Trust-Aware Adaptive Network Digital Twin for Multi-Slice Orchestration in 6G NTN-Edge Networks

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https://doi.org/10.56201/wjimt.v10.no10.2026.pg294.309

Abstract:
Although Network Digital Twins (NDTs) are considered enablers for sixth generation (6G) networks, there are several challenges involved in reliably and repeatedly leveraging NDTs for various use cases. In this work, we propose a trust-aware and adaptive framework called SATE-NDT, for multi-slice orchestration across various network domains (e.g. edge and non-terrestrial networks). The framework incorporates misalignment telemetry, semantic alignment, and drift compensation. Further, the framework integrates prediction and resource planning, as well as a trust gate. Compared to the state-of-the-art, SATE-NDT provides improvements in control and synchronization of various service classes (i.e., eMBB, URLLC and mMTC) in 6G networks. Rather than following a conventional control structure where the control and/or estimation errors are compensated, SATE-NDT aims to minimize eMBB, URLLC, and mMTC service class latencies and violation rates, by adjusting the synchronization frequency based on recent forecast errors and directional agreement. Further, SATE-NDT achieves improvement in eMBB and mMTC service class SLAs, while increasing the URLLC class violation rate. The results suggest trustworthy 6G NDT orchestration requires consideration of synchronization costs, model directionality, and slice-specific risks. Reliance on prediction is not sufficient.

Keywords: *6G; network digital twin; AI-native networks; network slicing; edge computing*

1. Introduction

Predictive and autonomous control of communications networks is the logical next step in mobile network evolution. The development of techniques like network slicing and edge computing result in increased network flexibility to support a wide range of services but makes network state more complex and harder to observe. The use case of digital twins for next generation networks is to model networks, visualize different network states, and test different configurations before making changes to the physical network. Digital twins have the potential to aid next-generation network management (Dao et al., 2024; Faye et al., 2024; ITU-T, 2022; Wu et al., 2024; Zhou et al., 2024). The concept of using digital twins and AI to manage next-generation networks is gaining traction. A recent study detailed the use of digital twins to continuously adjust bandwidth for eMBB services, and integrated the digital twin within the

overall network management and control framework (Ali & Arslan, 2025). Other works have detailed the integration of AI and network decision-making, and shown how digital twins can be used to manage Next-generation Networks (NGCNs) and integrate other network resources (Wu et al., 2024). Still other studies have integrated real-time data collection for network management even closer to the functions that implement the network services (He et al., 2025).

These developments illustrate that NDTs can be computationally sophisticated but still be operationally dangerous. The quality of a decision depends on a number of factors including how out-of-date the twin state is, whether telemetry has been aligned, the direction of change of the data being modeled, and whether the model responds correctly to a potential action. As a result, it has been suggested that for what-if analysis of NDTs, high R-squared or low mean absolute error should not be the only criteria for evaluating a given recommendation. Other methods such as Sign Agreement or Directional Sensitivity should also be considered (Jimenez Agudelo et al., 2026). Related research has also identified the same challenges including synchronization, flexibility, interoperability, and explanation for other application domains (e.g. heterogeneity of data and energy efficiency) (Sanjalawe et al., 2026; Sheraz et al., 2024).

The literature includes several key elements of an end-to-end system, but is generally incomplete. One work presents a case study of a pair of synchronized communication satellites, but does not address multi-slice or energy management, leaving these for future consideration (Ali & Arslan, 2025). Another work focuses on improving real-time telemetry, identifies validation and scalability/elasticity of the system as the main open issues, and leaves the rest to future work (He et al., 2025). Finally, a work in this area presents designs to integrate AI into twin architectures to provide telemetry and modify system behavior and to collaborate with other twins (Wu et al., 2024). Another work presents a case study of a 6G edge server and provides a numerical example of counterfactual resources (Jimenez Agudelo et al., 2026).

This work answers the following research question: How can a 6G network digital twin adjust its synchronization and gate resource allocation based on operational trust to provide a variety of communications slices in a Non-Terrestrial Network (NTN) edge scenario? This work does not seek to develop a predictor for a 6G communication system digital twin. Rather, a system closed-loop design is taken in which the sensors, prediction, and planning are integrated to respond to variability and system risks.

The main achievements include an end-to-end architecture, SATE-NDT, consisting of low-overhead telemetry, semantic harmonization, adaptive state synchronization, predictive slice-state estimation, what-if resource allocation, and a reply-to-policy gate; a trust score that is computed from the recent average relative prediction error and directional alignment. The trust score determines the length of the next synchronization interval and controls the trade-off in the candidate resource allocation; an optimization problem formulation that integrates joint bandwidth assignment and latency guarantees, considers mobility and blockage, and considers trade-offs between synchronization and latency for eMBB, URLLC, and mMTC; a pair of Wilcoxon signed-rank tests that assesses a suite of trade-offs in a controlled simulation. Adverse findings include latency, SLA violation rate, resource utilization, average synchronization time, twin error, and an energy proxy.

