

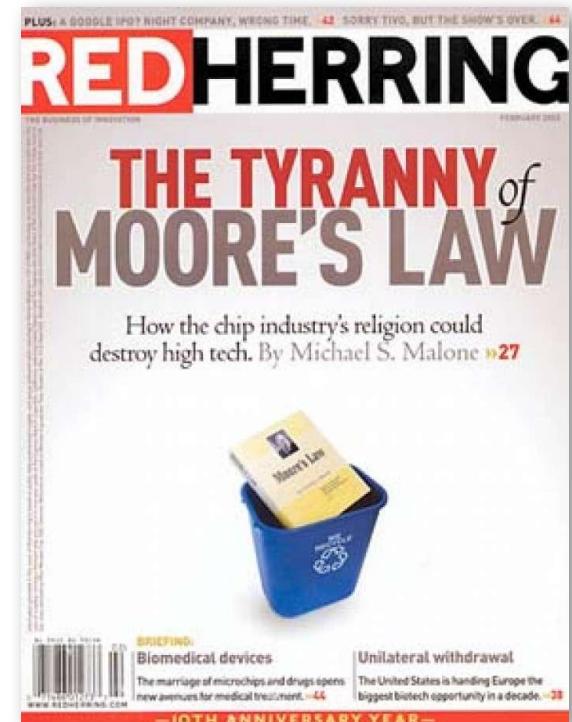
Moore's Law is over

Prepare for fewer upgrades, more
niche services, and sometimes the
crappiest computer possible

Michael Gat
Nerd Nite LA, January 2019

“The greatest truth of our lives”

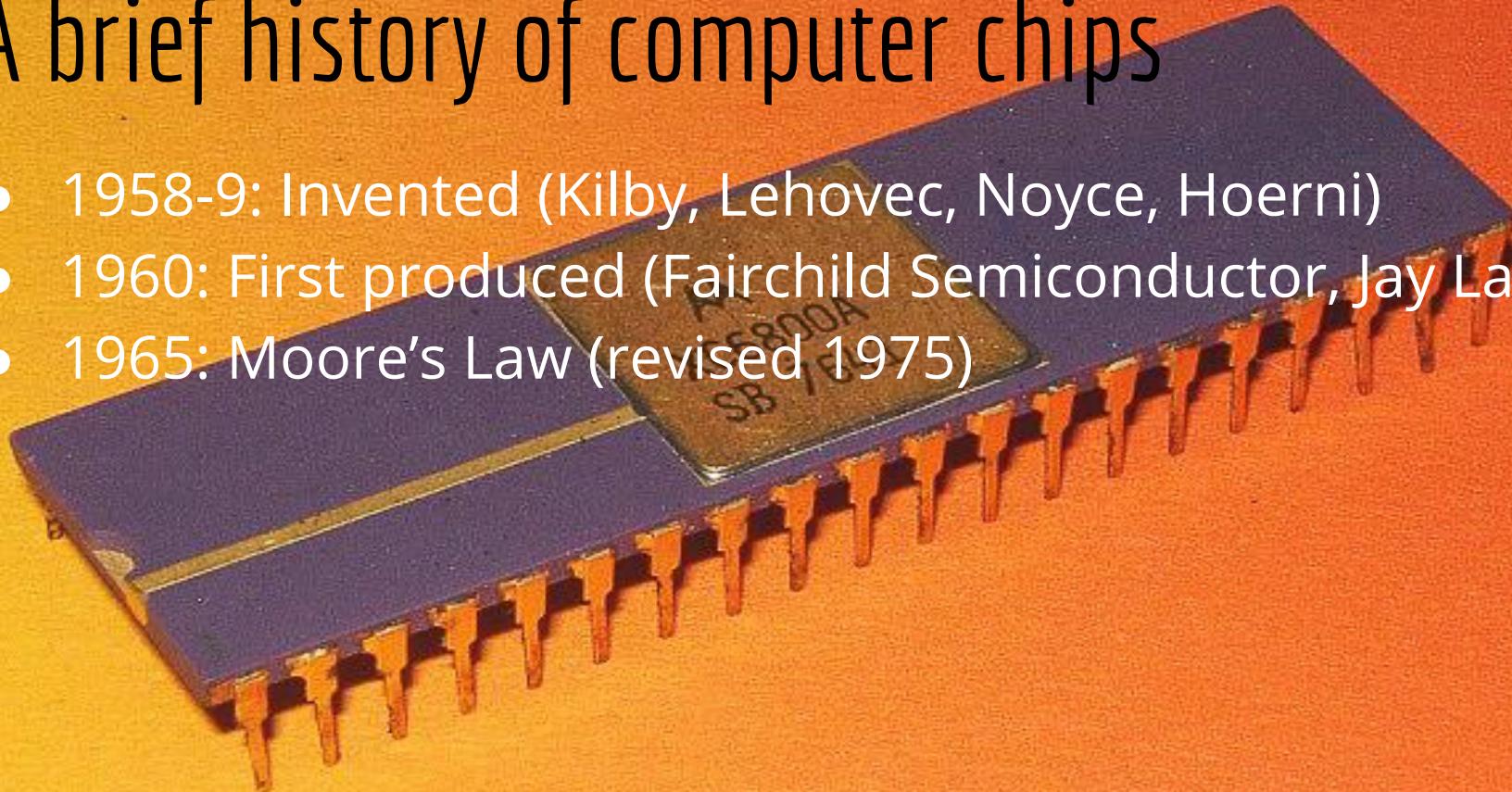
- For most of our lives, technology advance has followed “Moore’s Law”
- Invisible but relentless
- So pervasive, we take it for granted



