Implementation of

Business Linux Routers

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Why Use Linux as a Router ?

- Cost
- Performance
- Reliability
- Open nature of Linux
- It's not IOS
- Multi-function nature of Linux
- Strong networking
- One-box-does-it-all nature of Linux

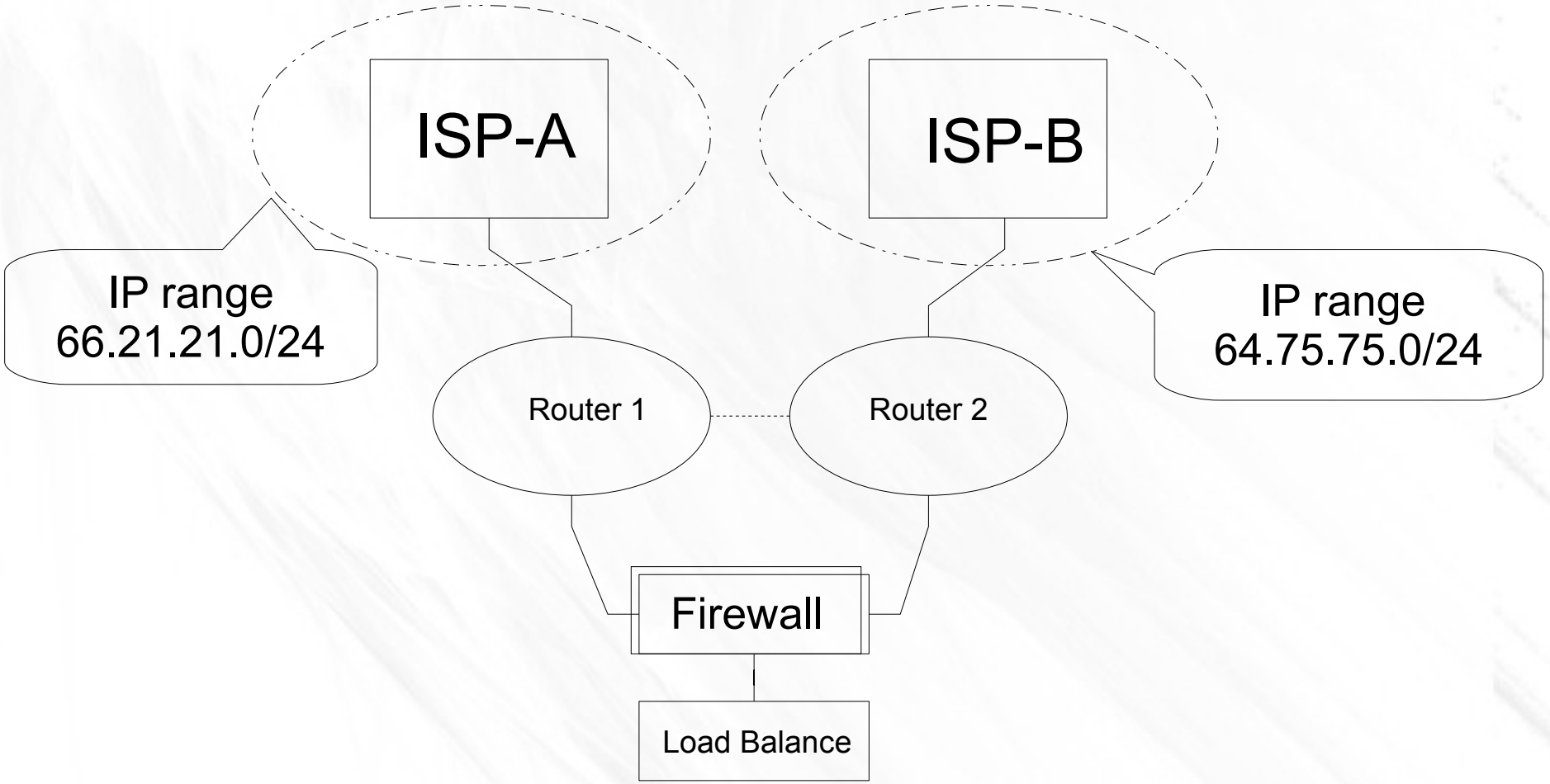
Tools for a Linux Router

- Zebra / Quagga
  - BGP
  - Metric, weighted, multiple routes
  - OSPF
  - IOS-like
- IP route 2 / Linux kernel / Unix tools
- Iptables / Firewall
- HA Tools, Ultra-Monkey Project / Keep alive
- Tracing tools, network reporting tools

Zebra / Quagga

- IOS-like Routing Daemons
  - OSPFv2, OSPFv3, RIP v1, v2, RIPng BGP-4
  - Quagga fork of Zebra www.quagga.net
  - TTY type interface language, IOS-like
  - Documentation assumes Cisco experience
  - About 80% like a Cisco router IOS
  - BGP is the work horse of ISP connections
  - Actively supported

