Spatially Enable the Transmission Enterprise

Liza van der Merwe
South Africa
Overview

• Who are we?
  – Eskom
  – Transmission
  – TxsIS
• Origins of GIS in Tx
• Where we are today
• Current initiatives
• Where we should be going
• Conclusions
Dark Africa
Africa is Huge!

The following countries could fit within Africa:

<table>
<thead>
<tr>
<th>Country</th>
<th>Area (sq. mi)</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>3,705,390</td>
<td>9,640,100</td>
</tr>
<tr>
<td>United States</td>
<td>3,618,770</td>
<td>9,372,620</td>
</tr>
<tr>
<td>India</td>
<td>1,266,595</td>
<td>3,286,224</td>
</tr>
<tr>
<td>Europe</td>
<td>1,905,000</td>
<td>4,935,553</td>
</tr>
<tr>
<td>Argentina</td>
<td>1,065,189</td>
<td>2,741,912</td>
</tr>
<tr>
<td>New Zealand</td>
<td>103,736</td>
<td>266,808</td>
</tr>
</tbody>
</table>

Africa's area: 11,707,000 sq. mi. or 30,321,130 km²
Southern African Power Pool

SNEL DR Congo
TANESCO Tanzania
ESCOM Malawi
ZESCO Zambia
ENE Angola
NAMPOWER Namibia
BPC Botswana
ZESA Zimbabwe
EdM Mozambique
SEB Swaziland
ESKOM South Africa
LEC Lesotho
SAPP Generation Capacity

- 79.9% South Africa
- 5.3% Mozambique
- 4.3% Zimbabwe
- 3.9% Zambia
- 2.8% DRC
- 3.8% Rest
Kimberley September 1, 1882
88kV Transmission line 1912
Strategic Intent
Eskom will be the pre-eminent African energy and related services business of global stature

Mission
Eskom will grow shareholder value by exceeding the needs of local and foreign customers for energy and related services
General Features

• State-owned
• Separate legal entity
• Connected more than 2.9 million homes in rural areas since 1991
• Internationally, amongst the lowest cost electricity providers
Electricity Supply in South Africa

World industrial electricity prices from a representative utility in each country

UK pence per kWh

Price per kWh*, including local taxes but excluding recoverable VAT, from a representative utility in each country for a typical 2,5 MW, 40% load factor supply as at 1 January 2003. Relative purchasing power of the respective currencies is not reflected in these values.

*Converted, using 31 December 2002 exchange rates, to UK pence per kilowatt-hour. Source: Extract from © Electricity Association Services Limited, International Electricity Prices - Issue 30
General Features

At 31 December 2003:

- Nominal capacity – 42 011 MW
- Power lines (all voltages) – 336 270 km (~ 209 000 miles)
- Revenue (Group) – $4 873 million
- Total sales – 196 576 GWh
- Peak demand on integrated system – 31 928 MW
- Total assets – $14 842 million
- Employees – 28 938
- Customers – 3 505 039
Eskom in Perspective

• Eskom received the Financial Times Global Energy Award for Power Company of the Year 2001

• Eskom received the Platts Global Energy Award for Community Development Programme of the Year 2003
Eskom in Perspective

• Eskom was ranked as the most caring company in South Africa for the second consecutive year (2002 and 2003) and among the top five since 1994.

