

Compliance Verification of 5G Service Level Agreements using Event-B

IEEE NCA 2025 Conference

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Plan



Introduction



Problem Statement



Proposition



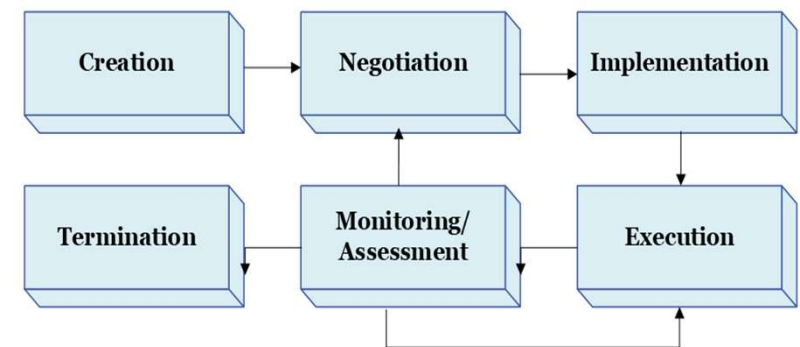
Results



Conclusion

Background

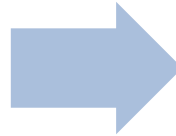
- Service Level Agreements (SLAs) are the formalization of the characteristics of a service between a service provider (SP) and a client.
- Like any other agreement written using comprehensive language, an SLA must be translated into a machine language.
- The SP is responsible at creating the SLA. For each service, he defines its detailed parameters.
- The consumer is the party who will use the service.



SLA Lifecycle

Problem Statement

- **Absence** of 5G SLA Template online
- **Lack** of models to verify 5G SLA correctness and compliance



Solution

1. Propose an SLA schema template based on International Standards
2. Apply Event-B modelling on 5G SLA slicing scenario

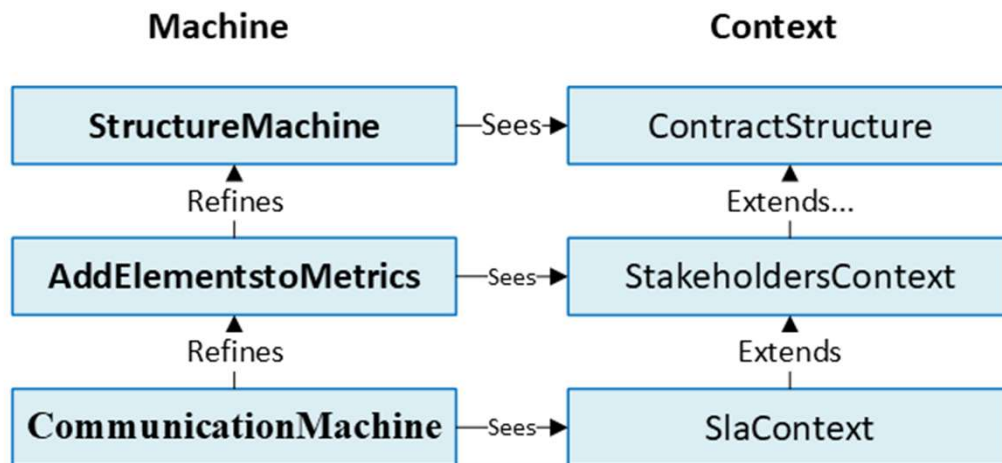
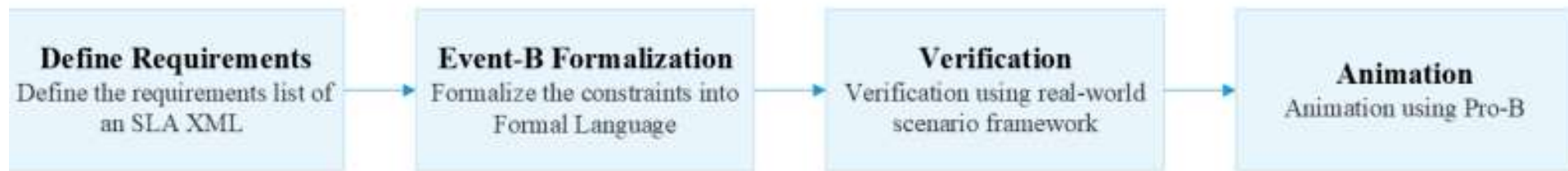
Proposing 5G SLA Schema Structure

Building upon established international standards and industry-recognized metrics, we have proposed and structured the critical 5G performance indicators and service quality parameters necessary for SLA definition.

According to the ISO/IEC 19086-2:2018 standard, the minimal form of an SLA should clearly define a set of properties:

- **Parties** that define the roles of the Service Provider, Consumer, and Supporting Party in the SLA lifecycle.
- **Terms** that specify service expectations, security and data requirements, and conditions for SLA termination.
- **Obligations** that outline responsibilities for service quality, audits, management, and billing procedures.

