Complexity Oblivious Network Management (CONMan)

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INM'06

Network Management is a Mess

- Ad-Hoc
- Complex
- Error-Prone
- Expensive

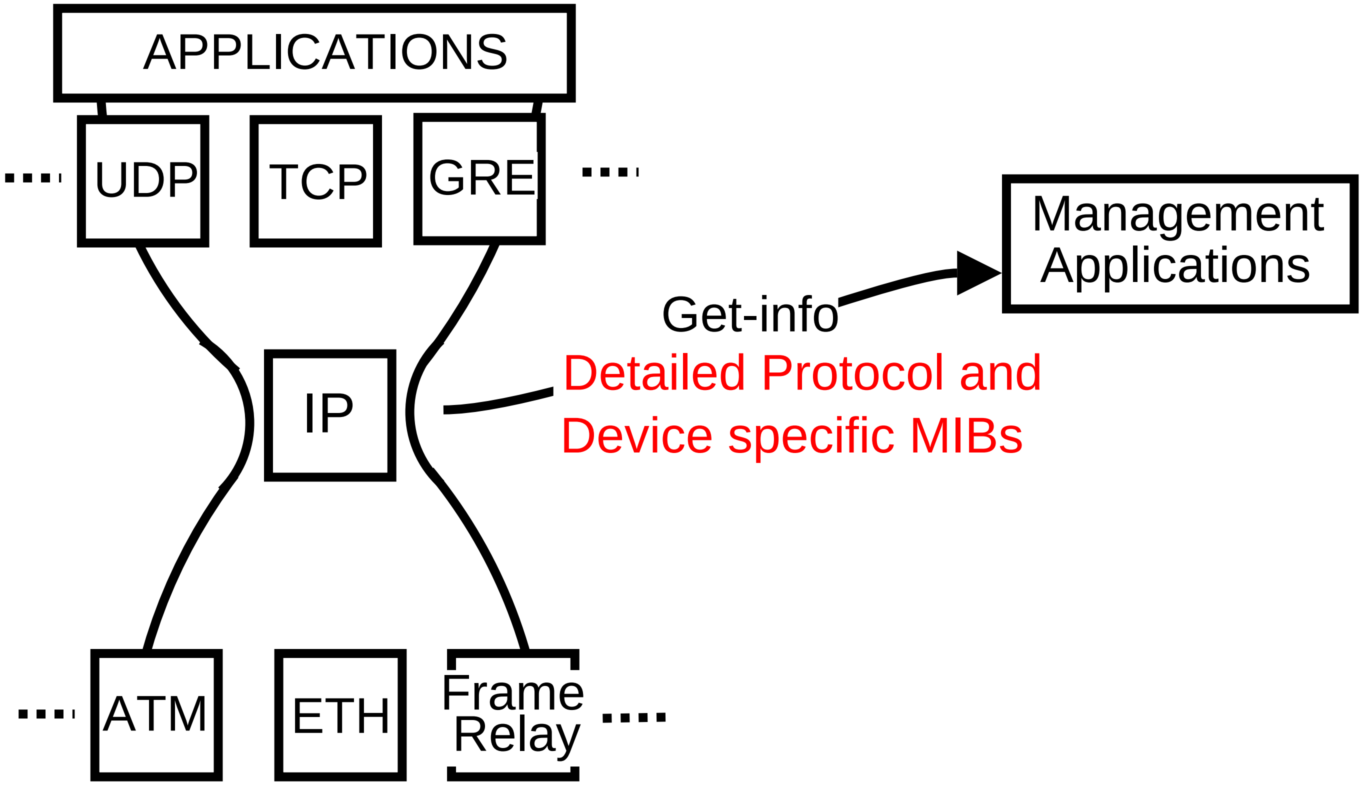
Worsening situation as network complexity increases

- 80% of IT budget in enterprises used to maintain status quo [Kerravala'04]
- Configuration errors account for 62% of network downtime [Kerravala'04]

Shortcomings of the existing architecture

- Dependency of the Management Plane on the Data Plane [4D, Greenberg et. al.'05]
- Control Plane Complexity [4D, Greeenberg et. al.'05] [RCP, Caesar et. al.'05]
- ...

Protocols expose their gory details



Hundreds of MIBs and Thousands of MIB objects

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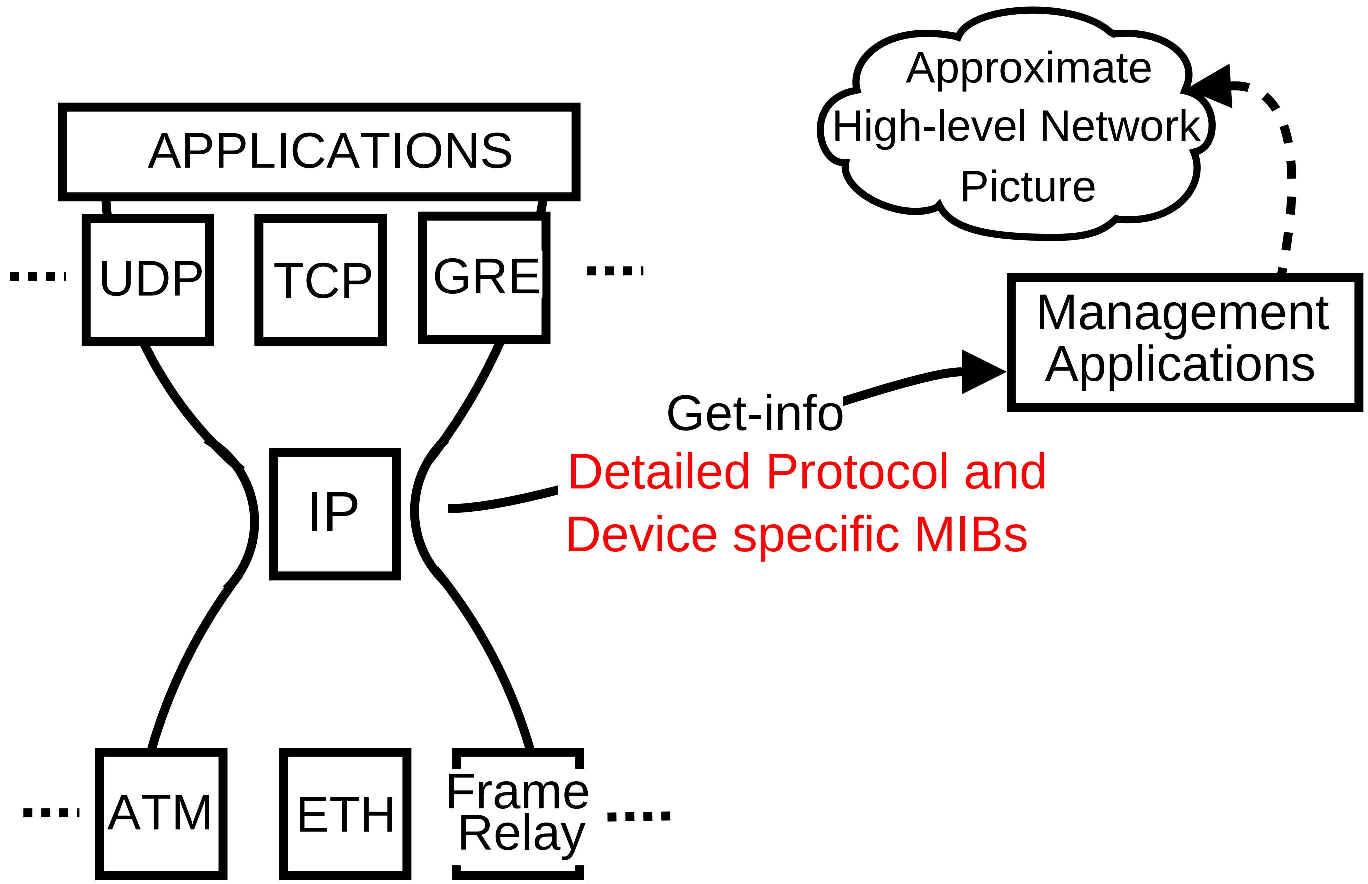

- Perception differs from reality
- Error-prone configuration
- Fragmentation of tools

