Public Transport Network Connectivity: Challenges and Prospects for the Future

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Outline:

1. Introduction
2. Urbanization Trends
3. Innovations and Technologies
4. Smart Cities
5. Elements to Impact Future Urban Transportation
6. Public Transportation (PT) vs Private Cars
7. Approaching Future Seamless PT service
8. Future Feasible Urban Mobility
Future Urban Transportation: Existing Confusion

- Different Communication Systems?
- Use of Biotechnology?
- Variations of Big data?
- Use of Artificial Intelligence?
- Use of Robotic?
- Vehicles Gasoline Powered?
- Electric Vehicles?
- Autonomous Vehicles?
- Solar Powered Vehicles?
- Modular Vehicles?
- Straddling Vehicles?
- ...

???
THE HYPERLOOP BECAME CLOSER TO REALITY TODAY.
PT: Is Hyperloop Concept will fly?
World’s current urban population \(\approx 4\) billion people (54\% in cities); by 2050 \(\approx 7\) billion (66\% in cities); source: United Nations report (2015).

The UN report predicted that by 2050, about 64\% of the developing world and 86\% of the developed world will be urbanized (see Figure below).

This increased rhythm of urban life will cause people to appreciate more time saved, reduced fares, and increased convenience.
Learning from Past:

- **Innovations** - difficult to predict, and not always as intended…Bell intended for the phone to play remote, live music, and Edison thought the phonograph would electronically deliver mail as spoken letters.

- **Innovations** have unintended consequences on society because of the usually limited scope of the inventors’ intentions, and…entrepreneurs are always there to use opportunities. Innovations can introduce new problems, e.g., urbanization resulted in air, water and sound pollution; a need for reading glasses was made evident subsequent to the invention of the printing press.

- **Time is required** for relevant technology to be tested, e.g., cell phones were initially demonstrated in 1973, commercialized in 1983, and adopted for massive use in the mid-90s, twenty years after their initial demonstration.
Years to Mass Production (50% Penetration) of Inventions and Innovations in the USA (source: Dediu, 2011)
Albert Einstein: “Logic will get you from A to B. Imagination will take you everywhere”

Proposed Approach:

A visionary, feasibility related and realist perspectives based approach to explore plausible perspectives of visionaries, based on feasibility evidence, and to realistically consider the imminent gap between progress and current struggles.
### Examples of Development of Inventions and Innovations

<table>
<thead>
<tr>
<th>Invention*/ Innovation*</th>
<th>Visionary’s event(s)</th>
<th>Feasibility-related event(s)</th>
<th>Realist’s event(s)</th>
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<tbody>
<tr>
<td><strong>Hardware-type</strong></td>
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<td>Airplane</td>
<td>People tried to navigate the air by imitating birds</td>
<td>The Wright Flyer on December 17, 1903</td>
<td>Mass production started during World War II (1939-1945)</td>
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<td>Automobile</td>
<td>Steam 'car' designed by Verbiest in 1672</td>
<td>Karl Benz built the Benz patent-Motorwagen in 1886</td>
<td>Mass production started by Ford 1913-1914</td>
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<td>Ship</td>
<td>Dates back about 10,000 years (vessels)</td>
<td>Circa 4,000 BCE, the ancient Egyptians were making wooden sailboats</td>
<td>Mass production of ocean ships started in 1940</td>
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<tr>
<td>Telephone</td>
<td>Early acoustic devices for transmitting speech and music</td>
<td>Invented by Johann Philipp Reis in 1860; first success by A. Graham Bell 1876</td>
<td>Mass production started after 1877</td>
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<tr>
<td>Maglev</td>
<td>Late 1940s, linear motor by British engineer E. Laithwaite</td>
<td>First maglev between the airport and railway station of Birmingham, 1984 to 1995</td>
<td>Expected to be widely available in the 2030s</td>
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<td>Quantum computer</td>
<td>Quantum computer with spins in 1968; Quantum computing, in 1980 by P. Benioff and Y. Manin</td>
<td>First quantum computer introduced by D-wave company in 2011</td>
<td>As of 2016, the development of actual quantum computers is still in its infancy</td>
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<td><strong>Software-type</strong></td>
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<td>Film</td>
<td>Huygens in the 1650s (magic lantern)</td>
<td>By the end of the 1880s (motion picture cameras)</td>
<td>Mass production started after 1910</td>
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<tr>
<td>Internet</td>
<td>Visions into packet switching started in the early 1960s</td>
<td>ARPANET created in 1969</td>
<td>The creation of the Hypertext Transfer Protocol (HTTP) in 1991</td>
</tr>
<tr>
<td>Smartphone</td>
<td>First conceptualized by Nikola Tesla in 1909 and Theodore Paraskevakos in 1971</td>
<td>First mobile phone with PDA features was an IBM prototype developed in 1992</td>
<td>Mass production of iPhone with multi-touch capabilities from January 2007</td>
</tr>
<tr>
<td>Wireless communication</td>
<td>The use of telegraph before 1600s</td>
<td>Heinrich Hertz in 1888 demonstrated the underlying base of wireless technology</td>
<td>Mass production from 1980s with the use of cellular communication</td>
</tr>
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</table>

*Invention (in its purest sense) is creation for the first time*

*Innovation is an improvement to an existing product, process or service*
New urban mobility services, such as innovative rideselling and ridesharing apps, will appear and merge. The key principle of mobility operations for a smart city will be the ability to optimize the connectivity of movement, so as to approach a seamless move while invoking the expression *door-to-door travel* with new meaning.

