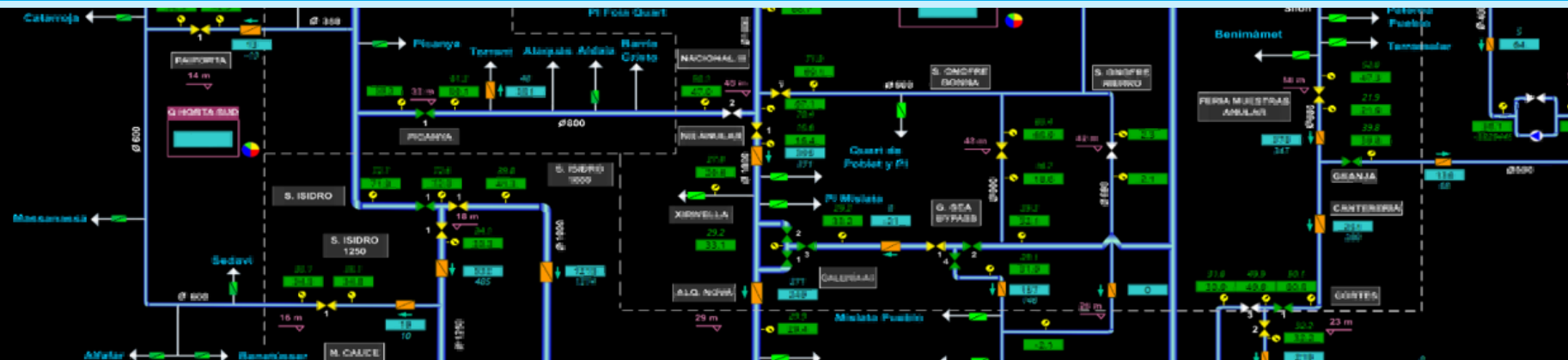


Past, present and future of Digital Twins for water supply

# Digital Twins for Water Distribution Networks

PILAR CONEJOS, PHD



xylem  vue  
powered by go-aigua

 IDRICA



Pilar Conejos is Digital Twin Manager at Idrica and Part-time Associate Professor at the Universitat Politècnica de València(UPV). Since 2023, member of the IWA Digital Water Programme's Steering Committee.

She is an Industrial Engineer and holds a PhD in the Hydraulic Engineering and Environment Program from the UPV.

Pilar has 25 years of experience in the water sector. She worked in the company Global Omnium, where she was responsible for network control and operation in the Great Valencia for 15 years.

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# OUTLINE

- 1) Going into....
- 2) Case example
- 3) What's next...



# 1. GOING INTO

*Digital Twin*



Digital Twins **REPLICATE** the real system **BEHAVIOR CONTINUOUSLY** in a  
**virtual model that serves as the basis for experimentation**

The concept of DT has been used **traditionally in the industry field**, but it can also be developed and exploited in a **city management context**, and in particular in **water supply and distribution networks (WSDN)**

# Why developing a DT for a water distribution network?



Complex  
Systems



Variable  
Environment



Water  
Scarcity



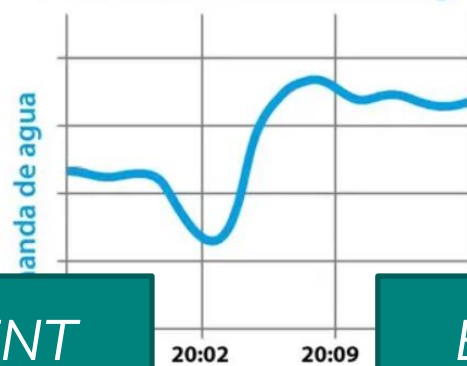
Essential  
Service

RESILIENT

EFFICIENT

SECURE

Evolución de la demanda de agua



# Digital Twin Capabilities





# Digital Twin Components

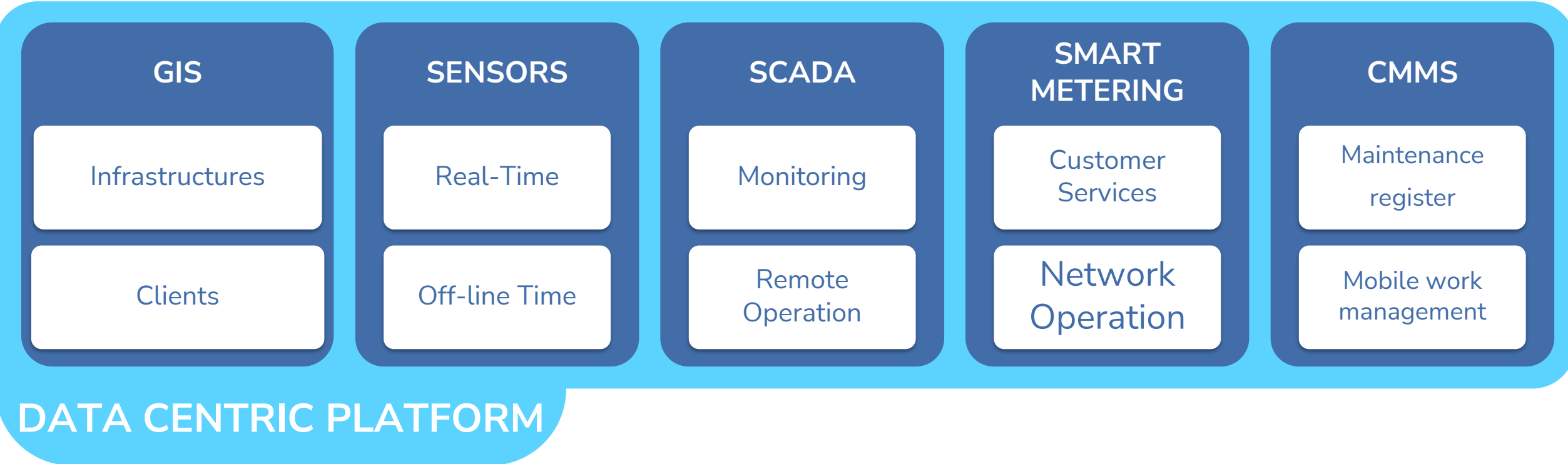
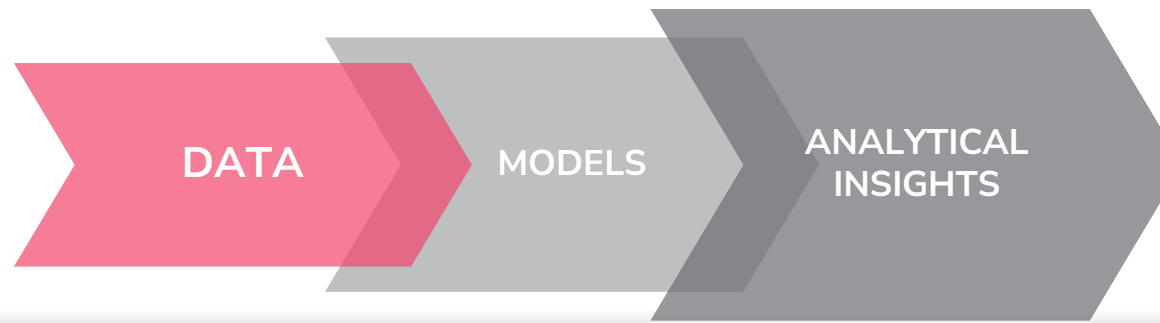
*Physical  
System*

