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Braunschweig

Institut für Verkehrssicherheit  
und Automatisierungstechnik **iva**

Prof. Dr.-Ing. Dr. h.c. mult. E. Schnieder



## Analyzing German Vehicle Traffic Using STAMP/STPA

Hosse, René S.; Schnieder, Eckehard

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Challenges for Traffic Safety

Defining Traffic Safety

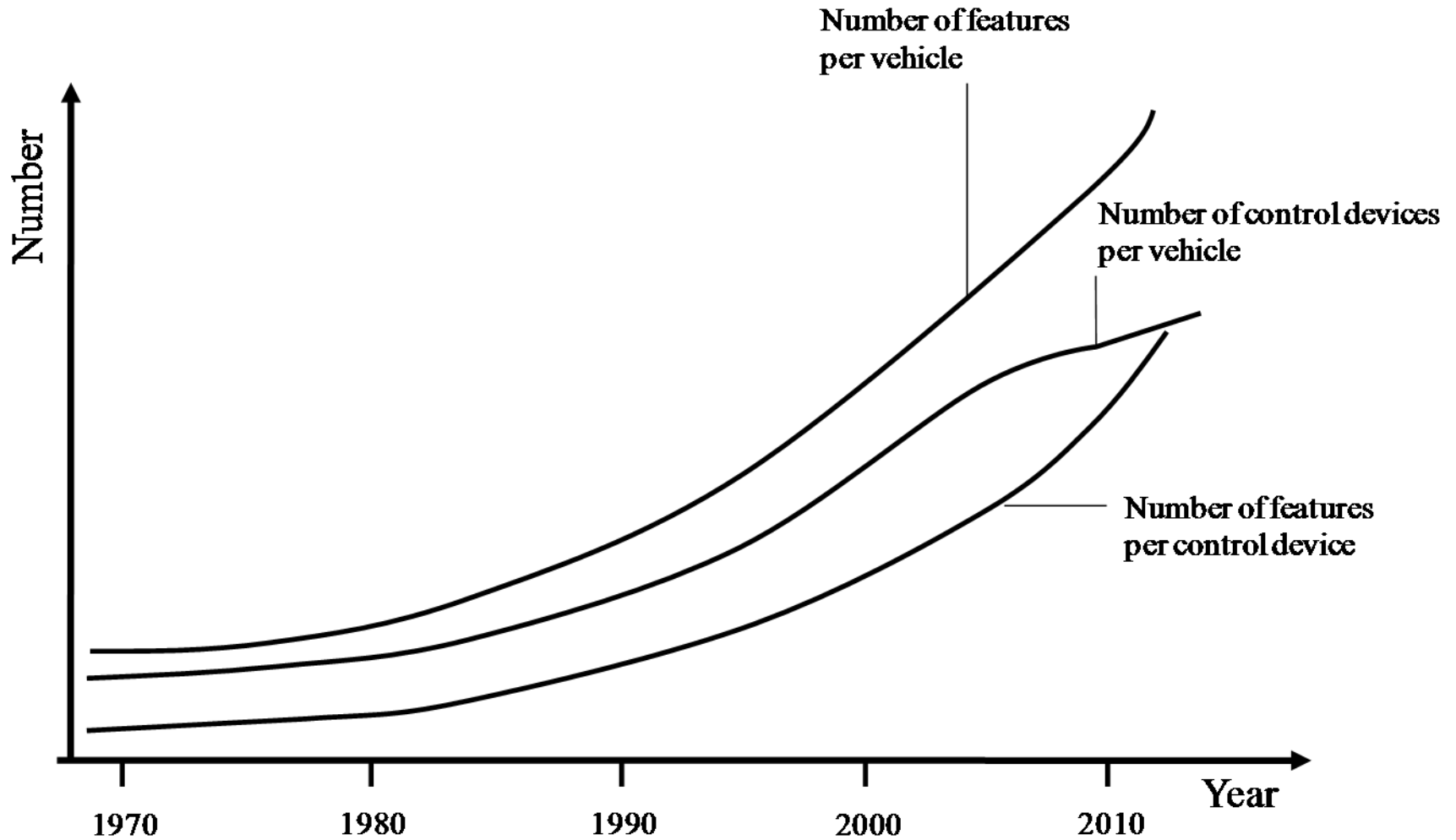
Analyzing German Vehicle Traffic Using STAMP/STPA

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# Challenges for Traffic Safety

