OKOS VÁROS
@ BME TMIT

# Intelligent Transportation Systems

# Lecturers

- Dr. Rolland Vida
  Associate Professor,
  vida@tmit.bme.hu
  IE348

- Hisham Zargar Manzoor
  PhD student
  hishamzargar@icloud.com

# Tell us about yourself…

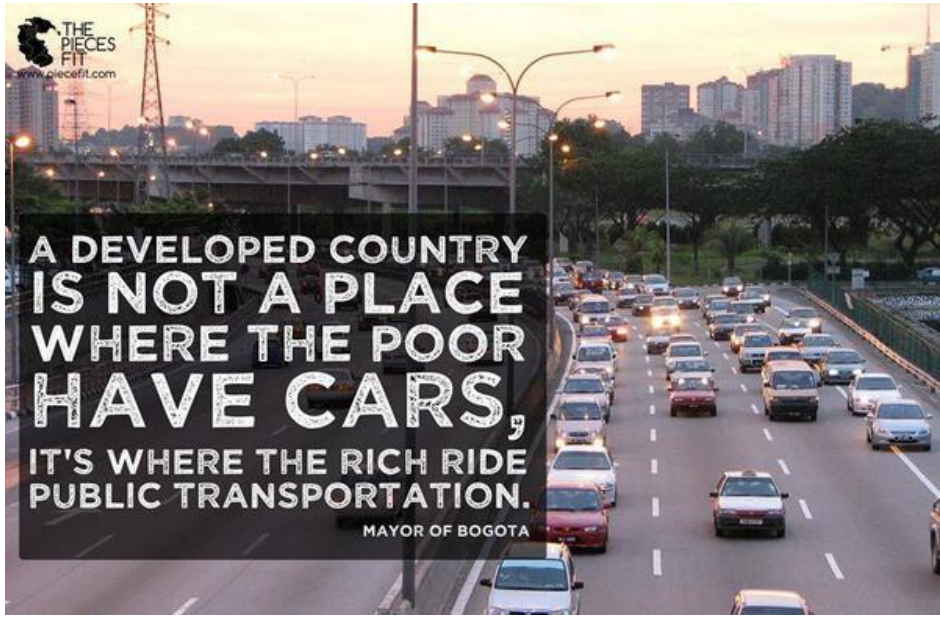
- Where do you come from?
- What main specialization?
- What is your background?
- How much do you know about transportation systems?
- How much do you know about networking, communication?
- Programming skills? Hardware or software?
- Why did you choose this course, what are your expectations?

# Intelligent transportation systems

- Smart City
  - A place where people like to live, good quality of life
  - Low pollution, low energy consumption
  - Sustainability
- One of the basic components of a smart city is the intelligent transportation system
  - Too many people in traffic jams – stress, lost working hours
  - Too many people in cars – pollution, energy wastage
    - In Budapest each year + 20-30,000 cars on the roads, more than 3 million cars in total in Hungary
  - **Too many cars**
    - Cars stay parked, empty, for 22 hours per day in average
    - Occupy a parking lot, at home or at work
- **The use of personal cars in not sustainable on the long run**
  - Thanksgiving traffic in Los Angeles

# Intelligent transportation systems

- Efficient public transportation
- Car sharing / Car pooling
- Connected car, C2C or V2V communication
- Intelligent road network, C2I or V2I communication
- Today mostly static traffic signs, like 100 years ago




- Electric cars
- Self-driving cars

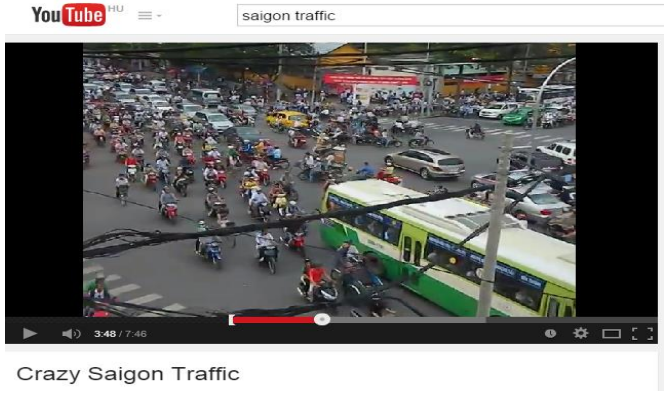
# Intelligent public transportation

Improving the efficiency and quality of public transportation is very important

- Bad example from the metro in Beijing (2013)
- https://www.youtube.com/watch?v=xG-meaGqg-M

- If too many people and bad public transportation – be aware of the motrocycles
  - Total chaos in transportation – see South-East Asia

