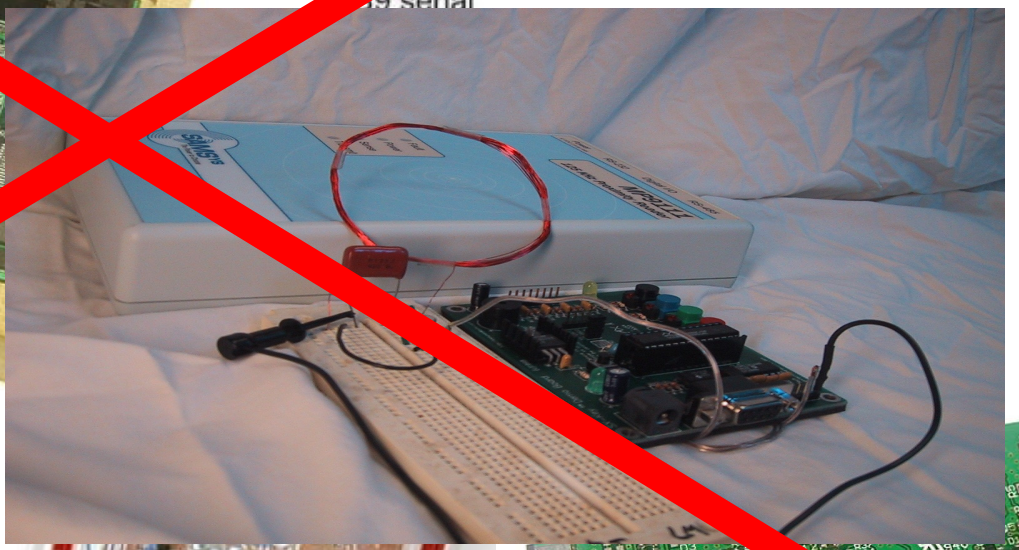


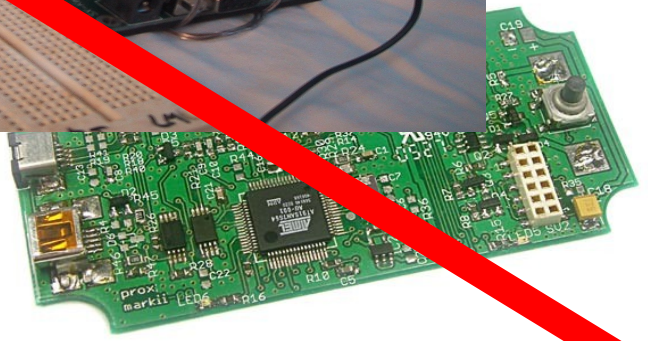
Cloning Devices











The Challenge

- Create a 'true' clone
  - Same ID
  - Same Form Factor

Understanding the ID

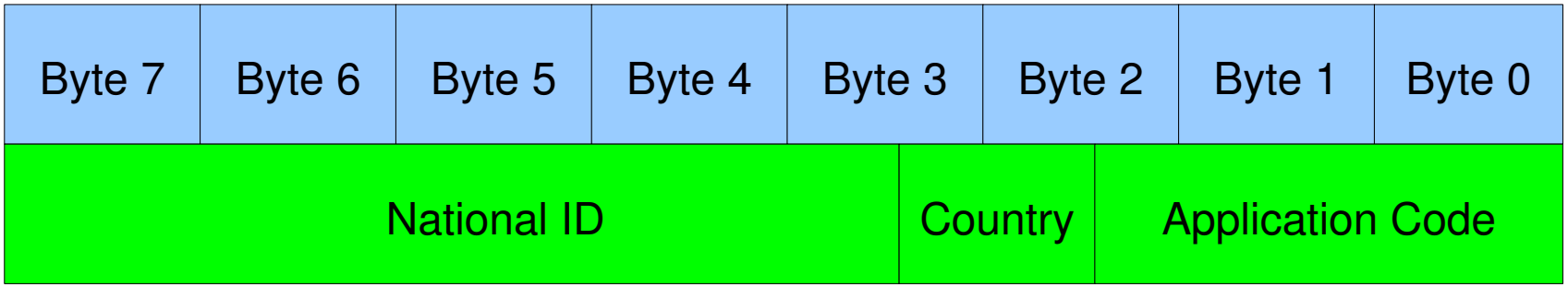
- Industry standard example
  - Animal Tagging
  - ISO-11784/5 FDX-B
    - Application flag (Animal/Non-Animal)
    - 3 Digit Country or Manufacturer code
    - National ID

