Notes Storage Facility (NSF) database file format

Analysis of the NFS database file format

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Summary

The Notes Storage Facility (NSF) database file is used by (IBM) Lotus Notes and Domino to store different kind of objects like e-mail, appointments and documents, but also application forms and views.

This document is intended as a working document for the NSF specification. Which should allow existing Open Source forensic tooling to be able to process this partitioning schema.

Document information

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Abstract: This document contains information about the Notes Storage Facility (NSF) database format.

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License

Version

Version	Author	Date	Comments
0.0.1	J.B. Metz	February 2010 March 2010 April 2010 July 2010	Initial version.
0.0.2	J.B. Metz	November 2012	Email update. License version update.

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1. Overview

The Notes Storage Facility (NSF) database file is used by (IBM) Lotus Notes and Domino to store different kind of objects like e-mail, appointments and documents, but also application forms and views.

An NSF is also referred to as an object store.

1.1. File structure

An Notes Storage Facility (NSF) database file consist of the following distinguishable elements:

- notes

Characteristics	**Description**
Byte order	little-endian
Date and time values	
Character string	Lotus Multi-Byte Character Set (LMBCS)

File size in increments of 65536?

1.2. Layout

NSF database layout:

- file header
- database header
- various
  - superblock
  - bucket descriptor block
  - bitmap
  - Record Relocation Vector bucket
  - summary buckets
  - non-summary buckets

An NSF database can contain various types data stored in notes:

- access control list note
- icon note
  - design note
  - resource
- help-using document
  - design note
  - resource
- help-about document
  - design note
  - resource
- view note(s)
  - design note
- form note
  - design note
- agent note(s)

    - design note
- data note(s)
    - document
- collection(s)
    - index(es)

2. Notes/Domino terminology

extension
private

2.1. Summary and non-summary

In the Notes/Domino terminology summary refers to 'summary information' about items (objects) in the NSF file, e.g. document summary information like author, creation date and time, etc. Non-summary refers to all other type of information e.g. formatted text, pictures, etc.

2.2. Data and non-data

TODO: data refers to content items, non-data to metadata items.

3. NSF data types

3.1. NSF date and time

The Domino and Notes TIMEDATE structure consists of 32-bit values that encode the time, the date, the time zone, and the Daylight Savings Time settings that were in effect when the structure was initialized.

The first 32-bit value contains the number of hundredths of seconds since midnight, Greenwich mean time. If only the date is important, not the time, this field may be set to ALLDAY (0xffffffff or -1).

The date and the time zone and Daylight Savings Time settings are encoded in the second 32-bit value. The 24 low-order bits contain the Julian Day, the number of days since January 1, 4713 BC.

The Julian Day was originally devised as an aid to astronomers and is not the same as the Julian calendar. Since only days are counted, weeks, months, and years are ignored in calculations. The Julian Day is defined to begin at noon; for simplicity, Domino and Notes assume that the day begins at midnight.

The high-order byte, bits 31-24, encodes the time zone and Daylight Savings Time information.

- bit 31 (0x80000000) is set if Daylight Savings Time is observed;
- bit 30 (0x40000000) is set if the time zone is east of Greenwich mean time;
- bits 27-24 contain the number of hours difference between the time zone and Greenwich mean time;
- bits 29-28 contain the number of 15-minute intervals in the difference.

For example, 2:49:04 P. M., Eastern Standard Time, December 10, 1996 would be stored as:

```
0x006CDCC0        19 hours, 49 minutes, 4 seconds GMT
0x852563FC        DST observed, zone +5, Julian Day 2,450,428
```

If the time zone were set for Bombay, India, where Daylight Savings Time is not observed, 2:49:04 P. M., December 10, 1996 would be stored as:

```
0x0032B864        9 hours, 19 minutes, 4 seconds GMT
0x652563FC        No DST, zone 5 1/2 hours east of GMT, Julian Day 2,450,428
```

3.2. NSF file position

The NSF file position is a 32-bit value that contains a file offset value divided by 256 (0x100).

3.3. On-disk structure signatures

The NSF format uses on-disk structure (ODS) signatures to mark the start and size of data structures.

3.3.1. Byte signature

The byte signatures (BSIG) is 2 bytes of size and consists of:

offset	size	value	description
0	1		Signature
1	1		Structure size

3.3.2. Word signature

The word signatures (WSIG) is 4 bytes of size and consists of:

offset	size	value	description
0	1		Signature
1	1	0xff	Marker value
2	2		Structure size

3.3.3. Long signature

The long signatures (LSIG) is 4 bytes of size and consists of:

offset	size	value	description
0	1		Signature
1	1	0x00	Marker value
2	4		Structure size

4. The file header

The file header is 6 bytes of size and consists of:

offset	size	value	description
0	2	0x1a 0x00	Signature
2	4		The database header size

Notes/Domino considers the file header a long-signature (LSIG) of the database header.

5. The database header

The database header contains the following values:

- database information
  - database identifier (DBID)
  - flags
- replication information
- database information buffer
  - title
  - categories
  - class
  - design class (template name)
- special note identifiers
- padding
- database information 2
- database information 3
- database information 4
- database information 5
- padding

- database instance identifier (DBIID)
- replication history

- user activity log
- UNID index

5.1. Database information

The database information (DBINFO) is 178 bytes of size and consists of:

offset	size	value	description
0	4		Format version on-disk structure (ODS) version See section: 5.1.1 Format version
4	8		Database identifier (DBID) Value consists an NSF date and time but is considered as an identifier See section: 3.1 NSF date and time Also used as creation date and time?
12	2		Application version
14	4		Non-data Record Relocation Vector

offset	size	value	description
			(RRV) bucket position See section: 3.2 NSF file position
18	4		(Next) available non-data Record Relocation Vector (RRV) identifier
22	2		Number of available non-data Record Relocation Vectors (RRVs)
24	4		Activity log offset
28	8		Bucket (last) modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time Also used as modification date and time?
36	2		Database class TODO
38	2		Database flags See section: 5.1.2 Database flags
40	4		Bucket Descriptor Block (BDB) size
44	4		Bucket Descriptor Block (BDB) position See section: 3.2 NSF file position
48	2		Bucket Descriptor Table (BDT) size
50	4		Bucket Descriptor Table (BDT) position
54	2		Bucket Descriptor Table (BDT) bitmaps
56	4		Data Record Relocation Vector (RRV) bucket position See section: 3.2 NSF file position
60	4		First data Record Relocation Vector (RRV) identifier Probably the first defined RRV not the first used
64	4		(Next) available data Record Relocation Vector (RRV) identifier
68	2		Number of available data Record Relocation Vectors (RRVs)
70	2		Record Relocation Vector (RRV) bucket size
72	2		Summary bucket size
74	2		Bitmap size
76	2		Allocation granularity
78	4		Extension granularity
82	4		File size The value contains 256 byte increments If version >= 0x15 ?

