

Metodika

Technical Design Document

for

Skalpell v10

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TECHNICAL DESIGN DOCUMENT SUBJECT TO CONTRACT

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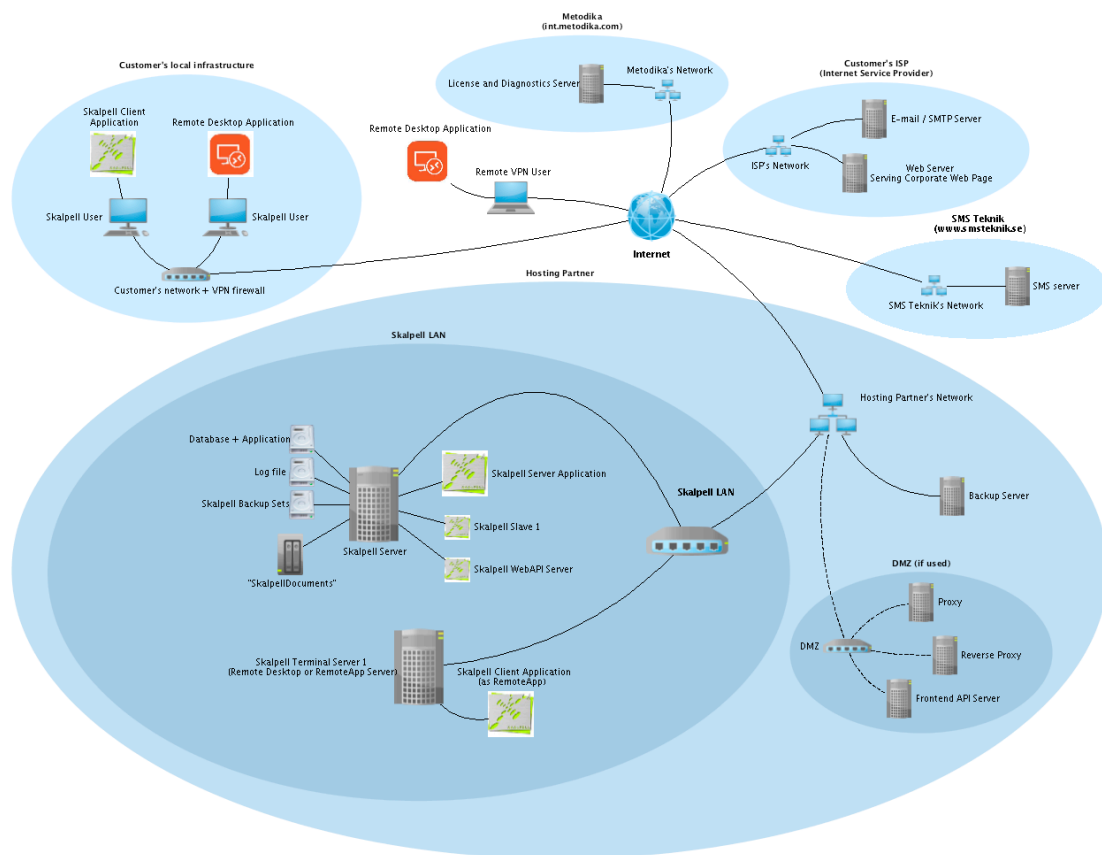
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Introduction

The purpose of this document is to define and describe the technical platform required to successfully deploy a Skalpell system.

The illustration below displays the different components of an entire Skalpell system installation, and their infrastructural relation to one another:

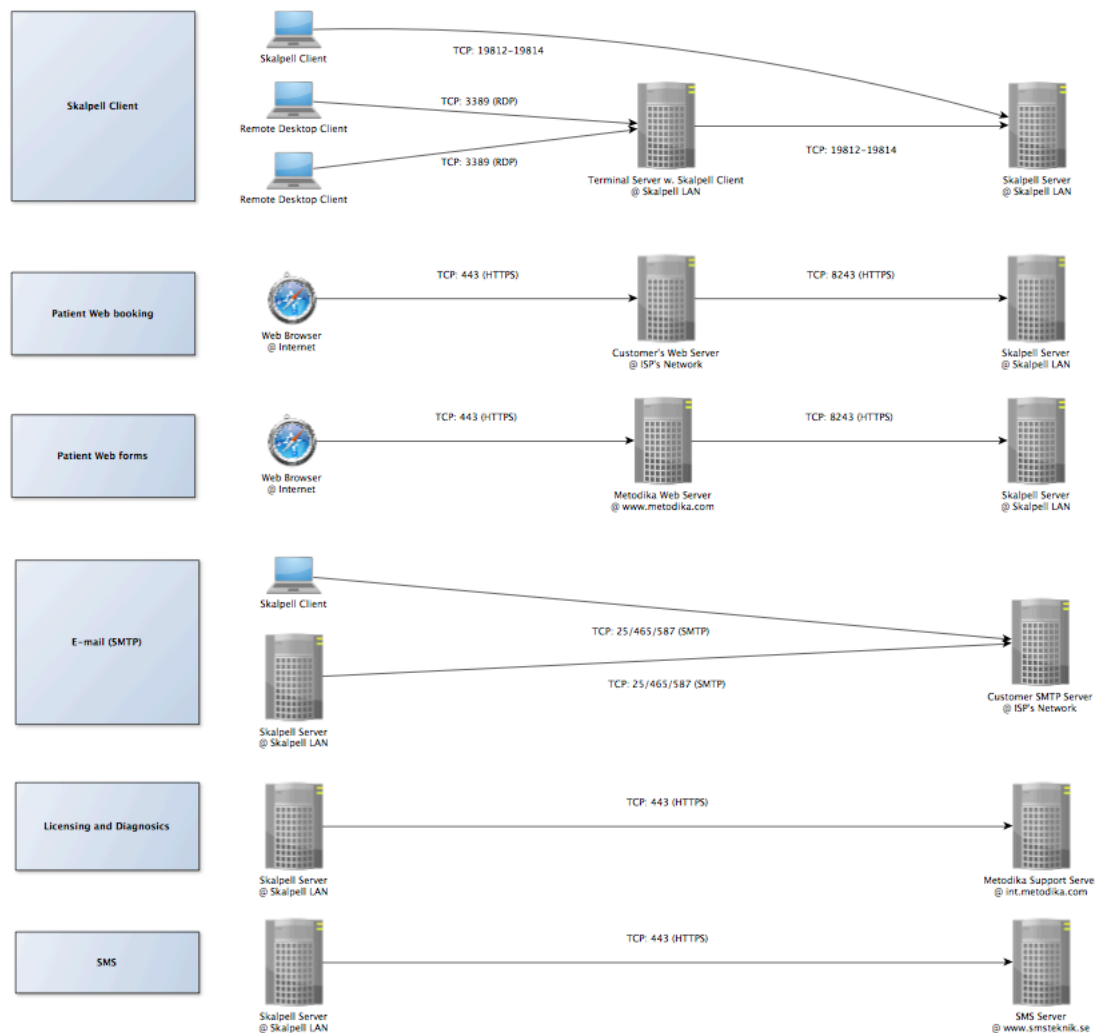


Picture: Overview A05

Security and network communications

With a centralized database, an application server and the usage of terminal servers, patient data is rarely leaving the local server subnet.

The illustration below displays the different traffic flows between each of the components in the Skalpell system setup. The arrow direction illustrates the initiating request:



Picture: Communication A05

Availability

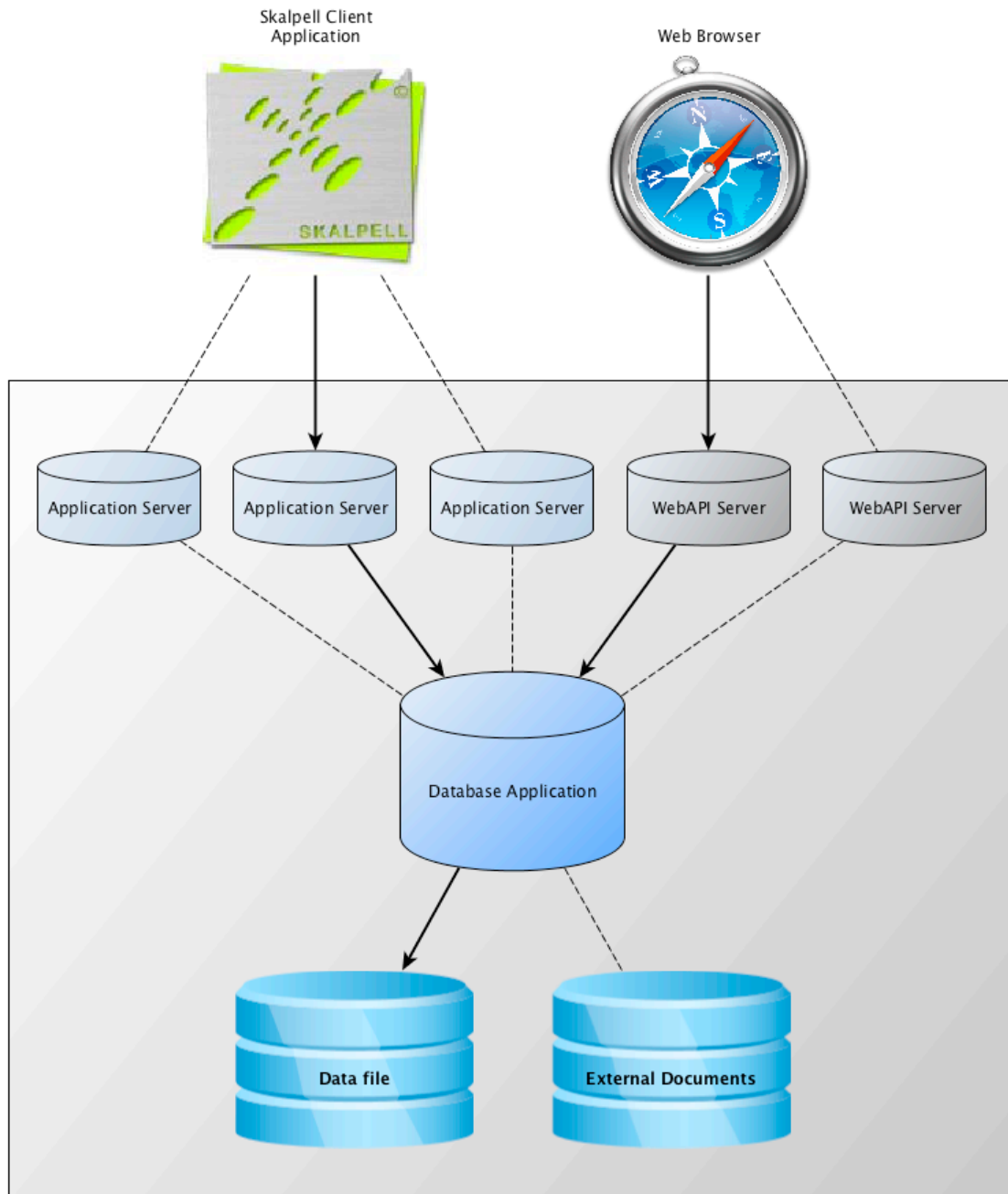
The usage of application servers and terminal servers is making sure each and every user has an identical system to work with. All the data each user needs will be available at his/her fingertips – regardless of a clinic's or a hospital's geographical location.

