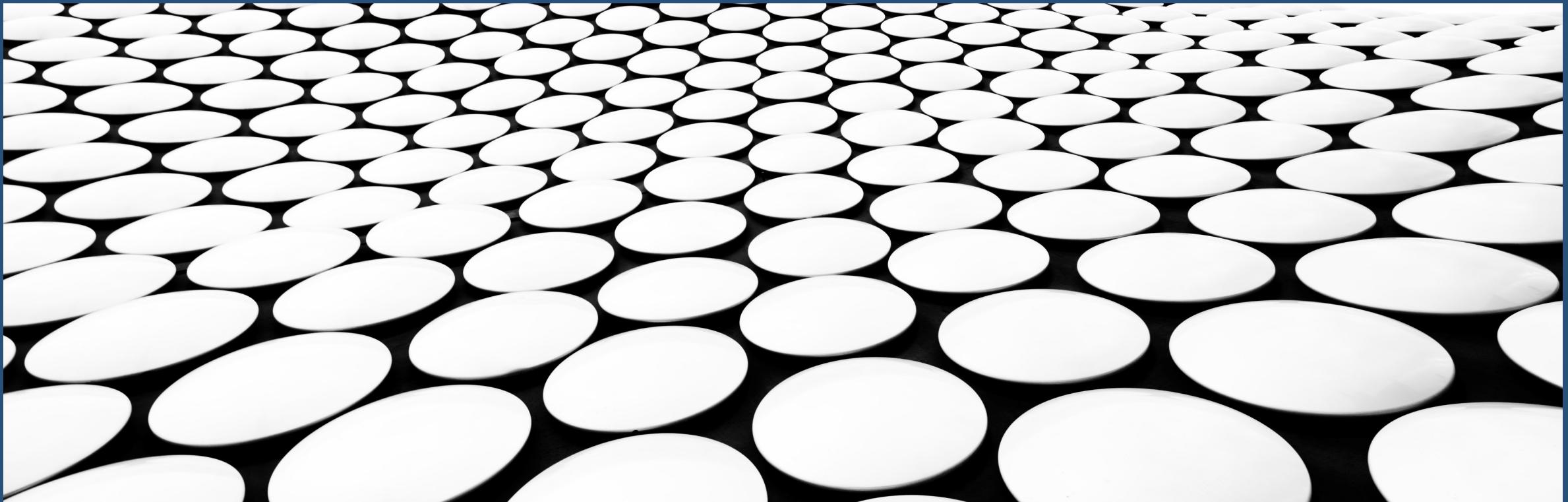


Introduction to Telecommunication

Dr. Thushara Weerawardane



My Self

- **BScHons in Electrical Engineering, University of Moratuwa, Sri Lanka.**
- **MSc in Information & Communication Technology (ICT by Research), University of Bremen, Germany.**
- **PhD in Mobile Communication (UMTS, HSPA, LTE and LTE Adv.), University of Bremen, Germany.**
- **More than 45 International Conferences, 10 International Journals, Books and Book chapters**
- **Scientist/Lecturer, University of Bremen, Germany and Technical University of Hamburg, Germany (2004 – 2012)**
- **Worked as Dean, Faculty of Engineering, Head of Department, Senior Lecturer Grade I, KDU (2012-2016)**
- **Worked as CEO/Director, Group of companies (Pharmaceutical & Cosmeceutical Manufacturing, Construction and Marketing, Sales & Distribution) 2016 – 2020**
- **Currently Working as Senior Lecturer Gr.I, Faculty of Computing, KDU (2021. Jan Onwards)**



COURSE OUTLOOK

(EE/ET STREAM)

Course outlook

Motivation and Trending Technologies

Why IT Important, IT requirement in Industry 4.0 Technologies (IOT, Cloud Computing, 5G, Blockchain, Cyber Security & Threats)

Analog and digital communication system

Elements of communication systems, Basic communication model development, Sensors and transducers, introduction to source coding and channel coding, overview digital and analog transmitters, and receivers

Classification of communication services and switching techniques:

Classification of communication services and types, simplex and duplex schemes, information transmission types, circuit switching and packet switching techniques, connection oriented and connectionless modes, coaxial cables, twisted pair cables and fiber cables, Internet over DSL, fiber LAN networks.

Wireless communication and electromagnetic waves

Introduction to history of wireless communication, Electromagnetic spectrum and applications, PSTN, terrestrial microwave systems, broadcasting and optical fiber networks, ground waves and skywaves, High frequency models, radio signal propagation and radio channels, Point to point communication, communication error handling schemes such as FEC and feedback error control

Course outlook

Modulation techniques and applications

Modulation and types of modulation, analog modulation techniques: Amplitude Modulation (AM), Frequency modulation (FM), Phase modulation (PM), and pulse modulation schemes, digital modulation schemes: ASK, FSK and PSK, Pulse code modulation (PCM), delta modulation (DM) and adaptive delta modulation (ADM).

OSI/TCP protocol models, network topologies and mobile networks

OSI 7 Layers Model, TCP/IP Model, IPv4 and IPV6, ARP, DNS, Network Topologies & Types: LAN, WAN, PAN, CAN, MAN, SAN, WLAN, GSM, UMTS and LTE Networks and Protocols, Current trends in telecommunication, 5G, IoT, Sensor Networks

ASSIGNMENT AND CLASSROOM ACTIVITIES

(EE AND ET)

Librarian Mrs Ranawella.
Tel: 0710219257
thanuja@kdu.ac.lk
libfoe_services@kdu.ac.lk



MOTIVATION

TECHNOLOGY TRENDS AND USAGE OF EFFECTIVE COMMUNICATION

Outcomes

- Define Introduction to modern communication
- Describe IOT and IIOT systems
- Describe 5G and modern technology trends
- Illustrate Industry Usage and Applications



LET'S LOOK AT INDUSTRY POINT OF VIEW

TECHNOLOGY SOPHISTICATION

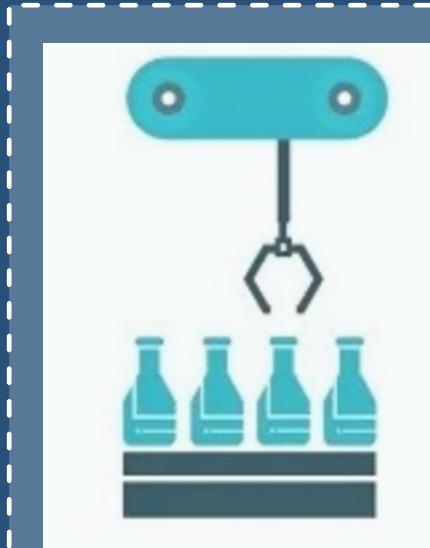


Industrial Revolution



Industry 1.0
Mechanisation,
Water and
Steam Power
(Mechanical)
1784

Mass Manufacturing



Industry 2.0
Mass Production,
Assembly lines,
Electrical Energy
(Electrical)
1870

Mass Production



Industry 3.0
Automation,
Computer driven,
IT & Robotics
(Electronic)
1969

Mass Customisation



Industry 4.0
Cyber Physical Systems,
IoT and Cloud,
AI Driven
(Network)
Now

Mass Personalisation

TODAY ENTERPRISE (FUNCTIONAL SPLIT)

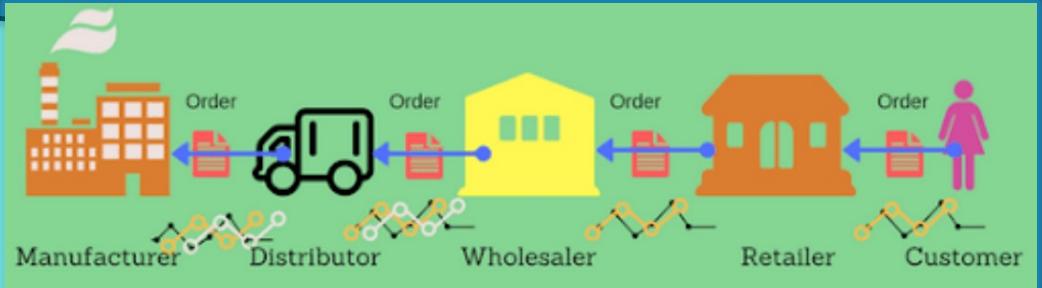
CRM
*Marketing
Sales
Customer oriented Processes*



ERP
Finance, HRM & All back-office functions



Manufacturing
Production processes, Quality Control and Assurance, Utility management, etc..t



SCM
Material, transport and all logistic related functions

What is changes in Industry over Years?

Productivity

Labour Content

Cost Reduction

Speed

Moore's Law

highlight the
rapid change
in information
processing
technologies.

Manufacturing - ?

What is Common ?

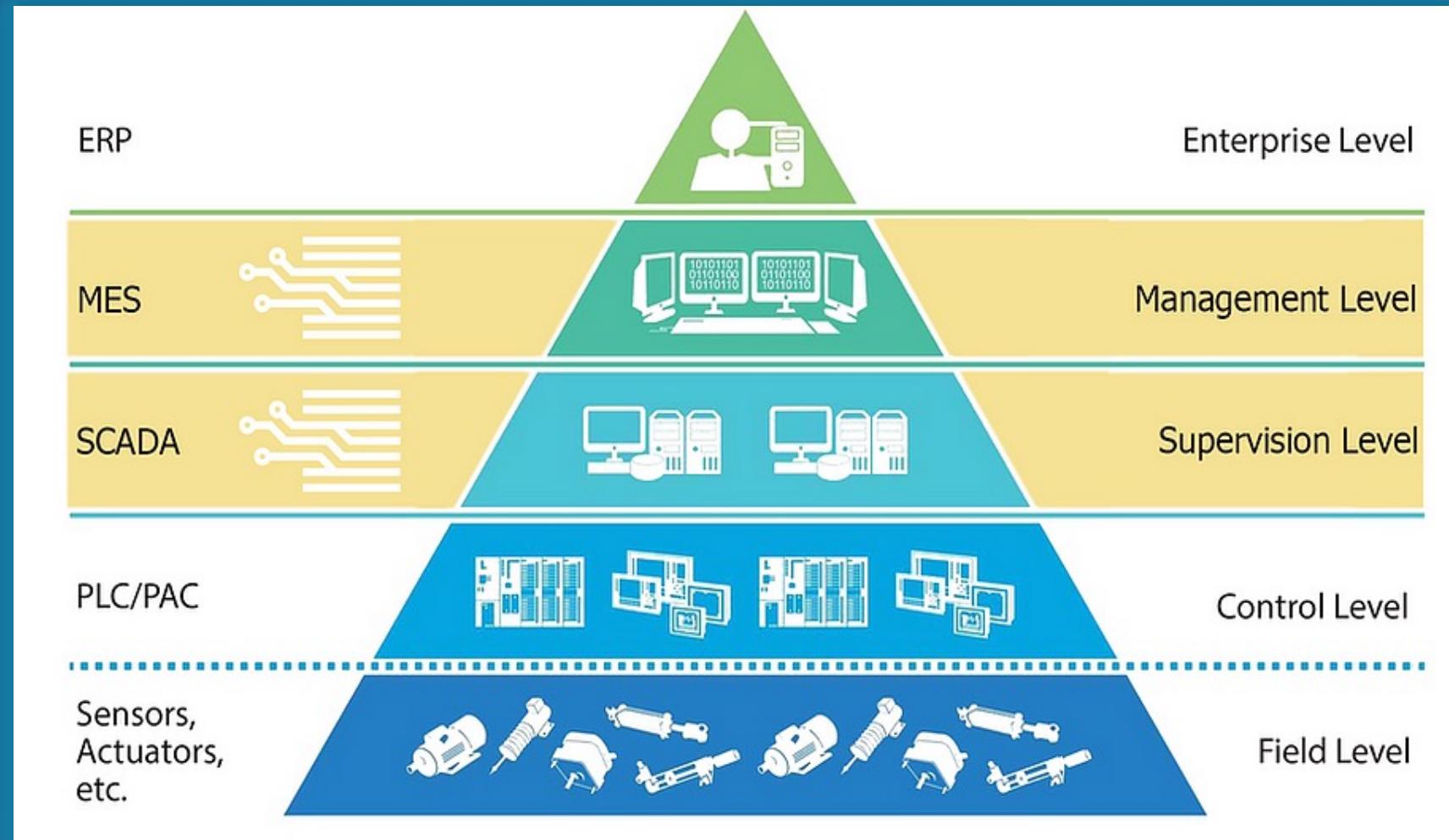


What is different ?



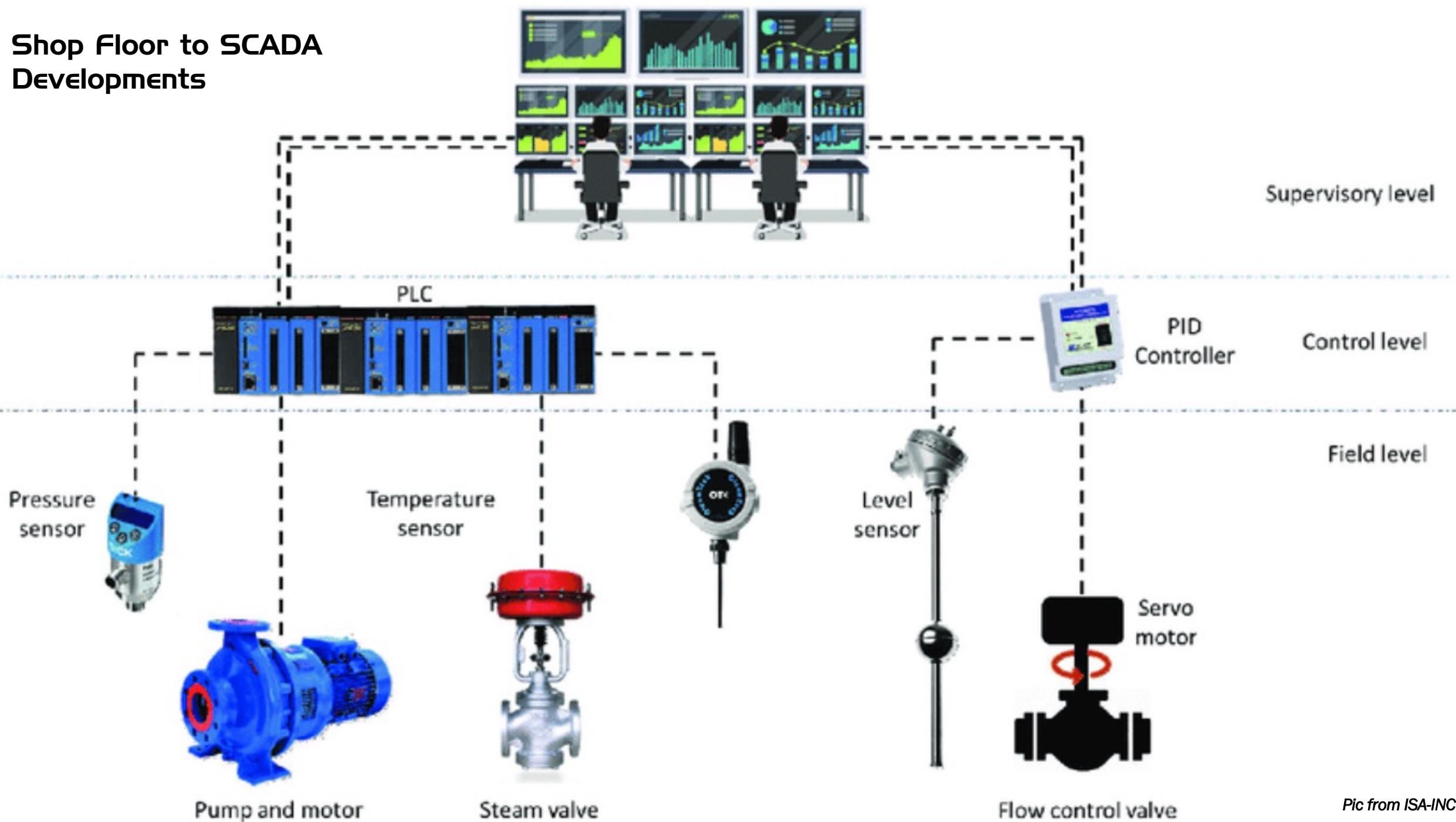
ISA-95 is the international standard for the integration of enterprise and control systems

