PRESENTATION OF A NEW MOBILITY IDEA

ComplexTrans - from Railway to Hyperrailway and more

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@Shift2Rail_JU
#S2RCall2020

There are comments to almost all slides (if needed).

Commentary to the slides are placed either on the same slide (if short) or just behind each slide

and refere to the slide number placed in the corner right up.

TRANSPORT RESEARCHERS AROUND THE WORLD ARE SEARCHING FOR ANSWERS TO THE FOLLOWING QUESTIONS

HOW TO

	OUR GOAL
ON RAIL	
..... join passenger and freight transport?	yes
..... transfer most freight from road to rail?	50% at least
..... make railways self-financing?	yes
..... make railways 'faster' than aircraft?	up to 1500 km
ON ROAD	
..... reduce urban traffic?	by up to 75%
..... eliminate parking problems?	yes
..... make electric cars in all respects better than cars of today?	yes
..... make the journey safer, faster and more comfortable?	yes
..... use the time during the journey effectively?	go driverless
ON BOTH	
..... save energy in transport?	up to 40%
..... reduce transport emissions?	by up to 90%

And many more questions.

SLIDE 1

Researchers from around the world are thinking about how to improve rail and road transport, save energy and eliminate emissions.

We have the same goal at the University of West Bohemia and we are solving it by mutual adaptation and deep cooperation between rail and road vehicles. On the right (in blue colour) you can see our goals.

SOLUTIONS PREPARED TODAY

CAR SHARING

ELECTRIC DRIVE

AUTONOMOUS CARS and 5G-CONNECTION

FLYING CARS

MOBILITY as a SERVICE MaaS

NOT BAD, BUT NOT GOOD ENOUGH!

(complicated, sensitive, restrictive, expensive)

By the way - do you know, that

electric driverless cars have been in operation in Europe for more than 60 years?

ROAD

RAILWAY

SUPER HST

HST for FREIGHT

SLIDE 2

Currently world development is oriented on
car-sharing, electromobility, autonomous cars with 5G-connectivity, even flying cars and Mobility as a Service
and
high-speed trains for passengers and newly also for consignments (in Italy and France).
It's not bad, but it can be better.

Do you know that driverless electric cars have been operating in Europe for 60 years?

Cars or trucks
that are transported in an electric train
are in fact autonomous electric vehicles

ANOTHER TYPE OF AUTONOMOUS ELECTRIC RIDE

WELL

WHAT CAN WE DO?

How to change the transportation jungle to a transportation paradise?

Shift 2 Road?

NO !!!

Shift 2 Rail?

NO !!!

Shift 2 Air?

NO !!!

Shift 2 Hyperloop?

NO !!!

Shift 2 Road´n´Rail

S2R-OC-IPX-03-2018 call - Innovative/breakthrough mobility concepts (with rail as backbone)

FACULTY OF MECHANICAL ENGINEERING
UNIVERSITY OF WEST BOHEMIA

SIEMENS
Ingenuity for life

COMPLEX TRANS

11 in 1 UNIVERSAL DOOR-DOOR LAND TRANSPORTATION SYSTEM

IN CITIES & INTER CITY
PASSENGERS & GOODS
PUBLIC & PRIVATE

ROAD & RAIL
PARTIALLY INSTEAD OF AIR
INTERMODAL & MULTIMODAL

LET´S CHANGE RAILWAYS TO HYPER-RAILWAYS AND MORE

HOW TO DO IT?

1. common passenger-freight trains (wagons)

2. uniform speed for passengers and freight (200 km/h ± 20%)

3. wheeled mobile transportation modules/adapted cars
   for intermodal last-mile transport of freight or passengers.

4. two-storey platforms
   upstairs passengers,
   downstairs self-loading mobile freight modules (and cars)

5. (semi) terminals at the city ends, with two-storey platforms and tracks for individually connected fast freight wagons or small groups of them

6. (semi)terminals connected by city-shuttles, going through the whole city
   for multimodal last-mile passenger transport

SLIDE 4

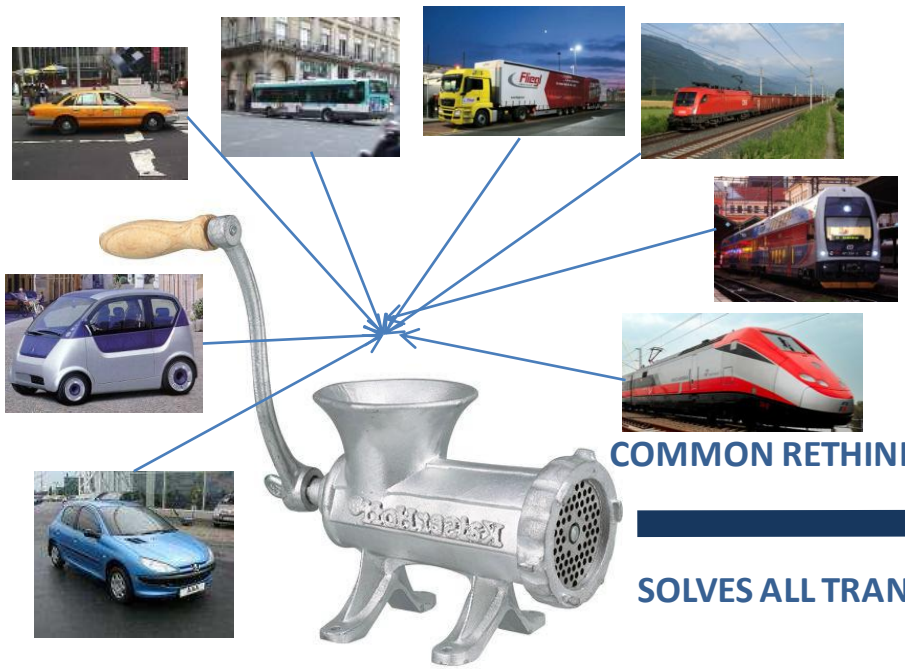
Professor Andy Doherty said - we don't need a hyperloop, but we need a hyperrailway.
And this is ComplexTrans with the following six changes compared to conventional rail

- common passenger-freight trains and wagons
- with uniform speed up to 230 km/h
- wheeled Mobile Transportation Modules
- two-storey passenger-freight platforms
- terminals or semi-terminals at both city ends
- connected by city-shuttles

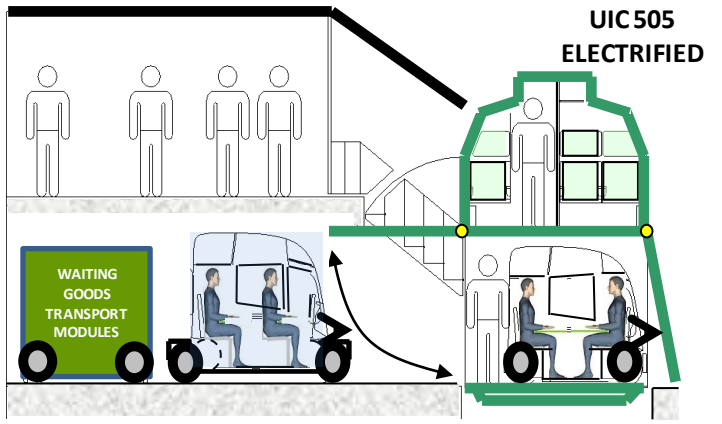
STEP ONE common development of **ALL** components of ComplexTrans system.

TRANSPORT OF TOMORROW

development

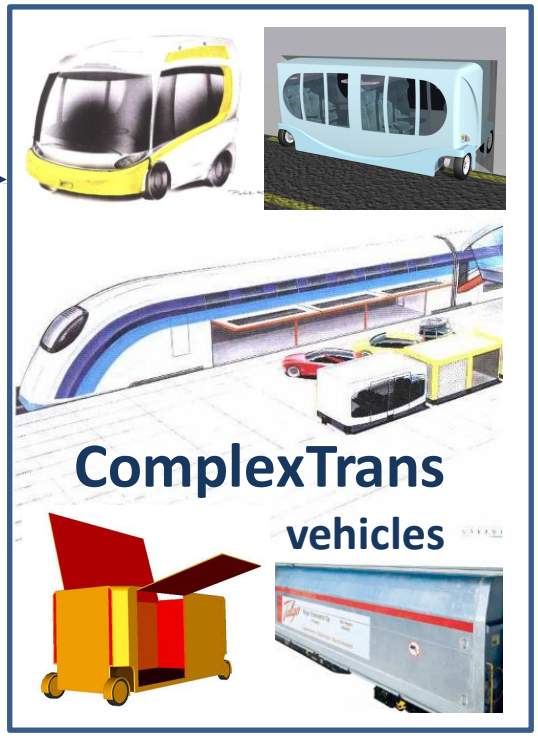


Passenger-freight railway platform



COMMON RETHINKING OF LAND TRANSPORT

SOLVES ALL TRANSPORTATION PROBLEMS



INSTEAD OF

TRAFFIC JAMS **PARKING PROBLEMS** **CROWDED MOTORWAYS** **DANGEROUS EMISSIONS** **FREQUENT ACCIDENTS**

WE WILL GET A STRONG DOOR-DOOR CONNECTION

SLIDE 5

The first step towards ComplexTrans is the joint development of all critical components.

We have today many great road and rail vehicles, but the results are not good.

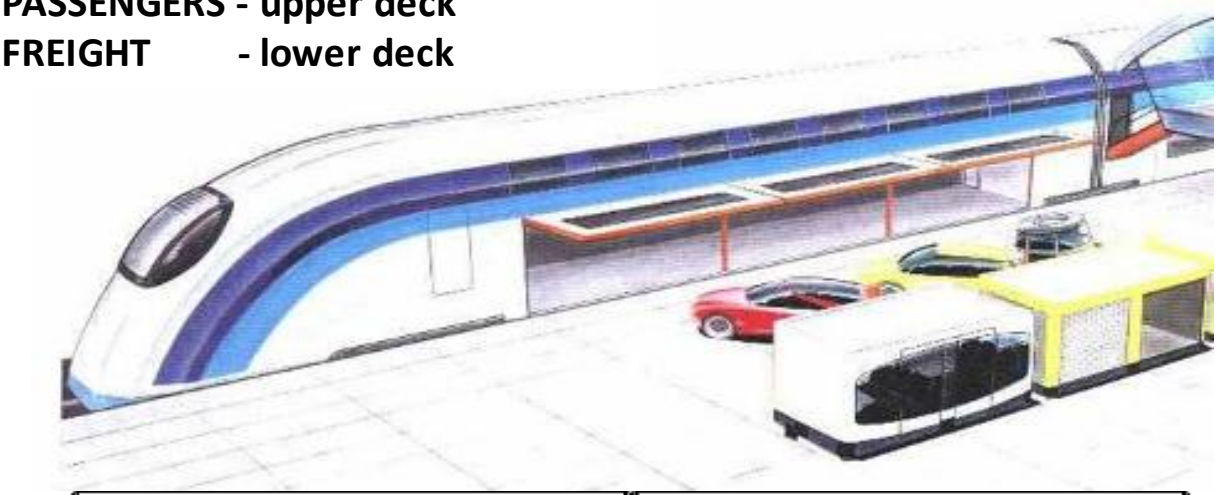
All current major means of land transport should be adapted to each other.
The backbone of the system are fast double-deck passenger-freight trains and fast cargo wagons.

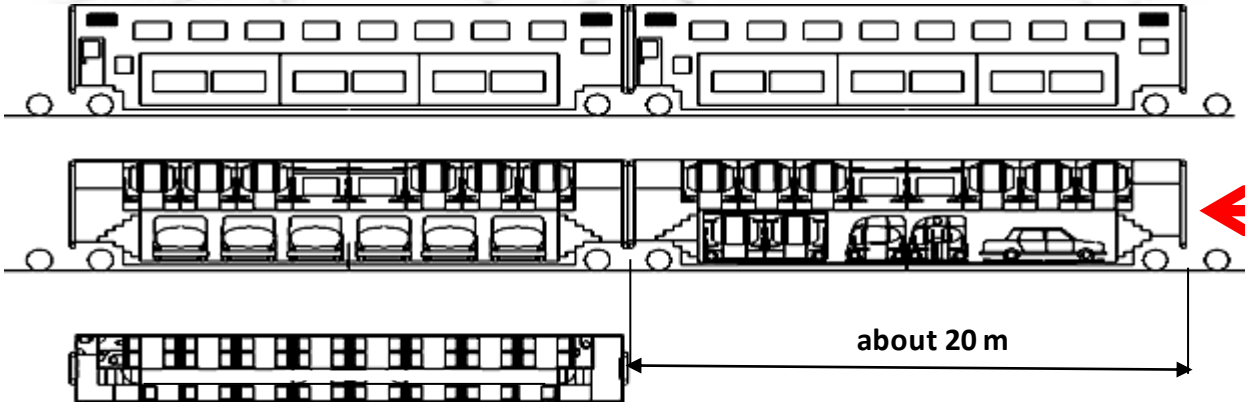
The system is completed by road freight or passenger mobile transport modules and adapted cars, called coupemobiles - named after similarity to the railway coupe.

Terminals with two-storey platforms serve as an interface between road and rail.

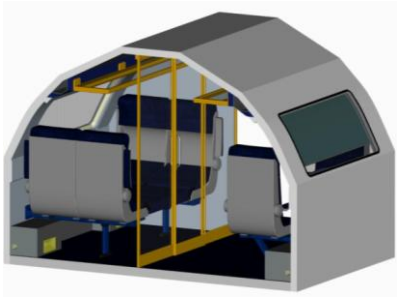
Main RAIL vehicles of ComplexTrans system – I and II

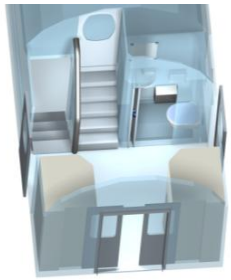
Double-deck mixed railway coaches
PASSENGERS - upper deck
FREIGHT - lower deck

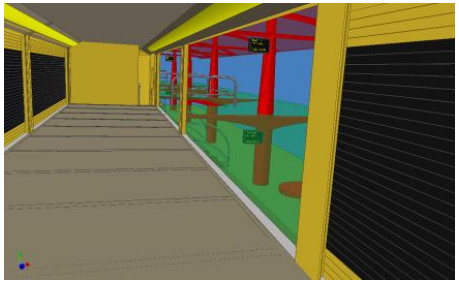




fast freight wagons
connected at end of train-
solo or in small groups







SLIDE 6

The backbone of the ComplexTrans system are fast double-deck railcoaches with Jakobs bogies that carry sitting or lying passengers on the upper-deck and passenger cars or transport modules on the lower-deck.

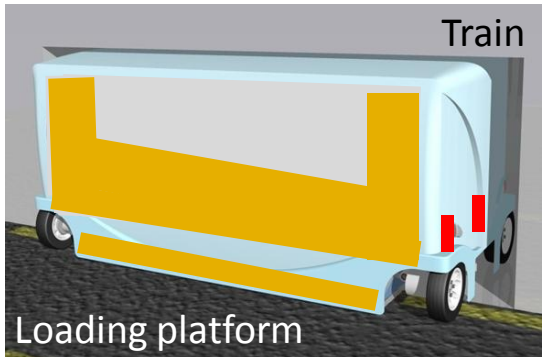
In addition, the system includes fast freight wagons attached to ComplexTrans trains from the back.

