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# Creating Our Robot Overlords

## Autonomous Drone Development with Java and IoT

CREATE
THE
FUTURE

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Oracle

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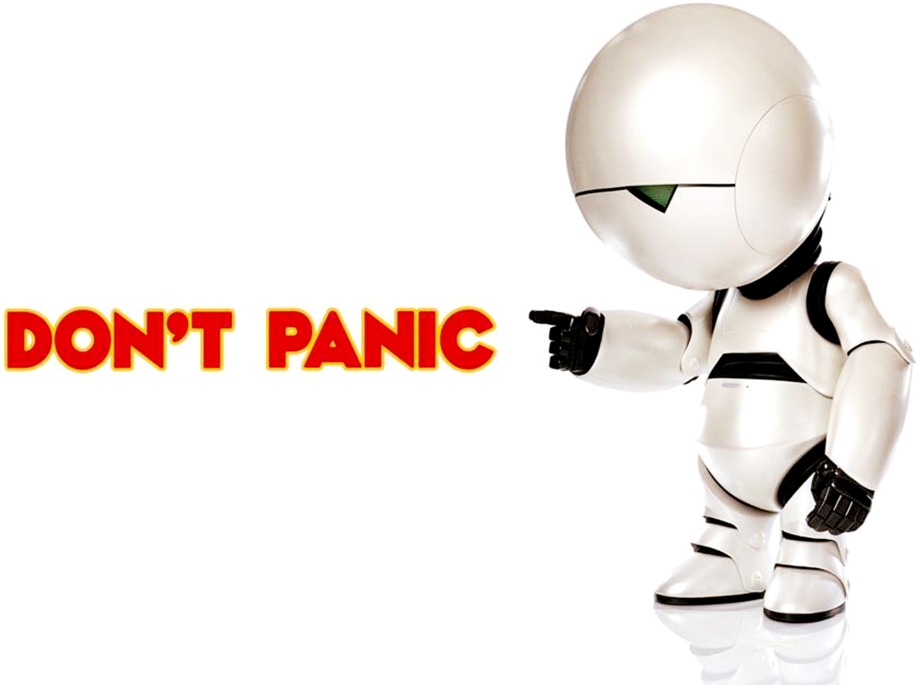
# Program Agenda

1. Achieving autonomous flight (and tearing up the house)
2. Anatomy of a quadcopter
3. Raspberry Pi for brains
4. Leveraging IoT concepts and tools
5. 3D flight simulation
6. Next step: Self-aware drone (implementing a control loop)

# Achieving Autonomous Flight!

- First things first
  - Choosing a drone
  - Finding or writing a foundational library
  - Determining level of autonomous ops
- Equipment list
  - Drone
  - Brain
  - Power
- Making it work
  - And **this** is where the story gets really interesting



# Achieving Autonomous Flight!
# Making the Tough Choices

- Which drone?
  - Published API
  - Community
  - Price of equipment
  - **Parrot AR.Drone 2.0 (Parrot.com)**
- Which library?
  - Capability
  - Reliability
  - Responsibility
  - **Parrots On Java/Parroteer (ParrotsOnJava.com)**

# Achieving Autonomous Flight!
# Assembling the Pieces

- Equipment list
  - Parrot AR.Drone 2.0
  - Brain
    - Raspberry Pi Model B with case
    - Two (2) Edimax EW-7811un wifi adapters
    - 16G Class 10 SD card
  - Power
    - dodocool 2600 mAh mini power bank/charger
    - Cablejive microStubz extra short USB to micro USB cable
  - Anything else?
    - Duct/gaffer’s tape! (Just kidding, we used Velcro)

