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GIS and GPS Technology
for Developing and Locating Gas Pipelines

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Sui Southern Gas Company Limited, Pakistan
Pakistan is divided into Four Provinces: Sindh, Punjab, Balochistan and N.W.F.P.

Two utility companies (SSGC and SNGPL) are responsible for transmission and distribution of natural gas in the country.

Gas is supplied through more than 100,000 KM of the Transmission & Distribution pipeline Networks in Pakistan.

SSGC covers supply of Gas to consumers of Southern Provinces of Pakistan i.e. Sindh & Balochistan.

The SSGC’s Gas Transmission System comprised of over 3200 KM of high pressure pipelines ranging from 12-24” in Diameter.
This paper focuses on Transmission Pipeline Network i.e. pipeline between Gas Fields & Towns/Villages.

The corridor of transmission pipeline is not limited to plain areas.

Transmission pipelines passes through mountains, forests, crop fields, river beds (seasonal), valleys, deserts etc.

Initially, benchmarks were placed along the corridor for identification, but later most of them had been removed due to ignorance and third party damages.

Pipeline corridors are not maintained properly hence unavailable in most of the cases.
Pipeline location information were limited to field crews’ knowledge or in raw forms on topographical maps (1:500000) and plan/CAD drawings. Mostly, as-built drawings were also not available.

SSGC has its own gas distribution and transmission network.

Initially, GIS project was limited to gas distribution only, but later to cover entire network and maintain pipeline connectivity, transmission network was also included.

Gathering information about entire pipeline location in the field was a challenging task.

Field crews had used pipeline locator to search pipelines within radius of 25 – 50m.

GIS Mapping has been completed for transmission pipeline network.

So far no pipeline model has been adopted for transmission network.

APDM is being evaluating as standard model to be adapted for GIS of transmission network.
Technology Used

- Trimble Pathfinder Office Software
  *Data Dictionary, Survey Planning, and Field Data Processing*

- Trimble Terrasync Field Software
  *Field Data Collection*

- Trimble ProXRS Receivers with Trimble Recon & Laptop
  *Field Data Collection for Pipeline Mapping*

- OmniStar VBS Subscription Service
  *Satellite differential correction during the survey*

- ESRI ArcGIS Desktop, Server Standard, Oracle
  *Development of GIS Layers*

- ESRI ArcPAD
  *Relocate buried pipeline using GIS layer in the field*

- SPOT 2.5 meter Pan Satellite Data (Rectified)
  *As background information in the field and GIS Mapping*

- Metropech 810 Pipeline Locator
  *Locate buried pipeline precisely*
Step by Step Process

- Selection of GPS System
- Use of DGPS with worldwide Differential Correction service subscription
- Coordinate System Selection (UTM Zone 42N)
- Development of data dictionary using pipeline identification features in the field
- Data dictionary and rectified satellite data loading on the field device
- Field survey planning using latest almanac for best PDOP & No. of satellites
- Collection of pipeline data in the field for GIS mapping
- Use of office software for field data import, processing and export into shape file format.
Step by Step Process

- GIS Mapping of transmission pipeline in SDE database

- Publishing transmission line data on web base GIS Application along with distribution network

- Load accurate pipeline data on handheld field device (with GPS & ArcPAD) and Pipeline locator to relocate buried pipeline
Conclusion

- We discussed the development and identification of transmission pipelines in the remote areas using GPS & GIS technology.

- Previously, pipeline locator (without GPS system) was used to search buried transmission pipelines within radius of 25 - 50 meters along the corridor.

- Using ESRI ArcPAD Mobile Software and Trimble Recon Field Device with XC GPS Receiver, 25 – 50 meters searching radius has been reduced to 5 -10 meters or some time 3 meters.

- Trimble ProXRS with OmniSTAR (VBS) gives <1.5 m accuracy.

- Mountainous region or high-rise buildings may be obstacles for GPS Satellites & OmniSTAR VBS, HP or XP services.

- Pipeline locator may locate other pipelines running parallel/near to gas pipelines.

- Research to find more solutions for getting better location accuracy is still required.
These products are offered by Telemark Solutions, USA.

A unique marker system that can trace pipelines and associated features quickly and easily in combination with GIS and GPS.

These products are yet to be tested and may give better results.

