Computer Networks (CS425)

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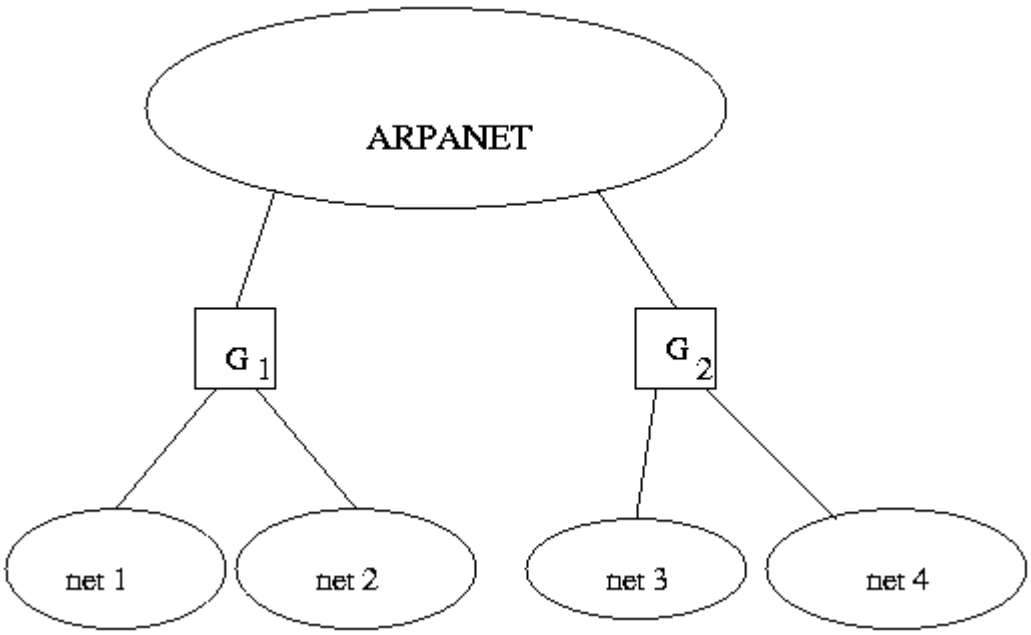
Routing in Internet

The Origin of Internet

The response of Internet to the issue of choosing routing tables with complete/par tail information is shown by the following architecture. There are a few nodes having complete routing information and a large number of nodes with partial information. The nodes with complete information, called core gateways, are well connected by a Backbone Network. These nodes talk to each other to keep themselves updated. The non-core gateways are connected to the core gateways. (Historically, this architecture comes from the ARPANET.)

The original internet was structured around a backbone of ARPANET with several core gateways connected to it .These core gateways connected some Local Area Networks (LANs) to the rest of the network. These core gateways talked to themselves and exchanged routing information's. Every core gateway contained complete information about all possible destinations.



How do you do routing ?

The usual IP routing algorithm employs an internet routing table (some times called an IP routing table) on each machine that Stores the information about the possible destinations, and how to reach them.

Default Routes

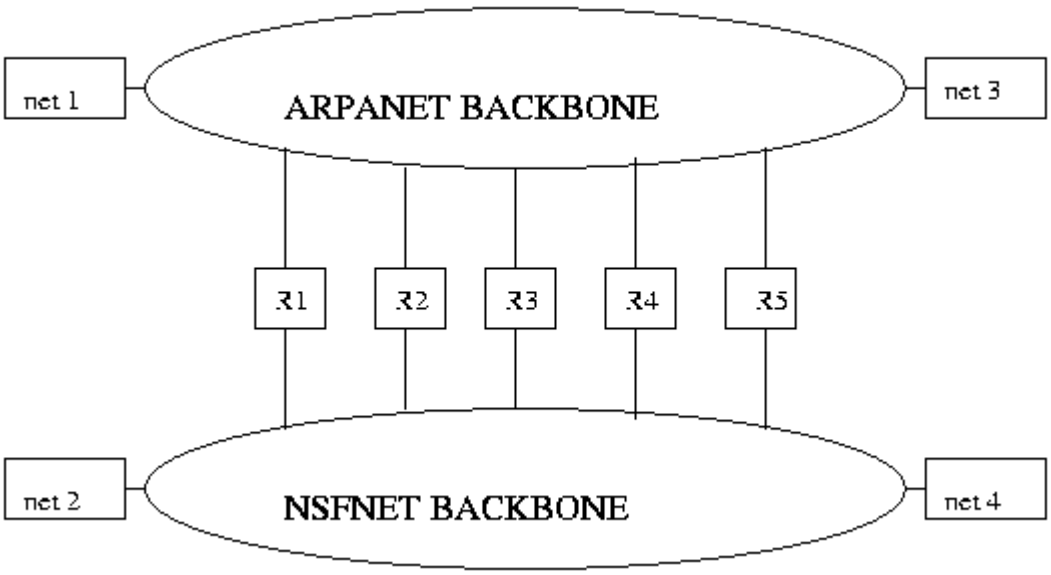
This technique used to hide information and keep routing table size small consolidates multiple entries into a default case. If no route appears in the routing table, the routing routine sends the data gram to the *default router*.