The Skalpell system will provide functions and features to in-house users, remote users as well as patients – depending on situation and permissions.

Performance

Depending on the estimated number of concurrent users and the need for future expansions, the Skalpell system needs to be fast, responsive and redundant. If need be, the workload with all its software layers can be distributed over multiple server- and client applications.

The illustration below displays the data flow distribution through Skalpell's software layers and applications: (dotted lines represent alternative paths)



Picture: Load Distribution A01

Performance – Skalpell software types and load distribution

Besides the Skalpell Server there are other server software application types, capable of handling incoming requests to more evenly distribute the load across multiple server machines. The Skalpell Server though, must handle all database access requests to and from the database engine and hardware.

The *Skalpell Server* can manage all types of incoming client requests, though it *must* handle database queries and be the database host. Though if no other server software is deployed, it can also handle application requests, data manipulation, Web requests and SOAP calls.

Main tasks:

- Database queries
- Database host – *Read/writes to the data file and external documents*

Supplementary tasks:

- Application requests
- Data manipulations
- Web requests
- SOAP calls

The *Skalpell Application Server* acts as a “slave”, that will automatically handle incoming client requests, whether it is an application function, data manipulation or database request. If the latter, the query is sent through the Skalpell Server to fetch the data from the database. You can deploy as many Skalpell Application Servers as your system and infrastructure can handle.

Main tasks:

- Application requests
- Data manipulations

The *Skalpell WebAPI Server* can handle incoming API requests sent to the Skalpell system whether it be Dynamic Forms, Web bookings or SOAP calls. Due to the sheer number of requests as well as accessibility to the outside world, having the API server separated from the rest of the Skalpell system is recommended. Like the Application Server, multiple WebAPI Servers can also be used.

Main tasks:

- Internal application requests
- External application requests
- SOAP calls
- Web portal

The *Skalpell Client* can perform local tasks to distribute the load away from the server applications, this to utilize the local client hardware and reduce the server workload.

Required technical platform

The requirements listed below define the specific technical needs that a Skalpell system requires to operate with full functionality.

These specifications should be seen as the minimum requirements.

Server environment and IT infrastructure disclaimer

It is the client's sole responsibility to make sure having a fully functional IT environment including: server(s), clients, network equipment/firewalls/cables and other hardware/software surrounding the IT infrastructure and Skalpell system.

The client is solely responsible for fixing any glitches, hardware/software/operating system failures, security breaches and maintaining a stable IT infrastructure. Failing to uphold a fully functional IT environment will most likely cause permanent loss of data, and/or inability to connect to the Skalpell System.

Servers – machine specifications

The servers' performance is critical for the Skalpell system's performance and reliability. It should support network surveillance and have enough cooling for 24/7 deployment.

