

buildingSMART Digital Twins

Three Horizons

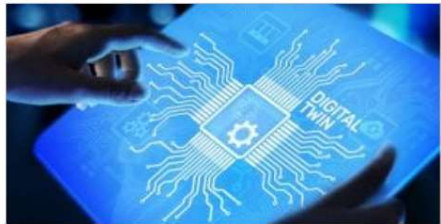
Rob Roef
buildingSMART
TNO

Antwerp, May 3, 2023

Digital twins strategic paper –2020



Enabling an Ecosystem of Digital Twins



How to unlock economic, social, environmental and business value for the built asset industry

Introduction

Rapid technological advancements are changing almost all aspects of our lives. Mobile and cloud-based technologies, IoT (Internet of Things), AI (Artificial Intelligence), sensors, robotics and other technological developments are leading to new business models, new ways of thinking and a multitude of opportunities. Under the broad umbrella of Industry 4.0, the process of digital transformation is reshaping entire industries. New terms and definitions, such as *Digital Twins* or the *Plan-Build-Operate-Integrate (PBO-I)* concept arise as a result. This transformation is helping to boost productivity with some industries setting an example. For example, manufacturing has applied digital twins to production lines to analyze and optimize production. This has resulted in productivity improvements and enabled better reliability. Water utilities interact with digital replicas to simulate flow and scenario planning ensuring better network reliability. The automotive industry uses digital technology to simulate material performance, temperature and other properties to develop and enhance products. The whole concept of digital transformation is also being verbalized and embraced in the built asset industry, although tangible examples of its implementation are still rare.

buildingSMART Positioning Paper: Enabling an Ecosystem of Digital Twins

London, U.K. – May 27, 2020 – buildingSMART International has made available a positioning paper on the subject of digital twins. This paper titled “Enabling an Ecosystem of Digital Twins” was worked on by the Digital Twins Working Group. The aim of the paper was to find ways of unlocking more value through the use of digital...

value for the built asset industry. There has however been widespread hesitancy for broader adoption and use. This is in part down to the nature of the industry. It is highly fragmented and still operates in a disconnected and transactional manner. There is also a clear lack of common standards and approaches. Underinvestment is prevalent, and often as little as 1% of revenues for firms is invested back into IT. There are many other contributing factors, but the industry is starting to recognize the need for change. While broader adoption of building information modelling (BIM) and openBIM in the built asset industry are promising, other considerations like population growth, urbanisation and climate change further increase the pressure for productivity and quality improvements. Global pandemics also raise questions about how affected businesses and world economies can continue to deliver efficiently. The industry is, therefore, asking itself critical questions. “How can cities contribute to the net-zero objective?” or “How can healthcare facilities prepare themselves for cases of an epidemic outbreak?” Or even “how can building infrastructure be optimised for challenging environmental conditions of the future?”. All these questions are at the forefront of the industry today.

