Mobile is eating the world

Benedict Evans

December 2016

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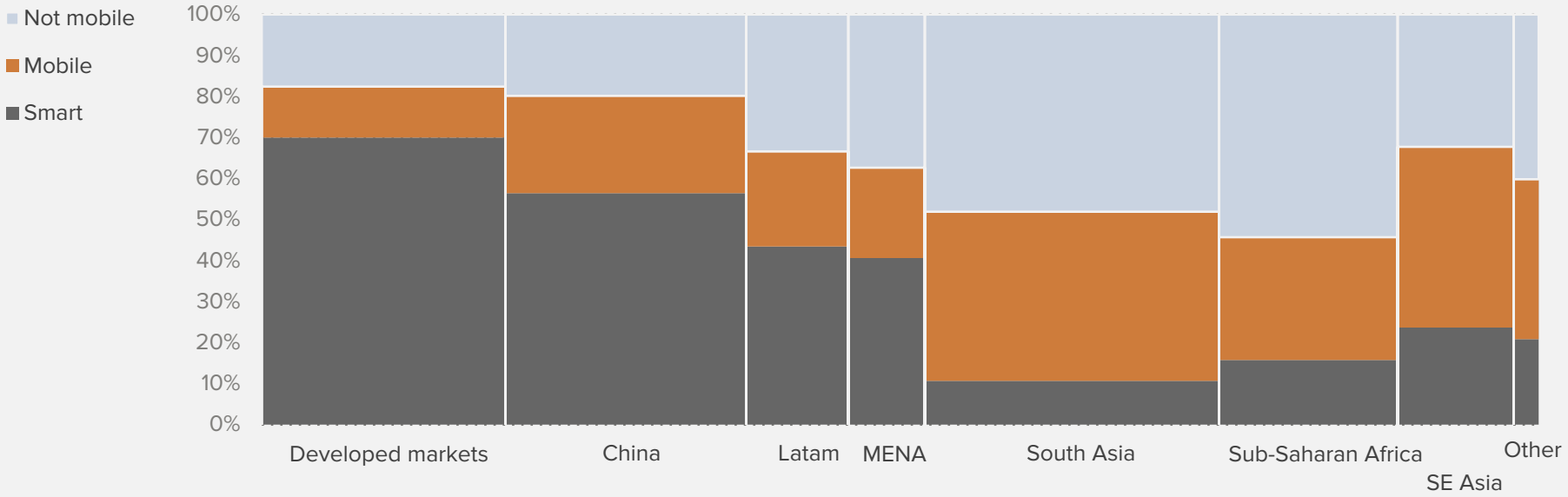
Mobile deployment

We’re halfway to connecting everyone

5.5bn people over 14 years old, close to 5bn with mobile phones, ~2.5bn smartphones

Global population and mobile penetration*, December 2016



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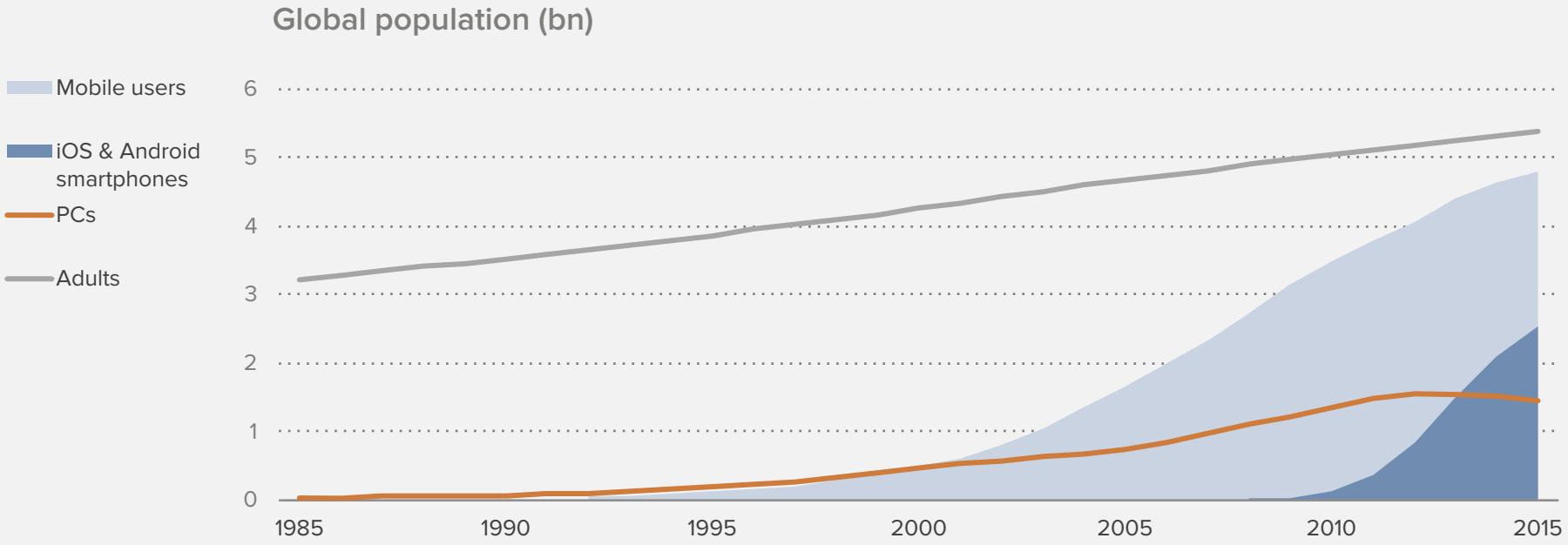
* SIM penetration is >100%. Source: World Bank, TMW, CNNIC, a16z

The mobile S-Curve is passing the PC S-Curve

Smartphones are moving past the PC and heading for 5bn+ users



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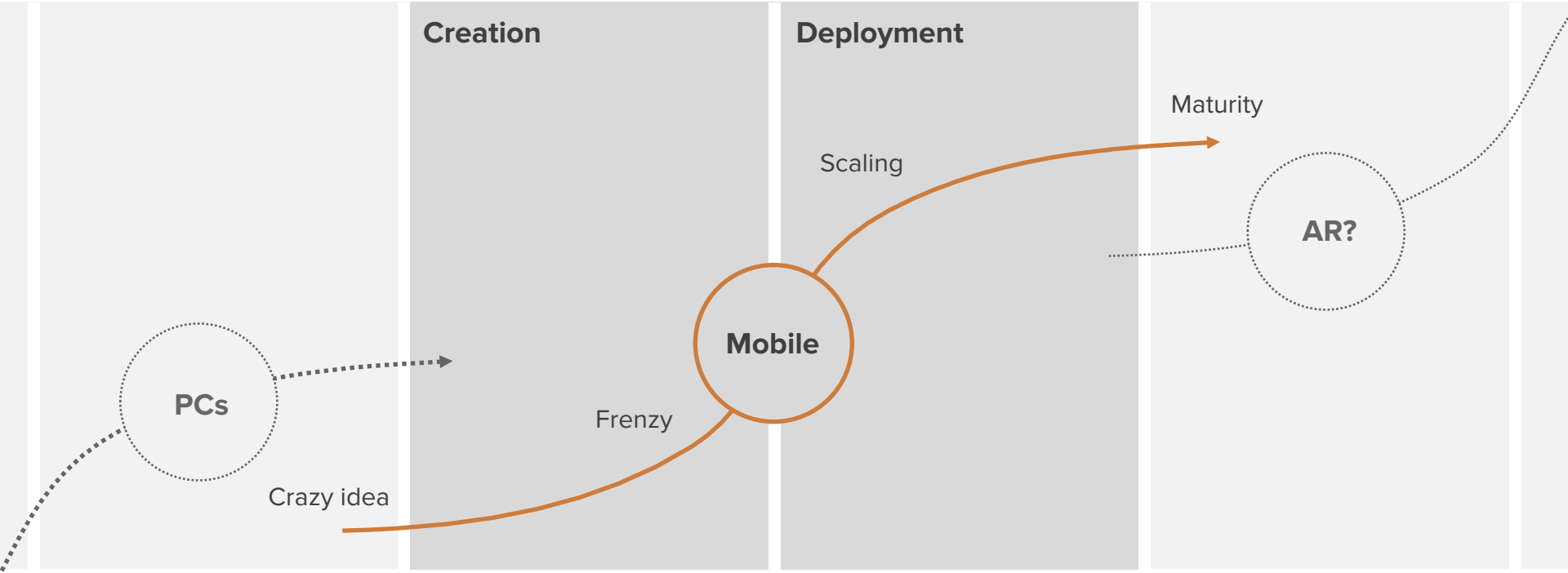
Source: Apple, Google, a16z, TMW, ITU, World Bank

Mobile S-Curve moving from creation to deployment

As we pass 2.5bn smartphones in use, the issues that matter are changing



What does mobile deployment mean?

As we pass 2.5bn smartphones in use, the issues that matter are changing

Creation	Deployment
Platform wars	The big winners are clear
The latest handset!	Steady, incremental improvement
Technology arguments	Commodity technology (mostly)
Millions of users	Billions of users
“Will this work? Who will win?”	*“What can we build with this?”*

“What can we build with this?”

A new kind of scale for technology, and new kinds of computer.

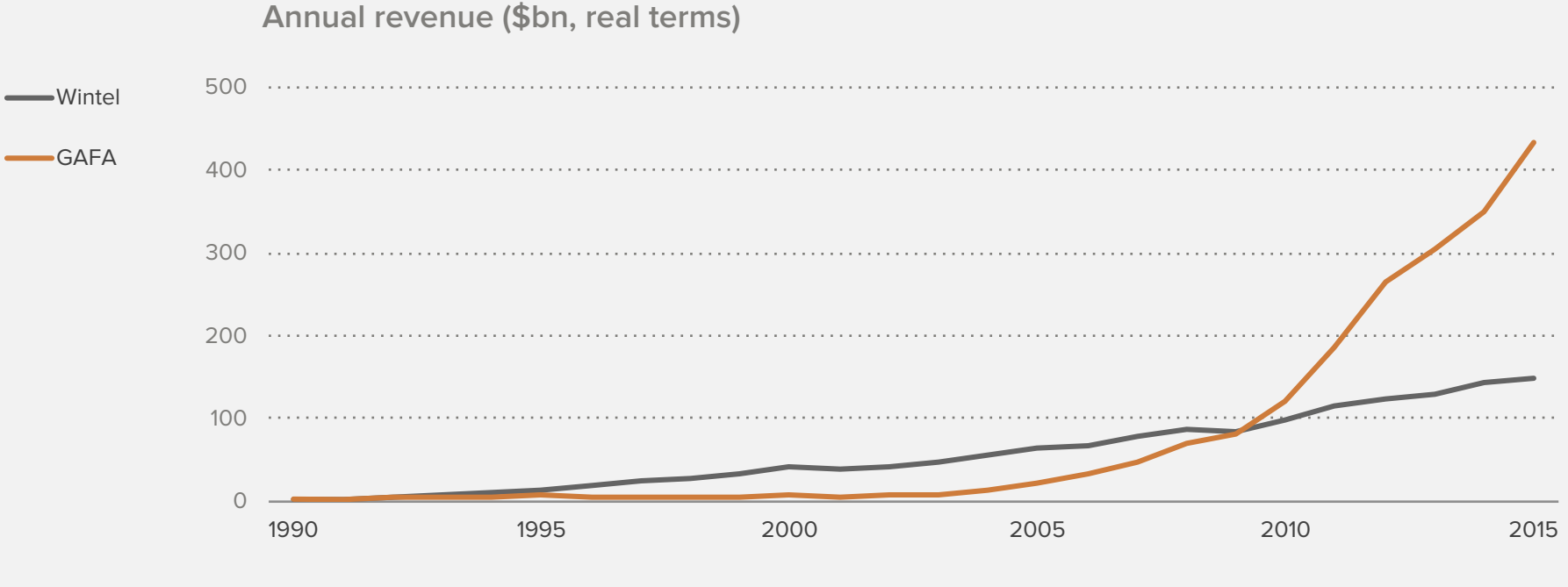
New ways to change other industries.

Two of those industries: ecommerce & cars.