Automation Pyramid



(STD - ISA95 hierarchy model)

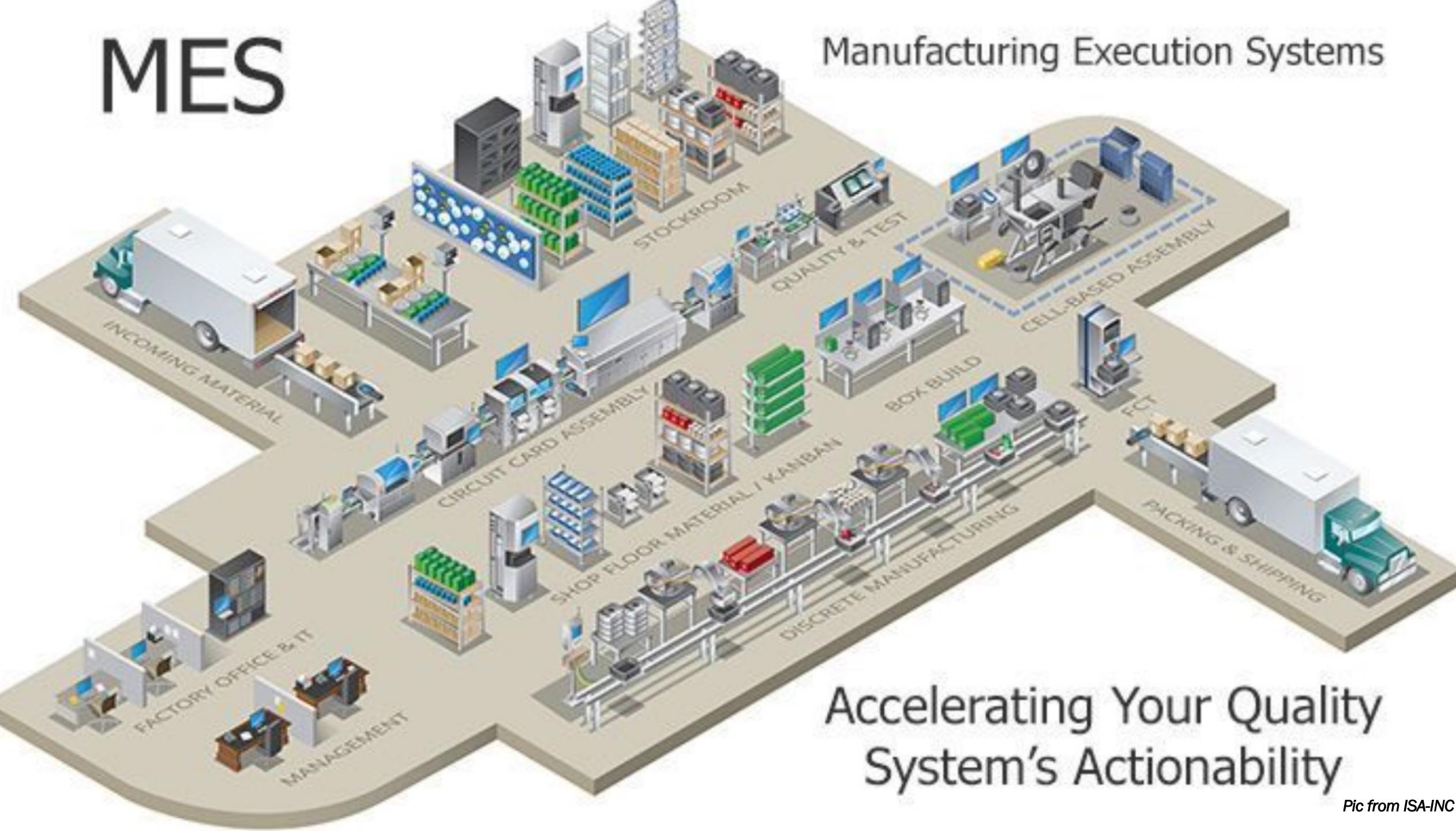
Shop Floor to SCADA Developments



Pic from ISA-INC

MES

Manufacturing Execution Systems



Accelerating Your Quality
System's Actionability

How to Measure of Efficiency of Factory

Overall Equipment Efficiency (OEE)



*Production Rejects
Startup*

*Setups, Adjustments,
Breakdown*

*Reduced Speed
Small Stop*

OEE (~50%)
(Q x A x P)

Account Equipment Losses

OEE measures the percentage of Planned Production Time that is truly productive

TEEP (Total Effective Equipment Performance)

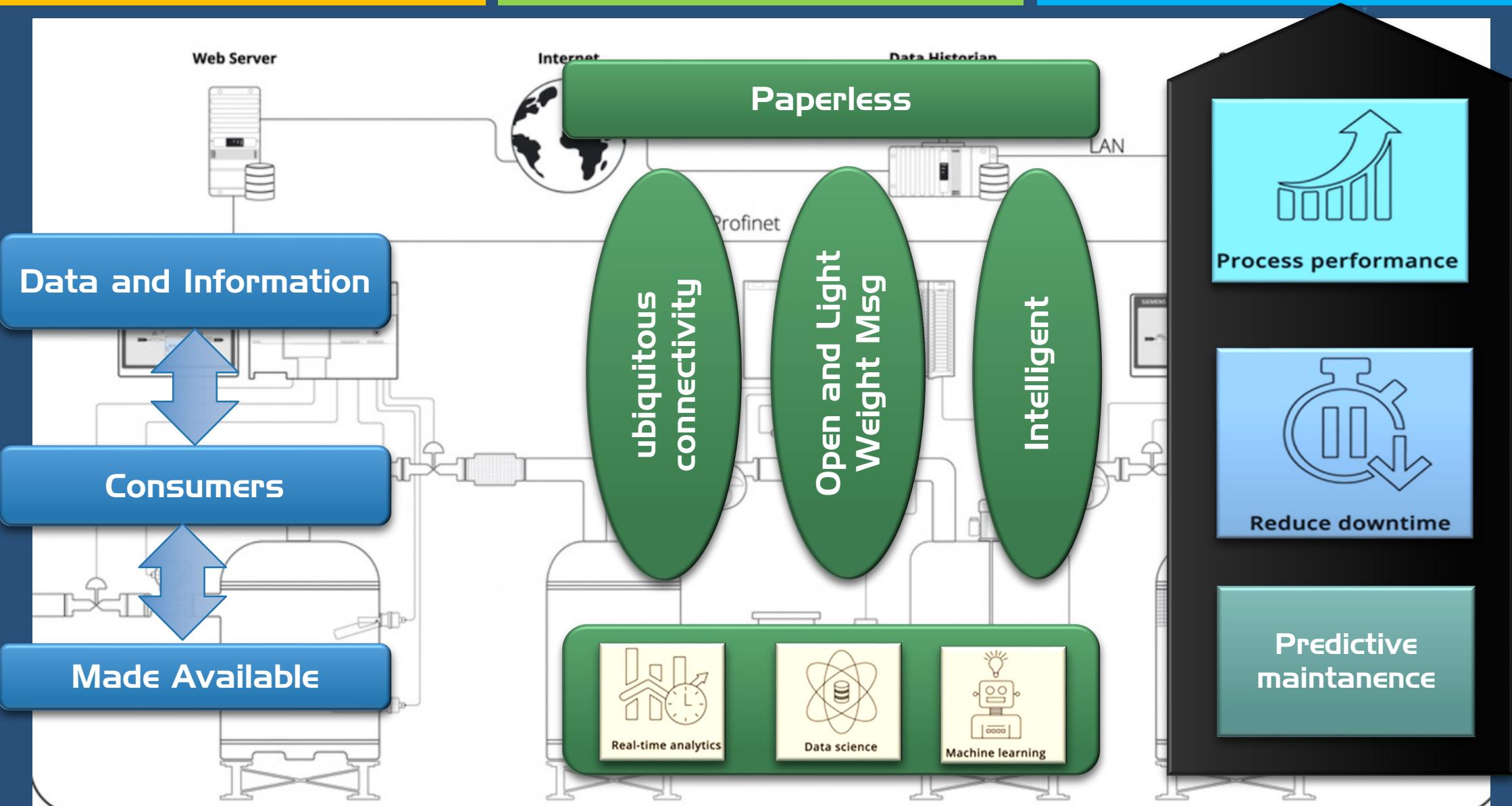


Utilisation = Planned Production Time / All Time

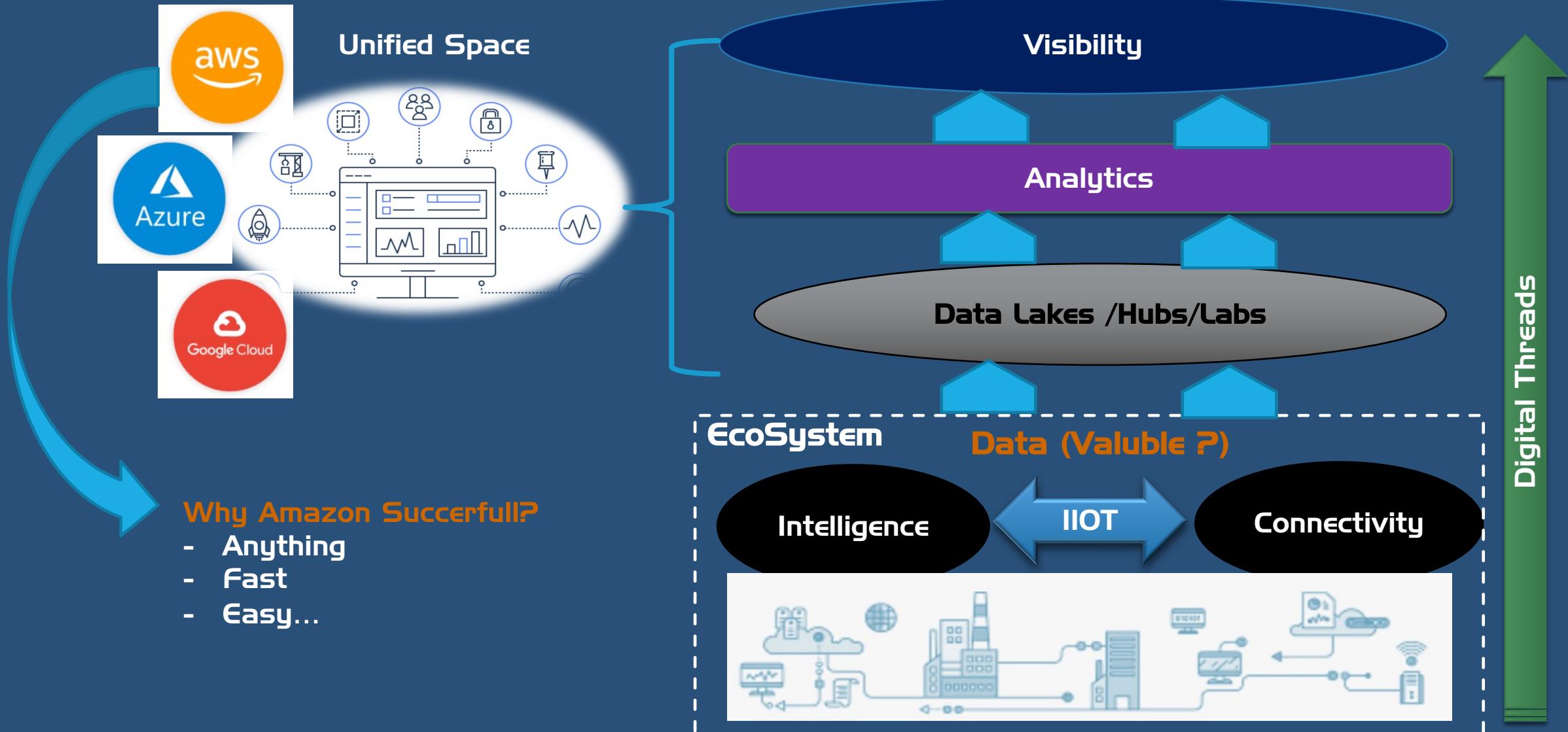
TEEP (~30%)
(OEE x A)

Account Schedule Losses

IIoT - To Create Real-time Cyber-Physical Automation System



Cloud Providers → Digital Threads → Data



AI and ML → Predictive Maintenance

Machine Learning

Artificial Intelligence

Acquire Knowledge

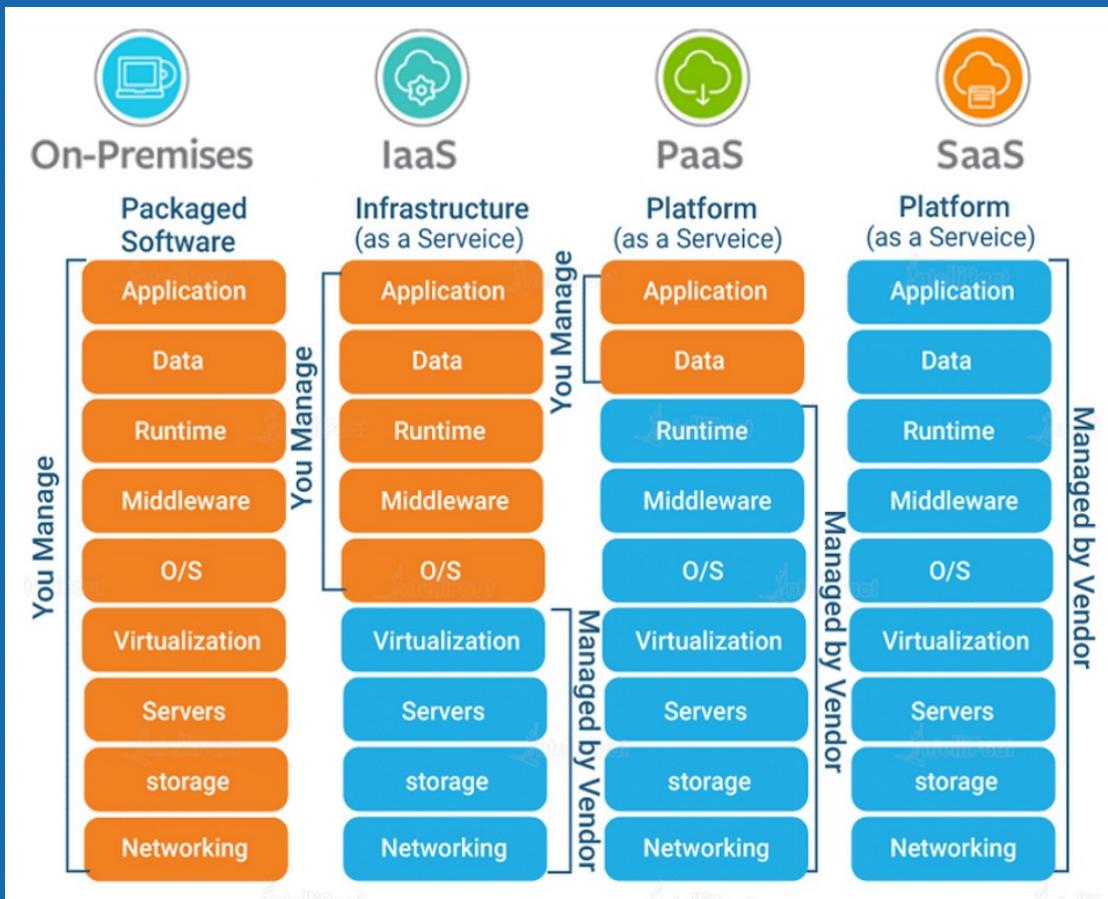
- Determine which Variable..
- Relationship Between Variables...
- Process Data and Information..

