An Incremental Restoration Approach in Routed Wavelength Networks

A.S. Hafid, Université de Montreal
In collaboration with
A. Maach and G. v. Bochmann
University of Ottawa

Outline

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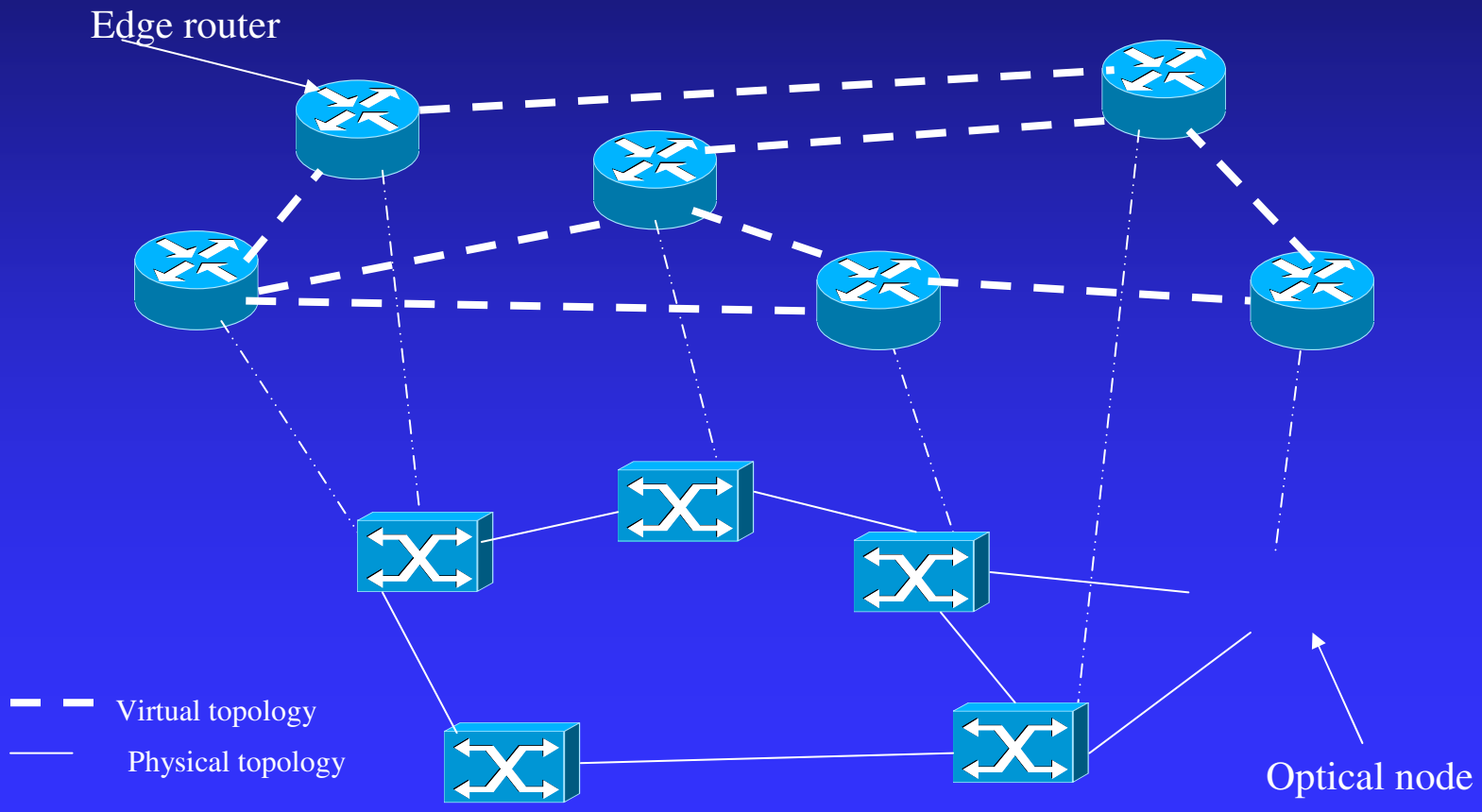
- Protection/Restoration Schemes
- Incremental Restoration Scheme
- Evaluation of the Scheme
  - Simulations Setup
  - Simulations Results
- Conclusion

Introduction



Protection/Restoration Schemes (1)

- In a protection scheme, protection routes are computed, and resources are reserved along the backup light paths at the time of the primary light-path setup.
  - The recovery is fast
- One cannot protect all the paths
  - expensive
- Primary and protection paths may fail at the same time

Protection/Restoration Schemes (2)

- In a reconfiguration scheme, when an existing light path fails, a new path, which does not use the failed components, is computed on the fly;
- The traffic is switched from the failed light path to the new light path.
  - Reconfiguration schemes do not guarantee successful recovery of failed paths since the computation of new paths may fail because of resource shortage
  - Recovery is not so fast