A new kind of scale

Changing of the guard

Google, Apple, Facebook & Amazon (GAFA) are 3x the scale of Wintel



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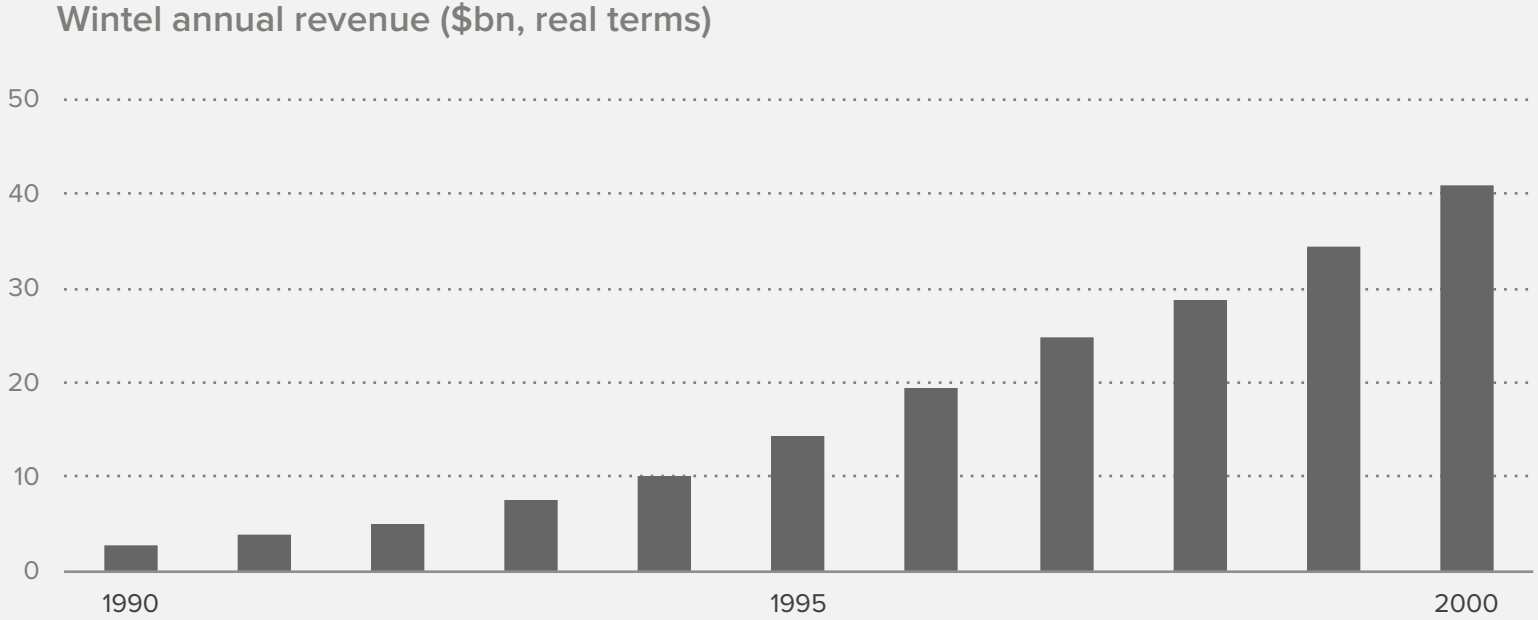
Source: Bloomberg, a16z

The Wintel explosion in 1990s – 14x growth

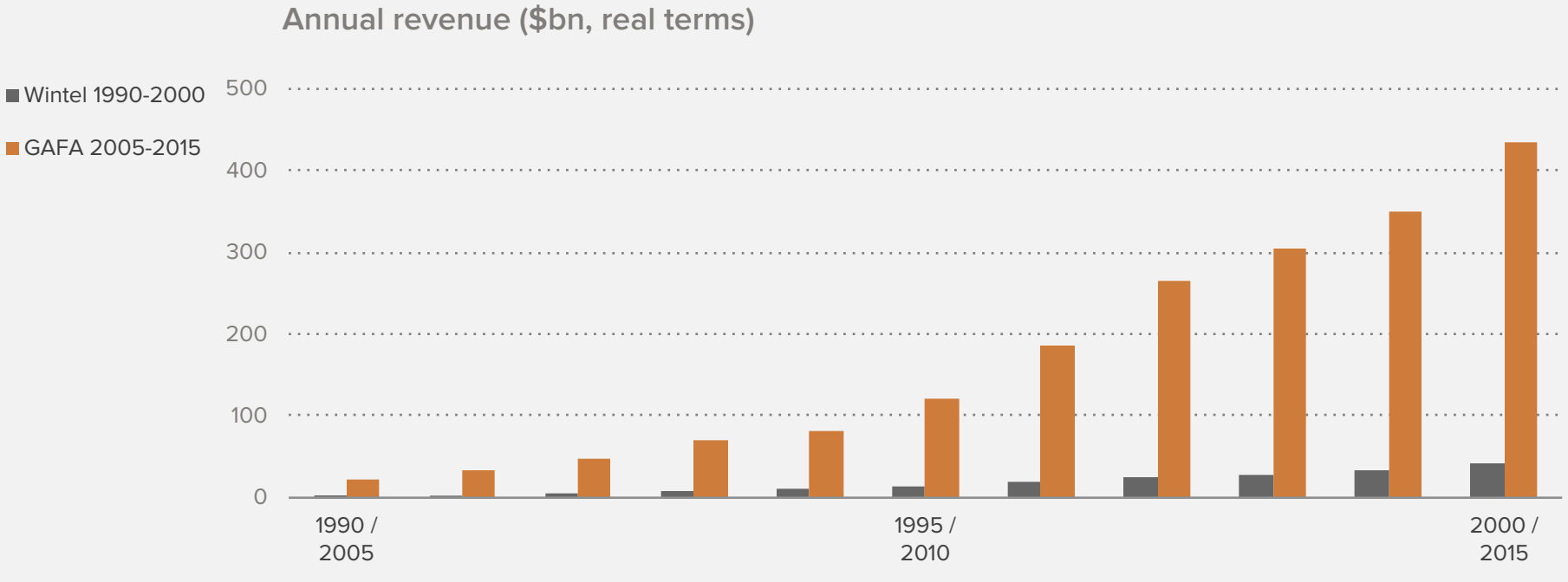
The golden age for Intel and Microsoft saw 14x revenue growth and dominance of tech



Source: Bloomberg, a16z

… But GAFA has 10x the scale

Fundamental change in what it means to be a leading tech company



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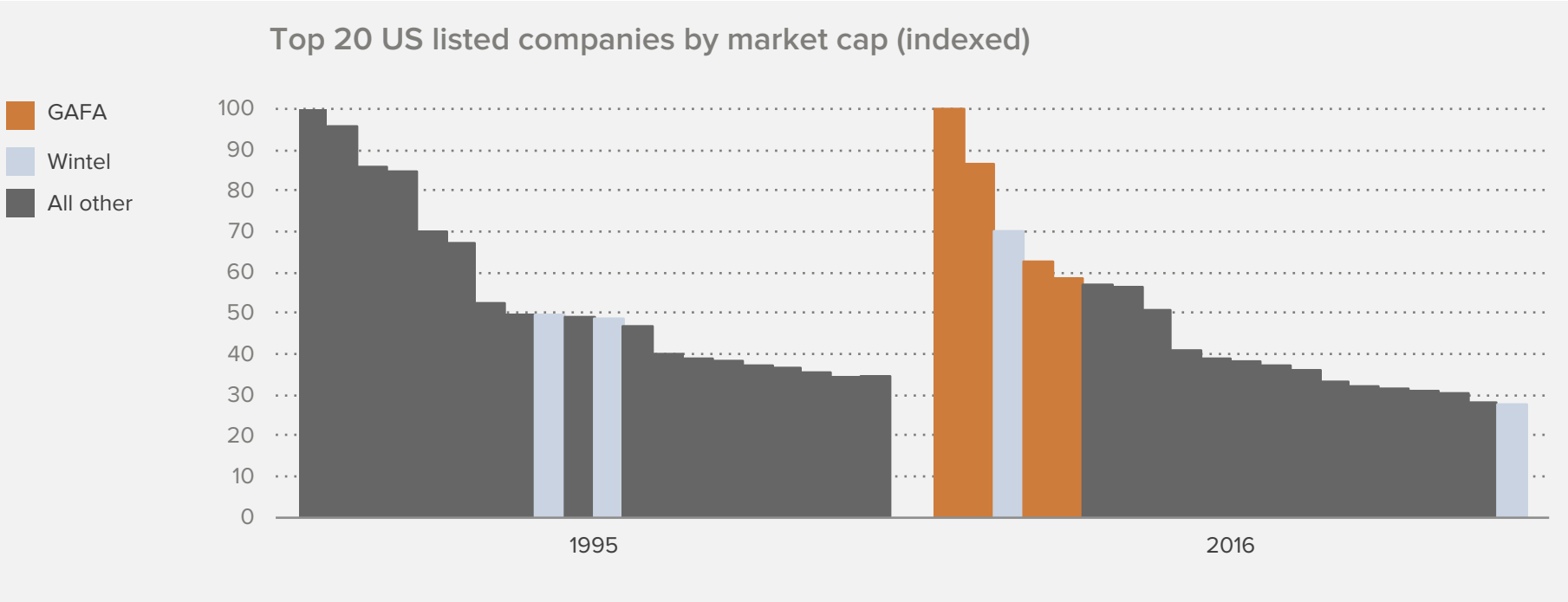
Source: Bloomberg, a16z

From important to dominant

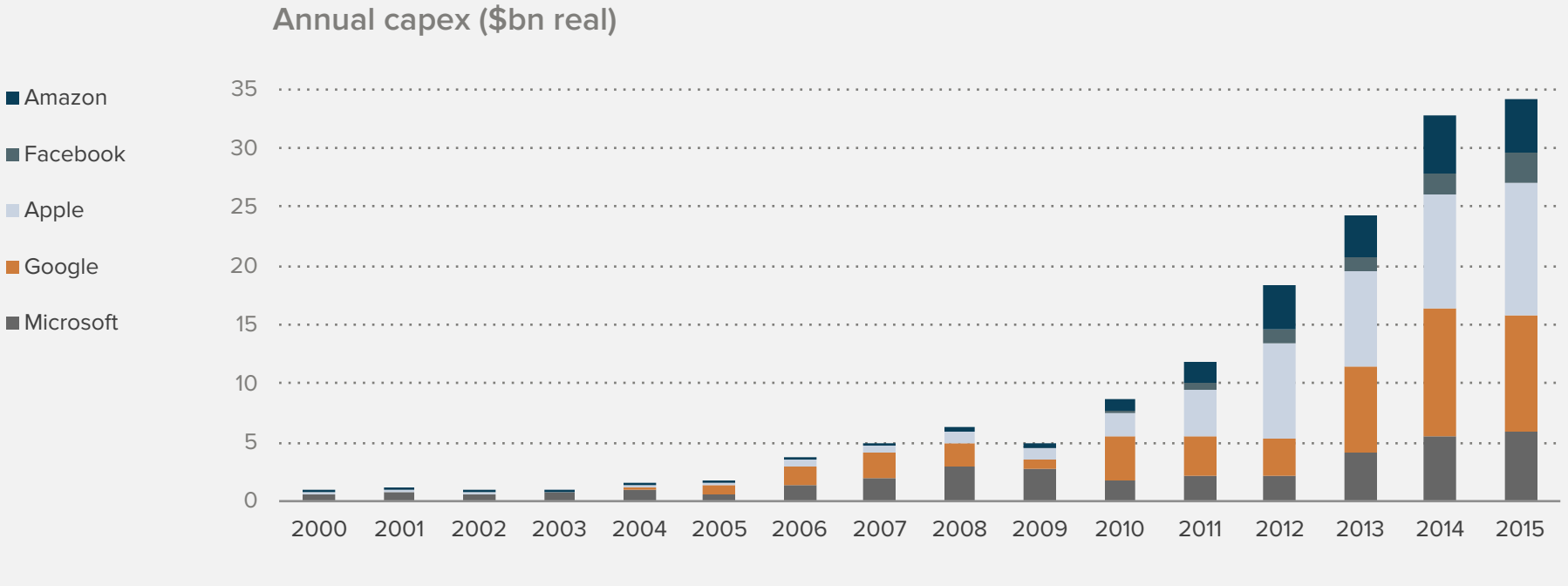
When tech was scared of Microsoft, it was a pretty small company