Typical ISP Router connect



Setting up the Linux Router

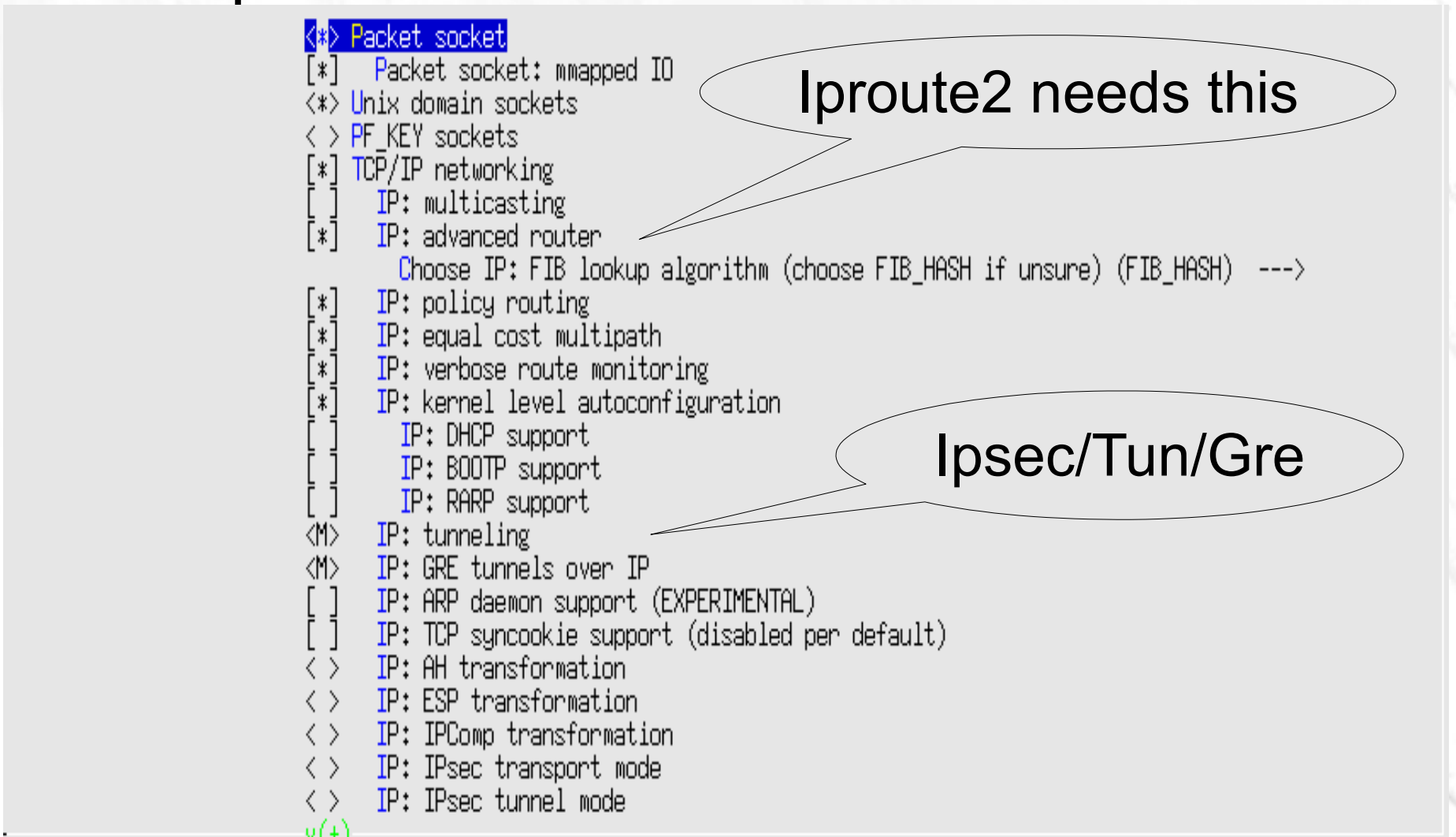
- Physical Hardware: Making it work
  - Strong Open Source NIC Drivers
  - Solid Server Hardware, memory
  - Flash-based HDs or raid1 HDs
  - Server BIOS, serial port, TTY access
  - 1U network rack
  - 10 Gig fiber
  - High end switches

