HASTUS

PLANNING & MANAGING AN ELECTRIC-BUS OPERATION

APTA - Sustainability & Multimodal Operations Planning Workshop

November 2021

GIRO

AGENDA

- Introduction
- E-bus challenges for operations
- Recommendations to meet challenges
- System approach with right technology
- Success stories

MONTRÉAL: INTERNATIONAL HUB FOR AI, BIG DATA & TRANSPORT RESEARCH

HASTUS CLIENTS

Worldwide

300+

HASTUS installations

28

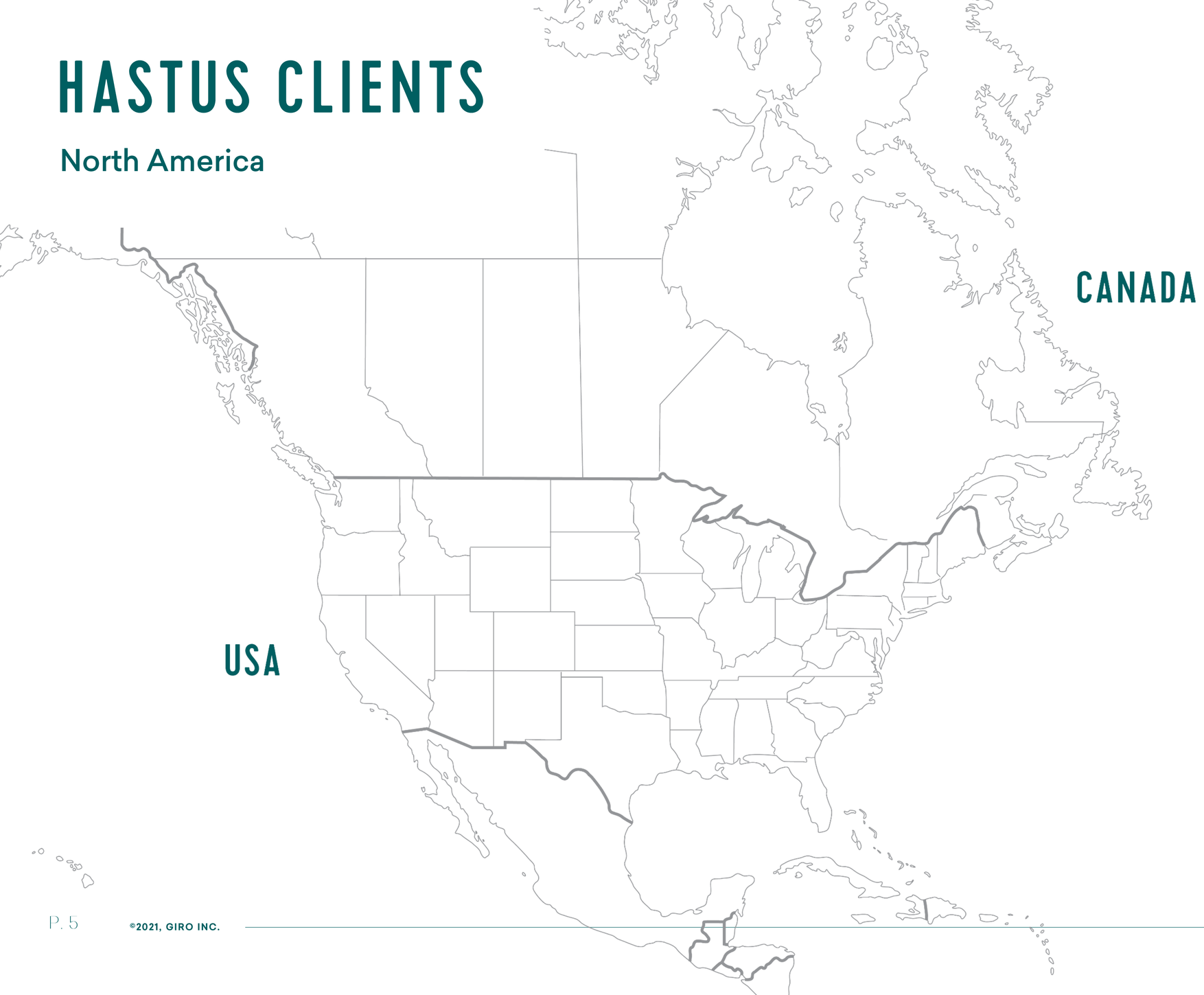
Countries

100+

Rail networks
of all kinds

HASTUS CLIENTS

North America



75+

Clients

7 of 10

Top US agencies

SOME OF OUR CLIENTS WITH ELECTRIC-BUS FLEETS

LEVERAGING HASTUS

transdev · KEOLIS · ARRIVA a DB company · Foothill Transit

Nobina · Qbuzz · LONDON UNITED RATP GROUP · Metroline

CONTEXT IN NORTH AMERICA

GOVERNMENT FUNDING

FTA awarded more than $182 million to over 45 agencies

Infrastructure bill will invest $39 billion. Replacing thousands of buses with clean, zero emissions buses

DEDICATION TO LOW OR NO EMISSIONS

North American agencies are pledging to reduce or eliminate emissions

SAVINGS! ENVIRONMENTAL & FINANCIAL

One battery-electric bus can save up to $400,000 in fuel during its lifetime


E-BUS CHALLENGES
FOR OPERATIONS

ELECTRIC BUSES

A strategic shift that is changing the public transit business

IRREVERSIBLE COMMITMENT

Climate change has become a global emergency

States & governments making massive investments

THINKING DIFFERENTLY

Reshaping the way we design transportation networks

Changing the way operations are scheduled & operated

INNOVATING FOR EFFICIENCY

Solving new problems

An ideal playing field for optimization & artificial intelligence

NEW CONSIDERATIONS FOR OPERATIONS

E-bus specifications

- Charging mode of buses
- Passenger capacity
- Battery capacity/life
- Energy consumption

Charging point

- Overnight or opportunity charging
- Location of charging equipment
- Capacity of each charger

Operational data

- Planning data influencing energy consumption
- Route characteristics
- Weather conditions

Energy supply

- Cost of energy
- Capacity/availability of the grid

MAIN CHALLENGES FOR OPERATIONS

Technology	Technical limitations Technological readiness	Electric buses are less flexible than diesel Battery range is limited Reliance on different charging options Lack of experienced/trained workers able to service e-buses
Scalability	Experience & expertise Space limitations	Lack of experience on large deployment projects Lack of expertise in e-bus scheduling & operations Charging-station space limitations
Energy management	Electrical/grid issues	Energy costs Peak electricity management Potential electricity outages


