virtual vehicle

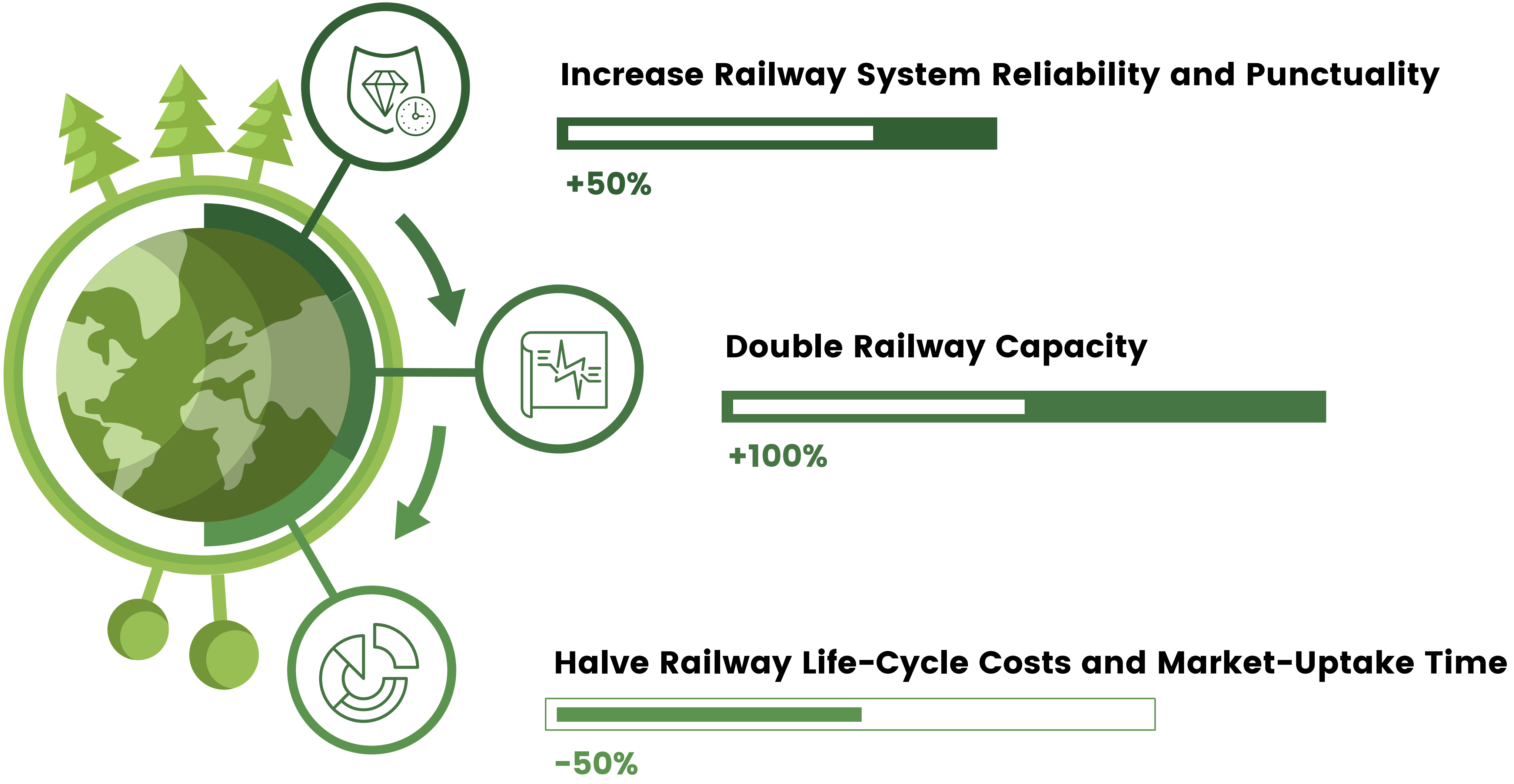
Enabling Future Vehicle Technologies

Railway Digital Twin, a distributed eco system

1. Forum Schiene, Graz

24. Jänner 2023

Main Objectives of the Railway Sector



Increase Railway System Reliability and Punctuality

+50%

Double Railway Capacity

+100%

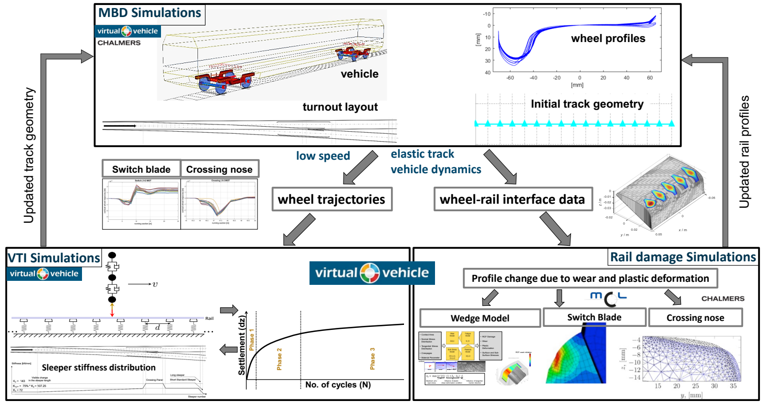
Halve Railway Life-Cycle Costs and Market-Uptake Time