offset	size	value	description
86	4		Number of file truncations
90	4		Delivery sequence number
94	4		Number of Bucket Descriptor Block (BDB) replacements
98	4		Number of allocated Record Relocation Vectors (RRVs)
102	4		Number of de-allocations
106	4		Number of non-bucket allocations
110	4		Number of bucket allocations
114	8		Folder (last) modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
122	4		Data note identifier table position
126	4		Data note identifier table size
134	8		Data (last) modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
142	8		Next purge date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
150	4		Version 3 named object hash position
154	4		named object hash position
158	8		Private (last) modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
166	2		Maximum number of privates
168	2		named object hash version Format version < 0x1c
170	8		Non-data (last) modification date and time Value consists of a NSF date and time but is considered as an identifier See section: 3.1 NSF date and time

5.1.1. Format version

Value	Identifier	Description
16		Notes 1.x, 2x
17		Notes 3.x
20		Notes 4.x

Value	Identifier	Description
41		Notes 5.x
43		Notes 6, 7 and 8
48		Notes 8
51		Notes 8.5

5.1.2. Database flags

TODO

Value	Identifier	Description
	DBFLAG_FIXUP	
	DBFLAG_CORRUPT	
	DBFLAG_SPARSE_RRVS	
	DBFLAG_PURGE_ON	
	DBFLAG_REPLFORMULA	
	DBFLAG_FULL_FOLDER_REPL	
	DBFLAG_FOLDERS_CONVERTED	
	DBFLAG_MAX_SPECIFIED	
	DBFLAG_FIXUP_FOLDERS	
	DBFLAG_DELSEQ_CORRECTED	
	DBFLAG_DEFERRED_UNIDINDEX	
	DBFLAG_FIXUP_CLEAR_LSN	
	DBFLAG_IS_A_BACKUP	
	DBFLAG_UNLOGGED_CHANGE_INPROGR	
	DBFLAG_DESIGN_IN_NAMOBJ	

5.2. Database replication information

The database replication information (DBREPLICAINFO) is 20 bytes of size and consists of:

offset	size	value	description
0	8		Replication identifier Value consists of a NSF date and time (in local time) but is considered as an identifier

offset	size	value	description
			See section: 3.1 NSF date and time
8	2		Replication flags See section: 5.2.1 Replication flags
10	2		Replication cutoff interval Value in days
12	8		Replication cutoff date and time Value consists of a NSF date and time See section: 3.1 NSF date and time

5.2.1. Replication flags

Value	Identifier	Description
0x0001		spare was COPY_ACL
0x0002		spare
0x0004	REPLFLG_DISABLE	Disable replication
0x0008	REPLFLG_UNREADIFFNEW	Mark unread only if newer note
0x0010	REPLFLG_IGNORE_DELETES	Don't propagate deleted notes when replicating from this database
0x0020	REPLFLG_HIDDEN_DESIGN	UI does not allow perusal of Design
0x0040	REPLFLG_DO_NOT_CATALOG	Do not list in catalog
0x0080	REPLFLG_CUTOFF_DELETE	Auto-Delete documents prior to cutoff date
0x0100	REPLFLG_NEVER_REPLICATE	DB is not to be replicated at all
0x0200	REPLFLG_ABSTRACT	Abstract during replication
0x0400	REPLFLG_DO_NOT_BROWSE	Do not list in database add
0x0800	REPLFLG_NO_CHRONOS	Do not run chronos on database
0x1000	REPLFLG_IGNORE_DEST_DELETES	Don't replicate deleted notes into destination database
0x2000	REPLFLG_MULTIDB_INDEX	Include in Multi Database indexing

The 2 MSB are used to store the replication priority

Value	Identifier	Description
0xc000	REPLFLG_PRIORITY_LOW	Low priority
0x0000	REPLFLG_PRIORITY_MED	Medium priority
0x4000	REPLFLG_PRIORITY_HI	High priority

5.3. Database information buffer

The database information buffer is 128 bytes of size and consists of:

offset	size	value	description
0	...		Database title
...	1	0x0a	Categories separator (“\n”)
			Categories
...	1	0x23	Class separator (“#”)
			Class
...	1	0x32	Design class separator (“2”)
...	...		Database design class (template name)
...	...	0x00	End of database information buffer (“\0”)
...	...		Unknown Remnant data

5.4. Special note identifier array

The special note identifier array is 128 byte of size and contains 48 32-bit note identifier values.

