

# A level-based approach to public transport network planning



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## ETH Zurich: Institute for Transport Planning and Systems

### Reference:

Hermann Orth, Andrew Nash and Ulrich Weidmann

*A Level-based Approach to Public Transport Network Planning*

Presented at: US Transportation Research Board 2015 Annual Meeting (15-1171)

# *The Idea*

Robert Cervero

*The Transit Metropolis – A Global Inquiry*  
(1998)

*Cervero describes Zurich's approach of (1) making surface public transport faster and (2) building closely spaced regional rail stations in the centre city as a solution that eliminates the need for a rapid rail system.*

# The Transit Metropolis

A GLOBAL INQUIRY



Robert Cervero

**So, what's a level?**



**Level = f (mode, market characteristics)**

# Characteristics

## Transport Mode

- Speed
- Capacity
- Capital cost
- Operating cost
- Flexibility
- Reliability

## Travel Market

- Distance (time)
- Cost
- Demographics
- Comfort
- Reliability

# Characteristics

## Transport Mode

- **Speed**

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## Travel Market

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***Speed influences all other characteristics.***

Speed = Trip length served “effectively”

*... for passengers and operators.*



**Speed = f (right-of-way)**

**Exclusive = fast**

**Shared = slow**

# Traditional Approach

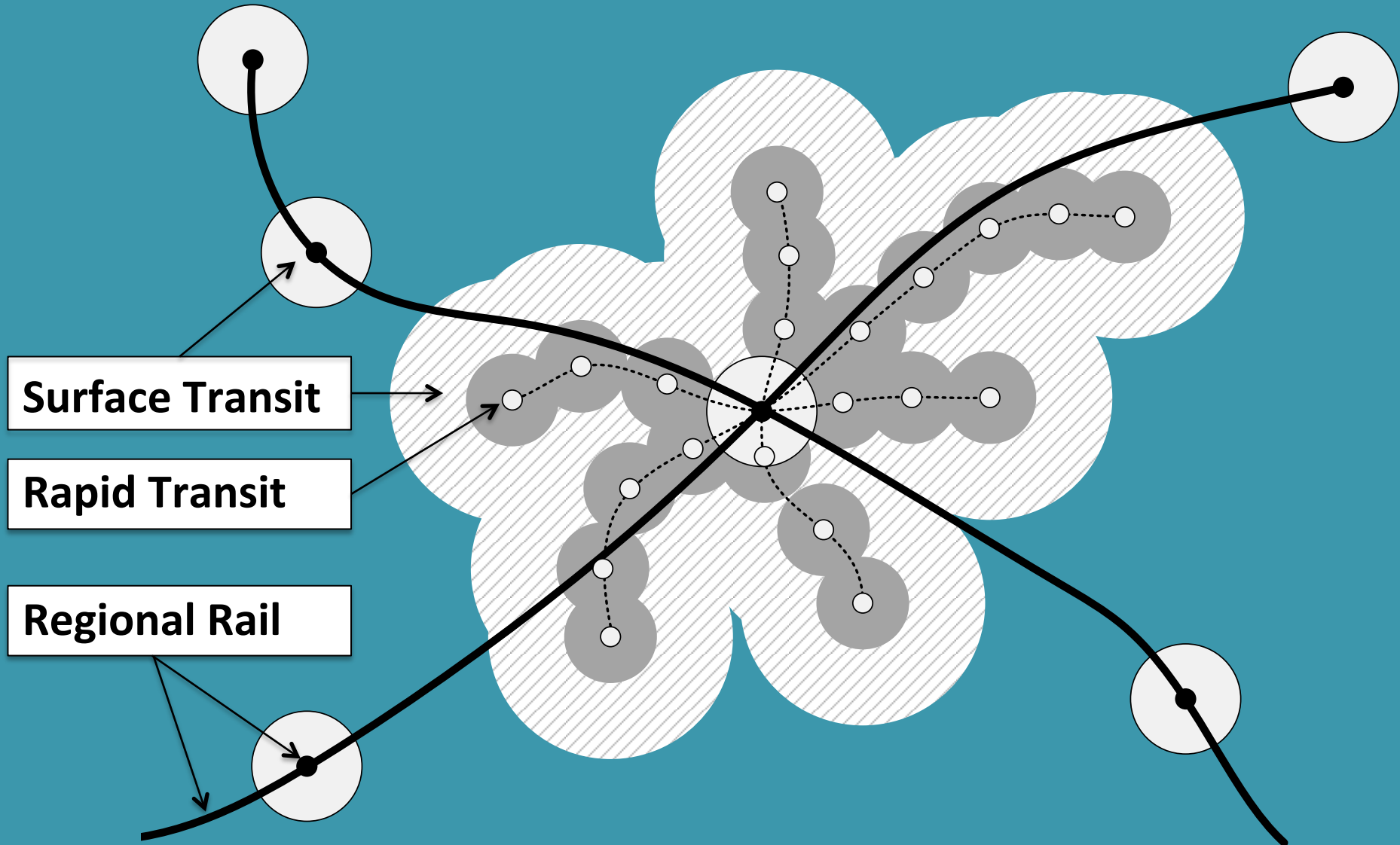
## 3-level System

Level	Cost	Speed	Stop Spacing	Network Density	Frequency	Capacity
Surface (Bus & Tram)	+	-	+	+	0	-
Rapid Transit	-	0	0	0	+	+
Regional Rail	0	+	-	-	-	+

*But, vehicle, infrastructure and services can be adjusted to serve “non traditional” markets.*

