# CHAPTER 1: INTRODUCTION

This chapter discuss about the underlying background of the research, followed with overview of several TCP enhacement for wireless sensor network prior to this research

## 1.1 Rationale

WSN generally made out a substantial amount of sensor devices that is equipped with a radio communication system, and used to observe an environmental condition or object condition such as room temperature, the level of air pollution, noise, the magnitude of vibration, movement of the object etc., without requiring the immediately present of humans. WSN commonly incorporate some strong constraints regarding resources such as: memory, energy, computational processing speed and data or transmission rate.

Bringing TCP/IP to Wireless sensor Network is a undertaking task, Because of their restricted physical size and the sensors are extremely constrained in terms of memory and processing power. Traditionally, these constraints have been considered as barrier for a sensor to be able to use the TCP/IP protocols. Using TCP/IP for sensor networks allows connecting the sensor networks directly to IP network infrastructures. Many applications of wireless sensor networks require external network connectivity to enable communication between monitoring / controlling entities and sensors. By using the TCP/IP protocols inside the sensor network, external connectivity can be achieved to any other IP node at the edge or outside the sensor network. TCP can then be used for remote management and reprogramming of sensor nodes.[10]

There are several issues which need to be solved, before TCP/IP is a viable protocol combination to be used in a WSN, such us: header overhead, packets fragmentation and reassembly, and the greatest hurdle which hinders TCP/IP from being widely adopted in wireless sensor networks is TCP's flow and congestion control mechanism[1].

The reliable byte-stream protocol TCP has serious performance problems in wireless networks, both in terms of throughput and in terms of energy efficiency. To be able to use TCP as a reliable transport protocol in wireless sensor networks, methods must be developed to increase the performance of TCP in the specific setting of sensor networks. There is several necessity consideration of TCP adoption for wireless sensor network, such as:

a. TCP is the most reliable transport protocol used in IP-based networks.
b. TCP ensures reliability of data transmission from a sensor to a host external IP and vice versa.
c. With TCP, we are able open SSH connection to log into wireless devices (sensors, actors, etc.) and execute commands.
d. TCP allows also remotely programming/retasking wireless devices over-the-air.

There were many works that already proposed to solve the problems of TCP for implementation to a certain network or a specific type of network. It is indicated by the presence of some types of TCP known as TCP Variant, such as: Bic TCP / Cubic, TCP Vegas, Compound TCP, TCP Westwood, Hybla TCP, TCP HS etc. [19]. Most of the existing TCP variant was developed following the trends in network technology which is showed by existence of wider bandwidth, so the main goal for developing TCP is to be faster in utilizing or maximizing throughput of the available bandwidth. But this is contrary to what happened in WSN, where available bandwidth is quite limited and the main objectives in WSN is the efficiency in network communication rather than getting larger throughput. This condition make almost of existing TCP variant is not suitable used on WSN.

Several specific works that focus to solve the problem of adoption of TCP in WSN also have been proposed. Some of them have significant improvement and contribution. One of them is TCP header compression which is proposed to address header overhead problem of TCP adoption in WSN[5]. Another is TCP MSS tuning which contribute to determine appropriate packet size of TCP for more efficient implementation in WSN[13]. There were others several works had been identified[7][8][17], but almost the works is still focusing on the adjustment or modification of TCP protocol stack (header,packet size, code size, option, etc) and we do not find any works that proposed new TCP congestion control variant designed according to WSN characteristics and especially used in WSN.

According to [20], by excluding specific used TCP algorithms like Compound TCP (Default TCP for almost Windows OS) and TCP Bic/Cubic (Default TCP for Linux OS), almost recent internet traffic is controlled by AIMD based TCP Algorithms and last standardized AIMD based TCP was TCP Newreno[3]. So this research will use TCP Newreno as baseline for existing method to be evaluated and enhanced.

In this thesis, the goal is focus to examine the TCP congestion control mechanism implementation for WSN and proposed enhancement that can improve TCP perfomance according to WSN characteristics. In other words, we proposed another TCP variant which is used especially for WSN named TCP LR-Newreno or TCP Low Rate Newreno.

## 1.2 Theoretical Framework

The figure.1 illustrates the framework of the TCP Congestion Control mechanism, where there are several main processes such as Slow Start, Congestion Avoidance, Fast Retransmit, Fast Recovery and Retransmission Timeout. Detail of each process will be explain in next section.

