# Assets Management 4.0, the Way Ahead

Amir Khaleghi, Mechanical and Reliability Engineer
Oil Industries Commissioning and Operation Company (OICO)

Industrial Revolution 4.0

PAM 4.0

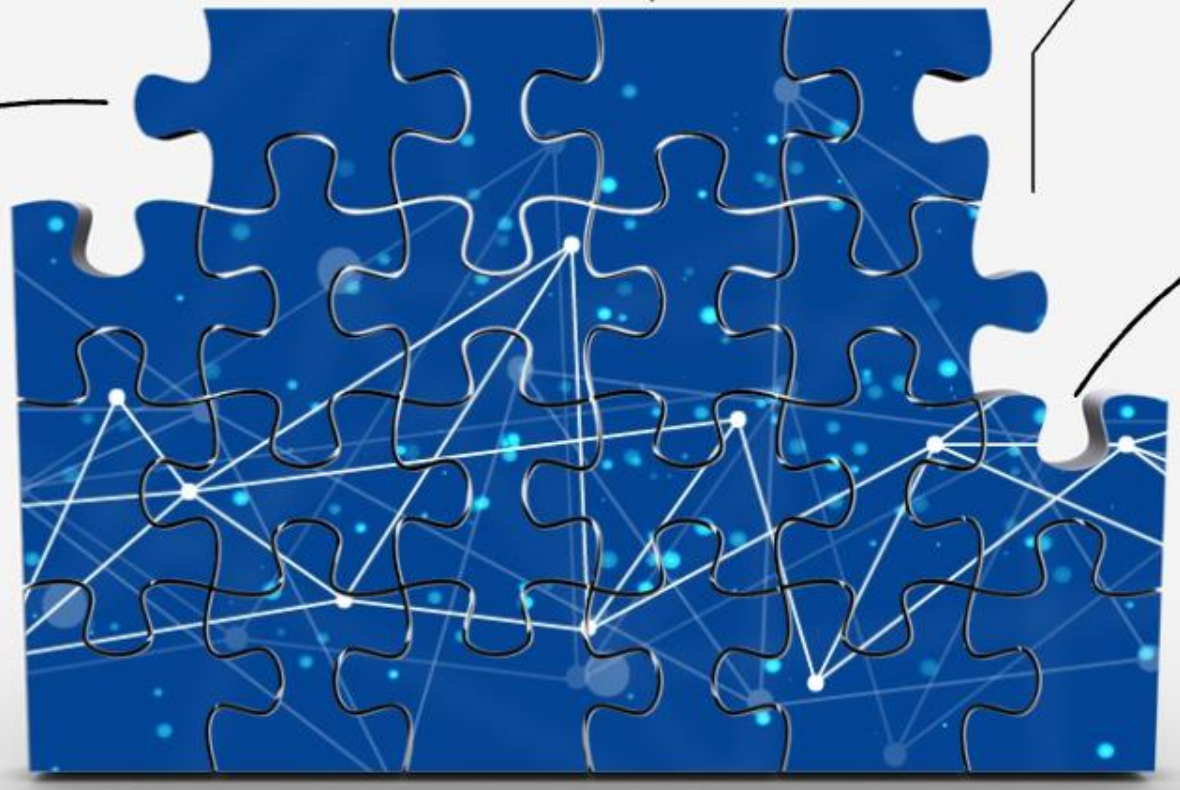
PAM Tools & Infrastructures

Industrial Revolutions

Where Are We?

The Way Ahead

Asset Management 4.0



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# Industrial Revolutions

- A series of events and inventions that make drastic changes in communities and economies in a certain period of time.
- Substantial evolutions in politics, culture, ethics, economy, military issues, sociological matters, and even the way of living.
- Exacerbation of inequality between leading countries and other countries

I1.0

I2.0

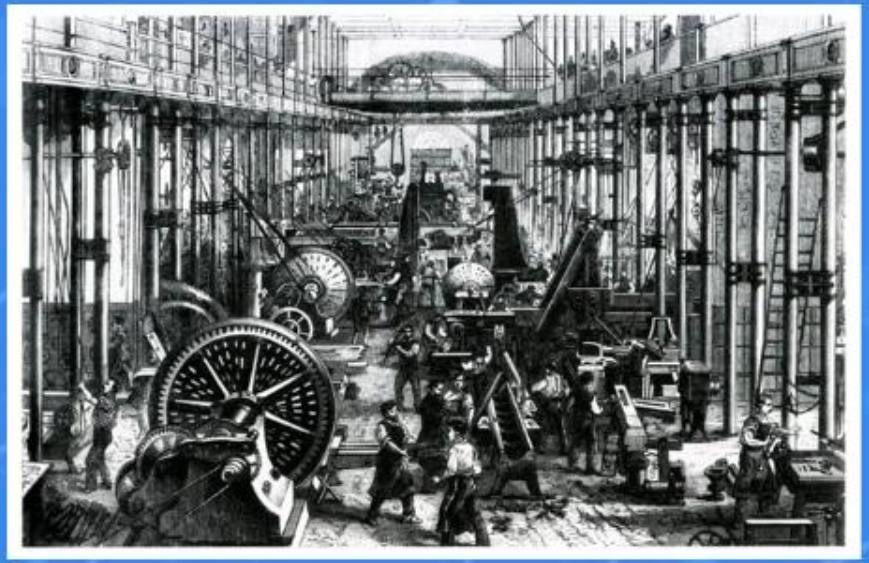
I3.0

I4.0

# First Industrial Revolution

Industrial Revolution

- Late 17th and early 18th centuries
- Steam power and Hydrolics
- Birth of "Industrial Production"
- Developement of "Middle Class"
- Great evolution in production and distribution
- Gradual change of the source of strength of countries/ states from resources/land to technology



# Second Industrial Revolution

Technology Revolution

- Late 19th and early 20th centuries
- Electricity and electric power
- Rapid transfer of people/goods/ideas/...
- Birth of "Production Line"
- Huge economic growth of industrial countries
- Increase in unemployment and origination of protest theories, such as Marxism, Anarchism etc.

