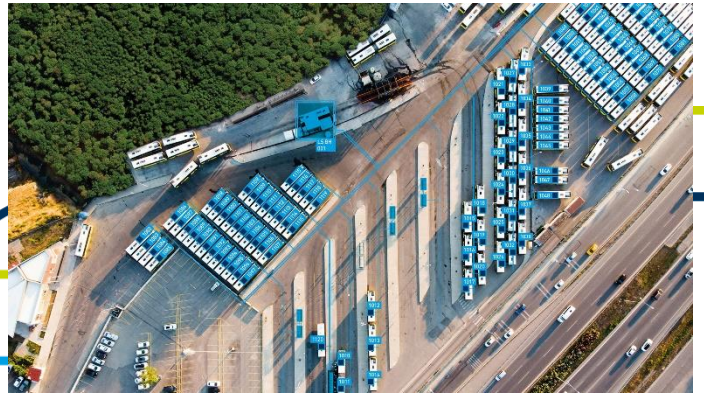
FROM PLANNING TO OPERATION OF ELECTRIC BUS DEPOTS

INTEGRATED IT SYSTEMS FOR DEPOT AND CHARGING MANAGEMENT

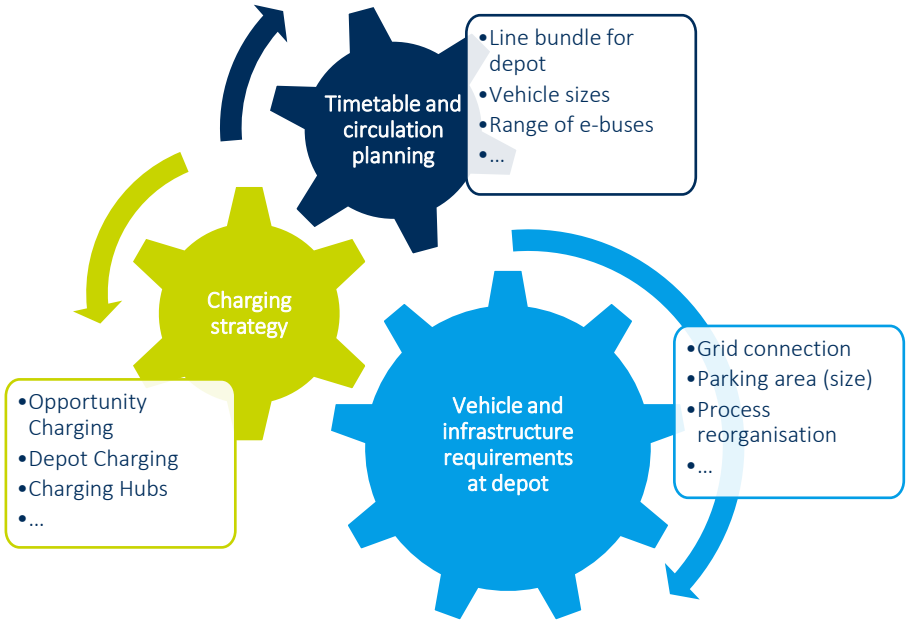
DR.-ING. ENRICO LAUTH



M2G-ITS Lab Workshop 2024, Kyoto 7th May 2024

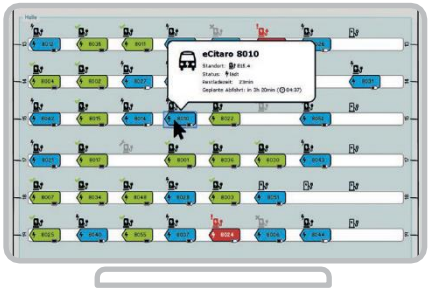
PLANNING OF DEPOTS FOR ELECTRIC BUSES

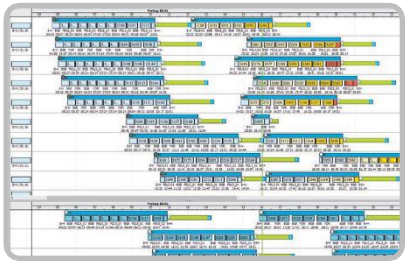
- *„Everything is connected to Everything"* (German quote, Alexander von Humboldt)
- Aim is an overall concept optimised in terms of costs and operation
- Difference between new depot (green field) and conversion of existing depot
- Simulation environments are necessary for larger projects (e.g. eFLIPS)

