

The unofficial DMO format description

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This document describes the DMO file format. This file format is the result of “recording” a game in Duke Nukem 3D or Redneck Rampage. This documentation covers Duke Nukem 3D in the versions 1.0, 1.1, 1.3D, 1.4, and 1.5. It also covers the alpha demo version 0.7 ‘moonshine’ of Redneck Rampage.

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1. Introduction

To create a DMO file start the game with the command line switch `/r` (and `/l` (level), `/s` (skill) etc.) and play as usual. If you press `F10` the record (and the game) stops. You will find a file `demo1.dmo` in the current directory. To play it back just start the game and hide the menu by pressing `ESC`.

In Duke Nukem 3D 1.0 and 1.1 the skill value is a bit strange: To record a skill n ($1 \leq n \leq 4$) game note to use `/sn+1`. So `/s2` is “Peace of Cake” and `/s5` is “Damn I’m Good”. The `dn3dhelp.exe` hint (`/sn` with $0 \leq n \leq 3$) is totally wrong.

Multiplayer recordings have always the skill 0. Cooperative recordings won’t play back properly.

It is impossible to record with version 1.0 more than one level. You can’t even record the summary screen at the end of each level.

In version 1.1 it *seems* to be possible (I got it some times). Some other times I got only the recording of the last level.

A DMO file records all player actions. The monster movements, respawn positions etc. are totally deterministic. The messages during a multiplayer game (macros and RemoteRidicule (tm)) do not appear in the DMO.

A DMO file consists of a header with some organizational information and the data area with all the (compressed) game tics.

The term “game tic” comes originally from DOOM and denotes the smallest unit of time during the game. The duration of a game tic is $1/26s$. To store a game tic in a file means to store all actions, like movement, open doors, fire weapons and so on, happened during this time.

2. Header

2.1. old Duke Nukem 3D Header

Duke Nukem 3D 1.0 and 1.1 use a 9 byte main header:

address	type	contents
0x0000	long	number of game tics times numberof players
0x0004	byte	episode (0-3)
0x0005	byte	map (0-8)
0x0006	byte	skill (0-4)
0x0007	word	player number

The first entry in the header (number of game tics) may be zero in version 1.1 recordings. This should mean, that there is more than one level recorded.

All `word` or `long` values in DMO files are Intel ordered (lowest byte first, little endian).

2.2. new Duke Nukem 3D Header

Duke Nukem 3D 1.3D uses a 24 byte main header:

address	type	contents
0x0000	long	number of game tics times number of players
0x0004	byte	volume - 1 (/v parameter - 1)
0x0005	byte	level - 1 (/l parameter - 1)
0x0006	byte	skill (0 .. 4) (/s parameter)
0x0007	byte	MP mode (/c 1 = DukeMatch(spawn), 2 = Coop, 3 = Dukematch(no spawn))
0x0008	short	player number (1..8)
0x000A	short	0x01 with /m (nomonsters), 0x00 else
0x000C	long	0x01 with /t1 (respawn monsters), 0x00 else
0x0010	long	0x01 with /t2 (respawn items), 0x00 else
0x0014	long	0x01 with /t3 (respawn inventory), 0x00 else

2.3. Duke Nukem 3D 1.4 or 1.5 Header

Duke Nukem 3D 1.4 and 1.5 use a 674 (0x2a2) byte fixed header and player number additional bytes:

address	type	contents
0x0000	long	number of game tics times number of players
0x0004	byte	version: 116 (0x74) is 1.4, 117 (0x75) is 1.5
0x0005	byte	episode
0x0006	byte	map
0x0007	byte	skill (0..4)
0x0008	byte	Multi Player mode (/c parameter - 1)
0x0009	byte	m_ffire (might be friendly fire)
0x000A	short	player number (1..16)
0x000A	byte	player number (1..8)

0x000C	short	0x01 with /m (nomonsters), 0x00 else
0x000E	long	0x01 with /t1 (respawn monsters), 0x00 else
0x0012	long	0x01 with /t2 (respawn items), 0x00 else
0x0016	long	0x01 with /t3 (respawn inventory), 0x00 else
0x001A	long	0x01 with /a (player AI for fake players), 0x00 else
0x001E	char[0x20]	name[0]
0x003E	char[0x20]	name[1]
...
0x01CE	char[0x20]	name[14]
0x01FE	char[0x20]	name[15]
0x021E	long	0x01 with auto_run, 0x00 else
0x0222	char[0x80]	board file name
0x02a2	byte	aim_mode[0]
...
0x02a2 + player_number - 1	byte	aim_mode[player_number - 1]

2.4. Redneck Rampage Header

Redneck Rampage uses a 543 byte main header:

address	type	contents
0x0000	long	number of game tics times number of players
0x0004	byte	0x6C, it may be a version
0x0005	byte	0x00, unknown
0x0006	byte	0x00, unknown
0x0007	byte	skill (0..4)
0x0008	byte	MP mode (/c parameter - 1)
0x0009	byte	level (1..11)
0x000A	byte	player number (1..8)
0x000B	byte	0x00, unknown

0x000C	byte	0x01 with /m (nomonsters), 0x00 else
0x000D	byte	0x00, unknown
0x000E	long	0x01 with /t1 (respawn monsters), 0x00 else
0x0012	long	0x01 with /t2 (respawn items), 0x00 else
0x0016	long	0x01 with /t3 (respawn inventory), 0x00 else
0x001A	long	0x01 with /a (player AI for fake players), 0x00 else
0x001E	char[0x201]	-name parameter

The episode (better: volume) number is one of the 0x00 bytes in the header.

The players name is a '\0' terminated string. The maximum number of characters for the name is 512.