## Development of Functions and Control Devices in Automobiles

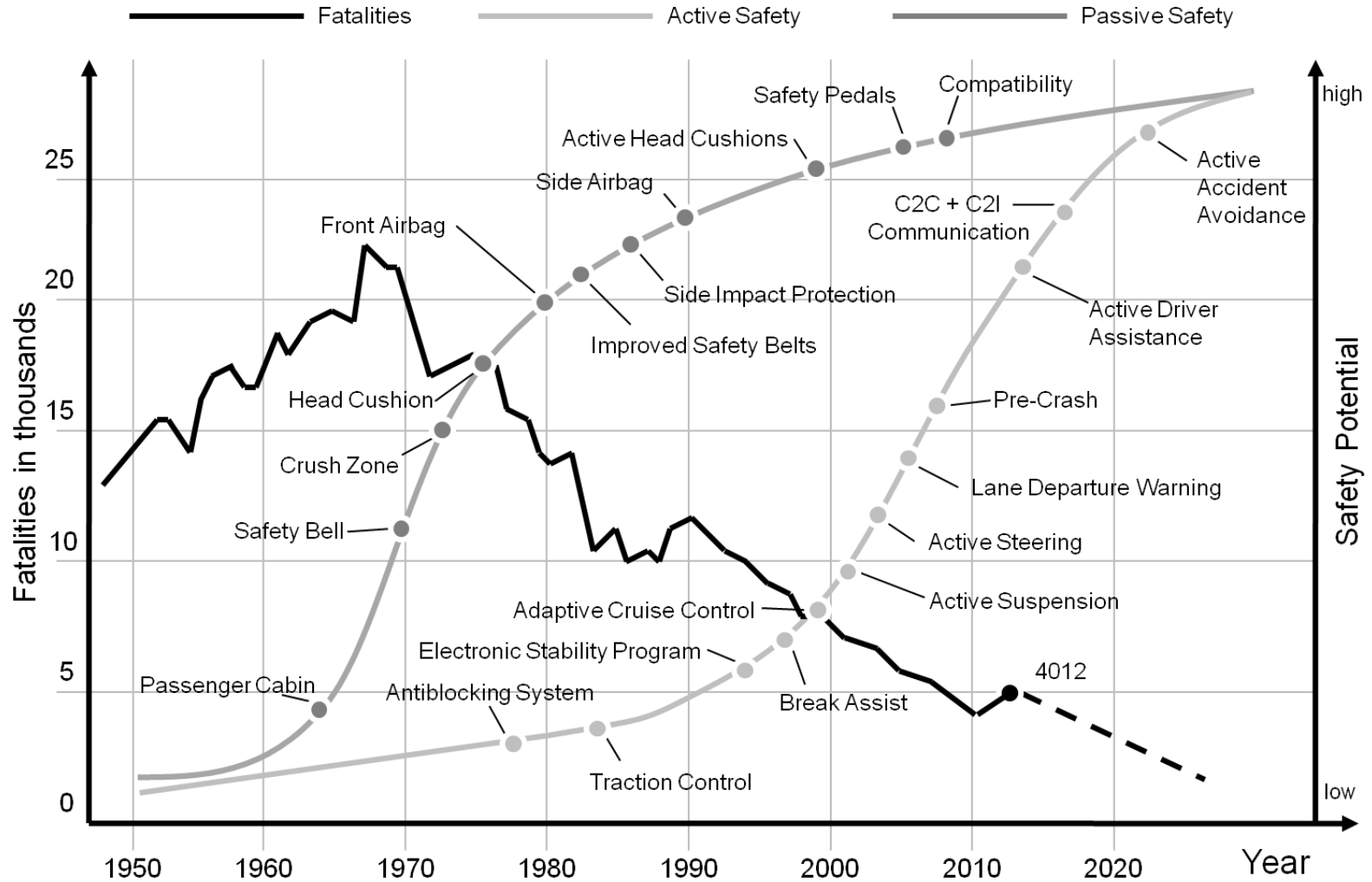


[Schüffele 2010]



# Challenges for Traffic Safety

## Development of Road Fatalities within Germany



[destatis 2012] and [Brühning/Seeck 2003]

19th April 2012 | René S. Hosse | Slide 4

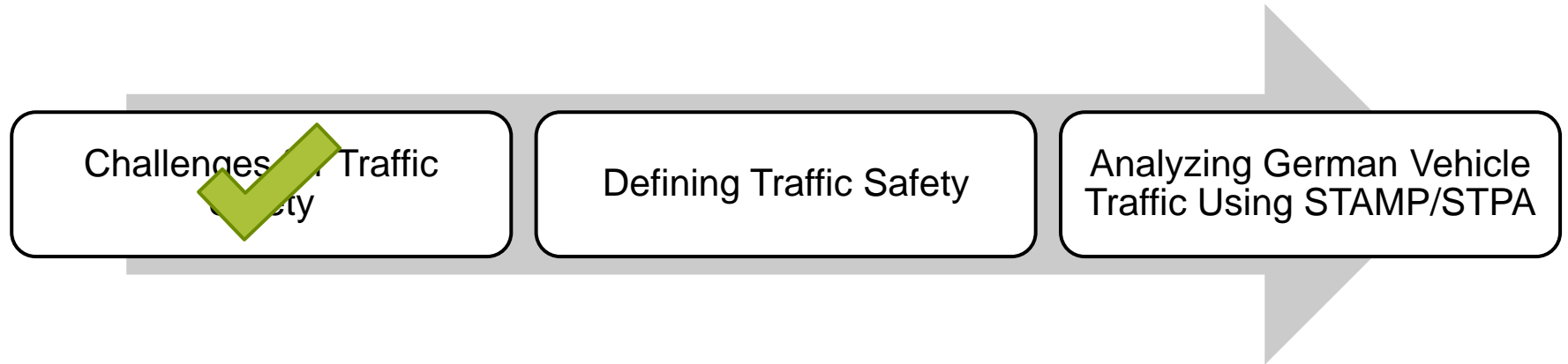


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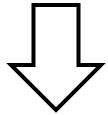
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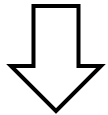
# Defining Traffic Safety

