Computer Science
Defense

Autonomic Formation of Large Scale Wireless Mesh Networks

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Abstract: A Wireless Mesh Network (WMN) is an appealing network architecture for low-cost and wide geographical coverage. It serves as a potential alternative solution to improve worldwide connectivity in low to high-income countries. Theoretical studies predict, however, insufficient capacity for such network architecture at larger scales. Moreover, the inherently distributed nature of WMNs and their typical distributed network control mechanisms turned them hardened and inflexible to adapt to specific and varying control customization demands. We propose the modernization of the WMN architecture by allowing the general applicability of Software-Defined Networking (SDN) on the implementation of WMN control planes for increased control flexibility while also enforcing frequency diversity to promote throughput capacity. To achieve this, we devised autonomic agents that induce the formation of WMN topologies as a set of interconnected partitions, supporting a cooperative, multi-domain SDN-based WMN control plane able to operate at large-scales and low-cost for increased control flexibility. Moreover, the nature of this autonomic network based on WMN partitions also allows the enforcement of frequency diversity at low-cost and low-complexity for improved throughput capacity. The partitioned topology format is the result of the concurrent and distributed operation of our autonomic agents that manipulate the formation of the WMN using local information, without relying on any central controlling entity, characterizing a scalable and resilient solution. Partitions hold as invariants their maximum diameter and their maximum per node interface degree. These two induce an additional invariant: the maximum partition size in mesh nodes. Finally, the three properties permit limiting control latency and workload on SDN control plane domains. Our agents have different objectives such as organize, heal, optimize; thus, they cooperate and compete to determine final WMN topologies. We show that the competitive/cooperative behavior of these agents converge to stable formations in bounded time even under extreme mesh node churn conditions. The solution relies on an in-network leader election and stochastic delays to achieve the eventual stabilization of formed WMN topologies."

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