



Building a Major Oilfield Around Pipeline GIS in the Sahara Desert of Algeria

The El Merk Project

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Presentation Objectives

- Demonstrate the power of GIS from project concept definition through bidding, surveying, design, construction, and implementation.
- Convince “old dogs” that “new tricks” can improve efficiency and productivity with GIS applications.
- Prove to “dinosaurs” that acceptance of GIS technology can improve work flow with minimal paperwork- the usual gripe and excuse.

The El Merk Story

Anadarko Petroleum Corporation- The Woodlands, Texas entered a Production Sharing Contract with Sonatrach- The National Oil & Gas Enterprise of Algeria in the late 1980's.

Extensive geological and geophysical seismic work was conducted in the Sahara Desert with exploratory drilling in the early 1990's.

Anadarko made their first oil discovery in Block 404 of the Hassi Berkine Basin early in 1994.

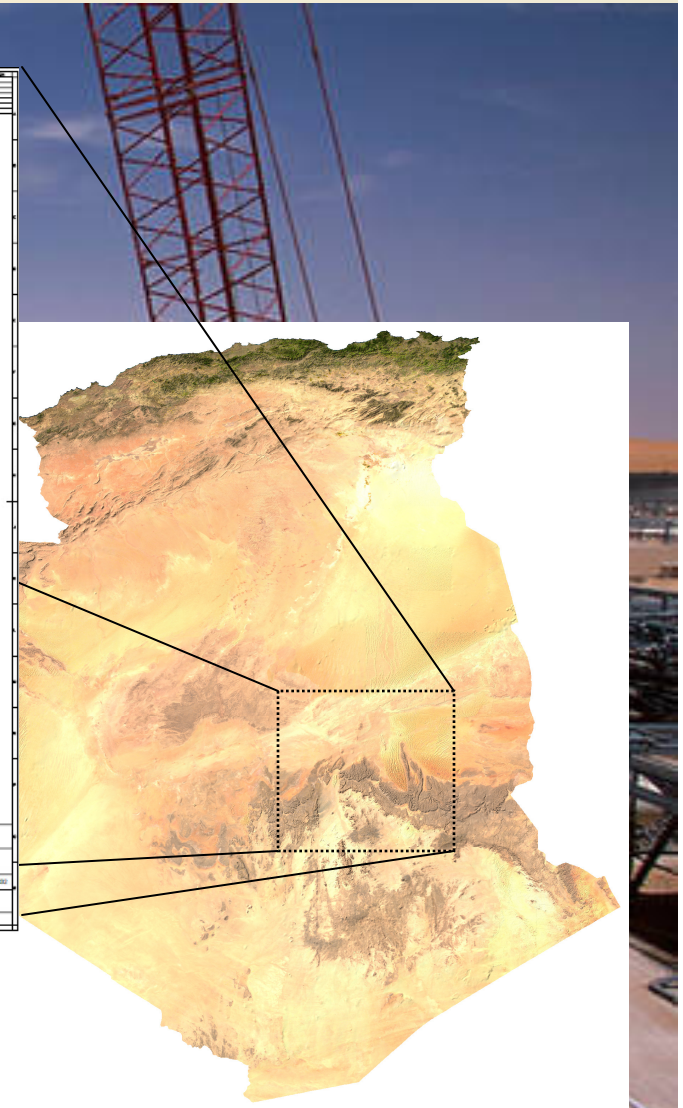
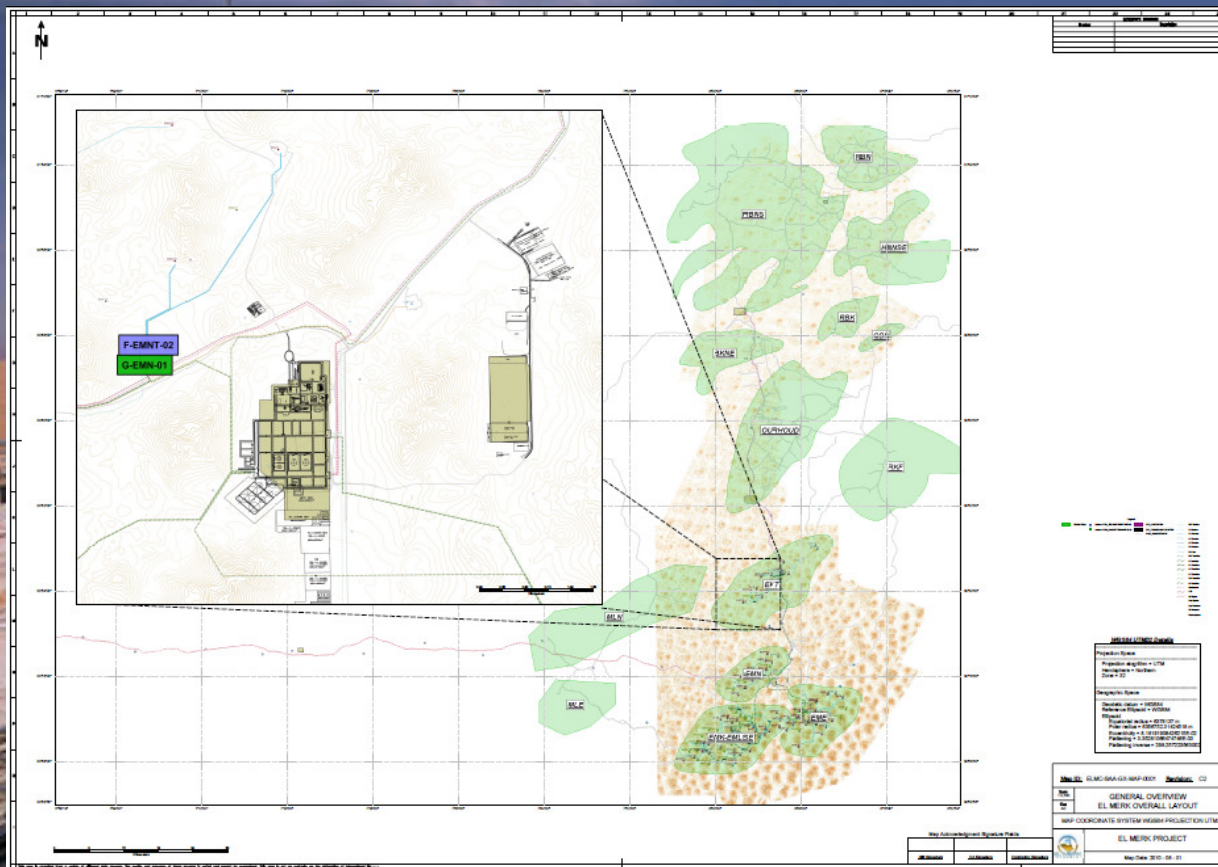
The Sonatrach Anadarko Association (SAA) developed the HBNS Field Stage 1 (60,000 BPD) during 1995-1997.

