

Description Paper

Net-Storage Guide

BS2000 (from OSD/BC V11)

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1. Terms

In the context of Net-Storage, the following terms are used in BS2000 OSD/BC:

Net Server

This is a file server in the worldwide computer network which provides storage space (Network Attached Storage, NAS) for use by other servers and offers the corresponding file server services.

Net-Storage

This is the storage space provided in the computer network by a net server and used by external servers.

Net-Storage can be a file system or simply a node in the file system of the net server. Net-Storage (to be more exact: the shared directory) is made available in BS2000 via the command MOUNT-NET-STORAGE and mounted on the Net-Client.

Net Client

Implements access to Net-Storage for the operating system that wants to use it. The Net-Client transforms the BS2000 file accesses together with the BS2000 subsystem ONETSTOR to the corresponding Unix file accesses and executes them on the net server via NFS. For server units /390 of SE Servers the bs2netsagent process, which represents the net client runs on an HNC; for server units x86 of SE Servers the net client or bs2netsagent resp. runs on the X2000 of the server unit.

Net-Storage Volume

Net-Storage volumes represent Net-Storage in BS2000. They are configured via the command ADD-NET-STORAGE-VOLUME and assigned to a pubset. A directory in the shared file system of the net server is configured and assigned to a local data pubset (SF or SM pubset) as a Net-Storage volume.

Net-Storage volumes are addressed via their volume serial number (VSN) and the volume type NETSTOR or NETVOL. The volume type NETVOL was introduced with BS2000 V21. The directory name in the shared file system of the net server corresponds to the VSN of the Net-Storage volume.

A Net-Storage volume (to be more exact: the directory with the name of the Net-Storage volume) contains the following:

- A file system label (file name .FSL) and a file catalog (file name .BS2FSCAT) with the meta data of the files stored on Net-Storage. The file catalog is only available for volumes of the NETSTOR type. This file catalog does not apply to volumes of the NETVOL type that were introduced with BS2000 V21 (as part of BS2000 OS DX).
- The user files of file type *BS2000 (see next section for more information)
- The user-specific directories which include the *NODE-FILE user files (see next section for more information).

BS2000 OSD/BC V11 does not support the new NETVOL volume types.

In addition to the new NETVOL volume type, BS2000 V21 also supports the previous NETSTOR type. Only volumes of the new NETVOL volume type can be created under BS2000 V21. However, volumes of the NETSTOR type from BS2000 OSD/BC V11 that already exist can be included and used in BS2000 V21.

Files on Net-Storage

From the BS2000 viewpoint, two basic types of file processing are offered on Net-Storage:

- Pure BS2000 processing, file type: BS2000
Users can save all types of BS2000 files (PAM, SAM, ISAM, PLAM) on Net-Storage, apart from files with PAM-Key, work files, temporary files and file generation groups. Systems other than BS2000 systems may not modify these files.
- Joint file processing of BS2000 and open systems, file type: node file
As of BS2000 OSD/BC V10, users can store files in user-specific directories within Net-Storage volumes and process them together with open systems. And vice versa, UNIX systems can create files in these directories which can be imported to BS2000 and processed. A file does not have a specific structure from a Unix/Linux/Windows viewpoint. This corresponds in BS2000 to the file format PAM (BLKCNTL=NO). A new attribute (FILE-TYPE = *NODE-FILE) has been introduced in BS2000 OSD/BC V10 to identify these files. This file type can be processed as PAM files from BS2000 OSD/BC V10. From BS2000 OSD/BC V11 also the text-based processing of node files by means of the access method of SAM is enabled.

Architecture

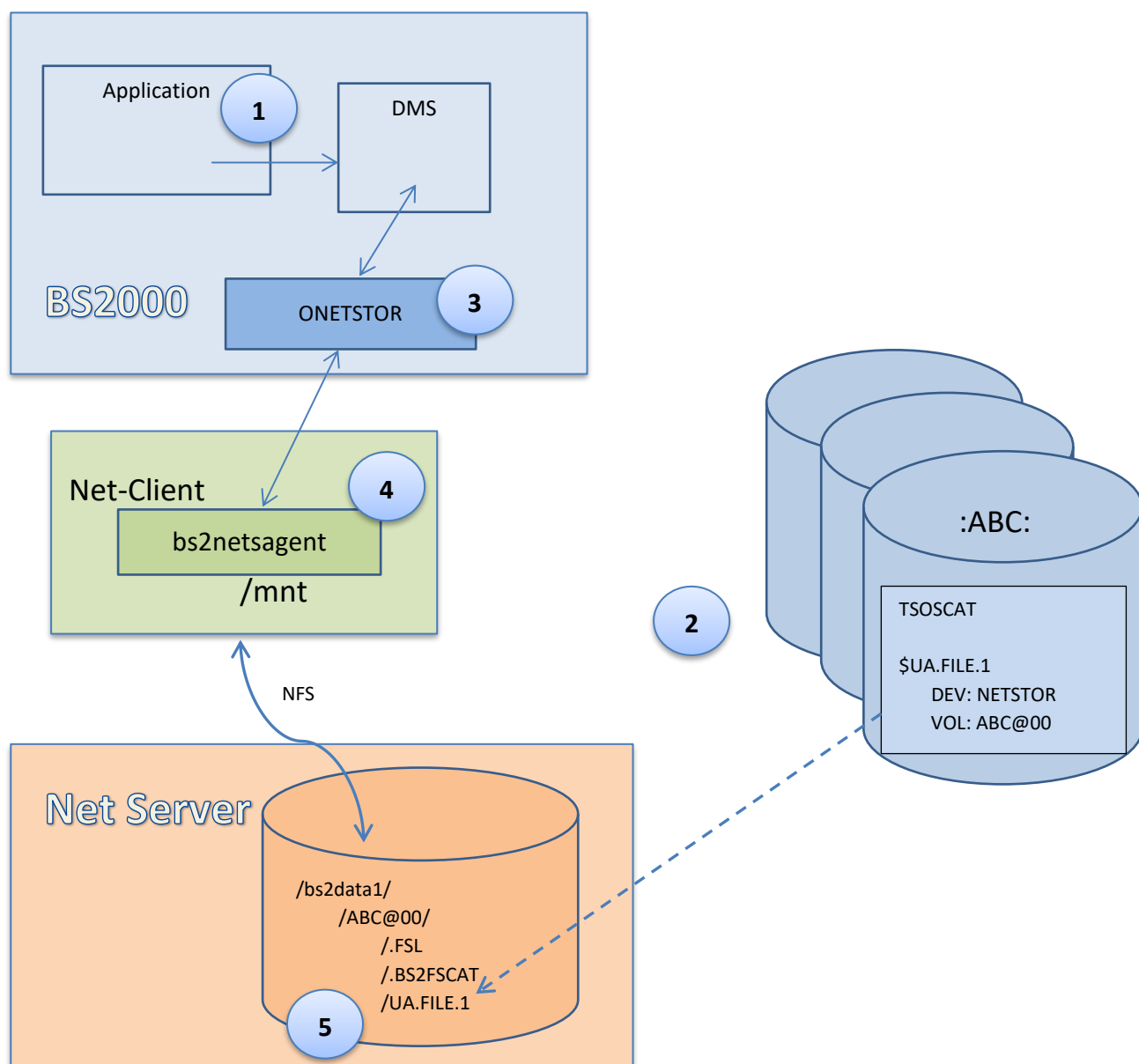


Image 1

An application (1) accesses a file via the DMS. The DMS recognizes that the file is located on Net-Storage via the catalog entry in TSOSCAT on the pubset(2). The file on the net server (5) is accessed via NFS via the subsystem ONETSTOR (3) and the net client (4). The process that performs the tasks of the Net-Client is the so called bs2netsagent.

2. Configuration

In order to enable the use of Net-Storage in BS2000, a connection (node, line) must be defined in BS2000 and the net client must be defined as end system (processor).

The connection between BS2000 and net client on the HNC or X2000 is via LOCLAN. For /390 architecture the LOCLAN connection to the HNC is implemented by fibre channel. For x86 architecture the LOCLAN is a software connection. The connections are configured in the SE Manager by *Devices* -> *<se server> (SE <model>) -> <unit> (SU<model>) -> BS2000-Devices*, folder *LAN*.

In case of SU /390 the device addresses need to be configured by IOGEN (see 2.2). This configuration refers only the accessibility (read/write channel and device MNs respectively) of the HNC or X2000.

The configuration of the Net-Client itself is done by the menu *Hardware* -> *Units* -> *<se server> (SE <model>) -> <unit> (HNC or SU<x86> resp.) -> Management*, folder *Net-Storage*.

In the following the examples for HNC1 with LOCLAN and connection via DANPU01 are presented. When using other networks or units, the configuration must be adapted to the network addresses used accordingly.

