SIMWALK

Sascha Behnsen + Alex Schmid, Managing Director

How to Evacuate a Railway Terminal

A Passenger Simulation Case Study

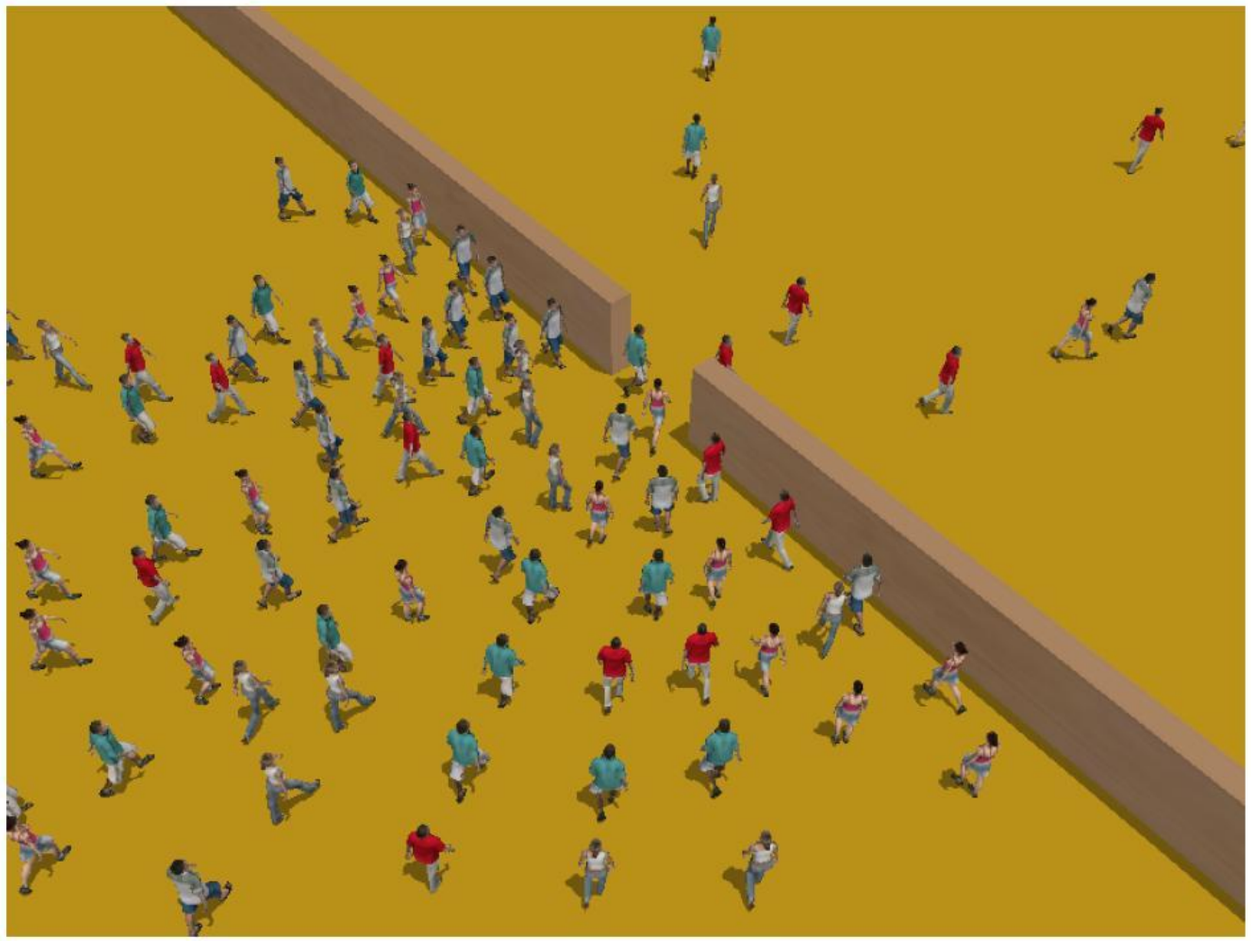
Why passenger simulation?

Real-world, operational and strategic problems: inefficiencies, high densities, bottlenecks etc.

Computer simulation experiments and optimization

Evaluation and implementation: design change, re-routing, scheduling change etc.

What is state of the art in simulation?



- Microsimulation: every passenger is simulated as a separated, single person
- Virtual passengers have properties (age, size, gender etc.), goals and behaviors
- Agents move realistically and continously in space
- All transport objects (trains, cars etc.) as well as operational objects (escalators, stairs, elevators etc.) can be integrated into a simulation scenario
- Current software allows 2D as well as 3D visualization and analysis

What is special about evacuation modeling?

- Movement: passengers move at the same time fast and reluctant, „complex“ depending on information about the danger

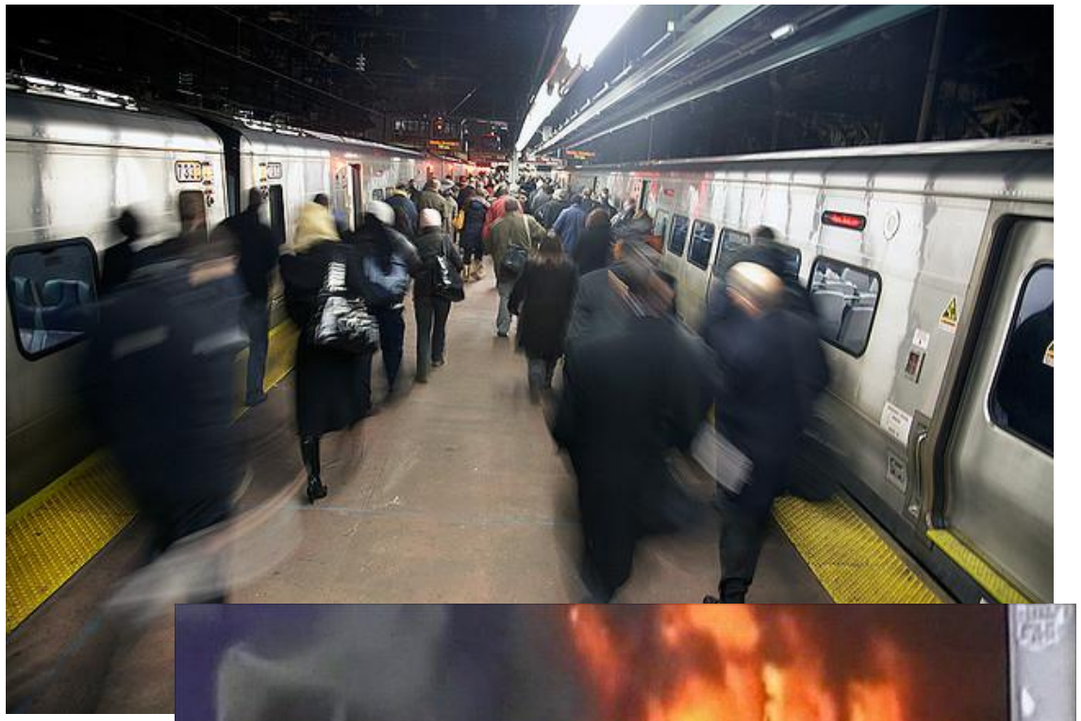
- Behaviour: Less goal driven than in normal flow where specific destinations exist (reaction time)

- Complexity of environment: Complex environments are more significant for escape behavior than for normal flows

- In railway terminals more complex environment (exit routes), complex reaction times than in building evacuation

- Psychology: what is panic?

