V2V COMmunication - Caution, Observe, Mitigate

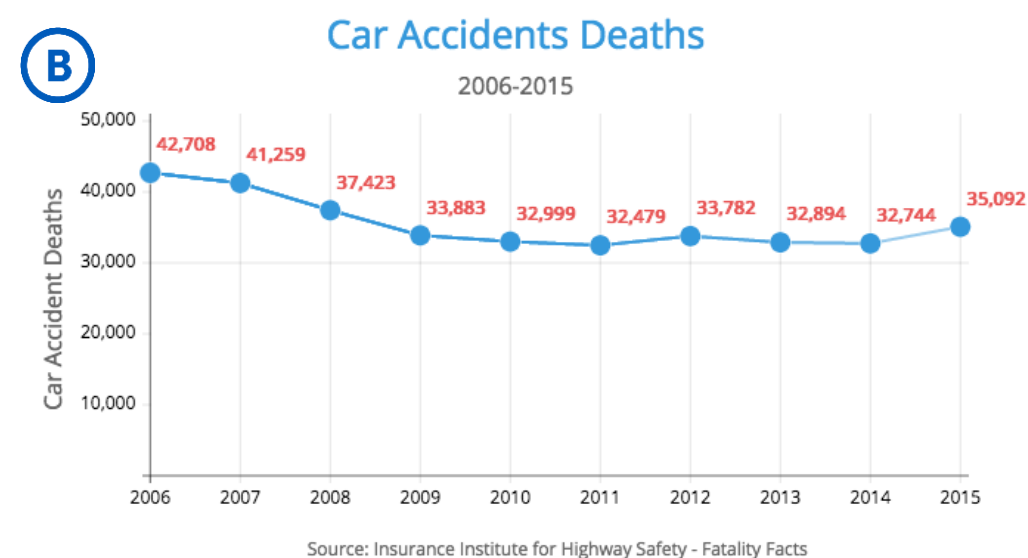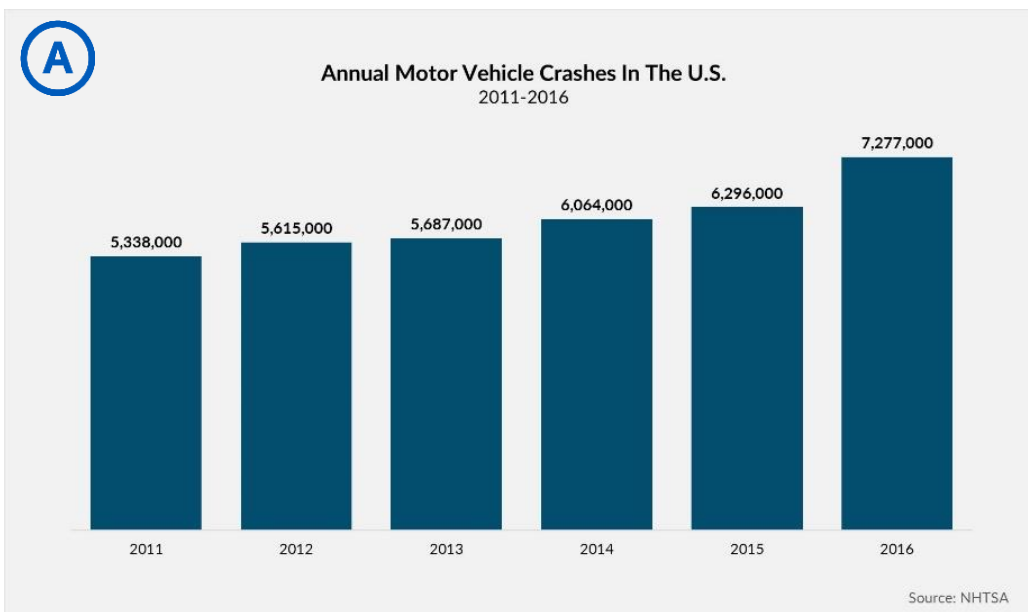Akshay Ravindra Shelke, Rakesh Tammineni

Introduction

Our project emphasizes the importance of Vehicle-to-Vehicle (V2V) communication using LoRa (Long Range) as wireless technology which offers long range, low power and secure data transmission for our IoT application in making the road a safer place.

