DPDK

DATA PLANE DEVELOPMENT KIT

Make DPDK's software traffic manager a deployable solution for vBNG

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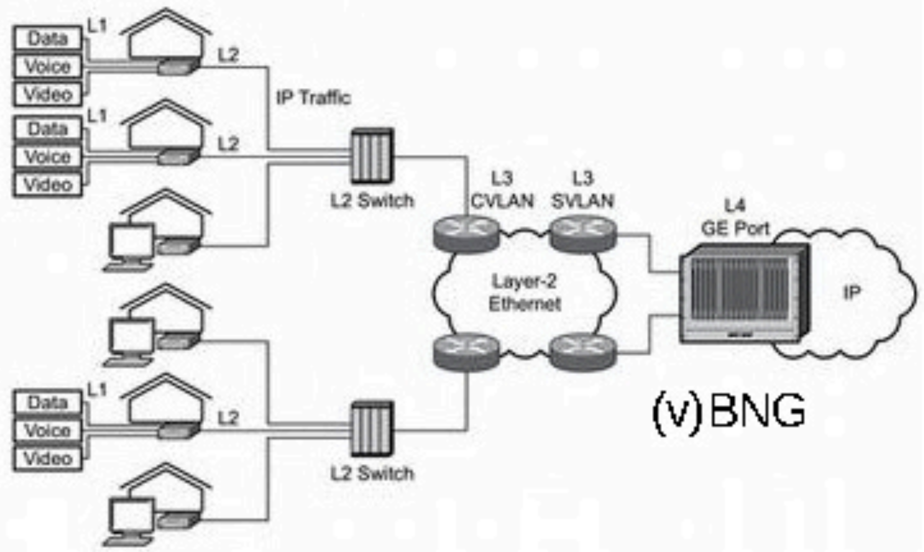
Agenda

- The TM problem in access and aggregation networks
- Limitations of DPDK software TM in the light of real deployments
- Other performance and usability tunings

Why do we need Traffic Management?

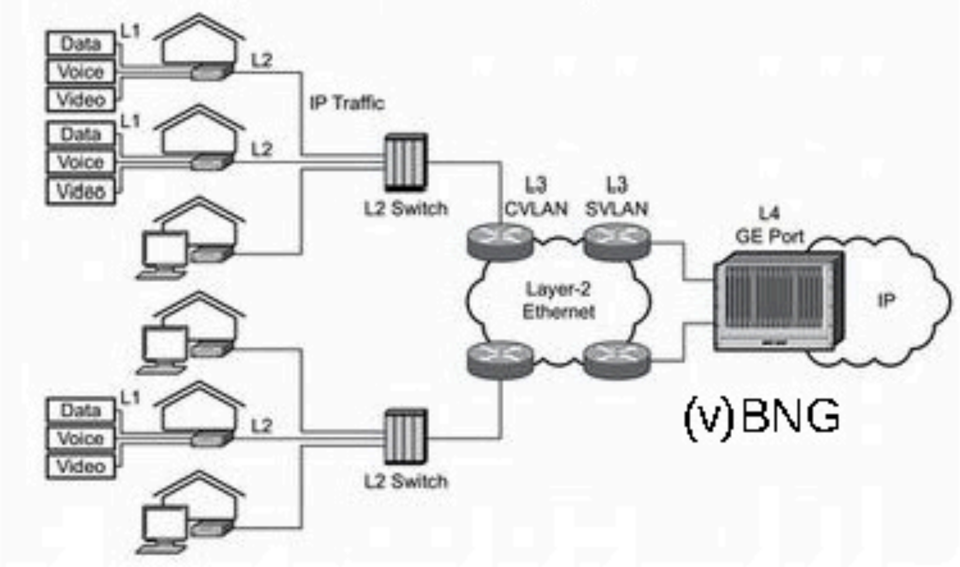
- Physical access network topology might be radically different
- Intermediate nodes typically lack per subscriber information
- Shape traffic in (v)BNG not to cause any congestion in the access network