NOTE HIERARCHY DISABLED
INDICES ARE COMPRESSED
BUCKETS ARE COMPRESSED
COMPRESSION PREVIOUSLY ENABLED
UNREAD MARKS NOT MAINTAINED
LAST ACCESSED TIMES MAINTAINED

5.5. Padding

offset	size	value	description
0	64		Unknown (padding)

5.6. Database information 2

The database information (DBINFO2) is 124 bytes of size and consists of:

offset	size	value	description
0	8		Last fix-up date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
8	4		Database quota limit
12	4		Database quota warn threshold
16	8		Unknown (FoldersCleanAsOf) Value consists of an NSF date and time See section: 3.1 NSF date and time

offset	size	value	description
24	8		Unknown (LastPurgedNoteTime) Value consists of an NSF date and time See section: 3.1 NSF date and time
32	8		Object store replica identifier Value consists an NSF date and time but is considered as an identifier See section: 3.1 NSF date and time
40	4		Superblock 1 position See section: 3.2 NSF file position
44	4		Superblock 1 size
48	4		Superblock 2 position See section: 3.2 NSF file position
52	4		Superblock 2 size
56	4		Superblock 3 position See section: 3.2 NSF file position
60	4		Superblock 3 size
64	4		Superblock 4 position See section: 3.2 NSF file position
68	4		Superblock 5 size
72	4		Maximum extension granularity
76	2		Summary bucket granularity
78	2		Non-summary bucket granularity
80	4		Minimum summary bucket size
84	4		Minimum non-summary bucket size
88	4		Maximum summary bucket size
92	4		Maximum non-summary bucket size
96	2		Non-summary append size
98	2		Non-summary append factor
100	2		Summary bucket fill factor
102	2		Non-summary bucket fill factor
104	4		Bucket Descriptor Block (BDB) 1 size
108	4		Bucket Descriptor Block (BDB) 1 position See section: 3.2 NSF file position
112	4		Bucket Descriptor Block (BDB) 2 size
116	4		Bucket Descriptor Block (BDB) 2 position See section: 3.2 NSF file position
120	4		Unknown

5.7. Database information 3

The database information (DBINFO3) is 44 bytes of size and consists of:

offset	size	value	description
0	2		ExpirationDays
2	1		LSECSetupState
3	3		LSECFlags
6	12		LSECEncKeyDataLen
18	8		LSECKeyCreationTime
26	4		LSECEncKeyDataPos
30	4		LSECExtKeyDataPos
34	4		LSECExtKeyDataLen
38	6		VirtualOffset

5.7.1. States

Value	Identifier	Description
	LSEC_STATE_NONE	
	LSEC_STATE_DONE	
	LSEC_STATE_NEXTENCRYPT	
	LSEC_STATE_NEXTDECRYPT	

5.7.2. Flags

Value	Identifier	Description
	LSEC_PUBLICKEY	
	LSEC_SECRETKEY	
	LSEC_INTERNATIONAL	
	LSEC_USEBKOBJECT	

5.8. Database information 4

The database information (DBINFO4) is X bytes of size and consists of:

offset	size	value	description
0	14		Unknown
662	4		NextVirtualRRV

offset	size	value	description
666	2		BackupTag
668	4		HighestFolderValidityID
672	16		DbOptions
688	8		DBIID (unique random number)
696	8		DBIID Creation
704	8		Last successful backup
712	8		LastSBWriteCount
720	8		LastBackupTimeLSN
728	4		LogNum
732	36		Unknown

5.9. Database information 5

The database information (DBINFO5) is 168 bytes of size and consists of:

offset	size	value	description
0	2 x 8		LogID
16	8		LastFullCompactionTime
24	4		SizeSCOSLow
28	4		SizeSCOSHigh
32	2		DollarRevisionsLimit
34	2		DollarUpdatedByLimit
36	4		InboxRRV
40	2		SoftDeleteRetainDuration
42	2		BackupFlags
44	8		Start time of last backup
52	2		Flags5
54	4		UsedSpace
58	8		UsedSpaceRecalcTime
66	8		DesignModified
74	8		LastCloseLSN
82	4		MarkCorruptLine
86	12		MarkCorruptFile
98	8		UnreadLogModified
106	8		RefreshDesignModTime
114	8		ProfileModified
122	8		LastCompactionTime

offset	size	value	description
130	4		DAOSObjectRefCt
134	4		DAOSSizeLow
138	4		DAOSSizeHigh
142	8		SBLastCloseLSN
150	8		BDBLastCloseLSN
158	8		DAOSSyncPoint
164	4		Unknown

5.9.1. Notes

offset	size	value	description
784	8		Unknown Value consists of an NSF date and time See section: 3.1 NSF date and time
792	34		Unknown
826	8		Unknown Value consists of an NSF date and time See section: 3.1 NSF date and time
834	8		Unknown Value consists of an NSF date and time See section: 3.1 NSF date and time
842	24		Unknown
866	8		Unknown Value consists of an NSF date and time See section: 3.1 NSF date and time
874	150		Unknown

5.9.2. Backup flags

TODO

Value	Identifier	Description
	DBBCKFLAG_IS_A_BACKUP	
	DBBCKFLAG_CLEAR_FIXUP	

5.9.3. Flags 5

TODO

Value	Identifier	Description
	DBFLAG5_DESTROY_UNLOGGED_CONTV	
	DBFLAG5_NAMED_OBJECT_NEW_HASH	
	DBFLAG5_MODNOTELOG_HAS_DESIGN	
	DBFLAG5_CONVERTED_REFNOTE	
	DBFLAG5_HAS_PROT_ATTACHMENTS	
	DBFLAG5_DESTROY_UNLOGGED_CONT	
	DBFLAG5_FULL_UNREAD_REPL_NEEDED	
	DBFLAG5_FULL_DESIGN_REPL_NEEDED	
	DBFLAG5_DB2NSF	
	DBFLAG5_AUTOFIXUP_DISABLED	

5.10. Padding

offset	size	value	description
0	90		Unknown (Filler2)

6. Superblock

The database information 2 contains the location and size of 4 superblocks.

Most of the time an NSF file contains two superblocks. The offset of these superblocks is stored in the database header. Most often the first superblock is stored at offset 0x0400 and the second superblock at offset 0x8400. Both superblock are stored in 'container' which is a 0x8000 bytes of size.

