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High Performance Terminals for Zero Emission Transport and Logistics Services in mid-size Cities

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Abstract. The emission targets for 2030 call for a significant shift of regional and urban transport to zero emission transport. Actors operating in both modes are now challenged to convert their existing or developing new services for commercially viable transport and logistics processes. The work of regional planning strategists is definitely affected by this new challenge. Needs and demands for a more flexible access to rail and road transport infrastructures show-up in their agendas with high priority. This paper proposes a time-horizon strategy for addressing this challenge with a new type of multimodal terminal and process flow model. We suggest to aim at developing the terminal as kernel of a smart logistic hub within the city development for both, today's and future business and consumer clients. Their needs for multimodal transport and logistics will take advantage of strategies of smart cities, automation, using cases with Industry 4.0. The first phase objective calls for a start with time-tabled regional services for zero-emission extended hinterland services in cooperation with main Inland terminals nearby. The services in the second phase will focus on new types of modal shift from road to rail transports for shorter distances and building on experiences from the first phase.

1 Multimodality as Solution Path

Any process of planning and executing interventional changes within existing infrastructures offers numerous challenges, and conflicting criteria and premises must be seriously considered. This paper deals with a strategy for a rail-road terminal for a mid-size city facing a rather soon implementation phase. When starting the pre-planning process with *moving premises and targets* and *"copying-history"* as principle, limited success was unavoidable. Instead, we applied a three-step strategy according to value and impact along time and domains. We are advocates for disruptive innovations in multimodality for the reason, that transport on rail is *sui generis* the most effective transport means for goods transports [1]. We trust in this physical fact that the performance parameter of rail transport will dominate the transport business world at the long run, especially in mega cities and more disperse agglomerations in industrialized countries. We believe that focussed innovations along the complete multimodal logistics process will be successful when introduced at the right domain and time. This paper is about first steps into this direction, covering the following topics: appropriate decision making in infrastructure interventions, introducing today's automation and digitalisation, and keeping positive future perspectives in mind.

2 Crucial Matter of Time and Domains

Some European and German policy makers seem to trustfully rely on rail as the climate-friendly main surface transport mode to meet the long term 2030/50 GHG objectives. However, the actual market share of rail and combined transport in main countries is behind expectations. Only few market actors earn profits, and when looking towards the near future, rail and intermodal transport will face even more grim market conditions due to ever competing truck-systems. Also, their R&D&I focus lies on defending their intra-modal markets and not on efforts to catch-up with the fast path of trucks' logistics innovations. It seems not unlikely, that the present rail and inter modality strategies may lead towards losing this battle. Entering a digital agenda for terminal and rail market design may help winning back lost ground. We suggest approaching them in different domains and riding the timely wave of innovations.