Sending the ID

- Reader and TAG will communicate with
  - Specific frequency
    - 125/134.2 kHz - 'dumb'
    - 13.56 Mhz - 'smart'
  - Specific data bitrate
    - RF/2 - RF/128
  - Specific encoding (modulation) scheme
    - FSK, Manchester, BiPhase, PSK, NRZ
  - Specific bit patterns
    - Header / Data / CRC

Decoding the ID

- 8 Byte raw ID from 'dumb' reader



  - Reverse MSB/LSB
  - Reverse each Nibble
  - Right shift (x2)
  - Convert to Decimal

Decoding the ID

- 8 Byte raw ID

70	91	53	12	EA	6F	00	01

  - Reverse MSB/LSB

10	00	F6	AE	21	35	19	07

  - Reverse each Nibble

80	00	F6	57	48	CA	89	0E

Decoding the ID

- 8 Byte raw ID

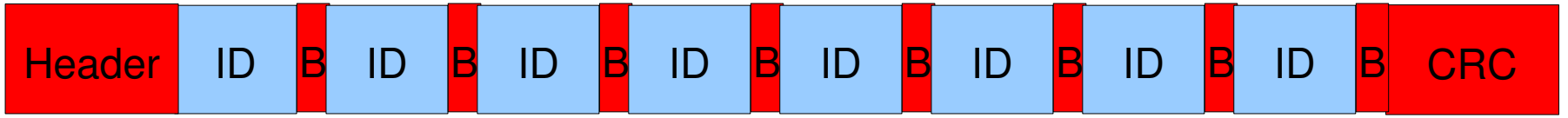
80	00	F6	57	48	CA	89	0E
Application ID 8000		Country F65		National ID 748CA890E			

  - Country F65 rightshifted: 3D9 == '985' decimal
    - icar.org: 'Destron Fearing / Digital Angel Corporation'
  - National ID 748CA890E == '31286003982'

Encoding the ID

- Reverse the decoding process

- Add Header / CRC to raw binary ID



  - Fixed bits embedded in ID prevent header being duplicated in datastream

- Now we have 128 bits of raw bit-level ID

  - How do we deliver it?

Multi-Format Transponders

- Why make 10 transponder types when you can make 1?
  - Lower manufacturing costs
  - Lower stocking/distribution costs
  - Convenience

Multi-Format Transponders

- Independently configurable parameters
  - Q5
    - Configuration for Bit Rate, Modulation etc.
    - 224 Bits user programmable memory
    - Dump <n> data blocks on wakeup
- Multiple 'personalities'
  - Hitag2
    - Configuration for 'Public Modes'
    - 256 Bit user programmable memory
    - Dump <n> data blocks on wakeup as per Mode setting

Sending the ID

- Take a redundant Door Entry tag
  - Re-Set configuration as appropriate
    - Bit Rate
    - Modulation
    - Inversion
    - Number of blocks to dump on 'wakeup'
  - Program data blocks with raw ID

Demonstration

- Clone Trovan 'Unique' TAG
  - Access Control System
- Clone ISO 11784 'Animal' TAG (FDX-B)
  - Cow Implant
  - VeriChip paperweight

RFID implanted chip threats

- Track individuals
- Target individuals
- Impersonate individuals
  - Gain access to restricted areas
  - Provide alibi for accomplice!
- 'Smart' Bombs
  - Device only goes off if target of sufficient rank is in range.

'Smart': Encryption is your friend

- RFID Enabled 'Biometric' passports
- 48 Items of Data
  - Fingerprint
  - Facial Image
  - Birth Certificate
  - Home Address
  - Phone Numbers
  - Profession

Keys to your kingdom

- Pseudo random UID
  - Cannot determine presence of specific passport without authentication
- Strong Authentication
  - Basic Access Control
    - 3DES
- Content Encryption
  - Extended Access Control