Acquire Wisdom

- Compare and Detect Anomalies
- Connect Information (Machinaries ML outputs)
- Arrange Optimal Solution

Cloud and Data Handling

Standard Models



DataBases

Mostly Structured or Relational databases

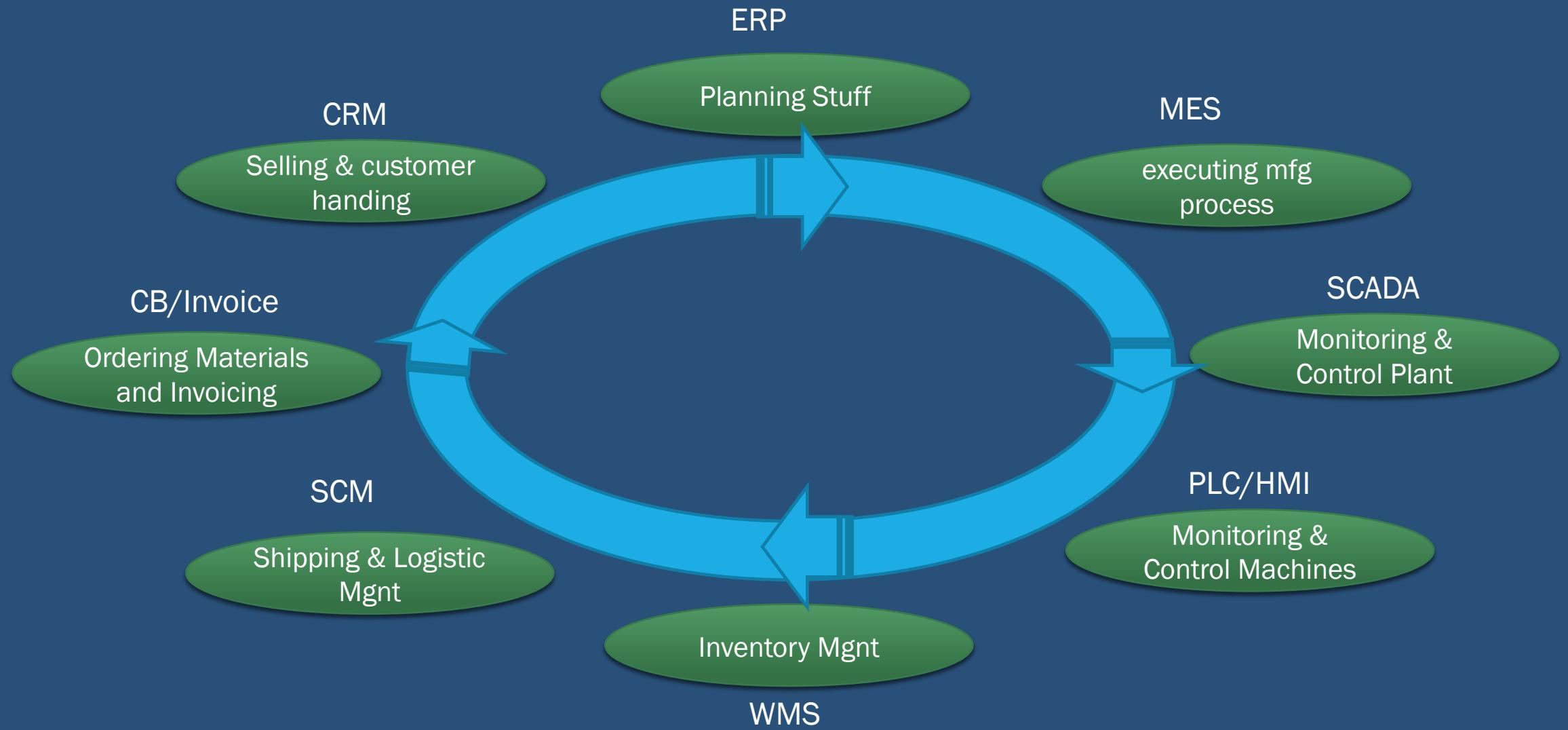
Data Warehouse

*Multiple databases, Batch Processing
(Structured and Unstructured, SQL and NoSQL, etc)*

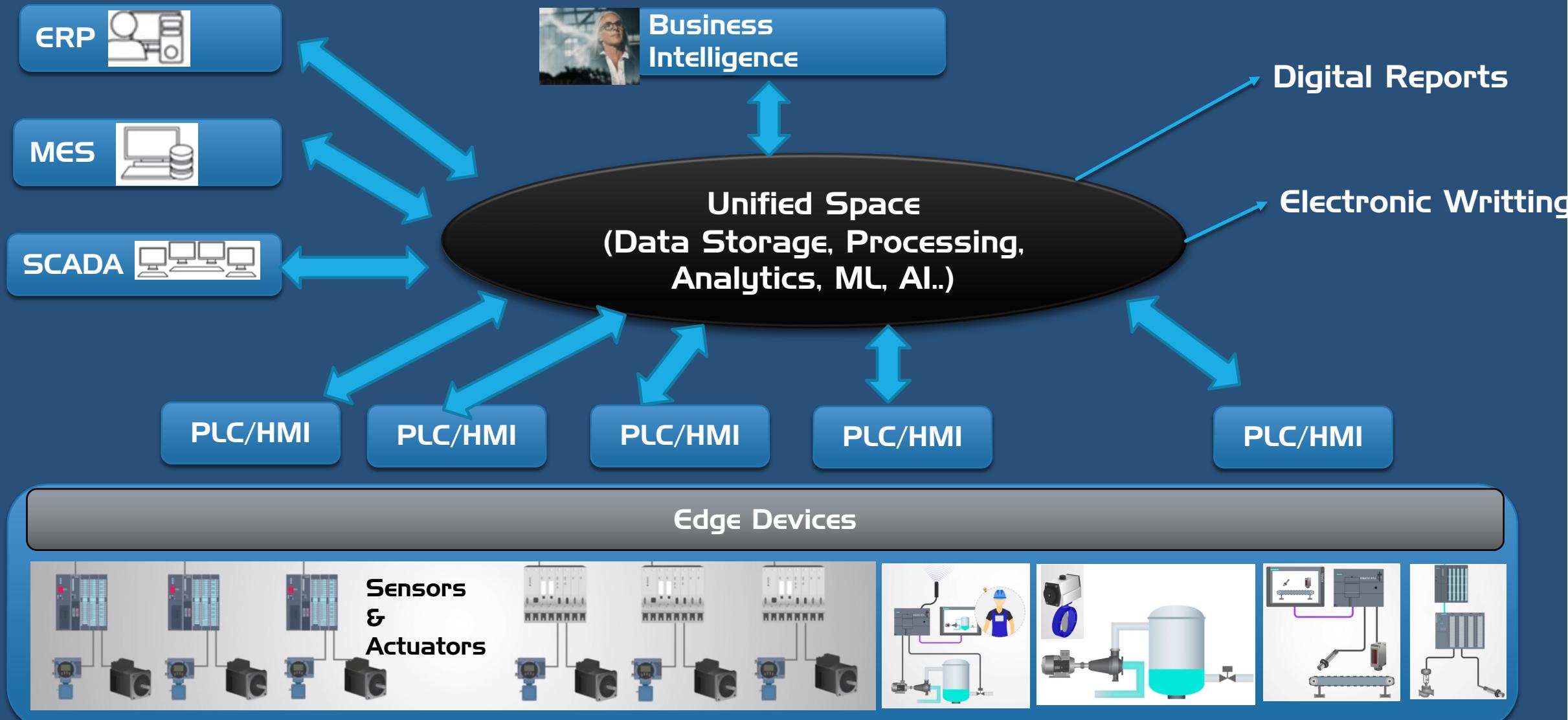
Data Lakes

Real-time data collection, unstructured semi-structured and Structured, ML outputs, Analytics at edge, multi mode, polyglot

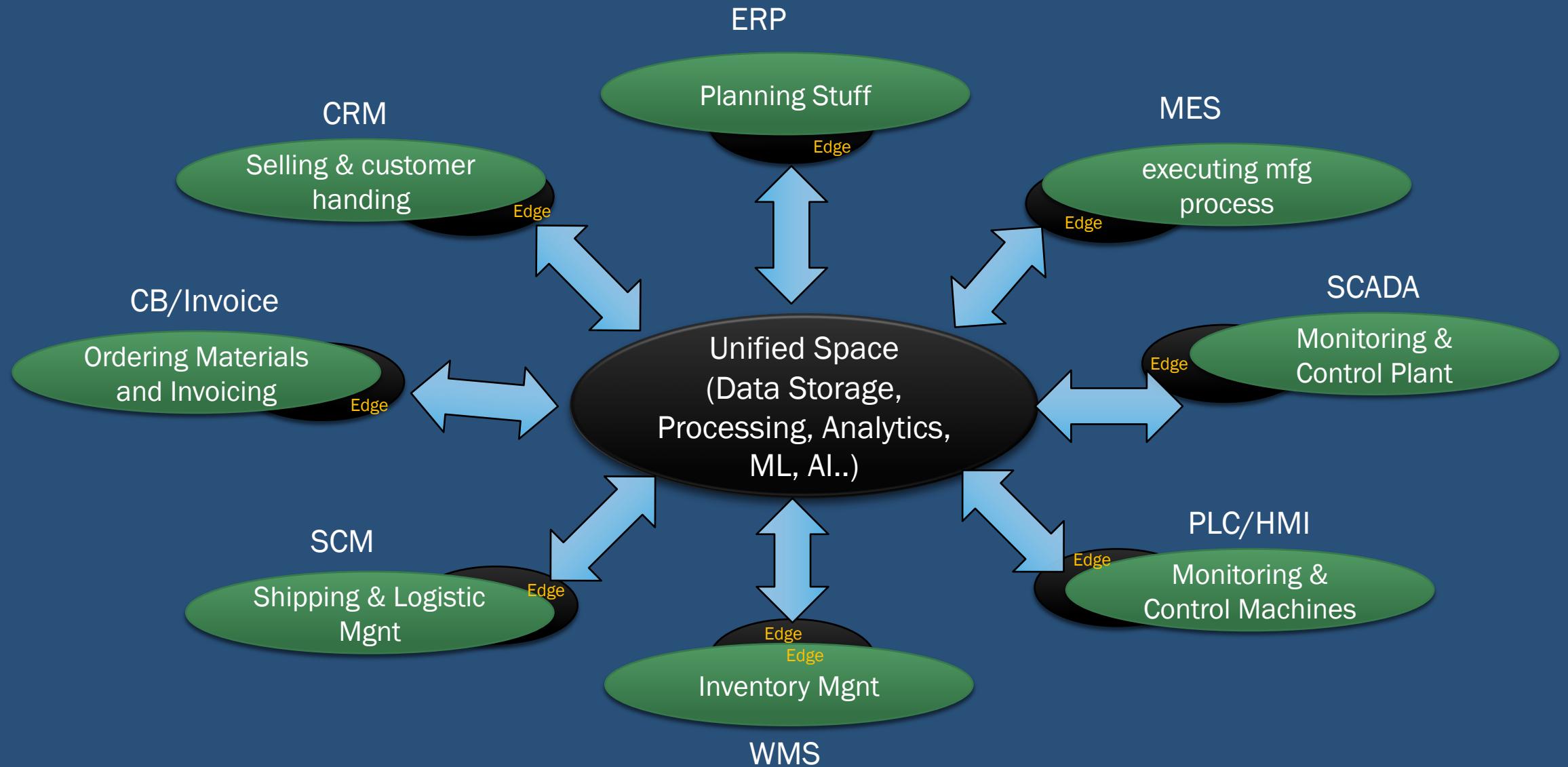
InDustry 3.0 - Automation



Step Towards Industry 4.0



InDustry 4.0 → Data and Connectivity → Analytics



Key Technologies for Disgitalization



5G &
Wireless

Artificial
Intelligence



Cloud
Computing

Cyber
Security



Edge
Computing



IIOT

Data
Science



Extended
Reality (XR)



Digital Transformation ?

Industry 3.0

Automation of the
Manufacturing Process

Digital Transformation

Digital Strategy
(Going for manual/paper
processes TO Integrated digital
Processes)

Industry 4.0

Digital Integration and
Automation of the
Business Processes

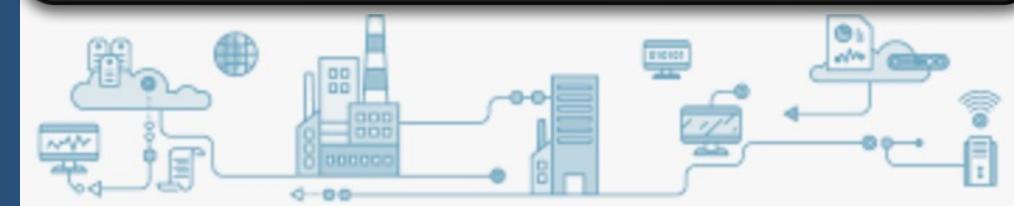
[Create Digital DATA]

[Create Information]



IIoT

(Digital Ecosystem – Data, Intelligent and
connected)



Enterprise - Digital Transformation

Why

- To be competitive in business (Availability, Quality and Performance)

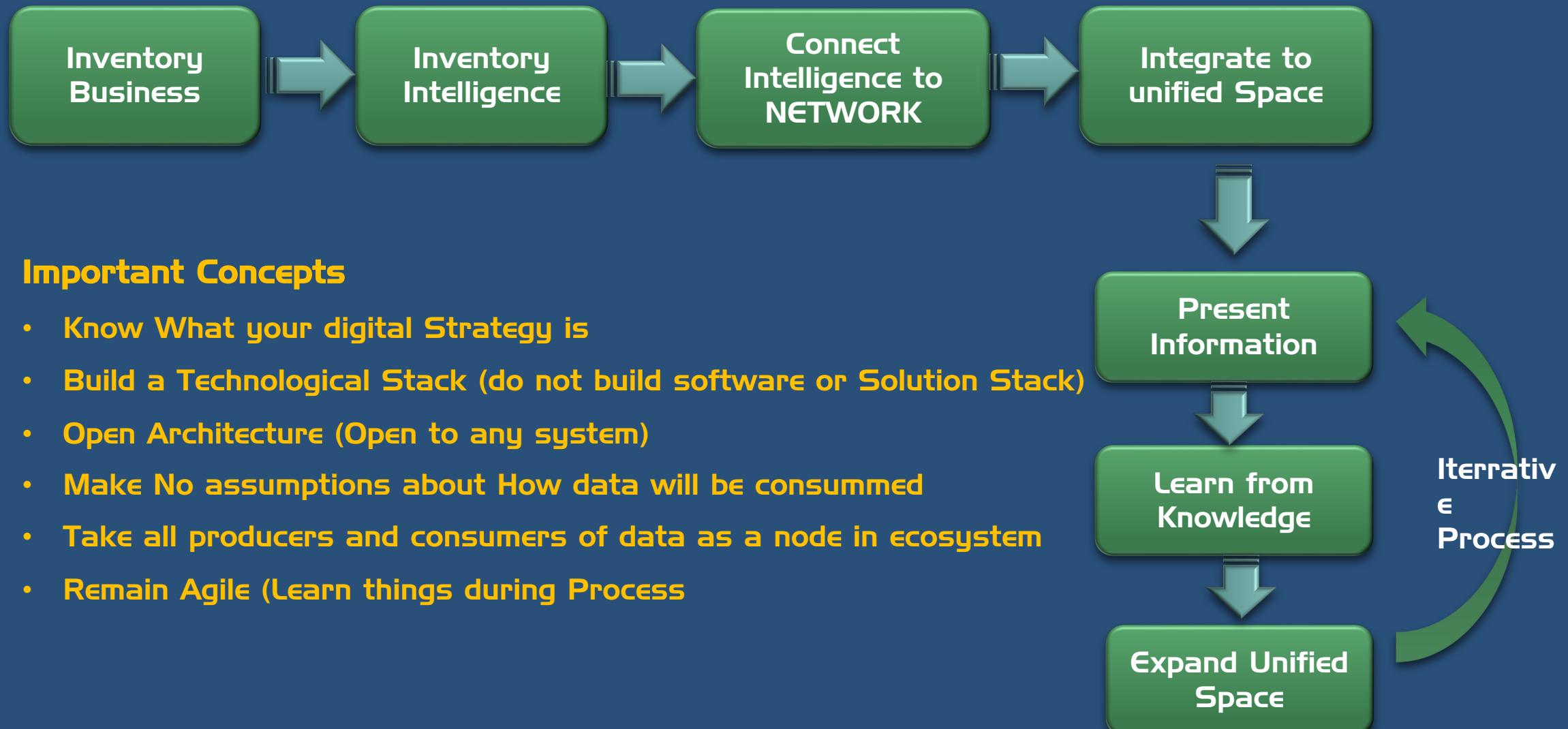
Issues

- Not Every one can be helped
- Investe your energy on the business, you can help
- Start finding people who admit they have problems