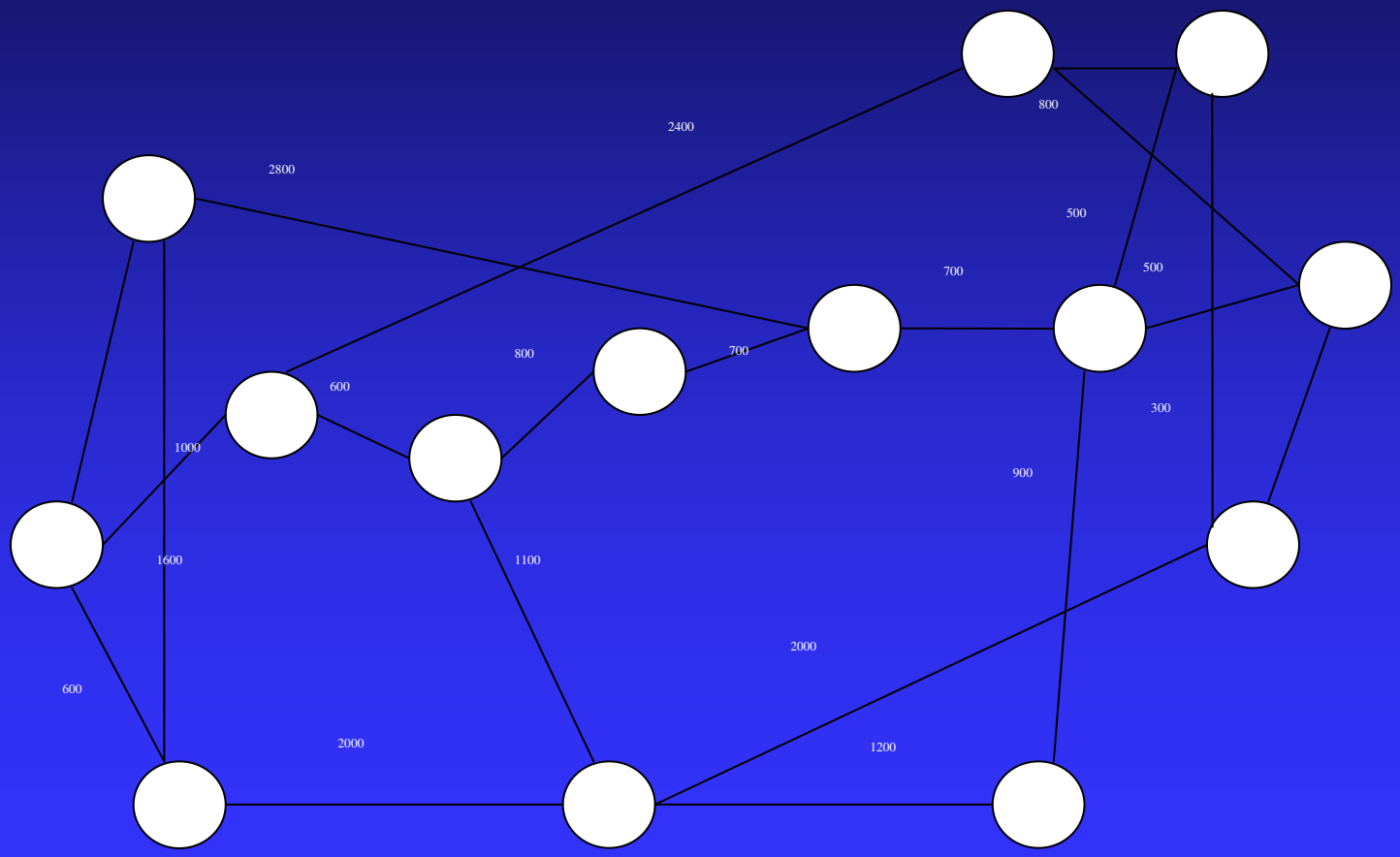
Proposed Incremental Restoration Scheme (1)

- Basic Idea
  - Restore the failed traffic and not the failed paths
  - Existing protection/restoration schemes try to restore the failed paths
- Incremental Restoration Scheme can be used as an add-on to protection schemes
  - When protection schemes fail, the incremental restoration kicks in

Proposed Incremental Restoration Scheme (2)

- Resource computation
  - Computes the current network state
- Failed traffic computation
  - computes the traffic matrix of the failed traffic
  - This is done in “parallel” resource computation
- Traffic Rerouting
  - Identifies existing paths with available bandwidth
  - Reroute failed traffic to these paths
- New path computation
  - If traffic rerouting is not sufficient to accommodate all the failed traffic, then
  - computes the paths, if they exist, in order to accommodate the still failed traffic

Simulations Setup (1)



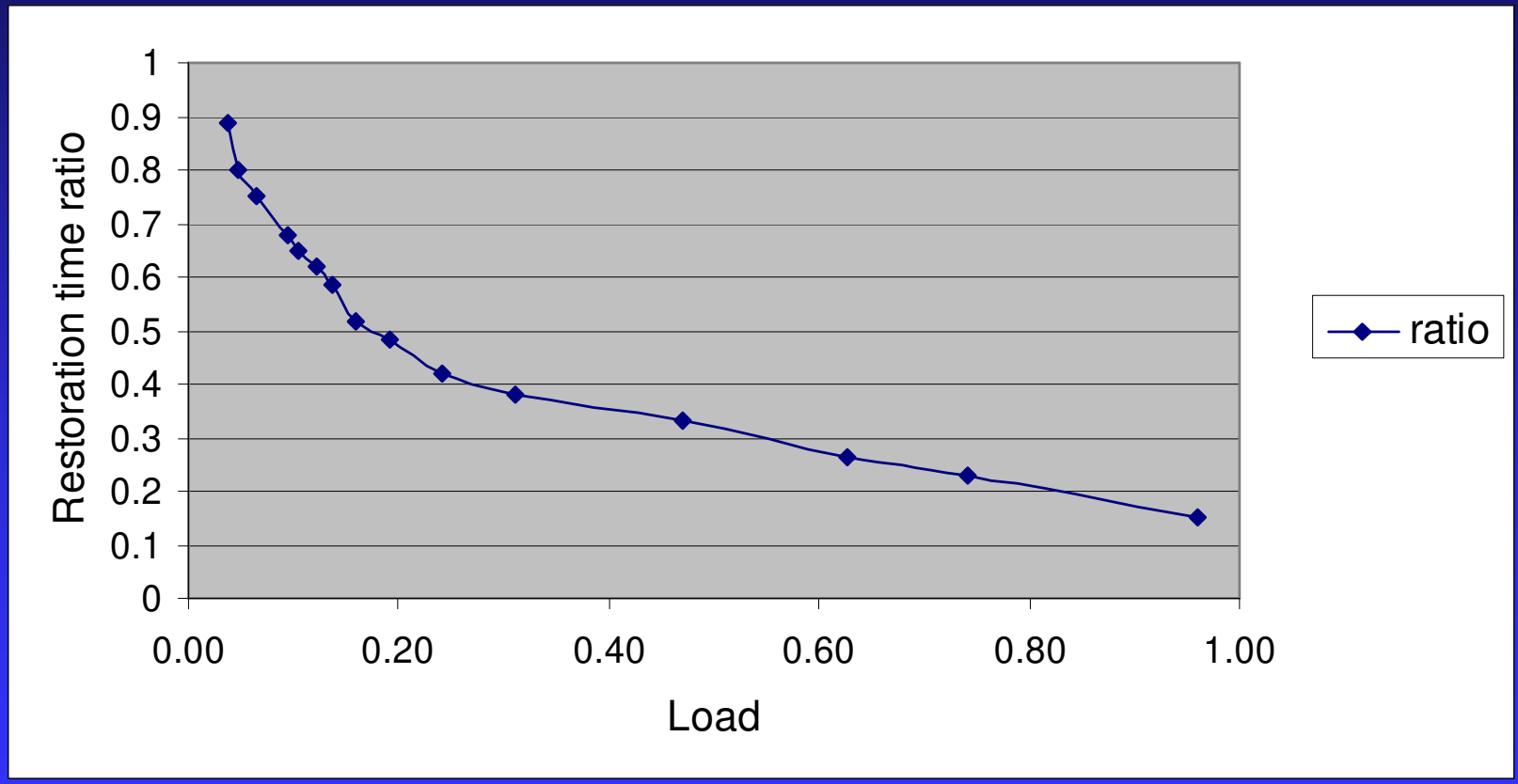
Simulations Setup (2)