-50%

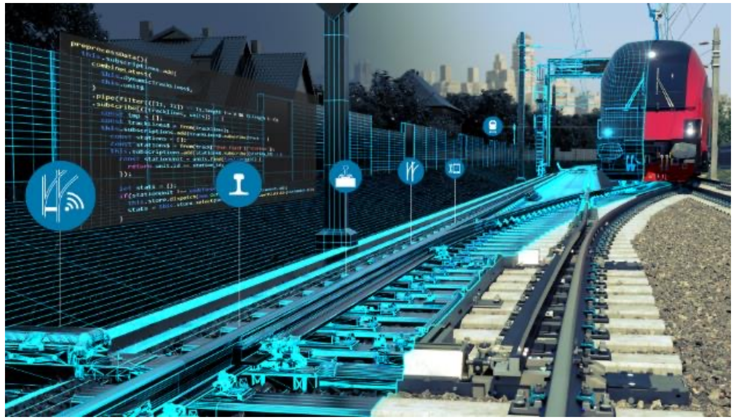
Capacity on rail tracks shall be made
more accessible through digital technologies

Where are we?

full system

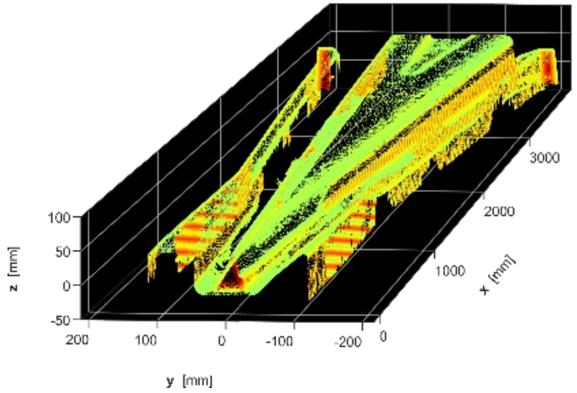

MBD Simulations
virtual vehicle
CHALMERS
vehicle
turnout layout
wheel profiles
[mm]
Initial track geometry
low speed
elastic track
vehicle dynamics
Switch blade
Crossing nose
wheel trajectories
wheel-rail interface data
Updated track geometry
Updated rail profiles
VTI Simulations
virtual vehicle
v
d
Rail
Sleeper stiffness distribution
Settlement (dz)
Phase 1
Phase 2
Phase 3
No. of cycles (N)
Rail damage Simulations
Profile change due to wear and plastic deformation
CHALMERS
Wedge Model
Switch Blade
Crossing nose
y, [mm]
z, [mm]

whole-system simulation



digital twin(s)

