FŐMTERV

Detailed Feasibility Study (DFS)
Danube Tunnel, Railway Investment

Budapest Fejlesztési Központ Nonprofit Zrt.

Timetable planning approach

Budapest, 06.10.2021

optimising railways

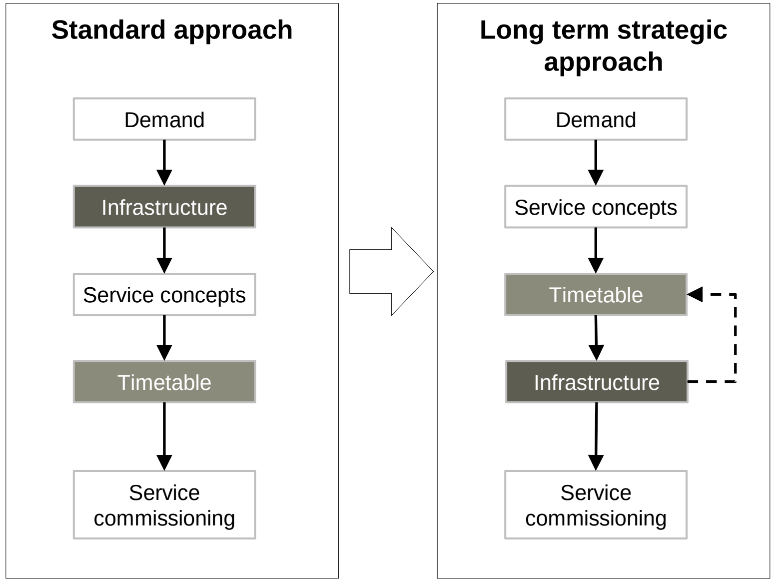
Confidential

An innovative planning approach

The strategic planning approach

- **The goal**: planning the network in line with the desired development of the service.
- **The approach**: establishing the timetable upstream, to determine the infrastructure and rolling stock required through an iterative process (timetable - infrastructure - rolling stock optimisation).

- **The timetable is not an end in itself but a means to an end** for continuous and integrated implementation across the core processes of planning, production and operation of the railway system.
- Timetable planning is carried out well in advance by establishing a strategic goal (**strategic timetable → strategic capacity structure**)

