

# Digital Transformation in the Elevator Industry

## Moving from Physical Testing to Simulation

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Schindler Elevators - Digital Transformation - Modelling

MATLAB Expo, Bern

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**Schindler**

# Key Takeaways

Digital Transformation is a change management project

Reduction of the time for a Software Release Test (SRT) from 4 Weeks to 1 night

Model based approaches drive fact based development

“We elevate Digital Transformation – Globally – For everyone”



# Agenda

1. Schindler Elevator Ltd.
2. Goals and Challenges of Digital Transformation
3. EDEn – The Elevator Dynamics Environment
4. Garden of EDEn – The Power of MATLAB Web Apps
5. Hardware In the Loop – From Physical Testing to a Model Based Approach
6. Conclusion & Outlook

# Schindler Elevator Ltd.

Founded:

1874, in the city of Lucerne, Switzerland.

Headquarter:

Ebikon, canton of Lucerne, Switzerland.

Activities:

Schindler develops, manufactures, installs, maintains (services) and modernizes elevators, escalators, moving walks and transit management solutions for all kinds of application requirements e.g. from train stations and hospitals to commercial and residential buildings.

Locations:

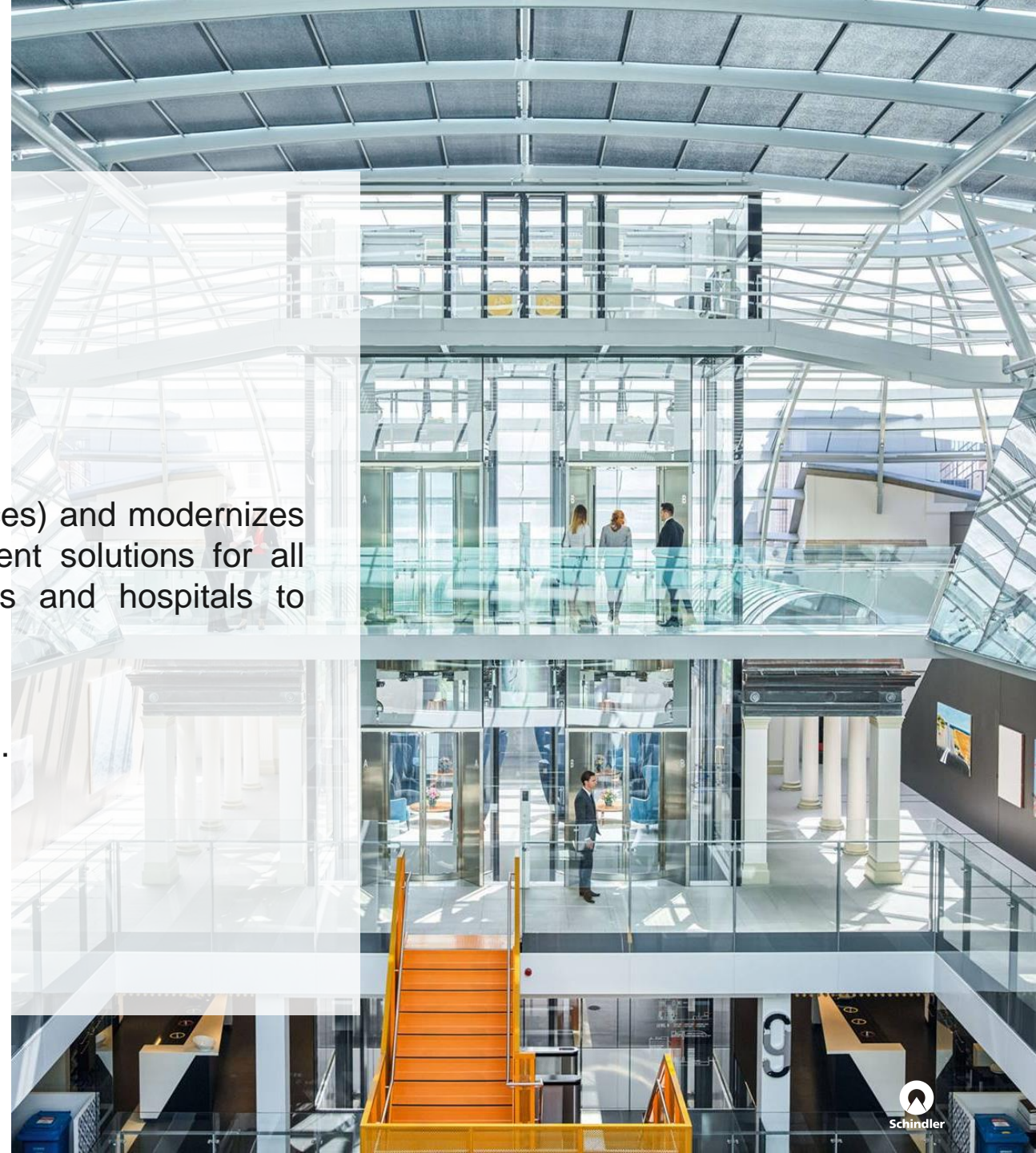
A network of more than 1,000 branches in over 100 countries.