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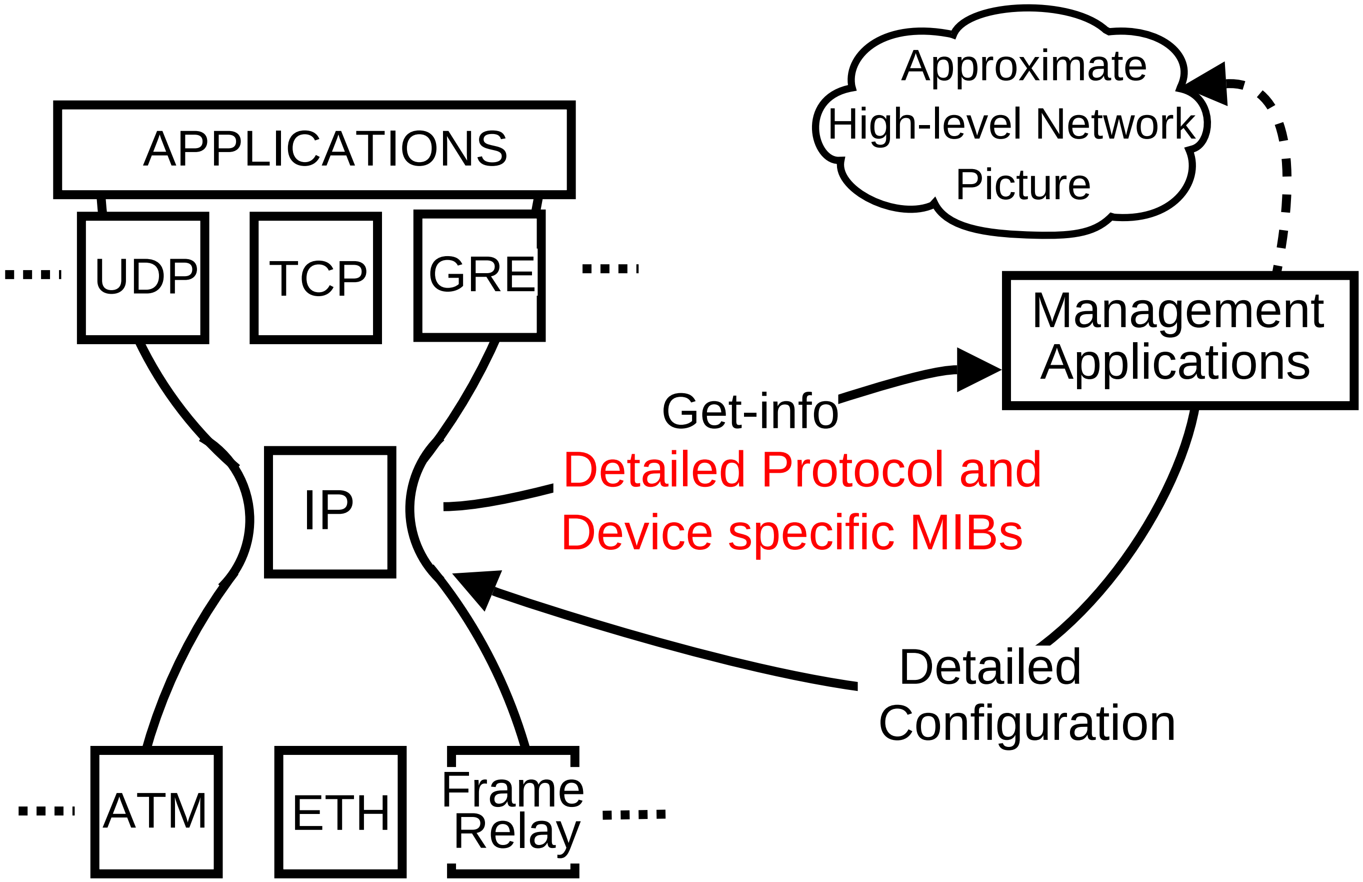

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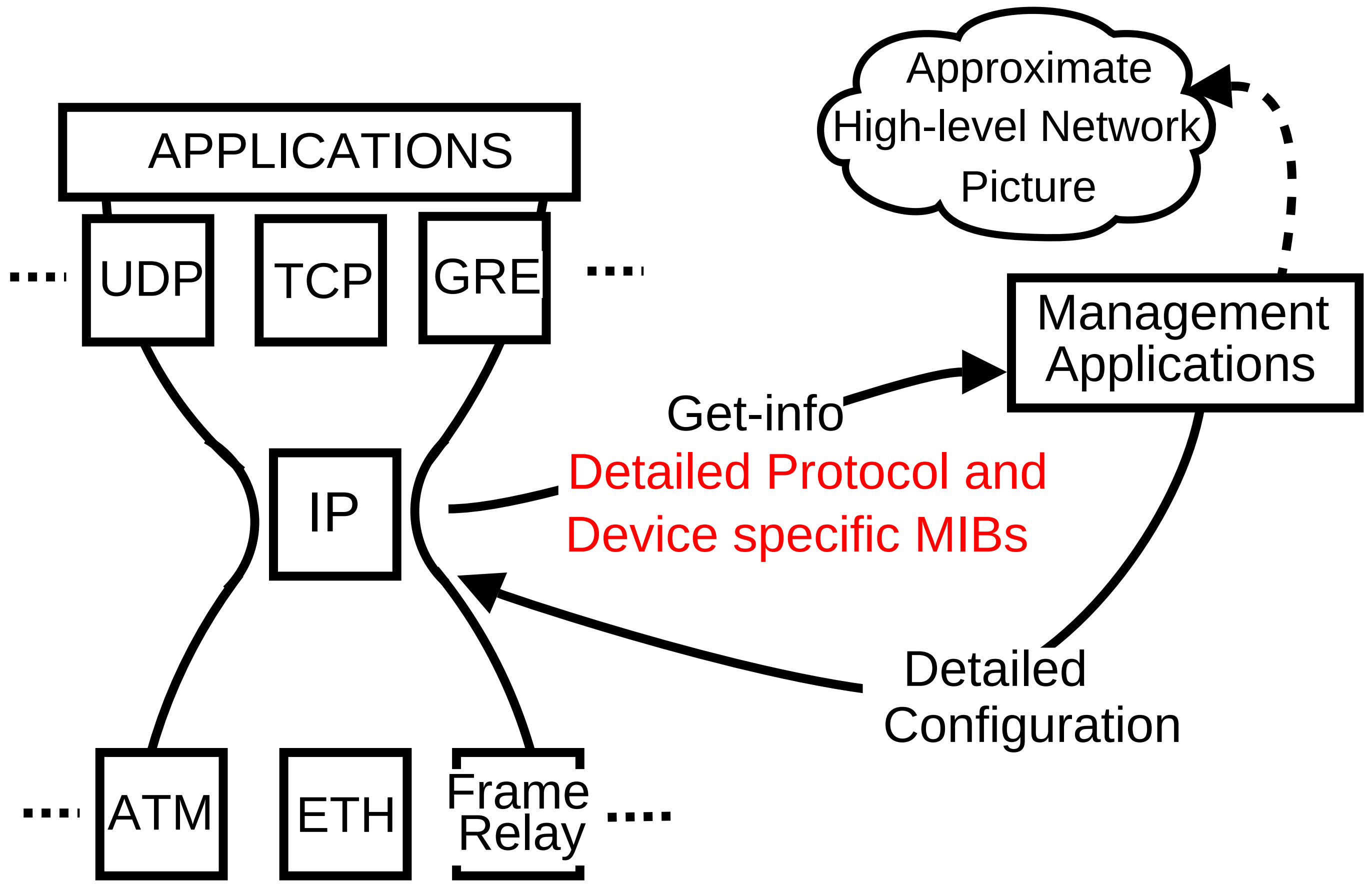

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Complexity Oblivious Network Management (CONMan)

A network management architecture that aims to

- Restrict protocol complexity to their implementation

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Assumptions and Caveats

- Presence of an independent management channel [4D, Greenberg et. al.'05]
- "Network" management; not "Service" management
- Management of data-plane protocols

Restrict protocol details to implementation

Scenarios where details need not be exposed

- Key values for GRE tunnels
- Sequence numbers for GRE tunnels
- Filtering undesired packets

