Super/Ultra-Basic Load-Balancing Introduction

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What is Load-balancing

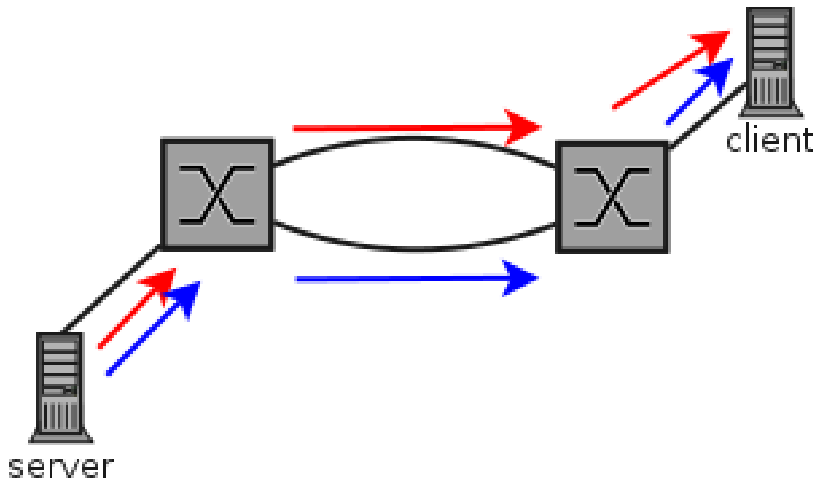
- The act of dividing a workload between N > 1 devices capable for performing a task.
- Multiple contexts in internet services where this concept occurs.
  - DNS
  - MX records
  - Multiple links (L2 trunks, L3 ECMP)
  - Multiple servers