2. Related Work

2.1 Digital Twins and AI-driven Management in 6G

Network digital twins expand the concept of digital twins to represent communication artifacts such as services and flow as well as control planes (Mihai et al., 2022; Saqib et al., 2024). The

components of a digital twin network management system in the ITU-T framework include data collection functions, a unified repository of data and models, as well as interfaces to control and expose the management functions (ITU-T, 2022). Other works bring in the role of NDTs for networking virtualization and intelligence for 6G architectures and networks (Khan et al., 2022; Shen et al., 2022). Employing AI within an NDT is to augment the learning capability of the user and infrastructure digital twin, and thus is considered as an extension of the network intelligence (Wu et al., 2024). In the context of slice management and networking, twins play a significant role in capturing the resource and networking state of a slice. It has been shown that, to make well-informed slice decisions, it is essential to have a combination of computing-path and data-path intelligence. Telemetry from the data path is collected at a fine grain, and the frequency is determined based on the mobility and variations of the workload, as well as the level of service criticality.

2.2 Real-time Telemetry and Semantic Invariance

Networks integrated with AI will require extremely low latency data-transport infrastructure (Song et al., 2022). In He et al. (2025), the authors take a similar approach and describe a system in which the processing of network functions is configured to collect system and network status. Deep Packet Inspection is not performed, and status is reconstructed later. The authors build a testbed to collect, process, and transmit telemetry using Open5GS and OpenAirInterface, Prometheus, and Kubernetes. The authors explore the challenge of collecting telemetry in a network function and highlight the need for similar work to target latency and throughput.

The challenge of system-level telemetry goes beyond transport. Telemetry from different layers of the network and different points of the end-to-end system arrive in different formats, units, and rates. In 6G-TWIN, raw telemetry is decoupled from a layer that aligns and integrates telemetry to ensure semantic invariance across 3GPP and ETSI/NFV (Faye et al., 2025; Jimenez Agudelo et al., 2026; Zaki-Hindi et al., 2024). In the context of NDT simulations in SATE, integration and alignment of semantic confidence are left for subsequent consideration.

2.3 Network Slicing, NTN, and Learning-based Control

Network slicing logically partitions a network into multiple service instances. Reliability-Aware Elicsive Slicing (Gomes et al., 2020) and Learning-based Slicing (Hamdi et al., 2024) are two major approaches to slicing for 5G/Beyond. The use of DRL for the same purpose is given in (Hurtado Sánchez et al., 2022; Koo et al., 2019). Joint resource management with UAVs and MECs for vehicular communications is studied using DRL (Peng and Shen, 2021). The integration of NTNs increases the variability of channel conditions and topology. It introduces long delays due to large propagation distances and blockages (Giordani and Zorzi, 2021). Complexities such as delay and variability in traffic patterns can be modeled using digital twins. Physical network interventions can be taken based on the output of the digital twin. (Ali and Arslan, 2025) model eMBB using digital twins and state that integrating U-RLLC and mMTC slices is a potential future work.

2.4 Trustworthy what-if analysis

What-if analysis is based on counterfactual thinking. Therefore, to enable what-if analysis, a trustworthy twin must provide trustworthy counterfactuals. In the case of data-driven network twins, learned models can be used for what-if analysis and network resource optimization (Ferriol-Galmés et al., 2022). In the area of prediction of the effect of variation in the system,

Jimenez Agudelo et al. (2026), demonstrate that models can be calibrated, but not correct in their direction, in predicting system variation. For validation, they employ both sign agreement and directional sensitivity. Directional agreement of recent measurements is used in the SATE-NDT method (Prucnal, 2022) to determine whether there is agreement in direction and to what extent, in order to establish trust in the twin for what-if analysis and to control the actions of the Twin. Overall, SATE-NDT provides an operational what-if analysis and convergence between twin systems during the off-line, rigorous, formal validation.

Source direction	Demonstrated capability	Open issue used here	SATE-NDT response
AI-driven DT slicing with NTN (Ali & Arslan, 2025)	Real-time twin update and adaptive eMBB bandwidth allocation	Multi-slice operation and energy-aware extension	Joint eMBB/URLLC/mMTC allocation with adaptive synchronization
Real-time AI-native data collection (He et al., 2025)	Parallel collection, Kubernetes/OAI/Open5GS, Prometheus data support	Validation, scalability, elasticity	Separates telemetry/harmonization and conditions actions on trust
AI-native NDT management (Wu et al., 2024)	User, infrastructure, and slice twins; adaptive model update	Data drift, scalable processing, collaborative decision-making	Drift-aware update interval and slice-level policy planning
Trustworthy counterfactual NDT (Jimenez Agudelo et al., 2026)	Directional validation of what-if models	Multidimensional scenarios and management integration	Online direction-aware trust gate for multi-slice resource actions
AI-DTN surveys (Sanjalawe et al., 2026; Sheraz et al., 2024)	Taxonomies and 6G research roadmap	Synchronization, robustness, interoperability, energy, explainability	End-to-end closed loop with explicit synchronization and trust metrics

