SimuLTE-MEC: extending SimuLTE for Multi-access Edge Computing

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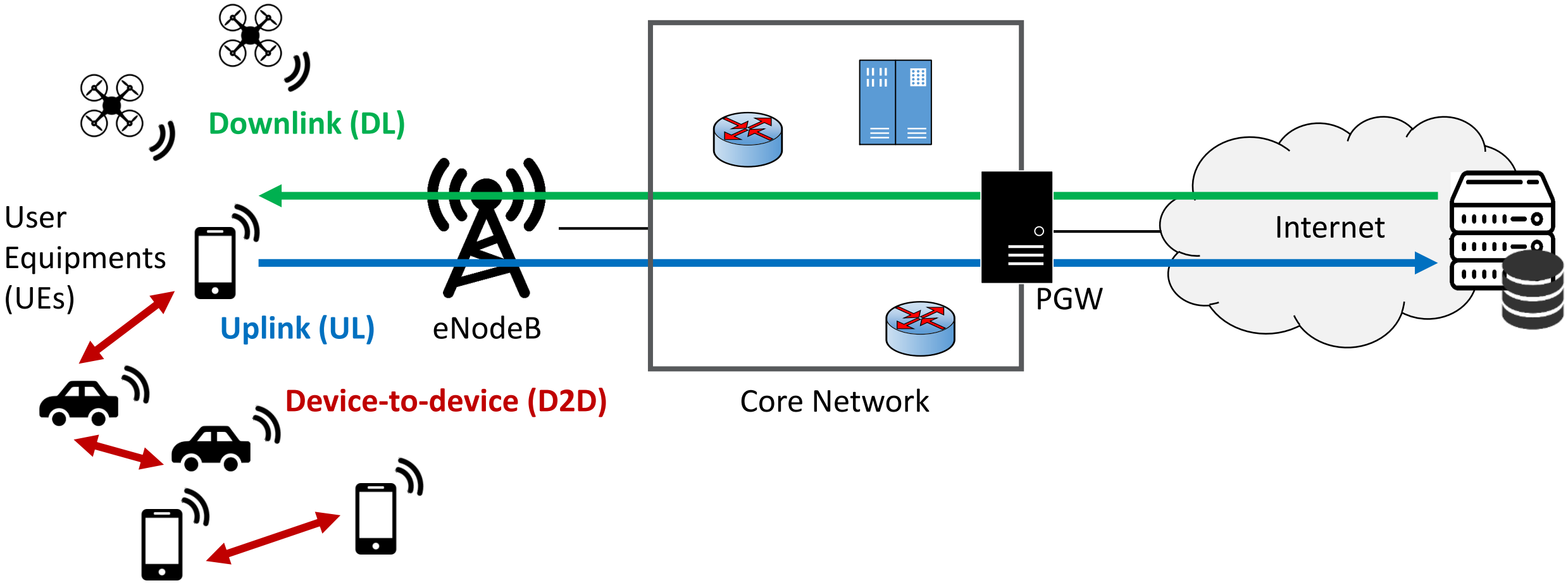
Outline

- Road towards 5G
- LTE/LTE-A & **Multi-access Edge Computing (MEC)** technologies
- Simulating LTE networks with OMNeT++: **SimuLTE**
- Modeling MEC within SimuLTE
- Use case: alerts in a vehicular network scenario
- Conclusions