**A visionary perspective of future smart cities**
(source: Tomorrowland, 2015)
From the News: Business Insider (Tech) website reported that 10 million self-driving cars will be on the road by 2020: semi-autonomous (vehicle can accelerate, brake, and steer a car's course with limited driver interaction) and a fully autonomous (vehicle can drive between two points and encounter the entire range of on-road scenarios without any driver interaction). Is this figure of 10 million realistic?

A rhetorical question: will this help reduce urban traffic congestion, pollution, waste of time, noise, and inefficiencies in terms of capacity and space consumption?

Observation: private cars are parked 95% of the time, demonstrating the inefficiency of their use → can we learn from WeWork company (shared workspace and services, founded in 2010) that won ‘2015 Most innovative Company’ with more than 10 Billion Dollars funding?
Zones in Copenhagen for TBC, CBT, and Same

PC: Private Cars  
PT: Public Transport  
TBC: Transit Beats Cars  
CBT: Cars Beats Transit  

X-minute contour: vehicles can travel from city centre at 4:00pm to the contour line in x-minutes  

Pink zone: represents CBT (less travel time)  
Blue zone: represents TBC (less travel time)  
Green zone: represents same for PC and PT (same travel time)
Thus, why not to think perhaps of the following feasible example:

All cars inside cities should be **electric and driverless**, owned and operated by an assets company. **City residents would page a car to take them anywhere.** **Driverless buses of different size** will move efficiently and automatically charge low fares. **No cars will be parked** on city streets and no noise will be caused by horns and engines. **Small rapid transit vehicles** will serve city dwellers, enabling merged arrangements which will be considered as **modular**. Furthermore, the vehicles will **draw power from an electromagnetic grid** that will line every street, and extend up the sides of buildings. **The infrastructure will bring new meaning to door-to-door travel.**
There are also PT Self-Driving vehicles (from early 2017)
# Web Definitions of Private Car

<table>
<thead>
<tr>
<th>Definition of Private Car/ Private Passenger Automobile/ Private Passenger Car/ Private Transport</th>
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</thead>
<tbody>
<tr>
<td><strong>Merriam-Webster Dictionary:</strong></td>
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<tr>
<td>A passenger car assigned for private use.</td>
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<tr>
<td><strong>Oxford Dictionary:</strong></td>
</tr>
<tr>
<td>A motor car owned and used privately.</td>
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<tr>
<td><strong>BusinessDictionary.com:</strong></td>
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<tr>
<td>Any kind of automobile used to transport private passengers, including a van, which has been approved for use on public motorways.</td>
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<tr>
<td><strong>Insuranceopedia:</strong></td>
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<tr>
<td>A private passenger car, in the context of insurance, is an automobile used for private needs as opposed to business uses. These vehicles are generally defined as having only four wheels, and they do not carry passengers for money.</td>
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<tr>
<td><strong>The Law Dictionary:</strong></td>
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<tr>
<td>The transportation of private individuals is undertaken in private passenger automobiles.</td>
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<tr>
<td><strong>Wikipedia:</strong></td>
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<tr>
<td>Private transport is transportation service which is not available for use by the general public.</td>
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</table>
How to get rid of problems related to public transport operations planning?
The Three Key Players of Future Public Transport System

**Input**
- Info; Cost; Social class
- Estimated pax demand; Fleet size available; Manpower; Cost components

**Activity**
- Waiting, riding and transferring PT modes 1,2,...,k
- User
- Reliability; Satisfaction; Comprehension

**Output**
- Discrepancy of/ agreement with info provided/ expectations

**Impact**
- On-time and safety performance; Discrepancy of/ agreement with expected pax demand

**Operator**
- Provide scheduled/flex service; Send updated info; Assign vehicles and drivers; Handle real-time control

**Community/Municipality**
- Plan and activate priority schemes; Encourage PT users; Restrict cars movements

**Input**
- Fixed/flex routes and stops; Interchanges; Priority schemes; Safety measures

**Activity**
- Less/more unused capacity on priority segments; Less/more PT-related accidents; Less/more PT use in modal split

**Output**
- Veh/km; Veh/hr; Pax-km; Pax-hr; Revenue; Reliability; Safety level
Seamless Travel

From Ceder (2007, 2016) re ideal public transport

“Advanced and attractive transit service that operate reliably, and relatively rapidly, part of the passenger door-to-door chain with smooth and synchronized transfers”

[seamless move]

Seamless move via direct (no wait) transfers

Longitudinal Transfer  Lateral Transfer
Food for Thought
Further Reading

End of the Presentation

Thank you!