Covid, Climate, China, Connectivity and Consolidation: How 2020 Changed the Evolution of Autonomous Vehicles and What That Means for Local Government Planning and Financing of CAV Projects in the US

MWCOG Travel Forecasting Subcommittee (TFS)
January 15th , 2021

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DNA Data Solutions LLC

About the Connected and Autonomous Vehicle 101 National Roadshow for Counties, Satellite Cities and Small Towns...

- Began with Smart Cities Task Force with the APA - ICMA
- Not just big cities – also "Micropolitan" satellite cities, towns and rural communities
- Planners, City Managers, Engineers and EDCs want basic “101” education
- Roadshow – (Phoenix, Yuma, Orlando, Lincoln, Baton Rouge, Louisville, Sarasota, Pinal County, Austin, Maryland)
- Corridor Economies
- 5 hours CM Certification

Today's Discussion

Baseline for CAV Development: How CAVs Have Evolved

What Changed in 2020:

- China
- Connectivity
- Climate
- Consolidation
- Covid

What it means for US Local Authorities

- Infrastructure
- Financing

Q&A: 15 Minutes

Key Take-Aways for Today…

- 2020 was a tumultuous year for CAVs: Marks the **End of Phase 1** of Connected and Autonomous Vehicle Development
- Realizing that privately-owned self-driving cars are only a small part of what is becoming **a fundamental digital upgrade in transportation** occurring around the world
- Advances in **cellular technology** mean the AV Economy is shifting from self-driving cars to connected vehicles
- From 2021, **climate change legislation** (the EU, China and probably the Biden Administration) will put paid to the internal combustion engine
- **China has become a big player in CAV technologies** and implementation
- **Covid Pandemic** has dramatically affected attitudes toward public transportation and travel generally – we don't yet know the long-term effect
- You may see some infrastructure money from the Feds, but **how and when you invest in CAV infrastructure is down to your local government**

Autonomous Vehicles 1.0: 2020 Hindsight…

Popular focus is primarily on **privately-owned, self-driving cars** (“Uncle Bob buying a Tesla…”)

Today Autonomous Vehicle technologies seen by the public and press as futuristic novelty, limited in application, and really not all that important…

That’s because pre-2020:

- Transportation marketplace was behind in the evolution to the **Digital Economy**
- Autonomous Vehicle development **driven by technology giants**
- AVs basically the **normal vehicle with AI** (ADAS Plus)
- **Auto manufacturers** reluctantly being dragged into the fray

The Transition from the Oil-based/Analog Economy to an Electric/Digital Economy

"What's Good for General Motors is Good for America…"

1960: Cars and Oil

Rank	Company	Revenues ($ millions)	Profits ($ millions)
1	General Motors	11,233.1	873.1
2	Exxon Mobil	7,910.7	629.8
3	Ford Motor	5,356.9	451.4
4	General Electric	4,349.5	280.2
5	U.S. Steel	3,643.0	254.6
6	Mobil	3,092.9	164.0
7	Gulf Oil	2,713.0	290.5
8	Texaco	2,678.0	354.3
9	Chrysler	2,643.0	-5.4
10	Esmark	2,475.5	19.1

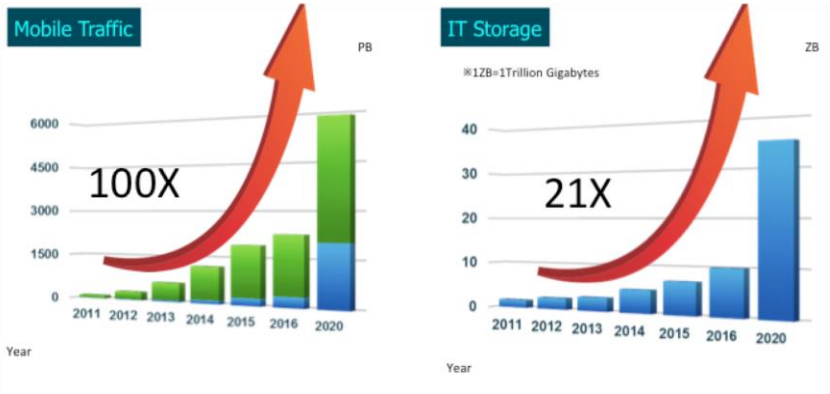
2006: Oil and Energy

2020: Big Data, the Cloud and Online Retailing

	Brand	Category
1	amazon	Retail
2		Technology
3	Google	Technology
4	Microsoft	Technology
5	VISA	Payments
6	facebook	Technology
7	Alibaba Group	Retail
8	Tencent 腾讯	Technology
9	McDonald's	Fast Food
10	AT&T	Telecom Providers

At the Heart of the Transition to the Digital Economy is Big Data…

- Massive **Data Collection**
- Complex **Trend Analysis**
- AI and **Machine Learning**
- Targeted **Advertising and Monetizing Data**



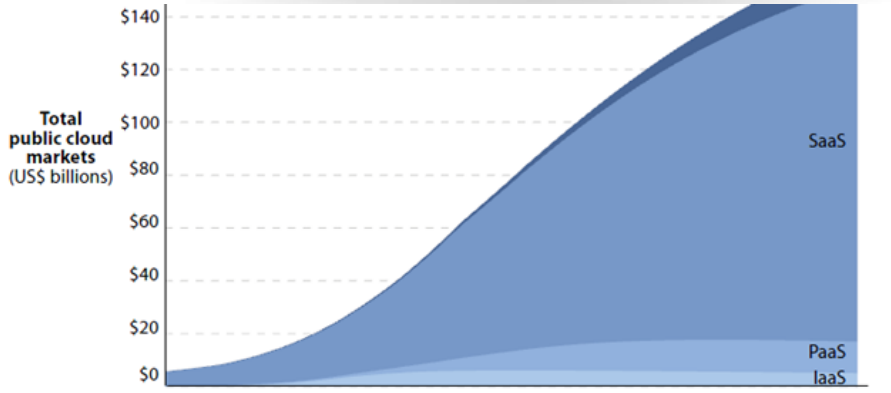
Moore's Law - Computing power doubles every two years

Quantum Computing - Processing capacity ***now increasing at 5 times that pace…***

All that Data is Going to the Cloud…

Data Storage and the Cloud: Biggest growth area in economy: **1/3 of overall IT infrastructure spending for the year**

- Amazon Web Services (between 3 and 5 million servers)
- Apple iCloud (300 million people store files)
- Microsoft OneDrive (250 million)
- Google Drive (120 million)



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BPaaS ($)	0.15	0.23	0.35	0.53	0.80	1.26	1.95	2.93	4.28	6.00	7.66	9.08	10.02
SaaS ($)	5.56	8.09	13.40	21.21	33.09	47.22	63.19	78.43	92.75	105.49	116.39	125.52	132.57
PaaS ($)	0.05	0.12	0.31	0.82	2.08	4.38	7.39	9.80	11.26	11.94	12.15	12.10	11.91

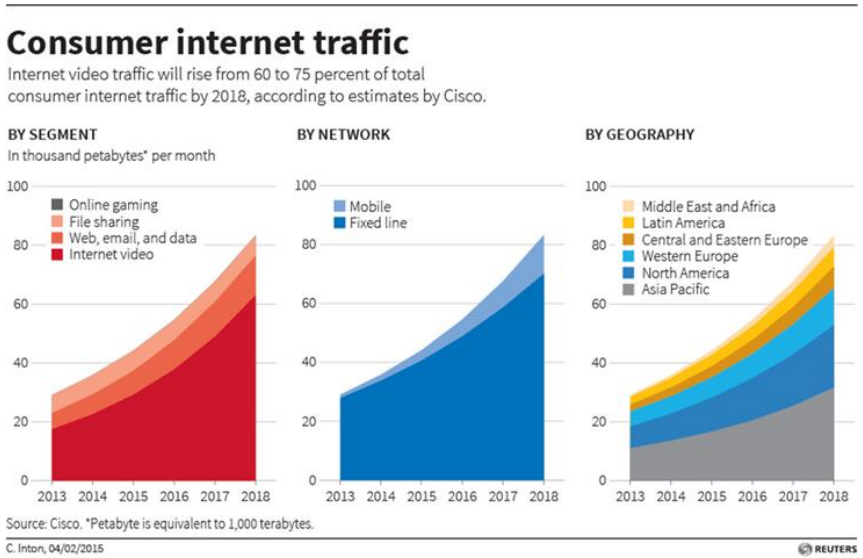
Online Shopping, the IoT and Home Delivery are All About Big Data and the Cloud – *Covid-19 has Accelerated That Trend…*

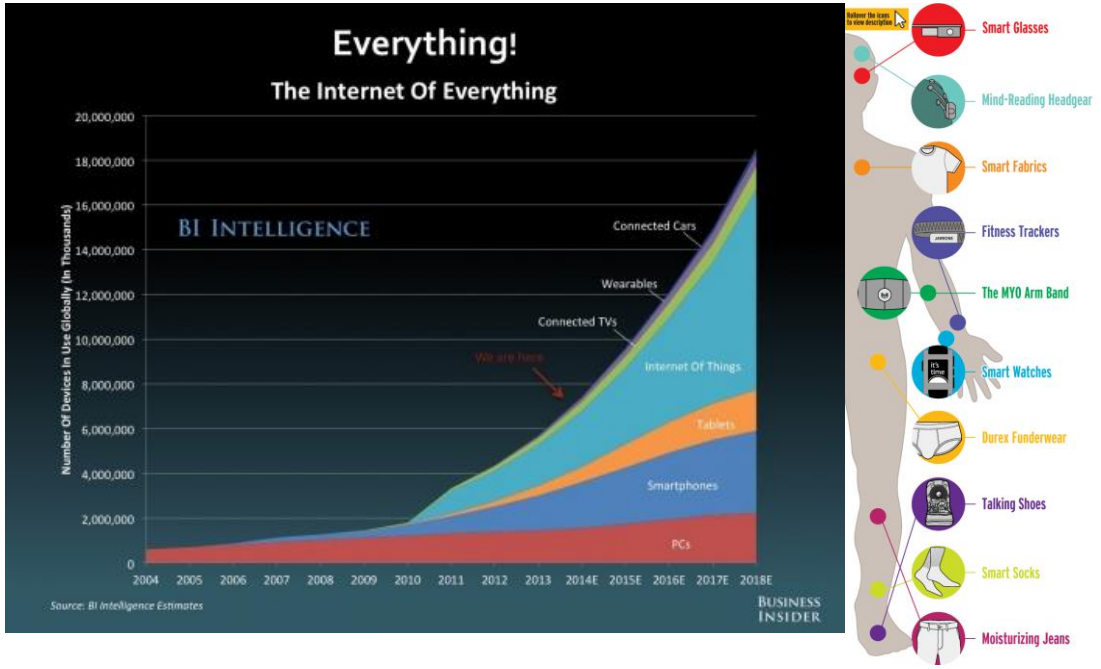
- **Working from Home: Platform-based Applications**
- Wearables, **health monitoring and tele-medicine**
- The **connected home**

Online advertising and **shopping** is**…**

- **Driving the Expansion of the Cloud**
- **Data Monetizing Everything**
- **Creating a Home Delivery Economy** (Amazon, Wal-Mart, Grocery, UPS, FedEx)

In 2019, the IoT network had **14.2bn** devices (Gartner) - by 2025 the network will grow to **41.6bn** (IDC)…





The New Economic Powerhouses in the Digital Economy…

"Surveillance Capitalism": profit from collecting user data and applying predictive analytics…

IT and Big Data (Google, Amazon, IBM, Microsoft, Cisco, Intel, Huawei, Baidu, Tencent)

Online Retail (Apple, Amazon, Google, Wal-Mart, Alibaba)

Data-focused Advertising (Google, Amazon, everyone else…)

Telecoms and Communications (Huawei, AT&T, Cisco, Intel, Verizon – and around the world)

- ***Earnings***
- ***Valuations***
- ***Jobs***
- ***Economic and Political Clout***...

	Brand	Category
1	amazon	Retail
2		Technology
3	Google	Technology
4	Microsoft	Technology
5	VISA	Payments
6	facebook	Technology
7	Alibaba Group	Retail
8	Tencent 腾讯	Technology
9	McDonald's	Fast Food
10	AT&T	Telecom Providers

This is the business focus (*not safety or consumer demand*) that is ***driving CAV development***...

A Lucrative Digital Platform for the Future…

Seven of the ten most valuable companies globally are now based on a **Digital Platform Business Model**:

- The creation of **digital communities and marketplaces around a technology platform**
- **Big Data** and the **Cloud**
- **Internet of Things**
- The value of the firm is driven by thousands **of supporting apps (bring in the innovation and $)**
- **First-mover advantage/winner often takes all** (Google, Amazon, Facebook, Apple)
- From **Local Single-sale to "Pay-as-you-go" in the Cloud**

The ability to **stay connected to your product (and customer) after sale**

Transforms a product into a service (more a license to operate than traditional ownership…User Agreements, can't repair, invalid if you don't update, etc.)