The superblock consists of:

- Superblock header
- Superblock data
- Superblock footer

6.1. Superblock header

The superblock header is 100 bytes of size and consists of:

offset	size	value	description
0	2	0x000e	Signature
2	8		Last modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
10	4		Uncompressed size The size of the run-time superblock
14	4		Number of summary buckets
18	4		Number of non-summary buckets
22	4		Number of bitmaps
26	4		Record Relocation Vector (RRV) bucket size
30	4		Data Record Relocation Vector (RRV) bucket position See section: 3.2 NSF file position
34	4		Record Relocation Vector (RRV) container low
38	4		Record Relocation Vector (RRV) container high
42	4		Bitmap size
46	4		Data note identifier table size
50	4		Modified note log size
54	4		Folder Directory Object (FDO) size
58	2		Flags
60	4		Superblock write count
64	4		Compressed size The size of the stored superblock
68	2		Compression type See section: 13.1 Compression type
70	4		Number of summary bucket descriptor pages
74	4		Number of non-summary bucket descriptor pages
If format version < 0x1e			
78	8		Unknown (Reserved)
If format version >= 0x1e			
78	4		Number of soft deleted note entries
82	2		Shared template information size
84	2		Unknown (Reserved)
For all versions			

offset	size	value	description
86	2		Number of form names
88	4		Form bitmap size What does -1 (0xffffffff) represent?
92	8		Unknown (StructLSN)

Notes/Domino refers to this structure as superblock signature.

6.2. Superblock data

The superblock data contains the following values.

- summary bucket descriptors
- non-summary bucket descriptors
- bitmap descriptors
- Initial (current) RRV bucket
- Initial (current) bitmap
- data note identifier table
- modified note log
- folder directory object

The superblock data is often stored compressed.

offset	size	value	description
0	4		Compressed data block size
4	...		Compressed data block

The uncompressed superblock data consists of:

offset	size	value	description
If number of summary bucket descriptor pages > 0			
0	8206		Summary bucket descriptors page TODO reference
If number of non-summary bucket descriptor pages > 0			
8206	8198		Non-summary bucket descriptors page TODO reference
If number of bitmaps > 0			
16404	20 x number of bitmaps		Bitmap descriptors TODO reference
...	RRV bucket size		Initial RRV bucket See section: 8 Record Relocation Vector bucket
...	Bitmap size		Initial (allocation) bitmap See section: 9 Allocation bitmap
...	Data note identifier table		Data note identifier table TODO reference

offset	size	value	description
	size		
...	Modified note log size		Modified note log TODO reference
...	Folder directory object size		Folder Directory Object TODO reference

soft deleted note entries?
shared template information?
form names?
form bitmap

6.2.1. The summary bucket descriptor page

The summary bucket descriptor page is 8206 of size and consists of:

offset	size	value	description
0	4		Unknown
4	10		Summary bucket page descriptor TODO reference
14	10 x 21 (Maximum)		Summary bucket group descriptors TODO reference
224	14 x number of summary buckets		Summary bucket descriptors TODO reference
...	...		Unknown Possible padding contains remnant data

Number of summary bucket group descriptors? How many descriptors per group?
A max of 21 group descriptors per page ? A max of 570 descriptors per page?

1 descriptor => 1 group
12 descriptor => 1 group
18 descriptor => 1 group
26 descriptor => 1 group
40 descriptors => 2 groups
45 descriptors => 2 groups
62 descriptors => 3 groups

256 / 14 = 18 max descriptors per group?

6.2.1.1. The summary bucket page descriptor

The summary bucket page descriptor is 10 bytes of size and consists of:

offset	size	value	description
0	8		Last modification date and time Value consists of an NSF date and time

offset	size	value	description
			See section: 3.1 NSF date and time
8	1		Largest number of free bytes
9	1		Second largest number of free bytes

6.2.1.2. The summary bucket group descriptor

The summary bucket group descriptor is 10 bytes of size and consists of:

offset	size	value	description
0	8		Last modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
8	1		Largest number of free bytes
9	1		Second largest number of free bytes

6.2.1.3. The summary bucket descriptor

The summary bucket descriptor is 14 bytes of size and consists of:

offset	size	value	description
0	4		File position See section: 3.2 NSF file position
4	8		Last modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
12	1		Largest number of free bytes
13	1		Second largest number of free bytes

- bucket size
- bucket free space

6.2.2. The non-summary bucket descriptor page

The non-summary bucket descriptor page is 8198 of size and consists of:

offset	size	value	description
0	4		Unknown
4	2		Non-summary bucket page descriptor TODO reference
6	2 x 32 (Maximum)		Non-summary bucket group descriptors TODO reference
70	6 x number of non-summary buckets		Non-summary bucket descriptors TODO reference

offset	size	value	description
...	...		Unknown Possible padding contains remnant data

Number of non-summary bucket group descriptors? How many descriptors per group?
A max of 32 group descriptors per page ? A max of 812 descriptors per page?

1 descriptor => 1 group
29 descriptor => 1 group
32 descriptor => 1 group
62 descriptor => 2 groups
100 descriptors => 3 groups
132 descriptors => 4 groups

256 / 6 = 42 max descriptors per group?

6.2.2.1. The non-summary bucket page descriptor

The non-summary bucket page descriptor is 2 bytes of size and consists of:

offset	size	value	description
0	1		Largest number of free bytes
1	1		Second largest number of free bytes

6.2.2.2. The non-summary bucket group descriptor

The non-summary bucket group descriptor is 2 bytes of size and consists of:

offset	size	value	description
0	1		Largest number of free bytes
1	1		Second largest number of free bytes

6.2.2.3. The non-summary bucket descriptor

The non-summary bucket descriptor is 6 bytes of size and consists of:

offset	size	value	description
0	4		File position See section: 3.2 NSF file position
4	1		Largest number of free bytes
5	1		Second largest number of free bytes

- bucket size
- bucket free space

6.2.3. Bitmap descriptors

The bitmap descriptors contain one or more bitmap descriptor entries.

The bitmap descriptor entry is 20 bytes of size and consists of:

offset	size	value	description
0	4		File position of bitmap
4	4		Unknown (BucketMaxFree)
8	4		Unknown (BucketNonMaxFree)
12	4		Unknown (NonBucketBegin)
16	4		Unknown (NonBucketEnd)

6.2.4. Data note identifier table

Contains the recently viewed/accessed notes?

