



LiSuM: Design and Development of a Middleware to couple Virtual LISA+ TLS Controller and SUMO Simulation

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Wissen für Morgen

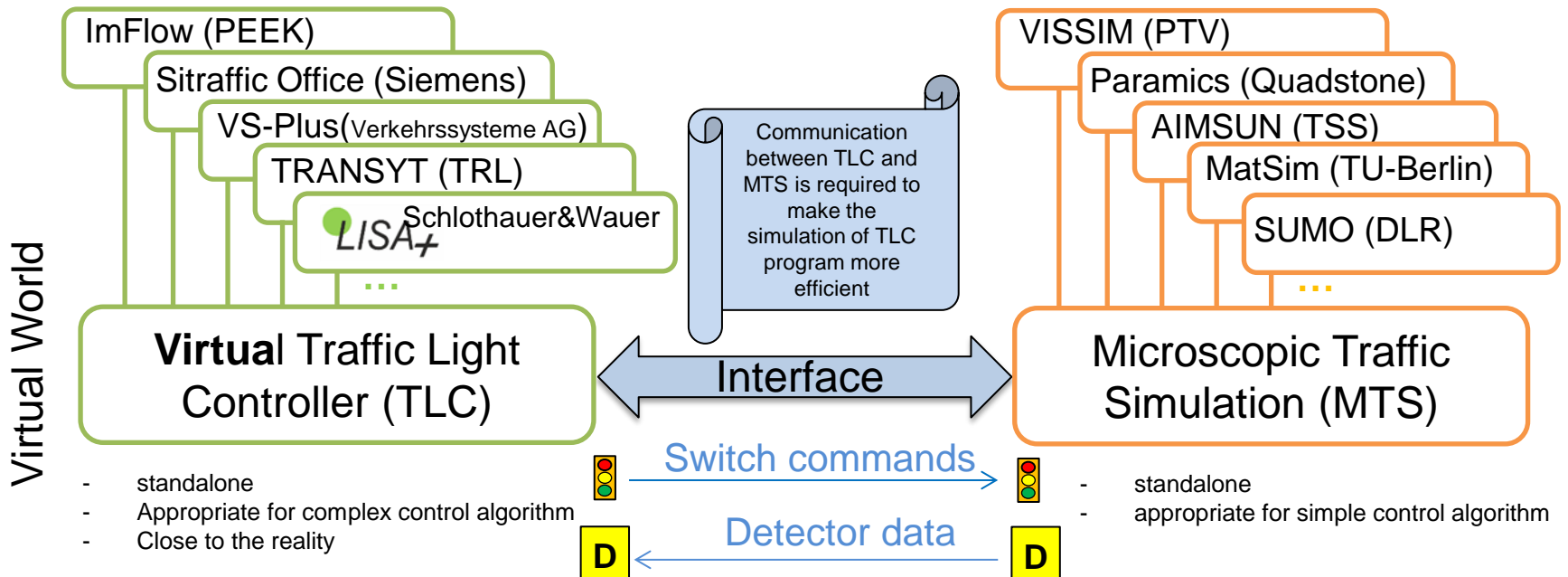


Agenda

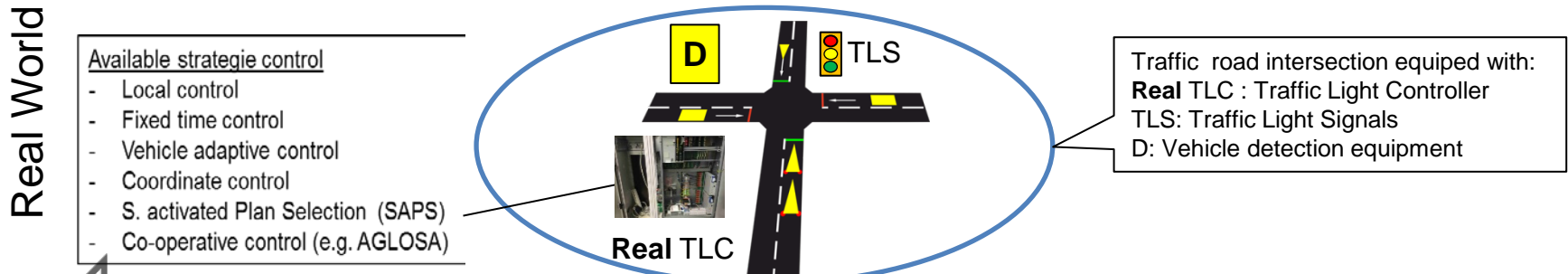
- 1. Motivation
- 2. LiSuM Software Concept
- 3. Use case scenario with LiSuM
- 4. Short video to demonstrate LiSuM
- 5. Conclusion and outlook



Motivation (1)

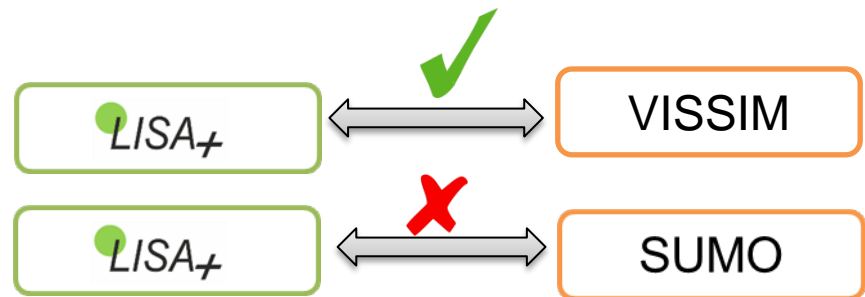


Traffic light control program designed and planned for a signalized intersection



Motivation (2)

- In DLR TLC Laboratory new methods for TLC are investigated
- For this purpose different tools like **Sittraffic Office VISSIM SUMO** and **LISA+** to design, plan and simulate new methods for traffic light control.
- The simulated control logic algorithms can be tested into the real controller available in the DLR Laboratory
- Fact:
 - Interface between LISA+ and VISSIM exists
- Problem:
 - no **open SUMO interface to LISA+** was **available** at the beginning this project
 - Complex control logic programs designed with professional LISA+ tools like cannot be executed with SUMO