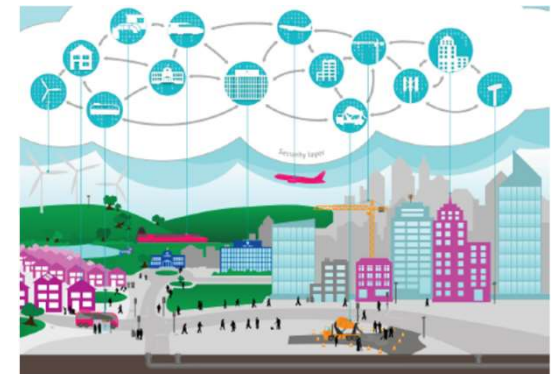
2 |

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Full lifecycle



Creating an ecosystem of digital twins



The journey since 2020

Market

Cross sector growth of digital twin agenda's, initiatives and examples

May 2020

March 2023

September 2023

Bsi community



Bsi Digital twin whitepaper



Digital twin strategic working group



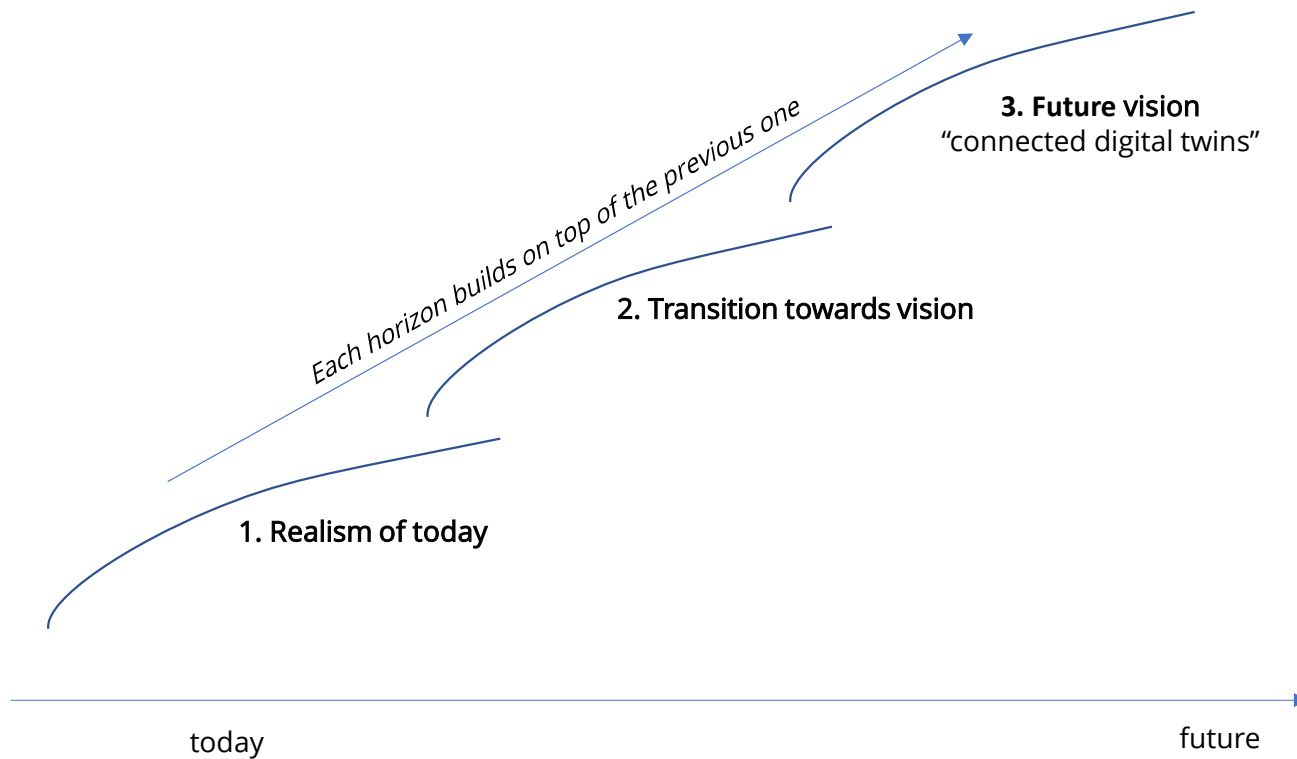
Digital twin think tank



Bsi Summit, Rome

Bsi Summit, Norway

Introducing three horizons model





buildingSMART Digital Twins

Horizon One

Challenges



Needs

Global instability

Energy crisis

