Solving Real-World Problems is Hard

Perspectives and Lessons from an Academic, DoD Researcher, and a CEO

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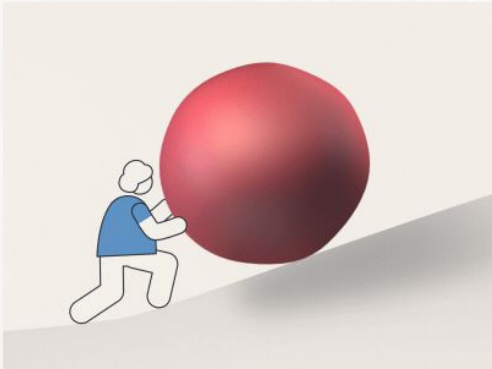

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Who am I?

- Hacker (lifetime)
  - Builder and tinkerer of many things
  - CTF Player
  - [redacted]
- Academic (lifetime)
  - BS in CS, Math, Economics from Pitt
  - MS in Computer Security from UNC-CH
  - Ph.D. in Computer Security from UCSB
    - **IBM Ph.D. Fellowship Recipient**
- Applied Researcher (10 years)
  - Technical staff at MIT Lincoln Laboratory
- Startup Founder (5 years)
  - Founded Allthenticate in 2020 to fix authentication once and for all

Real-world Problem

A **problem** that negatively affects people

typically in the form of **wasted time**

A **solution** must **significantly reduce** the current cost

Example: Real-World Problem

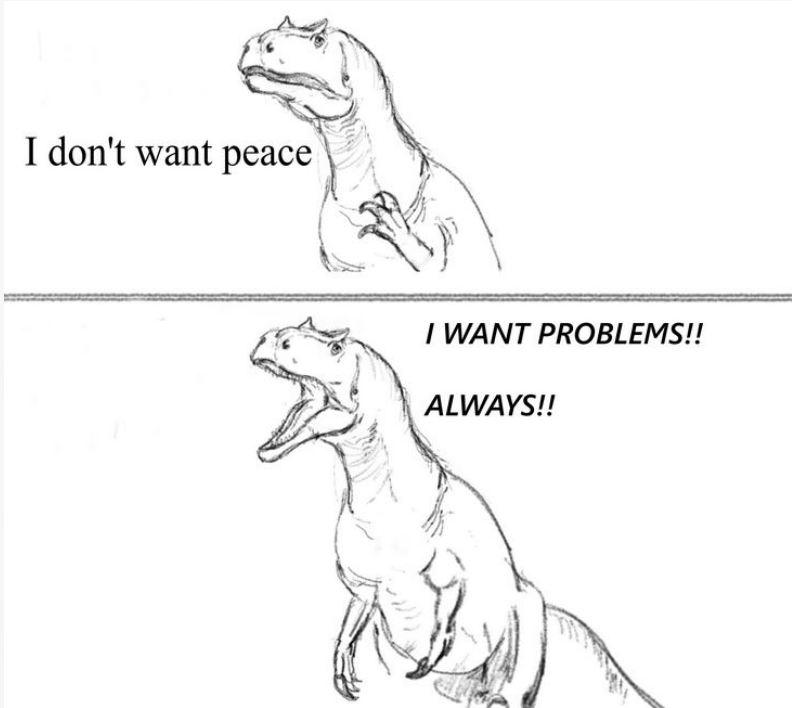
Problem: Humans need to move themselves and things, but are inefficient at it

Solutions:

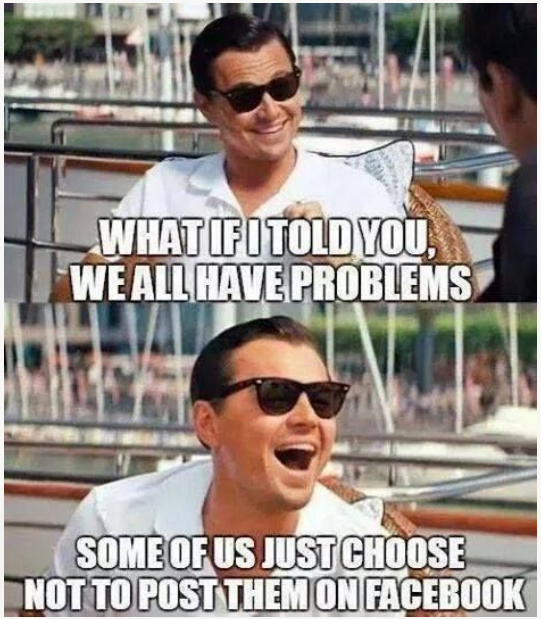
- Horse is faster and stronger than a human
  - Horse with wheels can carry even more things
- Car is faster than a horse
  - Large trucks can carry even more
- Train can carry much more than a car or a truck
- Boat can go on water and carry a lot
- Plane is the fastest and can go anywhere