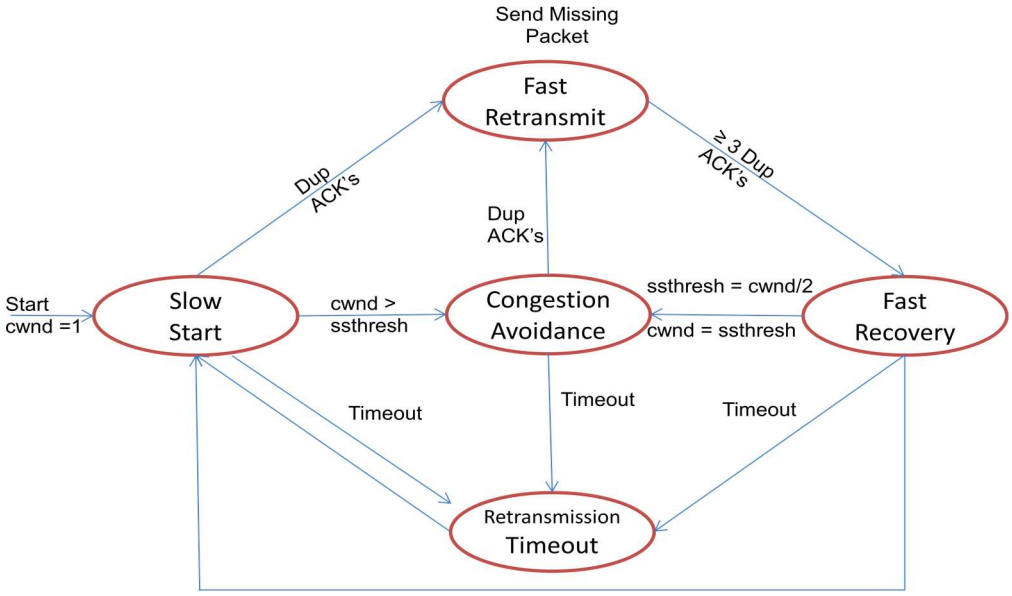


Fig. 1. TCP Congestion Control Main Process[26]

## 1.3 Conceptual Framework/Paradigm

Congestion Avoidance and Fast Recovery Phase is the most used function by TCP to adjust congestion window size while data transmission, so it is needed to improve those function to achieve more efficient and better performance for specific application like WSN.

## 1.4 Statement of the Problem

The following are some the problems that become the background of this thesis:

a. TCP was designed for wired networks, and always assume that all segment losses are resulted from congestion, and TCP responds by doing Multiplicative Decrease of

current congestion windows to an half (50%), while in the wireless network including WSN, other than as a result of congestion, loss often caused by channel noise or channel errors. This behavior will lead to poor performance of TCP in term of drop rate, throughput and energy efficiency.

b. Additive Increase mechanisms in TCP slow-start phase, increase the amount of congestion window in aggressive manner (exponentially). In the wired network with a large bandwidth availability, bandwidth utilization can be maximized in short periods of time. While in the wireless sensor network, according to the IEEE 802.15.4 standard (Lr-WPAN), the available bandwidth is very limited (250 Kbps), so the aggressiveness increase of TCP congestion window, resulting in the rapid touched of TCP maximum data rate and lead congestion occurs. Frequent congestion occurs mean require additional processes to do restrasmit data. This is certainly detrimental for WSN with resource constraints such as power, memory and CPU to build efficient data transmission.

## 1.5 Hypothesis

The following are the hypothesis that used in this thesis:

TCP implementations in the wireless sensor network can be done by performing modification of TCP congestion control algorithm by changing the growth function of congestion window in the congestion avoidance (Additive Increase) phase and congestion window reduction function (Multiplicative Decrease) in phase when losses is detected (Fast Recovery Phase), according to the limited bandwidth, energy consumption and average channels error rate (channel noise) that occurs in the wireless sensor network.

## 1.6 Objectives

The Following are the objectives of the research:

a. To provide detail information regarding the issues of using TCP on IEEE802.15.4 based WSN, that will be measured in the form of parameter tests such as Data Drop Rate, Throughput, and Energy Consumption.

b. To propose a new variant/scheme of TCP that comply with the characteristics of IEEE802.15.4 based WSN, by doing enhancement of existing TCP congestion control mechanisms so will improve TCP Performance and efficiency.

c. To provide reliable data communication in IEEE802.15.4 based Wireless Sensor Network using TCP with several benefit such as Remote Management and Remote Programming/Retasking.

## 1.7 Assumption

The following are the assumption used in this thesis:

a. Algorithm complexity time course is not counted.
b. Security system is not included.
c. Physical and Mac Layer of IEEE802.15.4 wireless link assumed to be in default function and working well.

## 1.8 Scope and Delimitation

The following are the scope and delimitation used in this thesis:

a. Topology design and test are using Network Simulator-2.
b. Configuration of coverage area for wireless node and wireless parameter are using standards that had existed.
c. Routing Protocol used are DSDV
d. Queue management used are Drop Tail
e. Evaluating the simulation performance limited to Data drop rate, Throughput and Node energy consumption.
f. We only focus on examine Congestion control mechanisme function of TCP rather than many other function like TCP Header, TCP MSS, TCP Three Way Handshake etc.

## 1.9 Importance of the Study

This thesis makes contributions which we believe that the congestion control research community would benefit from such us :

a. We propose a new TCP Scheme that comply with the characteristics of wireless sensor network, by doing enhancement of existing TCP congestion control mechanisms so will improve TCP Performance and efficiency in the wireless sensor network.
b. And then from the result of the research, gives newest information for implementaion of TCP over IEEE 802.15.4 based WSN that can be used as reference for next development of TCP.