Roads and Highways
Performance Improvements

Finding, Assessing, and Addressing Performance Bottlenecks
Ray L. Chilcote, PG GISP
NCDOT
Overview

NCDOT LRS, Data Stats

The Blindside – data (assurance) insurance

Know your system (parts)

R&H – the beast within (complexity)

Monitoring

Bottlenecks
NCDOT LRS Timeline

2007
100 personal geodatabases (1 per county)
Put together nightly for statewide LRS
Very few events edited

2009
SDE with beginnings of MUG (MultiUser Geodb) and ARID (Attribute Road Inventory Data)

2016
R&H in Production
Incorporation of non-system roads

2019
50+ events
NCDOT Current R&H Data Stats

- LRS
  - 366k Routes (78,796 system)
  - 86,916 miles (85,964 system)
  - Initially loaded 15m vertices, 1.5m intersections
  - Currently 21m vertices, 1.8m intersections

- Events
  - 50+ events, 4.4 million segments

- R&H Database size
  - Just under 6GB
Backups - insurance

The most valuable piece of your GIS system is what?

• How often

• When (during the day/night)
  • Timing vs nightly maintenance scripts is important

• Recovery expectations
  • How fast
  • To what point in time?

• Test!

• At NCDOT, SQL Server backups and fgdb backups
Backups (NCDOT)

- SQL Server
  - 3 days – immediately available to DBAs
  - 30 days on tape (slight delay in getting > 3 days)

- Fgdb (SDE replica)
  - 1 week daily retention (Monday overwrites previous Monday)
  - Archive Fridays
  - Zipped, 2.8GB
  - Besides backup, also useful for refreshing data to lower stages

- Have had to use each in data recovery (luxury of choice/advantage)
Know Your System

• Software
• Hardware
• Presentation
• Data
• People
Know Your System Architecture

Software
- Esri
- Extensions
- Add-ons
- Patches, BUG fixes
- 3rd party tools

Presentation
- ArcMap
  - Many layers
- ArcServer
  - Visibility levels
- Flow (Workflow Manager, Data Reviewer)

Hardware
- Expandable
- End points

Data
- Slivers
- QC (immediate/local/statewide)
- Schema/version locks
- Resolution/Tolerance
- Replication
- Verticies and exponential numbers

Change control (development, testing, QC, production, training)
System Load

ArcGIS can be intensive
  • A 2-minute SQL trace yielded 38k actions in the db... by ONE user
    • Network bandwidth is extremely important, especially with editing
  • Not only bandwidth (quantity), the quality of the network (no packet drops)
  • Slow down = time outs (incurs various sources of problems)

Single-server tiers will barely survive
  • Plan for load balancing, multi-server environment

HP (RAM, MHz, load balancing) is not everything
  • Many sources can slow down a system
  • Not only network and hardware, but also software, data, presentation
  • Identify the issue before applying the “fix”
Software

• ArcGIS. Repeat, ArcGIS. Esri.
• OS (Windows 7, 10, Server 2012)
• SSMS, RDBMS version
• ArcServer, Extensions

• Upgrades in place  If at all possible, No
Presentation – ArcMap and Server

• Tuning
  Perfmonstat
  Wireshark
  Simple pings
  New Relic

• End points
  Point to point testing
  Other network activities

• Reprojection
  Imagery
  Yay, our imagery is available via Esri?

• People
  Html vs json
  Well written Where clause
Hardware – End points

- License
- SDE, WMX, DR
- Local
- Services
Hardware: Future?
Database

- Overnight SDE processes
  - Analyze
  - Reconcile
  - Compress
  - Analyze

- Indexes

- Periodic
  - Stats
  - Rebuild of spatial indexes

- Look at all databases, not just Editing
Monitoring

Software
• ArcGIS
• Bugs

Network
• For integrity, do not just focus on capacity. Focus on quality as well.
• Finishing is great, even if slow.
• Failure of process is..._______________.