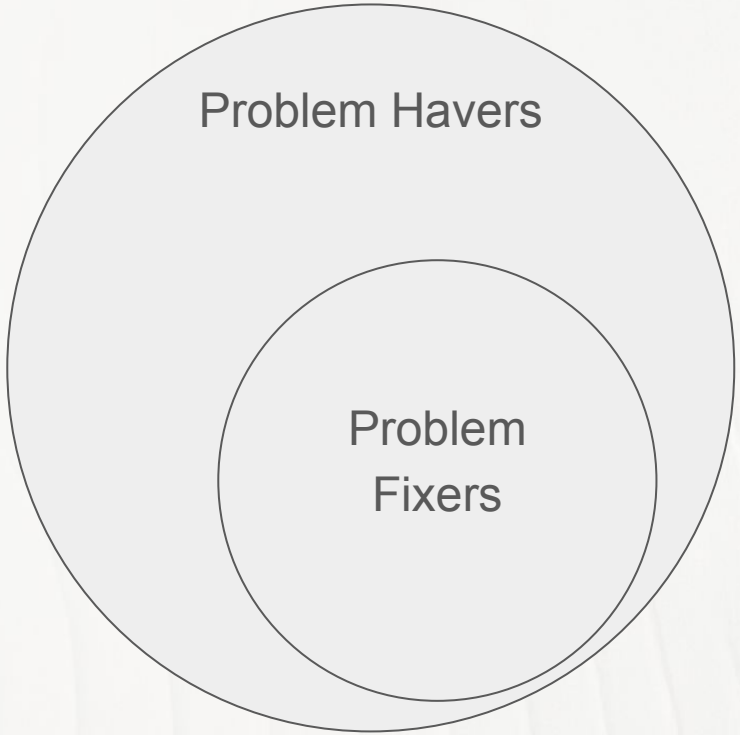
NOT “Real” Problems

- Homework
- Puzzles
- Games
- The beef with your coworker



Two kinds of people on Earth





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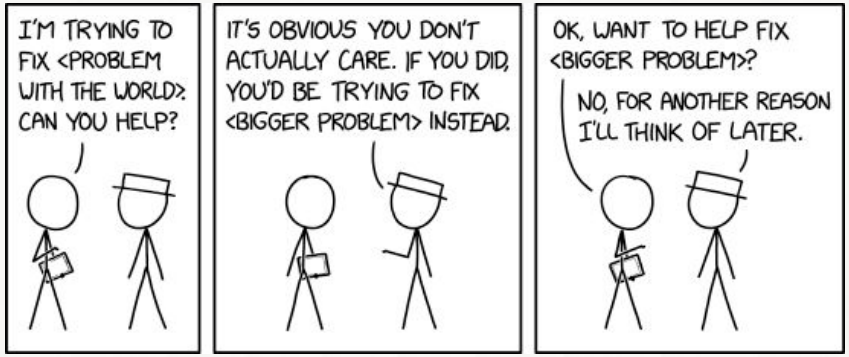
Scale of problems

1: This affects me

Thousands: This affects my tribe

Hundreds of Thousands: This affects everyone in a specific group

Millions-Billions: This affects everyone with X



Ingredients to solve real-world problems

- The people you are solving the problem for must want a solution
  - The problem must be painful enough
  - Or, the solution must be useful enough
- The solution you provide must scale to meet the problem
  - Cost effective
  - Be able to reach a majority of the problem-havers
- You must have the resources to solve the problem
  - Money
  - Time
  - People
  - Knowledge
  - Scientific advances

How to decide what problem to solve?

