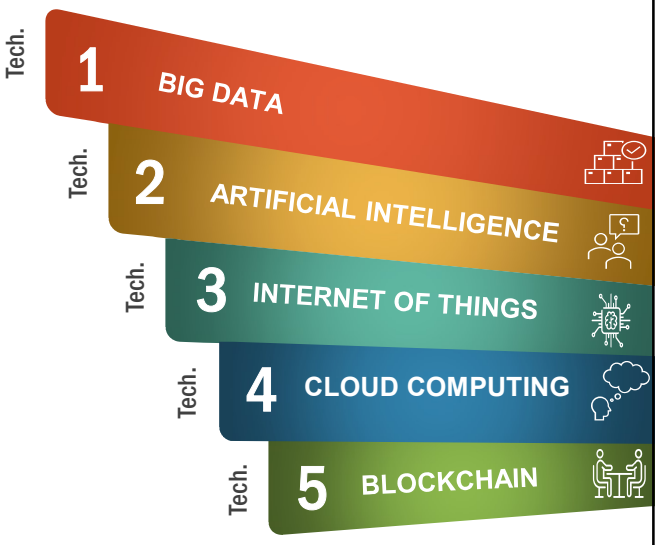

## 5 Core digital transformation technologies

Some examples of Drilling & Completion operations

5

**Core Digital transformation Technologies**

Explores the game-changing technologies that are driving digital transformation across the industry's production chain



## 5 Core digital transformation technologies

Lima Section

Tech. 1 BIG DATA

Tech. 2 ARTIFICIAL INTELLIGENCE

Tech. 3 INTERNET OF THINGS

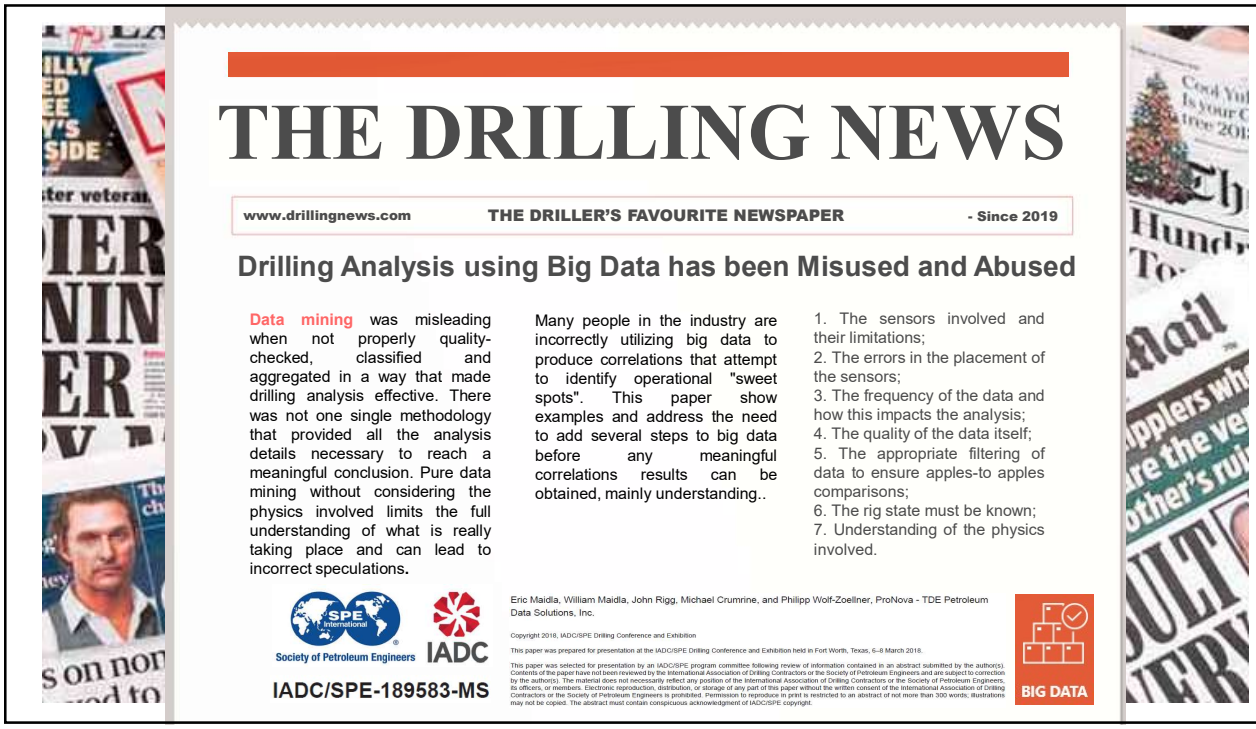
Tech. 4 CLOUD COMPUTING

Tech. 5 BLOCKCHAIN

### BIG DATA

**01**

A collection of data that is huge in volume and yet growing exponentially with time.



THE DRILLING NEWS

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### Drilling Analysis using Big Data has been Misused and Abused

Data mining was misleading when not properly quality-checked, classified and aggregated in a way that made drilling analysis effective. There was not one single methodology that provided all the analysis details necessary to reach a meaningful conclusion. Pure data mining without considering the physics involved limits the full understanding of what is really taking place and can lead to incorrect speculations.

Many people in the industry are incorrectly utilizing big data to produce correlations that attempt to identify operational "sweet spots". This paper show examples and address the need to add several steps to big data before any meaningful correlations results can be obtained, mainly understanding..

1. The sensors involved and their limitations;
2. The errors in the placement of the sensors;
3. The frequency of the data and how this impacts the analysis;
4. The quality of the data itself;
5. The appropriate filtering of data to ensure apples-to apples comparisons;
6. The rig state must be known;
7. Understanding of the physics involved.

Society of Petroleum Engineers IADC

IADC/SPE-189583-MS

Eric Maidla, William Maidla, John Rigg, Michael Crumrine, and Philipp Wolf-Zoellner, ProNova - TDE Petroleum Data Solutions, Inc.



This paper was prepared for presentation at the IADC/SPE Drilling Conference and Exhibition held in Fort Worth, Texas, 6–8 March 2018.



BIG DATA

## The fundamentals of Big Data

BIG DATA

**Big Data**

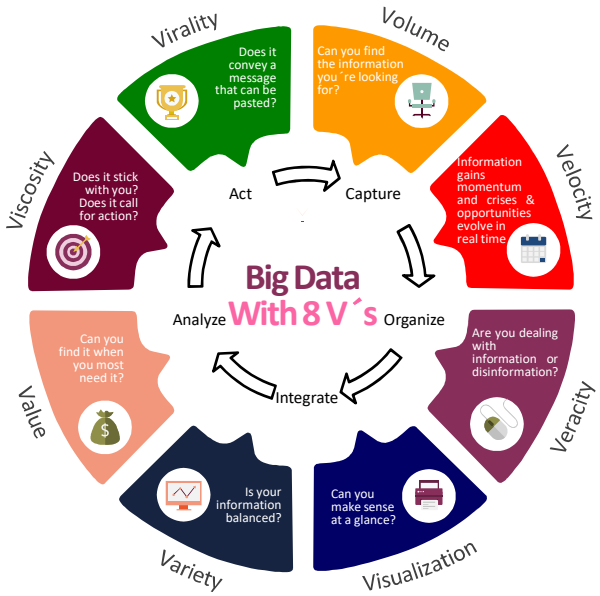
Is measured in terabytes, petabytes and even exabytes

| | | | Binary meaning |
|---|---|---|---|
| 01 | K | kilo | 1 kilobyte = $2^{10} = 1024^1$ bytes |
| 02 | M | mega | 1 megabyte = $2^{20} = 1024^2$ bytes |
| 03 | G | giga | 1 gigabyte = $2^{30} = 1024^3$ bytes |
| 04 | T | tera | 1 terabyte = $2^{40} = 1024^4$ bytes |
| 05 | P | peta | 1 petabyte = $2^{50} = 1024^5$ bytes. |
| 06 | E | exa | 1 exabite = $2^{60} = 1024^6$ bytes. |
| 07 | Z | zetta | 1 zettabyte = $2^{70} = 1024^7$ bytes |
| 08 | Y | yotta | 1 yottabyte = $2^{80} = 1024^8$ bytes |