Sw and hw improvements guarantee **rapid turnover - planned obsolescence**

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Transportation Awakens to a Digital Takeover…

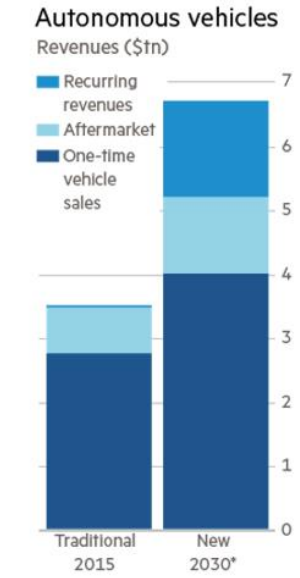
If it were a country, the auto industry would be **the world's sixth-largest economy…**

Transportation affects everyone: Individual, family and government expenditures (19% median household income spent on just 1 car)

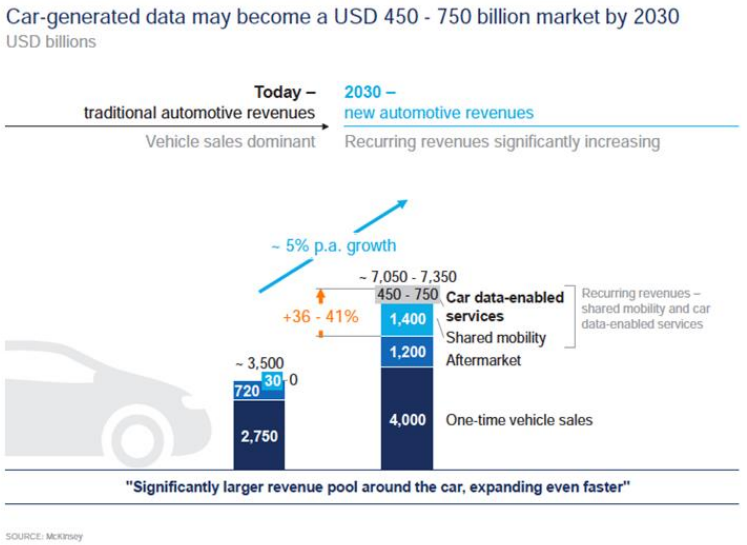
*– and has largely been **left out of the digital revolution***

The Promise of Connected and Autonomous Vehicles:

- Leverages **5G** and is **Edge and Cloud** dependent
- Taps into the profitability of **Big Data collection**: safety and marketable data on drivers'/riders' interests and driving habits
- Makes transportation an extension of **Smartphone and the Internet of Things - digitally connected driving system**
- Framework for continuous and targeted **digital advertising and online shopping**: (Americans travel by car an average of six hours a week)
- Taps into/mitigates the success/threat of **ride-hailing and car sharing**
- Supports the **shift to electric** and gets away from emissions issues
- Captures greater portion of "Aftermarket" and can be made a more profitable **"Pay-as-you-go" service offering**
- Have **global (sales and competition)** potential
- Attracts huge **external investments**



FT graphic Sources: McKinsey; Morgan Stanley; Bernstein



High Tech Start-ups: Waymo

- **Waymo (Alphabet):** leading on miles driven autonomously and “disengagements”
- More than 600 autonomous vehicles driving over 25,000 miles a day
- “**Data value stream**” from **Android, Google Maps, Search, YouTube and the Play Store, Google Home smart speakers**
- Android-like operating system (Driver) **operates on any vehicle platform**
- Valued at $250bn (**more than Ford, GM, Fiat-Chrysler, Honda and Tesla combined**)
- Probably aiming for **fleets of robotaxis:**
  - **Buying 82,000** vehicles from **FCA** and **Jaguar Land Rover**
  - **Partnership** with **Renault, Nissan,** and **Mitsubishi** to co-develop autonomous passenger and delivery vehicles

Threatens to **relegate auto makers to supplier status...**

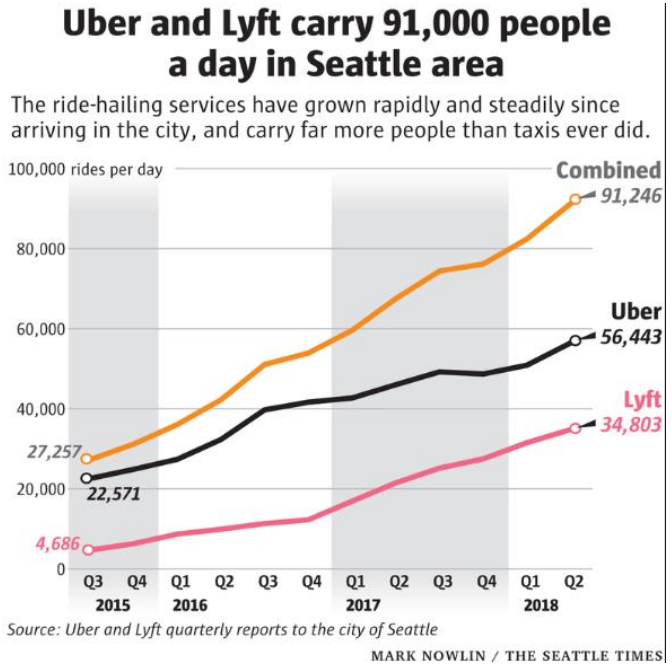
Uber: Ride-hailing and the Technology Networking Companies (TNCs)

Ride-hailing and Transportation-as-a-Service has hit the mass market – in single decade:

- 25+ million and 15+ million rides operated daily respectively by ride-hailing giants Didi and Uber
- More than half of Millennials (55%) use ride-hailing services

Global: Didi in China; Grab in Singapore, Ola in India

Digital Platform: Have a large pool of frequent users, capture a lot of personal (credit card and use) data, and have an integrated digital payment system



"We want Uber to be the operating system for your everyday life" - CEO Dara Khosrowshahi

Result: A High-tech Scramble for the AV Marketplace

Parts Suppliers:

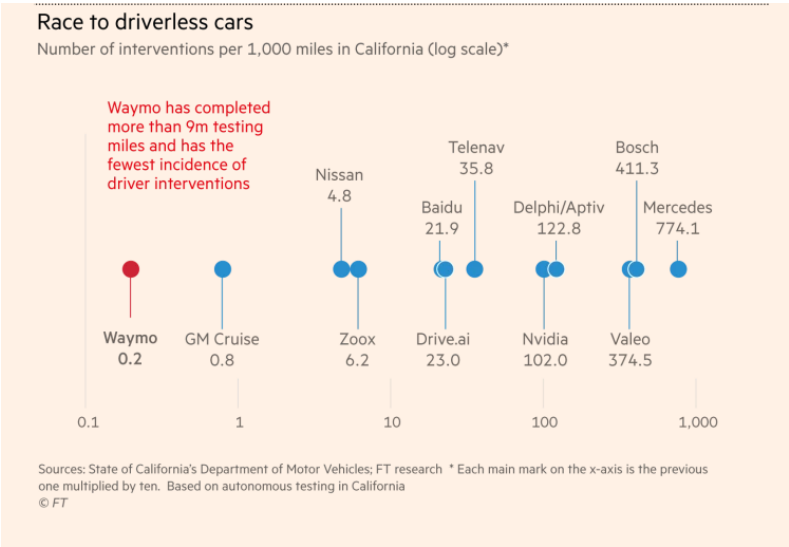
- **Aptiv (**formerly **Delphi Automotive**)
- **Valeo:** one of the largest global automotive part suppliers – full range of sensors and autonomous car – joined with **Baidu** to share **Apollo** platform

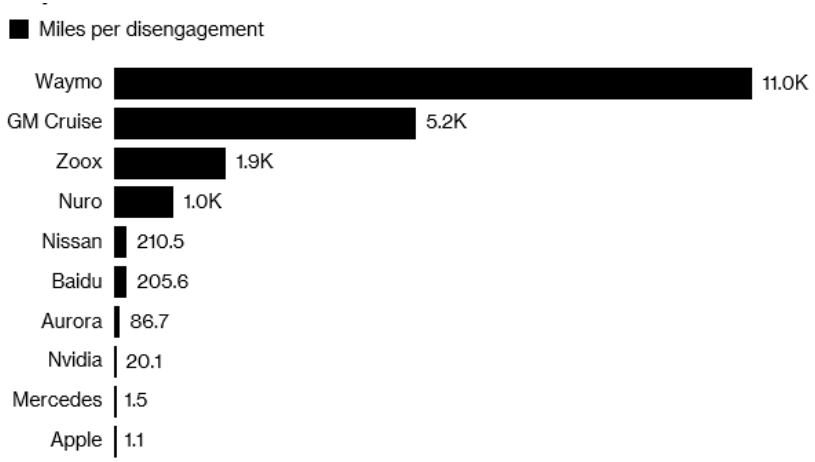
Chip Makers:

- **Intel**: Restructured in 2016 from a PC company to focus on the cloud - $250 million for autonomous driving business unit the Automated Driving Group (ADG) – acquired **Mobileye** in 2017 – working with **Volkswagen** and **Champion Motors** on mobility-as-a-service (MaaS)
- **Nvidia:** chipmaker – software and hardware platform for fully-autonomous vehicles on the road by 2022

Independent Start-ups, Online Platforms and others:

- **Zoox**: Independent start-ups raised $500m last year
- **Telenav**: Cloud software system monitors traffic and provides in-car advertising platform
- **Baidu: Apollo** – The "Android for AVs" open-source technology platform: sw tools (e.g., cloud-service platform, op system, algorithms, etc.) for companies to "build" their own AV system
- **Aurora**: Founded in 2016 by **ex-Tesla, Uber and Waymo** employees, integrates its sw and sensors with Fiat Chrysler, Hyundai





Source: Reports to California Department of Motor Vehicles
Note: Shows figures from 10 of the 48 companies that submitted information.

AutoSens Self Driving Track Days

The Build Up of Automated Vehicles

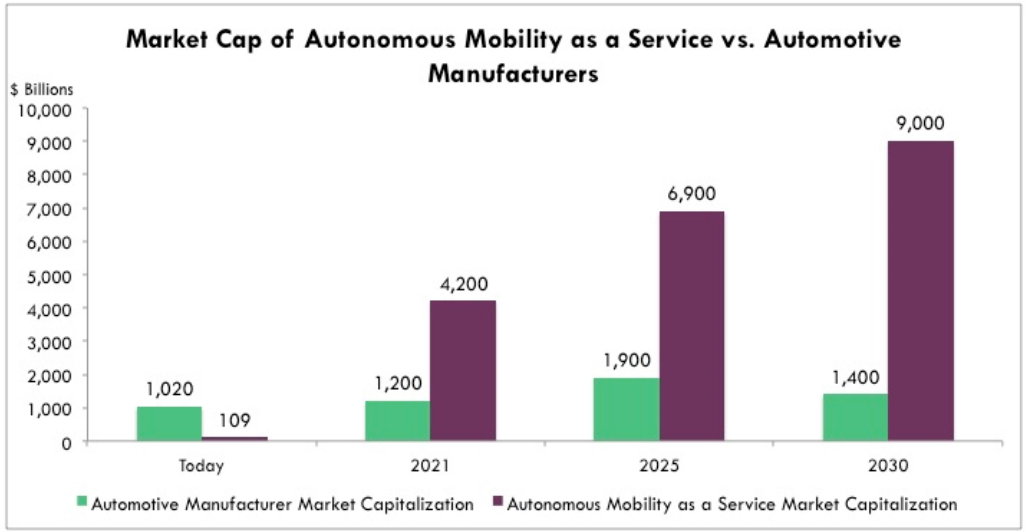
VSI Labs

AutoSens Conference (www.auto-sens.com)
Self Driving Track Days (www.selfdrivingtrackdays.com)

experiences.

Loads of Money: Investment Capital

- Bloomberg: Investment in CAV technology from 2013-17 was $4.4 billion
- In 2018:
  - 58 major deals
  - Around the world, AV startups secured $3.41 billion
  - **Softbank's Vision Fund**
    - $2.3bn investment in General Motors' self-driving car unit, **Cruise**, last May.
    - $940m investment into **Nuro.ai**
  - Autonomous driving start-up **Aurora** (founded by former Google engineers), investors including Sequoia Capital and Amazon, valued at more than $2bn
- In 2018 **Tesla** worth $11 billion more than **Ford**, even though Tesla delivered just 76,230 cars (in 2016) while Ford 6.65m
- **Uber's** $8.1 billion **IPO**



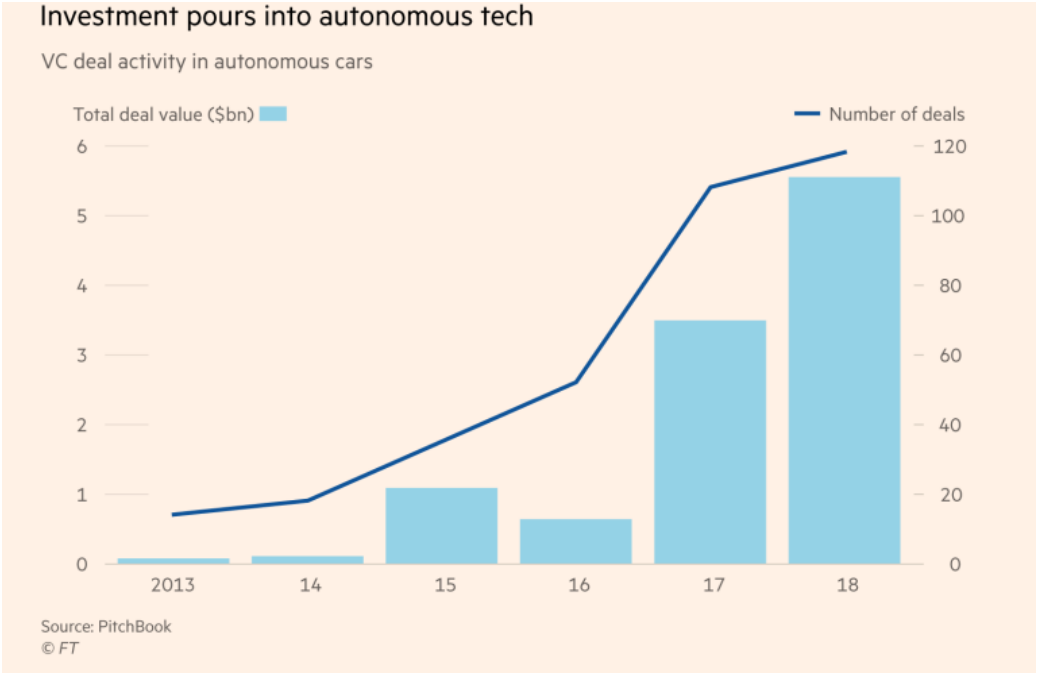
Source: ARK Investment Management LLC | ark-invest.com

Feb. 2020: GM's Cruise estimated the value of the global autonomous vehicle industry at $8 trillion

Shared and Autonomous is Where the Investment Money Is…

- In 2016 **GM bought Cruise** as their AV operation for $1bn – now valued at $19bn; attracted investment of $2.25bn from **SoftBank**

- **Tesla's** share price has doubled since October 2019, giving it a **market cap greater than Ford and General Motors combined**... (even though Tesla delivered just 367,200 cars in 2019, while Ford (2.4m) and GM (2.9m)



"Today the value of Cruise is underpinning the entire value of General Motors..." – Bain

A Scramble to Control the "Commanding Heights" of the Future Connected Digital Transportation Economy

Source: A.T. Kearney analysis

- Technology giants (Big Data, IoT and Cloud companies)
- Component Suppliers
- TNCs and Ridesharing groups
- Software, mapping and development technology
- Telecoms
- Retail stores (Amazon, Wal-Mart, Kroger)
- Data Storage and Management
- Advertising and advertising delivery
- Venture capital

Everyone wants this to happen: **except maybe the auto manufacturers** and the **consuming public**?