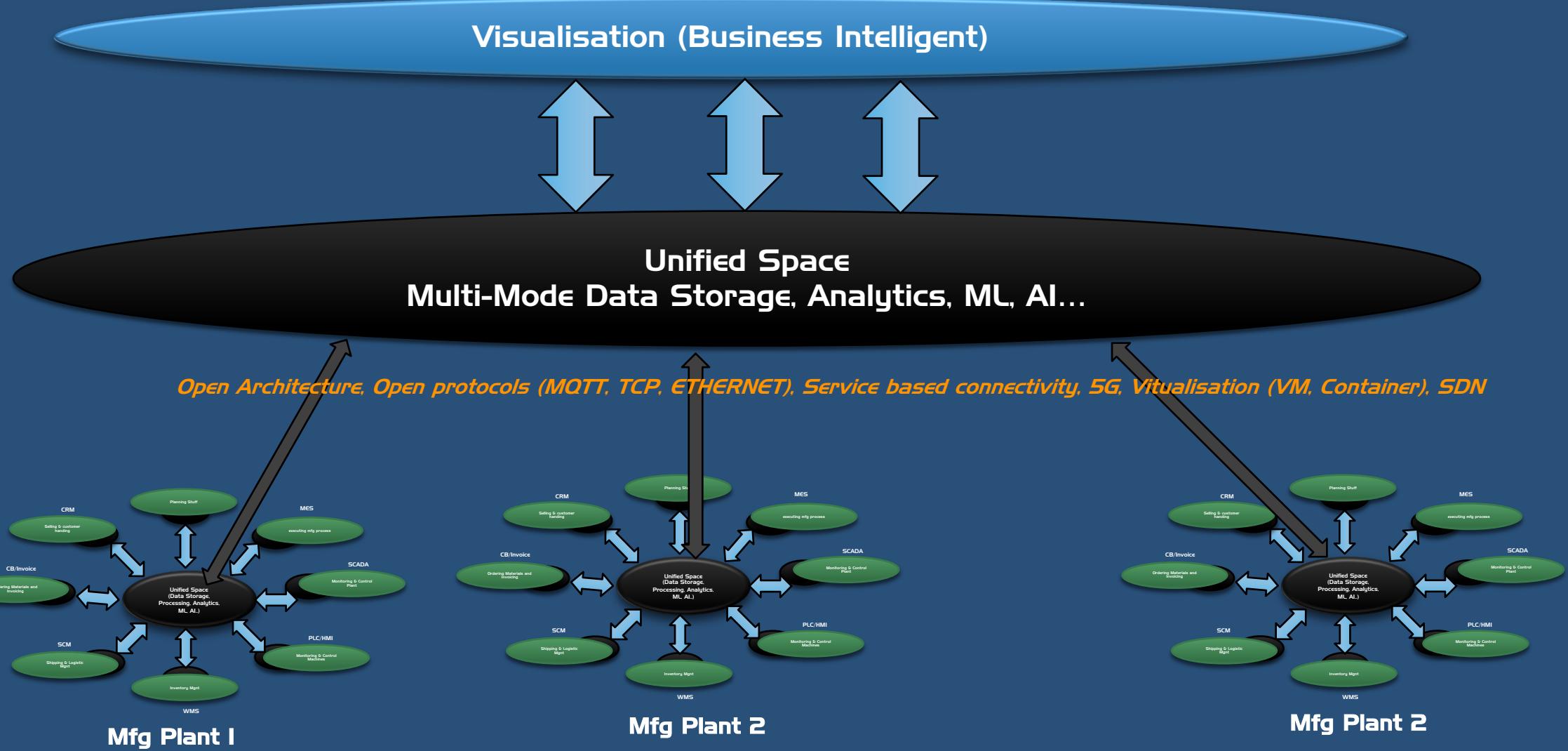
Solutions

- Admit you have a problem without wasting money
- Brainstorm a Solution (Keep a dream, time and money)
- Get Help (from available system architects)
- Work Together
- Architect a solution

Procedure for Digital Transformation of Enterprise



Digital Factory – Possible integrations



What is Digital Factory?

No Paper

Connected Stack

Real time matrix

Big Data Analytics

Overall Automations
(Digital Twin)

Benefits

More Competitive
Increase efficiency
Better Inventory Control



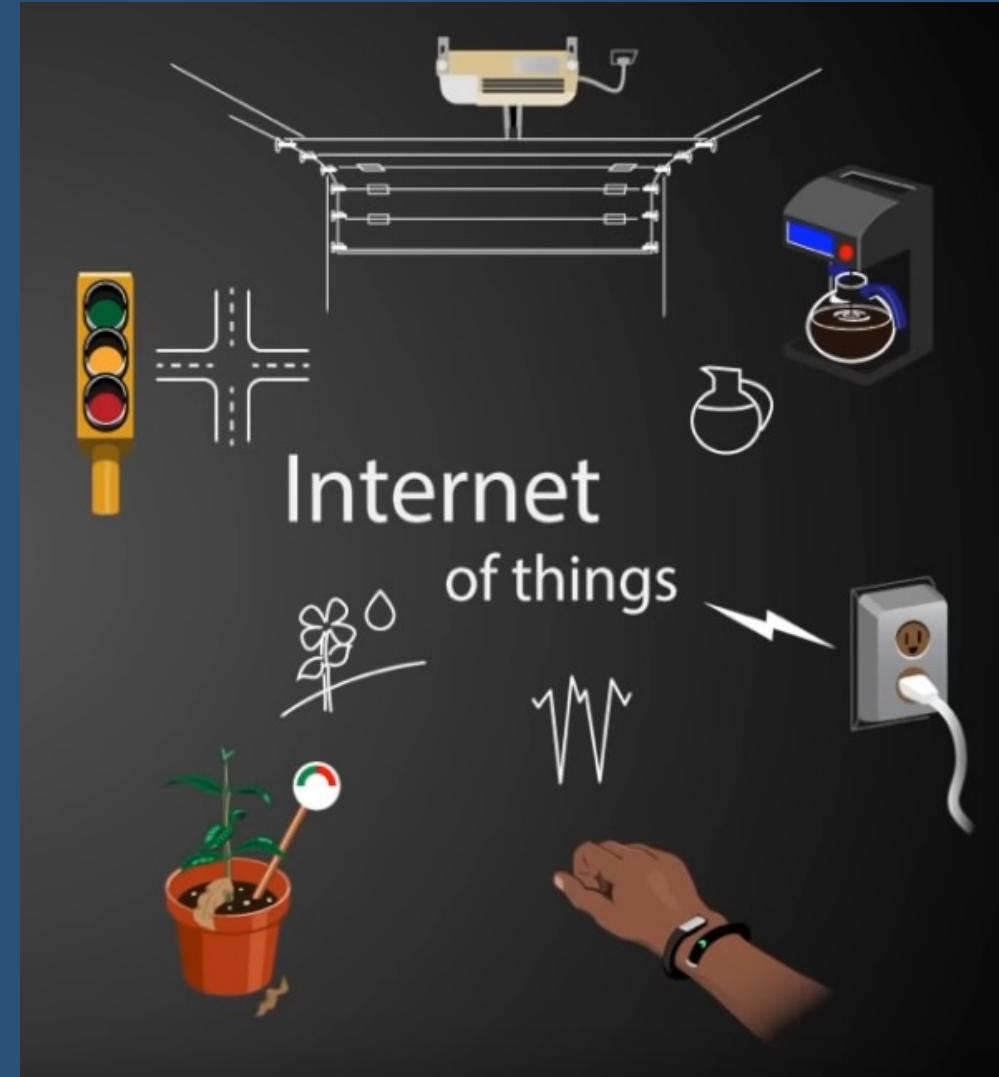
INTERNET

CHANGING TECHNOLOGY....

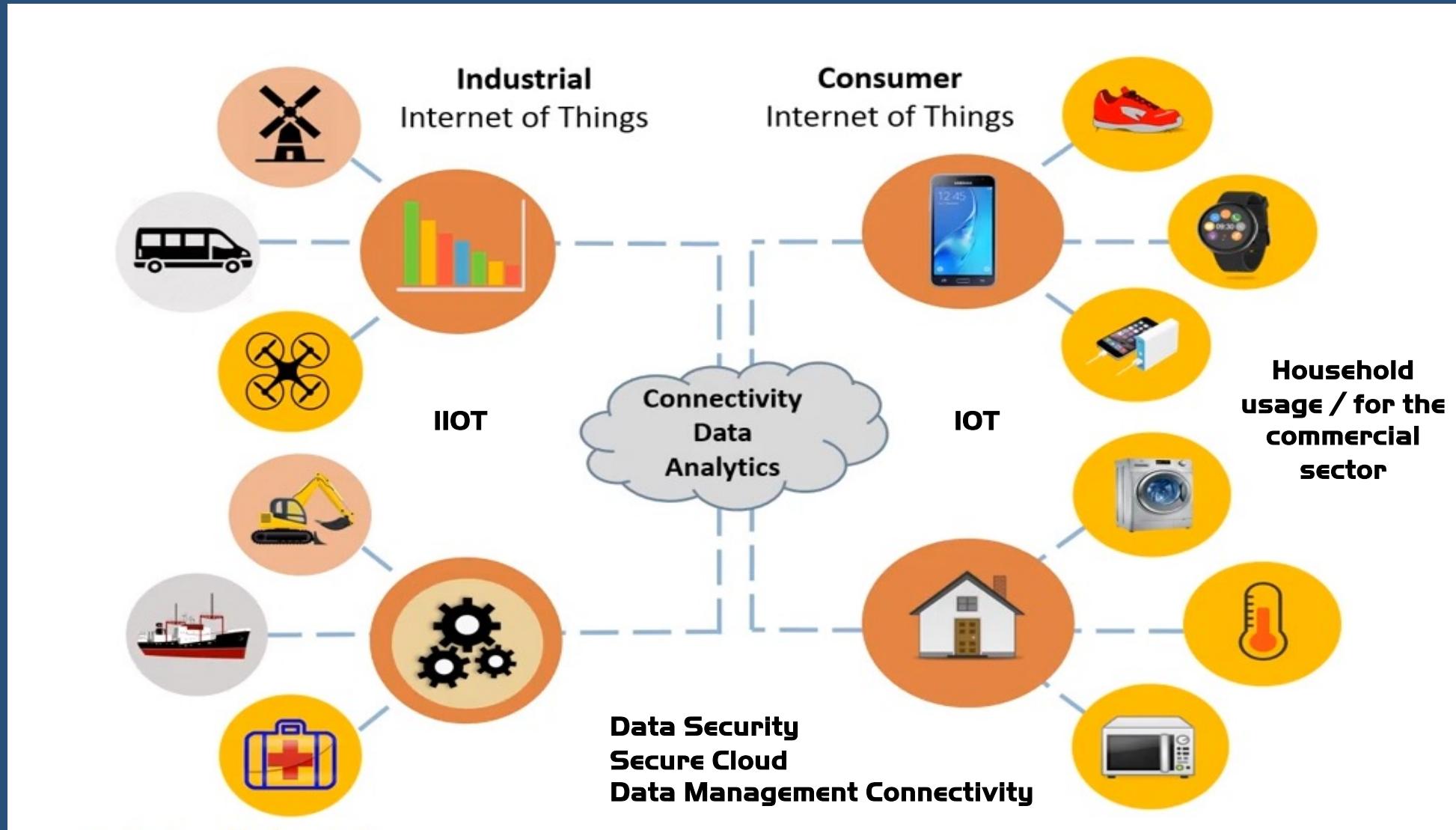
Internet of people



Internet of Things



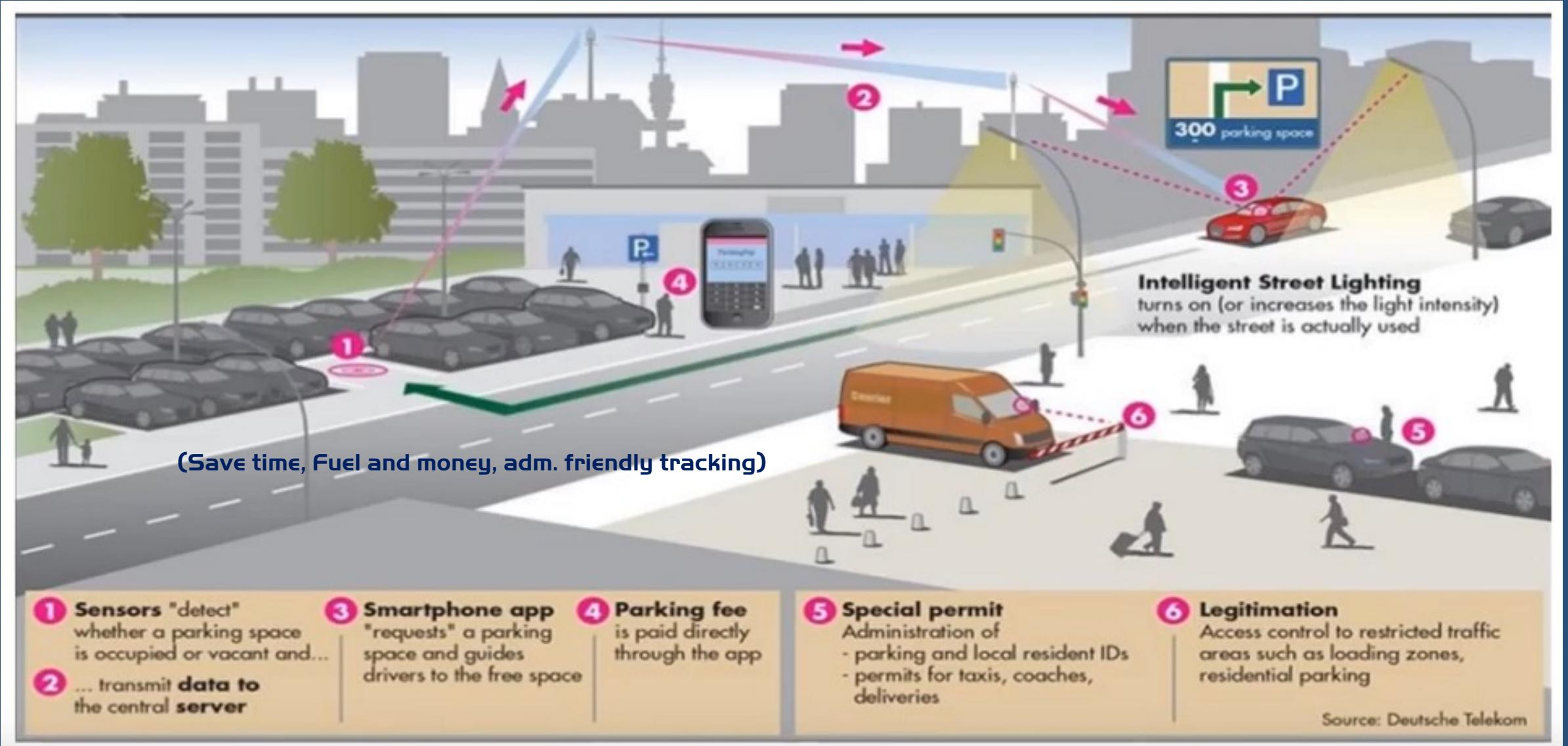
Internet of Things (Consumer/ Industry)