High inflation rates

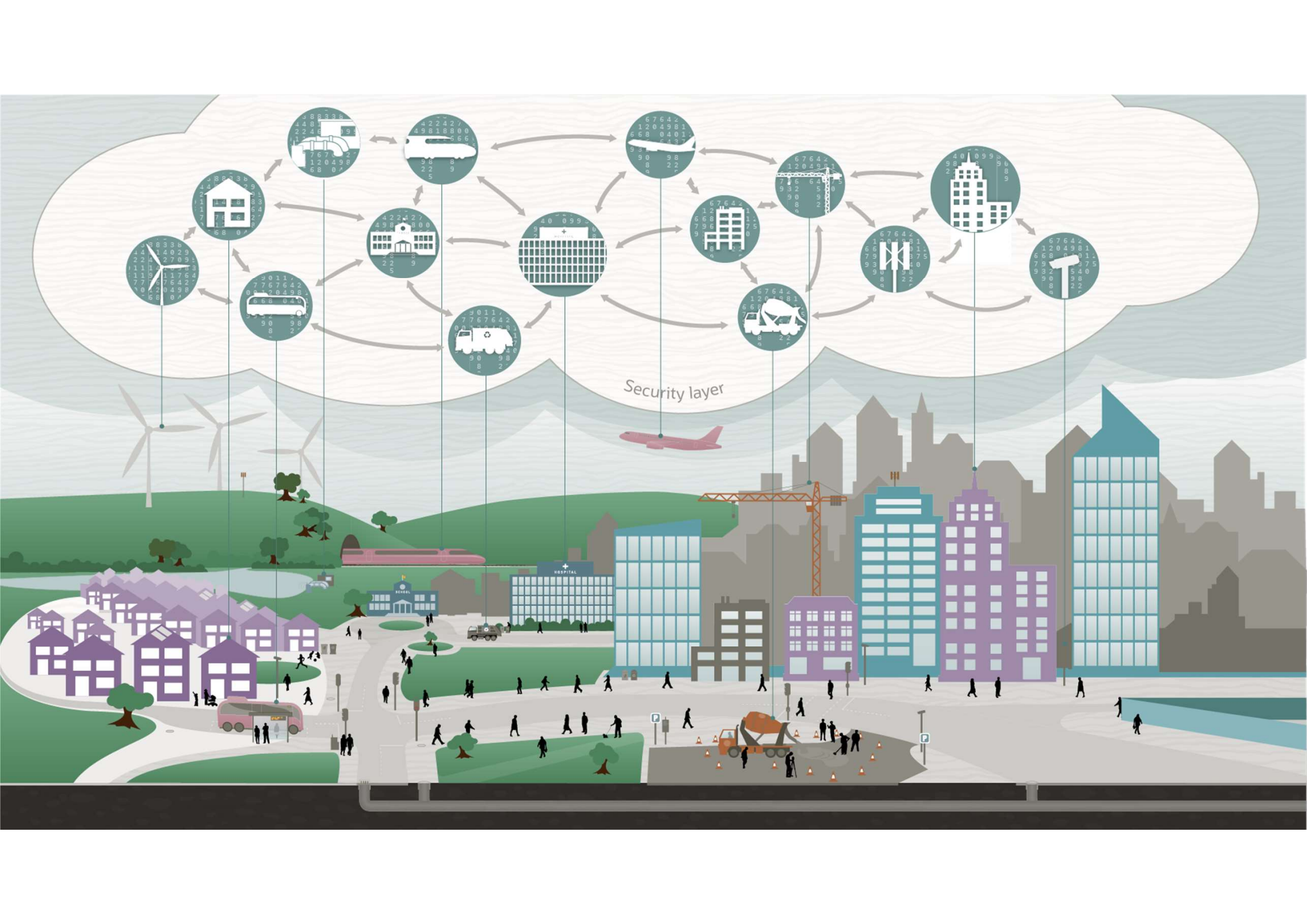
Global warming

Labor shortage

ESG

Digitization

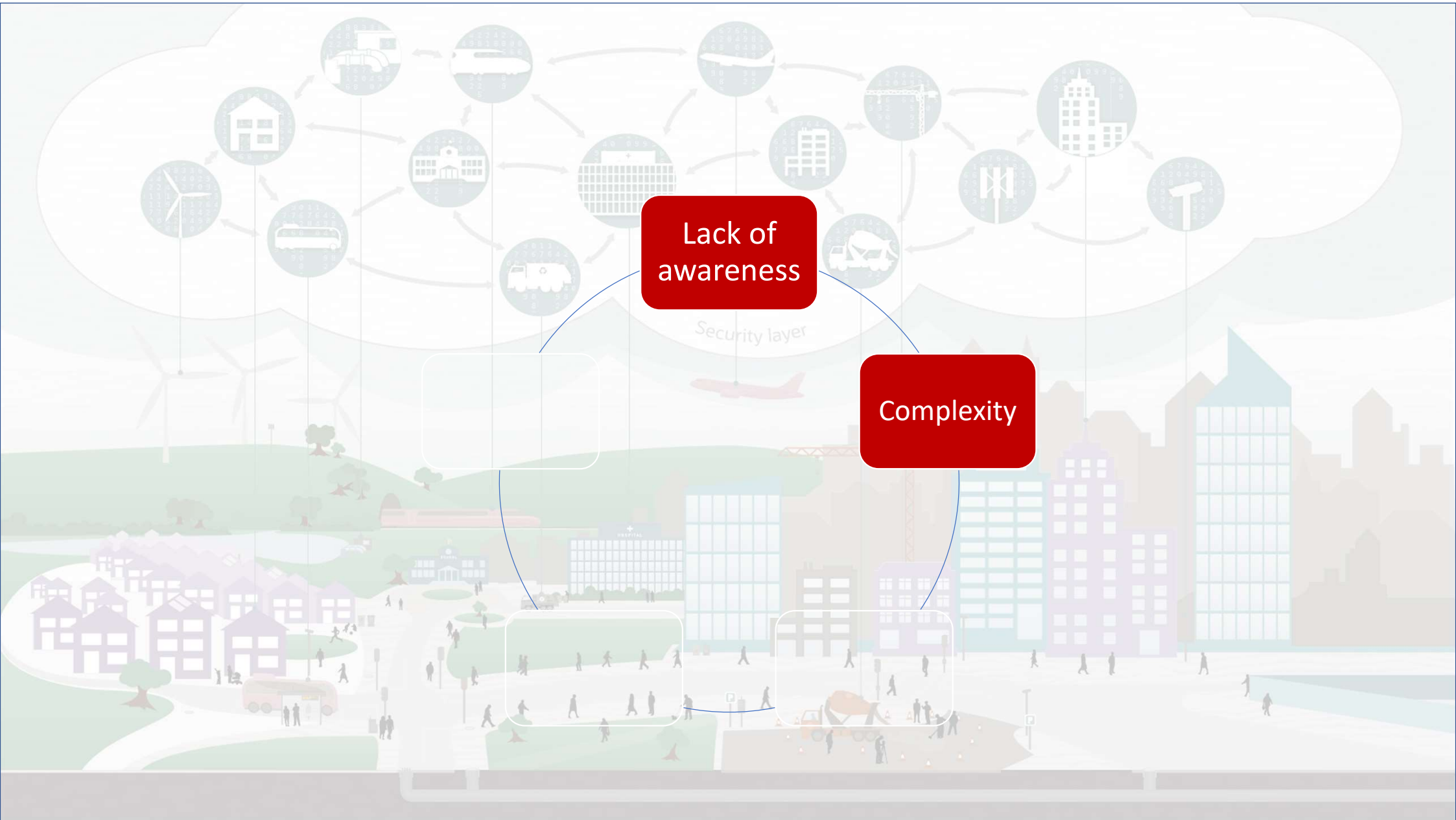
Productivity





Lack of awareness

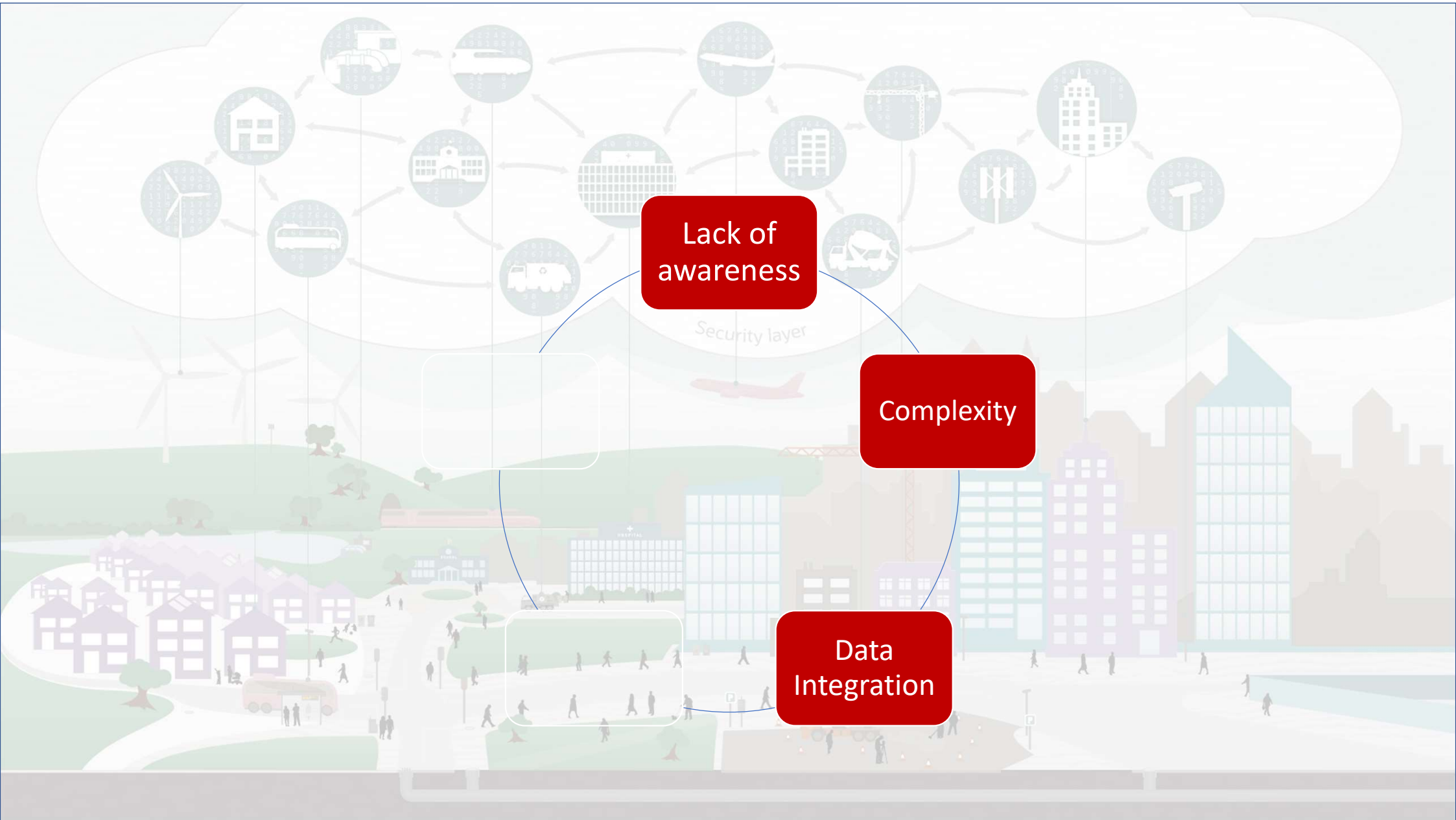
Security layer



Lack of awareness

Complexity

Security layer

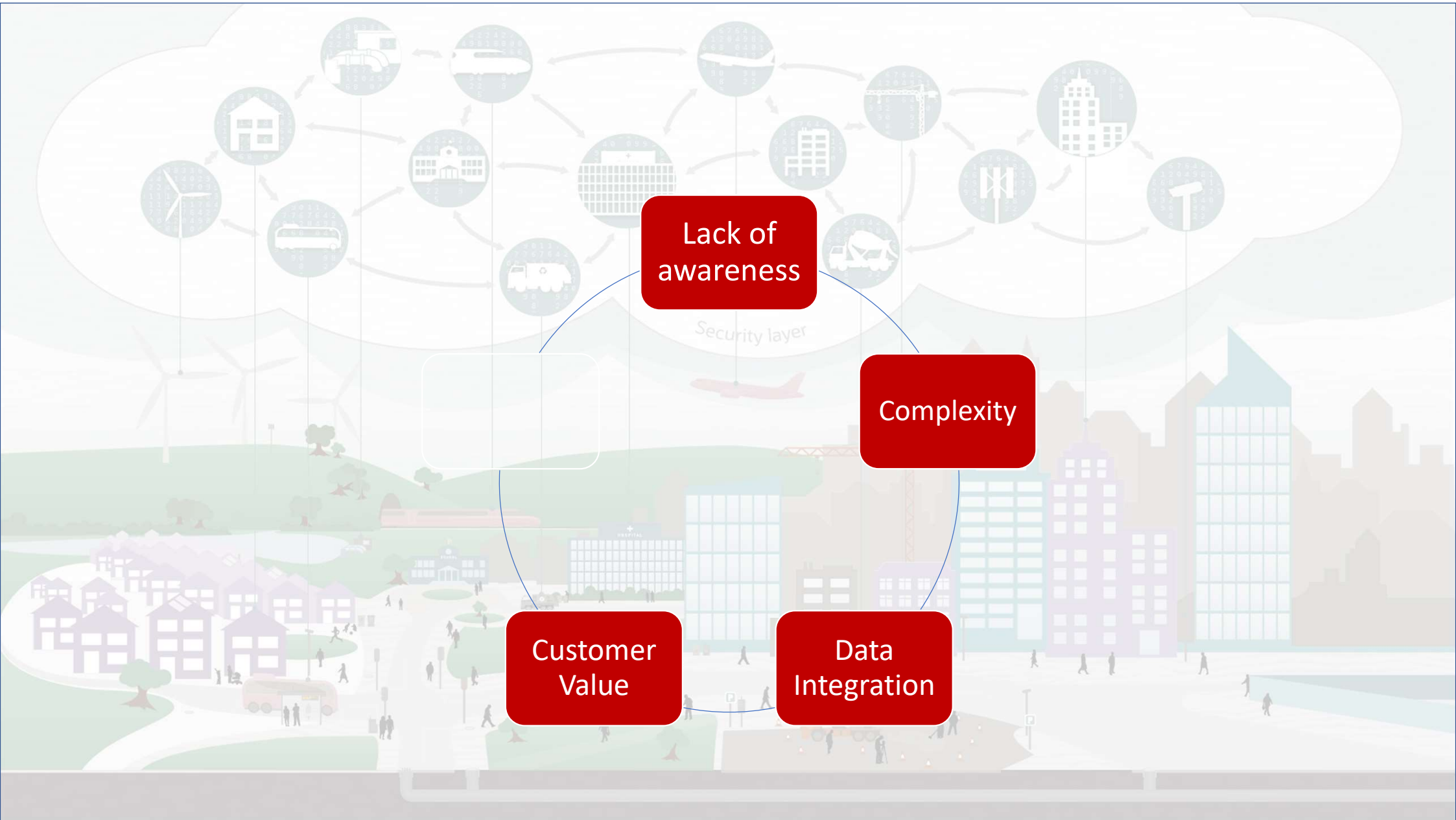


Lack of awareness

Complexity

Data Integration

Security layer



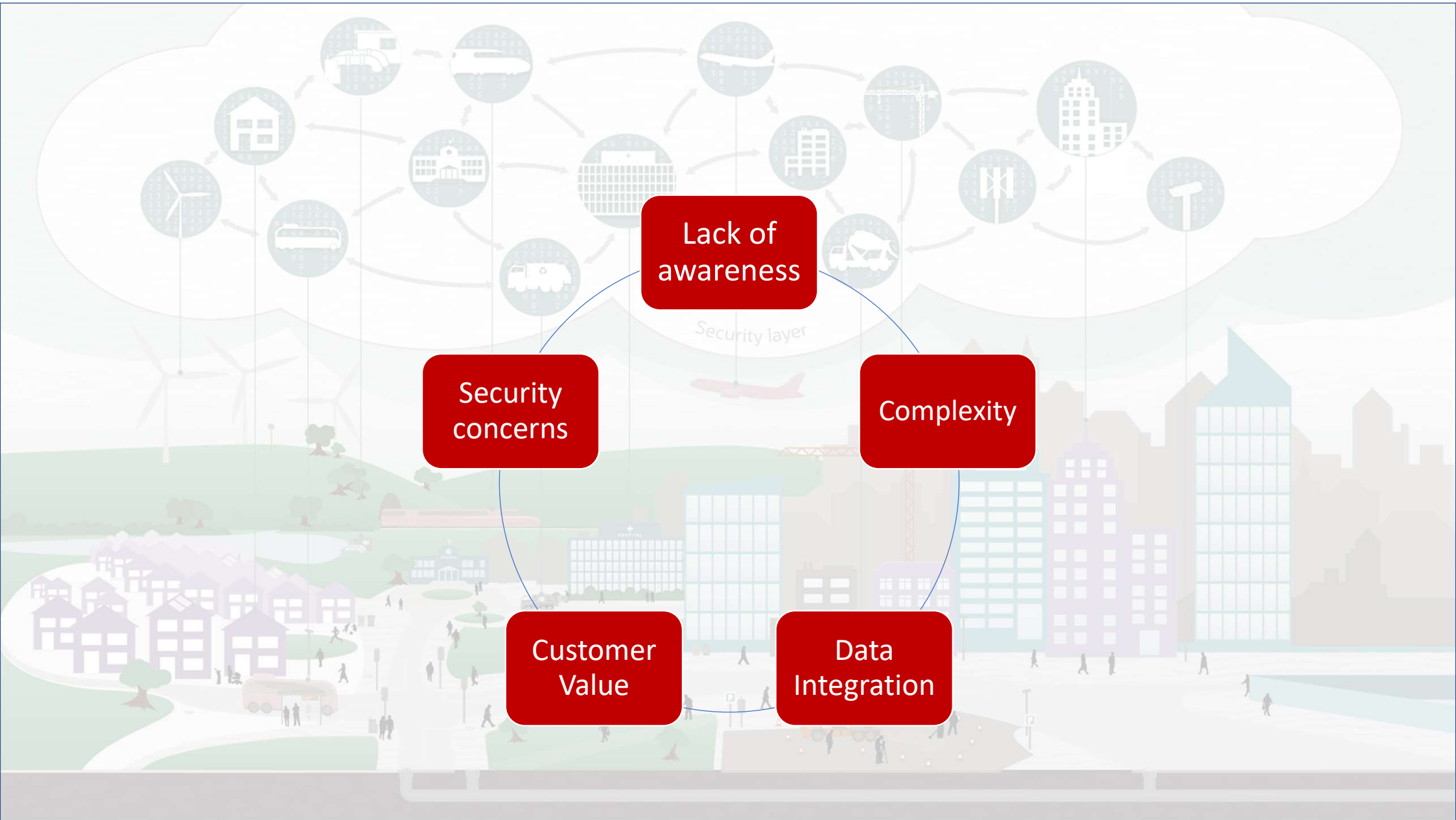
Lack of awareness

Complexity

Customer Value

Data Integration

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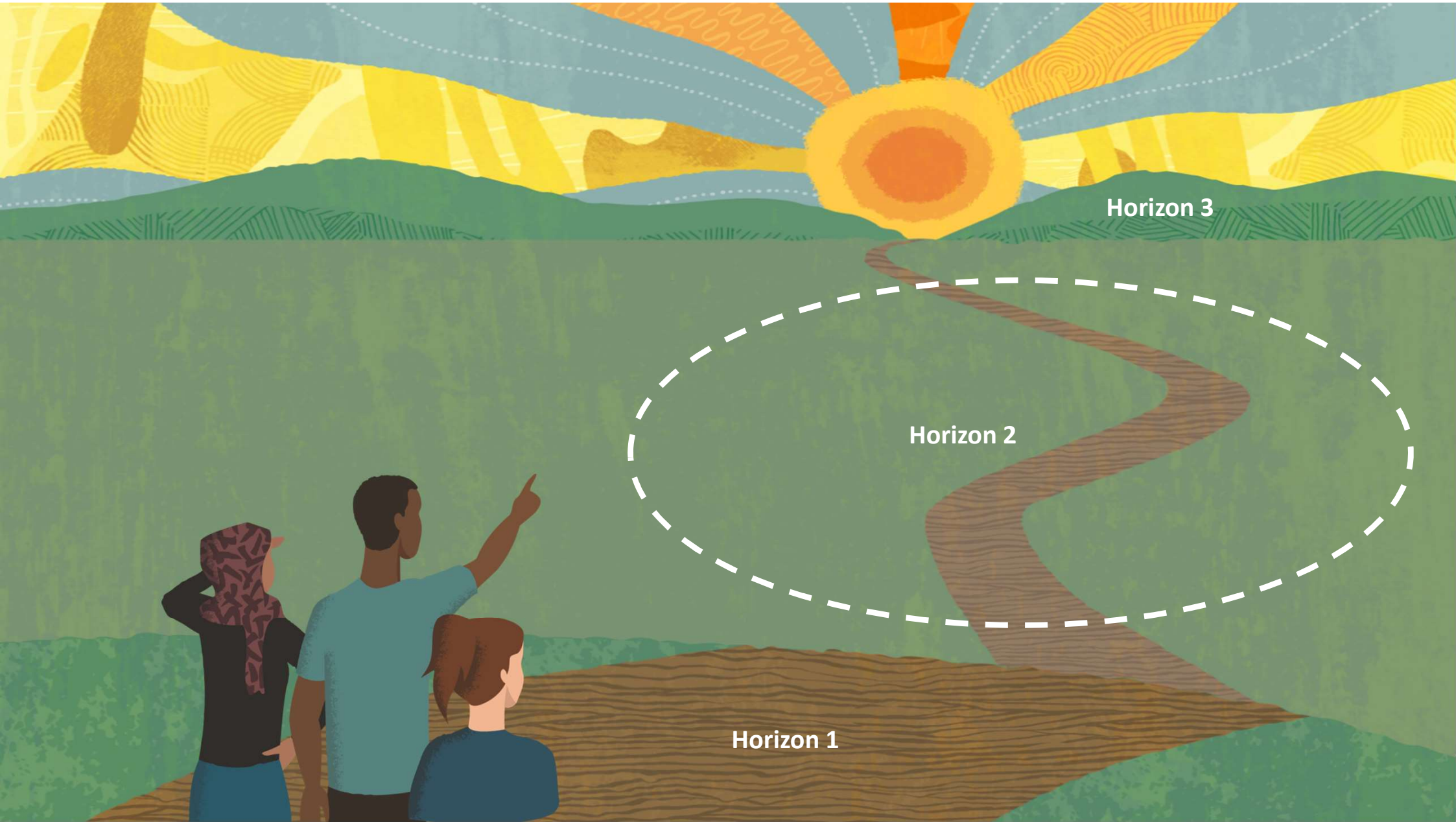
Lack of awareness

