# IoT:
# How it Changes the Way We Test

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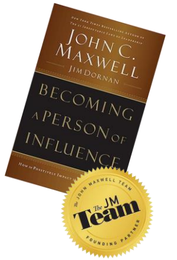
## About me

- 20+ years testing, many in management, Testing Web, Mobile apps and Infrastructure, Games, Social, E-commerce, Publishing & currently Robotics & AI
- Companies: Anki, EA, Vodafone, JustArrive, Bigwords, Corel
- Certified John Maxwell Coach, Trainer & Speaker

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# Session Goals

**Internet of Things adds a "thing"**

- A view of our Tools used to help test
- Our test Methodologies remain the same, but your toolkit needs additions
- You'll need Teamwork & Cooperation
- Things to think about: Networks, Environment….

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# Definition

- The Internet of Things, or IoT, refers to the billions of physical devices around the world that are now connected to the internet, collecting and sharing data. Thanks to cheap processors and wireless networks, it's possible to turn anything, from a pill to an aeroplane, into part of the IoT. This adds a level of digital intelligence to devices that would be otherwise dumb, enabling them to communicate without a human being involved, and merging the digital and physical worlds.
- https://www.zdnet.com/article/what-is-the-internet-of-things-everything-you-need-to-know-about-the-iot-right-now/

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## *Technologies of IoT*

- **RFID** [Radio Frequency Code]
- **EPC** [Electronic Product Code]
- **NFC** [Near Field Communication] contactless payment transactions
- **Bluetooth:** This is used where short range communications are enough to get away with the problem. This is mostly used in wearable technologies.
- **BTLE:** Bluetooth Low Energy
- **Z-Wave:** This is a low power RF comm technology. This is primarily used for home automation, lamp controlling etc.
- **WiFi:** This is the most commonly used choice for IoT. When on a LAN, this helps in transferring files, data and messages seamlessly.

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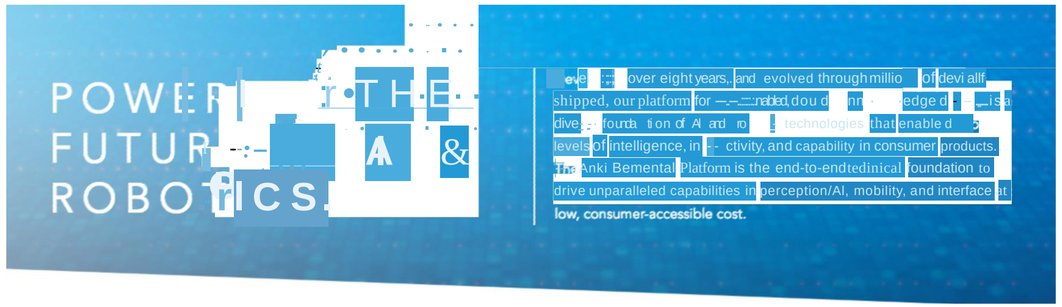
*“Thing” lives in the real world*

- Damage from dropping
- Temperature & Humidity
- Lighting: too much, too little
- Dust and Dirt and Pets
- Water
- Static Electricity
- Network interference






**6.5 Million+**
TOTAL ANKI DEVICES IN USE

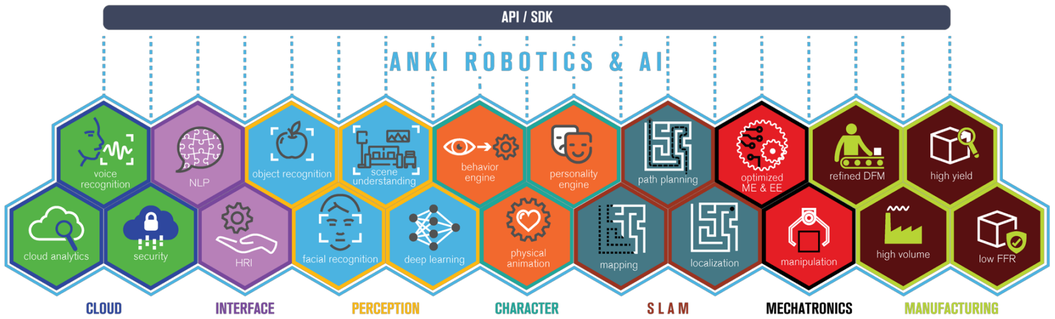
**140 Billion+**
ANALYTICS EVENTS INGESTED

