ESG

2021 NATO MODELLING AND SIMULATION
GROUP SYMPOSIUM

Simulation-Based Decision Support for the
Logistic System of the German Armed Forces

OUR SOLUTIONS AND SERVICES

AIRCRAFT SYSTEMS

HELICOPTER SYSTEMS

cUAS-SYSTEMS & UAS

SIMULATION & TRAINING

MARITIME SOLUTIONS

LAND SYSTEMS

C4ISTAR

SYSTEMS INTEGRATION
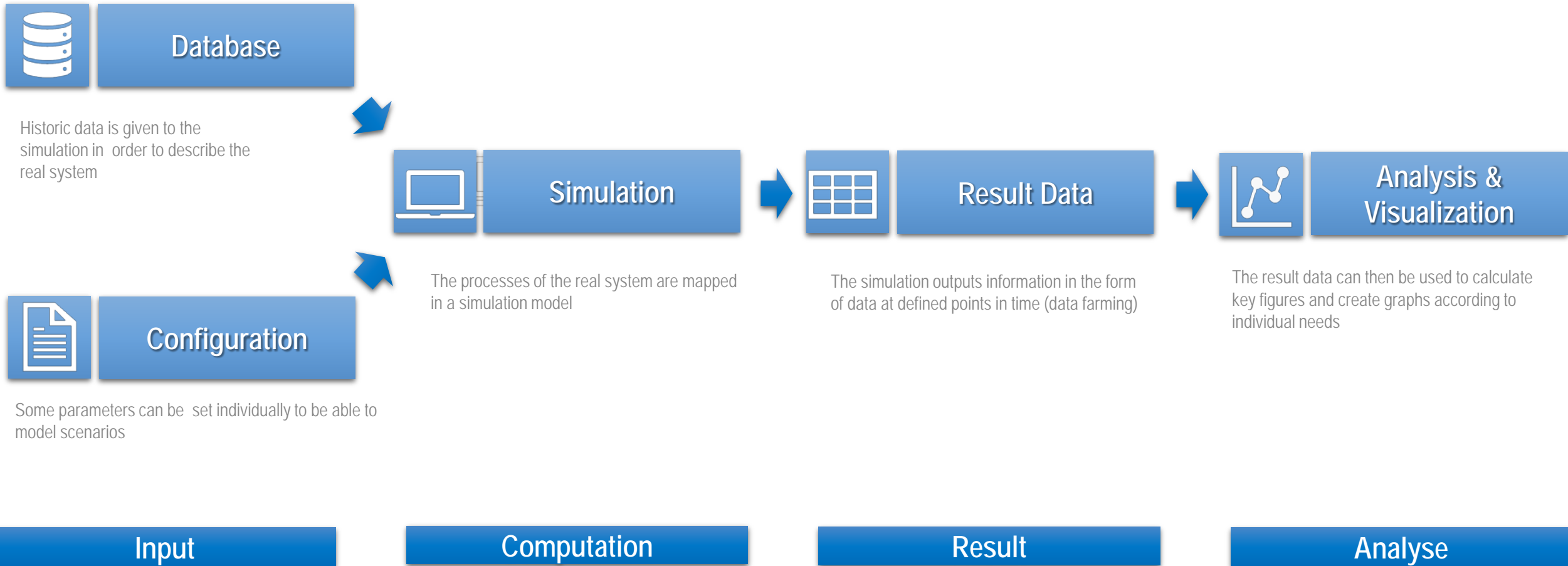

LOGISTICS

MEDICAL SERVICES

ESG DEFENCE + PUBLIC SECURITY

SIMULATION-BASED DECISION SUPPORT
IN THEORY

SIMULATION-BASED DECISION SUPPORT
SYSTEM ARCHITECTURE - PROCEDURE OF SIMULATION

Database

Historic data is given to the simulation in order to describe the real system

Configuration

Some parameters can be set individually to be able to model scenarios

Simulation

The processes of the real system are mapped in a simulation model

Result Data

The simulation outputs information in the form of data at defined points in time (data farming)

Analysis & Visualization

The result data can then be used to calculate key figures and create graphs according to individual needs

Input

**Computation**

Result

Analyse

OPEN

SIMULATION-BASED DECISION SUPPORT
SUPPLY CHAIN ANALYSIS & SIMULATION

What do we do?

