Intelligent Device Management with DCS, PLC, and RTU
EDDL-based Intelligent Device Management (IDM) software part of the Asset Management System (AMS) can be used with modern Distributed Control System (DCS), Programmable Logic Controller (PLC), and Remote Terminal Unit (RTU) provided the right hardware and software is specified.

System Architecture
The sensor & actuator level “H1” fieldbus networks supported by the control system depends very much on if it is a DCS, PLC, or RTU.

If 4-20 mA is used, make sure to specify 4-20 mA AI and AO cards which support native HART “pass-through”. Thus separate HART multiplexer (MUX) hardware and associated integration work is not required. Native HART pass-through AI and AO cards are much easier to integrate. HART communication is too slow for control, but is passed through to the IDM software. Be wary of proprietary smart protocols used by some DCS in the past.

Intelligent Device Management Integration
It is important to ensure DCS, PLC, and RTUs support “pass-through” of digital communication from underlying intelligent devices up to IDM software. If not, using IDM software for centralized device management is not possible.

DCS
The DCS comes with its own native IDM software based on EDDL. The IDM software therefore scans the underlying I/O systems to automatically detect the network hierarchy and the intelligent field devices, automatically selects the corresponding EDDL file, and establishes an instrument database. If the EDDL file is missing, the user will be notified to load it.

PLC
PLC is used with third-party IDM software. If the I/O-subsystem supports HART over PROFIBUS-DP, HART-IP, or FOUNDATION fieldbus HSE, the IDM software has the ability to scan the underlying I/O systems to automatically detect the network hierarchy and intelligent field devices.

For other I/O-subsystem protocols the network hierarchy and instrument database must instead be manually configured. Changes over time are inevitable and require manual update.

To manage intelligent devices part of a package unit integrated with a package unit PLC, make sure the PLC supports HART over PROFIBUS-DP or HART-IP for 4-20 mA/HART and WirelessHART devices, or FOUNDATION fieldbus HSE for FOUNDATION fieldbus H1 devices.

RTU
Some RTU manufacturers provide native IDM software similar to DCS, while others rely on third-party IDM software similar to PLC.

Conclusion
To enable centralized management like configuration and diagnostics for intelligent devices it is important to specify not only the IDM software capabilities but also built-in pass-through capability in main system I/O as well as for package unit controllers. Separate multiplexers should not be required for new systems, only to upgrade aging systems.
Appendix: DCS, PLC, or RTU

One of the most common questions on social media is regarding the difference between DCS and PLC as well as between PLC and SCADA – and if there is any difference at all between them.

Both the DCS and PLC were invented in the mid nineteen seventies. Because there are many brands of DCS, PLC, and RTU, only broad generalizations are possible. DCS is focused on process control with analog signals, used as the main control system in process industries like refining, petrochemicals, and chemicals etc. PLC is focused on discrete automation with discrete on-off signals, used on factory assembly lines and bottling lines etc. PLC and DCS are both constantly evolving. Today DCS support discrete I/O and some logic functions and PLCs support analog I/O and some control functions. There are many similarities between DCS and PLC so sometimes this debate can get confusing. However, there also are differences between them. As a result, each has carved out industry niches where they are used. Some plants use both DCS and PLC. For instance, in a refinery a PLC may be used on a package unit integrated with the main plant-wide DCS.

Hardware and Software

PLC today have features in the past only found in a DCS. However, this doesn't necessarily mean PLC and DCS features are now the same because DCS is also constantly evolving new features. The type of fieldbus used and how tightly it is integrated in the control system using EDDL files and with the IDM software is one of the main differences between PLC and DCS

DCS

DCS supports redundancy for controllers, power supply, and control network, as well as redundant I/O cards including fieldbus interface cards in the same backplane. The control network supports peer-to-peer communication between controllers. The control network is typically a proprietary application protocol over Ethernet media and IP. In a DCS the field cabling lands on a Field Terminal Assembly (FTA) where a special system cable with connector takes the signals to the I/O card.

Loops in a DCS are executed individually. The scan time in a DCS is set individually for each loop. Most loops run at 1000 ms although 250 ms is common for pressure and flow loops in refining and petrochemicals, and as fast as 100 ms is possible. Most importantly, the scan time is isochronous as required for PID control and time-based functions such as integration/totalizing and lead-lag dynamic compensation etc., meaning it is constant, not changing with task loading.

Loops in a DCS are also managed individually. Addition, change, and download to one loop do not affect other loops.

A DCS has an integrated development environment where I/O, control strategy, and operator graphics are created together and stored in a single database. This means that once a tag is created in the DCS it automatically becomes available everywhere in the system with the same human-readable tag name for use in basic control, advanced control, graphics, faceplates, trending, alarming, and tuning etc. without mapping data through registers or other tag names. This makes additions and changes easy.

The sensor & actuator level “H1” fieldbus network supported by DCS is primarily FOUNDATION fieldbus for instrumentation and PROFIBUS-DP for motor controls.