- Crossroad in Saigon
- **http://www.youtube.com/watch?v=gKLWZjBu2iQ**

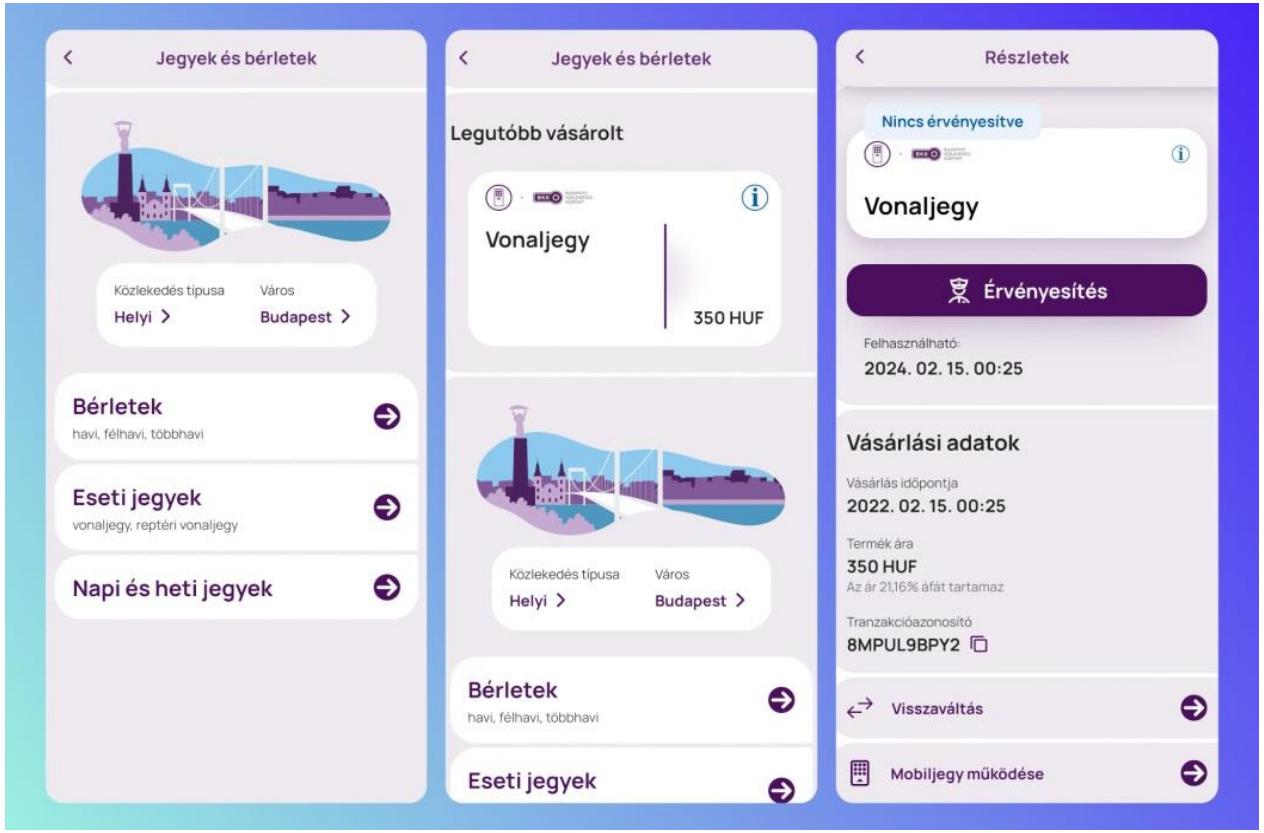


# Advantages of public transportation


- **Much larger capacity**
  - 200 people – on 200 bikes, 1 tram, 3 buses or 177 cars
- **Reliability, predictability**
  - Real-time monitoring of vehicles (GPS), trajectory planning
  - Track-based solutions – underground, ground level or elevated

# BKK Futár – Budapest Go

- Started in 2014, for a cost of 6 billion HUF
- GPS on 1597 buses, 551 trams, 141 trolley buses
- 263 screens in stations
- Mobile app

# Adaptivity in public transportation

- Currently, schedules based on historic data
  - Time of the day, day of the week, holidays
- Should be good to adapt to the current conditions, current demand
  - Higher than usual, or lower
  - Strikes, road closures, public events, Covid
- Needs additional capacity in buses, drivers
  - Not easy to implement

# BRT (Bus Rapid Transfer)

- Dedicated bus lane, possibly in the middle of the road (easy turning)
- Paying (by card) outside the vehicle, not at the driver – faster boarding
- Green lights at crossroads


# BRT (Bus Rapid Transfer)


Passing lanes at stations have increased the capacity of the system threefold

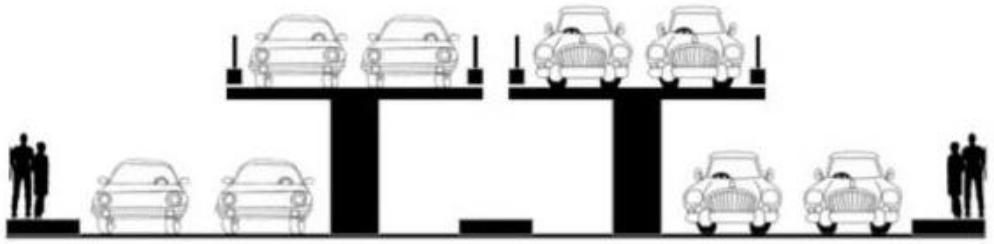
**TransMilenio, Bogota, Columbia**

Walter Hook, Stephanie Lotshaw, and Annie Weinstock, More Development For Your Transit Dollar: An Analysis of 21 North American Transit Corridors, https://www.itdp.org/wp-content/uploads/2013/11/More-Development-For-Your-Transit-Dollar_ITDP.pdf