Motivation

The on-road vehicle population is growing at a faster rate than the economic and population growth in many countries. The usage of automobiles has improved linearly over the past decade, which increased in the risk of human life.
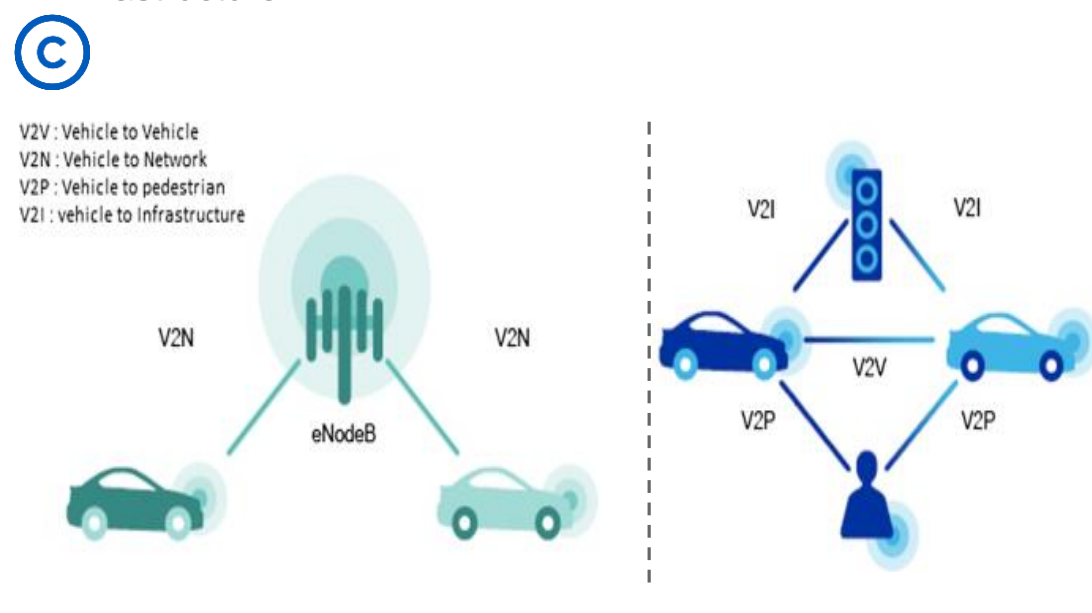
Key Points

- Vehicle crashes growing annually.
- Somewhat stable trend on fatal accidents.

Annual Motor Vehicle Crashes In The U.S.
2011-2016

5,338,000	5,615,000	5,687,000	6,064,000	6,296,000	7,277,000
2011	2012	2013	2014	2015	2016

Source: NHTSA

Car Accidents Deaths
2006-2015

Car Accident Deaths: 42,708 · 41,259 · 37,423 · 33,883 · 32,999 · 32,479 · 33,782 · 32,894 · 32,744 · 35,092