Security concerns

Complexity

Customer Value

Data Integration

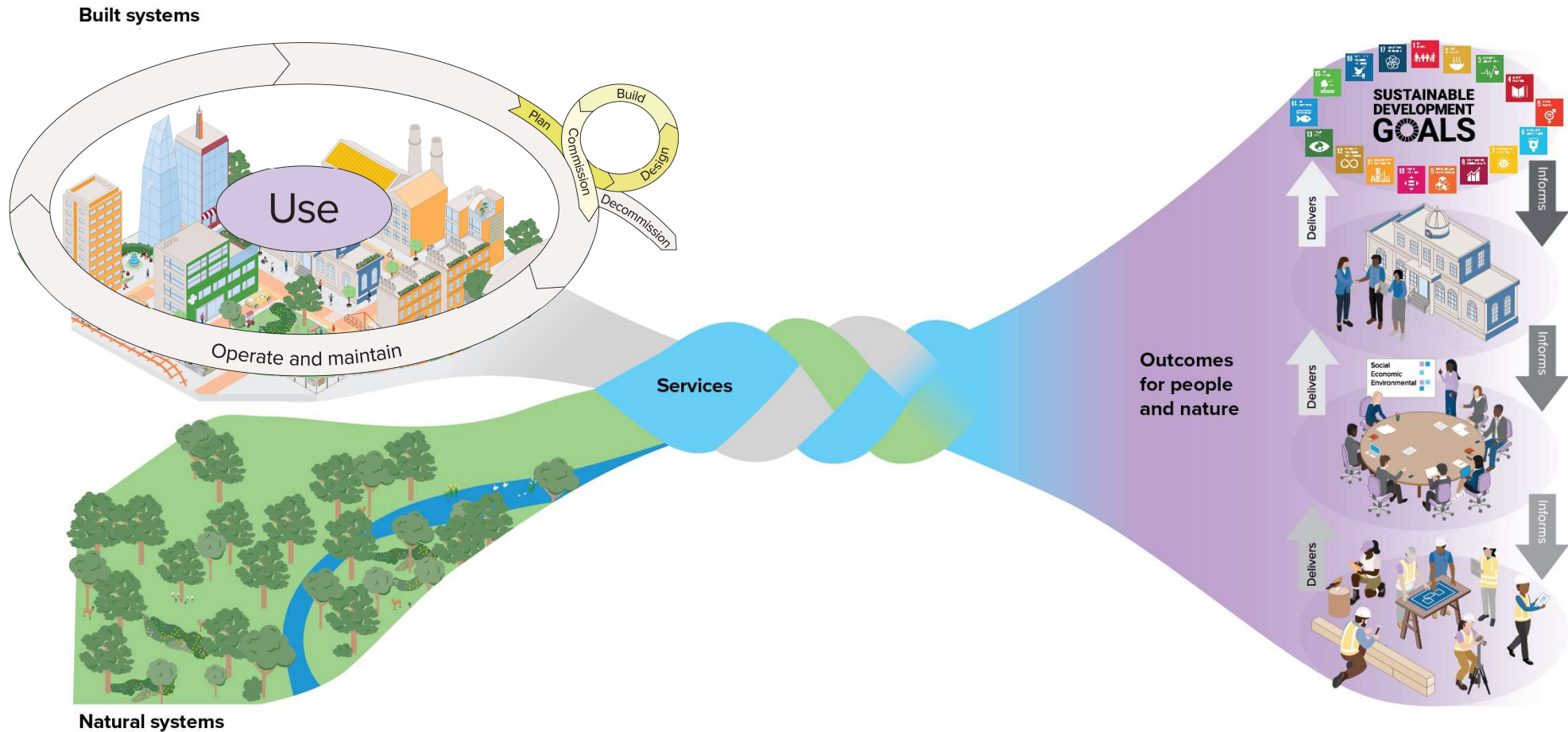


Horizon 3

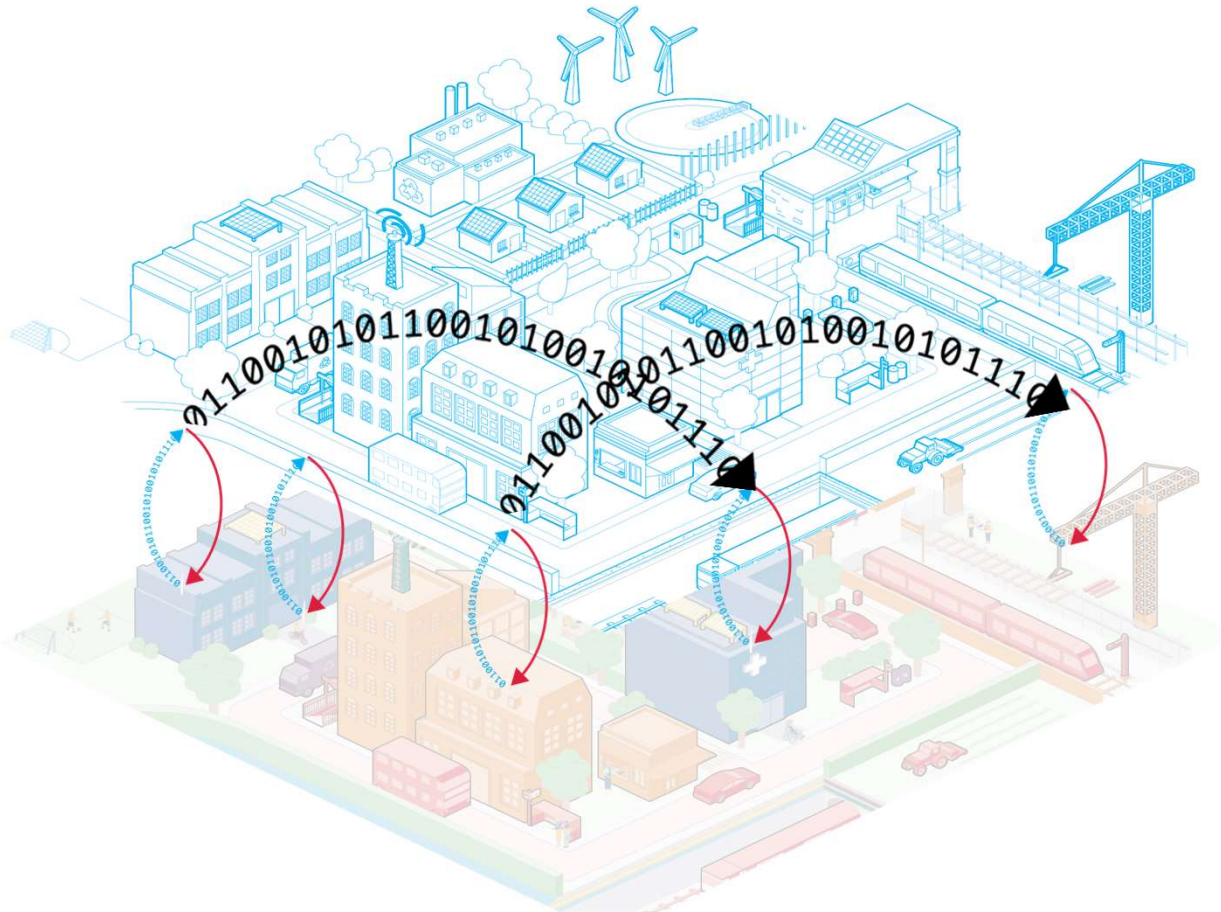
Horizon 2

Horizon 1

Outcomes-focused | Systems-based | Community-enabled



Horizon Three - An ecosystem of connected digital twins



- Outcomes-focused
- Systems-based
- Community-enabled



› **ROB ROEF**
TOWARDS A NETWORK OF PREDICTIVE
TWINS OF THE BUILT ENVIRONMENT --
HORIZON THREE

MAY, 2023



› NICE TO MEET YOU ROB ROEF

- › 1991 – now Entrepreneur
(BIM Captain)
- › 2012 – 2017 Director Sales & Marketing
(Construsoft, Trimble / Tekla business partner)
- › 2018 – 2019 OPEN BIM Program Manager
(GRAPHISOFT, A NEMETSCHEK COMPANY)
- › 2019 – now Business Developer Digitalisation in the built environment
(TNO, the Netherlands Organisation for applied scientific research)

buildingSMART:

- › 2018 – now Co-chair Building Room bSI
- › 2012 – now Chair & Board member Benelux chapter



SMART SOLUTIONS FOR CLIENTS & PARTNERS

THE NETHERLANDS ORGANISATION FOR APPLIED SCIENTIFIC RESEARCH



› SOCIETAL CHALLENGES

✂ RENOVATION INFRASTRUCTURE

- › RWS: 4.100 bridges/viaducts (NL: about 53,000)
- › 70% built before 1980 (peak around 1970)
- › Design lifespan 50-80 years
- › Increase heavy traffic (since 1960)

⚡ ENERGY TRANSITION OF EXISTING CONSTRUCTION

- › NL: 7 million residential and commercial buildings
- › Ambition for 2050: all homes CO2 neutral
- › Renovation task: 1.000 buildings per day

Note RWS = Rijkswaterstaat is the executive agency of the Dutch Ministry of Infrastructure and Water Management



OPTIMISATIONS AT THE CONSTRUCTION AND NETWORK LEVEL

WHAT IS IT FOR?

Infrastructure

SAFETY



SUSTAINABILITY



(TRAFFIC) DISRUPTION



COSTS



Buildings

ENERGY



COMFORT



HEALTH



COSTS



› DIGITAL DEVELOPMENTS

FOCAL POINTS TNO MOBILITY & BUILT ENVIRONMENT



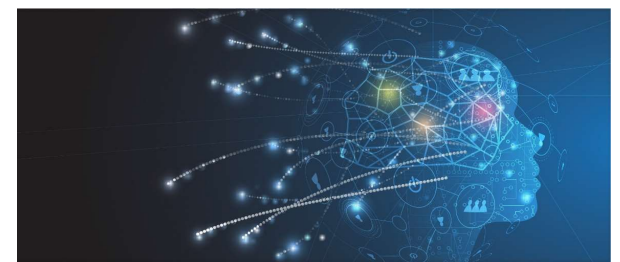
SMART METERING
SYSTEMS (SENSORS)



ASSET LIFECYCLE
INFORMATIE MODELLING



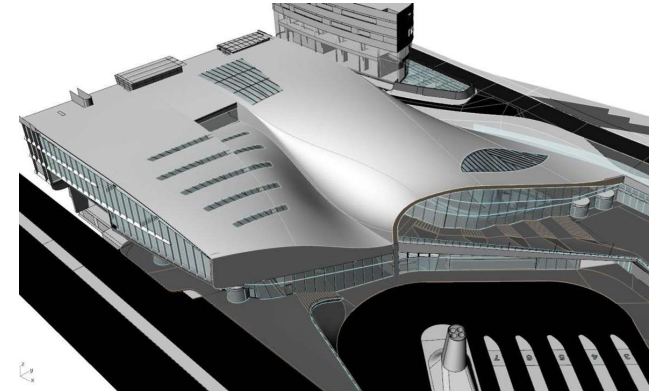
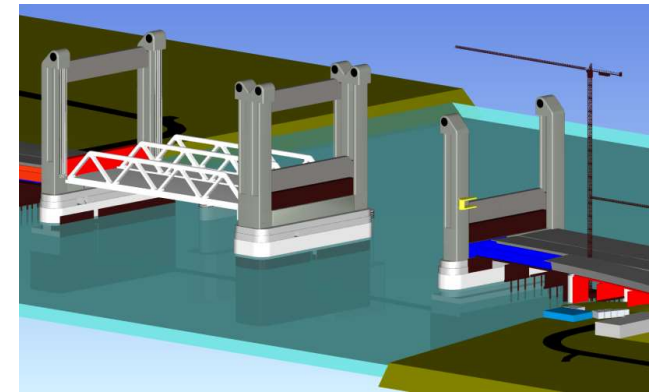
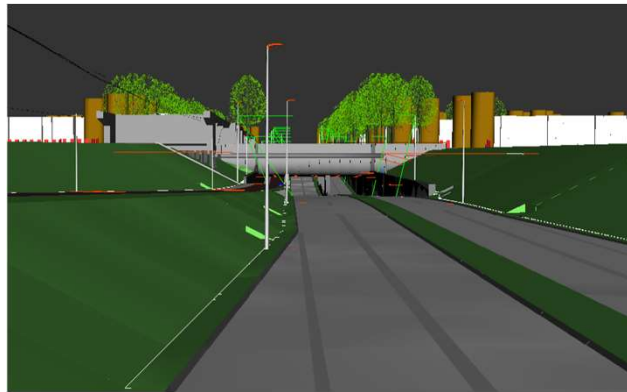
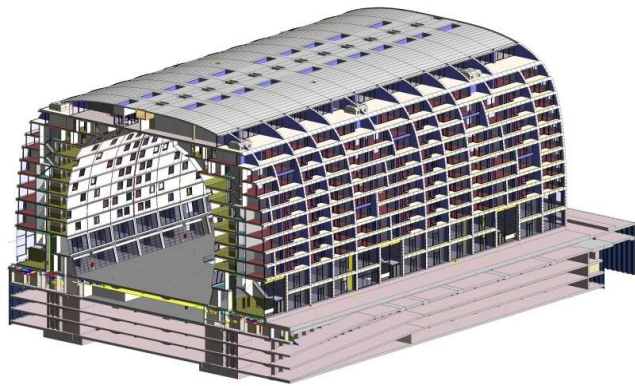
ARTIFICIAL INTELLIGENCE
& MACHINE LEARNING