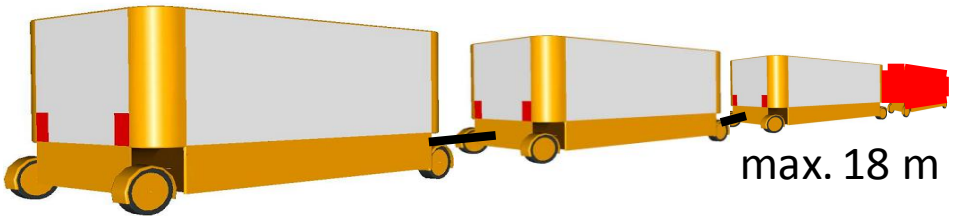
Main ROAD vehicles of ComplexTrans system – I

4.5 x 2.55 x 2 m, 8–9 Europallets
electric drive with limited range
swivelling wheels for self-loading

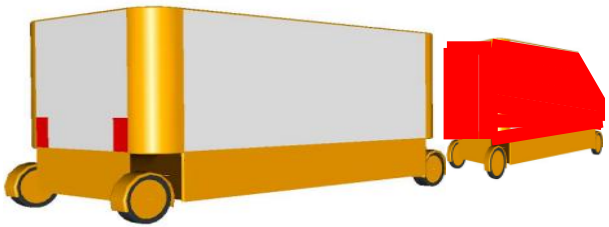
DOOR-DOOR
freight transport
road-rail modules

Advanced lorries





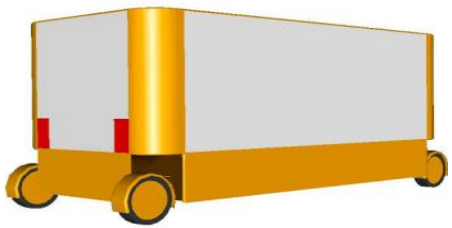
Express delivery during transportation peaks



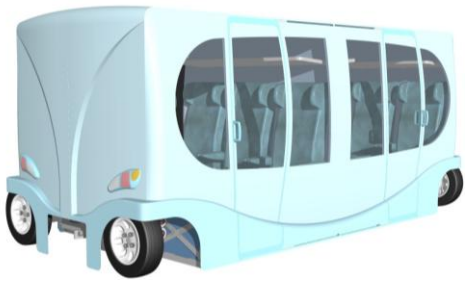
Standard transport outside of transportation peaks

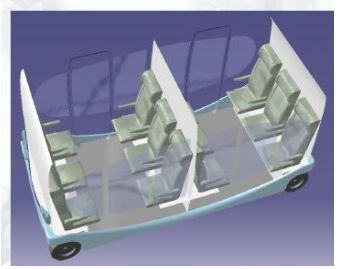
Towing vehicle - functions
- **Traction**
- **Place for driver + 3 free seats**
- **Energy supply for traction of towed vehicles**

Local manipulation by remote control



Modules for supplementary passenger transport





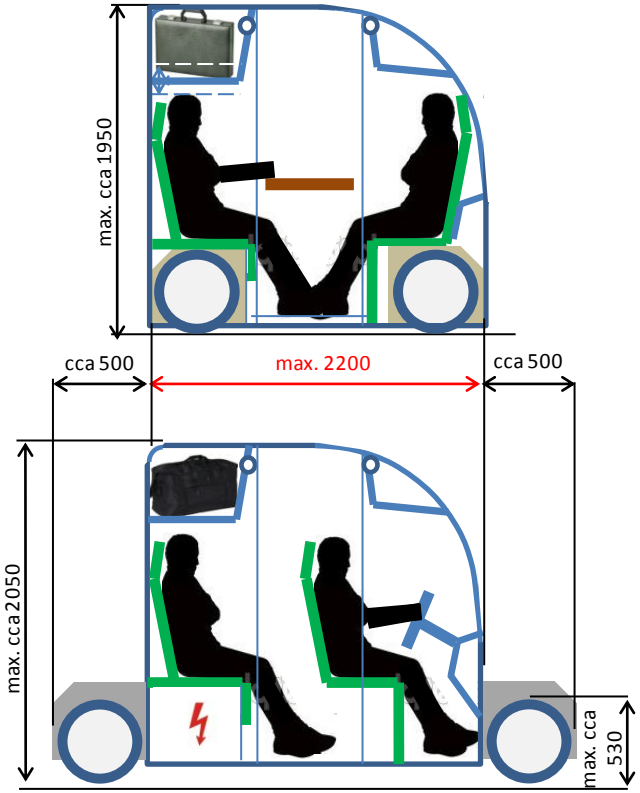
SLIDE 7

Part of the ComplexTrans system are also mobile transport freight modules with electric drive and four swiveling wheels, which allow lateral self-loading into the train. The freight modules are delivered to the customer in sets led by guide car. The remote control is used for local manipulation.

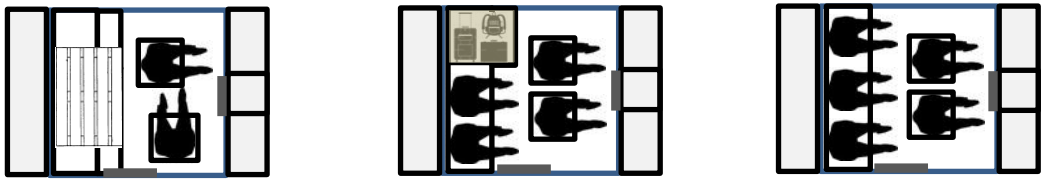
Similar to freight modules are mobile passenger transport modules used for system introduction and for additional purposes.

Main ROAD vehicles of ComplexTrans system – II

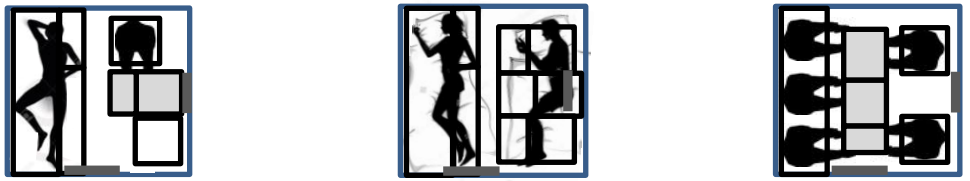
Coupemobile – adapted advanced car with E-drive



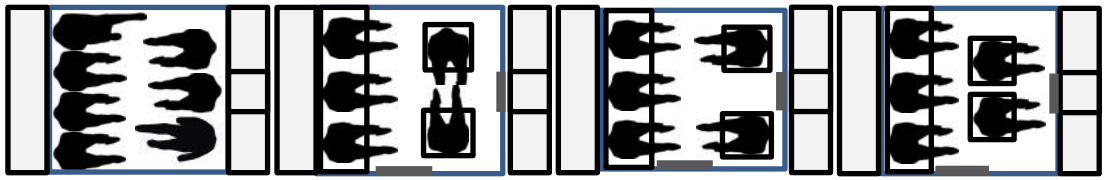
going solo



use during transport in the train or outside of traffic



going in the set (platoon)



- **mobile, spacy, variable 'autonomous' room** for up to 5 passengers
- **extendable axles with crash function**
- **e-drive with traction battery or range extender changeable** from back
- **catch points** in the roof **for lifting**
- **ride in** tight sets (**platoons)**

SLIDE 8

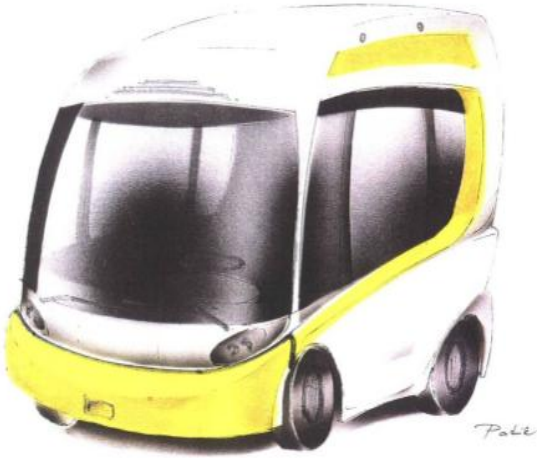
The system is completed by adapted cars for 5 persons and luggage, called coupemobiles.

New solutions are
- extendable and turnable axles with crash function
- half basic ground footprint and increased height
- door layout and variable interior
- electric drive with a replaceable battery from behind
- catch points in the roof for vertical handling
- capability to go in sets

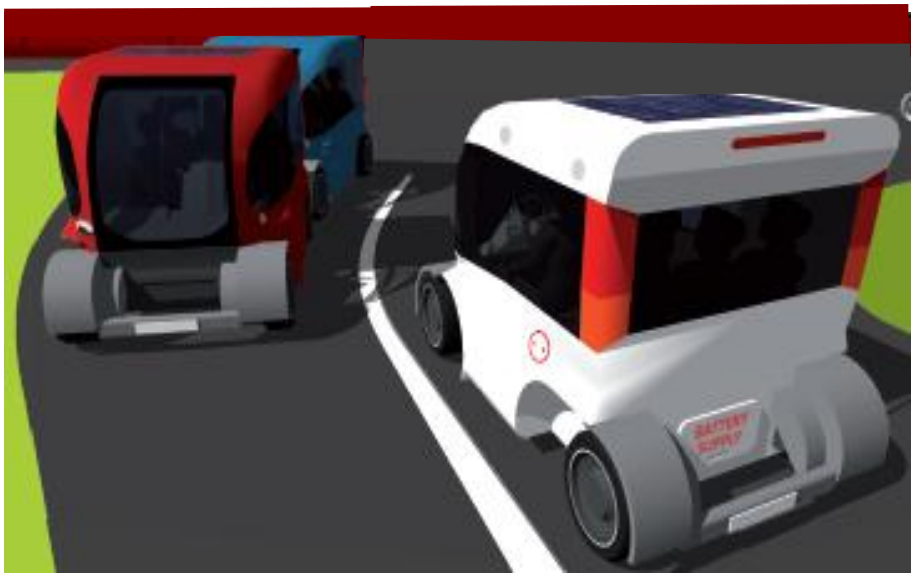
Coupemobile can comfortably carry 5 adults and their luggage or 4 persons with bulky luggage or two persons and one Europallet.

The interior can be used as a small living or meeting room.

A set of coupemobiles saves space and energy and can be included temporarily on a voluntary basis into the public transport - as a shared E-bus.

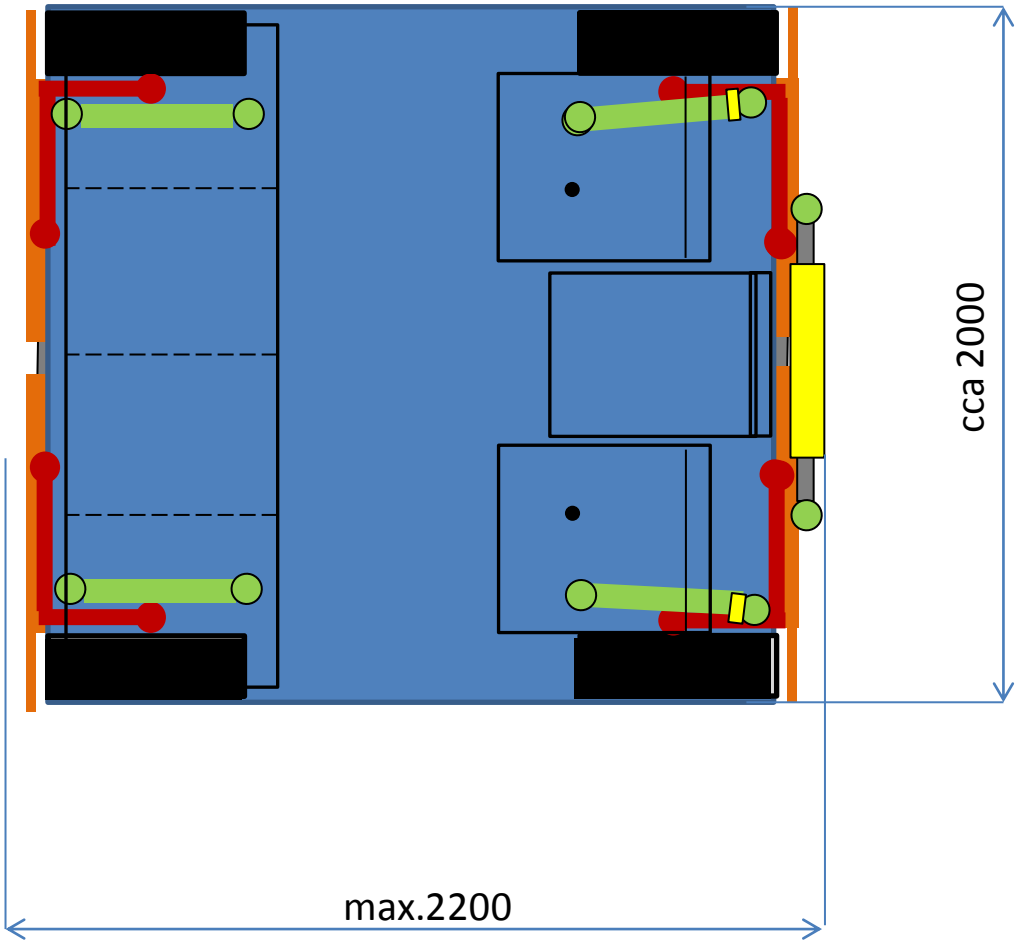


Some design variants of coupemobil.
Although the coupemobile is in fact a cube on wheels, it needn´t be ugly.



axles not extended

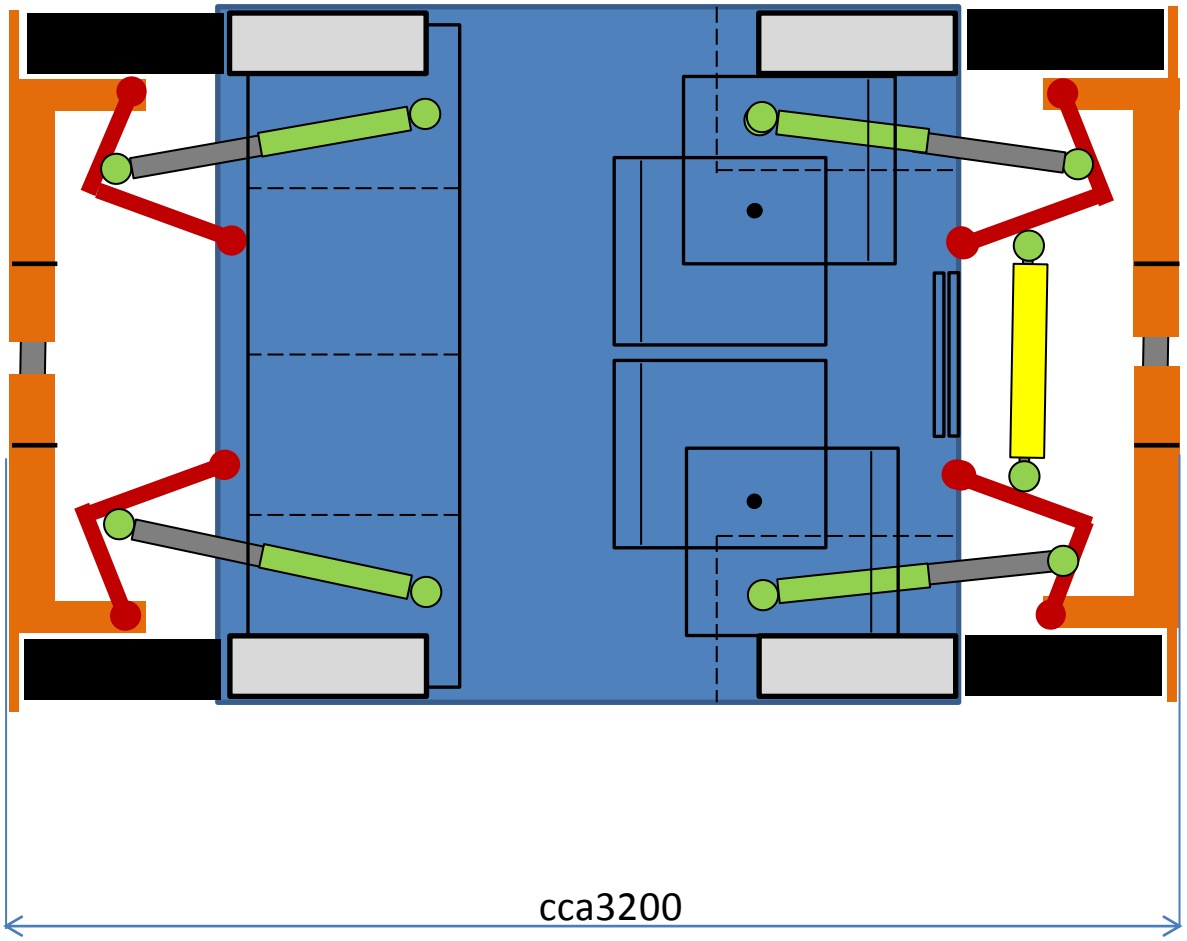
during transport in train or parking



The picture shows a plan view of a coupemobile with not extended axles.
In the next four pictures you will see the different position of the axles while driving.

