SUMMARY

[0005] In one aspect, the disclosure relates to a method of generating a forwarding table for a packet switch. The method includes identifying, in a forwarding table of a packet switch, a plurality of multi-path groups, wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein each identified multi-path group has a number of routing entries in the respective initial set of the plurality of routing entries that exceeds a predetermined number of entries in the forwarding table. The method includes obtaining an importance score for each of the identified multi-path groups, each importance score indicating importance of the network traffic carried by the identified multi-path group, and wherein the importance scores are obtained based on one of the following factors: a traffic reduction cost metric, types of transmitted packets, ranking of protocols used for flow transmission, exceedance of flow sizing limitation, source and/or destination address, transmitted amount of data during a period of time. The method includes generating, for one or more multi-path groups in the plurality of the identified multi-path groups based on the obtained importance scores, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group. The method includes selecting, based on the traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups. The method also includes replacing, in the forwarding table of the packet switch, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries. ~~identifying, in a forwarding table of a packet switch, a plurality of multi-path groups wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein the identified multi-path groups have a number of forwarding entries that exceed a predetermined number of entries. The method includes generating, for one or more multi-path groups in the plurality of multi-path groups, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group. The method includes selecting, based on a traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups, and replacing, in~~

~~the forwarding table of the packet switch, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries.~~ In some implementations, the traffic reduction cost metric includes a first traffic characteristic.

[0006] In another aspect, the disclosure relates to a system. The system includes a packet switch with a forwarding table, and a route manager for the packet switch. The route manager is configured to identify, in the forwarding table, a plurality of multi-path groups wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein each identified multi-path group has a number of routing entries in the respective initial set of the plurality of routing entries that exceeds a predetermined number of entries in the forwarding table. The route manager is configured to obtain an importance score for each of the identified multi-path groups, each importance score indicating importance of the network traffic carried by the identified multi-path group, and wherein the importance scores are obtained based on one of the following factors: a traffic reduction cost metric, types of transmitted packets, ranking of protocols used for flow transmission, exceedance of a flow sizing limitation, source and/or destination address, transmitted amount of data during a period of time. The route manager is configured to generate, for one or more multi-path groups in the plurality of the identified multi-path groups based on the obtained importance scores, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group. The route manager is configured to select, based on the traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups. The route manager is also configured to replace, in the forwarding table, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries.~~identify, in the forwarding table, a plurality of multi-path groups wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein the identified multi-path groups have a number of forwarding entries that exceed a predetermined number of entries and generate, for one or more multi-path groups in the plurality of multi-path groups, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group. The route manager is~~

~~configured to select, based on a traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups, and replace, in the forwarding table, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries.~~ In some implementations, the traffic reduction cost metric includes a first traffic characteristic.

In some implementations, the packet switch participates in a software-defined network (SDN) and the route manager is part of an SDN controller for the packet switch.

WHAT IS CLAIMED IS:

1. A method of generating a forwarding table for a packet switch, the method comprising:

identifying, in a forwarding table of a packet switch, a plurality of multi-path groups wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein the identified multi-path groups have a number of forwarding entries that exceed a predetermined number of entries,

generating, for one or more multi-path groups in the plurality of multi-path groups, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group;

selecting, based on a traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups; and

replacing, in the forwarding table of the packet switch, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries.

2. The method of claim 1,

wherein the traffic reduction cost metric includes a first traffic characteristic; and

wherein selecting, based on the traffic reduction cost metric, a replacement set of routing entries corresponding to a multi-path group having the first traffic characteristic comprises selecting a replacement set of routing entries with less than a maximum number of routing entries, each routing entry in the replacement set corresponding to a different network path.

3. The method of claim 2, wherein the replacement set of routing entries with less than the maximum number of routing entries has exactly two routing entries.

4. The method of claim 2, wherein the multi-path group having the first network traffic characteristic does not transmit, to the multi-path group, network packets that are one or more of: network packets using a stateful transport-layer protocol, network packets for a flow exceeding a sizing limitation, and network packets addressed to a particular network address range.

5. The method of claim 1, further comprising

comparing a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to the first multi-path group; and

selecting the first generated replacement set of routing entries based on the comparing.

6. The method of claim 1, further comprising

comparing a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to a second multi-path group; and

selecting the first generated replacement set of routing entries based on the comparing.

7. The method of claim 1, further comprising

comparing a first traffic reduction cost metric value for a first plurality of generated replacement sets of routing entries respectively corresponding to a first plurality of multi-path groups with a second traffic reduction cost metric value for a second plurality of generated replacement sets of routing entries respectively corresponding to a second plurality of multi-path groups; and

selecting the first plurality of generated replacement sets of routing entries based on the comparing.

