Autonomous Vehicles for Public Transportation : the whole iceberg

Experience from the AVENUE project

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After realising our ancient dream of flying

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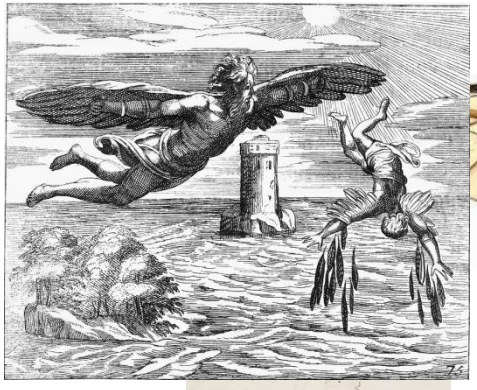
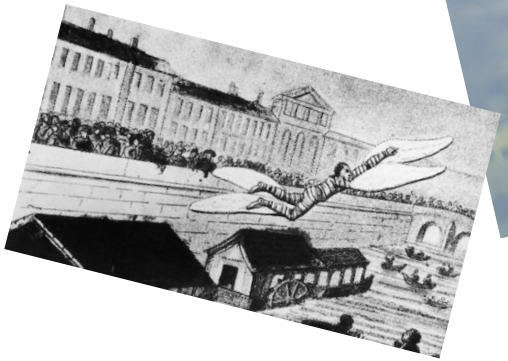
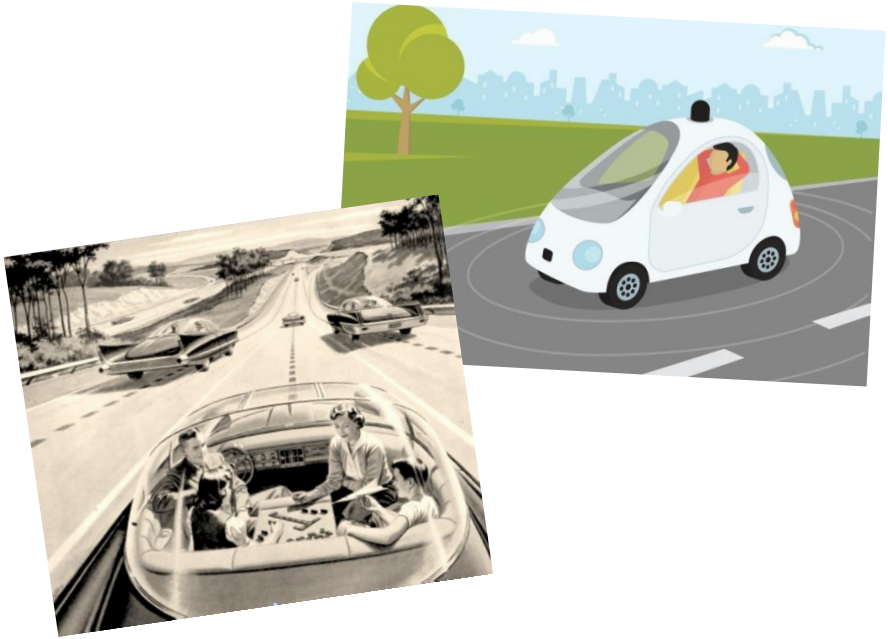




.. we now dream about intelligent cars ..

… and autonomous driving.



Connected and autonomous vehicles: An infinite number of advantages

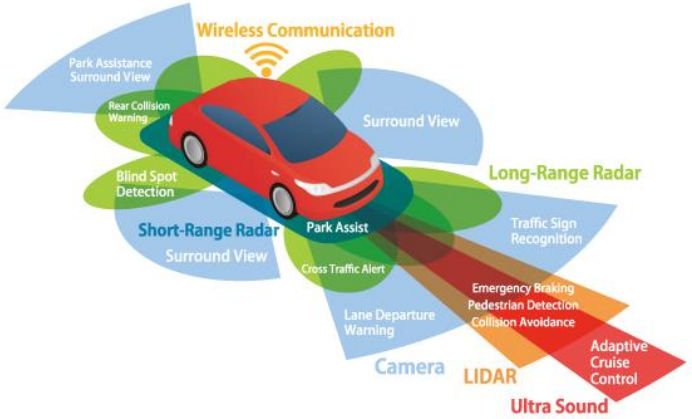
- Fewer accidents
- Less cars on the road
- Higher speeds
- Less energy consumption
- Reduction of parking space
- …….

"Speeding, officer? You'll have to ask the self-driving car."

BUT .. Life is not so simple…

Major Challenges

- Vehicle technology
- Vehicle certification
- Legal and Regulatory frame
- Business models
- User acceptance (services, safety)
- …….



