Geodatabase Replication in the Real World
Implementing an Enterprise-level Geodatabase 2-Way Replication model across poor ICT Infrastructure
Dr. Mark Norris-Rogers
July 2012
Introduction

**Presentation Overview**
- Mondi at a glance
- Mondi’s GIS – Old and New
- Mondi’s Replication Configuration
- Mondi’s Database Design Issues and System Limitations
- Mondi’s Critical Success Factors
  - Careful Database Design
  - Rigid Workflow Procedures
  - Thorough User Training
Mondi at a Glance

- International vertically integrated forestry, pulp and paper company
  - **Mondi South Africa:**
    - 320 000 ha: 6 areas in KZN and Mpumalanga
  - Forestry plantations situated in rural areas
    - Poor ICT infrastructure
      - Low bandwidth lines
      - Copper rather than Fibre optic backbone
      - Line theft
      - Very high costs
  - **Mondi’s GIS History**
    - 1994-2001: Arc/Info (Unix); ArcSTORM; ArcView
      - Distributed databases – little integration
      - One question = Different Answers.
    - 2001-2011: Customised MapObjects App
      - Written for Mondi
      - Centralised SDE Database
      - Edits on thick client via Citrix – Very slow
      - Line drops = data corruption
    - 2011: ArcGIS 10.0 Replicated GDB
ArcGIS 10.0 Replicated Geodatabase

Requirements for New GIS

- “Of-the-Shelf” Software
  - Minimal customisation required
  - “Plug and play” implementation
  - Industry standard – adequate support

-Disconnected Editing, with Archiving Capability
  - Work locally - Removes network constraints
  - Maintains advantages of centralised database
  - Allows quality-control processes on edits

- Topology Validation Capability
  - Essential to maintain spatial data integrity

Each of above requirements due to problems experienced with previous systems
  - System has achieved the desired results!
Logic for using Replication

**2-Way Replication System**

- **Recommended by Esri Geodatabase Experts in Redlands**
  - Original replication design required two separate 1-way replications:
    - Default to Local
    - Local to QA Version hanging off Default (Central Server)
    - Reconcile/Post operation from QA to Default
    - Delete QA Version
    - Compress Default to Base Tables
  - Esri experts thought there could be unintended consequences using this method (not design to work this way)

- **Very Poor Network Comms with Areas**
  - Most Area offices are in rural areas with very slow network speed.
  - Delta tables are small enough to not create problems across network
  - Major time savings/much more efficient editing can occur if done locally

- **Replication done as Geodata Service in ArcGIS Server**
  - Recommended that Replication be done as a Geodata Service in ArcGIS Server to overcome network speed problems.
  - Not yet implemented – normal SDE database connection works well.
  - Another option: Direct Connects – requires Oracle client on user PC
GIS Architecture: 2-Way Replication
GIS Functionality in Mondi

*Spatial and Attribute Data Maintenance Requirements in Mondi*

- Each Area is responsible for maintaining specific spatial and attribute data sets relating to their individual geographic entities. These include:
  - Compartments; Roads; Infrastructure (Fire Towers; Water points etc.)
  - The forest operations attribute data, which is linked to the spatial data via a Unique ID
  - The Forestry attribute data is managed using Syndicate’s MicroForest Application

*Spatial Data Maintenance:*

- Base Data *(e.g. national roads; rivers; contours)*: Maintained by GIS Unit (Pmb)
- Area Data *(Compartments; Roads; Dams; Infrastructure)*: Maintained by Area Data Controllers (DBAs) – Area Foresters own the data; initiate changes. Data Controllers synchronise spatial data with attribute data in MicroForest

*Data Storage:*

- Spatial data is stored in enterprise ArcSDE on Oracle (MFSDE Schema) on a server in Durban - DEFAULT version
- Attribute data is stored in Microforest (MF) on Oracle (MF Schema) on same server
- Spatial and Attribute data are synchronised using MF Spatial Tools application.
- Link is by unique key LID – generated by MF and posted into spatial data during synchronisation process.
Data Maintenance Workflow

