

# HVAC – Overview

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**LIEBHERR**

# Content

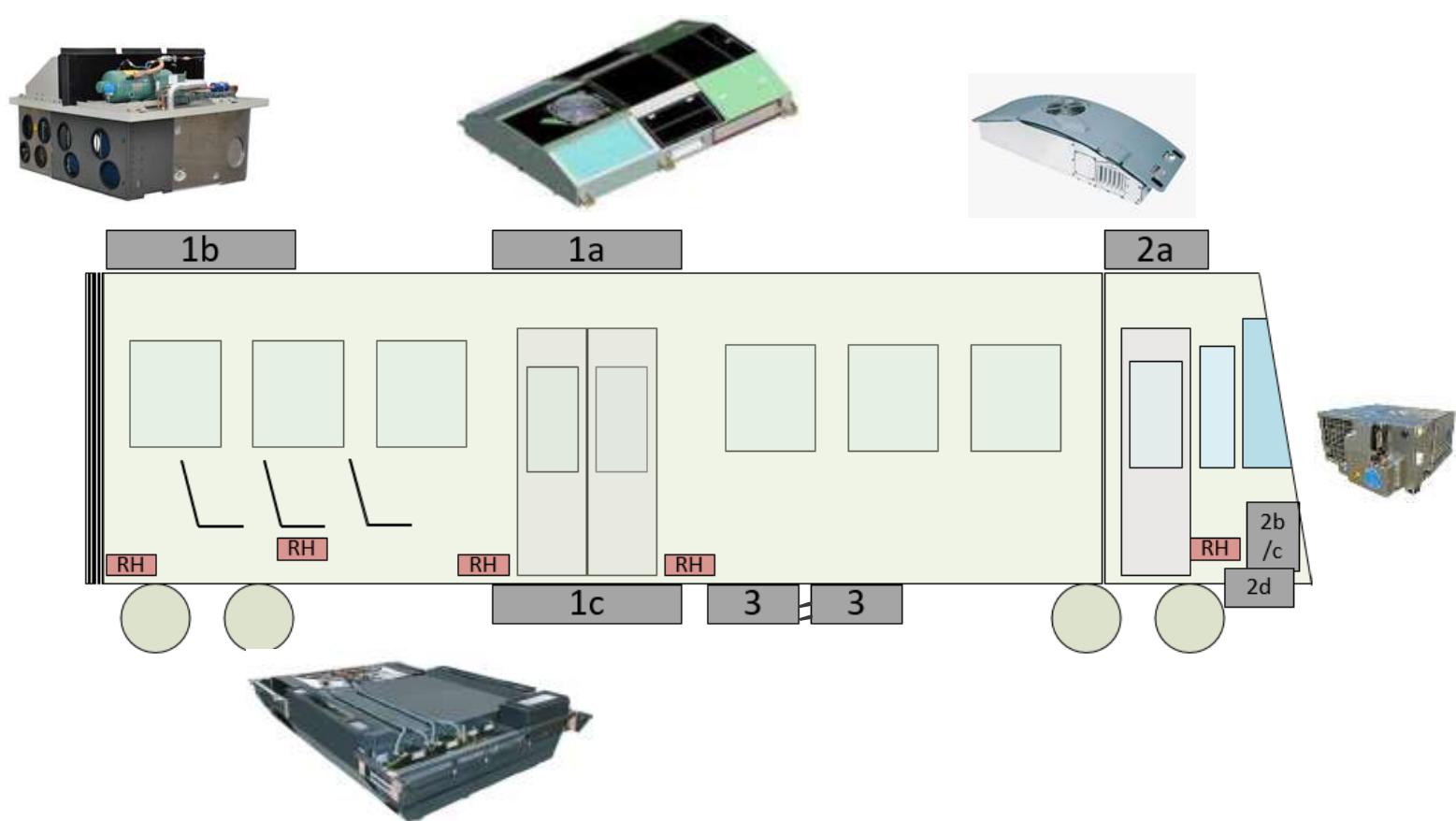
1. Portfolio of components for air conditioning
2. Air conditioning - getting the right cooling / heating capacity
3. Ducting - energy transfer into the train
4. Operating conditions
5. Air conditioning units
6. Air Cycle technology

# Portfolio of components for air conditioning

## Overview

- **Air conditioning unit**

1. Saloon compact unit
2. Cab compact unit
3. Saloon split unit



- **Duct system**

- **Heaters**

- Return air heater
- Duct heaters
- Side wall heaters
- Floor heaters

- **Exhaust air units**

- **Pressure protection systems**

- **Sensors**

# Needs for cooling / heating calculation

- **Specification of customer**
  - Design point / Definition of climatic zones
    - outside conditions
    - inside conditions
  - Parameter of the train
    - surfaces of wall and windows
    - k-values walls, g-factor windows
  - Internal heat sources (e.g lightning, electrical box)
  - Number of passengers
- **Standards**
  - EN 14750-1, EN 13129-1, EN 14813-1

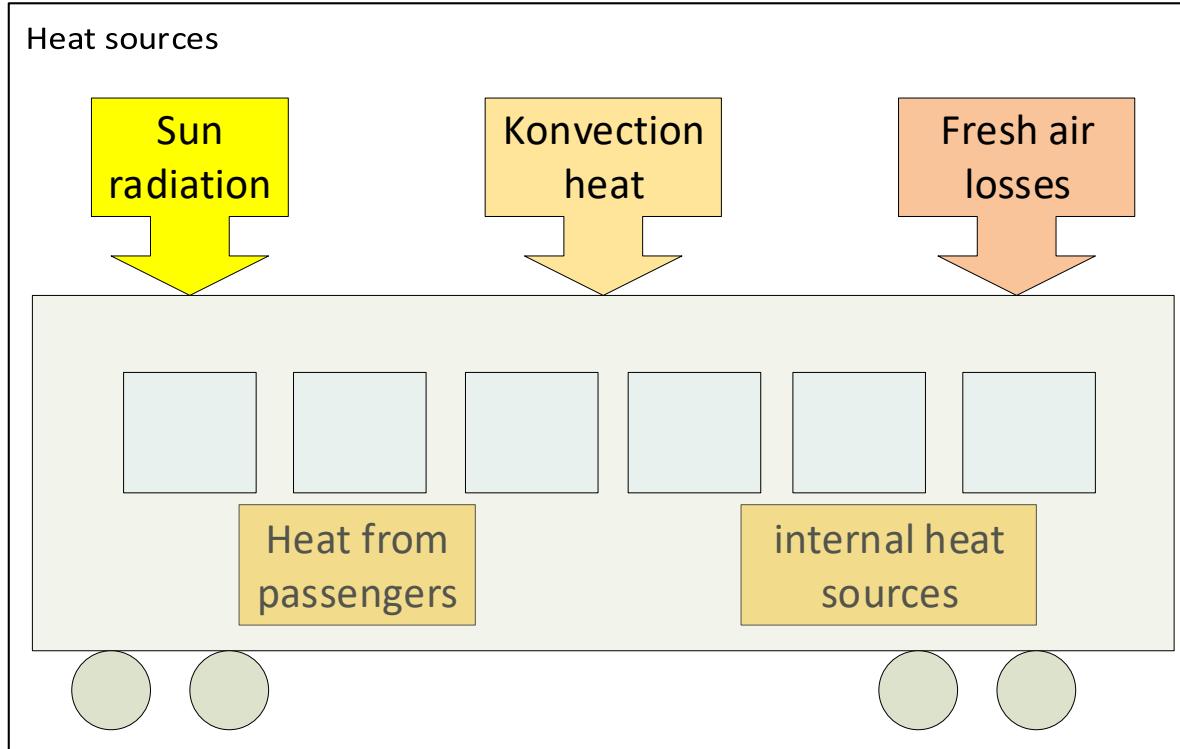
# Air conditioning - getting the right Cooling / Heating capacity