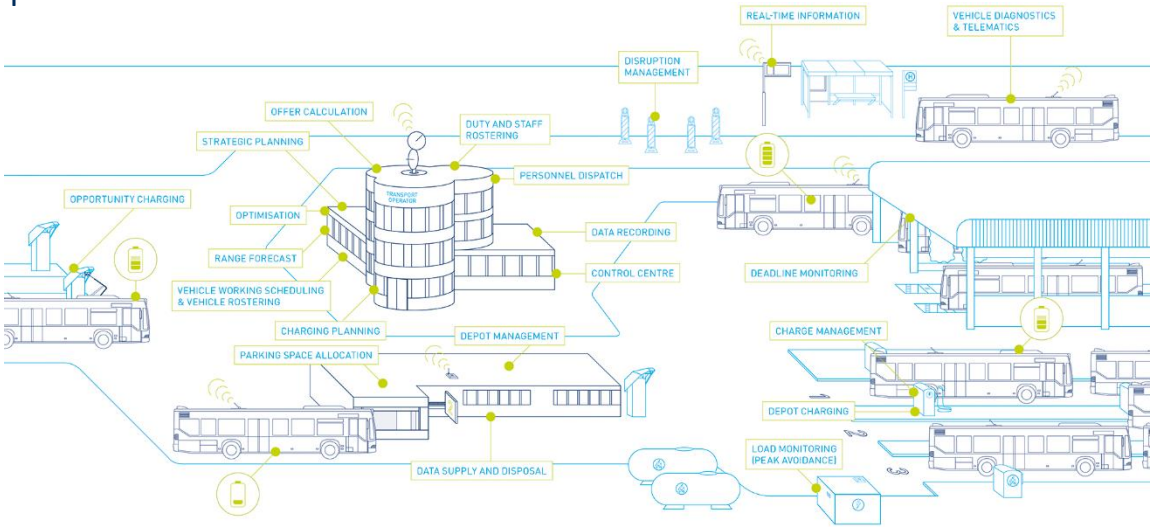


NEED TO USE IT SYSTEMS

- Challenges
  - Requirements are increasing significantly due to digitalization, automation and electrification
  - Technical requirements are becoming more complex, just like IT systems
  - The complexity is concentrated at the depot
- Secondary goals
  - Increase efficiency
  - Increase operational safety and quality
  - Keeping costs under control
  - Compensating for staff shortages and a lack of qualifications

