TRACK | Plenary Session A

TITLE | **Autonomous Communities**

SPEAKER | **Mary Smith**, *Walker Consultants*

DATE | February 28, 2018

A glossary of terms

- **Autonomous Vehicle (AV):** capable of performing all dynamic driving tasks without human intervention.
  - aka: self-driving vehicle, robocars, etc.
  - Can be owned by individual

  OR
  - Provided through subscription service (you sign up to use on demand)
- **Driverless Vehicle:** A vehicle operating with no human driver present.
  - Those sold for subscription service may not have steering wheel, brakes, etc.
  - Those sold to individuals may or may not have steering wheels and brakes and may sometimes be driven by humans.

Sources: primarily SAE and Wikipedia

Photo by Associated Press

Mercedes AV concept car first shown at Consumer Electronics Show, 1/2015

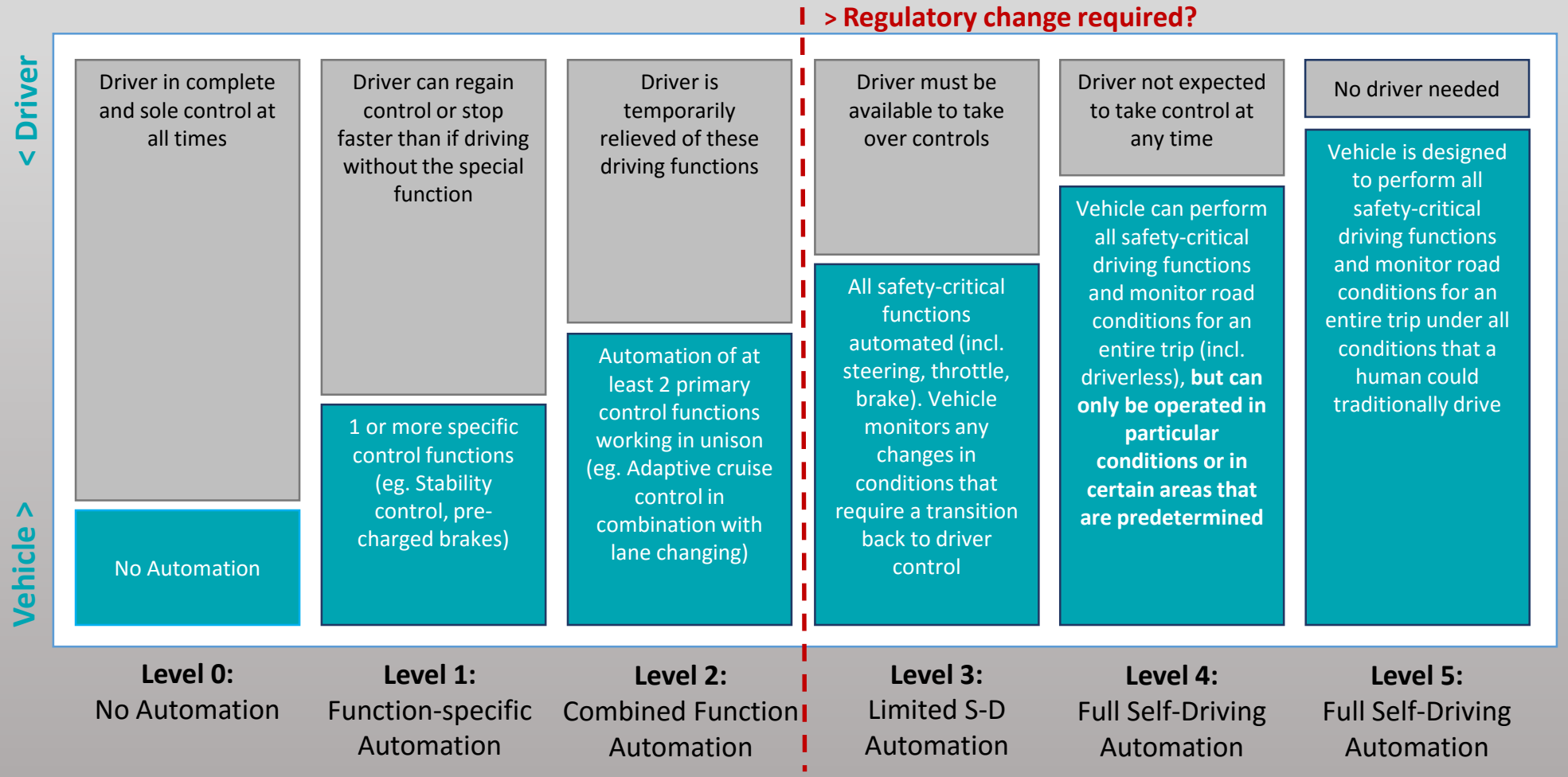
(NOT an auto show!)

Two more important terms

Image: rideapps.com

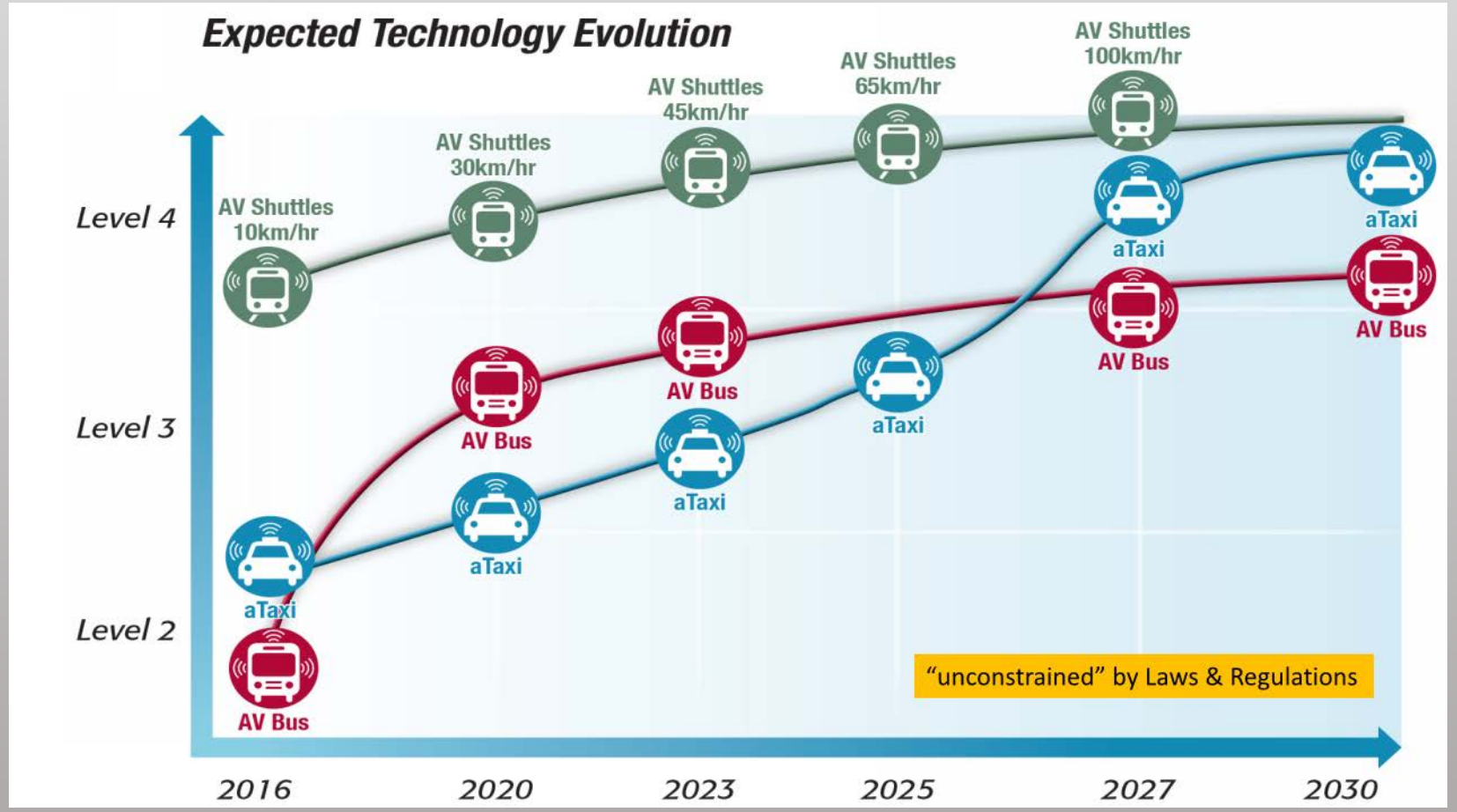
- **Car Sharing:** short term rental of vehicle, typically a subscription to service, then pay by hour.
  - Zipcar, car2go
  - Auto manufacturers are now entering this realm, by
    - Purchasing car sharing services
    - And, providing a month to month subscription to a range of cars (car normally, pickup on Saturday, minivan for trip) on demand, instead of a lease of a single vehicle.
- **Ride Sharing:** passenger rides in car owned and "driven" by another entity
  - Car Pooling, Van Pooling are traditional examples.
  - **Ride Hailing:** on-demand subscription, e.g. Uber, Lyft, curb.
    - Other terms: ride-booking, e-hailing, shared mobility, robo taxi, aTaxi
    - **Transportation Network Companies (TNC):** companies that offer ride hailing service
    - Can be private car (only your party rides in car at one time) OR shared/pooled rides like Uberpool/Lyft Line.
    - When pooled, some researchers use term Shared AV or **SAV**.
      - Important to understand when you read articles!