Before 2020: Crossing the Desert...

- Amounts to a **predatory attack by "New Money technology groups"** on the **traditional auto industry**
- **Forcing the auto industry into dramatic change** – to become part of the **digital economy**...
- **"Big Tech" companies** (e.g., Waymo, Alibaba, Huawei, etc.) dominated, because they have **more cash to burn on acquisitions than the automakers**
- Creating a **CAV "Arms Race" -** a question of **survival; adapt** or **become obsolete**
- Based on **AI technologies** and a **Digital Business Platform** that are tech company's core strength**…**

…Nobody is really sure if consumers **want or will pay for the technology –** or whether it will ever **earn a profit…**

"Everybody is worried about the next two to three years…We have the conditions for a perfect storm: lower demand, increasing R&D budgets, and [the potential of] fines…Everyone will be crossing the desert."

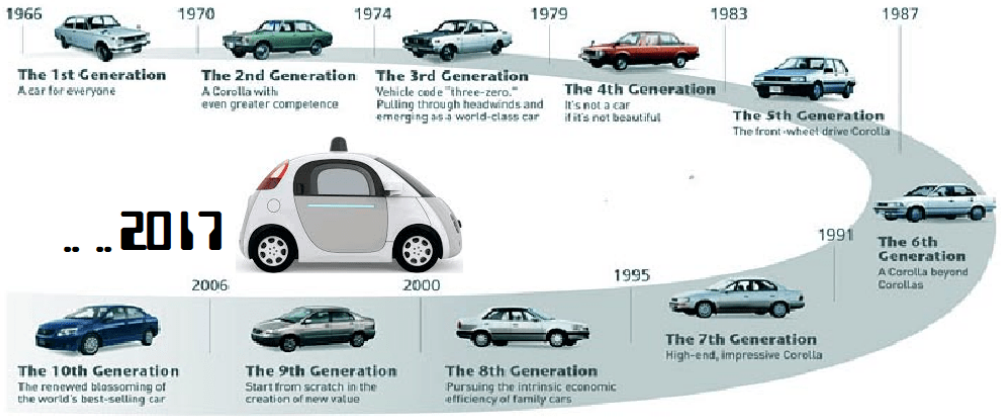
- Luca de Meo, CEO of VW's Seat brand.

Traditional Auto Makers: Catharsis and Restructuring

Profound Transformation

- From **privately-owned, ICE** to **electric, autonomous and on-demand**
- Economic cycle moving toward **"bust"**
- **Slowing demand** for vehicles: Aging population/young less likely to get license or initiate auto loans…

Bain: "US car sales could shrink from more than 17m [2018] to just 11.5m by 2025" — the same level seen in 2008-09 bankruptcies



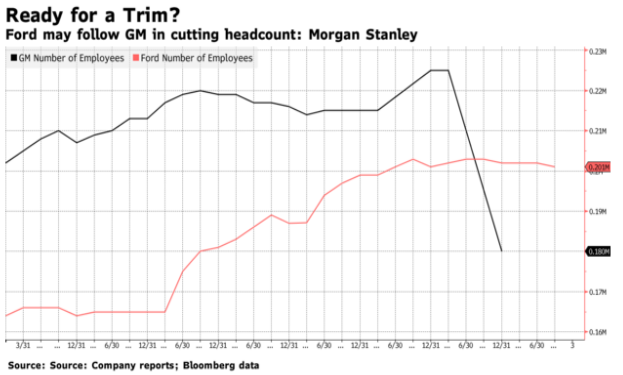
The real decision confronting the world's carmakers is not whether to move into Electric or Autonomous or stay with ICE… It's whether they should:

- **Develop AV technology themselves** or **buy it from a supplier**
- Try to **run transport services themselves** or simply **provide the hardware**

Carmageddon 2020…

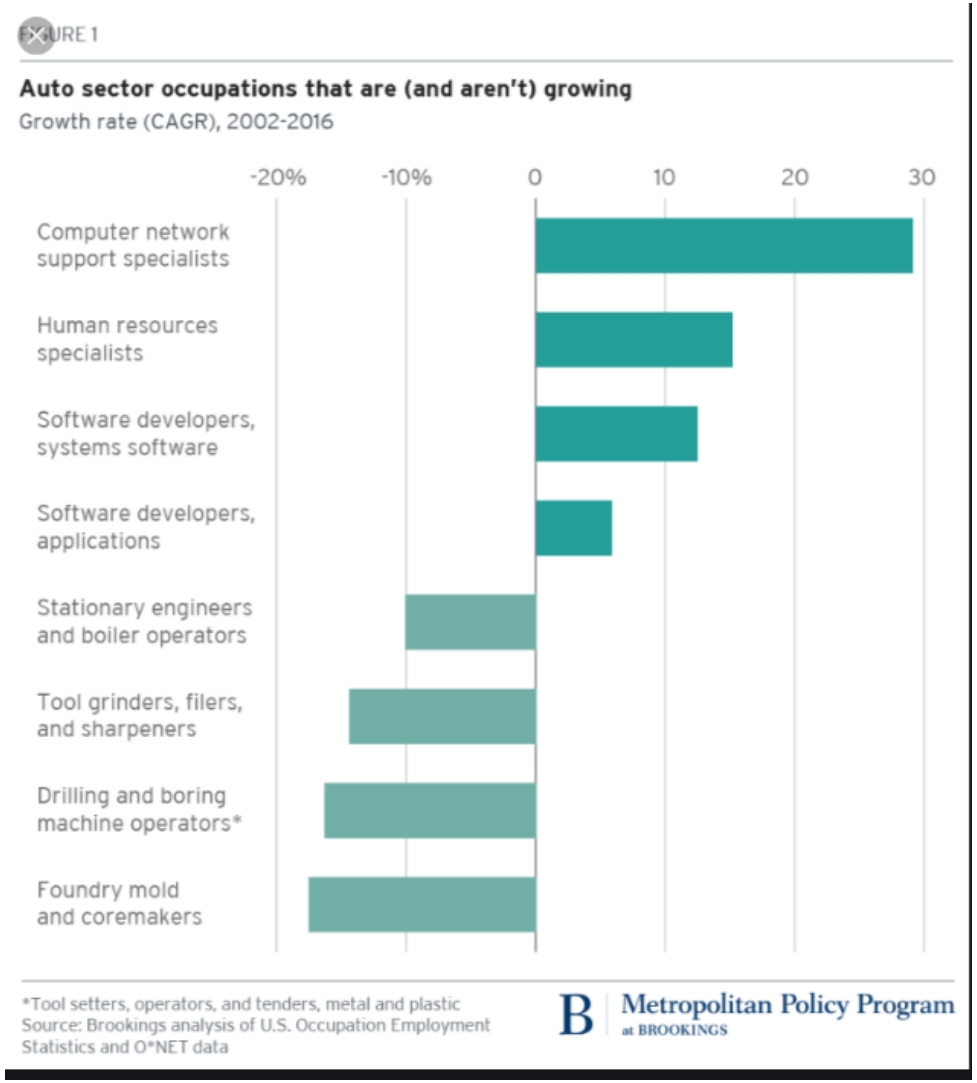
Kodak Moment: In the midst of **massive reorganizations**

- **GM** to idle five factories in North America and cut 14,000 jobs
- **Ford's** $11 billion restructuring, loss of 25,000 jobs
- **Jaguar Land Rover** shedding 4,500 jobs
- **Nissan** cutting more than 12,500 jobs
- **Audi** and **Mercedes-Benz** parent **Daimler** axed 20,000 in December 2019
- Carmakers will eliminate more than **80,000 jobs** during the coming years (mostly Germany, US and UK) – Bloomberg



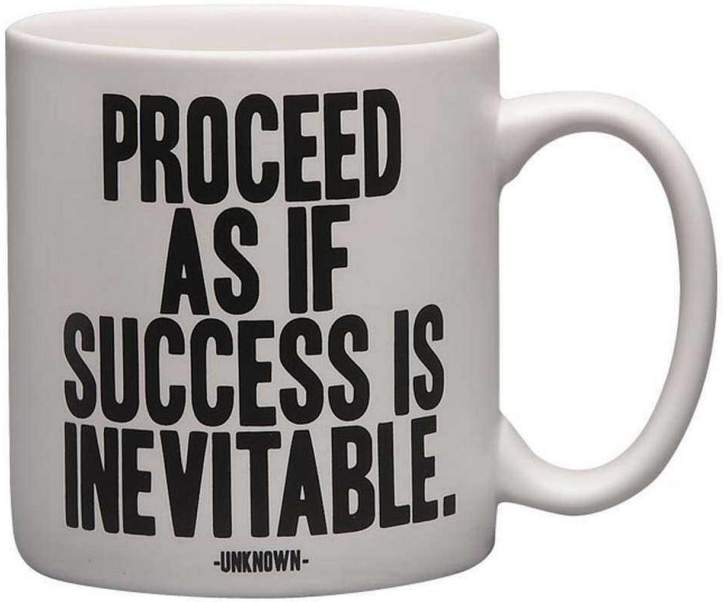
BCG: "the most profound challenge to their business models in a century…"

New Skills in the CAV Economy



Autonomous Vehicle Evolution Before 2020

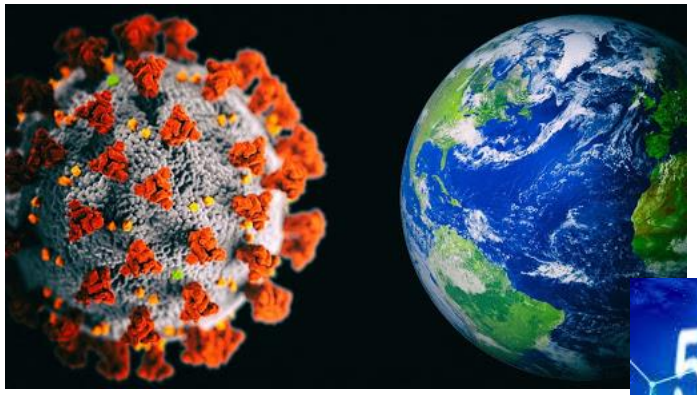
- Driven by **High Tech** and **Investment Market**...
- Auto Makers piled in because **they had to**...
  - There are billions at stake
  - Hugely competitive: every group feels that if they don't move quickly and decisively they'll be **left behind**
- That means that the AV Movement was largely:
  - **AI/Machine Learning-Inspired**
  - **Supply (not Demand) Driven**
- …but until 2020 they were collectively **proceeding as if success was inevitable...**

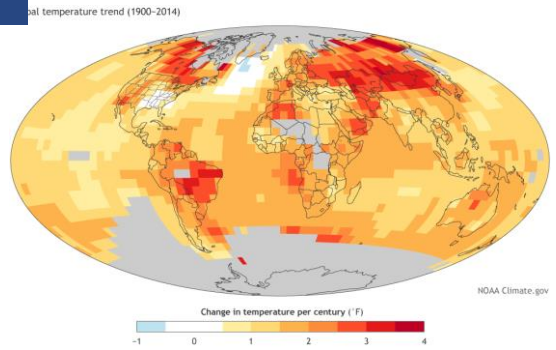


2021 Onwards – A New Era in Connected and Autonomous Vehicle Development

On the Horizon:

1. Climate Change
2. China
3. Connectivity
4. Consolidation
5. Covid





1. Climate Change and Electric Shock

From fossil fuels to electric power: Emissions and Climate Change Issues are leading to **Electric Vehicle Mandate:**

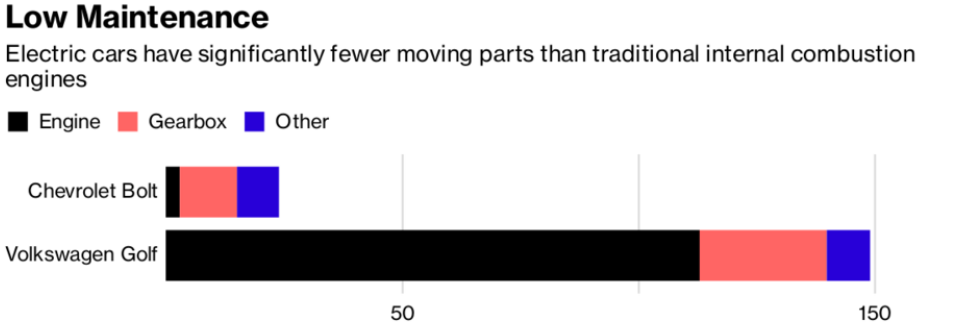
- **European Parliament -** carmakers to lower their 2020 CO2 emissions targets by 40 % by 2030 - **By 2040 all gas and diesel vehicles will be banned from European cities**
- Automakers facing **penalties of billions if they continue with ICE** (Norway entirely electric by 2025)
- **Emissions cheating scandals have undermined OEMs' ability to push back**
- **UK** sale of new cars and vans **powered solely by petrol or diesel will be banned** from 2040 under a policy called the **"Road to Zero"**
- **China:** 1/5 of Chinese cars will be electric by 2025
- **India** is the world's fourth-largest car market - **30% of new vehicle sales to be electric-powered by 2030** (versus zero in 2017)

Auto 2.0: ICE to Electric

"If we had to design a car from scratch..."