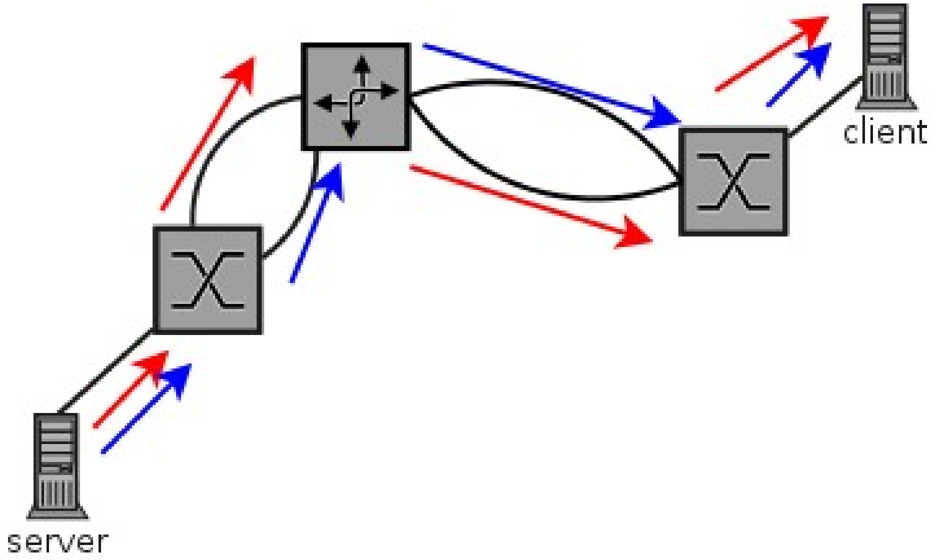
Goals

- Greater scalability
- Higher availability
- Reduced cost

Examples – L2 trunk or L3 ECMP

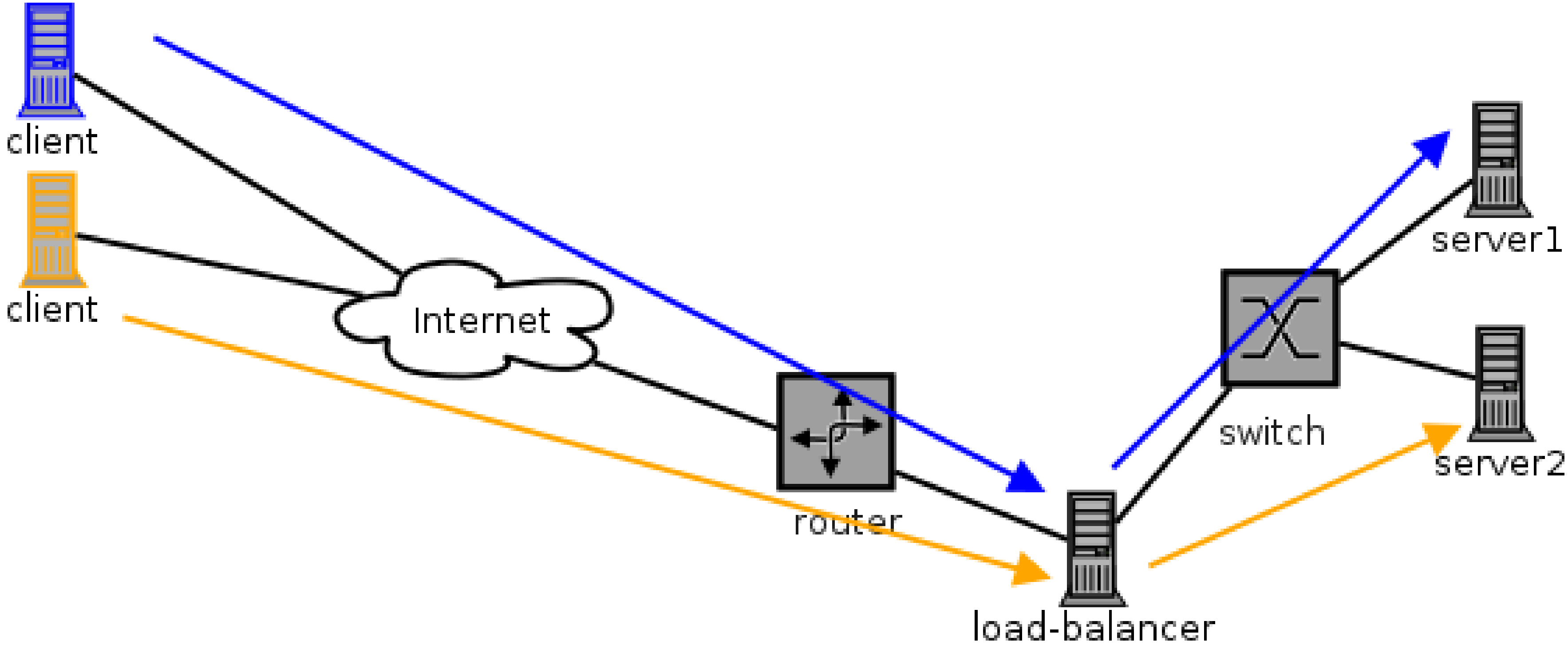
- Stateless per-flow-load balancing
- Per-packet causes reordering so...
- XOR 5-tuple





L3+L4 L4 or L7 Load-balancing

- IP+TCP or Application layer (http(s) imap etc)



Applications

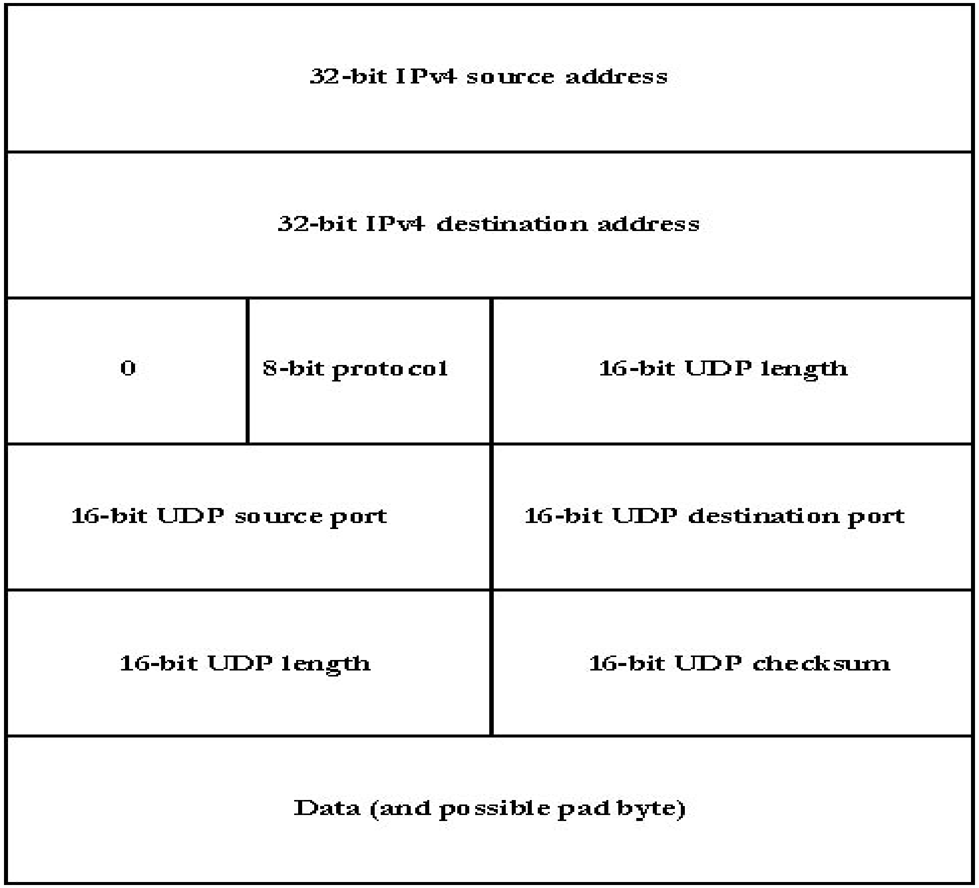
- L2/L3 Switches
  - LACP
  - L3ECMP
- L4+
  - Haproxy (L4, L7)
  - NGINX (L7)
  - F5 LTM
  - A10
  - Netscalar

