Prof. Dr.-Ing. Matthias Thein
February 2016

schaufenster elektromobilität
Eine Initiative der Bundesregierung

BAYERN – SACHSEN ELEKTROMOBILITÄT VERBINDET

Westsächsische Hochschule Zwickau
University of Applied Sciences

FAKULTÄT FÜR KRAFTFAHRZEUGTECHNIK

Institut für Energie und Verkehr IEV

e-Bus Skorpion – automatic overhead line contact system

Zwickau, Crimmitschauer Straße

Gefördert durch:

Die Bundesregierung

Bayerisches Staatsministerium für Wirtschaft und Medien, Energie und Technologie

STAATSMINISTERIUM FÜR WIRTSCHAFT ARBEIT UND VERKEHR

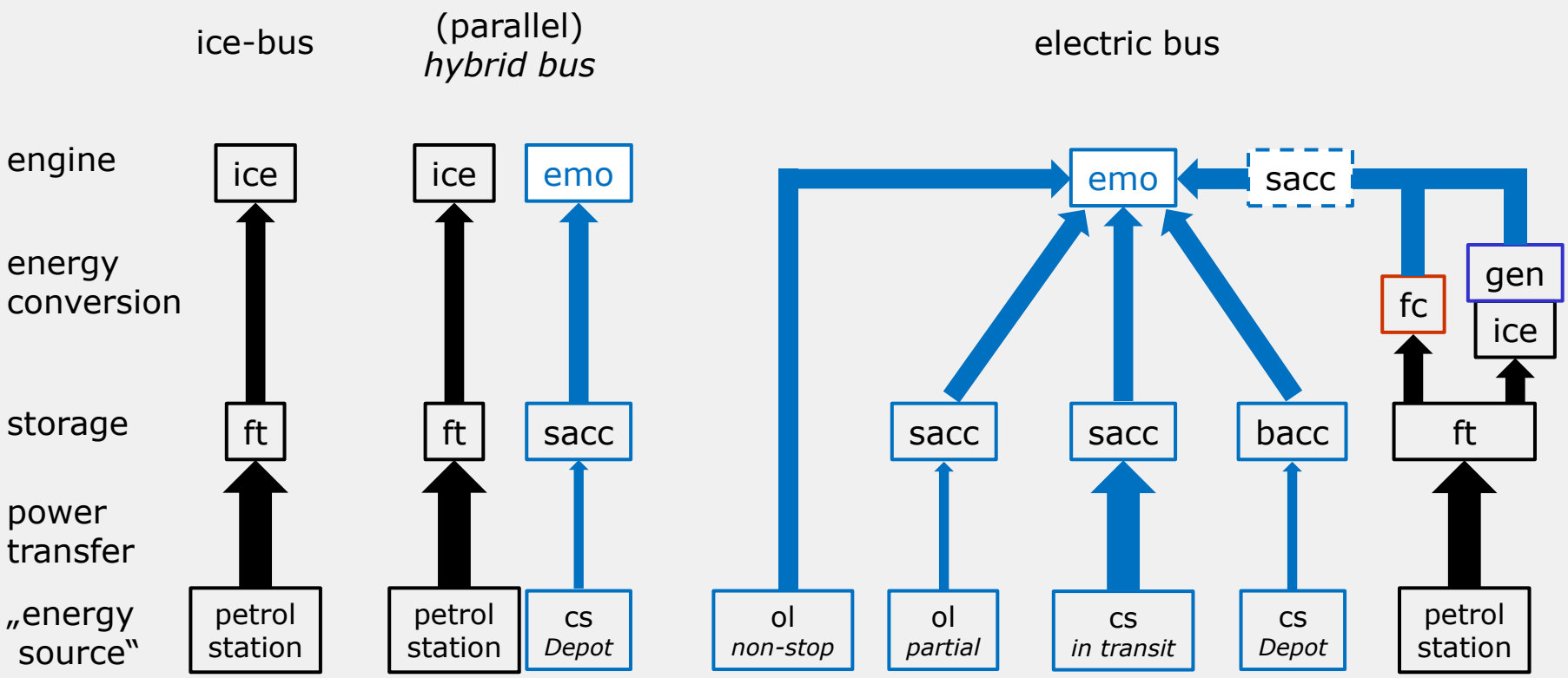
Freistaat SACHSEN

Koordiniert durch:

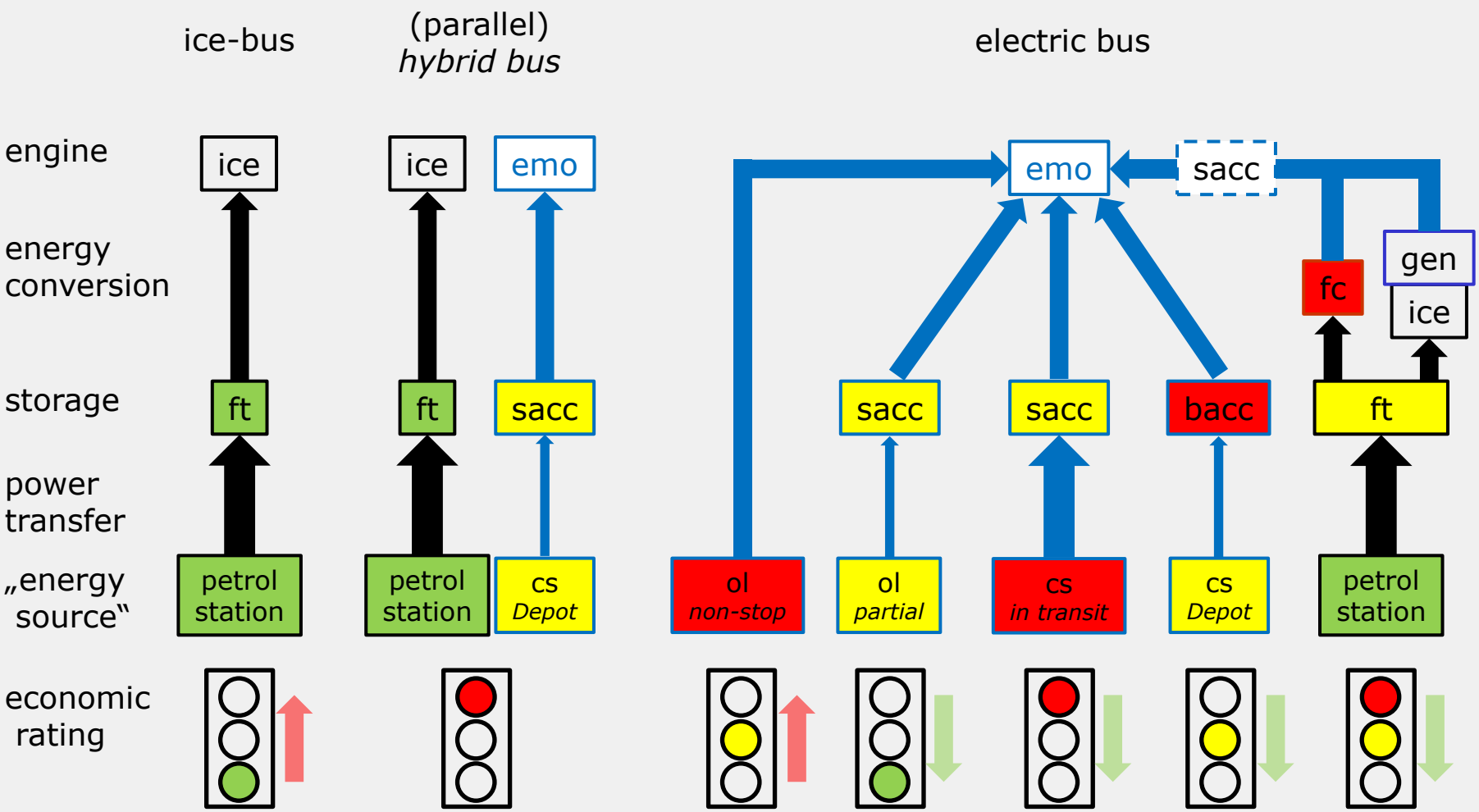
Bayern Innovativ

saena Sächsische Energieagentur GmbH

source: Kenning/Schindler- Obusse in Deutschland Band1

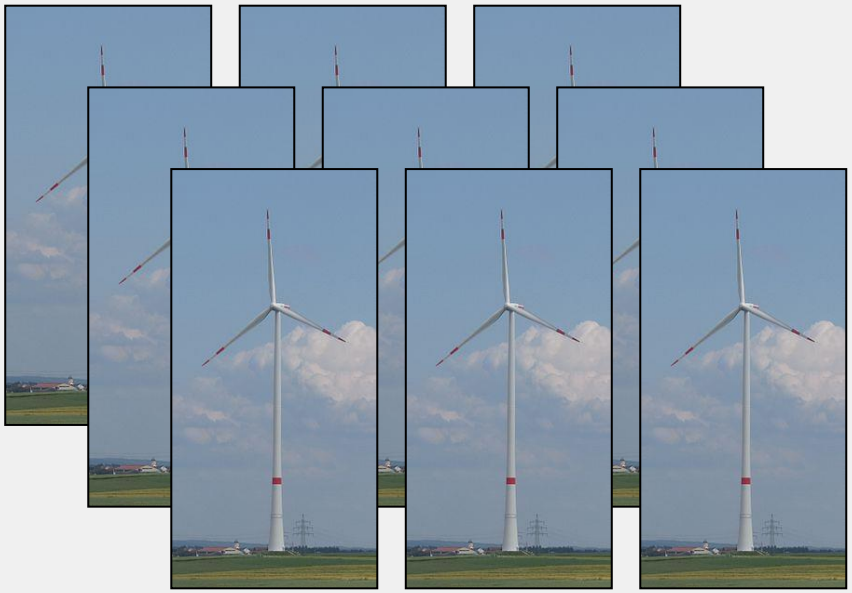


ice – internal combustion engine
emo – electric motor
gen – generator
fc – fuel cell
ft – fuel tank
sacc – small accumulator
bacc – big accumulator
ol – overhead line
cs – charging station



ice – internal combustion engine
emo – electric motor
gen – generator
fc – fuel cell
ft – fuel tank
sacc – small accumulator
bacc – big accumulator
ol – overhead line
cs – charging station

=



Connected wattage of a petrol pump: 27 MW

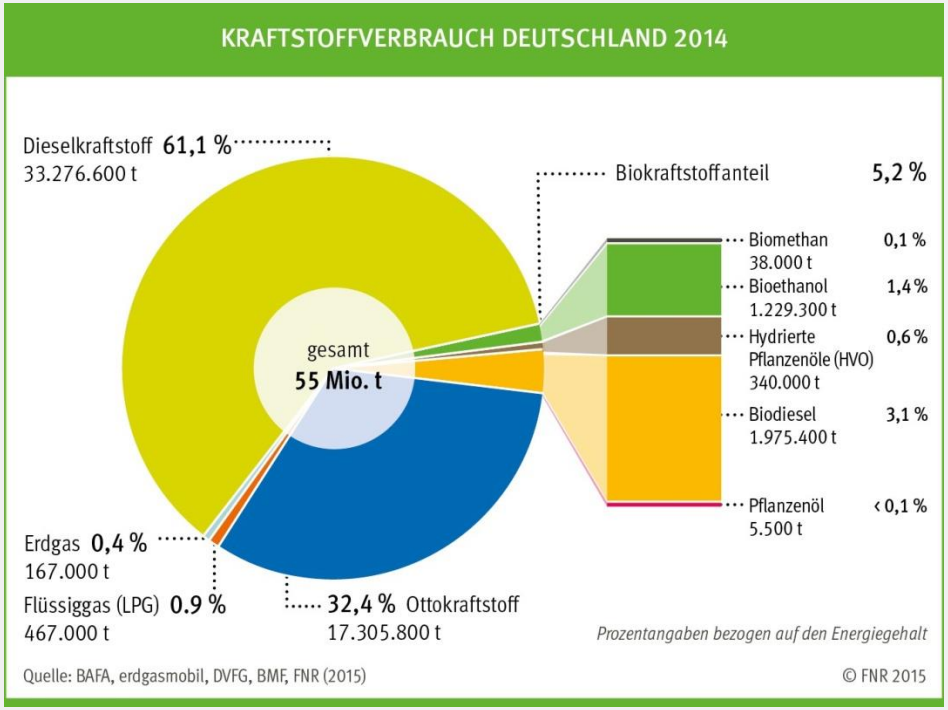
In Germany there are approximately 14.000 petrol stations each with 6 petrol pumps on average. That gives a total connected wattage of all petrol stations in Germany of:

14.000 x 6 x 27 MW = **2.268 GW**

A total transition to alternative drives, implying an even superior efficiency, would require at least **600 GW** of connected wattage, in order to transfer energy to vehicles as conveniently as fuel nowadays.

However the overall installed electrical power in Germany – according to the electric network agency – is only **190 GW**!

source: https://de.wikipedia.org/wiki/Windkraftanlage
and https://commons.wikimedia.org/wiki/Category:Petrol_pumps?uselang=de#/media/File:Petrol_pump_mp3h0355.jpg



The amount of energy of the annual fuel consumption in Germany approximately:

55 Mrd. kg x 12 kWh/kg = **660 TWh**

With consideration of a superior efficiency of alternative driven vehicles about **165 TWh** would be required (rough estimate).

However the gross power generation in Germany is about **614 TWh** every year .

