AUTONOMOUS VEHICLES: What Should We Expect?

Prof.Dr. Serhan TANYEL
Dokuz Eylül University
Department of Civil Engineering
Transportation Safety and Accident Investigation Application and Research Center

Content

- Transportation Concept
- Urban developmet-transportation relation
- Autonomous vehicles
- What do we expect from autonomous vehicles
- Threats and opportunities

Definition of Transportation

As transportation is defined as the displacement of a physical unit from a starting point to a destination or the transfer of cargo and passengers from one place to another, today not only physical elements are the subject of transportation, but also the transportation of information and images between two points has made it necessary to expand the definition.

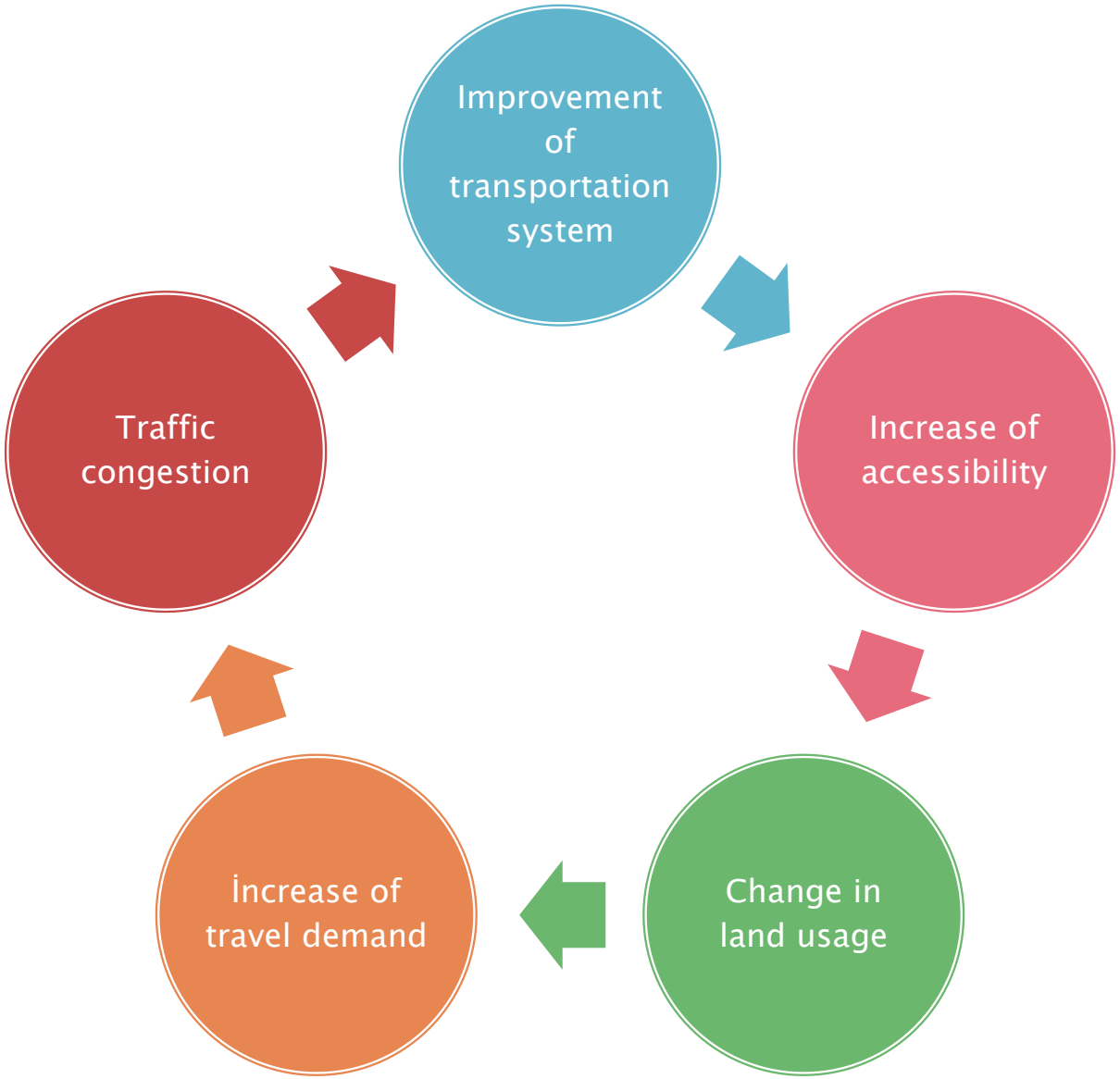
Definition of Transportation

In this context, transport or transportation; can be defined as "the activity of transporting people and their goods (raw or processed) and services (news, information and images) from one point to another by various means".

ULAŞIM SİSTEMLERİNİN MEKÂNSAL ANALİZİ (Doç. Dr. Muzaffer Bakırcı, İstanbul Üniversitesi Açık ve Uzatan Eğitim Fakültesi, İstanbul ,2021)

3 different perspectives have been used in the design of transportation systems since the 20th century.

- Traffic perspective
  - Movement of vehicles (especially passenger cars)
- Mobility perspective
  - Movement of passengers (people) or goods (freight etc.)
- Accessibility perspective
  - Ease of obtaining goods, services and activities

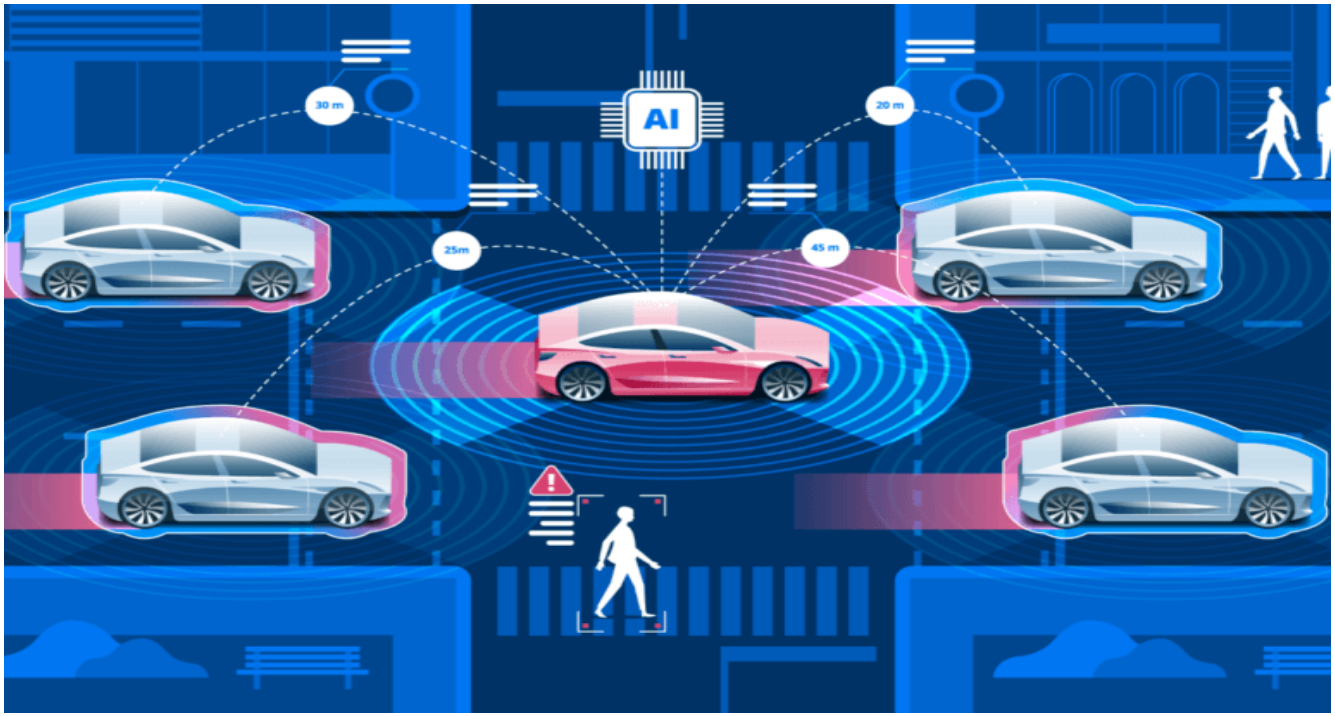

Improvement of transportation system
Increase of accessibility
Change in land usage
İncrease of travel demand
Traffic congestion

If plans are made by considering the transport-land use relationship, human-friendly, environmentally livable cities can be obtained.

If we design cities for automobiles, we will achieve an environment where environmental pollution reaches incredible rates, traffic jams are constantly experienced and people are unhappy.

What is an autonomos vehicle?

An autonomous vehicle can be defined as a vehicle that can transport the vehicle from one point to another without human intervention or remote control.



- Autonomous vehicles are thought to be able to detect certain dangerous situations in traffic faster than humans and react more quickly.
- As a result of all this, the use of autonomous vehicles is expected to achieve increased motorway and intersection capacities; reduced accident numbers; increase in time, fuel, and energy efficiency, and so on

- Noor, A. K., and S. A. Beiker. 2013. “İletişim Kurabilen Otomatik Araçlar.”Mühendis ve Makina 54 (642): 18–23