8. The method of claim 1, wherein replacing the initial set of routing entries with the replacement set of routing entries reduces the number of routing entries in the forwarding table by at least a predetermined amount.

9. The method of claim 1, wherein the traffic reduction cost metric includes a network bandwidth metric weighted by a score corresponding to traffic traversing the multi-path group.

10. The method of claim 1, wherein the packet switch is part of a software-defined network (SDN) and wherein replacing, in the forwarding table of the packet switch, the initial set of

routing entries with the replacement set of routing entries comprises transmitting instructions from an SDN controller to the packet switch.

11. A system comprising:

a packet switch with a forwarding table; and

a route manager for the packet switch, the route manager configured to:

identify, in the forwarding table, a plurality of multi-path groups wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein the identified multi-path groups have a number of forwarding entries that exceed a predetermined number of entries;

generate, for one or more multi-path groups in the plurality of multi-path groups, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group;

select, based on a traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups; and

replace, in the forwarding table, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries.

12. The system of claim 11,

wherein the traffic reduction cost metric includes a first traffic characteristic; and

wherein the route manager is configured to select, based on the traffic reduction cost metric, a replacement set of routing entries corresponding to a multi-path group having the first traffic characteristic by selecting a replacement set of routing entries with less than a maximum number of routing entries, each routing entry in the replacement set corresponding to a different network path.

13. The system of claim 12, the replacement set of routing entries with less than the maximum number of routing entries having exactly two routing entries.

14. The system of claim 12, wherein the multi-path group having the first network traffic characteristic does not transmit, to the multi-path group, network packets that are one or more of: network packets using a stateful transport-layer protocol, network packets for a flow

exceeding a sizing limitation, and network packets addressed to a particular network address range.

15. The system of claim 11, the route manager further configured to:

compare a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to the first multi-path group; and

select the first generated replacement set of routing entries based on the comparing.

16. The system of claim 11, the route manager further configured to:

compare a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to a second multi-path group; and

select the first generated replacement set of routing entries based on the comparing.

17. The system of claim 11, the route manager further configured to:

compare a first traffic reduction cost metric value for a first plurality of generated replacement sets of routing entries respectively corresponding to a first plurality of multi-path groups with a second traffic reduction cost metric value for a second plurality of generated replacement sets of routing entries respectively corresponding to a second plurality of multi-path groups; and

select the first plurality of generated replacement sets of routing entries based on the comparing.

18. The system of claim 11, wherein the route manager is configured to replace the initial set of routing entries with the replacement set of routing entries to reduce the number of routing entries in the forwarding table by at least a predetermined amount.

19. The system of claim 11, wherein the traffic reduction cost metric includes a network bandwidth metric weighted by a score corresponding to traffic traversing the multi-path group.

20. The system of claim 11, wherein the packet switch is part of a software-defined network (SDN) and wherein the route manager is part of an SDN controller, the SDN controller configured to replace, in the forwarding table of the packet switch, the initial set of routing entries with the replacement set of routing entries by transmitting instructions to the packet switch.

WHAT IS CLAIMED IS:

1. A method of generating a forwarding table for a packet switch, the method comprising:

identifying, in a forwarding table of a packet switch, a plurality of multi-path groups, wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein each identified multi-path group has a number of routing entries in the respective initial set of the plurality of routing entries that exceeds a predetermined number of entries in the forwarding table;

obtaining an importance score for each of the identified multi-path groups, each importance score indicating importance of the network traffic carried by the identified multi-path group, and wherein the importance scores are obtained based on one of the following factors: a traffic reduction cost metric, types of transmitted packets, ranking of protocols used for flow transmission, exceedance of flow sizing limitation, source and/or destination address, transmitted amount of data during a period of time;

generating, for one or more multi-path groups in the plurality of the identified multi-path groups based on the obtained importance scores, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group;

selecting, based on the traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups; and

replacing, in the forwarding table of the packet switch, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries.

2. The method of claim 1,

wherein the traffic reduction cost metric includes a first traffic characteristic; and

wherein selecting, based on the traffic reduction cost metric, a replacement set of routing entries corresponding to a multi-path group having the first traffic characteristic comprises selecting a replacement set of routing entries with less than a maximum number of routing entries, each routing entry in the replacement set corresponding to a different network path.

3. The method of claim 2,

wherein the replacement set of routing entries with less than the maximum number of routing entries has exactly two routing entries, or wherein the multi-path group having the first network traffic characteristic does not transmit, to the multi-path group, network packets that are one or more of: network packets using a stateful transport-layer protocol, network packets for a flow exceeding a sizing limitation, and network packets addressed to a particular network address range.