Source: Bloomberg, a16z

That scale means much more investment

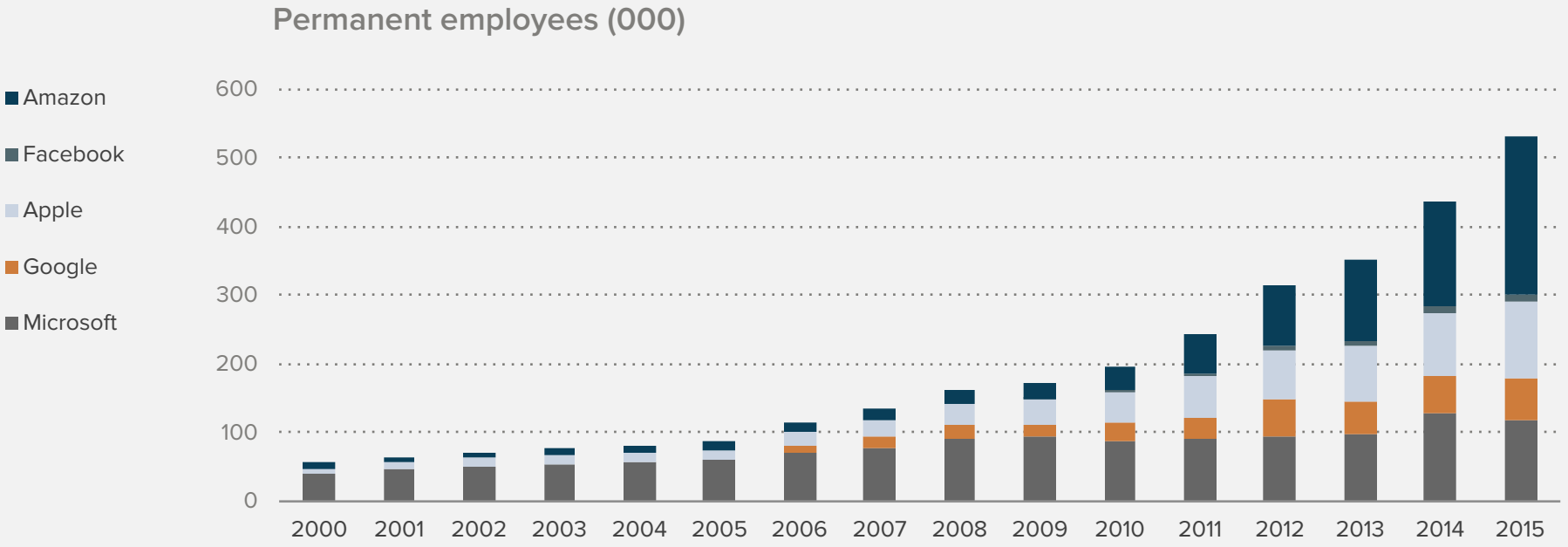
Annual capex has increased from $1bn to $34bn since 2000



Source: Bloomberg, a16z

And 10x more people

(Though this chart includes a lot of warehouse and retail staff)



Source: Bloomberg

Today's tech giants have a totally different character of scale to Wintel or IBM before them.

Giants in the economy, not just in tech.

And (at least) four competing giants, not one.

So Apple is a global top 10 retailer

500 stores, ~$25bn revenue make it a top 20 retailer.

$53bn including the online store...

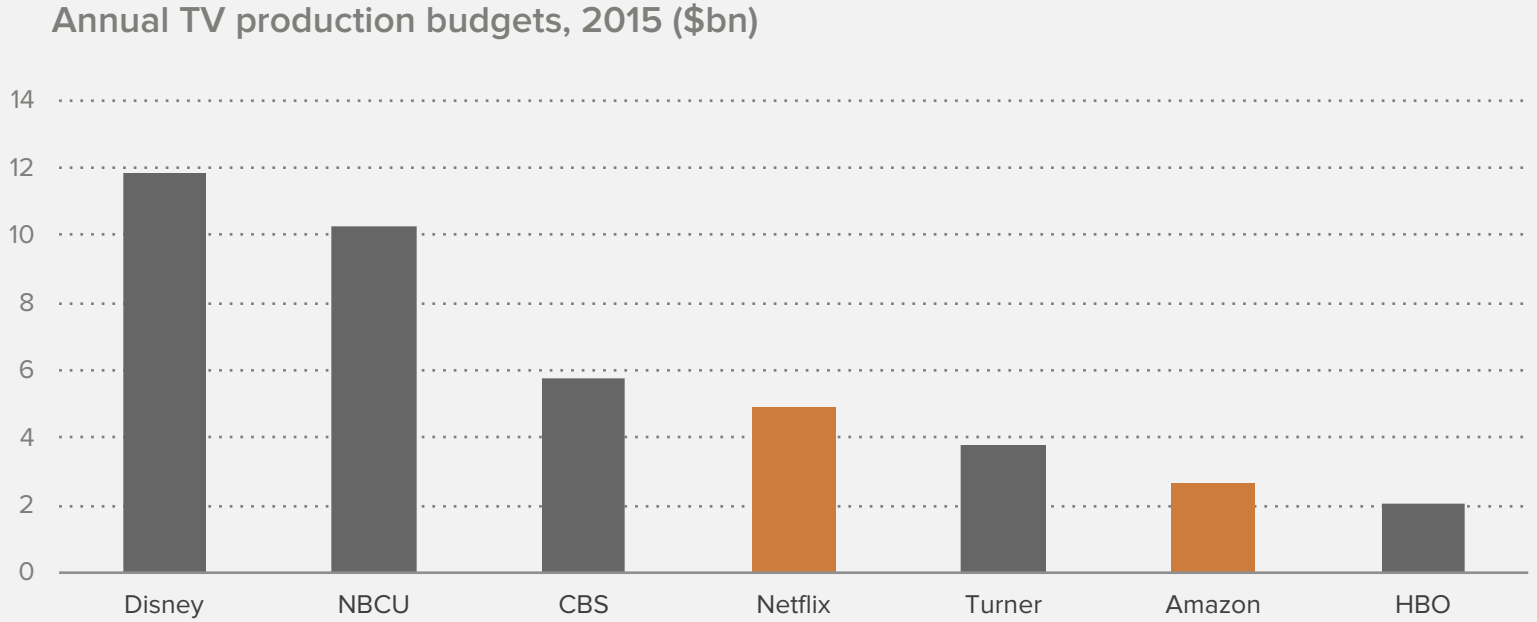
Making Apple the 10th largest global retailer by revenue.

Not bad for a marketing operation.

Retail ran at 12% of revenue before Apple stopped disclosing it: direct is 25%. Source: Apple, a16z

For Amazon, content is just a strategic lever

Original content is core for Netflix, but just another way to sell Prime for Amazon. Combined, they're 16% of US production budgets



Source: IHS

Is Netflix a threat?

"Is the Albanian army going to take over the world?"

- Jeffery Bewkes, CEO Time Warner, 2010

Making your own chips: Intel's whole business becomes an add-on.

Google: 'TPU' machine learning FPGA.

Amazon: 'Annapurna' networking ASIC.

Apple: A10 is the fastest mobile SoC – plus custom chips for TouchID, Airpods, etc.

Standing on the shoulders of giants

Huge companies building on an ecosystem that commoditises almost everything before

In the mean time,
the new thing –
machine learning

“Is there a dog in this picture?”

After 50 years of work, computer vision systems got this right 72% of the time.

A whole class of similar problems – easy for people and hard/impossible for computers.

Consensus: decades more work.

Then, in 2012, machine learning.

Source: Imagenet

The arrival of machine learning

Performance for decades-old challenges has been transformed

Image recognition

28% error rate → 7% →

Speech recognition

26% error rate → 4% →

Machine learning: data instead of rules

Fundamental shift in AI from trying to codify perception to massive data and applied maths

Old: rules

Build systems to look for ears, noses, legs, fur…

Hire linguists and write grammar rules.

Try to codify how human intelligence works (though we don't really know).

Machine learning: data

10k pictures labelled 'dog' and 10k labelled 'no dog', and let a neural network work it out.

Learning rather than rules.

Possible now because we have ~1m times more computing & data.

“Every time I fire a linguist, the performance of the speech recognizer goes up.”

- Frederick Jelinek

Since we're analysing data, not looking for dogs, this works for many other data sets.

"Which customers are about to churn?"

"Will that car let me merge?"

"Is anything weird happening on the network?"

Alpha Go – board games and air-con

Google took the machine learning platform that won Go and applied it to data center cooling.

Achieved a 15% energy saving.

Building systems that find patterns in data.

“We will move from mobile-first to AI-first.”

- Sundar Pichai, 2016

ML use cases: how many patterns, how much data?

Things that only people could do, but at a scale that people could never do

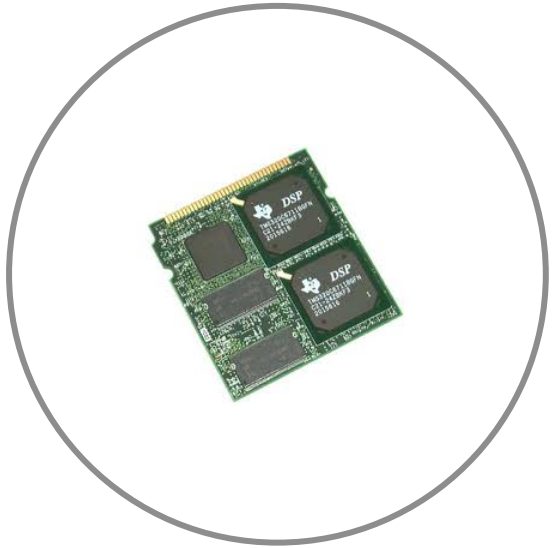
At the top and bottom of the stack

Training models at vast scale in the cloud…

But once trained, many models could run on very small/cheap devices.

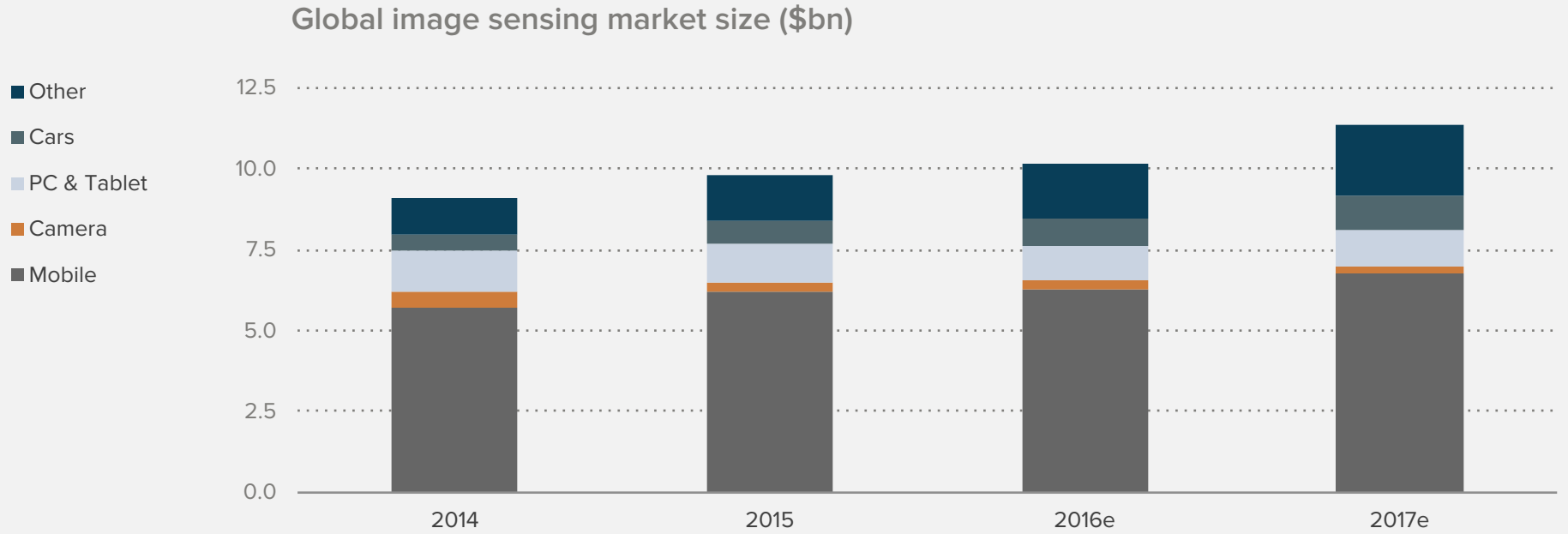
Run on a smartphone.