- Any physical link in the network has only one fiber
- The fibers have the same number of wavelengths which is equal to sixteen
- There are no wavelength converters in the network
- Failure type: a single physical link failure

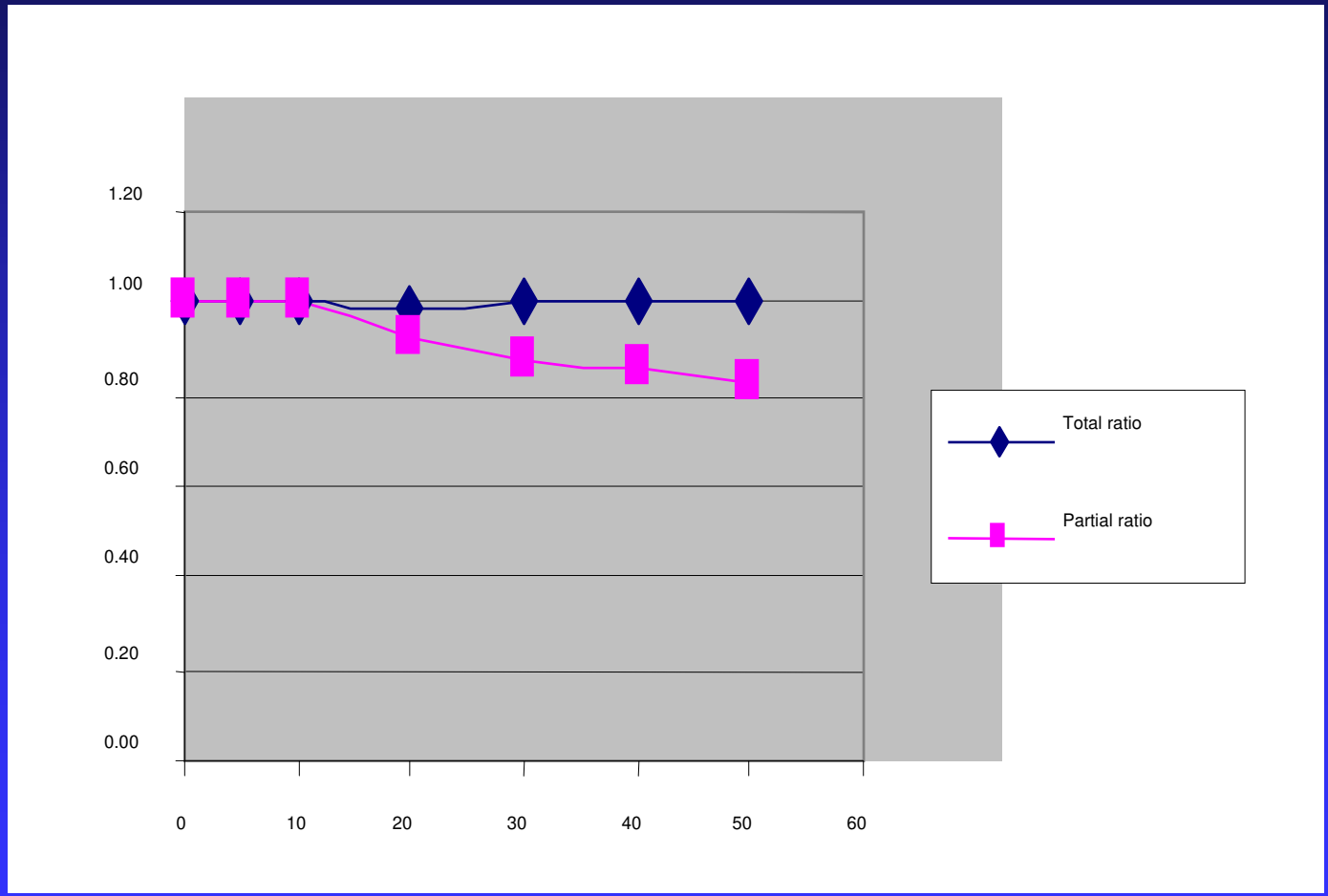
Simulations Setup: Simulations Metrics

- Restoration time
  - (time when the system returns the new set of light paths) – (time when the system is notified about failures)
  - Time to effectively configure NEs is not included
    - It is to the advantage of the incremental restoration scheme
- Restoration efficiency
  - Ratio between the total traffic after reconfiguration and the total traffic before the failure
  - Impact of rerouting ongoing traffic to new lightpaths (in the case of global reconfiguration) is not taken into account
    - It is to the advantage of the incremental restoration scheme
- Light path cost
  - The number of physical links that composes a light path

