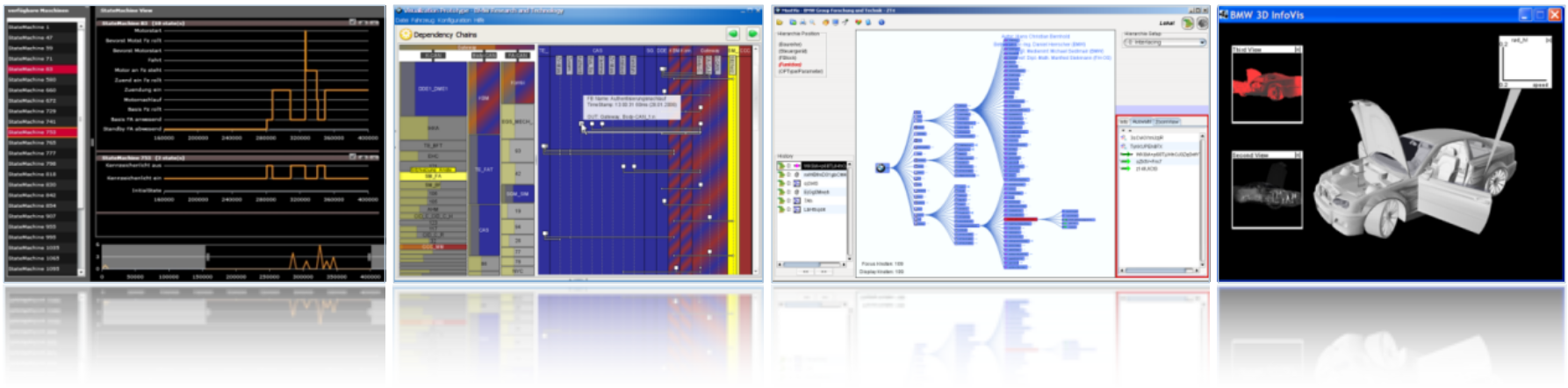
Michael Sedlmair
msedl@cs.ubc.ca

21-10-2010

Dissertation.

Visual Analysis of In-Car Communication Networks.



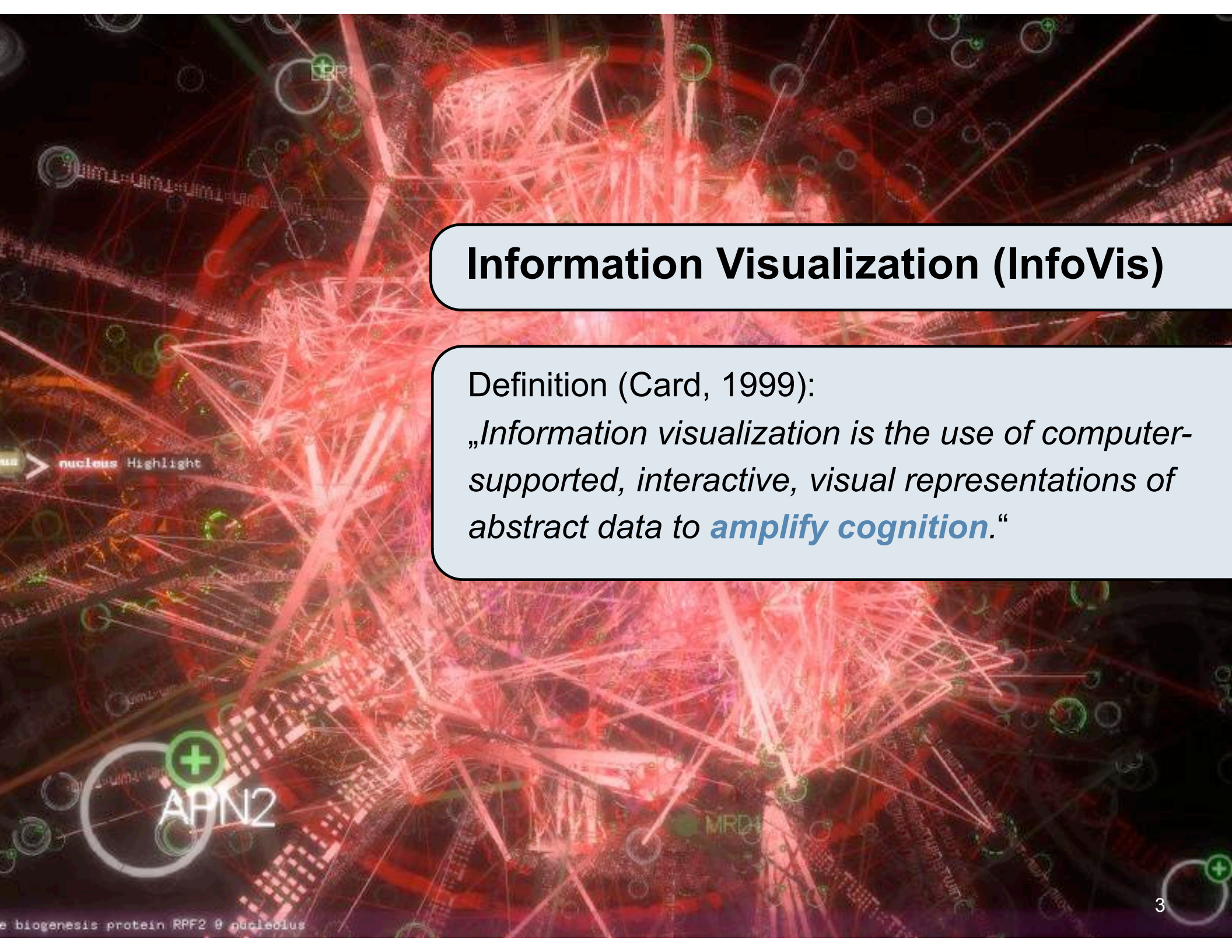
Michael Sedlmair.

BMW Group.
Research and Technology.

University of Munich.
Media Informatics Group.

Challenge: Data Flood

Insights into this Data?

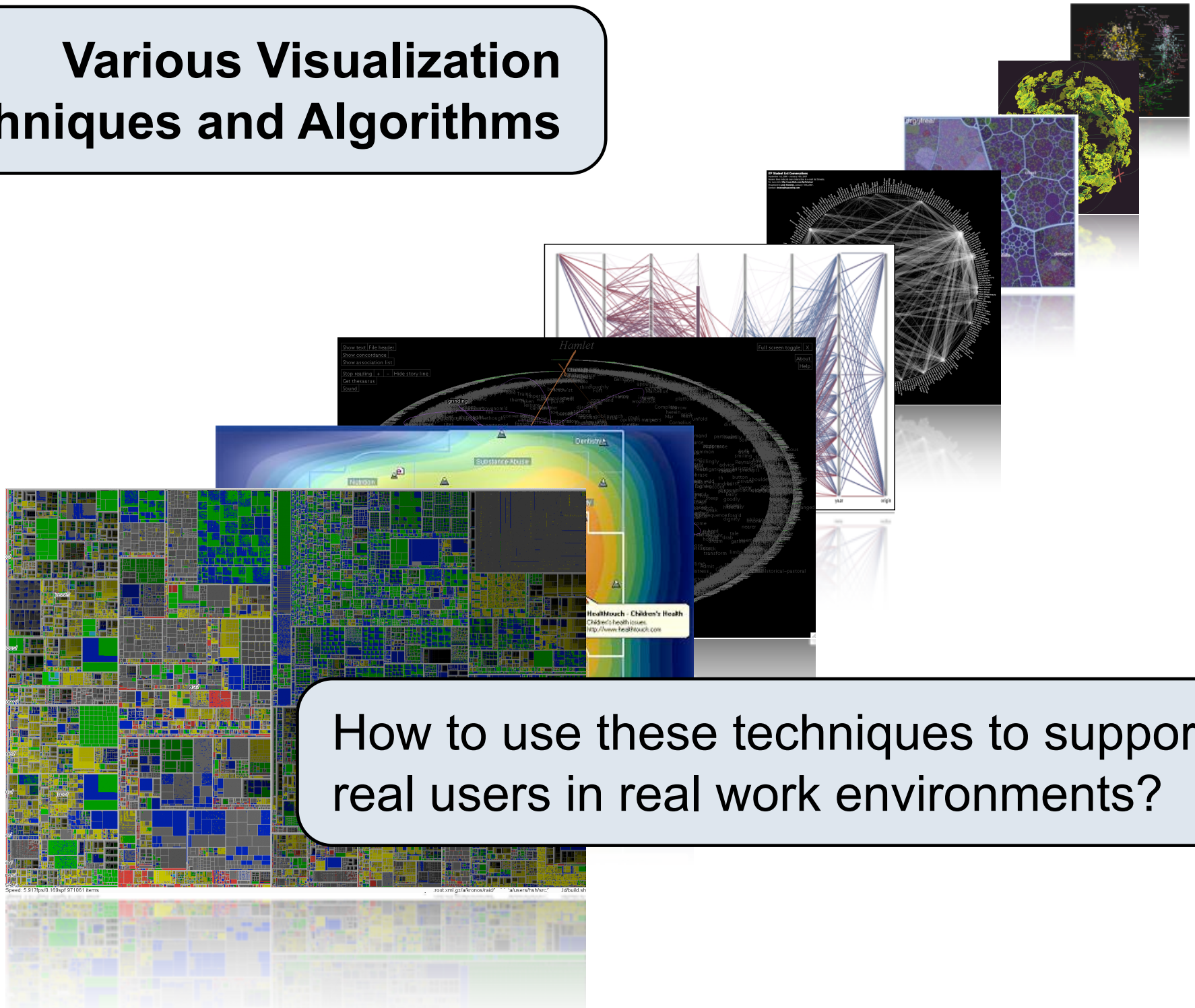


Information Visualization (InfoVis)

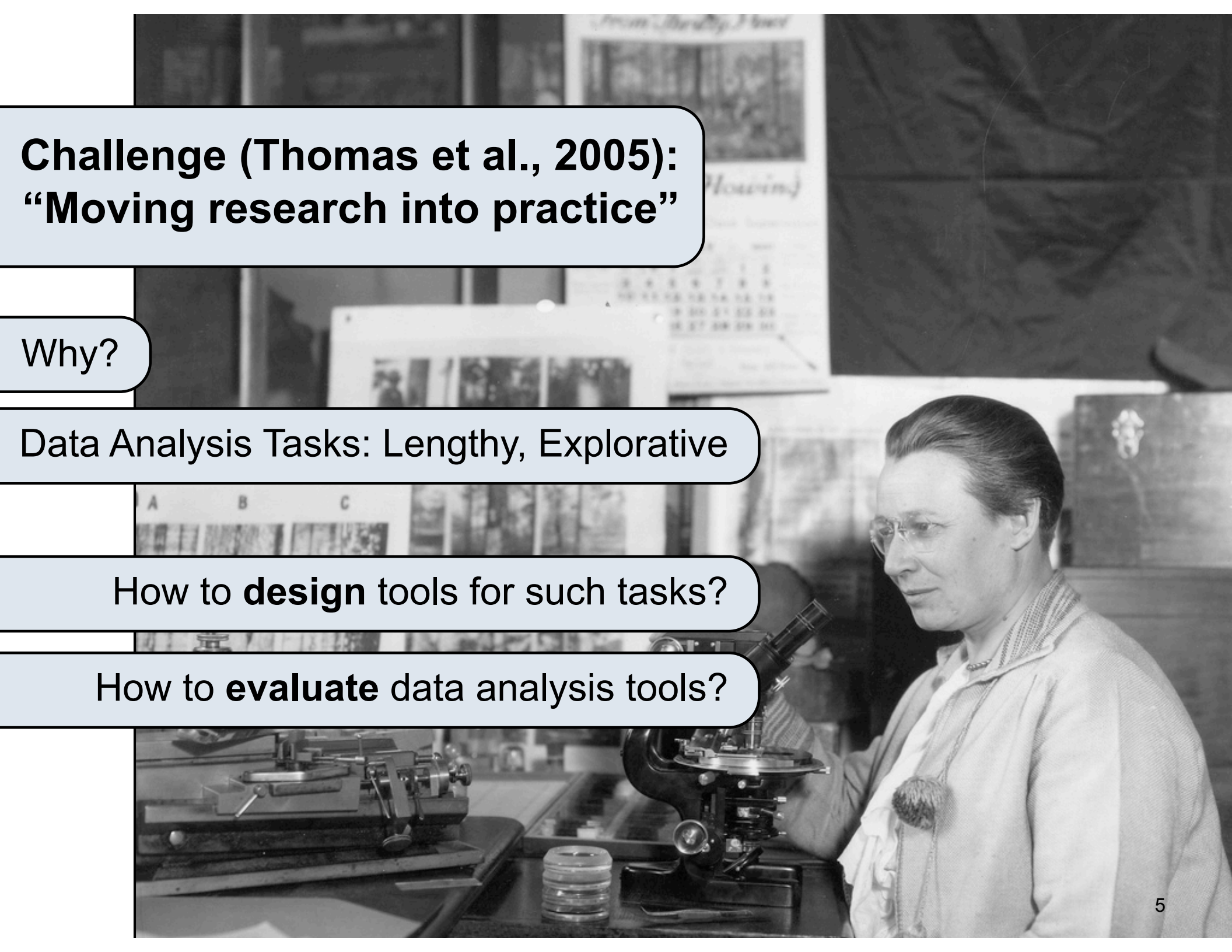
Definition (Card, 1999):

„*Information visualization is the use of computer-supported, interactive, visual representations of abstract data to* ***amplify cognition****.*“

Various Visualization Techniques and Algorithms



How to use these techniques to support real users in real work environments?



Challenge (Thomas et al., 2005): "Moving research into practice"

Why?

Data Analysis Tasks: Lengthy, Explorative

How to **design** tools for such tasks?

How to **evaluate** data analysis tools?

Challenge (Thomas et al., 2005): “Moving research into practice”

Call echoed by various researchers:

Plaisant: The Challenge of Information Visualization Evaluation. AVI. 2004.

Shneiderman, Plaisant: Strategies for Evaluating Information Visualization Tools: Multi-dimensional In-depth Long-term Case Studies. BELIV. 2006.

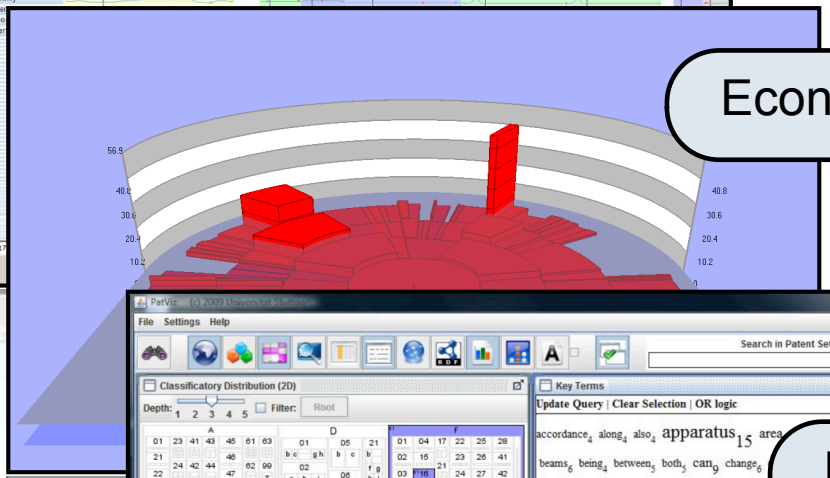
Johnson et al.: NIH/NSF Visualization Research Challenges Report. IEEE Press. 2006.

Carpendale: Evaluating Information Visualizations. In: Information Visualization: Human-Centered Issues and Perspectives

Munzner: A Nested Model for Visualization Design and Validation. InfoVis. 2009.

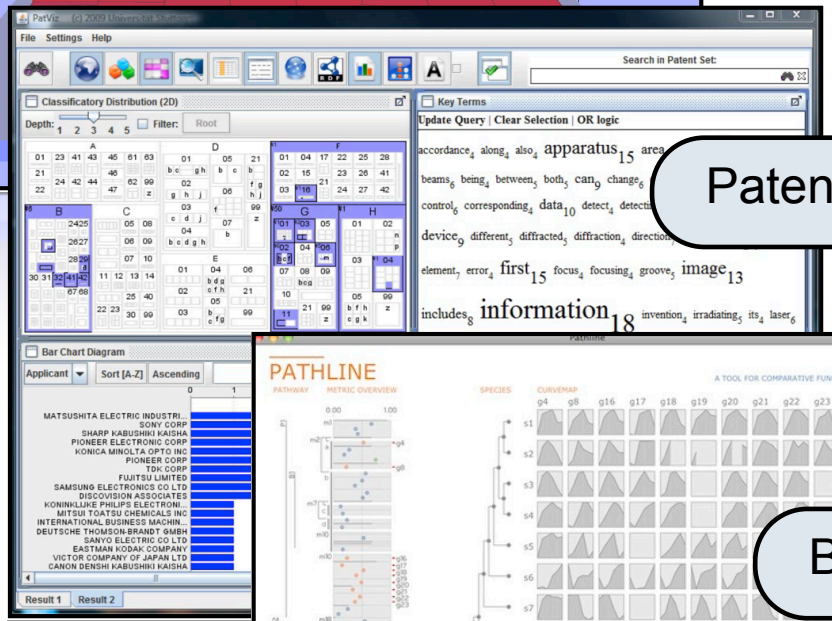
System Management Professionals.

McLachlan et al.: LiveRAC - Interactive Visual Exploration of System Management Time-Series Data. CHI. 2008.



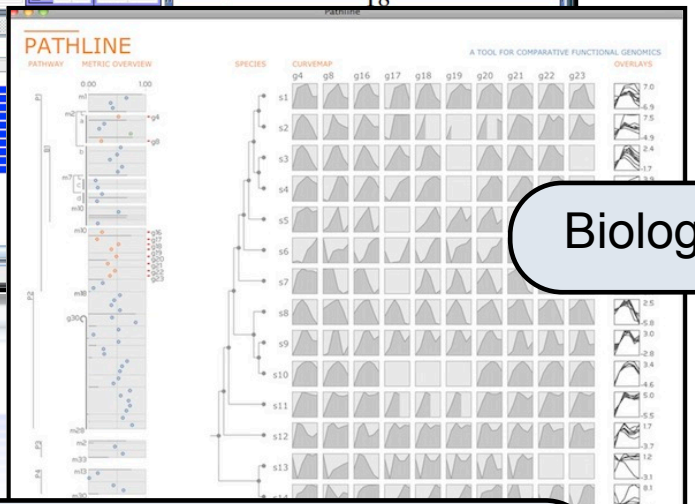
Economic Analysts.

Tekusova, Schreck: Visualizing Time-Dependent Data in Multivariate Hierarchic Plots - Design and Evaluation of an Economic Application. IV. 2008.



Patent Agents.

Koch et al.: Iterative Integration of Visual Insights during Patent Search and Analysis. VAST. 2009.



Biologists.

Meyer et al.: Pathline: A Tool for Comparative Functional Genomics. EuroVis. 2010.

End-User Collaboration in InfoVis Projects

Moving Research into Practice ...

Automotive Engineering

Within Large Company Setting

Long-term, In-depth Collaboration

Main Contributions.

I) 3.5-year, In-depth Field Analysis.

II) 9 Design Studies / 5 Adopted Systems.

III) Challenges and Recommendations for Studying InfoVis Tools in a Large Company Setting.

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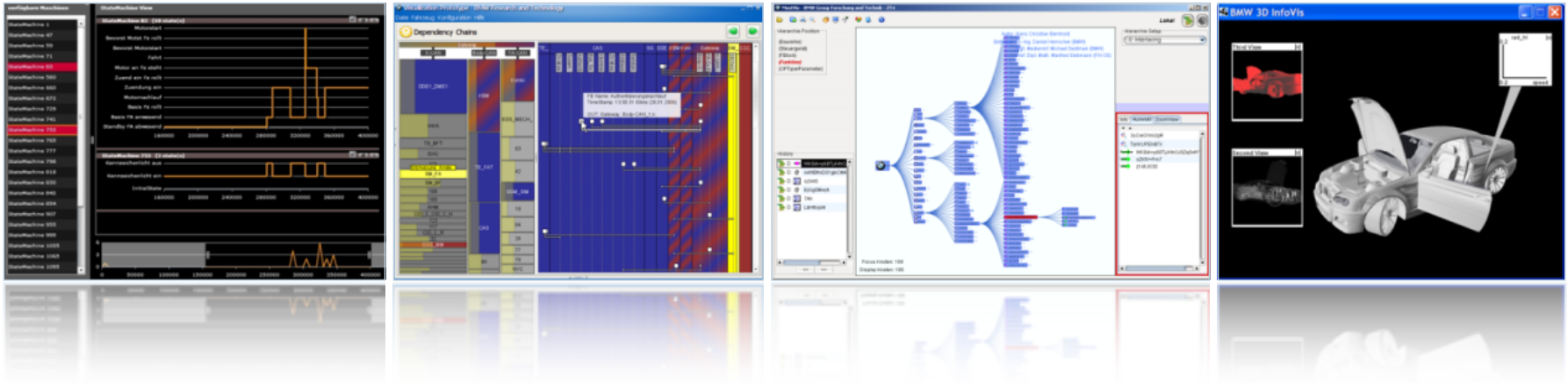
21-10-2010

VA of In-Car Communication Networks.
Outline.



- *Motivation*: Domain Problem
- *Overview*: Application Areas
- *Example 1*: AutobahnVis (detailed)
- *Example 2*: MostVis (brief)
- *Lessons Learned*: InfoVis in a Large Company
- *Conclusions*: Summary and Future Work

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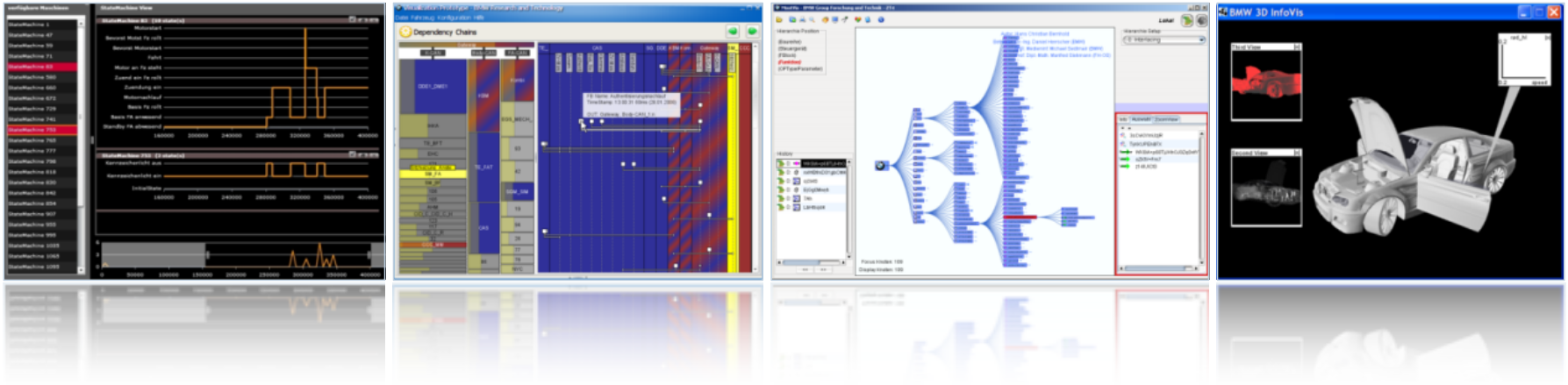

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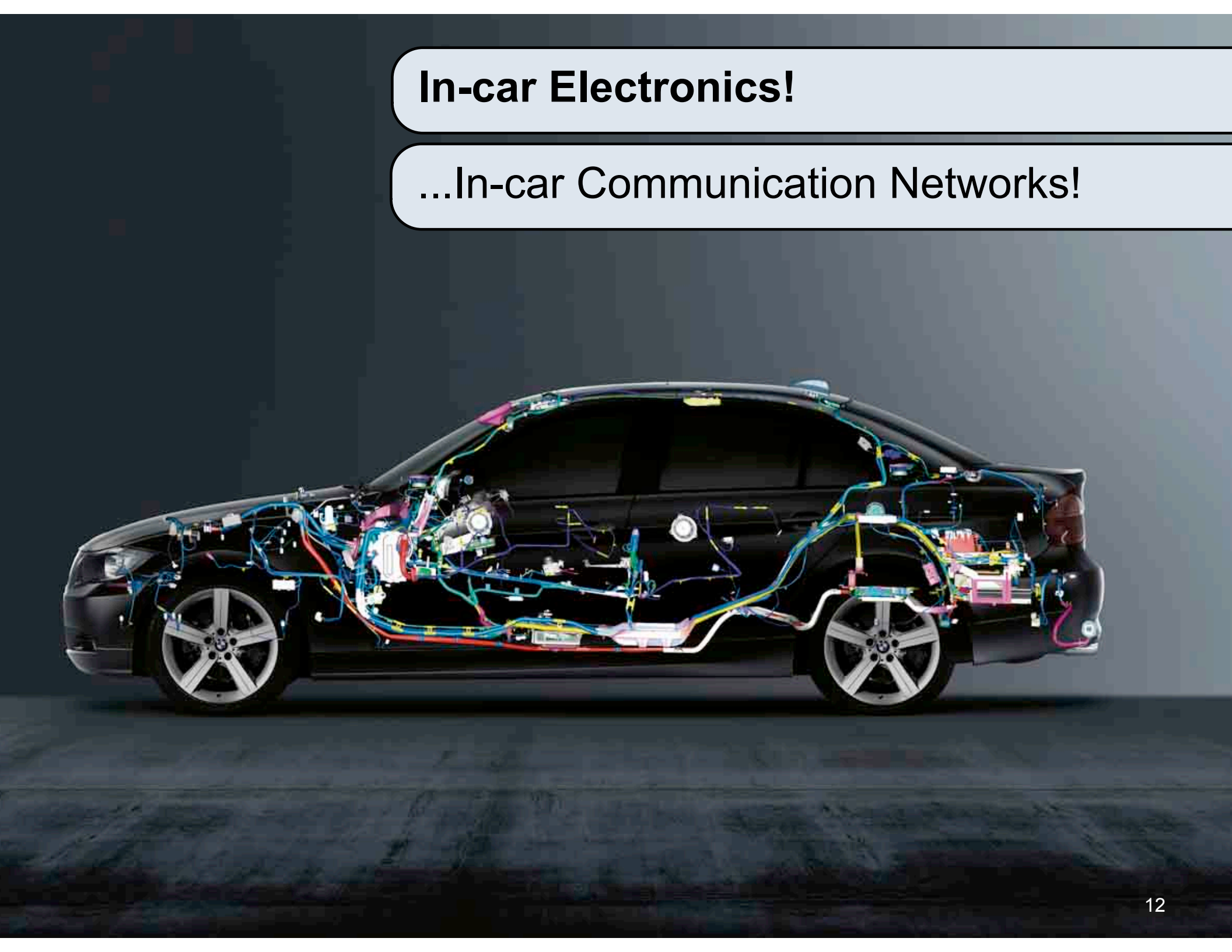
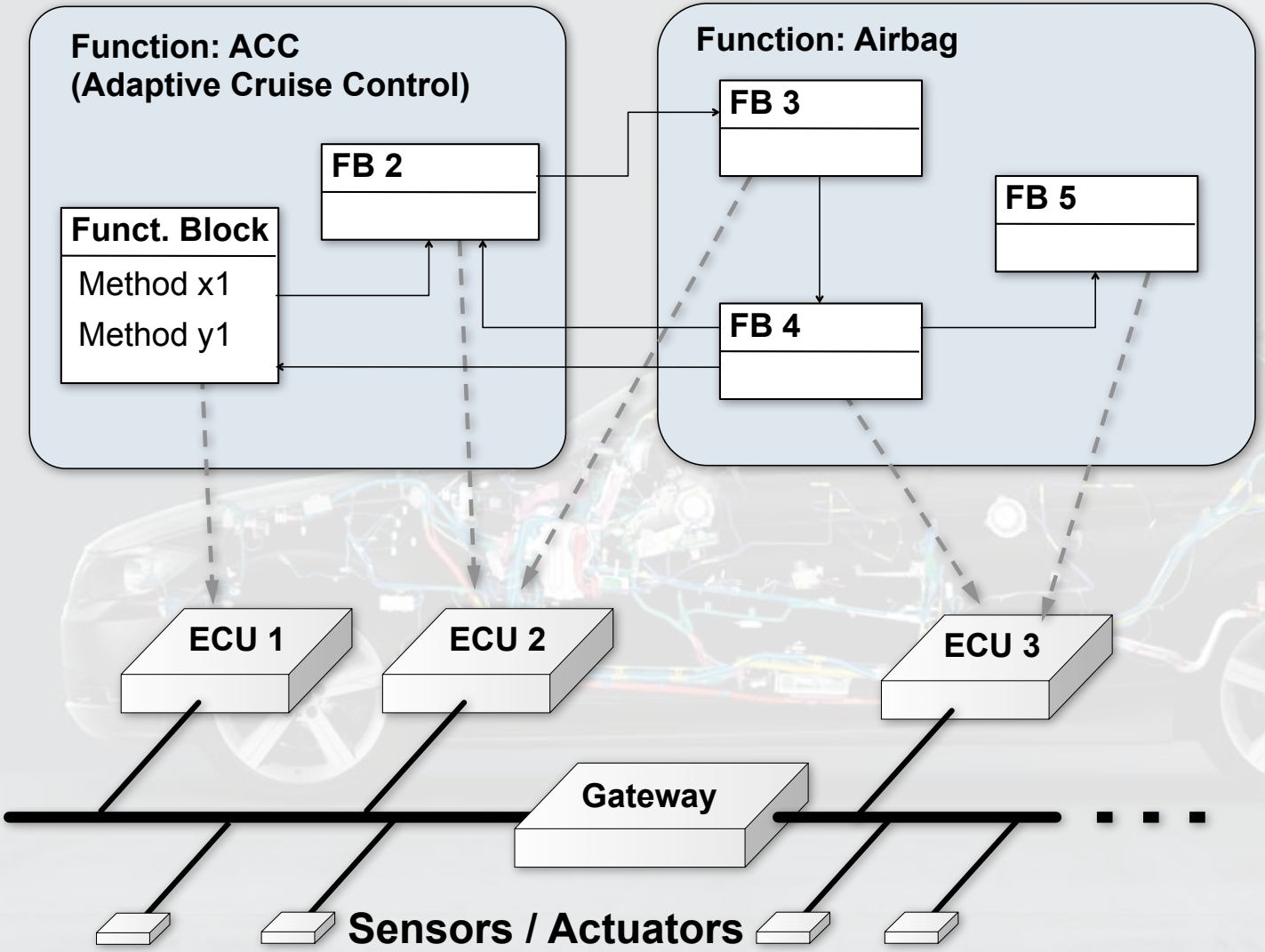
In-car Electronics!

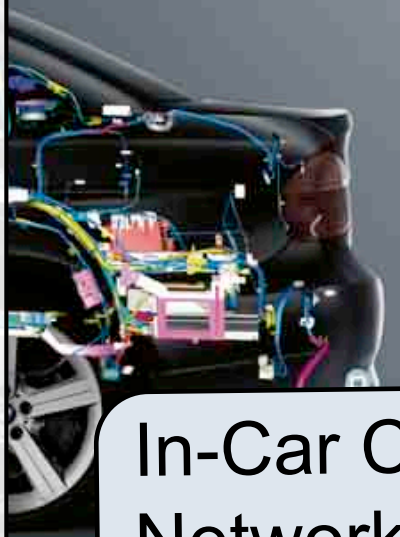
...In-car Communication Networks!



What are In-car Communication Networks?



Functional Network



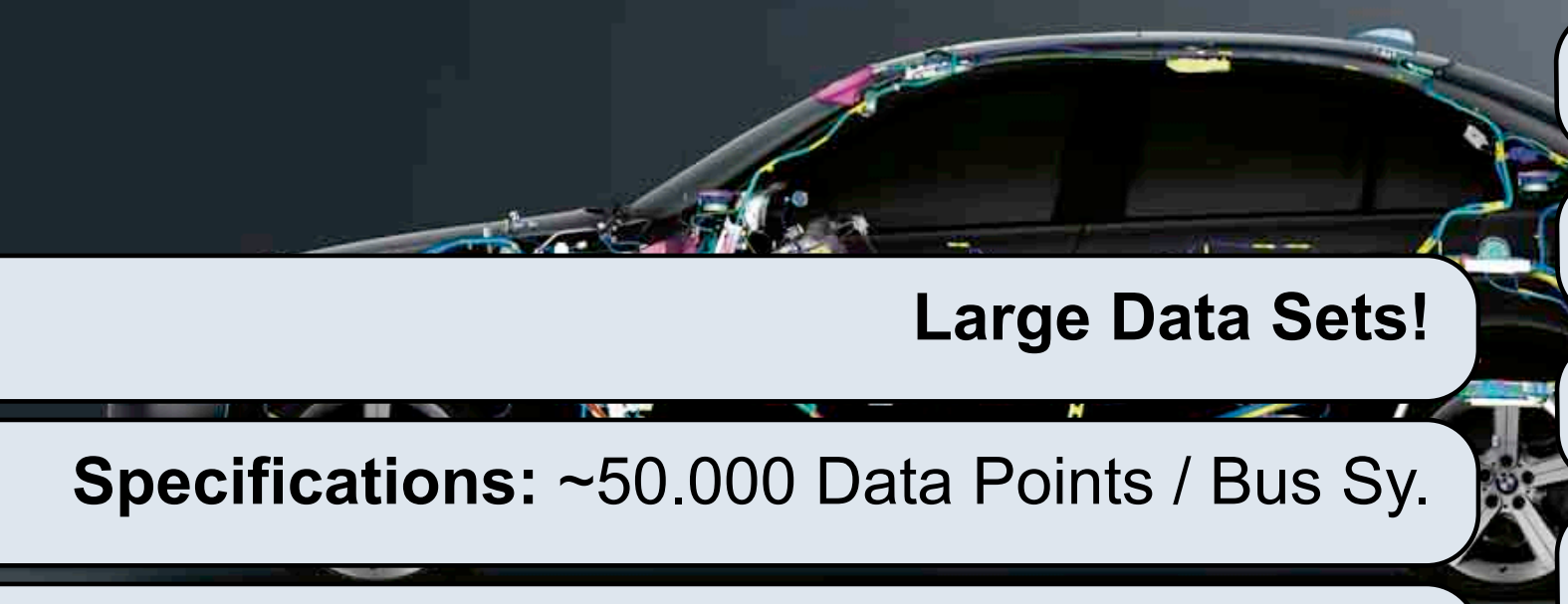
In-Car Com. Network

Exchanging Signals packed in Messages

What is the problem?

More and More Functions...

... Increasing Complexity!



~400 Funct.

~70-80 ECUs

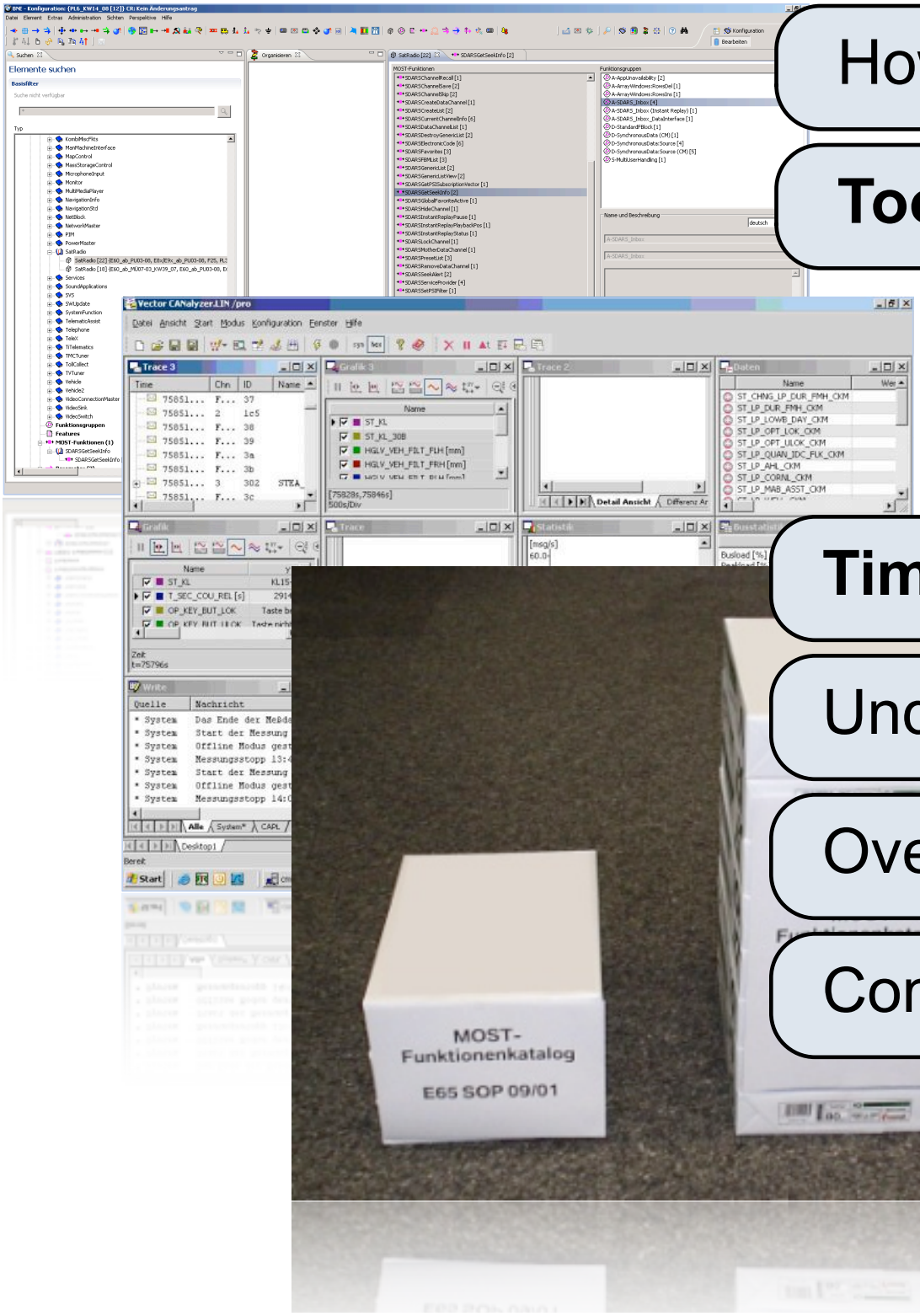
~10 Busses

~15.000 Messages/ s

Large Data Sets!

Specifications: ~50.000 Data Points / Bus Sy.

Traces: ~50 million Messages / Recorded Hour



However...