- **I**mpact – how many instances of the problem exist
- **M**eaning – ethical and moral stance
- **V**alue – how much societal value the solution presents
- **F**easibility – probability that the proposed solution will succeed

Problem Value = F(I+M+V)

No all problems are worth solving

1. Criminals have a hard time access other people's money

Corollary 1:

The problem must align both ethically and morally with society's current views

How to think about money and time

Money is a store of value for time – our most finite resource

If you have a lot of money, you can choose how others allocates their time

If you have a lot of time, you can invest it in your future or spend it now

Let’s be honest, no one has a lot of time

Time is all you need

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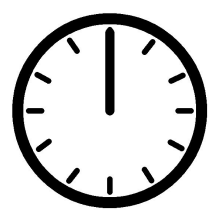
The problem with time

You don’t how much you have



Big Problems Take Time

Moving people and things took a lot of **time**

- Horses, Railroads, Cars, Planes, Amazon

Moving information took a lot of **time**

- Language, Libraries, Telephones, the Internet

Building things and foraging for food took a lot of **time**

- Farming, Modular Construction, Assembly Lines, Frozen Food, Fast Food

“Anytime that you can exchange money for time, do it.”

- *Dr. Charles V. Wright*

Experts

Do the same thing, but use less time.

The bigger the difference in time, the more money obtained.

