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Introducing Context-Adaptive Elevator Scheduling

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Outline

- Elevator Scheduling
- Context and Context-Awareness
- 3 Examples of Context-Awareness in Elevator Control
- Simulations and Results

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Elevator Scheduling

Elevator Scheduling is performed on two levels:

- **Group Elevator Controller**
  - in charge of all elevator banks and performs global planning
- **Elevator Controller**
  - once a call is assigned to an elevator, the appropriate elevator controller performs local planning in its scope

Various **Elevator Scheduling Algorithms:**

- **Round Robin, Up-Peak** (RR with Lobby parking)**, Zoning, Three Passage/ETA, …**
- all have **pro's and con's for certain traffic demands**

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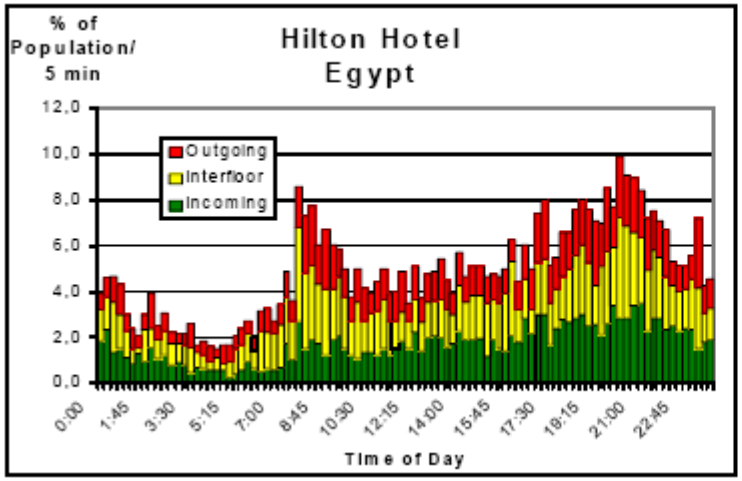
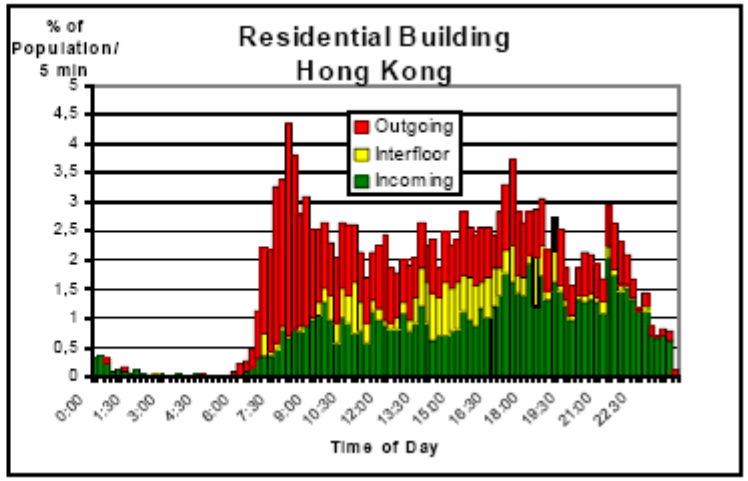
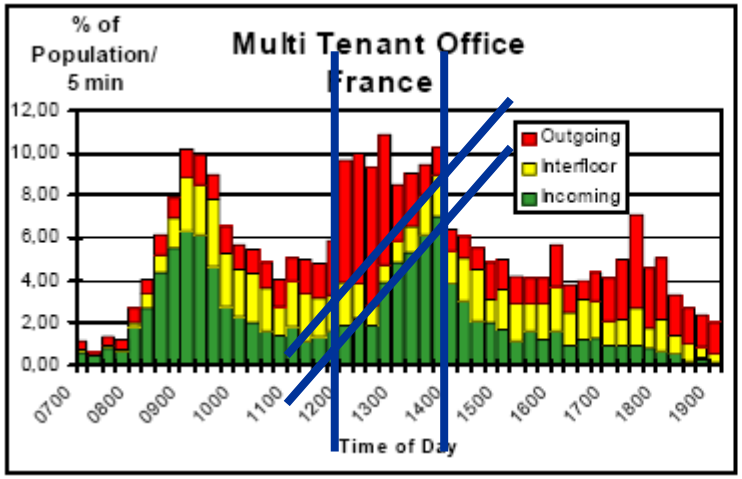
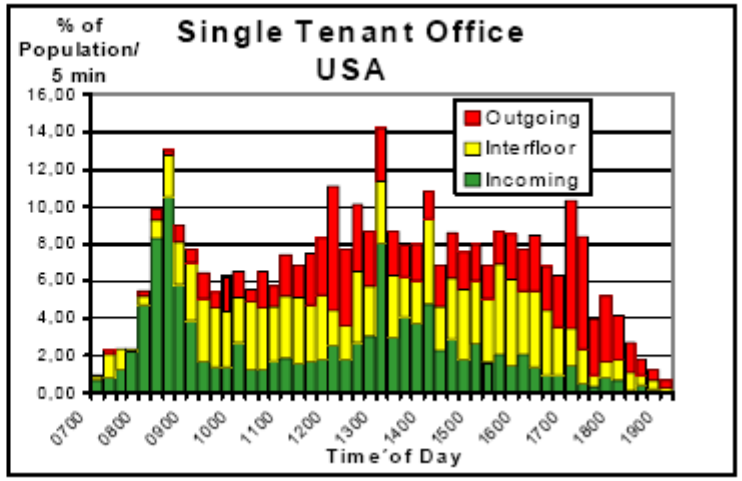
Traffic Demand Patterns (Statistics)









