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# FEASIBILITY ANALYSIS FOR INTRODUCING OF INTEGRATED WIRED/WIRELESS INDUSTRIAL COMMUNICATION NETWORKS

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## ABSTRACT
*This paper deals with research related to the needs and feasibility of introduction of integrated wired/wireless industrial communication networks and takes as an example the real plant of the Sugar Refinery in Brcko, Bosnia and Herzegovina. For purposes of research was used the Emerson Process Management calculator "I/O on Demand" which provides unlimited flexibility field device that contains the following options: Conventional Wired, Fieldbus, Wireless and Field Electronic Marshalling with possibility of using one or more of these options. The obtained results prove that the Wireless technology and Field Electronic Marshalling are feasible and cost-effective in applications to process control over longer distances and in process applications where distances are relatively small. Analysis of the network is implemented in such a way that the results can be applied to other types of plants adjusting field devices and their average distances from the control room and the junction box.*
**Keywords:** Wireless devices, Field Electronic Marshalling, Distributed Control System DeltaV

## 1. INTRODUCTION
For purposes of study of feasibility and needs for introducing integrated wired and wireless networks here is taken an example of a real plant in the Sugar Refinery in Brcko, Bosnia and Herzegovina, and was used Emerson's calculator "I/O on Demand" which provides the ultimate flexibility with devices installed in the plant [1]. It contains the following options:

- Conventional wired,
- Fieldbus,
- Wireless,
- Field Electronic Marshalling,

with possibility of using one or more of these options. The Field Electronic Marshalling is the evolution of communication technologies with potential to save significant amounts of money and time to get integrated networks in process applications [1], [2].

## 2. OVERVIEW OF THE METHODOLOGY FOR COSTS STUDY
Calculator "I/O on Demand" allows determining the best type of equipment and installation methods for each situation and network integration. Some of the key factors in the budget are:

- The average distance of the devices from the control room.
- The percentage of devices that can be installed using wireless technology and Electronic Marshalling.
- Scope of use Fieldbus.

There are two distances as a factor analysis of the costs of integration:

- length of the cable from the control room to the junction box,
- distance from the junction box to the installed devices in the plant.

The data required for the feasibility study of an integrated wired/wireless network have obtained from the Sugar Refinery in Brcko with existing conventional wired devices as shown in Figure 1, where in the control room was placed DCS (Distributed Control System) Delta V with containing controllers and I/O cards [2], [3]. The cabling continues to RIO cabinets and cable guide to the plant or junction boxes that are specially wired cables to the devices in the plant.

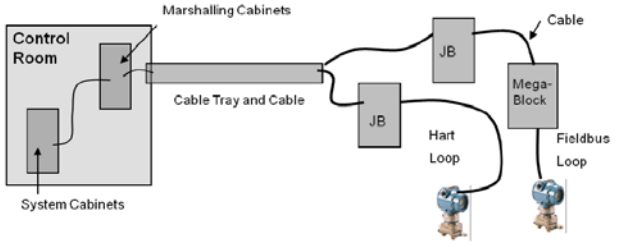



*Figure 1. Conventional wired devices [1]*

Existing control system DCS DeltaV in the Sugar Refinery in Brcko used in this study is using conventional wired technologies and integrate existing network with wireless technologies as shown in Figure 2. Someone needs to go through several scenarios using Emerson's calculator to obtain the optimal network that is economically viable for management of the factory.

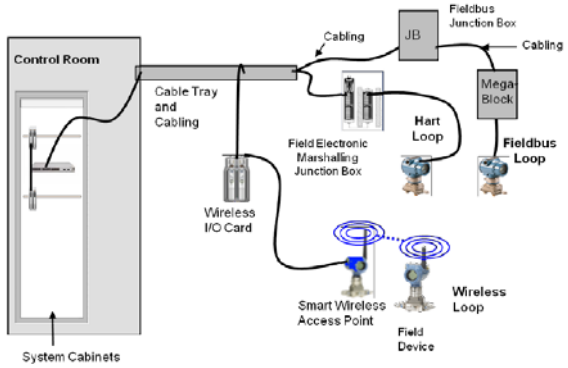



*Figure 2. Integrated wired/wireless network [1]*

In this study integrating wired and wireless networks include the following scenarios:

- Scenario 1: 75% Wired and 25% Fieldbus,
- Scenario 2: 33% Wired, 44% Field Electronic Marshalling and 23% Fieldbus,
- Scenario 3: 26% Wired, 39% Field Electronic Marshalling, 23% Fieldbus and 12% Wireless.