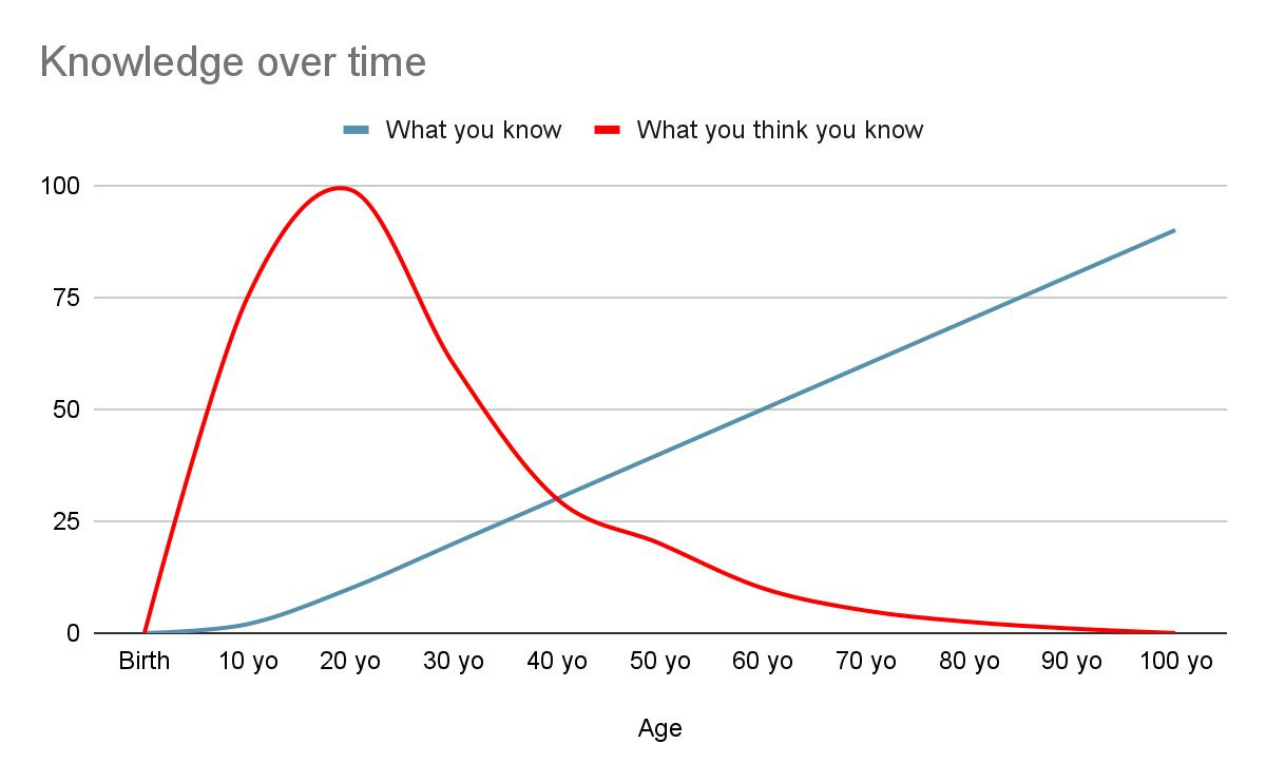
Inquisition

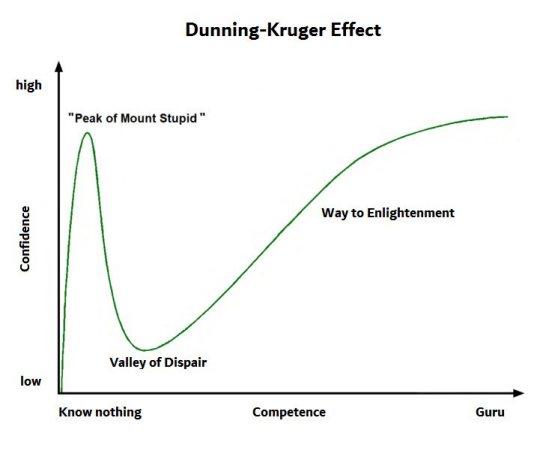
If all of the good problems are about reducing time, why do we spend billions of dollars a year on things that waste our time?

- Instagram, Netflix, YouTube, TikTok, etc.

We've made extraordinary advances in saving time to now waste the extra time we have?

Confidence vs. Age





OK, let’s solve some problems

My problem-solving journey

- High School Enthusiast
  - Solving my problems
- Honors Undergraduate - Pitt
  - Solving homework problems
- Ph.D. Student - UNC-CH (Dropout)
  - Researching advisor-driven problems
- Researcher at MIT LL (DoD work)
  - Researching DoD-driven Problems
- Ph.D. Student - UCSB
  - Researching my own original research problems
- Startup CEO
  - Solving societal-level problems, using previous research

High School Problems (2000-2004)

- **Porganizer**: Printed your daily schedule to hang on the fridge
- **Porganizer on the Go**: Web 2.0 calendar that worked with SMS (pre Google Calendar)
- **Carputer**: An in-car-computer that would automatically sync my downloaded mp3 files with my computer (pre iPhone)
- **r0x0rs.us**: An online video sharing site; specifically funny videos (pre YouTube and CollegeHumor)
- **Music Anywhere**: An in-home networked media player to play music simultaneously in every room (pre Sonos)
- **XBOX Modding**: A fun side business
- **Piracy Service**: Movies and games galore

High School Problems (Impact)

- **Porganizer**: 2 users
- **Porganizer on the Go (GCal)**: 2 users
- **Carputer**: 1 user
- **r0x0rs.us (YouTube)**: 20 users
- **Music Anywhere (Sonos)**: 3 users
- **XBOX Modding**: ~20 “customers”
- **Piracy Service**: 1,000s of users

Time invested in future expertise: **10,000+ hours?**

College Problems (2004-2008)

Homework assignments

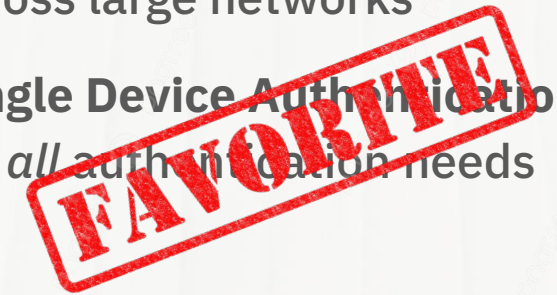
Impact: Summa Cum Laude BS in Math and CS with minor in Economics

Graduate School Problems (Round 1)

Bandwidth Puzzles: Proof-of-work to enforce fairness in peer-to-peer networks

Distributed Network Intrusion Detection: Spread out CPU/networking load across large networks

Single Device Authentication: Using smartphones as a unified hardware token for *all* authentication needs



Time invested in future expertise: **3.5 years**

Single Device Authentication (in 2009)

- **I**mpact – Everyone with a computer
- **M**eaning – Beat hackers
- **V**alue – Protect people's assets, time, and frustration
- **F**easibility – ????
  - Very few people own smartphones
  - What if the phone gets hacked?
  - What the phone is stolen?

