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Design Sharing in BIM

Introduction

Next to a great many benefits, Building Information Modeling (BIM) has also introduced new challenges for the design team. BIM models contain significantly more data and with much tighter integration than traditional 2D CAD drawings. As a result access by teams to projects now contain bottlenecks not known in earlier CAD design methods. Traditional work sharing, by assigning standalone CAD files to individual team members, does not work in case of model-based design since the entire project is incorporated within the BIM model therefore BIM projects require a completely new method of work sharing. To facilitate teamworking in BIM projects software vendors developed file-based model sharing solutions. Team members worked on copies of the BIM project and synchronization of the work of the team was achieved through merging the different versions of the project files. With BIM becoming mainstream and with the recent focus on accelerating construction project completion the clunky, file-based workflow quickly has become “the bottleneck” to timely project delivery.

This whitepaper aims to analyze the different solutions provided to the above-described problem and offer recommendations about the most important criteria one should be aware of when selecting an optimal design sharing solution for BIM implementation.

Basic Approaches to Design Sharing in BIM

BIM software vendors now offer different technology solutions to provide better solutions to model-based design sharing but with different levels of success in addressing the core problem of providing concurrent, real-time access to BIM projects for the larger and/or more distributed teams. Put simply: how easy and quick is it for team members to share the BIM model, and work securely on their own part of the design, while minimizing or most preferable eliminating the editing

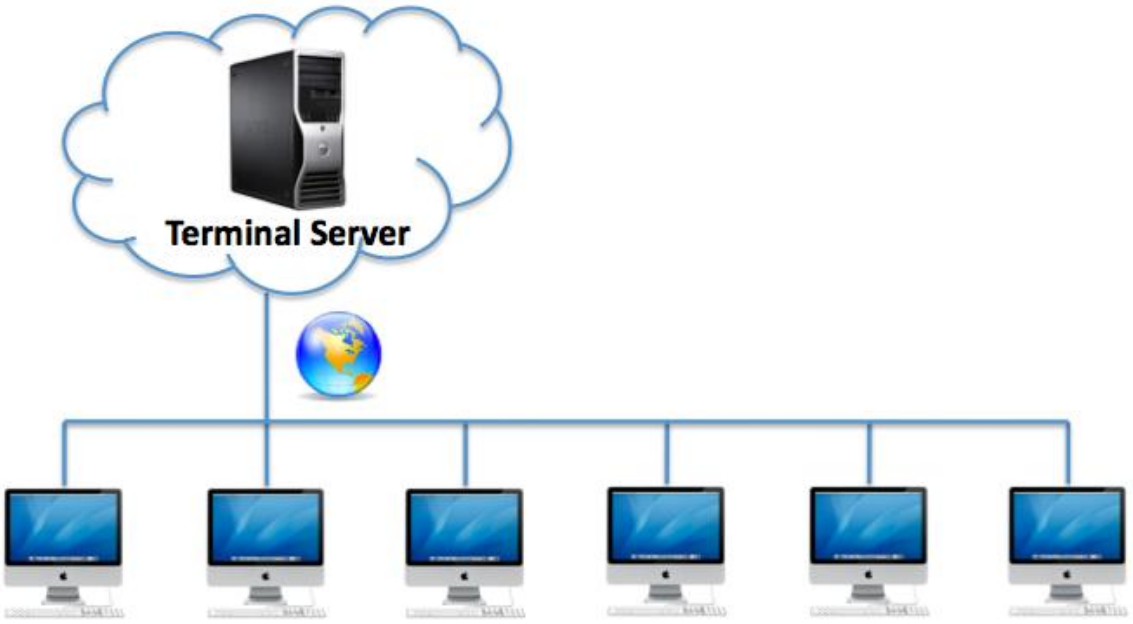
conflicts, being able to coordinate their work – all of these regardless of where they are physically located? Often this prompts the question of how these solutions – with seemingly identical promises – perform compared to each other. In order to be able to answer this question it is important to understand the conceptual differences between the technology solutions.