3. System Model and Problem Formulation

We study a region where 6G services are provided via terrestrial radio access, edge computing, and an NTN node. Here, an NTN node is a Flying Base Station (FBs) mounted on a UAV. Edge computing and radio resources collaborate to provide all three slices: eMBB, URLLC, and mMTC slices. The main objective of our work is to study the synchronization of slices and build trust among them, and not to design a PHY layer scheduler. Hence, the detailed design of the scheduler is not covered in this work. The designs of PHY and MAC layers can be taken care of in an experimental environment, for example, using ns-3, OAI, or HIL.

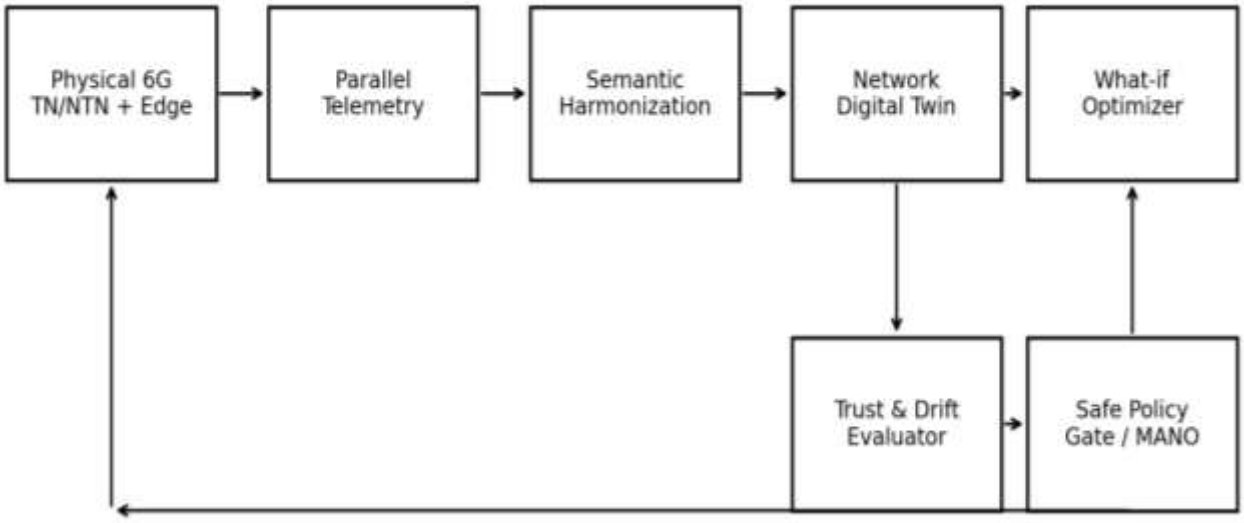


Figure 1. The SATE-NDT architecture integrates telemetry, state estimation, drift and trust management, safe what-if assessment, synchronization, and NDT.

3.1. Slice Traffic and Service Model

A network slice is characterized by the communications pattern of its users, e.g. low latency, mass connectivity, and high-speed. Let's consider a time slot and a slice commanded an aggregate offered load of Ds(t) in Mbit/s. The total radio bandwidth B is partitioned to Bs(t). Path loss, fading, and interferences are modeled by the effective spectral efficiency of the channel, eta_s(t).

Rs(t) = Bs(t) eta_s(t) .... (1)

Eqn (1) defines the maximum throughput of the channel in use. Note the similarity of this expression to the Shannon limit. As before, eta_s captures what is not modeled in the system. In this case, it captures the effects of the scheduler, transceiver, and radio channel. The queue length of slice s is given by Ds(t) and the slice throughput is given by Rs(t). The simulation uses a non-linear delay model and a series of traffic slices to illustrate the effect of a buffer overload condition in a communications system.

Slice Delay = Processing + Propagation + Queue + Scheduling Delay.

3.2 Digital-twin state and synchronization error

The NDT saves predicted values for both user and vehicle loads. Between two successive synchronizations, the values are estimated using a predictor with an exponentially decreasing weight and a short-term trend. Denote the predicted value for the demand at time t by D_hat_s(t). The mean relative state error is then defined as

$$e(t) = (1/|S|) \sum_s |D_hat_s(t) - D_s(t)| / \max(D_s(t), \text{epsilon}) \quad (3)$$

where |S| is the number of values in set S, epsilon is a small positive number, and the sum is computed over all demand values.