Each of these scenarios was calculated for distances of 30 meters, 60 meters, 90 meters, 120 meters, 150 meters and 180 meters. In each scenario wire connection the greatest distance cabling from the junction box to the device in the plant is about 10 meters.

## 3. COST ANALYSIS OF WIRING

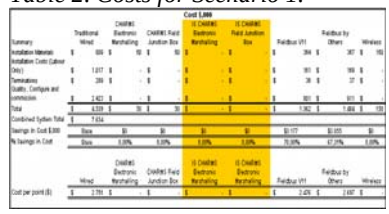
In the present study of feasibility for introducing of integrated wired and wireless network (Figure 2) for calculating the costs of labor, equipment installation, electrical installation and wiring of cable tray was used calculator "I/O on Demand" by comparing the results of the total costs for each scenario [4]. The presented results in the following tables were obtained for the average distance from the control room to the junction box of 90 meters. The average distance from the junction box to the installed equipment within the plant is about 10 meters and in Fieldbus Loop on average about 5 meters between junction boxes, Mega Block and device, while the average installation cost is 10$ per meter.

Integration of existing network is based on the scenario 1 where the total of 2000 signals in the Sugar Refinery using Emerson's calculator can potentially be 1500 signals connected to the Wired (so that is 75%) and 500 signals using the Fieldbus (so that is 25%), Table 1. The total costs for this scenario amount to 7,634$ and are presented in Table 2.

*Table 1. Number of I/O for scenario 1.*

| | I/O | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Instrument Description | Wired Number of I/O | CHARMS Control Room Number of I/O | CHARMS Field Junction Box Number of I/O | IS CHARMS Control Room Number of I/O | IS CHARMS Field Junction Box Number of I/O | Fieldbus V1 Number of I/O | Fieldbus by Others Number of I/O | Wireless Number of I/O |
| Number of Field Instruments | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| AI | 300 | 0 | 0 | 0 | 0 | 100 | 100 | 0 |
| AO | 300 | 0 | 0 | 0 | 0 | 100 | 100 | 0 |
| DI | 300 | 0 | 0 | 0 | 0 | 100 | 100 | 0 |
| DO | 300 | 0 | 0 | 0 | 0 | 100 | 100 | 0 |
| RTD | 300 | 0 | 0 | 0 | 0 | 100 | 100 | 0 |
| Total No of I/O | 1500 | 0 | 0 | 0 | 0 | 500 | 500 | 0 |

*Table 2. Costs for Scenario 1.*

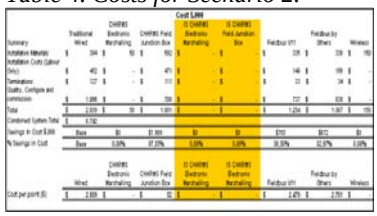


In scenario 2 the total of 2000 signals in the Sugar Refinery using Emerson's calculator can potentially be 660 signals connected to the Wired (so that is 33%), 880 signals using the Field Electronic Marshalling (so that is 44%) and 460 signals using the Fieldbus (23%), Table 3. The total costs for this scenario amount to 6,742$ and are presented in Table 4.

*Table 3. Number of I/O for scenario 2.*

| | I/O | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Instrument Description | Wired Number of I/O | CHARMS Control Room Number of I/O | CHARMS Field Junction Box Number of I/O | IS CHARMS Control Room Number of I/O | IS CHARMS Field Junction Box Number of I/O | Fieldbus V1 Number of I/O | Fieldbus by Others Number of I/O | Wireless Number of I/O |
| Number of Field Instruments | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| AI | 132 | 0 | 176 | 0 | 0 | 92 | 92 | 0 |
| AO | 132 | 0 | 176 | 0 | 0 | 92 | 92 | 0 |
| DI | 132 | 0 | 176 | 0 | 0 | 92 | 92 | 0 |
| DO | 132 | 0 | 176 | 0 | 0 | 92 | 92 | 0 |
| RTD | 132 | 0 | 176 | 0 | 0 | 92 | 92 | 0 |
| Total No of I/O | 660 | 0 | 880 | 0 | 0 | 460 | 460 | 0 |

*Table 4. Costs for Scenario 2.*

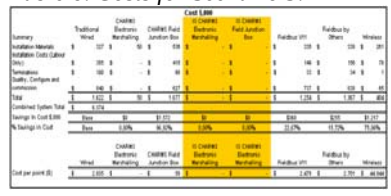


In scenario 3 the total of 2000 signals in The Sugar Refinery using Emerson's calculator can potentially be 520 signals connected to the Wired (so that is 26%), 780 signals using the Field Electronic Marshalling (so that is 39%), 460 signals using the Fieldbus (so that is 23%) and 240 signals for 8 Wireless networks (so that is 12%), Table 5. The total costs for this scenario amount to 6,374$ and are presented in Table 6.