Other fields followed HBNS with HBNS Stage 2 Development (330,000 BPD) in 1998-2000.

In 2002, SSA participated in the Ourhoud Development (220,000 BPD) about 60 km south of HBNS

SAA Block 208 oil and gas condensate discoveries were a further 90 km south of Ourhoud in a rugged sand dune terrain very remote from any existing infrastructure. SAA and partners with neighboring reservoirs for production came together to form the El Merk Project (150,000 BPD).

Area map showing HBNS/OO El Merk Infrastructure



El Merk Ownership

- Sonatrach
- Anadarko
- Conoco Phillips
- ENI
- Maersk

El Merk operating responsibility will be under the SAA “Groupement Berkine” organization

El Merk Contractors

- Petrofac- UAE for the Central Processing Plant
- ASP- Consortium of ABB (Milan, Italy)/ SARPI (Algeria) / PetroJet (Egypt)- Offsites
- Bentini- Faenza, Italy- Living Camp and Industrial Base
- Bonatti- Parma, Italy- Export Pipelines and Terminals
- Kahrif- Algeria – Powerlines
- Siemens- Lyon, France- Substation
- El Merk GIS Management- ABB/Intergraph- Milan, Italy

El Merk Project Scope

- Full Field Development → Three fields: EKT, EME, EMN + One unitized field: EMK
- Production zones → TAGI Oil, RKF/Strunian Gas Condensate
- Central Process Plant → Separation, Stabilization, Gas compression, Treating for export, Storage, Pumping Systems, NGL extraction, Utilities and Services
- Industrial Base → Offices, Warehouses, Shops, Emergency Power, Fire and Security Systems, Telecoms
- Living Base → Housing, Catering, Medical, Mosque, Recreation, Administration
- Infrastructure → Air Strip, Military Camp, Central Waste Management Area, Roads & Highways
- Telecoms → VHF Radio, Fiber Optic systems, Satellite
- Powerlines → 220 KV systems (150 km), 30 KV systems (150 km), Substation for primary and back up power supply to CPF, Base de Vie, and Offsites
- Pipelines → Crude Oil/ LPG/ Condensate (total of 410 km), Offsite Systems
- Temporary Worker Camps (6000 man peak)

El Merk Offsite Systems

- Well hook-ups,
- Field Gathering Stations,
- Gas Distribution Manifolds,
- Water Systems for Injection,
- Flowlines for production, gas lift, dilution water, water source supply
- Trunklines for oil and gas condensate production, gas injection, and water injection
- Field distribution of FO cable for telecoms and power supply



El Merk Challenges

- Pioneer development- no previous area infrastructure
- Remote harsh desert environment
- Terrain includes dunes over 1000' high
- Camp accomodation developed for 6000 peak manpower for project development
- Concurrent construction with developing reservoir drilling and testing
- Competing projects in Algeria for manpower and services
- Security concerns require military presence and escorts for expat personnel
- Logistics for civil materials, fuel, supplies, etc.
- Unique local geodetic conflicts require special survey considerations
- Compliance with government regulatory concerns impact importation, contract stipulations, bidding, inspection, and certifications
- Project Management includes multi-international locations, rotational staff, language barriers, cultural sensitivities, partner management structures.
- Management of change for maturing reservoir development plan
- Interface management between multiple contractors and operations
- Survey coordination between contractors and control networks.

El Merk GIS Development History

Front End Engineering Design

- In 2006, the paper mapping work failed to meet change management guidelines and GIS development specifications were adopted for the Project.
- The initial FEED contractor was expected to develop the total project under a full scale EPC contract but economics could not justify this approach.
- The initial FEED contractor insisted that over 700 alignment sheets would be required to bid the pipelines with international contractors
- Major field development changes were identified in 2007 that required major engineering change to the Offsites with a complete re-design while international tenders were underway
- AMEC Paragon was awarded an Engineering Assistance Contract to aid the El Merk project in developing a pipeline GIS for re-design, bid solicitation, and construction planning

El Merk GIS Development History

Tender Requirements

- AMEC's GIS Team used an ESRI Platform to import various Autocad files, available imagery, and infrastructure maps from Groupement Berkine and Ourhoud onto the LIDAR base map to establish the initial GIS model
- Layouts of revised well layouts, were used to locate FGSs OP wells and GDMs to GI wells. Trunklines were then routed to/from the CPF
- Data was extracted to develop profile information for pipeline hydraulics for various case studies
- Pipe specifications were developed with the pipeline design data
- The pipeline model was used to evaluate slugging studies and dynamic modelling for surge
- Structural evaluations were performed to analyze loadings for flexibility and anchoring.
- The GIS model was used to develop infrastructure and pipeline routings for the pipelines to establish pipe quantities for purchase and construction.
- A Pipeline GIS with PODS was specified as a deliverable. Alignment sheets were not required as a deliverable but an alignment sheet generator was required.
- AMEC developed a GIS viewer that enabled the bidders to query a CD database of the pipeline system. Base maps were provided for record.

El Merk GIS Development History

Contract Strategy & Tendering

- The revised contract strategy identified Lots of the overall project that bidders would be allowed to tender for but bids could be presented for multiple Lots:
 - Lot 1: CPF and ICSS/Telecoms
 - Lot 2: Export Pipelines
 - Lot 3: Offsite Facilities Design and Material
 - Lot 4: Offsite Installations (Combined 3&4 for Contract)
 - Lot 5: Industrial Base
 - Lot 6: Base de Vie (Combined 5&6 for Contract)
 - Lot A: Site preparation
 - Lot B: Overhead Powerlines
 - Lot C: Substation
- While tenders were being prepared by worldwide EPC contractors, B212 facilities were deemed uneconomic and delted from scope- requiring revision to the RDP and major scope change for Offsites.
- Tenders were put on hold and changes to scope were revised with Lot 1 and Lot 3&4 bidders during 2008 for end of year revised tender packages.
- It became evident that the Lot 3&4 Contractor would be required to manage the El Merk GIS to coordinate all interface locations for all Contract Lots using the Pipeline GIS model.
- Bid openings in December 2008 assured no single EPC contract and multiple teams would be required for engineering to start early 2009

El Merk GIS Development History

GIS Capabilities & Contract Award

- During the tender evaluation process, each of three European bidders presented experience and capabilities for GIS management
- One contractor uses GIS extensively in their projects and is now doing a neighboring development for an El Merk partner with similar export pipeline needs
- ABB and the other contractor required special GIS planning assistance to demonstrate suitable capability. ABB brought their business partner Intergraph Italia to demonstrate their expertise.
- The ASP Consortium was the low bidder for the Lot 3&4 Offsites and started work on the project in April, 2010

El Merk Project Management Assessment of GIS Importance

- GIS is the key to El Merk Project Success- “GIS Rules”
- Without the GIS tools developed by AMEC, El Merk would have been delayed at least a year (at 150,000 BPD)
- GIS enables El Merk and its contractors to manage change quickly and reliably
- GIS is being used to manage interfaces in infrastructure from drilling all the way to telecoms.