Equation 3 is evaluated for the mean relative state error. The SATE-NDT uses a variable synchronization interval. Depending on the current drift, the SATE-NDT decides on the next interval. By doing so, the trade-off between freshness and overhead is explicitly set. A small interval decreases the drift, but increases the load on the communication and processing

resources of the system.

3.3 Operational trust score

Operational trust is based on directional agreement and recent relative forecast error. Directional agreement is the fraction of slices in which the sign of the forecast demand change matches the sign of the actual demand change. If the forecast expects a decrease in load and in reality the load increase, the bandwith reduction may be unsafe even if the absolute forecast error is low. Let a(t) be the mean directional agreement and e_bar(t) be the mean relative forecast error. The trust score is given by

$$T(t) = \max[\exp(-k\, \bar{e}(t))\,(0.5 + 0.5\, a(t)), T_{min}, T_{max}]. \quad (4)$$

The idea here is that if mean relative forecast error is high, trust will be low. On the other hand, if directional agreement is high trust will also be high. Other, possibly more complex, methods to compute trust may be used in place of Equation 4. Some methods may use instead calibrated forecast uncertainty or confirmation, conformal prediction, Bayesian ensembles, or methods proposed by Jimenez Agudelo et al. (2026).

3.4 Multi-objective orchestration

At an update step, each twin computes slice-bandwidth vectors in a sandbox and evaluates slice Normalized Delay and saturation risk. SLA normalized slice delay is used to prioritize slice placement. Placement is evolved by the risk of SLA violation. Operation at slice saturation is also discouraged. We model the above slice placement strategy as shown in Eq. 5 and 6, where Eq. 5 describes the objective function and Eq. 6 describes the available bandwidth constraint.

In Eq. 5, L_s^{SLA} is the latency target for slice s, B_s is the available bandwidth for slice s, L_s is the length of slice s, L_s^{SLA} is the target latency of slice s, B is the total available bandwidth, and zeta is a positive constant. $\hat{L}_s$ is the computed slice delay for slice s, and w_s is the service weight for slice s. (PhimJ and rho_hat) are defined in Appendix C.

In this work, we consider only URLLC service, therefore URLLC slice is assigned a higher service weight compared to other slice types. When the trust score falls below a threshold, the planner assumes the headroom is not available, and therefore makes a conservative slice placement. Consequently, under low trust, slice placement is made more conservatively as compared to slice placement under high trust.

4. Proposed SATE-NDT Framework

4.1 Telemetry and Harmonization Layer

The SATE architecture defines a “sensing path,” which incorporates a couple of principles of architecture and design from 6G systems. The first of these is placing a telemetry generation function as close as possible to the network function under consideration. Placing this function close to the network function permits generation of control information and related Key Performance Indicators (KPIs). In the absence of this function, such information has to be inferred through Deep Packet Inspection (He et al., 2025). The second of these principles is that RAN, core and edge network functions must be decoupled from a semantic harmonization function. This decoupling allows the harmonization function to understand the relationships between different entities and align and reformat the measurements in a manner suitable for the digital twin (Zaki-Hindi et al., 2024; Jimenez Agudelo et al., 2026; ETSI, 2024).

4.2 Drift-Aware Synchronization Policy

During each synchronization of the NDT framework, SATE-NDT computes the residual of the previous forecast, and measures the short-term variations of the system's demands. The length of the next synchronization interval, Delta_t, is chosen from a predefined set of values. The larger the residual and the larger the demand variation, the smaller Delta_t is chosen to be. From a confidence interval perspective, the direction of agreement between forecast and actual system demand permits SATE-NDT to assign a small confidence interval to the forecast, even if the absolute or relative error is large.

Equation 7 uses the normalized volatility indicator V(t) to define an adaptive time interval Delta_t. The purpose of this definition is to adjust the frequency of updates to the model. The model is designed to ignore small variations in the data being processed and respond only to large, pertinent variations. The details of the implementation of the model to achieve this are outside the scope of this analysis.

4.3 Trust-gated counterfactual planning

In the twin, an allocation is made based on the best prediction of future demand. In order to implement a conservative allocation, a trust gate must first be traversed. In a fully deployed system, trust-gates may also be used to perform various policy checks, including intent checks and safety checks. Similar to the first trust gate, separation of prediction and action is a key design consideration of the system.

Algorithm 1. SATE-NDT control loop

Step	Operation
1	Collect synchronized RAN/core/edge telemetry and harmonize the state representation.
2	Update exponential demand/channel estimates and short-term trend.
3	Evaluate the previous forecast: compute recent relative error and directional agreement.
4	Calculate operational trust T(t) and volatility V(t); choose the next synchronization interval.
5	Forecast slice demand for the planning horizon.
6	If T(t) is below the trust threshold, inflate slice-specific safety reserves; otherwise use the forecast with a smaller uncertainty margin.
7	Evaluate feasible bandwidth allocations in the twin using the SLA-normalized objective in (5).
8	Pass the selected action through the policy gate and apply the validated allocation to the physical network.