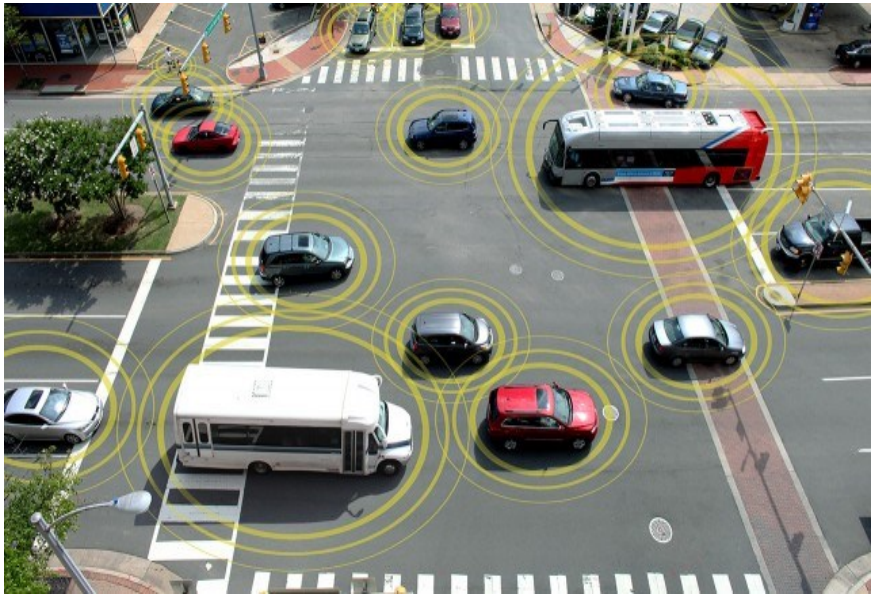
Path to autonomous vehicles: 1925-2025

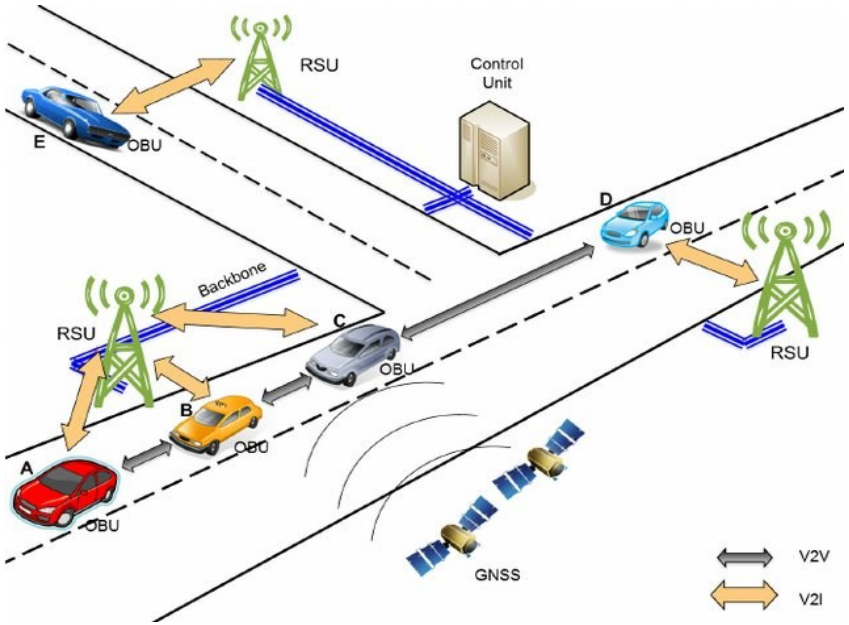
SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Source: SAE International J3016

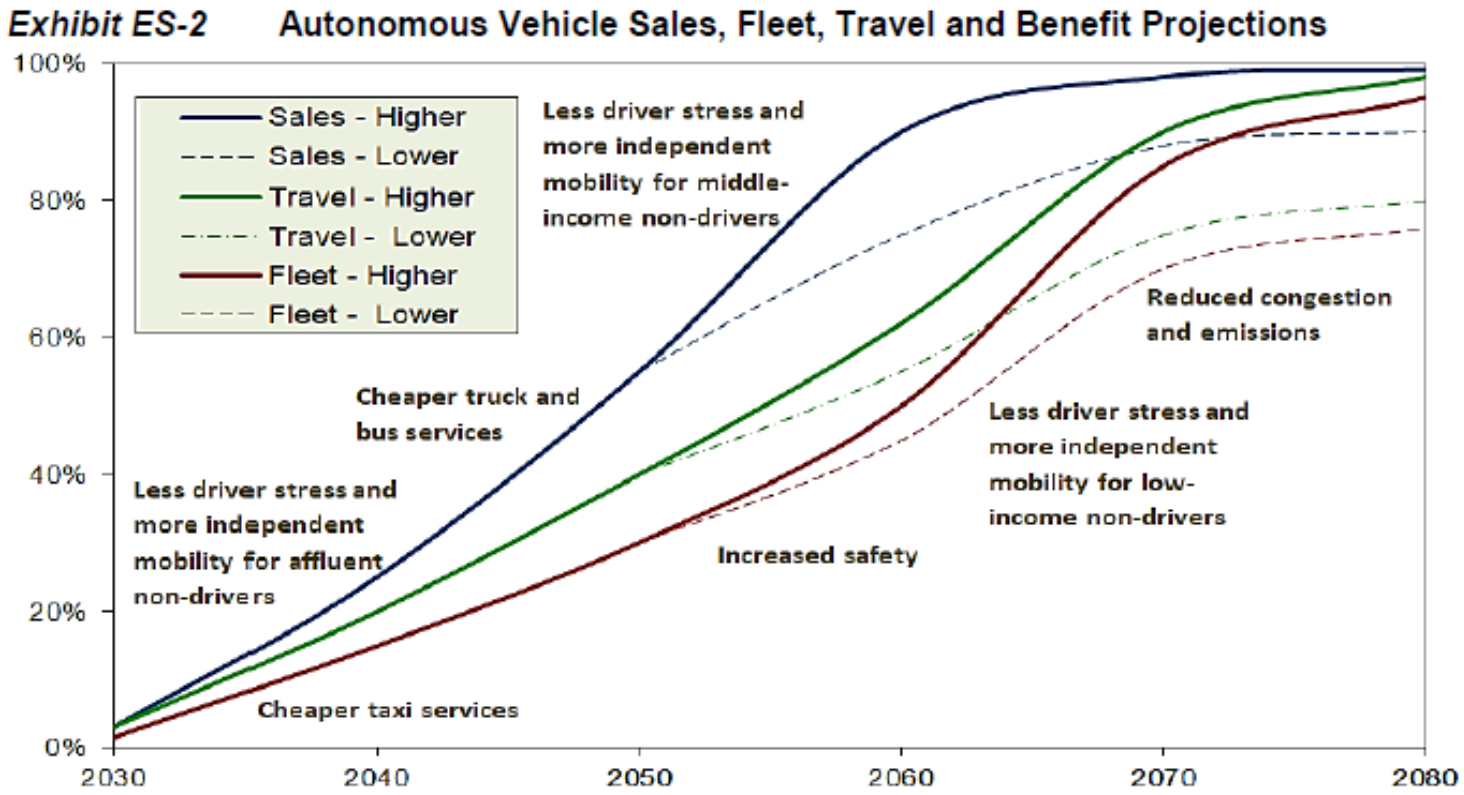
For autonomous vehicles 5 communicaion types can be defined (V2X Basics, 2018):

1. V2V (vehicle to vehicle),
2. V2N (vehicle to network),
3. V2I (vehicle to infrastructure),
4. V2P (vehicle to pedestrian) ,
5. V2X (vehicle to everything).





Autonomous Vehicles Sales, Fleet, Travel and Benefit Projections (Litman, 2022).



The potential impacts of connected and autonomous vehicles are wide ranging. These include, but are not limited to, the following broad subject areas:

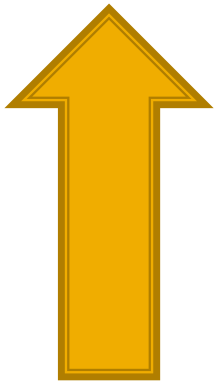
1. Safety and unplanned incidents;
2. Travel demand and car ownership;
3. Emissions, air quality and global climate change;
4. Route planning, choice and in-vehicle navigation;
5. Accessibility, travel choice and social inclusion;
6. Provision of data for network operations and strategic planning; and,
7. Link capacity, junction capacity and network service level.

SAFETY

Decrease in Traffic Accident Rates

Safety

Numerous sensors, lidars, etc. are used in the design of driverless vehicles. In addition to technologies, many mathematical algorithms which are constantly developed and tested especially for the prevention of traffic accidents.



For example, all newly manufactured vehicles will soon have new systems to ensure that speed limits are obeyed.

Uber'in sürücüsüz otomobili kaza yaptı, yayayı öldürdü

Dünya Haber Giriş: 19 Nisan 2021 Pazartesi 09:34 | Son Güncelleme: 19 Nisan 2021 Pazartesi 10:07 | Kaynak: KPRC 2, Reuters

Sürücüsüz Tesla otomobil kaza yaptı: 2 ölü

Son Haberler Tümü

- 22:34 Soğan tarlalarında aşı mesaisi
- 22:21 FETÖ firarisi istihbaratçı komiser saklandığı evde yakalandı
- 22:26 ABD'deki Delta varyantı son büyük varyant olabilir
- 22:19 12 gün önce adada bulunan kadın, zengin bir iş insanı çıktı
- 21:44 'Terörizmle Mücadele Müşterek Eğitimi ve Tatbikatı' gerçekleştirildi

