

Who Will Prevail:

**“The Dinosaurs” (Automotive OEMs),
“The Upstarts” (Tech Companies),
or Both?**

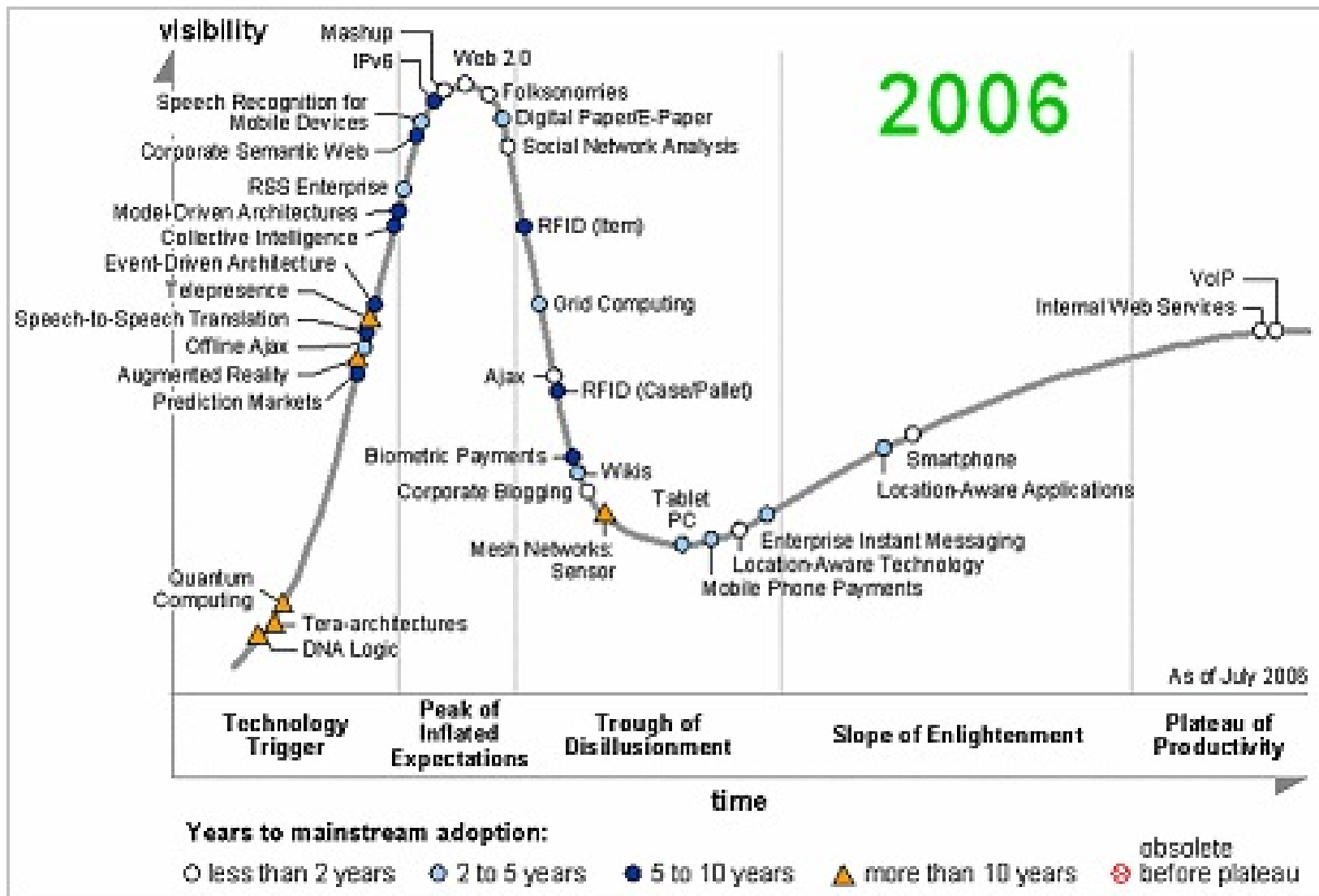
**Connected Truck, Connected Car Conference
June 2, 2017**

John Paul MacDuffie
Management Department and
Director, Program on Vehicle and Mobility Innovation

