SKEM4153
ROBOT TECHNOLOGY FOR AUTOMATION

CHAPTER 8
Robot and System Integration

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Contents

- Characteristics of the Future Factory
- System Overview
- Work Cell Architecture
- Interfaces
- CIM of ID Card Assembly

Characteristics of the Future Factory 1/3

Trends in manufacturing

      Shorter product life cycles

      Increased emphasis on quality and reliability

      More customised products

      New materials

      Growing use of electronics

      Pressure to reduce inventories

      Outsourcing

      Just-in-time production

      Point-of-use manufacture

      Greater use of computers

Characteristics of the Future Factory 2/3

Human workers in the Future Automated Factory

Equipment maintenance

Programming

Engineering project work

Plant security

Factory interface

Plant supervisor

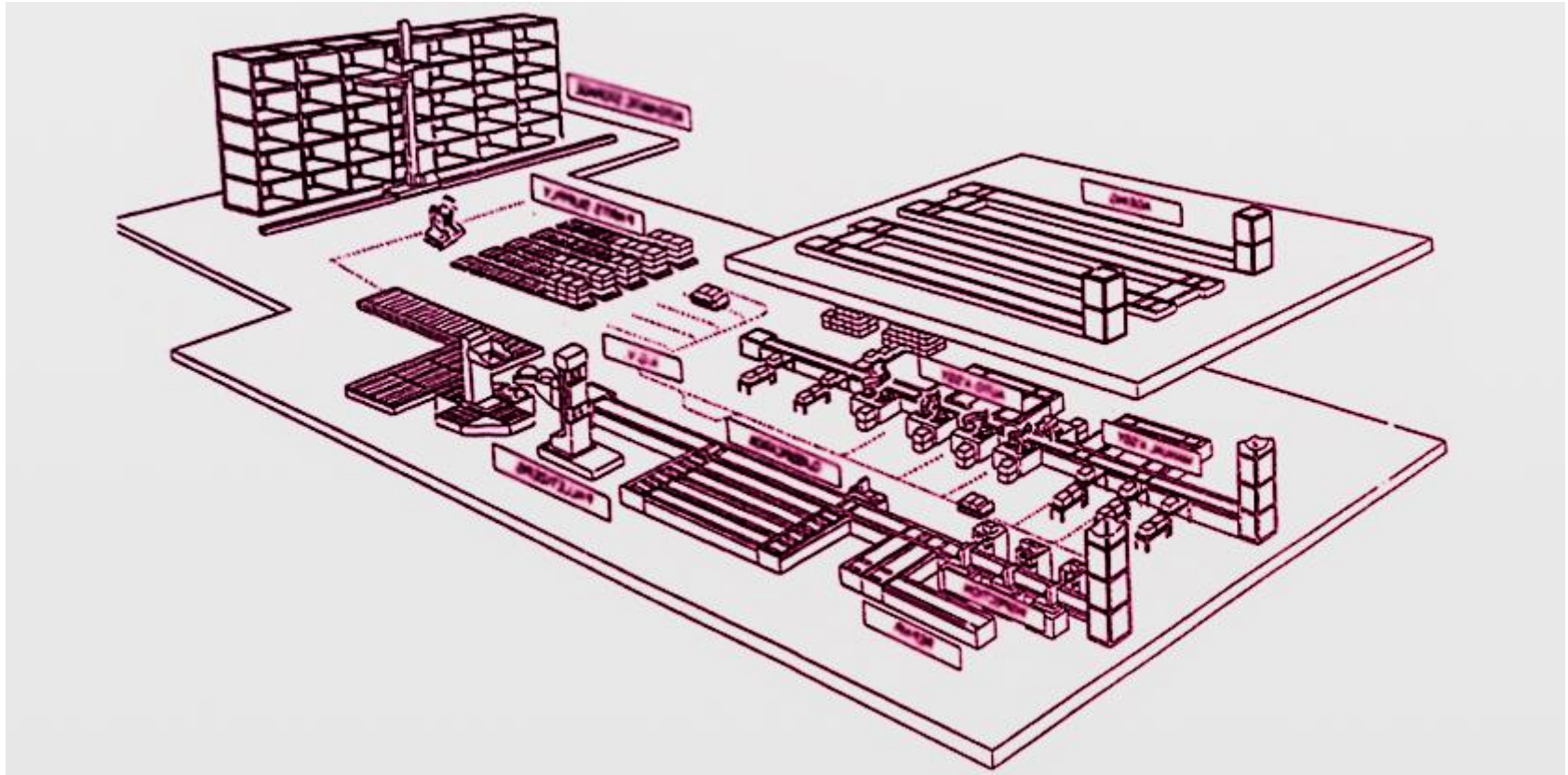# **Characteristics of the Future Factory 3/3**

The Social Impact

Impact on labour

Retraining and education
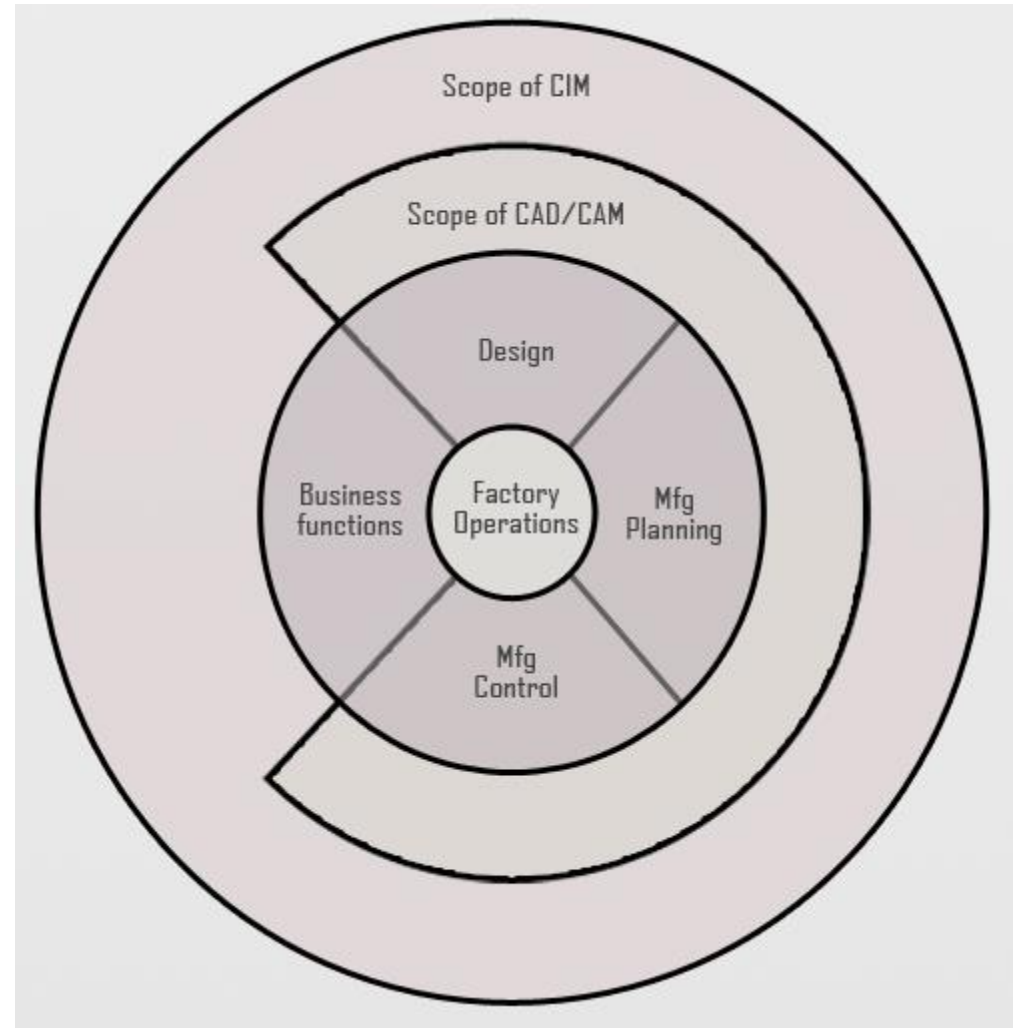
Social impact and economic forces
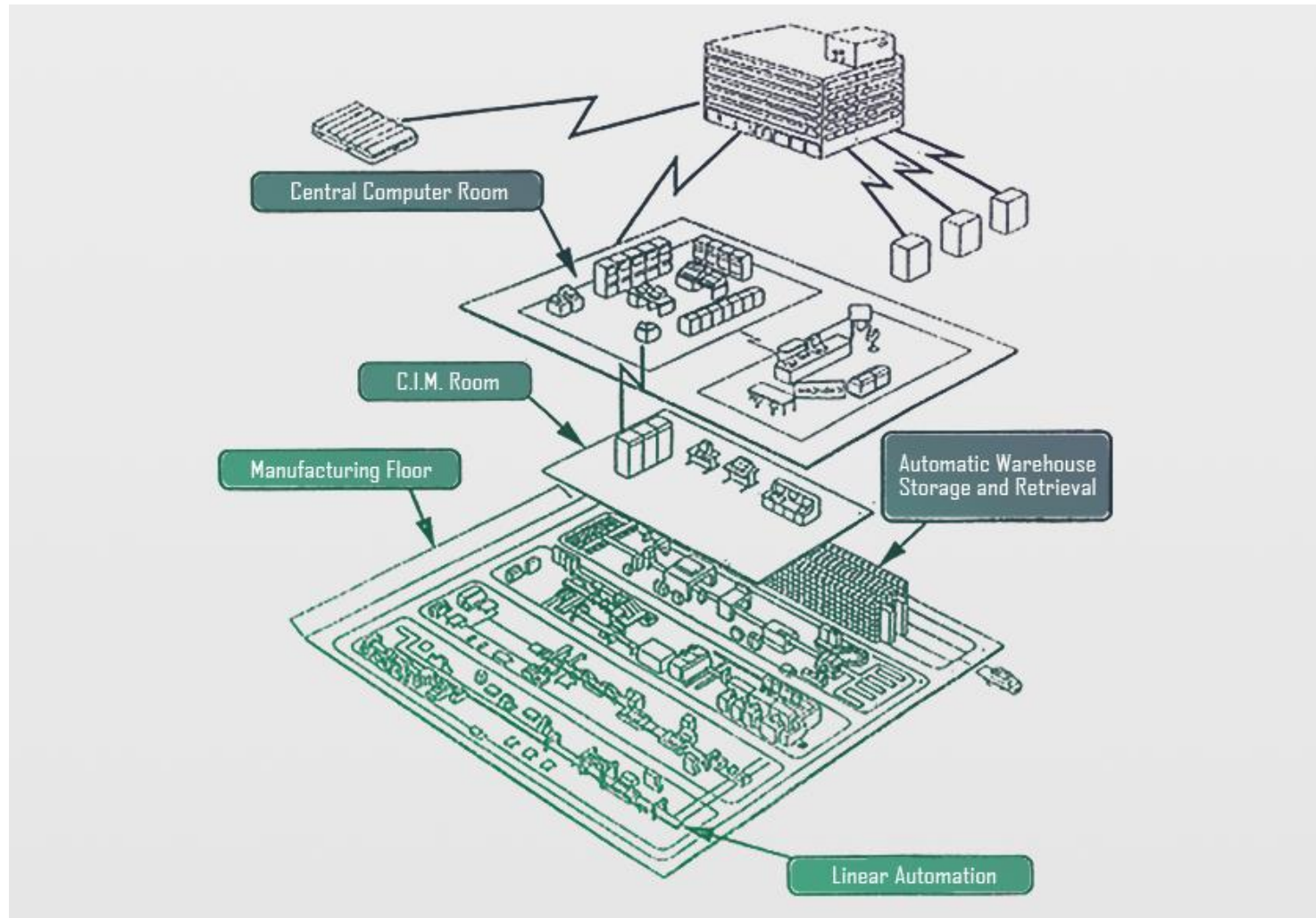
Characteristics of the Future Factory

Artist's drawing of the future automated factory.

