ALTER TECHNOLOGY GROUP

TÜV NORD GROUP DIGITAL ACADEMY

Virtual Lab

Our Lab is also yours
Our Lab and Knowledge at your fingertips

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About Us

During three intensive months the Digital Academy has assigned a cross-functional team consist of people from different parts of an organization to analyse de feasibility of one of the most complex project proposed during Ahaus event, the Virtual Lab.

The team is composed of two innovation managers from Industrial Services as well as two senior engineers from the Aerospace, with the support of most of the technical staff from Alter Technology test laboratories.

The project mainly has focused in the test related to Alter Radiation Laboratory,

OUR TEAM

José Carlos Muñoz

Matthias Vaterrodt

Saima Ansari

Why Choose Us

ALTER TECHNOLOGY TÜV NORD is an expert and trusted supplier in the field of engineering and testing of **EEE components** and equipment for **space and other technologies markets**.

Alter Technology offer a wide range of services, from parts procurement to equipment testing, including radiation, packaging design and assembly, screening, destructive physical analysis, qualification, environmental testing, failure analysis, obsolescence management, counterfeit assessment and many more.

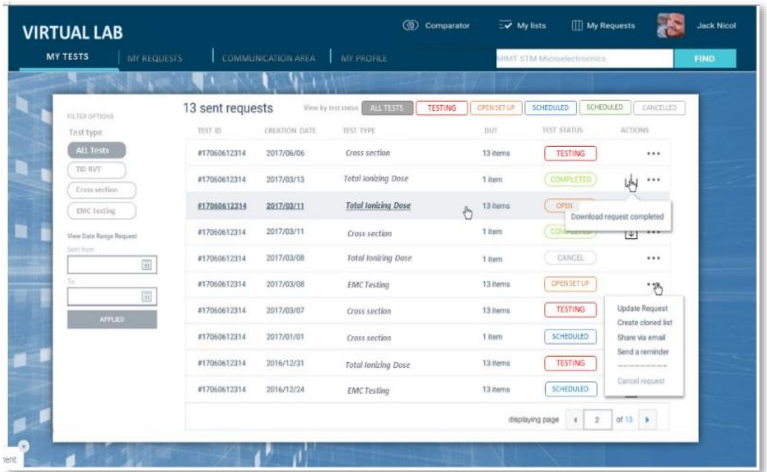
Our quality and environmental policy aims at continuous improvement of our processes to fully satisfy our customers by providing the best state-of-the-art and technologically advanced services.

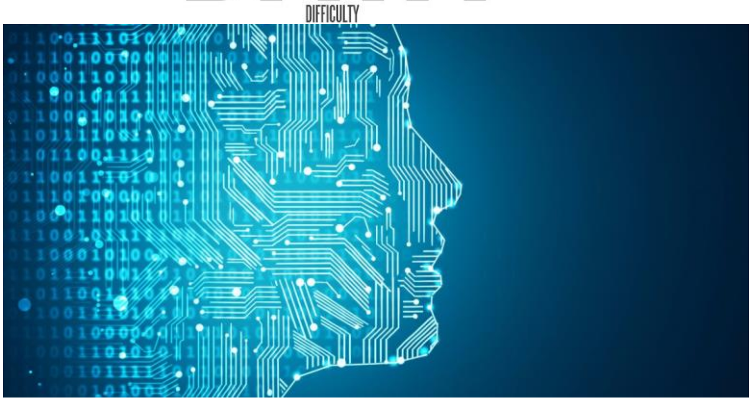
How Its Works

The system is designed as a virtualization of testing laboratory, that means the any customer may access to a certain service through the web without the need to invest on expensive equipments neither the need to be physically present during test execution.

The main characteristics that this new service will provide to the client is:

- **On-line monitoring**: The platform will make possible to **record and monitor in real time** the results of the test conditions to be implemented as well as the intermediate results or the running tests.
- **On-line tracking:** customer to access at any time to the information related to the status of the test





- **Big Data Analysis**: Simulating a component's behaviour before actually testing it can greatly improve design efficiency by making faulty designs known as such, and providing insight into the behaviour of electronics circuit designs.
- On-line **set-up description**: The complete set-up description: instrumentation, software and interface definition will be accessible through the platform.
- **Artificial Intelligence:** In combining machine learning (inputs and outputs) with analytics (behaviours) to facilitate decision making, you have the power to unlock the patterns in this data and improve testing efficiencies.