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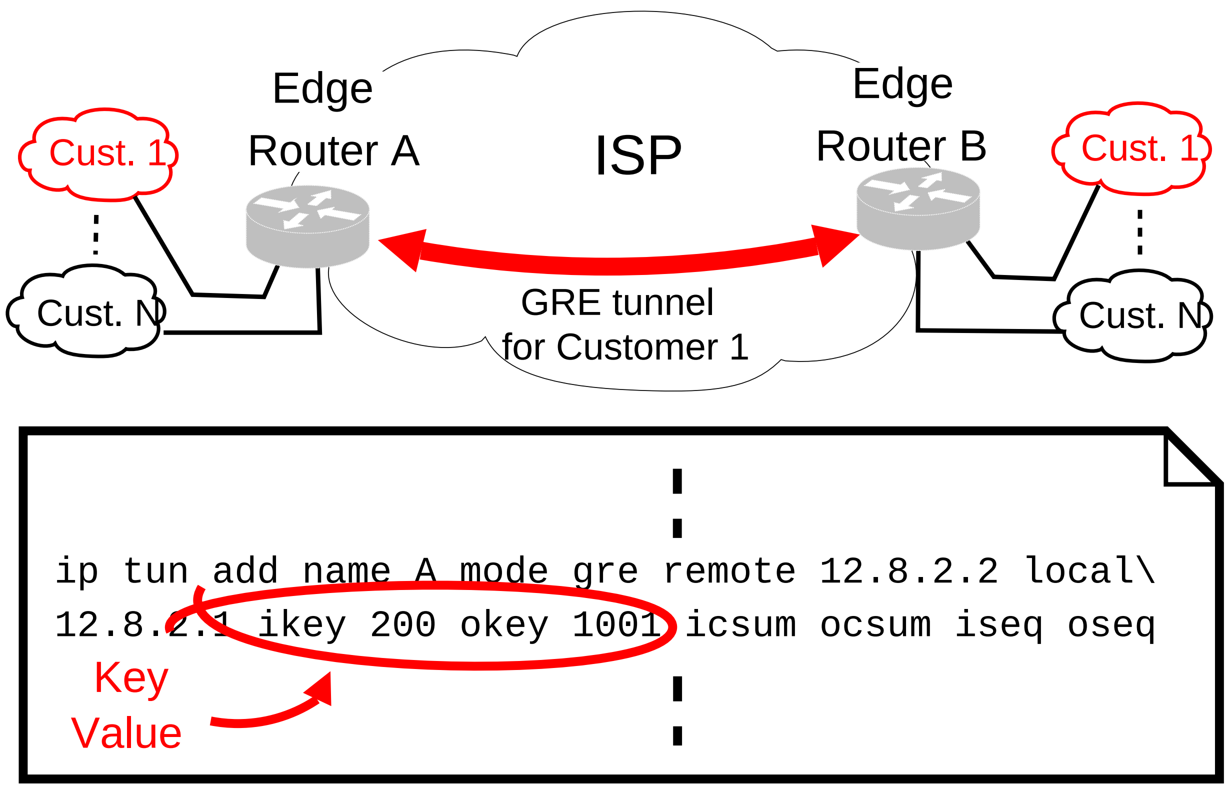

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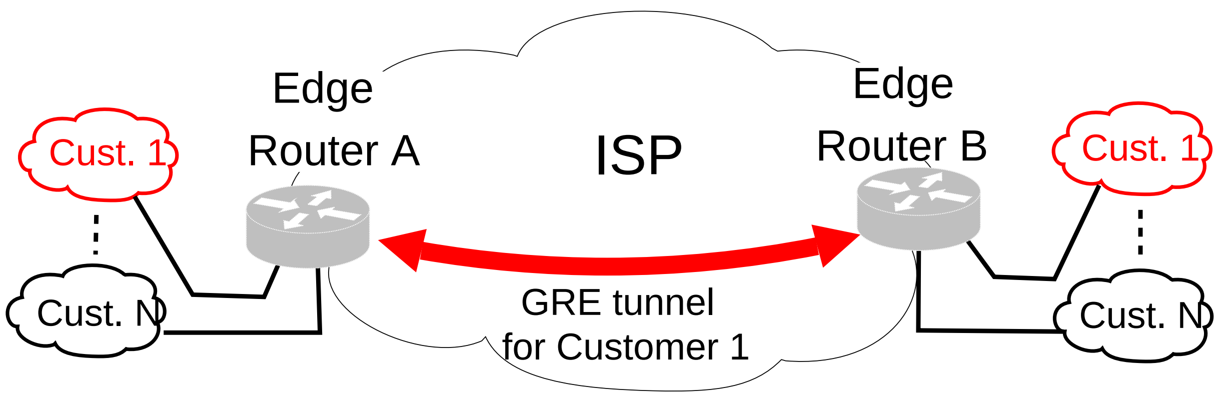


```
ip tun add name A mode gre remote 12.8.2.2 local\
12.8.2.1 ikey 200 okey 1001 icsum ocsum iseq oseq
```

Seq. No.
Usage

Restrict protocol details to implementation

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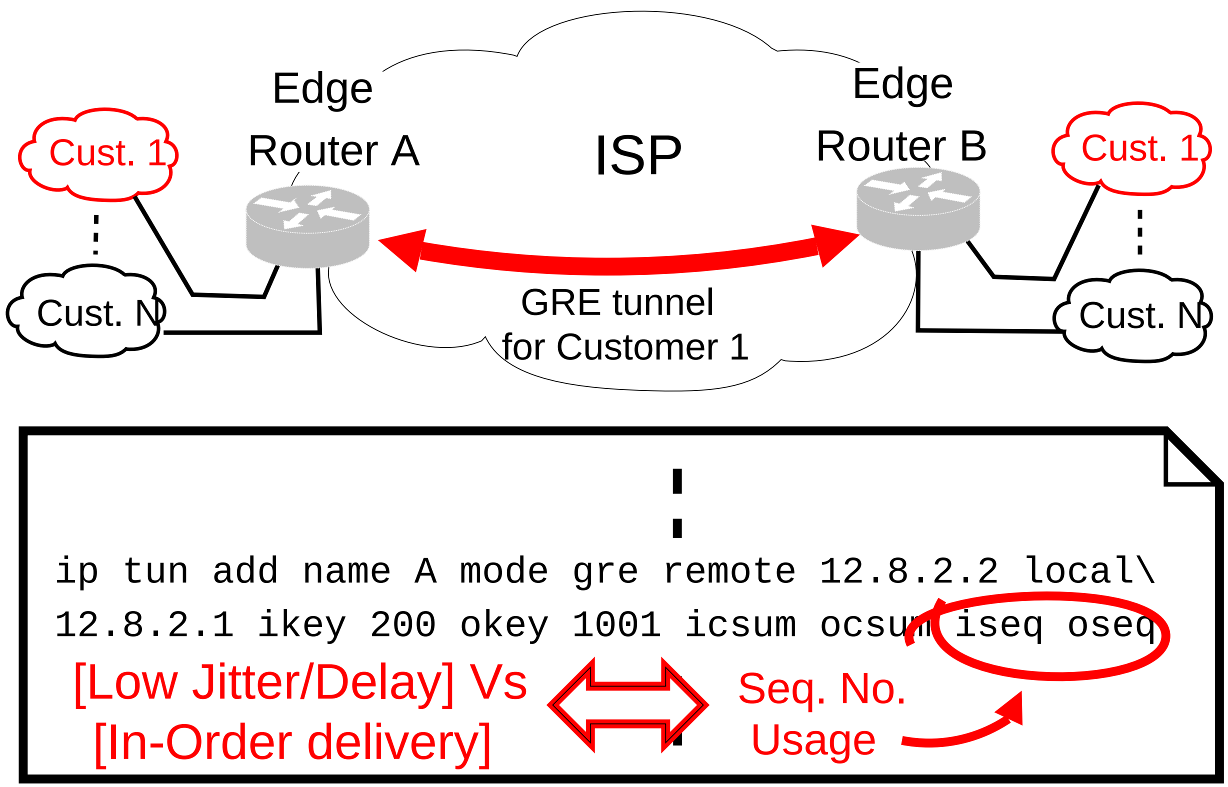

