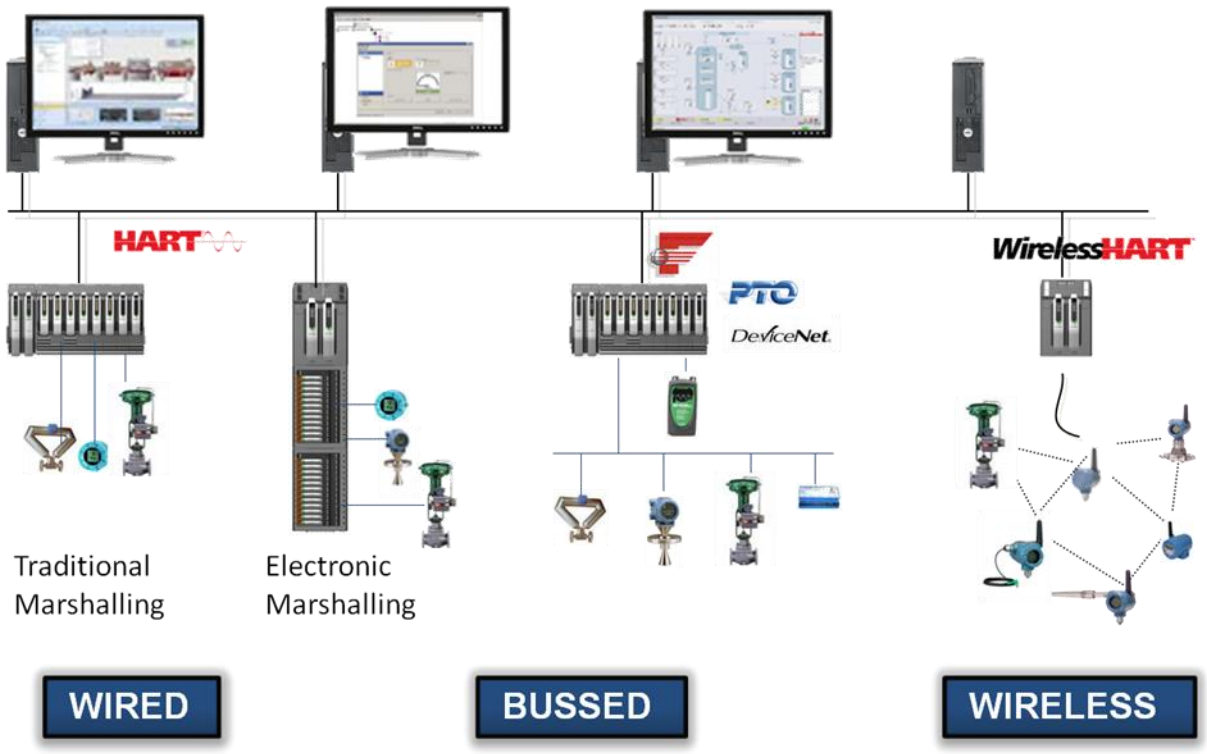
I/O On Demand Cost Study

Emerson released DeltaV™ v11 utilising Electronic Marshalling in the control room and in the field with the new CHARMs technology. In this study, data from an existing offshore manned platform was analyzed to compare the different combinations of capital cost of the as built wired / FOUNDATION™ Fieldbus versus Electronic Marshalling technology. The results show cost savings of between 7% and 26% which equates to $0.3M to $1.25M, depending on the options chosen, with additional value of saving of up to 30 tonnes in weight and up to 43 m^2 of deck space in cabling, cable tray, junction boxes and cabinets.



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Introduction

Emerson's I/O on Demand gives ultimate flexibility with field device and installation options with DeltaV. Users decide what makes sense for each situation – traditional wiring, busses, wireless or Electronic Marshalling. With DeltaV and I/O on Demand, systems can take advantage of one or multiple of these options. Electronic Marshalling is an evolution of communications technology with the potential to save significant amounts of money and time during offshore platform construction. The installation of Electronic Marshalling technology can also save money in typical process applications with shorter distances and densely populated topography. Data from an existing offshore production platform was examined to compare the installed costs of Electronic Marshalling on the platform with conventional point-to-point wiring, CHARMs in the Control Room or in the field, FOUNDATION™ Fieldbus, Wireless I/O or combinations of these technologies. The analysis is performed in such a way that the results can be extrapolated to other types of facilities by adjusting for proportions of monitoring devices and average distance.

When Emerson's DeltaV v11 or S-series controllers are used, additional project engineering and field commissioning savings are gained with both HART® I/O and FOUNDATION™ Fieldbus. For example, in the DeltaV controller, devices are native HART devices, so no extra engineering is required for mapping registers or designing control logic for scaling. Additionally, DeltaV has a built-in commissioning function that can automatically match tag names in field devices to tag names in control system placeholders – greatly reducing the amount of commissioning time. For Fieldbus, the DeltaV S-series H1 Fieldbus card includes an integrated power supply. Unique to Emerson, this new approach eliminates the cost and expense of purchasing, engineering, mounting and maintaining separate bulk power supplies and Fieldbus power conditioning modules.