- 2-Way Replication System
  - **Step 1: Default to Local (Only one way of 2-way replication run)**
    - Area Editable Feature Classes are replicated to Local PC (Personal SDE on SQL Express)
    - Spatial data is subset to extract only data relevant to particular Area (Select by Graphic)
    - There are separate database connections, each unique to its Area or User Replica
  - **Step 2: Spatial Edits done locally**
    - Spatial edits are done as required to update spatial changes.
    - NB. Only spatial edits are done at this stage – no attribute edits!
    - Polygon and Line topology rules built into database are replicated down to Local version
    - Editors must run these topology checks prior to completing edits
  - **Step 3: Local to Default (Only one way of 2-way replication run)**
    - Delta tables are replicated back to Default on central server
    - Use made of Multiversioned Views
  - **Step 4: Synchronise Spatial and Attribute Data**
    - Using the MF Spatial Tools application, the spatial changes are synchronised with MF
    - Attributes in MF are updated/added/deleted as required.
    - LIDs are written to spatial data as required.
  - **Step 5: Steps 1 – 4 are then repeated.**
Database Design Issues

- **Spatial Databases designed on “clean slate” basis**
  - New System – Opportunity to redesign databases
    - Applied successful principles of previous databases
    - Enhanced design to improve data integrity; performance
    - Added many new layers

- **Designed on Esri Geodatabase principles and recommendations:**
  - Use of Feature Datasets; Feature Classes
  - Feature Datasets only used where required – Features with Topology; Relationship Classes
  - NB! Everything in a Feature Dataset is included if any 1 feature in FDS is part of a replica
  - Feature Classes grouped appropriately with “tag” in FC name

- **Replicating Tables:**
  - Requires a Relationship class to be set up (in a Feature Dataset!)
System Issues & Limitations

- **Synchronising data with Third-Party Application/Database**
  - **Spatial Data has to link to Third-Party Attribute Database**
    - Third-party Vendor had written synchronisation module
    - Third-party App could only read Base Tables, not Adds/Deletes Tables
    - Issue resolved by using Multiversion View Tables of relevant layers to be synchronised
    - But, current MVV tables do not allow for Archiving on Default
    - Work-around: Archiving only enabled on local replicas – Most critical place!

- **Compress to Base Table Issues:**
  - All Users access Database via “common” user name
  - Prevented ‘Compress to Base Table’ operations completing successfully
  - Resolved by using Multiversion View Tables
  - All edits were visible to third-party application without running a Compress
  - Did try using models to run Compress, but often failed due to network failures

- **“Knock-on Effect” on other Systems and Databases:**
  - Need to review potential impacts on other Company systems and databases!
  - Interface software/links - new layer/table names
  - Involve IT Department!
Rigid Workflows, User Training Essential

- **Strict adherence to published Workflows critical**
  - **Develop and Publish Detailed (Step-by-Step) Workflows**
    - Need to clearly understand Replication Process and Organisational Workflows
    - Break each process down to a “Step-by-Step” Workflow
    - Clearly document these – screen-shots of each process
    - Decision-Tree process flows useful where choices are required
    - Mondi wrote 75 Page Manual detailing every step required in the Editing/Replication/Synchronisation Workflow
    - ~90% of problems due to not correctly following workflows

- **Thorough User Training critical**
  - **Initial Training, Follow-up Training, Refresher Training, Ongoing Training!**
    - System in daily use for last 8 months – Still holding training sessions!
    - Don’t under-estimate the need for repeat training
    - Initial 5 Day customised training course - Esri Instructor
    - Refresher training on-site at the time of actual implementation
    - Weekly visits to staff by Mondi Trainers (GIS Staff) for first two months
    - Monthly visits to staff ongoing.
    - However, amount of training may depend on how different new system is compared to system it is replacing
Useful Pointers

**Processes/Tools that are useful**

- **Replication Log File**
  - An xml log file is generated each time a synchronisation is run
  - ReplicaLog.dat
  - Stored at `C:\Users\user_name\AppData\Local\Temp\ReplicaLog.dat`
  - Details each layer synchronised and the time of replication
  - Very useful to check if Replica succeeded or where problem occurred

- **Distributed Database Toolbar**
  - Do not provide this to Users – “Synchronise Changes” icon inserted in Editing Toolbar
  - “Manage Replicas” Icon – Useful tools to manage Replicas
  - Right-click on a Replica Name – “View Log”: Quick way to check if Replica succeeded
  - However, can give “false positive”, i.e. Reports Succeeded, when it failed.
  - Check ReplicaLog to make sure!
  - Biggest risk with “Manage Replicas” – Users can inadvertently UNREGISTER Replica!
  - Deletes Replica and must recreate from scratch
  - Have not found a way to customise Toolbar with “Manage Replicas" Icon

- **Create Focussed Replicas**
  - “View-only” Replicas – One-way replication of layers for viewing purposes only
  - Replicas involving sub-set of data or specific layers – one-way or two-way
  - Replication process is flexible – can meet different needs across organisation
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