» **Tool-supported** evaluation of logistical processes along the supply chain with discrete event simulation

» **Forecasts and simulations** of future events based on specific questions in order to automatically identify bottlenecks in the supply chain

How do we ensure the right data?

» **Data quantity:** Potential lack of data → modelling via dummy data

» **Data quality:** Inconsistency and logical mistakes

» **Inaccurate data:** Roughly valuation of impact based on inaccurate data

» **Statistical analysis:** e.g. failure performance pro location

SUPPLY CHAIN ANALYSIS

CHALLENGE

DATA   PROCESSES

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PUBLIC SECURITY
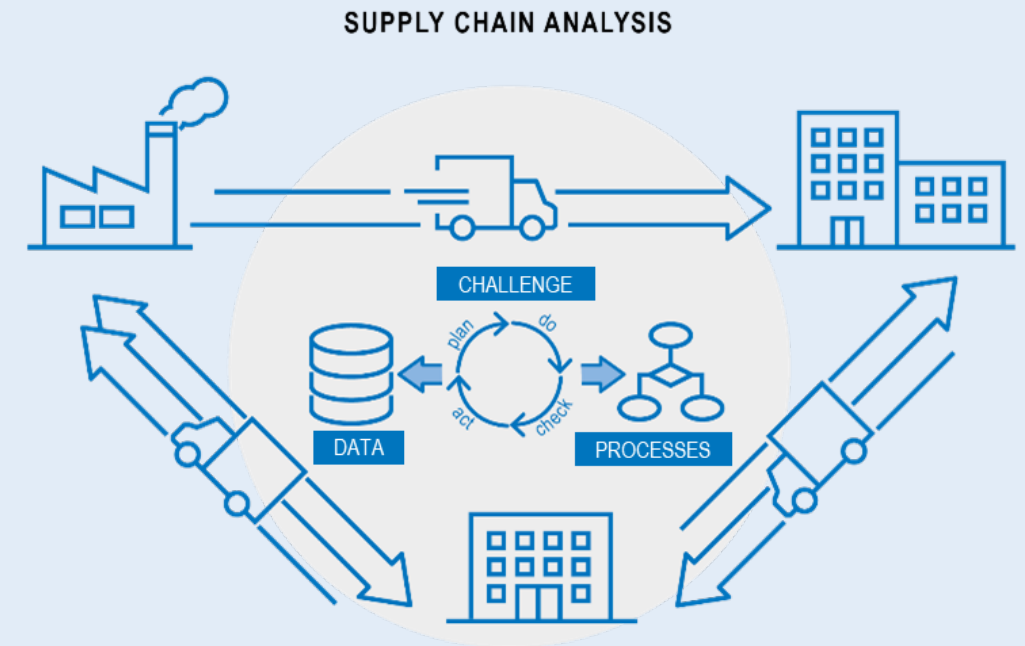
SIMULATION-BASED DECISION SUPPORT
PROJECTS FOR THE LOGISTIC SYSTEM OF THE GERMAN ARMED FORCES

SIMULATION-BASED DECISION SUPPORT
PROJECTS

Simulation-based capacity and systems management for **LEOPARD**

» How many devices/capabilities do I need to cover the need end to end?

Predictive ability of weapon system **EUROFIGHTER**

» What are the effects of change in maintenance capacities for spare part supply, delivery times, staff etc.?

Simulation for **military medical support**: from role 1 to 3

» When & under which conditions the rescue chain is reaching its capacity limit in terms of the potentially emerging requirements?

SIMULATION-BASED CAPACITY AND
SYSTEMS MANAGEMENT FOR LEOPARD

SIMULATION-BASED CAPACITY AND SYSTEMS MANAGEMENT FOR LEOPARD

Purpose of the study

» System for availability management of complex technical systems

» It must be investigated whether the required military equipment is available in operational condition for the case and time of activation

General conditions

» **Initial situation:** Concrete requirements/ capabilities with defined device, time, location (Maintenance, Exercise operations, Transports, Staff, …)

» **Time planning:** Allocation of concrete equipment (mobility carrier with assigned capability) taking into account relevant framework conditions (plannable maintenance, transports, etc.)

» **Execution of simulations:** Rolling out the concrete scenario, with additional consideration of system failures/consumption, fluctuations/intensities etc.