Note: *In order to get the most performance for the Skalpell Server application and avoiding possible software collisions, it is imperative that the server machine's sole purpose is to act as a Skalpell server. Therefore, no other (server) software should be running or even installed on the main server machine.*

Skalpell Server – Main server machine

The main server machine is the single most important server in the entire system. When optimizing the Skalpell system's performance you should almost always start with the main server machine.

OS	Windows Server 2012 R2 (or Windows Server 2008 R2)
Processor	3 GHz Xeon "Haswell" w. 4 cores (or better)
Memory	8 GB Registered ECC RAM (or more)
Storage	<i>See section: "Hard drive configuration" in this document</i>
Display	1280x800 pixels
Graphics card	Integrated graphics chip with 16 bits color palette
Network interface	Single or teamed physical Gbit

For more detailed information regarding specifications, see sections for each component in this document.

Terminal servers

The terminal servers' performance is dependent on a multitude of factors in the entire Skalpell system setup and infrastructure. Everything from network latencies and optimization, (terminal server) processor models and amounts of RAM, to user usage patterns, number of active user sessions, the responsiveness of 3rd party services and functionality, as well as the usage of 3rd party software (other than the Skalpell system) – just to mention a few – all have an effect on each user's experience in the Skalpell system.

It is therefore vital to investigate, test and analyze the IT infrastructure to better assess and accomplish the best configuration regarding the terminal server setup.

For more information see "The usage of a terminal server environment for Skalpell clients" in this document.

Frontend API Server (if used)

The Frontend API server will host the API reverse proxy server application and filters incoming traffic to the Skalpell LAN. Though it is a vital part for outside communication, its performance can be very modest compared to the other Skalpell server machines.

OS	Windows Server 2012 R2 (or Windows Server 2008 R2)
Processor	Xeon "Nehalem" w. 2 cores (or better)
Memory	4 GB RAM (or more)
Storage	50 GB single partition (for OS and Skalpell application software)
Display	1280x800 pixels
Graphics card	integrated graphics chip with 16 bits color palette
Network interface	1 Gbit

For more detailed information regarding specifications, see sections for each component in this document.

3rd party communications server (if used)

The server machine hosting 3rd party server applications can much like the Frontend API server, be of rather modest configuration. Though it is strongly advised to seek additional information from 3rd party software manufacturers to establish a satisfactory machine setup.

OS	Windows Server 2012 R2 (or Windows Server 2008 R2)
Processor	Xeon "Nehalem" w. 2 cores (or better)
Memory	4 GB RAM (or more)

For more detailed information regarding specifications, see 3rd party software documentation.

Client side – machines and specifications

Users' Remote Desktop Computers

The performance of a desktop client (computer) does not influence the overall system performance for other desktops. Although a slower desktop computer might make the system slower than acceptable for the individual user, though there are no adverse effects for the other users.

Note: *If an end-user computer enters power savings mode while logged on to the Skalpell system, the remote desktop session could be ended and will inevitably result in a session time-out on the terminal server machine. If such an event takes place, any unsaved data in that user's Skalpell session will be lost. (This has the same effect as pulling the network cord from the computer.)*

Desktop machines' hardware requirements

Any computer running Windows 7 or 8 that is capable of using the Microsoft Office Suite (Word, Excel, Outlook) and similar applications is sufficient for running Skalpell through a remote desktop application.

PC with Windows

OS	Windows 7 SP1 (or later)
Processor	Intel Core2Duo (or better)
Memory	4 GB RAM
Hard drive	5 GB free hard drive space
Display	1280x800 pixels minimum, color monitor <i>(recommended resolution: 1440x900 or more)</i>
Graphics card	integrated graphics chip with 24 bits color palette
Network interface	100Mbit (or better)

Mac with Mac OS X

OS	Mac OS X v10.7 (or later)
Processor	Intel Core2Duo (or better)
Memory	4 GB RAM
Hard drive	5 GB free hard drive space
Display	1280x800 pixels minimum, color monitor <i>(recommended resolution: 1440x900 or more)</i>
Graphics card	integrated graphics chip with 24 bits color palette
Network interface	100Mbit (or better)

Servers and infrastructure – detailed information

Operating System

A server operating system is required for maximizing hardware utilization, security, monitoring capabilities, as well as the maximum number of simultaneous TCP/IP connections.

The latest service pack and updates must be installed on all server machines unless specifically told otherwise. *(In case of an update that could i.e. render the system unstable, or create undesired behavior)*

Note: Remote access to the server desktop with admin permissions must be allowed for Skalpell administration.

The following server operating systems are recommended:

- Mac OS X v10.7.x Server or later
- Microsoft® Windows® Server 2008 R2, 64-bit
*(Skalpell Server is **not** compatible with the Microsoft® Windows® 2008 server Core® option.)*
- Microsoft® Windows® Server 2012 R2, 64-bit

Note: In order to minimize the risk of network port collisions and maximize the performance of the Skalpell Server application, the “Standard Edition” of any Windows operating system **must** be used.