Intergraph GIS Architecture

Mr. Massimo Pagani

***Intergraph technology and services to support GIS projects for the
Oil & Gas Industry***

Topics

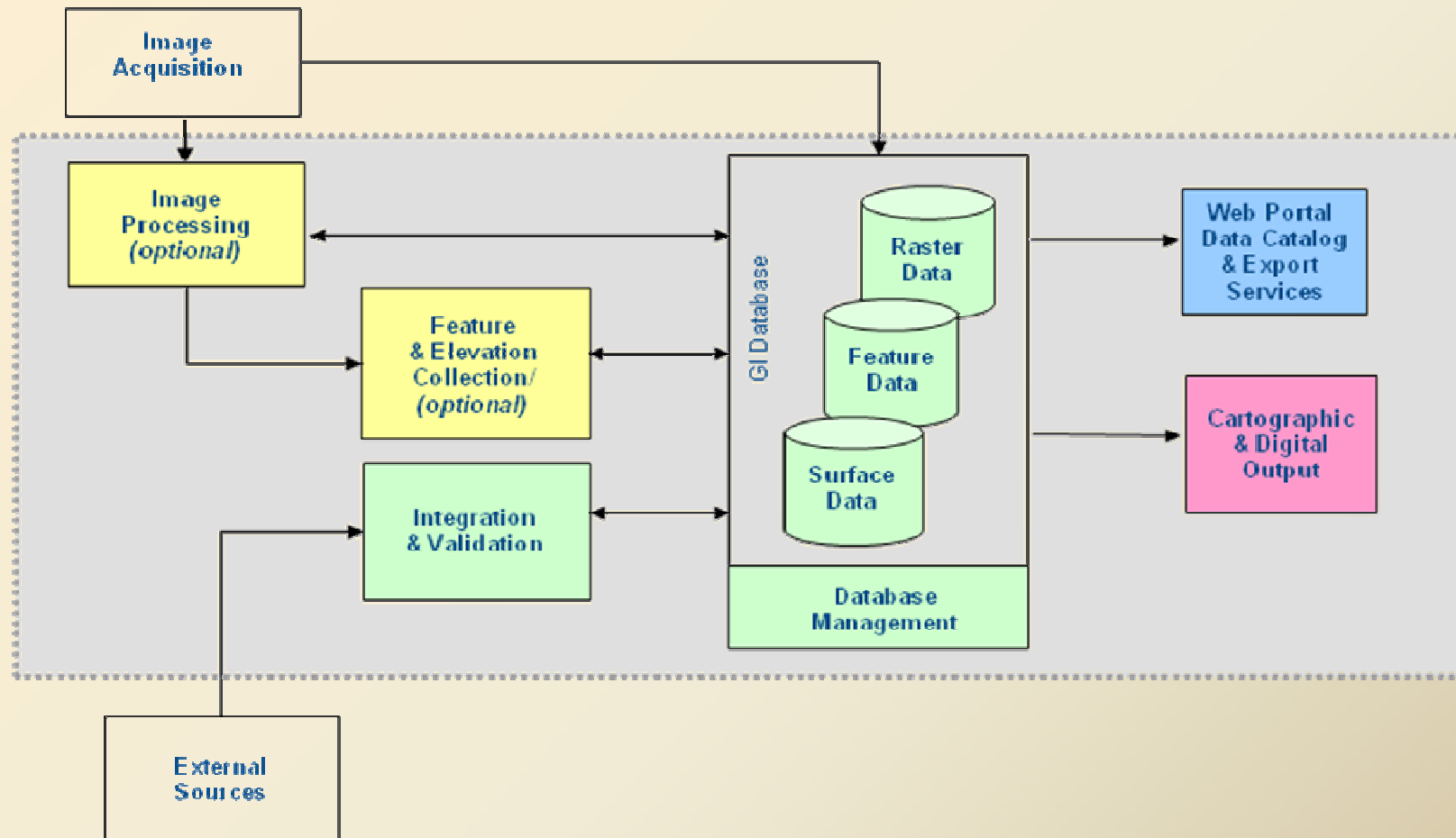
- GIS Scope of Work
 - Technological architecture
 - Topographic Survey
 - Users Access
 - Web Data Dissemination
- PODS Standard
- Ongoing project improvements:
 - Field Data Acquisition
 - Sub-Contractors Management
- Project status

GIS Scope of Work

- Catalog information acquired from various sources and in a variety of formats
- Provide necessary tools to integrate and manage this data
- Provide a foundation for downstream operations and maintenance activities
- Datasets included in the model are incorporated in near real-time and continue throughout the life of the pipeline system operation
- Regular updates to the datasets
- Provide additional decision making tool
- Web data dissemination
- Provide to Sub-Contrators GIS tools to access project data in real time
- GPS survey acquisition and project cost control
- Project cost/time reduction