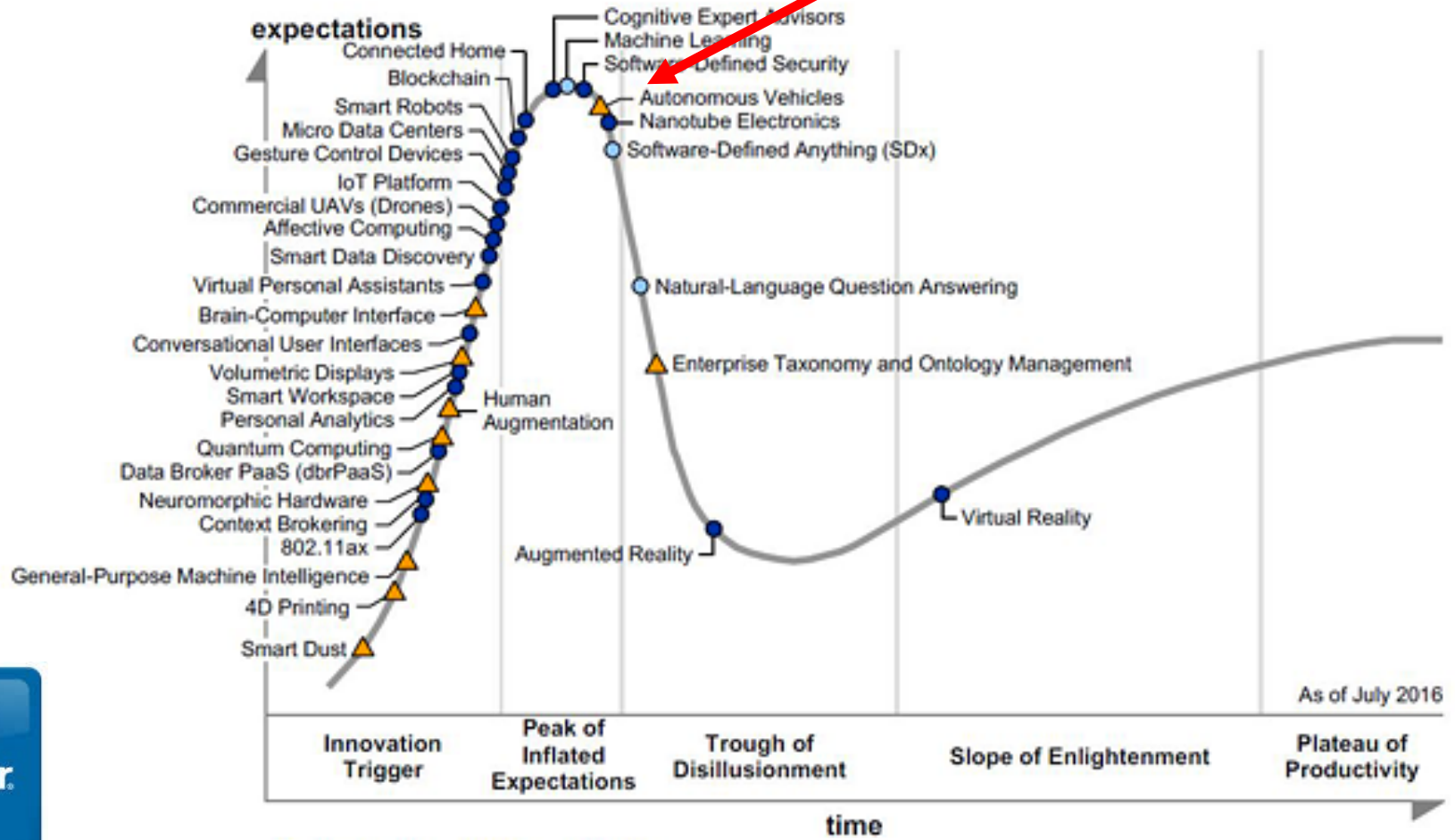


Although just ten years ago, Autonomous Vehicles (AV) not noticed much...

Not yet on the Gartner hype cycle



...by 2016, AV are beyond the hype cycle peak!



It may well be a time of disruptive change...

- Electric vehicles mark first fundamental change in automotive dominant design in nearly 100 years
- “Connected car” (aka “computer on wheels”) creates “third place” potential for “rolling office”, “mobile living room”, gateway to infotainment (but also a target for hackers...)
- Autonomous vehicles promise to reduce deaths, remake transportation services, change urban design, eliminate jobs, provide mobility to disabled and elderly
- Ride-hailing firms (eg Uber, Lyft) replace ownership with “usage” in scalable “asset-light” strategy that dooms incumbent taxis -- but could be transformative if coupled with self-driving cars
- All provide opening for new entrants from tech sector, race for dominance but also opportunities to collaborate



... yet in this industry, the existing structure will shape and slow the direction & pace of change

- 88.1 million vehicles sold worldwide in 2016; 0.78 million were electric vehicles (0.86%), none were fully connected cars or fully autonomous vehicles
- Automakers (aka Original Equipment Manufacturers, or OEMs) still dominate due to system integration role and being required to meet societal goals and expectations
- Complex, multi-technology product (5,000-10,000 parts) supported by complex multi-tiered global supply chain
- Stable dominant design (since 1920s) and primarily integral product architecture (vs. modular)
- New entrants, if they are actually designing/building vehicles, must master (most) current OEM capabilities



Taka Fujimoto and I have written earlier about the OEMs... do we still believe it?

Why Dinosaurs Will Keep Ruling the Auto Industry

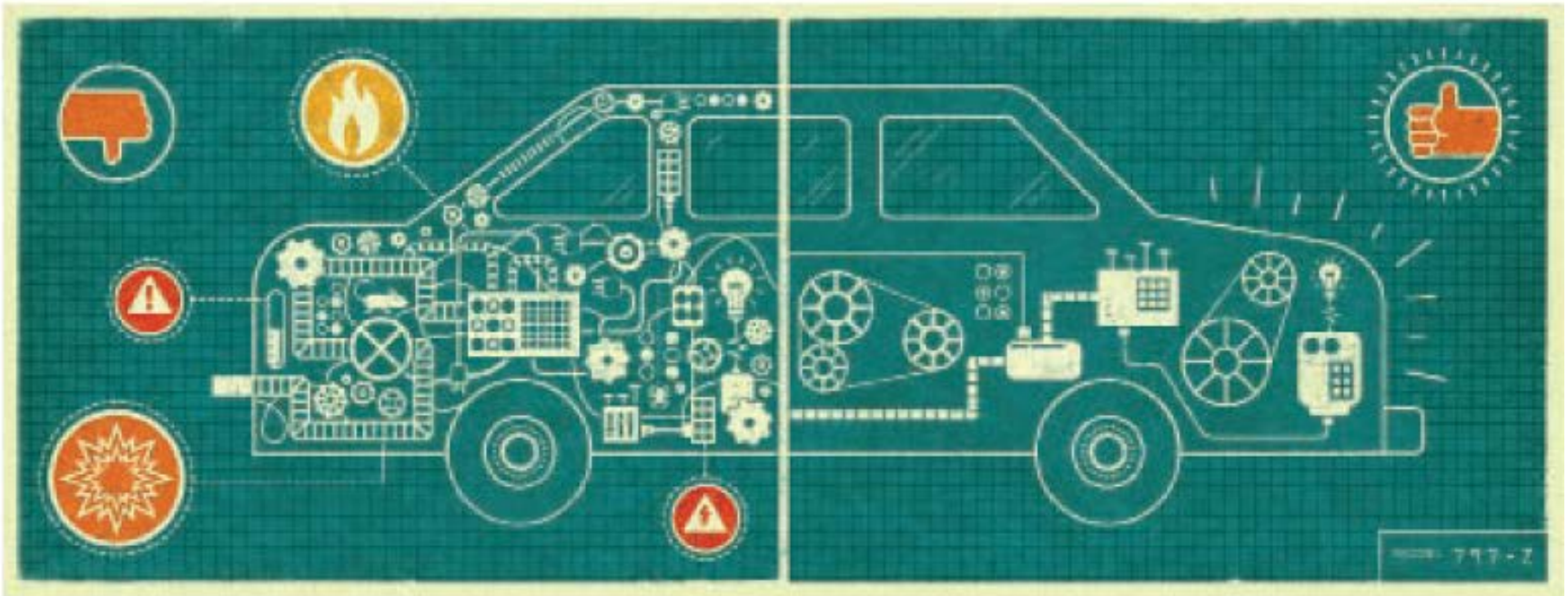
Get ready for the complexity revolution. *by John Paul MacDuffie and Takahiro Fujimoto*

Concluding paragraph:

Many strategists think that new entrants are ready to reinvent the industry. They see the automakers that dominated the twentieth century as dinosaurs: large, slow, and facing extinction. But this is one industry in which the dinosaurs—at least those that can successfully wage war on complexity—are positioned to beat new challengers for at least the next few decades.