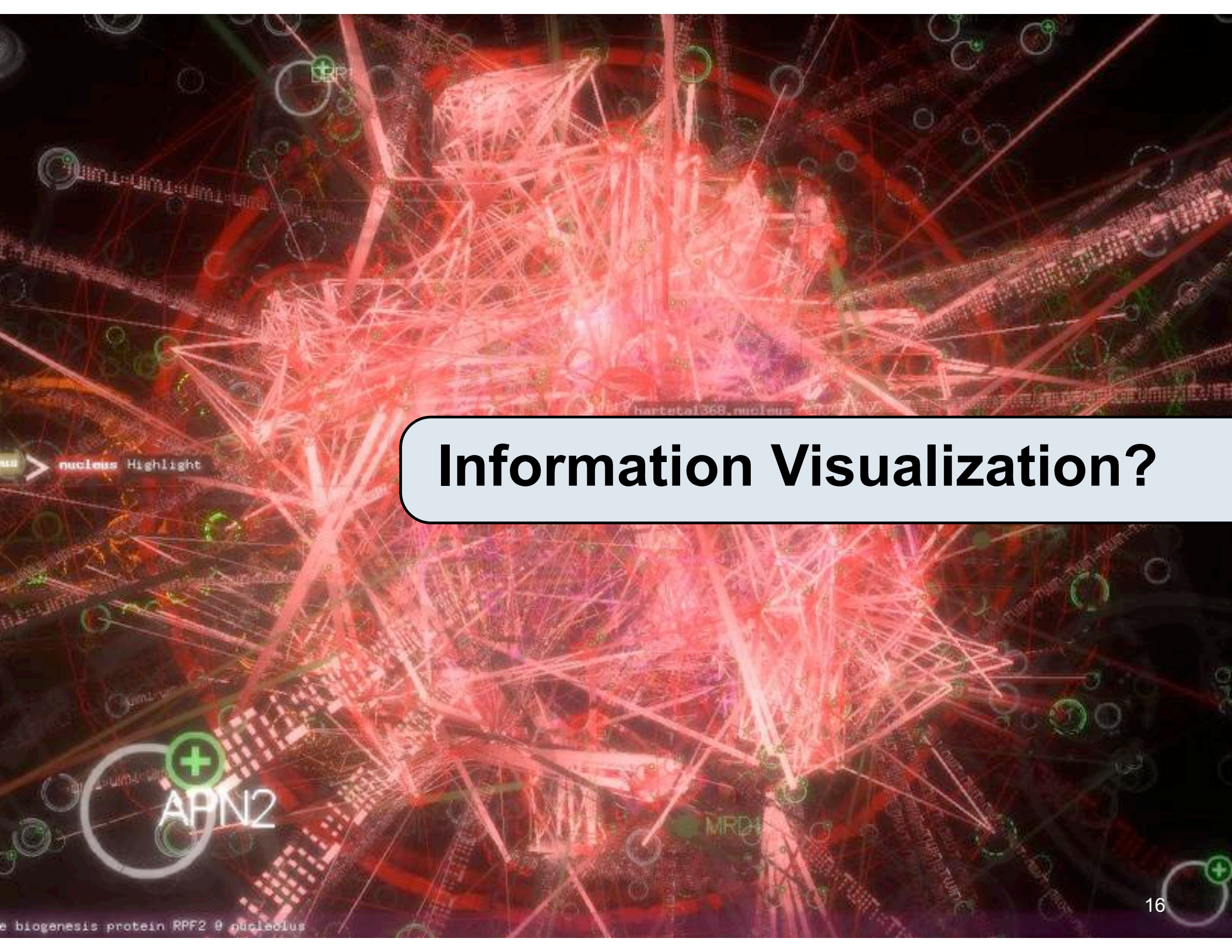
Tools are still text-based!

Time and experience required!

Understand Correlations?

Overview?

Communicate Findings?



Information Visualization?

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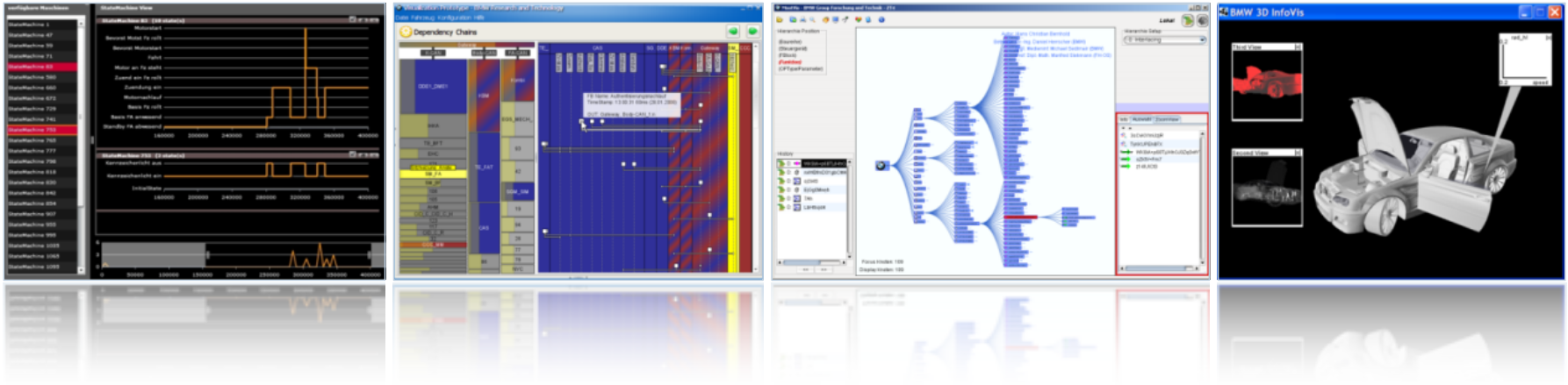

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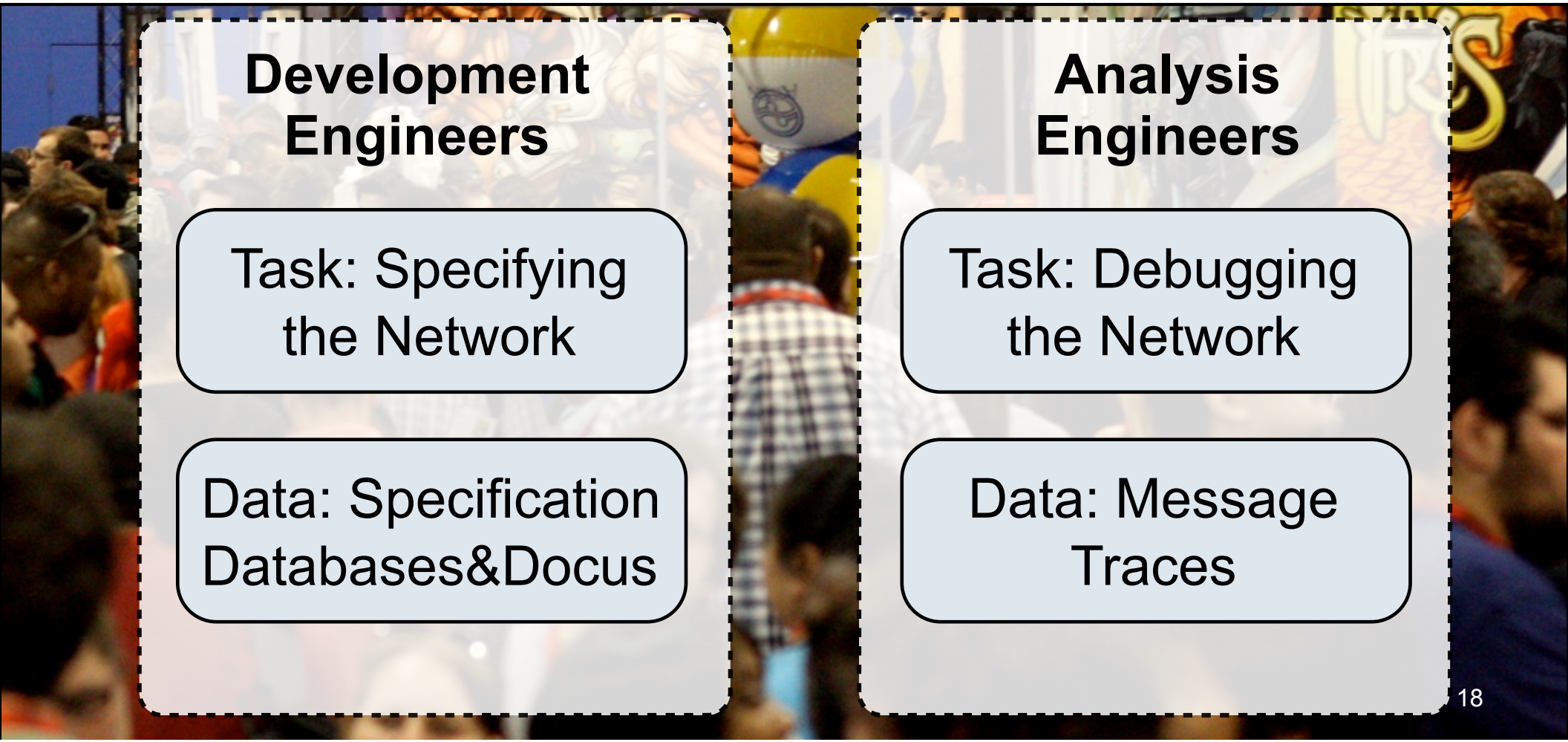
Who are the target **Users**?

What is their **Task**?

What is their **Data**?



Development Engineers

Task: Specifying the Network

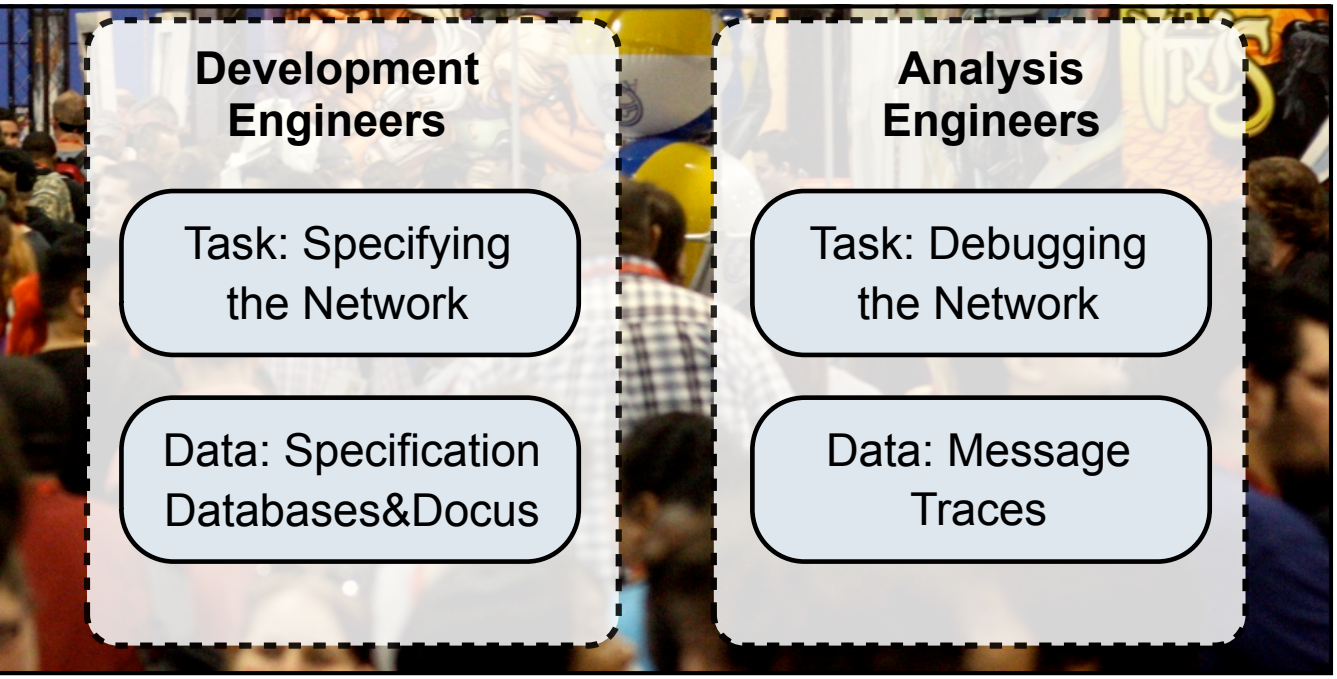
Data: Specification Databases&Docus

Analysis Engineers

Task: Debugging the Network

Data: Message Traces

Application Areas



Development Engineers

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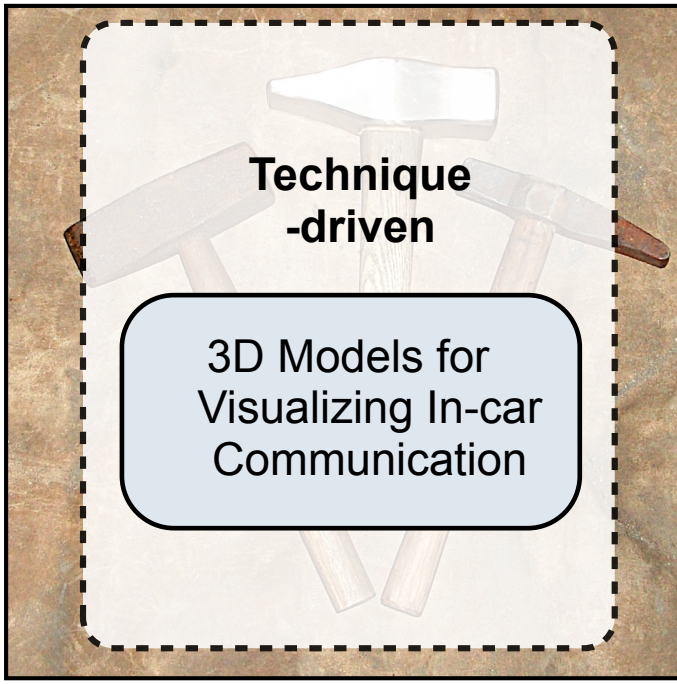
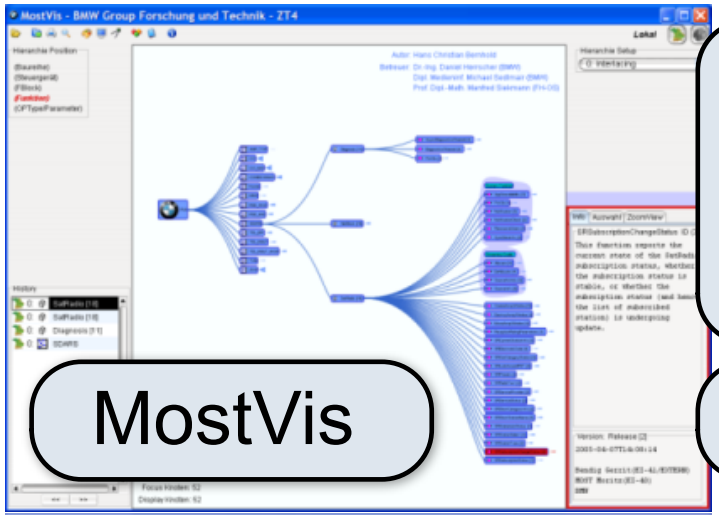


Technique -driven

3D Models for Visualizing In-car Communication

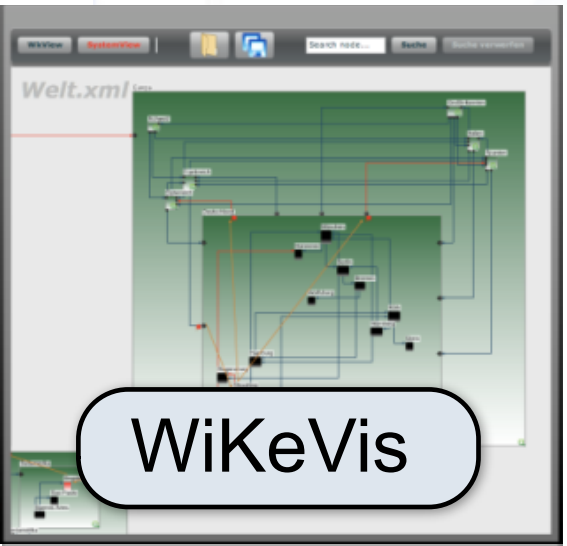
Visualization for Development Engineers



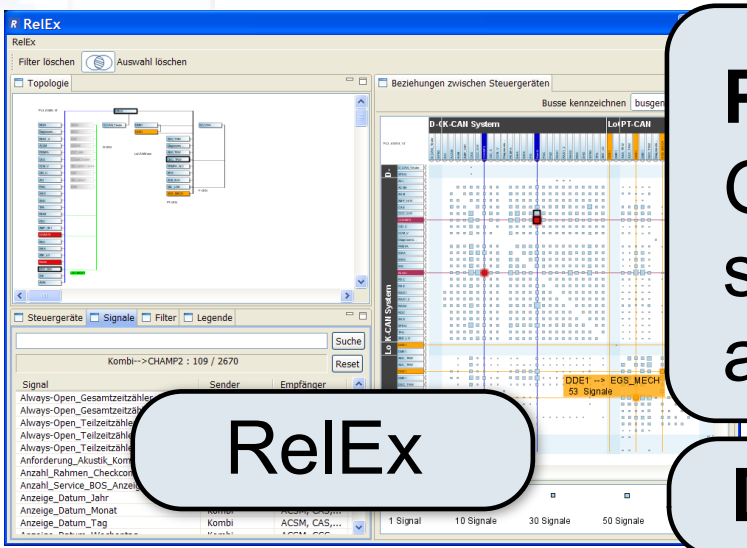
MostVis

Problem / Goal:
Speeding up browsing and searching in large specification catalogs!

Data: Hierarchical



WiKeVis

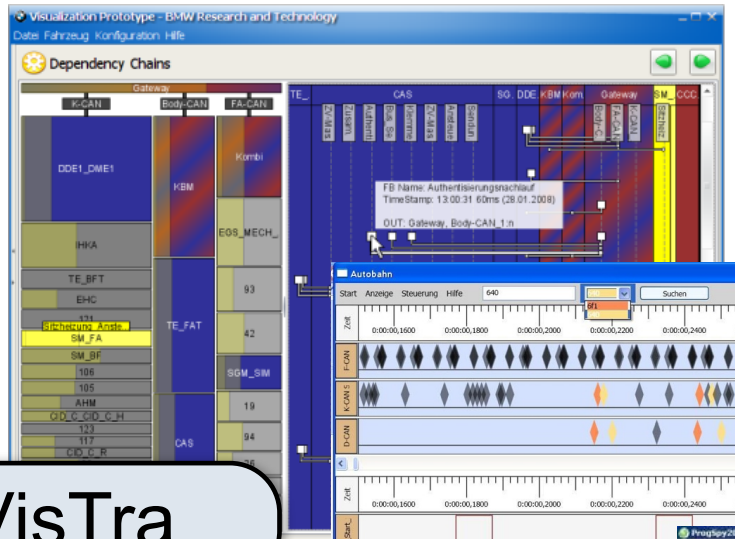


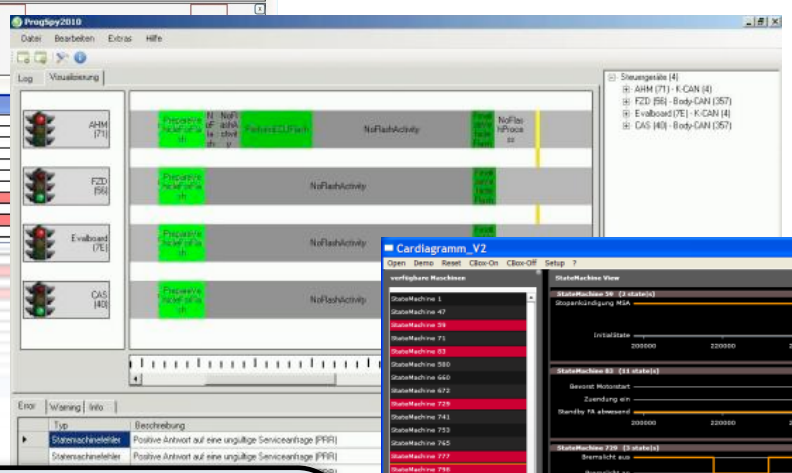
RelEx

Problem / Goal:
Getting Insights into specified dependencies and correlations!

Data: Graph

Visualization for Analysis Engineers





Problem / Goal:
Finding errors in traces!

Data: Time-based

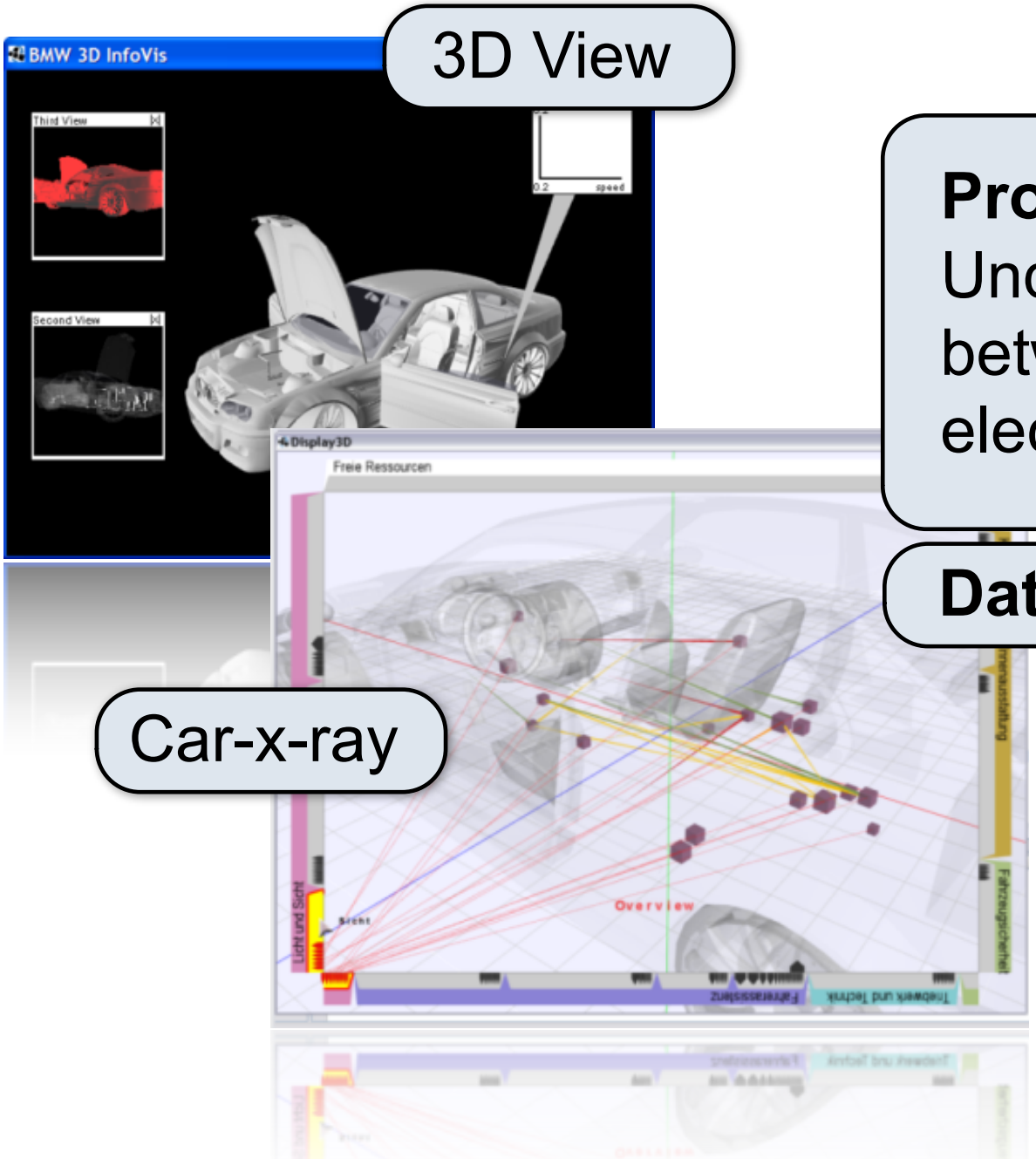
VisTra

AutobahnVis

ProgSpy

Cardiogram

3D Models for Visualization



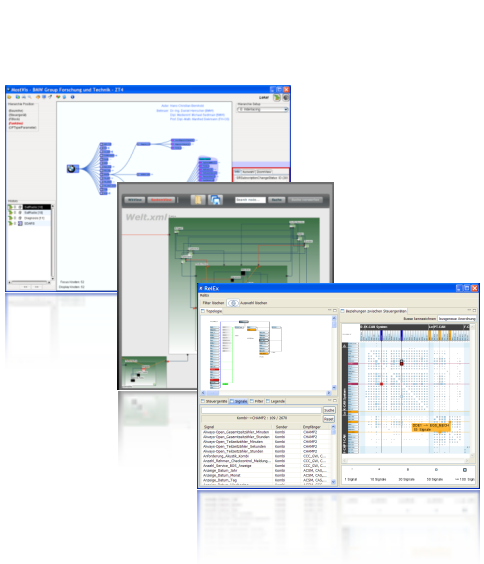
3D View

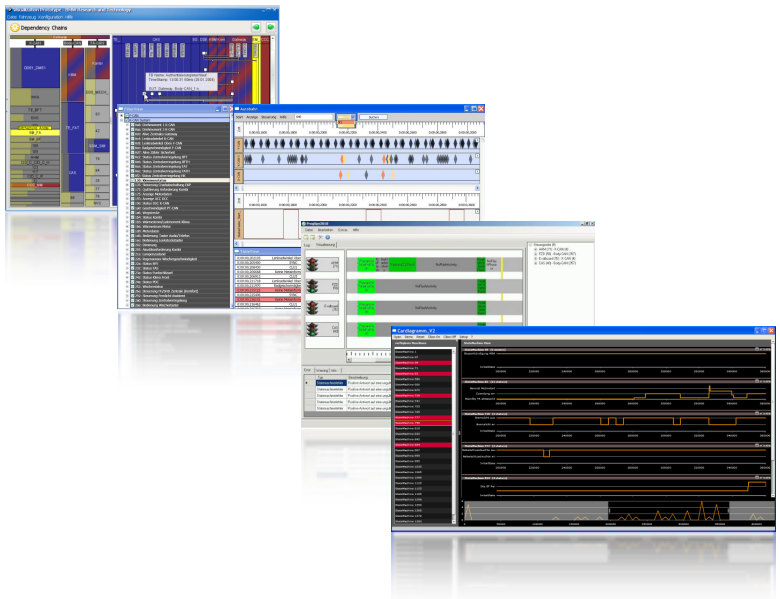
Car-x-ray

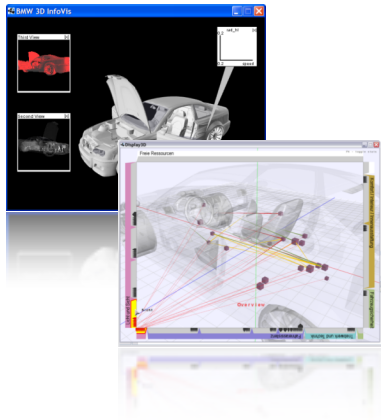
Problem/ Goal:
Understanding correlations between mechanical and electronic components!

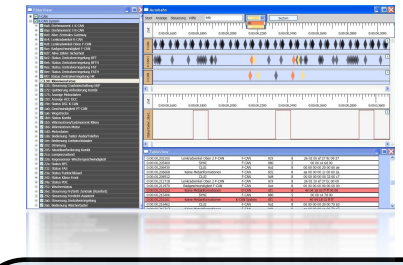
Data: Physical Location.

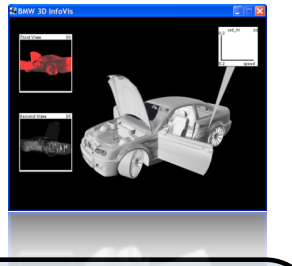
Examples today.

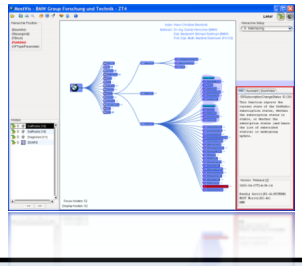












AutobahnVis + 3D View

- Analysis Engineers
- Detecting Errors in Traces

MostVis

- Development Engineers
- Browsing Specifications

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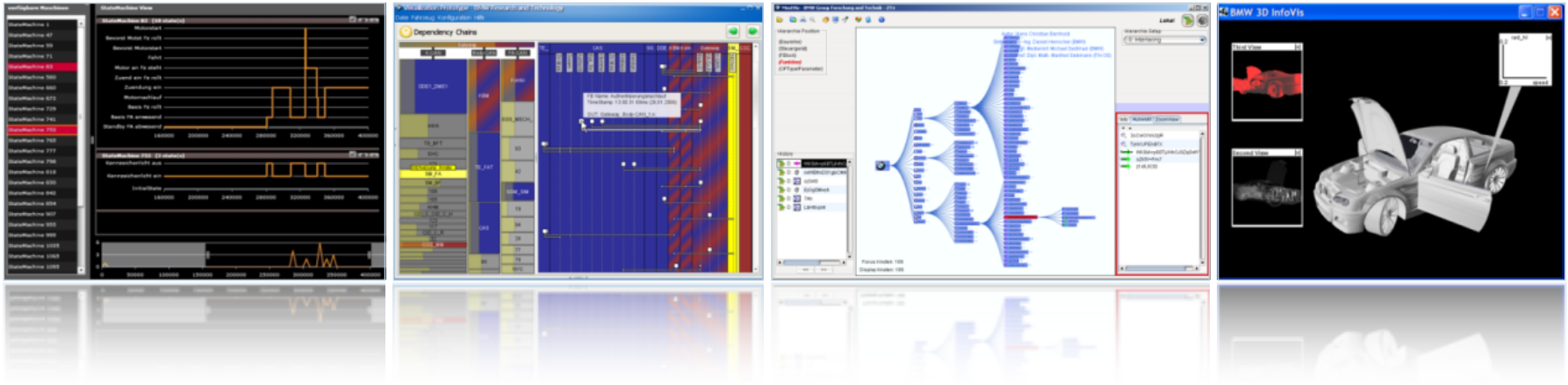
21-10-2010

VA of In-Car Communication Networks.
Outline.



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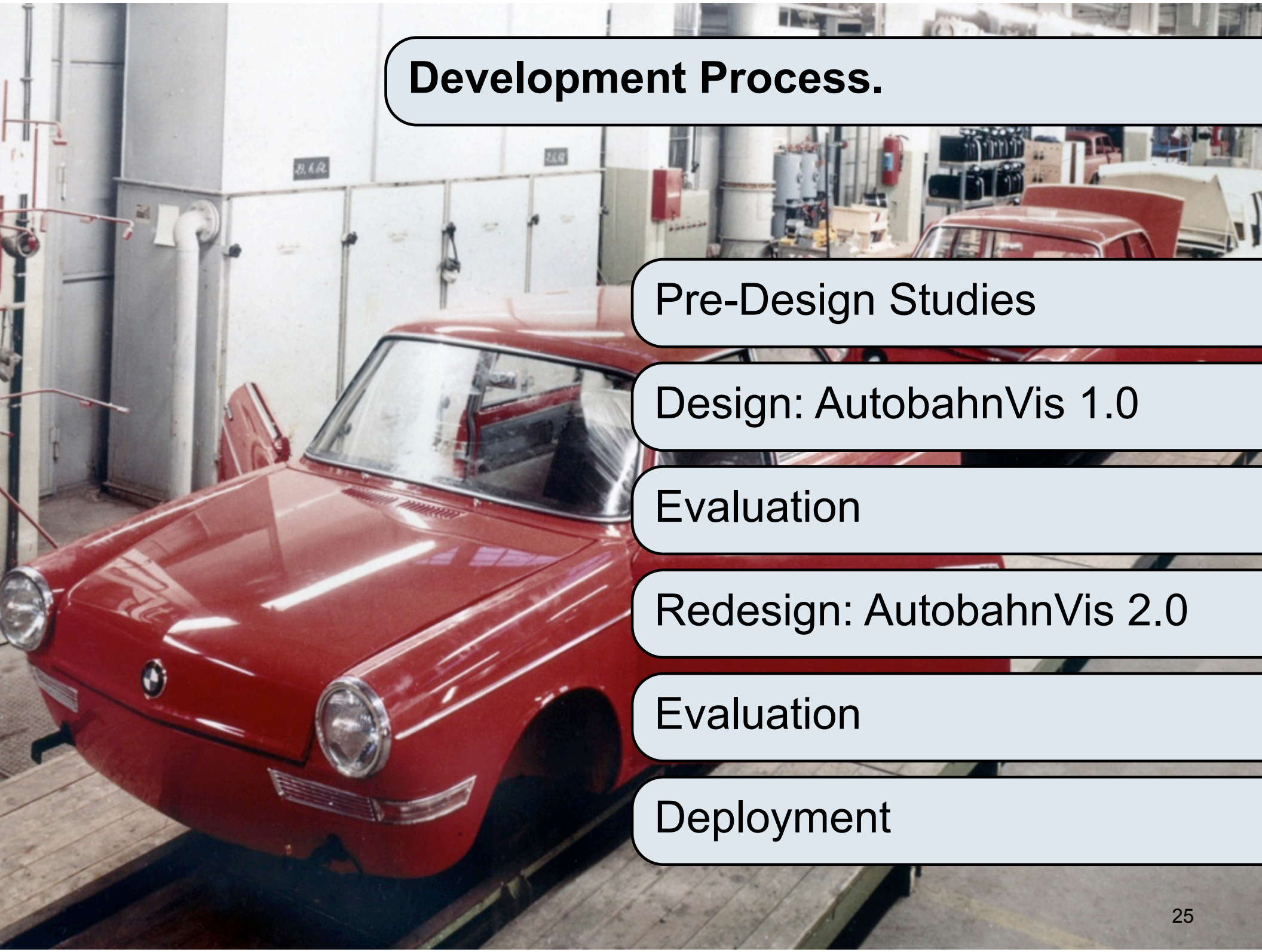


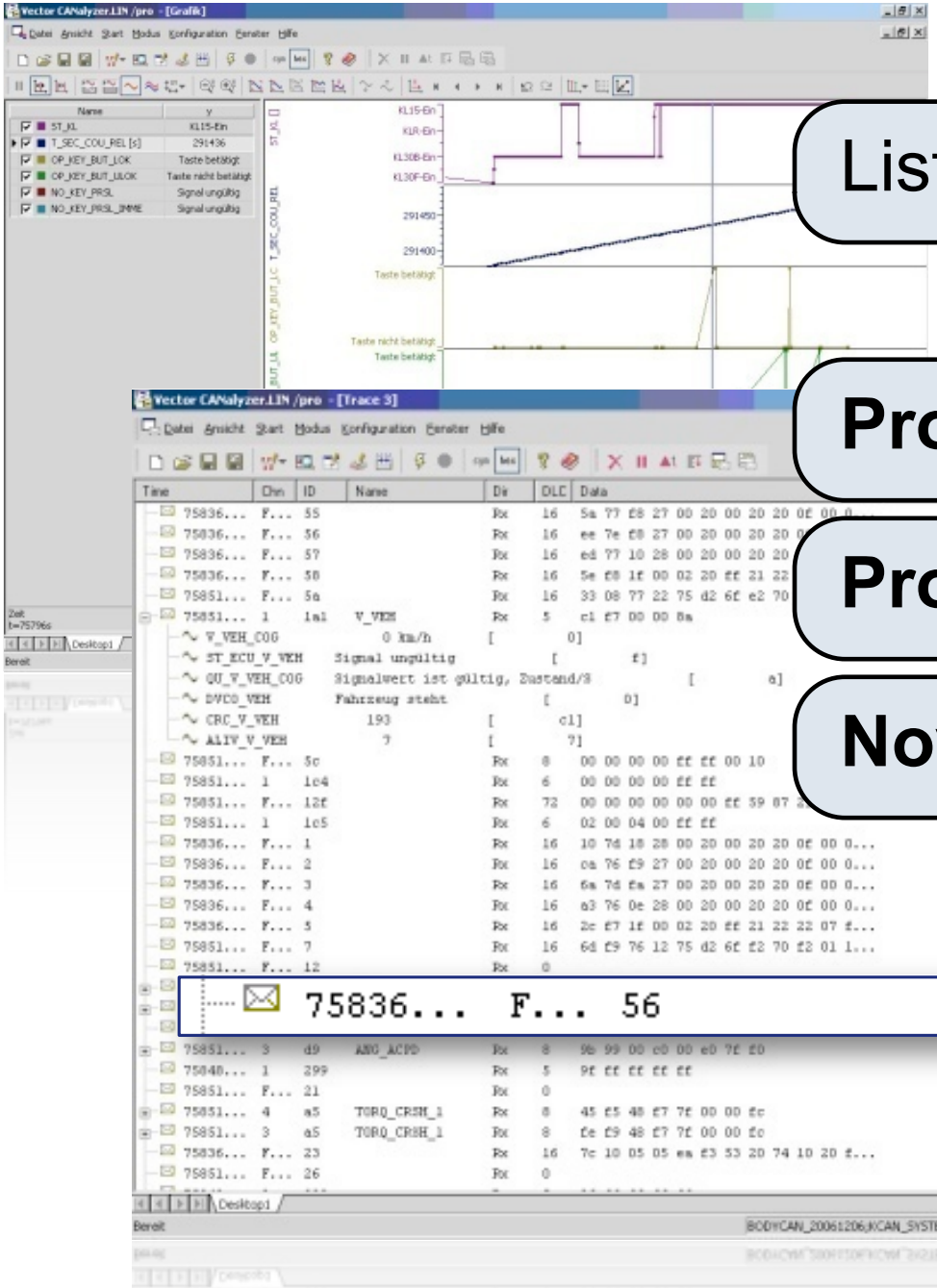
Development Process.

- Pre-Design Studies
- Design: AutobahnVis 1.0
- Evaluation
- Redesign: AutobahnVis 2.0
- Evaluation
- Deployment

Pre-Design Studies.

Ethnographic Studies

Current Practices in Trace Analysis.