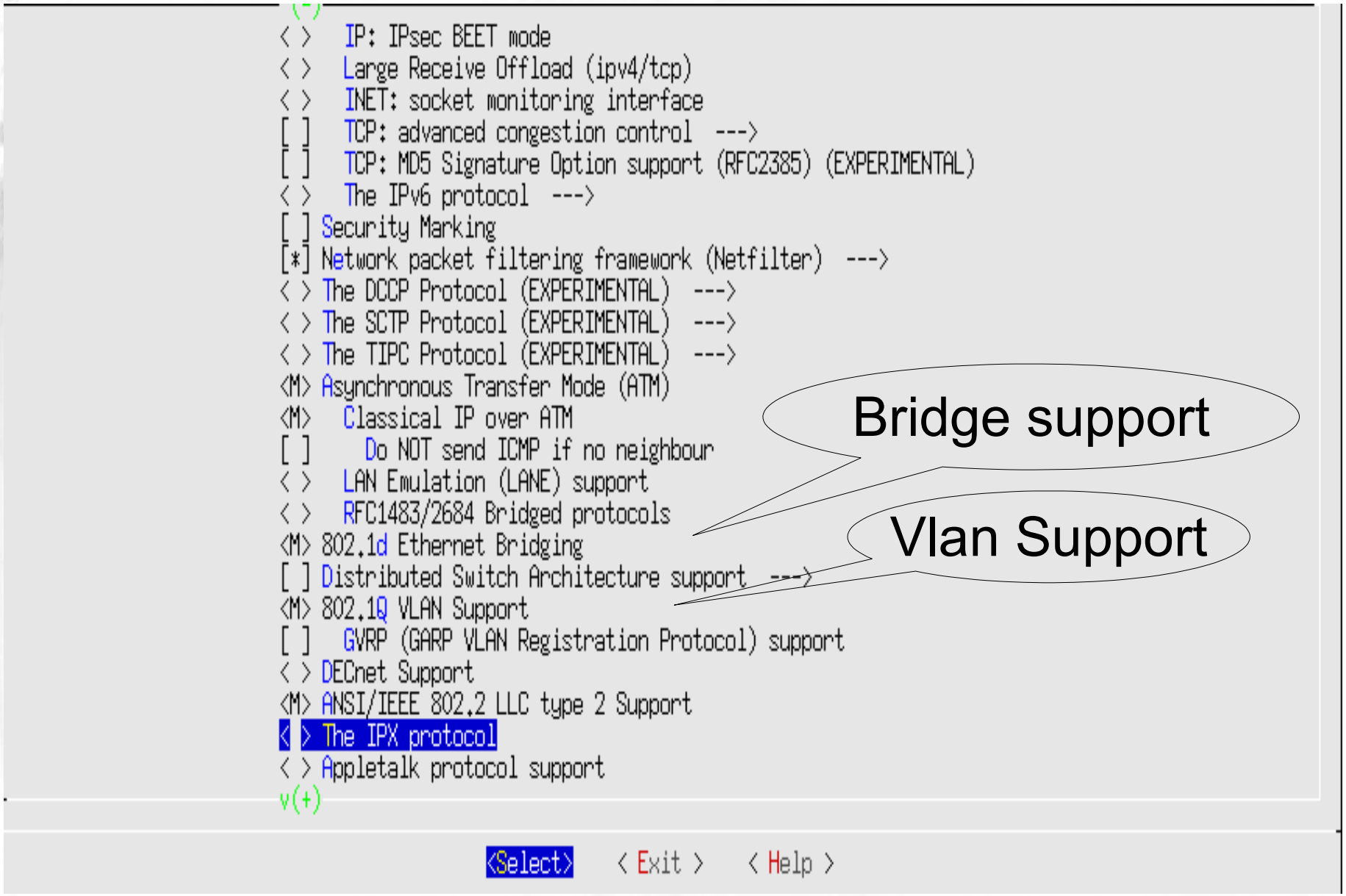
Setting up the Software/Linux

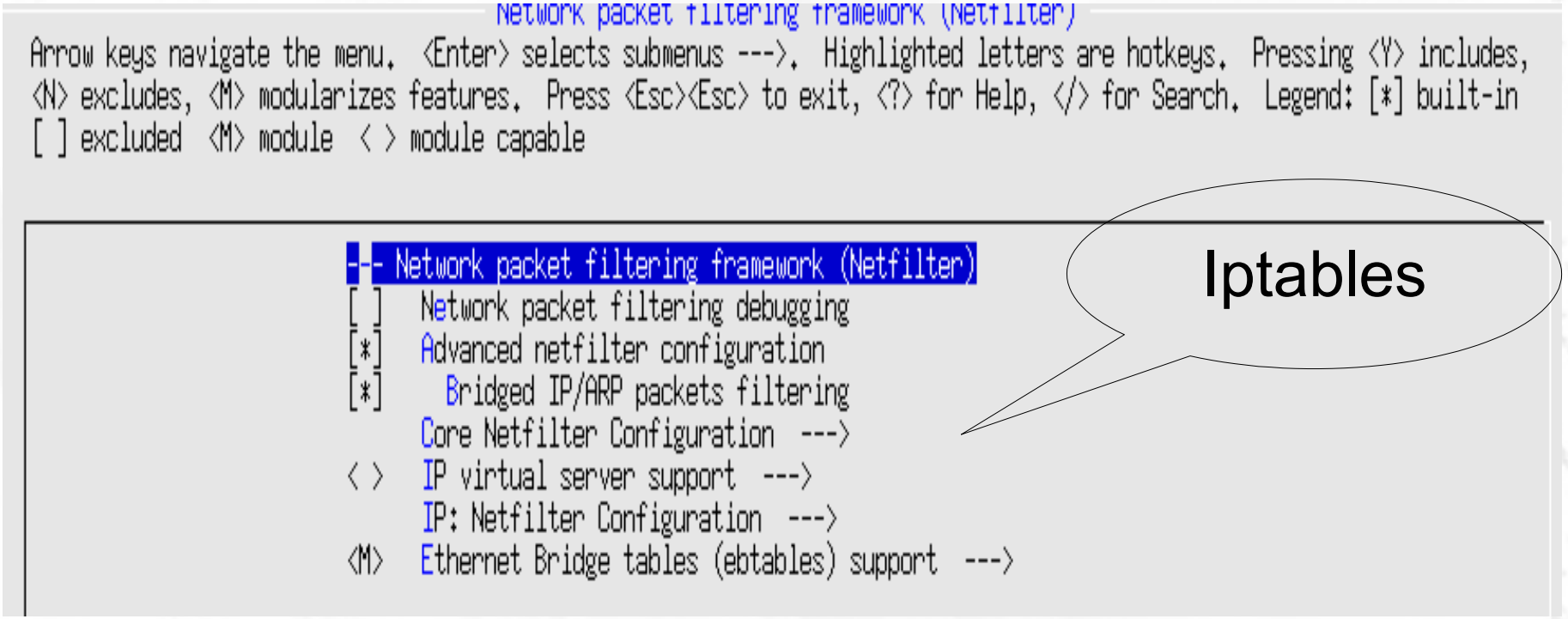
- The Distribution: load it, like it, reload, reload...
  - Can you upgrade? ease of use, philosophy
  - Packages, up to date, feature selection?
  - Red Hat, Debian, Suse, Slackware, Gentoo ...
  - Kernel Building, you should/have to
  - Can you control what gets loaded/started?
  - Setting up network daemons, Quagga
  - SSH access, key based , IP based
  - TTY console, TTY Zebra, BGP access