L0-L2 AVs are already on the market; L5 is expected by 2025 to 2027



Source: SAE, NHTSA

The Feds expect AV Ride-Hailing to happen but slower (2027) than many other projections (by 2021)

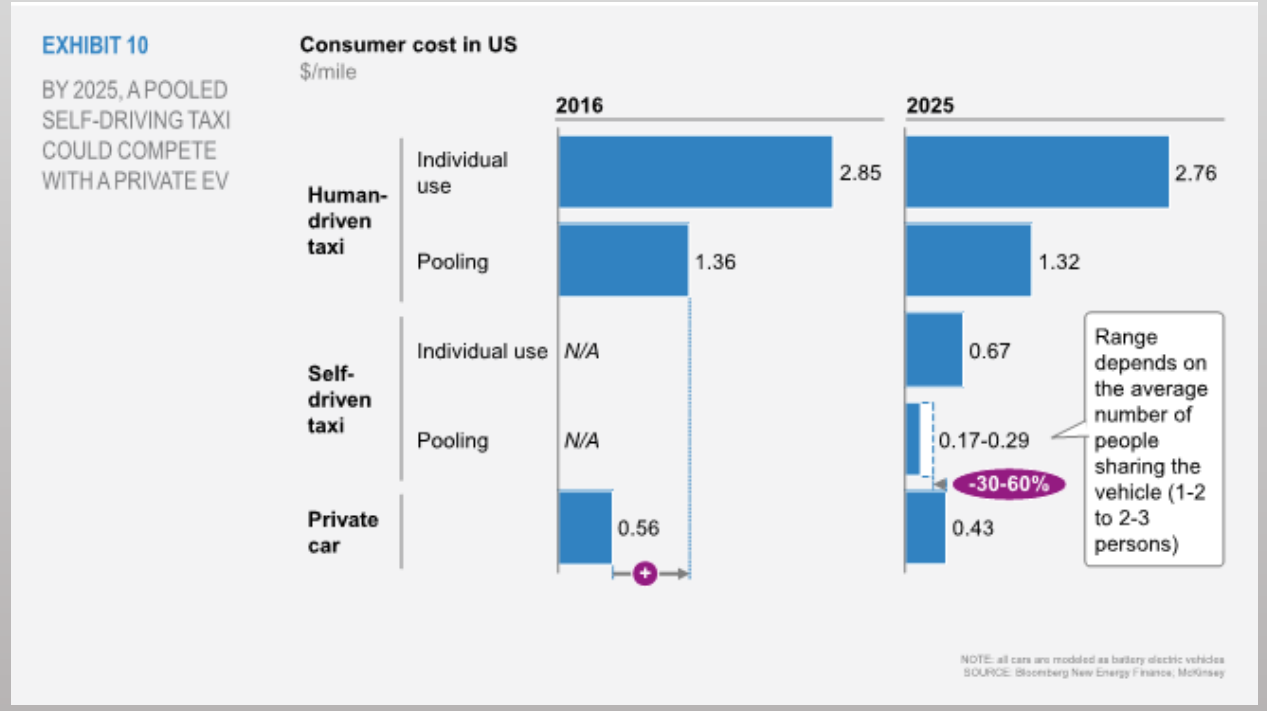


- They combine TNC and traditional taxis to "aTaxi".
- L4 is all that is needed for transit and TNCs because the vehicles operate within a defined area.
- L4 shuttles already operate driverless in several cities today.

The National Academies of SCIENCES · ENGINEERING · MEDICINE
TRANSPORTATION RESEARCH BOARD
Regulations and Policies Impacting AV/CV Introduction in Transit

The TNC end game: Driverless “mobility as a service” (MaaS)

- What makes TNCs attractive today: cost-effective **AND** convenient
- Some say Uber is “buying” market now on big bet that AVs will be cost-effective and significantly impact mobility in future.
- McKinsey projects cost to consumer of **SAVs** will be 30 to 60% less than owning car. But cost of individual ride will be about same if not more than vehicle ownership. Many others have similar figures with a few much more aggressive (lower) for TNC cost.



Many articles:
vehicles and/or parking could decrease up to 90%

Mention up to 90% reduction in parking.

- Clean Technica
- Mother Jones
- Newsweek
- Nelson Nygaard
- Daily Mail
- Medium
- BostonCommons.net
- GreenBiz.com
- Conservative Review
- Atlanta Constitution Journal
- Tech World from IDG
- Science Alert
- LinkedIn posts

Others that mention 90% reduction in cars:

- AutoFacts By Price Waterhouse Coopers
- LA Times
- The Economist
- Daily Mail
- Smart Cities Dive!
- PBS
- Corporate Partnership Board
- RethinkX

90% Reduction In PARKING is a fallacy!

- It's based on studies of potential for reduction in private cars with maximum adoption of **SAVs** using trip data from the National Household Transportation Survey.
  Note: this data source **is** widely accepted as reliable for such studies.
- Aggressive assumptions within studies, then conclusions taken out of context:
  - Study is usually for limited area, say 10 m x 10m and only considers trips that stay within area, not all trips in City
  - Studies assume everyone who could **will** use shared (pooled) service, aka SAVs
  - 90% is reduction in trips or car ownership, not parking,
    by those that choose to use SAVs,
    not all those who park today.