So what does an L4 load Balancer do.

- Looks and the Destination IP and Port to determine which pool of servers a connections is mount for.
- Forwards the incoming connection to one pool member on the basis of policy.
- Could be one-sided e.g. Direct-Server-Return
- Or Source-NAT
- Keep the connection pinned to the particular pool member by tracking the connection.
- How do you track?

5-tuple

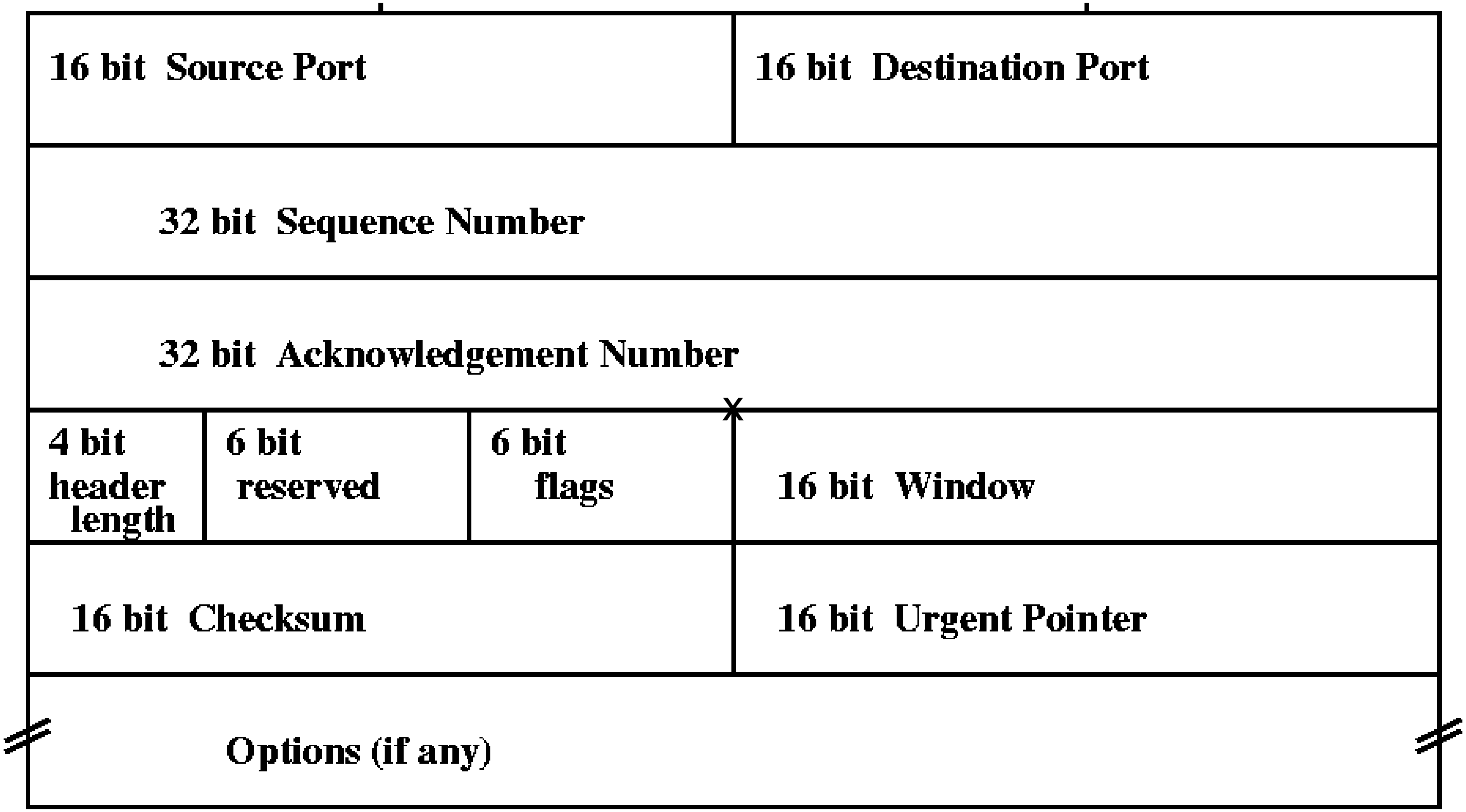
- What is a 5-tuple
- XOR hash of source/dest ip, source/dest port, protocol number.
- IP header