More Revolutionary than Evolutionary: An opportunity to completely **redesign the vehicles of the future**

- **Lower cost of EV ownership**: easier to build and maintain (20 moving parts versus 200)
- **Lightweight and fuel-efficient**
- Electric-vehicle **production takes 40% fewer hours** and **50% less factory floor space** than a traditional internal-combustion engine and transmission
- **ICE parts** (mufflers, fuel tanks, transmissions) will shrink in a range from 6% to 20% by 2025
- AV systems (cameras, sensing, mapping and guidance systems**) require a large amount of electricity to operate** + battery can act as a distributed energy resource



Auto Groups Being Forced Into Electric

Combination of Regulation, Competition and AV opportunities: All of the major auto manufacturers will launch a variety of electric and hybrid cars in the coming years: EVs models will go **from 49 in 2018** to **258 by 2025**

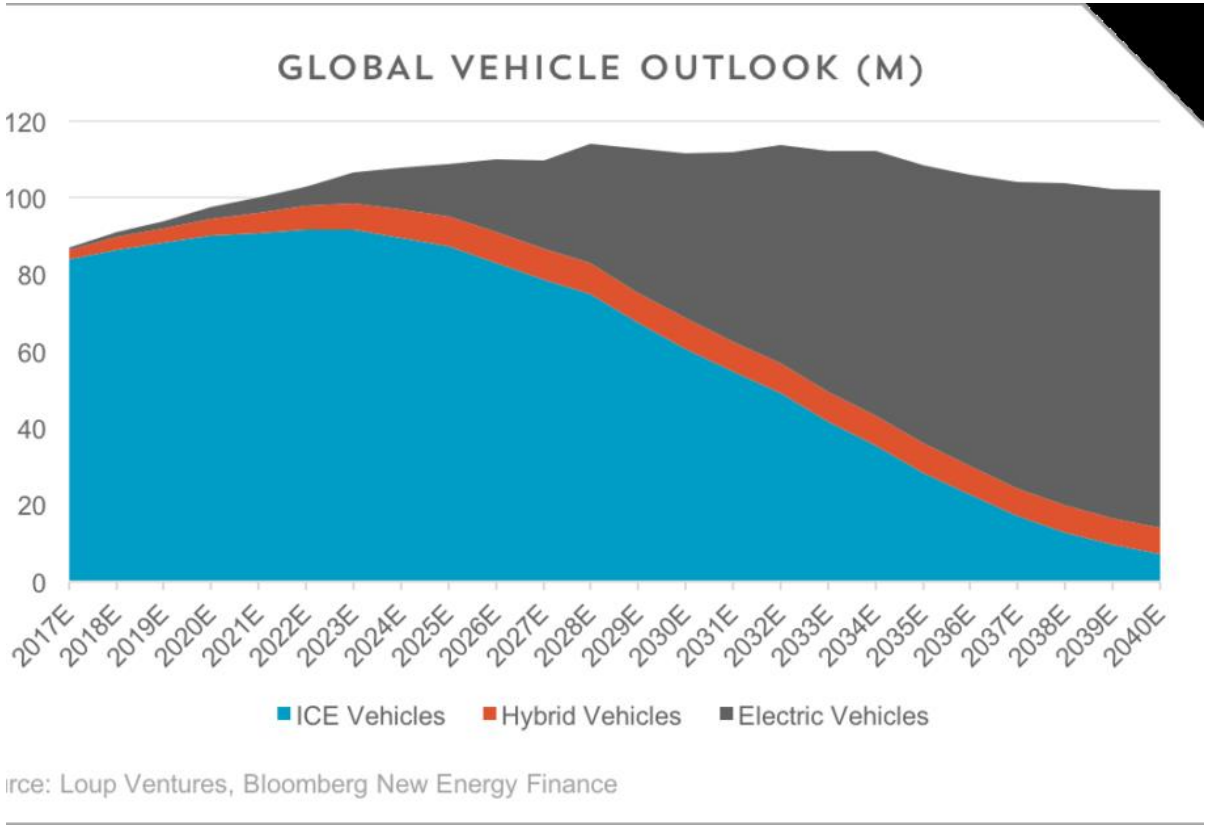
- **VW** to sell 3 million all-electric cars per year by 2025
- **Ford** will build electric versions of **all new vehicles in Europe + crossover SUV/Mustang** and an electric version of the **Ford F-150 pickup**
- **Volvo** - all vehicles from 2019 will be EVs or hybrid
- **Toyota** will have "electric options" for all its cars by 2025
- All **Nissan** Infiniti vehicles launched from 2021 will be hybrid vehicles or all-electric vehicles
- **GM** plans to have 20 electric vehicles globally by 2023 (+ an electric pickup truck by the 2021) + **GM** and **LG Chem** in $2.3 billion joint venture to mass-produce battery cells for future battery-electric vehicles

In the US:

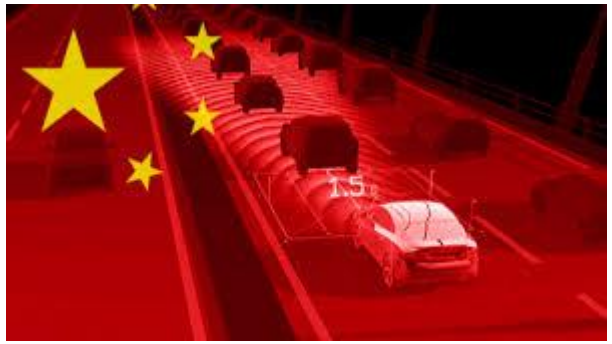
- Bloomberg estimates **54% of all new car sales in US by 2040**; RethinkX says by **2030**
- **California** and other states are requiring manufacturers to meet **quotas for zero-emission**
- **15 states + DC** (1/3 of the US population) **follow California's stricter standards**

Electric Shock: What Does EV Have to do With AV?

- Requires **retooling of traditional ICE-based manufacturing**
- Creates an **opportunity/requirement to co-evolve to Connected and Autonomous**
- Companies forced to **keep up or stay traditional** (risk falling behind if CAV is successful globally)
- **Abrupt change** instead of gradual



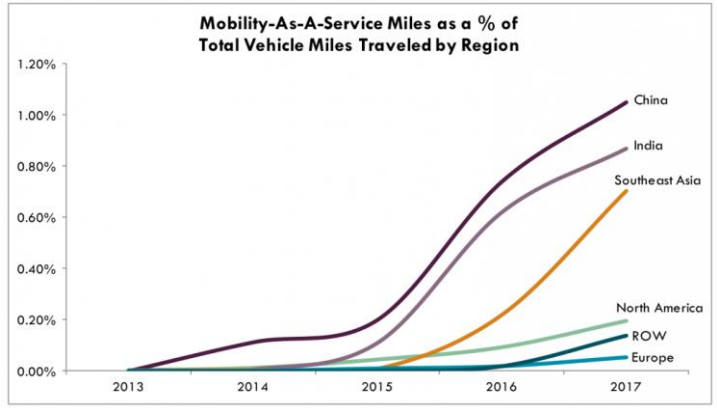
2. China and AVs

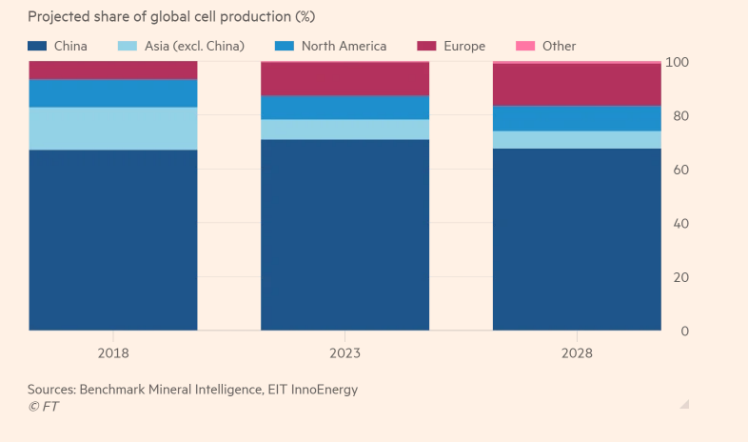


- US-China Competition and Trade War - “Tech Nationalism"
- “Made in China 2025”: Innovation-driven development in key areas (Connectivity, microchips, AI and robotics, biopharmaceuticals, AVs, etc.)
- Huge transportation market expansion (private and public) into Digital Transportation Platform model
- Climate change and electric
- Huawei and Cellular Connectivity
- Huge investment in AVs with an emphasis on connectivity

China: East Meets West

- **World's largest car market** since 2009, is now 1.7 times bigger than US, outselling the American market by 10.5m vehicles
- Chinese auto sales **almost all of the growth globally** – Chinese consumers bought 24m in 2018 (US only 17m)
- Probably will emerge as the **world's largest market** for **both electric and autonomous vehicles** and mobility services - McKinsey
- **Leader in battery technology and production** (nearly 3 x production of the rest of the world)
- **Alibaba, Tencent** and **Baidu** in forefront of China's AV development
- **DiDi**, largest mobility/TNC has a user base of around 450 million customers and operates over 30 million rides every day – ***Already launched Robo-taxi services in Shanghai***



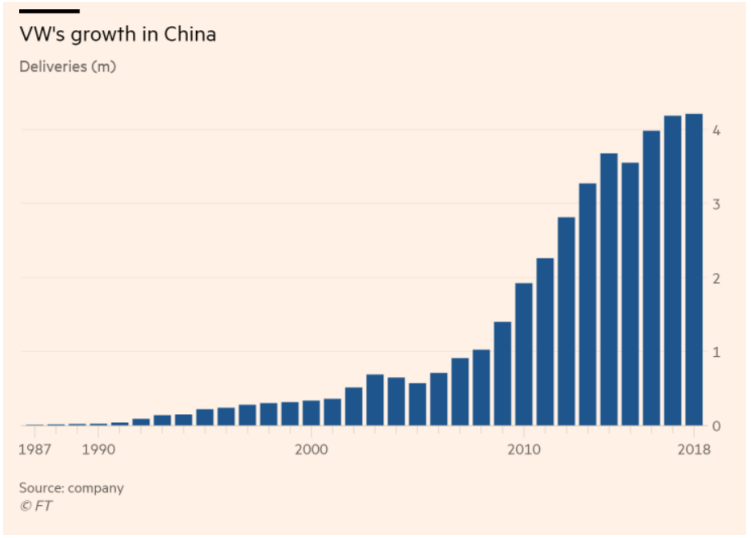


More "Western" manufacturers becoming mainstream in China – and China will begin to sell into non-Chinese markets...

West Meets East

Almost all **growth in demand** for vehicle ownership is in **developing countries**…

- **GM** sells more cars in Asia than it does in the United States
- **Ford** to launch **30 new Ford and Lincoln (mostly electric) vehicles in China** over the next three years – partnering with **Baidu**
- **Audi, Mercedes-Benz** and **BMW**, Germany's three largest carmakers, have all begun testing autonomous vehicles in China
- **Waymo** has set up a subsidiary in Shanghai
- **Volvo** working with **Baidu** to develop AV "robo-taxis"
- **Daimler** extends partnership with **Baidu** and was the first non-Chinese car maker to obtain Beijing AV testing license
- **Aptiv** (formerly Delphi Automotive) just opened the company's China Autonomous Mobility Center in Shanghai
- **Toyota** partnership with two Chinese battery producers and invested $600m in ride-hailing group **Didi** and investing in **Baidu**'s self-driving car program



VW CEO Herbert Diess has taken over the management of the group's China business: **"The future of Volkswagen will be decided on the Chinese market"...**

"The truth is, I believe China will soon be leading the automotive industry in terms of technology and innovation." – Toyota CEO Akio Toyoda

High Tech China and AVs

- Chinese Internet companies – **Alibaba**, **Tencent** and **Baidu** are developing self-driving vehicles with multiple partners
- 70% of AV value in **IT and Communications**
- Makes **"Digital Business Platform"** groups like these the **"kingmakers"** more than traditional car companies
- Emphasis on: **Robo-taxis, Shuttles, Public Transit**

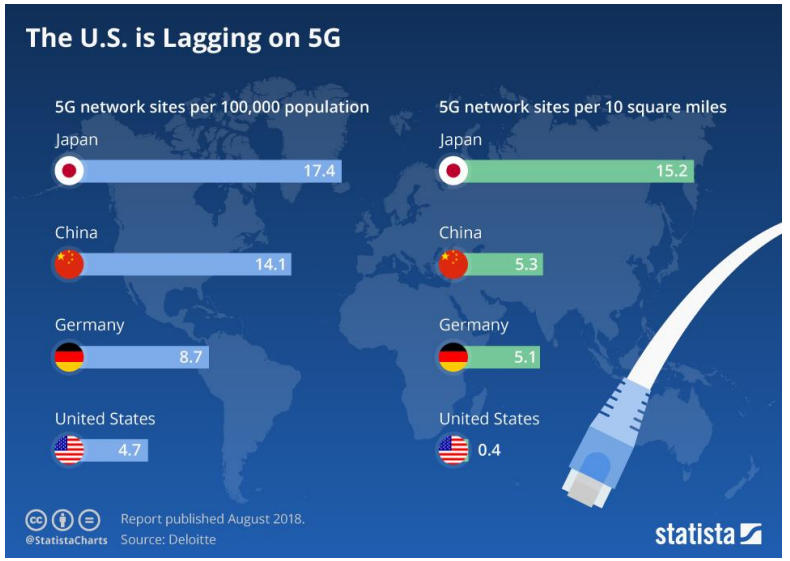
Alibaba.com™

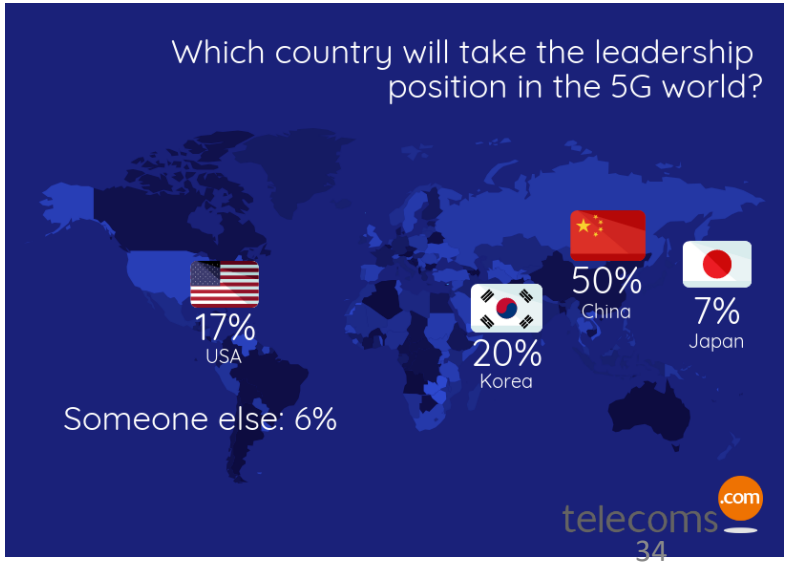
3. Connectivity

- 5g: **Super-fast, lower latency**, always-on wireless network connectivity
- The “Nervous System” of the Future Digital Economy and a **foundation technology** for:
  - Smartphones and extending the IoT
  - Edge Computing
  - Revolution in Sensors
  - Telemedicine
  - **Autonomous Vehicles**

Globally **the race is on**...