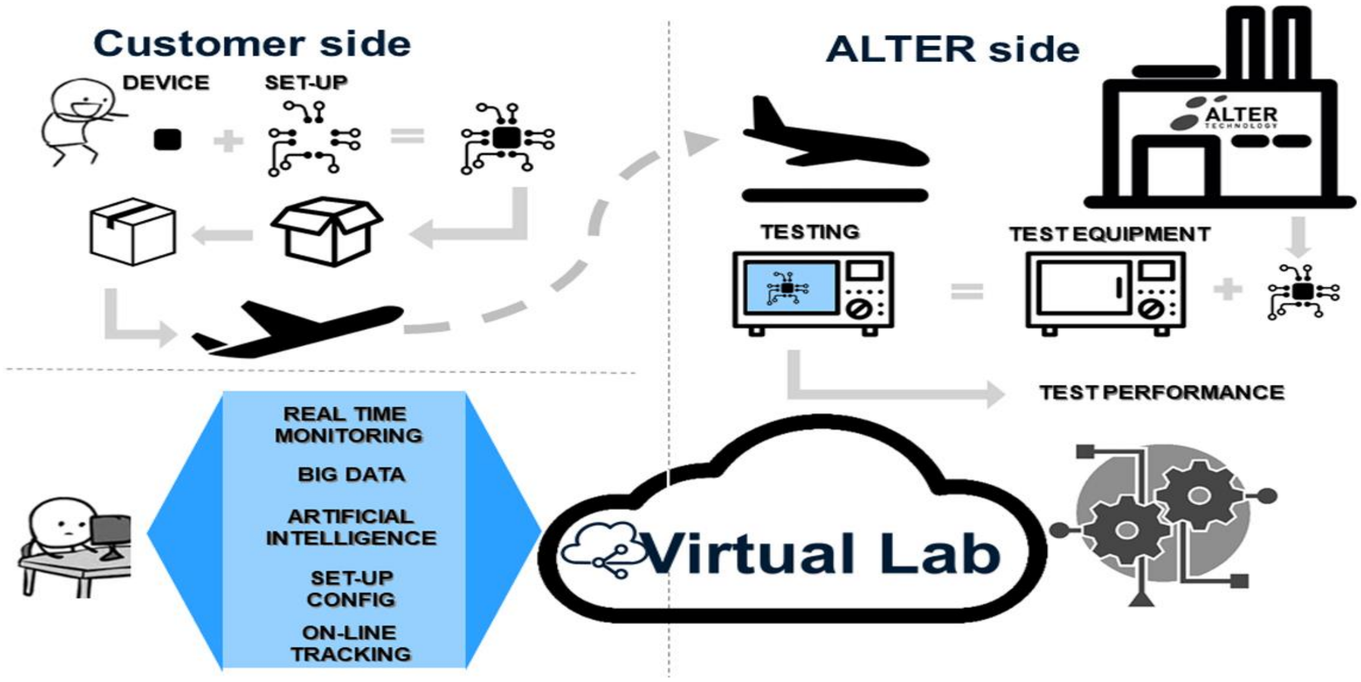
How It's made

Electronics have become an integral part of our lives, as standalone consumer and communications electronics devices and as components in vehicles, homes or industry. Electronics development and production are impossible without test and measurement equipment. The complexity of electronic-device testing varies widely, ranging from the simplest type—manual testing—to the most complex—large-scale automatic test equipment (ATE). Manual testing typically requires DVMs, oscilloscopes, and other equipment set up in a particular configuration. When the device type to be tested changes, you usually need to change the test hardware. ATE testers, on the other hand, provide tremendous flexibility, allowing many different types of devices to be tested without changes to the test hardware. But, these testers can cost upwards of a million dollars.

To solve this complexity, Virtual Lab covers the most critical needs of testing infrastructures in domains such as:

1. Automatic Testing Equipment (ATE)
2. Electronic Test and Measurement Equipment
3. Data Acquisition
4. Computing Platforms
5. Data Storage Architectures
6. Compute Provisioning and Management
7. Networks and Communication
8. Data Analytics

Making simple the access to all the results from a single platform. The power of Virtual Lab is not only the instrumentation behind the platform, but the access to predictive analysis. Data analytics (DA) can help understand and gain insights from the big data and in turn help advance towards modelling and simulation for a better decision making.



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Vision: With the Virtual Lab platform our labs will be virtually present for our customers anywhere, anytime in the world.

Pains/challenges

CUSTOMER

- Complicated testing process
- Expensive due to travel costs for equipment and people
- Time consuming (test execution and data analysis)
- Long time to market

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- Limited market coverage due to high travel efforts and expenses
- Lower efficiency
- Less competitiveness

Solution/benefits

PROCESS/FEATURES

- Digital platform virtually connecting the customer machine with ATG testing facilities in real time

BENEFITS FOR CUSTOMERS

- Real-time tracking
- Predictive Analysis and Data Mining
- Faster time to market at lower cost.
- Access to results and tests comparatives

BENEFITS FOR TNG

- First actor providing this kind of technology
- Access to new customers worldwide
- BIG DATA platform
- Internal efficiency improvement

Current status/roll out

STATUS END OF 2017

- Successfully acquired the first two paying key-customers
- Mock Up developed
- Implementation roadmap developed

NEXT STEPS

- 2018: Pilot with ATN Radiation Lab
- 2019: More tests, connection with doEEEt: AI and Big data.
- 2020: New services to access new markets
- 2023: Digital Twins: digital simulation and testing

FURTHER DEVELOPMENT

- 20XX: TNG wide platform: transferable platform concept

Business case

FINANCIAL FACTS

- Almost double turnover in two years (in the testing area)
- The total expected investment will reach 625K€

RESOURCES NEEDED

- Costs for platform development: 125K€ per year during the five year of project implementation
- Human Resources 2 people per year during the while project implementation

INDUSTRY 4.0

A brochure about the possibilities of Industry 4.0

FACTORY 4.0 INCLUDES:

1. Interoperability

Machines, devices, sensors and people that connect and communicate with one another.

2. Information Transparency

The systems create a virtual copy of the physical world through sensor data.

3. Technical Assistance

Both the ability of the systems to support humans in making decisions and solving problems and the ability to assist humans with task that are too difficult or unsafe for humans.

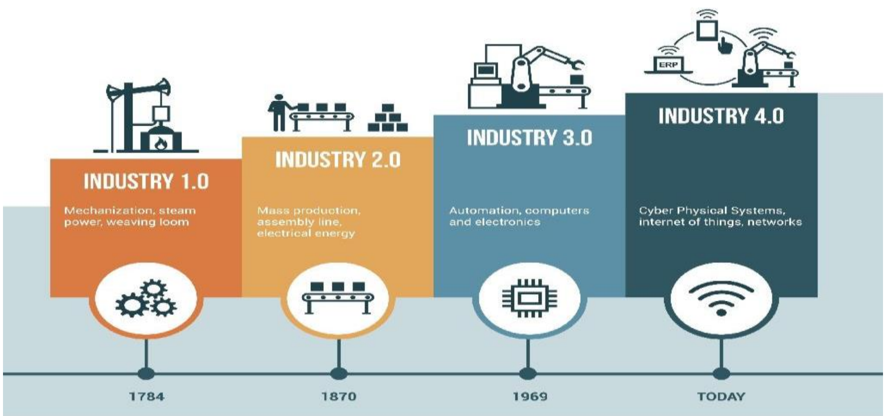
4. Decentralized decision-making

The ability of cyber-physical systems to make simple decisions on their own.[1]

FIRST CAME STEAM, ELECTRICITY, MASS PRODUCTION….