[Source: Sorsa et al, Elevcon Asia 2005]

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What is Context?

Definition of *Context*:

"Any information that can be used to characterize the situation of an entity. An Entity is a person, place or object that is considered relevant [..] [concerning service usage.]"
(A.K.Dey: "Understanding and using context", 1999)

Definition of *Context Awareness*:

"A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task."
(A.K.Dey: "Understanding and using context", 1999)

***Location Awareness* is specialization of Context Awareness.**

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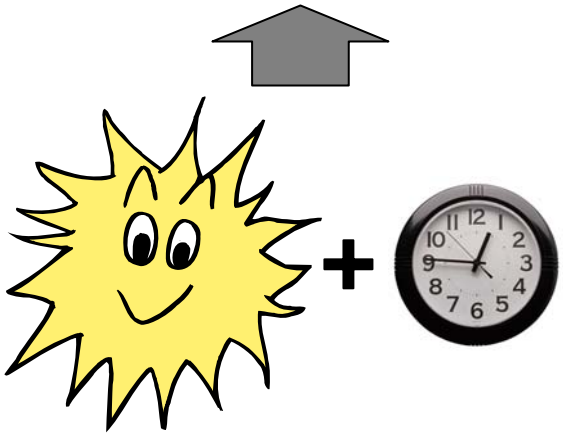
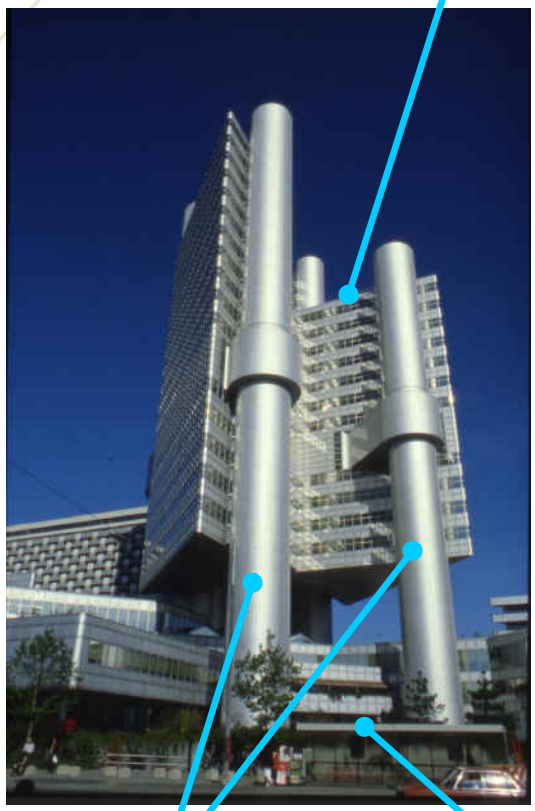
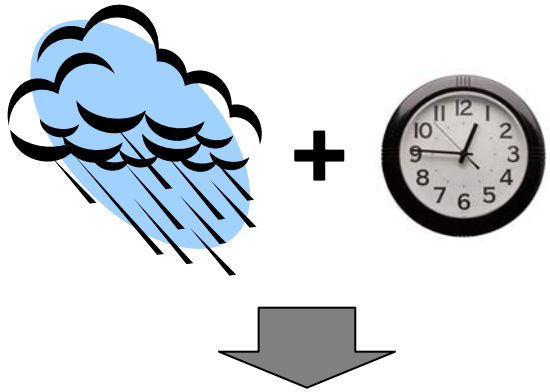
Example Context: The Weather

