Transducers and Instrumentation

Updated based on the version provided by Andy Watson

Content

- **Transducers/Sensor (type/variable)**
- **Instrumentation (amp, lineariser, filter)**
- **DDC, DCS, Supervisory, SCADA**
- **Architecture of automatic control system**

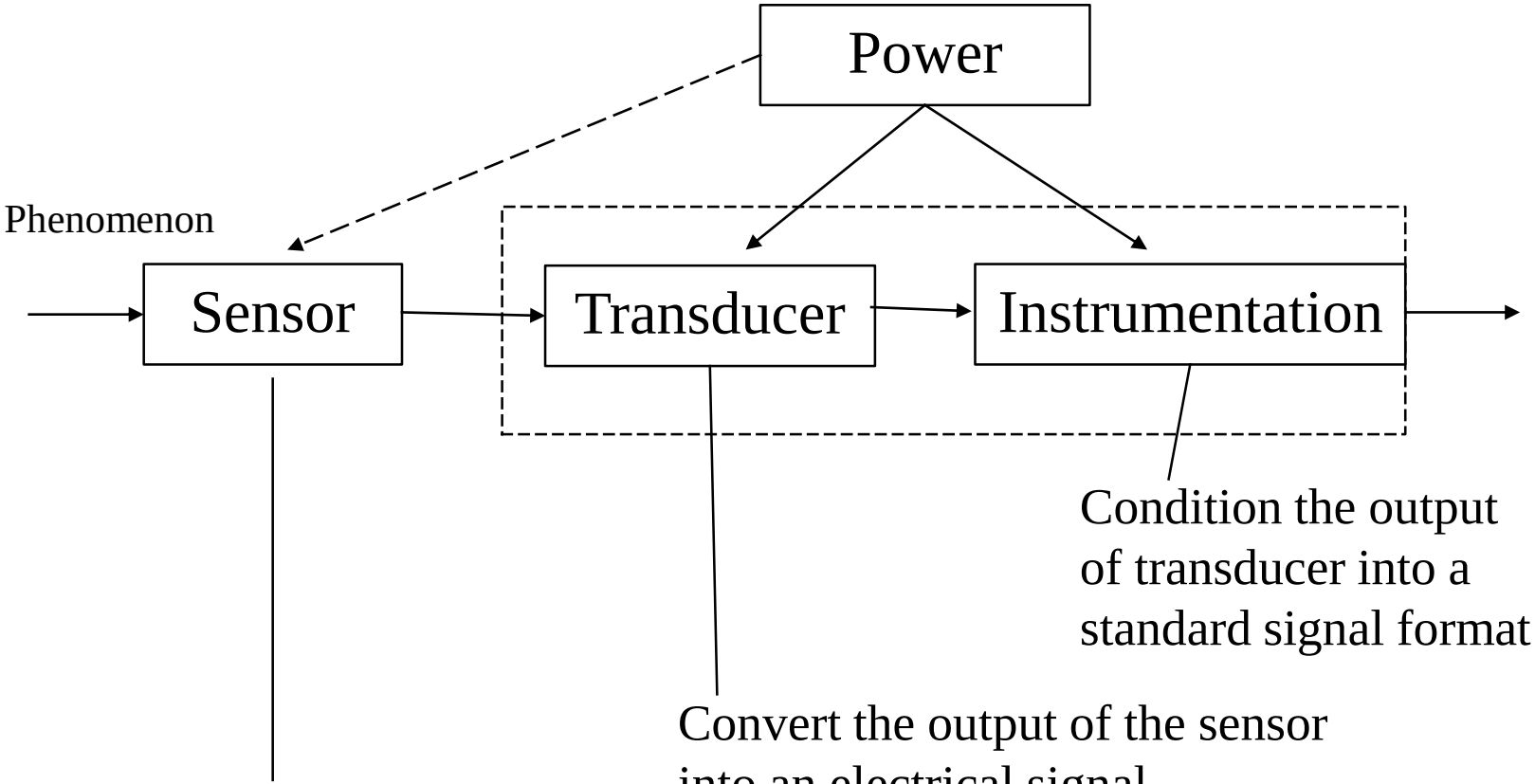
Definition of Transducer/Sensor

- **Definition (GB7665-87)**

Devices are able to sense the measured phenomenon and transfer into usable (readable) output signal .

