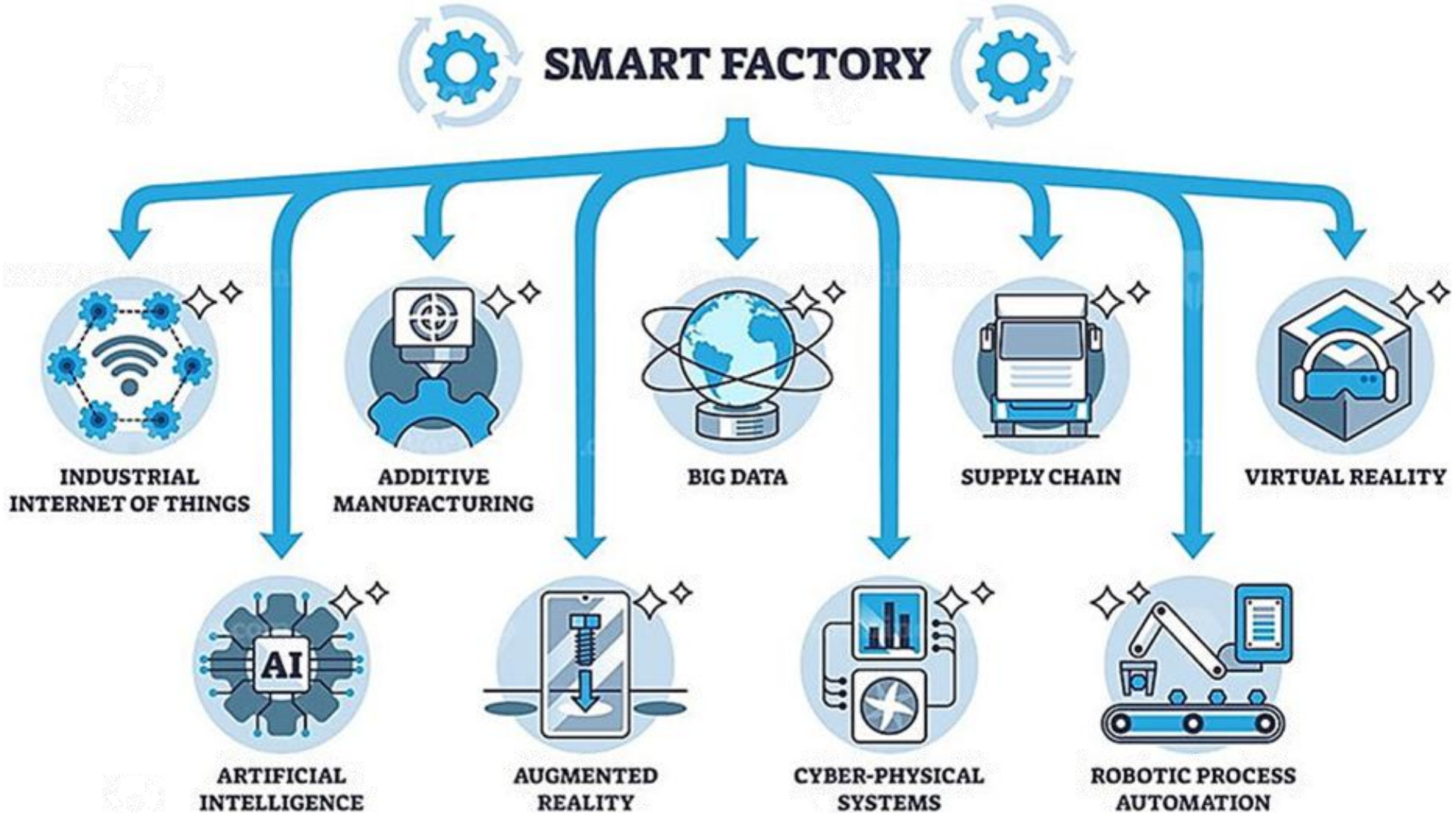
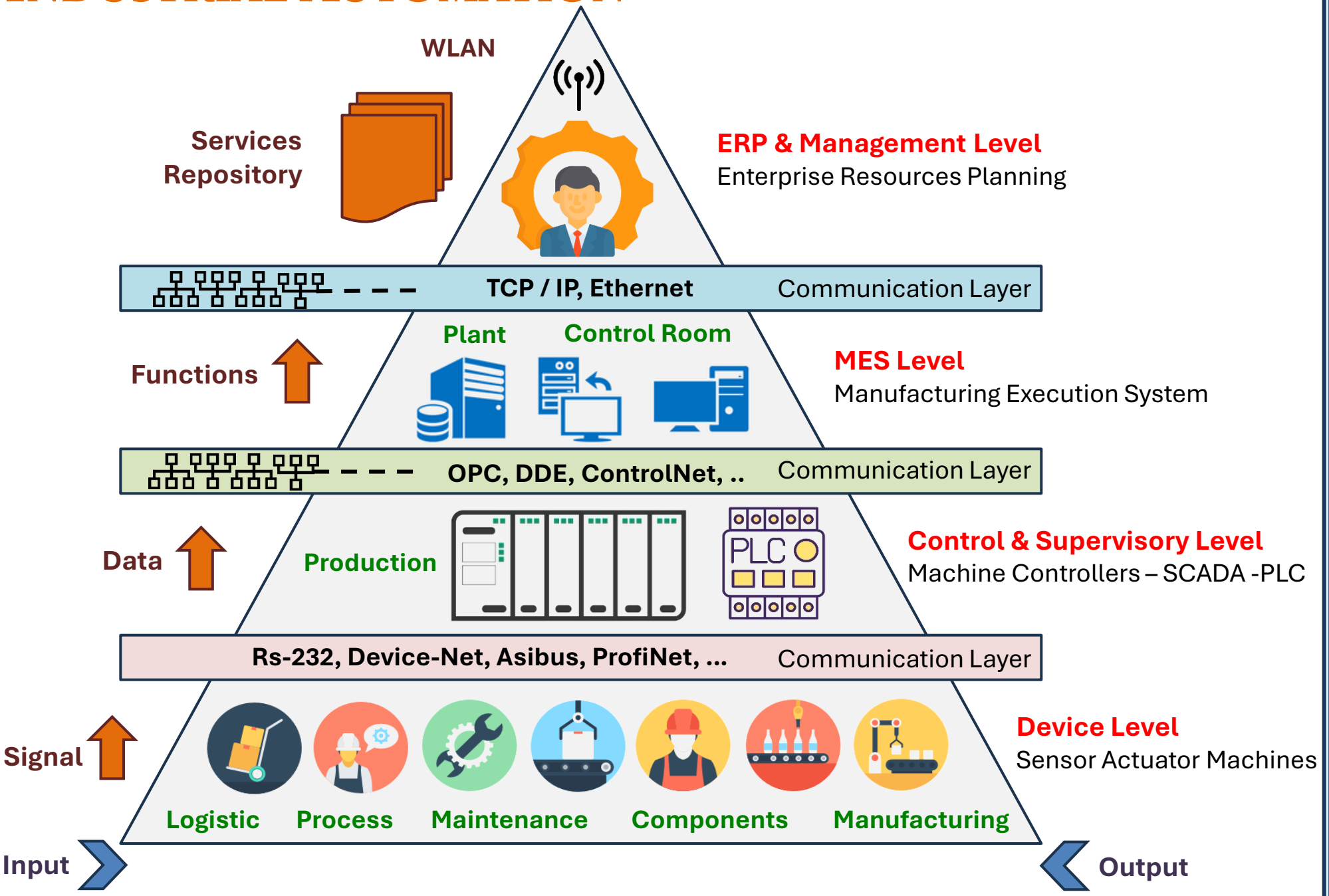
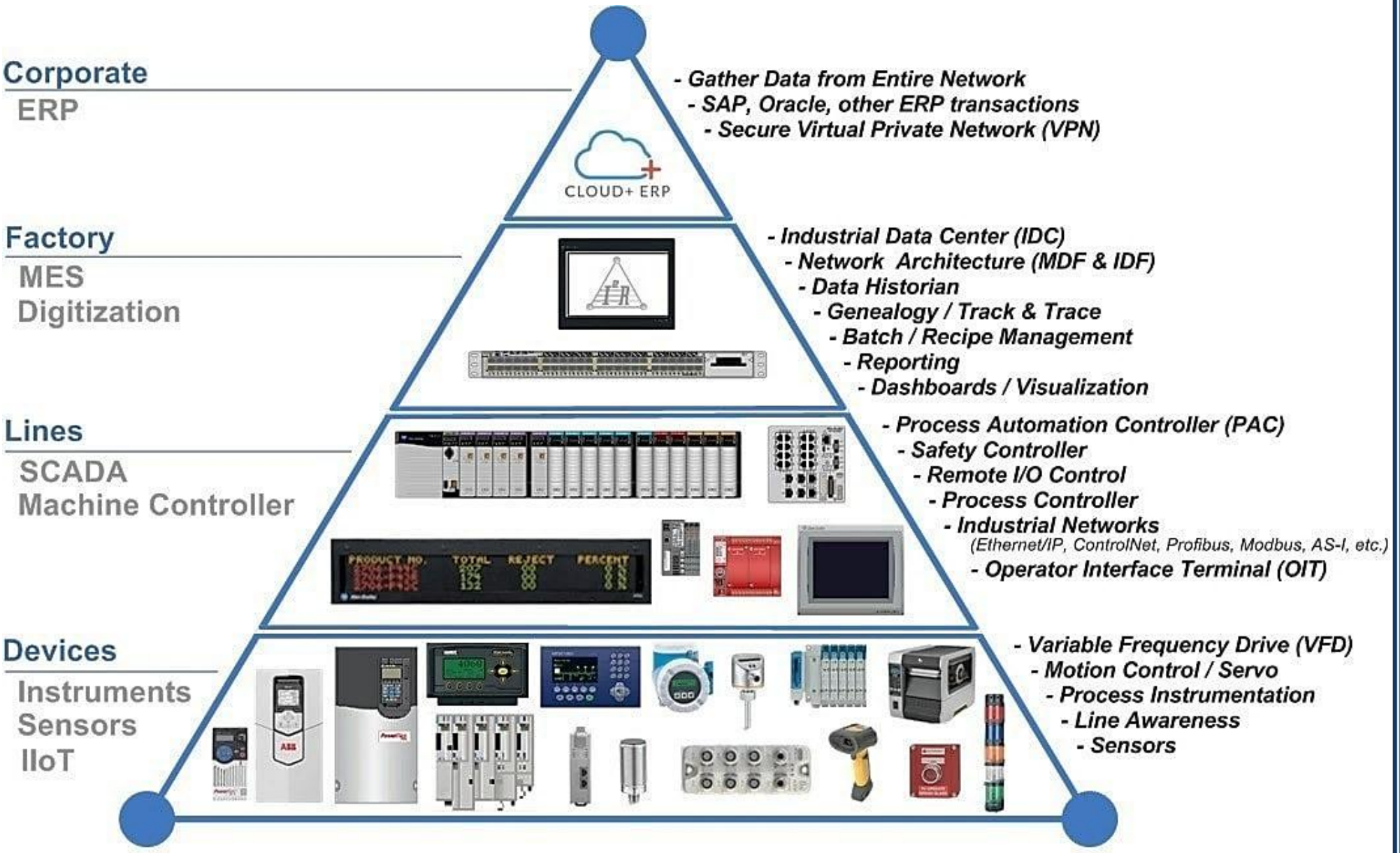