Layer 2 connectivity model

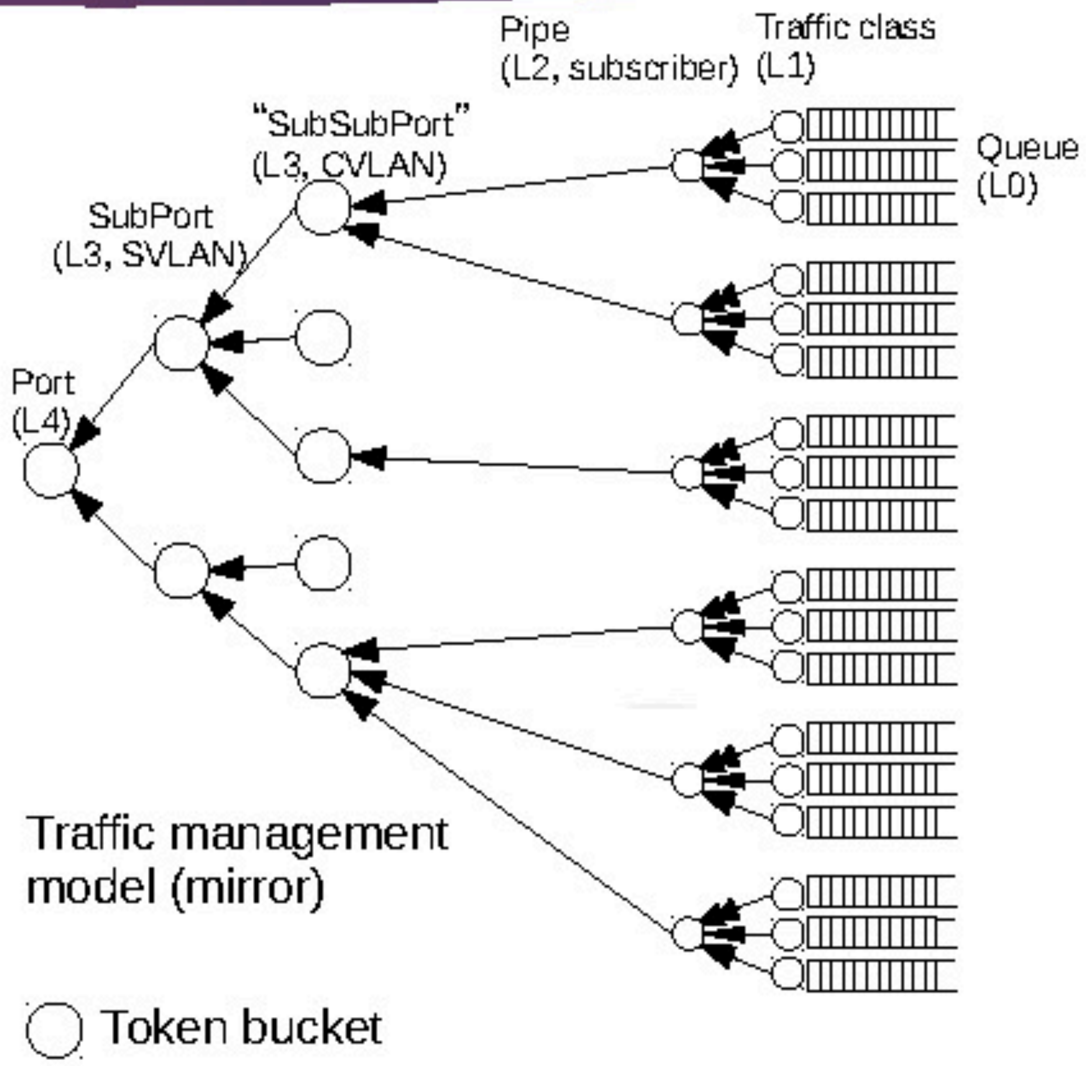


Model Access Network transport capabilities in TM tree

Layer 2 connectivity model

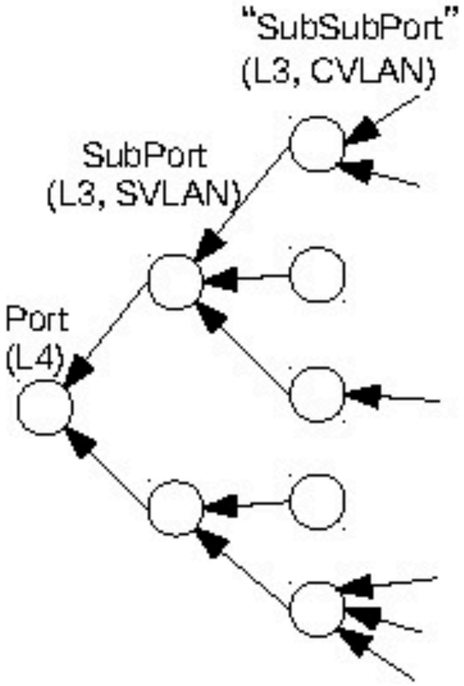


Shape traffic in (v)BNG not to cause any congestion in the access network.