A Complex Product Becoming More Complex

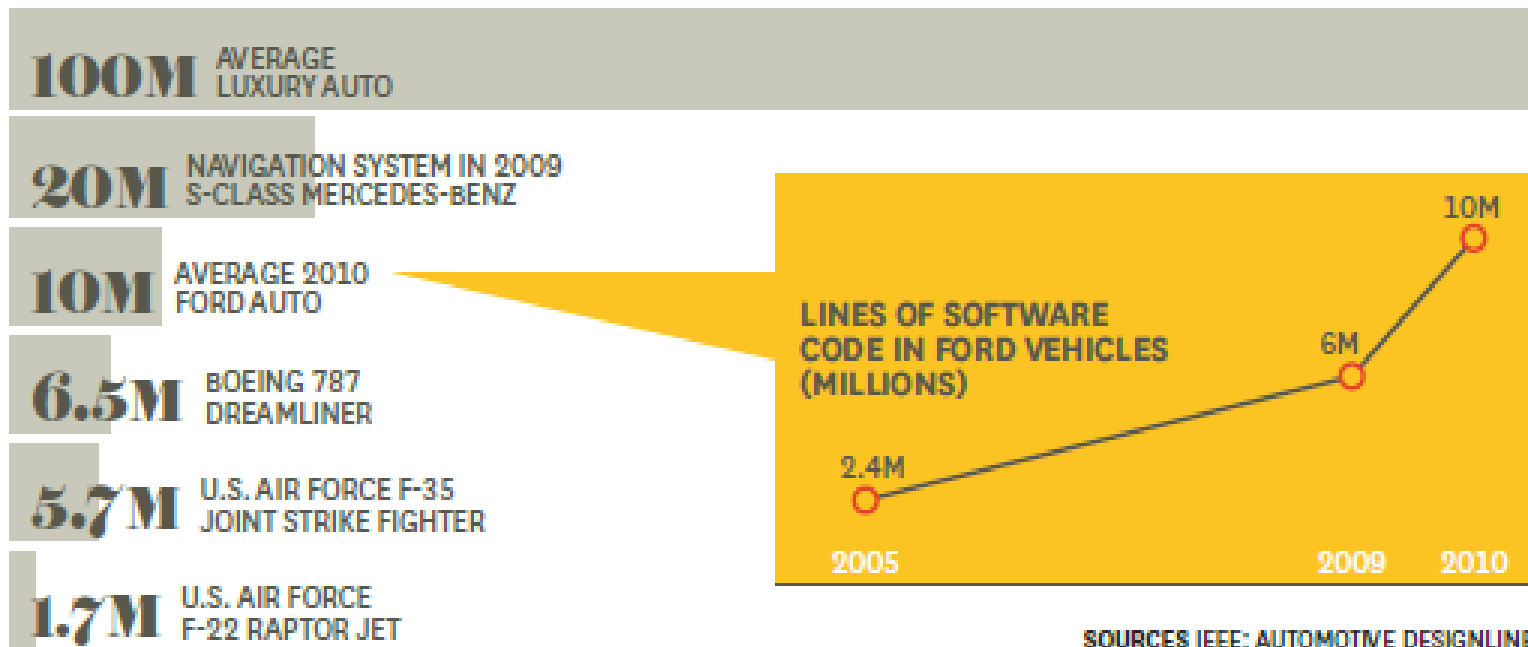


- Automotive “dominant design” hasn’t fundamentally changed in 100 years, but its complexity continues to rise
- Automobiles, as heavy, fast-moving objects operating in public space, face ever higher regulatory & consumer demands
- New technologies are only increasing this complexity

Software proliferation is one source of complexity

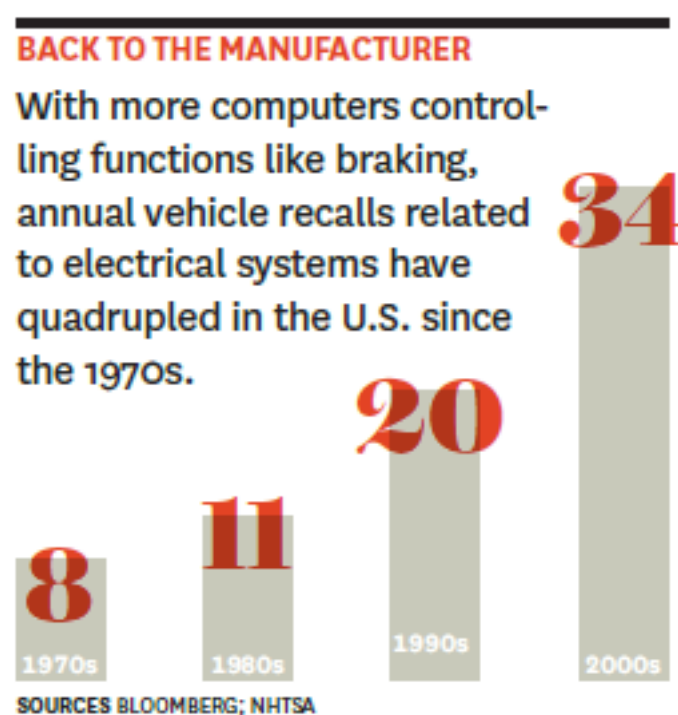
MORE COMPLEX THAN A FIGHTER JET

Safety regulations and consumer demand for performance and convenience have led to an exponential spike in cars' software complexity.



SOURCES IEEE; AUTOMOTIVE DESIGNLINE

Increases in Vehicle Recalls: Many Causes, Including Dramatic Increases in Complexity



- Recalls arise from intersection of technological and market drivers of complexity plus heightened regulatory standards and monitoring
- Still, vehicle reliability and safety are *increasing* at the same time as number of recalls surges higher

Context for “Dinosaurs Will Keep Ruling”

1. Structural Features of Auto Industry (*slow to change*)
2. Evolutionary Changes in Auto Industry (*moderate speed*)
3. Disruptive Technological Changes (*fast pace*)
4. Dilemmas of Competition and Collaboration Amid Disruptive Technological Change



Structural Features of Auto Industry (slow to change)

- Primarily integral (vs. modular) architecture
- Strong and persistent system integrator (SI) role for OEMs; OEMs need to “know more than they make”
- SI role bolstered by OEM desire for control of supply chain but also OEM’s regulatory responsibility and legal liability
- OEMs as SI pursue knowledge of all relevant technologies via massive R&D budgets, dwarfing supplier investments
- Strong preference for industry-specific standards (vs. open standards) and within-industry (vs. cross-industry) alliances
- System integrator capability is the fundamental basis of OEM competitiveness (and it can be gained in different ways)



Evolutionary Changes in Auto Industry (moderate speed)

- From vertically-integrated to reliance on suppliers (first manufacturing, then product design, then innovation) or alliance partners
- From internal combustion engine (ICE) only to portfolio of drive trains
- From electro-mechanical to digital & electro-chemical technologies
- From highly integral product architectures to (somewhat) more modularity
- From “know more than you make” vis-à-vis system integrator (SI) role to needing collaboration to gain access to technological expertise
- From hierarchically-controlled supply chains and within-industry alliances to cross-industry collaborations and acquisitions of tech startups
- From competition among OEMs (and OEM + its supply chain) to competition among ecosystems (and ecosystem strategies)
- From stable business model to challenges from new mobility and usage (rather than ownership) business models