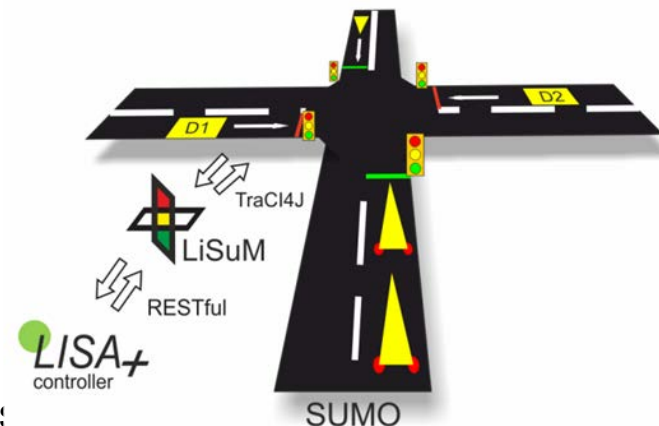
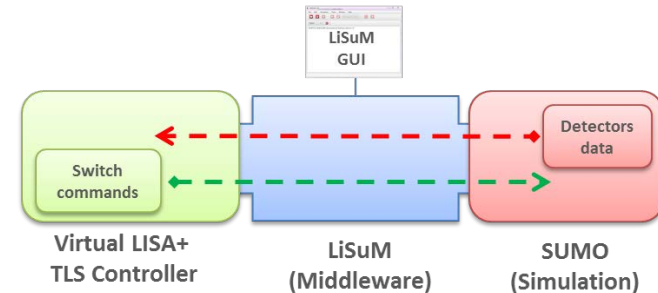


DLR Traffic Light Control Research Laboratory



DLR Solution: LiSuM Middleware Interface

- LiSuM = LISA SUMO Middleware
- LiSuM realizes the **communication** interface between SUMO and LISA+ controller
 - LiSuM communicates with LISA+ through a **RESTful API**
 - LiSuM communicates with SUMO using **TraCI4J**
 - LiSuM sends LISA+ induction loops detection data (read from SUMO)
 - LiSuM sends SUMO traffic light states (received from LISA+)
- LiSuM provides GUI, which allows the **user interaction** between LISA+ and SUMO during the simulation
- LiSuM supports the simulation of multiple TLC Unit
- LiSuM provides two sample TLC simulation projects as part of the distribution



What is LISA+?

- LISA+ is a traffic engineering software toolsuite developed by the german compagny **Schlothauer & Wauer**
 - LISA+ is a **commercial** product → it is recommended to purchase the software license to use the LISA+ products
 - The tools consists of :
 - **LISA+ OTMC** (Open Method of Traffic Control) **GUI** is a design and planning tool for traffic light control etc...
 - **Virtual LISA+ traffic light controller** (TLC) to simulate the traffic control logic
 - ...etc
- LISA+ products are mostly used in Germany and in some countries in Europe and in South America
- LISA+ products target groups are
 - Transportation engineers an planners
 - Local government officials
 - Lecturers- for teaching and research
 - Etc...