AVENUE

AVENUE

Autonomous Vehicles to Evolve to a New Urban Experience

To Prepare the adoption and deployment of Autonomous vehicles for public transportation.

To seek out new transport paradigms and new business models.

To test disruptive public transport services which no autonomous vehicle has done before!

An H2020 project

4.5 year

20 Partners – 6 cities

20 MEUR budget

15.6 MEUR EU Contribution

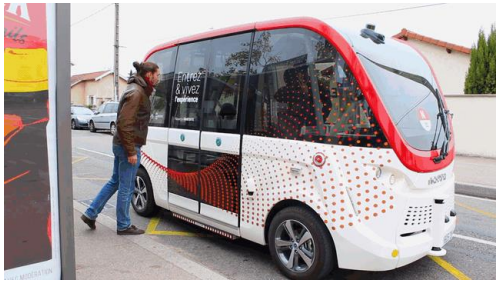
May 1st, 2018 – October 31, 2022

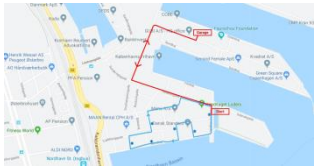
5 validation cities – 9 sites

(open street, mixed traffic, with regular public service)

- **Geneva – TPG**
  - Sept. 2018 – December 2020 Meyrin : regular service, 2 AVs
  - Since Sept. 2020 - Bell-Idee
    On-demand, door-to-door, fleet of 3+1 Avs
- **Lyon – Keolis**
  - Since May 2018 – regular service at Confluence – 2 AVs
  - Since November 2019 - Parc Olympique Lyonnais stadium
    Complex roads, hi-speed traffic, V2X – 2 Avs, Line N1
- **Luxembourg – Sales-Lentz**
  - Since September 2018 – Pfaffenthal - 2 AVs
  - Since Summer 2020 - Contern
    Complex road, link to train services, on-demand – 2 Avs
  - Since October 2021 – Esch-sur-Alzette
    To evolve to on-demand, door-to-door service - 2-4 vehicles
- **Copenhagen – Amobiliy (Holo)**
  - May 2018 – Oslo, Gothenburg - 3 AVs
  - Fall 2020 – january 2021– Nordhaven
    On-demand – 2 to 4 Avs, fixed route
  - Since September 2021 – Slagelse
    on-demand , door-to-door service, - 2 Avs
- **Sion– PostAuto**
  - Since May 2021 – Uvier - 2 Avs + conventional bus
    On-demand, intelligen bus stop

YouTube https://youtu.be/HaBy-JDfE1c





What is our target in AVENUE

Deploying Public Transportation services with the full power of Autonomous Vehicles

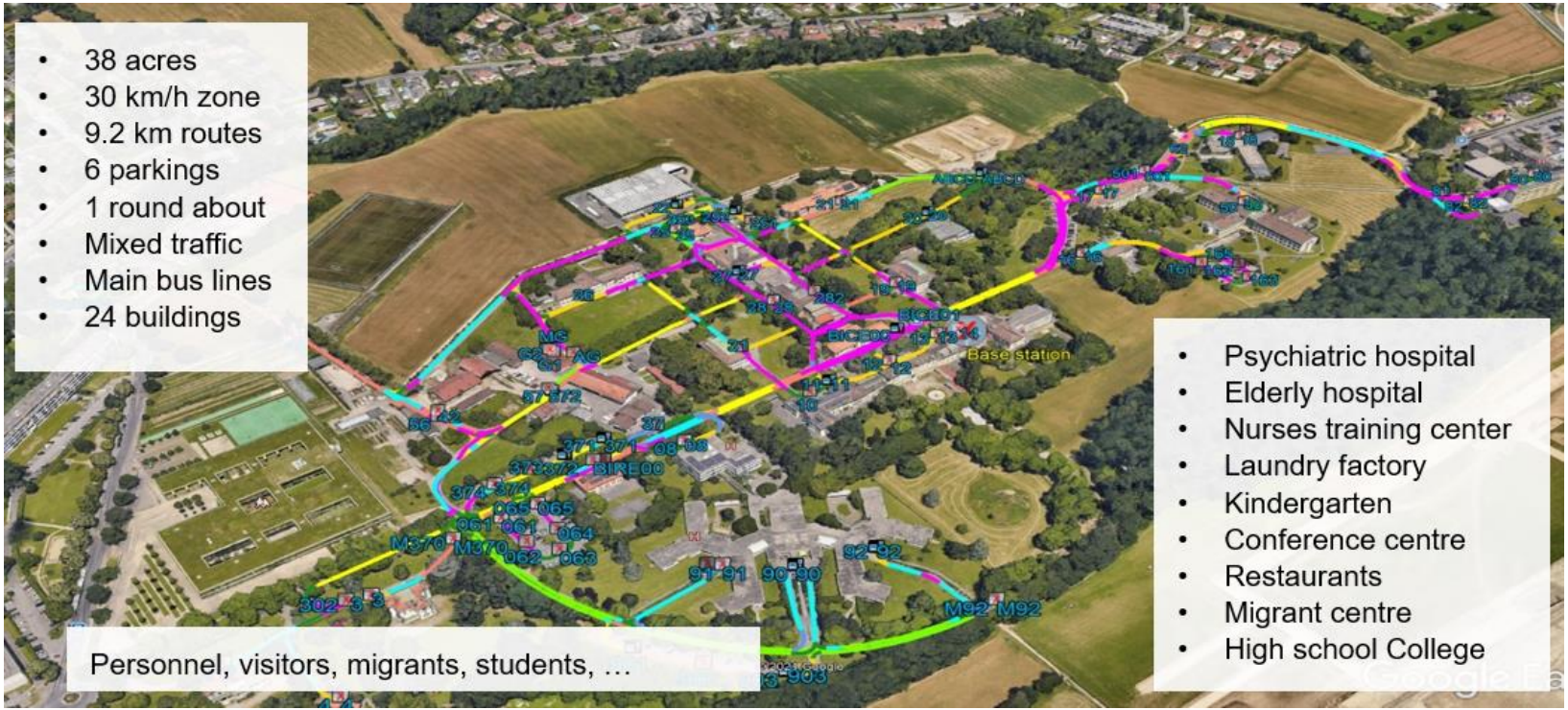
On-demand, Door-to-door public transportation service

