MoonGen

A Scriptable High-Speed Packet Generator
Design and Implementation

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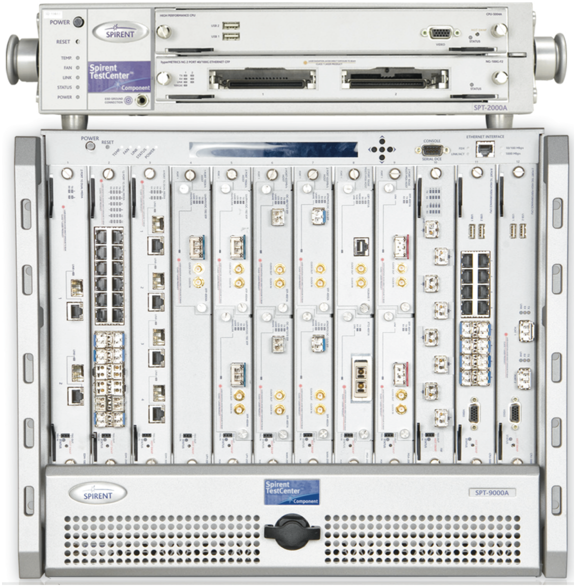
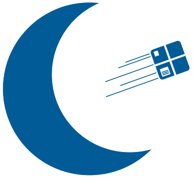


Source: www.spirent.com

MoonGen



- MoonGen is a software packet generator
- Cheaper than hardware boxes
- More flexible
- Key features
  - Fast: LuaJIT, DPDK[1], explicit multi-core support
  - Flexible: Craft packets in real-time in user-defined Lua scripts
  - Timestamping: Utilize hardware features found on modern commodity NICs

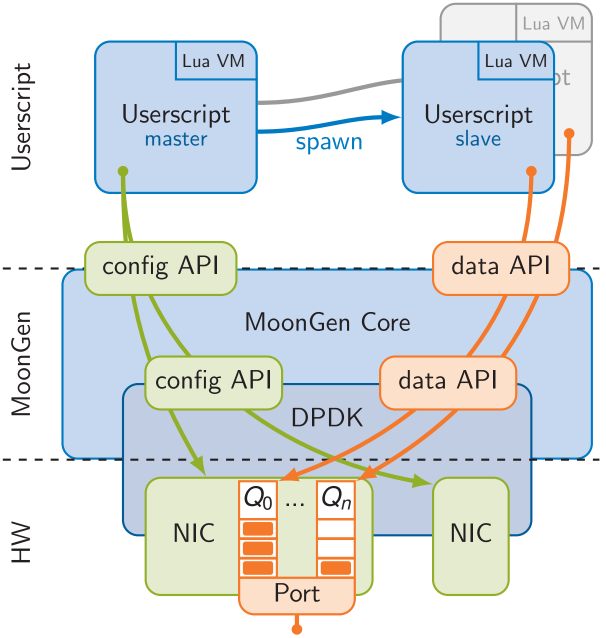
[1] Intel Dataplane Development Kit, `http://www.dpdk.org`

Multi-threading in Lua

- No native support, some libraries exist
- Our solution: multiple independent LuaJIT VMs
- Maps to our problem domain
  - Generate different traffic flows in different threads
  - Inter-thread communication rarely needed
  - Modern NICs support multiple independent queues natively
  - Serialization (via Serpent[2]) and C functions for (slow) inter-VM communication

[2] `https://github.com/pkulchenko/serpent`

Architecture



Example: Generating Load

```lua
function loadSlave(queue)
  local mempool = memory.createMemPool(function(buf)
    buf:getUdpPacket():fill()
  end)
  local bufs = mempool:bufArray()
  while mg.running() do
    bufs:alloc(60)
    for i, buf in ipairs(bufs) do
      local pkt = buf:getUdpPacket()
      pkt.ip4.src:set(math.random(0, 2^32 - 1))
      pkt.udp.src:set(math.random(0, 2^16 - 1))
  end
  bufs:offloadUdpChecksums()
  queue:send(bufs)
end
```

