WHITE PAPER

FUJITSU

FlexFrame® Orchestrator Version 1.4A

THE FLEXFRAME INFRASTRUCTURE SOLUTION - TECHNICAL WHITE PAPER

INTRODUCTION

This document describes the technical aspects of the FlexFrame® infrastructure solution.

The name FlexFrame® is a generic term for both the traditional "FlexFrame® for SAP®" (FF4S) and the current "FlexFrame® Orchestrator" (FFO).

All technical aspects described in this document and this document itself are subjects of change without further notice.

NAMING INFORMATION

PRIMEFLEX® is a registered trademark of Fujitsu Limited in Europe and other countries.
PRIMEFLEX for SAP Landscapes enables simplified, fast and secure implementation and operation of SAP applications and databases. The infrastructure solution is designed, delivered and supported as one product and supplemented by a broad services portfolio. The integrated FlexFrame Orchestrator software offers consistent and standardized administration of infrastructure, databases and applications.

TARGET AUDIENCE

The document addresses consultants, administrators and platform decision makers.

We assume that the reader of this document has technical background knowledge in the areas of operating systems Linux, IP networking and SAP basis.

DOCUMENT HISTORY

Document Version	Date	Changes

1.0	2013-05-21	First edition of FlexFrame Orchestrator (1.0A) Technical White Paper
1.1	2014-05-09	New chapter "FlexFrame backup with Simpana"
1.2	2015-01-16	Update for FlexFrame Orchestrator 1.1A
1.3	2015-03-20	Introduction of the Virtual Control Center
1.4	2015-12-01	Update for FlexFrame Orchestrator 1.2A
1.5	2016-12-05	Update for FlexFrame Orchestrator 1.3A
1.6	2017-12-08	Update for FlexFrame Orchestrator 1.4A

Contents

1   The FlexFrame® Infrastructure Solution

The FlexFrame® infrastructure solution is a revolutionary approach to run complex SAP® infrastructure solutions with higher reliability and efficiency.

At the same time some major changes to the configuration paradigms for infrastructures have been implemented.
These changes are:

- A shared operating system booted over IP networks for the SAP servers.

- Decoupling of application software and operating system, called virtualization of SAP software.

- Shared Network Attached Storage from NetApp.

- FlexFrame Agents providing revolutionary mechanisms to implement high-availability functions without cluster software.

A new major change started with the first Orchestrator version and is improved step by step:

- The solution gets stepwise independent from hardware and software restrictions. That means that some hardware component can be used by project based on defined interface to be provided by those (e.g. for network component, NAS storage system or virtual machine support)

FlexFrame Orchestrator manages environments running SAP Enterprise Resource Planning (ERP) applications and supports consistent and uniform management of all SAP landscapes, including SAP HANA infrastructures. This solution is designed for all enterprise environments and for every kind of IT provisioning model, regardless of whether the applications are running in the customer's data center, delivered as a managed service or a hosting service from an external provider, or deployed from the cloud.

2   Components

The concept of FlexFrame consists of several components which implement state-of-the-art functionality. Together with the FlexFrame Agents, the whole solution is far more than just the sum of its components. A major part of the benefits consists in a dramatic reduction in day-to-day operating costs for SAP environments.

It is, of course, possible to use parts of the FlexFrame infrastructure solution in individually designed implementations[1]. In such customer-specific configurations, professional service and maintenance have to be considered separately.

2.1   Hardware

A typical FlexFrame environment consists of the following types of hardware:
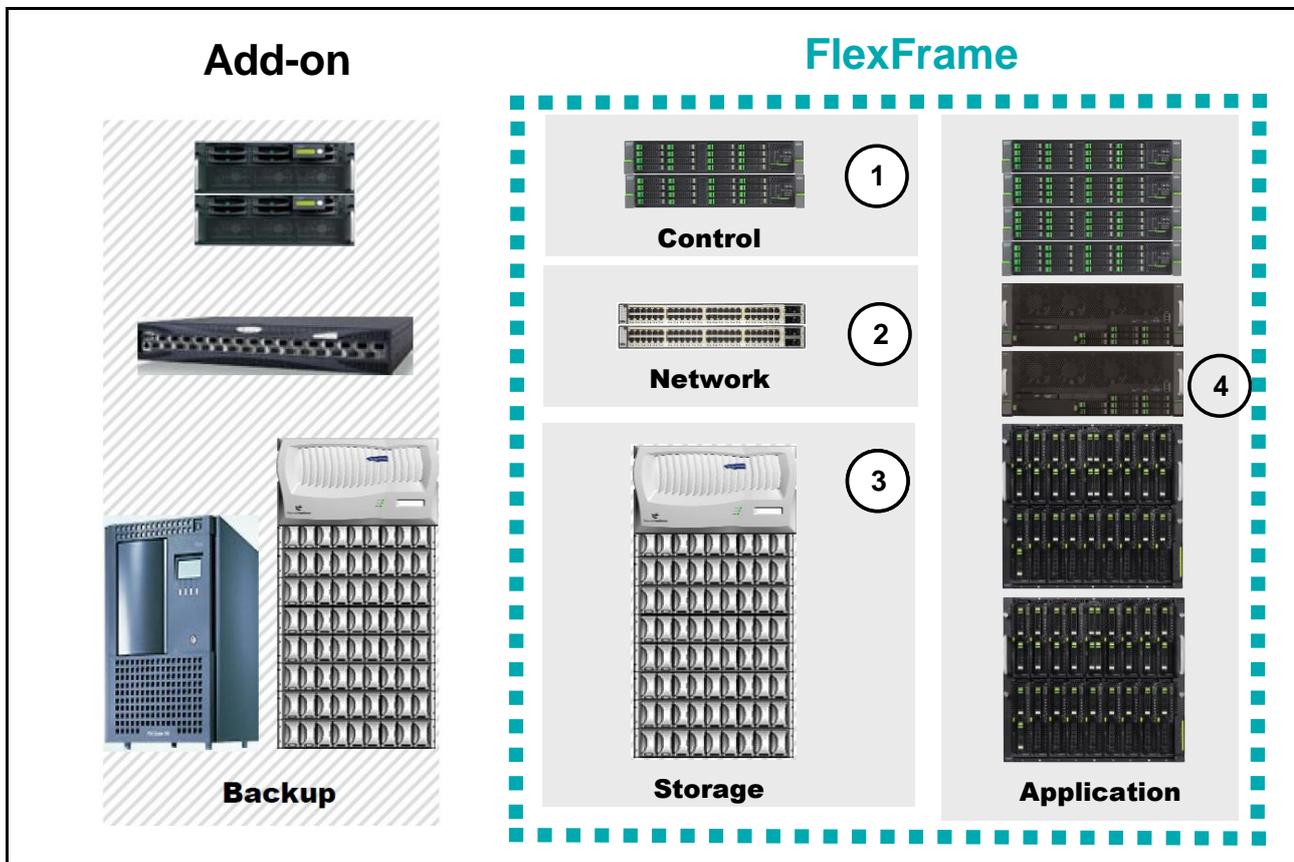
1. Control Nodes – the Control Center: Two PRIMERGY servers of type RX300/RX2540 with SUSE Linux Enterprise Server installed on local disks. Alternatively the Control Nodes can be realized as KVM virtual machines.

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[1] Such implementations are classified into "standard +" Solution projects, where a standard special release request has to be made to the product owner, and "extended" (enhancements that later become mainline) and "customized" (enhancements without path into the mainline) Solution projects, where the project manager needs to involve the product owner in order to get a proper solution, to generate the mutual back-to-back agreement

2. Network switches – Cisco® of type Catalyst 3750 or Brocade ICX, and/or Cisco® Nexus or Brocade VDX6740.

3. Network Attached Storage with a NetApp FAS System or a Storage Virtual Machine hosting shared OS file systems and application data.

4. Intel-based PRIMERGY and PRIMEQUEST Servers (standard rack servers or blade servers) serving as Application Nodes with SUSE Linux Enterprise Server (Shared OS).

For detailed information about the hardware currently supported in a FlexFrame environment, see the current FlexFrame Support Matrix (https://partners.ts.fujitsu.com/com/products/sol/sap/FlexFrame).

Any other functions, such as backup, can be implemented separately as an add-on to FlexFrame and need dedicated hardware, operating system, high availability, professional service and support etc.

2.2   Software

The FlexFrame infrastructure solution consists of both hardware and software. To enable the complete environment to function properly, the entire software set is strictly defined. Anything other than the software components listed below is not part of FlexFrame. This also applies if software from the list below is missing, is installed in other versions than specified below, or if software other than the current SAP components is added.

