INTEGRITY MANAGEMENT SYSTEM FOR THE ULTRA DEEPWATER MEDGAZ PIPELINE

23rd World Gas Conference, Amsterdam 2006

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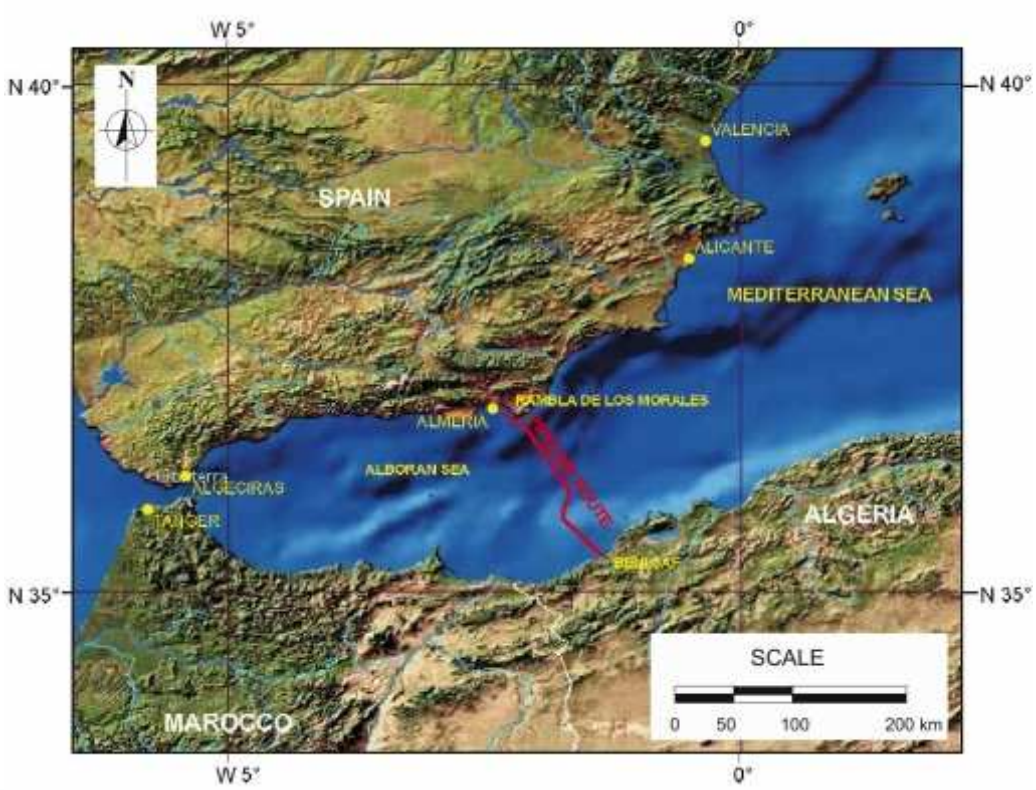
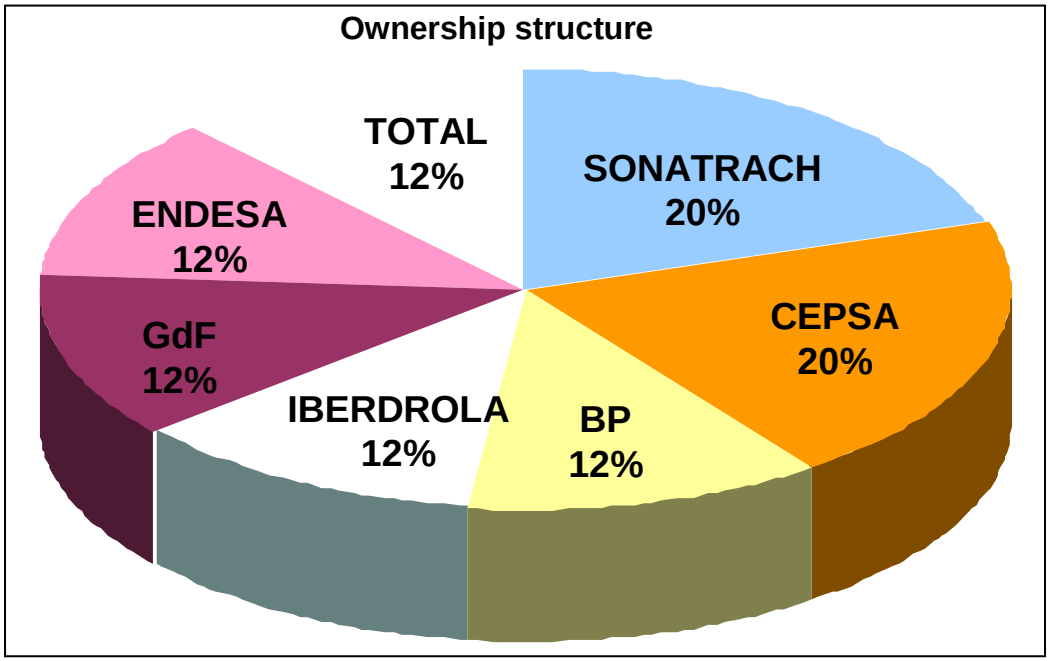


