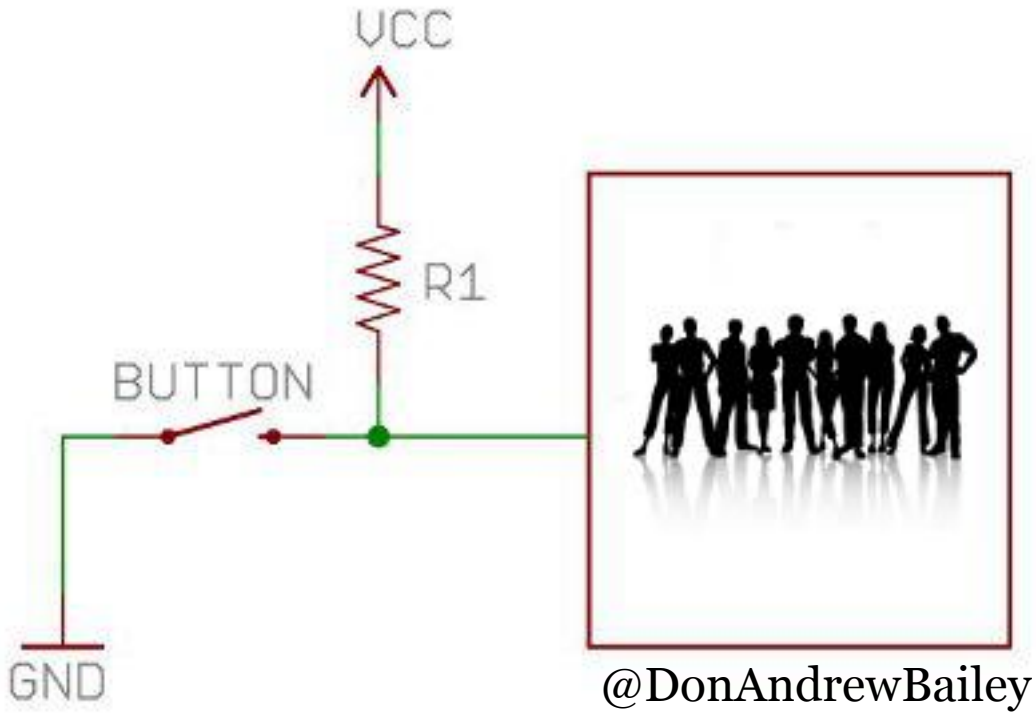


@DonAndrewBailey
donb@isecpartners.com

whois donb?