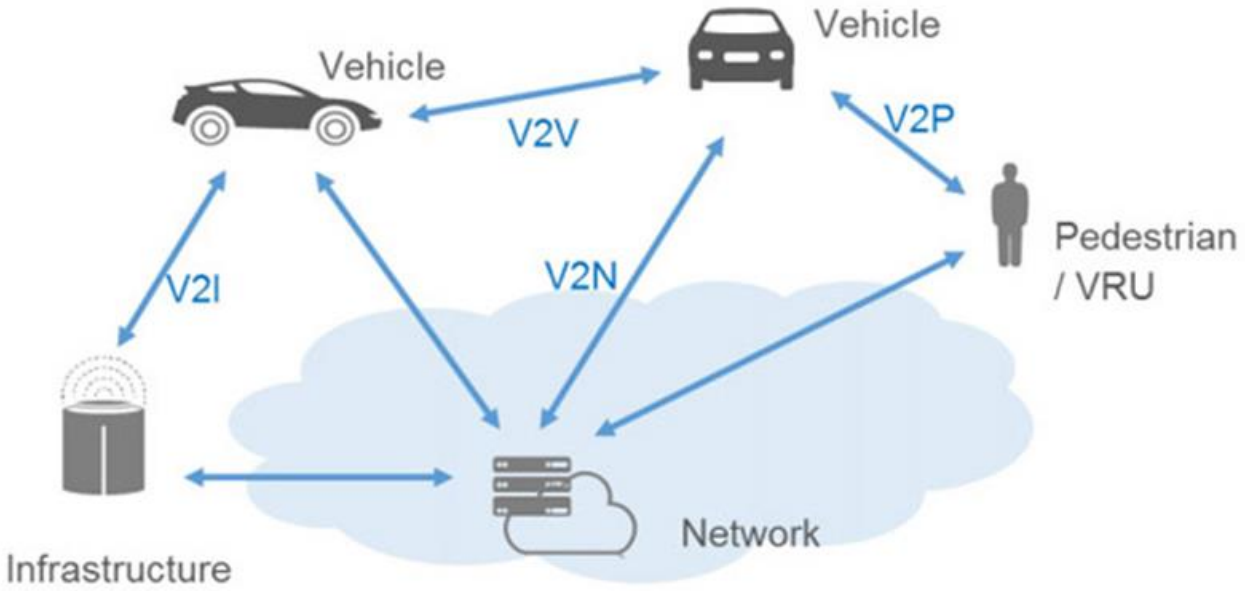
- **Huawei’s** 5G mobile technology
- **Qualcomm** estimates 5G could spur as much as $12.3 trillion in revenue for the automotive sector in 2035
- **AT&T** is creating an entire edge network of data centers to prepare for self-driving cars;
- **Verizon** and **AWS (Amazon)** announced 5G and Edge/Cloud partnership Verizon’s 5G Ultra Wideband network.





3. Connectivity: A Fundamentally Different View of Autonomous Vehicle Development…

- With 5G began to view AVs in terms of **Connectivity rather than AI/Machine Learning**
- For vast majority of transport-related companies, **all-functioning self-driving car model too complicated and not scalable**
- Huawei and 5G – **innovation market is much larger, inclusive, profitable if focused on Connectivity and Infrastructure**

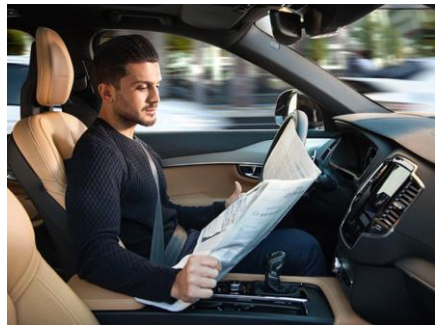


HUAWEI

Connectivity Drives a Change in Ownership Models

Private (Personal) Ownership model:

- Privately purchased or leased but potentially available for car sharing or rental schemes
- Private owners fuel/power and maintain vehicles



Shared mobility model:

- Vehicles owned, operated, and maintained by mobility groups, transit agencies or municipalities
- Cars, minivans, busses (single or multiple occupancy)
- Tied to MaaS Platform

Individual Ownership Vs Managed Fleets

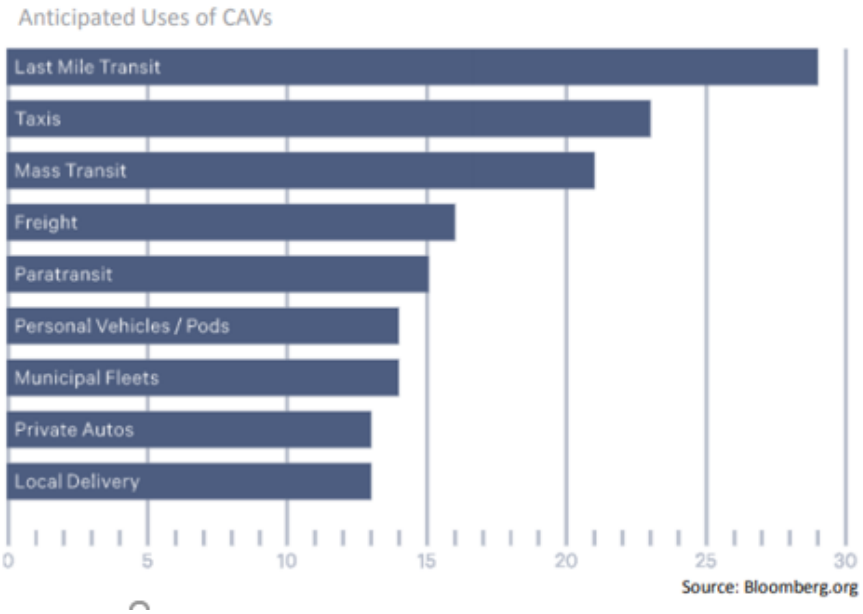
Private Consumer Ownership: Cost potentially very high ($250,000 to $300,000 per vehicle) This will change over time as costs are reduced

Public and Commercial ownership will probably greatly outpace **Private** ownership

- **Uber** had ordered 24,000 self-driving **Volvos**
- **Waymo** has ordered 62,000 autonomous **Chrysler** Pacifica hybrid minivans
- **Toyota** has invested $1 billion in **Grab** Holdings Inc., the Southeast Asian ride-sharing giant
- **Lyft** is creating an open platform to deploy autonomous vehicles built by other companies.
- **Volkswagen** has bought a 60 per cent stake in FleetCompany, which operates in more than 70 countries

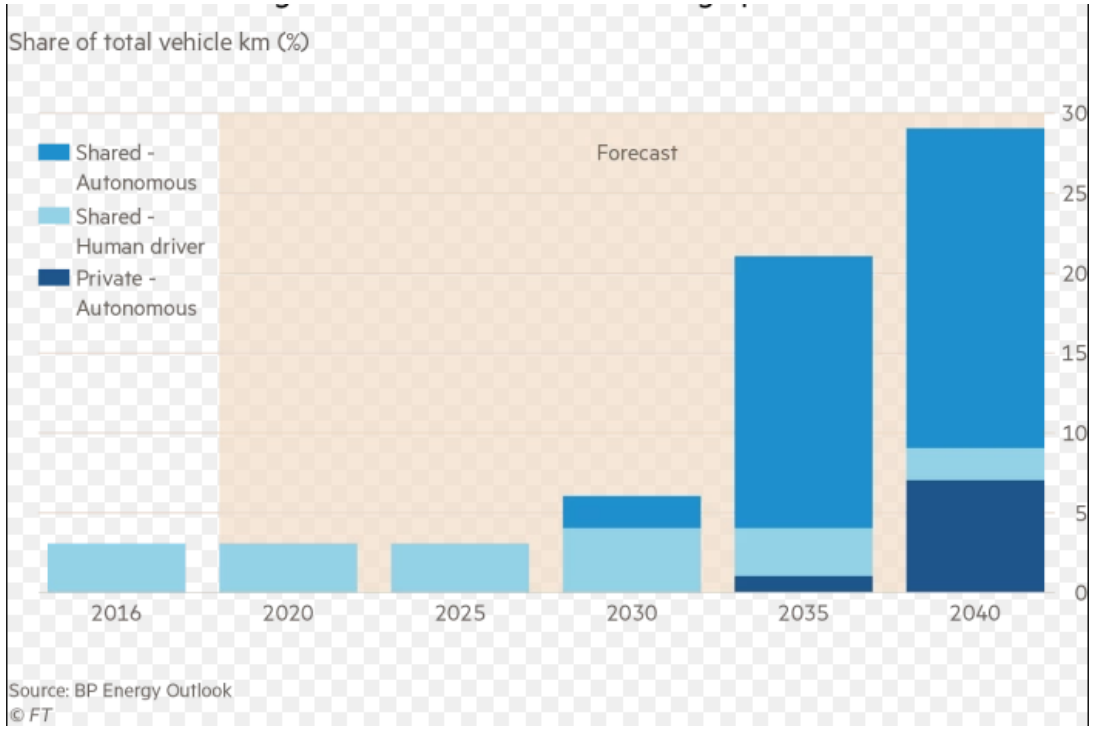
Who Owns the Fleets and Swarms?

- Traditional automobile manufacturers: Toyota, GM, Volvo, VW
- Logistics companies: UPS
- Rental groups: Avis
- SW and Tech platforms: Waymo
- Retail: Wal-Mart, Amazon
- Institutions: health, educational, private
- **Municipalities and transit agencies – (White Label)**