Default routing is especially useful when a site has a small set of local addresses and only one connection to the rest of the internet.

Host-Specific Routes

Most IP routing software allows per-host routes to be specified as a special case. Having per-host routes gives the local network administrator more control over network use, permits testing, and can also be used to control access for security purposes. when debugging network connections or routing tables, the ability to specify a special route to one individual machine turns out to be especially useful.

Internet with Two Backbones

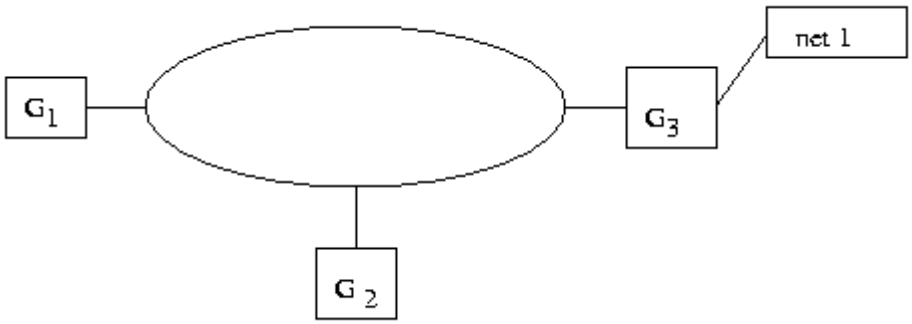


As long as there was just one single router connecting ARPANET with NSFNET there was no problem. The core gateways of ARPANET had information about all destinations and the routers inside NSFNET contained information about local destinations and used a default route to send all non-NSFNET traffic to between NSFNET and ARPANET as both of them used different matrices to measure costs. the core gateways through the router between ARPANET and NSFNET. However as multiple connections were made between the two backbones, problems arise. Which route should a

packet from net1 to net2 take? **Should it be R1 or R2 or R3 or R4 or R5?** For this some exchange of routing information between the two backbones was necessary. But, this was again a problem as how should we compare information.