Example of annual planning

Maintenance, predictable   Need   Transport

Maintenance, unpredictable

SIMULATION-BASED CAPACITY AND SYSTEMS MANAGEMENT FOR LEOPARD

Data analysis

» Even if unscheduled maintenance, transports and handovers are disregarded, availability falls short of 70% on around 90 days a year

» Given requirements cannot be adequately met with the given quantity of equipment

Simulation

» Implementation of a capacity and systems management significantly improves the percentage of demand coverage with an increase in transportation effort

» More equipment in the system increases predictable maintenance efforts and demand coverage
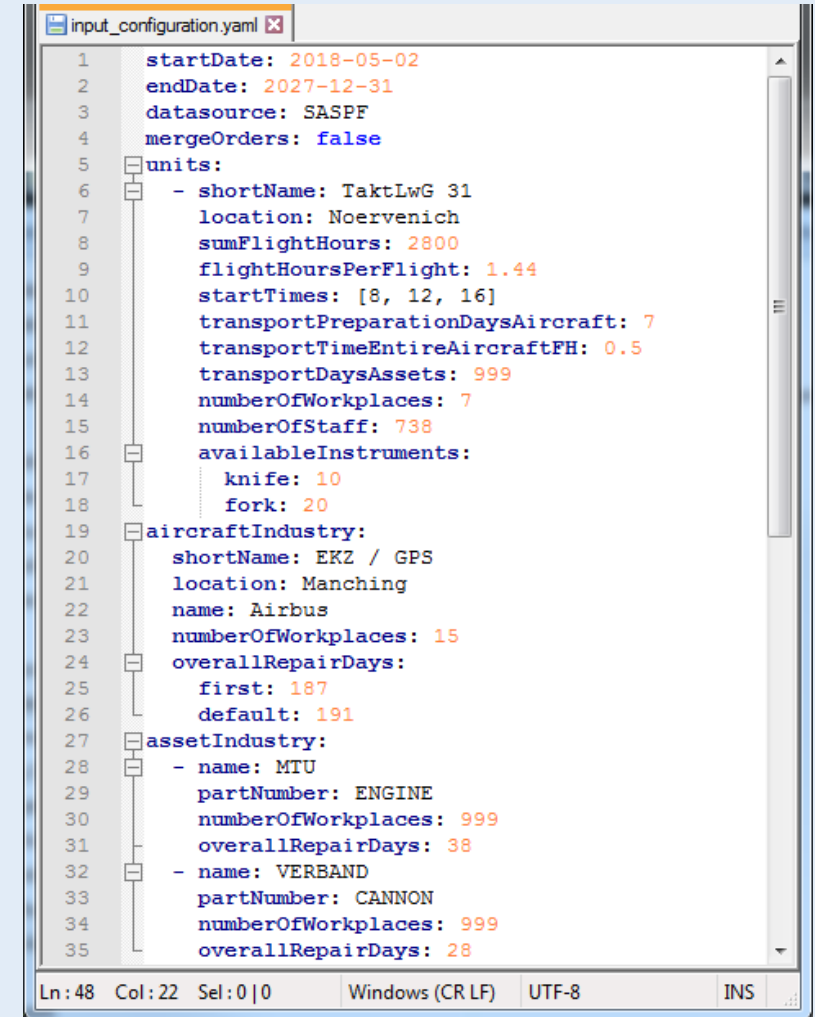
PREDICTIVE ABILITY OF
WEAPON SYSTEM
EUROFIGHTER

PREDICTIVE ABILITY OF WEAPON SYSTEM EUROFIGHTER

Purpose of the study

» Development of a "blueprint" for the future demanded prognosis capability for the control of utilization processes for the flying weapon systems

» Development of first recommendations for the improvement of the material operational capability as well as the material operational readiness of the WaSys EUROFIGHTER

General conditions

» **Model** (operation and maintenance): Concept to executable model incl. PM engine

» **Data** (data quality): Criteria such as data management, inconsistency, accuracy, completeness