Source: Author analysis (2019)

## The fundamentals of Big Data

BIG DATA



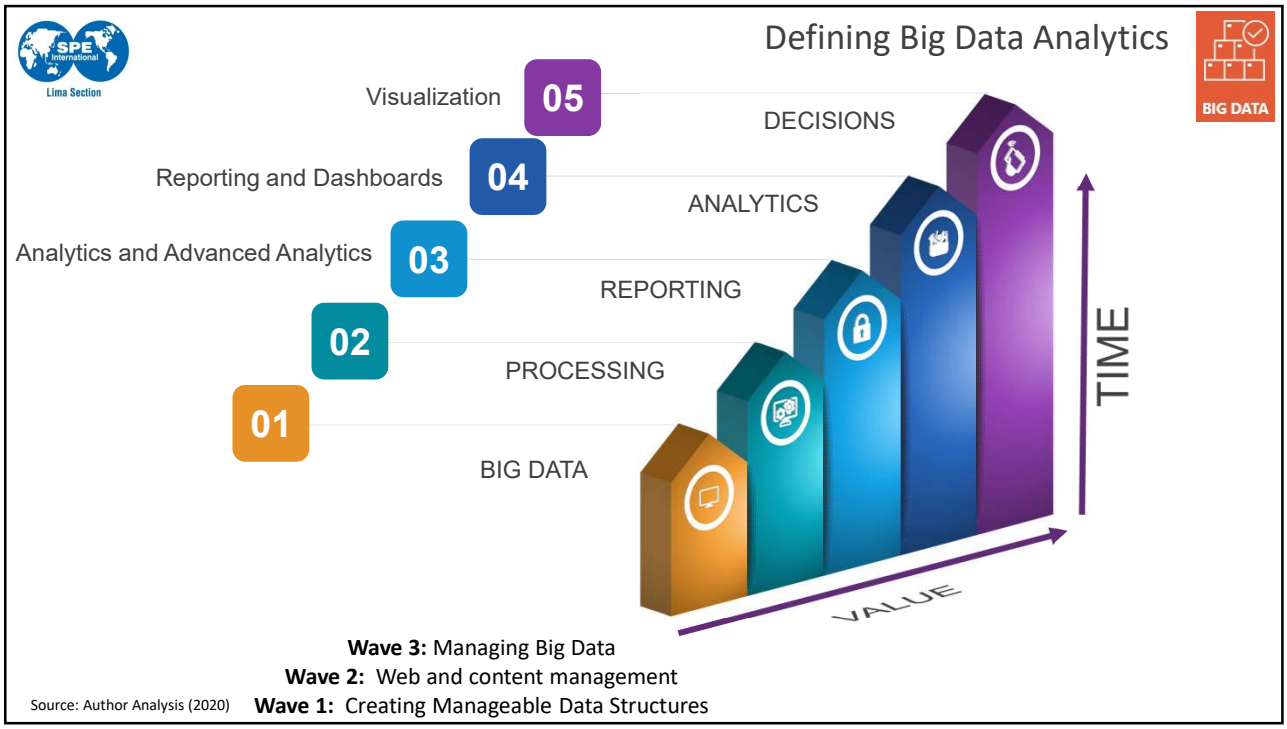

**Voluminous**

beyond the capabilities of the current database technology

**Complex**

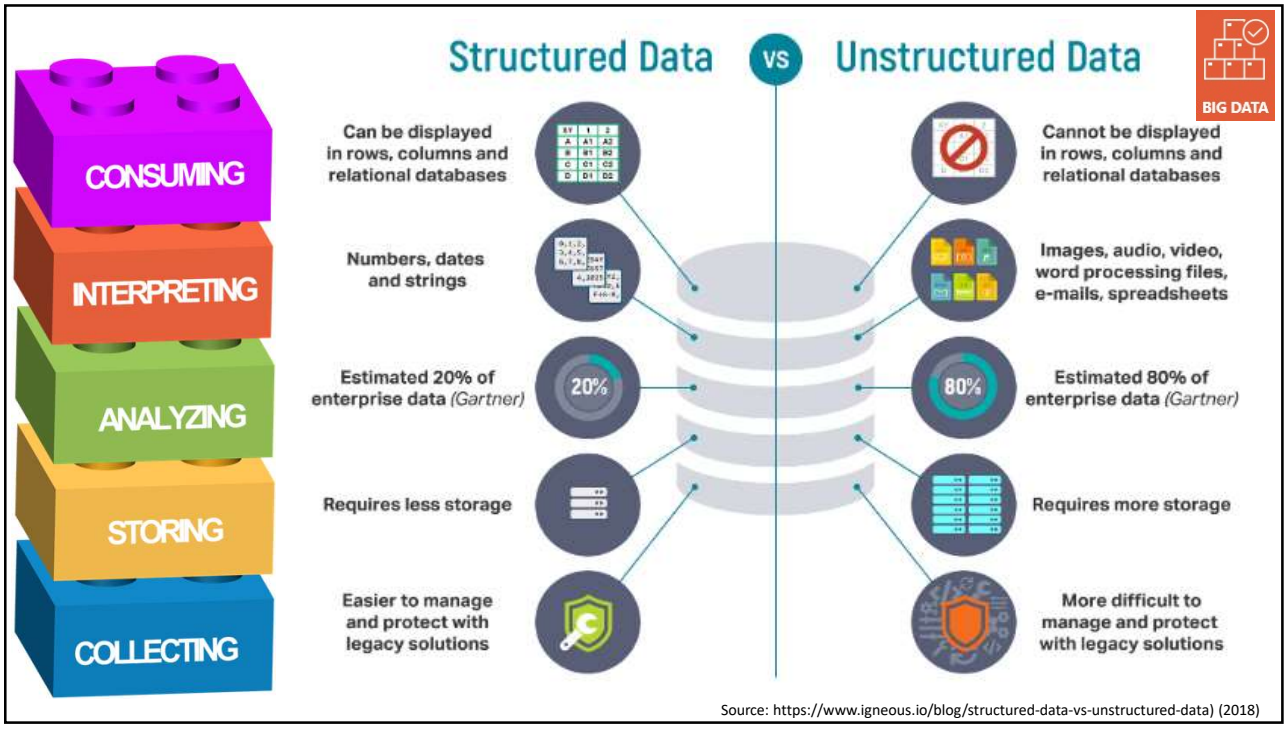
Any data that does not fall into the traditional field structure