Step	Operation
9	Repeat; retain residual and direction history for the next trust update.

5 Evaluation Methodology

5.1 Controlled simulation design

The evaluation presents a discrete time, proof of concept, controlled, simulation study. It models a part of the 3GPP framework, and establishes integrity by stating that it is not intended to represent a testbed. The environment in question runs for 60 seconds. Each of the three slices represents the time-varying, average, Load, and consists of superimposed random variations and bursty traffic. Spectral efficiency is modeled for each slice and represents the average case. The variation represents mobility and blockages. Short blockages models obstructions in the communication path. It is assumed that blockages occur for the uplink channel of the eMBB and URLLC. The variation represents mobility and obstructions for the NTN scenario. It is assumed that the blockages and variations occur for both the downlink and the uplink. 20 different random seeds are used for the variations.

The model represents the causal chain from the generation of traffic to the channel to the consumption of the bandwidth in the network and the delay experienced. There is a mismatch (prediction error) between what is expected and the actual state of the channel. More detailed modeling of the PHY and the MAC layers can be added in subsequent works, while keeping the same line of research.

Table 2. Represents controlled simulation parameters.

Parameter	Value	Rationale
Simulation duration / slot	60 s / 100 ms	Captures multiple traffic, mobility, and blockage cycles
Slices	eMBB, URLLC, mMTC	Heterogeneous 6G service classes
Total bandwidth	50 MHz	Shared slice resource pool
Minimum slice bandwidth	6, 8, 4 MHz	Prevents starvation of eMBB, URLLC, mMTC
Latency targets	100, 20, 200 ms	Simulation SLA thresholds, not standards claims
Mean offered-load scale	~35, 6, 12 Mbit/s plus bursts	Creates heterogeneous demand intensity
Effective spectral efficiency	Time-varying, floor 0.45 bit/s/Hz	Abstracts mobility, fading, and blockage
Fixed-DT synchronization	Every 4 slots (2.5/s)	Predictive baseline
SATE-NDT synchronization	Adaptive, 2-9 slots	Trust/volatility dependent

Monte Carlo repetitions	20 independent seeds	Paired comparison and non-parametric testing

5.2 Baselines and Metrics

Four different schemes will be considered. Static has a hard 24/12/14 MHz split. PF is a heuristic based on Proportional Fairness. It is run every five slots. Fixed-DT is based on the predictive sandbox of SATE-NDT, synchronized every four slots. SATE-NDT is considered in full proposal.

Evaluated metrics include average and 95th percentile latency, rate of SLA violations, throughput, mean active bandwidth, desynchronizations, relative error of twins, and a proxy for energy. The proxy for energy is a measure of active bandwidth and synchronization; it is not a measurement of power consumption. SATE-NDT and Fixed-DT are compared using the Wilcoxon signed-rank test using paired seeds. It is assumed that the metrics do not follow a normal distribution.