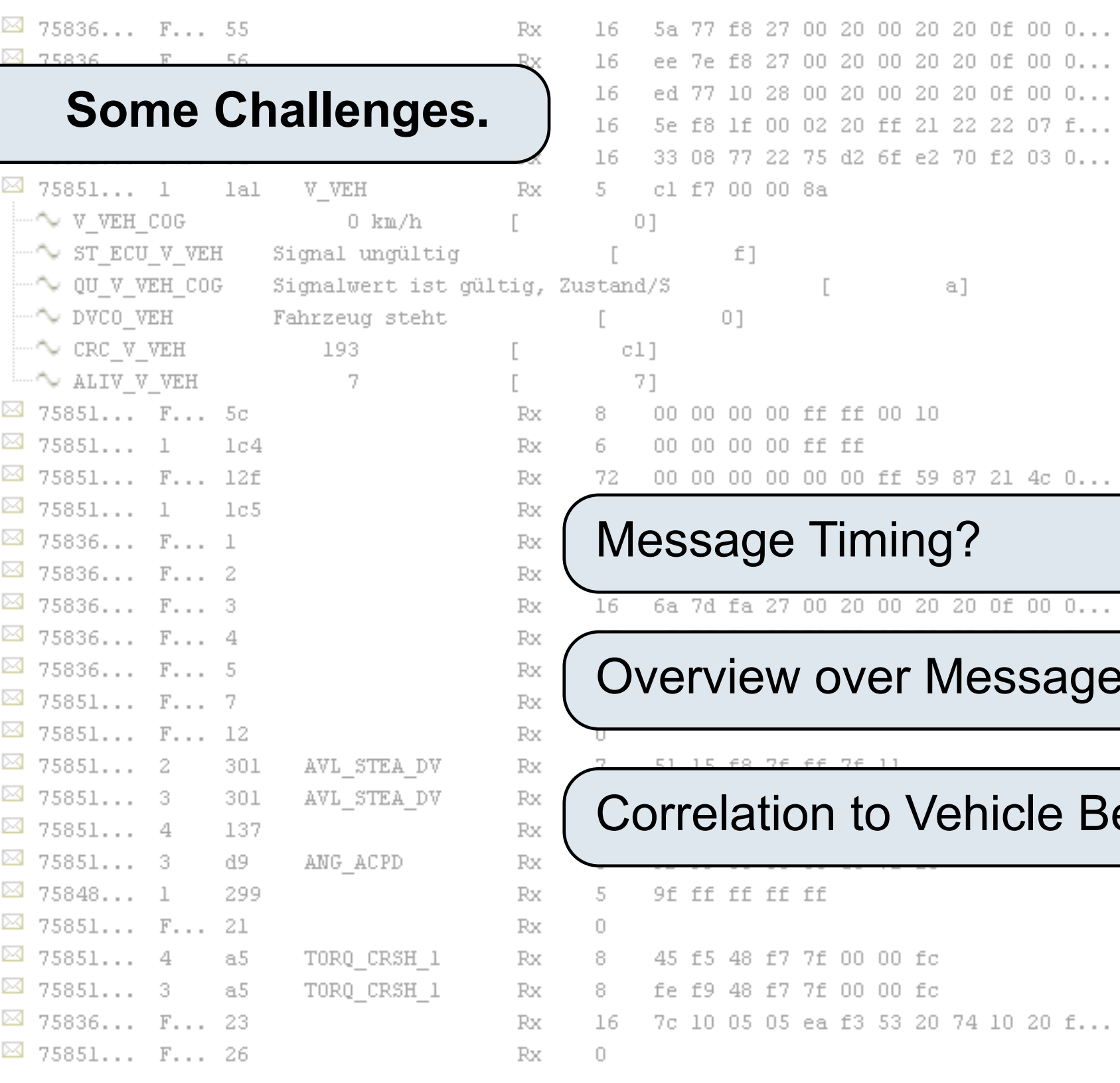
Lists and Simple Plots

Problem: Traces are very large!

Problem: Finding complex errors!

Novel Perspectives Needed!

Some Challenges.



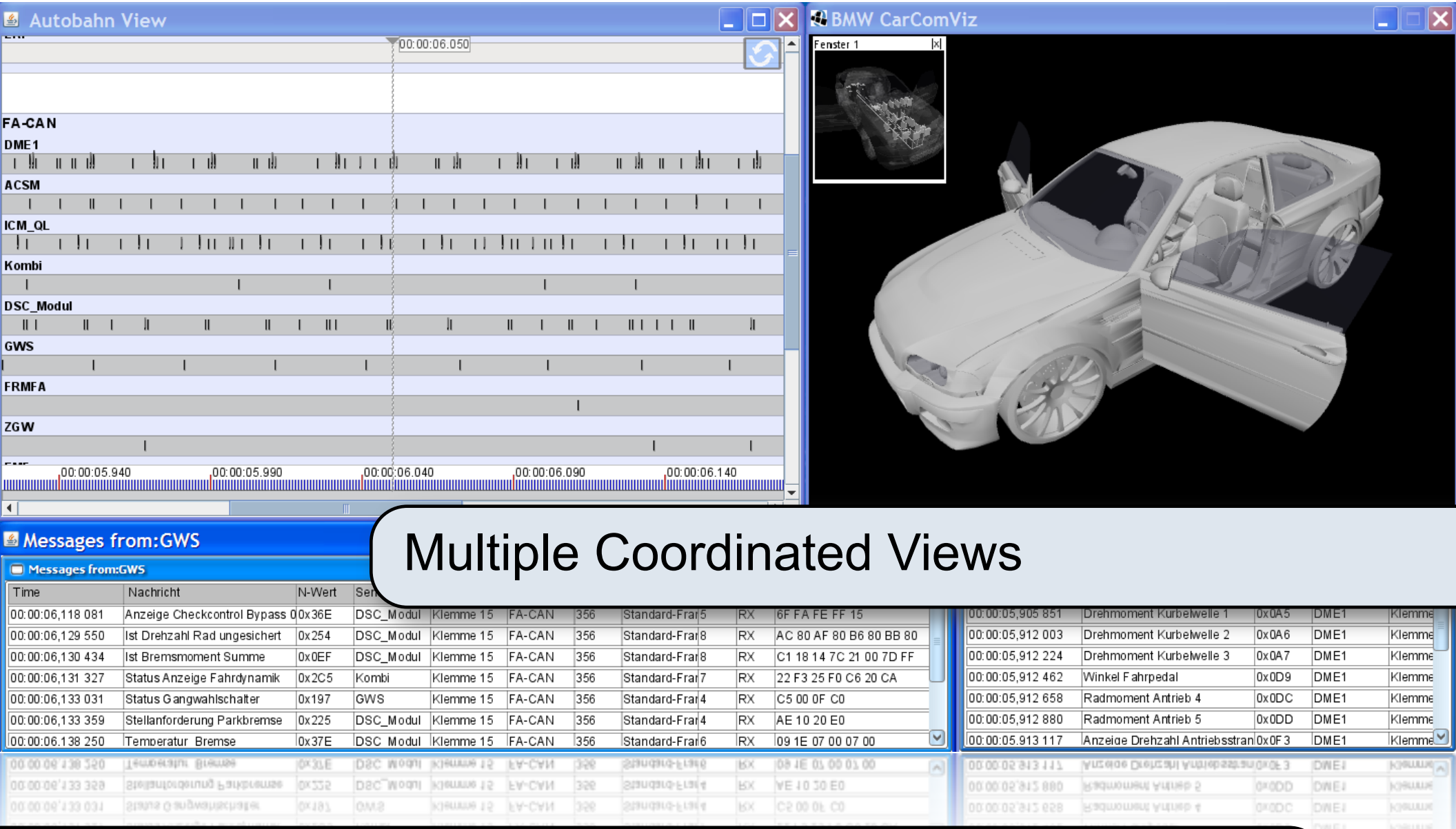
Message Timing?

Overview over Messages?

Correlation to Vehicle Behavior?


Tool Design and Development.
Paper Prototyping
Final Concept Workshops

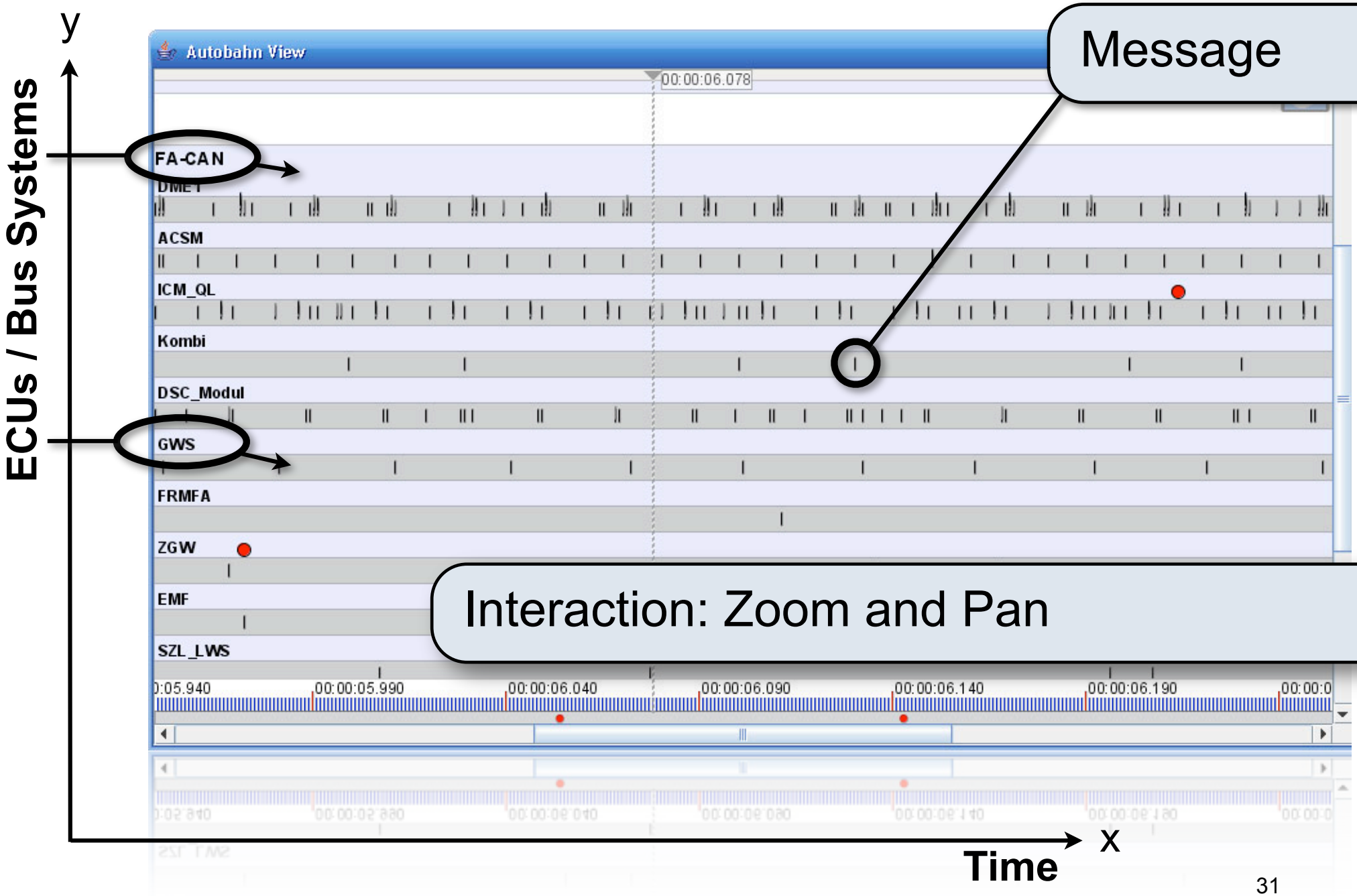
AutobahnVis 1.0*



Multiple Coordinated Views

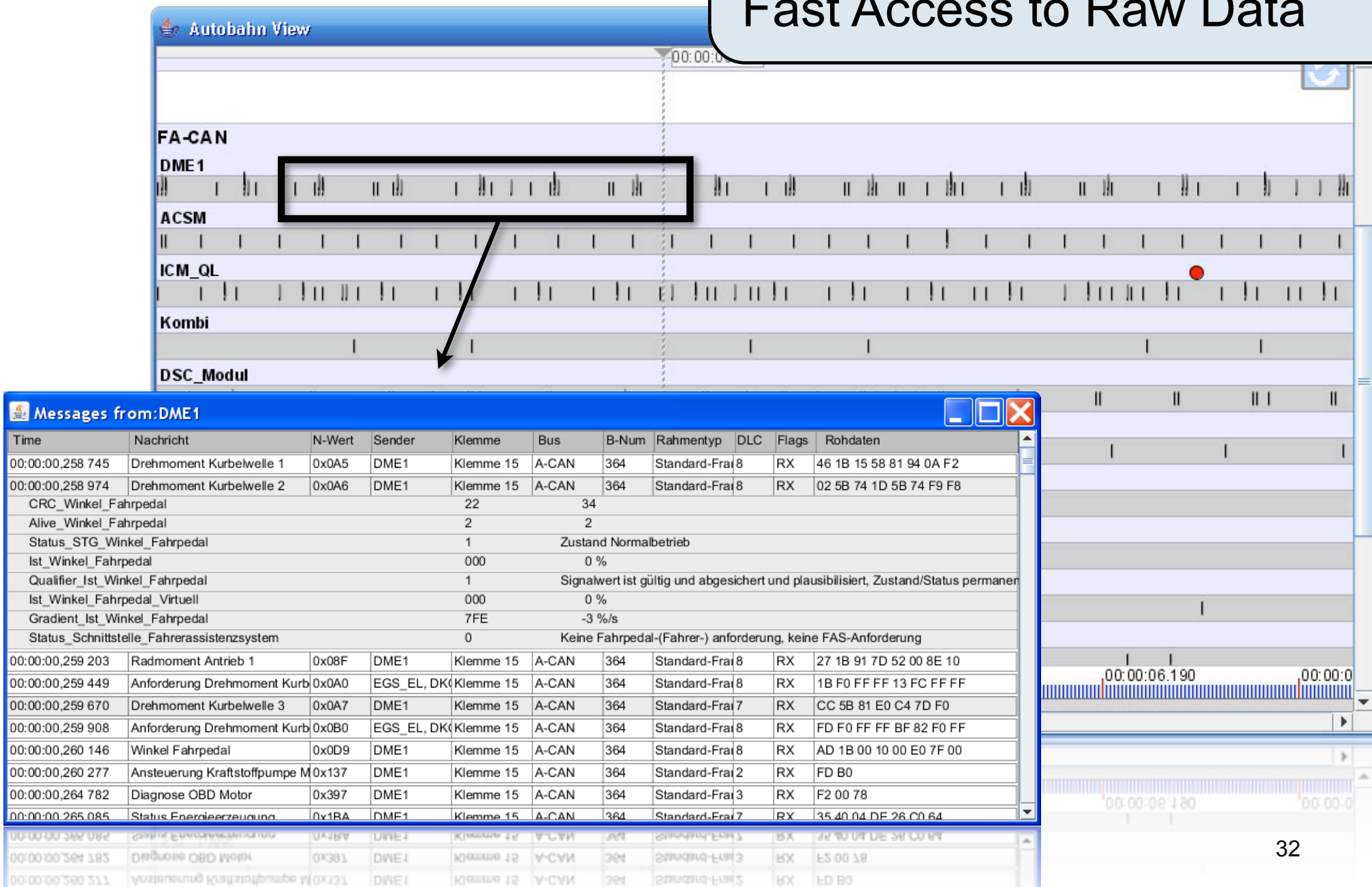
* **M. Sedlmair**, B. Kunze, W, Hintermaier, and A. Butz:
User-centered Development of a Visual Exploration System for In-Car Communication. SmartGraphics. 2009.

Autobahn View.



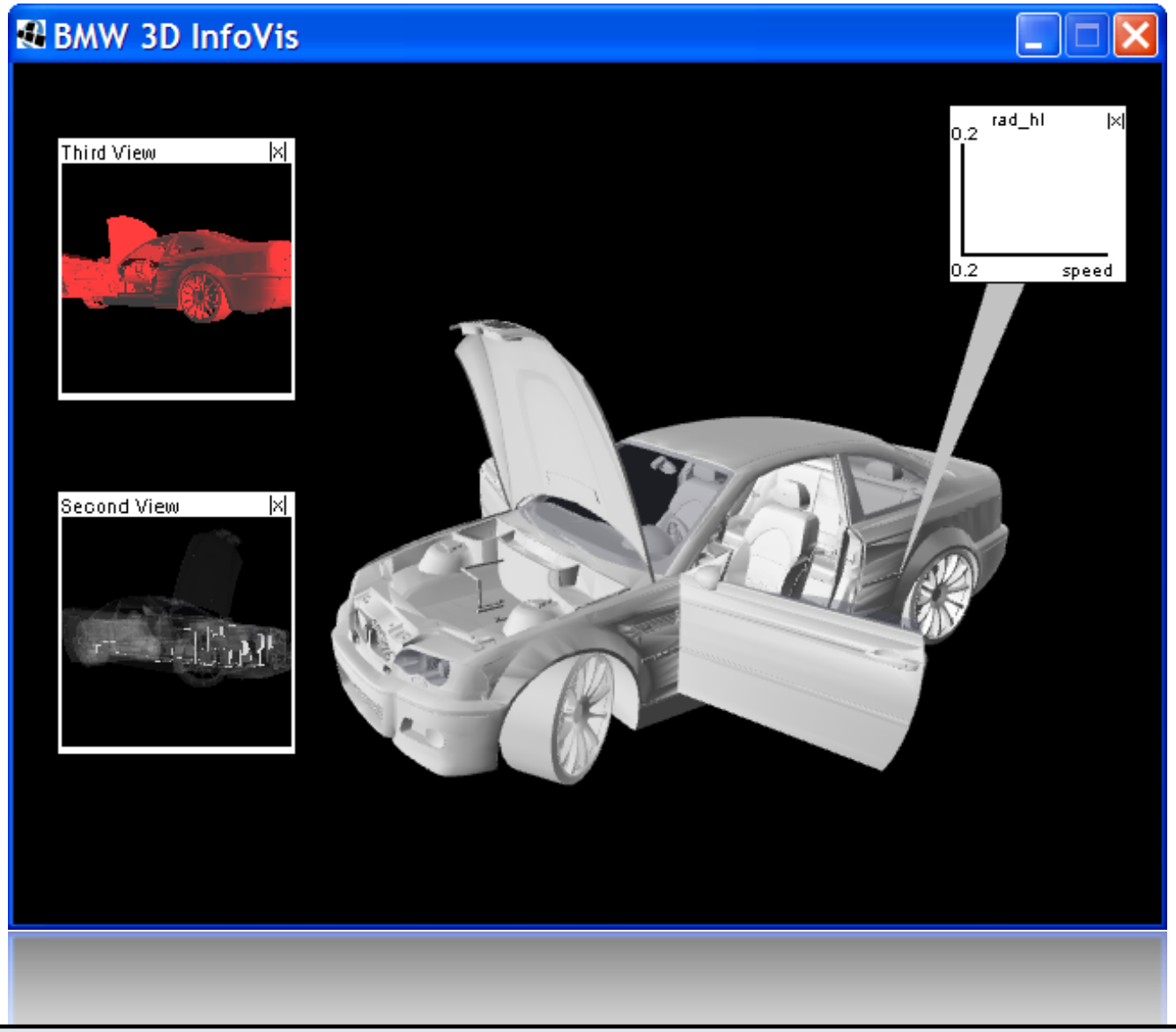
List Views.

Fast Access to Raw Data



Time	Nachricht	N-Wert	Sender	Klemme	Bus	B-Num	Rahmentyp	DLC	Flags	Rohdaten
00:00:00,258 745	Drehmoment Kurbelwelle 1	0x0A5	DME1	Klemme 15	A-CAN	364	Standard-Frai	8	RX	46 1B 15 58 81 94 0A F2
00:00:00,258 974	Drehmoment Kurbelwelle 2	0x0A6	DME1	Klemme 15	A-CAN	364	Standard-Frai	8	RX	02 5B 74 1D 5B 74 F9 F8
CRC_Winkel_Fahrpedal				22		34				
Alive_Winkel_Fahrpedal				2		2				
Status_STG_Winkel_Fahrpedal				1		Zustand Normalbetrieb				
Ist_Winkel_Fahrpedal				000		0 %				
Qualifier_Ist_Winkel_Fahrpedal				1		Signalwert ist gültig und abgesichert und plausibilisiert, Zustand/Status permanen				
Ist_Winkel_Fahrpedal_Virtuell				000		0 %				
Gradient_Ist_Winkel_Fahrpedal				7FE		-3 %/s				
Status_Schnittstelle_Fahrerassistenzsystem				0		Keine Fahrpedal-(Fahrer-) anforderung, keine FAS-Anforderung				
00:00:00,259 203	Radmoment Antrieb 1	0x08F	DME1	Klemme 15	A-CAN	364	Standard-Frai	8	RX	27 1B 91 7D 52 00 8E 10
00:00:00,259 449	Anforderung Drehmoment Kurb	0x0A0	EGS_EL, DK(	Klemme 15	A-CAN	364	Standard-Frai	8	RX	1B F0 FF FF 13 FC FF FF
00:00:00,259 670	Drehmoment Kurbelwelle 3	0x0A7	DME1	Klemme 15	A-CAN	364	Standard-Frai	7	RX	CC 5B 81 E0 C4 7D F0
00:00:00,259 908	Anforderung Drehmoment Kurb	0x0B0	EGS_EL, DK(	Klemme 15	A-CAN	364	Standard-Frai	8	RX	FD F0 FF FF BF 82 F0 FF
00:00:00,260 146	Winkel Fahrpedal	0x0D9	DME1	Klemme 15	A-CAN	364	Standard-Frai	8	RX	AD 1B 00 10 00 E0 7F 00
00:00:00,260 277	Ansteuerung Kraftstoffpumpe M	0x137	DME1	Klemme 15	A-CAN	364	Standard-Frai	2	RX	FD B0
00:00:00,264 782	Diagnose OBD Motor	0x397	DME1	Klemme 15	A-CAN	364	Standard-Frai	3	RX	F2 00 78
00:00:00,265 085	Status Energieerzeugung	0x1BA	DME1	Klemme 15	A-CAN	364	Standard-Frai	7	RX	35 40 04 DF 26 C0 64

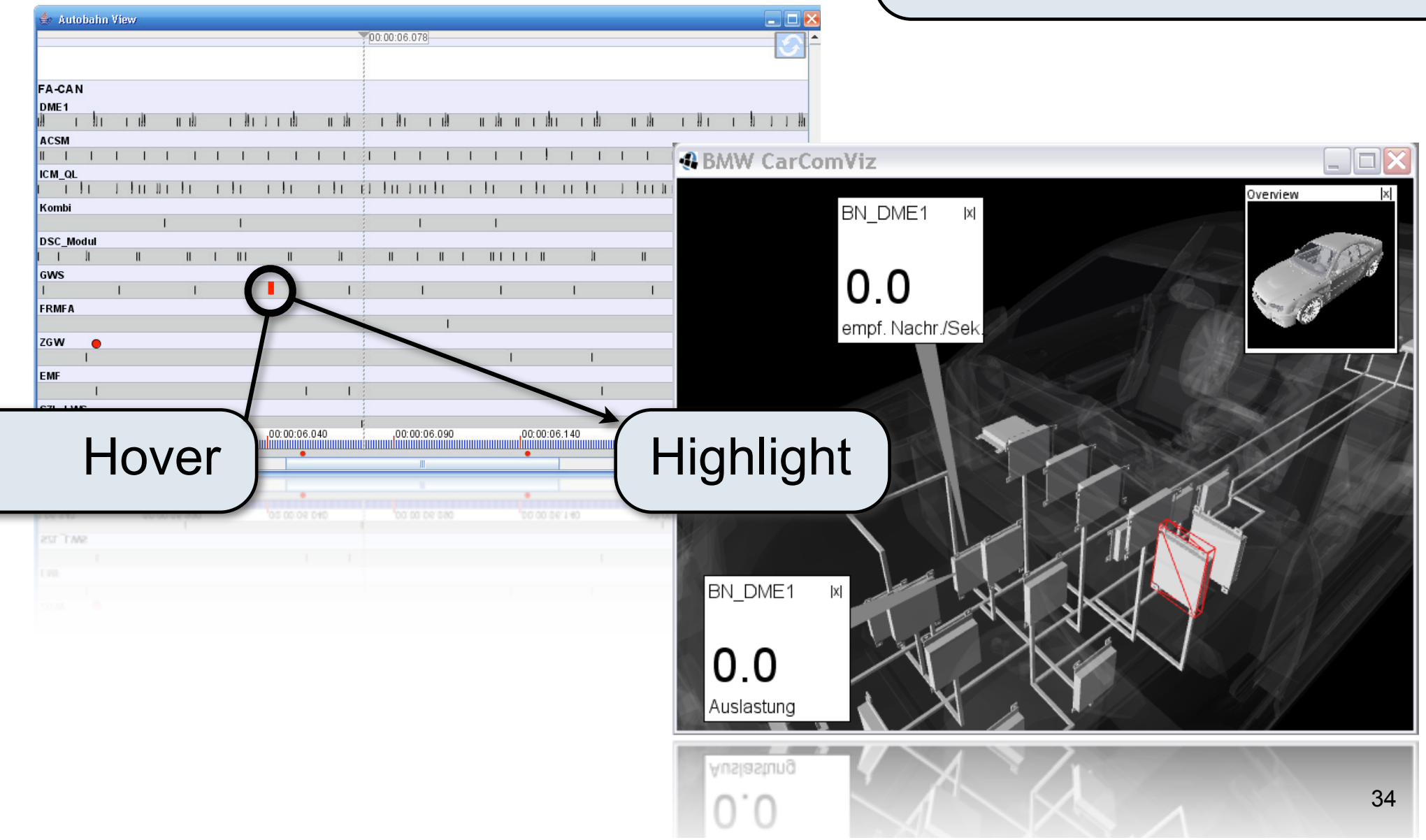
Adding an Additional 3D View.



* **M. Sedlmair**, K. Ruhland, F. Hennecke, A. Butz, S. Bioletti, and C. O'Sullivan.:
Towards the Big Picture: Enriching 3D Models with Information Visualisation and Vice Versa. SmartGraphics. 2009.

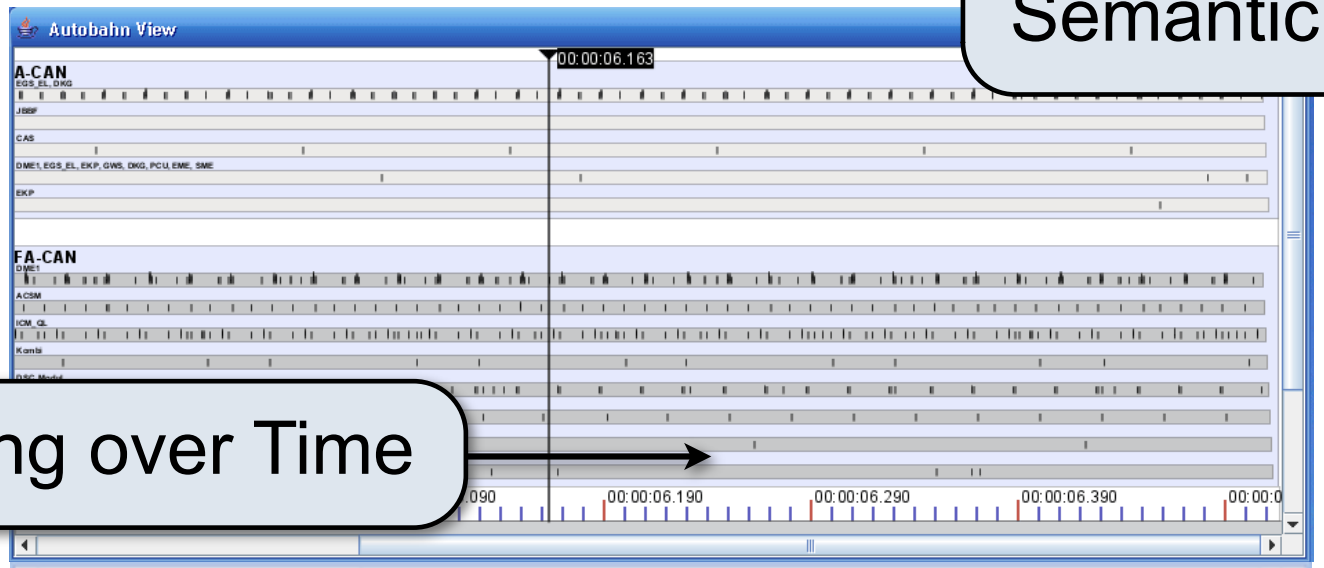
Coordinating the 3D View with AutobahnVis (1).

Linking and Brushing



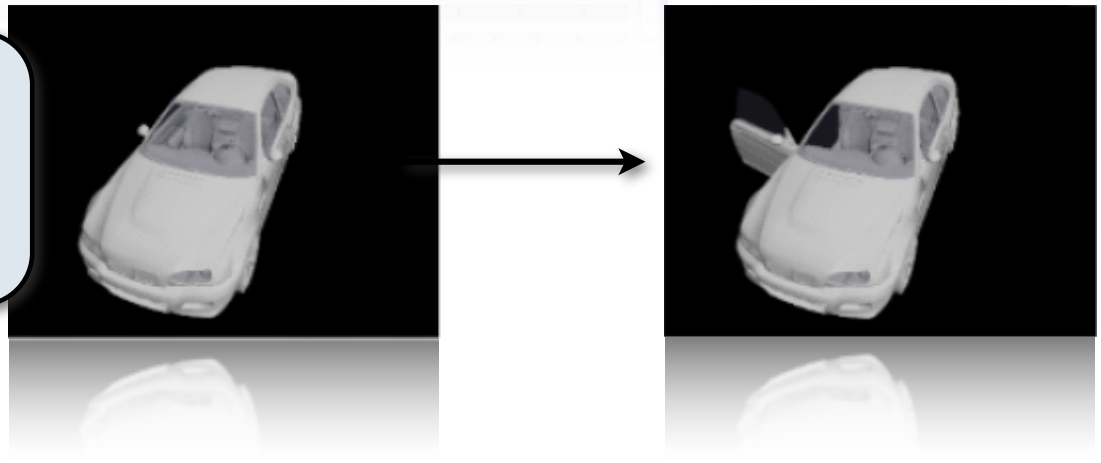
Coordinating the 3D View with AutobahnVis (2).

Semantic Linking

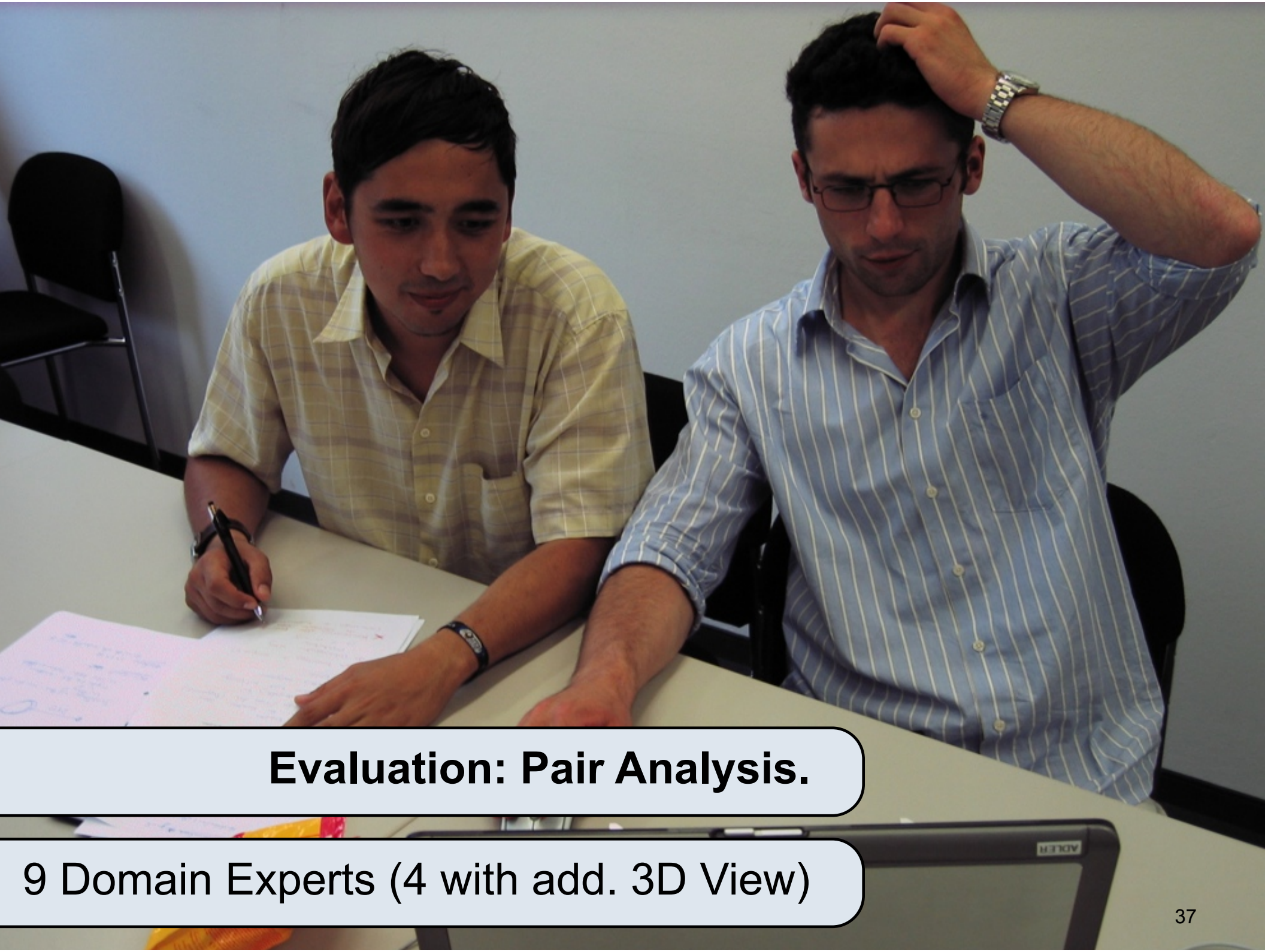


Panning over Time

Translating Messages into Mechanical Behavior



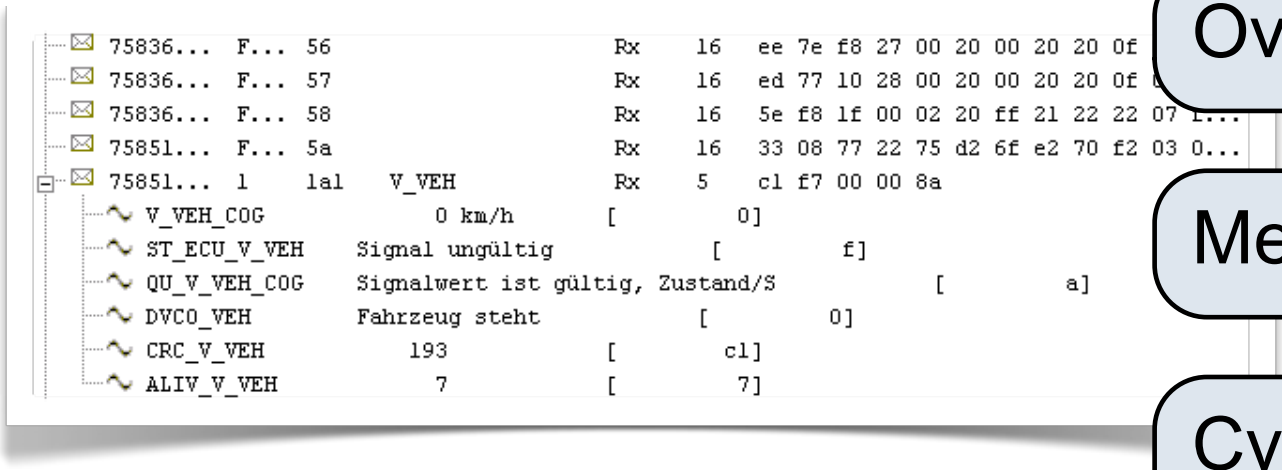
Video



Evaluation: Pair Analysis.

9 Domain Experts (4 with add. 3D View)

Results Autobahn View: Overview and Insights.

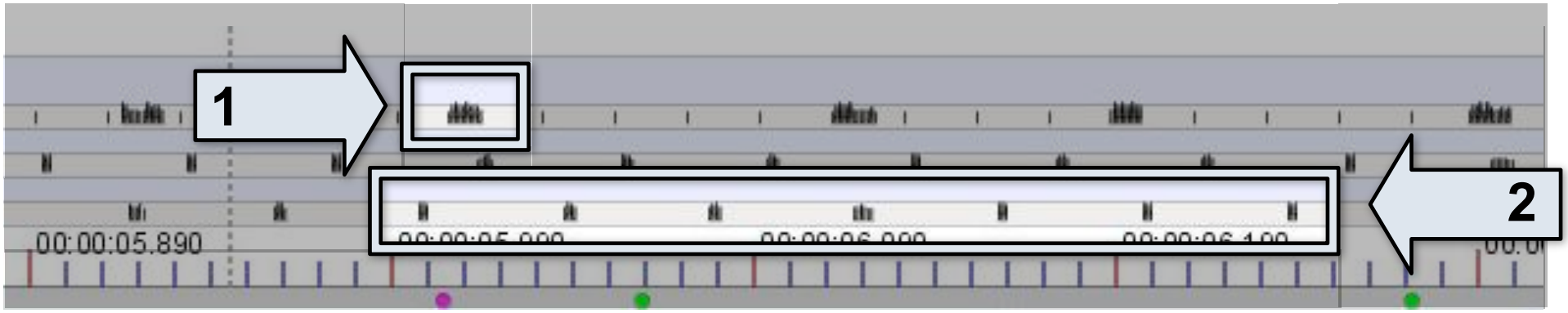


Overview and Navigation

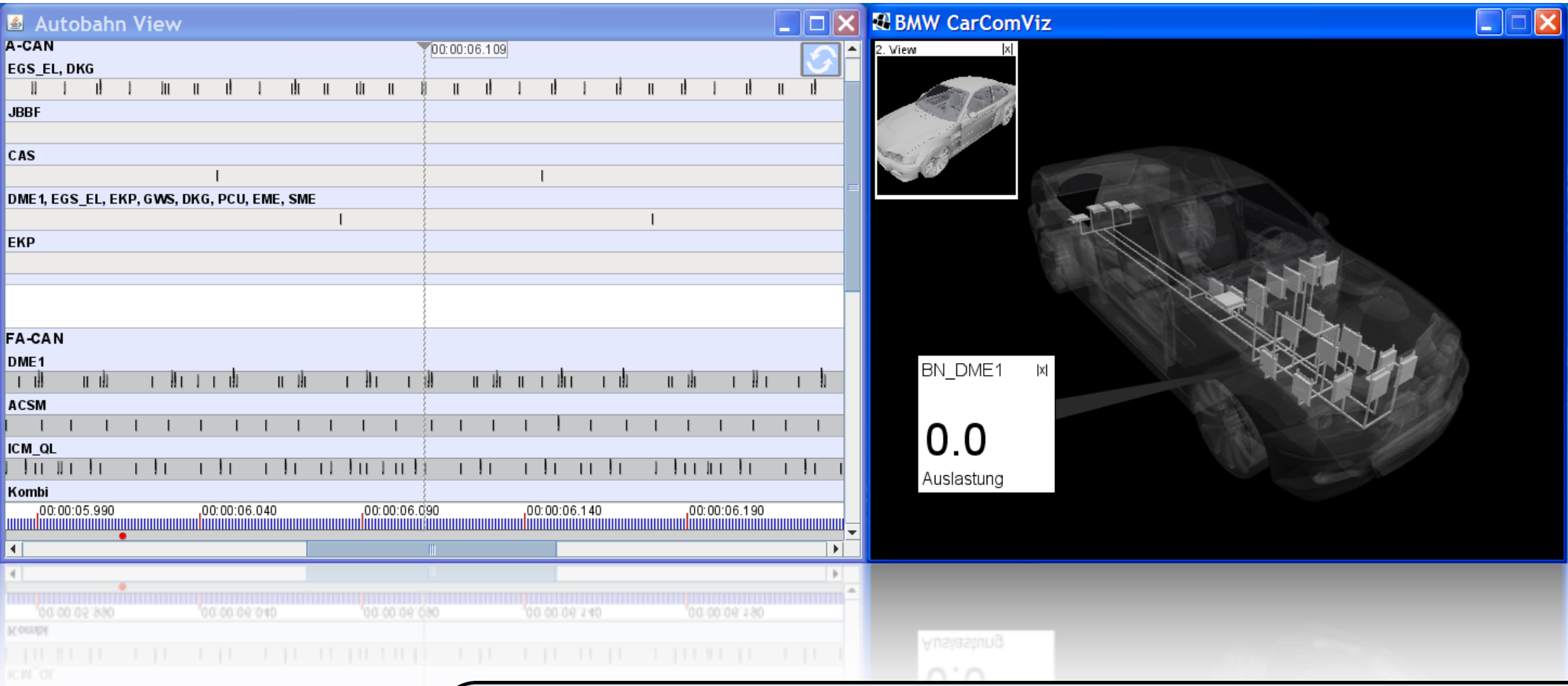
Message Burst (1)

Cyclic Messaging (2)

vs.