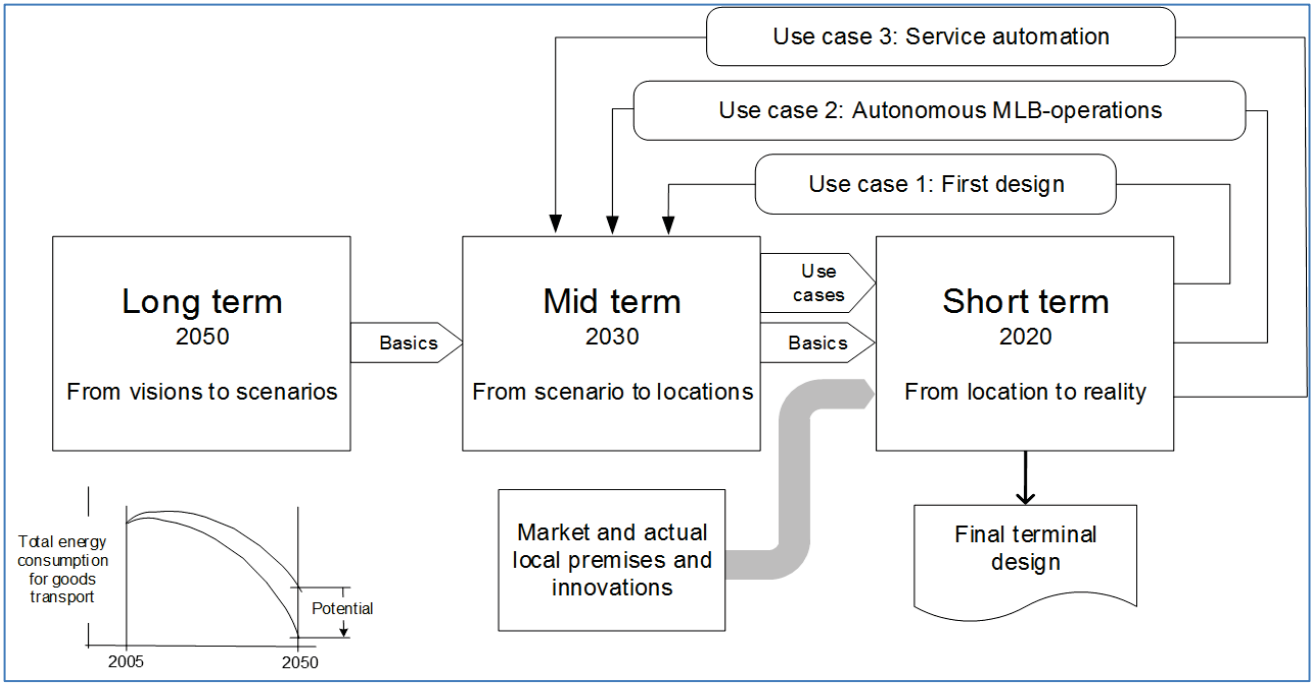

Figure 1. Terminal development map

2.1 Roadmaps for Terminal, Method and Timing

Present terminal designs in Germany are defined by standards which have remained unchanged in their key features since over 30 years. The recommended perspective for a mid and long-term planning horizon is 4 to 6, resp. 8 to 12 years [2]. If we take a few years for ramping-up its services for a new terminal to a profitable level, a terminal operator must accept the curios fact that he must compete with a 45 years old facility design within today's market environment. All terminals at present and under design till 2021 will face a similar challenge.

On the other hand, society and transport industry must face the challenge to significantly reduce primary energy consumption and GHG emissions. UBA [3] state the desperate need of zero emission mass market transport means for short transport distances in Germany, in order to come close to the path or option corridor towards the 2050 goals. In this situation and keeping more than one options open for achieving the 2050 goals, this paper suggests using a back-casting approach in combination towards a modular terminal and flexible terminal supra structure design.

The method of back-casting starts with four elementary facts: (1) COP21 goals for 2050, (2) *sui generis* rail transport performance, (3) actual terms of EU-legislations, i.e. for infrastructure planning, (4) stream of know-how and innovation in transport and logistics. The result of back-casting are multiple scenarios which may serve as inputs for a needed multi-party communication process. The time line includes relevant milestones, i.e. sub goals for 2030 and completion of infrastructure interventions in regions and locations from TEN-T on the national level, as well as in regional planning processes.