Restrict protocol details to implementation

Scenarios where details need not be exposed

- Key values for GRE tunnels
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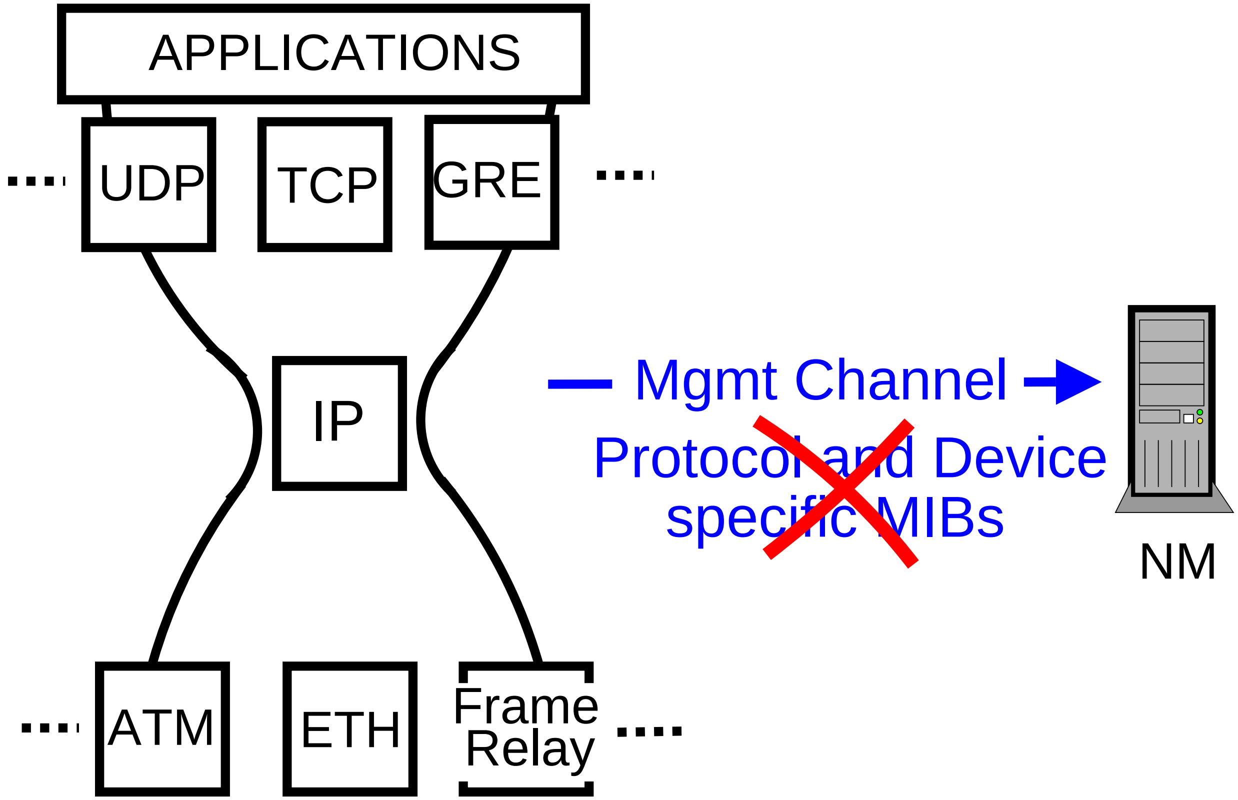
"Filter packets from source address 128.19.2.3 and destined to address 20.3.4.5, port 592"

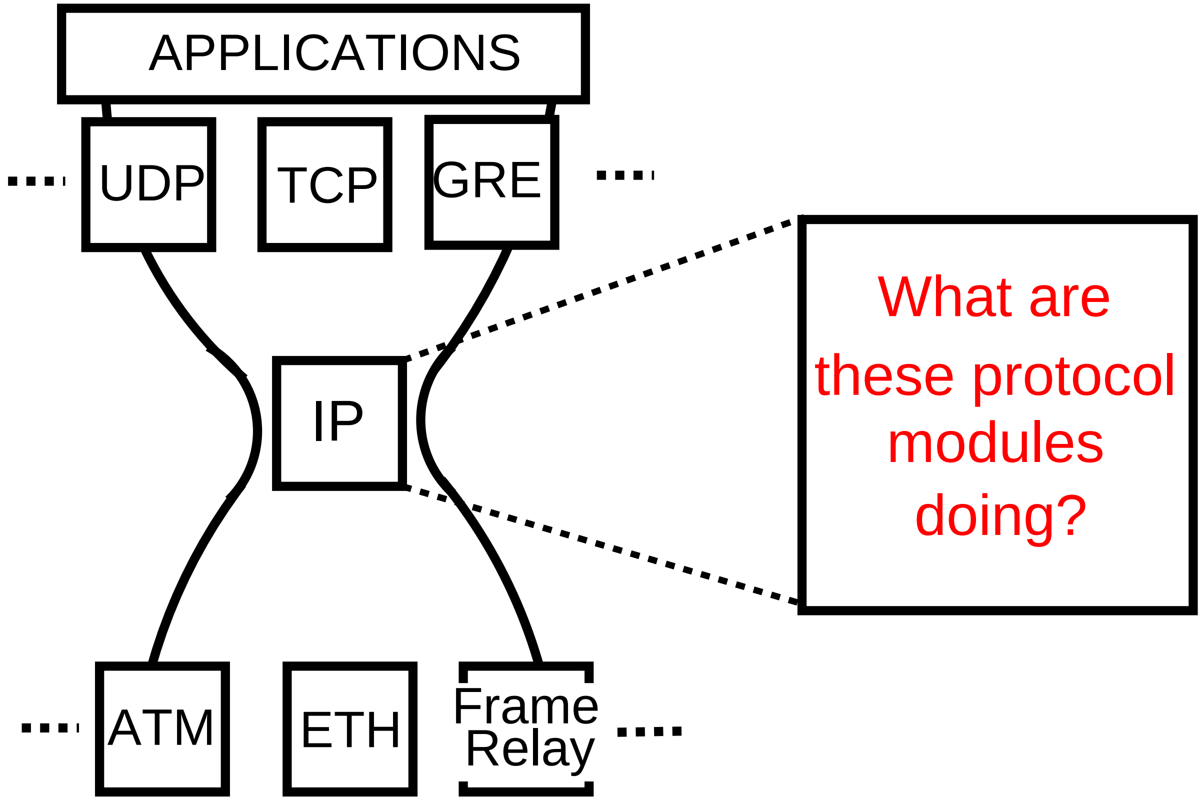
Abstract away the details



Protocols should not expose their gory details

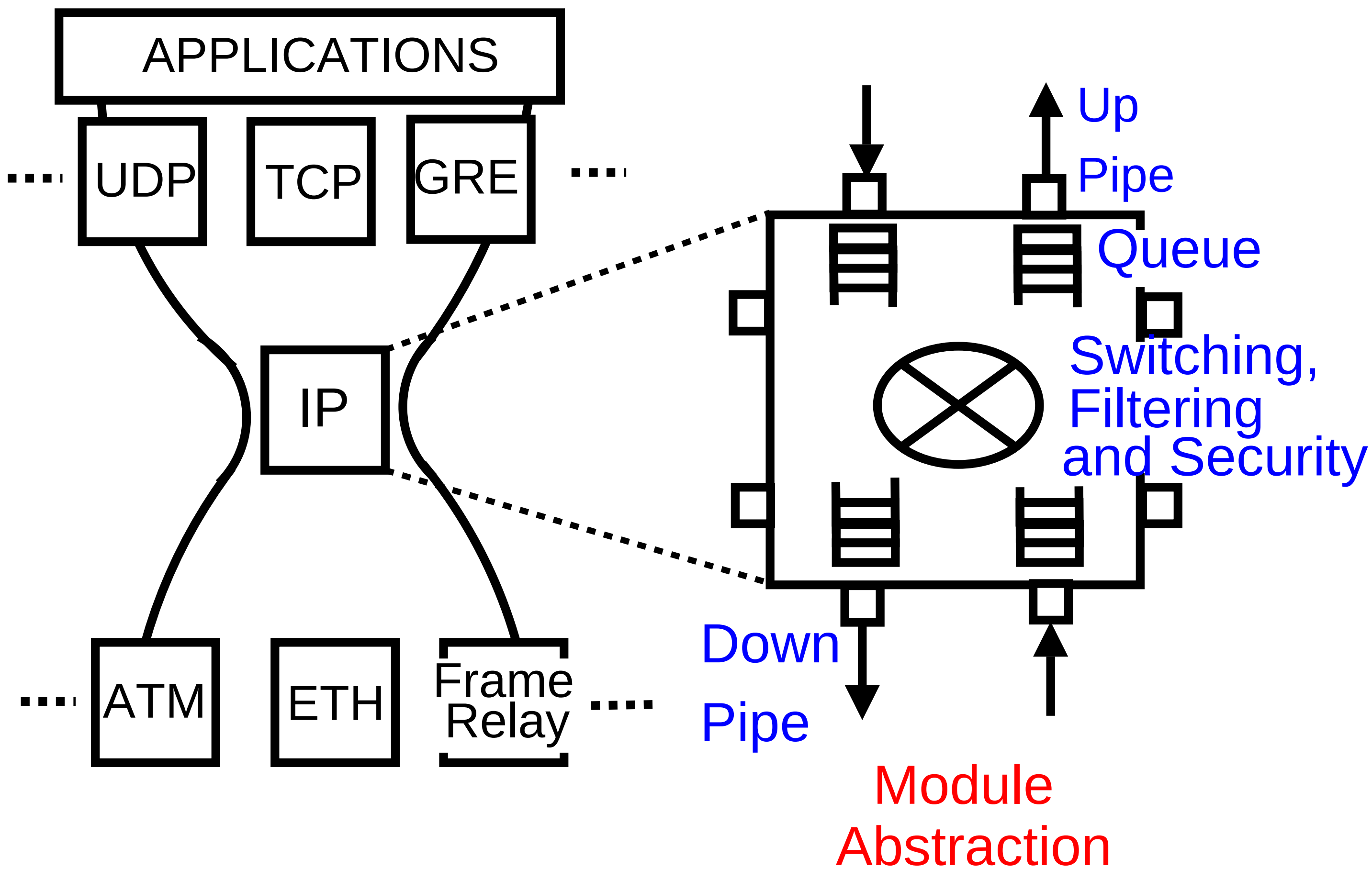
What do the protocols expose?