Source: Insurance Institute for Highway Safety - Fatality Facts
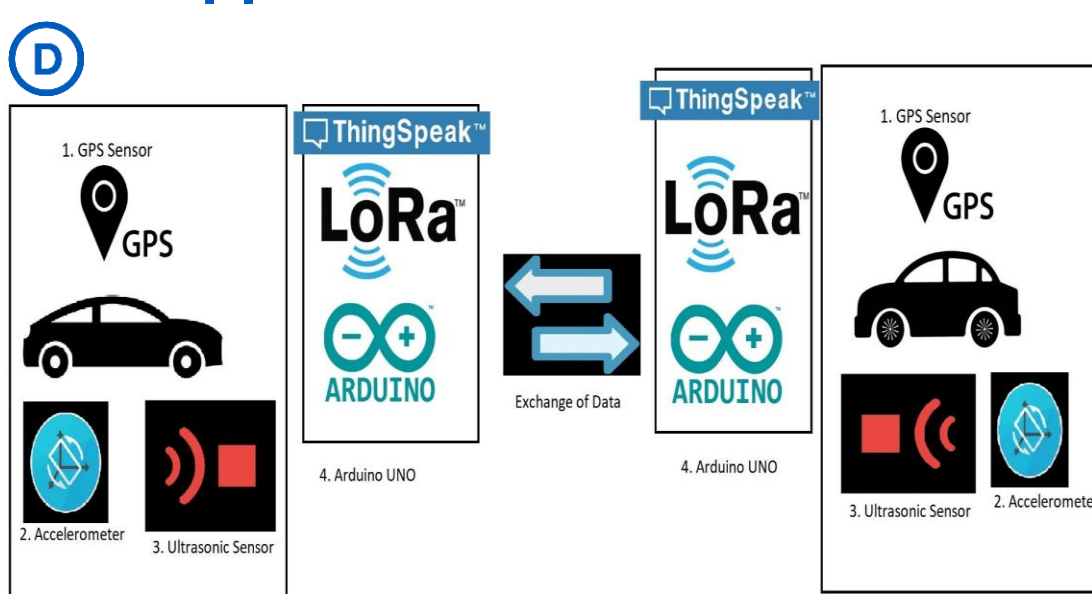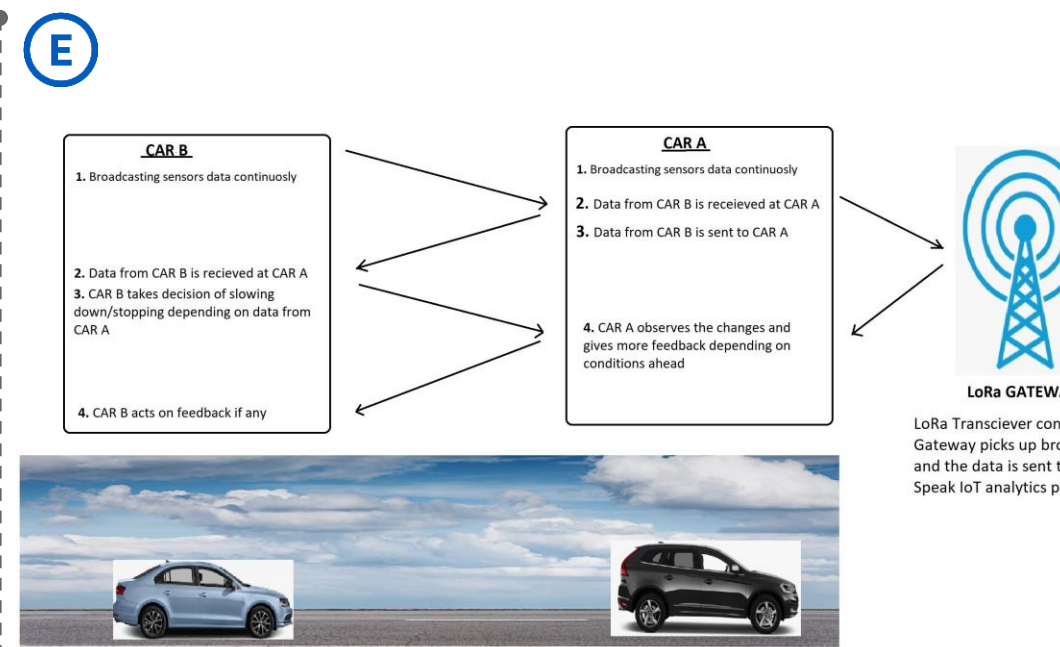
Different Types of Approach

Existing Approach V2N – So far, we are making use of the already deployed cellular infrastructures such as 4G. Although this approach provides high data rates, especially in urban scenarios, other technologies are needed in rural and remote ones for covering large distances without needing the deployment of an expensive and complex cellular infrastructure.

V2V : Vehicle to Vehicle
V2N : Vehicle to Network
V2P : Vehicle to pedestrian
V2I : vehicle to Infrastructure

Our Approach

1. GPS Sensor
2. Accelerometer
3. Ultrasonic Sensor
4. Arduino UNO
Exchange of Data

- A new technology so-called Low Power – Wide Area Network (LP-WAN) has emerged during the last years, promising **long coverage ranges** and low energy consumption.

- Our interest is the usage of this technology in alert-based scenarios, which can also take advantage of a potential long-range dissemination of messages to vehicles approaching an incident (e.g., vehicles alerting each other, accident, roadworks, road status).

