

Digitaalinen kaksonen ja DigiTwin-projekti: mitä miksi ja miten?

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Digital twin definition

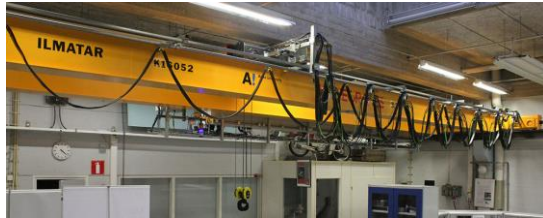
Digital twin is a virtual entity that is linked to a real world entity

By doctoral candidates Juuso Autiosalo, Tuomas Tiainen & Jari Vepsäläinen

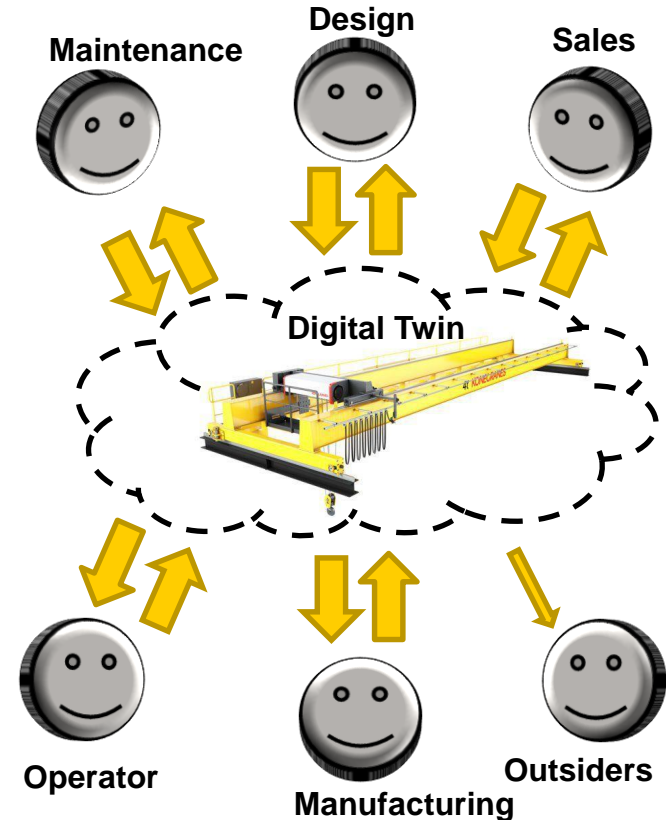
DigiTwin project

Project focuses on the design view of an industrial overhead crane.

Physical Twin



Project builds demonstrators to prove the industrial value of digital twin concept.

