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Abstract

Software-Defined Networking (SDN) has emerged as a transformative technology that decouples the control and data planes, enabling centralized network management, dynamic configuration, and improved efficiency. The key enabler of SDN is the OpenFlow protocol, which dictate how traffic should navigate through the network. The separation of control plane from the forwarding devices introduce significant flexibility and programmability, but it also brings a set of challenges that need to be addressed to ensure network security. Key challenges in SDN networks include maintaining flow rule integrity, mitigating the risk of a single point of failure, ensuring cross-domain flow integrity, and securely authenticating users within the network. Flow tables being one of the major component of SDN architecture, the attacker try to exploit the flow tables and maliciously modify the existing flow rules. This create a potential vulnerability where malicious actors can deceive security applications, leading to the installation of malicious flow rules on OpenFlow switches. Further, the centralized nature of the SDN control plane, where a single controller or a small set of controllers manage the entire network, introduces the risk of a single point of failure. Additionally, in large-scale networks, particularly those spanning multiple administrative domains, maintaining flow integrity across domain boundaries is a significant challenge as each domain may have its own policies, protocols, and security requirements. Further, an unauthorized access to the control plane could allow an attacker to manipulate flow rules and compromise the entire network.

In recent years, blockchain technology has emerged as a promising solution for addressing some of the security challenges in SDN. Their characteristics such as decentralized and immutable ledger can be leveraged to enhance the security of flow rule management, provide tamper-proof records of network transactions, and enable secure and transparent authentication processes. Therefore, this thesis is aimed at enhancing the security and resilience of SDN through the integration of blockchain smart contracts. This thesis addresses these challenges through four key contributions.

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Enhancing Security in Software-Defined Networks using Blockchain Smart Contract

by Birglang Bargayary

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