The DCS comes with its own native fieldbus interface cards. The engineering software therefore automatically configures the communication interface cards for the variables used in the control strategy and graphics etc.
PLC
PLC comes in many sizes; meaning various I/O and program capacities. Their capabilities vary greatly making generalizations difficult. The smallest sizes are typically referred to as nano PLC, micro PLC, and mini PLC having fixed I/O and are used in small stand-alone applications. These are not discussed further in this white paper as they generally do not support “pass-through” of digital communication with intelligent devices. This white paper looks at the larger PLCs with flexible I/O-subsystem in a backplane that work as part of a larger system.

Large PLC support redundancy for CPU, power supply, and possibly the control network, but typically not for I/O cards although there are large PLC that support I/O redundancy by using duplicate I/O-subsystems with separate backplanes where the field instruments are wired in parallel to both I/O subsystems. The control network is typically a standard industrial Ethernet application protocol over Ethernet media and IP. For PLC the field cabling lands directly on the I/O card.

PLC supports very fast scan times as required in discrete manufacturing, especially for discrete logic. However, it should be noted that PID loops add to the CPU load much more than discrete logic thus making the scan time slower. The scan time, although fast, may vary with task loading.

Loops are not handled individually in a PLC. Addition or change to loop requires a download of the entire program which affects other loops in the CPU as well

The PLC configuration software is separate from the HMI software as they generally come from different manufacturers. That is, two separate databases. The logic programming is first done in the PLC configuration software. Next the OPC server has to be configured. For a native OPC server this happens automatically, but for a third-party OPC server manual data mapping is required which is time consuming and error prone requiring thorough testing. Therefore native OPC server is preferred. Lastly the HMI database has to be configured for graphics, alarms, and trend etc.

If the HMI software comes from the same manufacturer as the PLC, the intermediate data mapping step may not be required, making the integration easier. However, even if the PLC and HMI manufacturer are the same, the data mapping may still be required in case the two products were designed separately.

The sensor & actuator level “H1” fieldbus network supported by PLC is primarily ASI, CompoNet, IO-link, and PROFIBUS-PA for instrumentation and PROFIBUS-DP or DeviceNet for motor controls.

Each PLC manufacturer typically has a native protocol, yet open standard, which the PLC architecture is built around. It may be PROFIBUS, DeviceNet, Modbus, or CC-link etc. The PLC comes with its own native interface cards for the native protocol supported by the PLC manufacturer, but relies on third-party interface cards for other fieldbus protocols. The engineering software therefore automatically configures the communication interface card for the native protocol. However, for other fieldbus protocols the interface card must be configured using separate to map the variables before they can be used in the control strategy and graphics etc.

RTU
RTUs are designed for use in applications in remote locations unattended where no power is available. This may include freshwater reservoirs, onshore oil & gas well pads, as well as unmanned offshore platforms. RTUs therefore have extremely low power consumption, much lower than DCS and PLC, to enable operation on solar power and batteries. These applications are typically referred to as Supervisory Control and Data Acquisition (SCADA) or telemetry meaning supervision from a far away central location. The SCADA software sits in the central office connected over a backhaul network typically using radio communication to far away and often widely geographically spread out RTUs. The communication may be interrupted for long periods of time. RTUs therefore have
onboard data storage continuing local data collection for more than a month if backhaul communication is lost as well as “history backfill” uploading this data once the connection is reestablished. Report by exception communication mechanisms are often used to minimize backhaul communication since pay per data volume long distance Wide Area Networks (WAN) like mobile (cellular), microwave, and satellite are often used in the remote applications served. Flow computing capability according to AGA is typically built-in.

The RTU configuration software is separate from the HMI software from a third-party manufacturer. That is, two separate databases. First the RTU is configured; next the OPC server is configured. For a native OPC server this happens automatically, but for a third-party OPC server manual data mapping is required which is time consuming and error prone requiring thorough testing. Therefore native OPC server is preferred. Lastly the HMI database has to be configured for graphics, alarms, and trend etc. The terms HMI software and SCADA software are used interchangeably.

The 4-20 mA AI and AO cards for a RTU optionally support native HART “pass-through”. Thus separate HART multiplexer (MUX) hardware and associated integration work is not required. Native HART pass-through AI and AO cards are much easier to integrate and should be specified if 4-20 mA is used. Because RTUs are generally used in very slow monitoring applications not requiring fast control, some applications do not use the real-time analog 4-20 mA, just the digital HART communication multi-drop topology. This means the field instruments draw less than 4 mA instead of up to 20 mA, thus further reducing overall power consumption.

**Business Model**

Perhaps the main difference between DCS and PLC is the business model, not just features

**DCS Business Model**

The DCS business model can be said to be based on a monolithic integrated system by a single manufacturer.

**DCS Architecture**

For a DCS the controller, I/O-subsystem, database server software, engineering software, and operator software are all a single monolithic unit designed together and only work with each other. It is not possible to use components from a third-party. It is not possible to use any of these components on some other system. A DCS uses I/O-subsystem network and control network based on standard Ethernet, but with a proprietary application protocol, and typically only with a particular approved model of Ethernet switches.