Organizational Spectrum of Innovation Platforms

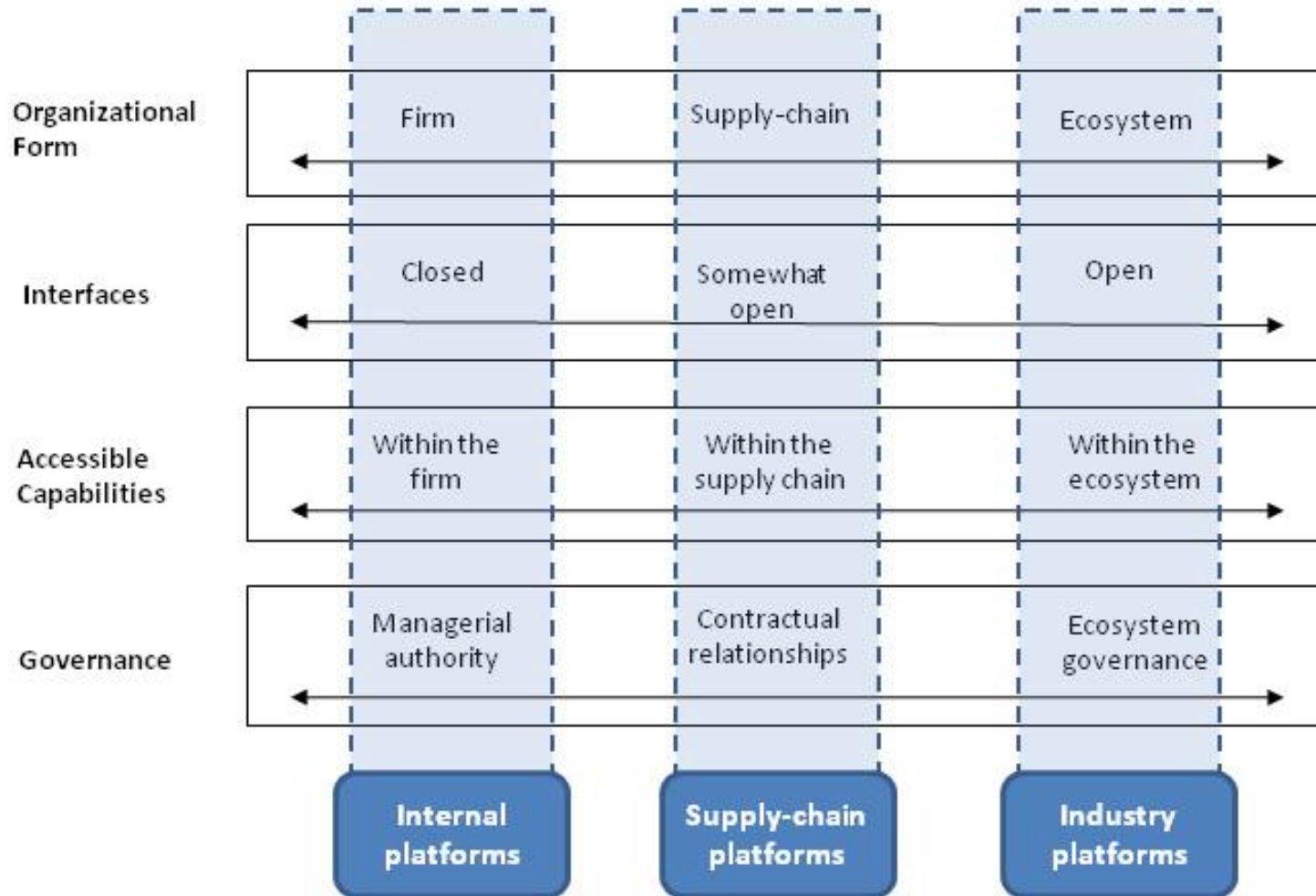


Fig. 1. The organizational continuum of technological platforms.



Disruptive Technologies/Concepts (fast pace)

- New drive trains (advanced ICE, HEV, PHEV, BEV, fuel cell) and new fuel sources (electricity, hydrogen, ethanol, biodiesel)
- “Connected car” – intra-vehicle networks (from industry-proprietary to open standards, e.g. Ethernet); vehicle-to-vehicle (V2V); vehicle-to-infrastructure (V2I); new infotainment services
- Autonomous vehicle (AV) – “driver assist” (Levels 1 & 2) to “primary vehicle control” (Level 3) to “full vehicle control” (Level 4)
- New mobility business models based on asset sharing (car-sharing/ride-sharing) that threaten to reduce vehicle ownership

