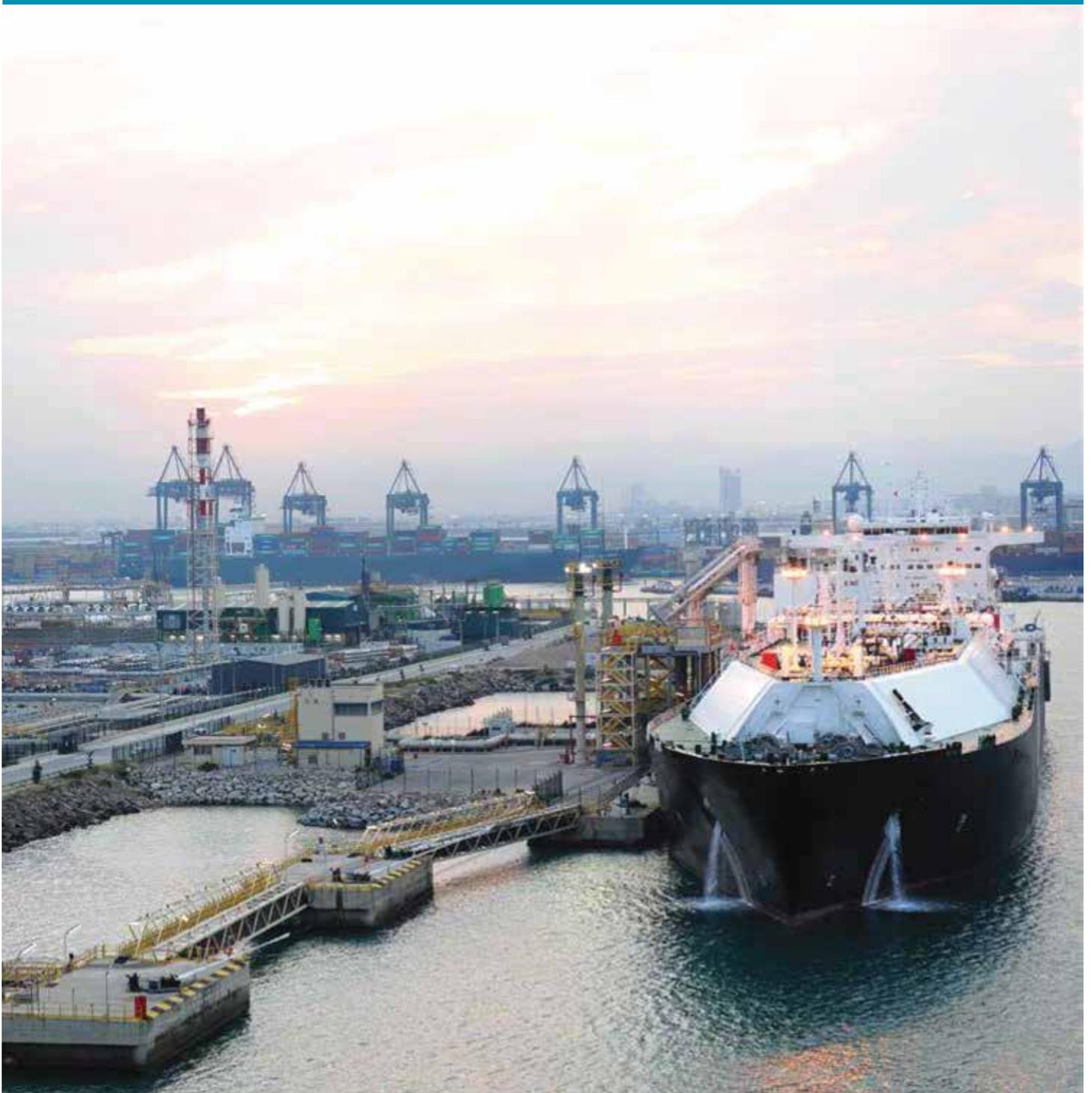


# INNOVATIVE INFORMATION SYSTEM LANDSCAPE FOR LNG TERMINAL MANAGEMENT



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## Abstract

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Natural gas is one of the largest sources of clean energy. It has several applications in industry that drive demand. With climate change legislation expected to become more stringent, and with the growing recognition of sustainable practices, the demand for Natural gas is expected to grow even further. By implication, the industry will benefit from best-in-class IT infrastructure to meet the challenges it faces as demand grows. This paper provides an approach to building a scalable, robust and collaborative information system for Natural gas terminal management.

## Introduction

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The Natural gas industry has evolved over the last 20 to 30 years. Exploration and production companies sell their product at wellheads to large transportation companies, who ship it to utility companies through pipelines. Utilities then distribute the gas to residential consumers. The prices at which producers could sell were federally regulated. State regulations decided the price at which local distribution companies sold natural gas to their consumers.