# Third Industrial Revolution

Digital Revolution

- Second half of 20th century
- Introduction of computers in industry
- Industrial automation
- Global Village
- Satellite telecoms and Internet
- More rapid transfer of people/goods/ideas/...
- "Leisure" and "Free Time" becomes public

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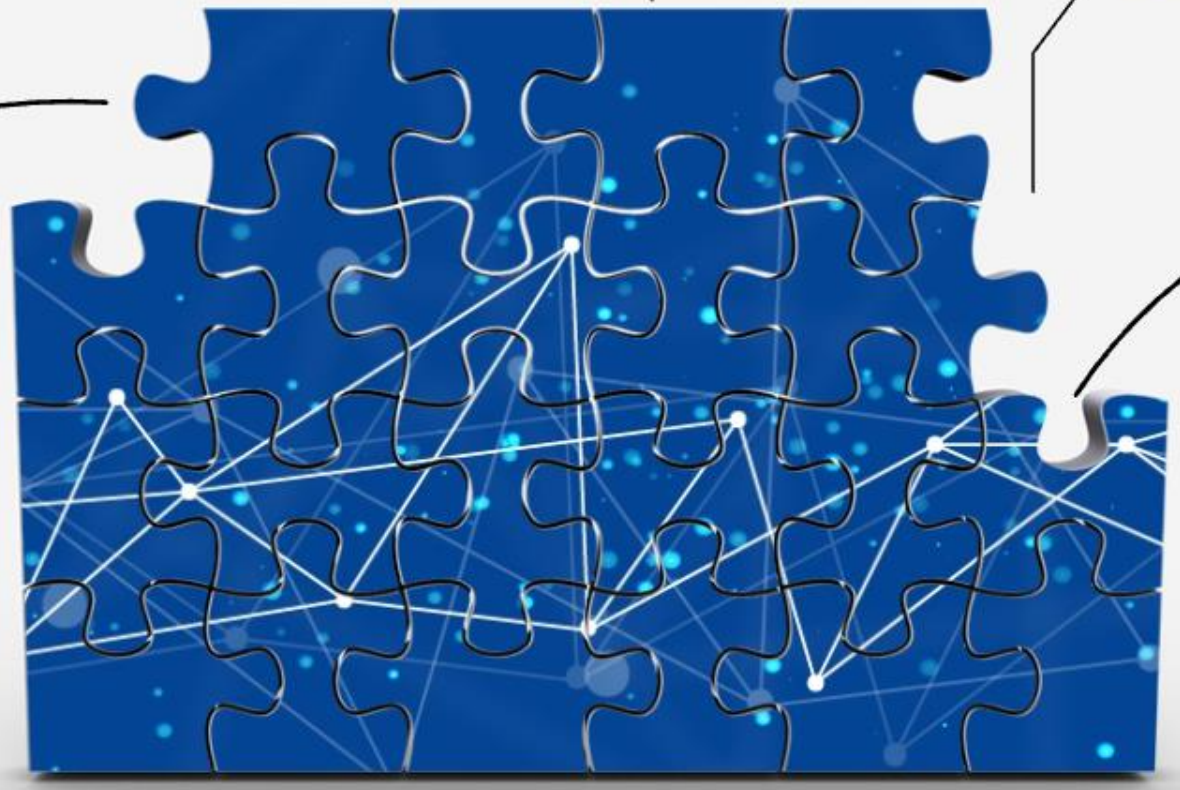

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# 4th Industrial Revolution

Pillars

Infrastructure (hardware)

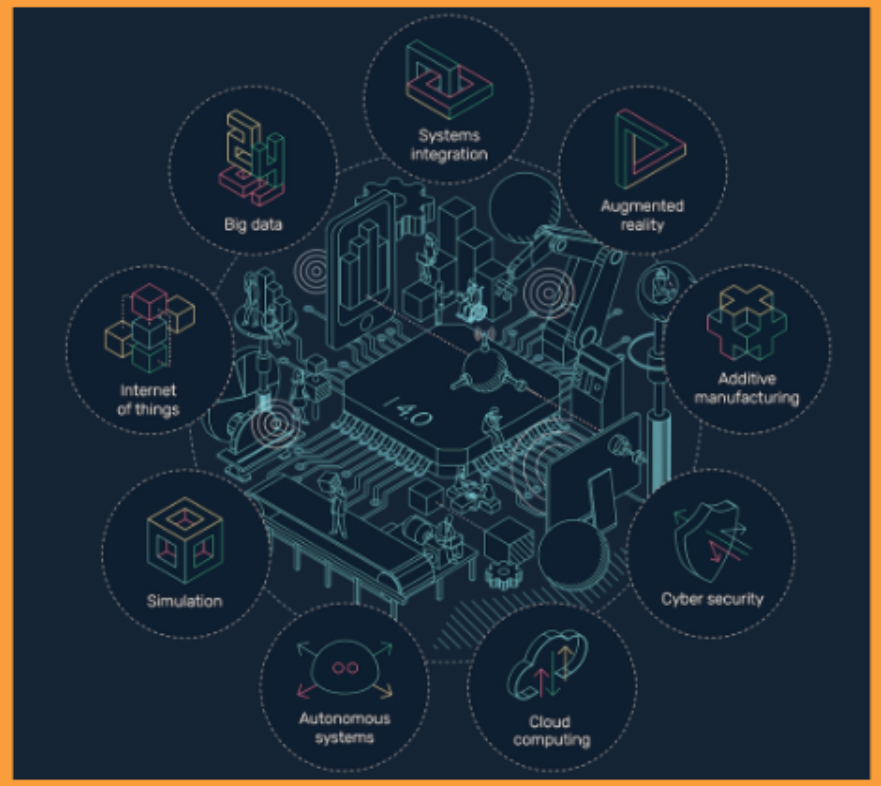
Basic Concepts

Infrastructure (software)

# Fourth Industrial Revolution

Pillars

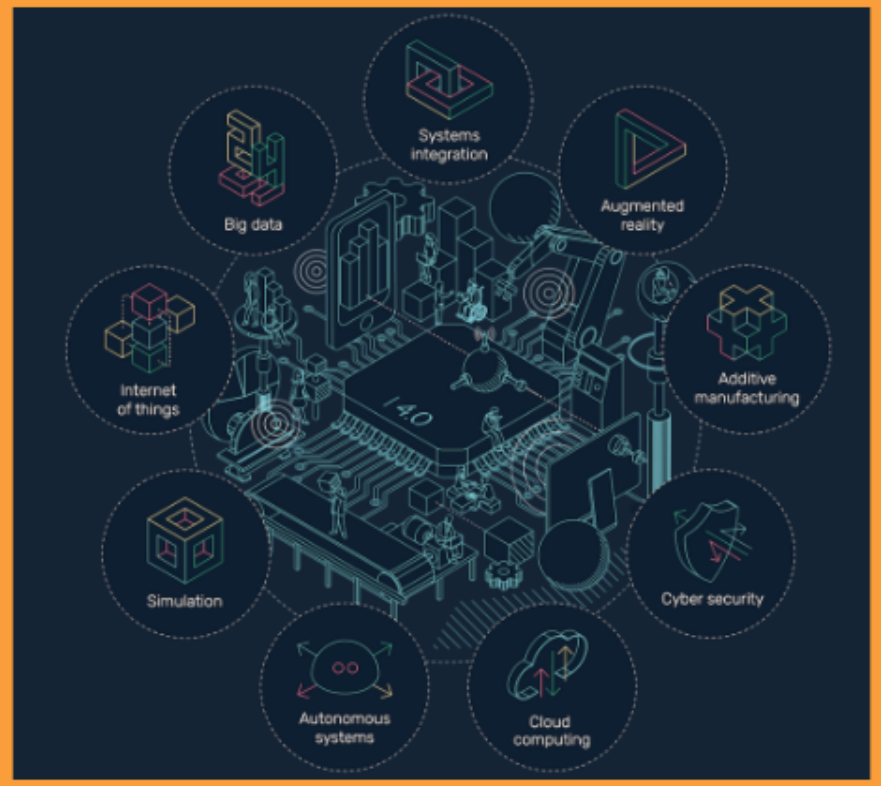
- Big Data
- IoT/IIoT
- Simulation
- Autonomous systems
- Cloud computing
- Cuber security
- Additive manufacturing
- Augmented reality
- Integrated systems