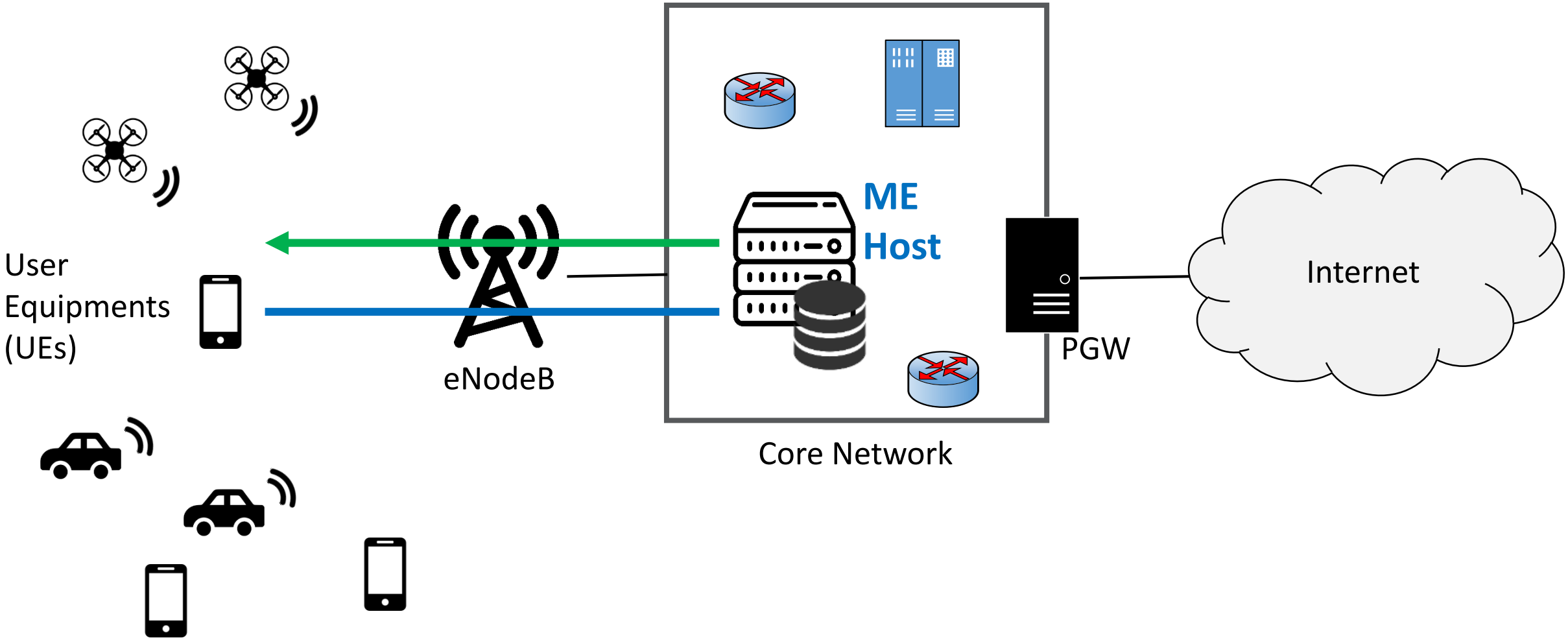

5G
Advanced
Pro
Lte
Lte
4DVANCED
Lte

The LTE/LTE-Advanced technology



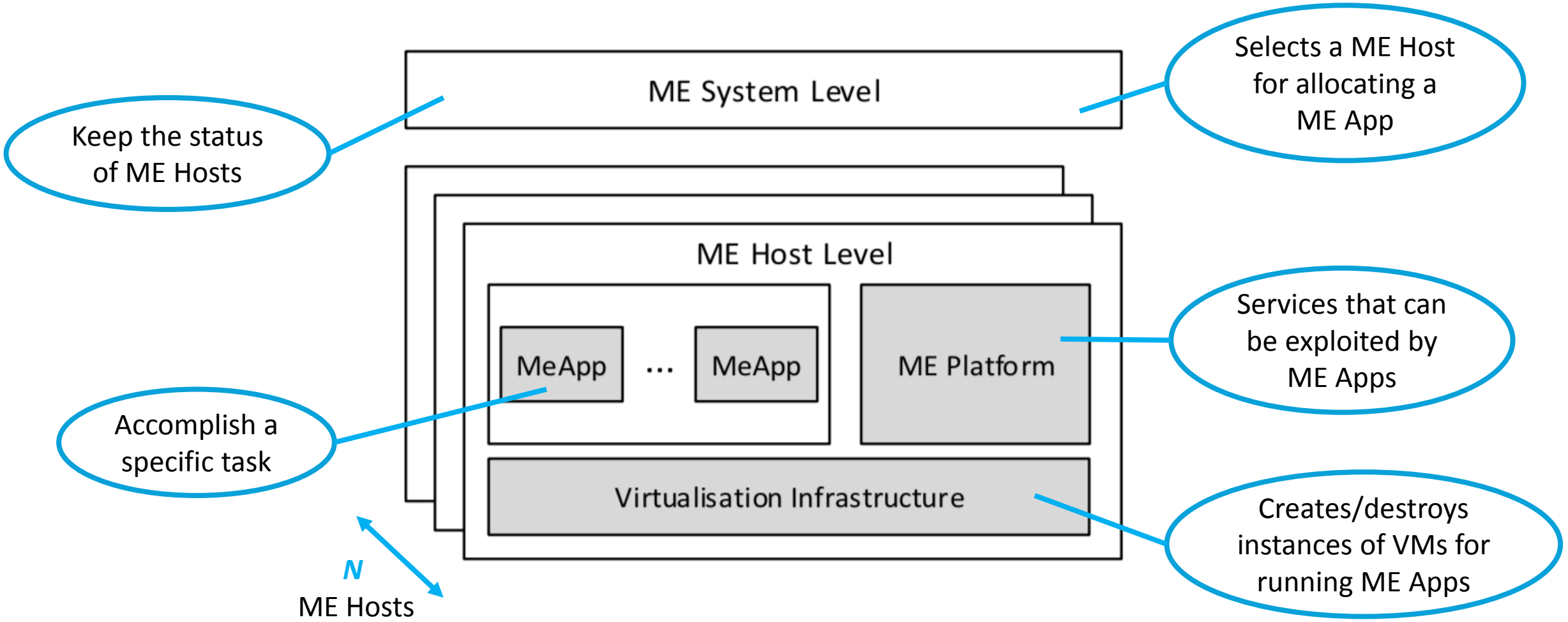
Introducing MEC

Multi-access **E**dge **C**omputing

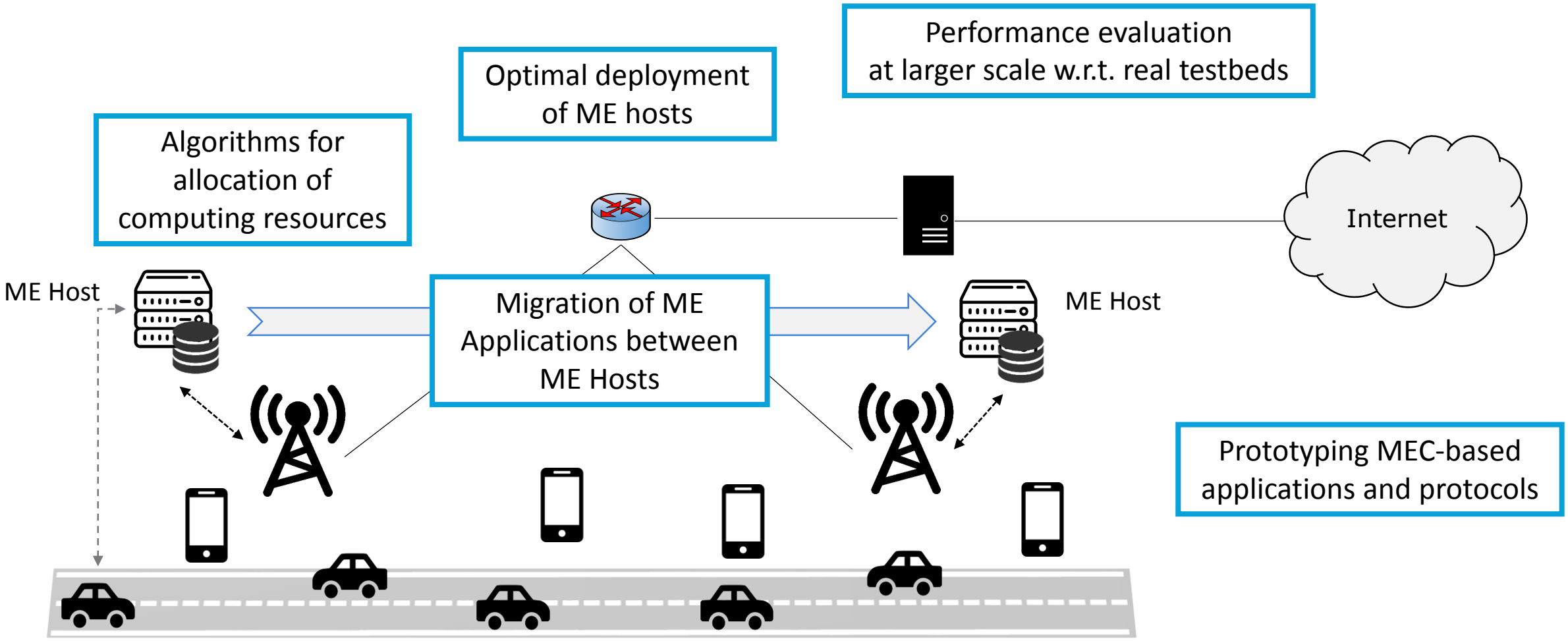


ETSI MEC Framework

[1] ETSI GS MEC 003, ''Mobile Edge Computing (MEC); Framework and reference architecture''



Simulating LTE+MEC



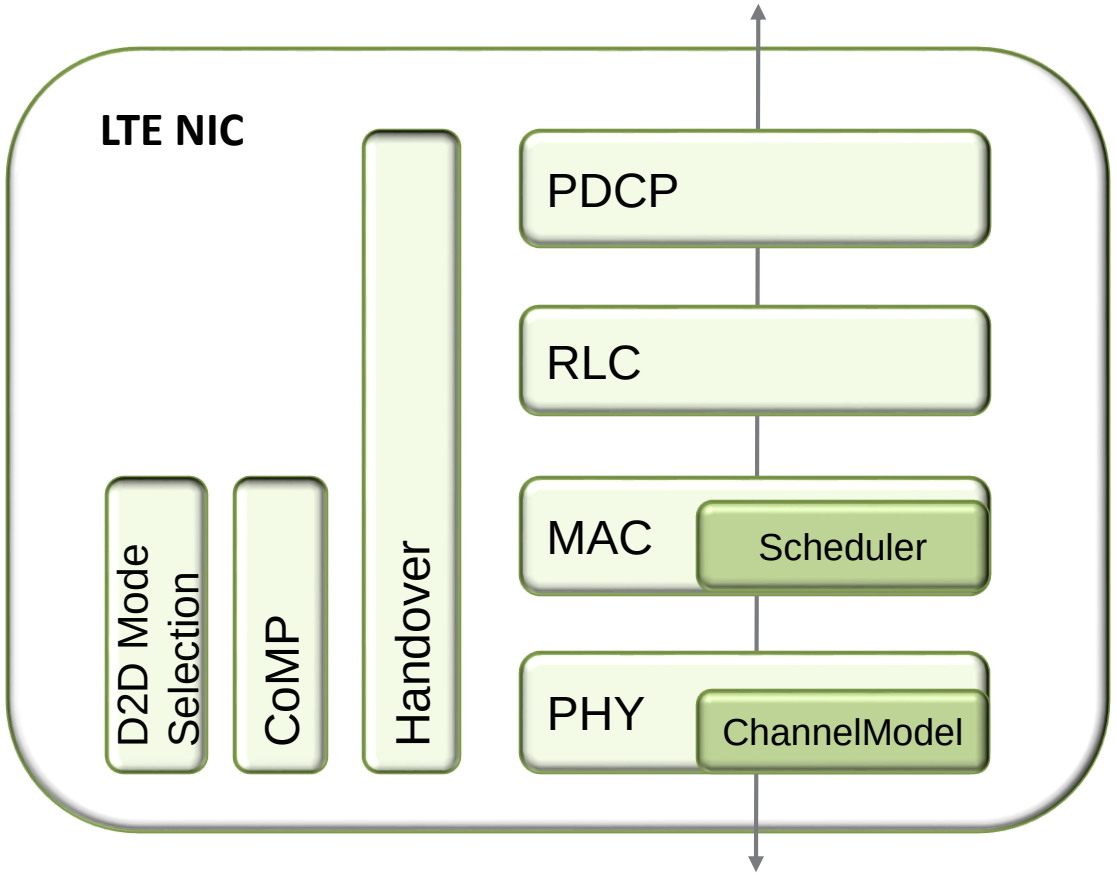
Simulating cellular networks with OMNeT++

System-level simulations of LTE/LTE-Advanced networks

http://simulte.com

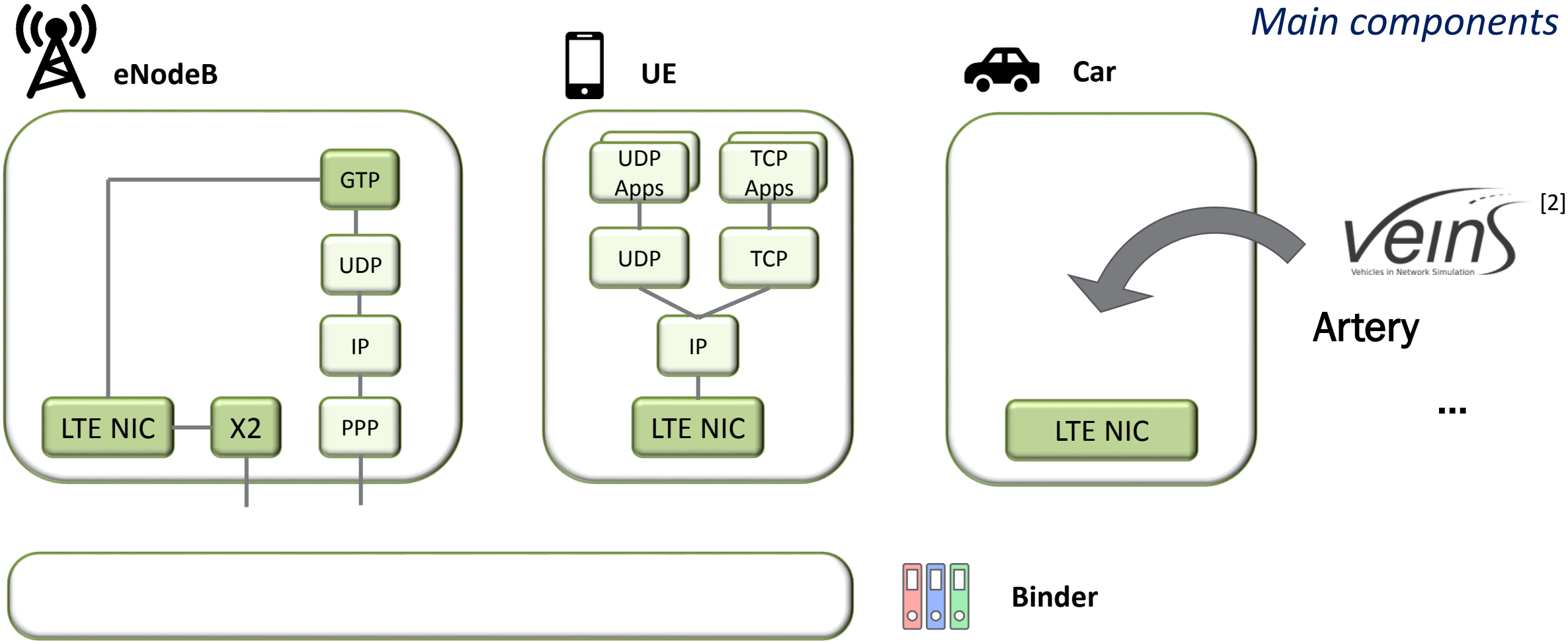
- Developed at the University of Pisa
- Full protocol stack implementation of the LTE Network Interface Card (**LTE NIC**)
- Extends the INET's *INetworkInterface* module
- Interoperability with INET's higher-layer protocol modules

