

## Libelle BusinessShadow<sup>®</sup> with Option Long Distance

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Libelle has been mirroring application systems across long distances for many years. The basic **BusinessShadow<sup>®</sup>** architecture is already able to mirror database and applications in Wide Area Networks. However, mirroring with large distances between a primary and a secondary system comes with specific challenges such as network latency, limited bandwidth, instable networks and many more. To address these challenges, Libelle provides the Option Long Distance which functionalities are outlined in this White Paper.

### Mirror Challenges in Long Distance Settings

We define „Long Distance Mirrors“ or simply „WAN Mirrors“ as mirroring IT systems across large distances, typically across more than 100 kilometres. Compared to a local mirror, we experience much less available bandwidth and some of the following specific problems:

- High network requirements result in high ongoing costs
- Network latency lead to inefficient data transfer
- Instable networks require manual intervention
- Replication tools are rarely providing sufficient mirror integrity checks
- Lack of data “consistency points” from an application perspective
- Typically very high investments

### Basic BusinessShadow Architecture

The Architecture of the **BusinessShadow** components **DBShadow<sup>®</sup>** (database mirror) and **FSShadow<sup>®</sup>** (flat file mirror) is in itself designed to support mirrors with limited bandwidth across large distances. Some of the features of the basic architecture include for example:

#### **BusinessShadow features during initial mirror setup:**

- Shorter initial copy duration with compressing database and files lead to shorter implementation time with less interruption.
- Optimized copy performance with parallel copy of multiple database files and dynamic configuration changes during the copy process.
- Initial mirror setup without interrupting the availability of normal application operation.
- Network downtime during the initial copy when using the network are covered with a set of “copy continue” functions.
- Initial Copy can be setup using the so-called „external copy“ functions which allow to automatically synchronize the mirror after restoring the tapes on the secondary system.

**BusinessShadow® features during normal mirroring operation:**

- Server-based mirror architecture with own, optimized TCP stacks is ideal for mirroring across large distances.
- Support for host setup using IP-Addresses, hostnames or mixed setup support different network topologies (for example setting up a DNS concept with hostnames or include the secondary system with a Virtual Private LAN into the network of the primary).
- Logfile and file-based mirroring is minimizing the transaction volume. Standard compression mechanisms are minimizing bandwidth requirements without interfering with performance on the production system.

**Option Long Distance: Overview**

With more and more requirements for Wide Area Networks, Libelle launched the first version of the “Option Long Distance“ in 1999 and is continuously improving and enhancing the same. The Long Distance features are enhancing and adding dedicated features to **DBShadow®** and **FSShadow®**. Existing mirrors can be transformed into a „Long Distance Version“ with changing the software key and are automatically optimized for standard Wide Area Network operations.

The following gives an overview on the extended functions of the Option Long Distance. The term “INITIAL COPY” refers to the initial load of the secondary system from the primary. The term “ARCHIVER” refers to the continuous transfer of change data to the secondary system.

Function	Process	Technology	Advantages
<b>Additional Compression</b>	INITIAL COPY	High Compression	<ul style="list-style-type: none"> <li>• Faster Initial Copy</li> <li>• More Performance</li> </ul>
<b>Additional Compression</b>	ARCHIVER	High Compression	<ul style="list-style-type: none"> <li>• Faster Log Shipping</li> <li>• More Performance</li> </ul>
<b>Parallel Shipping</b>	ARCHIVER	Parallel Archive Shipping	<ul style="list-style-type: none"> <li>• Better Network Utilization</li> <li>• More Performance</li> </ul>
<b>Configure number of parallel processes</b>	ARCHIVER	Parallel Archive Shipping	<ul style="list-style-type: none"> <li>• Adapt mirror to available network</li> </ul>
<b>Optimized TCP/IP stacks</b>	INITIAL COPY, ARCHIVER	Very Large Packages	<ul style="list-style-type: none"> <li>• Better network utilization</li> </ul>
<b>Encryption</b>	INITIAL COPY, ARCHIVER	Encryption, bit-rotation, package checksums	<ul style="list-style-type: none"> <li>• Basic Security in WAN settings</li> </ul>

## Overview of the features in the “Option Long Distance“

### High Compression

The feature "High Compression" is an optimized compression algorithm to provide better utilization of the bandwidth. While the standard compression algorithms is targeted to get data as fast as possible to the network, the algorithm is focused on limited network bandwidth and adds more compression before sending data on the way. While it takes a bit longer to compress data, less data has to be copied in return.

