

CLAIMS

1. An apparatus for switching network traffic, the apparatus comprising:
an ingress packet forwarding engine implemented in circuitry and configured to:
determine, in response to receiving a network packet, an egress packet forwarding engine for outputting the network packet; and
enqueue the network packet in a virtual output queue for output to the egress packet forwarding engine, wherein, to enqueue the network packet in the virtual output queue, the ingress packet forwarding engine is configured to enqueue the network packet in a first portion of a combined buffer assigned to the virtual output queue;
the egress packet forwarding engine implemented in processing circuitry and configured to, in response to a first scheduling event, output, to the ingress packet forwarding engine, information indicating the network packet in the virtual output queue and that the network packet is to be enqueued at an output queue for an output port of the egress packet forwarding engine;
wherein the ingress packet forwarding engine is further configured to, in response to receiving the information:
dequeue the network packet from the virtual output queue, wherein, to dequeue the network packet from the virtual output queue, the ingress packet forwarding engine is configured to dequeue the network packet from the first portion of the combined buffer;
and
enqueue the network packet to the output queue, wherein, to enqueue the network packet the network packet to the output queue, the ingress packet forwarding engine is configured to enqueue the network packet in a second portion of the combined buffer assigned to the output queue; and
wherein the egress packet forwarding engine is further configured to, in response to a second scheduling event that is after the first scheduling event:
dequeue the network packet from the output queue, wherein, to dequeue the network packet from the output queue, the egress packet forwarding engine is configured to dequeue the network packet from the second portion of the combined buffer; and
output the network packet at the output port.

2. The apparatus of claim 1, wherein, to output the information, the egress packet forwarding engine is configured to output, to the ingress packet forwarding engine, the network packet with a header comprising the information.
3. The apparatus of claim 2, wherein, in response to receiving the network packet with the header, the ingress packet forwarding engine is configured to:
perform a drop check for the network packet.
4. The apparatus of claim 2, wherein, to output the network packet with the header, the egress packet forwarding engine is configured to output the network packet with the header from a first port of the egress packet forwarding engine to a second port of the ingress packet forwarding engine.
5. The apparatus of claim 1, wherein, to output the information, the egress packet forwarding engine is configured to output metadata comprising the information to the ingress packet forwarding engine and refrain from outputting the network packet to the ingress packet forwarding engine.
6. The apparatus of claim 5, wherein, to output the metadata, the egress packet forwarding engine is configured to output the metadata to the ingress packet forwarding engine using local switching.
7. The apparatus of claim 1, wherein the egress packet forwarding engine comprises a scheduler implemented in circuitry and configured to:
select the output port from a plurality of output ports at the egress packet forwarding engine, wherein the information is generated to specify that the network packet is to be enqueued at the output queue based on the selection of the output port by the scheduler; and
determine the first scheduling event and the second scheduling event to regulate a speed at which data is exchanged from the apparatus.

8. ~~The apparatus of claim 1, comprising:~~

~~a combined buffer for the ingress packet forwarding engine and the egress packet forwarding engine;~~

~~wherein, to enqueue the network packet in the virtual output queue, the ingress packet forwarding engine is configured to enqueue the network packet in a first portion of the combined buffer assigned to the virtual output queue;~~

~~wherein, to dequeue the network packet from the virtual output queue, the egress packet forwarding engine is configured to dequeue the network packet from the first portion of the combined buffer;~~

~~wherein, to enqueue the network packet the network packet to the output queue, the egress packet forwarding engine is configured to enqueue the network packet in a second portion of the combined buffer assigned to the output queue; and~~

~~wherein, to dequeue the network packet from the output queue, the egress packet forwarding engine is configured to dequeue the network packet from the second portion of the combined buffer.~~

98. A method comprising:

determining, in response to receiving a network packet and by an ingress packet forwarding engine implemented in processing circuitry, an egress packet forwarding engine for outputting the network packet;

enqueueing, by the ingress packet forwarding engine, the network packet in a virtual output queue for output to the egress packet forwarding engine, wherein enqueueing the network packet in the virtual output queue comprises enqueueing the network packet in a first portion of a combined buffer for the ingress packet forwarding engine and the egress packet forwarding engine that is assigned to the virtual output queue;

outputting, in response to a first scheduling event and by the egress packet forwarding engine implemented in processing circuitry, to the ingress packet forwarding engine, information indicating the network packet in the virtual output queue and that the network packet is to be enqueued at an output queue for an output port of the egress packet forwarding engine;

dequeuing, in response to receiving the information and by the ingress packet forwarding engine, the network packet from the virtual output queue, wherein dequeuing the network packet from the virtual output queue comprises dequeuing the network packet from the first portion of the combined buffer, and enqueueing, by the ingress packet forwarding engine, the network packet to the output queue, wherein enqueueing the network packet to the output queue comprises enqueueing the network packet in a second portion of the combined buffer assigned to the output queue; and

dequeuing, in response to a second scheduling event that is after the first scheduling event and by the egress packet forwarding engine, the network packet from the output queue, wherein dequeuing the network packet from the output queue comprises dequeuing the network packet from the second portion of the combined buffer, and outputting, by the egress packet forwarding engine, the network packet at the output port.