No.	Hardware [1]	OS	Software	Services
1	Control Nodes: 2 x PRIMERGY RX2540 M1, M2 or M4 or 2 x PRIMERGY RX300 S7, S8, or 2 x PRIMERGY rack servers each equipped with a KVM hypervisor	SLES12 SP3	FlexFrame Agents (Control Agents), FlexFrame 1.4A File System Image CN, ServerView Agents, ServerView RAID etc.	TFTP, DHCP, LDAP, (SAPROUTER), etc
2	Network switches: pairs of 1 GbE switches (Cisco Catalyst 3750x or Brocade ICX 64xx), and/or pairs of 10 GbE switches (Cisco Nexus 50xx/55xx/9236/9372 or Brocade VDX6740 or [3])	IOS (proprietary) Brocade Network OS(propr.) NX-OS (proprietary) ….	(as delivered)	
3	Network Attached Storage: one or more NetApp storage systems (FASxxxx, AFF80xx, AFFAxxx, vFiler or SVM's), disk shelves as required [4] hosting shared OS file systems and application data	ONTAP (7-mode and cDOT) (proprietary) [5]	NetApp Tools	NFS, optional: cluster components, FlexClone, SnapVault, SnapMirror, SnapRestore

No.	Hardware [1]	OS	Software	Services
4	Intel- based PRIMERGY or PRIMEQUEST server (standard rack or blade server)	SLES11 SP4 / SLES for SAP [2] or SLES12 SP2 / SLES for SAP [2] or VMware vSphere ESXi running SLES11 SP4 / SLES for SAP [2] or SLES12 SP2 / SLES for SAP [2] or SLES11 SP4 / SLES for SAP [2] running as KVM Hypervisor, running SLES11 SP4 / SLES for SAP [2] or SLES12 SP2 / SLES for SAP [2]	FlexFrame V1.4A File System Image, FlexFrame Agents (Application Agents), SAP Applications, Database	SAP & DB Services

Overview of current software and hardware dependencies in FlexFrame

[1] allowed types according to current FlexFrame Support Matrix
[2] based on SLES11 SP4 (x86_64) resp. SLES12 SP2 (x86_64)
[3] or other switch pairs when adapter modules exist and are certified by Fujitsu
[4] The amount of disks required for customer-specific FlexFrame configurations can be determined together with Fujitsu Customer Support Filer Sizing Team
[5] The currently supported ONTAP version is kept up-to-date in the FlexFrame Support Matrix

2.3 Shared Operating System

One major aspect of FlexFrame is its shared operating system. Sharing in this case means that the very same files of essential parts of the underlying operating system are used to run multiple servers. This part of the file system is mounted read-only, so none of the Application Nodes that run the actual applications can modify it. Server-specific information is linked to a file system area that is server-specific and mounted read/write. The shared operating system (normally named "image") is kept to a NAS system (Network Attached Storage system from NetApp).

2.3.1 Shared OS Boot Concept

The figure below shows the boot process of a FlexFrame Application Node (PRIMERGY/Linux).

The FlexFrame Concept – Shared OS
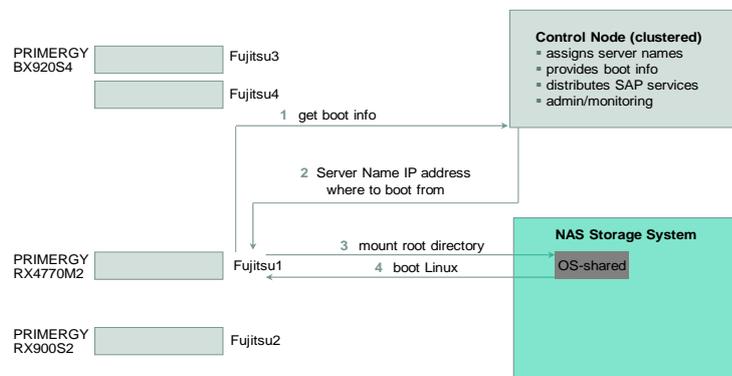
2.4   Control Nodes

Every FlexFrame environment always includes two Control Nodes. Their purpose is to be a single point of control for the Application Nodes, as well as to check and manage the proper operation of the Application Nodes.

The two Control Nodes are also called the Control Center.

Control Nodes do not run SAP software (with the exception of saprouter, as an option). They exclusively run SUSE Linux Enterprise Server Version 12 (based on SLES12 SP3), installed on local disks. Control Nodes provide and run services such as:

- Linux-HA high availability cluster framework
- Timeserver for the complete FlexFrame landscape
- Control Agents
- Web server to provide the Control Agents' user interface
- DHCP for assignment of IP addresses and TFTP for the boot process of the Application Nodes
- saprouter (optional)

Control Nodes at present are of the server type PRIMERGY RX2540M1, RX2540M2, RX2540M4 or RX300 Sn, n = 6, 7 or 8. Alternatively they are virtual machines placed on two distinct PRIMERGY rack servers of free choice each equipped with a KVM hypervisor.

2.5   Application Nodes

Application Nodes are the workhorses of the FlexFrame infrastructure solution.
Application Nodes run database and SAP services on the SUSE Linux Enterprise Server shared operating system. Application Nodes can be physical servers that offer CPU and memory, or virtual servers built on top of physical servers, using the physical server's CPU and memory through a virtualization layer.

For FlexFrame Orchestrator 1.4A the principal types of Application Nodes are:

- PRIMERGY or PRIMEQUEST server running SLES11 SP4 or SLES12 SP2
- Virtual machines running SLES11 SP4 or SLES12 SP2 on a PRIMERGY or PRIMEQUEST server running a vSphere ESXi or a KVM hypervisor

Admissible servers have to be approved for SAP on Linux by Fujitsu.

During the boot process using Intel's PXE® technology, each Application Node is identified using the hardware address of its boot interface (MAC address). The Control Node assigns an IP address to it and supplies the operating system via the network.

Selected file systems (especially the root file system "/") are mounted over the network read-only.

If, for any reason, an Application Node needs to be replaced or added, only a handful of settings need be adjusted to integrate it into the FlexFrame environment.

Intel's® PXE technology is implemented in Fujitsu's PRIMERGY and PRIMEQUEST servers and allows booting via the network. DHCP is used with static MAC address relationship for all the Application Nodes.

2.6   Integration of server virtualization into FlexFrame Orchestrator

Virtualization concepts play a fundamental role for the customer value of the dynamic infrastructure FlexFrame Orchestrator. Besides the concept of virtualization of the SAP software by decoupling application software and operating system and the concept of virtual IP addresses enabling the switch of services from one host to another, FlexFrame additionally offers the use of virtualized servers as Applications Nodes.

As of FFO 1.1A00-020 the Control Center of FlexFrame can either consist of physical Control Nodes or of virtual Control Nodes (vCN). In case of a virtual Control Center (vCC) both virtual machines are hosted on different physical PRIMERGY servers that run SUSE KVM as hypervisor.

Starting Point is the general virtualization design:

Before Virtualization:

- Single OS image per machine
- Software and hardware tightly coupled
- Running multiple applications on same machine often creates conflict
- Underutilized resources
- Inflexible and costly infrastructure

After Virtualization:

- Hardware-independence of operating system and applications
- Virtual machines can be provisioned to any system
- Can manage OS and application as a single unit by encapsulating them into virtual machines

Allowing Application Nodes with and without virtual machines the obtained picture in FlexFrame is
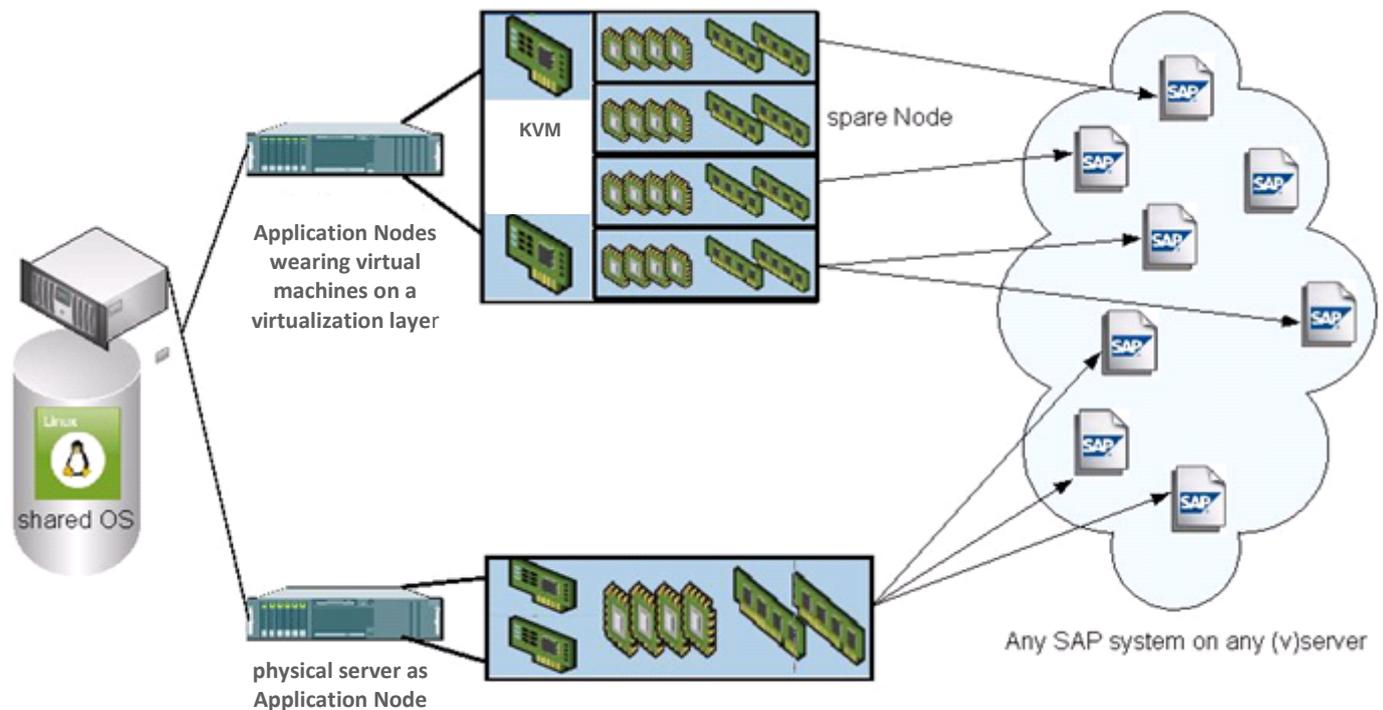
FlexFrame makes it possible for an SAP application to be started on any server in the FlexFrame environment. This can be a physical server or a virtual server. An SAP application can be relocated from a virtual server to a physical server and vice versa at any time. As a result, the application can be moved to the system with the best suited resources without any additional installation work. For example, several applications with low loads are run in parallel on several virtual servers, although if an application's load is high, a complete physical server is assigned to it. If this is not sufficient, a server with more or more powerful processors and main memory is chosen.

