DT6GV: Towards Intelligent and Safe Urban Transport System: Where Digital Twining and 6G Vehicular Communications Meet

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Problem and Purpose

We develop a programmable, and environmental-suitable 6G communication paradigm for intelligent and safe **vehicular networks** in dense city environments empowered by **digital twining (DT)**.

- Research question (RQ) #1: What are proper 6G technologies for safe urban vehicular networks with many building blockers?
- RQ #2: How to establish a radio environment DT to reflect and simulate these technologies in real-time?
- RQ #3: How much opportunity would a dynamic optimization of wireless communication networks provide?

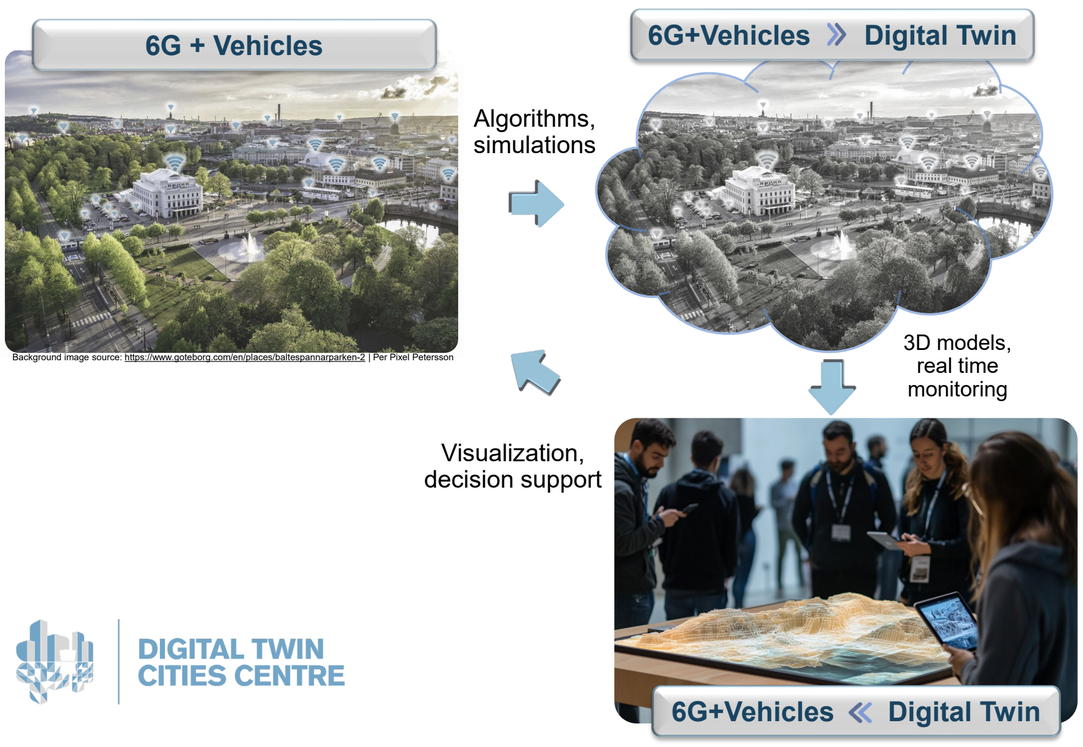

Figure 1: Overall structure of the DT6GV project.
WP1 [6G+V]: Reconfigurable intelligent surface (RIS)-assisted 6G vehicular communications in dense city environment RQ » #1
WP2 [6G+V » DT]: DT[3]-assisted pro-active wireless communications » RQ #1 & #2
WP3 [DT » 6G+V]: Visualization and decision support tool » RQ #2 & #3

Realization

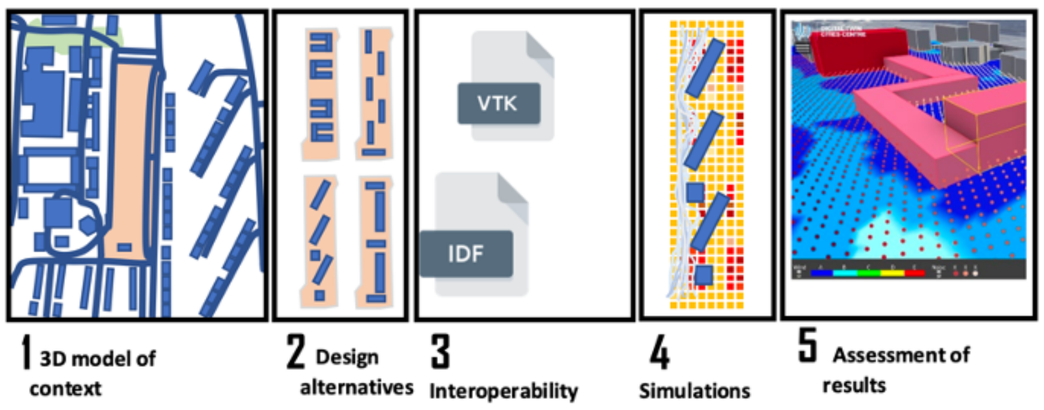

Figure 2: Simulation working flow of DT-based 6G systems.

Radio Simulators:

- Ray-tracing simulation: Wireless InSite@Remcom and Matlab raytracer
  - Considering reflections, diffraction, and foliage loss as well as atmospheric absorption
  - Outputting channel characteristics such as path loss, delay spread, direction of arrival/ departure, and the channel response
- Extract buildings and premises: Blender/Blosm

Digital Cities Twin Platform [5]

- An open source MIT licensed platform, part of the Digital Twin Cities Centre (DTCC), which aims to advance research, development, and implementation of digital twins for city-scale applications.
- The platform offers, among other features, multi-disciplinary integration, connection to simulations with a data-driven approach, allowing for big data, IoT devices, and sensors to update the digital twin in (near) real-time.