Now we enter Industry 4.0, in which computers and automation will come together in an entirely new way, with robotics connected remotely to computer systems equipped with machine learning algorithms that can learn and control the robotics with very little input from human operators.

Industry 4.0 introduces what has been called the “smart factory, in which cyber-physical systems monitor the physical processes of the factory and make decentralized decisions. The physical systems become Internet of Things, communicating and cooperating both with each other and with humans in real time via the wireless web. [1]



1 *Marr, 2016.*

INTERNET OF THINGS (IoT)

About the future of Industry 4.0

INTERNET OF THINGS

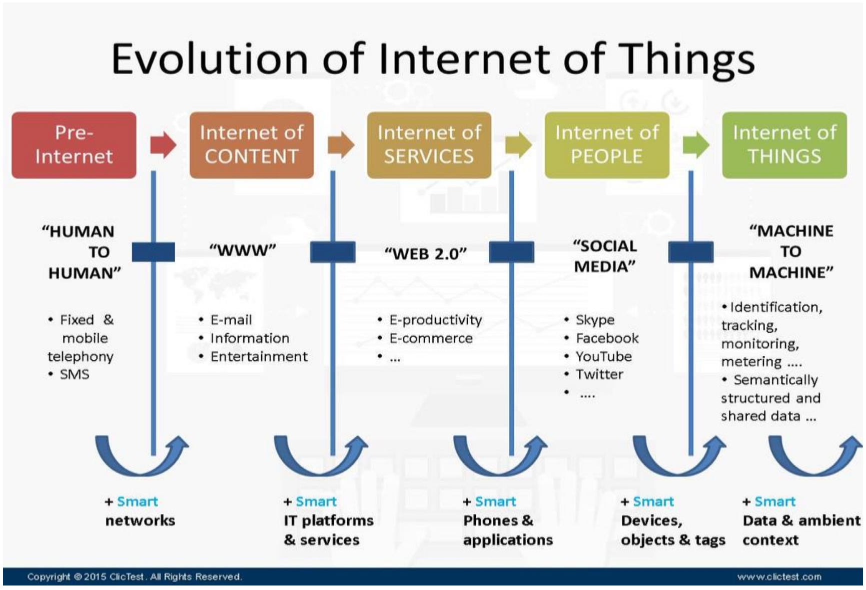
The Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure. [2]

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.[3]

THE FUTURE OF IOT

The Internet of things would encode 50 to 100 trillion objects, and be able to follow the movement of those objects. In 2015 there were already 83 million smart devices in people`s homes. This number is about to grow up to 193 million devices in 2020 and will for sure go on growing in the near future. [4]

In the Internet of things, the precise geographic location of a thing—and also the precise geographic dimensions of a thing—will be critical.



2 Brown, 2016
3 Vermesan & Friess 2013
4 Waldner 2007

THE FUTURE OF INTERNET OF THINGS

About the future of Industry 4.0

THE PREDICTIONS SAY:

IoT-enabled hospital labs will increase test through-puts by more than 3.02 billion diagnostic tests by 2020.

The improved health value of chronic disease patients through remote monitoring will be as much as $1.1 trillion per year in 2025.

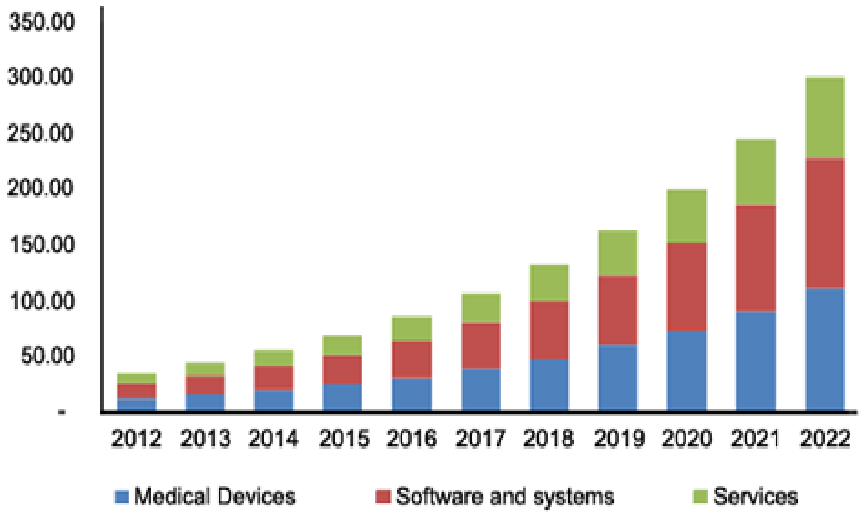
Consumers using home health gadgets will increase to 78.5 million by 2020.

'4' million patients globally will remotely monitor health conditions by 2020.

FIRST CAME STEAM, ELECTRICITY, MASS PRODUCTION….

The influence of Internet of things in healthcare has created a large set of data-fueled customers. As a result of this, consumerization of healthcare industry is increasing rapidly and redesigning many business models like never before.

According to a thorough research from Grand View Research Inc. it is predicted that the market of Internet of things in healthcare is going to increase radically each coming year. In 2012 it was a market of less that 30 billion whereas it is predicted that IoT will capture more than 200 billion by 2020 and 410 billion by 2022.[5]



5 *Gran View Research 2016*

MACHINE TO MACHINE (M2M) EVOLUTION

MACHINE TO MACHINE REFERS TO DIRECT COMMUNICATION BETWEEN CHANNEL, INCLUDING WIRED AND WIRELESS.

Machine to machine communication can include industrial instrumentation, enabling a sensor or meter to communicate the data it records (such as temperature, inventory level, etc.) to application software that can use it (for example, adjusting an industrial process based on temperature or placing orders to replenish inventory). Such communication was originally accomplished by having a remote network of machines relay information back to a central hub for analysis, which would then be rerouted into a system like a personal computer.[6]

91% Mobile users keep their device within arm's reach 100% of the time

75% Mobile shoppers take action after receiving a location based message

96% Year to year increase in mobile cyber Monday sales between 2012 and 2011

90% Users use multiple screens as channels come together to create integrated experiences

900% Increase of global machine-to-machine connections by 2022 (2 billion in 2011 to 18 billion at the end of 2022)

More recent machine to machine communication has changed into a system of networks that transmits data to personal appliances. The expansion of IP networks around the world has made machine to machine communication quicker and easier while using less power. These networks also allow new business opportunities for consumers and suppliers.