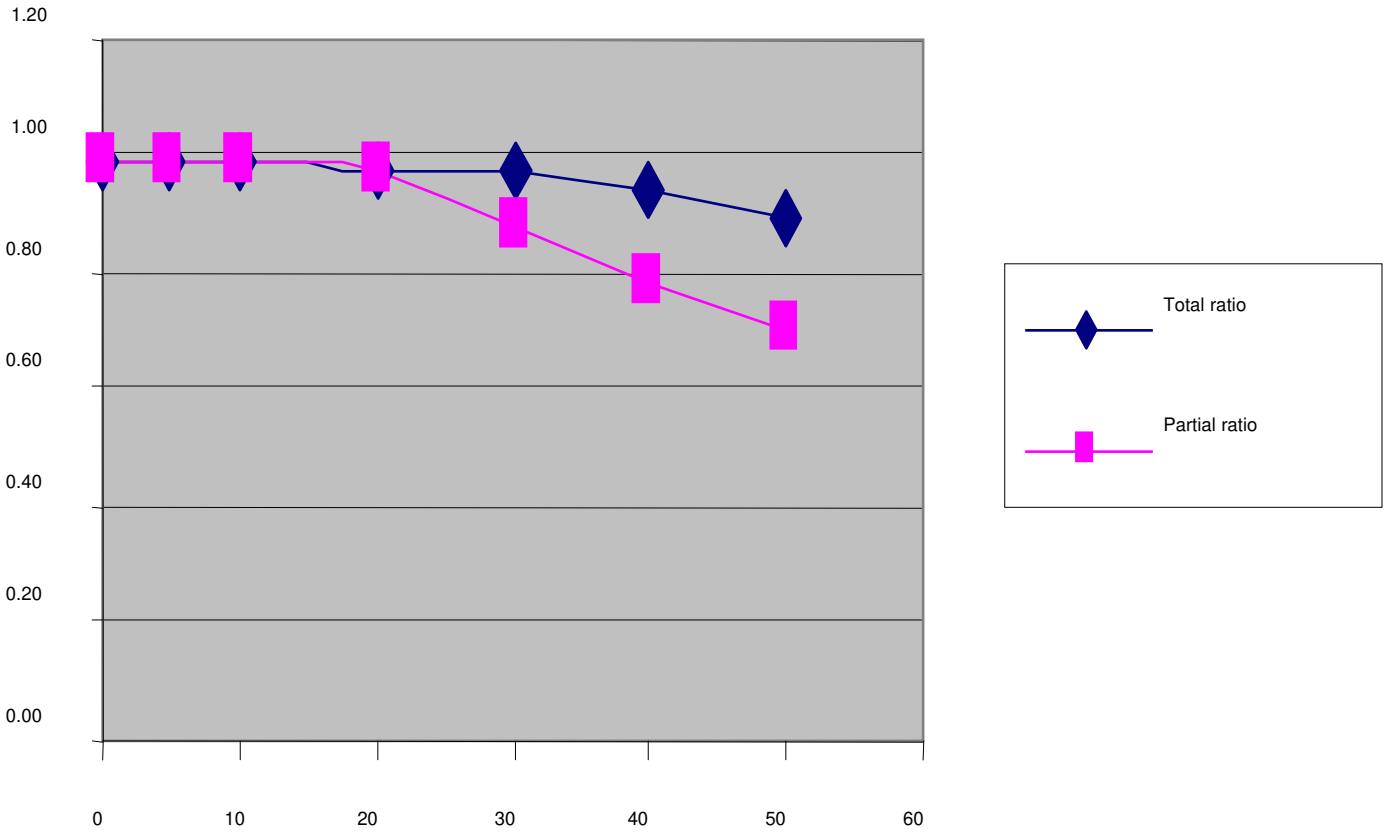
Restoration Time ratio (incremental over global)



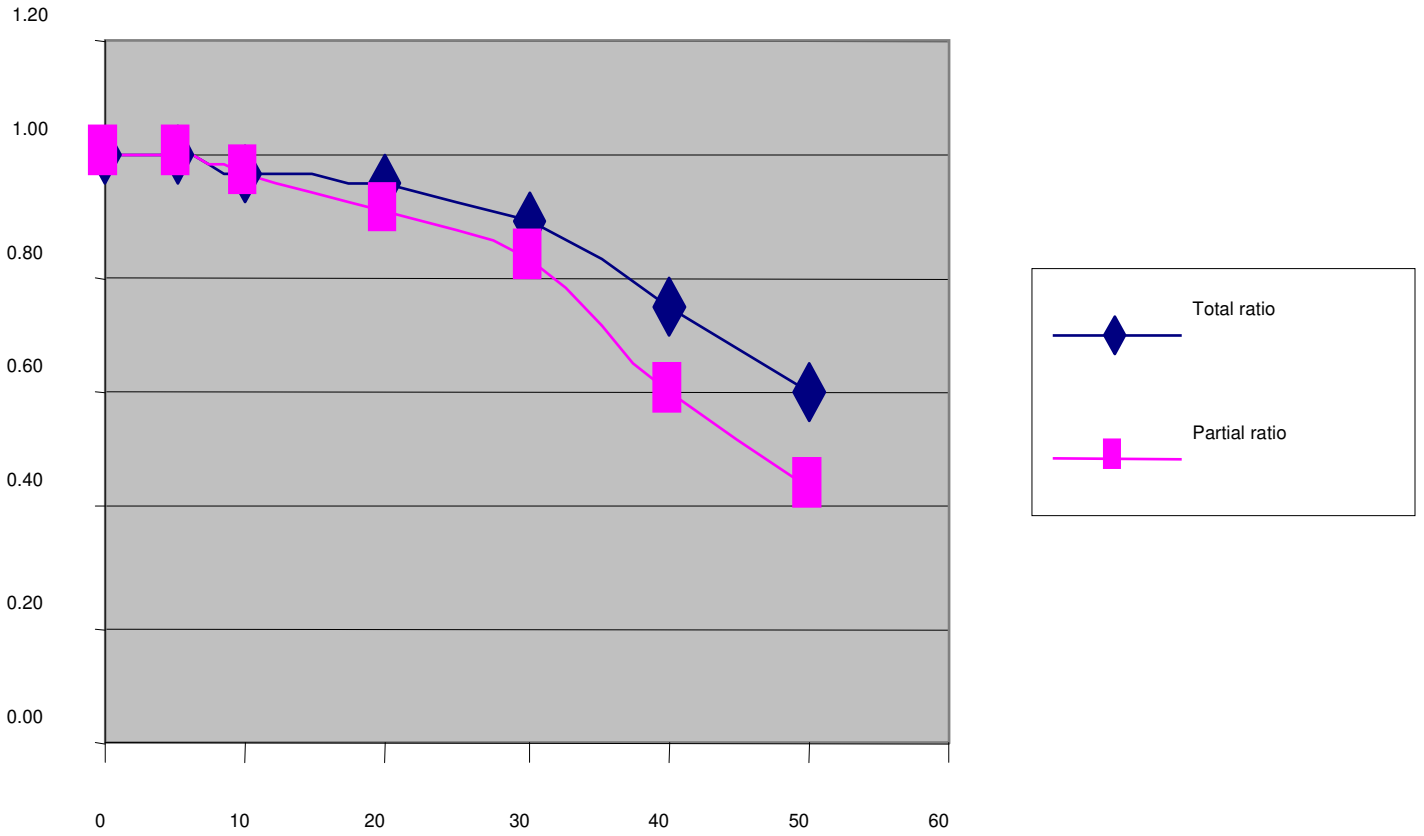
Restoration Efficiency with Low load and 90% restoration probability