Source: Adapted from M-Brain (2019)



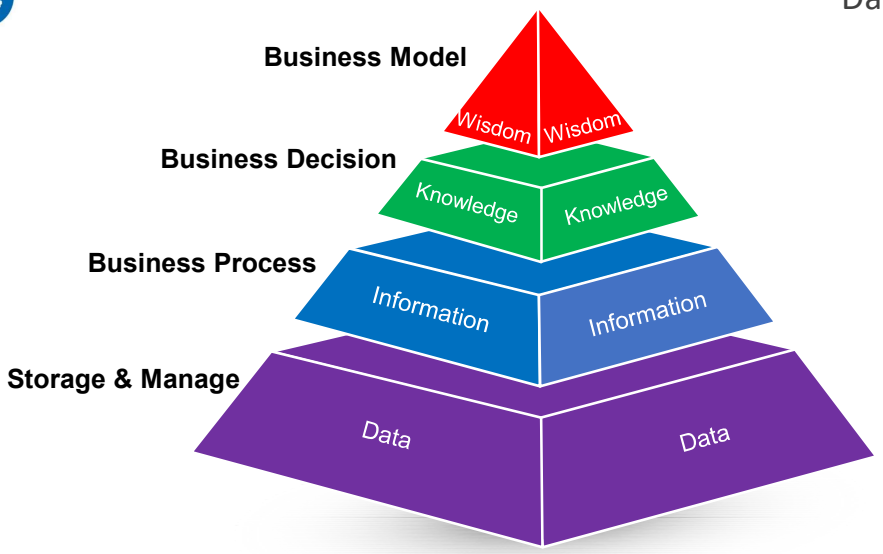

**Wave 3:** Managing Big Data
**Wave 2:** Web and content management
**Wave 1:** Creating Manageable Data Structures

Source: Author Analysis (2020)




Source: https://www.igneous.io/blog/structured-data-vs-unstructured-data) (2018)

## Data Mining

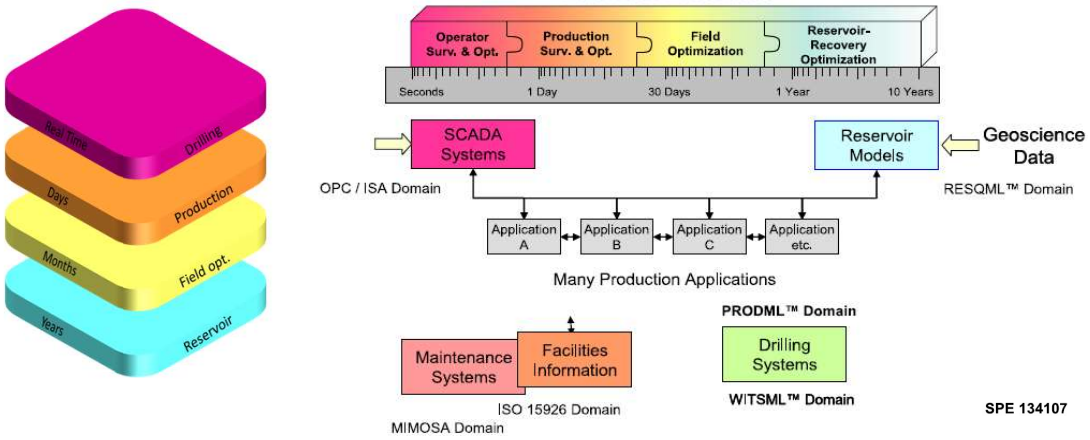



**Sources of big unstructured data**:
Computer or Machine generated (satellite images, scientific data, photos)
Human generated (text internal data)

Source: Author analysis (2020

## Integrating Data Sources in O&G

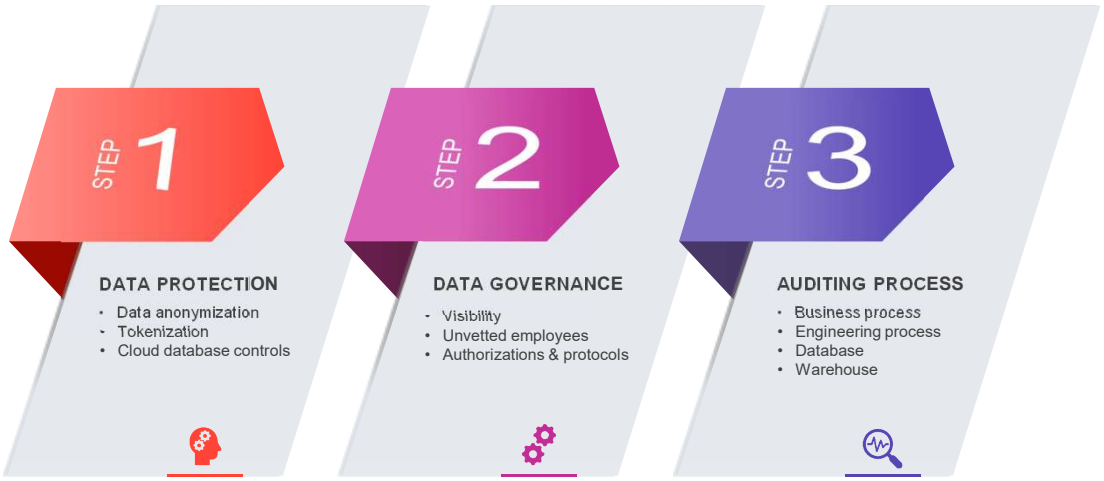
Low Latency – Scalability – Versatility – Native format




**Sources of big structured data**:
Computer or Machine generated (sensor, simulations, models, historic)
Human generated (input)

Source: Adapted from SPE 134107

## Security and governance for big data environments



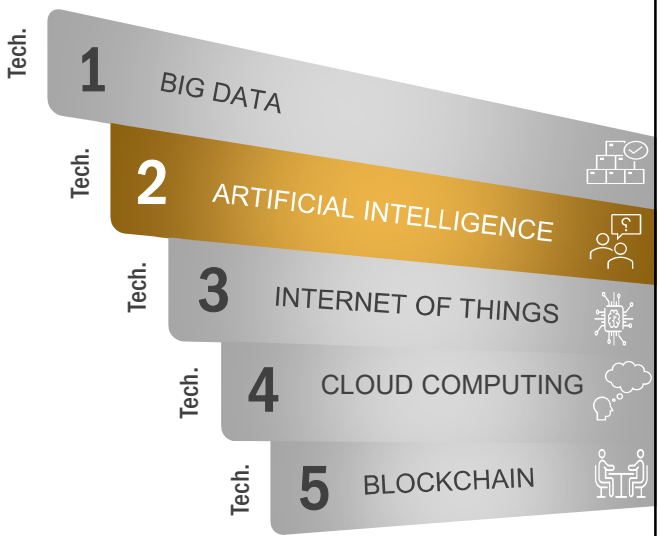

Source: Author analysis (2020)

## 5 Core digital transformation technologies

### ARTIFICIAL INTELLIGENCE (AI)

02

Refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions



# THE DRILLING NEWS

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## THE ROLE OF MACHINE LEARNING IN DRILLING OPERATIONS

**Machine Learning** has the possibility to definitively improve various important decisions taken on a daily basis by managers and engineers. Nevertheless, the forthcoming benefits of the data are only attainable if the suitable tools are exploited to incorporate the various data types and forms, and transmute them in to valuable knowledge contributing to smart deductions. Several applications using AI and DDM can be implemented to mitigate different drilling problems and to assist in the development **of cost effective solutions.**

Several disciplines, especially drilling are resorting to the replacement of physics-based models with AI and data-driven modeling or its combination via a hybrid approach. Even though data-driven techniques are powerful in unravelling complex industry challenges, a number of design glitches have the capability of disqualifying ML models. For improved solutions, several critical factors should be taken into consideration when dealing big data. The factors include optimizing the number of layers for problems, the number of units required per layer, and the algorithm's learning capability along with the model constrains for successful implementation.