A $10 widget could run on a cheap DSP with a commodity camera, looking for just one thing – people, leaks, cars…



Cameras in everything, except in cameras

Imaging, combined with machine learning, may be becoming a universal sensor

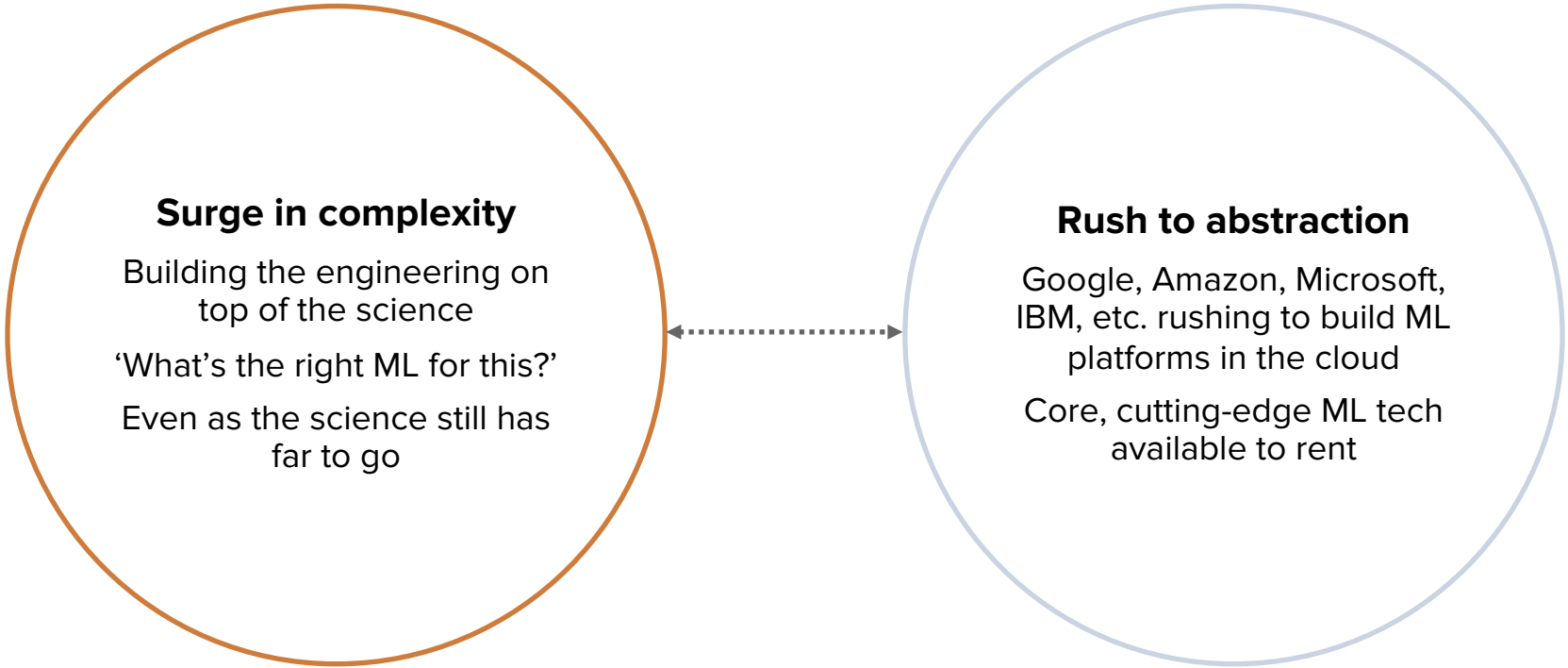


Source: Sony

What does it mean if computers can read images in the way they've always been able to read text?

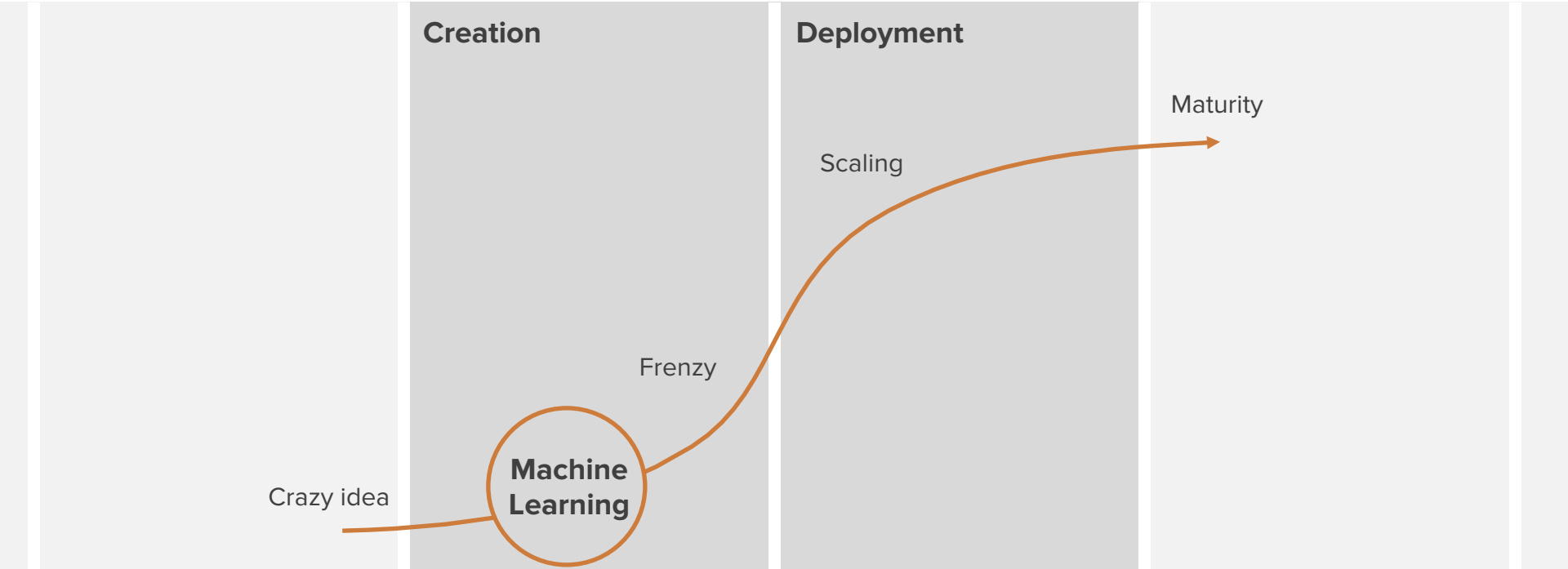
Complexity and abstraction

Arms race of science, engineering and product – a new front for GAFA competition



The machine learning S-Curve

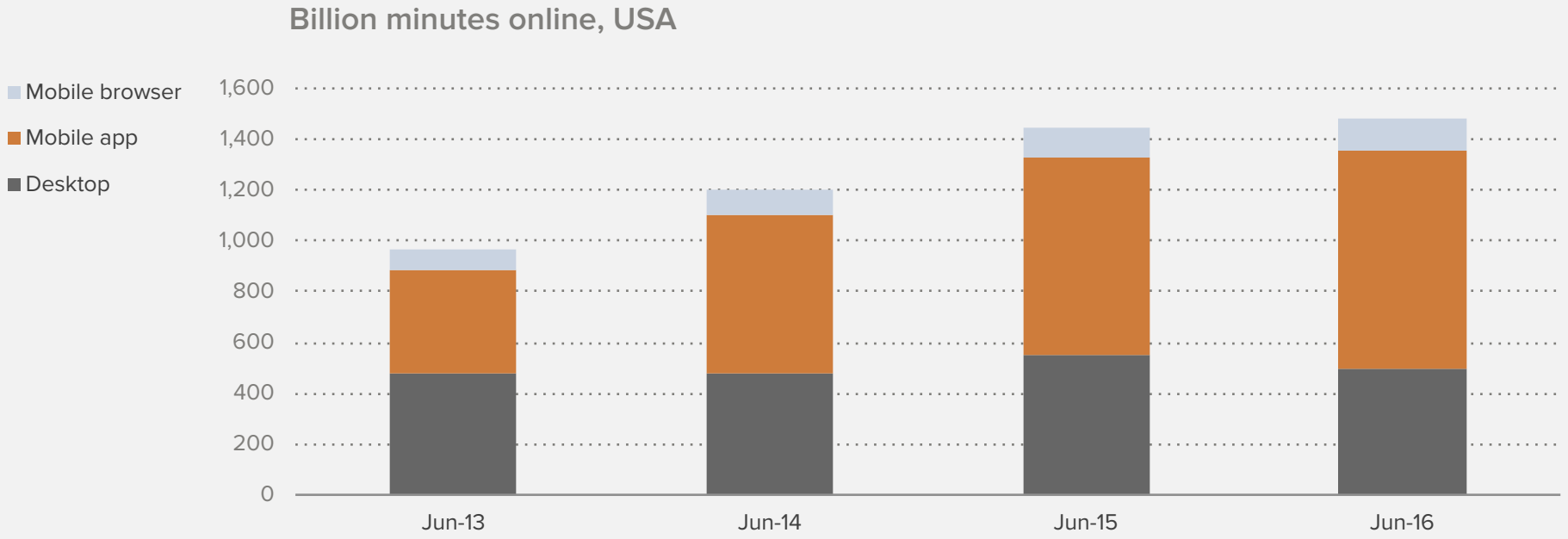
Still in the very early days of creation, with lots and lots of low-hanging fruit



New kinds of computer

Obvious but boring: apps have won mobile

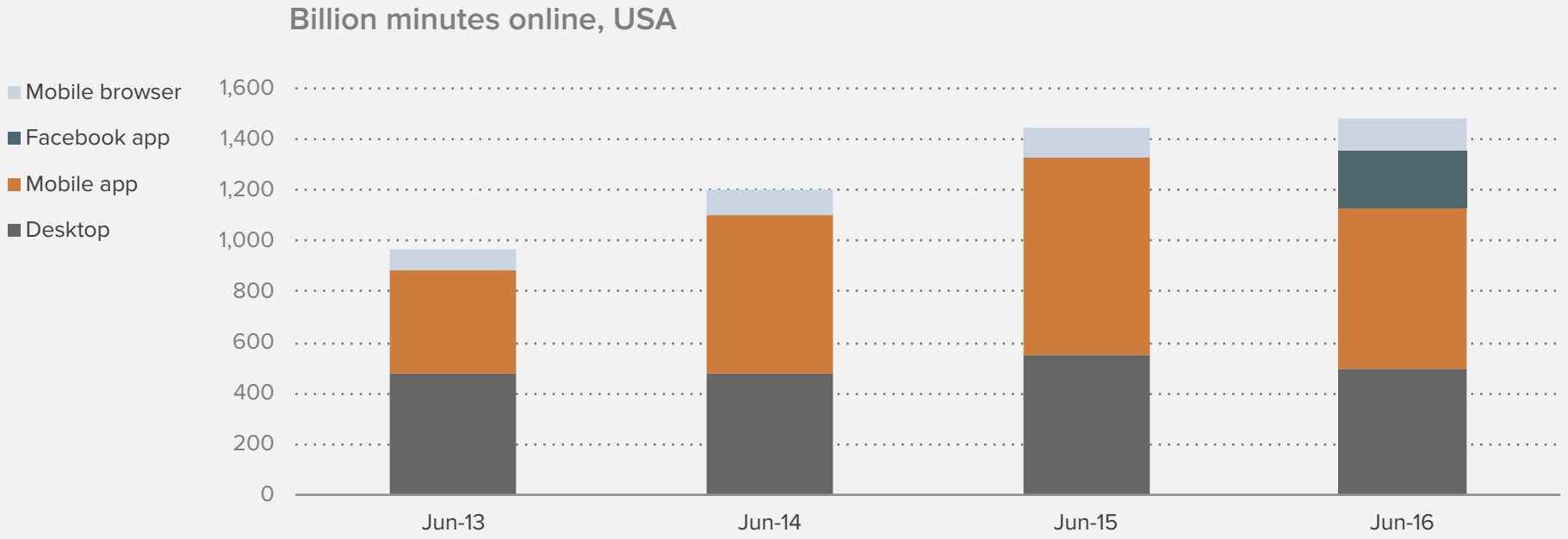
Smartphone apps are now close to 60% of all time spent online in the USA



Source: Comscore

… with increasing concentration

Facebook has 15-20% of mobile time (making it the largest mobile web browser)



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Source: Comscore, a16z

More important: a new generation of computing

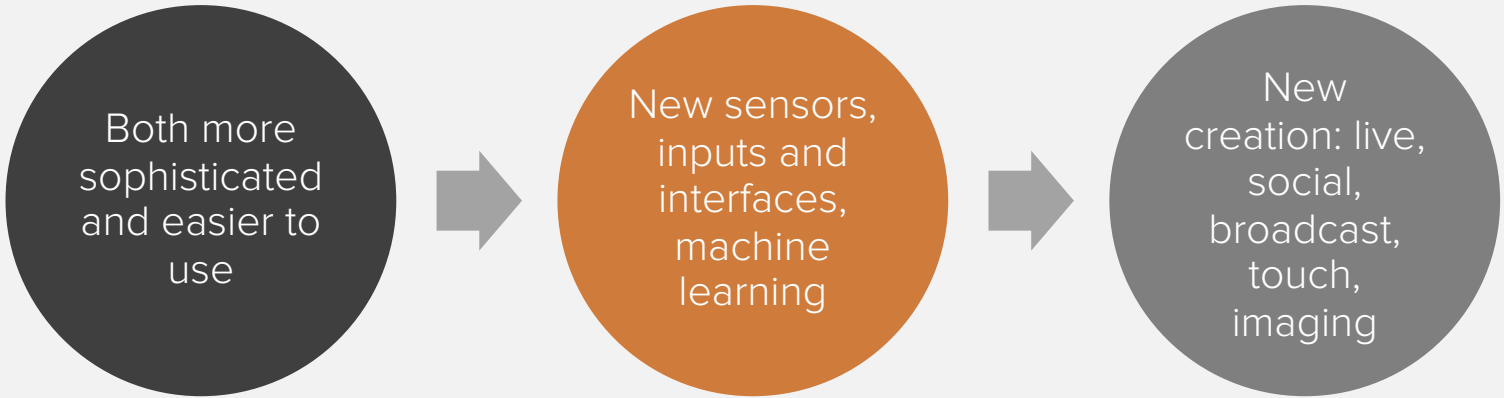
After 30 years, we shift to a new and more sophisticated kind of computer

Intensely personal	Always with you	Imaging as primary input
Touch, tilt, location, microphone	App stores	Ignore battery & bandwidth
1000x faster	Cloud & machine learning	And yet much easier to use…

New computing model

New computing model, and new creation models

Leave the PC behind, presume mobile-only and mobile-native, not mobile-first



How many old assumptions does live video break?

