

Transient States in OSPF

- Master's Thesis presentation
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Contents of the Presentation

- Introduction to OSPF
- Methodology
- OSPF Flooding Procedure
- Results of the Study
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Transient States in OSPF

- Transient ~ short-lived, temporary, momentary
- Open Shortest Path First (OSPF) is a common link state routing protocol
- The behavior of the OSPF protocol after a change in the network topology is studied. The objective is to find design guidelines for an OSPF network
- Methods of the study: literature survey and simulations

OSPF Protocol

- OSPF is a routing protocol, used to form paths between network nodes
- A link state protocol, each router advertises the state of the local links
- Link state advertisement (LSA) describes the environment of a router, together the LSAs in the network form the map of the network
- Works on Internet Protocol (IP) layer

OSPF Has Three Sub-protocols

- Hello protocol is used to discover the neighbors and to maintain relationships to neighboring routers
- Database Exchange protocol is used to synchronize the link state databases between neighboring routers
- Flooding protocol is used to disseminate topology information to the network, information (LSAs) packed into LS Update packets

OSPF Failure Recovery

- Majority of the link failures are transient
- Failure recovery consists of three parts
 - Failure detection -> use of network level detection mechanisms, HelloInterval optimization is well studied in earlier simulations
 - Information flooding -> flooding process optimization, focus of the simulations
 - Shortest Path First (SPF) calculation and routing table update -> SPF calculation time depends on the size of the network and routing table update time on the router's architecture

Methodology:

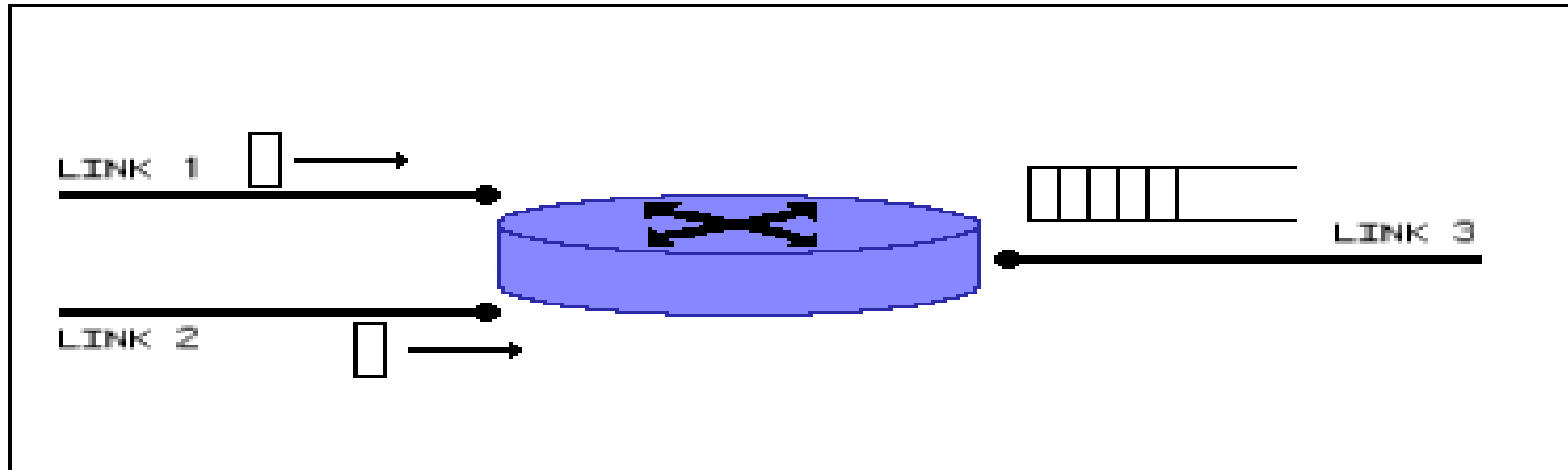
Discrete-event Simulation

- OSPF has earlier been researched by measuring operational networks, by using simulations and by mathematical analysis
- OSPF network: too complex to be studied by mathematical analysis, too expensive to build a realization only for the purpose of the research
- Artificial system histories can be produced by the means of simulation, model is measured like an operational network

OSPF Flooding Procedure

- Heaviest task in OSPF -> stable network operation is ensured by using delays between heavy tasks, PacingDelay, MinLSInterval, MinLSArrival, etc...
- Delays may slow down the network recovery time, are they necessary?
- Simulations are run to characterize the flooding behavior