Research-based sources for 90% reduction

1. Price Waterhouse Coopers discussed 90% reduction in **car ownership** in 2013[1]
   but reportedly intended as absolute maximum and "**wake up call**" to auto mfrs.
2. Paris-based Organisation for Economic Cooperation and Development[2] used data from Lisbon, Portugal:
   - 77% **trip reduction** if only one party per ride
   - 90% **trip reduction** if shared with multiple parties
   - Eliminated all on-street parking
   - 80% less off-street parking
- 3,4 Georgia Tech study found Shared AVs could reduce parking demand 90%[3] but only for those that use SAVs all the time.
  - Follow up study for Atlanta data found 5% SAV trips reduces parking demand 4.5%. One SAV can eliminate 20 parking spaces.
- 5,6 Kockelman & Fagnant of University of Texas (next slide).
- 7: RethinkX, Silicon Valley Think Tank: by 2030, 95% of VMT in US will be by TNCs, 5% private.

1 "look Mom, no hands!" AutoFacts, February 2013, Price Waterhouse Coopers
2 http://www.dailymail.co.uk/sciencetech/article-3052458/Study-Self-driving-taxibots-replace-9-10-cars.html#ixzz4gy6uN5fl
3 Zhang, Gubataktura, Fang & Zhang (2015) Exploring the impact of shared autonomous vehicles on urban parking demand. *Sustainable Cities and Societies, 19.*
4 Zhang, Gubataktura (2016) Parking spaces in the age of autonomous vehicles: How much parking will we need and where?

Kockelman & Fagnant AV studies using Austin trip data

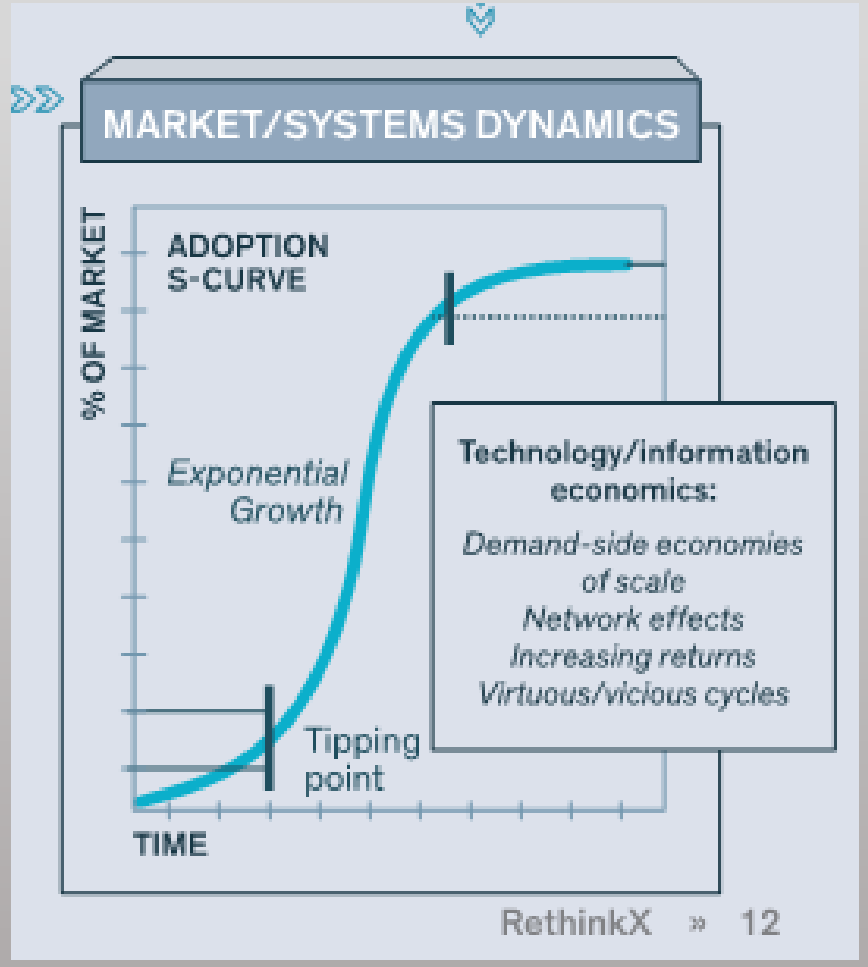
- 2014 study[1]: trips originating in 10 mile by 10 mile area
  - 1 shared AV (SAV) could replace 11 private vehicles.
- 2015 study[2]: trips originating in 12 mile by 24 mile area (288 sq miles)
  - 84% of trips originating within area could be SAV.
  - 1 SAV could replace 9.4 personal cars
  - Parking demand reduced by 8 spaces per SAV
  - VMT increases 8% due to empty trips
- Did not assign any trips in or out of area to SAV
- Assumed every trip that could be by SAV **is** SAV.

1. http://www.engr.utexas.edu/features/shared-autonomous-vehicles
2. Fagnant et al, "Operations of A Shared Autonomous Vehicle Fleet for the Austin Texas Market", *Transportation Research Record* No 2536:98-106, 2015.

Another disruption projection (2017):

Per RethinkX, a Silicon Valley think tank:

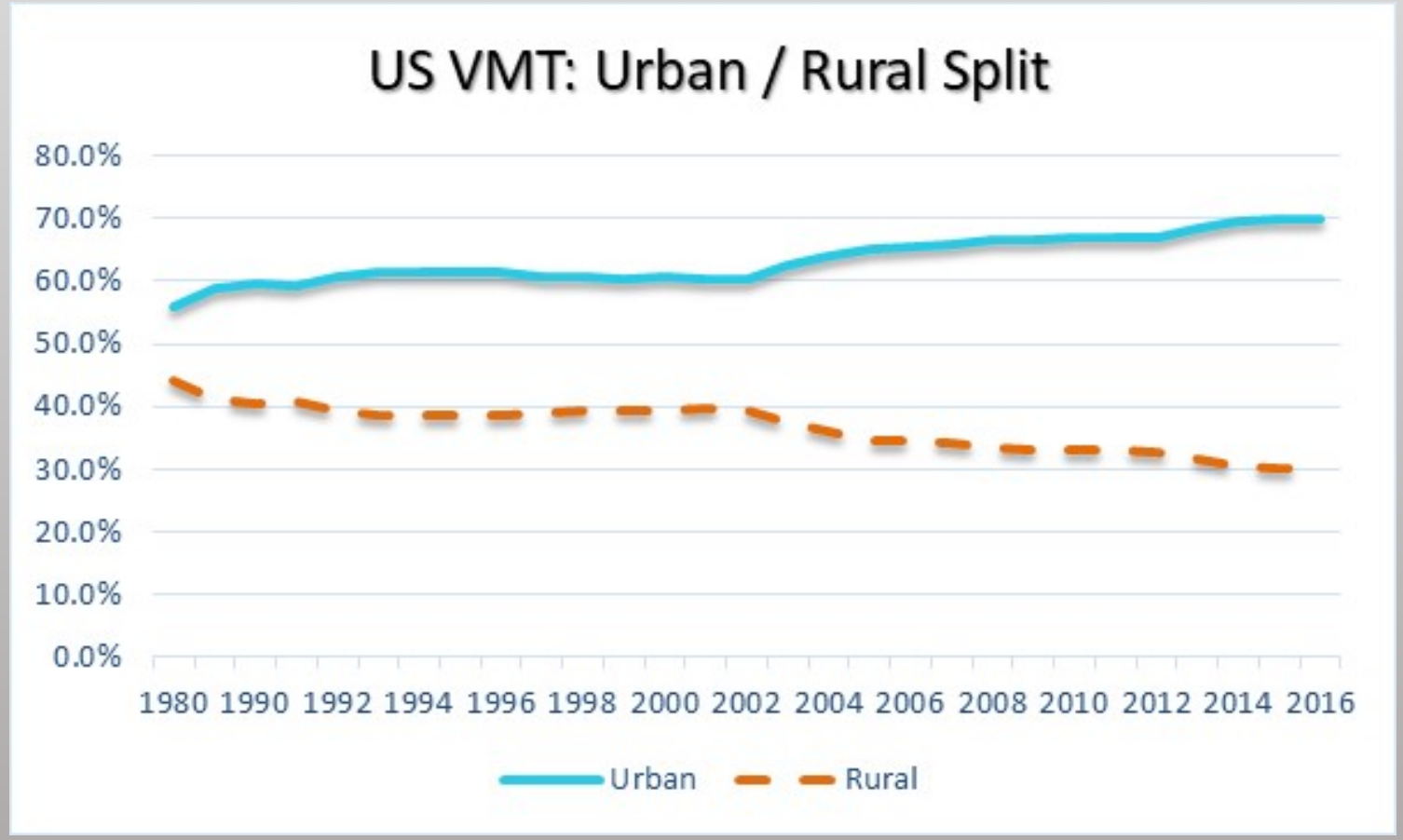
- Regulatory, insurance, technology and other hurdles to TNC AVs will be resolved by 2021.
- Cost of TNC use in 2021 will be:
  - 25% of owning a new car
  - 50% of owning paid-off car
- By 2024, TNCs will reach the tipping point of 15-20% of passenger miles, causing widespread adoption of TNCs
  - Collapse of both auto and oil markets.
    - New car sales will plunge 70% per year.
    - Used car market will be flooded, cars will be abandoned
- By 2030, 95% of VMT in US will be by TNC, 5% by private vehicles.
  - and **none** of the private cars are AVs!