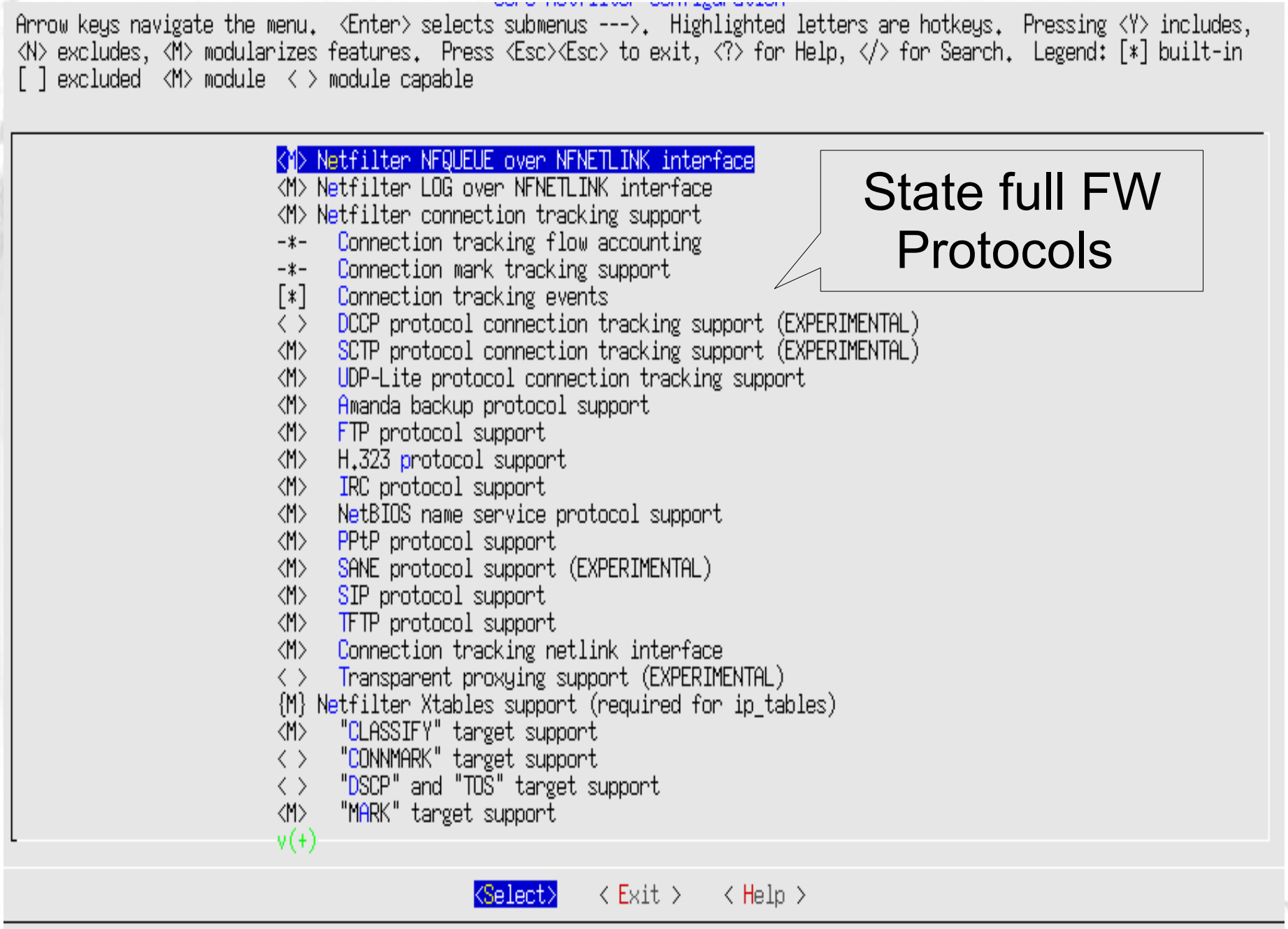
Kernel Building 101

