Connected Intelligence for Data Driven Fleet Management (DDFM)

Prakash Ramchandran
eOTF

***Abstract*— Driving fleets on the ground, air or space, all need to collect appropriate volume of data, ingest, and process in streams to deliver pipelines to process continuously to manage the fleets of vehicles. Thus fleet management has become a key use case in various applications in peace or war. Defense requires platooning vehicle to vehicle (V2V) and all roads lead to data-driven modeling and analysis to schedule, safeguard and prevent accidents be it autonomous or assisted driving to support intelligent transportation or missions to planets. highlight the need for innovation with data engineering and data science to deliver the new pipelines for fleet management. We cover here the background to autonomous driving and propose Edge Computing extension to air & space for Data Driven Fleet Management.**

Keywords*— *Vehicle to Vehicle, Connected cars, light detection and ranging, Edge Computing, Drones

Introduction

The Next Generation of Network (NGN) is beyond fifth generation (5G) into realm of sixth generation (6G) where the traditional Terrestrial network (TN) that include Fixed and mobile Cellular & Wireless Fidelity (WiFi) networks are being viewed as core and are being supplemented by non-Terrestrial Network (NTN) including ground (includes marine) and air and space networks. The ground Terrestrial communications are dominated by IEEE 802.nn variations and Cellular for outdoor communications. There are other Near Field Communications (NFC) like BlueTooth, Zigbi and LoRa Wide Area Network (WAN), mainly applied for Internet of Things (IOT) and we generally use them for specialized use cases using mobile phones and or for sensor & control automation.

Connection is key before one can collect data and derive intelligence through big data processing and closed loop systems to enhance the accuracy and predictions to apply as part of Data Modeling (DM) and Artificial Intelligence (AI). In this article I would like to point to research that may trigger a new trend in fleet management. The concept of Intelligent Transportation System (ITS) has been widely studied and has evolved over decades and that led to efforts in autonomous driving. Autonomous driving is a use case of Edge Computing and will refer you to IEEE International Next Generation Road (INGR) Map Edge Service Working Group as part of Future Networks [2].

AUTONOMOUS DRIVING

Connected cars are digitized vehicles with built-in wireless networking that help besides entertainment & infotainment the ability to leverage knowledge of location, Road map and Object recognition systems using light detection and ranging (LIDAR) & radio detection and ranging (RADAR) to navigate the Car or Vehicles. Specialized vehicles by players starting Google to several Automotive manufacturers have invested their significant capital and operational resources to reach a certain level of automation.

The levels of autonomy [3] have evolved over the last decade to reach between level four & five. Note level one is minor driver assistance technology like cruise control, stop-and-go, low speed driving in traffic, simplifying parallel parking etc. Level two helps human drivers to handle some steering and breaking controlled by electronics added to car functions through partial automation. Level three addresses complex automation via embedded on-board sensors to understand environment e.g. lane keeping at high-speed, recognizing blind spot alerting or changing lanes etc.

We are in the era of level 4 where complete self driving has been made possible by Billions of Kilometers (miles) covered by Self Driving cars with data collection and real time corrections. Having a Satellite image and corrected regularly by Self driving mappings the certain routes are well marked for licensed Self driving cars, with a caveat that legal licensing is required based on different state laws in the USA and other parts of the world. Level Five is full automation and No human interaction or intervention is required. This has although been achieved by several Auto Manufacturers and depending on laws and co-operation of the public this is enabling fleet management in certain specific use cases and most of these are considered as Pilot and moving towards general availability in near future or have achieved different milestones to deploy.

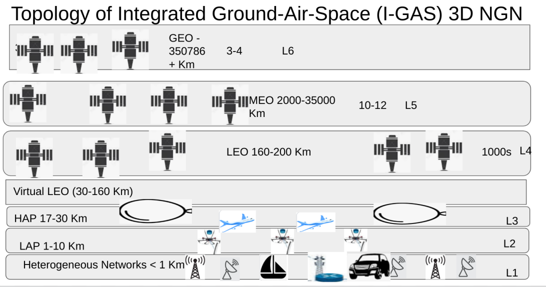

Figure 1. Topology of Integrated GAS 3D Next Generation Network [1]

DATA DRIVEN FLEET MANAGEMENT

Connected cars and Autonomous Driving on land can be applied to fleets of Drones or Air Taxis. The Intelligent Transportation Systems differ in terms of I-GAS 3D connectivity via same layer peer-to-peer as well vertically hierarchical.