32-bit IPv4 source address		
32-bit IPv4 destination address		
0	8-bit protocol	16-bit UDP length
16-bit UDP source port		16-bit UDP destination port
16-bit UDP length		16-bit UDP checksum
Data (and possible pad byte)		

5-tuple continued

- TCP Headers



16 bit Source Port

16 bit Destination Port

32 bit Sequence Number

32 bit Acknowledgement Number

4 bit header length

6 bit reserved

6 bit flags

16 bit Window

16 bit Checksum

16 bit Urgent Pointer

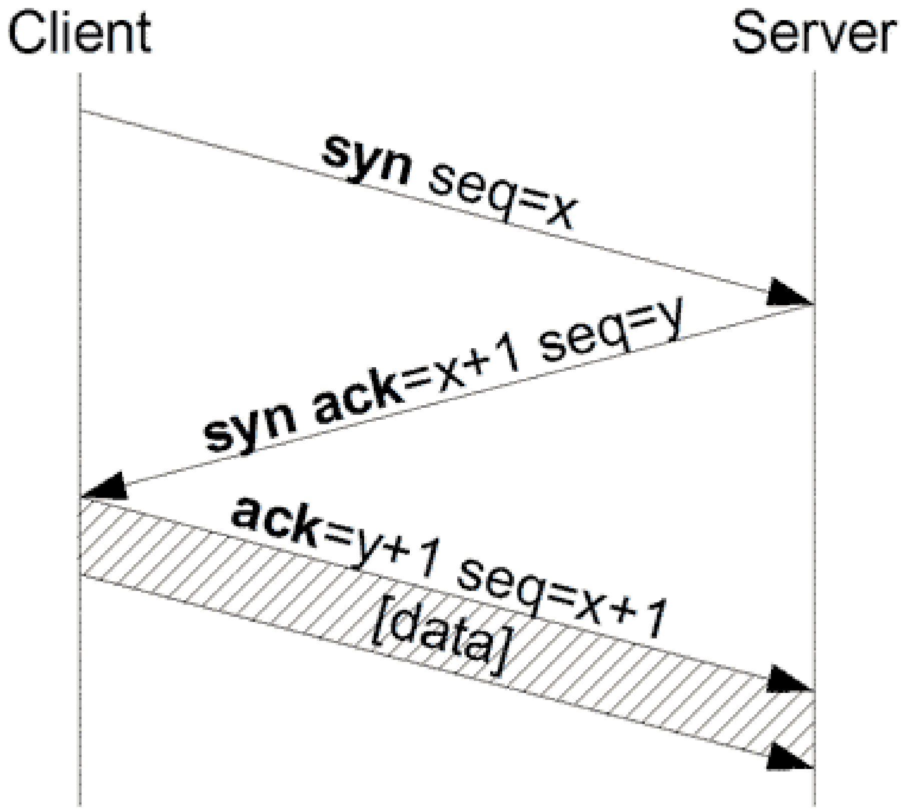
Options (if any)

What does an L7 load balancer do?

- An L7 load balancer answers incoming connection requests.
- It understands the protocol being spoken across the connection (e.g. HTTP IMAP FTP etc).
- On the basis of either 5-tuple hash or some higher layer value, (example a URI or a cookie or both) the request is directed to a member of the appropriate pool.
- L7 is another word for proxy or ALG (Application Layer Gateway).