ProFunD-Approach

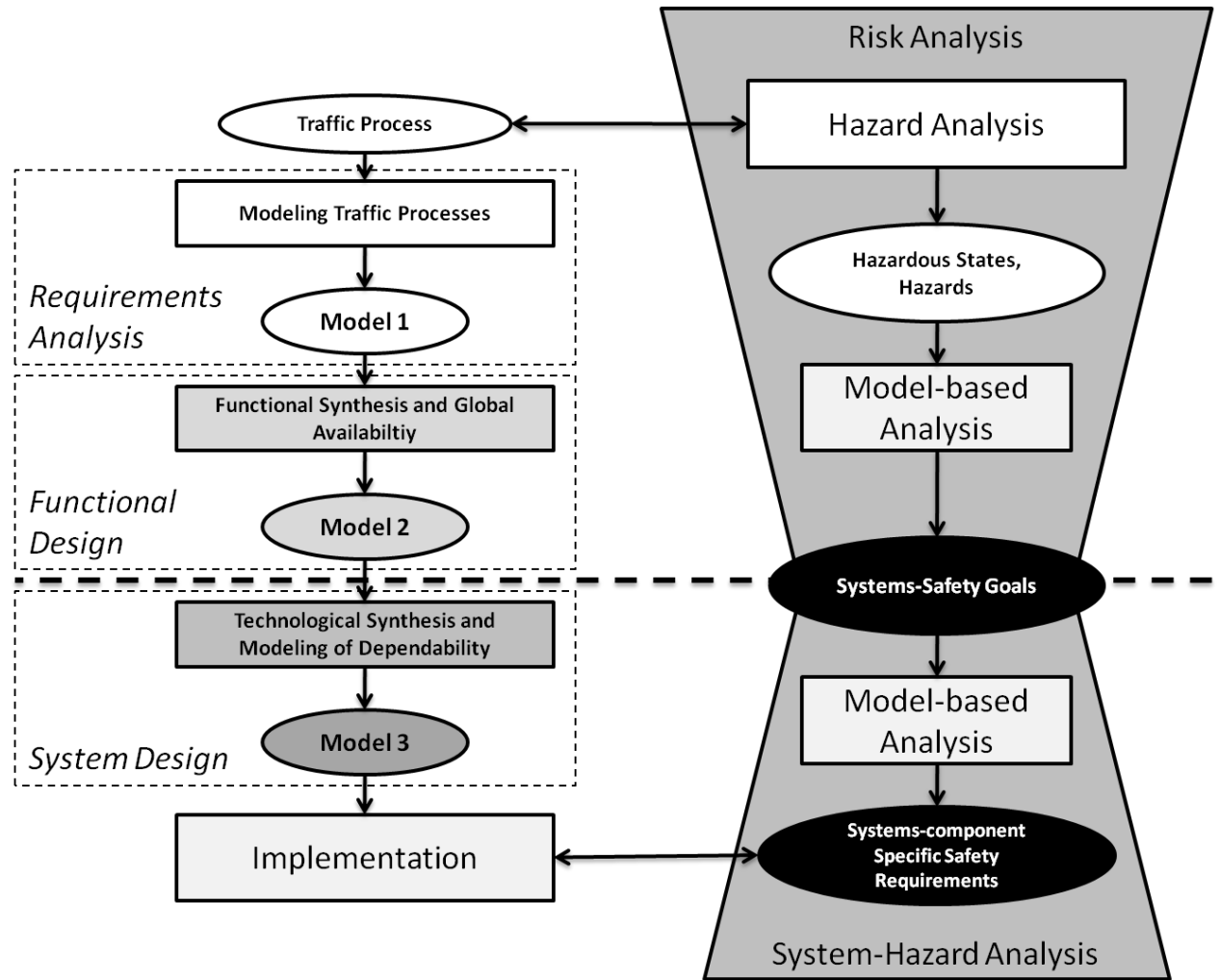
## 1. Process



## 2. Functions



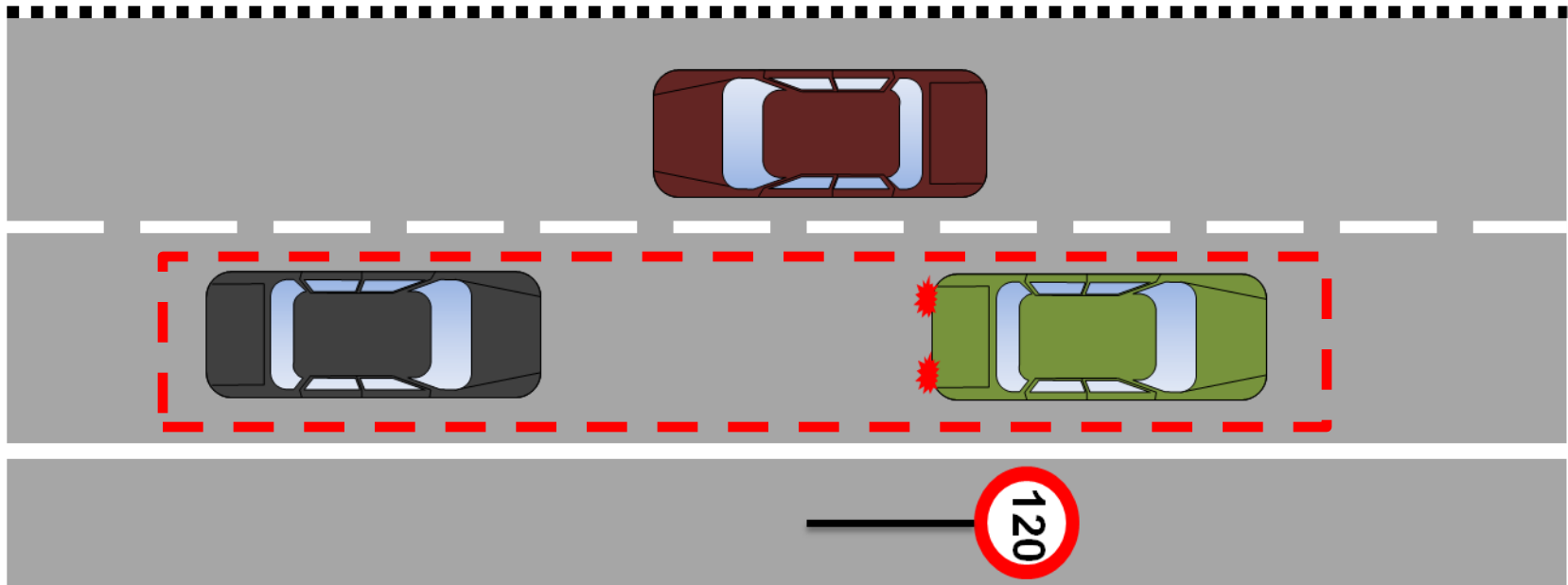
## 3. Dependability



[Slovák 2006]

