Test Study: Evaluating impact of visibility range on system performance and user experience

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Introduction

Performance problems can be elusive, but a good place to start looking for improvement areas is your web map. By default, layers in web maps draw at all scales. However, for most types of information, there are scales at which the density of data becomes too high to be useful. Additionally, zooming out and rendering all this data at increasingly smaller scales can put a significant burden on an ArcGIS system's resources and can ultimately cause maps and apps to respond slowly and deliver a poor user experience.

The goal of this test study is to assess the quantitative impact that visibility range settings can have on system performance and user experience. To provide meaningful results, this test study tested real-world workflows against a Network Information Management System hosted in Amazon Web Services (AWS) cloud infrastructure using AWS EC2 instances. The load test and user experience results of the system with poorly configured maps are compared to an identical system with optimized map configurations to evaluate the impact to performance and system utilization.

Note:

This test study is not intended to recommend a specific visibility range for any specific layers. Rather, it shows that employing visibility ranges appropriately is a straightforward, low-cost way to improve performance and user experience.

- Learn more About test studies.

Workflows

To ensure the test study provides valid results, the workflows need to represent real user experiences, and the actual steps that users will take in interacting with the system. The workflows used in this test study represent some of the foundational activities required to maintain and access an as-built electric network.

The contents of the workflows were defined by experienced staff, along with Esri customer feedback to identify the specific steps, sequencing and type of activities involved in each workflow. The following key workflows were run manually against the system under load to capture user experience and overall performance:

1. Create a new service with existing feature– provide service from existing transformer
2. Create new service from new feature – provide service with new pole and transformer

3. Update asset – move an asset or update attributes
4. Load management – Redirect load from one circuit to another
5. Phase management – move a service to a different phase
6. Electric tracing – upstream protective trace and downstream customer trace
7. View assets- search and view assets and attributes
8. Summarize assets – identify dirty feeders, counts of new features

You can read more about these workflows in the related system test study.

Software

The system capabilities are delivered through the following software, deployed, and tested as part of this test study, at the listed versions with all available patches applied:

- ArcGIS Pro 3.3 (latest version here)
- ArcGIS Enterprise 11.3 (latest version here)
- ArcGIS FieldMaps 24.2.2
- ArcGIS License Manager 2024.0 (latest version here)
- ArcGIS Monitor 2023 (latest version here)
- ArcGIS Online
- PostgreSQL v14.6

Test methods and results

Manual testing, combined with automated load testing, was conducted to examine how misconfiguration of map extent and layer scale visibility would impact editing and viewing workflow performance and user experience. Desktop machine instances, as well as ArcGIS Pro and the web apps were monitored as workflows were conducted under load.

Scripted testing was performed to simulate the steps an editor would take when performing the defined workflows. Upon test completion, results were assembled and analyzed to compare desktop utilization and end-user efficiency with different hardware configurations.

Test methods

To test the impact that map extents and layer visibility ranges can have on performance and user experience, a few modifications were made to otherwise well-configured maps that were previously tested and confirmed to have good performance and user experience:

- The Dashboard web map (used for the view asset workflow): the “electric layer” visibility was changed from neighborhood level to county level, and the default extent of map was changed from neighborhood to counties.
- The Experience Builder web app (used for the summarize assets workflow): electric line layer visibility and default map extent updated with the same settings as above.
- The ArcGIS Pro project map (used for editing workflows): removed visibility ranges of ‘medium voltage conductor’ layer inside the ‘electric line’ group layer, and the default map extent was set to 1:500,000.

These changes were chosen to view the impact of map extent and layer visibility configurations across different kinds of foundational electric utility network information management workflows. The read-only Utility Network service used for Viewer workflows operates on the hosting server, while editing workflows utilize the UN service hosted on the GIS Server. Therefore, the impact of poorly configured layer visibility and map extents on editing and viewing workflows can be seen on the respective system component’s instance.

Performance testing tools

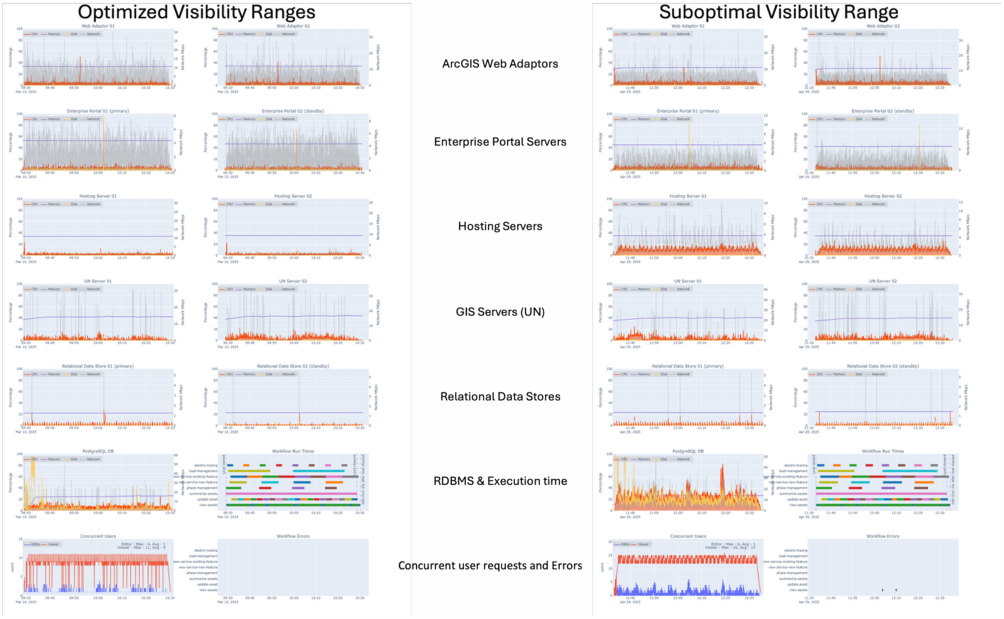
Because ArcGIS is a multi-tier system, performance tests were conducted across client, service, and data storage tiers, as well as the underlying infrastructure itself. In this test study, JMeter was used to simulate the user workflows and measure system performance under different loads. ArcGIS Pro requests were recorded and then replayed to simulate load in addition to manual workflows that were performed to assess end-user experience.