*Digital  
Twin*

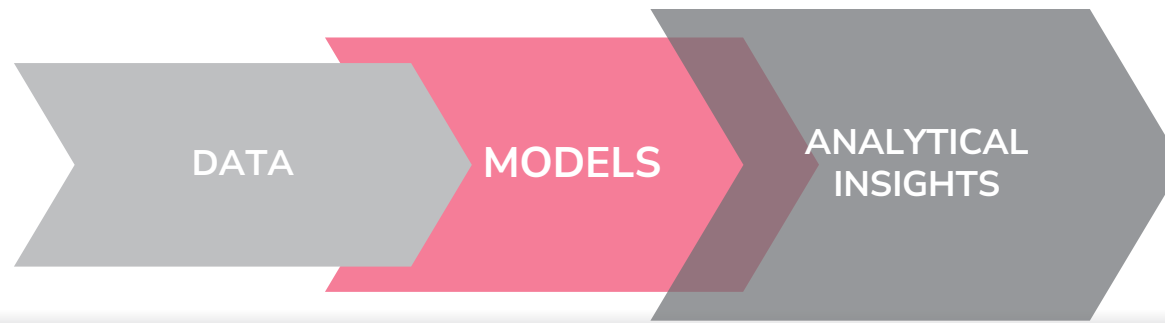


*Continuous Improvement – Informed Decisions*

# Digital Twin Components



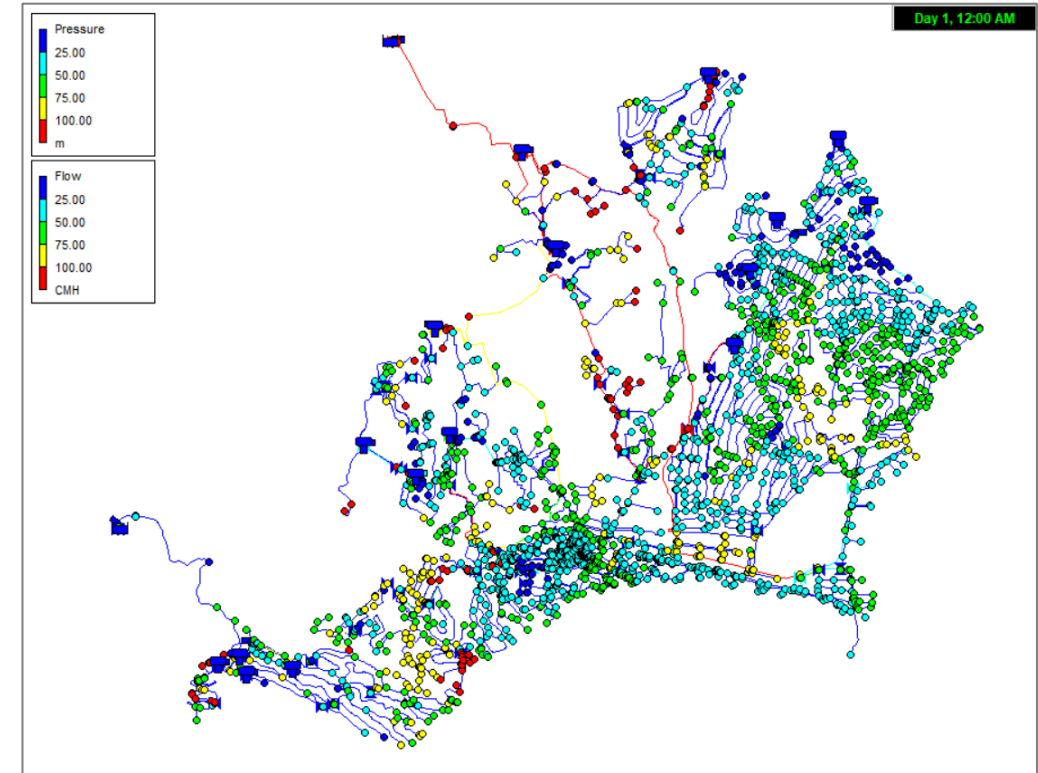
