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RESILIENT PACKET RING TECHNOLOGY: AN INTRODUCTION

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Abstract- The Resilient Packet Ring is a standard under development by IEEE and is used mainly in metropolitan and wide area networks .The main objective of a RPR is to utilise the bandwidth effectively Spatial reuse and fairness .The current technologies such as Gigabit Ethernet, SONET, and FDDI are not able to meet the current requirements and resilient packet ring provides an alternate way to meet the required objectives. This paper reviews the architectural features and technologies used in RPR. This article overviews how resilience is observed in RPR.

Keywords- Networking, Ring Network**,** Spatial Reuse, Fairness

I. INTRODUCTION

The Resilient packet Ring is a ring based network protocol being standardised by IEEE [1].Rings is a dominant topology and is built using several point to point connections. Rings are the dominant topology in metropolitan backbone primarily for their protection properties, that is, even under a link failure, full connectivity among all ring nodes is maintained [2].The network deployment by far has been done using SONET/SDH rings and Gigabit Ethernet. The dual ring configuration is present in them and one of the rings is used as a backup ring in case of link failure. But these technologies suffer from several disadvantages. The static bandwidth allocation and network monitoring requirements increase the total cost of SONET network [1]. On the other hand, a Gigabit Ethernet Ring can provide full statistical multiplexing, but suffers from poor utilization and unfairness [2]. Low utilization arises because Ethernet spanning tree protocol requires that one link be disabled to preclude “loops,” thereby preventing traffic from being forwarded along the true shortest path to the destination [3]. Other ring technology such as FDDI does not employ spatial reuse. The current standard suffers from several drawbacks-fairness algorithm, slow convergence, Class-of-service and dual ring utilisation [4].

The remaining paper is organized as follows: section 2 discusses about RPR architecture. In section 3 the traffic priority scheme is discussed. Section 4 provides a brief overview of RPR fairness and resilience. Finally, conclusions are provided in section 5.

II.RPR ARCHITECTURE

RPR has dual counter-rotating rings ringlet 0 rotating clockwise and ringlet 1 counter clockwise as shown in Fig 1.In unicast or broadcast addressing frames are added onto ring by a sender station that also decides on which of the two rings frame should travel [1]. At the receiving end the frame is completely removed from the ring, instead of copying contents which provides the bandwidth back to the sender station. This bandwidth thus can be used by other sending stations. This is known as spatial reuse.

To achieve spatial reuse two methods are used .One is Ring Access Method in which the station holding the token is the only station allowed to send and other is Buffer Insertion Method. In this every station on the ring consists of one buffer in which frames are inserted and are temporarily queued. The station may only start to add packet if the transit queue is empty and if transiting frame arrives after the station has started to add frame then it is temporarily stored [1] as shown in figure 2. The standard defines two implementations Primary Transit Queue (PTQ) and second is Secondary Transit Queue (STQ).In single queue mode the transit path consists of single FIFO queue which is PTQ .In this only strict priority traffic is employed [2]. In dual queue mode the two transit paths are provided for the transmission of less prioritised traffic. In both the cases the objective is to ensure hardware simplicity and to ensure that transit path is lossless i.e., once the packet is injected into the ring , it will not be dropped [2] . Different types of traffic and how it is transmitted over these queues which will be discussed later in the paper.

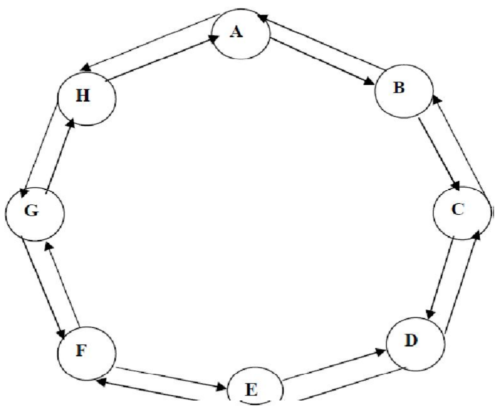

Figure 1.Two counter rotating rings in RPR

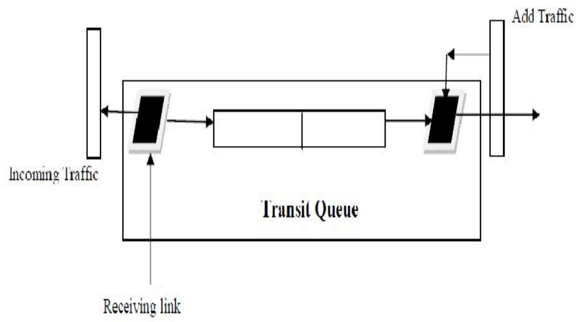

Figure 2.Transit Queue showing insertion of frames

III. TRAFFIC PRIORITY SCHEME

The access of station to ring communication medium in a RPR ring is controlled using a medium access control (MAC) protocol. RPR provides a three level, class based traffic priority scheme. These are class A, class B and class C. Class A is of low latency, low jitter class, class B is a class with predictable latency and jitter and class C is of best effort transport class. Class A traffic is divided into class A0 and A1 and class B traffic is divided into class B-CIR (Committed Information Rate) and B-EIR (Excess Information Rate). stations is pre allocated for Class A0 ,A1 and Class B-CIR. Bandwidth for Class A0 traffic is called reserved bandwidth and is used by stations holding reservations. Class A1 and Class B-CIR traffic bandwidth is 'reclaimable'. Class B-EIR and Class C are fairness eligible and are controlled by fairness algorithm [5].The remaining bandwidth called 'unreserved rate' can be used for all other traffic classes.