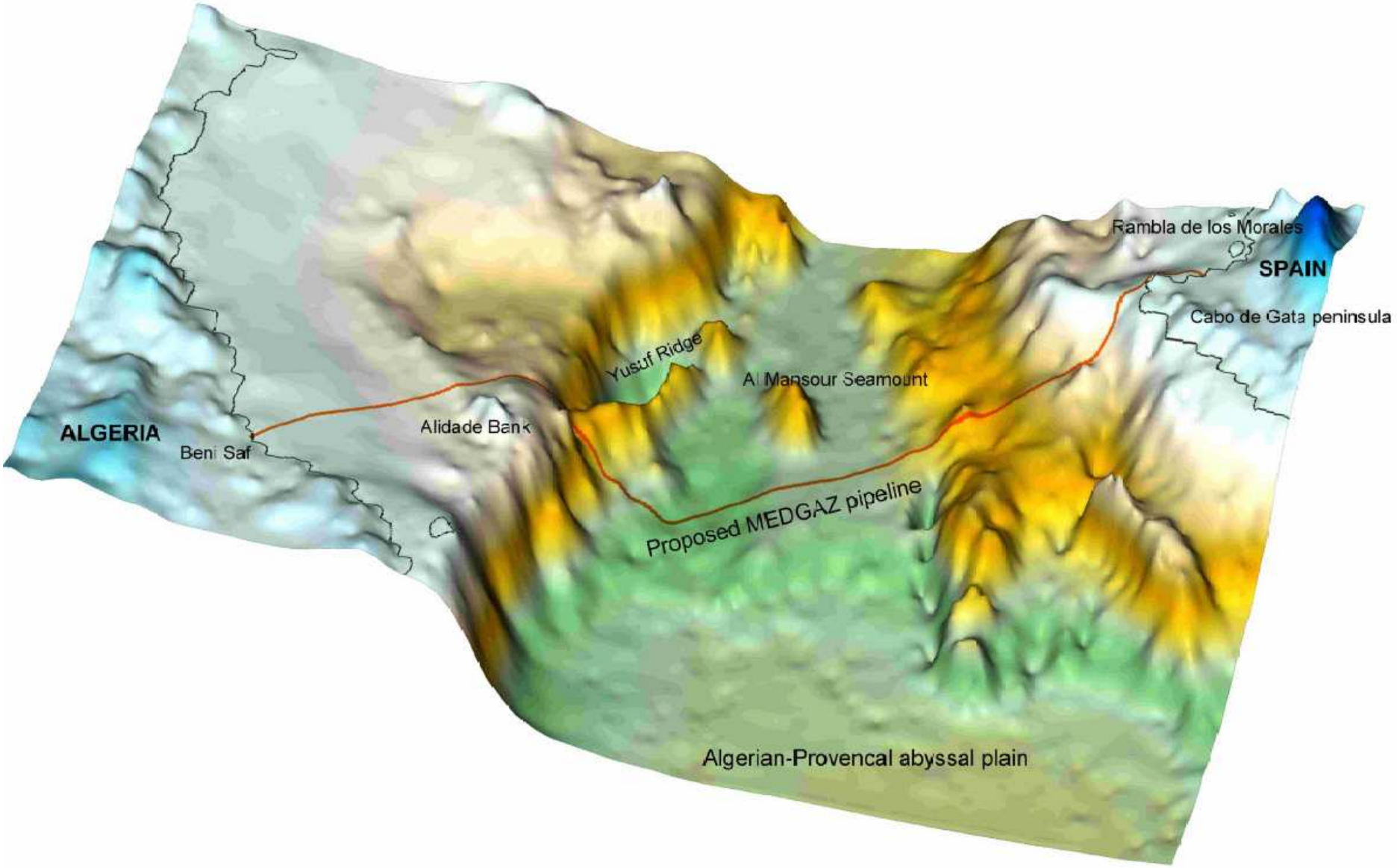
The MEDGAZ Project

Project Highlights

- Designed to deliver 8 BCM/y gas during Phase 1; potential for capacity upgrade to 16 BCM/y by installing a parallel pipeline.
- The Medgaz system will consist of an onshore compressor station at Beni Saf, Algeria (BSCS)
- A deepwater 24 inch diameter pipeline across the Alboran sea
  - Maximum depth: 2155 m – deepest depth for an European pipeline
  - Approximate offshore length: 210 kms
- A gas reception terminal near Almería, Spain (OPRT)
- Has received backing/funding from EU-TEN programme
- Spanish and Algerian institutional support for First Gas in early-2009



Proposed Pipeline Route



Medgaz Project : Economic Rationale

- **Spanish gas consumption has grown from 21.4 BCM in year 2002 to 28.3 BCM in year 2004**
  - **Anticipated demand for year 2011 exceed 44 BCM**

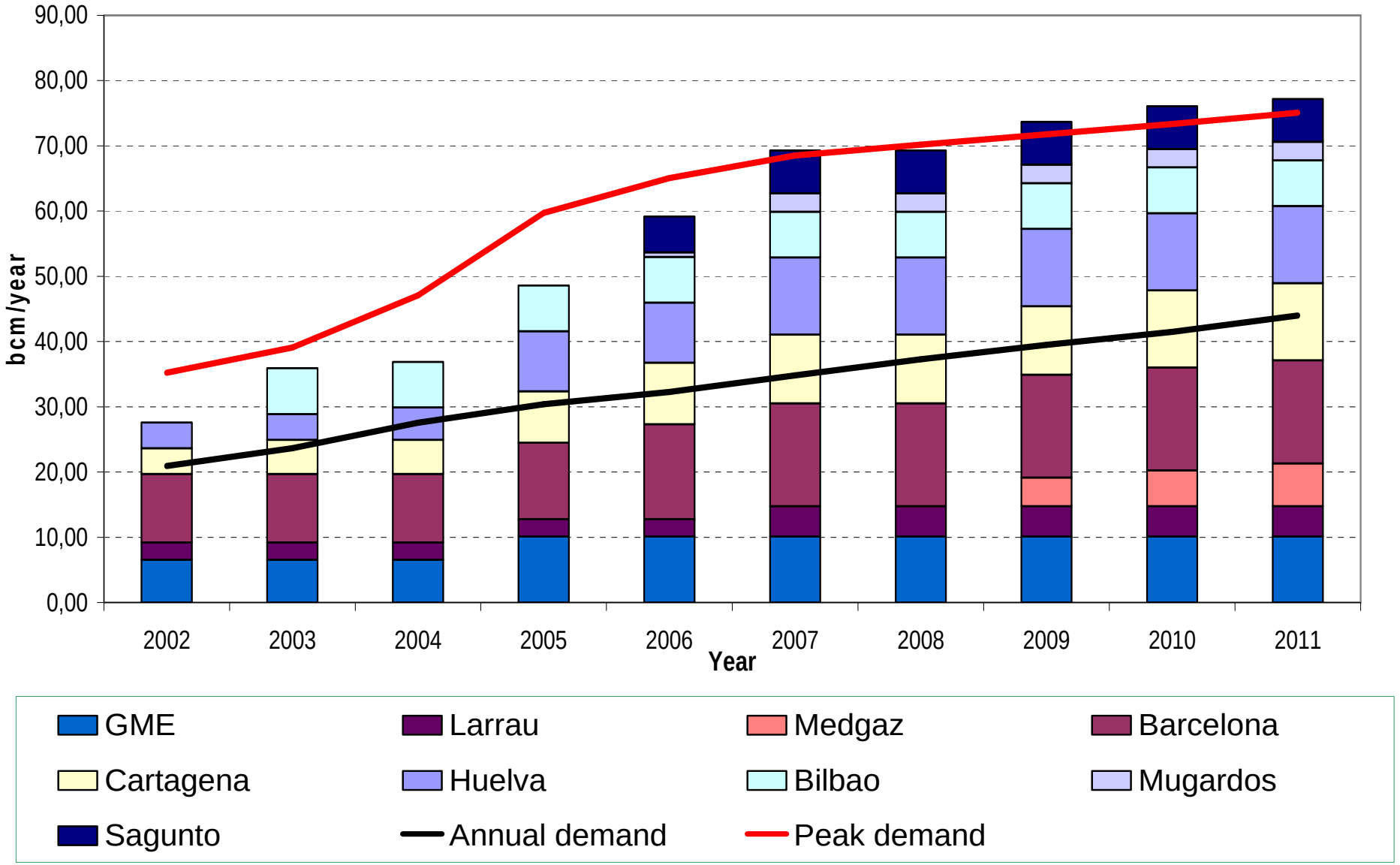
- **Gas demand at 18% compound rate.**
  - **Contributing Factors**
    - **Manufacturing growth**
    - **Switching to 'Kyoto Protocol' friendly fuels**

- **Economic growth rationale for investments in infrastructure capacity of energy market**

- **Gas demand from CCGTs increased by 66% in 2005, compared to 2004**
  - **Contributing factor: Start-up of a number of gas fuelled power stations (Source: Sedigas)**