„*Up-Peak Demand*“







„*Down-Peak Demand*“

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Example I: Context-Aware Scheduler Switching

weather

⋮

current scheduler

large meeting on nth floor

Sensors

- round-robin scheduling
- up-peak scheduling
- source zoning scheduling
- destination zoning scheduling
- three passages scheduling
- … scheduling

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Example II: Location-Aware Scheduling Algorithm

Floor Call Systems

direction only

manual destination

automatic destination

[Source: Schindler]

combined approach

employee

RFID chipcard

route passenger to elevator serving the right floor

aspnet_Profile

	Column Name	Data Type	Length	Allow Nulls
🔑	UserId	uniqueidentifier	16	
	PropertyNames	ntext	6000	
	PropertyValuesString	ntext	6000	
	PropertyValuesBinary	image	6000	
	LastUpdatedDate	datetime	8	

profile (incl. office location etc.)

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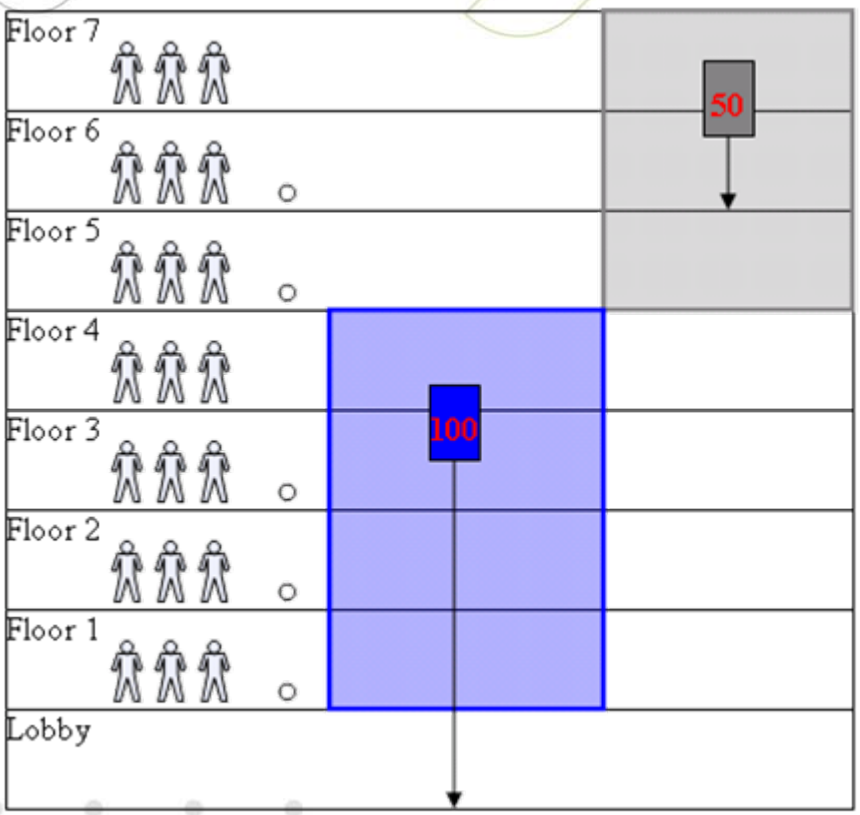
Example III: Emergency Context

Evacuation Zoning



If reason for evacuation allows for elevator usage (e.g. bomb alarm), the performance of Zoning can be further improved using context information such as from gas sensors or capacity sensors.

Main difference from Zoning:

all current and future calls will be ignored if max. number of passengers has boarded and moves directly to recall floor (usually lobby)