Conclusion:

In case of a total transition to alternative drives – especially battery-buffered electric drives – a quick-charge as fill-up according to current standard would be impossible.

On the contrary a charge at a low power level and therefore a slower supply of electrical energy would be possible. This could be realized with comaratively low capital expenditures in transportation facilities.

→ Long charging time (e.g. overnight) or driving under „wire"

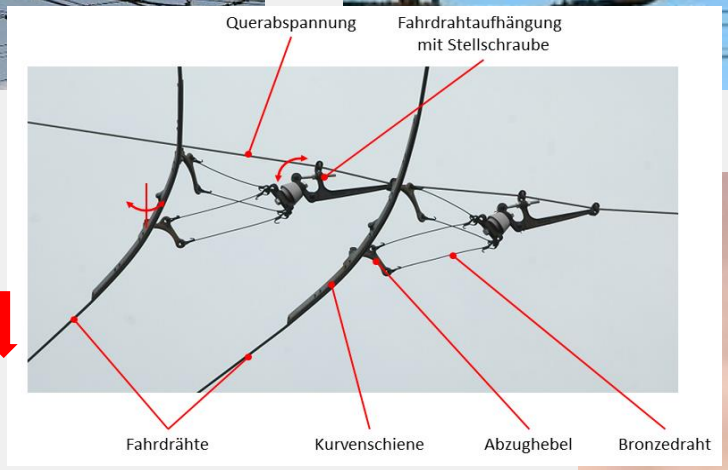
source: https://mediathek.fnr.de/grafiken/daten-und-fakten/bioenergie/biokraftstoffe/biokraftstoffe-in-deutschland.html

Solaris Trollino 18AC – in use at the Barnim Bus Company in Eberswalde since 2010

trolley bus + backup battery + automatic overhead line contact system

= modern and cost-efficient means of local public transportation

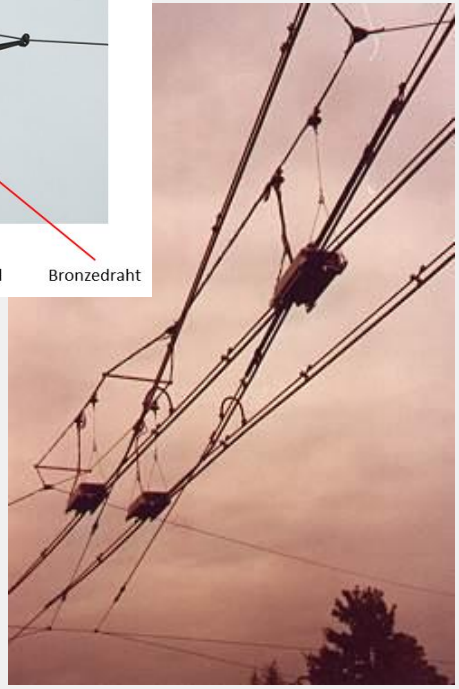
source: Barnimer Busgesellschaft mbH, www.obus-ew.de



some cost of overhead line systems

possible savings with partial catenary

dual overhead line per km	210.000 €
junction/intersection	~~20.700 €~~
junction gate (electrical)	~~55.000 €~~
merging switch (mechanical)	~~20.100 €~~
section insulators	~~14.800 €~~
power feed	6.400 €
catenary pole	3.500 €
rectifier station	430.000 €



source: http://de.wikipedia.org/wiki/Oberleitungsbus

The idea of a partial catenary is not new.
A remarkable example – even from today's point of view -
was the Duo Bus tested in Esslingen in the mid-70s.
However in terms of technical know-how, economic and political sense
the time was not yet ready to lead this development of the Duo Bus to success.

Given today´s technology we at the UAS Zwickau feel the urge to bring back
this technology and to develop it further particularly on the subject
of automatic overhead line contact system.

source: www2.mercedes-benz.co.uk

Auslegeschrift 24 60 843

(11)
(21) Aktenzeichen: P 24 60 843.3-32
(22) Anmeldetag: 21. 12. 74
(43) Offenlegungstag: 1. 7. 76
(44) Bekanntmachungstag: 30. 9. 76

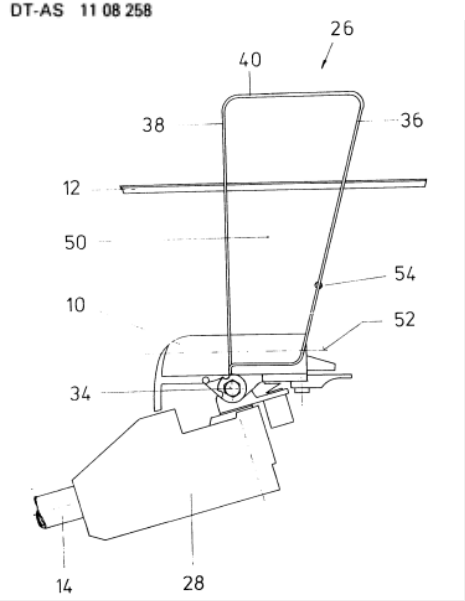
(30) Unionspriorität:
(32) (33) (31) –

(54) Bezeichnung: Stangenstromabnehmer für gleislose, elektrisch angetriebene Fahrzeuge

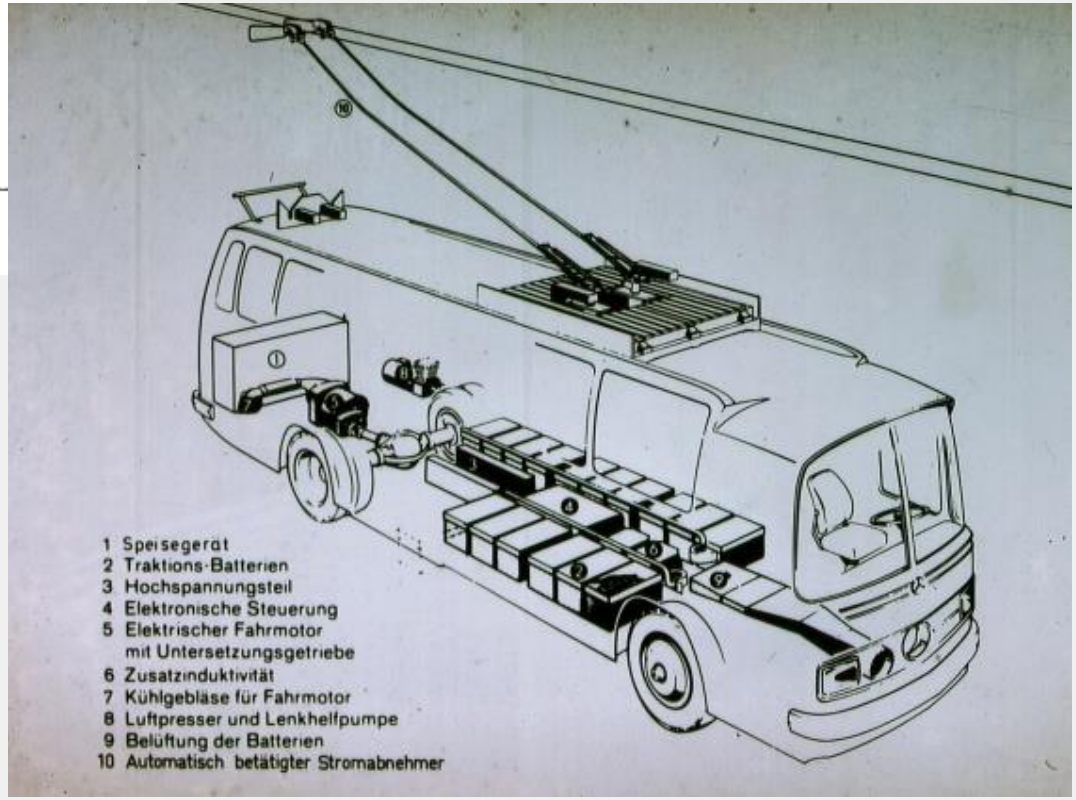
(71) Anmelder: Dornier System GmbH, 7990 Friedrichshafen