Isn't L7 going to be slower than L4?

- Probably but not always.
- Importantly there are optimizations that can reduce the expense.
  - TCP syn-cookies
  - Connection pooling
  - Consider 3-way handshake



Applications - Cont

- Open source
  - Apache mod_proxy_balance
  - Haproxy
  - NGNIX
  - LVS

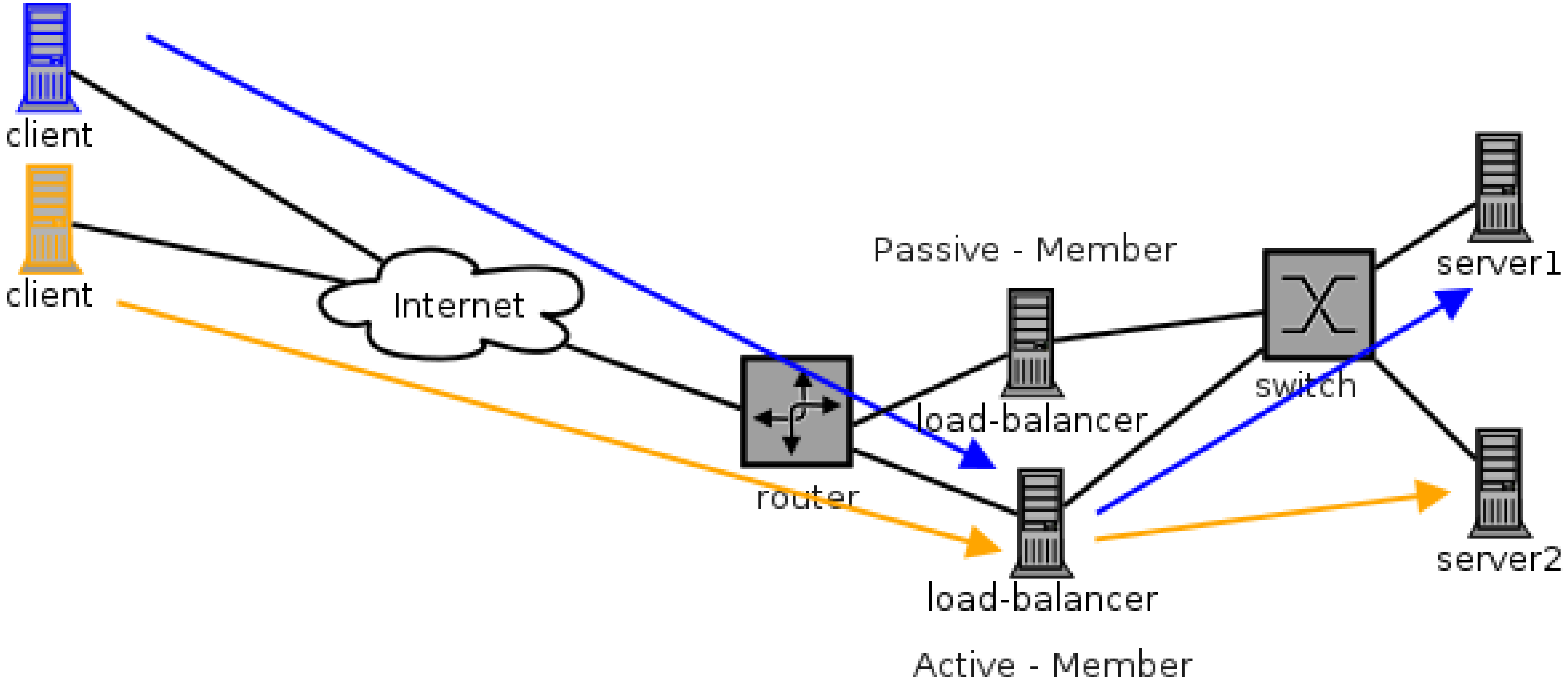
Applications Commercial

- Commercial
  - F5
  - Netscalar
  - A10
- Benefits of a commercial approach
  - Coordination of supporting elements
    - Routing
    - DNS
    - Complex health checks
    - HA
  - Can have ASIC based acceleration.