# Infrastructure + Market Areas

## 3-level System



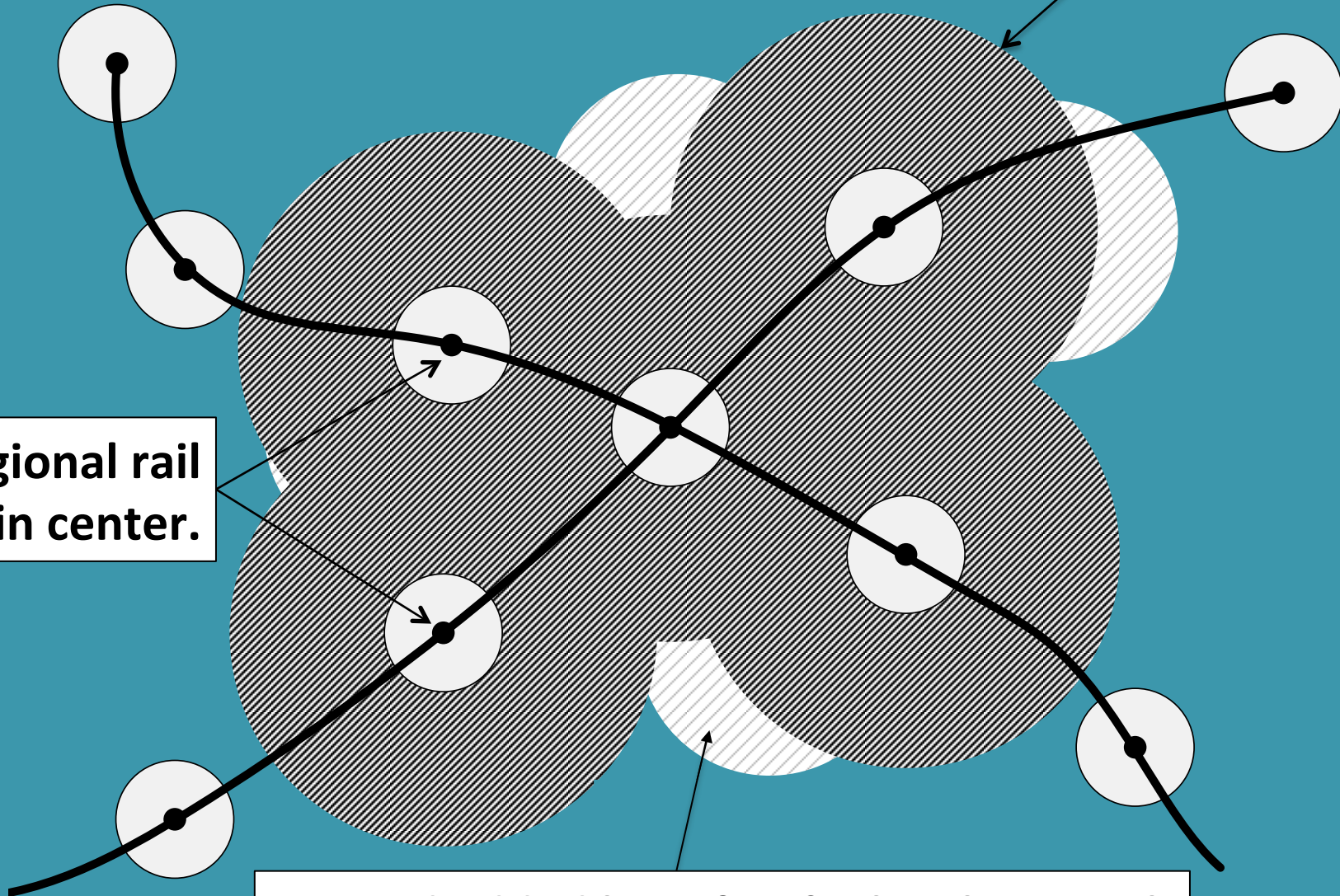
# Infrastructure + Market Areas

## 2-level System

Faster surface public transit.

More regional rail stations in center.

Limited added benefit of 3-level network









S-Bahn Zürich.

Die beste Verbindung zwischen Stadt und Land.