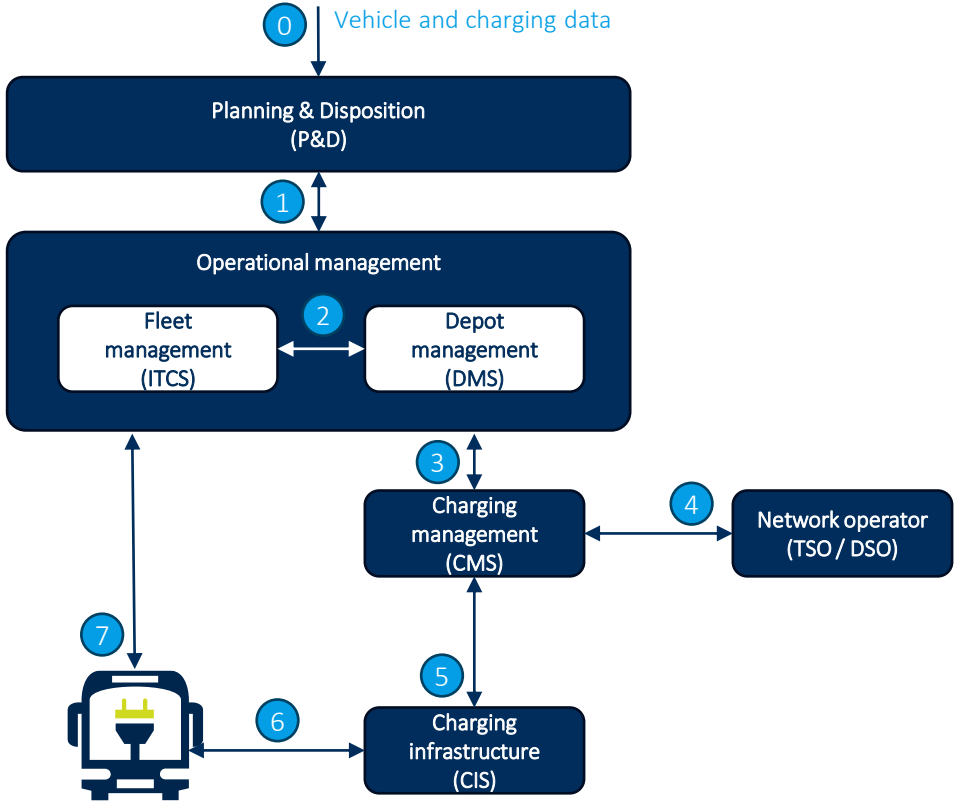






INTERFACES

COMPLEXITY REDUCTION THROUGH STANDARD INTERFACES

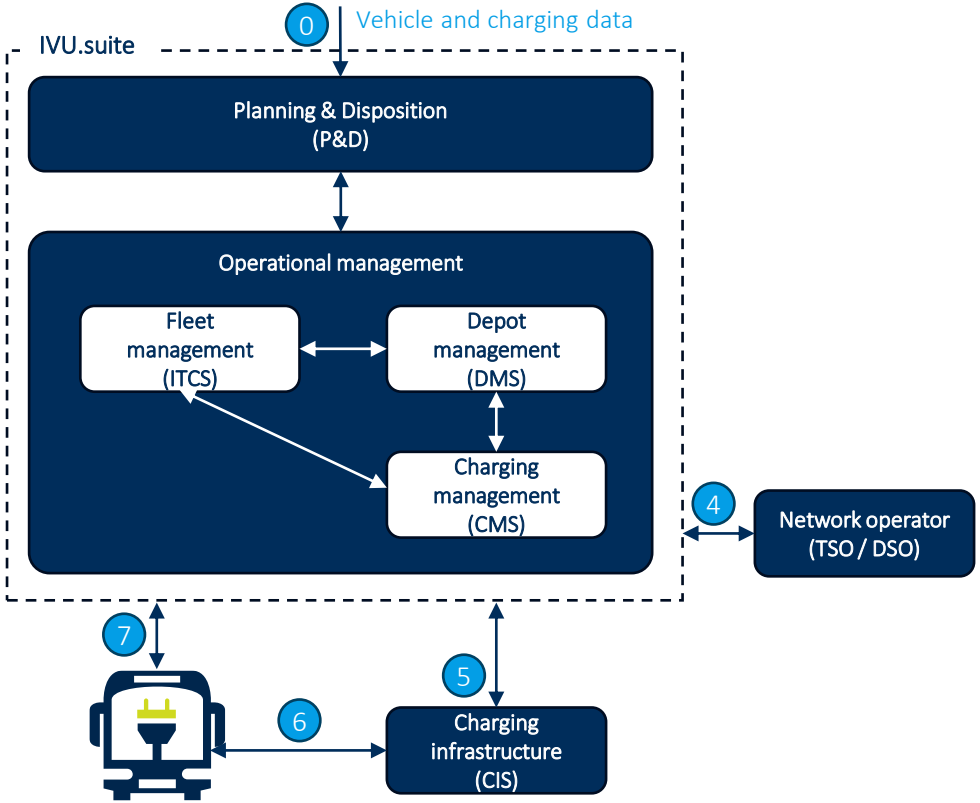


#	Systems		Standard
0		P&D	
1	P&D	ITCS, DMS	VDV452, VDV455
2	ITCS	DMS	VDV461
3	ITCS, DMS	LMS	VDV463
4	LMS	TSO/DSO	IEC-60870-5-104
5	LMS	LIS	OCPP, VDV261
6	LIS	BUS	ISO15118, VDV261
7	BUS	ITCS	VDV238, VDV435