The results from this study show that potential cost savings of 26% are achievable. Additionally, the study produces charts for extrapolating the cost savings as a function of average wired distance, showing that use of Electronic Marshalling can save money at ANY distance, and substantially more money at large distances.

For more details on what Electronic Marshalling is and the associated benefits, please see the Electronic Marshalling Overview Whitepaper. More information on the S-series H1 I/O Card with Integrated Power is available in its Product Data Sheet.

Overview of the Cost Study Methodology

The analysis includes the costs of materials and labour associated with the previously installed DeltaV control system of this project – an offshore manned platform. It includes the applications for I/O communication within the platform PAS – cabling, cable tray, marshalling cabinets, system cabinets, controller I/O cards and square footage of Equipment Rooms. It does not include Motor Control Center applications that can be implemented with either Profibus DP or DeviceNet communication, nor does it include the steel structures that hold piping and cable trays. Also excluded are the installation costs associated with the mechanical mountings of most instruments – such as valves, air tubing, and process connections because those costs occur regardless of the choice of communications technology.

Data Source

The data was supplied from an end user with an existing offshore manned platform, similar to what is shown in Figure 1.

Figure 1 - Typical Offshore Manned Platform

The Control Room is situated at one end of the Platform, such that the average cable length on the cable tray is about 90 metres. In that room are System Cabinets containing controllers and I/O cards. From there, the cabling continues to Marshalling Cabinets, then onto cable tray which runs out onto the platform. At various positions on the platform, cabling exits the cable tray to local Junction Boxes. From the Junction Boxes, there is an average of 10 metres of cable to each field device, and in the case of a Fieldbus loop an average of 5 metres between the junction box and megablock and the megablock and the field device.

The data did not include Motor Control Center I/O. The data only contained analog and digital signals that go out into the main plant, and did not include discrete signals, motors or drives, or anything that would ordinarily be expected to be controlled from a Motor Control Center (MCC) through a Profibus DP or DeviceNet digital bus.

The diagram below depicts the typical cable routing installed.

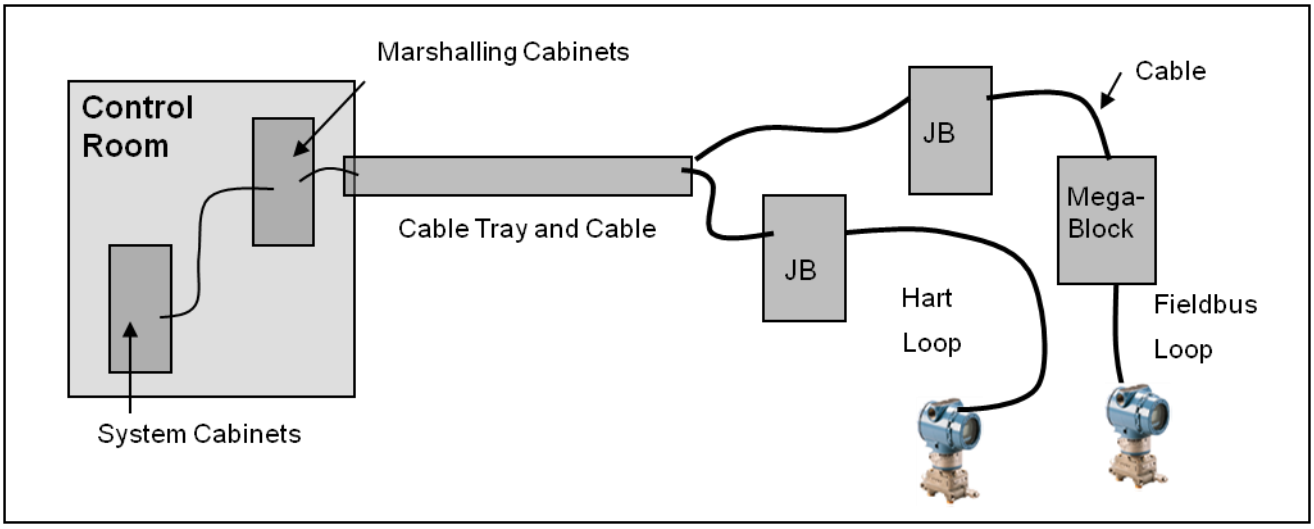

Figure 2 – Typical Cable Routing

Cost Data

The costs for labour rates, devices, wiring cable trays, marshalling cabinets, number of hours per type of activity, etc. were taken from experiential data from other projects, consistent with construction in Europe. In general, the any other costs were also taken from typical projects constructed in Europe.