Employees:

More than 64,000 (Dec. 2018).

Revenue:

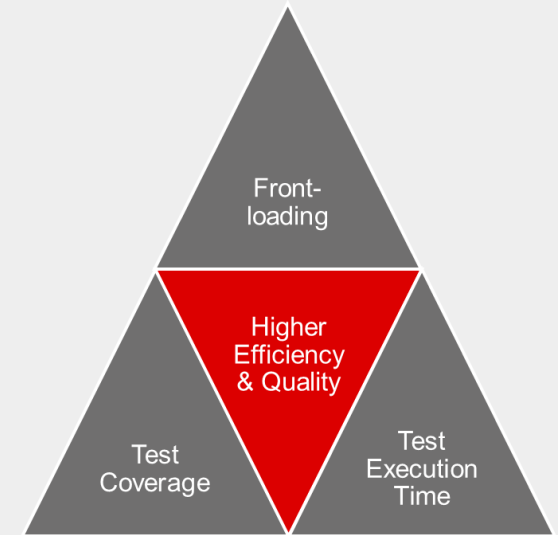
Group revenue CHF 10.879 billion in 2018



# Goals and Challenges of Digital Transformation

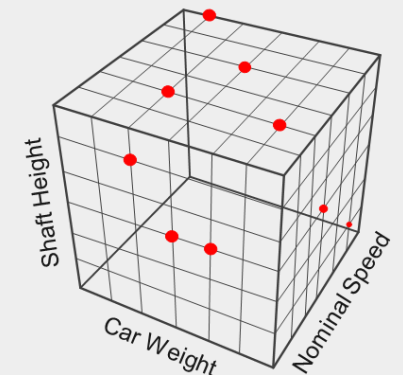
## Goals and Challenges

- Decrease the time and costs which are invested for physical testing (3200 hours in 2016 for software qualification tests in test towers)
- Elevator industry and certification is conservative
- Automated verification of different system configurations
  - ~ 20'000 independent system variants with hundreds of different component configurations
- Drive a model and fact based development process
  - Mindset of people and organizational structures