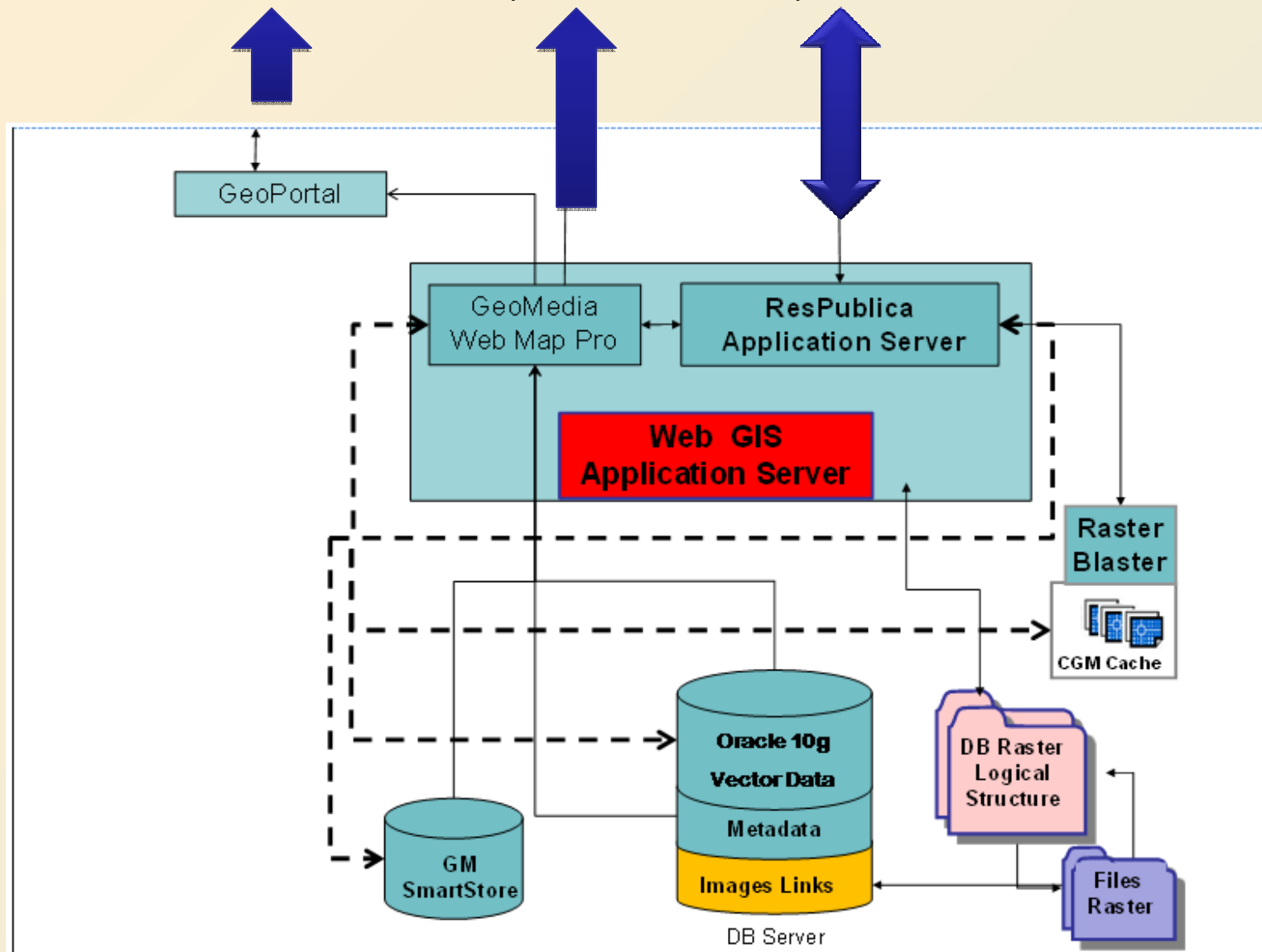
El Merk GIS Architecture Overview

The GIS system ingests data from different sources and provide functionalities for data sharing, Web dissemination and digital cartographic output



Technological Architecture

(Server Side)

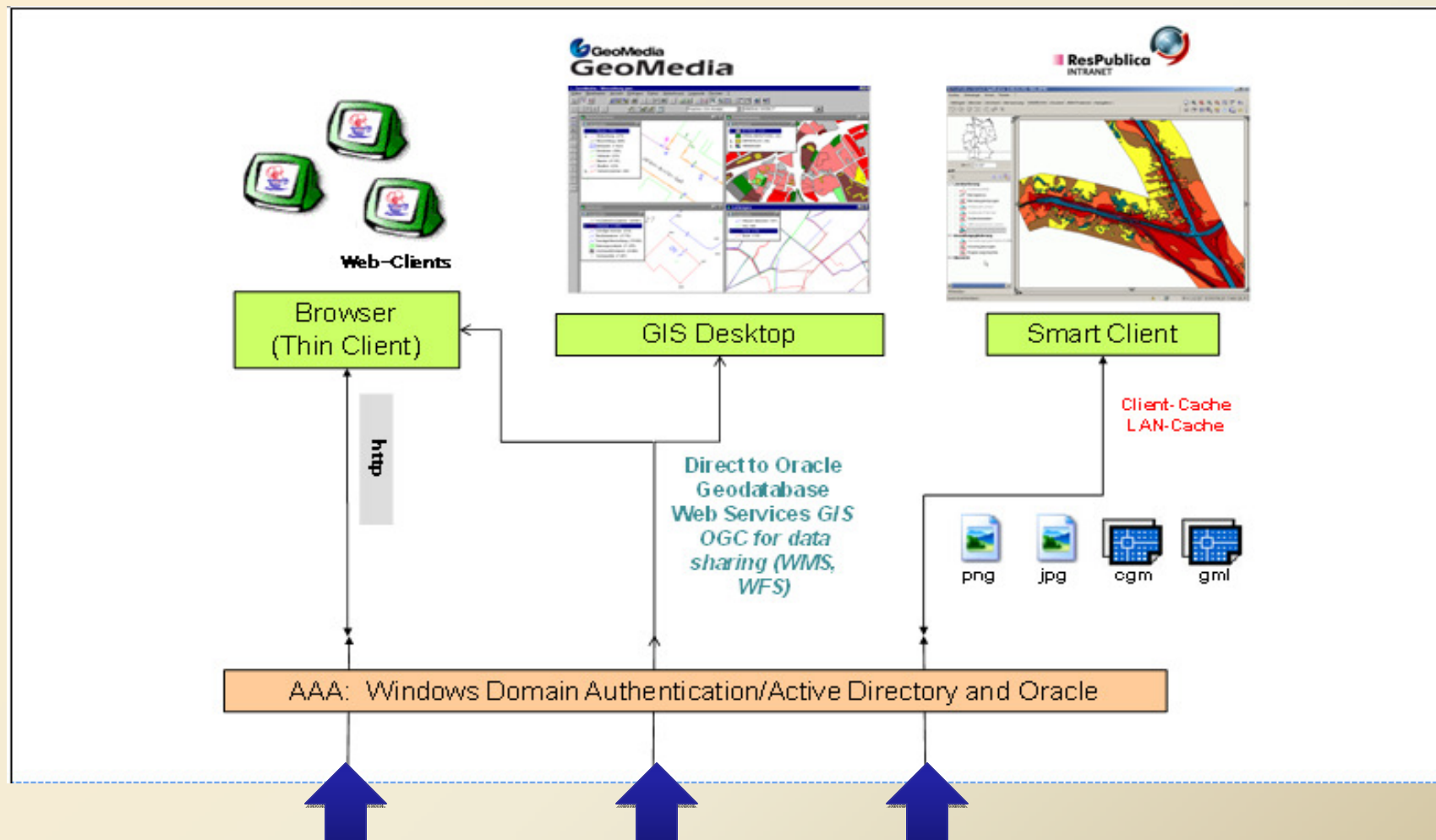


Technological Architecture (Client Side)