# Achieving Autonomous Flight!
# Configuring the Positronic Brain

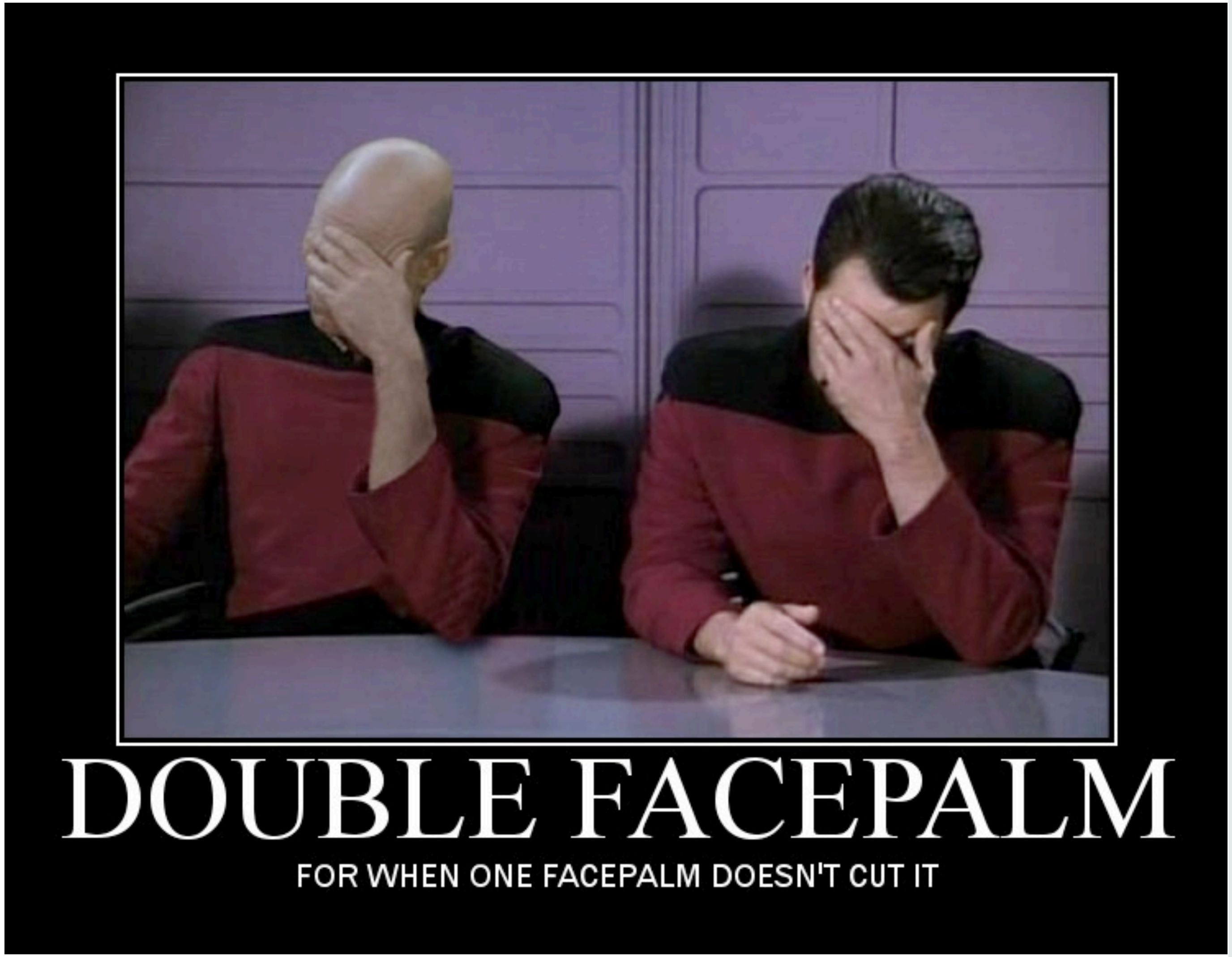
- Central piece of the puzzle
- Configure one wifi adapter to connect as a client to the drone
- Configure other with Pi running
  - Wireless Access Point
  - DHCP server
- More details in a bit…

# Achieving Autonomous Flight!
# Powering the Positronic Brain

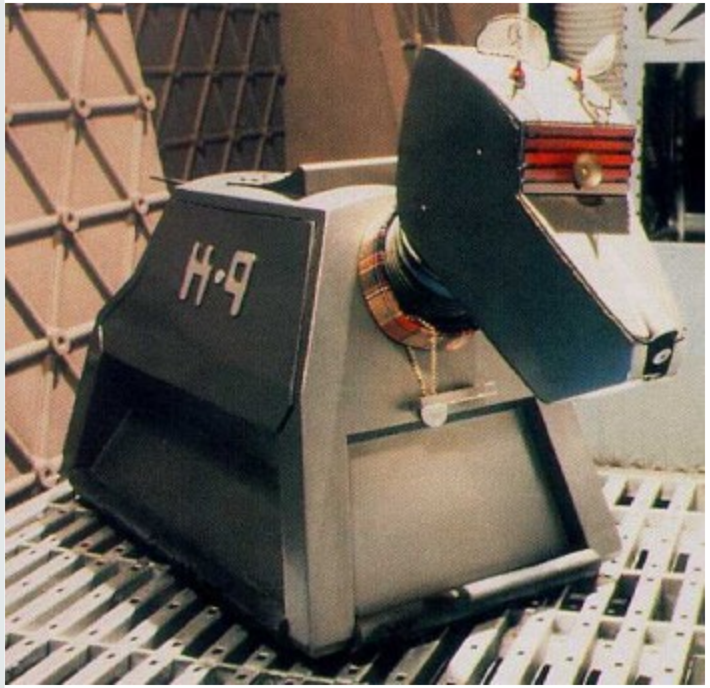
- No straightforward means of powering other devices from drone
- How to fix?
- Add a power source!