Port – Subport … - Pipe topology requirements

- Number of children should be dynamic
  - Topology change without traffic disturbance on the rest of the tree is a requirement
- Number of levels should also be dynamic
  - SVLAN+CVLAN is not supported by DPDK at the moment
  - Tunneling cases (like L2TP) could require more levels

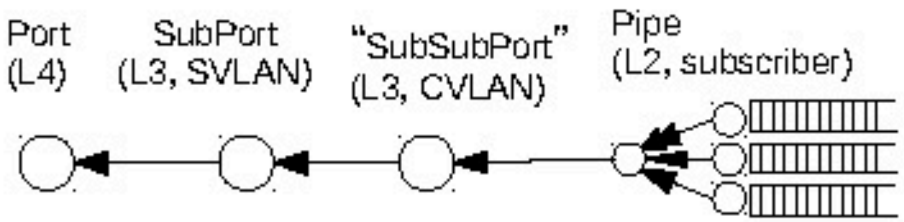


Store/traverse subport hierarchy as a linked list

```
struct rte_sched_pipe {
[…]
      uint16_t pipe_subport_id;
}
```

```
struct rte_sched_subport {
[…]
      uint16_t subport_parent;
}
```

- Refill subport credits in connection with pipe credit update
- Deduct/verify chain of subport credits upon pipe dequeue
- Fits into our processing budget in case of
  - ‘moderate’ number of subports
  - 3 levels
- No contradictions with new rte_tm_node_add() API



On-demand queue allocations

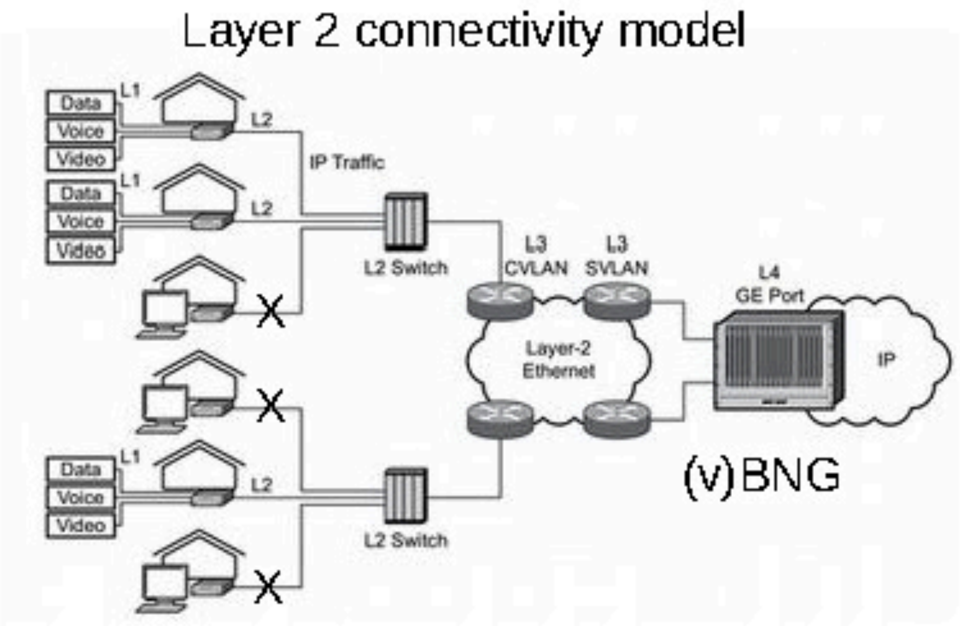
- Static allocation of queues wastes memory
  - 16*8*256 = 32K/Pipe for 256 long queues
  - 2GB for 64K subscriber slots
- Real topology is more diverse and dynamic, preallocating worst case is not feasible
- Low hanging fruit: allocate queues dynamically
  - Fits into prefetch pipeline
  - Allows for per pipe queue sizes