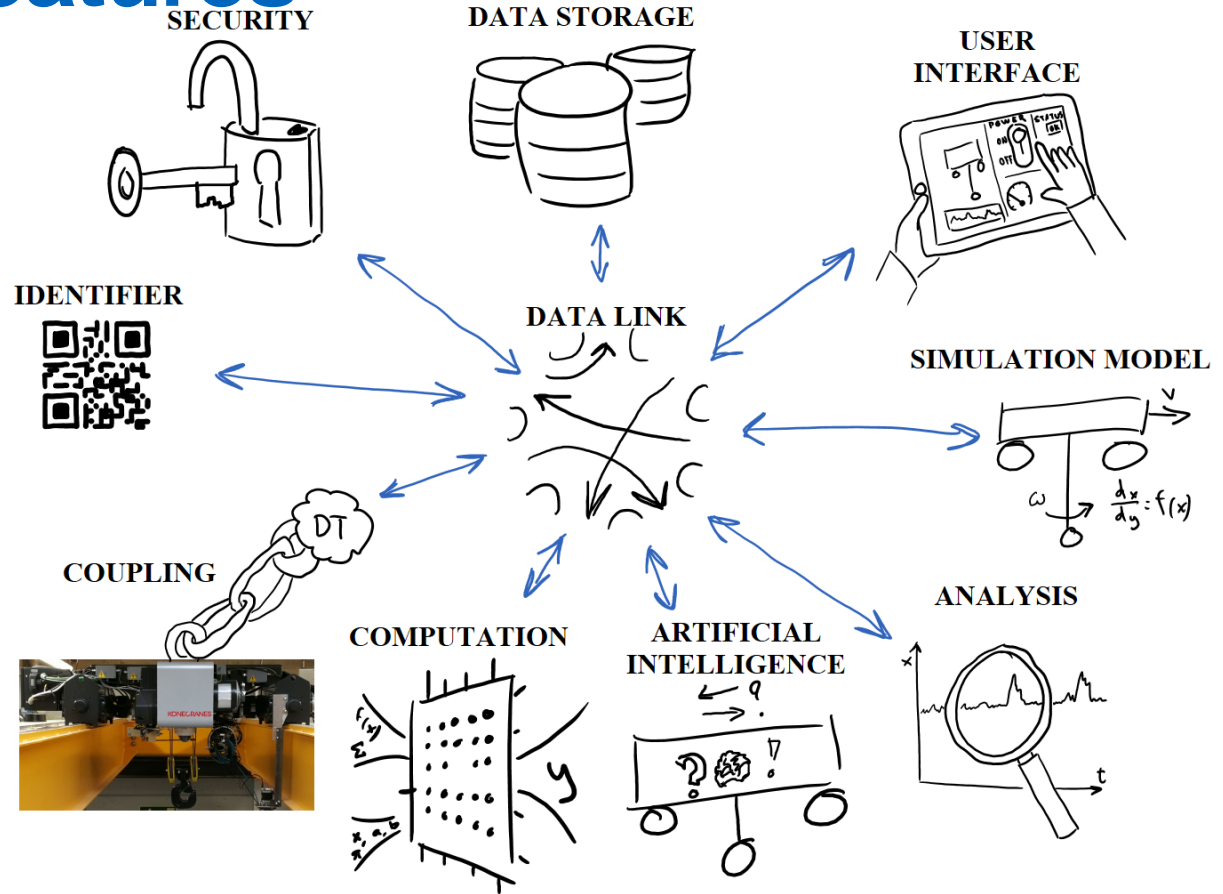


Digital twin features

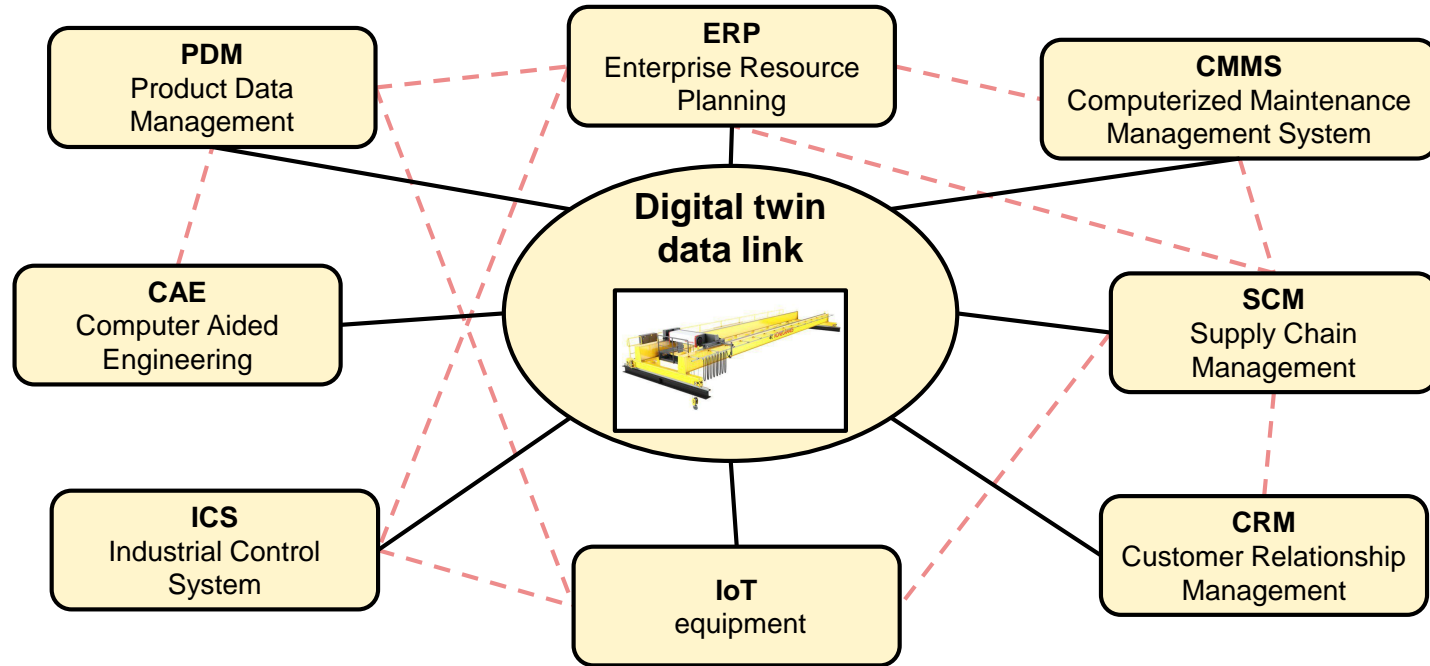
Feature-based definition:

Digital twin is a linked combination of **features**, customized for each **use case**.

“Data link” is being developed.



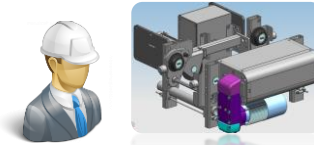
How to use DT in enterprise context?



ENGINEERING ASSUMPTIONS CHALLENGED BY IOT DATA

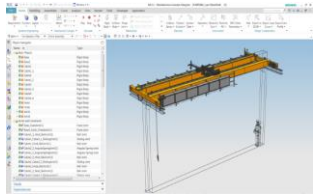


Assumptions from standards, books, ...



Crane engineering

+



Digital Twin



Physical crane



Analytics

IoT data



IoT driven Engineering / Matti Lehto, Valtteri Peltoranta

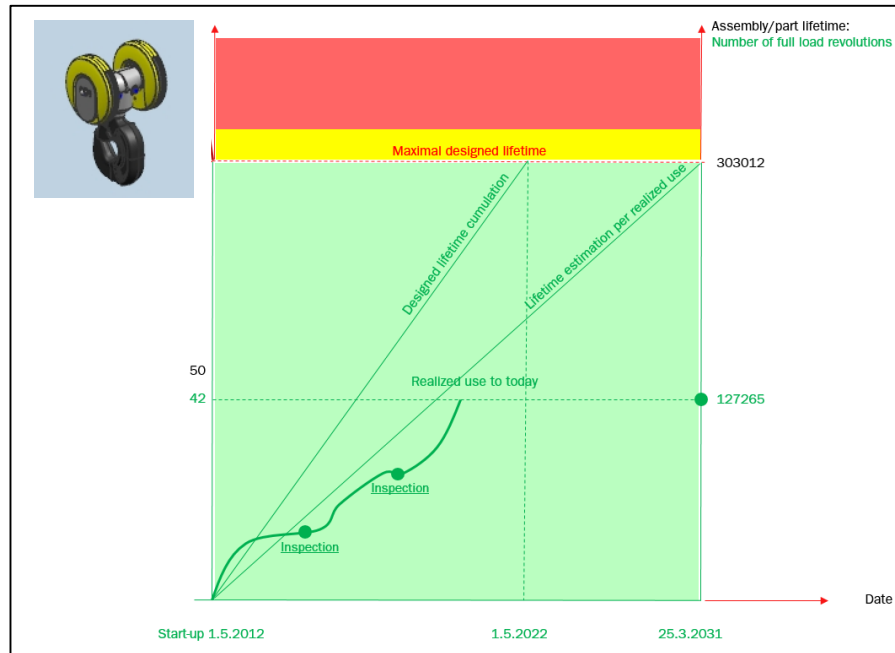
08/04/2019

ANALYZED COMPONENT INFORMATION

Service view

- Maintenance tasks & inspections based on Twin analyses
- Lifetime estimations for components

