

Computer Networks

Hierarchical Routing (§5.2.6)



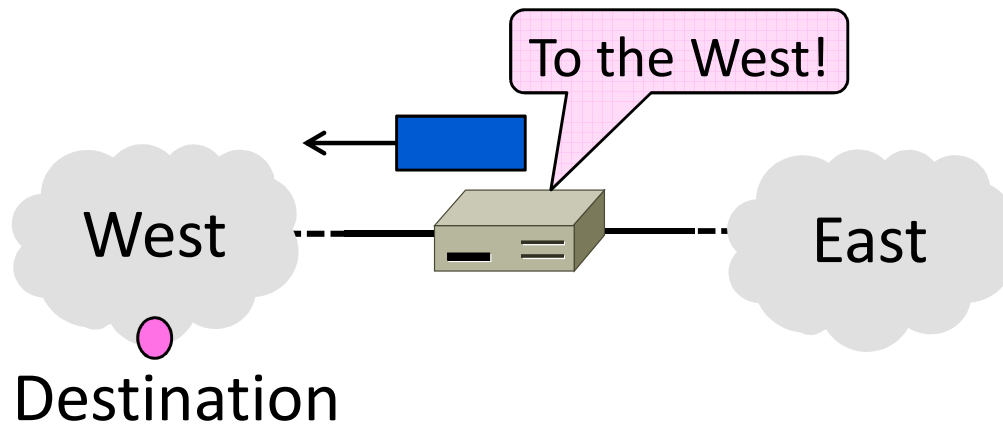
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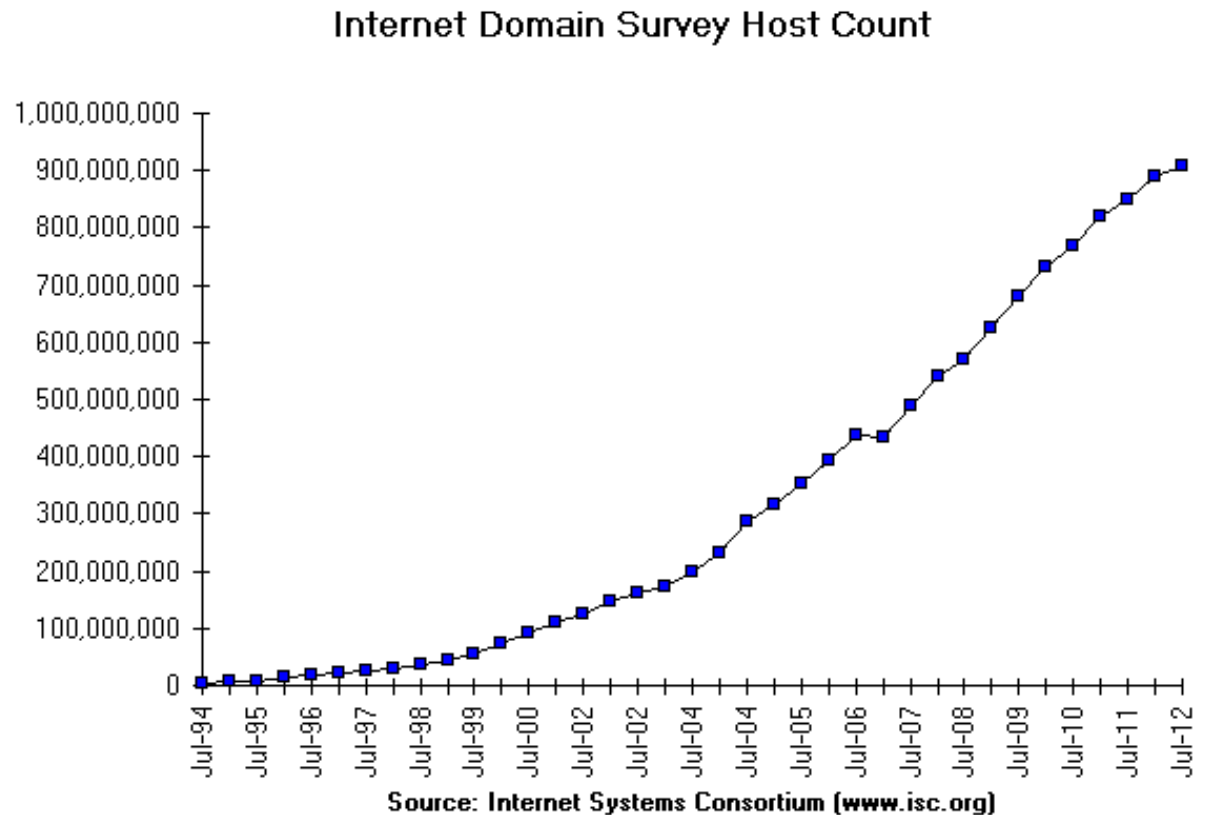
Topic

- How to scale routing with hierarchy in the form of regions
 - Route to regions, not individual nodes



