Industrial Internet of Things (IIOT)

Hadi Mohammed

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GO BEYOND

What we will talk about

IIOT & INDUSTRY 4.0

What are Things in IOT

What is the "Thing" in I+IOT

What is Industry 4.0 from a Manufacturing perspective?

Where, what and how do we even begin?

- ISA 95 Model and Technologies - OPC, Python, R, PowerBI/QlikSense/Tableau, streaming data analytics

Industrial Use Case:

- Quality/Productivity – sensors, NVH & SPC

Tying it back together

Ideation and discussion

Pratt & Whitney

DEPENDABLE ENGINES

https://www.prattwhitney.com/en/our-company/about

Fast Facts

Every second, a Pratt & Whitney powered aircraft takes off or lands somewhere in the world.

Global Activity

~17,000 customers using our engines

200+ countries and territories where our engines are in operation

85,000+ engines in service

By the Numbers

~43,000 employees in more than 40 countries

$23.7B adjusted net sales

$1.7B adjusted operating profit

2023 results

Smarter. Cleaner. Greener

Since 2006, Pratt & Whitney has tripled production while:

Reducing total greenhouse gas emissions equivalent to

- 680,000 passenger vehicles driven for one year

Reducing total water usage equivalent to

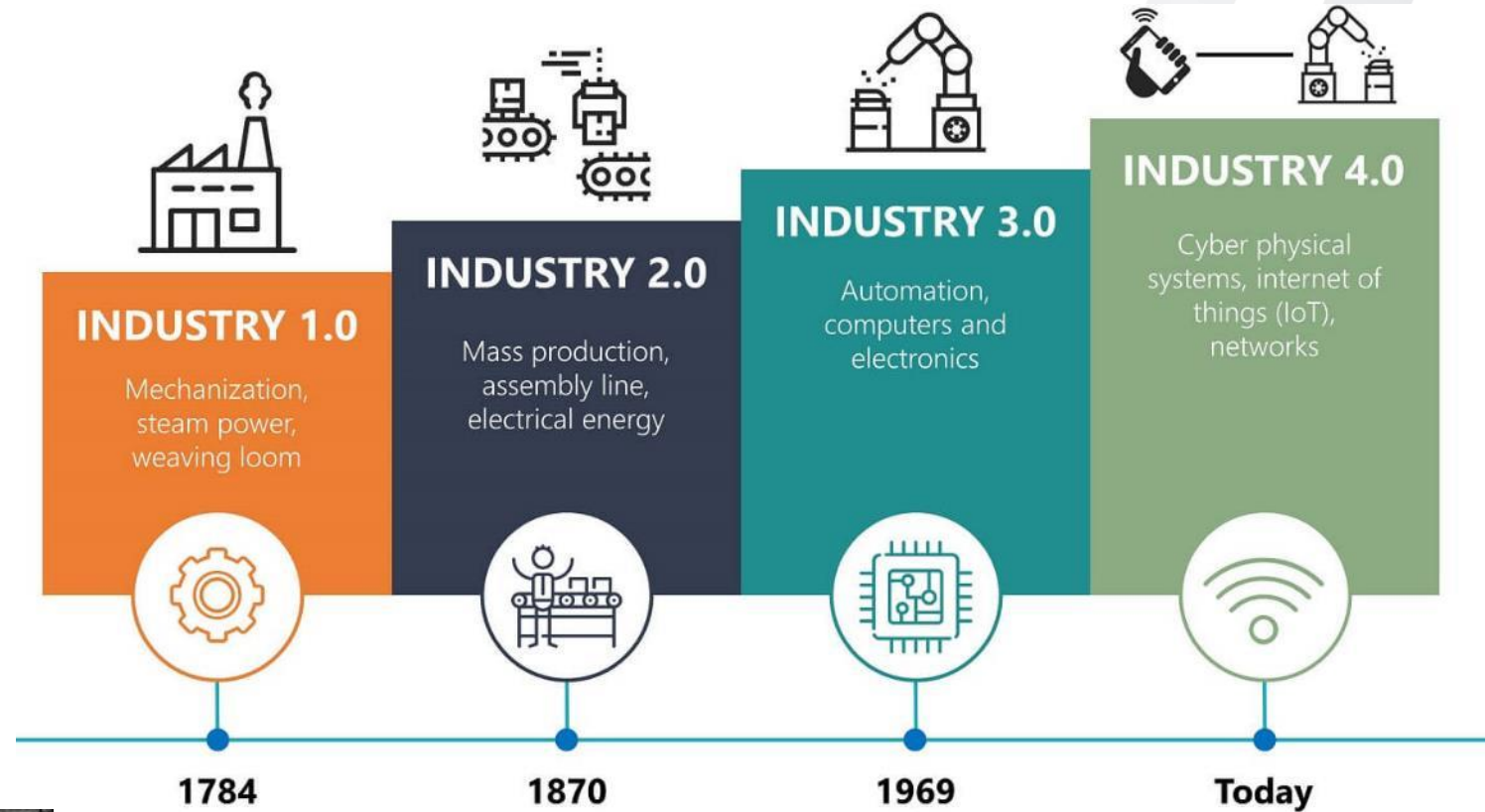- 654,000 individuals' water needs met for one year