3. Data

The data starts in byte 0x0009 (old Duke Nukem 3D), 0x0018 (new Duke Nukem 3D) or 0x021F (Redneck Rampage) of the DMO file and is organized in several blocks.

3.1. Block

Each block consists of a header with some organizational information and the compressed data.

A block header is:

address	type	contents
0x0000	word	size of the following block in bytes
0x0002	word	size of the uncompressed data block in bytes
0x0004	word	biggest code for Lempel-Ziv decompression

The compressed data starts in byte 0x0006 of the block. The block size (0x0000/0x0001) includes the rest of the header. This means there are only block size - 4 data bytes.

3.2. Compression technique

Duke Nukem 3D uses a modified Lempel-Ziv algorithm (similar to the UNIX command `compress(1)`) to compress the game tics. To reach an even better compression ratio not the game tic itself but the difference to the last one of the same player (difference per byte, without carry bits) will be compressed. This increases the number of 0 bytes enormously and allows long recording in short files.

In fact Steffen Winterfeldt changed the original `compress.c` until we could decompress a DMO file.

If you are really more interested in the compression/decompression routines look in the files `lzw.c` and `unlzw.c` included in LMPC, the Little Movie Processing Centre. You can get it from my Demo Specs page (<http://demospecs.half-empty.de>).

The published source (1.5) was needed to decompress 1.5 recordings. But LMPC still uses `unlzw.c` to decompress the 1.3D files.

The compression algorithm used in Redneck Rampage seems to be similar but I did not get `lzw.c` and `unlzw.c` to work with Redneck Rampage recordings.

3.3. Macro block

Some blocks of data form a macro block. This has to do with both decompression and game tic difference storing. The first game tic in a macro block is the original game tic. All the following game tics are only the byte-per-byte difference game tics to its specific predecessors. There is no special code to signalize the end of a macro block. It is simply the number $2520 / (\text{player number})$ game tics, which makes a macro block. Note that 2520 is divisible by 1, 2, ..., 8 without remainder. Only the last macro block may contain less game tics if the file ends before.

3.4. Data description

One game tic consists of the data from all players. The input for every player is listed below.

3.4.1. Duke Nukem 3D 1.0, Duke Nukem 3D 1.1

One game tic has 10 bytes per player:

address	type	contents
0x0000	signed short	go in x-direction
0x0002	signed short	go in y-direction
0x0004	signed short	turn
0x0006	unsigned long	use/open etc.

3.4.2. Duke Nukem 3D 1.3D, Duke Nukem 3D 1.4, Duke Nukem 3D 1.5,

Redneck Rampage

One game tic has 10 bytes per player:

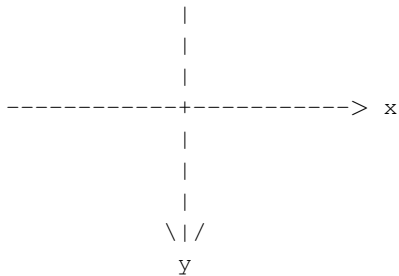
address	type	contents
0x0000	signed char	turn
0x0001	signed char	horizon movement (mouse aim up or down)
0x0002	signed short	go in x-direction
0x0004	signed short	go in y-direction
0x0006	unsigned long	use/open etc.

3.4.3. Go x and y

The two moving parameters are the player's speed or the displacement vector in length units per game tic.

To calculate the absolute value of the player speed just calculate $\sqrt{x^2+y^2}$.

A standard speed is 1280 (with running 2560). The coordinate system used is like this:



3.4.4. Turn

The turn parameter contains the current turning speed or the angle difference per game tic. A positive turning speed means right and a negative means left.

3.4.5. Use

There are many "use" actions in Duke Nukem 3D. You can do all at once, because there is a single bit for each action. The appropriate bit is 1 as long as you press the corresponding key.

bit	purpose
31	Escape
30	Inventory

29	Open
28	TurnAround
27	Inventory_Right
26	GameQuit
25	Jetpack
24	Holo_Duke
23	Mouse_Aiming new in 1.1
22	Quick_Kick
21	Pause
20	Inventory_Left
19	Holster_Weapon
18	Center_View
17	AutoRun
16	MedKit
15	NightVision
14	Look_Down
13	Look_Up
12	Steroids new in 1.1
8-11	Weapon number
7	Look Right
6	Look Left
5	Run
4	Aim_Down
3	Aim_Up
2	Fire
1	Crouch
0	Jump

4. Version History and Acknowledgements

0.0.0, 8 February, 1996

- First internal version (working paper); never announced.
- Many thanks to Steffen Winterfeldt (Steffen.Winterfeldt@itp.uni-leipzig.de)

(mailto:Steffen.Winterfeldt@itp.uni-leipzig.de)) for his reverse engineering and programming work.

0.0.1, 10 February, 1996

- First helpful documentation for further research on Duke Nukem 3D; never announced.

0.0.2, 12 February, 1996

- All header bytes decoded, never announced.

0.0.3, 19 February, 1996

- Minimal changes, some remarks to record properly.

0.0.4, 23 February, 1996

- New actions from version 1.1.
- Multi-level recording from 1.1.
- Reorganization of block/macro block description.

0.0.5, 4 May, 1997

- Redneck Rampage info included (incomplete).
- Duke Nukem 3D 1.3D info included.

0.0.6, 12 March, 1998

- PlanetQuake is the new home.
- SGML-Tools 1.0.5 used.

0.1.0, 5 August, 2006

- Duke Nukem 3D 1.4 and 1.5 header added.
- Full list of actions listed.
- Internal game tic structure for Duke Nukem 3D 1.3D and later added.

0.1.1, 20 March, 2007

- A Duke Nukem 3D game tic is 1/26s and not 1/30s. Thanks to jlennox@gmail.com (mailto:jlennox@gmail.com) for spotting this error.