# BRT (Bus Rapid Transfer)

3-lane carriageway

2 lanes + elevated road



Dedicated lanes for bus rapid transit

**Capacity:**

3,000 passengers per hour per direction

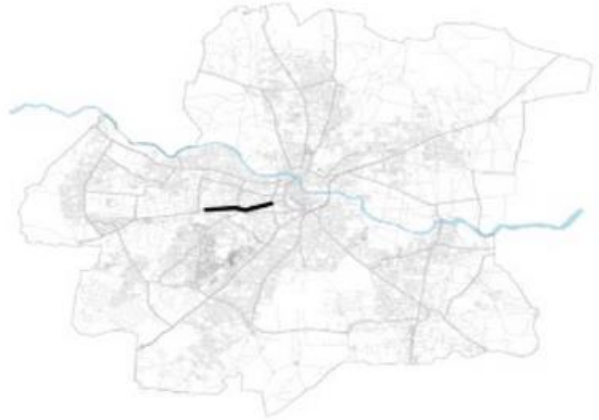
4,700

12,000 +

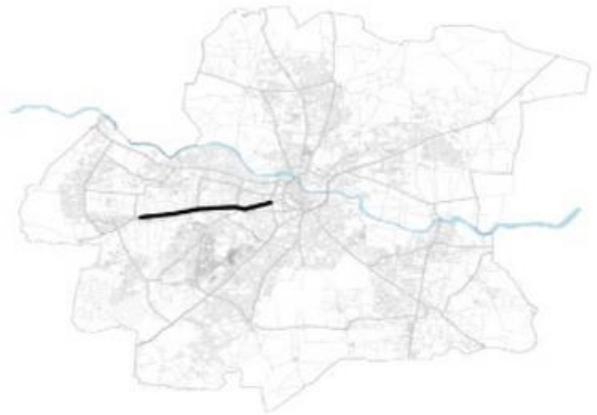
# How much does it cost?

- The BRT is the cheapest solution, but cannot be applied everywhere
  - No space
  - Should not build the city for the cars, but for people
  - Building roads for buses is more acceptable than for cars

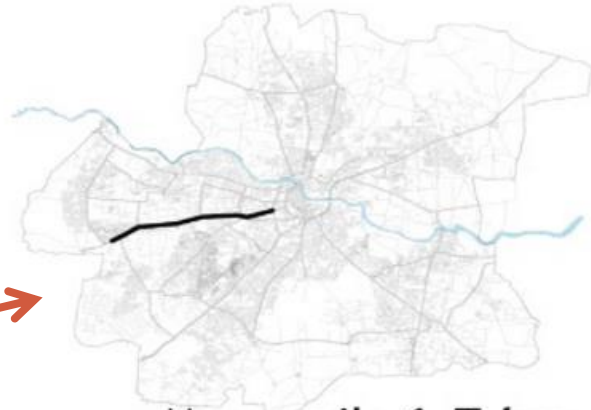
- **What could you build with 10 billion rupee (~ 156 million USD)?**



Underground metro: **2.5 km**



Elevated metro: **5.0 km**

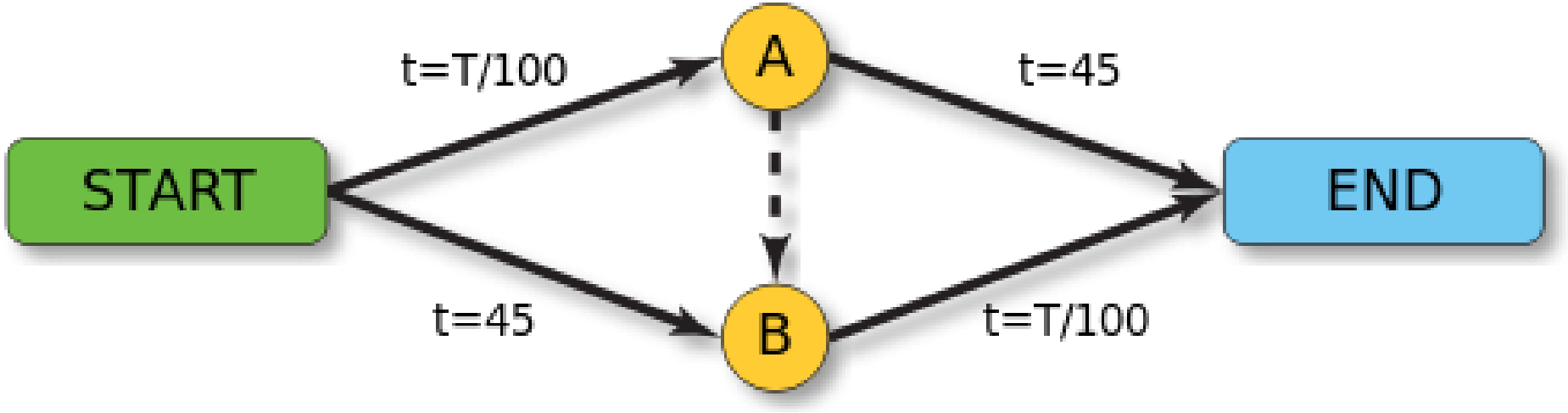


Monorail: **6.7 km**

BRT: **67 km**

# Braess paradox (1968)

- Dietrich Braess, German mathematician
- Adding a new connection to the network will not necessarily increase the overall capacity



