Click Modular Router

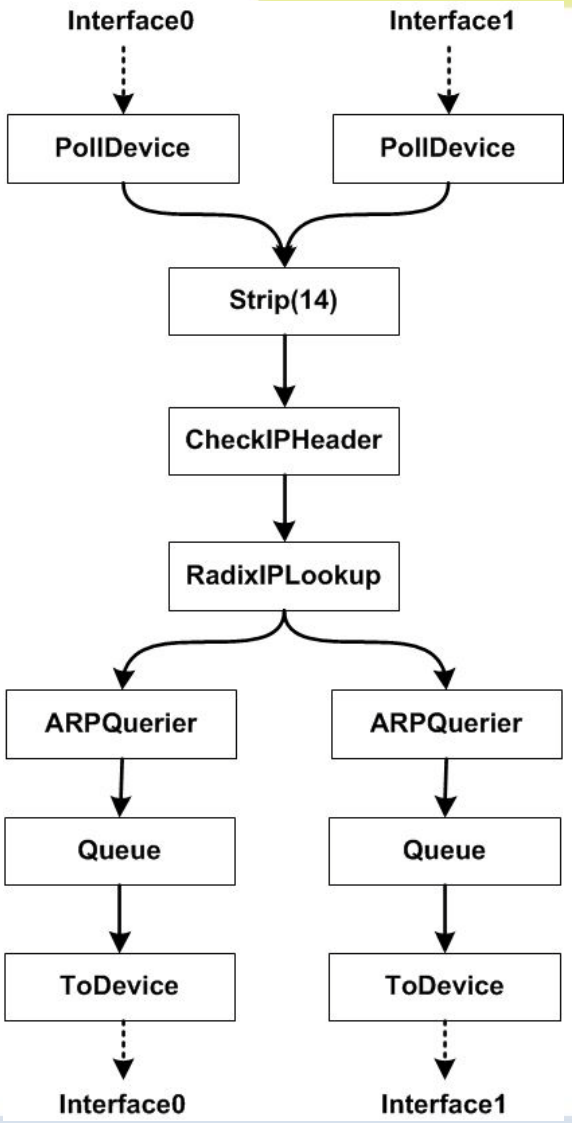
Future Internet Communications Technologies

Prof. Dr. Panagiotis Papadimitriou

Click Overview

Click Modular Router

- Click Modular Router
  - Running in the kernel
  - Plenty of available elements
  - Easy implementation of new elements
  - High performance
- Click Task Scheduling
  - Click assigns tasks to threads (using Stride scheduler)
  - Linux schedules threads



Essential Click Elements

- `PollDevice/FromDevice`:
  - Polls / reads packets from a network device
- `ToDevice`:
  - Sends packets to a network device
- `FastUDPSource`:
  - Generates UDP traffic at constant rate
- `Queue`:
  - Stores packets in a FIFO queue
- `Discard`:
  - Drops packets