Assume high quality camera, fast CPU/GPU for encoding and effects, touch, always on, always in your pocket.

Assume unlimited bandwidth & battery.

Assume 1bn high-end smartphones on earth - there can be 50 companies trying this.

And turn the whole phone into the camera.

Source: Houseparty, Yixia

Frictionless computing

No buttons, apps or intermediate steps, no ‘computer stuff’ between you and the service – just *use* it (hopefully).

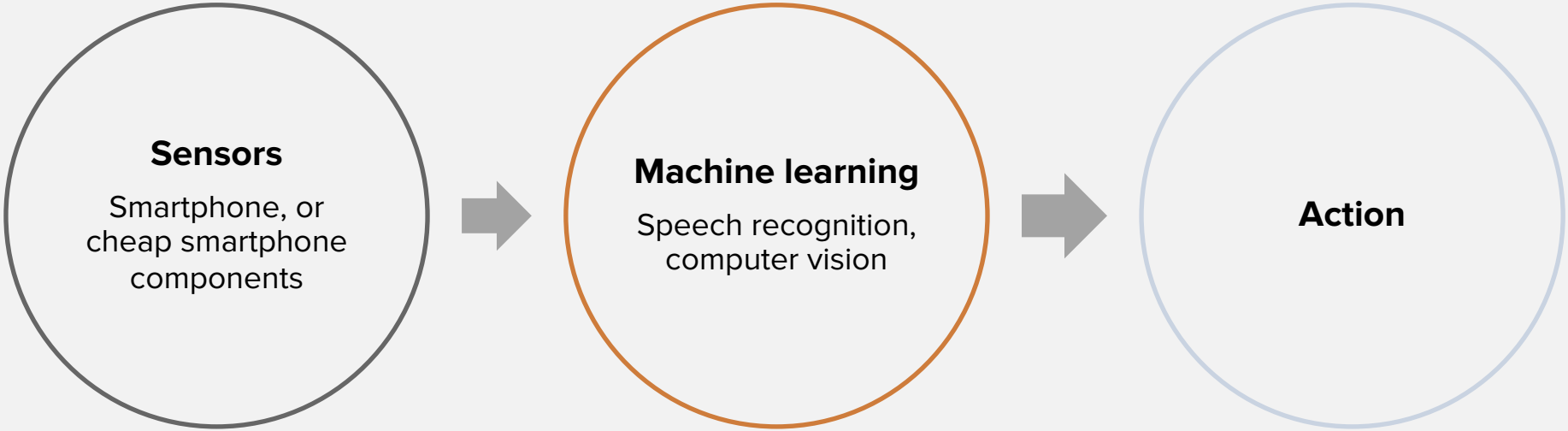
Hardware sensors as unbundled apps - deep links within apps.

Apps moved to a new context.

And of course all built with commodity components from the smartphone supply chain.

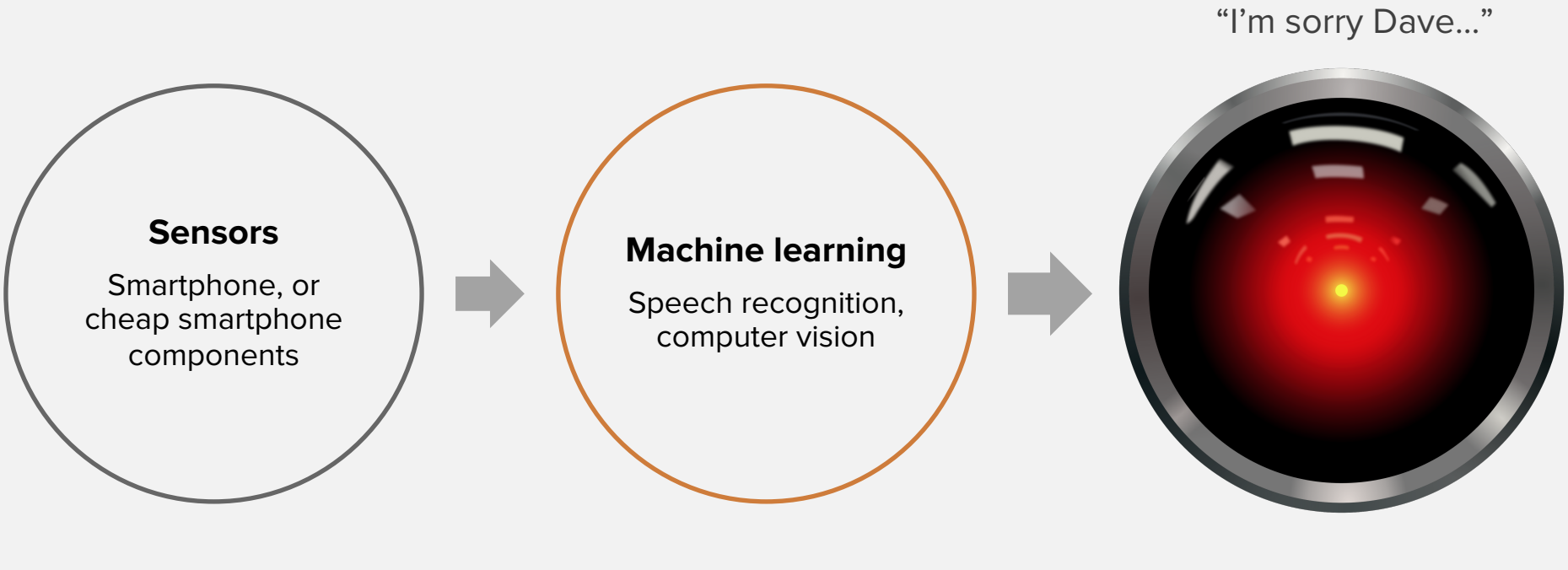
Lighting everything up with machine learning

Smartphone supply chain enables this – machine learning makes it useful



(If the machine can answer)

Still need to narrow the domain to things you can actually do, and tell your users



Changing friction and changing choices

Massive proliferation of UX models. All about removing friction. And choices…

Removing questions and friction

Do you have the printer driver?

What's your password?

Where did you save that file?

…

What soap do you want to buy?

With which app?

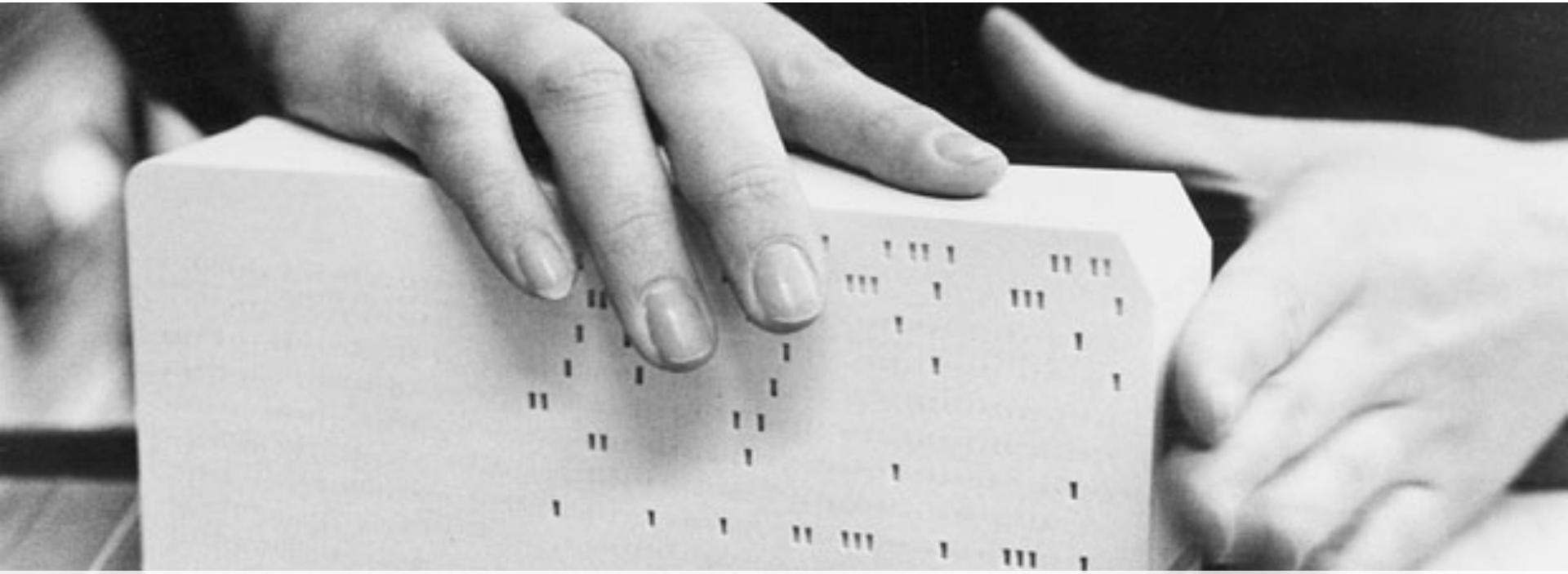
But also choices

Questions are also choices

Huge strategic incentive for big platforms to be the ones to answer the question for you

"Who owns the customer?"

From direct, physical interaction with data...



Source: IBM

To direct, physical interaction with data

Source: Magic Leap

Ecommerce

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Retailers as newspapers

“History doesn’t repeat, but sometimes it rhymes”

Fixed cost base with falling revenue.

Shift from paid to freemium, unbundling, different skills.

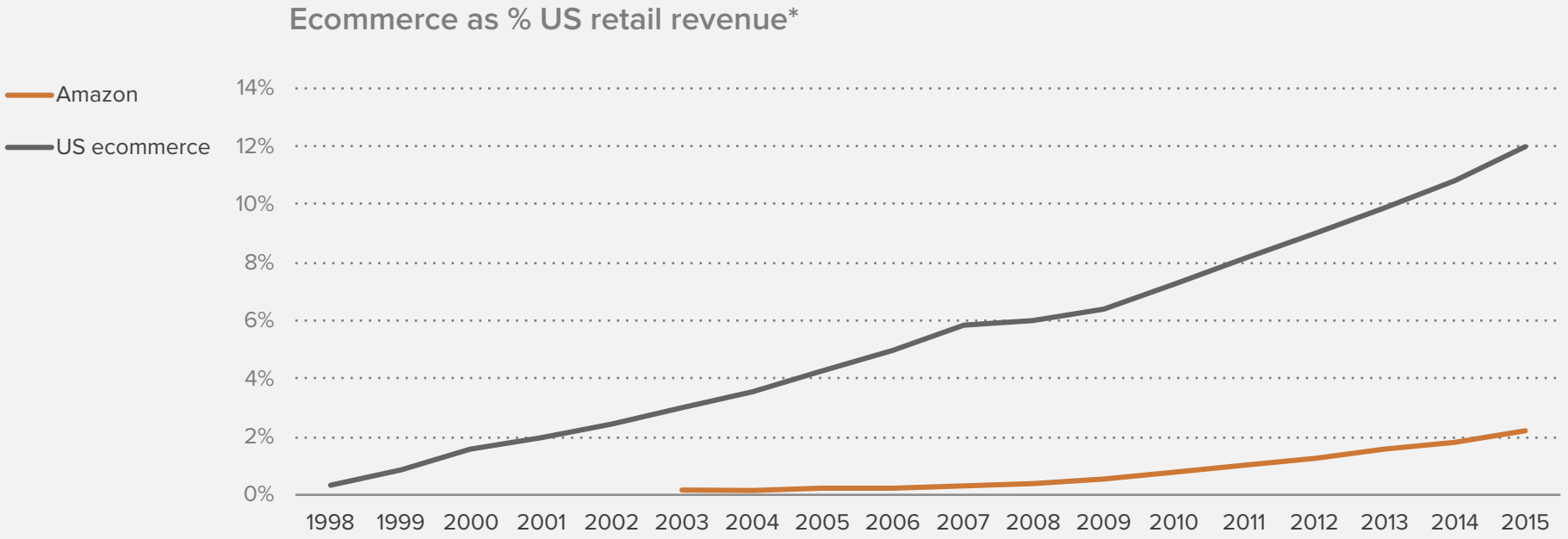
The distribution advantage moves.

New medium means different consumption – you buy different things, not just in different places.