RECOMMENDATIONS
TO MEET CHALLENGES

E-BUS CONSTRAINTS MORE IMPORTANT AS YOU SCALE

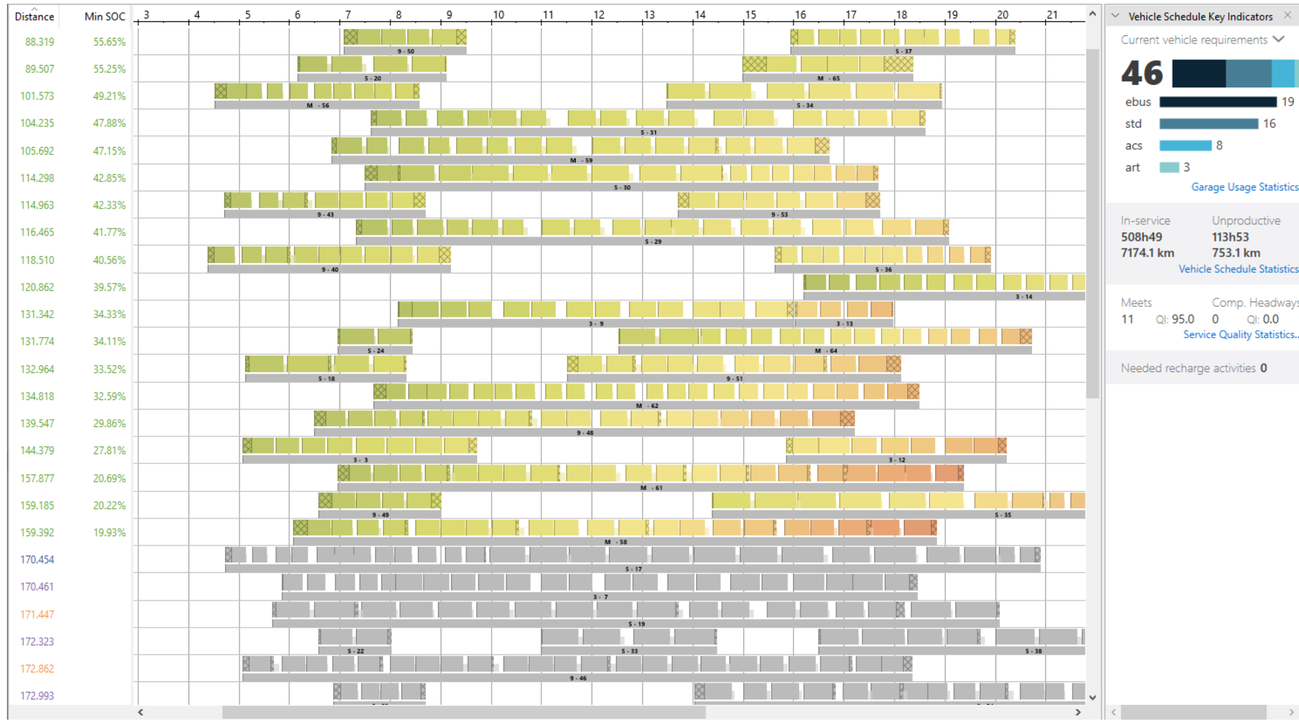
Limited impact in small pilot projects

What-if scenarios to evaluate different technologies & infrastructure

Evaluate the impact on fleet size

Optimize energy needs up front

Evaluate cost of driver time to cover recharging activity



KEY RECOMMENDATIONS

- Evaluate infrastructure costs & impacts
- Measure realistic e-bus capacity/mileage
- Discuss recharge strategies with unions
- Plan for all types of situations
- Build confidence vs day of operations

15% MIN SOC

Only at depot	21 buses 222 planned hours
At 1 terminal	17 buses 260 planned hours
At 2 terminals	17 buses 260 planned hours
Snowstorm	20 buses 288 planned hours
High ridership	18 buses 247 planned hours

OPTIMIZE VEHICLE ASSIGNMENTS OVER MULTIPLE DAYS

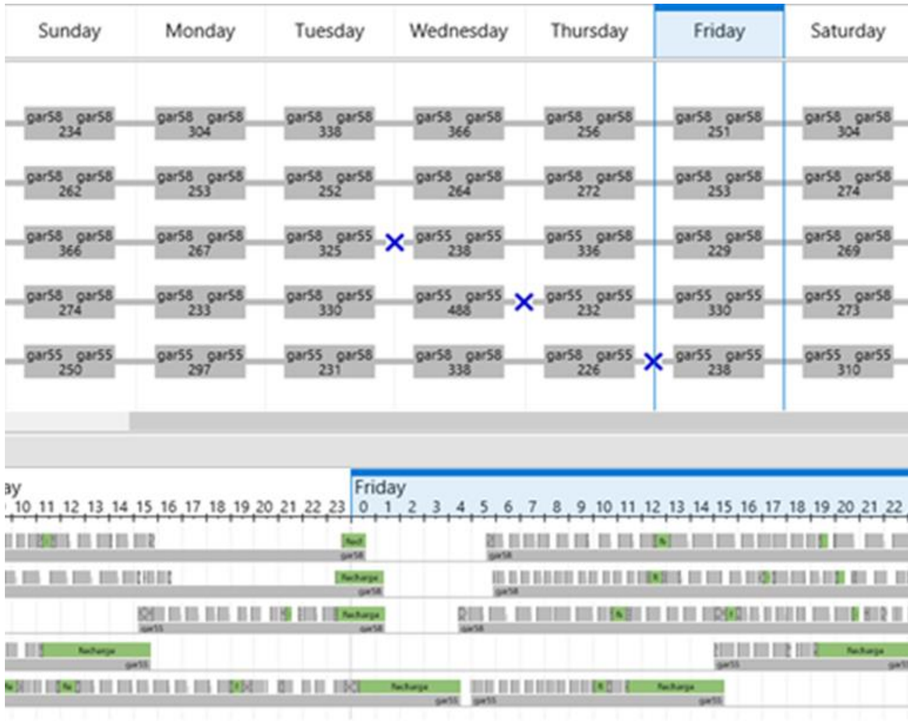
Plan daytime & overnight charging activities