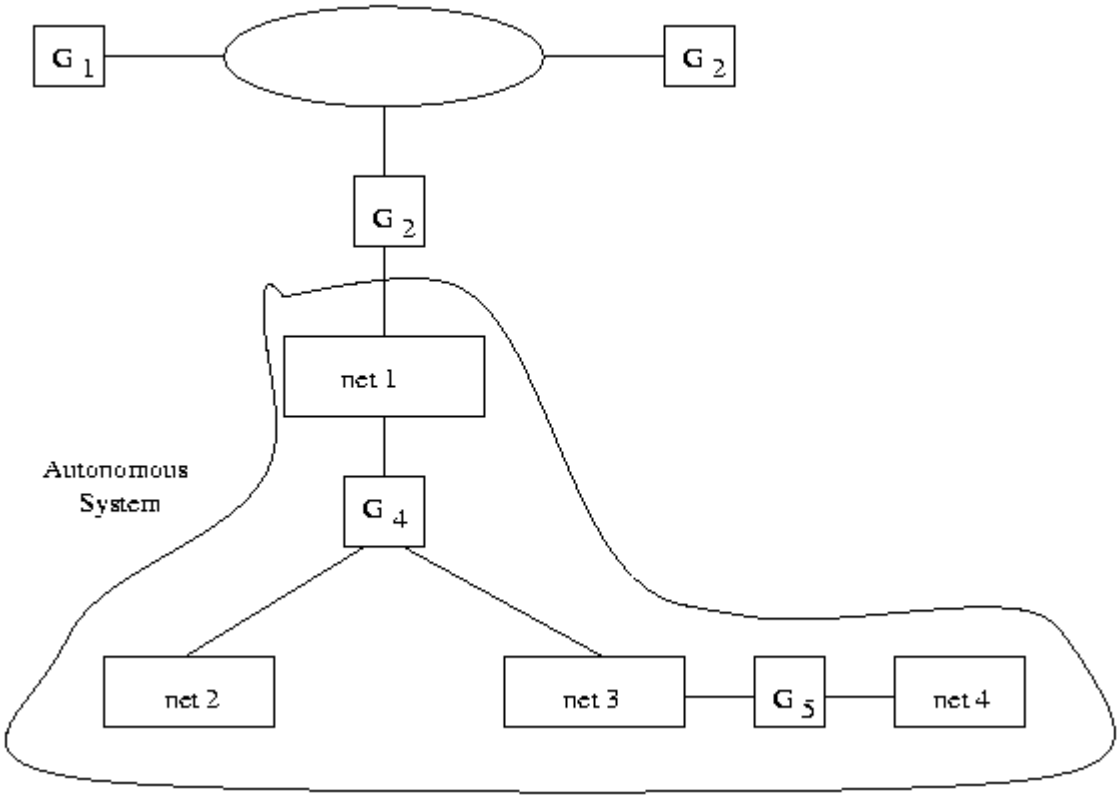
Gateway-To-Gateway Protocol (GGP)

This was the protocol used by the core-routers to exchange routing information among themselves. This is based on ***Distance Vector Algorithm*** and uses number of hops as the distance metric. This is a very poor metric as this does not take into account the load on the links and whether a link is slow or fast. A provision is made to manually increment the hop count in case a link is particularly slow.A protocol based on Shortest Path First Algorithm , known as **SPREAD** ,was also used for the same purpose.



Added Complexity To The Architecture Model

As the number of networks and routers increased, to reduce the load on the core gateways because of the enormous amount of calculations, routing was done with some core gateways keeping complete information and the non-core gateways keeping partial information.



In thisarchitecture, G_1 ,G_2 ,G_3 are all core gateways and G_4 and G_5 are non-core gateways. We must have a mechanism for someone to tell G_2 that it is connected to net2 , net3 and net4 , besides net1. Only G_5 can tell this to G_2 and so we must provide for a mechanism for G_2 to talk to G_5 . A concept of one backbone with core gateways connected to *Autonomous Systems* was developed. An *Autonomous system* is a group of networks controlled by a single administrative authority. Routers within an autonomous system are free to choose their own mechanisms for discovering , propagating ,validating , and checking the consistency of routes. Each autonomous system must agree to advertise network reachability information to other autonomous systems. Each advertisement propagates through a core router. The assumption made is that most of the routers in the autonomous system have complete information about the autonomous system. One such router will be assigned the task of talking to the core gateway.

Interior Gateway Protocols (IGP)

IGP is a type of protocols used by the routers in an autonomous system to exchange network reachability and routing information. Some of IGPs are given below.