single component

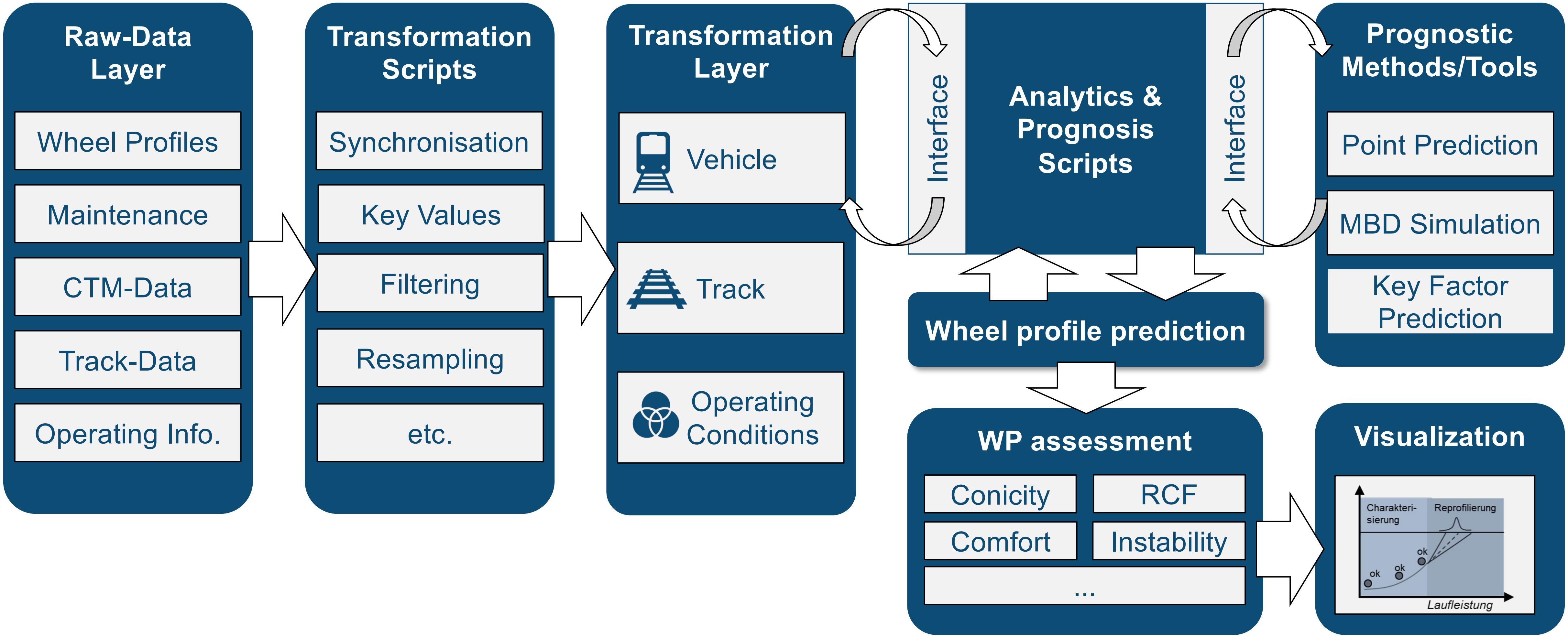


digital prototypes

descriptive analytics of specific assets

product development homologation operation

Where do we start?



Raw-Data Layer

- Wheel Profiles
- Maintenance
- CTM-Data
- Track-Data
- Operating Info.

Transformation Scripts

- Synchronisation
- Key Values
- Filtering
- Resampling
- etc.