- **Meaning**
  - **A sensing device**
  - **Input is a measured phenomenon**
  - **Output is in a readable format**
  - **There is a relationship between input an output**

Composition



Transducer/Sensor Types

In terms of the types of phenomenon or usage:

- **Temperature**
- **Pressure**
- **Displacement**
- **Flow**
- **Humidity**
- **Velocity**
- **Acceleration, etc, etc, etc…..**

Transducer/Sensor Types

In terms of the principle of operation of transducers：

- **Strain （应变式）**
- **Resistive（电阻式）**
- **Inductive （电感式）**
- **Capacitive （电容式）**
- **Piezoelectric （压电式）**
- **Thermoelectric （热电式）**
- **Etc, etc, etc, ……..**

Transducer/Sensor Types

In terms of the type of the output :

- **Analog （模拟式）**
- **Digital （数字式）**

Naming Transducer /Sensor

Output type +Principle + usage + "Transducer/Sensor"

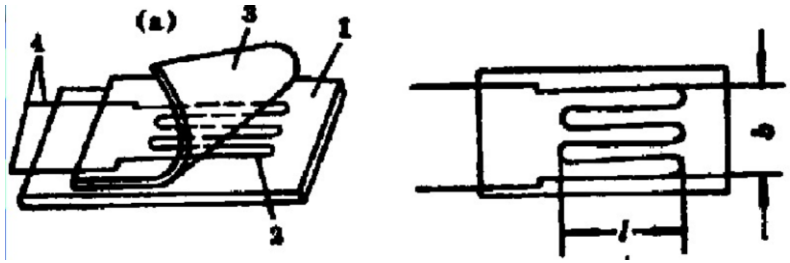
Example:

- **Analog resistive temperature transducer/sensor**
- **Digital piezoelectric weight transducer/sensor**

Resistive Transducers

These transducers usually rely on a resistance value changing because of either strain or temperature changes.

They are often used in a Wheatstone Bridge to effect a change of voltage proportional to the change of resistance



1. base; 2. resistance; 3. cover; 4. output pin

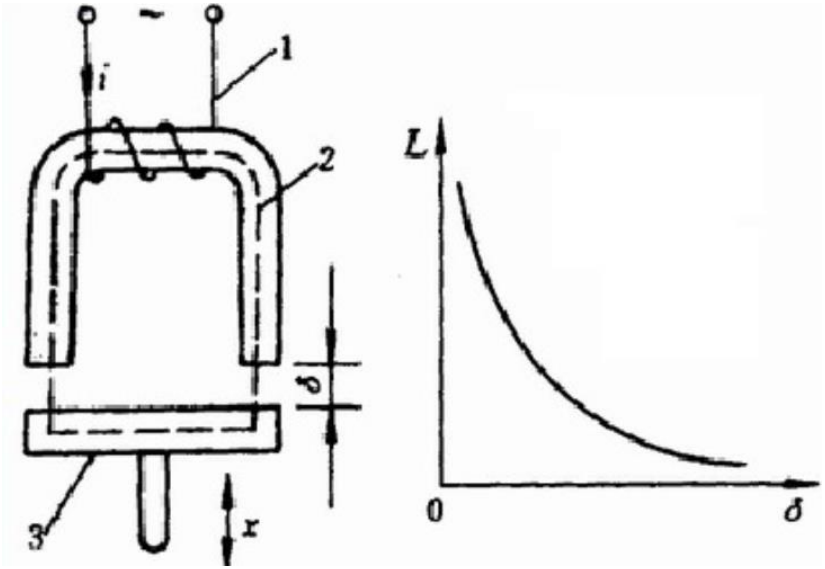
Inductive Transducers

These transducers rely on a change of inductance due to the movement of a ferromagnetic core.

They are often used in a tuned circuit to cause a change of frequency. This can then be applied to a frequency to voltage converter.