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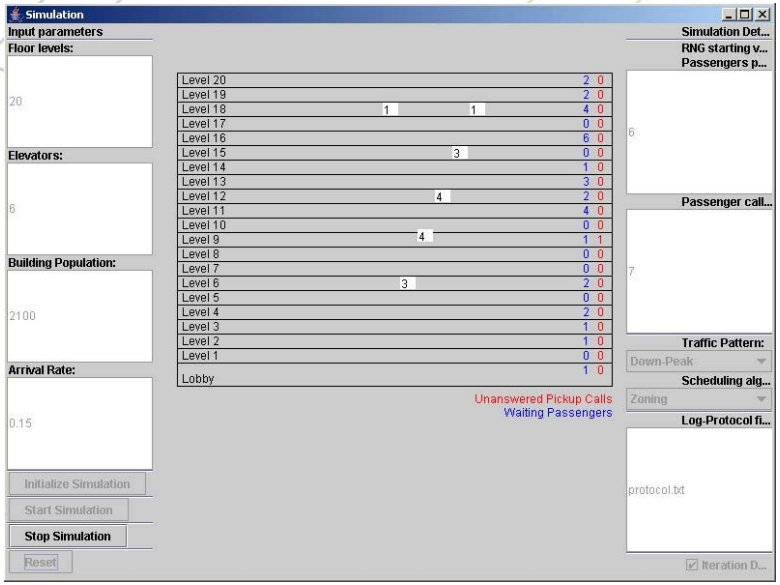
Simulations & Parameters



Building Layout	floors	elevs	pop
1180 Ave. of the Ame., NY	23	8	2300
Penn Ave Place, Pennsylv.	9	6	2800
Corning Inc, NY	10	3	500
AAAS Building, Washington	13	6	2800

[Source: Schindler]

Input Params (selection):

Building Layout

Passenger Arrival Rate: 12/9/6% of building population in 5min

Scheduling Algorithm

Traffic Demand Pattern

Virtual Sensor Data (context knowledge)

Output Params (selection):

Average Waiting Time (AWT - time between registering a floor call and boarding the elevator)

Average Ride Time (ART - time between having boarded the elevator and leaving the car)

Average Journey Time (AJT = AWT + ART)

WT>60s: # passengers not served after 60 seconds

➡ over 36.000 simulation runs!

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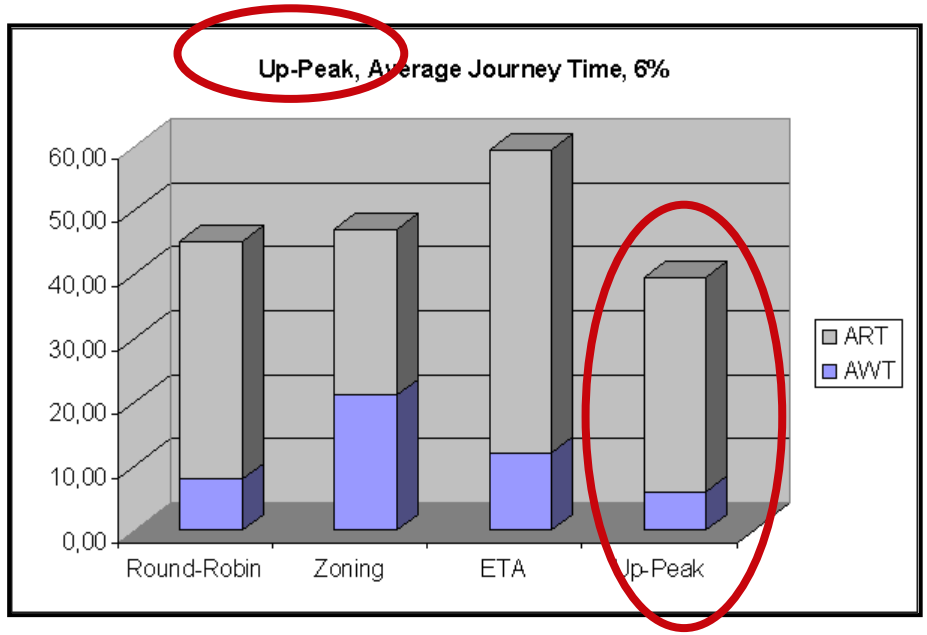
Results I: Verification of Simulations

Unsurprisingly, scheduling algorithms which were designed for a specific demand performed best for this demand

- Up-peak scheduling best for up-peak demand
- ETA best for lunch-peak
- Zoning best for down-peak