Transformation Layer

- Vehicle
- Track
- Operating Conditions

Interface

Analytics & Prognosis Scripts

Interface

Prognostic Methods/Tools

- Point Prediction
- MBD Simulation
- Key Factor Prediction

Wheel profile prediction

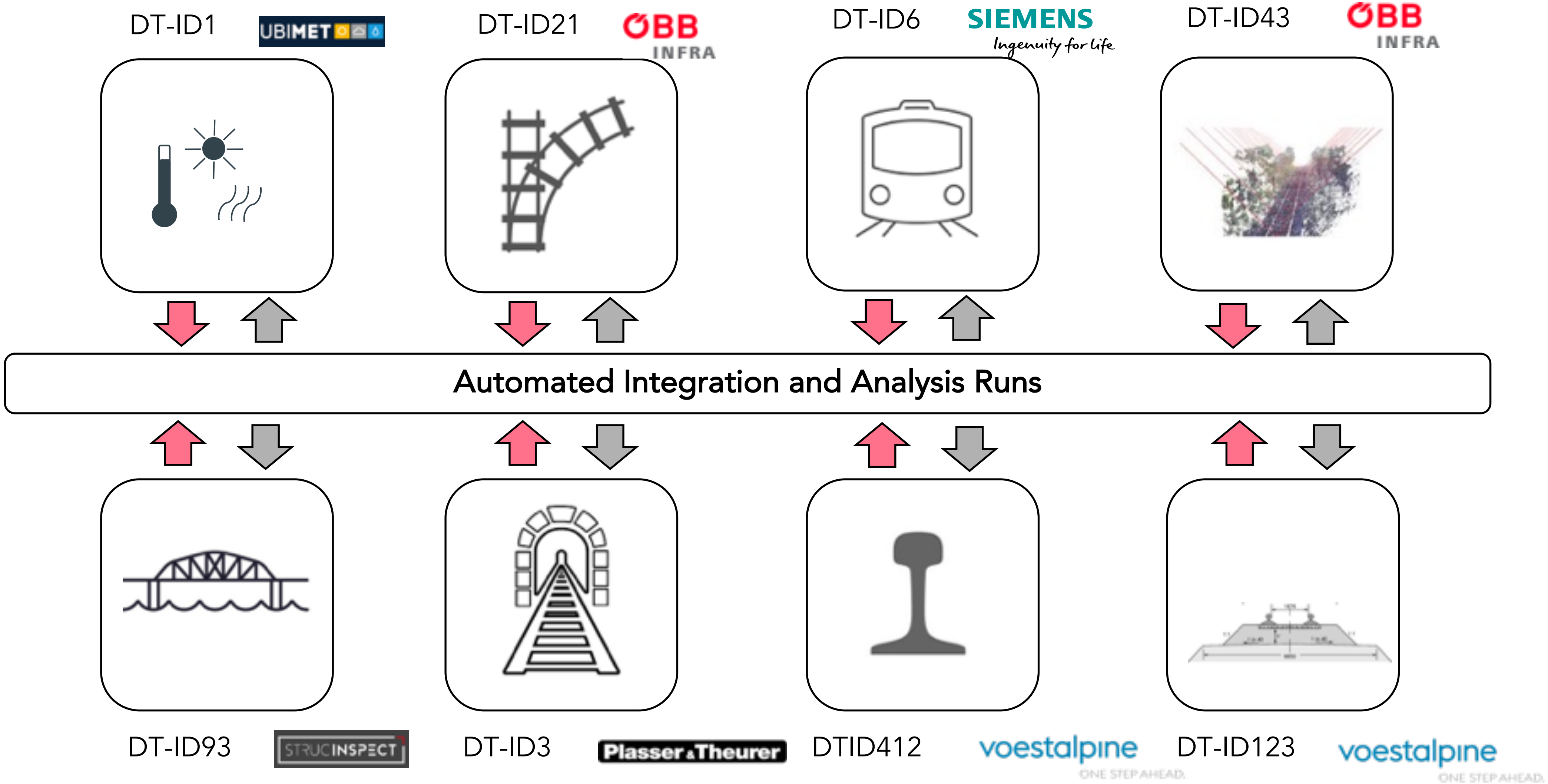
WP assessment

- Conicity
- RCF
- Comfort
- Instability
- ...

Visualization

Charakteri-sierung
Reprofilierung
ok
ok
ok
Laufleistung

Is this a way forward?



DT-ID1 UBIMET

DT-ID21 ÖBB INFRA

DT-ID6 SIEMENS Ingenuity for life

DT-ID43 ÖBB INFRA

Automated Integration and Analysis Runs

DT-ID93 STRUCINSPECT

DT-ID3 Plasser & Theurer

DTID412 voestalpine ONE STEP AHEAD.

DT-ID123 voestalpine ONE STEP AHEAD.