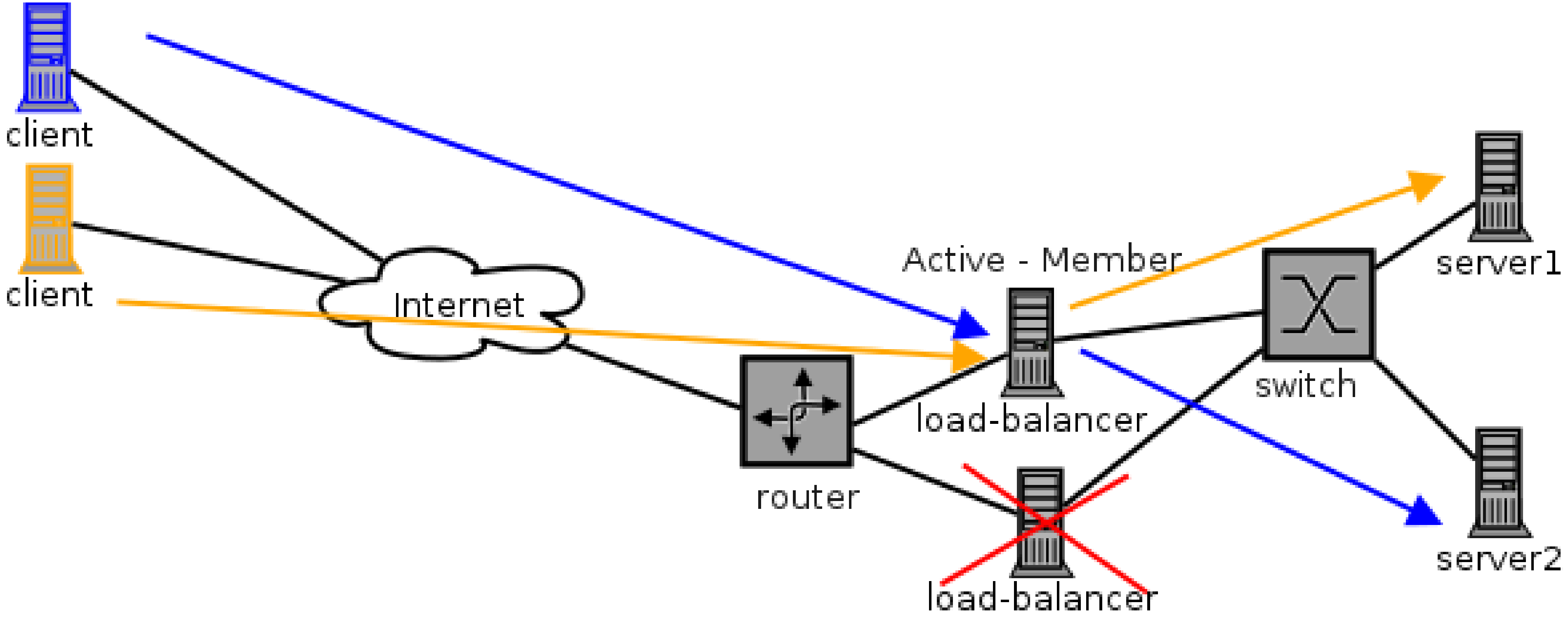
High Availability Approaches

- Active-Passive
  - VRRP
  - State replication
- Active-Active
  - State-replication considerations
- Horizontally scaled
  - GTM – DNS based approach
  - L3ECMP (routed)