Impact Meaning Value

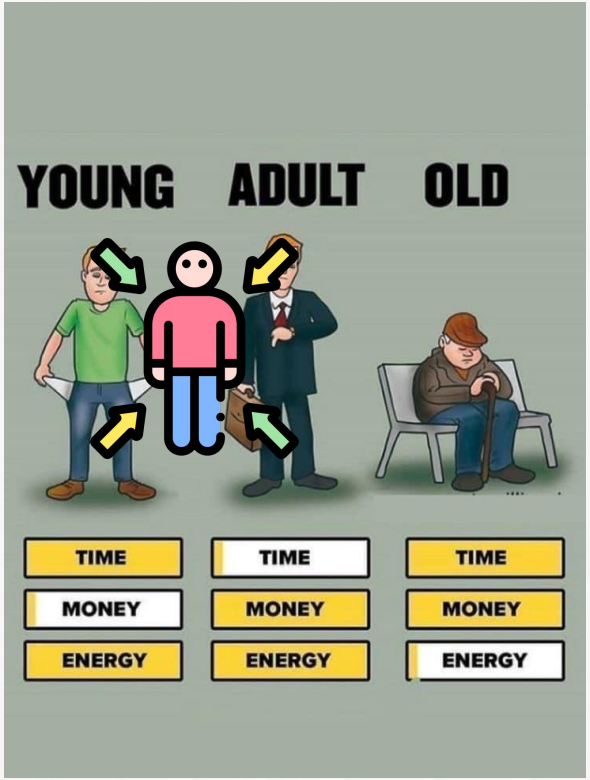
Problem Value = ???(VERY LARGE+VERY LARGE+VERY LARGE)

The problem with research

The value ($$) is unknown and speculative

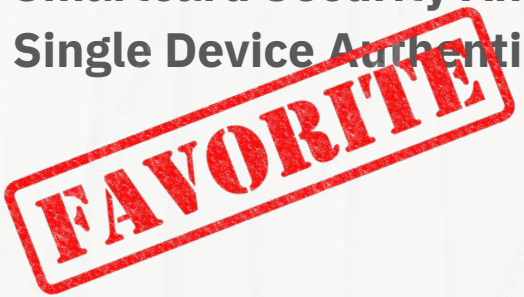
You must sell a vision – hopes and dreams

No money nor time to pursue it alone



MIT Lincoln Laboratory Problems

- **LO-PHI**: Low-artifact malware analysis on bare-metal hardware
- **CATAN:** Open-source ad-hoc communication mesh for disaster relief
- **Smartcard Security Analysis:** Expose vulnerabilities in popular smartcards
- **Single Device Authentication:** Internally funded to investigate feasibility



Graduate School Problems (Round 2)

- **BOOMERANG:** Discovered and helped fix vulnerability in all Qualcomm and Huawei phones in the TEE that permitted arbitrary memory read/write
- **Glitch Resistor:** Clang pass to make compiled software glitch resistant
- **Conware:** Automatically model peripherals of embedded systems to enable firmware analysis in emulated environments
- **Single Device Authentication:** Working Android prototype that worked in my car, my house, doors at UCSB, and on Linux computers

My #1 Problem: Single Device Authentication

The Problem: Authentication

- Authentication usability is a mess
  - Impossible-to-remember passwords
  - Numerous steps, multiple times a day
  - Way too many options!

- Authentication security is a mess
  - Phishing
  - Session Hijacking
  - MFA Fatigue
  - Prompt Bombing
  - Lost hardware tokens
  - Man-in-the-Middle Attacks

Time to solve a very hard problem

- Make a dreamy authentication experience
- Solve ***all*** of the current security shortcomings

The problem with startups

The value ($$) is unknown and speculative

You must sell a vision – hopes and dreams

Getting Started

- You must have the resources to solve the problem *[Someone said]*

✓ **Time:** Quit my consulting gig and committed 100% of my time
✓ **Knowledge**: educated intuitions and a decade of work experience
✓ **Scientific advances:** smartphones advanced and made numerous scientific discoveries