## Variant coverage

Current approach



# EDEn – The Elevator Dynamics Environment

## What it is

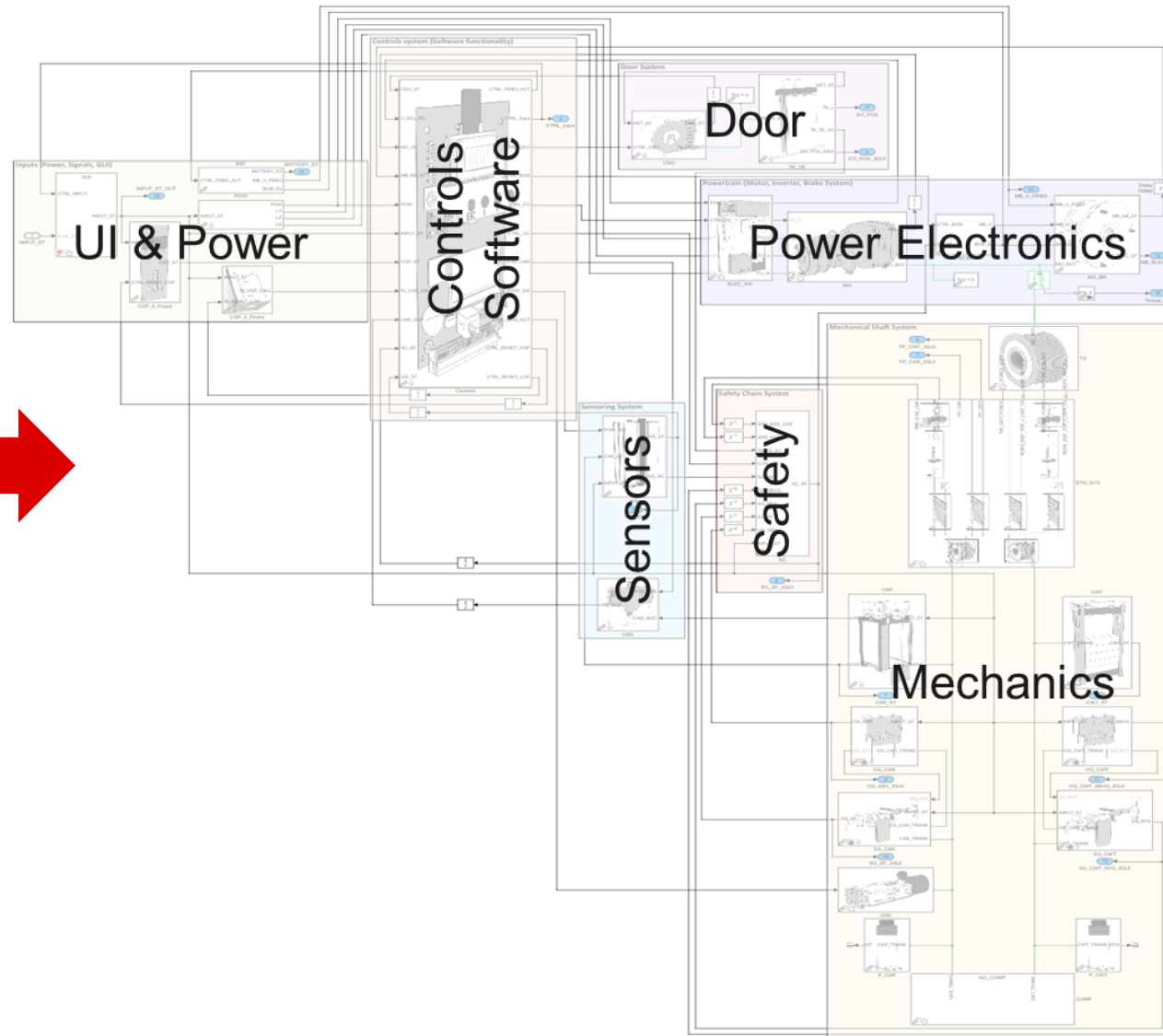
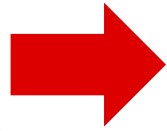
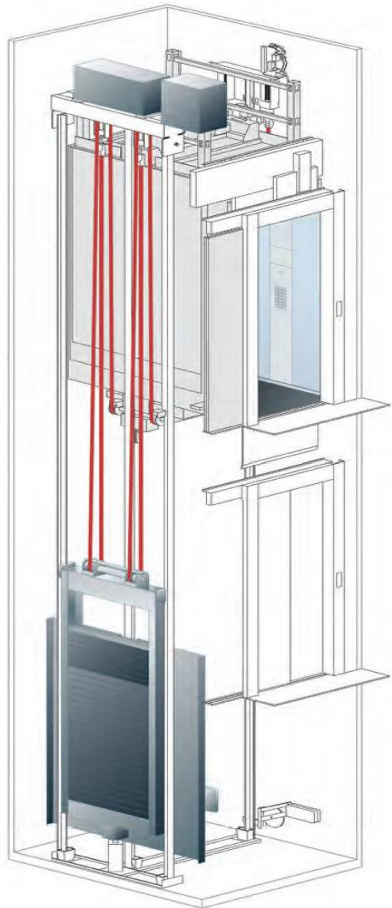
- EDEn as a pilot project  
Simulation of the physical behavior of elevator systems
- EDEn today  
Modeling and simulation framework for system-centric analysis and verification to support a holistic development of elevator products in an early stage
- EDEn is globally established  
Developed in Ebikon (CH) and India – used all over the world from internal customers in the engineering

## Project Setup

- *Project start*  
July 2017
- *Project team*  
4,5 people  
(Switzerland & India)
- *Development Process*  
SCRUM approach  
with 4 week sprints
- *Strong Collaboration with MathWorks*  
Training, Technical Support, Engineering, Development