Results and benefits of evacuation simulation



- Evacuation time: how long does it take for all passengers to reach safe areas?
- Escape routes: Given a certain kind of hazard, are possible escape routes efficient and able to evacuate passengers?
- Design verification: Is the general terminal design able to cope with different hazard scenarios and evacuate the passengers safely?
- Hazard management: What operational actions (information, signage etc.) are beneficial for evacuating passengers in a given time?

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Sascha Behnsen – Team Leader – kbr-projekte

Case Study

Evacuation Of Two Main Railway Station Designs

What‘s the basis of simulations in Germany?

- There is no law in Germany which makes microsimulations mandantory in approval processes
- But there are more and more recommendations for using these techniques as part of proofs for fire safety in the process of approval
- Technical specifications and standards are being developed.
- Until now, the full abilities of these models are not yet being used
- Besides simulations, also capacity calculations are possible for estimating evacuation time
- Models basing on cellular automata are very common

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Basis for simulations of railway stations

RiMEA - Richtlinie für mikroskopische Entfluchtungs-Analysen	Recommendations for standardised reports
vfdb - Leitfaden für Ingenieurmethoden	Recommendations for engineering methods in fire safety
Standards of DB Station & Service	Makes further specifications concerning simulations as engineering method for fire safety
DB AG Richtlinie 813 „Personenbahnhöfe planen“	Technical standard of DB AG references in Module 81304 to specifications of DB Station & Service
Eisenbahn-Bau- und Betriebsordnung (EBO)	EBO references to generally accepted rules of technology (anerkannte Regeln der Technik)
Allgemeines Eisenbahngesetz (AEG)	§ 4 Abs.1 AEG: Railways are obledged to build and hold a safe and secure infrastructure

It is in the responsibility of the owner to assure fire safety of his planned building.

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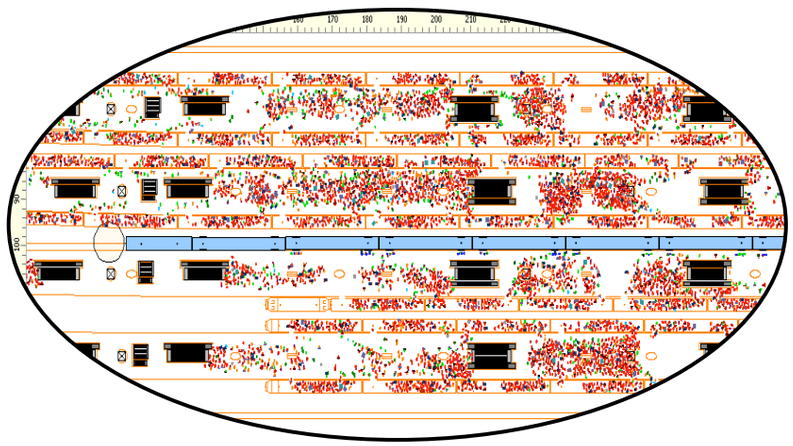
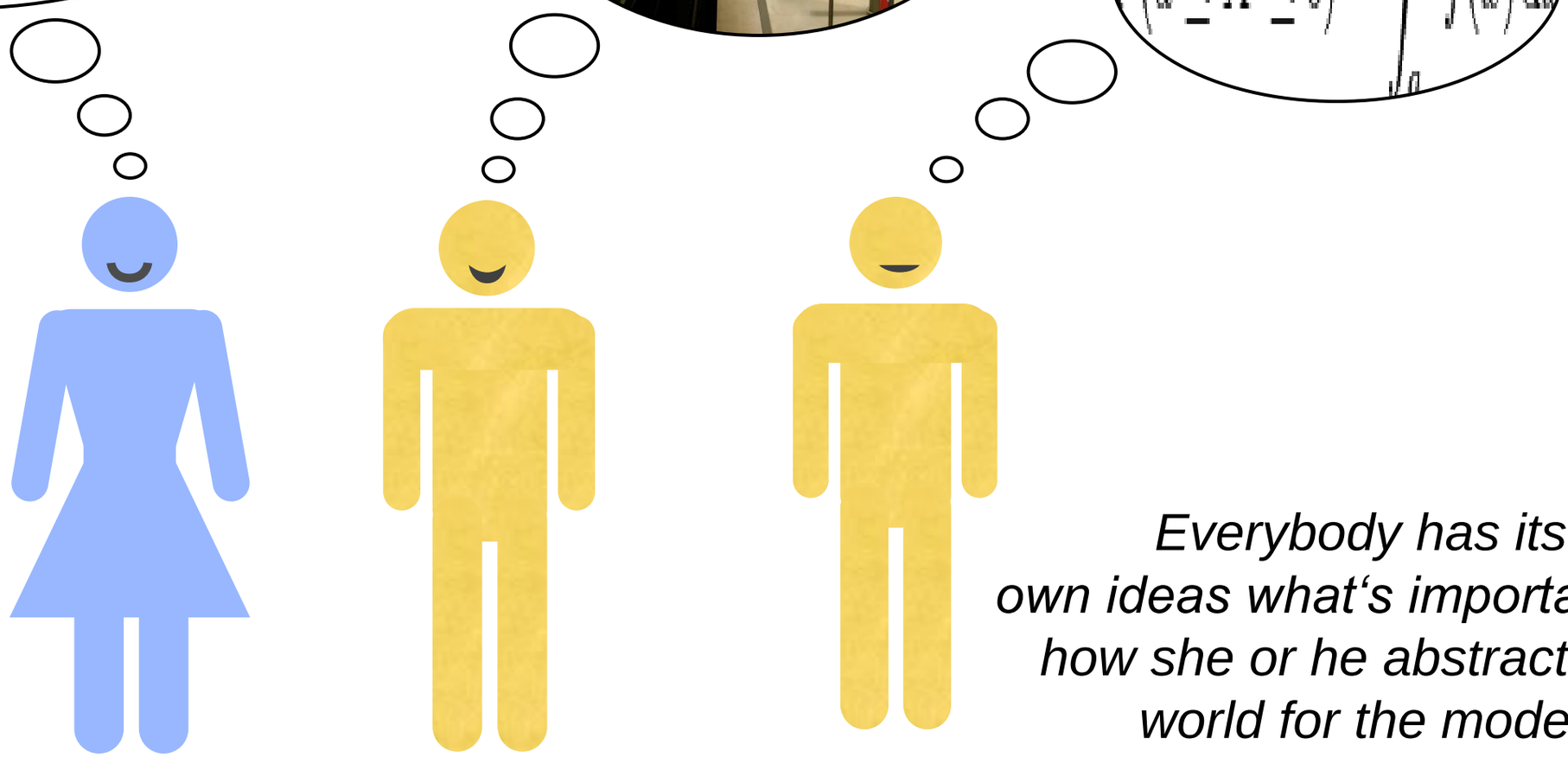
Multiple views...