INET Framework



SimuLTE basics

Main components

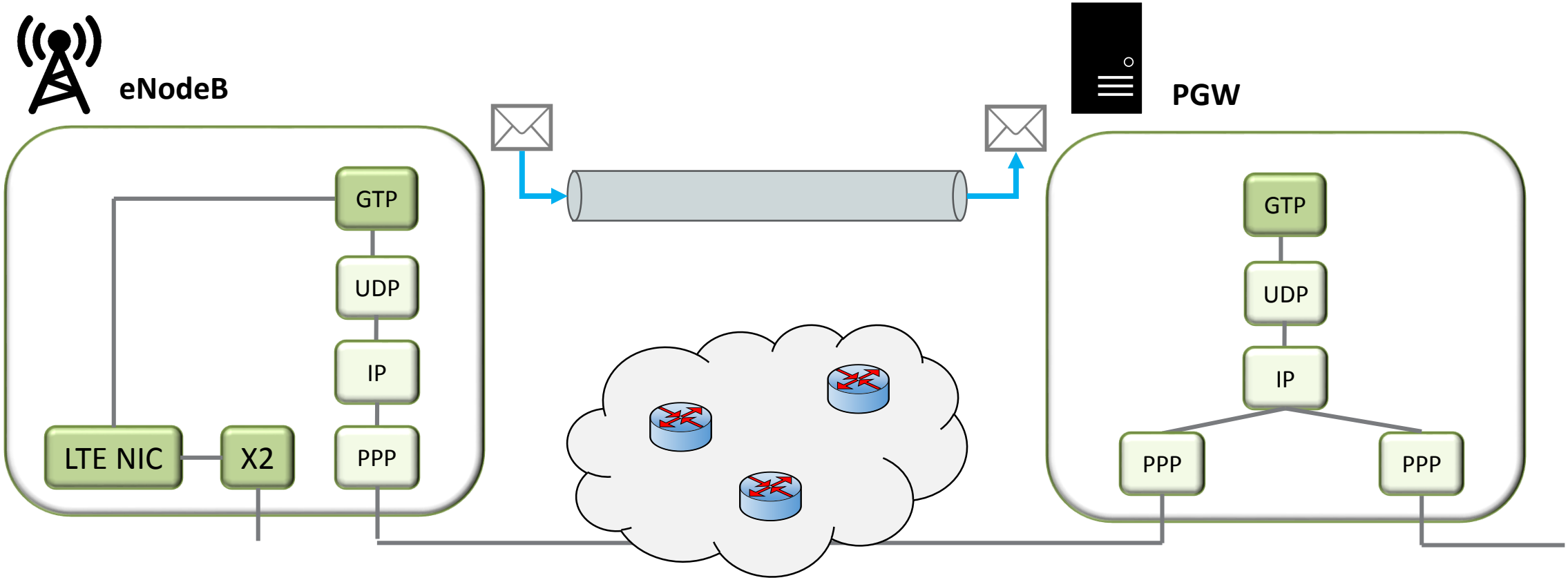


[2] G. Nardini, A. Virdis, G. Stea, ''Simulating cellular communications in Vehicular Networks: making SimuLTE interoperable with Veins'', OMNeT++ Comm. Summit 2017

SimuLTE basics

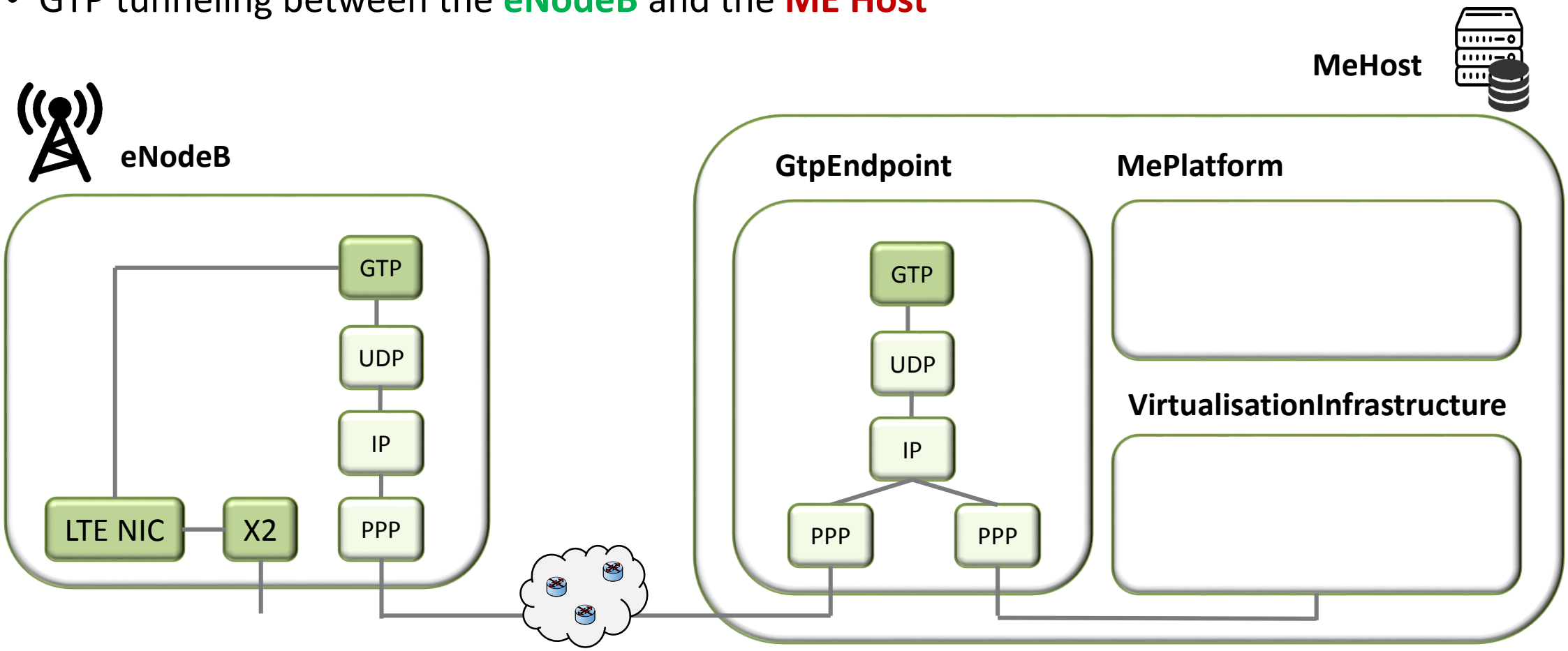
The core network

- Data-plane only
- GTP tunneling between the **eNodeB** and the **PGW**



Modeling the MEC architecture

- GTP tunneling between the **eNodeB** and the **ME Host**

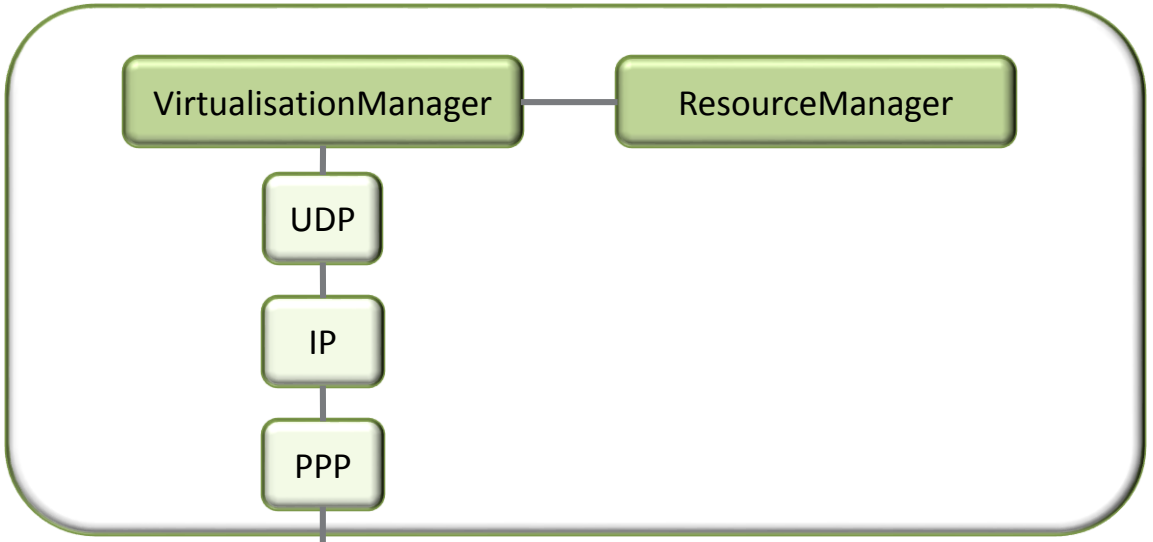


Modeling the MEC architecture

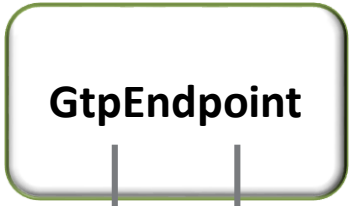
MeHost

```
//
// Template for ME Services.
//
moduleinterface IMEService
{
    parameters:
        @display("i=block/app");

    gates:

        input meAppIn[];
        output meAppOut[];
}
```