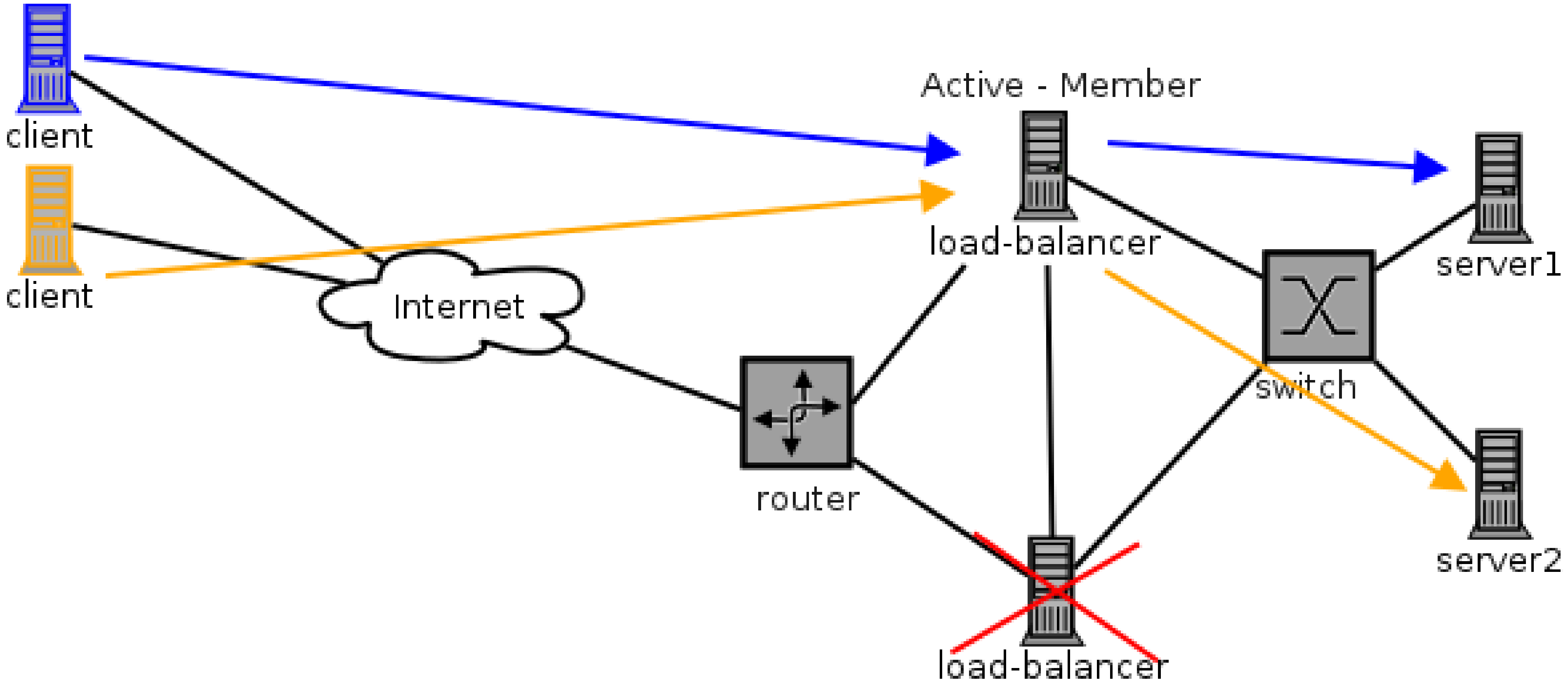
HA – active/passive



HA – active/passive - failover



HA – active/passive failover with replication



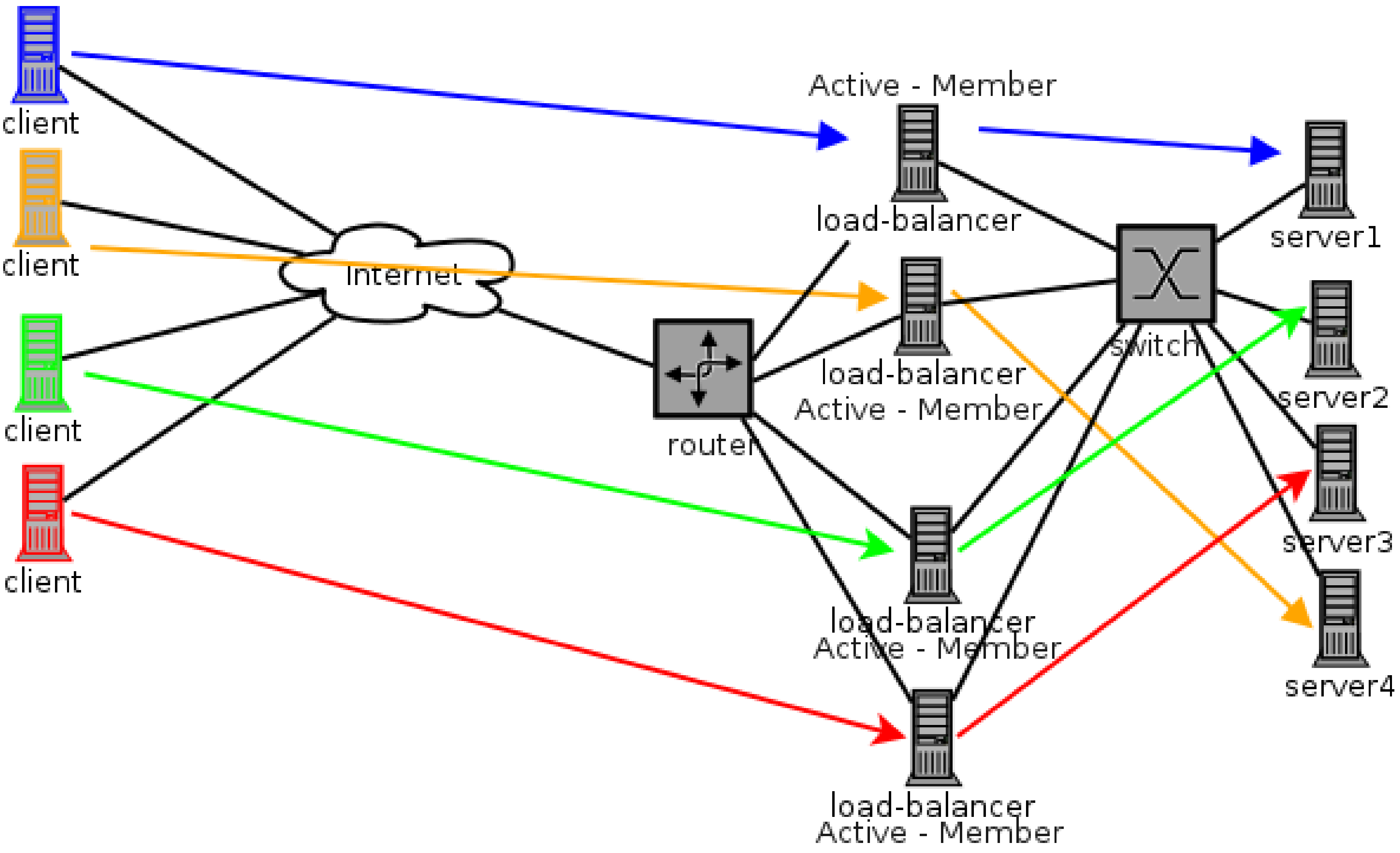
Active / Passive

- Active-passive failover requires a mechanism
- Could use:
  - VRRP (Virtual Router Redundancy Protocol)
  - CARP (Common Address Redundancy Protocol)
- If failover is not coordinated with load-balancer-health, a failed load-balancer may remain active (coordination problem).
- If state is not replicated between load balancers, failover will not account for existing connections (not a problem for short-lived connections with no affinity)

Active / Passive Cont

- Affinity can be preserved with a Cookie
- LVS (linux virtual server) can do state-replication (using a kernel module)
- State-replication doesn't help with scaling performance-wise (at all)

Active/Active



Active/Active – How?

- Need a mechanism to distribute requests to multiple front end load-balancers. In effect, a load balancer for your load balancers.
- HOW?
  - DNS e.g. each LB has a separate ip address associated with resources it's load-balancing
    - Return one or more resource records either randomly or on some externally instrumented basis.
    - Fail load balancers in or out using health check or manually
  - L2 or L3 stateless plus sticky mechanism.

Active/Active – Stateful vs Not

- Stateful is typically done by clusters of commercial load-balancers. State replication can be expensive and imperfect.
    - At scale, can be extremely expensive
