A Study of Building a New Warehouse Control System Architecture

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Introduction

1-1) Research of Summary
1-2) Purpose of study
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📖 Research of Summary

- Due to heavy cost and harsh work environment, the need for the automated material handling machine and the Warehouse Control System(WCS).
- WCS provides an integrated interface to a broad range of material handling equipment.
  - Manage and control equipment in the warehouse
  - Possiblity to enhance the efficiency of the material handling equipment

⊕ Purpose of study

- The The Definition of WCS
- Analyzed key function and limitations of existing WCS
- Suggest a new WCS architecture

The points at the issue

The points at the issue

A₁ Difficulties in integrating material handling control software

When a company adopts new material handling machine, the company should consider not only connectivity among material handling machines, but also Integration & expansion of control software

B₃ A Necessity of securing information visibility of material handling equipment

To operate efficient logistics site, we need to consider expansion method of gathering information from material handling equipments

Warehouse Control System

2-1) The Definition of WCS
2-2) A Review of Current WCS

The Definition of WCS(1/2)

Difference between WMS and WCS [1]
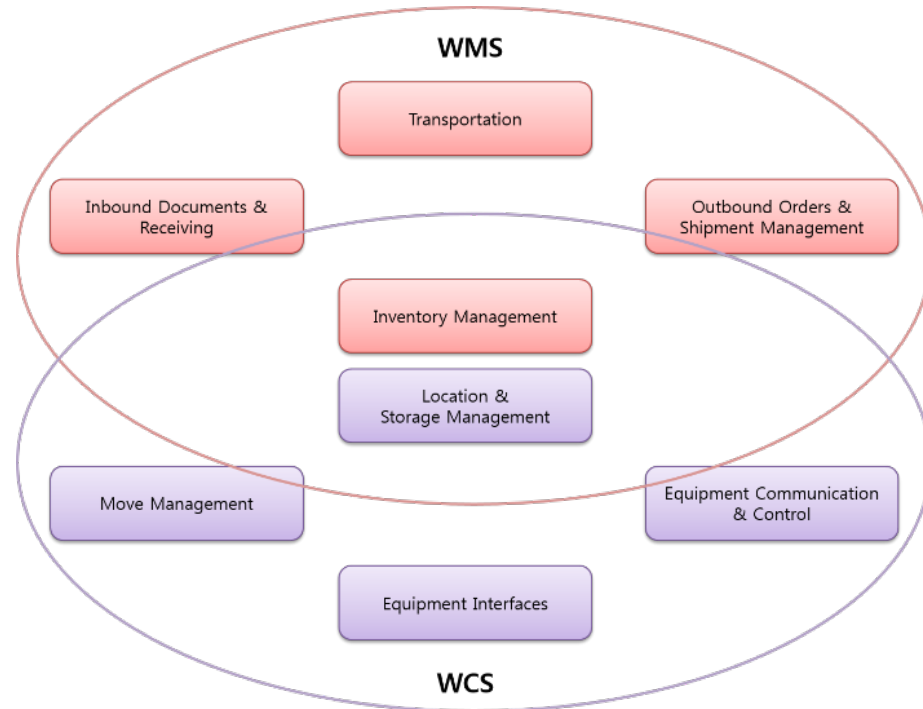
- WMS focused on the management of and order.

- WCS is more focused on the controlling of machines.

- WMS is appropriate for the management of order, of inventory, or cooperating with another Host System such as Enterprise Resource Planning(ERP) and Supply Chain Management(SCM).

- WCS suitable to deal with dynamic date such as the status of machine and work process.

The Definition of WCS

- Adams [2] tried to distinguish softwares used in the warehouse considering the objectives of each software.
- WMS is defined as a software which does overall management and operation plan in the warehouse.
  - Manage logistics flow and Control inventory
  - Manage Worker order, labor and transportation
- WCS is defined as a software which controls equipment in the warehouse.
  - Interfacing Equipment
  - Equipment status monitoring
  - Equipment Control