MePlatform



Virtualisation Infrastructure



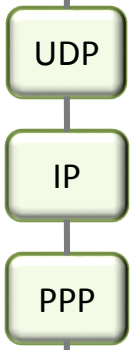
Modeling the MEC architecture

MeHost

```
moduleinterface IMEApp
{
    parameters:
        @display("i=block/app");

        string ueSimbolicAddress;
        string meHostSimbolicAddress;

    gates:

        input virtualisationInfrastructureIn;
        output virtualisationInfrastructureOut;

        input mePlatformIn;
        output mePlatformOut;
}
```

MePlatform

Virtualisation Infrastructure



Data flow

Definition of ***MeAppPacket***

- START_MEAPP
- STOP_MEAPP
- ACK_START_MEAPP
- ACK_STOP_MEAPP
- INFO_UEAPP
- INFO_MEAPP

```
packet MEAppPacket {

    unsigned int sno;
    simtime_t timestamp;

    //type of message
    string type;

    //communication information
    string sourceAddress;
    string destinationAddress;

    //instantiation information
    string MEModuleType;
    string MEModuleName;

    //identification information
    int ueAppID;

    //required resources
    unsigned int requiredDisk;
    unsigned int requiredRam;
    double requiredCpu;

    //required service
    string requiredService;
}
```

Data flow

Definition of ***MeAppPacket***

- START_MEAPP
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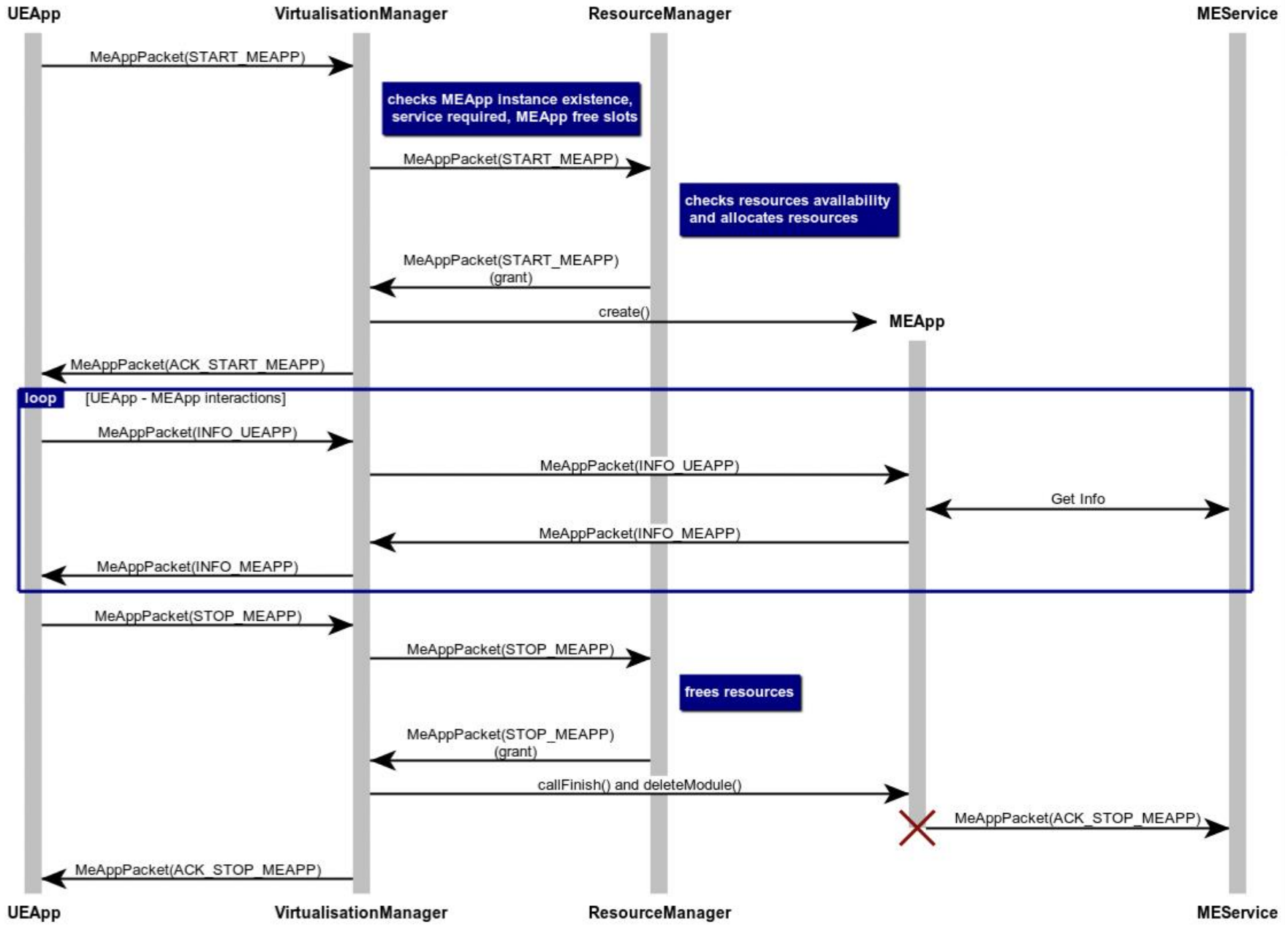


A use case for MEC

Car alert service

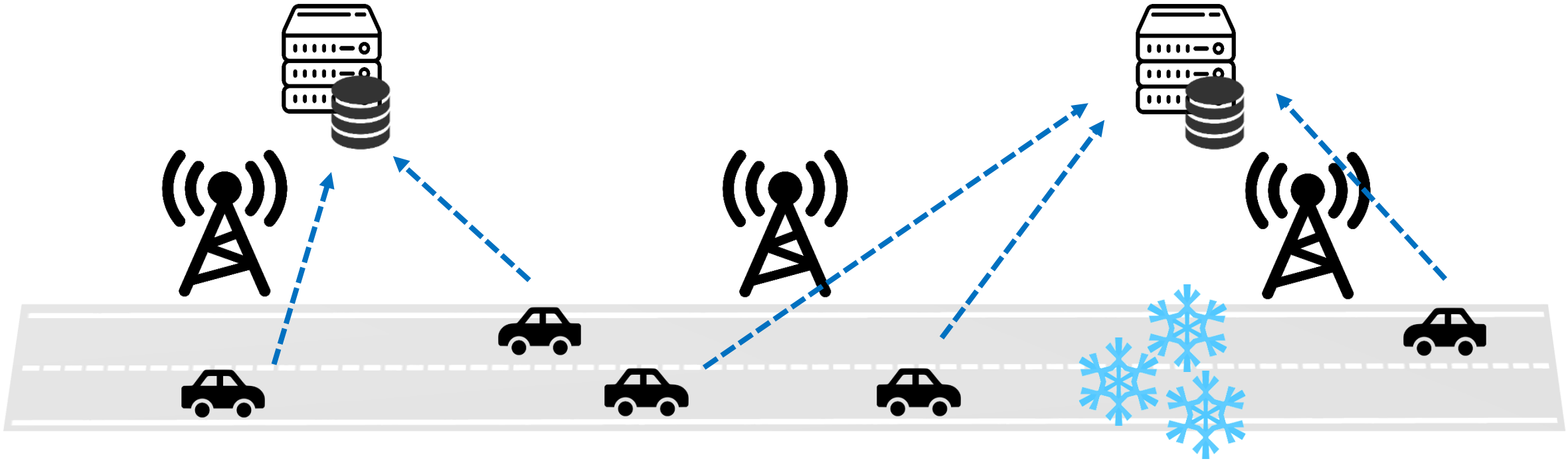
The car is approaching a black ice area:

- On-board sensors
- Vehicle-to-vehicle communications (VANETs)
- Vehicle-to-infrastructure communications (Wi-Fi access to Road-side units)
- Communication with a remote server