Processor(s)

The *Intel Xeon* processor with the *Haswell architecture* offers high performance with it’s many cores and high power efficiency.

- 3 GHz Intel Xeon “Haswell” (or better)

Memory – allocation and capabilities

The Skalpell Server is 64-bit and can allocate as much RAM as needed. However, it is always important to make sure the amount of installed RAM is enough for the operating system, other operating system related applications and services as well as the Skalpell Server application.

*Note: Since Skalpell Server is 64-bit; a 64-bit server operating system **must** be used.*

Hard drive configuration

Hard drive performances heavily depends on the *maximum* number of concurrent users. The importance is to reduce latency in any given situation by ridding bottlenecks and at the same time minimizing possible hardware failures.

RAID-10 offers the best performance boost while maintaining a high level of redundancy, allowing for one or two faulty drives simultaneously. In order to minimize risk for loss of data and database failure, the system should be divided into several hard drive arrays.

For maximum performance all of the RAID arrays should be configured using solid-state drives (SSD). In order to obtain the increased speed that SSD drives deliver, a matching SSD-RAID controller *must* be used – for each local volume.

In order to increase storage capacity and redundancy, the less latency sensitive data – the Skalpell system's external documents – can be placed on a Storage Area Network Device (SAN). This will also create a more cost effective storage setup.

Example 1:

- Volume 1 – **SSD RAID-1** – Operating system
- Volume 2 – **SSD RAID-10** – Skalpell Server database + application
- Volume 3 – **SAN Device** (*conn. through Fibre Channel*) – External Documents
- Volume 4 – **SSD RAID-1** – Transaction log file*
- Volume 5 – **(SSD) RAID-1** – Backup*

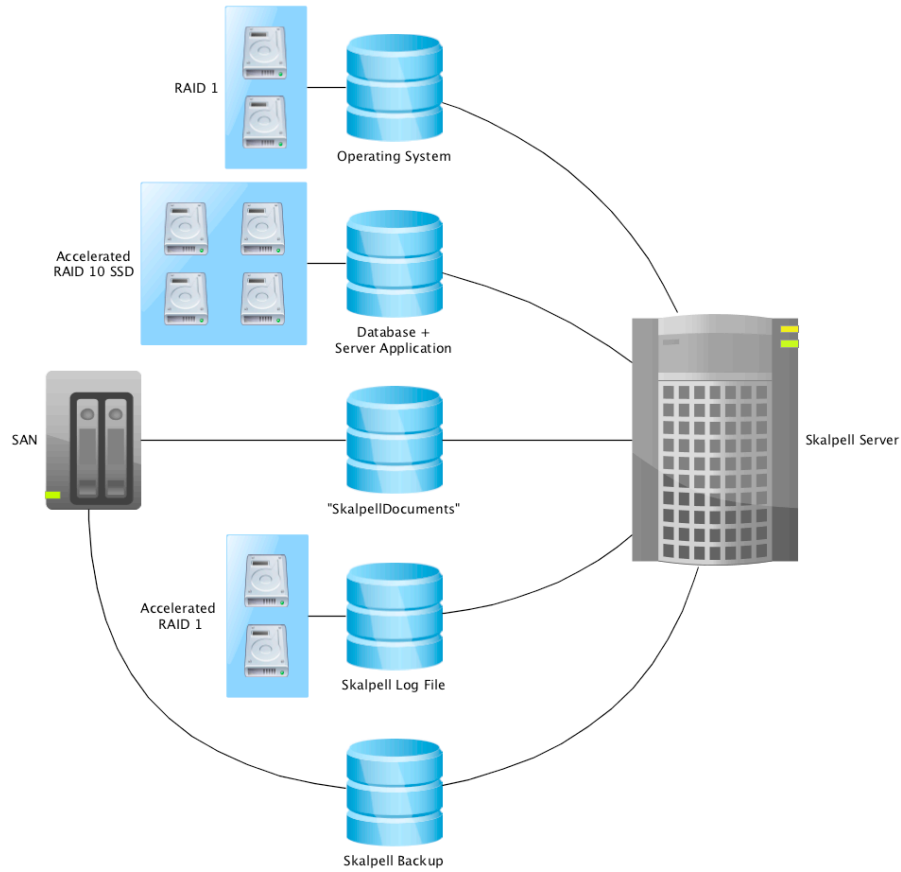
Example 2: (small installation w. 5-10 users)

- Volume 1 – **RAID-1** – Operating system
- Volume 2 – **SSD RAID-1** – Server database, documents, logfile + application
- Volume 3 – **RAID-1** – Backup*

** For maximum performance, a separate RAID controller should be used for each of the arrays, starting with separating the database array and backup/log file array.*

Note:** It is important that the log file hard drive array is not used for other tasks, this to reduce latencies and overall performance – since every write cycle done to the database, is also written to the log file. **Meaning: the more writes done to the database – the more writes is done to the transaction log file as well.