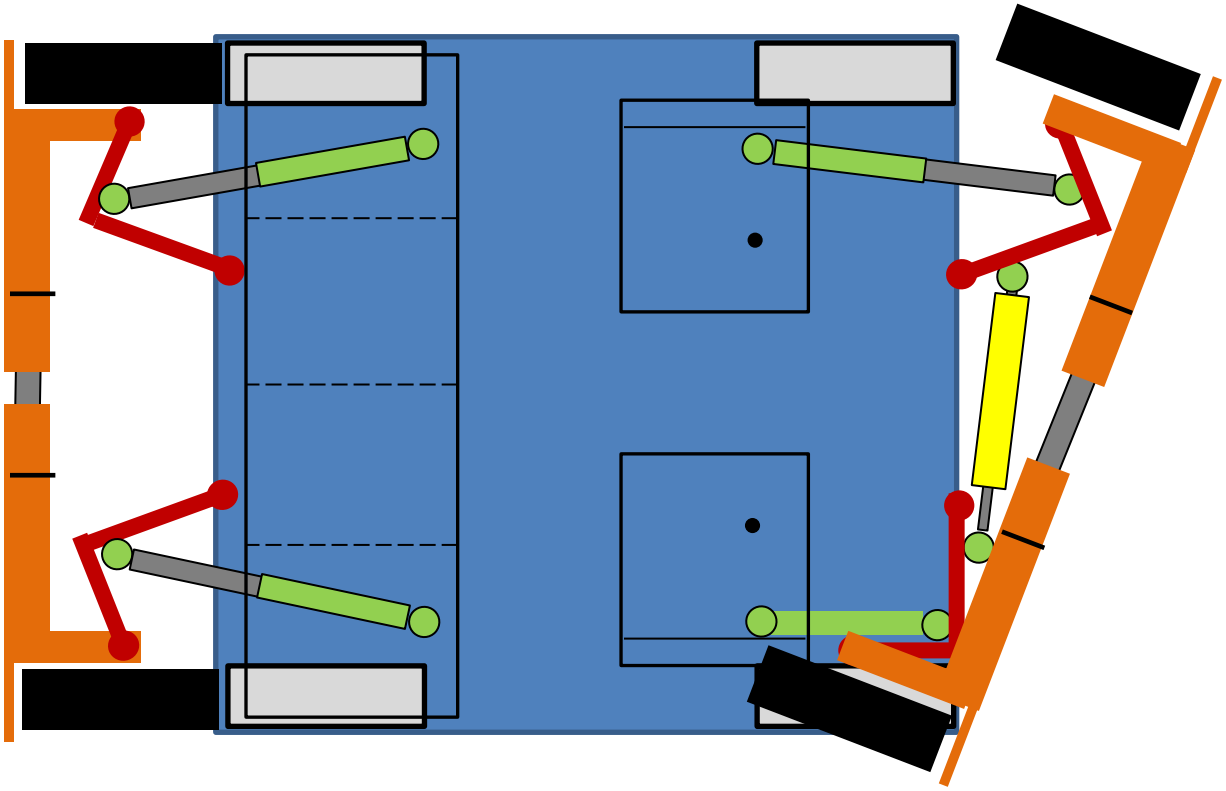
axles extended

during the ride in the straight



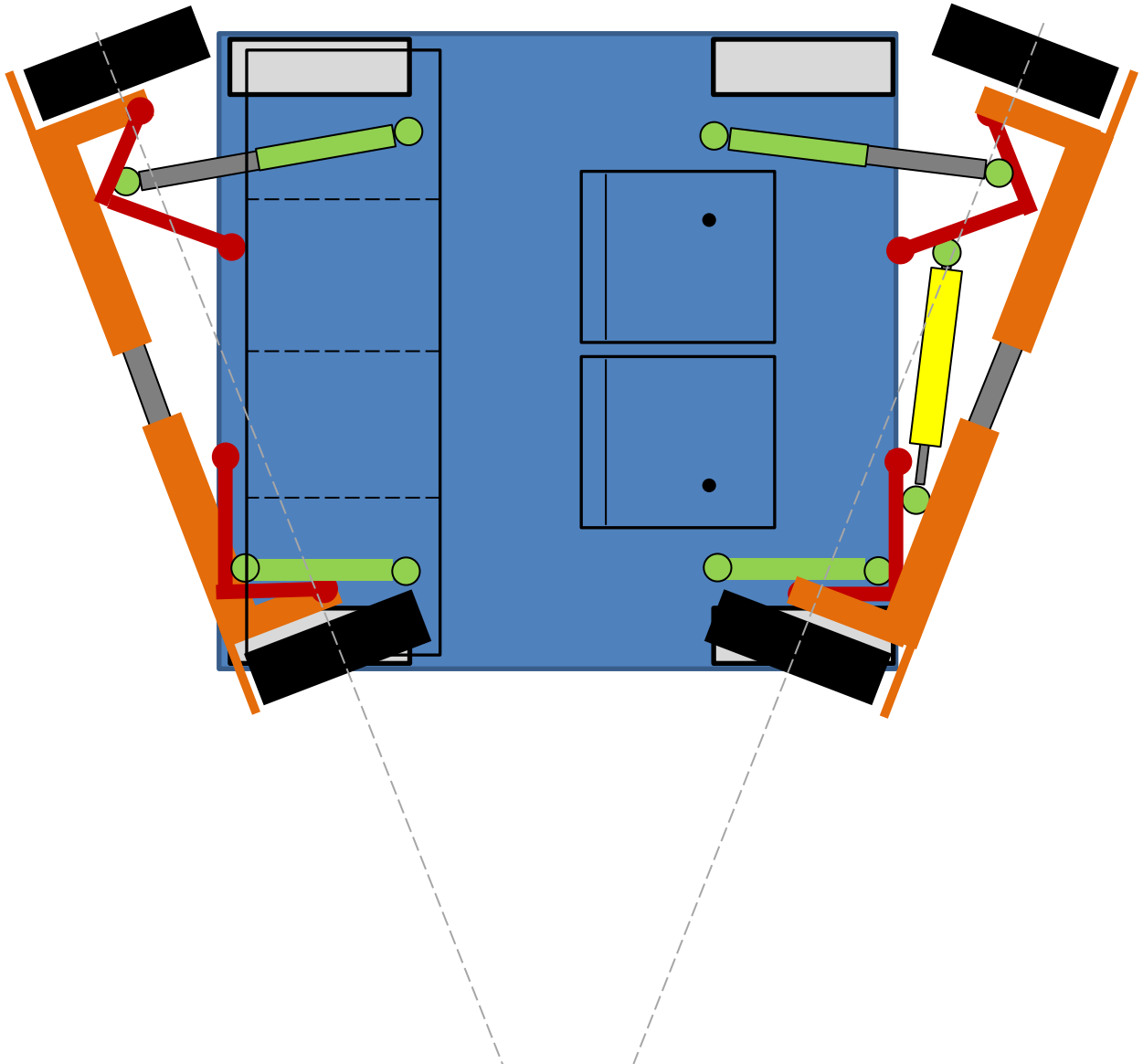
axles extended

during the ride in the curve

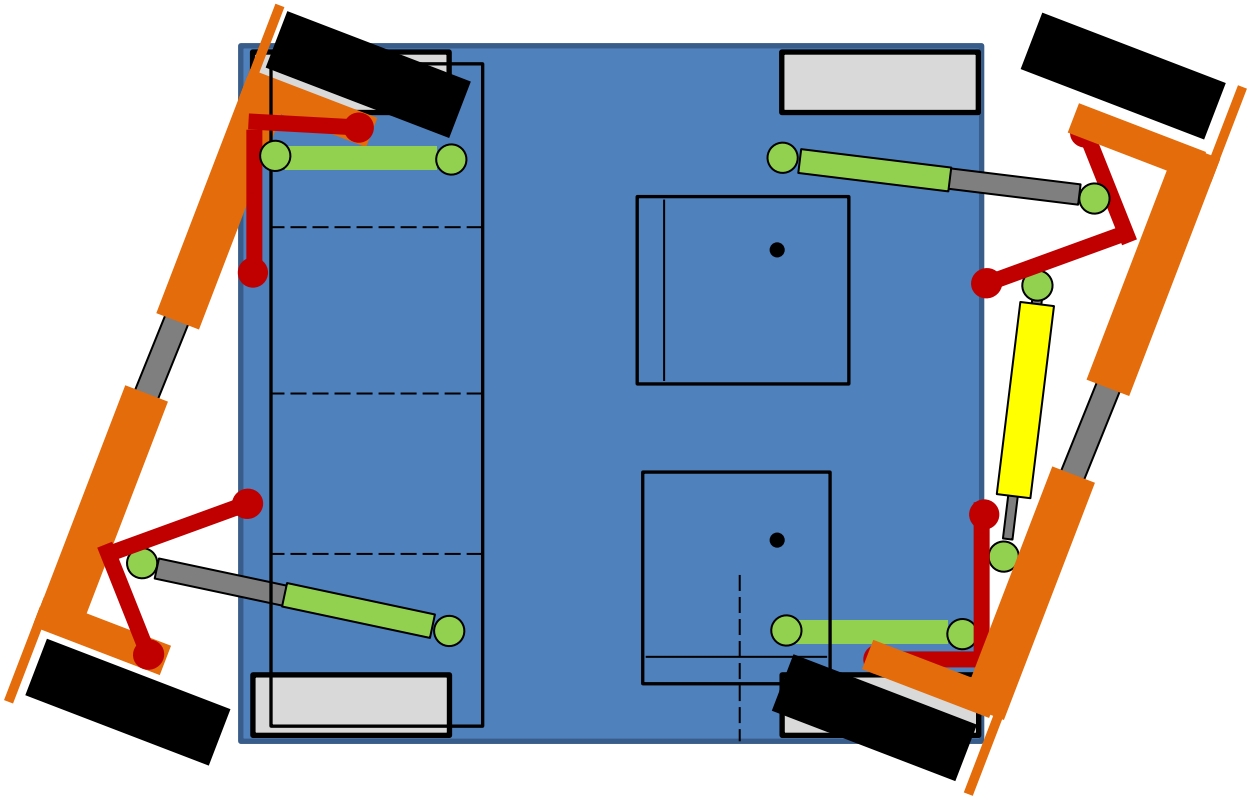


axles extended

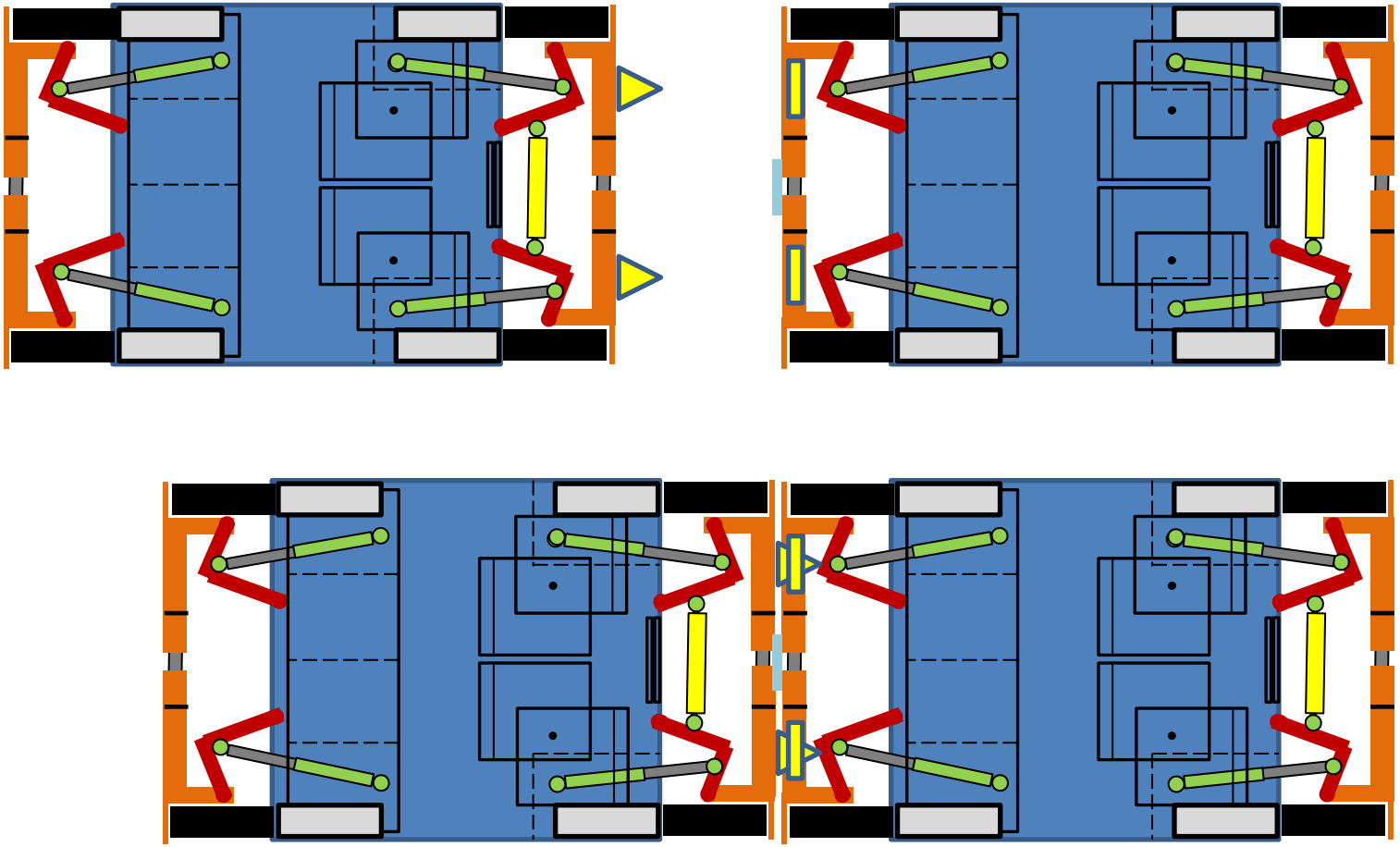
during the ride in the sharp curve



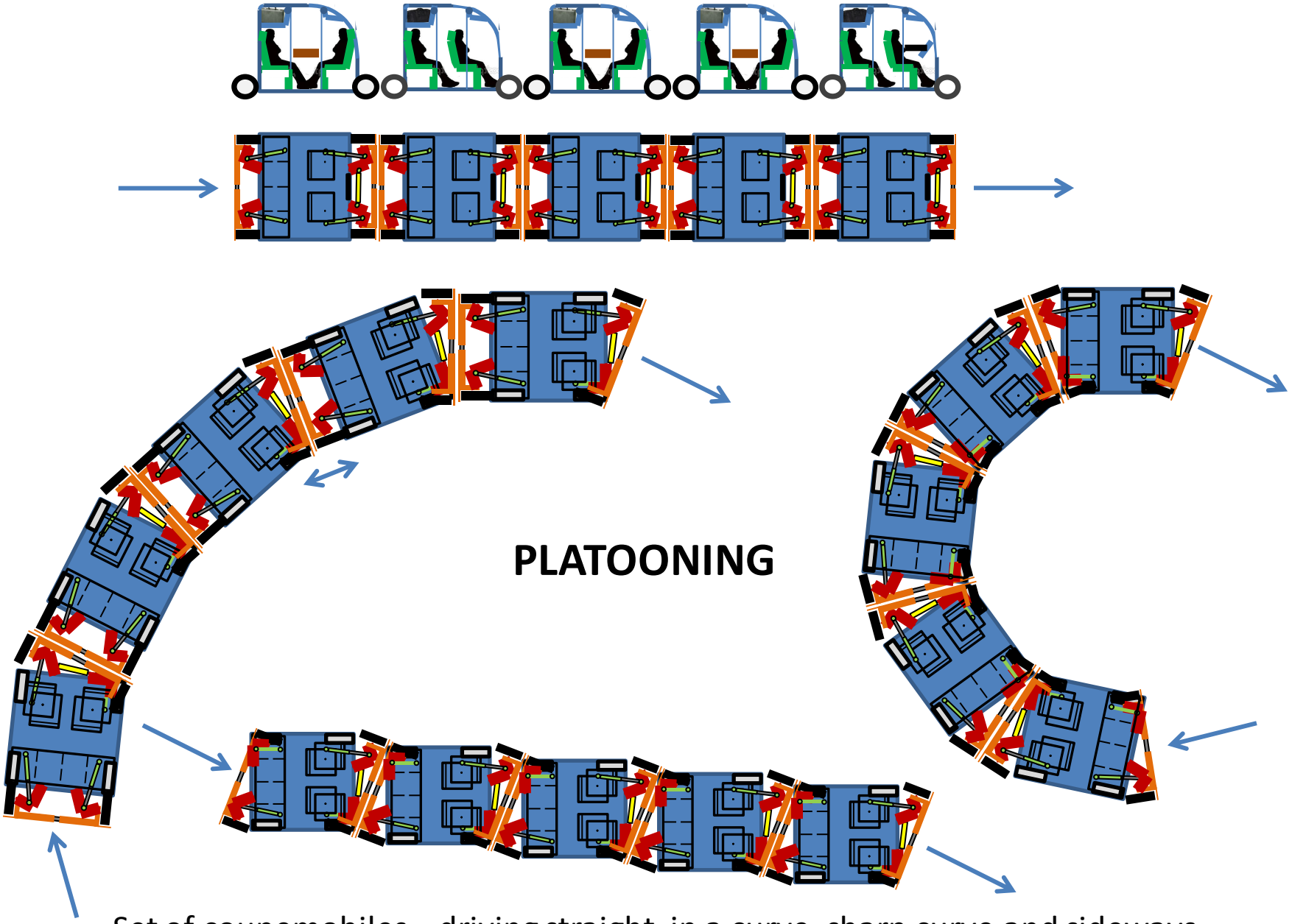
axles extended
during the side ride



unusual construction solutions
TIGHT COUPLED PLATOONS

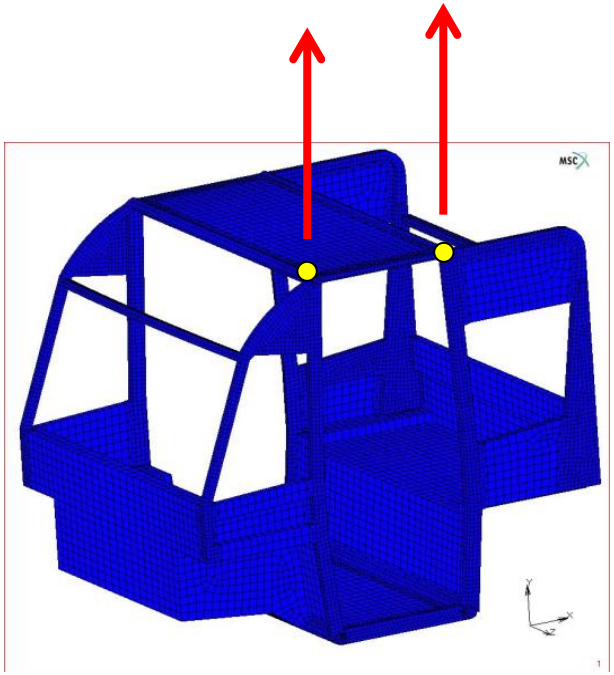


As it was said, coupemobiles can be joined into sets.



Set of coupemobiles – driving straight, in a curve, sharp curve and sideways.

unusual construction solutions
CATCH POINTS FOR LIFTING



The coupemobil can be lifted up by a manipulator by the yellow catch points in the roof.

Do you think, that a coupemobile is a fictional car ?
See alien concepts which already exist !

extendable axles

Renault Zoom

Honda Puyo

Toyota Rin

Cube form

Toyota PM

Rinspeed Presto

Nissan Pivo 2

Toyota PM

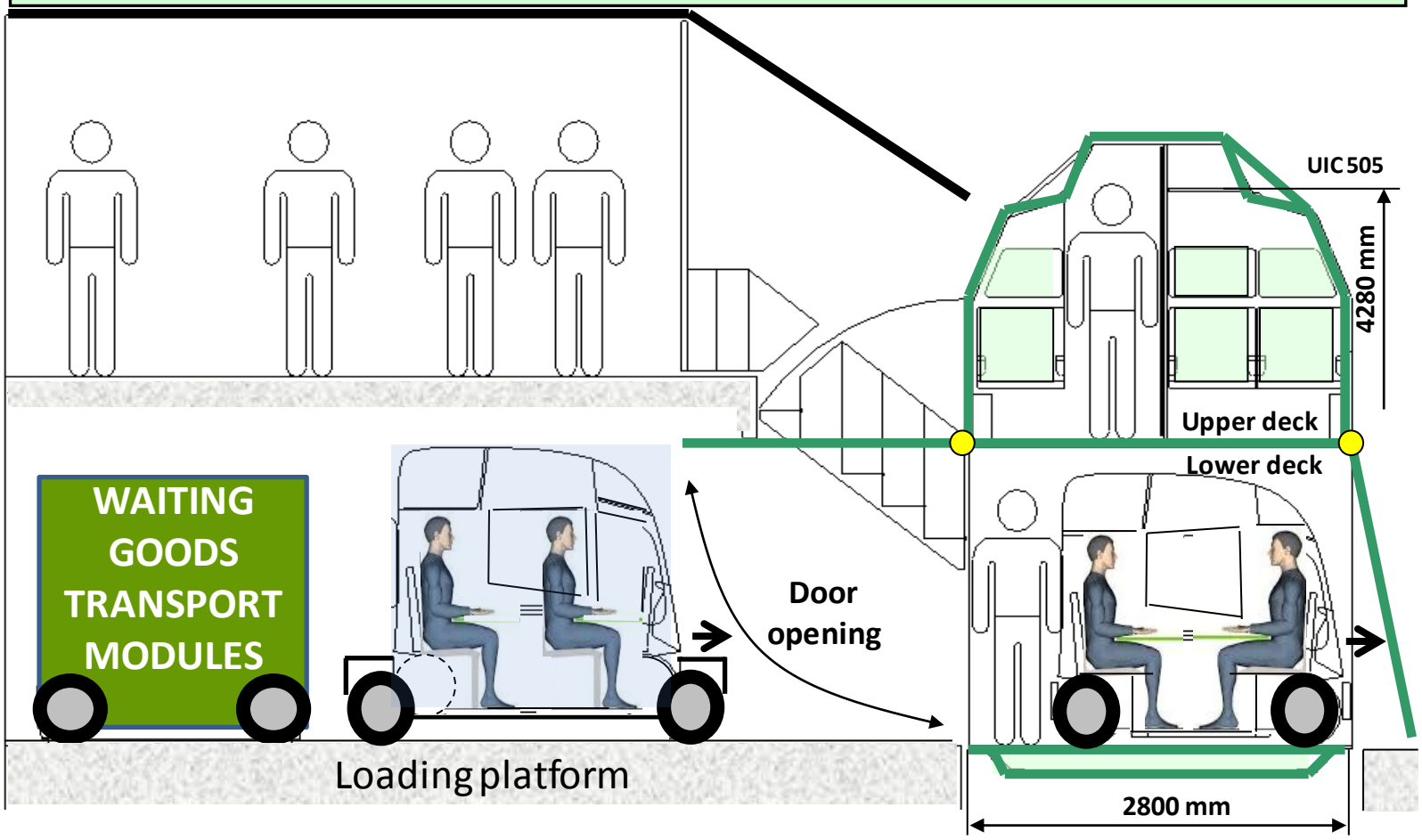
Platooning

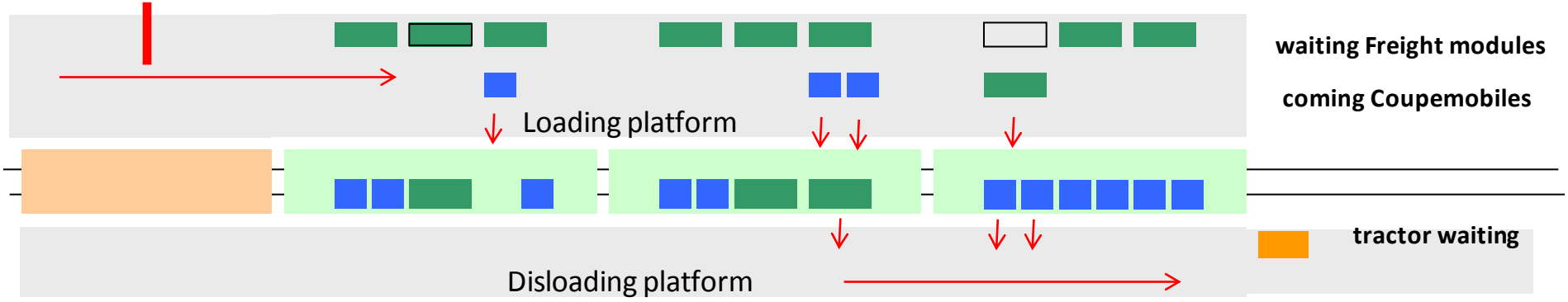
Range extender

EP Tender

Pininfarina Metrocubo

Two-story railway platform for double-deck coaches





SLIDE 19

An important part of the ComplexTrans system are the terminals at the city borders with double-deck platforms.
The upper floor is for ordinary passengers.