$$P(a \leq X \leq b) = \int_a^b f(x)\,dx$$



Everybody has its own ideas what‘s important and how she or he abstracts the world for the model

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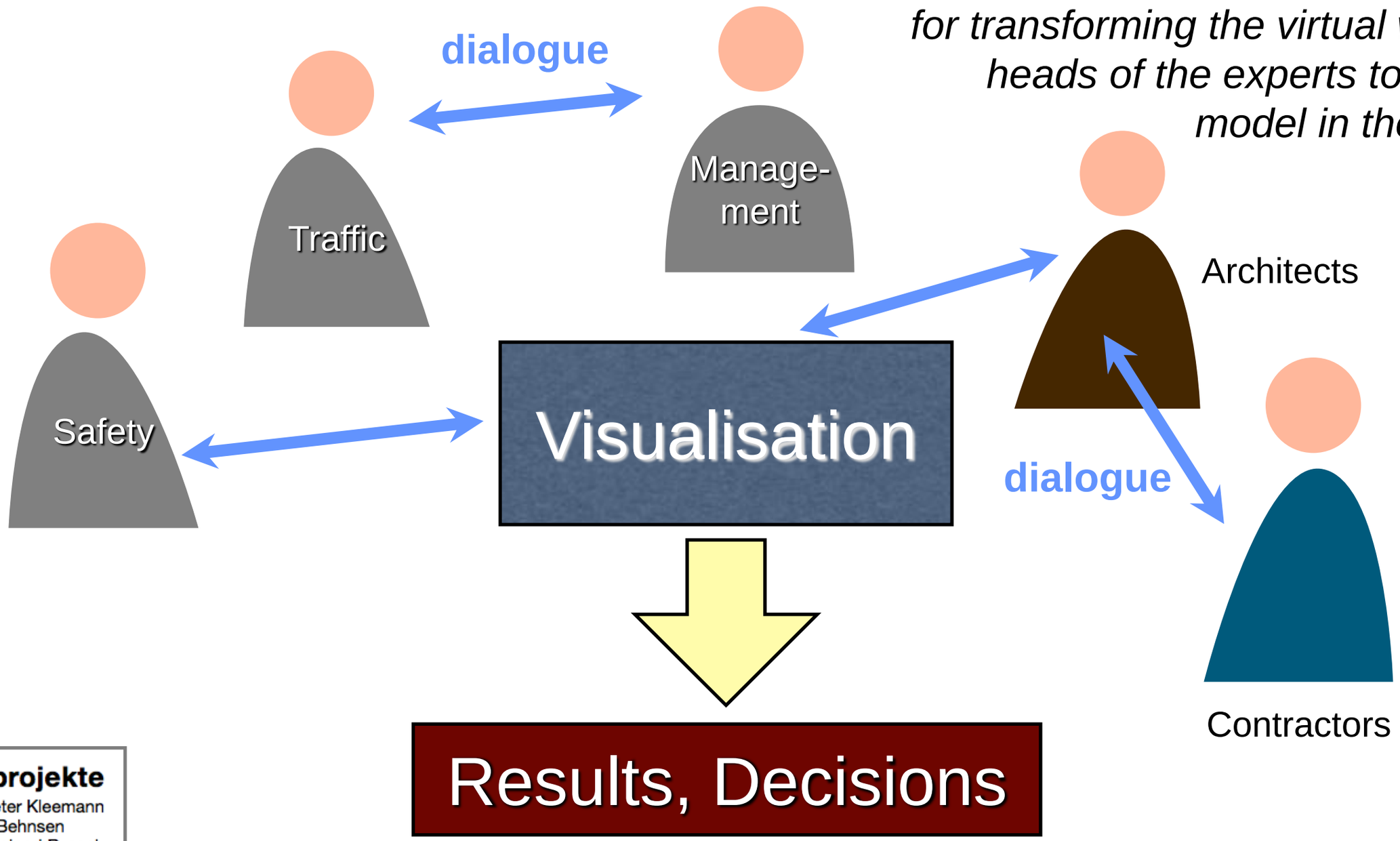
Bring the expert‘s knowledge on one table

The simulation model is an aggregate for transforming the virtual world in the heads of the experts to a viewable model in the real world



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The case study: motivation

- Scientific study on micro-simulation of Stuttgart main station(s) (Kopfbahnhof and Stuttgart 21)
- Several scenarios from the approval process of the new station from 2002 and 2003 and a passenger analysis from 1998 were available => good basis for making comparable tests
- Recent studies didn‘t compare planned station layout with actual station design and didn‘t incorporate the simulation of disabled or handicapped persons (had been criticised)
- Impact of architectural changes (staircases) on the evacuation time
- Challenge to find scientific answers with this micro-simulation and potentially comparation with cellular automata