### Encryption

As a component of the Option Long Distance, Libelle offers basic encryption mechanisms. The encryption methods are based on own procedures for data compression and basic bit-rotation. When customers use public Wide Area Networks to mirror critical data, we suggest to use secure lines between the primary and secondary site. One mechanism is to setup Virtual Private Networks or use additional hardware-based encryption mechanisms.

### Very Large Package Technology (VLP)

Standard TCP stacks are typically not optimized to mirror database and associated files across large distances. The Option Long Distance includes the so-called VLP technology to optimize the stacks for this purpose. The network communication is then based on very large IP-packets to address network latency in large distance settings.

We experience very good performance improvements especially with combining PAS and VLP technologies which result in much lower network requirements.

### Bandwidth Calculation

The following examples demonstrate how bandwidth between a primary and secondary system can be calculated. Factors such as database structure, database size and especially the way customers work with the database varies from customer to customer. Any calculation is based on assumptions and the actual optimal bandwidth can only be determined in actual operation.

### Copy Duration for the Initial Copy of Databases

The „initial copy process“ is the procedure to initially load the secondary system with the data from the primary. This process is automated with **BusinessShadow**<sup>®</sup> and enhanced with the Option Long Distance.

Factors to estimate copy duration are for example:

- Database size and database structure
- Number of database files
- Available bandwidth
- Number of parallel copy process
- Possible compression

The following table demonstrates an example calculation of the duration of an INITIAL COPY process with a given bandwidth, database size and assumed compression factor:

- Net database size **100 GB**
- Available network bandwidth **2 MBit**
- 2 Megabit per Second ~ 0.2 available Megabyte per second (reduced by Check/Parity Bits)
- 100 Gigabytes ~ 100.000 Megabytes
- 100.000 Megabytes with 0.2 Megabytes per second = 500.000 seconds
- 500.000 seconds ~ 8333 minutes ~ 138 hours
- LongDistance Edition compresses & parallel copy offers factor 3 up to 9

Necessary online copy time assuming compression factor 5 = 27,6 hours

Example for calculating the duration of the initial database copy.

The initial copy with both **DBShadow®** and **FSShadow®** is performed during normal operation while the primary system is in production. As an alternative, the “external copy” feature synchronizes the mirror after a e.g. tape with the backup of the primary system is restored on the secondary system.

**Log Shipping: Bandwidth Requirements during Normal Operation**

After the initial copy, the mirror is already in the “normal operation” mode. Database and flat file changes on the primary system are now detected and updated on the secondary system. The calculation of the necessary bandwidth for this normal operation depends on the following factors:

- Size and amount of Archive Files (database) and File Changes (file system) per day
- Available bandwidth
- Performance peaks (e.g. 10:00 am in the morning)
- Structure of the archive files (e.g. high/low workload)
- Structure of the changed files (e.g. compressible /non-compressible)
- Potential compression factor and number of parallel processes

The following table shows estimates how much bandwidth for transporting data is actually expected to available with assumed compression factors of approximately 30%.