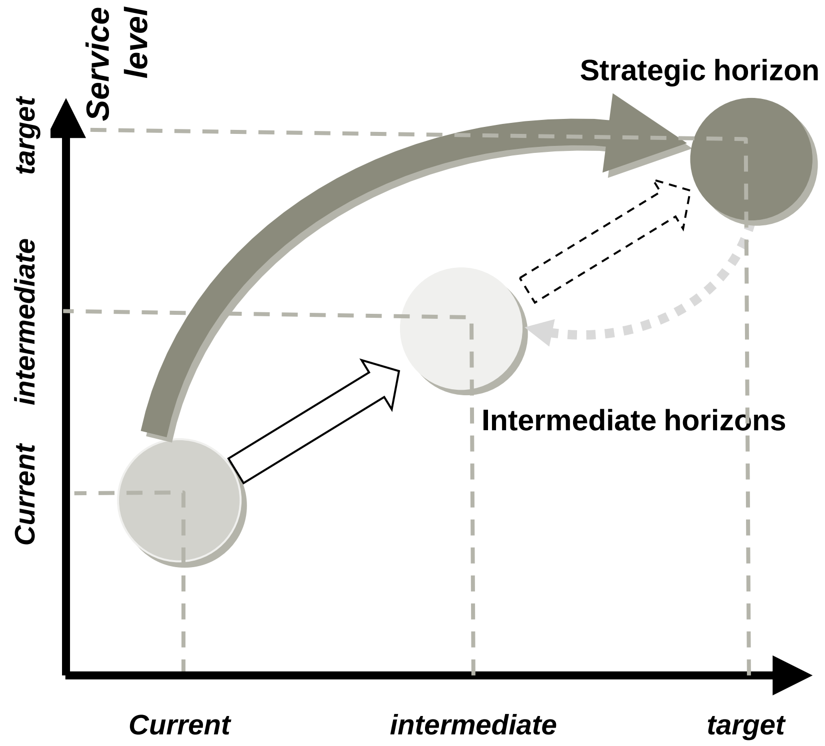


Project horizon

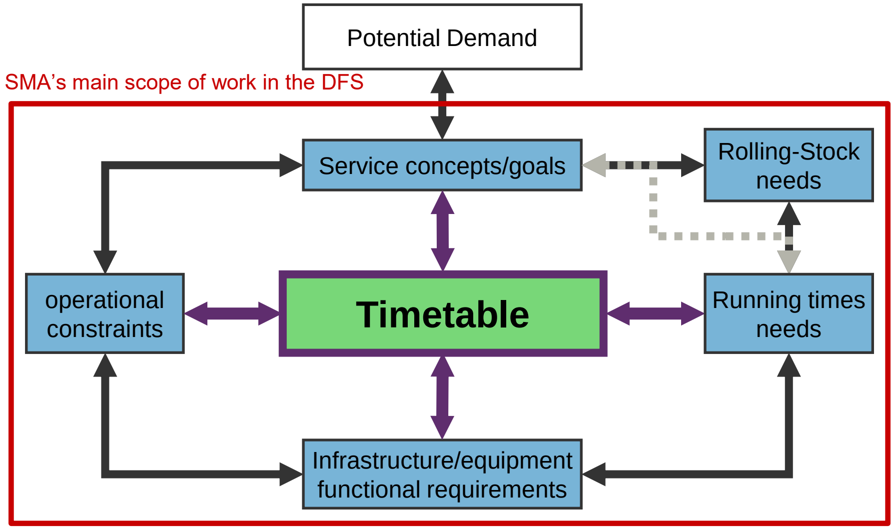
The service and operating concepts developed as part of this study target a long-term horizon, for which the tunnel and all the required additional infrastructures are put into operation.

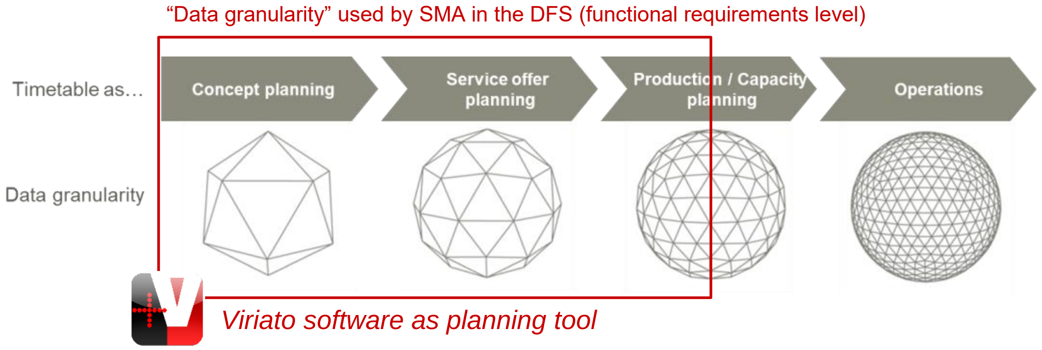
It is a prospective **Strategic horizon** for which the infrastructures are sized, rather than a horizon linked to a specific year.

Intermediate steps could be derived from the strategic horizon to avoid redundant or temporary investments (out of the scope of this projet).



The systemic iterative approach





The construction of network-scale regular interval timetables is the result of an **iterative process**: all the interacting parameters are treated simultaneously, in accordance with the systemic nature of railway operations in search of the best compromise (optimal solution).

The **optimisation of the system** as a whole is thus obtained by playing on the levers available (e.g. service objectives, performance in terms of journey times, infrastructure configuration and capacity, external constraints linked to other traffic or the graphical environment, etc.).

By varying the parameters, the iterative process will make it possible to achieve an organisation that:

– maximises the quality of the service;

– optimises capacity use and operating efficiency and

– minimises infrastructure investment.

Experiences from other countries

Switzerland, Germany, Belgium, France, ….