Internet User

Desktop User

Intranet User



Topographic Survey

- Definition of roles data acquisition on the field and delivery
- Implementation of acquisition processes
- Data exchange and format definition
- Validation definition parameters for geographic data
- No constraints about GIS technology, but only 3 files format to be used:
 1. Shape
 2. ASCII formatted file
 3. DWG/DXF
- Typical information that must be included into geographic files:

☐ Geographic coordinate system	Datum (geodesy)
☐ Spheroid	Prime meridian
☐ Map projection	Units used

 - Parameters necessary to use the map projection, for example:

✓ Latitude of origin	Scale factor
✓ Central meridian	Standard parallels
✓ False easting	False northing

GIS Projects - User Levels

ADMINISTRATOR

User Access Definition, Smart Client definition,
New data entry validation,
Data Uploading Rules to the central GIS System
This level is composed by ABB, Intergraph, C.A. offsite

POWER USER

Proposing modifications, New data acquisition (to be validated)
Data Process. Advanced query. Custom Interface for each organization.
Updating, CAD Data Upload

BASIC USER

Basic users: Data display, reading, querying, analyzing – Data Download
according to an extended list of people authorized by all involved entities
(C.A .offsite ,C.A. HMS, ABB, Sarpi, Petroject, Other Lots Contractors)

Web Basic User [Internet]

EL MERK - Web GIS - Windows Internet Explorer

https://gis.it.abb.com/el_merk/framesetup.asp

File Modifica Visualizza Preferiti Strumenti ?

EL MERK - Web GIS

Maps Legend

Display Order Groups

- ☒ FGS Names
- ☒ Wells Names
- ☒ Wells
 - ☒ Gas Injector
 - ☒ Gas Producer
 - ☒ Oil Producer
 - ☒ Water Injector
- ☒ Junction
- ☒ Surface Entry Point
- ☒ Water Source
- ☒ Water Wells
- ☒ Charges
- ☒ BEGT_GypsumQueryL
- ☒ BEGT_WaterWell
- ☒ BEGT_SurveyStation
- ☒ BEGT_SurveyPoint
- ☒ BEGT_DesignTrace
- ☒ BEGT_Road
- ☒ BEGT_Trail
- ☒ BEGT_Enbankment
- ☒ New Corridors
- ☒ Pipelines
 - ☒ DW Transfer
 - ☒ Gas Injector
 - ☒ Gas Lift
 - ☒ Gas Producer
 - ☒ Oil Producer

Overview Map

ABB - EL MERK Project

1 km

Scale 1: 90693

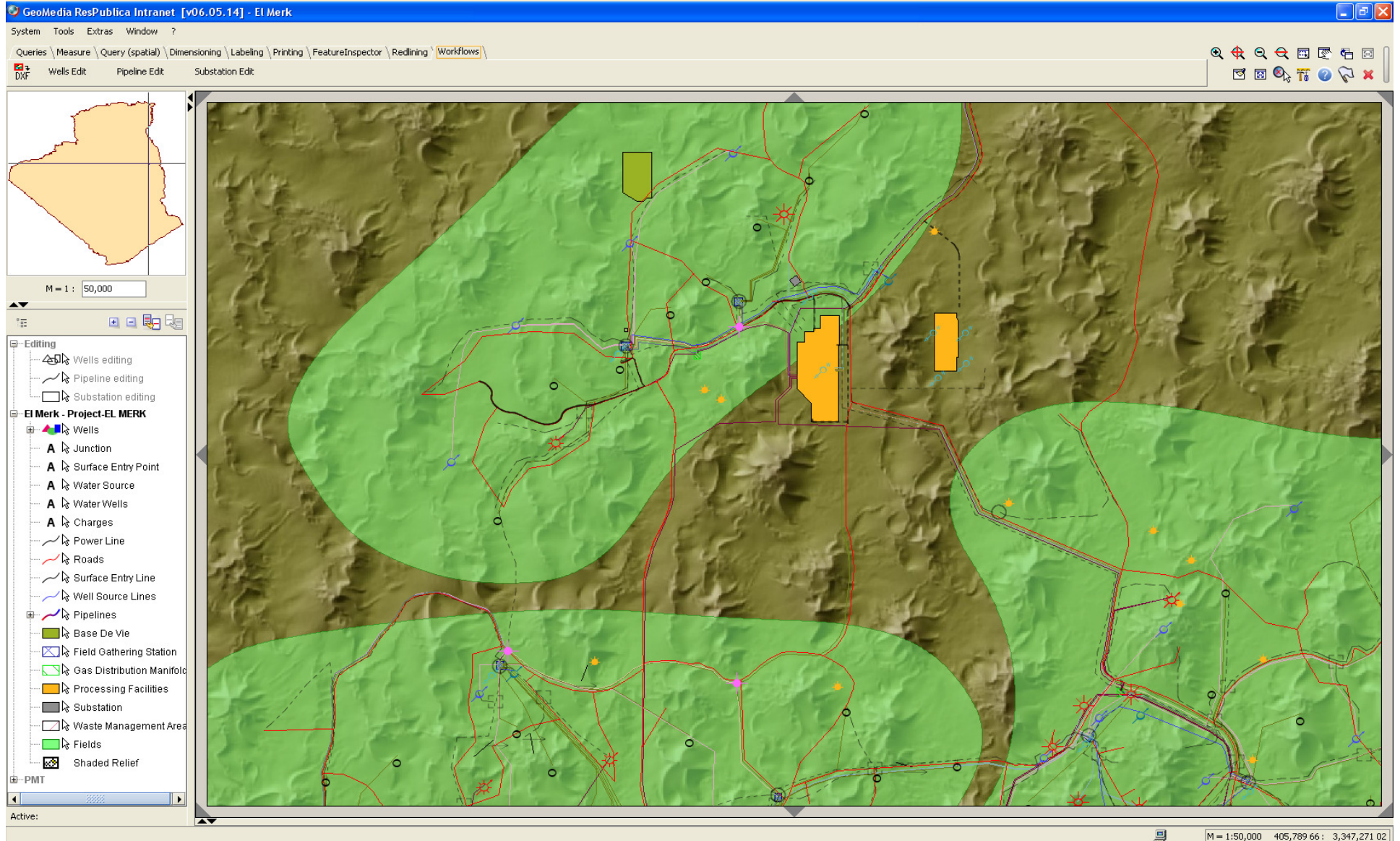
Alignment Sheet

Pipelines Properties - Windows...