INDUSTRIAL AUTOMATION

INDUSTRIAL AUTOMATION



INDUSTRIAL AUTOMATION



https://www.realpars.com/blog/automation-pyramid

https://www.youtube.com/watch?v=3bwAZPTBPgs

INDUSTRIAL AUTOMATION

Definition

- Set of all measures aiming at replacing human work through machines
  (e.g. automation is applied science)
  (e.g. the automation of the textile factory caused uproar of the workers)
- Replacement of conscious activity by reflexes
  (e.g. drill of the sailors allows the automation of ship handling)
- Development a machine of repetitively actions or boring activities
  (e.g. packing, counting, measurement, pallet & assembly) etc.
- Processing of the information flow
- Enforcement of safety and availability
- Reduction of personal costs

Expectations of Automation

Process Optimisation

- Energy, material and time savings, quality improvement and stabilisation
- Reduction of waste, pollution control
- Compliance with regulations and laws, product tracking
- Increase availability, safety
- Fast response to market
- Connection to management and accounting

-> Acquisition of large number of “process variables”, data mining

Personnel costs reduction

- Simplify interfaces, assist decision
- Require data processing, displays, data base, expert systems

-> Human-Machine-Interface (HMI)

Asset Optimisation (gestion des moyens de production)

- Automation of engineering, commissioning and maintenance
- Software configuration, back-up and versioning
- Life-cycle control, maintenance support

-> Engineering Tools

Examples

Cars I

today: 50..100 ECU (electronic control units)

Air-bag system	Antilock brakes	Automatic transmission
Alarm system	Climate control	Collision-avoidance system
Cruise control	Communication system	Dashboard instrumentation
Electronic stability control	Engine ignition	Engine control
Electronic-seat control	Entertainment system	Navigation system
Power steering	Tire-pressure monitoring	Windshield-wiper control

critical new applications:
brake-by-wire, steer-by-wire (“X-by-wire”) increased safety ?
extreme price squeezing
¼ of the cost is electronics, tendency increasing
http://spectrum.ieee.org/green-tech/advanced-cars/this-car-runs-on-code

Cars II

90% of the functions of a car rely on software,

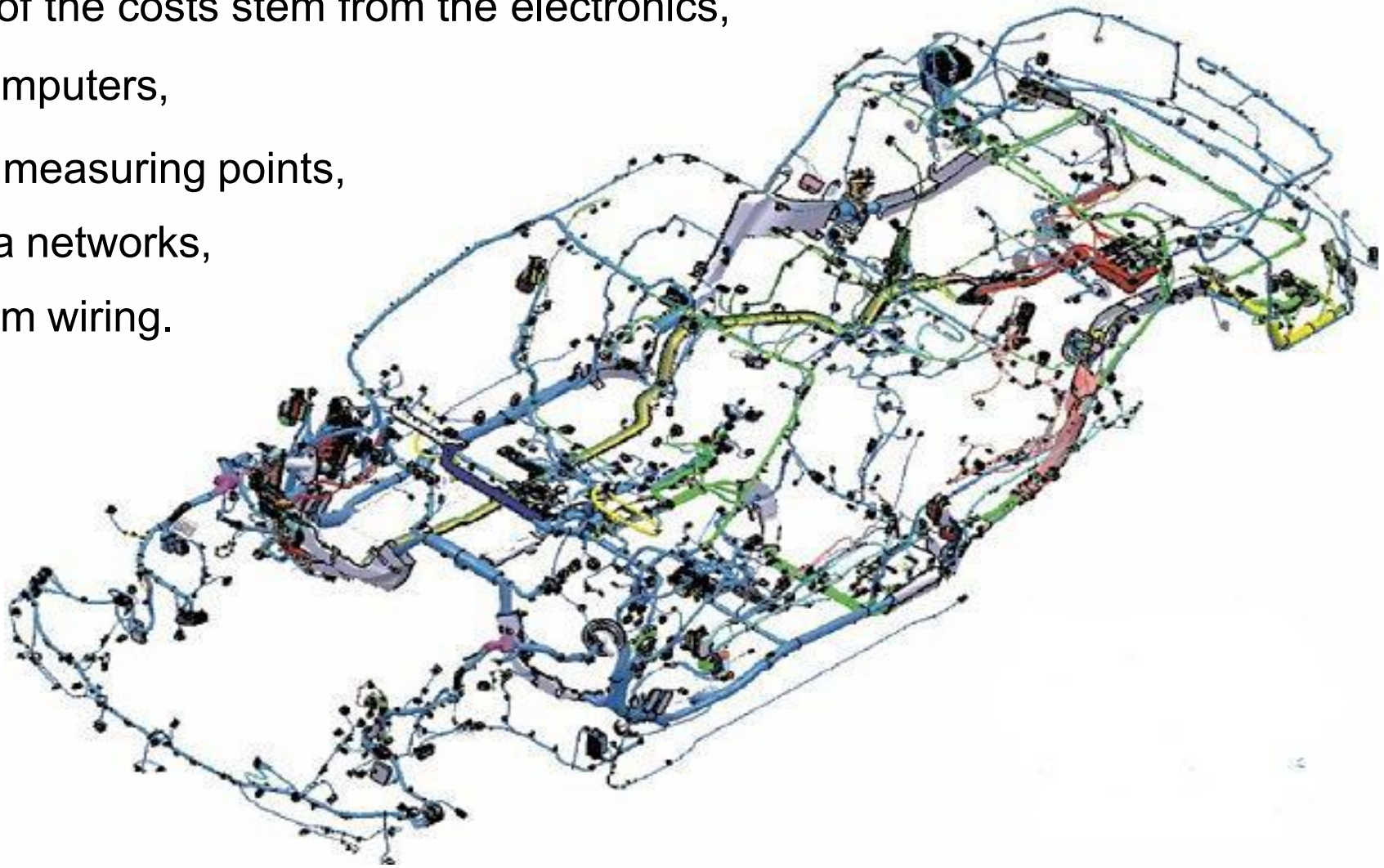
40% of the costs stem from the electronics,