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A Review of Current WCS

Compare of Warehouse Control System [3, 4, 5 ,6, 7]
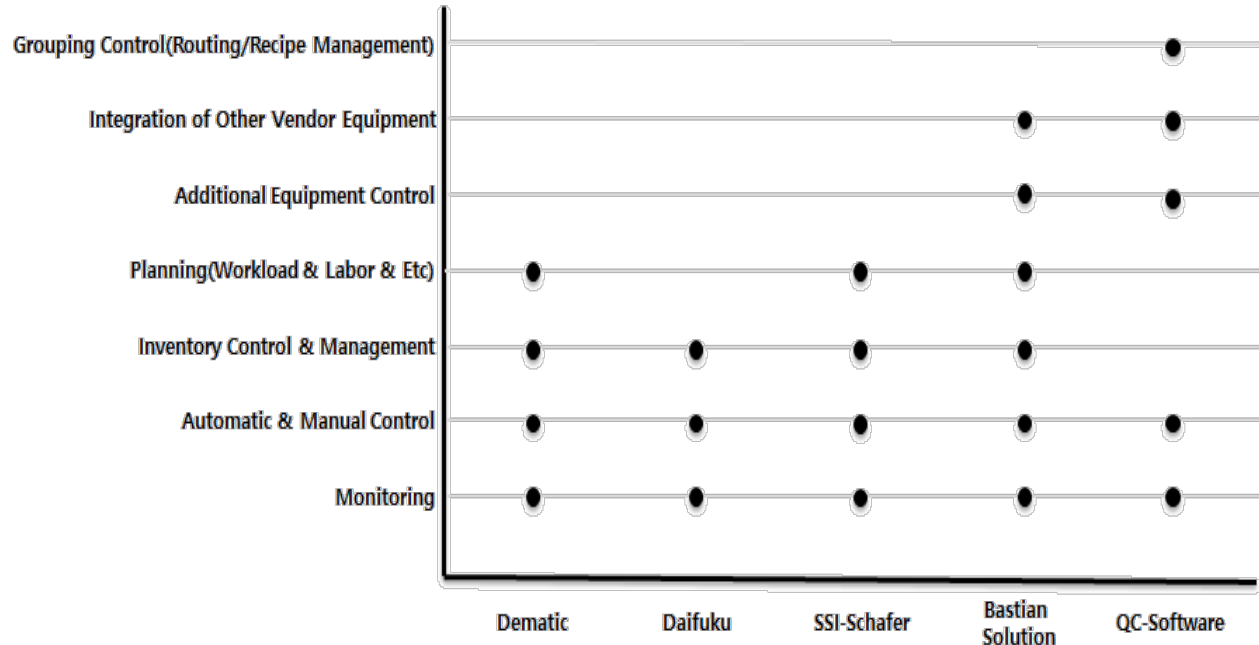
- Most companies provide Monitoring, Automatic & Manual Control, Inventory Control and Management.

- Material handling equipment companies typically do not provide generic interface for third parties.

- Most of companies do not provide flexible User Interface(UI) and functionality for life cycle management of equipment.

WCS and Equipment Control System

3-1) System Implementation – Architecture
3-2) System Implementation – Function
3-3) Pilot System of HMI-ECS

Concept of NEW WCS/HMI-ECS
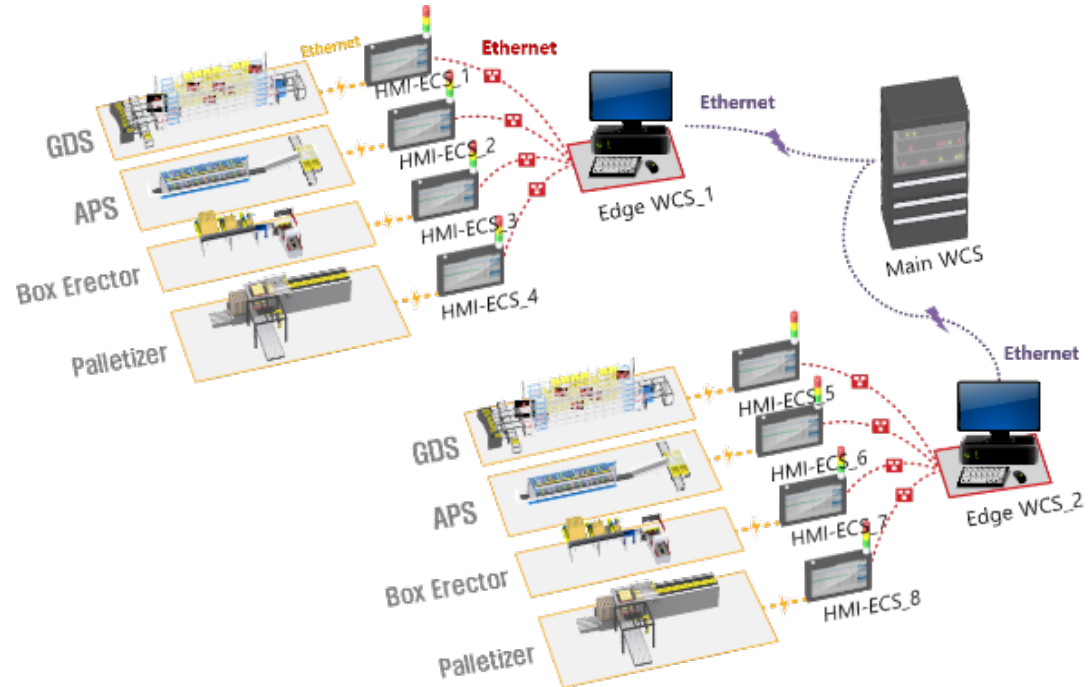
- HMI-ECS is human machine interface for equipment and control individual equipment.