## Calculation / heat loads

- Heat loads into car

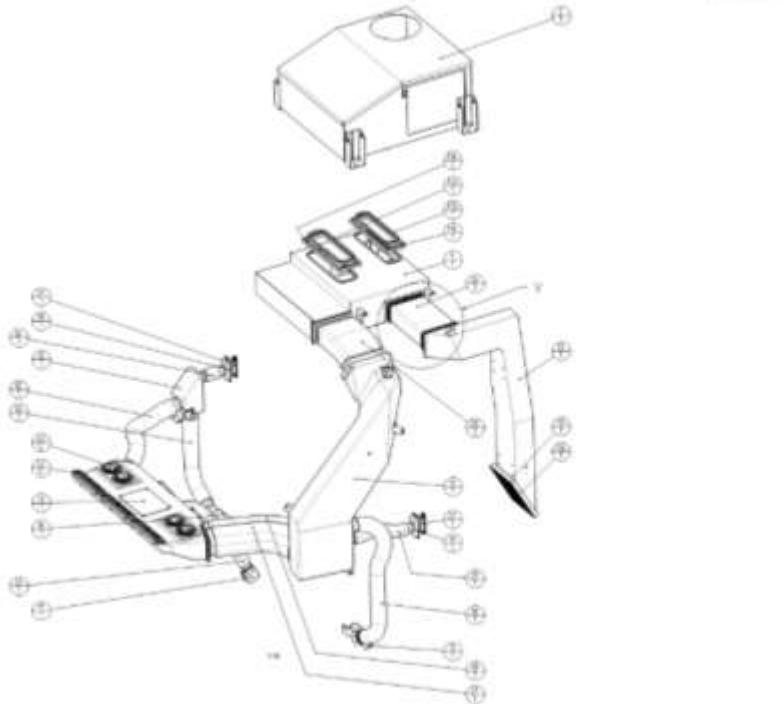
- Result

- Cooling capacity
- Heating capacity
- Amount of supply air



# Ducting

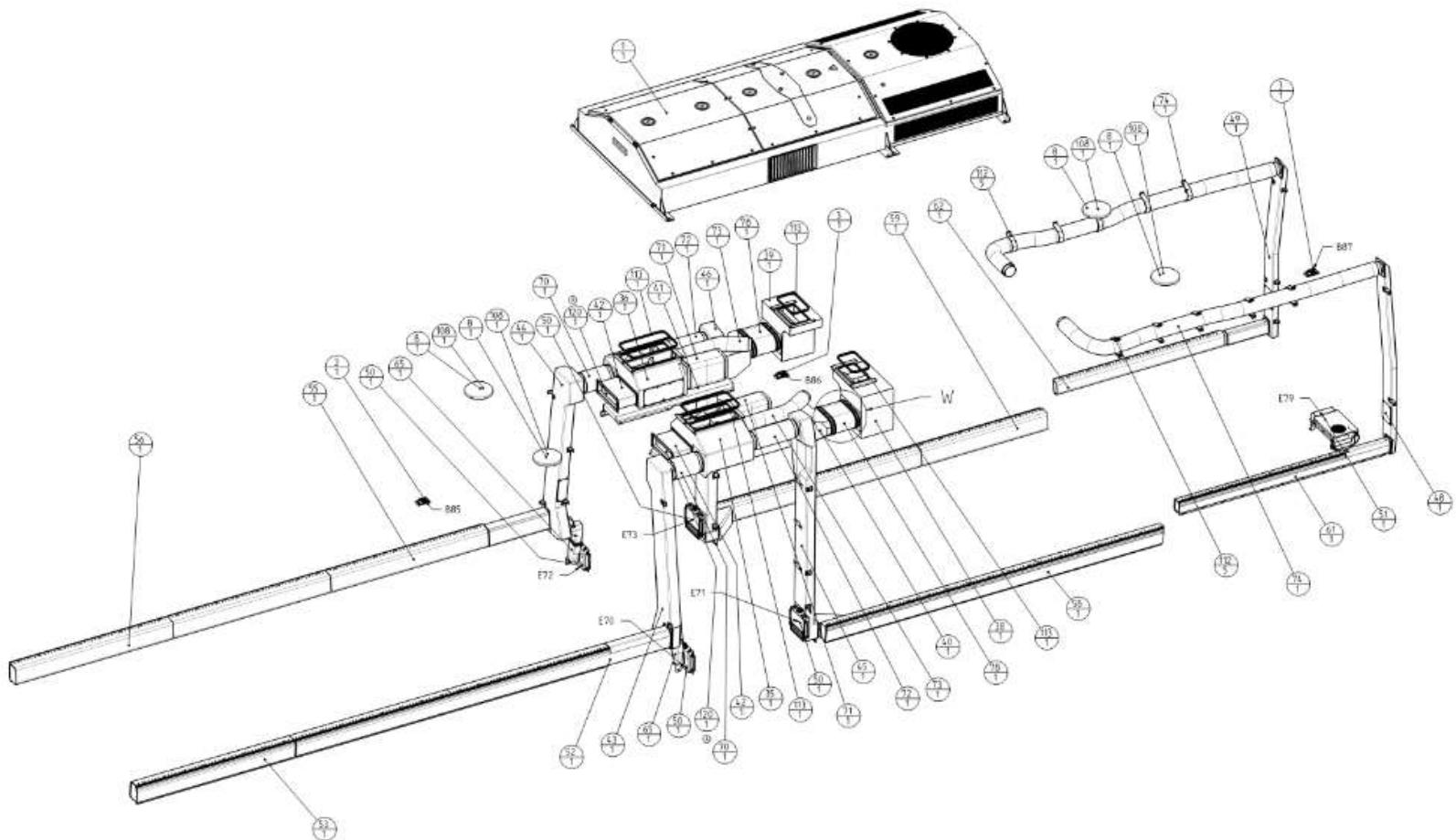
- **Energy transfer**
  - Cooling from ceiling
  - Heating from bottom area
  - Convection heaters or ducts
  
- **Ducts**
  - Distribution of supply air
  - Temperature distribution
  - Return air
  - Exhaust air