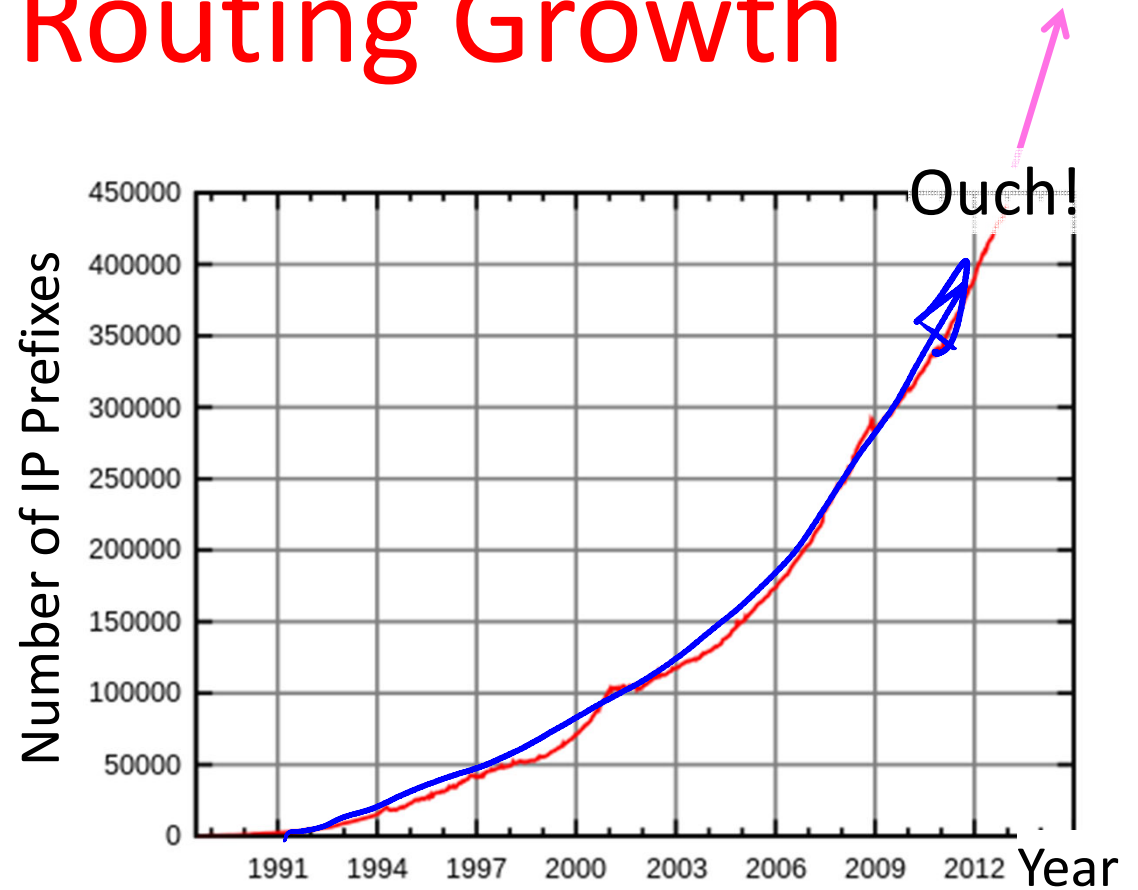
Internet Growth

- At least a billion Internet hosts and growing ...






Internet Routing Growth

- Internet growth translates into routing table growth (even using prefixes) ...









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Impact of Routing Growth

1.  Forwarding tables grow
 - Larger router memories, may increase lookup time
2.  Routing messages grow
 - Need to keep all nodes informed of larger topology
3.  Routing computation grows
 - Shortest path calculations grow faster than the size of the network

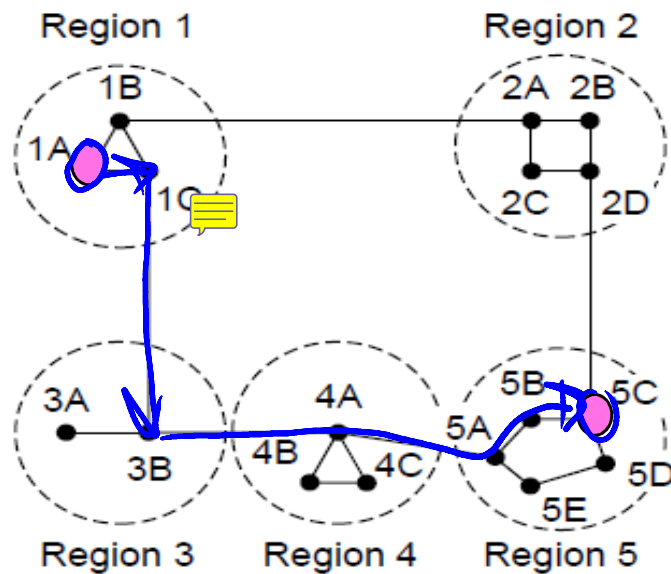
Techniques to Scale Routing

1.  IP prefixes
 - Route to **blocks of hosts** Last time
2.  Network hierarchy
 - Route to **network regions** This time
3.  IP prefix aggregation
 - Combine, and split, prefixes Next time

