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Digital Twins

Applied for Embedded Electromagnetic Sensors Development

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Plan

1. **Introduction & Context**
2. **Digital Twin Common Definition**
3. **Thales DMS Digital Twins application**
    1. Principle & Methodology
    2. Digital Twins In Real Life
    3. Benefits

Defence Mission Systems

DMS

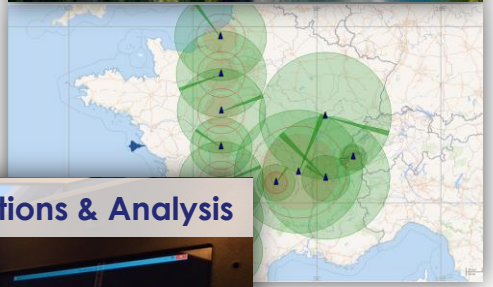
Supports the armed forces in gaining and sustaining decision-making and operational superiority in all theatres

Electro-Magnetic Sensors Simulation

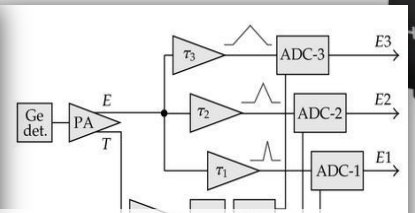
RF signal

RF waves

1. Environment & Tactical Situation



2. Antennas



3. HF & Firmware Signal processing

Measures

4. Software Data processing

Tracks

5. Visualisations & Analysis

Different Levels of Simulation for Different Needs

Fine Grain Simulations

- Physical models, Wave propagation
- Accurate environmental databases
- Accurate Antenna Modelling
- Digital signal generation
- Representative signal processing modelling
- Representative data processing modelling

- **Antennas and Algorithms studies**
- **System IVV-Q**

Operational Simulations

- Tactical situation only
- Generic environmental databases
- Measures generation with pseudo-random techniques
- Representative functional and performance modelling (data processing)

- **Solution orientation**
- **Training, Operational illustration**

What is a Digital Twin ?

- *"Digital twin refers to a digital replica of physical assets, processes and systems that can be used for various purposes."*

  > **[Ph.D. Collin J. Parris**, VP Software Research at GE Global Research Center**]**

- *"The digital representation provides both the elements and the dynamics of how an Internet of Things device operates and lives throughout its life cycle."*

  > **[Mr. Christopher O'Connor**, General Manager at IBM Internet of Things Offerings**]**

- *"A Digital Twin is a dynamic software model of a physical object or system which relies on sensor data" and "uses a combination of metadata, measures, algorithms and rules gathered from the physical system. "*