1. coil; 2. core; 3. armature

L: inductance, σ: gap length



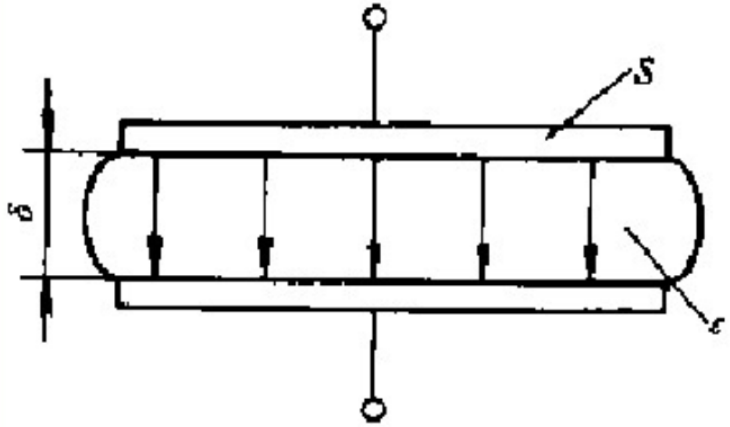
Capacitive Transducers

These devices rely on a change of capacitance value due to change of:

- **Plate separation**
- **Plate overlap**
- **Change of dielectric**

They are often used in a tuned circuit to cause a change of frequency. This can then be applied to a frequency to voltage converter.

S: area; σ: plate gap



Temperature Transducers

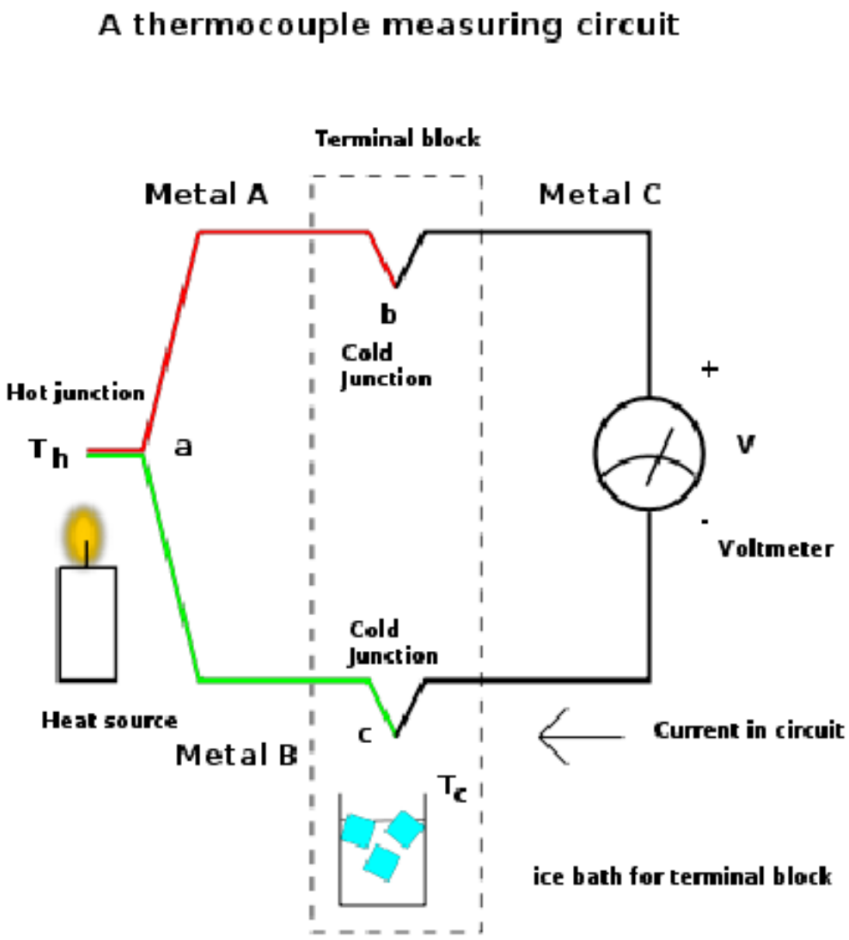
Temperature transducers are generally of three types, their applications depending mainly on the temperature range required.

Resistance thermometer: The resistance of materials changes with temperature and although that is a disadvantage for stable electronic circuits it is useful in this context. Nickel and platinum are useful. Nickel has a large temperature coefficient of resistance, but has a significant aging effect. Platinum has a lower coefficient but is more stable and so is more widely used.