Abstract away the details



What are these protocols modules doing?

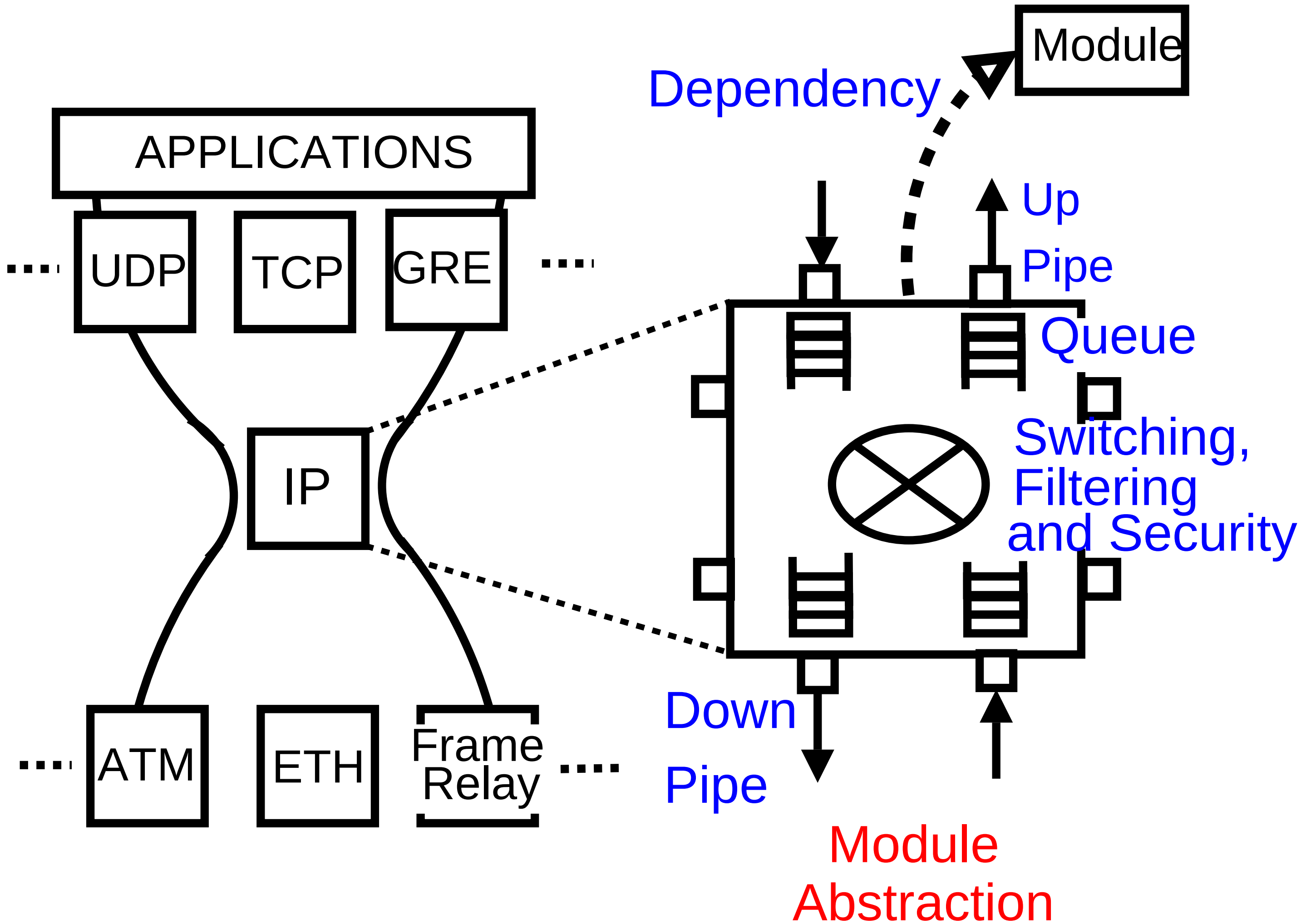
Abstract away the details



What are these protocols modules doing?

Switching packets under some **performance** constraints while **filtering** unwanted traffic

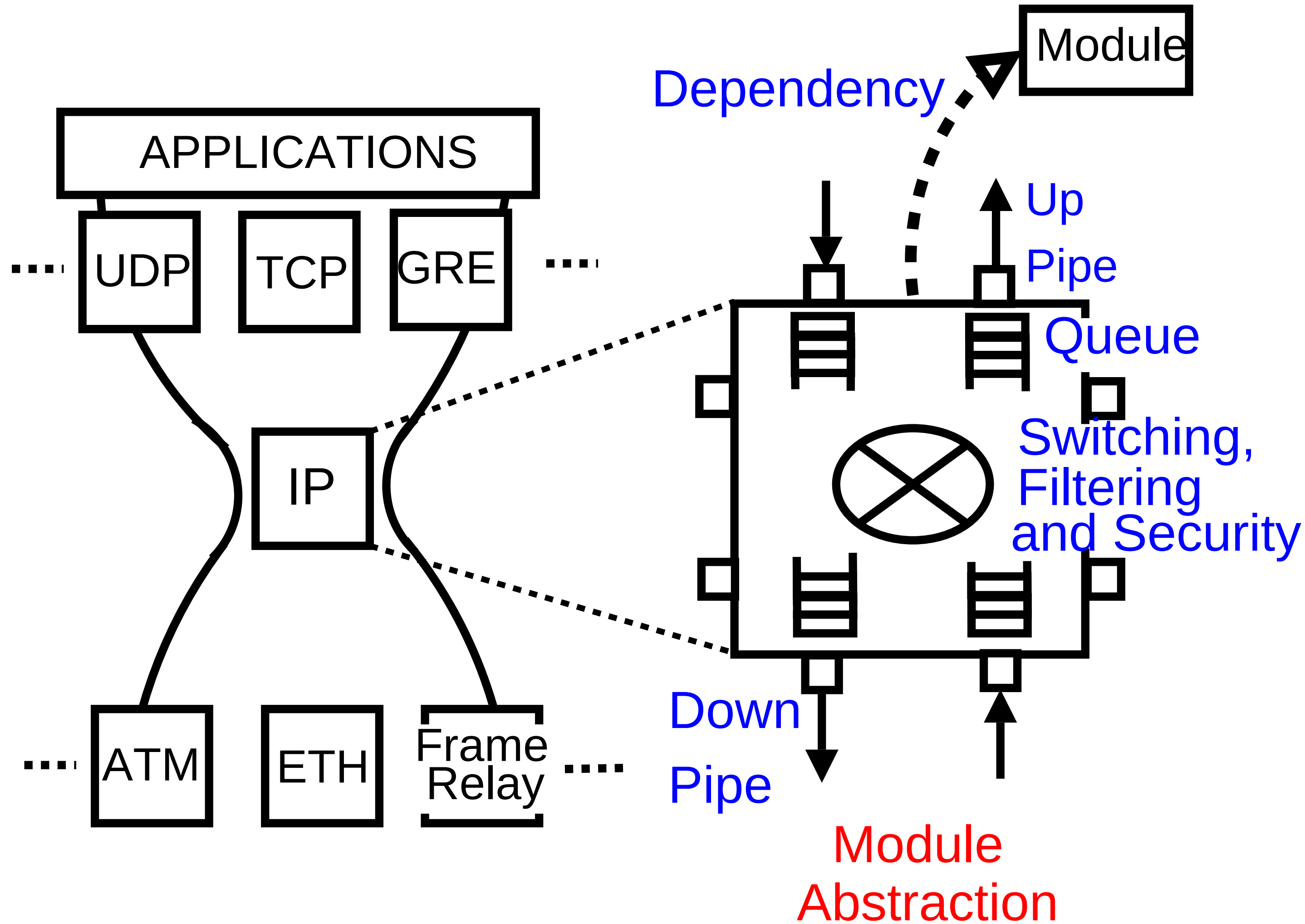
Abstract away the details



What are these protocols modules doing?