Calculation Tools

An existing proven calculation tool used for estimating point-to-point cabling costs was used for the calculation of wired, Electronic Marshalling, Fieldbus and wireless costs. The tool includes information such as:

- Number of I/O of each type
- Average distance of cable tray and average distance of cabling from control room to Junction Box and to device
- Estimates of amount of engineering and field labour required in the various project components, and their respective labour rates
- Costs of field Junction Boxes, Megablocks in the case of Fieldbus, Marshalling Cabinets, System Cabinets, and deck space footprint (additionally, square footage and weight if offshore)
- The number of terminations and the labour required for those terminations
- The cost of control system components, cards, etc.
- The engineering cost of control system configuration and drawings
- The labour costs of commissioning signals

Assumptions

A number of assumptions accompany this analysis:

- Exclude certain infrastructure costs which are not affected by the choice of what system will be utilized. Examples of infrastructure not included are:
    - Application Stations, Engineering Stations, Plant Historian, Asset Management System, etc.
    - Process Control Network (PCN) infrastructure — broadband wireless backhaul networks that service other plant operations and activities
    - The "plant steel" — support structures, vessels, piping, roadways, electrical substations, etc.
- A single-point device can have an integral process connection.
- This is a "macro-incremental" analysis, not a "micro-incremental" analysis — meaning the number of I/O reduces the amount of cable tray, cable, cabinets and I/O cards, not just increase the amount of spare space in them. A "micro-incremental" analysis, by contrast would assume the cost of one additional instrument does not affect number of pairs in a multi-pair cable, or space in cabinets, or spare points on cards, and so on.
- The wired topology consists of I/O cards in a system cabinet, cabled to marshalling cabinets in equipment rooms, carried to the field in cables on cable trays to field junction boxes, then in cable from field junction boxes to devices.
- The wireless topology consist of Emerson Process Management's Smart Wireless field devices, self organizing to a wireless network and access points which is integrated into a DeltaV or other type of controller.
- Wireless networks are limited to 30 wireless devices per system (conservative cost estimate). Although this will slightly increase the cost per point, it eliminates complexity of design in that no decisions have to be made regarding update rate – a 30 point Wireless network will support fast and slow update rates simultaneously – a reasonable price to pay for superior performance and flexibility of engineering. Flexibility of engineering is important because some decisions must be made early in a project before full design information is available. This design style reduces total elapsed project time.
- The commissioning of the systems utilizes the most efficient possible technique of pre-tagging field device and using the DeltaV "bind by tag" feature to save time, and that binding by tag proves the correct signal is associated with the correct placeholder in the DeltaV database.
- Costs of cabinets, labour, etc. are enumerated in Appendix A.

Analysis

The number of I/O of each type was stated from the data supplied.

The number of I/O that "can be wireless" was assumed, and is based on the total number of I/O of those that can be wireless and those that cannot.

The total number of I/O is the sum of all the I/O for the platform PAS, and the overall number of I/O that can be wireless is based on the actual monitoring function.

The number of wireless networks for each unit is calculated based on the number of I/O that can be wireless divided by the number of devices allowed per wireless network. (In this study, that number is 30 I/O per wireless network).

Using this I/O count, the costs of these I/O was then calculated for:

- Conventional wired with Fieldbus (separate power) – as built
- Conventional wired, Control Room Electronic Marshalling with Fieldbus (separate power)
- Conventional wired, Field Electronic Marshalling with Fieldbus (separate power)
- Conventional wired, Field Electronic Marshalling with Fieldbus (integrated power)
- Conventional wired, Field Electronic Marshalling, Fieldbus (integrated power) and wireless devices

Various scenarios were constructed to show a range of choices, including combinations of technology. Additionally, as distance has traditionally been perceived as a significant factor, the entire set of scenarios was evaluated at average distances ranging from 25 to 150 metres. The results revealed which factors had the greatest effect on average cost per point and magnitude of savings that could be expected under different scenarios.

The scenario with conventional point-to-point wiring and Fieldbus (separate power) is effectively the as-built system and is used as the baseline case for comparison. From that baseline, it was determined that some percentage of the I/O in the database could be wireless.

Due to inclusion of Fieldbus in the as-built system, it didn't seem appropriate to only calculate Fieldbus for the monitoring portion; therefore combinations of scenarios were considered. The benefit of this combination analysis is that it fits real-life possibilities with I/O on Demand, and suggests an all encompassing design strategy that could save substantial amounts of money and also provide ongoing ease of maintainability / sustainability during the life of the platform.

Extrapolations

The various scenarios were each calculated at distances of 25 metres, 50 metres, 75 metres, 100 metres, 125 metres, and 150 metres. In each wired case, the final 10 metres consisted of cabling between the Junction Box and the field device. The reason for always including the Junction Box to device cabling is to show that it is essentially a fixed cost for the wired scenario, and thus the variable cost related to distance is only the somewhat lower cost of cable tray, cabling and labour per unit length.

Results

This section lists detailed tabular information on the number of I/O of each type, per unit area, calculations on number of wireless networks, and materials and labour costs separated by significant cost areas. Results are given on the basis of costs per signal and total aggregate comparable costs for each scenario.

Signal Counts and Analysis for Existing System

Of the overall 1874 signals in the platform Process Automation System (PAS) data provided by the client, it was determined that only 168 of them could potentially be wireless, which is approximately 9%. The following tables illustrate the signal counts for each scenario, and the number of Wireless I/O Cards is also calculated for the wireless scenario.

