

Tofino Packet Generator

Interface Introduction

Tofino Packet Generator (PktGen)

- Generates packets at up to 100 Gb/s
 - Configured from the control-plane
 - Packets delivered to ingress of data-plane
 - Sends an arbitrary number of bytes provided by user
 - Prependded with a PktGen header
 - 8 possible PktGen apps
 - Headers for C API available on GitHub
 - <https://github.com/barefootnetworks/Open-Tofino/>
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Packet Generator Interface

- Control Plane

- Enable PktGen
- Write data to the buffer
- Configure the App
- Enable the App

- Data Plane

- Parse the PktGen header
 - Forward packet
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Control Plane: Preparing the data

- Enable packet generation globally

`p4_pd_pktgen_enable()`

- Write data to the buffer
 - 16 KB buffer shared by all PktGen applications
 - Each app will have a configured buffer offset and length

`p4_pd_pktgen_write_pkt_buffer()`

Control-Plane: PktGen Trigger Types

- Four types of triggers
 - One-time timer - Sends a number of batches each with a configured number of packets
 - Maximum of 2^{32} packets
 - Periodic timer - Sends a packet at a configured interval until stopped
 - Port down - Triggered when a port goes down
 - Packet recirculation - Triggered when a recirculated packet matches a pattern
 - Configuration varies depending on trigger type
 - Only One-time and Periodic are discussed here
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Control-Plane: PktGen Application Configuration

- Create an configuration instance

```
struct p4_pd_pktgen_app_cfg
```

- For all trigger types the following parameters should be set
 - `trigger_type` - The type of trigger to use
 - `source_port` - The device port that the packets will appear to come from
 - `pkt_buffer_offset` - Offset in the PktGen buffer for packet data
 - `length` - the number of bytes to use from the PktGen buffer



Control-Plane: PktGen Application Configuration

- With the One-time trigger type the following parameter should be set
 - `timer_nanosec` - Inter packet gap in nanoseconds
- With the Periodic trigger type the following parameters should be set
 - `batch_count` - the number of batch to send
 - `packets_per_batch` - the number of packets per batch
 - `ibg` - Inter batch gap in nanoseconds
 - `ipg` - Inter packet gap in nanoseconds
- Apply the configuration to the application

```
p4_pd_pktgen_cfg_app()
```

Data-Plane: PktGen Header

- The PktGen header is prepended to the packet after other metadata headers

```
header pktgen_timer_header_t {
    @padding bit<3> _pad1;
    bit<2> pipe_id;           // Pipe id
    bit<3> app_id;           // Application id
    @padding bit<8> _pad2;

    bit<16> batch_id;        // Start at 0 and increment to a
                            // programmed number

    bit<16> packet_id;       // Start at 0 and increment to a
                            // programmed number
}
```


Data-Plane: Header Parsing

- The source port can be used to identify generated packets

```
transition select(ig_intr_md.ingress_port) {  
    68      : parse_pktgen;  
    default: parse_ethernet;  
}
```

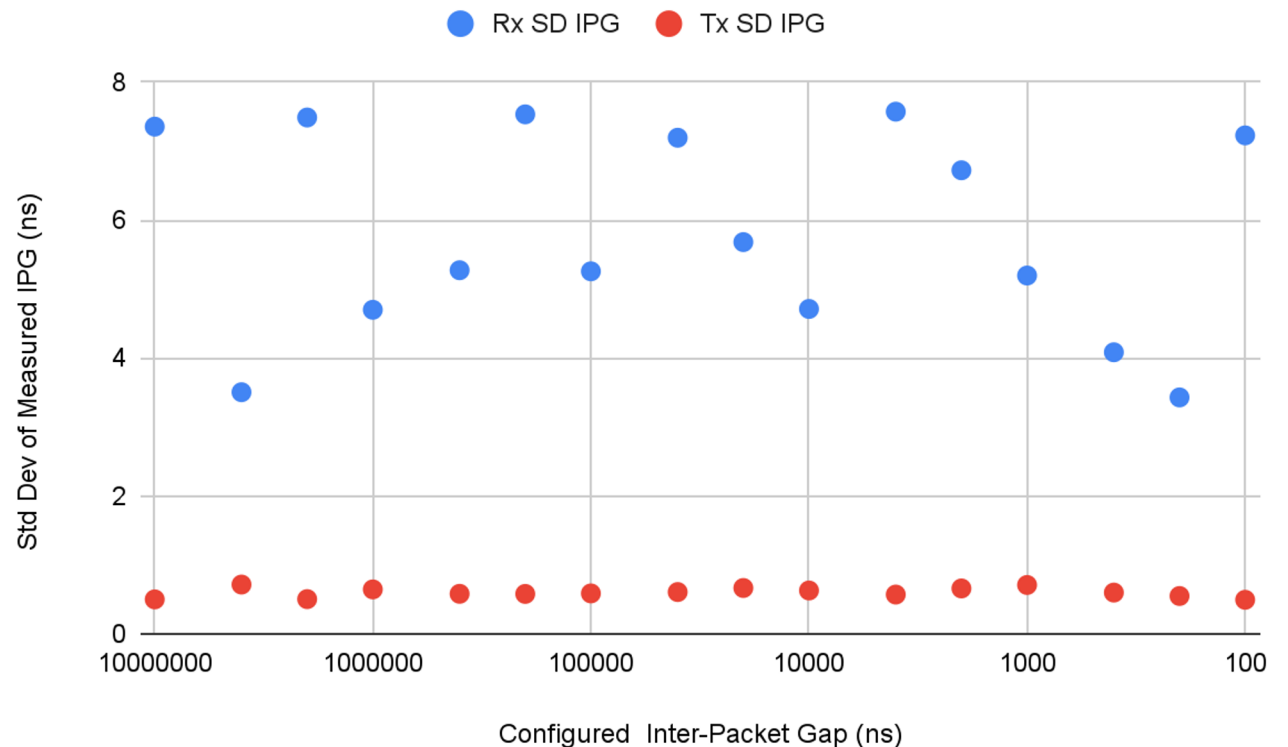
- The PktGen header should then be parsed or skipped

```
state parse_pktgen {  
    pkt.extract(md.pktgen);  
    transition parse_ethernet;  
}
```

- The packet can then be forwarded as desired
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Performance: Inter Packet Gap Standard Deviation

- IPG measured at source switch and receiving NIC
- StdDev independent of configured IPG
- StdDev always less than 1 and 8 at Tx and Rx respectively



Performance: Inter Packet Gap at Source

- Measured minimum IPG always greater than or equal to configured IPG
- Measured maximum IPG always 4 ns or less above configured IPG

Configured IPG	Tx Min IPG	Tx Mean IPG	Tx Max IPG
1000000	1000000	1000002.00	1000003
400000	400000	400001.50	400004
200000	200001	200001.62	200003
100000	100000	100001.69	100003
40000	40000	40001.62	40003
20000	20000	20001.64	20003
10000	10000	10001.64	10003
4000	4000	4001.64	4004
2000	2000	2001.64	2003
1000	1000	1001.64	1003
400	400	401.64	404
200	200	201.64	203
100	100	101.64	103

References

- https://github.com/barefootnetworks/Open-Tofino/blob/master/include/tofino/pdfixed/pd_common.h
 - https://github.com/barefootnetworks/Open-Tofino/blob/master/include/tofino/pdfixed/pd_conn_mgr.h
 - https://github.com/barefootnetworks/Open-Tofino/blob/master/share/p4c/p4include/tofino1_base.p4
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