Design of Link Layer Protocol For Free Space Optical links

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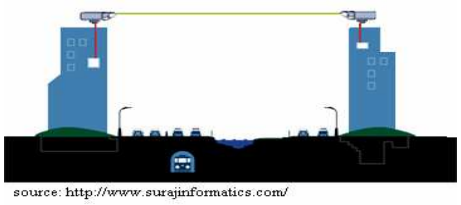
Free space optics (FSO) is considered to be a potential substitute for radio frequency (RF) systems owing to its high data rates, license free operation, low interference secure links and low cost. FSO links operate at speeds in the range of 100Mbps to 2.5Gbps and have a transmission range of about 5km to 50km depending on weather conditions. Under normal conditions, FSO links have much lower error rates than traditional RF, however because of other impairments like turbulence effects in the atmosphere (fog or smog), pointing and tracking errors at both sender and receiver, and short term blocking in line of sight etc., error rates increase resulting in burst errors.



Error Recovery Strategies

•Go-back-n (GBN) error recovery mode is efficient for low error rate channels owing to the processing delay in the implementation of selective repeat (SR) mode.

•SR mode is ideal for high error rate channels because of fewer retransmissions when compared to GBN mode.

•A FSO link layer protocol can be designed which employs GBN during the low error rate periods and switches to SR during the periods of burst errors.

Adaptive Hybrid GBN-SR Protocol

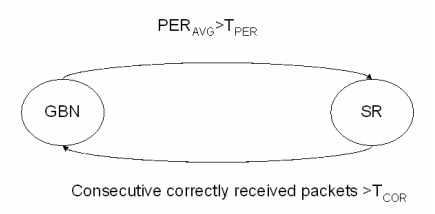
• Novelty in the adaptive hybrid GBN-SR protocol is that receiver always operates SR mode while the transmitter switches between GBN and SR depending on error conditions

•The time needed to switch modes in our protocol is reduced by a round trip time compared to previous adaptive protocols since there is no handshake between the transmitter and the receiver .

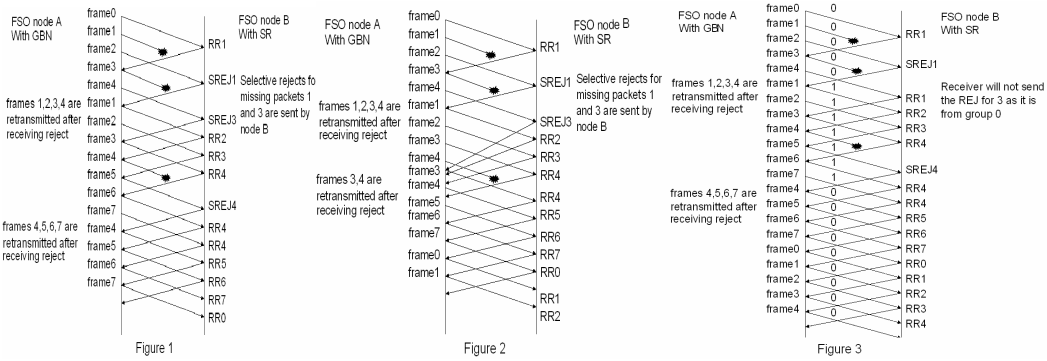
•Protocol switches to SR using a threshold of PER (T_{PER}) as the trigger. The PER is a weighted average (PER_{AVG}), and is updated every 100 packets as shown in the equation below, with alpha=.2

•To return to GBN, we use a threshold of consecutively received correct packets (T_{COR}) as the trigger.

$$PER_{avg} = (\alpha * PER_{avg}) + (1 - \alpha) * PER_{instant}$$



Need for an additional bit in the protocol



•When a single frame is lost or damaged, a SREJ is received by the transmitter after time t=round trip time + frame delay.

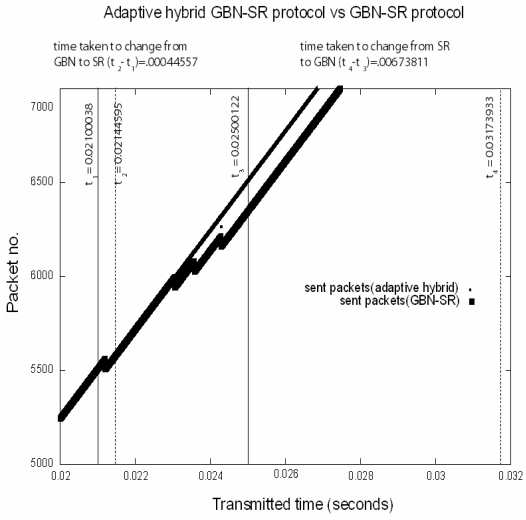
•If any of the subsequent frames are lost before the SREJ arrives at the transmitter, the transmitter will retransmit them as part of its initial retransmission.

•In ideal conditions, there are no unnecessary retransmissions as shown in the Figure 1, but when there is a variable delay, perhaps due to processing variations at the transmitter, there may be unnecessary retransmissions, shown in the Figure2.

•To fix the problem a single bit can be used to specify the retransmission group of the frames. The retransmission group is defined as the set of original packets that transmitter has sent since the last retransmission.

•The receiver sends a SREJ frame to the transmitter if a lost packet belongs to the same group as previous retransmissions, illustrated in Figure 3.

Results



•Adaptive hybrid GBN-SR protocol is simulated using T_{PER}=.0001 and T_{COR} =2000 on 1Gbps link with round trip time .0002s, in ns2 .

•PER is set 0 initially, then set to .005 for .004 seconds (from t=.021 to .025).

•The lowest possible transition time to switch from GBN to SR is .0002 seconds. This occurs only when a packet gets lost at t_1, right after PER is changed from 0 to .005 and PER_{AVG} is updated instantly.

•The highest possible transition time to switch from SR to GBN is 0.008 seconds (the time taken to send 2000 frames of size 500 bytes on a 1 Gb/s link); this happens when a packet gets lost at time t_3,right before the PER is changed from .005 to 0.

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