All in all, the available server capacities can thus be utilized better and thus reduced. Unused resources can also be switched off. Both measures cut procurement and power costs. Flexible allocation is also a great aid if a new SAP application does not run correctly on a virtual server. It is then moved to a physical server to test whether the problem is the result of virtualization or due to other reasons.

Management

All installed and configured resources are controlled from a central instance, the FlexFrame Control Center. It can essentially be assumed that an SAP environment consists of a mix of virtual and physical servers. Uniform management of all resources – virtual or physical – is therefore an important requirement for the IT infrastructure. Central management of the SAP services also offers many advantages in the event of a fault. If a

server has failed, the SAP application is automatically booted on a substitute system. SAP applications are also restarted on virtual servers. The basis for this is a FlexFrame Agent (see chapter 7) that is started on all application nodes when the operating system is booted and reports to the Control Center that it has been started and is running successfully. This agent allows SAP-specific problems to be detected and countermeasures to be initiated. As a result, not only availability of a virtual or physical server is monitored, but also whether the application is running smoothly and its utilization. That means administrators have an overview of all server resources and applications at any time and can also change the assignment of resources to applications. There is thus end-to-end control of the entire system.

2.7 Role Based Access Control (RBAC)

In computer systems security, role-based access control (RBAC) is an approach to restricting system access to authorized users. Within an organization, roles are created for various job functions. The permissions to perform certain operations are assigned to specific roles. Members of staff (or other system users) are assigned particular roles, and through those role assignments acquire the permissions to perform particular system functions.

In order to configure and administrate a FlexFrame environment numerous programs have to be used, nearly all of them needing root permissions to do their job. So the previous FlexFrame versions for example did not allow to separate administration for different pools (and often a pool corresponds to a customer in outsourcing environments)!

With RBAC a FlexFrame administrator

- need not have "root" privilege any more
- can be a named account on the Control Center
- can be restricted for different administration scopes (pool, sid, ..)
- will be logged with all its interface actions done by FlexFrame programs

RBAC uses two data structures to define access permissions:

- roles
  A role contains all permitted FlexFrame programs and operation modes for this role.
- user roles
  A user role maps FlexFrame administrator roles by pool to a user role name. This name has to match to an account or group name. If the account name matches any user role no more user roles are scanned. If no user role name matches the account name all the groups of the account are used to scan for user roles. The permissions of the group name matching user roles are added to a composed virtual user role.

2.7.1 RBAC standard role definition

Out of the box FlexFrame comes with six role definitions. Three of them are for configuration/administration and the other three for observation. They are divided into SID (SAP system identification) specific, pool specific and main FlexFrame and do not overlapping in most cases. This means to have grants to SID and pool specific tools both roles have to be added to user role. To get a non root user with root like FlexFrame permissions all three configuration/administration roles have to be added to the user role of the user.

The three configuration/administration roles are:

- ffadmin

- pooladmin
- sidadmin

The three observer roles are:

- ffobserver
- poolobserver
- sidobserver

The intention of the predefined rules is to give a non root user the ability to do all the SID or pool specific FlexFrame jobs or to do FlexFrame environment related work. These are divided into a "read only" observer part and an administrative part.

2.8   FlexFrame User Interfaces

A FlexFrame landscape can be accessed through Secure Shell (ssh) connections to the Control Node. Any other remote administration tools like rsh or telnet have been disabled for reasons of security.

The FlexFrame Control Nodes provide a web portal with links to Web interfaces of several FlexFrame components, i.e. FlexFrame Agents WebGUI (see chapter 7 about the FlexFrame Agents) and the FlexFrame documentation.

Beyond that the administration of FlexFrame is performed via CLI and GUI. The FlexFrame Administration GUI is offered additively for most of the standard administration tasks. This GUI is realized as a part of the FlexFrame Management Tool, which in Planning Mode enables the certified FlexFrame consultant to enter the necessary configuration data for a customer-specific FlexFrame environment. And in Administration Mode provides an easy and comfortable way to administrate the FlexFrame system environment. In Administration Mode the CLI commands are generated automatically by the Management Tool and need not be typed in manually.

3   Central Administration via LDAP Configuration Database

LDAP is used as the central information service for all shared OS nodes within a FlexFrame environment. The Control Nodes are used as LDAP servers. The LDAP database is located on shared file systems mounted from the NAS storage. The Application Nodes are configured as LDAP clients. LDAP requests from Application Nodes are restricted to the data of their own pool.

LDAP provides host-related network information such as:

- net boot
- automount
- user authentication
- groups
- host names and IP addresses
- shared services
- networks and netmasks

- LDAP client profiles

Additional information about configuration data is only applicable for Control Nodes. These are used FlexFrame internally to add, remove or modify the configuration of Application Nodes or SAP services.

The standard high availability and failover solution "Linux-HA cluster" is used for the two Control Nodes. This feature also guarantees that after breakdown of a Control Node the cluster provides its IP address and the corresponding LDAP resource (LDAP-master or LDAP-replica) to the other node and makes it available again for the entire system.

4   IP Network

The network is the backbone of the FlexFrame infrastructure solution. Communication between the various nodes and storage devices is done exclusively via the IP network infrastructure. This is used both for communication between server(s) and client(s) and for delivering IO data blocks from the NAS (Network Attached Storage) to the server.

The IP network infrastructure is essential for every FlexFrame configuration. FlexFrame is designed to use different IP networks for different purposes.

The following networks are mandatory:

- client

  The purpose of the client network is to have dedicated user connectivity to the SAP instances. This network also allows administrators to access the Control Nodes. This network can be routed outside the FlexFrame networks to connect to the existing network.

- control

  The control network carries all FlexFrame global administrative communication, e.g. between control nodes and iRMC or management blades or to change switch or NAS configuration or similar purposes.

- server

  The server network is used for the communication between SAP instances among each other and the databases.

- storage

  The storage network is dedicated to NFS communication for accessing the Application Nodes' shared operating systems, the executables of SAP and the RDBMS as well as the IO of the database content and SAP instances.

The following networks are optional:

- admin

 The admin network can be added to have dedicated user connectivity for server administration. If missing the client network must be used.

- backup

  The backup network can be added to separate backup traffic of an application node and a backup server. If missing the server network can be used.

- hanaint

  The hanaint network is dedicated to HANA scale out solutions to carry the HANA internal traffic.

- hanarep

  The hanarep network is dedicated to HANA system replication.

- sapdata

  The sapdata network can be added to separate NFS communication for accessing database files. If missing the storage network is used.

- saplog

  The saplog network can be added to separate NFS communication for accessing database log files. If missing the storage network is used.

- livemig

  The livemig network can be added to separate communication for virtual machine live migration. If missing the control network can be used.

4.1   Virtual Network Segments

The FlexFrame network concept relies on virtual LAN (VLAN) technology that allows running multiple virtual networks across a single physical network. Every FlexFrame IP network is associated to a dedicated VLAN, reserved for FlexFrame traffic only.

The following figure outlines the basic virtual network segments of a typical FlexFrame landscape with Application Nodes.
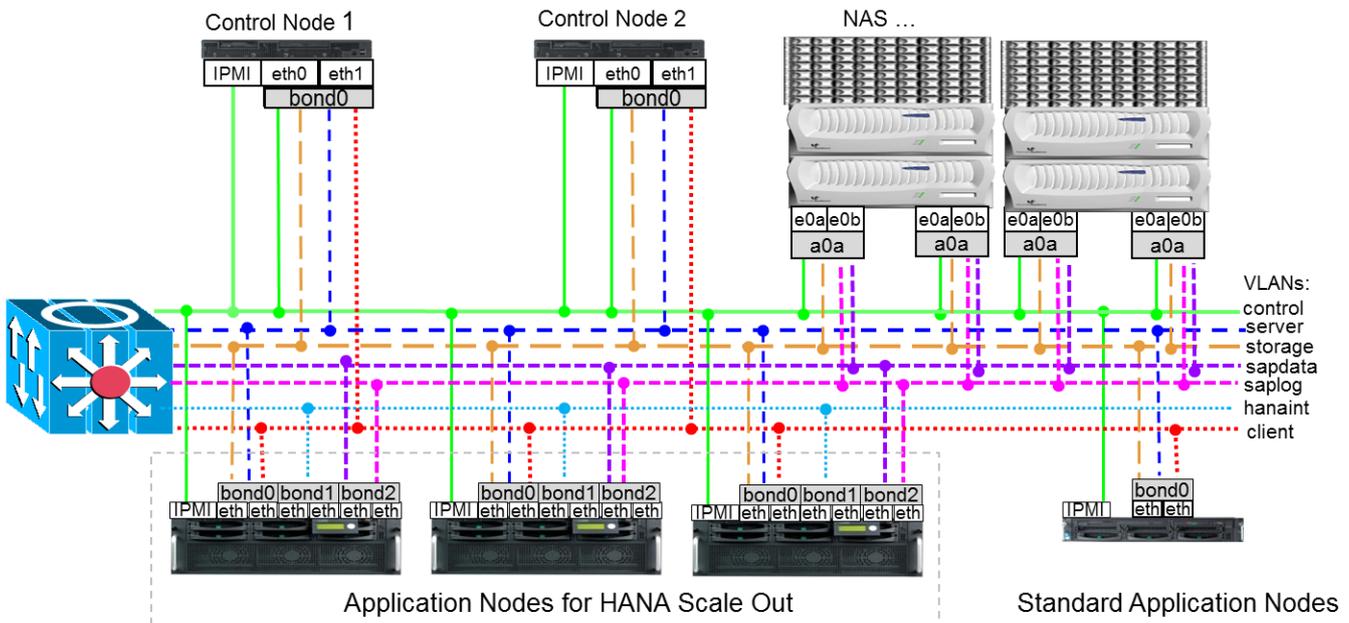
The bandwidth of the physical network has to be at least 1 Gbit/s for all components to handle intense data traffic. Selective network connections (for instance the connections from a FlexFrame NetApp NAS system or from a set of 10GbE-capable rack servers or blade servers (via switch blades) to the FlexFrame access layer switches) may be chosen as 10Gbit/s connections.