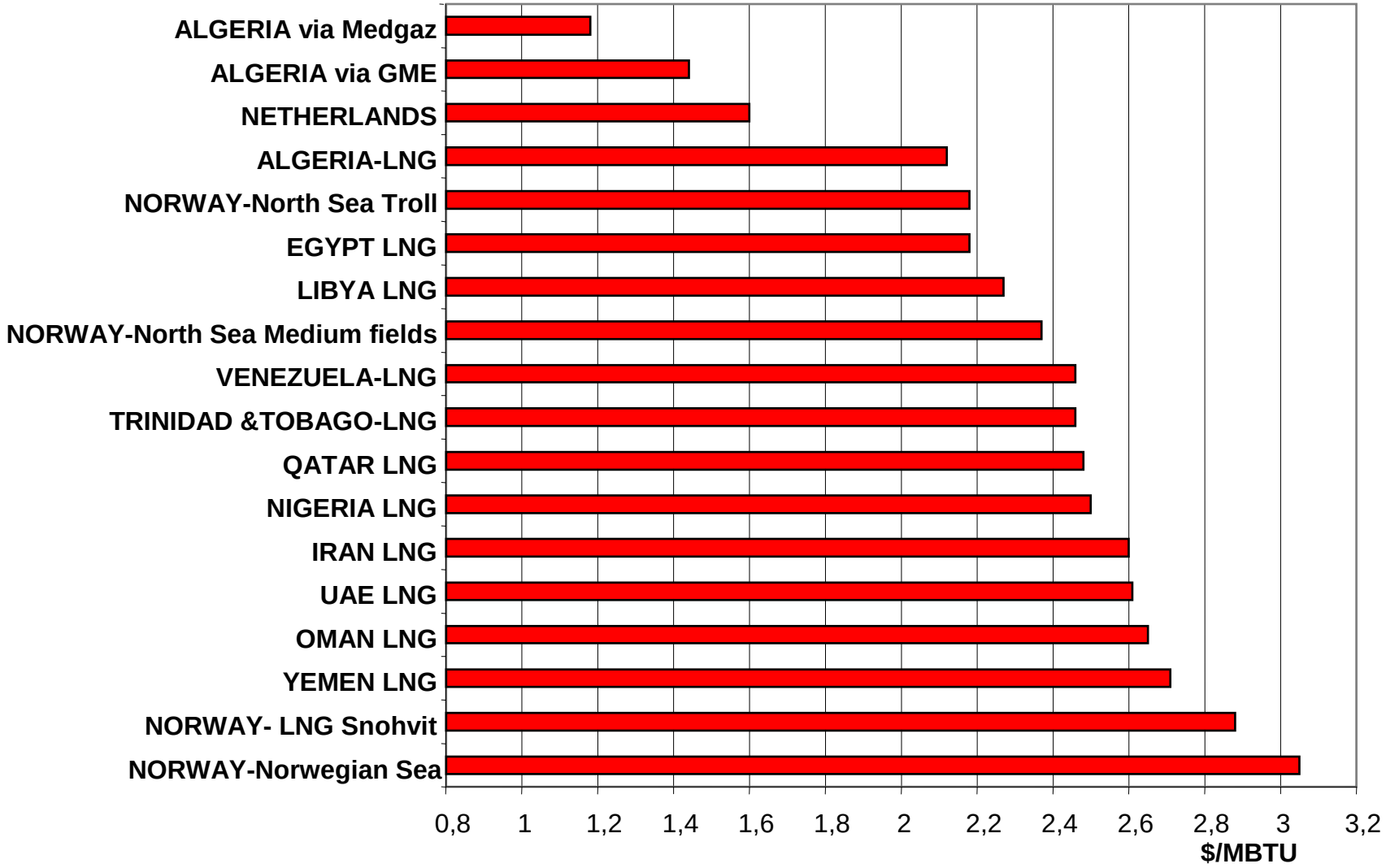
- **Spain dependency on gas imports: 99.6%**
  - **LNG: 65%**
  - **Gas via pipeline: 35%**
  - **LNG price penalty factors:**
    - **liquefaction**
    - **sea transportation**
    - **re-gasification**

Spanish Gas System Capacity (Source: CNE, 2004)



LRMC supply cost (source: OME)

Supply costs* for potential gas supply for SPAIN (2010 - 2020)



* Long Run Marginal Cost excluding producer country's royalty

Pipeline Integrity Management

- **Pipeline integrity 'core business' objective for MEDGAZ**
- **Framework to resolve the issues of Pipeline Integrity Management resulting from conventional design-construction-operation approach**

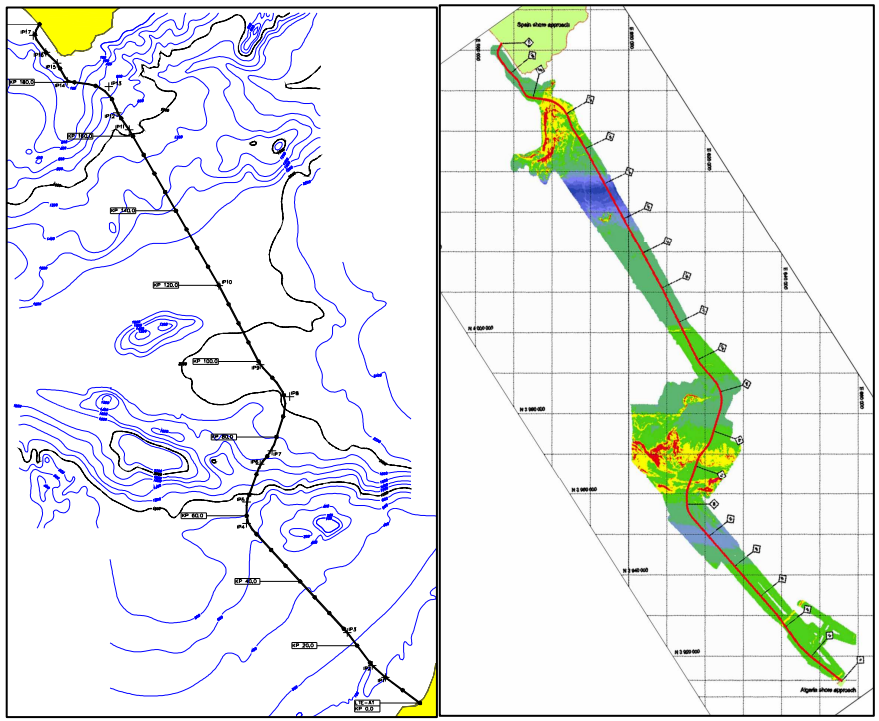
Phase	Design phase	Construction phase	Long-term operational Phase
Contributing Factors	• Routing alternatives • Geophysical and geohazard characterization of seabed and underlying strata • In-service loading • Construction/installation assessments	• Disjointed survey information and CAD information • Lack of simulation and accuracy • Requirement of manual correlation of data at all stages • Lack of centralized database • Sub-optimal collaboration between survey, engineering, construction and handover to Operations	• Maintenance of accurate data from design and construction phases and the project 'Knowledge Database' • Effective integration of In-Line-Inspection database with the construction 'As-Built' database