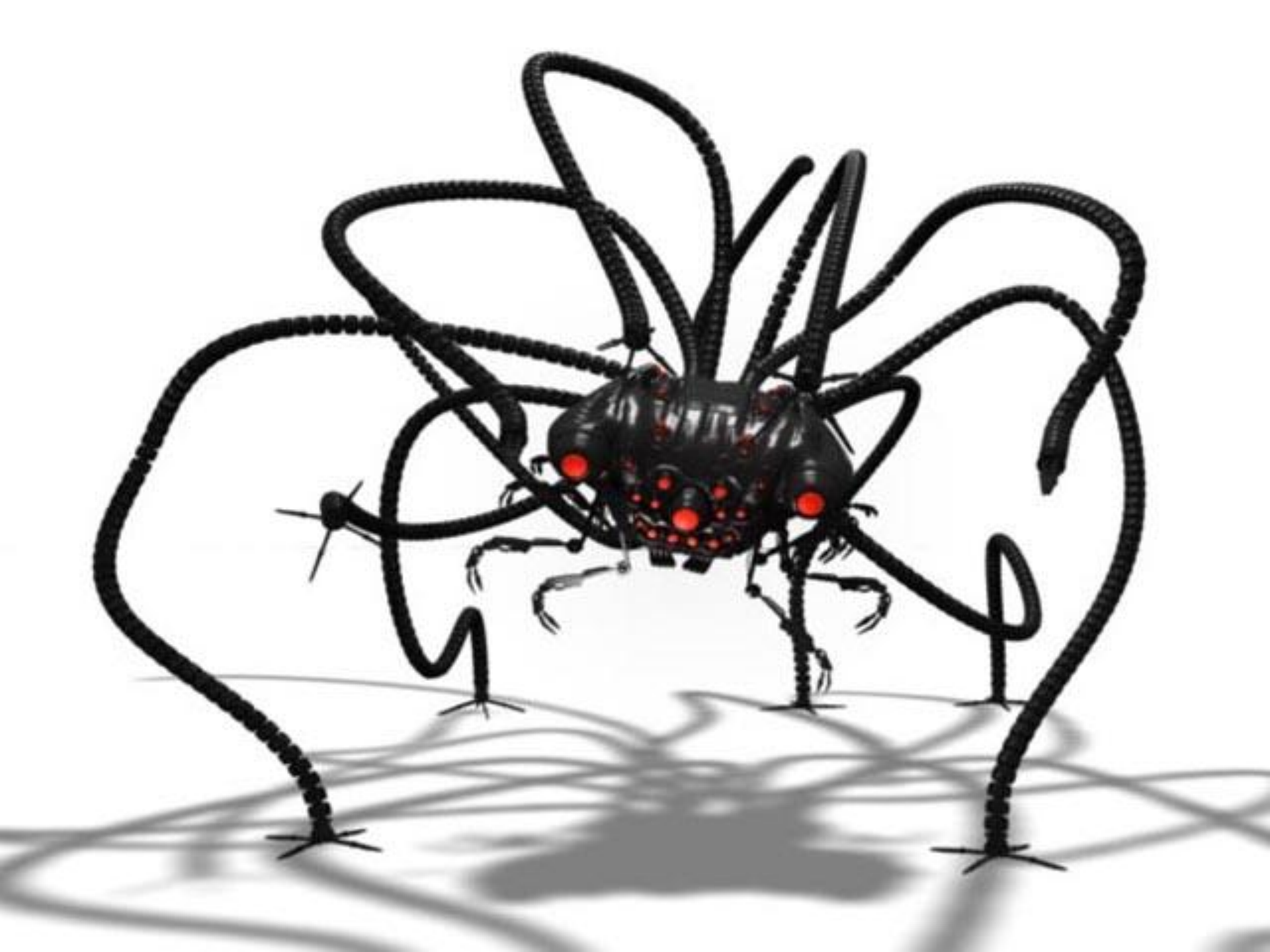

Hosted by :
Organized by :
pacto convex
DON BAILEY
BALAI SIDANG JAKARTA
CONVENTION CENTE

whatis iSEC Partners?