Federated Data Spaces Concept acc. IDS

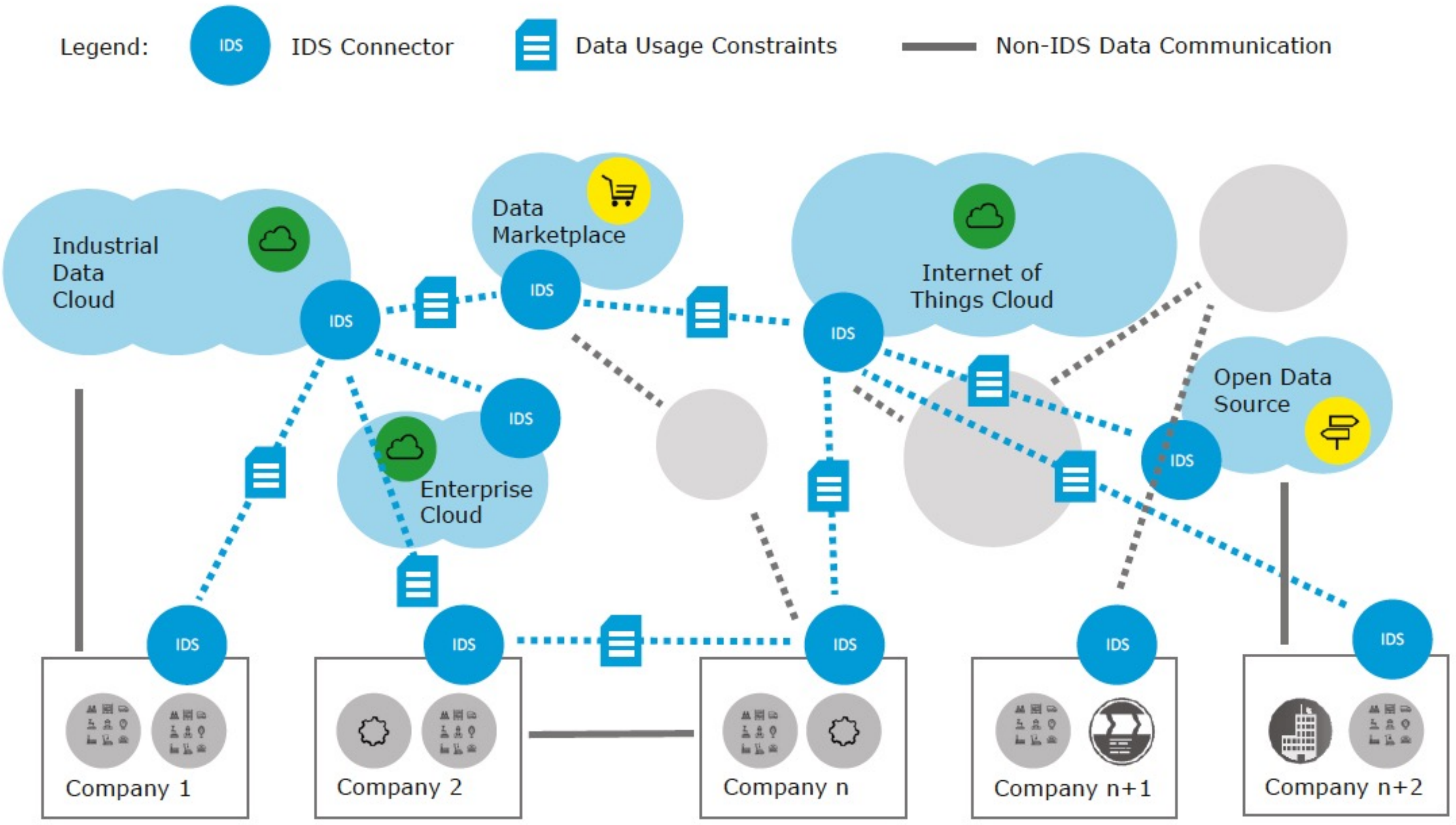
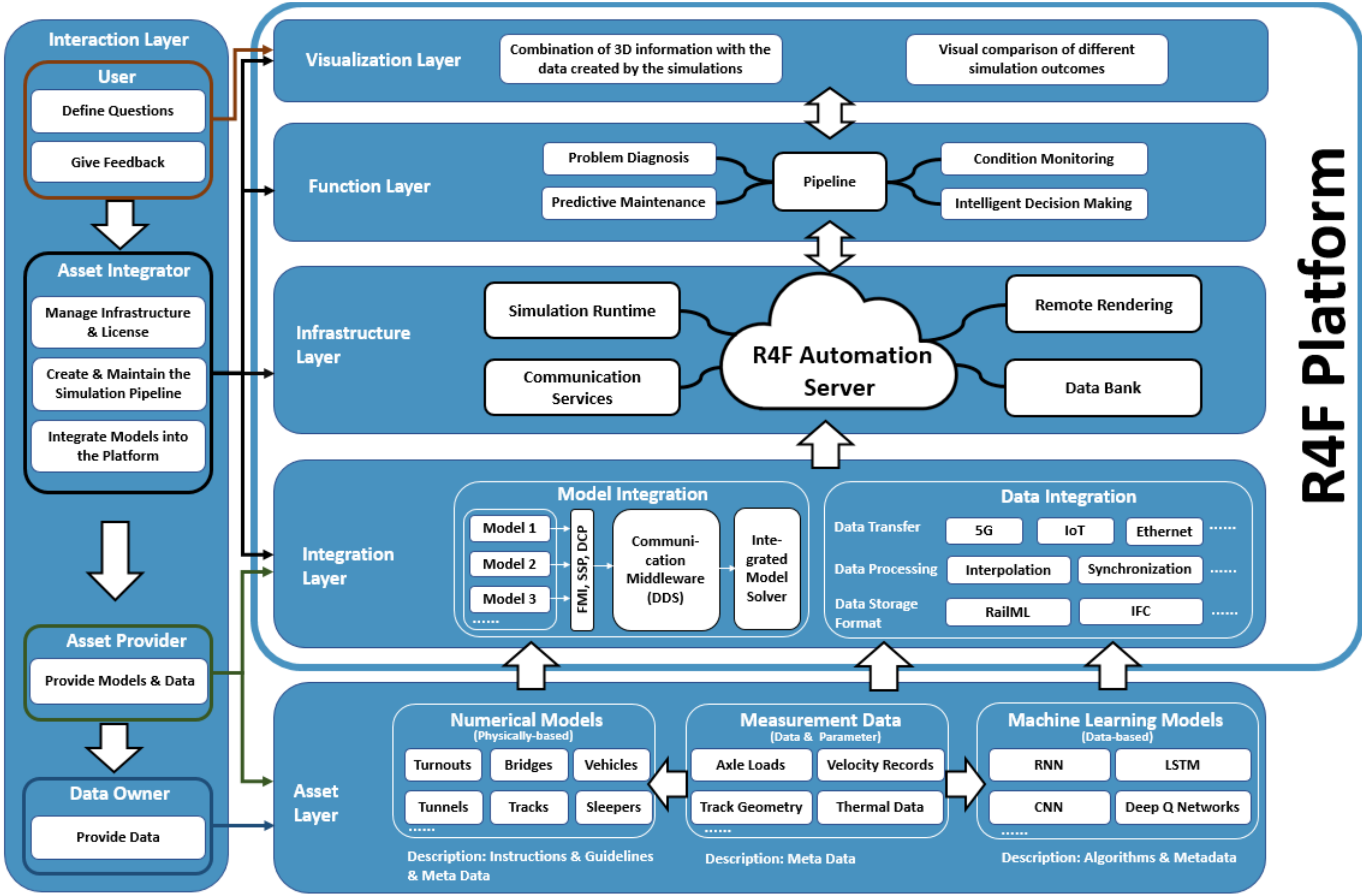

Legend:
IDS
IDS Connector
Data Usage Constraints
Non-IDS Data Communication
Industrial Data Cloud
Data Marketplace
Internet of Things Cloud
Open Data Source
Enterprise Cloud
IDS
Company 1
Company 2
Company n
Company n+1
Company n+2

Figure 2.6: International Data Spaces connecting different cloud platforms

(Data) collaboration across the entire value chain accelerates innovation towards a shared value proposition

Who does what and how?