→ “Digital Twin based maintenance”

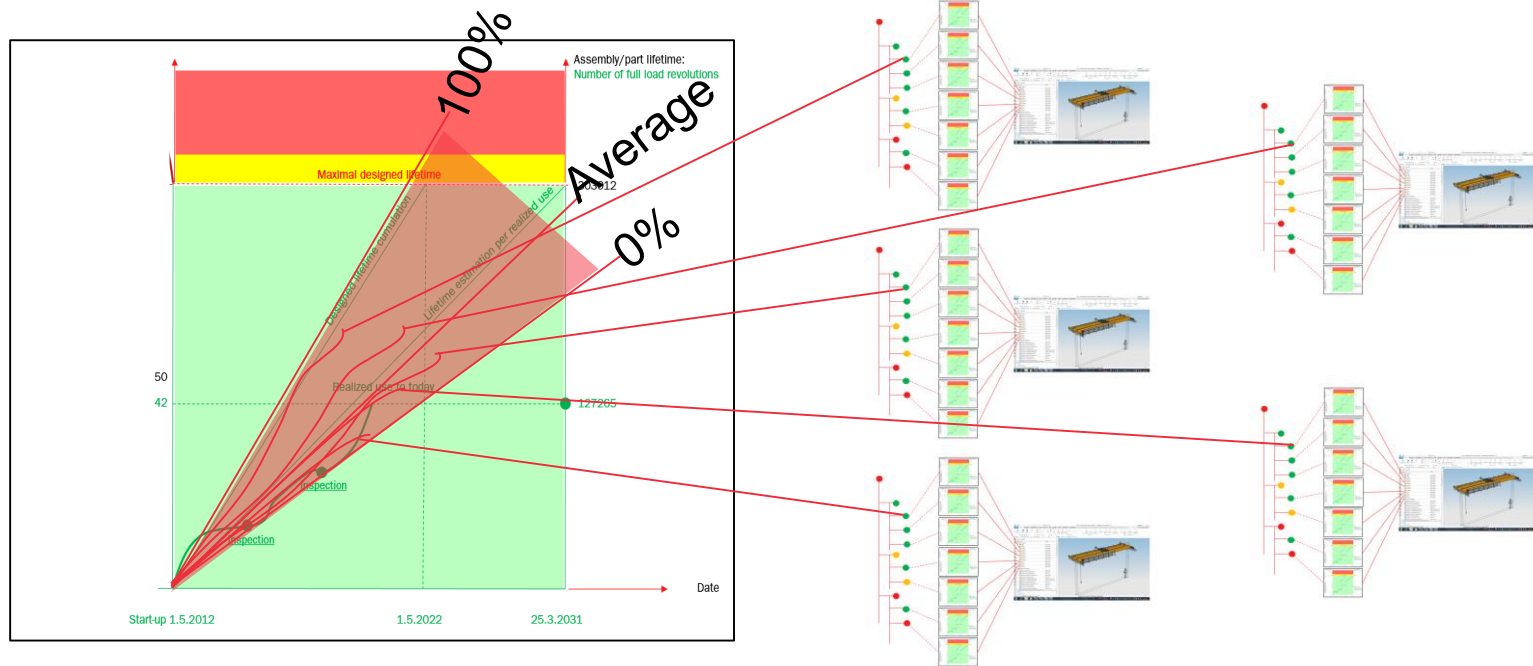


Engineering view

- Comparison of design calculations and realized use
- Information about weak points of products

→ Optimized dimensioning & selection of components

STATISTICAL VIEW TO SIMILAR COMPONENTS

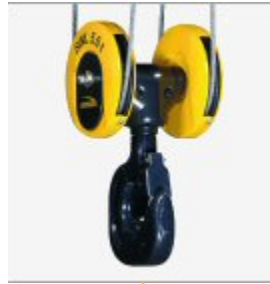


- Find similar parts in cranes on field
- Equalize data from different cranes
- Analyse statistically

