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Study of Shortest Path Routing Protocols

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ABSTRACT

The purpose of any routing protocol is to efficiently distribute dynamic topological information among its participants to facilitate routing calculations upon which packet forwarding decisions are then based. Due to the shortage of RIP protocol, OSPF protocol is used in large network. It is a dynamic routing protocol used in Internet Protocol networks. Specifically, it is a link-state routing protocol and falls into the group of interior gateway protocols, operating within a single Autonomous system. OSPF was designed to support Variable-length subnet masking (VLSM) or Classless Inter-Domain Routing (CIDR) addressing models. OSPF detects changes in the topology, such as link failures, very quickly and converges on a new loop-free routing structure within seconds. There are two types of routing-Link State routing and Distance Vector routing. The topology of the network can be generated by collecting the OSPF messages. In this paper, we also give evaluation of OSPF routing protocols for IPv6.

KEYWORDS: OSPF, RIP protocol, Link State Routing, Distance Vector Routing

1. INTRODUCTION

Due to the shortage of RIP protocol, OSPF protocol is used in large network. OSPF is shortened form of Open Shortest Path First. The following are typical scenarios for using OSPF:

1. **When a single router or communications server must accommodate different sized TCP/IPnetworks:** Increasingly, ISPs need to divide or combine subnets to ensure the most efficient use of TCP/IP addresses. This capability, called variablelength subnet masks (VLSM) or "classless" networking is supported by OSPF. In contrast, RIP does not allow a network to be segmented or combined with others to create networks of different sizes.

2. **When routing changes need to be propagated quickly:** RIP can create too much network downtimeby taking too long to update routers with networkchanges; RIP needs a hold-down period toensure that information it has generated has beenproperly propagated through the network. If a networkhas many routers, RIP updates can take severalminutes to alert the entire network to the failureof a single router. OSPF updates are muchfaster than RIP updates.

3. **When more than 15 hops between routers are required:** More than 15 hops might be a requirementin some larger networks. RIP will only support15 hops between routers, but OSPF can supportup to 255 hops.

4. **When routing advertisements need to be password-protected to prevent network instability or sabotage:** OSPF has packet authenticationcapability; RIP does not [1].

2. ROUTING PROTOCOLS BACKGROUND

The purpose of any routing protocol is to efficiently distribute dynamic topological information among its participants to facilitate routing calculations upon which packet forwarding decisions are then based. In a link-state routing protocol such as OSPF, each router is independently responsible for describing the state of its local neighborhood(e.g. links to neighboring networks, routers, and hosts) to the rest of the network [2].

In OSPF, the first step in the exchange of routing information is the creation of ***adjacencies*** between neighboring routers. A router first uses a Hello Protocol todiscover its neighbors. Once neighbor routers have 'met' via the Hello Protocol, then they go through a database exchange process to synchronize their databases with one another. Only then neighbor routers can become adjacent and exchange routing protocol information.

Information about the state of a router's local neighborhood is then assembled into a ***link-stateadvertisement*** (LSA), which is then distributed to every other router by reliable intelligent flooding. The basic flooding process is straightforward: upon receiving an advertisement from a neighbor, a router acknowledges receipt of the advertisement and, if new, forwards the advertisement to all other neighbors. Thus, after a short period of convergence, each router in the network will have an identical topological database of LSAs to be used for routing calculations.

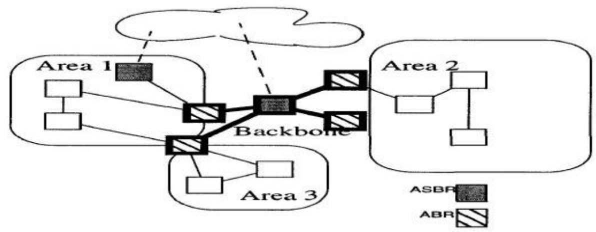

Figure 1. OSPF Terminology

OSPF is an interior routing protocol, designed to be used within a single *autonomous system* (AS). OSPF allows the AS to be divided into groups of networks called *areas.* Each area runs a separate copy of the basic link-state algorithm, and the topological details of the area are hidden from the rest of the AS, reducing routing traffic. All areas are connected by a single *backbone* area, in a logical hub and spoke configuration. Routers belonging to a single area are called *internalrouters.* Routers which belong to more than one area are called *area border routers* (ABRs). All ABRs belong to the backbone by definition. Any router which exchanges routing information with an external AS is called an *AutonomousSystem Boundary Router* (ASBR).

OSPF defines five*link-stateadvertisement*(LSA) types which correspond to router's respective roles. All routers generate *router links* (type 1) LSAs for each area they belong to, which describe the state and cost of a routers links to that area. Designated routers generate *network links* (type *2)* LSAs which describe all routers attached to the transit network (subnet). ABRs generate *summary link* (type *3* &4) LSAs, which inject into an area a single destination (a network or ASBR respectively) outside of that area. ASBRs generate *AS External* (Type *5)* LSAs, which describe a single destination external to the AS. Of the five types, only AS external LSAsare flooded throughout the AS, all others are only flooded within a single area. To prevent problems caused by 'immortal' LSAs, each contains an *age* field. An LSA's age is constantly incremented, both while being flooded and while installed in any link-state database. If an LSA's age reaches the value *MaxAge*(defined as one hour), it is removed from the router's link-state database and reflooded as a signal for other routers to remove it. An LSA's originator congestion the LSA from the system at any time by prematurely setting the LSAs age to MaxAge and flooding it. It is possible for more than one instance of an LSA to exist in the system at any one time. Thus each LSA has a *sequence number* When encountering multiple instances, the LSA with the greatest sequence number is considered newer. If the sequence numbers are equal, the age field and finally checksum are used as tie-breakers[3].