# Fourth Industrial Revolution

Basic Concepts

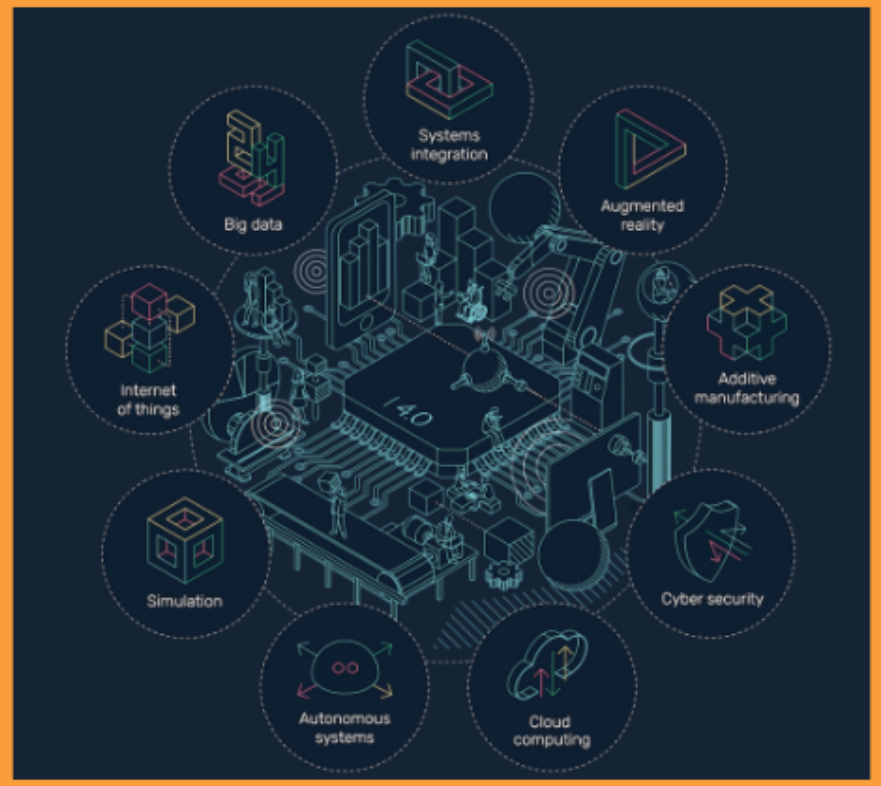
- Public access to information marketplace (thanks to cellphones)
  - Estimated penetration coefficient in Iran is 11% for fixed and 83% for mobile broadband (2020)
- Widespread usage of sensors
- Interrelation of processing systems
- Changing the role of computers, from "decision maker" to "decision taker"
- Evolution in interaction between man and machine



# Fourth Industrial Revolution

Basic Concepts (continued)

- Drastic shift in :"man-machine relationship"
- Fundamental change in the meaning of "Human"
- The thin line between man and machine is getting thinner day by day ...
- Utopian (or dystopian?) world of science fiction is now becoming a vivid reality ...

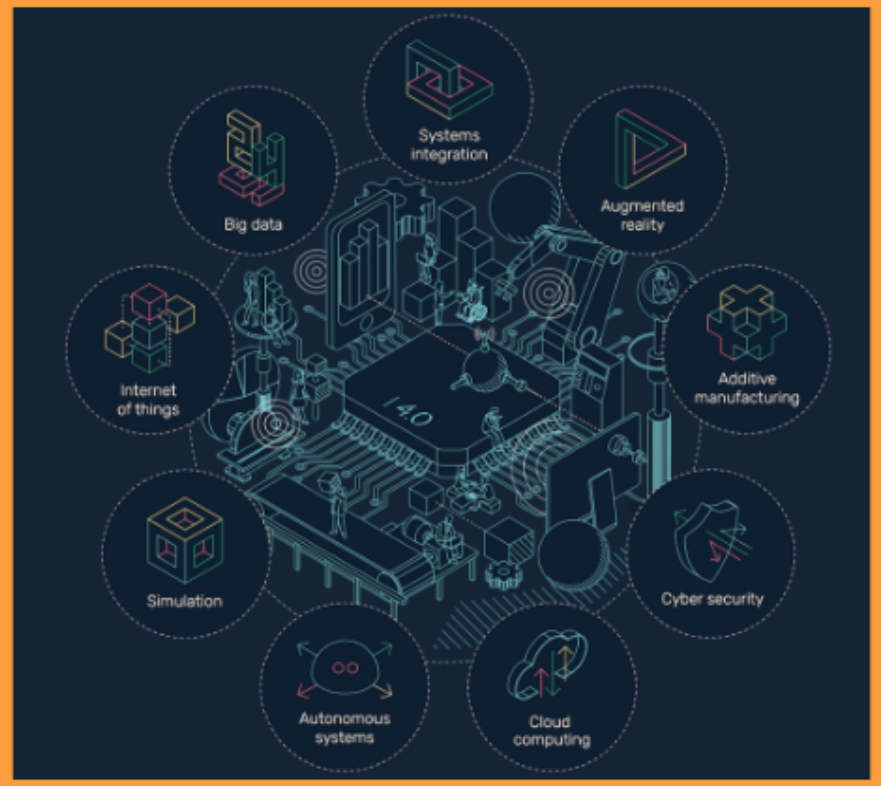


# Fourth Industrial Revolution

Basic Concepts (continued)

- ... the idea of smart factories in which machines are augmented with web connectivity and connected to a system that can visualize the entire production chain and make decisions on its own.

- ... a world where machines are intelligent, networked, and can communicate with each other and with humans.



# Fourth Industrial Revolution

Infrastructure (software)

- Government
  - Senior managers' and leaders' mindset
    - Accepting the necessity of change
  - Middle managers
    - Planning for change and providing infrastructure
- Private sector
  - Investing in absorption and development of new technologies
- People
  - Accepting the change and participating in it

# Fourth Industrial Revolution

Infrastructure (hardware)

- Public and inexpensive broadband internet connection
- Proportionate devices to connect to the internet
- Public education

# Industrial Revolutions, a Comparison

| Variant | I1.0 | I2.0 | I3.0 | I4.0 |
|---|---|---|---|---|
| **Product variety** | Very High | Very Small and Limited | Mediocre | High |
| **Productivity** | Very Low | Very High | High | High |
| **Type of Costumization** | Customized/Craft Products | Hardly Any Costumization, Mass Production | Mass Costumization of Products | High Personization of Mass Products<br>Consumer as a Co-producer |
| **Unit Cost** | High | Low | Mediocre | Low |
| **Costumer Involvement** | High | Low | Mediocre | High |
| **Market Type** | Market of One | Market of Masses | Market of Many | Market of One |
| **Time Period** | Late 17ths and Early 18ths | Late 19ths and Early 20ths | Second Half of 20ths | Verge of Time (After 2011 to Near Future) |
| **Driving Tech.** | Mechanization, Water and Steam Power | Electricity (Standardization, Transfer Lines) | Computer and IT (CNC, PLC) | CPS and Real-Time Technologies, Their Integration and AI |
| **Type of Market** | Simple Demand Driving Market | Stable Market | Volatile Market | Unknown and Uncertain |
| **Dimension of Market** | One Dimention: Volume | Two Dimention: Volume and Variety | Three Dimention: Volume, Variety and Delivery Time | Mass Personization at Low Cost Within No Time My Be One More Dimention |

