A Review of IS-IS Intrarouting Protocol

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Abstract- Need of global networking is increasing day by day and is as a primary need. This paper state the issues related to Intermediate System to Intermediate System (IS-IS) routing protocol, currently that supports routing of Internet Protocol version 4 (IPv4) and 6 (IPv6) and study both the strong and weak points of IS-IS routing protocol. This paper illustrate the working of IS-IS and issues (Routing, addressing, packet format, area and domain) related to IS-IS because it will be helpful for understanding the key things related to IS-IS. There are various intra routing protocols among which OSPF is very popular but IS-IS is more flexible than OSPF. This paper also gives some prospective ideas that why we can't ignore IS-IS. This paper also describe the issues that are related to different resources utilization in IS-IS and in similar link state routing protocol such as OSPF and describe the proper difference why and in which situations IS-IS is better than OSPF.

Keywords- (IPv4), IS-IS, OSPF.

I. INTRODUCTION

A span of interconnected routers operated and managed by the same administrative group is referred to as an autonomous system of routers or a routing domain. Such a system of routers allows forwarding of data traffic from one location to the other. When there is a concept of different autonomous systems, there also arise issues for connection or communication with one system to another and also within an autonomous system. The two basic types of routing protocols follow: Interior Gateway Protocols (IGPs)-Optimized only for operation within a single network domain. IGPs are also known as intradomain routing protocols. Exterior Gateway Protocols (EGPs)-Optimized for exchange of routing information between domains [2]. EGPs are also referred to as interdomain routing protocols.

Now concentrating on IS-IS, IS-IS is a link-state routing protocol, meaning that it operates by reliably flooding topology information throughout a network of routers. Each router then independently builds a picture of the network's topology. Packets or datagrams are forwarded based on the best topological path through the network to the destination. IS-IS is designed by International Organization for Standardization (ISO). The protocol was first defined to route Connection Less Network Protocol (CLNP), the Open Systems Interconnection (OSI) stack equivalent to IP. However, IS-IS is designed in such a manner that it can easily be extended to support routing of any layer three protocol. The support for IP was specified by the Internet Engineering Task Force (IETF) 1990 and the extensions for IPv6 were introduced in 2000[4].

Because of ease in extendibility, the motivation for implementing the IS-IS routing protocol was to provide the open source community with a version of IS-IS that supports IPv6, and thus in a small part help in the deployment of IPv6 [4].

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This paper firstly overviews IS-IS then its working steps after that in 3rd section it describes integrated IS-IS features, security etc. After that in next section comparison of IS-IS with OSPF is described and in finally conclusion about this paper is given.

II. IS-IS OVERVIEW

Following section gives a summarized description of IS-IS routing protocol and its components. Protocol description and algorithm specification are excerpted from ISO/IEC 10589 and RFC1195 documents. Intermediate System to Intermediate System protocol (IS-IS) is an intra-domain OSI dynamic routing protocol specified in ISO 10589. The protocol is designed to operate in OSI Connection-less Network Service (CLNS). Data is carried using the protocol specified in ISO 8473. The intra-domain IS-IS routing protocol is intended to support large routing domains consisting of combinations of many types of sub networks (i.e.: media types). In order to support large routing domains, provision is made for Intra-domain routing to be organized hierarchically. A large domain may be administratively divided into areas. Each system resides in exactly one area. Routing within an area is referred to as Level 1 routing. Routing between areas is referred to as Level 2 routing [6].

Level 2 Intermediate Systems keep track of the paths to destination areas. Level 1 Intermediate Systems keep track of the routing within their own area. For a packet destined to another area, a level 1 Intermediate System sends the packet to the nearest level 2 IS in its own area, regardless of what the destination area is. Then the packet travels via level 2 routing to the destination area, where it again travels via level 1 routing to the destination.

Now some issues related to integrated IS-IS are:-RFC 1195, Also called "DUAL IS-IS"

A proper superset of IS-IS, with new options and a new SPF algorithm.

Standard IS-IS implementations are required to ignore unknown options, so running Dual IS-IS won't break standard IS-IS that's already in place and working.

Uses the standard IIH handshake method, but with additional options for IP info

Uses standard controlled flooding algorithms without modification (except that LSPs contain new options for IP info). [6].

2.1- Working steps

1- Each IS-IS router distributes information about its local state (usable interfaces and reachable neighbors, and the cost of using each interface) to other routers using a Link State PDU (LSP) message. Each router uses the received messages to build up an identical database that describes the topology of the AS.