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A brief history of computer chips

- 1958-9: Invented (Kilby, Lebovec, Noyce, Hoerni)
- 1960: First produced (Fairchild Semiconductor, Jay Last)
- 1965: Moore's Law (revised 1975)



Moore's Law

- Number of transistors on an integrated circuit (chip) will double every 24 months, for the chip with the lowest cost per transistor.
 - Originally was 12 months, revised 1975
- Cost is part of the “law!”
- Effectively: “double the transistors at the same cost every two years.”

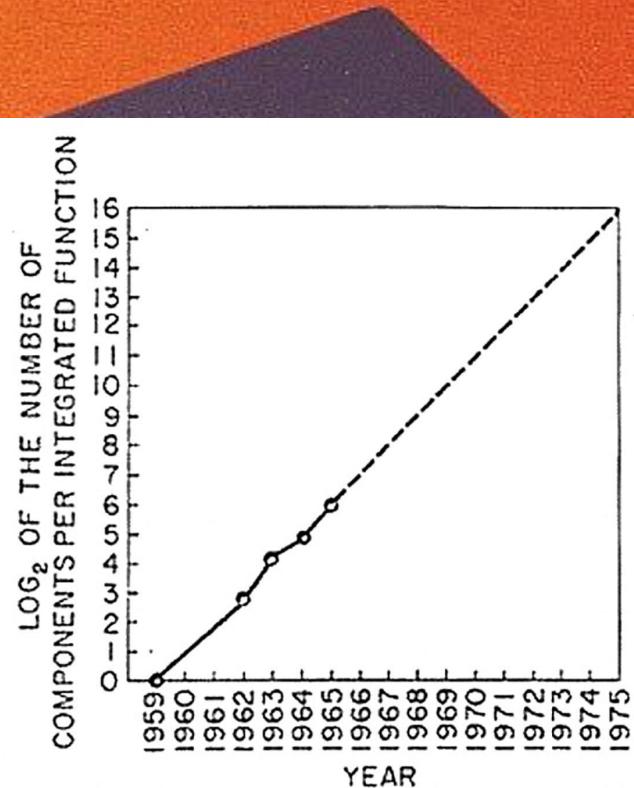
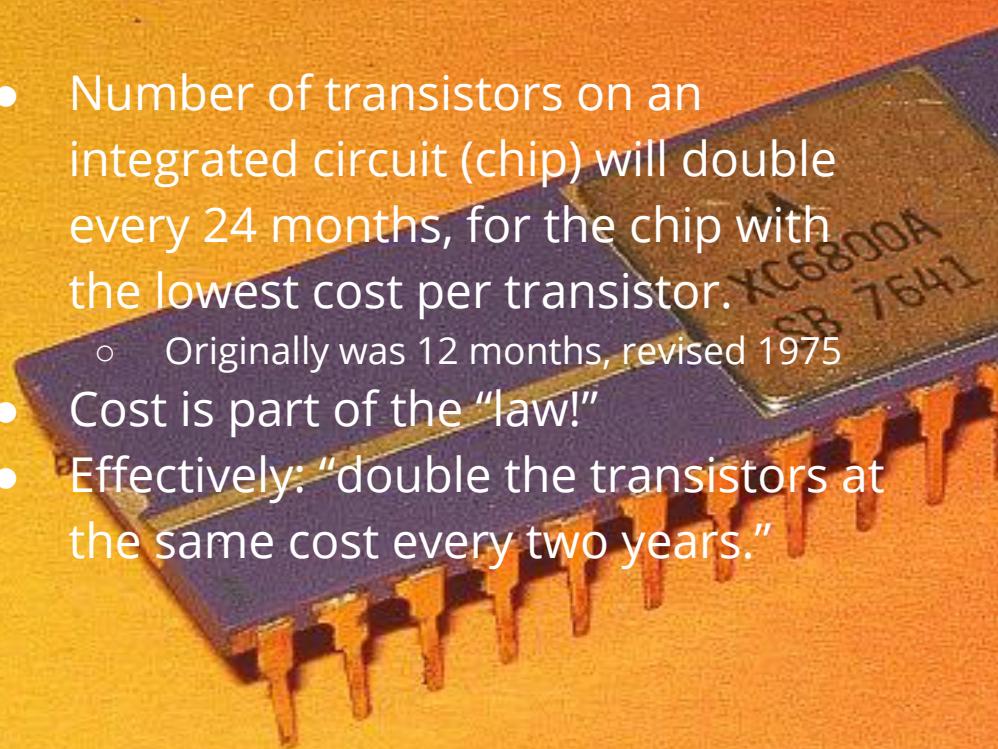