The illustration below displays how data can be distributed across several volumes on a Skalpell server machine (main server) – with a total of five different volumes:



Picture: Storage A03

Partitioning and available disk space

Depending on the need for performance and/or redundancy, the Skalpell Server machine can be configured with a total of or five volumes:

- 1) Operating system with all its files
- 2) Skalpell data – with database, index file, application files, scripts and settings
- 3) External documents folder partition, also known as *SkalpellDocuments*
- 4) Backup partition – containing the daily backup sets
- 5) Transaction log file partition

Note: *If using virtual hard drives, any automatic hard drive resizing/allocation feature must be **turned off** for the Skalpell Data partition. Failing to do so could incorrectly report the amount of available hard drive space and cause the database server to crash, or the backup to stop running.*

If only using virtual drives (thus deviating from the guidelines in this document), having the operating system and the Skalpell files on separate partitions is still required.

Skalpell Main server example 1:

- Partition 1 – Operating system 75GB
- Partition 2 – Skalpell_Data 100GB – *fixed disk size*
- Partition 3 – SkalpellDocuments 400GB – *fixed disk size*
- Partition 4 – Skalpell_Log 10GB – *fixed disk size*
- Partition 5 – Skalpell_Backup 100GB – *fixed disk size*

Note: *If the SkalpellDocuments folder is stored on the Skalpell_Data partition (and not on a separate partition), the size of the Skalpell_Data partition needs to be equal to both of the recommended partition sizes – combined (500GB).*

Skalpell Main server example 2: *(small installation w. 5-10 users)*

- Partition 1 – Operating system 50GB
- Partition 2 – Skalpell_Data 200GB – *fixed disk size*
 - SkalpellDocuments ""
 - Skalpell_Log ""
- Partition 3 – Skalpell_Backup 50GB – *fixed disk size*

On a (Microsoft Windows) terminal server where the Skalpell Client is installed and executed, there is much less need for low-latency access to local volumes. This makes distribution over several (local) volumes unessential why a one-partition system with plenty of storage is normally sufficient.

It is imperative to know that each user's Skalpell Client cache files are stored in **%localappdata%\Skalpell**. This folder will be downloaded and/or synchronized each time the user is connecting to the Skalpell system. It is usually between 300-500MB in size – per user, why it is crucial to take this into account when estimating the OS partition size during installation.

Note: *Failing to provide enough space on the C-partition will cause the entire terminal server to crash and makes it unable to even start!*

Terminal Server example 1:

- Partition 1 – Operating system +100GB

Note: *At least 10GB of data needs to be available on each partition on all servers running Skalpell Server or Skalpell Client – at all times. **Failing to maintain this threshold can result in permanent loss of data.** Dynamic drive size allocation is not sufficient for maintaining this threshold on the Skalpell partitions.*

Screen

Using a small resolution on the server will make server administration very difficult. In order to see the entire server window, at least 1280x800 pixels must be used.

- 1280x800 pixels minimum

Graphics adapter

The integrated graphics chipsets that comes with the vast majority of all servers work well for server administration.

- Integrated graphics chip (i.e. Intel GMA series)

Network communication and TCP ports

TCP port 19812, 19813 and 19814 must be set to allow inbound and outbound traffic to/from LAN. TCP port 80 and 443 must be set to allow outbound traffic to WAN (Internet) for Skalpell to support; messages, SMS-information, error logging and license reporting. For Skalpell web booking to work, TCP port 8081 and 8043 must be set to allow inbound and outbound traffic to/from WAN.

Network interface (NIC) and network optimization

Regardless of the number of concurrent users, a single port gigabit NIC as minimum is required.

It is also strongly advised use the common server brands* that are known for their reliability and performance due to less packet loss generation which allows a more stable and faster client/server communication.

To achieve maximum network performance and reduce latency, the operating system, server hardware, and network infrastructure used by the Skalpell system, need to be optimized for database communication (meaning large amounts of small TCP/IP packets).

The latency between the Skalpell Server and client terminal server should therefore **never** exceed 5 milliseconds. This is can be achieved with a physical gigabit network between the Skalpell Server machine and the terminal servers running Skalpell Client.

On larger installations with many concurrent users, teamed network interface cards can be used, though it is imperative that if used – ***the network equipment has support for this type of configuration.***

- Teamed Gbit NICs with its own processor
- The server tuned as a database server

** Commonly used network interface adapters known for their reliability, are: 3Com, Broadcom and Intel*

LAN

Switched networks with Gbit performance are considered standard by today's measurements. It is also important to use adequate network cables in order to minimize packet loss.