# Achieving Autonomous Flight!
# Making it Work

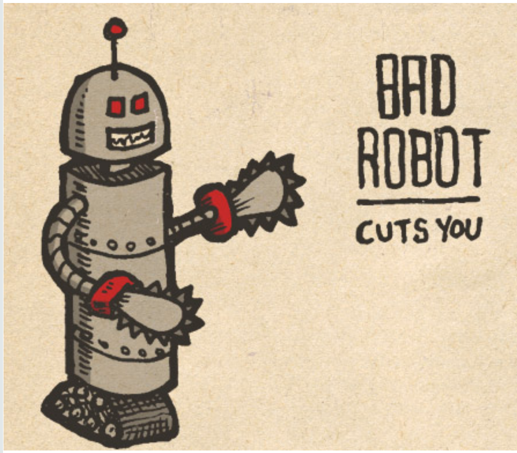
- Didn't anticipate many issues
- In hindsight, that was just silly
- Firmware challenges
- API challenges
- Equipment challenges
- Sensing a pattern?

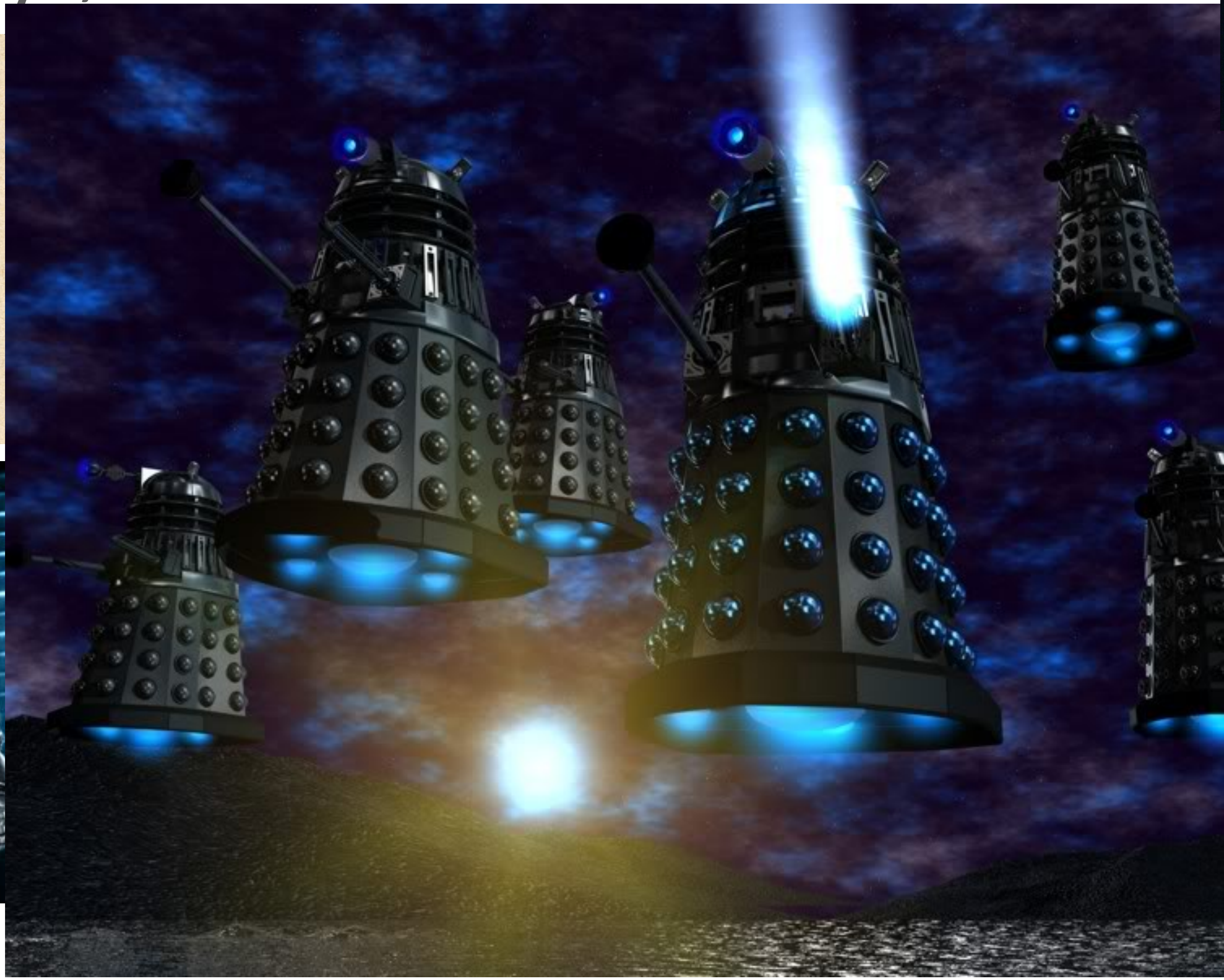


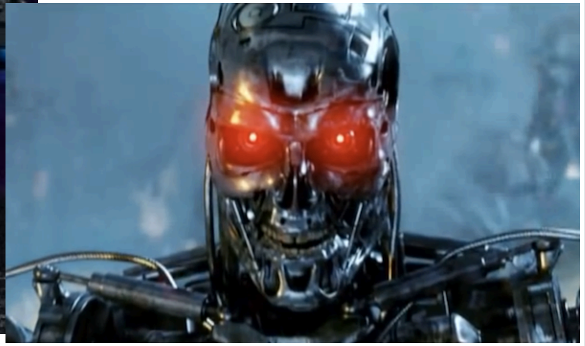
# Achieving Autonomous Flight!
(Unrealistic) Expectations