The importance of Natural gas as a sustainable source of energy and the dynamic business environment has made it necessary to adopt structured IT systems and processes to manage distribution.



Figure 1 – Natural gas value chain

## Natural Gas Business Challenge

Natural gas production starts by lifting gas out of the ground, refer Figure 1. Production covers the processing of Natural gas before sending it through pipelines for transportation. The processing activity removes various substances like heavy metal and other impurities from the Natural gas. The temperature of natural gas is cooled to -160 deg.C to convert into liquid. This cooling process makes transportation more economical as the volume is reduced significantly from gas to liquid. The liquefaction process removes the impurities and aids in recovery of another valuable product, ethane.

The storage of Natural gas is an important activity. It helps achieve reliable supply even when seasonal demand patterns vary.

Transporting Natural gas over long distances across oceans is complex and requires large investments. Such transportation constitutes 25% of the world Natural gas movement and requires dedicated ships with efficient planning and scheduling processes. Stoppages in production plants, adverse weather conditions, tides and ship failure events can disrupt the loading and transportation process.

At the receiving terminal, the objective is to minimize inventory and storage requirements. This involves unloading the Natural gas at optimum flow-rates and at the same time balancing (the send out rate for) distribution. Unloading operation need to minimize the demurrage cost in the case of any unforeseen events.

# Natural Gas Business Challenges

Transportation of Natural gas, therefore, presents a number of business challenges. These include:

- Meeting contractual obligations
- Health, Safety, Security and Environment (HSSE) Compliance
- Interoperability standards natural gas quality
- Integration of various systems like ERP, Manufacturing Execution and Automation systems
- Ship nomination handling - due to availability and reliability of transporters
- Customer nomination for gas redelivery – as number of customers is increasing
- Complexity of terminal scheduling is high – because of more operational constraints
- Achieving more accurate Mass/Energy balance – dynamic nature of operating conditions
- Demurrage analysis – to record different shipping related events and track them accurately



## Customer/ Extraction point nominations for redelivery of gas

At various extraction points of Natural gas pipelines, the redelivery nominations are to be performed in consideration with pipeline nomination procedures. The nomination is influenced by customer consumption or maintenance, shut down activities and other operational limitations.



## Complexity of Terminal scheduling

Complexity of terminal scheduling is ever increasing due to increase in number of customers at each consumption point and availability of Natural gas on Spot Market. Increase in customers poses the challenge of increase in marine terminal throughput (i.e. quantity of gas handled on a specified time duration, say per day). Natural gas on Spot Market expects adhoc scheduling of ships carrying Natural gas procured at significantly lower prices. Hence, more number of ships has to be accommodated on a very tight schedule.



## Health, Safety, Security and Environment (HSSE) Compliance

To meet increasing demand the volume of Natural gas handled by all modes of logistics also increases. Number of ships transporting Natural gas has increased from 120 in the year 2000 to 400 by 2014. (Source: IHS Fairplay). The bulk movement poses HSSE risks and may violate country-specific compliance policies.



## Interoperability Standards on Natural Gas Quality

In the European Union, the objective of providing consistent quality Natural gas to consumers is driven by interoperability standards. This policy assumes that the fundamental characteristic of the Natural gas market as a whole, from production to burner tip, needs to be taken into account to harmonize quality. Therefore, gas composition must be monitored throughout the supply chain.



## Accuracy of Mass/Energy balance at Terminals

Achieving good accuracy of Mass/Energy balance at Natural gas terminals is a challenge as the process is continuous and dynamic in nature. The unloading of Natural gas from ship is a faster process step and decided by the pumping rate of ship. But the rate of delivery of Natural gas to different distribution/consumption points depend on consumer usage, and slower in nature. Hence, achieving accurate Mass/Energy balance at terminals is a challenge and requires a right tool to address the same.



## Demurrage analysis

With multiple shippers sharing the same terminal, the challenge is to record various events related to ship (e.g. Mooring event, Hose connection event) and monitoring various activities. The events recorded above will form the basis for demurrage analysis.

The above business requirements require more robust framework and seamless integration between enterprise applications and core operations applications. Following are the few challenges faced by current solution landscape,

- Adaptability – less adaptable to ever changing business environment
- Process driven Integration – Integration is more application driven rather than business process driven
- Scalability - more of stand alone applications less scalable
- Future proof – lack of support for centralized analysis of enterprise data and decision support, predict analysis capabilities



## Integration of different business systems and execution systems

The integration of various systems in the Natural gas supply chain requires an in-depth understanding of business process, operational aspects, quality management, asset management and of high level business systems like ERP. Apart from business systems a list of manufacturing execution systems and automation systems need to be integrated.



## Ship nomination handling

Ship nominations become important with competition for berth and storage space. Nominations change due to operational constraints and other unforeseen events like weather and tide.