The data note identifier table is variable of size and consists of:

offset	size	value	description
0	4	0x00000004	Signature
4	2		Unknown
6	2		Number of data note identifier entries
8	8		Unknown
16	2		Unknown Empty value
Data note identifier entries			
18	1		Unknown
19	4		Note identifier Contains a data RRV identifier

6.2.5. Modified note log

TODO

6.2.6. Folder Directory Object

TODO

6.3. Superblock footer

The superblock footer is 12 bytes of size and consists of:

offset	size	value	description
0	8		Last modification date and time Value consists of an NSF date and time See section: 3.1 NSF date and time
4	4		Checksum

offset	size	value	description
			Value contains a 32-bit XOR of the superblock data (starting a offset 100) with an initial value of 0

Notes/Domino refers to this structure as superblock trailer.

7. Bucket Descriptor Block

The bucket descriptor block (BDB) consists of:

- Bucket descriptor block header
- Bucket descriptor block data
- Bucket descriptor block footer

7.1. Bucket descriptor block header

The bucket descriptor block header is 56 bytes of size and consists of:

Offset	size	value	description
0	2	0x0001	Signature
2	2		Version
4	2		Compression type
6	4		Uncompressed size
10	4		Write count The number of times the bucket descriptor block was written
14	4		Compressed size
18	8		(Last) modification date and time
26	4		Number of Unique Keys (UNKs)
30	4		Unknown
34	4		Unique Key (UNK) text size
38	4		Number of Record Relocation Vector (RRV) bucket descriptors
42	4		Number of Unique Key (UNK) hash table entries
46	8		Unknown
54	4		Checksum 32-bit XOR of the bucket descriptor block header without the checksum itself
48	8		Unknown

7.2. Bucket descriptor block data

The bucket descriptor block (BDB) data contains:

- Record Relocation Vector bucket descriptors
- Unique name key table
- Unique name key hash table

7.2.1. Record Relocation Vector bucket descriptors

The Record Relocation Vector (RRV) bucket descriptor is 12 bytes of size and consists of:

Offset	size	value	description
0	4		File position The lower bit is used to signify data or non-data RRV buckets. See section: 3.2 NSF file position
4	4		Initial RRV identifier

The lower bit of the file position is used to signify is the RRV bucket contains data (if the bit is 0) or non-data (if the bit is 1) RRV entries.

7.2.2. Unique name key table

The unique name key (UNK) table consists of unique name key (UNK) table entries. The name strings are stored after the table entries.

7.2.2.1. Unique name key table entry

The unique name key (UNK) table entry is 10 bytes of size and consists of:

Offset	size	value	description
0	4		Name text offset The offset is relative from the start of the name text
4	2		Name text length
6	1		Note item type
7	1		Note item class
8	2		Unknown

7.2.2.2. The note item class

Value	Identifier	Description
0x00	CLASS_NOCOMPUTE	No compute
0x01	CLASS_ERROR	Error
0x02	CLASS_UNAVAILABLE	Unavailable

Value	Identifier	Description
0x03	CLASS_NUMBER	Numeric
0x04	CLASS_TIME	Date and time
0x05	CLASS_TEXT	Text
0x06	CLASS_FORMULA	Formula
0x07	CLASS_USERID	User identifier

7.2.2.3. The note item type

The note item type is dependent on the note item class.

The CLASS_NOCOMPUTE note item types

Value	Identifier	Description
0x00	TYPE_INVALID_OR_UNKNOWN	Unknown
0x01	TYPE_COMPOSITE	Unknown
0x02	TYPE_COLLATION	Unknown
0x03	TYPE_OBJECT	Unknown
0x04	TYPE_NOTEREF_LIST	Unknown
0x05	TYPE_VIEW_FORMAT	Unknown
0x06	TYPE_ICON	Unknown
0x07	TYPE_NOTELINK_LIST	Unknown
0x08	TYPE_SIGNATURE	Unknown
0x09	TYPE_SEAL	Unknown
0x0a	TYPE_SEALDATA	Unknown
0x0b	TYPE_SEAL_LIST	Unknown
0x0c	TYPE_HIGHLIGHTS	Unknown
0x0d	TYPE_WORKSHEET_DATA	Unknown Only used by Chronicle product
0x0e	TYPE_USERDATA	Unknown
0x0f	TYPE_QUERY	Unknown Saved query CD records
0x10	TYPE_ACTION	Unknown Saved action CD records
0x11	TYPE_ASSISTANT_INFO	Unknown Saved assistant info
0x12	TYPE_VIEWMAP_DATASET	Unknown Saved ViewMap dataset

Value	Identifier	Description
0x13	TYPE_VIEWMAP_LAYOUT	Unknown Saved ViewMap layout
0x14	TYPE_LSOBJECT	Unknown Saved LS Object code for an agent
0x15	TYPE_HTML	Unknown LMBCS-encoded HTML, >64K handled by more than one item of same name concatenated
0x16	TYPE_SCHED_LIST	Unknown Busy time schedule entries list
0x17	TYPE_CALENDAR_FORMAT	Unknown Busy time schedule entries list
0x18	TYPE_MIME_PART	Unknown MIME body part
0x1f	TYPE_SEAL2	Unknown

The CLASS_ERROR note item types

Value	Identifier	Description
0x00	TYPE_ERROR	Unknown

The CLASS_UNAVAILABLE note item types

Value	Identifier	Description
0x00	TYPE_UNAVAILABLE	Unknown

The CLASS_NUMBER note item types

Value	Identifier	Description
0x00	TYPE_NUMBER	Floating point value 8 bytes of size
0x01	TYPE_NUMBER_RANGE	Unknown

The CLASS_TIME note item types

Value	Identifier	Description
0x00	TYPE_TIME	NSF date and time value 8 bytes of size See section: 3.1 NSF date and time
0x01	TYPE_TIME_RANGE	Unknown

The CLASS_TEXT note item types

Value	Identifier	Description
0x00	TYPE_TEXT	Text value Variable of size
0x01	TYPE_TEXT_LIST	An array of text values Variable of size
0x02	TYPE_RFC822_TEXT	Unknown RFC822(RFC2047) message header

The CLASS_FORMULA note item types

Value	Identifier	Description
0x00	TYPE_FORMULA	Unknown

The CLASS_USERID note item types

Value	Identifier	Description
0x00	TYPE_USERID	Unknown

7.2.3. Unique name key hash table

TODO

Offset	size	value	description
0	2		Unique name key hash value

7.3. Bucket descriptor block footer

The bucket descriptor block footer is 12 bytes of size and consists of:

Offset	size	value	description
0	8		(Last) modification date and time
8	4		Checksum 32-bit XOR of the bucket descriptor block information

8. Record Relocation Vector bucket

The Record Relocation Vector (RRV) bucket consists:

- RRV (container) bucket header
- an array of RRV entries

The RRV bucket is 4096 bytes of size.