# EDEn – The Elevator Dynamics Environment

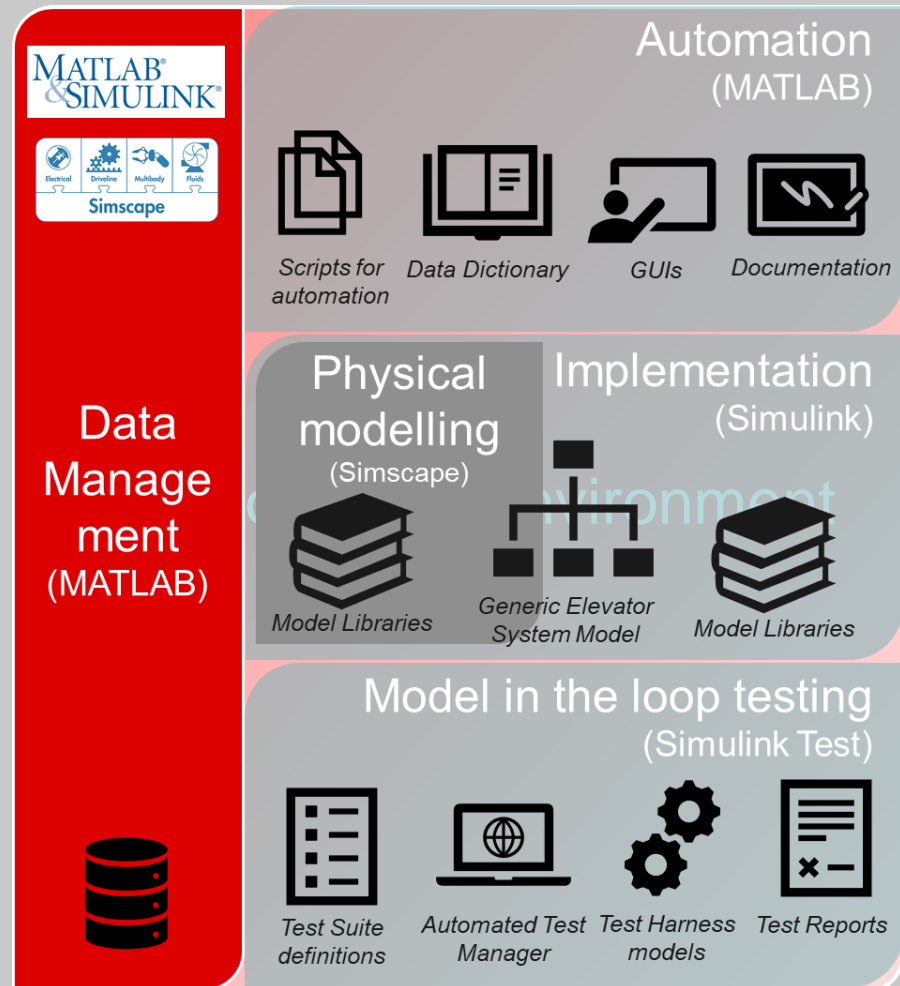
## The Model



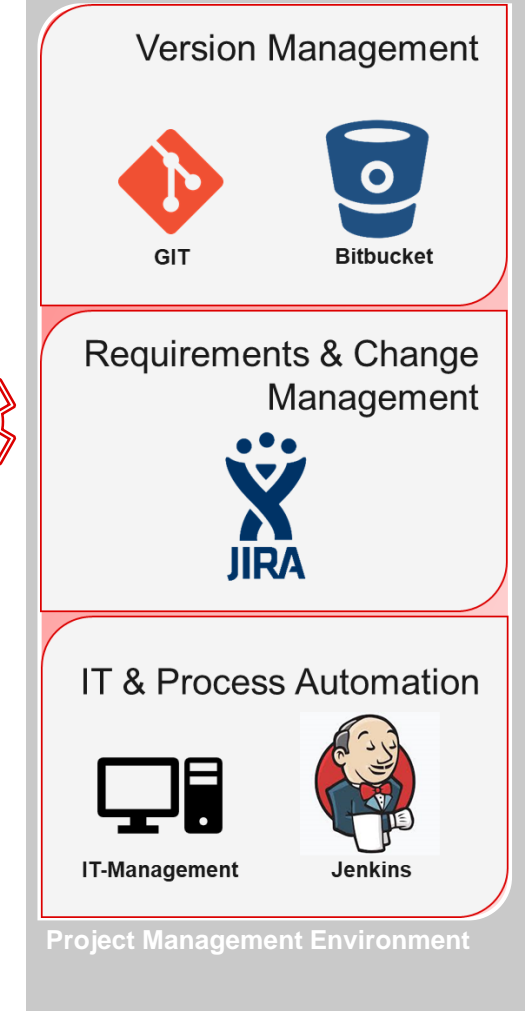
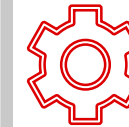
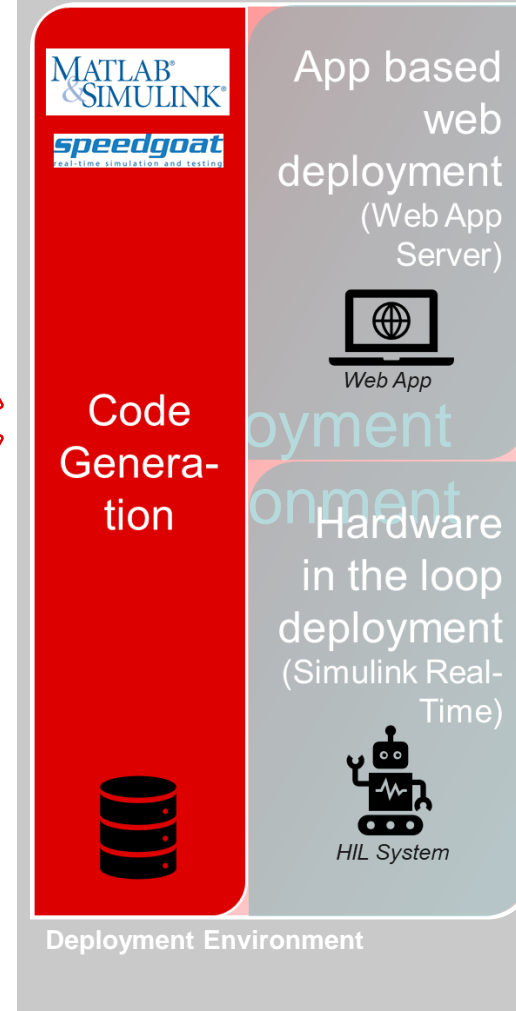
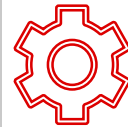
## Model Facts