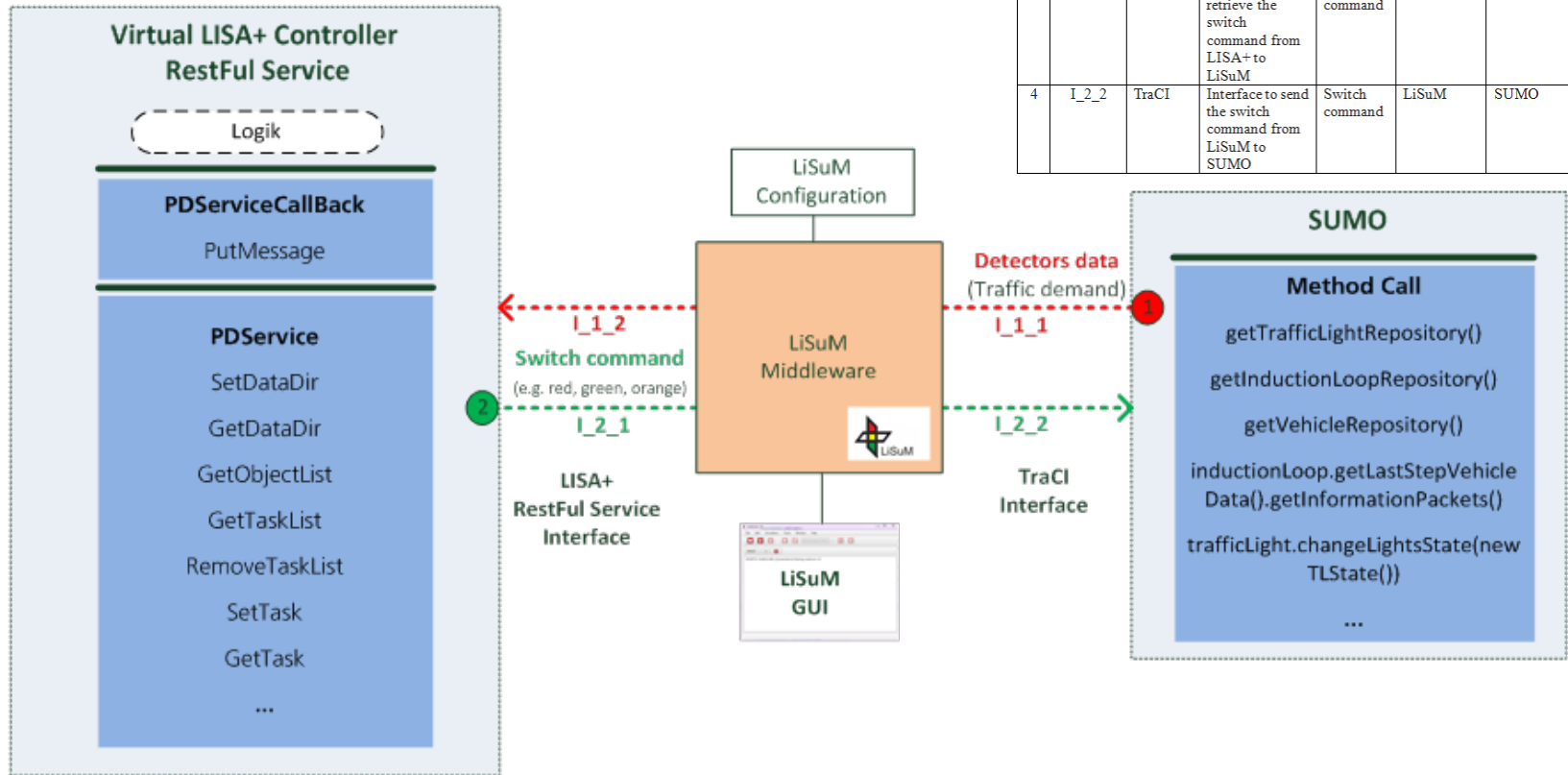
supported strategy control

- Local control
- Fixed time control
- Vehicle adaptive control
- Coordinate control
- Co-operative control

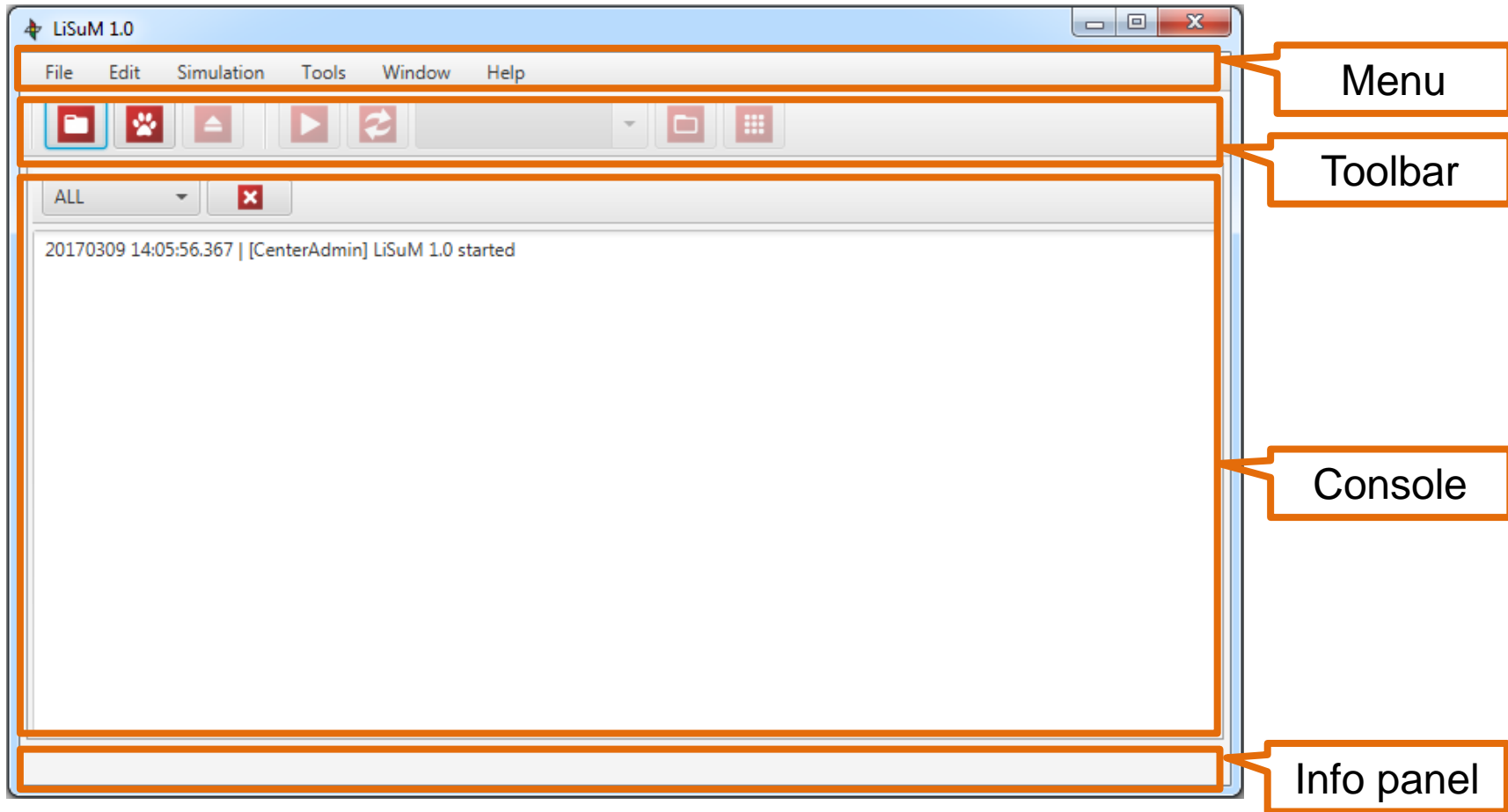


LiSuM Communication Interface

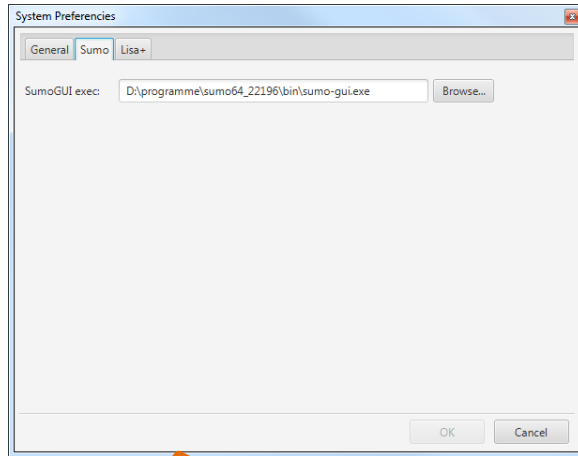
| No | Interface Identifier | Interface Type | Interface description | Exchange Data | Source Component | Destination Component |
|----|----------------------|----------------|--|----------------|------------------|-----------------------|
| 1 | I_1_1 | TraCI | Interface to retrieve the detector data from SUMO to LiSuM | Detector data | SUMO | LiSuM |
| 2 | I_1_2 | RESTful | Interface to send the detector data from LiSuM to LISA+ | Detector data | LiSuM | LISA+ |
| 3 | I_2_1 | RESTful | Interface to retrieve the switch command from LISA+ to LiSuM | Switch command | LISA+ | LiSuM |
| 4 | I_2_2 | TraCI | Interface to send the switch command from LiSuM to SUMO | Switch command | LiSuM | SUMO |