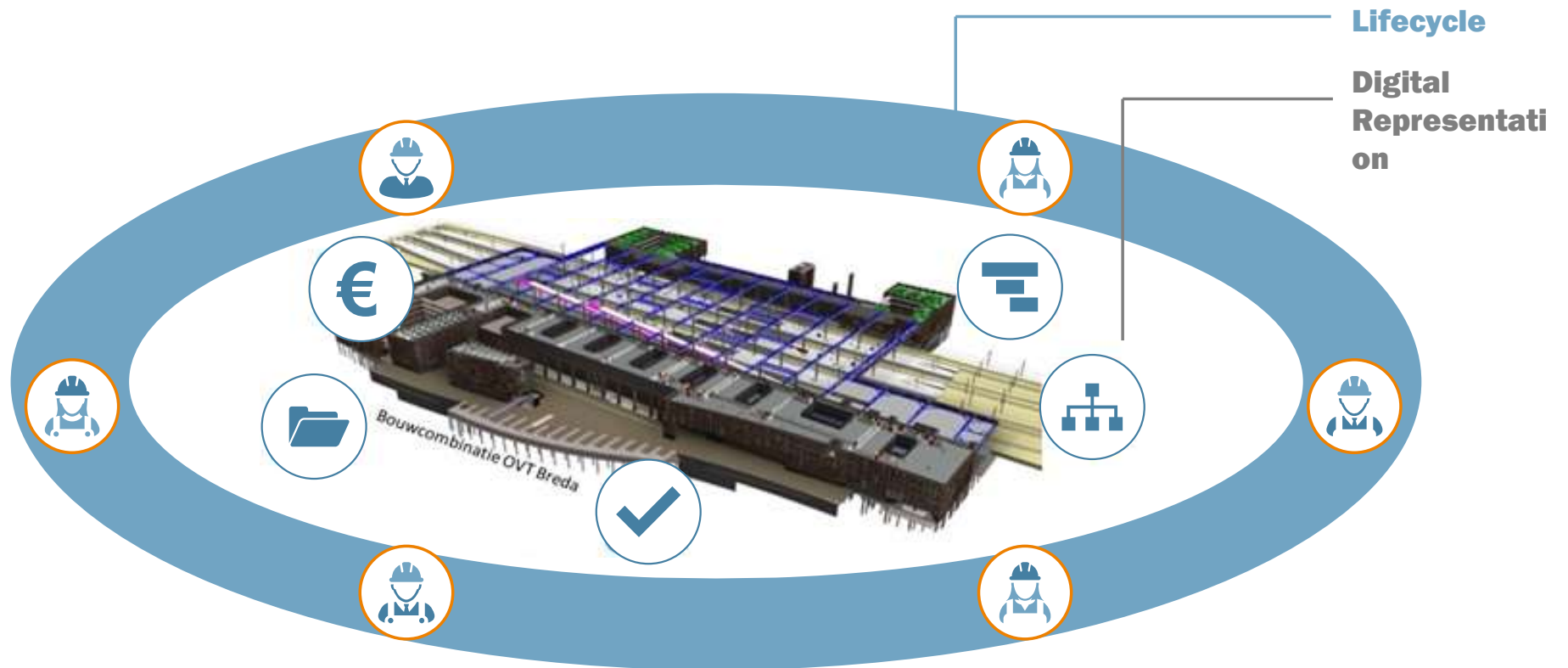
PREDICTIVE TWINS



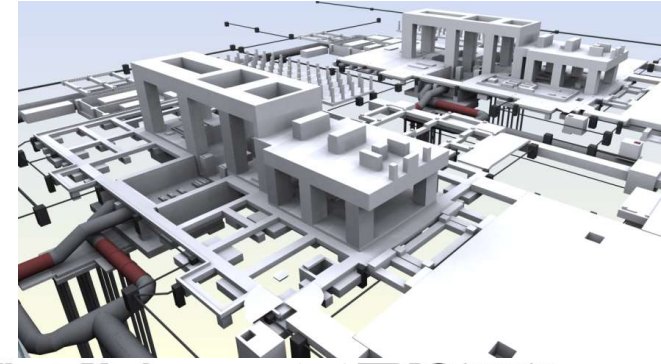
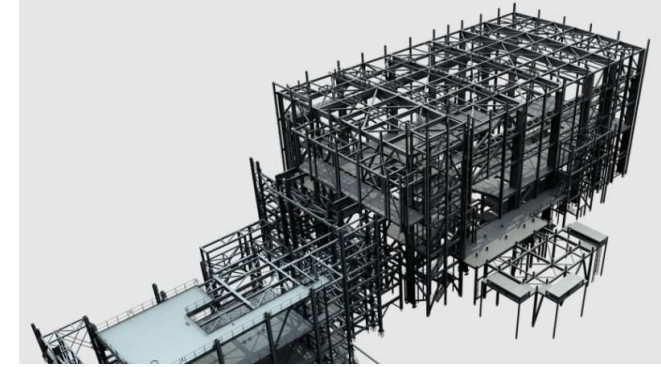
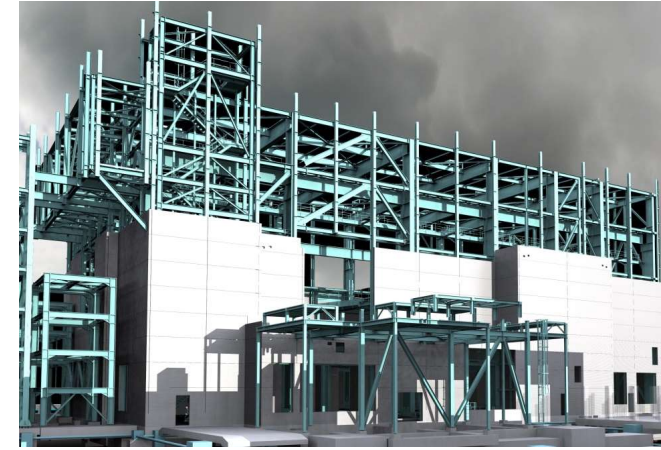
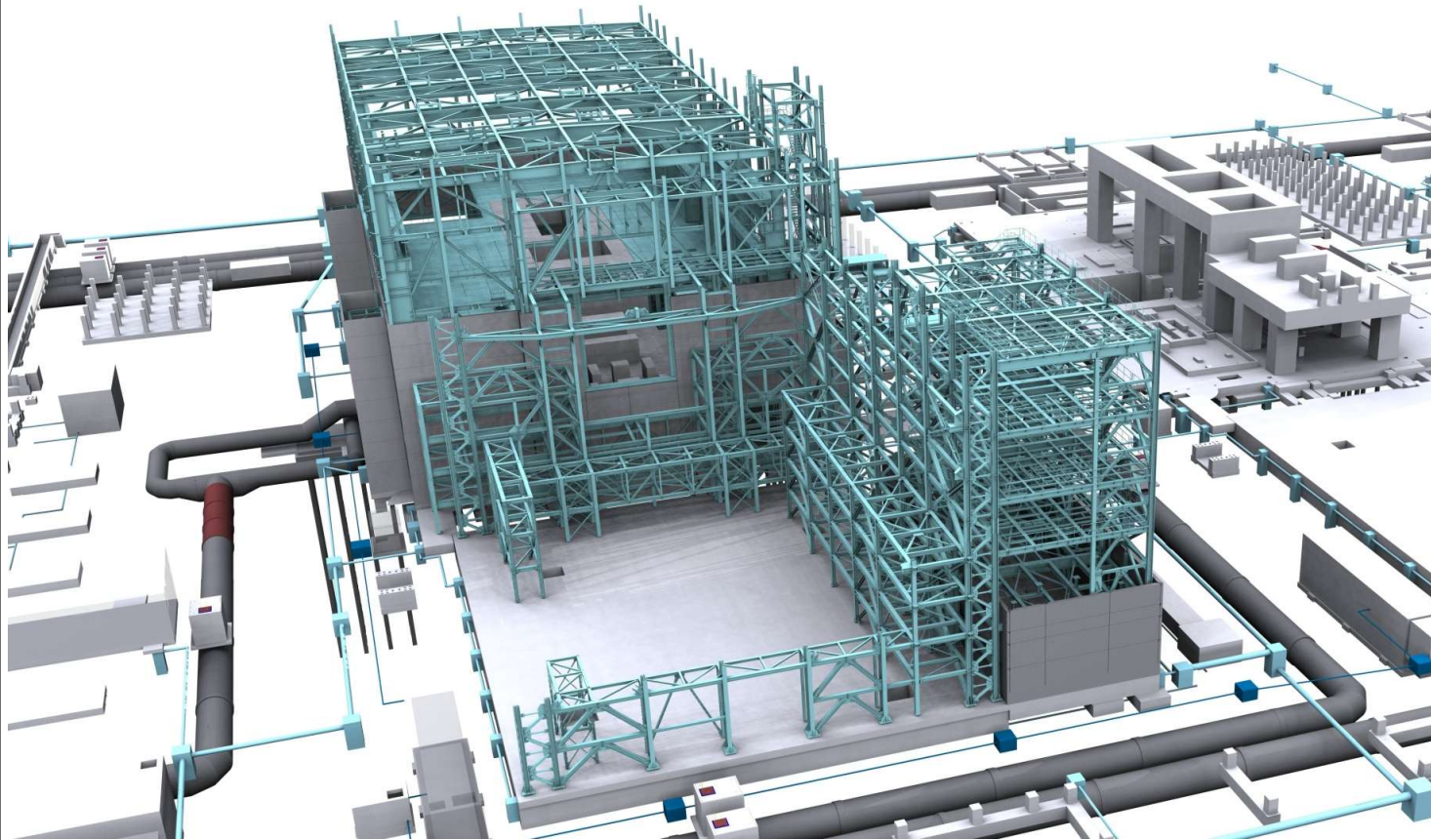
AN IMPORTANT STEP IN THE DIGITAL TRANSFORMATION WORKING WITH BUILDING INFORMATION MODELS (BIM)



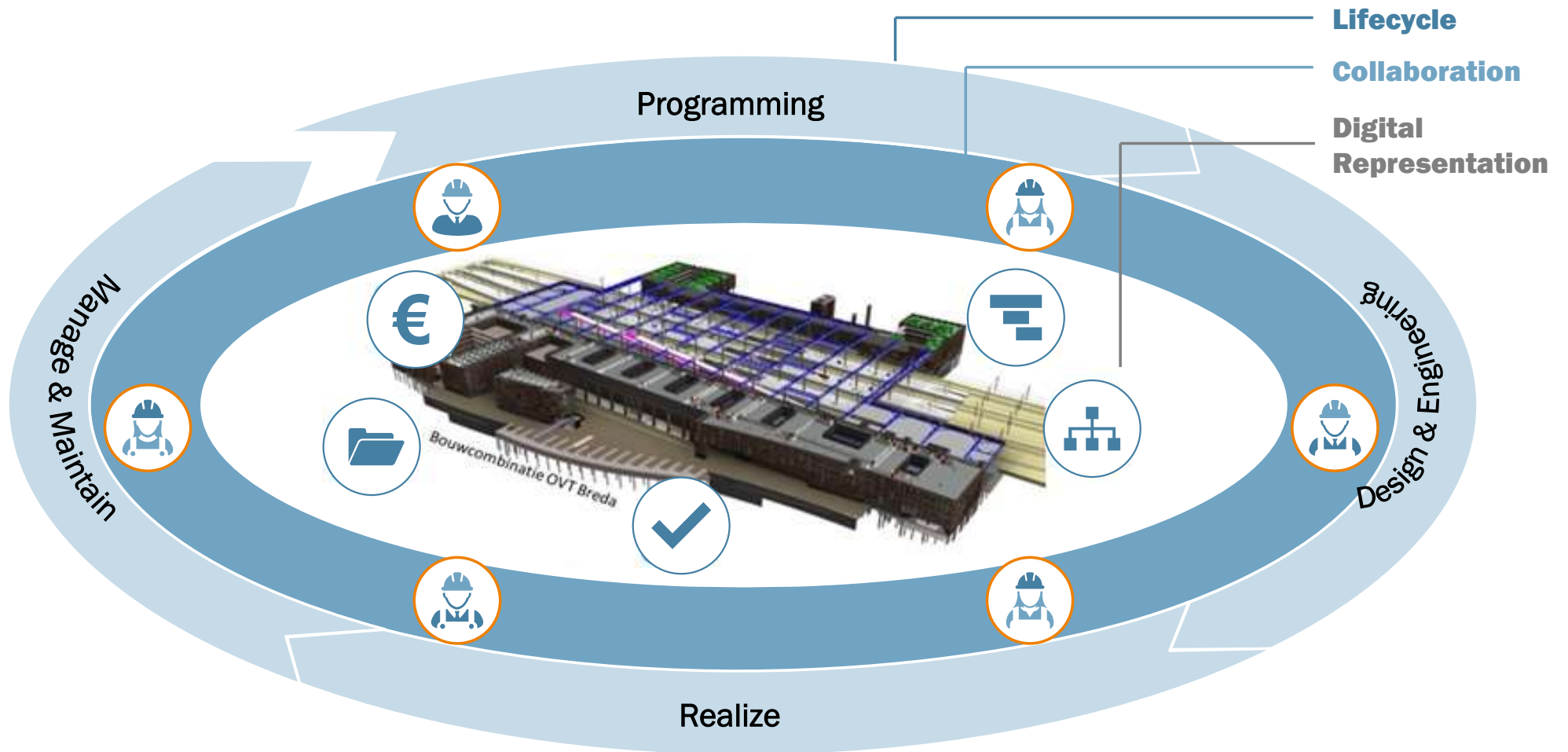
› BIM: TO BUILDING INFORMATION MANAGEMENT



