DOI: http://dx.doi.org/10.26483/ijarcs.v17i4.7553

Volume 17, No. 4, July-August 2026

ISSN No. 0976-5697

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

INVESTIGATING LINK-STATE ADVERTISEMENT AGING IN OSPF FOR NETWORK FAULT DIAGNOSIS

Amit Sharma
AIIT,
Amity University Haryana,
Gurugram, Haryana, India

Anil kumar
Department of ECE, ASET,
Amity University Haryana
Gurugram, Haryana, India

Mahesh Kumar
Government College,
Ateli , Mahendragarh,
Haryana, India

Abstract – Open Shortest Path First (OSPF) utilizes Link-State Advertisements (LSAs) to keep precise information about network topology. This research empirically examines the aging behavior of LSAs and their significance in diagnosing faults within OSPF networks. In a simulated OSPF environment, different fault scenarios including link failures, adjacency instability, and inconsistencies within the database are introduced and assessed based on LSA age variations among various LSA types. The findings indicate that unusual aging patterns are effective indicators of hidden network problems. The study verifies that tracking LSA aging metrics improves fault detection accuracy and enhances troubleshooting effectiveness in networks using OSPF.

Keywords—OSPF, LSA, LSA aging, fault detection, Eve-NG

I. INTRODUCTION

A popular inner gateway protocol called Open Shortest Path First (OSPF) uses a link-state routing technique to find the shortest paths in IP networks. In order to create and maintain a synchronized Link-State Database (LSDB), which is essential for precise route computation and network stability, OSPF routers exchange Link-State Advertisements (LSAs). OSPF includes an LSA aging mechanism that regulates the lifetime and refresh behavior of LSAs in order to prevent stale topological information.

Although database consistency is the main purpose of LSA aging, operational networks frequently underutilize its diagnostic value. Underlying problems including connection instability, adjacency flapping, excessive flooding, and database synchronization problems might be exposed by abnormal LSA aging behavior. In this research, we employ simulated OSPF environment to experimentally study LSA aging characteristics under controlled failure scenarios. The study shows how LSA aging may be used as a useful indicator for OSPF network fault diagnosis and troubleshooting by establishing a correlation between differences in LSA age and caused network failures.

II. LITERATURE SURVEY

A popular link-state inner gateway protocol in business and service provider networks is called Open Shortest Path First (OSPF). In order for routers to create consistent Link-State Databases (LSDBs) and calculate routes using Dijkstra's shortest-path algorithm, its primary technique entails flooding Link-State Advertisements (LSAs) to distribute topology information. Every LSA has an age field that controls its validity and longevity within the network. In order to stop stale data from spreading and guarantee routing accuracy, RFC standards specify how LSAs are aged, refreshed, and deleted once they reach MaxAge [2][3][4].

Understanding OSPF aging and control behavior is essential to comprehending fault conditions and network stability. A single network loss can cause many LSAs and complicate diagnosis, according to Hei et al.'s analysis of LSA flooding behavior to detect IP network problems [5]. By enhancing path selection during OSPF reconvergence, proactive solutions like Fast Emergency Paths were established to lessen the impact of temporary connection failures [6]. The importance of LSA behavior for network monitoring was highlighted by Shaikh and Greenberg's demonstration that capturing and analyzing LSA streams in operational networks enables the identification of topological changes, flapping links, and unusual circumstances [3].

Statistical and non-linear techniques have also been investigated for monitoring and anomaly identification. Al-Musawi and Branch highlighted the diagnostic significance of LSA time-series data by using recurrence quantification analysis to detect OSPF anomalies and hardware failures by monitoring anomalous LSA patterns [7]. The significance of keeping an eye on LSA age and flooding dynamics is indirectly supported by Garcia-Molina et al.'s further investigation of methods to guarantee LSDB consistency under dynamic topologies [8].

Inverse coupled simulated annealing was presented by Pan et al. for improved OSPF convergence in IoT networks, demonstrating how network performance is improved under failure scenarios through controlled change of LSA behavior

[9]. Liu et al. showed that sophisticated analysis of OSPF control-plane data can successfully identify severe fault scenarios by using graph neural networks to assess network failures and create reliable routing strategies [10]. Furthermore, age differences can be used as predictive indications for network failure identification, according to Smith et al.'s analysis of LSA dynamics using machine learning techniques [11].