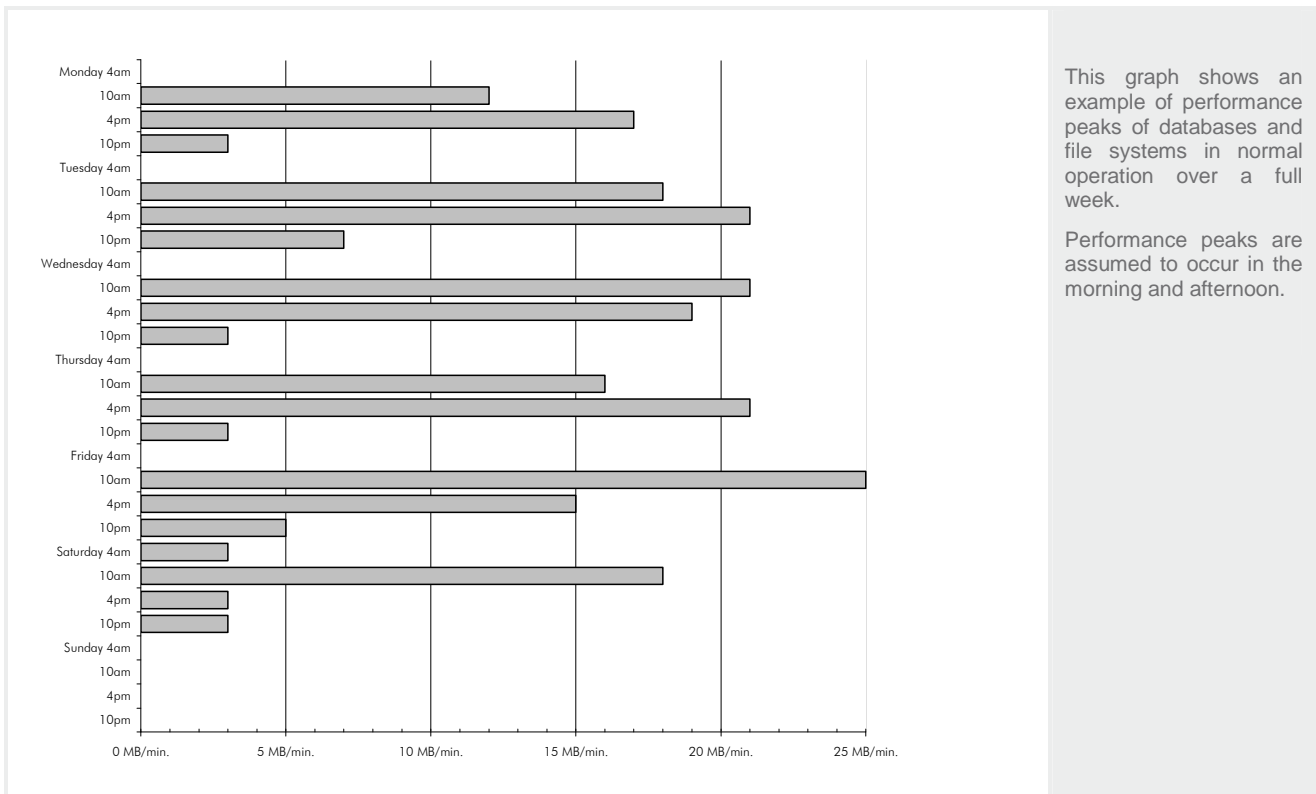
Nominal bandwidth in Megabit per second	Assumed available Bandwidth in Megabyte per second	Assumed Bandwidth in Megabyte per second after compression	Available Capacity in Megabyte per minute
1 Mb/s	0,10 MB/s	0,13 MB/s	7,50 MB/m
2 Mb/s	0,20 MB/s	0,25 MB/s	15,00 MB/m
4 Mb/s	0,40 MB/s	0,50 MB/s	30,00 MB/m
6 Mb/s	0,60 MB/s	0,75 MB/s	45,00 MB/m
8 Mb/s	0,80 MB/s	1,00 MB/s	60,00 MB/m
10 Mb/s	1,00 MB/s	1,25 MB/s	75,00 MB/m

The table gives an example of net bandwidths obtained from a Wide Area Network between two locations

In the next step, we calculate the total data change volume and analyze the same for performance peaks. It is recommended to use actual historic change volume data from the database operation. In Oracle databases, our consultants are using special SQL scripts to pull this information from the database to get data how peaks are distributed during the day or during the week.

It is important to keep in mind that defined Recovery Point Objectives (maximum data loss after a disaster incident) in Long Distance settings can vary during times of performance peaks since the network is temporary not able to update the secondary system with current change data. Specific bandwidth calculation give the data basis to either accept lower RPO values during these times or extend the bandwidth accordingly.

The following two tables show an overview how peak times and limited bandwidth are relating to each other. Data which is not transmitted to the secondary system in phases of peak times have to be transmitted right after. The longer the peak times, the longer it takes to catch up with older data.



This graph shows an example of performance peaks of databases and file systems in normal operation over a full week.

Performance peaks are assumed to occur in the morning and afternoon.

Using a simple spreadsheet, expected absolute bandwidth shortages and surpluses can be accumulated and different assumption and bandwidth pipe-sizes can be simulated.

The following gives two examples:

Day/Daytime	Required Bandwidth	Available Bandwidth (1 Mb/s)	Absolute Bandwidth Shortage/Surplus
Monday	4am	0,00 MB/min	7,50 MB/m
	10am	12,00 MB/min	7,50 MB/m
	4pm	17,00 MB/min	7,50 MB/m
	10pm	3,00 MB/min	7,50 MB/m
Tuesday	4am	0,00 MB/min	7,50 MB/m
	10am	18,00 MB/min	7,50 MB/m
	4pm	21,00 MB/min	7,50 MB/m
	10pm	7,00 MB/min	7,50 MB/m
Wednesday	4am	0,00 MB/min	7,50 MB/m
	10am	21,00 MB/min	7,50 MB/m
	4pm	19,00 MB/min	7,50 MB/m
	10pm	3,00 MB/min	7,50 MB/m
Thursday	4am	0,00 MB/min	7,50 MB/m
	10am	16,00 MB/min	7,50 MB/m
	4pm	21,00 MB/min	7,50 MB/m
	10pm	3,00 MB/min	7,50 MB/m
Friday	4am	0,00 MB/min	7,50 MB/m
	10am	25,00 MB/min	7,50 MB/m
	4pm	15,00 MB/min	7,50 MB/m
	10pm	5,00 MB/min	7,50 MB/m
Saturday	4am	3,00 MB/min	7,50 MB/m
	10am	18,00 MB/min	7,50 MB/m
	4pm	3,00 MB/min	7,50 MB/m
	10pm	3,00 MB/min	7,50 MB/m
Sunday	4am	0,00 MB/min	7,50 MB/m
	10am	0,00 MB/min	7,50 MB/m
	4pm	0,00 MB/min	7,50 MB/m
	10pm	0,00 MB/min	7,50 MB/m