# Digital Twin Components



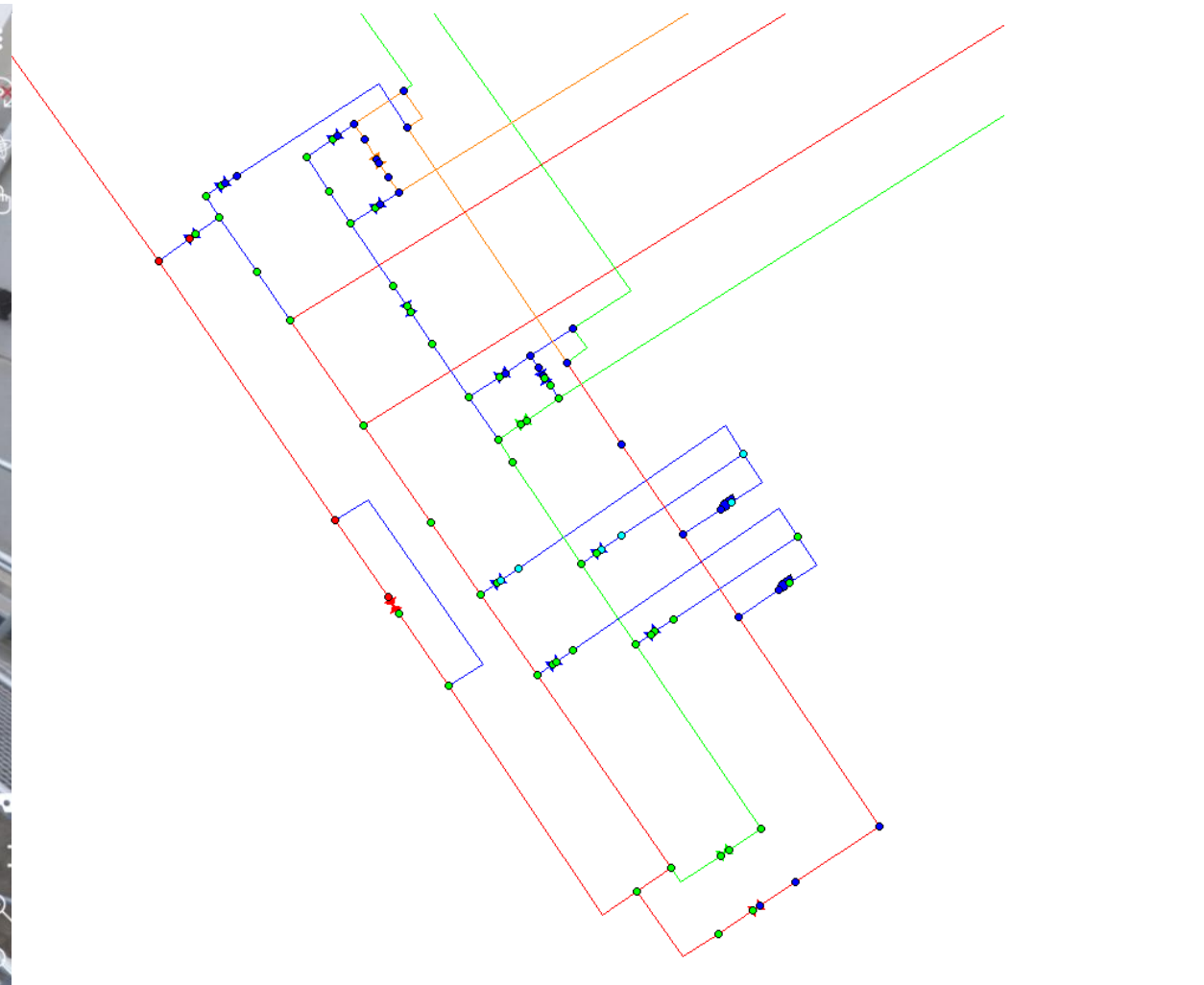
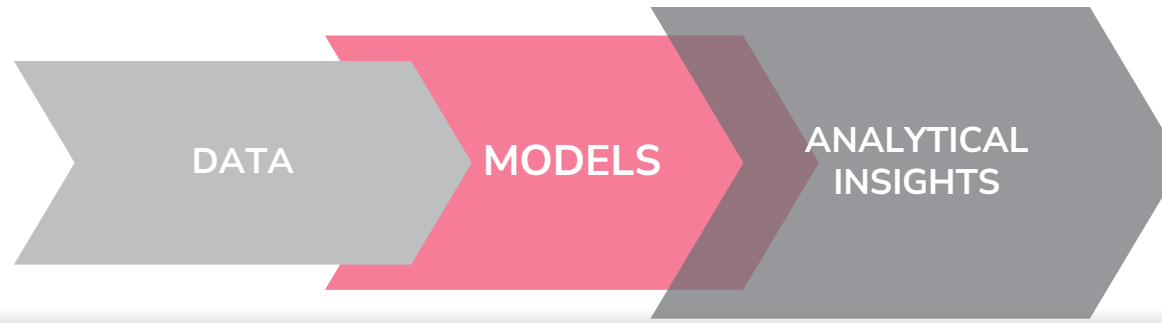
## Data Driven Models