The required permissions must be configured on the net server; the user and group ID permitted for access must be entered accordingly on the net client for the bs2netsagent (Net-Storage accesses), this is also valid for the NFSv4 domain name.

In addition the interface of the HNC or X2000 respectively must be entered, which implements the connection to the Net-Storage (Net-Storage connection properties and addresses, details see chapter 2.6).

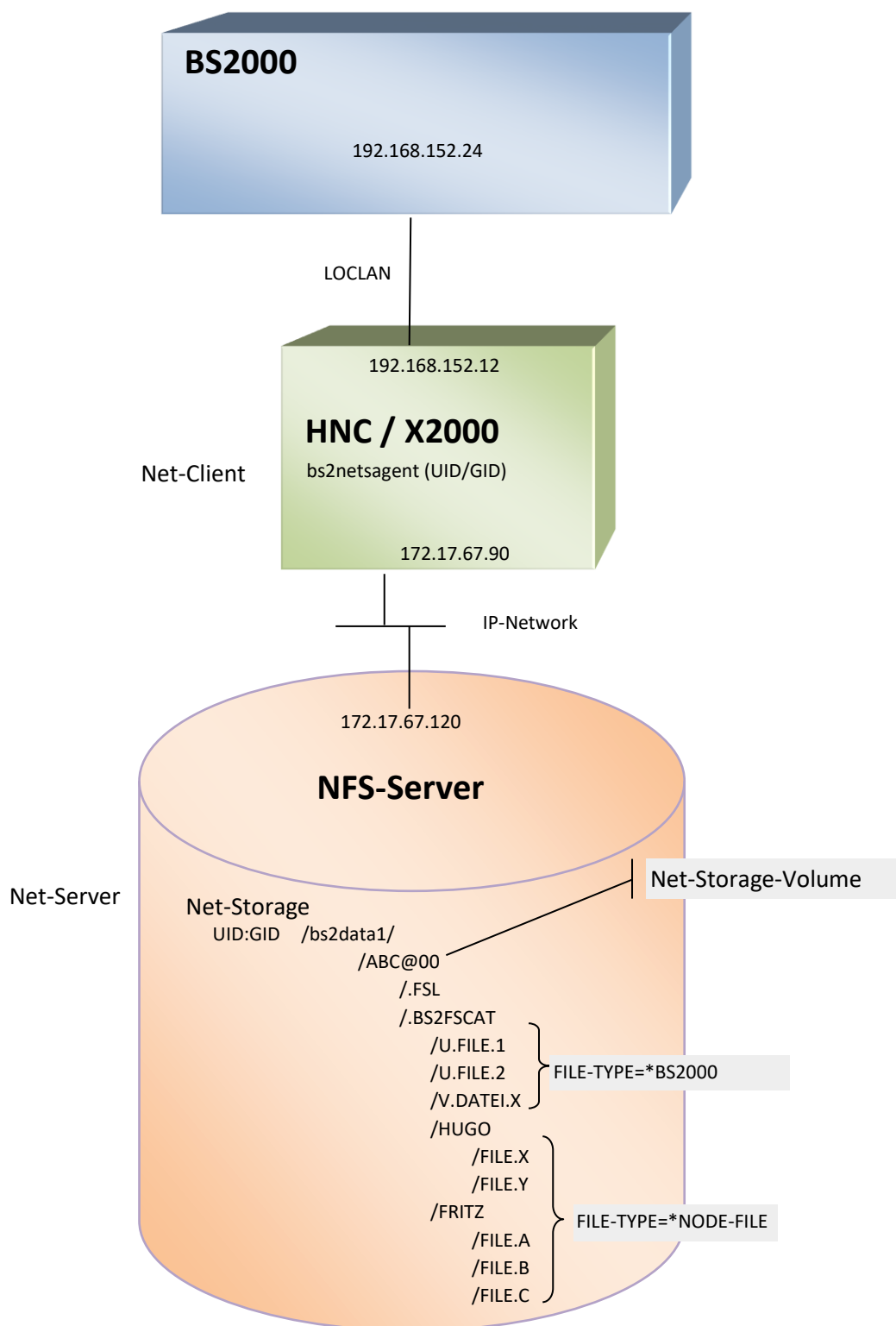


Figure 2

2.1. Access Permissions for BS2000 Interoperability with Open Systems.

The NFS server system administrator configures a share for a specific user (with ETERNUS CS: file group). In the example in figure 3, this user has the user and group number (UID:GID) 7890:2222.

This user and group number is configured on the net client for the bs2netsagent net client process. The process thus receives authorization to access the share and to create directories and files; it is thus the owner of the Net-Storage volume to be created under the share and its included *BS2000 files and BS2000 user-specific directories.

The BS2000 system administrator mounts the share in the BS2000 via MOUNT-NET-STORAGE. The mount is by BS2000 net client under root. The following is valid depending on the NFS version:

If the NFS server supports the NFSv4 protocol, the mount is automatically executed in version 4 or else in protocol version NFSv3.

When using NFSv4 the users must also be entered in an LDAP or AD directory service with user and group numbers. The NFS-Server must be connected to this LDAP directory service. NFSv3 does not necessarily require the use of LDAP or AD.

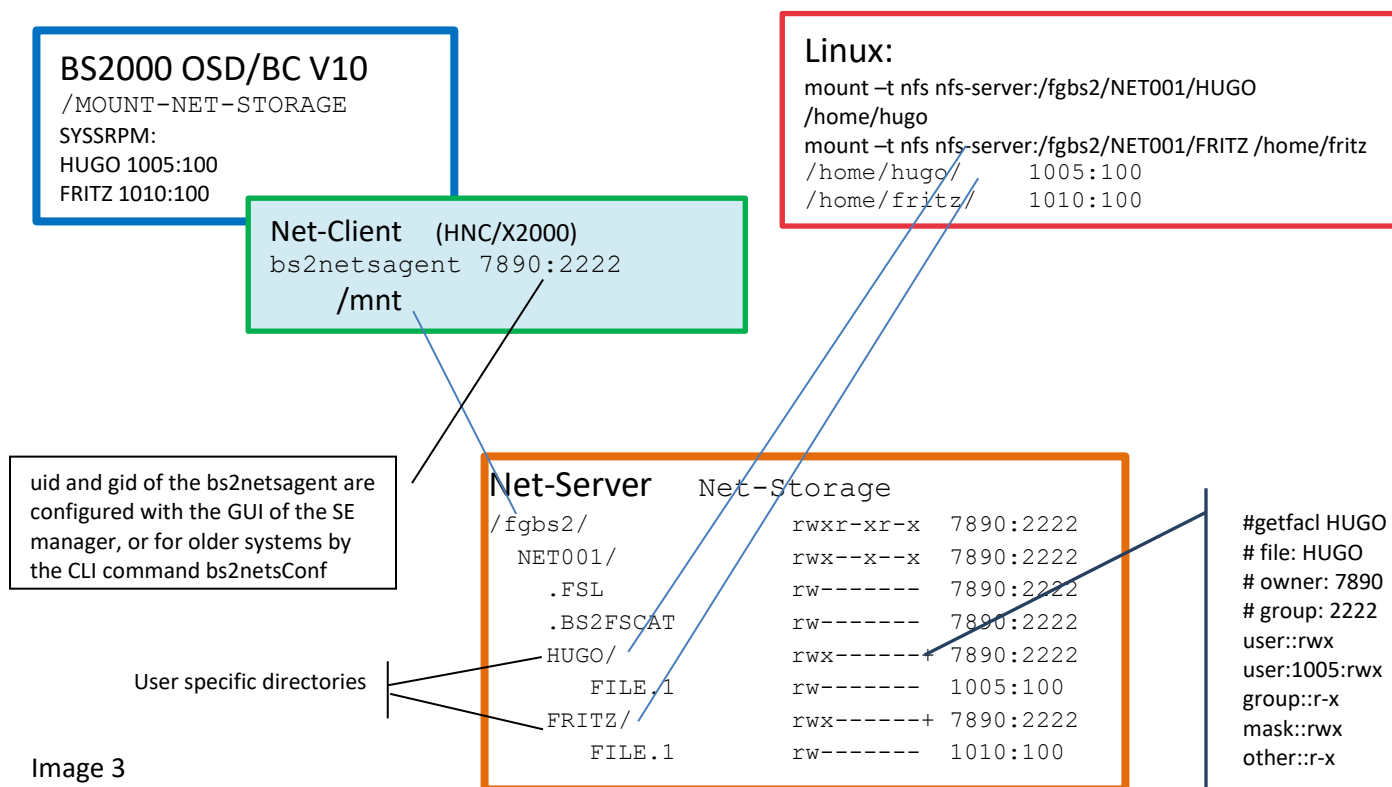


Image 3

Net-Storage node files are stored in user-specific directories, i.e. files which can be processed by BS2000 and by Unix/Linux systems. These directories have the name of the respective BS2000 user ID (upper case letters) and are automatically configured by the BS2000 with the initial creation of a node file.