2- From this database, each router calculates its own routing table using a Shortest Path First (SPF) or Dijkstra algorithm. This routing table contains all the destinations the routing protocol knows about,

associated with a next hop IP address and outgoing interface.
3- The protocol recalculates routes when network topology changes, using the Dijkstra algorithm, and minimizes the routing protocol traffic that it generates.
It provides support for multiple paths of equal cost. It provides a multi-level hierarchy (two-level for IS-IS) called "area routing," so that information about the topology within a defined area of the AS is hidden from routers outside this area. This enables an additional level of routing protection and a reduction in routing protocol traffic.
All protocol exchanges can be authenticated so that only trusted routers can join in the routing exchanges for the AS [5].

III. INTEGRATED IS-IS

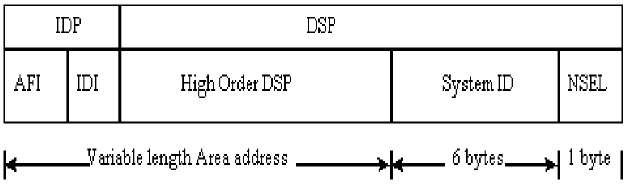
Intra-Domain IS-IS Routing Protocol, which may be used as an interior gateway, protocol (IGP) to support TCP/IP as well as OSI. This allows a single routing protocol to be used to support pure IP environments, pure OSI environments, and dual environments. There are two main methods that are available for routing protocols to support dual OSI and IP routers. One method, known as "Ships in the Night", makes use of completely independent routing protocols for each of the two protocol suites. This specification presents an alternate approach, which makes use of a single integrated protocol for interior routing (i.e., for calculating routes within a routing domain) for both protocol suites. By supporting both IP and OSI traffic, this integrated protocol design supports traffic to IP hosts, OSI end systems, and dual end systems. This approach is "integrated" in the sense that the IS-IS protocol can be used to support pure-IP environments, pure- OSI environments, and dual environments [6]. In addition, this approach allows interconnection of dual (IP and OSI) routing domains with other dual domains, with IP-only domains, and with OSI-only domains.

3.1- Default Routing

Default routing is achieved in two distinct ways with Integrated IS-IS:
Attached-bit: set by a level-1-2 router in its own Level-1 LSP and used to indicate all Level-1 routers (within the area) that this router is a potential exit point of the area.
Default information originating: configured in any kind of router (level-1 as well as level-2). The default route (0.0.0.0/0) is inserted in the router LSP (level-1 or level-2, according to the configuration command) and the LSP is flooded according to the router type (level-1 or level-2).
Level-1 routers will always prefer the explicit default route (0.0.0.0/0) found in an LSP before considering the attached bit [6]

3.2- Integrated IS-IS and CLNS addressing

ISO/IEC 10589 distinguishes only 3 fields in the NSAP format. This simplifies the address structure originally defined in ISO/IEC 8348 appendix A.
The 3 components are:
Area Address. This is a Variable Length field composed of high order octets of the NSAP excluding the SystemID and SEL fields. The area address is associated with a single area within the routing domain.
SystemID. The System Identifier defines an ES or IS in an area. Cisco implements a fixed length of 6 octets for the System ID, in compliance with version 2.0 of US GOSIP.
NSEL. This is the NSAP selector, also designated as N-selector. It is the last byte of the NSAP and identifies a network service user. A network service user is a transport entity or the IS network entity itself.



NSAP Format for use with Integrated IS-IS

An NSAP with 0 NSEL value is called a Network Entity Title (NET). A NET is used to denote the network entity or the routing layer. Note that the AFI filed describes format and length of the IDI (and therefore the format of the rest of the NSAP) [6].
For example- AFI =49 Addresses starting with value 49 are considered as local addresses (as network 10.0.0.0/8 in IP). These addresses are routed by IS-IS routing protocol. However, there should not be advertised to other CLNS networks. With AFI 49 the IDI value is null and IDP length is 2 digits.

Hierarchy: Areas and Domains

While deploying Integrated IS-IS with one single area, a choice can be made between a single level-1 Area and a single Level-2 Area. In both cases all routers are configured as part of the same area and will maintain a single Link-State Database. In a single level-1 area all routers will be configured in order to behave as level-1-only routers, while in a level-2 configuration, all routers will behave as level-2 routers [3]. All routers will have to maintain a single database (level-1 or level-2).The recommendation is to run (at least on a first phase) a single area where all routers are configured as Level-2-only routers.