  > **[Mr. Guillaume Serries**, www.zdnet.fr, *translated from French***]**

Digital Twins applied to Thales DMS Radars and EWS

Performance and Functionalities Representation

OPEN

Thales DMS Digital Twin concept

Behavioural System

Virtual System

Digital System

On Bench System

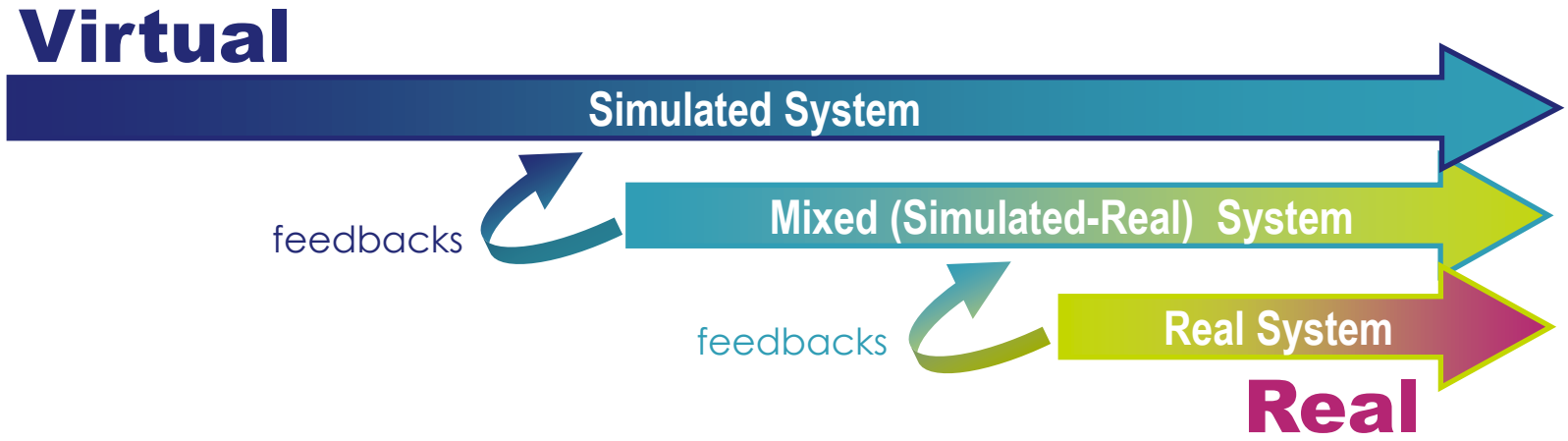
On Board System

Software	Software	Software	Software	Software	REAL
Digital Hardware	Digital Hardware	Digital Hardware	Digital Hardware	Digital Hardware	
RF Hardware	RF Hardware	RF Hardware	RF Hardware	RF Hardware	
Environment	Environment	Environment	Environment	Environment	

SIMULATION

General Principles

- A process starts from a totally "simulated system"…
- And then integrates more and more "physical or real" subsets…
- From which more and more "real data" is gathered…
- And finally re-injected into the "simulated system" to improve its fidelity.