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PAM 4.0

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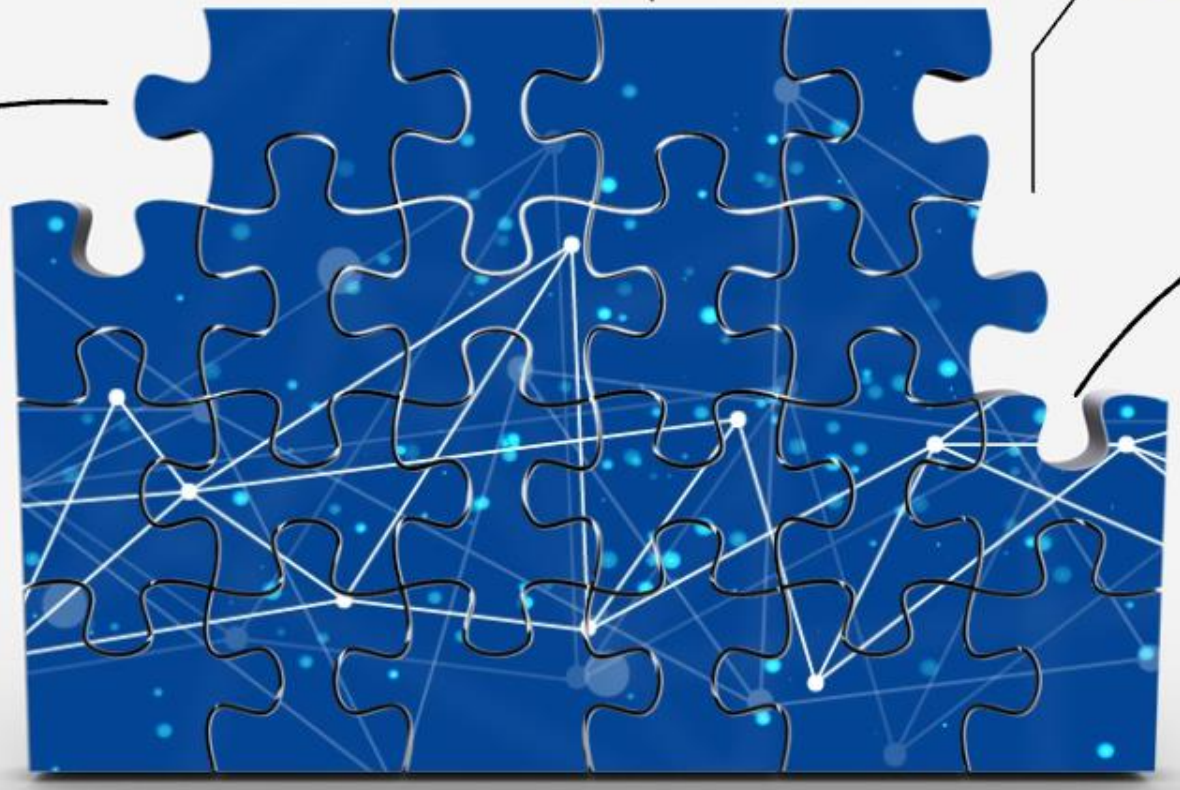

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# Assets Management 4.0

Assets Management

Basic concepts

how can we relate IR4.0 with PAM?

Asset Management 4.0 and its main Goals

Asset Management

Basic Concepts

Relation with I4.0

PAM4.0

# Asset Management

The systematic and coordinated practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life cycles for the purposes of achieving its organizational strategic plan