Lesson learned from the benchmark (1)

General reason for building the tunnel

– Allow the development of the railway network, generally hampered by the physical limits of the network and the impossibility of building new surface tracks in city centre (→ more frequencies and more connections)

Strategies in building the tunnel (generally independent and alternative)

– Developing direct connections from the peripheral districts and suburban towns to the various central districts of the conurbation (→ through suburban lines)
→ ***a real S-Bahn network***

– Simplifying the operation of terminal stations and speed up long-distance transit connections (→ through long distance services)
→ ***an efficient node at the heart of the national network***

Mixed solutions can't be excluded, but they have an impact on the capacity apportionment and thus the functional requirements and infrastructure layout.

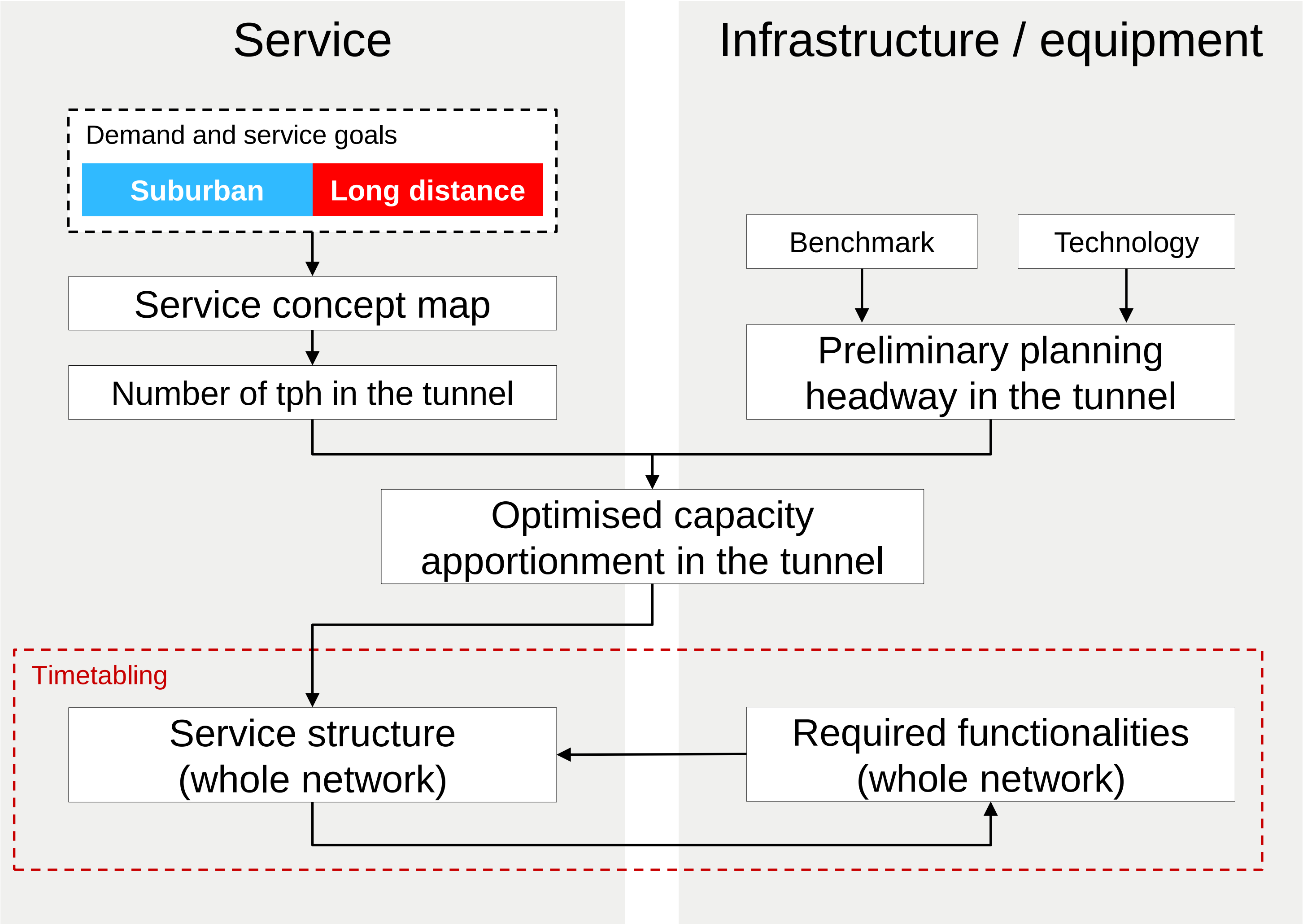
Lesson learned from the benchmark (2)