Aramak için buraya yazın

16°C

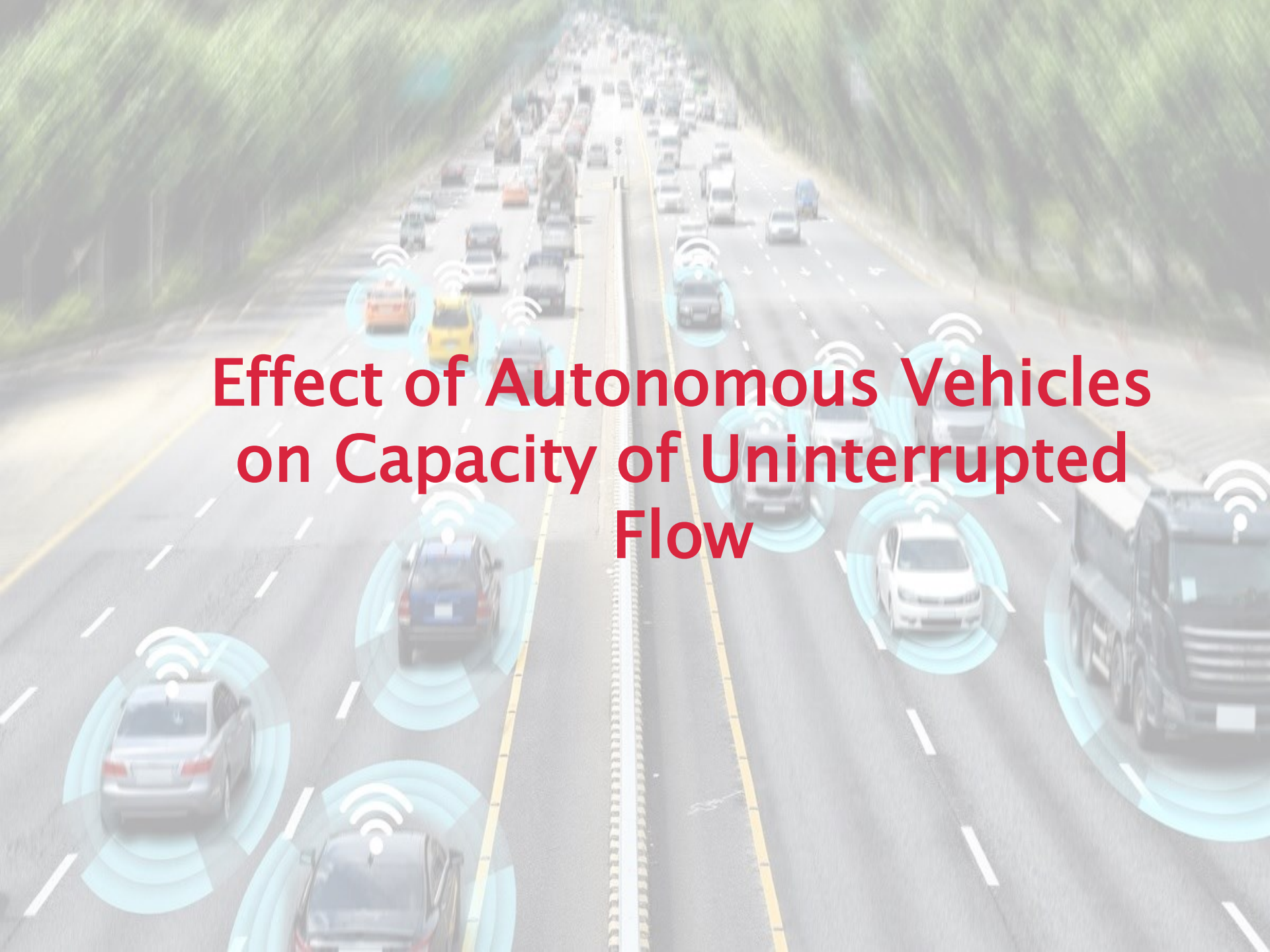
Safety

- Technologies are still in development.
- There are serious concerns, especially with night driving.
- While it is said that full participation of driverless vehicles in traffic will be achieved in 2020, this date has been postponed.

CAPACITY

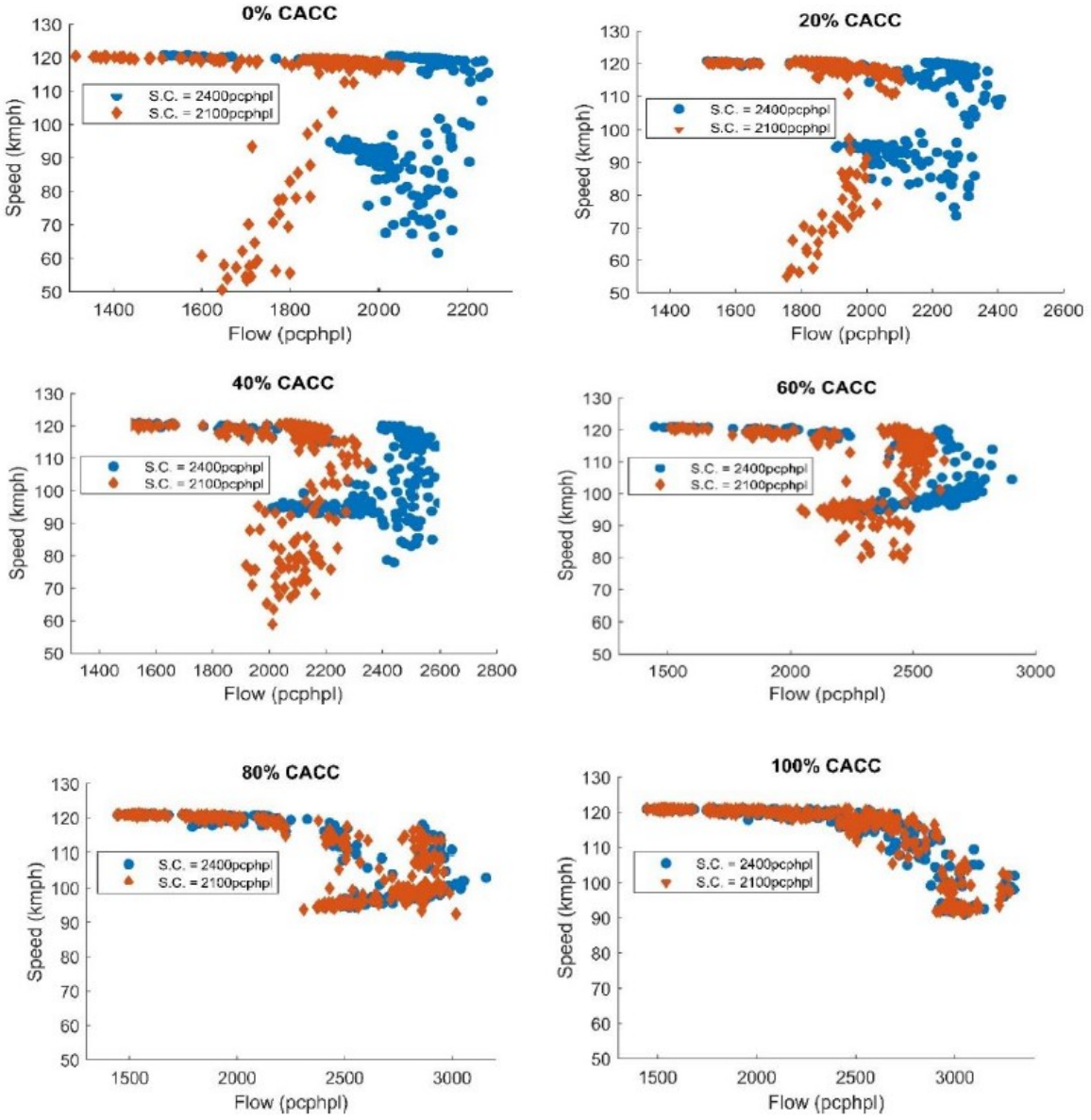
Increase in Road and Network Capacity

- Communication systems like V2V, V2I or V2X may provide significant increase in capacity and improvement in performance of highway network.
- However, in the case of using roads with human drivers, safety will come to the fore and the expected capacity may not be reached, and in some cases it may even lead to a decrease in capacity.

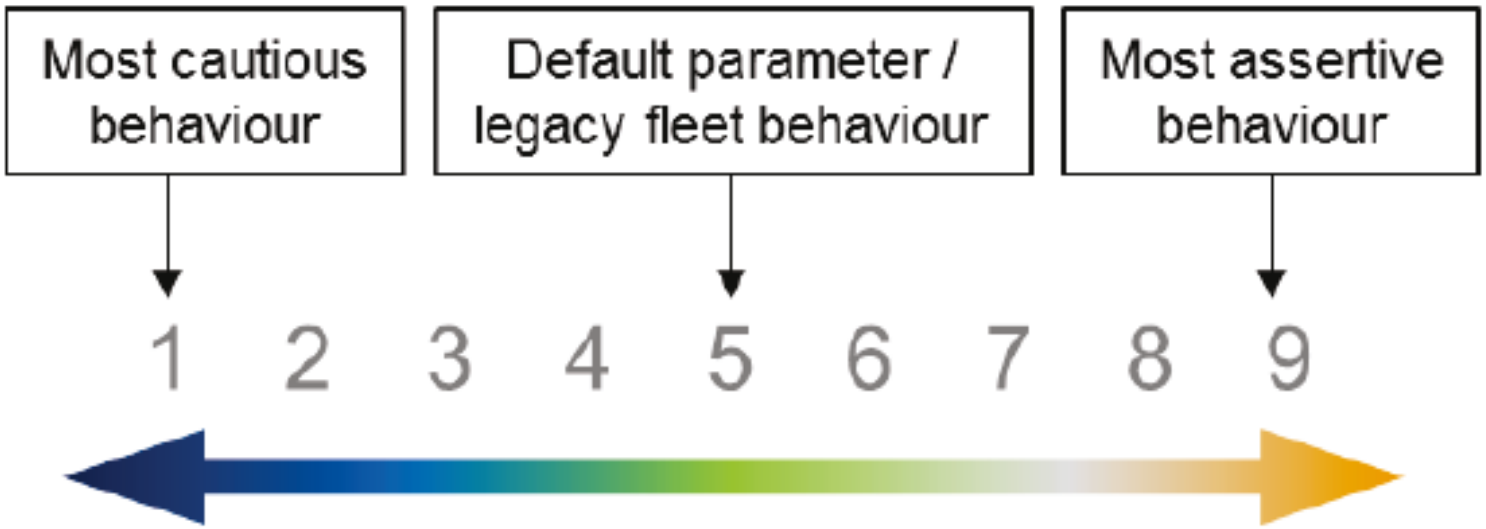


Effect of Autonomous Vehicles on Capacity of Uninterrupted Flow

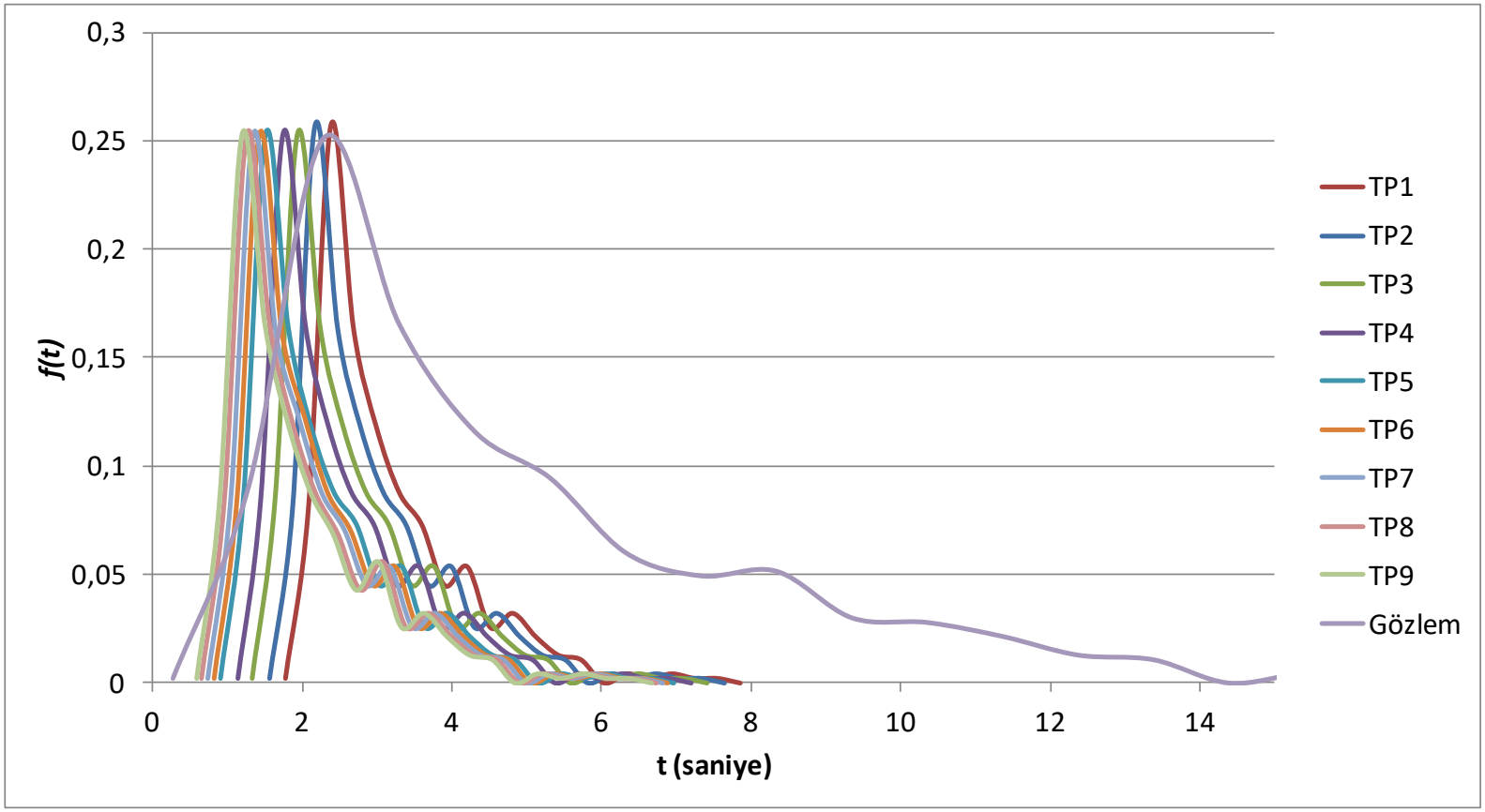
Speed-Flow Graphs for different rates of autonomous vehicles (HCM 7)