Solutions providing access for teams to central BIM projects usually employ one of three basic approaches:

- **Terminal Services** → Both the BIM project and the BIM software are physically running on a central server with workstation access through ”thin” clients
- **WAN Optimization** → The file server which hosts the BIM project is mirrored through multiple locations and is synchronized between mirrored servers through WAN optimized direct channels
- **Active Server/Client** → The BIM project is hosted on a server with an active BIM manager software installed (BIM Server) which provides direct concurrent parallel database access to full BIM clients through standard LAN as well as WAN networks

Terminal Services

Terminal services or remote desktop services are the most generic solution to access any type of information or service on distant computers. In this solution both the data and the computation are physically running on the “server” with only the server’s screen output being transmitted to the clients’ machines. User input, through the mouse or keyboard, is sent from the client machine for processing by the server. This approach is the backbone to many of the “cloud computing” solutions available currently.



This setup offers the advantage of universality but in reality it has no impact on the ability to share data on the terminal server. The only gain with this solution is that network operations are reduced substantially so clients are unlikely to face bandwidth problems since all the heavy processing is running on the same central computer. Yet the client software (now running in multiple instances on the terminal server) still have only sequential access to the BIM project which results in queuing for project access, i.e., users still have to follow the laborious file-merging process of synchronization before the next user can gain access. In the classic meaning of the word this method cannot be considered real “sharing” of the BIM model.

Pros:

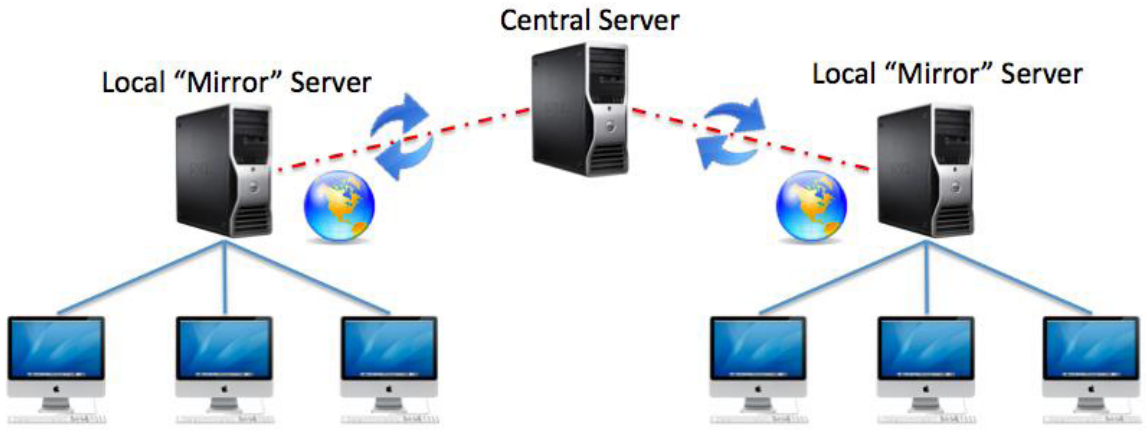
- Cheap BIM client computers
- Easy central IT management

Cons:

- Expensive server to scale with the number of BIM clients
- System responsiveness highly network dependent
- Offline work is not supported
- No improvement in team collaboration workflow

WAN Optimization

WAN Optimization is primarily employed in situations where "instant" access to content on remote servers (as if they were located in the local network) is required.
In this solution the BIM project is usually stored at a central location and cached copies ("mirror images") are placed constantly in local offices where they can be accessed through the local area network. Scheduled and/or forced server mirroring (synchronization) keeps the various cache copies of the project in-sync.



To optimize the performance of the synchronization between the different locations specific hardware/software solutions have to be used.

In all these solutions the optimization is limited to the network transfer part of the process but the actual BIM sharing processes remain intact (with all their particular features). Generic technologies are employed specifically manage and to accelerate file transfer. The most frequently used technologies include *server mirroring, data compression, protocol optimization, data caching, distributed ("delta") file transfer and unmatched bandwidth utilization*. With these technologies optimization of speed is limited to the file transfer between the mirror servers but **there is no**

improvement in communications between the local server and its clients, i.e., file access via the LAN remains at the same level.