Technology is The Great Equalizer

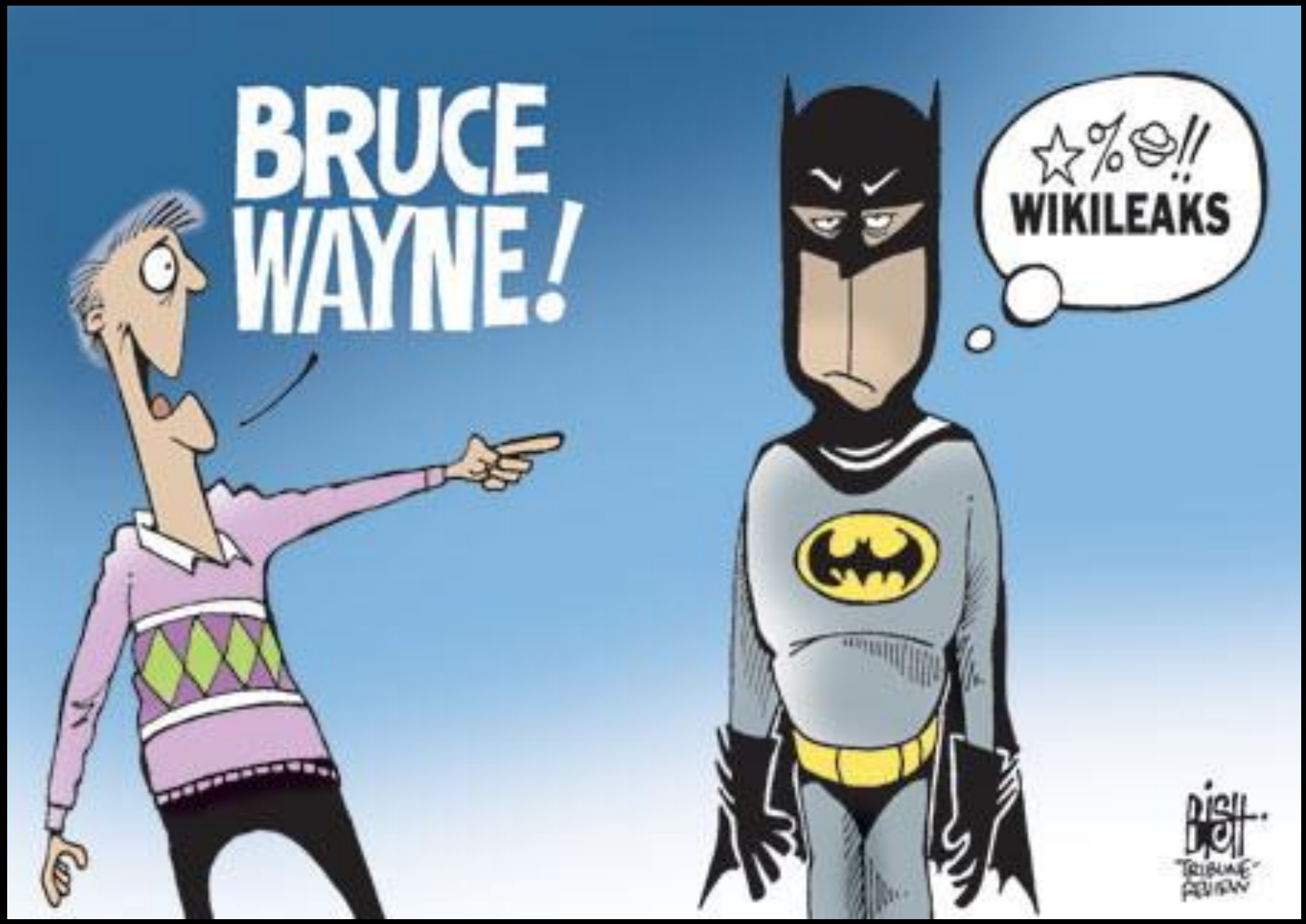






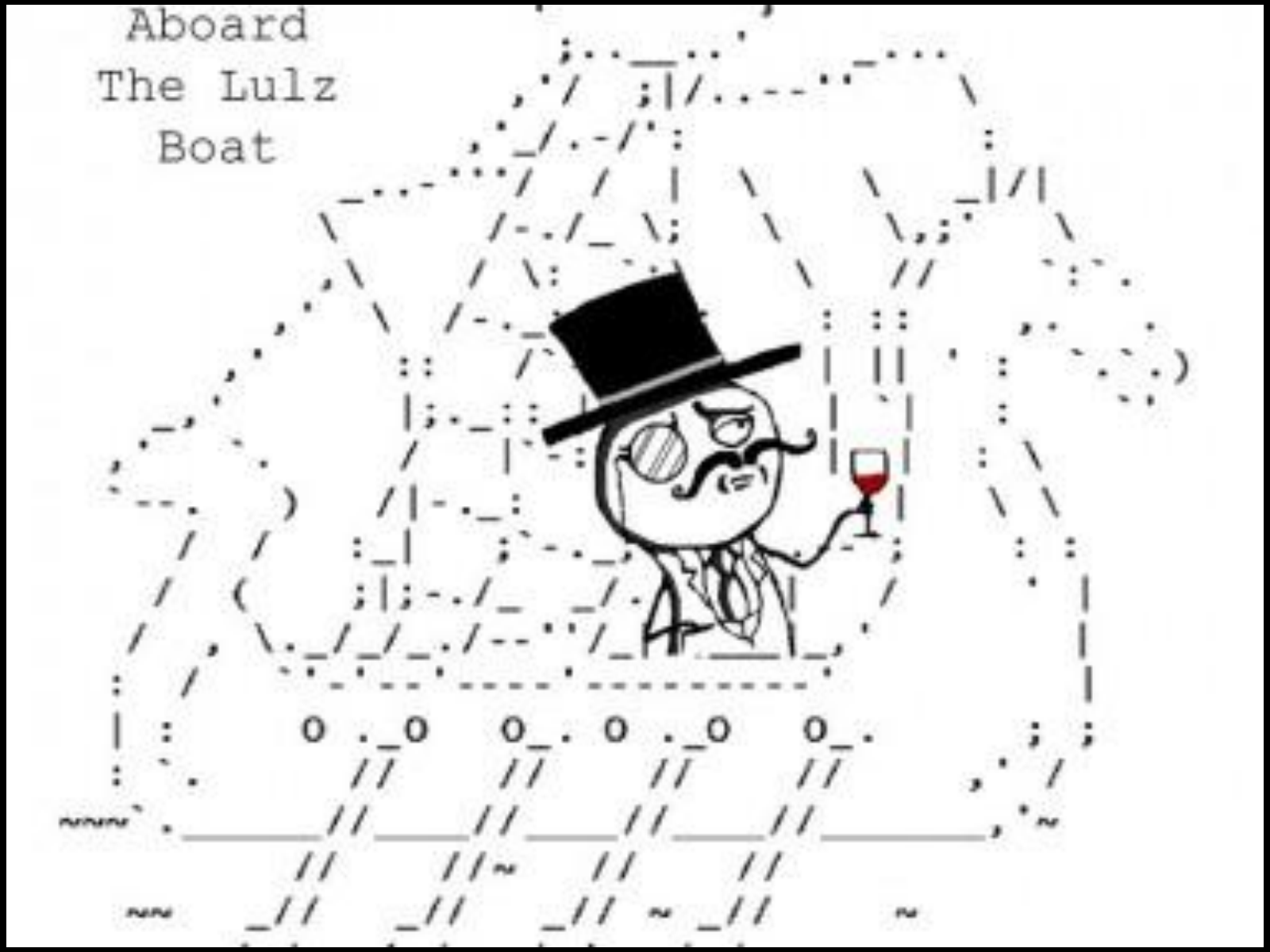

Hoboken411.com

As Technology Increases, Control Decreases


BRUCE WAYNE!
☆%@!!
WIKILEAKS
BISH
TRIBUNE MEDIA

libya
algeria
bahrain