**57 Million+**
CLOUD-AI VOICE QUERIES

**19 Million+**
MOBILE HAPPY SETS CONNECTED

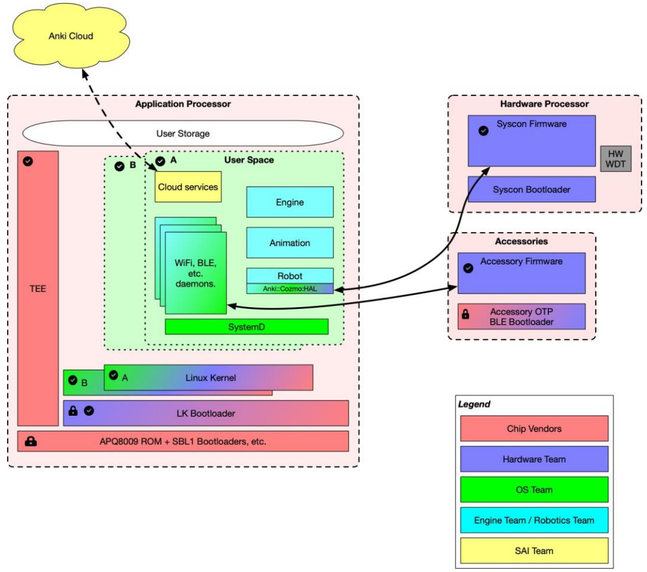
**90 Million+**
HOURS OF OPERATION ACROSS DEVICES

# Anki Robotics Platform

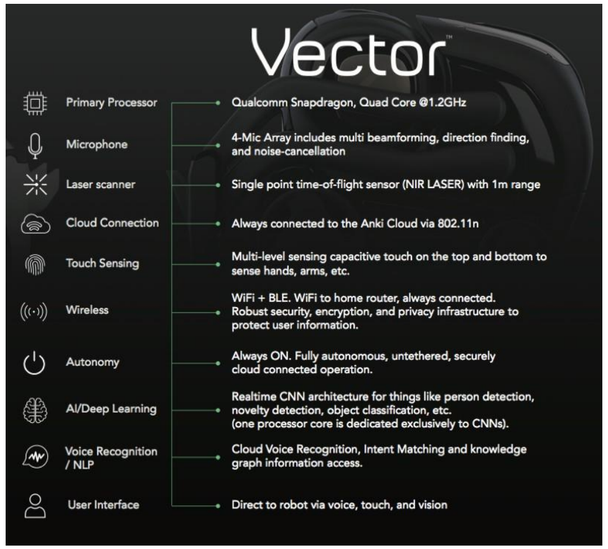





*Sample architecture*



# Robot HW Architecture

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**It's not just software anymore, but it is still testing**

- Early Prototype Hardware is not always reliable
- Addition of a network layer, to communicate
- Need to test the connection between hardware
- Need to partner with both software and hardware engineering and manufacturing
- Employing test fixtures in addition to test cases
- Adding different test tools to your arsenal

# Testing a "thing"

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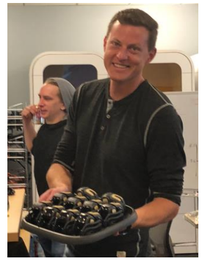
## Partnership

- Working with all departments
- Quality is a shared activity
- Helpful to brainstorm ways to test
- Ways to narrow down bugs



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## Prototypes & Test Fixtures

- Helps with “Works on my Device”
- Can help confirm working devices
- Can change to special configurations
- Pulling logs
- Seeing network traffic
- Seeing power settings
- Tools

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## Tools

- Our developers added internal tools so we could get info from the robot




## Data Movement

**Consider all ways data can get in the robot (not just digital packets)**

- Physical, Network, Firmware, OS, Applications, Cloud

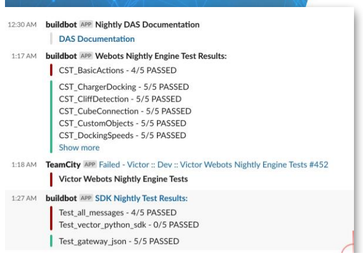
**What signals are received ?**

- Radio waves, vision, voice, touch, motion sensors
- Charging ports , diagnostic ports