Everything the internet did to media will happen to retail

So far, mostly, what you already know you want

Ecommerce is much better at logistics than demand generation



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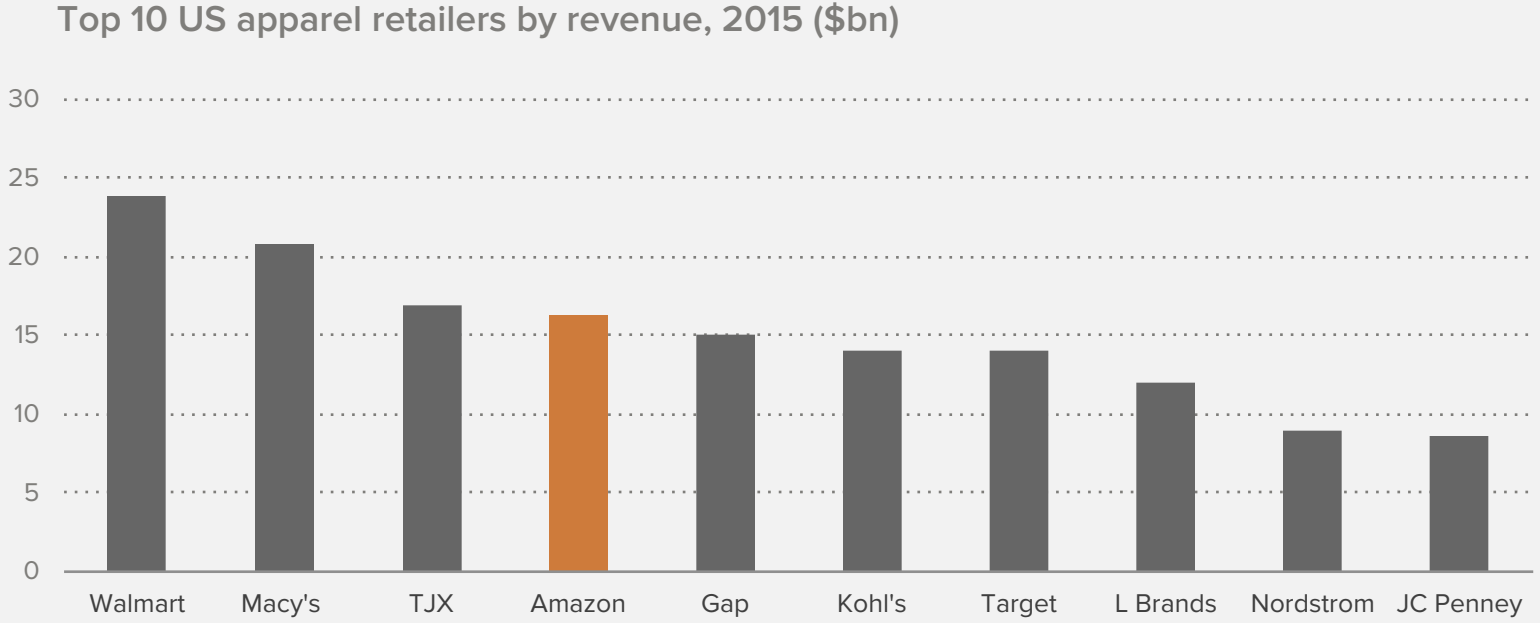
*Ex. food service, gasoline, auto. Source: US Census Bureau, Amazon, a16z

People will buy online if they know about it

Even clothes – especially with free returns (a new logistics arbitrage model)
So Amazon is the fourth largest apparel retailer in the USA



Source: Bloomberg Intelligence

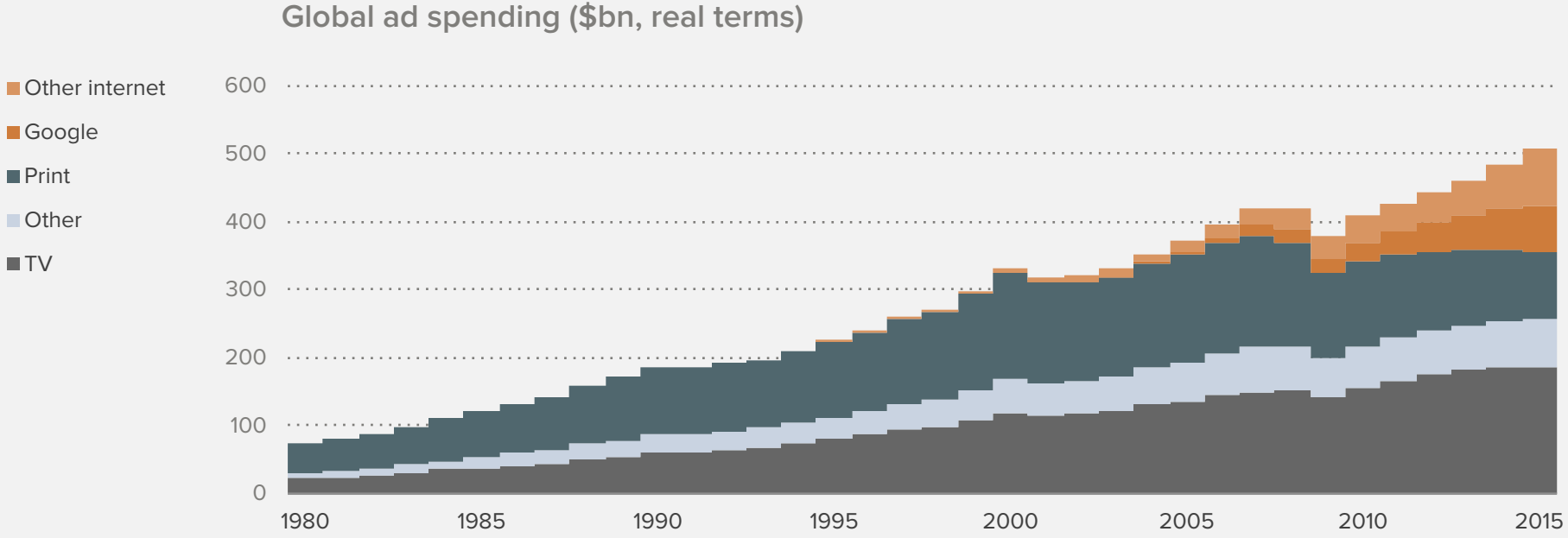
But how do you know what to buy?

Amazon is Google for products, but we don't have a Facebook or Buzzfeed – we don't have suggestion and discovery.

The internet lets you buy, but it doesn't let you shop.

Digital demand generation, step 1: spend $1tr

$500bn spent annually on ads (a third on digital) – and another $500bn on marketing



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Source: Zenith, Google, a16z

“Your margin is my opportunity”

- Jeff Bezos

(So what is advertising?)

The channel is the product

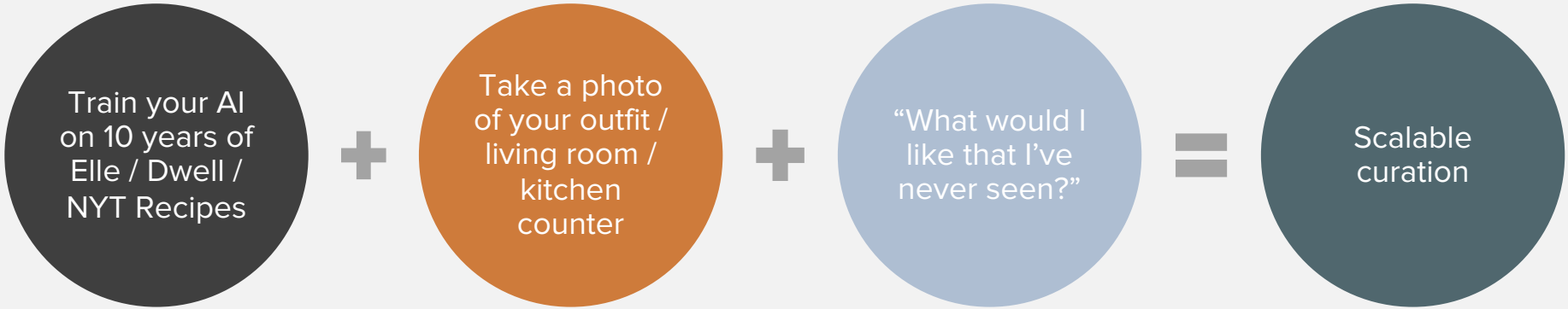
Soap as a Service.

New purchasing journeys mean new kinds of decisions.

If you change how things are bought, you change what gets bought.

Scaling curation with machine learning?

When can we infer taste and preference, without a purchase history or a salesperson?



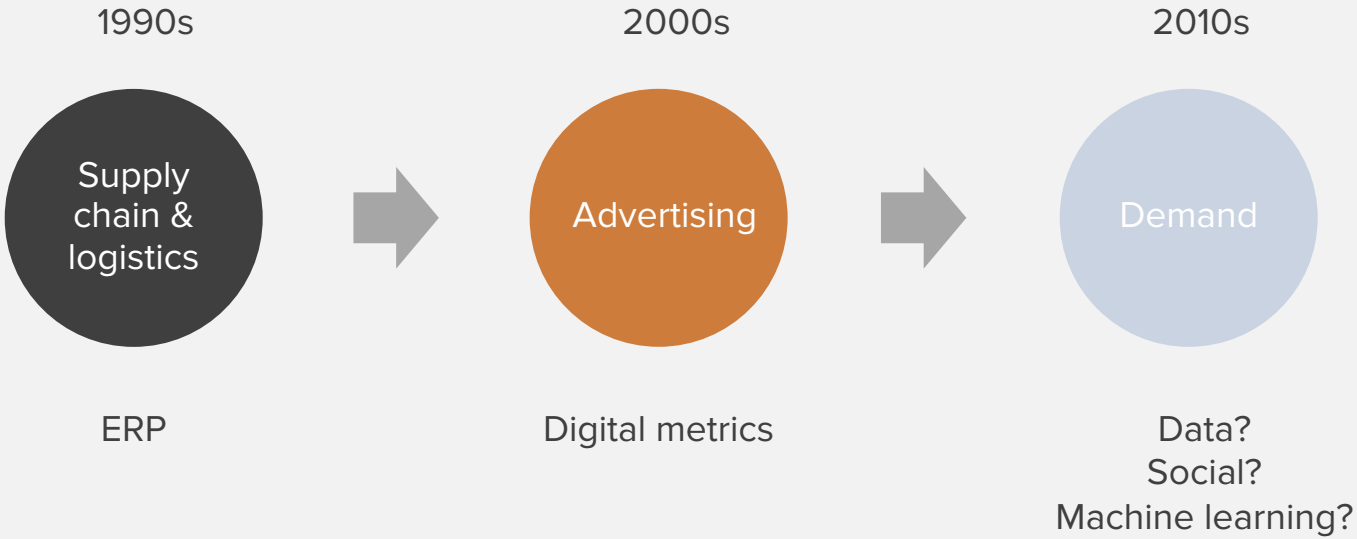
A computer should “never ask the user for any information that it can auto-detect, copy, or deduce.”

- Eric Raymond

(So what do you want to buy?)

