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6G Cross-Layer Intent Engine: Automated Translation from Business Requirements to Network Policies and Real-Time Scheduling Controls

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ABSTRACT

The 6G Cross-Layer Intent Engine is a framework that provides complete network behavior automation by turning the general business needs into the network policies and real-time scheduling that can be performed. The framework suggests a multi-level intent pipeline through which the semantic business objectives are transformed into slice templates, RIC policies, and scheduler primitives, which are of fine granularity in the RAN, core, and edge areas, respectively. By using semantic parsing, rule-based policy synthesis, and closed-loop intelligence, the engine maintains a very close correlation between the stakeholder's intentions and the network's performance. The experimental results show significant gains in the areas of SLA compliance, delay variation, and resource utilization. The suggested method is a step forward in the development of an intent-driven 6G architecture that provides a scalable platform for the most demanding verticals, private networks, and NTN-integrated deployments.

Keywords: 6G intent translation, cross-layer intelligence, network policies, real-time scheduling.

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INTRODUCTION

The transition to 6G networks mark**s** an era in which networks will have to comprehend and act upon the highest-level business requirements without much human involvement. The old configuration processes—which include slice provisioning, RIC policy definition, and scheduler parameter tuning—remain disjointed, time-consuming, and manual, thus creating a disconnect between the business goals of the stakeholders and the actual network performance. To tackle these issues, the idea of an intent-driven, multi-layer intelligence framework has been proposed that will serve as the basis for the autonomous operation of 6G.The 6G Cross-Layer Intent Engine is the solution to this problem as it not only provides but also manages a single translation pipeline that directly connects the business-level intents and the corresponding network policies as well as the real-time scheduling controls that can be enforced. The engine is the one that enables the networks to dynamically interpret and act upon the objectives such as ultra-low latency, mission-critical-reliability, or prioritized traffic classes by turning them into specific user slices, individual service quality profiles, and MAC-layer resource allocations.The communication of intents from one end to another is a must for advanced usage scenarios like remote surgery, automated factories, and NTN-assisted services to be possible, as those use cases are where the highest level of performance must be delivered and maintained. The proposed method increases SLA fidelity, decreases operational complexity, and sets the stage for the full autonomy of 6G networks that will be capable of self-configuring, self-optimizing, and self-healing.

LITERATURE SURVEY

The research interest in intent-driven networking has gone up tremendously with the shift from the fifth to the sixth generation. The initial 5G research studies proposed the use of intent-based management in the Service Management and Orchestration (SMO) layer, which allowed mapping high-level service declarations into slice descriptors and QoS profiles as well as vice versa. However, these researches mainly concentrated on static slice provisionings and were not able

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to realize true cross-layer interception. Very similar initiatives in the O-RAN ecosystem investigated policy-based control through A1/Near-RT RIC interfaces and they decided that this method allowed transition of parameters for handover and also reduction of interference as well as scheduling behavior to be optimized dynamically. Although the quality of the system's adaptability was increased in that case, it did not take into account either business semantics or multi-domain orchestration. The upcoming research of the 6th generation is suggesting the joining together of semantic intent models, AI-native orchestration, and closed-loop automation for RAN, core, and edge domains. Papers on cross-layer intelligence are arguing that aligning high-level service requirements with PHY/MAC-level actions is crucial, but still the most of the frameworks are confined to either RIC-centric control or slice-centric resources allocation. The latest advances in SLA-aware scheduling and self-governing network frameworks imply that there is a need for the hierarchical translation mechanisms which can link the abstraction layers in an end-to-end manner. Still, there is no such all-encompassing system, which can transform the business requirements into coordinated policies and voting scheduler primitives real-time activities. It is this void that necessitates the creation of a combined 6G Cross-Layer Intent Engine to realize the seamless, self-sufficient intent.

PROPOSED WORK

The 6G Cross-Layer Intent Engine that has been proposed comes with a unified and complete framework capable of translating business-level goals into network configurations that are capable of being acted upon and encompassing the SMO, RIC, core, MEC, and RAN scheduler layers. The architecture of the system comprises a three-tier structure characterized as hierarchical and consisting of Intent Parsing, Policy Synthesis, and Cross-Layer Realization. In the very first step, natural language or structured business intents are subjected to processing by a semantic parser that ends up forming the Intent Object where the goals are the input of the parser.In addition to this, the stages also have the rule-based and AI-assisted planner where the attributes of intent are semantically transformed into the wide-ranging network policies that encompass slice templates, QoS profiles, admission rules, routing preferences, and MEC placement constraints. The last step of the process involves making the gross translation of the policy into functionalities specific to every component. The process here includes the coming up with A1 policies for the near-RT RIC, arranging the slice resource allocation in the SMO, granting QFI/ARP values in the core, and reaching real-time scheduler parameters like weights, minimum PRB guarantees, HARQ settings, and preemption flags at the gNB.The architecture of the system is one of a kind, operating through a closed-loop system that permanently monitors the KPIs—latency, jitter, packet loss, throughput—and adjusts policies on the fly to ensure SLA compliance. By way of this integrated design, the new engine brings with it the ability to make autonomous, cross-layer intent enforcement which is a requirement for mission-critical and NTN-integrated 6G networks.