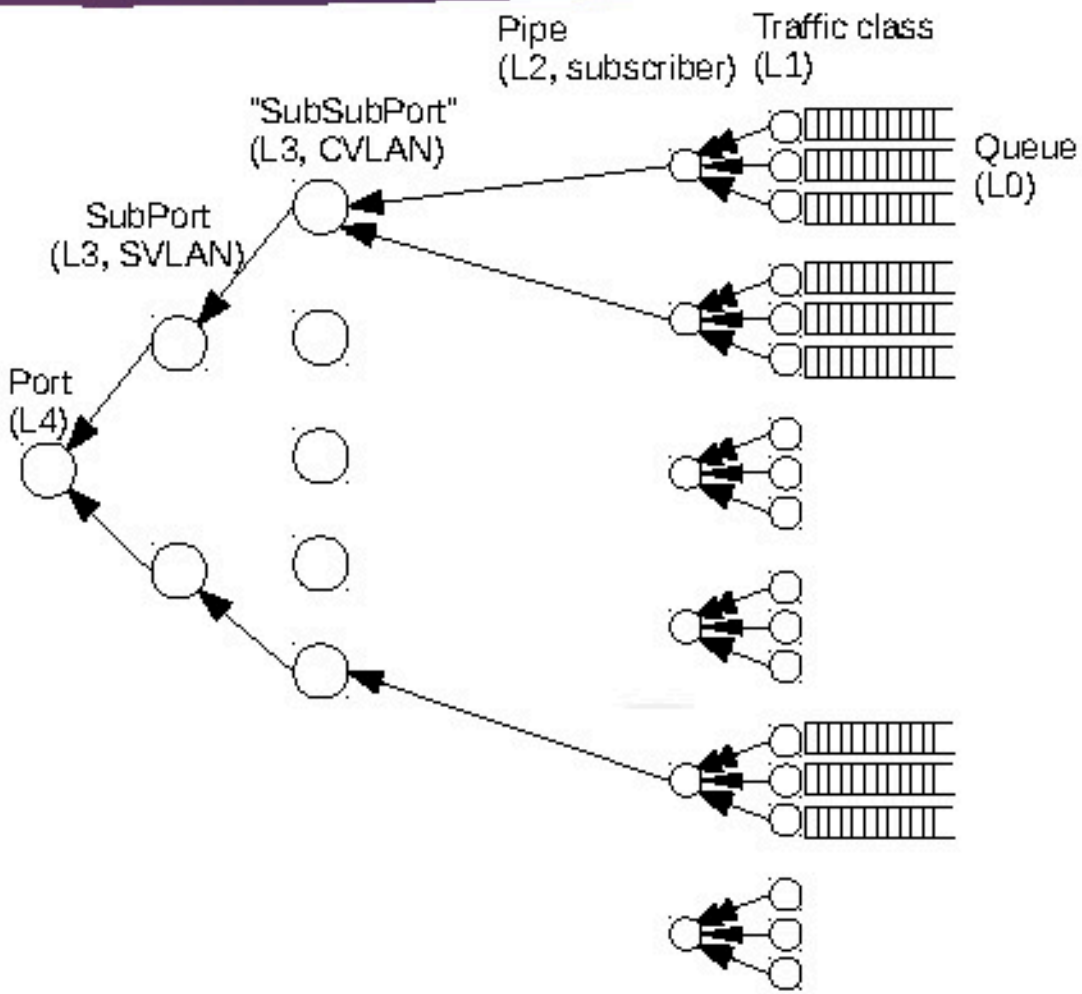
```
struct rte_sched_pipe {
[...]
	struct rte_mbuf **qbase;
}
```

Configuration example:

```
port ethernet 1/1
 no shutdown
 encapsulation dot1q
 dot1q pvc 3026 encapsulation 1qtunnel
 dot1q pvc on-demand 3026:1 through 4000
  qos rate max 100000
  idle-down 60
  startup-timer 600
  service clips dual-stack source-mac
  service clips dhcp max 100 context CLIPS_12
  service clips dhcpv6 max 100 context CLIPS_12
```