Ducting - energy transfer into the train

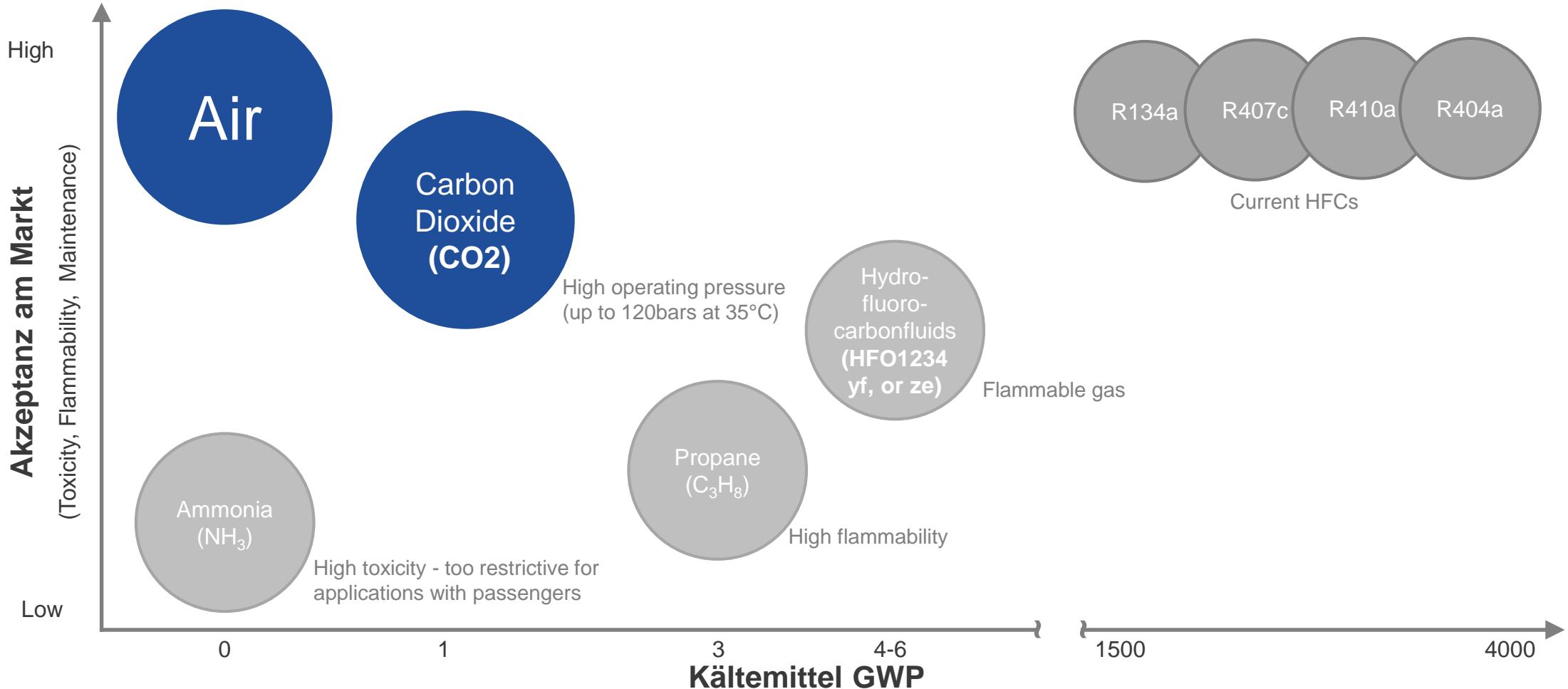
## Ducting

- Example from Talent 2



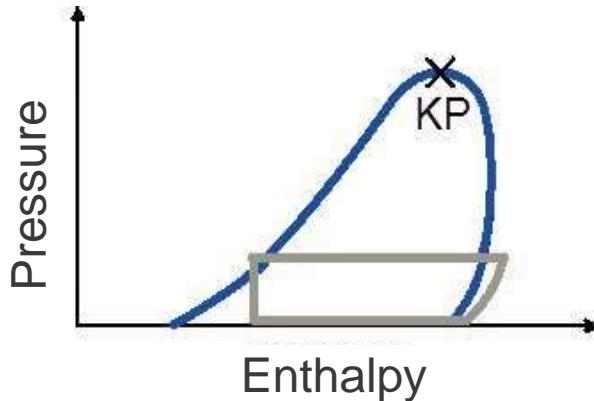
- **Conditions:**
  - Cooling / heating / ventilating
  - Pre-cooling
  - Pre-heating
  - Free cooling
  - Emergency
  - Dehumidification
  - Stand by / pre conditioning

# Actual situation on refrigerants



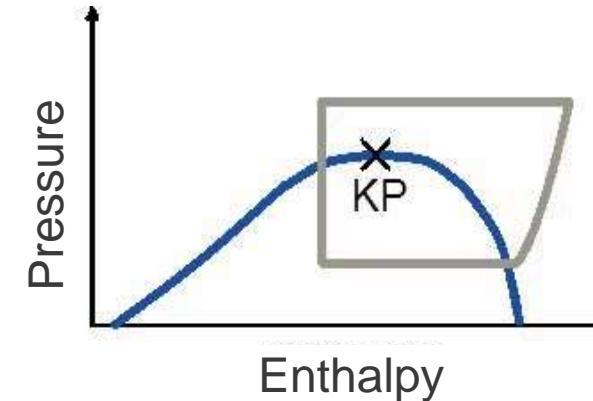
# Comparison CO<sub>2</sub> vs. R134a Working principals

## R134a: subcritical process



- pressure range:
  - 1 - 25 bar
  - typical pressure ratio 4...10
- heat release: condenser at constant temperature
- piping: large diameters

## CO<sub>2</sub>: transcritical process

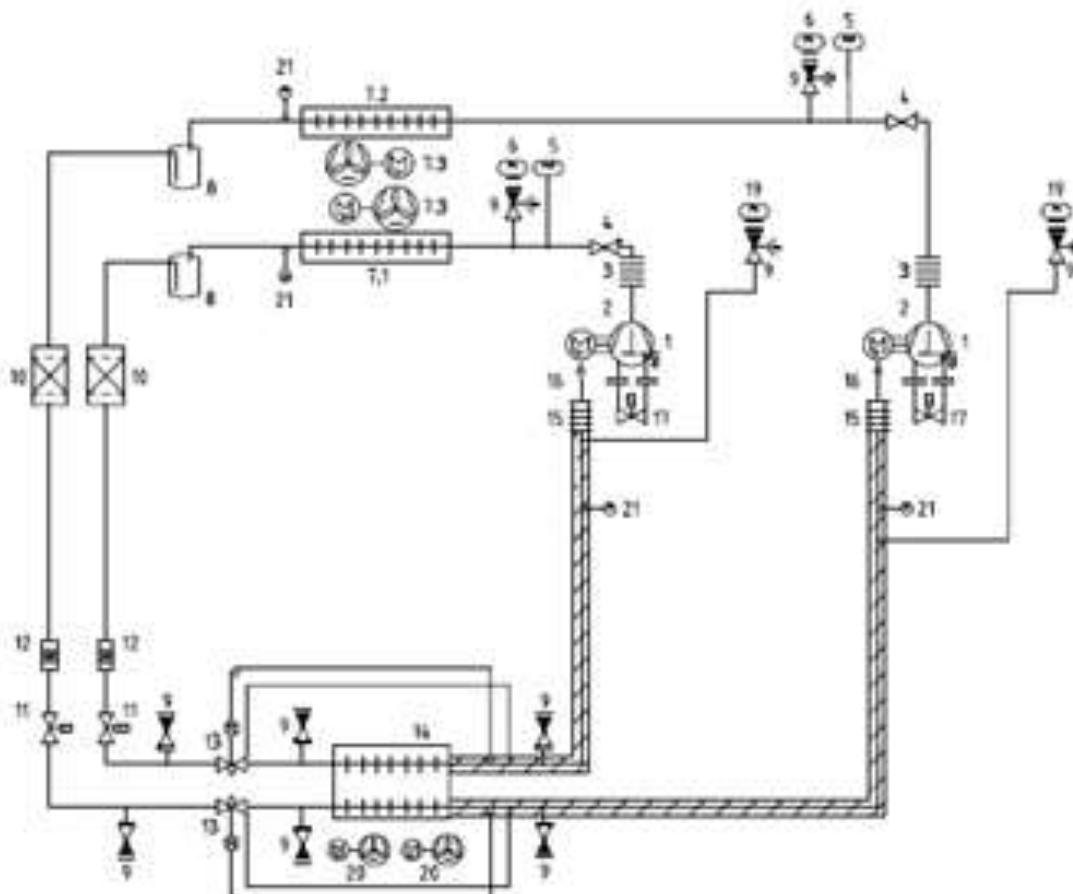


- pressure range:
  - 25 - 130 bar
  - typical pressure ratio 2...5
- heat release: gas cooler at sliding temperature
- piping: small diameters