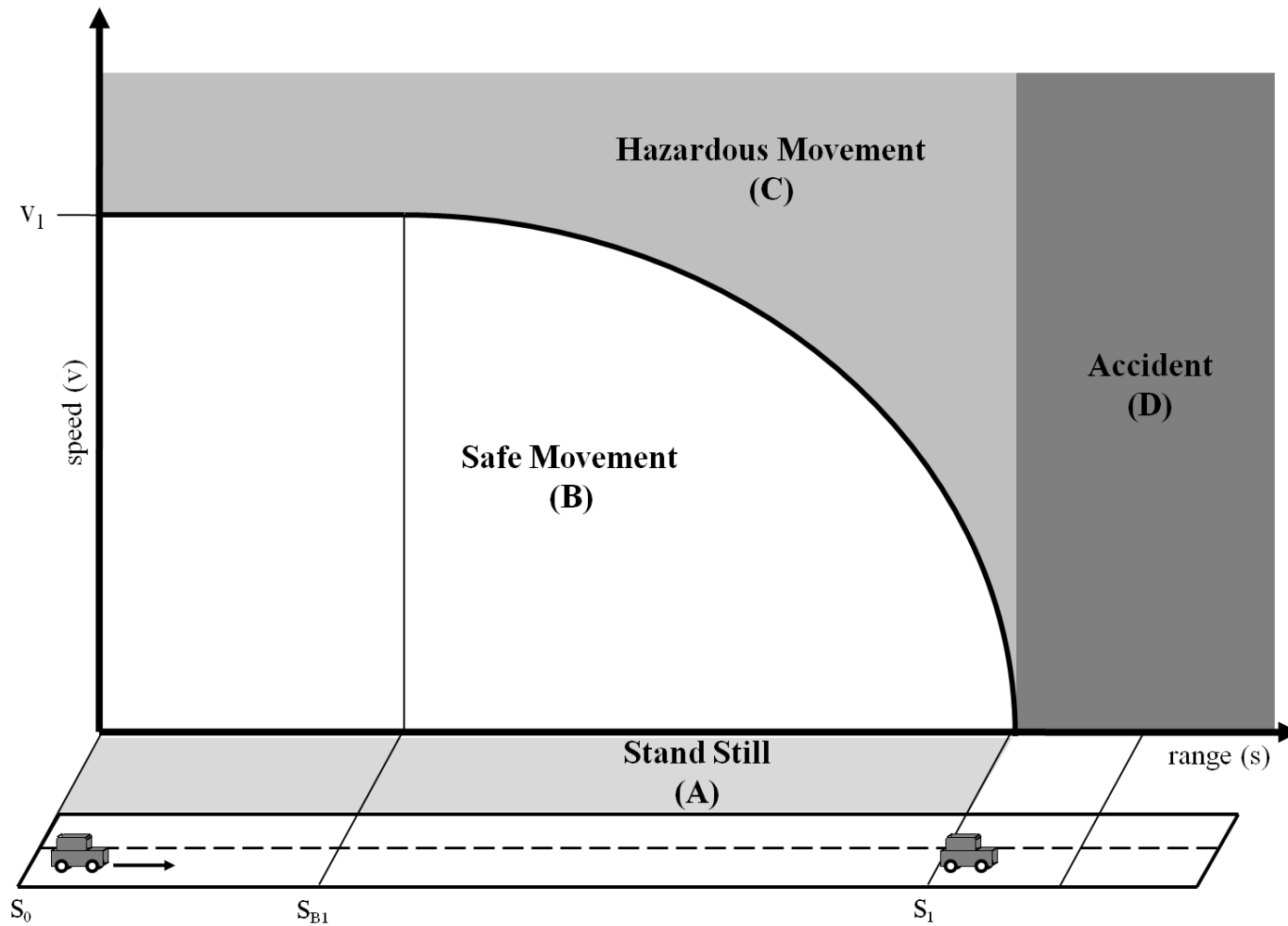
# Defining Traffic Safety

## Example of Traffic Process and Functions



# Defining Traffic Safety

## Trajectory of Approaching Cars

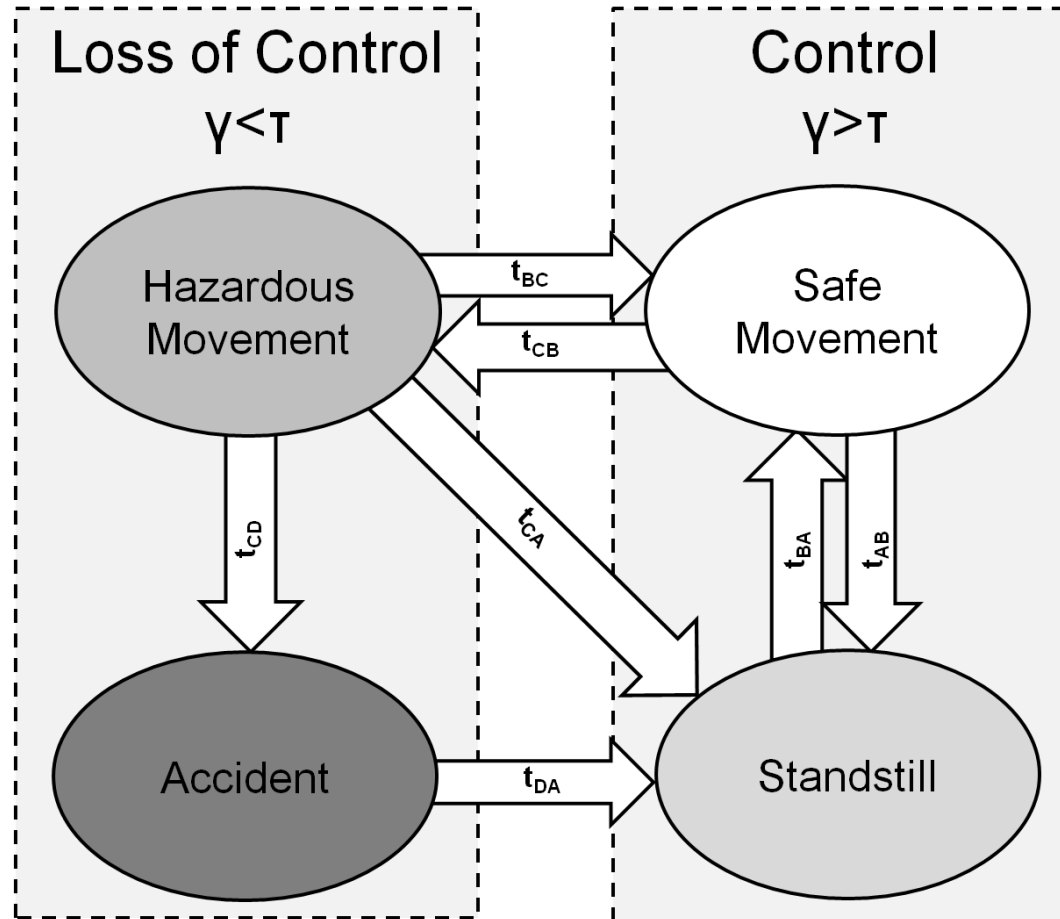


[Schnieder 2012]