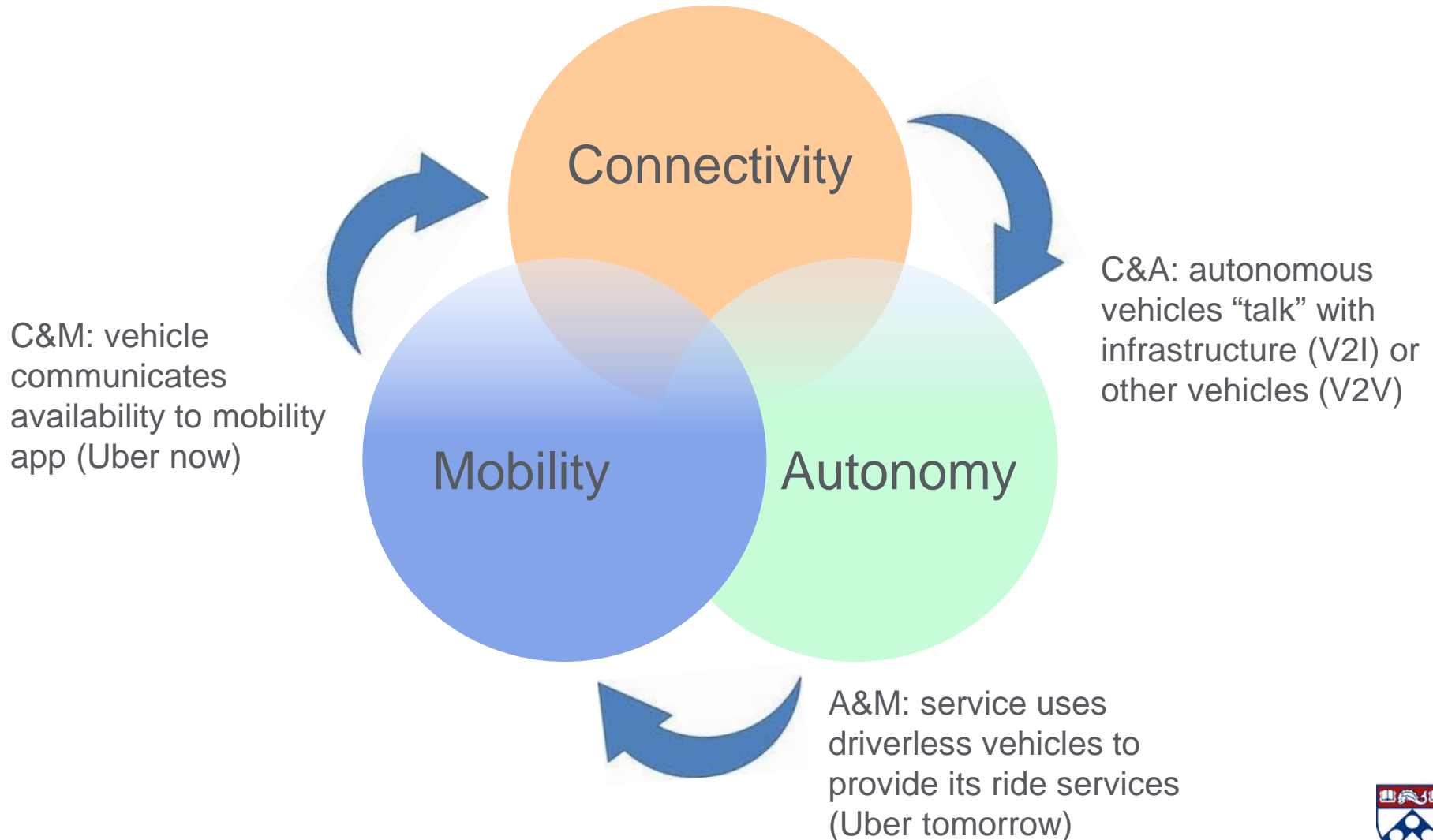


If each disruptive change arrived separately, OEMs could cope (as they have in the past)

- Given past investments in R&D, OEMs hold the majority of patents related to EVs, autonomous vehicles, etc.
- OEMs hire new technical talent to gain expertise in new technologies, e.g. chemical engineers to understand batteries
- OEMs also acquire to gain expertise, e.g. in software development, sensors, mapping, related to new features
- OEMs form alliances with each other to share the massive costs of developing new technologies and draw on supplier expertise
- BUT... new entrants and tech firms may have the advantage in making big leaps to new concepts and business models



Connectivity, Autonomy, and Mobility: Changing fast and increasingly inter-related



Dilemmas of Competition and Collaboration (from Incumbents' POV)

- We don't have mastery of all relevant technologies any more
- We have to rely on suppliers for innovations within technologies that we don't understand so well
- We can't count on hiring the necessary technical talent (or doing it fast enough or making the right acquisitions or retaining talent we hire/acquire)
- We can't get where we want simply by partnering with other OEMs, we have to collaborate with firms outside the industry
- With slow progress for our within-industry closed standard-setting efforts, we have to work on open standards – under processes we can't control
- We need to work with tech firms that believe “we can disrupt anything”, see us as slow and conservative, and want control of the data
- Our competitors make investments, establish alliances, acquire startups amid high uncertainty about technical change, and we have to respond
- Amid these developments, we face limits to our “collaborative capacity”



While partnerships among OEMs are common, new collaborations cross industry boundaries

Among OEMs:

GM-BMW-Mercedes on hybrid drive trains (*dissolved 2009*)

Honda-GM on fuel cells; also BMW-Toyota

Renault-Nissan joint vehicle development (also w/ Daimler, Mitsubishi)

Across Industries:

Nissan with NASA (AV); Sony/Konami (in-car game controller);
Microsoft (cloud-based telematics)

Mobileye-Intel-BMW on autonomous vehicle standards (*then Intel buys Mobileye*)

Ford-Google-Uber-Lyft-Volvo for autonomous vehicle regulation

Fiat Chrysler-Google – puts Google's AV tech into 100 Pacifica's

Uber-Volvo-Pittsburgh – test AV taxi service in a difficult-to-map city

Google-GM-Honda-Ford-Uber-Hyundai in patent protection alliance



The Driver Interface Challenge: Ford's Recent Moves (1)



- Ford Sync
 - Infotainment interface developed with Microsoft (MyFordTouch)
 - Acquisition of Livio for link to outside apps (SmartDevice Link platform)
 - Many problems with MyFordTouch – lower JD Power scores, bad press
 - Microsoft dropped (continued role in cloud support for software updates)
 - Sync 3.0 switches to QNX (from Blackberry) OS w/ Panasonic as integrator
 - Toyota agrees to adopt Ford's App Link (next gen SDL, fully open-source)
 - Sync 3.0 will ship with integration of Android Auto, Apple Car Play plus apps for Spotify, Pandora in all 2017 Ford models
- This example combines so many trends!
 - Partners outside auto industry (and changing those partners)
 - Acquisition of tech firm (Livio) for its platform software
 - Open source for new App Link; developing it with a competitor
 - Accepting that consumers want to use apps on their phone



The Organizational and Collaborative Challenge: Ford's Recent Moves (2)



- Ford sets up Ford Smart Mobility LLC as separate subsidiary “to design, build, grow and invest in new mobility services” (April 2016)
 - “We want to disrupt ourselves.... We needed to give them the flexibility and the operating structure to be competitive with other technology and mobility services companies that move really fast.” (former CEO Mark Fields, April 7, 2016)
- Ford, Uber, Google, Lyft, Volvo set up alliance to push for federal guidelines to speed the transition to autonomous vehicles (April 2016)
 - “Self-Driving Coalition for Safer Streets” has former NHTSA head Anthony Strickland as its chief counsel and spokesperson
 - “The best path ... is to have one clear set of federal standards.” (Strickland)
- Ford explains why its efforts to partner with Google and Uber failed (former CEO Mark Fields, May 31, 2016)
 - “What we want from anybody that we partner with is: One, an equal amount of benefit that each company can bring to the party. The dynamics get very funky very quickly if somebody thinks they're getting screwed.”
 - “And two: Cultural fit, because you’re going to be working with these folks. Beyond what the spreadsheet says, you’ve got to make sure there's cultural fit.”



The Strategic Positioning Challenge: Ford's Recent Moves (3)



- Ford (August 2016) announcement: Fully autonomous car launched in 2021
 - No steering wheel or other controls for a driver.
 - Will first prioritize commercial fleet applications, e.g. urban ride-sharing services
 - Prior steps: Investment in Pivotal (software to speed Ford's app development); testing 30 Ford Fusions at M-Place (testing ground at U. Michigan)
 - Makes big investment (along with Baidu) in Velodyne for Lidar technology (current cost per unit = \$8000; aiming for high volume @ \$500/each)
 - Also investing in Pivotal, Civil Maps (high-resolution 3D mapping)
 - Acquisition of SAIPS (Israeli firm doing machine learning software)
 - Exclusive licensing agreement with Nirenberg Neuroscience ("virtual retina")
 - Doubling size and staff at its Silicon Valley office
- "We abandoned the stepping-stone approach of driver-assist technologies and decided we'd take the full leap to deliver a fully autonomous level four-capable vehicle," R&D head Raj Nair said. "It's safer to develop a system that can be in control 100 percent of the time."