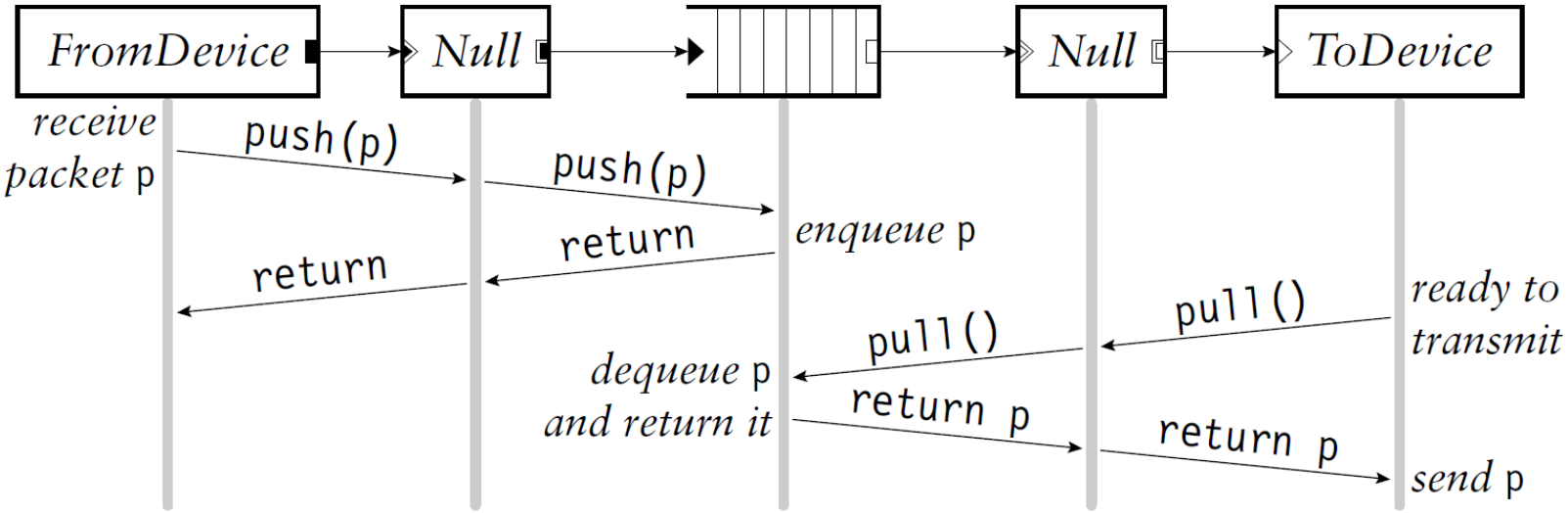
Basic Elements for Packet Management

- `Strip`:
  - Removes bytes from front of packets
- `EtherEncap`:
  - Encapsulates packets in Ethernet header
- `IPEncap`:
  - Encapsulates IP packets in IP header
- `StripIPHeader`:
  - Removes IP header

Basic Elements for Routing

- `RadixIPLookup`:
  - IP lookup using a radix trie
- `DirectIPLookup`:
  - IP lookup using direct-indexed tables
- `RangeIPLookup`:
  - IP lookup using binary search
- `DecIPTTL`:
  - Decrements IP TTL and drops expired packets

Click Control Flow



- Only `FromDevice` and `ToDevice` are schedulable
  - `FromDevice` invokes a *push* control flow
  - `ToDevice` invokes a *pull* control flow

Using Click in the Linux Kernel

- `/CLICKPATH/sbin/click-install [–t=threads] file`
  - Installs a Click configuration into the Linux kernel
    - threads: number of supported threads
    - file: Click configuration file