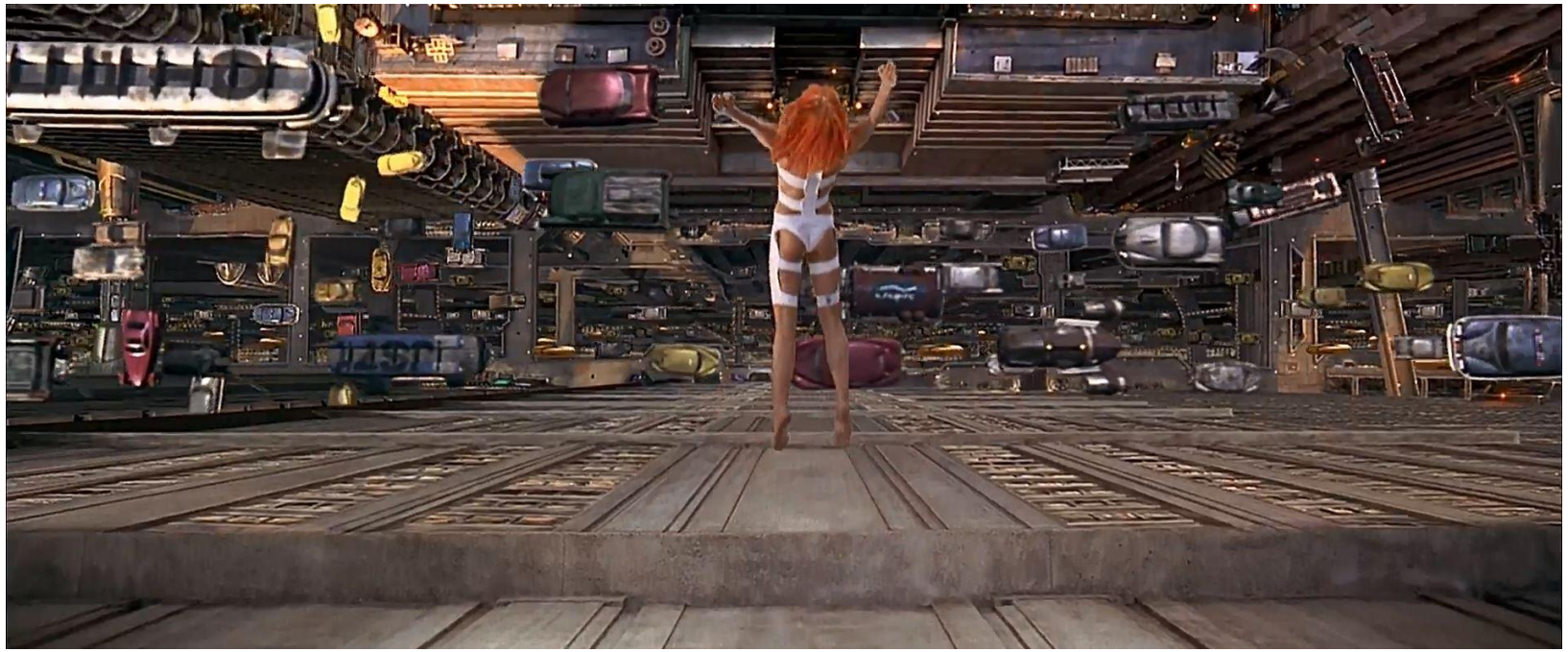
# Bringing down some roads

Seoul, South-Korea

Portland, Oregon

# Futuristic ideas

- Remember Leeloo's jump scene, in the Fifth Element?



https://www.youtube.com/watch?v=pK_sGCG-L_c

# Futuristic ideas

- Gyroscopic transportation, on multiple heights


https://www.youtube.com/watch?v=1m5vWdeTlno

# Futuristic ideas

**Elon Musk** (46)

- **PayPal** – online payment system
  - Bought by eBay in 2002 for $1.5 billion
- **SpaceX** – private space tourism, private satellites
- **Tesla** – electric cars
- **Solar City** – 2nd largest solar power provider in the US
- **Hyperloop** – transportation at 1200 km/h, in reducedpressure tubes