When creating such a directory, the POSIX-ACLs, i.e. the read, write and execute permissions, are set for the respective BS2000 user. The net client accesses the files in the user-specific directories (node files) via the user and group number of the corresponding user ID. The system administrator must compare the user and group numbers in BS2000 against those in the open systems and, using MODIFY-POSIX-USER-ATTRIBUTES (USER- and GROUP-NUMBER) enter them in the user catalog of the pubsets, to which the Net-Storage volumes have been assigned.

When the user-specific directory has been created on the BS2000-side, files can also be created on the Unix/Linux-side which can then be imported to the BS2000 catalogs via IMPORT-NODE-FILE. In the case of volumes of the NETSTOR type, these are TSOSCAT and BS2FSCAT; in the case of the volumes of the NETVOL type introduced with BS2000 V21, this is only TSOSCAT.

The BS2000 protection measures (USER-ACCESS, ACCESS, password protection, BACL, GUARDS) are only effective in BS2000.

From the UNIX viewpoint, the mechanisms apply which the file system provides regarding ownership (UID:GID, rwx for user, group, other) as well as POSIX-ACLs. However, if the minimum access rights of the file from UNIX/Linux shown in figure 3 are restricted, access can be prevented from the BS2000-side, which is then reported to the user via the corresponding messages (e.g. permission denied).

2.2. BS2000 IO Configuration

The generation of the IO configuration on SU /390 servers is via the utility IOGEN (see manual System Installation). A CTL instruction and two DVC instructions (for the read and write channels respectively) are specified for HW generation of the HNC.

Example of a generation instruction to connect the HNC via an FC switch on the FC channel A4:

```
CTL C0,, (A4,0,10000000C954F718)
DVC 4D20,6D,A,0000,(C0)
DVC 4D21,6D,A,0001,(C0)
```

or

```
CTL C0,, (A4,0,10000000C954F718)
DVC 4D20,6D,A,0000,(C0),MULT=2
```

The connections are configured by the SE Manager *Devices* -> <se server> (SE <model>) -> <unit> (SU<model>) -> *BS2000-Devices*, folder *LAN*.

2.1 BCAM Configuration

From a BCAM viewpoint, only the following must be described regarding the above physics:

(1) The connection of the BS2000 node and line

Either an HNC in the case of a SU /390 or a channel adapter in the case of an SU x86 servers, which does not differentiate BCAM in the description (see below "Defining the line" and SHOW-BCAM-ENVIRONMENT OWN-IP-ADDRESS 192.168.152.24)

(2) The processor on a node must be described with the address with which it must be reached from the BS2000. The BS2000 communication partner is the net client with the running bs2netsagent (PROCESSOR-NAME: LOFCAP and IP address: 192.168.152.12) which controls access to the files stored on the NFS server (the addresses in the IP network of the NFS server and the NFS server itself are not known to BCAM).

(3) Settings must be made for optimum use of the transport system

LPDU Link-Layer Protocol Data Unit (determined by the device)

TSDU Transport Service Data Unit (set for processor)

The following BCAM commands are used for description and can be saved in the SOF or a CALL-BCAM-COMMAND file to restart BCAM.

DEFINE NODE

```
/CREATE-NODE NODE-NAME=LOFCAP see (1)
```

DEFINE THE LINE

```

/CREATE-LINE LINE-NAME=LOCFCCAP -      see (1)
/ , IP-ADDRESS=192.168.152.24/24 -
/ , L2-PROTOCOL=*CSMACD ( -
/   NODE-NAME=LOCFCCAP -
/ , WRITE-DEVICE=4D20 -
/ , READ-DEVICE=4D21 -
/ , SLOW-POLL=ON -
/ , MAX-LPDU-SIZE=*BY-DEVICE -      see (3)
/ )

```

DEFINE PROCESSOR/ROUTE (AT THE NODE)

```

/CREATE-PROCESSOR PROCESSOR-NAME=LOCFCAP -      see (2)
/ , MAX-TDSU-SIZE=65530                  see (3)
/
/CREATE-ROUTE ROUTE-NAME=LOCFCAP -
/ , PATH=*NODE ( -
/   NODE-NAME=LOCFCCAP -
/ , LINE-NAME=LOCFCCAP -
/ , L3-PROTOCOL=*IP ( -
/ , IP-ADDRESS=192.168.152.12 -
/   ) )

```

ACTIVATE LINE AND NODE

```

/ACTIVATE-LINE LINE-NAME=LOCFCCAP
/BCIN NODE=LOCFCCAP

```

The output of the BCAM objects, that have been created to describe this partial configuration, is via:

```

/SHOW-BCAM-ENVIRONMENT PROCESSOR=LOCFCAP, INFORMATION=*ADDRESS

```

```

SHOW-BCAM-ENVIRONMENT                                     2012-06-06 08:46:11
Route "LOFCAP " of Processor "LOFCAP "
Host:                S170G04 , *NORMAL      *ACTIVE
  Own-IP-Address      192.168.152.24/24
  Line:               LOCFCCAP              *ACTIVE, *WORKING
  Mnemonic            4D20, 4D21
  Node:               LOCFCCAP, *NORMAL     *ACTIVE
Route:               LOFCAP                *ACTIVE, *READY, *WORKING
  IP-Address          192.168.152.12
  Processor:          LOFCAP                *ACTIVE

```

CONFIGURE REDUNDANCY

The net client (on HNC!) can be redundantly configured on SU /390. Make the BCAM configuration of the second HNC accordingly and define as redundant net client via SET-NET-CLIENT-ALTERNATE. (see below under "Utilization in BS2000: Mounting remote file systems").

2.4 BS2000 User Administration

The user and group numbers (USER-NUMBER and GROUP-NUMBER) must be entered in the user catalog of the pubset on which the files are cataloged so that users can save the files as node files and process them on Unix/Linux systems, or vice versa to access the BS2000 files created by these systems. The user and group numbers must be aligned with the UID and the GID of the corresponding Unix/Linux system users.

Enter via:

```
/MODIFY-POSIX-USER-ATTRIBUTES USER-IDENTIFICATION=<name 1..8>, -  
    /PUBSET=<catid 1..4>, -  
    /USER-NUMBER=<integer 0..60002>, -  
    /GROUP-NUMBER=<integer 0..60002>
```

(Note: Irrespective of the use of Net-Storage node files, the assignment of the user and group number to the BS2000 user ID of the home pubset user catalog is relevant for the BS2000 POSIX! Keeping the numbers per user identical on all pubsets is recommended.)

2.5 Net Server

The system administrator of the NFS server configures a share on the NFS server and defines the owner (user and group number) that is to receive the access permission to this share. These must match the numbers for the net client process that are configured for the HNC or X2000 respectively (see section below "User ID and group ID of the bs2netsagent process").

The configuration of the share (file group) is via GUI with ETERNUS CS. Further mount options are configured here:

Read/write access, authorized hosts, etc.

Notes:

- Details about the configuration of your NFS server are in the appropriate documentation.
- For security reasons, the mount option `no_root_squash` should not be set. If access from the client side is via root, it would also access with root rights in the released file system. However, the `root_squash` mount option is used for access with the rights of the ID "nobody".
- Secure mode: The standard sys (=specified user ID) is used as a secure mode for the authentication of a NFS connection.
- Under NFSv4, the net server requires a link to an LDAP directory service.
- The NFS server shares that are accessible for BS2000 can be output from BS2000 via LIST-NET-DIRECTORIES.

2.6 Net Client

2.6.1 Configuration on the SE server:

On SE servers, the net client settings are installed via the graphic interface of the SE Manager. The SE Manager facilitates central, web-based management of the entire SE infrastructure and most of the peripherals used by the SE server units.

The data network DANPU01 with uplink to the customer LAN is intended for the connection of net storage. Both HNCs and Server Units x86 (SU300) are preconfigured with a LAN connection to DANPU01 when the SE server is delivered.

The public data networks are configured in the SE Manager via Hardware -> IP Networks -> Data Network Public -> DANPU<n>. The table "NetUnit Information" shows the units configured on the network.