Contribution of the tunnel to network development

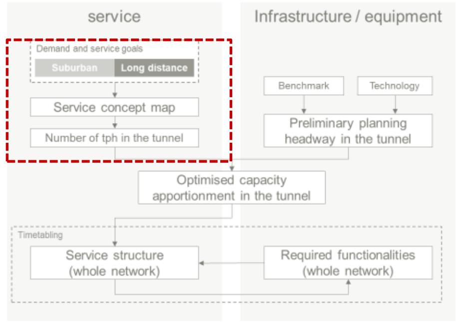
- A better operational quality due to better separation of flows
- The elimination of several shunting movements (less trains terminating in dead-end stations)
- (In some cases) The release of a large amount of railway land and brownfield for the benefit of urban regeneration in the heart of the city.
- The development of S-Bahn lines operated, with balanced service between the two directions, continuous throughout the day;
- The global balancing of the incoming and outgoing flows (→ diametral lines terminating outside the tunnel), with limited cases of additional services peak hours services

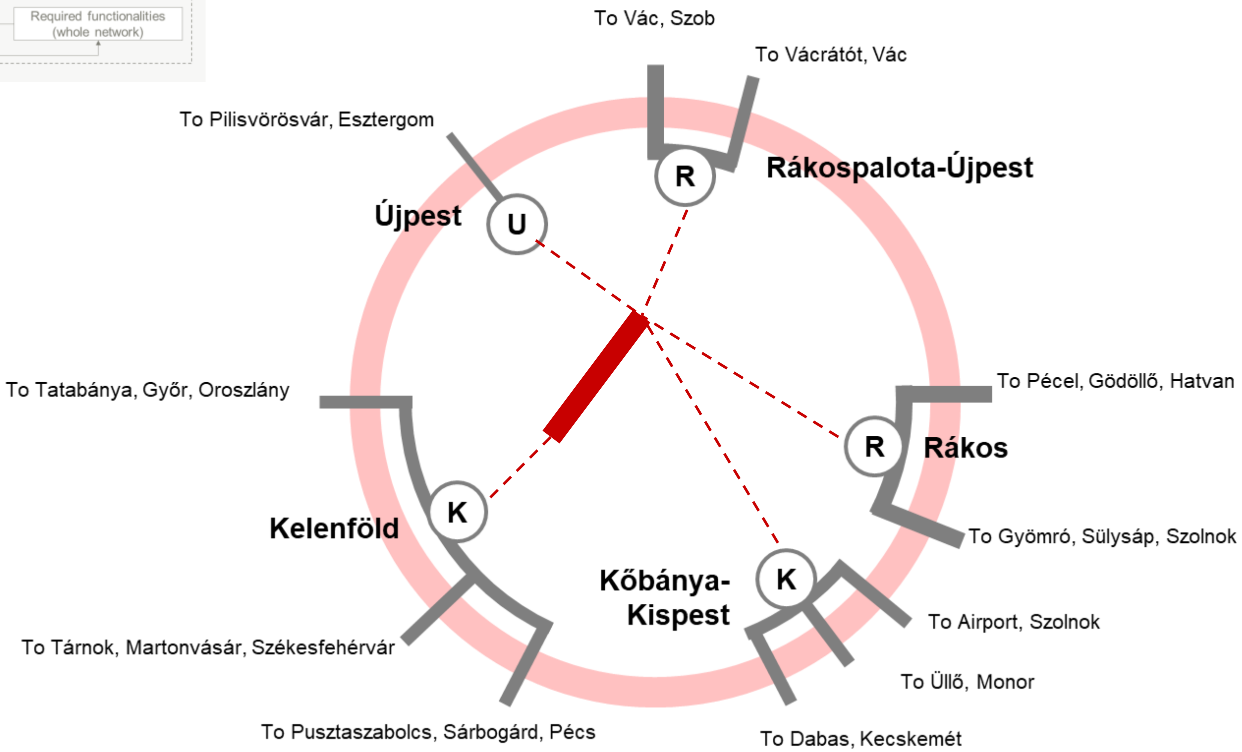
Danube railway tunnel: the challenge

General process

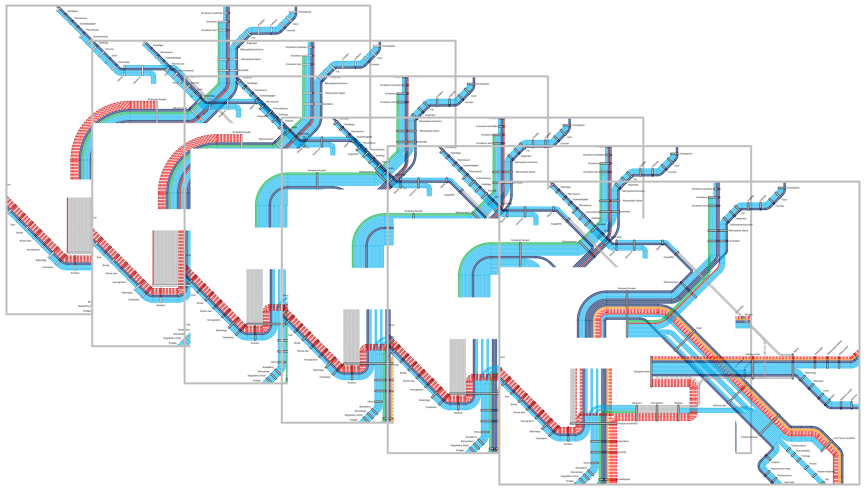


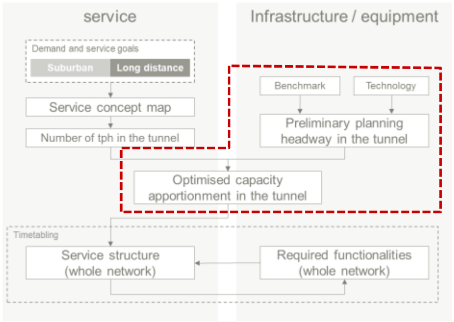
Creating service concept maps





- Extremely unbalanced flows between expected traffic from north, east and south-east (naturally linkable to Budapest Nyugati) and the south-west (naturally linkable to Budapest Kelenföld / Déli)
- Long distance service in the tunnel means diametral IC and IR lines through Budapest.