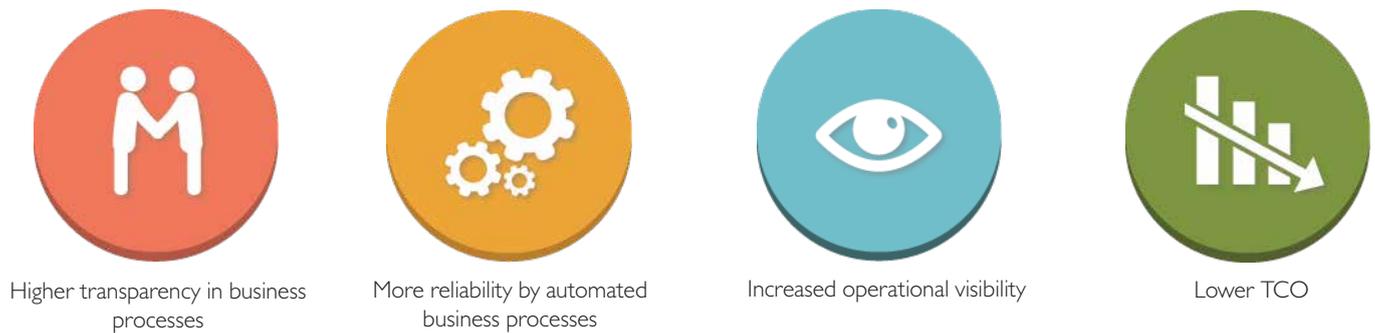
## Contractual Obligations

The Natural gas supply chain is asset centric. It requires large investments. Suppliers mitigate the risk by ensuring long-term contracts from customers. Most of these contracts dictate "Annual Contractual Quantity (ACQ)" and "Monthly Contractual Quantity (MCQ)" for supply of gas. As the demand peaks and the number of customers also increases, the expectation of excellence in operations continues to rise even though the constraints exist.

# Solution Architecture

Main objective is to provide reference architecture (Figure – 2) for organizations in the Natural gas business, based on current challenges and what they may face in the near future. This single architectural approach will encourage simplification and unification for the system integrators(SI) and Solution providers in this domain.

The solution will enable business to achieve,



The architecture will support more collaborative environment where operational staff will rely upon more data-driven events, work flows and automated analysis for identifying risks. Also provides up-to-date KPIs to fully understand the health of the business.