Table 1 – Wired with Fieldbus (separate power) as installed system

I/O						
Instrument Description	**Wired Number of I/O**	**CHARMS Control Room Number of I/O**	**CHARMS Field Junction Box Number of I/O**	**Fieldbus with integrated power Number of I/O**	**Fieldbus (separate power) Number of I/O**	**Wireless Number of I/O**
AI	**101**				**453**	
AO	**53**				**261**	
DI	**643**				**41**	
DO	**314**					
RTD	**8**					
Total No of I/O	**1119**	**0**	**0**	**0**	**755**	**0**
Total No of I/O plus Redundant I/O	**1119**	**0**	**0**	**0**	**755**	**0**

Table 2 – Wired, Control Room Electronic Marshalling and Fieldbus (separate power)

I/O						
Instrument Description	**Wired Number of I/O**	**CHARMS Control Room Number of I/O**	**CHARMS Field Junction Box Number of I/O**	**Fieldbus with integrated power Number of I/O**	**Fieldbus (separate power) Number of I/O**	**Wireless Number of I/O**
AI	**21**	**80**			**453**	
AO	**27**	**26**			**261**	
DI	**50**	**593**			**41**	
DO		**314**				
RTD		**8**				
Total No of I/O	**98**	**1021**	**0**	**0**	**755**	**0**
Total No of I/O plus Redundant I/O	**98**	**1021**	**0**	**0**	**755**	**0**

Table 3 – Wired, Field Electronic Marshalling and Fieldbus (separate power)

I/O						
Instrument Description	Wired Number of I/O	CHARMS Control Room Number of I/O	CHARMS Field Junction Box Number of I/O	Fieldbus with integrated power Number of I/O	Fieldbus (separate power) Number of I/O	Wireless Number of I/O
AI	21		80		453	
AO	27		26		261	
DI	50		593		41	
DO			314			
RTD			8			
Total No of I/O	98	0	1021	0	755	0
Total No of I/O plus Redundant I/O	98	0	1021	0	755	0

Table 4 – Wired, Field Electronic Marshalling and Fieldbus (integrated power)

I/O						
Instrument Description	Wired Number of I/O	CHARMS Control Room Number of I/O	CHARMS Field Junction Box Number of I/O	Fieldbus with integrated power Number of I/O	Fieldbus (separate power) Number of I/O	Wireless Number of I/O
AI	21		80	453		
AO	27		26	261		
DI	50		593	41		
DO			314			
RTD			8			
Total No of I/O	98	0	1021	755	0	0
Total No of I/O plus Redundant I/O	98	0	1021	755	0	0

Table 5 – Wired, Field Electronic Marshalling, Fieldbus (integrated power) and wireless

I/O							
Instrument Description	Wired Number of I/O	CHARMS Control Room Number of I/O	CHARMS Field Junction Box Number of I/O	Fieldbus with integrated power Number of I/O	Fieldbus (separate power) Number of I/O	Wireless Number of I/O	
AI	21		60	453		20	
AO	27		26	261			
DI	50		445	41		148	
DO			314				
RTD			8				Wireless Networks
Total No of I/O	98	0	853	755	0	168	6
Total No of I/O plus Redundant I/O	98	0	853	755	0	168	6

Effect of Distance on Costs with Different Installation Methods

There is some cost associated with the cable tray and cable installation, even in the installation of the field Electronic Marshalling and wireless systems. In this exercise, it is assumed that the wireless network is situated adjacent to the field Electronic Marshalling junction box. With large average distances, the cost per point increases linearly at a rate of about 4.1 dollars per metre for the wired and control room Electronic Marshalling, 0.85 dollars per metre for the field Electronic Marshalling systems, 0.9 dollars per metre for the Fieldbus systems and wireless system.