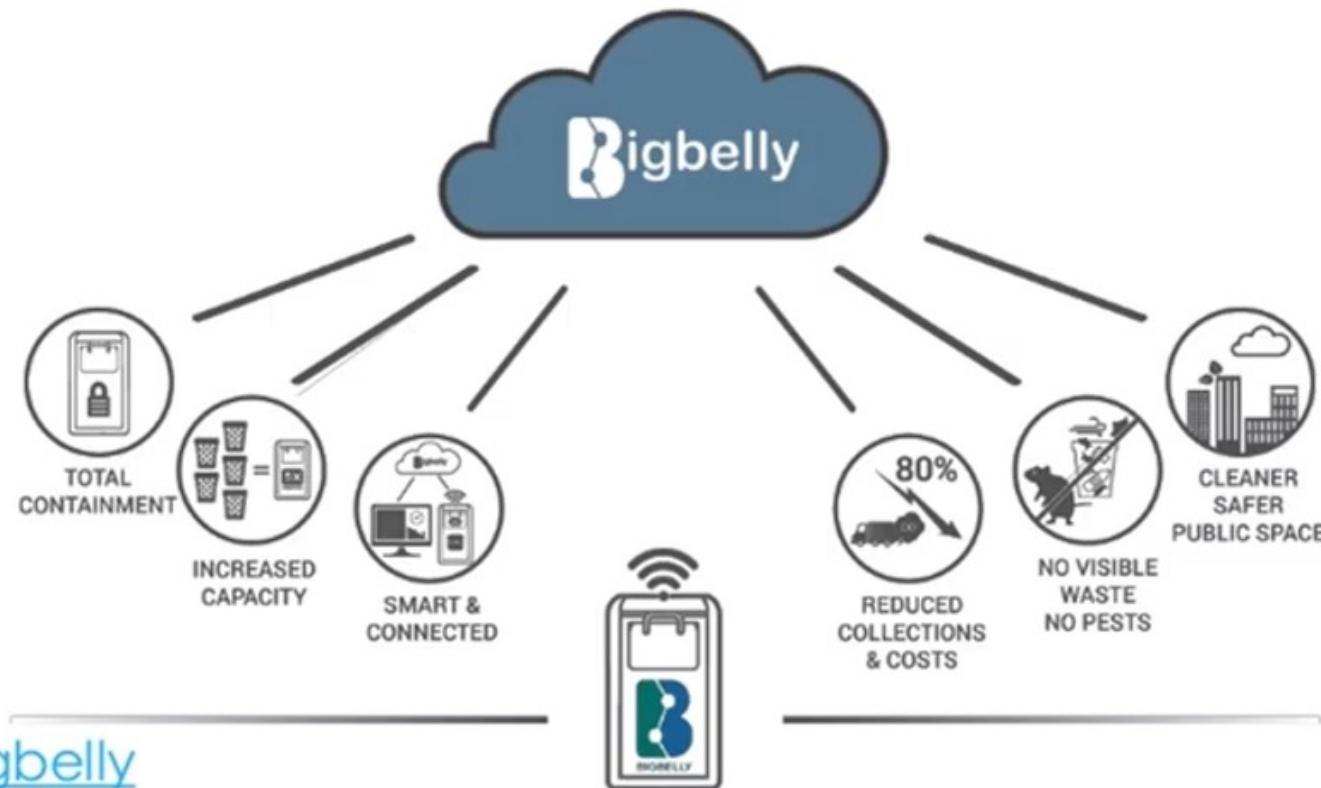
Why IOT ?



Example - Smart Parking



Example – Smart Waste and Recycling



Source: [Bigbelly](#)

Example - Logistic Management



Big Data

- 40 Giga byte per Mobile in average
- Total data is huge

Let's have a look at the data generated per minute on the internet



"2.1Million"



"3.8Million"



"1.0Million"



"4.5Million"



"188Million"

Photos

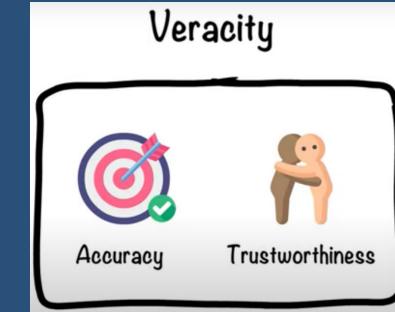
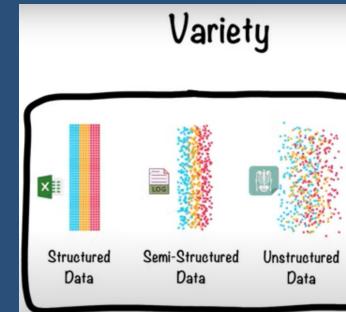
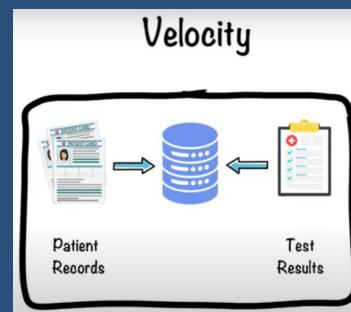
Web Search
Quarries

FB logins

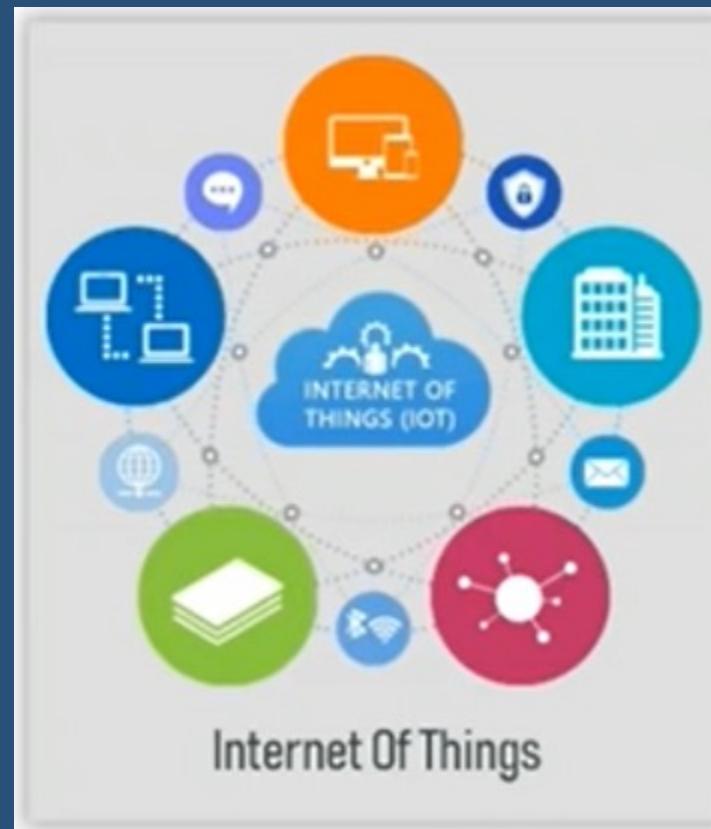
Videos watched

Emails

Classify: Big Data - 5V's

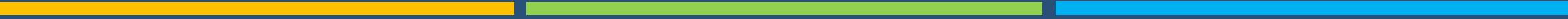


Growing Data Demand



Over 4 quintillion bytes of data are created every Single Day

Need for AI to process data in Real time: Machine Learning and Deep Learning

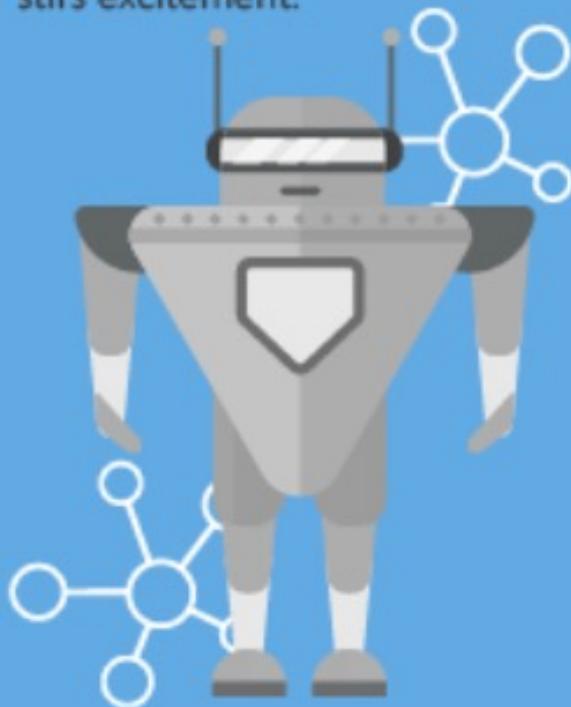


ARTIFICIAL INTELLIGENCE

CHANGING TECHNOLOGY....

ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



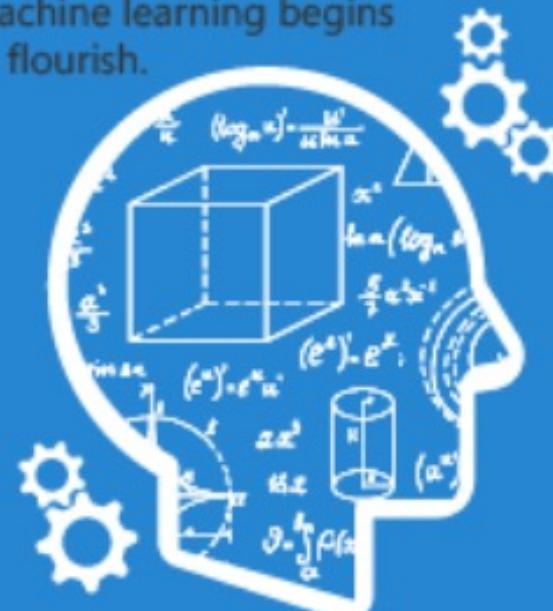
1950's

1960's

1970's

MACHINE LEARNING

Machine learning begins to flourish.



1980's

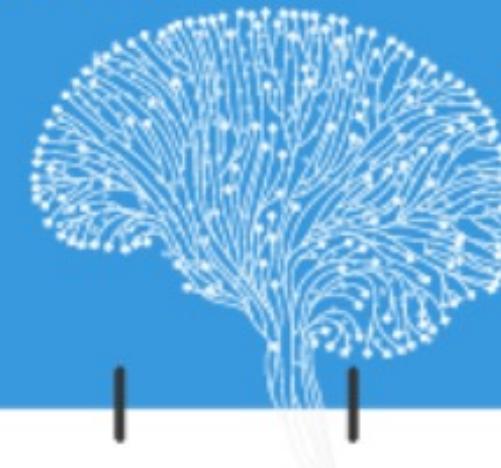
1990's

2000's

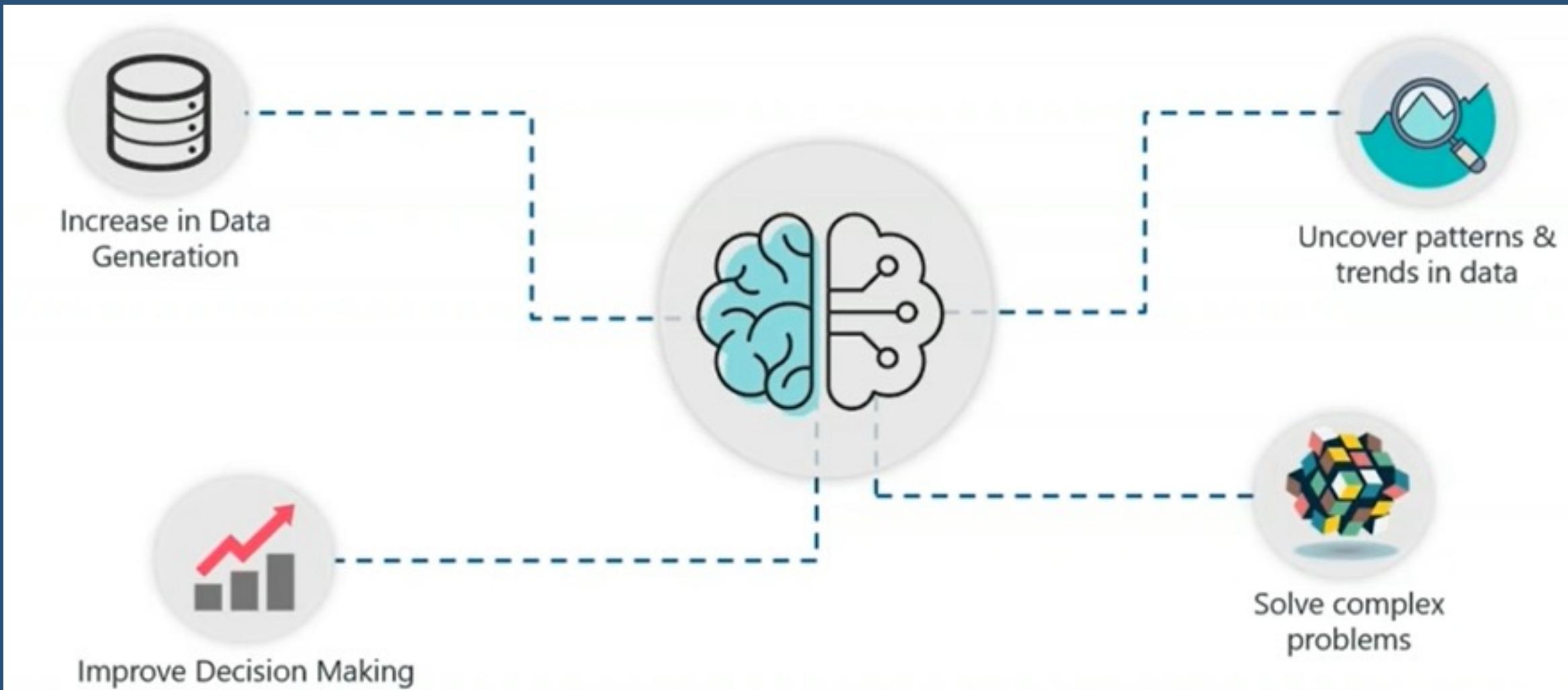
2010's

DEEP LEARNING

Deep learning breakthroughs drive AI boom.