- Edge WCS integrate the individual ECS in warehouse and provides control and monitoring service.

- Main WCS can integrate many distributed Edge WCSs and control and manage the whole warehouse.

System Implementation –Architecture(1/3)

New WCS/HMI-ECS Architecture
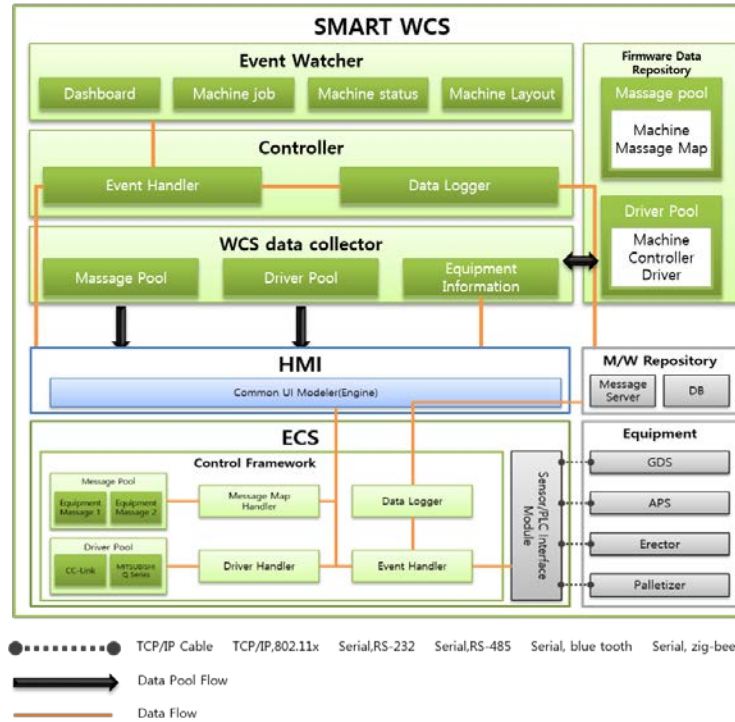
- WCS/HMI-ECS consists of event watcher, controller, WCS data collector, Firmware Data Repository, HMI and ECS.
  - WCS/HMI-ECS provides that function of dynamic plug and play by information of firmware data.
- ECS consists of control framework and Sensor/PLC interface module. Sensor & PLC interface module defines sensor and PLC Interface.

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System Implementation –Architecture(2/3)

📇 Communication method in Sensor/PLC Interface Module
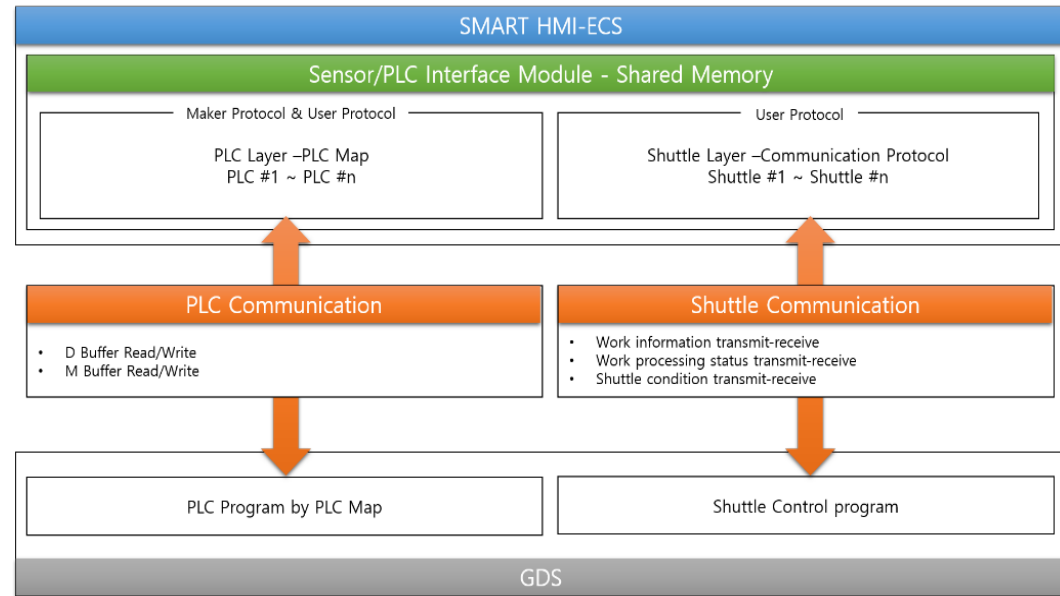
- Shared Memory was set in to handle with message with machine.(e.g. Goods to Destination System)