70 computers,

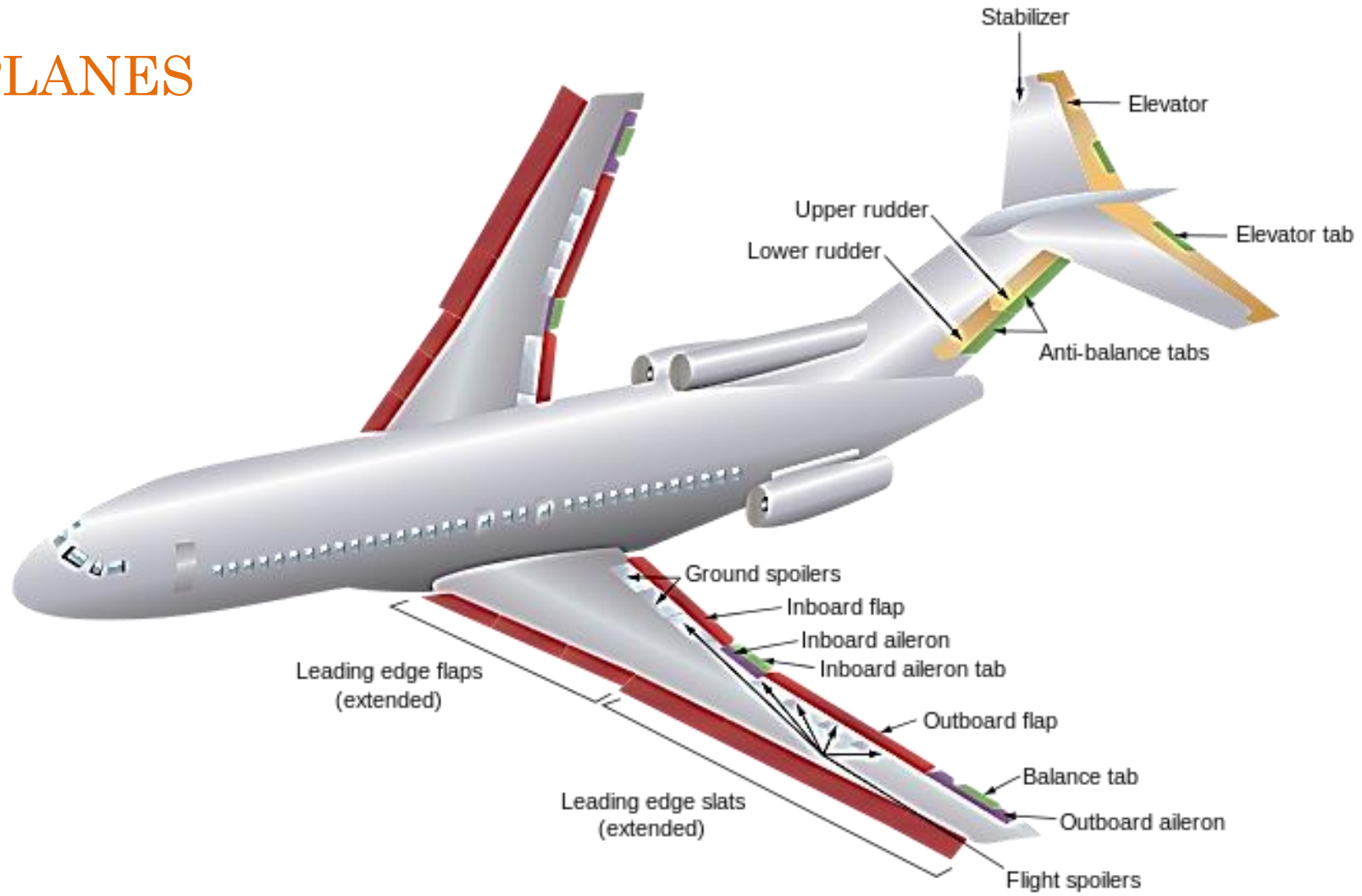
2000 measuring points,

6 data networks,

200 km wiring.



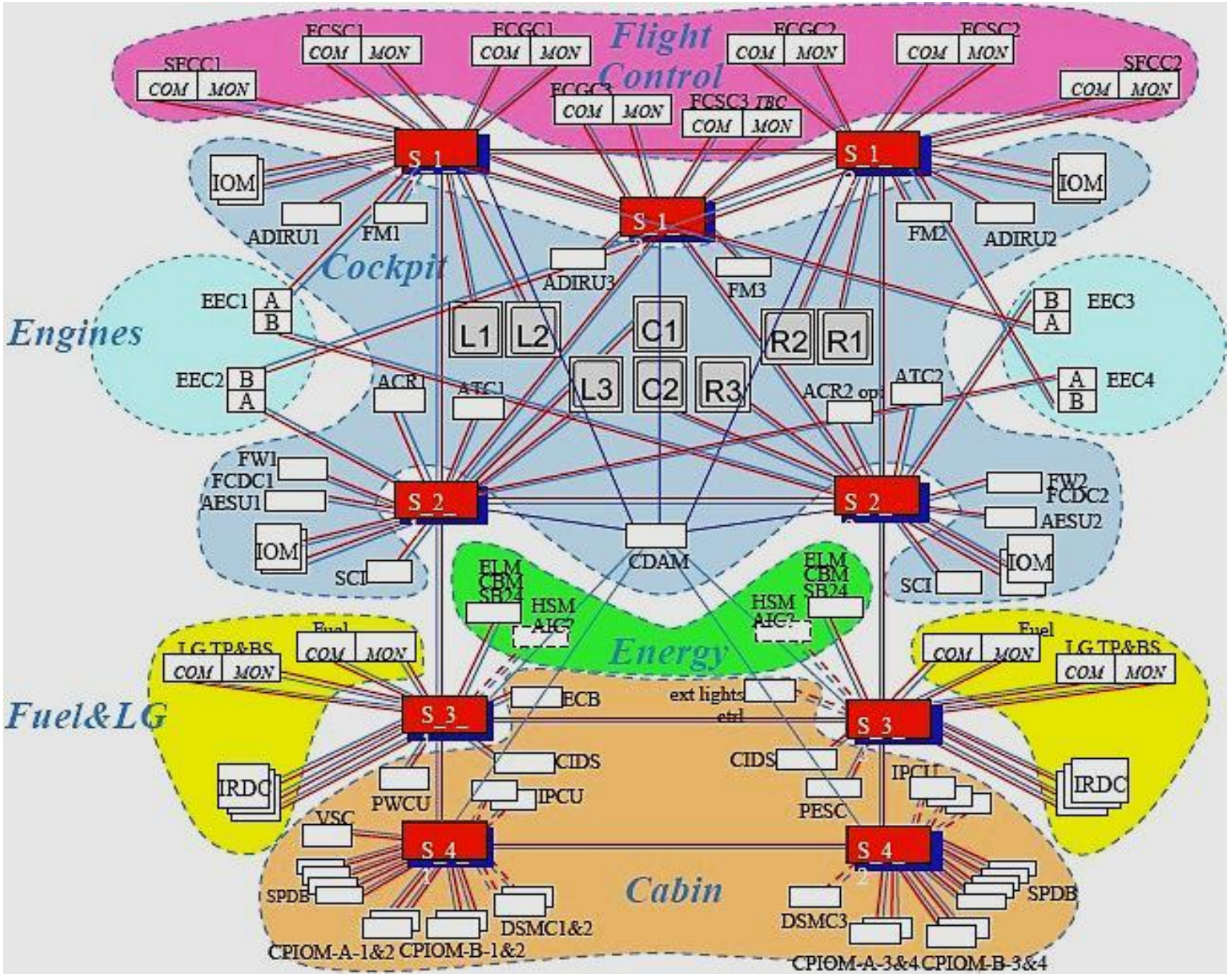
AIRPLANES



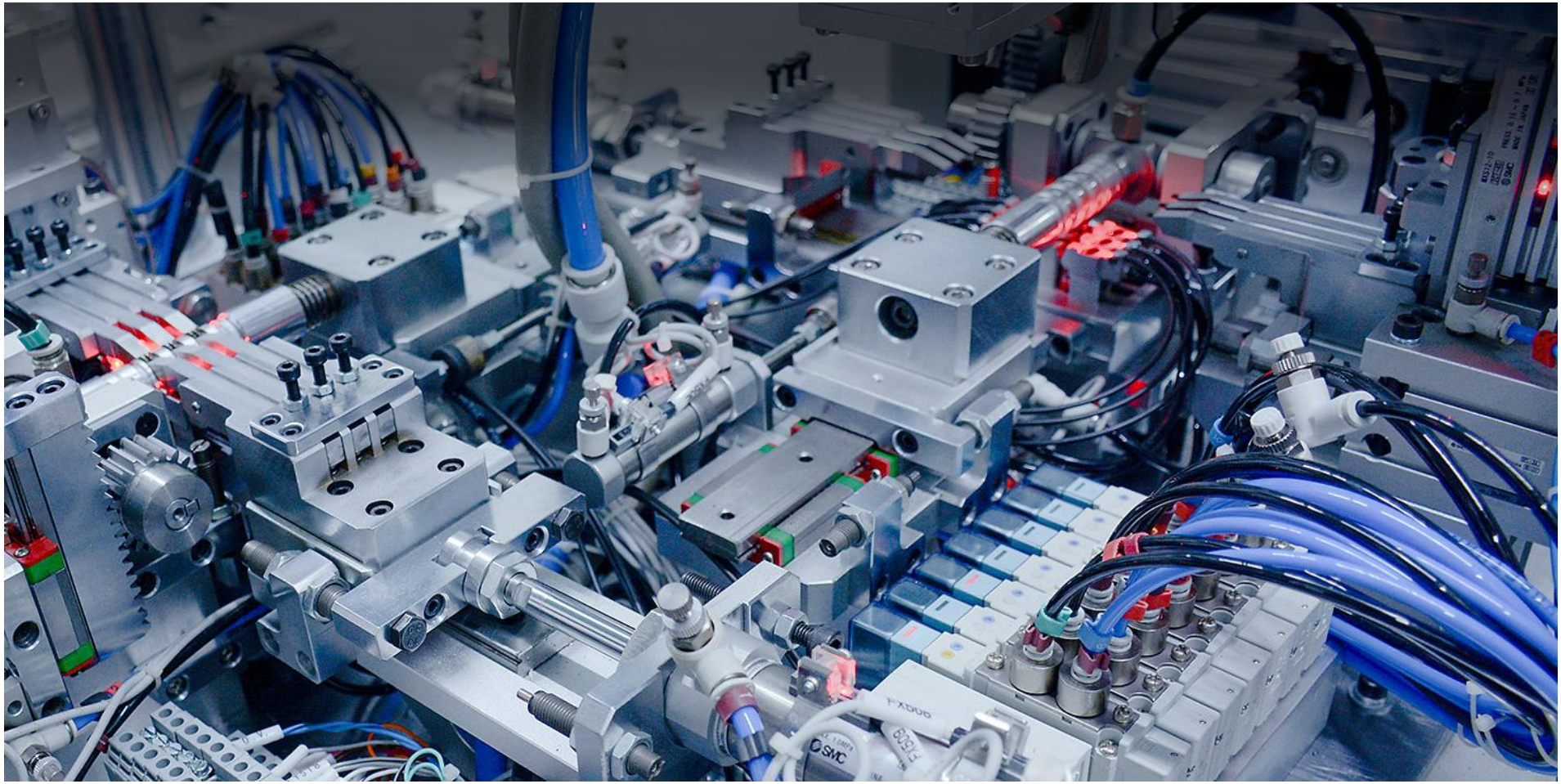
"avionics":