(72) Erfinder: Dietrich, Eckard, Dipl.-Ing.; Fischer, Klaus-Peter; Fritzsche, Albert, Dr.-Ing., 7778 Markdorf; Seidl, Ernst, 7990 Friedrichshafen; Wuch, Peter, 7778 Markdorf

(56) Für die Beurteilung der Patentfähigkeit in Betracht gezogene Druckschriften:
DT-PS 3 36 812
DT-AS 11 08 258

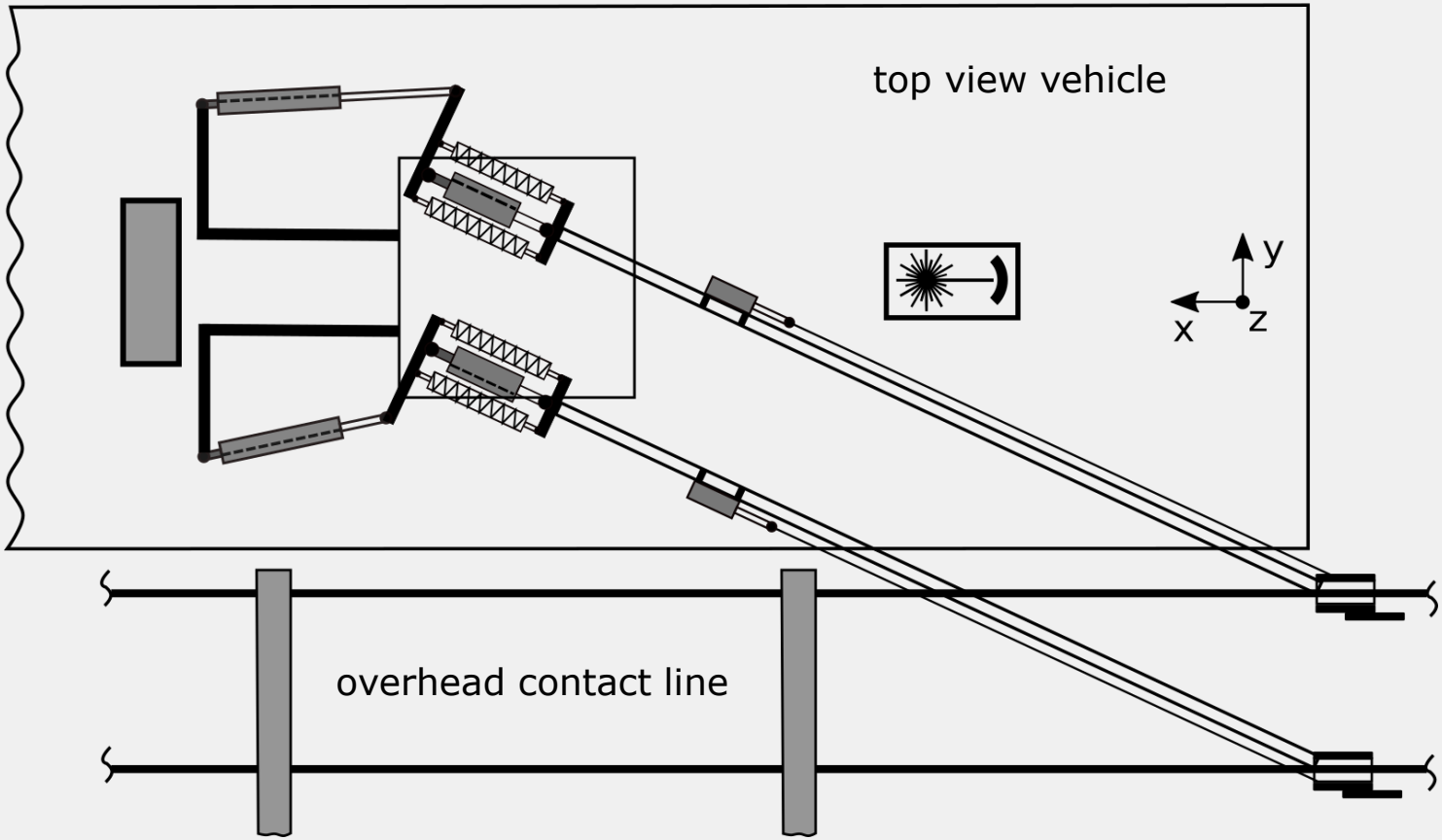


patent Dornier System GmbH 1974
with its special solution
at the connector head



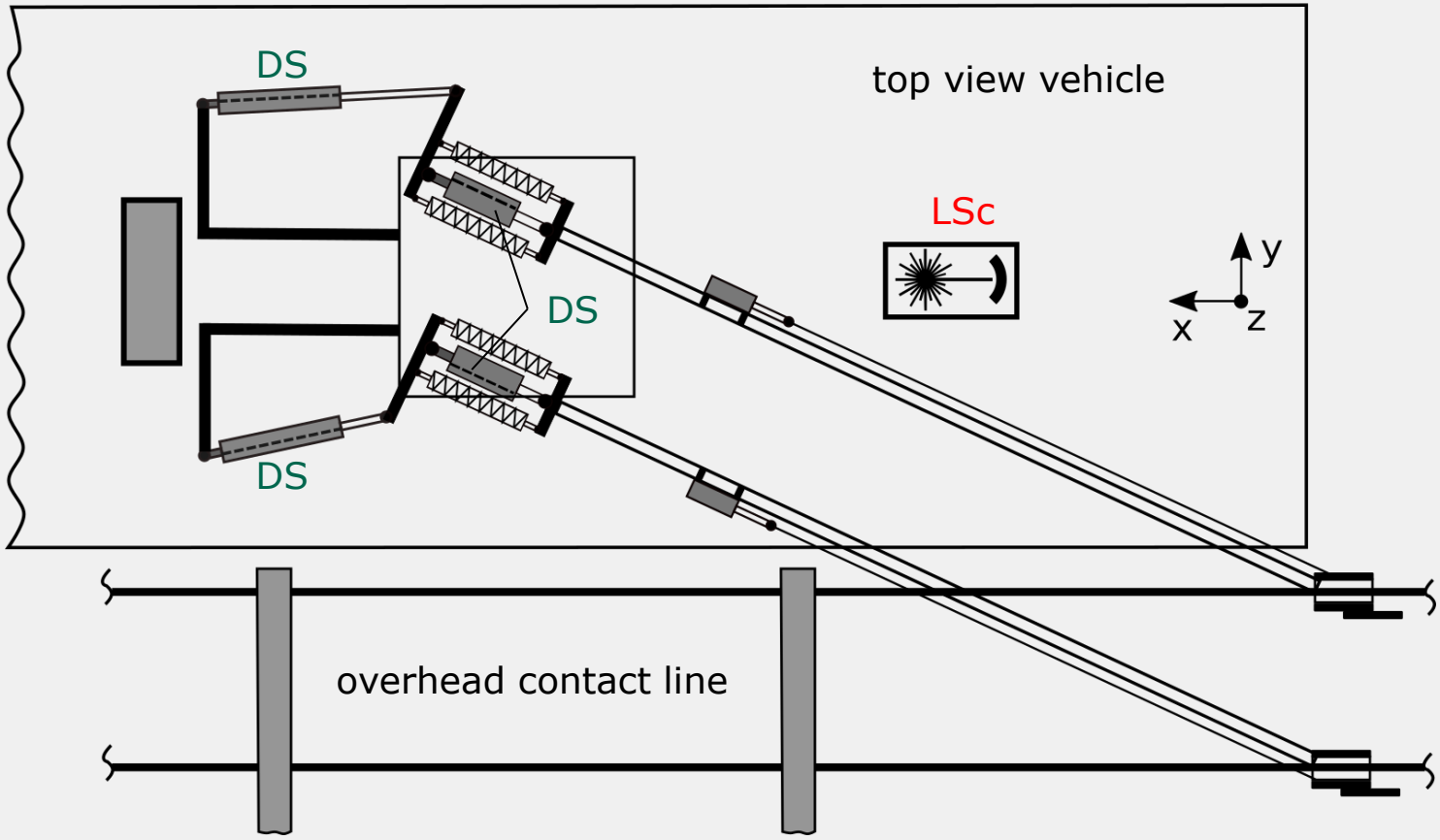
concept of the University of Applied Sciences Zwickau