# Achieving Autonomous Flight!
# In some ways, it’s more like…



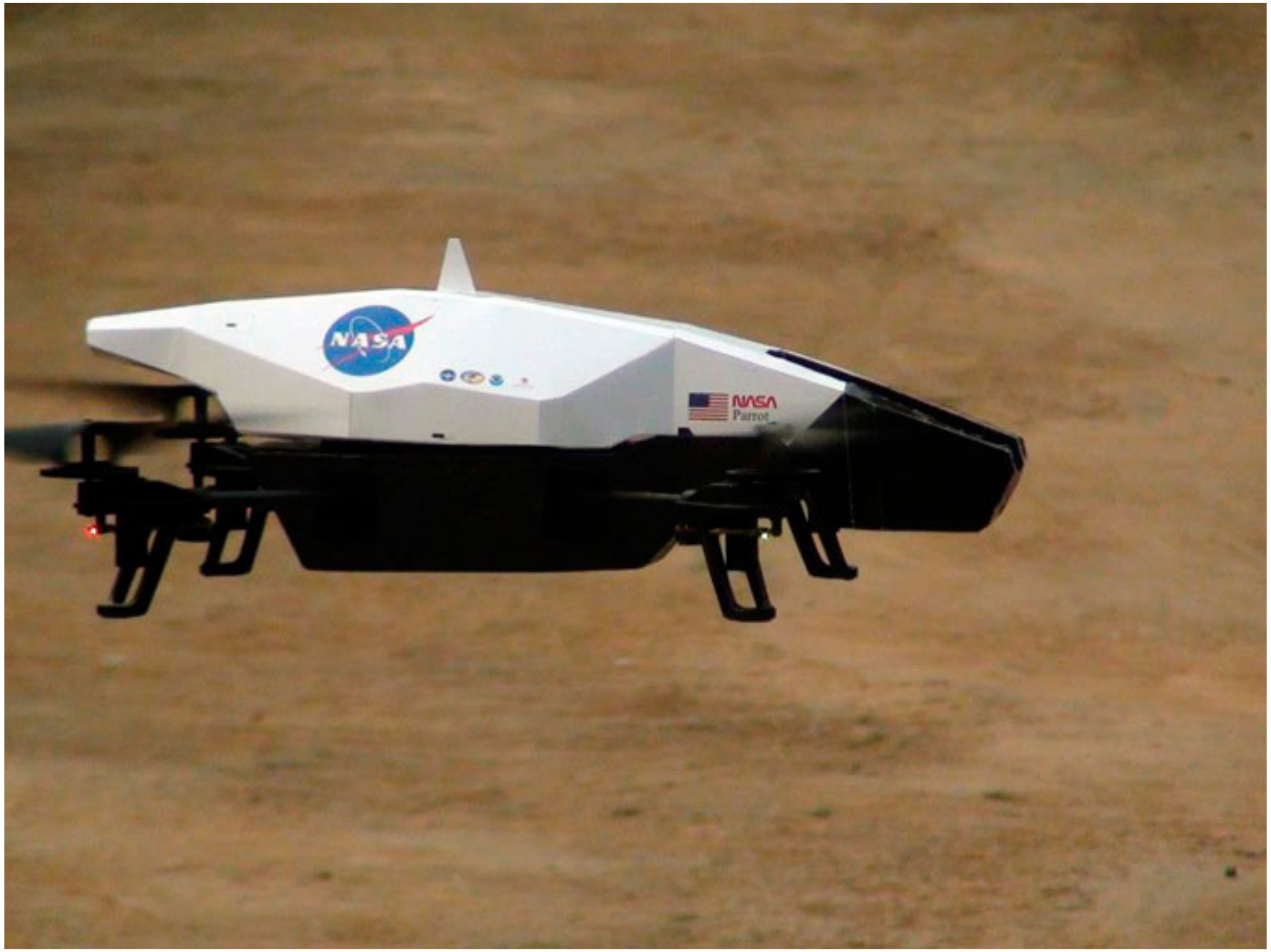




# Achieving Autonomous Flight!
# With a bit of this thrown in for good measure…

# Anatomy of a Quadcopter

# Anatomy of a Quadcopter



# Anatomy of a Quadcopter

- Four spinning blades of doom (!)
- Arms
- Onboard Wireless Access Point
- Firmware/Controller
- Cameras (forward and downward)
- Battery holder
- Shell (indoor or outdoor)

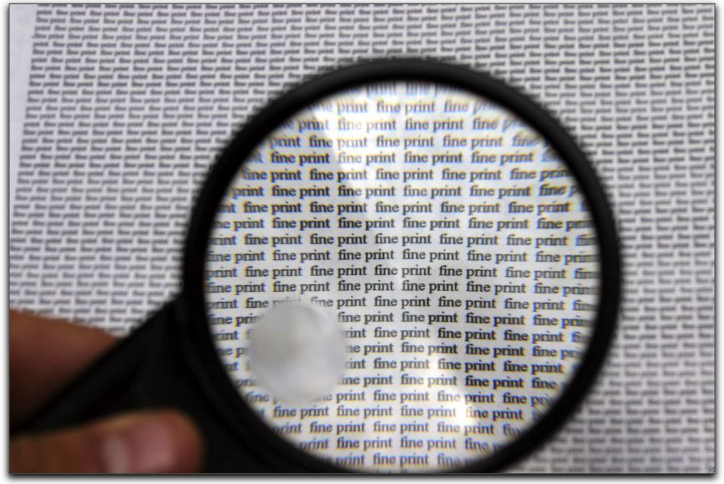
# Raspberry Pi for Brains

# Raspberry Pi for Brains
# Bill of Materials

- One (1) Raspberry Pi Model B
- One (1) Raspberry Pi case (smaller/lighter is better)
- One (1) SD card, Class 10, minimum 8G
- Two (2) Edimax EW-7811un wifi adapters
- One (1) Raspberry Pi power adapter (for initial configuration steps)
- One (1) portable USB mobile phone charger
- One (1) ethernet cable (for initial configuration steps)
- Parts list with links in appendix

# Raspberry Pi for Brains
# Configuring the Software Stack

- Raspbian, typical configuration
- Configure as Wireless Access Point (hostapd, DHCP server) – 1st adapter
- Configure to connect to drone, get IP address (DHCP client) – 2nd adapter
- Tweak ifplugd to maintain two concurrent connections
- Startup script, timing (initiating network connections, DHCP server a bit fiddly initially)
- Full documentation available upon request



