TCP Error Correction Review

CENG520 Homework 1

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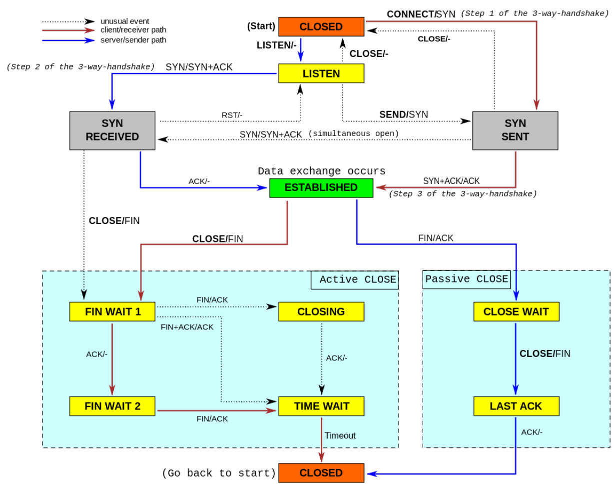

Fig. 1. Simplified TCP State (Source: By Scil100, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=30810617)

***Abstract*—Beside using wired techniques, there are wireless communication needs for transferring sensitive information with using Transmission Control Protocol. In this work some of the key works for error detection an corrections are reviewed for different layers of TCP.**

I. Introduction

Transmission Control Protocol(TCP) on the Internet Protocol(IP) developed for reliable data transmission with error checking between client and server sides. The data will be transmitted divided into chunks and these chunks are combined with headers which contains meta-data about communication for creating a TCP segment. These segments are encapsulated for exchanging with peers. Simplified TCP State diagram is given in Fig 1.

There are Open System Interconnection model for TCP with 5 layers. At the bottom, physical layer responsible for generating and requesting connections. At the top of physical layer, data link layer responsible for error prevention and framing. Then at the middle, internet layer responsible for logical transmmission of data. At the top op internet layer, transport layer ensure that packets are transmitted ordered and without error. At the last layer, application layer abstracts th application from complexity of data without errors.

Traditionally sequence number checking, duplicate packet discarding and checksum control is using for error detection, on the other hand recent methods are improved the error detection and correction as some of given in the next section.

II. Error Correction Methods

Teshima et al. [1] mentioned that instead of using UDP as a transport layer in real-time applications because of device rejecting in a network, TCP usage has increased. On the other hand congestion in TCP because of unstable throughput. They offered a Forward Error Correction(FEC) mechanism named with TCP-AFEC. This mechanism uses FEC in the bottom of transport layer. Sender side adds redundancy data after a data packet for recovering if the receiver lost the package. This FEC mechanism uses Reed-Solomon code because of its advantages against burst error. In the redundancy state transition structure of TCP-AFEC each level evaluated as redundancy level. A drop timer (DT) changes the redundancy level dynamically and determines if the redundancy decreases DT timeout occurs and redundancy increases when packet loss happens before DT. Their method was aimed to adjust the appropriate redundancy with using observed packet loss rate and adjusting the redundancy to achieve maximum efficiency. For securing a certain output, the recommended method should be set the receiving window size to be equal to the target throughput.

Krishnaprasad et al.[2] have worked on lossy wireless networks for improving the performance of TCP. They've developed a modified protocol named with TCP Kay. They modified ACK-DIV technique against lost ACK packets on the reverse path. And they combined this technique with FEC. They have represented their designs in four phases. At the first phase, Packet Error Rate(PER) measurement, they've used the congestion detection technique as like as the work performed LT-TCP[3]. Subramanian et al. used adaptive FEC reliability strategy with Explicit Congestion Notification[4] technique. In this technique congestion is detected proactively and the sender is notified. Krishnaprasad et al. calculates the PER with Exponantiall Weighted Moving Average of lost samples in the window. At the second phase limited version of ACK-DIV mechanism[5] while limiting the number of divided ACKs to maximum two (two ACK for one original ACK) increases the window size. At third phase LT-TCP like FEC generation performed but ignoring the retransmitted FEC packets preventing to use extra packets. At the last phase in the receiver side, corrupted packets recovered by TCP Kay algorithm with using FEC packet to correction. But unless

FEC exist dublicated ACKs are sent or timeout is waiting at the sender side.

Foerster et. al. offers a new transport layer protocol named with Another Transport Protocol (ATP) with packet loss handling and congestion control. A simple timeout control at the both sender and receiver side are used for loss handling with combining FEC mechanism. In this mechanism, XOR of the previously sent packets is sent after sending multiple packets. Therefore receiver can restore missing packet. Due to the increasing FEC sending rate is requiring higher bandwidth, also for minimizing overhead, the FEC mechanism is adjusted with sending high rates at the beginning of connection then decreased during transferring. In their congestion control mechanism window size increasing is slower due to the physical conditions of data centers which is their working field. Then the buffer can not fill fastly and the data can be lost. They offered informing sender for needing of FEC by the receiver with an event, so the window decreases slowly instead of sending re-transmission request.

The work of Wu et. al focused on High Definition wireless video transferring. The mentioned challenges which are high transmission rate and delay constraints, bandwidth limits and congestion mechanism. Their work offers a FEC mechanism dubbed with (Priority-Aware and TCP-Oriented codiNg). They developed analytical FEC based real-time video communication with TCP over wireless and proposed heuristic solution for prioritized frame selection. In their models, sender side has frame selector and FEC coder. Selected video frames converted to FEC packets and transmitted then FEC redundancy and packet size are recalculated in FEC coder in each decision step. The network status monitor at the receiver side periodically make estimations and sending information back to sender side. Therefore the network fed with physical conditions as like as round trip time and packet loss rate. Also with using improved pathChirp algorithm[8] channel status estimation is performed while taking the raw TCP data and generates processed output data for each probing step. They modelled communication network with round trip time, packet loss rate and available bandwidth. For FEC, if the number of receiverd oackets is less than number of source packets, received packets can be used for decoding process. Therefore soft-decision decoding algorithms are integrated to receiver side. Also sub-Gop level FEC coding algorithm[9] is used against delay constraints of real-time HD videos. They also modelled connection delays with application limitations from system transitions and network limitages. For determining the FEC redundancy they propose just enough redundant packets for minimizing the effective data loss rate against loss-delay trade off.

For mobile cloud gaming media, Wu et al. offered an adaptive source - FEC coding[10]. In the work they've mentioned wireless bandwidth and reliability limits, high throughput demand of the media and the deadline limits of congestion, they've minimized the end-to-end distortion of transmission and developed heuristic loss rate approximation for source rate control and FEC adaptation. The FEC adaptation algorithm minimize the distortion in real-time manner and performed sub-optimal decomposition of sub-problems for source rate control and the FEC coding applied in each decision epoch. For adapting FEC, packet size of FEC is determined with respect to loss rate of frames and tolerable loss rate for successfully recovering at the receiver side.

III. Conclusion

In this work mainly Forward Error Correction mechanisms are investigated. When the recent years literature was observed with respect to citations numbers of works, Forward Error Correction optimisations are stand out.

The literature is pointed out that wireless communications instead of wired in many fields from militaristic purposes to civil services are gained highly importance. Therefore, error correction works are focused on wireless communication fields. In the error tolerant systems especially searched for this review two step error coverage mechanism are revealed. In these systems, firstly the congestion check is performed with heart-beat or timeout mechanism then if the missing packet detects, sender sides attributes are tuned for re-sending the packets or sending recoverable summary of data with respect to limitations of bandwidth.

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