![Figure 1 In a DCS all components come from the same single manufacturer](image)

Only a specific version of Windows is permitted and only on one type of approved computer shipped from the DCS manufacturer. These restrictions enable the DCS manufacturer to test everything together very thoroughly, on a very large scale, heavily loaded, with many controllers and work stations. Applications like batch control, advanced control, and auto-tuning etc. are also tested together. This ensures there are no compatibility conflicts and unforeseen dependencies. Thorough large-scale testing is possible because there is essentially only one type of each component so only one or very few combinations. Third-party software is only permitted on
separate “application stations” where it cannot conflict the native DCS applications and must be
tested and approved by the DCS manufacturer; white-listed.

**A DCS is monolithic using the same brand I/O subsystem, controller, and software, and single
computer and operating system platform. This has been thoroughly tested on very large scale.**

**DCS Long Term Support**
Systems typically remain operational for 15 years or more. During this time there will be several
Windows versions, service packs, hot fixes, lots of virus definition updates, and computer hardware
will need to be replaced too. Typically DCS only support a single type of anti-virus software and
whenever there is a new virus definition or when there is a Windows operating system service pack
or hot fix, the entire monolithic suite of all hardware and software are tested together again by the
system vendor prior to release ensuring the virus definition and service pack can be deployed
without any compatibility conflicts.

**DCS Upgrade**
DCS versions are also upgraded as a single monolithic unit of all hardware and software such as I/O
card firmware, controller firmware, server software, engineering station software, operator station
software, as well as any other software are all upgraded together. Any time there is a new system
version all these components have been thoroughly tested together on a large scale by the system
manufacturer in advance ensuring they are all compatible with each other. Moreover, the online hot-
cutover process from earlier version to the new version has been thoroughly tested on a large scale
ensuring smooth deployment at site.

It is this reassurance that thorough and large-scale testing provides which makes DCS very popular
with large installations like petrochemical complexes. Such testing is made practical by the few
combinations in a monolithic system.

**PLC Business Model**
The PLC business model can be said to be based on flexible architecture by a system integrator (SI).

**PLC Architecture**
The PLC architecture is very flexible where each component can be freely selected from any of
many suppliers. The PLC is the CPU with configuration software and IO-subsystem. Sometimes the
I/O-subsystem may come from a third-party. Even I/O cards that plug into the backplane may come
from third-parties. The HMI software is typically from a third-party. A native OPC server from the
PLC manufacturer is typically best, but third-party OPC servers are sometimes used.

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**Figure 2** For a PLC components from different manufacturers are integrated

Basically any PLC works with any I/O-subsystem, OPC server, and HMI software because standard
protocols like PROFINET, Modbus/RTU, DeviceNet, and EtherNet/IP as well as OPC etc. are used. Networking gear, computers, and Windows version can be selected freely. Some components found not working are blacklisted.

[www.eddl.org](http://www.eddl.org)
This flexibility enables hundreds of combinations of hardware and software making it impossible for these manufacturers to get together to test every possible combination of their hardware and software on each version of Windows before a plant decides to purchase. Some combinations may be tested by the manufacturers involved, but it may or may not be on large scale with heavy loading.

The PLC manufacturer may supply all hardware and software components, all from the same manufacturer as many PLC manufacturers have acquired HMI companies. If so, this particular combination may have been tested more thoroughly than the other combinations tested.

Auxiliary third-party applications like batch control, advanced control, and auto-tuning etc. are generally not tested together as it results in an even greater number of combinations.

PLC uses proprietary configuration software just like DCS. That is, you cannot use third-party configuration software for your PLC, just like a DCS.

A native OPC server for the PLC is better than a third-party OPC server because the PLC configuration software generally automatically configures the address space for the OPC server.

**PLC Long Term Support**

During the 15 years or more of typical system operation there will be several Windows versions, service packs, hot fixes, lots of virus definition updates, and computer hardware will need to be replaced too. Typically PLC has no restriction on anti-virus software or Windows operating system version so again the number of combinations of virus definitions, service packs, and hot fixes becomes too vast and impractical for these manufacturers to get together to test every possible new combination before a deployment in plants to ensure there will be no compatibility conflicts when deployed on the large number of combinations of hardware and software.

The PLC manufacturer may limit to a single anti-virus software and Windows version. If so, this particular combination may have been tested more thoroughly than the other combinations they test.

**PLC Upgrade**

For a PLC, hardware and software components are upgraded individually. That is, I/O-subsystem firmware, CPU firmware and configuration software, OPC server, HMI software, as well as any other software are all upgraded independent of each other. Taking different versions for each option of components into account, the number of combinations becomes orders of magnitude larger. This flexibility makes it impractical for these manufacturers to get together to test every possible combination of new versions before deployment in plants. Testing the hot-cutover of one combination of versions to another combination of versions becomes nearly impossible.

The PLC manufacturer may supply all hardware and software components, limit to a single anti-virus software and Windows version which are tested before deployment, and limit to single
system-wide version upgrades, and test hot-cutover before deployment. This way the flexibility of the PLC would be abandoned to achieve the robustness of a DCS.