Ford's Raj Nair on what is needed to be a successful autonomous vehicle company

Five things:

- Large-scale manufacturing capabilities to build a flock of cars
- A virtual driver platform that routes a travel plan
- Autonomous technology that allows the car to drive
- A team to safely redesign cars to accommodate self-driving technology
- A way of managing vehicle servicing

Previously Executive Vice President, Product Development, and Chief Technical Officer (CTO). Now Executive Vice President and President of North America, Ford Motor Company



Questions Hovering Over Our Earlier Prediction

- Will a struggle over access/control of data limit the potential for collaboration between auto & tech sectors?
- Slow move of OEMs towards participating in developing open standards – better to join or to block?
- Regulatory role shifting towards more facilitative of coordinated change? Or new stage of adversarial relationship after flood of recalls (and VW deception)?
- Proliferation of partnerships between auto and tech firms driven by need to share costs and access knowledge & talent; will this exceed collaborative capacity of OEMs?
- Ecosystems go beyond firms to include policymakers and governments; what common goals can advance change?

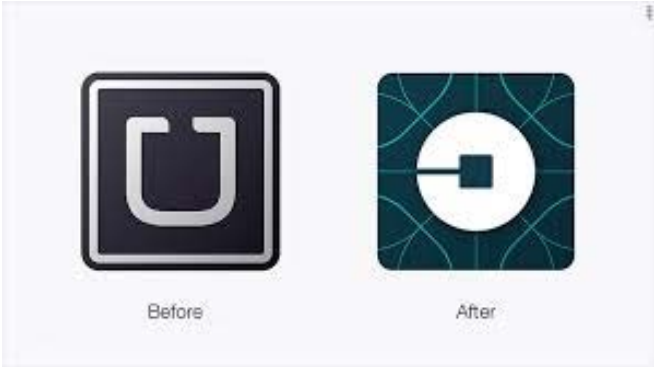


The Tech Upstarts Have Many Advantages

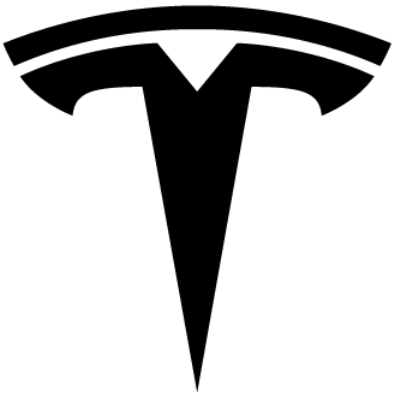
1. Vast amounts of money
2. Ability to attract talent (see #1)
3. Proven track record in successfully monetizing data
4. Strong software capabilities – plus some in HW/SW integration
5. Fresh look at old problems, more alert to new problems,
6. Believe that they can succeed in “winner take all” battle



But Each Prominent Upstart Has Challenges Too



WAYMO



TESLA



What about Tesla? Views Differ Widely

◆ Those who are impressed:

- First new OEM in many years, highly vertically integrated. Tesla had to master design, manufacturing, supply chain, distribution.
- Strong brand, high consumer enthusiasm and loyalty, high quality, has sold over 180,000 vehicles since 2012
- Innovative in changing the retail experience; remote software updates; free (super)charging infrastructure for owners only
- Valuations higher than GM and Ford!!

◆ Those who are skeptical:

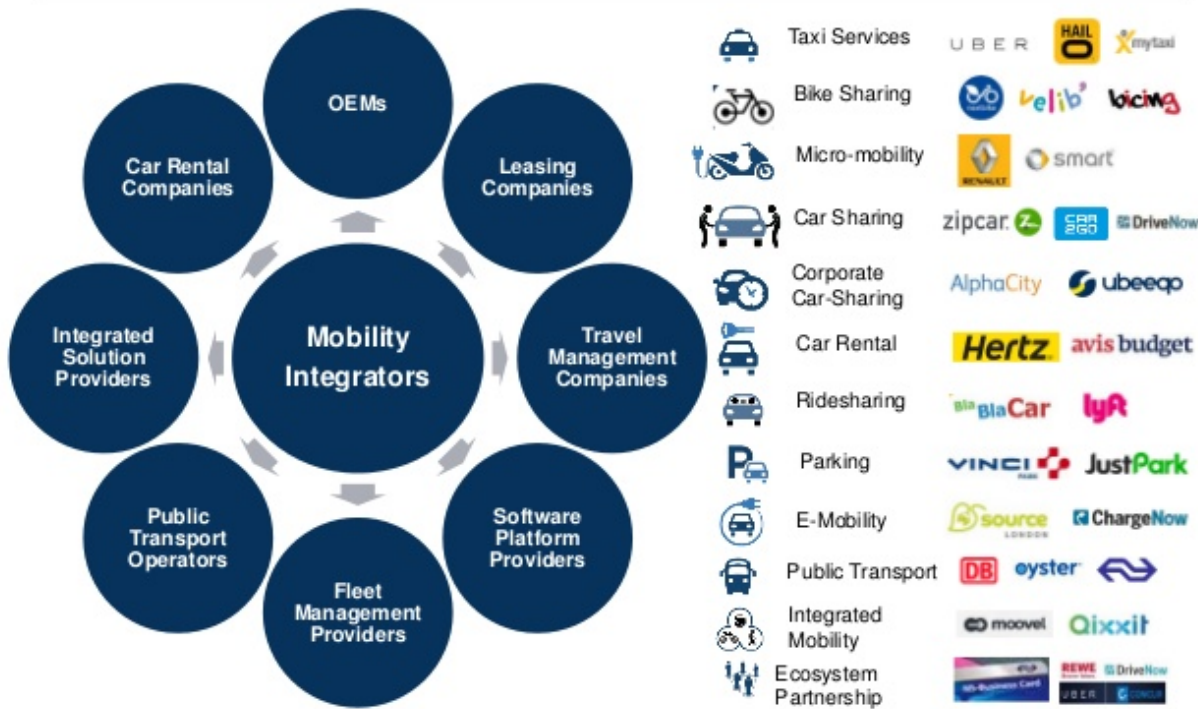
- High-priced luxury models (ARPU of \$79K vs. \$53K for Mercedes, \$48K for BMW), dependent on wealthy customers (\$300K for Model S; \$505K for Model X owners)
- Tesla benefits from selling credits for low-emission vehicles to other OEMs (more benefit from credits than subsidies of individual purchases)
- Despite getting 400,000 people to put down \$1000 on Model 3, Tesla has yet to prove that it can make a mass-market vehicle at scale
- Efforts to remove, completely, human labor from auto assembly have always failed; will this time be different?



Mobility Service Ideas Are Numerous, But Are They PROFITABLE?

Mobility Landscape – Many Players, New Partnerships, New Models

In both B2C and B2B environments customers are demanding intuitive services; many actors investing significantly in order to deliver the 'killer' seamless proposition & user experience.