Fig. 2 Number of components per integrated function for minimum cost per component extrapolated vs time.

A brief history of computer chips

- 1958-9: Invented (Kilby, Lebovec, Noyce, Hoerni)
- 1960: First produced (Fairchild Semiconductor, Jay Last)
- 1965: Moore's Law (revised 1975)
- 1989: First million-transistor chip
- 2005: First billion-transistor chip
- 2017:
 - 6-7 billion in “mainstream” microprocessors
 - 19 billion in extreme-performance/cost microprocessors*

*But not at lowest possible cost, so not really following “the law”

A self-fulfilling prophecy

- An entire industry scheduled around it
- Related industries trailed along
- “The hardware-software spiral” as business strategy
- CPU and memory-hogging practices were deemed to be OK and even desirable!
 - It meant customers always needed the next generation
 - Ka-ching!

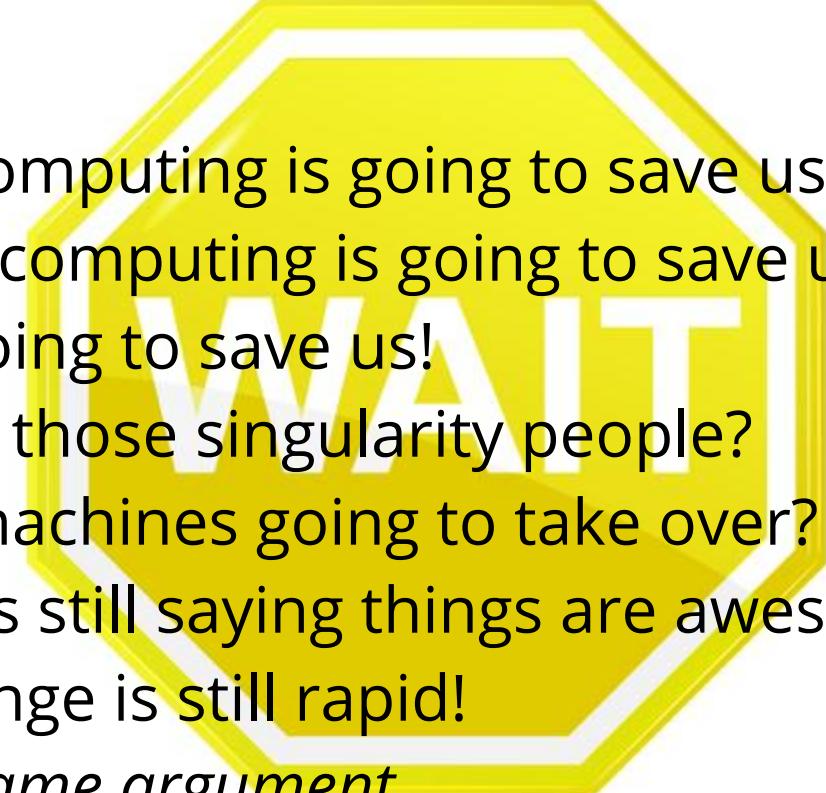
Result: programming sucks, apps suck!