• Eskom voted as most admired South African brand overall in 2004
## Plant Mix

<table>
<thead>
<tr>
<th>TYPE</th>
<th>NUMBER</th>
<th>NET MAX CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal fired</td>
<td>13 stations</td>
<td>32 066 MW</td>
</tr>
<tr>
<td>Gas turbine</td>
<td>2 stations</td>
<td>342 MW</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>6 stations</td>
<td>600 MW</td>
</tr>
<tr>
<td>Pumped storage</td>
<td>2 stations</td>
<td>1 400 MW</td>
</tr>
<tr>
<td>Nuclear</td>
<td>1 station</td>
<td>1 800 MW</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>24 STATIONS</strong></td>
<td><strong>36 208 MW</strong></td>
</tr>
</tbody>
</table>
Electricity Supply in South Africa

Eskom energy mix

- Coal 88%
- Import 4%
- Hydro 1%
- Pumped storage 1%
- Nuclear 6%
Financial Features

- Among the world’s top 10 utilities in generation capacity and 9th in sales
- >90% plant availability
- Annual revenue of $5 053 million
- Debt equity of 0.3
Generation makes the electricity. Transmission transports the electricity to Distribution. The Transmission Control Room ensures safe delivery. Distribution then sells the electricity to the customer.
Transmission Division

To be the most reliable transmission business in the world
Tx network in SA
Tx network location
Transmission Facts

Kilometres of lines per voltage

765 kV = 870 km
533 kV = 1 058 km
400 kV = 16 820 km
275 kV = 7 640 km
220 kV = 1 480 km
132 kV = 1 215 km

Total 29 083 km
(~18 000 miles)

156 Substations
TxSIS

Transmission Spatial Information System

• Vision: enterprise system
  – Origins: departmental point solution
Origins of GIS in Tx

- 1990 - Transmission Land Survey Department started SURGIS on Intergraph Unix
- 1994 - Converted to Windows-based GIS software
- 1996 - Started to be used for Property Portfolio Management
Origins of GIS in Tx

- 1997 - SURGIS was rolled out onto the Eskom Intranet using MapGuide
- 2000 - Migrated to ArcGIS & Oracle, renamed to TxSIS (enterprise vs departmental focus)
- 2003 - New TxSIS intranet roll-out to replace SURGIS
TxsIS System Architecture

Desktop GIS

Internet GIS

Oracle

Linex

HP-UX
Data in TxsIS

• Transmission Lines 29,083 km (~18,000 miles)
• Number of Towers 77,266
• Number of Sites 223
• Rural Properties in South Africa 411,368
• Servitude Rights:
  – Power Line Property Rights 27,786
  – Radio Sites 948
  – Fiber Optic Rights 7,796
  – Vacant Servitudes 2,950Km
1:50 000 Route Maps
TxSIS Usage

• Transmission
  – Total number of employees - 1,735
  – Professional & Managerial - 367

• TxSIS
  – Intranet users – 200
  – Desktop users – 6
What is it used for

- Maps
- Topological queries
- Asset management
- Reports on lines, towers or conductors
- Line lengths / distances
- Routes - how to get to specific sites
- System planning
What is it used for

- Line design & specifications
- Locate line fault positions using protection equipment
- Easy identification of profile sheet for specific tower
- Legal portfolio management
- Property right investigations
- Tx owned property boundaries
Internet Mapping Interface
Current Business Focus

• Improve system performance
  – Reduce line faults
  – Emergency response
  – Real-time system operations
  – Strategic planning & decision support

• Strategic & tactical response from TxsSIS initiatives
Line Fault Categories

- Bird: 38%
- Cane Fire: 4%
- Lightning: 23%
- Other: 17%
- Pollution: 1%
- Veld Fire: 17%
Current Initiatives

• Active fire project
• Real-time lightning information
• Weather forecasts
• Soil properties
• Photo layer
• Information integration with corporate system
  – Plant information
  – Performance
  – Maintenance schedule
  – Outage schedule
  – Audit findings
Grass fires
Cane fires
Active Fire Project

CSIR SAC

Internet Service Provider (IS)

ArcIMS Web Server

Internet Users

ESKOM
NDMC
SAFNET

MODIS

MSG

Email/SMS Fire Alert
Email / SMS fire alert system
Text message service

MODIS fires near "National Towers":
0.56 km from 1AP-CB 1249, 10:54 UTC
Project Progress