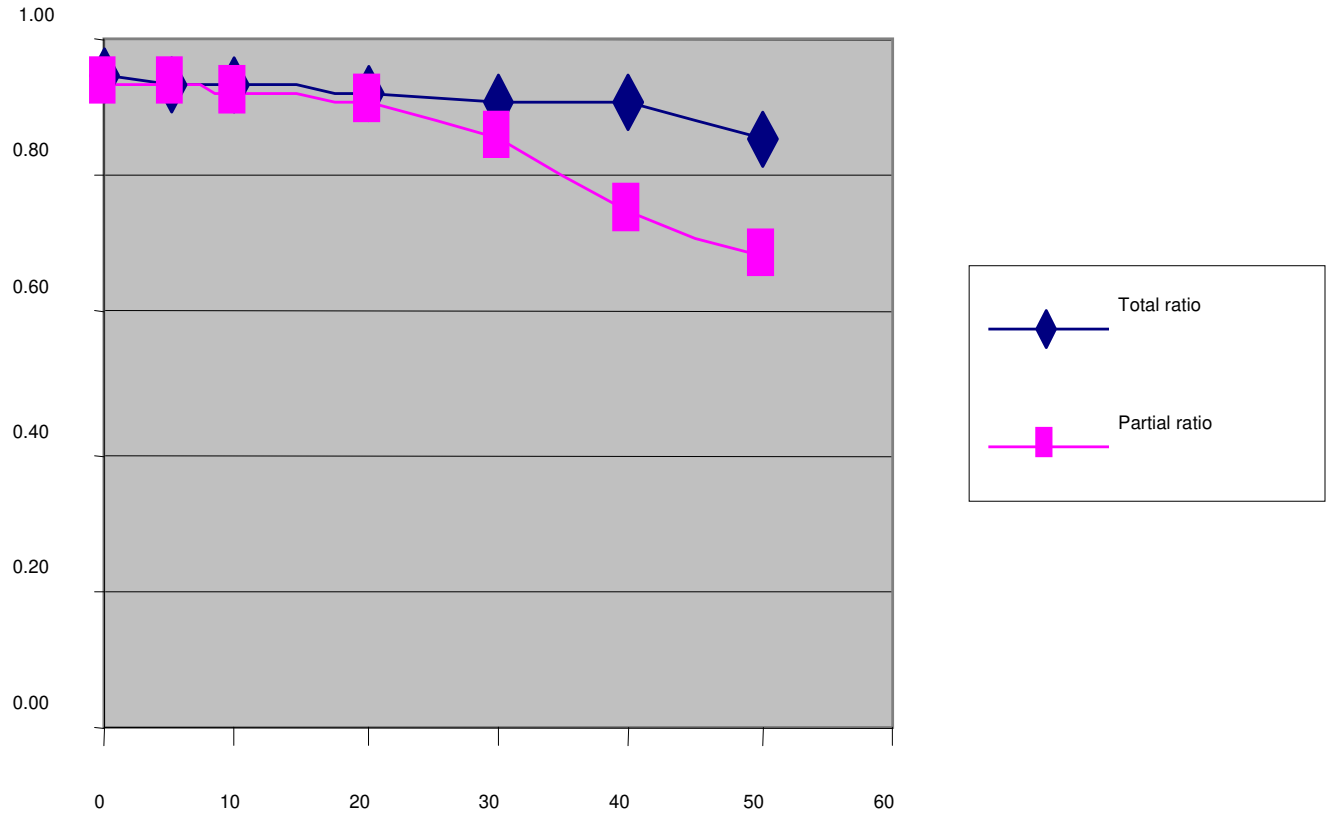
Restoration Efficiency with Low load and 50% restoration probability