A use case for MEC

Car alert service

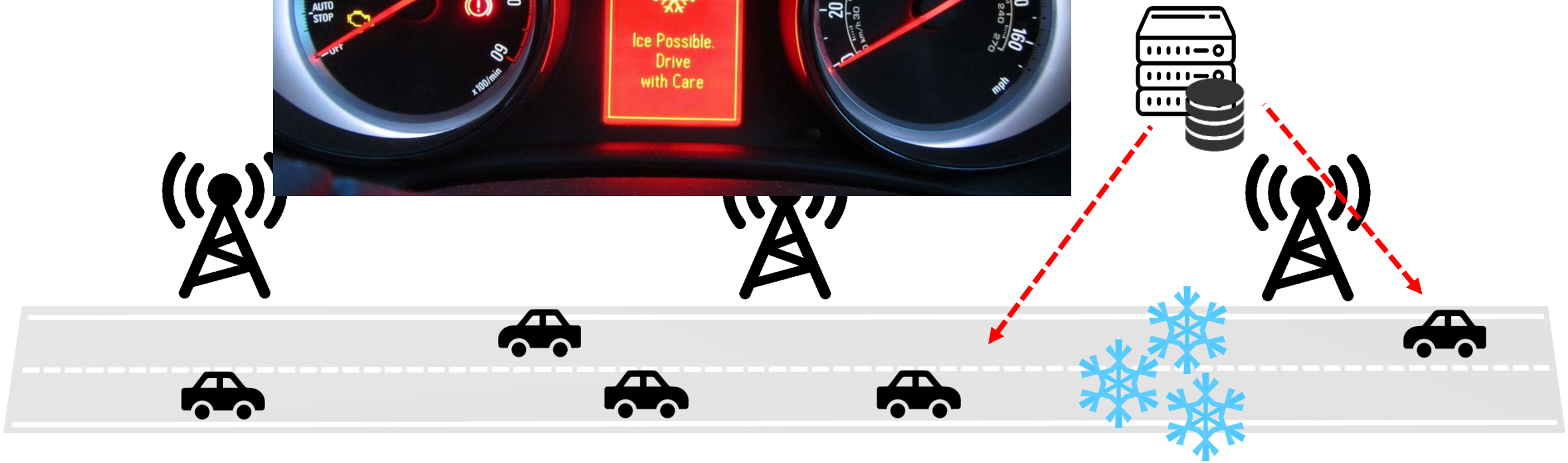
Using MEC



A use case for MEC

Car alert service

Using MEC



Implementing a MEC-based car alert service

- ***UEWarningAlertApp*** – periodically sends position updates to the ME Host

```
simple UEWarningAlertApp like IUDPApp
```

- ***MEWarningAlertApp*** – receives position updates from UEs

```
simple MEWarningAlertApp like IMEApp
```

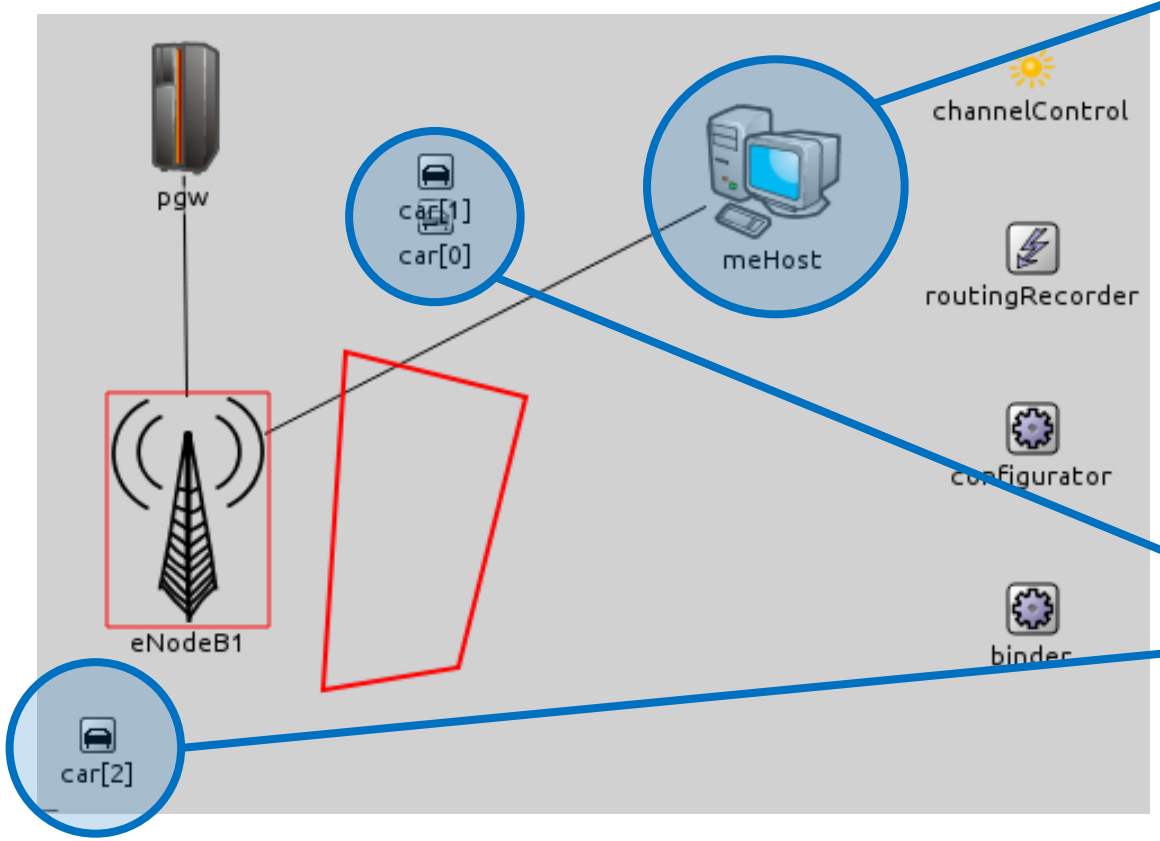
- ***MEWarningAlertService*** – keeps the map of danger zones

```
simple MEWarningAlertService like IMEService
```

- ***WarningAlertPacket*** – includes position information

```
packet WarningAlertPacket extends MEAppPacket
```