Temperature

- **Thermocouple:**

These are used for measuring high temperatures. This is a point junction of two dissimilar metal wires. This is called the hot junction. The other end of the wires is called the cold, or reference, junction. An emf (electromotive force) is generated and this is measured at the cold junction. The two metals used depend on the temperature values and the linear range required. The emf needs to be amplified and linearized and this is carried out by dedicated non-linear amplifiers.



Pressure Transducers

- **These often use the properties of Resistive, Inductive or Capacitive devices.**

Et Cetera

Think of as many others as you can……

Instrumentation

Instrumentation is required for two reasons:

- **Signal Processing. This is where the output is a different variable from the input.**
- **Signal Conditioning. This is where the output represents the same variable as the input.**

Instrumentation

Instrumentation is required to CONDITION the transducer output:

This will often involve:

- **Amplification**
- **Linearisation**
- **Filtering**

Levels of Automatic Control

- **Direct Digital Control, DDC, is where each part of a complex system is locally controlled by a dedicated controller.**
- **Distributed Control System, DCS, is a computerised system in which the local DDC controllers are networked for communication and monitoring. DCS systems incorporate LANs (local area networks) and MAPs (manufacturer's automation protocols).**
- **Supervisory control involves a human-machine interface that allows an operator to oversee the operation of the DCS and over-ride the control actions if necessary.**
- **SCADA is "Supervisory Control and Data Acquisition" and refers to a large-scale DCS system with human access and data storage for processing and recording the status of all aspects of the overall system's operation.**

Architecture of Automatic Control System

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"Internet-based
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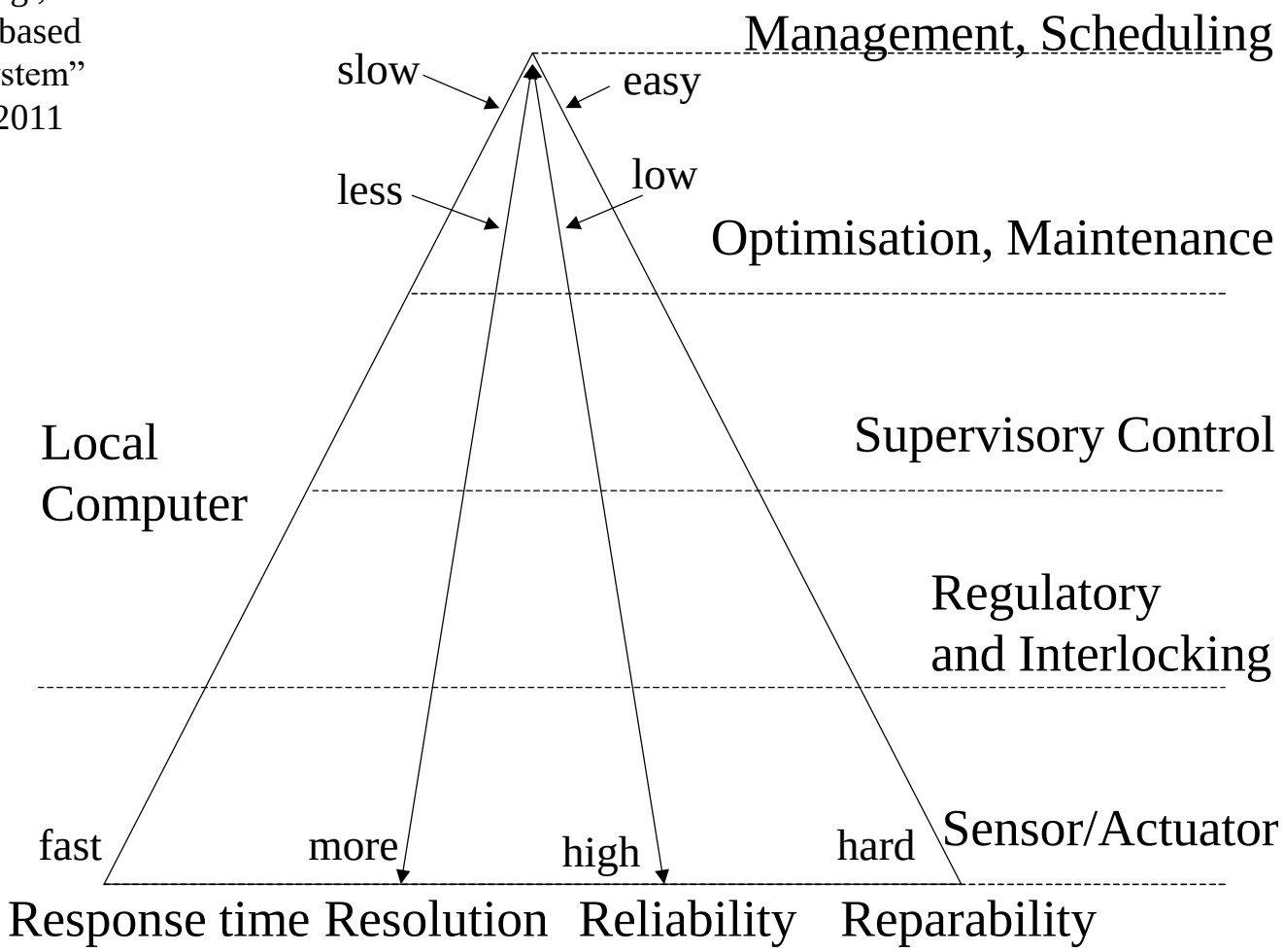