- You *should* learn to do better in school... but...
- CS Professors are as captive to big software companies as business school “professors” are to Wall Street
- Schools increasingly have access to the “latest and greatest,” so nobody has to struggle with limits
- Students aren’t stupid
 - They know what they need to know to get a job

There's a looming problem

- Moore's Law no longer holds
 - Intel admit it
 - nVidia admit it
 - International Tech Roadmap for Semiconductors dropped it (2016)
- Exponential advance has been the reality for so long that we take it for granted and we should not
 - Adjustment to a new reality will be messy

But Wait...

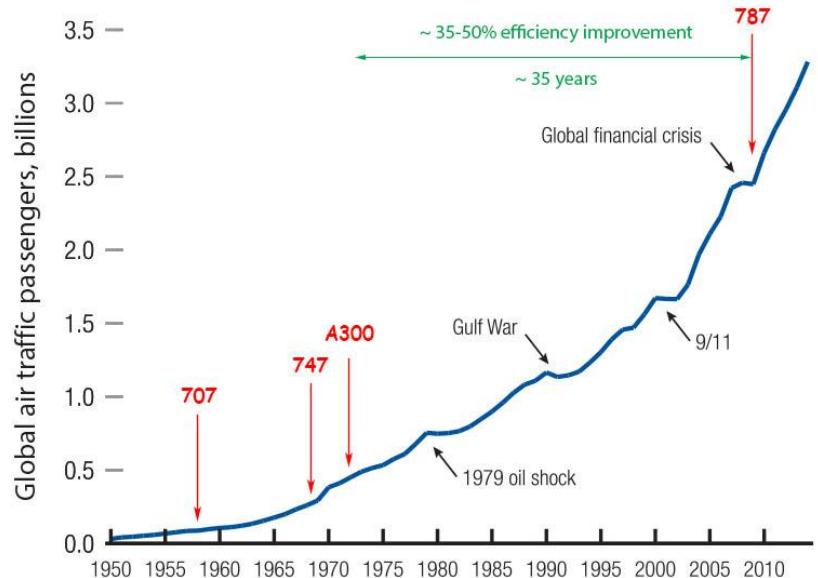
- 
- Quantum computing is going to save us!
 - Distributed computing is going to save us!
 - GPUs are going to save us!
 - What about those singularity people?
 - Aren't the machines going to take over?
 - Everybody is still saying things are awesome and the pace of change is still rapid!
 - *Mostly the same argument...*

We've seen this before

"Jet age"

- The most change to most people's lives was after the tech stabilized
- It was increased reach of stable tech that made for societal change
- Max hype just as maturity happened!
- Instead we got a cramped flying bus
- Smart people knew it at the time

Figure 1: Global air passenger traffic trend, 1950-2014
(IATA Forecast for 2014)