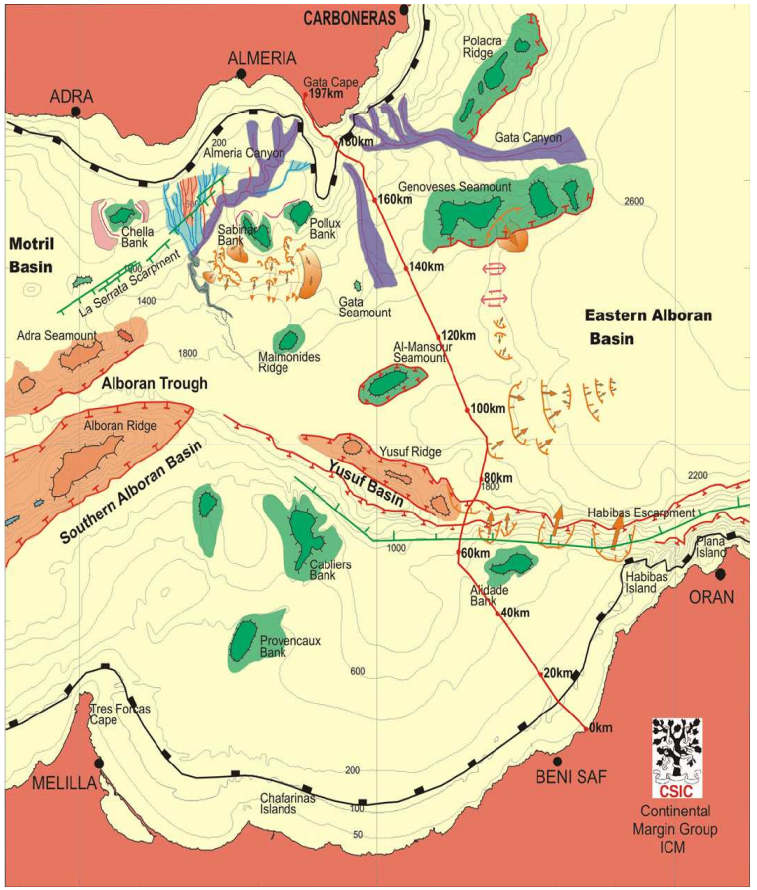
Managing Design Integrity

MEDGAZ

Design Issues

- Minimisation of environmental impact
- Protection of marine flora/fauna on the offshore and onshore sections on the Algerian and Spanish sides
- Avoidance of natural obstacles that exist along the route
- Low geological and geotechnical risks
- Minimization of “free-span” risks





SHELF- BREAK

TECTONIC FEATURES
- Tectonic-related highs
- Volcanic highs
- Lineal escarpments
- Base of escarpment

SUBMARINE VALLEYS
- Canyons
- Turbidite System Channel
- Contourite Channels
- Leveed Channels
- Gullies
- Channel-like features

DEPOSITIONAL FEATURES
- Sediment waves
- Contourite drifts

INSTABILITY FEATURES
- Scars
- Slide Deposits
- Direction of transport

Managing Design Integrity: Leveraging Technology

ROV-TRITON XL-14

Managing Design Integrity: Geohazard evaluations

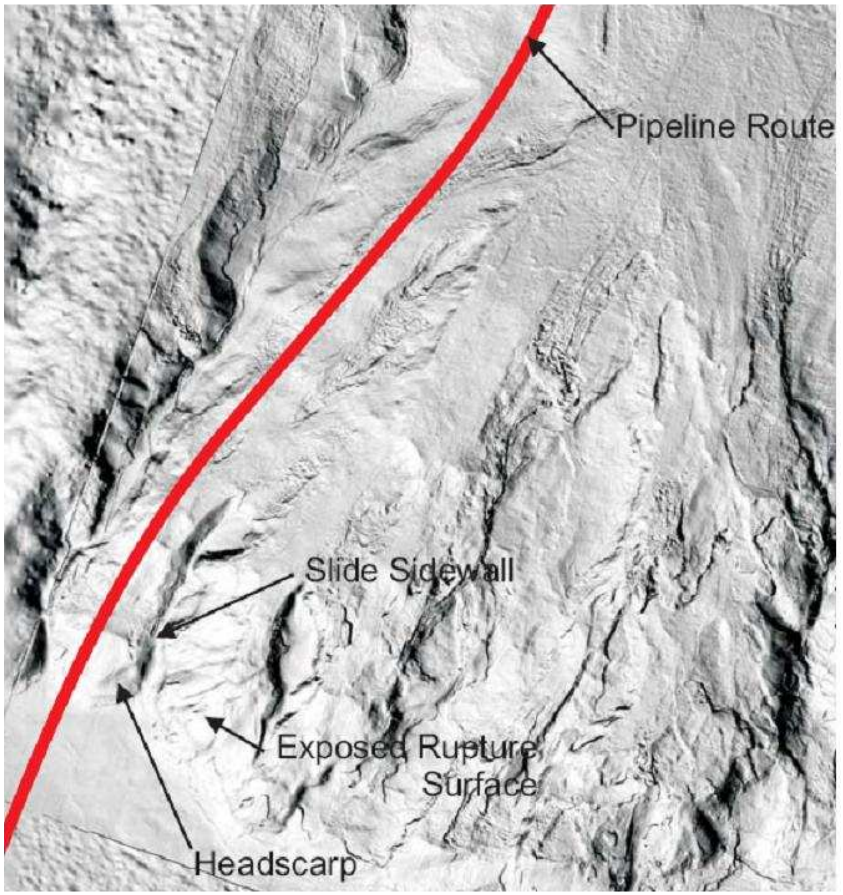
- **Objective:** To verify the integrity of the pipeline, thereby ensuring pipeline survival during extreme events.

Assessments conducted

- Geophysical interpretation
- Probabilistic Seismic Hazard Assessment (PSHA)
- Slope stability assessment
- Probabilistic Fault displacement hazard analysis
- Numerical runout modeling

Extreme failure events covered

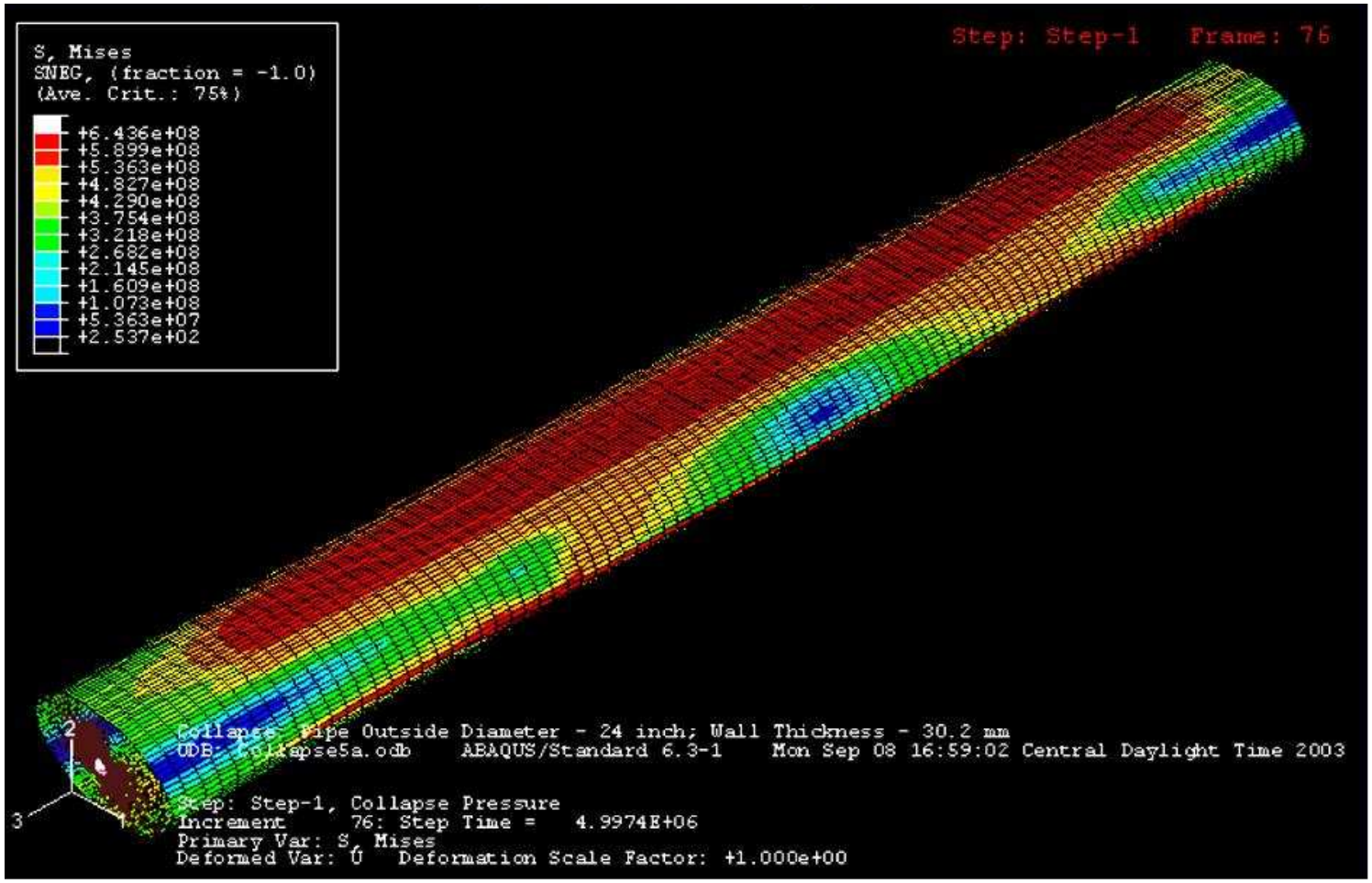
- Fault slip - reverse, normal and strike slip, and fault movement
- Slope failure - failure of the steeper slopes resulting in loss of support to the pipeline
- Mass sediment movements (turbidity flow and mud slide events) - impact of a fast-moving dense flow on the pipeline