- Money
- People

✓ Money

- Started with my checking account and a check from my dad
- Ultimately teamed up with some more investors
  - 2020 - Angel round (SAFE)
  - 2021 - Friends and family (Reg-CF)
  - 2022 - Seed Round
  - 2024 - Seed Extension

FUTO

Ping Identity

SILVERTON PARTNERS

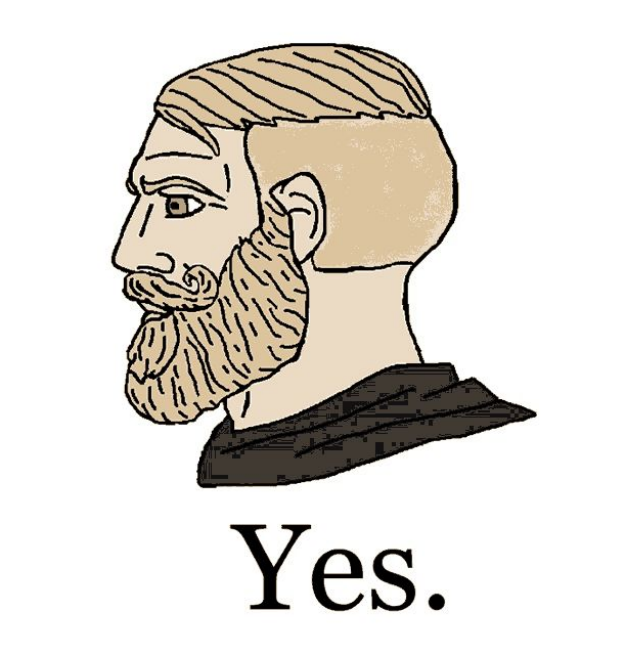
AMPLIFY

√ People

Two distinct teams

- Initial team of undergrad interns
  - 9 people
- Current full-time professional team
  - 11 people

Which part is the hardest?



My Biggest Fears (at the beginning)

- Finding funding
- Hiring a world-class team
- Marketing the product well

Things that were harder than I anticipated

- Software engineering
  - Building foolproof software that works for everyone and has a great user experience
  - You can never have enough “good” test cases
- Industry certifications
  - Certifying that we faithfully implemented protocols
- Figuring out which advice to trust and which to ignore
  - Everyone has an opinion
  - **Very few** people have good ones

Anything worth doing is worth re-doing

Rules of thumb

- It will likely take AAAAA LOOOOT longer than you budgeted
- It will likely be AAAAA LOOOOT harder than you estimated

