CHAPTER I

INTRODUCTION

1.1 Background

The Information Centric Network (ICN) paradigm has shown resilience over the years as it evolved from location-oriented computer networks to a future layer of computer networks based on content known as the Named Data Network (NDN) [1]. The hierarchy-based architecture of the NDN system allows matching with information that has the requested name as a prefix, which in turn helps in verifying the relationship between the hierarchical information name and the corresponding information object [2]. In NDN, there are two types of packets exchanged over the network, namely interest packets and data packets [3]. These two messages are signed by the consumer as the one requesting the content and the provider in charge of delivering the content among consumers or intermediate nodes using data packets [4]. Interest packets are triggered by the consumer to request specific data, whereas data packets containing the requested information are sent in response to these requests [5]. The three main types [2] of data structures in NDN routers : include the Forwarding Information Base (FIB) which is routing information based on prefix names, the Pending Interest Table (PIT) which is a table used to manage information about interests that are waiting to be fulfilled by data packets and the Content Store (CS) which is a local cache that stores copies of data that has been requested and cached by nodes for later reuse. This approach enables caching within the network as well as replication of content, which in turn makes it easier to deliver information efficiently and in a timely manner [6]. An aspect of the communication model in Named Data Networking (NDN) is to request the remaining chunks of the network by name, which can be retrieved from intermediate nodes if a similar request has been made previously and the associated data has been cached, or directly from the producer [7]. It overcomes the routing inefficiencies that occur in current Internet Protocol (IP)-based networks with regard to NDN's goal of providing efficient data dissemination by focusing on content rather than on host identity and location [8].

Inspired by NDN, the Vehicular ad-hoc Network VANET NDN communication architecture has been modified to adopt NDN directly [5]. Many studies have proposed integrated solutions for VANETs with NDNs involving optimized forwarding strategies [8] ,[9]. Vehicular Ad-hoc Network (VANET) is a spontaneously formed network among vehicles and other connecting devices, which communicate with each other through wireless media to exchange useful information [10]. However, nodes in VANETs have higher mobility speeds, presenting significant communication challenges [5]. In vehicular ad hoc networks [8], vehicles not only act as information users, but also as information sending and receiving points. However, since vehicles have a limited transmission range, they can only communicate directly with vehicles or nodes within a certain distance, following the end-to-end communication architecture of the traditional transmission control/internet protocol (TCP/IP). Therefore, the implementation of NDN in a vehicular environment benefits from the broadcast nature for data transmission. Broadcast mode is suitable for VANETs where vehicles move at high speeds [10].

The broadcast-based self-learning method, introduced [11] is a broadcast-based adaptive approach where every node in the network receives information. This method scales up [12] to understand paths without specific instructions, beneficial in dynamic wireless networks.

Other research [13], In MANETs with self-learning, NACK delivery faces costs due to potential mobility losses, causing delays and increased transmission overhead, including message exchange protocols. To address this, this research suggests implementing a Data Aggregation Forwarding (DAF) strategy in NDNs to reduce latency and overhead. The data-centric approach of NDN along with DAF shows advantages over IP, especially in scenarios involving mobility and multicast communication in MANETs. In the default multicast strategy, NACK messages are sent when a particular name is unreachable which leads to flooding the network with NACK packets due to constant changes in the network topology [14], this causes the data message cannot be received between neighboring nodes even though the NACK has been processed first.

The purpose of this study is to Performance Analysis of vehicular ad hoc networks (VANETs) on named data network (NDN) architecture, with negative acknowledgement (NACK) packet deletion scheme in self-learning forwarding strategy. Furthermore, the number of NACK packets in self-learning forwarding strategy is limited by considering the minimum round-trip time value, which serves to reduce the request response time. The goal is to establish a more stable connection between consumers and producers. Furthermore, we consider the possibility to improve the throughput and cache hit ratio values.

1.2 Problem Statement

In light of the discussed introduction, a potential issue was identified, namely the possibility of NACK loss due to mobility. In a wireless network, the transmission of a NACK may result in the loss of the path back to the consumer who initiated the request due to changes in the position of nodes. Consequently, this phenomenon can prolong the time required for data packets to traverse the network from the sender to the receiver and back, leading to an accumulation of data in the queue due to the extended waiting period. Additionally, it is essential to consider the number of packets that can be cached at each node within the network.