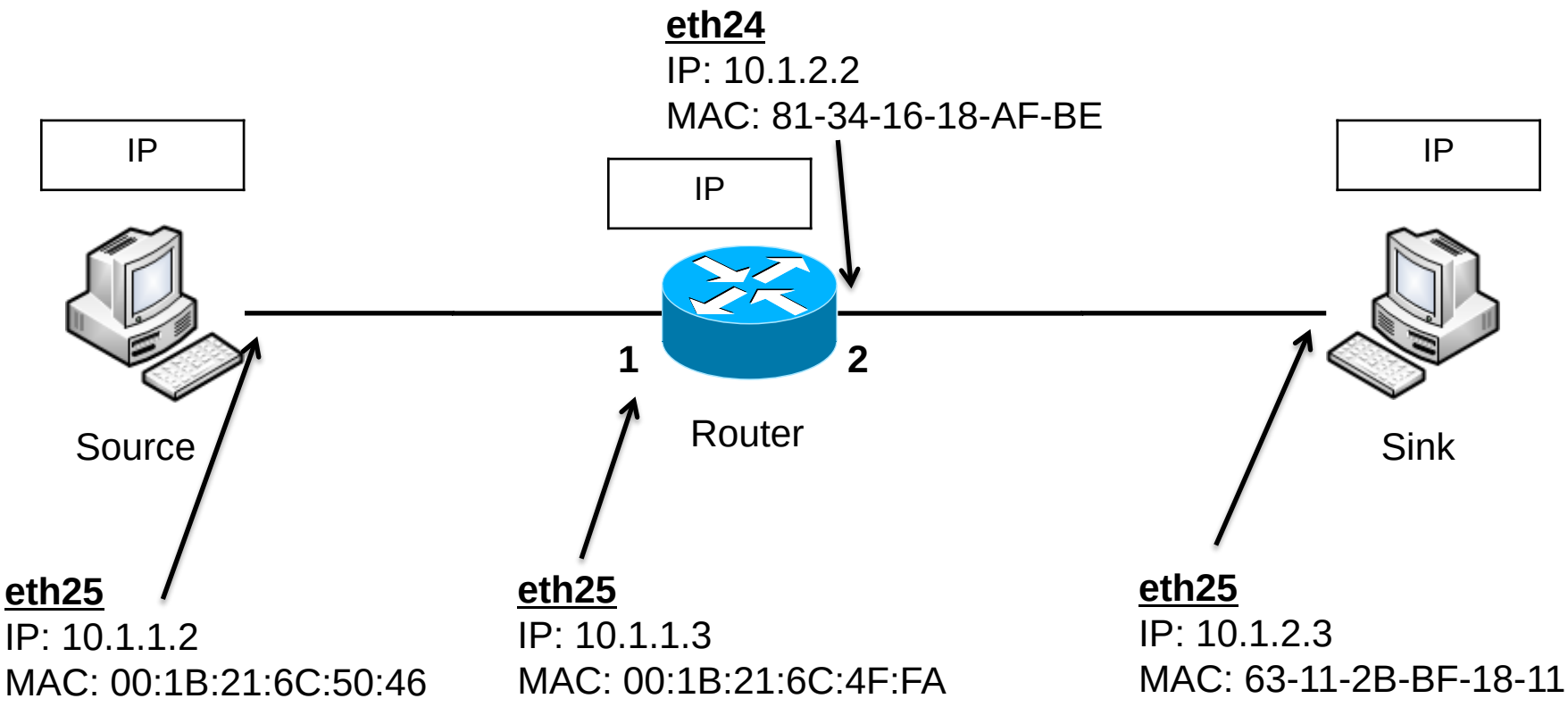
- `/CLICKPATH/sbin/click-uninstall`
  - Removes the current Click configuration from the Linux kernel

Click Statistics

- Statistics of Click elements can be accessed at `/proc/click` (which is automatically linked to `/click`)
  - `Rate`:
    - Rate in packets / sec
  - `Byte_rate`:
    - Rate in bytes / sec
  - `Bit_rate`:
    - Rate in bits / sec
  - `Drops`:
    - Number of packets dropped

Packet Forwarding Example

Packet Forwarding with Click



Click Configuration for Traffic Generation


```
Source::FastUDPSource(2000000, 900000000, 64,
        00:1B:21:6C:50:46, 10.1.2.2, 1234,
        00:1B:21:6C:4F:FA, 10.1.2.3, 1234)

td::ToDevice(eth25);

Source->td;

StaticThreadSched(td 0);
```

Click Configuration for Packet Forwarding


```
fd::FromDevice(eth25);
td::ToDevice(eth24);
ip::CheckIPHeader();
rt::RadixIPLookup(10.1.2.0/24 0);

fd->Strip(14)->ip->rt;
rt[0]->DecIPTTL->EtherEncap(0x0800,
00:1B:21:6C:4F:F9, 00:1B:21:6B:CB:DA)->
Queue->td;

StaticThreadSched(fd 0);
StaticThreadSched(td 0);
CpuPin(0 0); // CpuPin(Thread_ID Core_ID, …)
```

Click Configuration for Packet Capture


```
FromDevice(eth25)->Counter->Discard;
```

References

- Click Modular Router, http://read.cs.ucla.edu/click/
- E. Kohler, **The Click Modular Router**, Ph.D. Thesis, MIT, USA, 2001
- B. Chen and R. Morris, **Flexible Control of Parallelism in a Multiprocessor PC Router**, USENIX Annual Technical Conference 2001