• Results very promising
  – YTD Fire faults 2003 – 108
  – YTD Fire faults 2004 – 52

• Research still ongoing
  – Impact of atmospheric conditions on flash-over potential
  – Flash-over potential of species
  – Develop new FDI for overhead lines
Current Initiatives

- Active fire project
- Real-time lightning information
- Weather forecasts
- Soil properties
- Photo layer
- Information integration with corporate system
  - Plant information
  - Performance
  - Maintenance schedule
  - Outage schedule
  - Audit findings
Spatially enable LPATS information in TxsSIS
Tracking the Storm
Current Initiatives

• Active fire project
• Real-time lightning information
• Weather forecasts
• Soil properties
• Photo layer
• Information integration with corporate system
  – Plant information
  – Performance
  – Maintenance schedule
  – Outage schedule
  – Audit findings
Weather Data on the GIS

- Spatially visualise forecasted weather data for week ahead
- 7 day fire danger index
- Historic weather data
Current Initiatives

• Active fire project
• Real-time lightning information
• Weather forecasts
• Soil properties
• Photo layer
• Information integration with corporate system
  – Plant information
  – Performance
  – Maintenance schedule
  – Outage schedule
  – Audit findings
Emergency Response
Corroded Foundations
Soil Properties

- Soil types
- Corrosivity
- Water erodability
- Resistance
- Soil stability

- Bulk density
- Structure / texture “soil strength”
- Rain fall
Current Initiatives

- Active fire project
- Real-time lightning information
- Weather forecasts
- Soil properties
- Photo layer
- Information integration with corporate system
  - Plant information
  - Performance
  - Maintenance schedule
  - Outage schedule
  - Audit findings
Photo Layer
Annual Raptor Nest Survey
Current Initiatives