4.2   Network High Availability – LAN Failover

In FlexFrame every network runs through a logical network interface that consists of several physical network ports which in turn are using redundant network paths (cables and switches). This includes a double switch and at least double wiring infrastructure. A single logical redundant interface may be sufficient to get access to every network needed.

When a network component (port, cable, switch, etc.) fails, the network management logic will switch over to another network port and path. This will be described as „LAN failover".

4.3   Network Switches

Network switching components play a very important role within FlexFrame. Currently the following switches are tested and supported as FlexFrame access layer switch:

- Cisco Catalyst 3750 series
- Cisco Nexus series
- Brocade ICX 6430 / 6450
- Brocade VDX 6740

These switch families support VLAN technology for flexible configuration of the various network segments and cross-switch link-aggregation. For cross-switch link-aggregation the Cisco Catalyst models use the Cisco StackWise® Technology and the Brocade ICX models an analogue stacking technology, the Cisco Nexus models build a vPC domin and the Brocade VDX models a VCS fabric. Cross-switch link-aggregation is currently used for NAS system connections, switch group interconnects and switch blade connections.

There are two different network speeds supported:

- 1Gbit/s
- 10Gbit/s

With the 3750G and the Brocade ICX 6430 models you can only use 1Gbit/s network speed. With the 3750E or 3750X, the Nexus, the Brocade ICX 6450 and Brocade VDX 6740 models you can use 1Gbit/s and 10Gbit/s network speed.

For 1Gbit/s you can use copper or fiber ports. For 10Gbit/s you normally use fiber ports.

The 10Gbit/s network speed can be used for the connection of 10GbE-capable NetApp FAS Systems as well as for the connection of 10GbE-capable rack servers and blade servers and as uplink to the customer core network.

The 1Gbit/s network speed is used for the connection of the Control Nodes and management ports.

As of FlexFrame Orchestrator 1.2A there is a network API defined allowing the introduction and support of new switches in FlexFrame solely by

- an XML description
- a description for how to do an initial refueling
- a switch type specifically realization (of the API) by a Perl adapter-module

The adapter-module has to be certified by Fujitsu.

5   Central Network Attached Storage

The storage for all Application Nodes is consolidated on one (or more) central Network Attached Storage systems with a connection based on the network file system protocol (NFS). The central NAS storage is a FAS System from NetApp or a NetApp FAS system gateway connected to a Fujitsu ETERNUS storage system of type DX.

The NetApp implementation of the NFS (Networked File System) allows the same data files to be shared by multiple hosts and thus provides a built-in cluster file system.

The FlexFrame concept reduces the amount of "lost" disk space, since multiple SAP systems can optionally share the same set of disks. As the data grows, it is easy to add additional disks and enlarge the volumes without any downtime.

The storage configuration for FlexFrame concerning capacity and IO requirements are determined by the Fujitsu SAP Presales process.

The FlexFrame solution comprising a pool of physical and virtual servers, a central storage system, an intelligent control instance (Control Center) and a network linking all components together is a self-contained system. As one implication of this paradigm it is not allowed to share the central storage system with applications from outside of FlexFrame.

5.1   Central Network Attached Storage on NetApp FAS Systems

The operating system of the Filer is called "ONTAP". The disks will be used to build an aggregate. FlexVolumes can be created on top of aggregates. A FlexVolume contains a file system and is usable from NFS (UNIX) or CIFS (Windows) client systems. Data is stored using a Write Anywhere File Layout (WAFL) mechanism.The Filer has Non Volatile RAM (NVRAM) that buffers committed IO blocks. The contents of the NVRAM will remain intact if the power of the Filer should fail. Data will be flushed to the disks once power is back online.

The minimum FlexFrame environment has at least the following volumes:

- volFF (OS images of Application Nodes, SAP and database software, pool related files)

- sapdata (database files)
- saplog (database log files)

If the NAS system is a Filer from Network Appliance using the conventional ONTAP 7-mode the volume vol0 (ONTAP, configuration of Filer) is necessary too.

The amount of disks required for customer-specific FlexFrame configurations can be determined together with Fujitsu's Global Competence Centre Architecture Services Team.

Together with ONTAP 8.0 NetApp introduced its new paradigma of a Storage Virtual Machine (SVM) with its "Clustered Data ONTAP (cDOT)", which is on the way to replace the conventional ONTAP 7-mode, and which is the basis for NetApp's scale-out architecture.

As of FlexFrame Orchestrator 1.1A Clustered Data ONTAP is supported and the 7-mode DATA ONTAP support is continued as well.

A NetApp storage system's or a Data ONTAP cluster's networking and storage resources can be partitioned either with the help of Data ONTAP MultiStore technology into virtual filers or resp. with clustered Data ONTAP's technology into SVMs (storage virtual machines). Each virtual filer (vFiler) resp. SVM logically appears on the network as a separate storage resource and is dynamically configurable. Along the lines of FAS systems also V-series devices, vFilers and SVMs are supported within FlexFrame Orchestrator.

Usage of multiple Filer as well as NetAPP HA configurations (in contrast and additively to cDOT cluster configurations) is possible for redundancy and reliability. A storage system can be clustered to protect data against the failure of a single FAS System by specific NetApp tools. This switching from one storage system to its HA or cluster counterpart is transparent to the FlexFrame Application Nodes.

5.1.1   Snapshots

When a snapshot is taken, no data blocks are copied; just the information where the data blocks are located is saved. If a data block is modified, it is written to a new location, while the content of the original data block is preserved. A snapshot can therefore be created very quickly since only a small amount of data need be copied. The use of snapshots does not decrease the throughput and performance of the storage system.

Snapshot functionality allows the administrator to create up to 250 backup-views of a volume.

5.2   Other NAS types

FlexFrame Orchestrator defines an API for NAS. Providing an implementation of the NAS API allows the support of different NAS systems. Realizing a new NAS API is not covered by the FlexFrame Orchestrator core functionality and must be approved in a SFG process (Special Release Requests).

6   Use of SAN storage

If the requirements to the IO-performance of the used SAP systems and SAP services are extremely high, there is an alternative way to the use of NAS storage for the productive SAP databases: as of FlexFrame Orchestrator 1.1A

instead of using volumes from a NAS system over NFS, the database datafiles (sapdata) and database logfiles (saplog) of a SAP system can be placed on SAN based storage.

Configuring the SAN storage environment for a FlexFrame landscape is a complex task that needs careful planning and design. A team of specialists for storage systems, servers and SAN infrastructure must work out a concept that will be a guideline for the complete setup.

The SAN configuration for FlexFrame will usually be done by a storage systems expert in cooperation with a member of the FlexFrame implementation team.

The used SAN storage system and Fibre Channel switches are not considered as a part of the FlexFrame system; you can use LUNs from a storage system which is also used for other purposes in your computing environment. Also the administration and configuration of the SAN fabric and the Fibre Channel switches is completely in the responsibility of the customer. The FlexFrame software itself does not need an administrative access to the SAN storage system nor to the FC switches.

To manage the multiple paths between host and storage system, a multipath software is needed.The FlexFrame Linux Application Node Images contain a ready-to-use installation of the Linux native multipath software DM-MPIO.

And last not least all Application Nodes that will run database instances of SAP systems configured for SAN usage must be equipped with Host Bus Adapters (HBAs).

All Application Nodes on which a database instance will run must be able to access the LUNs used by the database. This are the Application Nodes of the poolgroup to which the Node where the instance is first started manually belongs.

7   High Availability with FlexFrame Agents

The following sections describe how SAP and database services are made highly available using FlexFrame Agents. The FlexFrame Agents consist mainly of two different types of component, the control agents and the application agents. These components together monitor hardware and software availability, and can intervene if any component of the FlexFrame environment should not react properly.

This intervention feature is a key feature of the FlexFrame infrastructure solution. Seen from a client viewpoint, it provides automatic repair of almost any imaginable failure.

