Research Diary

5G and Edge Computing assisted Mission Critical ITS Applications

Dr Antony Franklin (R), Associate Professor, and
Ms Shwetha Vittal (L), PhD Scholar,
Department of Computer Science & Engineering

KID: 20220203

We are living in a world with breathtaking technological innovations. Starting from self-driving cars to remote robotic surgeries in healthcare, there is no dearth of inventions. With these creative inventions uncovered every minute to improve the standards of living, there is a constant need for the fuel that will enable these technologies to function at their maximum potential. "The Internet, like the steam engine, was a breakthrough that changed the world"-Peter Singer, no doubt. But, we would not be wrong to state that "5G is the breakthrough that we all needed to enable the rapid advancements in technology in the 21st century". It enables a new kind of cellular broadband that is designed to connect virtually everyone and everything together, including machines, objects, and devices.

Current advancements in 5G and edge computing infrastructure increase the need to deploy location-based services for mission-critical and delay-sensitive applications like Vehicle to everything (V2X) and Intelligent Transport System (ITS). Research shows that human error is completely or partially the cause of accidents in most cases. And due to this, V2X communication has been continuously researched for more than a decade now with respect to safe transportation.

In this context, 5G and Multi-access Edge Computing (MEC) based Location Services (LCS) can assist the emergency services by providing the exact location of the caller/user to the authorities and first responders.

We, a team of members from Networked Wireless Systems Lab (NeWS Lab) at IITH, have built an end-to-end 5G-MEC assisted Location Services system. This system can aid the emergency services accessing authorities or the first responders like Police, Ambulance, and Fire Control to fetch the location of the caller/user in need of assistance. Our 5G-MEC coupled testbed, as shown in **Figure 10 and Figure 11**, addresses the need for location assistance in mission-critical, delay-sensitive, and emergency services in ITS and V2X by building an end-to-end LCS emulation framework. Our LCS framework is flexible to be deployed in the remote cloud and edge environments.

The 5G network aids in delivering the current location information of the user to the ITS emergency services running at the MEC running at the end of the network.