Interaction Layer

User
- Define Questions
- Give Feedback

Asset Integrator
- Manage Infrastructure & License
- Create & Maintain the Simulation Pipeline
- Integrate Models into the Platform

Asset Provider
- Provide Models & Data

Data Owner
- Provide Data

R4F Platform

Visualization Layer
- Combination of 3D information with the data created by the simulations
- Visual comparison of different simulation outcomes

Function Layer
- Problem Diagnosis
- Predictive Maintenance
- Pipeline
- Condition Monitoring
- Intelligent Decision Making

Infrastructure Layer
- Simulation Runtime
- Communication Services
- R4F Automation Server
- Remote Rendering
- Data Bank

Integration Layer

Model Integration
- Model 1
- Model 2
- Model 3
- ......
- FMI, SSP, DCP
- Communi-cation Middleware (DDS)
- Inte-grated Model Solver

Data Integration
- Data Transfer: 5G, IoT, Ethernet ......
- Data Processing: Interpolation, Synchronization ......
- Data Storage Format: RailML, IFC ......

Asset Layer

Numerical Models (Physically-based)
- Turnouts, Bridges, Vehicles
- Tunnels, Tracks, Sleepers
- ......

Description: Instructions & Guidelines & Meta Data

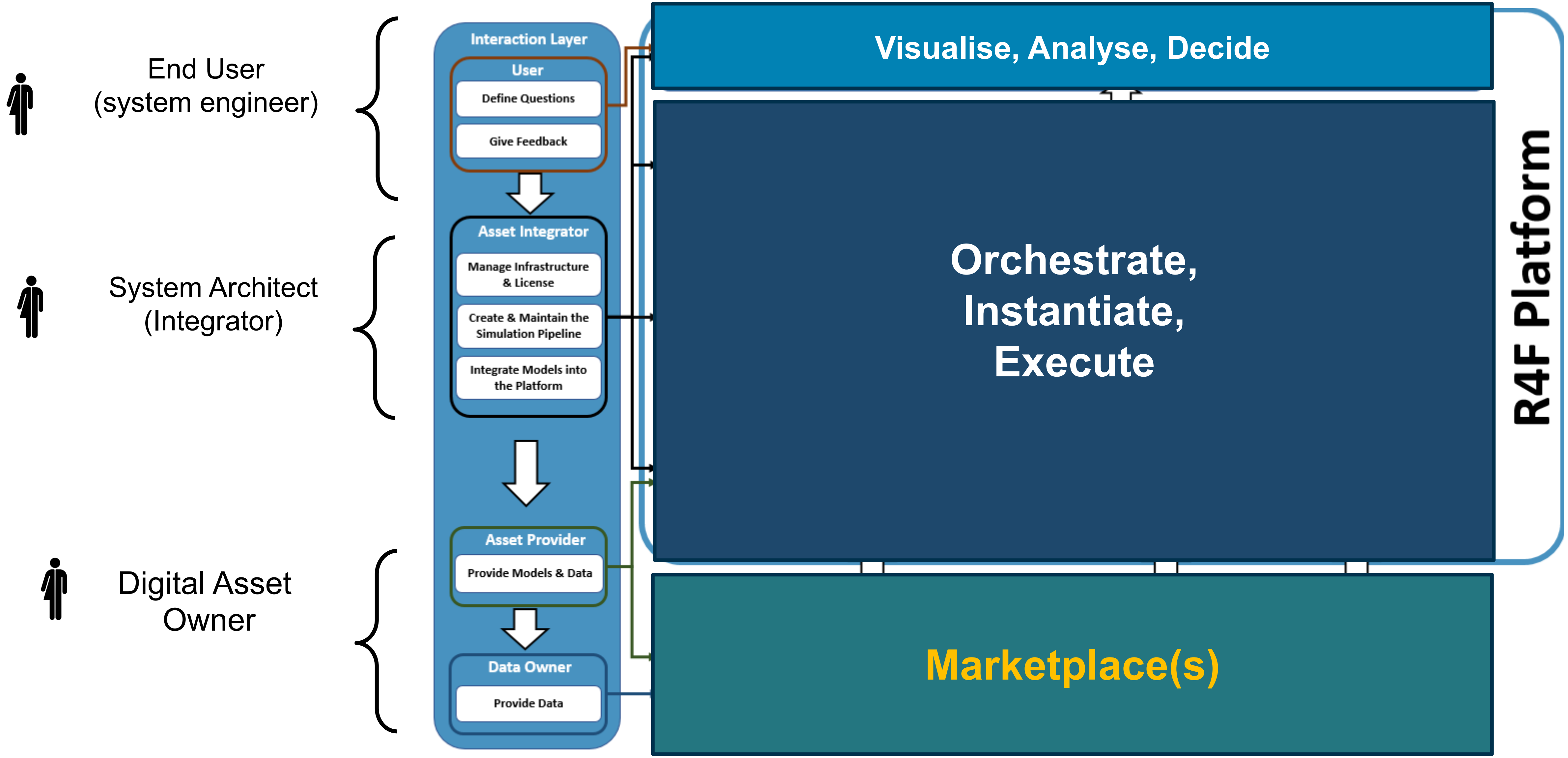
Measurement Data (Data & Parameter)
- Axle Loads, Velocity Records
- Track Geometry, Thermal Data
- ......