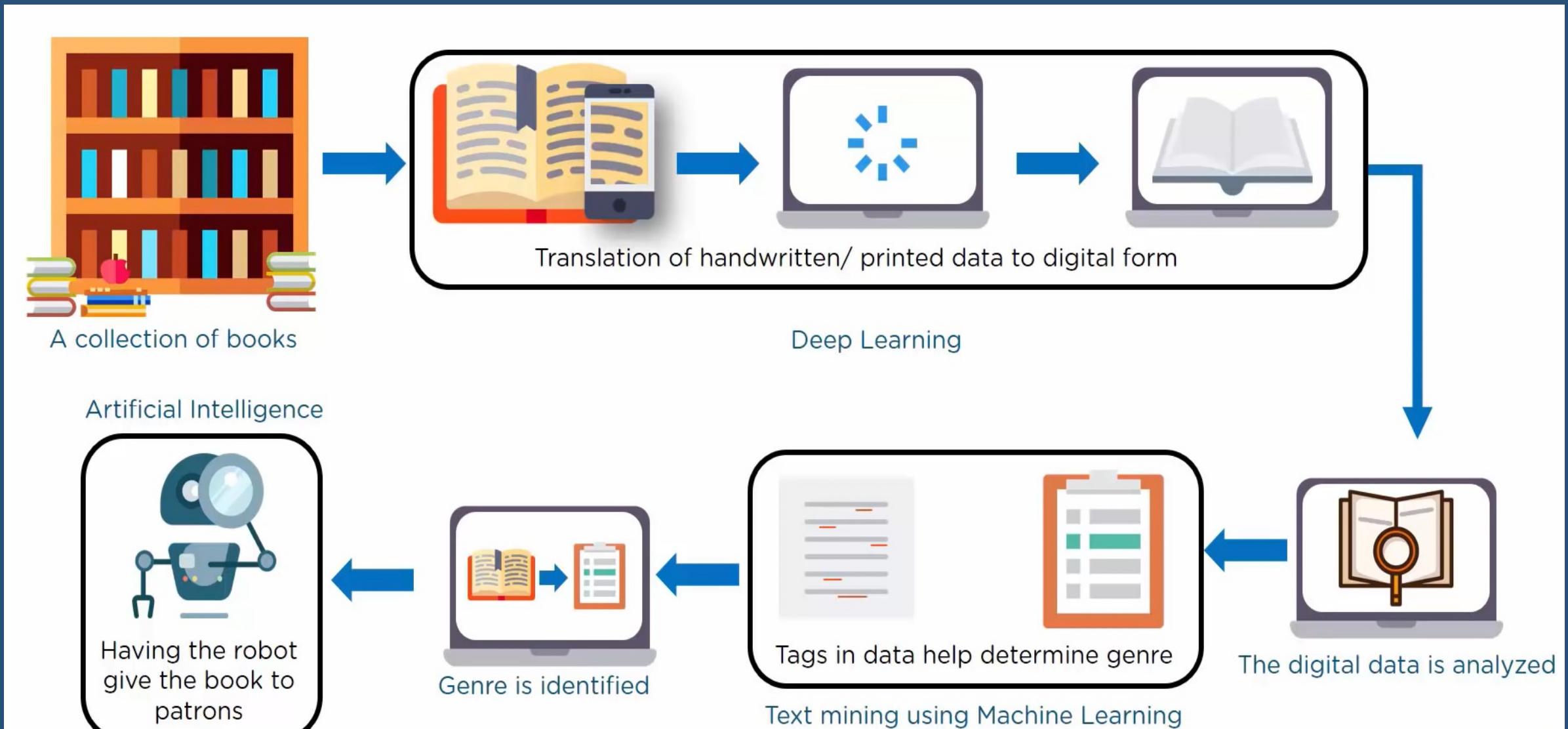
Artificial Intelligent – Key Functions



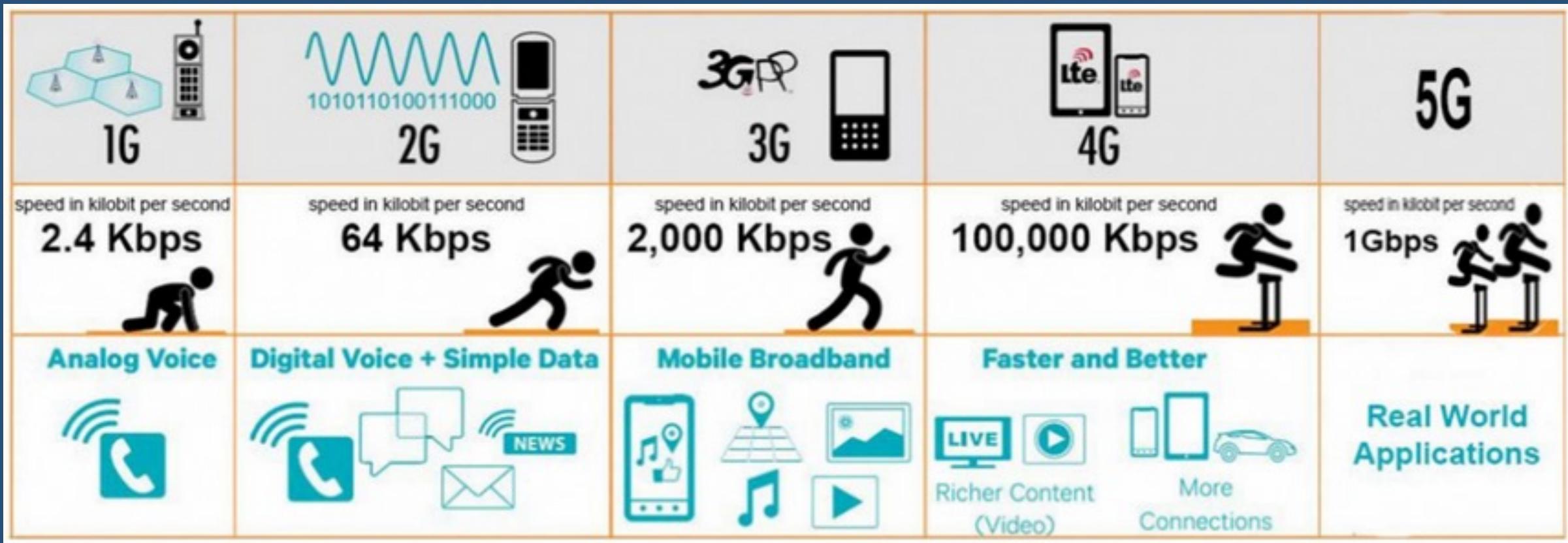
AI Usage



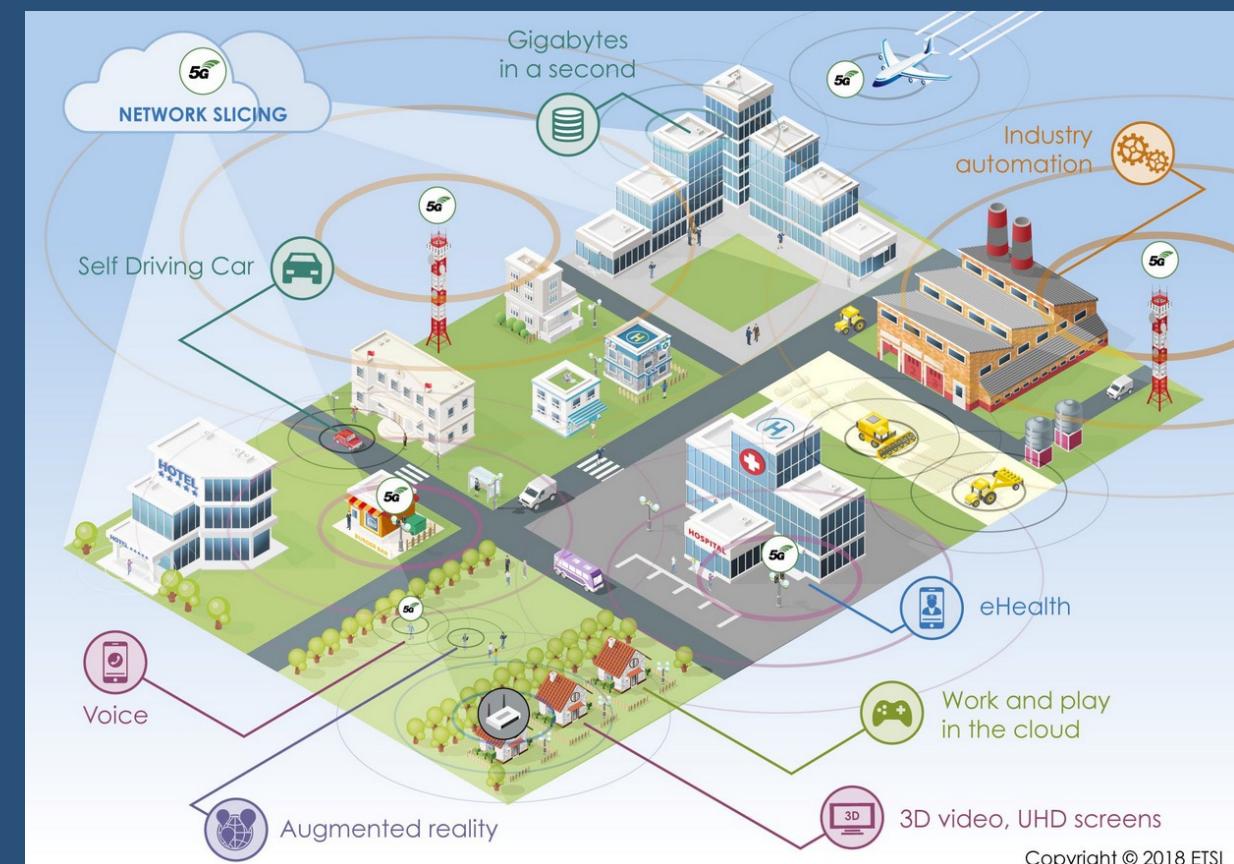
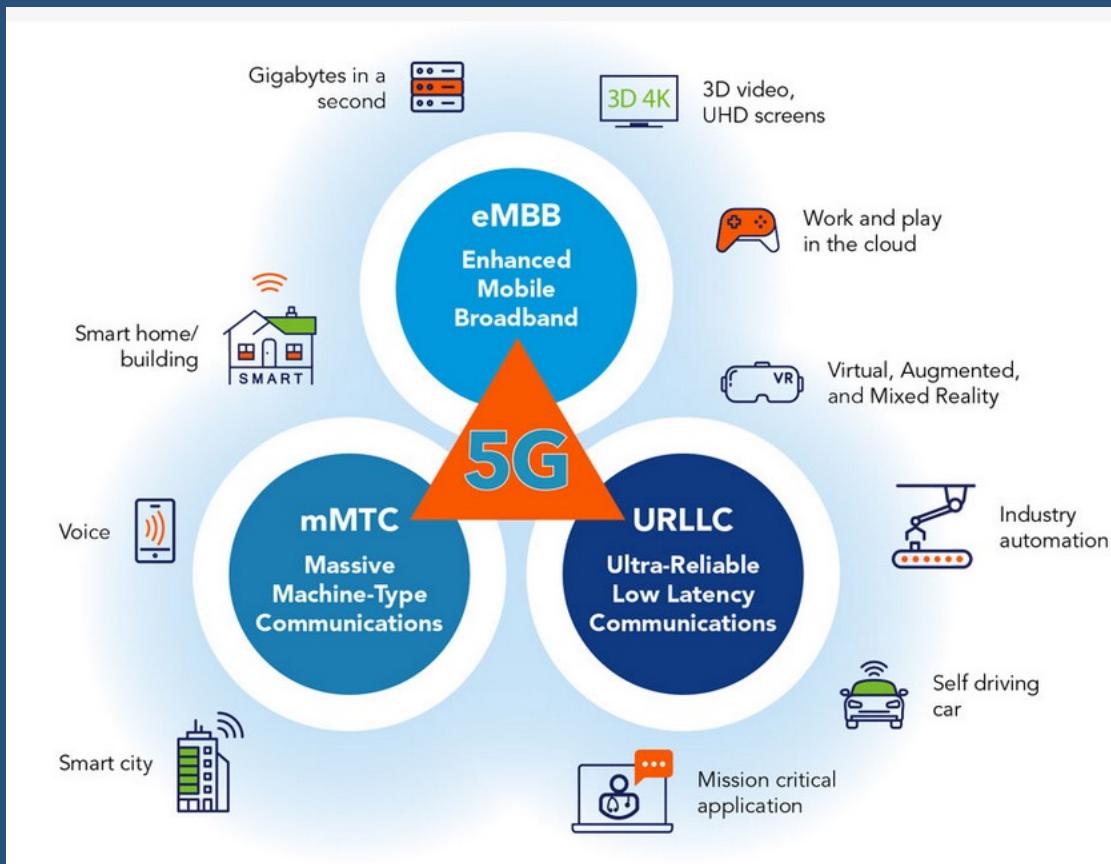
Example - AI, Machine Learning and Deep Learning



Cellular Technology Evolution



5G Application Scenarios





Example Analysis For

Predictive Maintenance

Industrial Maintenance Strategy ?

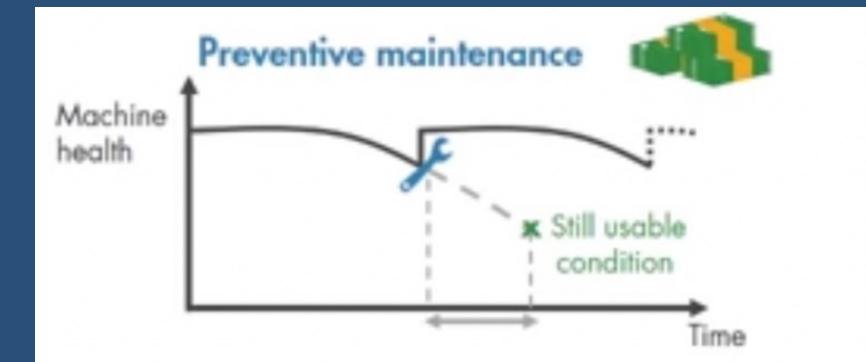
Reactive Maintenance

Do maintenance once there is problem



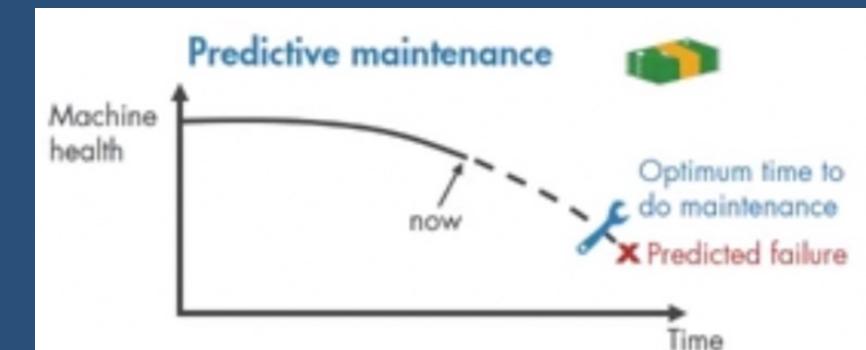
Preventive Maintenance

Scheduled/Regular Inspections, to avoid equipment failures



Predictive Maintenance

Proactive Strategy to avoid equipment Failures
(Intelligent monitoring
IoT/Sensors)



Predictive Maintenance ?