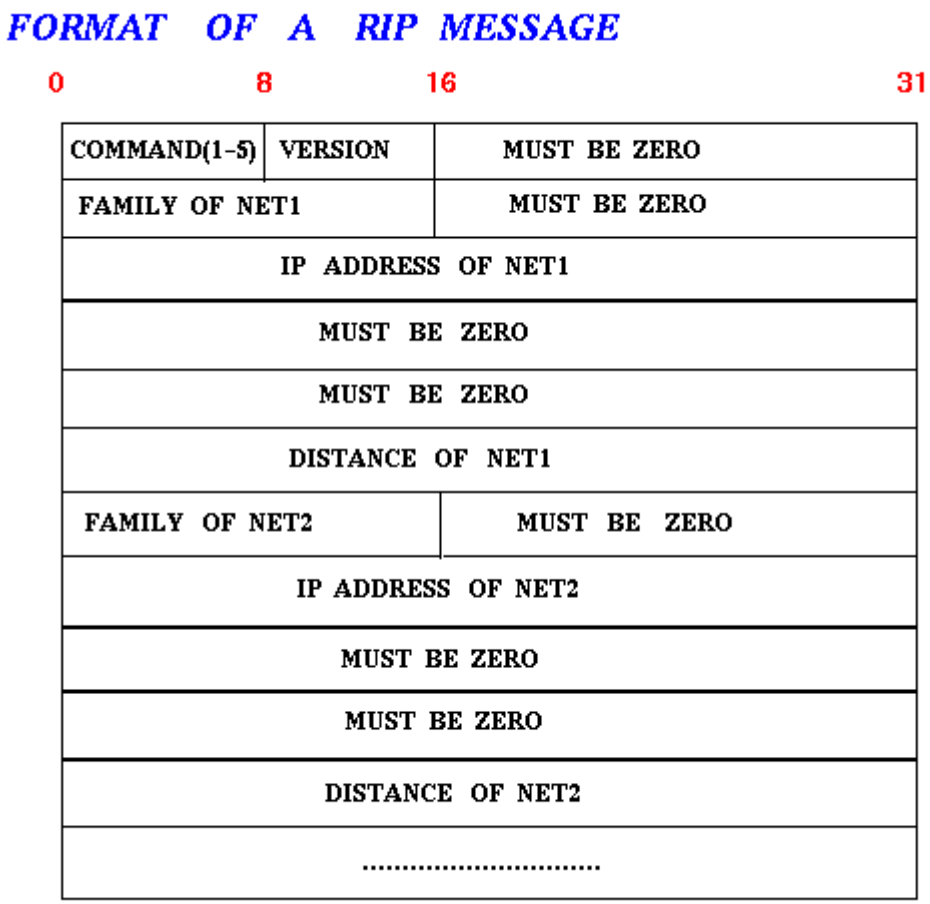
Routing Information Protocol (RIP)

This is one of the most widely used IGP. It was developed at Berkeley. This is also known by the name of the program that implements it, routed .This

implements Distance Vector algorithm.Features of RIP:

- RIP uses a hop count metric to measure the distance to a destination. To compensate for differences in technologies, many RIP implementations allow managers to configure artificially high hop counts when advertising connections to slow networks. All routinfg updates are broadcast. This allows all hosts on the network to know about the routes.
- To prevent routes from oscillating between two or more equal cost paths, RIP specifies that existing routes should be retained until a new route has strictly lower cost. Since RIP does not explicitly detect routing loops, RIP must either assume participants can be trusted (being part of one autonomous system) or take precautions to prevent such loops.
- To prevent instabilities, RIP must use a low value for the maximum possible distance.RIP uses 16 as the maximum hop count. This restricts the maximum network diameter of the system to 16.
- To solve the slow convergence problem arising due to slow propagation of routing information, RIP uses Hold Down. If a particular link is down , any new information about that link is not accepted till some time. This is because the router must wait till the information aboutthe link being down propagates to another router before accepting information from that router about that down link.
- RIP runs on top of TCP/IP. RIP allows addresses to be of a maximum size of 14 Bytes. The Distance varies from 1 to 16 (where 16 is used to signify infinity). RIP address 0.0.0.0 denotes a default route. There is no explicit size of the RIP message and any number of routes can be advertized.