Questions about RethinkX Assumptions

- Assumptions affecting 2021 TNC cost per mile result in very low figures
  - Vehicle Life: 500,000 miles (by 2021!!) increasing to 1 million by 2030 (!!!!), forced to be more durable by TNCs who demand 500,000 mile life. *Automotive News* does predict vehicles will be built to TNC specifications, but these assumptions are aggressive!
  - AV Vehicle Purchase Cost: driven down to **cost of vehicles today** by competition to produce for TNCs.
  - All Electric Vehicles (EV) so lower fuel and maintenance costs.
  - Annual Miles: 110,000 miles (Others 70,000 to 90,000; NYC taxis 70,000/year)
  - Apparently, no infrastructure costs passed to TNCs. Pay today's taxes only, no TNC or grid access fees?
  - Results in cost per mile: 16 cents with 6 cents for pooled rides
    (Nearly all other consultants say at least double if not triple that, but SAVs still lower than cost to own car)
- Assumptions about cost to own private vehicle appear skewed high
  - 11,000 miles per year (vs 13,500 per FHWA, 15,000 per most others; raises cost per mile)
  - No adoption of private AVs by 2030 (that is actually conservative, as AVs cost more)
  - Vehicles purchased by individuals will not be EV, higher fuel and maintenance costs in their model.
- Results conflict:
  - 40% of cars will be private vehicles in 2030, but they only travel 5% of miles. (There is multiplier, but at their 10x annual miles of TNCs vs private and 40% private cars, it would be 84% TNC/16% private VMT.)

30% of US Vehicle Miles Traveled (VMT) is rural
19% of US population is rural (per census bureau)



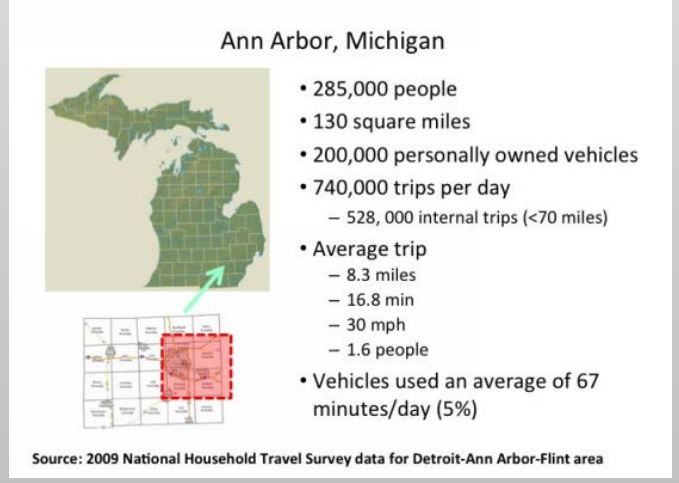
Source: US Bureau of Transportation Statistics

% rural VMT very well may go down further, but can't see VMT rural going down to 10% much less 5% as required for RethinkX

Note: this is personal vehicle travel, not commercial.

Columbia University Study: Ann Arbor NHTS data **130** Sq Mile Area

- 200,000 total vehicles owned by residents in 2009
- 18,000 TNC cars could replace 120,000 vehicles
  - 1 AV replaces 6.67 cars
  - Vehicles owned by locals who drive less than 70 miles/day and in patterns that allow use of TNC
- Appears **not** to have assumed SAVs, just driverless ride- hailing (pooled would result in less TNC AVs, but same potential reduction in private cars.)
- **Maximum change**
  - Cars on the road: 200,000-120,000 +18,000 =98,000
    98,000/200,000= 49% cars on road vs 2009 **(51% Reduction)**
  - Privately-owned: 200,000-120000=80,000
    80,000/200,000 = 40% of cars vs 2009 **(60% reduction)**
- Using Georgia Tech Study for every 5% of residents who give up cars & use TNCs, 4.5% reduction in parking demand
  - 60% reduction in cars*.9 = 54% reduction in parking



1 http://sustainablemobility.ei.columbia.edu/files/2012/12/Transforming-Personal-Mobility-Jan-27-20132.pdf

University of Michigan Transportation Research Institute[1]

- Used **all** US data on household trips, per NHTS.
- Determined households where one AV could shuttle for all daily trips.
- **Most optimistic ultimate** scenario: decline in cars per household from 2.1 today to 1.2, a reduction of 43% **nationally.**
  - More than 43% urban, less suburb, much less rural.
  - Impacts residential parking as well as commuter and other parking.

Note: Study did not consider costs of ownership, or TNCs.

Just if someone could give up a car based on one AV handling all trips.

When you only need one car, it will be much easier to pay for AV.

1 http://www.umtri.umich.edu/what-were-doing/news/driverless-vehicles-fewer-cars-more-miles

Why are the academics and many others pushing SAV?

- The " trifecta" of shared, electric AVs has potential for huge environmental savings: "How the U.S. Transportation System Can Save $1 Trillion, 2 Billion Barrels of Oil, and 1 Gigaton of Carbon Emissions Annually," 2015 article by RMI.
- And the reverse is true: If AVs are not shared and electric, there will be "more gridlock, more pollution and more emissions."
- To avoid the latter, public policy and regulations will have to force usage towards EVs, limited miles driven empty **and** SAV rides.

