INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Internet of things (IoT) is one of the rapidly growing network technologies which has the po- tential to serve millions of devices. Such a large scale IoT network (LSiN) requires network management to efficiently serve the end-user applications. The modern network management systems are expected to identify the time varying traffic pattern and take suitable actions to ensure fine grained network management. Taking this kind of dynamic decision requires pro- grammability in the network, where the programmable network management system can be used to deploy evolutionary protocols rapidly based on the objective. However, traditional Internet architecture suffers from lack of flexibility due to absence of programmability. Software-Defined Network (SDN) has emerged to provide a flexible architecture for network control and man- agement. Additionally SDN provides opportunities to cater ever increasing bandwidth demand by fine tuning the network resources. The objective of this thesis is to design a distributed scal- able SDN orchestration framework which is suitable for handling the dynamic nature of LSiN. In this thesis we explore the performance improvement of IoT applications by utilizing SDN. Subsequently we explore various deployment and architectural design related issues of SDN.

Modern IoT and hand-held devices are equipped with multiple interfaces. To leverage the bandwidth capacity of multiple interfaces several multi-path transport layer protocols exist which provide bandwidth aggregation. The first contribution in this thesis enhances the perfor- mance of IoT applications by proposing SDN control plane application SDN-MPTCP for Multipath TCP (MPTCP), where MPTCP is one of the popular multipath transport protocols. In this work we find that the performance of MPTCP has a strong correlation with the selected paths, and SDN can assist in path selection of MPTCP. During the performance improvement by employing SDN we understood that the deployment of SDN over an existing LSiN increases the capital expenditure (capex) of the system. Moreover the centralized nature of the SDN control plane becomes a single point of failure for the network operation. Therefore, in this next work we investigate the SDN deployment challenges for LSiN. As mentioned earlier, SDN requires deployment of SDN supported hardware, which In this work we utilized Network Function Virtualization (NFV) for development of FLIPPER. FLIPPER enables deployment of SDN like network management over existing Commercial off-the-shelf (COTS) devices of LSiN by con- verting them into Policy decision and enforcement point (PDEP). FLIPPER provides a scalable, flexible, fail-safe and distributed "self-stabilized" architecture. In the next contribution we use FLIPPER to design Aloe orchestration framework which utilizes the in-network or In-network processing (In-network processing) platforms of LSiN to achieve "servicification" of SDN con- trol plane. Aloe promises "plug-and-play" and "zero touch deployment" along with light-weight, fault-tolerant and auto-scalable network management platform for LSiN. Through exhaustive experimentation over an in-house test bed and Amazon web service (AWS) platform we find that Aloe can significantly improve performance of various IoT applications. During this study we also observed that various end-user applications targeted for LSiN require Virtual Network Function (VNF) based Service Function Chaining (SFC) depending on the network service ac- cess policy. However, dynamic deployment of VNFs and traffic steering through those VNFs to preserve the SFC ordering is difficult in a LSiN which spans across multiple administrative domains. In the next contribution we propose Amalgam which incorporates SFC management with Aloe to ensure scalability and dynamic SFC. Based on the NP-hard nature of VNF place- ment problem, Amalgam also proposes a greedy heuristic for VNF placement which ensures fast flow initialization and provides performance improvement for short-duration flows. As a whole, this thesis provides auto-scalable and fault-tolerant distributed architecture and orchestration framework for LSiN network management to provide fine-grained network control. We have compared the proposed solutions with the state-of-the-art works. Based on the experimental results we found that the proposed solutions can provide significant performance

improvement for short duration flows while incurring lower resource consumption of the system.