

## Performance Analysis of Soft-State Lightpath Management in GMPLS-Based WDM Networks

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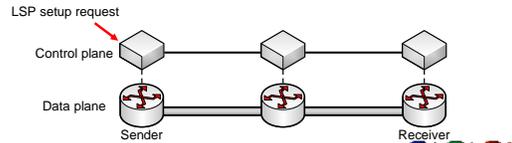
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## Signaling in wavelength routed networks

- GMPLS (Generalized Multi-Protocol Label Switching)
  - Protocol suite to control wavelength routed networks
  - RSVP-TE (Resource reSerVation Protocol – Traffic Engineering)
    - Soft-state signaling protocol for GMPLS
- RSVP-TE controls Path and Resv states in soft-state
  - Control states are deleted when they are **timeout**
  - Control states are held by **refresh**
    - State timeout timer is reset by receiving a refresh message



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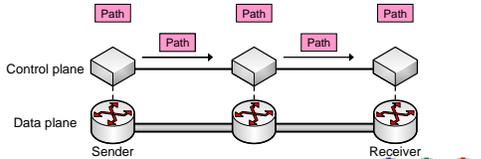
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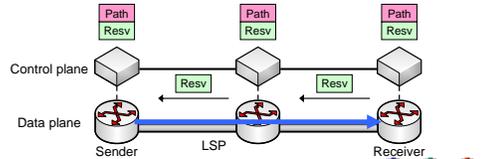
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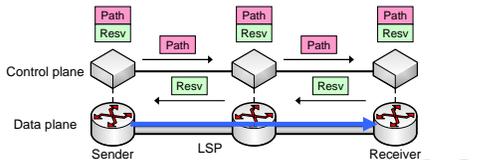
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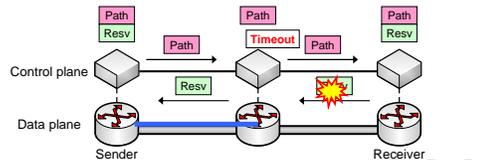
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### Previous studies on signaling in wavelength routed networks

- They assume no signaling message losses
  - Signaling protocols are evaluated as hard-state signaling
    - Control states are explicitly configured by signaling messages
- Signaling messages would be lost in real networks
  - Failures in the control plane, buffer overflow, software bug, etc...
  - Hard-state signaling cannot deal with signaling message losses
    - Cannot update control states without messages
  - Soft-state mechanism is indispensable
- But...
  - The performance of soft-state signaling protocols for wavelength routed networks is not revealed

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### Objectives of our research

- Our objective is to investigate
  - How control parameters of RSVP-TE affect the network performance
  - When the message retransmission of RSVP-TE works effectively
- Control parameters we are interested in
  - State lifetime
    - The period of time that states are held without refresh
  - Refresh interval
    - The time interval between the previous and the next refresh messages
  - Number of refreshes
    - The number of refresh messages sent during a state lifetime
- Signaling protocols for comparison
  - RSVP-TE: The standard RSVP-TE
  - RSVP-TE/Ack: The standard RSVP-TE + message retransmission
  - HS-BR: A hard-state signaling protocol for backward reservation

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### Model of RSVP-TE for single-hop LSP (1)