SBB CFF FFS



Winterthur

Selbstkontrolle Automaten  
Automaten  
Personen-Pass-Aus

# Other approaches





**Tram-Trains: Trams on regional rail tracks (Karlsruhe approach)**





**Bus Rapid Transit: Provide level 2 service with level 1 infrastructure (Curitiba approach)**





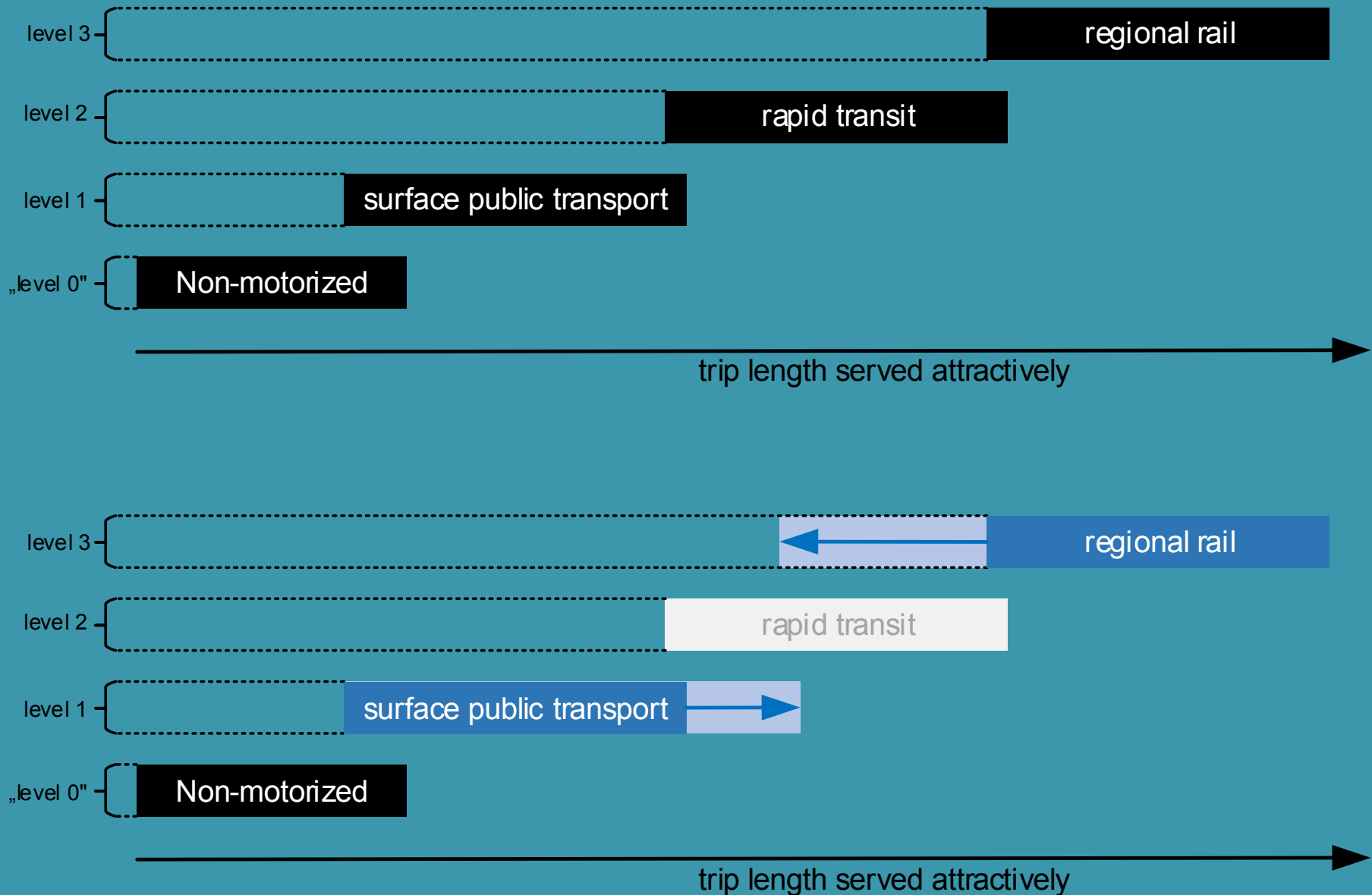
**Move level 1 underground**





**Build level 2 and eliminate level 1  
(German 1970s approach)**

# Functional Coverage Diagram: 3- vs. 2-level PT System





# Speed Comparison: 3- vs 2-level PT System

Vienna	Mode/Level		Speed [km/h]	Separate ROW
	Bus	1	17	Limited
	Tram	1	15	Partial
	Rapid Transit	2	32	Full
	Regional Rail	3	45	Full

Boston	Bus	1	18	Limited
	Light Rail	1	20	Partial
	Rapid Transit	2	25	Full
	Regional Rail	3	50	Full (GC)

Zurich	Bus	H	18	Limited
	Tram	H	15-20	Partial
	Regional Rail	H	50	Full

San Francisco	Bus	1	14	No
	Tram (Muni Metro)	H	15-27	Partial
	Rapid Transit (BART)	H	56	Full
	Regional (Caltrain)	3	65	Full (GC)

