

**Online Aggregation of the Forwarding Information Base: Accounting for Locality and Churn**

**Abstract:**

This paper studies the problem of compressing the forwarding information base (FIB), but taking a wider perspective. Indeed, FIB compression goes beyond sheer compression, as the gain in memory use obtained from the compression has consequences on the updates that will have to be applied to the compressed FIB. We are interested in the situation where forwarding rules can change over time, e.g., due to border gateway protocol (BGP) route updates. Accordingly, we frame FIB compression as an online problem and design competitive online algorithms to solve it. In contrast to prior work which mostly focused on static optimizations, we study an online variant of the problem where routes can change over time and where the number of updates to the FIB is taken into account explicitly. The reason to consider this version of the problem is that leveraging temporal locality while accounting for the number of FIB updates helps to keep routers CPU load low and reduces the number of FIB updates to be transferred, e.g., from the network-attached software-defined network controller to a remote switch. This paper introduces a formal model which is an interesting generalization of several classic online aggregation problems. Our main contribution is an *O(w)*-competitive algorithm, where *w* is the length of an IP address. We also derive a lower bound which shows that our result is asymptotically optimal within a natural class of algorithms, based on so-called *sticks*.

**Existing System:**

An interesting solution to alleviate the problem — before possible long-term solutions are deployed — is the *aggregation/ compression of the FIB*, i.e., the replacement of the existing set of rules by an *equivalent but smaller* set. The aggregation of FIB rules has the appealing property that it is a *purely local solution* in the sense that it does not affect neighboring routers and it can be done by a simple software update.

While the compression of the FIB is beneficial in terms of memory, it also entails a potential overhead: As the FIB of a router changes dynamically over time — typically several thousands rules are modified each second on a BGP core router— the rule compression may lead to a situation where already aggregated FIB entries need to be disaggregated again, resulting in a larger number of rule updates. There is a certain cost associated with each such update: First, each update entails some changes in the local data structure, which needs to be rebuilt. Moreover, transmissions of control messages is problematic as the communication channel between route processor and line card (resp. between the controller and the switch) can become a bottleneck. In the worstcase, the updates even have to be transmitted over a network featuring varying latencies: in the context of Software-Defined Networks (SDN), the *SDN controller* needs to send updates to a remote OpenFlow switch.

**Proposed System:**

This paper presents the first formal study of the tradeoff between FIB compression and update churn under dependent prefixes. After providing some empirical insights on the spatial and temporal locality of routing updates, revealing opportunities for improving this trade-off in online FIB aggregation, we present the online algorithm HIMS (HIDE INVISIBLE AND MERGE SIBLING). HIMS achieves an asymptotically optimal competitive ratio for a natural class of algorithms based on *sticks*. Sticks capture the subset of prefixes that are subject to optimization without violating forwarding correctness. HIMS (1) removes unnecessary and “invisible” prefixes from the FIB, and (2) merges FIB prefixes that are forwarded to the same port and describe adjacent IP address spaces.