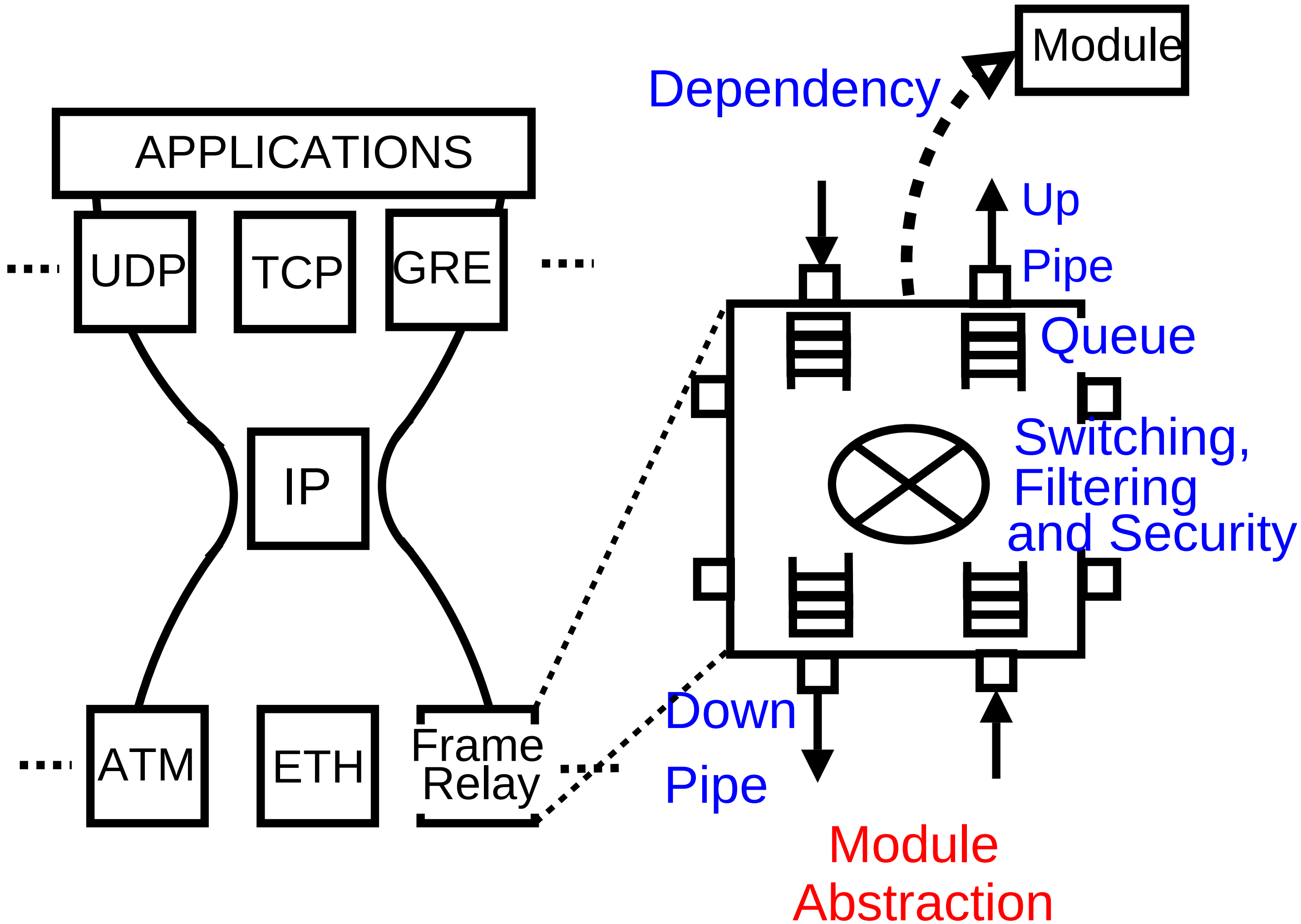
Modules may **depend** on other modules for doing their job

Abstract away the details



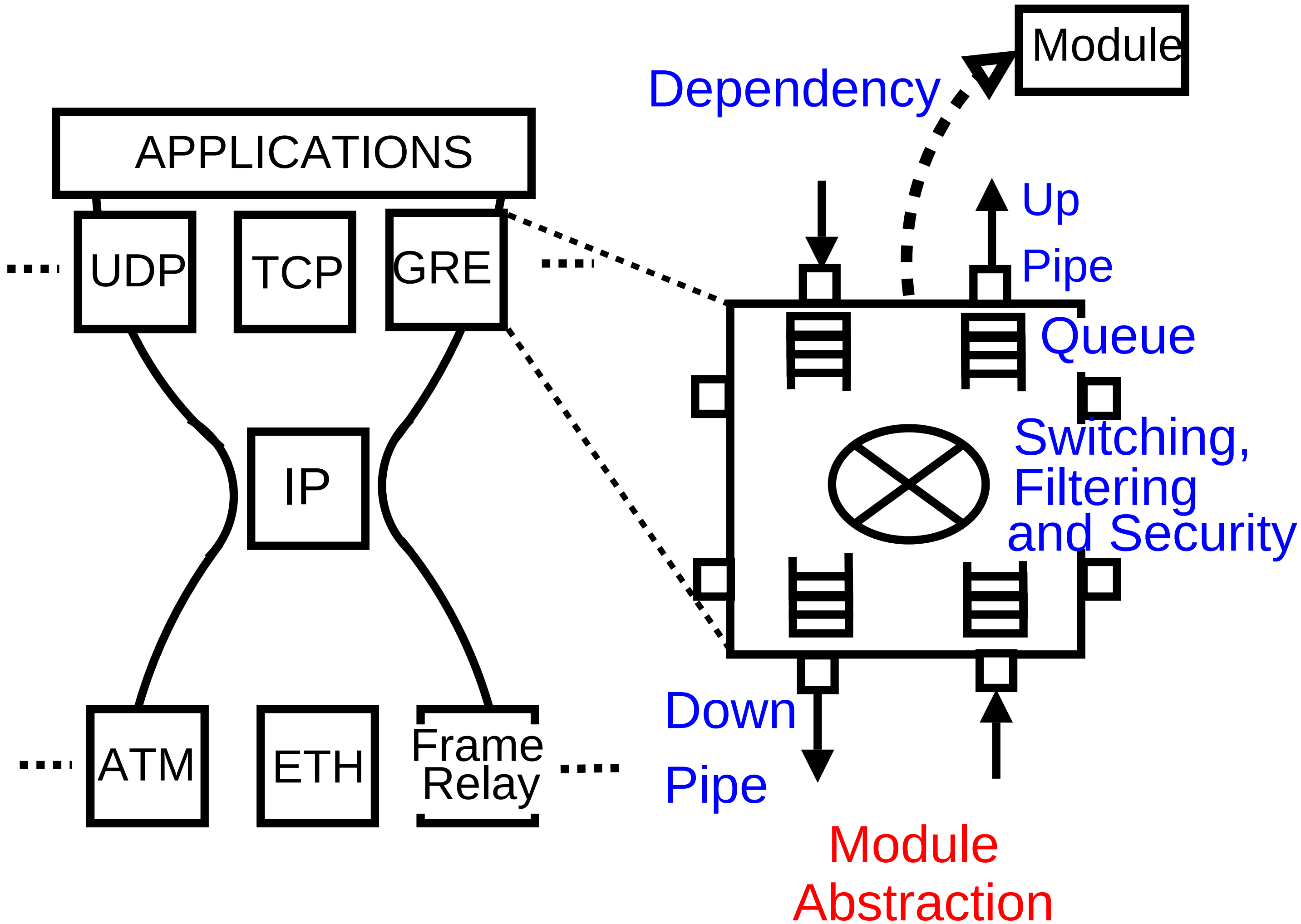
Abstraction models the capabilities and dependencies of modules

Abstract away the details



Abstraction applies to (almost) all data plane modules

Abstract away the details



Abstraction applies to (almost) all data plane modules

CONMan Abstraction and Primitives

Abstraction Components

- Name
- Up Pipes
- Down Pipes
- Physical Pipes
- Filter
- Switch
- Perf. Reporting
- Perf. Trade-off
- Security