Increasing total recycling rate by:

- 18% waste recycling

What is industry 4.0

Understanding IOT

WHAT ARE THE 'THINGS'

We're surrounded by them – communication is key

Internet as the backbone

Devices that can generate <u>data</u>

Capabilities that did not exist

If you can sense it
- You can "<u>control</u>" it
- You can <u>analyze</u> it
- You can make <u>better</u> decisions about it
- You improve <u>quality of experience</u> around it
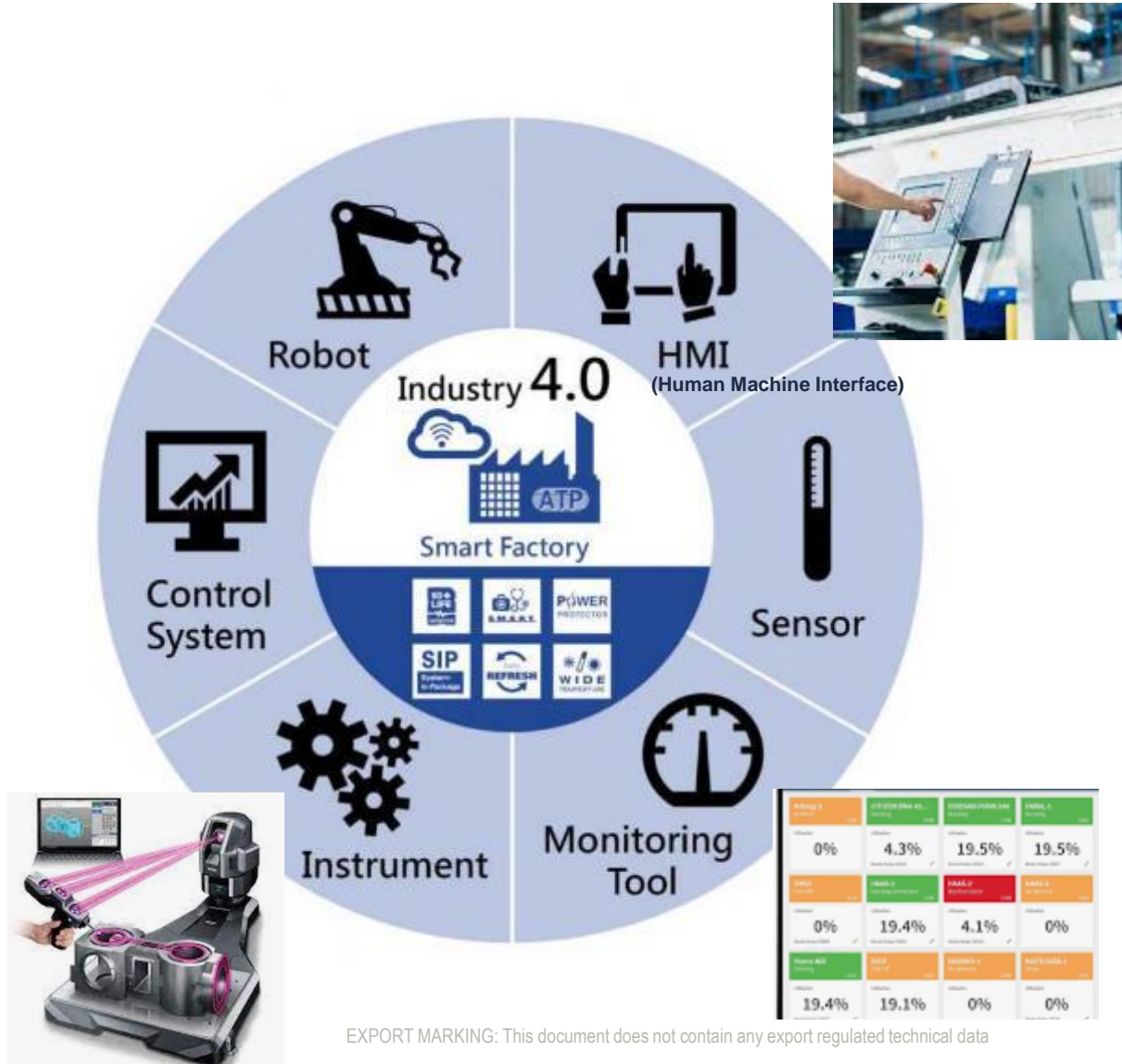
What are Pratt & Whitney's things?