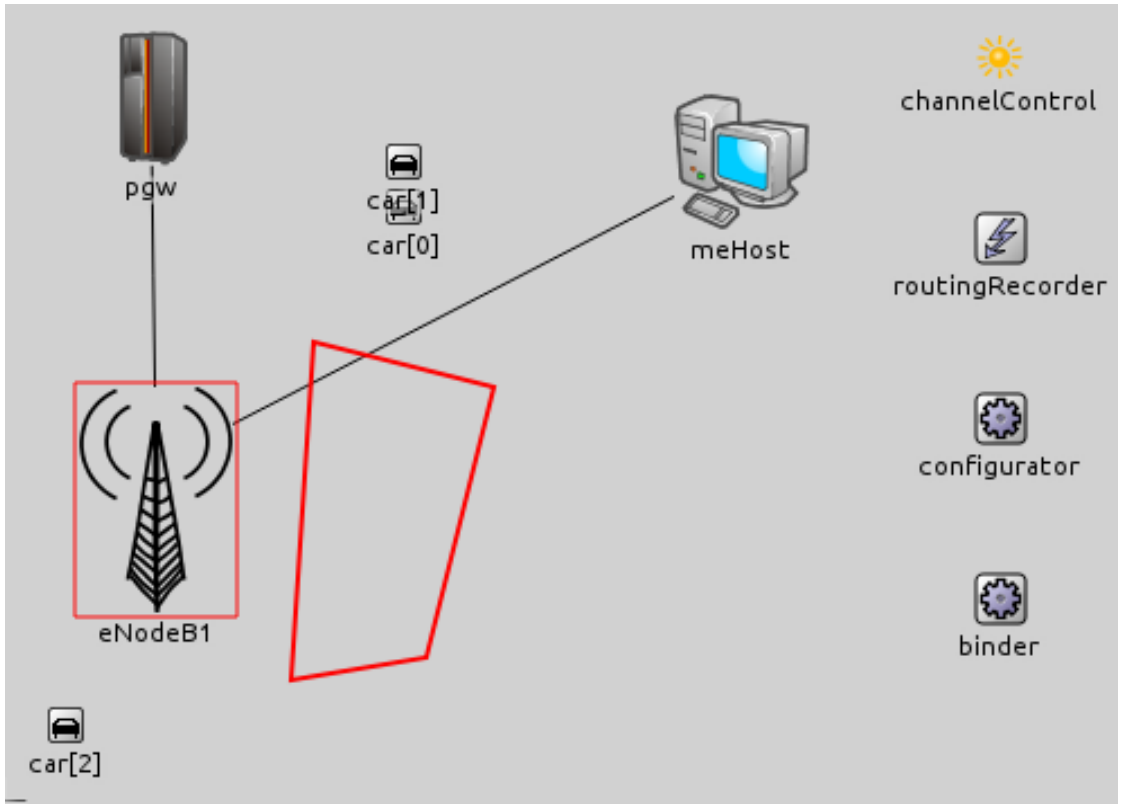
Configuring the simulation

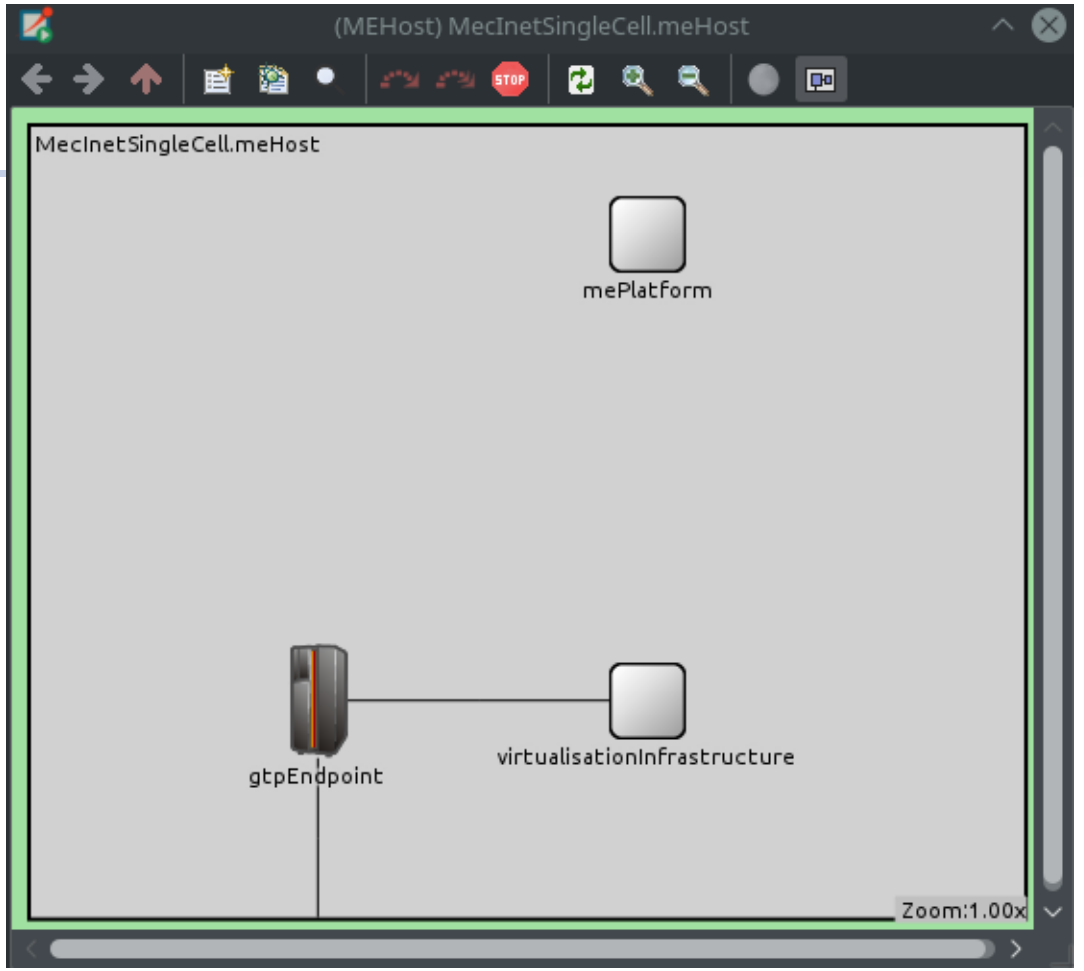



```
#   resources available
*.meHost.maxMEApps = 100
*.meHost.maxRam = 32GB
*.meHost.maxDisk = 100TB
*.meHost.maxCpu = 1
#---------------------------------------
#
#   MEServices available
*.meHost.mePlatform.numServices = 1
#
#-------MEWarningAlertService:---------------
*.meHost.mePlatform.udpService[0].typename = "MEWarningAlertService"
```

```
*.car[*].numUdpApps = 1
#
#------------UEWarningAlertApp---------------
*.car[*].udpApp[0].typename = "UEWarningAlertApp"
*.car[*].udpApp[0].startTime = 0s
*.car[*].udpApp[0].period = 0.1s
*.car[*].udpApp[0].stopTime = 25s
*.car[*].udpApp[0].destAddress = "meHost.virtualisationInfrastructure"
*.car[*].udpApp[0].requiredRam = 10MB
*.car[*].udpApp[0].requiredDisk = 10MB
*.car[*].udpApp[0].requiredCpu = 0.01
```

Running the simulation





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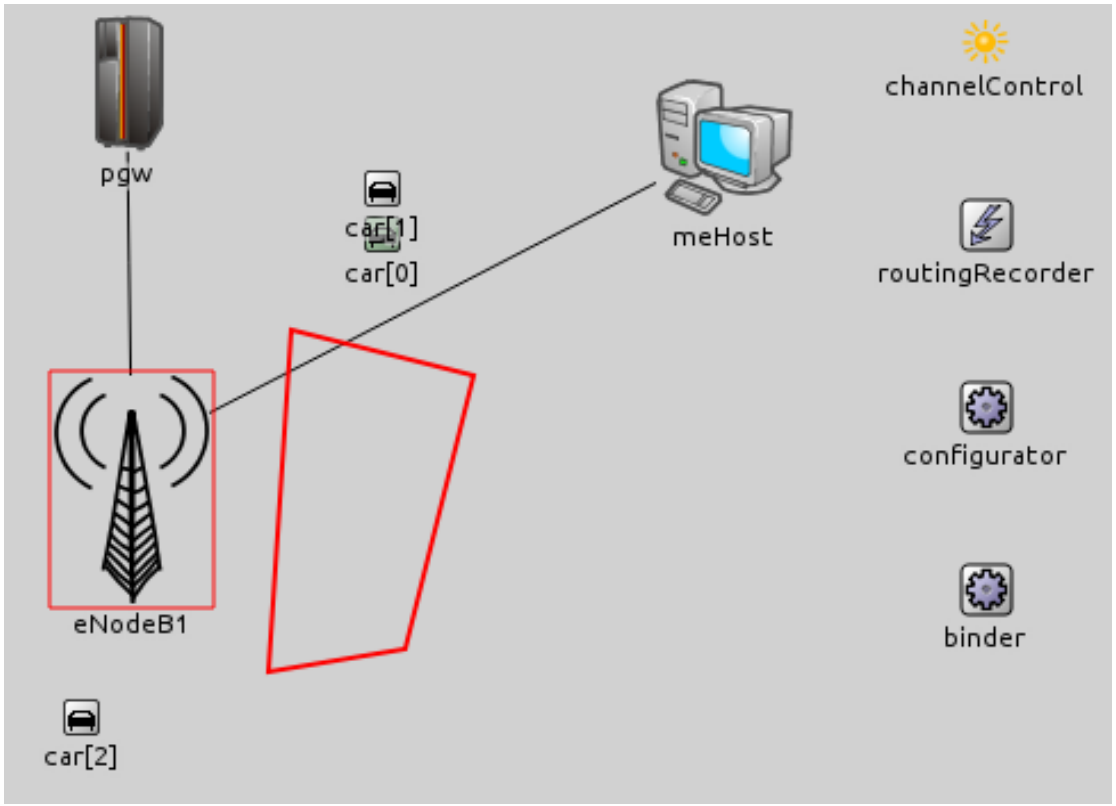