CONMan primitives

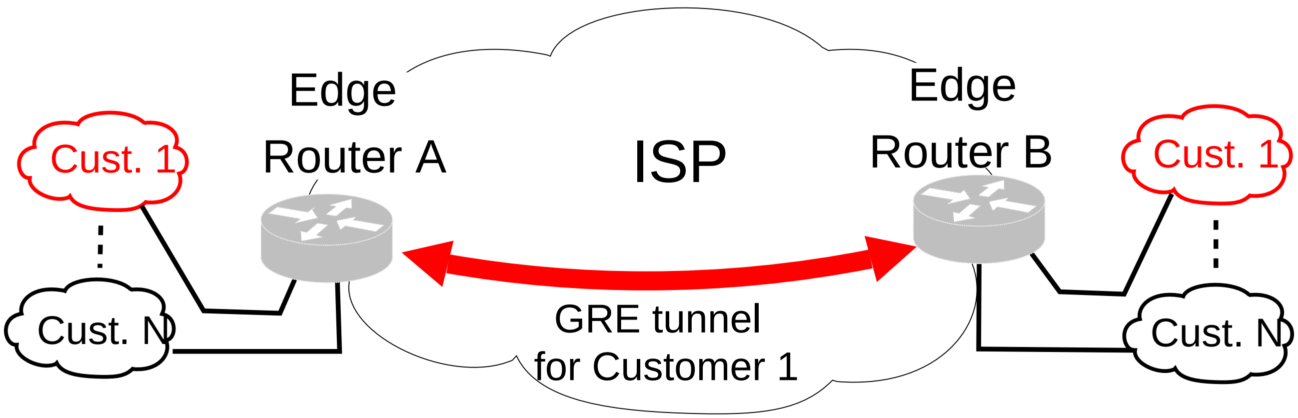
- *show*
- *create*
- *conveyMessage*
- *test*

Exceptions to the abstraction

Protocol details that need to be exposed

- IP address assignment
- Filtering based on regular expressions in HTML
- Broadcast suppression on switch ports

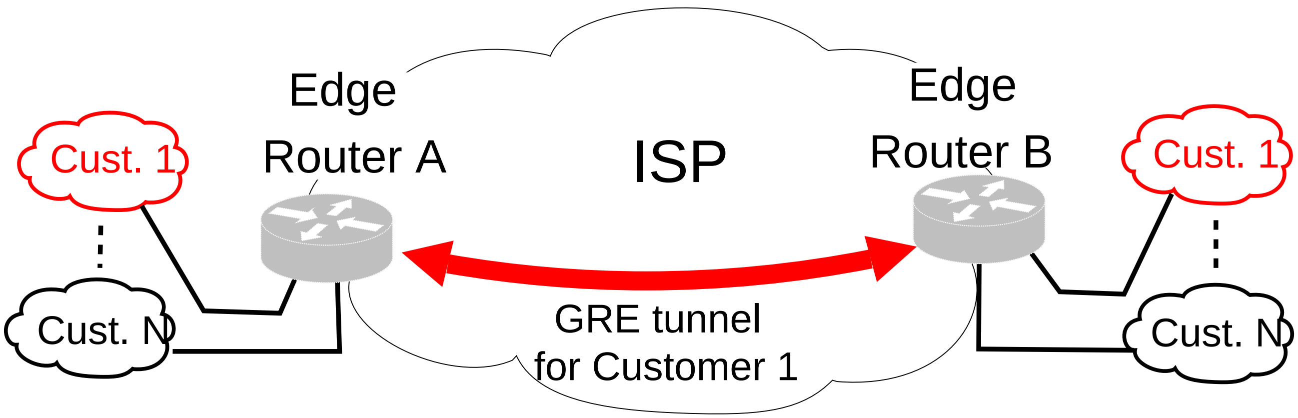
An example scenario : GRE Tunneling




```
#!/bin/bash
# Inserting the  GRE-IP kernel module
insmod /lib/modules/2.6.10-1/ip_gre.ko
# Creating the GRE module with the appropriate key
ip tunnel add name greA mode remote 128.84.223.112 local \
128.84.222.111 ikey 2001 okey 1001 icsum ocsum iseq oseq
ifconfig greA 192.168.1.3
# Enable routing
echo 1 > /proc/sys/net/ipv4/ip-forward
# Create IP routing state from customer  to tunnel
echo 202 tun-1-2 > /etc/iproute2/rt_tables
ip rule add iff eth0 table tun-1-2
ip route add default dev greA table tun-1-2
# Create IP routing state from tunnel to customer
echo 203 tun-2-1 > /etc/iproute2/rt_tables
ip rule add iff greA table tun-2-1
ip route add default dev eth0 table tun-2-1
```

Configuration at Router A "Today"

An example scenario : GRE Tunneling

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End-point IP Addresses

Key Values

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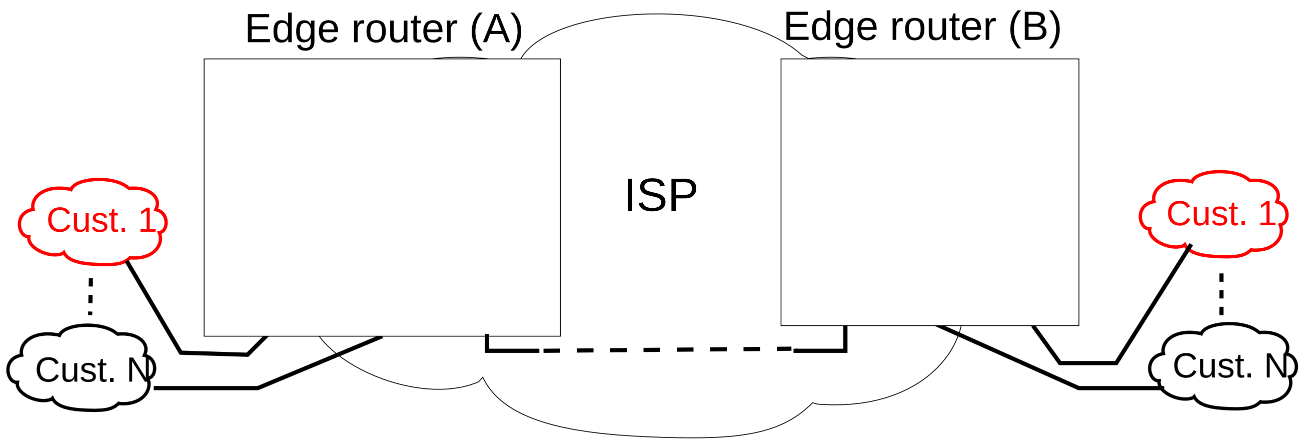
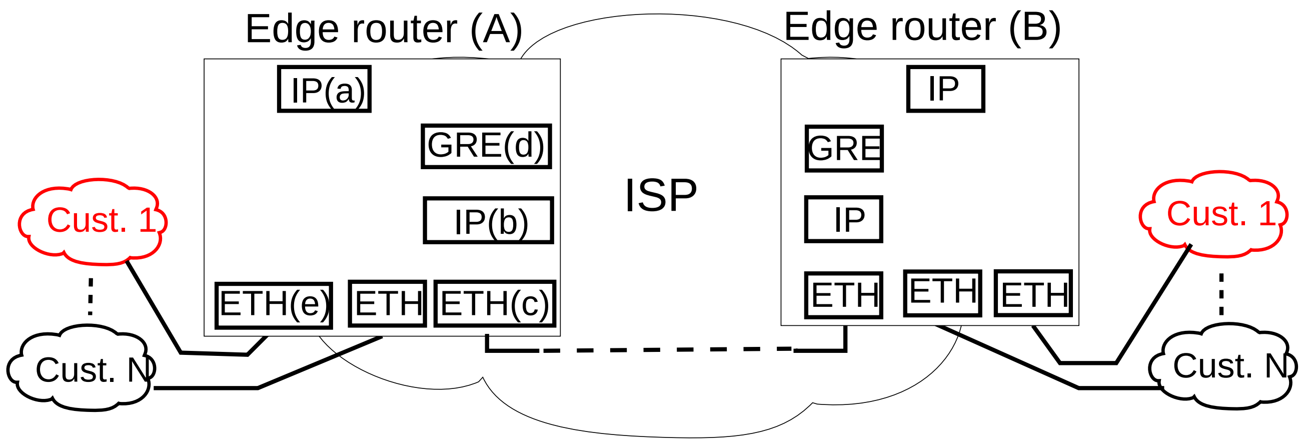


CONMan Goal: "Create virtual connectivity between the customer-side interfaces for Customer-1"