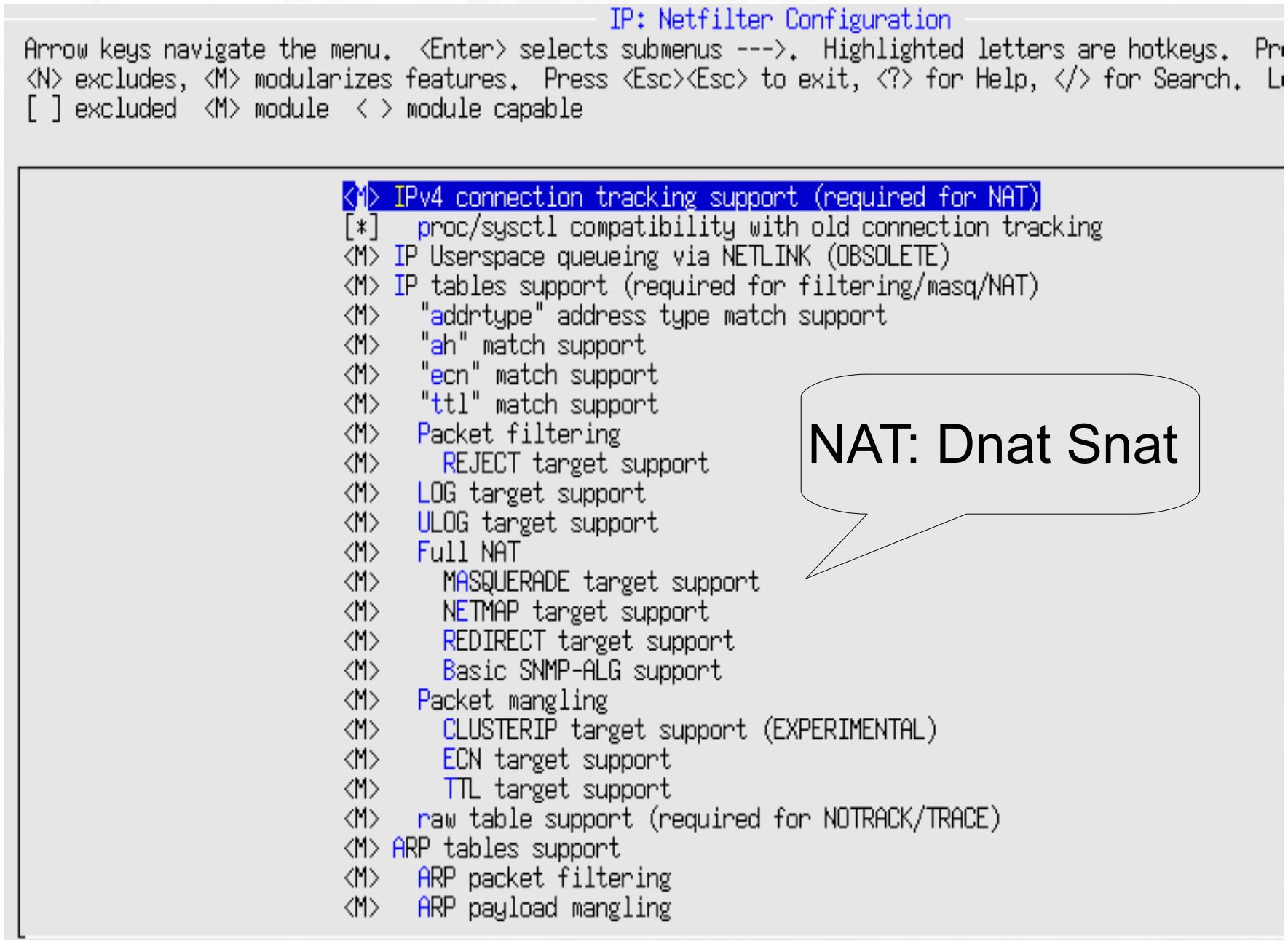
- Set up Kernel CPU / NIC / ACPI / Network