- Many systems and components increase complexity
- Standardised interfaces help to link and control systems

INTERFACES

REDUCING COMPLEXITY THROUGH INTEGRATION



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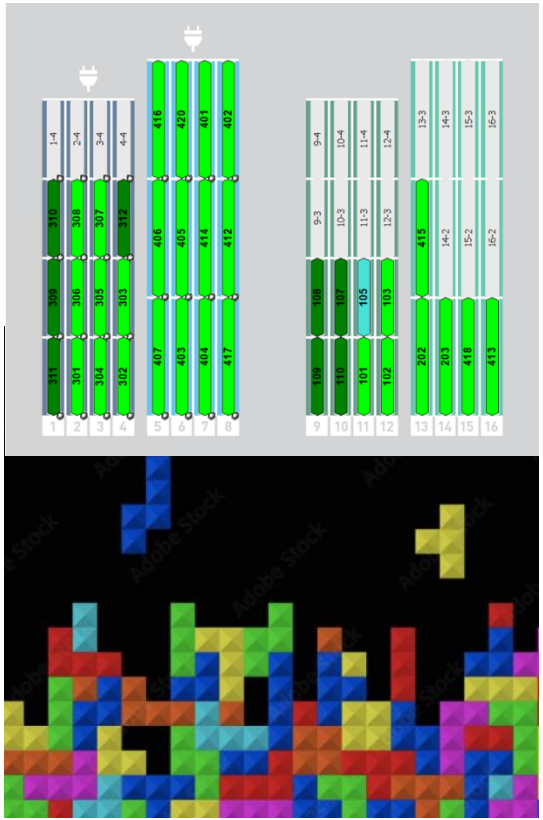
6	LIS	BUS	ISO15118, VDV261
7	BUS	ITCS	VDV238, VDV435

- Interfaces increase complexity, cost project time and (ongoing) money
- Integration eliminates this risk
- Furthermore, algorithms and data in all subsystems match in the integrated system

OPERATION

INTEGRATED DEPOT OPTIMISATION FOR OPERATIONAL STABILITY

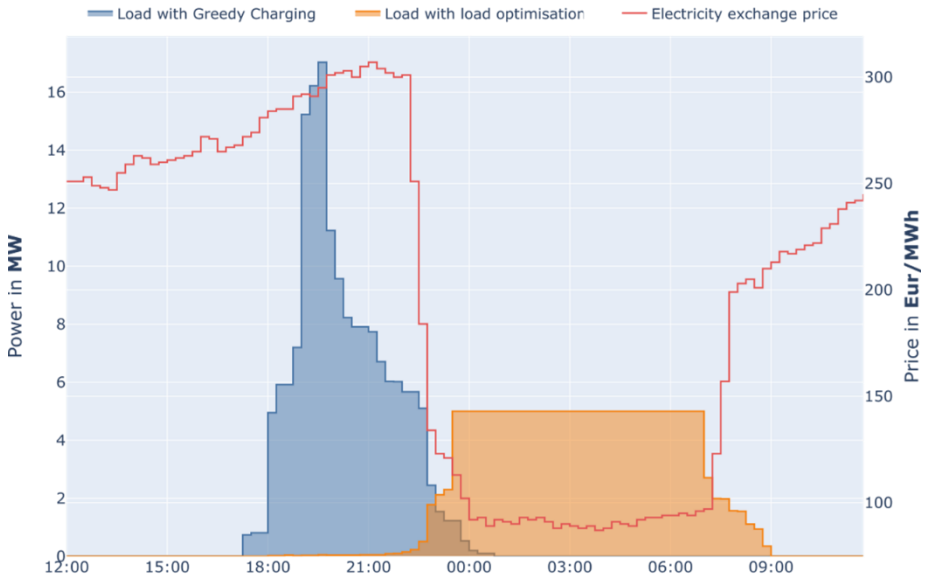
- Practical experience: Manual assignments are only manageable to a certain amount due to their complexity
  - Park vehicles in suitable parking spaces
  - Allocate rotations to suitable vehicles
  - Charge and prepare vehicles in the best possible way
  - Consider additional criteria: Vehicle type, topology, ...
- Electromobility increases the requirements
  - Compliance with the target SoC
  - Plan for preconditioning
- Integrated depot optimisation solves these challenges
  - Algorithmic solution finding in form of multi-criteria optimization
  - Automatically adjusts vehicle circulation allocations on an ongoing basis
  - Conflicts are eliminated or their effects minimised