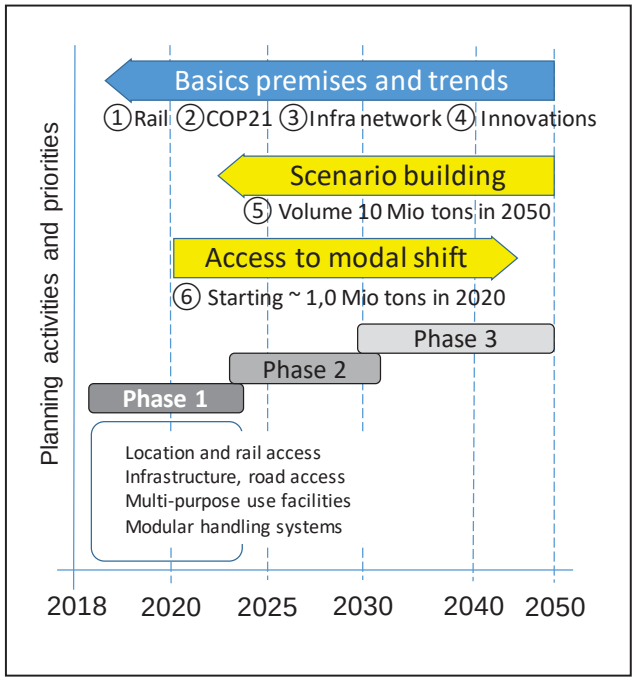

Figure 2. Terminal planning for use case 1

This process should be supported with creative scenarios offering flexible terminal solutions by use of advanced planning tools (i.e. BIM). However, in any case, the long-term premises should determine the framework. We suggest here to follow the basic concept of *multi modal network traffic* [4]. An example of results of this process "from scenario to locations" at the given location is shown in a roadmap in Figure 2; it serves as input for use case 1: *First design of the terminal*. The timing chosen is based on use cases maintaining a successful terminal development path.

2.2 Services portfolios in Discussion

2.2.1 Service portfolio Phase 1 "Winning confidence"

The service portfolio of the terminal in phase 1 aims at demonstrating its potential with extending existing hinterland services due to its favourable location. It can be reached by rail and motor way in 60 to 130 km by neighbouring North Sea inland terminals. The terminals' customers especially in the Southern Metropolregion will be served by time-tabled rail services (Figure 3). Drayage will be performed by traffic optimised ZEV (Zero-emission vehicles) either: (a) directly from the new feeder terminal with less than 20 minutes dwell time, (b) via buffer in regional depots in locations nearby customers.
This approach will result in a competitive and emission-free and disperse regional transport for hinterland services. Upon implementation, profitable services within 3 to 5 years are envisaged.

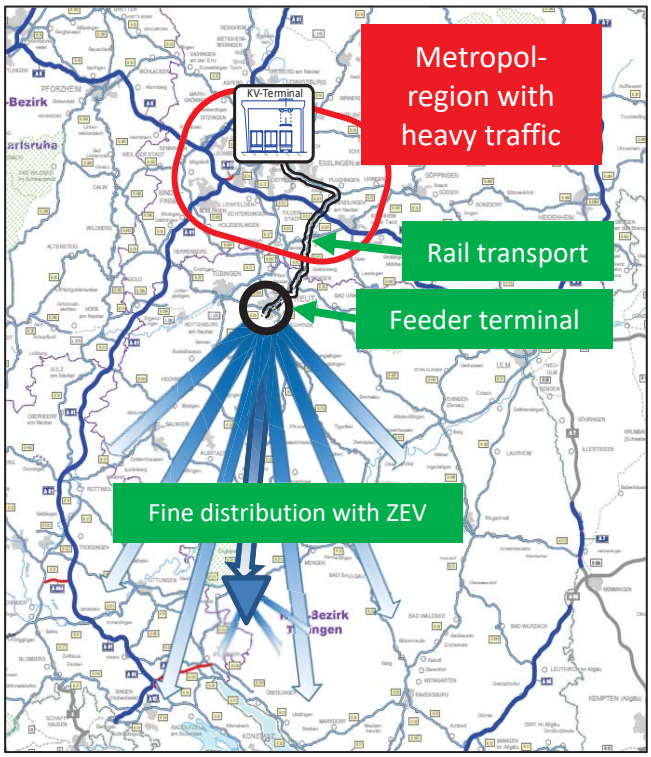

Figure 3. Drayage service coverage

2.2.2 Service portfolio Phase 2 "Creative Options"

Services in Phase 2 will address logistics customers' needs in 5 years from now. The service portfolio is determined by following trends: (1) creative third-party innovation projects for strong city customer concepts supported by time tabled city inbound or outbound services, (2) innovative transport solutions for fighting small particle, noise and GHG pollutions, (3) service record and verification of *multi modal network traffic'* benefits. The new terminal will follow the process innovations and technology requirements with high flexibility within its given location.