System Overview

System Overview

Scope of CAD/CAM and CIM

System Overview
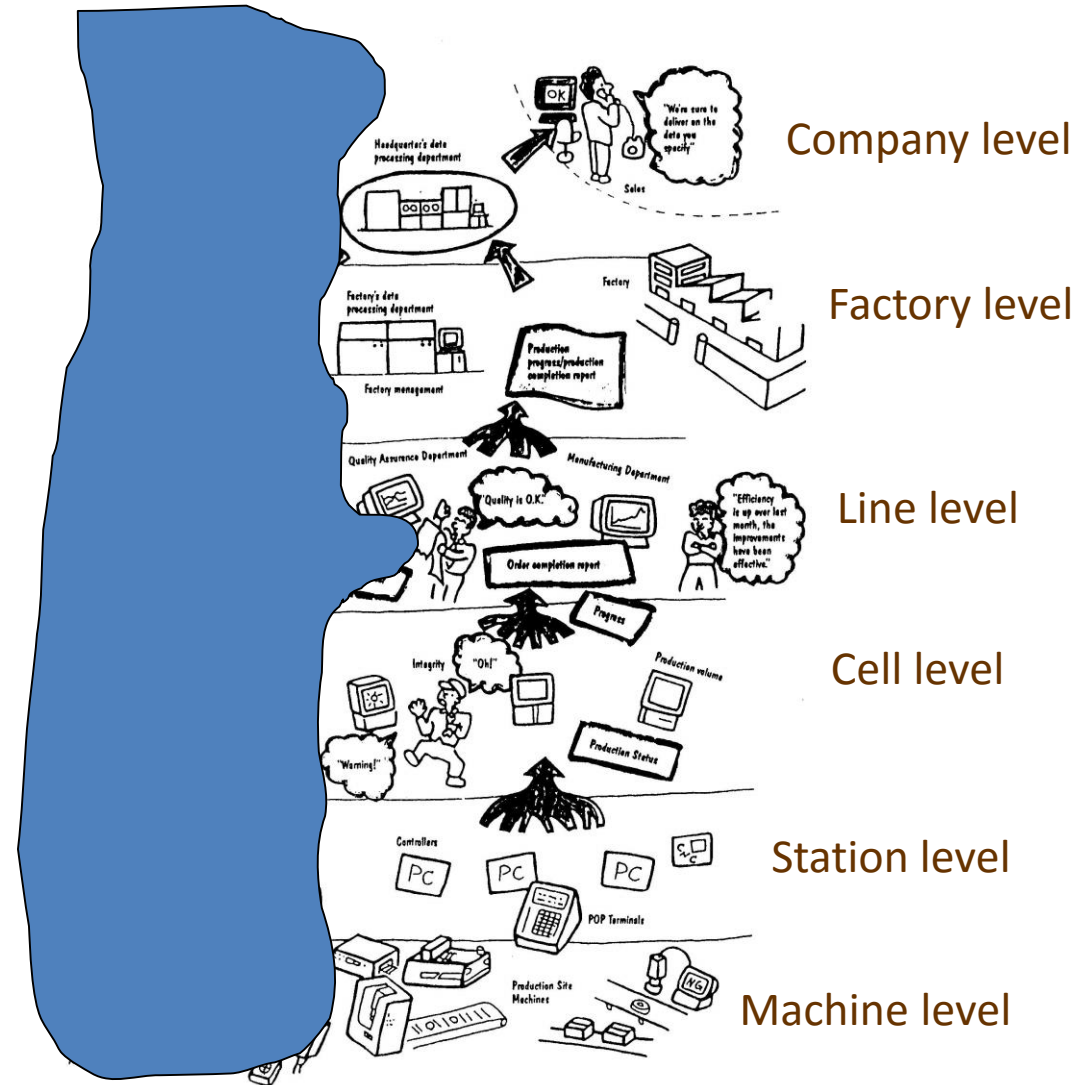
System Overview

Company level

Factory level

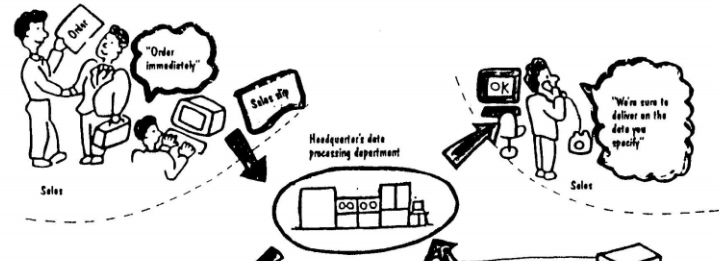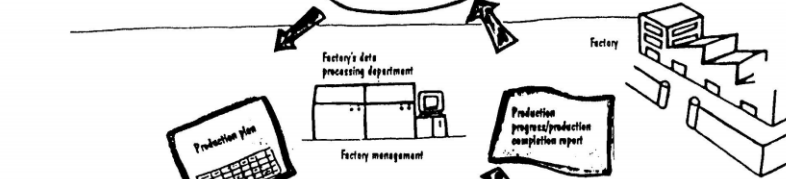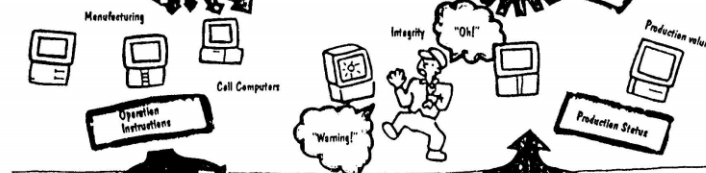Line level

Cell level

Station level

Machine level

System Overview

Company level

Factory level

Line level

Cell level

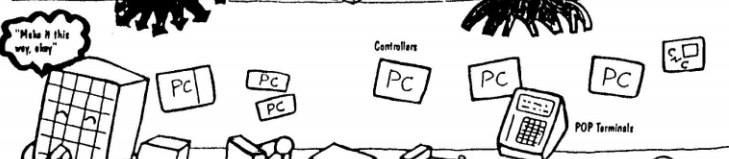Station level

Machine level

System Overview

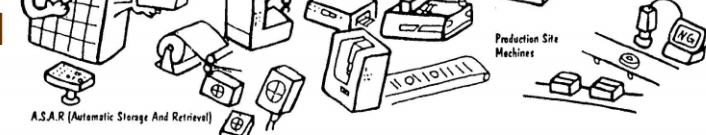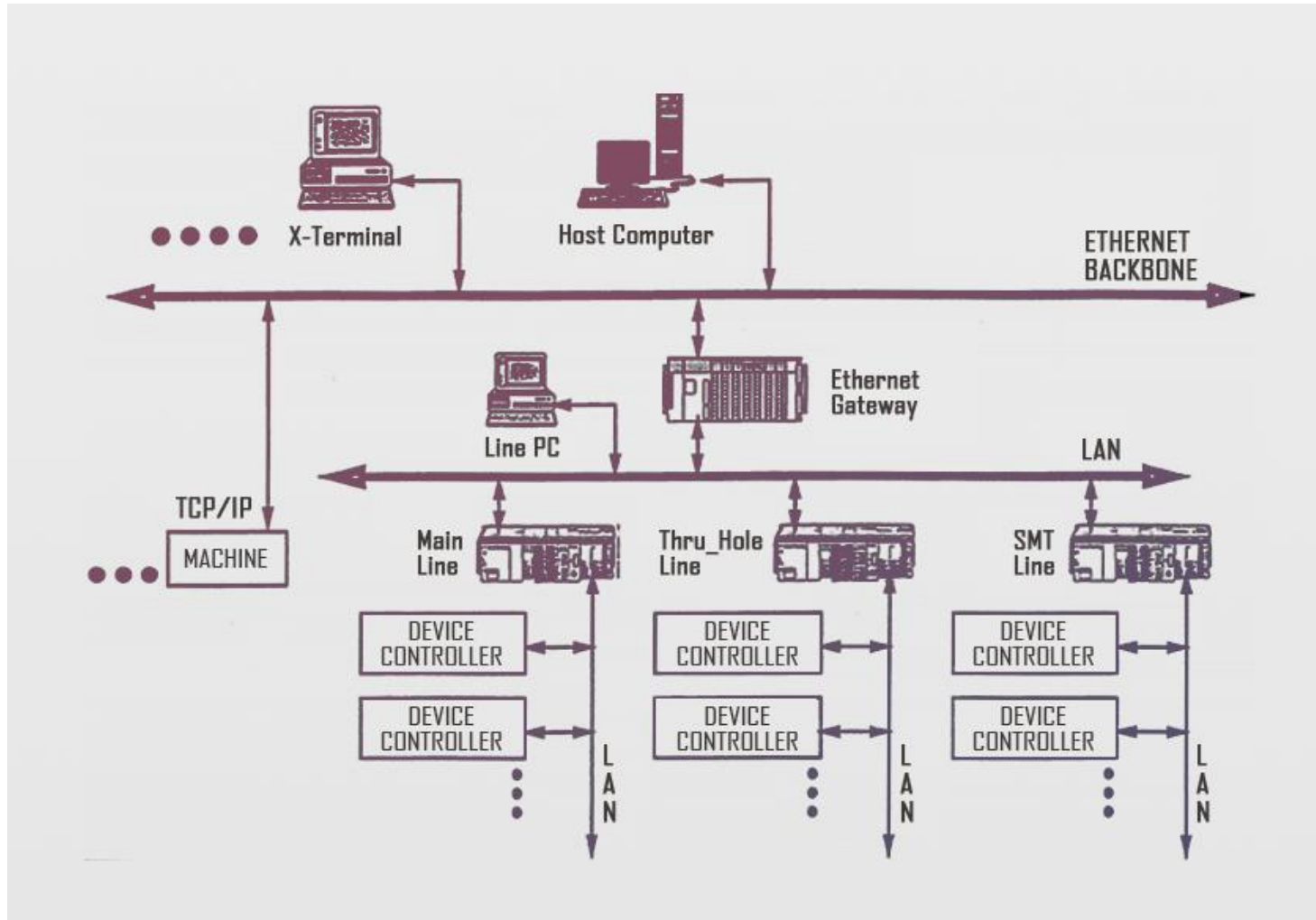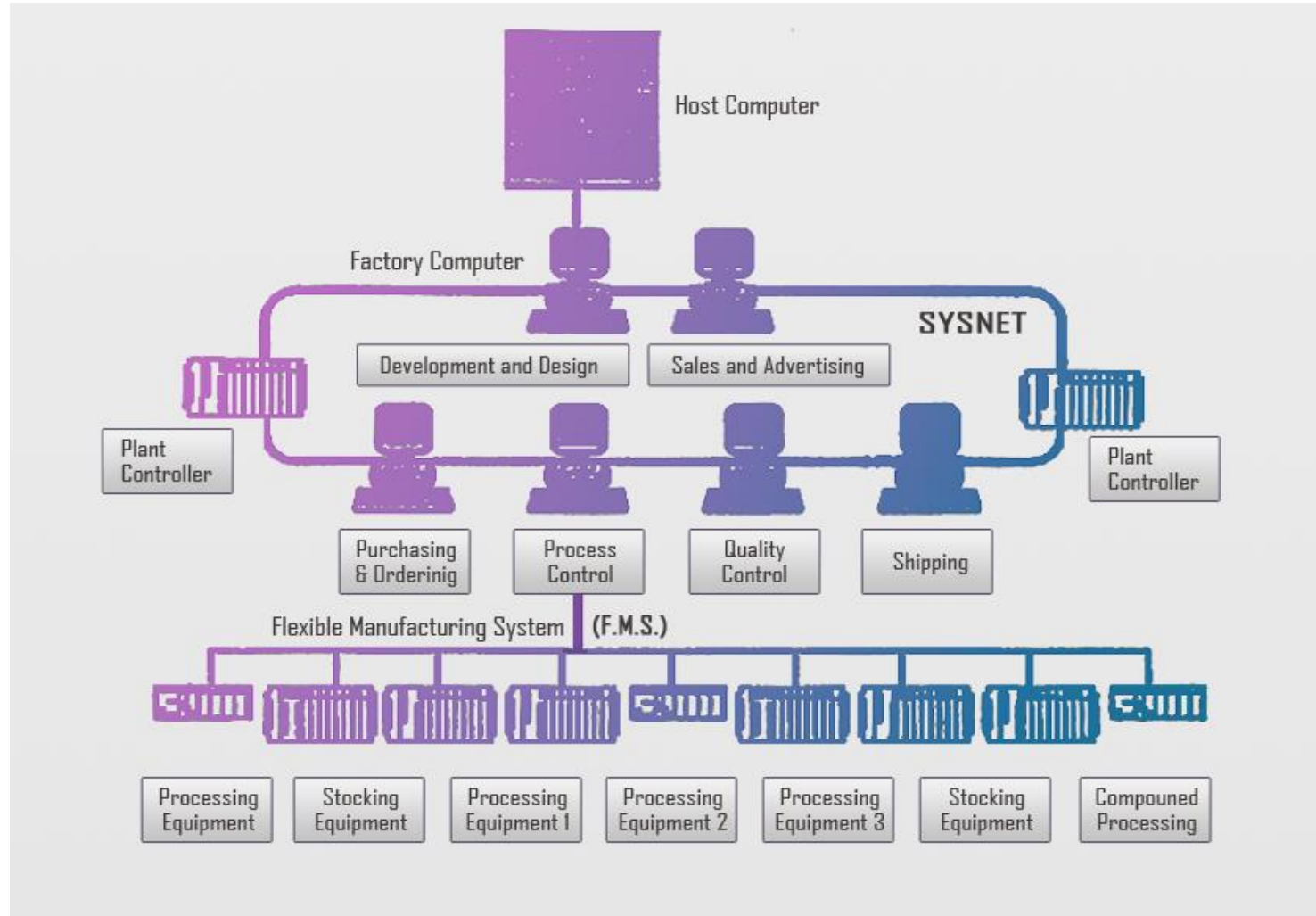Company level