Services
• Group data wisely
• Update schema checkbox
• Perfmonstat

SDE/database

Data
• QC

• Set up monitoring and alerts in db and task manager
SDE Monitoring

• Experienced SDE SME
  • Locks
  • Version/lineage counts
  • Version tree
• Geodatabase Toolkit (GDBT)
• DBAs
  • Traces
  • Top 10 costly queries
SDE Monitoring

GDBT (Geodatabase Toolkit)
/* Get Lineage count for each version */
SELECT v.owner + '.' + v.name "VERSION NAME", COUNT(sl.lineage_id) "LINEAGE LENGTH"
FROM sde.sde_states s, sde.sde_state_lineages sl, sde.sde_versions v
WHERE s.lineage_name = sl.lineage_name
AND sl.lineage_id <= s.state_id
AND v.state_id = s.state_id
GROUP BY v.owner, v.name, sl.lineage_name
ORDER BY "LINEAGE LENGTH" desc, "VERSION NAME" desc

/* Count monitors */
SELECT * from
(UPDATETEMP67907855) a,
(UPDATETEMP67907855) b,
(UPDATETEMP67907855) c,
(UPDATETEMP67907855) d,
(UPDATETEMP67907855) e,
(UPDATETEMP67907855) f
States – before/after compress (for a year)
## Scheduled Tasks

<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Triggers</th>
</tr>
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<tbody>
<tr>
<td>Adobe Acrobat Update Task</td>
<td>Queued</td>
<td>Multiple triggers defined</td>
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<tr>
<td>DailyFgdbBackup</td>
<td>Ready</td>
<td>At 4:00 AM every Tuesday, Wednesday, Thursday, Friday, Saturday of every week, starting 6/15/2018</td>
</tr>
<tr>
<td>FgdbSync</td>
<td>Ready</td>
<td>At 2:30 AM every Tuesday, Wednesday, Thursday, Friday, Saturday of every week, starting 10/10/2017</td>
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<tr>
<td>LockedRoutesScheduledTask</td>
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<td>At 9:00 AM every Monday, Tuesday, Wednesday, Thursday, Friday of every week, starting 8/19/2015 - After triggered, repeat every 1 hour for a duration of 12 hours.</td>
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<tr>
<td>MilePointAddsTableCount</td>
<td>Ready</td>
<td>At 12:15 PM every day - After triggered, repeat every 1 hour for a duration of 1 day.</td>
</tr>
<tr>
<td>Optimize Start Menu</td>
<td>Ready</td>
<td>When computer is idle</td>
</tr>
<tr>
<td>PreCon_Sync</td>
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<td>At 12:30 AM every Tuesday, Wednesday, Thursday, Friday, Saturday of every week, starting 6/16/2017</td>
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<tr>
<td>RPS Tool</td>
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<tr>
<td>UIP Tool Automation</td>
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<td>At 7:07 PM every Monday, Tuesday, Wednesday, Thursday, Friday of every week, starting 1/1/2017</td>
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</table>

### MilePoint Adds Table Count

![Graph showing MilePoint Adds Table Count](image)

### Locked Routes Prod

![Map of Locked Routes in North Carolina](image)
Not Just Editing

Select owner, count(*) from sde.sde_states group by owner

<table>
<thead>
<tr>
<th>Publication</th>
<th>StateCount</th>
<th>StateLineageCount</th>
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<td>5444219</td>
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<td>Test</td>
<td>81719</td>
<td>902883</td>
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<td>QC</td>
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<td>208862</td>
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<td>Prod</td>
<td>75381</td>
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<td>Test</td>
<td>13</td>
<td>48</td>
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<td>QC</td>
<td>57</td>
<td>207</td>
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<tr>
<td>Prod</td>
<td>216</td>
<td>2973</td>
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<table>
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<td>3</td>
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<tr>
<td>Test</td>
<td>2</td>
<td>3</td>
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<tr>
<td>QC</td>
<td>93</td>
<td>250</td>
</tr>
<tr>
<td>Prod</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Not Just Editing