Results

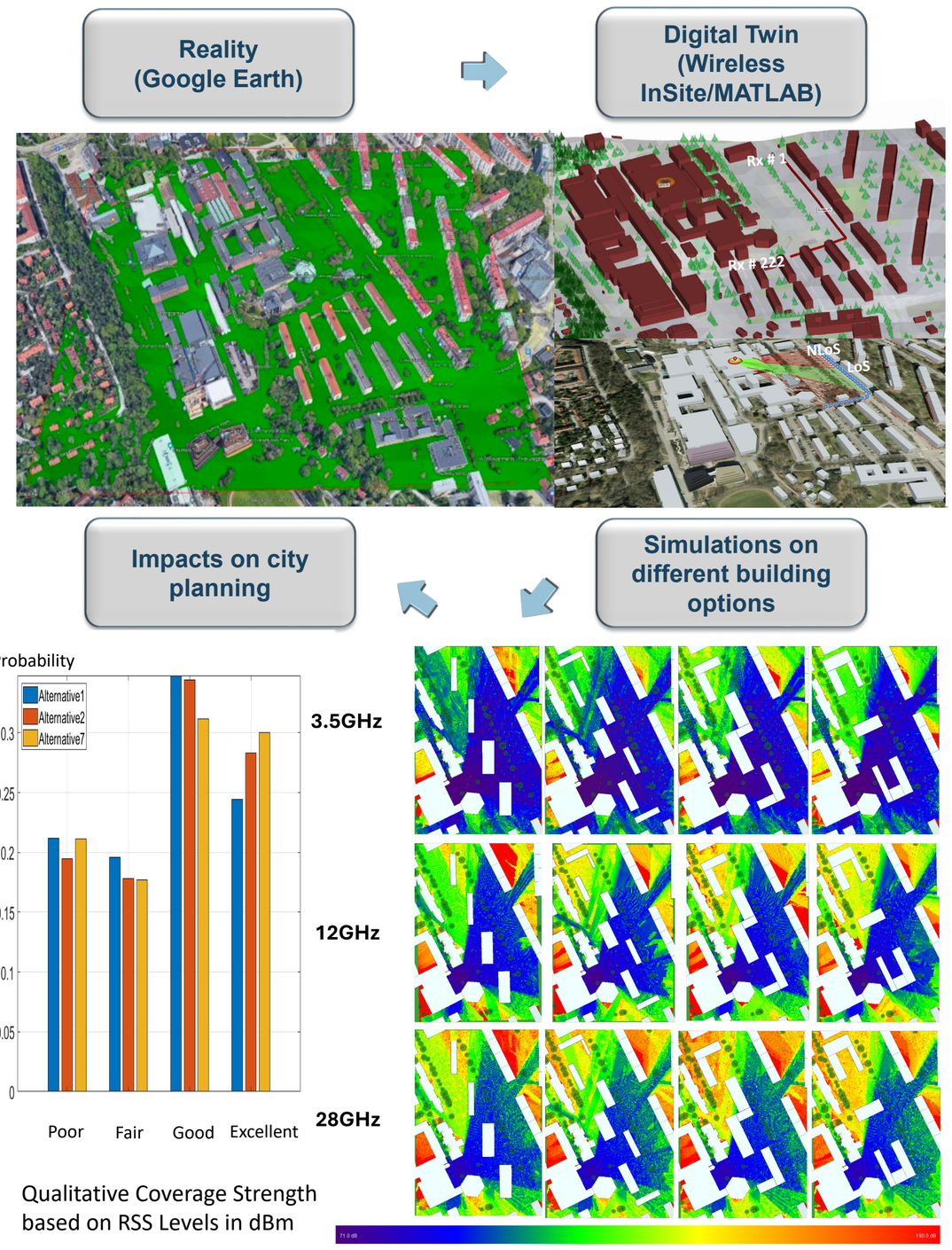

Figure 3: Highlighted results from the project [2][3]. We 1) build a DT from real world (E2 parking slot), then 2) simulate on the impact of different new building options in terms of radio power, and finally 3) propose actions on city planning.

Who Can Benefit From The Results?

- 6G companies and researchers: The simulation work flow we have established is general for DT-based 6G systems.
- Automotive and transportation industry: Will push forward by leveraging further smart transport systems, including reliable vehicle-to-everything (V2X) communication for real-time navigation and collision avoidance.
- City planning: The 6G perspective can be evaluated under our framework and provide insights on city/building plannings.
- Citizens, consumers, and overall end-users: For using 6G technology via enhanced mobile experience, including smart homes, connected devices and AI assistants.
- AI development and quantum communication: 6G networks will support distributed AI systems and reliable data exchange.
- Environmental and energy sectors: By using efficient monitoring of resources via IoT-enabled smart grids, wildlife tracking and by reducing the carbon footprint of communication systems.

Next steps

- Optimize and further integrate the radio simulators in DTCC.
- Generate DT data sets for ongoing national/international 6G projects.
- Seek additional funding for using DTs in 6G advanced air interface design for joint communications and sensing, and in 6G applications.

References

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[3] Gonzalez-caceres, Alex, et al. “Towards digital twinning for multi-domain simulation workflows in urban design: a case study in Gothenburg”. Journal of Building Performance Simulation, 2024, 1-22.
[4] V. Naserentin, H. Guo, S. Somanath, MG Aram, A. Logg, M. Yin, T. Svensson, “Urban digital twins for 6G intelligent radio environments”, to be submitted to IEEE Commag.
[5] https://github.com/dtcc-platform/
[6] https://dtcc.chalmers.se/

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