The main intervention mechanisms used are

- Stop and restart services
- Reboot node and restart services
- Switch over services to another node and shut down/reboot the former host
- Power-off a node (in case of damage)
- Displace services of lower priority for services of higher priority if needed

- Start a service on a node in addition to another service running there

7.1 Control Agents

The control agents run on the Control Nodes and basically monitor the application agents. If an application agent is no longer responding, the control agent has to react and restart the application agent's services on a spare Application Node. To avoid the split brain error, the control agent initiates a power-off sequence for the Application Nodes that failed. This power-off sequence is issued via system-specific power-off hardware and software facilities.

7.2 Application Agents

While an Application Node is booting, the autonomous application agents are started. Once an application (SAP instance, database etc.) is started, the application agents will start monitoring it. No extra configuration is required. If an application should fail or cannot be started, the agent will try to re-start it, and if this fails, the entire service is started on a different Application Node (spare node). Agents on spare nodes compete for such failed services and the "winner" starts the service. Failed services can also be started on active Application Nodes, for this purpose there exist sophisticated possibilities of add rules, replace rules and substitution rules matching customer specific circumstances.

7.3 Generic FlexFrame Agent – Autonomy and High Availability for User Specific Services

In many user scenarios additional SAP or non-SAP services shall be utilized on the application servers in the FlexFrame environment, so there is a need to integrate these services into the FlexFrame autonomy rules.

With the FlexFrame Agents it is possible to integrate other services into the autonomy scenarios. The functionality allows pool specific definition of autonomy rules for additional services.

In this case the rules for detection, reaction and high availability have to be defined in rule files. The generic FlexFrame Agent functionality allows an adaptation to project specific requirements. For this purpose a generic service is defined through a set of parameters which are used for its identification and which generate the service states. The description and definition of a service is arranged in state, detection and reaction models.

7.4 Spare Application Nodes

Legacy concepts (non-FlexFrame) have dedicated clusters for fixed services. In those concepts a complete set of redundant failover hardware is required, which is idle as long as no error occurs.

In FlexFrame any number of spare nodes will stand-in if any Application Node fails.

In FlexFrame the concept of server pools and groups is new invented. In a server group, only such types of server are configured which can stand-in for each other. Depending on the number of SAP services and their requested SAPS power, a number of servers may run in a server group (see also chapter "Pools and Groups").

Spare servers and servers running services of low priority are the failback resources to enable any SAP or database service that may fail to move to another node in the same server group.

Spare server could be individually allocated to a pool and could stand-in for any failure of an Application Node (with same OS image) in that pool. Additionally pool-independent spare servers are possible, which are assembled in a special spare Pool named *Adminpool*, and which can stand-in for any failure of an Application Node in any pool.

7.5   Control Node Availability

Control Nodes monitor and control the whole FlexFrame environment. Therefore Control Node functionality itself has to be highly available. The standard high availability and failover solution "Linux-HA" is used for the two Control Nodes. Linux-HA is an integrated part of SUSE Linux Enterprise Server supported in FlexFrame.

8   Virtualization of SAP Applications

Before the concept of FlexFrame was created, it was common practice to install SAP and database services on a "fixed" server.

Usually one IP address was used for:

- the host itself

- database

- each SAP Instance

Once installed, the service could not easily "be moved away" from its host.

In a cluster configuration, virtual IP addresses were introduced to be able to switch a service from one host to another. FlexFrame is using this technology for virtualization. This concept is one of the fundamental pillars enabling FlexFrame to constitute as a Dynamic Infrastructure Solution.

8.1   SAP Applications Managed by SAP LVM

With the integration of SAP LVM (Landscape Virtualization Management) Standard Edition, formerly SAP ACC (Adaptive Computing Controller), FlexFrame provides the standardized virtualization layer based on SAP NetWeaver™, this means the virtualization of released SAP services and the use of SAP LVM to manage SAP services with additional benefits (task planner & mass operation e.g. start or stop a complete landscape).

The LVM provides a "userexit" which is used to inform the FlexFrame Agents. In this way the LVM is integrated into the environment of Control and Application Agents. While the LVM provides a central console for the SAP instances, the FlexFrame Agents keep services and nodes highly available and execute self-repair functions.

The use of SAP LVM is an optional FlexFrame feature.

9   Pools and Groups

FlexFrame offers advanced functions for partitioning a FlexFrame environment into service-specific or customer-specific server pools and groups. This may be interesting for large installations or application service providers.

9.1   Server Pools

A pool is a number of Application Nodes belonging to the same department or a customer with exclusive hardware requirements. FlexFrame systems can be divided into pools. Each FlexFrame system consists of at least one pool. In a pool, all servers may communicate with each other, but not with the servers of other pools.

Servers of different pools can use different copies of the OS.

Server Pools are separated into different network segments. Server LAN, Storage LAN and Client LAN are pool specific.

The Control LAN is connecting the Control Nodes with all servers of all server pools.

All server pools share the Control Nodes, the Control LAN segment and the NAS storage containing the common volFF volume.

9.2   Server Groups

Within a server pool, various types of hardware can be used with different characteristics, such as operating system, architecture, number of CPUs and RAM size. The bulk of servers can be divided into groups of servers with similar operating systems and hardware performance. Servers in a single group have to be able to take over the services of each other server in this group. This ability may be very useful for groups of high-performance database servers (e.g. ORACLE or HANA database servers, see chapter 10) or groups of medium-performance application servers. Each pool consists of at least one group. In FlexFrame groups are denoted by server groups or pool groups.

Each SAP application running in a pool can use one or more servers in one or more groups of servers in the same pool. Each instance of this application runs in a selected group. In case of a failure, switchover to another server is possible in the same group. For example, a set of servers can be divided into high-performance database servers and smaller application servers. The group configuration makes sure that database instances run in a group of high-performance servers, while application instances stay on groups of smaller servers without interfering with each other.

All servers in a pool share the same LAN segments, even if they belong to different groups. They do not share LAN segments with other pools, except the Control LAN.

10   Integration of HANA Services into FlexFrame®

FlexFrame Orchestrator is the solution to manage all SAP infrastructure landscapes including HANA. Besides the offerings of Fujitsu infrastructure solutions for PRIMEFLEX for SAP HANA appliances stands the HANA integration into the FlexFrame Orchestrator solution.

 In a first step the so-called HANA Single Nodes (where the HANA DB or HANA service runs on one single (physical) host) have been integrated in FlexFrame Orchestrator 1.0A - you can define a HANA group in any pool, where this HANA group consists of servers "suitable" for HANA applications.   Thus analogously to the hitherto supported SAP databases SAPDB, ORACLE, SYBASE and DB2 also HANA "in memory" databases installed on a FlexFrame

application node are supported with the full FlexFrame range of functions as well as HANA services are supported similar to other SAP services like e.g. BOBJ, SMD or TREX.

The FlexFrame highlights like "any service on any server at any time", as are the virtualization of SAP services, the "automatic repair of almost any imaginable failure", the shared use of servers and storage space, the less downtime and improved change management (see chapter 17) are thus also valid for any HANA Single Node system within FlexFrame Orchestrator. The difference regarding automatic repair failure is:

If HANA System Replication is used IT IS NOT DONE by FlexFrame agent functionality. That means no automatic takeover from the primary to the secondary site if the primary as a whole fails.

From version FlexFrame Orchestrator V1.2 on you can also define a HANA scale out (or HANA Multi Node) configuration within FlexFrame Orchestrator. This specific configuration is configured and deployed with the same management tasks as for other SAP application nodes (means e.g.: single image concept, integrated network, shared storage). The different regarding automatic repair of failure is:

IT IS NOT DONE by FlexFrame agent functionality but only by the inherent high availability functionality of SAP HANA itself.

That means also that within FlexFrame Orchestrator the monitoring of the state of HANA server and HANA services is done by the FlexFrame agent. But a failure reaction is done by HANA high availability tasks only as that is the SAP supported functionality.

11 SAP Cloning

FlexFrame offers a SAP cloning function which performs an automatical cloning of an entire SAP installation from one pool to another. With this function also the binaries are copied to the target pool and so you get a complete independent copy of your source system! The command does most configuration tasks needed to run the SAP system in the target pool.

The cloning can be done even if the system is active and the database is online. As a storage-based snapshot is prerequisite, restrictions in place on snapshot based backup/recovery for SAP HANA apply.
(Starting with HANA 2 SPS 01 storage snapshot support is available for multitenant database containers that consist of one tenant database only. On details see https://launchpad.support.sap.com/#/notes/2039883 .)
The cloning cannot be done for HANA Scaleout configurations.

This cloning function is started with a CLI-command and is performed in a time interval of only a few minutes: the central component is NetApp's feature FlexClone allowing to make very fast and space-efficient copies of so-called FlexVol® database volumes. The feature requires an extra license key.

The user is responsible for license issues using SAP software, as this feature copies a complete SAP system.

12 Additional Management Functions

The following section describes additional functions of management options which help to fulfill requirements such as

- FlexFrame event and fault management expert
- FlexFrame performance and capacity management
- FlexFrame accounting management
- FlexFrame reporting option

These functions are generally useable within FlexFrame. They are based on the raw information which is provided by the FlexFrame Agents.