Different Driving Strategies for Autonomous Vehicles

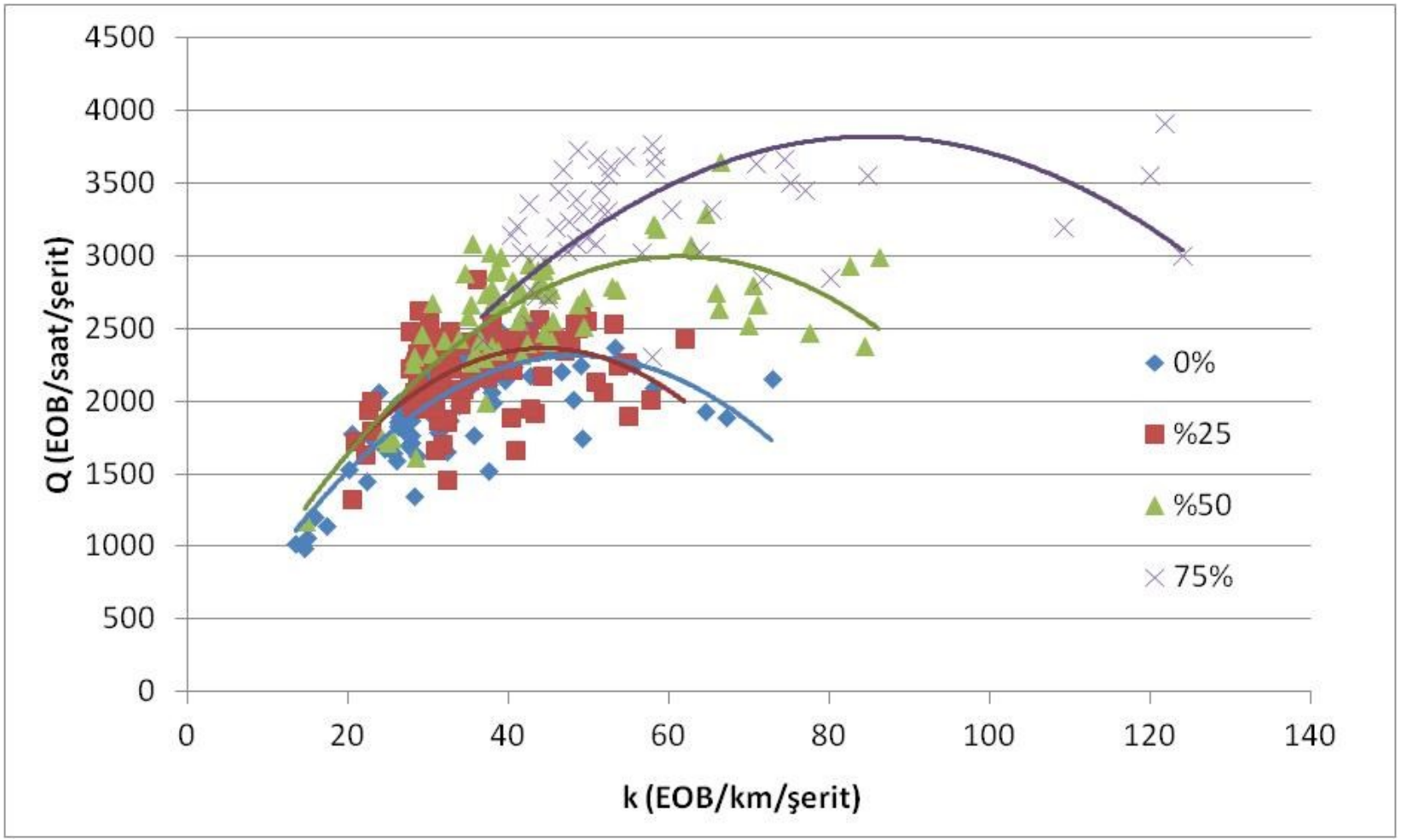


Headway Distribution Function Graphics for Different Driving Strategies

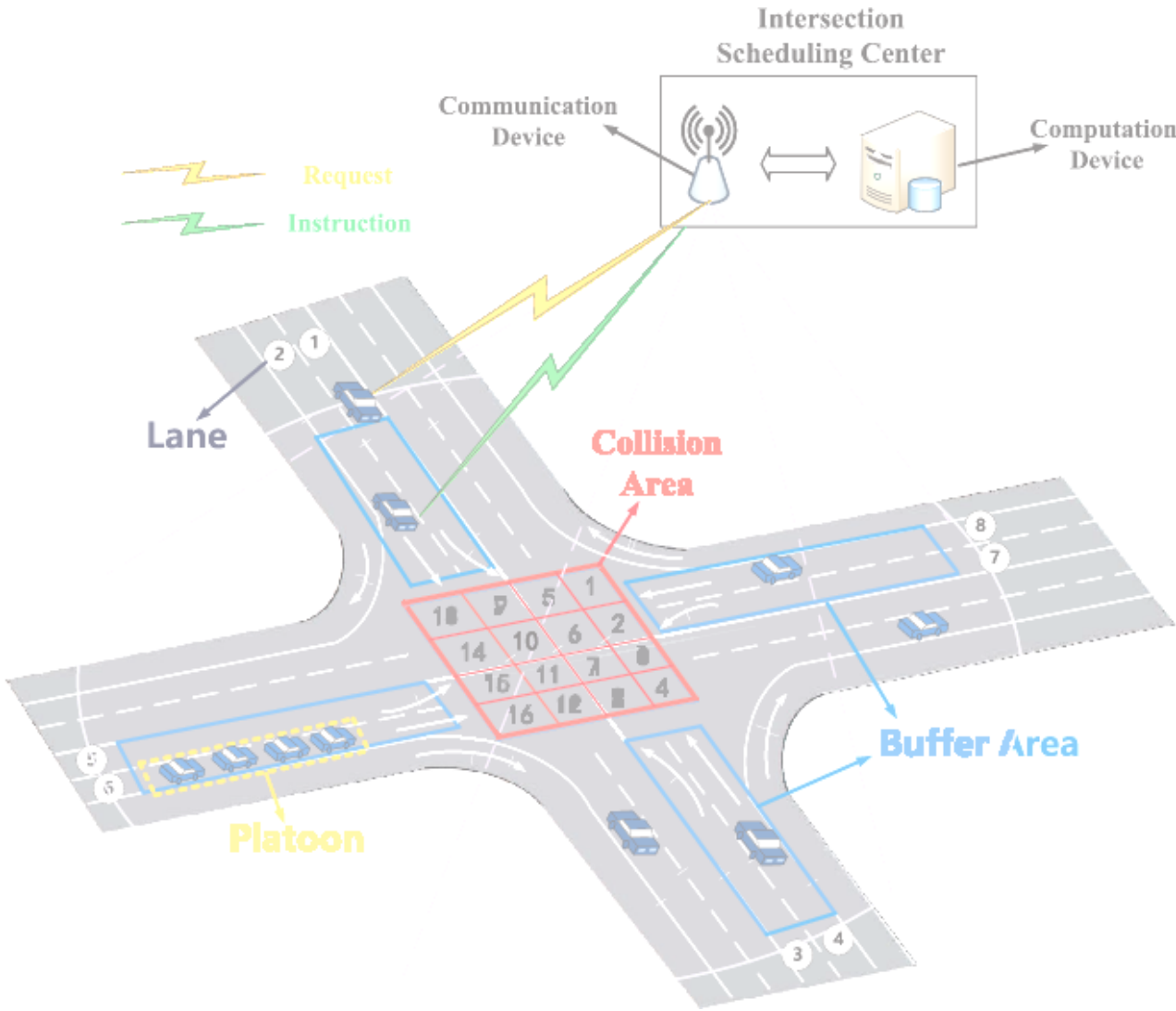


Analysis for a left lane in İzmir

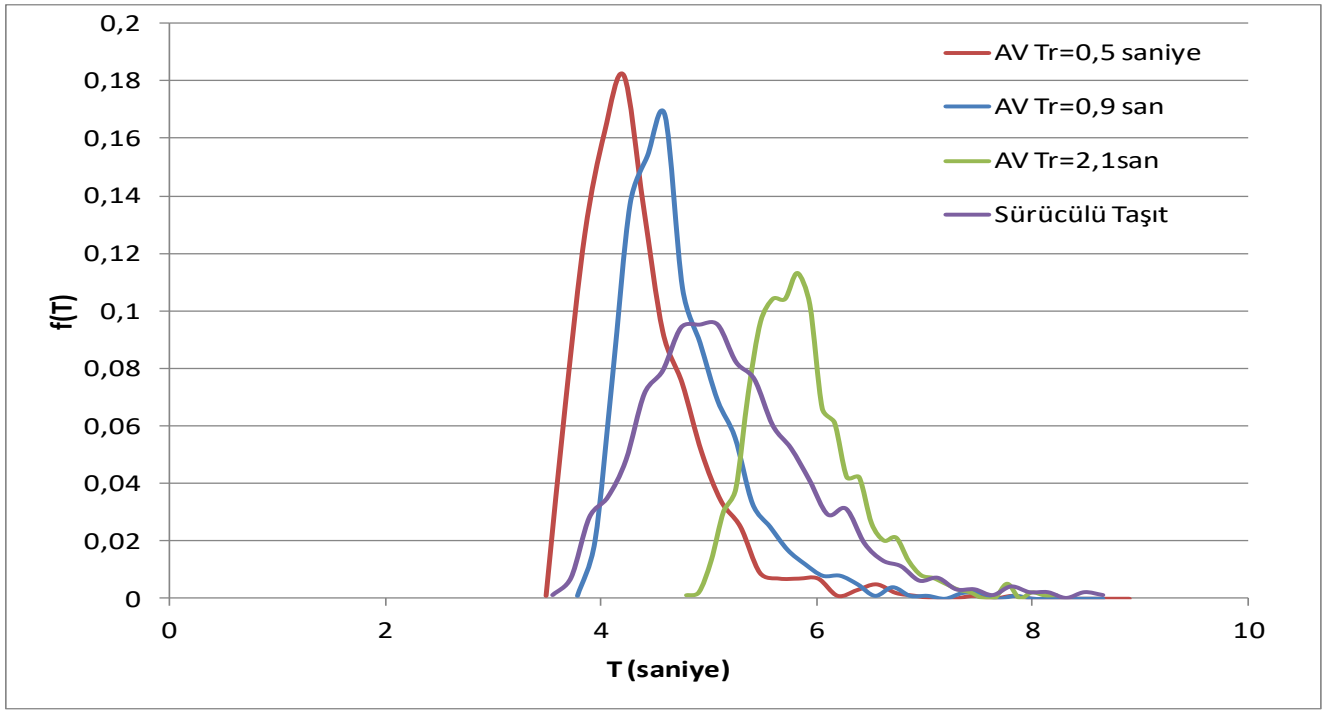
	Gözlem	AV=%10	AV=%20	AV=%30	AV=%40	AV=%50	AV=%60	AV=%70	AV=%80	AV=%90	AV=%100
TP1	2113	2022	1938	1862	1791	1725	1664	1607	1554	1504	1458
TP2	2113	2056	2003	1952	1904	1858	1815	1773	1733	1695	1659
TP3	2113	2096	2079	2062	2046	2030	2014	1998	1983	1968	1953
TP4	2113	2133	2153	2174	2195	2217	2239	2262	2285	2308	2332
TP5	2113	2175	2241	2311	2385	2465	2550	2641	2739	2844	2958
TP6	2113	2192	2277	2368	2468	2576	2695	2824	2967	3125	3301
TP7	2113	2205	2306	2416	2538	2672	2821	2988	3176	3390	3634
TP8	2113	2222	2344	2479	2631	2803	3000	3225	3488	3797	4165
TP9	2113	2236	2375	2532	2711	2917	3157	3441	3781	4195	4710


4500
4000
3500
3000
2500
2000
1500
1000
500
0
Q (EOB/saat/şerit)
0
20
40
60
80
100
120
140
k (EOB/km/şerit)
0%
%25
%50
75%

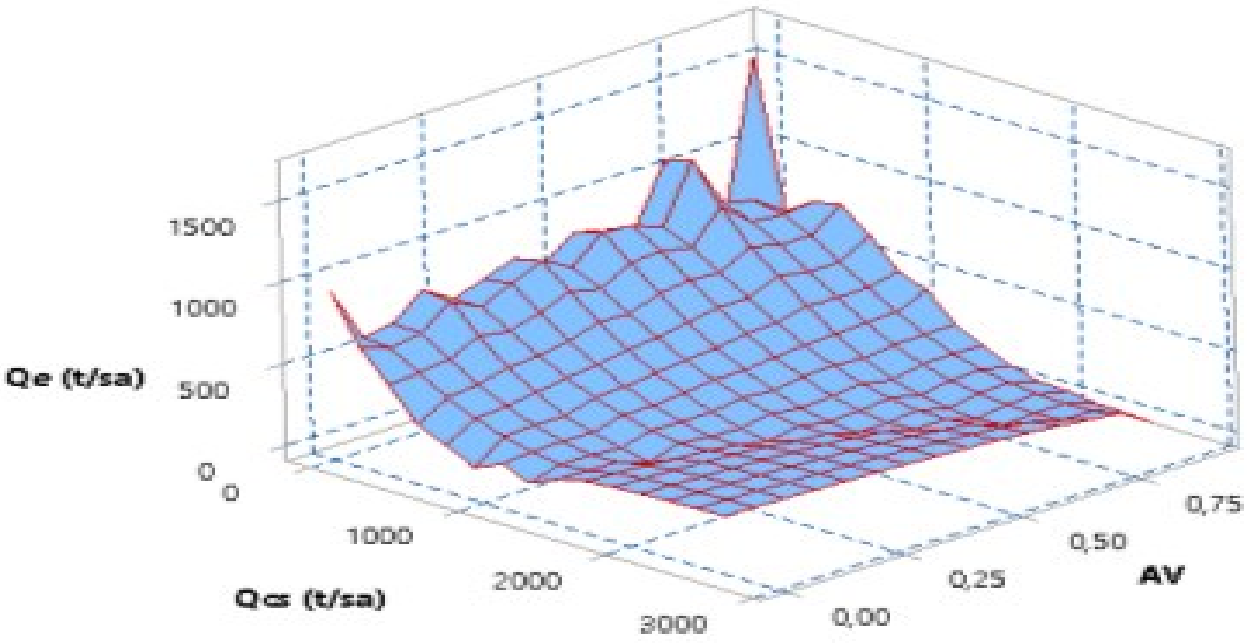
Effect of Autonomous Vehicles on Capacity of Unsignalized Intersections



