A Network Stack for Computation-Centric Vehicular Networking

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ABSTRACT

Recently, vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) connectivity transitioned from a vision of the future to reality. Applications in such environments vary from local propagation of road conditions to large-scale traffic flow control systems. In this demo, we present a network stack for the data exchange in the automotive IoT, based on the Named Function Networking (NFN) principles. In NFN, the communication model is not restricted to propagation of static data but natively supports computation-offloading to other nodes. We present solutions and report on experiments with real cars on a test course.

CCS CONCEPTS

• **Networks** → **In-network processing**; *Naming and addressing*; *Network protocol design*;

KEYWORDS

Connected Vehicles, Named Function Networking, Mobile Edge Computing, Information-Centric Networking

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1 INTRODUCTION

Content-centric networks (CCN) offer the service to deliver information based on the content's name [2]. This means, clients are released from holding server locations and request content in a hop-by-hop fashion. As an extension, Named Function Networking (NFN) allows users to request for derived, i.e. dynamically produced, data [7]. In NFN, named functions are published in the network, which can be applied to any available content on demand. For this purpose, a user composes a data name which encodes the application of named function(s) to certain data. It is the task of the network to compute and deliver the result. Behind the scenes, the network implements a forwarding strategy which decides where a computation is executed [6].

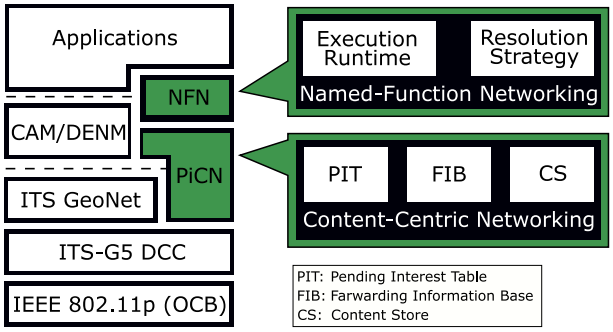

Figure 1: NFN on ETSI ITS-G5 protocol stack.

Mobile Edge Computing with NFN. In challenged networks such as connected vehicle environments, Edge Computing (EC) has become popular to bring computational resources to the edge of the network to produce and manage data closer to the consumers. By combining NFN and EC, the computation of data is performed only few hops away from the consumer. In NFN, the identification of the computation location is realized by using so-called resolution strategies. As part of this work, the Find and Execute (FaX) forwarding strategy is used, originally designed for mobile IoT environments [5]. An exemplary presentation of the strategy can be described as follows: it is expected, that a result of a computation intensive operation can not always be shipped directly to a mobile consumer. In FaX, the closest computation-capable node starts the computation immediately, and checks adjacent computation nodes for a already computed result in parallel. As a result, FaX reduces the resolution time and increases data delivery success rate.

This work contributes a full stack implementation of NFN for the 5th Generation of Intelligent Transportation Systems of the European Telecommunications Standards Institute (ETSI ITS-G5) connected vehicle protocol stack. Furthermore, the stack has been tested including real cars and a infrastructural deployment showing the offloading of computations from vehicles to the infrastructure.

2 INTEGRATION OF NFN INTO ETSI ITS-G5 SYSTEMS

The stack developed in this work integrates the NFN implementation PiCN and enables vehicular units to exchange ITS-G5 as well as CCN messages between other vehicles and an infrastructure in parallel. Figure 1 illustrates the process of integrating NFN into

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