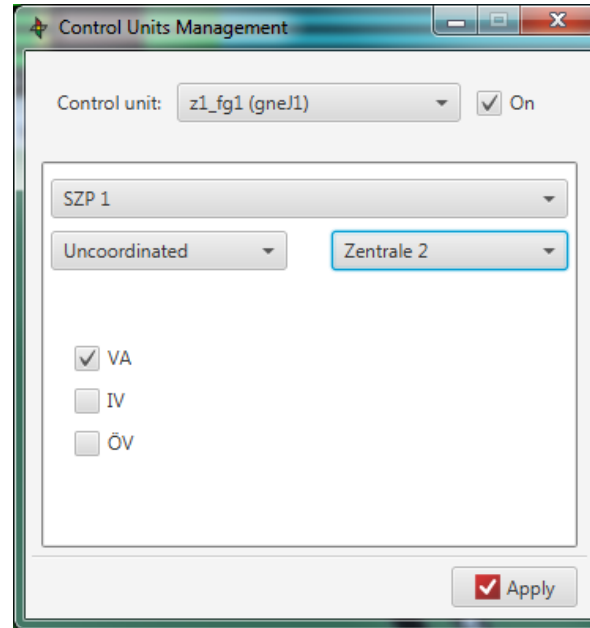
LiSuM Graphical User Interface (GUI)



LiSuM Graphical User Interface (GUI)



System Preference Panel



Control Unit Management Panel



LiSuM Configuration File (lisum.xml)

- XML file which contains all necessary information used to control the way that LISA+ communicates with SUMO
- Difference in the representation and naming between LISA and SUMO
- Mapping of signal group and detector between LISA+ and SUMO to resolve the difference in the naming and representation convention
- Configuration of multiple control units for different signalized intersections is possible

```

<?xml version="1.0" encoding="UTF-8"?>
<simulation>
  <input>
    <lisa>lisaDirectory</lisa>
  </input>
  <controlUnits>
    <controlUnit lisa="z1_fg1" sumo="gneJ1" >
      <signalGroups>
        <signalGroup lisa="K1" sumo="0" />
        <signalGroup lisa="K2" sumo="1" />
        <signalGroup lisa="K3" sumo="2" />
        <signalGroup lisa="K4" sumo="3" />
      </signalGroups>
      <detectors>
        <detector lisa="D1" sumo="myLoop1" />
      </detectors>
    </controlUnit>
    <controlUnit lisa="z1_fg2" sumo="gneJ2"
  >
    <signalGroups>
      <signalGroup lisa="K1" sumo="0,1,2" />
      <signalGroup lisa="K2" sumo="3,4" />
      <signalGroup lisa="K3" sumo="5,6,7" />
      <signalGroup lisa="K4" sumo="8" main="K3" />
    </signalGroups>
  </controlUnit>
</controlUnits>
</simulation>

```

dynamic control

static control



Recommended Steps to used LiSuM

Design & plan the road intersection traffic signal control logic with **LISA+ OMTC Tool**

1

LISA+ control logic files

Design & plan the road intersection and the traffic light for **SUMO**

2

SUMO files

Installation of the **virtual LISA+ TC** (RESTFull Server)

3

LISA+ executable Jar

Installation of **SUMO** (+GUI)

4

Sumo
version 0.29.0 or later

Installation of **LiSuM** Middleware

5

LiSuM Java Software
(java, JRE version 8 or later)

Lisum.xml configuration

6

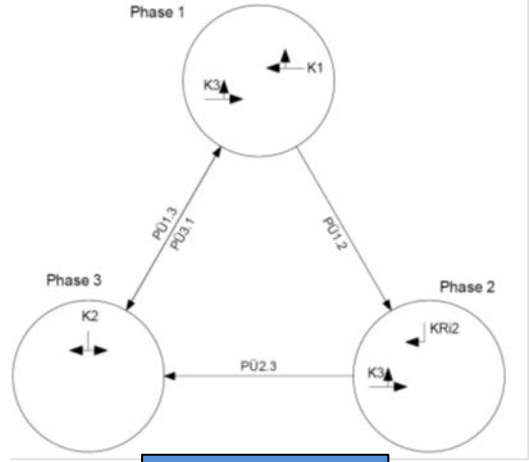
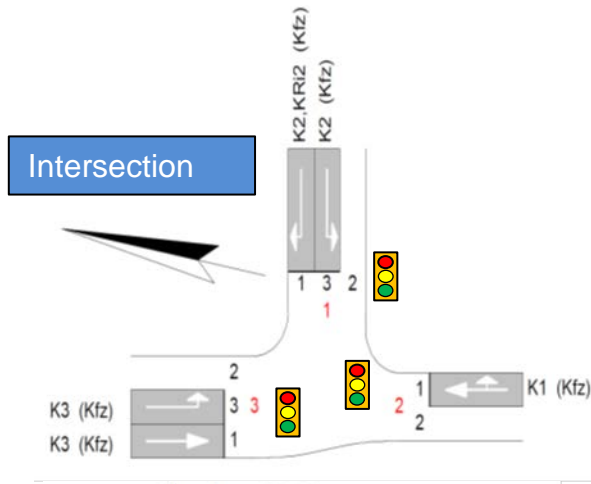
TLC Simulation mit LiSuM (Video)