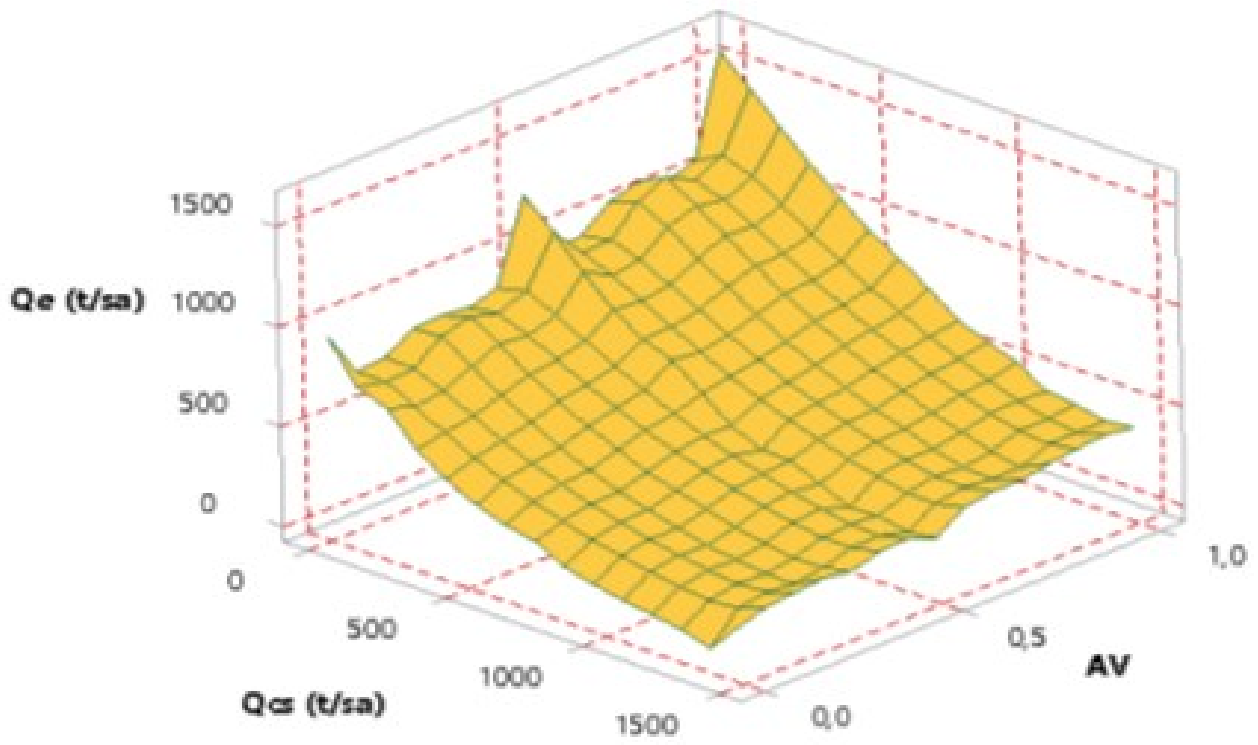
Critical Gap Acceptance Values



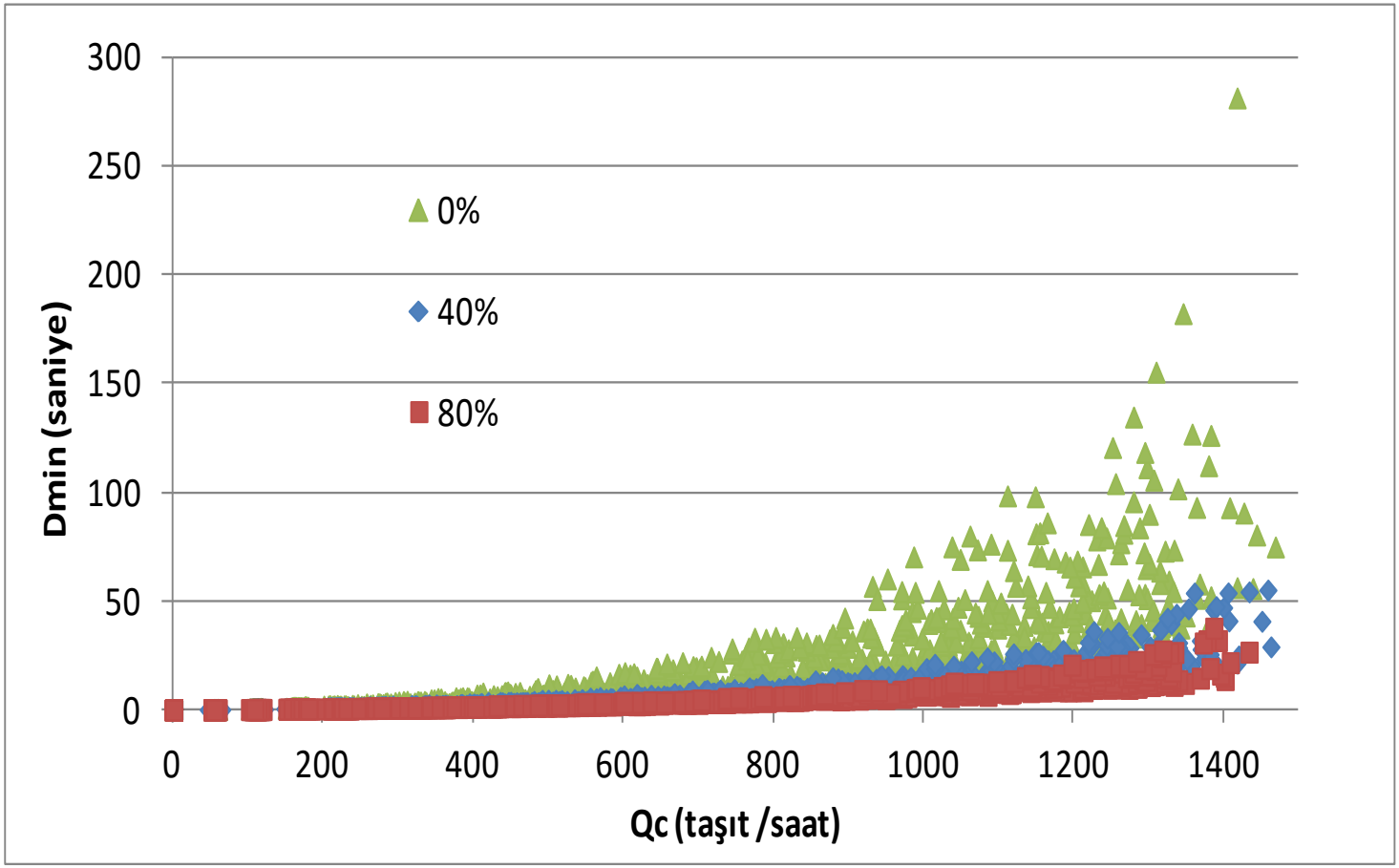
Change in capacity for most assertive behavior