# Air conditioning units

## Working principals

- Cooling schematics  
Talent 3 ÖBB

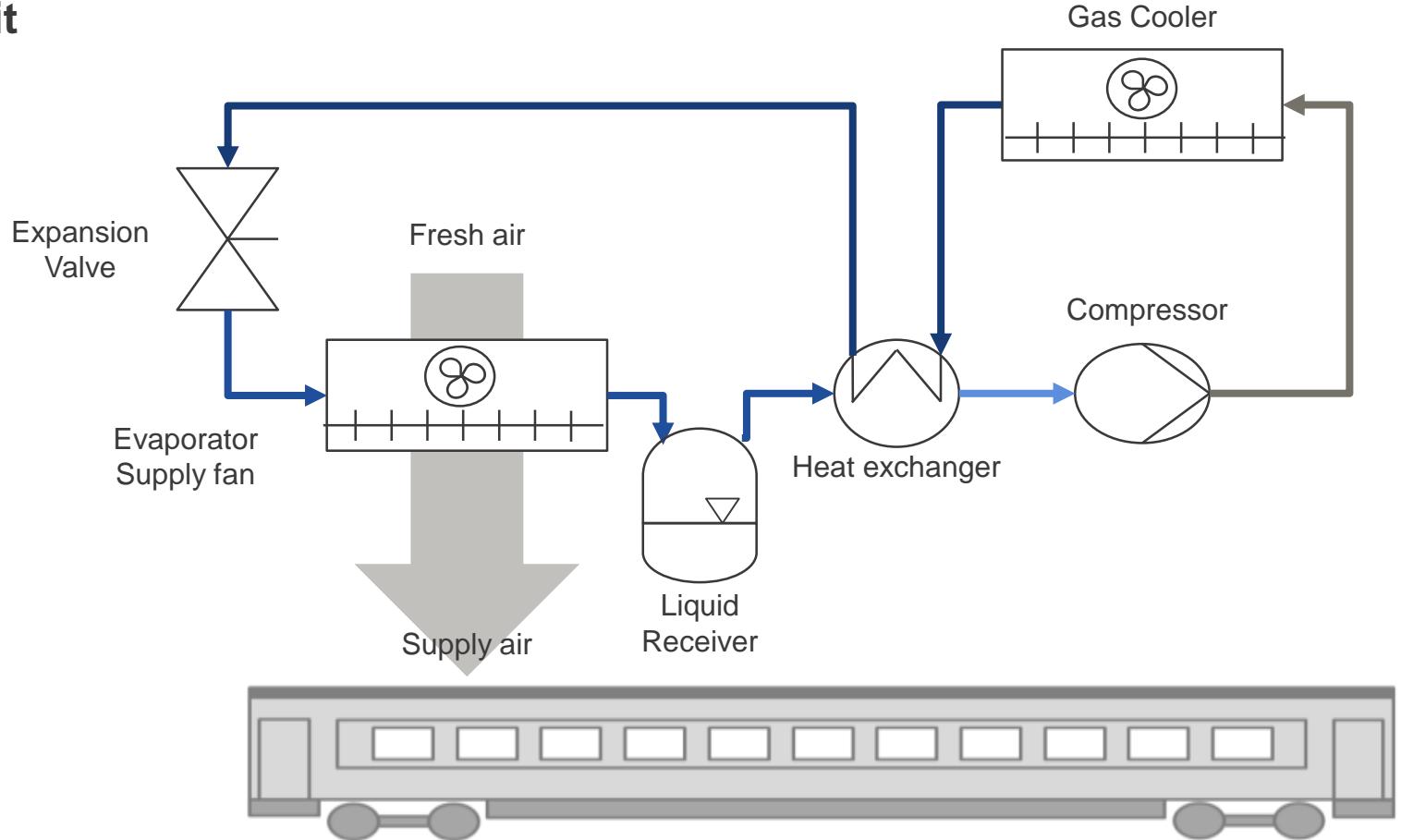


Pkt.	Name	Anzahl
1	Verdichter	2
2	Lötheadpter Druckselle	1
3	Rohrleitungs kompensator	2
4	Rückschlagventil	2
5	Druckwächter HP	2
6	Drucksensor HP	2
7,1	Vertflüssiger	1
7,2	Vertflüssiger	1
7,3	Vertflüssiger Lüfter	2
8	Sammler	2
9	Serviceventil	10
10	Filtertrockner	2
11	Hägelfenstl.	2
12	Schauglas	2
13	Expansionsventil	2
14	Verdampfer	1
15	Rohrleitungs kompensator	2
16	Lötheadpter Saugselle	1
17	Flügelventil Leistungsteuerung	2
18	Druckwächter LP	2
19	Drucksensor LP	2
20	Zuluftter	2
21	Temperaturführsensor	4

