# nParticles cache description

by S. Cieri, C. D'Angelis

## Maya Cache file format

The Maya Cache file format (*.mc*) is used in Maya for a variety of caching purposes.
Apparently, it is the format which Autodesk elected as Maya's unified standard for caches (this, until Alembic came out at least). Unfortunately, though, it is not yet a unified standard; neither it is properly documented.
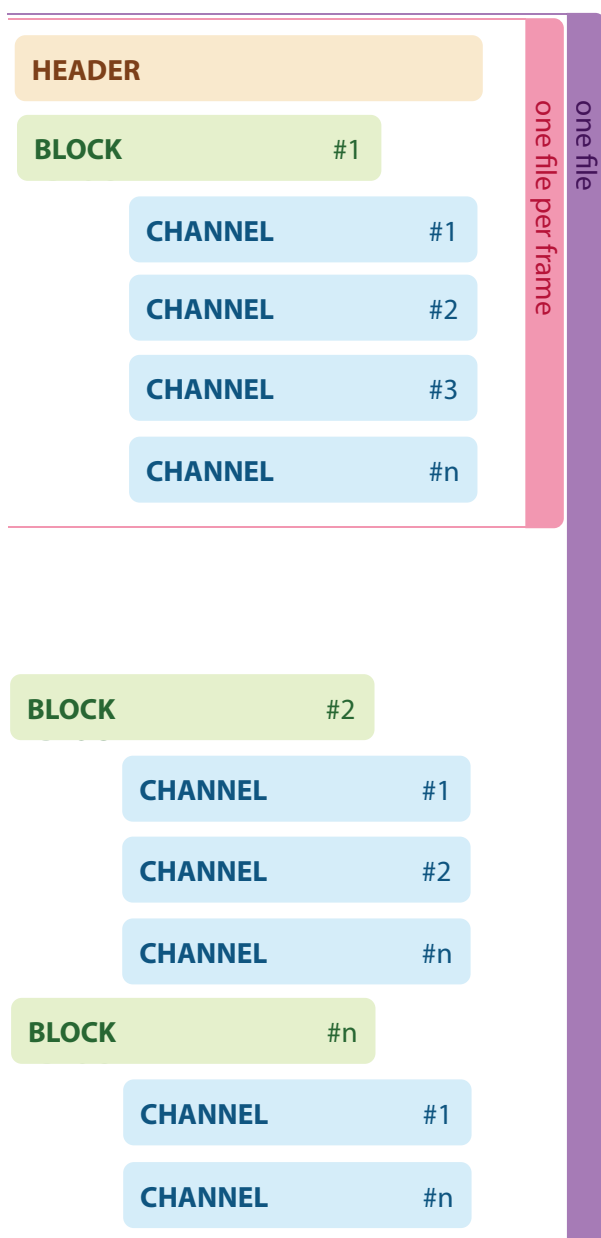
## nCache for nParticles

nCaches are a sub-class of Maya Caches, which store simulation data for nucleus objects or fluid effects; nParticles are a specific kind of nucleus objects.
Within this document, only the file structure of nCaches for nParticles will be described. Such description is to be taken with reserve, as it's merely resulting out of observations (and deductions) of .mc binary files and Python scripts provided by Autodesk.
Most likely, this will be the first step of a wider research, aimed to generalize the format description (so that it might include every kind of Maya Cache).

**note!** this document is to be intended as the report of a research study; we assume it won't be used for commercial purposes, where not allowed; we therefore decline any responsability for such cases.

**HEADER**

**BLOCK** #1

> **CHANNEL** #1
> **CHANNEL** #2
> **CHANNEL** #3
> **CHANNEL** #n

one file per frame

one file

**BLOCK** #2

> **CHANNEL** #1
> **CHANNEL** #2
> **CHANNEL** #n

**BLOCK** #n

> **CHANNEL** #1
> **CHANNEL** #n

## Format Specification (generalized)

Maya cache consists of an header and an arbitrary number of channels. Each channel stores data points in time (not necessarily regularly spaced, and not necessarily co-incident in time with data in other channels).

On disk, the Maya cache is made up of a XML description file, and one or more data files.
The description file provides an overview of the XML file; it is (almost) exaustively described within Maya's official documentation, then it won't be discussed here.

The data files contain the actual data for the channels, and can be organized in a single file per cache, or one file per frame.

The file format allows the use of an arbitrary number of channels. Channel names are restricted and case sensitive.
For Maya to work with an .mc file, such file must at minimum contain a Position channel.

The time unit used by nCaches is a "tick", which is 1/6000 seconds.

Data stored can be of different types, such as: "DBLA" (double array, when storing single values), "FVCA" (float vector array, Maya 8.5 and later), "DVCA" (double vector array, Maya 8.0 and earlier).
Please note that Maya Cache DLL Project works only with caches for Maya 8.5 and later (therefore not implementing "BVCA").

All data is in little-endian byte order.

# nParticles cache description (one file)

by S. Cieri, C. D'Angelis

## Format Specification for nParticles, in single .mc file

The multi-frame .mc file format for nParticles consists of:

• A header for general file information.
• A number of blocks which is equal to the cache duration; each block reports (only in the *one file* version) the current frame and its length in bytes (such length includes all the channels included in the block).
• A section, containing a number of channels, which is equal to the number of attributes you want to cache per frame; each channel defines the channel-wise data regarding the particles.