Canyon area on the Habibas Escarpment

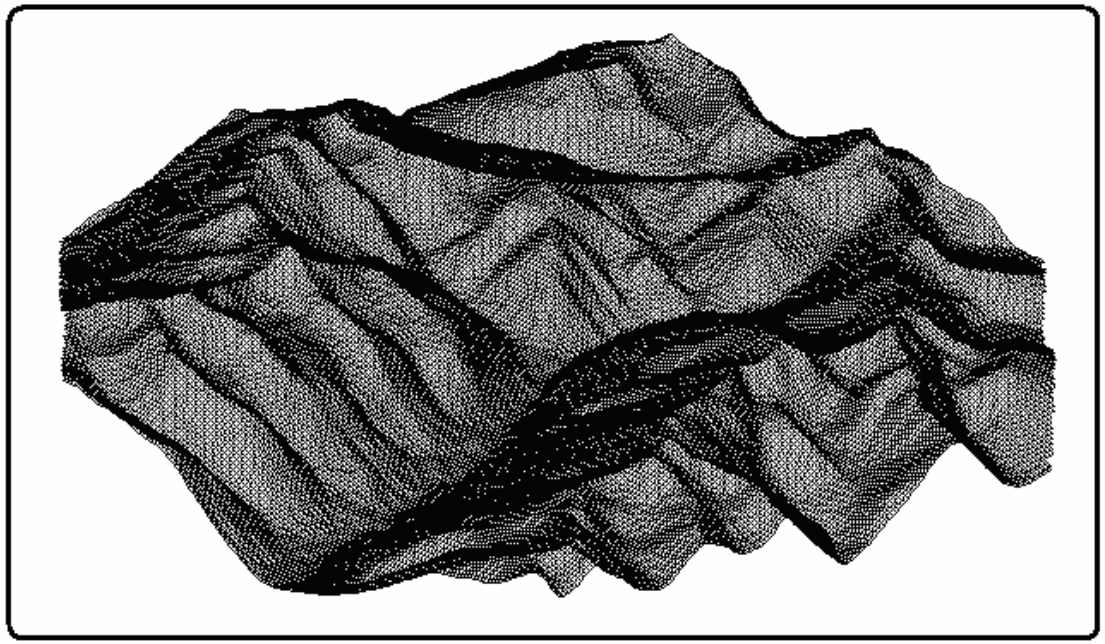
Managing Design Integrity: Design code governance

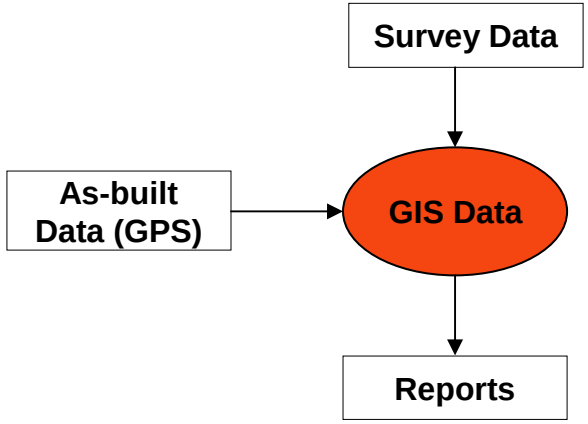
- **Medgaz pipeline design complies with the internationally known design code DNV OS - F101.**
- **Extensive material and full-scale testing have been performed for design validation.**



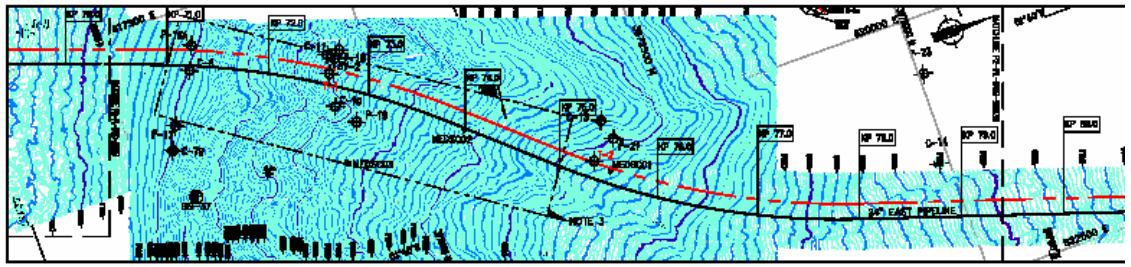
Finite Element Model - Buckling Collapse Analysis