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6 *M2M Communications*

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DATA DEMAND

About the future of Industry 4.0

56% OF THE WORLD DOESN'T HAVE ACCESS TO THE INTERNET.

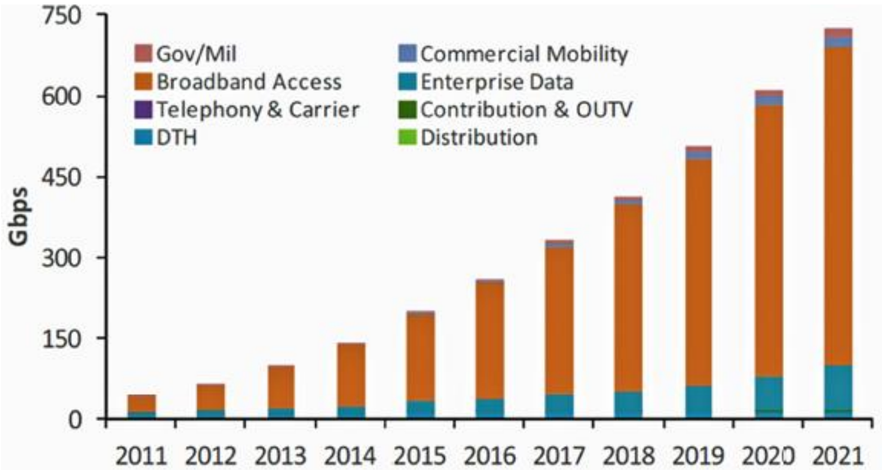
The ITU estimates over 4 billion people without internet access globally.

55 million people lack access to advance broadbond in the US alone.

OneWeb's market entry objectives align with public initiatives and international government goals.

FIRST CAME STEAM, ELECTRICITY, MASS PRODUCTION….

Smartphones, tablets and/or PCs are being used on the road in mobile applications as well as at home over Wi-Fi or fast broadband connections. This demand is illustrated in the schematic in the following figure where the overall data-rate is forecast to increase by a factor of 2 (up to 600Gbps) over the next five years.[7]



CURRENTLY, TERRESTRIAL 3G AND 4G TELECOM NETWORKS WITH ONE-AND TWO-WAY SATELLITE BACKHAUL NETWORKS ARE IMPLEMENTED TO COVER THE DEMAND. HOWEVER, THE AVAILABLE DATA-RATE IS NOT ENOUGH, ESPECIALLY IN THE SATELLITE SEGMENT.

As satellite networks have the great advantage of being able to provide cover quickly to any part of the world, this lack of data-rate is becoming more and more of an issue. That is why some companies that depend on full are seeking novel approaches to participate in the New Space sector. The satellite world/eco-system has to react to this growing data-rate demand.[8]

[7] NSR Source 2015

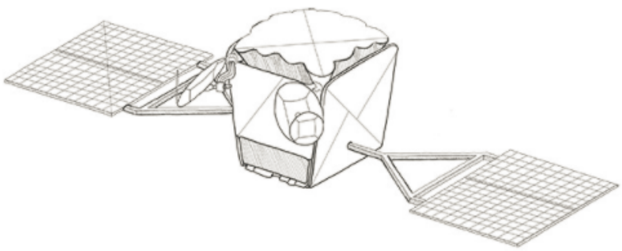
[8] Hostiou & Faria, TeamCast 2016

ONEWEB CONSTELLATION

A brochure about the possibilities of Industry 4.0

ONEWEB, FORMERLY KNOWN AS WORLDVU, IS A PLANNED SATELLITE CONSTELLATION CONSISTING OF 648 MICROSATELLITES TO PROVIDE WORLDWIDE INTERNET ACCESS FOR ON INDIVIDUAL CONSUMERS AND AIRLINES.

The current design of the OneWeb satellite network consists of 648 micro satellites of about 125 kg operating in 1200 km orbits. Each satellite is capable of delivering at least 8 gigabits per second of throughput to provide Internet access to homes and mobile platforms using its high throughput Ku-band payload.[9]