6. Results and Discussion

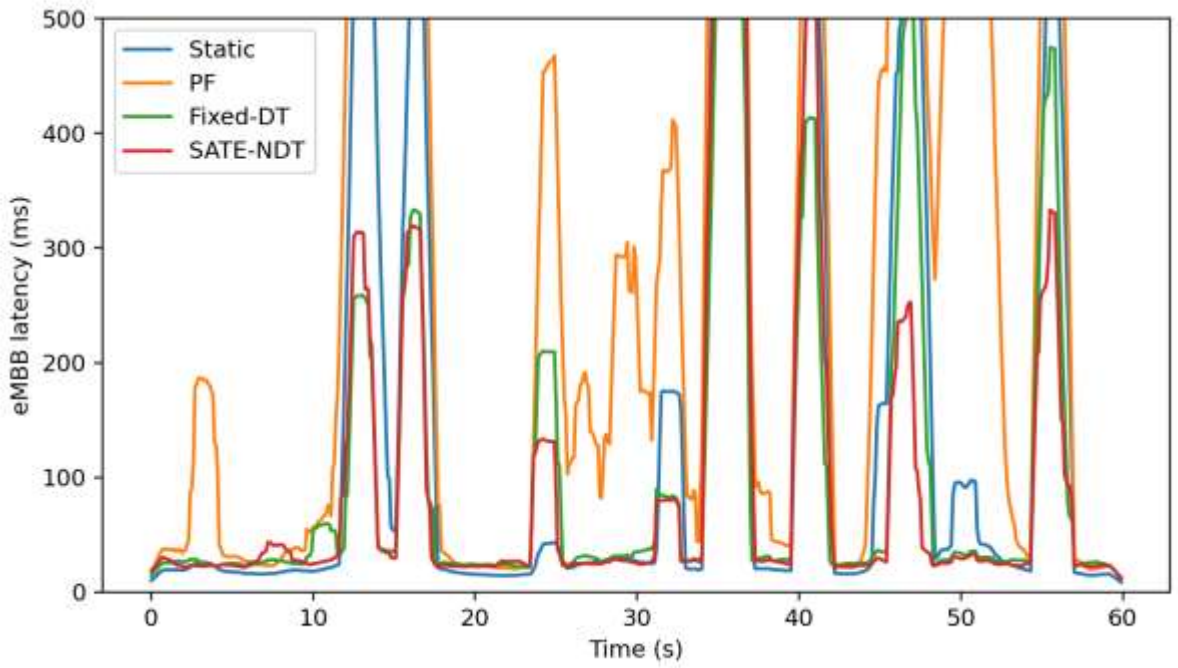


Fig. 2. Representative moving-average eMBB latency for one simulation seed. Extreme saturation peaks are clipped in the plotted y-axis for readability but remain included in the reported statistics.

Table 3. Mean performance over 20 independent simulation seeds

Scheme	eMBB lat. (ms)	URLLC lat. (ms)	mMTC lat. (ms)	eMBB SLA viol. (%)	URLLC SLA viol. (%)	mMTC SLA viol. (%)	Sync/s
Static	144.2	16.4	46.2	14.05	7.92	2.42	0.000
PF	311.8	8.9	202.7	36.32	0.31	23.47	2.000

Fixed-DT	101.7	14.6	116.4	10.19	8.23	9.71	2.500
SATE-NDT	98.7	14.0	104.3	9.42	10.07	8.32	2.085

The main point of distinction is with Fixed-DT and SATE-NDT. Both methods employ predictive what-if resource planning. Only SATE-NDT provides adjustment for synchronization and safety margins in the online trust plane. For 20 OMA-DATA seeds, SATE-NDT improved average end-to-end latency for eMBB, URLLC, and mMTC by 2.9%, 4.2%, and 10.3% respectively. Only the improvement for mMTC latency was statistically significant based on a paired Wilcoxon Signed Rank Test ($p < 0.001$). For eMBB and URLLC latency, improvements were seen but not statistically significant at the 0.05 confidence level.

The non-twin baseline cases show the value in the use of the multi-objective case. PF achieved the best URLLC latency, but at the cost of extremely high latency for eMBB and mMTC. Allocating resources statically performs well for mMTC in this case, but poorly for eBB in other cases. Latency improvements for eMBB and URLLC for this case study demonstrate the importance of understanding the features and demands of the varying use cases for 5G slicing.