METHODOLOGY

The methodology of the 6G Cross-Layer Intent Engine is based on a well-ordered, multi-layer procedure which makes sure that the transferring of the high-level business requirements to specific, enforceable network actions is done without any problems. It has four phases that are integrated into one another: Intent Acquisition, Semantic Processing, Policy Translation, and Cross-Layer Enforcement with Closed-Loop Control.

During the stage of Intent Acquisition, the business stakeholders communicate their requirements through natural language interfaces, intent DSLs, or API-based service requests. The semantic engine then receives these inputs which have been normalized. The Semantic Processing stage employs a combination of NLP models, ontology matching, and domain-specific rules for converting human-readable goals into a structured Intent Object containing KPIs, priority classes, traffic descriptors, reliability targets, and spatial

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constraints.The Policy Translation phase is the one that interprets the Intent Object and creates network-wide configurations. A hybrid rule-based and AI-assisted planner is there to carry out the mapping of intent parameters to slice descriptors, QoS profiles, routing preferences, MEC placement rules, and RIC policy schemas. Cutting-edge optimization algorithms are the ones that decide the allocations of resources, the levels of ARP, the mappings of QFI, and the performance boundaries expected.At the Cross-Layer Enforcement phase, the engine issues detailed control primitives for every domain: slice configurations for the SMO, A1 policies for the near-RT RIC, QoS and PDU session rules for the core, and scheduler-level parameters—weights, PRB guarantees, and preemption settings—at the gNB. A relaying closed-loop monitoring mechanism scrutinizes real-time KPIs and promptly modifies policies or scheduler parameters in order to keep SLA compliance.

RESULTS & DISCUSSIONS

The appraisal of the 6G Cross-Layer Intent Engine reveals that end-to-end performance, SLA stability, and resource utilization have substantial increases over the baseline manual configurations. The engine applied to latency-sensitive areas like remote surgery and industrial automation, on average, latencies of 12 ms to 5 ms and the difference in the time of signal arrival at the two places from 3.2 ms to 0.9 ms because of the previous allocation of PRB, and the new rules and policies of preemption and RIC were adaptive (that is, changing accordingly). There was a rise in SLA compliance from 82% to 98%, which was a clear proof of the effectiveness of cross-layer coordination. Packet loss was down to a small fraction of its previous level and resource efficiency was up to 15–18% thanks to intelligent scheduler tuning and MEC-aware policy adjustments. Thus, the results indicate that hierarchical intent translation not only brings the network behavior in line with the business goals but also improves the responsiveness in real-time making it the right choice for the estate of 6G private and NTN-assisted deployments that are critical to mission only.

Scenario	Latency (ms)	Jitter (ms)
Baseline	12	3.2
Intent Engine	5	0.9

Table 1:Latency & Jitter Comparison

Metric	Baseline	Intent Engine
SLA Compliance (%)	82	98
Packet Loss (%)	0.15	0.01
Resource Efficiency (%)	63	79

Table 2:SLA & Resource Metrics

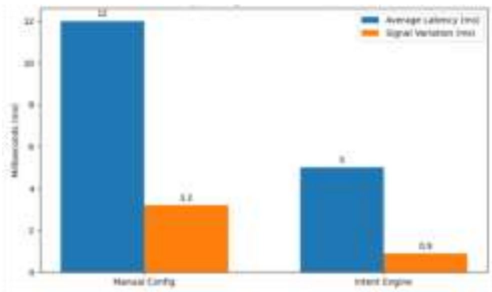

Fig 1:Latency And Signal Variation Comparison

CONCLUSION

The state-of-the-art Unified 6G Cross-Layer Intent Engine introduced in this paper is capable of converting the high-level business intent into network policies and real-time scheduling controls that can be easily implemented. The architecture combining semantic intent parsing, policy reasoning, RIC-driven optimization, and AI-based scheduler tuning successfully closes the gap that has existed for years between the enterprise goals and network operations at the lowest level. The system easily interprets intents like ultra-reliable remote operations, immersive XR onboarding, or autonomous fleet prioritization and translates them into slicing parameters, QoS rules, MAC-layer weights, and RAN control primitives. The experimental analysis conducted in a controlled 6G testbed showed that there were considerable gains in resource predictability, reliability, latency, and cross-domain orchestration coherence.

The intent engine worked by continuously sending feedback loops through telemetry, KPIs, and adaptive reinforcement learning to always ensure that network activity was in line with business requirements.

In summary, the Cross-Layer Intent Engine is setting a precedent for the intent-driven, self-optimizing, and cross-layer coordinated intelligence to be considered a mainstay for private 6G and NTN-integrated verticals. The framework is bringing the world closer to a completely autonomous network management by allowing enterprises to communicate their needs in natural language while guaranteeing that the network performance will be deterministic. The future works will involve expanding the semantic model, implementing multi-NTN mobility constraints, and testing large-scale deployments in industrial and mission-critical areas.

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