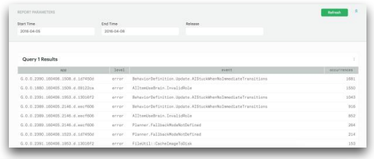
**What signals are emitted ?**

- Network advertisement / discoverability

# Analytics



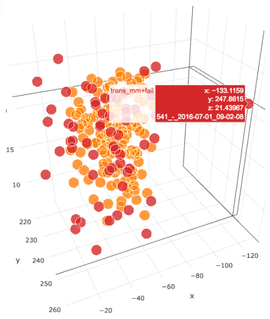

- Data is Key: collect the logs
- Analytics - error reports, performance reports
- Crash Reporting - crash logs
- Device ADB logs
- Network logs
- Automate what you can

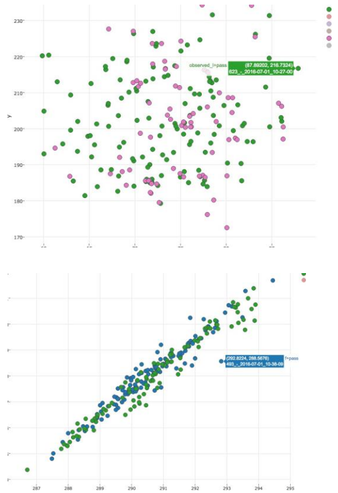





# Data from Test Fixtures

- Results of Manufacturing Tests




- **Firmware** is:
  - Software that runs on the “system controller” microprocessor in the robot’s body
  - Software which runs on the accessories (cube)
- **Firmware** is **not**:
  - Most of the software on the robot
  - Any of the software on the application processor in the robot’s head

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- Factory Firmware has to be solid - starting point for your device
- Typically locked at the factory
- Controls: power, charging, battery protection, configures sensors, streams sensor data to head, motor voltage, control, communication with test fixtures.
- #1 JOB - enable update to software 1.0
- Failsafe for revert in case of bad software

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# OTA

- Each “thing” needs to be updated. Not your server.
- Just keeping the device updated is a huge testing area.
- Android style update, with A/B slots for seamless updates. Reboot required to install the update in the working slot.
- Bricking a unit is a huge expense

https://source.android.com/devices/tech/ota/ab

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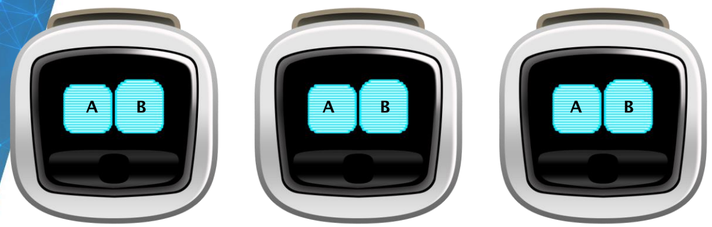
# Embeded OTA

## A / B Partitions for OTA




*Original State*
*A is Active*
*B is Empty*

*Upgrade*
*Downloaded*
*A is Active*
*B has new*
*version*

*Device Restarted*
*B is active*
*A has inactive*
*old version*

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# WiFi

- Phy Type: 802.11, 802.11b, 802.11g, 802.11n, 802.11ac
- Band: 5 GHz, 2.4 GHz
- Security: WEP, WPA2-AES, WPA2-TKIP,…
- Smart cards, USB tokens, and software tokens
- Hidden SSID, Hot spots

There are lots of different types and settings with networks

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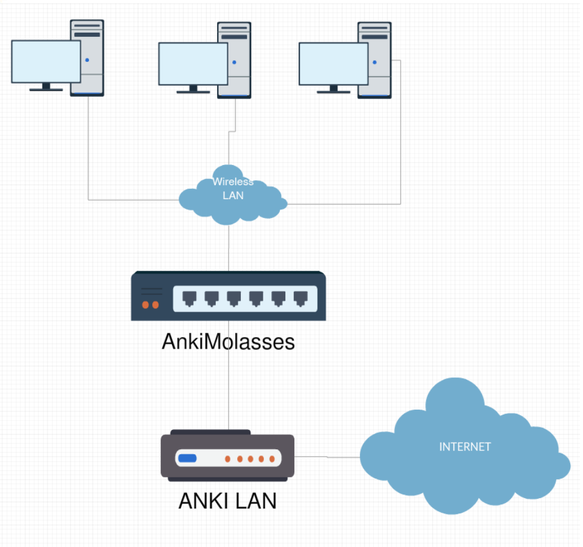
# Wifi Bandwidth