- **no-bus stops,**
- **no fixed itineraries,**
- **no time schedules,**
- **no intervention by the safety operator …**

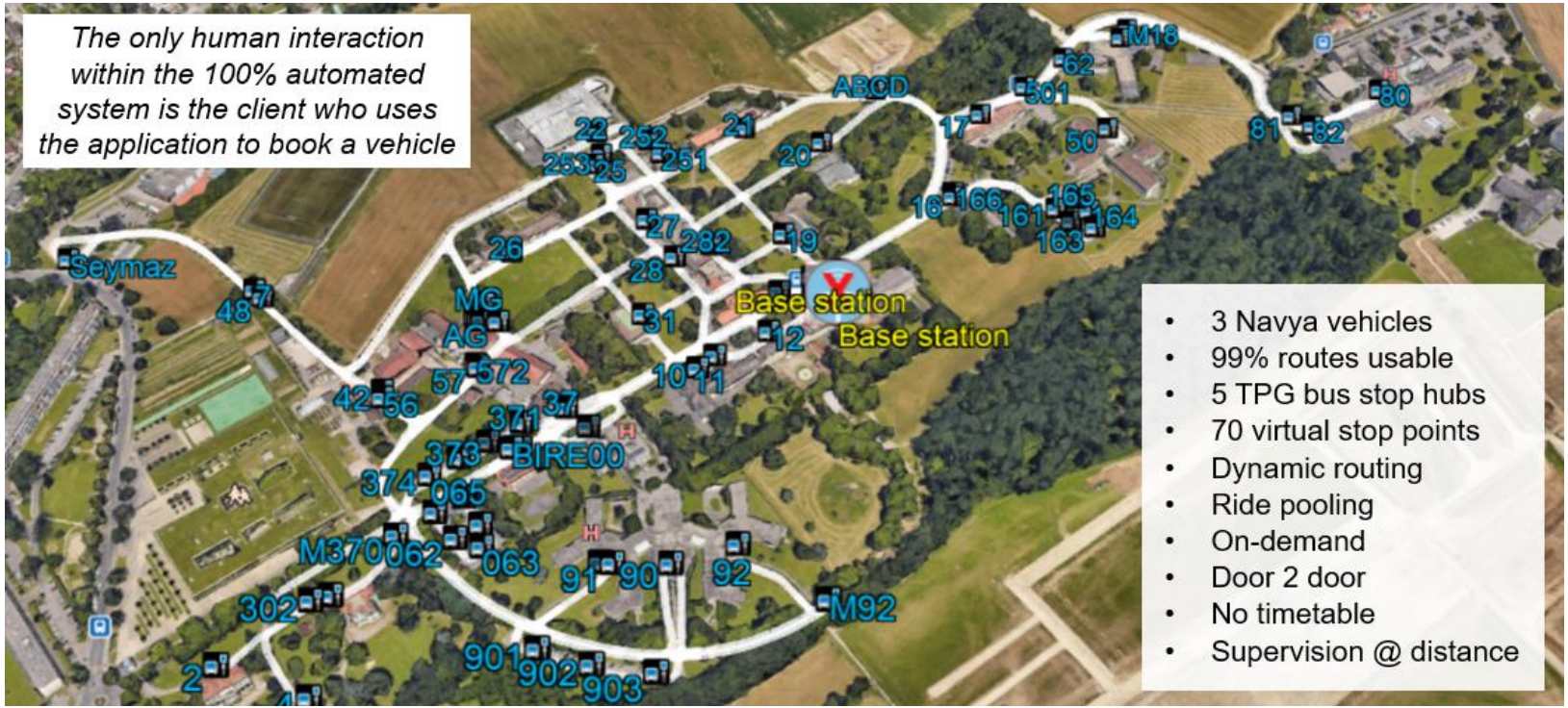
Belle-Idee – Geneva

Probably the most advanced site worldwide!

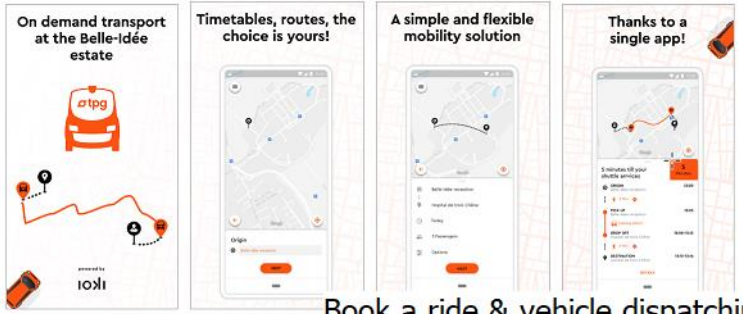
Belle-Idée estate



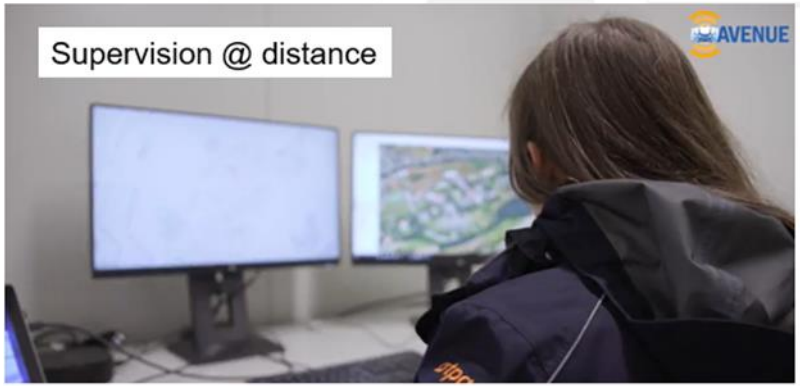