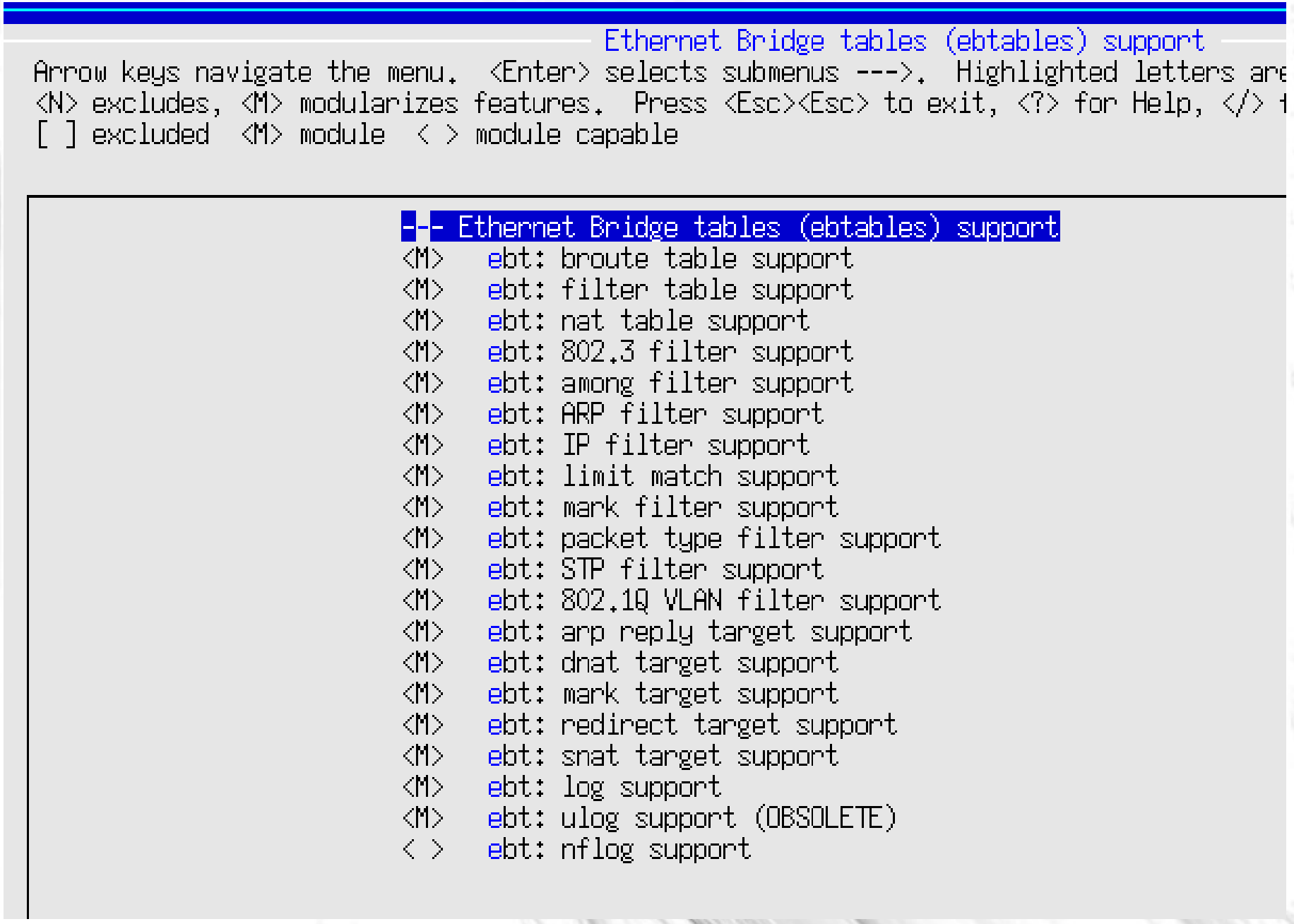



< > IP: IPsec BEET mode
< > Large Receive Offload (ipv4/tcp)
< > INET: socket monitoring interface
[ ] TCP: advanced congestion control --->
[ ] TCP: MD5 Signature Option support (RFC2385) (EXPERIMENTAL)
< > The IPv6 protocol --->
[ ] Security Marking
[*] Network packet filtering framework (Netfilter) --->
< > The DCCP Protocol (EXPERIMENTAL) --->
< > The SCTP Protocol (EXPERIMENTAL) --->
< > The TIPC Protocol (EXPERIMENTAL) --->
<M> Asynchronous Transfer Mode (ATM)
<M> Classical IP over ATM
[ ] Do NOT send ICMP if no neighbour
< > LAN Emulation (LANE) support
< > RFC1483/2684 Bridged protocols
<M> 802.1d Ethernet Bridging
[ ] Distributed Switch Architecture support --->
<M> 802.1Q VLAN Support
[ ] GVRP (GARP VLAN Registration Protocol) support
< > DECnet Support
<M> ANSI/IEEE 802.2 LLC type 2 Support
< > The IPX protocol
< > Appletalk protocol support
v(+)
<Select> < Exit > < Help >
Bridge support
Vlan Support


Network packet filtering framework (Netfilter)
Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are hotkeys. Pressing <Y> includes, <N> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] built-in [ ] excluded <M> module < > module capable
-*- Network packet filtering framework (Netfilter)
[ ] Network packet filtering debugging
[*] Advanced netfilter configuration
[*] Bridged IP/ARP packets filtering
Core Netfilter Configuration --->
< > IP virtual server support --->
IP: Netfilter Configuration --->
<M> Ethernet Bridge tables (ebtables) support --->
Iptables


Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are hotkeys. Pressing <Y> includes, <N> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] built-in [ ] excluded <M> module < > module capable
<M> Netfilter NFQUEUE over NFNETLINK interface
<M> Netfilter LOG over NFNETLINK interface
<M> Netfilter connection tracking support
-*- Connection tracking flow accounting
-*- Connection mark tracking support
[*] Connection tracking events
< > DCCP protocol connection tracking support (EXPERIMENTAL)
<M> SCTP protocol connection tracking support (EXPERIMENTAL)
<M> UDP-Lite protocol connection tracking support
<M> Amanda backup protocol support
<M> FTP protocol support
<M> H.323 protocol support
<M> IRC protocol support
<M> NetBIOS name service protocol support
<M> PPtP protocol support
<M> SANE protocol support (EXPERIMENTAL)
<M> SIP protocol support
<M> TFTP protocol support
<M> Connection tracking netlink interface
< > Transparent proxying support (EXPERIMENTAL)
{M} Netfilter Xtables support (required for ip_tables)
<M> "CLASSIFY" target support
< > "CONNMARK" target support
< > "DSCP" and "TOS" target support
<M> "MARK" target support
v(+)
<Select> < Exit > < Help >
State full FW Protocols