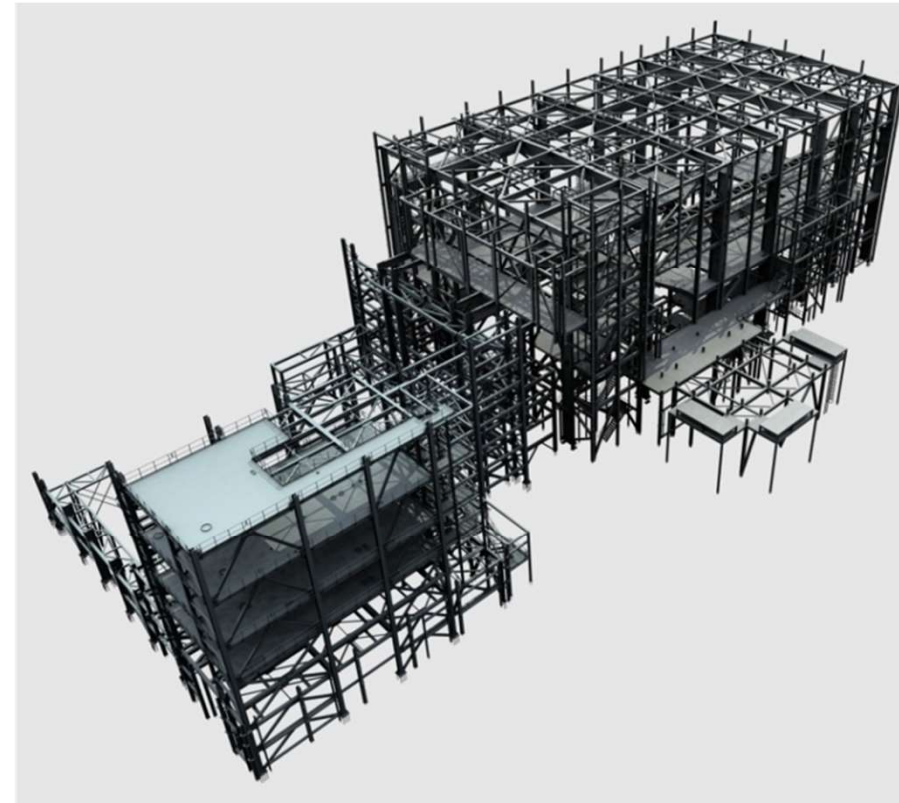
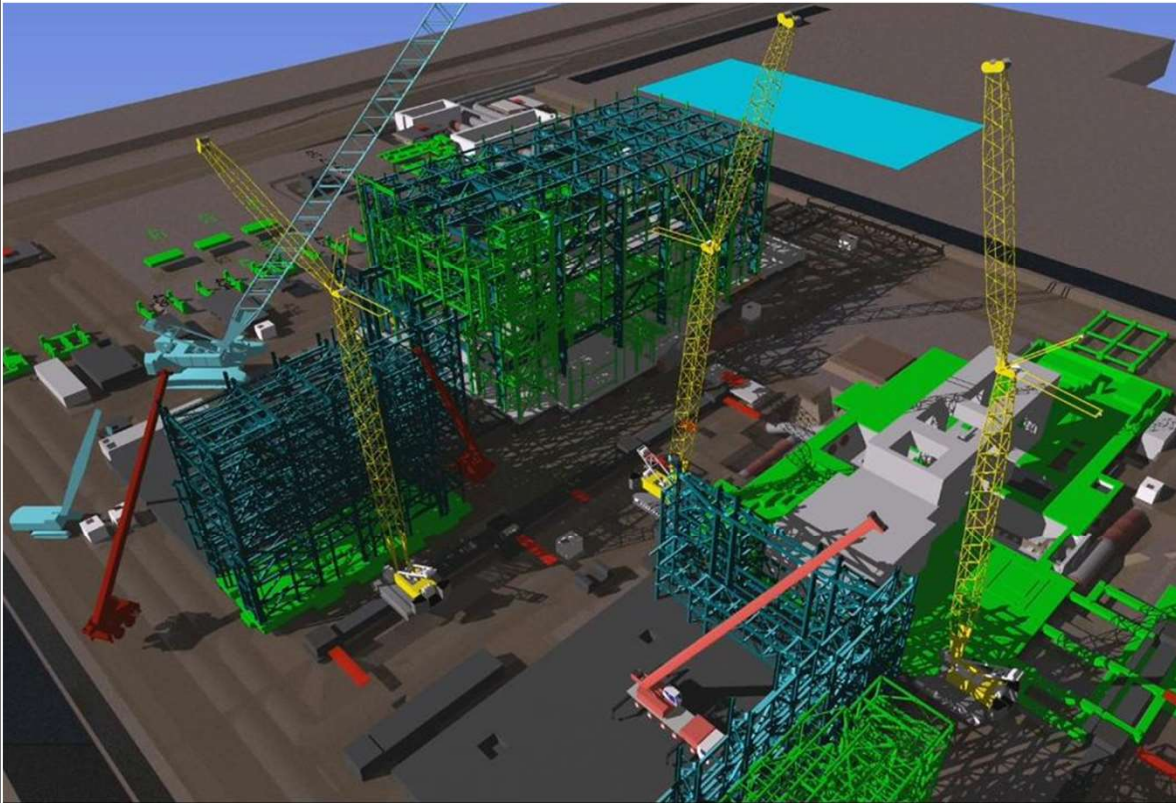
› BIM 3D DESIGN & DESIGN COORDINATION



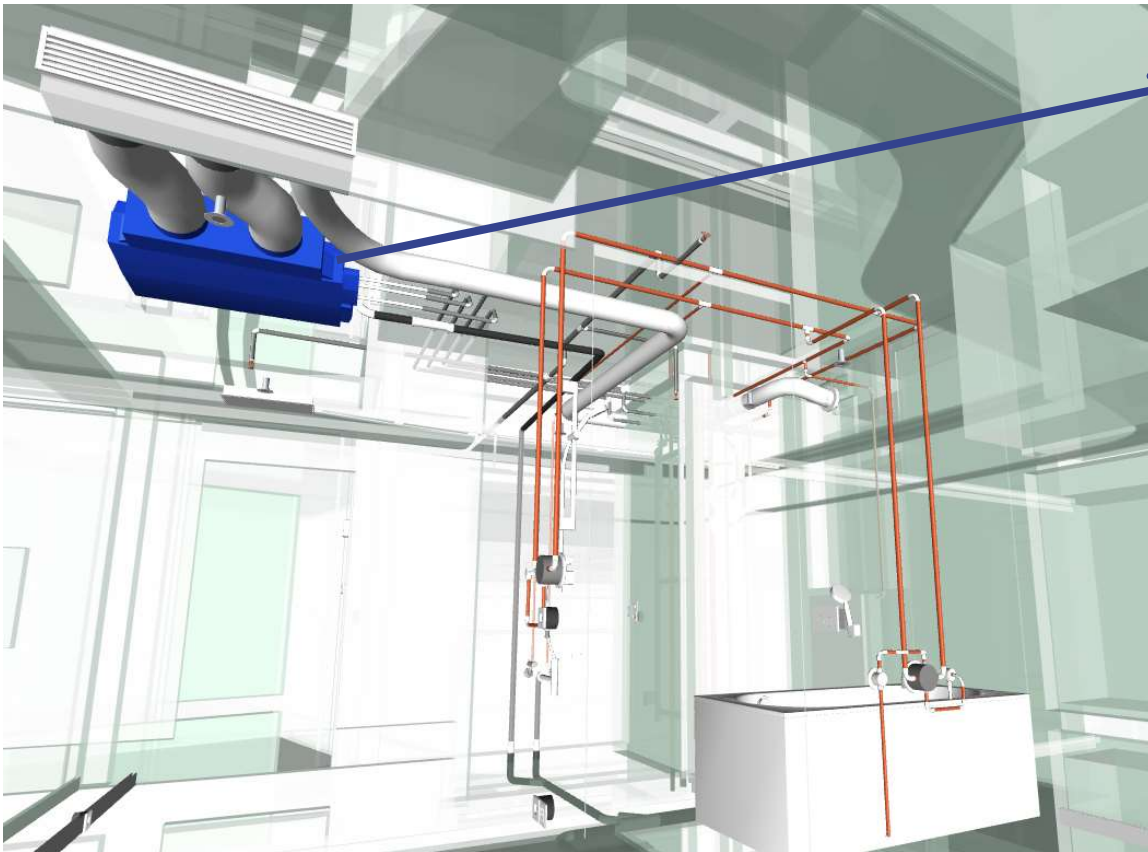
> BIM: TO BUILDING INFORMATION MANAGEMENT



› BIM: REALISATIE OPTIMALISATIE UITVOERING, AANSTURING FABRIEK



› BIM: BEHEER EN ONDERHOUD DIGITAAL GEBOUWDOSSIER



Leveranciersgegevens:

Eigenschap	Waarde
Contactgegevens (Leveranciers)	
Bezoekadres (incl postcode en plaats)	Annie M.G. Schmidtweg 229, 1321 NA Almere
Postadres (incl postcode en plaats)	
Telefoonnummer	+31 36 53 32 587

Modeleigenschappen:

Eigenschap	Waarde
Assembly Code (Revit Type)	3A(57)
Category (Element)	Mechanical Equipment
Category (Revit Type)	Mechanical Equipment
Description (Revit Type)	Fancoil

Locatie:

Object
08.03 - Kamer 08.03

Documenten:

Object
DOC_5198 - 5-9-V08.pdf
DOC_5036 - Major Line technische brochure.pdf
DOC_5037 - Technische specs.pdf

