FINNISH METEOROLOGICAL INSTITUTE

VISIBILITY ESTIMATION BASED ON CAMERA DATA AND WEATHER PARAMETERS

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The idea

- To estimate visibility on the roads based on camera data. Still picture or video data can be used
- To classify the observed visibility into three classes (normal, poor and very poor) and clarify the reason for the reduced visibility (for example snowfall, sleet, drifting/blowing snow on the road surface).
- Weather observations can been used to identify the precipitation form (snow, sleet or rain)
- **Neural network technology** has been used to detect the level of visibility

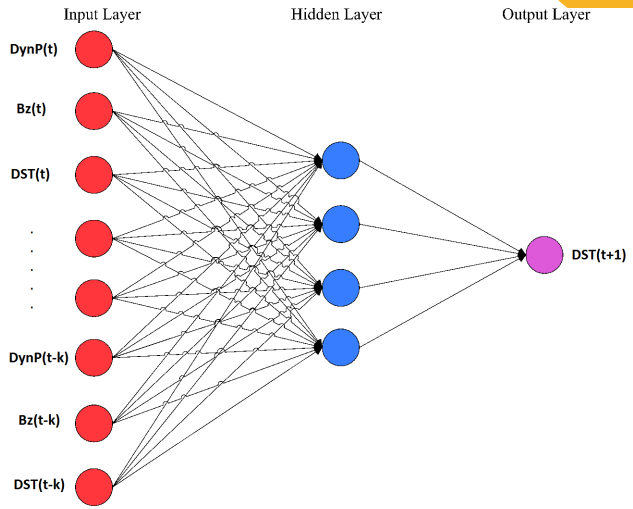
Road weather camera picture from FMI's Sodankylä road weather station

Visibility classification based on snowfall intensity

Visibility classes:
Normal → visibility > 1000 meters
Poor → visibility 500 … 1000 meters
Very poor → visibility < 500 meters

Neural network techology

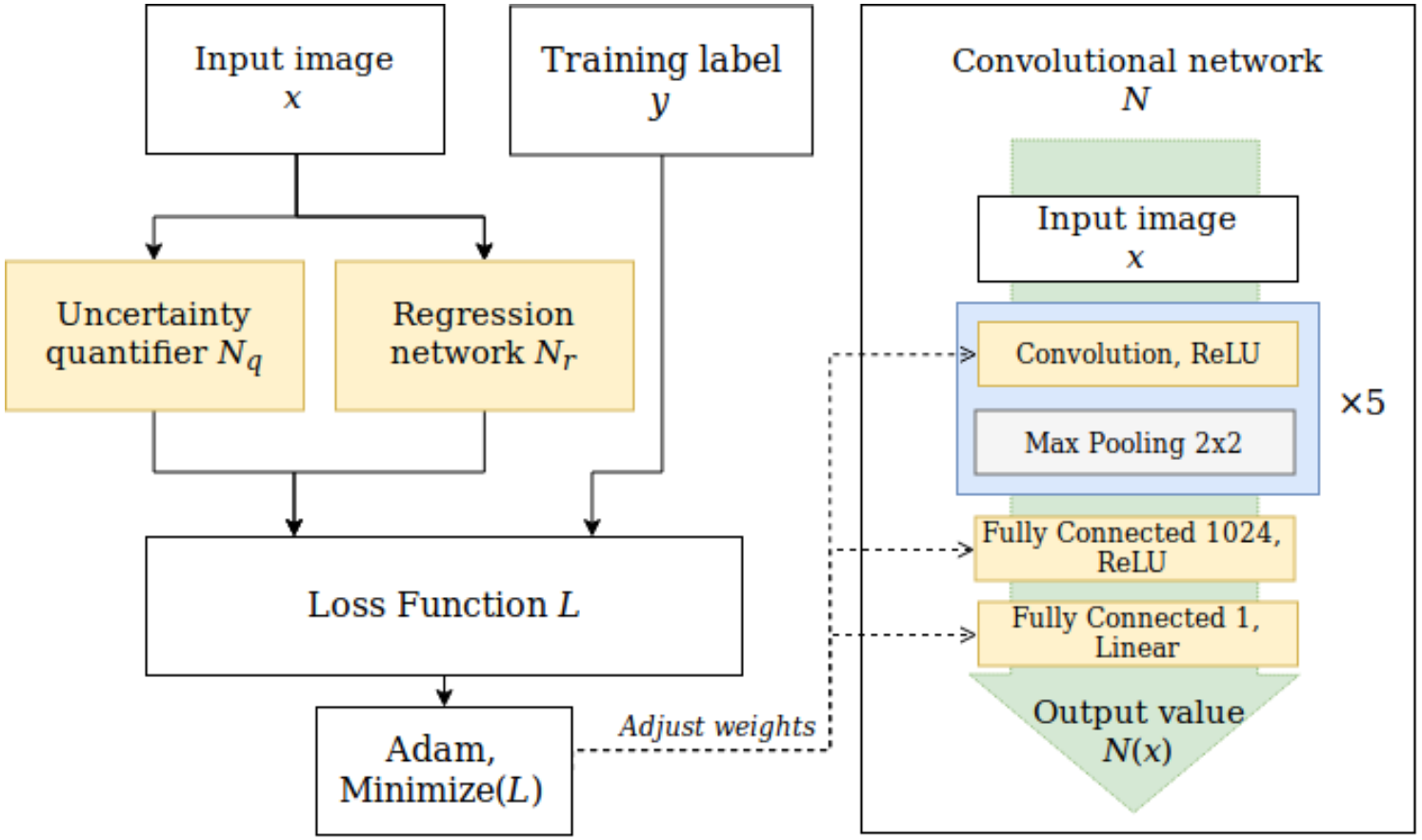
- Several neural network models has been used
- The models are trained with a large dataset of training examples
- A dataset of images with varying levels of visibility were chosen to train the network
- Only the image was used as an input: no other variables were used in predicting the visibility
- Tools such as *cropping, padding, rotation, flipping, contrast adjustment and random noise* are used to alter the original training image data