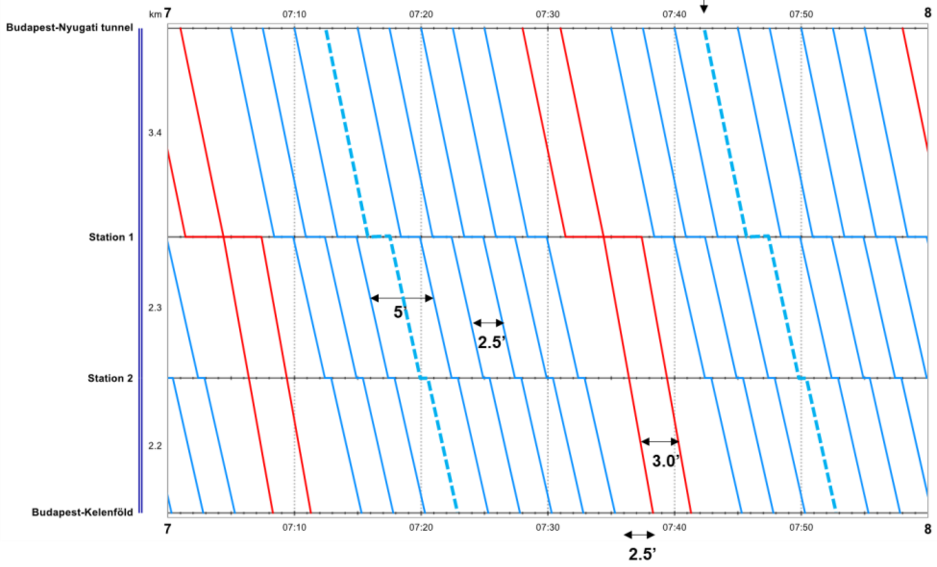




The tunnel
Preliminary functional requirements

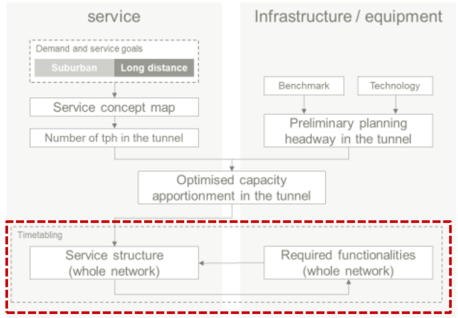
- The tunnel is a massive investment for which an optimal usage is required.
- The sequencing of the slots in the tunnel should minimise the headway loss due to different train categories.
- This is achieved by <u>bundling</u> same category trains.
- This structure becomes the grid on which the external lines are connected.

Optimised capacity apportionment in the tunnel

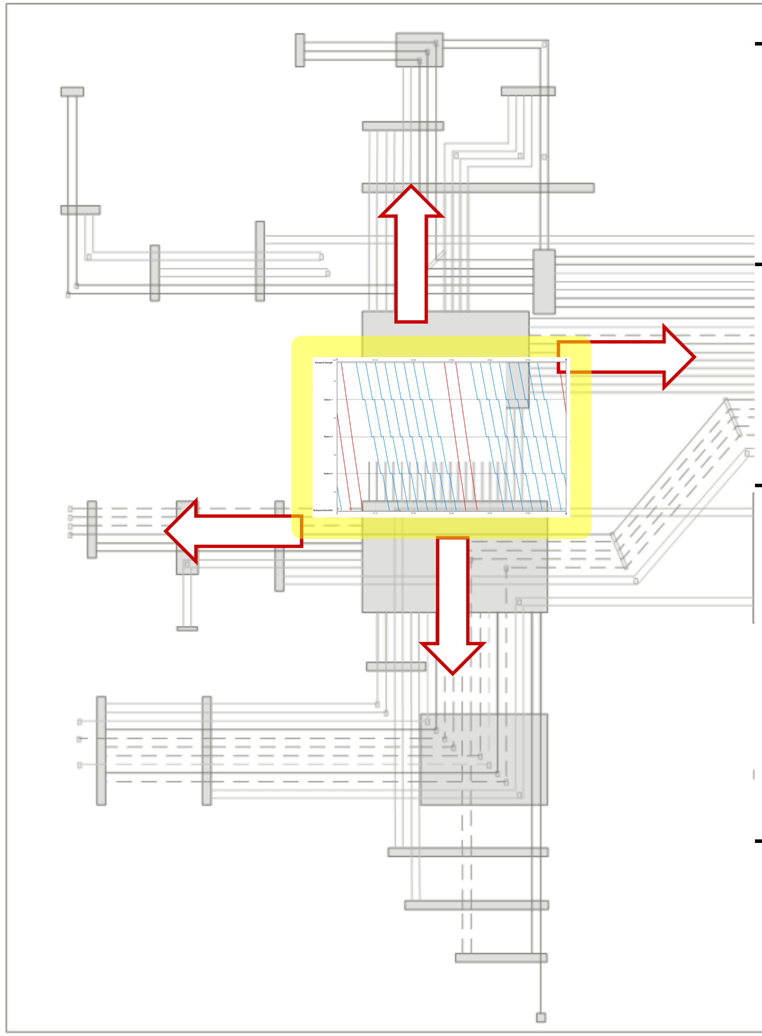


20 trains/h per direction in the tunnel selected as scenario to be developed

From the tunnel to the external lines

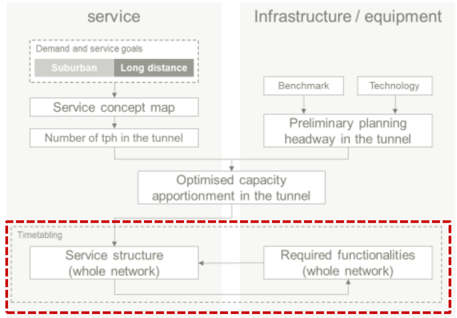


Maximising capacity in the tunnel with respect to an integrated and coordinated planning on the network