# Futuristic ideas

**Elon Musk** (46)

- **The Boring Company** (2016)
  - System of underground tunnels for rapid transportation
  - Digging started in LA in the summer of 2017

https://www.youtube.com/watch?v=uI3oJqMBpPs

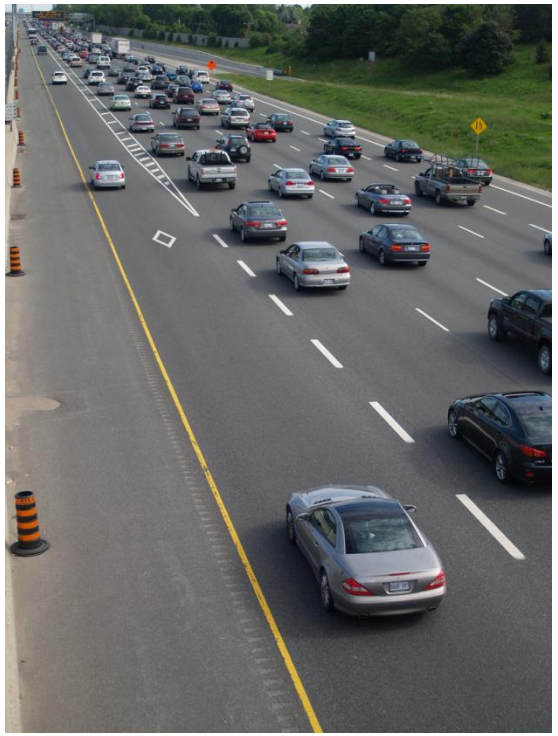
# AVO, SOV, ZOV, HOV

- The drawback of public transportation is that it does not reach individual homes everywhere
  - Especially in the suburbs and the agglomeration
  - People should reach the end stations somehow – usually by car
- Most people commuting from the agglomeration are alone in their car
- **AVO – Average Vehicle Occupancy**
  - In Western-Europe, USA around 1.5-1.6, but contantly decreasing
    - During peak traffic 1,1 – 1,2
  - Higher averages in deveoping countries, but because of economic reasosn, not because of being „green”
- **SOV – Single Occupancy Vehicles**
  - In peak times 85-90%
- **ZOV – Zero Occupancy Vehicles**
  - With the deployment of autonomous cars and „ride sharing”
- **HOV – High Occupancy Vehicles**
  - Incentives for people to do car pooling

# Car pooling

- More people in a car, fewer cars, lower pollution, cheaper rides
- Simplest car pooling solution - hitchhiking
- Many solutions but hard to optimize the matchmaking between drivers and passengers, problems of reliability, flexibility, trust

# HOV Lanes



- HOV – High Occupancy Vehicles
  - Can only be used if at least one passenger next to the driver
    - Usually limited to peak times
  - Buses, electric cars, motorbikes
  - Cars with just a driver, but who is willing to pay for it
    - HOT (High Occupancy Toll) Lane
    - Price changes depending on demand
- First bus lane in US in Washington (1969)
  - From 1973 turned into HOV 3+
  - Results of a 2005 study:
    - Morning rush hours, 6.30-9.30, 31.700 people in 8.600 HOV cars (3.7 AVO), 29 minutes ride
    - In normal lanes 23.500 people in 21.300 cars (AVO 1.1), 64 minutes ride

# Bus and HOV lanes

- Around the world
  - USA, China
  - Less in Europe
- HOV control with cameras
  - Inflated dolls or paper cuts on the side seat
  - Heat cameras
- Against the law, fines by the police
  - Nashville, 108 miles HOV, 130.000 commuters / day
    - 95% unjustified use, fines of only 50 USD
  - California, North Virginia – fines up to 1000 USD



# HOV jockeys

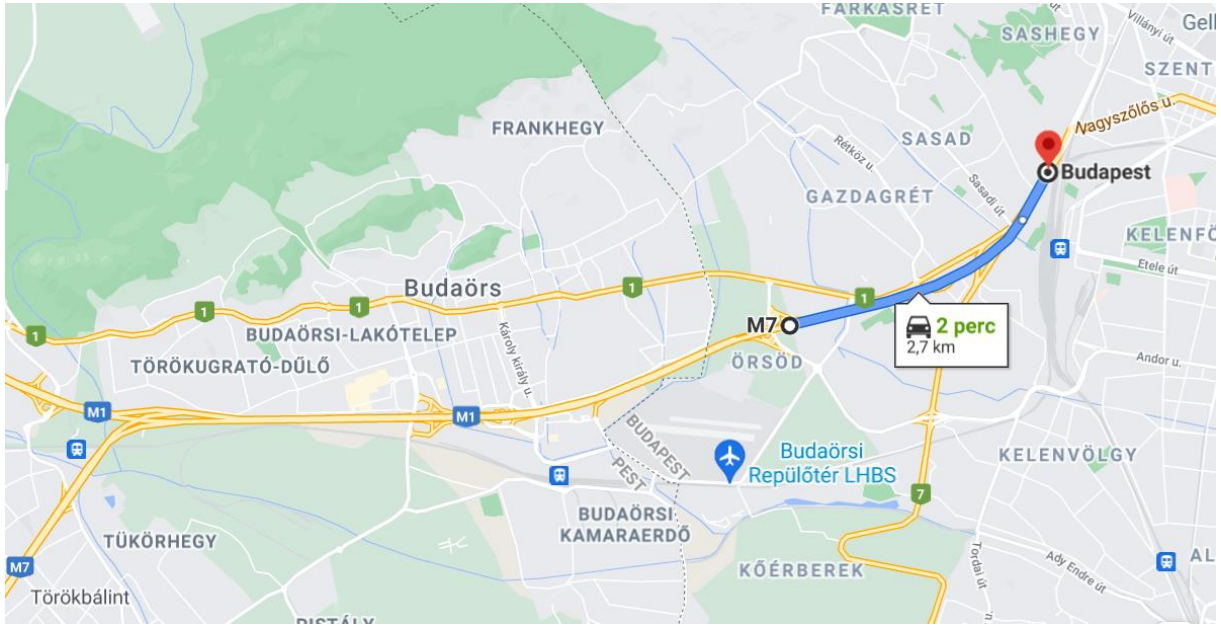
- Jakarta, Indonesia – HOV3+ lanes since 2003
  - Unemployed people, kids, mothers with their children „working” as „jockeys”, for money (1-2 USD / ride)
  - Many moved to the capital for this
  - 10-15 USD/day, not bad compared to the 600 USD/ month average salary
- Did not reach its goals, no decrease in the number of cars
- Discontinued in 2016, new system a few months later
  - Even plate numbers on even days, odd plate numbers on odd days