Electric_line_Cross	1
Note	
Piping_Class_P	AA45
Weight_kgm_P	42.09
Wall_Thick_mm_P	6.4
Above_Underground_P	U
Lenght_meters_P	3584.61324888
Lenght_percent_P	3764
Weight_kg_P	150876.371645359
Piping_Class_D	
Weight_kgm_D	
Wall_Thick_mm_D	
Above_Underground_D	
Lenght_meters_D	
Lenght_percent_D	
Weight_kg_D	
Document	Download
Interval	
Date	
Zone	



Web Power User [Intranet]



Pipeline Open Database Standard

Pipeline Open Data Standard

Release 4.01 Final

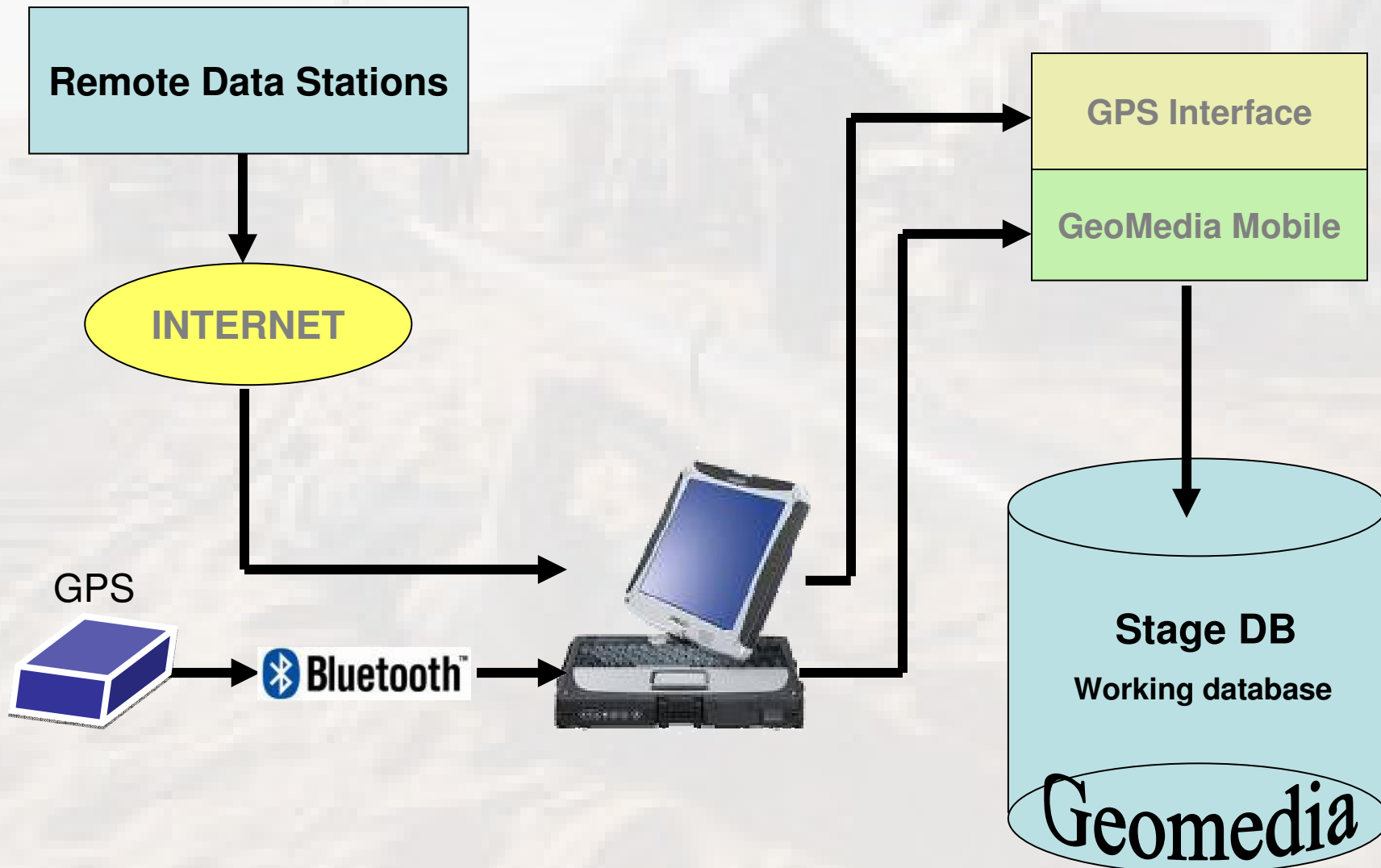
Physical Data Model
Model is subject to change

- PODS™ (Pipeline Open Database Standard) is an independent database modeling initiative applicable to gas and liquid gathering, transmission and distribution pipeline systems.
- The objective of PODS™ is to provide a common platform that will enable pipeline companies to create a standards-based GIS database. The PODS™ data model represents the requirements of the industry as a whole—it provides the framework that will enable an organization to concentrate on the unique aspects of the company rather than the generic requirements of the pipeline industry
- The PODS™ data model is implemented as a relational database in Oracle or Microsoft SQL Server. The model can also be spatially enabled providing tight integration with our GIS software platforms.
- The PODS data model is the most widely implemented and working pipeline data model in the industry. It has allowed many major oil and gas pipeline operators to quickly migrate from paper and legacy databases into a standards-based data model that has a strong organization behind it.