109. The method of claim **98**, wherein outputting the information comprises outputting, to the ingress packet forwarding engine, the network packet with a header comprising the information.

110. The method of claim **109**, comprising:

performing, in response to receiving the network packet with the header and by the ingress packet forwarding engine, a drop check for the network packet.

121. The method of claim **109**, wherein outputting the network packet with the header comprises outputting the network packet with the header from a first port of the egress packet forwarding engine to a second port of the ingress packet forwarding engine.

132. The method of claim **98**, wherein outputting the information comprises outputting metadata comprising the information to the ingress packet forwarding engine and refraining from outputting the network packet to the ingress packet forwarding engine.

143. The method of claim **132**, wherein outputting the metadata comprises outputting the metadata to the ingress packet forwarding engine using local switching.

1514. The method of claim 98, comprising:

selecting, by a scheduler implemented in circuitry, the output port from a plurality of output ports at the egress packet forwarding engine, wherein the information is generated to specify that the network packet is to be enqueued at the output queue based on the selection of the output port by the scheduler; and

determining, by the scheduler, the first scheduling event and the second scheduling event to regulate a speed at which data is exchanged.

~~16. —The method of claim 9,~~

~~wherein enqueueing the network packet in the virtual output queue comprises enqueueing the network packet in a first portion of a combined buffer for the ingress packet forwarding engine and the egress packet forwarding engine that is assigned to the virtual output queue;~~

~~wherein dequeuing the network packet from the virtual output queue comprises dequeuing the network packet from the first portion of the combined buffer;~~

~~wherein enqueueing the network packet to the output queue comprises enqueueing the network packet in a second portion of the combined buffer assigned to the output queue; and~~

~~wherein dequeuing the network packet from the output queue comprises dequeuing the network packet from the second portion of the combined buffer.~~

1715. An apparatus for switching network traffic, the apparatus comprising:
a plurality of interface cards;
an ingress packet forwarding engine implemented in circuitry and configured to:
determine, in response to receiving a network packet with the plurality of
interface cards, an egress packet forwarding engine for outputting the network packet;
and
enqueue the network packet in a virtual output queue for output to the egress
packet forwarding engine, wherein, to enqueue the network packet in the virtual output
queue, the ingress packet forwarding engine is configured to enqueue the network packet
in a first portion of a combined buffer assigned to the virtual output queue;
the egress packet forwarding engine implemented in processing circuitry and configured
to, in response to a first scheduling event, output, to the ingress packet forwarding engine,
information indicating the network packet in the virtual output queue and that the network packet
is to be enqueued at an output queue for an output port of the egress packet forwarding engine;
wherein the ingress packet forwarding engine is further configured to, in response to
receiving the information:
dequeue the network packet from the virtual output queue, wherein, to dequeue
the network packet from the virtual output queue, the ingress packet forwarding engine is
configured to dequeue the network packet from the first portion of the combined buffer;
and
enqueue the network packet to the output queue, wherein, to enqueue the network
packet the network packet to the output queue, the ingress packet forwarding engine is
configured to enqueue the network packet in a second portion of the combined buffer
assigned to the output queue; and
wherein the egress packet forwarding engine is further configured to, in response to a
second scheduling event that is after the first scheduling event:
dequeue the network packet from the output queue, wherein, to dequeue the network
packet from the output queue, the egress packet forwarding engine is configured to dequeue the
network packet from the second portion of the combined buffer; and
output, with the plurality of interface cards, the network packet at the output port.

~~18~~16. The apparatus of claim ~~17~~15, wherein, to output the information, the egress packet forwarding engine is configured to output, to the ingress packet forwarding engine, the network packet with a header comprising the information.

~~19~~17. The apparatus of claim ~~17~~15, wherein, to output the network packet with the header, the egress packet forwarding engine is configured to output the network packet with the header from a first port of the egress packet forwarding engine to a second port of the ingress packet forwarding engine.

~~20~~18. The apparatus of claim ~~15~~15, wherein, to output the information, the egress packet forwarding engine is configured to output metadata comprising the information to the ingress packet forwarding engine and refrain from outputting the network packet to the ingress packet forwarding engine.