Pros:

- Similar to LAN experience regardless of physical location

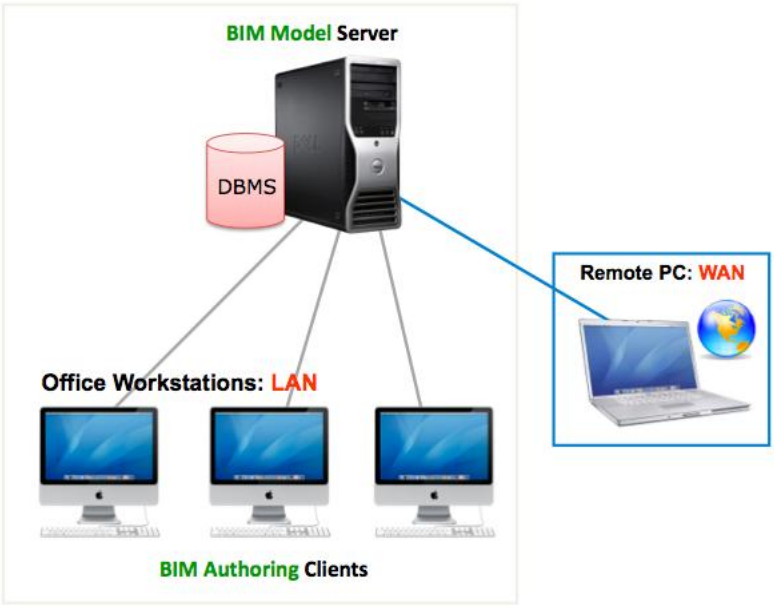
Cons:

- Costly additional hardware/software to be installed*
- Heavy IT management required
- No improvement in team collaboration workflow on LAN
- No real-time collaboration experience

* Only applicable to particular solutions

Active Server/Client

The active server/client solution is specifically designed to address the core issue of design file sharing in integrated BIM projects. With this solution the BIM server acts as an active object database server which not only hosts the central BIM project but in fact understands the inherent “business logic” of the BIM project. In contrast to “dumb” file servers (i.e. mere storage devices), that only share data at the binary level, the BIM server actively controls the sharing of parts of the BIM project with BIM clients. This approach utilizes concepts that are tried and tested in other commonly established database solutions.



To enable individual clients to work on their part of the BIM model requires that the model can be managed as discrete parts. To achieve this, within the BIM model parts need to be granulated at the level of “atomic” elements (building components) and stored as database records on the server. In addition it is essential that integrity of element relationships and their structure within the BIM model is maintained.

The result of accessing BIM models at an element level is a huge reduction (i.e. two orders of magnitude) in network traffic. This solution provides virtually any number of clients with concurrent parallel access to BIM models regardless of size or location. In addition real time integrated messaging ensures there’s the added benefit of truly interactive collaboration for all clients through any network (including WAN).

Pros:

- Highly improved collaboration workflow on LAN
  - Real-time collaboration
  - Minimized or none editing conflicts
  - Server-level protection against data corruptions
  - No performance penalty on huge projects
- Same experience through normal internet connection
- Offline workflow support

Cons:

- No known limitations compared to the other solutions

The first practical implementation of an active BIM server solution, which provides a dynamic collaboration environment for design teams is the GRAPHISOFT BIM Server.

Comparative Analysis

The solutions described above address the same problem in fundamentally different ways. Each has specific characteristics that provide more or less benefits to the everyday work of a design team. The table below compares the main differences between these solutions.