- One generic System Model
- ~11'000 blocks
- ~1'500 physical signals
- Covers 60 different system architectures
- 350 parameter to configure an elevator system
- ~70'000 lines of code

# EDEn – The Elevator Dynamics Environment



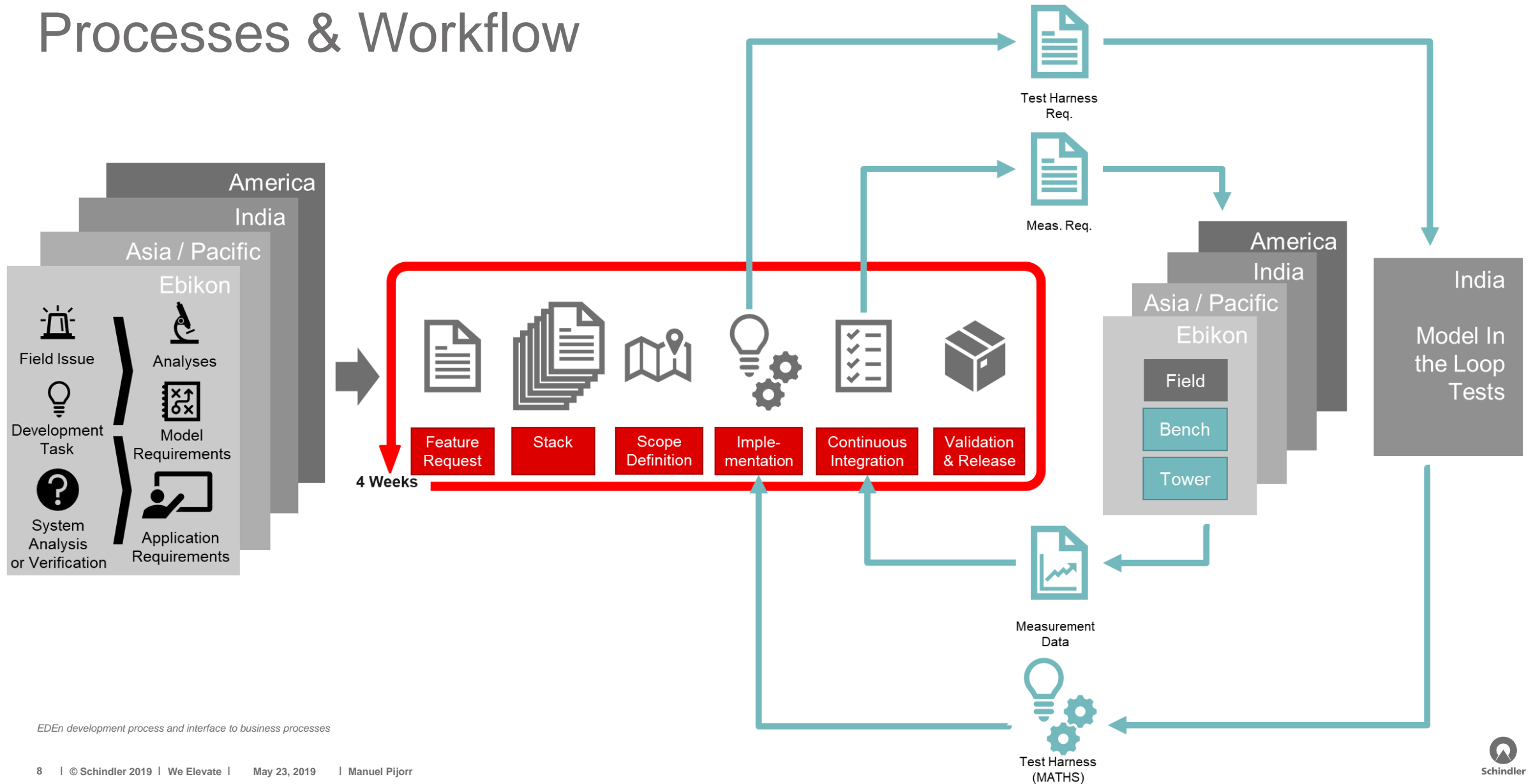
Development Environment





# EDEn – The Elevator Dynamics Environment

## Processes & Workflow



# Garden of EDEn – The Power of MATLAB Web Apps

- **Goal**
  - Enable the end-user to use EDEn and make system simulations with focus on his key issue
- **Solution**
  - Provide different view points on one generic system model (single source of truth) with different GUIs
  - Deployment of GUIs as applications which support & guide the handling of the model and the simulations
- **MATLAB Web Apps** empowers us to deploy Matlab applications so that they can be used inside our organization with an internet browser without any MATLAB license or installation

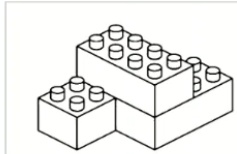
## Applications

- Today 8 applications supporting the whole simulation process
  - Simulation request and bug reporting
  - Configuration of elevator system
  - Definition of Simulation scenario
  - Simulation of different viewpoints
  - Reporting

# Garden of EDEn – The Power of MATLAB Web Apps

MATLAB Web Apps

Diagnostics



## Configuration Interface

by DT-M-MT

App to configure elevator systems and export the parameter file.

version 17.0



## Elevator System Simulation App

by DT-M-MT

Perform customized virtual elevator trips. There is even the possibility to conduct special operations such a...

version 17.0



## LBLC Interface

by DT-M-MT

An interface for importing configuration parameters from LBLC to EDEn apps.

version 17.0



## Load Factor App

by DT-M-MT

The Load Factor App simulates load cases and calculates all relevant load factors.

version 17.0



## PEBO App

by DT-M-MT

The PEBO app provides resulting evacuation distances and required battery charges for the pulsed...

version 17.0



## Rope Bouncing App

by DT-M-MT

The app simulates the car kinematics after inserting car load.

version 17.0



## Seismic Oscillation App

by DT-M-MT

Seismic oscillations of the magnetic band of SALSIS are simulated and the displacement of the lower...

version 17.0



## UCMP App

by DT-M-MT

Unintended car motion within the floor zone is detected and the maximum car displacement is...