# Bus and HOV lanes

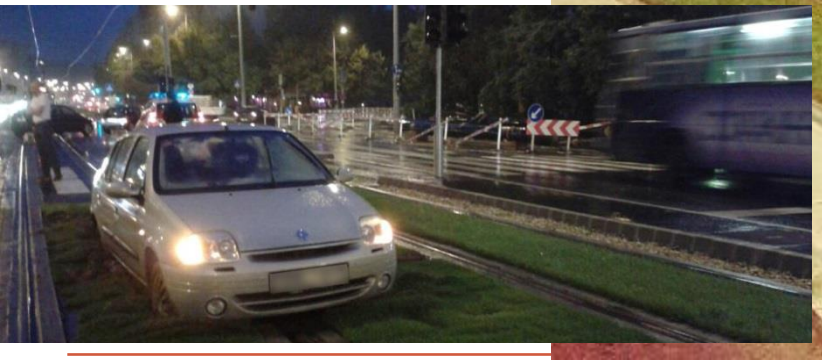
- **Drawback – sparsely used lanes**
- Experiment introduced in Lisbon in 2007
  - Bus lane only if a bus is approaching (based on sensors, timetables, or GPS)
  - Light and sound signals to the other drivers
- Some HOV lanes discontinued in Australia
  - **If sparsely used, it increases the pollution**
    - Fewer traditional lanes, slower traffic, larger fuel consumption
  - **If used by many, and efficient, it becomes an incentive to buy new cars**

# HOV lanes in Budapest

- Bus lane on the M1-M7 highway entering the city
- First try for 4 days (2011)
- From 2014 on the shoulder (breakdown/emergency lane)
  - Reduced speed, but does not disturb normal lanes


# Dedicated lanes – should be respected



# The Uber myth

Uber – one of the most innovative, and best known transportation apps of the last years

- **Is it a smart city, or a dumb city app?**

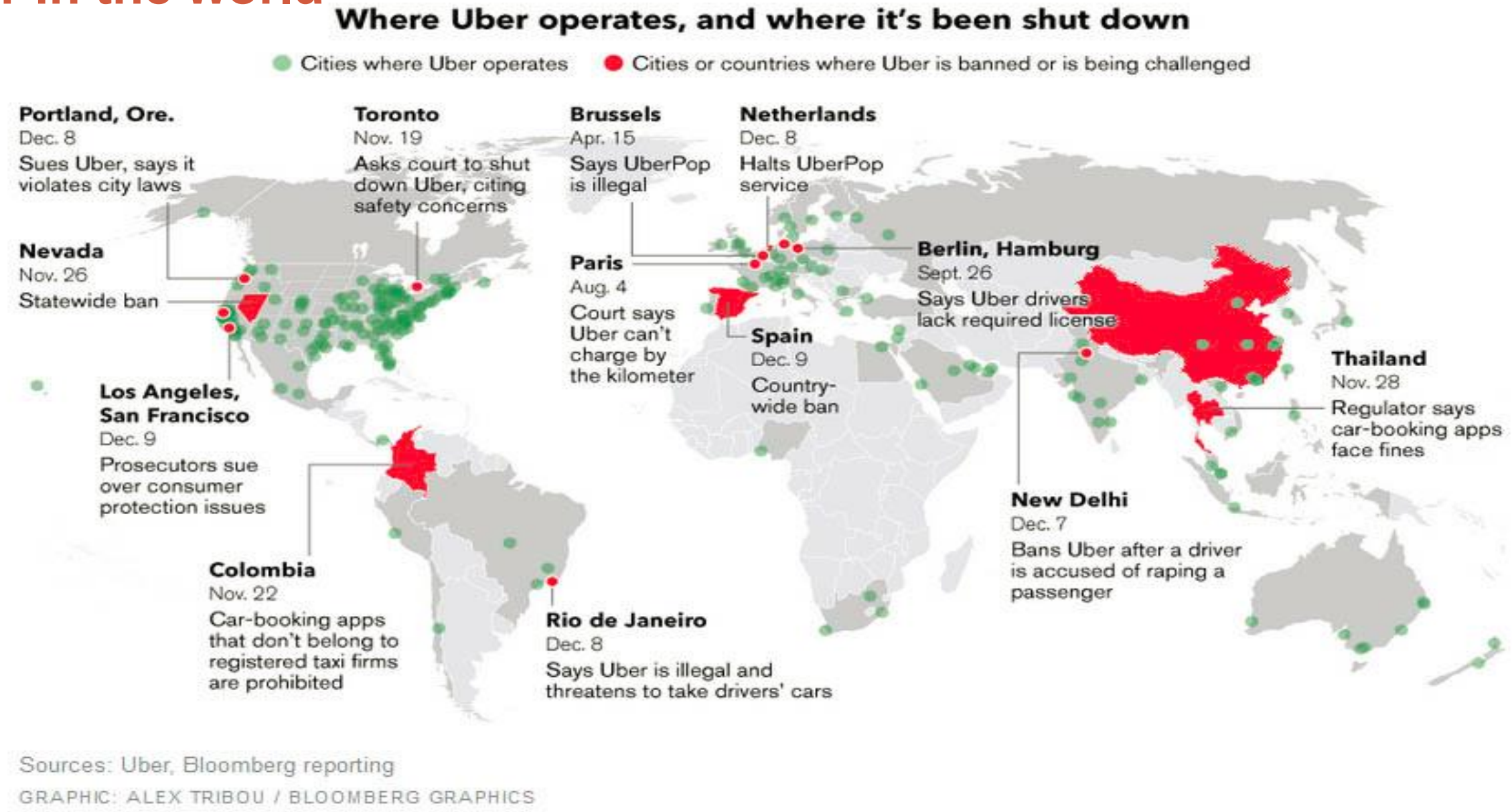
# How it works?