Traditional data preparation and analysis methods are not sufficiently capable of rapid information extraction and clear visualization of big complicated data sets. Due to the petroleum´s industry unfulfilled demand, Machine Learning (ML) assisted industry workflow in the fields of drilling optimization and real time parameter analysis and mitigation is presented.

Christine I. Noshi and Jerome J. Schubert, Texas A&M university



This paper was prepared for presentation at the SPE Eastern Regional Meeting held in Pittsburgh, Pennsylvania, USA, 7 - 11 October 2018.



Society of Petroleum Engineers

SPE-191823-18ERM-MS

AI

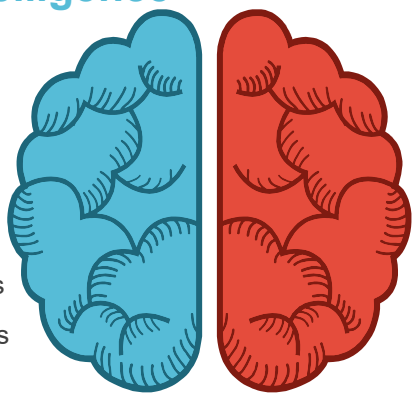
SPE International
Lima Section

# Artificial Intelligence

AI

## Discerning intelligence

Learning
Reasoning
Understanding
Grasping truths
Seeing relationships
Considering meanings
Separating facts from beliefs

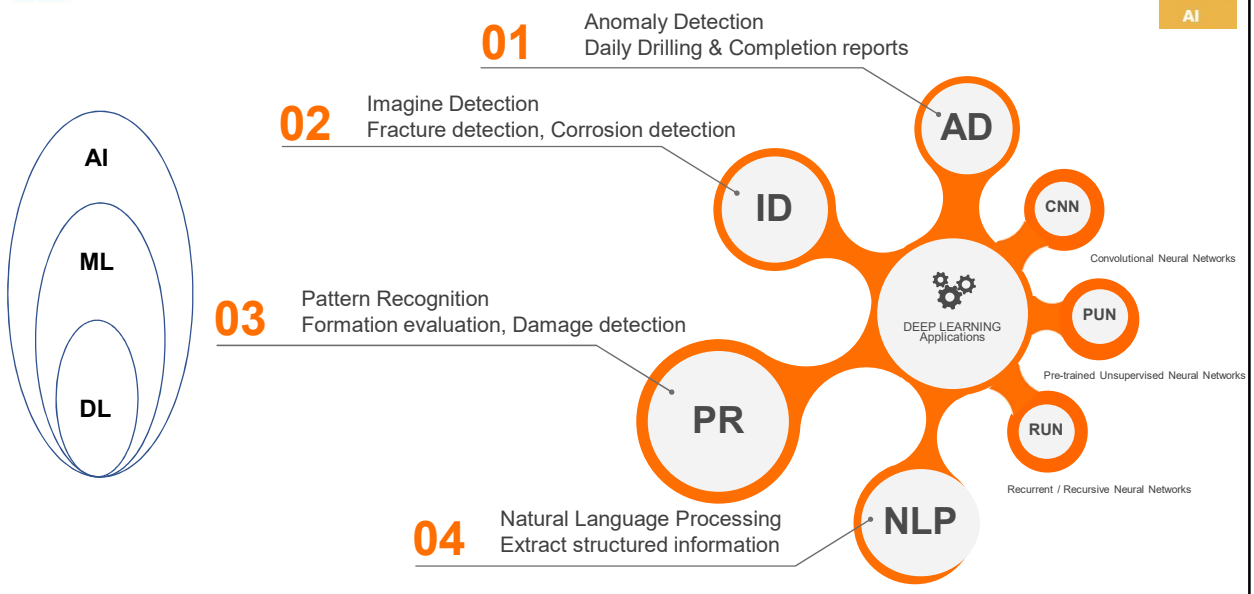


**Human** **Computer**

Set a goal based on needs or wants
Assess the value of any currently known information.
Gather additional information.
Manipulate the data such that it achieves a form consistent with existing information.
Define the relationships and truth values between existing and new information.
Determine whether the goal is achieved.
Modify the goal in light of the new data and its effect on the probability of success.

Source: Adapted from Mueller and Massaron (2018)

## Deep learning: performing data analysis




Source: Author Analysis (2020)

## Machine learning: hypothesis driven

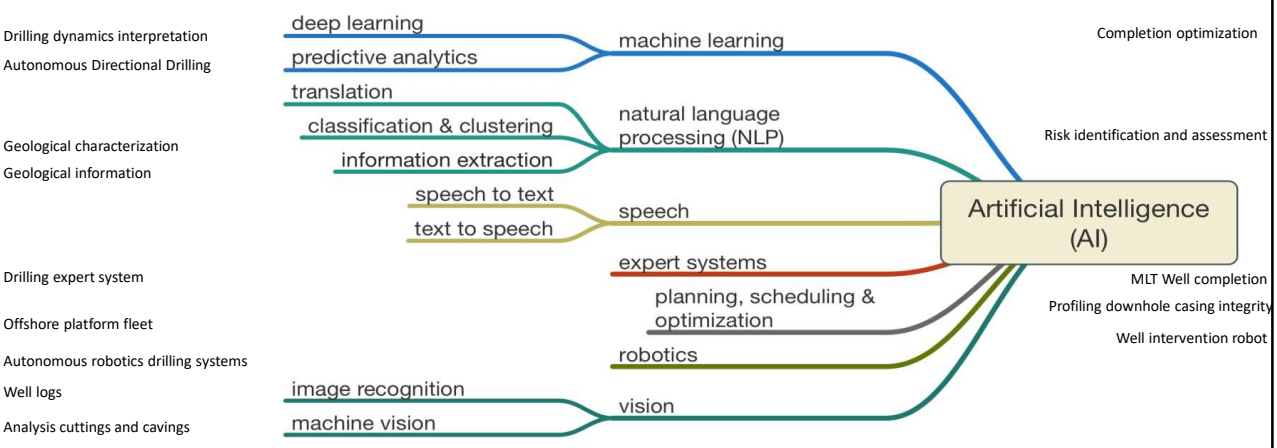

How one may acquire data with sufficient accuracy for detecting the movements of the fluids in a wide range of distances in the space around the production well?

Asset Value Maximization Through a Novel Well-Completion System for 3D Time-Lapse Electromagnetic Tomography Supported by Machine Learning.