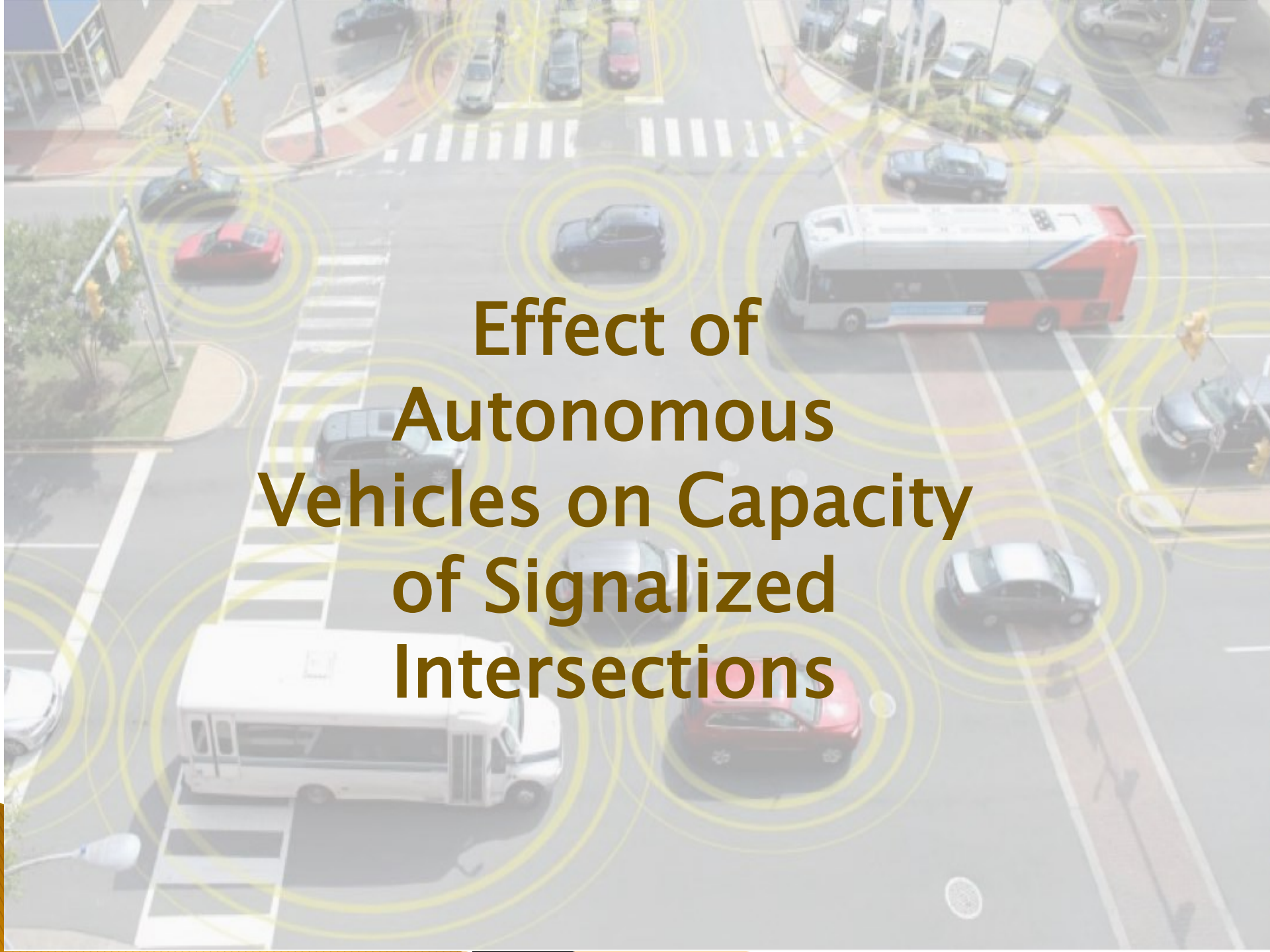


Change in Capacity for Combined Driving Behavior



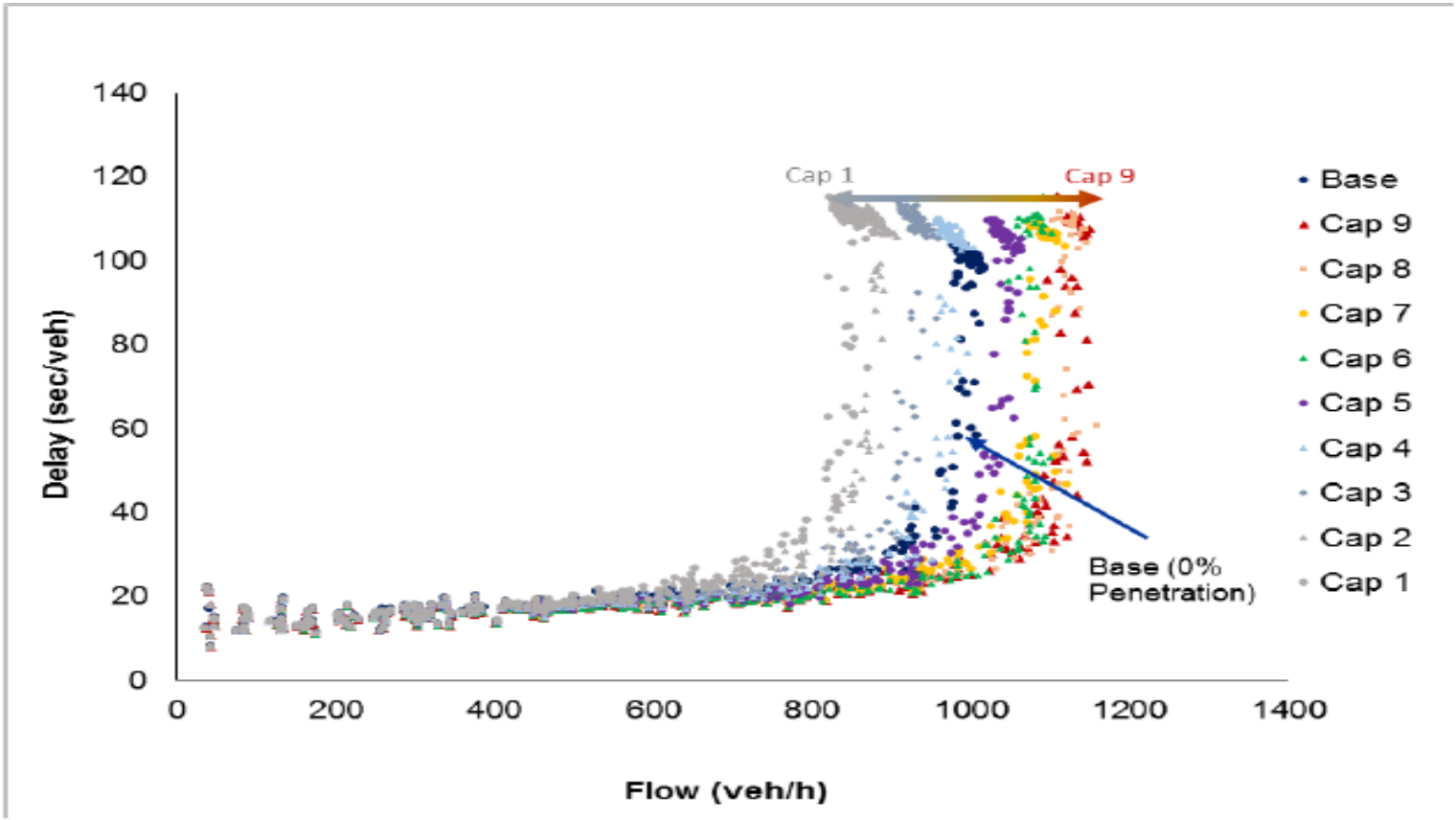
Change in Service (Minimum) Delay



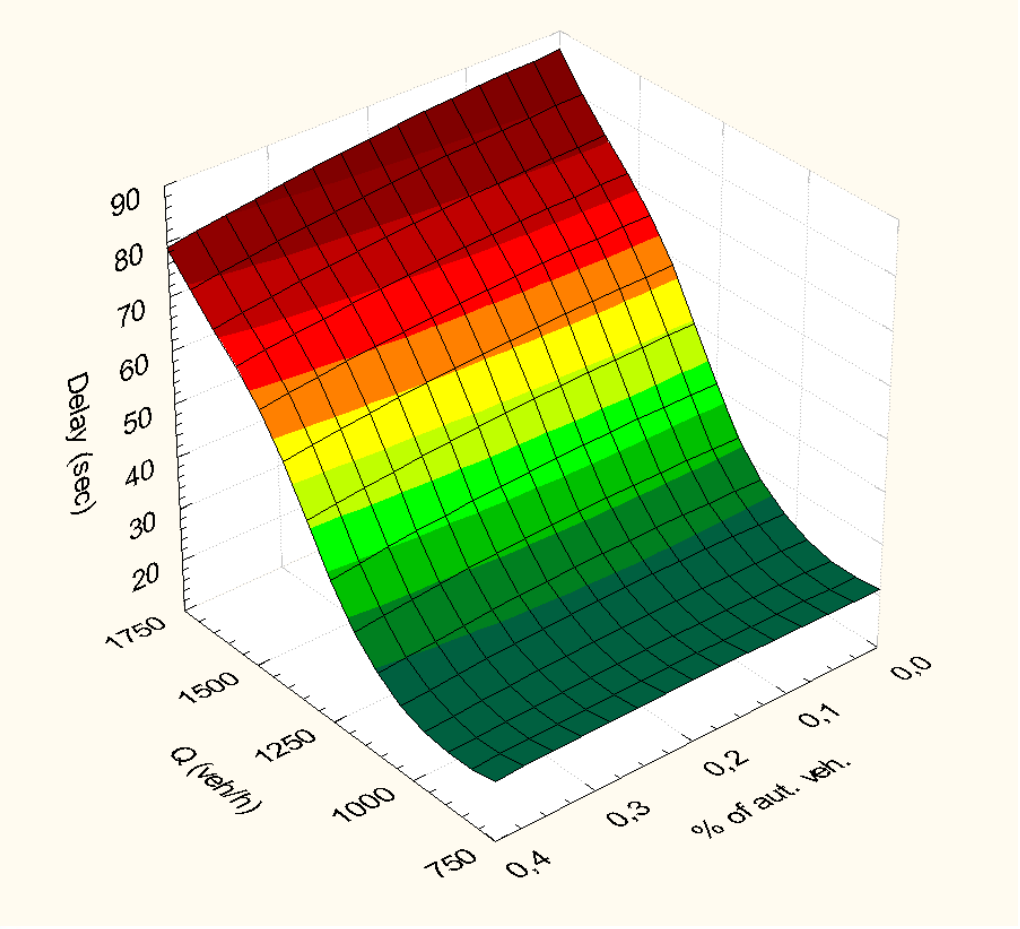


Effect of Autonomous Vehicles on Capacity of Signalized Intersections