- flight control (safe flight envelope, autopilot, "engineer")
- flight management
- flight recording (black boxes, turbine supervision)
- diagnostics
- "fly-by-wire"

AIRBUS A380 – DATA NETWORK



Manufacturing I

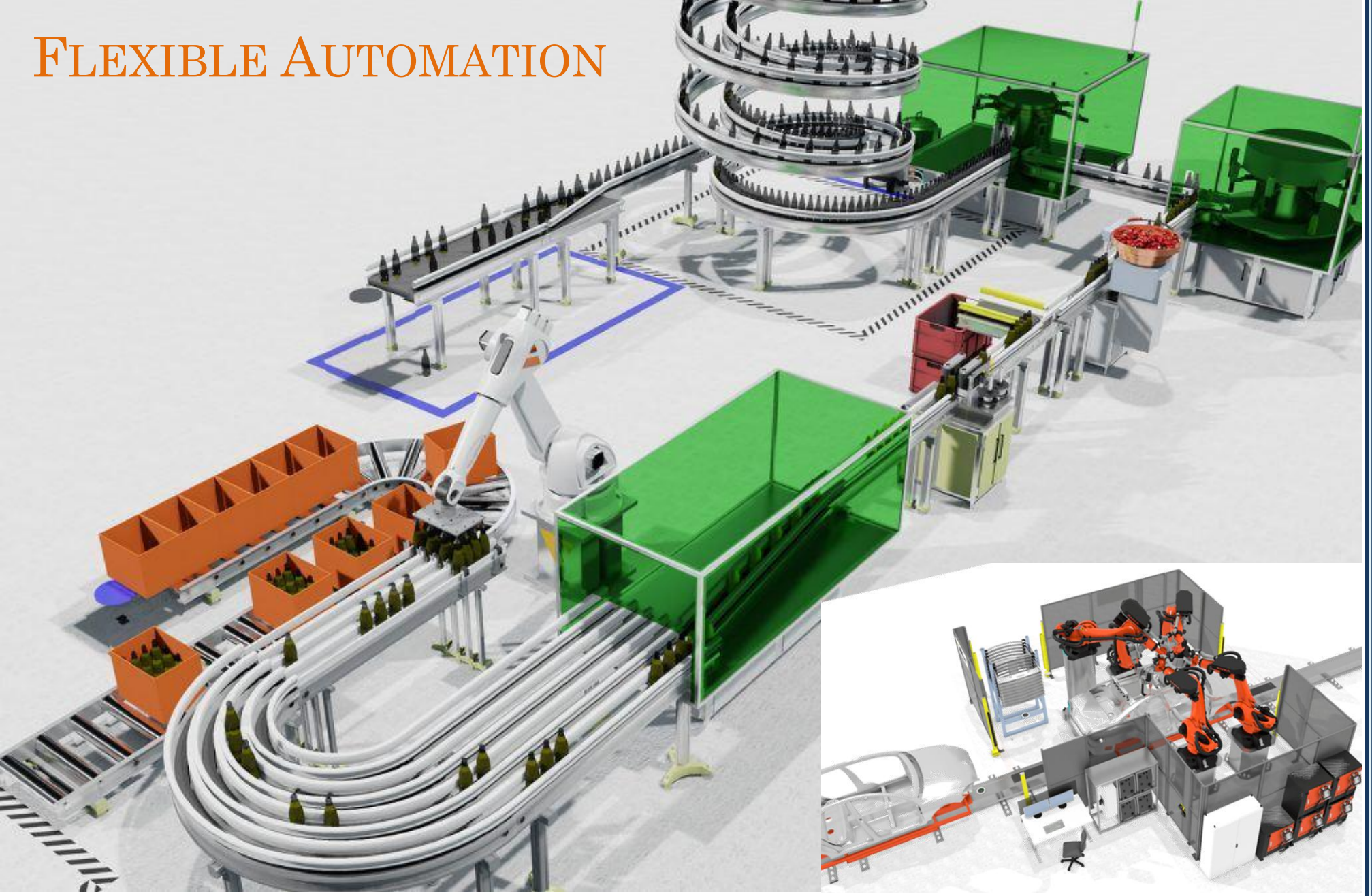


e.g., manufacturing parts

Manufacturing II

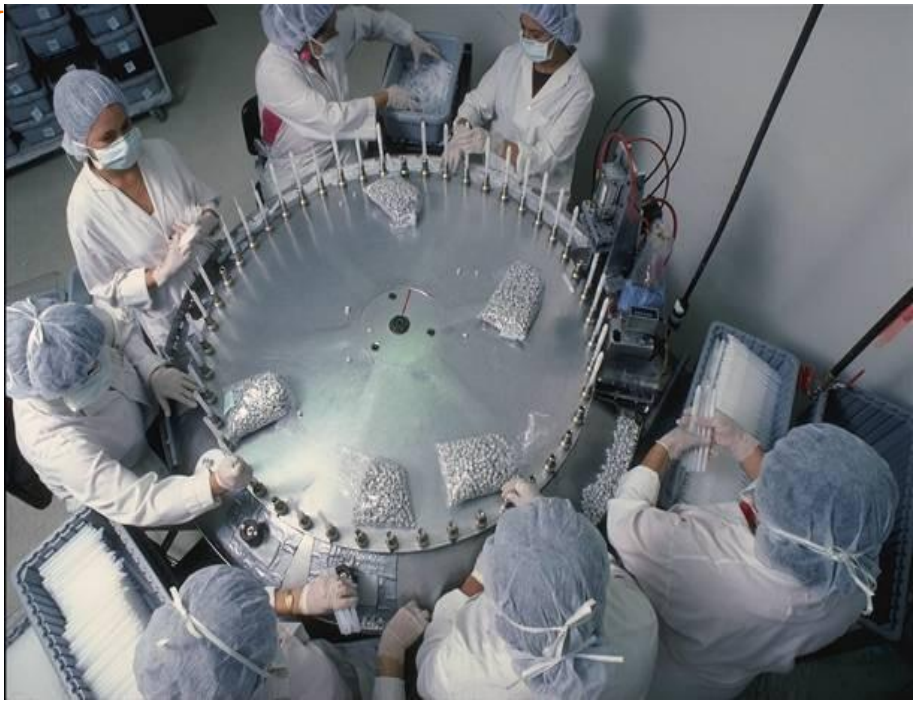
Robot extension limited to 2-3 m,
frequent reprogramming for new tasks, tool changes.
simple embedded computer, hierarchical control

Flexible Automation



Numerous conveyors, robots, CNC machines, paint shops, logistics.
Download from production management, connection to administration

Pharmaceutical Industry



Inventory Recipe management
Packaging Sampling Tracking & tracing
Comply with government rules:

FDA

Oil & Gas, petrochemicals

"upstream": from the earth to the refinery
down-sea control

special requirement: high pressure, saltwater, inaccessibility
explosive environment with gas.