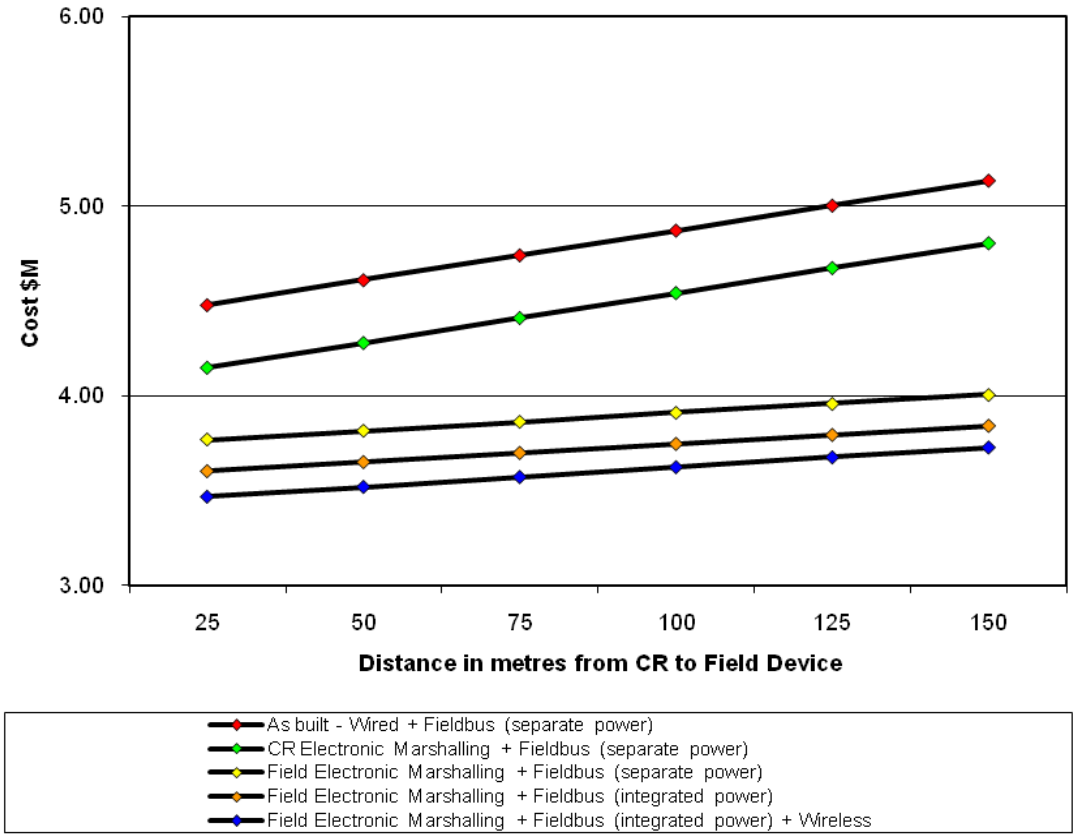

Figure 3 – Analysis of Cost over Distance on Platform PAS

Effect of Distance on Costs – Extrapolation to Platform Control System

The installed system used in this case study used conventional wired technology and FOUNDATION Fieldbus with separate power supplies. In these case studies the usage of control room and field Electronic Marshalling was considered along with wireless as stated below:

Case 1 – 60% Wired and 40% Fieldbus

Case 2 – 5% Wired, 55% Control Room Electronic Marshalling and 40% Fieldbus (separate power)

Case 3 – 5% Wired, 55% Field Electronic Marshalling and 40% Fieldbus (separate power)

Case 4 – 5% Wired, 55% Field Electronic Marshalling and 40% Fieldbus (integrated power)

Case 5 – 5% Wired, 46% Field Electronic Marshalling, 40% Fieldbus (integrated power) and 9% Wireless

Therefore, it is useful to extrapolate the comparison to the entire platform to answer the question of whether a platform with 5% Wired, 55% Control Room Electronic Marshalling and 40% Fieldbus with separate power is a lower cost than one that is 5% Wired, 55% Field Electronic Marshalling and 40% Fieldbus with integrated power. These comparisons were performed under the assumption that the I/O counts were a good representation of the platform PAS. That cost per signal was then extrapolated proportionally to represent the five cases above (using current commercially available products). The total costs, for the scope of the case studies under analysis, are seen in Table 6.

Table 6 – Comparison of Total Costs

	Installed System - Wired and Fieldbus (separate power)	Control Room Electronic Marshalling and Fieldbus (separate power)	Field Electronic Marshalling and Fieldbus (separate power)	Field Electronic Marshalling and Fieldbus (integrated power)	Field Electronic Marshalling, Fieldbus (integrated power) and Wireless
Costs ($M)	**4.87**	**4.54**	**3.91**	**3.75**	**3.62**
Savings ($M) from Installed System	**Base**	**0.33**	**0.96**	**1.13**	**1.25**
% Savings	**Base**	**6.77%**	**19.75%**	**23.13%**	**25.64%**

Total Number of Points Considered	**1874**	**1874**	**1874**	**1874**	**1874**
Wired	1119	98	98	98	98
Control Room Electronic Marshalling		1021			
Field Electronic Marshalling			1021	1021	853
Fieldbus (integrated power)				755	755
Fieldbus (separate power)	755	755	755		
Wireless					168

Analysis of Installation Costs

The most significant portion of the wired, Electronic Marshalling and Fieldbus cost is in the transmitter cable with its associated terminations between the junction box and the field device – $174 per point when it is Fieldbus and $410 per device when it is wired or with Electronic Marshalling. Another significant cost factor is the cost of cable tray between the control room and the field device – $119 per point when it is field Electronic Marshalling and $186 when it is wired or control room Electronic Marshalling. Also, because field Electronic Marshalling and wireless require fewer drawings and have easier commissioning, there are also engineering savings of about $975 per device when it is field Electronic Marshalling and $1819 when wireless. These costs are independent of the distance of the field device to the control room. The diagram below illustrates where the most significant wired costs are located:

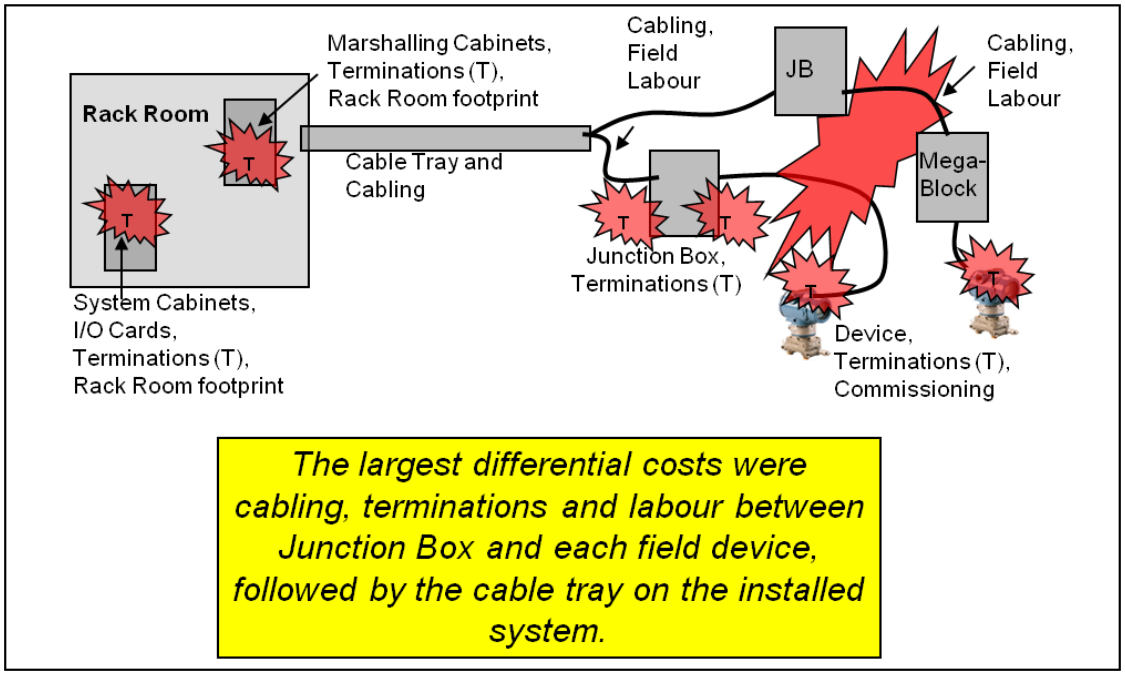

Figure 4 – Largest Differential Cost Locations – Installed System

Interpretation of Results

I/O on Demand enables engineers to determine the best type of device and installation method for each situation. Some key factors to consider are:

- The average distance of devices from control room
- The proportion of devices that can be installed either with field Electronic Marshalling or wireless
- The extent of the use of FOUNDATION Fieldbus

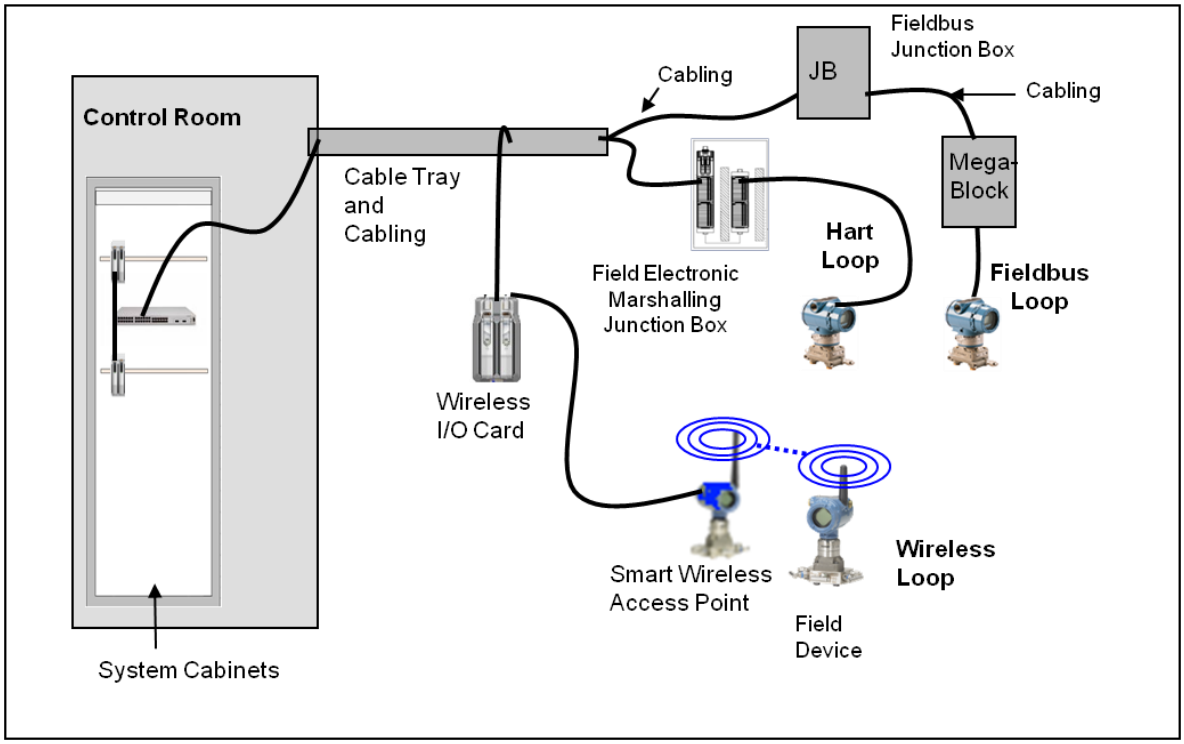

Figure 5 – Example of I/O on Demand Installation

Contribution of Distance to Savings

There are two distances that factor into the cost analysis: distance of the cabling and cable tray from the control room to the Field Junction Box and then to the field device. We used 90 metres as the average distance from the control room to the junction box, at larger distances, these savings will increase. The charts in Figures 3 and 4 depict the effect of cable tray and cabling distance. We used 10 metres as the average distance for the Field Junction Box to field device in this study; we used an average cost of about $10 per metre for this section of wiring. If one's individual circumstances require a different average distance or cost per metre, then adjust accordingly.