1. sensors 2. actuators 3. electronic and pneumatic control



1. main sensors

- laser scanner to capture the overhead line from a far distance (LSc)
- displacement sensors to measure the position of the piston in pneumatic cylinders (DS)

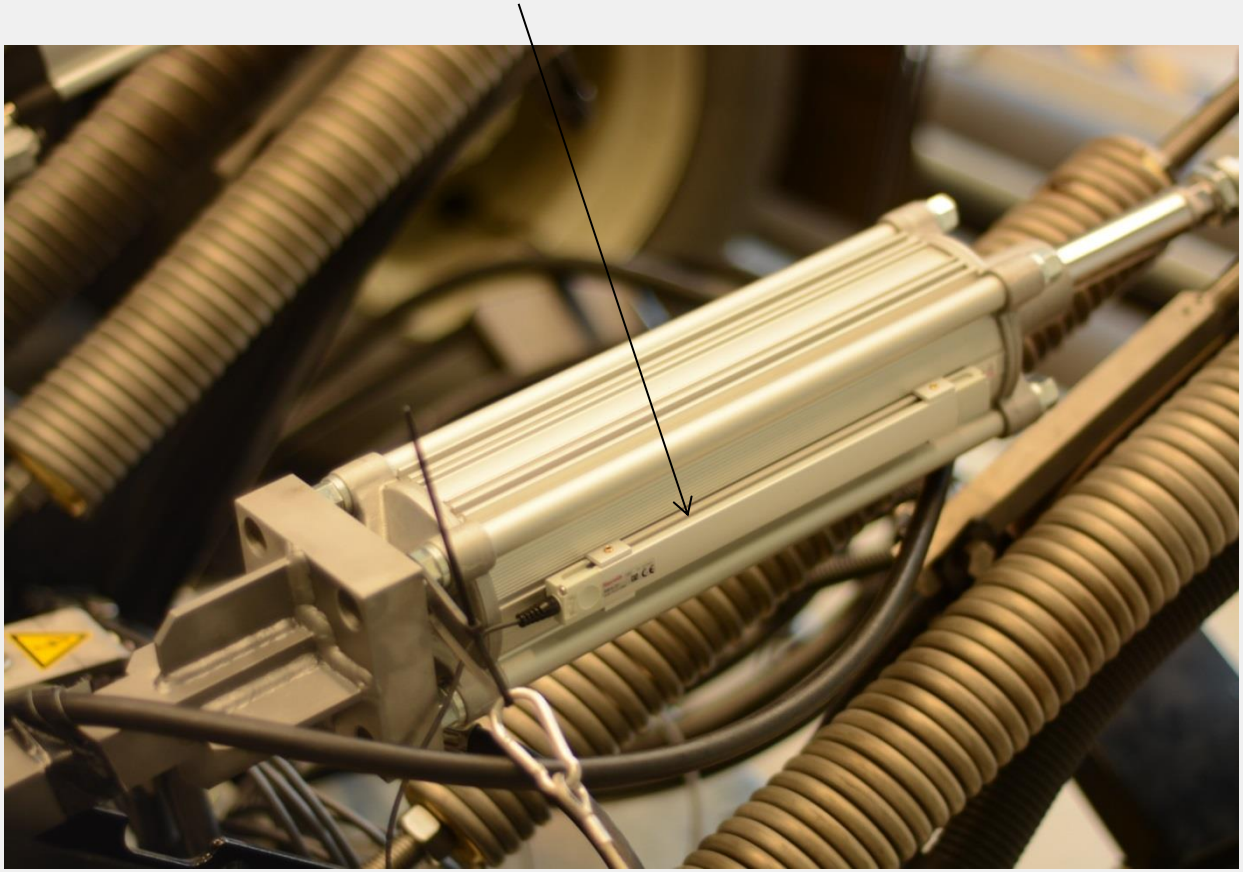


1. main sensors

- laser scanner to capture the overhead line from a far distance (LSc) (type: SICK LMS511)

1. main sensors

- laser scanner to capture the overhead line from a far distance (LSc)
- displacement sensors to measure the position of the piston in pneumatic cylinders (DS)