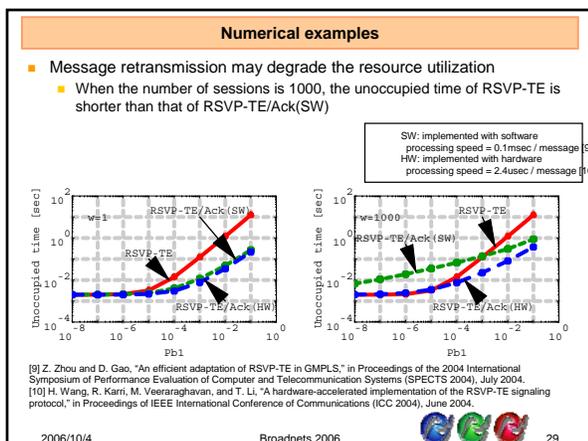
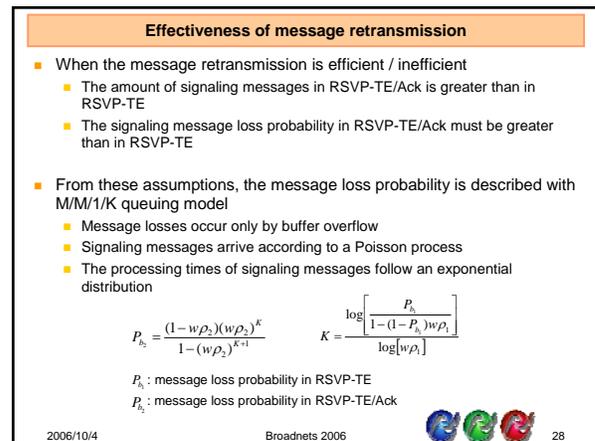
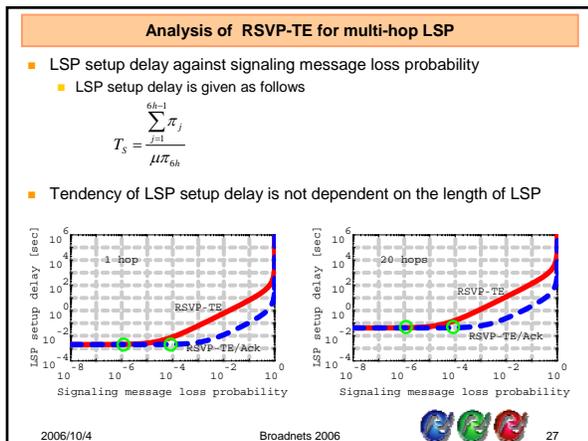
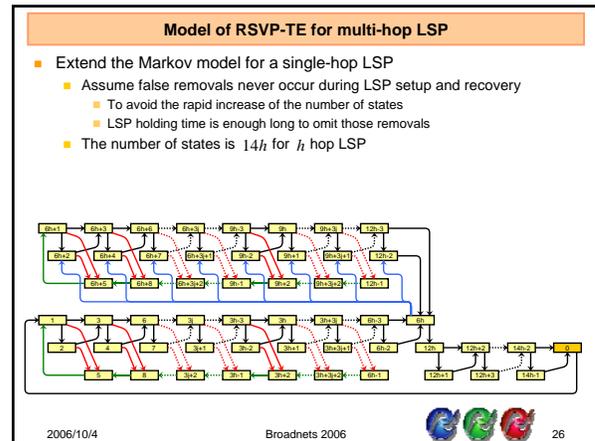
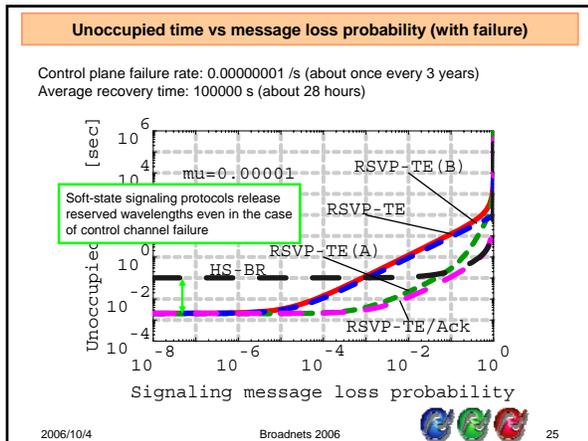
- Modeling the process of RSVP-TE for single-hop LSP
  - Extend the Markov model in [6]
- Assumptions to model RSVP-TE with Markov chain
  - For network
    - Holding times of LSPs follow an exponential distribution
    - Propagation delays of signaling messages follow an exponential distribution
    - Delay of message processing at nodes is 0
    - Blocking probability of wavelength reservation is constant
  - For RSVP-TE operation
    - Timeout intervals follow exponential distributions
    - Average timeout intervals of refresh timer, state-timeout timer, and retransmission timer are constant

[6] P. Ji, Z. Ge, J. Kurose, and D. Towsley, "A Comparison of Hard-state and Soft-state Signaling Protocols," in Proceedings of ACM SIGCOMM '03, August 2003.

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- ### Summary
- Summary
    - We developed Model of GMPLS RSVP-TE by Markov chain
      - For single-hop LSP with/without control plane failure
      - For multi-hop LSP
    - We analyzed the performance of GMPLS RSVP-TE with those models
      - Low signaling message loss probability lets RSVP-TE works as well as hard-state signaling protocols
      - Soft-state signaling protocols are stable to control channel failures
    - We evaluated the effectiveness of the signaling message retransmission
      - The message retransmission may result in poor resource utilization when there are thousands of sessions
  - Future work
    - Analysis of other signaling protocols for wavelength routed networks
      - e.g. Parallel reservation
    - Comparison of the performance between soft-state and hard-state signaling protocols in transient state
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