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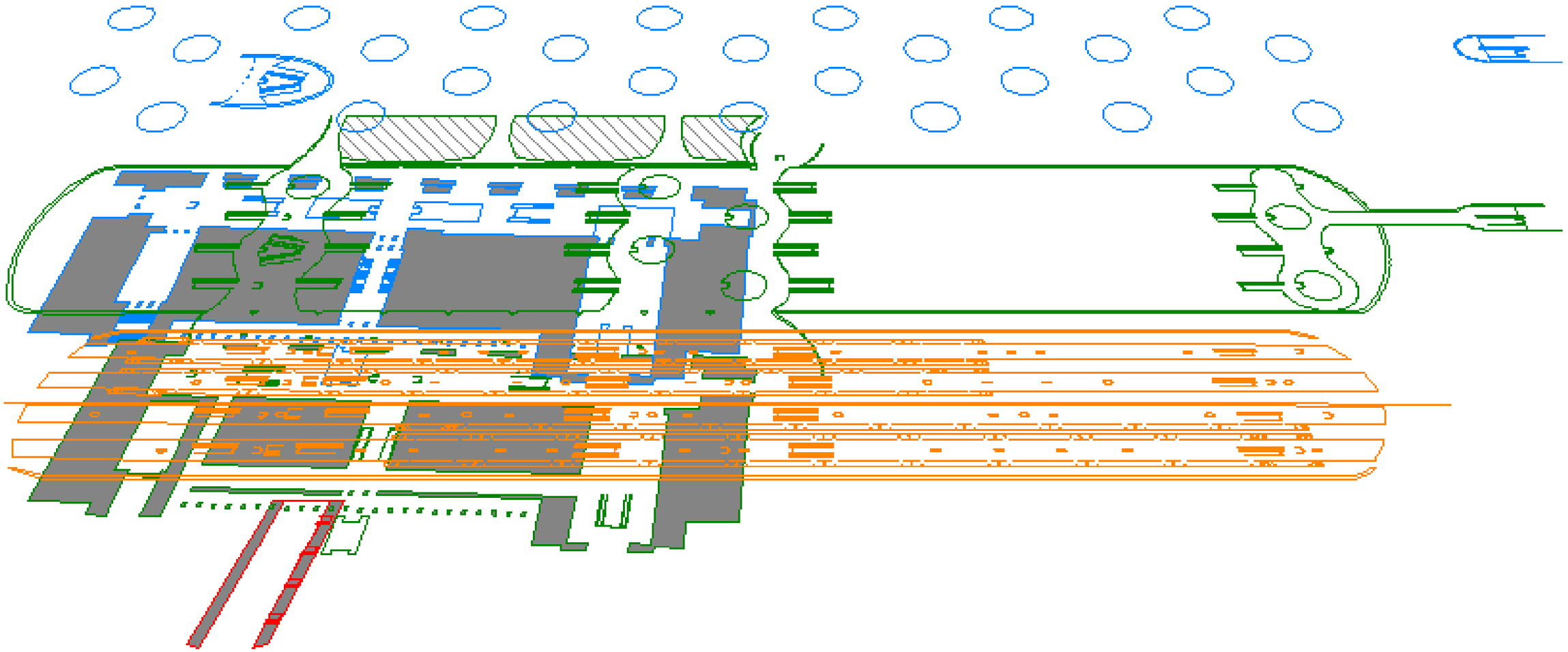
Scenario Stuttgart 21



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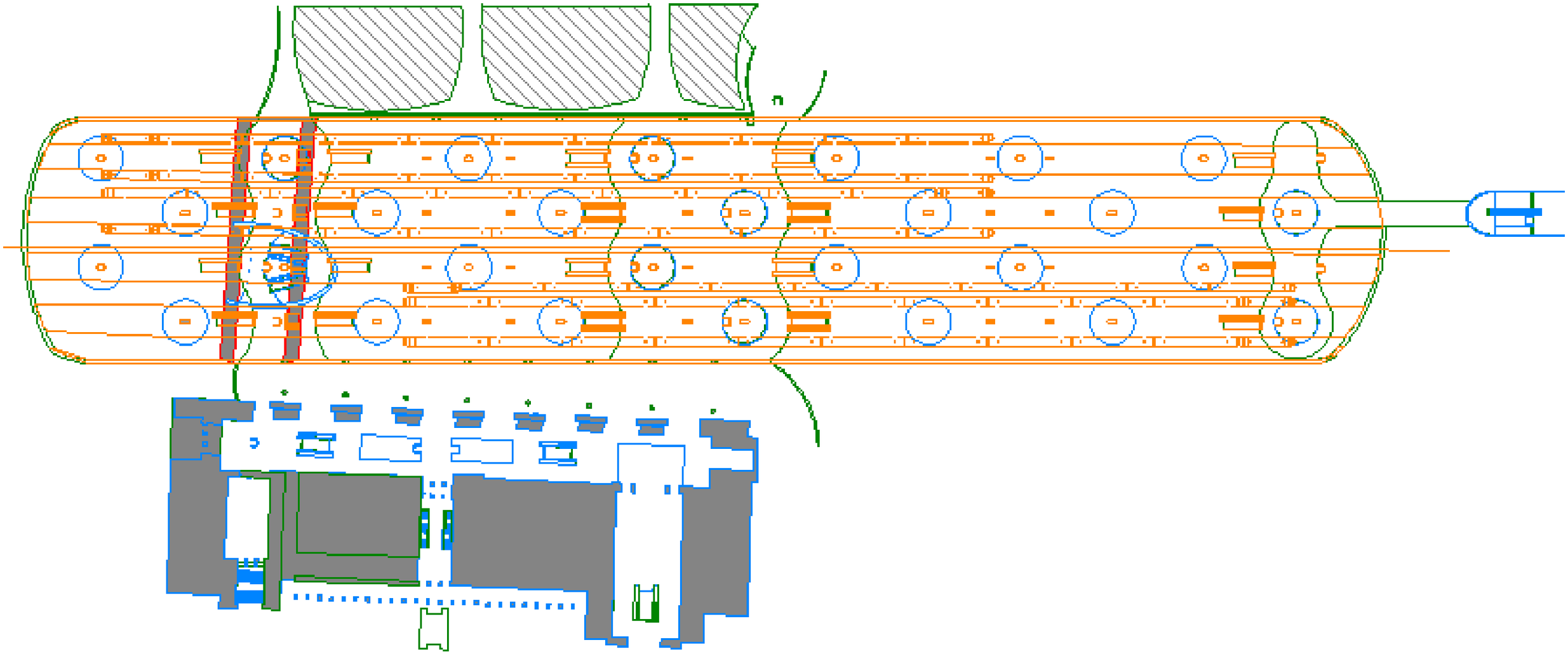