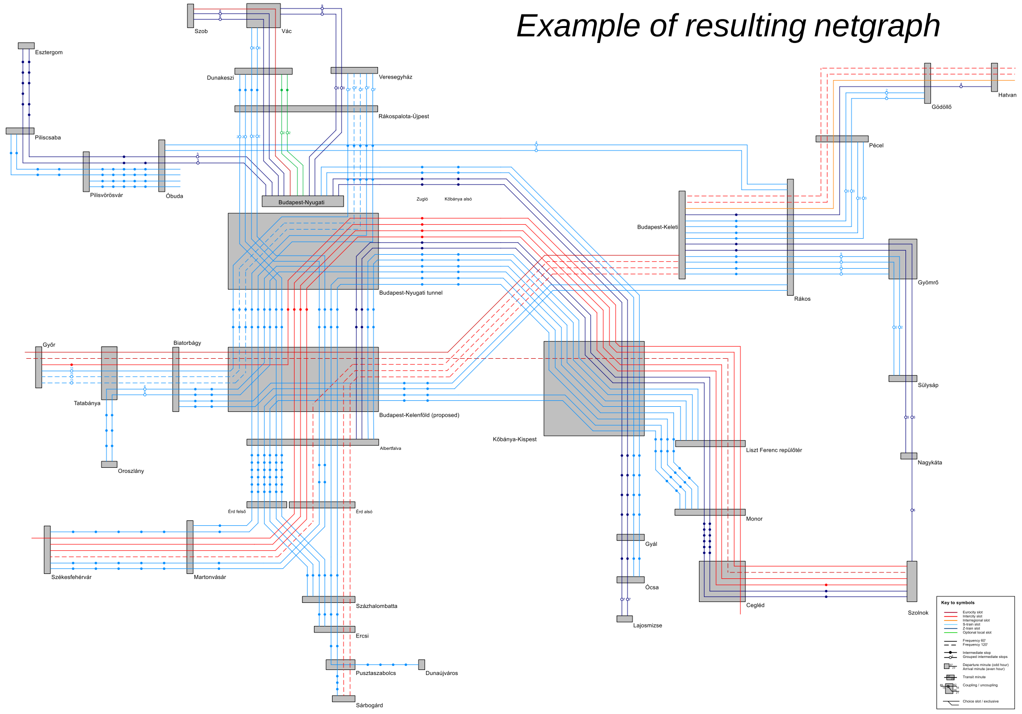


- Missions arrivals from external branches have to be **synchronised with the available slots in the tunnel** to avoid queueing (trip time losses, extended dwell time…).
- To achieve this synchronisation between the tunnel and the feeding lines, **the capacity apportionment in the tunnel is extended to the external branches**.
- This approach guarantees:
  - The **maximum usage of the capacity** in the tunnel
  - A **capacity structure on converging lines** maximising the usage of the capacity in the tunnel
- Missions are linked between the two portals according to possibilities offered by the tunnel capacity structure.

