FULL FORCE AHEAD
NIDays 2019
Embedded digital twin for manufacturing

Lower testing time, increase accuracy, thanks to a twin in your testing device

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www.irsweb.it
IIoT solutions and trends

Digital twin: what?

Embedded Digital Twin

A twin using model technology 4.0

Conclusion
20 years of experience

Home appliances, HVAC, Structural Health Monitoring, Automotive components

2500 test systems deployed
Why?

It can be done better.

How?

Innovation.
Increase customer value generation going beyond traditional solutions.

What?

Think to your daily life. Chances are that you saw a product tested using our systems.
I.R.S. mission and vision

Our mission and vision

Deliver augmented measurement, test and control solutions. IRS aims to be the company leader in development, manufacturing and delivery of test, measurement and control systems. IRS systems translate into value for customers thanks to technological innovation, advanced modeling and design as well as professional production and after sale services.

Increase customer value generation going beyond traditional solutions. We enable our clients to increase their value generation, going beyond traditional monitoring and control solutions, by providing self-intelligent subsystems for embedded industrial applications at a highly competitive cost of ownership.

Customer first
Value driven iterative system developments
Customers, developers and testers continuous interaction
Continuous attention to technical excellence and good design

Client focus
Innovation

Team work
Efficiency
IIoT solutions and trends
INDUSTRIAL
Internet of Things

CONSUMER
Internet of Things

SMART
Factory
Grid
Machine
City
Car

SMART
Phone
Wearable
TV
Appliances
Home

Connectivity
Data Analytics

Based on Moor Insights & Strategy's report "Segmenting the Internet of Things (IoT)"
Connected Manufacturers use Cloud to Tie Data Together

Fully connected enterprise delivers data points throughout the enterprise

Manufacturing is the #1 IoT Opportunity
• $1.2-$3.7 trillion of economic impact
• IIoT isn’t “technology looking for a problem” – this is a solution to existing needs
NI’s End-To-End Solution Architecture for IIoT
NI’s End-to-End Solution Architecture for IIoT

4 processing domains for data analytics:

1. RIO FPGA
2. System CPUs
3. Edge IT CPUs
4. Back-End IT CPUs

In Motion Early Life At Rest Archive

Data analytics executed throughout the data flow

Faster Insight vs. Deeper Analytics

Trade Off:
Digital twin: what?
“Digital twins are becoming a business imperative, covering the entire lifecycle of an asset or process and forming the foundation for connected products and services. Companies that fail to respond will be left behind.”

Thomas Kaiser, SAP Senior Vice President of IoT

“For every physical asset in the world, we have a virtual copy running in the cloud that gets richer with every second of operational data.”

Ganesh Bell, chief digital officer and general manager of Software & Analytics at GE Power & Water

Digital twin Explosion: billions of twins in next five years
A Digital Twin is a **real-time digital replica of a physical device**

**It is a bridge between the physical and digital world.**

**It is more than just a digital replica**
It is a bridge between the physical and digital world.
History
Logs the history of all devices and products.

Digital Twin

Future
- Forecast failure and maintenance need
- Predict user interaction
- Insight for your next products and service

It is more than just a digital replica
Digital Twin value and ROI

Understand using a learning model

Maintain & log the entire life of an asset

Enhance add virtual sensors

Warn on health & efficiency

Predict Failure and Optimize

Digital Twin
/// Beneficiaries

Physical products

Digital Twin
A twin for each device

- Market
  - Performance
  - Geographies
- Design
  - Features
  - Usage
- Quality
  - Suppliers
  - Procedures

- Operation
  - Efficiency
  - Reliability
- Service
  - Events
  - Incidents

Different customers
Different models
Different locations

Sales & Marketing
Manufacturing
Engineering
Customer Support
Embedded Digital Twin
Drivers of increasing cost & risk in manufacturing test

- Increasing system complexity
- Cost sensitive programs
- Retiring manpower & knowledge
- Unrealistic schedules
- New market players
Embedded digital twin benefit

Testing in unfeasible conditions

Shorter testing time

Better accuracy and quality

Physical end-of-line-testing

The chiller cannot be fully tested in production end of line

Digital Twin
Virtual end-of-line-testing

Thanks to the digital twin, virtual conditions are verified
Real time comparison $\rightarrow \delta = f(\tau) \rightarrow$ Test result

OK or KO for each test case
A platform ready for change

Productive Software
Our extensive portfolio of software, from LabVIEW to TestStand, helps you translate your programming ideas into reality, reduce project development times, improve system performance, and deliver business insights based on collected data.

Flexible, Modular Hardware
NI modular hardware, which ranges from high-performance RF instrumentation to low-cost measurement devices, has flexible I/O that helps you to reconfigure hardware in software and avoid buying new equipment every time application needs change.

Seamless Integration
With seamless integration of flexible hardware and productive software from one vendor, you can design measurement and control systems more rapidly. NI software and I/O hardware work together so you can stop sweating the details and focus on designing better systems faster.

Openness and Interoperability
The openness and flexibility of the NI platform allows you to choose to use NI software and hardware or third-party tools in multiple different combinations. You can accelerate your system design to reduce complexity, innovate faster, and continually integrate new technologies based on the tools that you prefer.
From monitoring to embedded digital twin

1. Lifelong Device history
2. Real time model computed virtual sensor
3. Real Time predictive alert
NI embedded hardware

Real time online measurement platform

Machine learning models

CompactRIO Single-Board inside
A twin using model technology 4.0
Model technology 4.0

Physical Model
- Fluid properties
  - Compressor
  - Heat exchangers
  - Fans
- Components
  - Phenomena
  - Heat transfer
  - Mass transfer
- DAQ correction

Machine learning

embedded digital twin
The *phenomenological model*, based on equations, can **identify the causes** of a possible malfunction.
Machine learning

The **machine learning approach** needs no detailed knowledge about machine operation.

It **needs a learning phase** to be able to predict the system performance.
Diagnostic detail and easy implementation

Sensor Data → Physical Model → Machine Learning → Test system

- Fluid properties
- Components
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Diagnostic detail and easy implementation
Merging model technology using NI platform

LabVIEW Machine Learning Toolkit

embedded digital twin
A smart box, featuring Linux real-time, FPGA hardware acceleration, that executes at the same time standard manufacturing tests and digital twin models in order to get better (shorter time, better fault accuracy, higher reliability, ..)
Test systems for fridge testing on 100 % production

- NI CompactRIO testing 4 appliance simultaneously
- Better understanding of test operations with LabVIEW NXG Web dashboards
- Digital twin for shortening testing time and get better fault accuracy
Automated test systems for washing machine on 100 % production

- Fully automated tests based on NI CompactRIO and NI LabVIEW
- Real-time telemetry data offer insights to people in different roles
- Adaptive testing sequence and algorithm
Implement digital twin using NI platform and partner like IRS.
Conclusions

Shorter testing time, better fault detection accuracy, higher reliability using NI platform and digital twin technology
Thank you for your attention.

any question or inquiry
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