Factory level

Line level

Cell level

Station level

Machine level

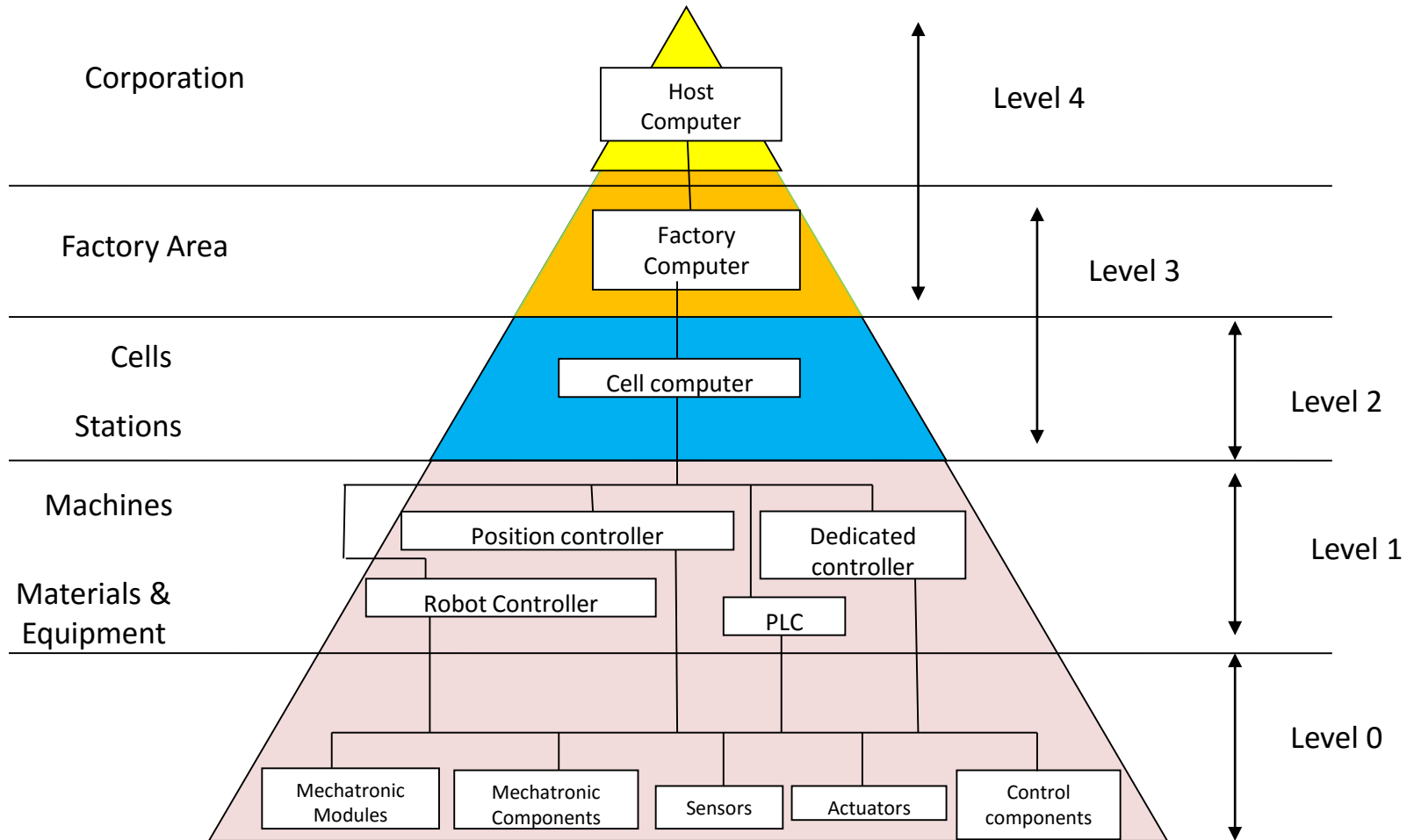# System Overview

FMS Line Control System Layout

System Overview

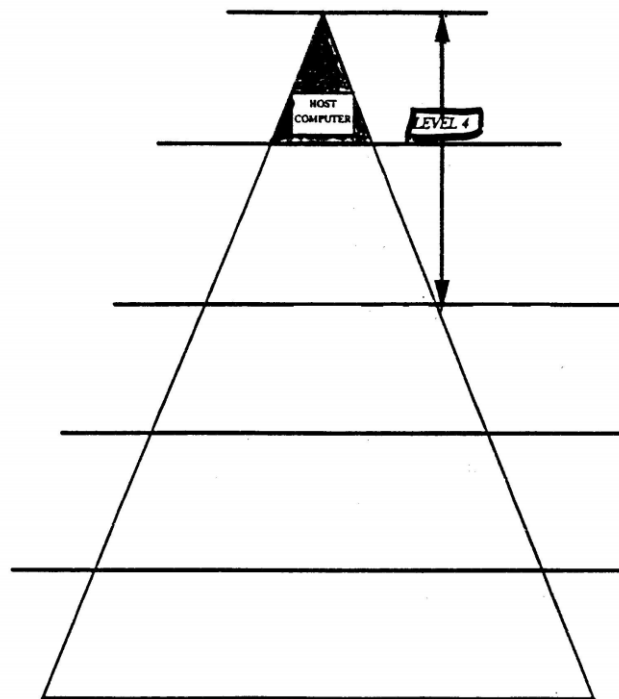FMS System Layout – SYSNET Application

Work Cell Architecture
CIM (Computer Integrated Manufacturing)
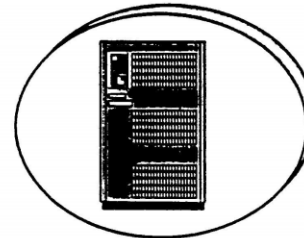
Work Cell Architecture
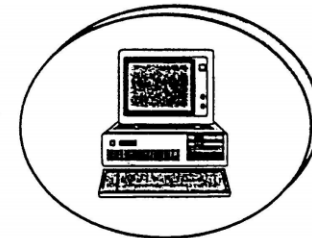## - Level 4

What is level 4 ?

Concerns With :

▲ Integration of plant floor activities with other major functions such as optimisation, forecasting and planning.
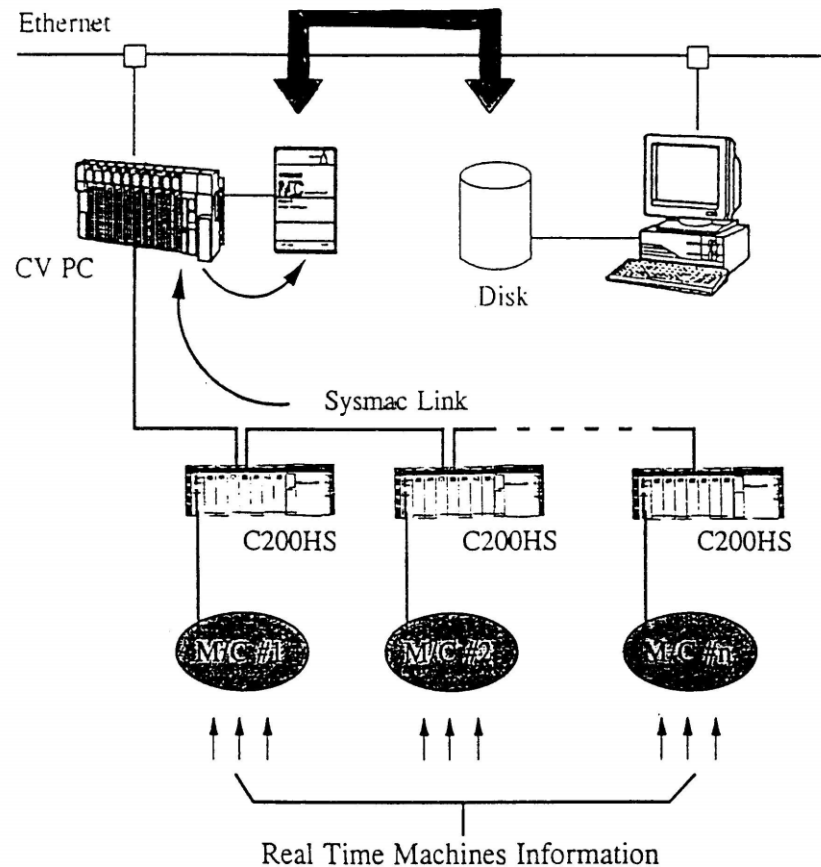
Mini Computer, Mainframe

Gateway Computer,

Omron offers Network Service Board to facilitate easy integration of level 4 computers to level 3 PLCs.

Work Cell Architecture
- Memory Card File Transfers

Ethernet

CV PC

Disk

Sysmac Link

C200HS   C200HS   C200HS

M/C #1   M/C #2   M/C #n

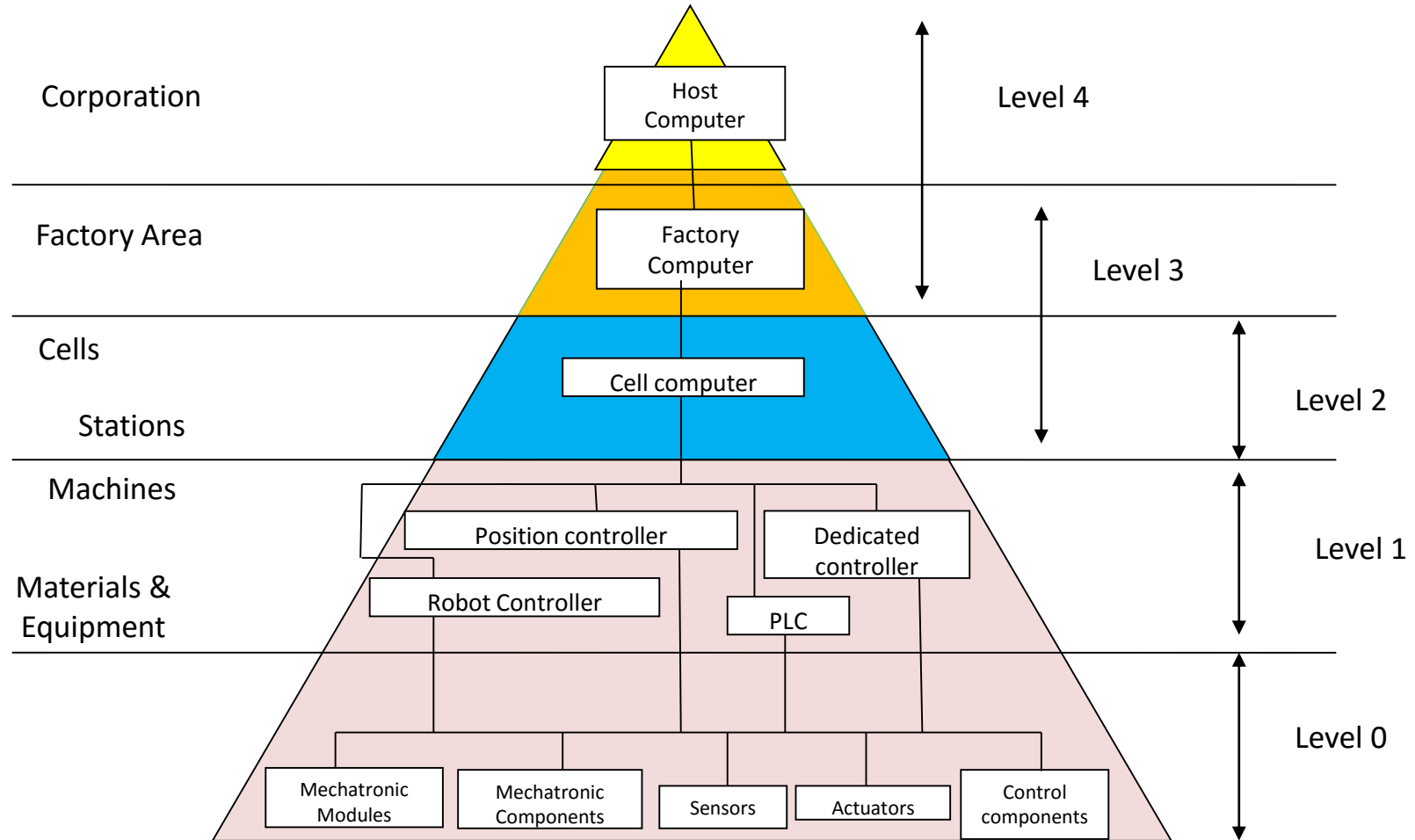Real Time Machines Information

Beneficial Application

● Allows huge amount of real time production data (down time, cycle time, production rate, faults, etc) to be stored historically at site on the PLC.