Managing Construction Integrity: Traditional approach





Survey Data → CAD Design → CAD As-Builts → Operations & Maintenance



Managing Construction Integrity: Fully Integrated GIS and CAD

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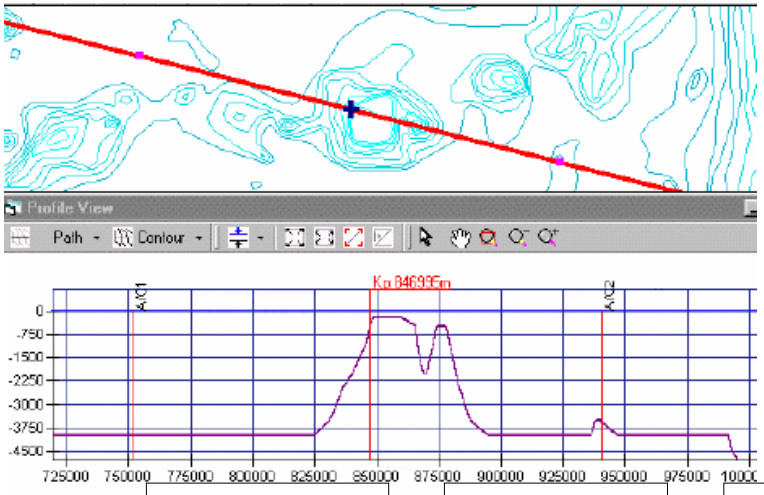
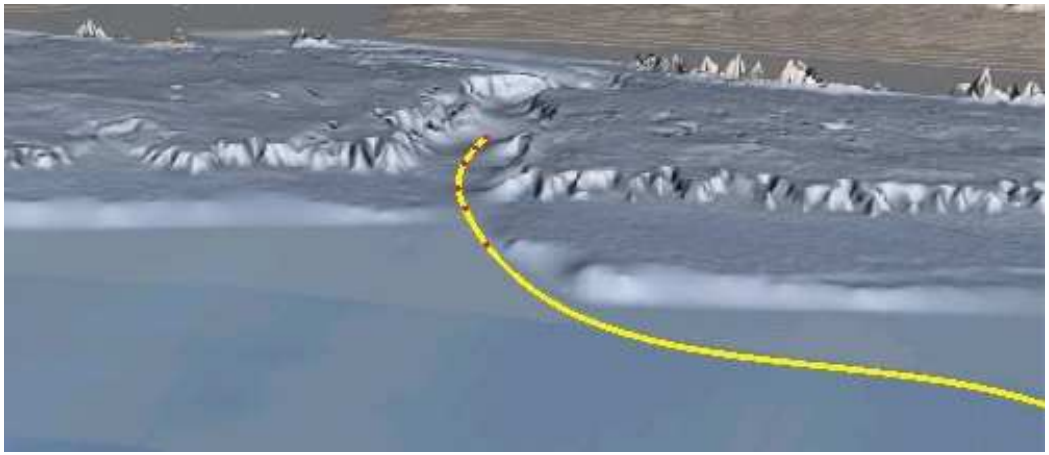
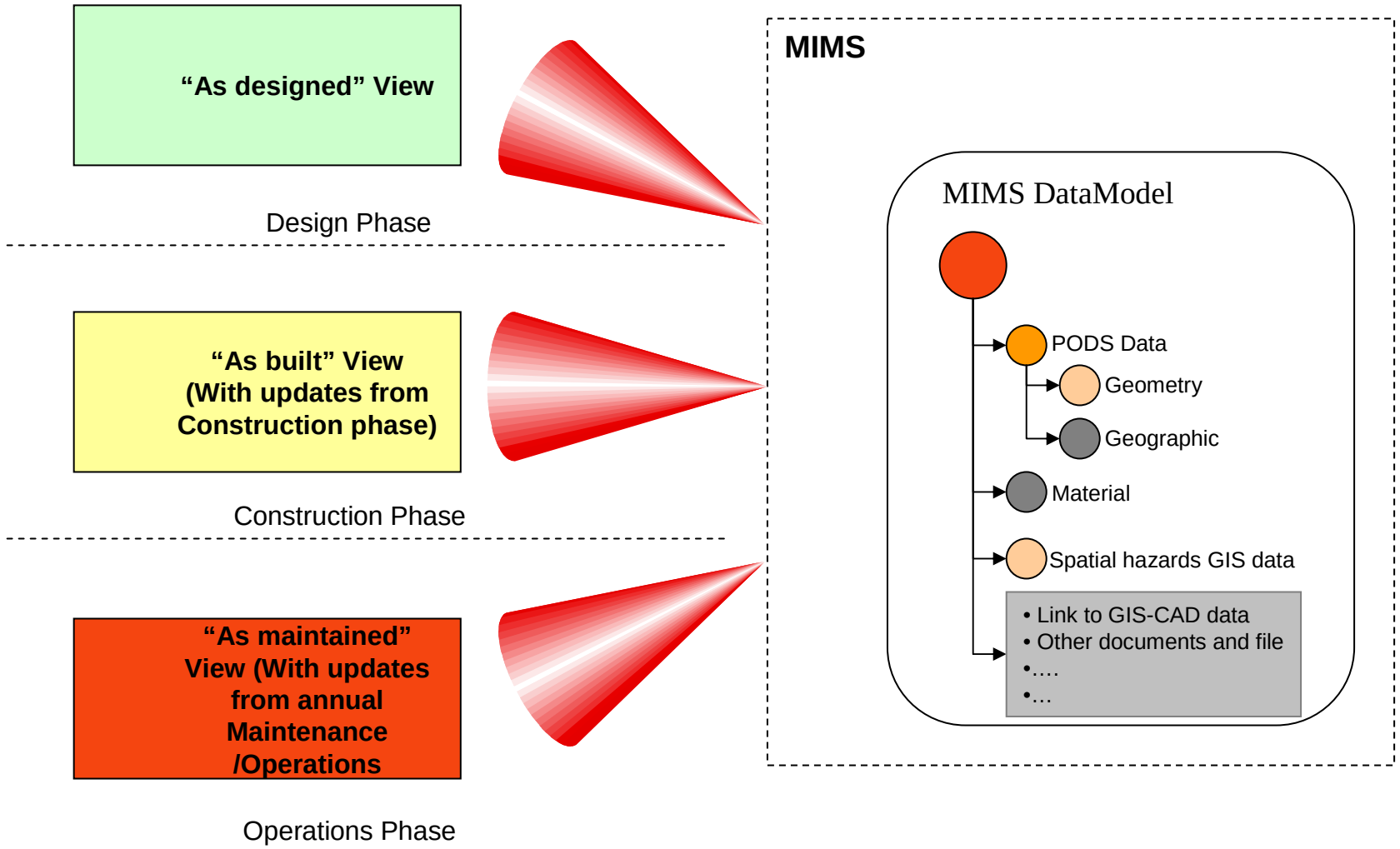


Survey Data → CAD Design → Construction → Project Construction Database → Enterprise GIS Data → Reports



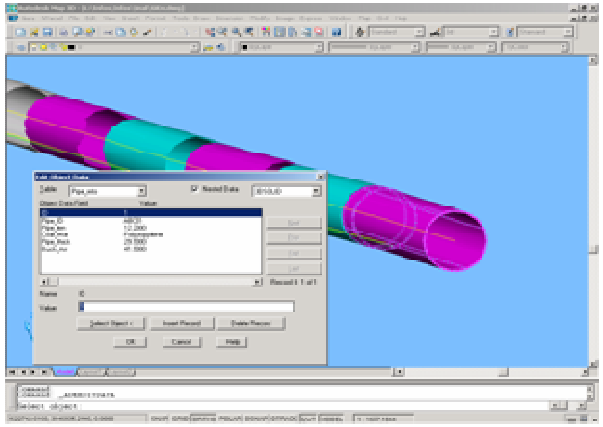
MIMS: Knowledge management based on different views of data



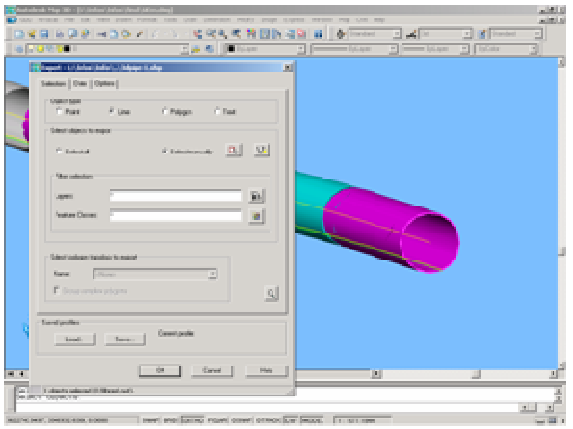
CAD – GIS – FEM : 3D Alignment Sheet

MEDGAZ

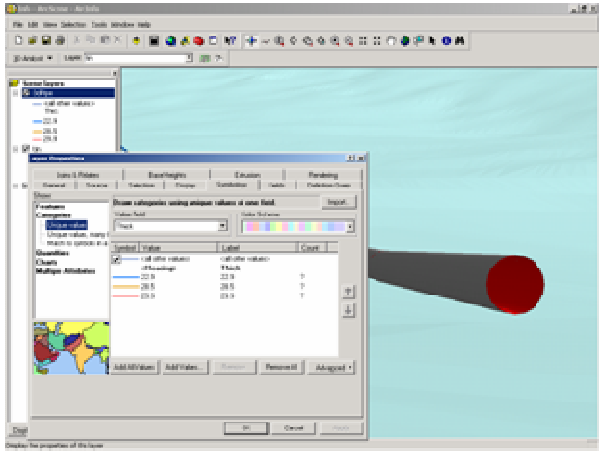
- 3D AutoCAD – ArcGIS data integrity
  - Export centerline of the 3D Pipe from AutoCAD and give thickness to represent the pipe in ArcGIS