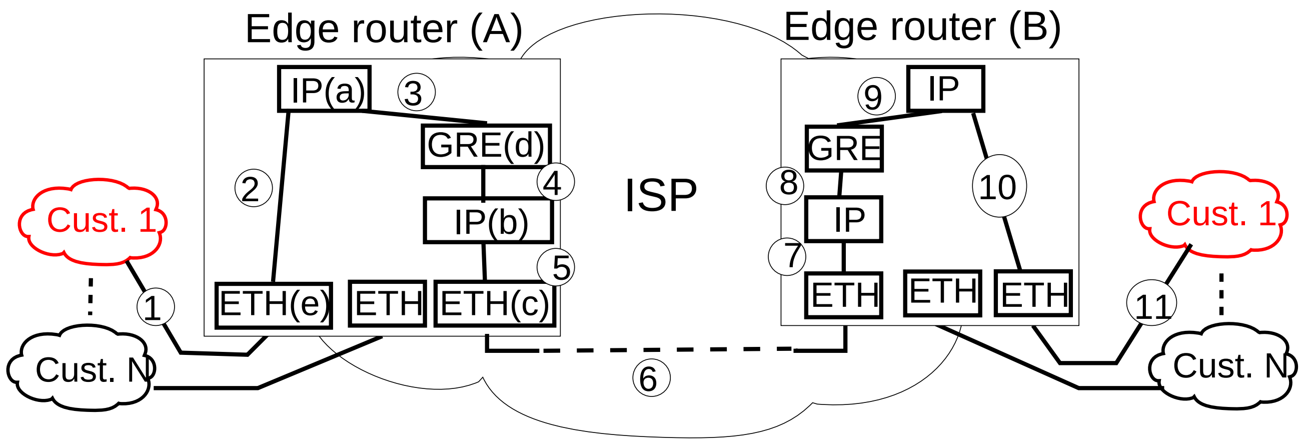
An example scenario : GRE Tunneling



NM discovers routers through the management channel

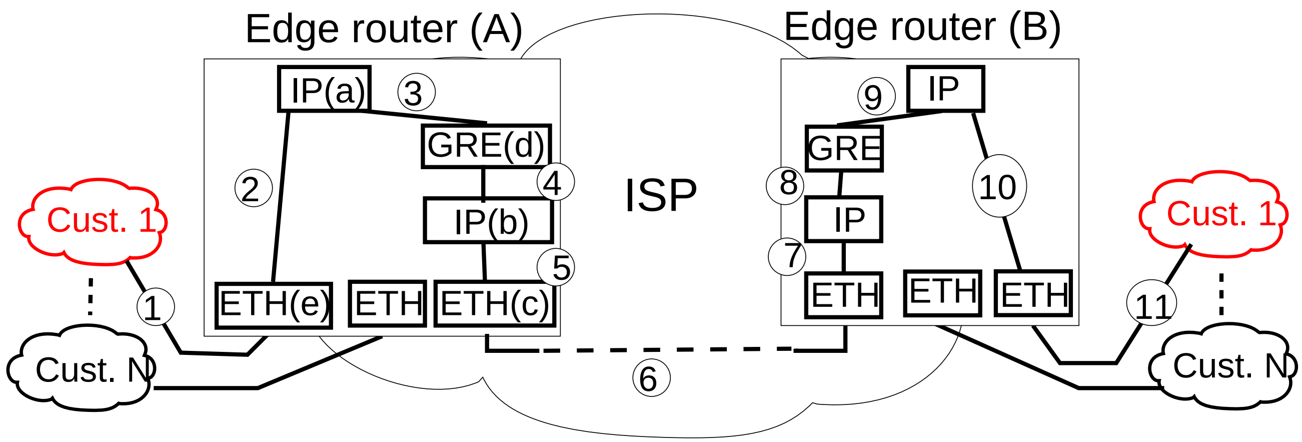
Uses *show* to determine the abstraction for the modules

An example scenario : GRE Tunneling



Map the high-level goal to the construction of path labeled (1) through (11)

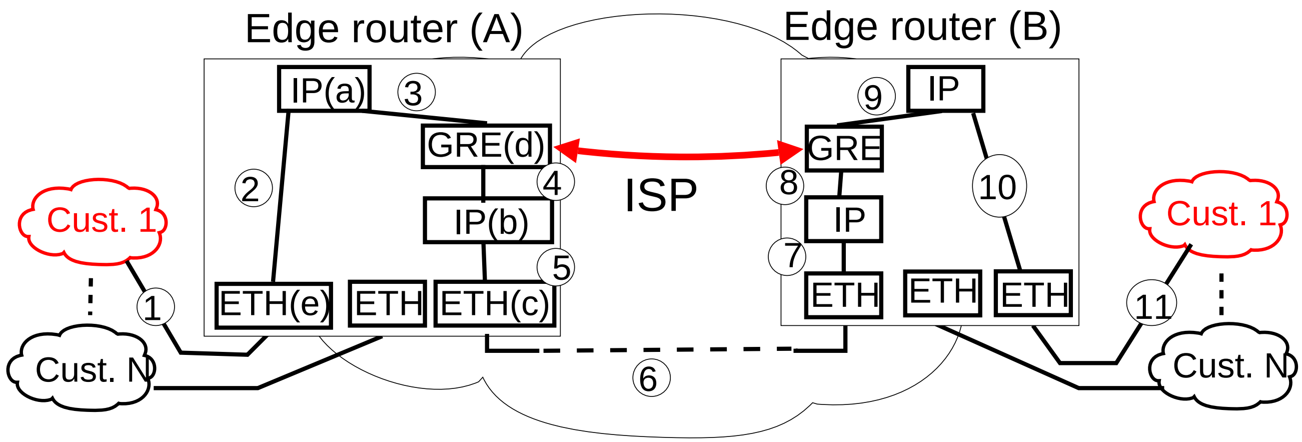
An example scenario : GRE Tunneling



create (pipe, e, a)
create (pipe, a, d)
create (switch-state, a, pipe-2, pipe-3)
create (pipe, d, b)
create (pipe, b, c)

Configuration at Router A with CONMan

An example scenario : GRE Tunneling



GRE Modules use conveyMessage to exchange key values, seq numbers, etc.

create (pipe, e, a)

create (pipe, a, d)

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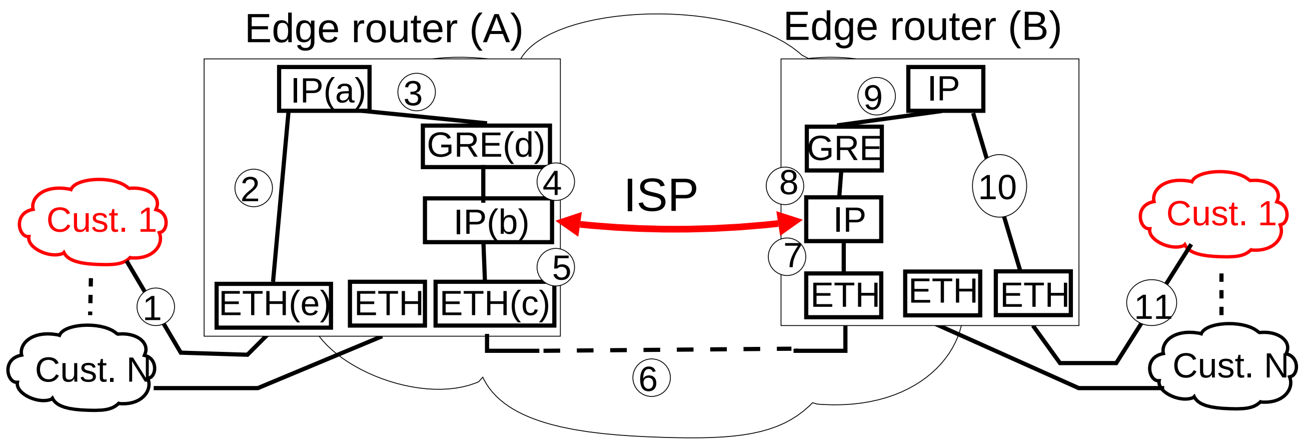

create (pipe, e, a)
create (pipe, a, d)
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create (pipe, b, c)

IP modules use conveyMessage
to exchange and test IP addresses

Configuration
at Router A
with CONMan

Conclusion

- **CONMan** : a coherent network management architecture
- Moves operational complexity of protocols to their implementation

Protocols and devices modelled

- GRE protocol (tunnel configuration)
- IP protocol (performance management)
- Layer-2 switches (VLANs, VLAN tunneling, etc.)

Work in progress

Open Issues

- Evaluation strategies
- Scalability, performance and reliability issues
- Impact on security
- Deployment strategies
- ...

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Thank You!