"distribution"

special requirement: environmental protection

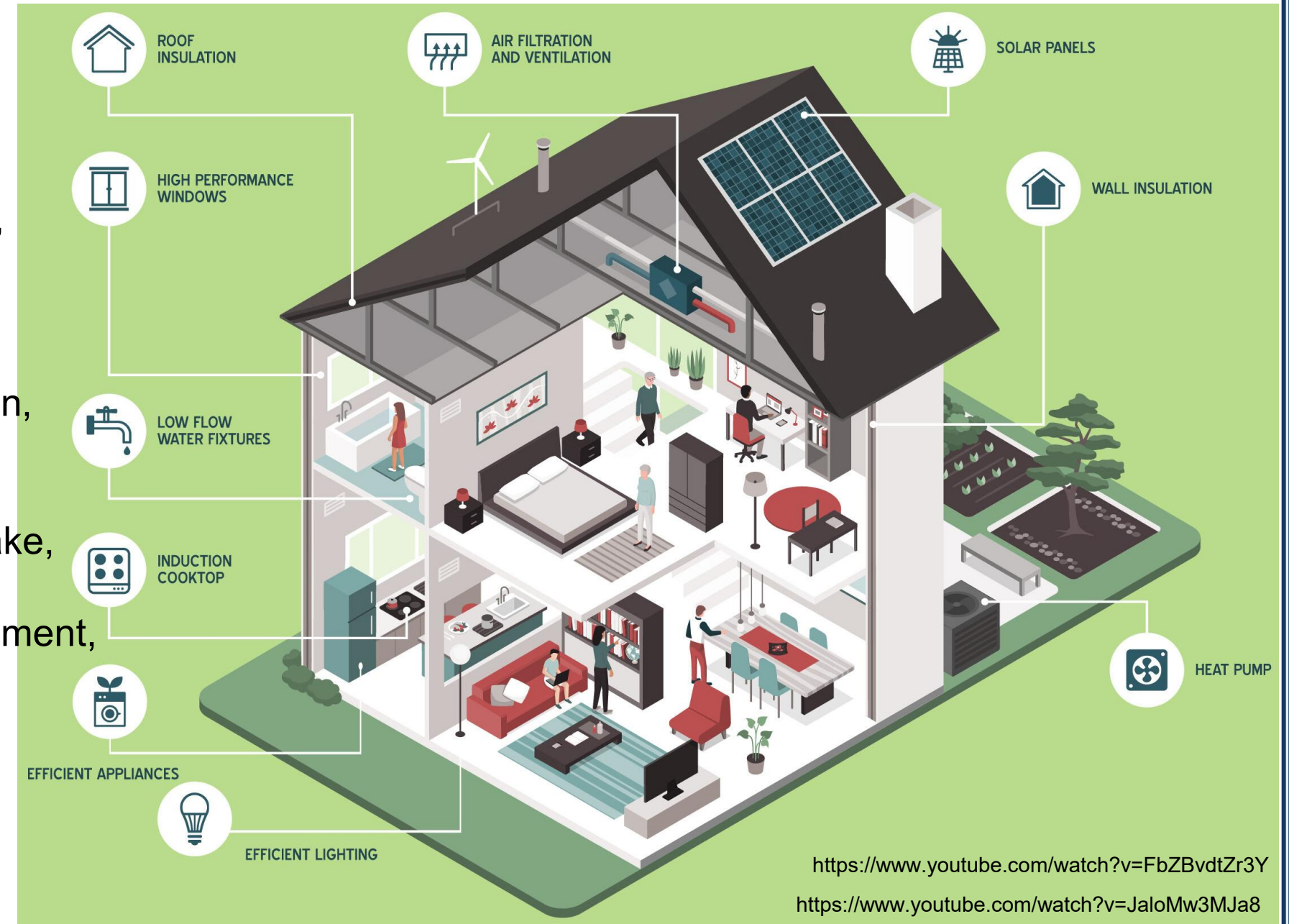
"downstream": from the oil to derived products

special requirement: extreme, explosive environment

Building Automation

Basics:

Fire,
Intrusion,
Climate,
Energy,
Heat,
Ventilation,
Cooling,
Water,
Earthquake,
Comfort,
Entertainment,
…

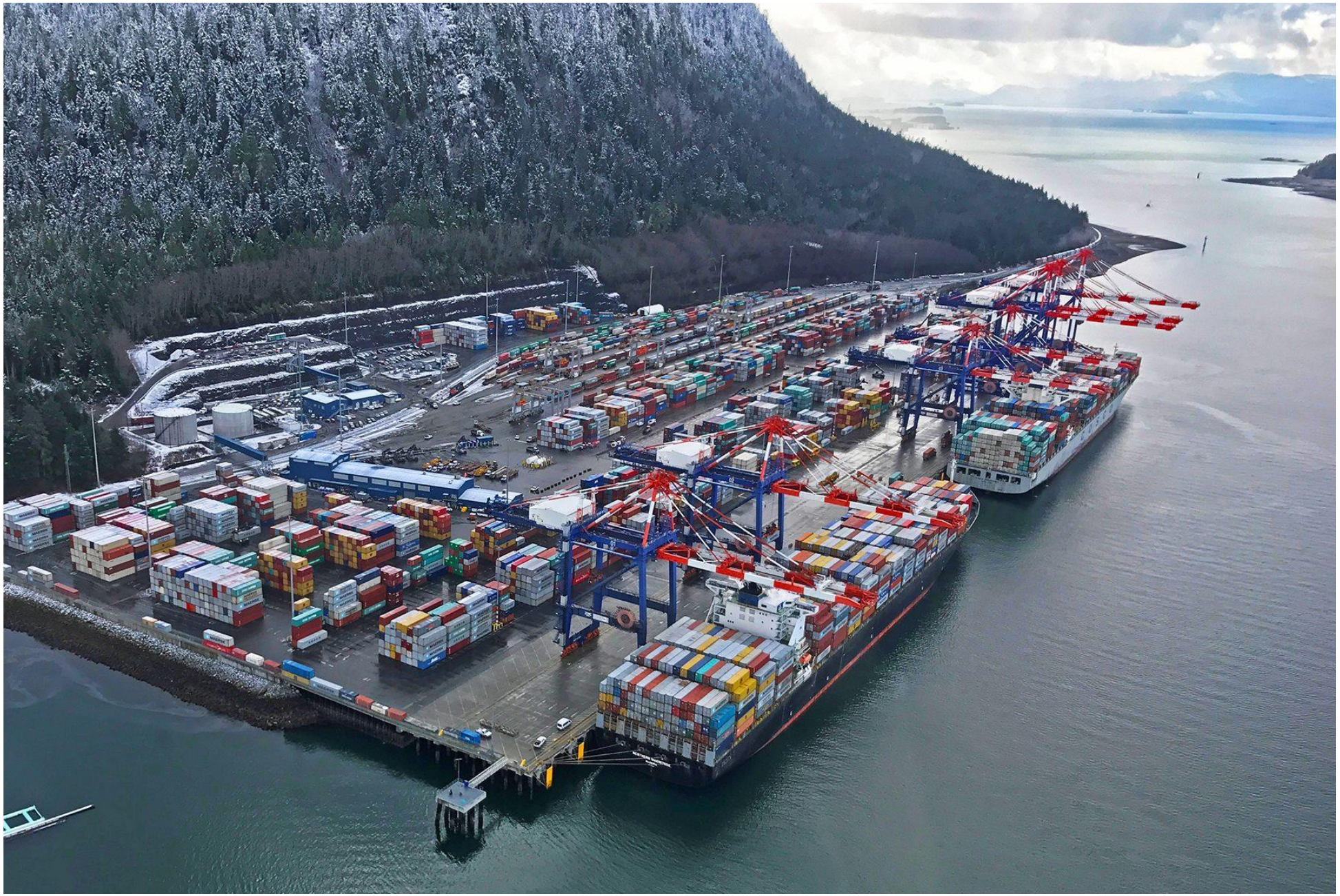


https://www.youtube.com/watch?v=FbZBvdtZr3Y

https://www.youtube.com/watch?v=JaloMw3MJa8

PORTS

from ship planning to crane manipulation and stock control



Water treatment

fresh and waste water treatment, manage pumps, tanks, chemical composition, filters, movers, quality... auxiliaries: methane electricity generation

Substations

protection (Lines, transformers, generators) very high speed response control (remote or local) to guarantee power flow, safe operation (interlocking) measurement (local and remote), electricity bill, power flow in grid