OSPF Flooding Continued

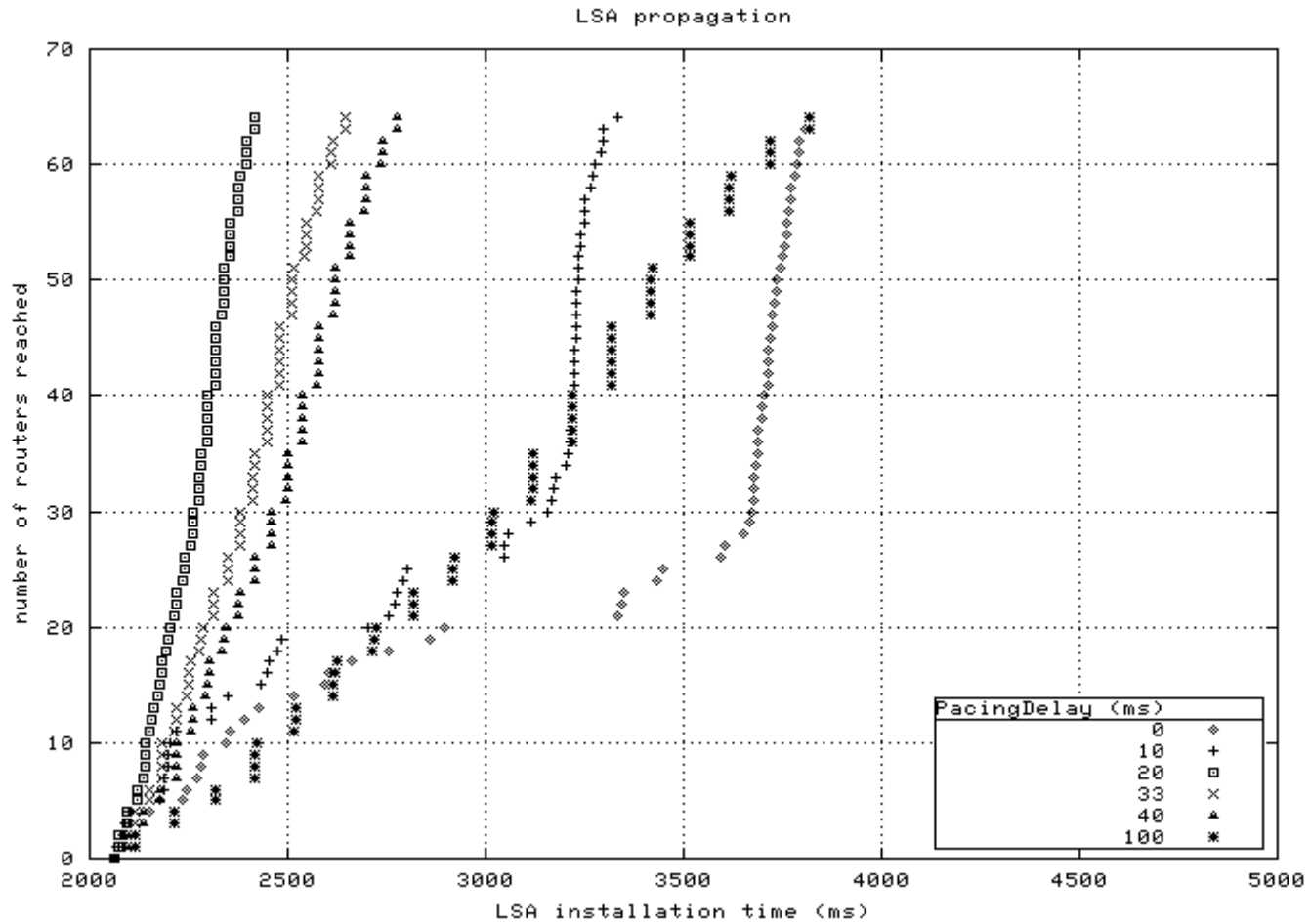


- LSAs are added to LS retransmission list, minimum time between sending LSAs to a link is defined by PacingDelay
- Received LS Acknowledgement removes LSAs from LS retransmission List
- Too small PacingDelay -> duplicate LSA traffic