7



Design and plan the Example Intersection with LISA+ OMTc

1
Design & plan the road intersection traffic signal control logic with LISA+ OMTc Tool



Signal phases

Signalgruppen - Nur lesen [SUMO:Example\LISA_SUMO] - LISA+ 6.0.0

Start Basisdaten Festzeit-Planung Koordinierung VA-Planung Versorgung Zahlung Ansicht

Eingabe-assistent Grafik Tabelle Bewertungs-parameter Signalgruppen Ausrüstung HBS 2001/2009 HBS 2015 NLSA

| Lfd.Nr. | Name | Typ | ID-Nr. | Signalisierte Ströme | Teil-knoten | Symbol | tf _{min} | tf _{max} | ts _{min} | ts _{max} | Anwurf | Abwurf | Vmax [km/h] | Aus = Frei | Farbbild Aus Gelb-Blk | Verkehrstyp | Bemerkung |
|---------|------|--------------------------|--------|----------------------|-------------|--------|-------------------|-------------------|-------------------|-------------------|------------|---------|-------------|------------|-----------------------|-------------|-----------|
| 1 | K1 | Kfz (3-feldig) | 1 | Arm2 -> 1,3 | TK1 | | 5 | - | 1 | - | Rotgelb 1s | Gelb 3s | 50 | X | Dunkel | Kfz | |
| 2 | K2 | Kfz (3-feldig) | 2 | Arm1 -> 2,3 | TK1 | | 6 | - | 1 | - | Rotgelb 1s | Gelb 3s | 50 | - | Gelbblinker | Kfz | |
| 3 | K3 | Kfz (3-feldig) | 3 | Arm3 -> 1,2 | TK1 | | 5 | - | 1 | - | Rotgelb 1s | Gelb 3s | 50 | X | Dunkel | Kfz | |
| 4 | KRI2 | Kfz Gelbgruen (2-feldig) | 4 | Arm1 -> 3 | TK1 | | 5 | - | - | - | - | Gelb 3s | 50 | - | Dunkel | Kfz | |

Signal group

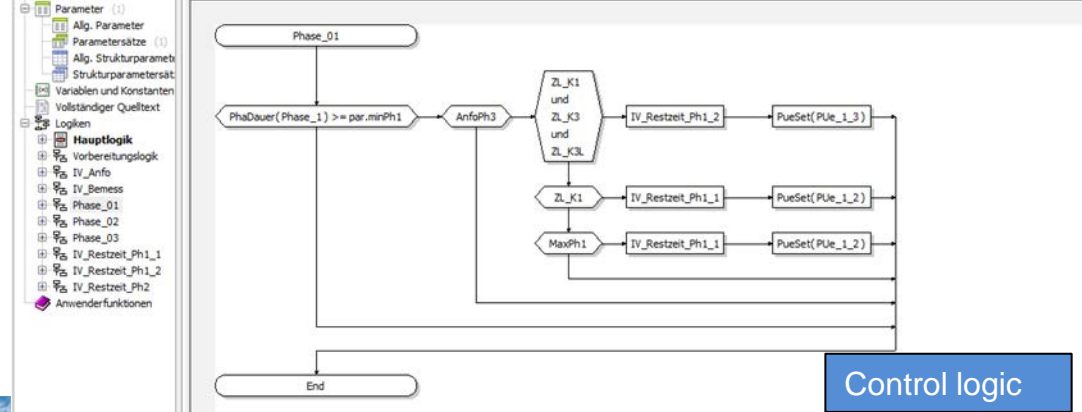
Detektoren [SUMO:Example\LISA_SUMO]

Start Basisdaten Festzeit-Planung Koordinierung VA-Planung Versorgung

Detektoren ÖV Rahmen Logik Testplatz OMTc

| Lfd.Nr. | Name | Typ | ID-Nr. | SGR1 | SGR2 | Losch-Sak | PrelI | Min-Bel. | Mast | Bemerkung |
|---------|--------|----------|--------|-------|-------|-----------|-------|----------|------|-----------|
| 1 | IS2.1 | Schleife | 1 | K2 | keine | 0,0 | 0,0 | 0,0 | - | |
| 2 | IS2.2 | Schleife | 2 | K2 | keine | 0,0 | 0,0 | 0,0 | - | |
| 3 | IRD1 | Infrarot | 3 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 4 | IRD2.1 | Infrarot | 4 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 5 | IRD2.2 | Infrarot | 5 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 6 | IRD3 | Infrarot | 6 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 7 | RD1 | Radar | 7 | keine | keine | 0,0 | 0,0 | 0,0 | - | |

Detectors



Control logic

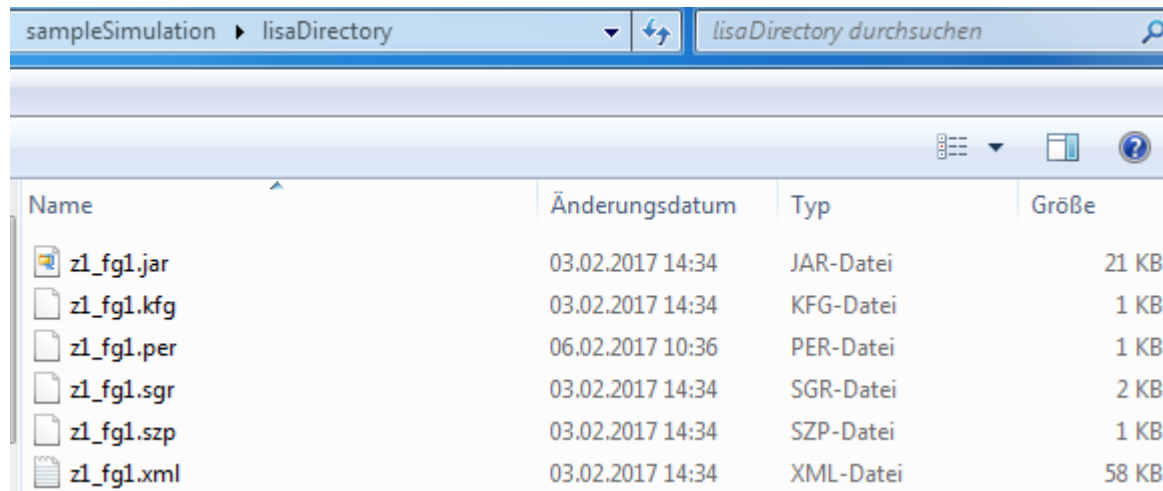


Generated Control Logic from LISA+ OMTC

Design & plan the road intersection traffic signal control logic with **LISA+ OMTC Tool**