- 1 Gbit (or better) on the server side
- Cat6 UTP network cables between server and clients

Backup – Hardware and transaction log file management

Software, hardware and media to handle the daily backup is required. Each patient record is about 10 KB and each digital image in high resolution is approximately 1-10 MB. For 10,000 patient records with a normal load of appointments and images, the backup can reach 10 to 50 GB per night.

To secure the backup in case of a very serious server failure, it is better to use a separate set of hard drives for the backup where the Skalpell Server application will place the daily backup files. SAS or S-ATA is recommended as backup hard drive interface. Depending on the backup window, the size of the data file and overall system performance, SSD drives can be used to greatly reduce the backup time.

To avoid file access privileges when the Skalpell Server application is launched as a service, it is important that the Skalpell Server's backup files are stored locally on the server machine. *For more information see: "A note about Skalpell Server running as a service (on Windows) performing backup to a network drive" in this document.*

- RAID 1 – Hardware acc. SAS/S-ATA (SSD)

Note: *In order for the transaction log file to properly work after restart/reboot, the log file must be stored locally on the Skalpell server machine. If maximum performance and reliability is required, it is highly recommended to store the transaction log file on a separate set of hard drives with a dedicated hard drive controller. The SAS or S-ATA interface (as opposed to i.e. USB or 1394) is required due to much less overhead data.*

Backup – Including the Skalpell data in your daily backup routine

Skalpell Server will regularly perform a full backup of the database, creating backup sets containing the database and transaction log file in a separate folder. This folder is usually named *Skalpell_Backup* and is located on the Skalpell Server machine.

In order to secure all your data, pictures and documents produced in the Skalpell system, it is imperative to include all the necessary files in your backup software's daily/nightly server backup routine. If such a task is not performed, it needs to be implemented.

Depending on your system's performance, your backup window and the total size of your pictures and documents, certain adaptations might have to be made to the server hardware (such as hardware accelerated RAID, solid state drives, gigabit network etc.). Though it is *strongly* recommended to perform a backup of these folders with the same frequency as the data file – which is once a day/night.

Backing up the data file: The Skalpell Server application is normally running 24/7 why the data file is always open and consequently cannot be part of your backup routine. Furthermore, Skalpell Server's backup function will keep track of open records and transactions – something a third party backup software is unable to do. That is why it is crucial to always use the built-in backup feature in Skalpell to securely backup data from Skalpell **and** use a third party backup software to achieve maximum data security and recoverability.

You therefore need to include the backup files generated by the Skalpell Server in your backup routine, and make sure the Skalpell backup is finished *before* your server backup has started.

Pictures, documents and preference files: In order to backup the Skalpell System's pictures and external documents, the folders *SkalpellDocuments* and *Preferences* need to be included in your backup routine. These two folders can be backed up when the Skalpell Server application is running, though it is advised to do this when no (or only a few) users are logged on to the Skalpell system.

Important folders to backup: (*where X equals your Skalpell partition drive letter*)

<u>Name</u>	<u>Common location</u>
• Skalpell_Backup	X:\Skalpell_Backup
• SkalpellDocuments *	X:\Skalpell_Data\SkalpellDocuments
• Preferences	X:\Skalpell_Data\Preferences

Note: *The SkalpellDocuments folder contains picture files, documents, medical messages, dynamic forms, e-mail attachments and many more files, which is therefore by far the biggest folder to backup. It can easily reach a size 10x bigger than the data file if pictures and documents are used in the Skalpell system.*

The usage of a terminal server environment for Skalpell clients

Using a terminal server environment for the Skalpell clients is a very efficient way of optimizing client/server communication. Though there will be a reduction in speed regarding picture management when importing and handling large pictures.

It is strongly advised to use load balancing with a maximum of 10 concurrent users per terminal server*. The memory usage on the terminal server for each Skalpell Client can exceed 200 MB, why a 64-bit Windows server operating system is recommended due to bigger RAM allocation capabilities.

Since the processor and memory load for each Skalpell Client session is rather low, the entire workload (from all Skalpell users combined) can be spread out on as many terminal server machines as needed – physical and virtual.

** Based on a physical system w. Windows 2008 R2, 4 Xeon "Nehalem" CPU cores, 4 GB RAM running only OS and Skalpell Client.*

Note: *In order to get adequate performance from the Skalpell system, it is imperative that the Skalpell database server application is installed on a separate physical or virtual machine and **not** installed/run in a terminal server environment/machine.*

The Server application and database files are also much more vulnerable to virus, malware, intrusion and malicious intent if residing on a terminal server!

Terminal server connections over WAN

Bandwidth requirements are significantly reduced when using a terminal server environment for remote users connecting over WAN. Expect 0,5 Mbit for the first user and then add an additional 128 Kbit for subsequent users, both upstream and downstream to see similar performance to a VPN connection. There are some issues concerning Skalpell with a terminal server environment using thin-clients.