Source: Http://e360.Yale.Edu/features/will-self-driving-cars-usher-in-a-transportation-utopia-or-dystopia

The more likely scenario than 90% SAV trips:

LOTS of choices, and behaviors:

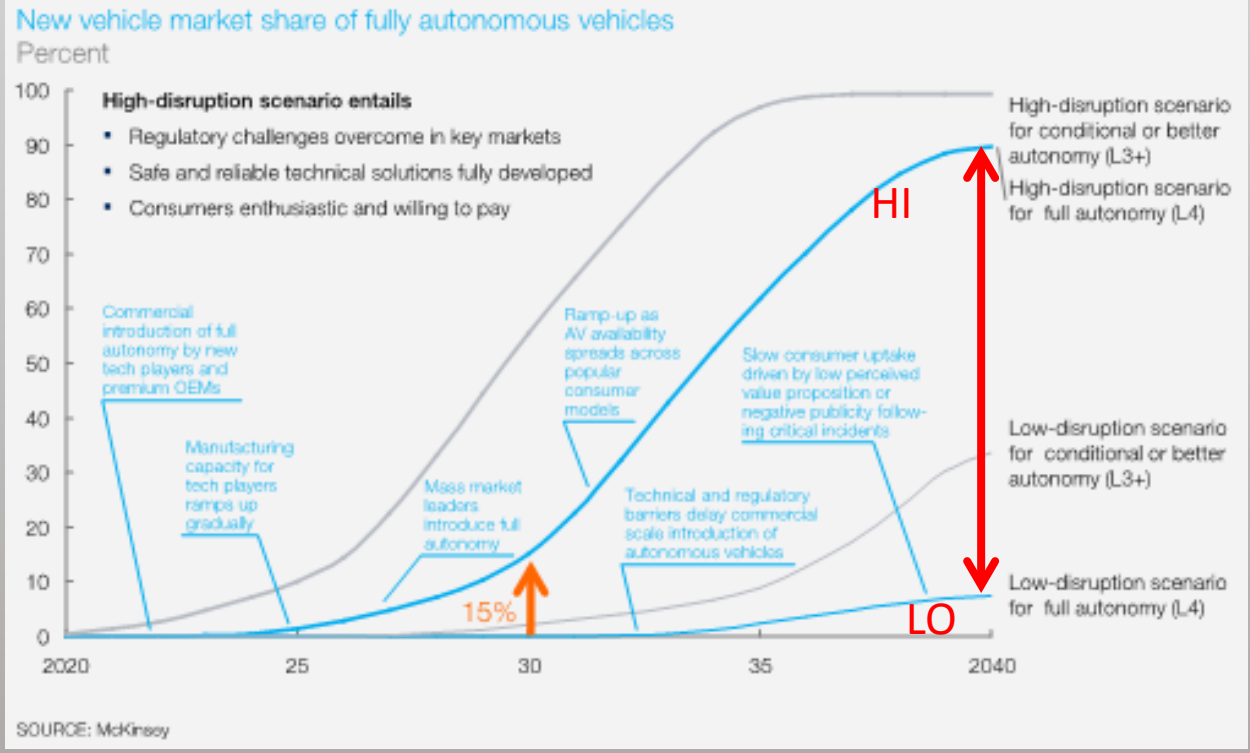
- SAV for commuting and/or all rides
  - Many of these may come from bus transit, car pooling, biking and walking, as well as from SOV commuting.
- Private TNC rides rather than shared ones for at least some trips for those that do give up cars
- One owned AV with TNC for remaining trips.
  - AV used for long commute (parked at work) and TNC for errands/short trips
  - AV used for short commute and use TNC to transit for long commute
- One owned AV for all trips, returning home between
- Commute by AVs and gain productivity time, justifying the increased cost of vehicle. Park on the perimeter not at workplace.
  - Move farther out but use personal AV while maintaining up to 1 hour commute. (Many transportation officials/academics worry about this.)

Our Conclusions:

- More realistic potential, average parking demand reduction **nationally** is **-40% per unit landuse** (per residence, per sq ft floor area office or retail.)
- Significant variation based on **residentia**l density:
  - City by city
  - Neighborhood by neighborhood
    - Variations also based on land use (e.g. office versus entertainment) and geographic areas (e.g. Massachusetts vs Montana) too.

Timing projections:
Wide range (↕) of market share of L4/5 AVs in sales

Subject to progress on the technical, infrastructure, and regulatory challenges, up to 15% of all new vehicles sold in 2030 could be fully autonomous



Article does predict:

- 15% **new cars sold** in 2030 AVs, with 2/3 to TNCs
- Sales, not all vehicles on road; nothing on overall impact on vehicles on road and VMT

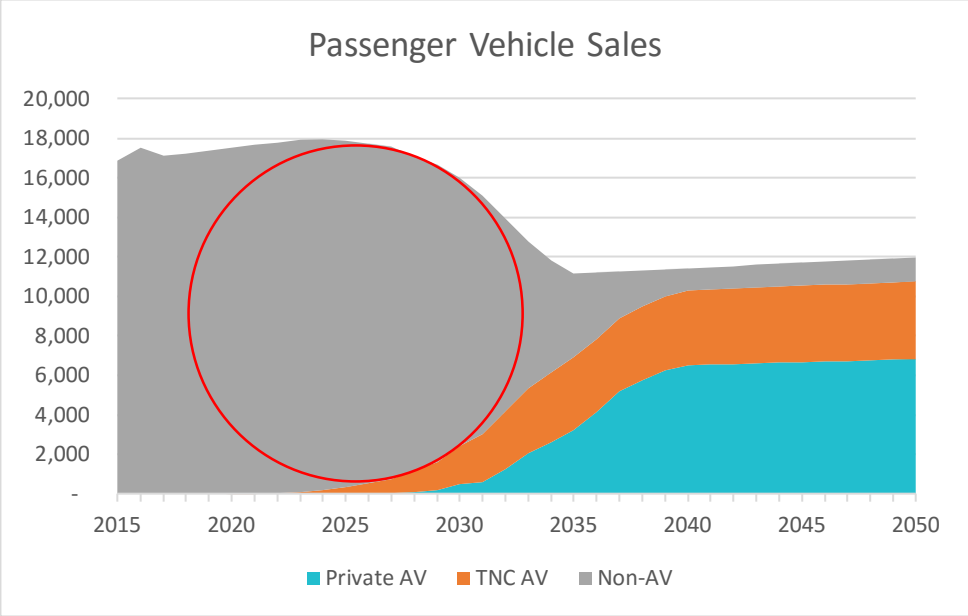
Factors in disruption scenarios	High disruption	Low disruption
Regulatory challenges	Fast	Gradual
Safe, reliable technical solutions	Comprehensive	Incomplete
Consumer acceptance, willingness to pay	Enthusiastic	Limited

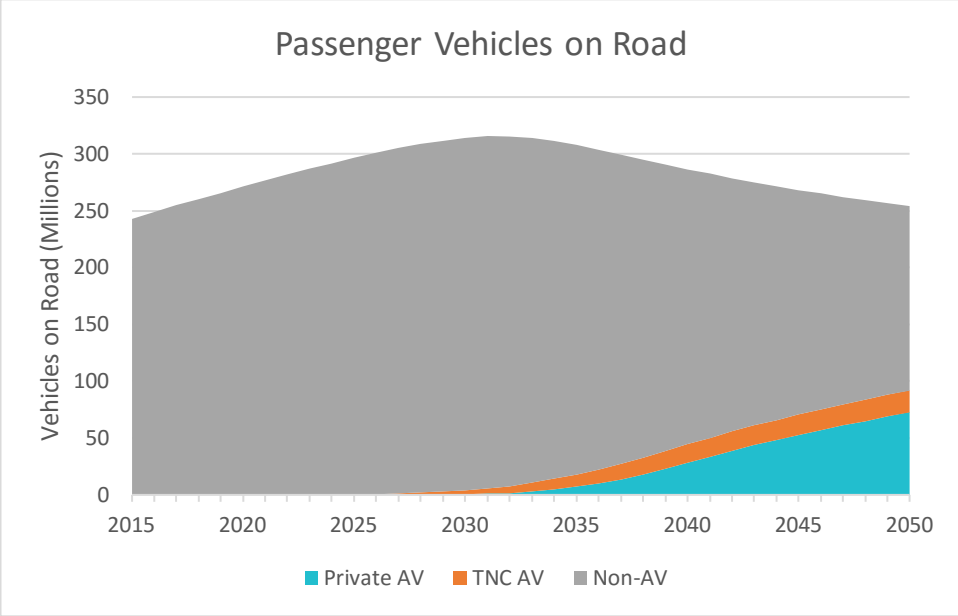
[1]Conditionally autonomous car: the driver may take occasional control.
[2]Fully autonomous car: the vehicle is in full control.
[3]Original-equipment manufacturers.