IP: Netfilter Configuration
Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are hotkeys. Pr
<N> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </> for Search. L
[ ] excluded <M> module < > module capable
<M> IPv4 connection tracking support (required for NAT)
[*] proc/sysctl compatibility with old connection tracking
<M> IP Userspace queueing via NETLINK (OBSOLETE)
<M> IP tables support (required for filtering/masq/NAT)
<M> "addrtype" address type match support
<M> "ah" match support
<M> "ecn" match support
<M> "ttl" match support
<M> Packet filtering
<M> REJECT target support
<M> LOG target support
<M> ULOG target support
<M> Full NAT
<M> MASQUERADE target support
<M> NETMAP target support
<M> REDIRECT target support
<M> Basic SNMP-ALG support
<M> Packet mangling
<M> CLUSTERIP target support (EXPERIMENTAL)
<M> ECN target support
<M> TTL target support
<M> raw table support (required for NOTRACK/TRACE)
<M> ARP tables support
<M> ARP packet filtering
<M> ARP payload mangling
NAT: Dnat Snat


Ethernet Bridge tables (ebtables) support
Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are
<N> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </> f
[ ] excluded <M> module < > module capable
--- Ethernet Bridge tables (ebtables) support
<M> ebt: broute table support
<M> ebt: filter table support
<M> ebt: nat table support
<M> ebt: 802.3 filter support
<M> ebt: among filter support
<M> ebt: ARP filter support
<M> ebt: IP filter support
<M> ebt: limit match support
<M> ebt: mark filter support
<M> ebt: packet type filter support
<M> ebt: STP filter support
<M> ebt: 802.1Q VLAN filter support
<M> ebt: arp reply target support
<M> ebt: dnat target support
<M> ebt: mark target support
<M> ebt: redirect target support
<M> ebt: snat target support
<M> ebt: log support
<M> ebt: ulog support (OBSOLETE)
< > ebt: nflog support

Setup of the Network parts

```
! Zebra configuration saved from vty
!   2008/06/05 05:21:02
!
hostname Router
password verybigpw
enable password verbigpw
log stdout
log syslog
!
interface eth0
 shutdown
interface lo
!
```

```
!
interface vlan100
 description My ISP info phone # ticket instructions etc
 ip address 109.16.19.129/29
 ipv6 nd suppress-ra
!
interface vlan200
 ip address 10.129.28.50/24
 ipv6 nd suppress-ra

!
access-list 10 permit 192.168.1.0 0.0.0.255
!
ip forwarding
ip route 0.0.0.0/0 10.199.128.221 200
ip route 0.0.0.0/0 10.199.128.2 205
ip route 65.44.42.0 255.255.255.0 10.129.28.1
ip route 68.17.188.0 255.255.255.0 10.129.28.1
!
line vty
!
```

BGP Config

```
router bgp 77688
 bgp router-id 217.201.249.2
 network 217.201.249.0/25
 network 64.87.141.0/24
 network 67.128.177.0/24
 neighbor ibgp-eb peer-group
 neighbor ibgp-eb remote-as 77688
 neighbor ibgp-eb next-hop-self
 neighbor ibgp-eb default-originate
 neighbor ibgp-eb soft-reconfiguration inbound
 neighbor ibgp-eb route-map INT_WO_PRE out
 neighbor ibgp-eb filter-list 6 out
```

ASA #

Floating ip ranges

Internal BGP group def.

BGP Internal

```
neighbor ibgp-eb filter-list 6 out
 neighbor 10.199.128.251 peer-group ibgp-eb
 description 221 is the secondary site1 router
 neighbor 10.252.1.221 peer-group ibgp-eb
 neighbor 10.252.1.221 weight 11
 description 222 is thel primary verizon router
 neighbor 10.252.1.222 peer-group ibgp-eb
 neighbor 10.252.1.222 weight 12
 description 242 is the secondary site2 router
 neighbor 10.252.1.242 peer-group ibgp-eb
 neighbor 10.252.1.242 weight 9
```

Neighbor statements:
Note the use of group Ibgp-eb and weight

BGP external

```
neighbor ebgp-eb peer-group
neighbor ebgp-eb remote-as 6461
neighbor ebgp-eb soft-reconfiguration inbound
neighbor ebgp-eb route-map AB_net_IN in
neighbor ebgp-eb route-map AB_net_Out_PRE out
neighbor ebgp-eb weight 300
neighbor 212.66.199.226 peer-group ebgp-eb
neighbor 212.66.199.227 peer-group ebgp-eb
```

BGP Filters

```
access-list 15 permit 216.200.249.0 0.0.0.128
access-list 25 permit 66.117.177.0 0.0.0.255
access-list 25 permit 63.86.141.0 0.0.0.255
access-list 35 permit 216.200.249.0 0.0.0.128
!
ip as-path access-list 6 permit ^$
ip as-path access-list 8 permit ^$
ip as-path access-list 8 permit .*
!
route-map AB_net_Out_PRE permit 20
 match ip address 25
 set as-path prepend 77688 77688 77688
!
route-map AB_net_Out_PRE permit 30
 match ip address 15
!
route-map INT_WO_PRE permit 20
 match ip address 35
!
route-map AB_net_IN permit 10
 match as-path 8
```