egypt★
tunisia★
support the people's
revolution

Emerson 2011

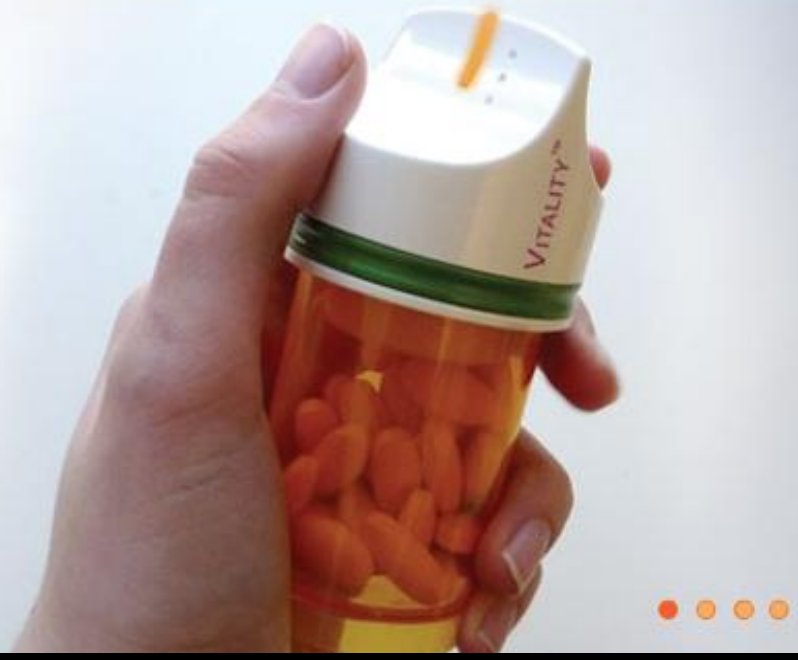

Aboard
The Lulz
Boat

Examples of Emerging Technology?

GlowCaps™

light and sound

remind you to take your prescriptions every day



No, really.