	Terminal Services	WAN Optimization	Active BIM Server
Remote Access	✓	✓	✓
Standard Network Access	✓	✓*	✓
Performance Gain on WAN	✓	✓*	✓
Performance Gain on LAN	✗	N/A	✓
Concurrent Access to the Central Project	✗	✗	✓
Synchronization Time Unrelated to Project Size	✗	✗	✓
BIM-Specific solution	✗	✗	✓

*With limitations

Intrinsic Criteria for Real-time Design Sharing in BIM

Already it should be evident that the Active BIM server, with its object database infrastructure, is the only effective design sharing solution for BIM projects. Software vendors often misuse terminology such as “delta exchange”, which makes it really hard to differentiate generic network optimization from genuine sharing of BIM models. It is only with this sharing that collaboration across the design team becomes practical and real. To be able to identify BIM solutions that are capable of facilitating real-time design sharing it is useful to understand a number of basic criteria.

System Architecture

Active BIM server vs. passive file server >>> In case of active BIM server solutions the BIM clients never need to access directly the central BIM project for any design purposes. Clients only send requests to an “active” BIM server application running on the server. The “active” nature of the BIM server, independent from its clients, manages all aspects of the central BIM project including the “project”, “user” and “transaction” organization. In contrast to the Active BIM server other more generic network optimization solutions are completely client-dependent for the manipulation of the central BIM project. This means that large chunks of data need to be downloaded to client computers each time project synchronization and management are scheduled or required. The only added value these generic systems provide is that they make the central BIM project appear “more accessible” to the BIM clients by accelerating the otherwise heavy network traffic to a certain degree.

Project Structure

Object database vs. fake database >>> In case of active BIM server solutions the central project must be an object database which can provide access to data at the single “element record” (building component) level. In addition these databases

monitor and maintain their element and project integrity ensuring the project is accessible at all times. In contrast to the Active BIM server's object database other more generic network optimization solutions may only provide element level access to a limited degree, as they do not utilize the capabilities of an object database. In these solutions the central BIM project must be consolidated on a regular basis to avoid performance problems. Consolidation is a "manual" process that purges the data structure and eliminates temporary data. This time consuming process requires the system administrator to lock the central project for the entire duration of the consolidation meaning that clients are unable to access or work on the project. In addition the consolidation process deletes all "history" information about the project sharing so project "rollback" is only possible by re-sharing the entire project from an earlier backup file.

Project Synchronization

Parallel access vs. sequential access >>> In case of active BIM server solutions team members can access the central project at any time, and from anywhere. This means there are no queues waiting for server synchronization. In contrast to the Active BIM server other generic network optimization solutions can only accelerate, to some extent, the synchronization process but cannot eliminate its sequential nature. Obviously the larger the project the longer the file synchronization takes. As the team gets bigger there's an exponential growth curve for the synchronization queue, which, inevitably, reaches a point where the law of "diminishing returns" applies and is not worth adding any more members to the team. There is no such practical limit with the Active BIM Server solution. See more about this under "System Performance" below.