- At Share Memory, Maker Protocol and User Protocol corresponding to controller of equipment are set by equipment component.

  - User protocol is defined as information of Message Pool of HMI-ECS.

  - Maker Protocol is defined as information of Driver Pool of HMI-ECS.

- Based on Maker Protocol and User Protocol information, HMI-ECS communicated by reading information of specific Memory Buffer(Ex. D buffer, M buffer) which used at PLC Program set in the machine and writing new information.

System Implementation – Architecture(3/3)

SMART WCS/HMI-ECS Architecture

- WCS/HMI-ECS supports has two types of connection.
  - Type 2 is recommended if there is only one warehouse or user doesn't have separated space for integrated control
- It could assign a list of function depending on the system architecture and permissions for users.

System Implementation – Function(1/2)

Function of HMI-ECS

Category	Function
Monitoring	Work order monitoring
	Action monitoring
	Status monitoring
	The quantity of goods transported monitoring
	Equipment utilization monitoring
	Consumable monitoring
	Alarm
Emergency Control	Emergency stop
	Unit operation control
	Input check report

- Using HMI-ECS, users process basic operation and semi-auto operation.
- HMI-ECS processes the orders by controlling the equipment.
- Semi-automatic control can be used in the case of an emergency or with control authority.

System Implementation – Function(2/2)

Function of WCS

Category	Function
Monitoring	Dashboard
	Work order monitoring
	Action monitoring
	Status monitoring
	The quantity of goods transported monitoring
	Equipment utilization monitoring
	Consumable monitoring
	Alarm
Emergency Control	Emergency stop
Warehouse Management	Warehouse Inquiry, Create, Update, Delete
Equipment Management	Equipment Inquiry, Create, Update, Delete
	Equipment Grouping
Inquiry History	Work order history inquiry
	Equipment control history inquiry
	Equipment install history inquiry
	Maintenance history inquiry
	Change of condition history inquiry
Labor Management	Labor Inquiry, Create, Update, Delete

- WCS roles as middleware between external software (ERP, WMS, etc.) and various warehouse equipment.
- Users can register logistics machines and manage them.
  - Especially by grouping machines heterarchically, users can allocate work orders structurally.

Pilot System of HMI-ECS(1/2)

System Configuration
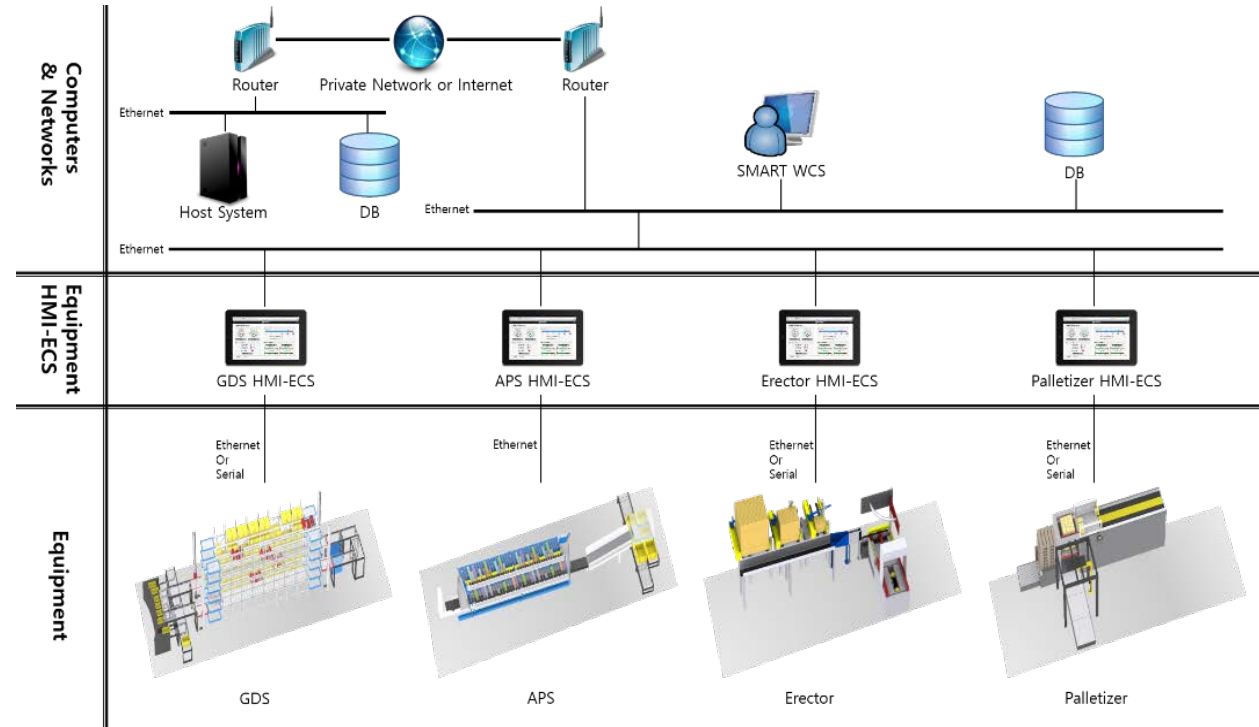
- HMI-ECS is connected to the controller of each equipment by Ethernet or Serial.