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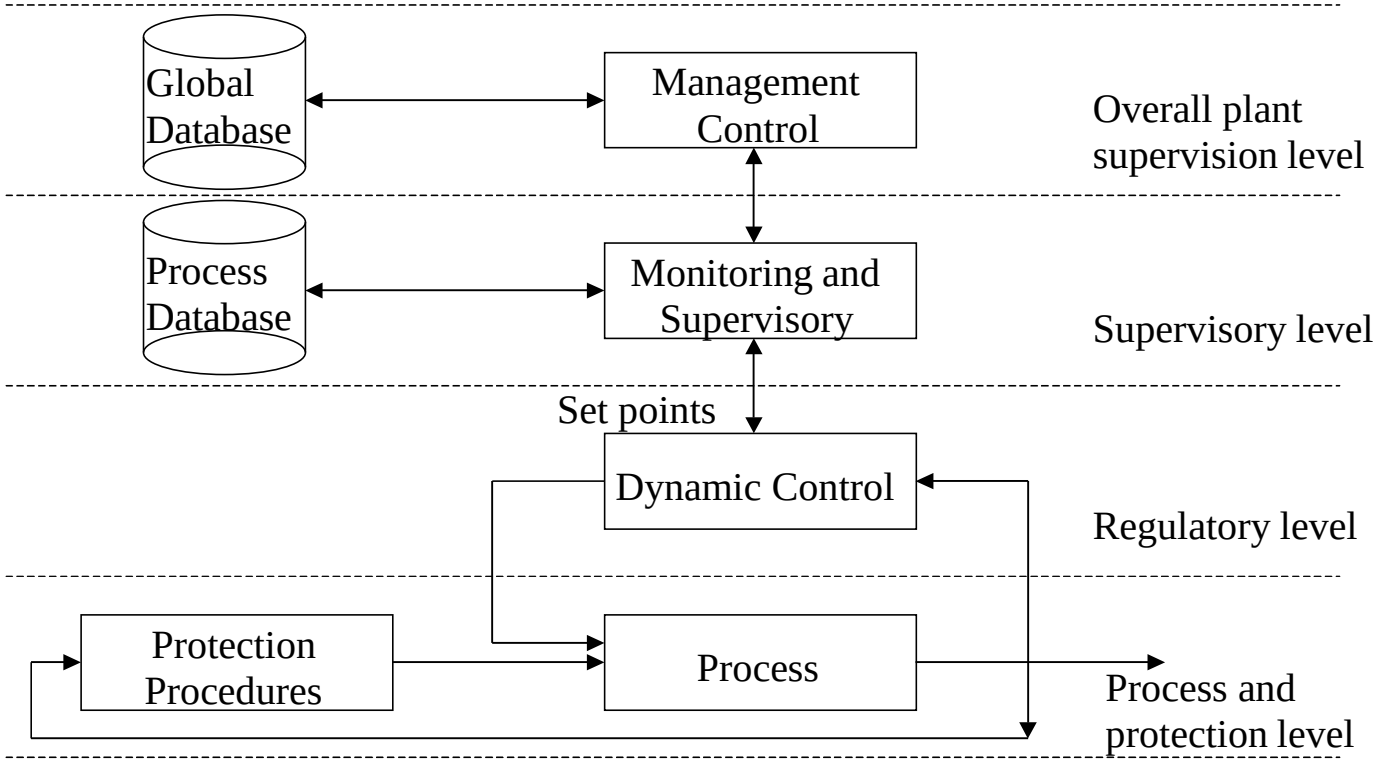
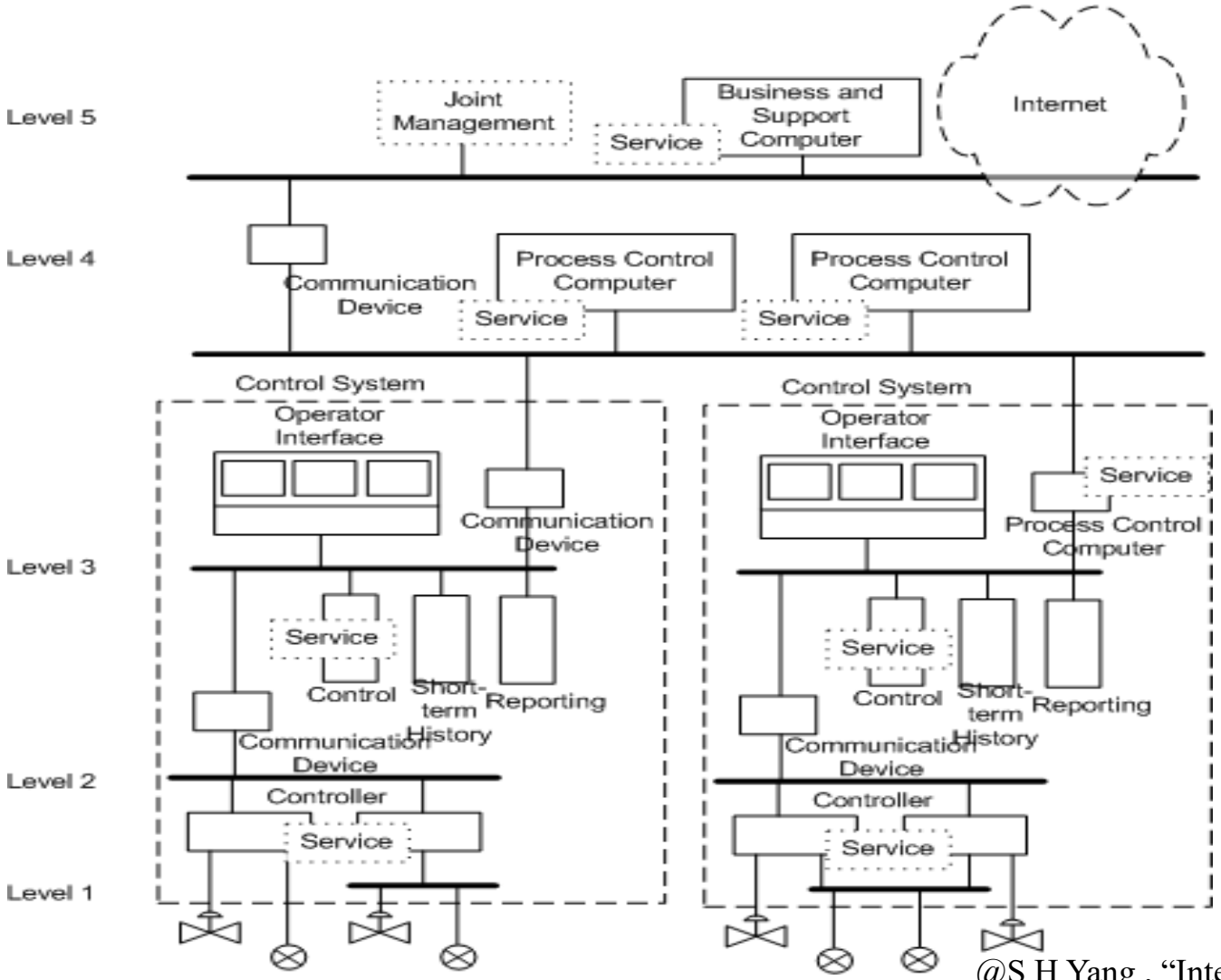


Architecture of Automatic Control System



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