version 17.0



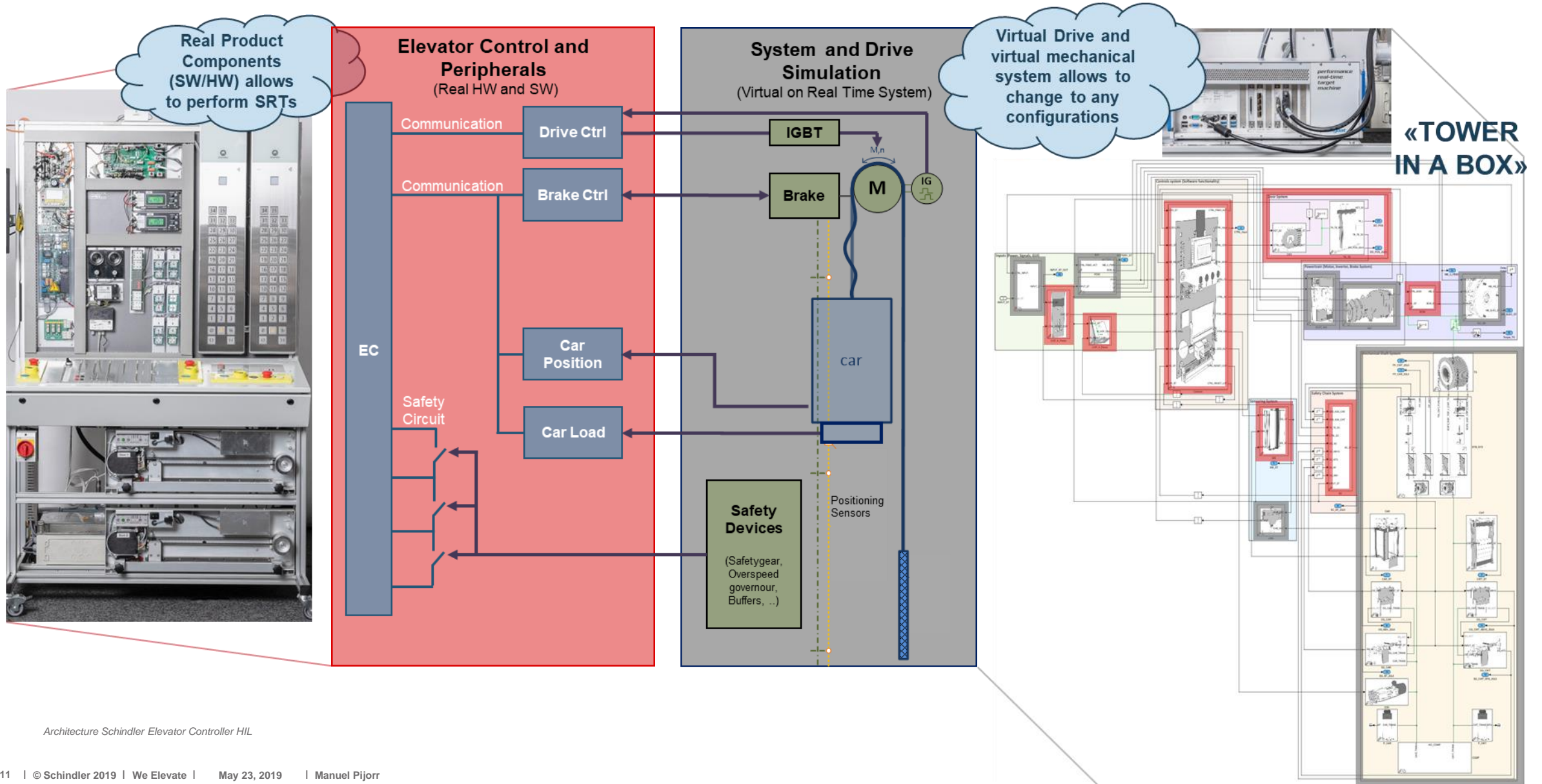
## Jira Interface

by DT-M-MT

Report feature requests and bugs to the development team. Track status of reported issues.

version 17.0

# HIL – From Physical Testing to a Model Based Approach



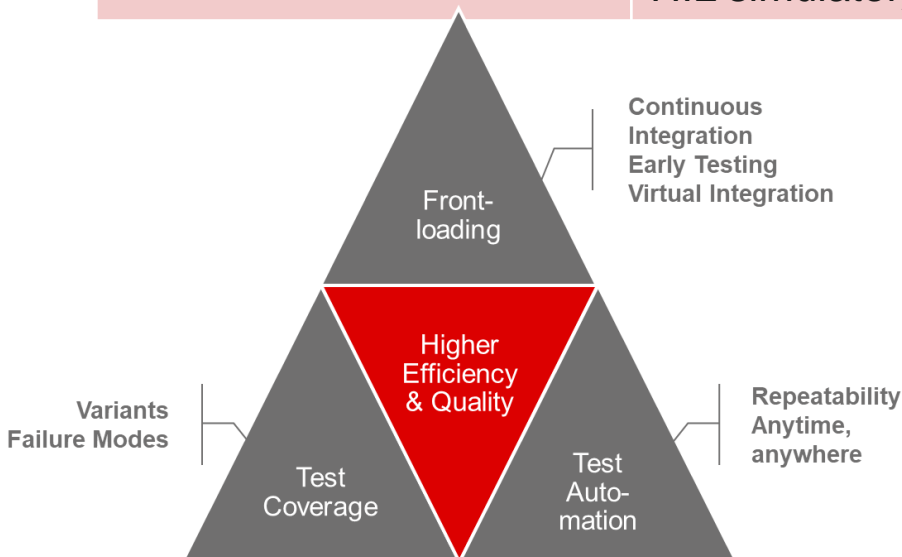
# HIL – From Physical Testing to a Model Based Approach

Ressources	Elevator Controller HIL	Test tower testing
Infrastructure	1 HIL test bench	1 Test Tower installation 2 people (test engineer, fitter)
One example of SRT task: "Safety Gear Acceptance Test"	90 s	2 – 6h
Cost <small>Conclusion for Safety Gear test</small>	70'000 CHF (investment for HIL simulator)	x times 45'000 CHF (material + installation of x Elevators)

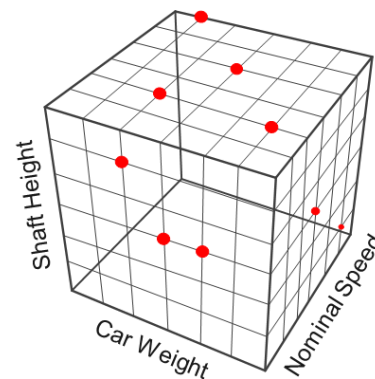
## Benefits with EC-HIL

- Increased variant coverage
- Earlier system integration
- Less real test tower installation needed
- Virtual Enhanced test execution
- Faster software releases
- Boundary tests