Deriving the Keys

- MRZ
  - Machine Readable Zone
- Key
  - Document Number
  - Date of Birth
  - Expiry Date

ePassport Demonstration

Applications Places System 11 °C Wed 22 Nov, 14:06

addy@nostromo: ~/work/suppose-addy-talks/research/RFID/acg/python

File Edit View Terminal Tabs Help

```
Tag: 5f36 (Unicode Version)
  Length:  6
    Data:  303430303030
Tag: 5c (Tag List)
  Length:  2
    Data Group:  61 (EF.DG1 Data Recorded in MRZ)
    Data Group:  75 (EF.DG2 Encoded Identification Feat
EF.COM stored in /tmp/EF_COM.BIN

Select EF.SOD:  File Length:  2054
Reading: 00000
EF.SOD stored in /tmp/EF_SOD.BIN

Select DG1:
615b5f1f
File Length:  93
Reading: 00000
EF.DG1 stored in /tmp/EF_DG1.BIN
EF.DG1:  Data Length:  88
  Decoded Data: P<AUSKENNEDY<<[redacted]<<<<<<<<<
    Document code:  P<
    Issuing State or [redacted]ganisation:  AUS
    Name:  KENNEDY<[redacted]<<<<<<<<<<<<<<<
    Passport Number:  [redacted]
    Check Digit:  8
    Nationality:  AUS
    Date of Birth:  [redacted]
    Check Digit:  5
    Sex:  F
    Date of Expiry:  151208
    Check Digit:  5
    Personal Number or other optional elements:  <[redacted]
    Check Digit:  0
    Composite Check Digit:  0

Select DG2:
File Length:  23391
Reading: 00000
EF.DG2:  JPEG image stored in /tmp/EF_DG2.JPG
EF.DG2 stored in /tmp/EF_DG2.BIN
```

mrpkey.py

Type: P

Code: AUS

Document No.: [redacted]

Surname: KENNEDY

Name: [redacted]

Date of Birth: [redacted]

Issuing State or Organisation: Australia

Sex: F

Date of Expiry: 08/12/15

Personal Number / Optional: [redacted]

P<AUSKENNEDY<[redacted]N<<<<<<<<<<<<<<<

[redacted]<8AUS[redacted]F1512085<[redacted]<<<00

http://rfidiot.org

Quit

addy@nostromo: ~/work/supp... | addy@nostromo: ~/work/supp... | addy@nostromo: ~ | mrpkey.py | Starting Take Screenshot

ePassport Modification

- “Not Possible” due to cryptographic signatures
  - Certificate Authority (CA) not verifiable
    - Signatures provided by document
    - CA Key provided by same document
    - Public Key Directory PKD now available
      - As of April 2007
      - 15 Participating Countries
- Self-Signed Forgery may not be detected!

ePassport Certificates

New Zealand genuine:

Certificate:
    Data:
Version: 3 (0x2)
        Serial Number: 1122333666 (0x42e573e2)
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: C=NZ, O=Government of New Zealand, OU=Passports, OU=Identity Services Passport CA
        Validity
            Not Before: Jan 23 21:46:58 2007 GMT
            Not After : May 18 12:00:00 2012 GMT
        Subject: C=NZ, O=Government of New Zealand, OU=Passports, OU=MRTD, CN=Document Signer 200701241034
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
            RSA Public Key: (2048 bit)
                Modulus (2048 bit):
                    00:a8:bf:fb:c0:ae:f4:c7:fe:ec:19:71:b6:25:e9:
                    ...

ePassport Certificates

New Zealand forgery:

Certificate:
Data:
Version: 3 (0x2)
Serial Number: 1122333666 (0x42e573e2)
Signature Algorithm: sha256WithRSAEncryption
Issuer: C=NZ, O=Government of New Zealand, OU=Passports, OU=Identity Services Passport CA
Validity
Not Before: Jan 23 21:46:58 2007 GMT
Not After : May 18 12:00:00 2012 GMT
Subject: C=NZ, O=Government of New Zealand, OU=Passports, OU=MRTD, CN=Document Signer 200701241034
Subject Public Key Info:
Public Key Algorithm: rsaEncryption
RSA Public Key: (2048 bit)
Modulus (2048 bit):
00:dc:19:33:f3:11:86:a4:82:b9:c7:21:45:ca:81:
...

Other ePassport threats

- Key data may be obtained through other channels
- Passport profiling
  - Determine country of origin without logging in
  - Implementation errors:
    - Australian passport does not start with '08' on select
    - Australian passport does not require Basic Auth on 'File Select', only on 'File Read'.
- Target specific passport holders
  - Bomb that works for Australians only...

RFIDIOt

- Open Source Python library
- Hardware independent
  - ACG
  - Frosch
  - PCSC-Lite
  - OpenPCD coming soon

http://rfidiot.org

Questions?

http://rfidiot.org

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