



## Proposal 3

**Title:** The digital tunnel twin: safe, predictable, adaptable

**Theme:** What can underground spaces contribute to smart cities?

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**Abstract:**

The challenges of the future require safe, predictable and adaptable tunnels, and in The Netherlands we have started work on creating a network of digital tunnel twins (both new and renovated tunnels) to bring about the next step in futureproof asset management.

The digital twin ensures that communication and interaction with all stakeholders in tunnel projects can be raised to a higher level. The result is a broader support base, better solutions and added value. A digital twin also contributes to integral construction and renovation.

Thanks to the use of virtual tunnels, the (operating) processes and system behaviour can be made transparent early on in the project, which allows early verification of the control software, even before installation work is performed at the project location. Tunnel managers, road traffic controllers and tunnel operators can be involved early in the process through virtual tunnels, allowing their feedback to be included in the final design phase. Competent authorities, safety officers and emergency services are offered insight into (tunnel) processes and can respond to and anticipate them.

By adding gaming functionality, it is also possible to test and tighten scenarios, educate, train and practice without the tunnel being physically available. It also has a positive effect on incident handling, as emergency services familiarise themselves with the specific characteristics of the tunnel and can practice their responses (in a virtual environment).

The use of virtual tunnels reduces testing at the project location, because:

- The on-site work has been reduced to assembly, commissioning and verification of performance requirements. The validation of processes and system behaviour has taken place at an earlier stage.
- There has already been regular and early alignment with the competent authorities, emergency services, tunnel managers and safety officers. There is better mutual understanding.

If maintenance and operating instructions and the current status and maintenance data have been included in the model, the virtual tunnel will also be of great value in the operating phase:

- New road traffic controllers/tunnel operators can be trained
- Exercises involving emergency services can be organised regularly without disturbing the flow of traffic.
- Upgrades, downgrades, cybersecurity and new developments, insights and requirements can be tested in a safe but identical environment before implementation.
- New procedures, scenarios, etc. can be tested together with the competent authorities, safety officers and emergency services without compromising the actual tunnel and its availability and safety (safe area to experiment).
- If deployed widely and based on collected data from all tunnels (national/non-national tunnels):
  - It will better predict the ageing behaviour of civil construction installations and the ageing, malfunction and failure behaviour of the technical installations of the assets.
  - The required asset management budget can be planned better.
  - The scope of both new construction and renovation projects can be determined and controlled better.

This paper discusses the challenges we are facing and the participation of existing newly built and renovated tunnels. We would also like to discuss the pros and cons of digitisation.