» **Analysis** (derivation of input parameters for simulation on targeted issues such as failure behavior, failure rates etc.): Unplanned failures (MTBF) + maintenance schedules + personnel etc.

```yaml
input_configuration.yaml
1    startDate: 2018-05-02
2    endDate: 2027-12-31
3    datasource: SASPF
4    mergeOrders: false
5    units:
6      - shortName: TaktLwG 31
7        location: Noervenich
8        sumFlightHours: 2800
9        flightHoursPerFlight: 1.44
10       startTimes: [8, 12, 16]
11       transportPreparationDaysAircraft: 7
12       transportTimeEntireAircraftFH: 0.5
13       transportDaysAssets: 999
14       numberOfWorkplaces: 7
15       numberOfStaff: 738
16       availableInstruments:
17         knife: 10
18         fork: 20
19   aircraftIndustry:
20     shortName: EKZ / GPS
21     location: Manching
22     name: Airbus
23     numberOfWorkplaces: 15
24     overallRepairDays:
25       first: 187
26       default: 191
27   assetIndustry:
28     - name: MTU
29       partNumber: ENGINE
30       numberOfWorkplaces: 999
31       overallRepairDays: 38
32     - name: VERBAND
33       partNumber: CANNON
34       numberOfWorkplaces: 999
35       overallRepairDays: 28
```
Ln : 48   Col : 22   Sel : 0 | 0   Windows (CR LF)   UTF-8   INS

PREDICTIVE ABILITY OF WEAPON SYSTEM
EUROFIGHTER

What is the impact of a change in maintenance capacity in terms of:

» Parts supply, Circulating reserve, maximum stock level, reorder level, safety stock level

» Delivery & transport times

» Personnel (number, level of training), Organization (single shift/two shift operation, etc.)

» Tools & Infrastructure

What is the impact of merging

plannable operations?
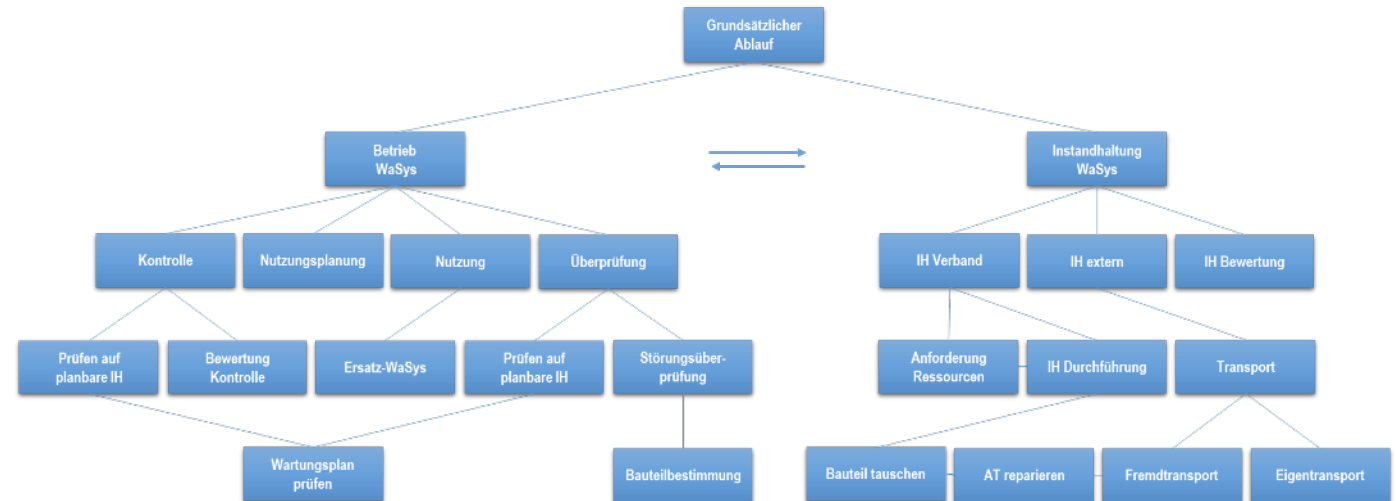
PREDICTIVE ABILITY OF WEAPON SYSTEM
EUROFIGHTER

Simulation & Data Results

» Repair in industry has a major impact → improving technical stability of system by increasing the inspection intervals

» Docking places in the unit must not fall below a special limit

» Input parameters influence each other, e.g. dock places - personnel capacities

» Centralized data storage & maintenance required (in SASPF/BI) & full access capabilities