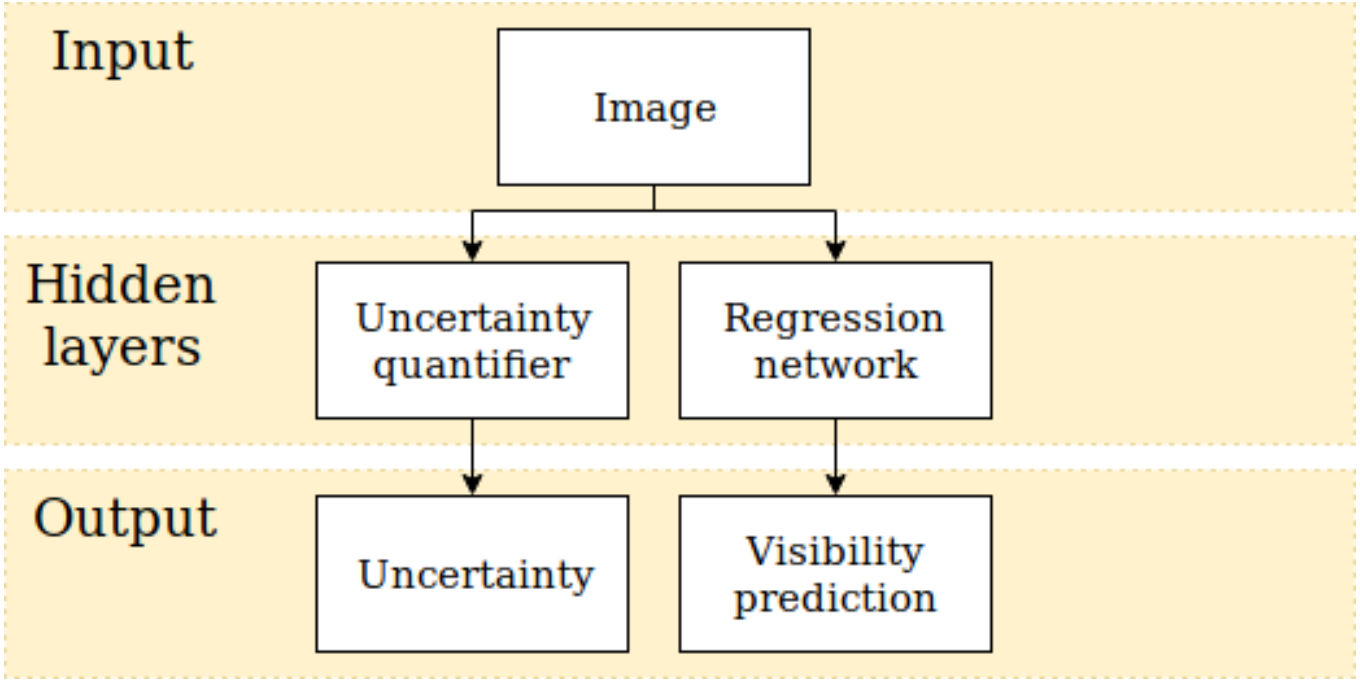
Neural networks

Training: Visibility 900 meters

Training process



Schematic picture of the visibility prediction process



Example of the visibility estimation

4 different neural network methods have been used

Different methods and different training materials give slightly different results