USE CASE



Sensored raw data



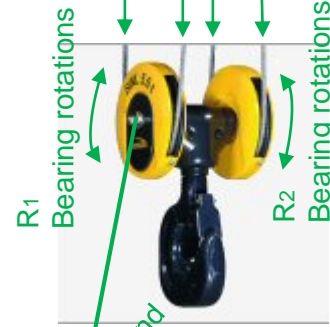
Z Vertical position

F_L
Load forces

Processed info
from raw data

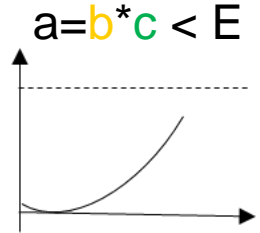
Rope forces

$F_{r1} F_{r2} F_{r3} F_{r4}$

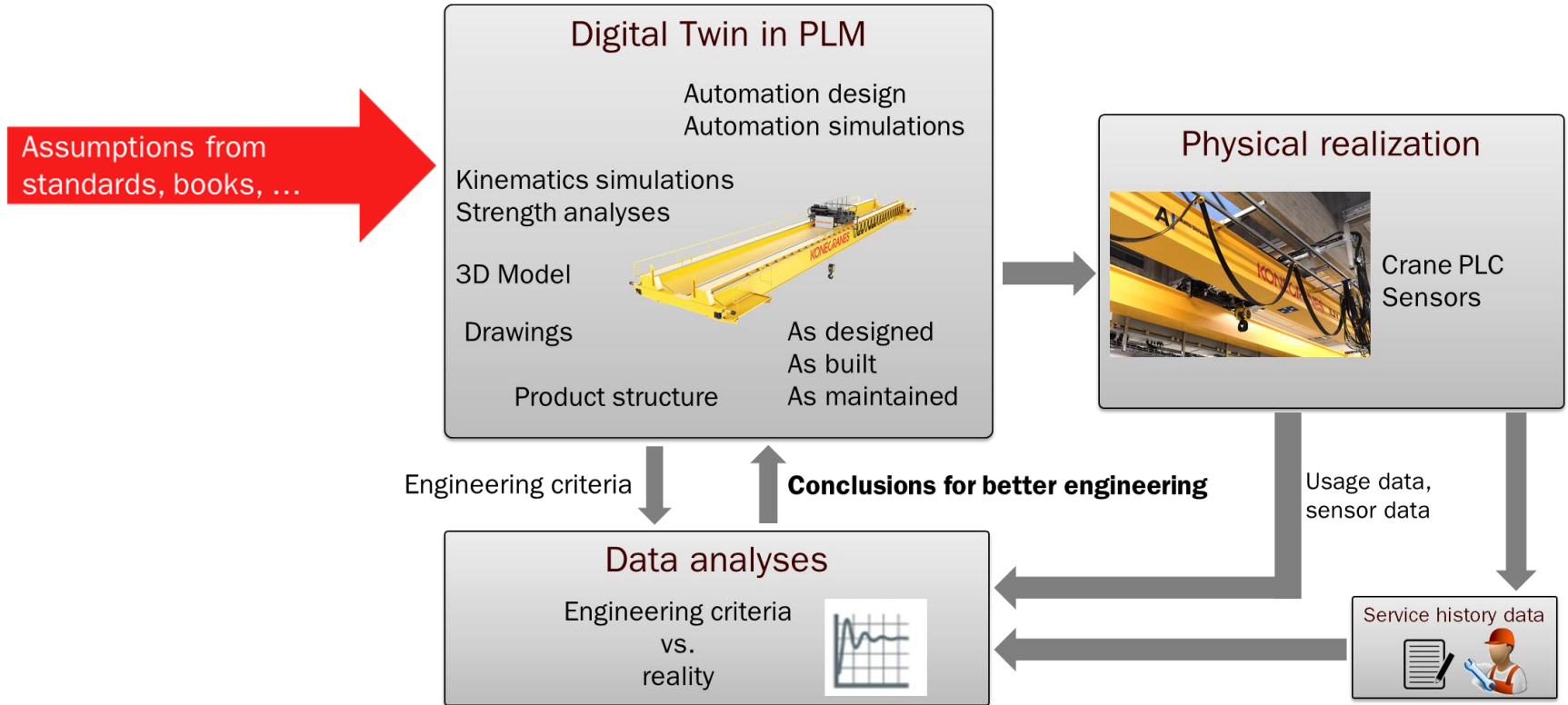


Bearing type and
capacity info

Algorithms
analyzing and
reporting
bearing status
& estimation



IoT driven engineering



Crane bearing use case



Sensored raw data



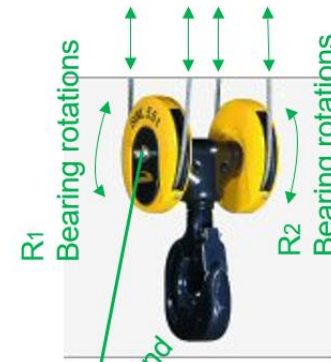
F_L
Load forces

Z Vertical position

Processed info
from raw data

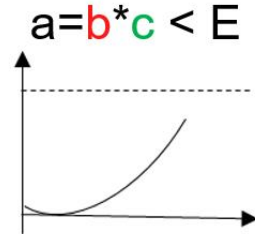
Rope forces