1

- Control logic created with LISA+ OMTC consists of a serie of files containing the control logic program and its parameters
- Control logic created with LISA+ OMTC is uploaded to the virtual LISA+ controller and can be directly simulated with the SUMO using LiSuM



| Name | Änderungsdatum | Typ | Größe |
|------------|------------------|-----------|-------|
| z1_fg1.jar | 03.02.2017 14:34 | JAR-Datei | 21 KB |
| z1_fg1.kfg | 03.02.2017 14:34 | KFG-Datei | 1 KB |
| z1_fg1.per | 06.02.2017 10:36 | PER-Datei | 1 KB |
| z1_fg1.sgr | 03.02.2017 14:34 | SGR-Datei | 2 KB |
| z1_fg1.szp | 03.02.2017 14:34 | SZP-Datei | 1 KB |
| z1_fg1.xml | 03.02.2017 14:34 | XML-Datei | 58 KB |

LISA+ control logic files



2

Design & plan the road intersection and the traffic light for SUMO

Design and Planning the Sample Intersection for SUMO

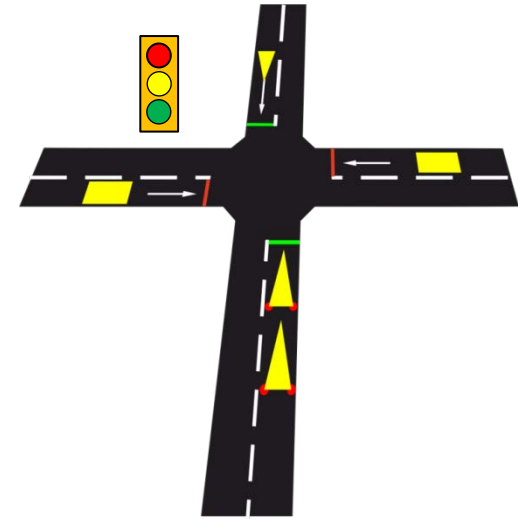
• demo.sumocfg

```

1 <configuration>
2   <input>
3     <net-file value="lsa.net.xml"/>
4     <route-files value="lsa.rou.xml"/>
5     <additional-files value="lsa.add.xml"/>
6   </input>
7
8   <time>
9     <step-length value="1"/>
10  </time>
11 </configuration>

```

- SUMO net file
 - **lsa.net.xml**
- SUMO route / vehicle demand / TLS file
 - **lsa.rou.xml**
- SUMO detector config. file
 - **lsa.add.xml**



```

<tlLogic id="0/1" type="static" programID="0" offset="0">
  <phase duration="31" state="GgrrrGGg"/>
  <phase duration="4" state="yggrrrryg"/>
  <phase duration="6" state="rGGrrrrG"/>
  <phase duration="4" state="rrrrrrry"/>
  <phase duration="31" state="rrrGGGr"/>
  <phase duration="4" state="rrrrrrrr"/>
</tlLogic>

```

simpleSampleSimulation ▶ simpleSampleSimulation durchsuchen

| Name | Änderungsdatum | Typ | Größe |
|---------------|------------------|---------------|-------|
| lisaDirectory | 24.04.2017 14:35 | Dateiordner | |
| demo.sumocfg | 22.07.2016 17:48 | SUMOCFG-Datei | 1 KB |
| lisum.xml | 09.03.2017 17:11 | XML-Datei | 1 KB |
| lsa.add.xml | 20.06.2016 12:08 | XML-Datei | 1 KB |
| lsa.net.xml | 13.06.2016 10:56 | XML-Datei | 6 KB |
| lsa.rou.xml | 18.07.2016 17:20 | XML-Datei | 1 KB |