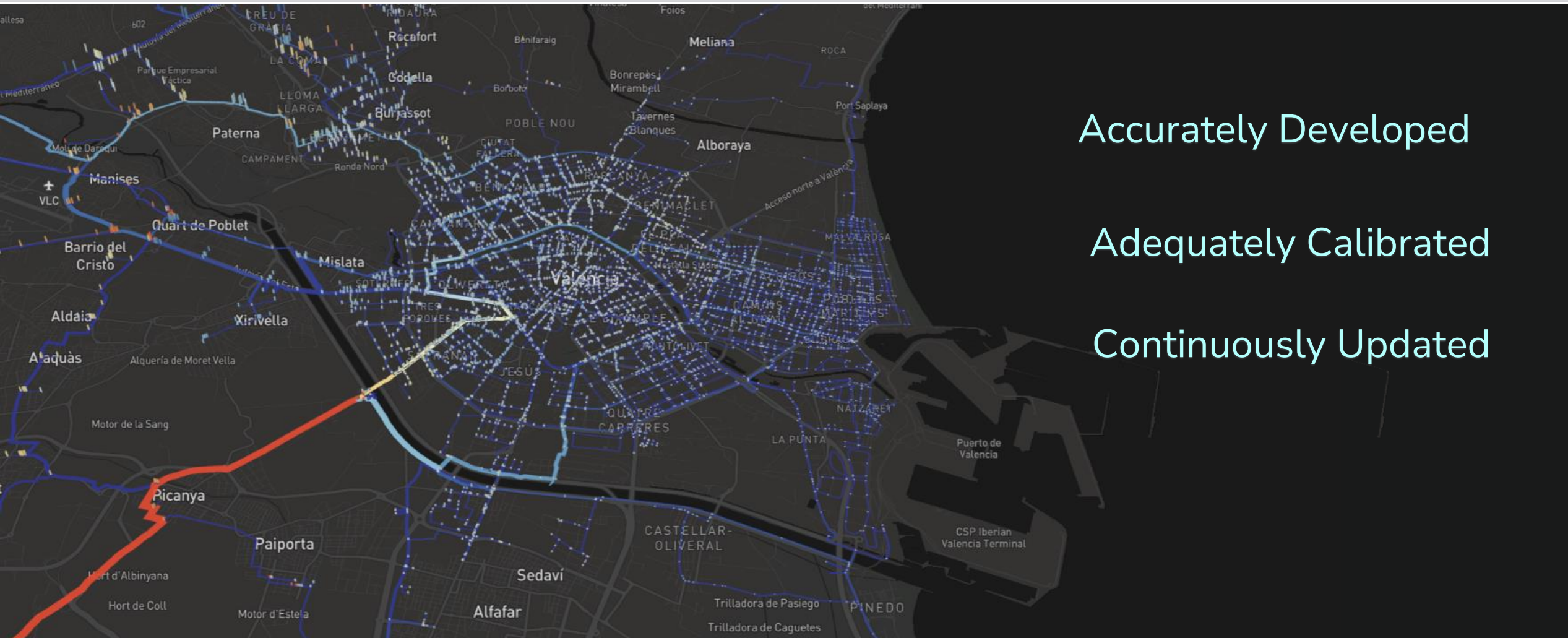
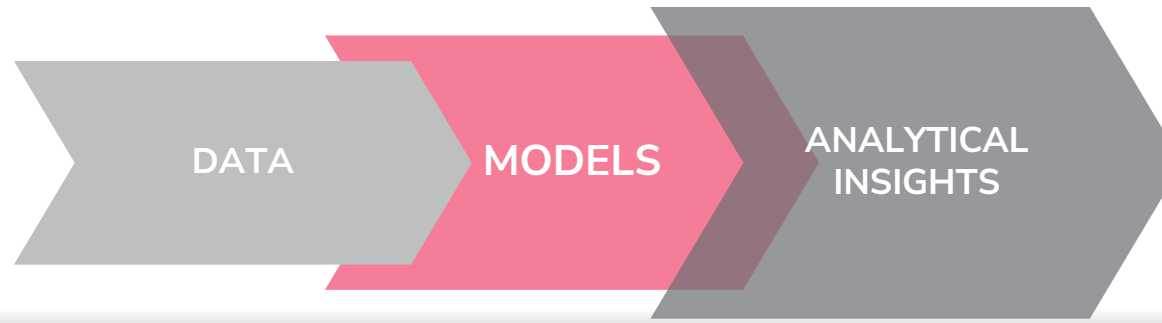
## Physics Based Models



# Digital Twin Components

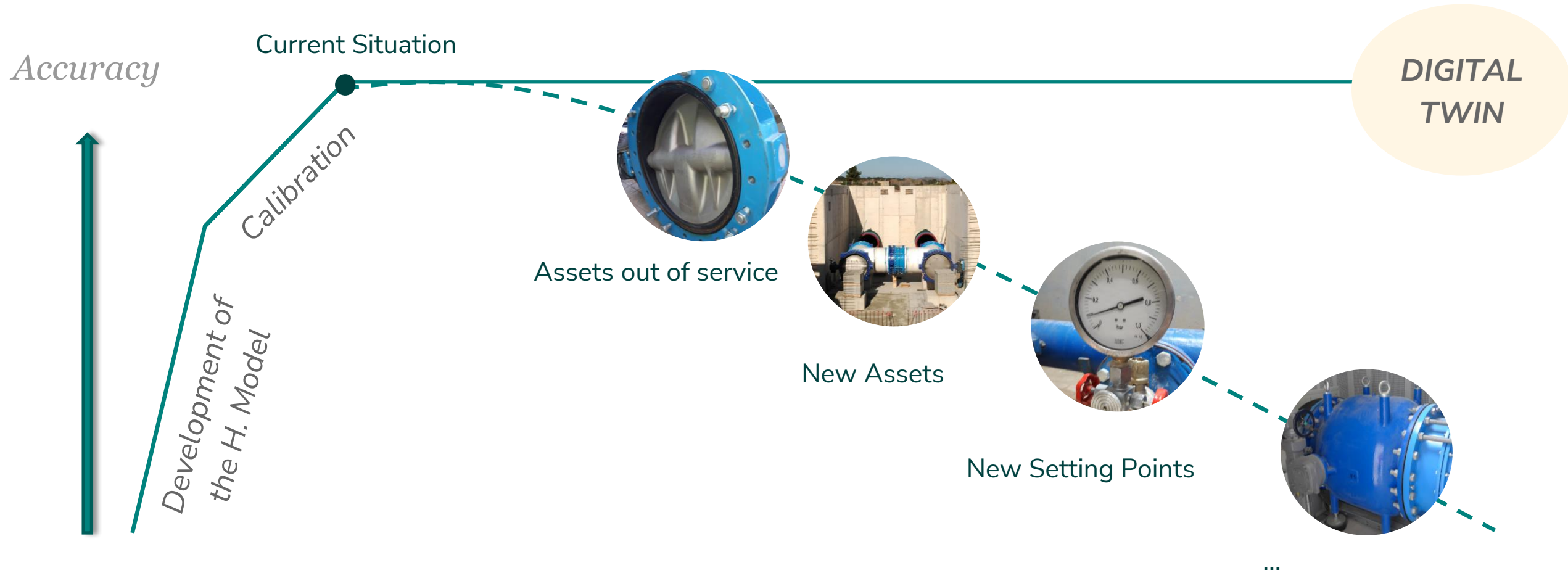
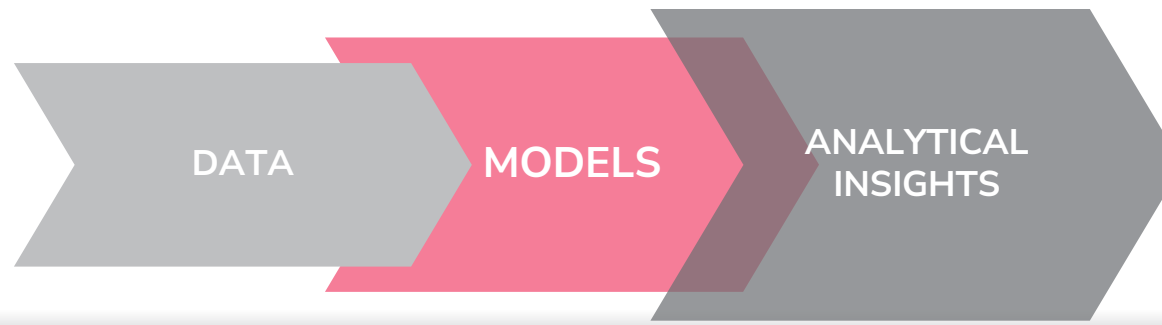