$F_{r1} F_{r2} F_{r3} F_{r4}$

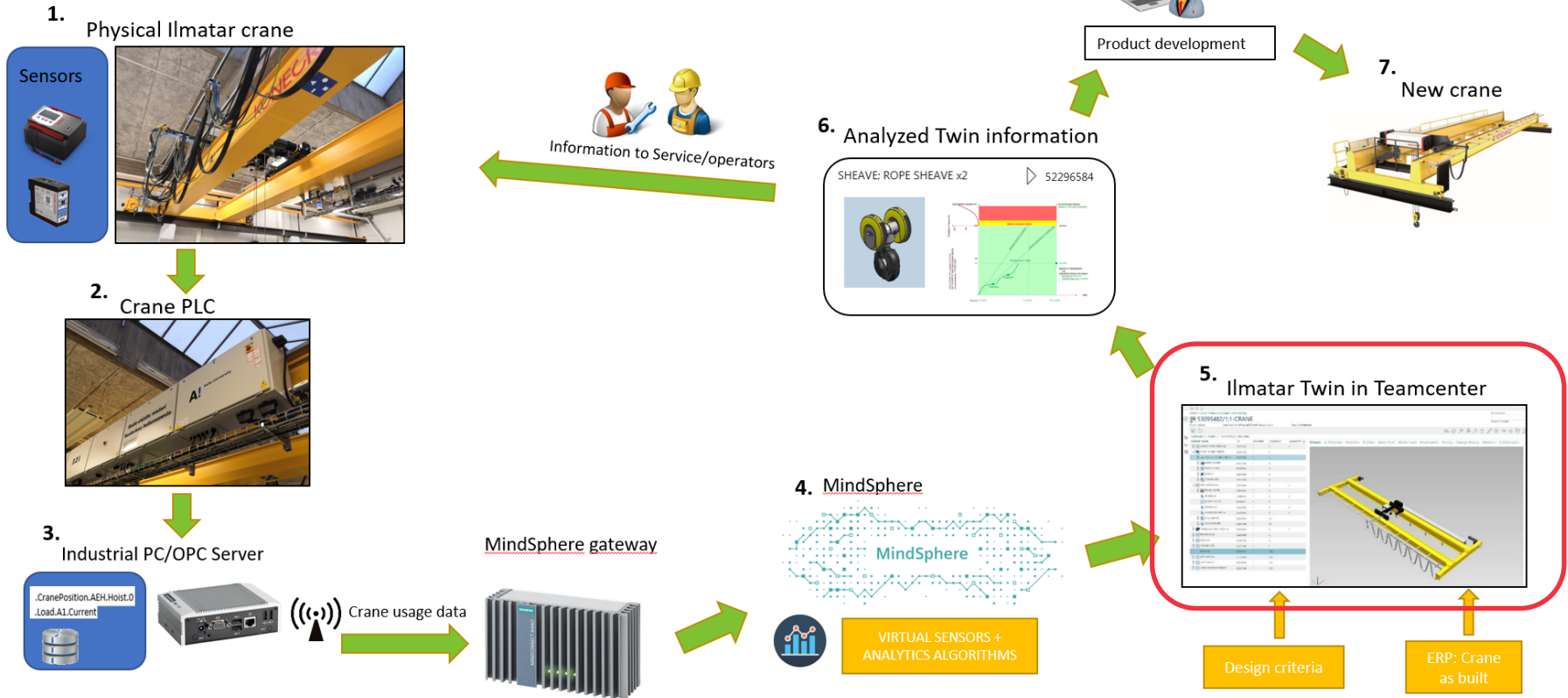


Bearing type and
capacity info

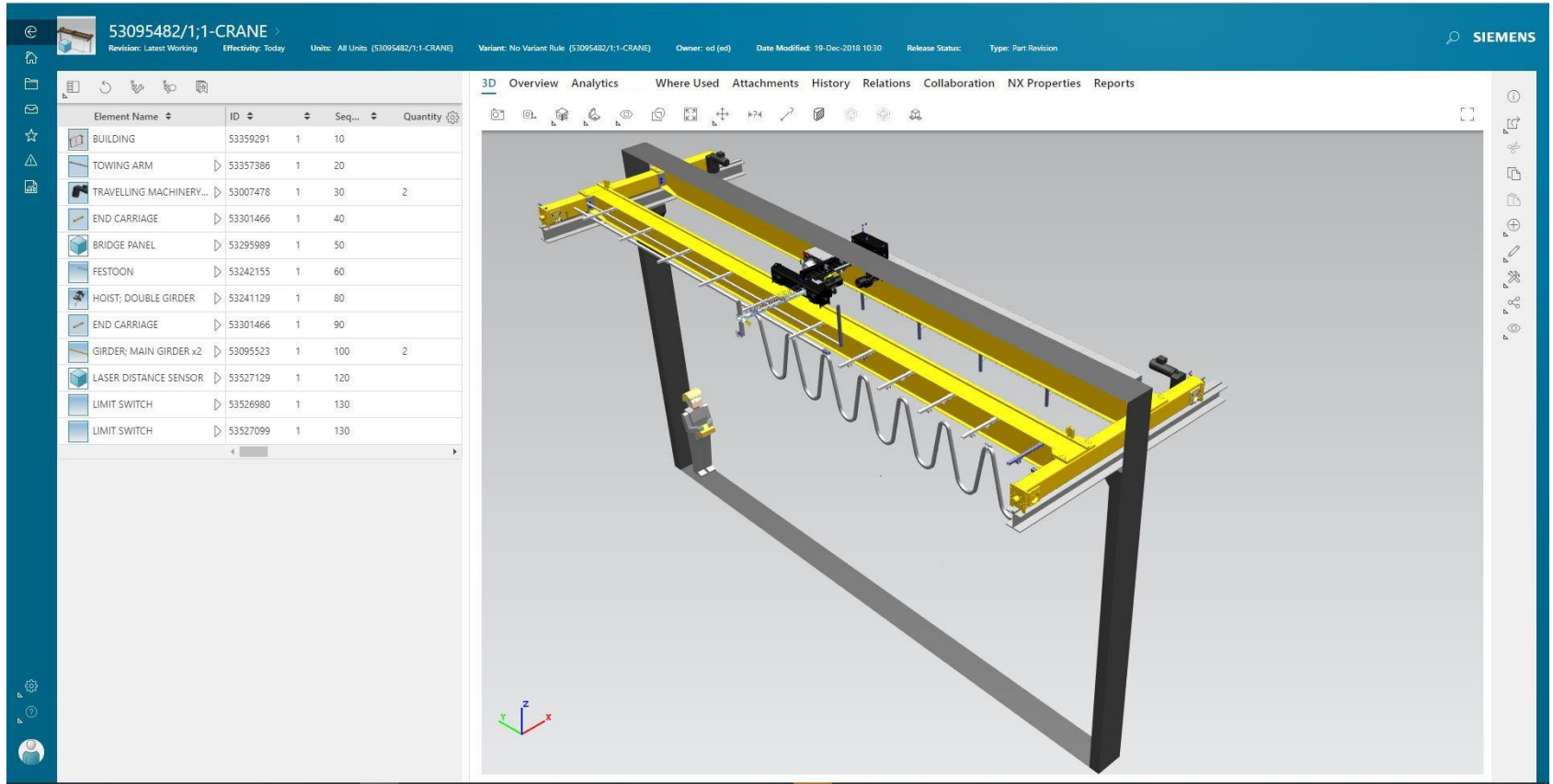
Algorithms
analyzing and
reporting
bearing status
& estimation



Data flow description



How does DT help engineers?



The screenshot displays the Siemens NX CAD environment for a crane assembly. The top bar shows the part name "53095482/1;1-CRANE" and various metadata including revision, units, variant, owner, date modified, and release status. The main interface is divided into a left-hand parts list, a top navigation menu, and a central 3D model view.