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# *Wifi Take Home Test*

- Goal - Easy to use, Report all needed data.
- Ability to connect to wifi in different rooms with different distances to router
- Track upload / download speed to our cloud
- Tested various forms of traffic: Big and Small packet size, Burst Traffic, Big and Small maximum segment size (MSS)
- Found consistent results and works with most home setups
- Visualization to see how long each test took and the rates we achieved

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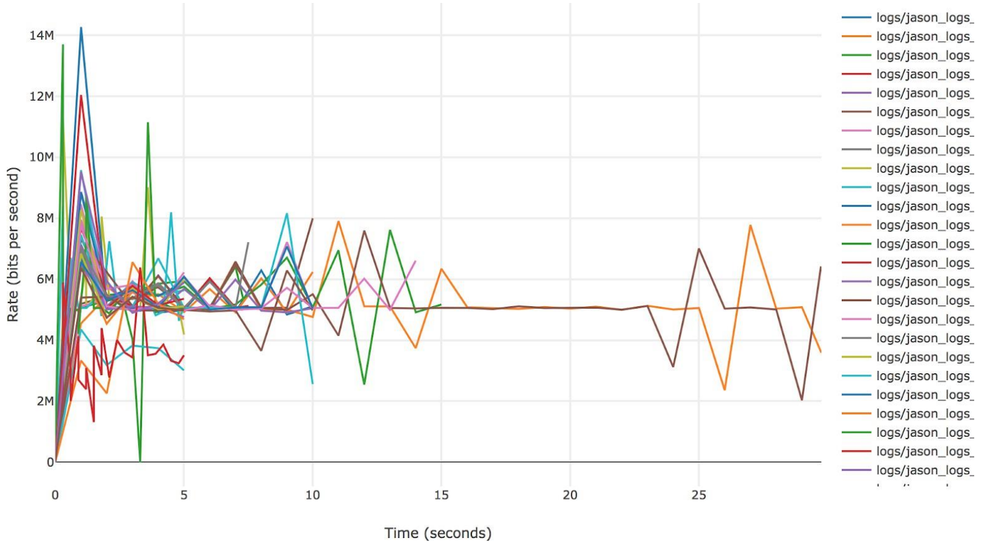


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# Network Tools, Network Sniffers

- Charles Proxy is an HTTP proxy / HTTP monitor / Reverse Proxy that enables a developer to view all of the HTTP and SSL/ HTTPS traffic between their machine and the Internet. This includes requests, responses and the HTTP headers (which contain the cookies and caching information).
- Wireshark is the world's foremost and widely-used network protocol analyzer. It lets you see what's happening on your network at a microscopic level.
- Ntop is a network traffic usage monitor that shows network usage in much the same way that top shows processes.
- TCPDump: command-line packet analyzer; and *libpcap*, a portable C/C++ library for network traffic capture.
- best free network sniffers

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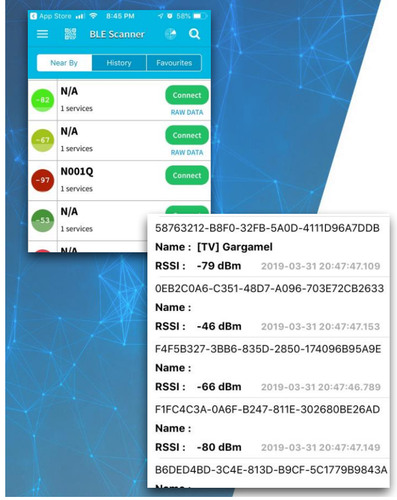
# BTLE




- Bluetooth Low Energy is a power-conserving variant of Bluetooth personal area network (PAN) technology, designed for use by Internet-connected machines and appliances.
- Uses frequency hopping wireless technology in the 2.4 GHz unlicensed radio band to interconnect nearby devices
- Different devices have different chips.
- BLE scanners can help. BLE Scanner several different apps that give different results.

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# Factory Line Testing

- Seeing the assembly
- Understanding the process

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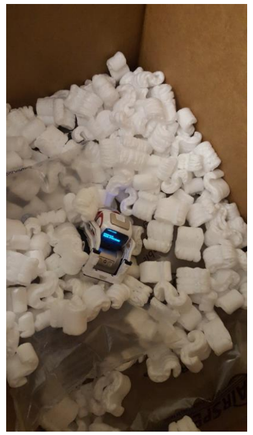
# Drop Testing



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# Environment Testing

- Hardware can be affected by heat, cold, moisture, humidity, dust, pet hair, water….
- Need to determine what can affect your device.
- Some is through shipping, others through use.