OPERATION

SMART CHARGING FOR ROBUST OPERATION AND COST OPTIMISATION

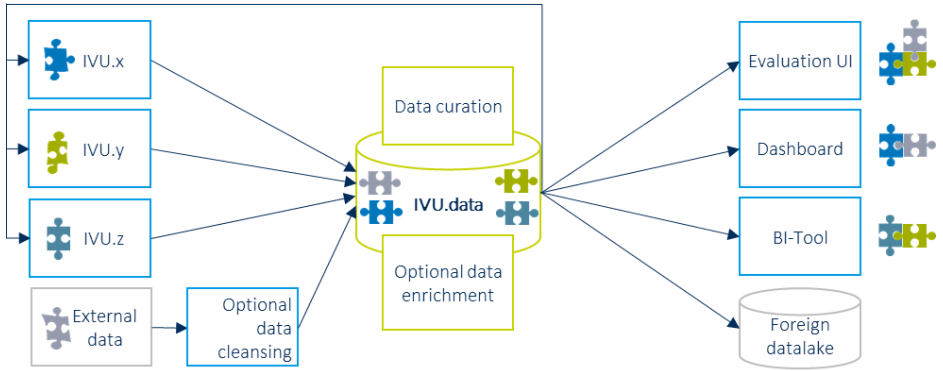
- Practical experience: Smart charging requirements cannot be handled manually
  - Prioritisation of charging power and load distribution
  - Grid connection of depot
  - Better distribution of power consumption to reduce grid charges (peak shaving, atypical load)
  - Utilisation of time-variable electricity tariffs
  - Preconditioning
  - Minimisation of battery ageing
  - Opportunity charging en route
  - Self-generated electricity e.g. PV
- Close interaction between depot and charging management is essential
- Enables intelligent allocation of rotations, vehicles and charging infrastructure



DATA DATA DATA

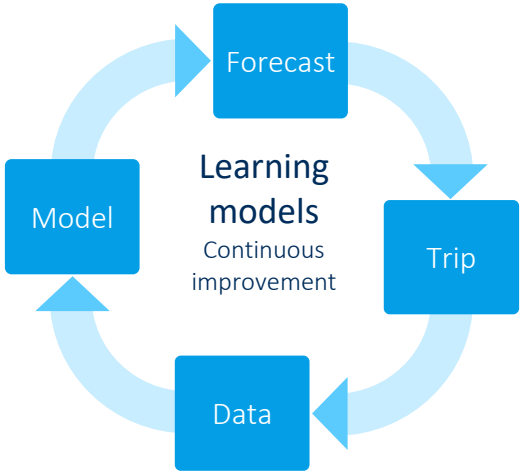
DATA ACQUISITION AND ANALYSIS OPTIMISE PROCESSES

- Analysing vehicle and charging data in conjunction with operating data
- Aggregation of information in a central data pool
- Context-related evaluation
- Data analysis requires professional and technical expertise
- Based on this, optimisation of operation (of electric buses)