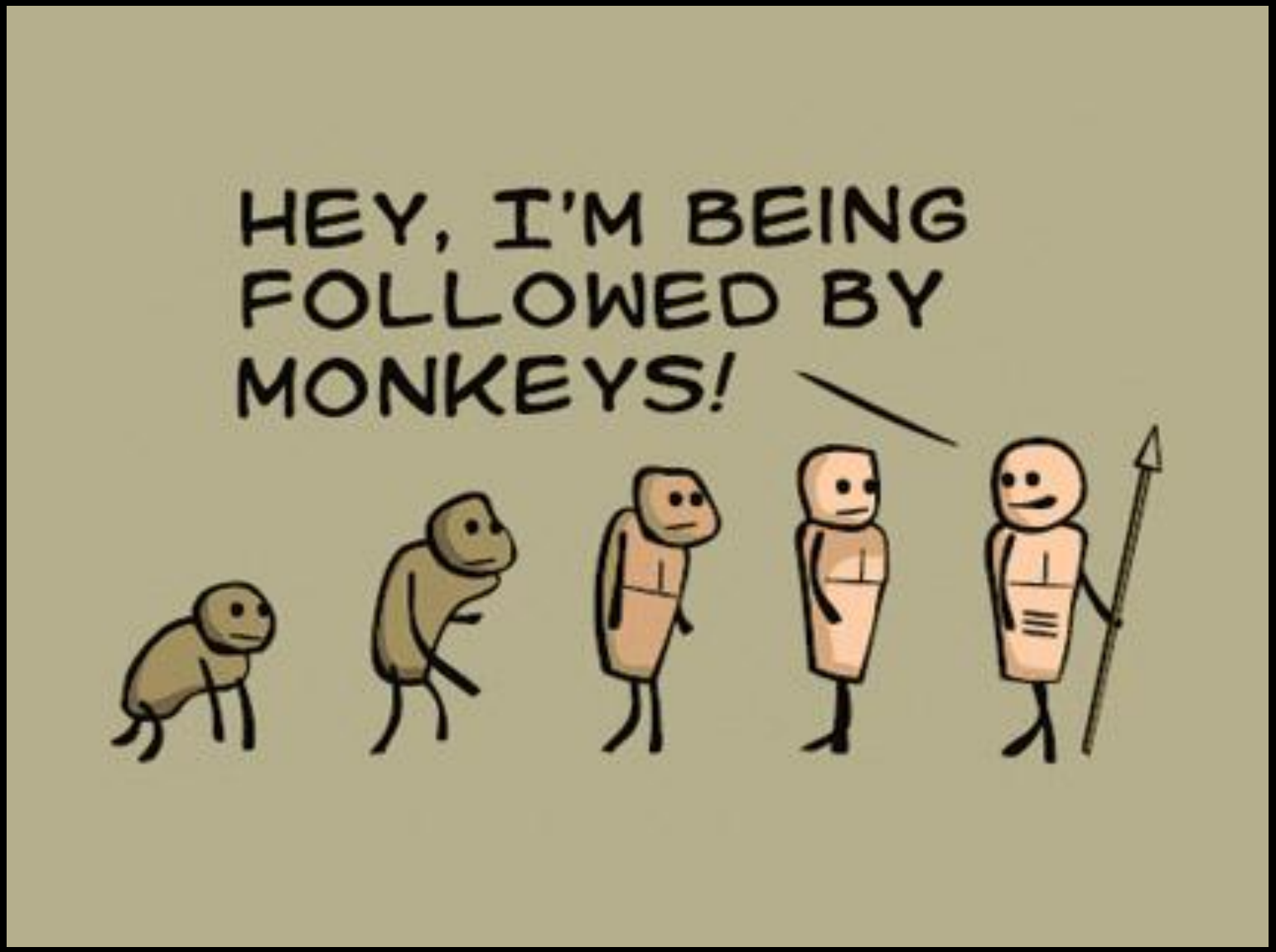
- Cellular enabled pill bottles
- Track pill usage remotely
- Email alerts when
  - Pill count is low
  - Pills haven’t been taken
  - When its time to take your pill

Wait. That sounds bad.

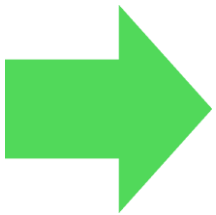
But, it’s helping people.

- Alzheimer’s patients
- Children with severe diseases
- Physically disabled patients
- Overworked security consultants

Wait. That sounds *good*.


HEY, I'M BEING FOLLOWED BY MONKEYS!


IBM




AT&T
9:42 AM
Text
Calendar
Photos
Camera
Weather
Maps
Stocks
Settings
YouTube
Notes
Calculator
Clock
Phone
Mail
Safari
iPod

Every*thing* will *be* a computer

Examples?

- Medical devices (personal, industrial)
- Industrial monitoring
- Automated Teller Machines
- Industrial/Commercial Alarm Systems
- Home Alarm Systems
- *…Car security systems*

Common M2M Example from Microchip

M2M PICtail™ Daughter Board

Find Architectural Commonalities

- Baseband
  - modules must be *approved*
  - The approved list is *public*
  - few *features*
  - can't drive *Application Logic*
- Microcontrollers
  - Small RAM
  - Small Code Space (flash)
  - Minimal security surface (if any)

Find Architectural Commonalities

- Communication
  - Network Comm = Baseband
  - Peripheral Comm = uC
  - Comm between Baseband & uC = UART
- Cryptographic Capability
  - Only *some* Basebands provide HTTPS/SSL
    - Usually only Java VM capable
  - uC is usually baked (or non-existent)

Easiest Way to Attack?

- Sniff
  - USART
  - SPI
  - I2C
- Debug ports
  - JTAG
  - SWIM
  - DebugWire
  - etc

The GoodFET

Open Source JTAG Adapter (and more)

- SPI
- I2c
- JTAG
- AVR
- Glitching
- SmartCard
- NordicRF
- PIC

Architecture

- Simple hardware architecture
  - Few components
  - Open Source
- Simple software architecture
  - Python based
  - Open Source

AVR Port

- Simple hardware architecture
  - Few components
  - Open Source
- Simple software architecture
  - Python based
  - Open Source

AVR GoodFET Requirements

- Simple board design
- Boot loader needed
- No soldering!
- Portable to almost any Atmel AVR
- Cheap!!
- Components must be easily accessible
  - world wide