4. The method of claim 1, further comprising:

comparing a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to the first multi-path group; and

selecting the first generated replacement set of routing entries based on the comparing.

5. The method of claim 1, further comprising:

comparing a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to a second multi-path group; and

selecting the first generated replacement set of routing entries based on the comparing.

6. The method of claim 1, further comprising:

comparing a first traffic reduction cost metric value for a first plurality of generated replacement sets of routing entries respectively corresponding to a first plurality of multi-path groups with a second traffic reduction cost metric value for a second plurality of generated replacement sets of routing entries respectively corresponding to a second plurality of multi-path groups; and

selecting the first plurality of generated replacement sets of routing entries based on the comparing.

7. The method of claim 1,

wherein replacing the initial set of routing entries with the replacement set of routing entries reduces the number of routing entries in the forwarding table by at least a predetermined amount, or

wherein the traffic reduction cost metric includes a network bandwidth metric weighted by a score corresponding to traffic traversing the multi-path group, or

wherein the packet switch is part of a software-defined network (SDN) and wherein replacing, in the forwarding table of the packet switch, the initial set of routing entries with the replacement set of routing entries comprises transmitting instructions from an SDN controller to the packet switch.

8. A system comprising:

a packet switch with a forwarding table; and

a route manager for the packet switch, the route manager configured to:

identify, in the forwarding table, a plurality of multi-path groups wherein each multi-path group corresponds to a respective initial set of a plurality of routing entries in the forwarding table and each routing entry identifies an egress port of the packet switch and wherein each identified multi-path group has a number of routing entries in the respective initial set of the plurality of routing entries that exceeds a predetermined number of entries in the forwarding table;

obtain an importance score for each of the identified multi-path groups, each importance score indicating importance of the network traffic carried by the identified multi-path group, and wherein the importance scores are obtained based on one of the following factors: a traffic reduction cost metric, types of transmitted packets, ranking of protocols used for flow transmission, exceedance of a flow sizing limitation, source and/or destination address, transmitted amount of data during a period of time;

generate, for one or more multi-path groups in the plurality of the identified multi-path groups based on the obtained importance scores, at least one replacement set of routing entries with fewer routing entries than the initial set of routing entries corresponding to the respective multi-path group;

select, based on the traffic reduction cost metric, one or more of the replacement sets of routing entries, each selected replacement set corresponding to a different respective multi-path group in the plurality of multi-path groups; and

replace, in the forwarding table, the initial set of routing entries for each multi-path group corresponding to a selected replacement set of routing entries, with the respective corresponding selected replacement set of routing entries.

9. The system of claim 8,

wherein the traffic reduction cost metric includes a first traffic characteristic; and

wherein the route manager is configured to select, based on the traffic reduction cost metric, a replacement set of routing entries corresponding to a multi-path group having the first traffic characteristic by selecting a replacement set of routing entries with less than a maximum number of routing entries, each routing entry in the replacement set corresponding to a different network path.

10. The system of claim 9,

wherein the replacement set of routing entries with less than the maximum number of routing entries having exactly two routing entries, or

wherein the multi-path group having the first network traffic characteristic does not transmit, to the multi-path group, network packets that are one or more of: network packets using a stateful transport-layer protocol, network packets for a flow exceeding a sizing limitation, and network packets addressed to a particular network address range.

11. The system of claim 8, the route manager further configured to:

compare a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to the first multi-path group; and

select the first generated replacement set of routing entries based on the comparing.

12. The system of claim 8, the route manager further configured to:

compare a first traffic reduction cost metric value for a first generated replacement set of routing entries corresponding to a first multi-path group with a second traffic reduction cost metric value for a second generated replacement set of routing entries corresponding to a second multi-path group; and

select the first generated replacement set of routing entries based on the comparing.

13. The system of claim 8, the route manager further configured to:

compare a first traffic reduction cost metric value for a first plurality of generated replacement sets of routing entries respectively corresponding to a first plurality of multi-path groups with a second traffic reduction cost metric value for a second plurality of generated replacement sets of routing entries respectively corresponding to a second plurality of multi-path groups; and

select the first plurality of generated replacement sets of routing entries based on the comparing.

14. The system of claim 8,

wherein the route manager is configured to replace the initial set of routing entries with the replacement set of routing entries to reduce the number of routing entries in the forwarding table by at least a predetermined amount, or

wherein the traffic reduction cost metric includes a network bandwidth metric weighted by a score corresponding to traffic traversing the multi-path group, or

wherein the packet switch is part of a software-defined network (SDN) and wherein the route manager is part of an SDN controller, the SDN controller configured to replace, in the forwarding table of the packet switch, the initial set of routing entries with the replacement set of routing entries by transmitting instructions to the packet switch.