2.2.3 Service portfolio Phase 3 "Regions in networks"

Services in Phase 3 will extend its scope towards 2030 and beyond, and try to predict their role as key locations within a multimodal rail network with high performance rail liner transport capabilities.
In this phase, the following dimensions may become attractive: (I) regional node services for distance network, i.e. via Gotthard Rail Tunnel, (II) value adding and flexible logistics services for manufacturing or consumer products inside the node, (III) reference location for service automation in a regional context with latest innovations.

3 The new Terminal with Node Function

3.1 Use case 1: Long term planning required

For performing service during phase 1 the following features require *compulsory* long-term planning and decent infrastructure investments:
(1) Terminal infrastructure serving liner transports: this feature requires the installation of additional track switches in the main rail line tracks for trains entering and departing the terminals rail loading zone without shunting operation.
(2) Terminal-rail track interaction is part of train control and includes signalling and train identification: this feature requires upgrading the present rail management system and integration of additionally installed signalling systems and rail gates at drive-in and departing rail tracks,
(3) Truck loading process is performed automatically and off-site the terminal: this feature allows planners more flexibility for designing a fast road access and a flexible and material-flow-oriented terminal layout.
(4) Multi-functional and business oriented terminal design. This feature would require a terminal design which includes innovative office, service and multi-purpose (MP) buildings, which are interconnected by flexible tracks and autonomous transport means. The MP buildings can serve both, logistics and non-logistics demand which will evolve over time; i.e. a large flat floor functional area of decent size for logistics functions close to the rail loading zone and for temporary use by other services would fit.

3.2 Use case 1: Mid term planning required

For performing service during phase 1 the following features require *mandatory* mid-term planning and supra structure investments.
(5) Operational supra structure for performing the complete flow of material for standardized load units between rail and road vehicles. This feature would require two interconnected main areas: (a) the installation of a set of modular equipment for performing the logistics functions *Move*, *Lift* and *Buffer* at various places, and (b) an infrastructure for manual and autonomous operation of the functions within the terminal. The machine set is fully modular, with scalable and remote operation and maintenance possible.

(6) Automation of processes and autonomous operations in parts of the terminal. This feature would require a step-by-step upgrading of process operations within two to four years towards full automation and for 24/7/350 hr autonomous operation.
(7) Service automation for advanced customer interaction along the supply chain. This feature would require an in-depth understanding of the processes between customers and logistics/transport service providers and knowledgeable process expertise. This feature should lead to two goals: (a) horizontal proliferation of this concept of extended hinterland traffic and (b) gaining know ledge and experience for terminal evolution towards Phase 2.

3.3 Use case 1: Attention and monitoring required

For performing service during phase 1 the following features require *attention and monitoring* in terms of progress with regard to development, availability and business models of heavy duty e-freight trucks.
An important part of the business model of extended Hinterland services is the regional distribution and collecting concept with ZEV. A business model is being presented and positive feedback obtained. The risk is low that no suitable truck for realizing this concept would be available when starting competitive services upon completion of the terminal.

4 Results and Future

This terminal design follows the following strategic objectives, which are imperative for mid-size cities: (1) to demonstrate new options of radical new terminal infrastructures in combination with automation, (2) to show the making and power of time-tabled rail services in combination with eTruck services, (3) to underline the crucial importance of rail multi-purpose facilities for future logistics, close to future rail networks and with direct access to city centres, (4) to beat existing terminals in value adding relevant processes per square meter, (5) to design and build a terminal with modular supra structure in order to achieve a high degree of operational flexibility and scalability and (6) to demonstrate short distance ZEV transport.
First modules are planned for 2018, a first complete terminal for 2020.

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