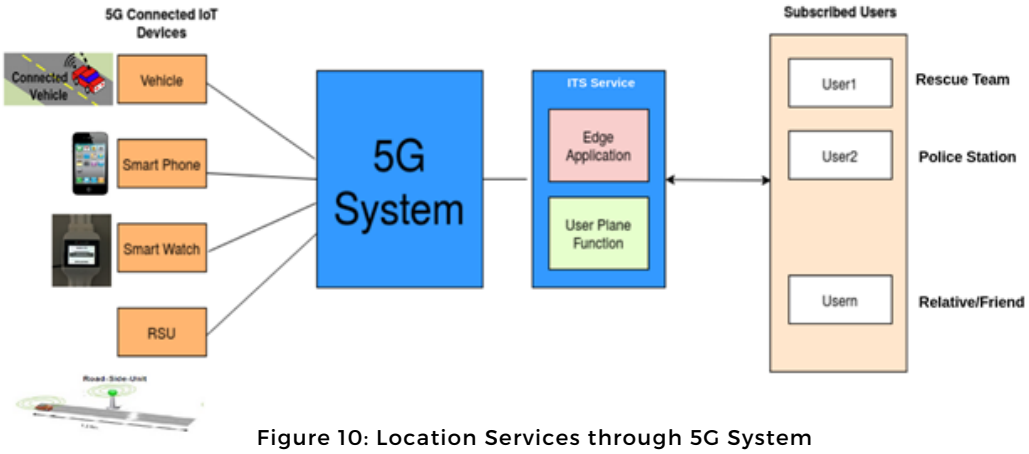

Figure 10: Location Services through 5G System

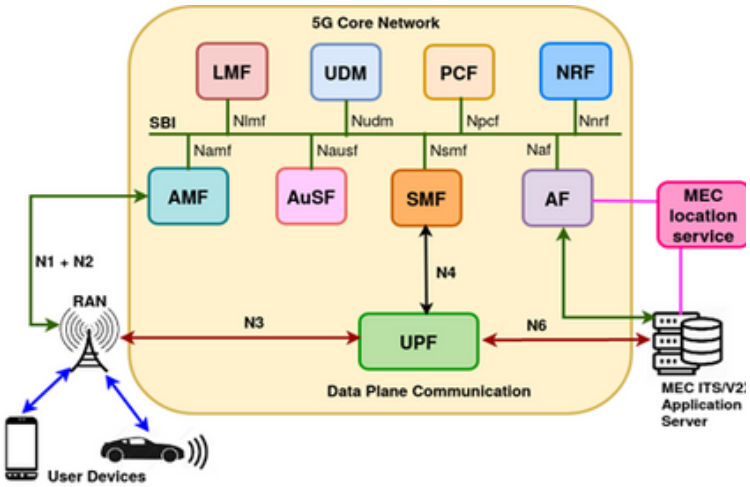

Figure 11: 5G System Architecture for Location Services

Research Diary

5G connected devices like smartphones, vehicles, and IoT devices (e.g., wearables) can avail the benefit of this service using an application running on these devices, which can request the location services required for the emergency services. The request, along with the associated location information, is sent to the ITS server via the 5G network. Additionally, the ITS application itself can request the user to provide its current location to enhance the emergency services response. Using this, the ITS application can assist the user in reaching a safe location at times when the user does not know where and how to reach a safe location.

Human safety, as well as the safety of materials, are vital and a necessary component of any armed forces organization. LCS with ITS can assist in close monitoring of the location of Infantry Fighting Vehicles (IFVs) and suspect the entry of intruders in the remote military/navy zones.

We have sample applications on ITS working using our testbed. The details of it can be availed from the recent demonstration we had at IEEE International Conference on Network Softwarization. https://youtu.be/wxirflvpTjc.

In addition to on-road transportation assistance, LCS can be quite useful in Ocean Networks, too, with a private 5G deployment, as illustrated in **Figure 12**. Offshore fishing is a common occupation providing a livelihood for tens of millions worldwide. Lack of timely warning can lead to missing fishing vessels, collisions between ships and boats during night times, bad weather, lack of offshore communication resulting in late information/message arrival to their families, and so on. In this regard, a 5G-based LCS system can assist in building a maritime safety information communication system, tracking fishing vessels with the fishing vessel to shore (V2I) and fishing vessel to vessel communication (V2V), Maritime IoT, and local community network for fishermen.

The observance of 'safety first, safety always' is intended to strengthen the professional approach to enhance combat capability. It also strongly aligns with the Digital India initiatives and is a key driver for economic growth and technological development in India, and we are more than glad to have played a role in it.

Figure 12: LCS assisted IFVs & Ocean Networks using Private 5G

Research Diary

Heterogeneity in the Driver Behavior: An Exploratory Study Using Real-Time Driving Data

Dr Digvijay S Pawar (L), Assistant Professor
Ms Jahnavi Yarlagadda (R), PhD Scholar
Dept of Civil Engineering

KID: 20220204

Road traffic accidents are one of the leading causes of death, resulting in approximately 1.35 million deaths every year [WHO, 2018]. The factors associated with road crashes have been studied over decades, and driver behaviour is concluded to be the major contributory factor. Therefore, understanding the driver's behaviour is important for many applications like driver assistance or personalized feedback provision for enhancing driving safety, economy, and comfort. In addition, the implications of driver behaviour research are significant inputs for the design of autonomous vehicles. Driver behaviour indicates the manner of executing various driving tasks, which can be perceived as controlling the vehicle in the longitudinal and lateral directions.

The habitual way of performing driving manoeuvres is considered a driving style, which characterizes the individual driver or a group of drivers. Many researchers have attempted to classify the drivers and the driving styles based on the outcomes of driving tasks from the perspective of driving safety.

In this context, the study investigates the extent of variations in the individual's driving styles during routine driving. The driving styles are conceptualized using the vehicle kinematic data, that is, speed and accelerations performed during longitudinal control.

The data is collected for 42 professional drivers using instrumented vehicles over a defined study stretch. An algorithm is developed for data extraction, and a total of 7548 acceleration and 6156 braking manoeuvres and corresponding driving performance features are extracted. The driving manoeuvre data are analyzed using the unsupervised techniques (PCA and K-means clustering), and three patterns of acceleration and braking are identified, which are further associated with two patterns of speed behaviour. The results showed that each driver is found to exhibit different driving patterns in different driving regimes, and no driver constantly shows safe or aggressive behaviour. The aggression scores are found to be different among drivers, indicating behavioural heterogeneity.