*Table 5. Number of I/O for scenario 3.*

| | I/O | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Instrument Description | Wired Number of I/O | CHARMS Control Room Number of I/O | CHARMS Field Junction Box Number of I/O | IS CHARMS Control Room Number of I/O | IS CHARMS Field Junction Box Number of I/O | Fieldbus V1 Number of I/O | Fieldbus by Others Number of I/O | Wireless Number of I/O |
| Number of Field Instruments | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| AI | 104 | 0 | 156 | 0 | 0 | 92 | 92 | 48 |
| AO | 104 | 0 | 156 | 0 | 0 | 92 | 92 | 48 |
| DI | 104 | 0 | 156 | 0 | 0 | 92 | 92 | 48 |
| DO | 104 | 0 | 156 | 0 | 0 | 92 | 92 | 48 |
| RTD | 104 | 0 | 156 | 0 | 0 | 92 | 92 | 48 |
| Total No of I/O | 520 | 0 | 780 | 0 | 0 | 460 | 460 | 240 |

*Table 6. Costs for Scenario 3.*



Results obtained for costs using the calculator on all the scenarios are presented in Table 7 and lead to the following results of depending of the cost on the distance which increases linearly at a rate of 6.42$ per meter for scenario 1, at a rate of 3.88$ per meter for scenario 2, and at a rate of 3.28$ per meter for scenario 3. The total costs of introducing an integrated wired and wireless network can be seen in Table 8.

*Table 7. Costs depending on the distance*

| Distance (m) | Scenario 1 ($) | Scenario 2 ($) | Scenario 3 ($) |
|---|---|---|---|
| 30 | 7172 | 6462 | 6138 |
| 60 | 7403 | 6602 | 6256 |
| 90 | 7634 | 6742 | 6374 |
| 120 | 7865 | 6881 | 6492 |
| 150 | 8096 | 7021 | 6610 |
| 180 | 8327 | 7161 | 6728 |

*Table 8. Costs of all scenarios*

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Costs ($m) | 6,42 | 3,88 | 3,28 |
| Savings ($m) from Installed System | | 2,54 | 3,14 |
| % Savings | | 39,56 | 48,9 |
| Total Number of Signals | 2000 | 2000 | 2000 |
| Wired | 1500 | 660 | 520 |
| Field Electronic Marshalling | | 880 | 780 |
| Fieldbus | 500 | 460 | 460 |
| Wireless | | | 240 |

Therefore, it is necessary to perform comparisons throughout the plant to be able to answer the question of whether the integrated wired/wireless network in scenario 3 has a lower price than network in scenario 1. The resulting obtained diagrams are shown in Figure 3. This study proves that the wireless technology through the Field Electronic Marshalling for the applications of industrial processes is cost-effective in any scenario as long distances as well as in applications where distances are relatively small.

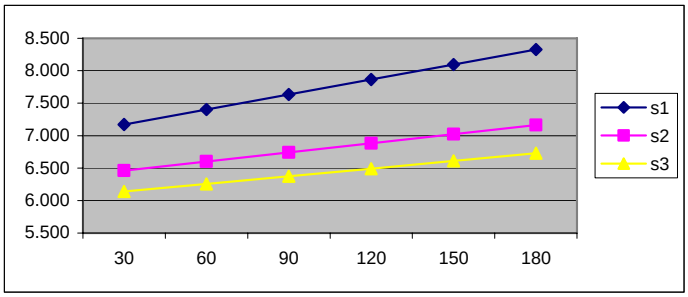



*Figure 3. Results of cost analysis for introduction of integrated network*

## 4. CONCLUSION

It can be concluded that the study results show savings between 39.56% and 48.9%. The achievable potential savings of 48.9% are using scenario 3, which contains 26% Wired, 39% Field Electronic Marshalling, 23% Fieldbus and 12% Wireless. In general, the study results show that the presence of wireless network in the integration is cost-effective and contributes positively with additional savings at any distance and much more at great distances.

## 5. REFERENCES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[4] www.ioondemandcalculator.com