Belle-Idée status @ today



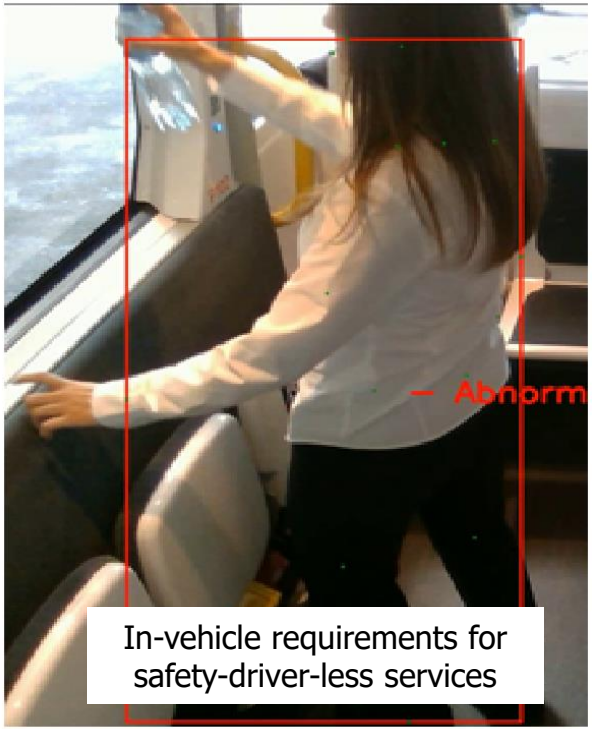
Belle-Idée operations



Book a ride & vehicle dispatching



Belle-Idée research



Belle-Idée ongoing developments

Operating an AV small experimental public transport service is just the tip of the iceberg…

Going full scale commercial … is the rest of the iceberg!!!