High-End Applications



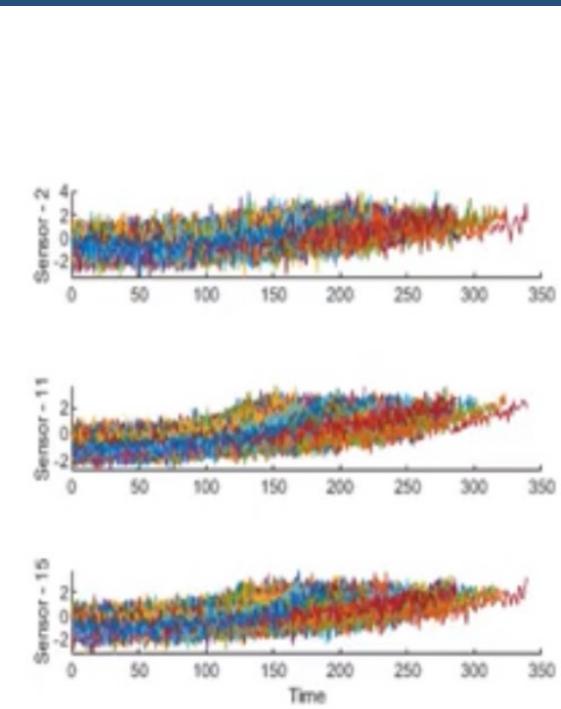
Turbofan Engin Test



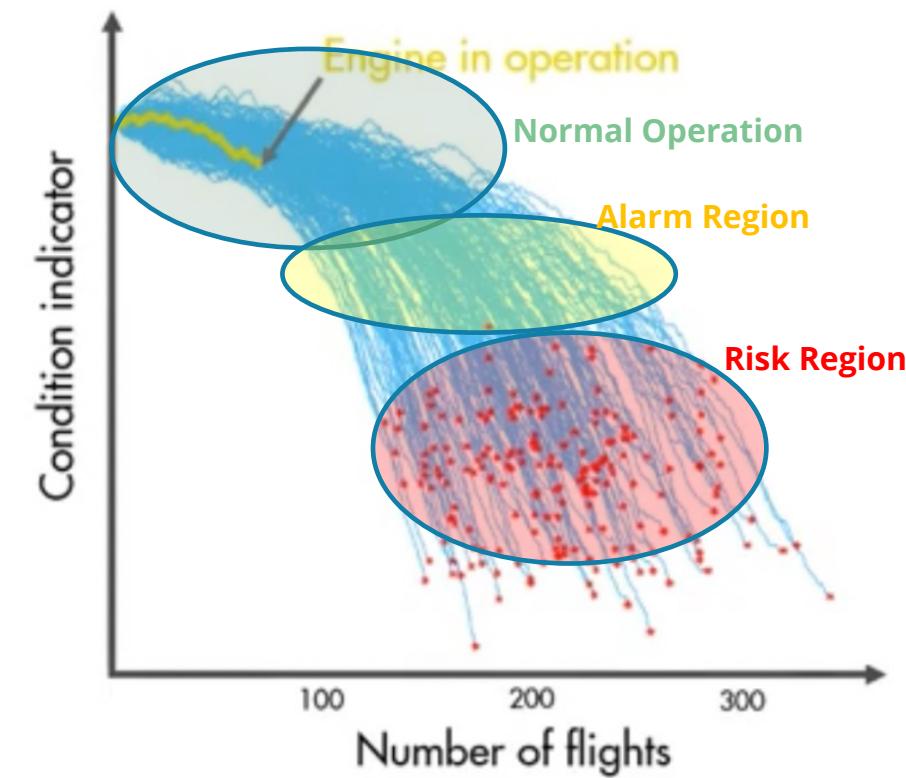
Wind turbine



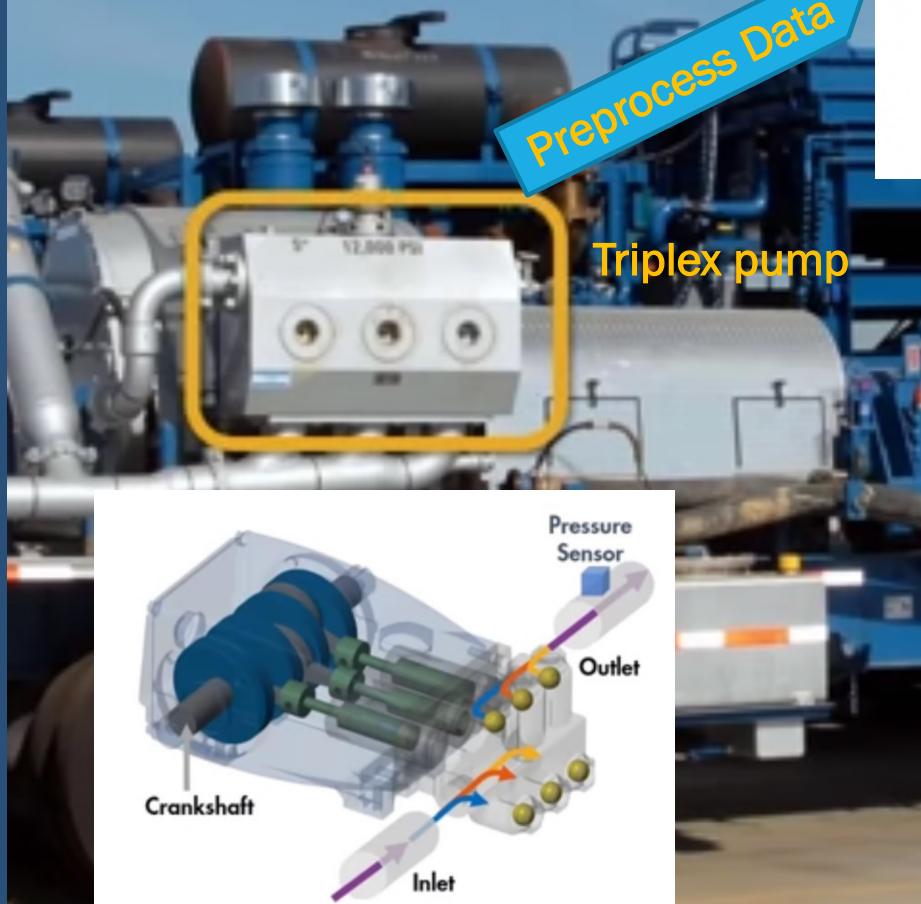
Turbofan Engin



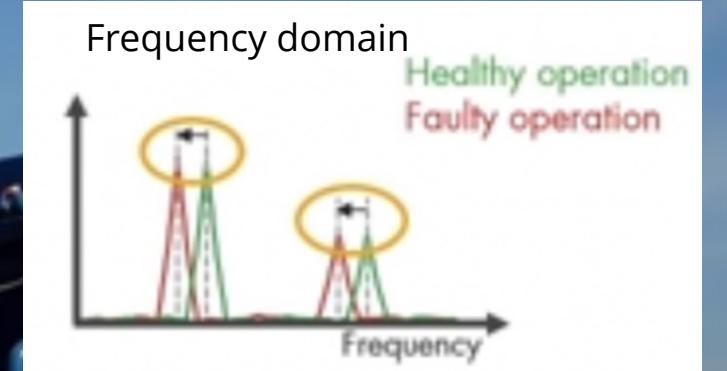
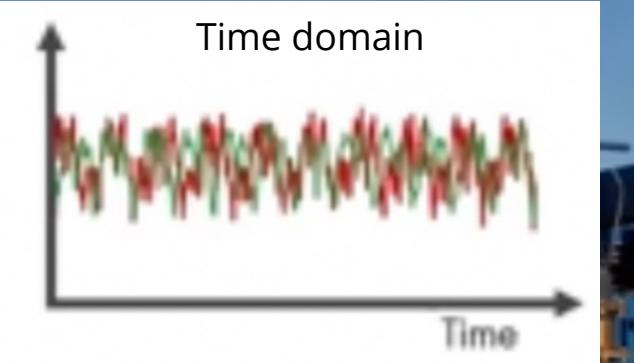
Combine the most trendable sensors to compute condition indicators



Oil & Gas Extraction Machine



Mathematical Model



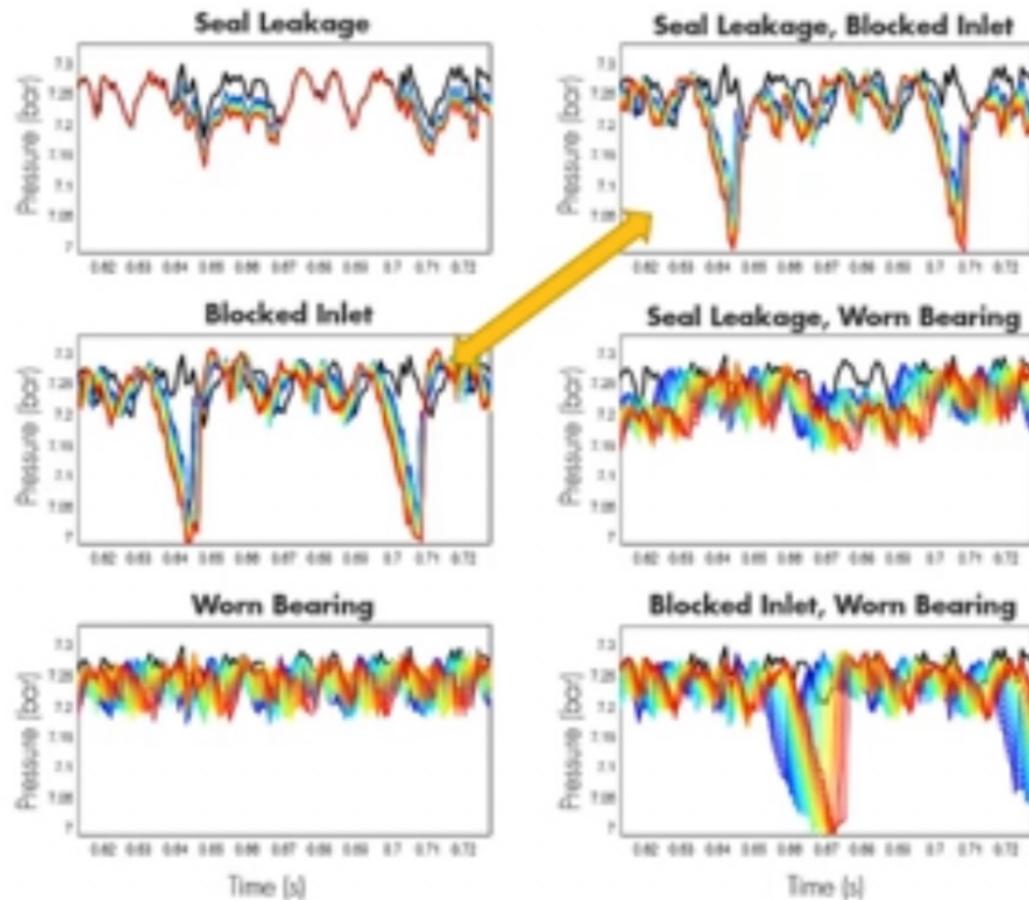
Feature Extraction / Identify condition indicators

- Mean
- Standard Deviation
- Confidence Interval
- Skewness
- Root Mean Square
- Kurtosis
- Etc..

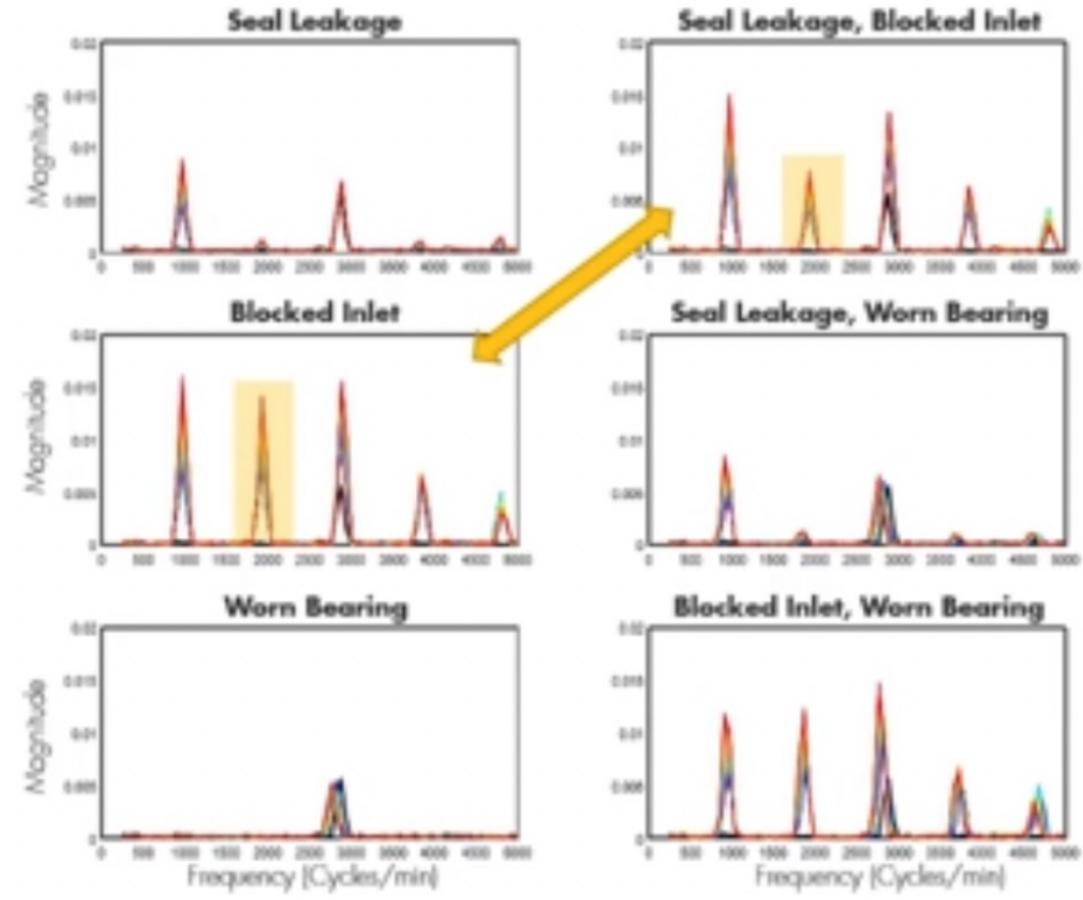
- Peak Bandwidth
- Mean Frequency
- Peak Values
- Peak frequencies
- Harmonics
- Etc..

- Special Entropy
- Special Kurtosis
- Etc..