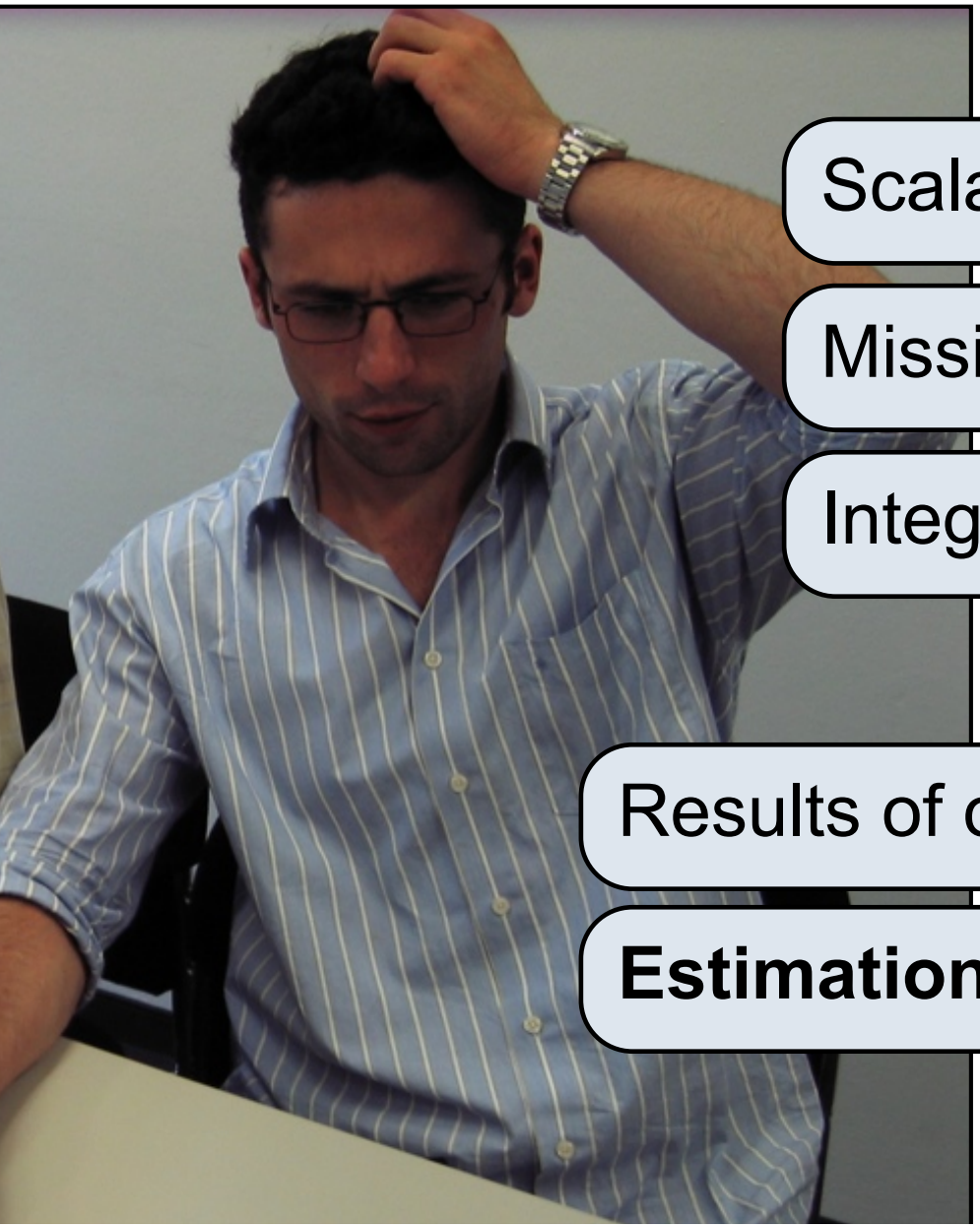


Results 3D: Communication.



Com. between different levels of expertise

But not usable in daily practices...



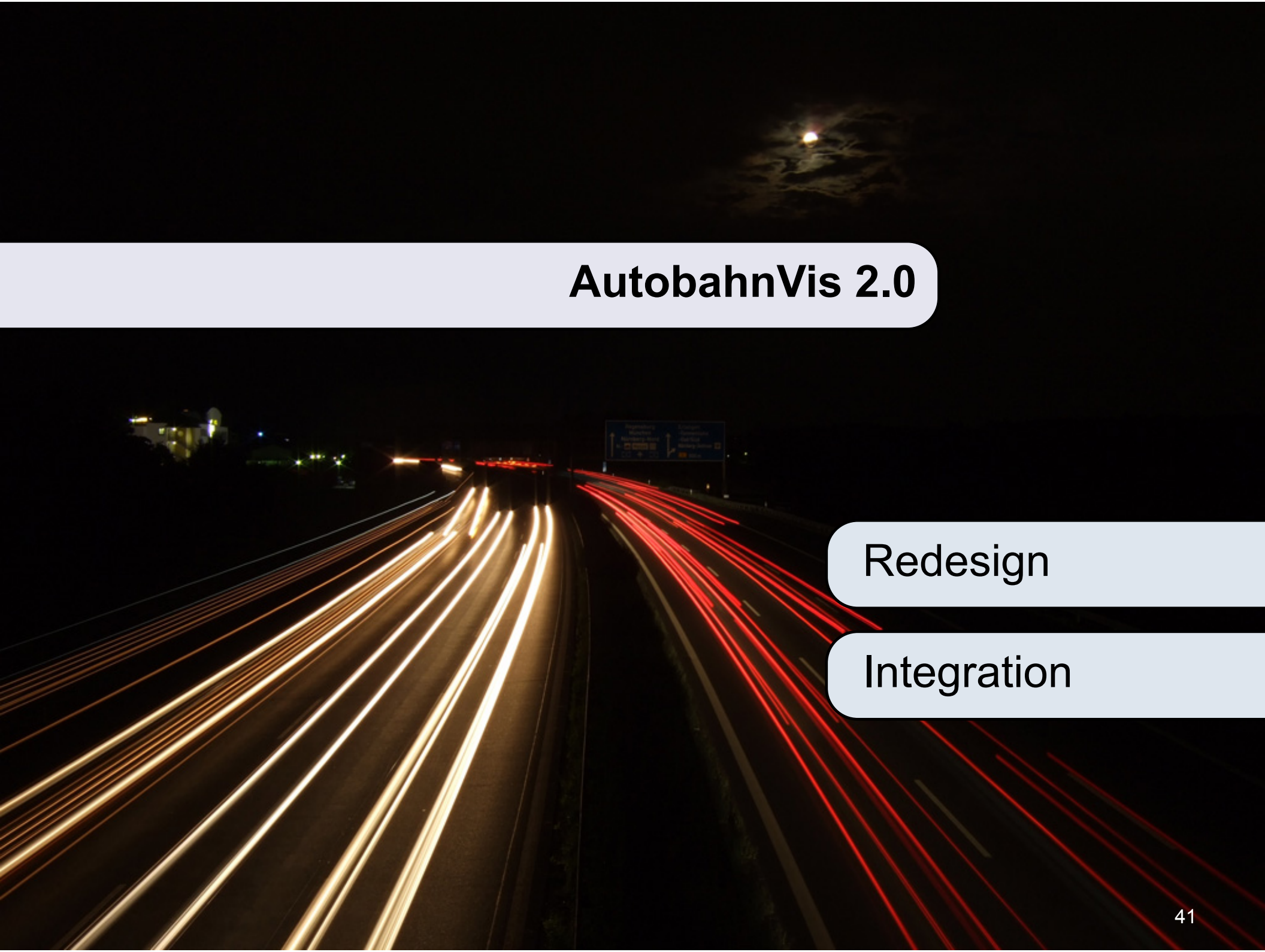
Scalability!

Missing Features!

Integration with data and other tools?

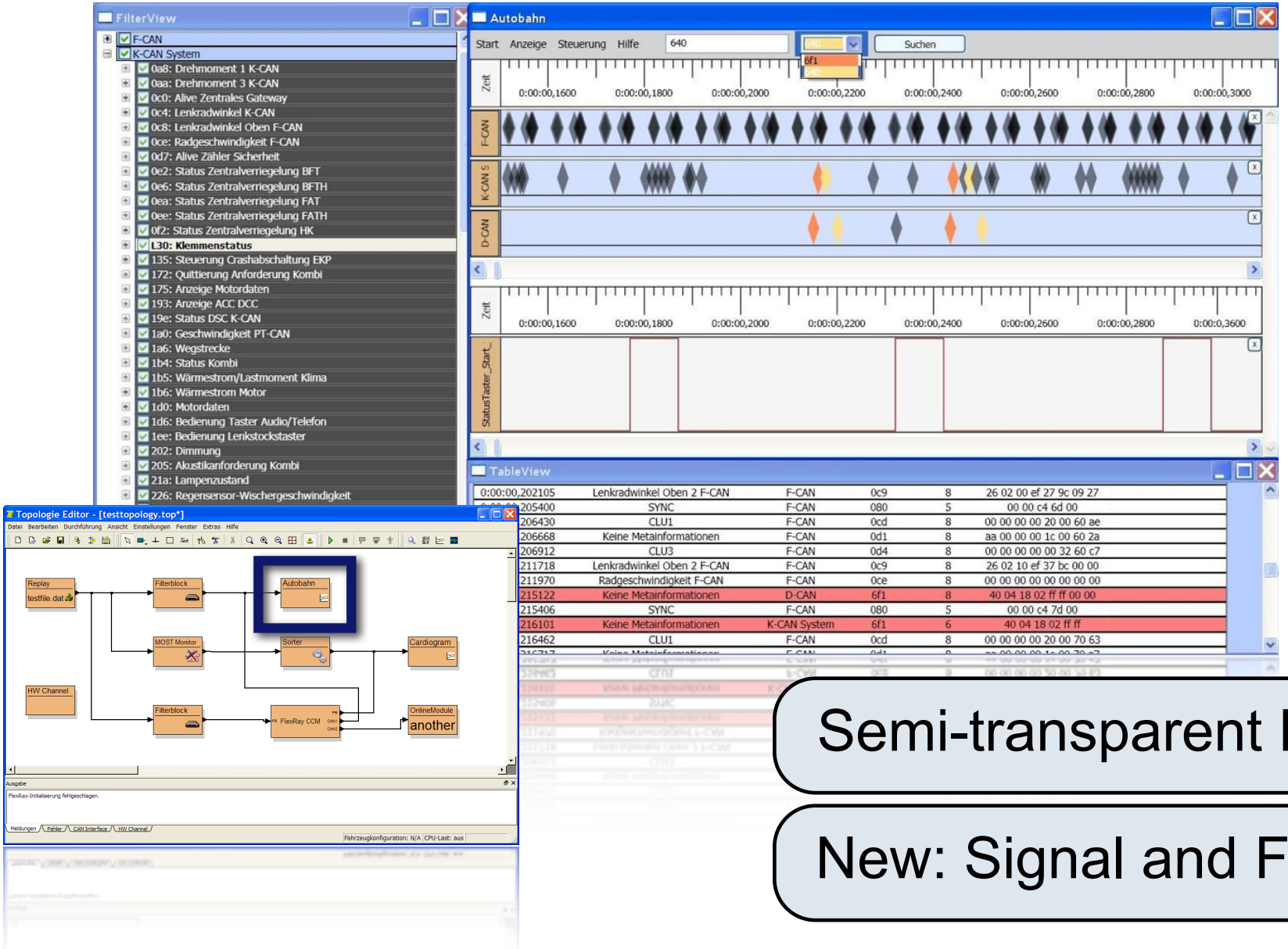
Results of our studies:

Estimations, not Real Usage Examples!



AutobahnVis 2.0

- Redesign
- Integration



Semi-transparent Diamonds

New: Signal and Filter View

Integration with an In-house tool

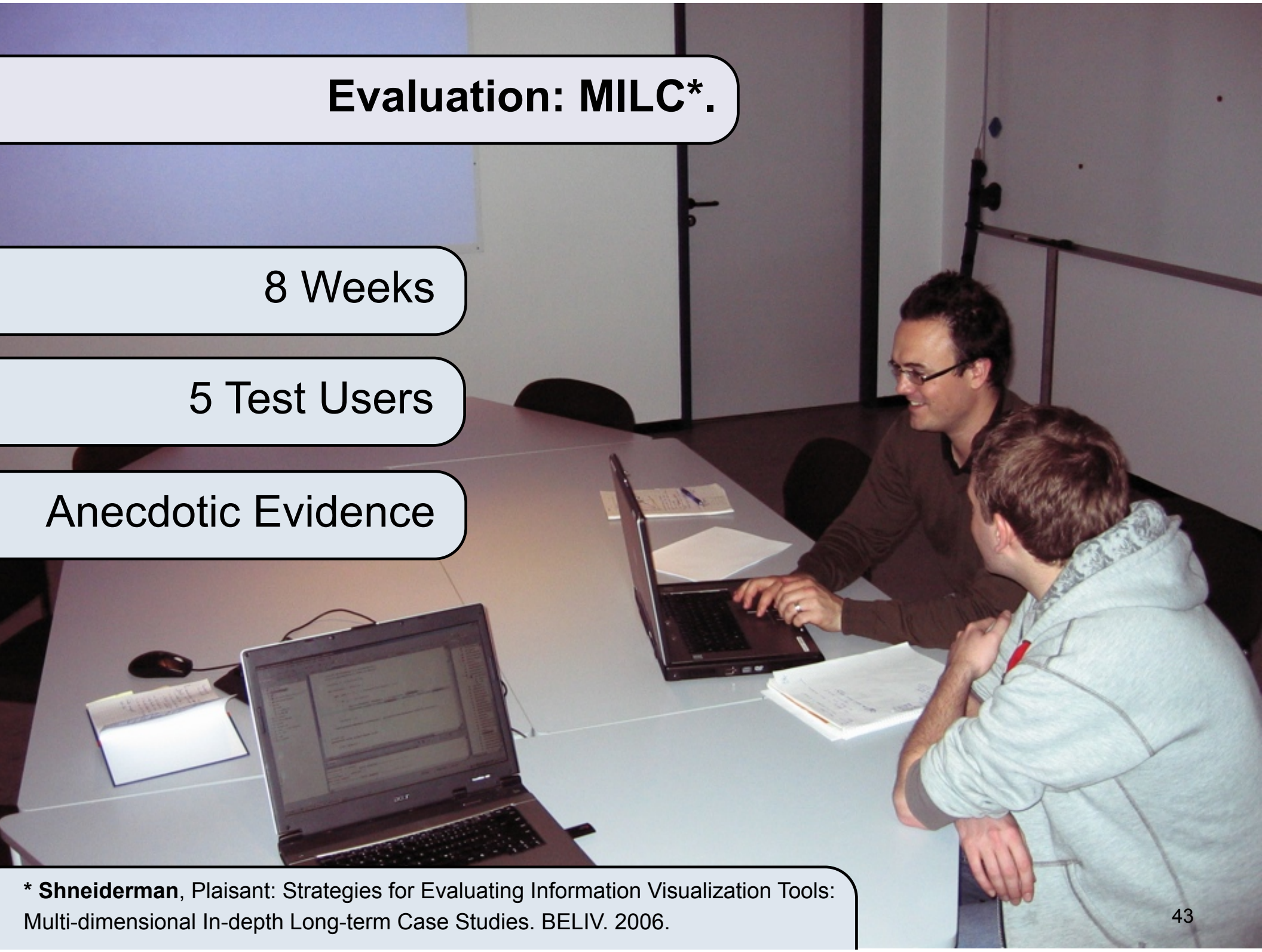
Restrictions: 3D, “ECU-Lanes”

Evaluation: MILC*.

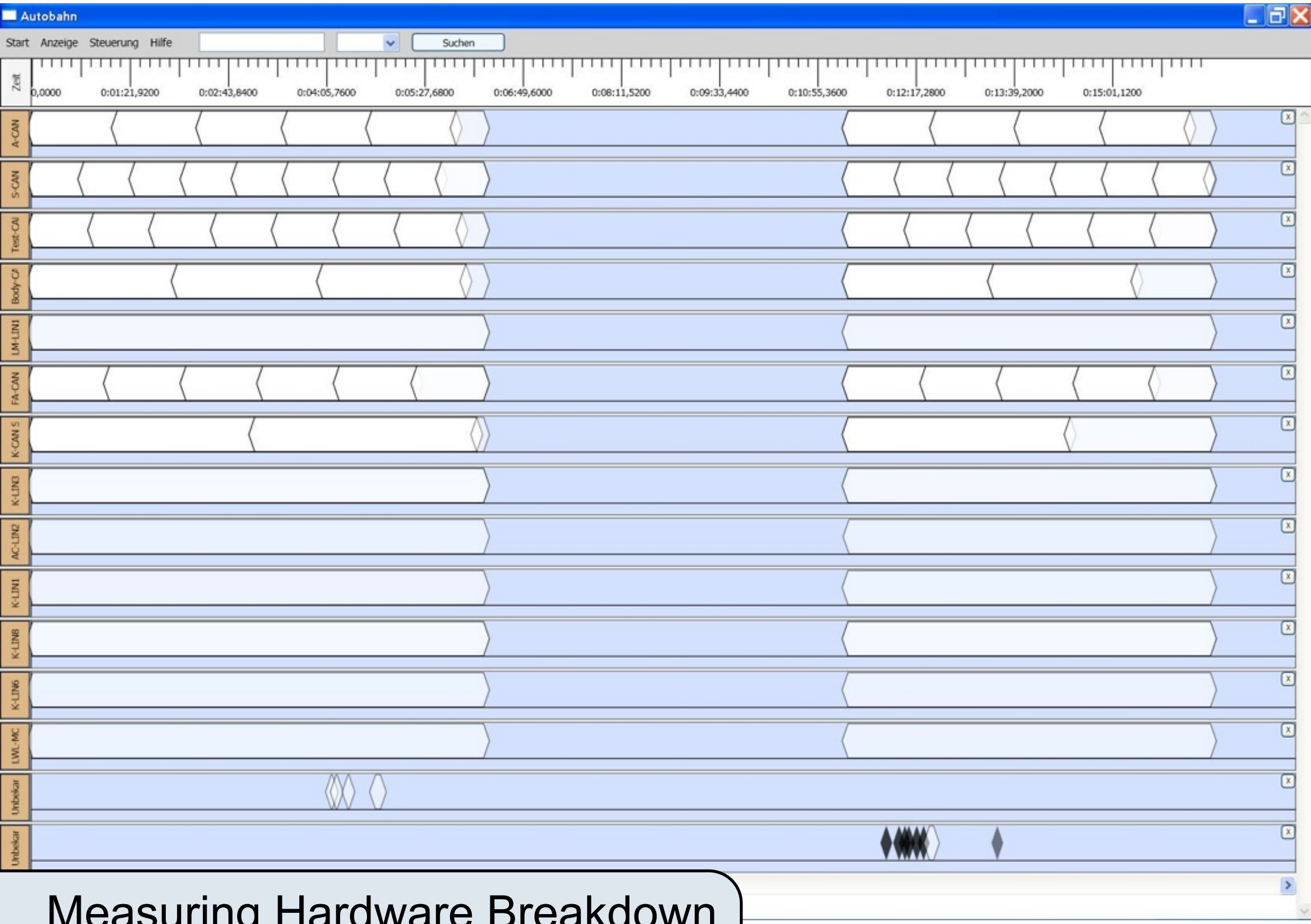
8 Weeks

5 Test Users

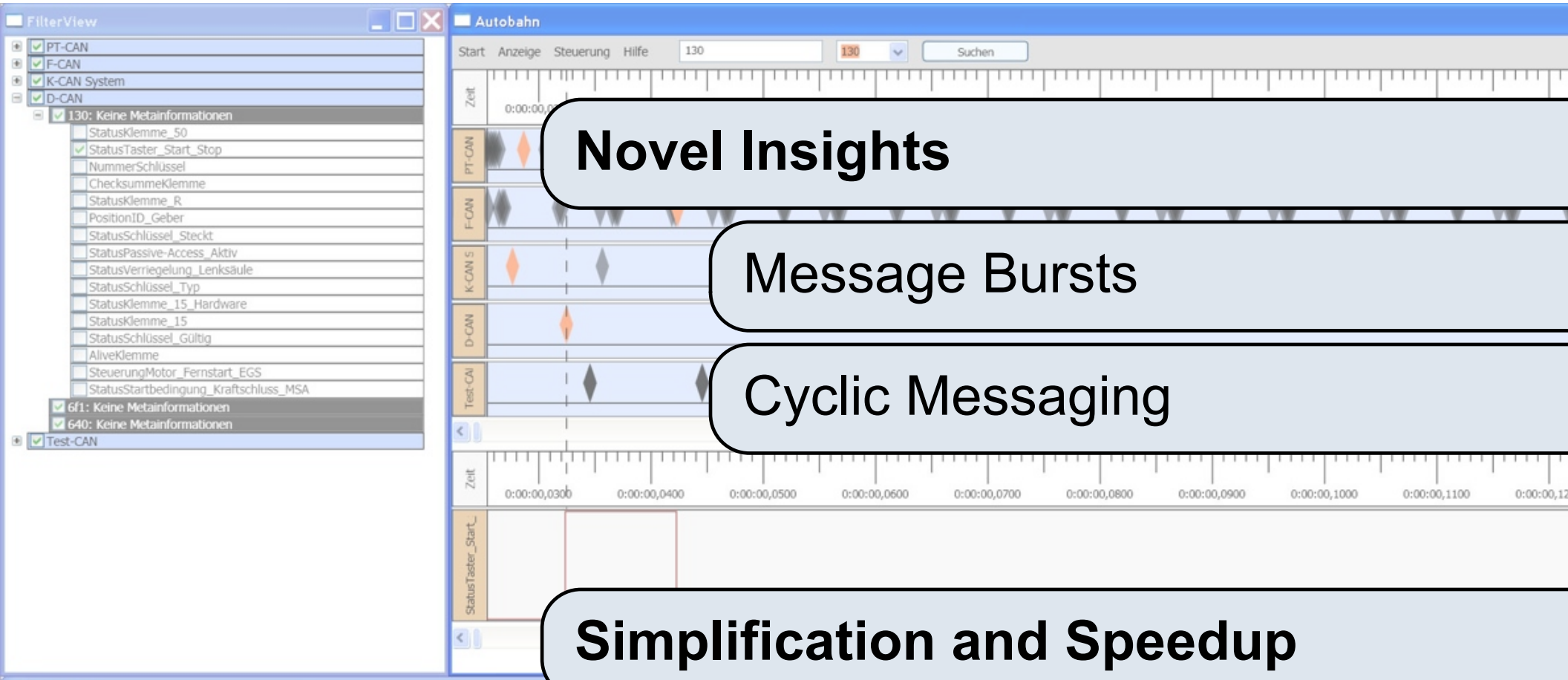
Anecdotic Evidence



* **Shneiderman**, Plaisant: Strategies for Evaluating Information Visualization Tools: Multi-dimensional In-depth Long-term Case Studies. BELIV. 2006.



Measuring Hardware Breakdown



Novel Insights

Message Bursts

Cyclic Messaging

Simplification and Speedup

Correlating Messages to Signals

Request/ Response Messaging

... more and detailed examples in the thesis.

Deployment of AutobahnVis 2.0

Participants still use the Tool

End-Users convinced Stakeholders

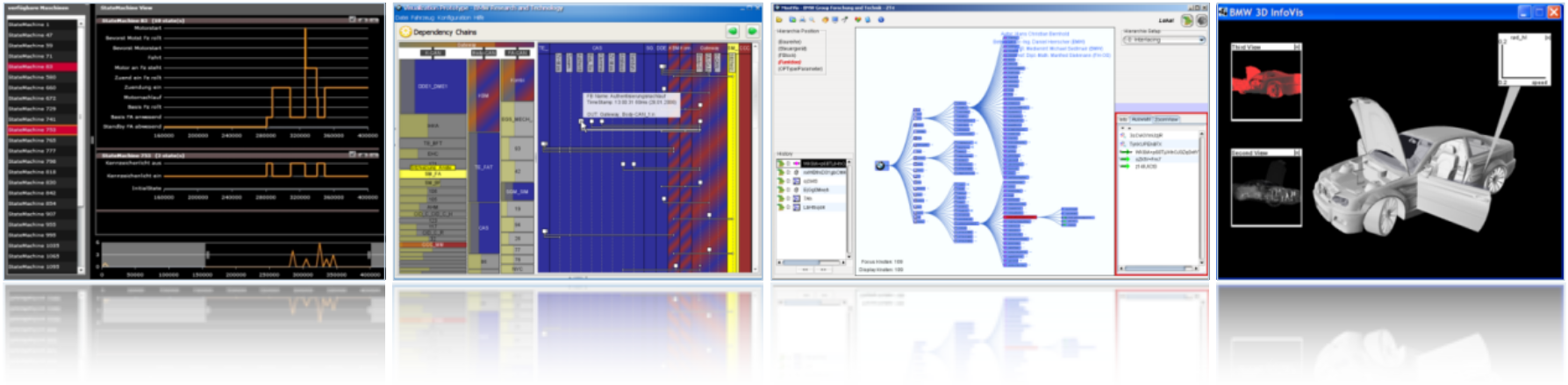
Integration into ‘Core Components’

Moving Research into Practice!

Michael Sedlmair
msedl@cs.ubc.ca

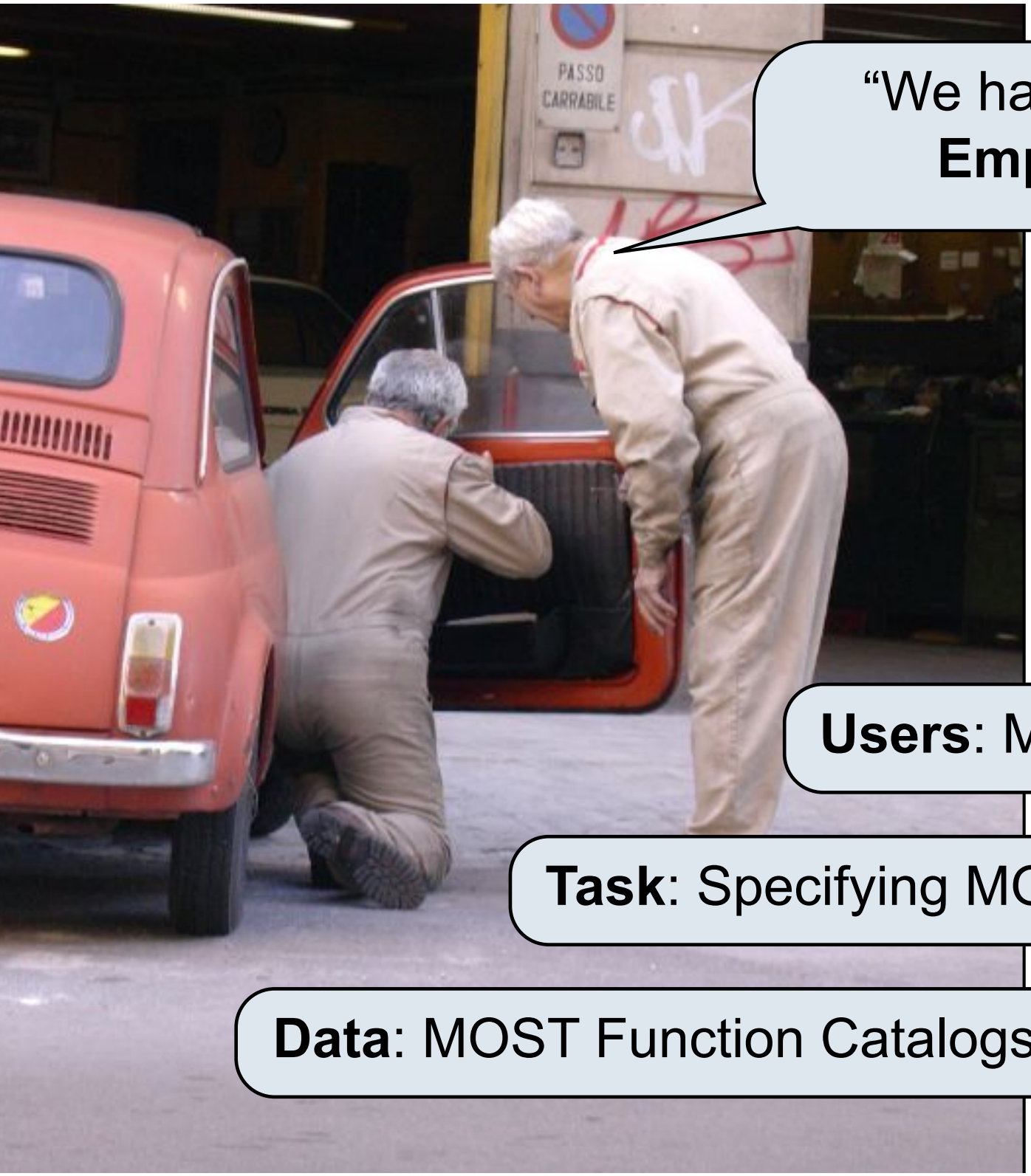
21-10-2010

VA of In-Car Communication Networks.
Outline.



- *Motivation:* Domain Problem
- *Overview*: Application Areas
- *Example 1:* AutobahnVis (detailed)
- ***Example 2*: MostVis (brief)**
- *Lessons Learned*: InfoVis in a Large Company
- *Conclusions*: Summary and Future Work


Development Engineers
Task: Specifying the Network
Data: Specification Databases&Docus
Analysis Engineers



"We have a problem!"
Employee-Pull

Users: MOST Engineers

Task: Specifying MOST

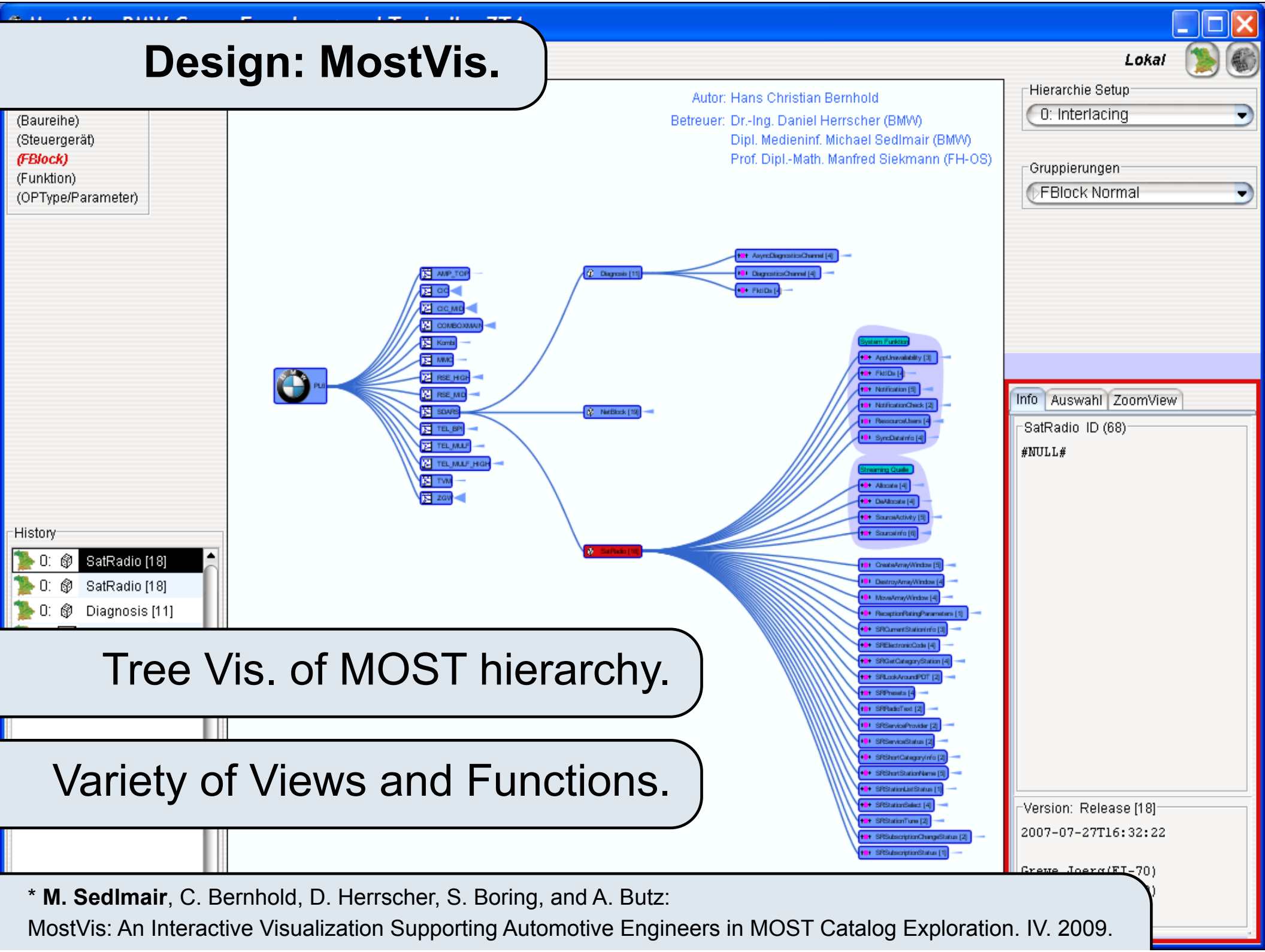
Data: MOST Function Catalogs, ~40.000 Elements

Problem

Problem: Increased data has made searching and browsing time-intensive with current tools

Text-based Tools:
BNE, Specs (Pdf, Paper)

Design: MostVis.

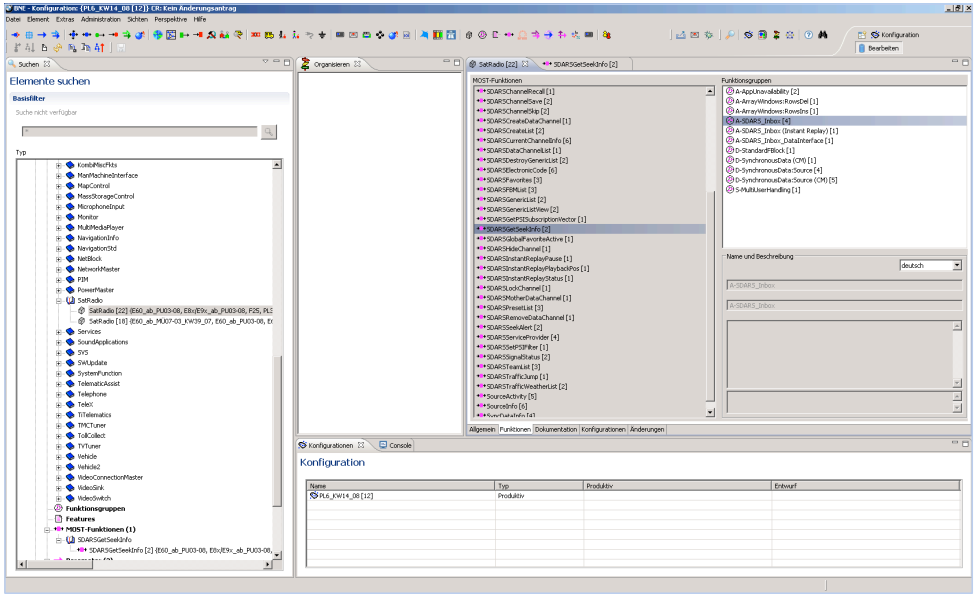


Tree Vis. of MOST hierarchy.

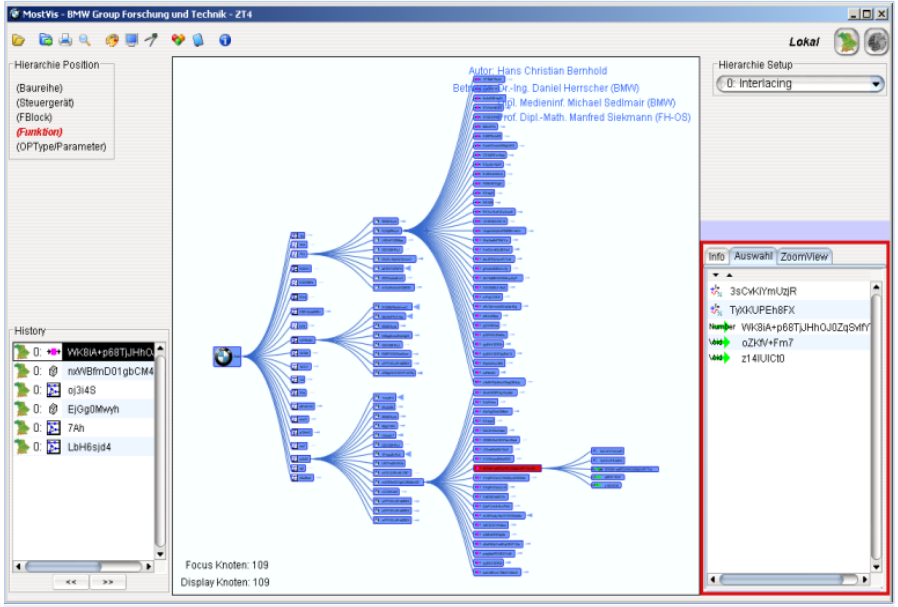
Variety of Views and Functions.

* **M. Sedlmair**, C. Bernhold, D. Herrscher, S. Boring, and A. Butz:
MostVis: An Interactive Visualization Supporting Automotive Engineers in MOST Catalog Exploration. IV. 2009.

Evaluation: Lab Study.