On-demand queue allocations

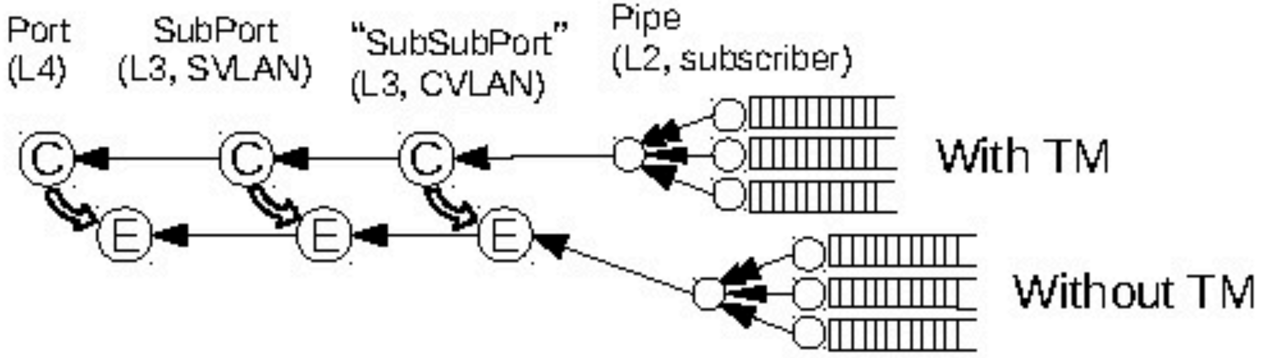




Remaining bandwidth

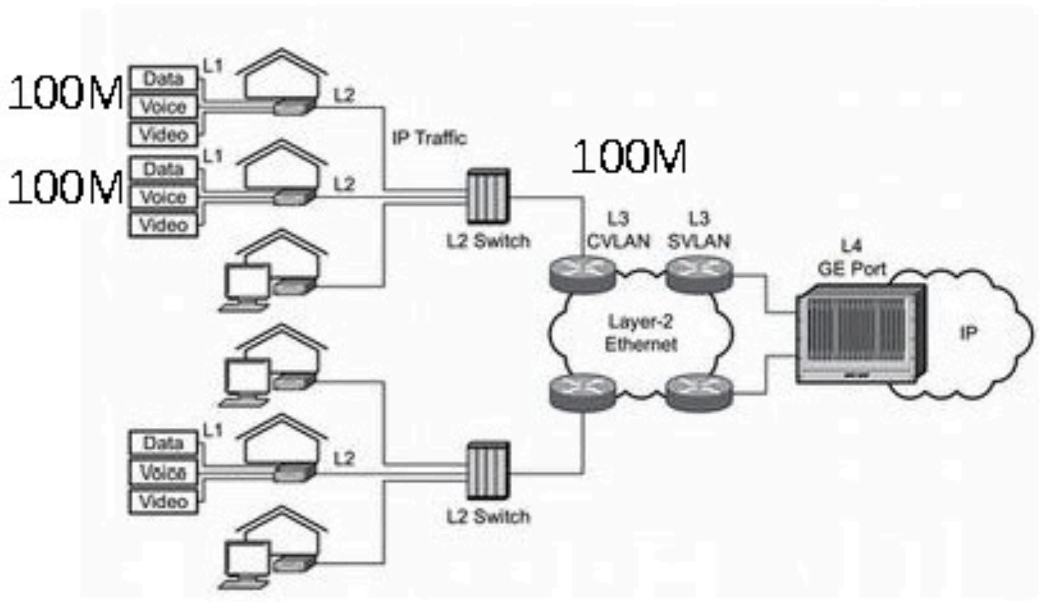
- Use case: re-distribute remaining bandwidth in a subtree to users without configured TM
  - Not feasible with static configuration
  - Algorithmic change is needed at (sub)port level
- Use RFC2697 color-aware srTCM
  - TM enabled use conform (green) bucket
  - Rest use excess (yellow) bucket
  - Red means skip to next pipe

```
struct rte_sched_subport {
[...]
      uint32_t tb_credits[2];
}
// We do not use subport level TCs
```



