Digital Twins for Mobile 5G / 6G Networks

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Abstract

This research proposes the use of digital twins for 5G and 6G networks to optimize network performance. Digital twins are virtual representations of physical devices that can simulate and predict their behaviours with high accuracy. Throughout the methodology of the research, we shall incorporate machine learning techniques to create highly accurate models that can be used to optimise network performance and resource allocation.

1. Motivations, state of the Art

Communication networks are faced by challenges such as latency, synchronization, security, complexity, spectrum availability and energy efficiency.

2. Impact

Digital twins for 5G and 6G can address key challenges faced by modern communication networks, including testing what-if scenarios, improving network efficiency, enhancing quality of service, improving network security and enabling faster and more reliable communication. Overall, the research has the potential to revolutionize the way networks are managed and optimized, making an important area of investigation for the future of wireless communication systems.

3. Approach & tools used

- **Comnetsemu: Network Emulation Simplified.** Comnetsemu simplifies the emulation and testing of network configurations in a controlled setting. The tool empowers users to verify and adjust networks for optimal performance before deployment minimizing deployment risks and enhancing reliability.
- **Machine learning: Transforming data into Insights.** ML leverages algorithms to analyze data, learn from patters, and make informed decisions. This is at the heart of digital twins from predictive analytics to automation, revolutionizing how SDNs interpret vast amounts of information

4. Architecture

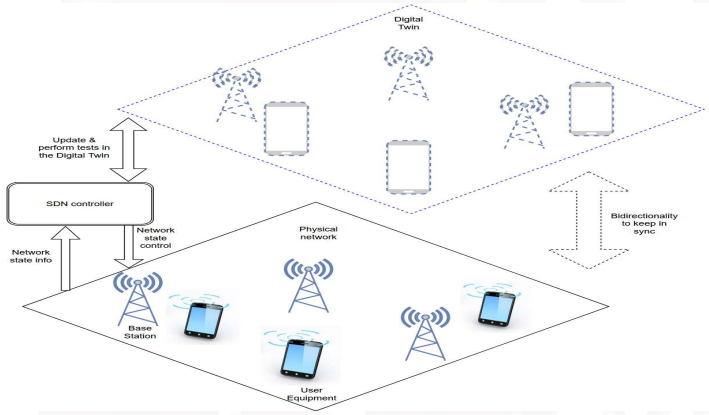

Figure 1: Digital Twin and Physical Network Ecosystem

- **SDN controller:** Commands a comprehensive, global perspective of the physical network landscape, continuously assimilating real-time updates from the physical network to steer traffic with enhanced efficiency. Its inherent adaptability guarantees that network behavior is finely tuned and responsive, meeting the advanced and evolving needs of 5G and 6G infrastructures with precision.
- **From Physical to Digital:**

  The physical network devices (links, user equipment, and base stations) continually report their statuses, performance metrics, and traffic loads to the SDN controller. This information is used to update the digital twin, a virtual replica of the physical network.

  Changes in the physical network due to new devices being added, failures, or maintenance are reflected in the digital twin, ensuring that the virtual model is always an accurate representation of the physical network.
- **From Digital to Physical:**

  The digital twin is used for simulations and analysis to optimize network performance and for planning changes without affecting the live network.

  When the digital twin simulations indicate a beneficial change, instructions are sent from the SDN controller back to the physical devices to reconfigure the physical network according to these optimized parameters.

5. Applications in networks

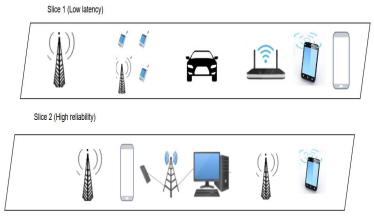

Figure: Network slicing

6. Conclusion

Digital twins for 5G and 6G networks can address key challenges and revolutionize network management. Overall, this research has the potential to optimize network performance and enable faster and more reliable communication.

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