8.1. RRV (container) bucket header

The RRV bucket header is 32 bytes of size and consists of:

Offset	size	value	description
Byte signature (BSIG)			
0	1	0x06	Signature
1	1	0x20	Header size Includes the size of the signature and size value
RRV bucket header data			
2	4		Unknown
6	4		Initial RRV identifier
10	6		Unknown
16	2		Unknown (block size)
18	4		Checksum 32-bit XOR of the RRV entry data
22	10		Unknown

8.2. RRV entry

There are two types of RRV entries:

- a basic RRV entry
- a BSID RRV entry

After format version 21 (0x15) the RRV was extended, instead of a file position the RRV also can consists of a bucket slot identifier (BSID).

Unused entries contain 0xffffffff (-1) for both A and B and/or 0.

8.2.1. Basic RRV entry

The basic RRV entry is 4 bytes of size and consists of:

Offset	size	value	description
0.0	32 bits		File position See section: 3.2 NSF file position

After format version 21 (0x15) the basic RRV entry is stored in 8 bytes.

Points to ODS type 0x07

8.2.2. BSID RRV entry – format version 22 and later

The BSID RRV entry is 8 bytes of size and consists of:

Offset	size	value	description
0.0	24 bits		Bucket identifier Where 1 represents the first bucket
3.0	4 bits		Unknown
3.4	3 bits		Upper 3 bits of NONSUM
3.7	1 bit		Extended RRV flag
4.0	11 bits		Slot identifier Where 1 represents the first slot
5.3	21 bits		Lower 21 bits of NONSUM

The BSID RRV entry requires the Extended RRV flag to be set.

9. Allocation bitmap

The bitmap is 2048 bytes of size. Each bit signifies a block of 256 bytes.

10. Universal identifier index

Universal identifier (UNID)

11. The bucket

Data is stored in buckets ranges from 4 to 32 KiB in size. The bucket is used for both summary and non-summary data.

A bucket consist of:

- bucket header
- bucket entries
- bucket index
- bucket trailing data

11.1. The bucket header

The bucket header is 66 bytes of size and consist of:

offset	size	value	description
Byte signature (BSIG)			
0	1	0x02	Signature
1	1	0x42	Record size Includes the size of the signature and size value

offset	size	value	description
Bucket header data			
2	4		Unknown Bucket identifier?
6	4		Bucket size
10	8		Modification date and time Value consists of a NSF date and time See section: 3.1 NSF date and time
18	20		Unknown Empty values
38	2		Unknown
40	4		Checksum
44	4		Number of slots
48	2		Unknown Empty values
50	4		Bucket footer size
54	4		Unknown
58	4		Unknown
62	4		Unknown

11.2. Bucket index

Index entries stored from back to front.

11.2.1. Bucket index entry

The bucket index entry is 4 bytes of size and consist of:

offset	size	value	description
0	2		Start offset of the slot entry The value is relative to the start of the bucket
2	2		Size of the slot entry

12. The note

The note contains:

- The note (body) header
  - non-summary
  - attachments
- (note) item descriptors
- (note) item values
  - Summary-item values
  - Response entries or overhead

- Non-summary-item values

12.1. The note header

The note (body) header contains:

- database handle (rrv?)
- note identifier
- originator identifier
- note class
- last modification time
- pre version 3 privileges mask
- note flags
- last access time

The note header is 100 bytes of size and consists of:

offset	size	value	description
Long signature (LSIG)			
0	2	0x0004	Signature
2	4		Size Includes the size of the signature and size value
Note identifier (NOTEID) *Or Note global instance identifier (GLOBALINSTANCEID)?*			
6	4		RRV identifier
Originator identifier (ORIGINATORID)			
10	8		File identifier (OID.File) Value consists of a NSF date and time but is considered as an identifier See section: 3.1 NSF date and time
18	8		Note identifier (OID.Note) Value consists of a NSF date and time but is considered as an identifier? See section: 3.1 NSF date and time
26	4		Sequence number (OID.Sequence)
30	8		Sequence date and time (OID.SequenceTime) Value consists of a NSF date and time See section: 3.1 NSF date and time
Note header data			
38	2		Status flags TODO add reference
40	2		Note class See section: 12.1.1 Note class
42	8		Last modification date and time

offset	size	value	description
			Value consists of a NSF date and time See section: 3.1 NSF date and time
50	2		Number of note items
52	2		Unknown (Pre-V3 Privileges mask) (Note Flags)
54	2		Number of responses
56	4		Non-summary data identifier TODO add reference
60	4		Non-summary data size
64	8		Last access date and time Value consists of a NSF date and time See section: 3.1 NSF date and time
72	8		Creation date and time The date and time the note was added to the database file Value consists of a NSF date and time See section: 3.1 NSF date and time
80	4		Parent note identifier Contains a data RRV identifier
84	2		Unknown 0x0002 0x0003
86	4		Folder reference count
90	4		Unknown (response table identifier?) 0x00000003
94	4		Folder note identifier Contains a non-data RRV identifier
98	2		Unknown