Smart people know this today too



Katherine Scott

@kscottz

Following

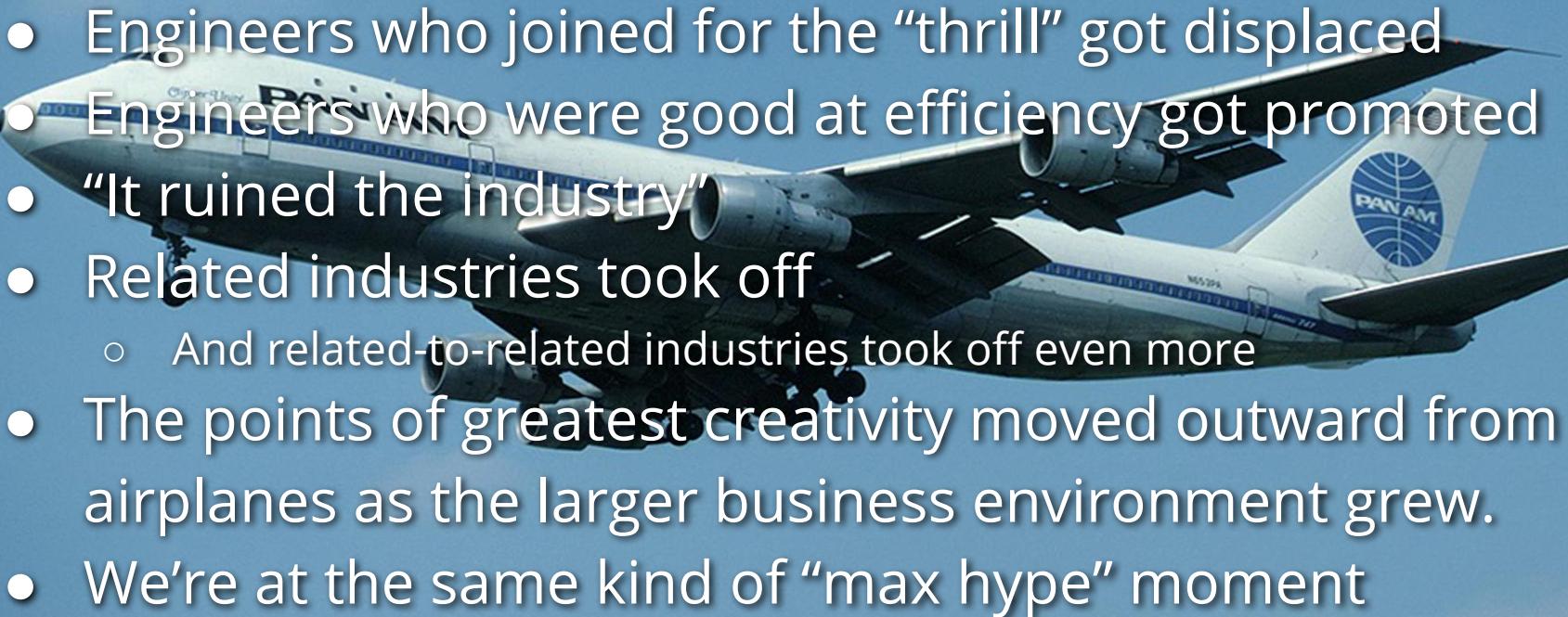


J C , we have kids coming out of school who know the deep learning literature forwards and back but they can't do memory management or understand object oriented design patterns. This is a huge problem. It erases all of our hardware wins of the past 20 years.

1:57 AM - 17 Feb 2018 from [San Francisco, CA](#)

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What did the jet age teach us?

- 
- A Pan Am Boeing 747 jumbo jet is shown from a low angle, flying towards the viewer against a clear blue sky. The aircraft's distinctive humpback profile is visible, along with its four engines and the iconic Pan Am globe logo on the tail fin.
- Engineers who joined for the “thrill” got displaced
 - Engineers who were good at efficiency got promoted
 - “It ruined the industry”
 - Related industries took off
 - And related-to-related industries took off even more
 - The points of greatest creativity moved outward from airplanes as the larger business environment grew.
 - We’re at the same kind of “max hype” moment



So where does the point of greatest creativity move next?

For a start, where won't it be?

- \$1000+ cellphones?
 - Their very existence proves this trend is exhausted
- Power-intensive hardware
 - It'll be as commodified as airplane seats
 - Sorry/notsorry fanboys!
- Probably not “big” software either
 - The low hanging fruit is long gone, and the end of Moore's Law means we're not going to grow much more

“Big picture” ideas often fail at this stage

“Big Airplane” circa 1970

We’re going to connect the world and make everything better!

Reality

Awful service, planes hijacked and held for ransom, ridiculous security procedures, more and more charges and limitations, divides as much as it connects.