# Measures of Success: Zurich

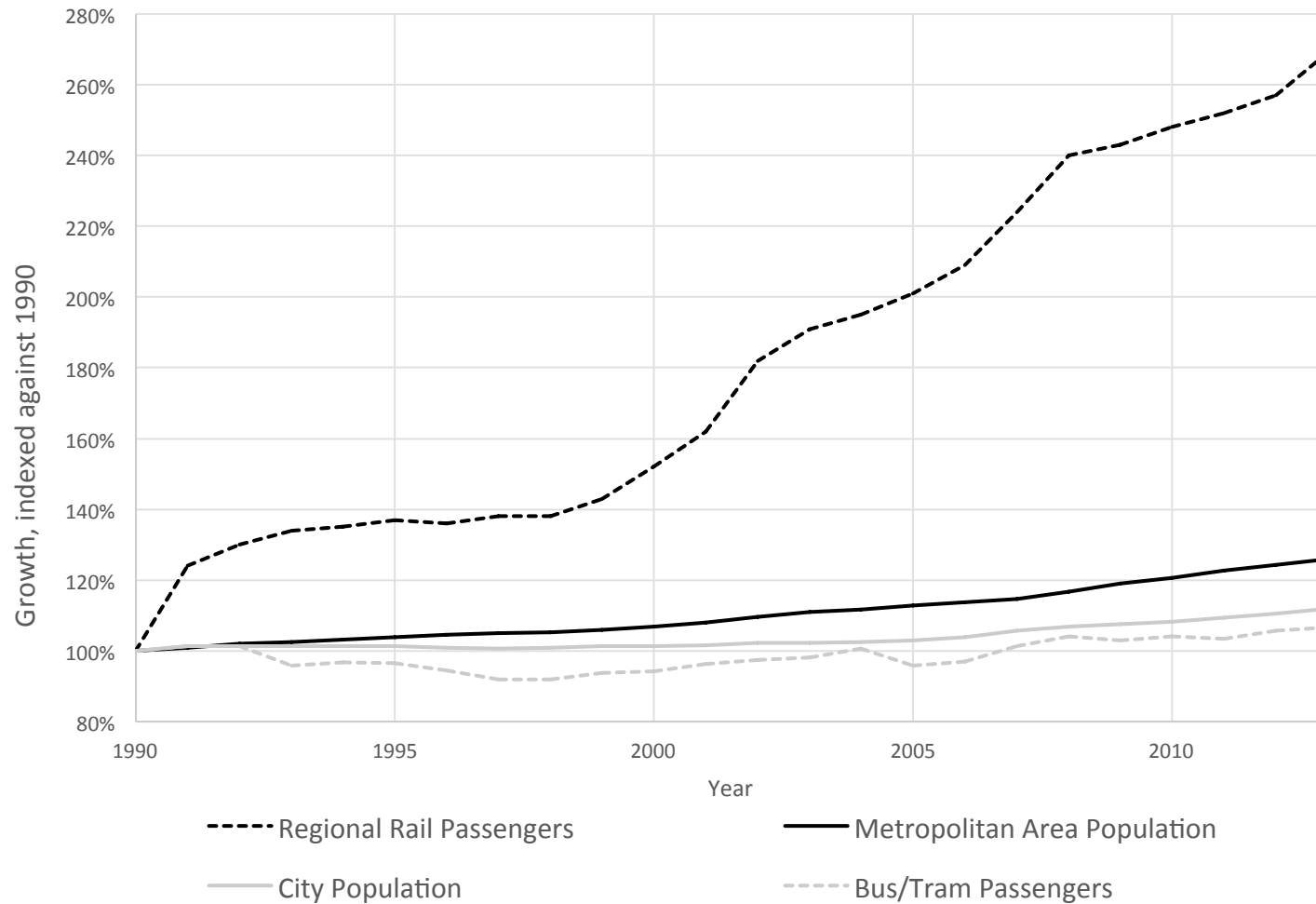
## **Passenger**

- Good coverage
- Relatively high speeds
- High frequency

## **Operator**

- High farebox recovery
- Growing market share

# Passenger demand vs population in Zurich

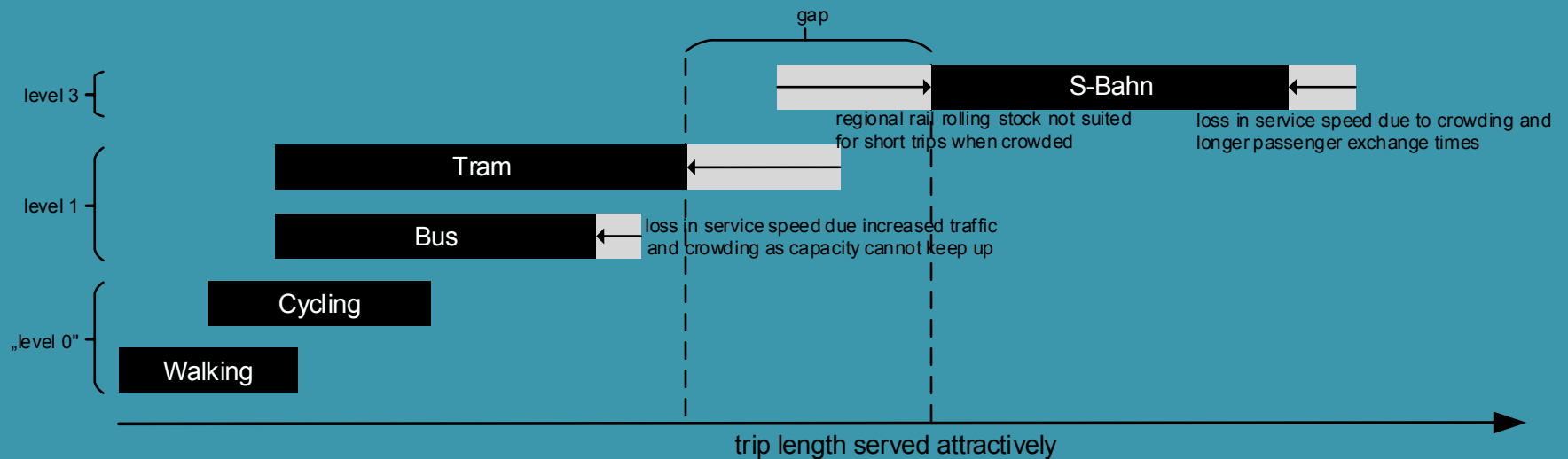


# **But now ... too many passengers!**

**Zurich's system is operating above its effective capacity.**

- **High regional rail use for very short center city trips;**
- **Extreme crowding on regional rail within city;**
- **High crowding on city buses and trams.**

# Functional Coverage Diagram: Impact of capacity problems on Zurich system



**Over Capacity = Reduced Speed = Reduced Effectiveness**

*Without a dedicated medium-distance medium-speed service (rapid transit), capacity constraints on surface and regional rail levels become acute.*

# **Traditional approaches for solving capacity problems**





**Larger vehicles with more doors**  
*(so large it doesn't fit on the slide!)*





**Speed-up boarding**



SBB CFF FFS

2

FW



ZVV  
Ein Ticket für alles.





