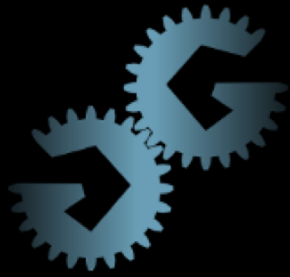
OPENING BLACK BOX SYSTEMS WITH GREATFET+FD

TROOPERS18

KATE TEMKIN & DOMINIC SPILL



WHO WE ARE

Kate Temkin (@ktemkin):

- slayer of Tegras, destroyer of worlds
- glitch witch & tool-builder
- educational (reverse) engineer

Dominic Spill (@dominicgs):

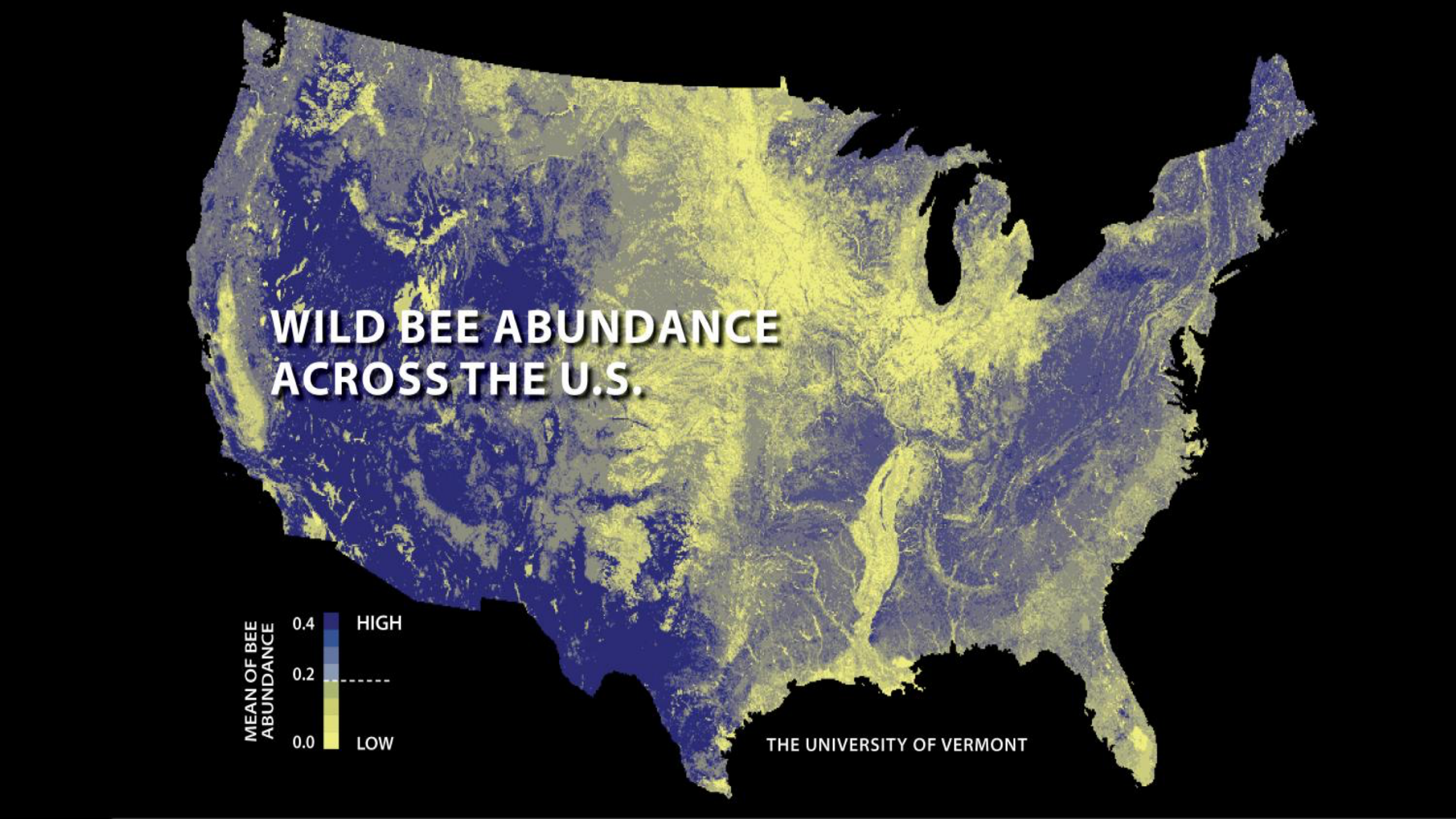
- cannot stop being extraordinary, on penalty of deportation
- shark whisperer & demo dancer