Coupemobiles and freight modules are waiting for loading down.

At the bottom of the picture you can see a plan view of the platform.
- The empty spaces are beeing filled in by further freight modules (in green).
- Coupemobiles (in blue) are coming to the platform and the entrance is closing.
- A train arrives and the doors open.
- Unloading follows.
- Coupemobiles and freight transport modules enter the train.
- The train is leaving.
- Coupemobiles are leaving.
- Finally, the freight transport modules leave in a set guided by the guiding vehicle.

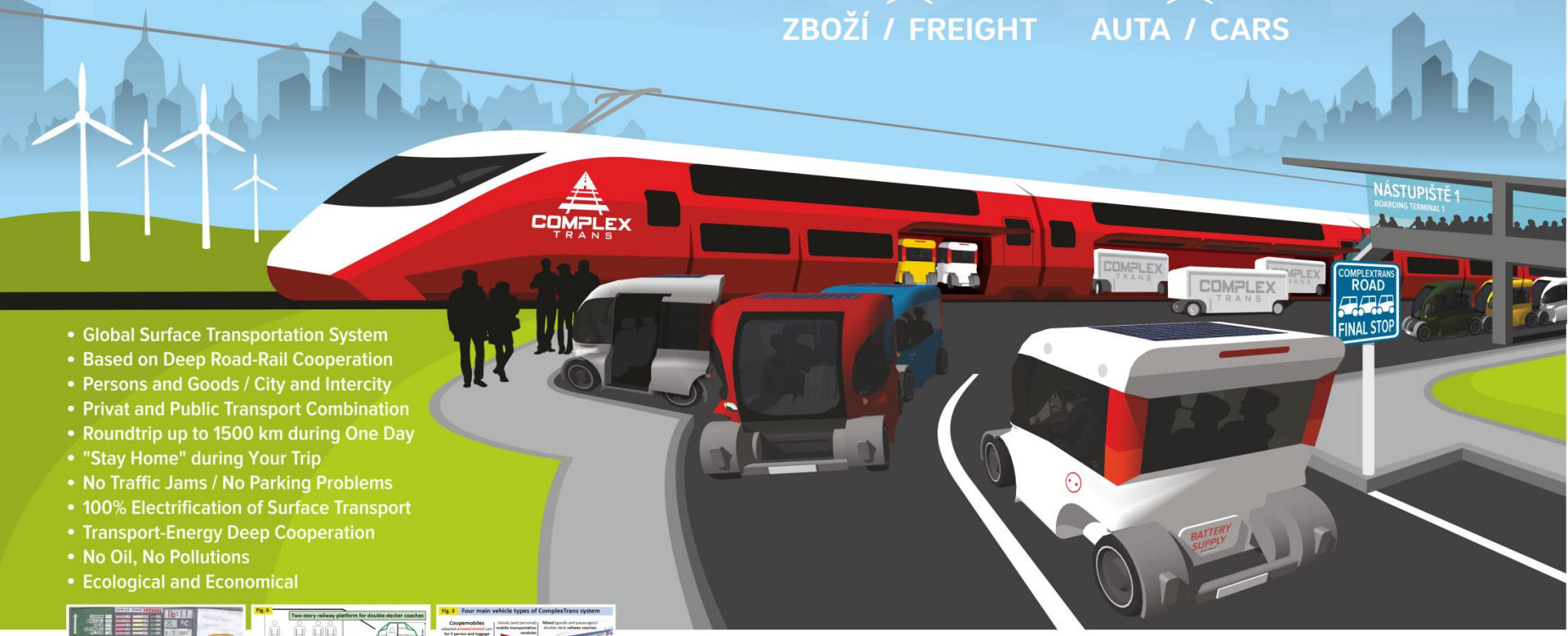
COMPLEX TRANS

CESTUJÍCÍ / PASSENGERS

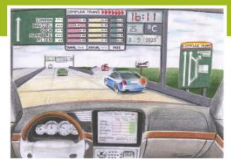
CARGO

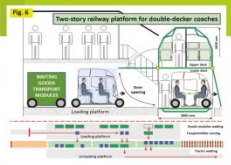
ZBOŽÍ / FREIGHT

AUTA / CARS



- Global Surface Transportation System
- Based on Deep Road-Rail Cooperation
- Persons and Goods / City and Intercity
- Privat and Public Transport Combination
- Roundtrip up to 1500 km during One Day
- "Stay Home" during Your Trip
- No Traffic Jams / No Parking Problems
- 100% Electrification of Surface Transport
- Transport-Energy Deep Cooperation
- No Oil, No Pollutions
- Ecological and Economical





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Ministerstvo životního prostředí

SIEMENS

Ingenuity for life

SLIDE 20

And here is the 3D-visualisation.