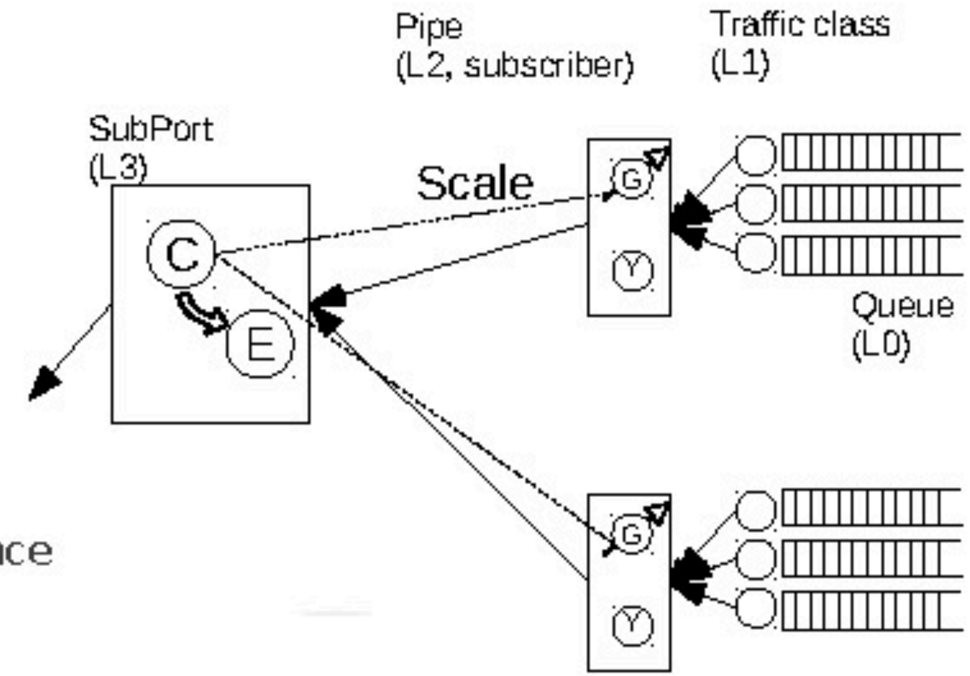
Over-subscription

- Fixed pipe traversal order
- First-come first served on subport level
- Nothing guarantees
  - Fairness
  - Configurable resource share



Over-subscription

- Idea: dynamically mark green the fair share
  - Inspired by 'TC3 over-subscription' but more generic
  - Use RFC2698 trTCM on pipe level (PIR = tb_rate)
  - Scale all CIRs in the subtree to match configured subport rate
  - Configured CIRs become weights
  - Users without configured TM get PIR = port_rate, CIR = 0



- Control loop
  - Pipes visited in a fixed order, to make it fair, make changes once per full round
  - Bottleneck: subport where we are out of conform credits
    - Theoretically one per path
  - Adjust subport associated scale
    - Overshoot is the bigger problem
    - Unused bandwidth is re-distributed in an unfair way

Speed up credit updates

- *idiv* instruction is also expensive
  - FPU operation is removed via commit:
    - 'sched: eliminate floating point in calculating byte clock'
  - Few integer divisions are still visible hot-spots
- After simplifications: shift + multiply
  - Granularity is impacted
  - Actual *rate* is the fraction of port rate

```
grinder_credits_update()
{
[...]
        uint64_t n_periods;
        /* Subport TB */
        n_periods =
                (port->time - subport->tb_time) /
                subport → tb_period;
[...]
        /* Pipe TB */
        n_periods =
        (port->time - pipe->tb_time) /
        params → tb_period;
```

```
uint64_t period = (time - tb_time) >>
        tb_period_bits;
tb_time += period << tb_period_bits;
tokens = tb_credits_per_period * period;
```

```
tb_period_bits = log2(512.0 / rate);
tb_credits_per_period = rate *
        (1 << tb_period_bits);
```

Effective storage of hierarchy of rates

- *tc_period* is not intuitive
  - Example for 40ms:
    - Minimal rate is 300kbps to pass a 1500 bytes packet
    - At least 5M buffer per queue (78125 64 bytes packets) is needed to avoid buffer under-run for 1G rate, unrealistic
  - No intuitive burst size
- Store TC rates, CIR as a fraction of TB rate
  - Cost is granularity, simplifications possible by handling CIR as % of TB rate
  - Fits into the processing chain of division-less credit updates
  - Opens the possibility of real TC level burst size (+CBS)
- Saves few bytes in the structures
  - Especially when profiles need to be embedded