McKinsey&Company

http://www.mckinsey.com/industries/high-tech/our-insights/disruptive-trends-that-will-transform-the-auto-industry

Projections, US
(using McKinsey High Disruption Scenario)





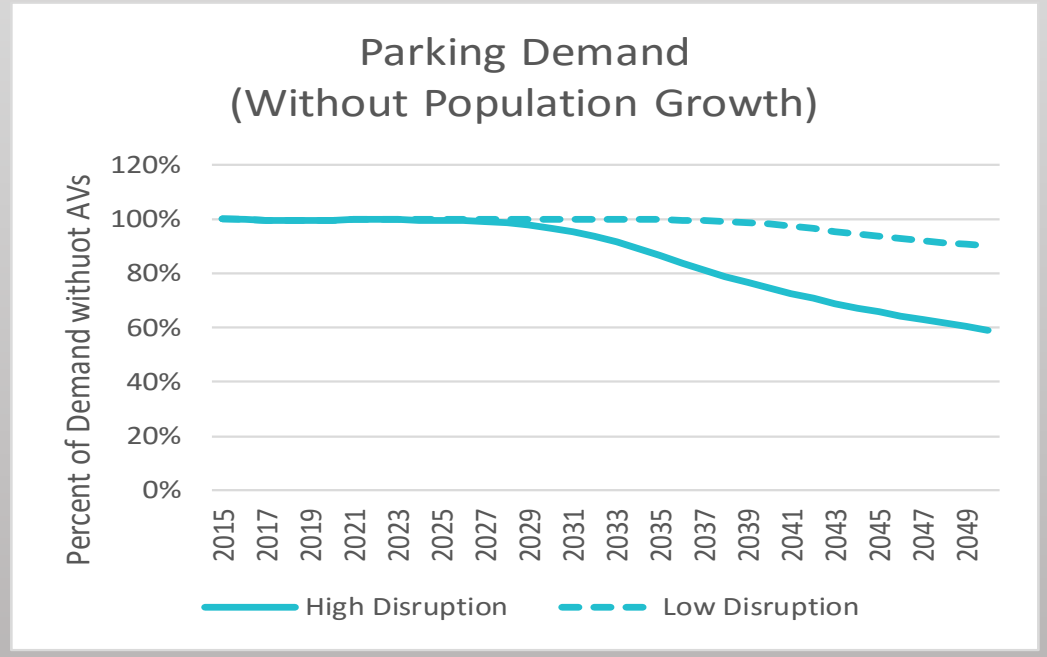
Time line for L4/5 AV sales:
- 15% AV by 2030, 12% TNC*
- 90% AV by 2040, 33% TNC, practical limit based on multiplier of TNC miles/vehicle

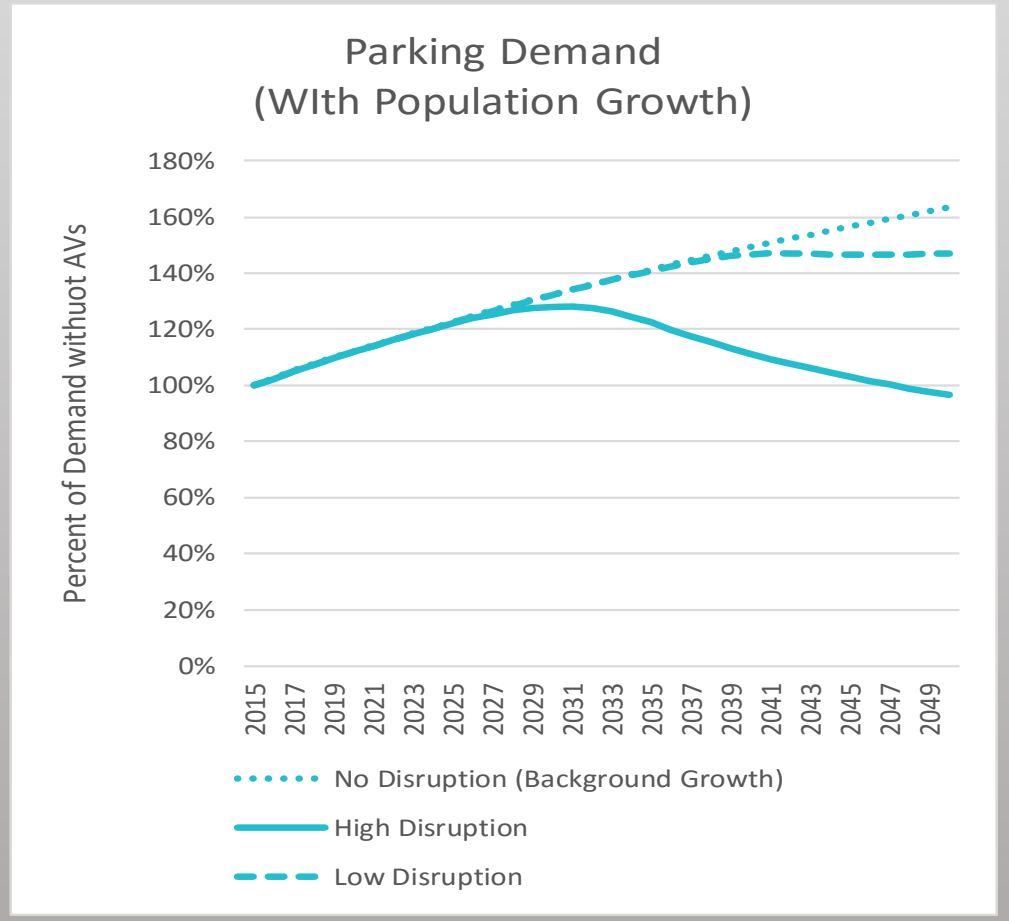
Based on:
- 5 year life of TNC AVs, then scrapped & replaced.
- -2.3 personal car sold per TNC AV sold (per McKinsey)
- Population growth per US Census Bureau

- Scrappage for private vehicles = 4.5%[1]
- At full adoption:
  - Vehicles on Road: 2/3 private, 1/3 TNC
  - VMT: 72% TNC, 28% private

[1] http://news.ihsmarkit.com/press-release/automotive/vehicles-getting-older-average-age-light-cars-and-trucks-us-rises-again-201

Impact on Parking Demand: NOT 90% reduction…. somewhere **between** -10% and -40%





- High disruption uses 40% maximum impact
- AV sales per McKinsey study
- Adjusted to vehicles on road
- Population growth per US Census Bureau

#AirportSymp

We can…and should… Think/Plan/Do now

#1: Avoid over supply of parking.

- Provide **just enough** for commerce to thrive.
- Shared parking & mixed uses…. **not chicken pox** development!
- Provide flexibility in planning and design to increase **or** decrease supply.