Down - the ComplexTrans train arrives and is connected with one fast freight wagon from behind.

Up - the picture shows a double-deck train - passengers upstairs, coupemobiles or freight modules downstairs.
Two-storey platform.
Coupemobiles are going individually or in a set.
One coupemobile parked perpendicular to the sidewalk.

PART 1 From Railway to Hyper-Railway

PART 2 From E-Mobility to Hyper-E-Mobility

PART 3 From Smart-City to Hyper-Smart-City

DAILY IN EACH DIRECTION

- up to 500 ComplexTrans trains – SELF-FINANCING

upper deck: **PASSENGERS (multimodal)**

a) up to 400 000 (together) or up to 140 000 (individually)

lower deck: **PASSENGERS and/or FREIGHT (intermodal)**

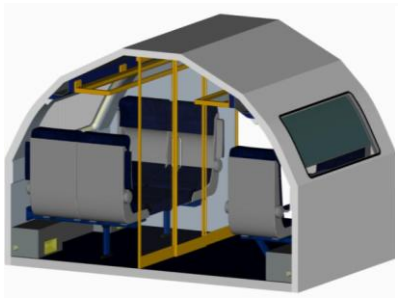
b1) 300 000-0 passengers in 60 000-0 (adapted) cars

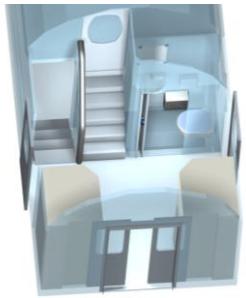
b2) 0-60 000 t freight in up to 0-30 000 door-door transportation modules

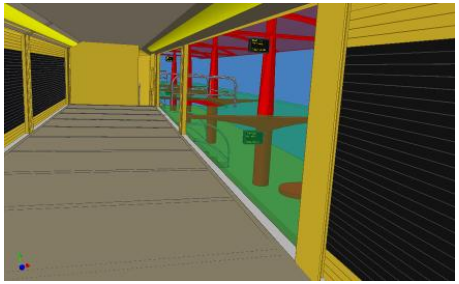
train end: **FREIGHT (multimodal/intermodal-containers)**

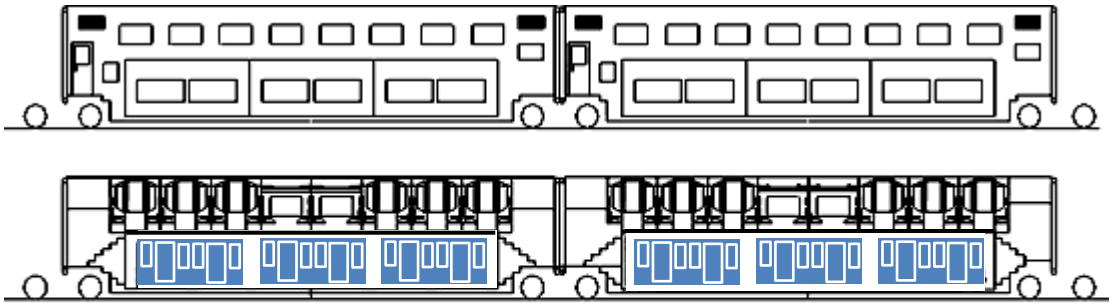
c) up to 75 000 t in 1500 fast wagons

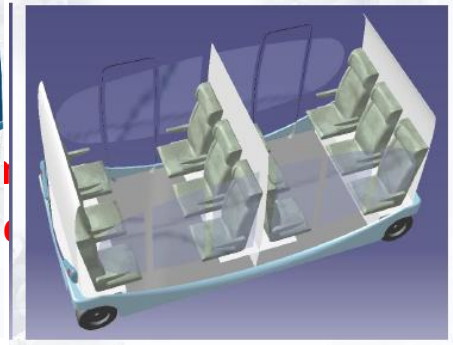
STEP TWO (a) Let's introduce the double-deck ComplexTrans trains **passenger variant** and let's go with it through Europe.

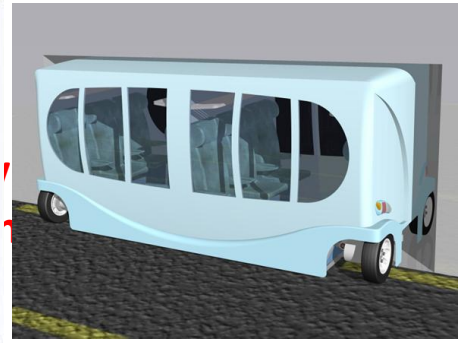


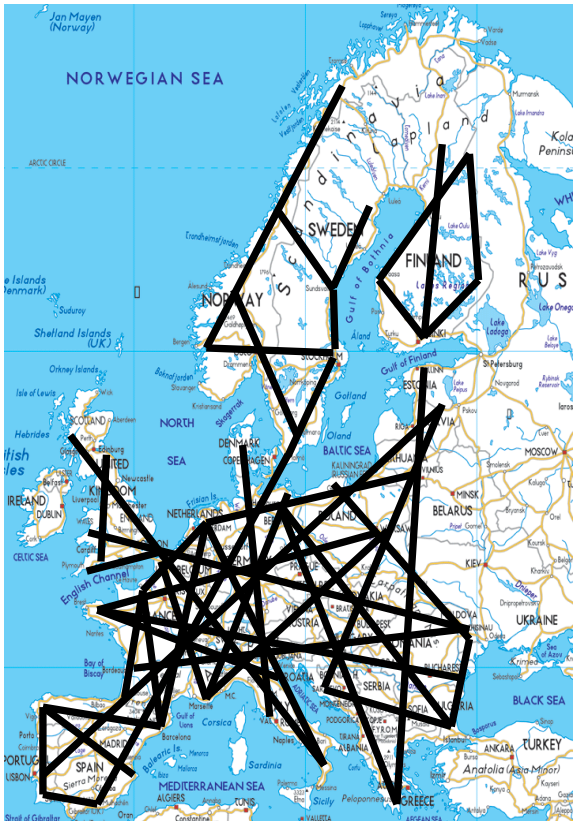








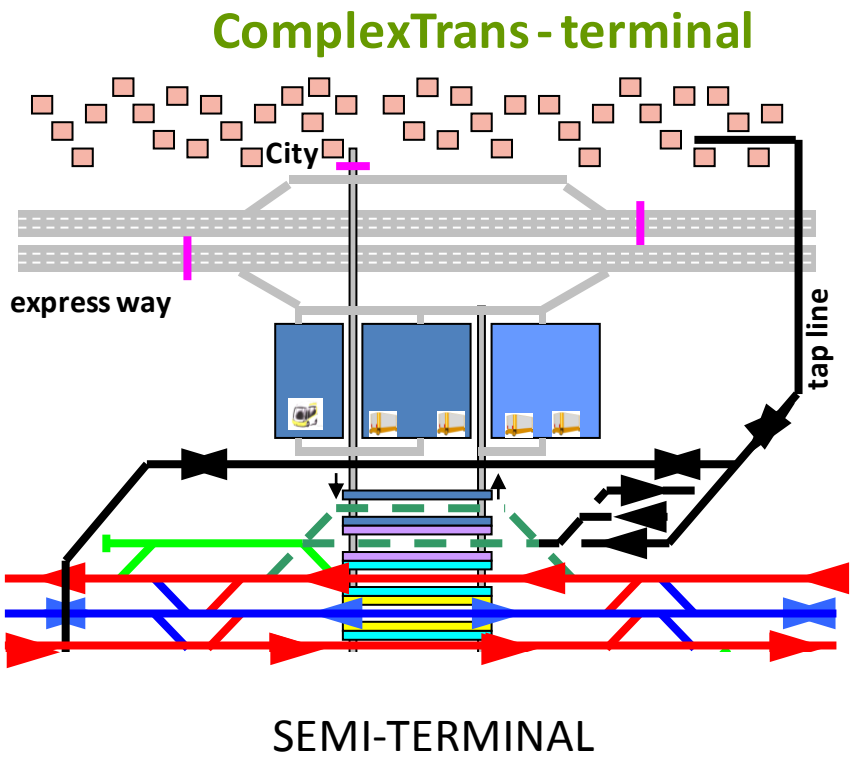




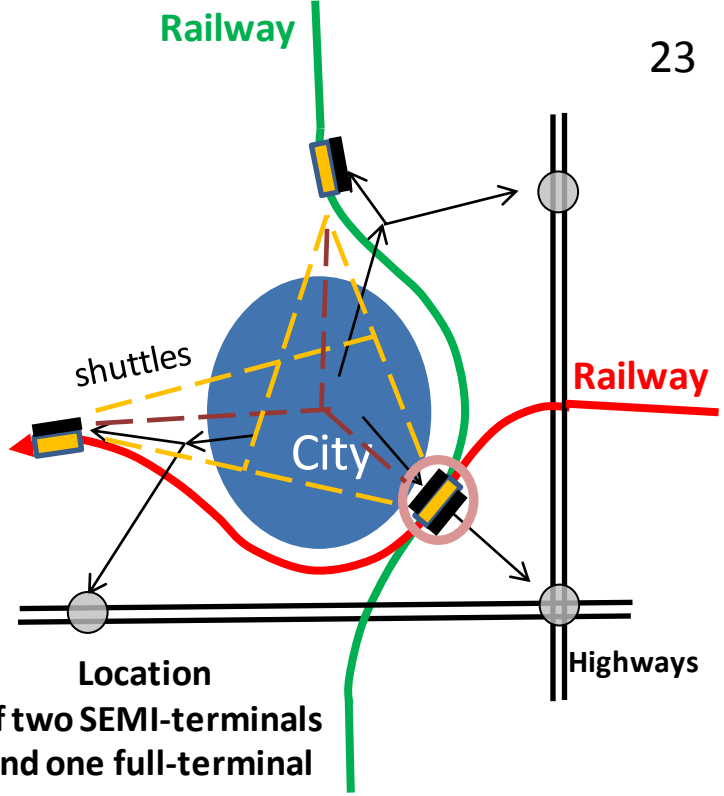
SLIDE 22

As soon as all the components have been developed, implementation can begin. Initially, ComplexTrans double-deck trains take only passengers on both floors and are prepared to switch to passenger-freight transport.

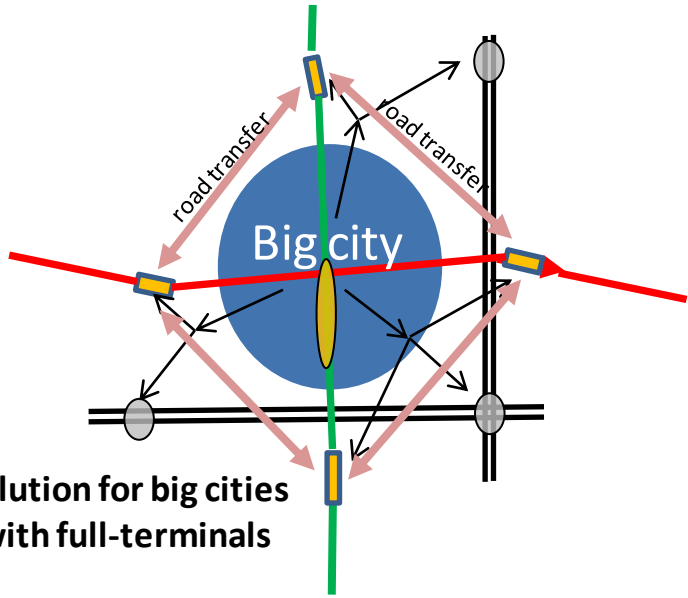
STEP TWO (b) Let's choose one railway line and start constructing a simple ComplexTrans **(semi)terminals with double-deck platforms at the city ends**



SEMI-TERMINAL



Location of two SEMI-terminals and one full-terminal



Solution for big cities with full-terminals

SLIDE 23

Let´s equip the lines step by step with simple terminals or semi-terminals on the city borders, connected by shuttle services.

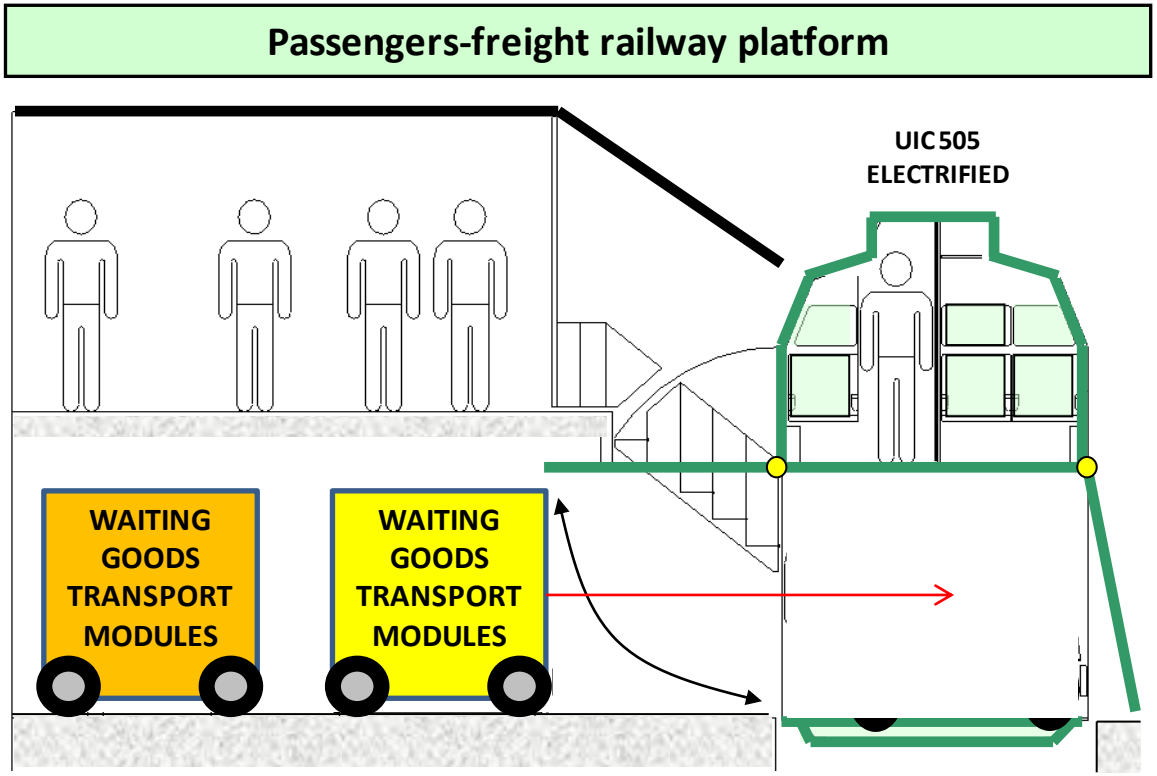
Each terminal is equipped with several parallel double-deck platforms for ComplexTrans trains.