The following figure shows the configuration of the DANPU01 network of an SE server with redundant NetUnit, 2 HNCs and one SU300:

General information (DANPU01)

Properties	Value
VLAN ID (NetUnit)	4

Total: 1

IP switch uplinks

Filter	Port	Link	Mode	Status
nswa1-se2	1/1/5	UP	untagged	NORMAL
nswa1-se2	2/1/5	UP	untagged	NORMAL

Total: 2

IP switch ISL

Filter	Port	Link	Port	Link	Description
nswa1-se2	1/2/1	UP	1/2/3	UP	ISL-S
nswa1-se2	2/2/1	UP	2/2/3	UP	ISL-S
nswa1-se2	3/2/1	UP	3/2/3	UP	ISL-S
nswa1-se2	4/2/1	UP	4/2/3	UP	ISL-S
nswa1-se2	1/2/2	UP	2/2/2	UP	ISL-I
nswb1-se2	1/2/1	UP	1/2/4	UP	ISL-S
nswb1-se2	2/2/1	UP	2/2/4	UP	ISL-S
nswb1-se2	1/1/1	UP	2/1/1	UP	ISL-I

Total: 8

NetUnit information (DANPU01)

Members	SENETname	IP switch	Portname1	Port	Link	Mode	Portname2	Port	Link	Mode
-	hnc1-se2	nswa1-se2	HNC1S2P1	1/1/14	UP	dual	-	-	-	-
-	su1-se2	nswa1-se2	SU1S1P1	1/1/18	UP	dual	SU1S2P1	2/1/18	UP	dual
-	hnc2-se2	nswa1-se2	HNC2S2P1	2/1/14	UP	dual	-	-	-	-

Total: 3

In the designation of the port names with the unit name (HNC1, HNC2, Su1SE2) as prefix, S<n>P<m> stands for "Slot n" "Port m".

Configure Net-Storage via Hardware -> Server/Units -> <se server> (SE <model>) -> <unit> (HNC or SU300<model>) -> Management, Folder -> Net-Storage.

Example HNC:

The screenshot shows the SE Manager interface with the 'Net-Storage' tab selected. The left sidebar shows a tree view of units, with 'hnc1-se2 (HNC)' selected under 'Management'. The main content area displays the configuration for 'HNC hnc1-se2: Net-Storage accesses'. It includes a table for 'Access' with columns 'User ID' and 'Group ID', showing values '7013' and '2003' respectively. Below this is a section for 'Configuration of NFSv4 domain' with a 'Domain' field set to 'localdomain'. Further down is a section for 'HNC hnc1-se2: Net-Storage connection properties' with an 'Add connection' button and a table showing 'No data available'. At the bottom is a section for 'HNC hnc1-se2: Net-Storage connection addresses' with an 'Add IP address' button and a table showing one connection with IP address '192.168.151.12'.

Access	User ID	Group ID
	7013	2003

Configuration of NFSv4 domain	
Domain	localdomain
Total: 0	

HNC hnc1-se2: Net-Storage connection properties						
Add connection						
Connection	Slot / port	VLAN	Properties			
No data available						
Total: 0						

HNC hnc1-se2: Net-Storage connection addresses						
Add IP address						
Connection	IP address	Mask	VLAN	MAC address	Conf.	
LOCLAN	192.168.151.12	-	-	0A:00:14:10:80:FF	-	
Total: 1						

Changes in the menus can be made having clicked on the pen symbol.

Attention: Changes to the settings lead to a reset and restart of the Net-Client. This can lead to data loss during ongoing I/O. Changes should therefore only be made if no shares of a Net server (NAS) are mounted from BS2000.

Access:

The user ID and group ID are set via which the net client jobs are processed on the net server. They are the owner IDs of the share to be mounted on the net server and must be agreed with the net server system administrator. The default-value 0 should not be used for data protection reasons.

Configuration of NFSv4 domain:

LDAP is only necessary if NFSv4 is in use and node files are to be stored which are to be accessed by external systems. The corresponding users must be in the LDAP server directory. Information about the LDAP server configuration is at the end of this section.

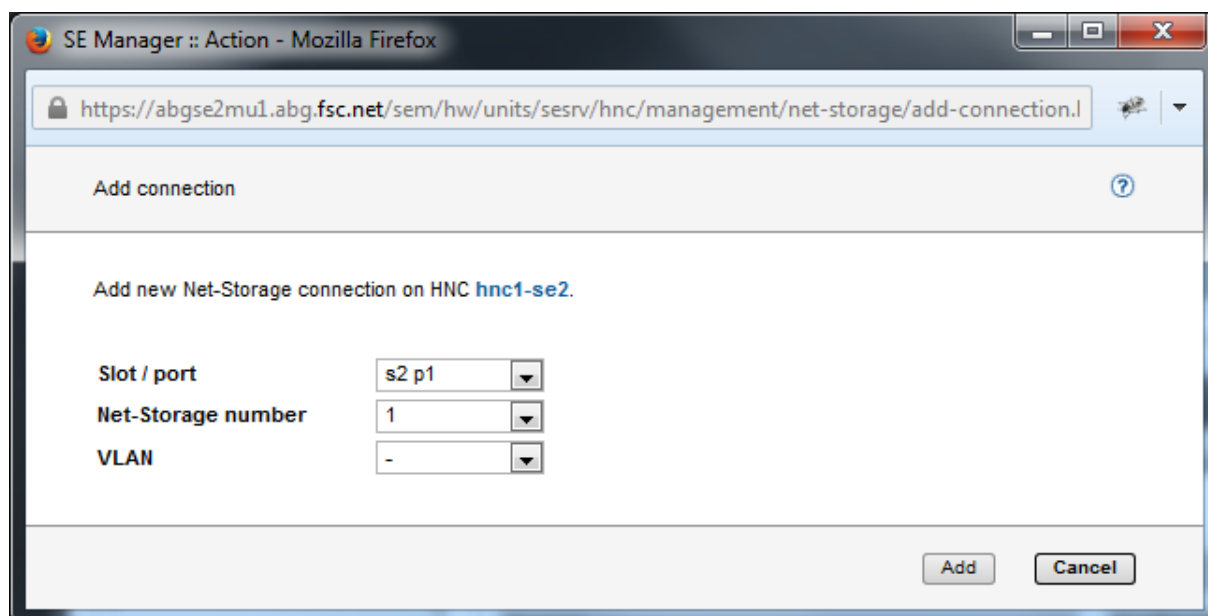
Net-Storage connection properties and add connection:

The following defines the PCI connections via which Net-Storage can be reached, whether a dynamic address should be assigned (check DHCP), or whether a static address should be entered ("Add IP address").

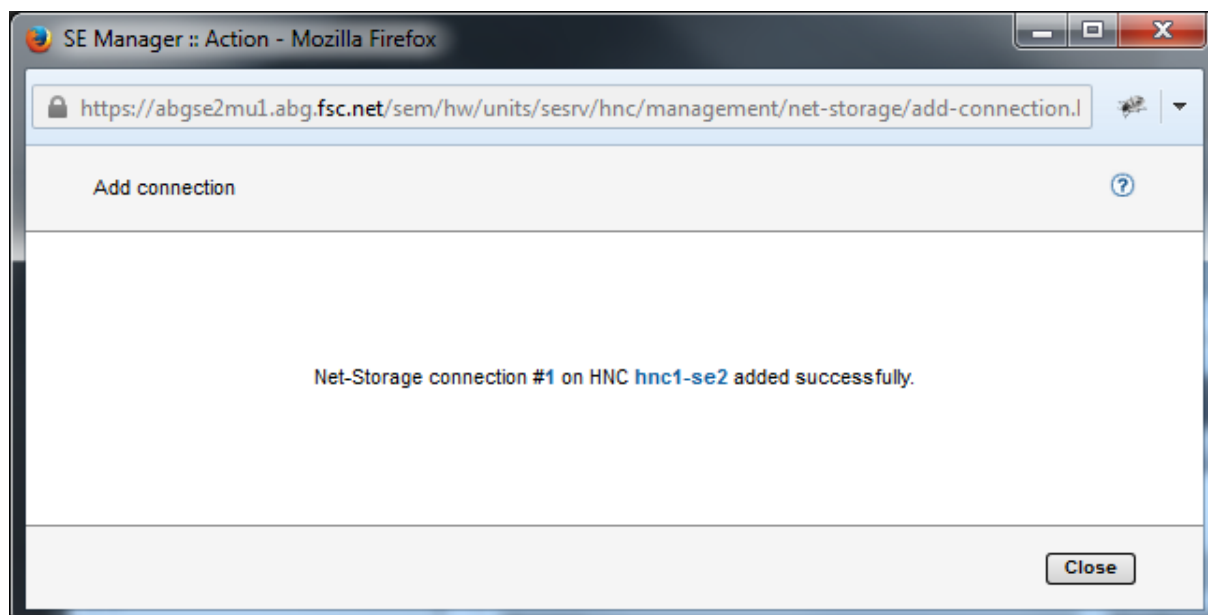
On an HNC, the PCI port "Slot 2" "Port 1" is already preconfigured on the first public data network DANPU01 (Data Net Public 01) when the SE server is delivered.