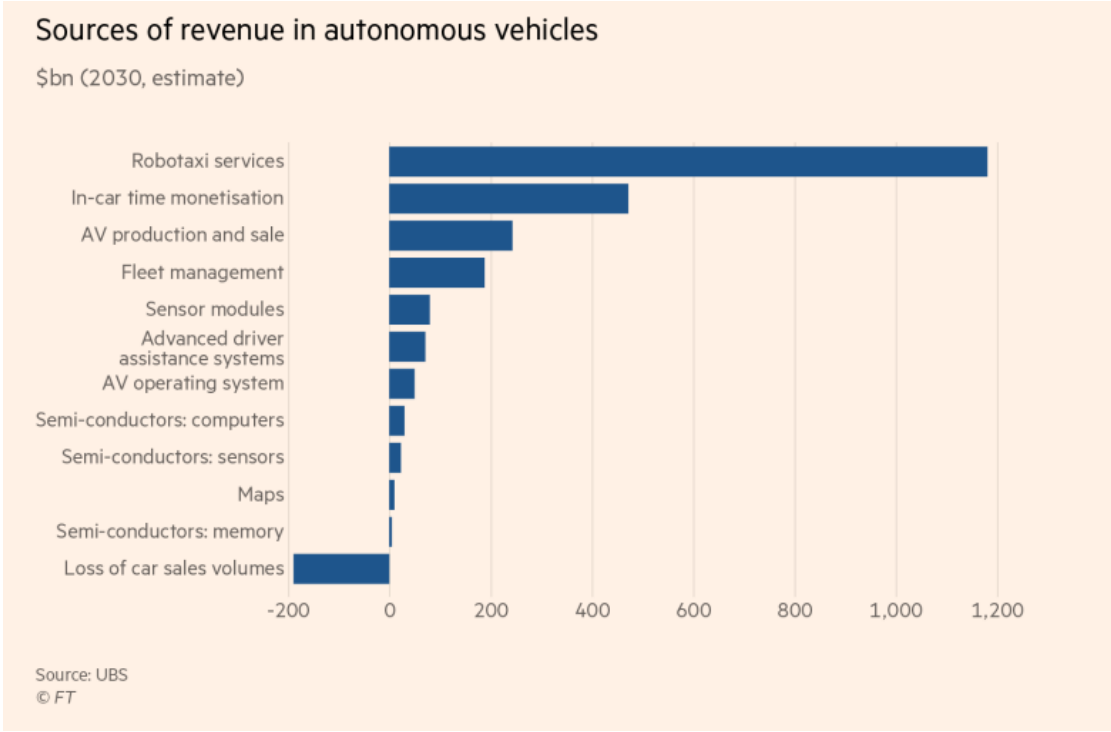


Ownership Models

Shared Vs Private



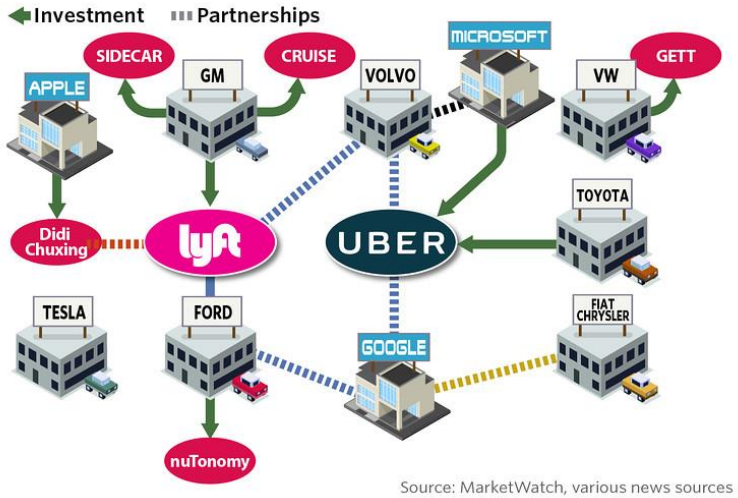
Sources of AV Revenue



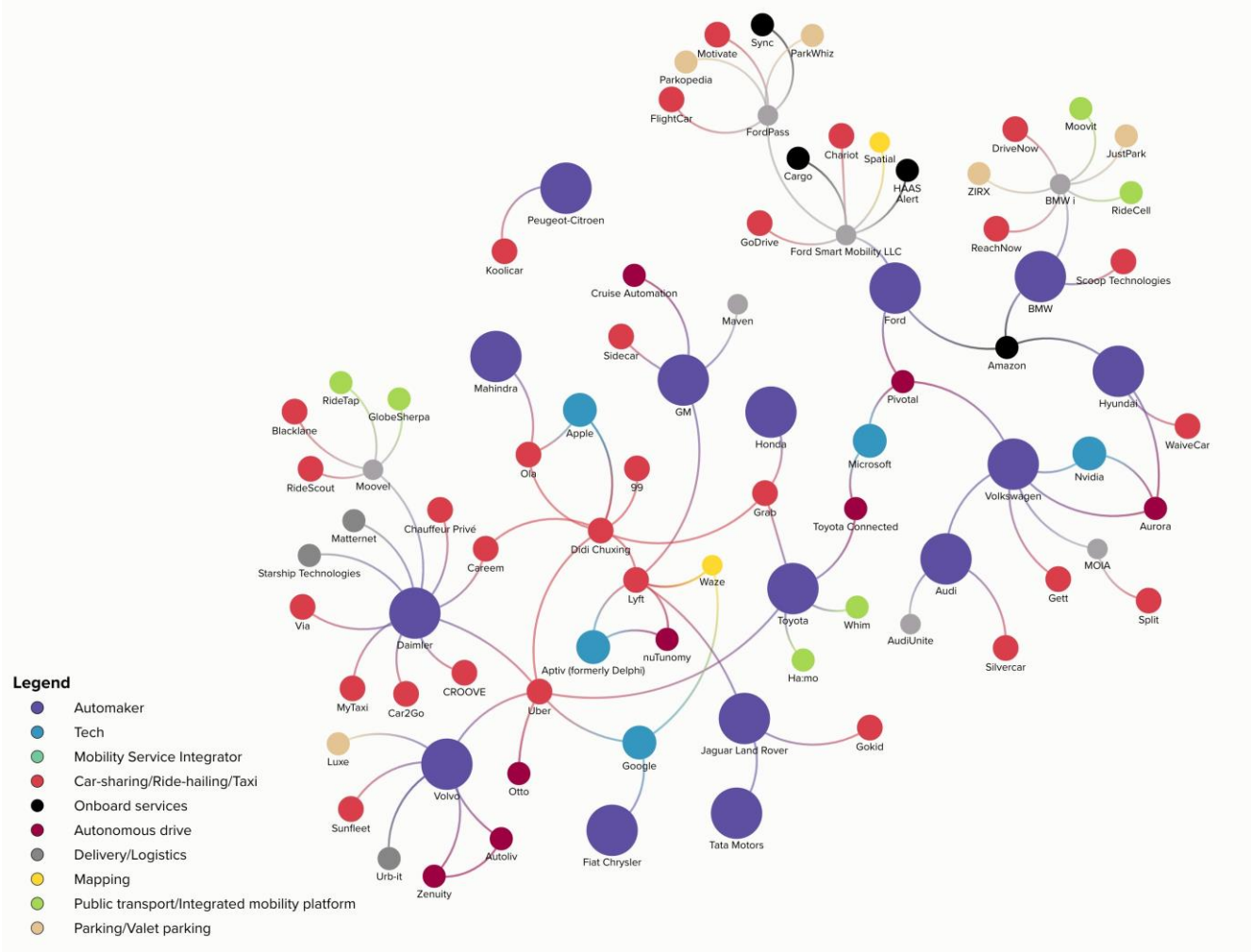
4. Consolidation: Scramble for $ and Alliances

No Single Group Has Enough Expertise Alone

- Manufacturing and Assembly
- SW
- Communications
- Infotainment
- Connectivity



Source: MarketWatch, various news sources



Consolidation Around AVs

GM teaming with Honda – invested $750m into Cruise, with promise of a total of $2.75bn over 12 years + $2.25bn from **SoftBank**

Volkswagen + Ford's Global Alliance: co-developing electric cars, self-driving systems and other vehicles. Co-investing in **Argo AI** (Ford 5-year, $1 billion; Volkswagen $2.6 billion)

Renault/Nissan/Mitsubishi & **FCA**: 4 x companies would be the largest carmaker in the world - global presence

Toyota/Subaru/Suzuki – collaboration and mutual share ownership: Toyota invested $500m in **Uber** to collaborate on self-driving technology

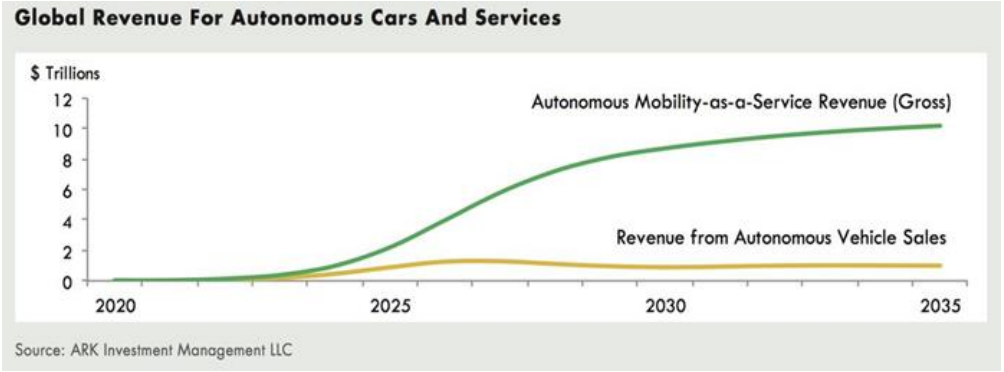
- **Hyundai** $4bn joint-venture with **Aptiv** in March
- **Amazon** bought **Zoox** in June for $1.3 billion
- **Uber** just sold driverless division to **Aurora**, along with a $400m investment, for 26% stake and a board seat
- **PSA** and **FCA** $50bn merger (FCA brings relationship with **Waymo + Aptiv)**

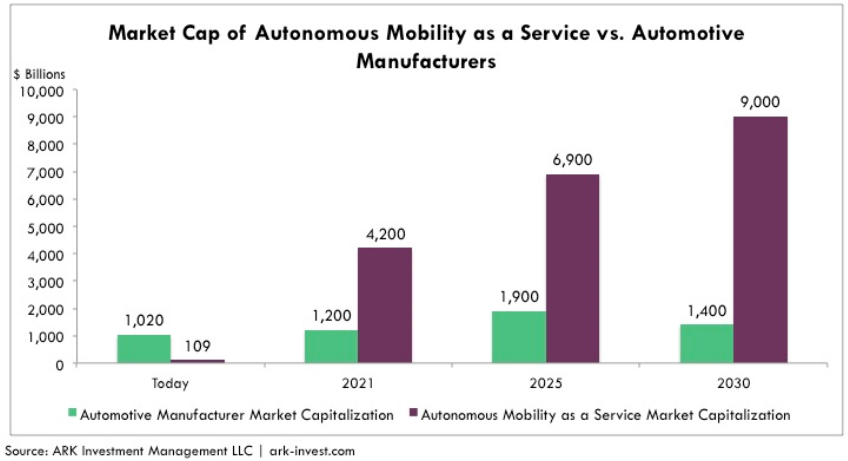
The Race to Build and Own the Transportation Mobility Cloud

Holy Grail Among All the Major Players (TNCs, Tech, Auto, Telecoms)

- AV V2V and V2X connectivity
- Data collection

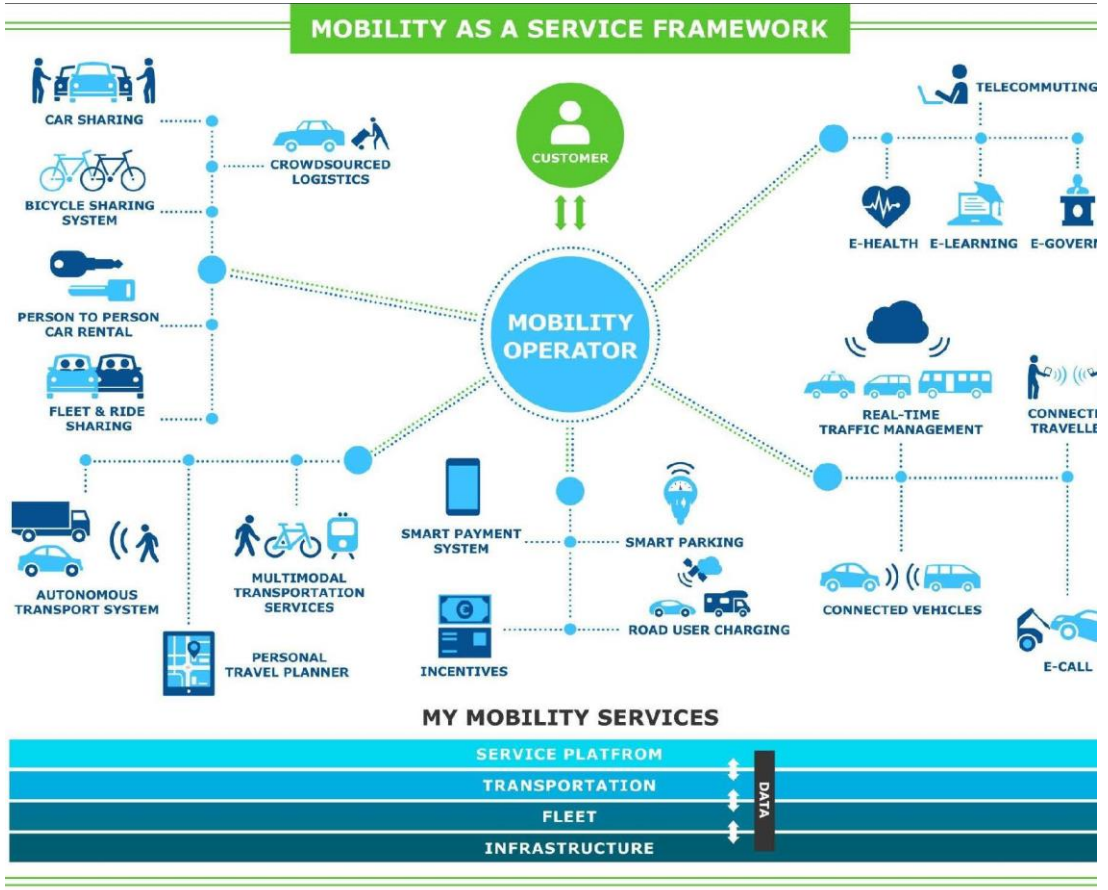
- **Transportation Mobility Cloud (TMC): Ford** partnering with **Qualcomm** to install "vehicle-to-everything" (V2X) cellular technology in all of its cars and have signed an MOU with **Alibaba Cloud** to bring to China
- **Alliance Intelligent Cloud: Renault-Nissan-Mitsubishi Alliance** and **Volvo** have partnered with **Google** to incorporate **Google Assistant** and IoT AI – all cars sharing Android-based operating system for Infortainment
- **Volkswagen Automotive/Azure Cloud: Volkswagen** and **Microsoft** developing service for 5 million VW vehicles p/y from 2020 to be connected in the **Azure cloud** to each other and the IoT
- **Toyota**'s e-Palette platform MONET (Mobility Network) will be an **Autono-MaaS***





Mobility-as-a-Service

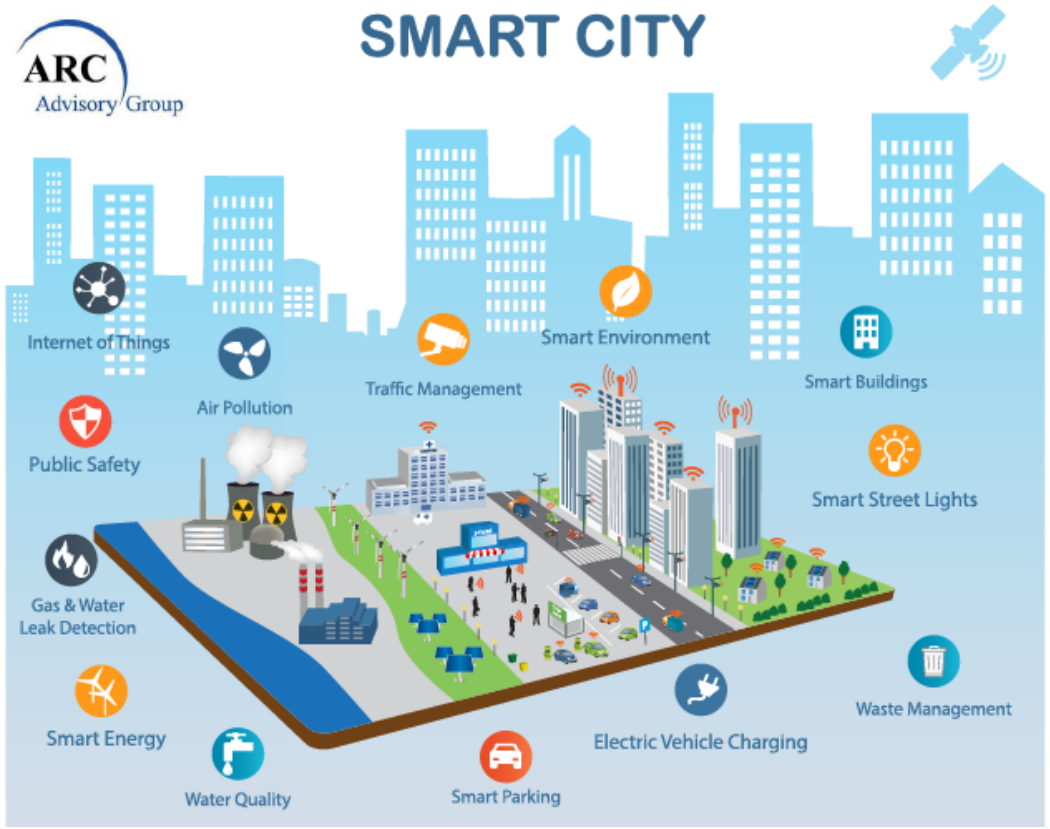
- **Synchronize all modes of transportation, public and private + payment**
- Complete **Journey Planner** on your **Smartphone**:
  - **All available modes** of transportation
  - Nearby mobility options – **location, availability and timing**
  - On-demand **ride-hailing** (TNC/RoboTaxis)
  - **Static and dynamic bus and metro** schedules
  - **Smart routing by preference (cheap, fast, green, etc.)**
  - **Payments**: trip, by month, or subscription of services