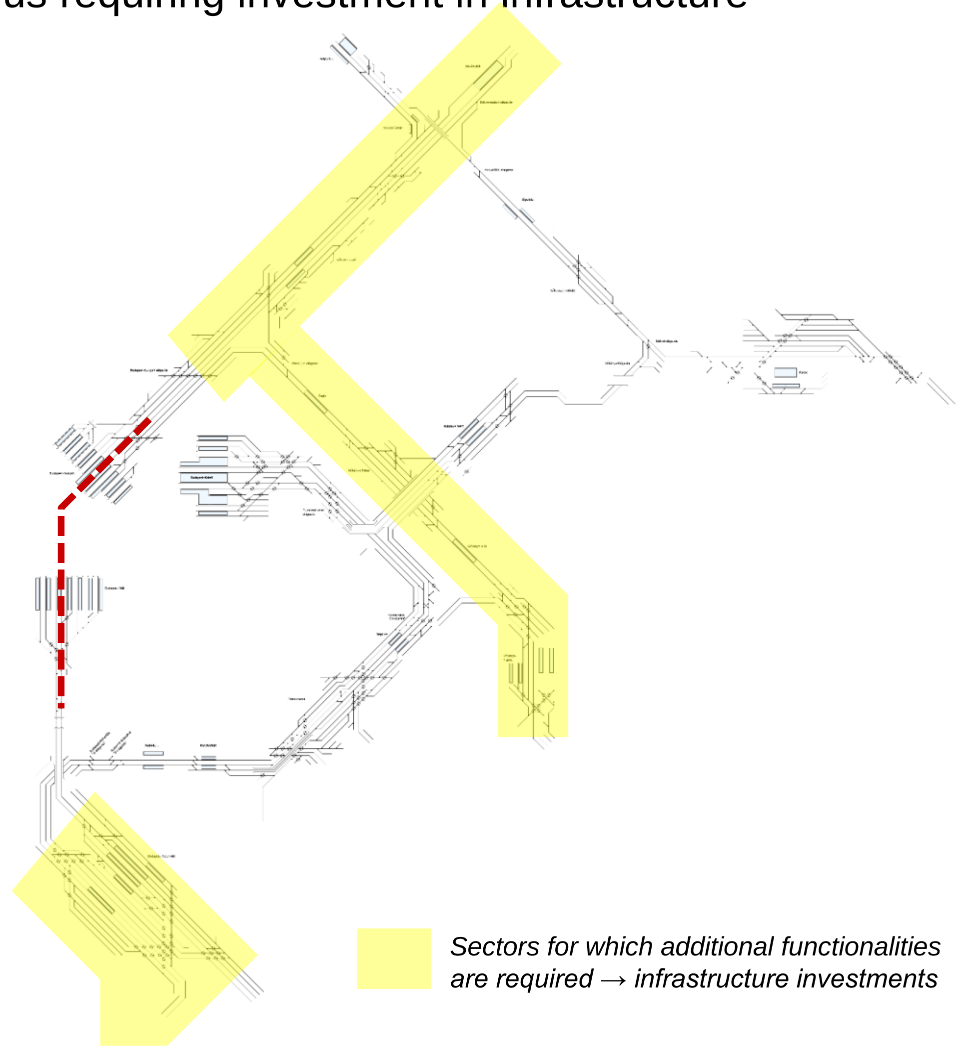
Timetable and functional requirements



Identifying sectors which show lack of capacity, thus requiring investment in infrastructure



Example of resulting netgraph



Sectors for which additional functionalities are required → infrastructure investments

Conclusions

Lesson learned (…so far)

The project is still ongoing…

- The **structuring of capacity** on the core network and beyond is impacted by:
  - The opportunities offered by the new tunnel (new through connections)
  - The number of expected frequencies on each external line
  - The mixing ratio between long-distance and local traffic
- The **general increase in expected frequencies** in line with the Budapest node study goals increases the pressure over the core network. The tunnel will contribute in mitigating this challenge.
- The **layout of some major stations in the core network has to be adapted** to the expected flows, to minimize / avoid conflicting routes. Heavy infrastructure modifications are needed in the core network (e.g. Kelenföld)
- Some **measures are under investigation on external lines** to support the capacity scheme (reducing conflicts and increase slot performances). These measures are mainly linked to frequencies and service concept rather than to the tunnel itself.

Outlook: from a project to a process …

This project is a footprint for new methods and approaches.

As confirmed by benchmarked countries:

- The insertion of a brand new piece of infrastructure on the network (i.e. the tunnel) requires an integrated and strategic approach to provide the most efficient capacity structure (and thus the best return on investment);

- A strategic planning approach embraces a wider network: putting the timetable – the ultimate promise to the customer – at the heart of the system is the real innovation.

- The iterative nature of the planning approach requires a rolling process along the timetable which from upstream solutions (long term) develops continuous improvement through homogeneous and refined data.

- Methods and tools that guarantee data continuity (continuous refinement) and consistency (spatial and temporal coherence) throughout the processes should be implemented.

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