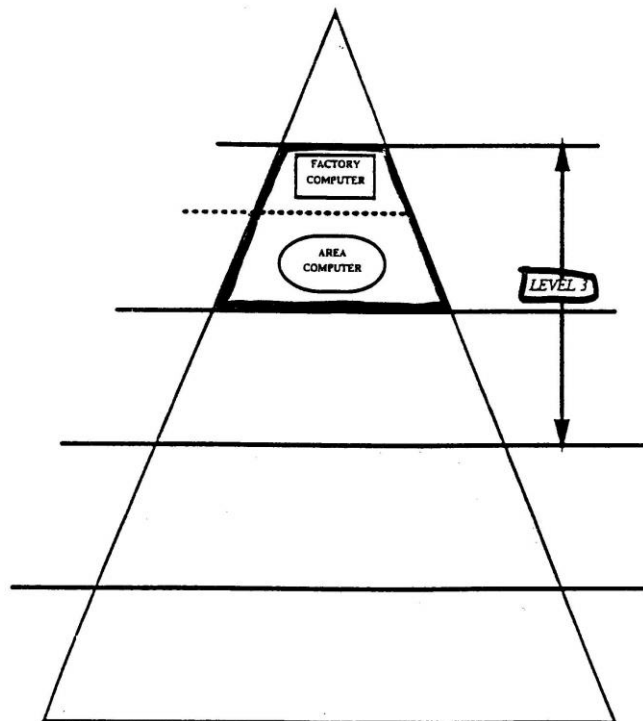● Consolidated data can be retrieved anytime of convenience by the computer thru' Ethernet.

Work Cell Architecture
- CIM (Computer Integrated Manufacturing
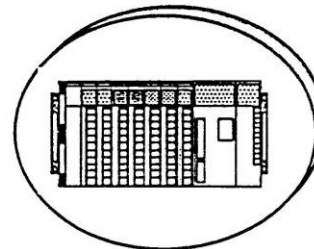
Work Cell Architecture – Level 3

What is level 3 ?

Concerns With :

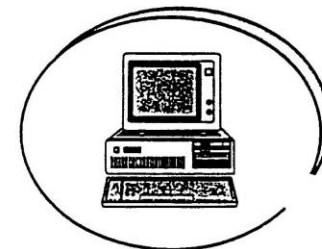▲ Controlling, Scheduling & Supervision of the activities of the cell controllers in level 2.

▲ Responsibility confine within a department or specific area in a factory.

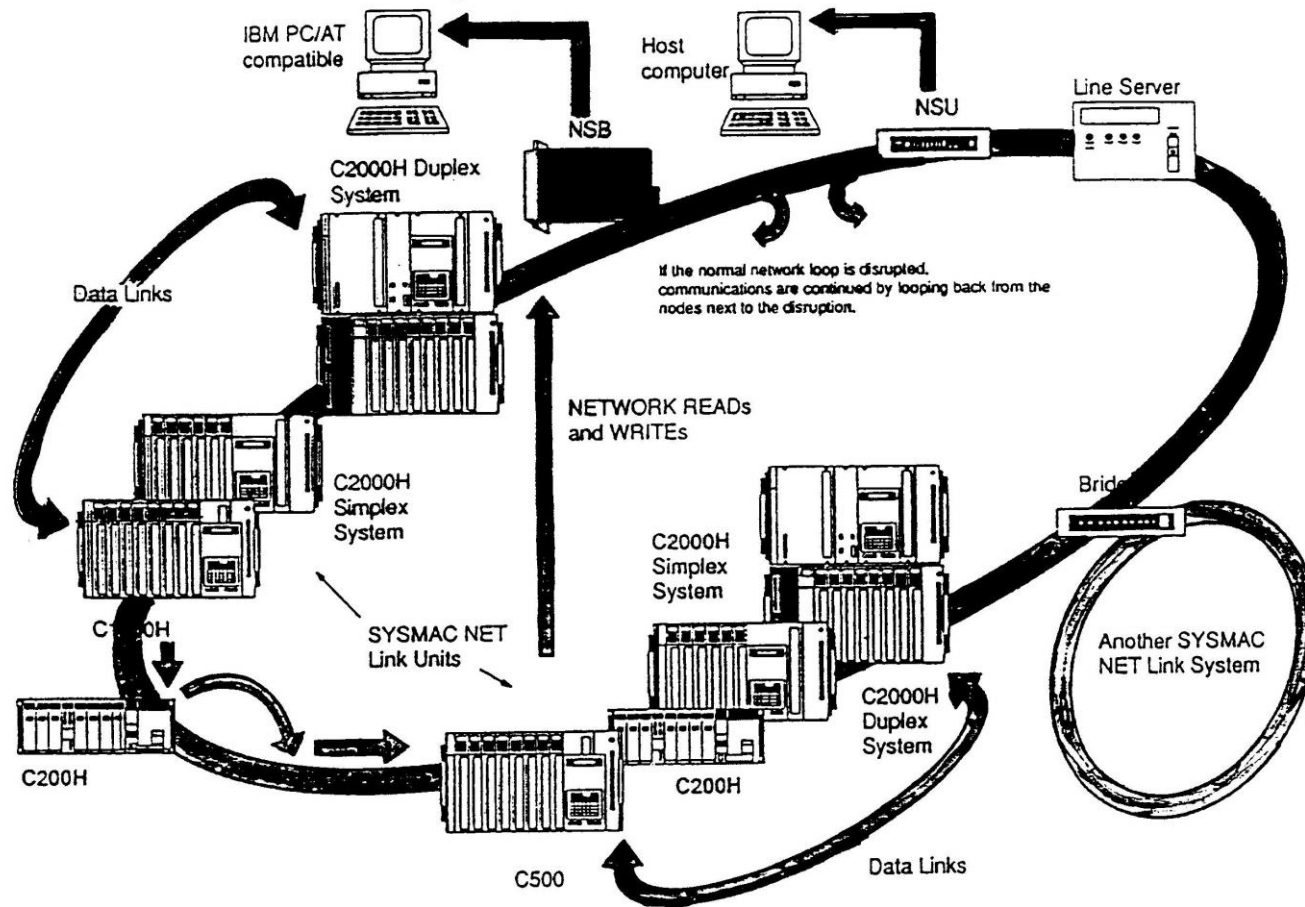▲ Changes made at level 1 & 0 has no impact at this level.

High Function PLC
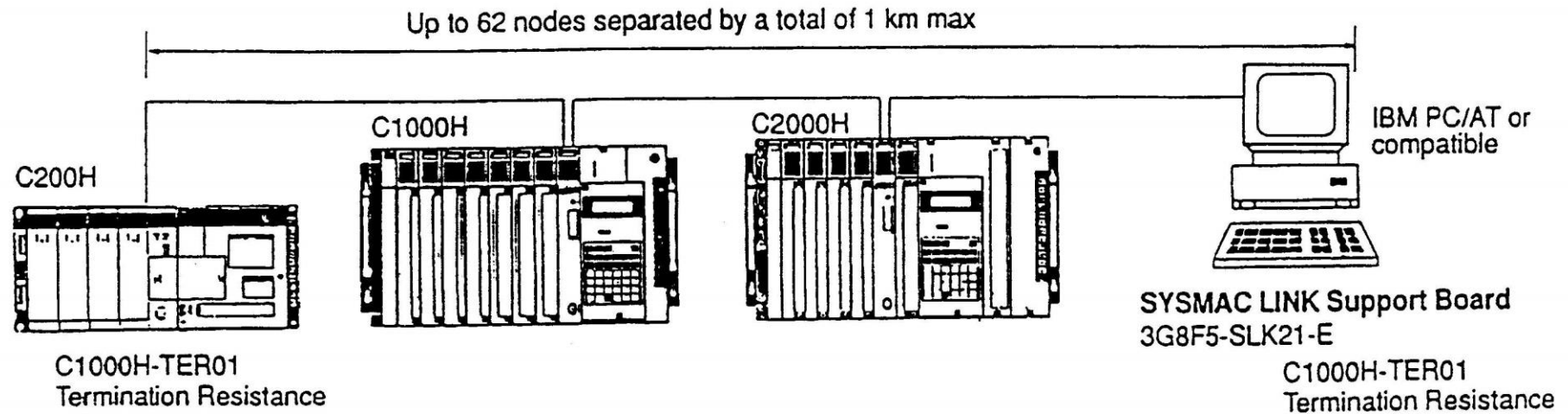
Computer, Workstation

Omron offers large memory CV PLC with High Speed peer to peer communication facilities - Sysmac Link, Sysmac Net & Ethernet.

Work Cell Architecture

SYSMAC Net Link Systems Network Configuration

Work Cell Architecture

SYSMAC Link Systems: Coxial Cable System
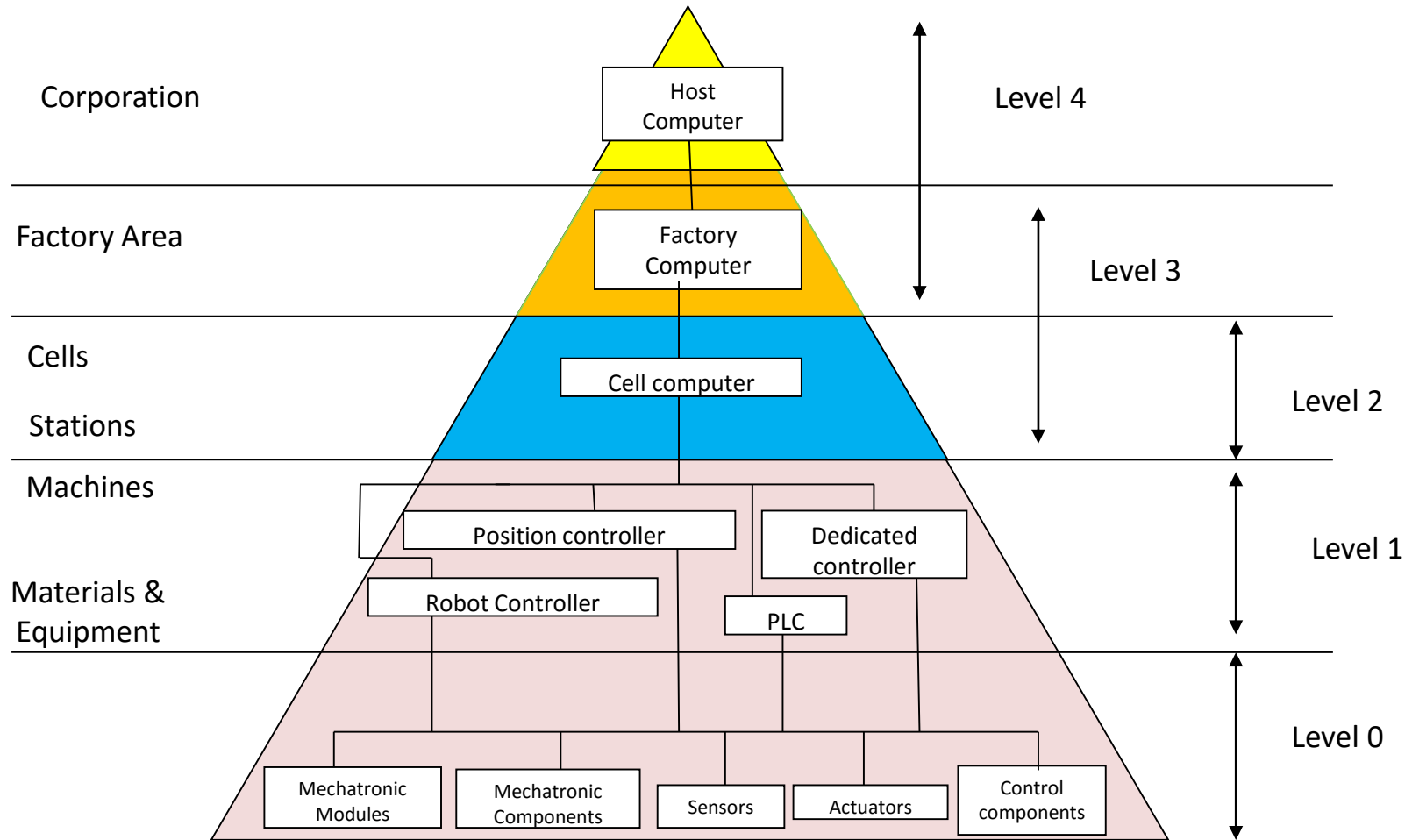
Work Cell Architecture