AVR GoodFET Hardware

- ATmega1284P
- One pull-up resistor (1K Ohm)
- One 0.1uF and one 1uF capacitor
- 20MHz external clock (Abracon ACHL-20MHz)
- FTDI Cable

AVR Boot Loader

- 20MHz
- 0.5M USART baud rate
- Flash from file
- Flash from web
- Peek
- Signature
- Fuse bytes
- Page Size

```
donb@localhost ~/lab/research/atmel/bls/src/c $ ./goodfet.donbL
boot loader found. entering command mode.
donbL> pagesz
donbL: retrieving page size
pagesz: 100
donbL> peek 0x0
donbL: peeking address
peek 0x0: 940c
donbL> peek 0x02
donbL: peeking address
peek 0x02: 0050
donbL> fuse
donbL: retrieving avr fuse and lock bytes
fuse: ff ff 9c e0
donbL> signature
donbL: retrieving avr signature
signature: 1e 97 05
rc calibration: 51
donbL>
```

AVR Boot Loader

- Shouldn't have to know Chip
  - Requirement of Travis'
- Fromweb & signature = solution
  - Request sig (1E9705)
  - Download per-sig image 1E9705.hex
  - Flash image
- Fuses can be validated per signature
  - Each chip has slightly different fuses

```
donb@localhost ~/lab/research/atmel/bls/src/c $ ./goodfet.donbL
boot loader found. entering command mode.
donbL> flash goodfet.hex
donbL: flashing image
pagesz: 100
flashing pages: ..........................................................
donbL> reset
boot loader found. entering command mode.
donbL> signature
donbL: retrieving avr signature
signature: 1e 97 05
rc calibration: 51
donbL>
```

Boot Loader Bugs

- A section can’t exceed one file
- Can’t use .data, .bss
- Word address versus Byte address
- Vectors are /required/
- IVTs must get naked (ISR -> BL_ISR)
- WatchDog spinlock
- Pgm_read_byte_far() is buggy
- Undocumented bits in –P models (SIGRD)

AVR Port Code

- Build library files
- Integrated “donbfet” support
- Adjusted for silly AVRnesses
- Go!

```
donb@localhost ~/lib/src/goodfet/c/goodfet/trunk/client $ platform=donbfet ./goodfet.monitor apps full
GoodFET with 0000 MCU
Clocked at 0x0000
Build Date: 2011-10-10 23:31
Firmware apps:
Monitor
        The monitor app handles basic operations on the MSP430
        such as peeking and poking memory, calling functions and
        managing the baud rate.

SPI
        The SPI app handles the SPI bus protocol, turning
        your GoodFET into a USB-to-SPI adapter.

AVR
        The AVR app adds support for debugging AVR based devices.

JSCAN
        The JScan app adds support for JTAG brute-force scanning.

donb@localhost ~/lib/src/goodfet/c/goodfet/trunk/client $ platform=donbfet ./goodfet.avr info
Identifies as Atmel 0x9705, lock=ff
donb@localhost ~/lib/src/goodfet/c/goodfet/trunk/client $
```