Image per Google Earth

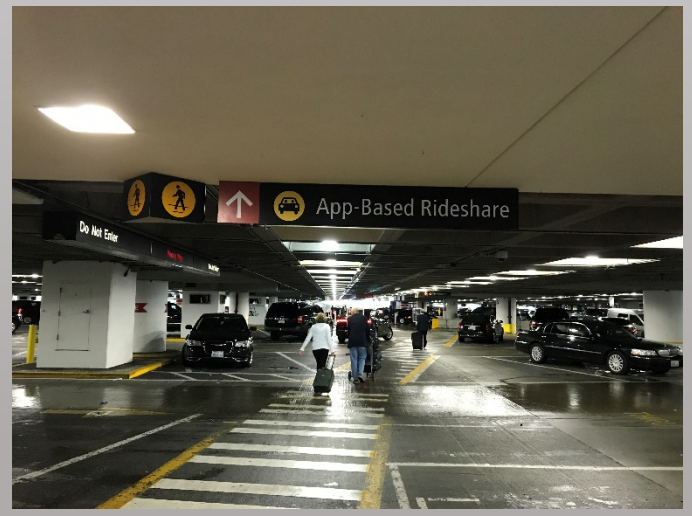
TNCs are already affecting Passenger Loading Needs AVs will accelerate the problems

- Hospitals and other buildings that have some passenger loading zones now, may not have enough.
- Event facilities are having significant issues with post-event pickup
- Most downtown properties today do not have off-street passenger loading zones
  - Cities will likely have to convert on-street parking spaces to passenger loading. Eventually could result in significant loss of parking and revenue.
    - Do curb management, TNC user fees/P3s and transition plans, **NOW**!
  - Private properties, both existing and new, should plan for passenger loading inside parking facilities for autonomous parking and perhaps for TNCs.

Passenger waiting area inside parking facility at The Grove, Los Angeles.

Airports have most impact from TNCS so far

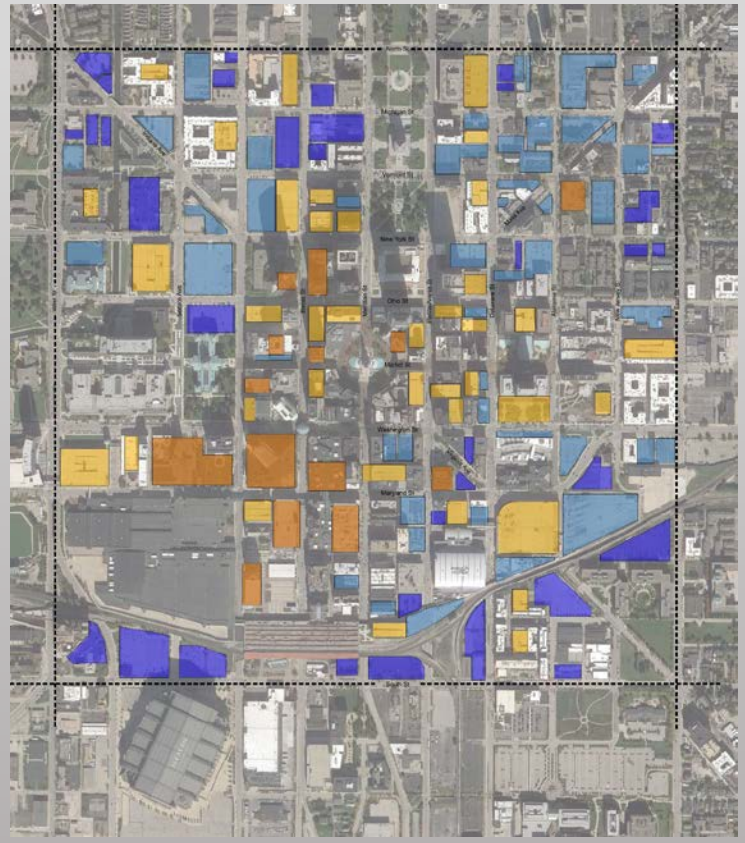
- Almost half already having congestion and capacity issues at the curb.
- Airports are moving TNC passenger loading inside parking
- EVERY airport parking improvement plan should include study of future need for passenger loading zones



#AirportSymp

Longer term: **Multi-Parking facility** systems

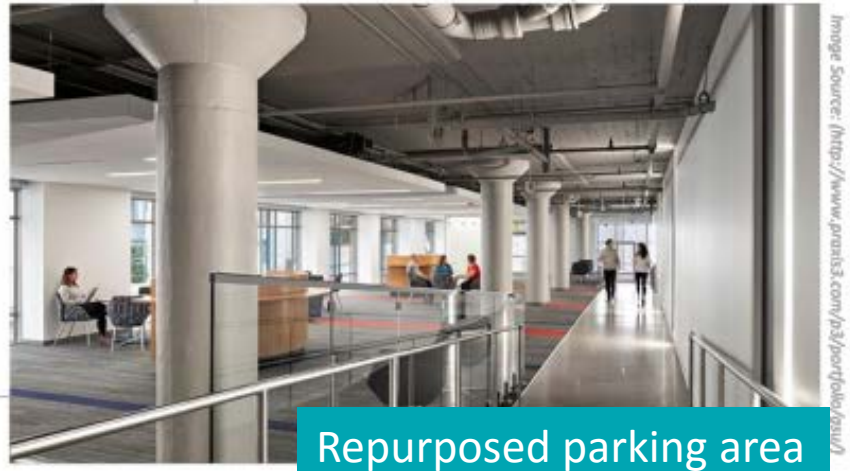
- Decreased importance on parking close to destination
  - More parking on perimeter of downtown, campus and remote airport facilities, less needed in core
- Campuses, hospitals, downtowns, large mixed use
  - Surface lots will be redeveloped first
  - Oldest and/or deteriorated stand-alone garages may be torn down and replaced by new buildings with little or no parking.



In other words, parking market will likely absorb most of the changes in demand over time.