Example of the visibility estimation

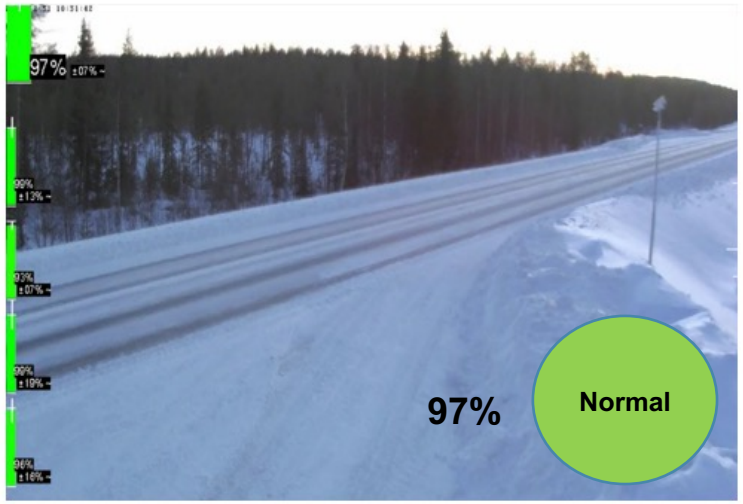
The level of visibility (75%) and uncertainty (8%) available for all neural network methods

Example of the visibility estimation

Final result is an average of two values (93%) (highest and lowest values are thrown away)

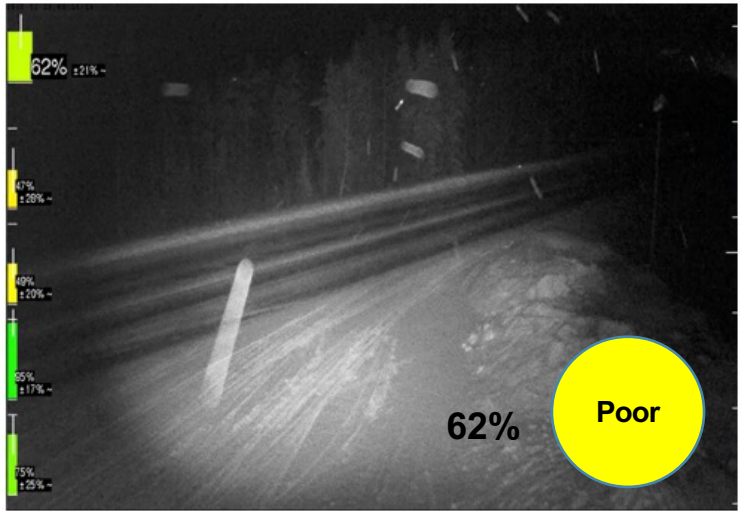
Uncertainty is a mean absolute deviation around the median (±13%)

Examples

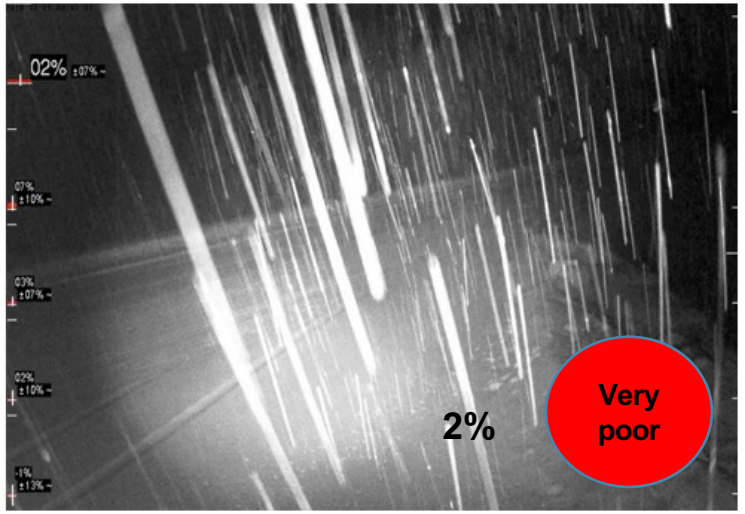


Good visibility

Very poor visibility (blowing snow)