1. main sensors
   - laser scanner
   - displacement sensors

and additional sensors for locating of the vehicle

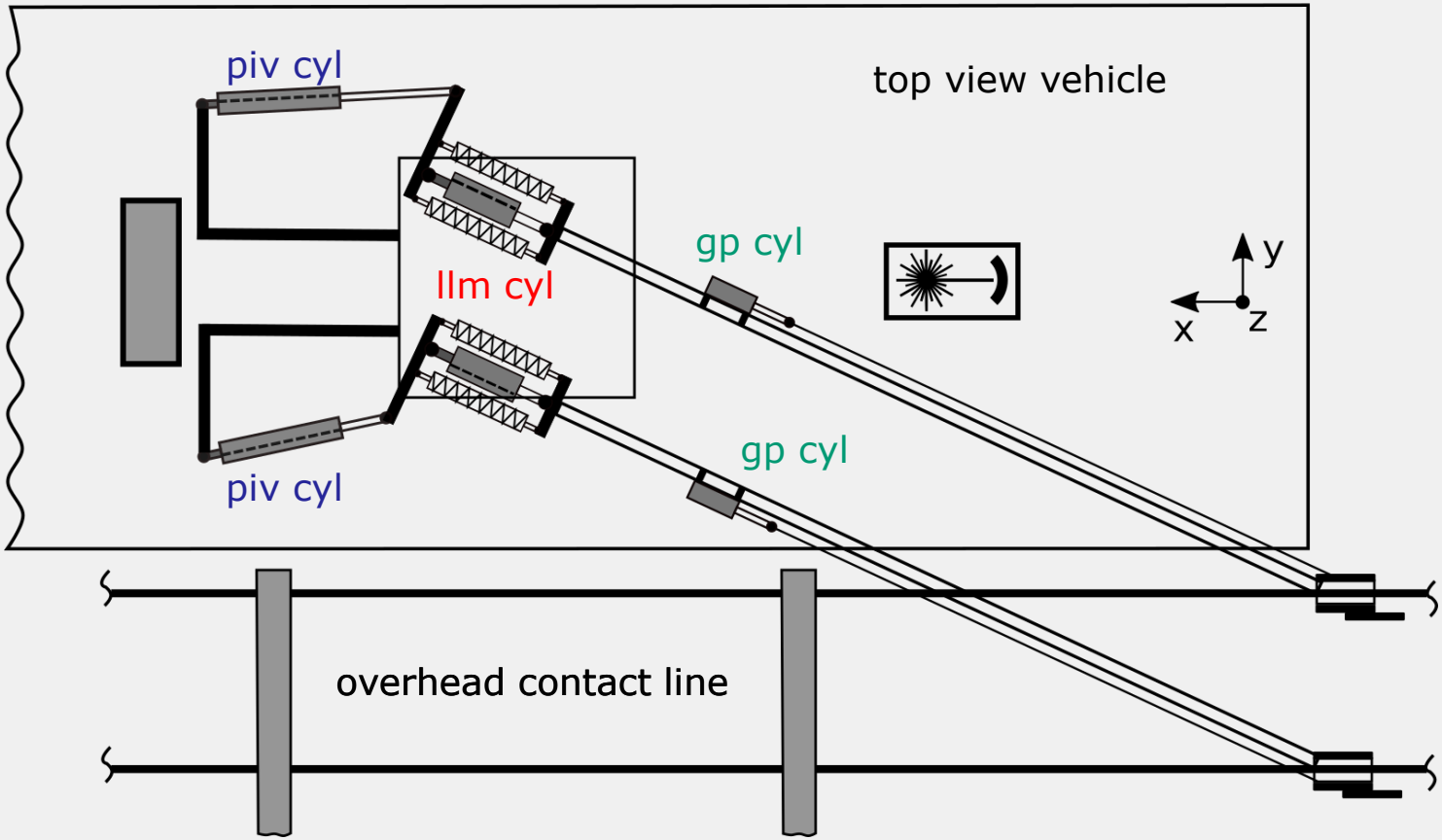
- distance and motion sensor

- Diff.GPS Modul

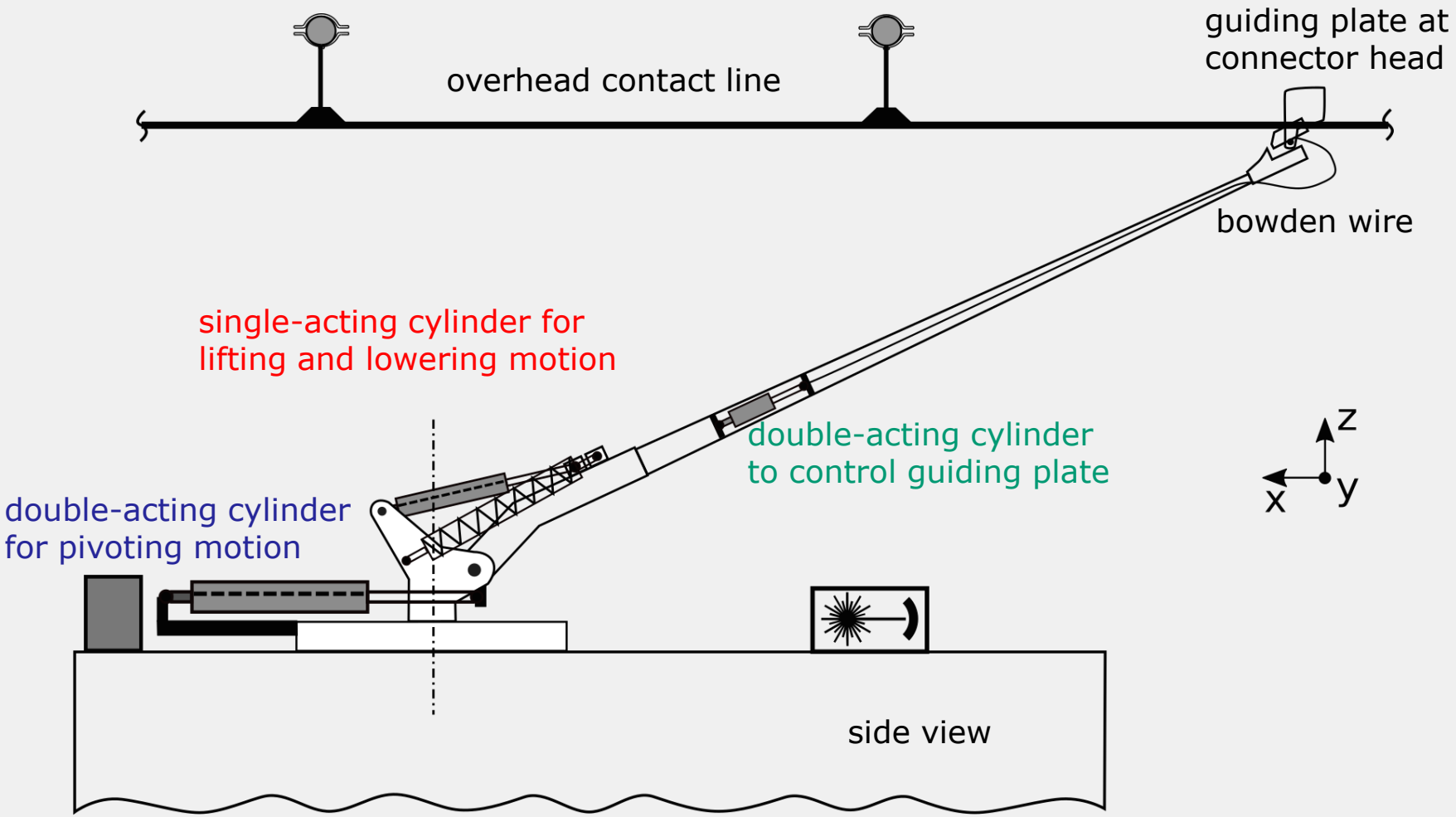
- 2 x 4 ultra sonic sensors for monitoring surroundings of poles