# Digital Twin Components

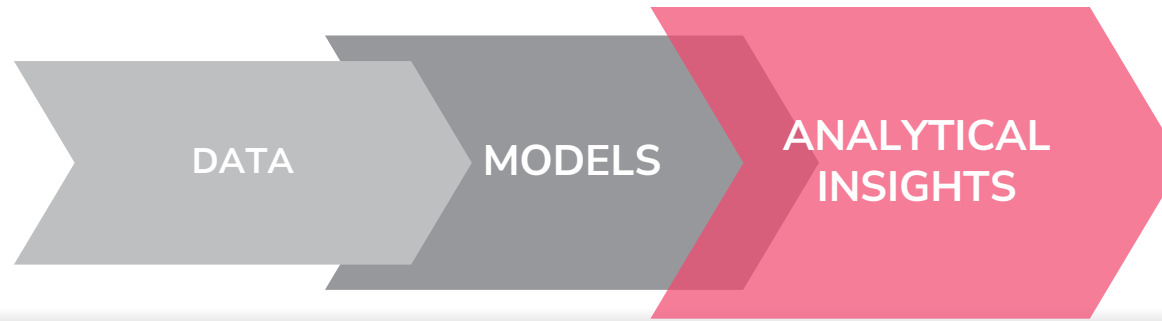


Accurately Developed  
Adequately Calibrated  
Continuously Updated

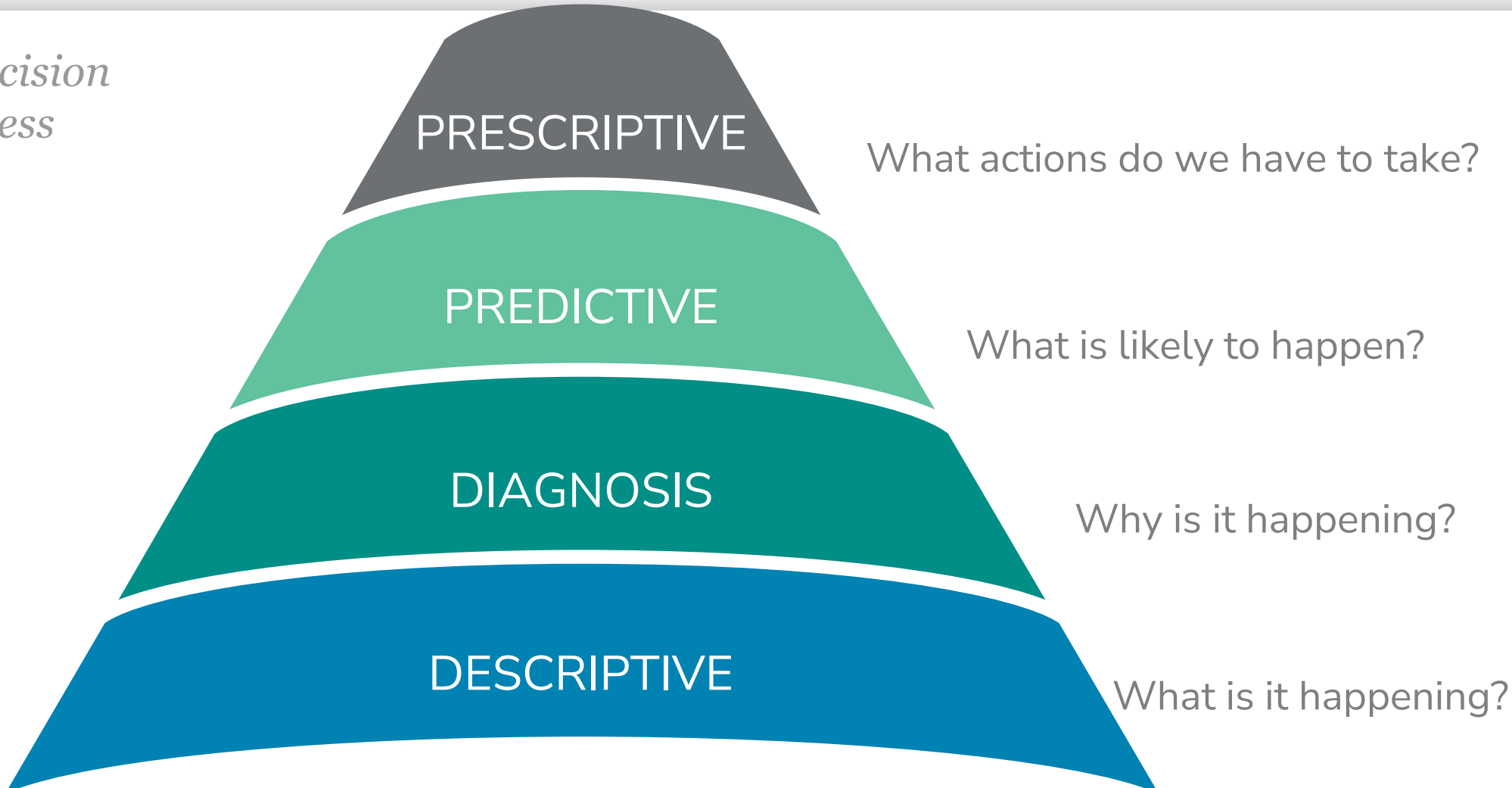
# Digital Twin Components



# Digital Twin Components



*Value for the decision making process*



# MAIN OBJECTIVES OF THE DIGITAL TWIN

## SUPPORT TO DAILY OPERATIONS

Water quality monitoring & control



Leak location and NRW reduction



Energy optimization