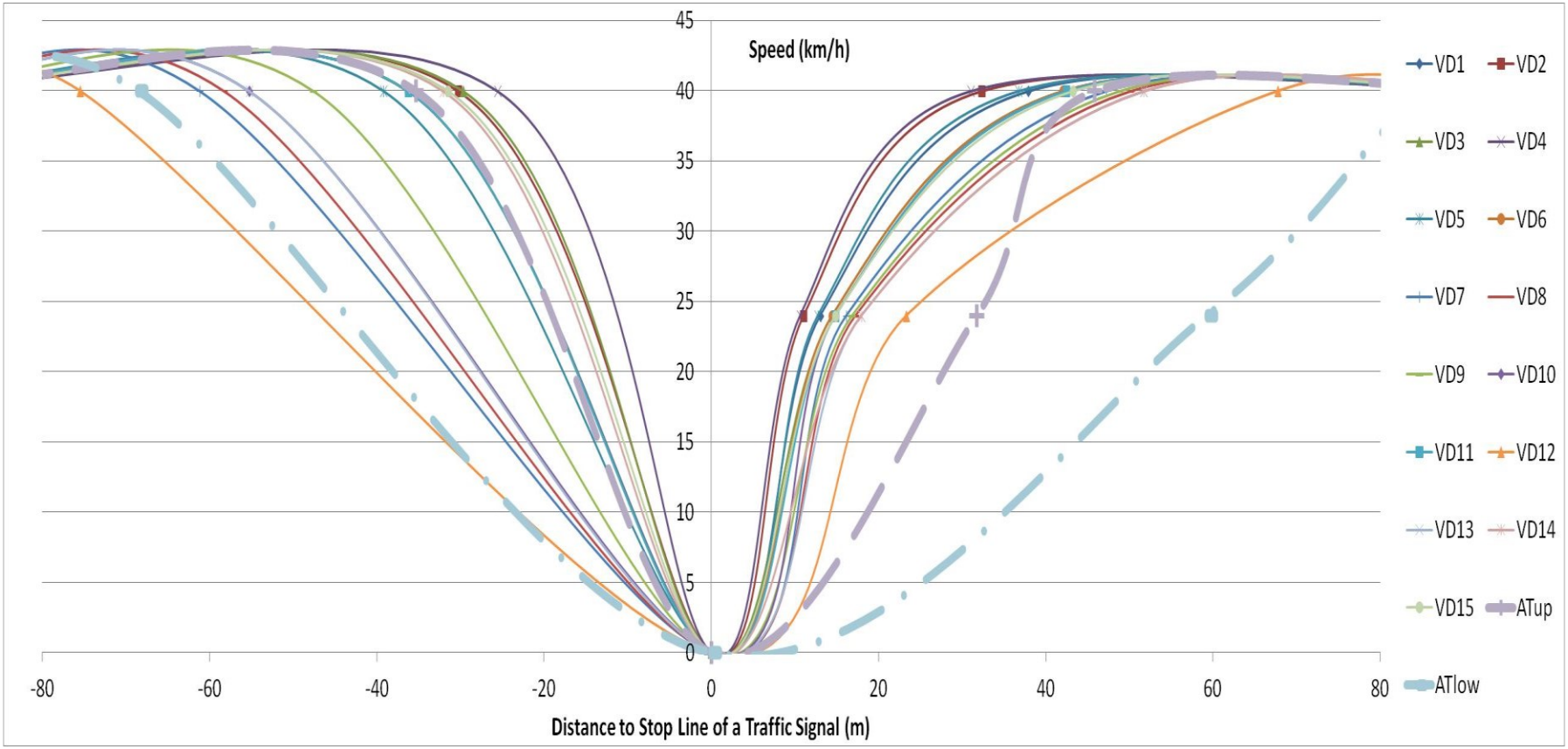
Change of Delay with respect to different driving behaviors



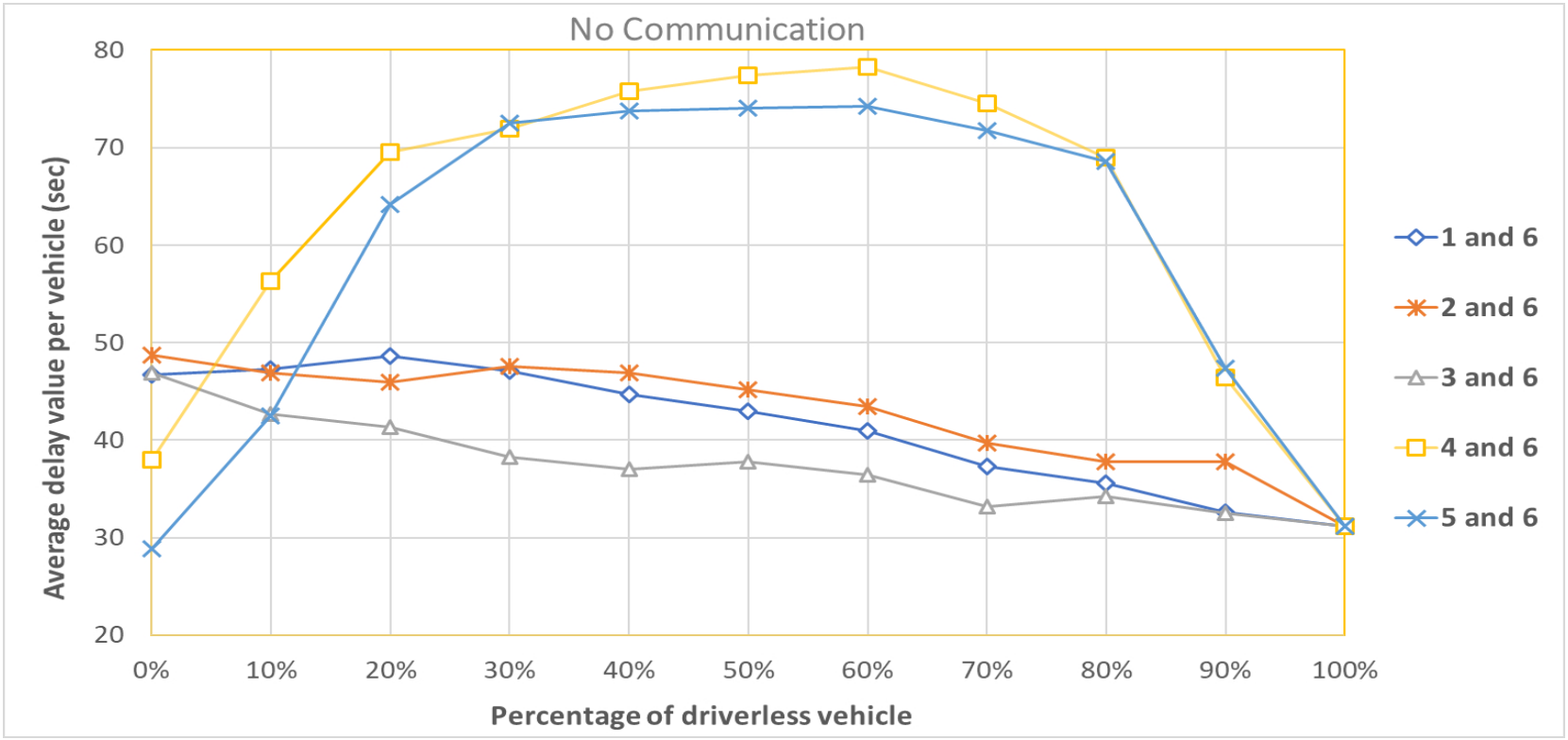
Delay Values for different penetration rates



Comparison of human drivers and autonoous vehicles for acceleration and deceleration of