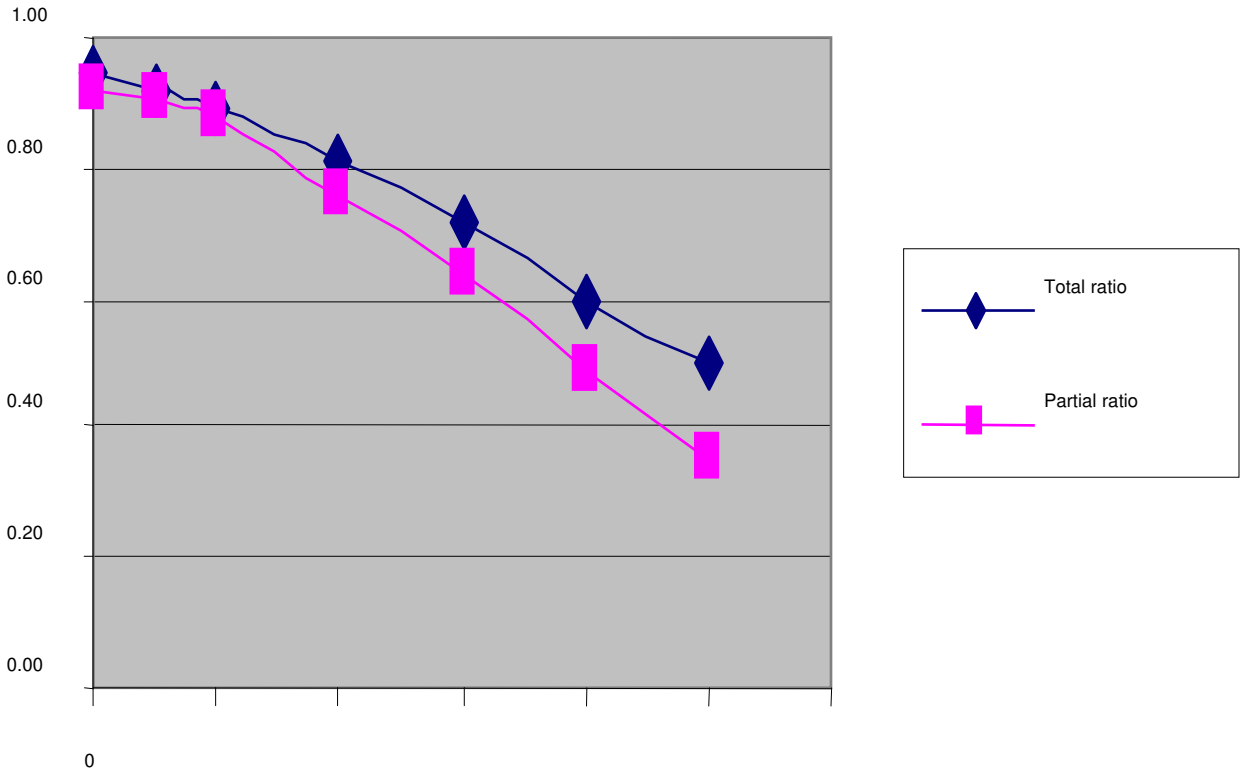
Restoration Efficiency with Low load and 10% restoration probability



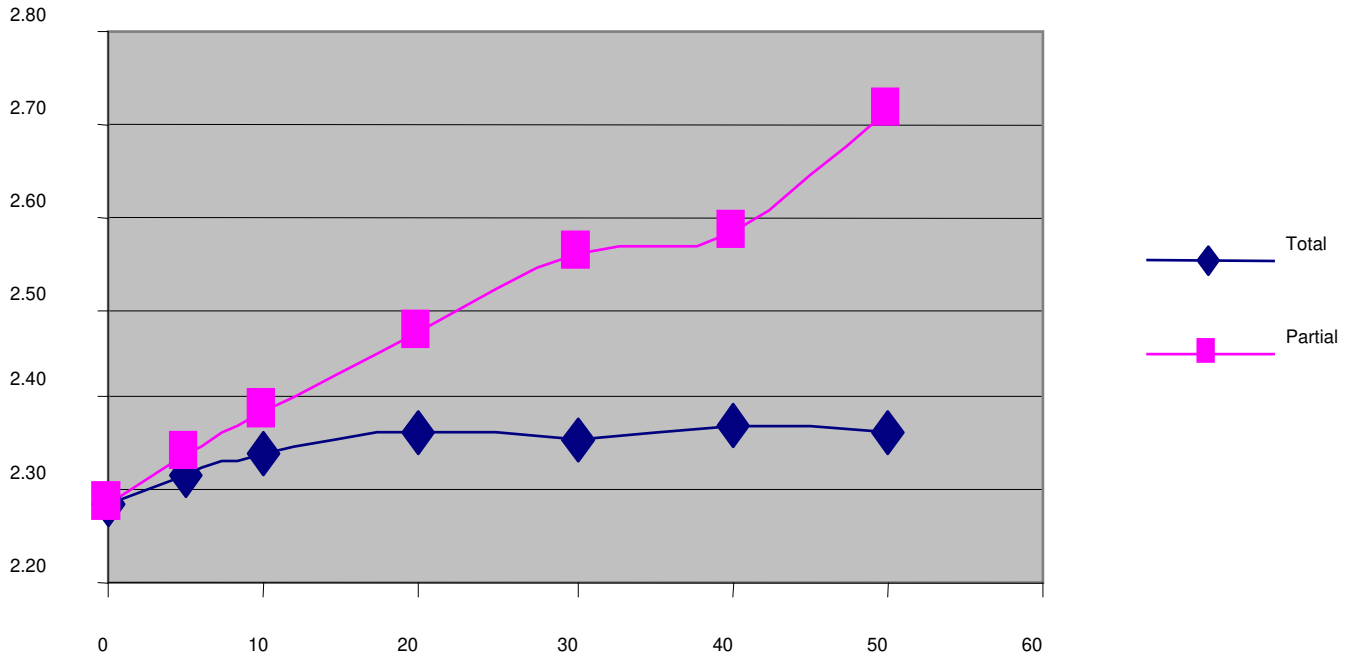
Restoration Efficiency with high load and 90% restoration probability