Bandwidth surplus/shortage calculation based on a 1 MB/s line.

Day/Daytime	Required Bandwidth	Available Bandwidth (2 Mb/s)	Absolute Bandwidth Shortage/Surplus	
Monday	4am	0,00 MB/min	15,00 MB/m	15,00 MB/m
	10am	12,00 MB/min	15,00 MB/m	3,00 MB/m
	4pm	17,00 MB/min	15,00 MB/m	-2,00 MB/m
	10pm	3,00 MB/min	15,00 MB/m	12,00 MB/m
Tuesday	4am	0,00 MB/min	15,00 MB/m	15,00 MB/m
	10am	18,00 MB/min	15,00 MB/m	-3,00 MB/m
	4pm	21,00 MB/min	15,00 MB/m	-6,00 MB/m
	10pm	7,00 MB/min	15,00 MB/m	8,00 MB/m
Wednesday	4am	0,00 MB/min	15,00 MB/m	15,00 MB/m
	10am	21,00 MB/min	15,00 MB/m	-6,00 MB/m
	4pm	19,00 MB/min	15,00 MB/m	-4,00 MB/m
	10pm	3,00 MB/min	15,00 MB/m	12,00 MB/m
Thursday	4am	0,00 MB/min	15,00 MB/m	15,00 MB/m
	10am	16,00 MB/min	15,00 MB/m	-1,00 MB/m
	4pm	21,00 MB/min	15,00 MB/m	-6,00 MB/m
	10pm	3,00 MB/min	15,00 MB/m	12,00 MB/m
Friday	4am	0,00 MB/min	15,00 MB/m	15,00 MB/m
	10am	25,00 MB/min	15,00 MB/m	-10,00 MB/m
	4pm	15,00 MB/min	15,00 MB/m	0,00 MB/m
	10pm	5,00 MB/min	15,00 MB/m	10,00 MB/m
Saturday	4am	3,00 MB/min	15,00 MB/m	12,00 MB/m
	10am	18,00 MB/min	15,00 MB/m	-3,00 MB/m
	4pm	3,00 MB/min	15,00 MB/m	12,00 MB/m
	10pm	3,00 MB/min	15,00 MB/m	12,00 MB/m
Sunday	4am	0,00 MB/min	15,00 MB/m	15,00 MB/m
	10am	0,00 MB/min	15,00 MB/m	15,00 MB/m
	4pm	0,00 MB/min	7,50 MB/m	15,00 MB/m
	10pm	0,00 MB/min	7,50 MB/m	15,00 MB/m

Bandwidth surplus/shortage calculation based on a 2 MB/s line.

In this example, a 4 MBit-Line would be required to likely provide enough bandwidth to get all archive files immediately on the mirror system, even in times of high loads (not shown in the tables). With an existing 1 MBit-Line the log files will be transferred to the mirror system, but not immediately.

During peak times, the archive files are potentially “getting behind” and stay temporarily on the primary system. A crash during these times can lead to lost change data which is not yet transmitted to the secondary system.

With limited budgets, we recommend a reasonable balance between bandwidth and peak times. In this example, a 2 MBit-line is a good compromise between cost for the bandwidth and a relatively high security. The time where the archive files are lagging behind are minimal.

## Summary

Our experience in projects over many years showed that the Long Distance Extensions provide high value for our customers. A side-by-side comparison of activating and deactivating the Long Distance Option from the basic **DBShadow**<sup>®</sup> and **FShadow**<sup>®</sup> functionality shows much better network utilization.

In addition to network optimization and bandwidth calculation, there are a variety of additional issues we are addressing when planning and implementing Wide Area Network mirrors. Our consultants would be glad to support you with your project requirements.

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