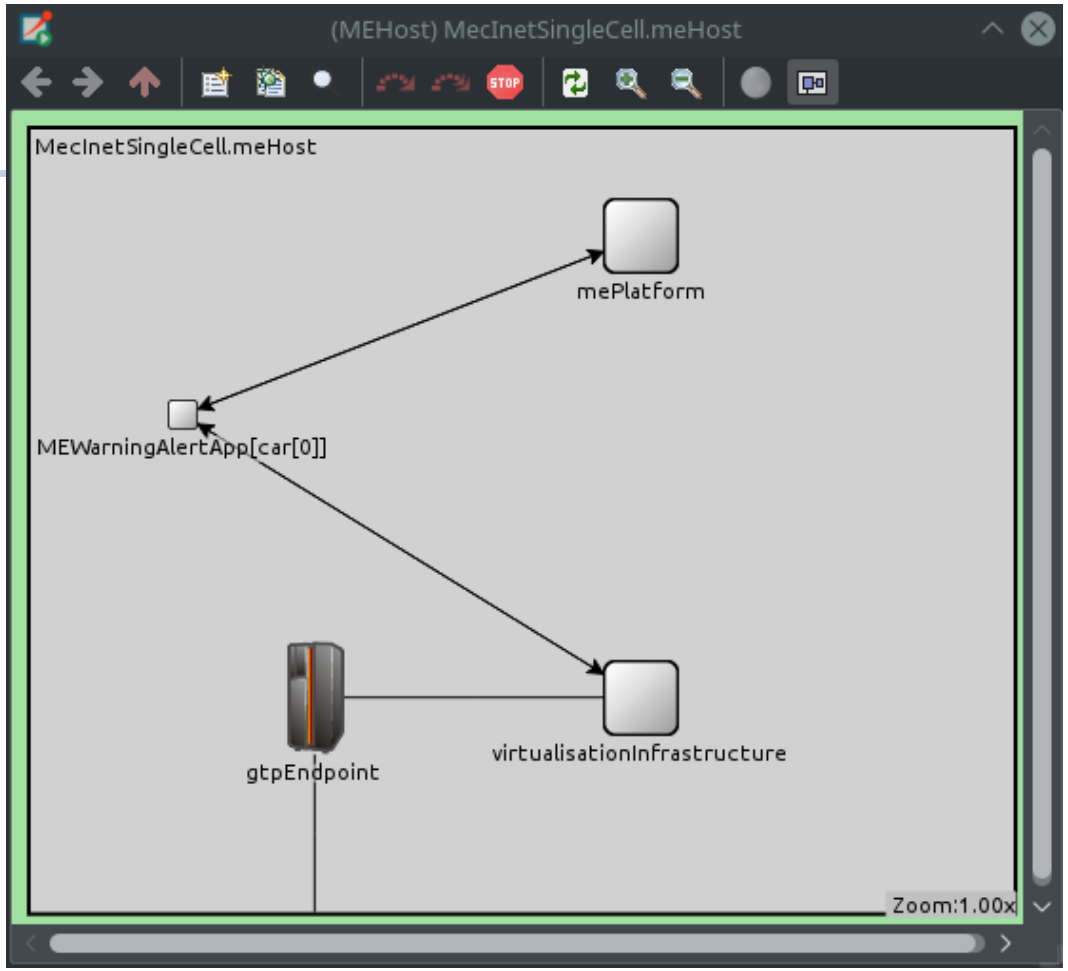

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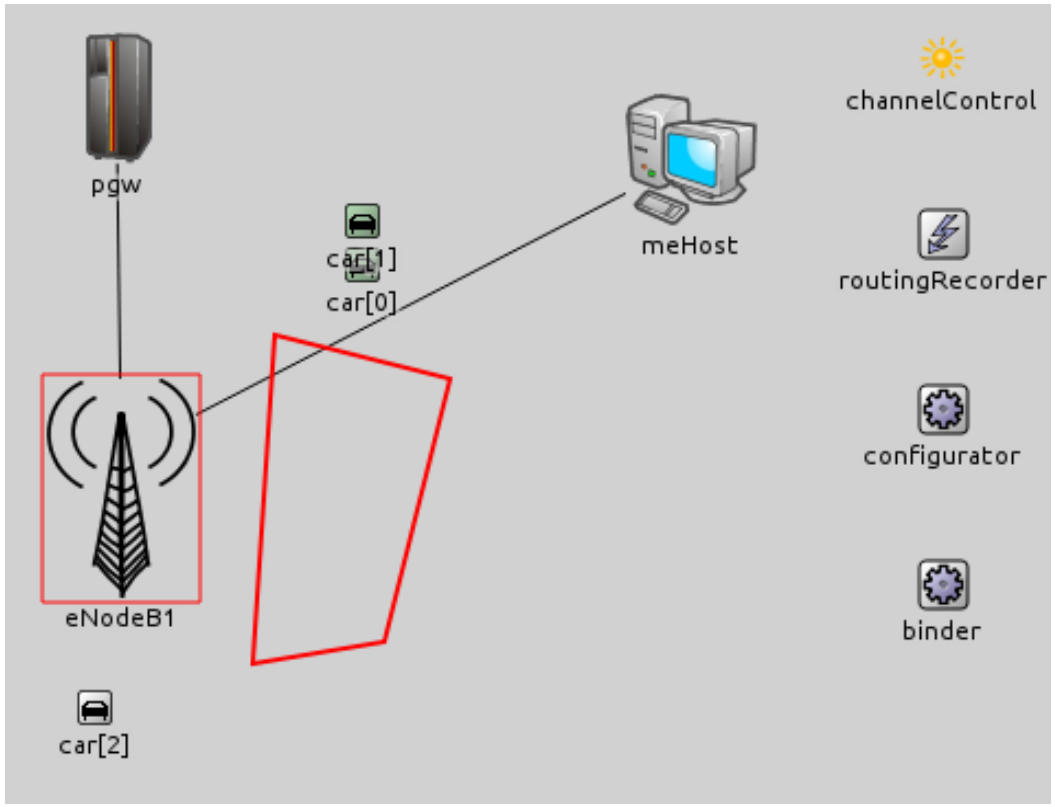

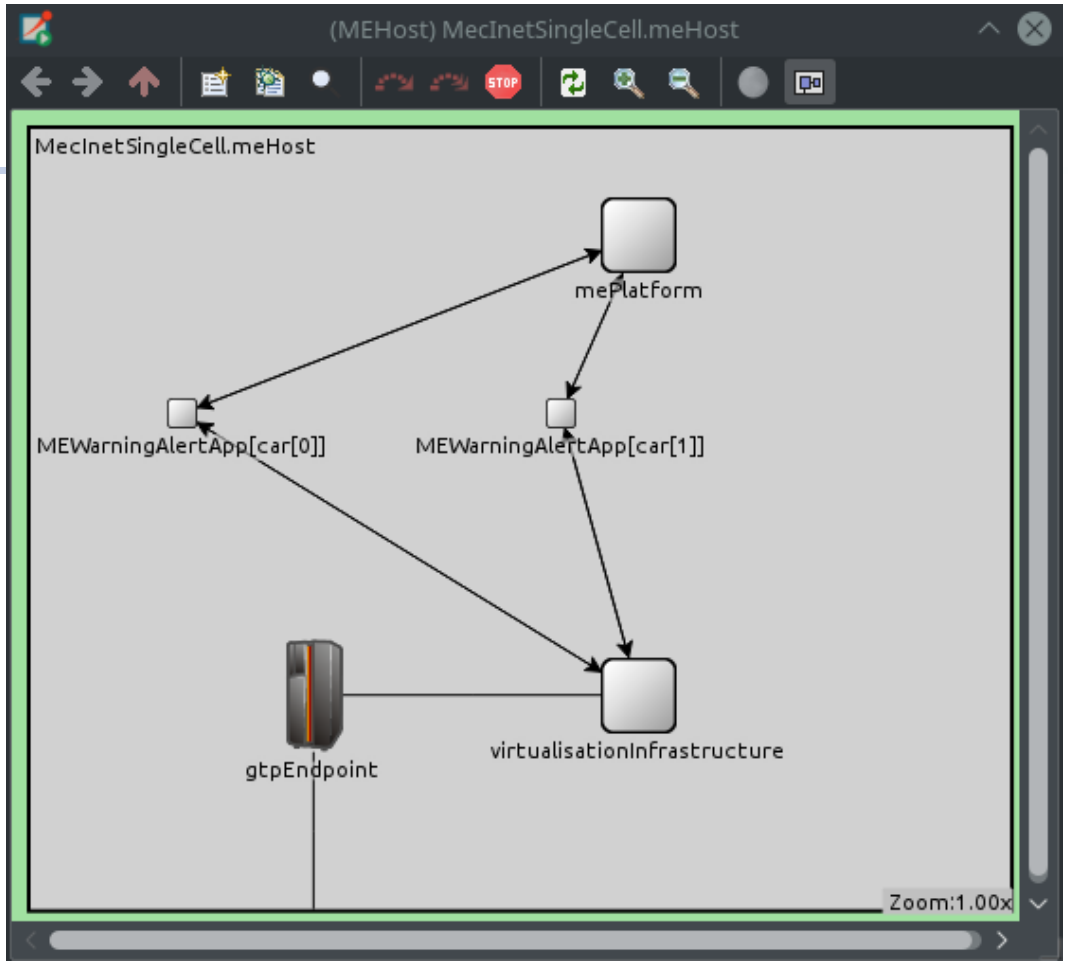

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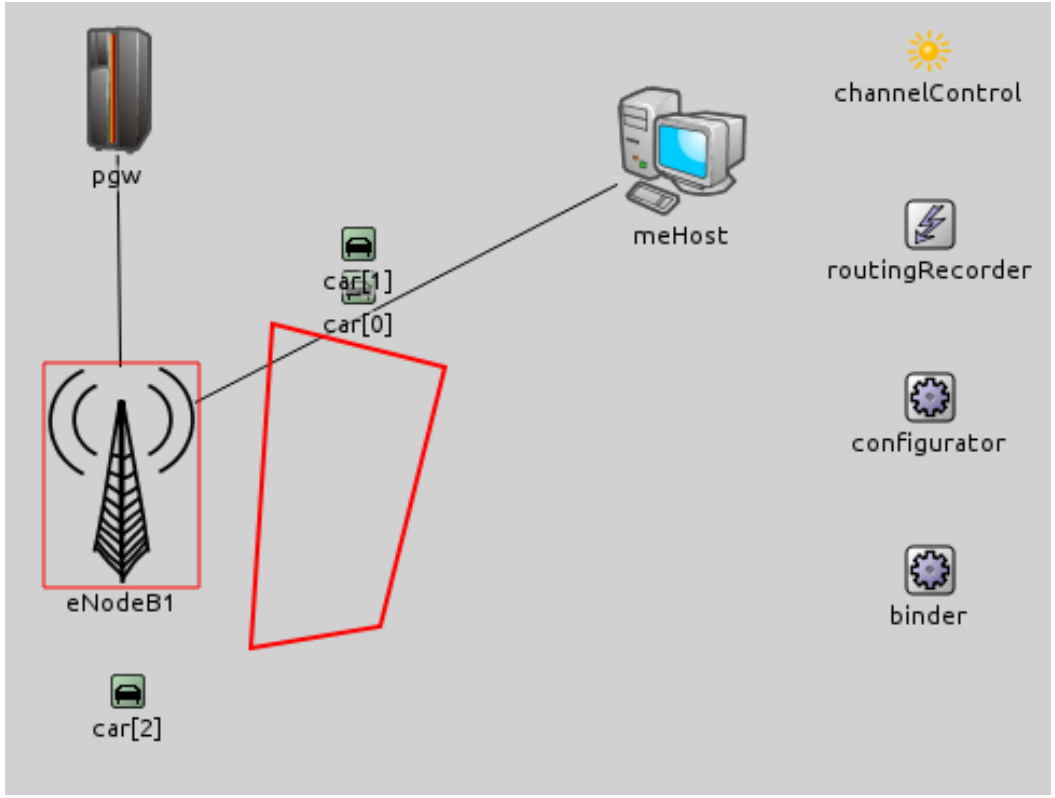