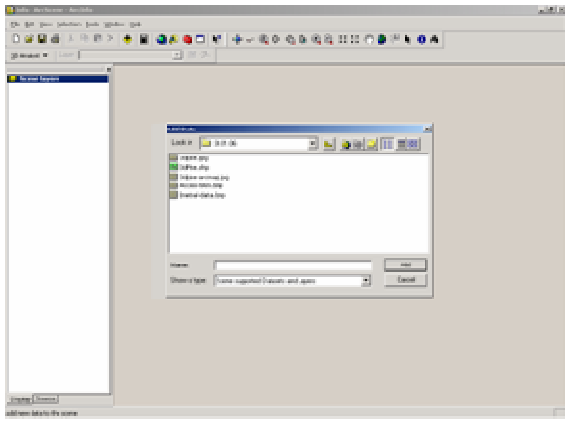
3D Pipe in AutoCAD



Adding Metadata

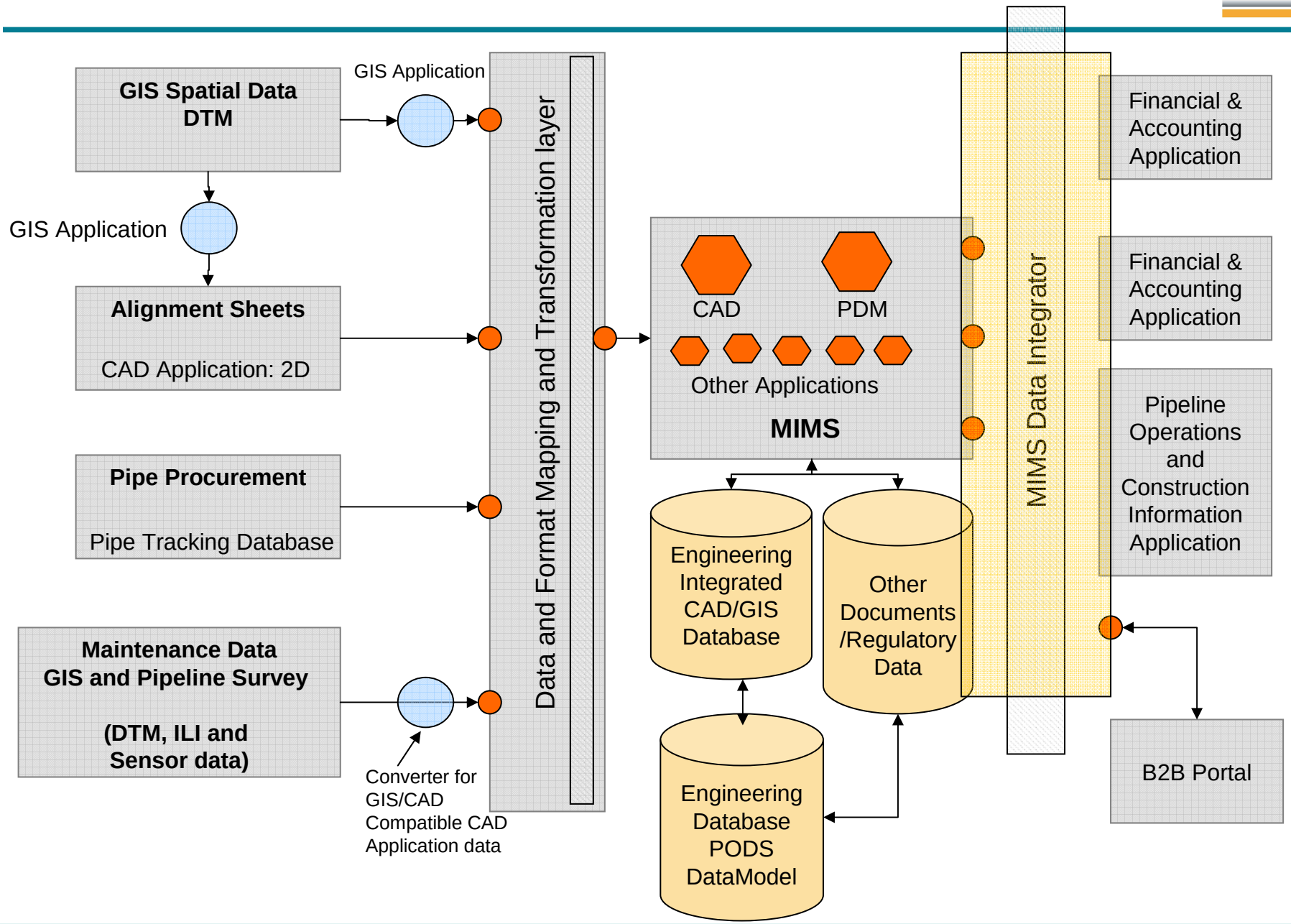


3D Pipe in ArcGIS

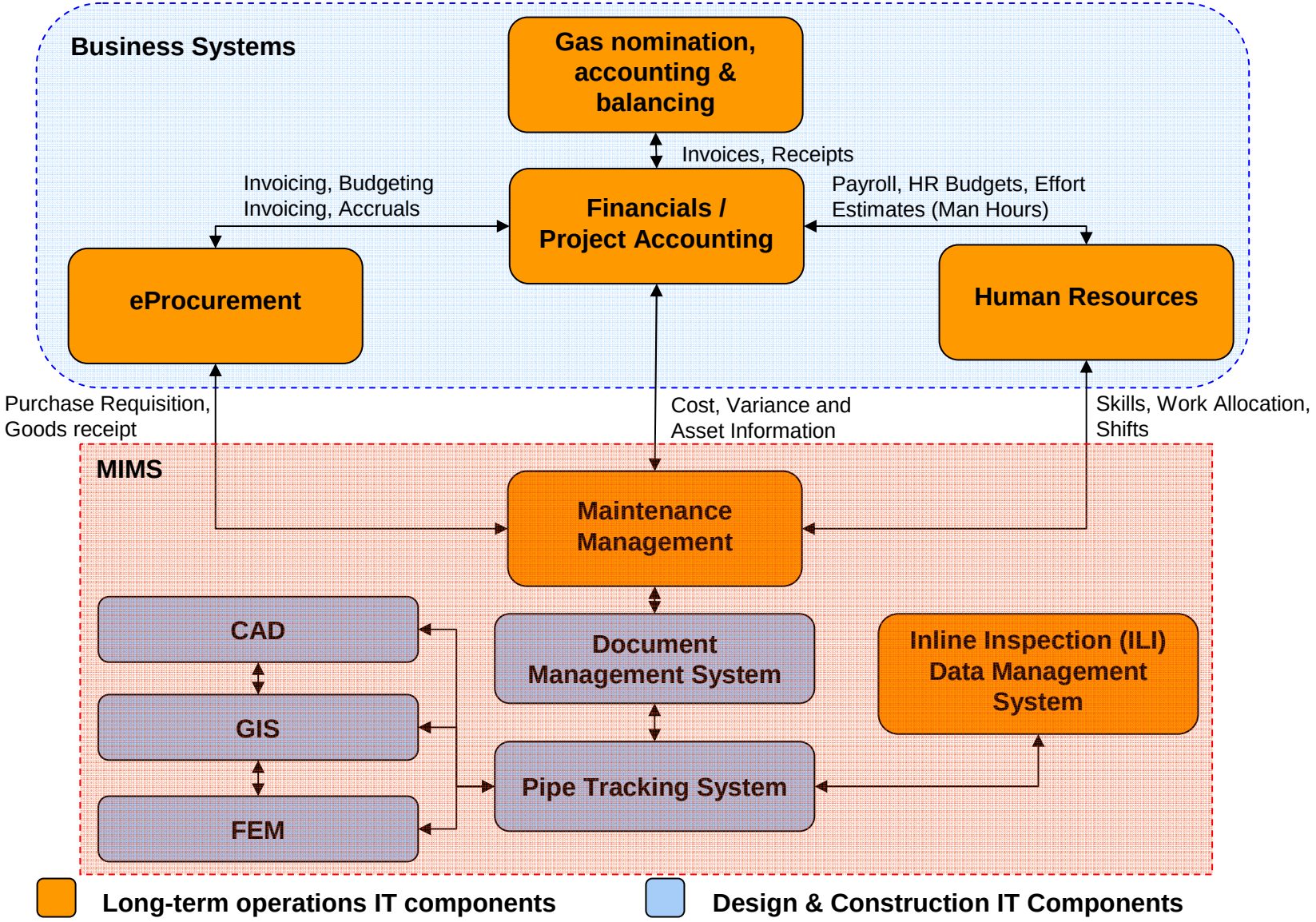


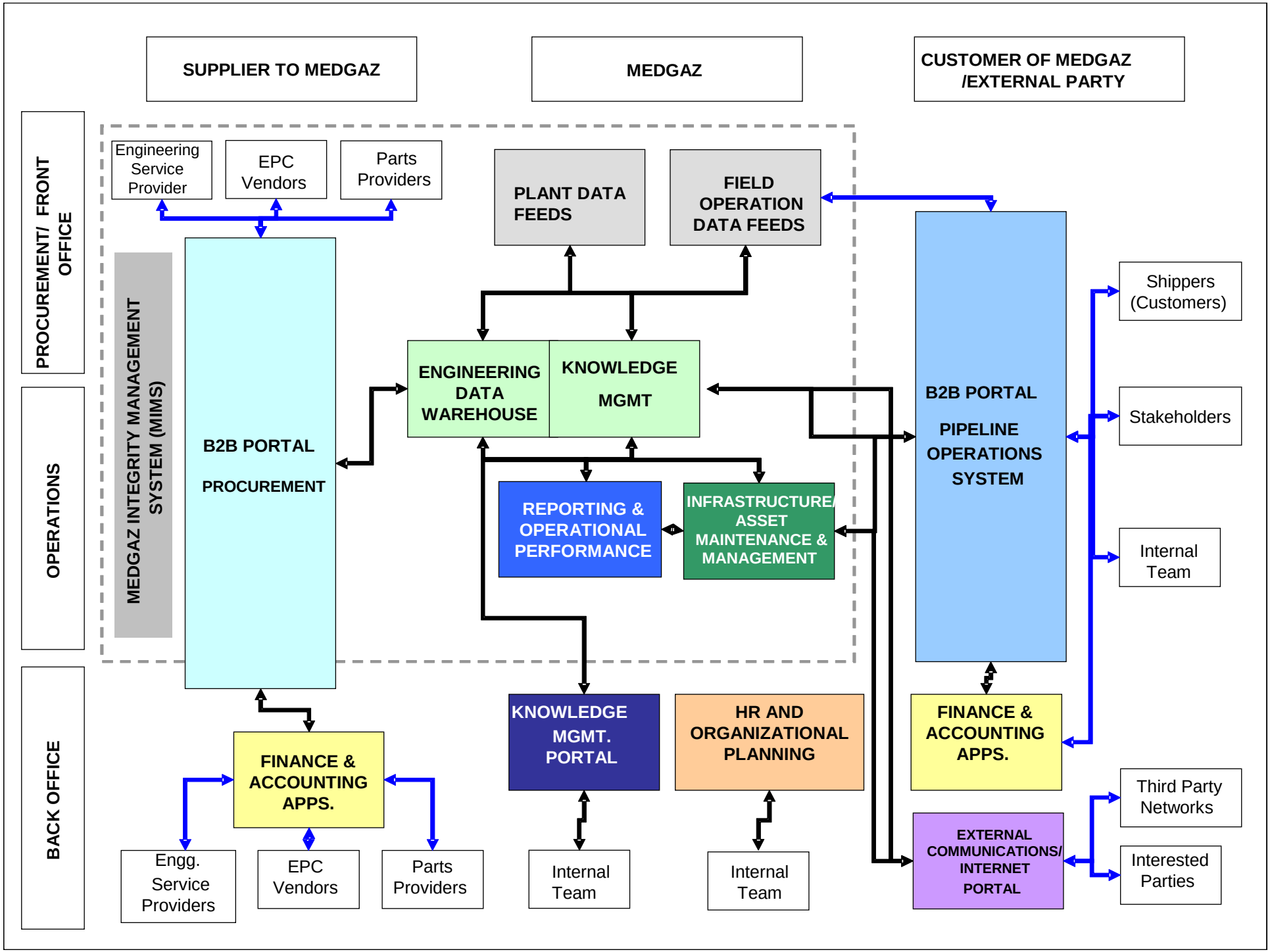
Importing to ArcGIS

MIMS: Logical architecture and Data handshake points



MIMS Application Landscape & Business Systems Landscape




SUPPLIER TO MEDGAZ
MEDGAZ
CUSTOMER OF MEDGAZ /EXTERNAL PARTY
PROCUREMENT/ FRONT OFFICE
OPERATIONS
BACK OFFICE
MEDGAZ INTEGRITY MANAGEMENT SYSTEM (MIMS)
Engineering Service Provider
EPC Vendors
Parts Providers
PLANT DATA FEEDS
FIELD OPERATION DATA FEEDS
B2B PORTAL PROCUREMENT
ENGINEERING DATA WAREHOUSE
KNOWLEDGE MGMT
REPORTING & OPERATIONAL PERFORMANCE
INFRASTRUCTURE/ ASSET MAINTENANCE & MANAGEMENT
B2B PORTAL PIPELINE OPERATIONS SYSTEM
Shippers (Customers)
Stakeholders
Internal Team
FINANCE & ACCOUNTING APPS.
KNOWLEDGE MGMT. PORTAL
HR AND ORGANIZATIONAL PLANNING
FINANCE & ACCOUNTING APPS.
Third Party Networks
EXTERNAL COMMUNICATIONS/ INTERNET PORTAL
Interested Parties
Engg. Service Providers
EPC Vendors
Parts Providers
Internal Team
Internal Team

Summary

- Medgaz is making significant investment in IT systems and operating processes to ensure that integrity management of the pipeline system becomes a core business function.
- The proposed technology platforms will use proven engineering and database technologies; ensuring cost-effective implementation.
- Higher system availability and lower operational cost are expected outcomes from efficient use of ‘knowledge management’ in Medgaz’s business processes.