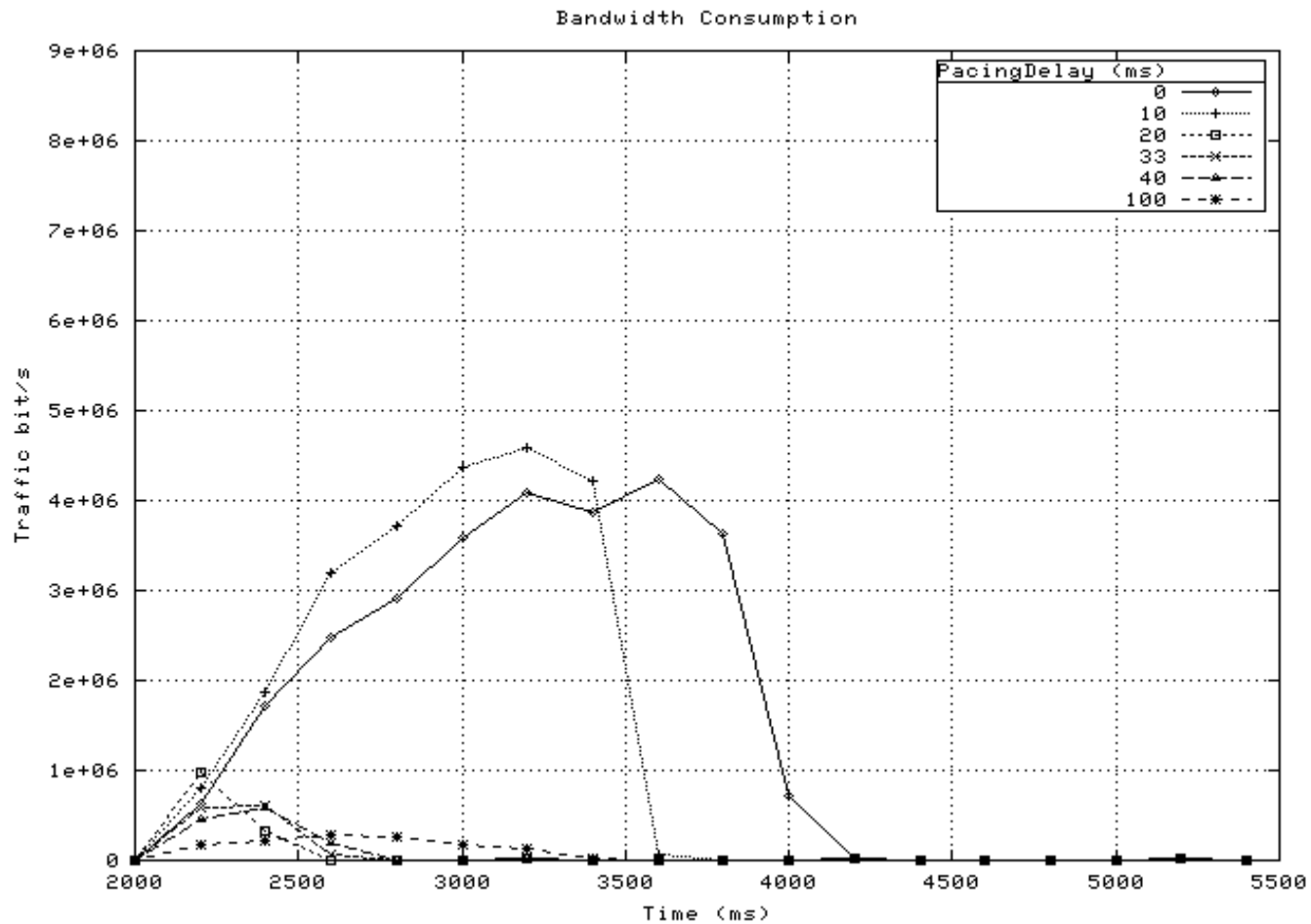
OSPF Settings in Next Simulation

- Simulated network has 65 nodes and 108 links
- Configuration
 - HelloInterval 1000 ms / RouterDeadInterval 4000 ms
 - MinLSInterval 50 ms (also 0 ms was used but caused congestion)
 - MinLSArrival 0 ms
 - RxmtInterval 2000 ms
 - SpfDelay 5000 ms / SpfHoldTime 10000 ms
 - Various values for PacingDelay 0 – 100 ms