POWER PLANTS

Hydro
- river
- dams
- storage dams

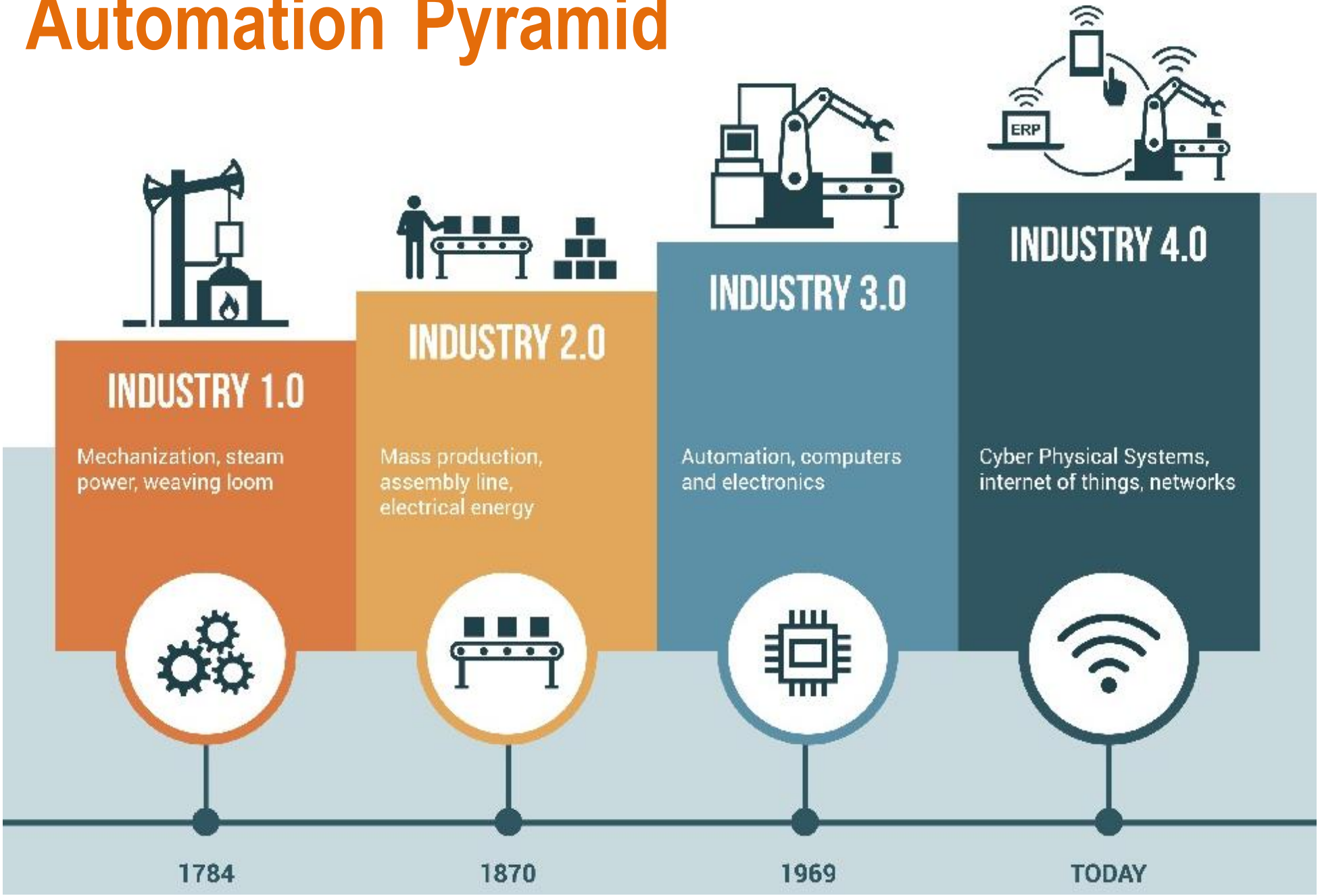
Thermo
- coal
- gas
- atom
- solar
- waste

Alternative
- wind
- photo-voltaic
- sea
- geothermal

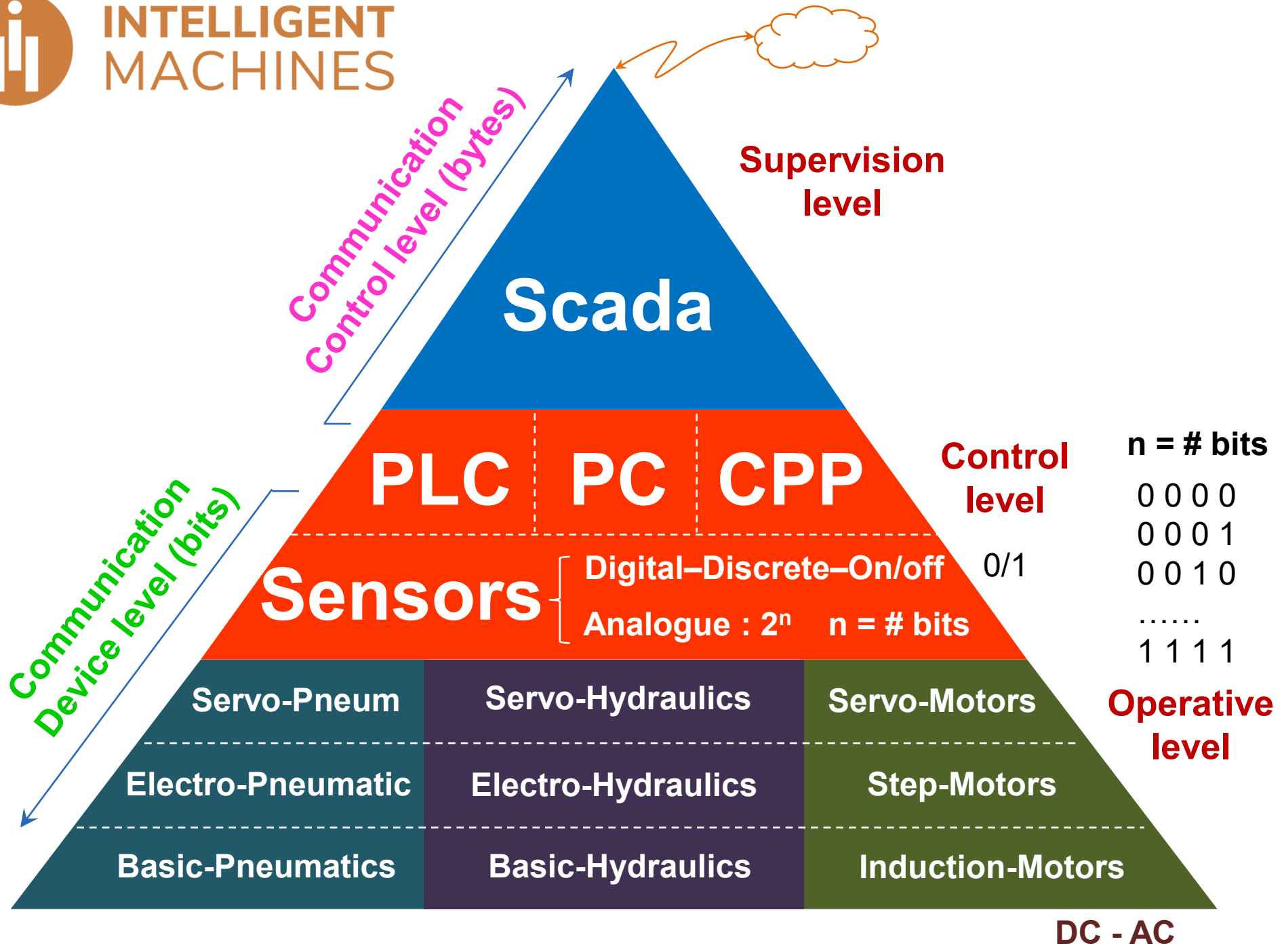
tasks: fuel supply
primary process control (steam, wind) personal, plant and neighbourhood safety monitoring environmental impact electricity generation (voltage/frequency) energy distribution (substation) 24 / 365 availability