# Defining Traffic Safety

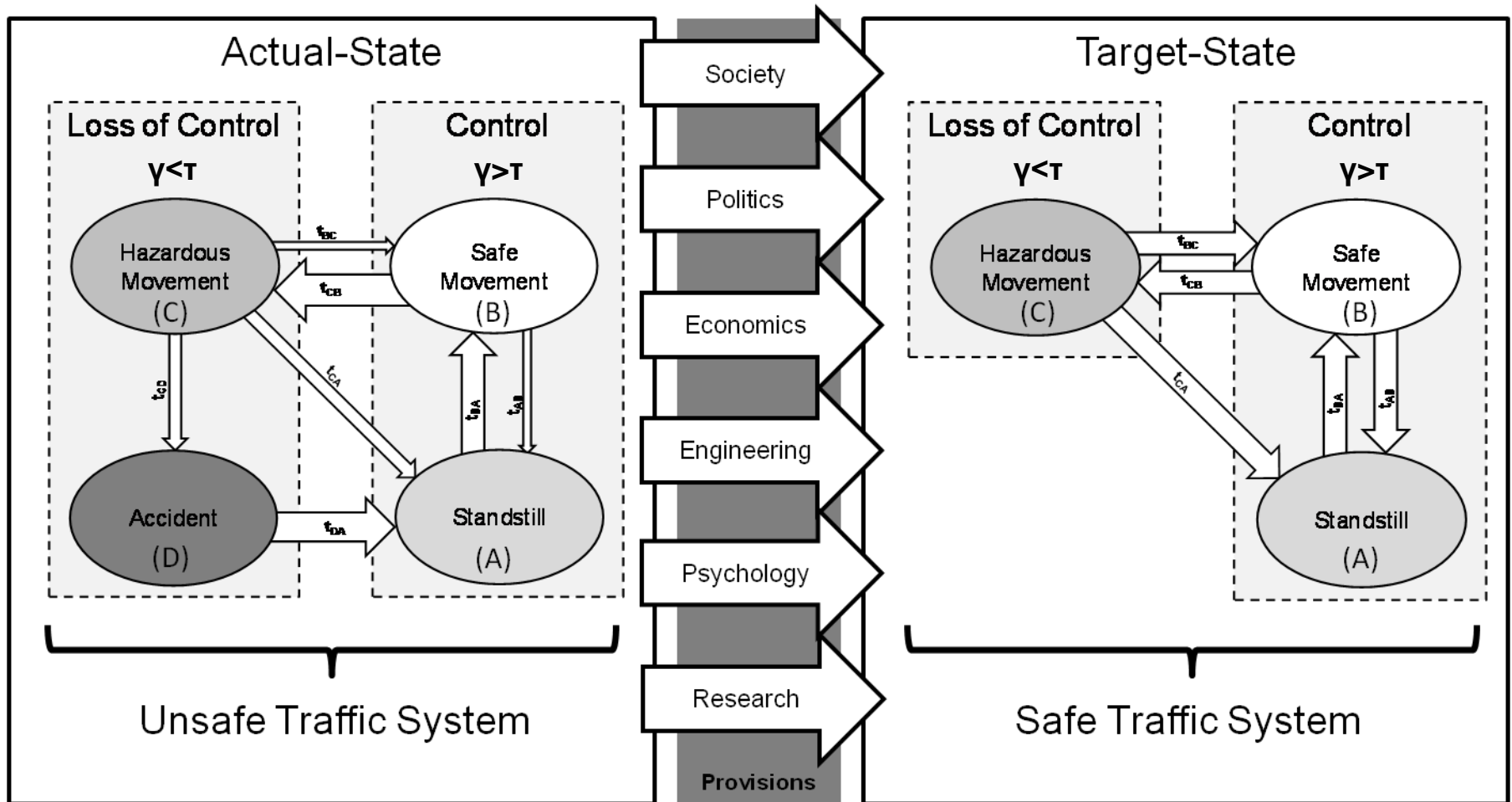
Interdisciplinary Definition of Traffic Safety – Engineering & Psychological Approach



[Schnieder 2012] & [Fuller/Santos 2002]

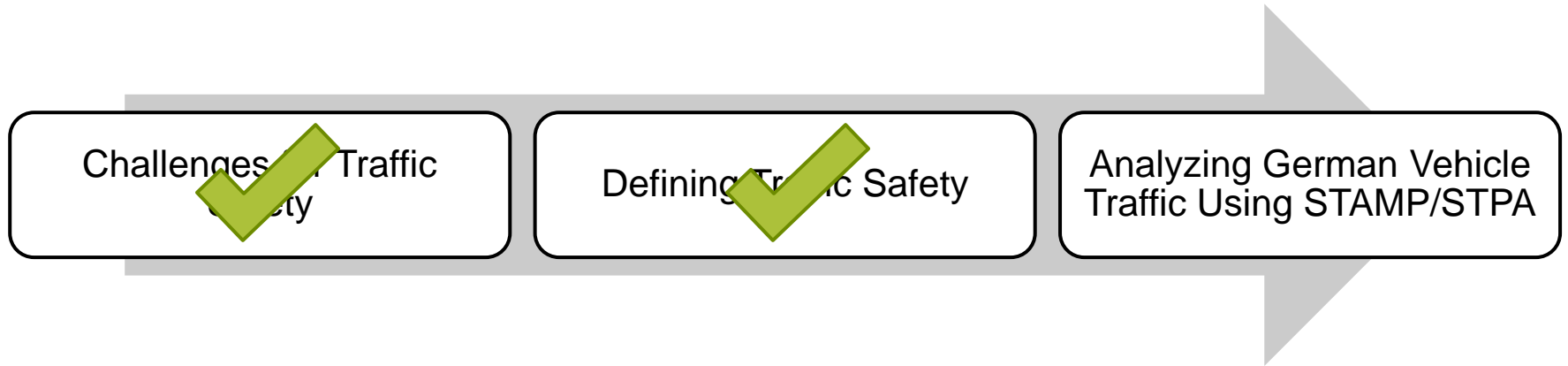
# Defining Traffic Safety

Required Adaptations of Traffic Systems for Safety-Compliance



[Hosse/Schnieder 2012], [Schnieder 2012] & [Leveson 2011]