2. actuators

- single-acting cylinder for lifting and lowering motion (llm Cyl) (in cooperation with double tension spring)
- double-acting cylinder for pivoting motion (piv Cyl)
- double-acting cylinder to control guiding plate at connector head (gp Cyl)



2. actuators


overhead contact line
guiding plate at connector head
bowden wire
single-acting cylinder for lifting and lowering motion
double-acting cylinder to control guiding plate
double-acting cylinder for pivoting motion
z
x
y
side view

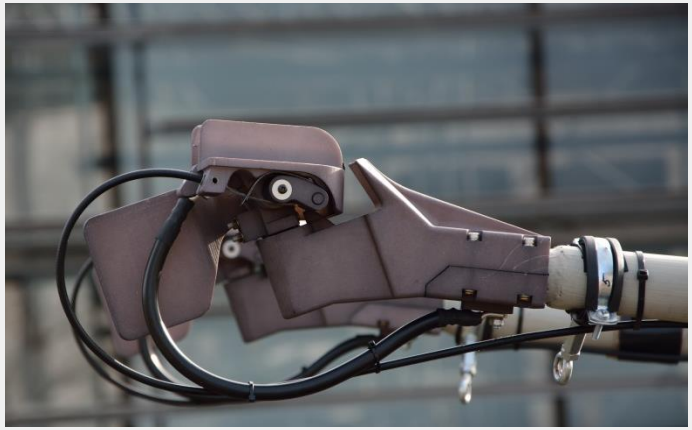
2. actuators

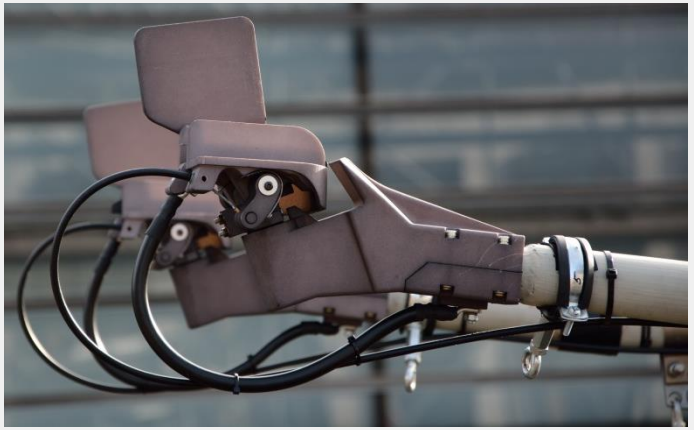
double-acting cylinder
for pivoting motion

single-acting cylinder for
lifting and lowering motion

2. actuators

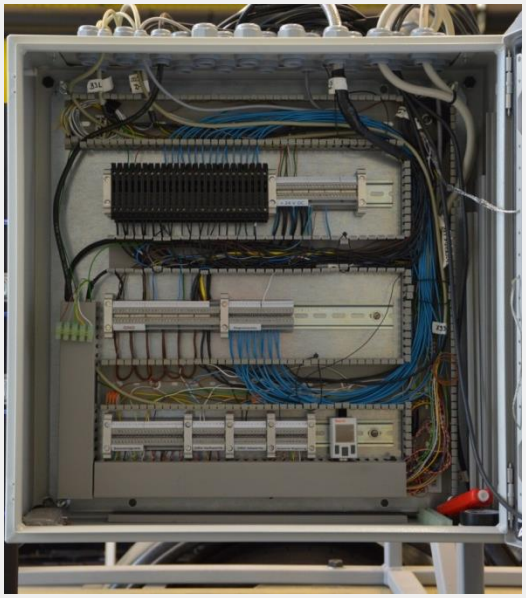
guiding plate in its two positions





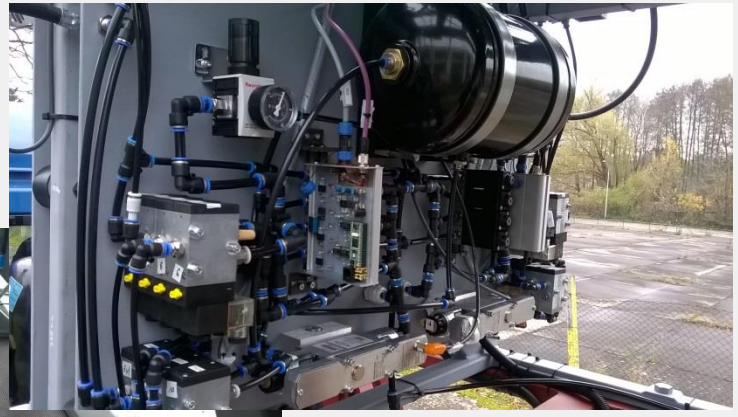
double-acting
cylinder to
control guiding plate