197573-MS SPE Conference Paper - 2019

Source: Adapted from Mueller and Massaron (2016)

## Considering some uses of AI in Drilling & Completions




*O&G companies are using AI alongside their existing digital infrastructure to increase the efficiency and productivity of operations.*

Source: Adapted from Kumar, (2018)

## Robotics and Autonomous systems

| Robot Manipulators | Robot Vehicles | Man-Robot Systems | Biologically Inspired Robots |
|---|---|---|---|
| Serial | Land | Haptic Robotics | Humanoids |
| Parallel | Water | Telemani Pulators | Robots from Animal world |
| Micro & Nano | Air | Exoskeletons | |

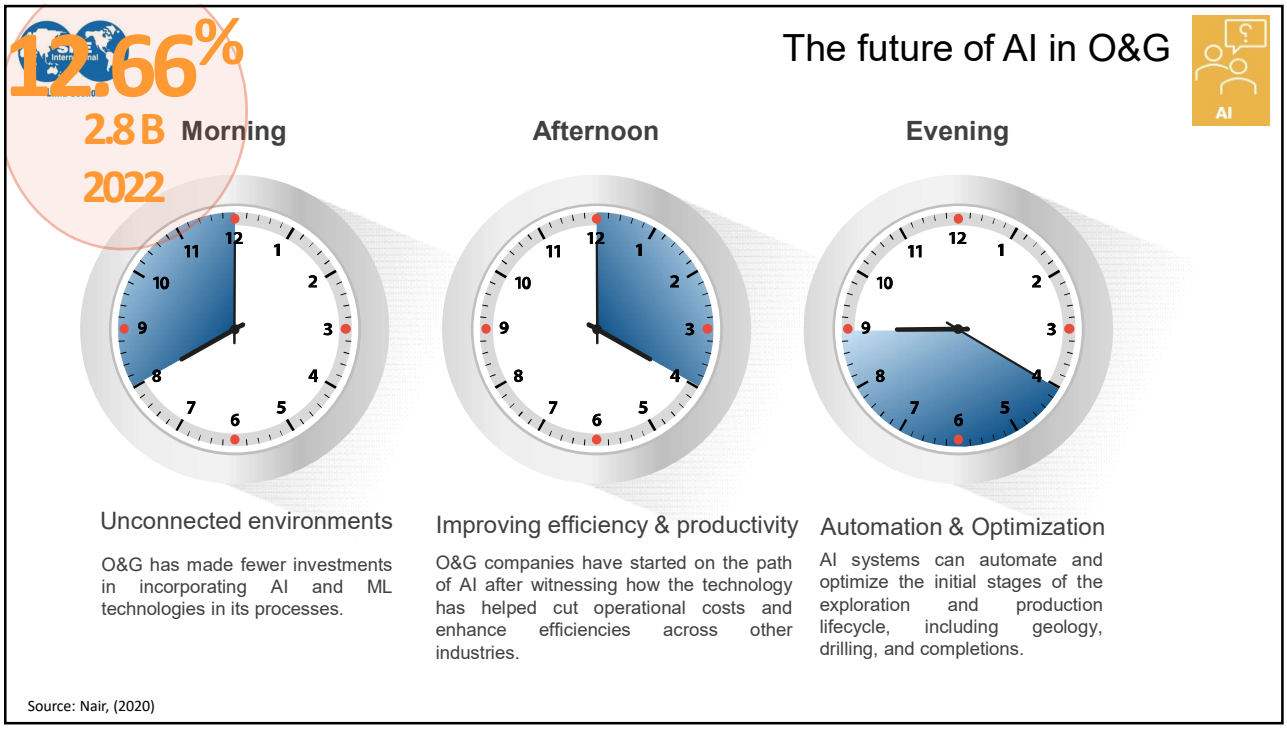
Research Distribution in Robotics

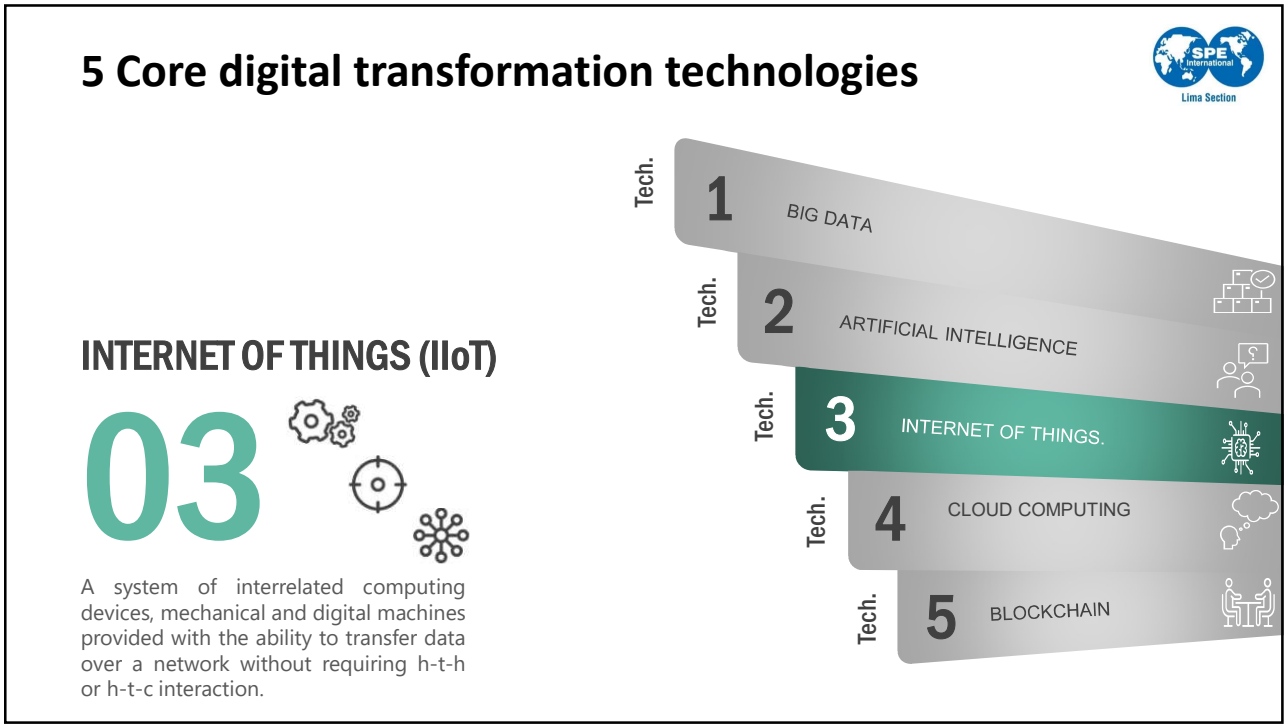

- Robotic Drilling Systems 40%
- Nano Robotic Drilling bits 20%
- Robotic Drilling fluids 20%
- Robotic steerable systems 20%