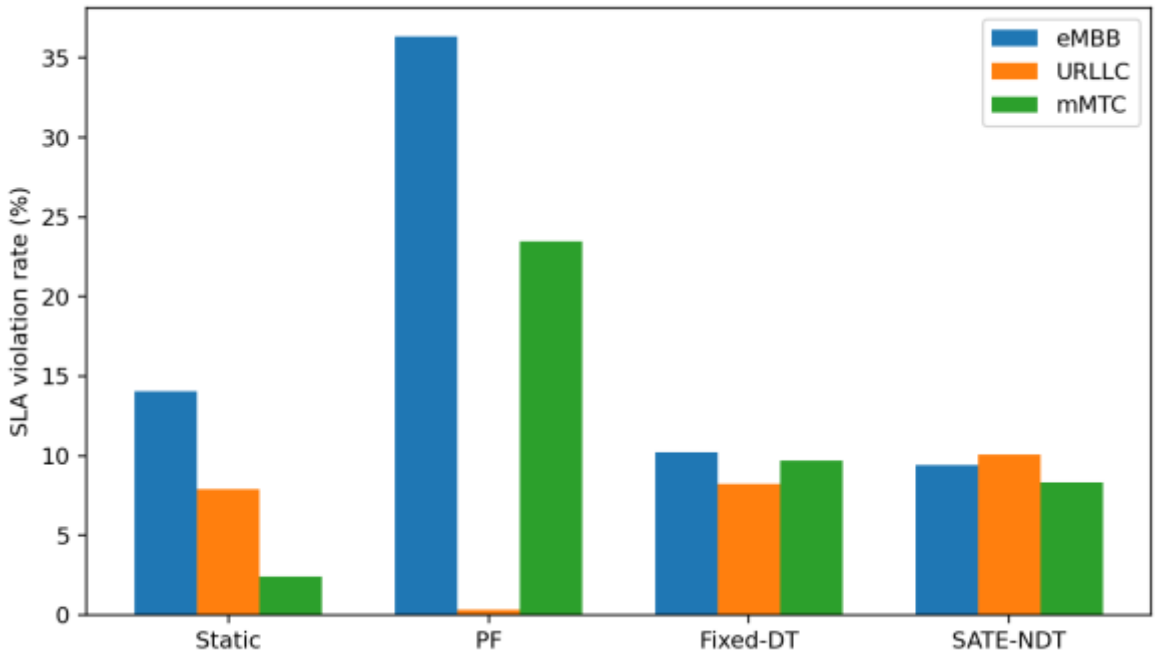


Fig. 3. SLA Violation Rate by Slice, averaged over 20 seeds

An important trade-off between trust and safety is shown by SLA violations. Compared to Fixed-DT, SATE-NDT reduces eMBB violations from 10.19% to 9.42% and mMTC violations from 9.71% to 8.33%. The reductions in eMBB and mMTC violations are significant in a paired test ($p = 0.018$ and $p = 0.005$ respectively). Increasing URLLC violations from 8.23% to 10.07% ($p < 0.001$) shows that mean URLLC latency further improves. The adaptive synchronization policy explains this case. When the system determines that there is no variance or traffic on the channel, the policy increases the synchronization interval. This policy reduces the overhead of the system, but, in this case, it increased URLLC violations. From this case, we learn that in a system that uses Trust and latency as its safety guards, violations do occur, and mean latency

cannot be relied upon to ensure safety of a stringent slice. A guard should be incorporated that ensures URLLC traffic is not relaxed, such as a slice-specific Age of Digital Twin.

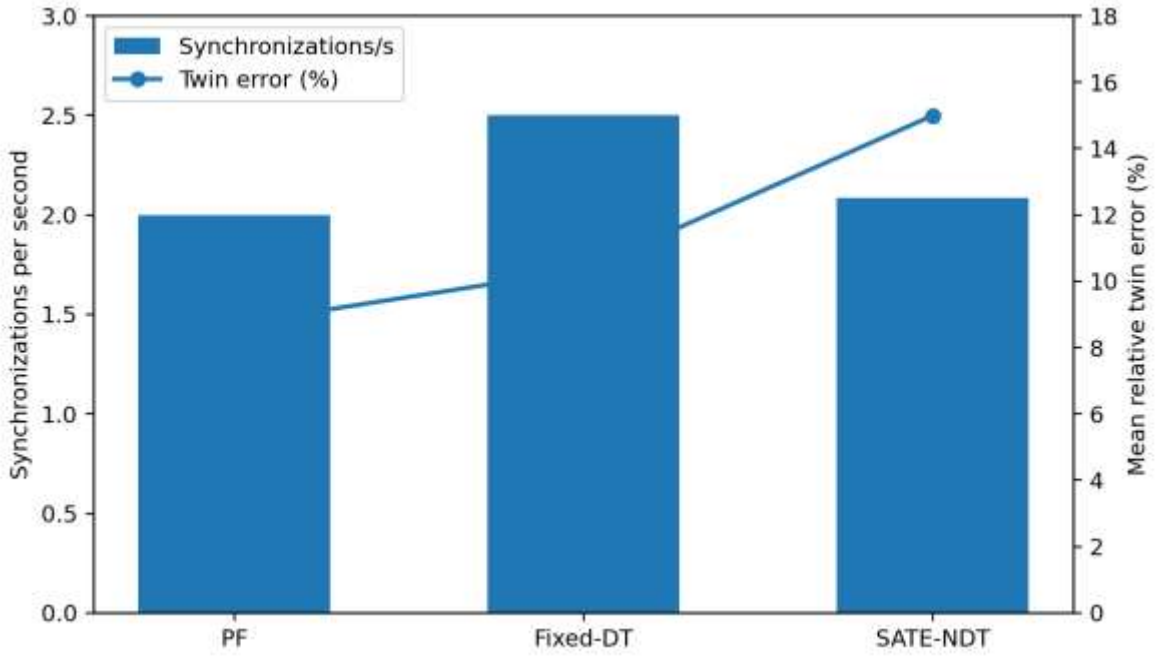


Fig. 4. Synchronization-overhead vs. twin-error trade-off. SATE-NDT increases the mean absolute error between updates and reduces the update frequency.

Synch. overhead is the principal effect of the mechanism. Comparing SATE-NDT with Fixed-DT, the average synch. overhead for SATE-NDT was 2.085 compared with 2.50 for Fixed-DT, which represents a 16.6% reduction. The reduction is significantly ($p < 0.001$) (1). The mechanism increases the duration of stable time windows. During stable time windows, SATE-NDT relies more on predictions and less on measurements. This increases the relative twin error. The mean relative twin error for SATE-NDT was 15.0% and for Fixed-DT, it was 10.35%.

SATE-NDT demonstrates that the objective of a control mechanism for a synch. protocol is to strike an appropriate balance for the error with respect to the decisions to be made, rather than to achieve absolute preciseness for all states. This approach is applicable to URLLC services. Per the URLLC report, adequacy of decisions for a service class must be defined for each service class, rather than for all service classes.

(1) Paired samples tests for proportions were used for all significant difference tests.