Schedule & optimize recharging activities over several days

Plan recurrent maintenance activities

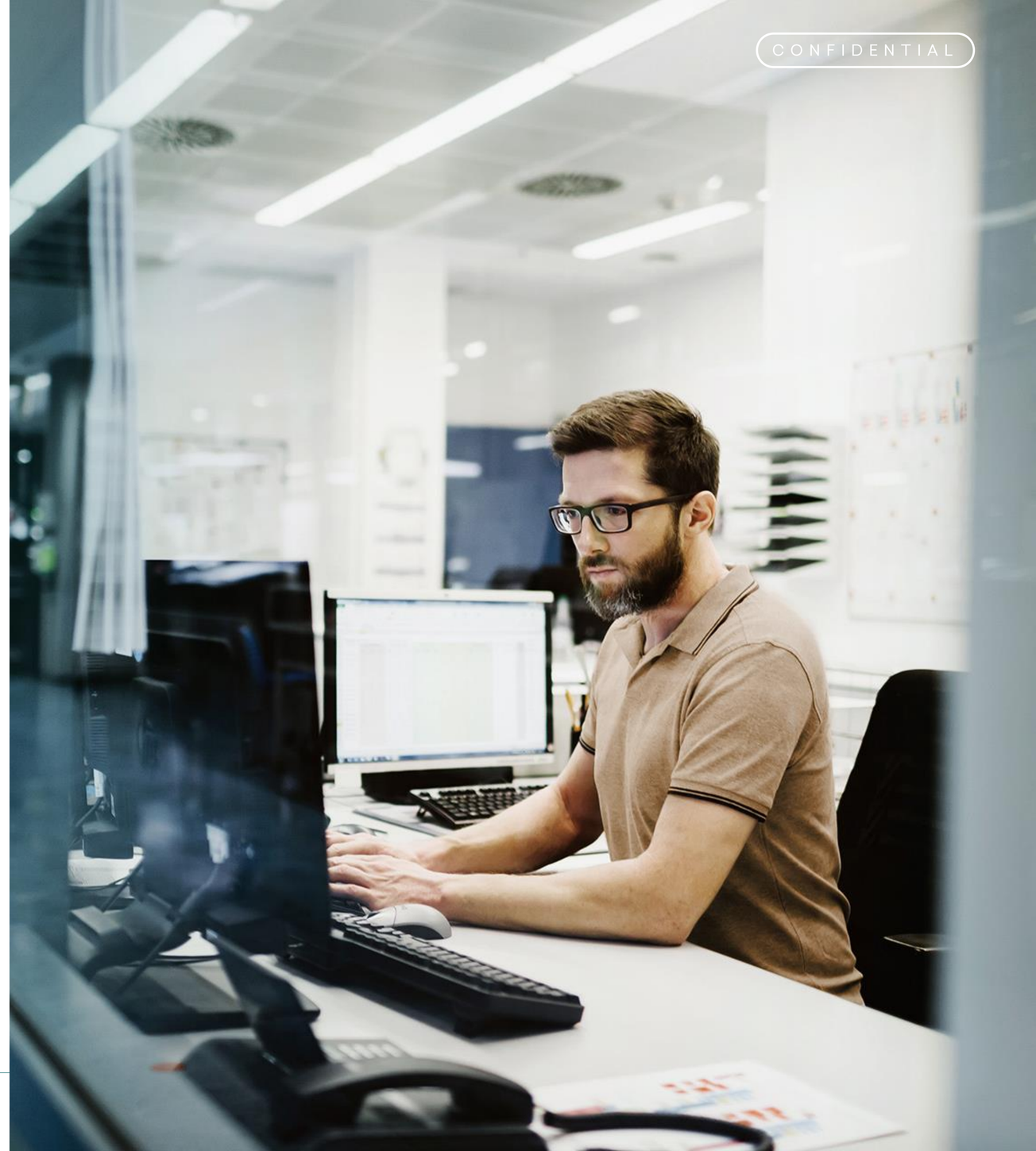
Use what-if scenarios to evaluate impacts of different SoC on vehicle schedule