The literature shows that thorough examination of LSAs, including age, flooding patterns, and refresh behavior, offers important insight into network health, fault conditions, and convergence behavior, even though few studies solely concentrate on LSA aging as a diagnostic metric. This bolsters the idea that problem identification and operational stability can be enhanced by systematic monitoring of OSPF LSA parameters [1][5][7][9].

This research work is innovative in the following aspects:

- A distinct and fast troubleshooting approach for OSPF LSA age related issues.
- Finding distinctive LSA Age patterns linked to aberrant floods, route withdrawal, interface flapping, and LSDB synchronization problems.
- A simple monitoring method that makes use of already-existing OSPF protocol data without the need for any hardware or software agents.
- LSA Age's efficacy as a network stability indicator is demonstrated through experimental validation of its behavior in a controlled OSPF environment.
- A methodical approach that helps network administrators reduce troubleshooting time and speed up root-cause analysis.

III. NETWORK DESIGN

The EVE-NG network emulation platform, which offers a versatile environment for testing and modeling OSPF routing behavior, is used to create the network architecture for this study. Five routers, designated R1-A, R2-B, R3-C, R4-D, and R5-E, are connected in the planned architecture, as illustrated in Fig. 1. OSPF routing is made possible over several network segments by configuring each router with unique IP addresses on its interfaces.

In order to assess LSA propagation, aging, and convergence behavior under both normal and fault scenarios, the topology incorporates several pathways between routers and is meant to mimic a realistic intra-domain OSPF network. By ensuring that every router is a part of a distinct subnet, the IP addressing system makes it possible to clearly see route calculation, LSA exchange, and fault diagnostics during simulation.

Fig. 1 illustrates the network layout, with all routers and interface IP addresses clearly labeled for reference.