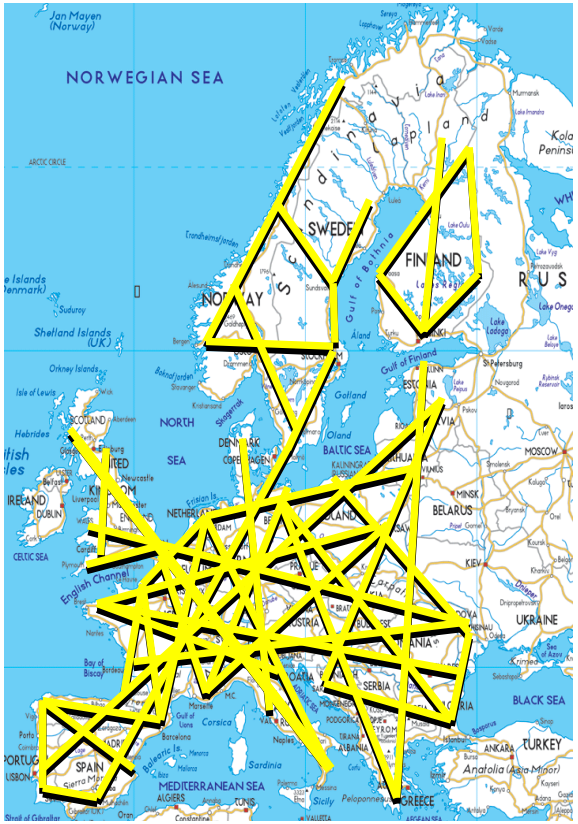
It also contains several tracks for fast freight wagons (in black).

Two arrival carparks for cars and freight transport modules and one departure carpark where the last-mile sets are coupled.

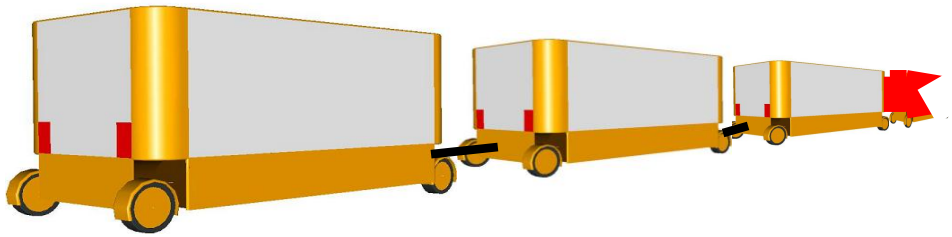
The semi-terminal has platforms in one direction only.

STEP THREE Implementation of **passenger-freight transport** in ComplexTrans trains





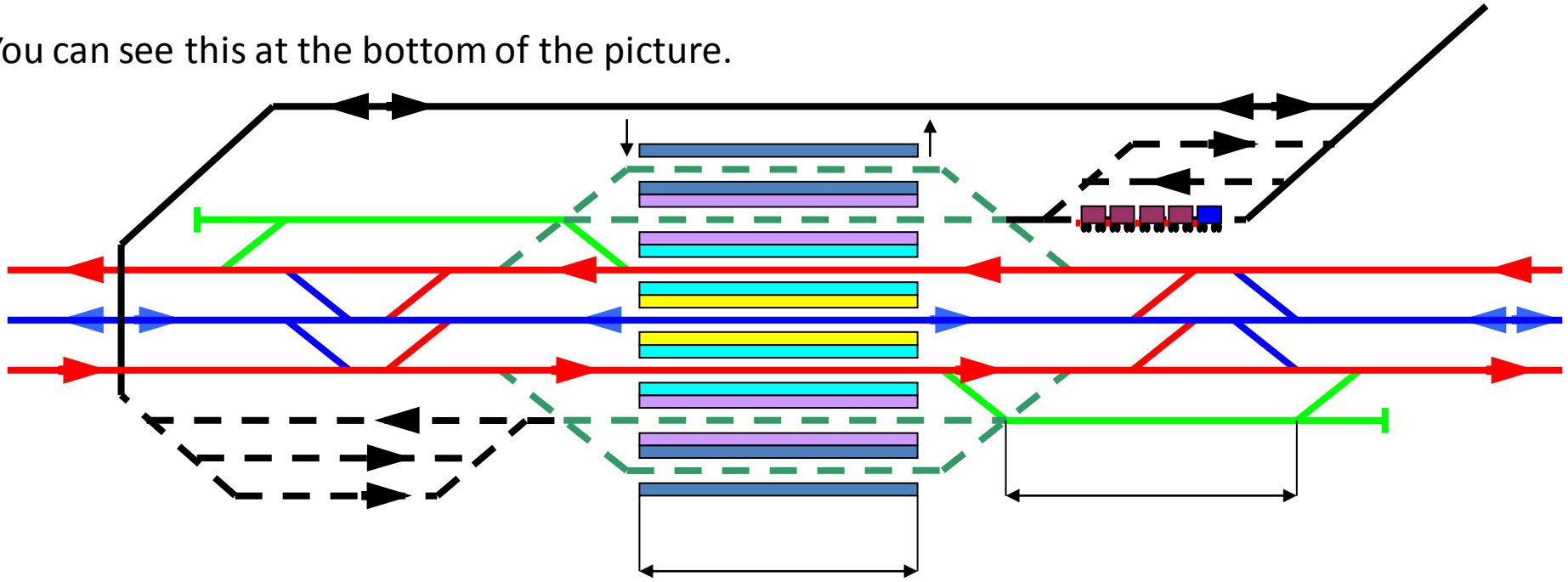
When the terminals are finished, mixed transport of passengers and freight can begin.
This will ensure railway transport efficiency and competitiveness with road freight transport.

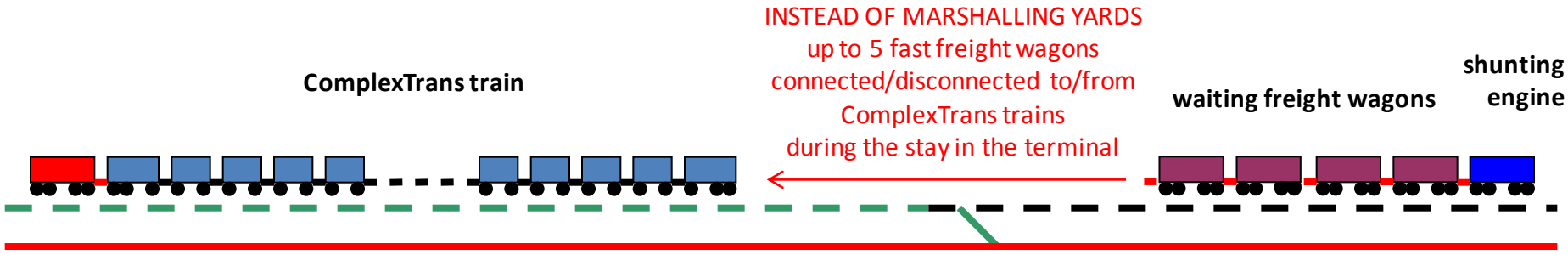


STEP FOUR Implementation of **fast freight wagon transport**

Subsequently, fast freight wagons will be attached to ComplexTrans trains - individually or in small groups.

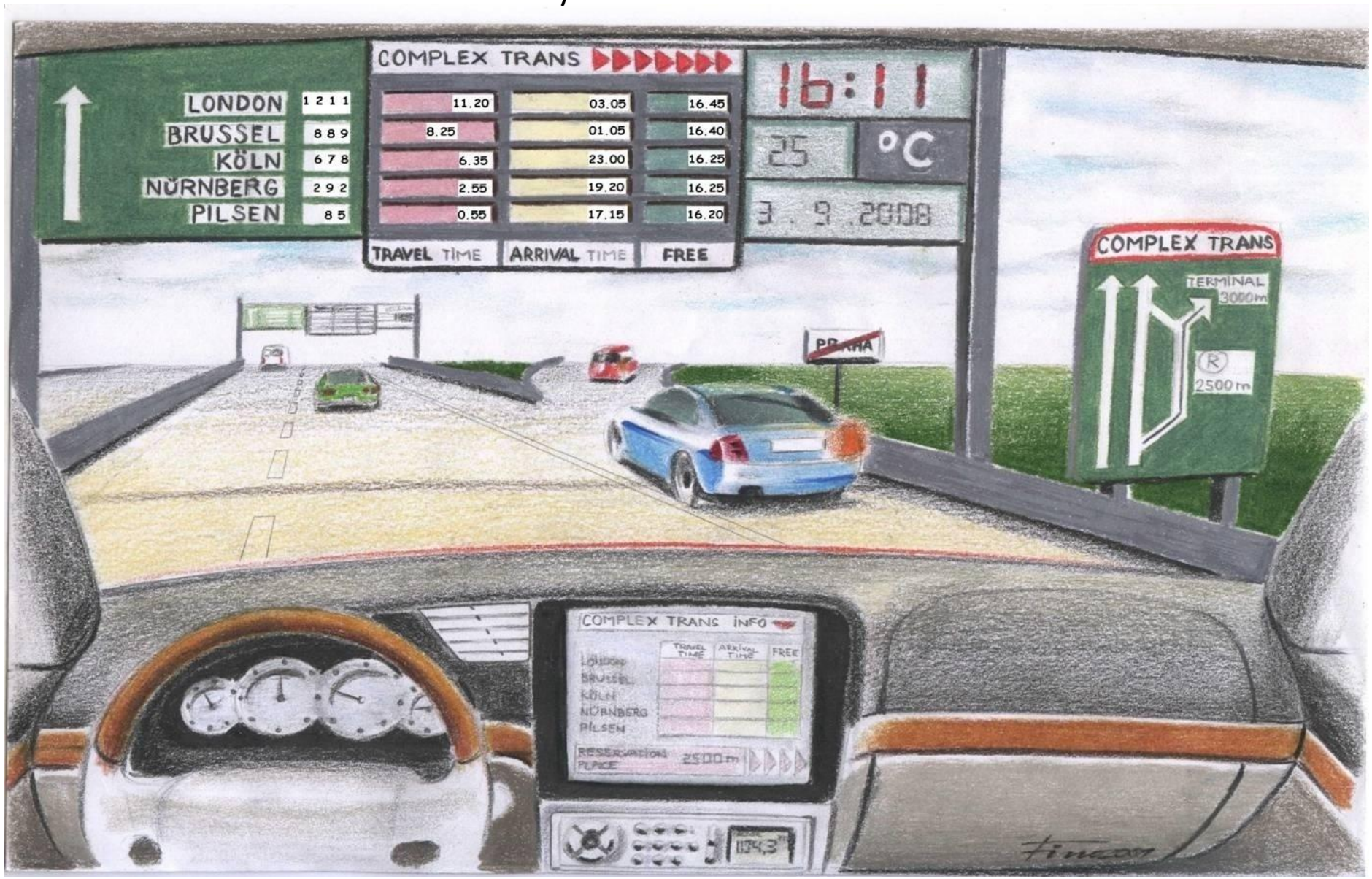
You can see this at the bottom of the picture.





STEP FIVE **Car transport** by ComplexTrans trains

The car driver has every times a choice between road and rail



SLIDE 26

As freight transport on the lower deck of ComplexTrans trains expands, the service will also be of interest for car drivers, who can choose between road and rail transport.

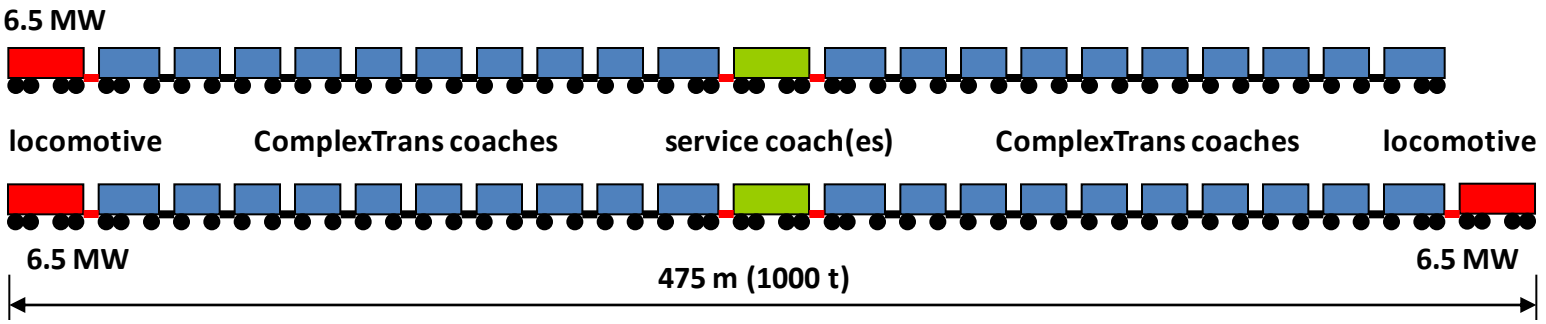
The direct costs will be the same.

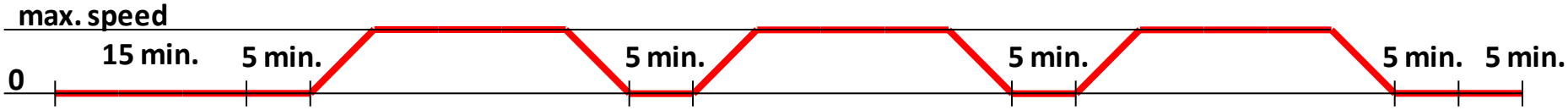
Leaving the city, they will pass the ComplexTrans terminal and will be able to make a last-minute decision. Reservation will be made online.

ComplexTrans trains and travel speed

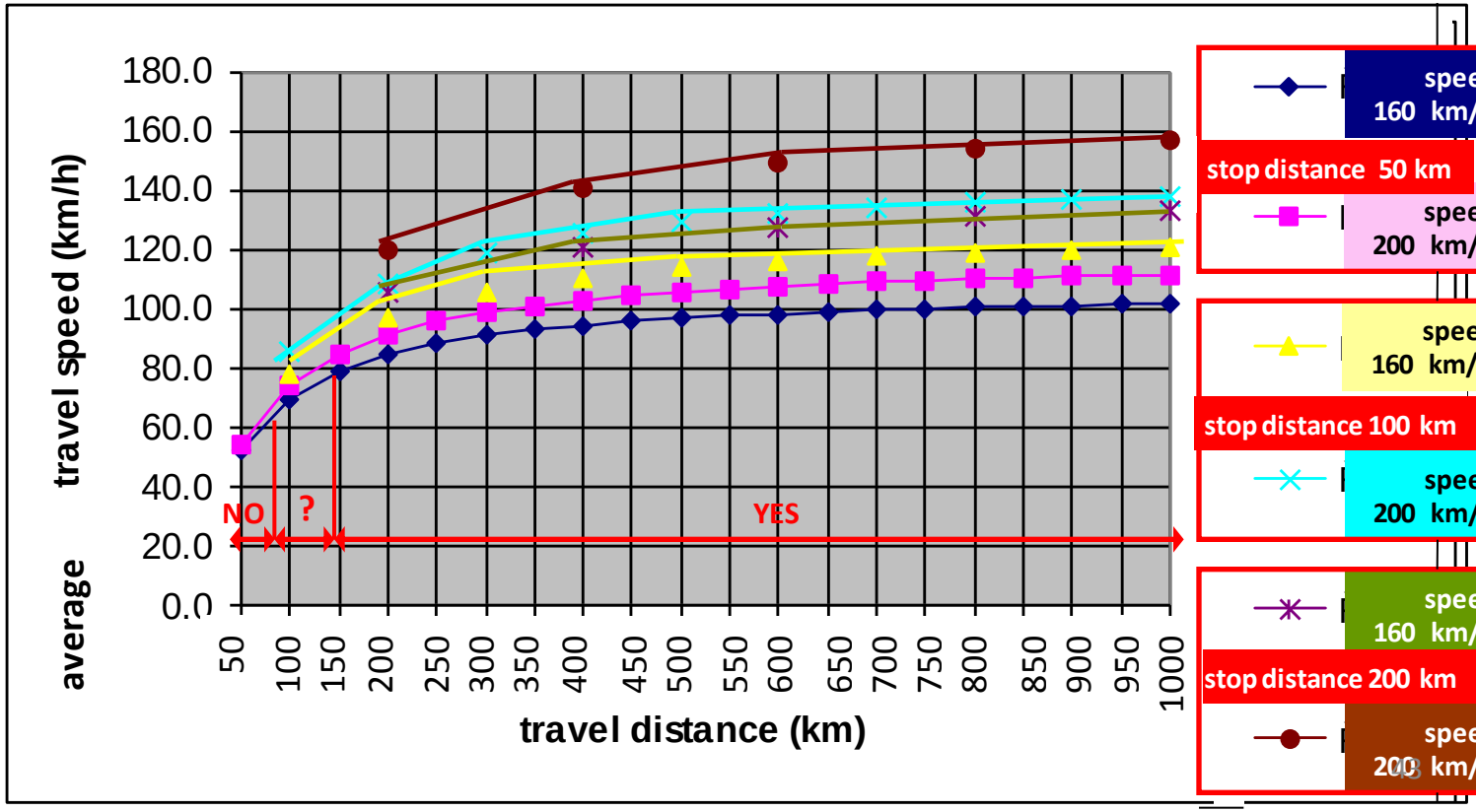
max. speed
---
160 km/h
(flat land)

200 km/h
(flat/hilly land)





In travel speed included:
---
come near and waiting time 15 min.
.
stationing time 5 min. each
.
acceleration
max. speed ride
deceleration
time
.
come away time 5 min.