Poor visibility (snowfall)



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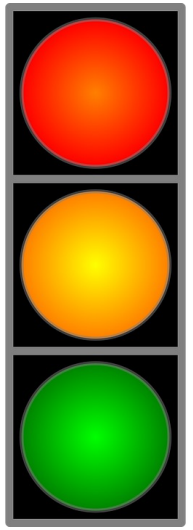
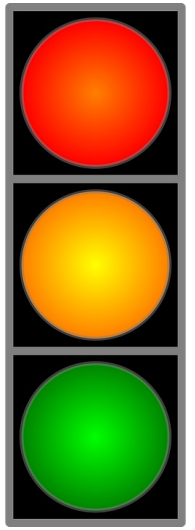


Very poor visibility
0 – 25 %

Poor visibility
25 – 70 %

Normal visibility
70 – 100 %

Examples



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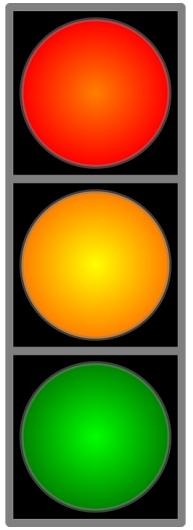

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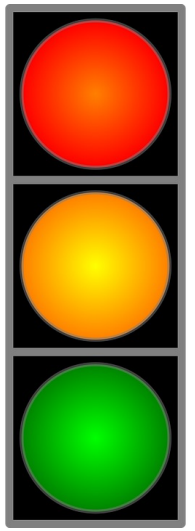

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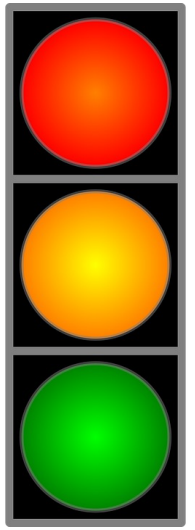

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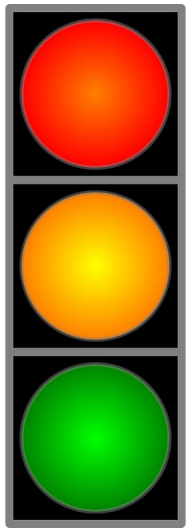

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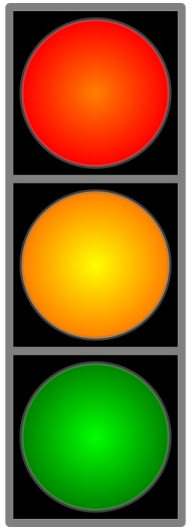