    - Memory on cluster members and bandwidth/cpu for replication is the limiting factor for state and connections per section.
- Stateless
    - In the DNS case resource records for a failed LB have to time out of caches before that LB stops being used.
    - In the L3-ECMP case a failure will cause some fraction of connections to rehash across other load-balancers anywhere from a quarter to half (they will then be rendered out of state and lost).

Our Exercise - HAProxy

- We're going to deploy HAProxy to load-balance connections to two http servers.
- HAProxy can do L4 (any TCP) or L7 (HTTP) load balancing
- We're going to do L7, this allows us to access http related features, including for example including a cookie.

HAProxy vs NGINX

- L4 vs L7
- HAProxy can load balance anything over TCP or do L7.
- NGINX is L7 only (HTTP(s) and IMAP/POP3).
- SSL
  - HAProxy doesn't support (can't only treat as TCP)
  - NGINX does, so cookies for example can be parsed, can be used for SSL offload etc.
- Model
  - HAProxy is threaded, effectively allowing it to engage multiple cpus in the activity.
  - NGINX uses an event driven single threaded model.
  - Both have merit, HAProxy is probably more scalable.

Goals

1)Install and perform a basic configuration of HAProxy.

2)Configure two additional webserver instances on alternate ports in Apache.

3)Demonstrate load-balanced-http connections between them.

4)Log X-Forwarded-For.

5)Bonus: use a cookie to pin a requesting host to one server or another.

Bibliography

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