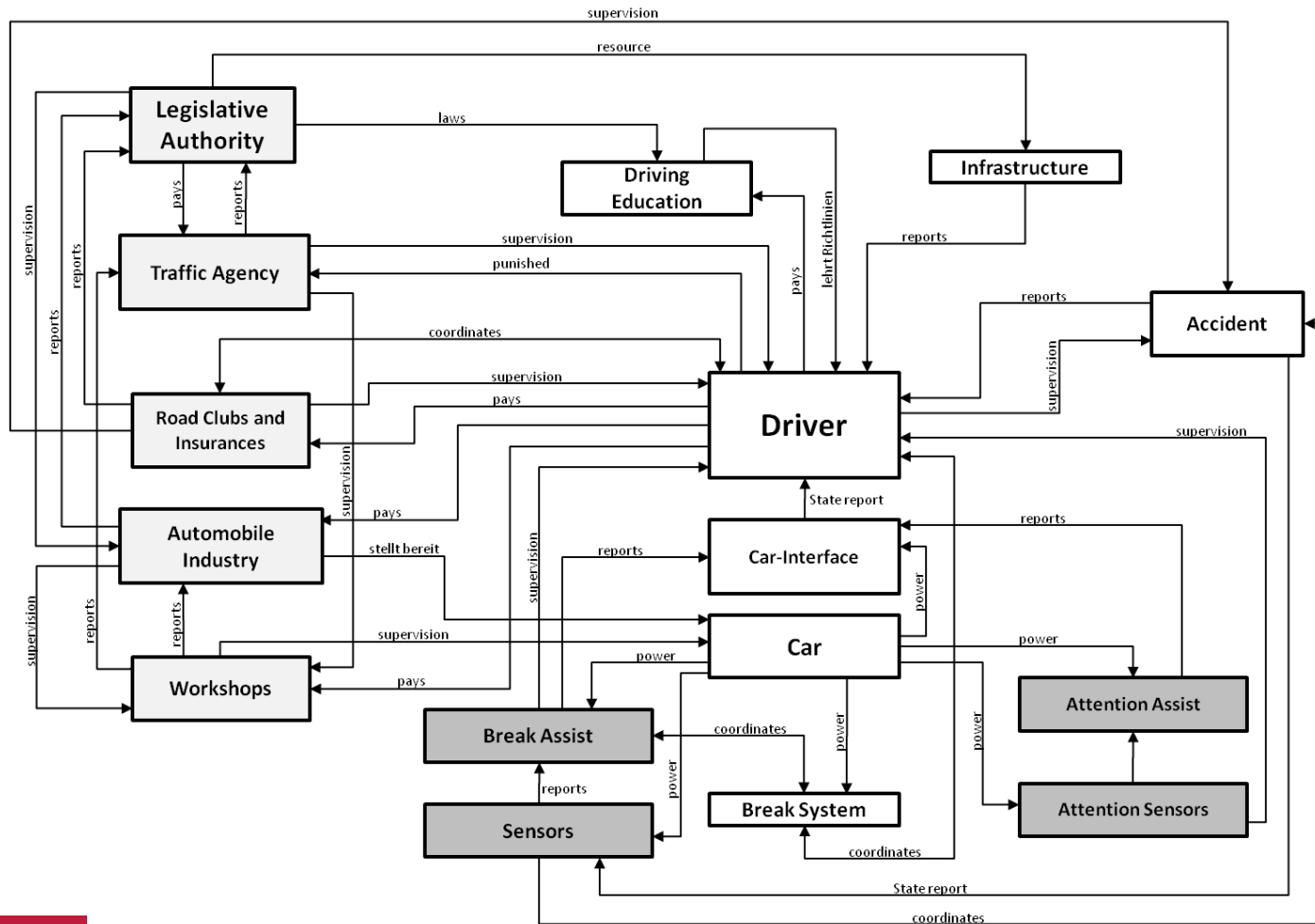
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# Analyzing German Vehicle Traffic

## 1st Analysis: Approaching Maneuver Supported by Driver Assistant Systems

### Control Structure:



[Hosse 2011a]

# Analyzing German Vehicle Traffic

## 2<sup>nd</sup> Analysis: “Complete” German Road Traffic System

Identifiable Control Components:

<b>System Designing Control Components</b>	
1.1	Legislative Authority
1.2	BMVBS
1.3	KBA
1.4	BAST
1.5	Federal States
1.6	Institutions for Engineering Standards
1.7	Engineering Standards
1.8	Insurances
1.9	Professional Insurances
1.10	Society
1.11	Traffic Clubs
1.12	Verification Clubs
1.13	Driving Schools
1.14	Traffic Control Institutions
1.15	Management
1.16	Production
1.17	Research and Development
1.18	Workshops

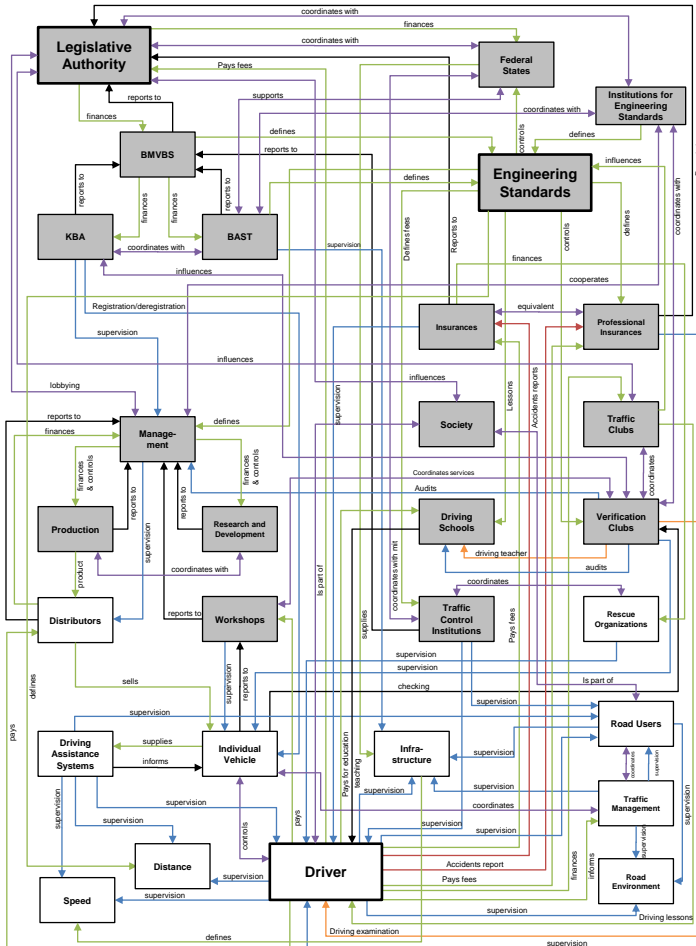
<b>System Operating Control Components</b>	
2.1	Driver
2.2	Vehicle
2.3	Distributors
2.4	Infrastructure
2.5	Road Users
2.6	Road Environment
2.7	Traffic Management
2.8	Rescue Organizations
2.9	Driver Assistant Systems
2.10	Speed
2.11	Distance