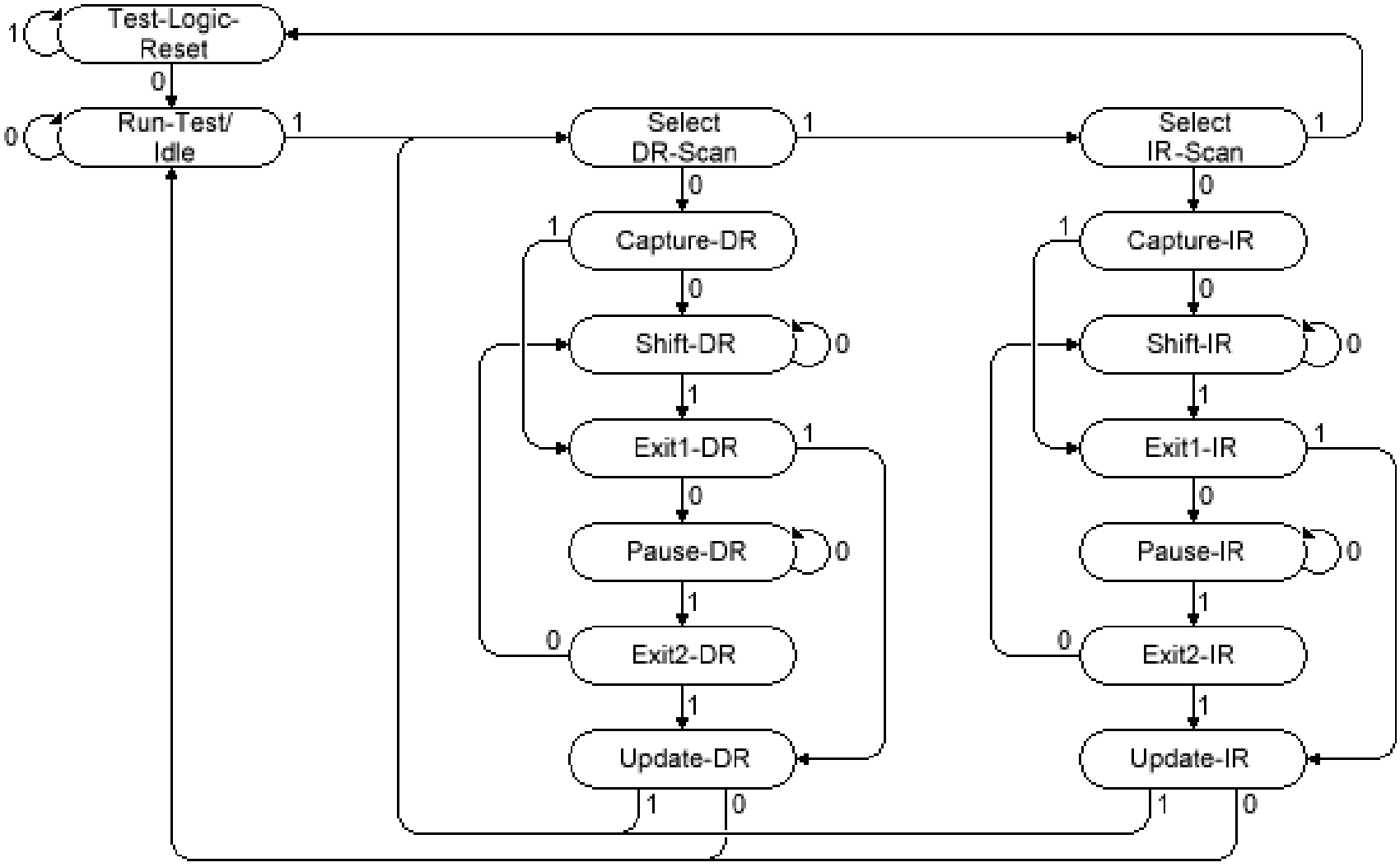
JTAG Scanning

What is JTAG?

- Standard for debugging/monitoring chips
- Originally used to test manufactured equipment
- Used to test/debug embedded devices
- Simple state machine protocol
- Daisy chain-able
- Field updates!

What is JTAG?

- 5 Pins
  - TCK – Clock
  - TMS – Mode Select
  - TDI – Data In
  - TDO – Data Out
  - TRST – Reset
- TRST is “optional”
  - Not always (AVR)


Test-Logic-Reset
Run-Test/ Idle
Select DR-Scan
Capture-DR
Shift-DR
Exit1-DR
Pause-DR
Exit2-DR
Update-DR
Select IR-Scan
Capture-IR
Shift-IR
Exit1-IR
Pause-IR
Exit2-IR
Update-IR
0
1

JScan Application

- 646 Lines of C (firmware)
- 143 Lines of Python (client)
- Dynamic Pin definition
- Control endianness
- Select delay (pin state sync)
- Store/retrieve results
- Core is based on
  - Hunz's slides
  - ArduiNull (LeKernel)

How Do We “See” JTAG?

- 11111b is Always a state machine Reset
- Then
  - 0: Run Test Idle
  - 1: Select DR
  - 1: Select IR
  - 0: Capture IR
  - 0: Shift IR
- Shift IR activates TDO
- Shift in via TDI, monitor TDO

Hunz's Method

- Only 4 pins are required
- Yes, still NRST
- Still N! operations
- Approximately 120 tests per minute

```
donb@localhost ~/lib/src/goodfet/c/goodfet/trunk/client $ ./jscan.sh
scan verb: 7f
scan count: 01
addpin returned ID 80
scan verb: 7f
scan count: 01
addpin returned ID 81
scan verb: 7f
scan count: 01
addpin returned ID 82
scan verb: 7f
scan count: 01
addpin returned ID 83
scan verb: 7f
scan count: 01
addpin returned ID 84
Endian is 0x01
Endian set 0x01
Delay is 0x01
Delay set 0x01
donb@localhost ~/lib/src/goodfet/c/goodfet/trunk/client $ platform=donbfet ./goodfet.jscan scan
scan verb: 7f
donb@localhost ~/lib/src/goodfet/c/goodfet/trunk/client $ platform=donbfet ./goodfet.jscan results
scan verb: 7f
scan count: 05
tck=80, tms=82, tdi=83, tdo=81, nrst=84
```