INTERNET OF THINGS

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Newsflash - We Are the Thing in IOT

Industry 4.0

THINGS FROM A MANUFACTURING PERSPECTIVE

- **Interconnected sensors, instruments, robots, floor devices**

- **Networked with industrial applications in manufacturing environments**

- **Generates massive data – milliseconds, seconds**

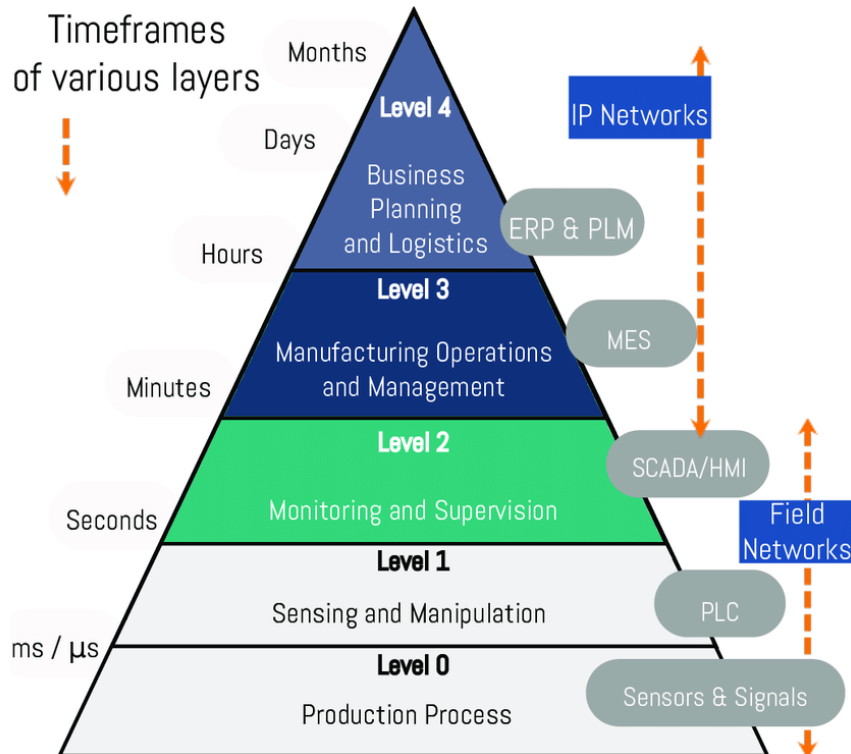- **Building management systems**
  - Energy consumption
  - Waste generation

- **Human Machine Interaction**

- **Digitizing the 4Ms – Man, Machine, Method, Material**

- **Process simulation**

ISA 95 model
TECHNOLOGIES

Standard model from International Society of Automation (ISA)

Enterprise applications VS Industrial applications

- Analogy
  - Car Play/Android Play versus Engine Codes
  - Email utility from college vs Email server management

Change the car, Car Play still functions the same

However Ford Sync is different from Toyota interface

Why?

Why ISA-95 and OPC-UA

How should machines and end systems interact?

This was a huge problem when end users/companies started looking at developing techniques, codes and programming languages to connect, extract and share data.

Every machine manufacturer had their own controls logic and it was extremely hard for a company to have machines from different manufacturers to interact

In comes the OPC foundation (Open Platform Communications) which created the OPC UA (Unified Architecture) to enable machine to machine communication based on standard definitions and protocols set by the International Society of Automation (ISA) and they created a standard model for Industry 4.0 and more

The ISA-95 standard was set up to allow for the standard communication protocols between industrial control systems and the enterprise applications – truly enabling data from a manufacturing floor to start getting digested by enterprise applications

Think – how is your workout data generated by your sensors showing up on your web dashboard. The technology and sources are different if the data is coming from an IOS or Android platform. However standard protocols and translation between the platforms allow you to create a translation of the app in IOS or Android. That translation is what ISA-95 and OPC-UA aim to enable in the industrial context!

From Model to reality

Things

Sensors

Machines

Interfaces

Capabilities

- Quality Sensing
- Condition Monitoring
- Smart Anomaly Detection
- Predictive Maintenance
- Augmented Reality

Environmental & Operational Data

Feedback & Triggers

Systems

- Real-time Inventory Tracking
- Enterprise Resource Planning
- Warehouse Management
- Supply Chain & Logistics

Operational Technology (OT)