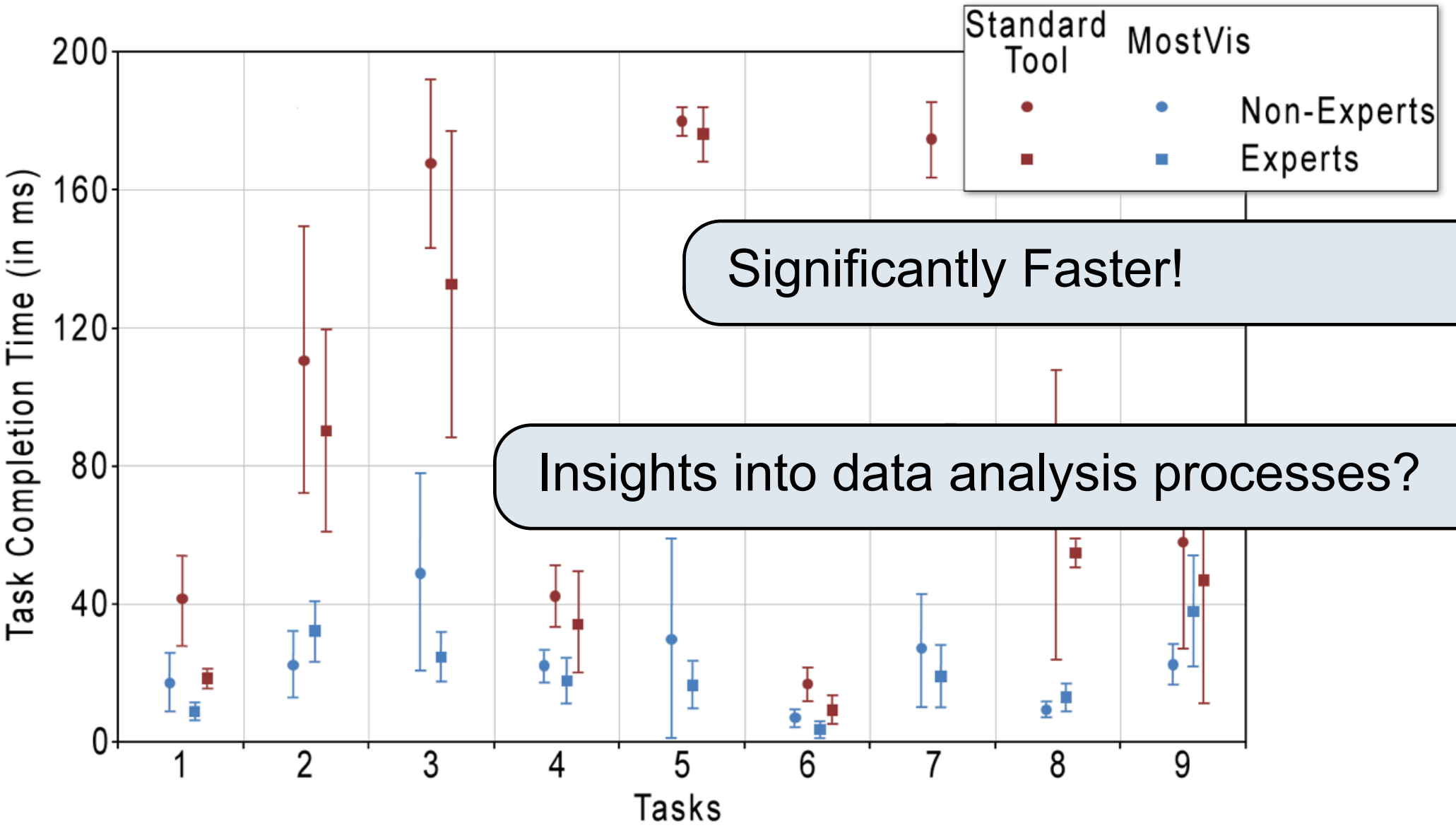
vs.



14 Domain Experts

9 Domain-specific Tasks

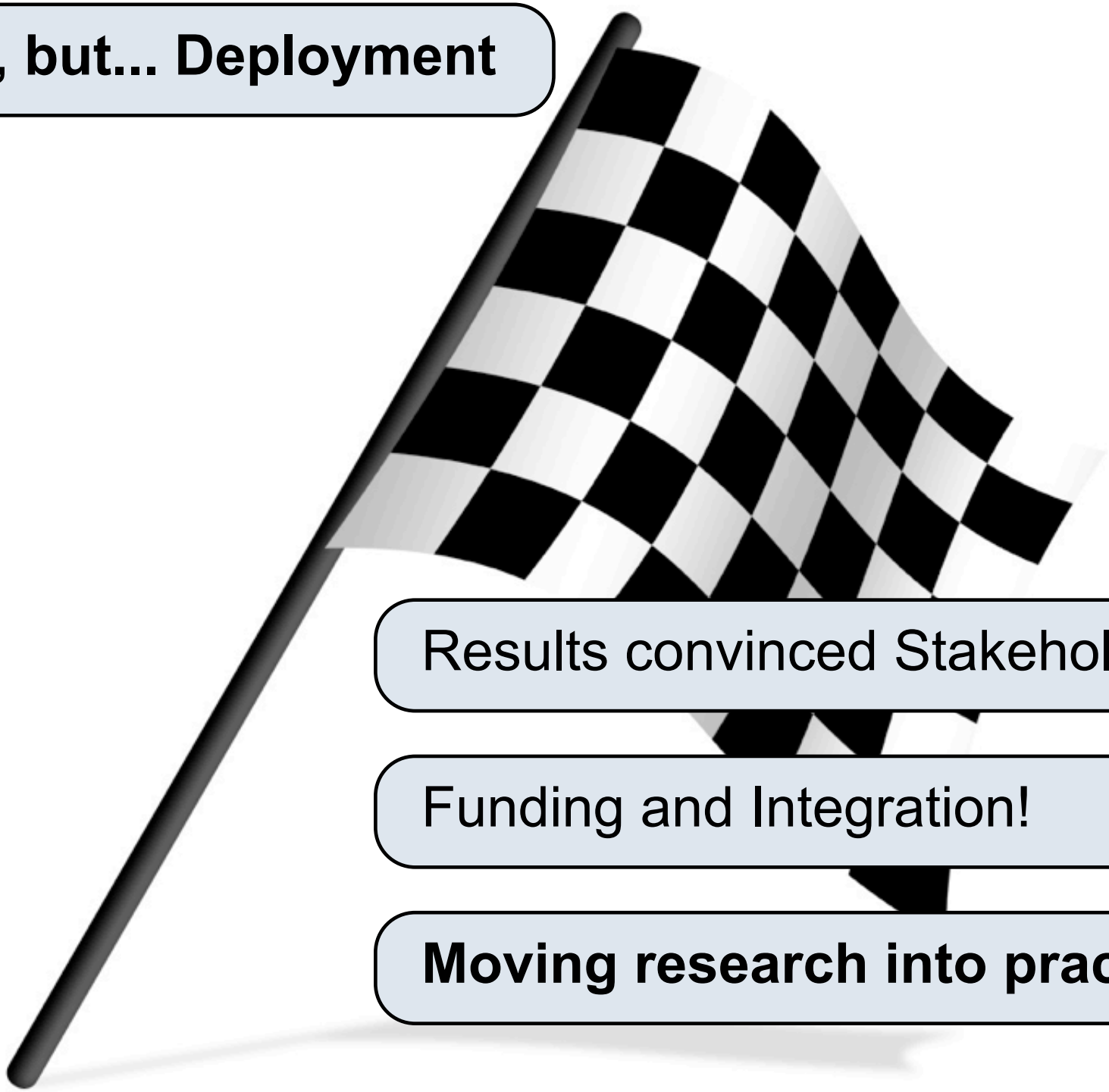
Results.



Significantly Faster!

Insights into data analysis processes?

No, but... Deployment



Results convinced Stakeholders

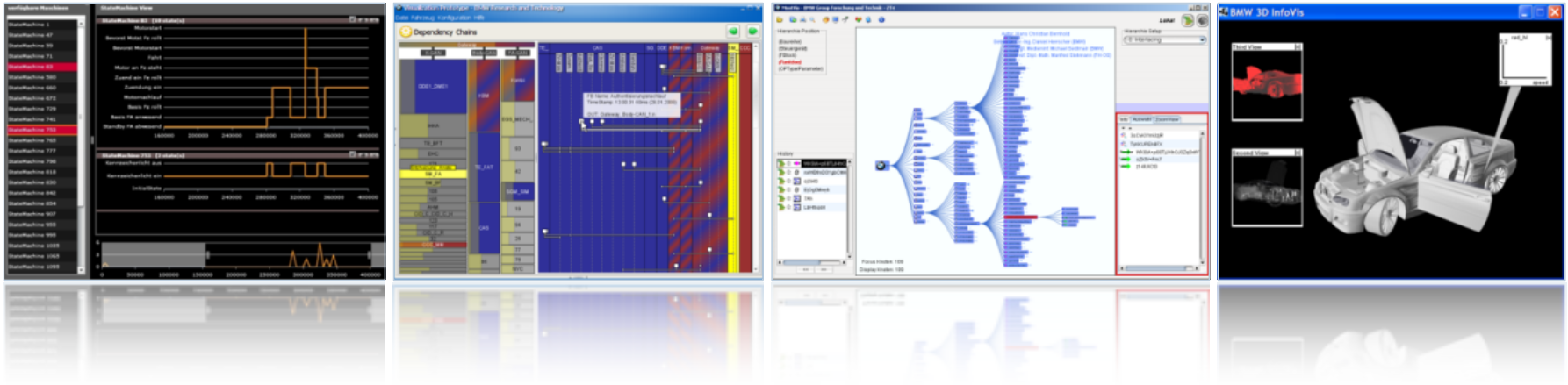
Funding and Integration!

Moving research into practice!

Michael Sedlmair
msedl@cs.ubc.ca

21-10-2010

VA of In-Car Communication Networks.
Outline.



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After all this experience...

Pre-Design

Observational Studies

Focus Groups

Explorative/ Predictive Studies

Interviews

Design

Heuristics

Thinking Aloud

Test Users

Formative Studies

Design Workshops

Post-Design

Pair Evaluation

Formal Experiments

Questionnaires

Summative Studies

Longterm Studies (MILCs)

...Practical Guidance for other Researchers?

InfoVis-Research in Large Companies.

Interesting Problems

Real Data and Users

Funding and Integration

Moving Research into Practice!

Specific Challenges for Designing, Deploying and Evaluating InfoVis tools

Tool	Standalone Prototypes	Fully implemented & integrated System
Studies	Long-term Studies	No Time
Metrics	Find new Insights	Save Money
Results	Publication	Confidentiality

Practical Guidance for other Researchers!

9 Challenges*

16 Recommendations*

* 1. **M. Sedlmair**, P. Isenberg, D. Baur, and A. Butz:
Evaluating Information Visualization in Large Company Settings. BELIV. 2010. **(Best Paper Award)**
2. Submitted as invited Journal Paper to: Palgrave Information Visualization Journal.

Challenges - Recommendations.

Short Name	*Description*	*pre*	*during*	*post*
	Study/Application Design			
C1-INTEGRATE	Integrating Tools in Daily Work Processes		x	x
C2-DATA	Getting the Data		x	x
	Participants			
				x
				x
				x
	Data Collection			
C6-CONFIDENTIALITY	Confidentiality of Information	x	x	x
C7-COMPLEX	Complex Work Processes	x		
	Results			
C8-STAKEHOLDERS	Convincing the Stakeholders	x	x	x
C9-PUBLISHING	Publishing	x	x	x

Studying Tools “In-depth”?

tion	*pre*	*during*	*post*
Study/Application Design			
ne Technical Obstacles of Tool Integration		x	x
dditional Steps to Work with Domain-specific Data		x	x
your Study Environment with Care	x	x	x
r both Employee-pull and Researcher-push Solutions	x	x	
with Usability and Aesthetics, Avoid Window-dressing		x	
Installation and Tech Support		x	x
Participants			
R7-ONEHOUR The Magic One Hour Limit	x	x	x
R8-CONVINCE Convincing the Target Audience		x	x
R12-LEGAL Try to get a License, Do Studies in any Case	x	x	x
R13-CCC Be in Constant, Close Cooperation	x	x	x
Results			
R14-MONEY The Magic Metric: Money			x
R15-SKILL Factor in High Skill with Current Techniques			x
R16-PUBLISH Clarify Publishing Conditions Upfront	x	x	x

Overcome Technical Problems of Tool Integration!

Challenges - Recommendations.

Short Name	*Description*	*pre*	*during*	*post*
	Study/Application Design			
C1-INTEGRATE	Integrating Tools in Daily Work Processes		x	x
C2-DATA	Getting the Data		x	x
	Participants			
C6-CONFIDENTIALITY	Confidentiality of Information	x	x	x
C7-COMPLEX	Complex Work Processes	x		
	Results			
C8-STAKEHOLDERS	Convincing the Stakeholders	x	x	x
C9-PUBLISHING	Publishing	x	x	x

Getting Time from Domain Experts

tion	*pre*	*during*	*post*
Study/Application Design			
ne Technical Obstacles of Tool Integration		x	x
dditional Steps to Work with Domain-specific Data		x	x
your Study Environment with Care	x	x	x
r both Employee-pull and Researcher-push Solutions	x	x	
with Usability and Aesthetics, Avoid Window-dressing		x	
Installation and Tech Support		x	x

The Magic One Hour Rule!

R11-REMIND	Gentle Reminders			x

Delight with Usability and Aesthetics, not Eye-candy!

R14-MONEY	The Magic Metric: Money			x
R15-SKILL	Factor in High Skill with Current Techniques			x
R16-PUBLISH	Clarify Publishing Conditions Upfront	x	x	x

Challenges - Recommendations.

Short Name	*Description*	*pre*	*during*	*post*
	Study/Application Design			
C1-INTEGRATE	Integrating Tools in Daily Work Processes		x	x
C2-DATA	Getting the Data		x	x
	Participants			
C6-CONFIDENTIALITY	Confidentiality of Information	x	x	x
C7-COMPLEX	Complex Work Processes	x		
	Results			
C8-STAKEHOLDERS	Convincing the Stakeholders	x	x	x
C9-PUBLISHING	Publishing	x	x	x

Complex Work Processes

tion		*pre*	*during*	*post*
	Study/Application Design			
	ne Technical Obstacles of Tool Integration		x	x
	dditional Steps to Work with Domain-specific Data		x	x
	your Study Environment with Care	x	x	x
	r both Employee-pull and Researcher-push Solutions	x	x	
	with Usability and Aesthetics, Avoid Window-dressing		x	
	Installation and Tech Support		x	x
	Participants			
R7-ONEHOUR	The Magic One Hour Limit	x	x	x
R8-CONVINCE	Convincing the Target Audience		x	x
R12-LEGAL	Try to get a License, Do Studies in any Case	x	x	x
R13-CCC	Be in Constant, Close Cooperation	x	x	x
	Results			
R14-MONEY	The Magic Metric: Money			x
R15-SKILL	Factor in High Skill with Current Techniques			x
R16-PUBLISH	Clarify Publishing Conditions Upfront	x	x	x

Be in Constant Close Cooperation!

Challenges - Recommendations.

Short Name	*Description*	*pre*	*during*	*post*
	Study/Application Design			
C1-INTEGRATE	Integrating Tools in Daily Work Processes		x	x
C2-DATA	Getting the Data		x	x
	Participants			
C6-CONFIDENTIALITY	Confidentiality of Information	x	x	x
C7-COMPLEX	Complex Work Processes	x		
	Results			
C8-STAKEHOLDERS	Convincing the Stakeholders	x	x	x
C9-PUBLISHING	Publishing	x	x	x

Convincing Stakeholders?

tion	*pre*	*during*	*post*
Study/Application Design			
ne Technical Obstacles of Tool Integration		x	x
dditional Steps to Work with Domain-specific Data		x	x
your Study Environment with Care	x	x	x
r both Employee-pull and Researcher-push Solutions	x	x	
with Usability and Aesthetics, Avoid Window-dressing		x	
Installation and Tech Support		x	x
Participants			
Data Collection			
R16-PUBLISH Clarify Publishing Conditions Upfront	x	x	x

The Magic Metric Money!

Consider Employee-pull and Researcher-Push!

Michael Sedlmair
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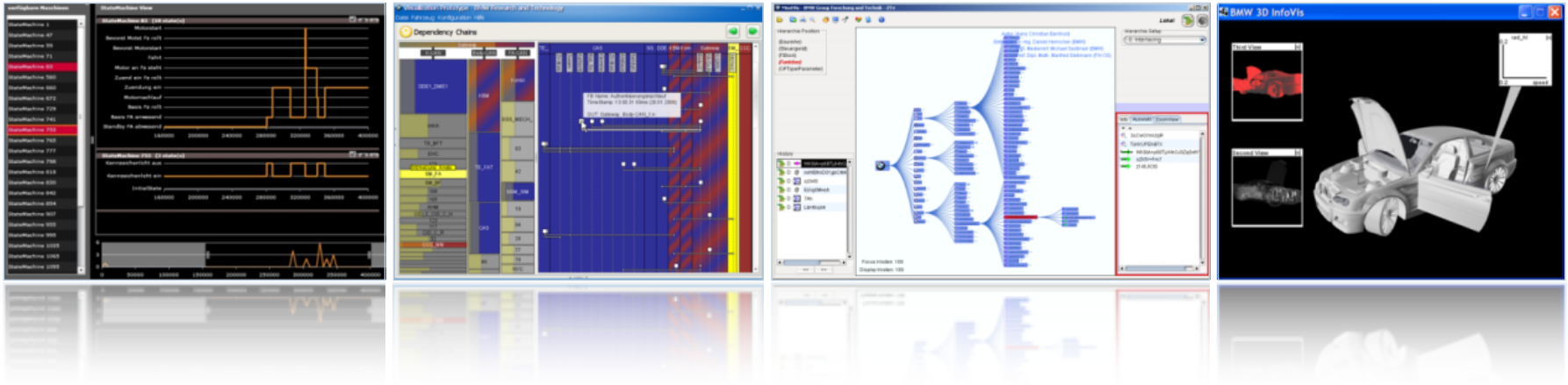
21-10-2010

VA of In-Car Communication Networks.
Outline.



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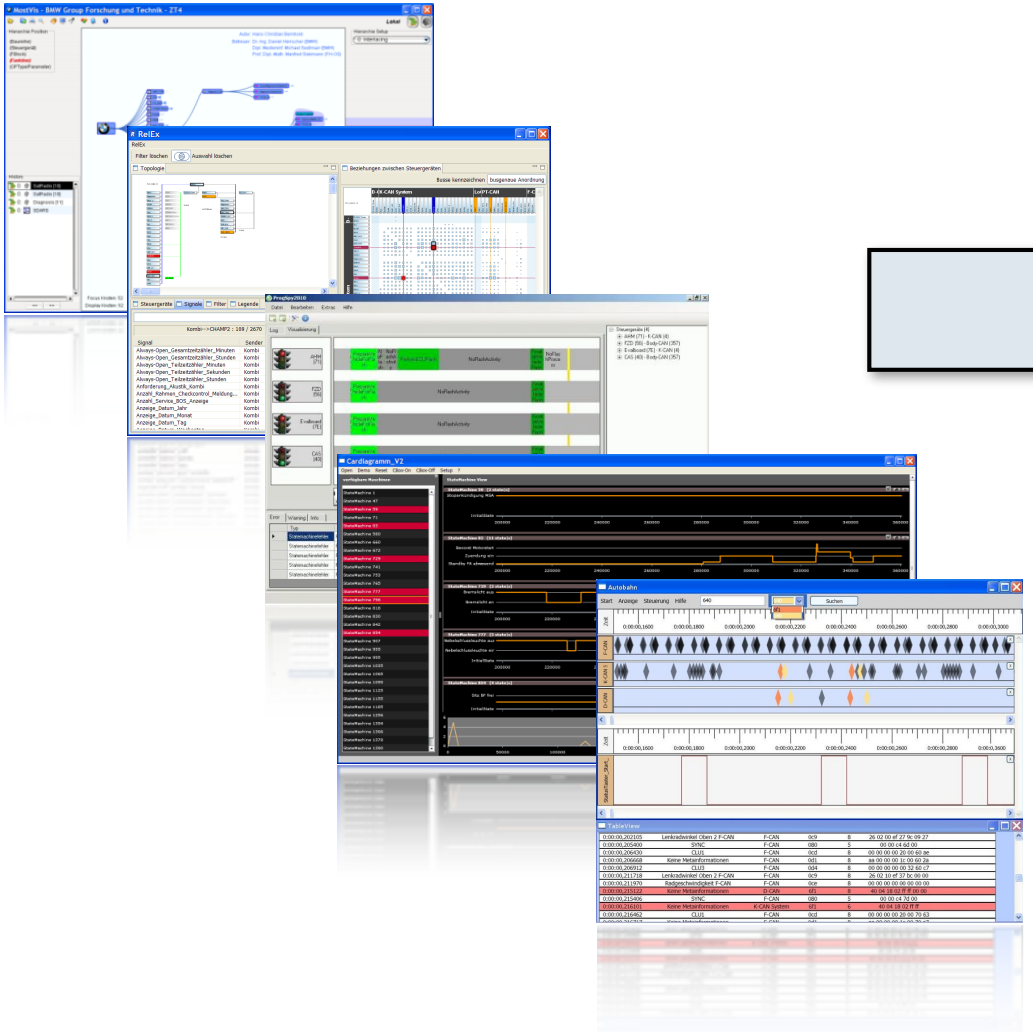
- ***Conclusions*: Summary and Future Work**

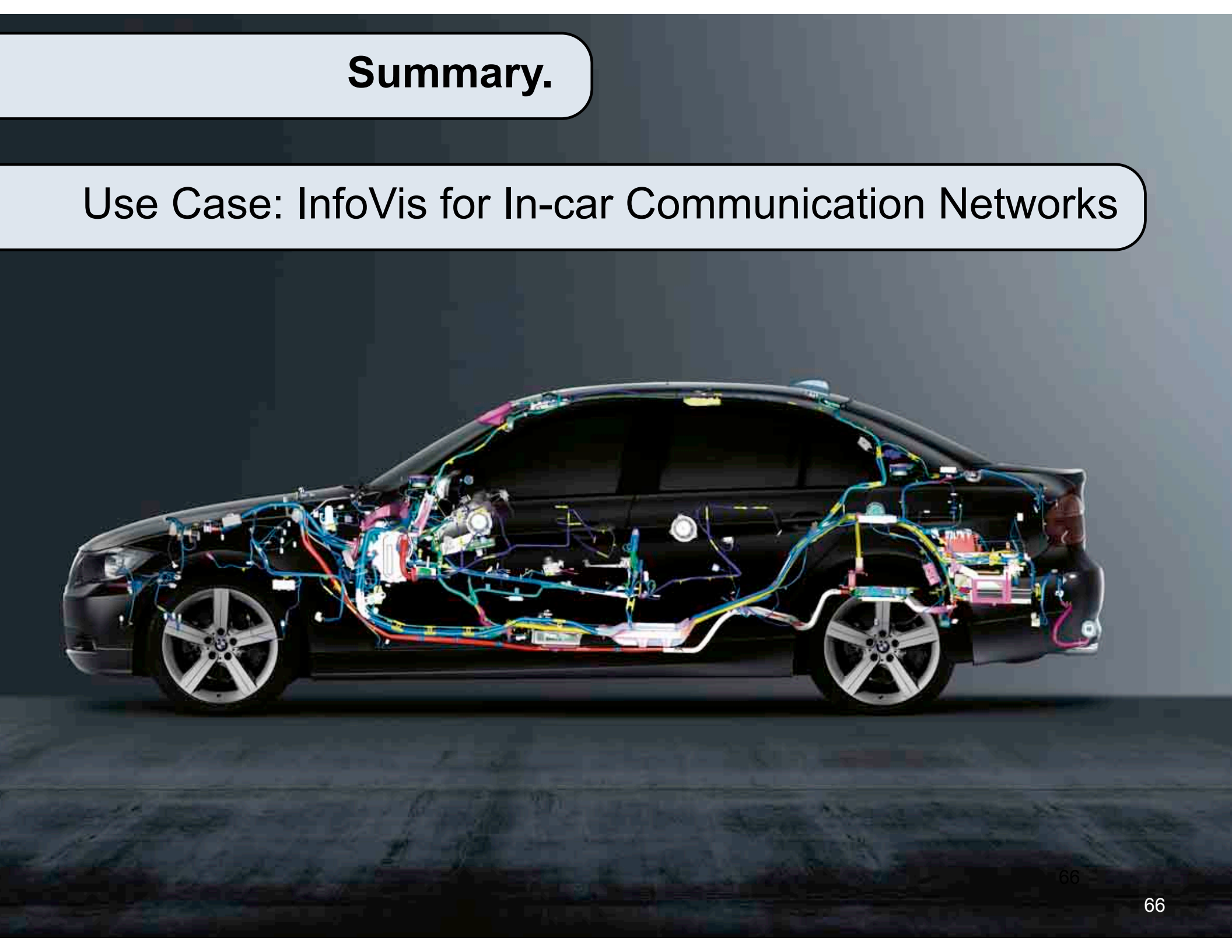
Summary.

Moving Research into Practice in a Large Company



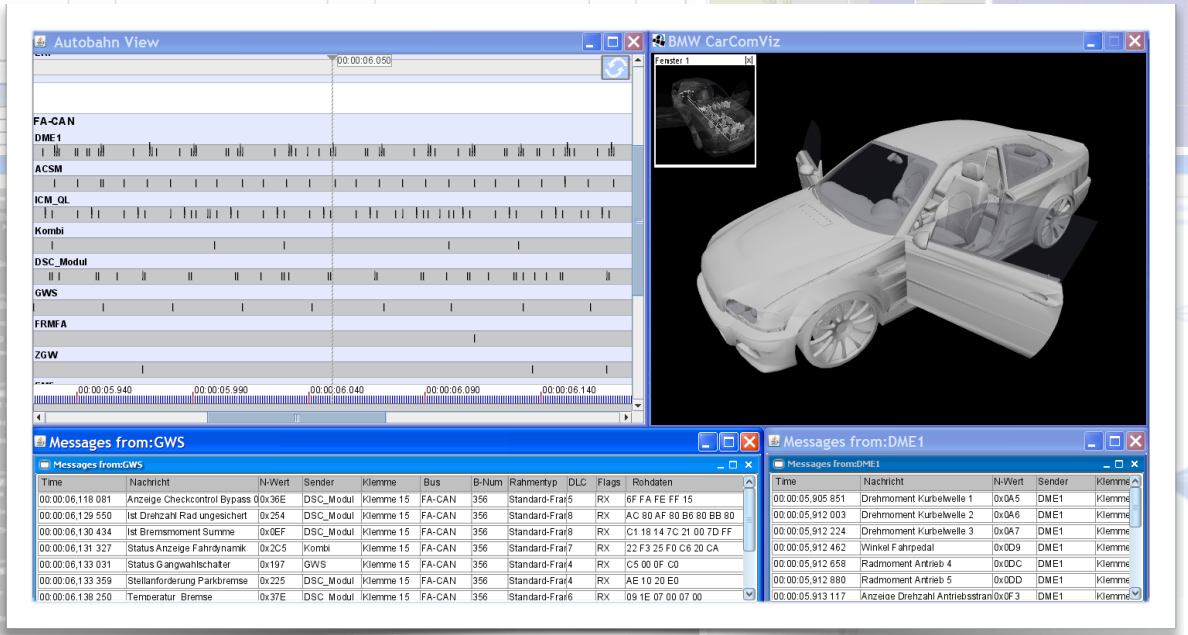
Summary.

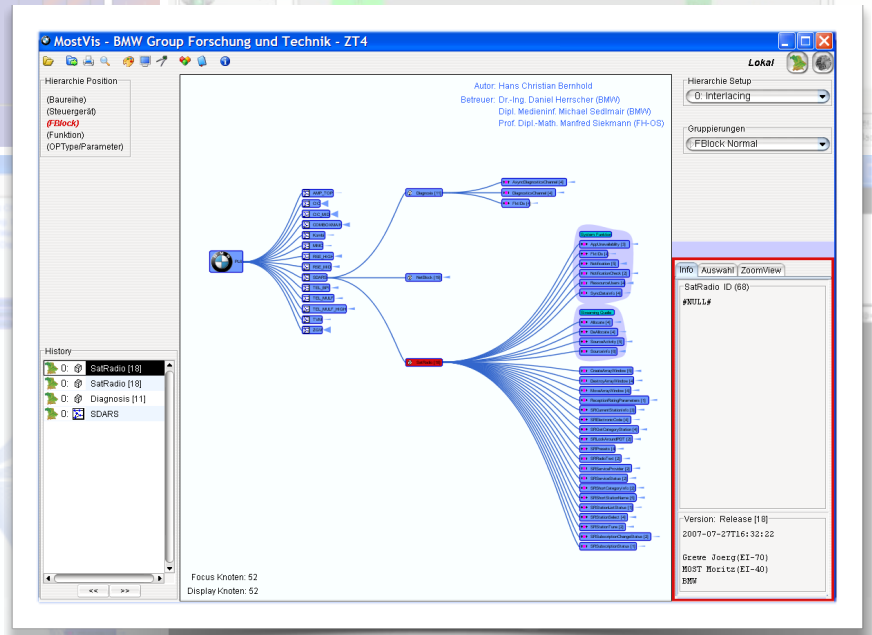
Use Case: InfoVis for In-car Communication Networks



66

Summary.





2 Example Projects (from 9 Design Studies)

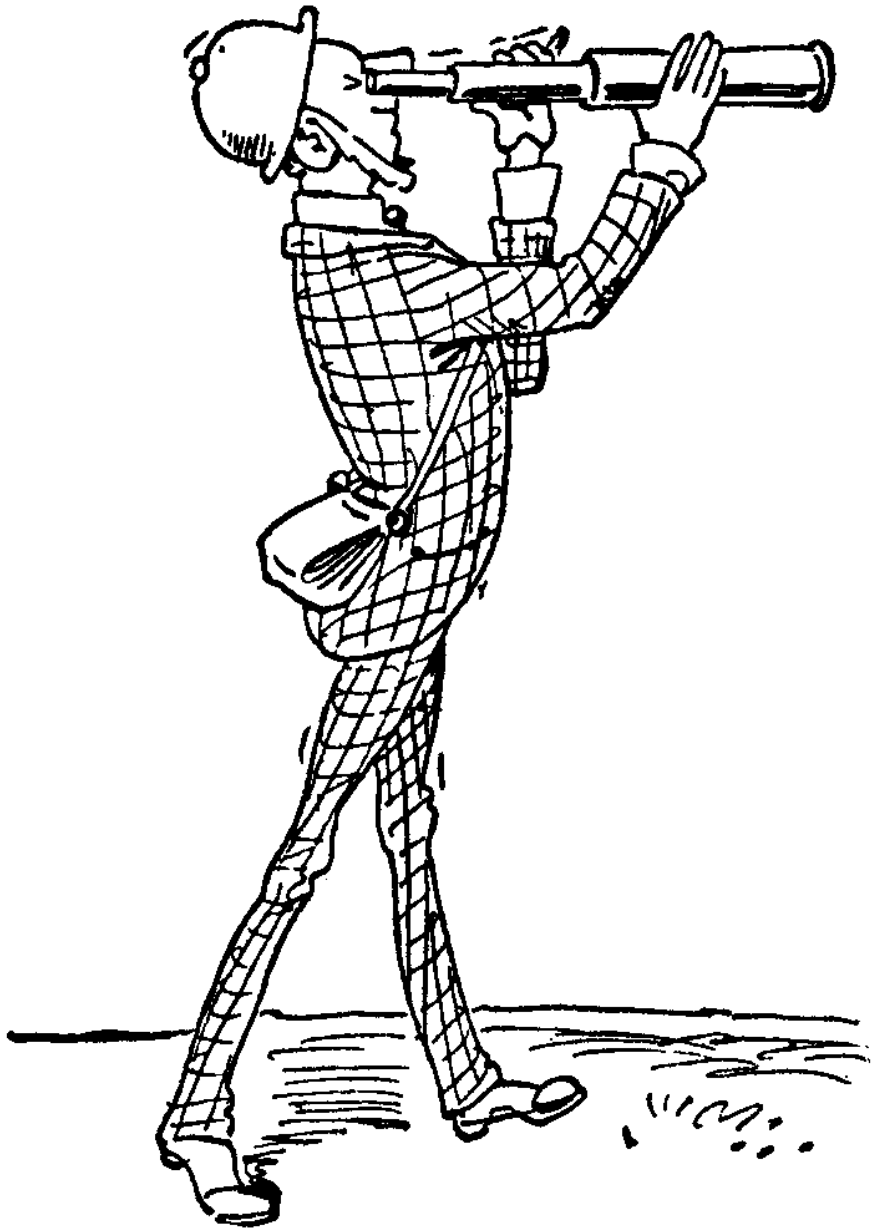
Summary.

Short Name	*Description*	*pre*	*during*	*post*
	Study/Application Design			
C1-INTEGRATE	Integrating Tools in Daily Work Processes		x	x
C2-DATA	Getting the Data		x	x
	Participants			
C3-CHOOSE	Choosing Domain Expert Participants	x	x	x
C4-TIME	Getting Time From Domain Experts	x	x	x
C5-CONVENTIONS	Attachment to Conventional Techniques			x
	Data Collection			
C6-CONFIDENTIALITY	Confidentiality of Information	x	x	x
C7-COMPLEX	Complex Work Processes	x		
	Results			
C8-STAKEHOLDERS	Convincing the Stakeholders	x	x	x
C9-PUBLISHING	Publishing	x	x	x

tion	*pre*	*during*	*post*
Study/Application Design			
me Technical Obstacles of Tool Integration		x	x
dditional Steps to Work with Domain-specific Data		x	x
your Study Environment with Care	x	x	x
r both Employee-pull and Researcher-push Solutions	x	x	
with Usability and Aesthetics, Avoid Window-dressing		x	
Installation and Tech Support		x	x
Participants			
gic One Hour Limit	x	x	x
cing the Target Audience		x	x
om the Experts	x		
t Usability Studies with Outside Testers		x	
Reminders			x
Data Collection			
R12-LEGAL Try to get a License, Do Studies in any Case	x	x	x
R13-CCC Be in Constant, Close Cooperation	x	x	x
Results			
R14-MONEY The Magic Metric: Money			x
R15-SKILL Factor in High Skill with Current Techniques			x
R16-PUBLISH Clarify Publishing Conditions Upfront	x	x	x

InfoVis in a Large Company Setting

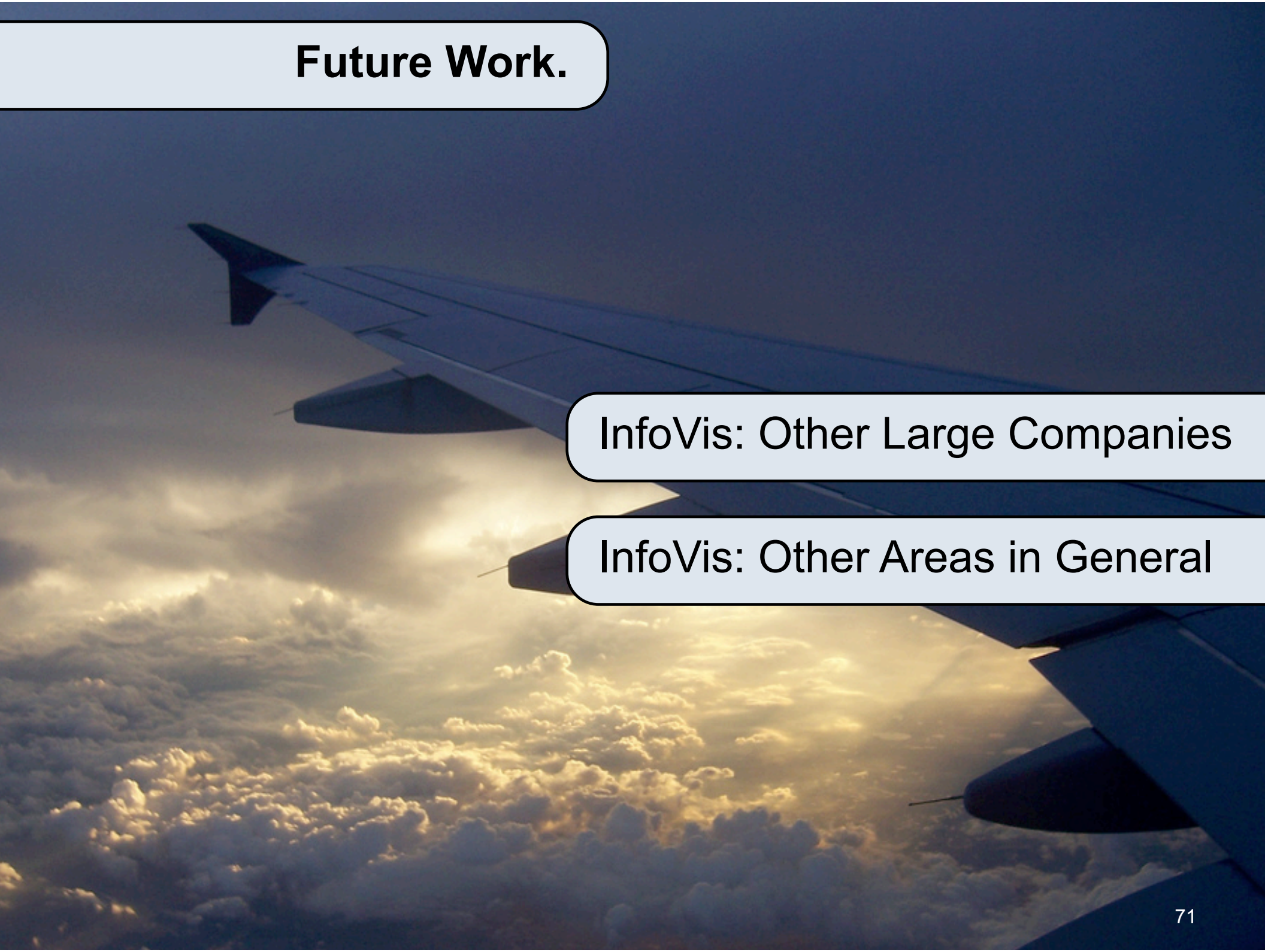
Future Work.



Future Work.

BMW: More In-depth Studies

Future Work.



InfoVis: Other Large Companies

InfoVis: Other Areas in General

Future Work.

Me: Users of DimRed

Michael Sedlmair
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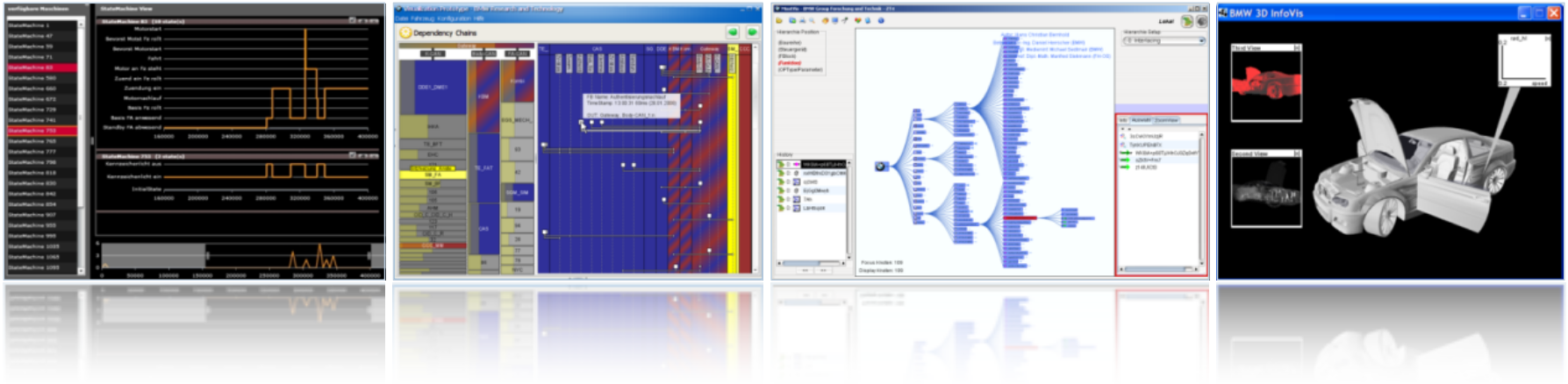
21-10-2010

Thank you.

Questions?