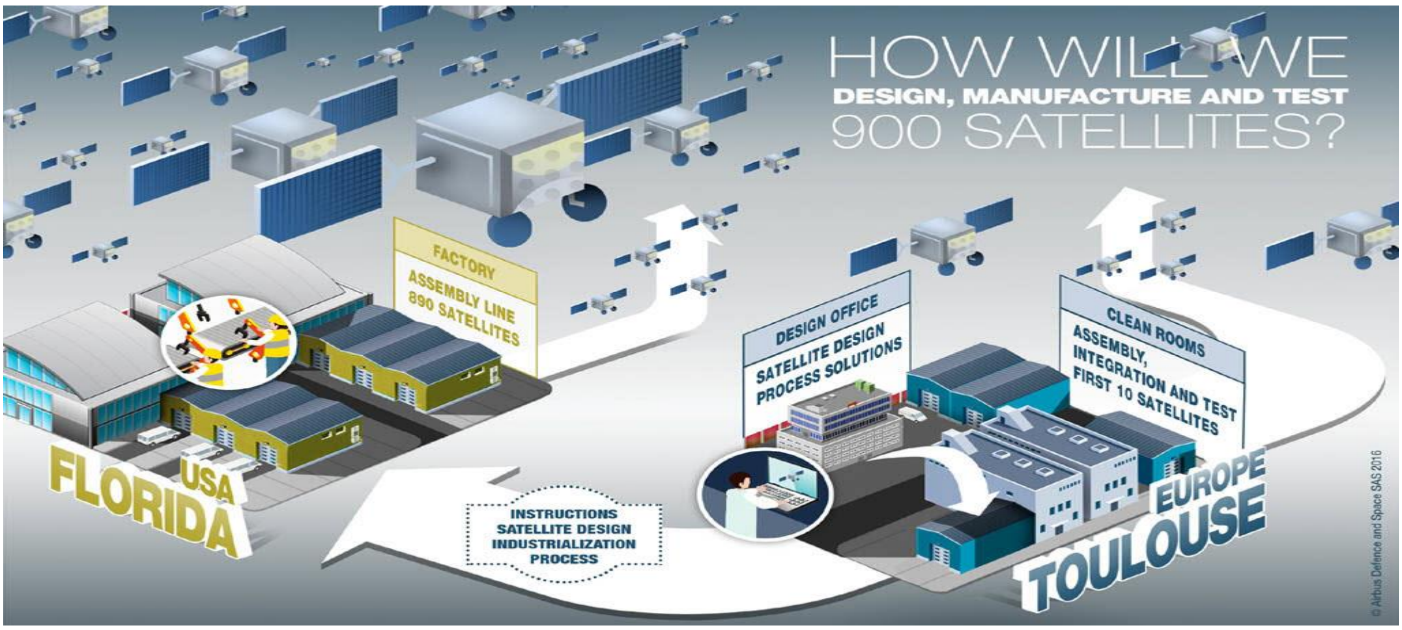
OneWeb

How Small Satellites Are Made

Mass production and satellites have never been used in the same sentence. Each satellite used to be handcrafted by hundreds of engineers. Until now. OneWeb is changing things. Today, satellites can be made in the same way high quality medical and avionics equipment are.

OneWeb Satellites:

- Fewer components
- Lighter weight
- Easier to manufacture
- Cheaper to launch



[9] Gunter's Space

SPACE X CONSTELLATION

Bringing the world online.

4425 SATELLTITES BRING THE ENTIRE WORLD ONLINE

SpaceX is among those targeting the unconnected, with plans to bring high-speed, reliable and affordable broadband internet service to consumers in the U.S. and the world, including areas underserved or currently unserved by existing networks. The SpaceX system will initially consist of 4,425 satellites to provide a wide range of broadband and communications services for residential, commercial, institutional, governmental and professional users worldwide. SpaceX has separately filed for authority to operate in the V-Band, where it has proposed an additional constellation of 7,500 satellites operating even closer to Earth.

For the consumer, SpaceX says its end-user terminals, which will amount to a relatively small flat panel the size of a laptop, will use phased array technologies to allow for highly directive, steered antenna beams that track the system's low-Earth orbit satellites.

THE BOEING CO. CONSTELLATION

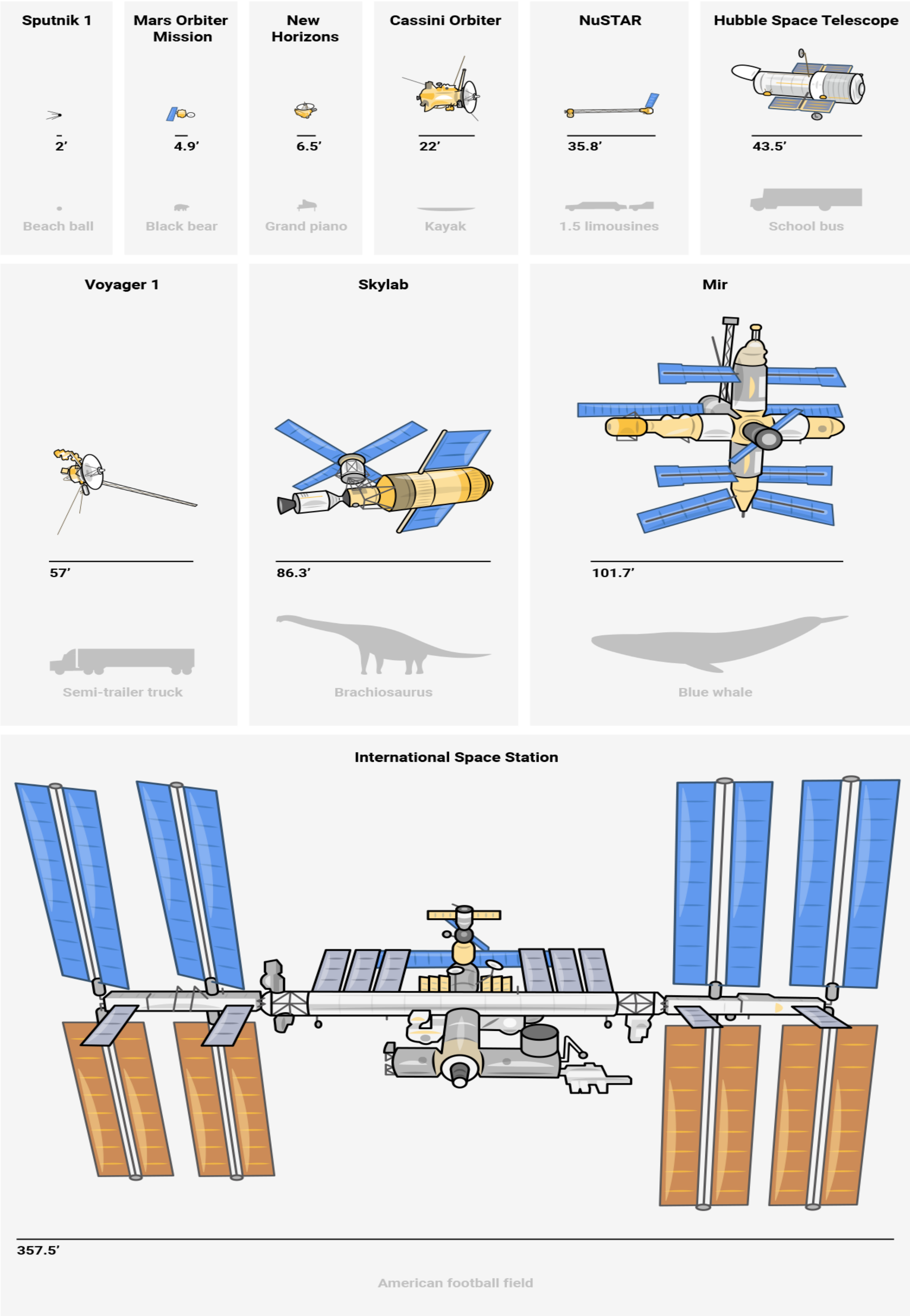
Aeronautical giant Boeing proposes to operate a constellation of satellites in low Earth orbit to provide internet access to government and commercial customers in the United States and globally. Boeing plans to deploy the first portion of the system within six years following license grant and to subsequently increase the constellation to a total of 2,956 satellites.