Proportion of Devices that can be Wireless

In this data set, it was determined that 9% of the platform PAS signals could have gone wireless. One should adjust this percentage to suit their individual judgment and circumstances.

Summary

This study proves that Electronic Marshalling or wireless technology in process control applications is cost effective in any scenario over wired technology, not only in the longer distance applications. Indeed, savings ranging between 7% and 26% are possible in typical process applications where the distances are relatively short.

However, it is important to emphasize that the hard wired paradigm has already excluded many user cases because of cost. Those cases should be revisited to see if Electronic Marshalling or wireless technology can bring added value with regards to useful process data and/or predictive maintenance information, leading to the protection of valuable plant assets and higher availability.

It should also be noted that this study did consider other economic factors such as reduced time to start-up, which in turn leads to earlier start of positive cash flow and reduced cost of money borrowed for construction but have not included those findings within this paper.

This study has established a methodology for calculating project savings due to use of Electronic Marshalling and wireless technology. If others wish to pursue other scenarios to determine the level of cost savings, this method can be used in the calculations. It is only necessary to have a data set, signal counts and costs to be considered. Interested parties should visit the DeltaV website or contact a local sales office to contract a specific study.

Appendix A — Cost Input Data

Table 7 - Cost Input Data

Number of Channels per AI HART Card	16	
Number of Channels per AO HART Card	8	
Number of Channels per DI Card	16	
Number of Channels per DO Card	8	
Number of Channels per RTD/TC Card	8	
Number of Devices per Fieldbus Segment	10	
Number of Devices per Wireless Network	30	
Average cable length (Control room to Field Junction Box)	90	Metres
Average spur length (FJB to Device)	10	Metres
Engineering labour rate	$ 200.00	/hr
Field labour rate	$ 100.00	/hr
Process control engineer	$ 150.00	/hr
% Savings on commissioning time	80%	
Labour to commission traditional device	5	Hrs
Number of Pairs in Home Run Multi Pair Cable	24	
Number of Home Run Multi Pair Cables in 24 inch Tray	288	(24" cable trays, 40% full)
Number of cards per Cabinet	32	
Hours to Install Marshalling Cabinet (just cabinet)	20	
Hours to install FJB (Just box)	8	
Hours to Configure Signal in System	0.5	

Table 8 - Number of Terminations per Device

I/O Card	Marshalling Cabinet	Junction Box	Devices	**Total**
3	6	6	2	**17**

Table 9 - Wired device wiring

Wired Device Wiring						
Materials						
Item	**Basis Quantity**		**Prorating Factor**		**Cost/Unit**	
Marshalling Cabinets	1	ea.	200	pair/cabinet	$ 3,000.00	/cabinet
Control Room Cable	90	Metres	24	pair/cable	$ 25	/metre cable
Cable Trays	90	Metres	288	pair/tray	$ 75	/metre tray
Junction Boxes	1	Ea	120	pair/box	$ 1,000.00	/box
Device Cable	10	Metres	1.00	pair/dev	$ 10	/Metre cable
Labour						
Task	**Basis Quantity**		**Prorating Factor**		**Labour Cost**	
Pull Control Room Cable	90	Metres	24	pair/cable	$ 100.00	/hr
Pull Device Cable	10	Metres	1	pair/cable	$ 100.00	/hr
Terminate wire Pair	17	terms/pair	1	pair	$ 100.00	/hr
Install Marshalling Cabinets	1	Ea	200	pair/cabinet	$ 100.00	/hr
Install Junction Boxes	1	Ea	120	pair/box	$ 100.00	/hr
Install Cable Trays	90	Metres	288	pair/tray	$ 100.00	/hr
Install Cable Tray	10	Metres	1.00	pair/cable	$ 100.00	/hr

Table 10 - Control Room Electronic Marshalling device wiring

Control Room Electronic Marshalling Device Wiring						
Materials						
Item	**Basis Quantity**		**Prorating Factor**		**Cost/Unit**	
CHARMS Cabinets	1	ea.	576	pair/cabinet	$ 6,000.00	/cabinet
Control Room Cable	90	Metres	24	pair/cable	$ 25	/metre cable
Cable Trays	90	Metres	288	pair/tray	$ 75	/metre tray
Junction Boxes	1	Ea	120	pair/box	$ 1,000.00	/box
Device Cable	10	Metres	1.00	pair/dev	$ 10	/Metre cable
Labour						
Task	**Basis Quantity**		**Prorating Factor**		**Labour Cost**	
Pull Control Room Cable	90	Metres	24	pair/cable	$ 100.00	/hr
Pull Device Cable	10	Metres	1	pair/cable	$ 100.00	/hr
Terminate wire Pair	17	terms/pair	1	pair	$ 100.00	/hr
Install CHARMS Cabinets	1	Ea	576	pair/cabinet	$ 100.00	/hr
Install Junction Boxes	1	Ea	120	pair/box	$ 100.00	/hr
Install Cable Trays	90	Metres	288	pair/tray	$ 100.00	/hr
Install Cable Tray	10	Metres	1.00	pair/cable	$ 100.00	/hr