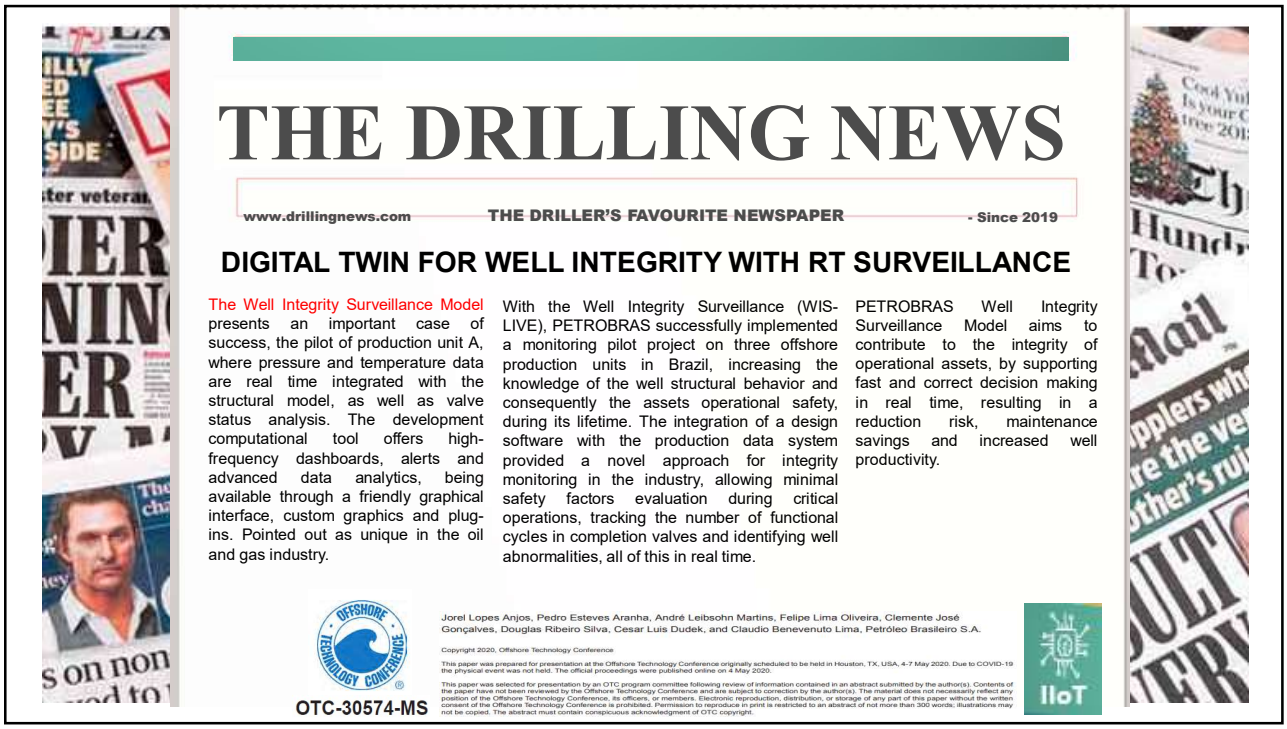
Applications

- Extreme environments (Arctic);
- Subsea;
- Deepwater & Ultradeepwater;
- Remote operations;
- Autonomous well intervention;
- Autonomous pipe identification;
- Pipe inspection;
- Repair and maintenance.

Source: Mihelj, Bajd, et al, (2019)


12.66%
2.8 B
2022
The future of AI in O&G
AI
Morning
Afternoon
Evening
Unconnected environments
O&G has made fewer investments in incorporating AI and ML technologies in its processes.
Improving efficiency & productivity
O&G companies have started on the path of AI after witnessing how the technology has helped cut operational costs and enhance efficiencies across other industries.
Automation & Optimization
AI systems can automate and optimize the initial stages of the exploration and production lifecycle, including geology, drilling, and completions.
Source: Nair, (2020)


5 Core digital transformation technologies
SPE International
Lima Section
INTERNET OF THINGS (IIoT)
03
A system of interrelated computing devices, mechanical and digital machines provided with the ability to transfer data over a network without requiring h-t-h or h-t-c interaction.
Tech. 1 BIG DATA
Tech. 2 ARTIFICIAL INTELLIGENCE
Tech. 3 INTERNET OF THINGS.
Tech. 4 CLOUD COMPUTING
Tech. 5 BLOCKCHAIN



# THE DRILLING NEWS

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## DIGITAL TWIN FOR WELL INTEGRITY WITH RT SURVEILLANCE

The Well Integrity Surveillance Model presents an important case of success, the pilot of production unit A, where pressure and temperature data are real time integrated with the structural model, as well as valve status analysis. The development computational tool offers high-frequency dashboards, alerts and advanced data analytics, being available through a friendly graphical interface, custom graphics and plug-ins. Pointed out as unique in the oil and gas industry.

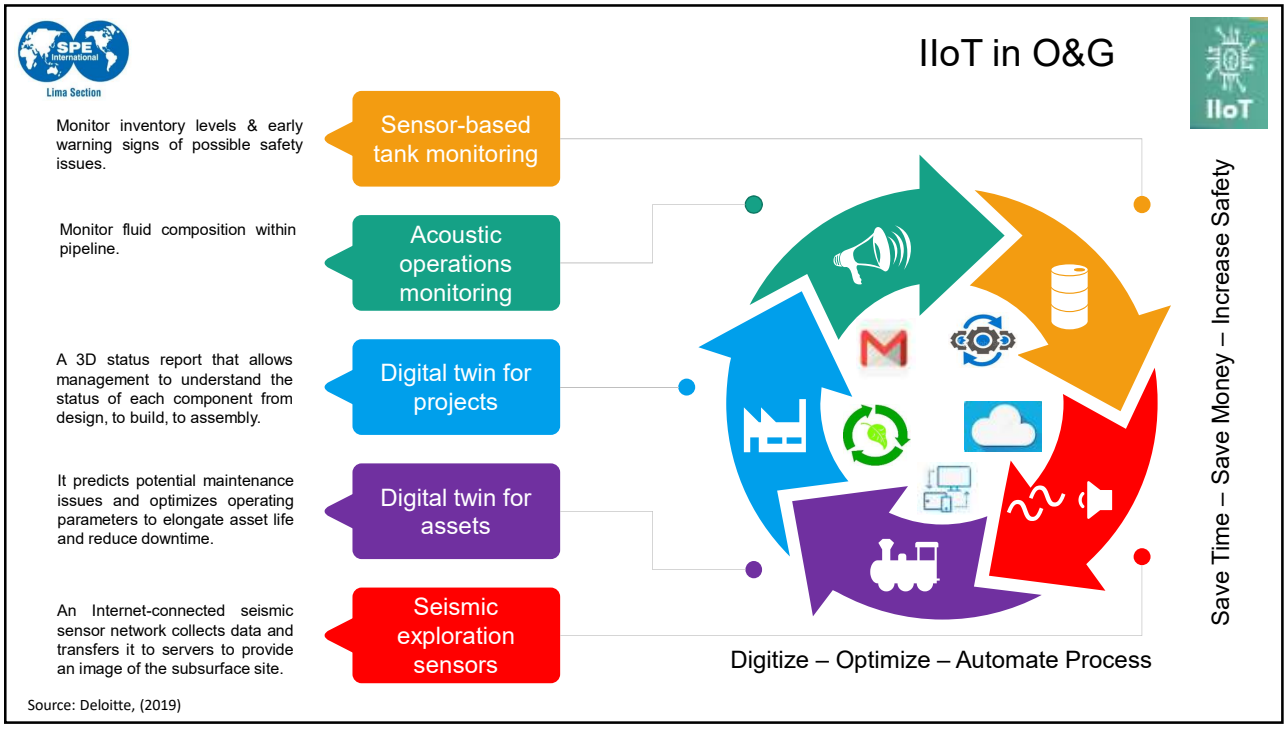
With the Well Integrity Surveillance (WIS-LIVE), PETROBRAS successfully implemented a monitoring pilot project on three offshore production units in Brazil, increasing the knowledge of the well structural behavior and consequently the assets operational safety, during its lifetime. The integration of a design software with the production data system provided a novel approach for integrity monitoring in the industry, allowing minimal safety factors evaluation during critical operations, tracking the number of functional cycles in completion valves and identifying well abnormalities, all of this in real time.