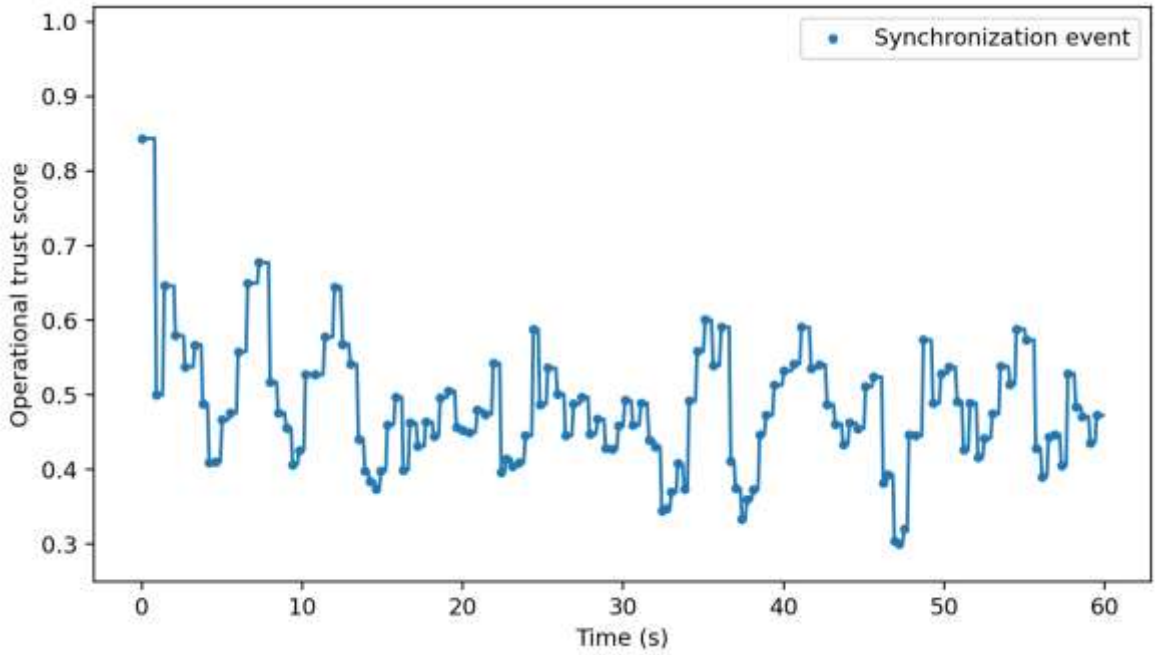


Figure 5 illustrates how the SATE-NDT components build and maintain operational trust. The horizontal lines illustrate trust boundaries, and the vertical lines illustrate synchronization events.

Operational trust is dynamic and is reflected in the trust boundary. Events, such as non-zero residuals and direction checks, influence trust. Operational trust has an expiration time. In SATE-NDT, trust is represented as a low score, which corresponds to a shorter operational time-to-live. If the score is high, trust is considered sufficient. Trust level can be, in some sense, considered an exchange rate, where a sufficient level of trust allows the twin to remain asynchronized. In this respect, the design complements offline trust validation. In practice, trust should be validated by online model evaluation. Matched-pairs directionality (Jimenez Agudelo et al. 2026) should be performed and complemented by policy constraints defined in MANO (ETSI, 2024).

Table 4 summarizes pair-wise Wilcoxon tests comparing SATE-NDT and Fixed-DT.

Metric	SATE-NDT	Fixed-DT	p-value
Mean eMBB latency (ms)	98.701	101.675	0.202
Mean URLLC latency (ms)	14.010	14.624	0.546
Mean mMTC latency (ms)	104.328	116.367	<0.001
eMBB SLA violation	9.42%	10.19%	0.018
URLLC SLA violation	10.07%	8.23%	<0.001

mMTC SLA violation	8.32%	9.71%	0.005
Synchronizations/s	2.085	2.500	<0.001
Analytical energy proxy	65.857	66.063	<0.001

7. Conclusion

SATE-NDT is a trust-aware adaptive network digital twin that forms part of a multi-slice management framework for 6G NTN-edge scenarios. The framework includes features such as low-overhead telemetry, predictive state estimation, flexible synchronization, counterfactual resource allotment, and others. In a controlled experiment, SATE-NDT outperformed a fixed-interval predictive twin in synchronization frequency, and reduced mean end-to-end latency for all slices, with statistically significant improvements for mMTC latency and SLA violations for eMBB/mMTC. The latency improvements for mMTC came at the expense of increased SLA violations for URLLC. The results presented in the paper demonstrate that improving trust for one slice of a network may come at the expense of trust for other slices. Thus, for the evaluation of trust for a digital twin, concerns of absolute latency, service class, and synchronization freshness are of primary importance.

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