For detailed information on this chapter see also the FlexFrame manual

> FlexFrame Agents Installation and Administration

12.1 FlexFrame Event Management Expert

To view the trap in the virtual, physical and service context FlexFrame provides

- standardized traps with events
- pool and group information
- the virtual and physical server and service information

The events are based on the FlexFrame Messenger service and part of every FlexFrame installation. The standardized FlexFrame trap format and the FlexFrame MIB for the trap format make it easy to integrate in every management platform.

In addition filtering and routing of traps is possible. The FlexFrame Messenger provides a standard MIB structure, this is the base for the fast and easy integration in Enterprise IT Management products, one of the additional values is the frame id to identify FlexFrame Events very easy in an enterprise IT console.

The event management option consists of log file agent to produce SNMP traps from log files e.g. the SAP CCMS log files and to integrate it into the FlexFrame IT management environment with a central IT Data Warehouse (Repository, ITDW).

For detailed information on this chapter see also the FlexFrame manuals

> FlexFrame Messenger Concept and Usage
>
> FlexFrame LogAgent Concept and Usage
>
> FlexFrame Agents Accounting

FA_WebGui Messageview

Enterprise event console

FA_Messenger

Email, SNMP Trap, External programs

FA_Messenger

Application-specific messages, alerts, events

FA Agents

Server, Network, Storage

FA_Log-Agent

Master Repository

Logfiles
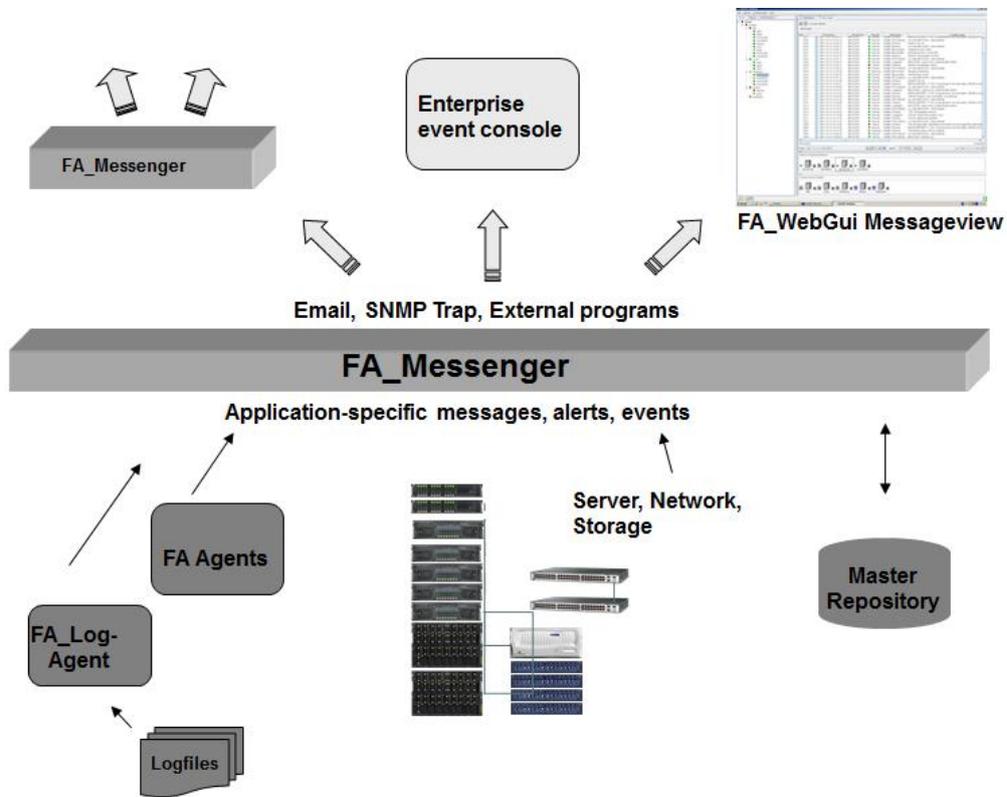
12.2 Performance and Capacity Management

The FlexFrame Agents provide optional performance and accounting data. The agents collect node-based, service-based and group-based information. The performance management meets the need for monitoring and historical trending and support intelligent orchestration of resources.

The FlexFrame performance and accounting option requires the activation of additional services on the Control Node. This service does a performance and accounting calculation of the raw data.

The following graphic shows the architecture of the performance and accounting option.

FlexFrame® Performance and Accounting
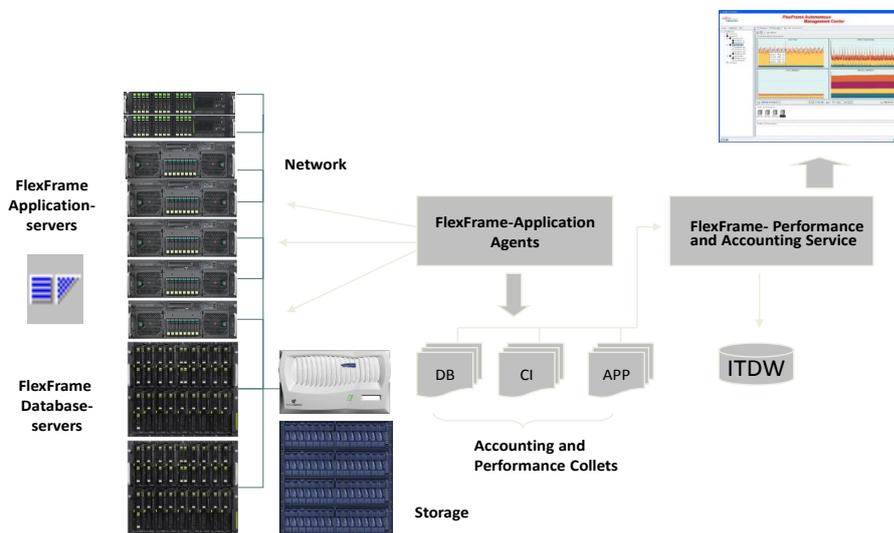
1

12.3 Accounting Management

The accounting option is, like the performance option, an optionally activated part of FlexFrame. The production of the accounting data is a multistage process determining accounting data through aggregation and analysis of the recorded raw data. The accounting option is available for performance values of the server and services and also for the file utilization accounting.

The performance option enables monitoring and evaluation of the server and services over a longer period of time. For every node the following data are available as a minimal, average and maximum value:

- load of SAP, database or generic services
- other services
- Machine idle

The data of the performance and accounting option can be directly visualized with the FlexFrame Agents WebGUI with performance and accounting management plug in. The granularity of the view and the time span can be freely defined.

Important parameters for the accounting are detection and report cycles. The detection cycle defines the number of measurements within a report cycle. The minimum, maximum and average values are calculated on the basis of individual measurements for a report cycle. The detection cycle therefore always corresponds to the detection cycle of the FlexFrame Agents, which is also a parameter for the autonomy function.

In addition to the accounting data the FlexFrame IT management option allows you to transform your accounting data directly to billing data. A flexible transformation table allows you compute directly the billing value. The billing factor can change independency from service contract number, system ID, service type and day or time ranges. So you get a flexible out of the box billing model absolutely integrated in the FlexFrame environment with no extra effort.

CPU/ SAPS Values					**Aggregation cycle**						
Service-Contract	System ID	Service typ	fromDate	toDate	dayType	from Time	to Time	Service level rule	Accounting rule	Accounting Price	Unit
SC_12345	P22	all	01.01.1900	01.01.2100	workday	00:00	24:00	Sapsrule	Standard	0.25 €	
SC_12345	P22	all	01.01.1900	01.01.2100	weekend	00:00	24:00	Sapsrule	Standard	0.15€	
SC_12345	P23	DB	01.01.2006	01.01.2100	daily	00:00	24:00	Sapsrule	Standard	0.30€	
SC_12345	P23	other	01.01.2006	01.01.2100	daily	00:00	24:00	Sapsrule	Standard	0.20€	
SC_12345	Q22	all	01.01.2006	01.01.2100	daily	00:00	24:00	Sapsrule	Standard	0.15€	

Accounting cycle   **Accounting report**

12.3.1 Filesystem Monitoring

Another feature together of the FlexFrame Agents is the filesystem monitoring. The FlexFrame Agents are able to monitor the filesystem utilization for configured filesystems. For each filesystem individual thresholds can be defined. On transgression of the limits an event is generated and can be dispatched with the FlexFrame Messenger expert functionality.

12.3.2 Performance, Capacity and Accounting Profiles

The Performance, Capacity and Accounting collects statistics on CPU and SAPs consumption calculated on server, system or service level to provide powerful analysis and reporting capabilities. An additional feature is to define profiles in which limiting values for the CPU and SAPs consumption can be defined. On transgression of the limiting values a FA performance event is generated.

The profiles can be defined on servicelevel, systemlevel and nodelevel. The user can individually decide which profiles exist and for which values events have to be generated. A profile can apply to all systems, nodes and services or pool-, system- , service-, group- or node-specific, depending on the hierarchylevel of the profile.

12.3.3   Dynamic Workload Management

The Performance profile together with the FlexFrame Messenger can be used to establish a dynamic workload management. The average CPU load event can activate a reaction on the FlexFrame Messenger to start an additional application server.

12.4   FlexFrame Filesystem Utilization and Filespace Accounting Option

This option enables the observation of filesystems and the node- and system- or service-based accounting of the filespaces. The fill degree of filesystems on local servers and also on storage systems can be supervised through the filespace accounting system. On reaching a specific percentual threshold this system will generate an event. The second feature of the filespace accounting option is to store values for the filespace accounting in the IT Datawarehouse repository.