Maintenance work schedule



Early response to emergencies



Anomalies detection



## NETWORK PLANNING

Contingency planning



Optimal network design



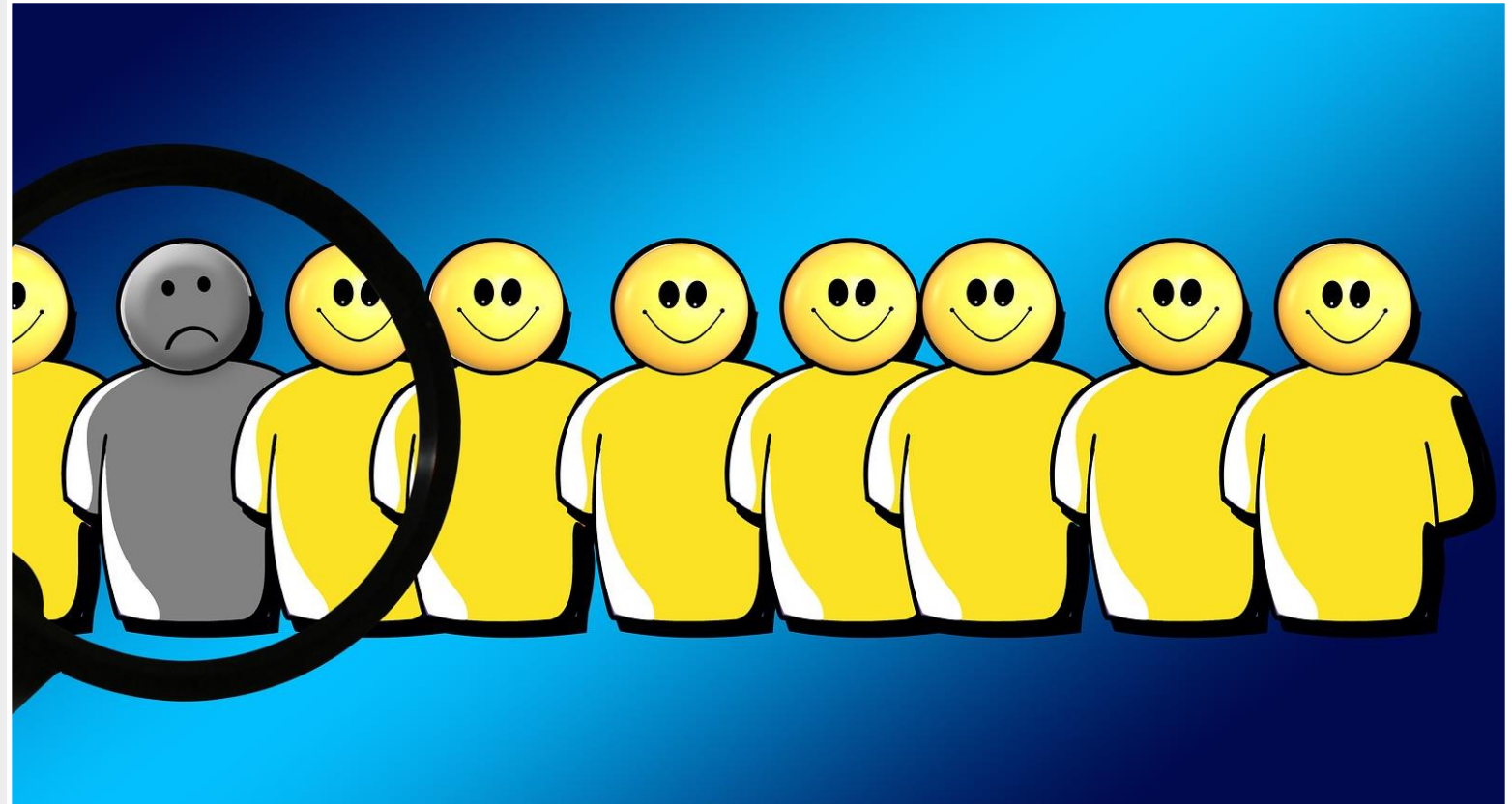
Master plans for infrastructures





# A Digital Twin is much more than...

- ⊗ Monitoring system: SCADA
- ⊗ Digital representation: GIS, BIM,...
- ⊗ Hydraulic model built with static data set



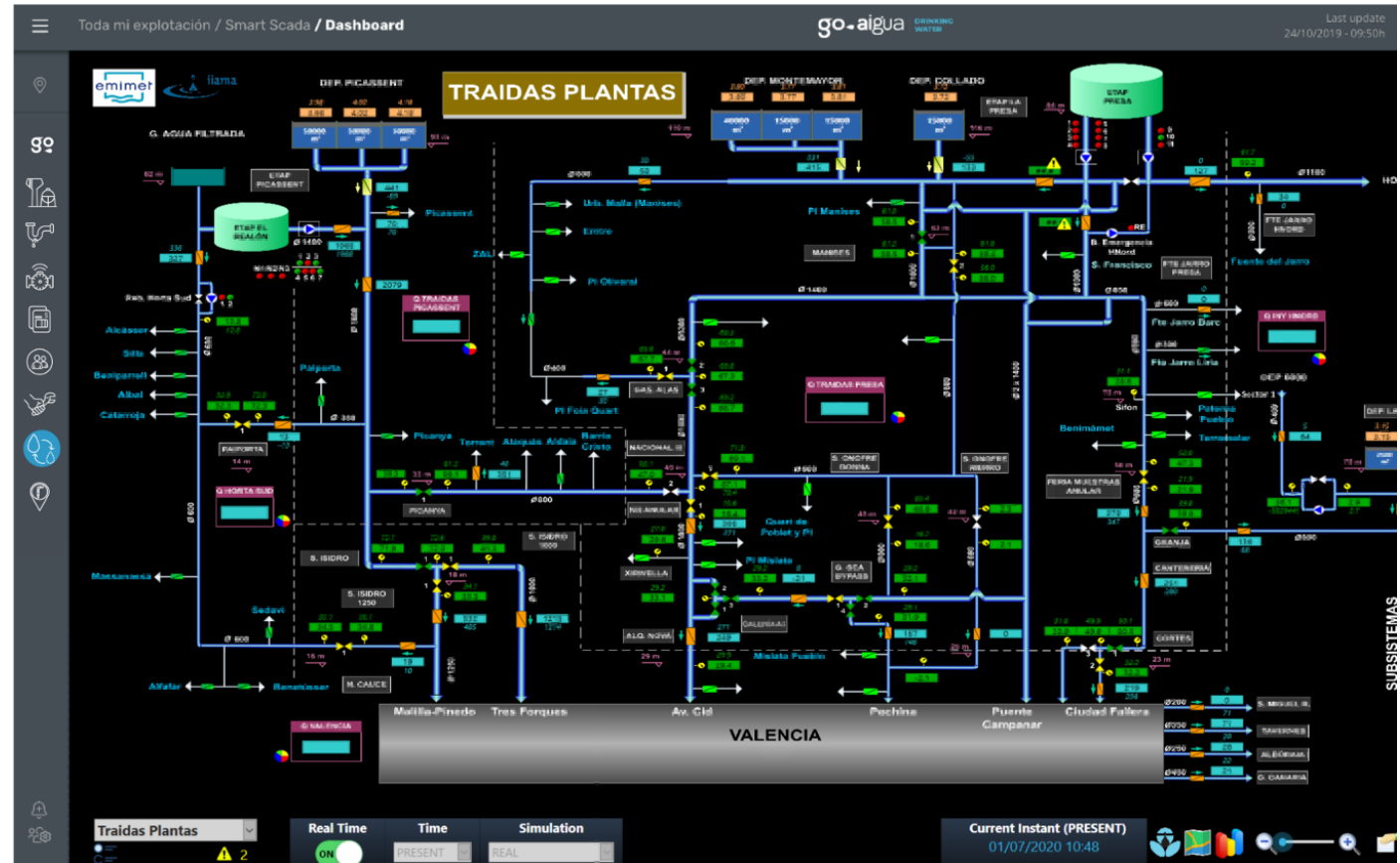
# 2.