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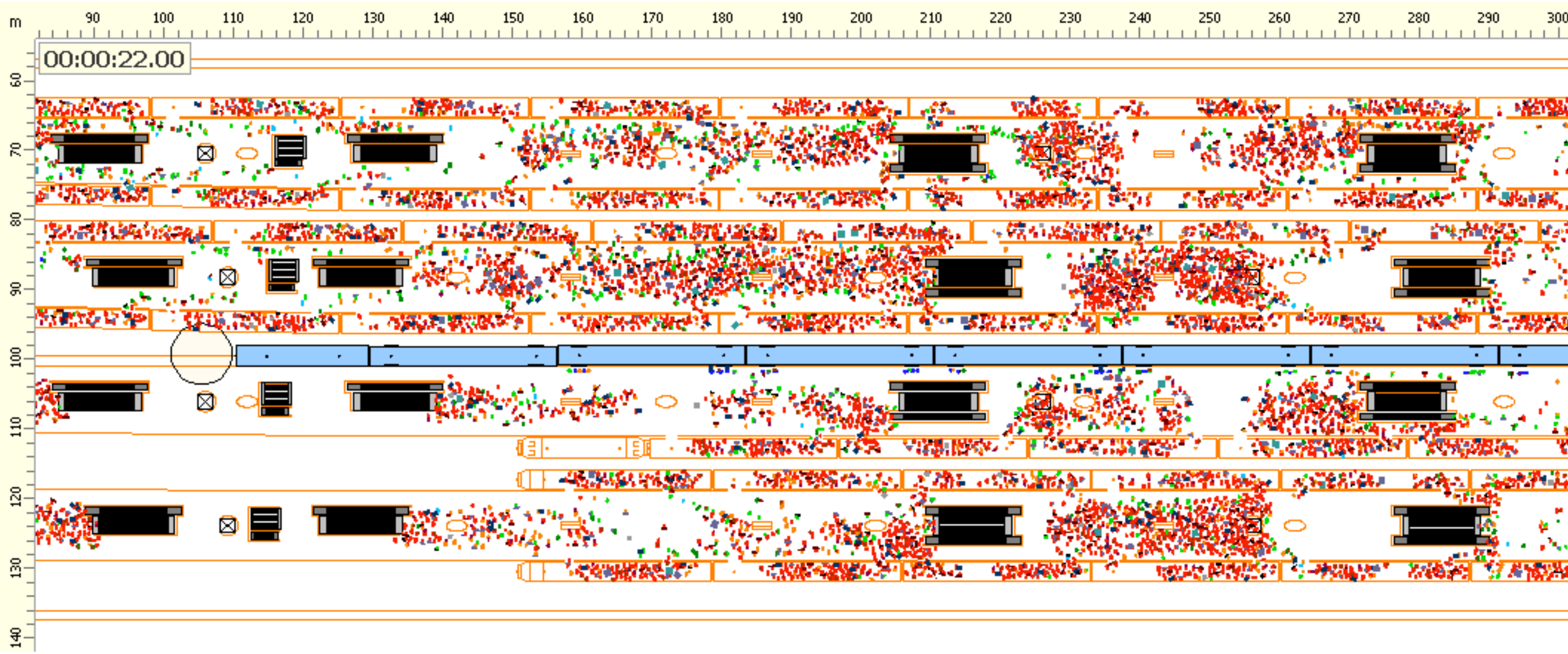
Simulation of 4 platforms and 8 trains



960 Persons per trains and 1500 per platform

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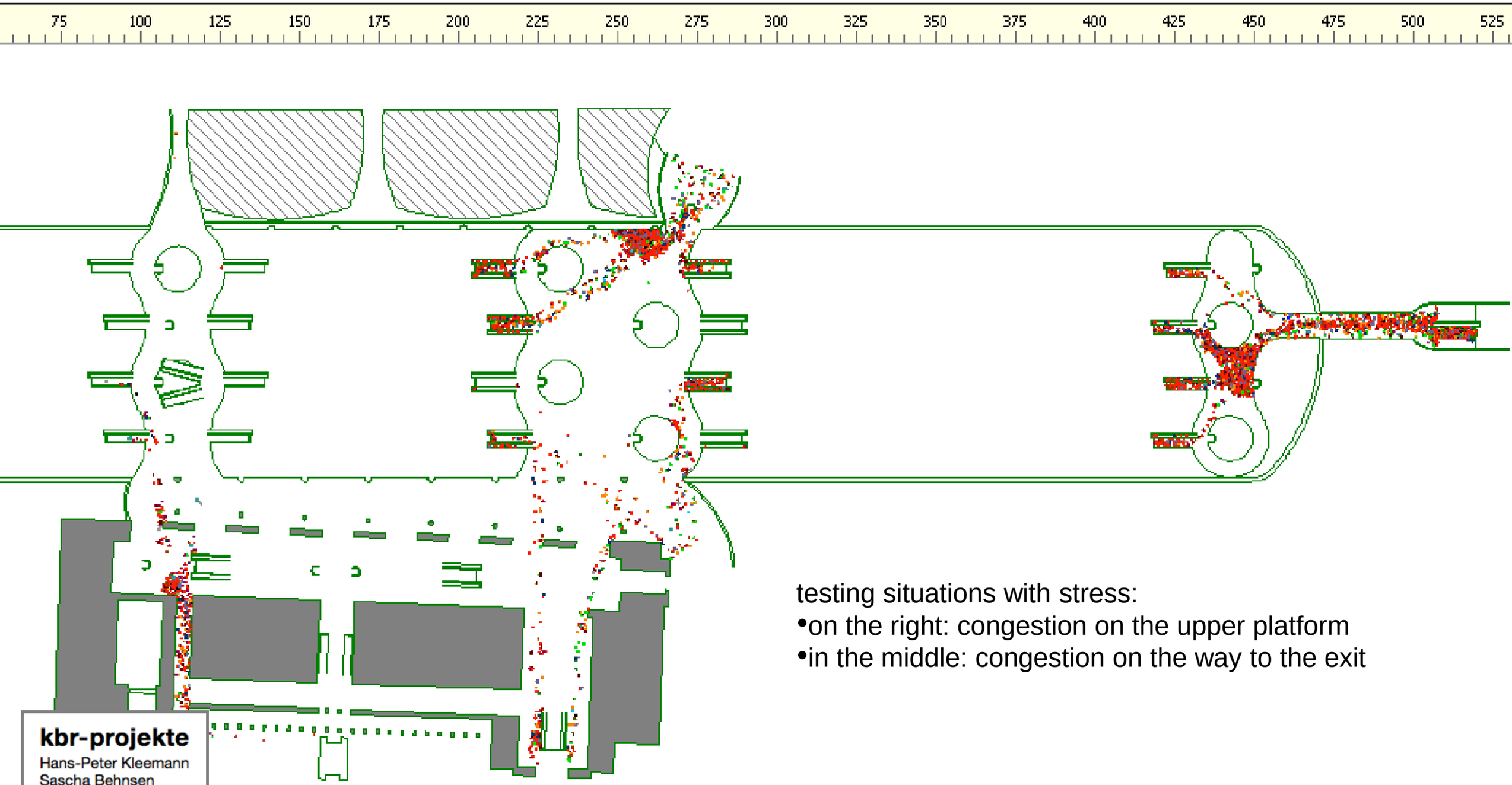
Case: Effect of the architecture



testing situations with stress:

- on the right: congestion on the upper platform
- in the middle: congestion on the way to the exit

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Example video

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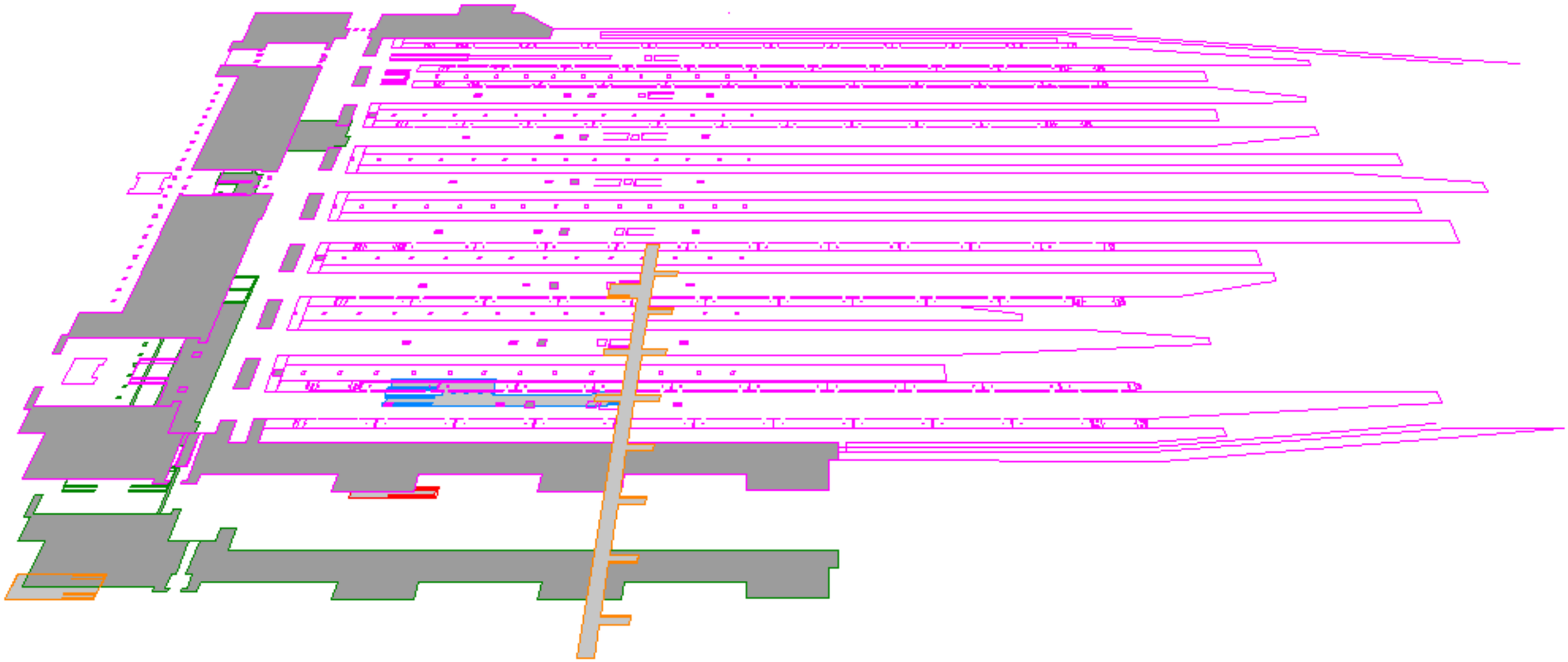
Scenario Stuttgart recent main station



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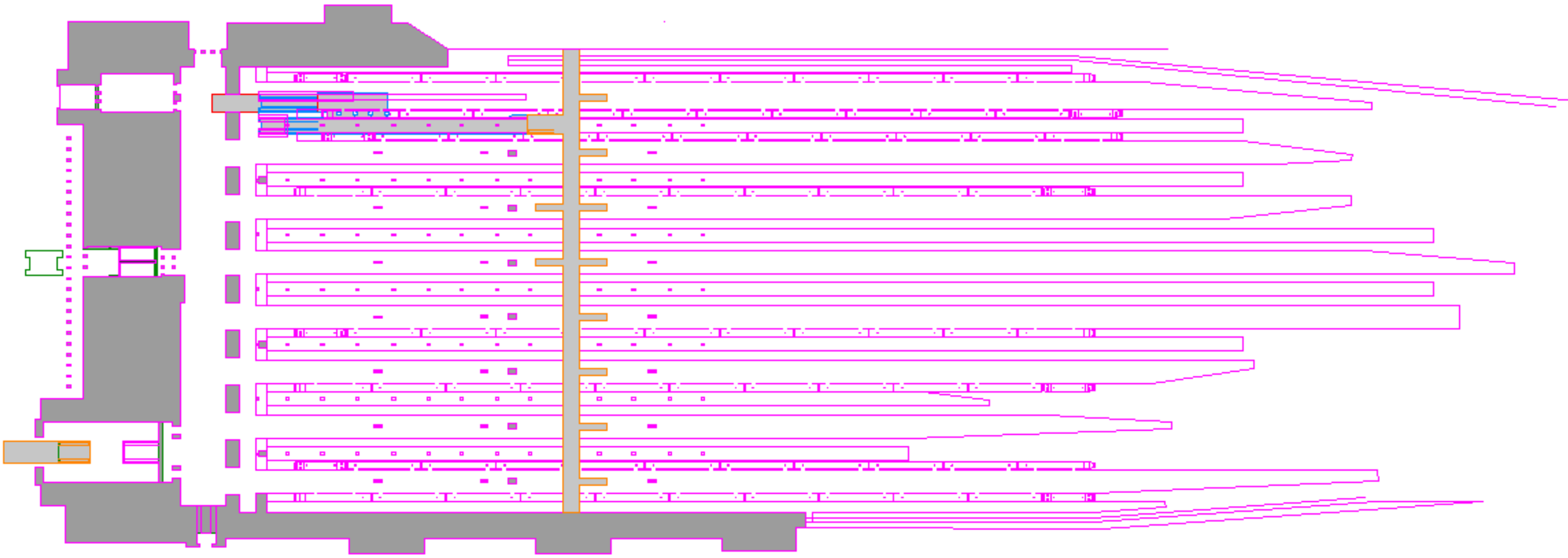