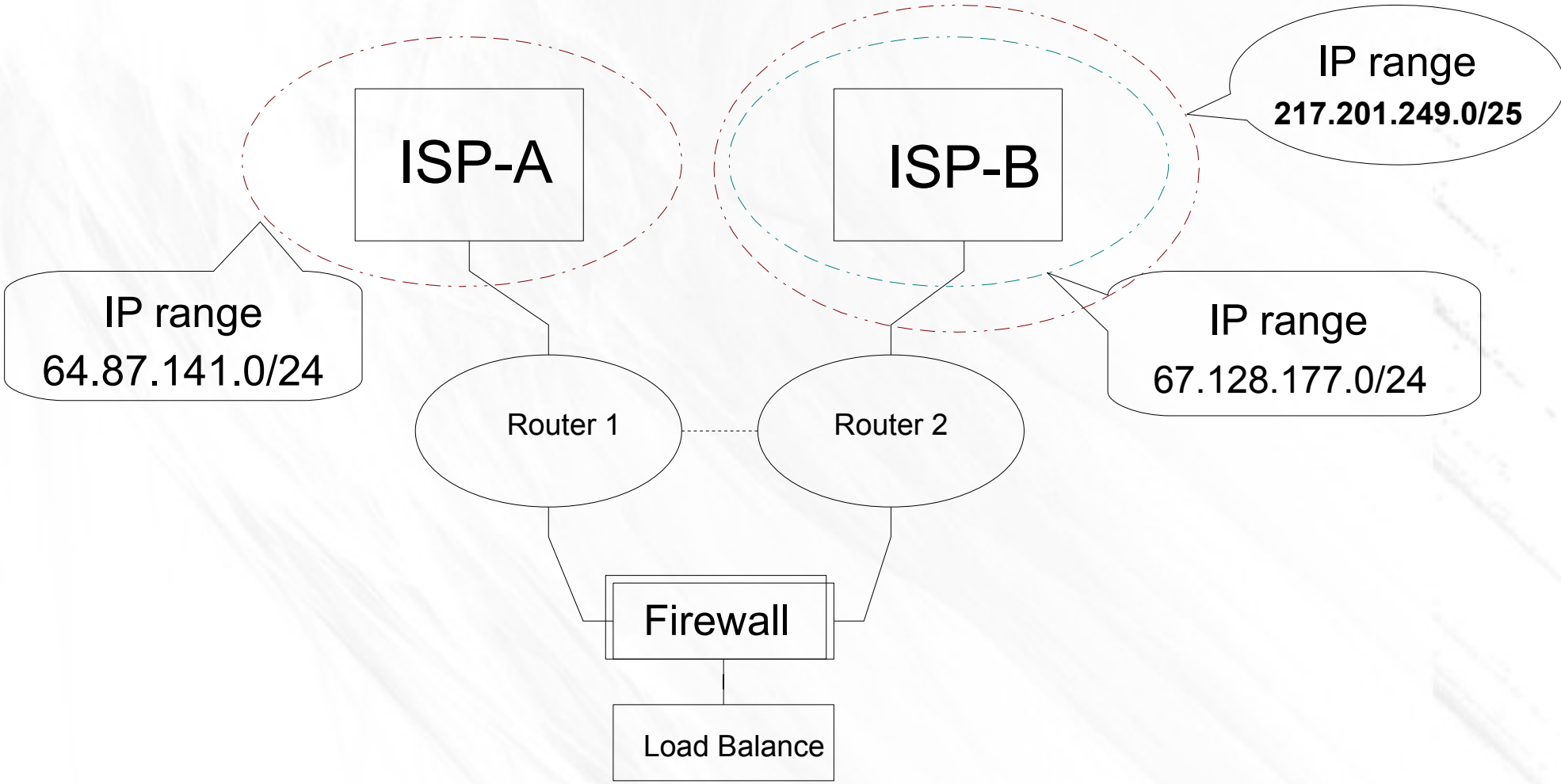
Like Cisco Access List builds IP filters for allowing IP ranges

Regx expressions

The longer the path, the more the path will not be used

Host this IP range

Typical ISP Router connect



BGP Summary

- Used to get the default route from ISP
- Used to manage active ISP IP Ranges
- Used to manage groups of routers
- Problems with BGP
  - Old, well-supported, but not as nice as OSPF
  - BGP ISO support language is hard to understand

Linux Firewall

- Input, Output and Forward queues
- Nat, Dnat, Snat and MASQUERAD
- Mangle, a packet
- Load Balance
- Map IP to IP ranges
- Randomize to a dest
- And more … Very active development in the Kernel

Linux LB (IP virtual server)

- IP virtual server, in the Linux kernel since 2.4
  - Many Load Balance types
    - round-robin scheduling
    - weighted round-robin scheduling
    - least-connection scheduling
    - weighted least-connection scheduling
    - locality-based least-connection scheduling
    - locality-based least-connection with replication scheduling
    - destination hashing scheduling
    - source hashing scheduling
    - shortest expected delay scheduling
    - never queue scheduling

Using IP Virtual Server

- Ipvsadm – base package to control IP VS
- HA Heart Beat or Keepalive to control IP VS
- HA uses ld director perl script to control VIP and target hosts, and test if active
- Ld director will test many types of services, lots of flexible options for testing

Conclusions, Observations

- The Linux platform opens networking up to many normal Unix administration employees, whereas Cisco networking is very specialized and can take years to learn. Many small businesses can't handle this.
- The equipment cost savings can be huge at high bandwidth rates, and taking ownership of your network has many other advantages.
- Upgrade of software is easy and painless.
- Combining routers with FW/LB is possible .

More info on Topics

- Zebra/Quagga - quagga.net, zebra.org
- BGP – O'Reilly BGP
- Iptables/Netfilter - netfilter.org
- HA Project - linux-ha.org
- IP route2 - linuxfoundation.org/en/Net:Iproute2
- Keep alive - www.keepalived.org