FH-Vorrat vs. Lfz in EKZ

Lfz_EB

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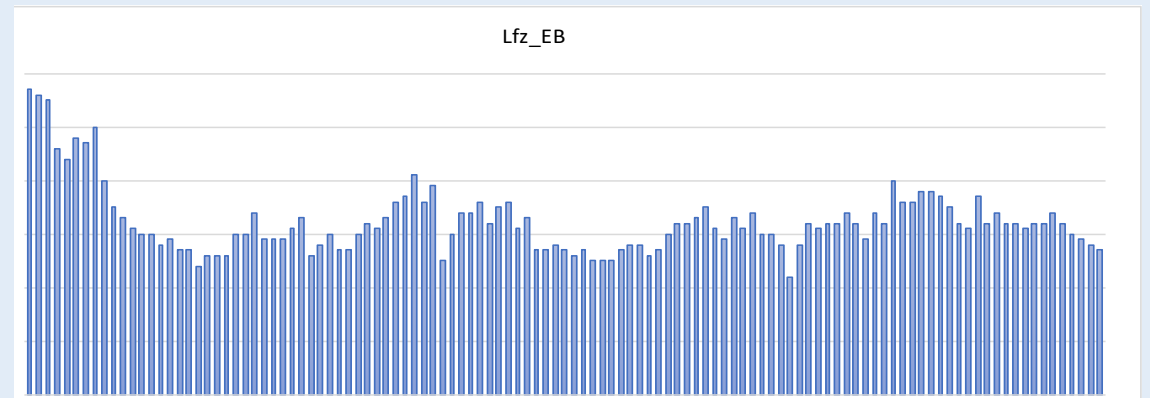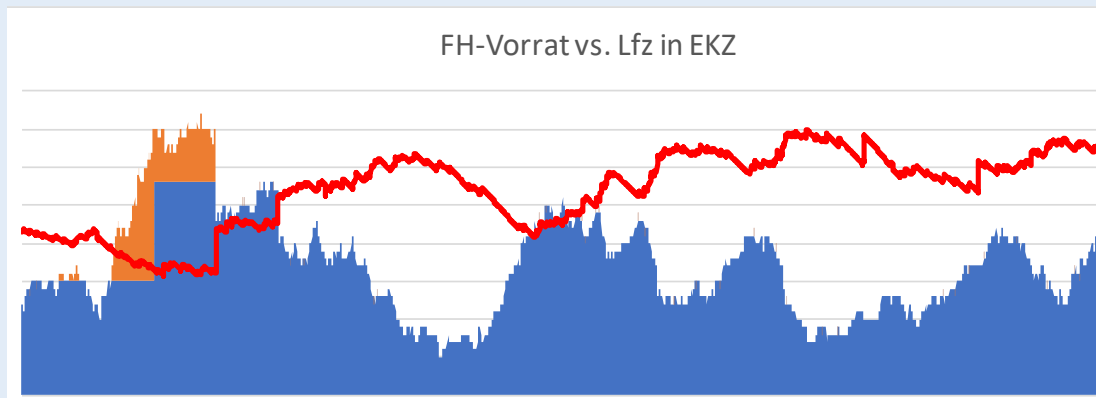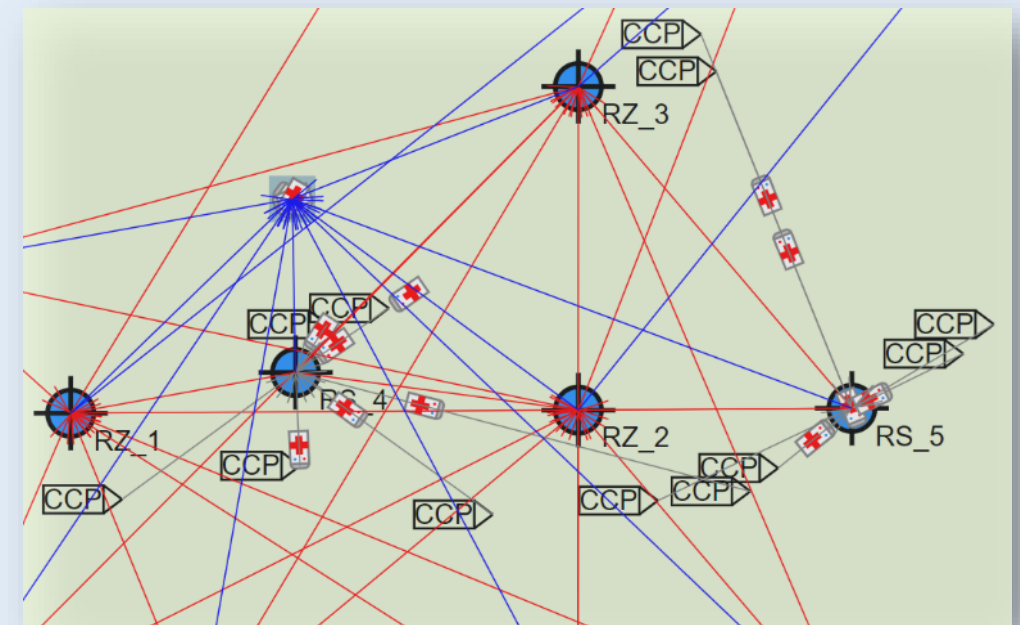
SIMULATION FOR
MILITARY MEDICAL SUPPORT