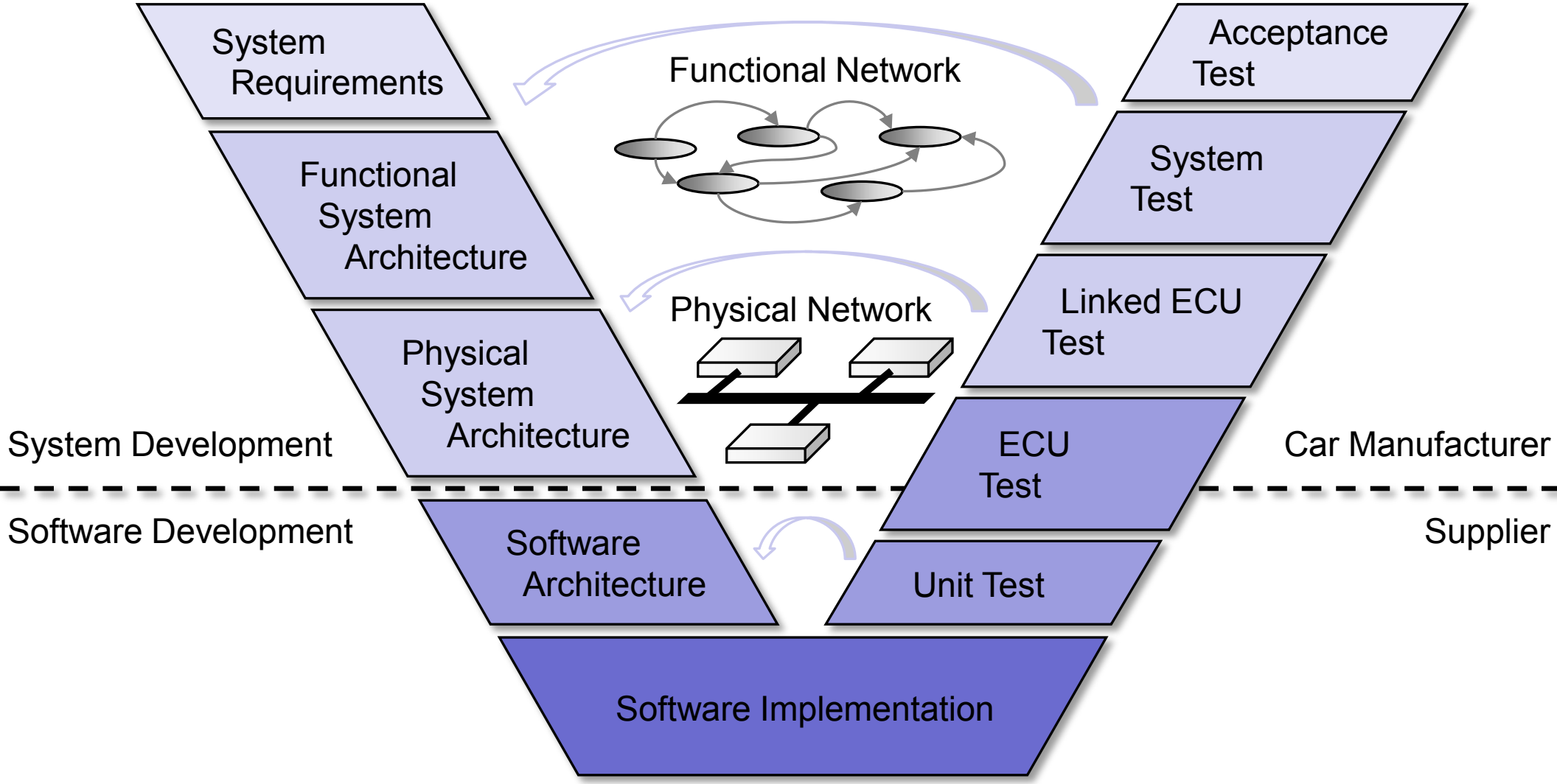
Michael Sedlmair

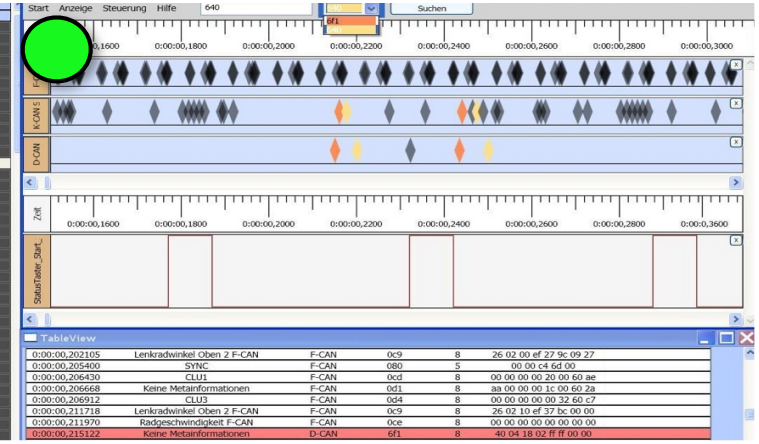
BMW Group.
Research and Technology.

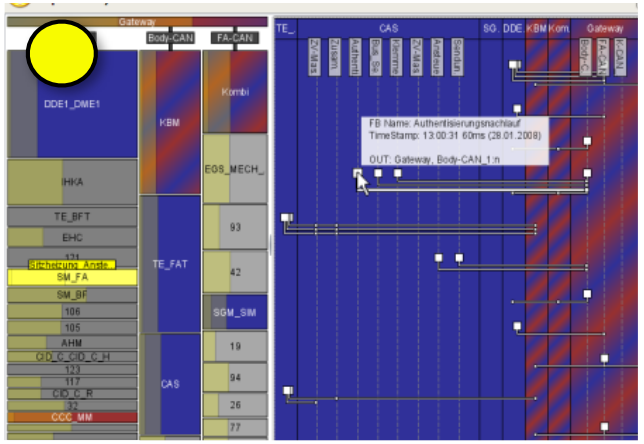
University of Munich.
Media Informatics Group.

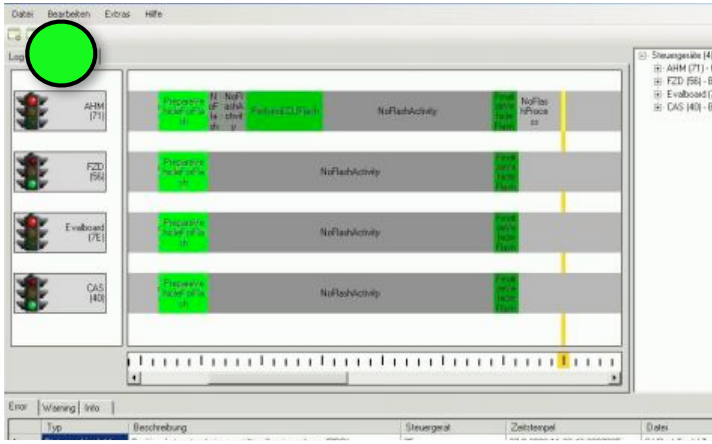
Backup Slides

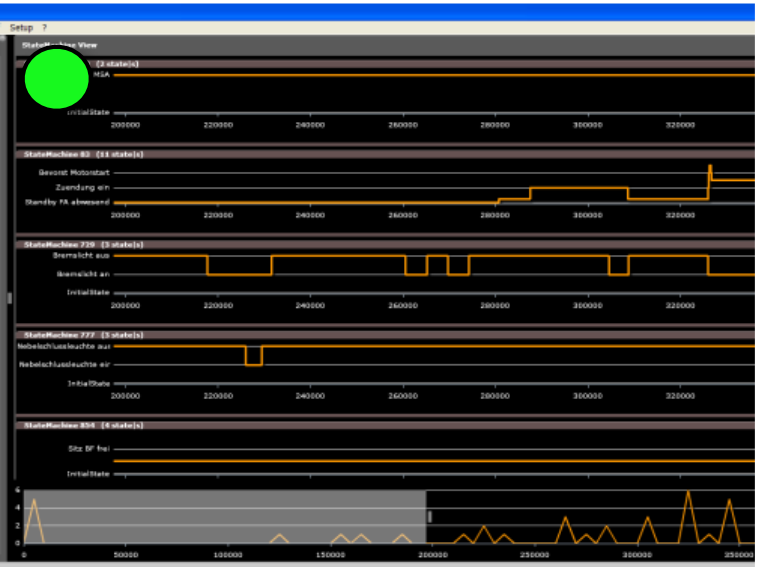
Publication	Prototype
M. Sedlmair, C. Bernhold, D. Herrscher, S. Boring, and A. Butz. Mostvis: An interactive visualization supporting automotive engineers in most catalog exploration. In *Proceedings of the International Conference Information Visualisation (IV'09)*, pages 173–182, Los Alamitos, CA, USA, 2009. IEEE Computer Society.	MostVis
M. Sedlmair, W. Hintermaier, K. Stocker, T. Büring, and A. Butz. A dual-view visualization of in-car communication processes. In *Proceedings of the International Conference on Information Visualization (IV'08)*, pages 157–162, Los Alamitos, CA, USA, 2008. IEEE Computer Society.	VisTra
M. Sedlmair. MSCar: Enhancing Message Sequence Charts with Interactivity for Analysing (Automotive) Communication Sequences. In *Proceedings of the International Workshop on the Layout of (Software) Engineering Diagrams (LED'08)*. 2008. Electronic Communications of the EASST Vol. 13. Article 7.	VisTra (parts)
M. Sedlmair, B. Kunze, W. Hintermaier, and A. Butz. User-centered Development of a Visual Exploration System for In-Car Communication. In *Proceedings of the International Symposium on Smart Graphics (SG'09)*, pages 105–116, Berlin, Germany, 2009. Springer-Verlag.	AutobahnVis (Early)
M. Sedlmair, P. Isenberg, D. Baur, W. Jacobi, M. Mauerer, C. Pigorsch, and A. Butz. Visual Analysis of In-Car Communication Traces. *In submission.*	AutobahnVis & Cardiogram
M. Sedlmair, K. Ruhland, F. Hennecke, A. Butz, S. Bioletti, and Carol O'Sullivan. Towards the Big Picture: Enriching 3D Models with Information Visualisation and Vice Versa. In *Proceedings of the International Symposium on Smart Graphics (SG'09)*, pages 27–39, Berlin, Germany, 2009. Springer-Verlag.	Autobahn3D
M. Sedlmair, P. Isenberg, D. Baur, and A. Butz. Evaluating Information Visualization in Large Companies: Challenges, Experiences and Recommendations. In *Proceedings of CHI Workshop on BEyond Time and Errors: Novel Evaluation Methods for Information Visualization (BELIV'10)*, pages 79–86, New York, NY, USA, 2010. ACM Press. *Best Paper Award, Extension for Journal Paper (Information Visualization, Palgrave Macmillan) in preparation.*	AutobahnVis & Autobahn3D (as examples)

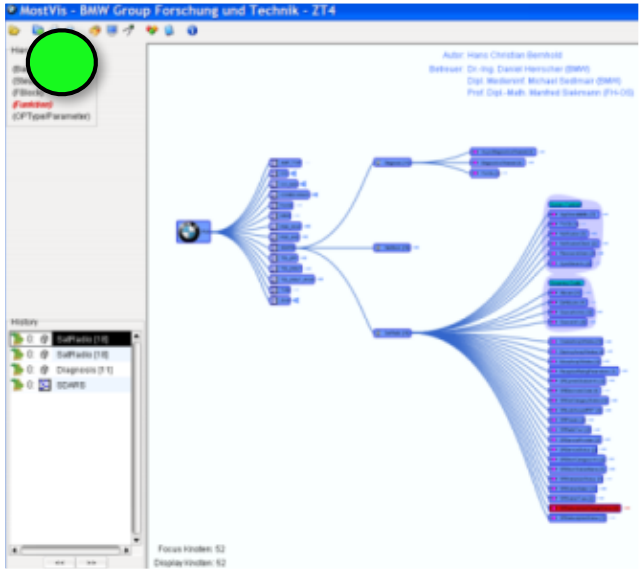

System Requirements
Functional System Architecture
Physical System Architecture
Software Architecture
Software Implementation
Unit Test
ECU Test
Linked ECU Test
System Test
Acceptance Test
Functional Network
Physical Network
System Development
Software Development
Car Manufacturer
Supplier

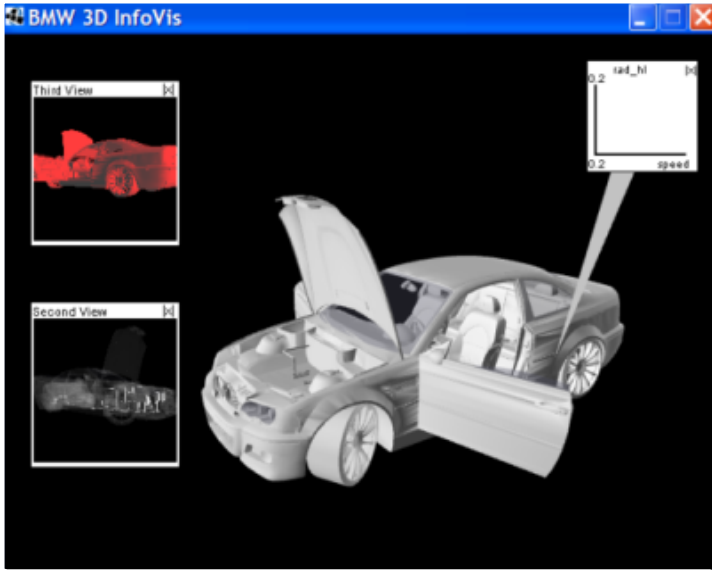

TableView

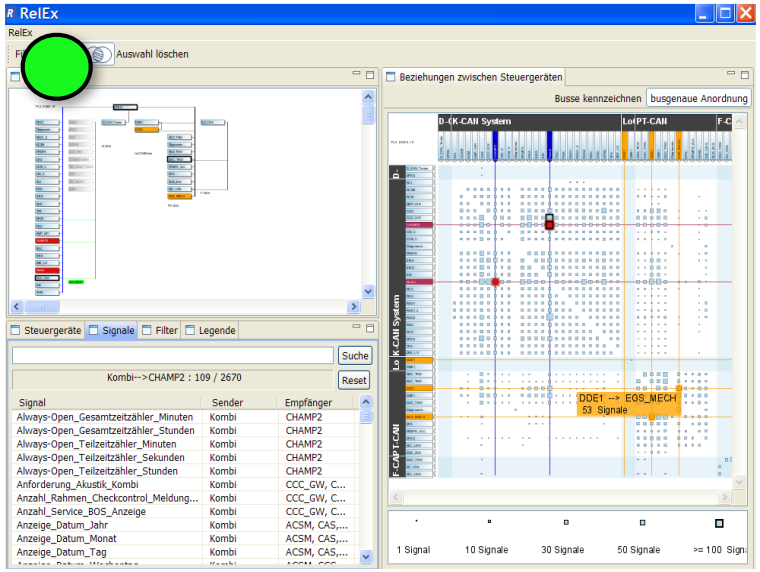

Gateway
DDE1_DME1
KBM
Kombi
IHKA
TE_BFT
EHC
SM_FA
SM_BF
AHM
CAS
FB Name: Authentisierungsnachlauf
TimeStamp: 13:00:31 60ms (28.01.2008)
OUT: Gateway, Body-CAN_1.n

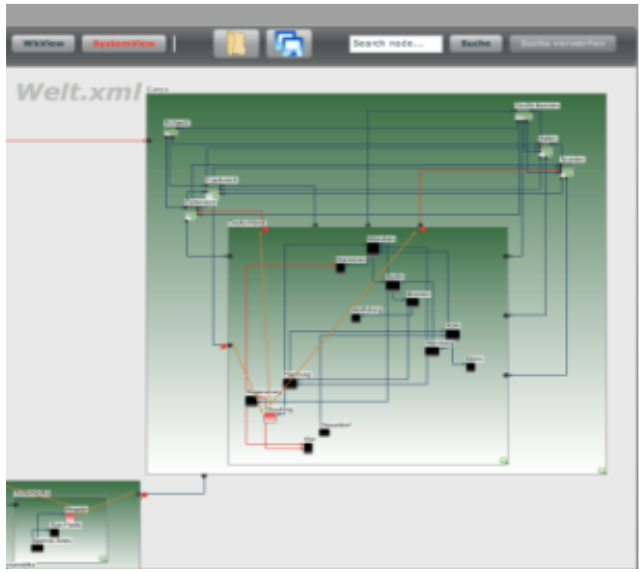

AHM
FZD
Evalboard
CAS
NoFlashActivity

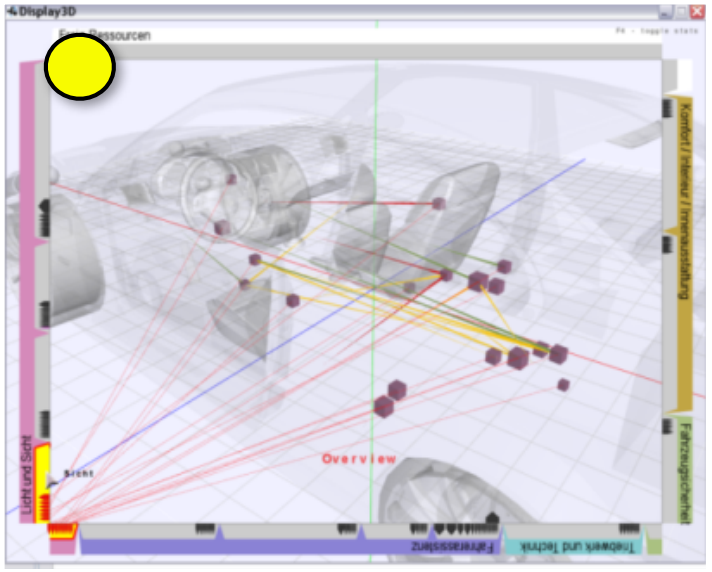

Setup

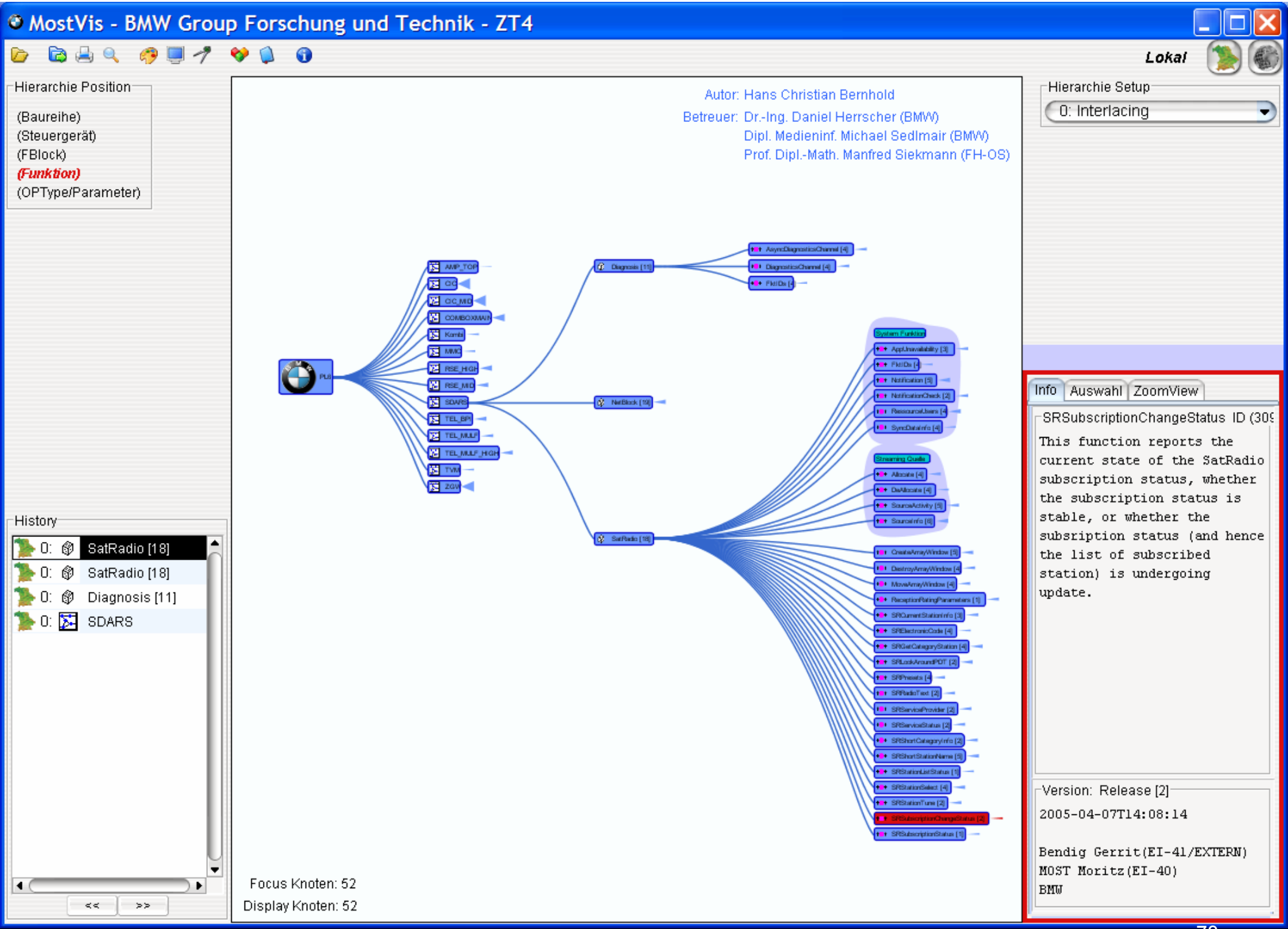

MostVis - BMW Group Forschung und Technik - ZT4

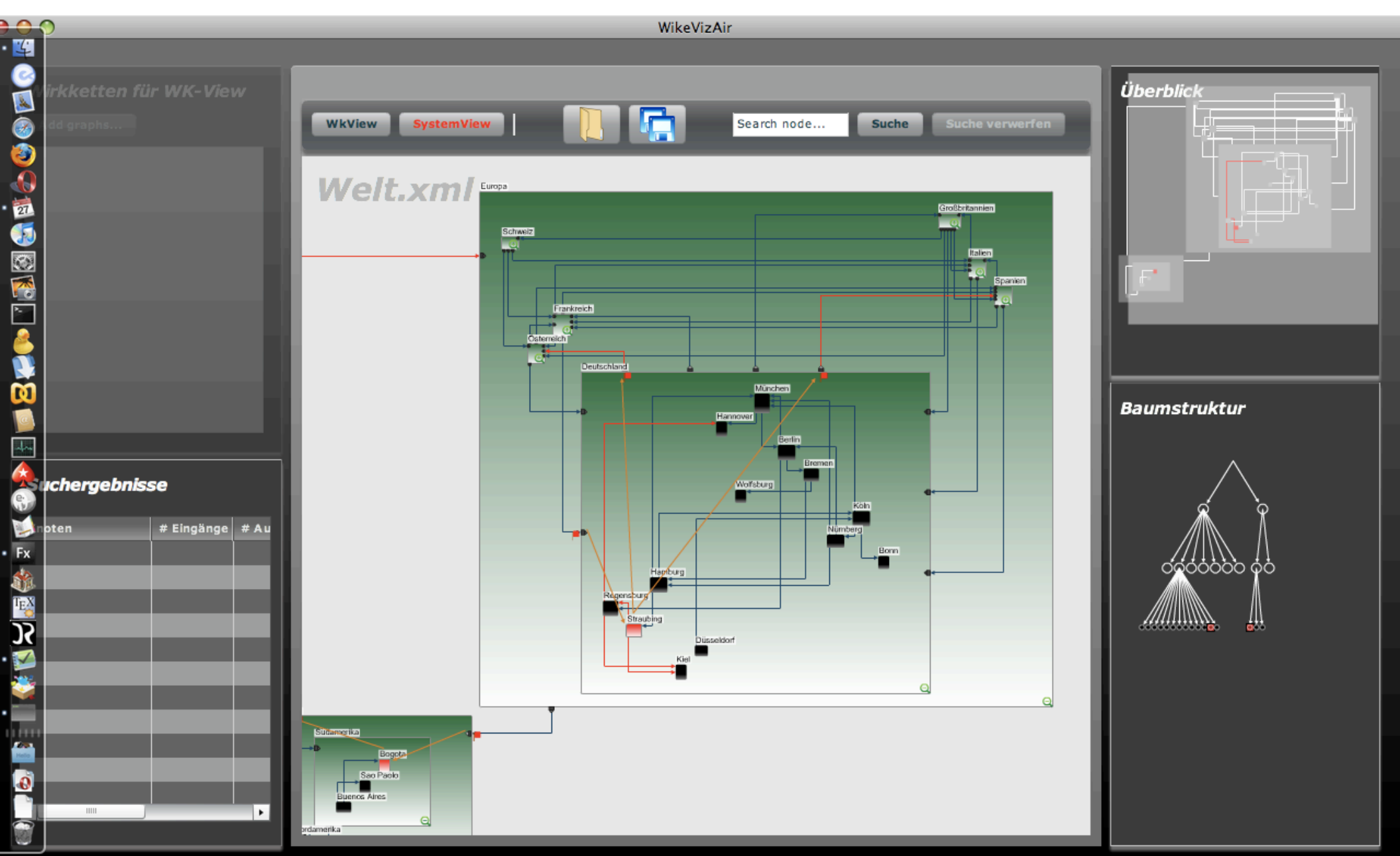

BMW 3D InfoVis
Third View
Second View
speed

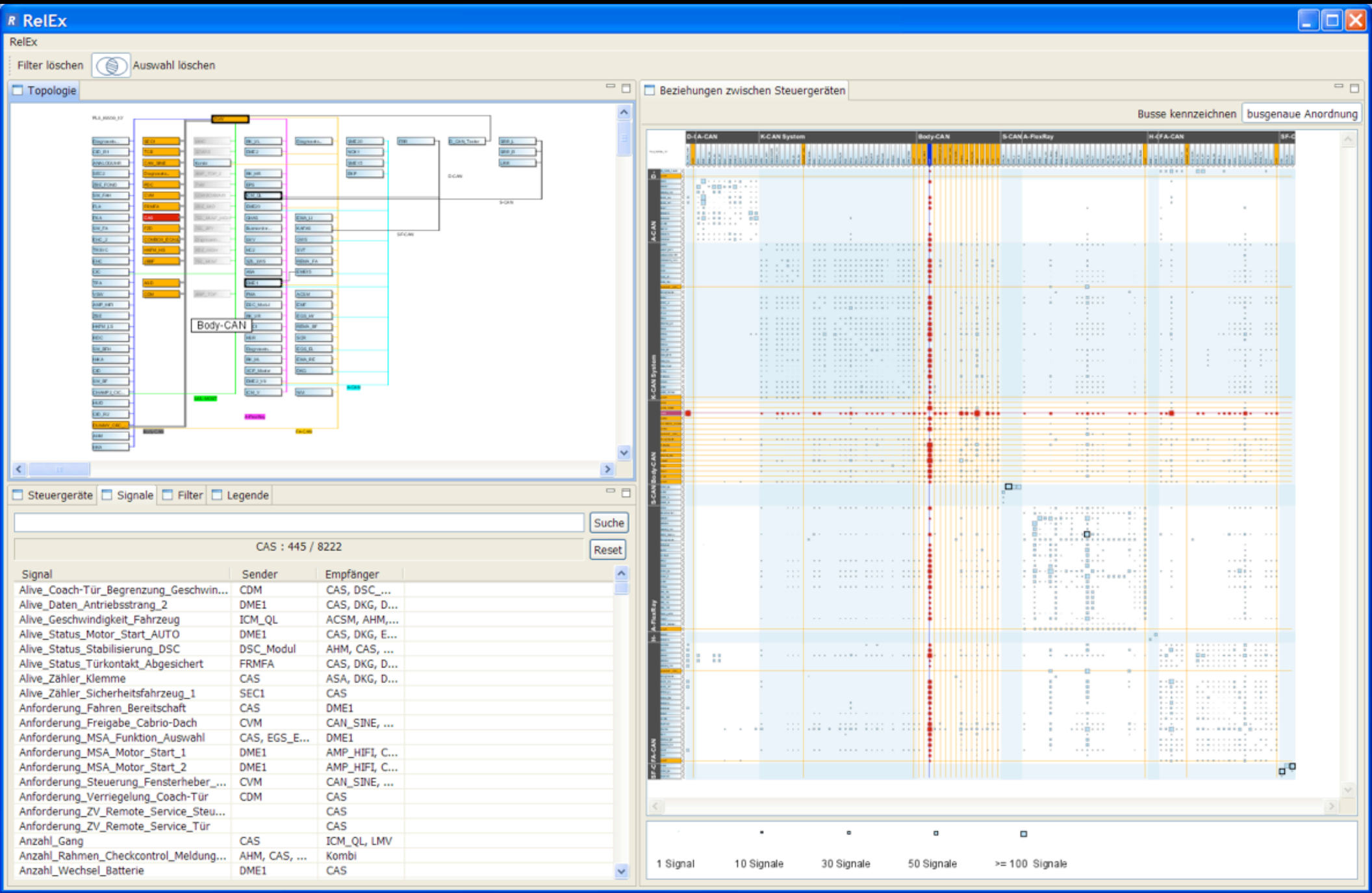

RelEx
Auswahl löschen
Beziehungen zwischen Steuergeräten
Busse kennzeichnen
busgenaue Anordnung
Steuergeräte
Signale
Filter
Legende
Suche
Reset
Kombi-->CHAMP2 : 109 / 2670
Signal
Sender
Empfänger
Always-Open_Gesamtzeitzähler_Minuten
Always-Open_Gesamtzeitzähler_Stunden
Always-Open_Teilzeitzähler_Minuten
Always-Open_Teilzeitzähler_Sekunden
Always-Open_Teilzeitzähler_Stunden
Anforderung_Akustik_Kombi
Anzahl_Rahmen_Checkcontrol_Meldung...
Anzahl_Service_BOS_Anzeige
Anzeige_Datum_Jahr
Anzeige_Datum_Monat
Anzeige_Datum_Tag
D-(K-CAN System
Lo(PT-CAN
DDE1 --> EGS_MECH
53 Signale
1 Signal
10 Signale
30 Signale
50 Signale
>= 100 Signale

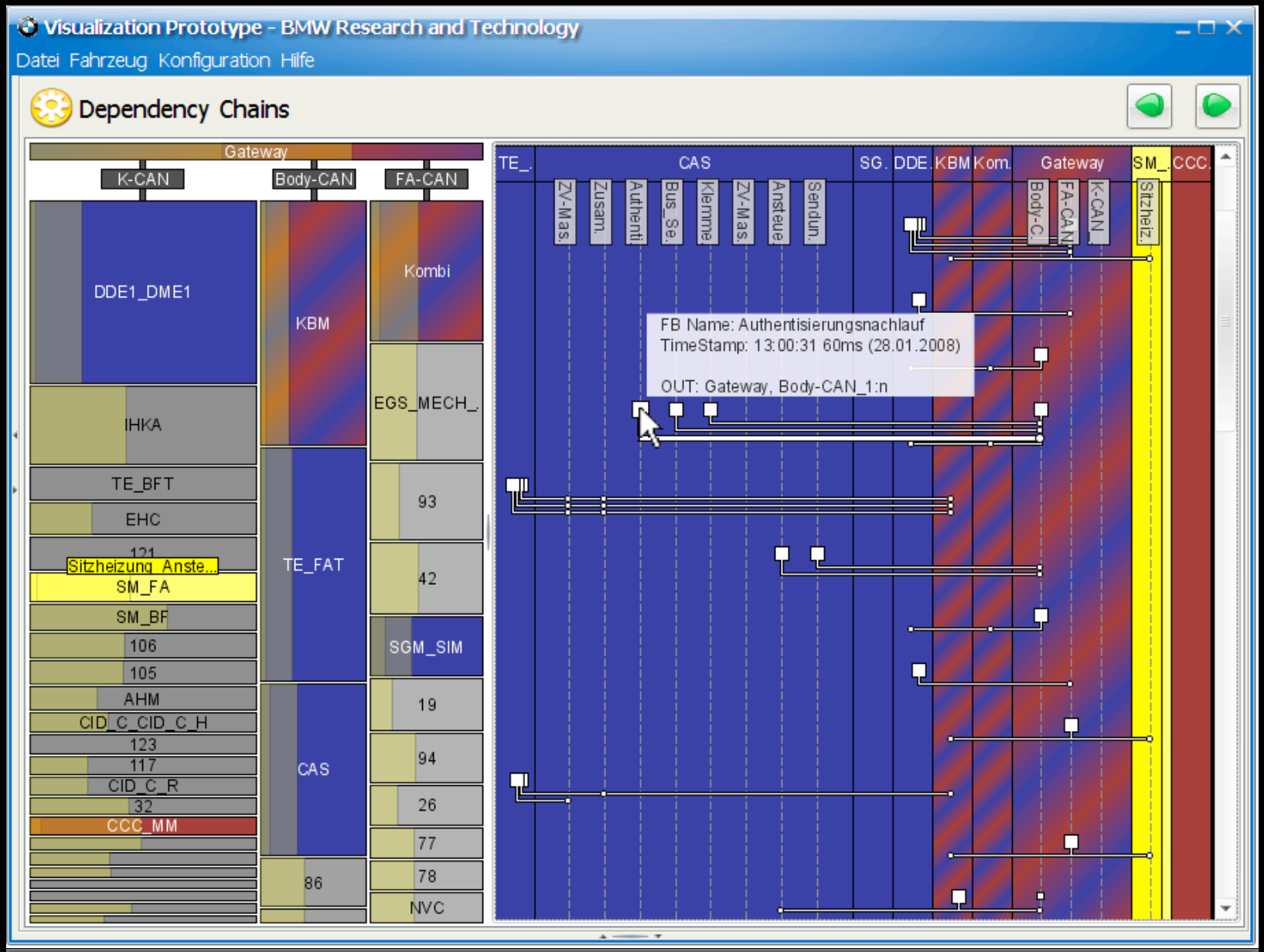

Welt.xml

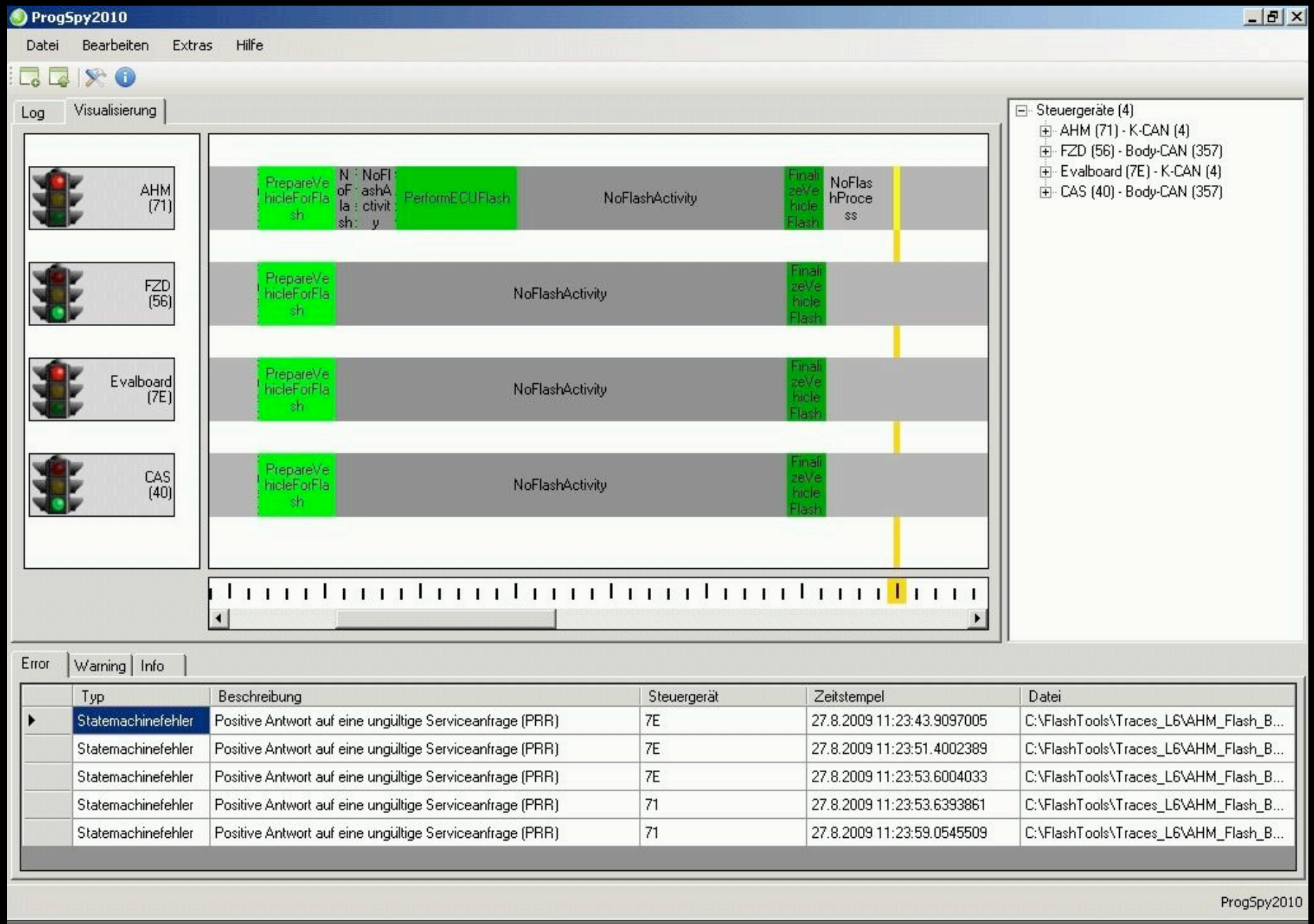

Display3D
Overview
Licht und Sicht


MostVis - BMW Group Forschung und Technik - ZT4
Lokal
Hierarchie Position
(Baureihe)
(Steuergerät)
(FBlock)
(Funktion)
(OPType/Parameter)
Autor: Hans Christian Bernhold
Betreuer: Dr.-Ing. Daniel Herrscher (BMW)
Dipl. Medieninf. Michael Sedlmair (BMW)
Prof. Dipl.-Math. Manfred Siekmann (FH-OS)
Hierarchie Setup
0: Interlacing
History
0: SatRadio [18]
0: SatRadio [18]
0: Diagnosis [11]
0: SDARS
<<
>>
Focus Knoten: 52
Display Knoten: 52
Info
Auswahl
ZoomView
SRSubscriptionChangeStatus ID (309
This function reports the current state of the SatRadio subscription status, whether the subscription status is stable, or whether the subsription status (and hence the list of subscribed station) is undergoing update.
Version: Release [2]
2005-04-07T14:08:14
Bendig Gerrit(EI-41/EXTERN)
MOST Moritz(EI-40)
BMW

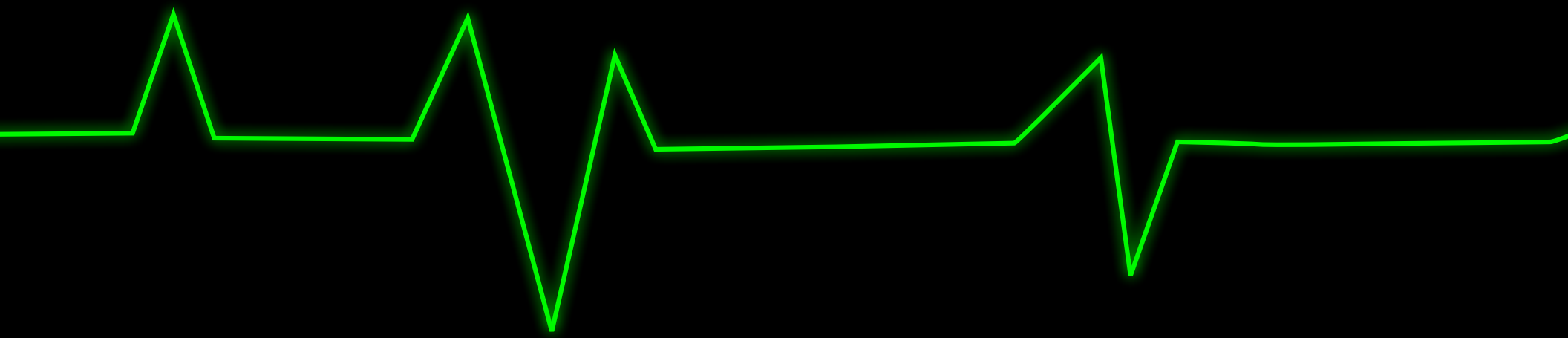

WikeVizAir
Wirkketten für WK-View
Add graphs...
Suchergebnisse
Knoten
Eingänge
Au
WkView
SystemView
Search node...
Suche
Suche verwerfen
Welt.xml
Europa
Großbritannien
Schweiz
Italien
Spanien
Frankreich
Österreich
Deutschland
München
Hannover
Berlin
Bremen
Wolfsburg
Köln
Nürnberg
Bonn
Hamburg
Regensburg
Straubing
Düsseldorf
Kiel
Südamerika
Bogota
Sao Paolo
Buenos Aires
Überblick
Baumstruktur


RelEx
RelEx
Filter löschen
Auswahl löschen
Topologie
Body-CAN
Beziehungen zwischen Steuergeräten
Busse kennzeichnen
busgenaue Anordnung
D-(A-CAN
K-CAN System
Body-CAN
S-CAN
A-FlexRay
H-(FA-CAN
Steuergeräte
Signale
Filter
Legende
Suche
CAS : 445 / 8222
Reset
Signal
Sender
Empfänger
Alive_Coach-Tür_Begrenzung_Geschwin...
CDM
CAS, DSC_...
Alive_Daten_Antriebsstrang_2
DME1
CAS, DKG, D...
Alive_Geschwindigkeit_Fahrzeug
ICM_QL
ACSM, AHM,...
Alive_Status_Motor_Start_AUTO
DME1
CAS, DKG, E...
Alive_Status_Stabilisierung_DSC
DSC_Modul
AHM, CAS, ...
Alive_Status_Türkontakt_Abgesichert
FRMFA
CAS, DKG, D...
Alive_Zähler_Klemme
CAS
ASA, DKG, D...
Alive_Zähler_Sicherheitsfahrzeug_1
SEC1
CAS
Anforderung_Fahren_Bereitschaft
CAS
DME1
Anforderung_Freigabe_Cabrio-Dach
CVM
CAN_SINE, ...
Anforderung_MSA_Funktion_Auswahl
CAS, EGS_E...
DME1
Anforderung_MSA_Motor_Start_1
DME1
AMP_HIFI, C...
Anforderung_MSA_Motor_Start_2
DME1
AMP_HIFI, C...
Anforderung_Steuerung_Fensterheber_...
CVM
CAN_SINE, ...
Anforderung_Verriegelung_Coach-Tür
CDM
CAS
Anforderung_ZV_Remote_Service_Steu...
CAS
Anforderung_ZV_Remote_Service_Tür
CAS
Anzahl_Gang
CAS
ICM_QL, LMV
Anzahl_Rahmen_Checkcontrol_Meldung...
AHM, CAS, ...
Kombi
Anzahl_Wechsel_Batterie
DME1
CAS
1 Signal
10 Signale
30 Signale
50 Signale
>= 100 Signale


Visualization Prototype - BMW Research and Technology
Datei Fahrzeug Konfiguration Hilfe
Dependency Chains
Gateway
K-CAN
Body-CAN
FA-CAN
DDE1_DME1
IHKA
TE_BFT
EHC
121
Sitzheizung_Anste...
SM_FA
SM_BF
106
105
AHM
CID_C_CID_C_H
123
117
CID_C_R
32
CCC_MM
KBM
TE_FAT
CAS
86
Kombi
EGS_MECH_
93
42
SGM_SIM
19
94
26
77
78
NVC
TE_
CAS
SG.
DDE
KBM
Kom.
Gateway
SM_
CCC
ZV-Mas.
Zusam.
Authenti
Bus_Se.
Klemme
ZV-Mas.
Ansteue
Sendun.
Body-C.
FA-CAN
K-CAN
Sitzheiz.
FB Name: Authentisierungsnachlauf
TimeStamp: 13:00:31 60ms (28.01.2008)
OUT: Gateway, Body-CAN_1:n


ProgSpy2010
Datei
Bearbeiten
Extras
Hilfe
Log
Visualisierung
AHM (71)
FZD (56)
Evalboard (7E)
CAS (40)
PrepareVehicleForFlash
NoFlashActivity
PerformECUFlash
FinalizeVehicleFlash
NoFlashProcess
Steuergeräte (4)
AHM (71) - K-CAN (4)
FZD (56) - Body-CAN (357)
Evalboard (7E) - K-CAN (4)
CAS (40) - Body-CAN (357)
Error
Warning
Info
Typ
Beschreibung
Steuergerät
Zeitstempel
Datei
Statemachinefehler
Positive Antwort auf eine ungültige Serviceanfrage (PRR)
7E
27.8.2009 11:23:43.9097005
27.8.2009 11:23:51.4002389
27.8.2009 11:23:53.6004033
71
27.8.2009 11:23:53.6393861
27.8.2009 11:23:59.0545509
C:\FlashTools\Traces_L6\AHM_Flash_B...
ProgSpy2010

Example: Cardiogram.