MANY THANKS TO

- Travis Goodspeed (@travisgoodspeed)
- Sergey Bratus (@sergeybratus)
- Michael Ossmann (@michaelossmann)

PEOPLE WHO GIVE US MONEY

- Great Scott Gadgets (@gsglabs)


WILD BEE ABUNDANCE
ACROSS THE U.S.
MEAN OF BEE ABUNDANCE
0.4
HIGH
0.2
0.0
LOW
THE UNIVERSITY OF VERMONT

WHY USB?

The capability to monitor, MITM, & emulate USB devices enables:

- **Understanding the behaviors of** USB and driver stacks
- **Building tools** that work with existing hardware / software
- Building implants and tools for **playing NSA**.
- One to get a **foot in the door** for understanding black box systems.

WHY PROXY?

All too often-- as with black box systems-- we don't control the host software stack:

- Game consoles [e.g. the Nintendo Switch]
- In car entertainment [e.g. Tesla consoles]
- Point of sale
- Televisions

- … pretty much any embedded device that can act as a USB host!

USBPROXY NOUVEAU

USBProxy is a tool that allows us to **proxy the connection** between a USB host and device. While proxying a connection we can:

- Log USB packets (cheap protocol analysis)
- Modify data being sent to or received from a device
- Inject new packets into the connection, or absorb packets
- capture side-channel information and precisely time glitching attacks

Original version was based on a BeagleBone Black in C++.
We've rewritten it to take advantage of FaceDancer's more granular control.

[let's monitor some USB]

https://github.com/ktemkin/Facedancer/blob/master/facedancer-usbproxy.py

USB CLASSES

In addition to specifying the standard protocol used for enumeration/configuration, the specs also specify protocols for **standard device classes**, allowing e.g. operating systems to provide **standardized drivers**.

- Human Interface Device (keyboards, mice, datagloves; the usual)
- Serial (e.g. CDC-ACM)
- Mass storage (UMS bulk only / UAS)
- Audio / Video
- Midi
- Scanners
- Networking
- etc.

[let's slack off]

https://github.com/ktemkin/Facedancer/blob/master/usbproxy-switch-invertx.py

EXPLORATORY RE

There are many USB hosts and devices for which firmware isn't easily available--but we don't always need firmware to do interesting things to a system.

- Can we discover behaviour?
- Find firmware functions?
- What about identifying hosts?

EXPLORING FUNCTIONALITY

By monitoring and modifying USB packets we can discover functionality of a host system

- Does it take firmware updates via USB?
  - What filename is it looking for?
  - Does it read that file multiple times?
- How does the host enumerate the device?
  - Order and length of requests
  - Timing
  - Windows Compatibility ID
  - umap2 already does this, let's port it to new FaceDancer

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- What are the device's access patterns?

[let’s run a simulated firmware update]

UMS DOUBLE FETCH

Of course, nothing says our emulated devices have to **behave nicely.**

Example: most systems assume that disk contents *don't change on their own*
Reality: in practice, *they totally can*

Example firmware update sequence:

- USB host reads firmware off flash drive, computing a checksum as it does
- USB host verifies the checksum, which passes
- USB host *rereads the firmware and flashes it to ROM*

[let's fetch... *twice*]