Whenever a station wants to add a frame into a ring it puts it in transit queue. Frame can also be added if the transit queue is not empty. The transit queue in this situation is specified as priority queue where high priority transit frames (Class A) are dequeued first. Besides this RPR also provides a optional solution by having two transit queues with Class A traffic to be queued in PTQ and Class B and C in STQ. An RPR ring may consist of both one and two transit queue station depending upon the requirement.

IV.RPR FAIRNESS & RESILIENCE

When the bandwidth on transit link of the station is exhausted, the link and station gets exhausted. This bandwidth then need to be distributed fairly among the contending stations .For this purpose RPR uses a fairness algorithm to distribute this bandwidth among Class B-EIR and Class C traffic. Congestion is different in both single and dual queue stations. In single queue station congestion occurs when the frames to be forwarded have to wait longer before they are forwarded .Dual queue station is said to be congested if STQ is filling up [1]. A congested downstream node conveys its congestion state to upstream nodes such that they control their traffic and ensure that there is sufficient capacity in downstream station traffic [2].For this a fair rate is calculated by dividing available bandwidth between all upstream stations that are currently sending frames. This value is sent to all upstream stations and they adjust their FE –traffic accordingly. There are two modes of operation of a fairness algorithm one is 'Conservative' mode and other is 'Aggressive' mode. In the Conservative mode congested station has to wait to sends the new fair rate until all stations in congestion domain adjust to new fair rate [1]. In 'Aggressive' mode congested station continuously sends packets at the rate of 100 microseconds. If all frames are sent successfully then congestion gets cleared. After clearance stations periodically increase their sending rates that they are receiving their maximal bandwidth share [2].

An important feature which makes RPR better than other ring topologies is its ability to provide resilience to a great extent. Resilience ensures that even in the case of link failure data is sent over the ring. Packet Rings have a natural resiliency advantage. In the Ethernet case, this resiliency is observed by a spanning tree protocol. This restoration mechanism is relatively slow. Ring fail-over is often known as "self-healing" or "automatic recovery i.e. it gets automatically recovered if any break point occurs in between". Today ring-based transport systems have reliably achieved less than 50 ms fail-over periods. To achieve this several design considerations have been considered including circumference of the ring, number of stations attached and speed of execution inside each station. In a Packet Ring protocol wherever there is a cut in between a ring wrap gets initiated. In this the station may wrap up the ring at the break point and immediately sends frame back on other direction. The other is packet "steering" by causing the sending node to redirect packets. In any of the case, traffic reaches the original destination by going around the ring in the opposite direction in the event of a fibre cut as shown in figure 3 and figure 4.

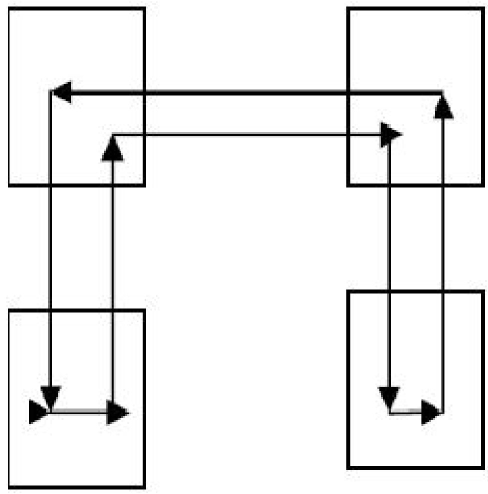

Figure 3.Ring Wrapping after failure

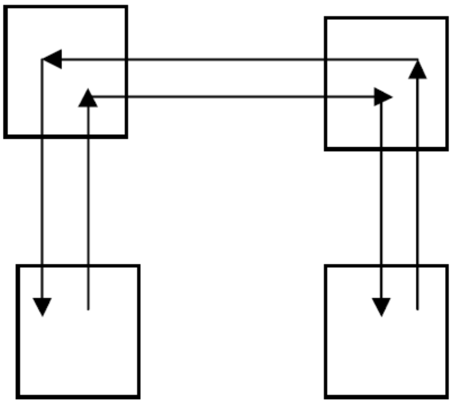

Figure 4.Ring Steering after failure

CONCLUSIONS

This paper has discussed and reviewed basic features of RPR architecture. RPR is a new MAC layer technology that can be easily spanned in MAN's and WAN's. The design goals of RPR are fast recovery from faults, guaranteed bandwidth, spatial reuse, fairness and high throughput. It has discussed various advantages of RPR over other ring protocols. How fairness is achieved and resilient properties of RPR have been detailed.

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