Well known Issues faced and lessons learned in AVENUE (and other AV projects!)

Legal and regulatory EU frameworks not adapted to *public transportation* on-demand services

- Obligation to have fixed bus-stops, predefined itineraries
- Vehicle homologation is a complex process (from 8 months to 3 years)
- GDPR and application to public transportation

Driver suppression requires services' replacement

- Vehicle status (cleanness, small incidents, ..)
- Passenger services (safety, aggressions, lost objects …)

Business model not yet well understood

- Pricing of rides, integration to existing models
- Changes of passenger behaviour (very short rides)
- Vehicle life time

Technology is still under evolution

- Improvements are introduced constantly

A dream of a future AV urban public transportation

- Backbone of tram/metro service
- Localized transport with AVs
  - Last-mile to/from backbone
  - Full service for transport in region or across regions
  - Door-to-door service

And what is Missing???

How can we create a **commercially viable, large scale public transportation service** with autonomous vehicles???

The rest of the iceberg !!!

1. Investment Valorisation

Life time of Automated vehicles

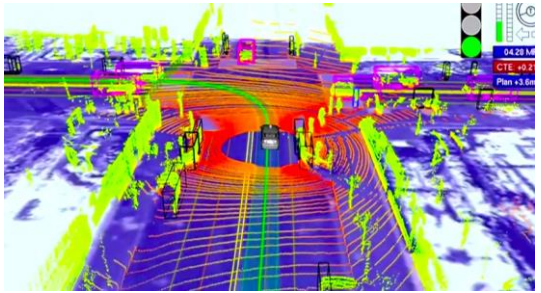
- Design is not adapted for public transport
- Computer and sensor systems follow the law of Moore
- Expected life today does not exceed 6 to 7 years (compared with 15 to 18 for thermal vehicles).

2017 model – company closed down

2016 model – no more spare parts

2. City mapping Scale-up

- Cost charged per Km more than 2-3 KEUR (commissioning)
- Commercial deployment will cover 4.000 Km at least in a city !!
- Keeping maps up to date (less then 24 h updates)
- Maps not compatible between manufactures – double costs!!!



3. Free choice of AV model

- Each AV model has different capabilities and interfaces
- Fleet-management systems are fine tuned for a specific model and its capabilities
- No standardized interfaces

4. Scaling up

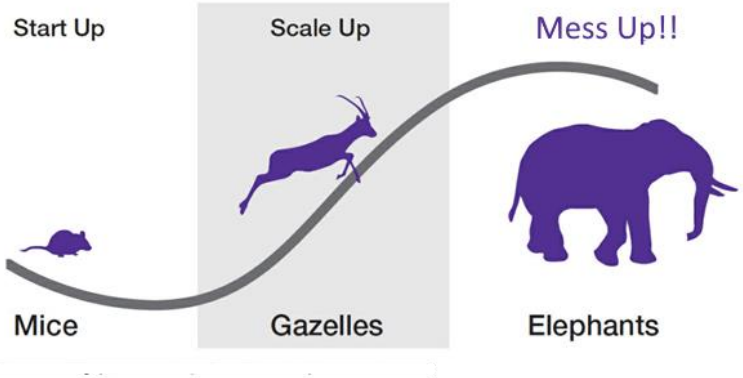
- Public transportation requires long term planning
  - Routes, budget, choice of new vehicles ….
- City infrastructure
  - Charging stations
  - Parking space
  - V2I installations
- What is the minimum number of vehicles for a viable deployment?
- Infrastructure needs at the PTO site

5. Transport policies – Paradigm change

- On-demand, door-to-door automated public transportation : paradigm change
- What to do when passenger :
  - blocks the door
  - did not show up
  - places order for 20m trip
  - vandalizes the vehicle
  - brings in large suitcase
- Minimal number of passengers per ride?
- What is the “right” trip price?

6. Scalability of technology

- AV management supports small scale deployments and small AV numbers (maybe 100-200)
  - All data are centrally controlled by the AV manufacturer – not scalable to tenths of thousands of vehicles
- Fleet management systems have not been tested for hundreds of AVs in a single site
  - Complexity of the dynamic re-routing, re-allocation of trips, dynamic road changes



Conclusions

Autonomous vehicles is a promising solution

1. Technology will catch in the next 2 to 5 years
2. Regulatory framework is evolving and will be there in a few years

BUT

1. Business models are not yet neither understood, nor desinged
2. Scaling up constrains and needs is the hidden part of the iceberg : nothing has been studied

We will not see large scale deployments for at least 5 years from today