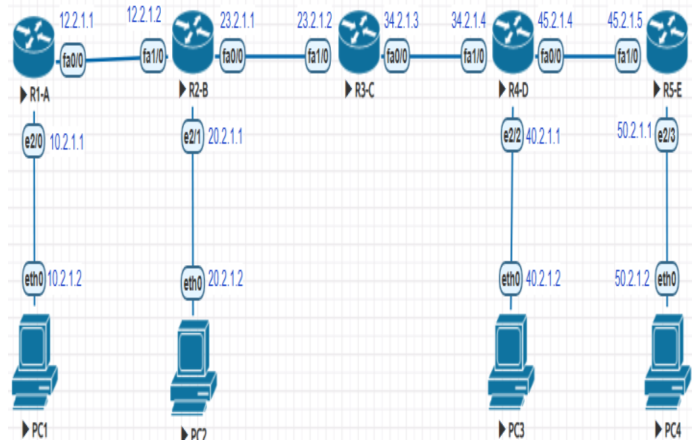


Fig. 1. Network Topology

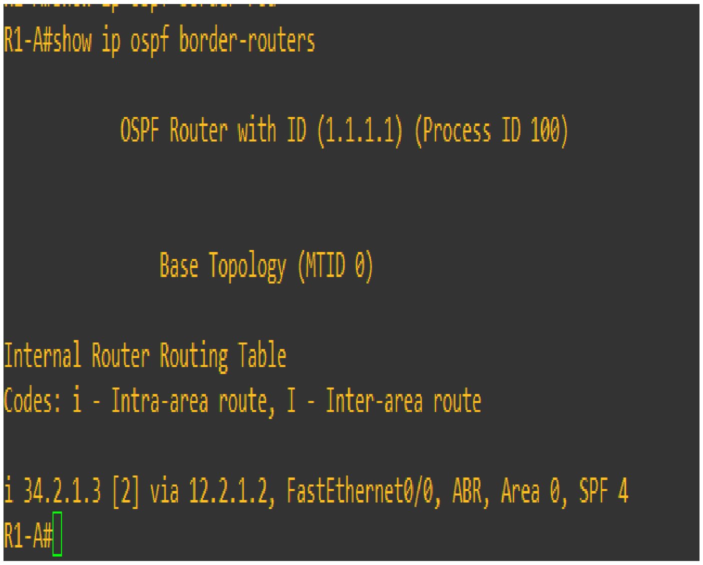
IV. RESULTS & DISCUSSION

Figure 2 states that router R3-C is ASBR. The number of areas in this router is 2, i.e., area 0 and area 1. Router ID of R3 is 34.2.1.3, and default administrative distance (AD) value for OSPF is 110.

```
Routing Protocol is "ospf 100"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 34.2.1.3
  It is an area border router
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
  Routing on Interfaces Configured Explicitly (Area 0):
    FastEthernet1/0
  Routing on Interfaces Configured Explicitly (Area 1):
    FastEthernet0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    5.5.5.5              110      00:07:21
    4.4.4.4              110      00:10:47
    1.1.1.1              110      00:18:35
    2.2.2.2              110      00:18:35
  Distance: (default is 110)

R3-C#
```

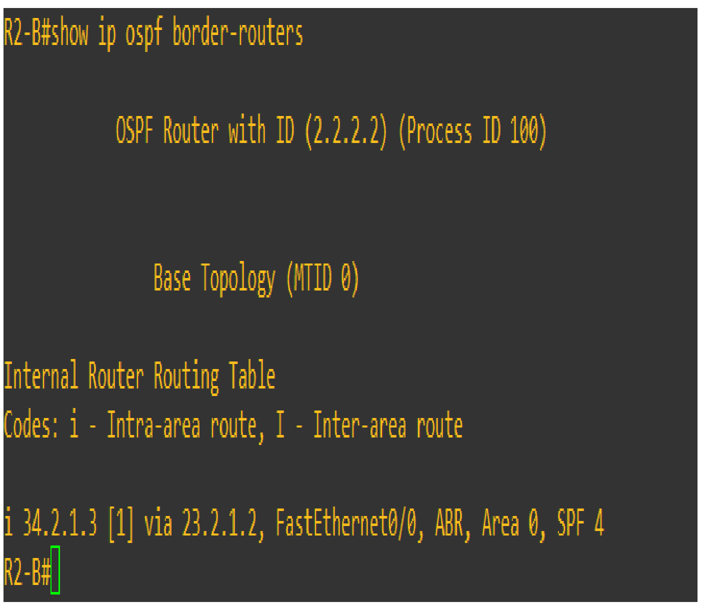
Fig2. Logs depicts R3 as ASBR

Figures 3, 4, and 5 illustrate the router ID of ABR (34.2.1.3), cost, and respective interfaces.



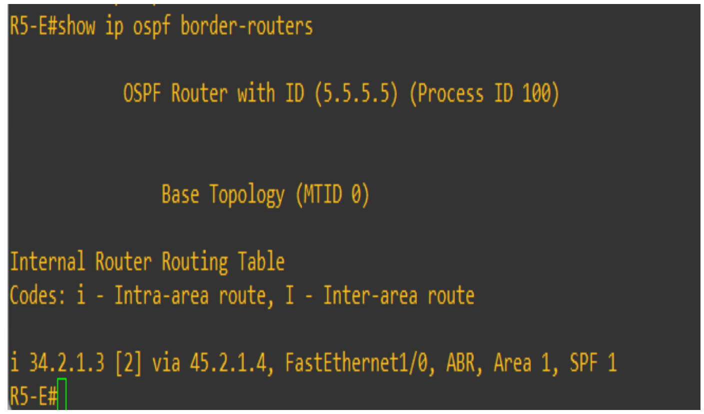
```
R1-A#show ip ospf border-routers

            OSPF Router with ID (1.1.1.1) (Process ID 100)

                Base Topology (MTID 0)

Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

i 34.2.1.3 [2] via 12.2.1.2, FastEthernet0/0, ABR, Area 0, SPF 4
R1-A#
```

Fig3. Logs related to Border-Router at R1



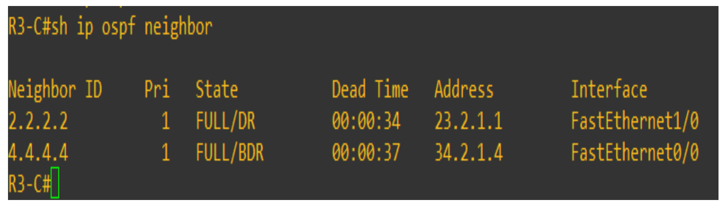
```
R2-B#show ip ospf border-routers

            OSPF Router with ID (2.2.2.2) (Process ID 100)

                Base Topology (MTID 0)

Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

i 34.2.1.3 [1] via 23.2.1.2, FastEthernet0/0, ABR, Area 0, SPF 4
R2-B#
```