Skalpell has been tried and tested in a terminal server environment. It is compliant with a central environment based on Microsoft Terminal services or an environment based on Citrix presentation servers.

Antivirus software

Many types of antivirus software's real-time scanners and so-called "internet security bundles" are notoriously memory- and CPU demanding. These types of applications tend to make your computer unnecessarily slow. Though it is still imperative that antivirus software is installed and active, it is equally important to choose a software based on reliability and minimum interference with the rest of your installed software.

From our experiences we **only** recommend **NOD32** Antivirus, **AVG** Antivirus or **Avira** Antivirus – **antivirus only** – due to its minimal interference with open files and overall low resource usage.

A note about – Virtual layer optimization

The single most imperative factor in creating a fast and responsive user experience in a Skalpell installation is reducing the latency times in every single component of the environment. It is especially important to embrace this mindset when running the Skalpell client/server system in a virtual system, due to the many software layers in a virtual environment that generates a great deal of overhead – often resulting in higher latencies.

Regardless of the total data throughput in processor, memory, hard drives or network – the system can and most likely will be perceived as slow and skittish by the users if the latency is too high. Meaning that **low latency optimization is crucial for all components of the system**, but mostly network and hard drive access. This is something that many, often cheaper virtual server setups i.e. cloud servers, severely lack. And when it comes to database performance, they often perform less than a bare metal equivalent.

However, these issues can quite easily be resolved with a dedicated physical hard drive array for the Skalpell database and having physical dedicated network interface cards for all servers running the Skalpell system.

- **Virtual CPU allocation/optimization**

Even when running a virtual environment, the Skalpell server(s) need to have as many (virtual) cores as recommended by this document, regardless of the virtualization manufacturer's recommendations – this to accommodate the CPU cycle calculation done by the Skalpell software.

- **Virtual memory allocation and optimization**

Citrix memory optimization could cause an application to stop working or become unstable. If the Skalpell Server quits unexpectedly, try setting this option to “off”.

- **Virtual hard drive setup**

In order to get adequate performance for the Skalpell Server, the virtual server machine must have physical dedicated drive array(s) and RAID controller(s) for the Skalpell data volumes. It is preferable to have as many physical arrays as possible from a performance perspective – one for each volume.

- **Virtual Network adapter optimization (if used)**

Microsoft recommends having a dedicated network adapter for virtual machines under heavy load. In accordance with these guidelines, we recommend each virtual server to have it's own dedicated network adapter(s) in order to maximize throughput and minimize latency.

- **Virtual Network**

Virtual network often generate higher latencies between nodes why it is **not** recommended to use any virtual networks between server and client machine(s).

A note about – Microsoft Windows and DEP (Data Execution Prevention)

Microsoft has from Windows XP SP2, Windows 2003 Server SP1 and Windows XP Tablet PC Edition 2005, introduced a function that prevents applications from running in critical areas of RAM. This function is essentially a very good idea since it will reduce some of the problems with poorly written applications and viruses/trojans that may accidentally or intentionally access any part of the operating system's critical functions. All desktop computers and servers sold today fully support DEP. As default the DEP function is activated which also is the safest setting.

Skalpell is now compliant with Data Execution Prevention, meaning that no action needs to be taken regarding this feature under normal circumstances.

Should suspicions arise that DEP might prevent the Skalpell Server application from launching, follow these steps to exclude the server application from the DEP monitoring:

Note: Administrator rights is required

- In the start menu, click *Run*
- Type *sysdm.cpl* and press *Enter*
- Click the tab *Advanced*
- In the *Performance* section, click the button *Settings*
- Choose the *Data Execution Prevention* tab

Under Data Execution Prevention you may select to Turn on DEP for Essential Windows programs and services, or simply exclude Skalpell from DEP monitoring by adding SkalpellServer.exe (or SkalpellClient.exe) in the programs list, leaving DEP on for other applications. The latter option is recommended.

- To do so, click *Add* and select the file SkalpellServer.exe
- Click OK and save. (You might be prompted to restart your machine.)

To learn more about DEP, please visit: <http://support.microsoft.com/kb/875352>

A note about – Skalpell Server running as a service (on Windows) performing backup to a network drive.

When running Skalpell Server as a service (or any other application as a service on Windows), the default setting is to run it as “Local System account”. This predefined account has for security reasons no access outside the server*, thus preventing the Skalpell Server application from accessing any network drives.

The recommended configuration for this limitation is to have an additional set of hard drives (RAID 1 array) for this purpose only in the server machine, and let the backup software access that drive when the daily backup is performed.

Note: *The log file needs to be stored on a reliable hard drive interface (S-ATA or SCSI) on the server machine as read/write delays may cause the log file to become corrupt thus useless.*

** The built-in Local System Account supports the opening of null sessions. Accessing network drives requires a user name and password, which the Local System Account doesn't have.*