Optimize energy needs up front



KEY RECOMMENDATIONS

- Correctly evaluate energy needs/costs
- Stay flexible in terms of charging strategies
- Provide guidelines to depot managers



AN OPPORTUNITY TO MODERNIZE VEHICLE-MANAGEMENT PROCESSES

Resource-consuming task

Can be source of conflict between operations & maintenance

Lack of an overall view on vehicle availabilities & planned maintenance activities

In case of last-minute changes, select the first available vehicle in a reactive mode

Constraints of electric buses add an additional layer of complexity

PLAN & OPTIMIZE VEHICLE ASSIGNMENTS

Optimize vehicle assignments in accordance with vehicle availabilities & SoC

Respect route requirements (incl. geofences) & employees' qualifications

Set smart SoC targets

Integrate with Maintenance & Fleet systems

Communicate charging requests to Charging Station Management System (CSMS)

Reoptimize in case of major deviation

INTEGRATE CHARGING NEEDS INTO THE VEHICLE-PARKING PROCESS

Model parking spots & charging points

Automate parking in accordance with upcoming vehicle activities (charging, cleaning, maintenance, etc.)

Respect in/out order

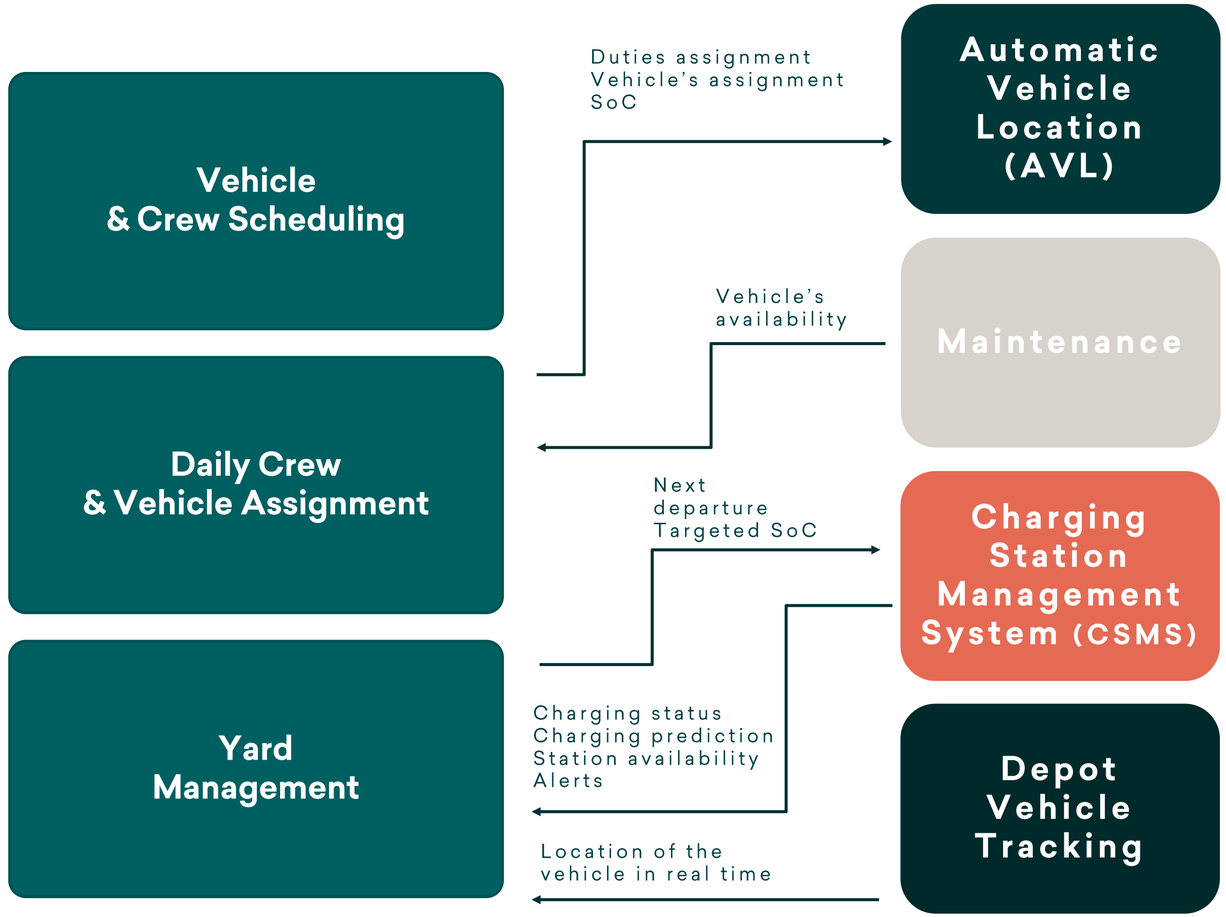
Receive alerts in case of insufficient SoC

Communicate target parking place to driver

Validate bus parking location through integration with depot vehicle-tracking system


SYSTEM APPROACH
WITH RIGHT TECHNOLOGY

INTEGRATED SOLUTION FOR SCHEDULING & DAILY OPERATIONS



Integrated system for scheduling, vehicle assignment & yard management

Management of SoC in real time to improve vehicle scheduling & assignment

Vehicle SoC monitoring through better integration between systems