# Leveraging IoT Concepts and Tools

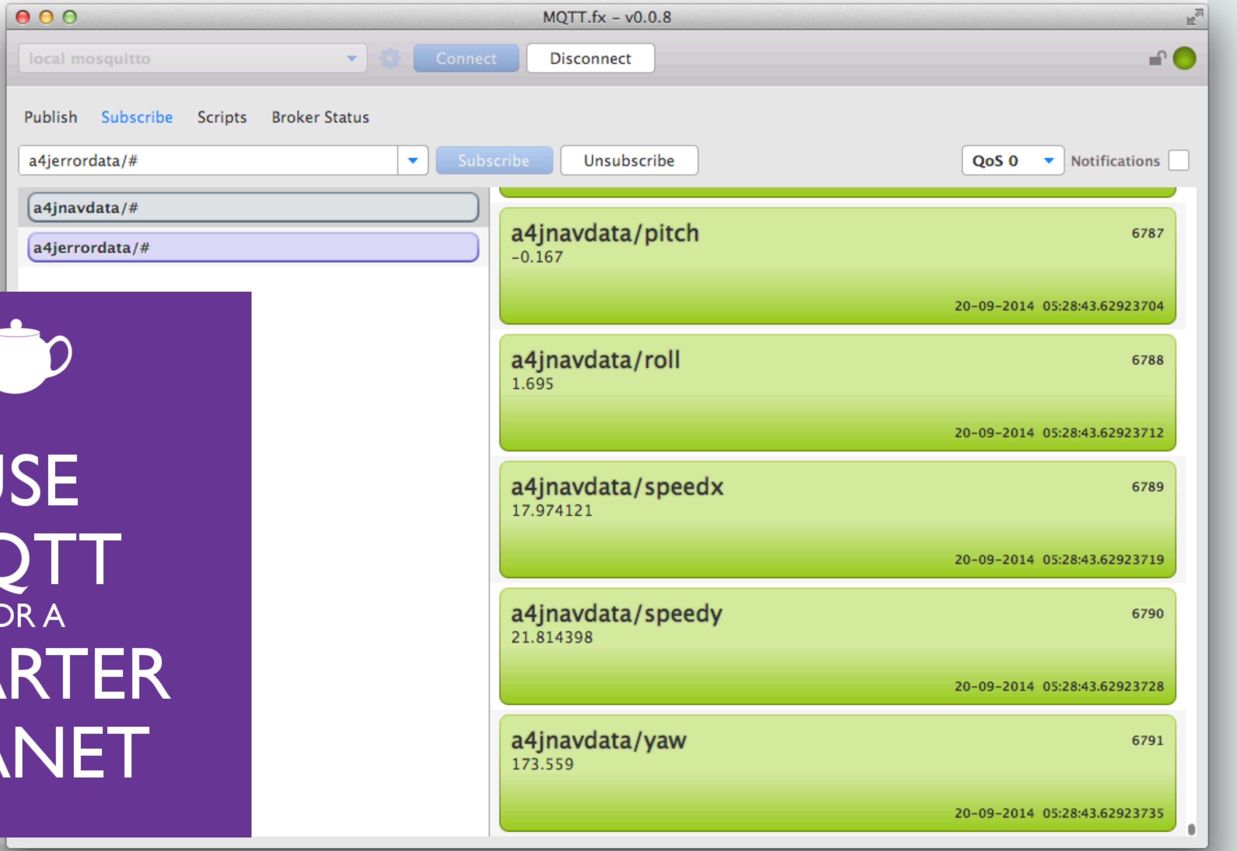
NetBeans

Java

Mosquitto

An Open Source MQTT v3.1/v3.1.1 Broker

USE
MQTT
FOR A
SMARTER
PLANET



```
a4jnavdata/pitch                                   6787
-0.167
                          20-09-2014  05:28:43.62923704

a4jnavdata/roll                                    6788
1.695
                          20-09-2014  05:28:43.62923712

a4jnavdata/speedx                                  6789
17.974121
                          20-09-2014  05:28:43.62923719

a4jnavdata/speedy                                  6790
21.814398
                          20-09-2014  05:28:43.62923728

a4jnavdata/yaw                                     6791
173.559
                          20-09-2014  05:28:43.62923735
```