Virtual LISA+ Controller Installation

3
Installation of the virtual LISA+ TC
(RESTFull Server)

LISA+ executable Jar

```
OmifgServer.ini
1 pdBase=http://localhost:9081/
2 vdBase=http://localhost:9080/
3 ;controllerAddr=http://localhost:9081/services/FGService
4 ;vdAddress=http://localhost:9080/services/VDSservice
5 ;datDirAddress=http://localhost:9081/services/DDService
6 ;pdAddress=http://localhost:9081/services/PDSservice
7 ;pdCallbackAddress=http://localhost:9081/services/PDCallback
```

```
C:\ProgramData\Oracle\Java\javapath\java.exe
INFORMATION: Invoking POST on /getTaskList
Feb 14, 2017 4:35:19 PM org.apache.cxf.binding.http.interceptor.URIParameIn
ceptor handleMessage
INFORMATION: URIParameInceptor handle message on path [/getTaskList] with
content-type [text/plain; charset=UTF-8]
2017-02-14 16:35:19.627 DEBUG [htpoo10-1] (??:) - Executing getTaskList
Feb 14, 2017 4:35:19 PM org.apache.cxf.binding.http.interceptor.DispatchIntercep
tor handleMessage
INFORMATION: Invoking POST on /setTaskList
Feb 14, 2017 4:35:19 PM org.apache.cxf.binding.http.interceptor.URIParameIn
ceptor handleMessage
INFORMATION: URIParameInceptor handle message on path [/setTaskList] with
content-type [text/plain; charset=UTF-8]
2017-02-14 16:35:19.637 INFO [htpoo10-1] (??:) - Executing setTask
Feb 14, 2017 4:35:19 PM org.apache.cxf.binding.http.interceptor.DispatchIntercep
tor handleMessage
INFORMATION: Invoking POST on /putMessage
Feb 14, 2017 4:35:19 PM org.apache.cxf.binding.http.interceptor.URIParameIn
ceptor handleMessage
INFORMATION: URIParameInceptor handle message on path [/putMessage] with c
ontent-type [text/plain; charset=UTF-8]
2017-02-14 16:35:19.649 DEBUG [htpoo10-1] (??:) - Executing putMessage(25,?? ms)
Request: 1 0 60 0:0<"init"><4;1;1;1;2;1;1;0><> Response: 0:<0>0<0;1;0;1;0
;1;1;1;><0/12/0/0/3/0/0/0/><><>
```

```
http://localhost:9081/services/DDService?wsdl
<wsdl:part name="setDataDirRequest" element="tns:setDataDirRequest"> </wsdl:part>
</wsdl:message>
<wsdl:portType name="DataDirREST">
  <wsdl:operation name="getDataDir">
    <wsdl:input name="getDataDir" message="tns:getDataDir"> </wsdl:input>
    <wsdl:output name="getDataDirResponse" message="tns:getDataDirResponse"> </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="setDataDir">
    <wsdl:input name="setDataDir" message="tns:setDataDir"> </wsdl:input>
    <wsdl:output name="setDataDirResponse" message="tns:setDataDirResponse"> </wsdl:output>
    <wsdl:fault name="FGFaultREST" message="tns:FGFaultREST"> </wsdl:fault>
  </wsdl:operation>
</wsdl:portType>
<wsdl:binding name="DataDirRESTServiceHttpBinding" type="tns:DataDirREST">
  <wsdl:operation name="getDataDir">
    <wsdl:input name="getDataDir"> </wsdl:input>
    <wsdl:output name="getDataDirResponse"> </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="setDataDir">
    <wsdl:input name="setDataDir"> </wsdl:input>
    <wsdl:output name="setDataDirResponse"> </wsdl:output>
    <wsdl:fault name="FGFaultREST"> </wsdl:fault>
  </wsdl:operation>
</wsdl:binding>
<wsdl:service name="DataDirRESTService">
  <wsdl:port name="DataDirRESTPort" binding="tns:DataDirRESTServiceHttpBinding">
    <soap:address location="http://localhost:9081/services/DDService/">
  </wsdl:port>
</wsdl:service>
</wsdl:definitions>
```

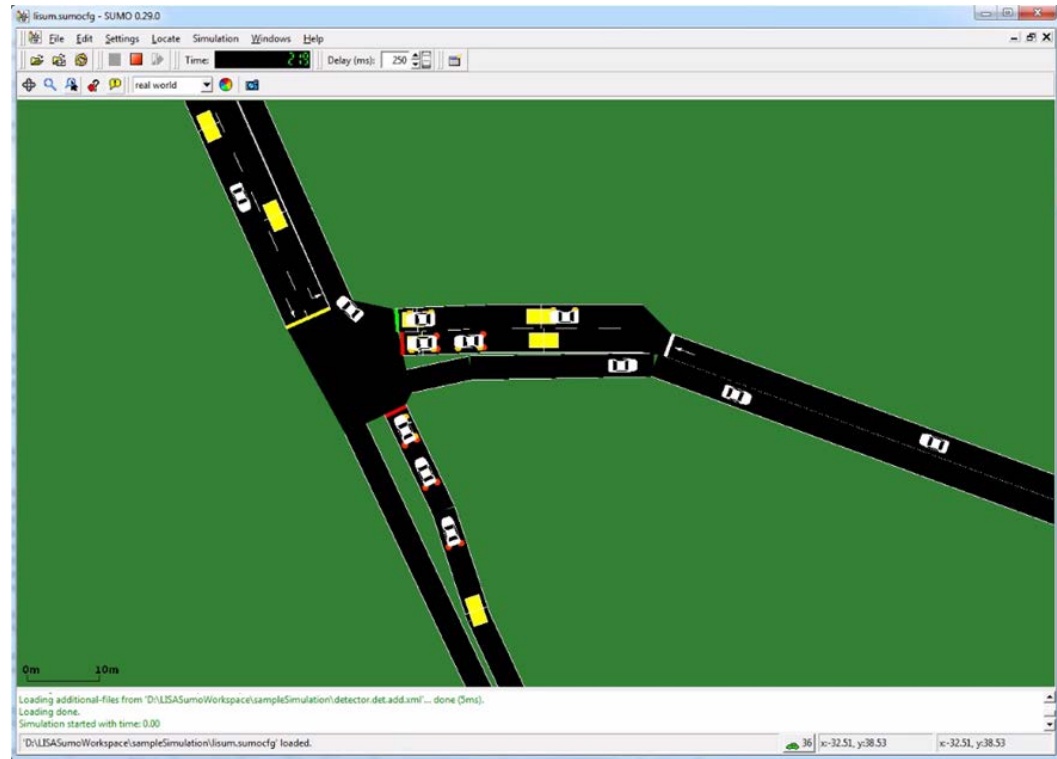
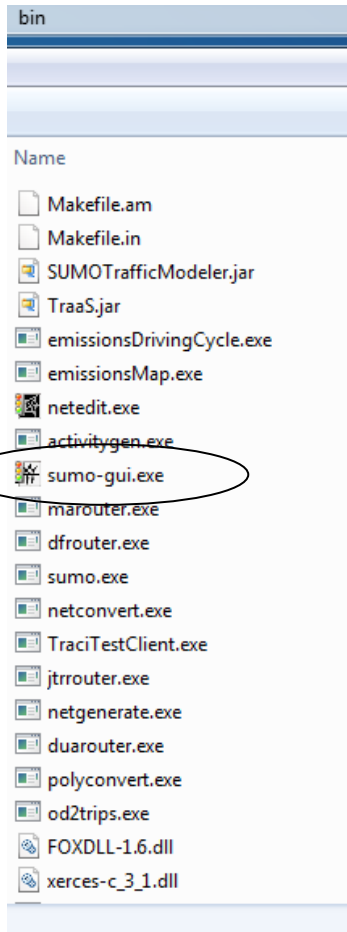
LISA+ virtual controller acts als RESTfull Server