Hierarchical Routing

- Introduce a larger routing unit
 - IP prefix (hosts) ← from one host
 - Region, e.g., ISP network
- Route first to the region, then to the IP prefix within the region
 - Hide details within a region from outside of the region

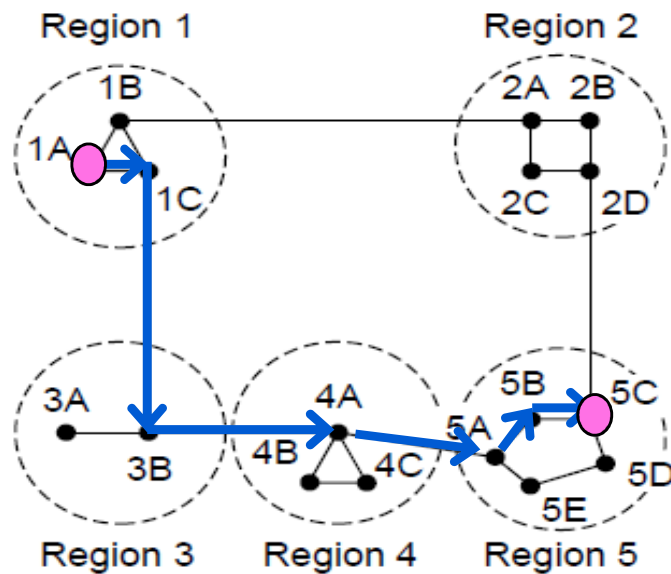
Hierarchical Routing (2)



Dest.	Line	Hops
1A	—	—
1B	1B	1
1C	1C	1
2A	1B	2
2B	1B	3
2C	1B	3
2D	1B	4
3A	1C	3
3B	1C	2
4A	1C	3
4B	1C	4
4C	1C	4
5A	1C	4
5B	1C	5
5C	1B	5
5D	1C	6
5E	1C	5

Dest.	Line	Hops
1A	—	—
1B	1B	1
1C	1C	1
2	1B	2
3	1C	2
4	1C	3
1C	1C	4

Hierarchical Routing (3)



Full table for 1A

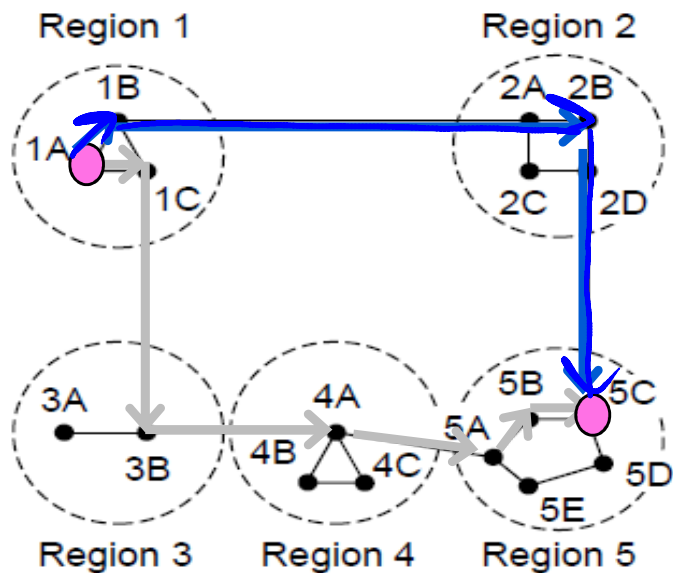
Dest.	Line	Hops
1A	—	—
1B	1B	1
1C	1C	1
2A	1B	2
2B	1B	3
2C	1B	3
2D	1B	4
3A	1C	3
3B	1C	2
4A	1C	3
4B	1C	4
4C	1C	4
5A	1C	4
5B	1C	5
5C	1B	5
5D	1C	6
5E	1C	5

Hierarchical table for 1A

Dest.	Line	Hops
1A	—	—
1B	1B	1
1C	1C	1
2	1B	2
3	1C	2
4	1C	3
5	1C	4

Hierarchical Routing (4)

- Penalty is longer paths



Full table for 1A

Dest.	Line	Hops
1A	—	—
1B	1B	1
1C	1C	1
2A	1B	2
2B	1B	3
2C	1B	3
2D	1B	4
3A	1C	3
3B	1C	2
4A	1C	3
4B	1C	4
4C	1C	4
5A	1C	4
5B	1C	5
5C	1B	5
5D	1C	6
5E	1C	5

Hierarchical table for 1A

Dest.	Line	Hops
1A	—	—
1B	1B	1
1C	1C	1
2	1B	2
3	1C	2
4	1C	3
5	1C	4

1C is best route to region 5, except for destination 5C

Observations

- Outside a region, nodes have one route to all hosts within the region
 - This gives savings in table size,
messages and computation
- However, each node may have a different route to an outside region
 - Routing decisions are still made by individual nodes; there is no single decision made by a region

END

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