Compliance Verification of 5G SLA using Event-B

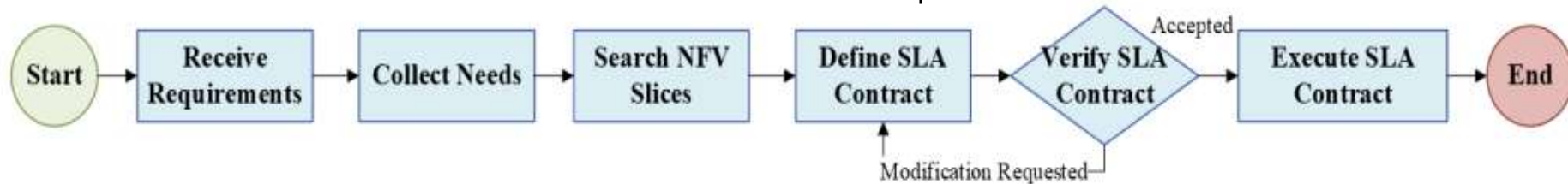


An Overview of the Incremental 5G SLA Event-B Model

- The **StructureMachine** forms the foundational layer of the SLA model, defining key entities such as SLA contracts, service definitions, and performance metrics.
- The second machine **AddElementstoMetrics** refines the **StructureMachine** and models the integration of various elements into an SLA framework.
- The **CommunicationMachine** handles the communication and negotiation between clients and service providers, ensuring that SLA contracts are proposed, accepted, and executed correctly.

5G Usecase & Events

Communication Events process



Event Name	Machine	Description
Receive_Requirements	CommunicationMachine	SP receives requirements from the client
Collect_Needs	CommunicationMachine	SP collects the client's needs
Search_NFV_Slices	CommunicationMachine	SP searches for matching available NFV slices
Define_SLA_Contract	CommunicationMachine	SP proposes SLA contract
Verify_SLA_Contract	CommunicationMachine	Client verifies the contracts then either: Accept_Contract event or Reject_Contract event
Accept_Contract	CommunicationMachine	Client choose to accept the proposed contract
Reject_Contract	CommunicationMachine	Client choose to reject the proposed contract
Execute_SLA_Contract	CommunicationMachine	Contracts execution begins
Finish_Contract	CommunicationMachine	Terminate the contract execution
AddContractToListofContracts	StructureMachine	Add a new contract to the list of available contracts

Verification: Proof-based Verification & Pro-B Animation

Proof-based Verification

- Proof obligations (POs) in Event-B are generated for multiple key reasons to ensure the correctness and reliability of the model.
- Based on the event-B model's mathematical definition, it is simple to conduct assessments that demonstrate the model's compliance with the formal constraints.
- The Rodin platform creates POs to achieve this objective.

Pro-B Animation

- The ProB animator checker plug-in further validates the proposed model.
- This animator allows for automated animation of model specifications.
- By analyzing different states, we can assess the correctness of the model's behavior.

Verification: Proof-based Verification & Pro-B Animation

The screenshot displays the Eclipse Platform interface for the Rodin IDE, specifically for the project `myprojectsrodin - SLA_Model_U01-U06/AddElementstoMetrics.bum`. The interface is divided into several panes:

- Event-B Explorer:** Located on the left, it shows a tree structure of the model. The `Events` pane is highlighted with a red dashed box, showing a list of events such as `AddServiceManagementSubElements`, `AddPenaltyClausesSubElements`, `AddStakeholdersContent`, `AddHeaderSubElements`, `SP_Receive_requirements (x4)`, `SP_Collect_Needs`, `Search_NFV_Slices (x2)`, `Define_SLA_Contract`, `Verify_SLA_Contract`, `Accept_Contract (x2)`, `Execute_Contract`, `Reject_contract`, and `Finish_Contract`. The `StructureMachine` pane is also highlighted with a red dashed box, showing a list of variables and invariants.
- Events:** A table on the left showing the parameters for each event. For example, `AddServiceManagementSubElements` has parameters `cl1, ..., sp1, ...`.
- AddElementstoMetrics:** A code editor on the left showing the definition of the `AddElementstoMetrics` event. It includes a `where` clause and a `then` clause.
- State:** A table in the center showing the state of the system. It has columns for `Name`, `Value`, and `Previous value`. The table lists various system components and their current and previous values.
- CommunicationMachine:** A table on the right showing the communication machine structure. It lists various communication elements and their relationships.

The bottom of the interface shows a status bar with the text `Ctrl Contrib (Bottom)` and `Statusitem`.

Conclusion & Future Work

- Since there is absence of online 5G SLA template, we have proposed and structured the critical 5G performance indicators and service quality parameters necessary for SLA definition, built upon established international standards and industry-recognized metrics.
- We achieved to verify our results through Event-B formalization.
- Future research may focus on improving scalability and automation to handle complex, dynamic network slicing scenarios. Integrating machine learning with formal methods could enable adaptive SLA monitoring, strengthening real-time compliance in 5G systems

Thank
you for
your
Attention