Adaptive Reuse: Relative Premiums Above New Structure Cost

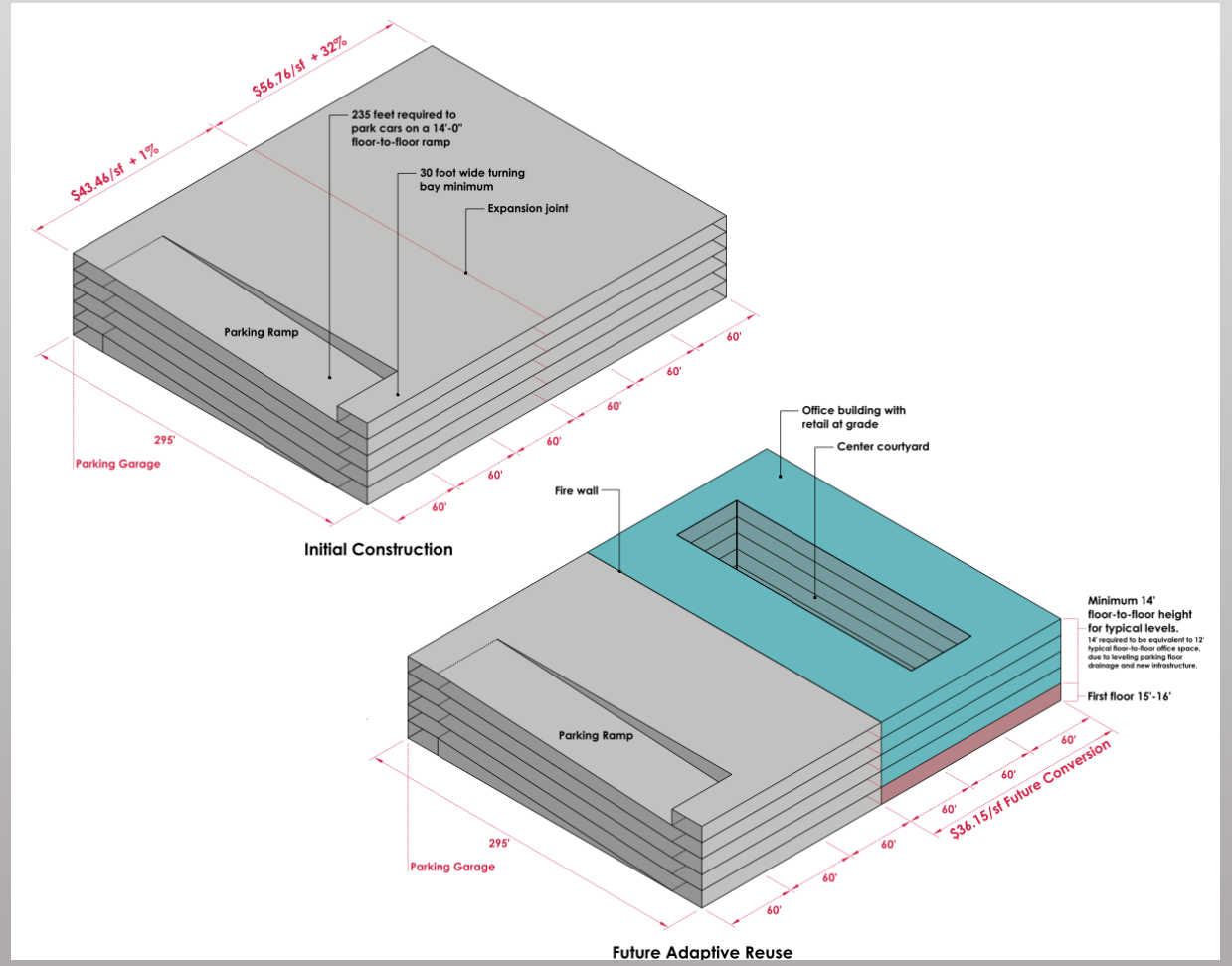
Up to 10 % Premium	11-25 % Premium	>25% Premium & Above
• Design for taller floor-to-floor heights, especially at grade; • Design for increased floor loads; • Design for less drift (lateral deflection) for future occupied space; • Design for less vertical differential settlement and deflection for future occupied space; • Design for ramps on the edge of floor plan for partial conversion; • Design façade for future building conversion; • Design for future shafts and floor penetrations; • Plan for additional empty utility infrastructure (duct banks, blank panels, sleeves, etc.); • Plan for oversized or additional MEP rooms; and • Design for wider stairs for more occupants in future or provide areas for future stairs and elevators.	• Review if medium span construction is required for future alternate use (30x45 ft.); • Increased set back to property line for future liner buildings, stairs/elevators, etc. on one or more sides; and • Design top level of parking for assembly or other "heavy" use like a garden or park, or events.	• Review if short span construction (30x30 grid) is required for future alternate use; • Provide all express ramps, all flat parking areas for future removal of express ramps; • Design all floors (or many floors) for 80 psf (or more) live load for future occupant flexibility; and • Provide one level of the parking below grade for future support space (MEP, storage, etc.).



Repurposed parking area

Case Study: Design ½ Structure for conversion

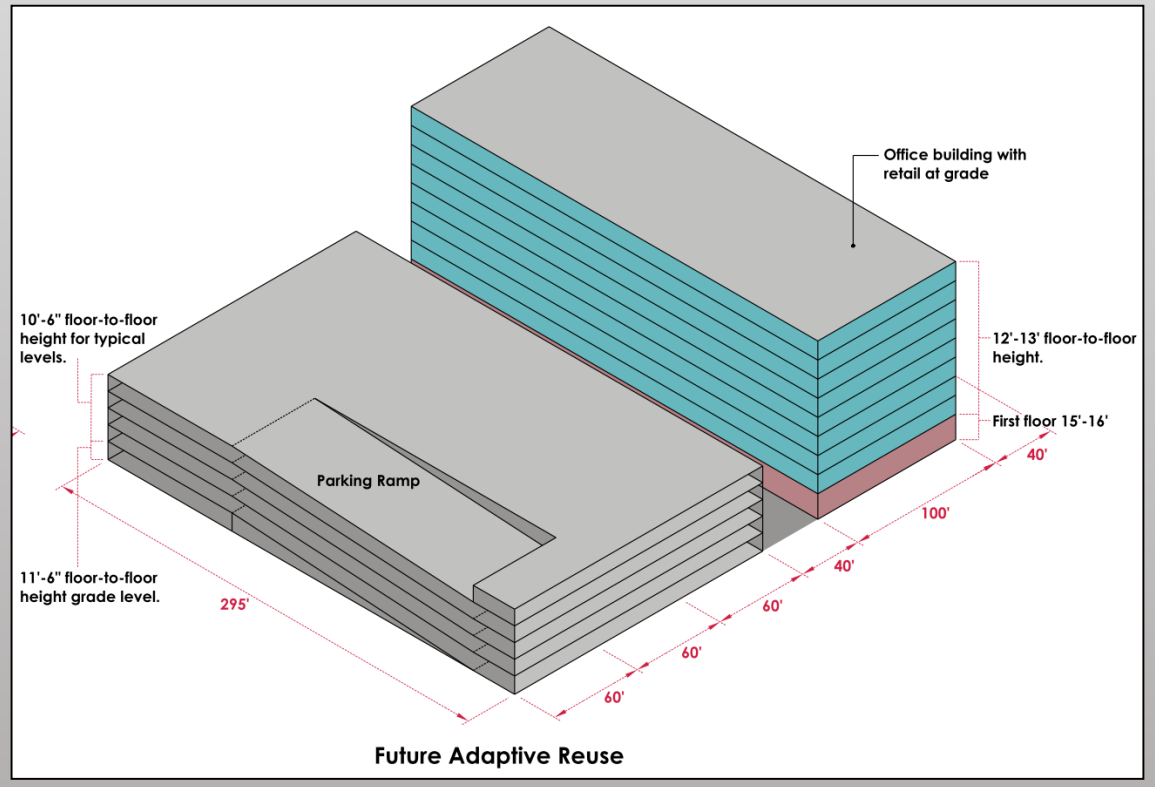
- Cost of additional floor-to-floor height: **<1%**
- Cost to use express ramps rather than parking ramps all floors: **10 to 15%**
- Cost in initial design for conversion in future:
  - More drains to reduce cost of leveling floor
  - Structural modifications for future office loads
  - Removeable parking bay for future courtyard
  - Removable/adaptable exterior façade
  - Cost for Future Conversion **+32%**
    (applicable to area designed for conversion)
- Future cost of conversion to **cold dark shell**:
  - Demolition
  - New façade
  - Added stairs and elevators
  - Remove and replace grade slab
  - Roof treatment
  - Future cost to convert: **$36.15/sf.**
- Total cost of conversion (net of normal parking cost)
  - **$ 49.32/sf** of initial area designed for conversion.
- Total cost of cold dark shell **$92.30**



#AirportSymp

Doesn’t this make more sense?

- Provide expansion joint for ease of future demolition.
- Construct ideal building to suit the market…and add demand for unused parking… in 20 or 30 years.



Future Adaptive Reuse

In sum, designing for 100% conversion may not be appropriate for **most** parking structures built today

- Any site/area with multiple parking structures: **Better to tear down oldest, poor parking** than convert newer, state-of-the-art parking.
- But do provide for conversion of logical areas:
  - future retail at grade (15’ min fl to fl height, express ramp to P2)
  - future additional occupied floors (cost of foundation and column increases)
  - alternate uses on roof (cost of foundation, column and top floor framing increases)
  - future residential wrap (underutilized site opening day, careful planning of openness to keep natural ventilation)
  - horizontal “un-expansion” (double-column expansion joint)

Innovative Adaptive Reuse

US Ski team training in Slovenia

https://www.wsj.com/articles/this-u-s-olympic-team-practices-in-a-refrigerated-parking-garage-in-slovenia-1519039660?mod=searchresults&page=1&pos=1

THANK YOU!