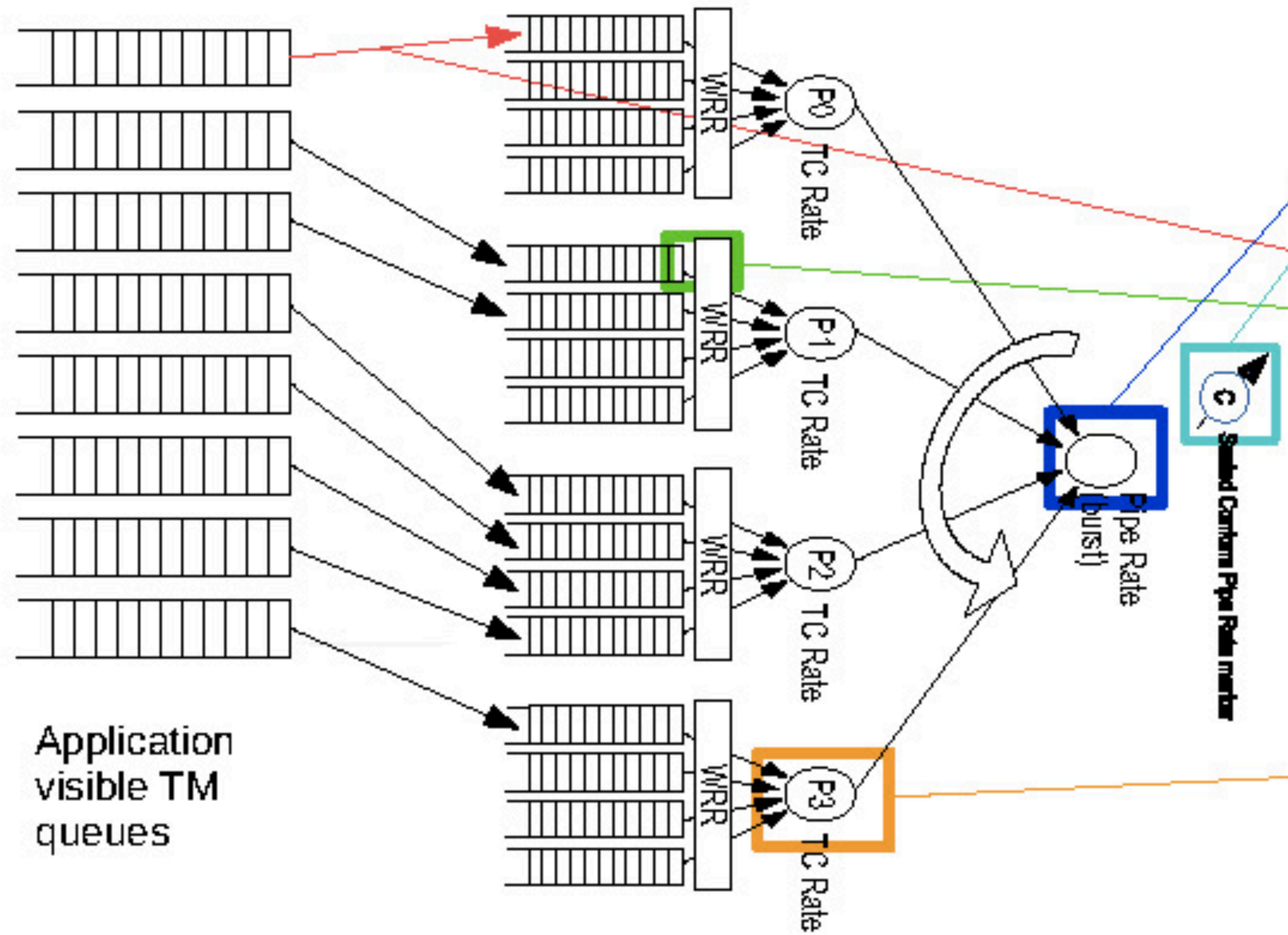
```
/* Pipe traffic classes */
uint32_t tc_period;
uint32_t tc_credits_per_period[4];
```

```
/* Traffic classes (TCs) */
uint64_t tc_time; /* time of next update */
uint32_t tc_credits[4];
```

```
/* Pipe traffic class shares from root rate (1/128) */
uint8_t tc_ratio[4];
```

```
uint32_t tc_credits[4];
/* keep track of lost credits on TC/CIR level */
uint8_t tc_remainder;
```

Complete picture via Ericsson vBNG CLI




```
qos policy pwfq2 pwfq card-family 3
 rate maximum 100000
 rate minimum 5000
 queue-map qmap1
 queue 0 priority 0 weight 100
 queue 1 priority 1 weight 50
 queue 2 priority 1 weight 50
 queue 3 priority 2 weight 25
 queue 4 priority 2 weight 25
 queue 5 priority 2 weight 25
 queue 6 priority 2 weight 25
 queue 7 priority 3 weight 100
 queue priority-group 0 rate percentage 1
 queue priority-group 1 rate percentage 5
 queue priority-group 2 rate percentage 100
 queue priority-group 3 rate percentage 100
```