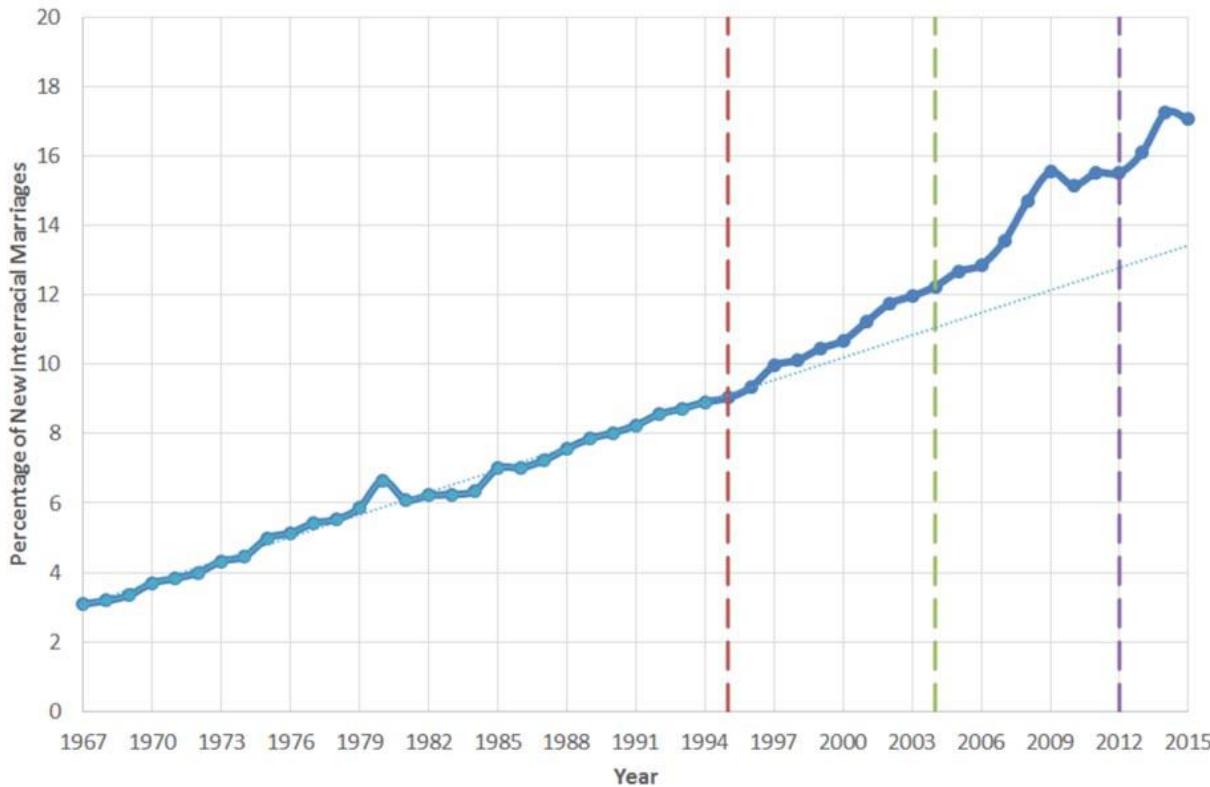
Facebook circa today

We’re going to connect the world and make everything better!

Reality

Awful service, sites hijacked and held for ransom, ridiculous security procedures, more and more charges and limitations, divides as much as it connects.

Others achieve things unintentionally





So...

Time to think small!

- IOT opens up millions of niche opportunities using dirt-cheap, old, crappy, or low powered hardware
 - Leverage the big players (like my new employer) for heavy-duty processing at dirt-cheap prices
- The ability to quickly deploy without owning anything makes other apps easier and cheaper to do
 - So we'll have more of them
 - Experiments are dirt cheap

Think Ecosystem

- The jet age made Vegas possible!
 - This was not part of Boeing's game plan
 - It was not part of any aerospace engineer's game plan
- What business or product can exist in a world that has billions of interconnected, cheap devices with cheap common backbones?
 - Not "let's stick the internet in something!"
 - Second and third order effects
- Make small changes



But also, a modest proposal...

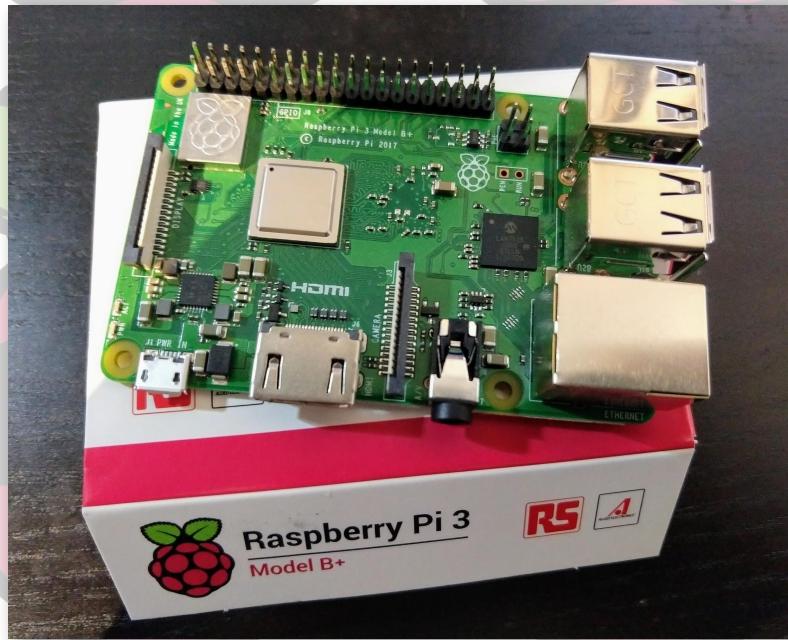
“Crappy Computers!”