SYSMAC Link Systems

- provide automatic data exchange through data links

Specifications

| ITEM	C200H-SLK21-V1	C200H-SLK11
COMMUNICATIONS METHOD	TOKEN RING (N:N)	
TRANSMISSION METHOD	MANCHESTER ENCODING, BASEBAND	
DATA TRANSMISSION RATE	2 Mbps	
MEDIA	COAXIAL CABLE (5C-2V)	HARD-PLASTIC-CLAD QUARTZ OPTICAL FIBER CABLE
TRANSMISSION PATH	BUS	DAISY CHAIN
NO. OF NODES	62 MAX.	
DISTANCE BETWEEN NODES	TOTAL: 1KM	Total: 10KM (800m MAX. BETWEEN NODES)
MESSAGE LENGTH	512 BYTES MAX. (NOT INCLUDING HEADER)	

Work Cell Architecture
- CIM (Computer Integrated Manufacturing
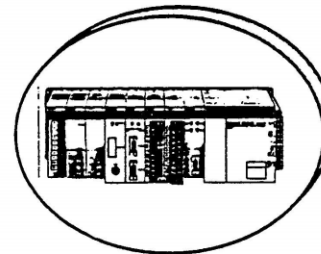
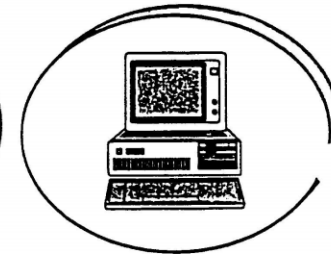# Work Cell Architecture – Level 2

What is level 2 ?
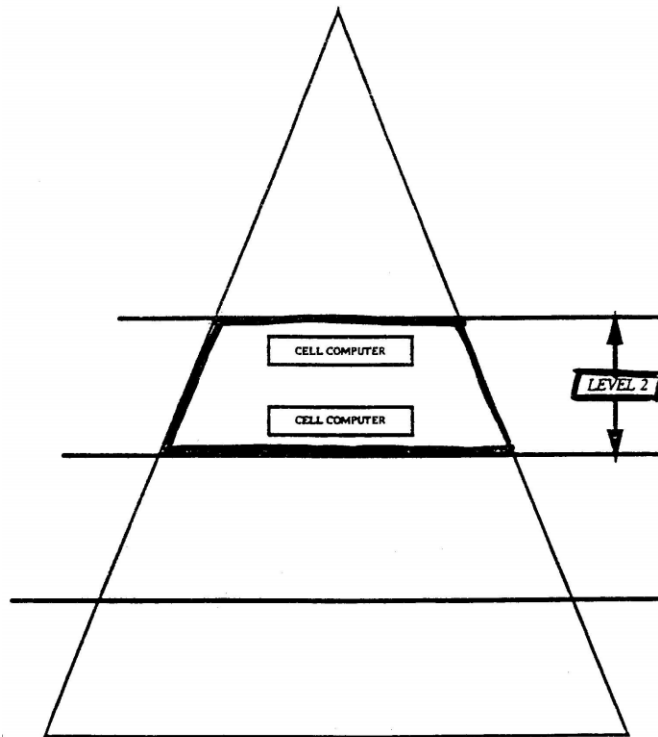
Concerns With :

▲ Control and co-ordination of devices in level 1.

▲ Has flexibility to change control function corresponding to devices changes in level 1.

▲ Ability to communicate in real-time to devices it controls as well as to other cell controllers and higher level systems.
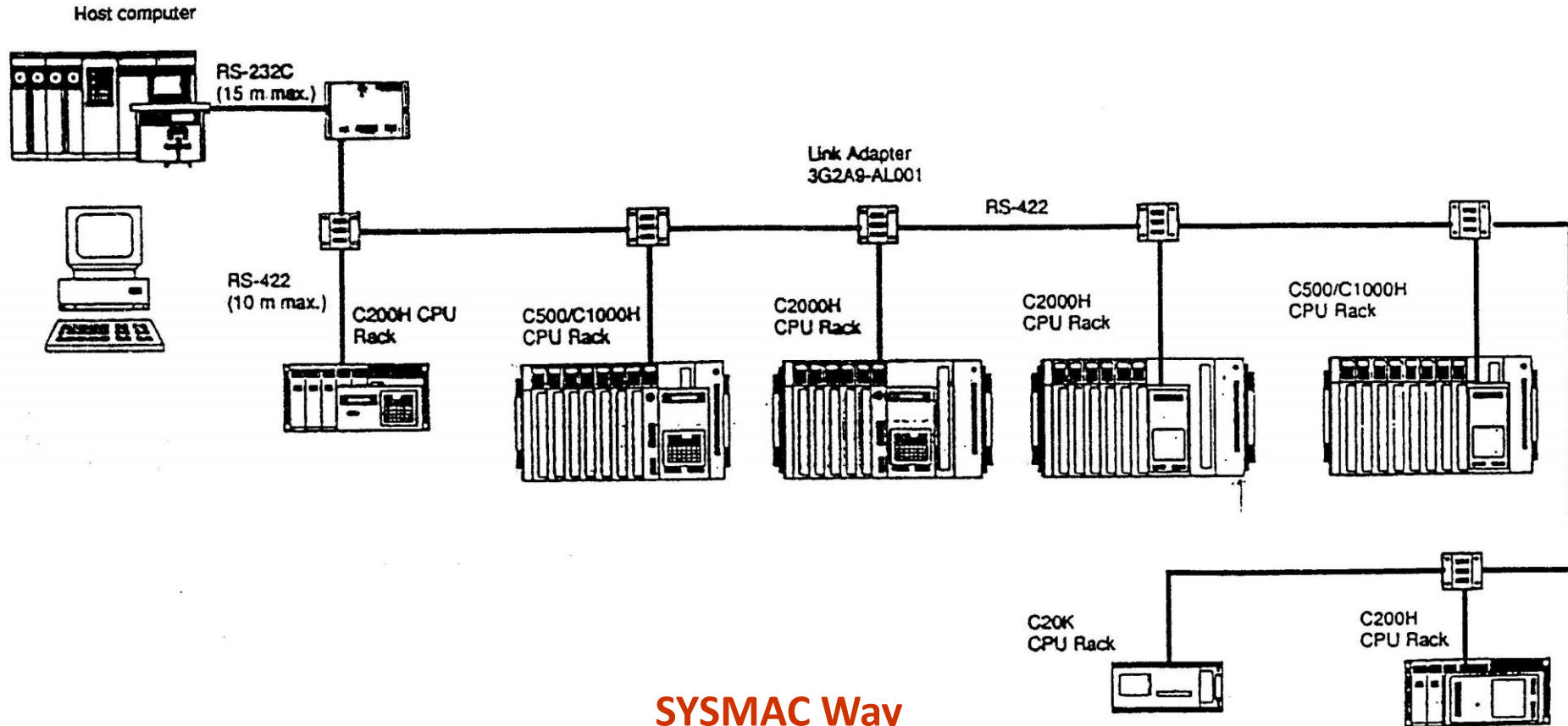
High Function PLC   *Computer*

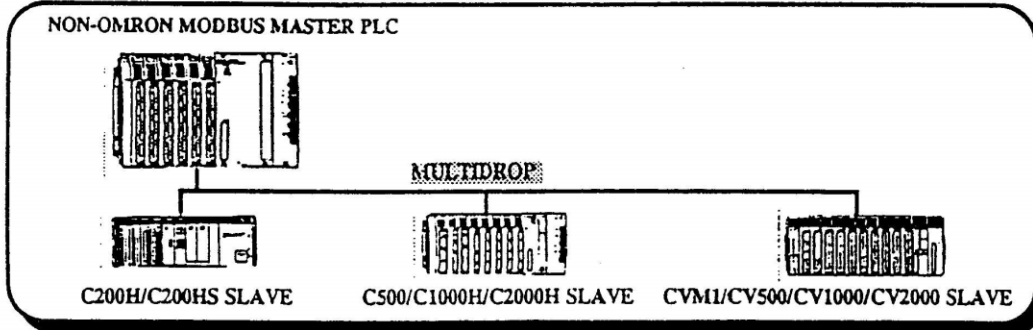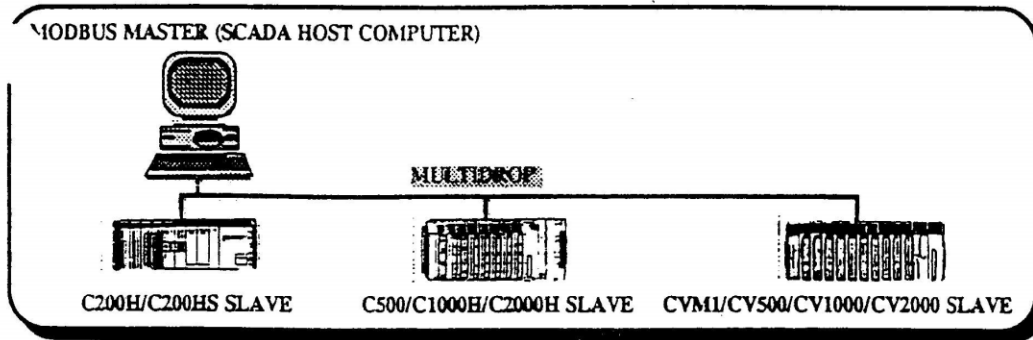Omron offers high function PLCs (C200HS & CV Series) with communication facilities - Sysmac Way, Sysmac Link.