Packet data in Lua

- Different protocols are combined to build protocol stacks
- Endless combinations (e.g., tunnels in tunnels...)
- Efficient access to all protocol header fields required

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- Dynamically build LuaJIT FFI cdata structs

```lua
vxlanPkt = createPacket("eth", "ip4", "udp",
   "vxlan", {"eth", "innerEth"}, {"ip4", "innerIp4"})
local pkt = vxlanPkt(buf)
pkt.innerIp4:setSrc("10.0.0.1")
```

- Dynamically create “class” for the whole protocol stack
- Extremely fast modification operations
- Memory layout defined by cdata struct (can be sent out directly)

Summary

- User-defined Lua scripts instead of configuration or DSLs
- LuaJIT is really really fast
- LuaJIT FFI cdata for packet structs
- ≥ 10 Gbit/s per CPU core (≥ 15 million packets per second)
- Execute user-defined script code for each packet
- LuaJIT FFI and C libraries for low-level stuff (drivers)

Q & A

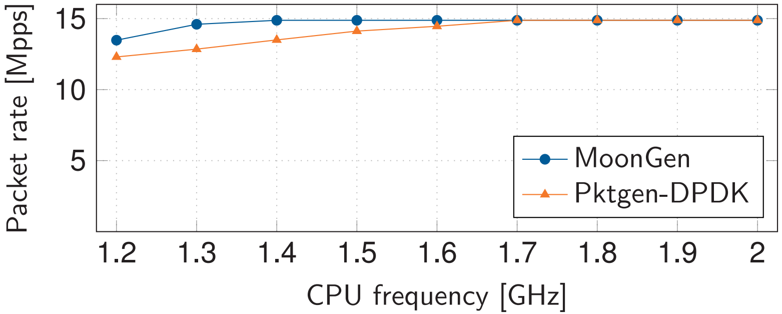
Try MoonGen yourself!

https://github.com/emmericp/MoonGen

Questions?

[Backup slide] Performance I: Lua can be faster than C

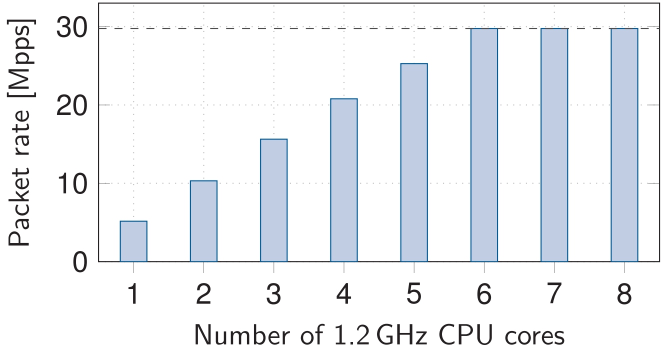
- UDP packets from varying source IP addresses



- Pktgen-DPDK needs a complicated main loop that covers all possibilites
- MoonGen can use a tight inner loop

[Backup slide] Performance II: heavy workload and multi-core scaling

- Generate random UDP packets on 2 10 Gbit NICs
- 8 calls to Lua's standard `math.random` per packet
- CPUs artificially clocked down to 1.2 GHz



[Backup slide] Performance III: 40 GbE

- Generate random UDP packets on 2 10 Gbit NICs
- 8 calls to Lua's standard `math.random` per packet
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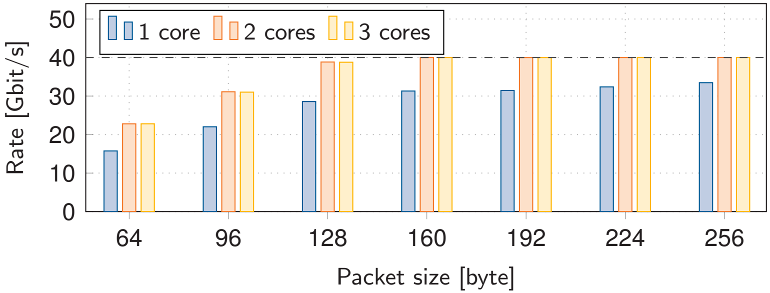
1 core
2 cores
3 cores
Rate [Gbit/s]
Packet size [byte]