# Air conditioning units

## Working principals

### ■ Cooling schematics CO2-unit



## Air conditioning units

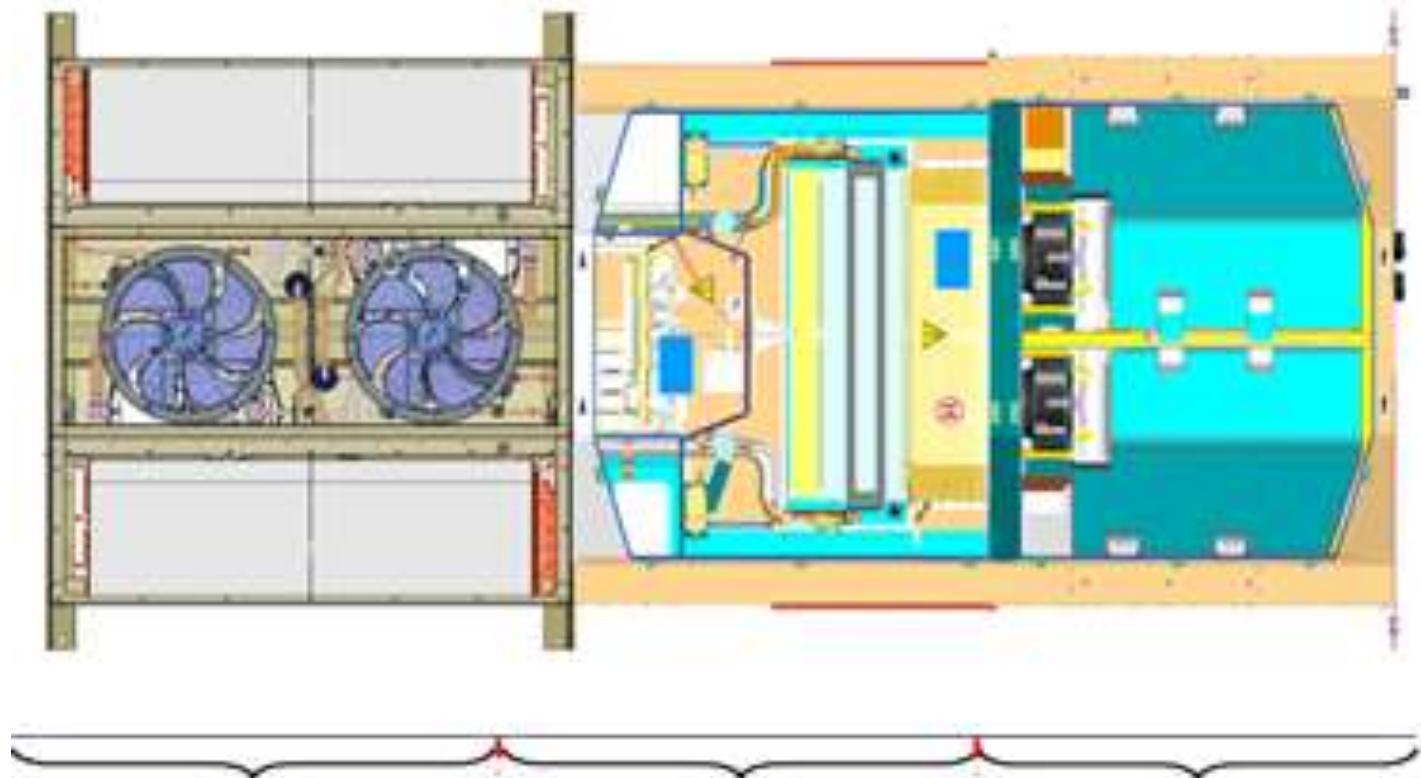
# Architecture example

- Talent 2
- Talent 3 ÖBB  
saloon unit



### General Technical Data

supply air volume	cooling 2,900 m³/h heating 2,200 m³/h
refrigerant	R134a
cooling capacity	27 kW
heating capacity	30 kW
supply air fan	2 x radial
condenser air fan	1 x axial
compressor	1 x screw
weight	775 kg
dimensions	width 2,070 mm length 4,190 mm height 591 mm