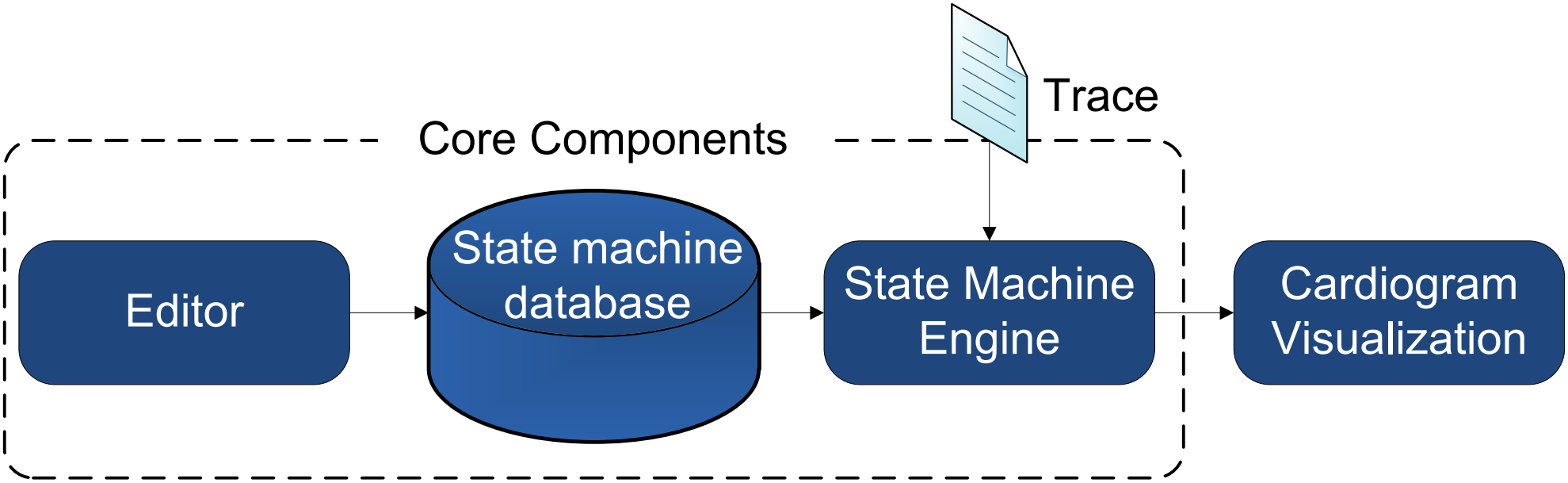


Many more Problems Beyond AutobahnVis...

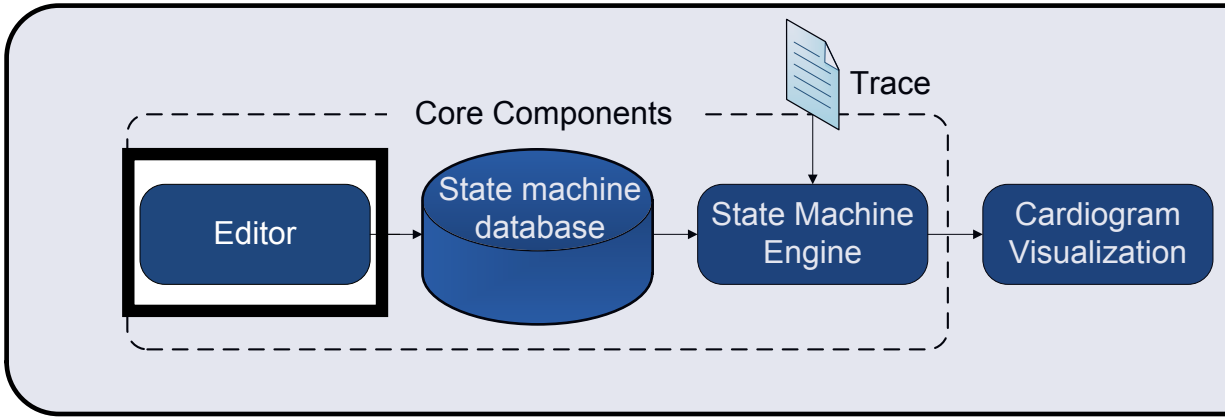
- Very large Traces?
- Tons of Traces?
- Visualization...
- + Data Abstraction!
- + Automation!

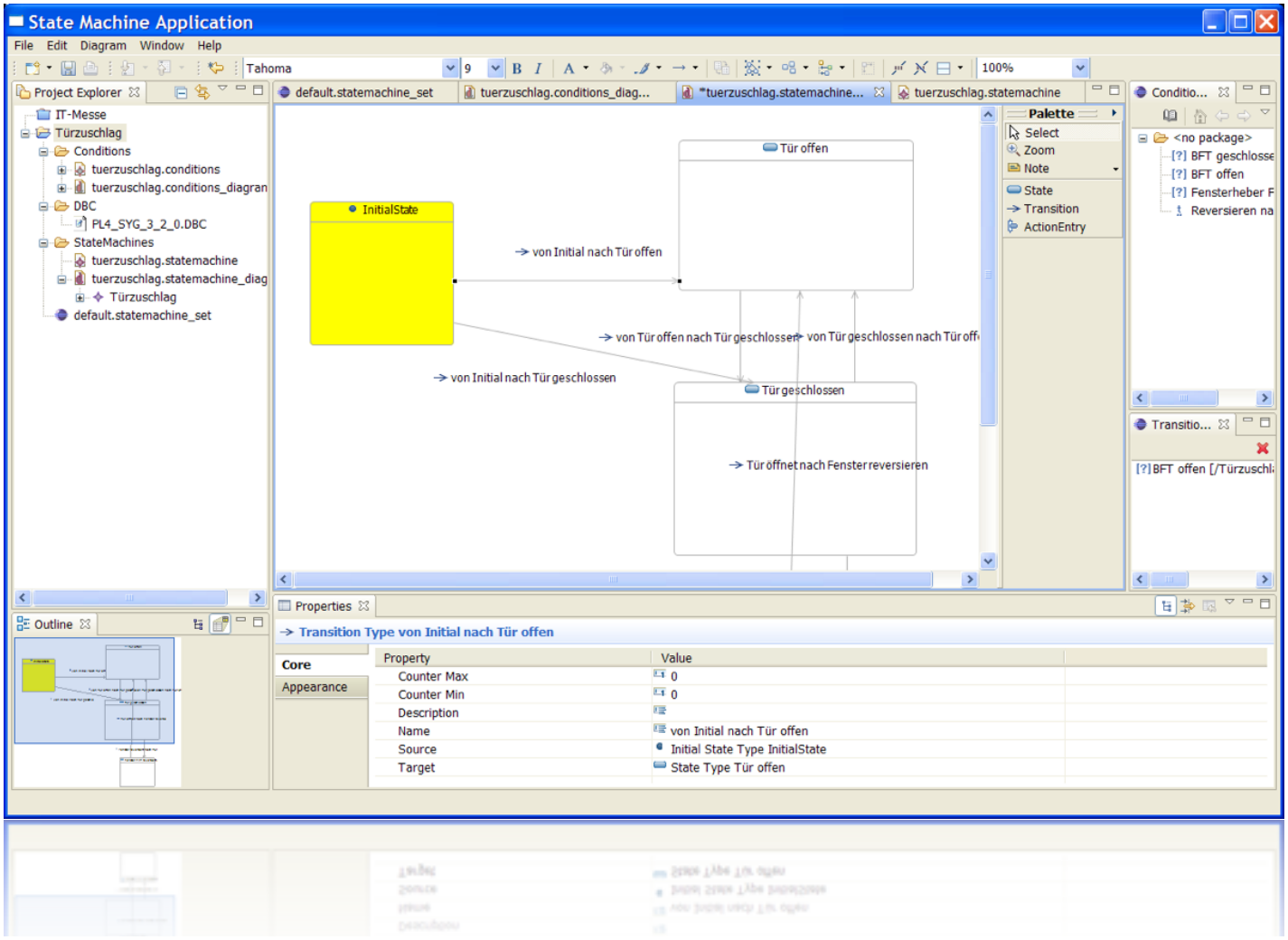
Cardiogram: Basic Idea ...

... Using State Machines.

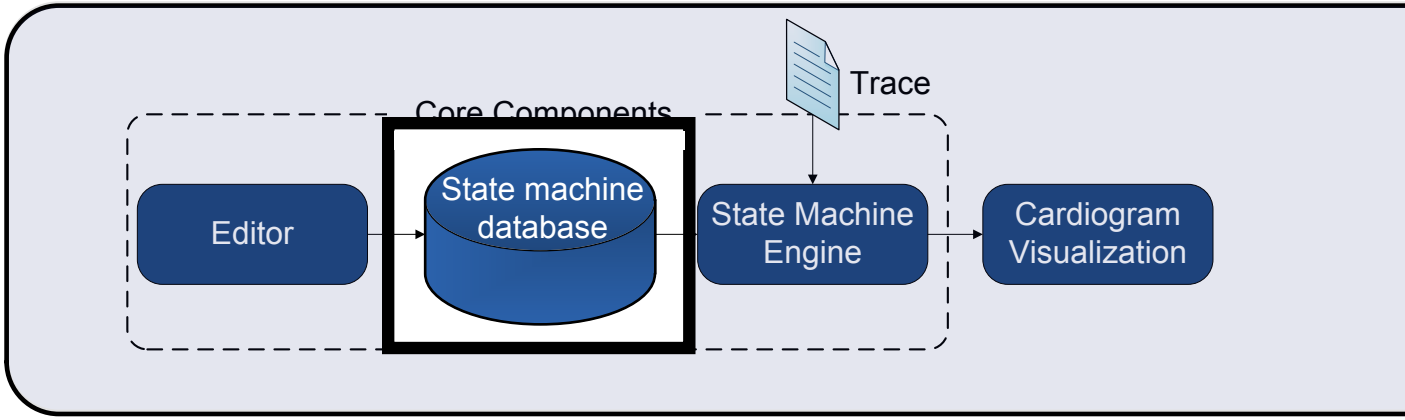


Editor.


Trace
Core Components
Editor
State machine database
State Machine Engine
Cardiogram Visualization


State Machine Application
File Edit Diagram Window Help
Project Explorer
IT-Messe
Türzuschlag
Conditions
tuerzuschlag.conditions
tuerzuschlag.conditions_diagran
DBC
PL4_SYG_3_2_0.DBC
StateMachines
tuerzuschlag.statemachine
tuerzuschlag.statemachine_diag
Türzuschlag
default.statemachine_set
default.statemachine_set
tuerzuschlag.conditions_diag...
*tuerzuschlag.statemachine...
tuerzuschlag.statemachine
Palette
Select
Zoom
Note
State
Transition
ActionEntry
Tür offen
InitialState
von Initial nach Tür offen
von Tür offen nach Tür geschlossen
von Tür geschlossen nach Tür off
von Initial nach Tür geschlossen
Tür geschlossen
Tür öffnet nach Fenster reversieren
Outline
Properties
Transition Type von Initial nach Tür offen
Core
Appearance
Property
Value
Counter Max
0
Counter Min
0
Description
Name
von Initial nach Tür offen
Source
Initial State Type InitialState
Target
State Type Tür offen

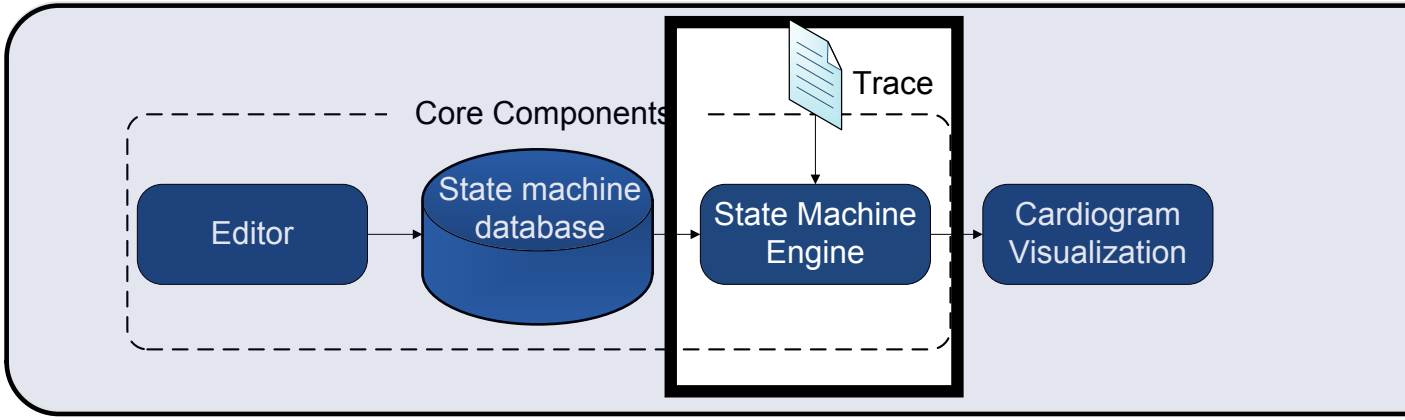
Database.

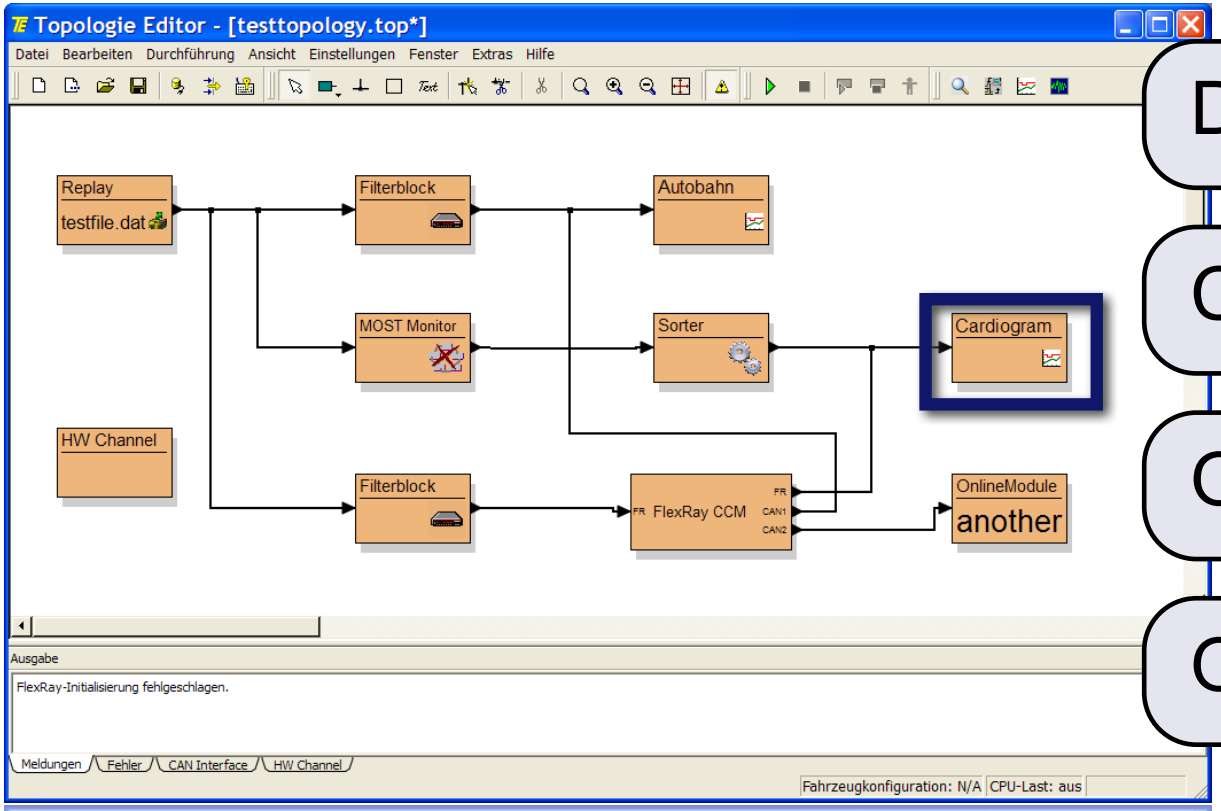


State Machines + Description.

Enables Collaboration

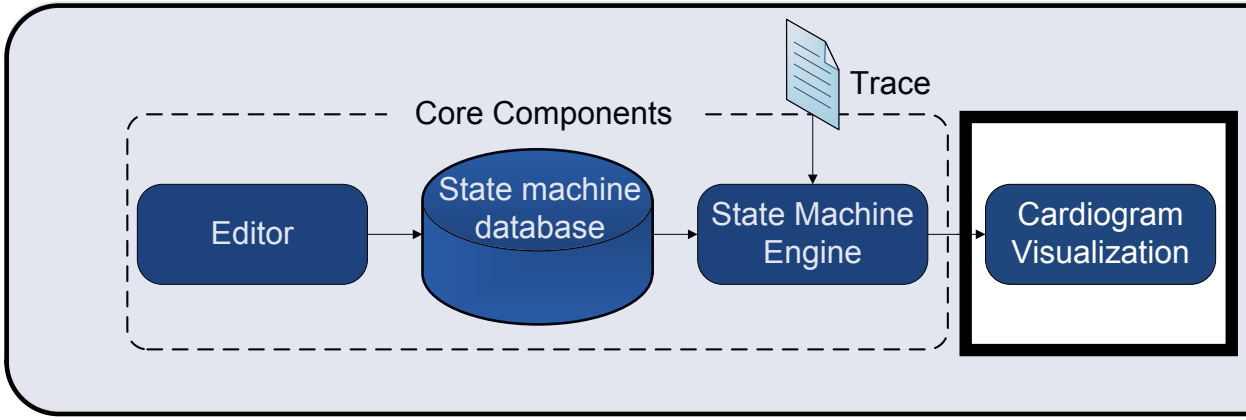
Engine.



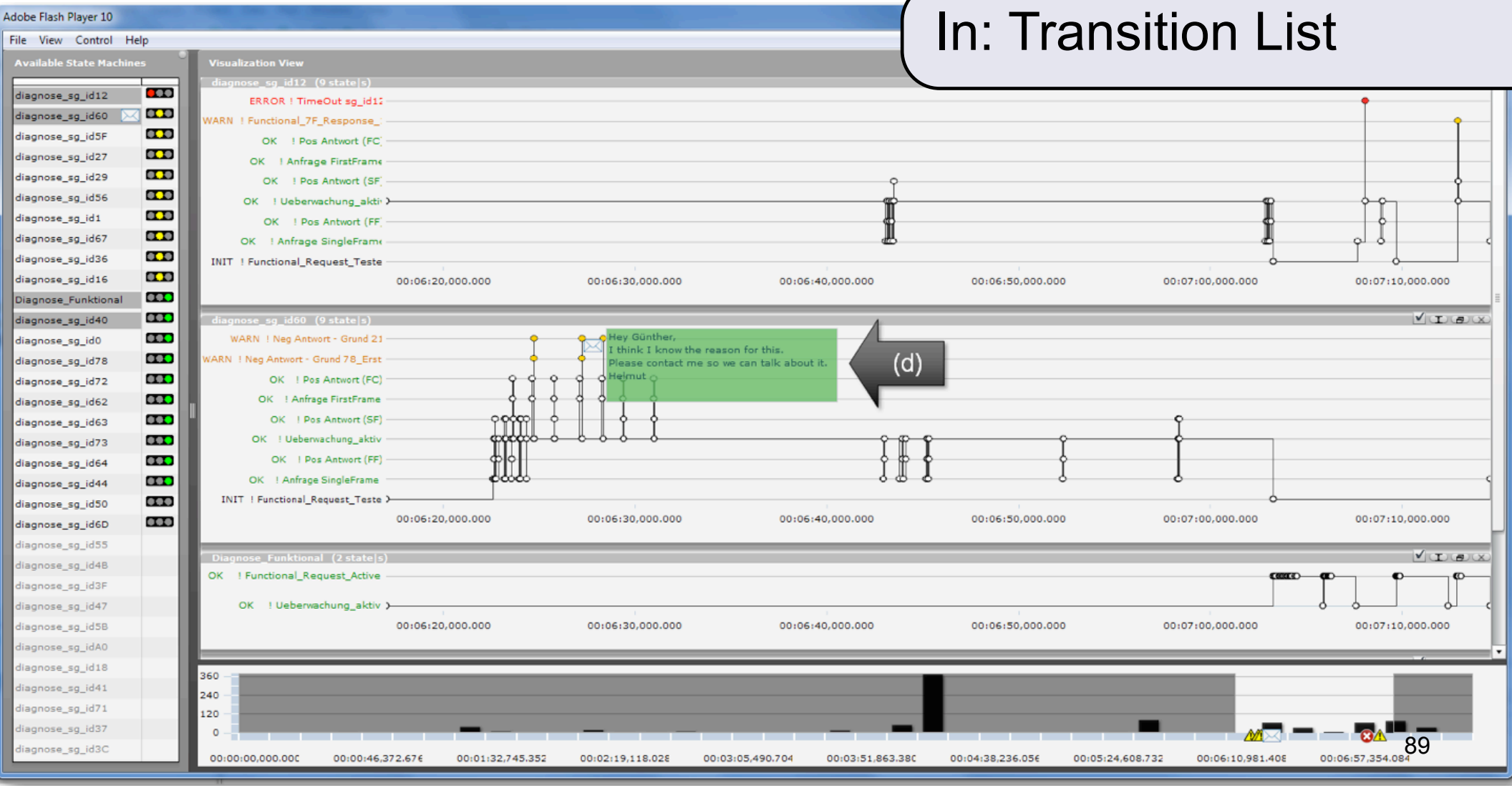


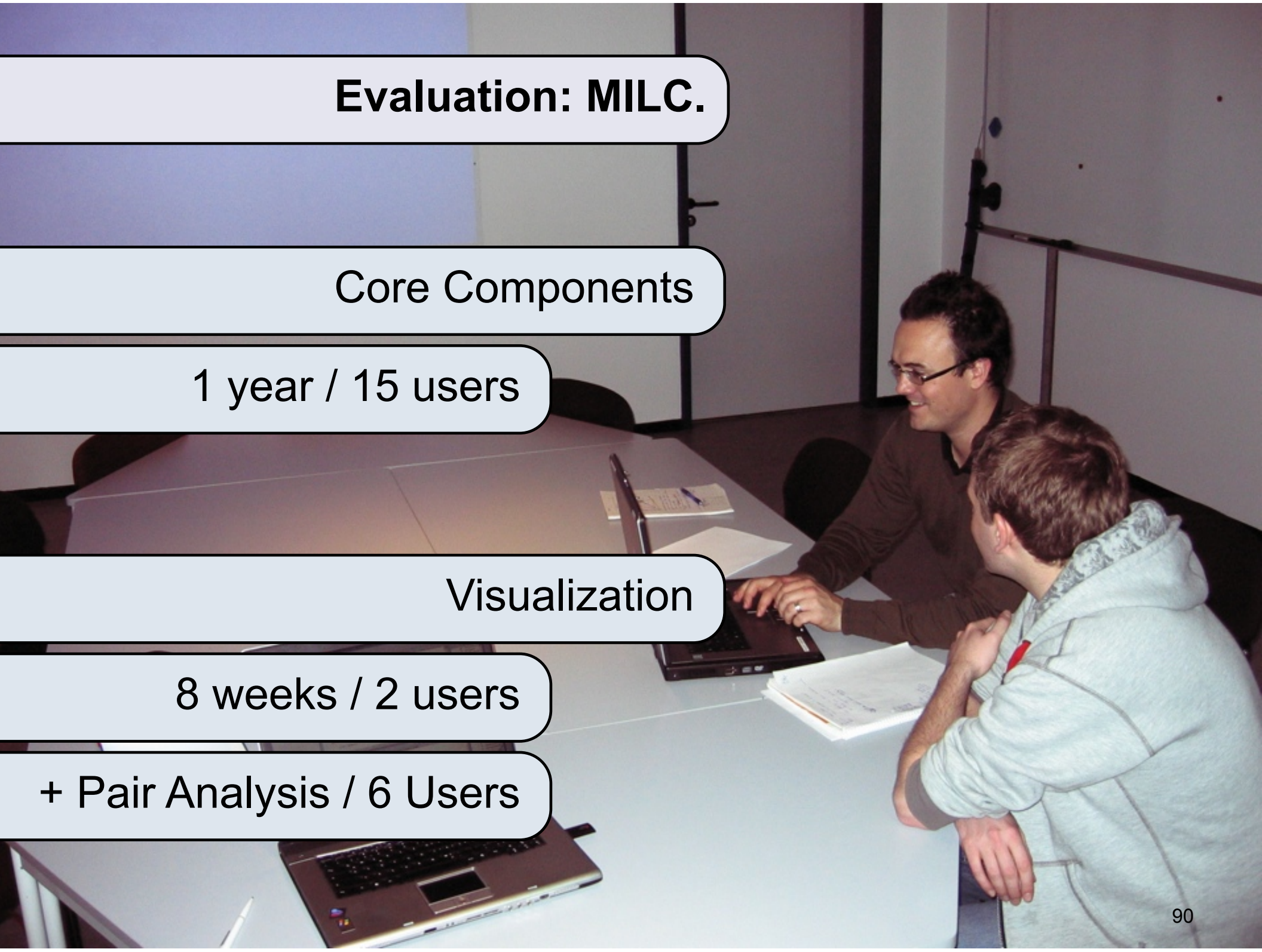
- Data Preparation
- Carmen Integration
- Out: Verification Tag
- Out: Transition List

Visualization.



In: Transition List





Evaluation: MILC.

Core Components

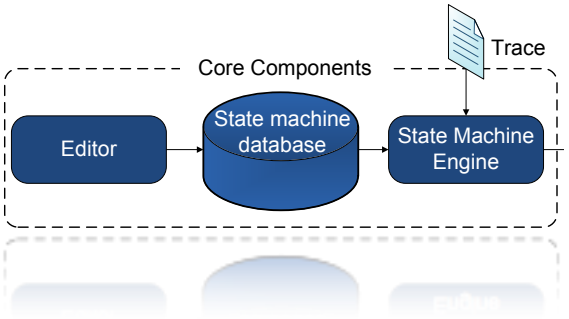
1 year / 15 users

Visualization

8 weeks / 2 users

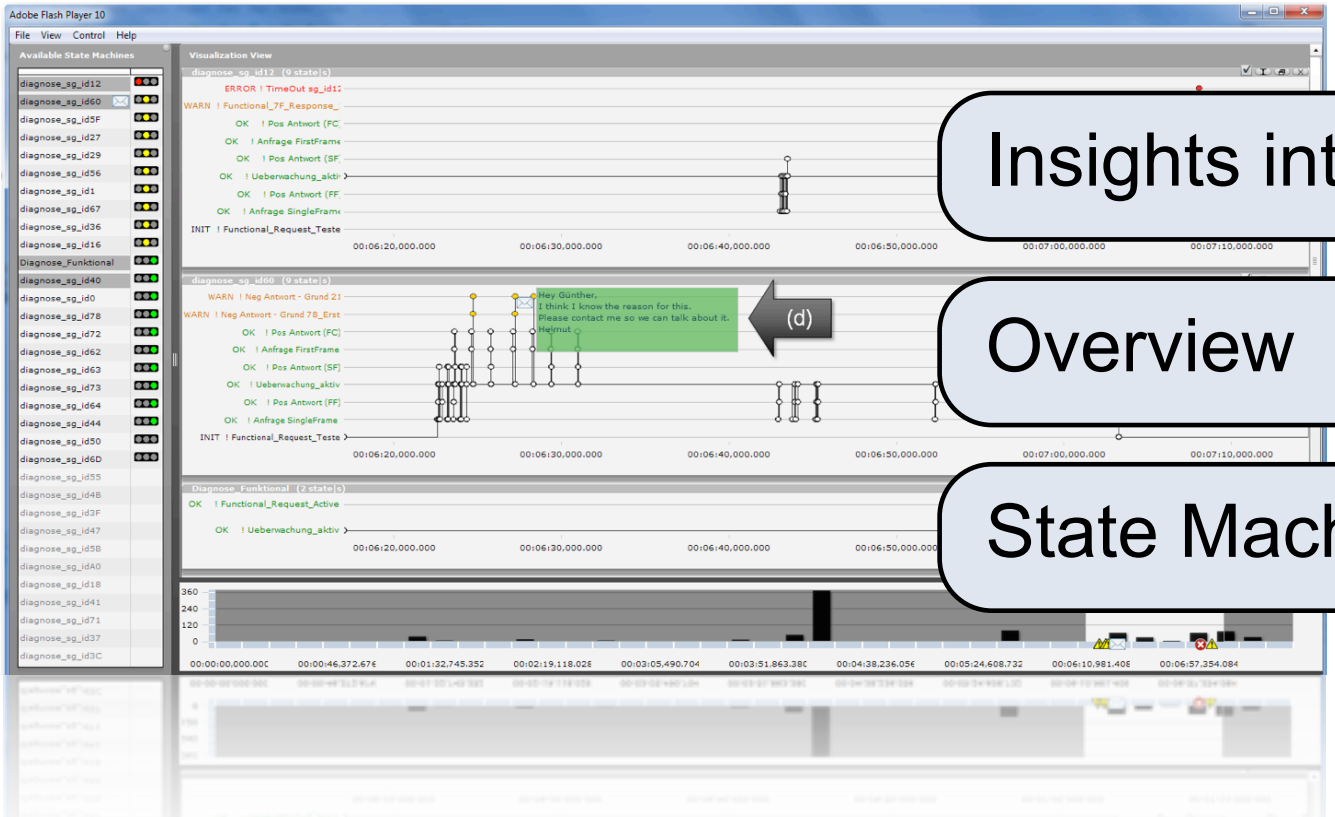
+ Pair Analysis / 6 Users

Results.