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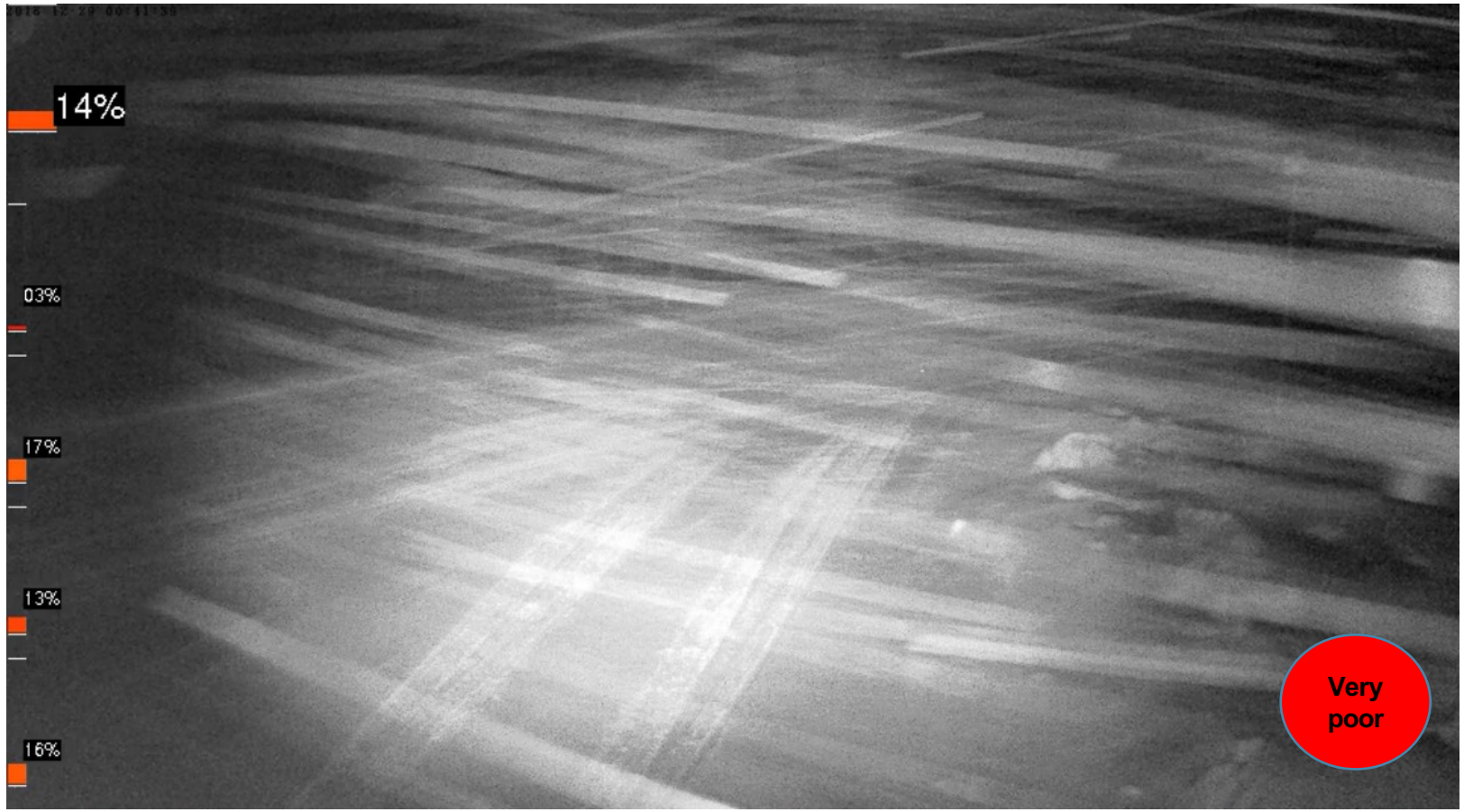

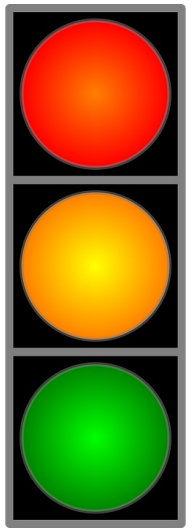

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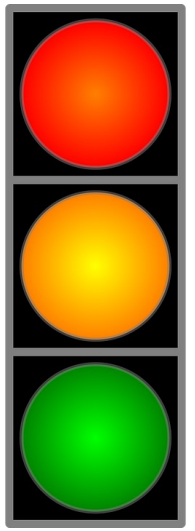

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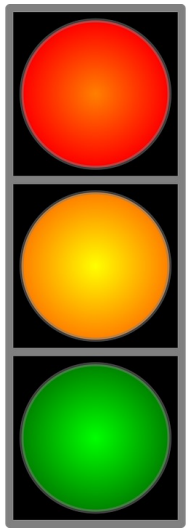

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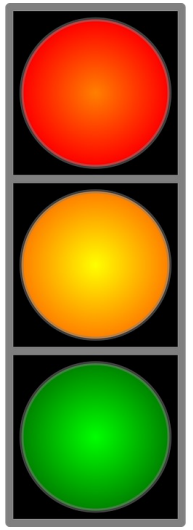