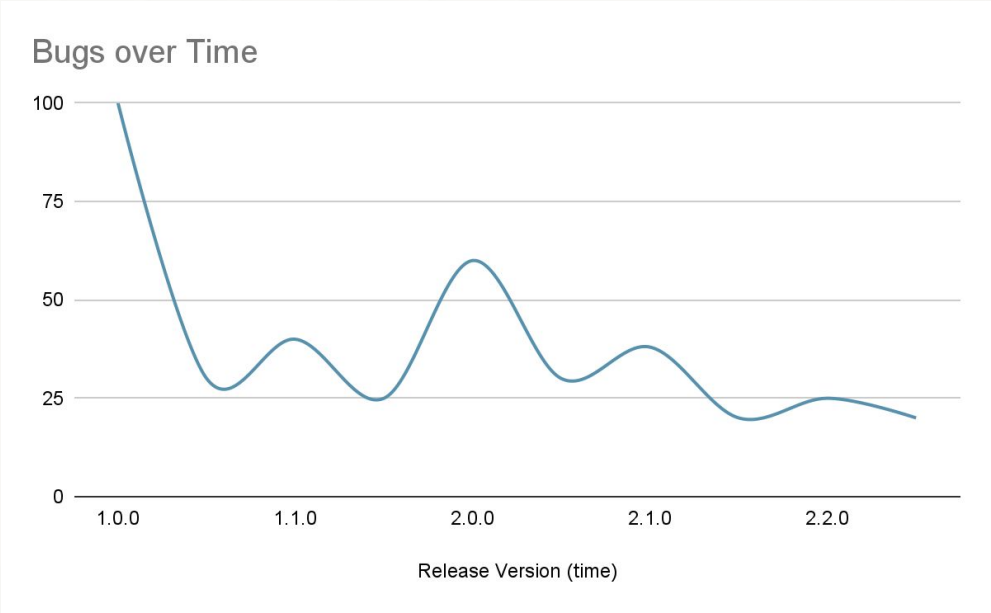
Software is a living thing

Software needs constant maintenance

There is no such thing as a solve it once and move on

Successful software needs even more attention to scale

Software stability over time



Things can go very wrong in the real-world

Let’s say your phone locks and turns off when you phone disconnects

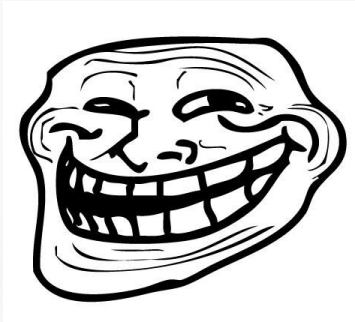
And your phone dies

Your stack, your problem

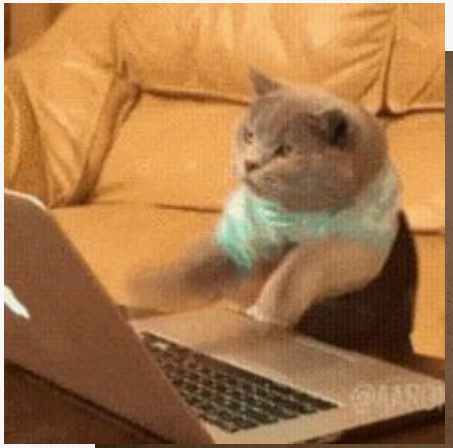
Sometimes the crash is in the kernel… CVE-2021-43400 (9.1 Critical)

Building is much harder than breaking

Hacker Me: “These developers must be idiots!”



Now, **Builder Me**



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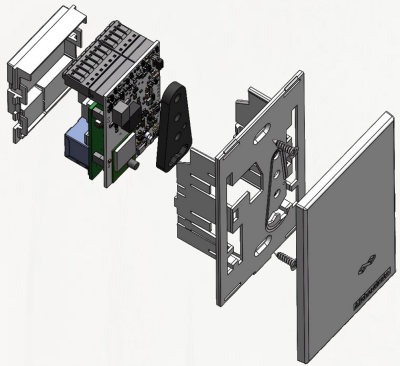
What we've built so far

- New hardware to unlock doors
- Software for Windows, Mac, Linux
- App for iOS and Android
  - FIDO2 Certified
  - SSH keys
  - OTP Codes
  - X.509 Certs
- Cloud-based admin portal
- SSO Connectors for OIDC and SAML
- Proximity Login
- Decentralized Recovery
- Robust cross-platform Bluetooth stack



How’s it going?

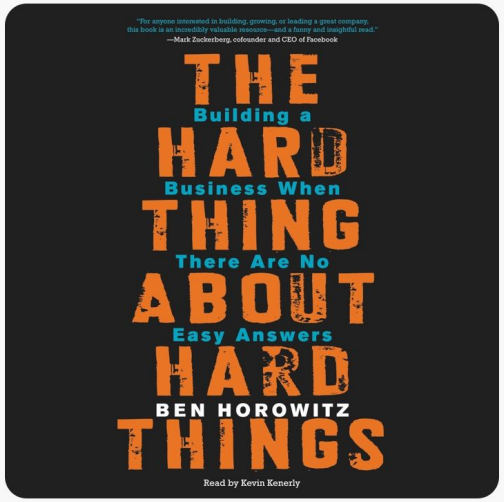
- Technical problem is solved
  - You’re welcome world
- Still building the business and trying to grow adoption
  - The harder part


WE AIN'T
DONE YET
memegenerator.net

Summary

1. Do hard things
    a. On the other end of struggle is happiness
2. Time is the most valuable resource on earth
    a. Money is way to store time
3. Solve the problems worth solving
    a. Just because you “can” do something, doesn’t mean you “should”
4. Buckle up – it will be harder than you think
    a. And more rewarding

Questions?



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