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SAN Self-Aware Networks
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Adaptive Resilience of CPN in the presence of Network Worms

Cognitive Packet Network (CPN)

CPN [1] is a packet routing protocol which addresses QoS using adaptive techniques based on on-line measurements.
It provides QoS driven routing and performs Self-Improvement in a distributed manner, by learning from the experience of packets.

[1] E. Gelenbe, R. Lent, and A. Nunez. Self-aware networks and QoS. *Proceedings of the IEEE*, 92(9):1478–1489, Sep 2004
[2] E. Gelenbe. Random neural networks with negative and positive signals and product form solution. *Neural Computation*, 2:239–247, Feb 1990.

Operation of CPN

It makes use of 3 types of packets:

- **Smart packets** (SP) for discovery
- **Dumb packets** (DP) to carry the payload.
- **Acknowledgement (ACK) packets** to bring back information.

SPs discover routes by using Random Neural Networks [2] with reinforcement learning .

Enhancements & Applications of CPN

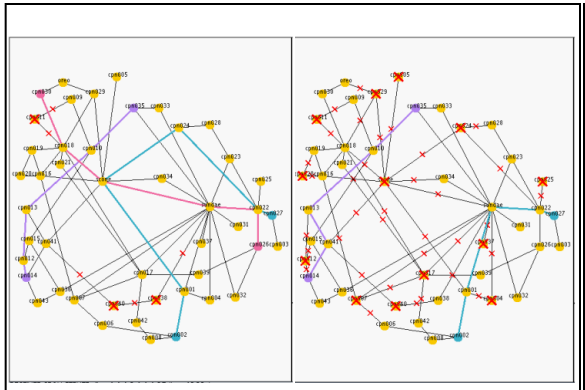
- Defence mechanisms against Denial of Service Attacks
- Admission Control
- Mobile AD-HOC CPN
- Hardware implementation of CPN
- Routing in Sensor Networks
- Autonomic Auctions and CPN
- Traffic Engineering

Experimental Results on Network Reliability during a Worm Spread

Configuration of the experiments

- Each node can be in one of the following states: *infected*, *immunised*, or *vulnerable.*
- The node failures are propagated as a computer worm, spreading randomly around the network and trying to infect it.
- The infections (failures) are spread according to two parameters: the *scanning rate* and the *failure duration.*
- *scanning rate*: the average number of machines scanned (infection attempt) per unit time, *failure duration*: the time an infected node will stay under failure. After that time the node is patched (immunised).

Our 46-node testbed at the beginning and during the spread of the worm



Packet Loss and Delay with CPN and the Internet Protocol for different worm spread rates and failure durations