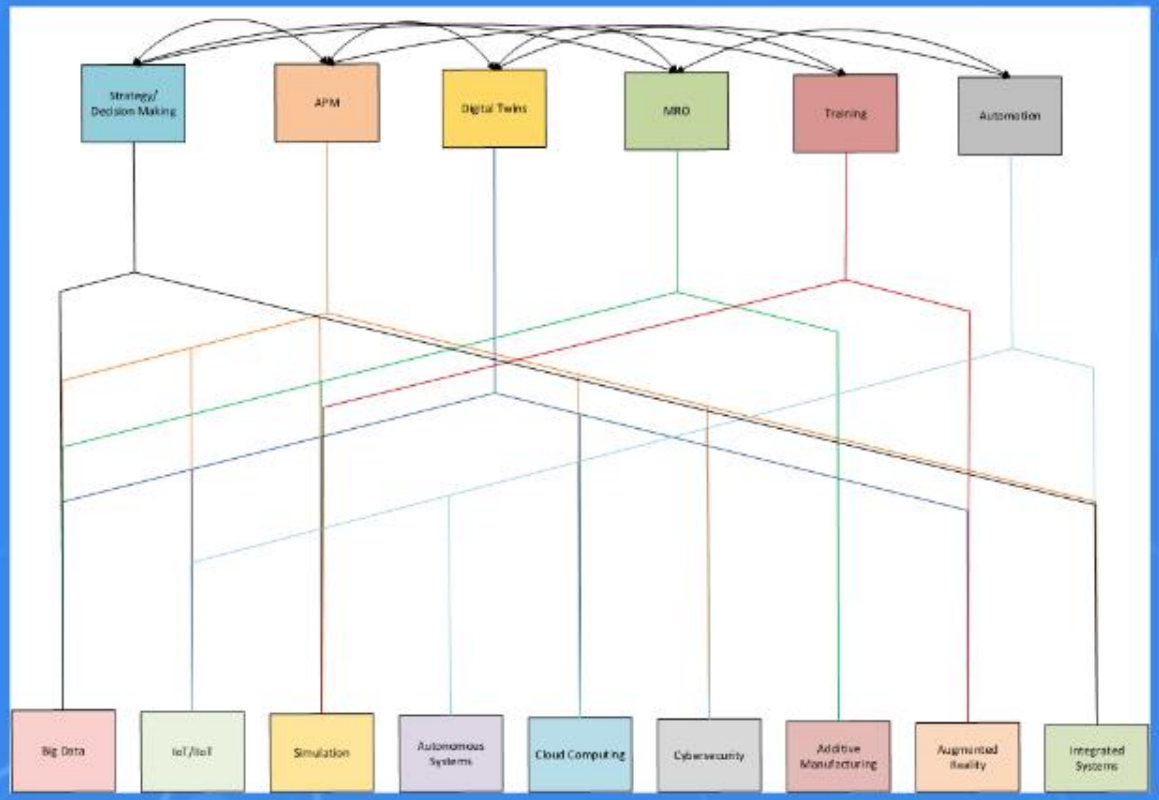
# Basic Concepts of PAM

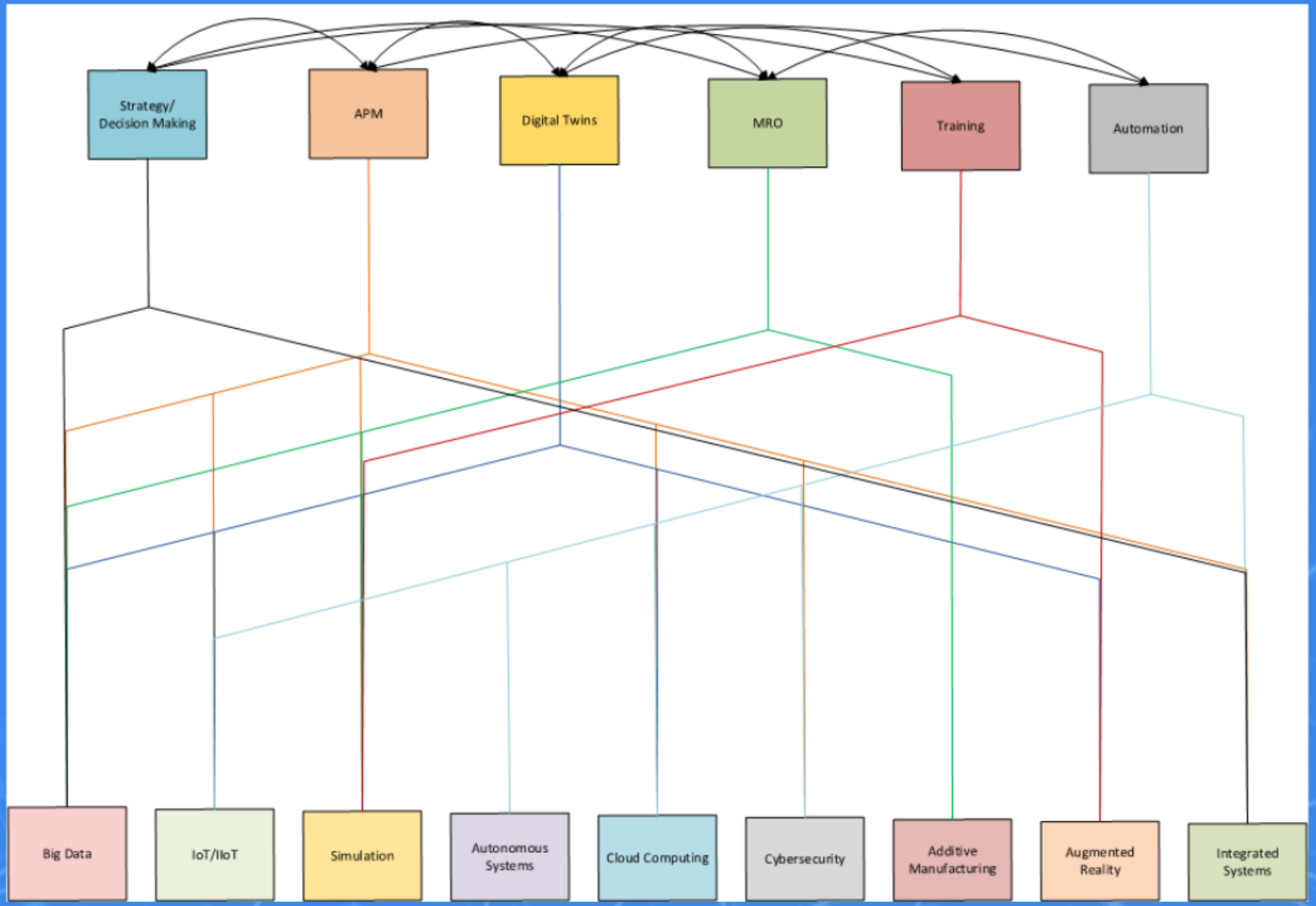

**Effectiveness**
Methods, technology, empowerment

**Efficiency**
People, Processes and Tools

**Enable**
You and your people

# Relation Between PAM & I4.0




Strategy/ Decision Making
APM
Digital Twins
MRO
Training
Automation
Big Data
IoT/IIoT
Simulation
Autonomous Systems
Cloud Computing
Cybersecurity
Additive Manufacturing
Augmented Reality
Integrated Systems

# PAM4.0 Main Goals

In short, Industry 4.0 will do for machines what social media has done for human beings.

Ideally, embracing I4.0 concepts by Asset Management will lead to increase in:

- Efficiency
- Effectiveness
- Profit

It seems these are the same old goal of assets management, but the huge wave of novel technologies, will bring new (and somehow unknown) opportunities.

The picture of future is not clear yet, but is promising.

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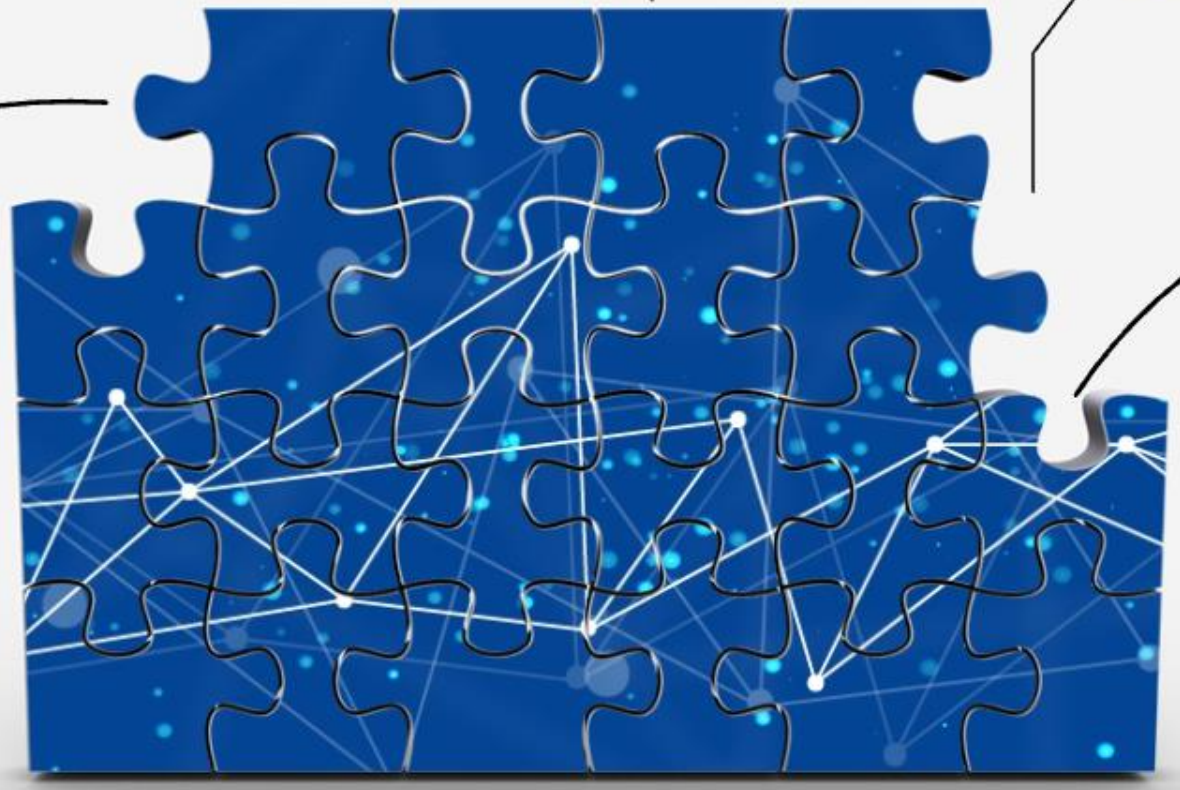