IS-IS provides a two-level hierarchy. Level 1 routing is based on the ID portion of the OSI address and Level 2 routing deals with the Area Address portion of NET, and treats it as a prefix, so that the longest matching prefix is selected [4],[1]. The Level 2 has actually multiple levels since a number of hierarchies can be built with the Area Address part, so that a shorter prefix means a higher place in the hierarchy.
Each System belongs to a single Routing Area
Each routing area belongs to a single Routing Domain
IS-IS is an intra-domain routing protocol. It does not figure out routes between routing domains (that is for inter-domain routing protocols.)
Every IS in an area has a complete picture of the area.
Every L2 IS in a domain has a complete picture of the Level 2 routing "backbone" [1].
3.3- Security
As both IS-IS and OSPF support authentication, as Plain-text passwords and MD5 cryptographic hash [3]. While Non-IP nature makes ISIS inherently more secure, but authentication still a good idea.

IS-IS enforces basic security through packet authentication by using special TLVs. ISO 10589 specifies TLV Type 10, which can be present in all IS-IS packet types. RFC 1195 also specifies TLV Type 133 for authentication, which removes password length restrictions imposed by ISO 10589. Both specifications define only simple passwords transmitted as clear text without encryption [2].

Simple, clear-text password authentication obviously does not provide enough protection against malicious attacks on the network, even though it can help isolate operator configuration errors related to adjacency setups. TLV Types 10 and 133 both provide accommodation for future TLV field types, which might permit more complex and secured authentication using schemes such as HMAC-MD5. An IETF draft proposal specifies this approach for improved and sophisticated authentication of IS-IS packets.

Now the most important a unique security advantage of IS-IS compared to other IP routing protocols is that IS-IS packets are directly encapsulated over the data link and are not carried in IP packets or even CLNP packets. Therefore, to maliciously disrupt the IS-IS routing environment, an attacker has to be physically attached to a router in the IS-IS network, a challenging and inconvenient task for most network hackers. Other IP routing protocols, such as RIP, OSPF, and BGP, are susceptible to attacks from remote IP networks through the Internet because routing protocol packets are ultimately embedded in IP packets, which makes them susceptible to remote access by intrusive applications.

3.4- Weak Points-

However IS-IS is a better approach of forwarding, But there are also some notable points of this methodology that gives a negative feedback.

IS-IS does not support administrative tags.

IS-IS does not support external information across L1 adjacencies (OSPF uses NSSA's to support this type of leasking from an area into the backbone).This means that external routes must be injected at L2, or that the entire network run at least L1/L2 across all links where redistribution is necessary [2].

IS-IS does not support point to multipoint configuration [2].

IS-IS runs directly over layer 2 and hence

Cannot support virtual links unless some explicit tunneling is implemented.

Packets are intentionally kept small so that they don’t require hop-by-hop fragmentation.

Uses ATM/SNAP encapsulation on ATM but there is hacks to make it use VcMux encapsulation.

IV. COMPARISON WITH OSPF

Except weak points all others characteristics of IS-IS show its strengths. Now we will compare IS-IS with OSPF and show how it is better than OSPF:

S.N.	Property	IS-IS	OSPF
1	**Area Architecture**	support two-level hierarchy of areas, OSPF area boundaries fall within a router, Interfaces bound to areas, Router may be in many areas, Router must calculate SPF per area [1]	support two-level hierarchy of areas, IS-IS area boundaries fall on links, Router is in only one area, plus perhaps the L2 backbone (area), Biased toward large areas, area migration, Little or no multilevel deployment (large flat areas work so far)
2	**Database Granularity**	IS-IS database node is an LSPacket, LSPs are clumps of topology information organized by the originating router, Always flooded intact, unchanged across all flooding hops (so LSP MTU is an architectural constant--it must fit across all links), Small topology changes always yield entire LSPs (though packet size turns out to be much less of an issue than packet count), Implementations can attempt clever packing	OSPF database node is an LSAdvertisement, LSAs are mostly numerous and small (one external per LSA, one summary per LSA), Network and Router LSAs can become large, LSAs grouped into LSUpdates during flooding, LSUpdates are built individually at each hop, Small changes can yield small packets (but Router, Network LSAs can be large) [5].
3	**LAN Flooding**	IS-IS uses multicast LSP from all routers, CSNP from DR, Periodic CSNPs ensure databases are synced (tractable because of coarse database granularity), Flood traffic constant regardless of number of neighbors on LAN [5], But big LANs are uninteresting	OSPF uses multicast send, unicast ack from DR,Reduces flood traffic by 50% (uninteresting), Requires per-neighbor state (for retransmissions), Interesting (but complex) acknowledgement suppression, Flood traffic grows as O(N)
4	**Database Refresh**	LSP refresh every 15 minutes,Minus random jitter timer of up to 25%, LSP Lifetime = 20 minutes (default), Down-counting timer, LSP Lifetime configurable up to 18.2 hours, Major reason ISIS scales better to large areas [3].	LSA refresh every 30 minutes MaxAge = 1 hour Up-counting timer Design flaw: Cannot change MaxAge
5	**Overload Bit**	Enables router to signal memory overload, No transit traffic sent to overloaded router, Set separately for Level 1 and Level 2, Can be manually set [3], useful for graceful router turn-up	No comparable OSPF feature