---

```sql
SELECT * from
(SELECT count(*) StateCount from sde.sde_states) a,
(SELECT count(*) StateLineageCount from sde.sde_state_lineages) b
```

---

Select owner, count(*) from sde.sde_states group by owner
Database - indexes

/* List when attribute indexes were last refreshed */
SELECT 'Index Name' = i.name, 'Statistics Date' = STATS_DATE(i.object_id, i.index_id)
FROM sys.objects o
JOIN sys.indexes i ON o.name = 'LRSN_MilePoint' AND o.object_id = i.object_id;

/* List when spatial indexes were last refreshed */
SELECT 'Index Name' = i.name, 'Statistics Date' = STATS_DATE(i.object_id, i.index_id)
FROM sys.objects o
JOIN sys.indexes i ON o.name = 'SDE_States' AND o.object_id = i.object_id;
Data QC

Remember the 21 million vertices

- 2.8 million vertices are newly created, extremely dense, seemingly straight arcs with vertices every .1 ft
- Increase in 3 weeks ~ 14% increase in overall count (do math)
- This didn’t receive any attention until they were compared with verticy counts of entire counties
  - Example: near straight route has 102k vertices
    - Has more vertices than 49 of 100 counties
    - More than the lowest 8 counties... combined
  - Smallest county has < 8k (initial load)
  - Largest county has 730k (initial load)
  - Longest statewide route has 26k vertices
- 138 routes have > 10k vertices
  - These 138 routes contain 2,931,224 vertices
  - 0.037% of the routes contain 14% of all vertices

- Tyrell County - 7400 to 630k
- Pender County - 82k to 755k

DR check:
- SHAPE.STNumPoints() > 500
Person County ranks 49/100 by number of vertices
GP Metadata

  <CatalogPath/>
  <Name />
  <ChildrenExpanded>false</ChildrenExpanded>
  <WorkspaceType>esriRemoteDatabaseWorkspace</WorkspaceType>
  <WorkspaceFactoryProgID />
  <ConnectionString />
  <ConnectionInfo xsi:nil="true" />
  <Domains xsi:type="typens:ArrayOfDomain" />
  <MajorVersion>3</MajorVersion>
  <MinorVersion>0</MinorVersion>
  <BugfixVersion>0</BugfixVersion>
  <Realm />
</DEWorkspace>
Data Configuration – R&H Design

Editing across a network
Few constraints
Some useless indexes
  • Nulls allowed, especially ToDate (where it’s a default meaning live data)
  • This is an editing overhead
Not Normalized
  • Repetitive data
    • Intersection Points
    • Route overlaps
    • Duplication of spatial component
      • Admittedly needed for faster drawing time
      • But painful for QC and Publication needs
Network vs Event resolution not equal
  Moreover: in the Events, spatial resolution <> Measure column resolution/precision
Data Configuration

Feature Class Resolution

Esri stores integers of coordinate pairs. To accomplish, the coordinate is multiplied by the reciprocal of the XY Resolution

12345678901234

Vs

12345678901234567890123456789012

Why is this important?

Esri stores integers of coordinate pairs. To accomplish, the coordinate is multiplied by the reciprocal of the XY Resolution

12345678901234

Vs

12345678901234567890123456789012

Database size reduction – 10%

<table>
<thead>
<tr>
<th>#places</th>
<th>#vertices</th>
<th>X, Y</th>
<th>bits to store</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 x 15,100,000</td>
<td>2</td>
<td>= 966,400,000</td>
<td></td>
</tr>
<tr>
<td>14 x 15,100,000</td>
<td>2</td>
<td>= 211,400,000</td>
<td></td>
</tr>
</tbody>
</table>
Summary

• Build Smart
  • Plan ahead
  • Optimize – I/O is particularly important
  • Have team(s) in place for *when* issues arise

• Many potential sources of system slowdown
  • Find the resistance. In order to do this, you need:
    • To have *baseline* and *metrics*. Know what is normal and what is not.
    • Monitoring in place
  • Software
  • Hardware
  • Data
  • Network
  • Presentation