Work Cell Architecture

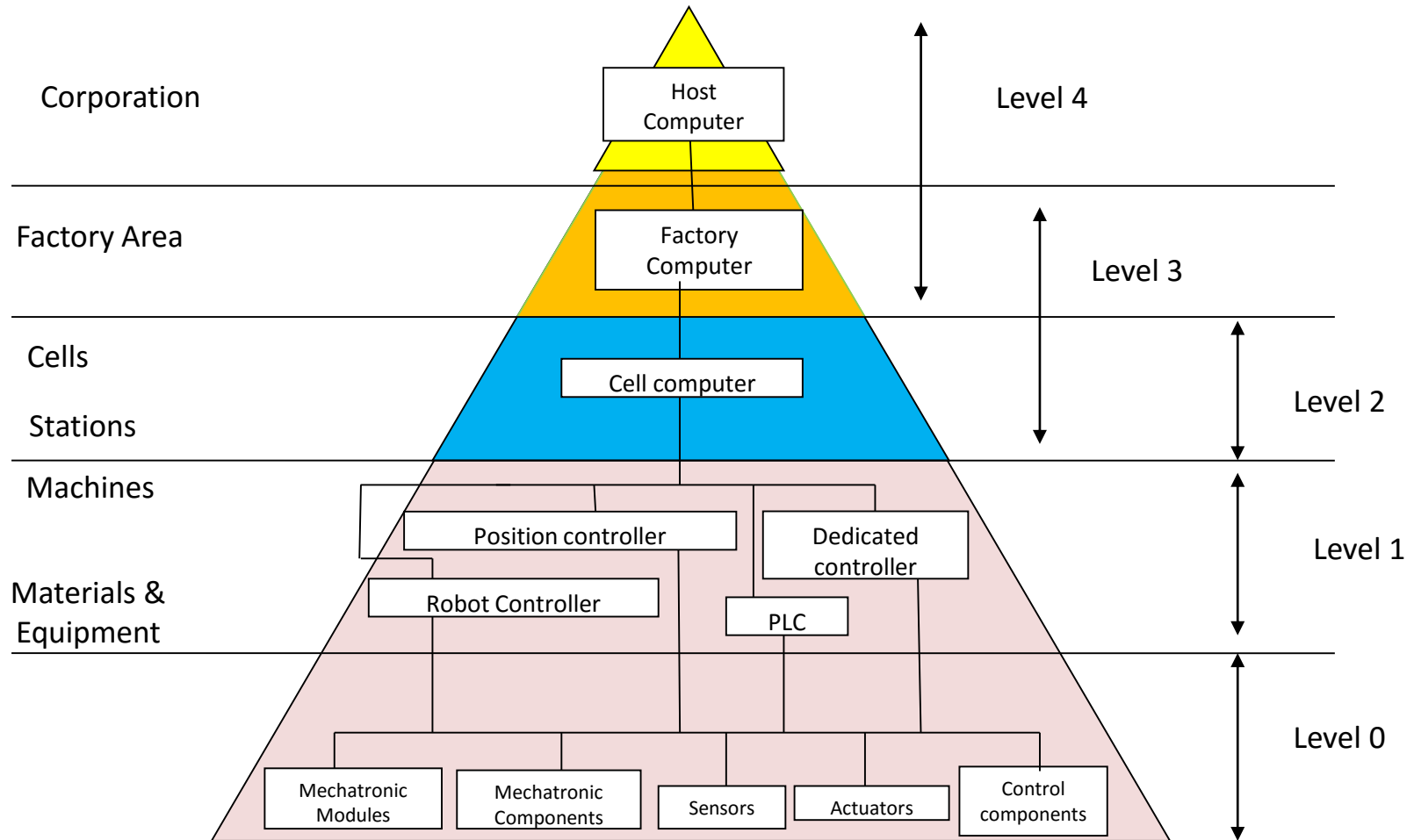

SYSMAC Way

Work Cell Architecture

- ☑ Allows OMRON PLC to interface to MODBUS network.

- ☑ Uses MODBUS RTU protocol with CRC checking.

- ☑ Multi-drop support for multiple slaves (RS422)

MODBUS

Work Cell Architecture
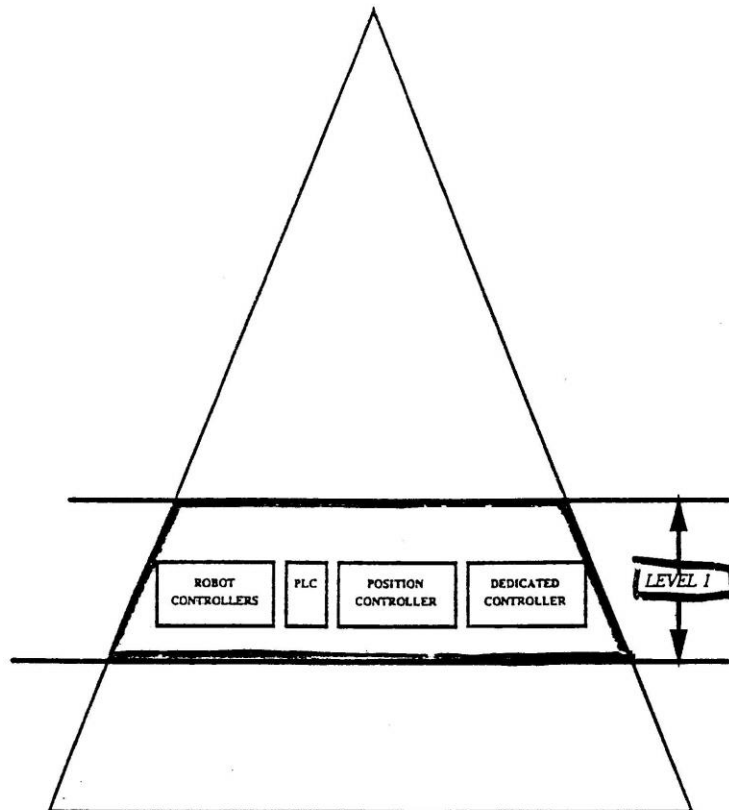## - CIM (Computer Integrated Manufacturing

Work Cell Architecture – Level 1

What is level 1 ?

This level encompass devices such as:

- ▲ Numerical Control Machines
- ▲ PLCs
- ▲ Vision Inspection Station
- ▲ Industrial Robots
- ▲ Operator Workstation

PLC   *Vision*   *Robot*
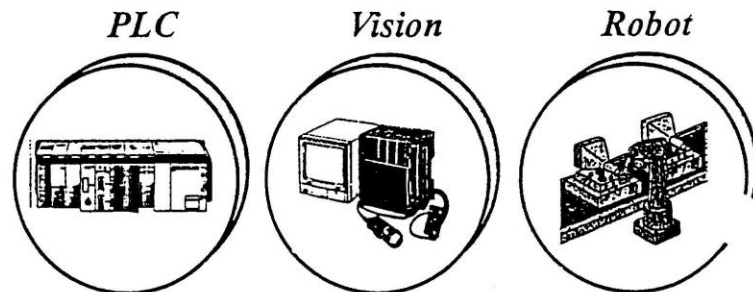
Omron offers PLCs, vision inspection system & motion control system for level 1. Provides Sysmac Bus Link to level 0.

Work Cell Architecture
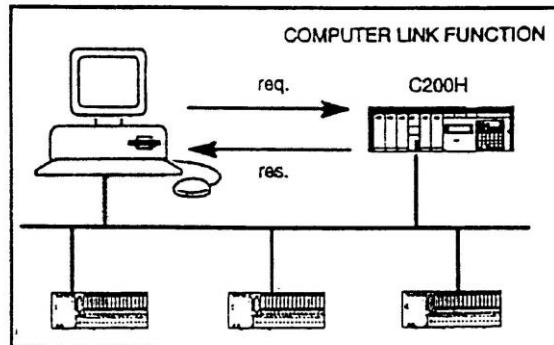
- Supports complete Profibus protocol (DIN 19245-1/2)
- The international open communications network for field bus
- Act as gateway to other networks
- Easy data exchange with third party devices
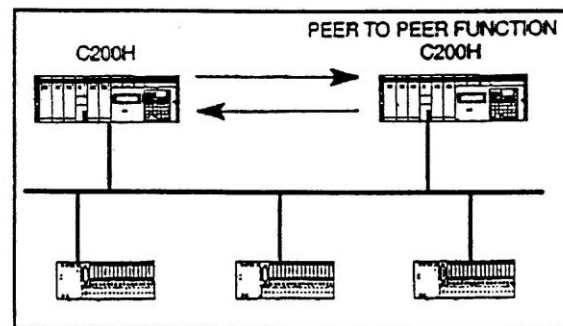
Profibus

Work Cell Architecture
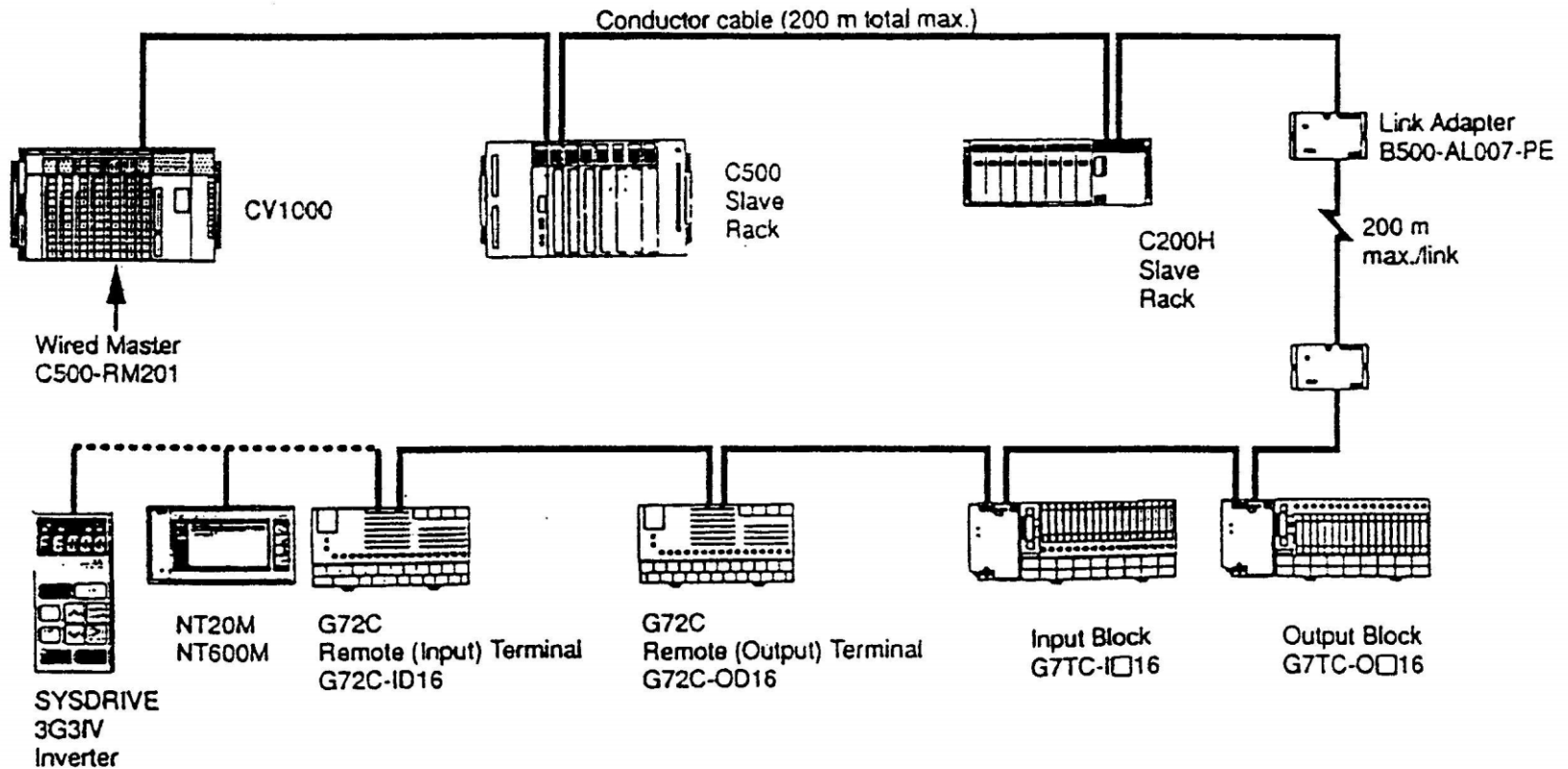
SYSMAC Bus

Work Cell Architecture - Level 0

What is level 0 ?