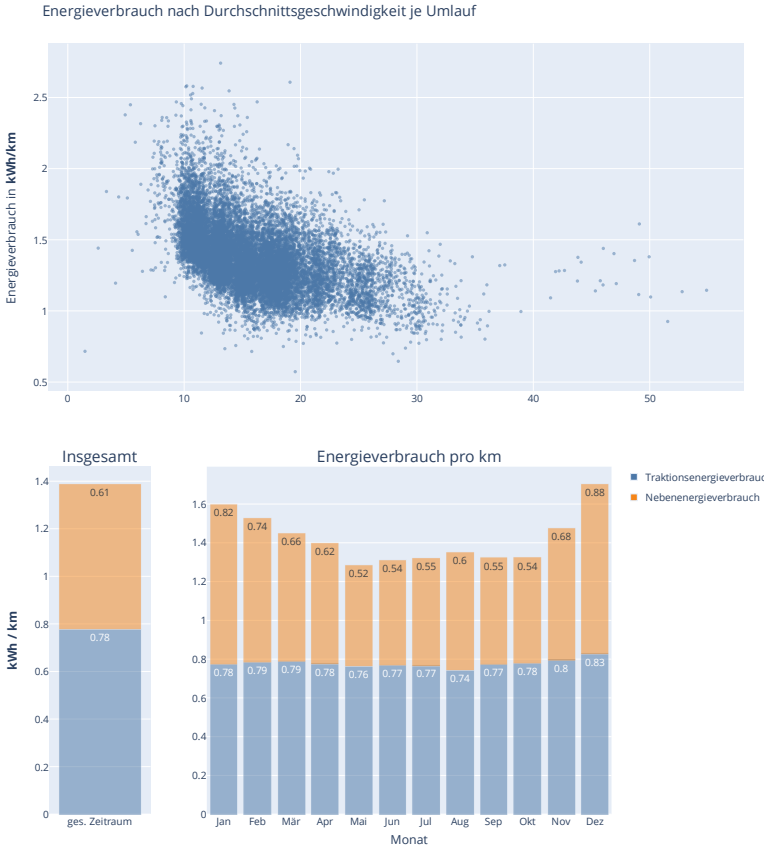


DATA DATA DATA

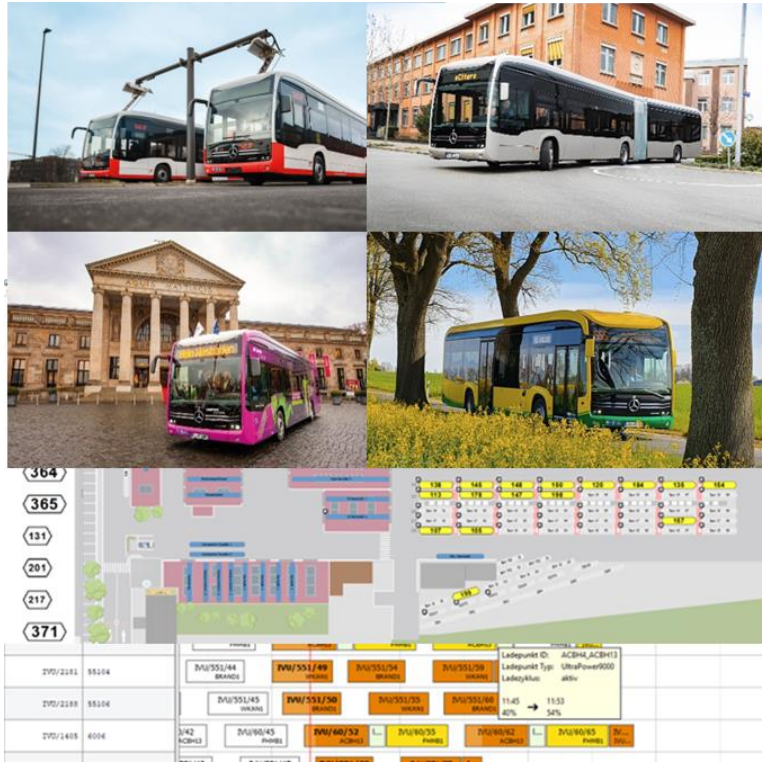
CONTINUOUS IMPROVEMENT THROUGH SELF-LEARNING MODELS



- Conservative forecasts with large safety buffers
- Forecasts based on data and algorithms are much more accurate
- Self-learning models continue to do this



THANK YOU VERY MUCH
FOR YOUR ATTENTION



- Dr.-Ing. Enrico Lauth
  Project Manager Public Transport

  enrico.lauth@ivu.de

- IVU Traffic Technologies AG
  Bundesallee 88
  12161 Berlin
  Deutschland

  www.ivu.de