Cooling part

air handling part

silencer

# Air conditioning units

## Architecture example

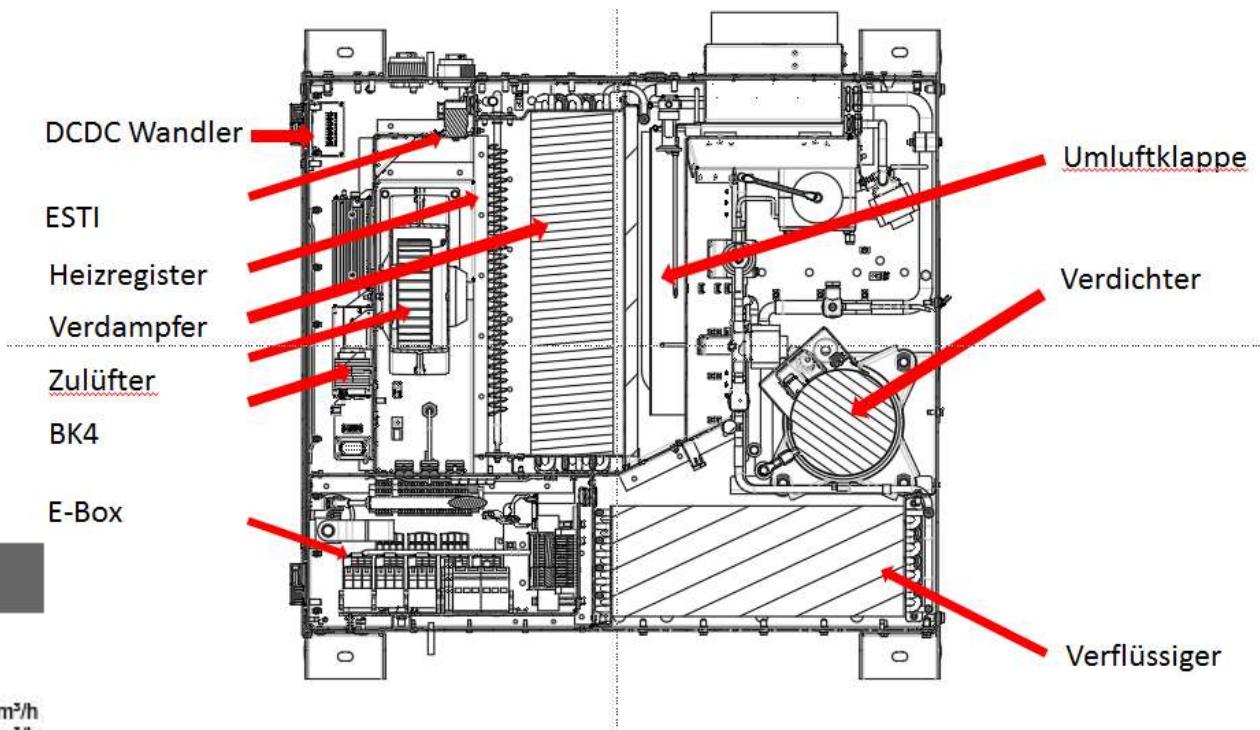
- Talent 3 ÖBB cab unit

### Technical Information



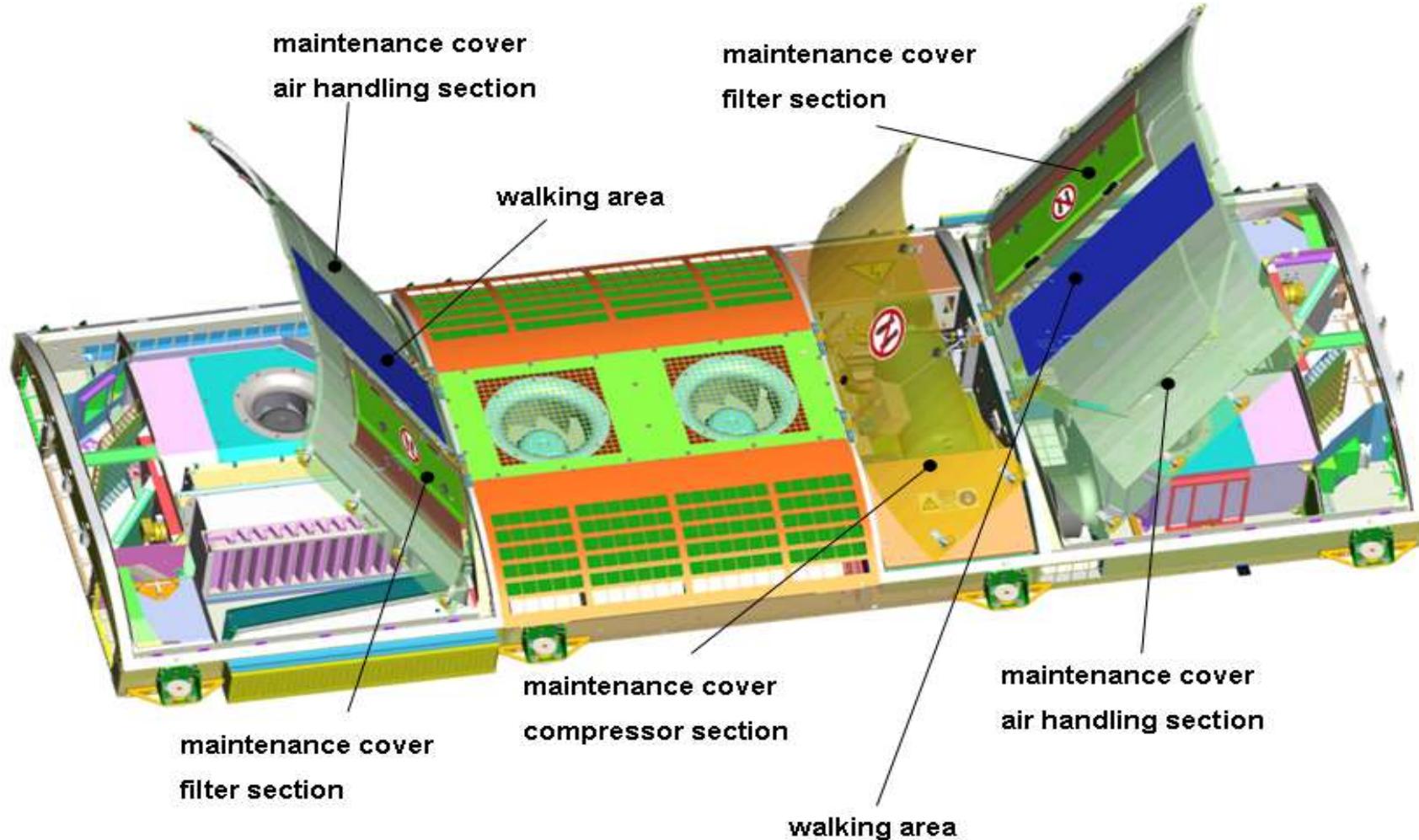
#### General Technical Data

supply air volume	cooling 550 m³/h heating 550 m³/h
refrigerant	R134a
cooling capacity	4.5 kW
heating capacity	5.4 kW
supply air fan	1 x radial
condenser air fan	1 x axial
compressor	1 x scroll
weight	182 kg
dimensions	width 1,020 mm length 1,013 mm height 495 mm