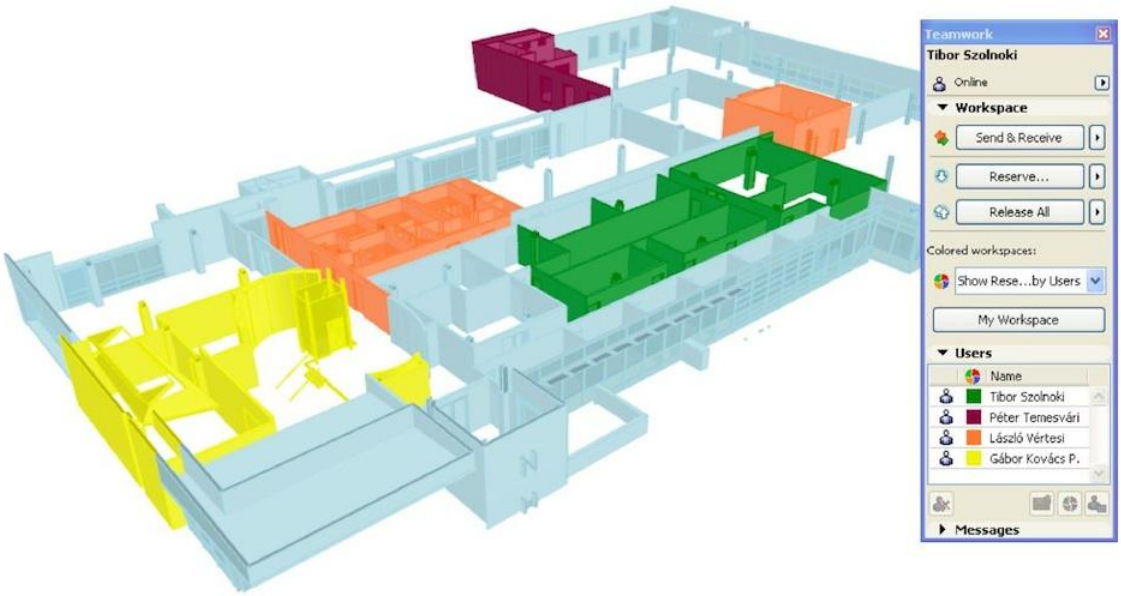
Remote Access

Standard Internet channels vs. custom "WAN optimized" channel >>> In case of active BIM server solutions, as noted before the network traffic is reduced by huge orders of magnitude. This means the size of data packages transferred through the network during synchronization stays in the range of kilobytes, which is comparable

to standard network operation such as browsing the web. This enables communication through standard TCP/IP protocol through any network (including LAN/WAN). In contrast to the Active BIM server other generic network optimization solutions usually require a dedicated communication channel (such as a VPN connection) and/or specific protocols to provide adequate (i.e. fast and secure) remote access to the BIM project.

Collaboration Environment

Live visual feedback on the team's activities >>> In case of active BIM server solutions instant visual feedback is provided to individual clients about the activities of the entire team showing continuously to each user, which parts of the BIM model are being worked on, and by whom. Coupled with the user's ability to request easily the reservation and release of elements/workspaces this solution provides an "integrated" collaboration environment, resulting in a very productive and rewarding design experience for the user. In contrast to the Active BIM server other generic network optimization solutions do not contain the technology to provide any feedback about the distribution of work across BIM clients – so collaboration is practically flying blind!

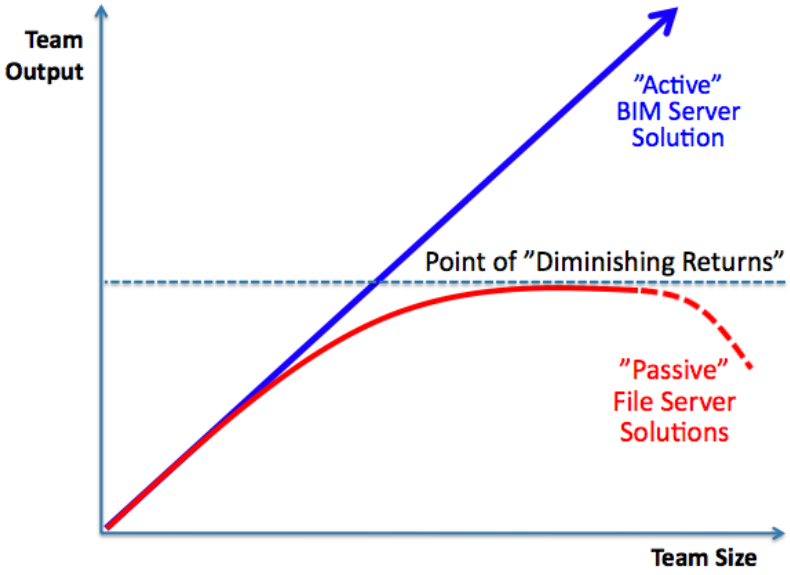


Workflow Support

BIM workflow management vs. project communication management >>> In case of active BIM server solutions powerful workflow support is provided for the entire project team including project leaders, project members and server/project administrators. As an example, project leaders can assign tasks to team members who then can communicate, via “chat” messaging within the BIM environment, with each other to request the reservation or release of elements/workspaces. Frequently the generic term “element borrowing” is confused with live collaboration but it only refers to any “offline” series of steps to acquire ownership of a certain part of the BIM project. In contrast to the Active BIM server other generic network optimization solutions can at best provide “content management” support for the files related to the project.