Field Data Acquisition

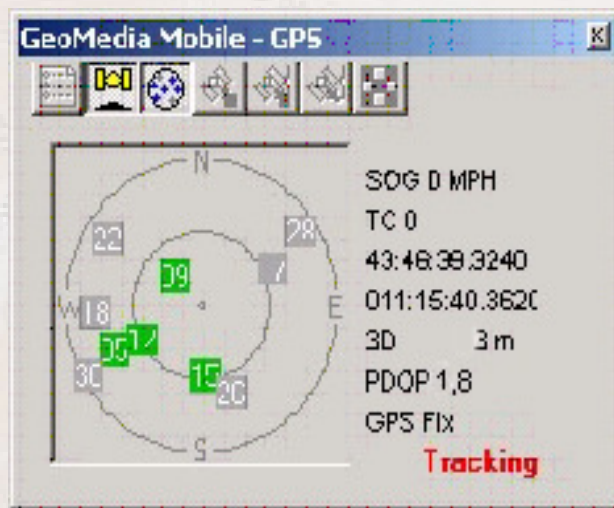


Workflow GPS Acquisition in RTK Mode

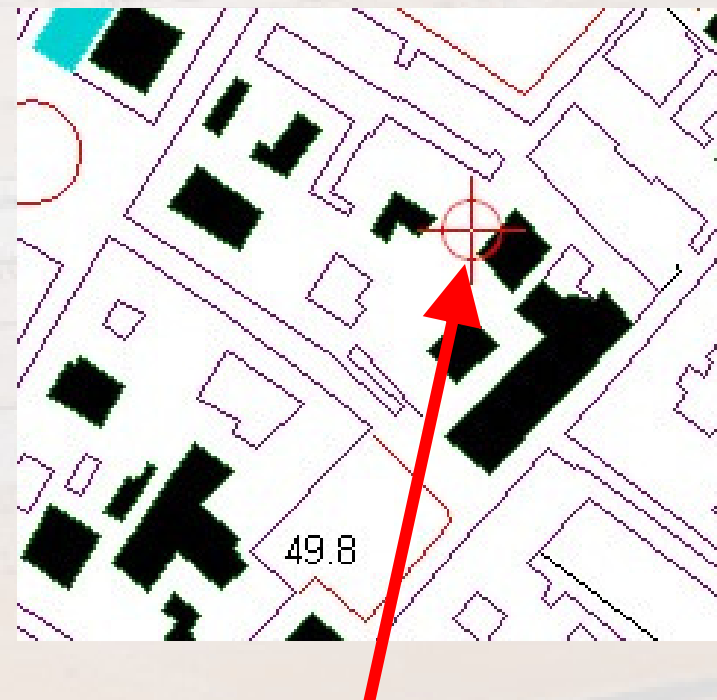


GPS Data Acquisition

GeoMedia Mobile with integrated GPS navigation



*Satellite constellation with
PDOP planimetric
indication accuracy*



GeoMedia map pointer

GIS Site Coordination Activities

- Topographic survey workflow
- Data uploading from Field to Central DB
- Data validation procedures
- Survey validation using GPS technology
- Field feedback (construction crews) management
- Work in progress control:
 - a structured breakdown in fields and type of pipeline
 - each pipeline broken down into the main erection activities (laying, alignment, welding, X-rays , test),
 - each one with an assigned weight
 - simple algorithms defined to calculate the progress
- Project cost control in a real time

Progress Monitoring

1. Objective

- To measure using a simple tool, GIS integrated, the progress of the construction direct
- Activities for flowlines, trunklines, gas lift lines, water injection and water source lines

2. Structure

- Excell file to be filled by simple information got at the cut-off date by a site survey and ingested by GIS that automatically calculate the progress, according to agreed weight for the various activities and agreed formulas.
- Breakdown completely aligned with contract

3. Managing report

- Easy visualization through GIS of the overall progress of pipelines network
- Possibility to select and know, through GIS system, any single line construction progress
- Possibility to input in a direct correct way the relevant invoice construction progress matrix.