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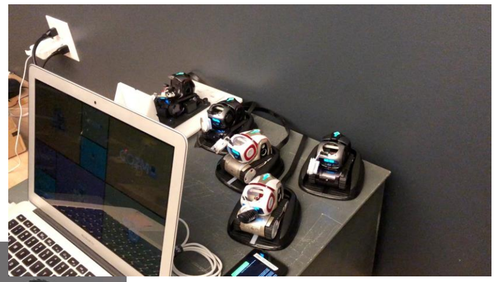
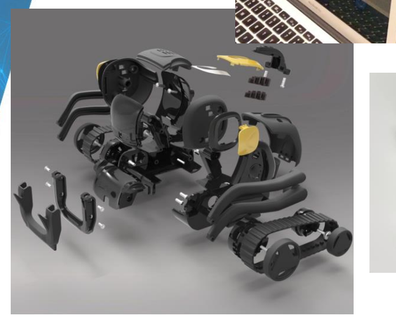
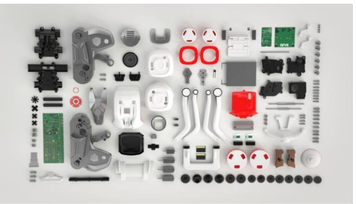
# Life Testing







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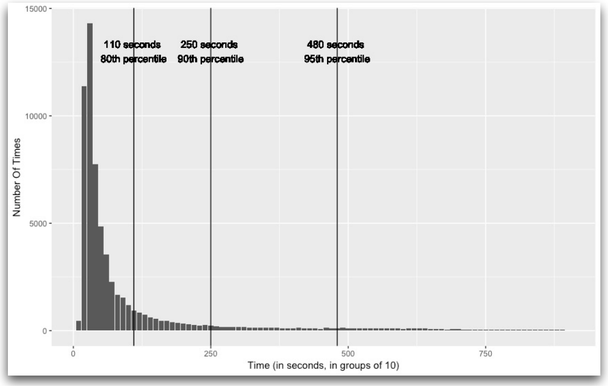
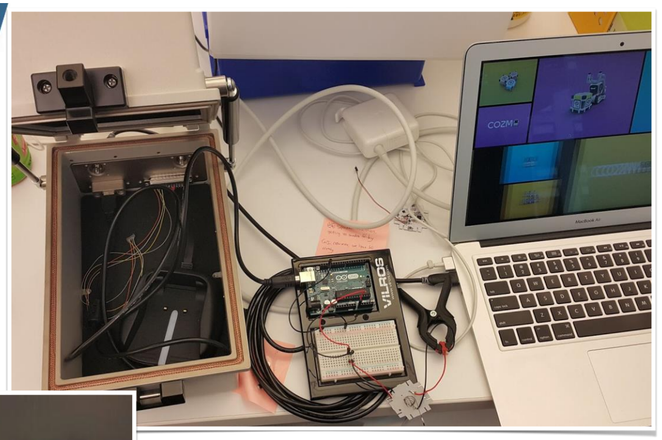
# Battery

- Time between leave charger and low battery for all robots over time histogram
- Vectors are reaching low battery approximately 35-40 minutes after leaving their chargers.





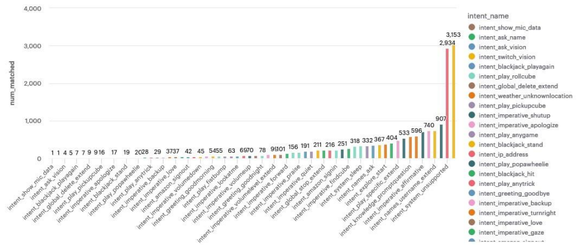

# Hardware Automation



# Speech Recognition

- Voice Commands Analytics

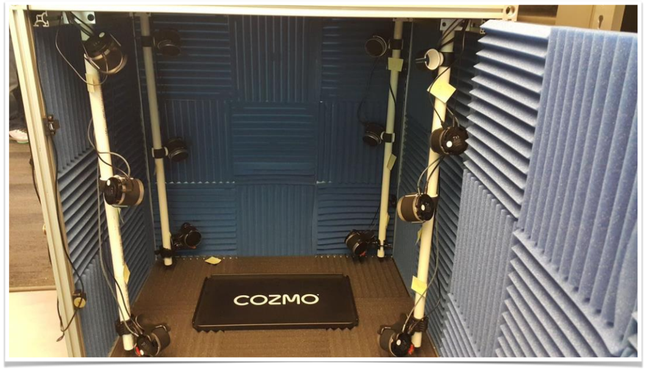

Total Number of Intent Runs (30 days default, or use filter to the right)