This may be a cheaper solution.
Thank You for Your Time & Attention
## Selection of GPS Systems – For Pakistan

<table>
<thead>
<tr>
<th>Feature</th>
<th>Handheld GPS (OPTION 01)</th>
<th>High Accuracy Survey Grade DGPS (OPTION 02)</th>
<th>High Accuracy DGPS (Local Base &amp; Rover) (OPTION 03)</th>
<th>High Accuracy DGPS (Worldwide) (OPTION 04)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy Range</strong></td>
<td>5 to 10 m (horizontal)</td>
<td>5-12 mm + 2.5 ppm (horizontal)</td>
<td>1-50 cm + 1 ppm (Horizontal)</td>
<td>VBS &lt;1.5 m (Horizontal)</td>
</tr>
<tr>
<td></td>
<td>10 to 25 m (vertical)</td>
<td>10-15 mm + 2.5 ppm (vertical)</td>
<td>&lt;1m + 2 ppm (Vertical)</td>
<td>&lt;3 m (Vertical)</td>
</tr>
<tr>
<td><strong>Accuracy Mode</strong></td>
<td>None</td>
<td>Post Processing</td>
<td>Real Time (RTK)</td>
<td>Real Time</td>
</tr>
<tr>
<td></td>
<td>WAAS, EGNOS etc. are not applicable in Pakistan</td>
<td>No Real Time</td>
<td>More Accurate with Post Processing (Static)</td>
<td>More Accurate with Post Processing</td>
</tr>
<tr>
<td><strong>Differential Correction Service Subscription</strong></td>
<td>None</td>
<td>None (Local Base)</td>
<td>None (Local Base)</td>
<td>$ 2000/System OmniStar Annual Subscription Service (World-wide)</td>
</tr>
<tr>
<td><strong>Survey Range</strong></td>
<td>World Wide</td>
<td>10-20 Km</td>
<td>10-20 Km</td>
<td>Continental or Regional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Continuous Shifting of Base Station Required</td>
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</tbody>
</table>

- Option 04 was selected due to Regional Coverage, High Accuracy, Hassle Free Survey and some Issues like Security, Rugged Terrain etc along the corridor.
OmniStar Subscription Service

- OmniSTAR provides differential corrections for GPS via geo-stationary satellite channels like EA-Sat, AF-Sat, AP-SAT etc.
- Differential corrections are based on data from worldwide network of OmniSTAR reference stations.
- Our corrections are based on reference stations installed in Mumbai (India) and Abu Dhabi (UAE) and through AP-SAT Geo-stationary satellite (Range: 28°E to 168°W, 80°S to 80°N)
- OmniSTAR offers two types of correction service: VBS, HP & XP
- VBS allows for sub-meter accuracy and HP+ allows decimeter level accuracy around the world (within < 1000 KM from the reference station).
- SSGC is the subscriber of VBS Service. We have Trimble ProXRS Receivers which support only VBS Service.
- For Pakistan, the accuracy is within 1.5 m (VBS) due to our distance from reference stations (> 1000 KM).

It is obsolete product. The new product is Trimble ProXRT which supports OmniSTAR VBS, HP & XP
Data Dictionary & its Loading
Almanac: A data file that contains orbit information on all satellites, clock corrections, and atmospheric delay parameters. It is transmitted by a GPS satellite to a GPS receiver, where it facilitates rapid satellite vehicle acquisition within GPS receivers.

PDOP (Percent Dilution of Position): Measure of the geometrical strength of the GPS satellite configuration. The amount of error in your position. PDOP less than 4 gives the best accuracy (under 1.5 meter). Between 4 and 8 gives acceptable accuracy. Greater than 8 gives poor accuracy.
Field Data Collection for Mapping

- GPS Readings have been collected in Real Time at Benchmarks (KMP, MP, TP, CTP, CX, Temp Points) and other installations like SMS, Valve Assemblies, CP Stations etc.
Data Import and Export into Shape File
Pipeline Mapping & Web Base GIS Application

- Pipelines have been drawn in ArcGIS using GPS points collected at KMP, MP, TP, CTP, CX, Temp Points, Valves etc.
Pipeline Data Loading to Handheld Device
Relocate Buried Pipeline in the Field

- Ready to relocate pipelines in remote areas within 5 - 10 meters accuracy. Some times within 3 meters.

- ESRI ArcPAD Mobile Software and Trimble Recon Field Device with XC GPS Receiver has been used for this solution.

- For locating buried pipeline precisely, pipeline locator is also used.

- Trimble ProXRS can also be used for <1.5 meters accuracy. But this may not be cheaper solution.
Pipeline Corridor Ground Realities
Topographical Map (1:50000) / CAD Drawings

PENCIL / PEN WORK

Turning to turning Point Information Only