Table 11 - Field Electronic Marshalling device wiring

Field Electronic Marshalling Device Wiring						
Materials						
Item	**Basis Quantity**		**Prorating Factor**		**Cost/Unit**	
Ethernet Cable	90	Metres	1	pair/cable	$ 55	/metre cable
Cable Trays	90	Metres	12	pair/tray	$ 40	/metre tray
CHARMS Marshalling Junction Boxes	1	Ea	48	pair/box	$ 3,000.00	/box
Device Cable	10	Metres	1.00	pair/dev	$ 10	/Metre cable
Labour						
Task	**Basis Quantity**		**Prorating Factor**		**Labour Cost**	
Pull Ethernet Cable	90	Metres	1	pair/cable	$ 100.00	/hr
Pull Device Cable	10	Metres	1	pair/cable	$ 100.00	/hr
Terminate wire Pair	8	terms/pair	1	pair	$ 100.00	/hr
Install CHARMS Marshalling Junction Boxes	1	Ea	48	pair/box	$ 100.00	/hr
Install Cable Trays	90	Metres	12	pair/tray	$ 100.00	/hr
Install Cable Tray	10	Metres	1	pair/cable	$ 100.00	/hr

Table 12 - Field Device Wiring

Fieldbus Device Wiring						
Materials						
Item	**Basis Quantity**		**Prorating Factor**		**Cost/Unit**	
Marshalling Cabinets	1	ea.	240	pair/cabinet	$ 3,000.00	/cabinet
Control Room Cable	90	Metres	10	pair/cable	$ 15	/metre cable
Cable Trays	90	Metres	72	pair/tray	$ 75	/metre tray
Junction Boxes	1	Ea	60	pair/box	$ 1,000.00	/box
Megablock Cable	5	Metres	1	Pair/cable	$.....10	/metre/cable
Device Cable	5	Metres	1.00	pair/dev	$ 10	/Metre cable
Labour						
Task	**Basis Quantity**		**Prorating Factor**		**Labour Cost**	
Pull Control Room Cable	90	Metres	10	pair/cable	$ 100.00	/hr
Pull Megablock Cable	5	Metres	1	Pair/cable	$.....100.00	/hr
Pull Device Cable	5	Metres	1	pair/cable	$ 100.00	/hr
Terminate wire Pair	15	terms/pair	1	pair	$ 100.00	/hr
Install Marshalling Cabinets	1	Ea	240	pair/cabinet	$ 100.00	/hr
Install Junction Boxes	1	Ea	60	pair/box	$ 100.00	/hr
Install Cable Trays	90	Metres	120	pair/tray	$ 100.00	/hr
Install Cable Tray	10	Metres	1.00	pair/cable	$ 100.00	/hr

Appendix B – Wireless Gateway Equivalents

The table below shows what a single Wireless network takes the place of.

Table 13 - Wireless network Equivalents

	50 devices per wireless network	100 devices per wireless network
I/O Cards	3.125	6.25
System Cabinets	0.1	0.2
Marshalling Cabinets	0.25	0.5
Cable metres (100 metres distance)	208	416
Junction Boxes	0.42	0.84

Appendix C — Weight and Space Savings

Table 14 - Weight and Space Savings

Weight Savings (Tonnes)					
	Installed System - Wired and Fieldbus (separate power)	Control Room Electronic Marshalling and Fieldbus (separate power)	Field Electronic Marshalling and Fieldbus (separate power)	Field Electronic Marshalling and Fieldbus (integrated power)	Field Electronic Marshalling, Fieldbus (integrated power) and Wireless
Weight (Tonnes)	**52.10**	**51.30**	**24.90**	**24.70**	**21.90**
Savings (Tonnes) from Installed Syst	**Base**	**0.80**	**27.20**	**27.40**	**30.20**
% Savings	**Base**	**1.54%**	**52.21%**	**52.59%**	**57.97%**

Total Number of Points Considered	**1874**	**1874**	**1874**	**1874**	**1874**
Wired	1119	98	98	98	98
Control Room Electronic Marshalling		1021			
Field Electronic Marshalling			1021	1021	853
Fieldbus v11				755	755
Fieldbus Pre v11	755	755	755		
Wireless					168

Space Savings (m2)					
	Installed System - Wired and Fieldbus (separate power)	Control Room Electronic Marshalling and Fieldbus (separate power)	Field Electronic Marshalling and Fieldbus (separate power)	Field Electronic Marshalling and Fieldbus (integrated power)	Field Electronic Marshalling, Fieldbus (integrated power) and Wireless
Space (m2)	**158.70**	**152.30**	**121.70**	**120.10**	**116.10**
Savings (m2) from Installed System	**Base**	**6.40**	**37.00**	**38.60**	**42.60**
% Savings	**Base**	**4.03%**	**23.31%**	**24.32%**	**26.84%**

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