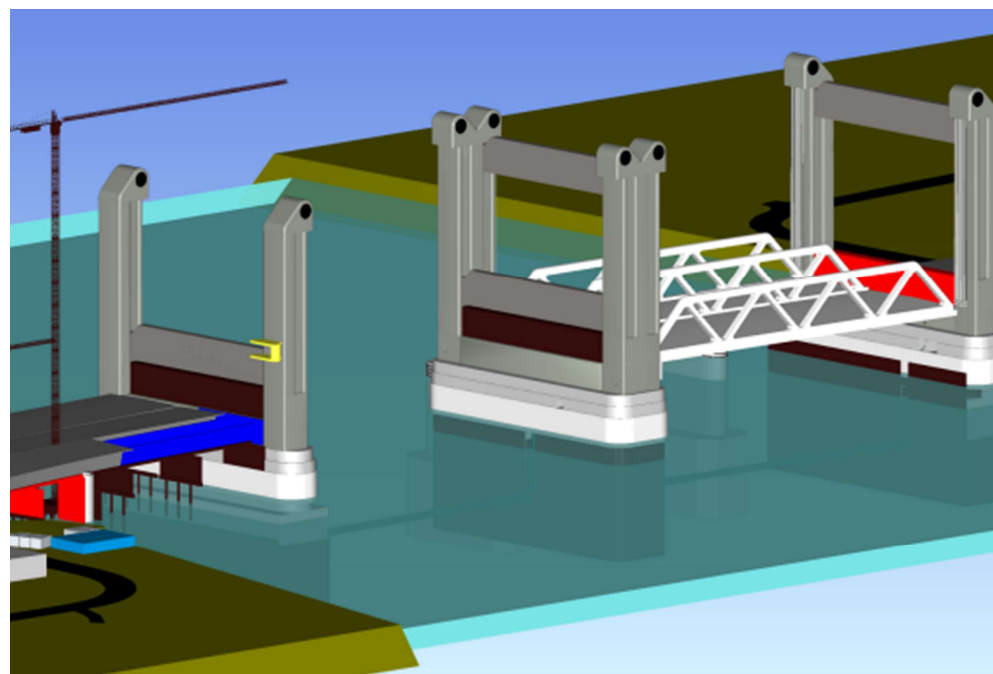


Ballast Nedam

UNIVERSITY
OF TWENTE.

TNO innovation
for life

WE HEBBEN STEEDS BETERE INFORMATIE VAN BOUWWERKEN



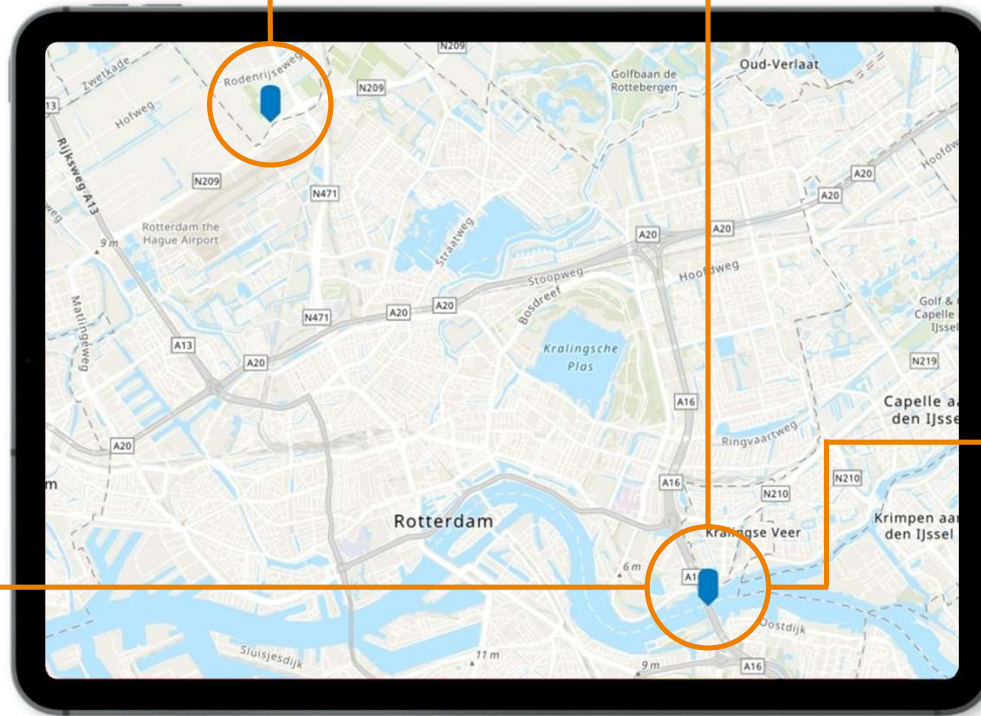
› THERE IS MORE AND MORE (CURRENT) DYNAMIC DATA

≈20 data points per hour



KNMI weather data

- › Temperature
- › Sunshine
- › Clouds
- › Precipitation....



>4M data points per hour



TNO measurement data bridge

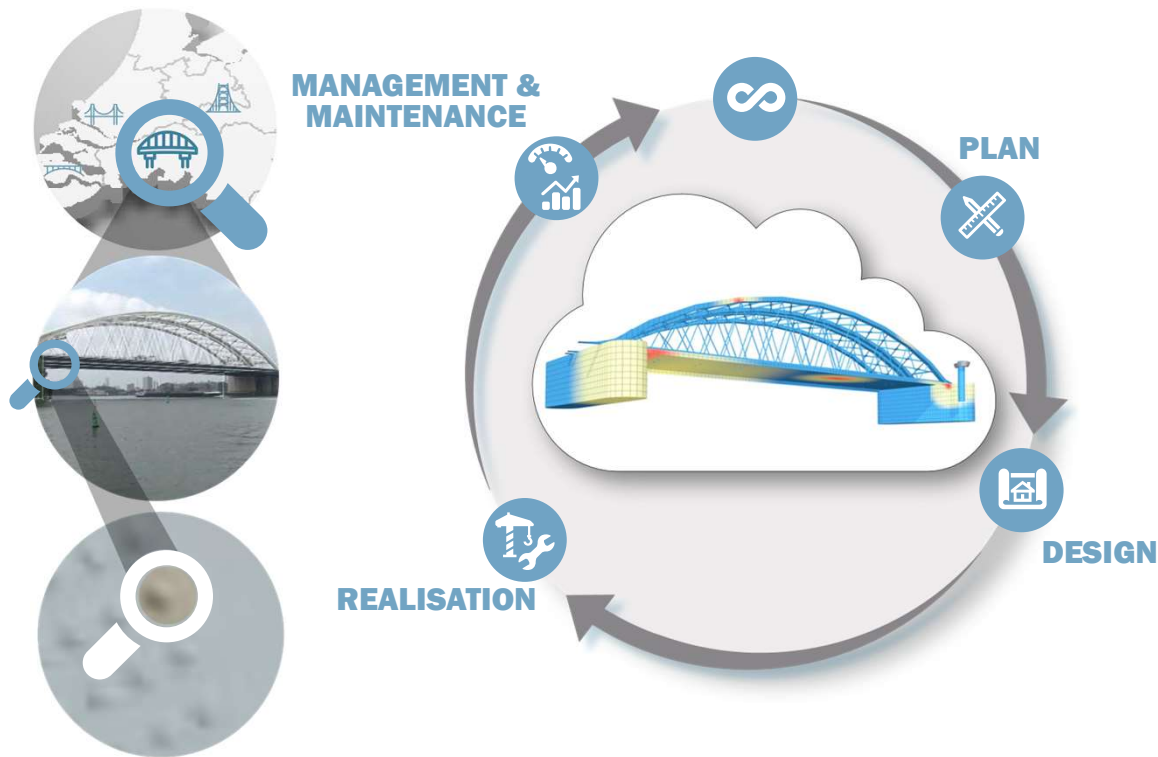
- › Thermal expansion

300 data points per hour per lane

NDW traffic data

- › Number of vehicles per hour
- › 5 length categories

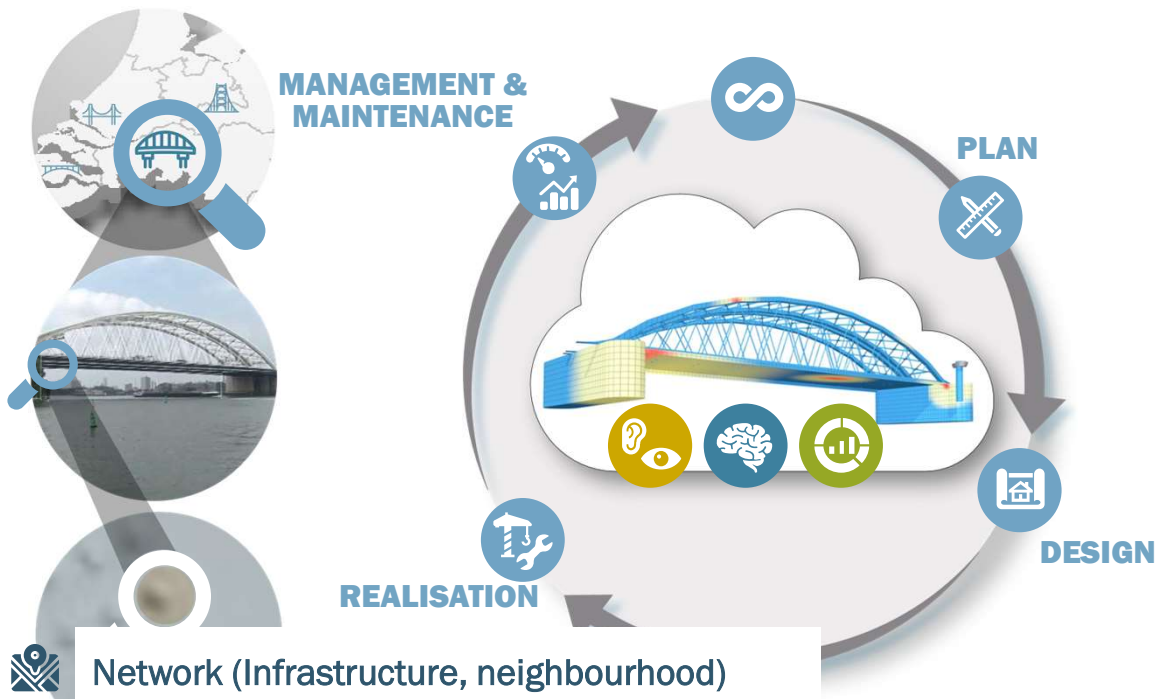
› VISION: NETWORK OF PREDICTIVE TWINS OF THE BUILT ENVIRONMENT



A predictive twin:

- › Is a **digital replica** of the physical twin
- › Assesses the **current situation**
- › Makes **predictions**
- › **Learns** from new information
- › Proposes (or decides) **decisions**

TNO MBE: civil constructions, roads, buildings, offshore wind, greenhouse horticulture