[Hosse 2011b]

# Analyzing German Vehicle Traffic

## 2<sup>nd</sup> Analysis: "Complete" German Road Traffic System

### Control Structure



### System Dynamics Model



[Hosse 2011b]







# Analyzing German Vehicle Traffic

## 2<sup>nd</sup> Analysis: “Complete” German Road Traffic System

### Required Safety Constraints - Excerpt

1. Continuous Medical Tests of Drivers to Ensure Capabilities
2. Adaptation of Driver Education to Individual Habits
3. Adapting Punishment to Individual Income
4. Designing Driver Assistant Systems in Compliance with Standards/Laws
- 5. Implementation of Award-Systems for Safe Driver**
- 6. Creating a Direct Feedback of Drivers' Level of Control**

[Hosse 2011b]

# Analyzing German Vehicle Traffic

## 2<sup>nd</sup> Analysis: “Complete” German Road Traffic System

### Implementation of Award-Systems for Drivers

#### *PAYD-Insurance (pay-as-you-drive)*

- Black-box in each car measuring and evaluating the driver’s behavior
- **Pros:**
  - Insurance fees adequate to individual driving behavior
  - Good results in Denmark and Germany (novice driver)
- **Cons:**
  - Many data transferred to insurance companies

[Bordoff/Noel 2008]

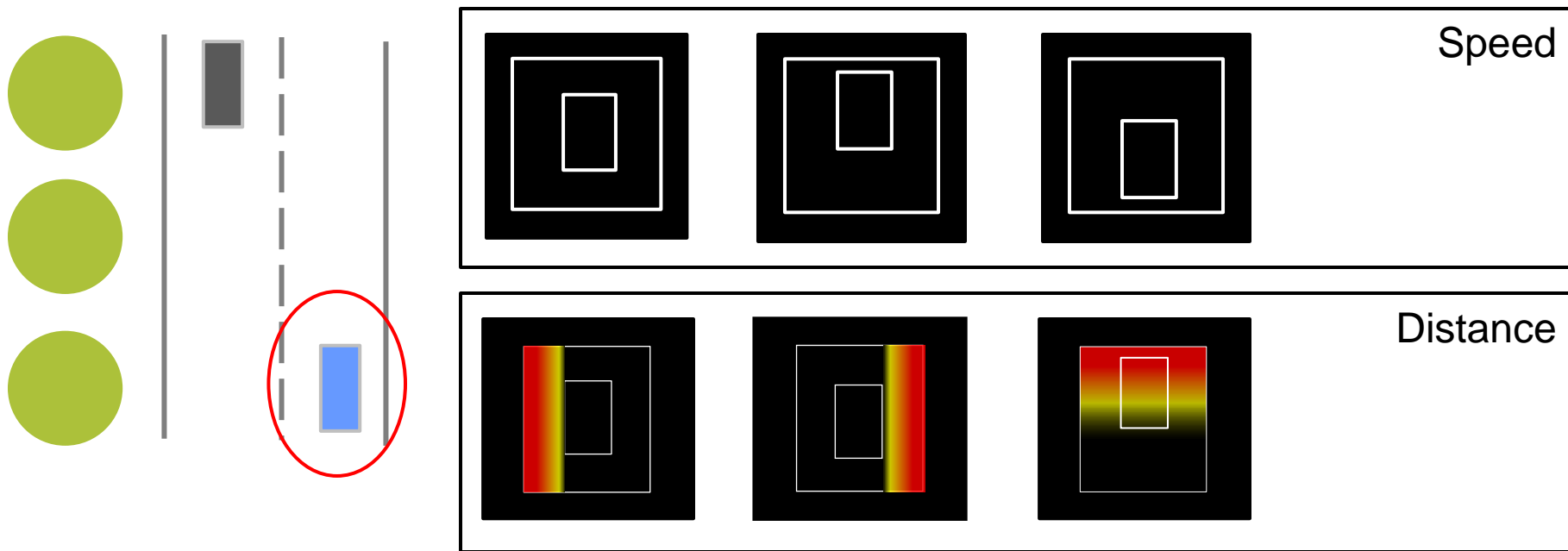
# Analyzing German Vehicle Traffic

## 2<sup>nd</sup> Analysis: "Complete" German Road Traffic System

Creating a direct Feedback of Driver's Level of Control

*VIDE-Display Concept (behavioral-theory based concept)*

- **Idea:** Create a Short Latency between Action (Behavior) and Reaction of Driver



[Hosse/Schwarze 2012]