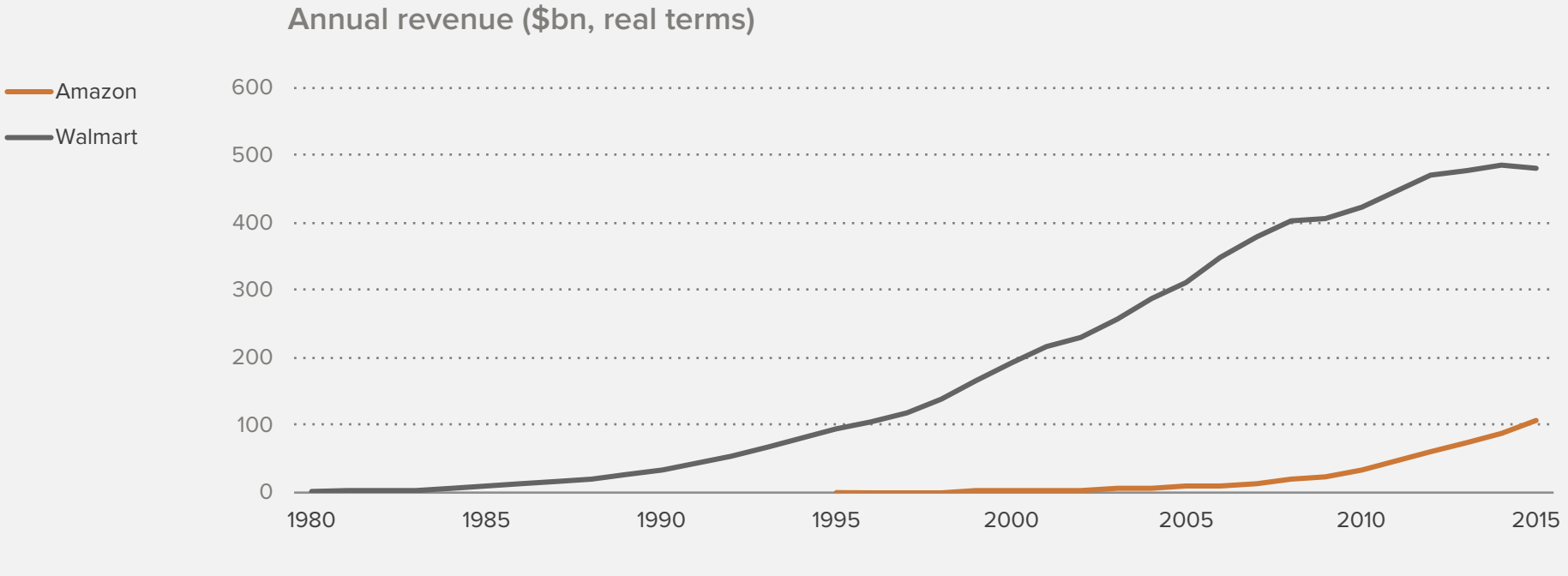
Data works its way through retailing

Data has affected every part of retail except demand itself, so far



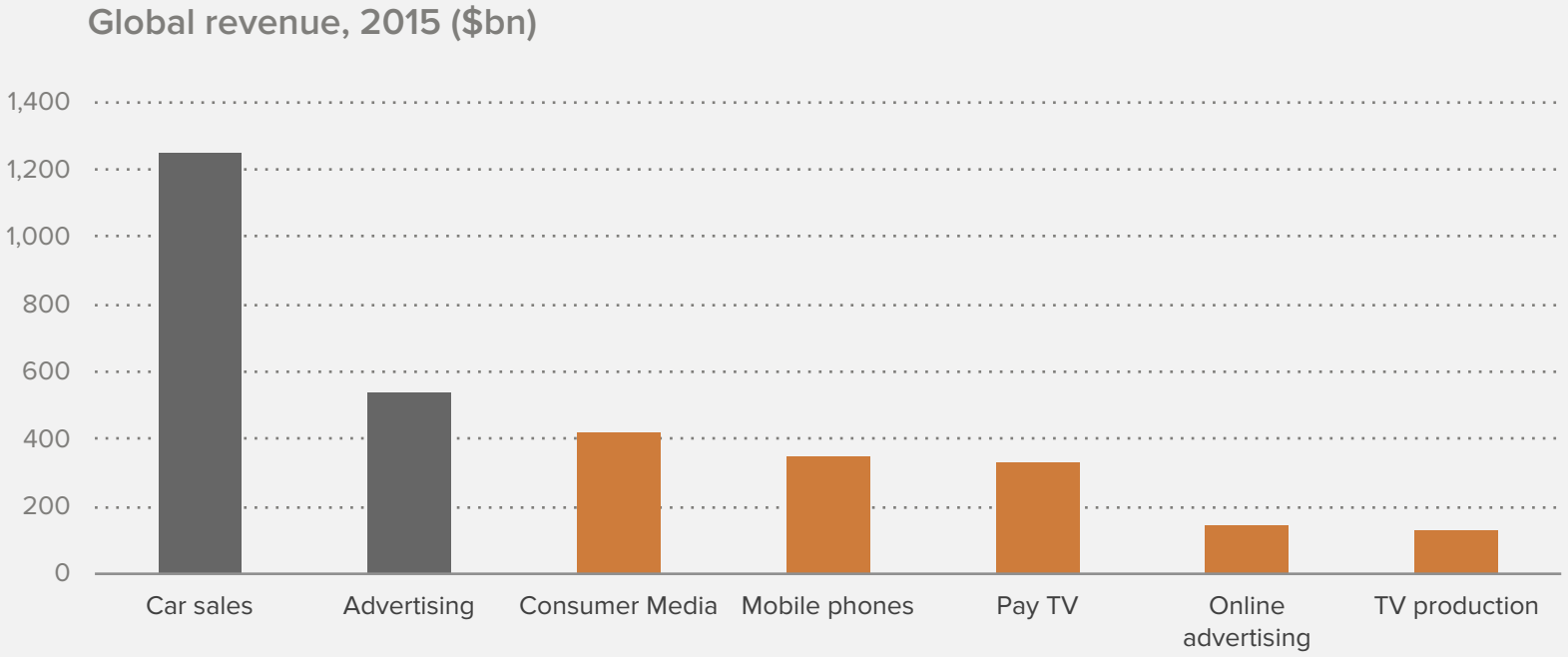
Retail S-Curves

Walmart used new technologies to change retail – the same is happening again



Source: Amazon, Bloomberg

Sectors up-ended by software so far...



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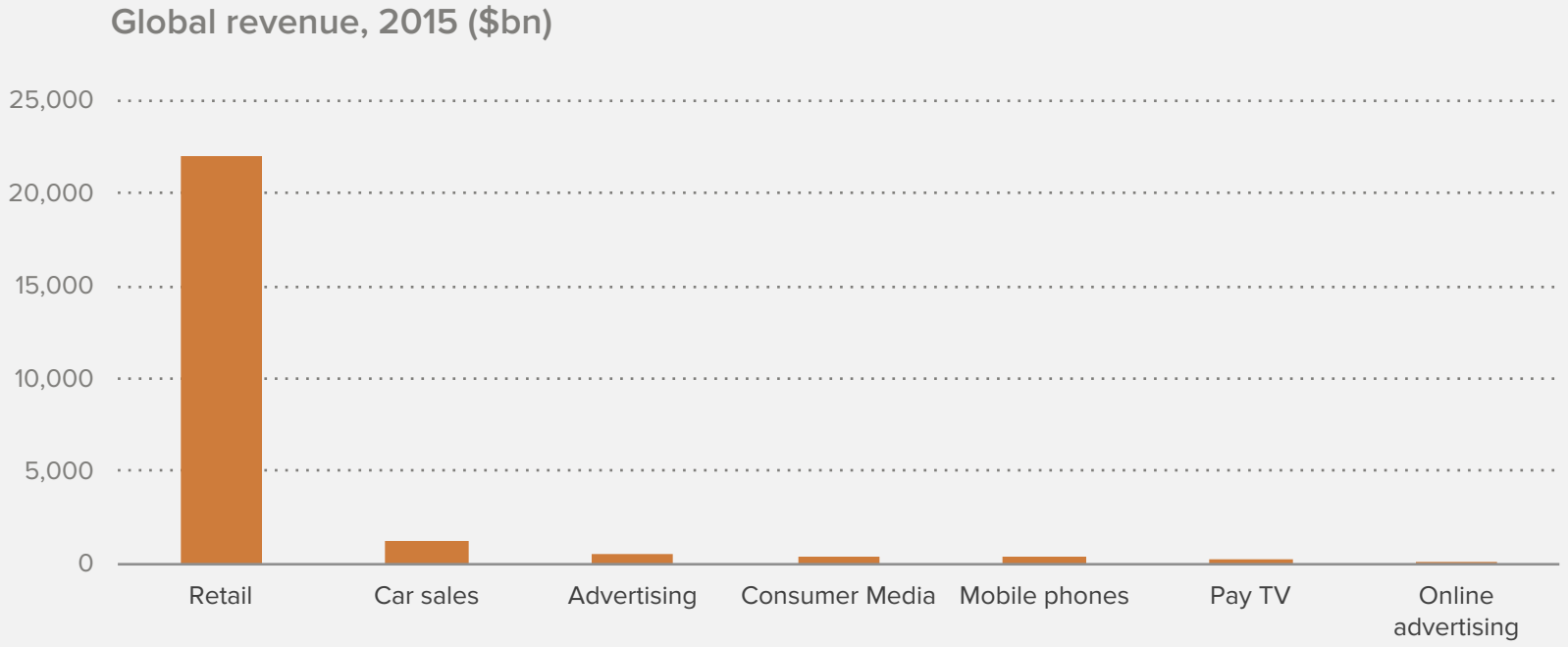
Source: a16z

And in the future



Source: a16z

Cars

Cars as phones

“History doesn’t repeat, but sometimes it rhymes”

Today’s tech moat disappears.

Key components become commodities.

Value moves to software.

Network effects move away from hardware.

‘Phone’ means something totally different.

Two paths for disrupting cars

The growth of electric and autonomy are both, separately, changing what cars are

Electric

Happening right now.

Removing the engine & transmission destabilizes the car industry and its suppliers.

Doesn't change how cars are used (much).

Autonomy

5-10 years? Longer?

Many challenges to resolve.

Changes where the value is.

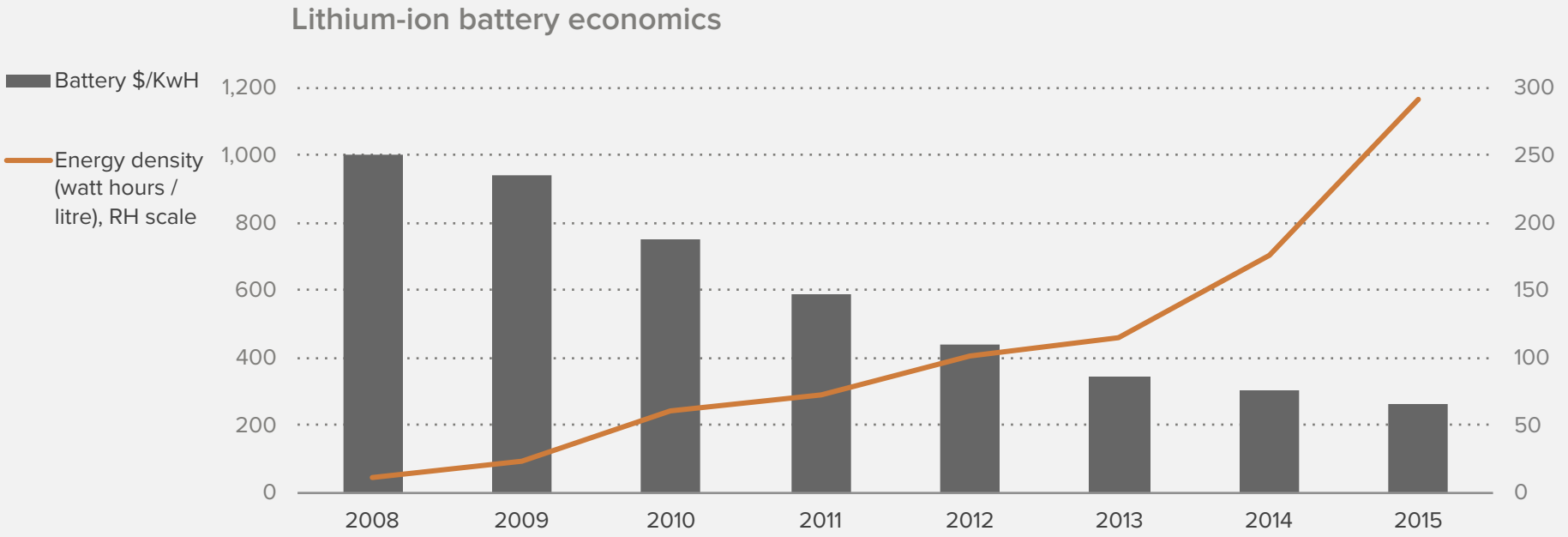
Accelerates on-demand.

Changes what cars are.

Changes cities as much as cars changed cities.