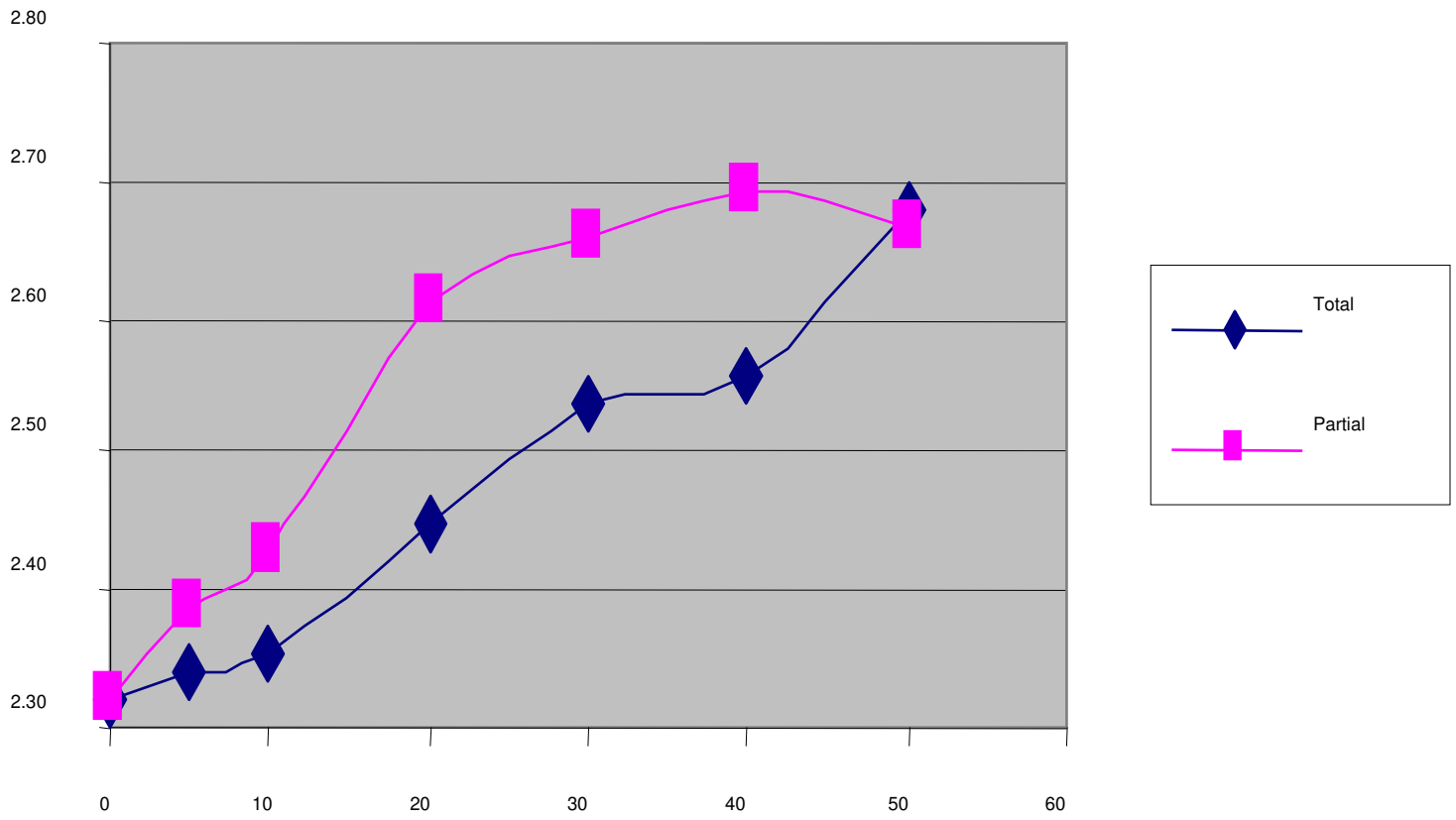
Restoration Efficiency with high load and 10% restoration probability



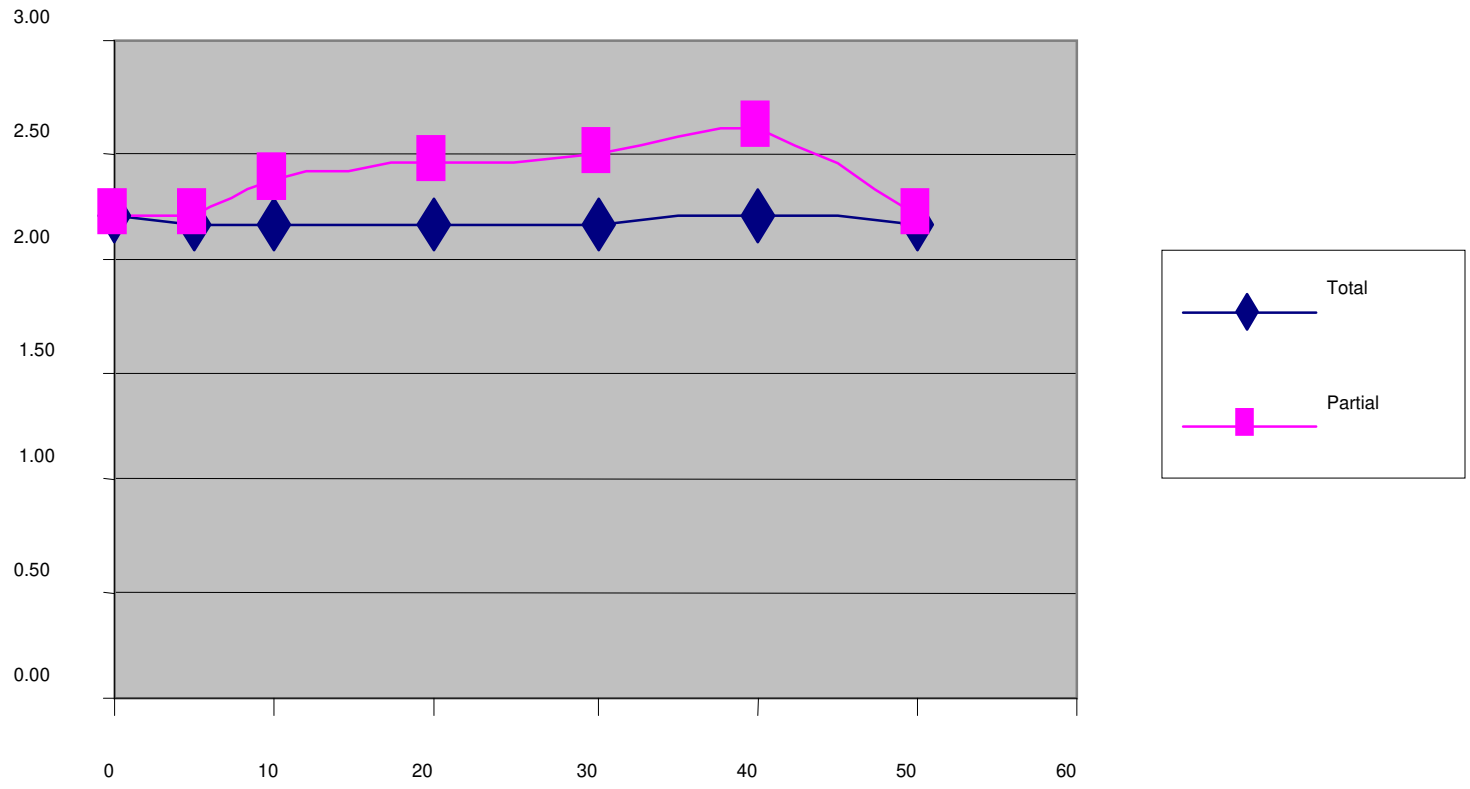
Average light path cost for low load and 90% restoration probability