# Squawk Box

- Voice Command Automation: Vector & Alexa
- Multiple speaker heights, direction



# Security

- Vector - single account to robot
- Unique certificate per robot assigned at the factory
- Signed software - secure updates
- Security Monitoring
- Development Devices - special whitelisted robots
- Facial Recognition: Encoded Facial Features
- Voice Features: Process in the cloud, deleted after translation.
- Photos: stored on robot, app can view, delete or share

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# Development Devices

## Requirements for Dev and QA

For developers in the Anki offices and working remotely; internal QA and offshore (LG) QA team.

1. Load specific builds onto a robot:
    1. Production build
    2. Master branch
    3. TeamCity builds
    4. Local branches, including incremental builds
2. Access user data stored on the robot, for any build type
3. Access log data stored on the robot, for any build type
4. Use Anki debug tools against robots running Production builds, including:
    1. Load animations using the Anki SDK
    2. Access the robot's web interface
    3. Connect to and control the robot using Webots
    4. Modify the date/time set on the robot

**Developer Build Details**

The developer build will only be available inside the Anki corporate network.
The developer build is a special version of the release build that "unlocks" (makes writeable) the root directory of Victor and enables ssh, allowing the developer to push, inspect, and modify local builds via ssh over WiFi.
Only root/user-space may be edited - the kernel and initramfs cannot be updated, since they remain signed/locked.
It is expected that the base level developer build is rarely updated - maybe 3-4 times a year.

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## What do we want to protect

- ROM, Bootloader, Filesystem (programs, config data, app data)

## How

- Verified boot with HW root of trust (and Trusted Execution Environment)
- Signed ROM, bootloaders, Kernel
- Filesystem integrity verification (using dm-verity)
- Encrypted and Signed OTA Updates

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## Hardware Security

- Unique (Crypto) ID
  - ✳ Helps with counterfeiting, fraud and abuse
- Tamper resistant CPU ID
- Hardware backed keystore & key derivation
- File Data Protection (Hierarchy of keys)
- Disable debug interfaces e.g. JTAG, UART, USB

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# Security

## Physical security is hard

- What is good enough *physical* security ?
- Balance for cost for a mass consumer market device
- Secure hardware vs open hardware (modular and easy to service)
- Challenges with Intellectual property protection
- Tamper resistant / tamper evident
- B2B / vs B2C requirements
- After-market, resale, refurb, repair issues

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# Privacy

## Visual cues for:

- Voice activity detection
- Streaming to cloud
- Taking a picture
- When the robot is ON and observing

*"The internet now thinks and senses and acts and to me that's the definition of a robot," -Schneier.*

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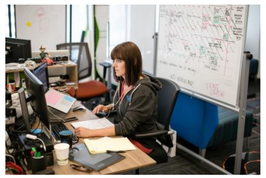
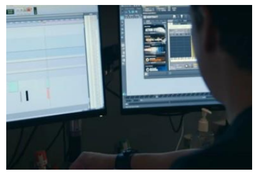
# Audio Animation

- Audio & Animation testing
- Bandwidth (downloading and
- Interruptions
- Volume





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# Manufacturing Troubles

- When things go wrong its all hands on deck!
- I'll review an actual manufacturing "emergency" where we had to halt production
- It all started with a supplier shipment that many parts didn't meet our standard.
- This dropped our yield to 60%.
- Hardware, software and test needed to test and understand what we needed to do.
- Figure out how to adjust the firmware to account for the problem or stop production.

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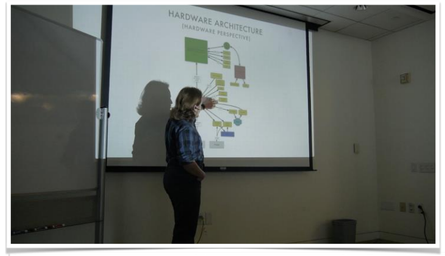
# Collaboration





## Questions

**“The important thing is not to stop questioning. Curiosity has its own reason for existing.”**

**- Albert Einstein**

*Please fill out the evaluation form*

**If you have any questions please feel free to contact me.**
**jane@anki.com**
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**Also we are hiring:**
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