FROST & SULLIVAN

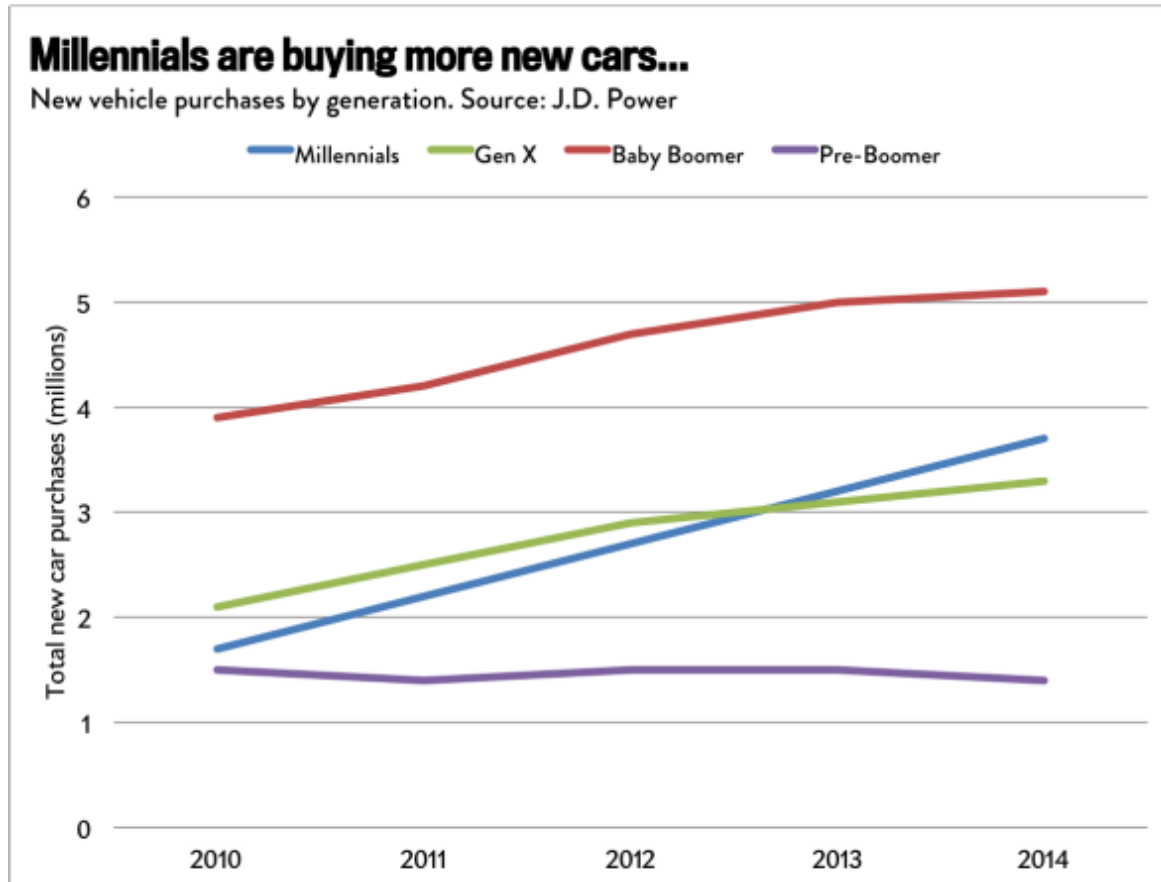
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- ◆ Uber is losing money
- ◆ Lyft is losing money
- ◆ Sidecar is gone...

So far the biggest gains achieved vis-a-vis regulated taxi business. Is this really a winner-take-all market?

Already evidence that millennials not *so* different in car owning behavior...

Millennials Aren't Rejecting Vehicle Ownership....



... they are simply delaying it! (even more true in 2016)

Uber and Autonomous Vehicles: What Will Happen to “Asset Light”?

Who will own the autonomous vehicles that Uber hopes, one day, to deploy?



Who is skilled at owning and operating fleets of expensive physical assets that are intensively utilized, hence require maintenance, retrofits, and replacement?

Can Waymo “Win It All” with First-Class Auto OS?

Challenge #1: Finding a partner to make vehicles for a well-integrated HW/SW package that can bid to become industry standard

→ *strongest potential partners may be most reluctant to sign on*

Challenge #2: Winning in a race to be dominant OS

→ *this is hard, e.g. Windows vs. Apple OS; Android vs. iOS)*

Challenge #3: Gaining monopoly position through regulatory mandate

→ *FAA analogy vis-à-vis value of interoperability and safety suggests “Yes”; user heterogeneity and politics suggest “No”*

Without being the dominant auto OS with quasi-monopoly position, how can Waymo possibly reach valuations of \$70-140B?

Will Apple Have the Patience to Master Vehicle Design and Supply Chain and Contract Manufacturing??

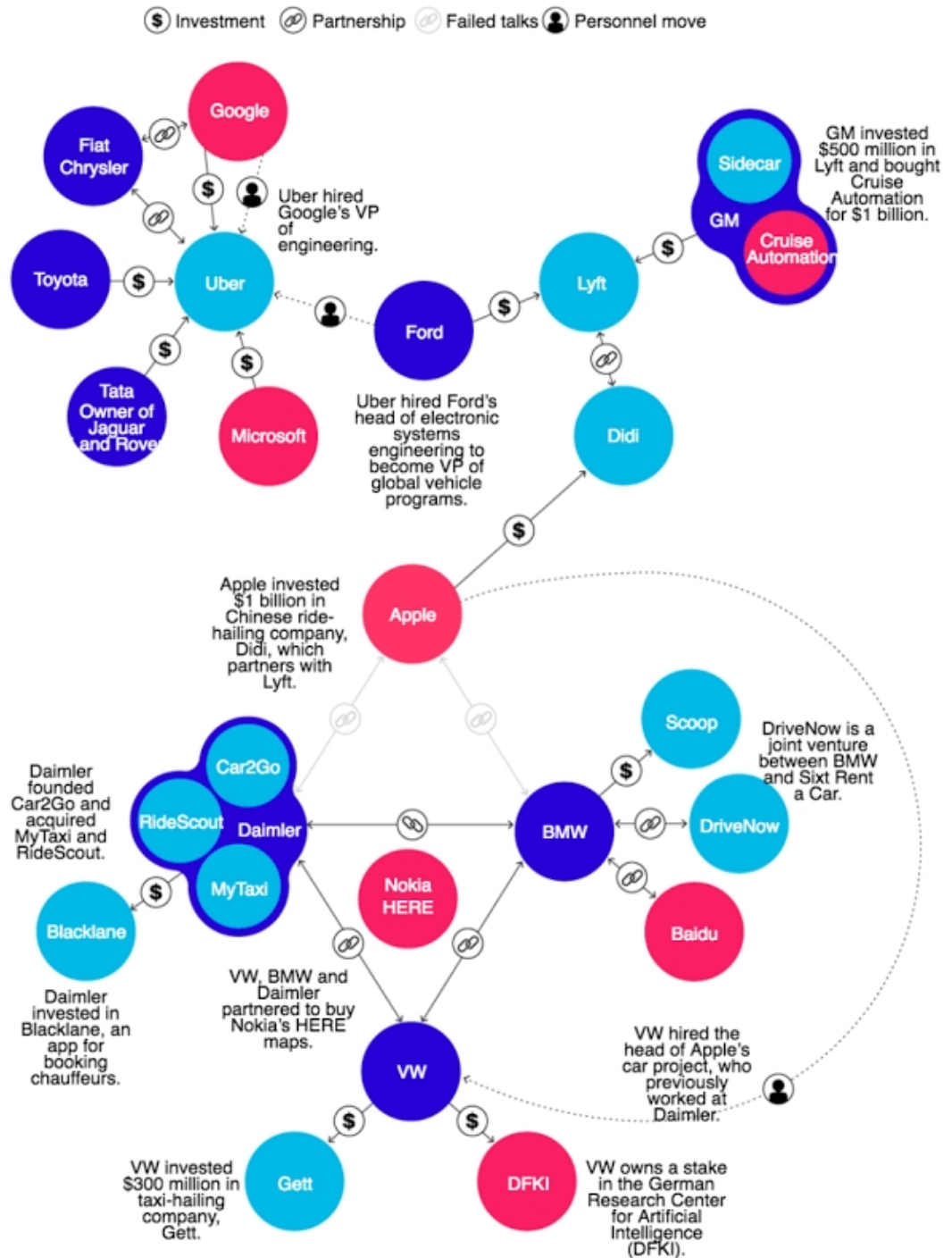
- As Tesla has learned, mastering all the stages (*from design through manufacturing, retailing, after-market*) is **hard**
- Quasi-vertical integration is still the best way to learn the system integrator role in autos
- Contract manufacturing in autos has been decreasing, not increasing
- Identity and pride: BMW will **not** be Foxconn for AppleCar