## VALENCIA'S DIGITAL TWIN

*20 years journey...*



*Supporting daily operation for over 15 years*



# Valencia's Metropolitan Area Digital Twin

8th Annual Water Distribution Systems Analysis Symposium, Cincinnati, Ohio, USA, August 27-30, 2006

## SCA-Red, A GENERAL PURPOSE SCADA APPLICATION FOR TAKING DECISIONS IN REAL TIME WITH THE AID OF A HYDRAULIC MODEL

**Bou, Vicente<sup>1</sup>; Martínez, Fernando<sup>1</sup>; Conejos, Pilar<sup>2</sup>**

<sup>1</sup>REDHISP Group, Inst. of Hydraulic and Environmental Engineering (IIAMA),  
Polytechnic University of Valencia, SPAIN.

*vibouso@dihma.upv.es ; fmartine@hma.upv.es*

<sup>2</sup>Network Operation Department. EMIVASA, Aguas de Valencia Group

XXXV Jornadas AEAS, Valencia 27-29 Marzo 2019

## RETOS EN LA CONEXIÓN DE UN MODELO HIDRÁULICO AL SISTEMA SCADA. EXPERIENCIAS DE UN CASO DE ÉXITO

# La simulación hidráulica como herramienta de apoyo a la toma de decisiones en Global Omnium

La moderna gestión de los sistemas de abastecimiento de agua requiere el uso de modelos matemáticos como herramienta de soporte para la toma de decisiones, tanto en el ámbito de la planificación como en la operación diaria de la red. Los modelos son, además, claves para garantizar una gestión eficiente de los recursos hídricos y energéticos disponibles, así como una reacción rápida y segura frente a una situación de emergencia. Con este objetivo Global Omnium tiene implantado desde hace años en su Centro de Control de la red de abastecimiento a Valencia y su área metropolitana un modelo matemático de

nº 26 - Julio-Agosto 2017

1 Martínez et al. | Calibración Sistema de Distribución de Agua Complejo a partir de variables SCADA

JIA 2017 | Línea Temática B

## Calibración de un Sistema de Distribución de Agua Complejo a partir de variables SCADA

Martínez Alzamora, F. <sup>a</sup>, Conejos, P. <sup>b</sup>, Urban, P. <sup>c</sup>

<sup>a</sup> Catedrático de Ingeniería Hidráulica. E-mail: [fmartine@hma.upv.es](mailto:fmartine@hma.upv.es)

<sup>b</sup> Dr. Ing. Industrial. Responsable Departamento Regulación y Control de Red Agua en Alta. E-mail: [pconejos@emimet.es](mailto:pconejos@emimet.es)

<sup>c</sup> Ing. Agrónomo. Departamento de Regulación y Control de Red Agua en Alta. E-mail: [purban@emimet.es](mailto:purban@emimet.es)

<sup>a</sup> Instituto de Ingeniería del Agua y Medio Ambiente (IIAMA), Universitat Politècnica de València, Camino de Vera s/n 46022, Valencia, España.

<sup>b,c</sup> Empresa Mixta Metropolitana, S.A. Global Omnium. C/ Pedrapiquers, 4, 46014 Valencia, España

Línea temática | B. Hidrología, usos y gestión del agua.

## Building and exploiting a Digital Twin for the management of drinking water distribution networks

P. Conejos Fuertes , F. Martínez Alzamora , M. Hervás Carot & J.C. Alonso Campos

To cite this article: P. Conejos Fuertes , F. Martínez Alzamora , M. Hervás Carot & J.C. Alonso Campos (2020): Building and exploiting a Digital Twin for the management of drinking water distribution networks, Urban Water Journal, DOI: [10.1080/1573062X.2020.1771382](https://doi.org/10.1080/1573062X.2020.1771382)

To link to this article: <https://doi.org/10.1080/1573062X.2020.1771382>

hydrolink 2 | 2021

IN DEPTH > ARTIFICIAL INTELLIGENCE

## Digital Twins - A new paradigm for water supply and distribution networks

By Fernando Martínez Alzamora, Pilar Conejos, Mario Castro-Gama and Ina Vertommen

A digital twin (DT) is a virtual copy (a digital model) of a real system continuously fed with data to mimic the systems' past, present and future behaviour. This makes it possible to detect anomalies, test new ideas and changes in the virtual system and assess how it reacts, minimizing the risks to the real system. In this sense, the DT can be seen as a playground to explore the effects of different scenarios and to practice how to best react and operate the physical system under these circumstances. The concept of DT has been used traditionally in the industry field<sup>1</sup> but it can also be developed and exploited in a city management context, and in particular in Water Supply and Distribution Networks (WSDN), where it can be applied to all aspects of the system<sup>2</sup>.