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OK, maybe not *that* crappy...

But how about one of these?



Pause for obligatory cat photo

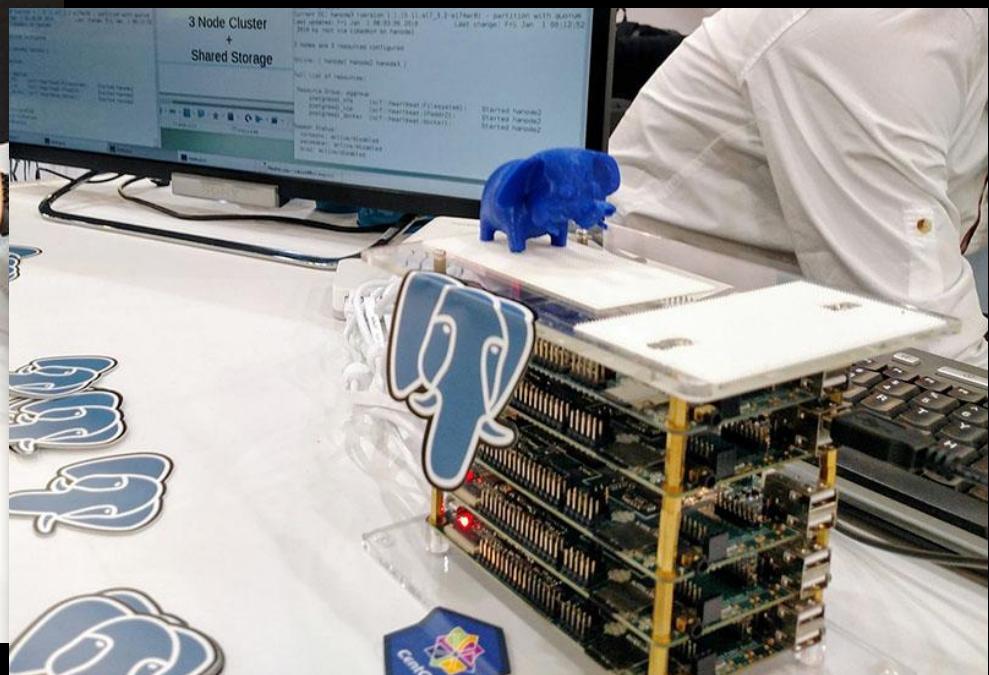
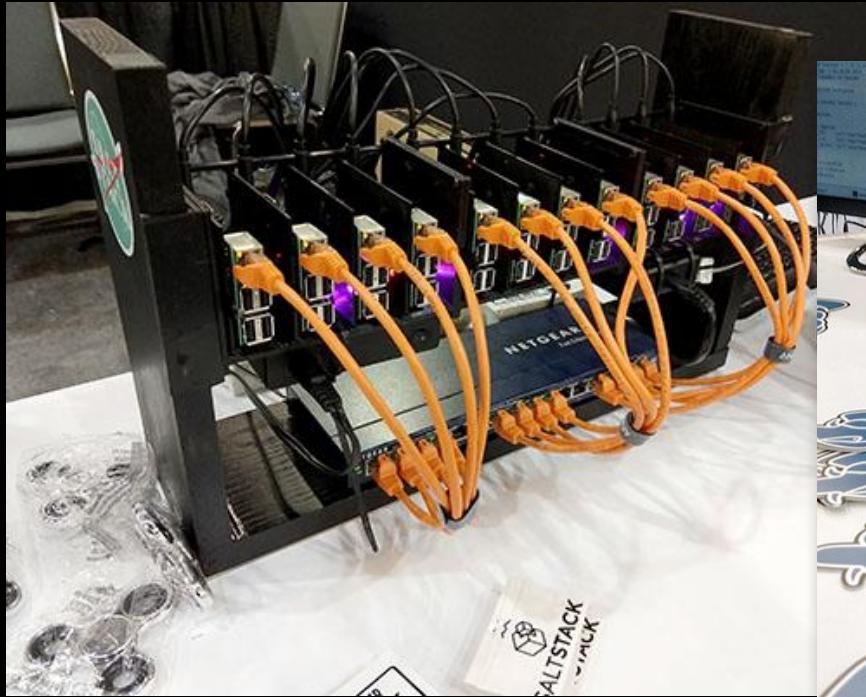