1.3 Objectives

Based on the formulation of the problems that have been described, the objectives to be achieved from this research are to perform Performance Analysis on Vehicular Ad Hoc Network (VANET) on Named Data Networking (NDN) architecture by considering the minimum Round-Trip Time (ms) value, considering the increase in throughput value (kBps) and also increasing the value of cache hit ratio (%). This research has a novelty, which is as follows:

1. Modifications to the self-learning forwarding strategy entail the elimination and limitation of the sending of NACK packets, with the objective of minimizing the minimum round trip time value and increasing the throughput value and cache hit ratio value supported by the ndn4ivc framework.

2. The testing scheme employs a variety number of node configurations and content storage sizes (CS) to assess the impact of these variables on the system's performance.

The benefits of this research are :

1. The implementation of this modification can facilitate the simplification of the communication protocol, based on the elimination and limitation of NACK, thus minimizing the round trip time (RTT) value and increasing the throughput value and cache hit ratio.

2. The functionality of the self-learning forwarding strategies in a VANET NDN can be evaluated by analyzing the test values and determining the performance of the RTT (ms), throughput (kBps), and cache hit ratio (%) parameters.

1.4 Scope of Work

The problem limitation can be determined based on the background description that has been presented :

1. The NDN-based NDN4IVC Framework is employed for the integration of the ndnSIM simulator software (NS-3-based NDN Simulator) and the SUMO simulation model (Urban Mobility Simulation), with the objective of facilitating the visualization of the vehicle node environment. The operating system utilized is Linux Ubuntu version 20.04.
2. Does not address the issue of network security.
3. The adaptive mechanism is based on three fundamental parameters: round-trip time (RTT), throughput, and cache hit ratio (CHR).

1.5 Expected Results

As previous research on stateful and adaptive forwarding in Named Data Networking (NDN) has demonstrated, these techniques can offer substantial benefits for vehicular communication [8]. It demonstrates optimal performance in a vehicular ad hoc network (VANET) environment, as evidenced by prior research [15], [9]. Therefore, previous research introduced a suitable broadcast self-learning method [11], [12], [16]. However, this method ignores the movement of nodes which is considered as link failure, thus causing the NACK to lose its path back to the consumers who need it. Consequently, this may increase the time it takes for the data packet to travel from the sender to the receiver and back again to the sender and the amount of data pending in the queue will increase due to the longer waiting time. A Data Aggregation Forwarding (DAF) strategy on NDN to reduce latency and overhead has been proposed [14]. Nevertheless, its principal applications are in scenarios involving mobility and multicast communication in MANETs. It is therefore necessary to conduct a performance analysis of the self-learning method in vehicle ad hoc networks (VANET) on the named data networking (NDN) architecture in order to ascertain the optimal method for achieving the desired outcome. The objective of this research is to modify the self-learning method based on NACK elimination and limitation in order to optimize data transmission, reduce round trip time, and increase throughput and cache hit ratio.

1.6 Research Methodology

This research adopts a quantitative approach obtained through simulation analysis using a simulation tool called ndnSIM. This approach ensures a more systematic and structured research continuity. The use of quantitative methods was chosen because it fulfills scientific principles, such as concrete, objective, measurable, rational, and systematic. This approach provides a clear and reliable framework for collecting, analyzing, and interpreting data objectively, supporting the reliability of the research results.

The methodology used in completing the final project is a method that is carried out in stages, namely as follows :

- The initial stage was carried out to develop a research plan. Starting with the literature study process. In this method, various data and information related to vanet named data network (VNDN) are collected. Collection of data and information based on journals, internet and books.

- The problem identification method is carried out to find current problems based on the research topic. The formulation of problem identification is obtained from the state-of-the-art scheme of self-learning methods in reading journals and literature studies.

- The data collection method is carried out by running simulations related to the tools to be used, namely ndnSIM.

- The next stage is the system analysis method. In this method, analysis, design and design are carried out on the self-learning method. Before going to the next stage, it must analyze how the system runs with several use cases to later get a new system proposal.
- The design method is the process of designing the self-learning method by designing the proposed performance analysis design.
- After the design stage, the next method is coding. At this stage, program coding is carried out. The programming language used in making this research is python using ndnSIM tools supported by SUMO as a form of visual tools and ns-3.
- The next stage is the testing method. At this stage, the implementation of the optimization of the self-learning forwarding strategy is carried out and a comparison is made with the previous algorithm.
- The analysis method is performed when the self-learning forwarding strategy has been implemented and then minor improvements such as bugging or errors are made.
- The final stage is the conclusion method. Drawing conclusions and documentation in the form of making a book.