# RESEARCH



# DIGITALIZATION



# UTILITY KNOWLEDGE



The key of  
success

# Why did we start?

*Operating the network required to overcome several challenges...*



Planning new infrastructures

Improving the decision-making process

Easing the generational change

2007

2012

2018

# Valencia Metropolitan Area

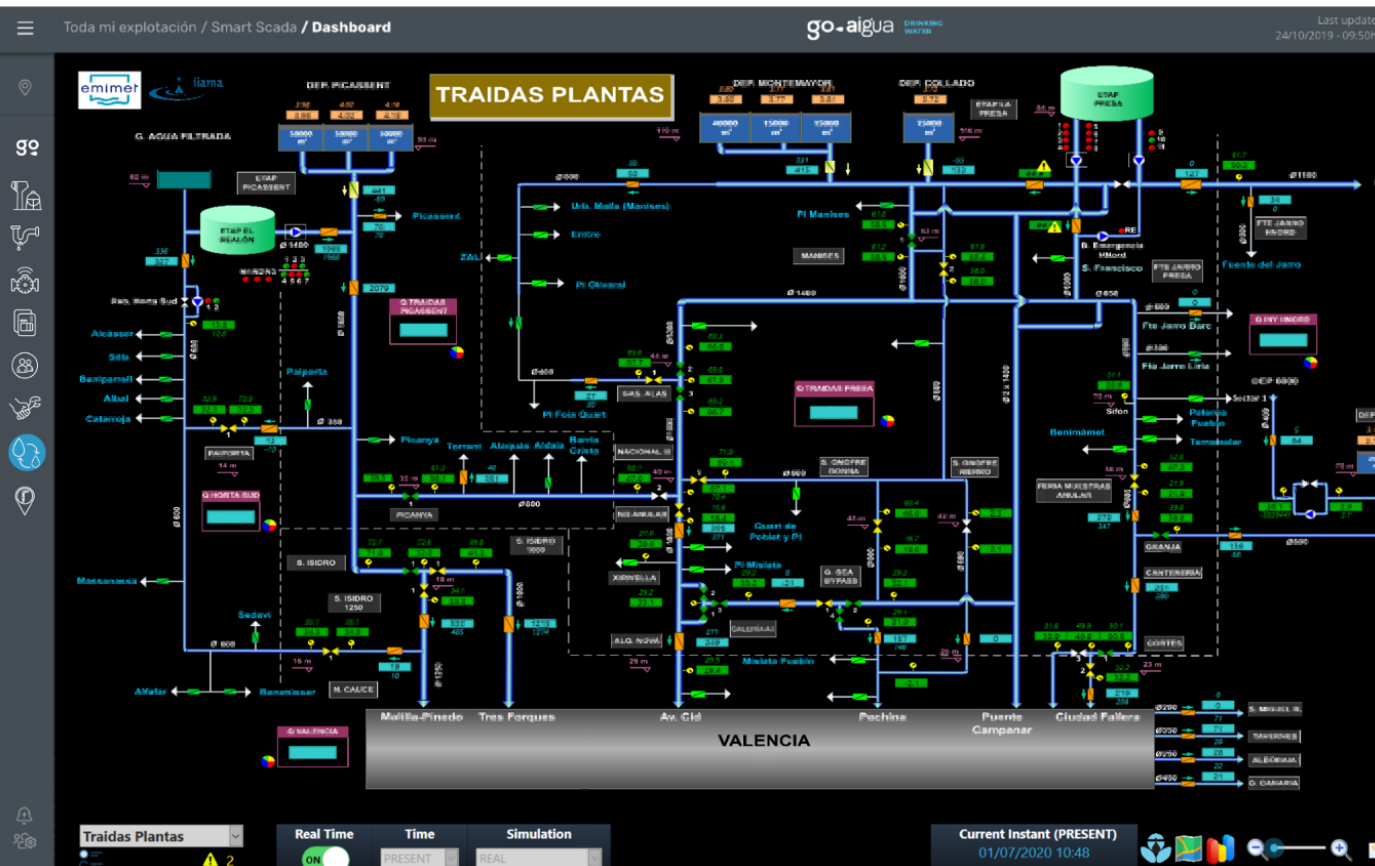
## Digital Twin

1,700,000 Inhabitants

200 km Main Network

1,200 km Distribution Network

3,0 m<sup>3</sup>/s



## THE HYDRAULIC MODEL

900 km

50 Pumps

30 Tanks

250 Valves

## CONNECTED IN REAL TIME WITH

430 Pressure sensors

200 Flowmeters

10,000 VIRTUAL SENSORS



# Valencia Digital Twin Use Cases

## *Daily Operation*



### WHAT-IF SCENARIOS SIMULATION

live, past and future

### FORECAST

of the system behaviour the next 24h

### DECISION SUPPORT SYSTEM

emergency response

### ESTIMATE

values at non-metered points

# Valencia Digital Twin Use Cases

## *Planning*



### **ASSESS**

network requirements

### **DESIGN**

new infrastructures

### **DEFINE**

the behaviour of new infrastructures

### **DETERMINE**

the commissioning stages

# 3. TO BE CONTINUED

*What's next?*



# Challenges



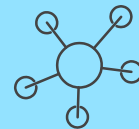
Definition of a **clear business case** and its **objectives**



Development and calibration of a **hydraulic model** that runs in real time



**People engagement** and adoption of this new technology



**Data silos** and quality

# Lessons Learned

*“Old ways do not open new doors”*

*— author unknown*



DT is a tool that **empowers and enriches** people's work

Implementing a DT requires a new innovative culture

Data quality is key, so it is important to preserve it from the source

Keep it simple and focus on your main challenges

# Connecting Digital Twins



Developing DT for every phase of the water cycle

Integrating WDN DT with Smart cities:  
Connecting DT for every infrastructure  
Active role of the citizens

# Integrating Water DT with a Smart City


Two way communication channel citizens - utility

Citizens can make a more responsible use of water

Adapting infrastructures to the needs of the city



# Digital Twin in Water Distribution Networks



Digital Twins have reached the water sector to stay

Develop and maintain live a Digital Twin of a WDS is an objective for most of the utilities

Data and tools available nowadays make it possible





The best is yet to come...

**THANK YOU**

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pconejos@dihma.upv.es