> *Boeing hasn't traditionally been a direct competitor to terrestrial cellular operators. But it's a large manufacturer of commercial satellites and has been a leader in the satellite industry in the last 50 years.* [10]

2956 SATELITTES TO PROVIDE INTERNET ACCESS GLOBALLY

[10] Alleven, 2017

SIZING UP HISTORY'S MOST FAMOUS SCIENCE SATELLITES



SOURCES: NASA, Space.com, Smithsonian National Air and Space Museum, Wikipedia

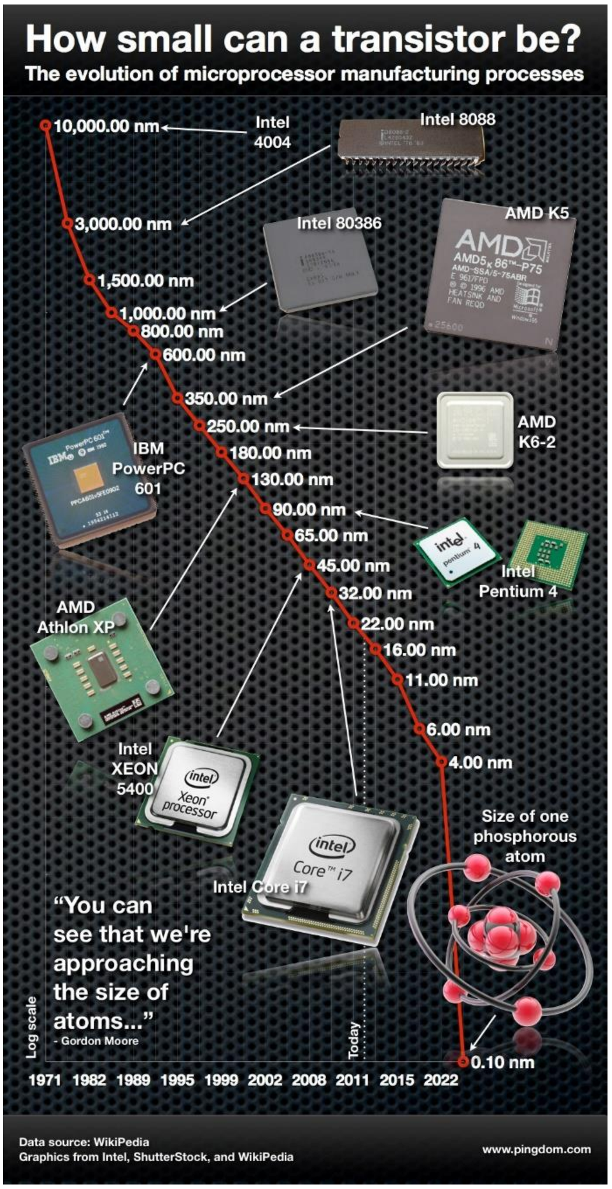
BUSINESS INSIDER

THE FUTURE OF MINIATURIZATION

Its impact in the size of satellites

THE CHIPS ARE DOWN FOR MORE'S LAW

In 1971 a small company called Intel released the 4004, its first ever microprocessor. The chip, measuring 12 square millimetres, contained 2,300 transistors—tiny electrical switches representing the 1s and 0s that are the basic language of computers. The gap between each transistor was 10,000 nanometres (billionths of a metre) in size, about as big as a red blood cell. The result was a miracle of miniaturisation, but still on something close to a human scale.



BY THE EARLY 2020S, WE'LL GET TO THE 2–3-NANOMETRE LIMIT, WHERE FEATURES ARE JUST 10 ATOMS ACROSS.

A child with a decent microscope could have counted the individual transistors of the 4004.

A rule of thumb that has come to dominate computing, Moore's law states that the number of transistors on a microprocessor chip will double every two years or so — which has generally meant that the chip's performance will, too. The exponential improvement that the law describes transformed the first crude home computers of the 1970s into the sophisticated machines of the 1980s and 1990s, and from there gave rise to high-speed Internet, smartphones and the wired-up cars, refrigerators and thermostats that are becoming prevalent today.[11]

[11] Nature, 2016

FALLING LAUNCH COSTS AND ITS IMPACT

Why is it important?

LAUNCH PRICES INFLUENCED BY:

1. Customer requirements (payload mass, size, orbit parameters)
2. Bulk buys of launch vehicles
3. Special launch services required
4. World launch market competitive situation
5. Launch demands– number of launches/payloads per year
6. Insurance cost for launcher and payload, depending on past launch vehicle reliability

FIRST CAME STEAM, ELECTRICITY, MASS PRODUCTION….