Parts List Table:

Element Name	ID	Seq...	Quantity	
BUILDING	53359291	1	10	
TOWING ARM	53357386	1	20	
TRAVELLING MACHINERY...	53007478	1	30	2
END CARRIAGE	53301466	1	40	
BRIDGE PANEL	53295989	1	50	
FESTOON	53242155	1	60	
HOIST; DOUBLE GIRDER	53241129	1	80	
END CARRIAGE	53301466	1	90	
GIRDER; MAIN GIRDER x2	53095523	1	100	2
LASER DISTANCE SENSOR	53527129	1	120	
LIMIT SWITCH	53526900	1	130	
LIMIT SWITCH	53527099	1	130	

The 3D model view shows a detailed perspective of the crane structure, featuring yellow main girders, black support legs, and various mechanical components like hoists and festoons. A coordinate system (X, Y, Z) is visible in the bottom left corner of the model area.

How does DT help engineers?

53241129/1;1-HOIST; DOUBLE GIRDER >
Revision: Global (Latest Working) Effectivity: Today Units: All Units (53241129/1;1-HOIST; DOUBLE GIRDER) Variant: No Variant Rule (53241129/1;1-HOIST; DOUBLE GIRDER) Owner: ed (ed) Date Modified: 22-Oct-2018 13:24 Release Status: Type: Part Revision

3D Overview Analytics Where Used Attachments History Relations Collaboration NX Properties Reports

Element Name	ID	Revi...	S...
TROLLEY; DOUBLE GIRDER	53297705	1	10
CUBICLE	53357365	1	20
TOWING ARM	53357366	1	30
HOISTING UNIT	53357332	1	40
ROPE REEVING	53357354	1	50

The 3D model shows a complex mechanical assembly with various components, including a large black housing, a motor, and a yellow pulley system. A coordinate system (X, Y, Z) is visible in the bottom left corner of the 3D view.

How does DT help engineers?

53357354/1;1-ROPE REEVING >

Revision: Global (Latest Working) Effectivity: Today Units: All Units (53357354/1;1-ROPE REEVING) Variant: No Variant Rule (53357354/1;1-ROPE REEVING) Owner: ed (ed) Date Modified: 19-Dec-2018 09:34 Release Status: Type: Part Revision

3D Overview Analytics Where Used Attachments History Relations Collaboration NX Properties Reports

Revision Na...	ID	Rev...	Sequence	Quantity
1 > OVERLOAD DEVICE	53034487	13	10	
1 > HOOK BLOCK	52301084	9	20	
htty SHAFT	52261859	4	30	
1 > ROPE PULLEY	52298386	4	40	

3D view of a rope reeving device assembly, showing a yellow pulley, a black hook, and a white overload device.

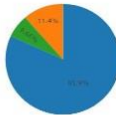
How does DT help engineers?

53357354/1;1-ROPE REEVING > 52261859/4;1-SHAFT
Revision: Global (Latest Working) Effectivity: Today Units: All Units (53357354/1;1-ROPE REEVING) Variant: No Variant Rule (53357354/1;1-ROPE REEVING) Owner: ed (ed) Date Modified: 19-Dec-2018 09:34 Release Status: Type: Part Revision
SIEMENS

Revision Na...	ID	Rev...	Sequence	Quantity
OVERLOAD DEVICE	53034487	13	10	
HOOK BLOCK	52301084	9	20	
SHAFT	52261859	4	30	
ROPE PULLEY	52298386	4	40	

3D Overview Analytics Where Used Attachments History Relations Collaboration NX Properties Reports

Occurrence Name: <https://aaltodev-appilmatar-aaltodev.eu.1.mindsphere.io/data?bearing=A>



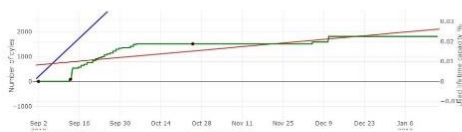
- Cycles until next inspection
- Cycles with low load <= 30kg
- Cycles with high load > 30kg

Bearing has made:
 1142.24 cycles with load <= 30kg
 666.21 cycles with load > 30kg
 3898.45 cycles and out of 10000 cycles before next inspection.

Hook has moved in total 254.07 metres in lifting path

Values updated 2019-01-17 04:00:00

[Back Refresh](#)



Number of Cycles (Left Y-axis, 0 to 2000)
 Maximal designed Lifetime Bearing (%) (Right Y-axis, -0.1 to 0.03)

Legend:
 Bearing (Cycles) [Blue line]
 Bearing (Maximal designed lifetime bearing) (%) [Red line]
 Inspections Bearing [Green line]
 Maximal designed Lifetime bearing (cycles) [Black line]
 Inspections Bearing (cycles) [Black line]
 Maximal designed Lifetime bearing (%) [Black line]

NB! Removing traces etc. Data graph can cause y-axis to not be in same relation to each other as before.

Y-axis on the left side has number of cycles and Y-axis on the right side shows number of cycles in relation to maximum designed lifetime of bearing in percent.

Graph plots bearing's total number of cycles made in reference to time axis.

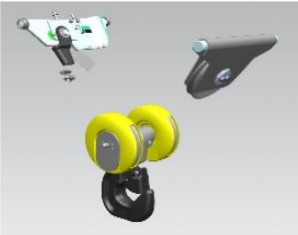
Maximum designed lifetime line shows maximum number of cycles bearing can do.