Solar farms: 3000 mirrors or panels to control

Automation Pyramid



INTELLIGENT MACHINES



AUTOMATION AS A HIERARCHY OF SERVICES

5 Planning, Statistics, Finances

4 Production planning, orders, purchase

3 Workflow, order tracking, resources

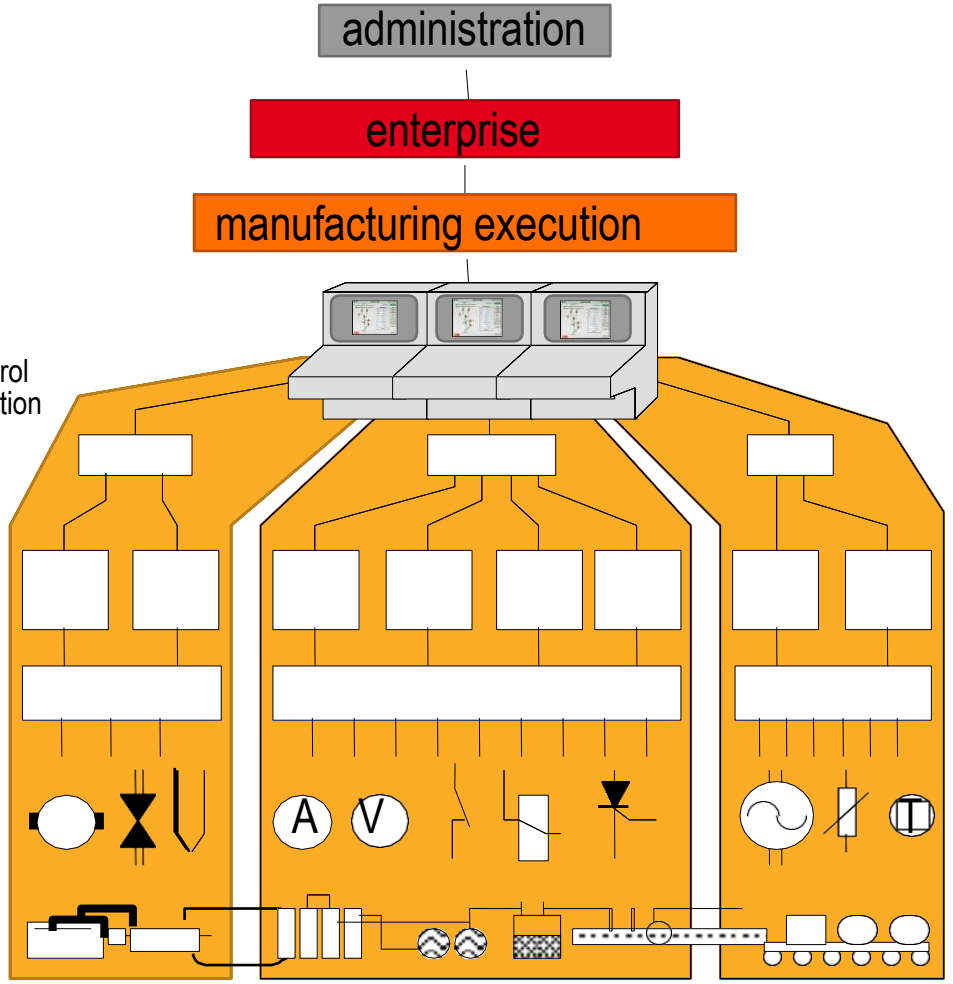
2 Supervision

1 Control
- Group control
- Unit control

Field
- Sensors & actors

0 Primary technology

SCADA = Supervisory Control And Data Acquisition

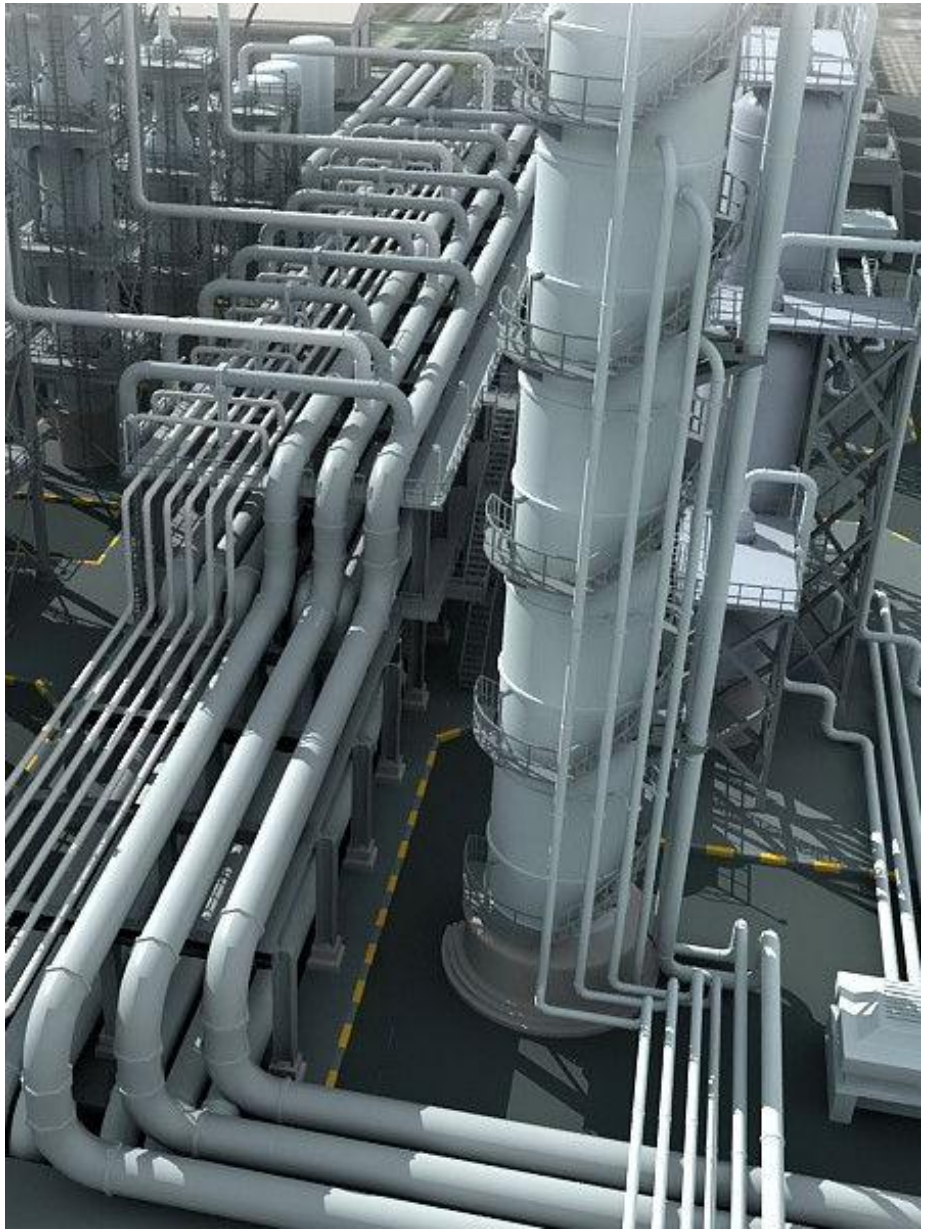


Details of control system hierarchy

Administration	Finances, human resources, documentation, long-term planning
Enterprise	Set production goals, plan resources, coordinate sites, manage orders
Manufacturing/Ex	Manages execution, resources, workflow, quality supervision, production scheduling, maintenance.
Supervision	Supervise production and site, execute operations, visualization, store process data, log operations, history (open loop control)
Control	Group (Area) Control: Responsible for well-defined part of plant (closed loop, except for intervention of an operator) • Coordinate units • Adjust set-points and parameters Unit (Cell) Control: Regulation, monitoring and protection of group part (closed loop except for maintenance) • Measure: Sampling, scaling, processing, calibration. • Control: regulation, set-points and parameters • Command: sequencing, protection and interlocking
Field	data acquisition (sensors, actuators), data transmission no processing except measurement correct·ion and built-in protection.

FIELD LEVEL

the field level is in direct interaction with the plant's hardware (primary technology)



CONTROL

Group control coordinates activities of several unit controls

Typically hierarchical, can be peer-to-peer

Note: "Distributed Control Systems" (DCS) commonly refers to a hardware and software infrastructure to perform Process Automation

SUPERVISORY LEVEL: SCADA

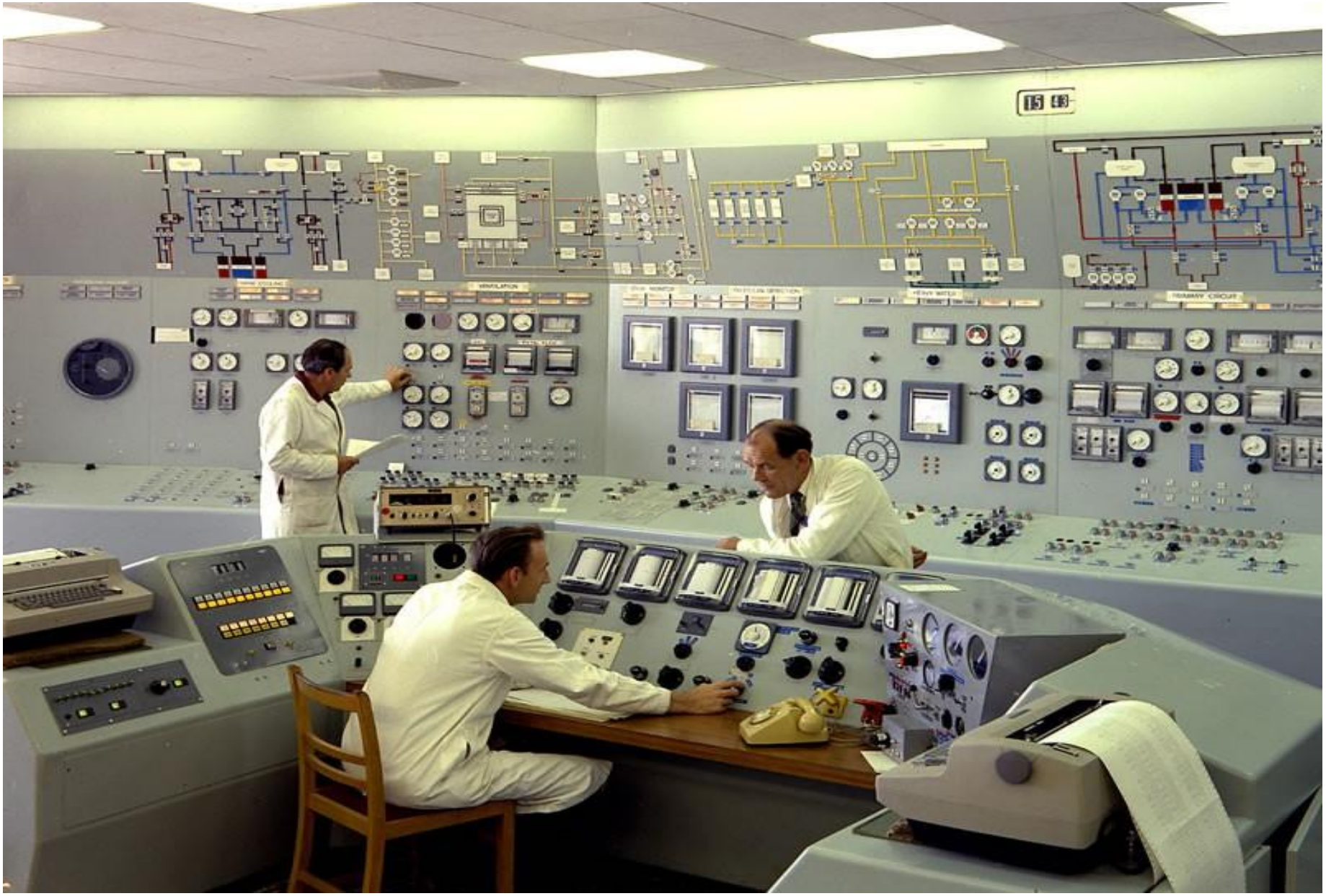
(SCADA = Supervisory Control and Data Acquisition)

