Archangel Protocol for Pedestrian to Vehicle Communication via 5G Networks

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Overview

Introduction

- Autonomous driving has a growing interest
  - More self-driving cars
  - Less human control
- Pedestrians are the potential victims
  - Exposed to traffic dangers
  - No protection
- Smartphones
  - Share location
  - Increase safety
- Huge amount of data
  - 5G networks

State of the art – Communication

- V2X – Vehicle to everything
    - Direct communication within short distances ($\sim$1km)
    - WiFi technology in the licenced 5,9 GHz bandwidth
- C-V2X – Cellular vehicle to everything
    - Prerequisite: Long-Term Evolution (LTE)
    - Two operational modes:
        - Direct communication over PC5 interface
        - Indirect communication over Uu-interface
    - Long distance, latency-tolerant warnings
    - Problem: LTE not fast enough for life-critical systems
- C-V2X over 5G mobile-network
    - Designed to deliver peak data rates up to 20 Gbps
    - Beamforming technology

State of the art – Prediction & Scoring

- There were several attempts in this area
  - neural networks, decision trees and clustering algorithms
  - Prediction time concidered to be optimal: $>0,5s$ and $<2s$
- Most accurate former attempt
  - Based on Mixed Markov-Chain Model (MMM)
  - Accuracy score: 97% with average delay of 783 ms
  - With a new protocol via 5G this time can be reduced

speed($\frac{km}{h}$)	speed($\frac{m}{s}$)	distance(m)
30	8,3	6,5
50	13,8	10,8
70	19,4	15,2
90	25	19,6

Table: Distance traveled during delay time

The Archangel protocol – Intro

- P2V – Pedestrian to Vehicle
- Prerequisites:
  - 5G coverage
  - Smartphone with 5G and Archangel-protocol capability
- High reliability and fault tolerance
- Prediction, Scoring system, Warning messages
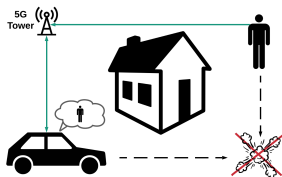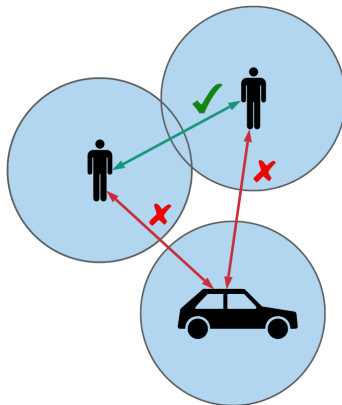- Handles the case of street corners with thick walls
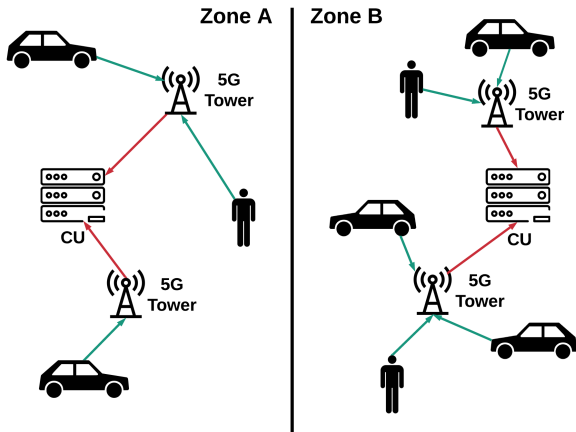

Figure: Direct signaling blocked by a building

- Endpoints cannot process large amount of data
- Border coverage is needed
- Centralized points
- High computing capacity
- Computations within critical time constraints
- Precision

Communication

- Node $\rightarrow$ 5G Tower $\rightarrow$ Computational unit
- Area described by a given computational unit is a zone

Zone A | **Zone B**

5G Tower

5G Tower

CU

Edge case

- Pedestrian and a car in a separate computational zone
- The car's computational unit needs to know the pedestrian's data
- Which of the two CUs should calculate the data for the car?
    1. Optimal case → The CU which is in the zone of the car
    2. Network round trip to save time in case when the car's CU is already critically loaded
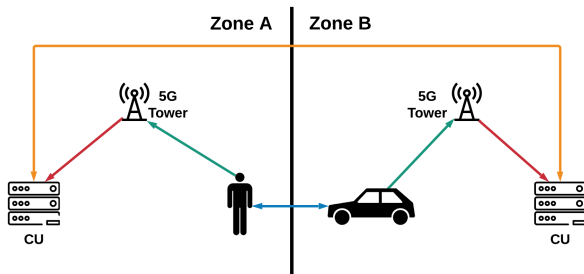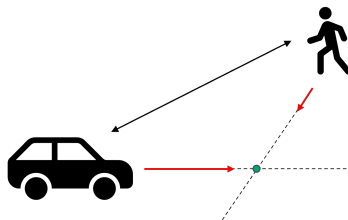
Scoring system

- Analysis of the situation
- Define the order of urgency between the notifications

Calculations - key points
- movement
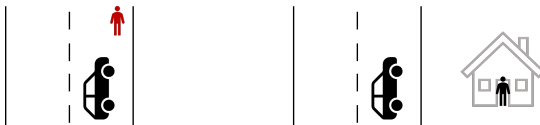 - speed
  - direction
- position

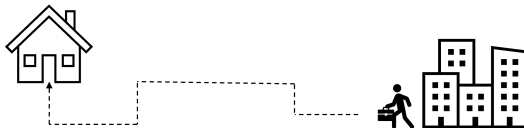|	
←——→	*distance*
—→	*movement vector*
●	*calculated meeting point*

Scoring system

Environment

If data is available about the environment, it can increase or decrease the score.

Predictions

The last part of the score calculation is to assess the possibility of certain routes and to predict movements.

Package structure

Theorem (Mass–energy equivalence)

$E = mc^2$

Figure

Uncomment the code on this slide to include your own image from the same directory as the template .TeX file.

Citation

An example of the \cite command to cite within the presentation:

This statement requires citation [Smith, 2012].

References

📄 John Smith (2012)

Title of the publication

Journal Name 12(3), 45 − 678.

The End