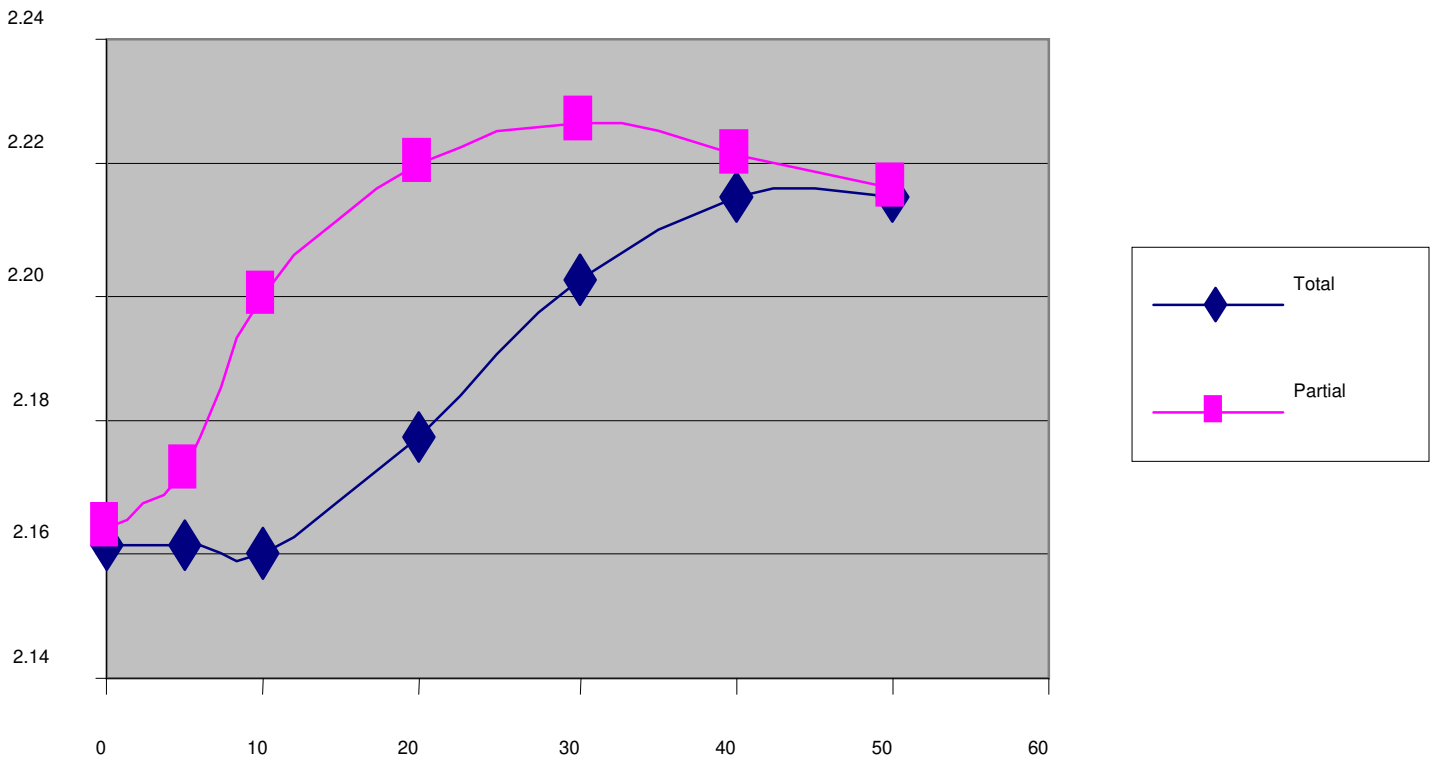
Average light path cost for low load and 10% restoration probability



Average light path cost for high load and 90% restoration probability



Average light path cost for high load and 10% restoration probability



Conclusion

- Incremental Restoration Scheme is a “good” complement of protection schemes
- Allows to restore the failed traffic that existing schemes fail to restore
- Does not impact, in terms of violations of agreed upon SLAs, ongoing traffic
- Successive applications of the incremental restoration scheme can negatively impact the performance of the network
  - Either re-optimize at this point
  - Or, make the incremental restoration decisions temporary and switch to the initial setup when failures are repaired
- We used, in the past, the same basic idea of the scheme and apply it successfully to MPLS networks
  - Patent pending