The following graphic shows the architecture of the filesystem utilization:

FlexFrame® FlexFrame File utilization Management
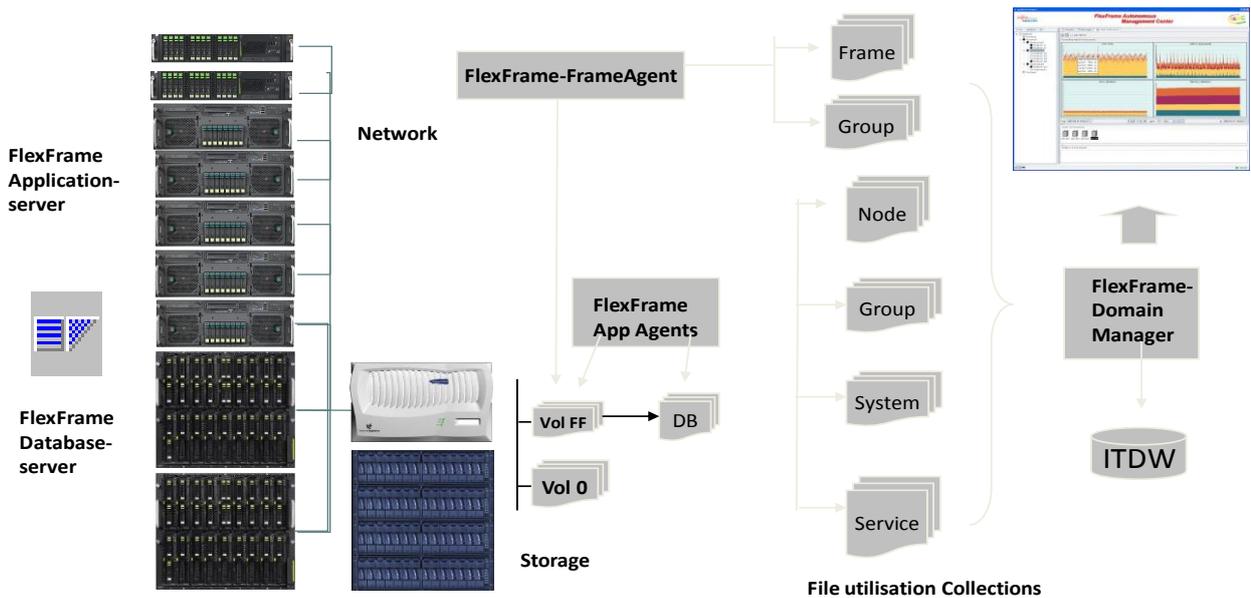
1

The data for filesystem utilization and filespace accounting can be determined with the FA-App-Agents and the FA-Frame-agents. The parameter- and rulesets for the filesystem utilization allow very granular definitions, in which cycles and for which filesystem or file the storage consumption and the increase will be ascertained.

Statistic definition in the ruleset

The observed filesystems, directories and filedata can be staticly defined in the ruleset, i.e. the start of the FlexFrame Agents activates the collection of the data and the calculation for every reportcycle.

Dynamic definition in the ruleset

The ascertainment of the filesystems, directories and filedata can also be achieved in dependency to systems and/or specific servicetypes. The generation of the filesystem utilization data ensures only if the defined system or a specific servicetype actually runs on a node. The FA-App-Agents ascertain through the dynamic triggering.

12.5 Management Reporting Option

Based on a crystal reports technology with integrated viewer, predefined report templates can be used directly to report event, performance and accounting data.

13   Prerequisites and Assumptions

Certain global prerequisites and assumptions apply for the FlexFrame concept, and these have to be taken into consideration.

13.1 Computing Center Infrastructure

FlexFrame is based on an existing computing center infrastructure. A stable air conditioning is expected. The necessary cooling capacity is depending on HW configuration.

An uninterruptible electric power supply and at least for the Control Nodes two independent current entries are highly recommended.

13.2 Host Names and IP Addresses

Host names and their correspondent IP addresses are used by FlexFrame system software for addressing objects over a selected LAN segment. The following table gives details about the different networks. The listed suffix is the suffix appended to a base name to build a host name for an IP address. The base name is the node name in case of a Control Node, Application Node, Hypervisor Node or NAS system or derived from the SID and instance number in case of a SAP service as described below.

Networks

network	scope	suffix	associated to
control	global	-co	CN, iRMC, MMB, Switch, HN, NAS
livemig	global	-lm	HN
admin	pool	-adm	CN, AN
backup	pool	-bak	AN
client	pool		CN, AN
hanaint	pool	-hni	HANA interconnect
hanarep	pool	-hnr	HANA System Replication
sapdata	pool	-sd	CN, AN, NAS

saplog	pool	-sl	CN, AN, NAS
server	pool	-se	CN, AN
storage	pool	-st	CN, AN, NAS

13.3 SAP Service Host Names and IP Addresses

The SAP service host name and its corresponding IP address are used by applications for addressing the SAP service. The IP address will be assigned to a host interface before an SAP instance is started. If a SAP service is moved to another node this SAP service is again addressable using the same IP address.

SAP service host names or its corresponding IP addresses are also used for communication from applications outside FlexFrame systems, i.e. SAP front ends such as SAPGUI.

SAP service host names are generated automatically by the FlexFrame Management Tool, that supports the planning and configuration of a FlexFrame environment.

Formation rules for SAP service host names

The SAP service host name is formed from the service type, the two-digit instance number for the service type `app,` the SID and the network suffix as described above:

    <service_type>[<ID>]<SID>[<network suffix>]

`<service_type>` can be one of:

```
db       - database instance
hdb      - HANA database instance, Single Node Configuration
hdb-mn   - HANA database instance, Scaleout Configuration
ci       - central instance (ABAP)
pai      - primary application instance (ABAP), replaces ci as of SAP 7.4
app      - application instance (ABAP)
scs      - SAP central (common) services (JAVA)
ascs     - SAP central (common) services (ABAP)
jc       - JAVA central instance
j        - JAVA application instance
lc       - Live cache instance
ers      - Enqueue Replicated Server instance

bobj     - SAP business objects (SPOB)
cms      - Content Server (CMS)
mds,     - Master Data Management Services (MDM)
mdss,
mdis
smd      - Solution Manager Diagnostic Agent
trx      - Search and Classification (text retrieval and information extraction)
```

`wd`   - SAP WebDispatcher

`<ID>` is a number from 00 to 96 (except 2, 25, 43, 72, 89) for `app` and `j` only. It is empty for other service types.

`<SID>` is the system ID of a SAP system.

This host name formation rule is mandatory for the FlexFrame infrastructure solution. Some components rely on this rule.

In a FlexFrame environment, each node name must be unique. However, each node may have multiple host names that are derived from the node name using a defined naming rule.

In the SAP environment, host names are currently limited to 13 alphanumeric characters including the hyphen ("-"). The first character must be a letter. In the SAP environment host names are case-sensitive (see SAP Note No. 611361).

13.4 Access Rights

The current implementation of the NFS client does not allow specification of the client's IP address; hence the virtual addresses cannot be used for NFS exports (which control access to data paths). Therefore any client in a specific pool can and must be able to mount any path of this pool.

This condition is valid within each server pool but is not permitted between different server pools.

14 FlexFrame Backup with Simpana

A common concept for backup & restore for all types of databases in a FlexFrame environment has been set up with CommVault Simpana software.

Our backup concept of the database backup is performed using Simpana's IntelliSnap feature together with Simpana's database agent. It brings the database in backup mode and takes a hardware snapshot on the NetApp system.