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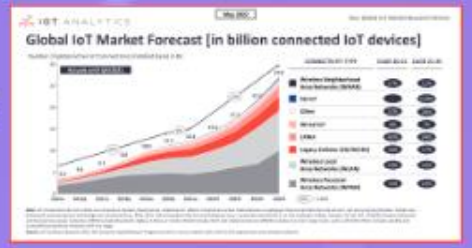
# 5 Most Important Concerns of Organizations

In a research report by ReliabilityWeb, over the period of 2014-2019:

- Life cycle Cost Reduction
- Identifying and Managing Risk
- Extracting Data to Support Evidence-Based Asset Management Decisions
- Determining the Optimum Maintenance Approaches for Assets
- Changing Company Culture

# Emerging Technologies

- More IoT/IIoT devices connected to internet than people, and it is increasing constantly (from less than 4B devices in 2015 to more than 11B in 2020 and more than 12B in 2021; growth is hindered by chips' shortage, but expected to boom after 2023)




- Use of sensors in asset condition monitoring is widespread.
- APM softwares interpret data obtained by these sensors.
- Digital twins are being used commercially (by IBM, Siemens, Microsoft, GE, Dassault systems, Oracle, CISCO, Bosch, ANSYS, PTC, etc)
- Autonomous Production is not a dream anymore

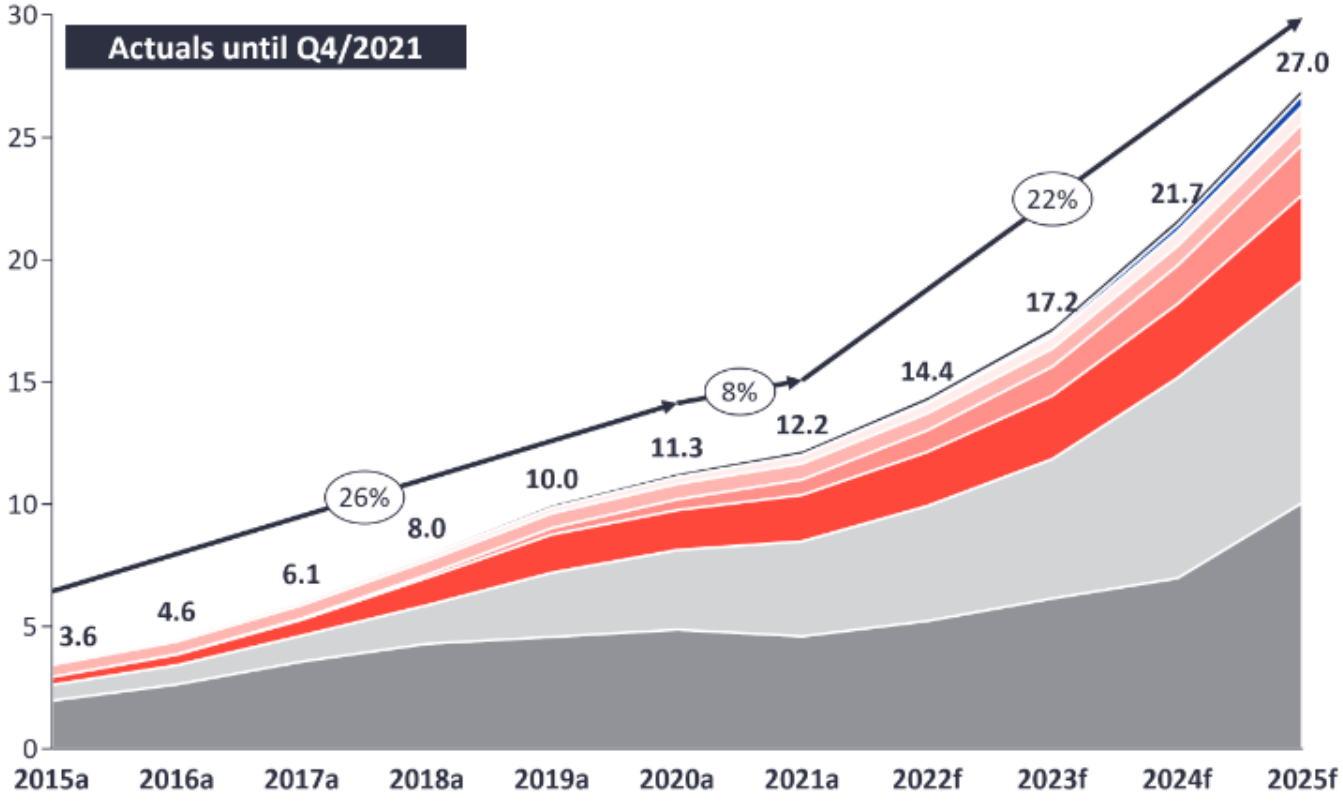
IOT ANALYTICS

May 2022

Your Global IoT Market Research Partner

# Global IoT Market Forecast [in billion connected IoT devices]

Number of global active IoT Connections (installed base) in Bn




| CONNECTIVITY TYPE | CAGR 20-21 | CAGR 21-25 |
|---|---|---|
| Wireless Neighborhood Area Networks (WNAN) | 17% | 11% |
| 5G IoT | - | 159% |
| Other | 22% | 20% |
| Wired IoT | 4% | 7% |
| LPWA | 42% | 34% |
| Legacy Cellular (2G/3G/4G) | 16% | 17% |
| Wireless Local Area Networks (WLAN) | 19% | 24% |
| Wireless Personal Area Networks (WPAN) | -6% | 22% |

XX% = CAGR

**Note**: IoT Connections do not include any computers, laptops, fixed phones, cellphones or tablets. Counted are active nodes/devices or gateways that concentrate the end-sensors, not every sensor/actuator. Simple one-directional communications technology not considered (e.g., RFID, NFC). Wired includes Ethernet and Fieldbuses (e.g., connected industrial PLCs or I/O modules); Cellular includes 2G, 3G, 4G; LPWAN includes unlicensed and licensed low-power networks; WPAN includes Bluetooth, Zigbee, Z-Wave or similar; WLAN includes Wi-fi and related protocols; WNAN includes non-short range mesh, such as Wi-SUN; Other includes satellite and unclassified proprietary networks with any range.