1. INFORMATION & MEASURING DATA

- › Information (e.g. BIM)
- › Measuring data



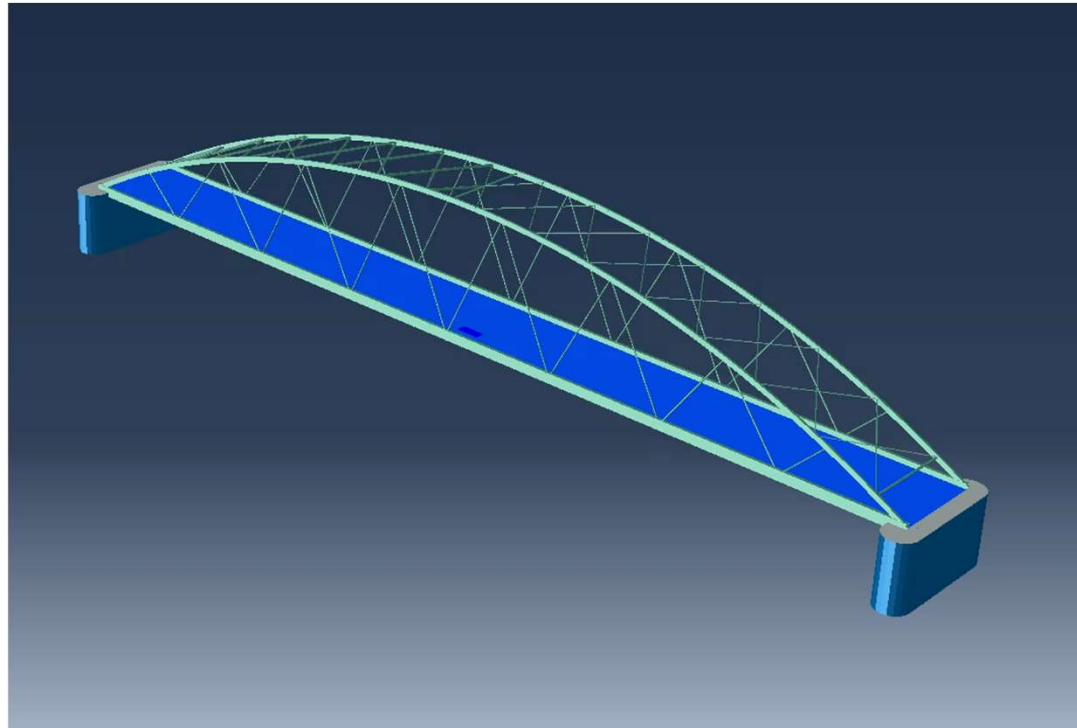
2. MODES & LEARNING

- › Fysical models
- › Machine learning



3. SIMULATE & DECIDE

- › Predictions
- › Scenarios



 Network (traffic network, neighbourhood)

 Construction (bridge, building)

 Component (bridge deck, space)



1. INFORMATION & MEASURING DATA

- › Static
- › Dynamic data



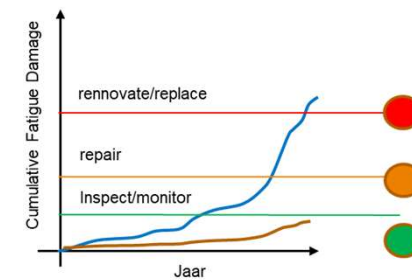
2. MODELS & LEARNING

- › Physical models
- › Machine learning




3. SIMULATE & DECIDE

- › Predictions
- › Scenarios





 Network (Infrastructure, neighbourhood)

 Construction (bridge, building)

 Component (bridge deck, space)



1. INFORMATION & MEASURING DATA

- › Static
- › Dynamic data



2. MODELS & LEARNING

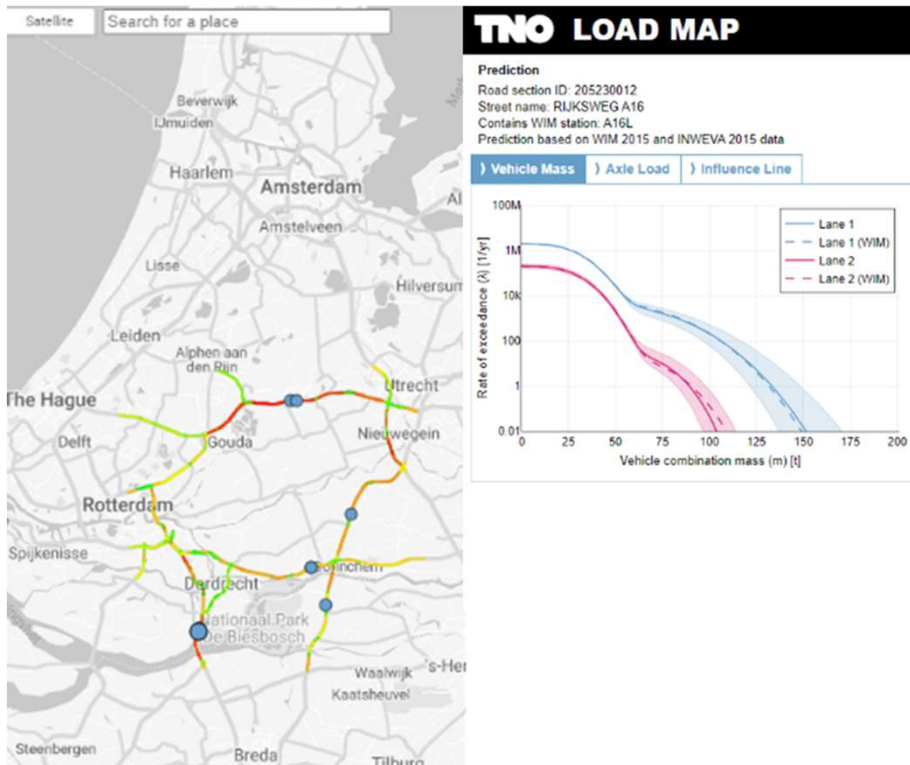
- › Physical models
- › Machine learning



3. SIMULATE & DECIDE

- › Predictions
- › Scenarios





Network (Infrastructure, neighbourhood)



Construction (bridge, building)



Component (bridge deck, space)



1. INFORMATION & MEASURING DATA

- › Static
- › Dynamic data



2. MODELS & LEARNING

- › Physical models
- › Machine learning



3. SIMULATE & DECIDE

- › Predictions
- › Scenarios



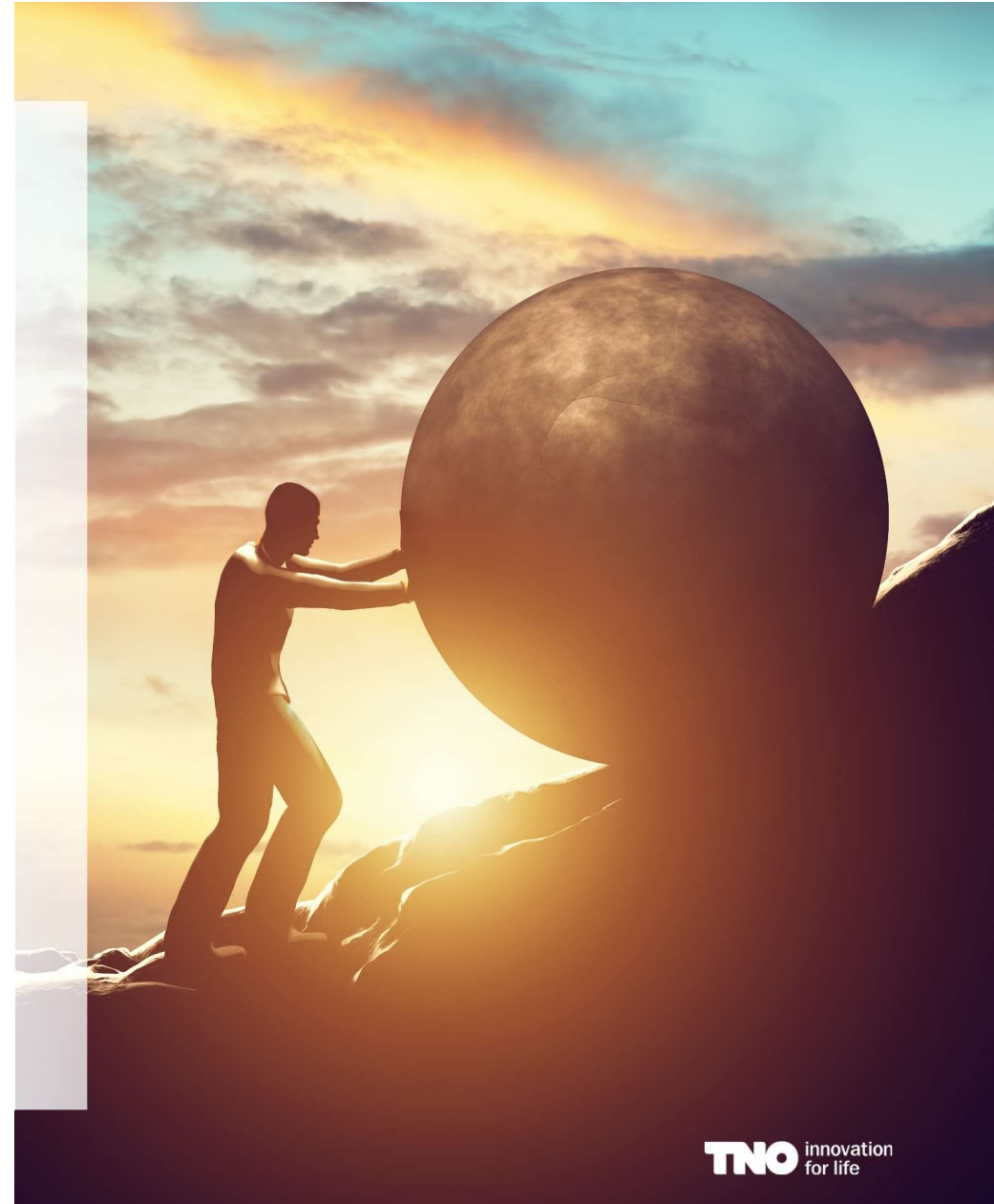
TNO innovation
for life

BUT... NOT ONLY IN THE INFRASTRUCTURE



› SOME CONDITIONS AND CHALLENGES

- › Needs vs. forms
of predictive twins: 'fit for purpose'
- › Develop predictive twin solutions
flexible and reusable
- › Structuring and connecting sources of information
(on asset life cycles)
- › Integrate knowledge domains
(engineering, AI, information modelling, etc.)
- › Different interests and 'fragmented'
business models



TNO POSITION PAPER



NAAR NETWERKEN VAN PREDICTIVE TWINS VAN DE GEBOUWDE OMGEVING

INHOUD

Inleiding	3
BIM als opstap naar predictive twins	5
Steeds meer meetdata	7
De predictive twin-visie van TNO	8
2 toepassingsgebieden:	
1) Vervangings- en renovatieopgave civiele infrastructuur en circulair bouwen	10
2) Energetransitie gebouwde omgeving (gebouwen en wijken)	12
Voorwaarden voor de ontwikkeling en het gebruik van predictive twins	15
Conclusie	16
Eindnoten	17

CONTACT INFO



WEBSITE & SOCIAL MEDIA:
www.tno.nl/BIM-digitalisering



Twitter: [@TNO_Nieuws](https://twitter.com/TNO_Nieuws)



LinkedIn: [TNO](https://www.linkedin.com/company/tno)



ROB ROEF

rob.roef@tno.nl