Secondary status flags

```
Pre-V3 privileges mask (16-bit)

Obsolete in Notes 3.0 [Notes 2.X: Get/set the Access Control List (ACL)
privileges associated with manipulating this Note(WORD). Only the low order 5
bits of the WORD used in Notes 2.X.

bit 0 = privilege 1
bit 1 = privilege 2
bit 2 = privilege 3
bit 3 = privilege 4
bit 4 = privilege 5

Note flags (16-bit ?) (as of V3)
```

```
* Response count (32-bit)
Get the number of immediate response notes for this note (DWORD).
* Responses ?
Get a handle to the ID Table of Note IDs of the immediate responses of this
note (HANDLE). If a note has no responses, NULLHANDLE is returned. There is no
ordering of the response Note IDs in the table. The OPEN_RESPONSE_ID_TABLE
flag must be specified when the note is opened in order to obtain a valid ID
Table handle. If the OPEN_RESPONSE_ID_TABLE flag is not specified when the
note is opened, NULLHANDLE will be returned as the value of the ID Table
handle. Do not explicityly deallocate the ID Table. It will be deallocated by
NSFNoteClose().
* added-to-file date and time?
  In file creation date and time
* object store database handle?
DBHANDLE of object store used by linked items.
```

12.1.1. Note class

Value	Identifier	Description
0x0001	NOTE_CLASS_DOCUMENT NOTE_CLASS_DATA	Document or data note
0x0002	NOTE_CLASS_INFO	Help-About (File information) note
0x0004	NOTE_CLASS_FORM	Form note
0x0008	NOTE_CLASS_VIEW	View note
0x0010	NOTE_CLASS_ICON	Icon note
0x0020	NOTE_CLASS_DESIGN	Design note collection
0x0040	NOTE_CLASS_ACL	Access control list note
0x0080	NOTE_CLASS_HELP_INDEX	Notes product help index note
0x0100	NOTE_CLASS_HELP	Designer's help note
0x0200	NOTE_CLASS_FILTER	Filter note
0x0400	NOTE_CLASS_FIELD	Shared Field note
0x0800	NOTE_CLASS_REPLFORMULA	Replication formula
0x1000	NOTE_CLASS_PRIVATE	Private design note use $PrivateDesign view to locate/classify
0x8000	NOTE_CLASS_DEFAULT	MODIFIER - default version of each

12.1.2. Note status flags

Value	Identifier	Description
0x0001	NOTE_FLAG_READONLY	The note is read-only
0x0002	NOTE_FLAG_ABSTRACTED	The note is missing data?

Value	Identifier	Description
0x0004	NOTE_FLAG_INCREMENTAL	Incremental note (has placeholders)
0x0008		
0x0010		
0x0020	NOTE_FLAG_LINKED	The note contains linked items or linked objects
0x0040	NOTE_FLAG_INCREMENTAL_FULL	Full incremental note (has no placeholders)
0x0080		
0x0100		
0x0200	NOTE_FLAG_DELETED	Notes with this flag seem to be ignored as valid notes, possible that this is the (soft) deletion flag?
0x0400		
0x0800		
0x1000		
0x4000	NOTE_FLAG_CANONICAL	Canonical note

```
DELETED
UPDATED
OBJECTS
PROTECTED
0x40 GHOST
RESPONSEOBJ
NAMED
UNAMBIGUOUS
APPT
NOPURGE
NONSUMMARYAPPEND
PUBLICACCESS
SOFT_DELETED
```

12.1.3. Secondary note status flags

The note should have secondary note status flags

```
HASREADERSLIST
REFERENCE

NOTE_FLAG2_NO_UPDATE
NOTE_FLAG2_NO_CHANGE
```

12.1.4. Non-summary data identifier

The non-summary data identifier contains either a file position or non-summary bucket slot-identifier (BSID).

The non-summary data identifier BSID is 4 bytes of size and consists of:

Offset	size	value	description
0.0	24 bits		Bucket identifier Where 1 represents the first bucket
3.0	7 bits		Slot identifier Where 1 represents the first slot
3.7	1 bit		Extended flag must be set

12.2. The note item entry

The note item entry is 8 bytes of size and consists of:

offset	size	value	description
0	2		Unique name key table index
2	2		Field flags
4	2		Data size
6	2		Unknown

The summary data is stored after the last note item entry. Summary data is identifier by the ITEM_SUMMARY note item field flag. Non-summary data is stored in separate location which can be retrieved using the non-summary data identifier.

12.2.1. The note item field flags

Value	Identifier	Description
0x0001	ITEM_SIGN	The field will be signed if requested
0x0002	ITEM_SEAL	The field will be encrypted (sealed) if requested
0x0004	ITEM_SUMMARY	The field can be referenced in a formula Also the field is stored in the note data not in the non-summary data
0x0008		Unknown, set if data is store ind the note item data
0x0020	ITEM_READWRITERS	The field identifies a subset of users that have read/write access
0x0040	ITEM_NAMES	The field contains user/group names
0x0100	ITEM_PLACEHOLDER	Add this item to "item name table", but do not store
0x0200	ITEM_PROTECTED	The field cannot be modified except by its owner
0x0400	ITEM_READERS	The field identifies subset of users that have read access
0x1000	ITEM_UNCHANGED	The item is unchanged (similar to the one on-disk)

12.2.2. Summary note item data

The contents of the summary note item data is dependent on the note item type. See section: 7.2.2.3 The note item type.

If the data size is 0 the value is empty.

12.2.2.1. The TYPE_TEXT_LIST note item type

The TYPE_TEXT_LIST note item type is variable of size and consists of:

offset	**size**	**value**	**description**
0	2		Number of entries
2	(2 x number of entries)		Entry size
...	...		Entry data

12.2.3. Non-summary note item data

TODO

offset	**size**	**value**	**description**
Long signature (LSIG)			
0	2	0x0010	Signature
2	4		Size Includes the size of the signature and size value
Note identifier (NOTEID) *Or Note global instance identifier (GLOBALINSTANCEID)?*			
6	4		RRV identifier
Originator identifier (ORIGINATORID)			
10	8		File identifier (OID.File) Value consists of a NSF date and time but is considered as an identifier See section: 3.1 NSF date and time
18	8		Note identifier (OID.Note) Value consists of a NSF date and time but is considered as an identifier? See section: 3.1 NSF date and time
26	4		Sequence number (OID.Sequence)
30	8		Sequence date and time (OID.SequenceTime) Value consists of a NSF date and time See section: 3.1 NSF date and time

offset	size	value	description
Note header data			
38			

12.3. Trailing data

The note sometimes contains several bytes of trailing data, which probably contain remnant data.