Construction Progress Monitoring

PRICE BREAKDOWN EXAMPLE - GROUPS CONSTRUCTION

4100 – BLOCK 208 FIELDS

4110 - GATHERING NETWORK

4120 - FGS

4130 – WATER INJECTION NETWORK

4140 – GAS INJECTION NETWORK

4150 – SOURCE WATER NETWORK

4160 – ACCESS ROADS

4170 – POWER AND TELECOM NETWORK

4400 – MISCELLANEOUS WORKS

4200 – UNITIZED EMK FIELDS

4210 - GATHERING NETWORK

4220 - FGS

4230 – WATER INJECTION NETWORK

4240 – GAS INJECTION NETWORK

4250 – SOURCE WATER NETWORK

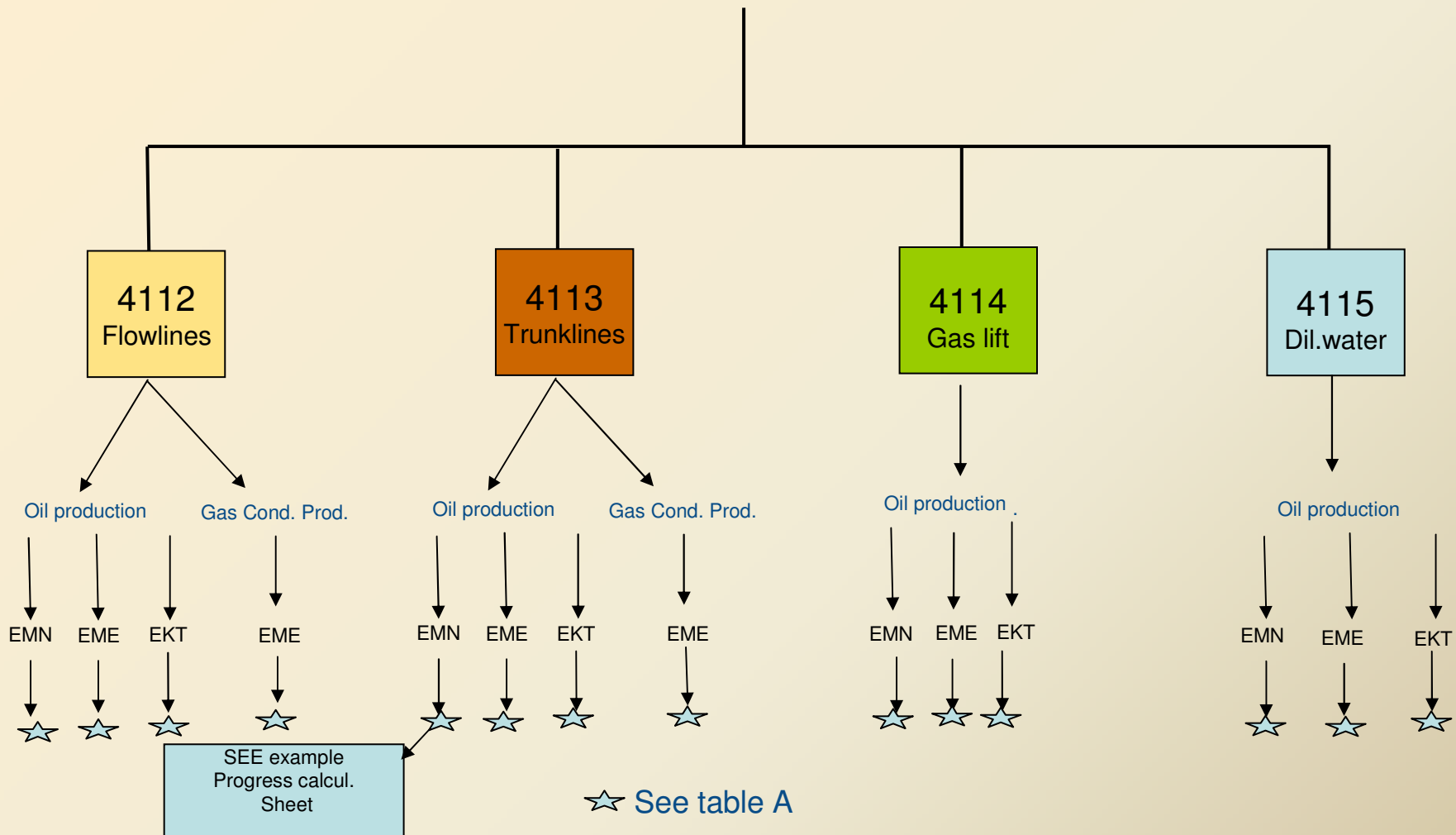
4260 – ACCESS ROADS

4270 – POWER AND TELECOM NETWORK

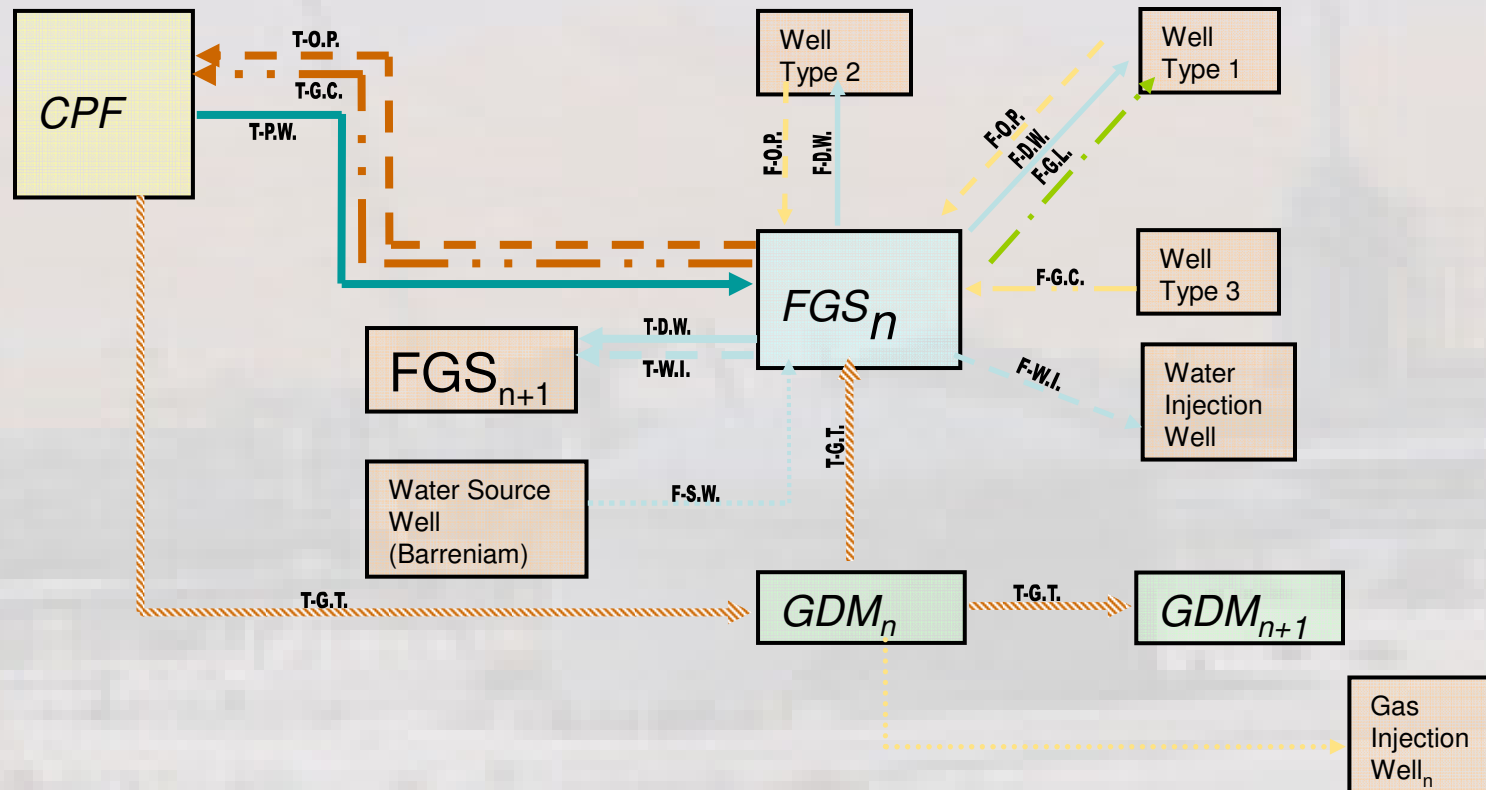
4500 – MATERIAL SUPPLY(FUTURE)

Construction Progress Monitoring

4110 - Gathering network



Typical Field Schematic



Flowlines	Trunkline – Dialution Water		Flowline – Dialution Water	
Trunklines	Trunkline – Production Water		Flowline – Source Water	
Gas lift	Trunkline – Water Injection		Flowline – Gas Condensate	
Dil.water	Trunkline – Gas line		Flowline – Gas Lift	
	Trunkline – Gas Gathering Network		Flowline – Gas Injector	
	Trunkline – Oil Production			

Construction Progress Monitoring

<u>Civil w. ass. to pipelines</u>	<u>Pipelines</u>	<u>Testing</u>
40% Excavation	10% Laying	100% Test done (site hydraulic test)
60% Backfilling	15% Alignment 50% Welding 25% X rays done	

<u>Corrosion protection</u>	<u>Crossing</u>	<u>Fiber Optics</u>
35% Pits + Anodes install. 45% Cable laying 20% Transf./rect. install.	100% Crossing work done	20% Excavation works 50% Cable laying 30% Backfilling

Progress Evaluation Sheet

Gathering network----> Trunklines----->Oil production-

T= trunk line ; O.P. =Oil Producer

FIELD	LINE TYPE	LINE N°	FROM	TO	DIAMETER	TOT.LENGTH	UNIT WEIGHT	TOT. WEIGHT
					(")	(m)	(Kg/m)	(Kg)
EMN	T- O.P.				6"	252	15	3780
EMN	T- O.P.				8"	1200	20	24000
EMN	T.-O.P.				8"	2424	18	43632

PIPELINES					Progr.
10%	15%	50%		25%	%
Layed	Aligned	Welds executed		X rays done	
ACT.	ACT.	N°	N°	N°	
m	m	Tot. Welds	Actual.welds	Actual X rays	
144	96	20	2	1	0.176786
180	180	99	8	6	0.093056
1212	1164	201	107	54	0.455363
1536	1440	320	117	61	0.318854

Video demo

Conclusions

- “Old Dogs” at ABB have learned to appreciate these GIS tools as the detailed engineering has progressed on the Offsites
- When the “Dinosaurs” who have been skeptical about GIS value to the project see what the tool can do to save their skin, we have new converts.
- There is still a lot of sand in the Sahara for “Ostriches” to keep their head buried with regard to the potential of this technology. We will get to them in due time...

Many thanks for your attention

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