Description: Meta Data

Machine Learning Models (Data-based)
- RNN, LSTM
- CNN, Deep Q Networks
- ......

Description: Algorithms & Metadata

Who does what and how?


End User
(system engineer)
System Architect
(Integrator)
Digital Asset
Owner
Interaction Layer
User
Define Questions
Give Feedback
Asset Integrator
Manage Infrastructure & License
Create & Maintain the Simulation Pipeline
Integrate Models into the Platform
Asset Provider
Provide Models & Data
Data Owner
Provide Data
Visualise, Analyse, Decide
Orchestrate,
Instantiate,
Execute
Marketplace(s)
R4F Platform

Organizations attempting to collaborate are blocked by risk, lack of trust, and technical complexity.

57%

are citing intellectual property and sensitivity of data as top challenge

46%

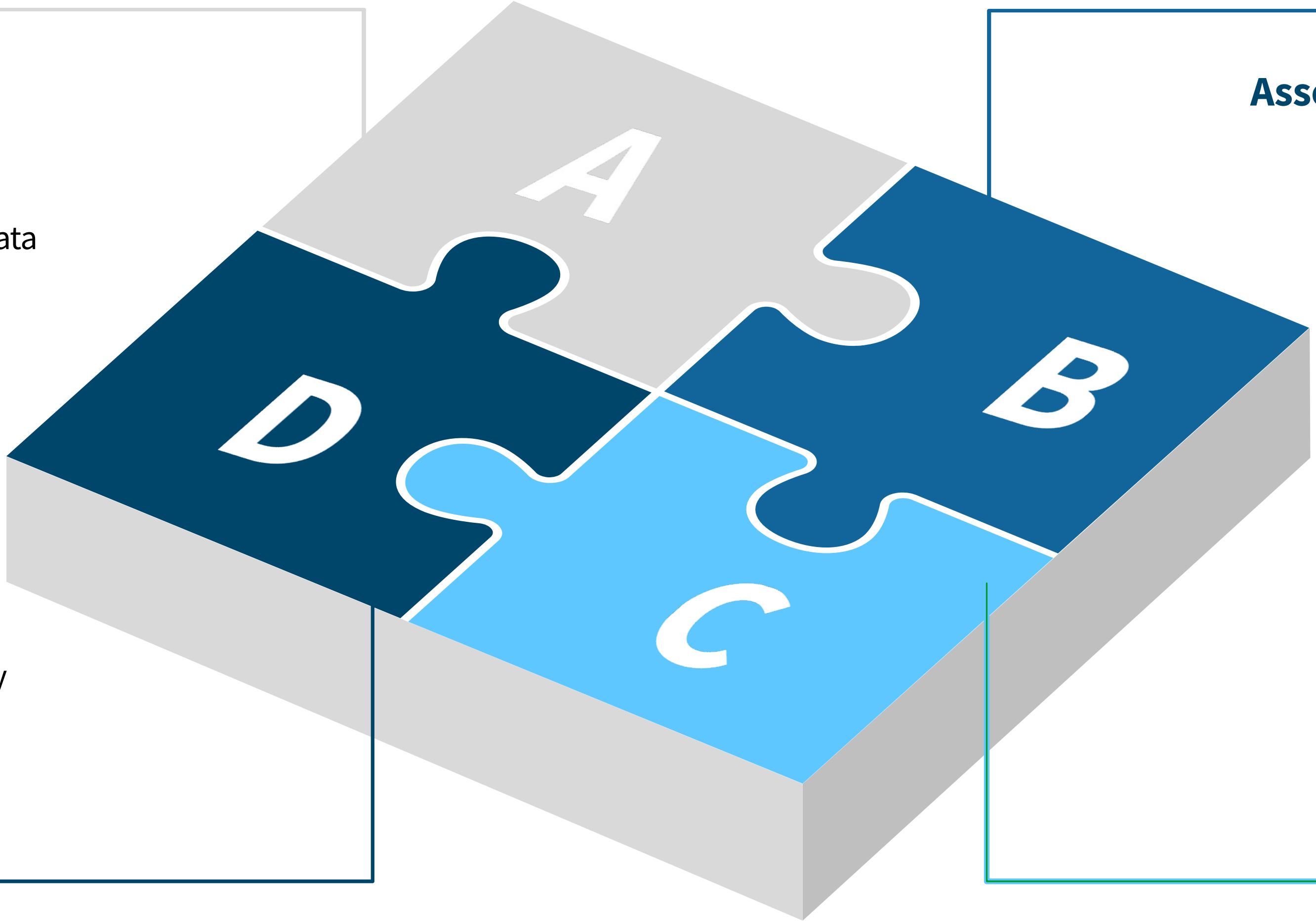
have a lack of trust in external data

50%+

see technological complexities as bottleneck

Source: Capgemini, "Data sharing masters: How smart organizations use data ecosystems to gain an unbeatable competitive edge", 2021