Remaining lifetime shows estimation how long it will take for bearing to reach the maximum designed lifetime. It is calculated using least square regression. [LSD algorithm](#)

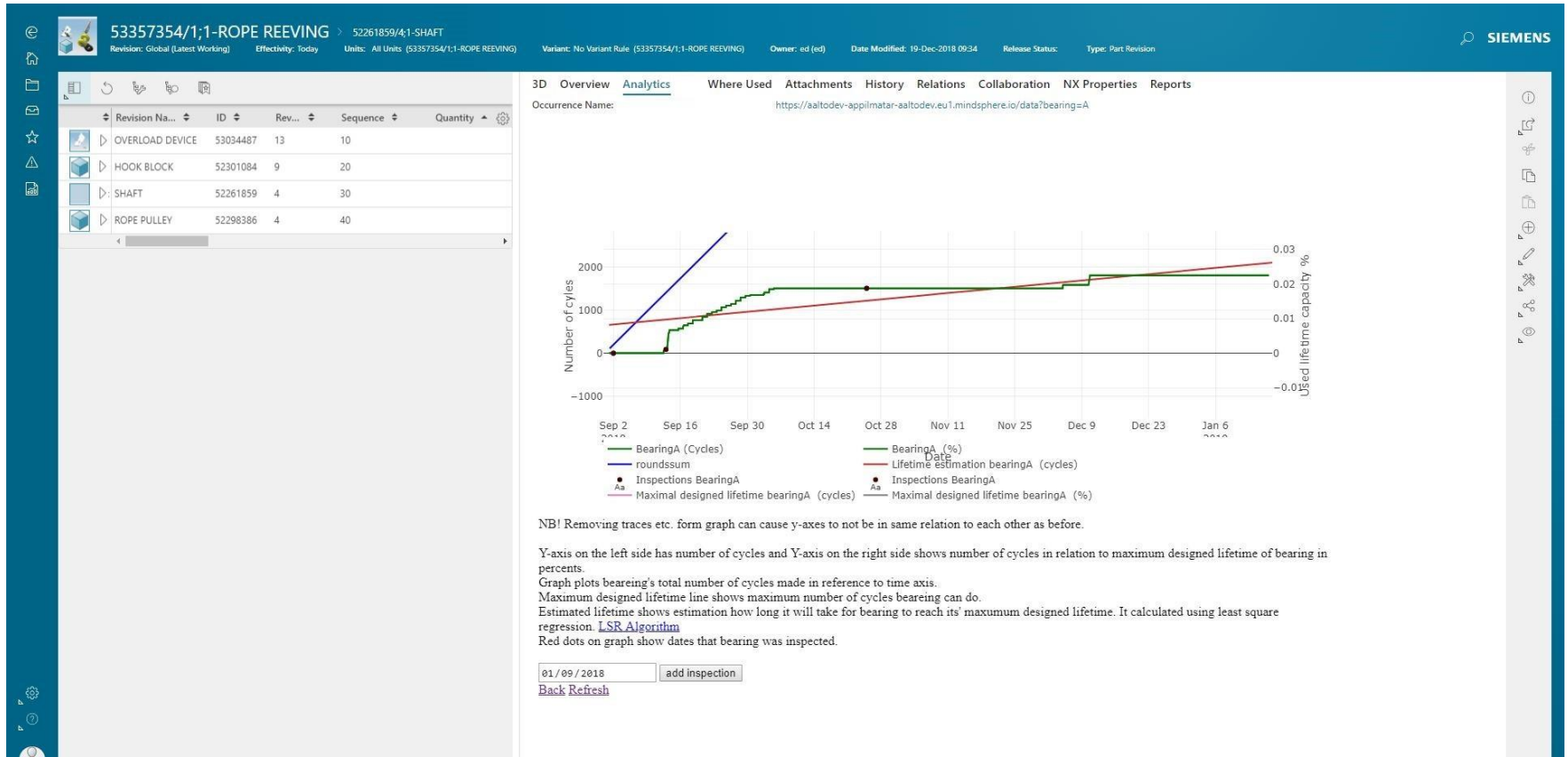
Real data on graph shows data that bearing was inspected.

01/09/2018 [add inspection](#)
[Back Refresh](#)

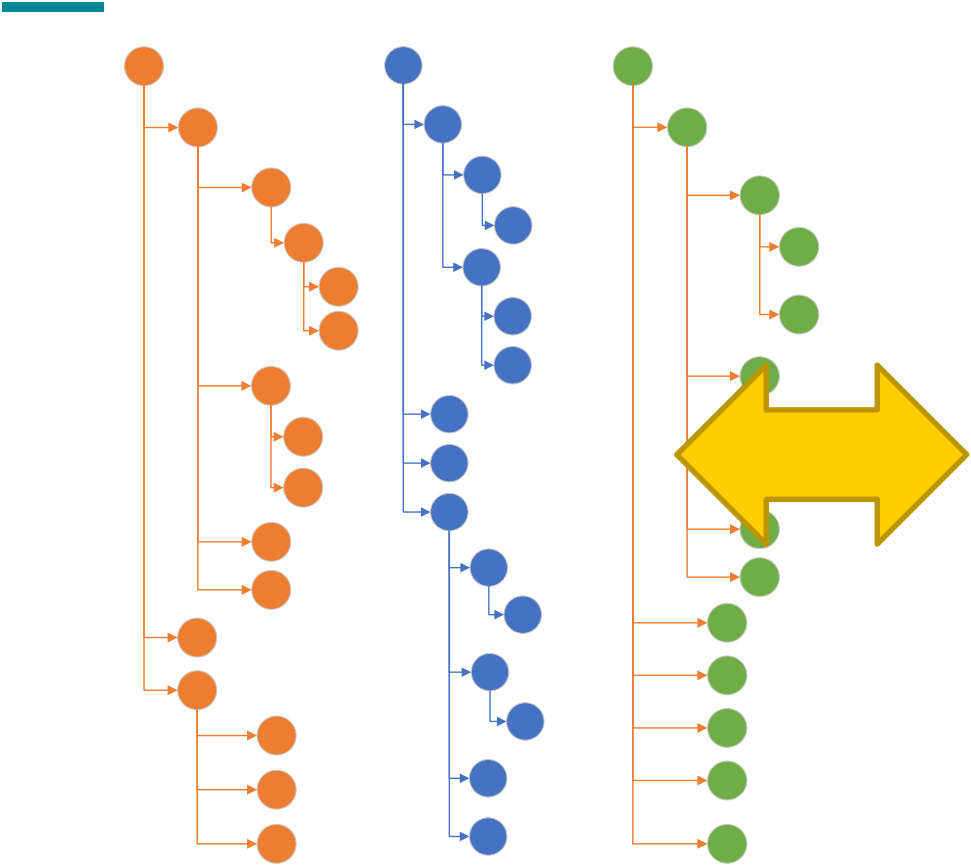
PREVIEW



How does DT help engineers?