Results

- ~0.55% FP rate
  - 5 pins
  - 6 pins
  - 7 pins
  - 8 pins
- @20MHz, 120 tests per minute
- Pull-ups are required
- False positives are easy to detect
- Output arrays should feed other Apps

Issues

- False positives often drive invalid states
  - Logic gate w/ power control
- Delays should be adjusted when R = 0
- 220 – 330 Ohm resistors Must be used
- Output -> App requires dynamic Pin control
- Can only fit ~100 results in response
  - Limited by GoodFET protocol

Future Requirements

- Select “Profile” mode (i.e. AVR, ARM, etc)
- Fingerprint JTAG subtleties
- Automated target power control ala JTagger
- Apps should interleave
- Protocol scanning should be genric
  - Pattern based
- Language should define pattern

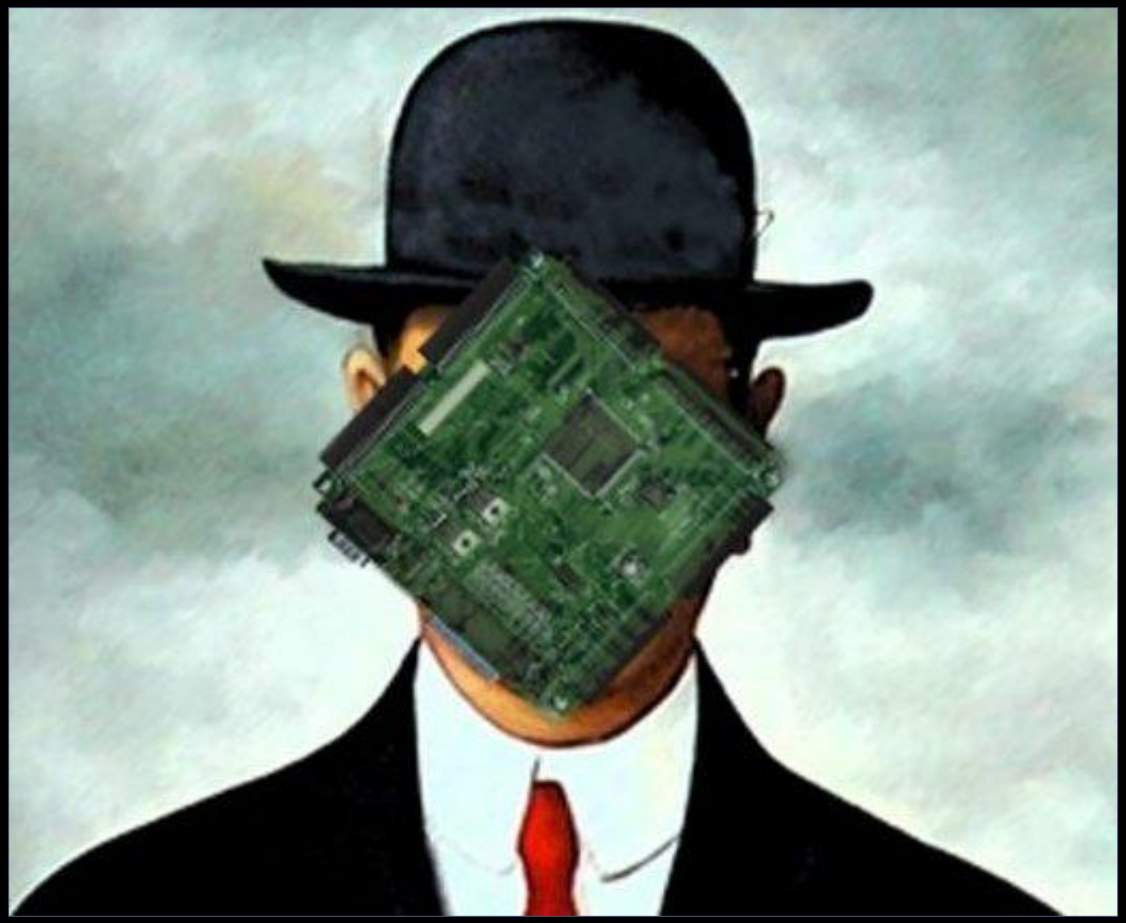
Demo

Summary?

- Need More Tools like GoodFET and UberTooth
- Opening up GoodFET's arch further will help
- JTAG scanning is easy
- Integrating it is hard
- Other protocols are needed

Thanks to…

- iSEC Partners
- Travis Goodspeed
- Mike Kershaw
- Mike Ossmann
- Nick DePetrillo
- hunz@hunz.org
- LeKernel.net



“Pull up the people. Pull up the poor.”
- M.I.A.