Smart yard management through advanced communication with CSMS

SUCCESS STORY

TRANSDEV SWEDEN

Successful deployment of 145 battery-electric buses, electrifying 35% of Gothenburg's bus fleet

- Vehicle & charger specifications modified during implementation
- Also added on-route fast-charging stations & not just overnight at depot
- HASTUS helped create multiple scenarios & generate optimized vehicle & crew schedules, including the optimal plan for charging activities

About Transdev Sweden

- 36 local & express routes including commuter runs to downtown LA
- Sweden’s 2nd-largest bus company
- Country’s 3rd-largest public transport operator
- Launched the Nordic region’s largest electric-bus fleet in Gothenburg in 2020

SUCCESS STORY

FOOTHILL TRANSIT

Early adopter of battery-electric buses; experience can guide US agencies

- Plan for cost & operational impacts from BEBs
- Be ready to train operators, maintenance technicians, dispatchers & other staff
- Develop procedures to ensure BEBs fully charged in time for service
- Monitor BEB performance to identify potential issues & understand how your BEBs are operating in service

HASTUS helped build & analyze multiple scenarios, considering BEB autonomy limits & charging-station capacity/availability

HASTUS enabled optimizing use of stops & chargers with no loss of efficiency in vehicle planning or driver duties

About Foothill Transit

- 36 local & express routes including commuter runs to downtown LA
- Pioneer in e-buses since 2010; operates 34 BEBs
- First all-electric double-deck buses deployed in 2021

QUESTIONS ?

DRIVEN BY EFFICIENCY

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