PETROBRAS Well Integrity Surveillance Model aims to contribute to the integrity of operational assets, by supporting fast and correct decision making in real time, resulting in a reduction risk, maintenance savings and increased well productivity.

OTC-30574-MS

Jorel Lopes Anjos, Pedro Esteves Aranha, André Leibsohn Martins, Felipe Lima Oliveira, Clemente José Gonçalves, Douglas Ribeiro Silva, Cesar Luis Dudek, and Claudio Benevenuto Lima, Petróleo Brasileiro S.A.





SPE International Lima Section

## IIoT in O&G

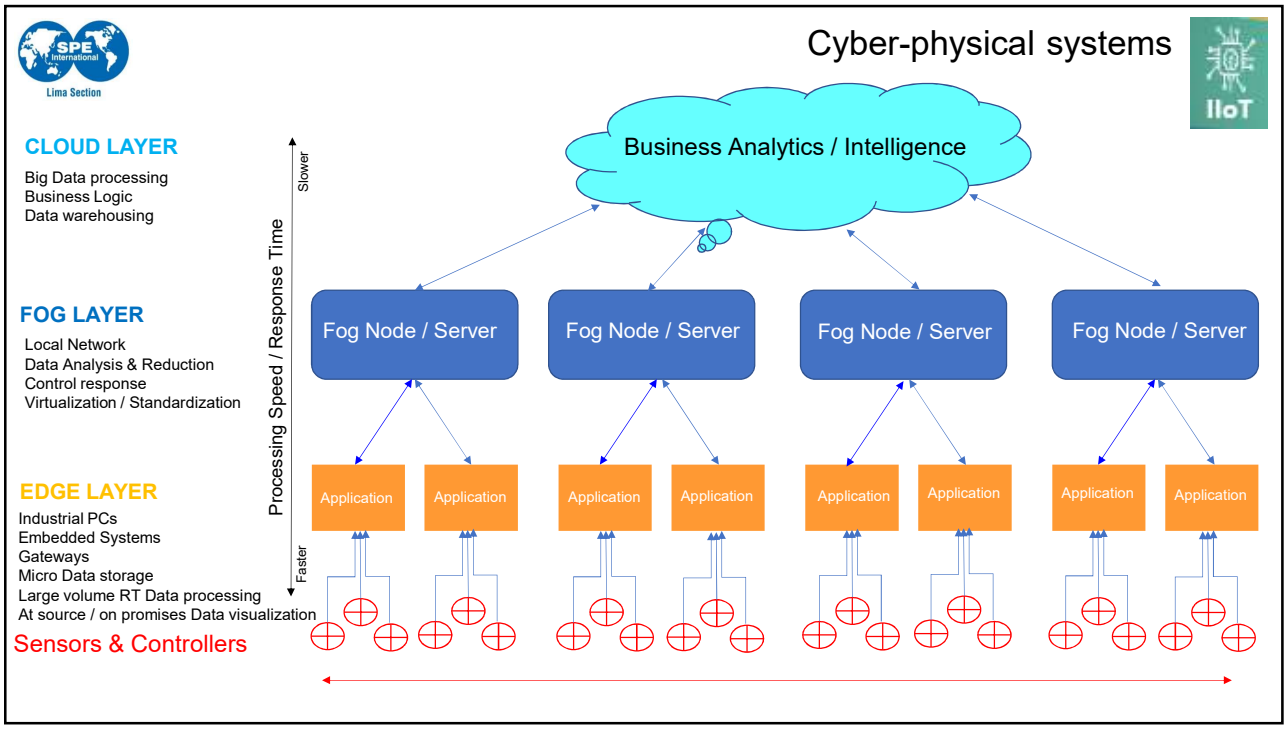
IIoT

- Sensor-based tank monitoring: Monitor inventory levels & early warning signs of possible safety issues.
- Acoustic operations monitoring: Monitor fluid composition within pipeline.
- Digital twin for projects: A 3D status report that allows management to understand the status of each component from design, to build, to assembly.
- Digital twin for assets: It predicts potential maintenance issues and optimizes operating parameters to elongate asset life and reduce downtime.
- Seismic exploration sensors: An Internet-connected seismic sensor network collects data and transfers it to servers to provide an image of the subsurface site.

Digitize – Optimize – Automate Process

Save Time – Save Money – Increase Safety

Source: Deloitte, (2019)


Cyber-physical systems
IIoT
Lima Section
CLOUD LAYER
Big Data processing
Business Logic
Data warehousing
FOG LAYER
Local Network
Data Analysis & Reduction
Control response
Virtualization / Standardization
EDGE LAYER
Industrial PCs
Embedded Systems
Gateways
Micro Data storage
Large volume RT Data processing
At source / on promises Data visualization
Sensors & Controllers
Processing Speed / Response Time
Slower
Faster
Business Analytics / Intelligence
Fog Node / Server
Fog Node / Server
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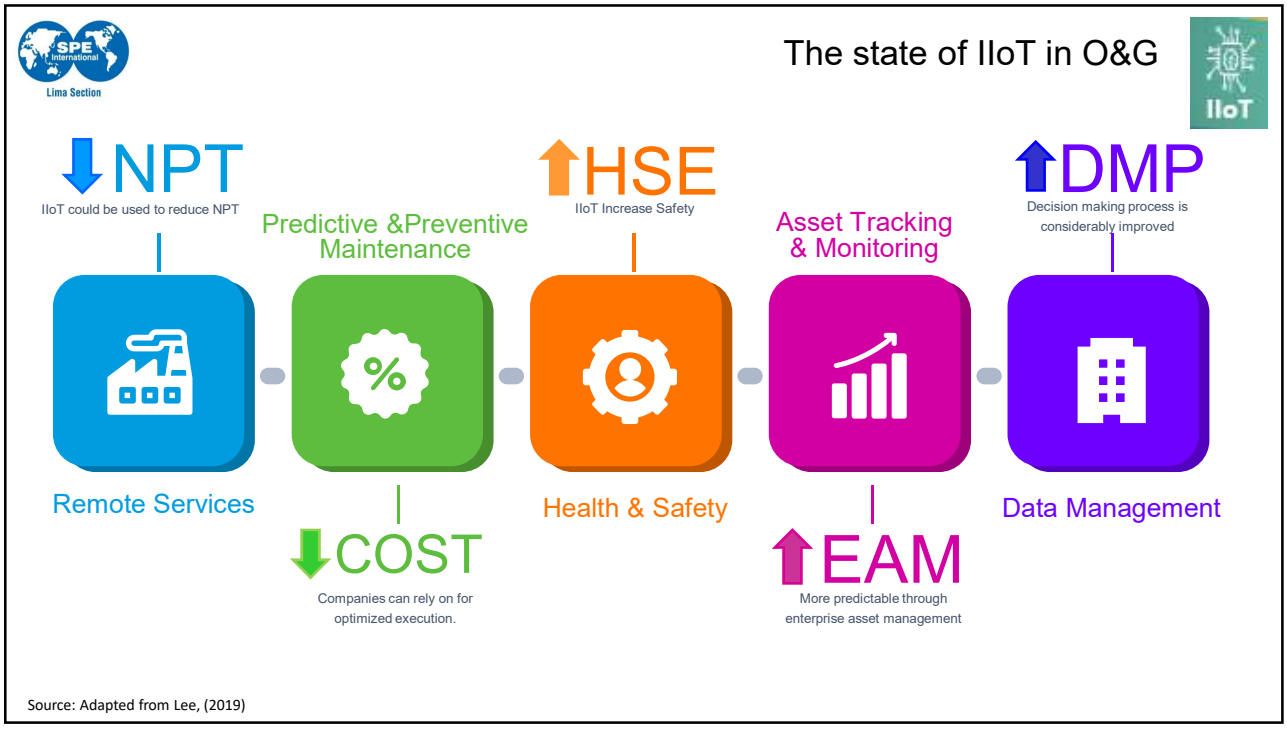
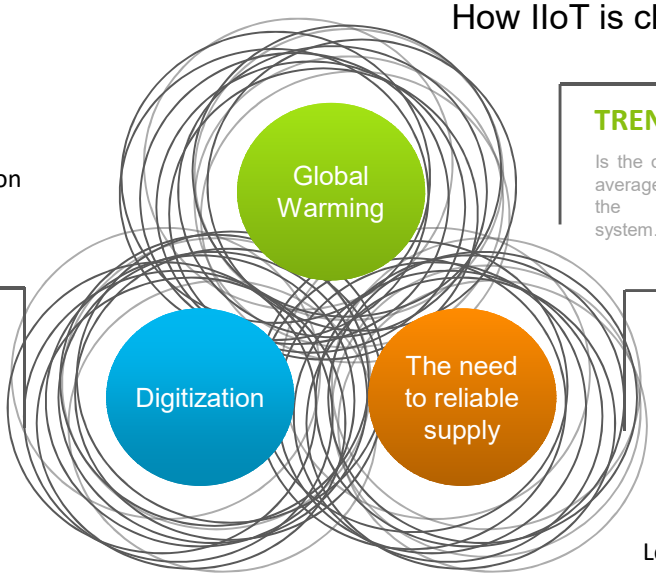