Externalization of Expert Knowledge

Mass Analysis instead of Sample Testing

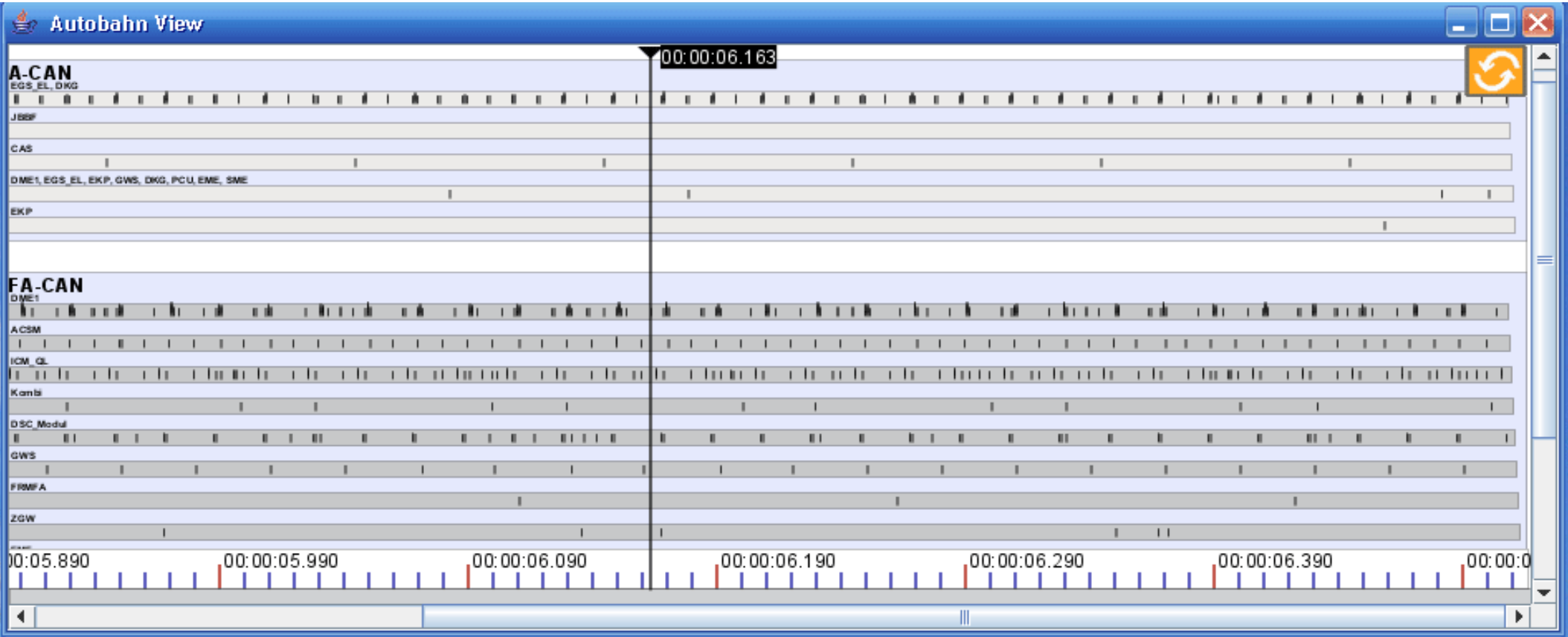


Insights into State Correlations

Overview

State Machine Verification

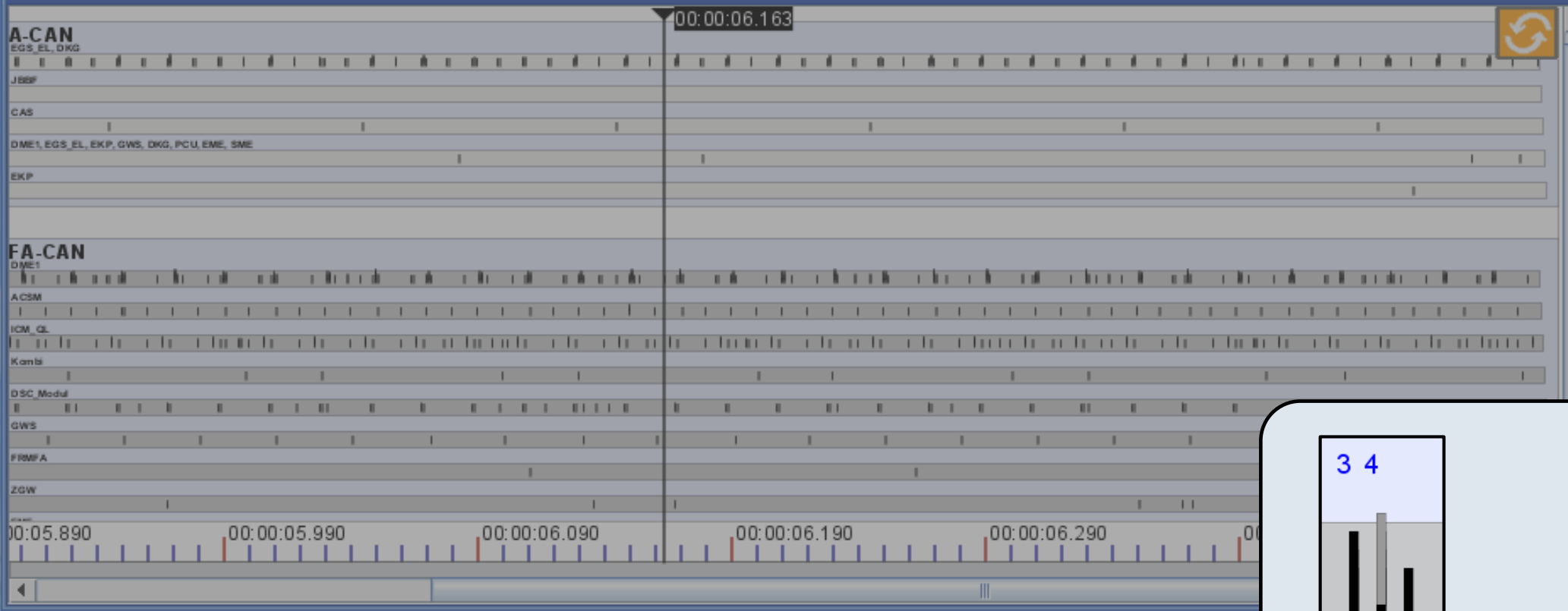
AutobahnVis



List Messages

Time	Nachricht	N-Wert	Sender	Klemme	Bus	B-Num	Rahmentyp	DLC	Flags	Rohdaten
00:00:05,692 490	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	A6 79 FF FF FF 77 FF FF
00:00:05,701 338	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	41 7A FF FF FF 77 FF FF
00:00:05,711 340	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	1C 7B FF FF FF 77 FF FF
00:00:05,721 318	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	92 7C FF FF FF 77 FF FF
CRC_Daten_Roll-Over_Sensor				92	146					
Alive_Daten_Roll-Over_Sensor				C	12					
Qualifier_Wankgeschwindigkeit_Fahrzeug_Rohdaten				7	Sensor nicht vorhanden					
Wankgeschwindigkeit_Fahrzeug_Rohdaten				FFF	Signal invalid					
Vertikalbeschleunigung_Fahrzeug_Rohdaten				FFF	Signal invalid					
Qualifier_Vertikalbeschleunigung_Fahrzeug_Rohdaten				7	Sensor nicht vorhanden					
Qualifier_Querbeschleunigung_Airbag_Rohdaten				7	Sensor nicht vorhanden					
Querbeschleunigung_Airbag_Rohdaten				FFF	Signal invalid					
00:00:05,732 418	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	CF 7D FF FF FF 77 FF FF
00:00:05,741 372	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	28 7E FF FF FF 77 FF FF
00:00:05,751 473	Alive Zähler Sicherheit	0x0D7	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	2	RX	0C FF

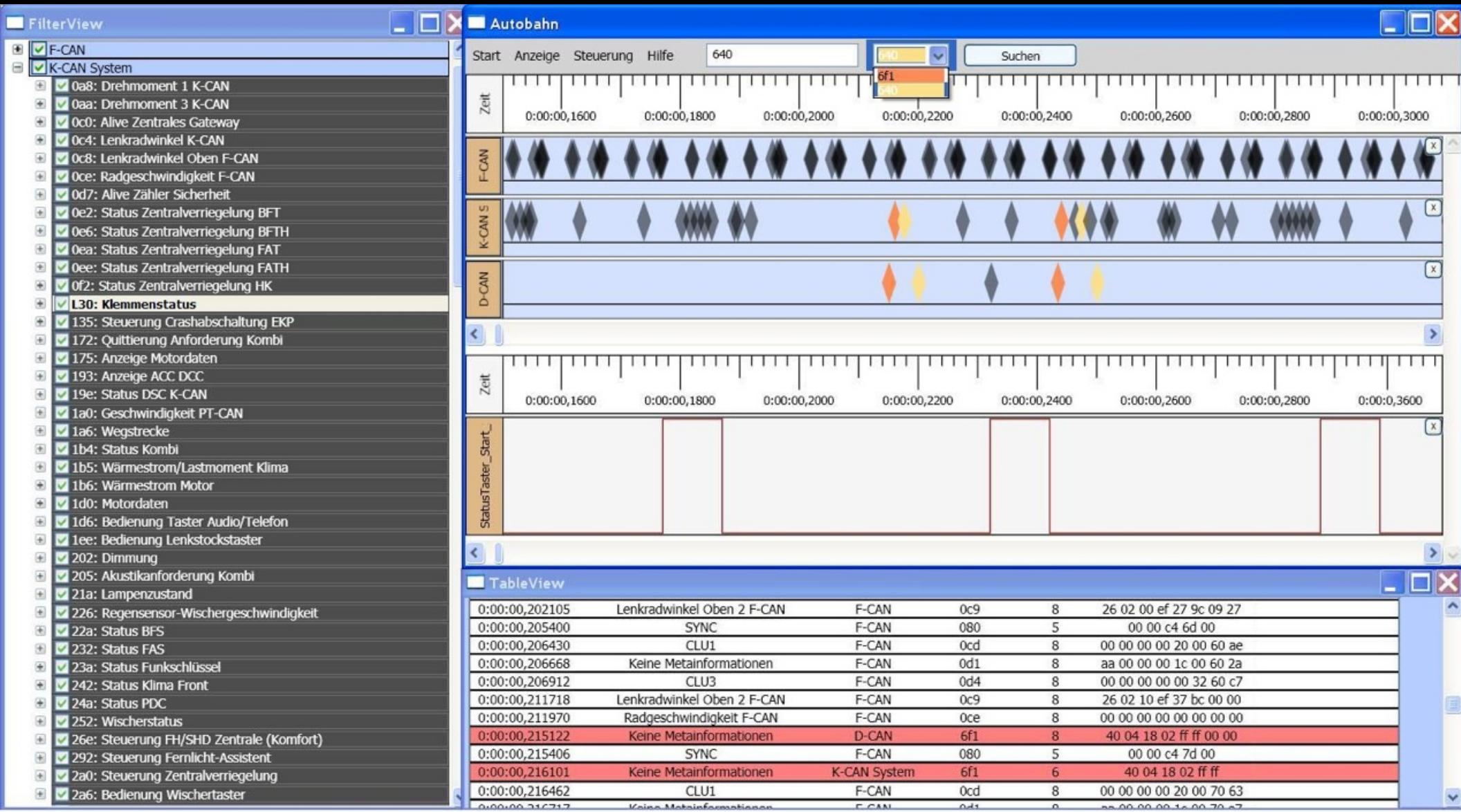
Autobahn View

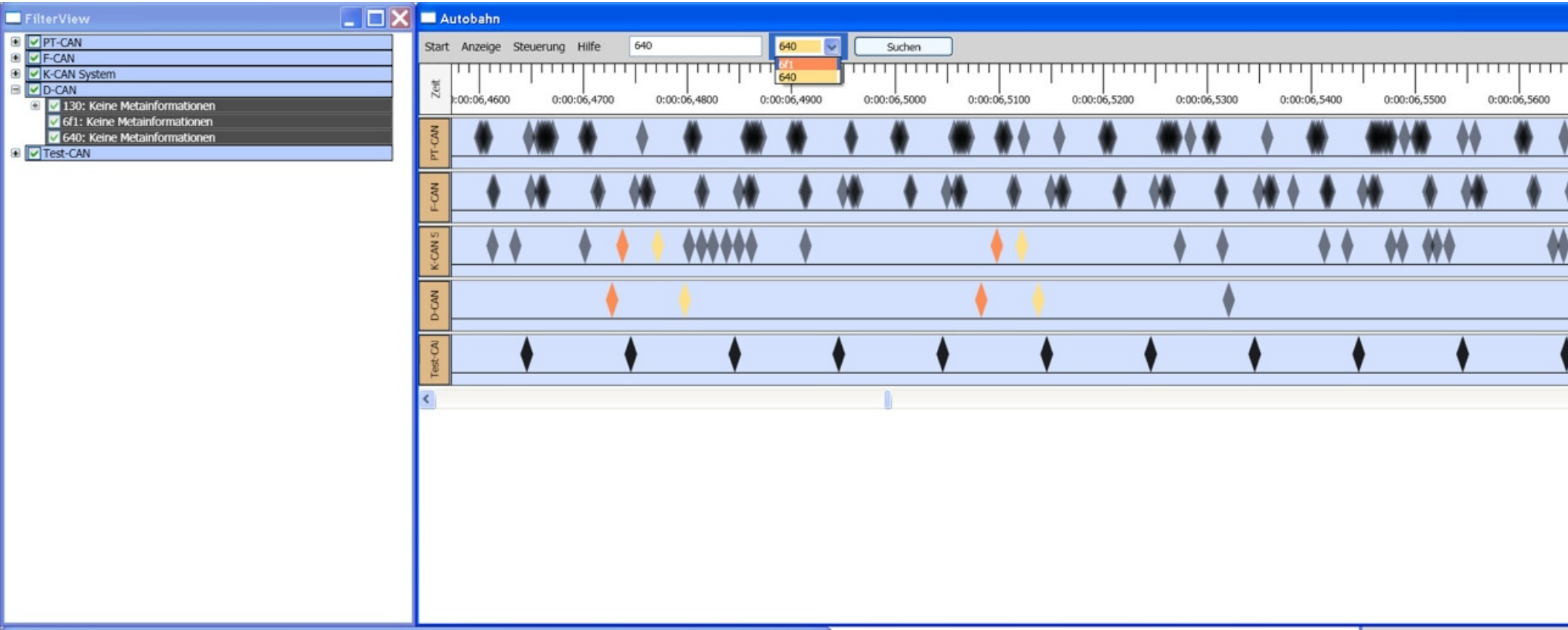


Length?
Staples?

List Messages

Time	Nachricht	N-Wert	Sender	Klemme	Bus	B-Num	Rahmentyp	DLC	Fla	
00:00:05,692 490	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	
00:00:05,701 338	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	
00:00:05,711 340	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	
00:00:05,721 318	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	
CRC_Daten_Roll-Over_Sensor				92	146					
Alive_Daten_Roll-Over_Sensor				C	12					
Qualifier_Wankgeschwindigkeit_Fahrzeug_Rohdaten				7	Sensor nicht vorhanden					
Wankgeschwindigkeit_Fahrzeug_Rohdaten				FFF	Signal invalid					
Vertikalbeschleunigung_Fahrzeug_Rohdaten				FFF	Signal invalid					
Qualifier_Vertikalbeschleunigung_Fahrzeug_Rohdaten				7	Sensor nicht vorhanden					
Qualifier_Querbeschleunigung_Airbag_Rohdaten				7	Sensor nicht vorhanden					
Querbeschleunigung_Airbag_Rohdaten				FFF	Signal invalid					
00:00:05,732 418	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	CF 7D FF FF FF 77 FF FF
00:00:05,741 372	Daten Roll-Over Sensor	0x0F5	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	8	RX	28 7E FF FF FF 77 FF FF
00:00:05,751 473	Alive Zähler Sicherheit	0x0D7	ACSM	Klemme 15	FA-CAN	356	Standard-Frai	2	RX	0C FF

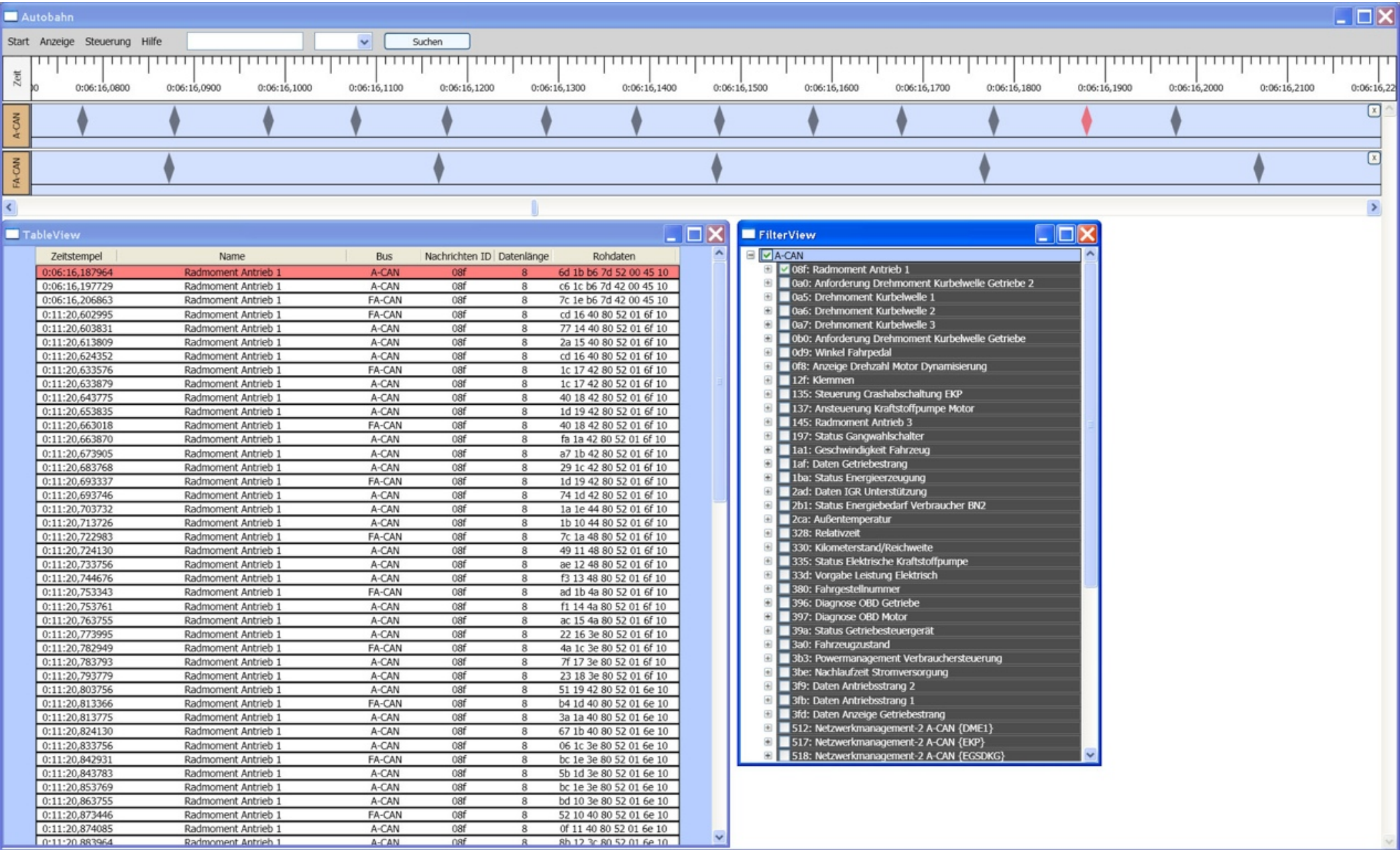

FilterView
F-CAN
K-CAN System
0a8: Drehmoment 1 K-CAN
0aa: Drehmoment 3 K-CAN
0c0: Alive Zentrales Gateway
0c4: Lenkradwinkel K-CAN
0c8: Lenkradwinkel Oben F-CAN
0ce: Radgeschwindigkeit F-CAN
0d7: Alive Zähler Sicherheit
0e2: Status Zentralverriegelung BFT
0e6: Status Zentralverriegelung BFTH
0ea: Status Zentralverriegelung FAT
0ee: Status Zentralverriegelung FATH
0f2: Status Zentralverriegelung HK
L30: Klemmenstatus
135: Steuerung Crashabschaltung EKP
172: Quittierung Anforderung Kombi
175: Anzeige Motordaten
193: Anzeige ACC DCC
19e: Status DSC K-CAN
1a0: Geschwindigkeit PT-CAN
1a6: Wegstrecke
1b4: Status Kombi
1b5: Wärmestrom/Lastmoment Klima
1b6: Wärmestrom Motor
1d0: Motordaten
1d6: Bedienung Taster Audio/Telefon
1ee: Bedienung Lenkstockstaster
202: Dimmung
205: Akustikanforderung Kombi
21a: Lampenzustand
226: Regensensor-Wischergeschwindigkeit
22a: Status BFS
232: Status FAS
23a: Status Funkschlüssel
242: Status Klima Front
24a: Status PDC
252: Wischerstatus
26e: Steuerung FH/SHD Zentrale (Komfort)
292: Steuerung Fernlicht-Assistent
2a0: Steuerung Zentralverriegelung
2a6: Bedienung Wischertaster
Autobahn
Start
Anzeige
Steuerung
Hilfe
640
Suchen
6f1
Zeit
0:00:00,1600
0:00:00,1800
0:00:00,2000
0:00:00,2200
0:00:00,2400
0:00:00,2600
0:00:00,2800
0:00:00,3000
F-CAN
K-CAN S
D-CAN
Zeit
0:00:00,1600
0:00:00,1800
0:00:00,2000
0:00:00,2200
0:00:00,2400
0:00:00,2600
0:00:00,2800
0:00:0,3600
StatusTaster_Start_
TableView
0:00:00,202105 Lenkradwinkel Oben 2 F-CAN F-CAN 0c9 8 26 02 00 ef 27 9c 09 27
0:00:00,205400 SYNC F-CAN 080 5 00 00 c4 6d 00
0:00:00,206430 CLU1 F-CAN 0cd 8 00 00 00 00 20 00 60 ae
0:00:00,206668 Keine Metainformationen F-CAN 0d1 8 aa 00 00 00 1c 00 60 2a
0:00:00,206912 CLU3 F-CAN 0d4 8 00 00 00 00 00 32 60 c7
0:00:00,211718 Lenkradwinkel Oben 2 F-CAN F-CAN 0c9 8 26 02 10 ef 37 bc 00 00
0:00:00,211970 Radgeschwindigkeit F-CAN F-CAN 0ce 8 00 00 00 00 00 00 00 00
0:00:00,215122 Keine Metainformationen D-CAN 6f1 8 40 04 18 02 ff ff 00 00
0:00:00,215406 SYNC F-CAN 080 5 00 00 c4 7d 00
0:00:00,216101 Keine Metainformationen K-CAN System 6f1 6 40 04 18 02 ff ff
0:00:00,216462 CLU1 F-CAN 0cd 8 00 00 00 00 20 00 70 63



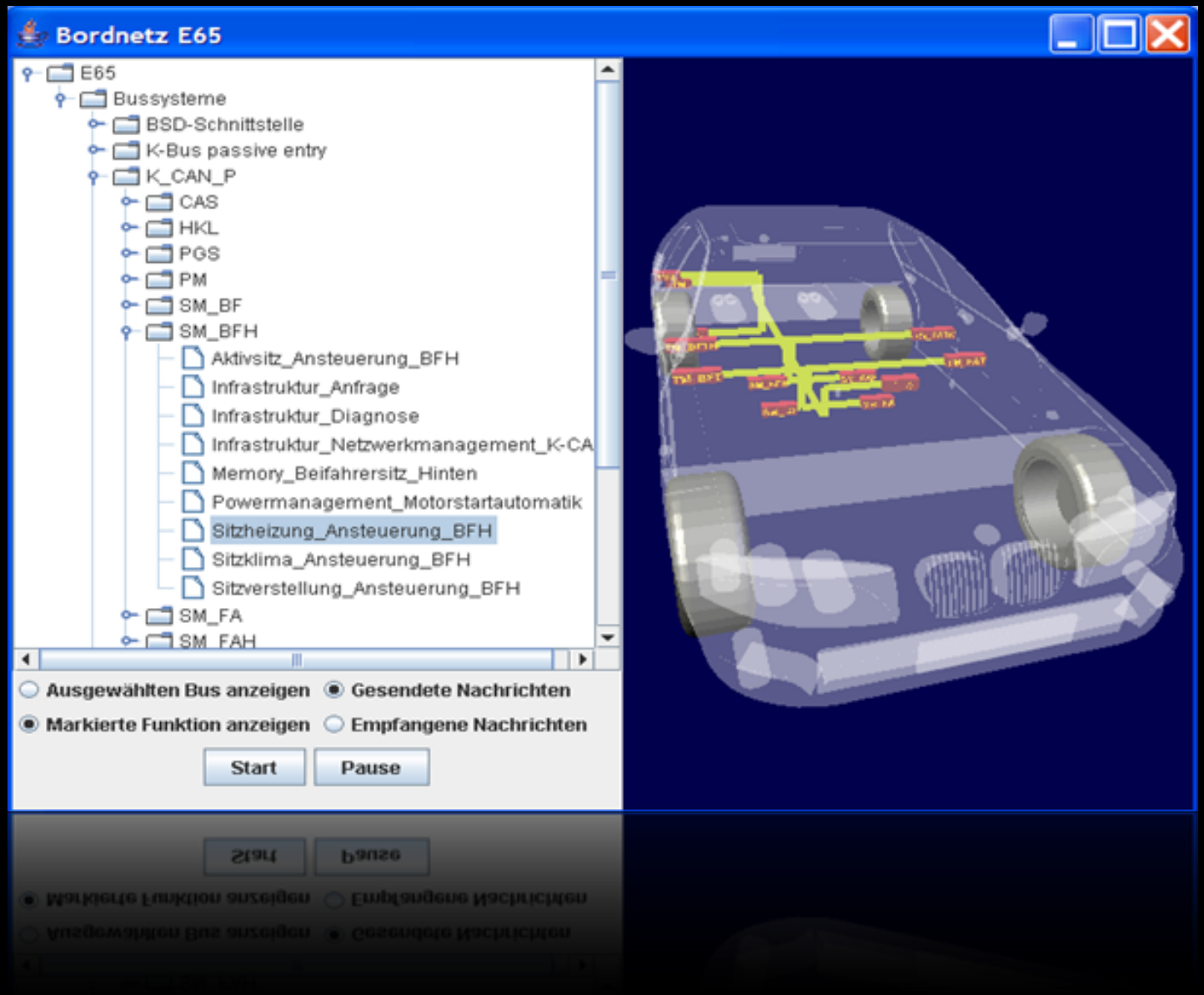
TableView

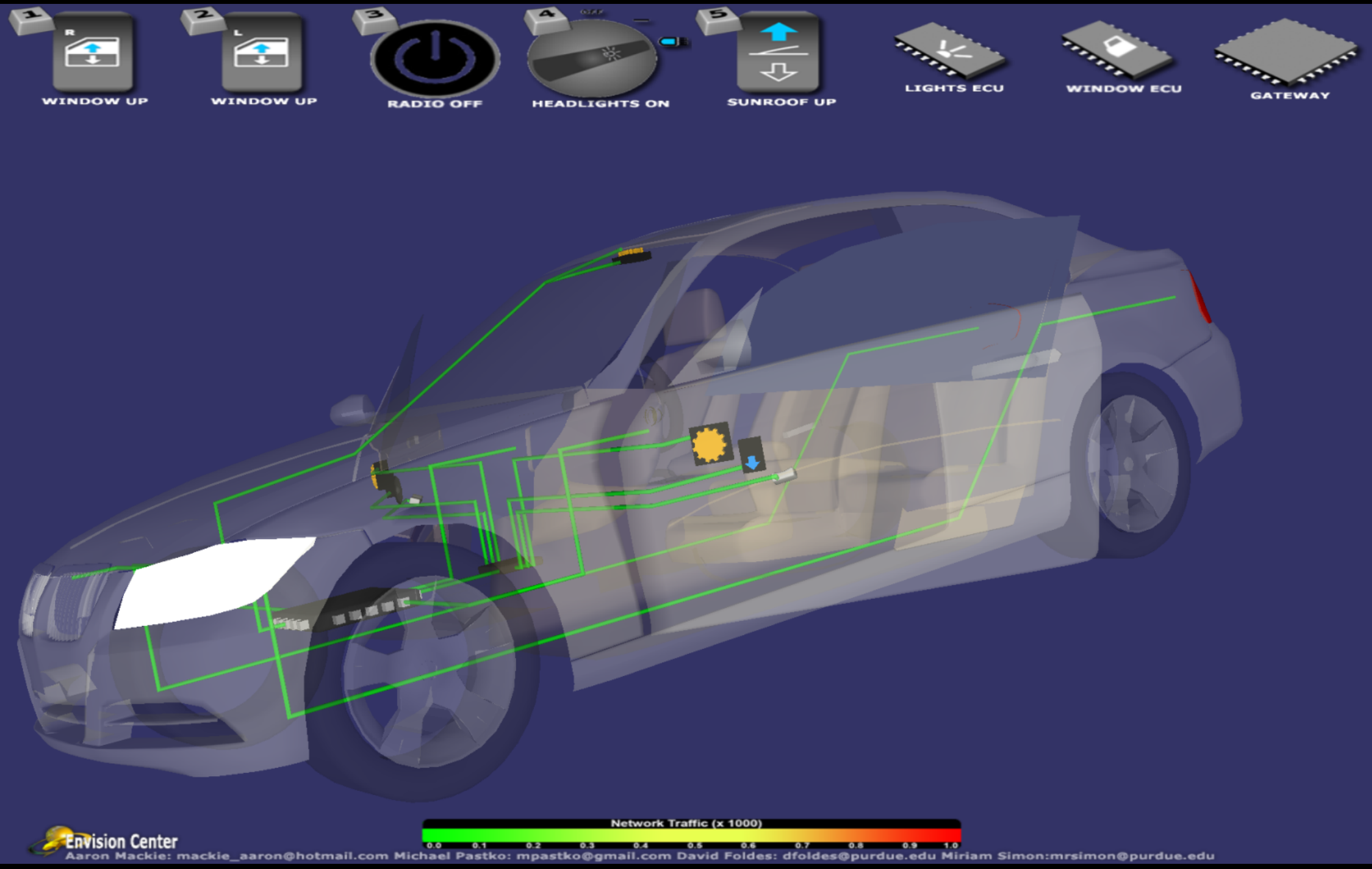
Zeitstempel	Name	Bus	Nachrichten ID	Datenlänge	Rohdaten
0:00:06,140078	Drehmoment 1 K-CAN	PT-CAN	0a8	8	71 7e fd 70 fd 0c cf 02
0:00:06,140306	Drehmoment 2	PT-CAN	0a9	8	a0 0e 8d 0f 32 9c 7f fd
0:00:06,140542	Drehmoment 3 K-CAN	PT-CAN	0aa	8	6c 0e fe 00 12 18 80 0a
0:00:06,140776	Radmoment Antriebsstrang 2	PT-CAN	0ac	8	b6 fe ff ff 35 7c c8 90
0:00:06,141012	Anzeige Schalthinweis	PT-CAN	2f3	3	01 fc f3
0:00:06,141319	Anzeige Schalthinweis	K-CAN System	2f3	3	01 fc f3
0:00:06,141322	Lenkradwinkel Oben 2 F-CAN	F-CAN	0c9	8	26 02 90 ef 27 9c 09 27
0:00:06,141574	Radgeschwindigkeit F-CAN	F-CAN	0ce	8	00 00 00 00 00 00 00 00
0:00:06,141807	Klemmenstatus	F-CAN	130	5	45 40 21 9f 13
0:00:06,141995	Radtoleranzabgleich	F-CAN	374	5	fe fe 00 00 fc
0:00:06,144532	Keine Metainformationen	Test-CAN	010	4	0c 00 00 00
0:00:06,144532	Keine Metainformationen	Test-CAN	012	4	f0 53 00 00
0:00:06,144532	Keine Metainformationen	Test-CAN	014	4	8a 07 00 00
0:00:06,144957	SYNC	F-CAN	080	5	00 00 c4 0d 00
0:00:06,145762	Lenkradwinkel K-CAN	PT-CAN	0c4	7	28 02 fc 00 00 ff f1
0:00:06,145933	CLU1	F-CAN	0cd	8	2f 00 15 00 22 00 00 3b

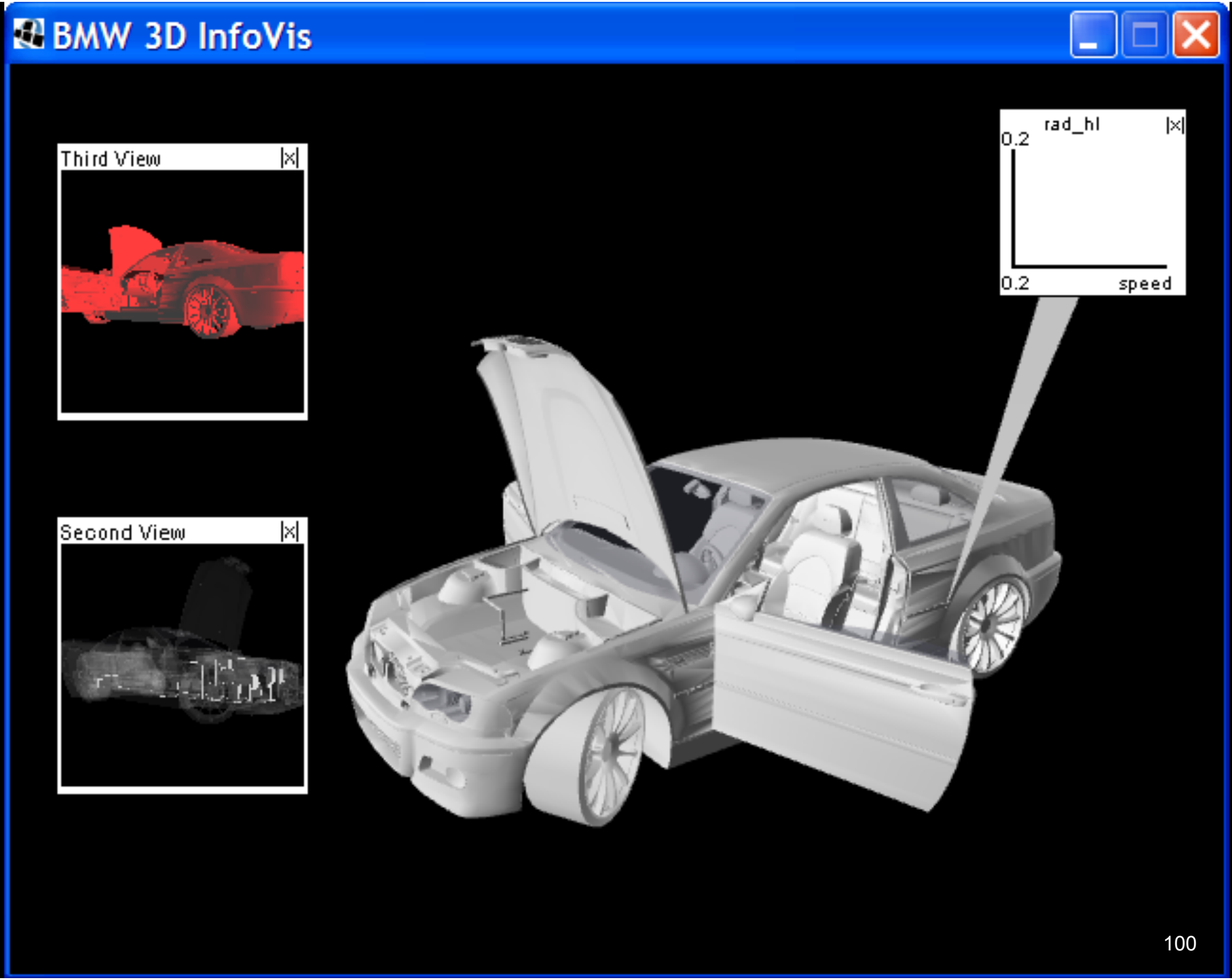
Message Timing

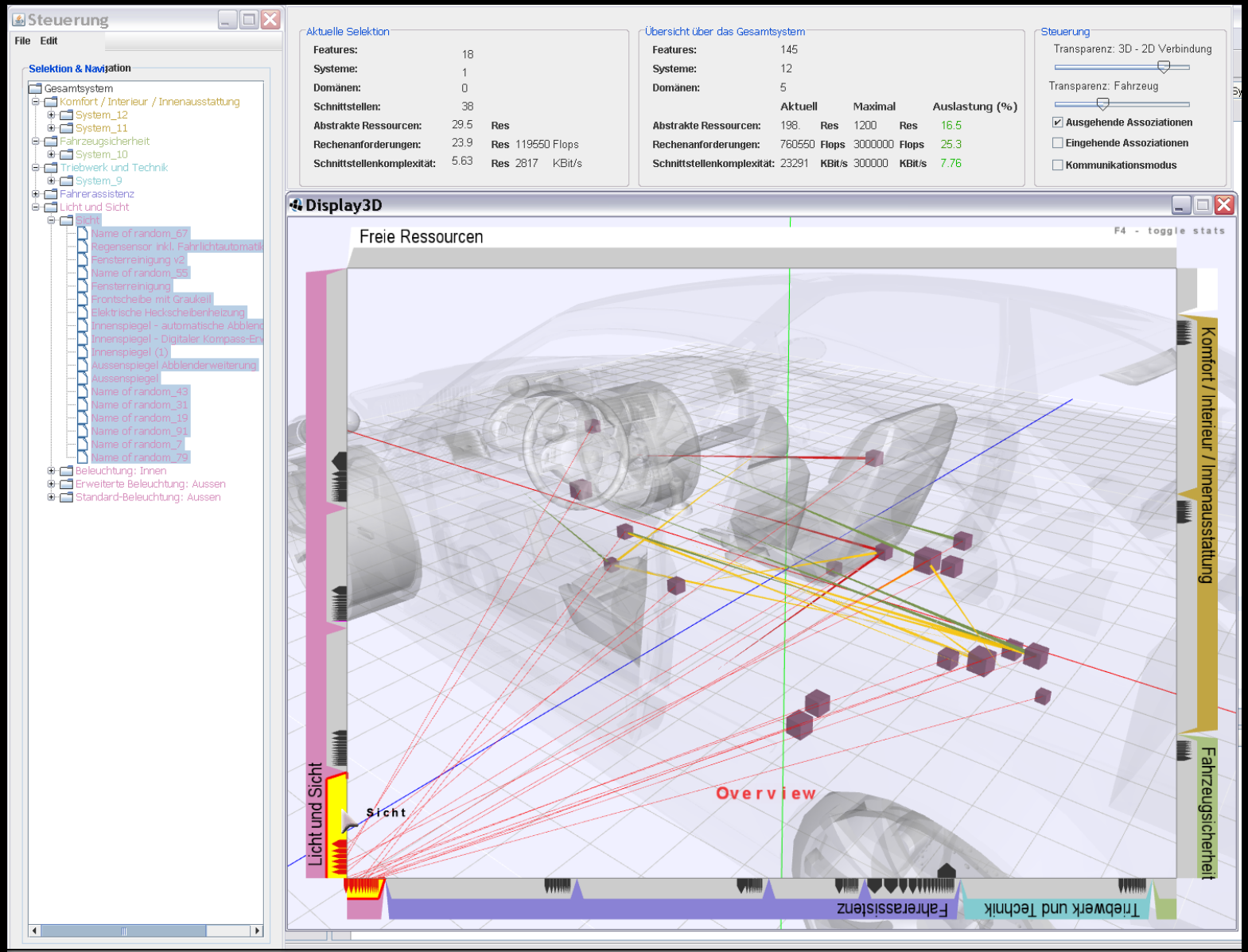


Cyclic Messaging


Bordnetz E65
E65
Bussysteme
BSD-Schnittstelle
K-Bus passive entry
K_CAN_P
CAS
HKL
PGS
PM
SM_BF
SM_BFH
Aktivsitz_Ansteuerung_BFH
Infrastruktur_Anfrage
Infrastruktur_Diagnose
Infrastruktur_Netzwerkmanagement_K-CA
Memory_Beifahrersitz_Hinten
Powermanagement_Motorstartautomatik
Sitzheizung_Ansteuerung_BFH
Sitzklima_Ansteuerung_BFH
Sitzverstellung_Ansteuerung_BFH
SM_FA
Ausgewählten Bus anzeigen
Gesendete Nachrichten
Markierte Funktion anzeigen
Empfangene Nachrichten
Start
Pause


1
R
WINDOW UP
2
L
WINDOW UP
3
RADIO OFF
4
OFF
HEADLIGHTS ON
5
SUNROOF UP
LIGHTS ECU
WINDOW ECU
GATEWAY
Network Traffic (x 1000)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Envision Center
Aaron Mackie: mackie_aaron@hotmail.com Michael Pastko: mpastko@gmail.com David Foldes: dfoldes@purdue.edu Miriam Simon:mrsimon@purdue.edu


BMW 3D InfoVis
Third View
Second View
rad_hl
0.2
0.2
speed
100


Steuerung
File Edit
Selektion & Navigation
Gesamtsystem
Komfort / Interieur / Innenausstattung
System_12
System_11
Fahrzeugsicherheit
System_10
Triebwerk und Technik
System_9
Fahrerassistenz
Licht und Sicht
Sicht
Name of random_67
Regensensor inkl. Fahrlichtautomatik
Fensterreinigung v2
Name of random_55
Fensterreinigung
Frontscheibe mit Graukeil
Elektrische Heckscheibenheizung
Innenspiegel - automatische Abblend
Innenspiegel - Digitaler Kompass-Env
Innenspiegel (1)
Aussenspiegel Abblenderweiterung
Aussenspiegel
Name of random_43
Name of random_31
Name of random_19
Name of random_91
Name of random_7
Name of random_79
Beleuchtung: Innen
Erweiterte Beleuchtung: Aussen
Standard-Beleuchtung: Aussen
Aktuelle Selektion
Features: 18
Systeme: 1
Domänen: 0
Schnittstellen: 38
Abstrakte Ressourcen: 29.5 Res
Rechenanforderungen: 23.9 Res 119550 Flops
Schnittstellenkomplexität: 5.63 Res 2817 KBit/s
Übersicht über das Gesamtsystem
Features: 145
Systeme: 12
Domänen: 5
Aktuell Maximal Auslastung (%)
Abstrakte Ressourcen: 198. Res 1200 Res 16.5
Rechenanforderungen: 760550 Flops 3000000 Flops 25.3
Schnittstellenkomplexität: 23291 KBit/s 300000 KBit/s 7.76
Steuerung
Transparenz: 3D - 2D Verbindung
Transparenz: Fahrzeug
Ausgehende Assoziationen
Eingehende Assoziationen
Kommunikationsmodus
Display3D
Freie Ressourcen
F4 - toggle stats
Komfort / Interieur / Innenausstattung
Fahrzeugsicherheit
Triebwerk und Technik
Fahrerassistenz
Licht und Sicht
Sicht
Overview