Core Elements of a Collaborative Eco System



Digital Assets

Digital Twins, Sensor data,
Algorithms, Scripts, ERP Data

Assets and Data Integration for exploration

Pull and transform
heterogenous data
into visible context and
valuable knowledge

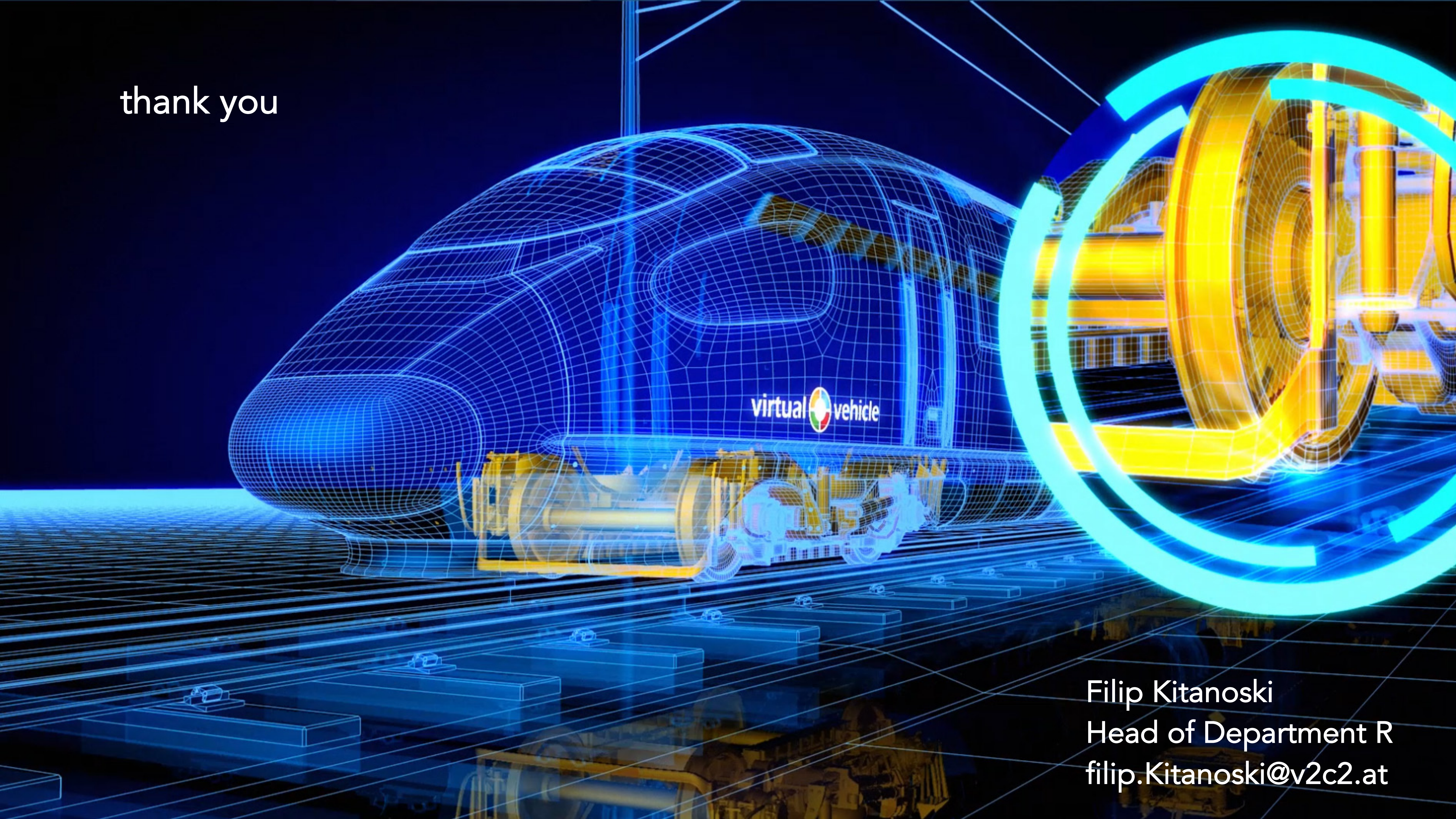
Digital Assets Governance

Deliver trusted and quality
digital assets in the right
format and time

Deployable Assets

Functional and executable tool
chain for analysis and prognosis

thank you


virtual vehicle

Filip Kitanoski
Head of Department R
filip.Kitanoski@v2c2.at