3. INTERIOR ROUTING PROTOCOLS

Interior routing protocols are classified into two categories: distance vectors [4] and link state routing protocols. Link state routing protocols maintain a complete map of the network and associate a cost value with links between routers; these costs are used to determine the best route for forwarding data, typically the lowest cost path to a destination. [6]. Distance vector routing uses distance to the destination as the key routing consideration, this distance is typically the number of intervening routers or hops necessary to reach the destination using a given interface. Distance vector routing protocols typically favor the shortest paths available causing routers to forward packets out of interfaces which have shorter hop counts to the destination [8][9]. Routers periodically share routing information by flooding to neighboring routers; each recipient router uses this information to update their routing table before passing it on to other routers [10].

OSPF performs routing calculations based upon data stored within a Link State Database (LSDB)[11]; this database is a logical tree structure of the network topology. The Dijkstra's algorithm is used to determine the shortest path from the source to the destination within the LSDB using the accumulating cost of links in the path [12]. The cost of a link is calculated based upon the bandwidth of the link; with higher bandwidths being allocated a lower cost, this can be manually changed by a network administrator. The LSDB is maintained by routers who regularly send hello packets out their interfaces to neighbor routers and wait for a reply. If a reply has not been received within the time limit, the link state will change to down and the LSDB will be updated . OSPF routers inform the network of changes to the LSDB using Link State Advertisements (LSA), these are flooded to routers in the same area periodically or whenever there is a change in a network link. Network topology changes must be reflected in the LSDB to ensure consistent routing throughout the network; once a LSA is received the router updates their copy of the LSDB and recalculates route costs accordingly. The OSPF protocol uses a hierarchical structure which is split into areas to ensure that the LSDB of an area does not grow too large; using excessive bandwidth, memory and processing power to remain accurate.

The hierarchical structure also helps to ensure that network performance is not degraded in large OSPF domains by limiting routing traffic flooding and LSA to within the routers current area . Each area in OPSF is labelled with a unique 32 bit area ID, which are dotted decimal format and not compatible with IPv4 addresses, Area 0 is the backbone area of an OSPF domain, all OSPF areas need to connect to this backbone area; which manages all inter-area routing. OSPF has a number of advantages which make it a very popular routing protocol; it features rapid convergence when a topology changes and will support several routes to a destination with different costing associated with each route, this means that backup routes will be available if a route goes down. Another advantage is the hierarchical nature of the protocol; this allows OSPF networks to scale very well with negligible impact upon routing overhead. However the memory requirements on routers to maintain the LSDB can become an issue especially in larger OSPF areas where large numbers of nodes need to be stored in the LSDB tree and shared using LSA which adds to routing overhead. Another problem with the OSPF protocol is the difficulty in configuring and managing areas which can be configured in a number of ways such as stubby or transit areas, this adds to the complexity of deploying the protocol.

4. IMPLEMENTATION CONSIDERATIONS

Operating multiple protocols on a network is possible but has numerous issues which must be considered;

- Protocol interoperability: protocols are not designed to interoperate with one another; the metrics used by the different protocols may result in different paths to a destination being selected or the creation of routing loops.
- System resources: additional CPU and memory will be required to maintain multiple routing tables and process updates.

Due to these issues it is often ideal to select a single routing protocol per autonomous system, although this is not always possible in every situation. Examples include networks which require both IPv4 and IPv6 routing or situations such as an organization merger where multiple protocols are in use as different systems are brought together, alternatively departments with different network administrators may feature different protocols. From the strengths and weaknesses identified it can be argued that OSPFv3 [5] will be most appropriate deployed in large networks which can make best use of its hierarchical nature and benefit from the scalability of the protocol, as well as networks which face budgetaryconstraints due to the flexibility of the hardware which the protocol can be deployed upon.

CONCLUSION AND FUTURE SCOPE

The new features and changes of these protocols have been highlighted and discussed; the strengths and weaknesses of protocol have also been evaluated. So paper has OSPF protocol study in detailed along with the disadvantages of OSPF -Difficult to configure and more memory requirements. Finally, we compared the IPv4 and IPv6 versions of popular routing protocol OSPF identifiedthe changes made to these protocols to incorporate IPv6 Support. OSPF has advantages in large networks where its hierarchical nature increases scalability. Future work will involve collecting performance data such as network throughput, convergence speed or CPU and memory utilization for networks operating the IPv6 routing protocols. OSPF can be used in various real life problems of traffic, road map, goggle map, genetic engineering, biotechnology etc. where directed and undirected graph problems are solved with help of OSPF protocol.

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