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Indicating a possible bottleneck

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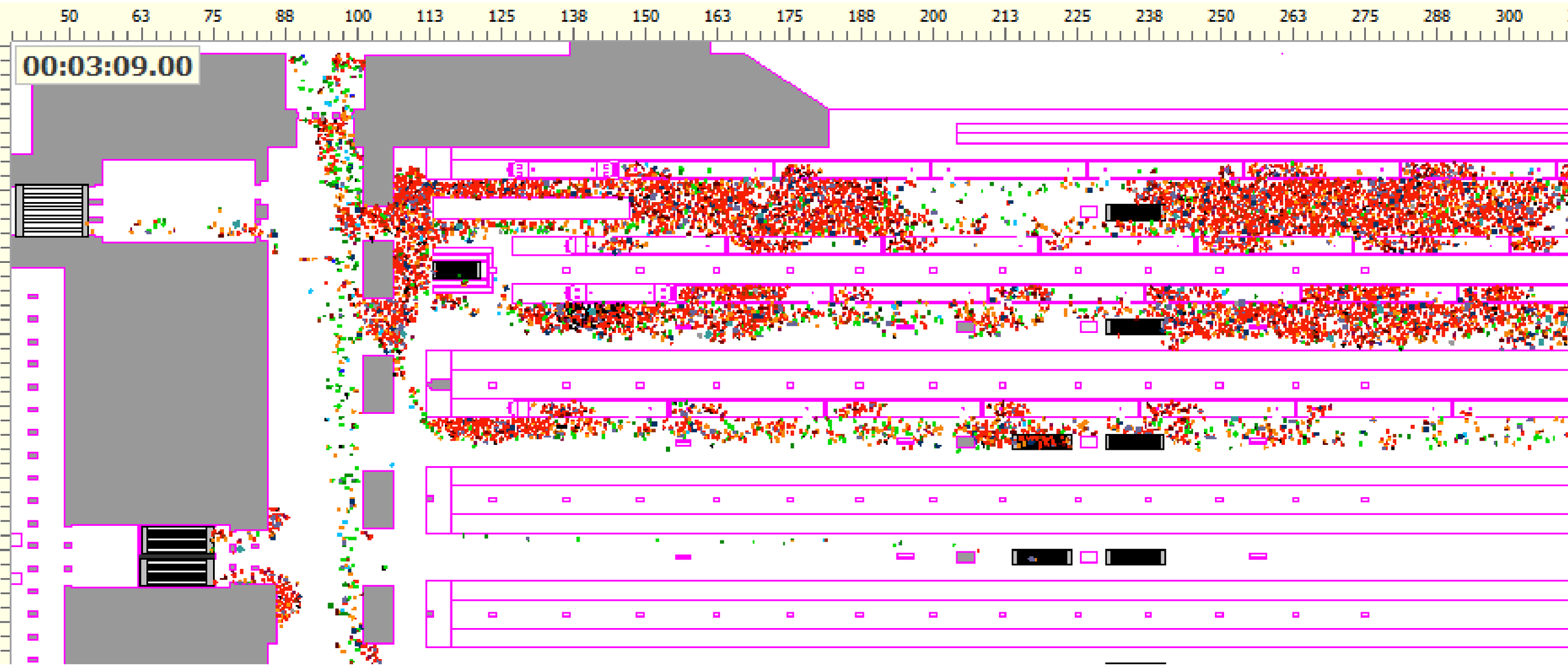
Case: simulating “stressing scenarios”



- 960 passengers per train and 1500 per platform
- People shall use in this case mostly the northern exit in order to produce a congestion
- In reality, they would mostly go into one direction from the right to the left

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What‘s important in modeling?

- Use actual train stations as test beds
- Be aware of possible bottle-necks– they should be simulated in the model
- Think also about very unlikely cases – people are acting very often irrational!
- Once a model is established, complexity could be raised every time
- For this, consider different experts with different points of view as an advantage for your project
- Take enough time for validation and let different parameters be tested in order to get good and valuable results

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What‘s also important in modeling?

- Mind the demographic change and also accessibility
- Think of special cases e.g. sports events or concerts
- Incorporate known bottle necks
- WYMIWYG: what you model is what you get – not the “real world”
- Tools and models do not substitute experience

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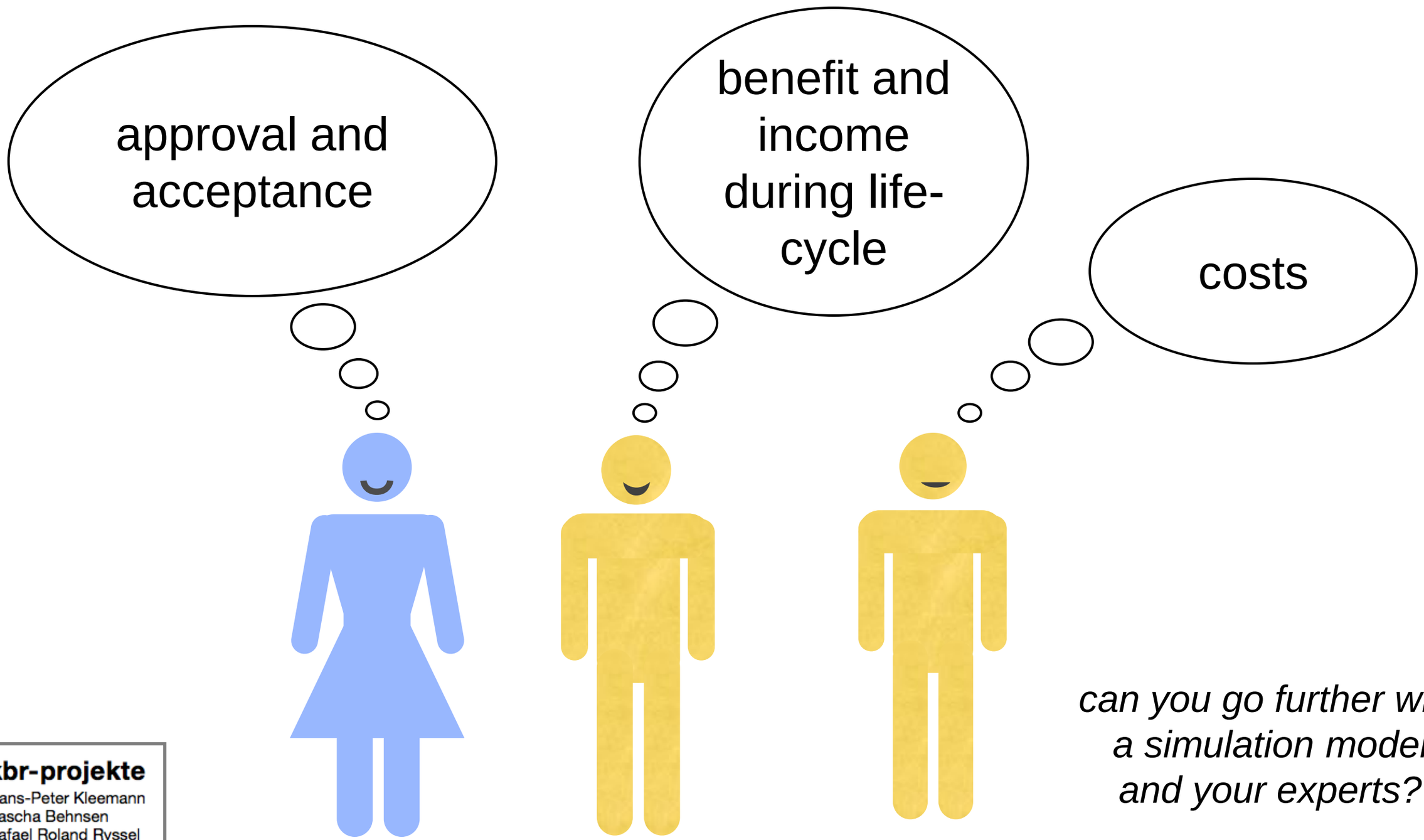
Can one model help for multiple problems?