Procedure:

First the PCI port must be added to DANPU01 via the button "Add connection":



The screenshot shows a web browser window titled "SE Manager :: Action - Mozilla Firefox" with the URL <https://abgse2mu1.abg.fsc.net/sem/hw/units/sesrv/hnc/management/net-storage/add-connection.l>. The page has a header "Add connection" with a help icon. Below it, a message says "Add new Net-Storage connection on HNC **hnc1-se2**." There are three dropdown menus: "Slot / port" with the value "s2 p1", "Net-Storage number" with the value "1", and "VLAN" with the value "-". At the bottom right are "Add" and "Cancel" buttons.



The screenshot shows the same web browser window after the connection has been added. The message now says "Net-Storage connection #1 on HNC **hnc1-se2** added successfully." There is a "Close" button at the bottom right.

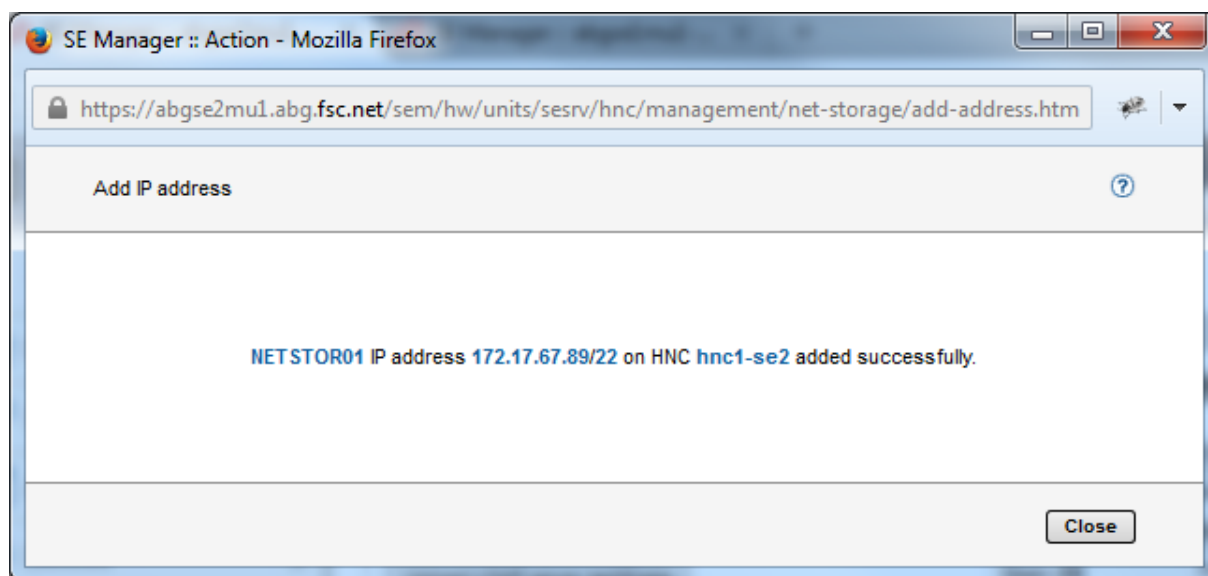
The screenshot shows the SE Manager web interface. The left sidebar contains a navigation menu with options like Dashboard, Systems, Applications, Devices, Hardware, and Units. The main content area is titled 'SE Manager' and 'Management Unit (abgse2mu1) [Abg-DC6]'. It has tabs for IP configuration, Routing & DNS, and Net-Storage. The 'Net-Storage' tab is active, showing configuration for HNC hnc1-se2. It includes sections for Net-Storage accesses (User ID: 7013, Group ID: 2003), Configuration of NFSv4 domain (Domain: localdomain), Net-Storage connection properties (Connection: NETSTOR01, Slot/port: s2 p1, VLAN: -, Properties: DHCPv4, IPv6, Autoconf, DHCPv6), and Net-Storage connection addresses (Connection: LOCLAN, IP address: 192.168.151.12, Mask: -, VLAN: -, MAC address: 0A:00:14:10:80:FF, Conf.: -).

If the IP address is to be assigned dynamically, it is sufficient to tick DHCPv4 or DHCPv6 with the pencil symbol for the now displayed connection "NETSTOR01".

Net-Storage connection addresses:

Via the button "Add IP address" a static IP address can be entered:

The screenshot shows a web browser window titled 'SE Manager :: Action - Mozilla Firefox' with the URL 'https://abgse2mu1.abg.fsc.net/sem/hw/units/sesrv/hnc/management/net-storage/add-address.htm'. The dialog box is titled 'Add IP address' and contains the text 'Add new IP address for Net-Storage on HNC hnc1-se2.' Below this, there is a 'Net-Storage' dropdown menu set to 'NETSTOR01' and an 'IP address / mask' input field containing '172.17.67.89 / 22'. At the bottom right, there are 'Add' and 'Cancel' buttons.



SE Manager

Management Unit (abgse2mu1) [Abg-DC6]

Dashboard

Systems

Applications

Devices

Hardware

Units

abgse2 (SE700)

EM2 (SU700)

abgse2mu1 (MU)

abgse2mu2 (MU)

hnc1-se2 (HNC)

Information

Management

Service

hnc2-se2 (HNC)

hnc3-se2 (HNC)

su300se2 (SU300)

abgqa500 (AU47)

abgqa600 (AU47)

abgse4 (SE710)

IP networks

Data Network Public

Data Network Private

IP configuration

Routing & DNS

Net-Storage

HNC hnc1-se2: Net-Storage accesses

Access

User ID

7013

Group ID

2003

Configuration of NF Sv4 domain

Domain

localdomain

HNC hnc1-se2: Net-Storage connection properties

Add connection

Connection	Slot / port	VLAN	Properties
NETSTOR01	s2 p1	-	<input type="checkbox"/> DHCPv4 <input type="checkbox"/> IPv6 <input type="checkbox"/> Autoconf <input type="checkbox"/> DHCPv6

Total: 1

HNC hnc1-se2: Net-Storage connection addresses

Add IP address

Connection	IP address	Mask	VLAN	MAC address	Conf.
Filter	Filter	Filter	Filter	Filter	Filter
LOCLAN	192.168.151.12	-	-	0A:00:14:10:80:FF	-
NETSTOR01	172.17.67.89	/22	-	A0:36:9F:28:2A:39	static

Total: 2

If the net server is not in the same network as HNC or X2000, a router must also be defined. This is done via the tab "Routing & DNS".

In an SE server with redundant NetUnit and second HNC, a Net-Storage connection should also be set up on the HNC2 (also on slot 2, port 1) for reasons of high availability.

Example SU300:

An SU300 is preconfigured at the factory with slot 1 port 1 on the first public data network DANPU01. The following figure shows the net storage configuration of an SU300 with dynamically assigned IPv4 address.

SE Manager
Management Unit (abgse2mu1) [Abg-DC6]

IP configuration | Routing & DNS | **Net-Storage**

Server Unit su300se2: Net-Storage accesses

Access	
User ID	7013
Group ID	2003

Configuration of NFSv4 domain

Domain	localdomain
--------	-------------

Server Unit su300se2: Net-Storage connection properties

Add connection

Connection	Slot / port	VLAN	Properties
NETSTOR01	s1 p1	-	<input checked="" type="checkbox"/> DHCPv4 <input checked="" type="checkbox"/> IPv6 <input checked="" type="checkbox"/> Autoconf <input type="checkbox"/> DHCPv6

Total: 1

Server Unit su300se2: Net-Storage connection addresses

Add IP address

Connection	IP address	Mask	VLAN	MAC address	Conf.
LOCLAN	192.168.138.12	-	-	0A:00:14:10:08:FF	-
NETSTOR01	172.17.67.182	/22	-	A0:36:9F:4D:13:0D	dynamic
NETSTOR01	172.17.64.201	/22	-	A0:36:9F:4D:13:0D	static
NETSTOR01	fd11:fd52:4f34:c5b0:a236:9fff:fe4d:130d	/64	-	A0:36:9F:4D:13:0D	dynamic
NETSTOR01	fe80::a236:9fff:fe4d:130d	/64	-	A0:36:9F:4D:13:0D	static

Total: 5

Units

- abgse2 (SE700)
 - EM2 (SU700)
 - abgse2mu1 (MU)
 - abgse2mu2 (MU)
 - hnc1-se2 (HNC)
 - Information
 - Management
 - Service
 - hnc2-se2 (HNC)
 - hnc3-se2 (HNC)
 - su300se2 (SU300)
 - Information
 - Management**
 - Service
 - abgqa500 (AU47)
 - abgqa600 (AU47)
 - abgse4 (SE710)
- IP networks
 - Data Network Public
 - Data Network Private

Further details about the configuration of net client are in the current manual "Operate and Manage SE series Business Servers".