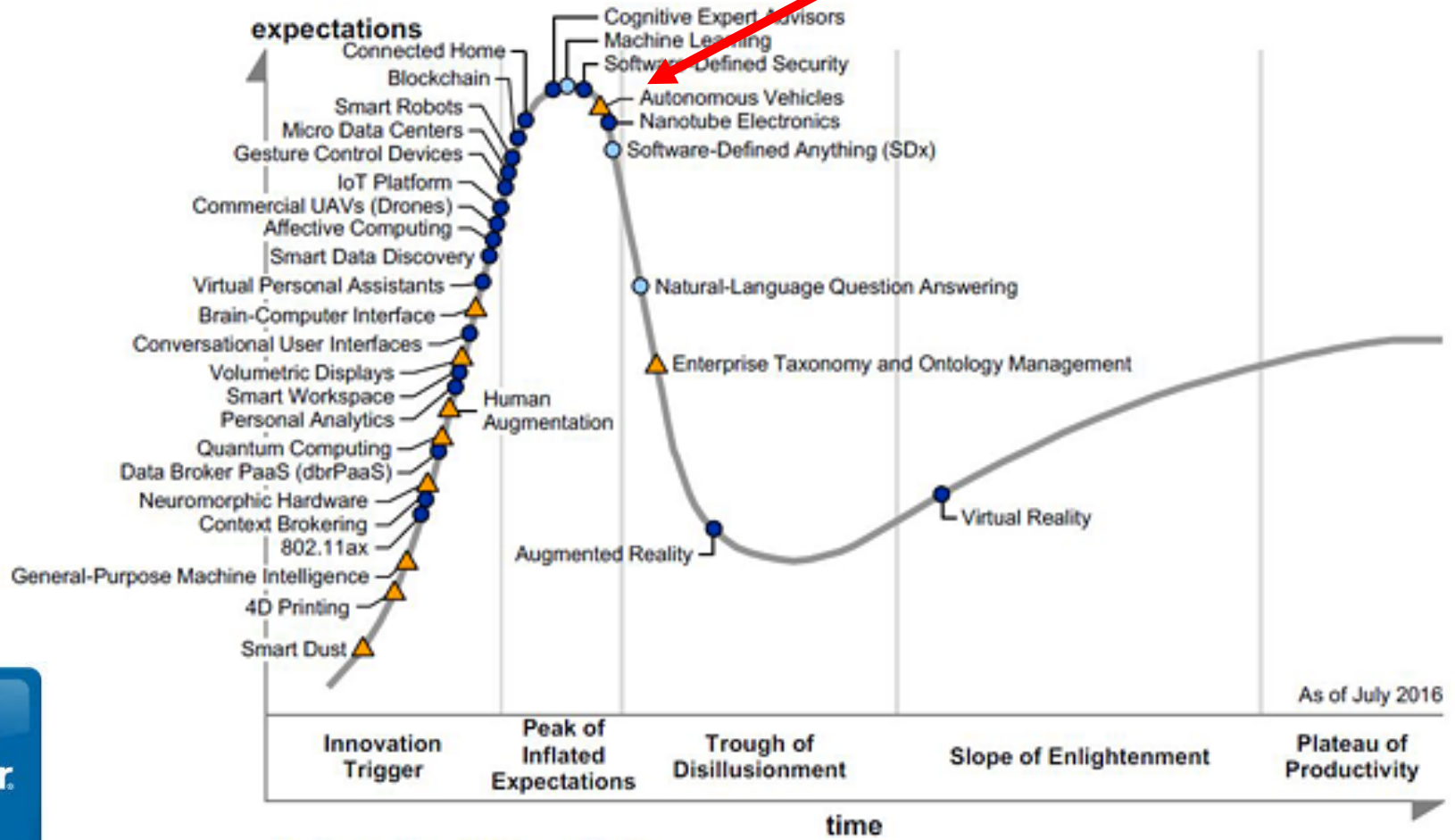
Maybe This Will Be a Battle of Coalitions Within Ecosystems

BTW, scratch that Google/Uber link... and draw in Google/Lyft

Google/Lyft/GM /Honda vs. Coalition B? (OS/RS/OEM/ Service Provider)



...by 2016, AV are beyond the hype cycle peak!



Four Main Obstacles to Progress in the Hype Cycle

Performance - Technology's performance improvement is slower than hoped/expected (e.g. EV batteries)

Ecosystem - Even when technology's core performance reached satisfactory level, its value creation is limited by other elements in the ecosystem (e.g. working out liability for AVs)

Adoption Barriers - Technology's difficulty of use and limited benefits (e.g. user interface to connect drivers to needed/wanted services)

Business Case - Even if all of the three obstacles are overcome, the economics of the technology may not result in a viable business proposition wrt Breakeven/ROI (e.g. mobility services if no winner)

Rate of progress is slowest for technologies facing fundamental challenges with respect to science and engineering, such as speech recognition, virtual reality, personalized medicine (Level 3 automation as infeasible engineering task?)



SUMMARY

- We tend to think in terms of “winners” and “losers”. Hence:
 - Pace of change will be fast if the tech upstarts win
 - Pace of change will be slow if the auto OEMs win
- What if the opposite (and somewhat circular) logic holds?
 - If pace of change is slow, auto OEMs are advantaged
 - If pace of change is fast, tech upstarts are advantaged
- Tremendous complexity and uncertainty around the factors affecting pace of change
 - Progress of the technology
 - Whether humans are compliant or rebellious vis-à-vis algorithms
 - What society will ask of these “heavy fast-moving objects operating in public space”