can you go further with a simulation model and your experts?

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Possibilities...

- Use one model for multiple purposes in the whole life-cycle
- Once built-up you can use during approval, building, facility management
- Assure safety with the model during construction or maintenance
- Cooperation with traffic planners and center management (shopping mall): model as part of an overall system-view
- Station design has impact on the transfer time and so on the minimum dwell time – this can be scrutinised with the same model

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Conclusion

- Train stations are very complex structures. With simulations, impacts on passenger behaviour could be seen and examined, that simple calculations don’t allow you.
- Not only the experience, but also seeing the station with all its facets, help to improve the results. This is also dependent on the input from other experts.
- A simulation model does not replace the expert‘s knowledge, but could help to visualize the different points of view, increasing its benefit.
- The today‘s technology allows to use one model for multiple purposes e.g. traffic planning, safety concepts or center management.
- One should differ between the approval process and the opportunity for raising your own knowledge level in order to make better decisions.

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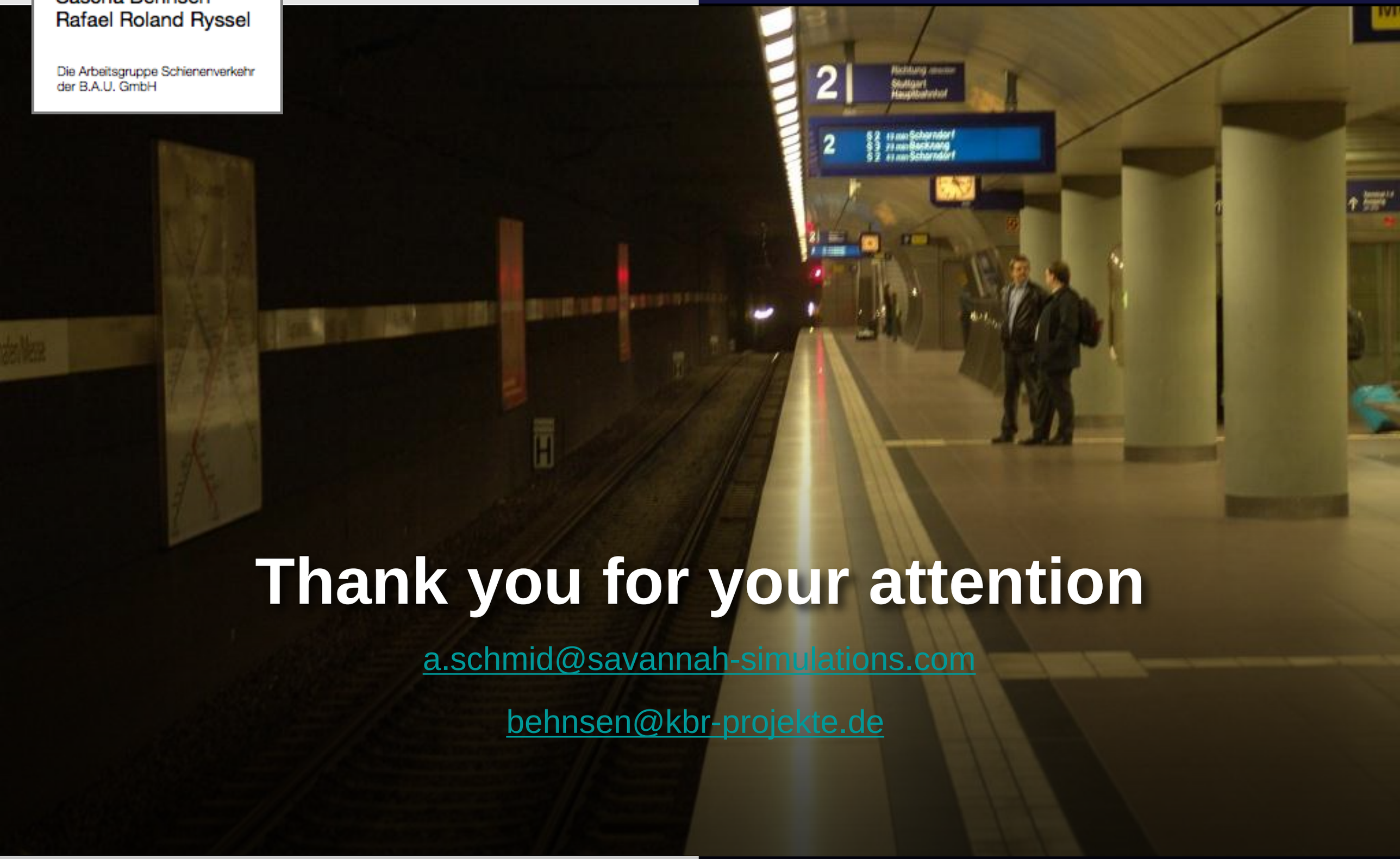

Thank you for your attention

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