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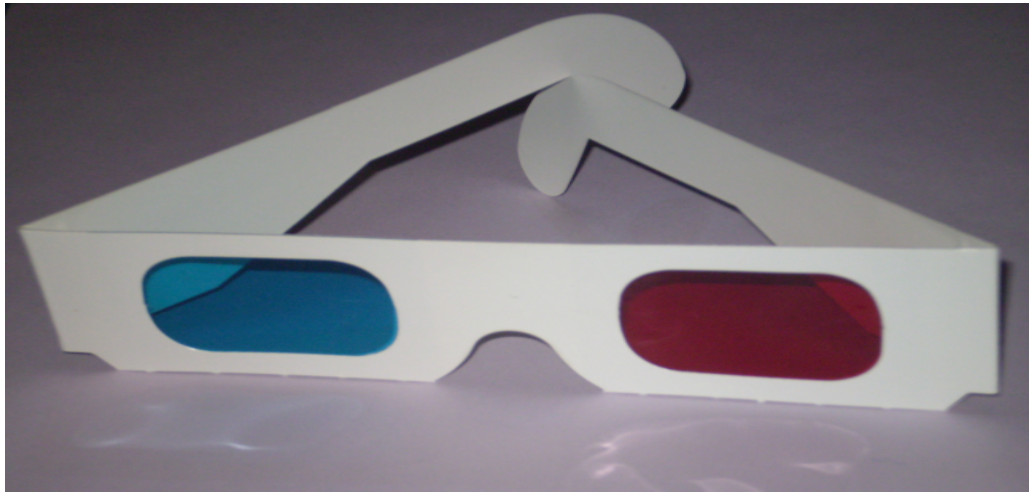
# Demos
# Let’s have a look!

MOON MONSTERS LAUNCH ATTACK AGAINST EARTH!
HOW CAN SCIENCE MEET THE MENACE of ASTRAL ASSASSINS? New SCIENCE-FICTION THRILLS!
3D
ADVENTURES INTO THE FUTURE in New TRU-3 DIMENSION!
ROBOT MONSTER
RELEASED THRU ASTOR PICTURES CORP.
with GEORGE NADER CLAUDIA BARRETT Produced by AL ZIMBALIST

## Welcoming our Robot Overlords…

# IN 3D!!! *



* *Skull Faced Alien Space Helmeted Gorilla Suit not included.*

# Know your Overlord!!

## Loading a Robot Overlord 3D Model

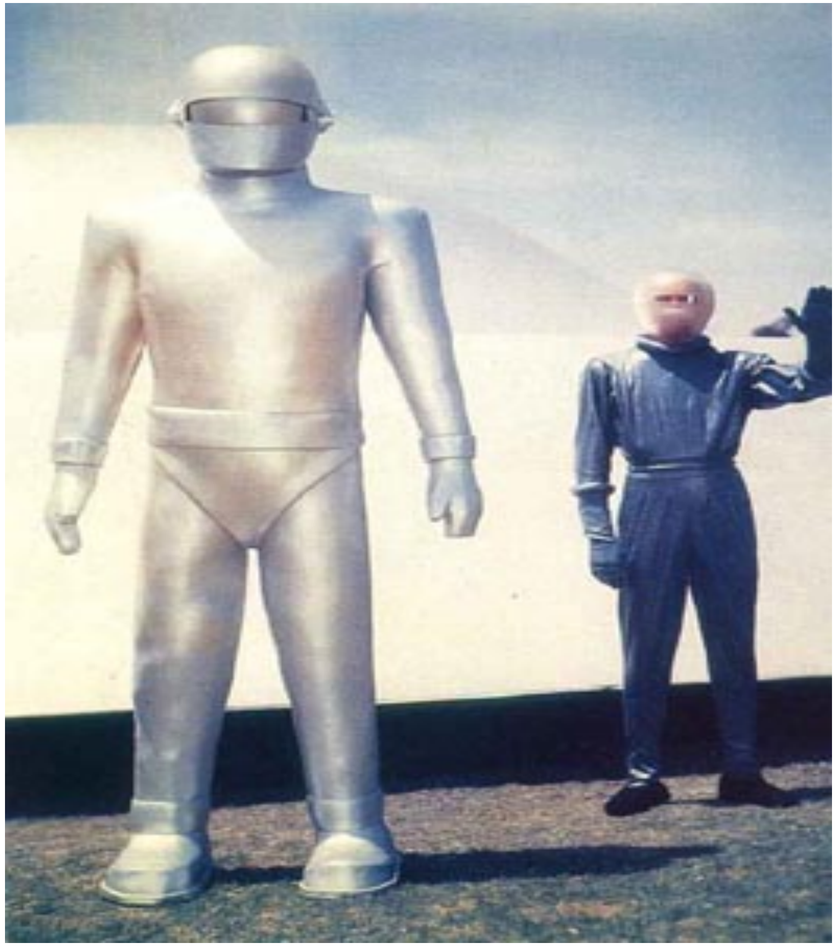
- Overlord class is a Group
  - Load model assests (.obj) within constructor
  - Leverages Interactive
    - http://www.interactivemesh.org/models/jfx3dimporter.html
  - Importer adds object MeshViews as children
- All transforms made on the entire group
- Overlord has no control smarts only API
- Exceptions handled at next years JavaOne