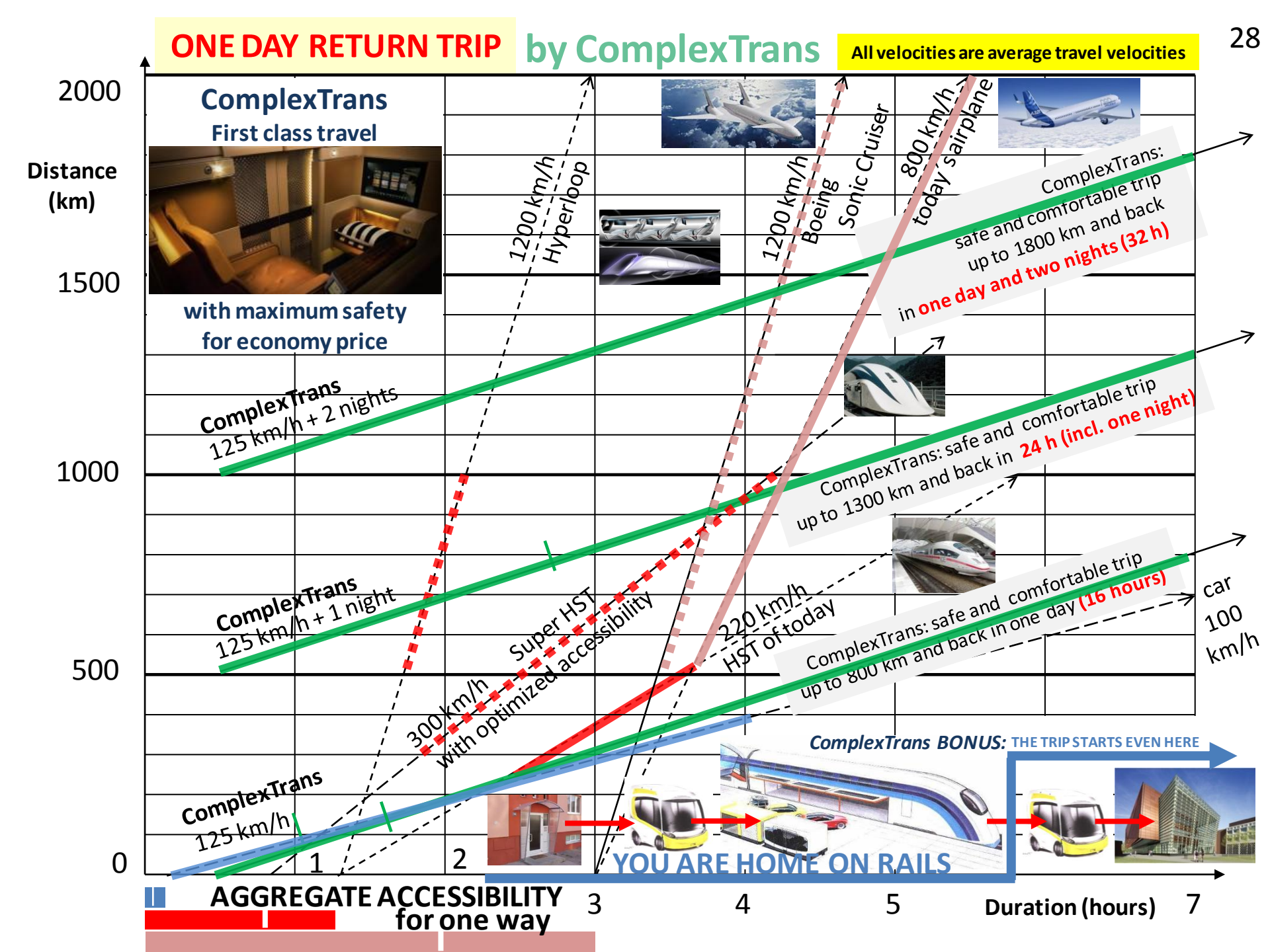
SLIDE 27

Depending on the train speed, on the distance between the terminals (50 to 200 km) and the total distance, travel speeds will be between 90 and 160 km/h.

For further consideration, we choose a travel speed of 125 km/h.

ONE DAY RETURN TRIP by ComplexTrans

All velocities are average travel velocities



SLIDE 28

This is a comparison between a car (in blue), a high-speed train (in red) and an airplane (in violet).
Travel time on x-axis, travel distance on y-axis.
Travel time depends not only on speed but also on accessibility.
The car is fastest up to a distance 250 kmthe , up to 550 km high-speed train and above a plane.
Dotted lines:
A super high-speed train with increased speed and improved accessibility will be more suitable.
Unless Hyperloop comes.
What can ComplexTrans do?

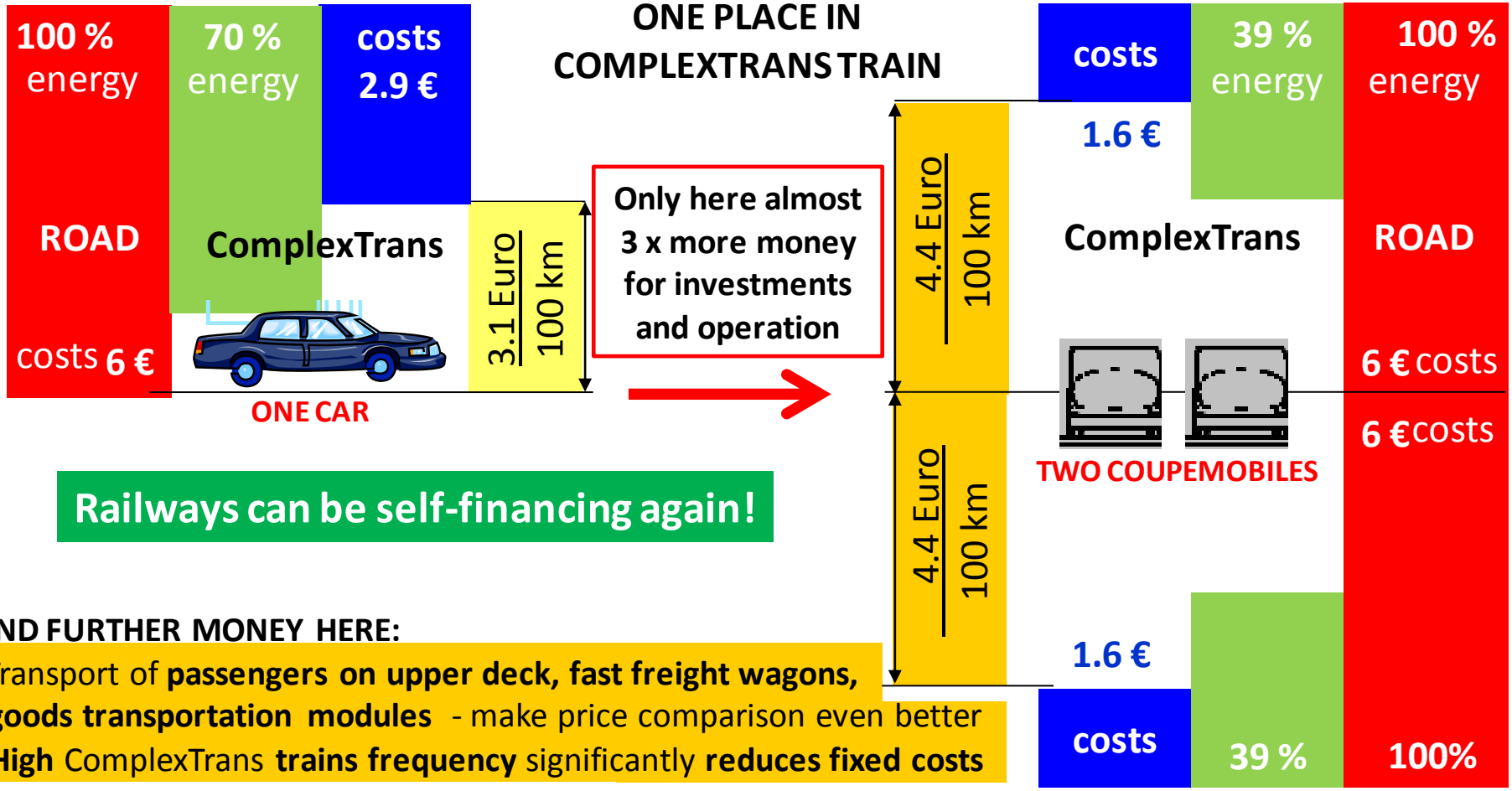
ComplexTrans is slightly faster than a car and more comfortable than a train and can replace a conventional high-speed train.

You can add one or two nights to the one-day trip. You travel 1000 km every night and up to 1500 km you are faster than any other means of transport.
Faster than a plane or Hyperloop.

And the best is that your journey actually begins near your goal - until then you can feel at home.
First class travel at an economic price.

Energy consumption and price in individual personal transport

		Energy /100 km		Energy costs
ComplexTrans train 160-200 km/h		30 Wh/t.km		0.07 €/kWh
Coupemobile in ComplexTrans **train**	**(1.6+ 6) t**	22.8 kWh	(39%)	**1.6 €/100 km**
Car in ComplexTrans **train**	**(1.6+12) t**	40.8 kWh	(70%)	**2.9 €/100 km**
Car on the road 130 km/h	6 l oil/100 km	58.8 kWh	(100%)	**6 €/100 km**



Railways can be self-financing again!

AND FURTHER MONEY HERE:

-Transport of **passengers on upper deck, fast freight wagons, goods transportation modules** - make price comparison even better

- **High** ComplexTrans **trains frequency** significantly **reduces fixed costs**

SLIDE 29

It is possible to transport two coupemobiles instead of one car and to earn almost three times more money for each place.

Additional revenues can be obtained from passenger transport on the upper deck, freight wagons at the rear and the carriage of freight transport modules.

omplexTrans railway becomes **self-financing**.

Economy of ComplexTrans System

Calculation for **one train = 1 loco + 20 double-deck coaches**

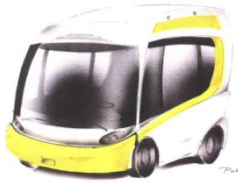
ComplexTrans transport prices (prices comparable with road)

Passengers

person single

2 €/100 km

coupemobile



6 €/100 km

corresponds with energy price on the road

standard car

12 €/100 km

needs double space as coupemobile

Goods

pick-up (13 m³)

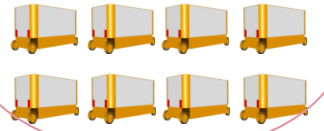
30 €/100 km

lorry (40 m³)

3 x 20 €/100 km

truck (100 m³)

8 x 15 €/100 km



Income of one ComplexTrans train (after energy costs deduction)

6 - 7 mil. € (per year) and about 270 mil. € during the lifetime (40 years)

2000 km daily and 330 days a year (after energy costs deduction)

Lower deck

coupemobiles or cars only or	3.5 mil. € yearly or
goods transport modules **(truck rate)** or	4.4 mil. € yearly or
goods transport modules **(lorry rate)** or	5.8 mil. € yearly or
goods transport modules **(van rate)**	8.8 mil. € yearly
Upper deck	+
only 5 paying **passengers** per coach	1.3 mil. € yearly

Yearly about 660 000 km and about 7 mil. € income (10.6 €/km) for track, manpower, maintenance and for profit.

Railways can be profitable again

SLIDE 30

The economy of one ComplexTrans train is shown here.

One ComplexTrans train, after deducting energy costs, earns in fourty years of its life a total of 270 millions euros - nearly 11 € per kilometre.

THANKS ComplexTrans **Hyper-Railway**

PART 2 From E-Mobility to Hyper-E-Mobility

PART 3 From Smart-City to Hyper-Smart-City

ComplexTrans cars (COUPEMOBILES) remove all problems of e-mobility

Battery is changeable from back + all cars park perpendicular to pavement =

- the discharged battery can be replaced by a recharged one in a short time everywhere by mobile replacement vehicle
- no large recharging infrastructure needed – battery will be recharged in recharging centre
- nobody has to take care of replacing the battery; the car will do it by itself
- the e-car can be cheaper than a car with combustion engine, because the battery needn't be a part of the car

For long trips will be used
transport in ComplexTrans trains or ride with changeable (hydrogen) range extender

- battery needn't be big (200 km range is enough)
- no range anxiety more (the battery full at your destination)

SLIDE 31

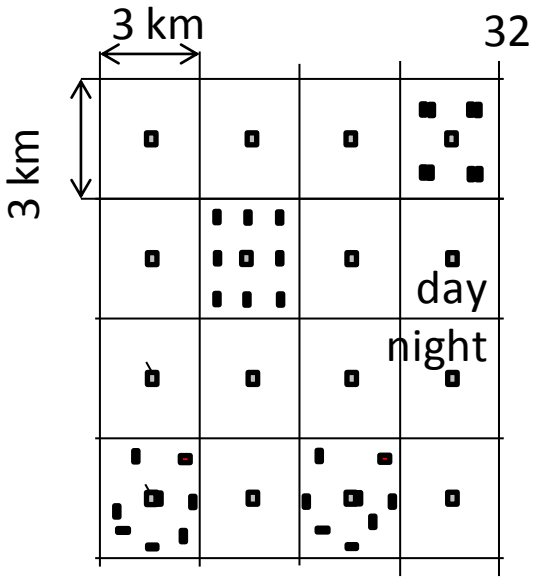
It is interesting that the change from railway to hyper railway will also support the expansion of road e-mobility.

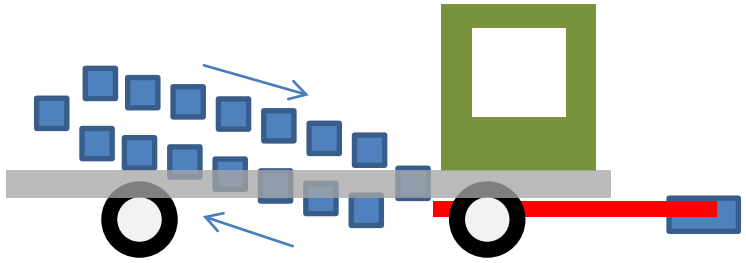
Coupemobiles – need neither a large battery, nor a large charging infrastructure, can be cheaper than ordinary cars, because batteries stay the property of the energy distributor, and relieve the owner of the electric car of charging care and of range anxiety.