2.7 Configure LDAP Server for Node Files with NFSv4

In order to ensure that access to node files – functions when using NFSv4–, an additional attribute "NFSv4Name" is compulsory in an LDAP POSIX account, in which the UID number is entered. The POSIX group can also be extended by the attribute "NFSv4Name", but this is currently not compulsory

The attribute NFSv4Name comprises the user name and the NFSv4 domain <user@nfsv4domain>. An entry in an LDAP directory could be as follows: "NFSv4Name: hugo@localdomain". If not available, the LDAP scheme must be extended with the attribute NFSv4Name. The attribute definition of NFSv4Name is below:

```
attributetype ( 1.3.6.1.4.1.250.1.61
    NAME ( 'NFSv4Name' )
    DESC 'NFS version 4 Name'
    EQUALITY caseIgnoreIA5Match
    SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
    SINGLE-VALUE)
```

The LDAP server must be configured so that the net server and the net client have read access to the LDAP directory.

The two following object classes must be entered. The object class NFSv4RemotePerson contains the NFSv4Name, uidNumber and gidNumber

```
objectclass ( 1.3.6.1.4.1.250.1.60
    NAME 'NFSv4RemotePerson'
    DESC 'NFS version4 person from remote NFSv4 Domain'
    SUP top STRUCTURAL
    MUST ( uidNumber $ gidNumber $ NFSv4Name )
    MAY ( cn $ description) )

objectclass ( 1.3.6.1.4.1.250.1.63
    NAME 'NFSv4RemoteGroup'
    DESC 'NFS version4 group from remote NFSv4 Domain'
    SUP top STRUCTURAL
    MUST ( gidNumber $ NFSv4Name )
    MAY ( cn $ memberUid $ description) )
```

The NFSv4Name attribute guarantees a one-to-one linking between the NFSv4 domain and the uidNumber of a local user. Below is a short example for an entry "hugo" in an LDAP directory:

```
# hugo, S170G04, netstorage, osd.fts.net
dn: uid=hugo,ou=S170G04,o=netstorage,dc=osd,dc=fts,dc=net
objectClass: posixAccount
objectClass: NFSv4RemotePerson
cn: Hugo Hugomann
uid: hugo
loginShell: /bin/bash
homeDirectory: /home/hugo
uidNumber: 2002
gidNumber: 2222
NFSv4Name: hugo@localdomain
```

2.8 Further Information

If a firewall is between net client and net server, note that the ports 2049 and 111 (RPC) for NFS must be opened for TCP and UDP. A change in the standard port 2049 is currently not planned.

During maintenance work (e.g. software update or new installation) and configuration changes with bs2netsConf, make sure that Net-Storage (which is operated via the respective net client) is disconnected beforehand from all connected BS2000 systems via the BS2000 command UMOUNT-NET-STORAGE.

3 Usage in BS2000 – Brief Overview

Having implemented the above configuration steps, Net-Storage can now be used in BS2000. Proceed as follows (operand values of the commands in the examples correspond to the examples in figures 2 and 3):

3.1 Mount the Remote File System

The remote file system is mounted via MOUNT-NET-STORAGE. The mount is initiated in the net client.

```
/MOUNT-NET-STORAGE DIRECTORY='/bs2data1', -  
                      /NET-SERVER=*IP(172.17.67.120), -  
                      /NET-CLIENT=*IP(192.168.152.12)
```

SHOW-NET-STORAGE provides an overview of the mounted shares and, if necessary, any existing Net-Storage volumes.

A redundant net client can be added as follows:

```
/SET-NET-CLIENT-ALTERNATE CLIENT=*IP(192.168.152.12), -  
                           /ALTERNATE-CLIENT=*IP(192.168.154.12)
```

If the net client fails, there is an automatic switchover to the alternative net-client.

3.2 Creating Net-Storage Volumes

Net-Storage volumes are created on the mounted Net-Storage via ADD-NET-STORAGE-VOLUME. The Net-Storage volume is permanently assigned to *one* pubset.

```
/ADD-NET-STORAGE-VOLUME VOLUME=*STD, PUBSET=ABC, -  
                        /DIRECTORY='/bs2data1', SERVER=*IP(172.17.67.120)
```

A volume with the name ABC@00 is assigned to the pubset ABC. This is implemented by creating a directory with the name ABC@00 under the share /bs2data1 of the NFS server with the IP address 172.17.67.120. The administration files .FSL and .BS2FSCAT are created in this directory. An administration entry for the Net-Storage volume is created on the pubset ABC.

Instead of the standard name derived from the pubset name, the system administrator can assign any volume name for the Net-Storage volume. Several Net-Storage volumes can be defined for a pubset. The volume names must be unique in the system; if there is already a private disk with the same VSN, the access to the Net-Storage volume is preferred by the system.

SHOW-PUBSET-NET-STORAGE displays the Net-Storage volumes assigned to a pubset (this command can also be used by non-privileged users). Volume types of the NETVOL type are displayed as "not supported" (NO SUP) by systems lower than BS2000 V21.

Further hints:

Net-Storage can be assigned to both SF- and SM-Pubset, however not to a Home-PVS.

The assignment of the Net-Storage volumes to a pubset is retained beyond EXPORT-/IMPORT-PUBSET and shutdown/startup.

Net-Storage volumes can also be assigned to shared pubsets. The creation of the volumes needs to be done at the master system; the slave systems gain access to the newly created volume by entering the same statement ADD-NET-STORAGE-VOLUME. This is only necessary in the context of creation of the Net-Storage-Volume, to

allocate the volume by NDM. Later after shutdown/startup or EXPORT-/IMPORT-PUBSET respectively the allocation is done automatically by the system.

After a system restart, make sure that MOUNT-NET-STORAGE is only executed after BCAM has been started and the subsystem ONETSTOR has been loaded.

It is sensible - before importing a pubset (IMPORT-PUBSET) which has been assigned to the Net-Storage volume, to make it available in the system via MOUNT-NET-STORAGE. This ensures that its data is immediately available after IMPORT-PUBSET.

3.3 Create, Import and Process Files on Net-Storage

Create *BS2000 files

```
/CREATE-FILE :ABC:$USER.FILE.1, -
              /SUPPORT=*PUBLIC-DISK (STORAGE-TYPE=*NET-STORAGE)
```

If several Net-Storage volumes exist for a pubset, the volume (in this example volume NET001) can be specified as follows:

```
/CREATE-FILE :ABC:$USER.FILE.1, -
              /SUPPORT=*PUBLIC (STORAGE-CLASS=*NONE (VOLUME=NET001, -
              /DEVICE-TYPE=NETSTOR) )
```

This syntax applies equally to BS2000 OSD/BC V11 and BS2000 V21 - regardless of the NETSTOR or NETVOL volume type!

Create *NODE-FILE files for interoperability with open systems (as of OSD V10)

```
/CREATE-FILE :ABC:$USER.FILE.1, -
              /SUPPORT=*PUBLIC-DISK (STORAGE-TYPE=*NET-STORAGE (FILE-TYPE=*NODE-FILE) )
```

or short:

```
/CRF :ABC:$USER.FILE.1, FILE-TYPE=*NODE
```

respectively:

```
/CREATE-FILE :ABC:$USER.FILE.1, -
              /SUPPORT=*PUBLIC-DISK (STORAGE-TYPE=*NET-STORAGE (FILE-TYPE=*NODE-FILE) , -
              /STORAGE-CLASS=*NONE (VOLUME=NET001, DEVICE-TYPE=NETSTOR) )
```

From now on, the file can be accessed via its path names. The storage location of the file is completely transparent for the application.

With the SHOW-FILE-ATTRIBUTE command, the user can determine the storage location of the file, e.g.:

```
/SHOW-FILE-ATTR :NET1:$UA.NEU1, INF=*PAR (ALLOCATION=*YES)
%00000000004n:NET1:$UA.NEU1
% ----- ALLOCATION -----
% SUPPORT      = PUB          S-ALLOC      = 16          HIGH-US-PA = 2
% EXTENTS      VOLUME        DEVICE-TYPE    EXTENTS      VOLUME        DEVICE-TYPE
%      1      NET001          NETVOL
% NUM-OF-EXT = 1
%:NET1: NET    :      1 FILE RES=          4 FRE=          2 REL=          0 PAGES
```

The user can already tell from the letter “n” between the file size specification and the CATID that the file is on Net-Storage. The example shows that the file is on the Net-Storage volume with the VSN NET001; it is a NETVOL volume type.