**GO**

**GO**

**GO**

**MOBIB**

**NEW**

**Abonnement mensuel**

**Maand-abonnement**

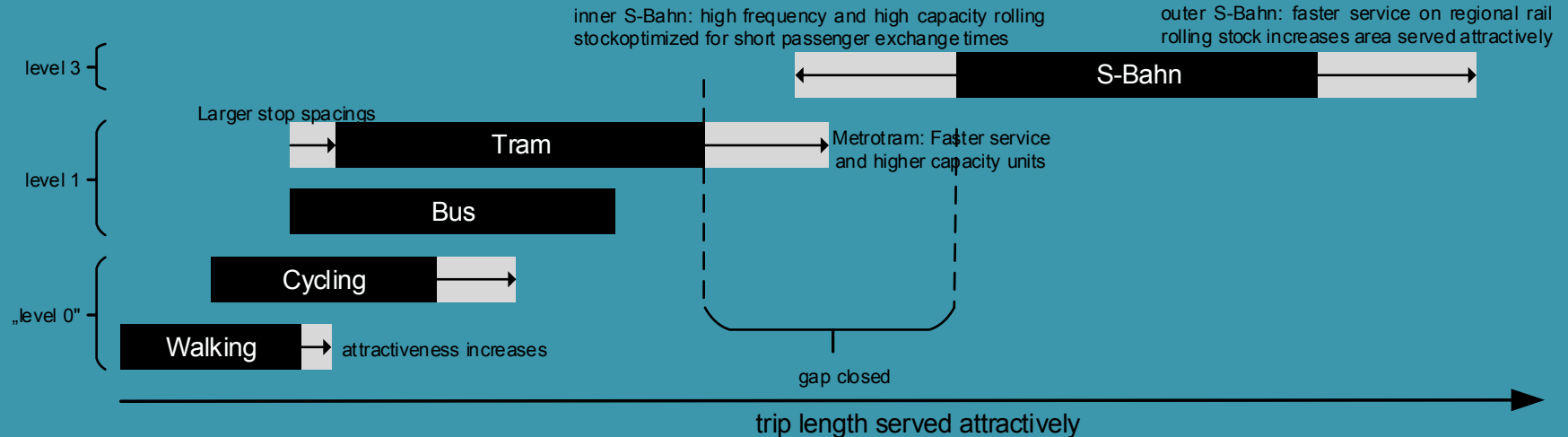
**Abonnement scolaire**  
*Schoolabonnement*

**Abonnement annuel**  
*Jaarabonnement*

**Off-board ticketing and  
Proof-of-payment**

# **Level-based approaches for solving capacity problems**

# Solving capacity problems in Zurich's 2-level system



## Surface

- Longer stop spacing
- More priority
- “Metrotram” (LRT)

## Regional Rail

- Differentiated service
  - Inner
  - Outer





**Metrotram – larger vehicles & tunnels**





**Shift short trips from public transit to  
Level “0” – Biking and Walking**





**Prioritize the limited space  
available for transport in cities**



# Slow Transit



**Designed specifically to serve short trips.**

Example: Line 100 – Circle Line Woensel  
Municipality of Eindhoven  
Bus route designed by and for seniors.

Source: <http://www.muzus.nl/>

# Conclusions

- Public transport vehicle, infrastructure and services can be adjusted to serve “non traditional” markets.
- 2-level systems can be a flexible and very cost effective way to provide public transport service (no rapid transit system).
- 2-level systems could be especially attractive for medium-to-low density metropolitan areas (e.g., USA).
- Capacity is the Achilles Heel of 2-level systems, but there are many design strategies to overcome this limitation.
- Since 2-level systems use streets for bus and tram operations, they require clear priority setting for the use of street space.
- High quality pedestrian and bicycle systems reduce the demand for capacity on public transport and are increasingly being considered as alternatives to PT expansion projects.



**Andrew Nash** helps clients design and manage innovative public transport, railway, urban planning and active transport projects. Current work includes [greencitystreets.com](http://greencitystreets.com) (using information technology for better public participation), open source railway dispatching applications, public transport planning and active transport projects. See [andynash.com](http://andynash.com) for details and contact information.