Windows Performance Monitor and ArcGIS Monitor were also used to monitor resource utilization across different components. For more information, see tools for performance testing.

Test results

The system was tested in three scenarios to understand how poor map configuration impacts performance and user experience at different loads. For each load scenario you can compare the impact relative to an otherwise identical system with optimized visibility ranges (left). At a high level, test results show that maps with even one or two inappropriate layer visibility and map extent configurations can greatly impact system utilization and user experience, particularly at higher loads.

Test scenario : 2x design load



Observations:

- Overall, acceptable utilization across system components, but with double the utilization on the database, Utility Network (UN), and hosting server instances as compared to the optimized system

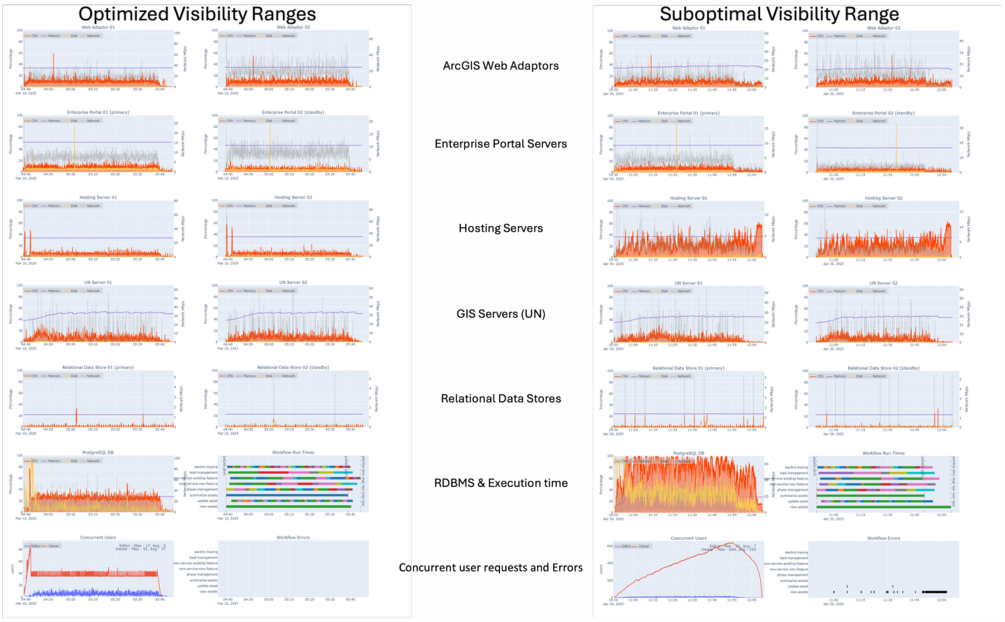
- Hosting and UN servers exhibit CPU utilization spikes throughout the run
- Service wait times and ArcSOC utilization remain within acceptable thresholds

Test scenario : 4x design load

Observations:

- The hosting server and database exhibit significant resource utilization throughout the test, with roughly four times the utilization as compared to the optimized system
- PostgreSQL instance shows over 200% increased resource utilization as compared to 2x design load
- Service wait times continue to increase
- Most ArcSOCs on the hosting server are busy throughout the run, with some instances peaking
- ArcSOCs on the UN server show linear and gradual increase, less impacted as compared to hosting server

Test scenario : 8x design load (optimized) compared to 6x design load (suboptimal)



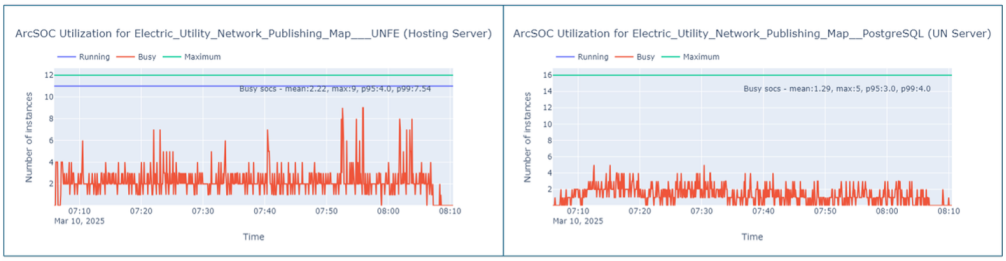
Observations:

- The suboptimal configuration shows overall poor performance with unacceptable service wait times, particularly for viewer workloads running on the hosting server
- In the suboptimal configuration, the hosting servers exhibit roughly four times the utilization at 6x, even compared to 8x design load on the optimized system
- The PostgreSQL instance is reaching its threshold at 6x with a suboptimal configuration, which is more than double the utilization of the optimized system at 8x design load
- Most ArcSOCs on the hosting server reach maximum thresholds with the suboptimal configuration – unusual behavior is observed resulting from the server being busy and unable to retrieve SOC utilization values
- ArcSOCs on the UN server (editors) show linear and gradual increase, less impacted as compared to hosting server

ArcSOC utilization comparison

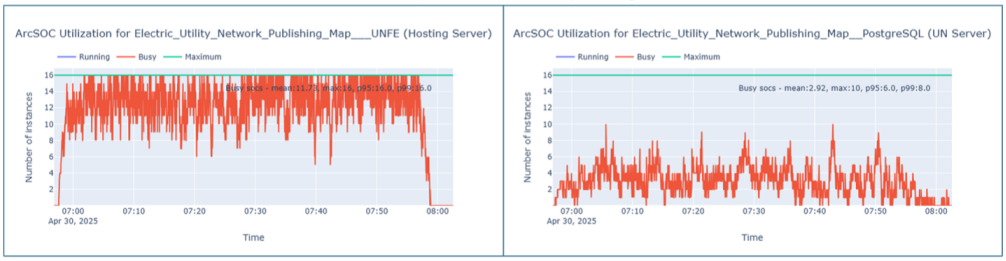
Increases in ArcSOC utilization often causes an increase in service wait time, which ultimately impacts users' ability to do their work efficiently. ArcSOC utilization was monitored across all load scenarios. In every test, ArcSOC utilization was notably higher as compared to the system with optimized maps. The graphs below illustrate the significant difference at 4x design load. Compared to the optimized system, the ArcSOC utilization on the hosting server increases by roughly 3 to 4 times and the UN server by about two times.

Optimized Visibility Ranges



ArcGIS Enterprise GIS Server (hosting) ArcGIS GIS Server (editing)

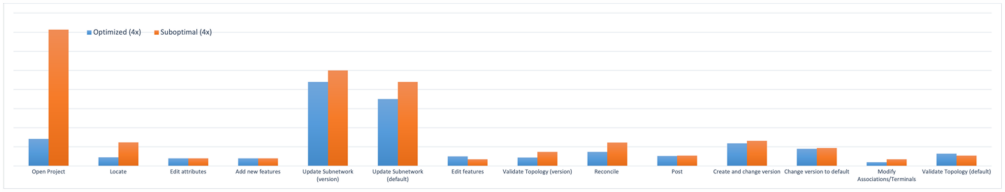
Suboptimal Visibility Range



ArcGIS Enterprise GIS Server (hosting) ArcGIS GIS Server (editing)

User experience

To evaluate user experience, workflow step durations were captured. When workflows take longer for users to complete, it signals the system is responding more slowly to their requests. The chart below shows the average time it took users to complete a given step within a workflow in both the optimized and sub optimally configured systems.



In all workflows other than load management, there is a measured increase in total workflow time with increased load. At 6x design load, the view assets workflow takes about fifteen times longer as compared to at 2x. The login and open project step in the update asset and electric workflows take the longest time, with notable jumps in duration as the load on the system increases. Additionally, the locate, zoom to device, and downstream trace steps all have exponential jumps in duration at 6x design load compared to 4x design load.

Conclusions and key takeaways

This test study is not intended to recommend a specific layer visibility range or map extent. Rather, it shows that configuring appropriate visibility ranges is a straightforward, low-cost way to significantly improve performance and user experience.

Though this test study used electric utility workflows, the need for proper map configuration applies across industries and workflows. Properly configured maps are essential to delivering a positive user experience, impacting workflow and user efficiency and increasing the overall return on investment of your ArcGIS system.

Therefore, every organization should regularly review their map configurations (especially if users are reporting poor performance) to confirm that they are configured optimally to support the users' needs while balancing use of resources.

- Learn more about how to Display layers at certain scales.

Key takeaways

- Improving sub optimally configured maps is a low-cost and straightforward way to improve a system's performance and end user experience.
- Improper map extent and layer visibility ranges on even just one or two layers can significantly impact system performance and user experience.
- Poorly configured maps resulted in two to four times the resource utilization as compared to system with well-configured maps.
- Bad map extent and layer visibility range configuration resulted in significantly slower (from 3 to 14 times longer) execution times across workflows on key workflow steps.
- It is critical to regularly monitor and assess map and layer configurations to optimize resource utilization with the users' needs.