BS2000 saves node files in user-specific directories within Net-Storage volumes (see the example in figure 3: directories of users HUGO or FRITZ). BS2000 creates a user-specific directory the first time a node file is created for a user and automatically sets the required ACLs for access. Open systems can also create files in these directories.

Import of node files that were created by open systems into BS2000 catalogs.

If files were created by open systems in user specific directories, these files need to be imported into the BS2000 catalogs TSOSCAT and BS2FSCAT before they can be processed by BS2000.

From BS2000 OSD/BC V11 the user can specify, if a node file should be catalogued as PAM or SAM file:

```
/IMPORT-NODE-FILE VOLUME=NET0001, FILE-NAME=$USER.FILE.1, -  
  /FILE-STRUCTURE = *SAM, PUBSET=ABC
```

To specify FILE-STRUCTURE = *SAM is recommended, if the file should be processed as a text. And vice versa, node files can be removed from the BS2000 catalogs via EXPORT-NODE-FILE (see EXPORT-FILE) without deleting them in the user-specific directory on Net-Storage. LIST-NODE-FILES is used to obtain information about the files (which can be imported) in the user-specific directories of a Net-Storage volume. Only files with names that meet the BS2000 file name conventions are output.

```
/LIST-NODE-FILES VOLUME=NET001, USER-DIR=*OWN, NODE-FILE-NAME=*  
  
%NET001/USER/  
%-rw----- 0 Oct 28 09:18 ABC.1  
%-rw-r--r-- 6 Mar 21 13:58 FILE.TXT  
%-rw----- 0 Oct 17 13:31 SYSOUT.REPORT.1
```

3.4 Export and Import of Net-Storage-Volumes

Net-Storage volumes can be separated (exported) from a pubset and imported to another pubset.

Detaching a volume:

```
/REMOVE-NET-STORAGE-VOLUME VOLUME=NET001, PUBSET=ABC, FILES-ON-VOLUME=*EXPORT
```

Reattaching a volume to a pubset:

```
/ADD-NET-STORAGE-VOLUME VOLUME=NET001, PUBSET=XY, -  
  /DIRECTORY='/bs2data1', SERVER=*IP(172.17.67.120), -  
  /IMPORT=*YES
```

In the case of volumes of the NETSTOR type, the catalog entries for the files in the Net-Storage volume must then be imported manually using IMPORT-FILE.

In the case of volumes of the NETVOL type, this is done automatically within the framework of the ADD-NET-STORAGE-VOLUME. If there are file name conflicts because files with the same name already exist, a corresponding error message is output and the command must be entered again.

When importing a volume of the NETSTOR type under BS2000 V21, the volume can be converted into a volume of the NETVOL type with IMPORT=*YES(CONVERT=*YES). The volume can then no longer be accessed from systems lower than BS2000 V21. Also, the conversion cannot be reversed.

For further details, especially when using mirror disks, please refer to the Introduction to Systems Administration and the DVS Introduction manuals.

3.5 File Processing

BS2000 supports the processing of node files by means of the access methods PAM (from OSD V10) and SAM (from OSD V11).

3.4.1 PAM node file processing

PAM node files are non-structured data, i.e. NK-PAM files from the BS2000 viewpoint. They can be read/write accessed via the UPAM access method. A node file can be any size up to a maximum of 4TB, i.e. in contrast to BS2000 disks there is no restriction to a multiple number of PAM blocks. This is already guaranteed with the previous PAM macros. The UPAM call to write is, for example:

```
PAM fcbadr, WRT, LEN = <STD|(STD,n)|length>, ...
```

i.e. with LEN=STD or STD,n a multiple number of standard blocks of 2048 bytes is transferred; LEN=length transfers data of the specified length for node files

Example:

```
OPEN  fcbadr,OUTIN
PAM   fcbadr,WR,...,LEN=STD      (corresponds to 2048 Byte)
PAM   fcbadr,WR,...,LEN=50
CLOSE fcbadr
```

In this example the file on the NAS after CLOSE has a size of 2048 + 50 = 2098 bytes.

In order to write the exact file size of a BS2000 files, a new field was introduced in the catalog entry: the Last Byte Pointer (LBP) - analog to Last Page Pointer (=Highest-Used-Page) which points to the last valid page of a file - and the LBP points to the last valid byte of the last logical block. (A logical block has the size BLKSIZE=(STD,n), i.e. consists of n * PAM pages (n*2048 Byte)). The value of the LBP can be determined via the macro FSTAT (field: OUTALBP). It is always supplied with node files. With PAM files on public space the LBP is only supplied if the caller sets the flag LBP_required with OPEN in P1FCB (support of this interface as of BS2000 OSD/BC V10 KP2/15).

If the application reads the file as far as end-of-file with LEN=(STD,x), it always receives complete PAM blocks – both with files on disk as well as on Net-Storage or as node files. The area of validity in the last logical block is displayed with the LBP.

If the application reads the file with LEN=<length>, it receives the data in the specified length.

As node files can also be processed by open systems, the properties of these files in the BS2000 catalog are outdated in certain circumstances. Any necessary update of values such as file size, LPP (=Highest-Used-Page), LBP and CHANGE-DATE occur as part of OPEN processing which is why the updated values are not available to the application until after OPEN. Updates can also be made outside OPEN/CLOSE via IMPORT-NODE-FILE REPLACE=*NODE-FILE-UPDATE.

Further details concerning the introduction of the last byte pointer can be found under:

<http://docs.ts.fujitsu.com/dl.aspx?id=22aafa65-9393-4a28-95fd-4959fc6aa77d>

3.4.2 SAM node file processing

a) Access method SAM:

There are two key differences between the processing of node files using the SAM access method and the processing of SAM files in the traditional public space - which in practice can mostly be neglected, these are specifically:

1. Whereas SAM records within SAM files in the public space may automatically contain any type of data, including binary, SAM node files are primarily intended for the purposes of text processing; when transferring logical SAM blocks, the net-client removes the characteristic SAM related structural information such as the BLKCTRL field and length fields and executes a code conversion from EBCDIC into either ASCII or ISO character sets. This is generally not possible where any binary content is concerned - at least not without any loss of information.

2. All SAM files stored on a traditional disc will be read from within the same block/record structure where they were previously written. In the file's description, the user may make a note of the retrieval addresses for each of the records allowing them to access these at a later point in time.

It may further be added to the description of SAM node files that the SAM method of access, processes information in a block-oriented manner. However, in transferring the data to the NAS, the net-client removes the BLKCTRL field and length fields, so that the data is stored in a byte stream as would generally be the case for open systems. The individualized records are separated using a line feed (LF, x'0A'). The mapping of which record number was written to which block number was governed for the duration of the writing process between OPEN and CLOSE. That is to say, the application can be pointed back (SETL) to a block that has already been written to and subsequently overwritten. Furthermore, it is not mandatory to write a complete block, but may rather, as previously be closed with the macro RELSE; a following record (PUT) shall then appear in the next SAM block. This record will in any case be attached, without a gap, to the previous one within the NAS file system. After closing and then re-reading the file upon opening, the net-client prepares the data for SAM; standard SAM blocks are once more created from the byte stream of the Unix file and sent to the BS2000; by utilizing the BLKCTRL field and records, including fields indicating record length, the data is once again converted into the specified EBCDIC code. However, the original structure cannot be recreated. This means that only the sequence of the records may be guaranteed: individual records within the same block as well as record numbers cannot be read as they were written. In this way, retrieval addresses are as a rule no longer valid following a CLOSE and a re-OPEN.

In order to prevent any inadvertent processing of SAM files as node files through the use of legacy applications - which are dependent upon full compatibility in terms of retrieval addresses - a new flag SAM_NODE_FILE_ENABLE

(FCB+B9(+6): ID1SNFEN) has been introduced which the caller must implement ahead of the OPEN process within the FCB associated with the file.

An application that sets this bit signals to the operating system that it can both process SAM node files and also recognize their characteristics.

In its processing of SAM node files, BS2000 is supported by the following components:

EDTU from V17.0D20
SHOW-FILE from V17.1B30
LMS/LMSCONV V3.5B
openFT from V12.1A
CRTE from V11.0A
SYSFILE of OSD V11
HSMS/ARCHIVE V11.0A

The user creates a node file as described in 3.3 and will then be able to process the file using either the aforementioned program or one they have written themselves.

As previously described when processing PAM node files, the SAM node files of systems in the outside world may be changed, e.g. extended or overwritten. The file properties FILESIZE, LPP and CHANGE-DATE are updated within the context of OPEN and are only then made available to the caller as current.

The largest SAM node file size that may be processed is 32GB. Having said that, the size of file that can be processed is limited by the number of logical SAM blocks that are required to allow it to be processed by BS2000. This limit is set at 16,777,216 blocks. Should more blocks be required, the OPEN will be rejected. The specific max. file size will for this reason depend in individual cases upon the length of records used as well as what fill capacity may be achieved within the SAM blocks. Based on this and depending upon the length of the records to be processed, the max. file size will be between 13 and 32GB.