6	**Mesh Groups**	ISIS feature (RFC 2973)- Can sharply curtail LSP flooding in full-mesh topologies, Each router in mesh group receives only one copy of each LSP (one-hop flooding), Risk of lost LSPs- Insure design is robust enough, Interfaces can be manually configured to block LSPs (increased scalability, but increased risk) [5].	OSPF has no comparable feature.
7	**Neighbor Establishment**	Settable hello/holding timers to allow tradeoff between stability, overhead, and responsiveness IS-IS requires padding of Hello packets to full MTU size under some conditions (deprecated in practice)	Settable hello/holding timers to allow tradeoff between stability, overhead, and responsiveness Requires hello and holding timers to match on all routers on the same subnet (side effect of DR election algorithm) making it difficult to change timers without disruption Requires routers to have matching MTUs in order to become adjacent (or LSA flooding may fail, since LSUpdates are built at each hop and may be MTU-sized)[5].
8	**Authentication and Security**	Support cryptographic authentication	Support cryptographic authentication, OSPF really needs this (packet bombs)
9	**Encapsulation**	IS-IS runs directly over L2 (next to IP), Sort of makes sense, architecturally, Partition repair requires tunneling (rarely implemented), More difficult to spoof or attack, Requires ATM SNAP encapsulation, forcing two-cell TCP acks (but Henk SmitÅfs NLPID hack fixes this)	OSPF runs on top of IP, Traditional IP routing protocol approach, Relies on IP fragmentation for large LSAs, Subject to spoofing and DoS attacks (use of authentication is strongly advised), Allows use of ATM VCmux encapsulation (so TCP acks fit in one ATM cell)

4.1- Better than OSPF

Now after studying both IS-IS and OSPF it can be conclude that how IS-IS is better than OSPF.

So now It can be said that IS-IS and OSPF are similar in some ways and are also different according to their different properties. We can talk about convergence speed, configuration complexity and flexibility, breadth and depth of deployment, and so on and now we show how IS-IS is better.

IS-IS is more easily extensible. This is because any new information that needs to be carried is done so by way of a new TLV (or Sub-TLV) depending on the information added. With OSPF, you need to create new LSA types.

IS-IS is the fact that the backbone area is more flexible than OSPF's area 0. With IS-IS's two-tiered approach, the backbone can "snake" around the network easier than OSPF's area 0 [5].

Since IS-IS is multiprotocol by design, it may initially support newer non-IPv4 protocols (i.e. multicast, IPv6, etc.) before OSPF.

IS-IS can support more routers in an area than OSPF. This makes IS-IS favorable in ISP environment.

But the biggest strength in IS-IS is that it deployed in the largest ISP networks, which represent the bleeding edge in routing protocol implementation. As such, and certainly as of recently, IS-IS gets new technology faster than OSPF.

V. CONCLUSION

Finally we reach on the conclusion that both IS-IS and OSPF have some common characteristic But some specific qualities of IS-IS protocol prove itself better than OSPF. IS-IS is a better choice for large ISP's, IS-IS is unique among today's routing protocols, because of its multi protocol design. Integrated routing of CLNS and IPv4 might not interest many, but IS-IS used as single routing protocol for both IPv4 and IPv6 is a possibility not to be ignored. This paper overviewed IS-IS characteristics and we are working for routing optimization for dynamic changes as dijkstra's algorithm etc. already implemented we are seeking to optimize the routing so that IS-IS become more faster. IS-IS was the first link state routing protocol that supports IPv6 inside the routers of biggest Vendors. Broadly deployed within the large ISP market, Groups who build very large, very visible networks are comfortable with it.

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