His name is Flash and he loves Raspberry Pis! (His counterpart RIP was "Floppy.")

Great tools for forcing yourself to learn

- Limited memory, CPU, and storage bandwidth for \$35
 - Save and push yourself more with a Pi Zero for \$10
- Do things better because you get sick of waiting!
 - And sometimes because they just blow up
- Or, really, just use that ancient laptop in the closet
 - Or Pine64, BeagleBoard, NanoPC, adafruit Circuit Playground...
- You can get through all the CS core material on RPi
 - A lot of people could do their entire jobs on one
- What can you build on that!?!???

Very smart people are already going there



In summary

- We won't have Moore's Law to help us along
- This is a generational paradigm shift
 - We don't know where it's going to take us, but the recent patterns won't work
- In software, we need to go back to basics
 - We don't want to be "coal miners" looking for the old days
- As consumers, stop worrying about the next upgrade
 - It probably doesn't matter
 - The interesting stuff is going to be in a million small places harnessing behind-the-scenes hardware efficiencies

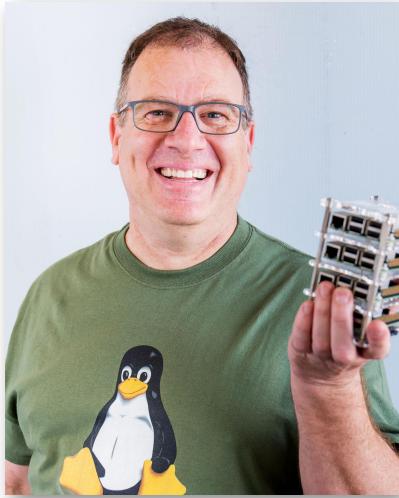
The future is unknown, and different

- The ends of long-term trends are hard to predict
- We must be cautious and opportunistic
- We need to look for second and third-order effects
- It's going to be messy

"The old stuff gets broken faster than the new stuff is put in its place. The importance of any given experiment isn't apparent at the moment it appears; big changes stall, small changes spread."

~ Clay Shirky, 2009

Thank You!



Michael Gat
@michaelgat
michaelgat.com

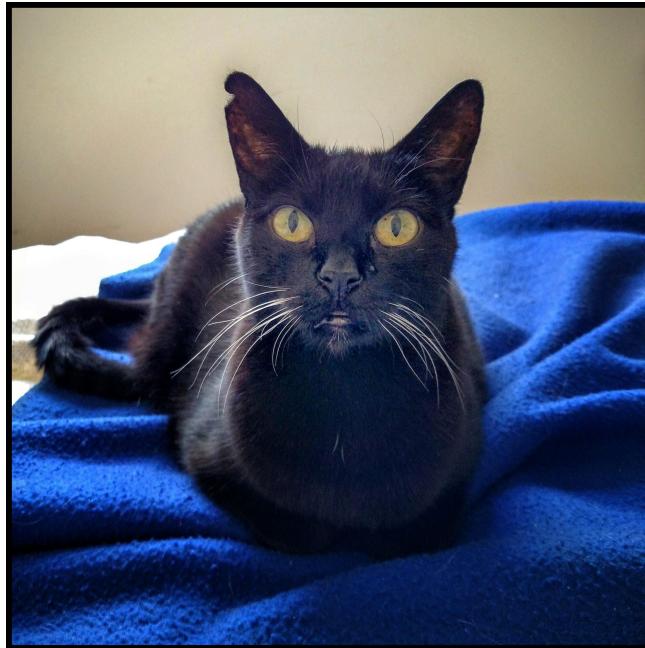
Slides at github.com/michaelgat/Presentations

Questions!

Not:

- Calling bullshit
- An irrelevant story
- Your resume

Floppy RIP



Floppy RIP