SIMULATION FOR
MILITARY MEDICAL SUPPORT

Purpose of the study

» Provide an orientation guide and a **collection point for future investigations of** the assessment of required qualitative and quantitative **capabilities in the further development of the concept of principles for Medical Support** of the Bundeswehr in Operations.

Documents & Regulations

» MC 326/3 NATO Principles and Policies of Medical Support

» AJP-4.10 B, STANAG 2228 Med, STANAG 2546

» Guideline for Simulation-Based Analysis (Bundeswehr)

» Guide to model documentation (Bundeswehr)

» National basic documents (e.g. concepts, handbooks)

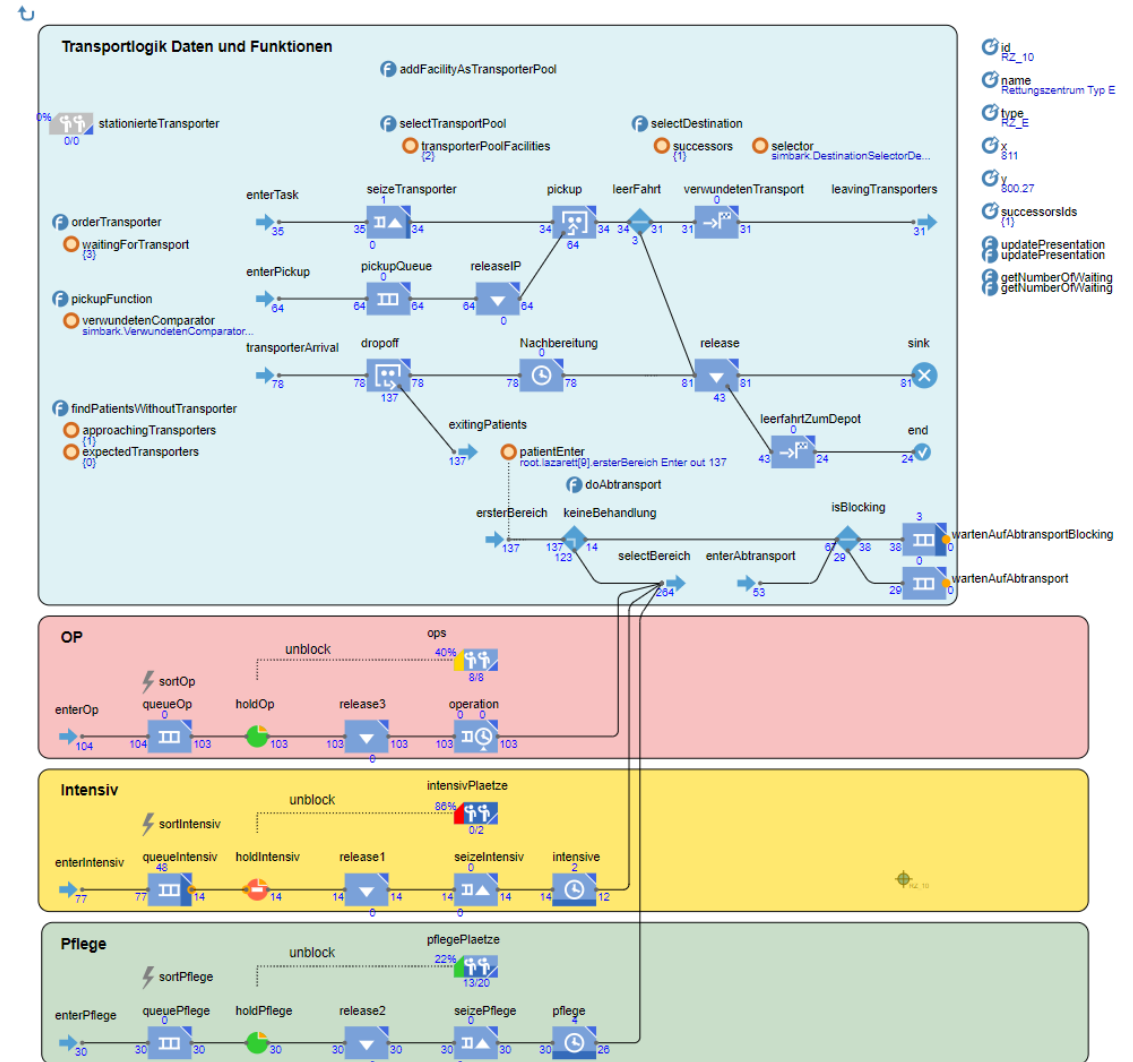# SIMULATION FOR **MILITARY MEDICAL SUPPORT** - IMPLEMENTATION

Flow Chart

» Transport logic

» Surgery logic

» Intensive care

» Normal care

Patient status diagram
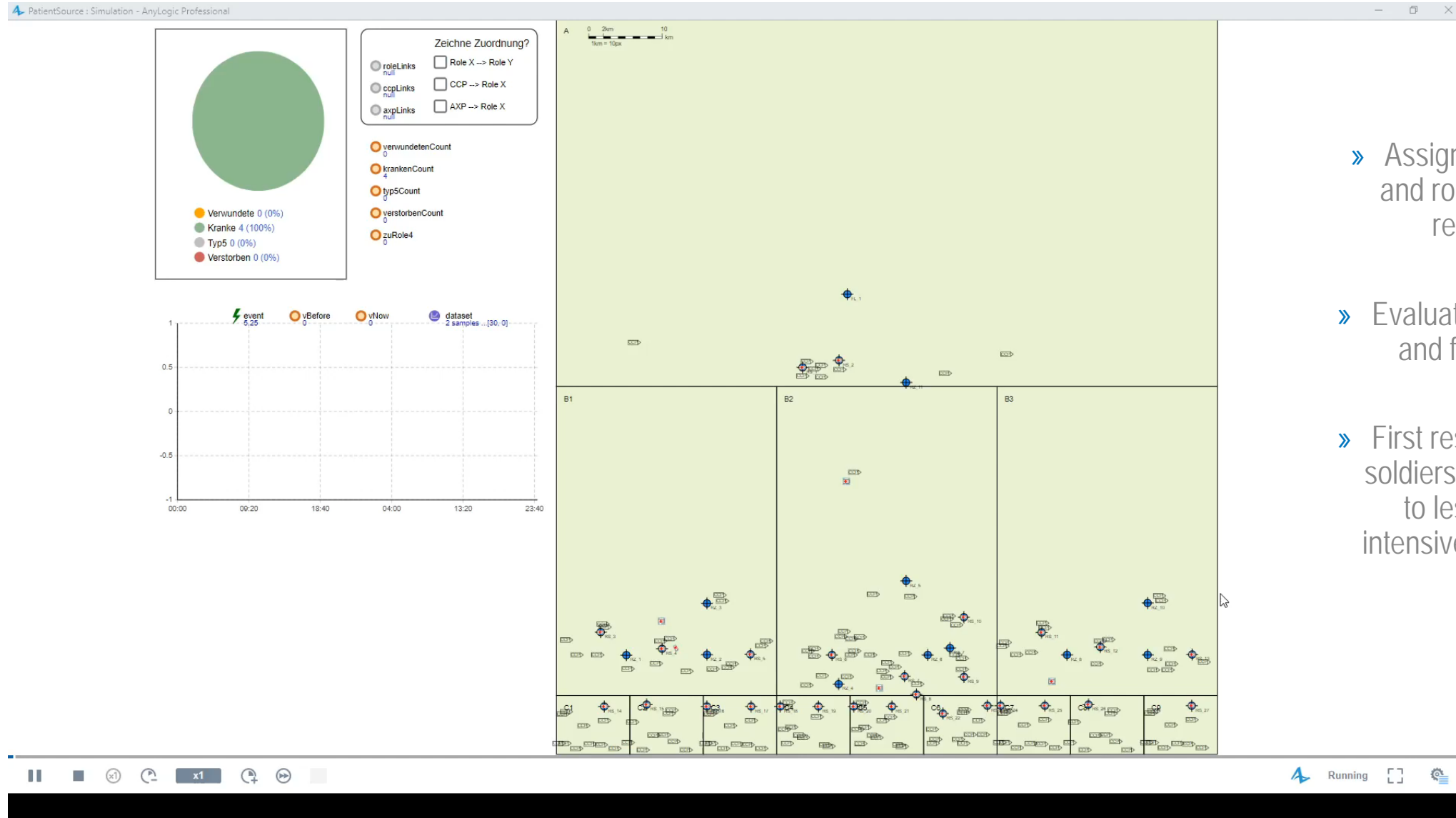
» Emergence, Wait, In treatment (no dying)