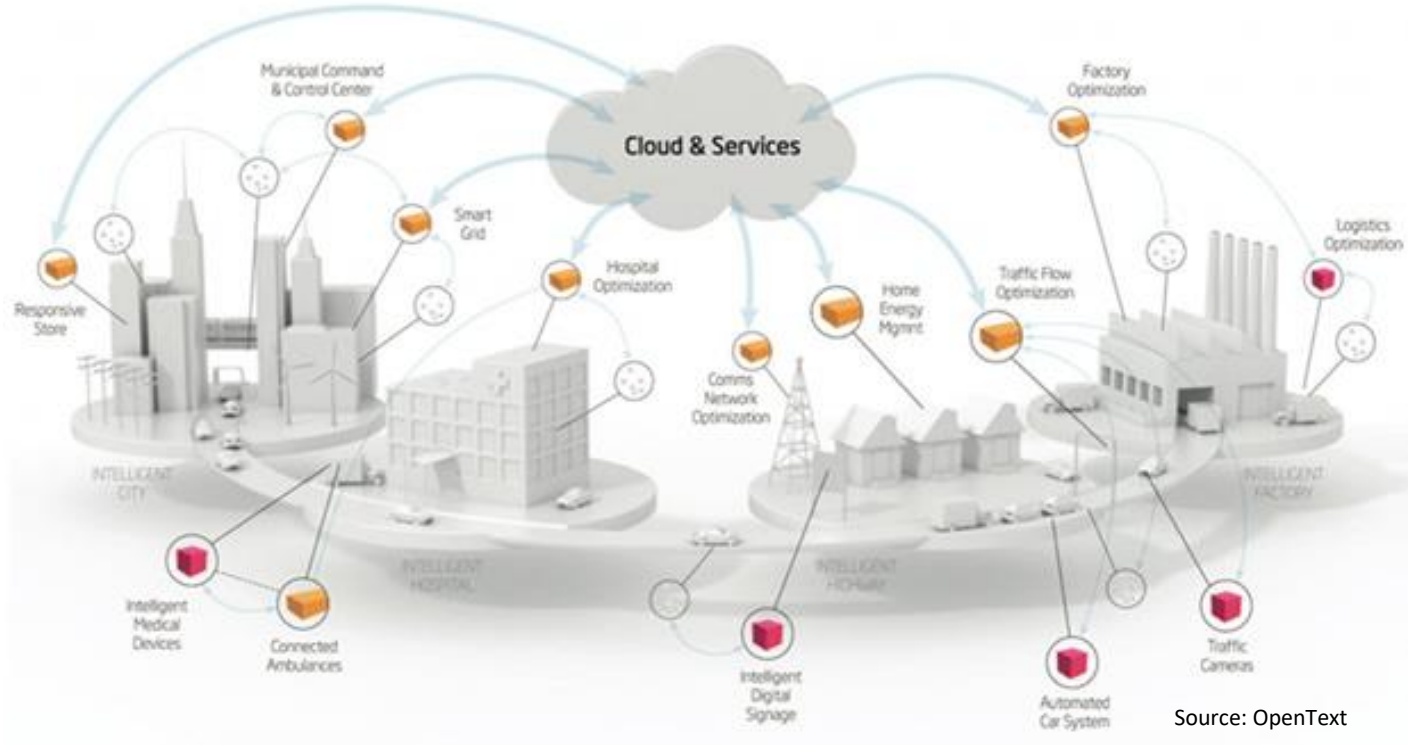
The mobility-on-demand market is set to grow from its current industry value of more than $100bn to over $200bn by 2024

Advanced Traffic Management Systems

- Predictive **real-time traffic signal information**
- Quantum computing and 5G to optimize traffic routing by predicting traffic flow and optimizing the distribution of ***all*** local vehicles
- Gives **priority** to buses, emergency vehicles, snowplows, pedestrians, etc.
- Can also be used to **optimize traffic congestion**
- Be integral to a **multi-function city-wide network**
- Goal: Seamless communication between vehicles and their surroundings



2020 Vision: The Connected AV Economy…

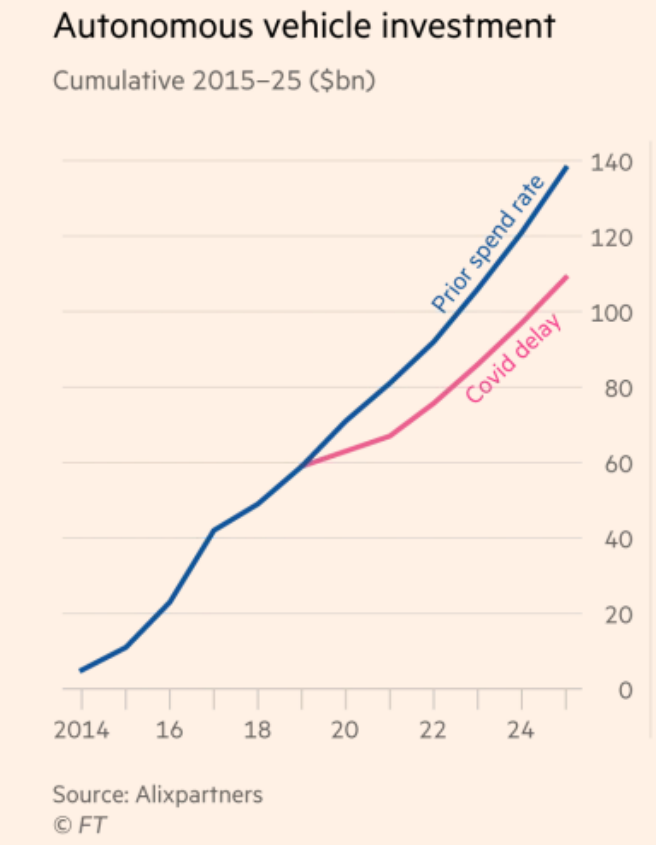


Source: OpenText

Communications network driving the autonomous vehicles as part of a broader, coordinated transportation and mobility platform…

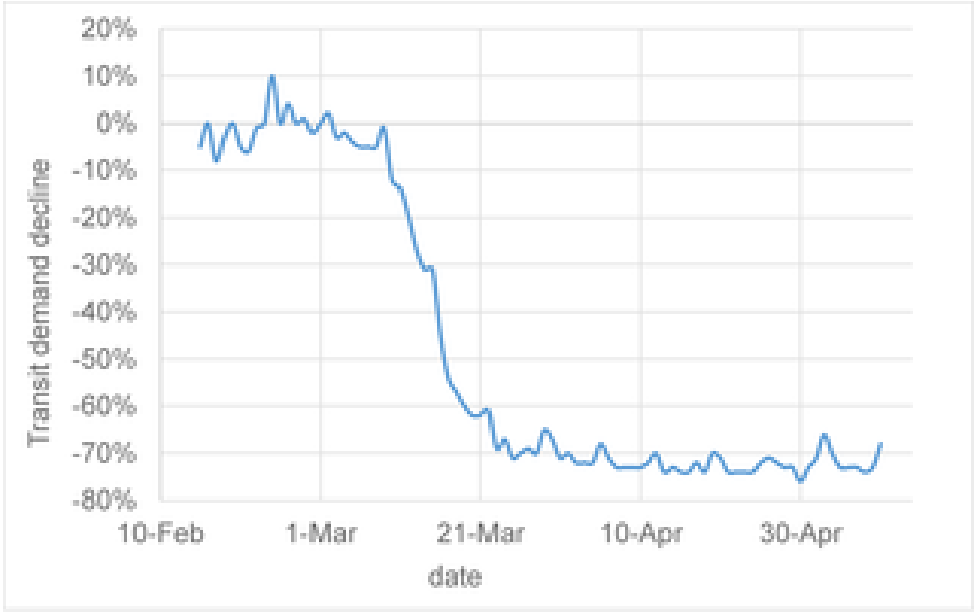
Then Came Covid…

- Economic shut-down globally
- Transportation comes to a halt
- Fear of shared vehicles – rush toward personal ownership
- National/Local budgets slashed
- Future of home working and telemedicine validated
- Death knell for traditional transportation and car economy – now really being shifted to digital economy…



Buses and Public Transit

- Public transportation (Bus) systems in US expensive and collapsing
  - Already suffering from poor funding and old vehicles
  - Undermined by ride-hailing (U.C. Davis study found that **61% of people choose ride-hailing over public transit**)
  - **Covid** (70% drop)
- Self-driving buses and AV shuttles – with Robo-Taxis
- On-demand, trackable, repeatable, predictable
- **Synchronized to solve "last-mile" point-to-point problems** currently undermining public transportation
- **Could be first adopters** – lower complexity



Reshaping the Economic Landscape: Unstoppable Growth of E-Commerce and Online Shopping

Explosion of online shopping and delivery

Retail **Bricks-and-Mortar closures**

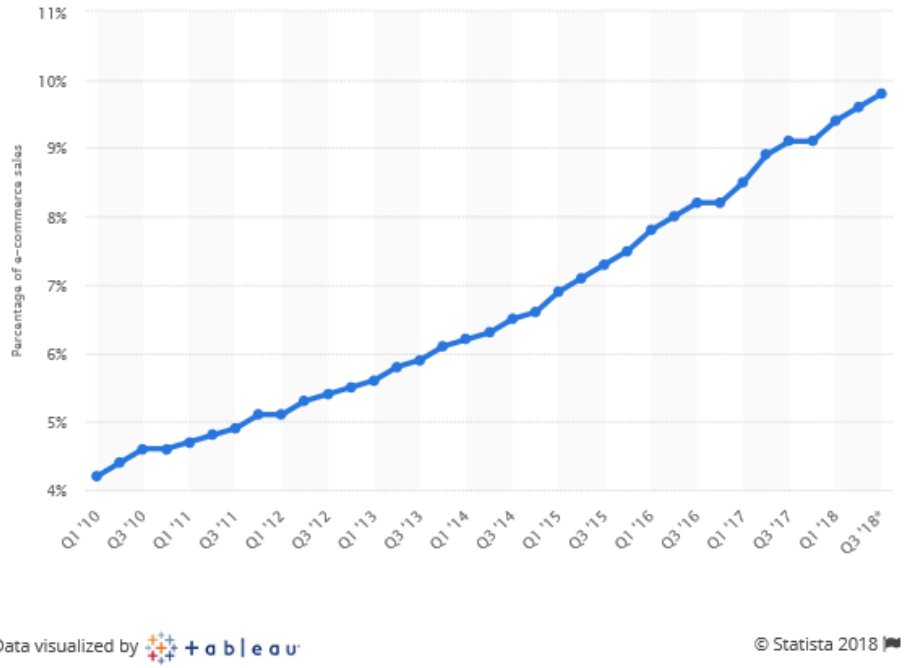
US retailers to shut 4,800 stores this spring; 5,400 closed in 2018; 7,000 closed in 2017

Malls under particular pressure:

- Gap to close 230
- Victoria's Secret 50
- Abercrombie & Fitch 40

Bankruptcies: Payless, Sears, ToysRUs

Dislocation for retail workers, and **ever greater demand for home deliveries...**



Quarterly share of e-commerce sales of total U.S. retail sales from 1st quarter 2010 to 3rd quarter 2018

Delivery

"The economics of pulling the driver out of the vehicle to get the last mile or the last 50 feet is astonishing. That's why everybody is investing in AV technology." - KPMG

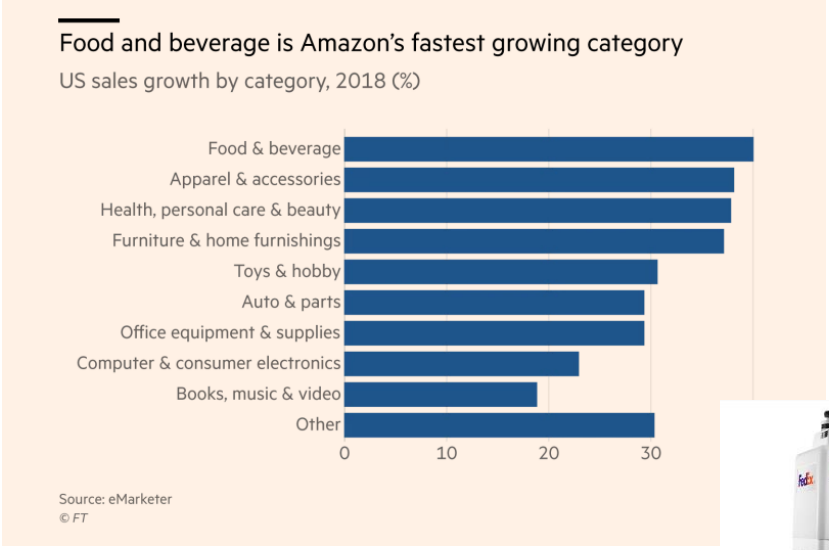
Online grocery market in the US to grow 18% per cent a year, from less than $20bn of revenue in 2019 to almost $40bn by 2023