In the case of an IMPORT-NODE-FILE, the logical block size (BLKSIZE) will be set at STD,16 so that large records may also be processed without issue (32k). The opposite also applies, where SAM node files are created in BS2000, the use of larger blocks is recommended (BLKSIZE=(STD,16)).

Code conversion:

The user can in the case of SAM node files specify by file, a character set for the data on the NAS - the Net-Coded Character-Set or NETCCS. The net-client then performs the conversion from the file's specified CCS into the NETCCS. In order to simplify the system administrator process for the user of setting up and selecting the character sets, the below procedure was introduced:

Similar to the Class-2-Parameter HOSTCODE as well as the CCSN of a user, as of OSD V11, both a Class-2-Parameter NETCODE as well as a NETCCSN will be introduced to the user entry.

When creating a new user, the NETCCSN is selected from the CLASS2OPT NETCODE and deployed in the user entry, just as has been common practice to date for the CCSN.

The CLASS2OPT NETCODE, or rather the NETCCSN within the user entry, controls which NETCCS the SAM node file will contain as standard at the point it is created:

NETCCSN	resulting file property/conversion: NETCCS of a file in CREATE-FILE
*ISO	Depending on the CCS of the file, a standard conversion is performed from EBCDIC to ISO8859x; within this context: EDF03IRV, EDF03DRV, EDF04IRV and EDF04DRV -> ISO88591 EDF04x -> ISO8859x with x = 1,2,...,9,F Even where a user specifies a 7-bit character set as the CCS, internally, an 8-Bit code table will be used. That is to say, in place of CCS EDF03IRV, EDF041 will be adopted and instead of EDF03DRV, EDF04DRV will be utilized.
*NO-CONV	No conversion will be performed, i.e. NETCCS = CCS.
<name_1..8>	When creating a new file, the assigned NETCCSN will be registered in the file attributes. Self-defined character sets may be assigned in XHCS.

In addition to the standardized procedure for querying the NETCCS of the file - as described, when creating the file (CREATE-FILE) the user can specify the NETCCSN themselves or amend it using MODIFY-FILE-ATTRIBUTES. If data is being written by BS2000 for the first time, the file's NET-CODED-CHARACTER-SET should undergo no further changes; the next time it is read could result in an error in the code conversion associated with the data, or where the file has been extended, data containing potentially incompatible code sets may have been added to the beginning of the file.

Solely conversions from EBCDIC to ISO character sets are supported; by way of further qualification, conversions to UTF character sets are also unsupported. With the UTF character set as the CCS, data processing is performed automatically without the need for code conversions (e.g.: CCS=UTF8, NETCCS=UTF8).

b) UPAM access method:

SAM node files can be processed two ways in conjunction with UPAM:

- **In SAM mode**, in reading the SAM blocks, the UPAM access method acts as if the file were located in a traditional Pubset (public space). For this purpose the net-client prepares the byte stream associated with the Unix file into SAM blocks as described above. Here too, the flag SAM_NODE_FILE_ENABLE (ID1SNFEN) must be introduced, in order to open the file in a writable format; this is not required for purely read access.
- **In Raw Mode**, the net-client provides the data associated with the SAM node file in the same form as it is stored on the UFS. This form of access is significantly quicker as no conversion is necessary. The size of the file to be processed can from the UPAM perspective be quickly determined from the inode properties. This mode of processing is utilized by, for example, HSMS in order to be able to secure the file in a performant manner. To activate this method of processing, the application must place the flag UPAM_RAW_ACCESS (FCB+B9(+7): ID1URWAC) next to the flag SAM_NODE_FILE_ENABLE (FCB+B9(+6): ID1SNFEN).

3.5 Guidance on selected BS2000 commands:

COPY-FILE further supports the copying of SAM files onto Net-Storage as a SAM node file; here too, the user must first create the target file on the Net-Storage using CREATE-FILE FILE-TYPE=*NODE-FILE. In this way the user can

specify the target character set as NETCCS, alternatively a NETCCSN will be automatically assigned as described above (3.4.2 Code Conversion). When copying a SAM node file to a public disc, the attribute NETCCS will not be carried over; on the other hand, when a SAM node file is copied over a SAM node file the NETCCSN of the source file will be carried over to the target file, that is to say any potential NETCCSN related discrepancy with the target file shall be overwritten.

COMPARE-DISK-FILE supports SAM node files. SAM node files may be compared with SAM node files as well as SAM node files with SAM files on a public disc.

CONCATENATE-DISK-FILES likewise supports SAM node files. Where SAM node files are concatenated, the files must match in terms of the NETCCS attribute. Where SAM files on a public disc are to be concatenated to SAM node files, it must be possible to convert the source character set into the target character set as per the above stated rules.

4. Notes on Products and Components

4.1. HSMS

HSMS permits the saving and restoring of SAM node files. In place of the commands to save (BACKUP-FILES), long term archival (ARCHIVE-FILES) and to export (EXPORT-FILES), the new operand SAVE-SAM-STRUCTURE = *YES/*NO offers a choice between the two processing modes that follow:

1. SAVE-SAM-STRUCTURE = *NO is the quickest way of saving files: the file is saved in raw mode and in an unstructured form; no SAM structures are created and no code conversion is performed. SAM node files saved in this way may only be restored to being SAM node files.
2. SAVE-SAM-STRUCTURE = *YES: when transferring data, the net-client inserts the SAM structures within the data stream and where required performs a code conversion into EBCDIC. As a result the backup runs slower than with the operand SAVE-SAM-STRUCTURE = *NO. SAM node files backed up in this way can be restored to a public space (Operand: NEW-SUPPORT).

SAM files on a public disc can be restored as SAM node files (Operand: NEW-SUPPORT).

The structure of SAM files is not as standard preserved in the backing up (BACKUP-FILES) of SAM node files (Performance!). The SAM structure is preserved as standard when SAM node files are backed up for the purposes of long term archival and data transfer (ARCHIVE-FILES, EXPORT-FILES), this ensures that the data can be restored or imported to a system, which does not have access to Net-Storage.

HSMS reports may also be stored as SAM node files; the report file is to be created accordingly ahead of the HSMS run.

4.2. SYSFILE

SYSFILE is able to access SAM node files, which, for example, may contain procedures as well as data entered (SYSCMD and SYSDTA). The user may redirect logging output to SAM node files. The procedure is more or less standard, with the exception that first of all a file must be created on the Net-Storage before either SYSOUT or

SYSLST may be assigned. If the character set needed on the Net-Storage is different from the standard one, the user will still need to specify the appropriate NETCCSN as a Net-Coded-Character-Set within CREATE-FILE or make the change by using MODIFY-FILE-ATTRIBUTES. As already mentioned, the creation of the file as well as the setting up of the CCSN or the NETCCSN must take place before either the file is opened or SYSOUT or SYSLST are assigned!

Within the output of node files, SYSDFILE suppresses binary control characters within the first column of a record, e.g. linefeeds (x'01', x'02' -> are replaced by blank x'40'; form feed x'C1' = A is kept). These elements would affect the appearance of applications in the open systems world.

4.3. EDT/EDTU

SAM node files are supported by EDTU. Ahead of writing a file to the Net-Storage it must first be created as a node file and set up with the appropriate character sets.

4.4. BS2ZIP

BS2ZIP is able to create ZIP archives as PAM node files, permitting open systems to gain access to them.

The user must first of all create a node file on the Net-Storage. BS2ZIP will then be able to open it with write access and add files to the zip archive. An already existing zip archive can also be copied to this file. BS2ZIP cannot add SAM node files to a zip archive.

Example:

```
/CREATE-FILE :ABC:$USER.FILE.ZIP,VOLUME=NET001,FILE-TYPE=*NODE
/START-ZIP
//OPEN-ZIP-CONTAINER CONTAINER=:ABC:$USER.FILE.ZIP,MODE=*UPDATE,-
//      FORMAT=*WINZIP-COMPATIBLE
//ADD-FILE FROM-FILE=:X:$TSOS.BCF.REPORT.1, CHARACTER-CON=*TO-WIN-ANSI,-
//      DATA-TYPE=*CHARACTER
//END
```

4.5. CONVERT-TO-PDF

For PDF files only the PAM format is intended for node files.

Example:

```
/CREATE-FILE :ABC:$USER.FILE.PDF,VOLUME=NET001,FILE-TYPE=*NODE
/CONVERT-FILE-TO-PDF FROM-FILE=:ABC:$USER.FILE,-
/      TO-FILE=:ABC:$USER.FILE.PDF,FILE-FORMAT=*PAM
```