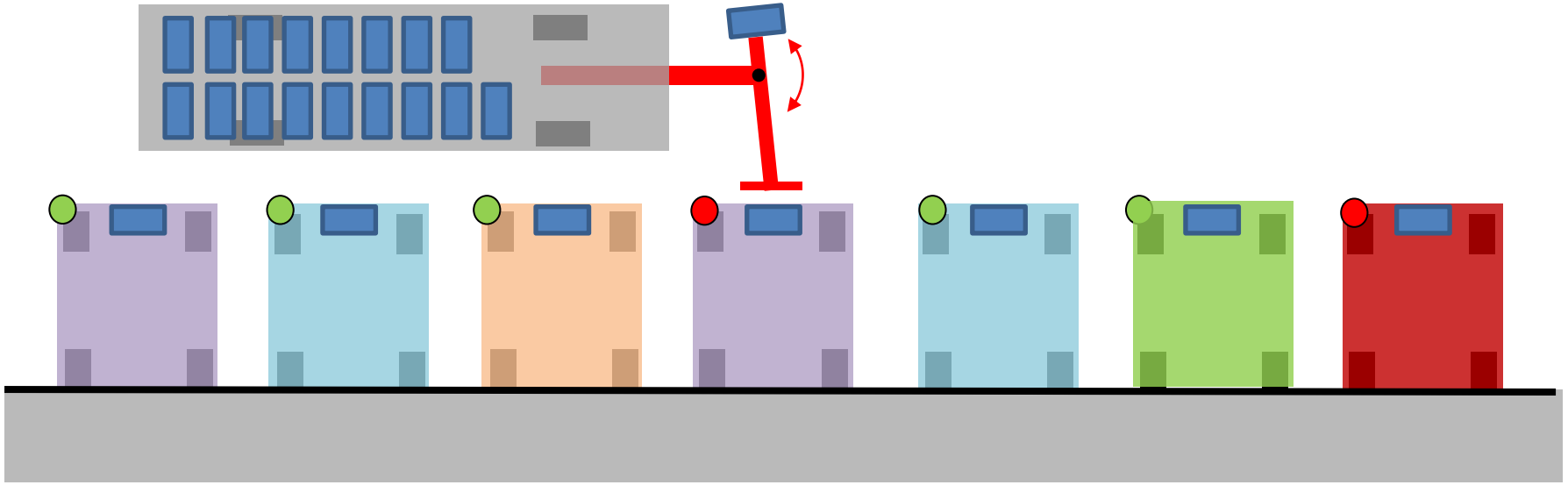
BATTERY CHANGE

This is how to replace a discharged traction battery by a charged one.

Coupemobile will order a battery replacement itself, and it will be replaced mainly during the night by a distribution vehicle without the owner´s assistance.

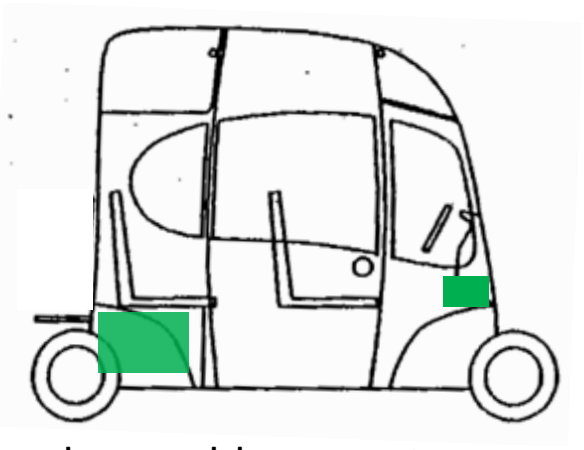




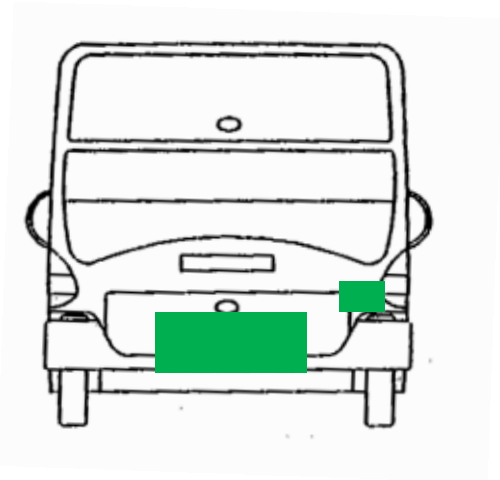


Changeable range extender

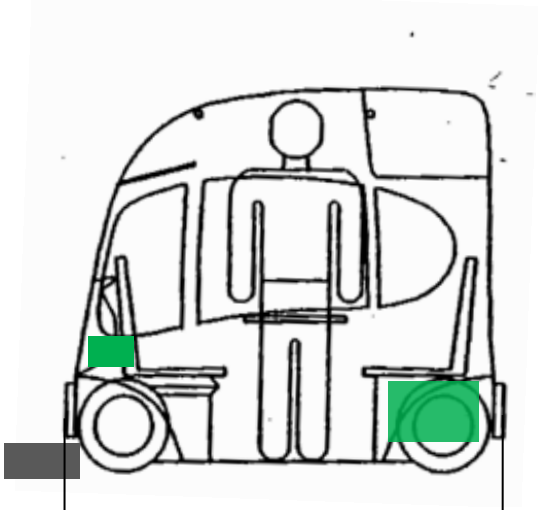
for the long trips on the road (if there is no suitable rail connection)

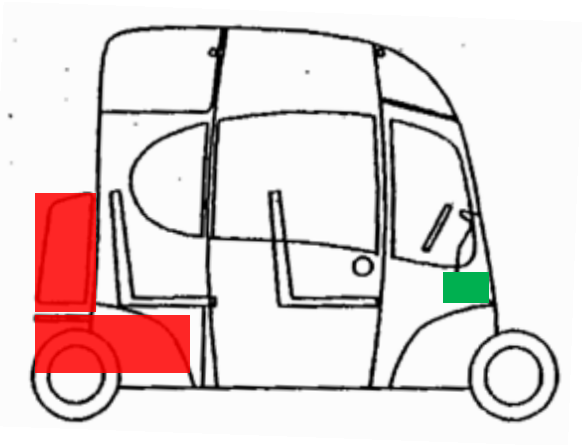


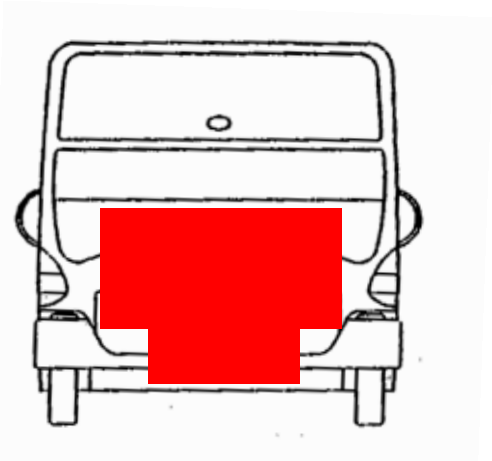
changeable battery cca 80%

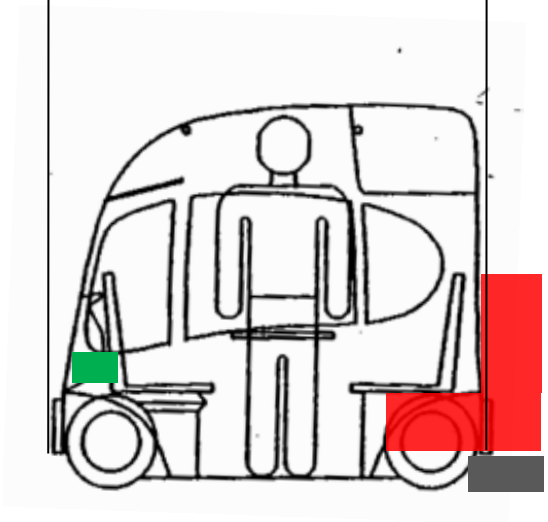


fixed battery cca 20%







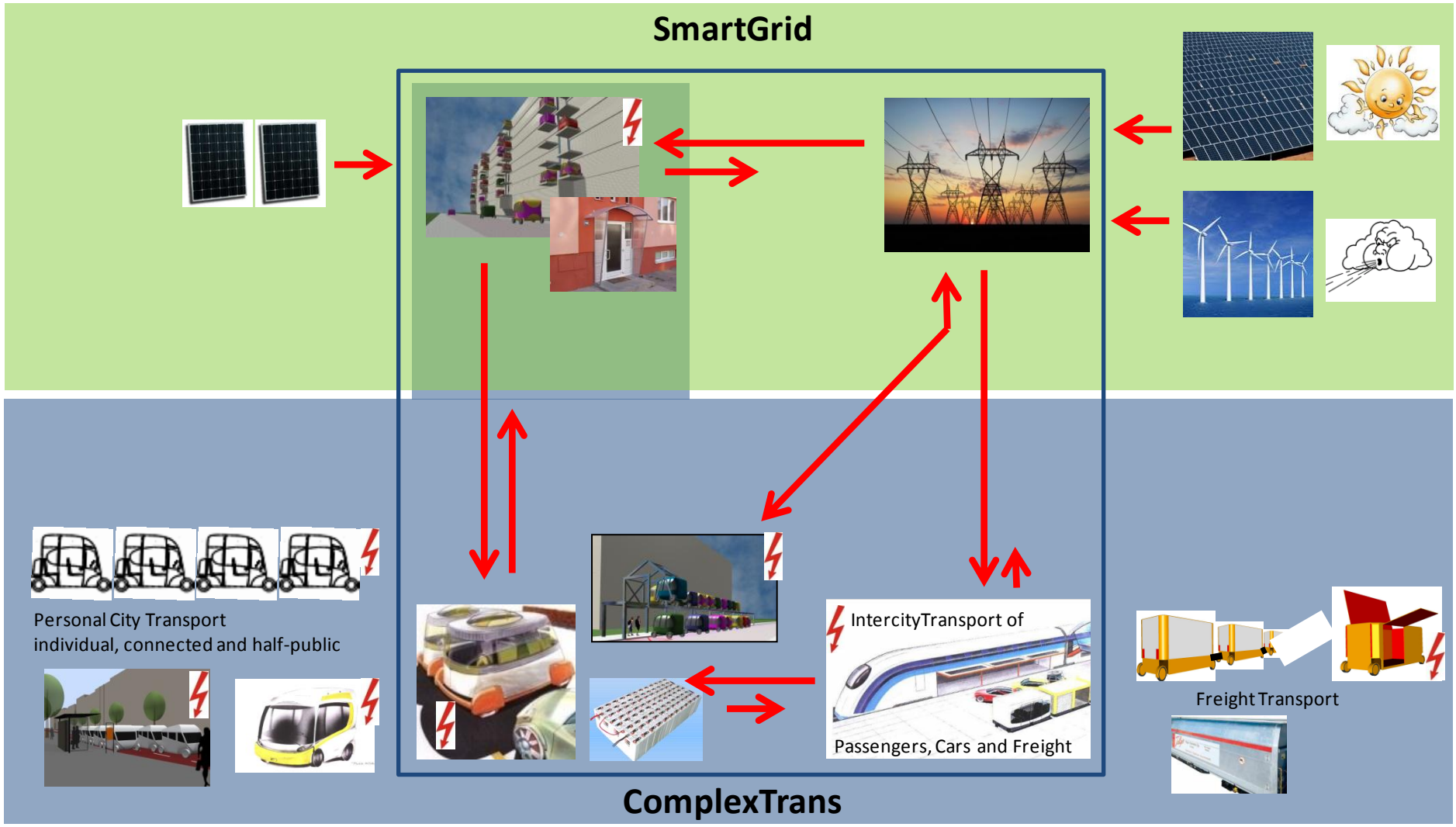


Range extender (petrol, gas, hydrogen …)

SLIDE 33

When leaving the city, the bigger part of traction battery (in green) can be replaced by a range extender (petrol, gas or hydrogen – in red). A long-distance route can thus also be made by road.

CONNECTION WITH SUSTAINABLE ENERGY RESOURCES



The multiple connection between ComplexTrans transport and energy grid creates a large energy storage comparable with energy production output.

SLIDE 34

Thanks to the ComplexTrans system and coupemobiles and their properties, a dense interconnection of land transport and the energy network will be created.

Thanks to frequent connecting - the batteries of coupemobiles create an adequate and reliable energy reservoir for renewable resources.

PART 1 From Railway to Hyper-Railway

PART 2 From E-Mobility to Hyper-E-Mobility

PART 3 From Smart-City to Hyper-Smart-City

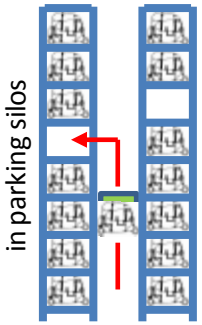
By turning the car into a coupemobile,
ComplexTrans will also completely change the road traffic in cities.

Thanks to new construction solutions coupemobiles can also

1. save parking places and create completely new parking possibilities = 3 x more parking places

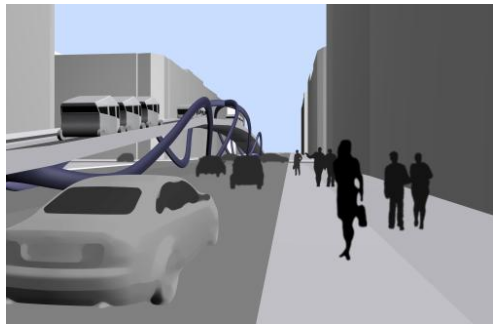
Perpendicular to pavements everywhere

over pavements in special parking facilities

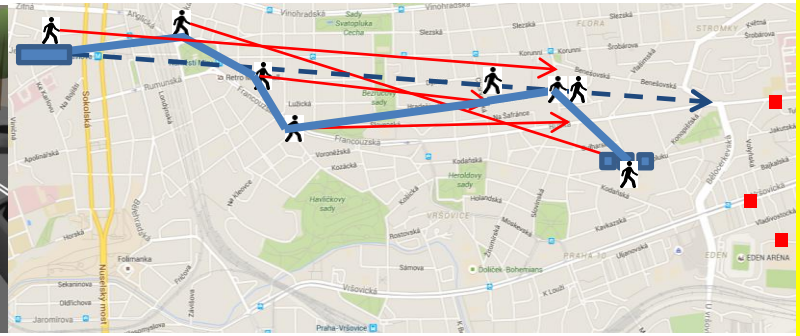


lifted by exterior lifts

2. go in tight platoons (mechanically coupled) and use special light junction crossings - thus reducing traffic density



3. be temporarily incorporated into public mass transport on voluntary contract basis and be paid for it.



City transportation density can be reduced by 50 – 75% by points 1, 2 and 3.

A contemporary and new, comfortable high-capacity almost door-door public transport system will arise.

SLIDE 36

The number of parking spaces will triple and the lack of parking spaces will be removed as a result of the implementation of coupemobiles.

Coupemobiles can be coupled into sets for part of the journey.
Driving in road-trains reduces traffic density by up to 50%.
The sets will be able to use light junction bridges and eliminate congestion.

Sets of private coupemobiles will be able to be incorporated into the public transport system on a voluntary basis while traveling through the city. Public transport sets will have a preference and the owners of the coupemobiles will be paid by the transport authority for this service.
A very comfortable and fast additional high-capacity public transport system will be created.

Urban traffic density decreases by up to 75%.

Which way will we go?

MaaS

COMPLEX TRANS

FACULTY OF MECHANICAL ENGINEERING
UNIVERSITY OF WEST BOHEMIA

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THANK YOU
FOR YOUR ATTENTION

… to be continued …