Dynamic model for assignment in "sky-car" transit system – Spatial interactions with other common transport modes

11th Conference on *Traffic & Granular Flow*
October 28, 2015

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Projet porté par

Labellisation principale

Labellisations secondaires

Soutien de collectivités territoriales

Outline of the presentation

Outline

01 Background and Motivation

Personal Rapid Transit

1 - Background and Motivation

Transport and Mobility

- Focus: Traffic modeling in Demand Responsive System equipped (DRS) with Personal rapid maglev travellers
- Traffic Demand optimization inside the DRS
- Reactive dynamical assignment - Stochasticity - Relocation
- Multimodality - Spatial interactions of the DRS with other common transport modes

1 - Background and Motivation

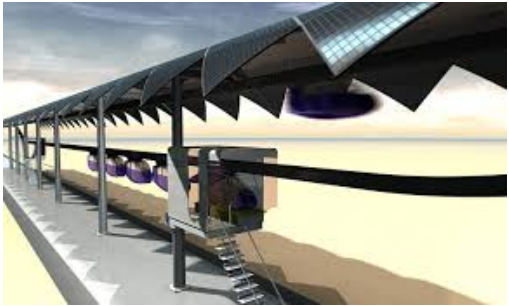
Transport and Mobility

1 - Background and Motivation

Traffic congestion

1 - Background and Motivation

New traffic game area - Personal maglev rapid travellers



1.4 - New traffic Game Area

Personal Rapid Transit

Definition:

Personal rapid transit (PRT), also called podcar, is a public transport mode featuring small automated vehicles operating on a network of specially built guideways.
PRT is a type of automated guideway transit (AGT), a class of system which also includes larger vehicles all the way to small subway systems.

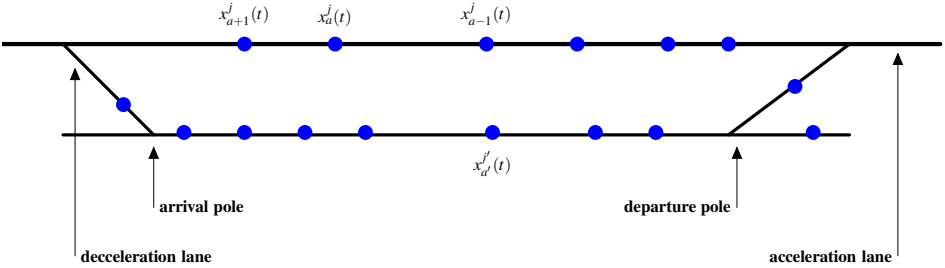
Outline

02 The Traffic Model

How do the sky-pods move ?
Intersection model
Demand optimization
Mutimodality - Spatial interactions

2 - The Traffic Model

Representation of portals, sky-lines



2.1 - The Traffic Model

How do the sky-pods move ?

Motion of sky-pod in Lagrangian coordinates

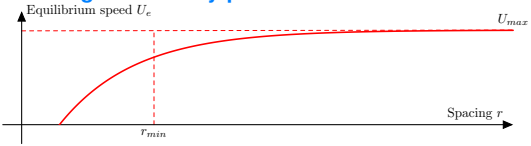
a	sky-pod label
t	time-step
$x_a^j(t)$	position of sky-pod a at time t on the arc (j)
$r_a^j(t)$	distance between the leader $a-1$ and the follower a
u_{p_a}	velocity profile depending on its mission

$$\begin{cases} x_a^j(t+1) = x_a^j(t) + \delta t \; u_a^j(t) \\ u_a^j(t) = \min\left(U_e\left(r_a^j(t)\right), u_{p_a}\left(x_a^j(t)\right)\right) \end{cases}$$

Choice of $U_e(r_a(t))$:

$$U_e(r) = U_{max}\left(1 - \exp(-r + \delta r)\right)$$

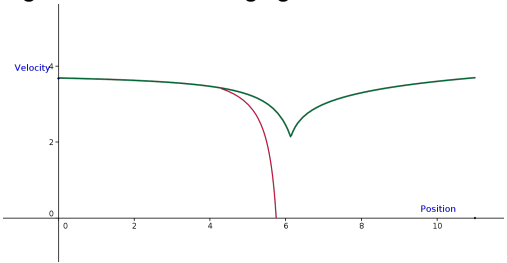
Spacing-equilibrium speed fundamental diagram of a sky-pod in motion



2.2 - The Traffic Model

Intersection model

Speed profile in Merging and Diverging zones



Deceleration Problem

$$Dist_{dec} = \frac{U_{max}^2}{2\gamma_{a-}}; \text{ (braking safety distance)}$$

$$u_a(t) = U_{max} - (t - t_0)\gamma_{a-}; \text{ (t_0 the instant we decelerate)}$$

$$x_a(t) = x_0 + U_{max}(t - t_0) - \frac{(t - t_0)^2}{2}\gamma_{a-}$$

$$t_{dec} - t_0 = \frac{U_{max}}{\gamma_{a-}}$$

2.3 - The Traffic Model

Demand optimization

$W(t) \in \mathbb{R}^{+}_{Ns}$: the workload at time t in the system, *i.e.* $W_s(t)$ is the number of users at station s at time t.
At time t, a user at station s requires service independently of the others with probability $\frac{1}{s' \in \mathcal{V}_s W_{s'}(t)}$. This user receives service if he is the only user requiring service in $\mathcal{V}_s$ at time t and when there is available offer at the station s or in its neighborhood.

2.4 - The Traffic Model

Mutimodality - Spatial interactions

Combined networks - Route and mode choices

Assumption:

Any pair OD pair could be joined with the below choices:

- **mode m_1 :** use of road vehicle, then parking search availability to park and parking, and pedestrian walk for attending final destination, or
- **mode m_2 :** use of sky-car and pedestrian walk, or
- **mode m_3 :** use of modes m_1 and mode m_2.

Logit-based rules

For $\forall k \in \{1,2,3\}$ (k being the index of the mode) and for $\forall w = (o,d)$,

$$\pi_{od}^{k} = P[choice = m_k \mid (o,d) = w \in W]$$

$$= \frac{\exp\left(-\theta C_{od}^{m_k}\right)}{\sum_{p \in \{1,2,3\},(o,d)=w \in W} \exp\left(-\theta C_{od}^{m_p}\right)}$$

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The probability of choosing a mode well verifies:

$$\begin{cases} 0 \leq P[choice = m_k \mid (o,d) = w \in W] \leq 1, \\ \qquad \forall k = 1,2,3\ , \forall w = (o,d) \in W, \\ \sum_{k=1}^{3} P[choice = m_k] = 1. \end{cases}$$

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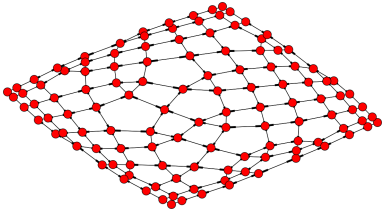
Outline

03 Conclusions & Futur work

3 - Conclusions & Futur work

- Lagrangian model for Sky-pods in motion
- We provide intersection model for autonomous Demand-responsive system of personal maglev rapid travellers
- Demand optimization due to a Random Multiple Access Protocol with Spatial Interactions.
- **Challenges:**
  - Method to reduce computational tasks in Large-scale Autonomous Demand responsive system of Personal maglev rapid travellers.
  - Traffic simulation.
  - Stability analysis of the Random Multiple Access Protocol with Spatial Interactions.



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3 - References

Thanks for your attention

Questions ?

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