• Error messages – don’t always believe what you read

Lack of SDE maintenance
  If no maintenance, this IS a problem
  Compress. Often.
  Long-standing versions
  Fix is nightly reconcile of all versions
  Not *some*, ALL!
References

• State locks
  • https://community.esri.com/thread/206938-error-trying-to-view-locks#comment-739912

• GDBT
  • https://community.esri.com/thread/9124
Resolution

\[0.0000001 \text{ miles} \times 5280 \text{ ft/mile} = 0.000528 \text{ feet}\]
Raleigh, We Have a Problem

Exception from HRESULT: 0x80041538

Column value is NULL

The version could not be reconciled.
Insufficient permissions [CDROMEDIT:ROME.LRS_INTERSECTIONPOINT]

An error occurred while trying to execute this step. Unable to reconcile:
the target version is currently being reconciled against [ROME.LockRoot]

Desktop Viewer

The connection to 'Road and Highways' failed with status (Unknown client error 1110).

pythonw.exe has stopped working
A problem caused the program to stop working correctly. Please close the program.

- Close the program
- Debug the program

Citrix Receiver

Unable to launch your application. Contact your help desk with the following information:
Cannot connect to the Citrix XenApp server. Network issues are preventing your connection. Please try again. If the problem persists, please call your help desk.
When there is a problem

• Look at the system (database, hardware, software, network)
• Test each piece of the architecture
  • Monitoring needs to already be in place
  • Huge challenge for network, database
    • Needs to be repeatable
• Database (DBAs)
• Table, schema locks (SDE SME)
• Services (Service Group)
• Network (Operations, IT)

• Software
  • Bugs

• Data
  • Can data induce the error? (example: vertex density, overlaps, lightning bolts)
Identify the Bottleneck— (seriously, *everything* is slow?)

- Is it the database, software, hardware, network, or data?
  - See the error, take it at face value, *but*...
  - Keep eyes/ears open. 50/50 the error is *not* indicative of the actual error.
  - Timeouts stop a system cold... in the middle of actions. So error returned can mislead.
- DBAs are your friends
- Topology of your system – interaction of the parts
  - R&H is on top of Esri software
    - Find a baseline - How long does it take for ArcMap to open?
  - Versioning tree length
    - At least a successful partial Compress - often
    - Statistics, analyze – often
    - Schedule – no such thing as too often – over achieve here!
  - Are Adds/Deletes table numbers high?
  - Replicas (data dispersement)
  - Publication tier
- Increasing RAM or adding hardware is *rarely* the solution!
  - We have seen I/O cards on new hardware be very helpful
- Esri BUGs
  - Ordering on full table, no selection, *with a query def*... doesn’t use the indexes (BUG-000114011)
<table>
<thead>
<tr>
<th>RowNumber</th>
<th>EventClass</th>
<th>TextData</th>
<th>A...</th>
<th>NT...</th>
<th>Logi...</th>
<th>CPU</th>
<th>Reads</th>
<th>Writes</th>
<th>Duration</th>
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<th>SPID</th>
<th>StartTime</th>
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<td>16</td>
<td>4018608</td>
<td>11492</td>
<td>70</td>
<td>2018-11-26</td>
</tr>
</tbody>
</table>
Database

**Edit**
- SDE
- OWNER1
- DATAREV
  - LrsEdit
  - EventEdit
  - IntersectionEdit
  - RomeRead
  - WmxEdit

**Wmx**
- SDE
- WMX
- WMX_APP
  - WmxEdit
  - WmxOwner

**Stage**
- SDE
- GdbWkspc
- Gdb workspace
  - OWNER1
  - TblWkspc
  - Table workspace

**Pub**
- SDE
- OWNER1
- WKSPC
- MAJORAPP1
- MAJORAPP2
- MAJORAPP3
- MAJORAPP4
- MAJORAPP5

**Services**
- Internal File Servers
- ExportNetworks
- Replicas
- Publication
- Gdb/Shape

**Black** – Database name
**Orange** – Schema/Data owner
**Red** – Permission Role