# Architecture example

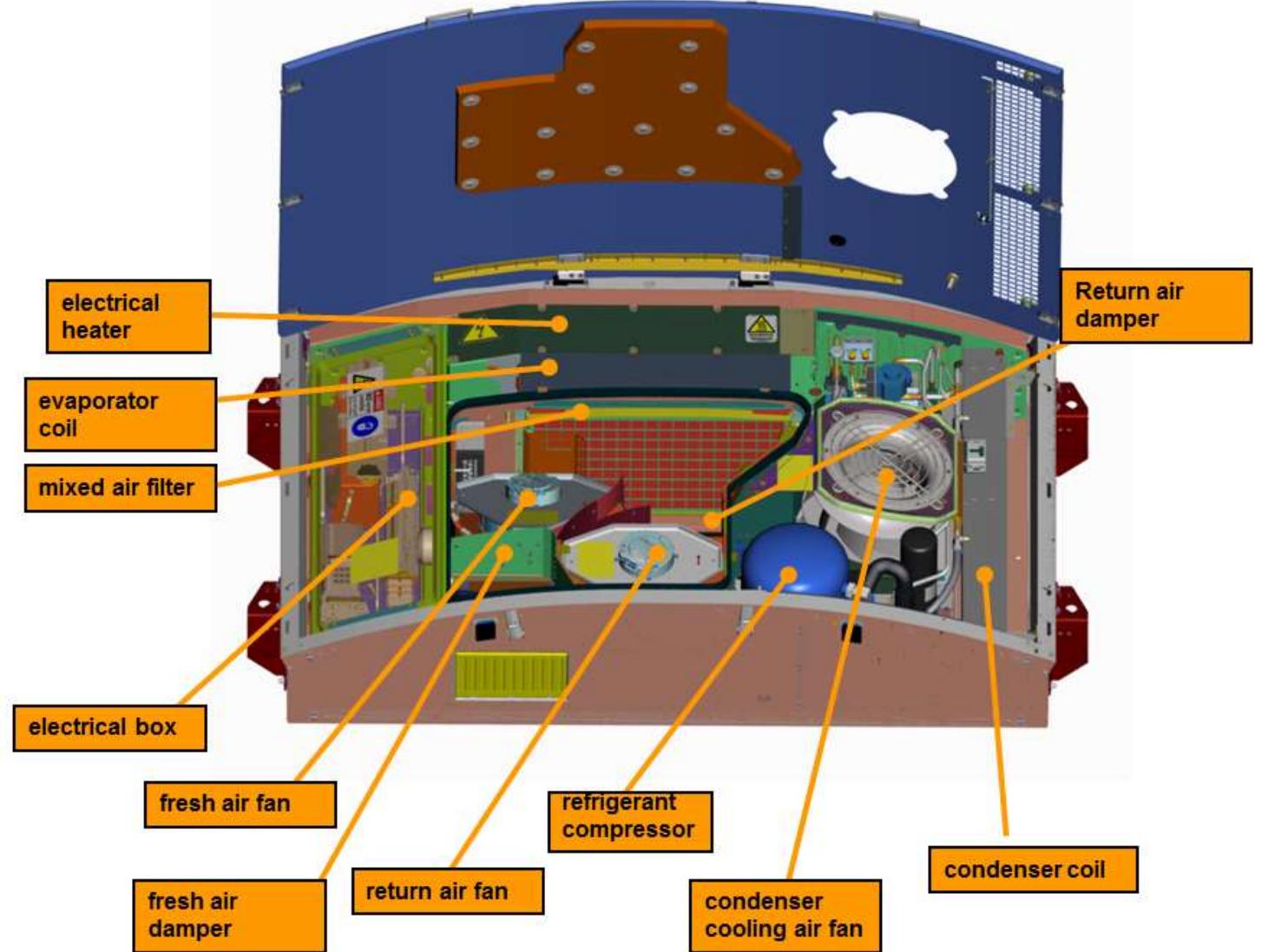
- Thameslink saloon unit



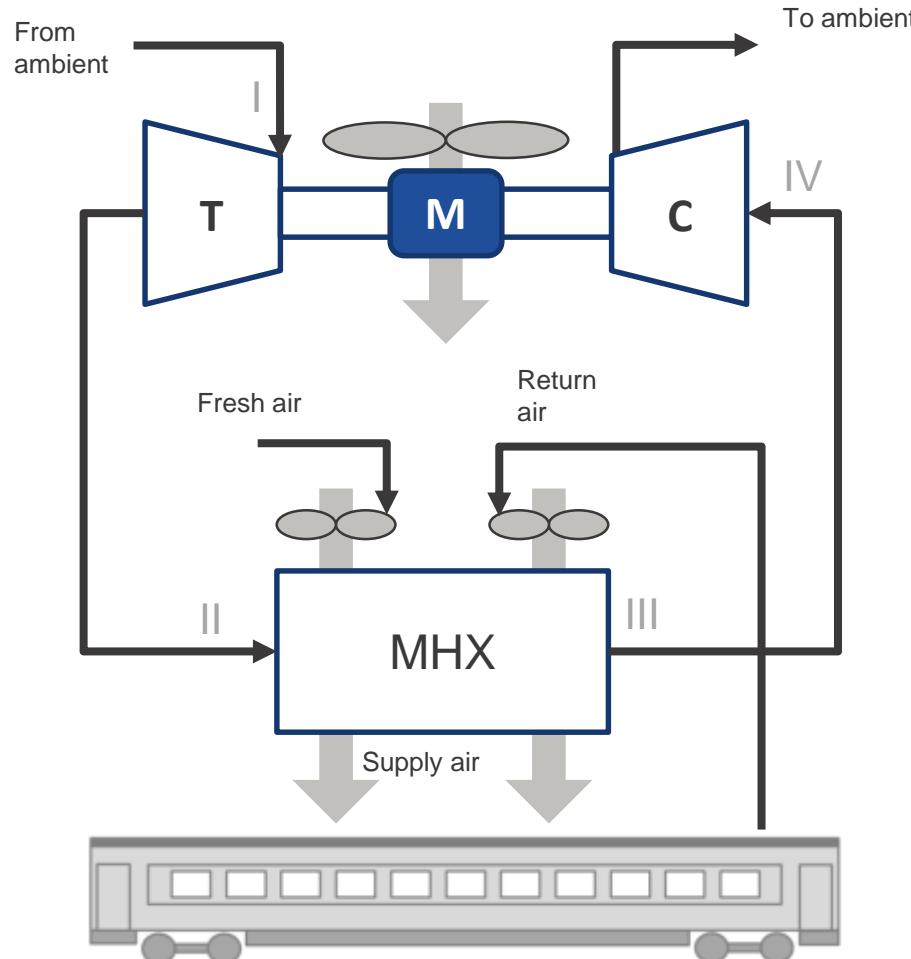
# Air conditioning units

## Architecture example

- Thameslink cab unit

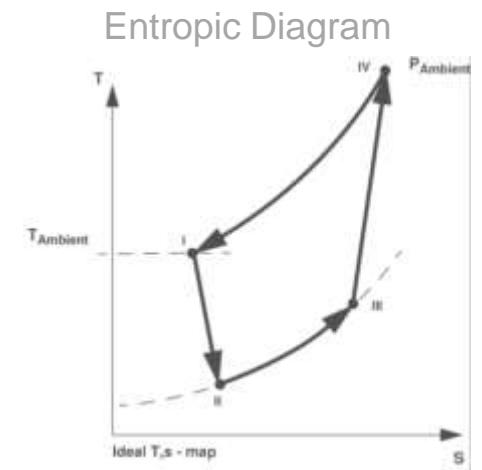


# Operating principals - Air Cycle Reverse Loop Architecture



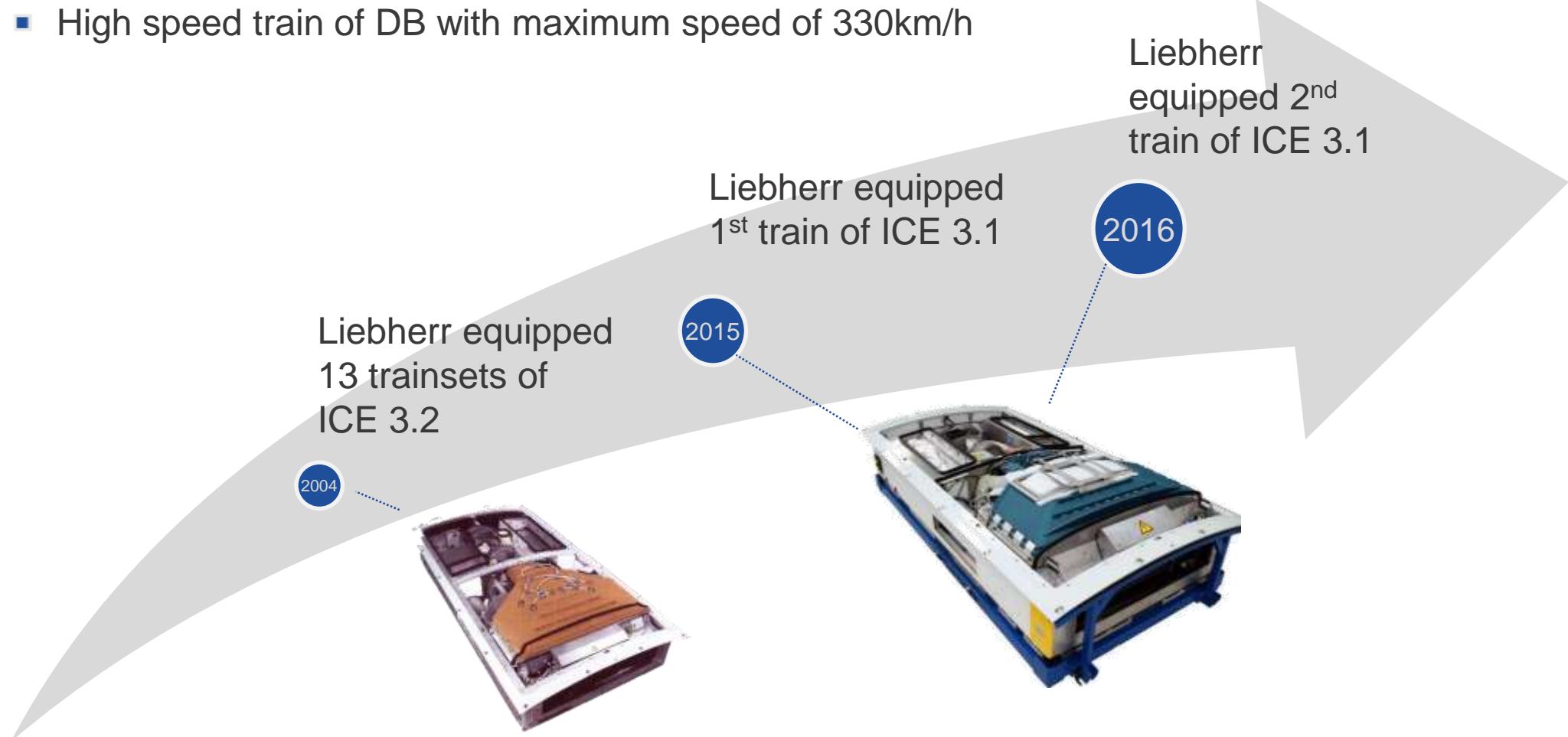
- Basic principle:
  - I-II: Expansion of the ambient air flow (turbine stage)
  - II- III: Decrease of the temperature (heat transfer)
  - III-IV: Compression to ambient pressure (compressor stage)
  - IV: Hot air streams into atmosphere, “cools” down to ambient temperature
- Refrigerant: ambient air (R729)

MHX : Main Heat Exchanger  
 T : Turbine stage  
 C : Centrifugal compressor stage  
 M : Synchronous motor