Going electric: riding the battery cost curve

Growth of electric cars is a function of battery economics starting to work



Source: US Department of Energy

Electric unbundles cars

Electric makes cars much simpler and turns many elements into commodities

Radical simplification

Complex, proprietary gasoline engines & transmissions disappear

Replaced by simple, commodity batteries & motors

10x fewer moving parts

Whole basis of competition changes

New bases for competition

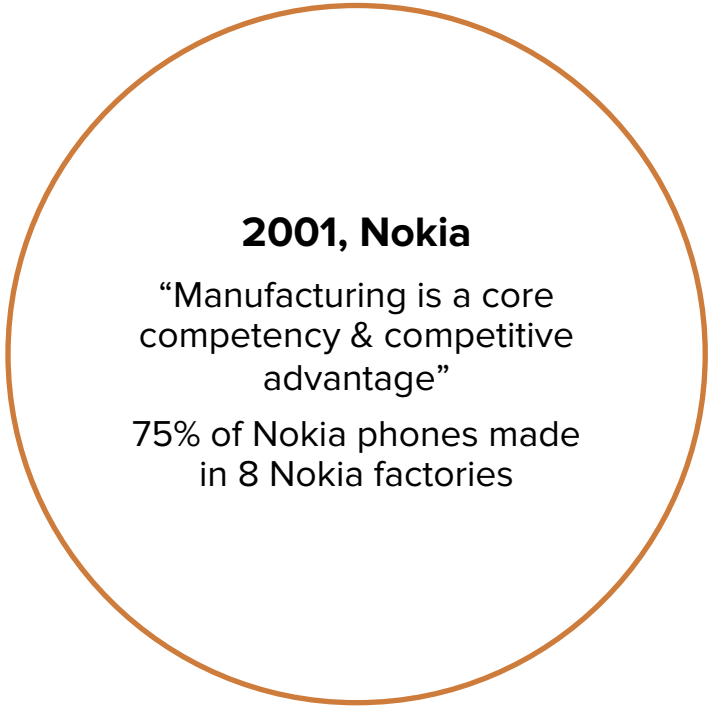
Scale, design, distribution remain, for those who can navigate the change

But value moves to software - entirely new skill set

And then with autonomy, new layers of value built on top

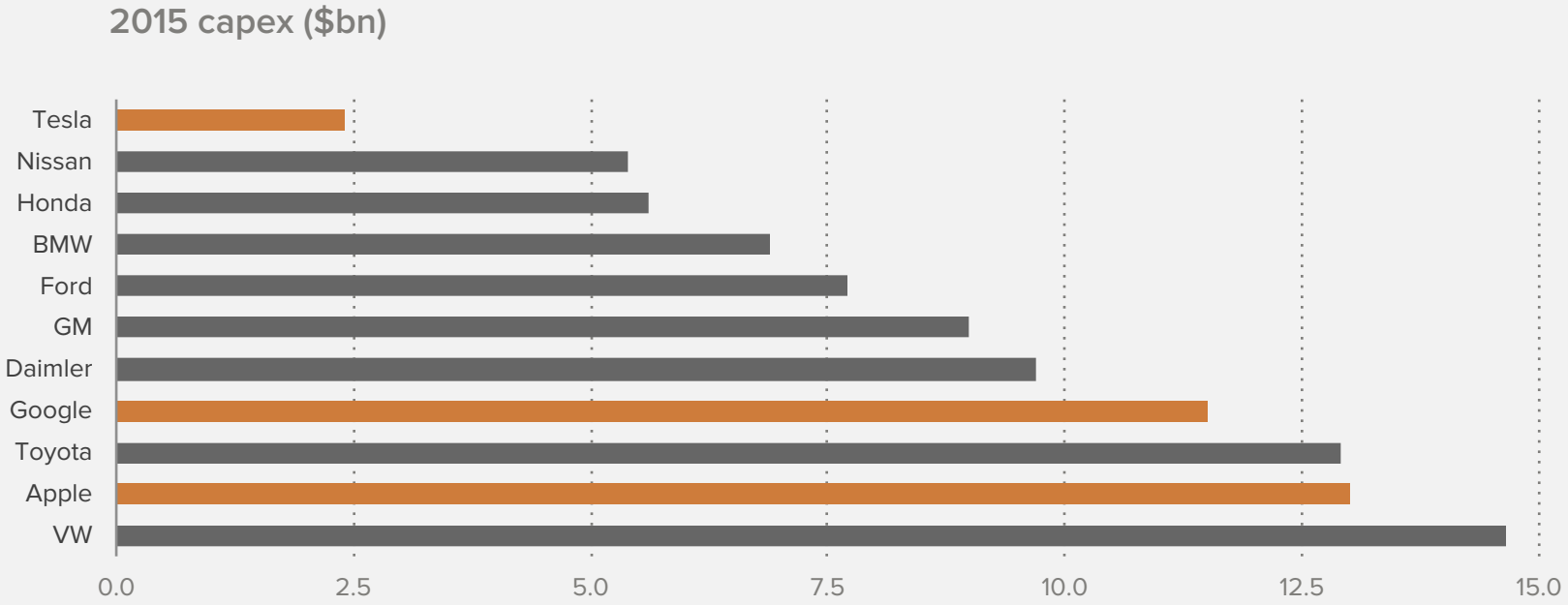
Precedent – unbundling phones

Once, you had to have co-invented GSM to make phones. Now, all components unbundled



(Unfair but relevant – capex scale)

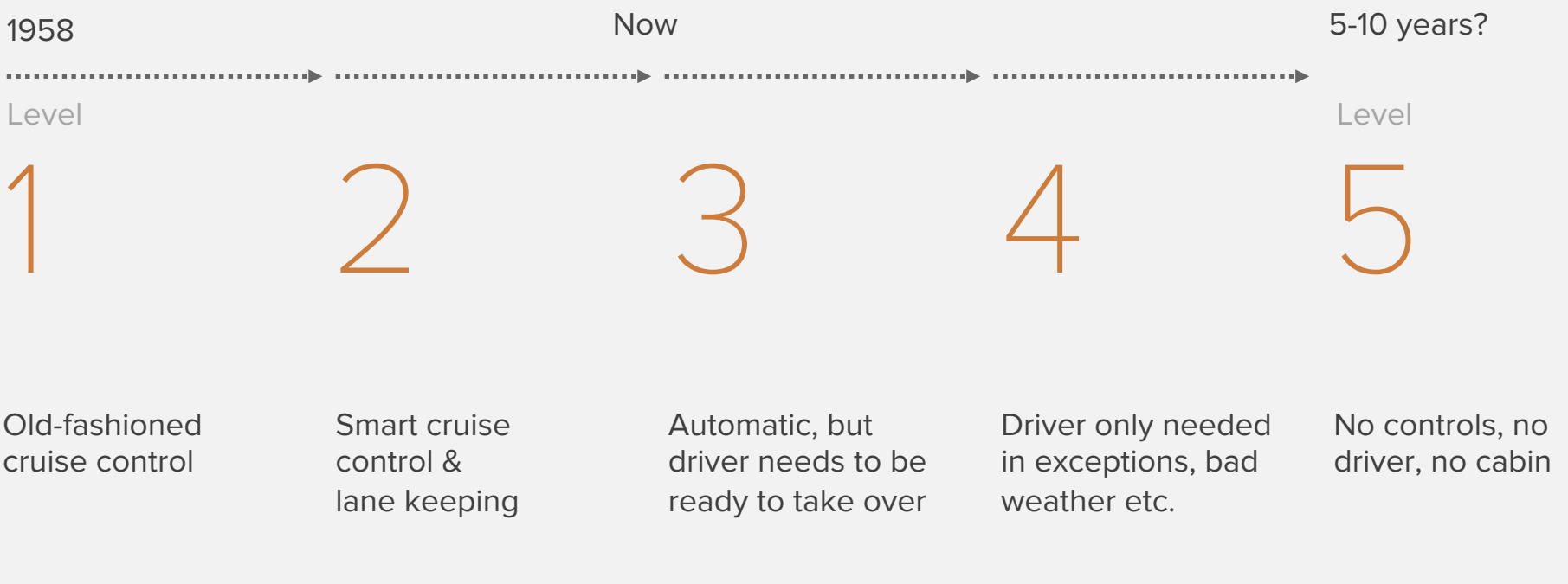
Leading tech companies now spend as much on capex as car OEMs
Apple has $237bn gross cash, while Google has $73bn



Source: Bloomberg

Meanwhile, progress to autonomy

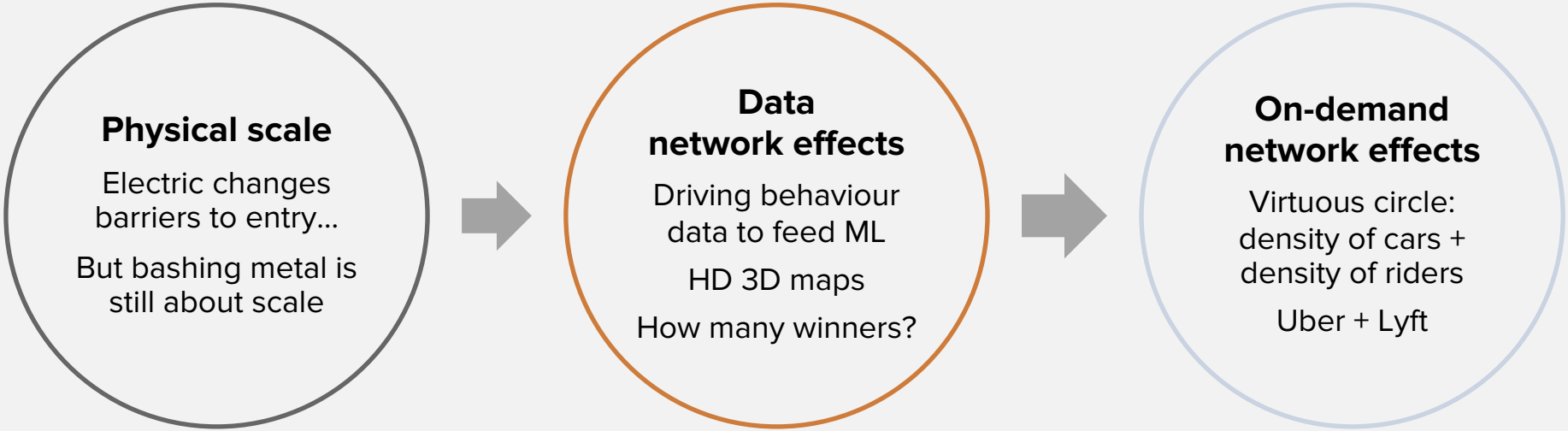
Steady, incremental progress, solving one tech challenge at a time



Source: VDA, a16z

Where is the competitive moat in cars?

Once batteries and sensors are commodities, where are the strategic levers? Still lots of unanswered questions



Self-driving car = horseless carriage

First, we make the tech fit the old patterns.

Then, we change to take advantage of what's new.

And removing the driver changes even more than removing the horses.

Source: Daimler

The obvious impact: oil and safety

It’s easy to talk about the obvious impacts of electric and autonomy…

But the second-order effects will be much bigger

Electric changes the whole car ecosystem

Service & repair with 10x fewer moving parts

Machine tools

Power generation & storage

Half of oil production

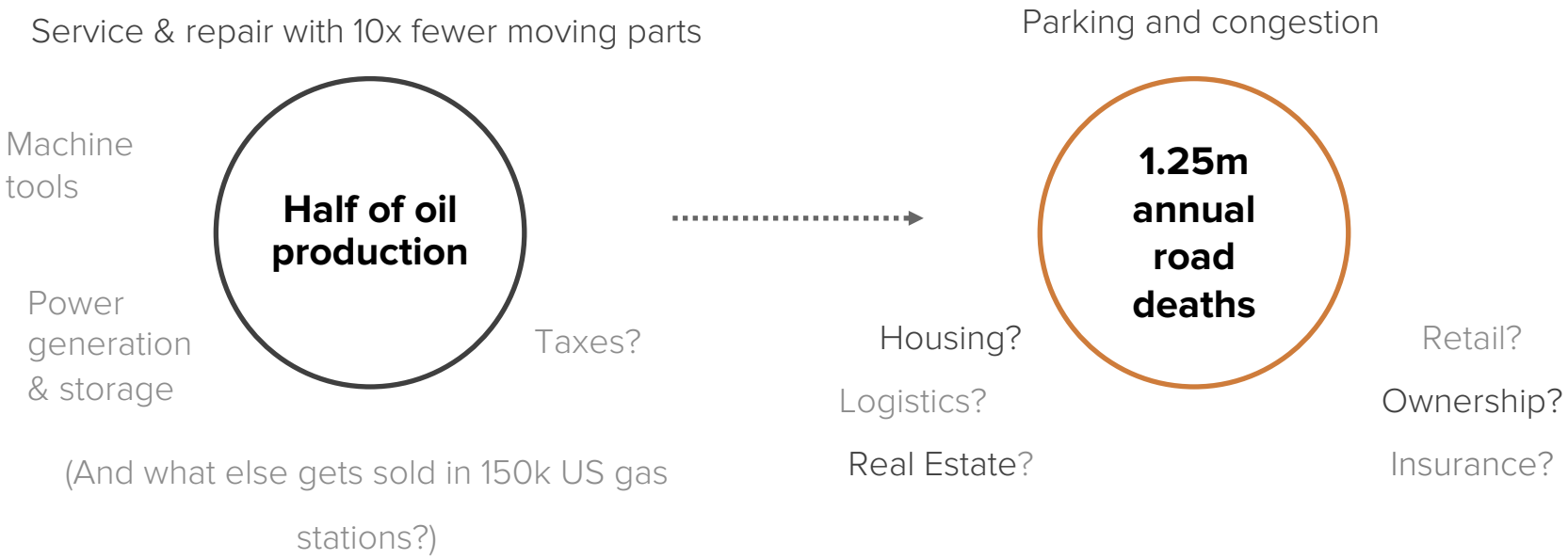
Taxes?

1.25m annual road deaths

(And what else gets sold in 150k US gas stations?)

But the second-order effects will be much bigger

Electric changes the whole car ecosystem - autonomy changes what cars and cities are



… And the biggest changes are unknowable

“Going to the opera in the year 2000”

Source: Albert Robida

Thank you

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