- displays the current state of the process (**visualization**)
- display the alarms and events (**alarm log, logbook**)
- display the trends (**historians**) and analyse them
- display handbooks, data sheets, inventory, expert system (**documentation**)
- allows communication and data synchronization with other centres

Control Room From the 1950s

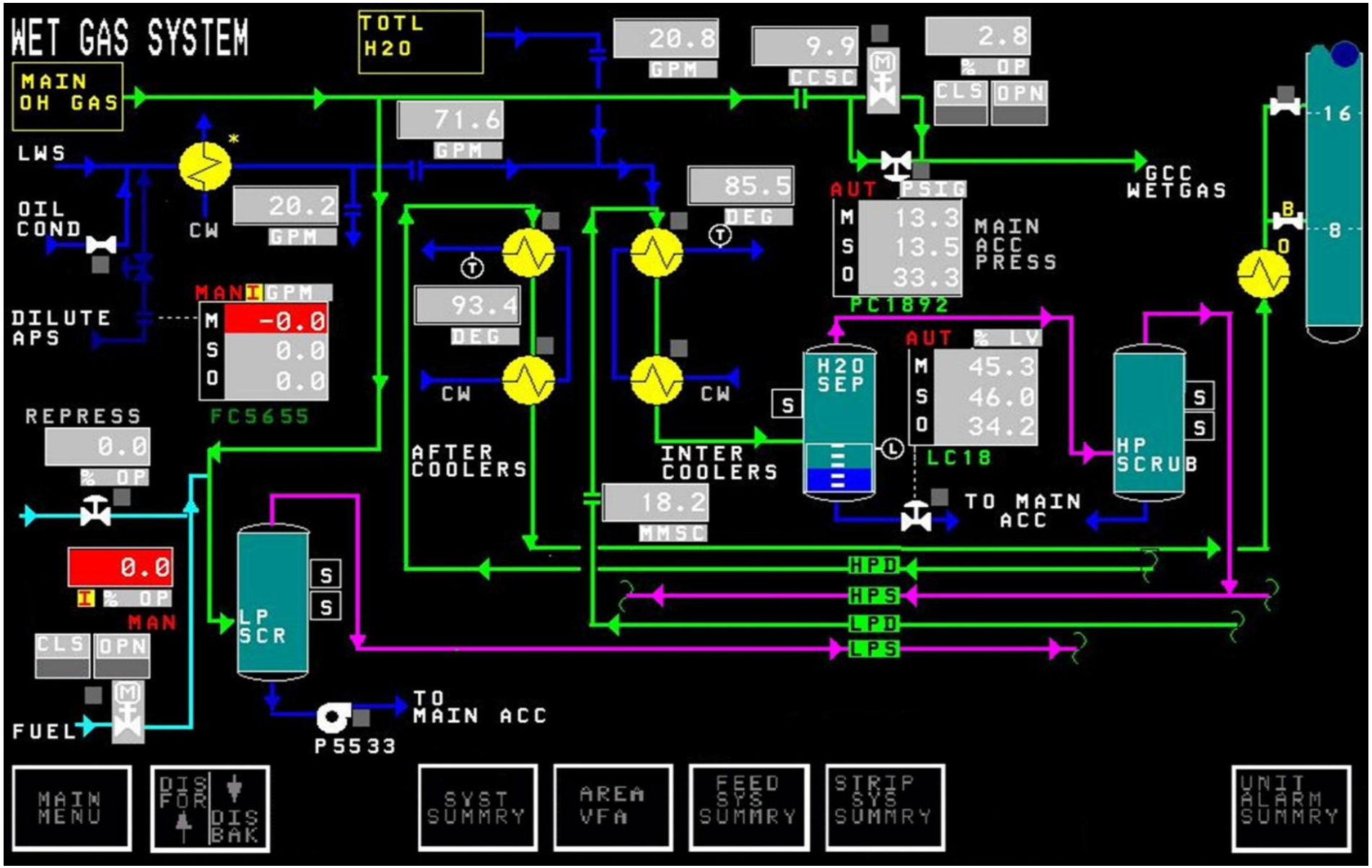
Coal-Fired Battersea Power Station – South London, UK – 1950s
Photo: Fox Photos/Getty Images

Control Room Example From the 1970s



Steam Generating Heavy Water Reactor – (Water Cooled Nuclear Reactor) - Dorset, UK - 1970s

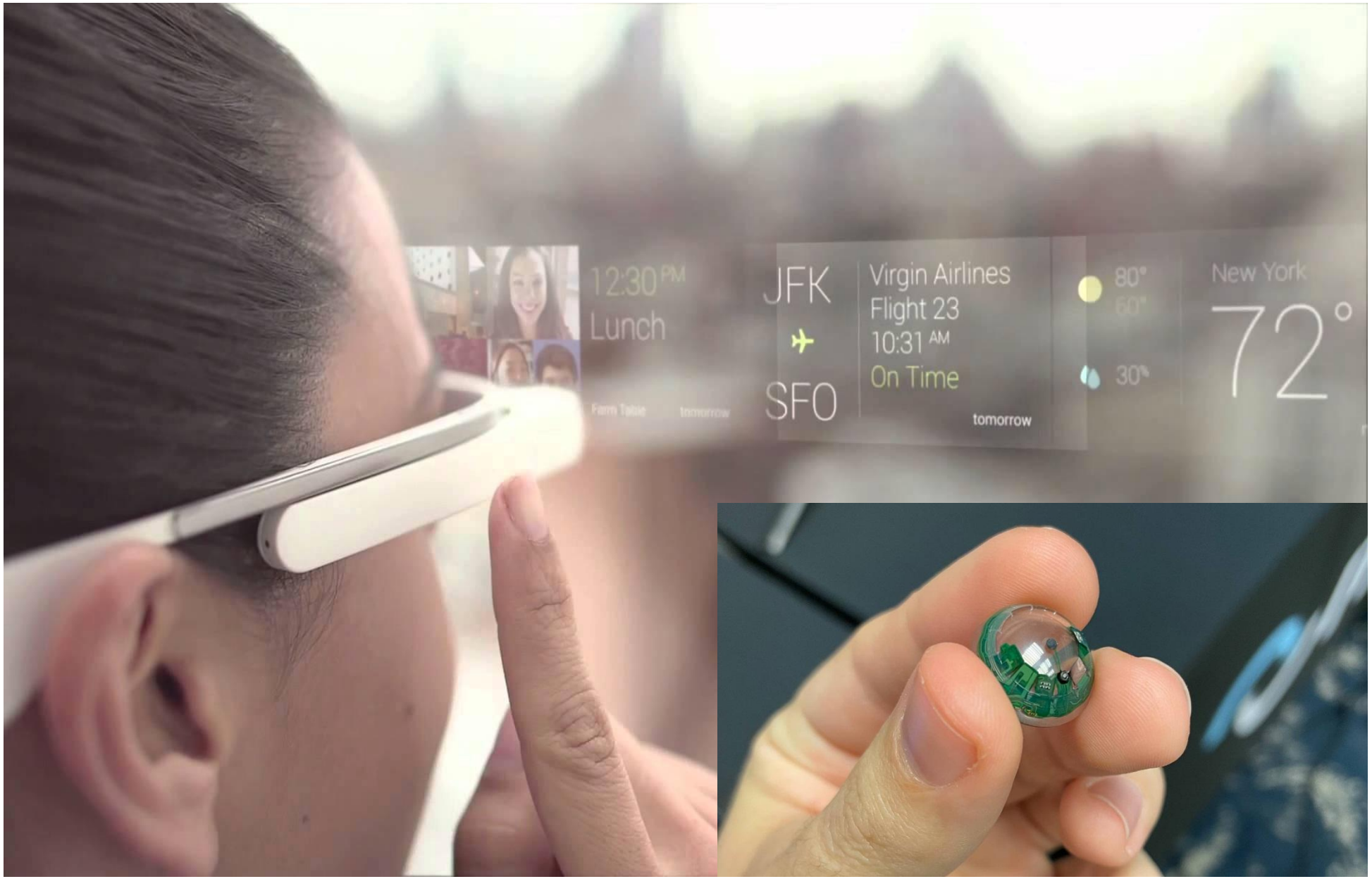
Control Room from the 90s



Control Room From the 2010s

ISO New England Control Room

NEXT?



Mojo Lens: https://www.youtube.com/watch?v=d2fBBJRjccs&t=458s