https://github.com/ktemkin/Facedancer/blob/master/facedancer-ums-doublefetch.py

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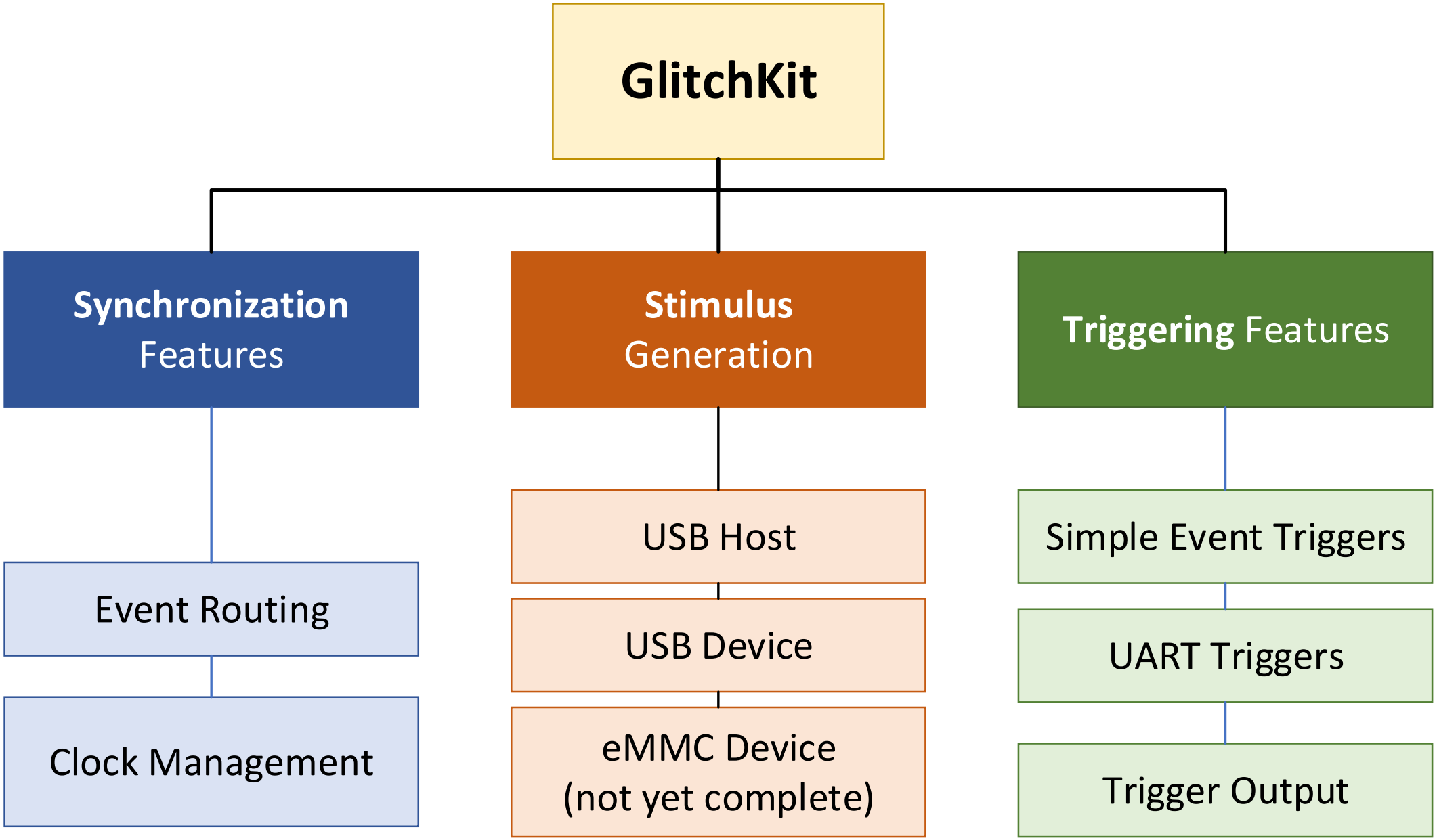
[let’s talk about firmware filenames]


GlitchKit
Synchronization Features
Stimulus Generation
Triggering Features
Event Routing
Clock Management
USB Host
USB Device
eMMC Device (not yet complete)
Simple Event Triggers
UART Triggers
Trigger Output

GLITCHKIT LIBRARY

```
gf = GreatFET()
gf.switch_to_external_clock()
gf.glitchkit.provide_target_clock(VBUS_ENABLED);

gf.glitchkit.simple.watch_for_event(
     1, [('EDGE_RISING', 'J1_P7')])
gf.glitchkit.use_events_for_synchronization(COUNT_REACHED)

gf.glitchkit.trigger_on_events(HOST_SETUP_TRANSFER_QUEUED)
gf.glitchkit.usb.capture_control_in(request=GET_DESCRIPTOR,
     value=GET_DEVICE_DESCRIPTOR, length=18)
```

QUESTIONS?

THANKS FOR LISTENING!

JOIN US:

https://github.com/greatscottgadgets/greatfet

https://github.com/ktemkin/Facedancer

https://github.com/glitchkit