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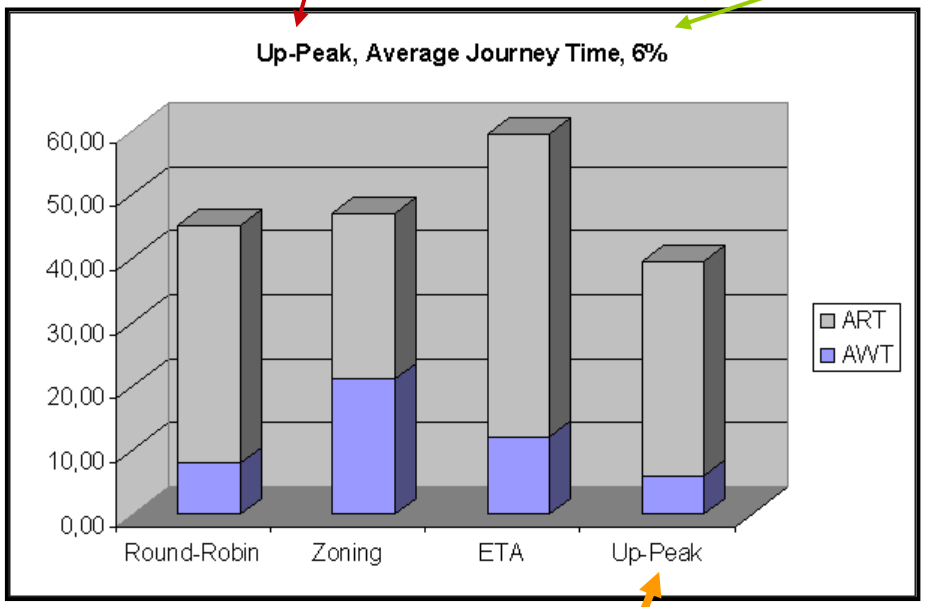
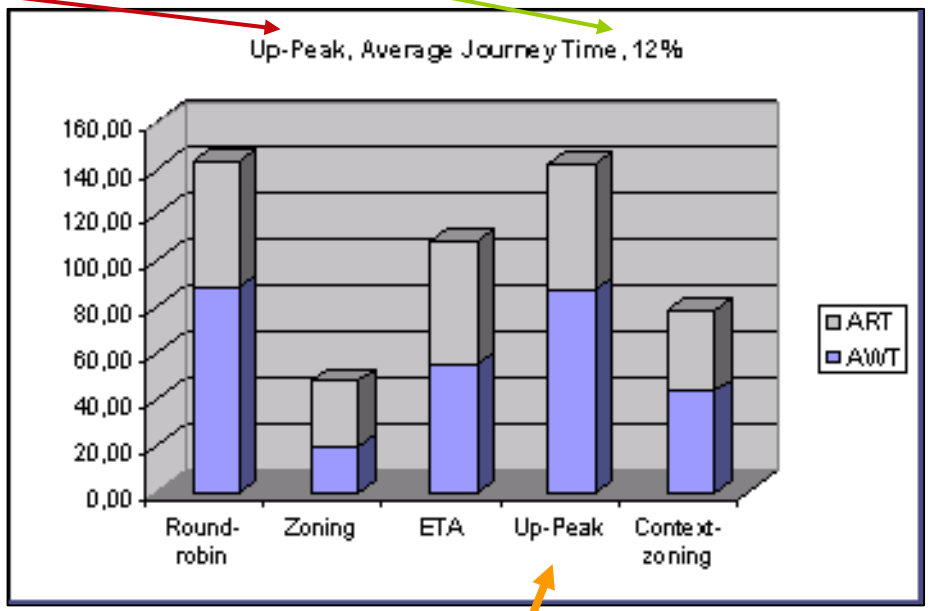
Results II: Context helps