3. electronic and pneumatic control

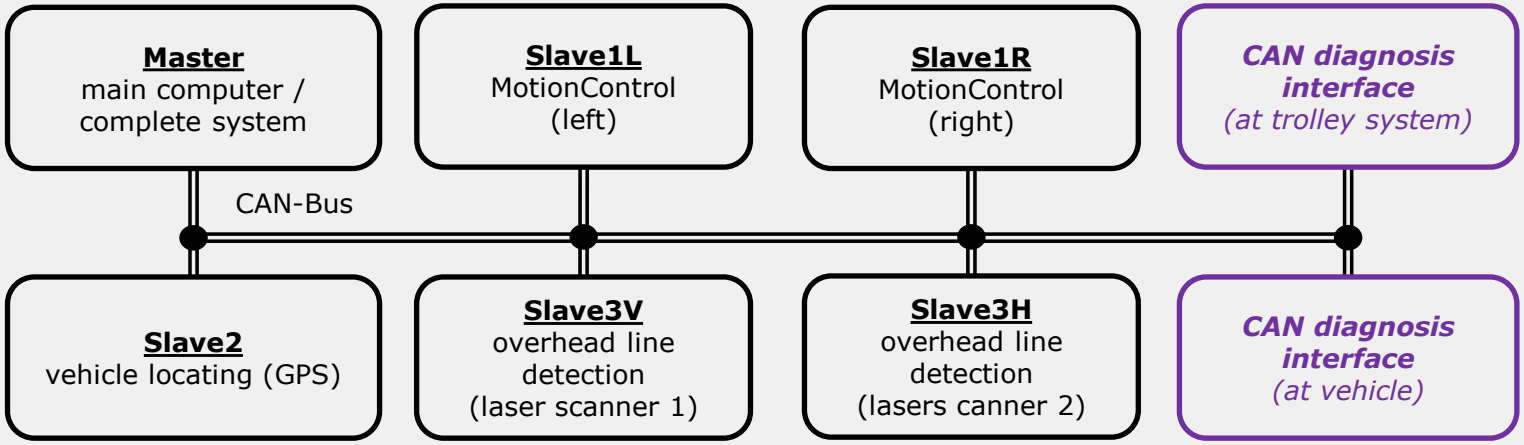


control box

main controller (at debugging)

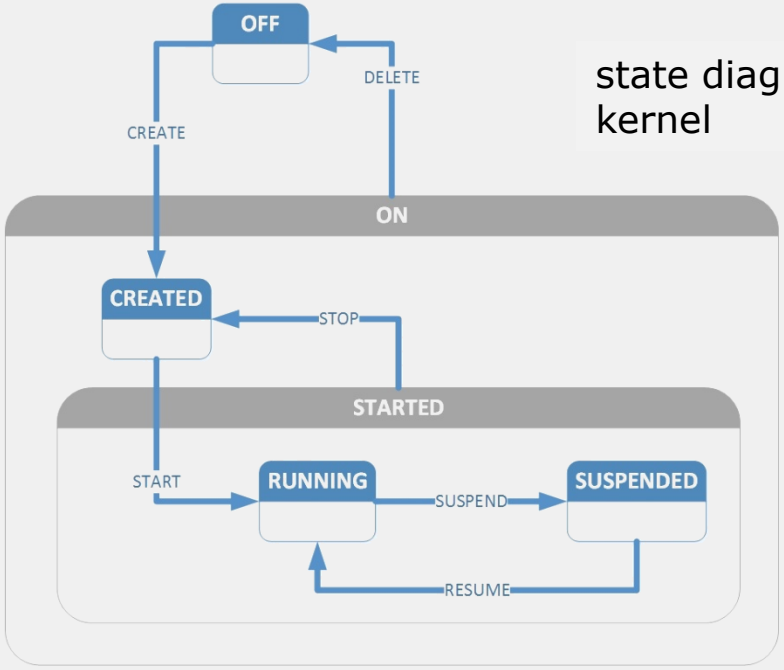


valve control with opened ECU

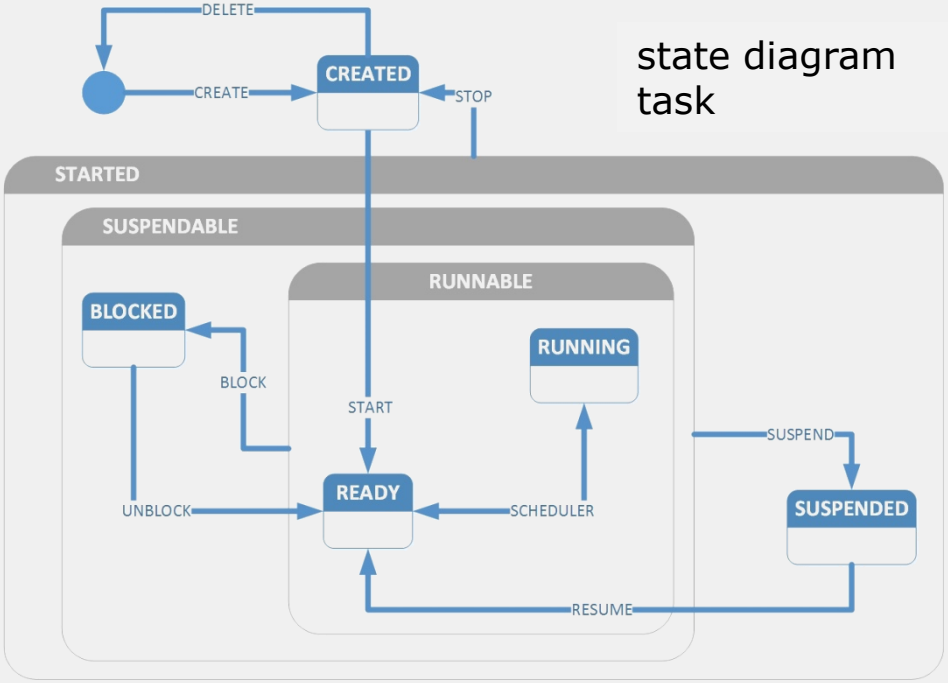


3. electronic and pneumatic control

Development of our own preemptive multitasking robust real-time operating system for used microcontrollers (Infineon TriCore and Microchip PIC32)



state diagram kernel



state diagram task

The operating system is due to an abstract layer for the hardware specific functions in principle capable of running on any computer.

At the 10th and 11th of November 2015 we have done our first practical tests on a real catenary in Eberswalde.

We thank our colleagues from the Barnim Bus Company for their great support.

Video 1: automatic wiring on the right of the catenary (Eberswalde 11.11.2015)

Video 2: driving at the catenary with new developed trolley heads

Meanwhile we have installed our own small experimental plant at the University of Apllied Sciences Zwickau.

Video 3: automatic wiring on the left of the catenary (Zwickau 29.01.2016)

Video 4: automatic wiring while vehicle and catenary not parallel to each other (Zwickau 04.02.2016)

Next task (until completion of the project on 30.06.2016):

Connect and disconnect the trolley heads from the Overhead line based on GPS and implementing sensors for extrapolating the vehicles position in case of malfunction of the GPS module

Next necessary stage of development (after official completion of the project):

Making the prototype of the automated wiring system suitable for series production

The team of the University of Applied Sciences Zwickau thanks you for your attention.

contact:

Westsächsische Hochschule Zwickau
Fakultät Kraftfahrzeugtechnik
Prof. Dr.-Ing. Matthias Thein
Postfach 201037
08012 Zwickau

Tel. +49 (0) 375 536 3863
Fax +49 (0) 375 536 3393
E-Mail: Matthias.Thein@fh-zwickau.de

www.fh-zwickau.de/Skorpion