# Autonomous Production

- Autonomous Production needs some perquisites:
  - AI and machine learning
  - Machine vision and sensor data processing
  - Simulation (due to ever-changing batch size and product specs)
  - Reliable and consistent network connectivity
  - Decentralized systems
  - Robots and autonomous transport systems

# Autonomous Production

- Main challenges:
  - Data in sufficient quantity and quality
    - Systems are often unique; no overlapping data pools of other systems
    - Mistrust between suppliers and costumers and the argument of know-how protection complicate company-overlapping data pooling; data sovereignty of the users must be taken into account
  - Real-time machine communication: 5G as a prerequisite
    - More "clean" data means better machine learning
    - Better machine learning means less errors in decisions taken by AI

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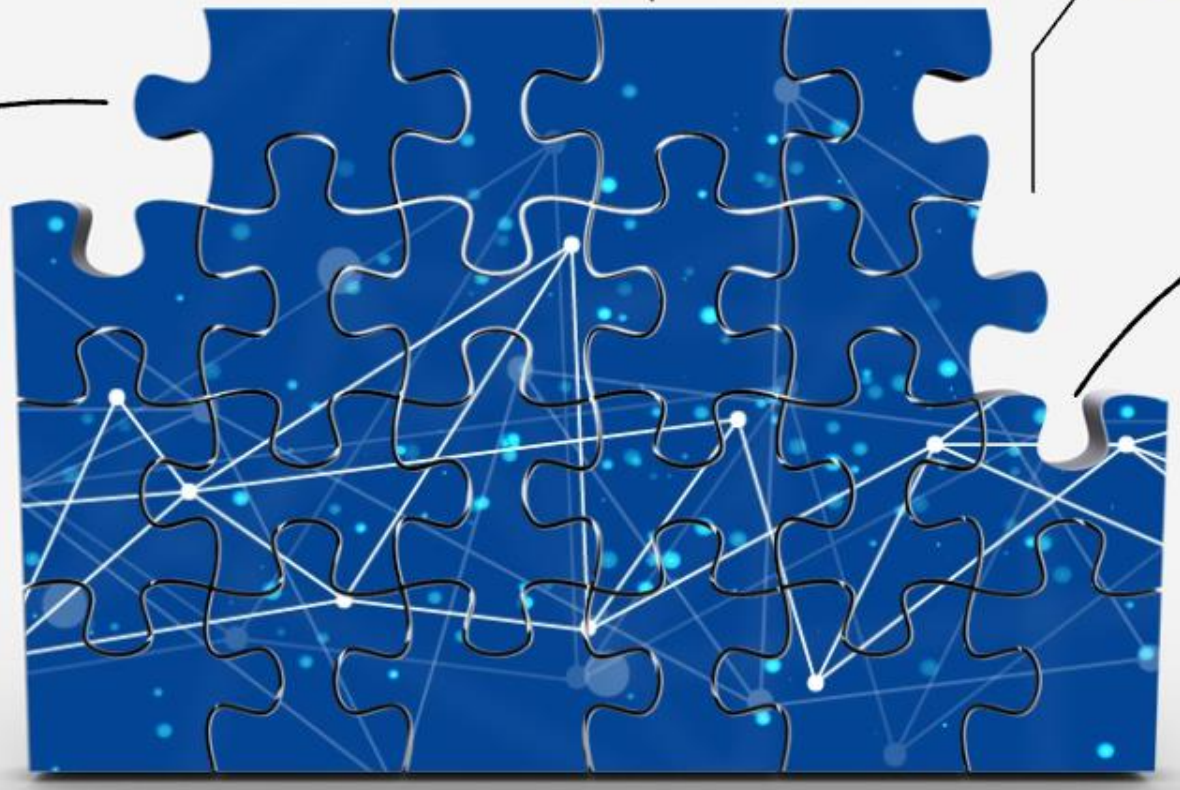

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# Global Challenges

- Need of IT infrastructure and Manufacturing Specific IT Tools
  - Huge technological infrastructure for communication, instant intelligent decision making, high volume data transfer etc.
- Data Security
  - If handled improperly, it will easily lead to an era of end of privacy.
- Standardization
  - Integration and adoption of these complex technologies require standardization.
- Skilled personnel
  - Empowering the existing manpower and recruiting new skilled employees requires commitment and investment.
- Potential Job Losses
  - Many jobs will disappear, many will be unemployed.
- Human Substitution by technological initiatives
  - Technological innovation is substituting humans by machine everyday.
- Potential Loss of human control
  - It is completely possible that people will lose control over systems and machine.

# Global Challenges

- Knowledge Base
  - Availability of effective knowledge base is a major challenge, because of uncertainties in manufacturing requirements.
- Modular and flexible smart devices
  - Requirement of modular smart and flexible devices to handle the changing system and manufacturing processes.
- High investment and need to management willingness and commitment
  - Technologies, their integration and availability of smart artifacts need a huge investment and commitment of management to adopt.

# Trends in Iran

- I4.0 literature and key concepts are being discussed in academia.
- I4.0 nomenclature is starting to be used and recognized by government.
- Some studies conducted on I4.0 and its impact on industry.
- Some companies are publishing related content on their web-pages.
- There are plans to develop 5G communication networks by ministry of ICT and mobile operator companies.
- First indoor 5G site in July 23rd 2021, first outdoor site in November 12th 2021.
- 14 active sites by the end of 2021.

# Main Challenges

- There is no sign of strategic planning (or at least belief and trust in new tech) in the
- Educational authorities don't have a correct mindset to change educational programs to conform this evolution.
- Internet connection coverage and quality decreased significantly (compared with 2018/2019); Mobile internet penetration rate growth is slowed down.
- Obtaining new tech has a lot of difficulties due to sanctions.
- 5G cellphones are generally expensive (because of depreciation of currency)
- Investing in I4.0 infrastructure (first of all 5G communication as the main perquisite) needs huge resources, much more than majority of private sector companies and need government support.