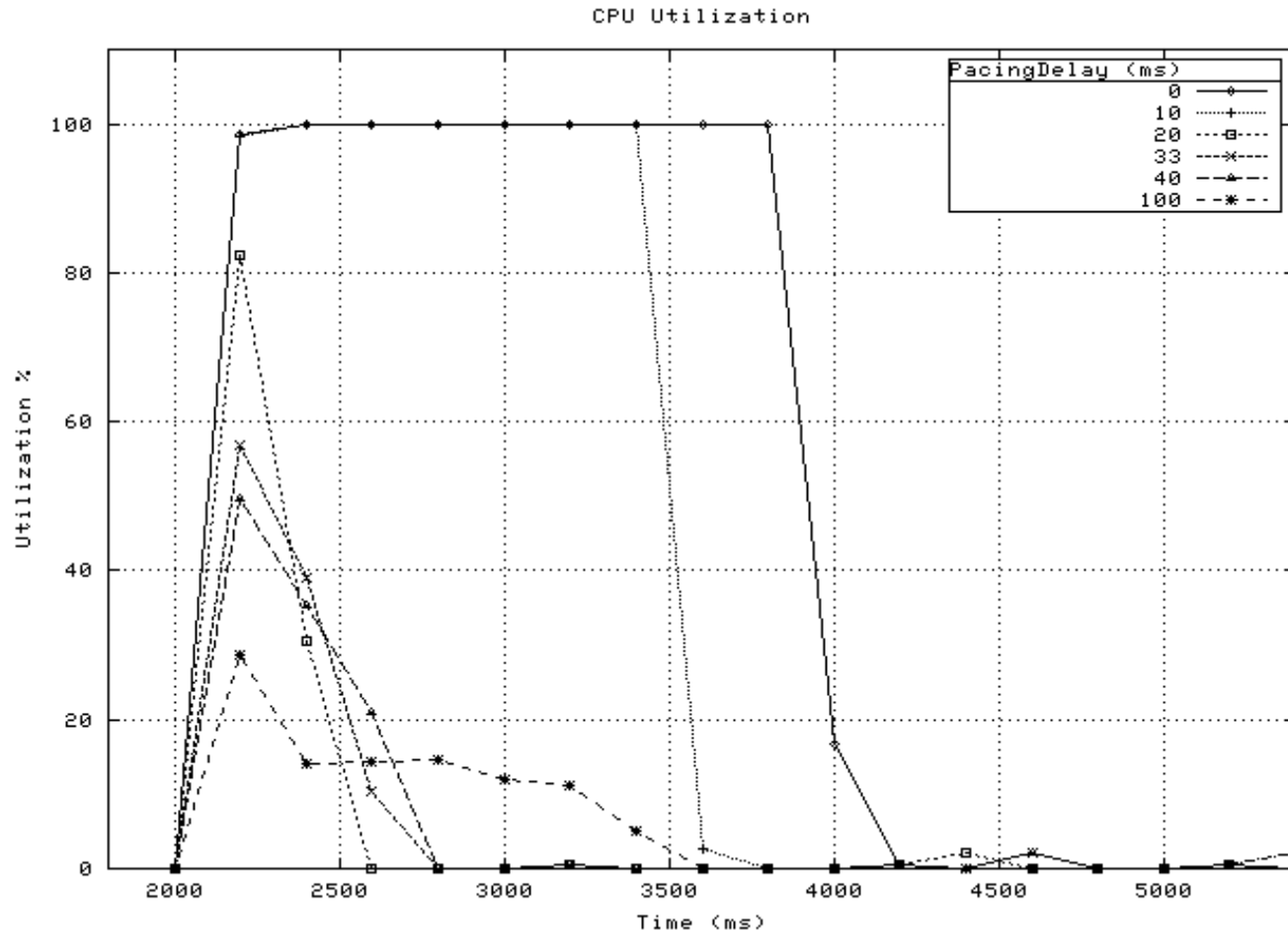
LSA Propagation



Routing Traffic in Bottleneck



CPU Utilization in Bottleneck



Effect of the OSPF Configuration

- Non-zero PacingDelay is recommended, optimal value depends on the number of LSAs simultaneously in transit
- Number of LSAs in transit depends on
 - Topology of the network
 - Failure model of the network
- MinLSInterval should also be non-zero, value 50ms was used instead of default 5 seconds -> good behavior, $\text{MinLSArrival} < \text{MinLSInterval}$

Conclusions

- The operation of an OSPF network can be substantially improved by using aggressive configurations
- In a simulated network with 26 nodes the convergence time after a link failure dropped from 45 seconds to 2,2 second
- OSPF delays are essential in order to guarantee stable operation of the network
- Subsecond failure recovery times in large OSPF networks are unlikely to be achieved with current implementations

Questions & Answers

- Any questions are welcome!
- Thank you for your attention!