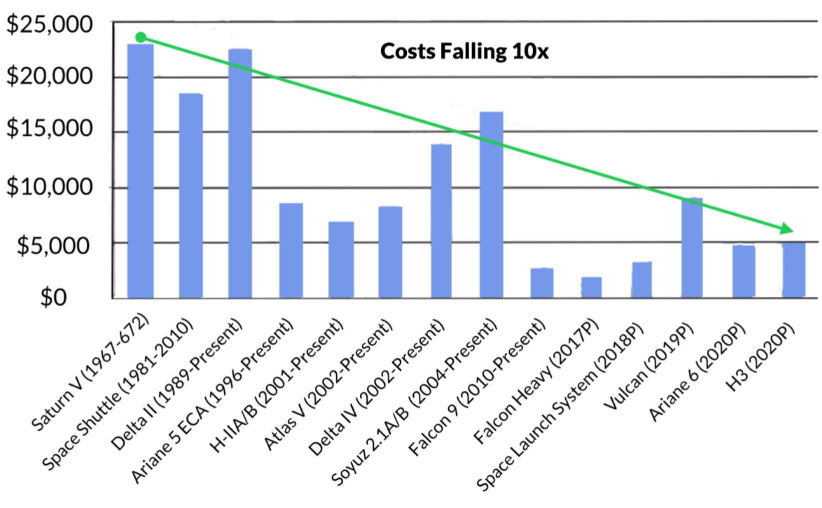
Price for space transportation generally viewed as biggest obstacle to growth of space commercialization and exploration

- Cost for space transportation represents typically 25 – 70 % of a specific space program
- "Cost-per-Flight" definition for Flight":
- Vehicle Production Cost (Learning Factor))

Direct Operations Cost: e.g. Propellants & Materials, Ground operations, flight & mission planning, transport & recovery, refurbishment, fees & public damage insurance

INDIRECT OPERATIONS COST

For example program administration & system management, technical system support, launch site support & maintenance, insurance Cost for launcher & payload, specific Transportation Costs Specific Transportation Costs (Cost per kg payload) depend strongly on payload size and launch frequency.



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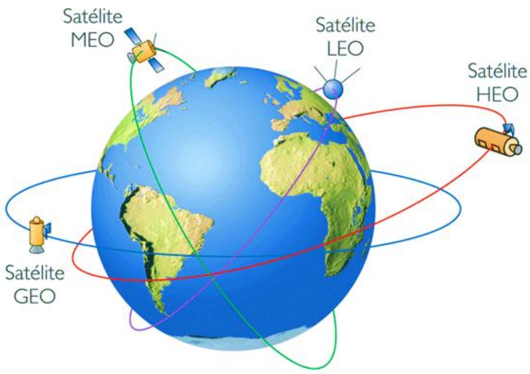
SPACE ENVIRONMENT. ORBITS



THERE ARE ESSENTIALLY THREE TYPES OF EARTH ORBITS: HIGH EARTH ORBIT, MEDIUM EARTH ORBIT, AND LOW EARTH ORBIT. [12]

HIGH EARTH ORBIT

When a satellite reaches exactly 42,164 kilometres from the centre of the Earth (about 36,000 kilometres from Earth's surface), it enters a sort of "sweet spot" in which its orbit matches Earth's rotation. Because the satellite orbits at the same speed that the Earth is turning, the satellite seems to stay in place over a single longitude, though it may drift north to south. This special, high Earth orbit is called geosynchronous.

MEDIUM EARTH ORBIT

Closer to the Earth, satellites in a medium Earth orbit move more quickly. Two medium Earth orbits are notable: the semi-synchronous orbit and the Molniya orbit. The semi-synchronous orbit is a near-circular orbit (low eccentricity) 26,560 kilometres from the centre of the Earth (about 20,200 kilometres above the surface). A satellite at this height takes 12 hours to complete an orbit. In 24-hours, the satellite crosses over the same two spots on the equator every day. This orbit is consistent and highly predictable. It is the orbit used by the Global Positioning System (GPS) satellites.

LOW EARTH ORBIT

Most scientific satellites and many weather satellites are in a nearly circular, low Earth orbit. The satellite's inclination depends on what the satellite was launched to monitor. The Tropical Rainfall Measuring Mission (TRMM) satellite was launched to monitor rainfall in the tropics. Therefore, it has a relatively low inclination (35 degrees), staying near the equator.

[12] NASA, Earth Observatory

SPACE ENVIRONMENT

SPACE IS ONE OF THE MOST EXTREME ENVIRONMENTS IMAGINABLE. ABOVE THE INSULATING ATMOSPHERE OF THE EARTH, SPACECRAFT ARE SUBJECTED TO EXTREMES OF TEMPERATURE, BOTH HOT AND COLD, AND A SIGNIFICANTLY INCREASED THREAT OF RADIATION DAMAGE.

Temperatures in space can range from the extremely cold, hundreds of degrees below freezing, to many hundreds of degrees above – especially if a spacecraft ventures close to the Sun.

Radiation in space can be split into 'trapped' and 'transient' types. The trapped particles are the subatomic particles, mainly protons and electrons, trapped by Earth's magnetic field which creates the so-called Van Allen radiation belts around our planet.

The transient radiation is mainly composed of protons and cosmic rays that constantly stream through space and are enhanced during the magnetic storms on the Sun known as 'solar flares'

WHEN THIS RADIATION COLLIDES WITH ELECTRONIC CIRCUITS, THEY CAN CHANGE THE CONTENTS OF MEMORY CELLS, CAUSE SPURIOUS CURRENTS TO FLOW AROUND THE CRAFT OR EVEN BURN OUT COMPUTER CHIPS.

Building integrated circuits that resist the effects of radiation is known as 'space hardening'. Usually this involves redesigning the chips so that they are shielded in some way from the harmful radiation. Another approach is to detect the errors produced by space radiation and correct them.

Meteor showers can also damage spacecraft. The little dust particles that cause us to see 'shooting stars' travel through space at several kilometres per second and can have the effect of 'sand blasting' large arrays of vital solar panels.

Cosmic rays

The atmosphere filters most of these, so they are primarily a concern for spacecraft and high-altitude aircraft.

Solar particle

Events come from the direction of the sun and consist of a large flux of high-energy (several GeV) protons and heavy ions, again accompanied by x-ray radiation.

Van Allen radiation belts

Due to their position, they pose a concern for satellites.

Secondary particles

Result from interaction of other kinds of radiation with structures around the electronic devices.

Chip packaging materials

These effects have been reduced today by using purer packaging materials, and employing error-correcting codes to detect and often correct DRAM errors.