Parameters

» Number of soldiers on the battlefield

» Wounding/ disease patterns

» Treatment/ surgery times

» Care times/ lethal times

» Transport times and capacities

» Individual components in the rescue chain

SIMULATION FOR **MILITARY MEDICAL SUPPORT** - DEMO

» Assignment of units and roles coherence relationship

» Evaluation with charts and files possible

» First results show that soldiers die because of to less space for intensive care in Role 2

SUMMARY AND BENEFITS OF SIMULATION

SUMMARY AND BENEFITS OF SIMULATION FUTURE IDEAS

## Digital Military Supply Chain - Autonomous Systems

» What is the impact of the use of autonomous and networked systems on the military supply chain?

Impact of additive manufacturing in military supply chain

» What is the impact of "3D" printing on material readiness and how will the Bundeswehr need to position itself optimally for this in the future (locally, in terms of content, etc.) in order to use this efficiently?

Forecasting approaches for new military weapon systems (MAWS, MGSC, FCAS)

» How has logistic simulation/forecasting and feedback data look like in the future programs?

https://www.allesdrucker.de/info/3d-druck.html

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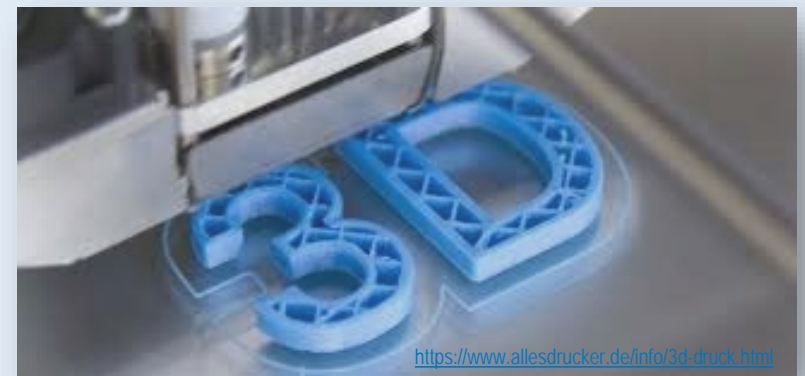
SUMMARY AND BENEFITS OF SIMULATION
SWOT

STRENGTHS

- » No Real-Case-Szenario (experiment) necessary
- » Various test scenarios/Monte Carlo experiments in combination possible ("What if, ...?")
- » Simulation as a tool for data farming
- » Increases the understanding of the real system already at the modelling stage

WEAKNESSES

- » Number-based and more difficult to communicate
- » Suggests a precision that is not possible in this way
- » Requires specialist knowledge (mathematics, statistics, etc.) for interpretation & interdisciplinary work in modelling

OPPORTUNITIES

- » Can be used when reality cannot be tested
- » Substantiation of qualitative statements with facts & figures
- » Out of the box thinking possible without any real consequence
- » Learning from existing data or start collecting data

THREATS

- » Misinterpretations and wrong conclusions
- » Unreflected reuse of models
- » Overestimation of predictive power, neglect of prediction errors ("All models are wrong, but some are useful", George Box)

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THANK YOU FOR YOUR ATTENTION

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