Click

- [http://pdos.lcs.mit.edu/click](http://pdos.lcs.mit.edu/click)
- Computational problem that Click targets
- Model of computation
- Library of elements
- Target architecture
- Pattern of implementation
- Example application
Computation Problem

- Network packet processing
- Data is streams of packets
  - Manipulating bits in packets
  - Buffering packets
  - Manipulating packet flow
    - Space: path of packet flow
    - Time: rate of packet flow
    - Ordering of packet flow
Model of Computation

• Divide the problem into two parts
  • What we want to specify explicitly (actors)
  • What we want to be implicit in the model of computation (communication and control)

• Actors
  • Manipulating bits in packets
  • Buffering packets
  • Manipulating packet flow
    • Space: path of packet flow
    • Time: rate of packet flow

• Model of computation
  • How packets are passed between actors
  • How actors perform computation in parallel
Model of Computation

- Control starts at packet sources
- Control follows packets from port to port
- Multiple threads of control can run simultaneously

Two threads can execute here in parallel
Library of Elements

- Manipulating bits in packets
- Buffering packets
- Manipulating packet flow
  - Space: path of packet flow
  - Time: rate of packet flow
Target Architecture

- Linux box with Ethernet cards
Pattern of Implementation

• Match communication and control semantics required by model of computation with those implemented by target architecture

<table>
<thead>
<tr>
<th>Application</th>
<th>Architecture</th>
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<tbody>
<tr>
<td>• Control starts at packet sources</td>
<td>• Control starts with interrupts:</td>
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<tr>
<td>• Control follows packets from actor to actor</td>
<td>• When source has packet</td>
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<tr>
<td>• Multiple threads of control in parallel</td>
<td>• When sink has space</td>
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<td></td>
<td>• Pass skb’s with function calls</td>
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<td>• Multithreading</td>
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Matching Control

• Tighten MoC’s definition of control to match architecture
  • Architecture starts threads of control at packet sources and packet sinks
  • Threads of control stop at buffers

• This type of control is not a fundamental characteristic of network packet processing
**Push and Pull Threads of Control**

- Packet headers and control is transferred with push and pull function calls
- Ports are of type push or pull
- Agnostic ports can be used in either a push or pull context
Click is…

- Model of computation
- Library of elements
- Target architecture
- Pattern of implementation

- These characteristics are interrelated
Click Traffic Shaper

Based on IP header's Differentiated Services Code Point field (DSCP)

Stream is dropped when more than 7,500 packets per second are received on average

Reclassifies as best-effort delivery and sent to lower priority queue when stream is more than 12,500 packets per second

Leaves queued any stream that is more than 10,000 packets per second
Different Concerns

- Application modeling – ease of capturing behavior (conciseness)
- Pattern of Implementation – ease of understanding (more deterministic)
- Architecture Development – silicon concerns
Patterns of Implementation

• Definition: for a given MoC it encapsulates that there is a predictable architecture which preserves the behavior of the MoC
• Constraint (performance) spans from application to architecture
• Directness of support for key application primitives