# Analyzing German Vehicle Traffic

## 2<sup>nd</sup> Analysis: “Complete” German Road Traffic System

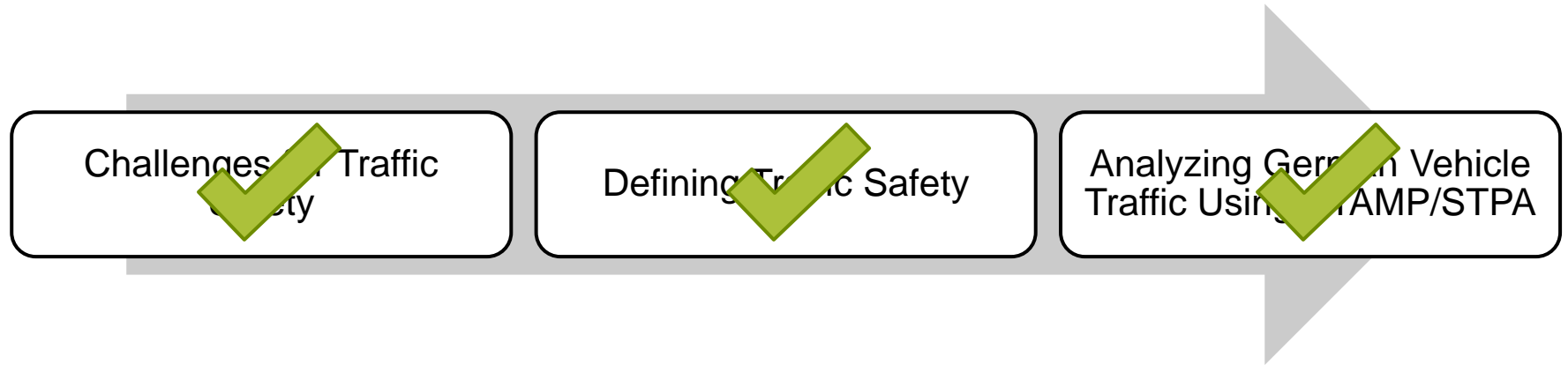
Creating a direct Feedback of Driver’s Level of Control

*VIDE-Display Concept (behavioral-theory based concept)*

### Empirical Findings

- Subjective Data:
  - 69 % of test persons feel safer with the information provided by VIDE
  - 62 % of test persons think VIDE is useful
  - 77 % of test persons feel themselves influenced by VIDE significantly
  - 58 % of test persons believe to drive safely with VIDE
  - **92 % of test persons believe that VIDE enables safe driving**
- Objective Data:
  - Driving behavior is more adequate to guidelines/laws

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# Conclusions

- STAMP/STPA can be used for traffic analysis
- Traffic safety can be defined as a state analysis of individuals drivers' behavior
- Primary problem of traffic safety: Lacking feedback of drivers' adequacy to driving behavior
- STAMP/STPA can help identify adequate safety constraints for increasing traffic safety
- PAYD and VIDE show significant impact on increasing traffic safety

## Future Research:

Adaptation of STAMP/STPA to hybrid (discrete and continuous) formal models

# Contacts



Dipl. Wirtsch.-Ing. René S. Hosse  
Technische Universität  
Braunschweig  
Institute for Traffic Safety and  
Automation Engineering  
**hosse@iva.ing.tu-bs.de**

# References (1/3)

[Brühning/Seeck 2006] Brühning, Ekkehard; Seeck, Andre: Bewertung – Der Sicherheitsgewinn bisher entwickelter Fahrerassistenzsysteme und ein Blick in die Zukunft. Fahrerassistenzsysteme: Im Dienste der Sicherheit, Bonn, 2006

[destatis 2012] Deutsches Statistisches Bundesamt: Entwicklung der Zahl Getöteter im Straßenverkehr. <[https://www-genesis.destatis.de/genesis/online;jsessionid=B587D31DD556D523ECEAF7E448FB5088.tomcat\\_GO\\_2\\_2?operation=abruftabelleBearbeiten&levelindex=2&levelid=1291386160296&auswahloperation=abruftabelleAuspraegungAuswaehlen&auswahlverzeichnis=ordnungsstruktur&auswahlziel=werteabruf&selectionname=46241-0001&auswahltext=&nummer=4&variable=2&name=VERSK1&werteabruf=Werteabruf](https://www-genesis.destatis.de/genesis/online;jsessionid=B587D31DD556D523ECEAF7E448FB5088.tomcat_GO_2_2?operation=abruftabelleBearbeiten&levelindex=2&levelid=1291386160296&auswahloperation=abruftabelleAuspraegungAuswaehlen&auswahlverzeichnis=ordnungsstruktur&auswahlziel=werteabruf&selectionname=46241-0001&auswahltext=&nummer=4&variable=2&name=VERSK1&werteabruf=Werteabruf)>, Rev. 2012

[Fuller/Santos 2002] Fuller, Ray; Santos, Jorge: Human Factors for Highway Engineers. Pergamon, Amsterdam, 2002

[Hosse 2011a] Hosse, René Sebastian: Einsatz des Beschreibungsmittels System Dynamics zur Gefährdungsanalyse von Fahrerassistenzsystemen. Studienarbeit, Braunschweig, 2011



## References (2/3)

[Hosse 2011b] Hosse, René Sebastian: Modellierung von Regelkreisen der Verkehrssicherheit mit einem systemtheoretischen Ansatz. Diplomarbeit, Braunschweig, 2011

[Hosse/Schnieder 2012] Hosse, René Sebastian; Schnieder, Eckehard: Analyzing Meshed Control Loops between Socio and Technical Control Components within Road Traffic Systems. SDPS 2012, Berlin, 2012

[Hosse/Schwarze 2012] Hosse, René Sebastian; Schwarze, Anke: Kybernetische Analyse vermaschter Regelkreise im Straßenverkehr unter Berücksichtigung einer verhaltenswissenschaftlich basierten Mensch-Maschine-Schnittstelle. AAET 2012, ITS Niedersachsen e.V., Braunschweig, 2012

[Leveson 2011] Leveson, Nancy: Engineering a Safer World. MIT Press, Cambridge, 2011

[Schnieder 2012] Schnieder, Eckehard: Verkehrssicherheit – Maße, Modelle und Methoden. Springer, Berlin, 2012

# References (3/3)

[Slovák 2006] Slovák, Roman: Methodische Modellierung und Analyse von Sicherungssystemen des Eisenbahnverkehrs. Dissertation, Braunschweig, 2006.

[Schüffele 2010] Schüffele, Jörg: Automotive Software Engineering. Grundlagen, Prozesse, Methoden und Werkzeuge effizient einsetzen, 4., überarbeitete und erweiterte Auflage., Vieweg + Teubner, Wiesbaden, 2010.