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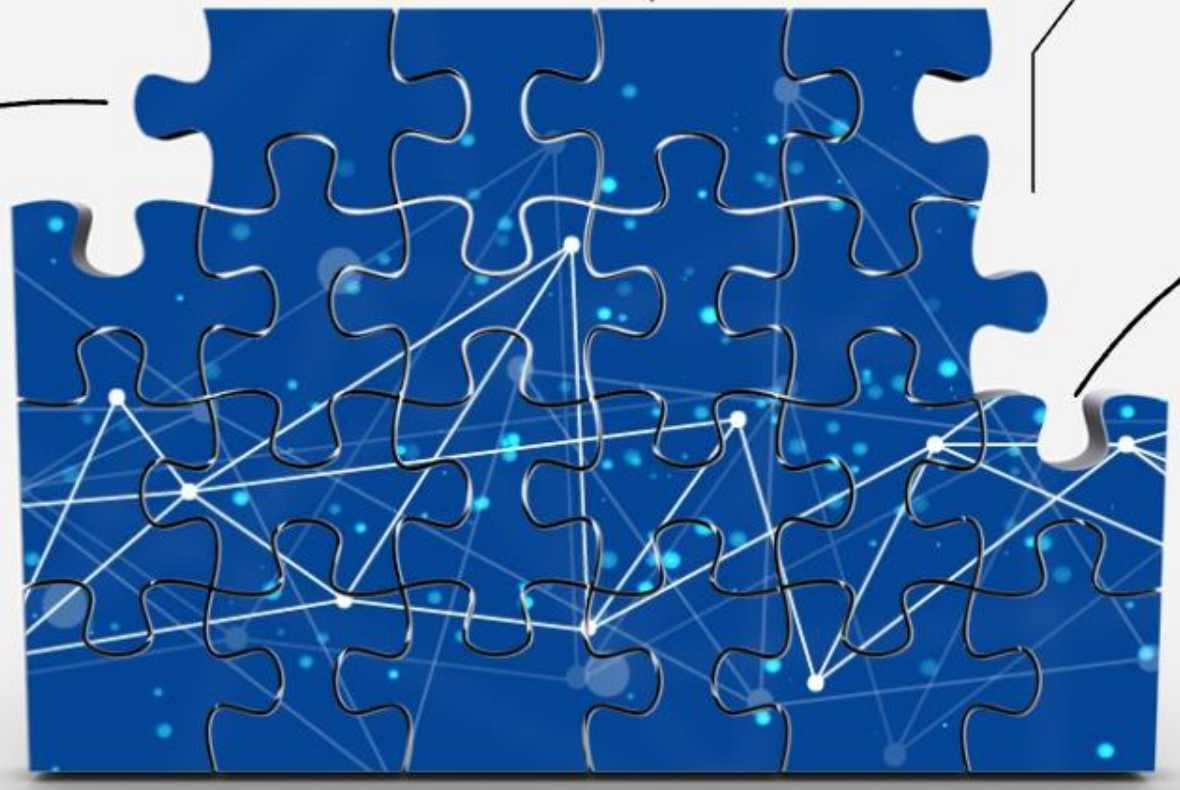

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# How Companies Can Evolve?

- Companies need to change.
- But only about 24% of them have a proper strategy for digital transformation. (In Iran, this amount is much less)
- One third of them believe that it takes at least 2 years for them to evolve.
- But companies need some infrastructure e.g. Macro Policy, communication infrastructure, financial support and incentives (specially in economies like Iran)

But How?

Requirements

Final Word

# How to Start??

But how to take the first step of this journey?

1. Make clear (at least to yourself) that why are you trying to change? Define strategic goals.

2. Assess your present condition. Make a comprehensive SWOT analysis.

3. Start a pilot project. Make sure that you can demonstrate its ROI

4. Devise a practical road map. It must be flexible and can change due to changing priorities.

5. Provide budget and resources. Assign them based on priorities.

6. Start the company-wide project. Train your employees. Make sure that they fully understand the benefits of this evolution. Make sure that all of them will benefit from the achievements

# Requirements

- Major change in mindset (government officials/private sector/people), and reviewing upstream documents to conform new approach.
- Trying to revoke sanctions and make structural economic reforms to encourage big companies to invest in Iranian market.
- Structural reform in educational system (program/resources/ approach)
- Government must define incentive plans for medium and small enterprises.
- Public education programs to prepare people to face the wave of I4.0.
- All of these need grate alignment between government/private sector/people.

# Final Words

- I4.0 is complex, disruptive, but inevitable.
- We can take it or leave it (albeit with consequences)
- The world is like a train; the developed countries are like the locomotive and the other countries are like the rolling stock.
- Until today, the locomotive was pulling the  cars uphill.
- In I3.0 the connecting rod between them started to loosen. In I4.0 it will rupture.
- After that, the locomotive will accelerate increasingly and the rolling stock start to decelerate, then stops and eventually starts to go back down the hill.
- It may be the final opportunity for Iran to grow and move towards industrial development.

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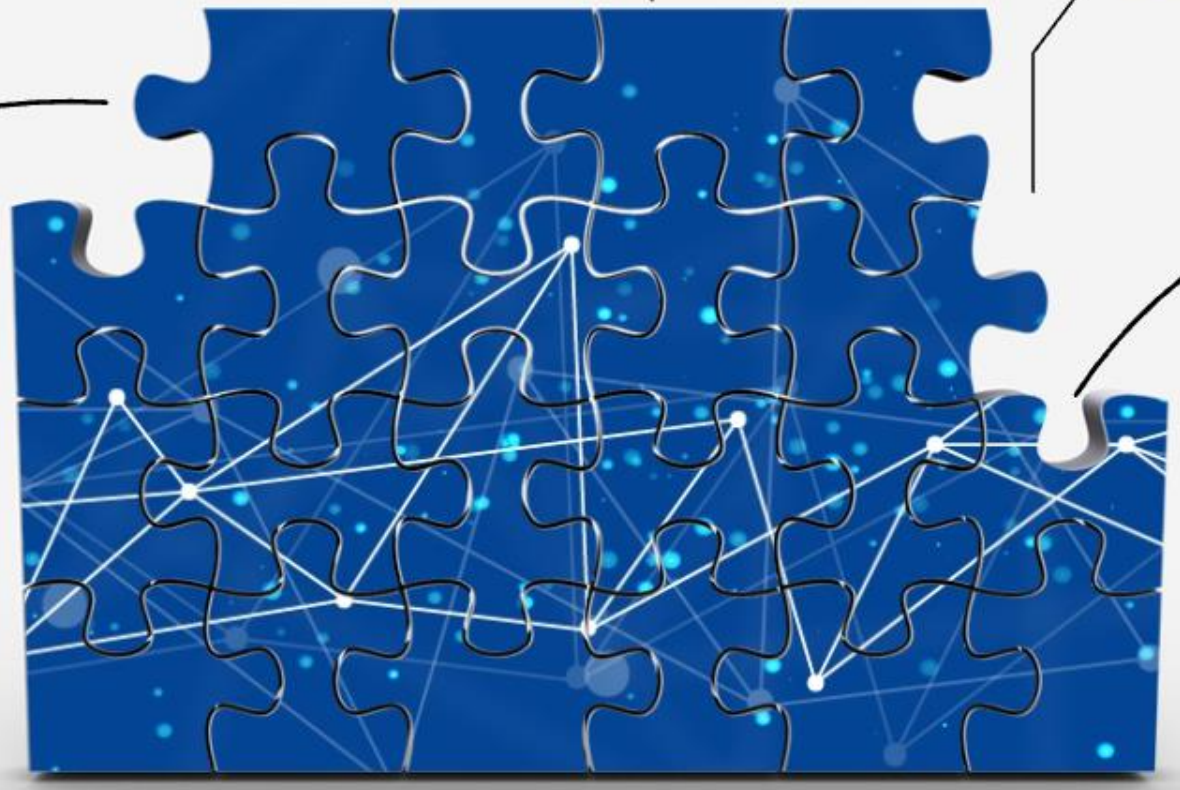

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# Stay Connected

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