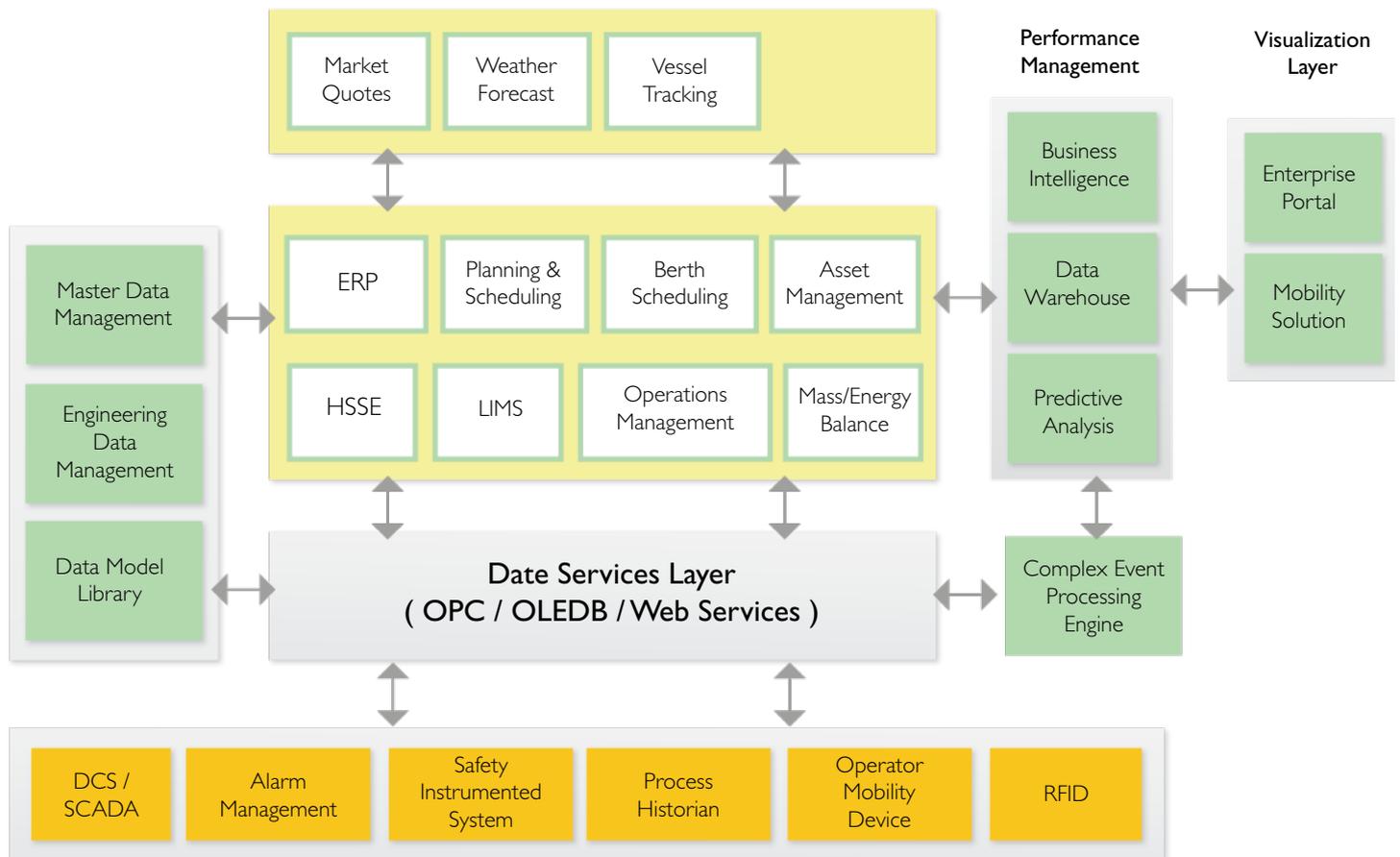


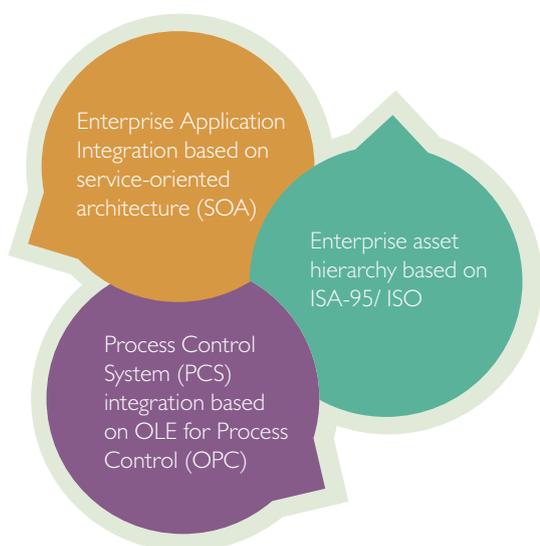
Figure 2 – Solution Architecture for Natural gas business

## A Collaborative Approach

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The Natural gas value chain requires interaction of multiple stake holders spanning across different domains in a seamless manner. In order to achieve this, the IT landscape must have a collaborative environment where multiple stake holders can exchange information, create simple work flows and achieve more visibility on the operations.

The collaborative framework has to be built on industry standards to name a few,



## Focus on Planning and Scheduling

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Planning and scheduling have to be developed over a collaborative environment like web-based portal. The input for the planning and scheduling have to be validated based on individual users or departments. Publishing of production/delivery plan need to be iterative in nature and version for the plans have to be maintained. The input data changes to the plan must be event-based. These changes have to propagate the dependent data/activity by the system in an automated manner. At any point in time, all the departments involved in planning and scheduling should have access to the 'single source of truth'.

The transactional data has to be transported to the business data warehouse. Industry standard data mining and statistical analysis tools have to be a part of it. The predictive analytics tools need to support various simulation options like "what-if" scenario analysis.

Visualization layer must be Web-based/portal-based and supported in any standard browser. The portal must support viewing engineering data (drawing). Provision must be made for deploying the visualization components/widgets across all standard mobile devices.

## Predictive Analytics

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Predictive Analytics have to be applied in order to process the high volume stream of data from different operational systems. This helps the business to plan proactively and keep the related assets up-to-date and more reliable and thereby minimizing the downtime.

## Security

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Process Control Domain (PCD) security guidelines have to be adhered throughout the IT system lifecycle processes. IT compliance for corporate IT systems and IACS (Industrial Automation and Control Systems) must be implemented and processes need to be established for monitoring the same.

## Conclusion

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As Natural gas business complexity increases, the back-end IT solution landscape must also evolve. Current applications and tools can support the emerging needs of Natural gas terminal management, but selecting the right System Integrator (SI) is the first step in achieving this. An experienced SI will provide accelerators, integration methods and project plans to meet timelines at optimum cost.

## About Author

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Pandiarajan Palanichamy is a consulting partner with Oil and Gas domain team of Wipro Limited. He is a Chemical engineer with a Masters Degree in Petroleum Refining and Petrochemicals. He has more than 20 years of experience in application development and Refinery MES application and SAP IS-Oil project implementations. Currently, he is working on solution development for downstream business.

## About Wipro Ltd.

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