The state of IIoT in O&G
IIoT
Lima Section
NPT
IIoT could be used to reduce NPT
Predictive &Preventive Maintenance
HSE
IIoT Increase Safety
Asset Tracking & Monitoring
DMP
Decision making process is considerably improved
Remote Services
Health & Safety
Data Management
COST
Companies can rely on for optimized execution.
EAM
More predictable through enterprise asset management
Source: Adapted from Lee, (2019)

## How IIoT is changing O&G




**TREND 1**

Is the ongoing rise of the average temperature of the Earth's climate system.

Reduced carbon footprint
.

**TREND 2**

is the conversion of analog to digital

Optimized profit, no losses created
.

**TREND 3**

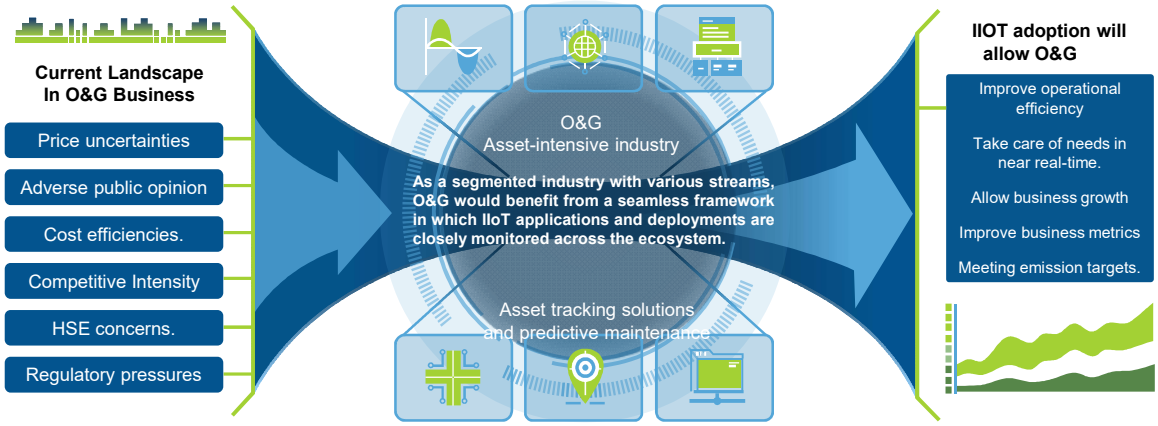
Reliable, affordable and environmentally sound energy

Less wasted primary energy.

O&G IIoT applications may even become necessary for a competitive edge among rising geopolitical and climate change tensions.

Source: Author analysis (2020)

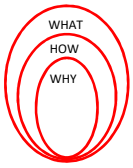
## IIoT changing everything in Today's Business Landscape




Early adopters of IIOT will gain competitive advantages in a changing business environment!

Source: Adapted from Lee, (2019)

## What is a digital twin and why it's important to IIoT




The Golden Circle of Digital Twin

### WHAT

A digital twin is a digital representation of a physical object or system.

### HOW

A computer program takes real-world data about a physical object or system as inputs and produces as outputs predications or simulations of how that physical object or system will be affected by those inputs.

### WHY

The twin is constructed so that it can receive input from sensors gathering data from a real-world counterpart. This allows the twin to simulate the physical object in real time, in the process offering insights into performance and potential problems.

The more that a digital twin can duplicate the physical object, the more likely that efficiencies and other benefits can be found

Digital Twin = IIoT + AI + Data Analytics

Source: Adapted from Shaw and Fruhlinger, (2019)

## DUPTS Drilling Uncertainty Prediction Technical Section

**DUPTS provide a multidisciplinary forum for technical exchange and skill development focused mainly on data science, artificial intelligence and machine learning solutions supporting drilling planning and execution challenges in a safe, fast and cost-effective manner.**

**Members** 2000

**Regions** 15

**SPE ATCE 2020**

**Student Competition**

SPE-DUPTS are collaborating with DSATS on the Drillbotics® competition.

## DUPTS Drilling Uncertainty Prediction Technical Section

- ✓ Clarifying existing challenges in drilling domain.
- ✓ Pointing education resources.
- ✓ Stimulating the community to share knowledge and collaborate in this area.
- ✓ Spread the awareness about AI, ML and data mining.

connect.spe.org/dupts/home

### Monthly Webinars

Conducted by international experts

### We take part in special events

SPE ATCE 2020
Workshops

### Student Competition

SPE-DUPTS are collaborating with DSATS on the Drillbotics® competition.

**Ramon A. Perdomo**
Email: raperdomo@mail.ru.

Ramon Perdomo

*Thank You!*

#SPELima

#WeAreSPE

Ukhta State Technical University (УГТУ)
Oil and Gas Faculty
Oil and Gas Drilling Department
25.00.15 Drilling and Well Completion Technology

Senior Drilling Engineer, over 14 years of oil and gas upstream sector experience. PhD student at Ukhta State Technical University, his research focuses on how use concrete down-hole data collected and the use of analytical workflows/process to achieving drilling performance. He is paying close attention to the journey to digital transformation in the Oil and Gas industry.