# Klaatu barada nikto

## Acquiring and Processing Commands

- Drag and Drop your .afr Flight Command Log onto the 3D scene.
- Function to parse into FlightCommand Object
- Add your Overlord like any other object

```
Task <Void> task = new Task<Void>() {
  @Override
  protected Void call() throws Exception {
  try {
    //Read in the playback file:
    List<FlightCommand> playback = Files.lines(file.toPath())
      .filter(line -> !line.isEmpty())
      .map(mapToFlightCommand)
      .collect(toList());

Platform.runLater(() -> {
    sceneRoot.getChildren().add(overlord);
});
```



# This is the Voice of World Control.

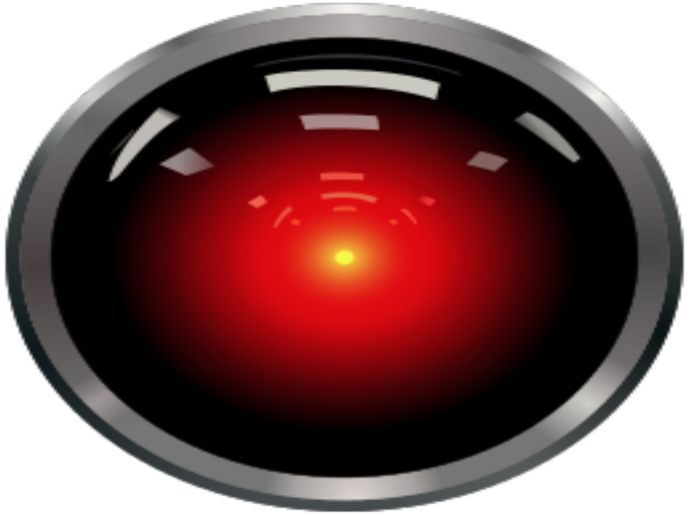
- Command & Control

```
playback.stream().forEach(flightCommand ->{
  switch(flightCommand.commandType) {
    case TAKEOFF : {
      overlord.takeoff(flightCommand.power, flightCommand.duration);
      break; }
    case FORWARD : {
      overlord.forward(flightCommand.power, flightCommand.duration);
      break; }
}
try {
    Thread.sleep(flightCommand.duration);
} catch (InterruptedException ex) {

  //The choice is yours: Obey me and live, or disobey and die." — Colossus

}
```

# Everybody… Do the Robot!

## Overlord Animation

```
public void takeoff(Integer power, Integer duration) {

//Can't really use a Path here because we are in 3D
   final Timeline t = new Timeline();
   t.getKeyFrames().addAll(new KeyFrame[]{
      new KeyFrame(
         Duration.millis(duration),
         new KeyValue[]{
            new KeyValue(yTranslateProperty(),
            getyTranslate() + (-power*sensitivity),
    Interpolator.EASE_BOTH),
         })
      });
   t.playFromStart();
}
private final DoubleProperty yTranslate
        = new SimpleDoubleProperty(0) {
                @Override
                protected void invalidated() {
                        updateGroup();
        }
};
```



Demo.  Pay attention.

# Next Step: Self-aware Drone Implementing a Control Loop

- "General Autonomy" vs. "Advanced Autonomy"
- Creating an external control loop
- Self-adjustment to achieve/maintain goal
- Higher-level goals vs. commands
- May require change of platform

# In Conclusion…

- Thank you for attending
- Keep the information flowing
  - Sean Phillips (@SeanMiPhillips)
  - James Weaver (@JavaFXpert)
  - Mark Heckler (@MkHeck)
- Any questions?

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# Appendix A
# Parts list: Positronic Brain

- Raspberry Pi Model B
- Pi case (ex: http://www.amazon.com/gp/product/B008TD1FSQ/)
- SD card (ex: http://www.amazon.com/gp/product/B00DX5D9I4/)
- Edimax wifi adapters ( http://www.amazon.com/Edimax-EW-7811Un-Adapter-Raspberry-Supports/dp/B003MTTJOY/)
- Power adapter (ex: http://www.amazon.com/gp/product/B00GWDLJGS/)
- USB charger (ex: http://www.amazon.com/gp/product/B00H7TR9WY/)
- Ethernet cable

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