CAR B
1. Broadcasting sensors data continuously
2. Data from CAR B is recieved at CAR A
3. CAR B takes decision of slowing down/stopping depending on data from CAR A
4. CAR B acts on feedback if any

CAR A
1. Broadcasting sensors data continuously
2. Data from CAR B is received at CAR A
3. Data from CAR B is sent to CAR A
4. CAR A observes the changes and gives more feedback depending on conditions ahead

LoRa GATEWAY
LoRa Transciever configured as Gateway picks up broadcasts and the data is sent to Things Speak IoT analytics platform.

Working

- Sensors such as GPS, Accelerometer and Ultrasonic are integrated with Arduino on board with LoRa module.

- Each vehicle is equipped with above mentioned sensors can exchange data with other vehicle in proximity.

- If the vehicles are too close or there is an incident on the road that needs to alerted, the information is broadcasted in real time and is picked up by other vehicles and the gateway.

- Gateway further uses this and maps it on the IoT analytics platform, such a ThingSpeak™ and the data can easily be shared for different purposes such as safety audits, policing, etc.

Results

- The vehicles when in proximity are cautioned about each other's relative speed and location. If the vehicle is very close and distance is picked up by the ultrasonic sensor, then immediately the braking can be acted upon.

- LoRa has very wide coverage range about 5 km in urban areas and 15 km in suburban areas.

- This data can further be accessed on end devices such as cellphone through ThingSpeak™ in real-time.

Things Speak Graph and Visualizing Data from Sensors
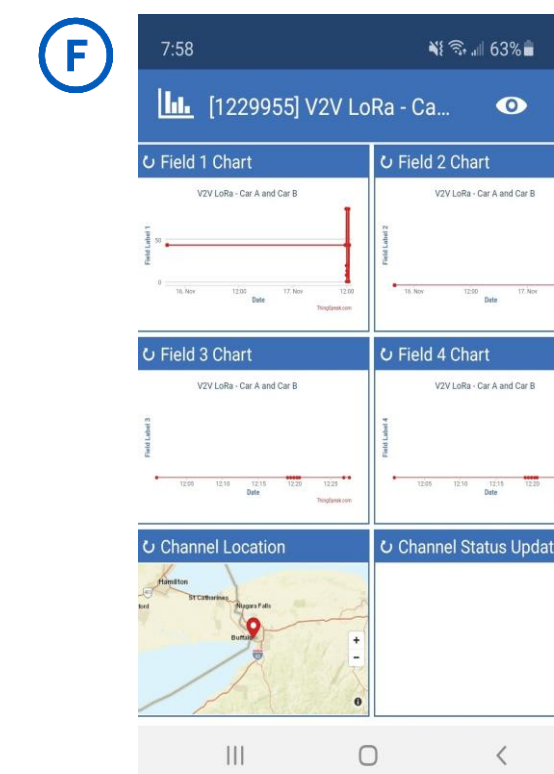
Conclusion

In future, global, national and regional networks have to support billions or even trillions of devices. LoRa can play a significant role for providing a smart, low cost and highly efficient network for future applications. It has association of more than 400 companies globally to contribute, improve and implement smart network for future needs.

- **Long battery life for devices and sensors due to low power consumption**

- **Low cost implementation due to low cost hardware and unlicensed spectrum**

- **Long range coverage and in-building penetration**

References

[1] S. W. Turner and S. Uludag. Intelligent transportation as the key enabler of smart cities. In Proc. of the 2016 IEEE/IFIP Network Operations and Management Symposium (NOMS'16), Istanbul, Turkey, pages 1261– 1264. IEEE, April 2016.

[2] C. M. Silva, F. A. Silva, J. F. Sarubbi, T. R. Oliveira, W. M. Jr., and J. M. S. Nogueira. Designing mobile content delivery networks for the internet of vehicles. Vehicular Communications, 8:45–55, January 2017.

[3] Loussaief, F., Marouane, H., Koubaa, H. et al. Radio resource management for vehicular communication via cellular device to device links: review and challenges. Telecommun Syst 73, 607–635 (2020). https://doi.org/10.1007/s11235-019-00644-x

[4] Integrating LP-WAN Communications within the Vehicular Ecosystem Ramon Sanchez-Iborra, Jesus S´anchez-G´omez, Jos ´e Santa, Pedro J. Fern´andez, and Antonio F. Skarmeta ∗ University of Murcia, Murcia, Spain {ramonsanchez, jesus.sanchez4, josesanta, pedroj, skarmeta}@um.es