Terrestrial at Ground propagation delay is ultra low and progressively increases as we move to L2 or LAP (5-10 km) <34 us and L3 or HAP Airships, Balloons etc. of the order of 56-100 us. The throughput also comes down at HAP to about 1.25 Gb/s. Typically these are programmable for specific missions like emergency support using Balloons in a flood or relief efforts due to severe weather conditions.

The Aerial transport or Air Taxis fit into a 10-17 km gap between LAP & HAP. This can then be divided into typical lanes like we have for highways and freeways and some of them are being proposed by various countries to work in their sky's as part of UAV & Air Taxis for commercial purposes. There are rules of lanes and UAV and Air taxi pilots need special training and can be done autonomously too based on remote piloting.

Data Collection as we do on buses, rails, boats will be applicable to UAV and Air Taxis. The data and its interpretation will be guided by aerial environments and traffic conditions. Commercial Air traffic has grown by a factor of 2.3 since 2000 and is likely to double in 20 years. The UAV (Drones) are being used more widely and almost quadrupling in the same time frame. Besides 1000s of LEO satellites are being launched for commercial use in all parts of the globe. The challenge is increasing probability of interference and at the same time this may be overcome by traditional radio techniques of filtering or Free Space Optical (FSO) which leads to better QoS in terms of latency throughput etc. 3GPP has been standardizing Network Data Analytics Function (NWDAF) [4] for 5G core elements and similarly O-RAN alliance has Radio Interface Controller (RIC) Analytics over its O1 & E2 interfaces [5] for real time data points and as always Operation Analytics & Management (OA&M) of Faults, Configuration, Accounting Performance & Security (FCAPS) has been managed by Telecom network operators and Cloud service providers for their platforms. Thus the cycle of data collection at source, data analytics & predictions processing using AI models and application of the same to steer better paths for vehicles in the transport fleet is being pursued by many auto and aero manufacturers.

The mixing of domain specific tools of telco to apply to transportation is in-evitable. As Base Stations in mmWave and Optical spectrum find their place in Air and Space vehicles in UAV, Airships and Satellites, the location based applications will get the same kind of reception as in autonomous driving on the ground with Terrestrial Networks.

CONCLUSION

Drawing the analogy between Terrestrial Hybrid Network Cloud and Edge Computing for Autonomous Driving, it is logical to predict future directions in the International Next Generation Roadmap (INGR) to extend the Edge to part of Sky in Air and Space. To this effect INGR is calling for CFP in its Future Networks Edge Service Workshop in November 2022 for proposals to present from Edge Service and

Architecture, Industry applications and Research point of view.

ACKNOWLEDGMENT

I acknowledge my colleagues at Future Networks INGR Dr. Ashutosh Dutta, and Mr Tapan K Lala for their encouragement to experiment as part of the working Edge Service roadmap and Chinatn Oza of TMA, Mumbai, India..

REFERENCES

1. Multiobjective optimization for Integrated Ground-Air-Space Networks -Sept 2021 | IEEE VTS Magazine
2. INGR Roadmap for Edge Working Services - https://futurenetworks.ieee.org/
3. Transforming Industry Through Data Analytics - Cisco / O'Reilly - by Raghuram Nambiar
4. Network Data Analytics Function - ETSI TS 129 520 V15.3.0
5. O-RAN Architecture - https://docs.o-ran-sc.org/en/latest/architecture/architecture.html

The author is currently affiliated with eOTF, Mumbai, India. Author is leading the Emerging Open Tech Foundation (eOTF) as Co-Founder and Secretary since 2020. The objectives of eOTF are helping the Indian subcontinent in its Digital and Operational Transformation. He is the co-chair of INGR Edge Service working group focused on Next Generation Networking beyond 5G since 2019 from Silicon Valley. He has been a part of IEEE CS SCV chapter and a constant promoter of eOTF & INGR partnership for several years. With 40+ years of ICT industry experience in the US, EU, India and Asia-Pacific, he has led several startups and managed technically and innovated as ISP, ASP, CSP companies for decades. His insight into Vehicular Transportation Systems (VTS), Data Analytics and AI is equally formidable and has several presentations in Open Source forums globally. He holds a Master's degree in EE from IIT Bombay.Contact him/her at secretary@eotf.info.

Event Recording of the August 2nd Webinar

A New Approach for Storage-Centric Computers

Peter Schade

https://ieeetv.ieee.org/video/a-new-approach-for-storage-centric-computers