13. Compression

TODO

13.1. Compression type

Value	Identifier	Description
0	COMPRESS_NONE	No compression
1	COMPRESS_HUFF	CX compression (Huffman encoding)
2	COMPRESS_LZ1	LZ1 compression

13.2. CX compression

TODO

First byte contains initial tag bit position?

If first tag bit = 0 followed by uncompressed byte
if first tag bit = 1 followed by a compression tuple

If compression tuple tag bit = 0 followed by compression size - 2
If compression tuple tag bit = 1 followed by compression offset

If the compression size tag bit = 0 followed by extended compression offset
If the compression size tag bit = 1 followed by compression offset

The extended compression offset contains the upper bits (> 8) of the compression offset. The compression offset point backwards relative from the end of the uncompressed data.

In the compression tuple the number of 0 bits after a tag bit represent the size in bits of either compression size or (extended) offset.

13.3. LZ1 compression

TODO

Introduced in Notes 6

14. The access control list

TODO

15. Notes

15.1. Replication history

offset	size	value	description
0	8		Replication date and time
8	2		Access level
10	2		Access flags
12	2		Replication direction
14	4	30	Server name offset (in packed data?)
18	2		Server name size (in packed data?)
20	2		Filename size (in packed data?)
22	2		Unknown (MoreInfo) includes complete replication flag
24	2		Reserved (wSpare)
26	4		Reserved (dwSpare)
30	...		Server name NUL-terminated
...	2	“!!”	Separator
...	...		Filename NUL-terminated

15.1.1. Replication direction

Value	Identifier	Description
0	DIRECTION_NEVER	Never
1	DIRECTION_SEND	Send
2	DIRECTION_RECEIVE	Receive

15.2. Encryption levels

Value	Identifier	Description
0	DBCREATE_ENCRYPT_NO	None

Value	Identifier	Description
	NE	
1	DBCREATE_ENCRYPT_SIMPLE	Simple
2	DBCREATE_ENCRYPT_MEDIUM	Medium
3	DBCREATE_ENCRYPT_STRONG	Strong

15.3. User activity records

```
typedef struct {
        WORD DataReads;                                 /* # of data notes
read */
        WORD DataAdds;                                  /* # of data notes
added */
        WORD DataUpdates;                               /* # of data notes
updated */
        WORD DataDeletes;                               /* # of data notes
deleted */
        WORD NonDataReads;                              /* # of nondata notes
read */
        WORD NonDataAdds;                               /* # of nondata notes
added */
        WORD NonDataUpdates;                    /* # of nondata notes updated
*/
        WORD NonDataDeletes;                    /* # of nondata notes deleted
*/
} ACTIVITY_ENTRY_DETAILS_DUP;

typedef struct {
        TIMEDATE First;                         /* Beginning of reporting
period */
        TIMEDATE Last;                          /* End of reporting period */
        DWORD Uses;                                     /* # of uses in
reporting period */
        DWORD Reads;                            /* # of reads in reporting
period */
        DWORD Writes;                           /* # of writes in reporting
period */
        DWORD PrevDayUses;                      /* # of uses in previous 24
hours */
        DWORD PrevDayReads;                     /* # of reads in previous 24
hours */
        DWORD PrevDayWrites;            /* # of writes in previous 24 hours */
        DWORD PrevWeekUses;                     /* # of uses in previous week
*/
        DWORD PrevWeekReads;            /* # of reads in previous week */
        DWORD PrevWeekWrites;           /* # of writes in previous week */
        DWORD PrevMonthUses;            /* # of uses in previous month */
        DWORD PrevMonthReads;           /* # of reads in previous month */
        DWORD PrevMonthWrites;          /* # of writes in previous month */
} DBACTIVITY;

typedef struct {
```

```
        TIMEDATE First;                         /* Beginning of reporting
period */
        TIMEDATE Last;                          /* End of reporting period */
        DWORD Uses;                                     /* # of uses in
reporting period */
        DWORD Reads;                            /* # of reads in reporting
period */
        DWORD Writes;                           /* # of writes in reporting
period */
        DWORD Adds;
        DWORD Updates;
        DWORD Deletes;
        DWORD PrevDayUses;                      /* # of uses in previous 24
hours */
        DWORD PrevDayReads;                     /* # of reads in previous 24
hours */
        DWORD PrevDayAdds;
        DWORD PrevDayUpdates;
        DWORD PrevDayDeletes;
        DWORD PrevWeekUses;                     /* # of uses in previous week
*/
        DWORD PrevWeekReads;            /* # of reads in previous week */
        DWORD PrevWeekAdds;
        DWORD PrevWeekUpdates;
        DWORD PrevWeekDeletes;
        DWORD PrevMonthUses;            /* # of uses in previous month */
        DWORD PrevMonthReads;           /* # of reads in previous month */
        DWORD PrevMonthAdds;
        DWORD PrevMonthUpdates;
        DWORD PrevMonthDeletes;
} DBACTIVITYEXTENDED;

typedef struct {
        TIMEDATE Time;                          /* Time of record */
        WORD Reads;                                     /* # of data notes
read */
        WORD Writes;                            /* # of data notes written */
        DWORD UserNameOffset;           /* Offset of the user name from the
beginning
                                                                of this
memory block */
                                                              /* User names
follow -- '\0' terminated */
} DBACTIVITY_ENTRY;

typedef struct {
        TIMEDATE Time;                          /* Time of record */
        ACTIVITY_ENTRY_DETAILS_DUP AEDetails;
        DWORD UserNameOffset;           /* Offset of the user name from the
beginning
                                                                of this
memory block */
                                                              /* User names
follow -- '\0' terminated */
} DBACTIVITY_ENTRY_EXTENDED;
```

Appendix A. References

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URL: http://www.ibm.com

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Version 1.3, 3 November 2008

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