Same pattern, different passenger arrival rates: **big difference!**





best

almost worst

- good estimate of **all** influencing params essential to reach optimum

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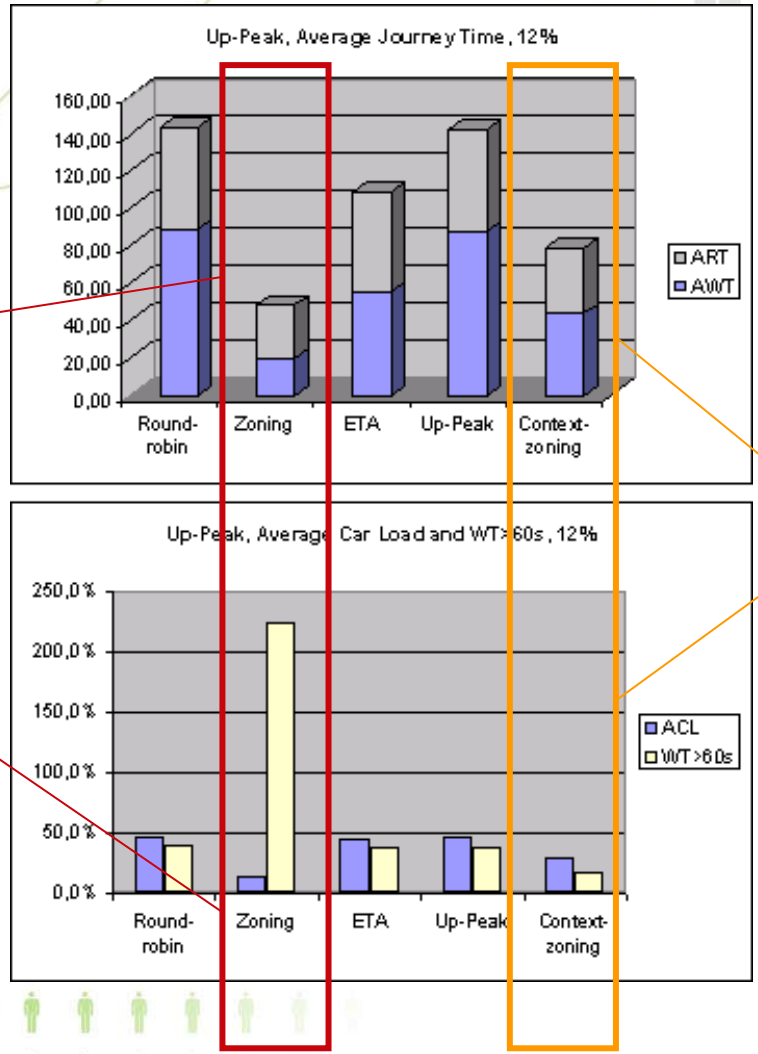
Results III: Trade-offs

Zoning performs best for high up-peak demands,

but is strongly affected by a high amount of not served passengers



Context Zoning has the best trade-off between low AJT and low number of not served passengers for high up-peak demands

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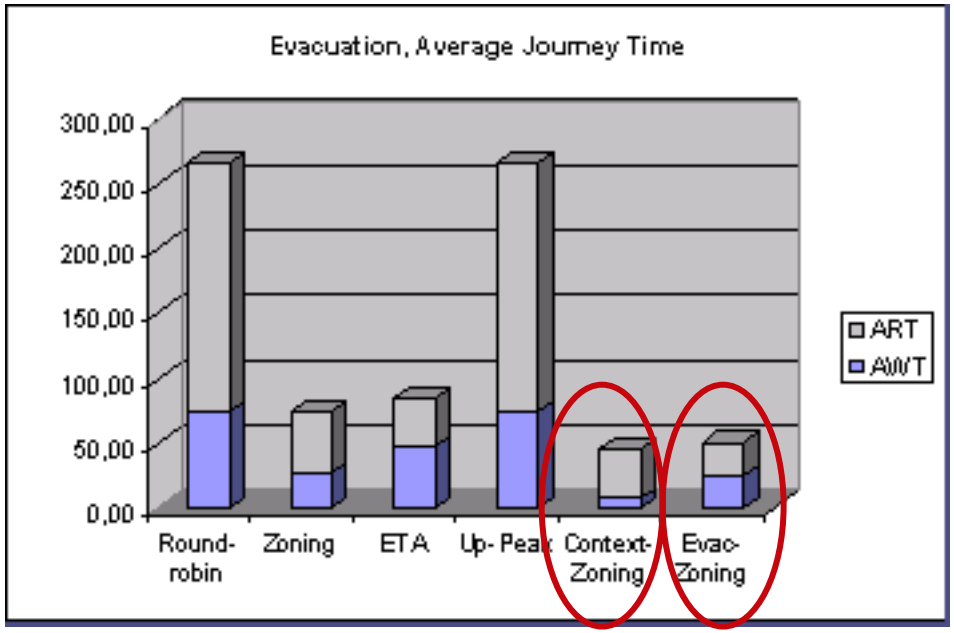
Results IV: Evacuation

Evacuation is most extreme scenario of high down-peak demand

Similar trade-off for high down-peak demand:

Context Zoning performs best on AJT, but **Evacuation Zoning** was almost as good having about half as many not served passengers in average



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Summary

- Introduced the application of context-awareness to elevator scheduling
- Showed different examples where context may help to optimize efficiency
- Simulation results verified our findings, in particular that context-adaptive elevator scheduling *improves efficiency in some situations* and *does not harm* in the remaining ones

Thus, we conclude that context can be used as *support technology* for elevators and other vehicle systems such as people movers.

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We are happy to try to answer any questions!

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