DIGITAL TWIN: COMBINING LIFE CYCLE STAGES



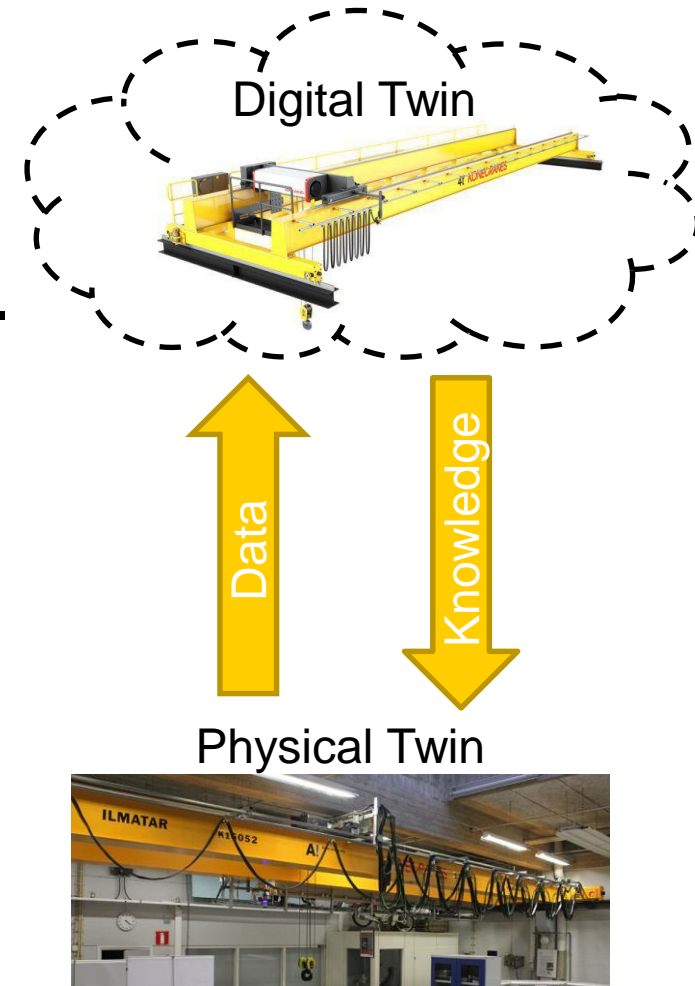
Slide credits: Ville Pantsar, IDEAL PLM

Summary

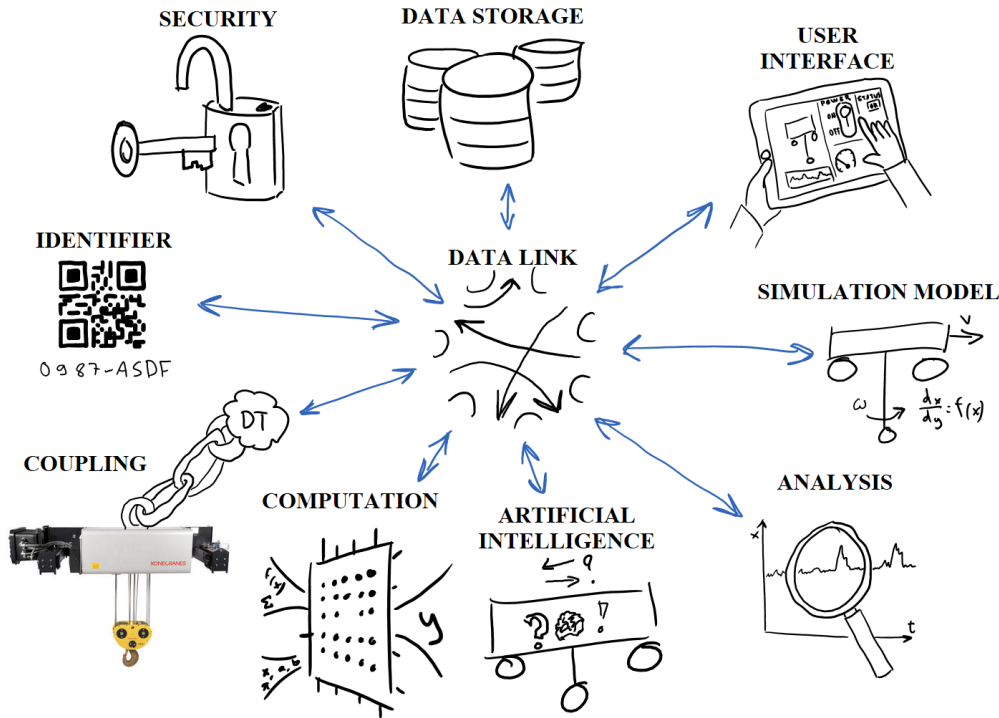
Digital twin *features* depend on use case.

Crane engineering use case:

- select component
 - data flow
 - analysis
 - helping engineers
- Shift to IoT driven engineering



Questions?



More info:

digitwin.fi

Share your perspective on digital twin at Slack?

digitwin.fi/join-slack

Propose a meeting?

[Jari Juhanko](https://digitwin.fi/join-slack)