The Simpana software including the UNIX File System iDataAgent, MediaAgent and the special database iDataAgent (one for each type of database, e.g. MaxDB, Oracle, DB2, SYBASE, HANA) are required to be installed on the application nodes. All SIDs need to be configured as virtual database instances in Simpana. All Simpana clients are configured in the Server LAN IP address range and the backup data traffic is performed in the Storage LAN.
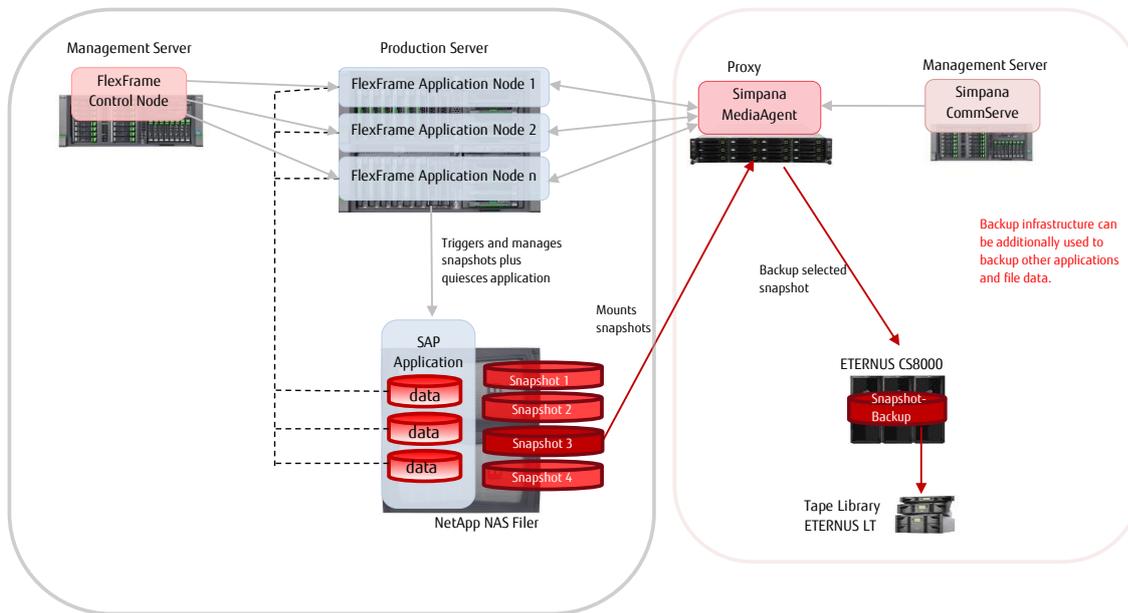
The backup is performed using Simpana's IntelliSnap feature in combination with Simpana's database agent (iDataAgent). They bring the database in backup mode and take a hardware snapshot on the NetApp system. In order to meet longer term backup requirements the snapshot will be mounted on the so-called Simpana Proxy System, a server running a Simpana MediaAgent instance and having access to secondary storage like tape. Using NetApp's FlexClone feature Simpana MediaAgent copies the database data from the NetApp system to secondary storage. It is possible to configure Simpana in a way that only selected snapshots are copied to secondary storage. The snapshots (and secondary storage) will be aged automatically using Simpana's Data Aging feature. The recommendation is to assign a short retention time to the snapshot backups (e.g. 1-3 days) and keep the copied snapshots for 2-4 weeks in order to serve restore requests targeting older database versions. The database logs are saved to secondary media in a regular basis by Simpana without using IntelliSnap in the Server LAN. The concept consists of scheduled backups of the database using the database modules in combination with IntelliSnap. NetApp snapshots are performed several times a day. During the night a so-called Selective Full is performed to tape.

In order to run restores, Simpana can copy the data back from the mounted snapshot or initiate a hardware revert of production volumes to roll back to a specific snapshot. Simpana always performs SAP Restore and Recovery (resp. recovery using other database agents). It can be done from secondary media, from snapshot by copying to the original location or using the so-called SnapRestore feature.

All information necessary to use that concept is given in a Best Practice Paper "FlexFrame Backup with Simpana" located on the FlexFrame Extranet – you may ask your Fujitsu Customer Support for getting a copy.

15   Third-Party Software

The interfaces FlexFrame provides are basically the standard interfaces of the operating systems supported with FlexFrame. The Operating Systems are installed in a way that they behave like standard OS installations for SAP. One big difference is that the root file system "/" is mounted and accessed via NFS. The third-party software has to be capable to deal with NFS-only file systems.

Some third-party software (e.g. system management tools,   tools, etc.) may not be able to handle moving (virtual) services and assume a fixed server-to-service relationship. In addition, those products may write files at locations that are mounted read-only and must therefore be relocated to a read/write location.

During implementation of a FlexFrame project the required third-party products must be identified and a project-specific analysis of this product must be initiated. Fujitsu offers such validation of third-party software as a service.

As mentioned it is also possible with the FlexFrame Agents to integrate "third-party services" into the autonomy scenarios. For this purpose a generic service is defined through a set of parameters which are used for its identification and which generate the service states.

16   Support

16.1   Fujitsu Customer Support

FlexFrame environments are fully integrated into the support structure of Fujitsu. A large number of consultants are available for design, planning, installation and further customer support.

16.2   SAP

The FlexFrame infrastructure solution approach is well-known and fully supported by SAP. Customers can create problem reports through existing SAP mechanisms (SAP Support Portal) in the same way as for conventional SAP system environments. Fujitsu are fully integrated and are informed by SAP if a problem is platform-specific. Support staff from Fujitsu work on such problems using SAP's support structures.

During installation of a SAP environment (FlexFrame or not) it is advisable to open TELNET access and a SAP Support Portal connection to the installed system. If a problem occurs, the customer can open the SAP Support Portal connection (with TELNET or SAPGUI) and provide logon information for support purposes. This remote support allows rapid detection and correction of problems.

17   Benefits of the FlexFrame® Platform

The following sections briefly describe some of the benefits of the FlexFrame general concept.

17.1   Shared Use of Storage Space

Legacy installations require dedicated LUNs for data volumes. Since growth of the data volumes is hard to predict, a lot of free space is required to assure continuous operation of the database.

With the NAS systems as storage, multiple databases (SIDs) can share the same space (volume), and the disk space is utilized much more efficiently.

17.2   Shared Usage of Servers

Due to the virtualization of SAP services, the total number of servers required can be reduced. Following are two sample scenarios.

17.2.1   Less Servers Required for High Availability

Legacy concepts usually require a pair of dedicated servers for clustering SAP databases or central instances. In a larger SAP environment, multiple cluster pairs of this type lead to a large number of servers just to cover hardware failures. Usually the capacity installed is much larger than the capacity used.

In FlexFrame, spare servers are used to take over failed services from the complete FlexFrame environment, or, if server pools and groups are used, from the complete pool/group, or in case of pool independent spare servers even from the complete FlexFrame server park.

17.2.2   Better Coverage of Performance Peaks

In larger SAP environments, multiple SAP systems (SIDs) communicate with each other. This may result in the situation where an ERP system processes, for example, month-end calculations and passes on information to a BW system. This BW system now builds aggregates of the new information. The servers for both the ERP and BW systems must be sized to be able to handle the maximum load. In legacy system environments both servers may be idle most of the time.

With FlexFrame, the available hardware can be shared between processes. Processes can be moved to a faster host when the load increases, and moved back to slower hardware after a load peak has been processed. The number of high-end servers that are able to handle maximum peaks can therefore be significantly reduced.

17.3   Less Administration

The shared operating system feature provides advantages in an administrator's daily life.

Linux Application Nodes share their "/" root file system. Hence, updates of software packages are available immediately to all Application Nodes. This means that, after updating and testing with a Test Application Node, you can activate a new root file system version by simply rebooting the Application Nodes.

17.4   Less Downtime during a Change of OS

Imagine you want to update a large number of servers to a new version of Linux. Usually this means creating backups of each server, and updating and testing each server individually.

With FlexFrame you can simply create a new directory on the NAS storage and install your new version of the OS in this directory.

Once tested sufficiently, you only change the boot configuration to use the new root file system, and you reboot the Application Nodes whenever convenient. And there is a most simple way of fallback to the old OS version if needed.

17.5 Improved Change Management

An improved change management in FlexFrame environments is guaranteed by

- dynamic SAP operation - you have a very high level of adaptivity and short response times in fulfilling requirements
- the higher quality of service - possible errors in making changes are minimized and downtimes are reduced
- low-cost adaptations - personnel expenses and costs for external service providers and capital spending are reduced
- Simple further development of the SAP environment - the standardization of the IT infrastructure minimizes the time and work involved in adaptations, FlexFrame scales very easily and virtually without limits and systems and new services can be rolled out at little cost and effort.

17.6 Simplified Multi-Client Operation

If services are provided for multiple customers, a conventional approach requires a separate infrastructure for each one. As a result, the topics and problems in planning, implementation, operation and adaptation multiply. Now FlexFrame is the ideal platform for supporting multiple clients with a single IT infrastructure or running different SAP systems. The various environments are kept strictly apart from each other by separate networks. It is also possible to reassign hardware between different customers or systems in a matter of minutes. Numerous functionalities make it possible to configure SLAs for the individual customers to handle individual agreements. Functions such as event and error management, accounting management, performance and capacity management and convenient reporting options additionally support operations management for various customers.

17.7 No Standby Database Server Required

A shadow database is commonly used for an additional level of high availability. An additional server is required for such a concept. The changes to the database ("redo logs") are shipped to this remote server and are applied to a copy of the database with a defined time lag. That means the shadow database is always some hours behind its master DB. If a logical error occurs in the original database, the shipping of the logs is stopped and the "waiting" logs will not be applied. If the error occurred before the fixed time delay (e.g. three hours), a restore from other media is required. Most decision-making processes take a long time to decide whether to switch over to the standby database or fix the issue in a different way.

Since FlexFrame is based on NAS storage systems that enable large amount of snapshots per volume to be created, a more granular recovery procedure has been provided. It is possible to separate logs and data files by volume. You can make rotating snapshots, e.g. on an hourly basis. If an error occurs the database will be stopped. A snapshot from a time before the error happened is restored only for the data volume (or even on data file level). Since the log files are still available, it is now possible to recover to a time just before the error occurred.

In FlexFrame, the additional server for an e.g. Oracle or DB2 Standby Database is not necessary.

18 FlexFrame® and SAP® Business Suite

FlexFrame is a platform explicitly designed for the SAP® Business Suite. The components supported by the FlexFrame infrastructure solution are limited by SAP's product availability matrix (PAM) and the managed systems supported by SAP's LVM.

Components which are not supported by FlexFrame should run on separate, dedicated servers. FlexFrame Agents do not monitor such components unless these are virtualized services integrated into the autonomy monitoring and reaction scenarios by means of the **generic services** (see 7.2).

The databases supported by FlexFrame are MaxDB (SAP DB), Oracle, DB2, SYBASE ASE, SYBASE IQ and HANA.

The SAP services currently supported by FlexFrame are TREX, MDM, Business Objects, Business Objects Enterprise, SMD, Content Manager, WebDispatcher and HANA.