- WCS integrates all HMI-ECS by Ethernet.

- WCS and Host System (e.g. WMS, ERP, etc…) are also connected by Ethernet.

Pilot System of HMI-ECS(2/2)

Pilot System of HMI-ECS(Ex. For Automatic Picking System)
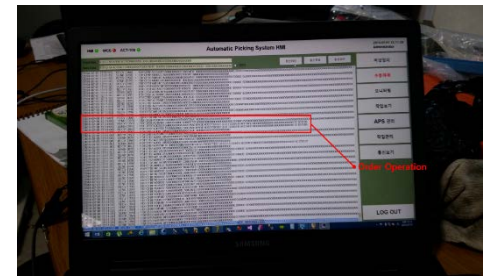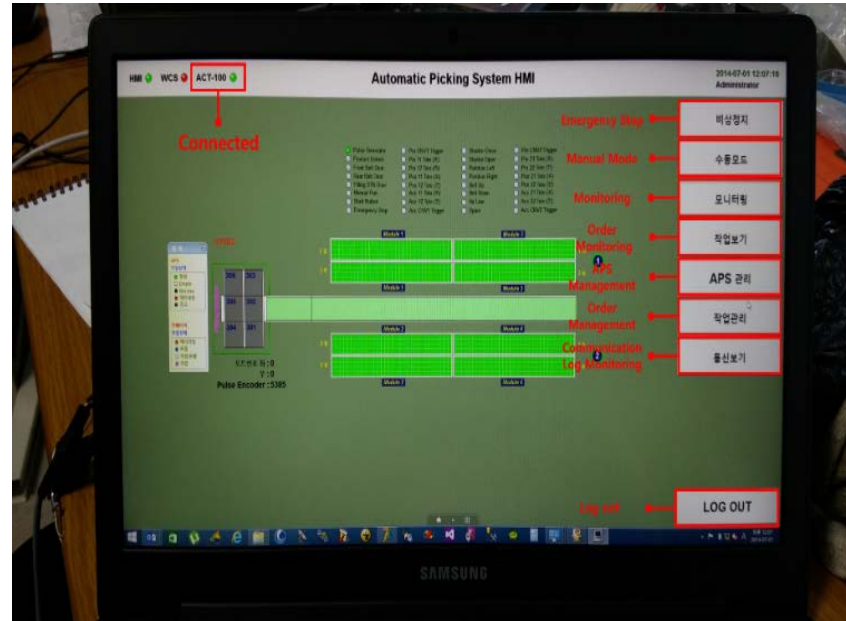
- The pilot system was developed for the purpose of testing link between Message Pool and Driver Pool.

- Pilot system can be used after Log-in and the command including Emergency Stop, Manual Mode, Monitoring, Order Monitoring, APS Management, Order management, Communication Log Monitoring and Log-Out.

Conclution

New generation of warehouse control system have to be exoteric and easy to customize. It provide securing visibility of logistical information and smooth integration method of material handling machine.

WCS expanded information visibility and connectivity of information

- We reviewed some limitations of Warehouse Control System available today.

  - Poor Versatility

  - Expandability

  - Week information-visibility

- As a solutions to those issue, We proposed new architecture.

  - Dynamic PnP

  - A variety of Function

  - Expandability and strong data collection capability

Chapter 5

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Thank you