Time-domain

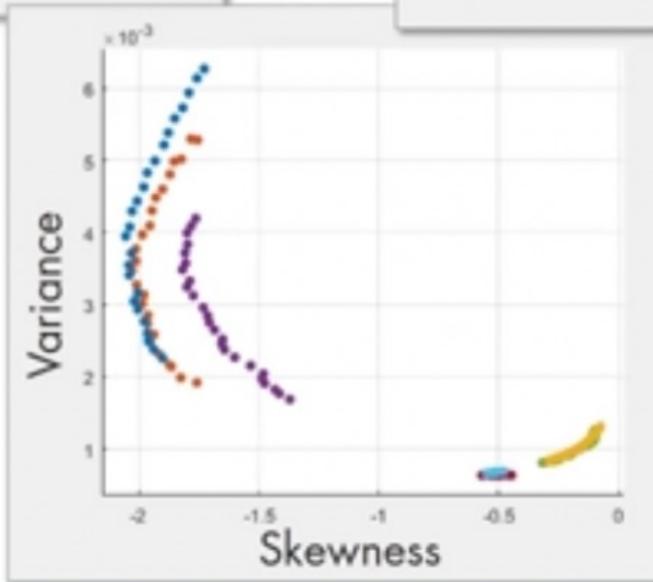
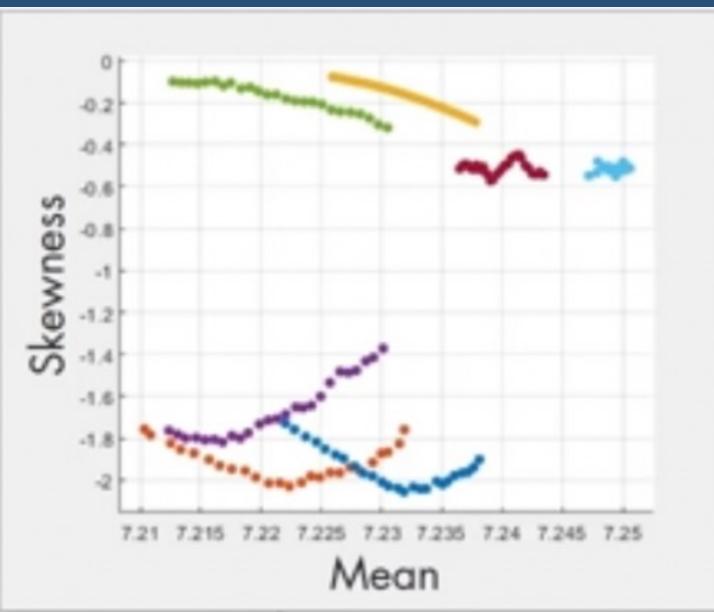
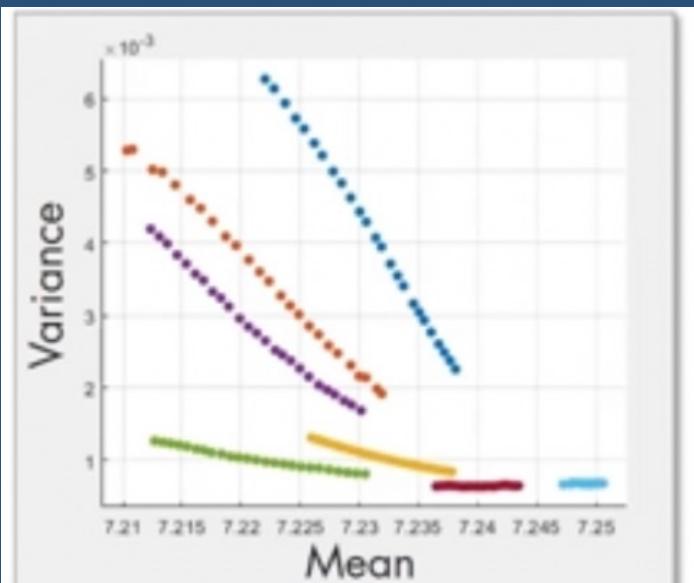


Frequency-domain



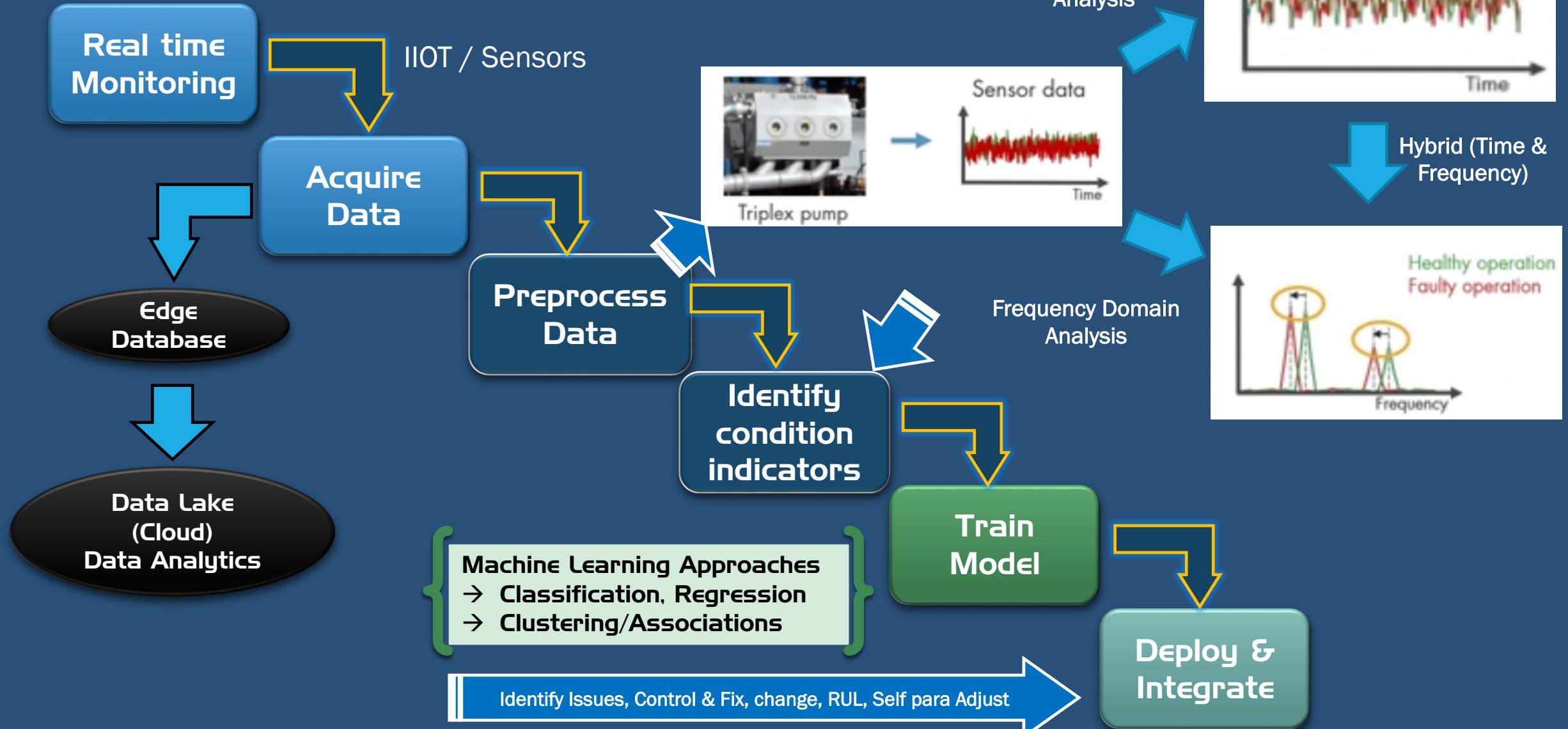
Time-domain features:

- Mean
- Variance
- Skewness
- Kurtosis



- Healthy
- Blocked Inlet
- Seal Leakage
- Worn Bearing
- Blocked Inlet, Worn Bearing
- Seal Leakage, Worn Bearing
- Seal Leakage, Blocked Inlet

Predictive Maintenance





CYBER SECURITY

CHANGING TECHNOLOGY....

What is Cyber Security?

Cyber security and information security are different from one another



Cyber security is the practice of protecting systems, networks, and programs from digital attacks

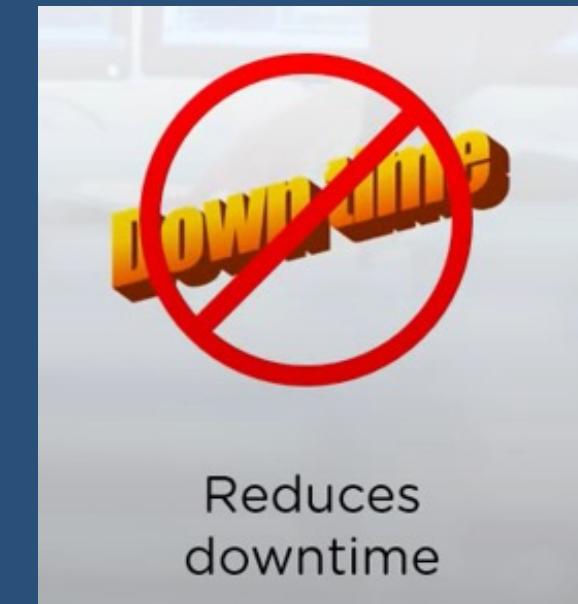
Why Cyber Security?



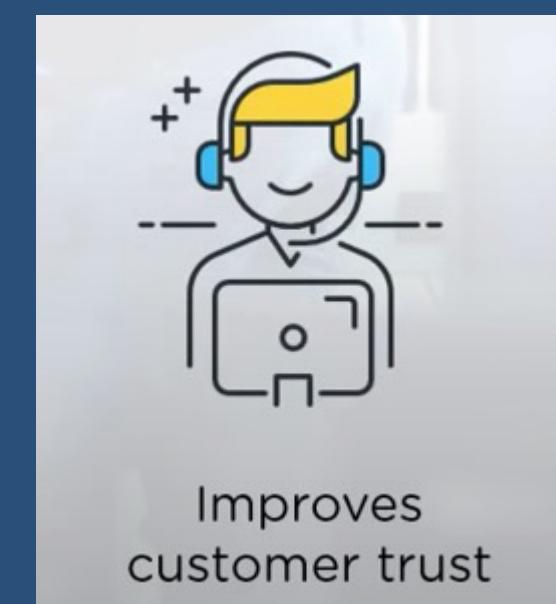
Increased
productivity



Protection against
cyber attacks



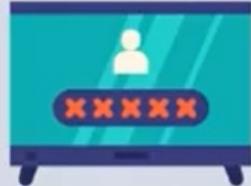
Reduces
downtime



Improves
customer trust

Cybercrime statistics

300 billion passwords will be generated by 2020



In the healthcare sector, ransomware attacks will quadruple



90% of hackers use encryption



1

2

3

4

5

24,000 malicious mobile apps blocked daily



Cybercrime to cost \$6 trillion in 2021



Types of Cyberattacks

Malware



01

Phishing



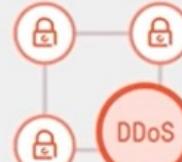
02

Password Attacks



03

DDoS



04

Man in the Middle



05

Drive-By Download



06

Malvertising



07

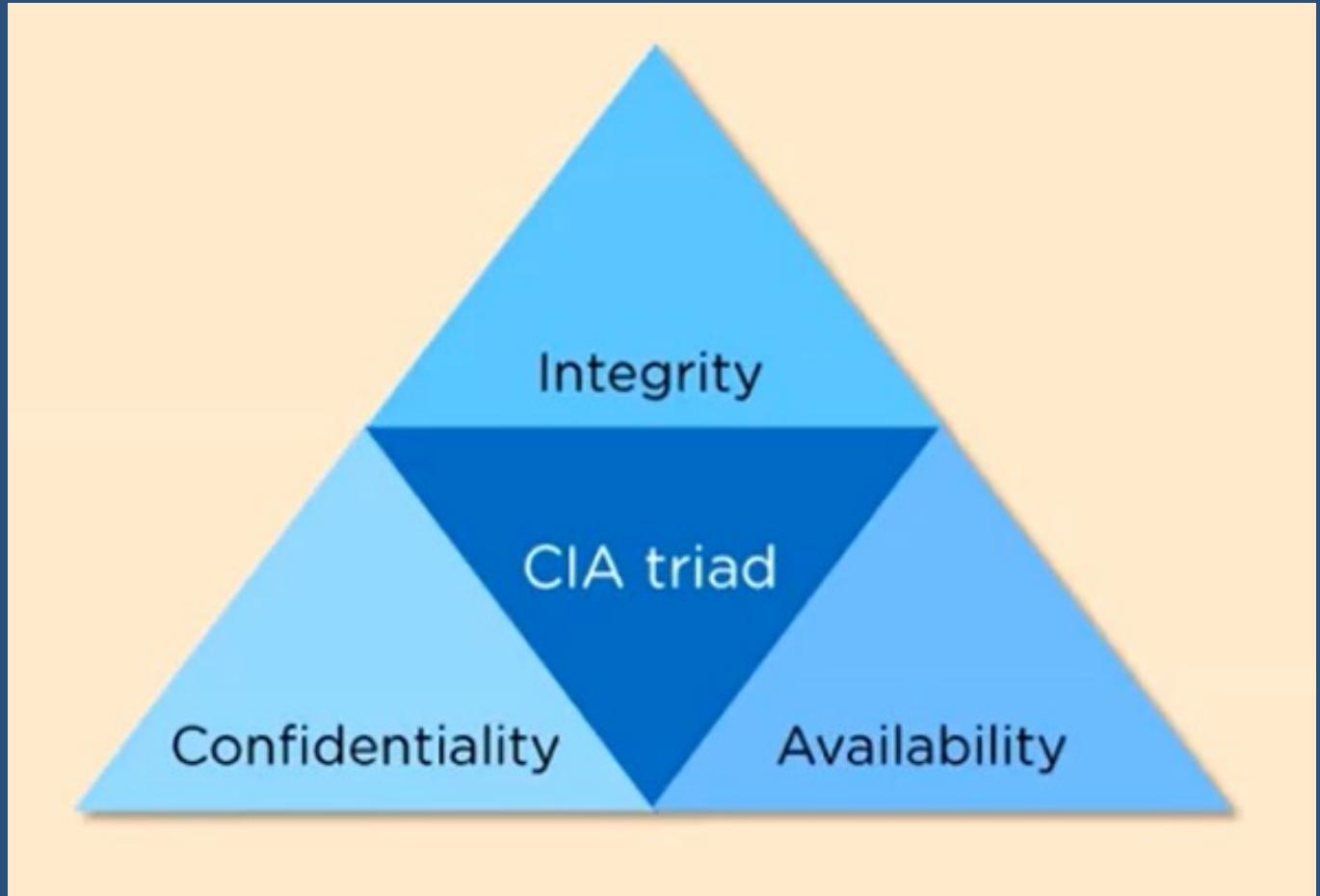
Rogue Software



08

Cyber Security Goals - CIA

Confidentiality, Integrity and Availability (CIA) is a security Model that designed to Protect information within a company



Tackling Cybercrimes - Measures



What is Digital Forensics

Digital Forensics is defined as the process of preservation, identification, extraction, and documentation of computer evidence which can be used by the court of law. It is a science of finding evidence from digital media like a computer, mobile phone, server, or network.



Process of Digital forensics

Identification

- Identify the purpose of investigation
- Identify the resources required

Preservation

- Data is isolate, secure and preserve

Analysis

- Identify tool and techniques to use
- Process data
- Interpret analysis results

Documentation

- Documentation of the crime scene along with photographing, sketching, and crime-scene mapping

Presentation

- Process of summarization and explanation of conclusions is done with the help to gather facts.



COURSE OUTLOOK

(LAW STREAM)

Course outlook

Motivation and Trending Technologies

Why IT Important, IT requirement in Industry 4.0 Technologies (IOT, Cloud Computing, 5G, Blockchain, Cyber Security & Threats)

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Elements of communication systems, Basic communication model development, Sensors and transducers, introduction to source coding and channel coding, overview digital and analog transmitters, and receivers

Classification of communication services and switching techniques:

Classification of communication services and types, simplex and duplex schemes, information transmission types, circuit switching and packet switching techniques, connection oriented and connectionless modes, coaxial cables, twisted pair cables and fiber cables, Internet over DSL, fiber LAN networks.

Wireless communication and electromagnetic waves

Introduction to history of wireless communication, Electromagnetic spectrum and applications, PSTN, terrestrial microwave systems, broadcasting and optical fiber networks, ground waves and skywaves, High frequency models, radio signal propagation and radio channels, Point to point communication, communication error handling schemes such as FEC and feedback error control

Course outlook

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Modulation and types of modulation, analog modulation techniques: Amplitude Modulation (AM), Frequency modulation (FM), Phase modulation (PM), and pulse modulation schemes, digital modulation schemes: ASK, FSK and PSK, Pulse code modulation (PCM), delta modulation (DM) and adaptive delta modulation (ADM).

OSI/TCP protocol models, network topologies and mobile networks

OSI 7 Layers Model, TCP/IP Model, IPv4 and IPV6, ARP, DNS, Network Topologies & Types: LAN, WAN, PAN, CAN, MAN, SAN, WLAN, GSM, UMTS and LTE Networks and Protocols, Current trends in telecommunication, 5G, IoT, Sensor Networks

ASSIGNMENT AND CLASSROOM ACTIVITIES

(EE AND ET)

Librarian Mrs Ranawella.

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thanuja@kdu.ac.lk

libfoe_services@kdu.ac.lk



THANK YOU VERY MUCH!

ANY QUESTION?