Change in delay with respect to different driver behaviors



THREATS

Increase in car ownership

Sanctions Regarding Pedestrians

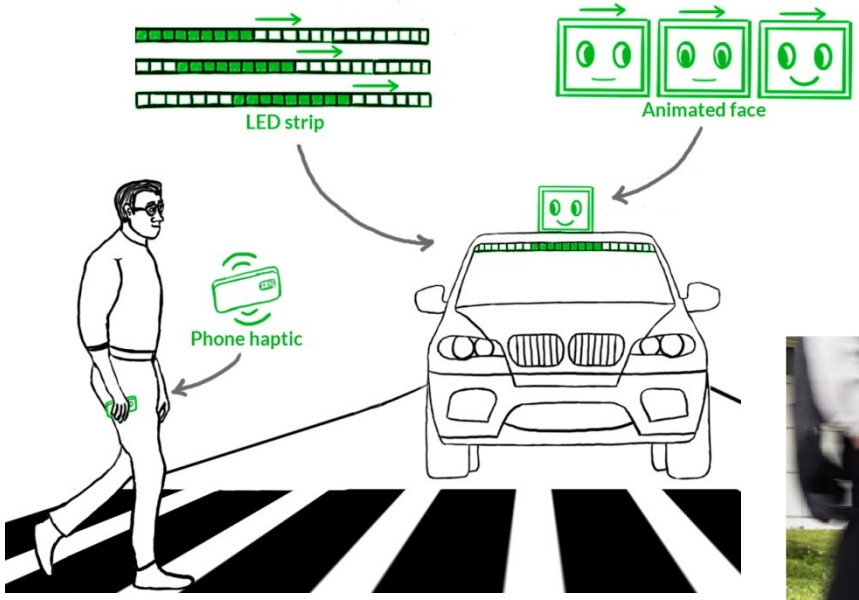
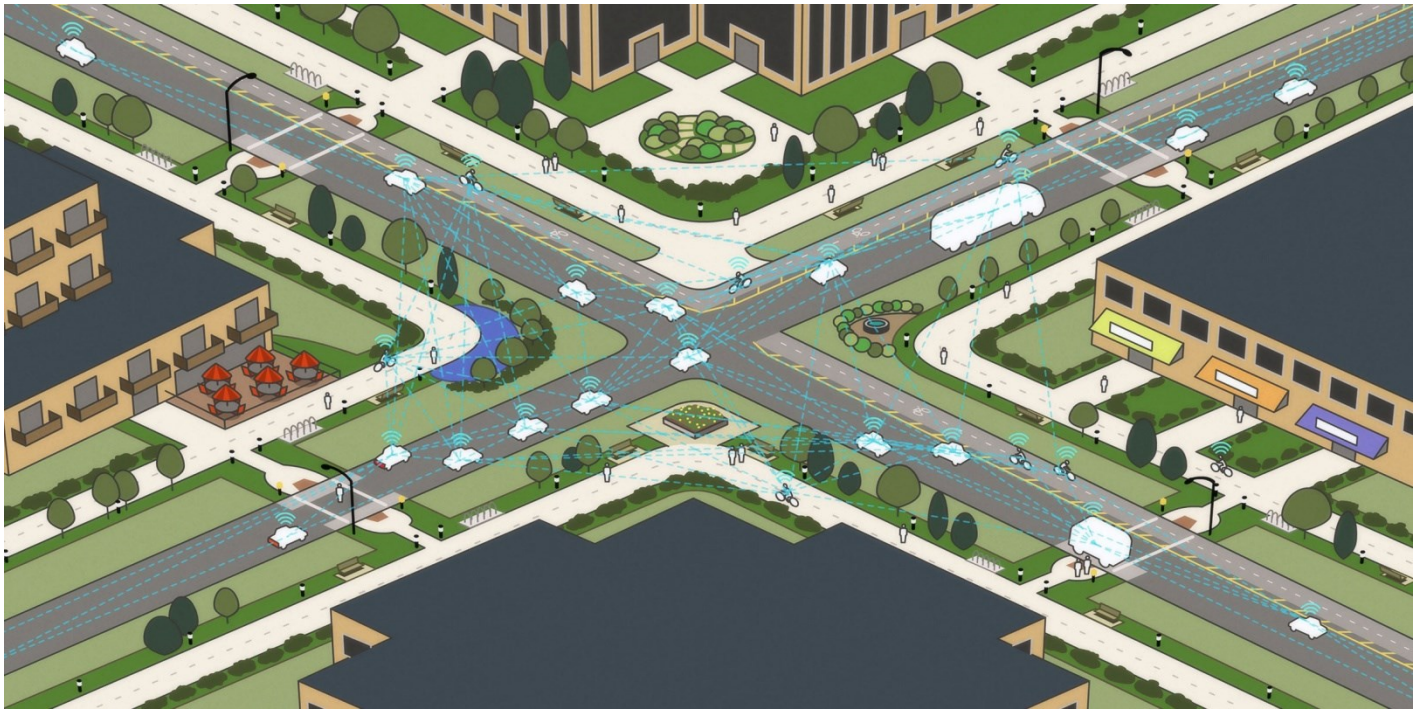


Fig. 1. The autonomous car is communicating with pedestrians at a crosswalk

OPPORTUNITIES

They Can Make a Positive Contribution to the Urban Structure

- If we can increase capacity with driverless vehicles, we can provide less space for the road and more space for pedestrians and bicycles..

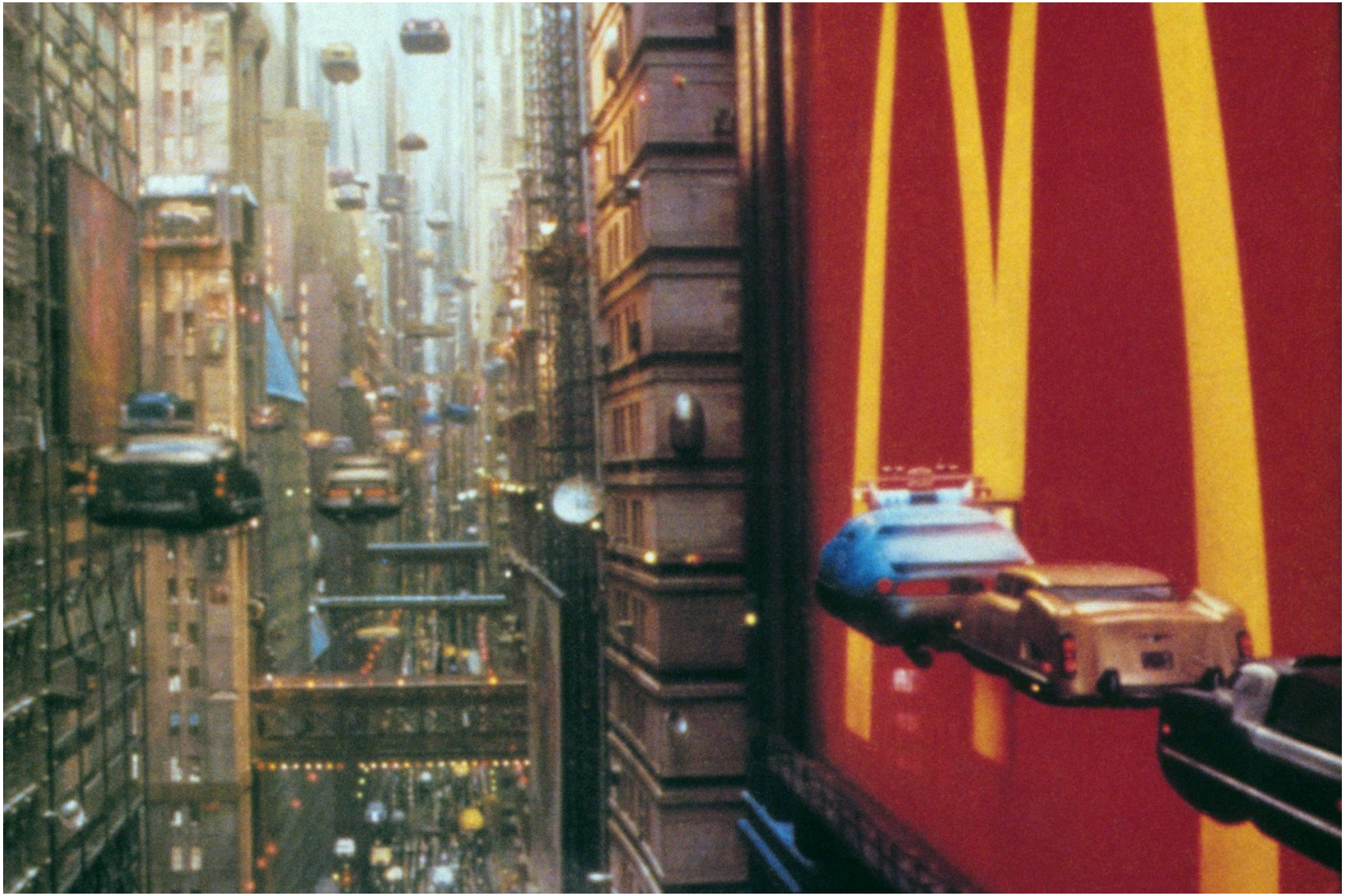


We Can Increase Access Opportunities for the Elderly and Disabled

We Can Use It For Public Transport In Small Settlements or Campuses

We Can Reduce Environmental Impacts of Transportation

- Capacity increase reduces fuel consumption and emissions of air polluting gases due to delays.
- Driverless vehicles will be largely electric or hybrid. This is a positive result for the environment.
- *However, even electric vehicles pollute the environment*.
- This shows that an optimization needs to be made.



Thank you for listening

References

- https://www.semanticscholar.org/paper/Autonomous-Vehicles-That-Interact-With-Pedestrians%3A-Rasouli-Tsotsos/852998c60e4a62d0508de11b6297e6e97a0d3fac
- https://karthikm0.github.io/projects/
- https://www.hurriyet.com.tr/teknoloji/uberin-surucusuz-otomobili-kaza-yapti-yayayi-oldurdu-40777908
- https://www.trthaber.com/haber/dunya/surucusuz-tesla-otomobil-kaza-yapti-2-olu-573943.html
- https://land8.com/how-autonomous-vehicles-are-influencing-urban-design/
- https://www.theengineer.co.uk/driverless-cars-design-disabled-people/
- https://www.tokyotimes.com/auto-pilot-cars-to-increase-sells-due-to-elderly-drivers/
- https://www.haberturk.com/iste-yerli-ucan-araba-aircar-haberler-3140840-teknoloji
- https://www.mynet.com/hyundai-ucan-arabalar-icin-tarih-verdi-110106824899
- https://dijitaltekerlek.com/hyundai-ucan-araba-tanitimini-2020-senesinde-gerceklestirecek/
- https://ew.com/movies/2017/07/19/fifth-element-oral-history-luc-besson/