- Active fire project
- Real-time lightning information
- Weather forecasts
- Soil properties
- Photo layer
- Information integration with corporate system
  - Plant information
  - Performance
  - Maintenance schedule
  - Outage schedule
  - Audit findings
<table>
<thead>
<tr>
<th>INCIDENT_N</th>
<th>START</th>
<th>END</th>
<th>DESCRIPTION</th>
<th>FAILURE_CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>100017345</td>
<td>01/01/2002</td>
<td>01/01/2002</td>
<td>Grootevlei - Leander No1 400kV Line Trip and ARC</td>
<td>Unknown</td>
</tr>
<tr>
<td>100017330</td>
<td>02/01/2002</td>
<td>02/01/2002</td>
<td>Hydra - Perseus No3 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Un-identi</td>
</tr>
<tr>
<td>100017332</td>
<td>02/01/2002</td>
<td>02/01/2002</td>
<td>Midas - Mercury No1 400kV Line Tripped and ARC</td>
<td>Fatigue</td>
</tr>
<tr>
<td>100017407</td>
<td>05/01/2002</td>
<td>05/01/2002</td>
<td>Matimba - Midas No2 400kV Line Trip and ARC</td>
<td>Unknown</td>
</tr>
<tr>
<td>100017395</td>
<td>06/01/2002</td>
<td>06/01/2002</td>
<td>Droenrivier - Muldersvei No2 400kV Line Trip and</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017437</td>
<td>11/01/2002</td>
<td>11/01/2002</td>
<td>Dephi - Poseidon No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017443</td>
<td>14/01/2002</td>
<td>14/01/2002</td>
<td>Droenrivier - Hydra No2 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017445</td>
<td>14/01/2002</td>
<td>14/01/2002</td>
<td>Droenrivier - Hydra No2 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017446</td>
<td>14/01/2002</td>
<td>14/01/2002</td>
<td>Droenrivier - Hydra No2 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017448</td>
<td>15/01/2002</td>
<td>15/01/2002</td>
<td>Matimba - Midas No2 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017449</td>
<td>15/01/2002</td>
<td>15/01/2002</td>
<td>Athene - Umfolozi No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017451</td>
<td>15/01/2002</td>
<td>15/01/2002</td>
<td>Matimba - Midas No2 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017463</td>
<td>16/01/2002</td>
<td>16/01/2002</td>
<td>Perseus - Leander No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017465</td>
<td>16/01/2002</td>
<td>16/01/2002</td>
<td>Hydra - Perseus No3 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017462</td>
<td>16/01/2002</td>
<td>16/01/2002</td>
<td>Majuba - Venus No2 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017506</td>
<td>18/01/2002</td>
<td>18/01/2002</td>
<td>Amot - Maputo No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017519</td>
<td>22/01/2002</td>
<td>22/01/2002</td>
<td>Bacchus - Muldersvei No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017557</td>
<td>23/01/2002</td>
<td>23/01/2002</td>
<td>Hermes - Pluto No2 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017586</td>
<td>23/01/2002</td>
<td>23/01/2002</td>
<td>Camden - Normandie No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017635</td>
<td>25/01/2002</td>
<td>25/01/2002</td>
<td>Graseridge - Poseidon No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017676</td>
<td>29/01/2002</td>
<td>29/01/2002</td>
<td>Duhha - Kendal No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017700</td>
<td>31/01/2002</td>
<td>31/01/2002</td>
<td>Duhha - Apollo No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017732</td>
<td>31/01/2002</td>
<td>31/01/2002</td>
<td>Duhha - Apollo No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017721</td>
<td>02/02/2002</td>
<td>02/02/2002</td>
<td>Grootvlei - Zeus No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017719</td>
<td>03/02/2002</td>
<td>03/02/2002</td>
<td>Midas - Mercury No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017761</td>
<td>06/02/2002</td>
<td>06/02/2002</td>
<td>Maputo - Edwaleni No1 400kV Line Trip and ARC</td>
<td>Environment - Pollution - Bird - Bird Stre</td>
</tr>
<tr>
<td>100017778</td>
<td>08/02/2002</td>
<td>08/02/2002</td>
<td>Camden - Incandu No1 400kV Line Trip and ARC</td>
<td>Environment - Foreign Object - Bird - Bird</td>
</tr>
<tr>
<td>100017800</td>
<td>08/02/2002</td>
<td>08/02/2002</td>
<td>Camden - Incandu No1 400kV Line Trip and ARC</td>
<td>Environment - Foreign Object - Bird - Bird</td>
</tr>
</tbody>
</table>
Current Systems Environment

Presentation Layer
- LPATS Power User
  - ArcEdit / ArcView

Application Layer
- TxsIS Web Front End
  - ArcIMS

Data Layer
- ArcSDE
- TxsIS

Front End
- Phoenix
  - Plant
  - Performance
  - Maintenance
  - Audits
  - Outage Scheduling
Integrate info between TxSIS & Phoenix Plant module
Spatially enable Phoenix modules in TxsSIS
Where we should be going

• Objective with TxSIS
  – Spatially enable the enterprise
• Why change is necessary
  – Changing IM governance
  – Reduce IM expenditure
Changing IM Environment

Past vs Present

Departmental vs Enterprise
Own h/w & db vs Shared h/w & db
Complete control over s/w and system development vs Need permission for all modifications / enhancements
"Techie-toy" driven vs Business & bottom-line driven
Nice to have vs Financial justification
Where we should be going

• New development has been opportunistic
• Incremental path not acceptable to decision makers
• Top-down vs bottom-up
• Need big picture of what is possible with GIS & where we are going with TxsSIS
• Tx GIS applications in their infancy…
Key Success Factors

- Vision
- Path
- Priorities
- Phased implementation

... Small Stepping Stones Showing Success
Conclusions

• TxSIS evolved slowly & naturally
• Widely used in Tx, but vast untapped potential
• Balancing act:
  – Facilitate spatial enterprise
  – Delighted customers
  – Satisfied IM governance
Thank You