Fig4. Logs related to Border-Router at R2



```
R5-E#show ip ospf border-routers

            OSPF Router with ID (5.5.5.5) (Process ID 100)

                Base Topology (MTID 0)

Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

i 34.2.1.3 [2] via 45.2.1.4, FastEthernet1/0, ABR, Area 1, SPF 1
R5-E#
```

Fig5. Logs related to Border-Router at R5



```
R3-C#sh ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           1   FULL/DR         00:00:34    23.2.1.1        FastEthernet1/0
4.4.4.4           1   FULL/BDR        00:00:37    34.2.1.4        FastEthernet0/0
R3-C#
```

Fig.6 DR/BDR elected

From figure 6 it is found that DR/BDR election is done, so LSA type 2 is also generated. Figures 7 and 8 depict the OSPF database. Router link states are LSA type1, Net link states are LSA2, and Summary Net Link States are LSA type3.

In OSPF, the Link-State Advertisement (LSA) age field indicates the lifetime and validity of an LSA within the Link-State Database (LSDB). Proper interpretation of LSA age is crucial for monitoring network stability and diagnosing faults. The LSA age can be classified as follows:

0 seconds: The LSA has just been originated or refreshed by the router.

1–1800 seconds: The LSA is aging normally and is considered a valid advertisement within the network.

1800 seconds: The LSA has reached its refresh interval (typically 30 minutes), prompting the originating router to re-flood the LSA to maintain database consistency.

3600 seconds: The LSA has reached MaxAge and is considered expired. At this point, the LSA is removed from the LSDB unless it is refreshed, ensuring that stale topology information does not affect routing.

```
R3-C#show ip ospf database

            OSPF Router with ID (34.2.1.3) (Process ID 100)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1241        0x80000003 0x00CF12 2
2.2.2.2         2.2.2.2         956         0x80000004 0x008304 3
34.2.1.3        34.2.1.3        916         0x80000004 0x009314 1

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
12.2.1.1        1.1.1.1         1241        0x80000002 0x003CDC
23.2.1.1        2.2.2.2         956         0x80000002 0x0013D2

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
34.2.1.0        34.2.1.3        916         0x80000002 0x005697
40.2.1.0        34.2.1.3        412         0x80000002 0x006C71
45.2.1.0        34.2.1.3        412         0x80000002 0x00D011
50.2.1.0        34.2.1.3        412         0x80000002 0x00F3DE

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
4.4.4.4         4.4.4.4         206         0x80000004 0x0002FE 3
5.5.5.5         5.5.5.5         288         0x80000003 0x00D17E 2
34.2.1.3        34.2.1.3        412         0x80000003 0x007E11 1

                Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
34.2.1.3        34.2.1.3        412         0x80000002 0x00337D
45.2.1.4        4.4.4.4         206         0x80000002 0x0012BE

                Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
10.2.1.0        34.2.1.3        916         0x80000002 0x00FDFC
12.2.1.0        34.2.1.3        916         0x80000002 0x007F83
20.2.1.0        34.2.1.3        916         0x80000002 0x007180
23.2.1.0        34.2.1.3        916         0x80000002 0x00E513
R3-C#
```

Fig. 7 Logs depicts OSPF Database

```
R5-E#show ip ospf database

            OSPF Router with ID (5.5.5.5) (Process ID 100)

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
4.4.4.4         4.4.4.4         875         0x80000005 0x00FFFF 3
5.5.5.5         5.5.5.5         962         0x80000004 0x00CF7F 2
34.2.1.3        34.2.1.3        1085        0x80000004 0x007C12 1

                Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
34.2.1.3        34.2.1.3        1085        0x80000003 0x00317E
45.2.1.4        4.4.4.4         875         0x80000003 0x0010BF

                Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
10.2.1.0        34.2.1.3        1590        0x80000003 0x00FBFD
12.2.1.0        34.2.1.3        1590        0x80000003 0x007D84
20.2.1.0        34.2.1.3        1590        0x80000003 0x006F81
23.2.1.0        34.2.1.3        1590        0x80000003 0x00E314
R5-E#
```