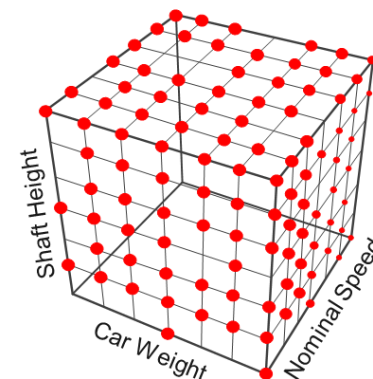
## Variant coverage



Current approach



HIL approach



# Conclusion

Digital Transformation  
as a change  
management project  
Best practice projects  
and benefit of model  
based processes

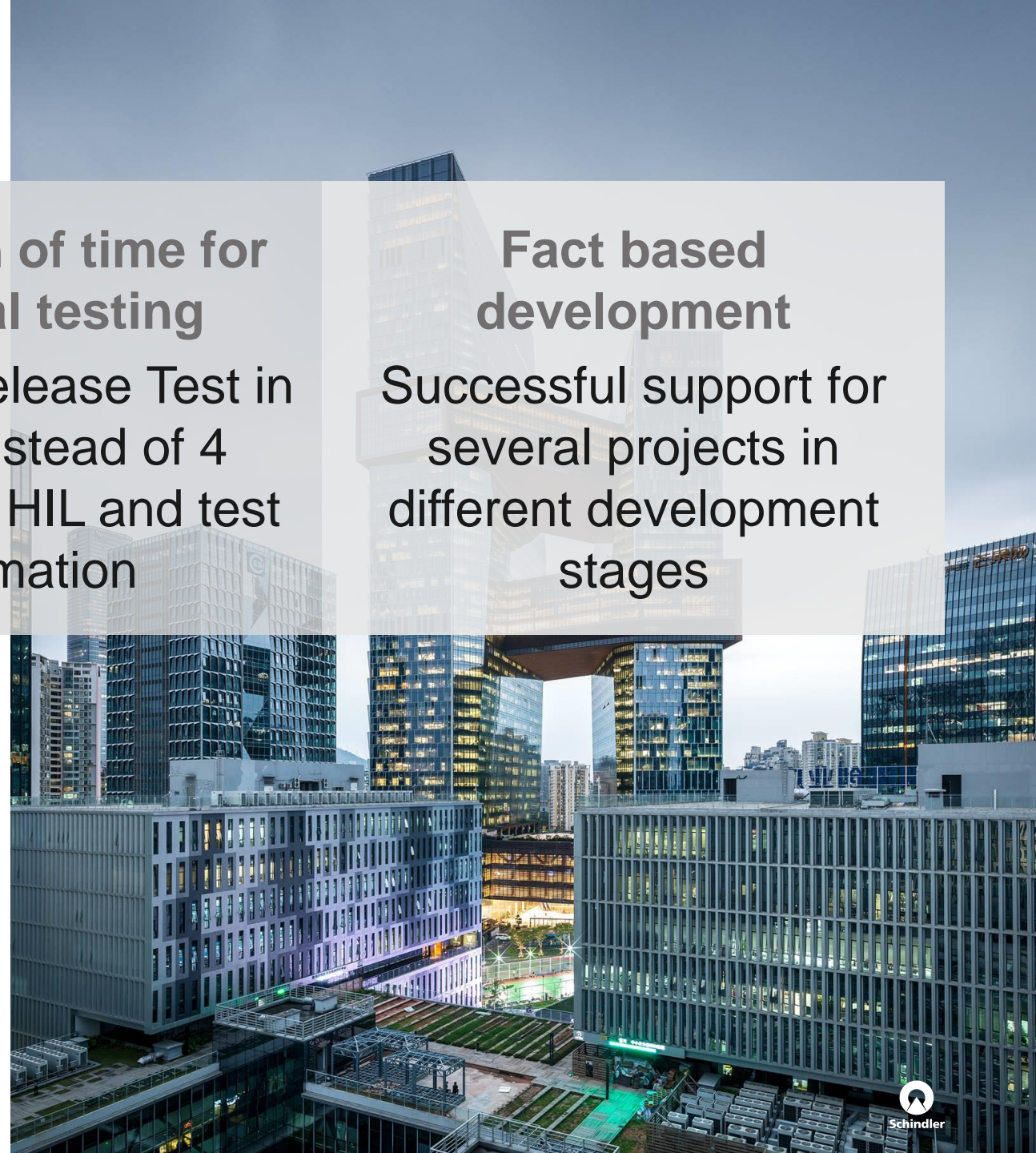
Reduction of time for  
physical testing  
Software Release Test in  
1 night instead of 4  
weeks with HIL and test  
automation

Fact based  
development  
Successful support for  
several projects in  
different development  
stages

# Outlook

- Controller HIL deployment to international sites
- Fully automated simulation process with Web apps
- Further model validation

“We elevate Digital Transformation –  
Globally – For everyone”



# Q&A

## Thanks for your attention!

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