- Free to download
- Registered credit card
- Fast response for a ride request
  - 3-5 minutes
- Surge pricing, based on demand
- Automatic payment
- Drivers are private people
- Fast, simple, cheap

# Uber in numbers

- **2009** - launched in San Francisco
- **19 000** employees around the world
- **9 million** Uber drivers
- **65** countries, **600** cities
- **14 million** rides per day
- **100 billion** USD market value
- **14 billion** USD revenue in 2019
- **8,5 billion** USD loss in 2019

# Uber in the world



# Uber = peer-to-peer ridesharing ??

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THIS STORY IS FROM OCTOBER 2

Uber to test
sharing in Pu

Corpus ID: 169256353

**The impact of peer-to-peer ridesharing on travel mode: Empirical study of Uber effects on travel**

WIKIPÉDIA
A szabad enciklopédia

szócikk | vitalap

**Március 21. és május 31. között** ismét nevezhetsz szóc
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# Uber [bevezető szerkesztése]

A Wikipédiából, a szabad enciklopédiából

Az **Uber** egy P2P utazásmegosztó személyszállító szolgáltatás.

# Uber = peer-to-peer ridesharing ??


- **Peer-to-peer (P2P) – opposite to client- server**
  - No dedicated tasks and resources, sometimes operating as client, sometimes as server
  - Bittorrent, Vatera, FON, Waze

- **Uber is not a P2P service**
  - A Uber driver will not be a Uber passenger
    - Or just very rarely
  - This is not needed for the service to work

# Uber = Ridesharing?

MAVENCLUSTER COMPANY SERVICES TECHNOLOGY SOLUTION


The Best Ride-sharing and Taxi apps in the USA

SECTIONS SEARCH Chicago Tribune

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## With ride-sharing curbed during the pandemic, Uber and Lyft try new routes to profitability

By DAMIAN J. TROISE
ASSOCIATED PRESS | FEB 19, 2021 AT 1:42 PM

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## Uber's ride-sharing service faces ban in S Netherlands

The New York Times

## Uber's Food Delivery Business Nearly Matches Ride-Sharing

Last Updated March 1, 2021, 7:25 a.m. ET

# Uber = Ride sharing?

NO!

- **Ride sharing or car pooling**
  - The driver goes to a given destination anyway
  - Takes other passengers going in the same direction
  - Not for profit, but fuel costs can be shared
  - Oszkár, Waze Carpool, GoKid

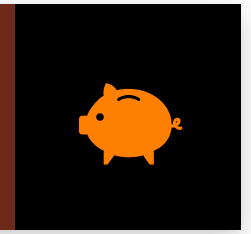
- Uber **is not a ride sharing** app
  - I take you because you pay, not because I want to go there anyway

# Uber = ride-hailing?

NO!

- Uber cars **cannot be „hailed”**
  - The mobile app is needed

# Uber = cheap taxi?

- **Organized transportation of people to specific destinations for a financial return = taxi**

- **Why is it cheap?**
  - Does not apply the same technical obligations, restrictions
  - Hidden employment
  - Tax avoidance
  - **Unrealistically small prices**
    - Huge losses, but the goal is increasing the market share, and bankrupting the competitors

# Uber business model

- Surge pricing – based on demand and offer
  - If high demand, prices increase (Saturday night)
  - If low demand, prices decrease (Sunday morning)
  - **Adaptivity – smart city feature**