SUMO Installation

4

Installation of SUMO
(+GUI)



Sumo
Version 0.29.0 or later



7

TLC Simulation mit LiSuM (Video)

Short video to demonstrate LiSuM

Simulation of traffic-actuated control scenario for a sample
signalized intersection



Configuration of the Sample Intersection

```

<simulation>
  <input>
    <lisa>lisadirectory</lisa>
  </input>

  <controlUnits>
    <controlUnit lisa="z1_fg1" sumo="C" >
      <signalGroups>
        <signalGroup lisa="K1" sumo="2,3" />
        <signalGroup lisa="K3" sumo="4,5" />
        <signalGroup lisa="K2" sumo="1" />
        <signalGroup lisa="KRi2" sumo="0" main="K2"/>
      </signalGroups>

      <detectors>
        <detector lisa="IS2.1" sumo="IS2.1" />
        <detector lisa="IS2.2" sumo="IS2.2" />
        <detector lisa="IRD1" sumo="IRD1" />
        <detector lisa="IRD2_1" sumo="IRD2_1" />
        <detector lisa="IRD2_2" sumo="IRD2_2" />
        <detector lisa="IRD3" sumo="IRD3" />
        <detector lisa="RD1" sumo="RD1_long" />
      </detectors>
    </controlUnit>
  </controlUnits>
</simulation>
    
```

Signal group

Detector

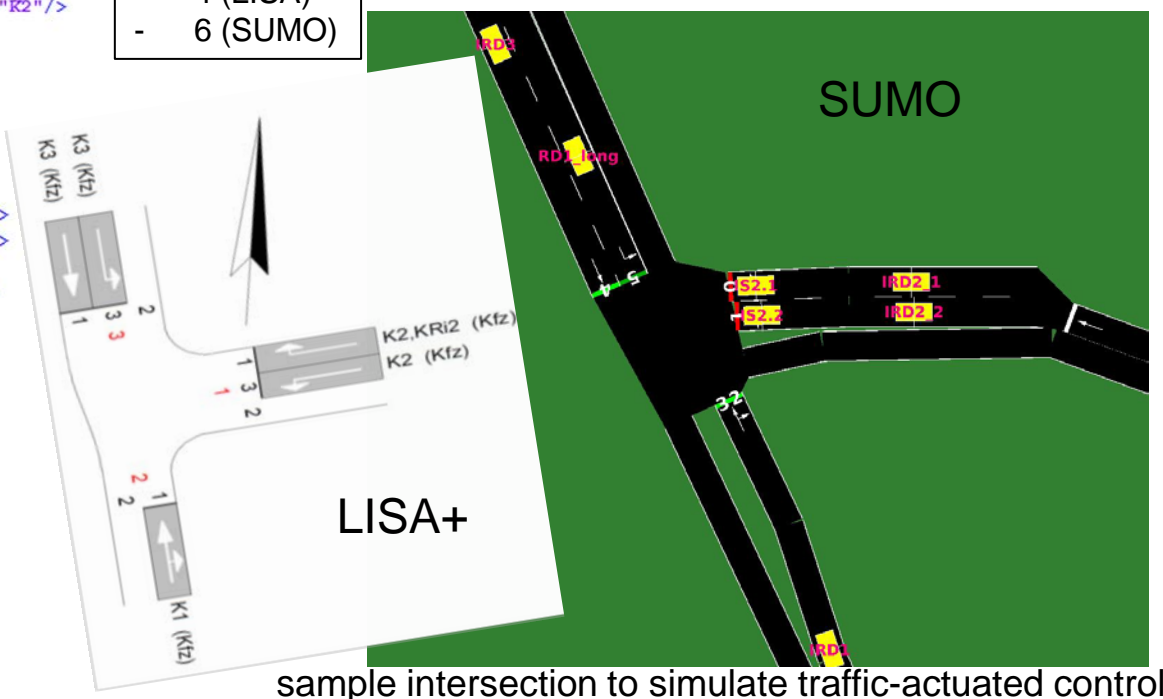
lisum.xml

- Detection typ**
- 2 Induction loops
 - 4 Infra red detectors
 - 1 Radar detectors

- Signal group**
- 4 (LISA)
 - 6 (SUMO)

Detektoren [SUMO\Example\LISA_SUMO]

| Lfd.Nr. | Name | Typ | ID-Nr. | SGR1 | SGR2 | Losch-sak | Prell | Min-Bel | Mast | Bemerkung |
|---------|--------|----------|--------|-------|-------|-----------|-------|---------|------|-----------|
| 1 | IS2.1 | Schleife | 1 | K2 | keine | 0,0 | 0,0 | 0,0 | - | |
| 2 | IS2.2 | Schleife | 2 | K2 | keine | 0,0 | 0,0 | 0,0 | - | |
| 3 | IRD1 | Infrarot | 3 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 4 | IRD2_1 | Infrarot | 4 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 5 | IRD2_2 | Infrarot | 5 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 6 | IRD3 | Infrarot | 6 | keine | keine | 0,0 | 0,0 | 0,0 | - | |
| 7 | RD1 | Radar | 7 | keine | keine | 0,0 | 0,0 | 0,0 | - | |



sample intersection to simulate traffic-actuated control



Conclusion and Outlook

- First step:
 - Technical realization of a LiSuM Middleware that provides
 - **communication** interface between LISA+ TLC and SUMO
 - GUI to support the **user interaction** by the simulation process
 - The LiSuM tool has been used to test a traffic-actuated signal control on an selected example intersection
- Next step:
 - Simulation of traffic light control scenario for complex/multiple intersections (→scalability and performance evaluation)
 - Comparation of the simulation between VISSIM, SUMO and LISA+ controller
 - Optimization of the current LiSuM software version
 - Make the LiSuM (source + distribution) available for download to the community (as part of SUMO distribution. come soon)



Thank you for your attention

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