RADIATION PROBLEMS

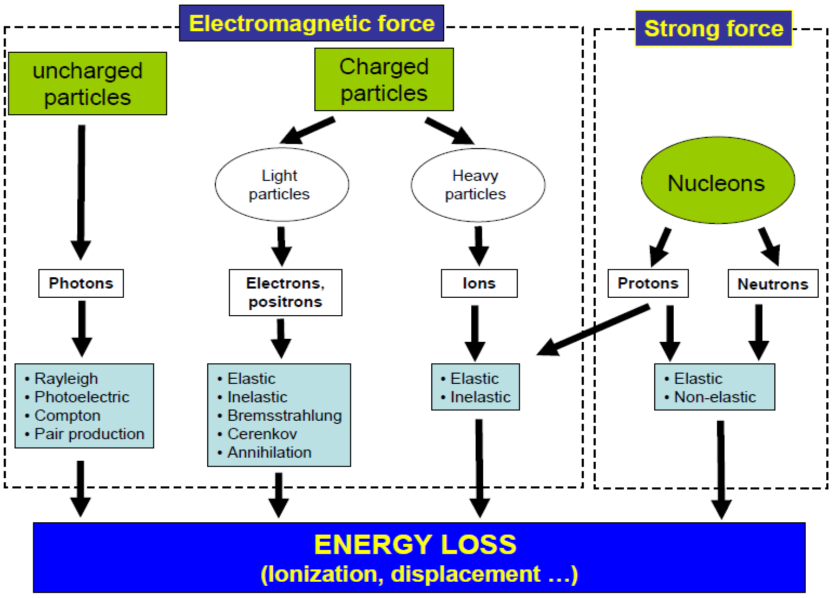
SEVERAL STUDIES SHOW:

1. Identifying satellites damages due to cosmic rays,
2. Defects and failures were found in high altitude avionics,
3. Devices malfunction due to alpha particles coming from the material used in its manufacturing (plastic encapsulated).

IS THE RADIATION ENVIRONMENT A PROBLEM FOR ELECTRONICS?

Counters installed on the Explorer 1 and Explorer 3 missions detected particles and the presence of a severe radiation environment in the fifties, demonstrating the presence of energetic particles as part of the space environment.

The first lost satellite due to radiation effects was (TELSTAR, 1963). A general system failure, which was associated with a combination of radiation effects: human (nuclear test at high altitude) and natural.



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SATELITTE MANUFACTURING CYCLE

Life cycle phase A

THE PROJECT LIFE-CYCLE PHASES OF FORMULATION AND IMPLEMENTATION ARE DIVIDED INTO INCREMENTAL PIECES. THIS ALLOWS THE DEVELOPMENT TEAM TO ACCESS THEIR PROGRESS, ESTIMATE SYSTEM AND PROJECT PERFORMANCE, PLAN THE NEXT PHASE AND ALLOWS DECISION MAKERS TO ASSESS MANAGEMENT AND TECHNICAL PROGRESS.

Purpose: To produce a broad spectrum of ideas and alternatives for missions from which new projects can be selected.

- Define the mission needs, goals & objectives.
- Perform studies of a broad range of mission concepts that contribute to goals and objectives.
- Develop draft project-level requirements, operations concept, and potential technology needs.
- Show that at least one mission concept can work.

PHASE A (CONCEPT & TECHNOLOGY DEVELOPMENT)

Purpose: To determine the feasibility of a suggested new system in preparation for seeking funding.

- Define mission success, and minimum mission.
- Perform trade studies to compare mission concept options.
- Develop a baseline mission concept, including best technical approach, project execution, cost and schedule.
- Complete the requirements to the subsystem level.
- Identify requirements flow between and across subsystems.
- Begin needed technology developments.

SATELITTE MANUFACTURING CYCLE

Life cycle phases B, C, D

PHASE B (PRELIMINARY DESIGN & TECHNOLOGY COMPLETION)

Purpose: To define the project in enough detail to establish an initial baseline capable of meeting mission needs.

- Refine concept of operations.
- Allocate functions and resources (e.g., mass margins).
- Requirements: continue to refine; define flow to the box level; develop verification matrix.
- Establish design solution that meets mission needs.
- Demonstrate that technology development is complete

PHASE C (FINAL DESIGN AND FABRICATION)

Purpose: To design a system (and its associated subsystems, including its operations systems) so that it will be able to meet its requirements.

- Demonstrate that the detailed system design meets requirements.
- Demonstrate that the design drawings are complete.
- Establishes the product baseline, also known as the 'build-to' baseline.
- Begin fabrication of test and flight article components, assemblies, and subsystems.

PHASE D (SYSTEM ASSEMBLY, INTEGRATION AND TEST, AND LAUNCH)

Purpos*e*: To build the subsystems (including operations systems) and integrate them to create the system, while developing confidence that it will be able to meet the systems requirements.

- Perform system assembly, integration, and test.
- Verify system meets requirements.
- Prepare system for deployment.
- Launch system.
- Verify deployment and operations.

APPLICABILITY TO OTHER INDUSTRIES

If the vision of Industry 4.0 is to be realized, most enterprise processes must become more digitized. A critical element will be the evolution of traditional supply chains toward a connected, smart, and highly efficient supply chain ecosystem.

SUPPLY CHAINS ARE EXTREMELY COMPLEX ORGANISMS, AND NO COMPANY HAS YET SUCCEEDED IN BUILDING ONE THAT'S TRULY DIGITAL.

Indeed, many of the applications required are not yet widely used. But this will change radically over the next five to 10 years, with different industries implementing digital supply chain (DSC) at varying speeds. Companies that get there first will gain a difficult-to-challenge advantage in the race to Industry 4.0, and will be able to set, or at least influence, technical standards for their particular industry. The advantage will by no means be limited to the greater efficiencies. The real goal will be the many new business models and revenue streams the digital supply chain will open up.

The supply chain today is a series of largely discrete, siloed steps taken through marketing, product development, manufacturing, and distribution, and finally into the hands of the customer. Digitization brings down those walls, and the chain becomes a completely integrated ecosystem that is fully transparent to all the players involved — from the suppliers of raw materials, components, and parts, to the transporters of those supplies and finished goods, and finally to the customers demanding fulfilment.[i]

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[i] *https://www.strategyand.pwc.com/reports/industry4.0*