- 20-30% is Uber's share form the price of the ride

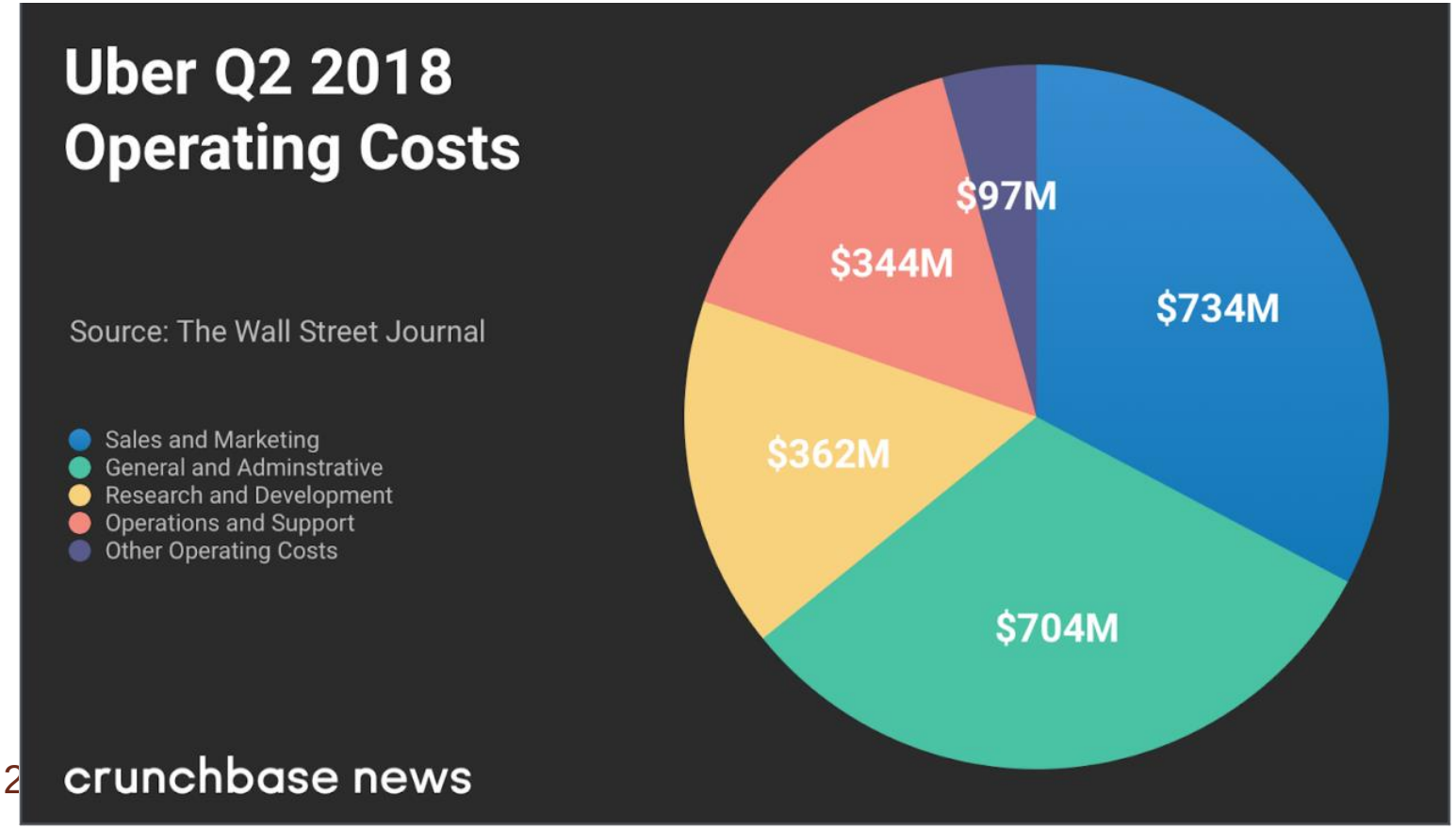
- Other services:

Uber Eats

Uber Freight

# Why the losses?

No car fleet, so on what do they spend money?



# How to cover the losses?

- On the stock exchange from 2019
- (For the moment) high trust from the marke
  - Attractive (partly false) buzzwords
    - Ridesharing, Green, Smart City, Disruptive
- **Not sustainable** on the long run
- **One of the biggest „bubbles" of our days**
  - The question is just when it will explode

# Why is Uber a dumb city application?

- **A „cheap taxi” bad for the city**
  - People use it instead of public transportation
  - Increases the number of cars on the road
  - Increases pollution
  - Around 30% of the traveled distances by Uber vehicles are made empty (no passengers)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POLICY TRANSPORTATION UBER

Uber and Lyft finally admit they're making traffic congestion worse in cities

*Ride-hailing accounts for up to 14 percent of vehicle miles traveled in some cities, according to a study commissioned by Uber and Lyft*

By Andrew J. Hawkins | @andyjayhawk | Aug 6, 2019, 1:33pm EDT

# The Uber myth

Uber – smart city or dumb city?

- ✓ Builds on ICT technologies
- ✓ Adaptive mobility service, taking into account the current demand
- ✗ Not energy efficient, increased pollution
- ✗ Not sustainable

# waze CARPOOL

- True P2P ridesharing service
- People traveling in the same direction (colleagues) grouped in the same car
- Decreases the number of cars on the roads
- The driver cannot earn money with it, just partly cover its costs
- Only two rides per day

- Started in 2018 – USA, Brazil, Canada, Izrael