Fig. 8 Logs depicts OSPF database

Figure 8's Quantitative Evaluation: LSA Age values ranging from 875 to 1590 seconds were found through experimental investigation of nine OSPF LSAs. Stable OSPF operation without route expiration was indicated by the fact that no LSA crossed the MaxAge (3600 s) criterion. By examining quantitative LSA Age patterns in relation to the MaxAge threshold (3600 s) and standard OSPF refresh interval (1800 s), the suggested monitoring strategy effectively distinguished between normal and abnormal operational states.

V. CONCLUSION

An OSPF network's stability and overall health can be inferred from the pattern of LSA age values. Since the ads are continually being created or renewed, LSAs that consistently stay between 0 and 5 seconds usually point to flapping interfaces or network instability. The network is stable and operating as intended when an LSA reaches roughly 1800 seconds, which is the typical refresh time. While LSAs that reach 3600 seconds (MaxAge) frequently indicate route withdrawal or expired topological information, values over 3000 seconds may indicate excessive flooding or network splitting. Lastly, different LSA ages throughout the network point to possible synchronization problems with the Link-State Database (LSDB), which might cause inconsistent routing tables and delayed convergence. Network engineers may detect and diagnose issues early on by keeping an eye on these LSA age patterns, which enhances the OSPF domain's overall reliability.

An essential indicator for evaluating network stability and LSDB consistency in OSPF is LSA Age. Flapping interfaces, delayed flooding, route withdrawals, and synchronization issues can all be found by analyzing LSA Age patterns. Proactive troubleshooting, correct routing information, and overall OSPF network dependability are all made possible by monitoring LSA Age.

By measuring LSA Age behavior under various OSPF operating situations, the proposed work offers experimental evidence in contrast to earlier research that primarily describe the theoretical significance of LSA Age. In order to evaluate network stability, detect anomalous routing events, and facilitate useful troubleshooting in operating OSPF networks, the study shows how measured LSA Age values can be methodically analyzed.

REFERENCES

[1] J. Moy, OSPF: Anatomy of an Internet Routing Protocol. Addison-Wesley, 1998.

[2] RFC 2178 — OSPF Version 2, Internet Engineering Task Force, July 1997.

[3] A. Shaikh and A. Greenberg, "OSPF Monitoring: Architecture, Design and Deployment Experience," AT&T Labs-Research, 2004.

[4] RFC 4136 — OSPF Refresh and Flooding Reduction in Stable Topologies, Internet Engineering Task Force, July 2005.

[5] Y. Hei, T. Ogishi, S. Ano, and T. Hasegawa, "IP Network Failure Identification Based on the Detailed Analysis of OSPF LSA Flooding," IEICE Trans. Commun., vol. E91-B, no. 5, pp. 1320–1330, May 2008.

[6] F. Barreto, E. C. G. Wille, and L. Nacamura Jr., "Fast Emergency Paths Schema to Overcome Transient Link Failures in OSPF Routing," arXiv, Apr. 2012.

[7] B. Al-Musawi and P. Branch, "Identifying OSPF Anomalies Using Recurrence Quantification Analysis," ICNP, 2018.

[8] H. Garcia-Molina et al., "LAPGN: Accomplishing Information Consistency under OSPF in General Networks (an Extension)," J. Netw. Comput. Appl., vol. 119, pp. 57–69, Oct. 2018.

[9] C. Pan, H. Lu, H. Shi, Y. Wang, and L. Qin, "Inverse Coupled Simulated Annealing for Enhanced OSPF Convergence in IoT Networks," Electronics, vol. 13, no. 22, 4332, 2024.

[10] C. Liu, V. Aggarwal, T. Lan, N. Geng, Y. Yang, M. Xu, and Q. Li, "FERN: Leveraging Graph Attention Networks for Failure Evaluation and Robust Network Design," arXiv, May 2023.

[11] Z. Smith, X. Wang, and J. Kumar, "Machine Learning for OSPF Fault Diagnosis Based on LSA Dynamics," IEEE Access, vol. 12, pp. 2345–2358, 2025.