- **Amazon** (paid $13.7bn for **Whole Foods** in 2017) **– controls 1/3 of market**
- **Uber** Eats and bought majority stake in online retailer **Cornershop**
- **Walmart** offered $225m for **Cornershop** but was refused for anti-trust concerns

Autonomous small-package delivery services:

- **GM's Cruise** and **DoorDash**
- **Kroger/Home Chef/Ocado/Alibaba** and **Nuro**
- **Robomart** and **Stop & Shop** in Boston for self-driving grocery fleets
- **"Shipping with Amazon,"** or **SWA:** new service for business and Amazon delivery to compete with FedEx and UPS
- **Amazon's** Scout, **Google's** Sidewalk Labs
- **FedEx Corp. FedEx, UPS, DHL, USPS**

Amazon has a 38% share of all e-commerce…

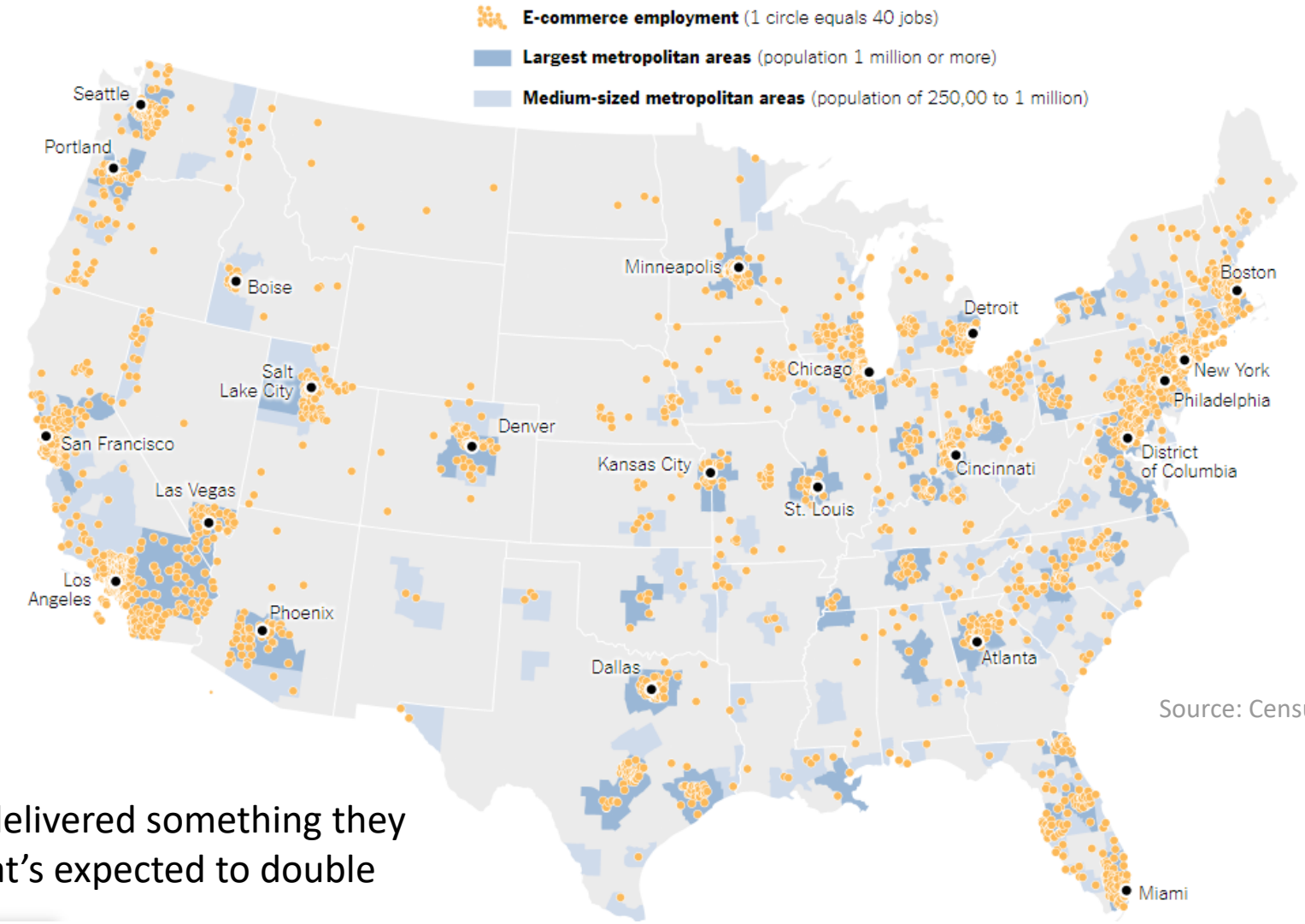


E-commerce and Next-day Delivery Shifting Employment …

Speed-to-market expectations drive localization…

Warehousing and **fulfillment centers** opening in **satellite cities** around large Metro centers

- Delivery **hubs**
- Delivery **traffic and maintenance**
- **Shift in middle-class Employment**



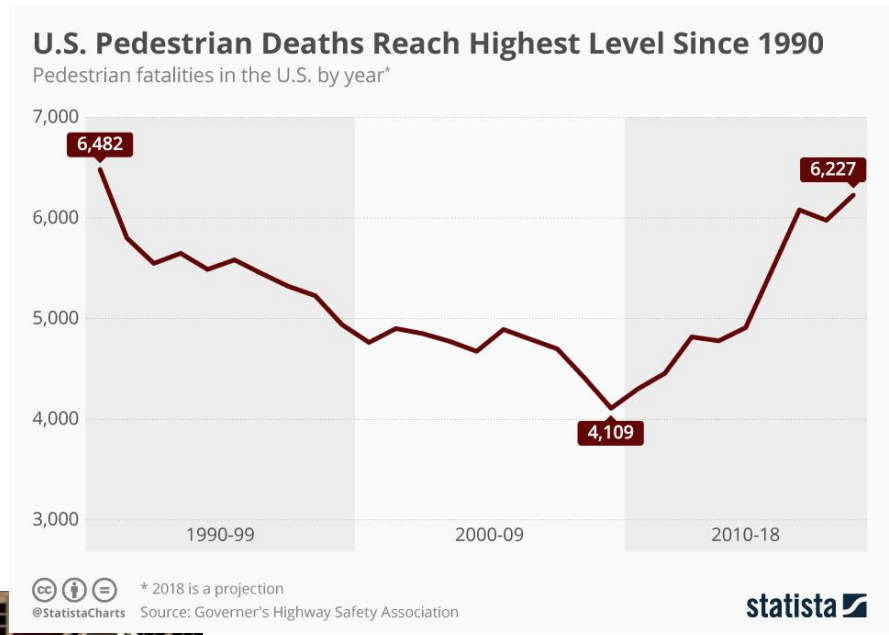
Source: Census Bureau

Every day, one in eight Americans is delivered something they bought on the internet, a number that's expected to double within five years…

Trucks and Next-day Delivery: The Good, the Bad and the Ugly…

- Next-Day Delivery/same-day delivery = **decentralized network** of **thousands of vans, operating everywhere**, dropping **millions of packages**, **7 days a week**
- U.S. **pedestrian fatalities** have increased **41% since 2008** and now account for 16 percent of all traffic fatalities - pedestrian deaths by **delivery vans up 9% in 2018**
- **Traffic fatalities** involving large trucks **rising 9% percent year-on-year** to the highest level in 29 years (**26.8 deaths** per 10,000 workers, compared with **3.5 deaths** per 10,000 for all professions)
- Double-parking on city streets, blocking bike lanes and sidewalks, etc.

If home delivery is growing exponentially, maybe CAVs are the only answer…



2020 Onward…

- **CAV 1.0** (2015-2020)
  - AVs dominated by (a few) **technology giants**
  - Concept of self-driving auto simply **reflected Big Tech skill set** (AI/Machine Learning added to a normal car)
  - Real concerns about production, market demand, coordination with other traffic, safety – and **profitability**
  - Limited in effect, but **inspired the emergence of the digital transportation economy**
- **CAV 2.0** (2021 +)
  - Heavily influenced by **Connectivity, China, Climate Change** and **Covid**
  - Shifting to **connected, autonomous vehicles of all types** (robo taxis, public transit, deliveries, etc.) – not just privately-owned, stand alone AVs
  - Moving toward a **"Digital Transportation Platform"** – combines data collection, messaging, social media, advertising, online shopping, delivery and transportation in a single coordinated platform
  - Will be driven by **5G** (and 6G and 7G) and the myriad infrastructure to support **Mobility-as-a-Service** (MaaS) platforms, overseen by local governments (counties, cities, MPOs?)
  - **Will not just be US**: EU/China/Japan/South Korea

Why Municipalities Need to be Proactive

There is a real danger in believing that “industry” or Federal government will take care of everything…

- **Governance and Policy Making**
  - Engaging with private 3rd parities will be key, but the responsibility for **planning, regulation, licensing, 3rd-party selection and oversight** falls to local government
  - CAV will mean changes to **revenue collection and expenditures** and will require, infrastructure and policy changes
  - Will involve coordination between **multiple agencies and departments**
- **Infrastructure**
  - Key **supporting infrastructure** (EV charging infrastructure, 5G communication networks, advanced traffic management systems, etc.) will require forward planning and continuous adjustment – as well as both public and private sector funding
  - Municipalities will have the **legal authority over most rights-of-way, conduit deployment, installation of roadside sensors, wireless siting,** etc.
- **Citizen outreach and representation**
  - Not yet obvious what the popular reaction to connected and autonomous vehicles will be – but **will depend in part on what you do**
  - Will need to be inclusive and accessible to all
  - Will need to **anticipate and manage disruption**: jobs, right-of-way issues, privacy policies, etc. – there will be discontent

Layers of Responsibility

Regional agencies' role

Action	Cities & counties	Transit agencies	Regions	States
Developing plans	✓	✓	✓	✓
Forecasting impacts			✓	✓
Improving data	✓	✓	✓	✓
Adopting AV policies	✓			✓
Develop pricing	✓		✓	✓
Regulating new services	✓		✓	✓
Testing AVs	✓	✓		✓
Funding projects/pilots	✓	✓	✓	
Convening & education	✓		✓	

19

✓ = lead
✓ = coordinate

Federal Role

- Vehicle safety testing and certification
- Funding for state and local V2I and pilot projects

State Role

- Vehicle (AV) Registration
- AV operations on state roads
- Funding for V2I and pilot projects

Regional Role

- Coordination & Information
- Funding for state and local V2I and pilot projects

Local Role

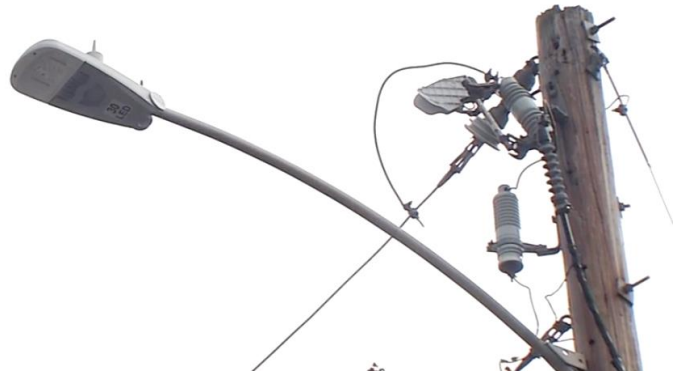
- Innovate Labs: Collaborate to test strategies to advance outcomes, e.g. Vision Zero, equitable access
- Manage infrastructure & technologies to support vibrant land uses
- Service provision: direct and contract

So far, government–industry discussions mostly limited to safety and data sharing policies. Municipalities will have to address infrastructure, revenue and public attitudes…

Policy Implications for Municipalities

- **Finance**
  - Reduced revenues
  - Extra expenditures
  - Payment platforms tied into transit agencies
- **Data Collection and Privacy**
  - Data sharing agreements and control over wireless and broadband deployment right-of-way
  - Privacy policies
  - IT/network security
  - Capacity planning and data management (tomorrow and in the future)
  - “Open” technology architectures
- **Codes, permissions, zoning**
  - Assess existing (or needed) laws and municipal codes, land-use plans and zoning ordinances that will affect deployment of AV technology
  - Revisit right-of-way access and pole attachment policy/agreements
  - Curb usage, fees, priorities
  - Wireless sites on public property
- **Coordination with other agencies**
  - Public Transportation
  - Emergency services and law enforcement
  - Road maintenance
  - IT
- **Procurement**
  - Flexible contracting to promote more collaborative procurement programs
  - Identify roadblocks to purchasing the technology necessary
- **Public and Private and Regulatory Policy and Oversight**
  - Congestion charging and new taxes (dynamic road use charging/vehicle miles)
  - Pedestrian zones and dedicated AV areas
  - AV “loitering“ laws
- **Not just Contracts - PPPs**

Infrastructure Implications



- **Right of ways and dedicated zones** (spatial segregation) for AVs and pedestrians
- Next generation traffic **lights, poles,** intersections
- **Road markings, signals, signs and maintenance**
- Street parking and **curb access drop-off and pick-up** (ride hailing and deliveries)
- **High-speed Fiber**
- **Cellular networks** for connectivity: broadband requirements will grow exponentially – DSRC or 5G
- **Roadside sensors, conduit deployment, wireless hw siting**
- Central and "edge" **data center(s)** capacity
- **Electrical recharging infrastructure:** manual and self-refueling charge points and supporting electricity generation and distribution

CAV 101 Education for Counties and Municipalities

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