Methodological Point of View

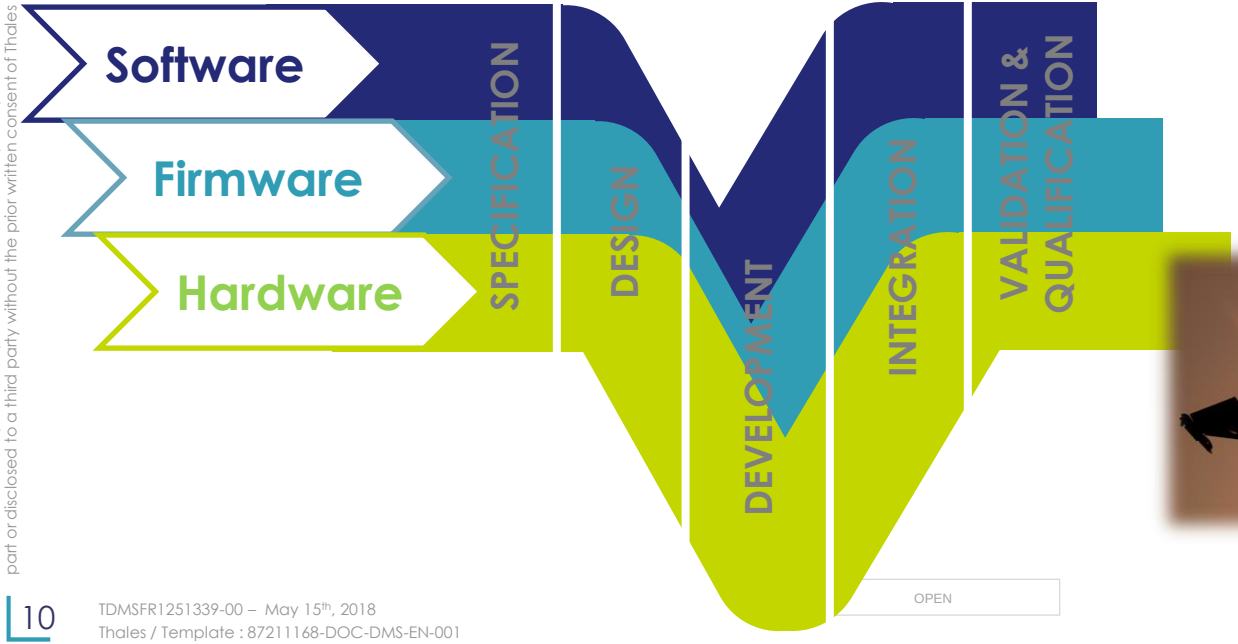
Behavioural System

Virtual System

Digital System

On Bench System

On Board System



Operational & Trial Flights

Data Recording & Analysis

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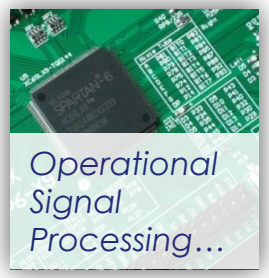
Digital Twin in Thales DMS Real Life

Radar Digital Twin

1. *Beam orientation + Waveform + Emitted Power*

3. *Radar Measures*

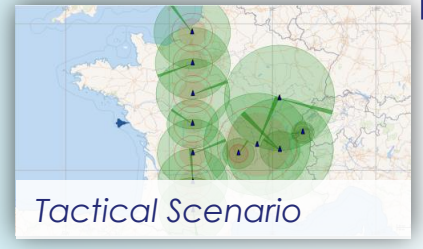


…Emulated on computer

OR

…Executed on real board

Simulated World



2. *Received Digital Signal*

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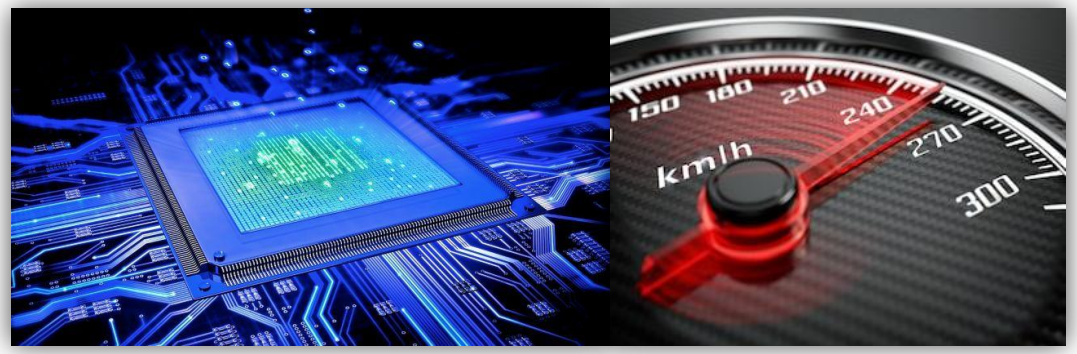
Main Challenges

Firmware Emulation

- Implies compatibility between embedded and computer hosted technologies
- Needs very fast calculation devices for real-time simulations



Main Challenges

On Flight Data feedbacks

- Insufficient connectivity
  - Huge amount of data versus Tactical Data Link rates
  - Electro-Magnetic compatibilities
- Extreme SSI and data protection constraints
  - Dedicated secured wireless networks versus risks of critical data interception
- Automating Data analysis
  - Big Data algorithms still to design and develop
- IP Issues
  - Operational data does not belong to the Industry

Benefits

Scope	Gain	Remarks
Risks	Minimized	The virtual system can anticipate testing at the earliest. → **Reduced risks in integration, validation, qualification and in response to customer needs.**
Planning	Reduced	Elongation → **- 33%**
Trials	Optimised	Benches → **- 50%** Trial Flights → **-66%**
Maturity	Increased	The virtual system allows infinite testing compared to trial flights.
Use	Easier	The virtual system allows understanding of unexpected behaviour and simplifies: • EW Libraries validation • Trial flights preparation • Training

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Thank you for your attention !