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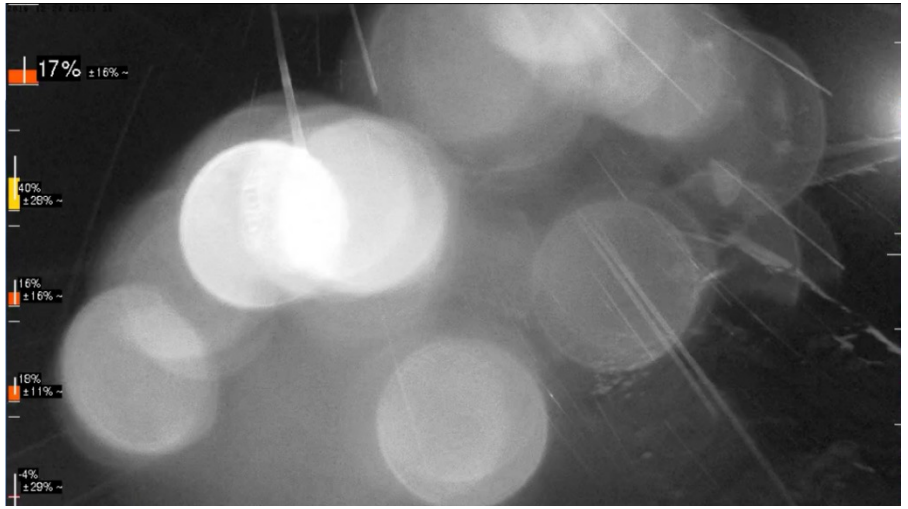
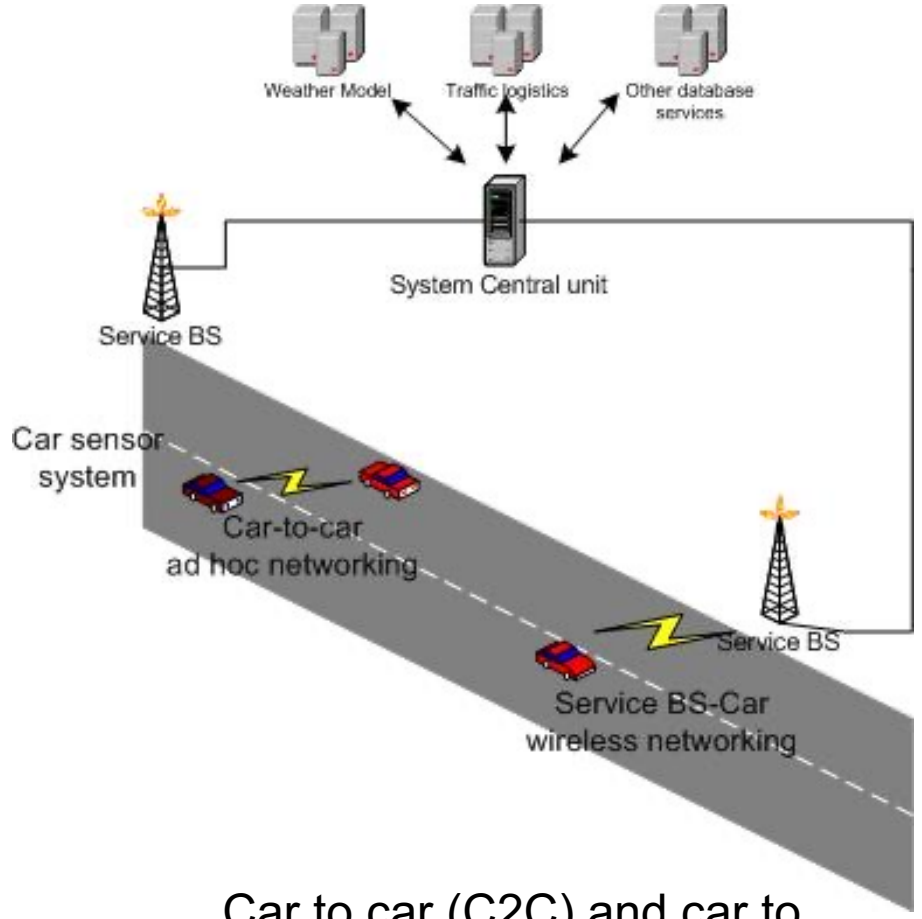
Problematic cases



How to use visibility information

- Visibility estimation is a fast and light process and can be done for example on cell phones
- Variable speed limit signs could use the visibility information
- Warning services:
  - Information about very poor visibility can be delivered to other drivers using C2C or C2I techologies
  - Visibility information important also for weather services when giving road weather warnings for public



Car to car (C2C) and car to Infrastructure (C2I)

Next steps

- Validation need to be done during winter 2018-2019
- Collect more training material and do more training
- The neural network system for visibility detection has been tested only for snowy situations → could be tested also for rainy, foggy and smoggy situations (needs training material)

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Thank you

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