The message format is as shown:

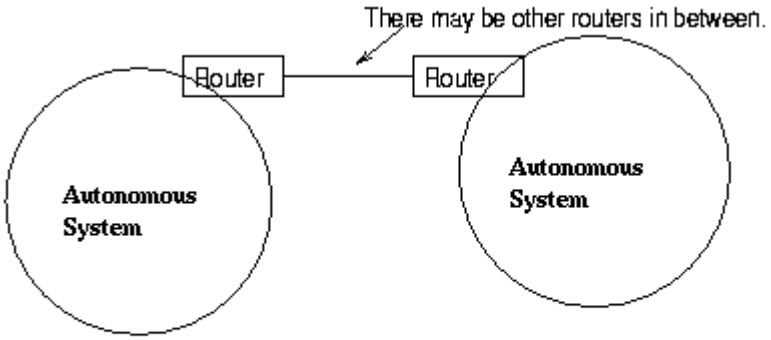


OSPF(Open Shortest Path First)

This is an Interior Gateway Protocol designed by the Internet Engineering Task Force (IETF). This algorithm scales better than the vector distance algorithms. This Protocol tackles several goals:

- OSPF includes type of service(ToS) routing. So, you can installmultiple routers to a given destination, one for each type of service. When routing a datagram, a router running OSPF uses both the destination address and type of service fields in the IP Header to choose a route.
- OSPF provides load balancing. If there are multiple routes to a given destination at the same cost, OSPF distributes traffic over all the routes equally.
- OSPF allows for creation of AREA HIERARCHIES. This makes the growth of the network easier and makes the network at a site easier to manage. Each area is self contained, so, multiple groups within a site can cooperate in the use of OSPF for routing.
- OSPF protocol specifies that all exchanges between the routers be authenticated. OSPF allows variety of authentication schemes, and even allows one area to choose a different scheme from the other areas.
- To accomodate multi-access networks like ethernet, OSPF allows every multi-access network to have a designated router(designated gateway).
- To permit maximum flexibility, OSPF allows the description of a virtual

network topology that abstracts away from details of physical connections.
- OSPF also allows for routers to exchange routing information learned from other sites. The message format distinguishes between information acquired from external sources and information acquired from routers interior to the site, so there is no ambiguity about the source or reliability of routes.
- It hastoo much overhead of sending LSPs but is gradually becoming popular.



Two routers may be configured to think they are neighbours

Exterior Gateway Protocol (EGP)

If two routers belonging to two different autonomous systems exchange routing information ,the protocol used is called EGP . EGP consists of:

- **Acquisition Request:** A router sends a request to another neighbour router saying 'I want to talk'.
- **Acquisition Confirm:** This is a positive reply to the Acquisition request.
- **Acquisition Refuse:** This is a negative response to the Acquisition request.
- **Cease Request:** This requests termination of neighbour relationship.
- **Cease Confirm:** This is a confirmation response to the Cease Request.
- **Hello :** This is used to find if the neighbour router is up or down.This requests router to respond if alive.
- **I Heard You:** This is a response to the Hello message confirming that the router is alive. Because it is possible for Hello or I Heard You messages to be lost in transit, EGP uses a k-out-of-n rule to determine whether a network is down.At least k of the last n messages must fail for the router to declare its neighbour down.
- **Poll Request:** This is a request for network routing update.
- **Routing Update:** This conveys routing information about reachable networks to its EGP neighbour. The routing information is the distance vector of the reachable networks.
- **Error:** This is a response to an incorrect message.

EGP is used only to find network reachability and not for differentiating between good and bad routes. We can only use distance metric to declare a

route plausible and not for comparing it with some other route (unless the two route form part of a same autonomous system). Since there cannot be two different routes to the same network, EGP restricts the topology of any internet to a tree structure in which a core system forms the root. There are no loops among other autonomous systems connected to it. This leads to several problems:

- Univerasal connectivity fails if the core gateway system fails.
- EGP can advertise only one path to a given network.
- EGP does not support load sharing on routers between arbitrary autonomous systems.
- Multiple backbone networks with multiple connections between them cannot be handled by EGP.

Border Gateway Protocol(BGP)

BGP is a distance-vector protocol used to communicate between different ASes. Instead of maintaining just the cost to each destination,each BGP router keeps track of the exact path used.Similarly,instead of periodically giving each neighbour its estimated cost to each destination, each BGP router tells its neighbours the path it is using.Every BGP router contains a module that examines routes to a given destination and scores them returning a number for destination to each route. Any route violating a policy constraint automatically gets a score of infinity. The router adapts a route with shortest distance.The scoring function is not a part of the BGP protocol and can be any function that the system managers want.BGP easily solves the count to infinity problem that plagues other distance-vector algorithms as whole path is known.

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