# Air Cycle Technology ICE 3

- High speed train of DB with maximum speed of 330km/h



# Operating principals - Air Cycle Next Generation

MHX: Main Heat Exchanger

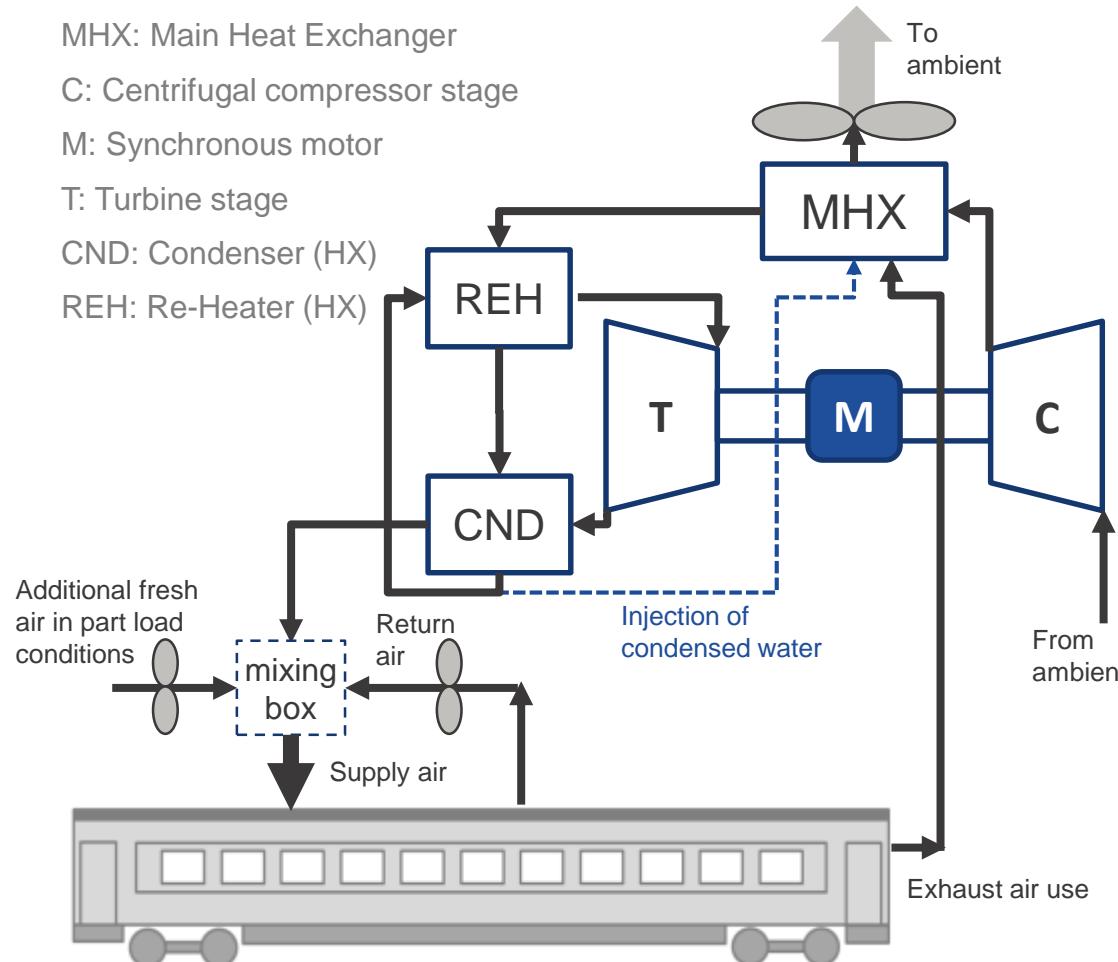
C: Centrifugal compressor stage

M: Synchronous motor

T: Turbine stage

CND: Condenser (HX)

REH: Re-Heater (HX)



- Two additional heat exchangers (REH, CND)
  - Generate practically conditions for water extraction from process air flow (CND)
  - Improve energy efficiency with re-heating process air flow before expansion (REH)

FINAL ARCHITECTURE

# Operating principals - Air Cycle Next Generation

MHX: Main Heat Exchanger

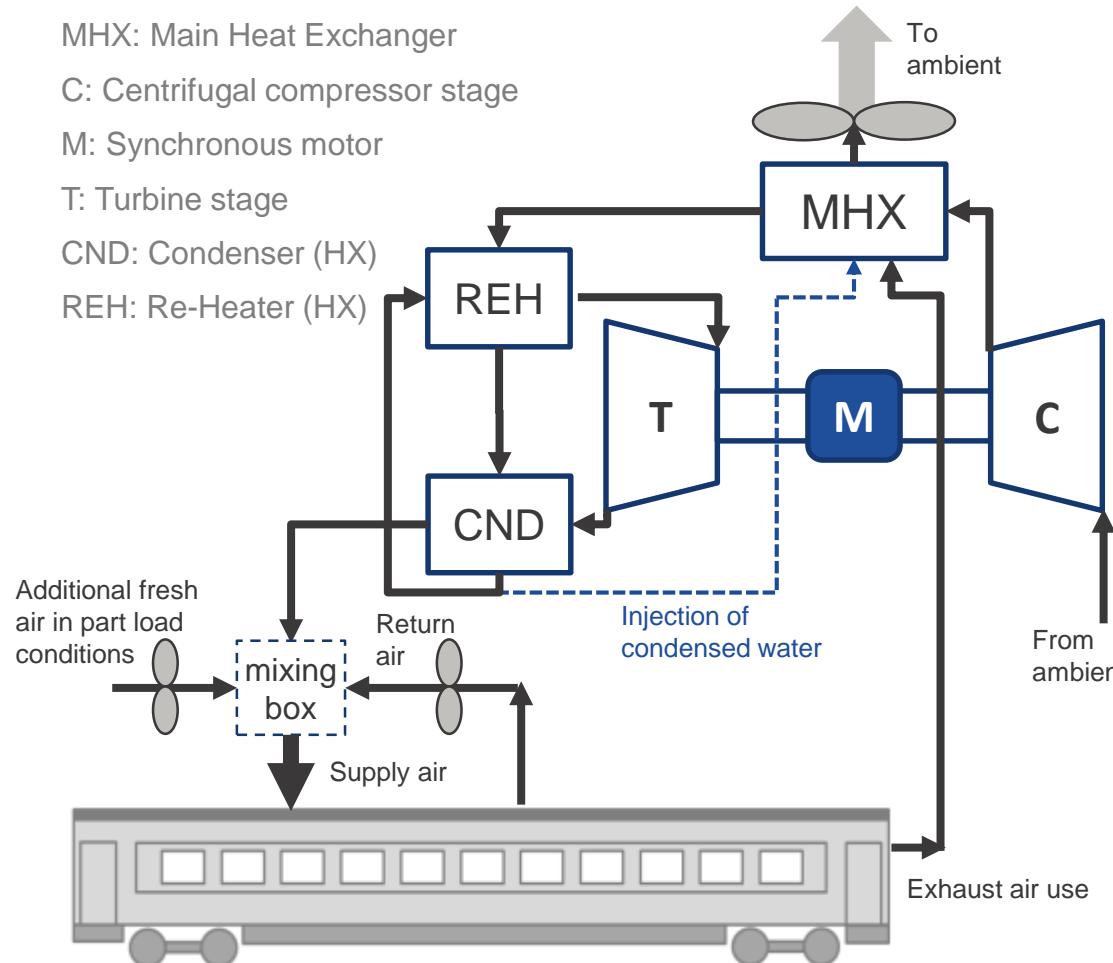
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FINAL ARCHITECTURE



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