MECHATRONIC COMPONENTS | MECHATRONIC MODULES | SENSORS | ACTUATORS | CONTROL COMPONENTS

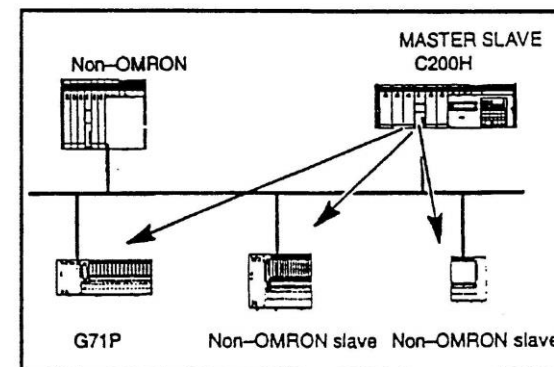LEVEL 0

Basically classified as automation components

▲ Sensors
▲ Pneumatic Modules
▲ Mechatronic Modules
▲ Control Components
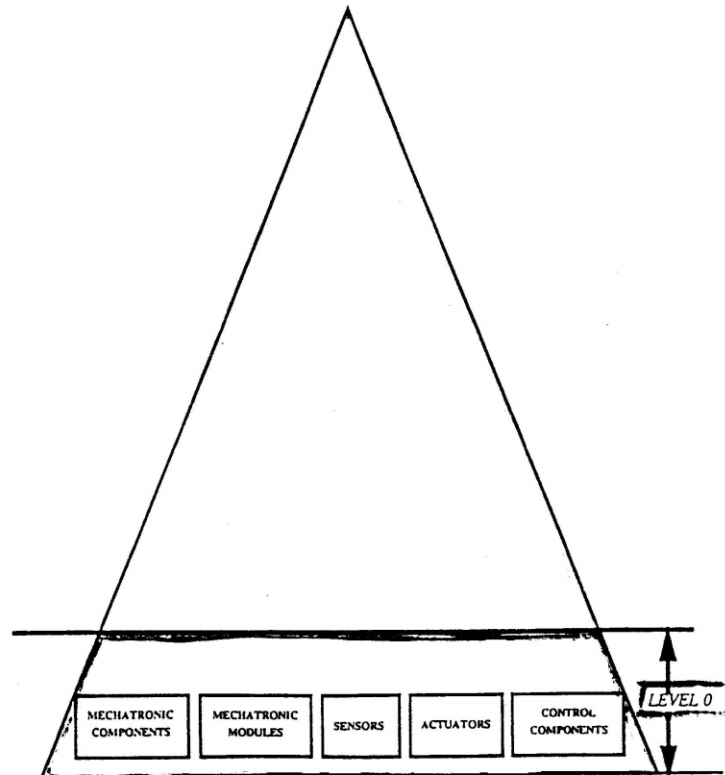
Sensors   *Counter, Timer*   *Inverter*

Omron offers wide ranging of sensors and other control components for level 0.

Work Cell Architecture

Differences Between TCP & UDP

TCP Communications
(Transport Control Protocol)

UDP Communications
(User Datagram Protocol)

Transmitted data

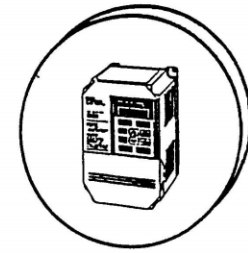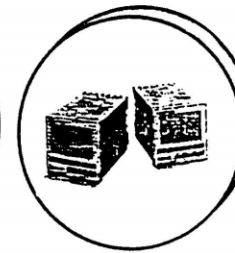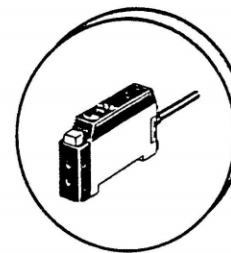| Local node | → | Destination node |

ACK

Re-transmitted data

Transmitted data

| Local node | → | Destination node |

ACK (only when processed by application)
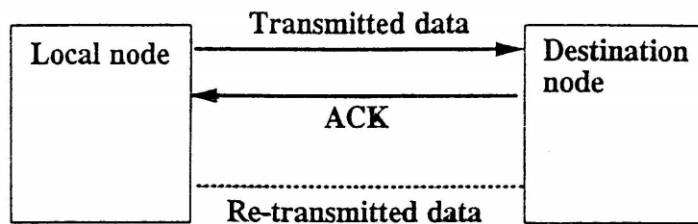
The following procedure is followed each time data is transmitted to ensure that the data arrives normally at the destionation node:

1. The destination node returns ACK when data is received normally.

2. The local node sends the next data after it receives ACK, or it resends the same data if ACK is not returned within the specified time.

Data is simply sent to the destination. Unlike TCP, the receipt of data is not checked and data is not re-transmitted. To increase communication reliability, data resends must be programmed by the user in user applications.

Work Cell Architecture

File Transfer Protocol (FTP)

The Ethernet Unit supports the Server functions of FTP, a standard protocol of TCP/IP, for file transfer between PC memory card & computer.

FTP Clients and FTP Server

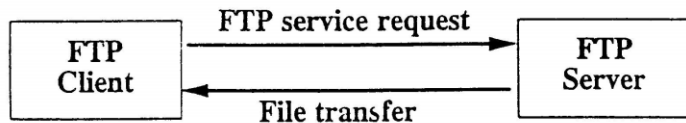CV PC Memory Card

When the FTP service is started, the node requesting file transfer to/from another node is called the FTP client and the node responding to the request is called the FTP server The Ethernet Unit supports *FTP server functions*
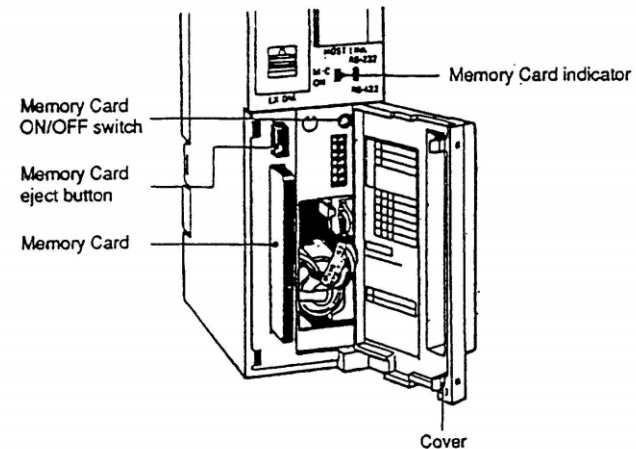
Card	Capacity
HMC-ES641	64K bytes
HMC-ES151	128K bytes
HMC-ES251	256K bytes
HMC-ES551	512K bytes

Work Cell Architecture

The Power of FINS Communications

Basic Flow of FINS

Frame Format

Factory Intelligent Network Service (FINS)

Communication developed for efficient Network communication.
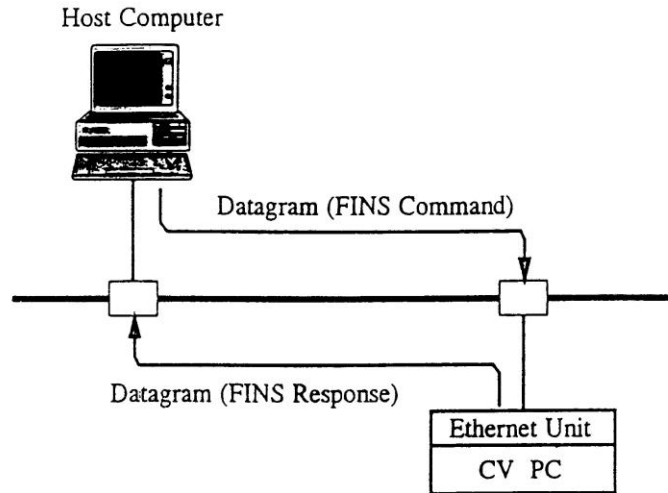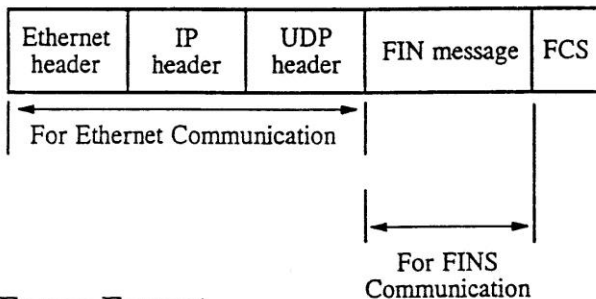
Benefits

1 **FINS communications allow PCs on networks to be controlled by reading or writing memory area data without the need to program these operations into the PC user program.**

2 **FINS has unique set of address different from the address system of Ethernet network. This is to provide consistent communications method that can be used to communicate between different networks such as Ethernet, Sysmac Net & Sysmac Link.**

Work Cell Architecture
Overview of FINS Procedure Across Network
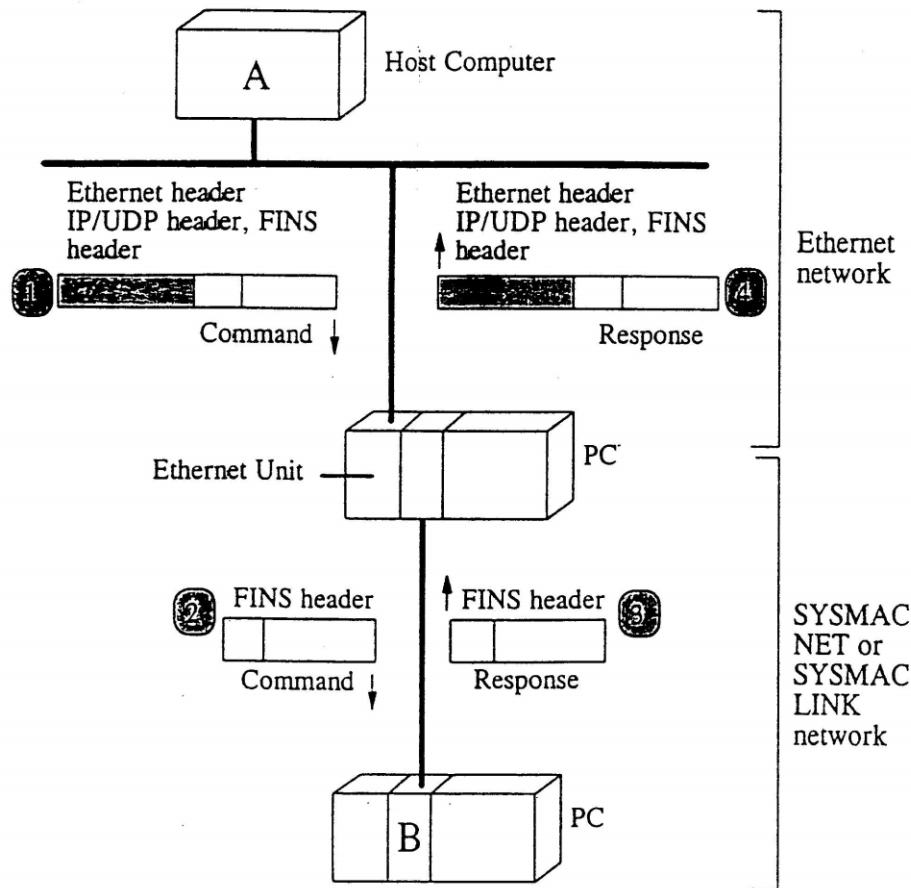
Simple procedure to transfer datagrams across different network !

1. The Ethernet Unit on the middle PC receives the Ethernet message (data-gram) sent from host A, saves the FINS message only, and disposes of the unneeded header information.

2. The FINS message is then delivered to the destination node, node B, by using routing tables.

3. The destination node returns a response for the FINS command it received. This response is delivered to the Ethernet Unit on the middle PC, again by using routing tables.

4. the FINS response received by the Ethernet Unit contains the FINS node number of the remote node (host computer) but no IP address, which is required to return the response over the Ethernet network.