Information Technology (IT)
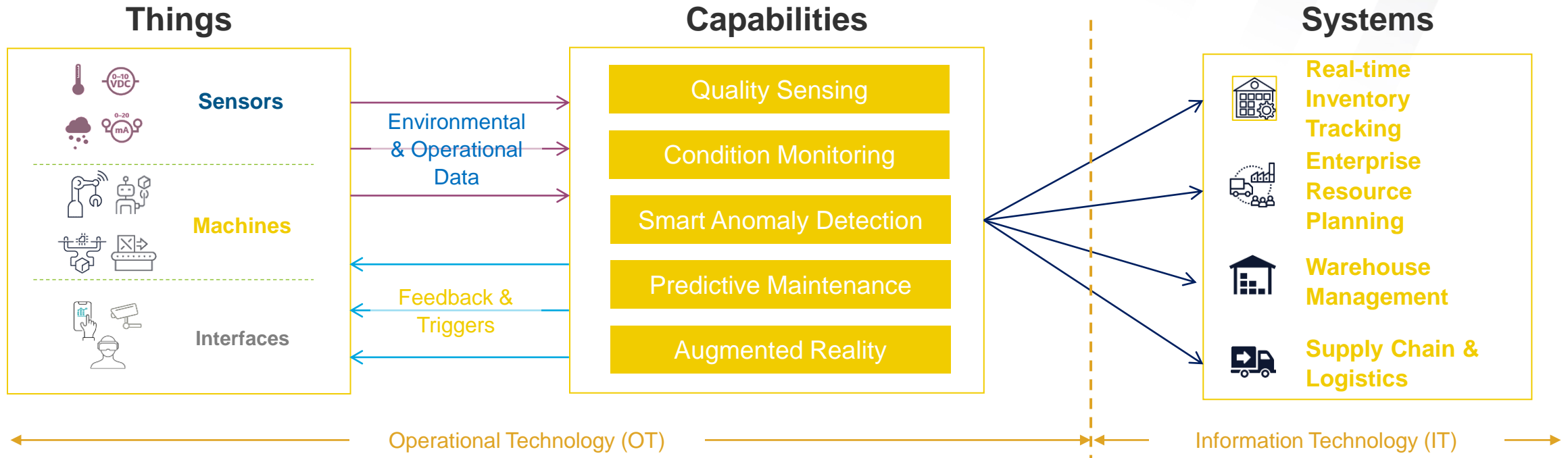
Use Case
QUALITY & PRODUCTIVITY

LINE	TARGET	ACTUAL	DELTA	RUN TIME (MIN)	TARGET RR	ACTUAL RR	RUNNING STATUS
HTL40 SHIFT A	2400	360	2040	79	5	6	5 JPM

STATION	OEE	Avail	Perf	Qlty
Station 10	90	92	100	98
Station 20	94	96	100	98
Station 30	90	91	100	99
Station 40	94	96	100	98

Line Overall Status

OEE 86% = Availability 88% x Performance 100% x Quality 98%

Station #	Station 10				Station 20				Station 30				Station 40			
Event	Count	Cum. Time (min)	Curr. Down Time (min)	Last Down Time (min)	Count	Cum. Time (min)	Curr. Down Time (min)	Last Down Time (min)	Count	Cum. Time (min)	Curr. Down Time (min)	Last Down Time (min)	Count	Cum. Time (min)	Curr. Down Time (min)	Last Down Time (min)
Breakdown	3	3	0	2	1	1	0	1	4	4	0	2	1	1	0	1
Material Call	4	2	0	1	2	2	0	1	3	2	0	1	2	2	0	1
Quality Call	6	2	0	1	6	2	0	1	2	2	0	1	5	3	0	2
Total	7	5			3	3			7	7			3	3		

Generic dashboard example from web search

Overall Equipment Efficiency (OEE)

- One metric to rule them all

Connection to IIOT

Noise – Vibration – Heat (NVH) -→ SENSORS

Anomaly based detection and statistical correlation to events related to

Machine availability – On or Off

Performance   - Number of parts made

Quality   - Number of parts scrapped

Tying it all back together

Industry 4.0/IIOT is happening now

- **Starts with digitizing machine level signals thru sensors**
- **Sensors drive data generation**
  - Raspberry Pi, MQTT, IO Broker
- **Key technologies/standards/certifications**
  - Inductive Automation's Ignition certifications
  - ISA 95 standard

Data is Key

- **Data must be collected – big data storage**
  - SQL, Oracle, Azure data ingestion, Databricks, Snowflake
- **Data must be organized – data conditioning**
  - OPC UA – Kepware
  - Databricks, Snowflake, Kafka, Azure Cosmos
- **Data must be visualized – data visualization**
  - PowerBI, Qlik
  - Python, React.JS
- **Data must become information – data science**
  - R, Python, AWS/Azure Machine Learning

Data to create Information

- **Data Science & machine learning is key**
- **Factory hours are valuable**
  - Unplanned downtime is extremely expensive
  - Prediction of an event prevents downtime
- **Automated monitoring of events improves quality**
- **Machine learning, deep learning, AI are all components of IIOT**

Questions that define our world

Q&A Session