Challenge Title – Urban Underground Space Digital Twin

City/county and country – Tallinn, Estonia

Main contact from your city / county – Andres Maremäe, Tallinn Strategic Management Office, Digital Twin Project Manager, andres.maremae@tallinnlv.ee, +372 502 3561

1. **What is the future urban challenge that would need a solution to?**

Please describe the challenge of your city / county neighboring a city?

The challenge our city faces is understanding and managing its underground urban space. This includes utility networks (e.g. water and electricity), traffic tunnels, archaeology, geology, ground water and natural entities (e.g. tree roots or habitats for fauna) These underground elements are crucial for the city's functioning, but they are often hidden, making it difficult to capture reliable data and visualize it.

Why is it important for your city to solve it? How big priority it is for you and why?

Solving the challenge of modeling underground urban infrastructure is a paramount priority for our city, as we have to manage *limited* underground space. Its significance lies in ensuring the safety of our residents and infrastructure, enhancing operational efficiency by reducing maintenance costs and service disruptions, facilitating smart urban planning, preserving our green spaces, and future-proofing our city against growth and development.

According to prior analyses the direct cost for the city is approximately one million euros annually because of the low data quality of underground utility networks. It is just *one* direct and measurable loss, and the losses related to other underground objects add to the sum.

Is this a unique challenge/problem of your city, why or is this by your knowledge a challenge/problem that many cities have – which kind of other cities?

This challenge is not unique to our city; it's a common issue faced by many urban areas worldwide. Cities with aging infrastructure, rapid development, and a need for environmental conservation are likely to face similar challenges. Other cities, both large and small, can relate to the complexities of managing underground utility networks, tree roots, and traffic tunnels. Therefore, the solutions developed through this project could be valuable not only to our city but also to other urban areas dealing with similar issues. Some sample cities interested in the concept are Riga, Helsinki and EUDAP network members (Denmark - Agency for Data Supply and Infrastructure; Nederland (The Netherlands - Department of Digital Economy Ministry of Economic Affairs and Climate Policy; Norway - The Norwegian Mapping Authority, Ministry of Local Government and Regional Development; UK - Geospatial Commission; Scotland - Transport Scotland).

2. **Innovation.**

How have you solved that issue so far? Why aren't the present solutions good enough? Are there legal obstacles, which ones?

The issue remains unresolved and is a complex problem involving multiple stakeholders with sometimes ambiguous interests. Another aspect is the challenge of collecting underground situational data, as the currently available technologies are insufficient. Laser scanning and other remote sensing technologies are not suitable for this purpose. However, we should not limit the issue to the data capture and visualisation in 3D, and there are many other aspects related to the issue, for example, conflicting stakeholder interests, data ownership, privacy issues and financial aspects of data sharing.

To date, our city has primarily relied on manual data collection, 2D mapping, and sporadic inspections to tackle the challenges related to underground urban infrastructure modeling. However, these methods have proven insufficient due to their labor-intensive, time-consuming nature, often resulting in incomplete or outdated information. Furthermore, 2D representations lack the depth required to accurately depict the 3D complexity of underground networks and tree root systems. Additionally, these approaches fail to meet modern urban planning demands, lacking real-time insights and predictive capabilities.
Underground space resource is not infinite, and management of the resource needs good data to make smart decisions. Current developments are often focused on modeling the surface objects. However, visualization of the hidden underground space is even more important than visualization of tangible surface objects.

What should be the main features, characteristics of the future solution to be potentially best for that challenge or problem?
The ideal solution for our city's underground urban infrastructure modeling challenge should boast key features such as robust 3D visualization, data capture technologies, real-time data integration, data flow design, user-friendly interfaces, stringent data privacy and security measures, scalability to accommodate future growth, interoperability with existing systems, predictive analytics capabilities for proactive maintenance, and cost-effectiveness. This comprehensive solution would not only enhance accuracy and efficiency but also address legal concerns by ensuring that sensitive data is managed in compliance with relevant regulations.
The proposed solution should not work as a stand-alone solution but needs to be integrated into the digital twins of Tallinn. Therefore, an approach which integrates into the modular system is necessary. To achieve this data management standards need to be elaborated and applied. Moreover, this approach will enable other cities to apply the developed solution into their systems as well, which avoids that the proposed solution is not transferrable. We need different digital twins because one digital twin can’t serve all purposes.

3. Expected impact of your pilot solution.

What is the expected impact to your city environment you expect to see if the challenge gets solved?
If we successfully address the challenge of modeling underground urban infrastructure, we anticipate a significantly positive impact on our city's environment. First and foremost, the enhanced ability to accurately map and manage tree root systems will lead to the preservation and protection of our green spaces. This will not only maintain our city's aesthetic appeal but also contribute to improved air quality, reduced urban heat islands, and enhanced biodiversity. Furthermore, by optimizing the management of utility networks and traffic tunnels, we can reduce the environmental footprint of maintenance activities, decreasing disruption and resource consumption. Overall, a more comprehensive and efficient approach to underground infrastructure will contribute to a healthier, more sustainable urban environment.
In the digital twin concept, we aim to see all of these aspects and objects in a mutual interaction. For example, we expect the answer to the question, how to find room for tree roots and utility networks in the limited underground space?

What is the expected impact to your citizens you expect to see if the challenge gets solved?
The successful resolution of the underground urban infrastructure modeling challenge will have a direct and positive impact on our citizens. Improved safety, resulting from better management of utility networks and tree roots, will reduce the risk of accidents and service interruptions, enhancing the overall quality of life for our residents. Additionally, the efficient planning and management of

underground infrastructure will lead to cost savings that can be passed on to citizens through lower utility bills and taxes. Furthermore, a more user-friendly and data-rich interface for accessing underground infrastructure information will empower citizens to make informed decisions about their properties and neighborhoods. In summary, addressing this challenge will make our city safer, more affordable, and more accessible for our residents.

What is the expected impact to your city governance you expect to see if the challenge gets solved?
Solving the challenge of modeling underground urban infrastructure will have a transformative impact on city governance. City officials and administrators will gain access to real-time data and predictive analytics, enabling them to make more informed decisions related to urban planning, resource allocation, and emergency response. This increased efficiency will lead to cost savings and improved resource management, optimizing the allocation of taxpayer funds. Moreover, the enhanced transparency and accessibility of underground infrastructure information will foster better communication between city governance and its citizens, promoting a more inclusive and responsive government. Ultimately, solving this challenge will lead to more effective, data-driven governance, better-equipped to meet the evolving needs of our city.

4. **Piloting**

Would you be interested to become a piloting partner of a proposed solution? Why? Describe shortly your capability to participate.
We are indeed very interested in the prospect of becoming a piloting partner for the proposed solution to tackle the underground urban infrastructure modeling challenge. Our interest is driven by our city's deep commitment to resolving this critical issue. However, it's important to note that our city has a limited capacity to actively engage in development work. Our participation can primarily take the form of attending regular meetings on a weekly basis, where we can provide essential information, insights, and feedback as end-users. While we may not have the capability for hands-on development, we are fully committed to contributing our local knowledge, sharing data, and actively participating in user testing and feedback processes to ensure the solution aligns closely with our city's needs and requirements. This collaborative approach will help us collectively address the challenge effectively while respecting our limitations in development capabilities.