5. The IP address can be generated automatically or thru' IP address table.

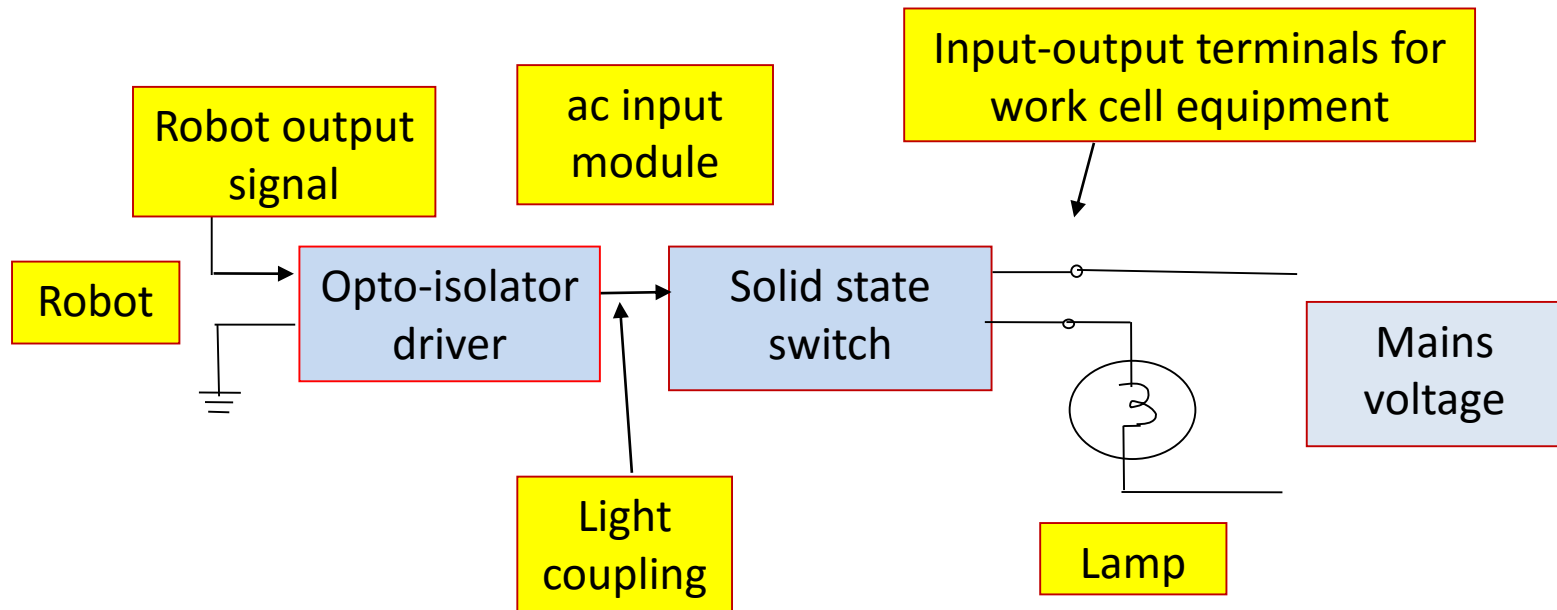# Work Cell Architecture
- CIM (Computer Integrated Manufacturing
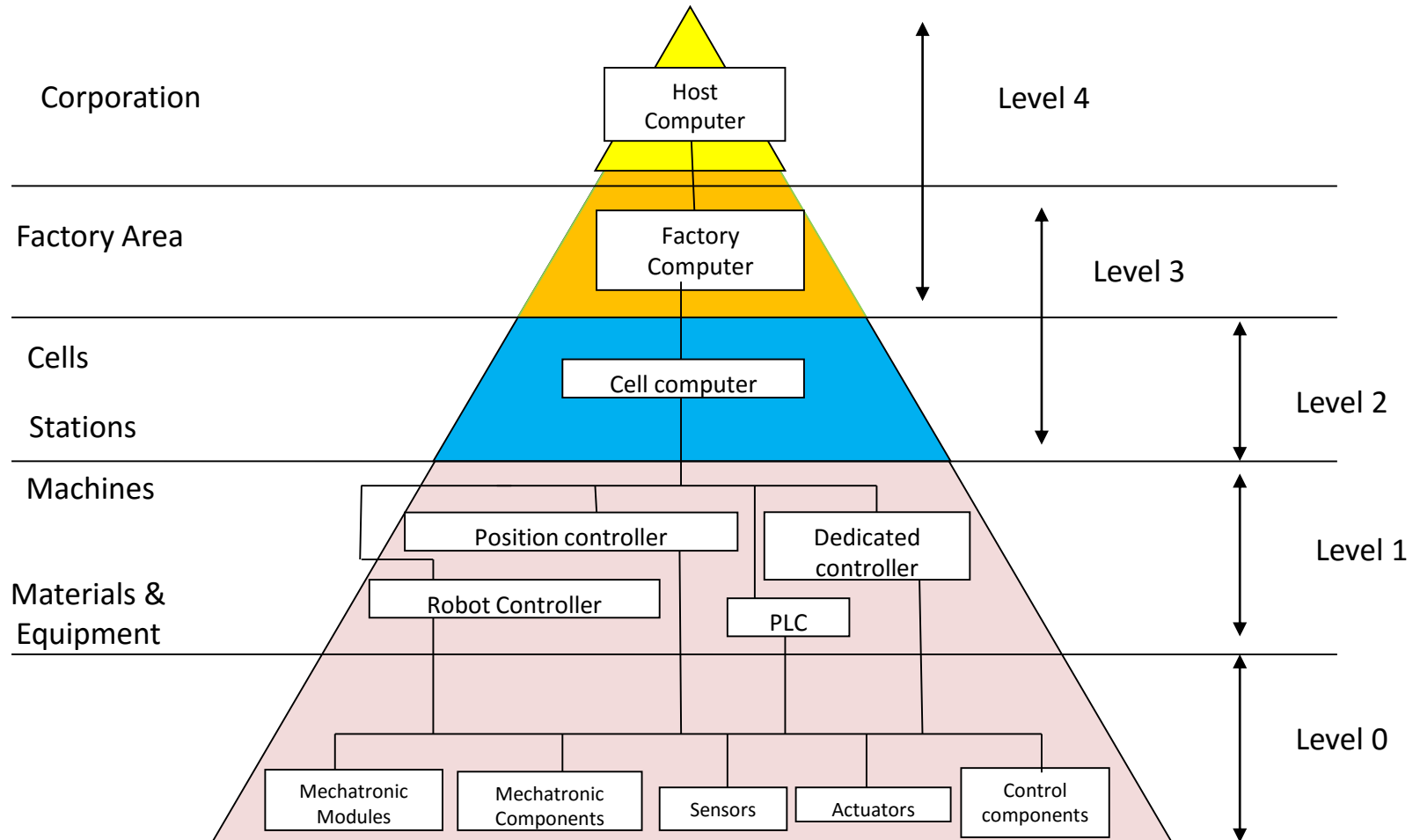
Interfaces

- Simple Sensor Interface
- Complex Sensor Interface
- Enterprise Data Interface

Interfaces

- Simple Sensor Interface

Robot output signal

ac input module

Input-output terminals for work cell equipment

Robot

Opto-isolator driver

Solid state switch

Mains voltage

Light coupling

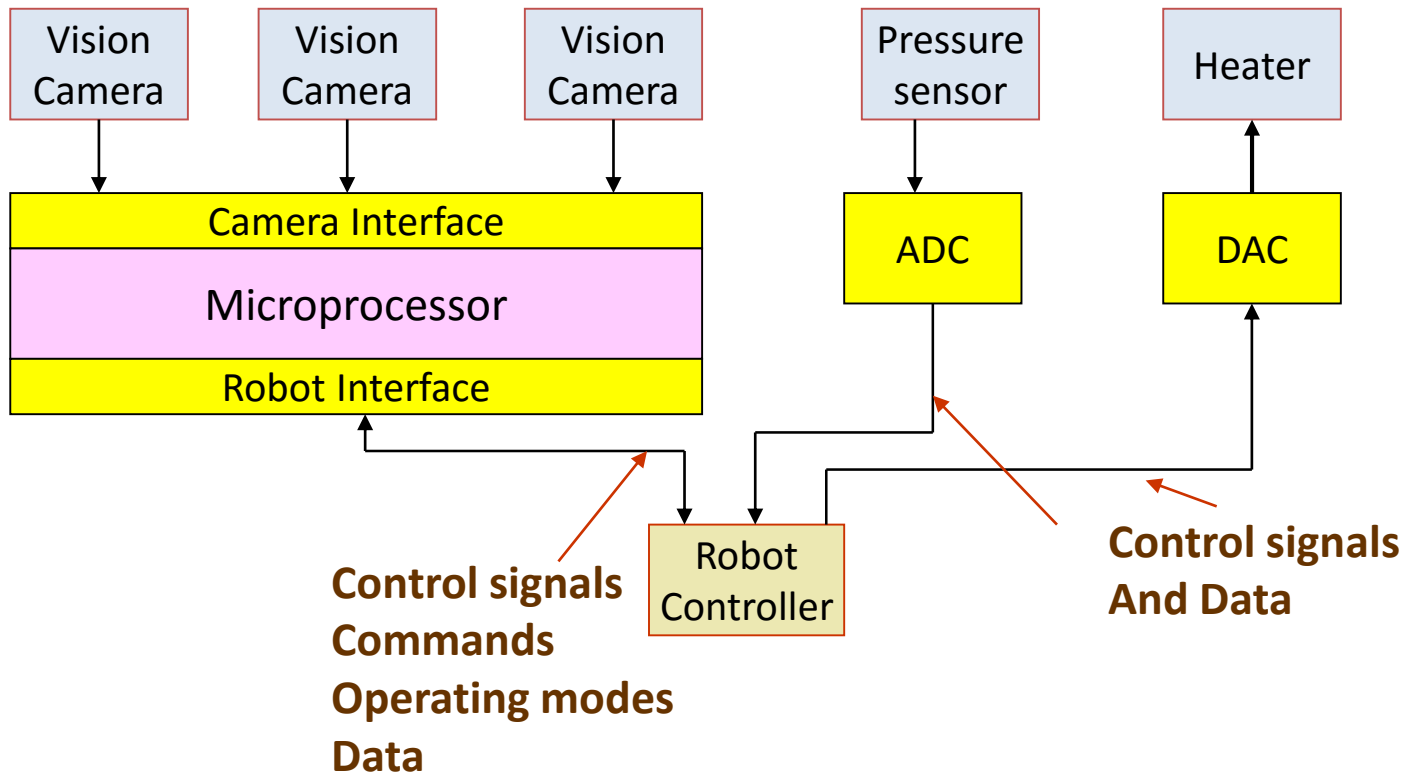Lamp

Interfaces

- Simple Sensor Interface
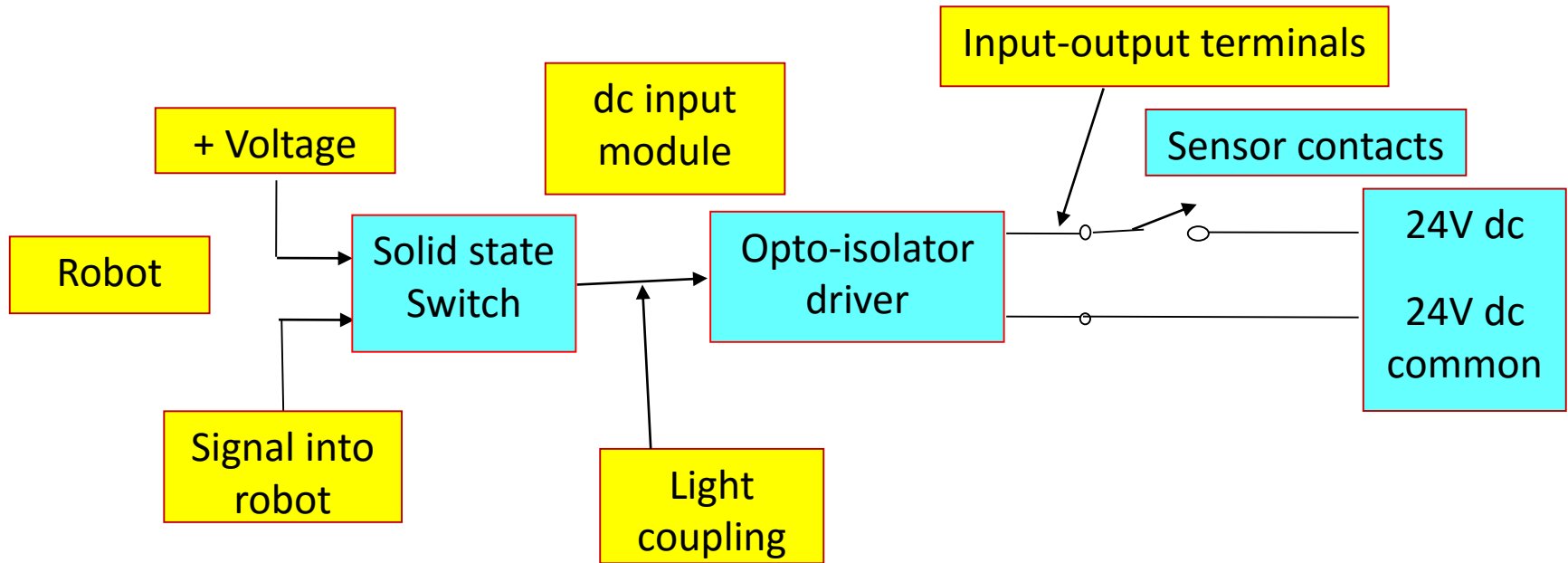
Interfaces
- Complex Sensor Interface

TEXT AND REFERENCE BOOKS

- **Textbook:**
1. James A. Rehg: Introduction to Robotics in CIM Systems. Fifth Edition, Prentice-Hall. 2003.

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- **Reference book:**
1. Mikell P. Groover: Automation, Production Systems, and Computer Integrated Manufacturing, Second Edition. 2004.
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey: Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill. 1986.
3. Farid M. L. Amirouche: Computer-Aided Design and Manufacturing. Prentice-Hall.
4. Richard K. Miller, Industrial Robot Handbook. Van Nostrand Reinhold, N.Y. (1987).