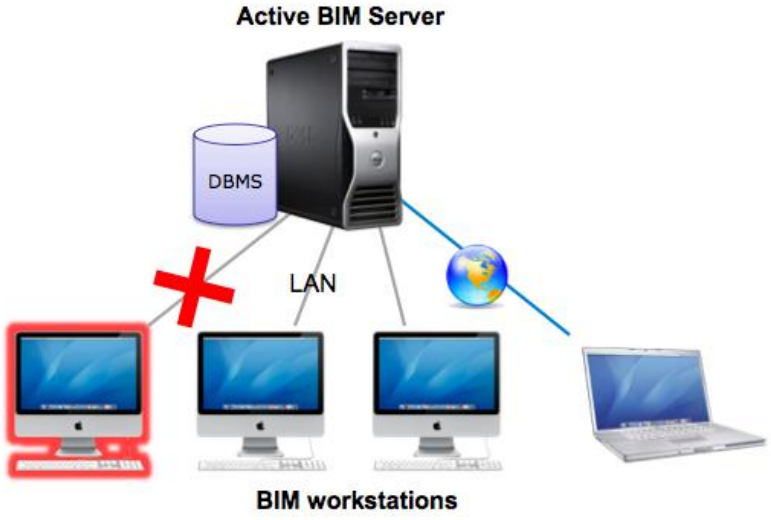
System performance

Scalability >>> In case of active BIM server solutions, because of the database infrastructure the size of the team and the size of the project does not increase the network traffic between the server and the clients. In contrast to the Active BIM server other generic network optimization solutions are only capable of compressing the actual network traffic. But as the design develops the size of the files are certain to grow, and as more and more people wait in the synchronization queue, these solutions very soon get to a stage where collaboration becomes so slow that the project virtually stops. User experience shows that solutions that are based on file sharing technology reach a practical limit of team size between 5-10 people. This is due to the diminishing marginal returns of adding more and more people to the team because synchronization of the entire team becomes so long that it exceeds the time available to do productive work.



Data Safety

Protection against system errors >>> In case of active BIM server solutions, the active server component provides solution to one of the most feared problems of shared projects – data corruption originating from a faulty client workstation propagated through the entire network during synchronization. The active server component has built-in safety processes to ensure that any data included in the central BIM project is clean of data corruption. In contrast to the Active BIM server other generic network optimization solutions don't have this intelligence.



Conclusion

BIM software vendors offer different technology solutions to provide better solutions to model-based design sharing but with different levels of success in addressing the core problem of providing concurrent, real-time access to BIM projects for the larger and/or more distributed teams. In this paper we have analyzed the different solutions provided to the above problem and collected the most important criteria to be aware of when selecting the optimal design sharing solution for BIM implementation.

We have identified three main approaches to the above problem and found that only one – that includes an active BIM server solution – is capable of providing real-time concurrent access to BIM projects regardless of the size and distribution of the project and the team. We have also identified unique characteristics specific to such solutions:

→ Element level access to the BIM model at any time
→ 100x reduced network load during synchronization
→ Concurrent access to the BIM model for any number of clients
→ Access to the BIM model through standard LAN/WAN networks
→ Real-time collaboration environment with communication support
→ Server-level support for workflow and user management
→ Server-level protection against data corruptions

Further Reading

Design File Sharing with Building Information Modelers – An Open Letter to the AEC Vending Community, by the CIO Large Firm Roundtable (LFRT) in the Newsletter of the Technology in Practice Knowledge Community

NEXT-GEN BIM – Graphisoft Teamwork 2.0 will revolutionize BIM/IPD workflow and collaboration, by Jerry Laiserin in the LAISERIN Letter

ArchiCAD 13 – Product review by Lachmi Khemlani of AECbytes

GRAPHISOFT Revolutionizes BIM Collaboration with ArchiCAD 13 – Technology & product review by Anthony Frausto-Robledo of Architosh

Setting up and managing the GRAPHISOFT BIM Server – Wiki articles by technical support experts on ArchiCAD-Wiki