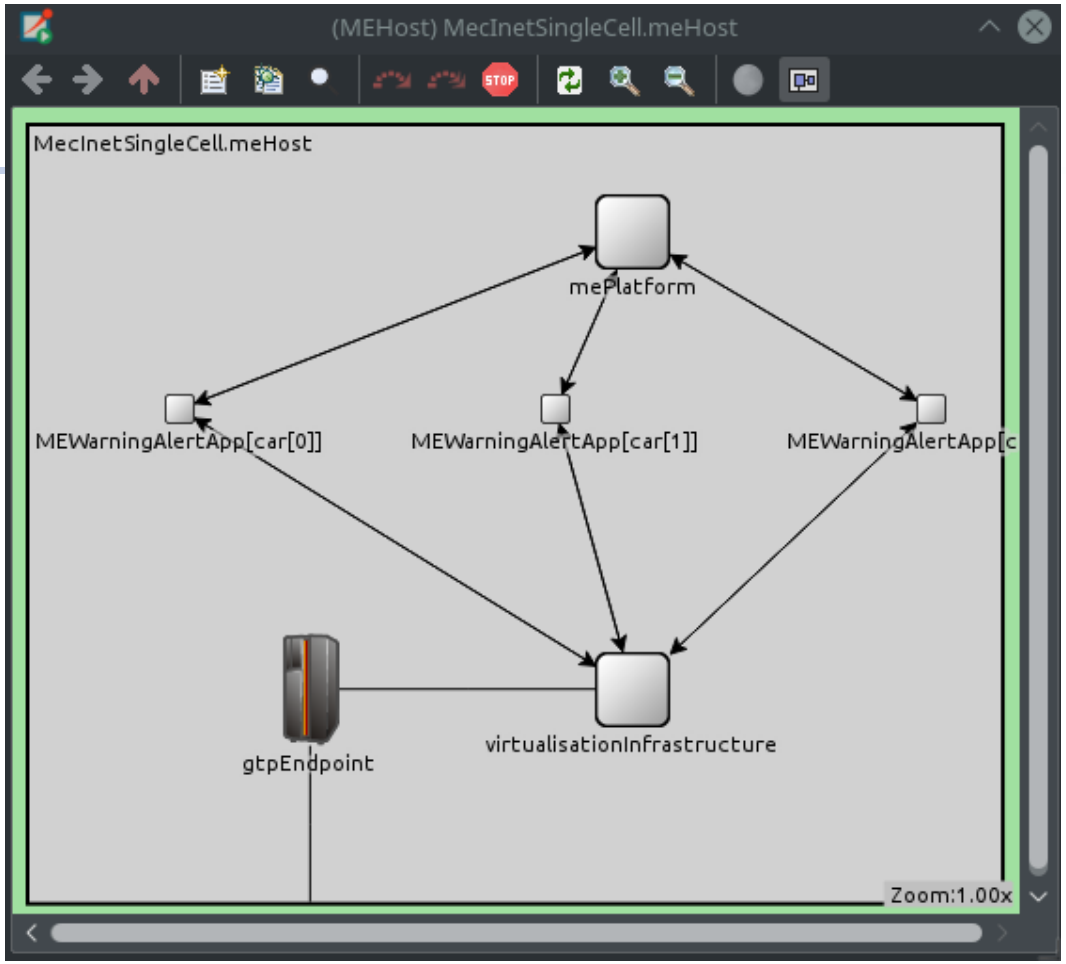

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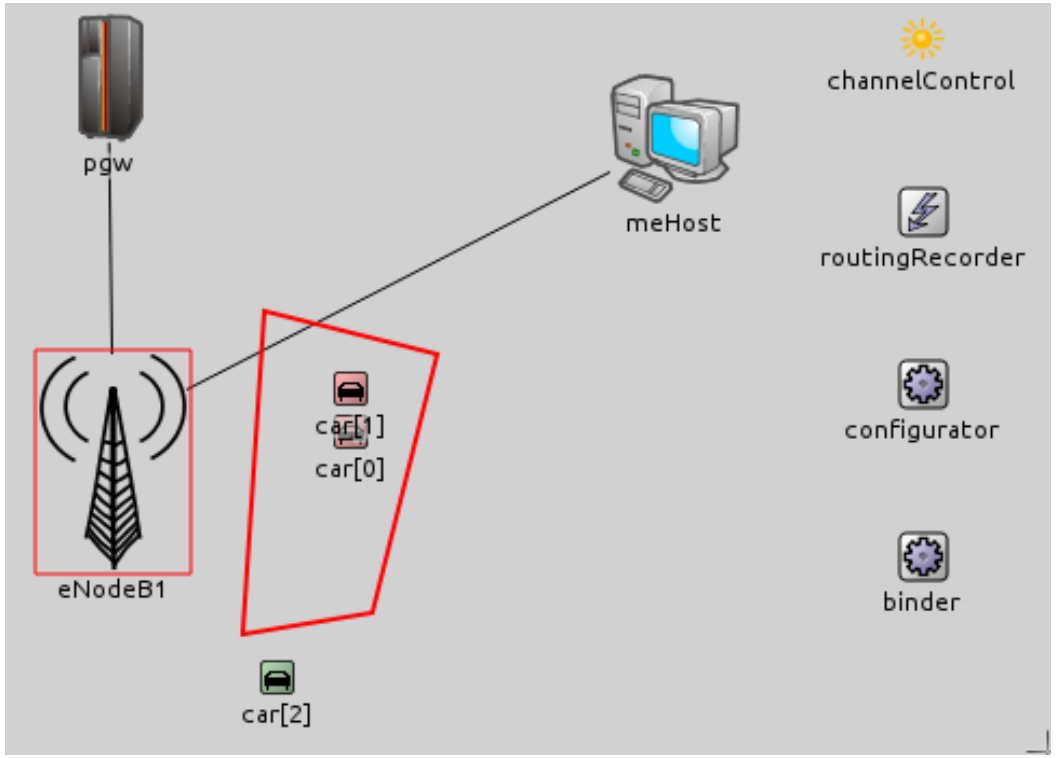

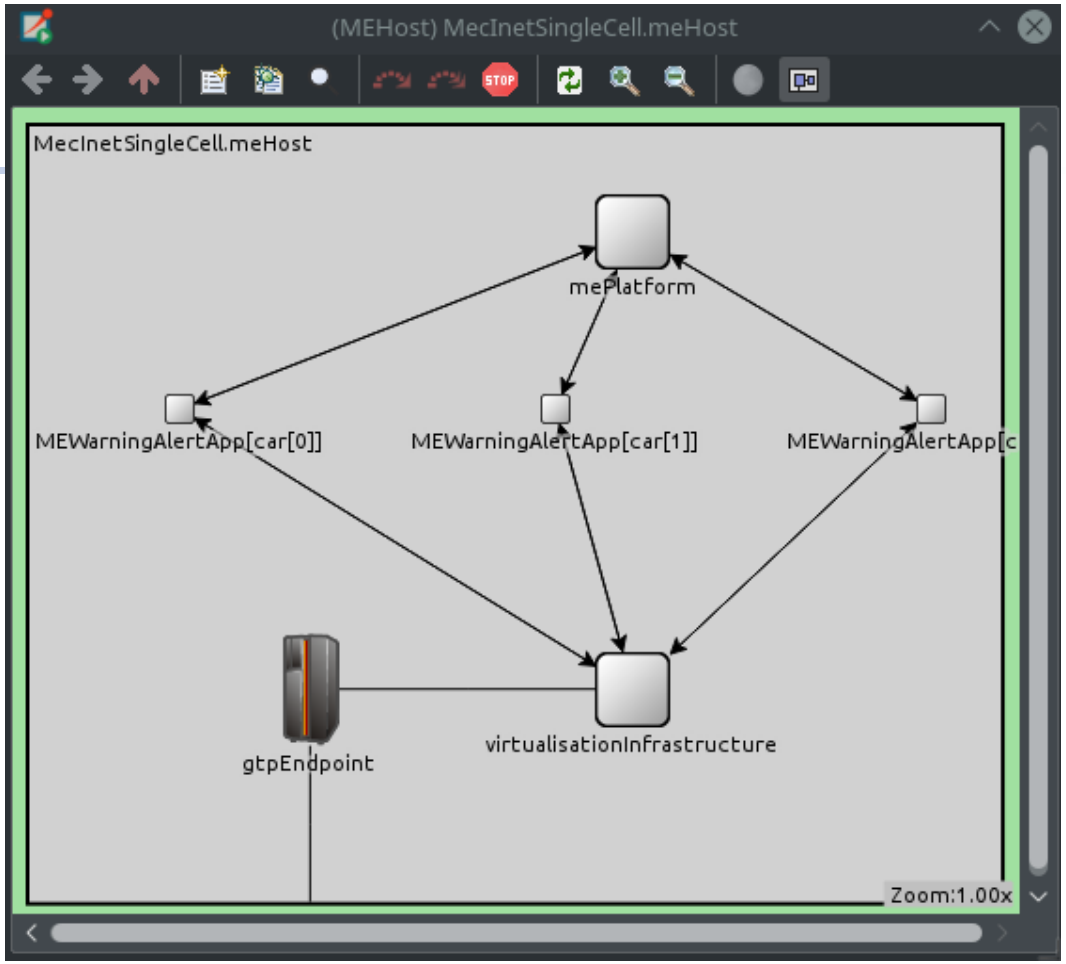

Conclusions

- **Multi-access Edge Computing** and **cellular networks**
- Modeling **MEC** within **SimuLTE**
  - Compliance with ETSI specifications
  - Pluggable interface to allow researchers evaluating new apps and services
- Use case: car alert service
  - Implementation
  - Simulation configuration

Future work

- **Additional services** as per ETSI specifications, e.g. Location Manager
- Support for **migrating ME Applications** between ME Hosts
- Detailed modeling of **ME Applications lifecycle** and **resource utilization**
- Evaluation of new **use cases** and **scenarios** (suggestions are welcome!)

Thank You!

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