**HEADER**
- cache format
- header length
- cache version
- start time
- end time

**BLOCK** #1
- cache format
- block length
- block tag
- current time

**CHANNEL** #1
- channel name
- array size
- data type
- data array

**CHANNEL** #2

**CHANNEL** #3

**CHANNEL** #n

| Offset(h) | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00000000 | 46 | 4F | 52 | 34 | 00 | 00 | 00 | 28 | 43 | 41 | 43 | 48 | 56 | 52 | 53 | 4E | FOR4...(CACHVRSN |
| 00000010 | 00 | 00 | 00 | 04 | 30 | 2E | 31 | 00 | 53 | 54 | 49 | 4D | 00 | 00 | 00 | 04 | ....0.1.STIM.... |
| 00000020 | 00 | 00 | 00 | 00 | 45 | 54 | 49 | 4D | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 01 | ....ETIM........ |
| 00000030 | 46 | 4F | 52 | 34 | 00 | 00 | 02 | 08 | 4D | 59 | 43 | 48 | 54 | 49 | 4D | 45 | FOR4....MYCHTIME |
| 00000040 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 00 | 43 | 48 | 4E | 4D | 00 | 00 | 00 | 13 | ........CHNM.... |
| 00000050 | 6E | 50 | 61 | 72 | 74 | 69 | 63 | 6C | 65 | 53 | 68 | 61 | 70 | 65 | 31 | 5F | nParticleShape1_ |
| 00000060 | 69 | 64 | 00 | 00 | 53 | 49 | 5A | 45 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 02 | id..SIZE........ |
| 00000070 | 44 | 42 | 4C | 41 | 00 | 00 | 00 | 10 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | DBLA............ |
| 00000080 | 3F | F0 | 00 | 00 | 00 | 00 | 00 | 00 | 43 | 48 | 4E | 4D | 00 | 00 | 00 | 16 | ?ð......CHNM.... |
| 00000090 | 6E | 50 | 61 | 72 | 74 | 69 | 63 | 6C | 65 | 53 | 68 | 61 | 70 | 65 | 31 | 5F | nParticleShape1_ |
| 000000A0 | 63 | 6F | 75 | 6E | 74 | 00 | 00 | 00 | 53 | 49 | 5A | 45 | 00 | 00 | 00 | 04 | count...SIZE.... |
| 000000B0 | 00 | 00 | 00 | 01 | 44 | 42 | 4C | 41 | 00 | 00 | 00 | 08 | 40 | 00 | 00 | 00 | ....DBLA....@... |
| 000000C0 | 00 | 00 | 00 | 00 | 43 | 48 | 4E | 4D | 00 | 00 | 00 | 1A | 6E | 50 | 61 | 72 | ....CHNM....nPar |
| 000000D0 | 74 | 69 | 63 | 6C | 65 | 53 | 68 | 61 | 70 | 65 | 31 | 5F | 62 | 69 | 72 | 74 | ticleShape1_birt |
| 000000E0 | 68 | 54 | 69 | 6D | 65 | 00 | 00 | 00 | 53 | 49 | 5A | 45 | 00 | 00 | 00 | 04 | hTime...SIZE.... |
| 000000F0 | 00 | 00 | 00 | 02 | 44 | 42 | 4C | 41 | 00 | 00 | 00 | 10 | BF | A5 | 55 | 55 | ....DBLA....¿¥UU |
| 00000100 | 55 | 55 | 55 | 55 | BF | A5 | 55 | 55 | 55 | 55 | 55 | 55 | 43 | 48 | 4E | 4D | UUUU¿¥UUUUUUCHNM |
| 00000110 | 00 | 00 | 00 | 19 | 6E | 50 | 61 | 72 | 74 | 69 | 63 | 6C | 65 | 53 | 68 | 61 | ....nParticleSha |
| 00000120 | 70 | 65 | 31 | 5F | 70 | 6F | 73 | 69 | 74 | 69 | 6F | 6E | 00 | 00 | 00 | 00 | pe1_position.... |
| 00000130 | 53 | 49 | 5A | 45 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 02 | 46 | 56 | 43 | 41 | SIZE........FVCA |
| 00000140 | 00 | 00 | 00 | 18 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 40 | A0 | 00 | 00 | ............@ .. |
| 00000150 | 40 | DF | FF | FB | 00 | 00 | 00 | 00 | 3B | B6 | A8 | 82 | 43 | 48 | 4E | 4D | @ßÿû....;¶¨‚CHNM |
| 00000160 | 00 | 00 | 00 | 1B | 6E | 50 | 61 | 72 | 74 | 69 | 63 | 6C | 65 | 53 | 68 | 61 | ....nParticleSha |
| 00000170 | 70 | 65 | 31 | 5F | 6C | 69 | 66 | 65 | 73 | 70 | 61 | 6E | 50 | 50 | 00 | 00 | pe1_lifespanPP.. |
| 00000180 | 53 | 49 | 5A | 45 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 02 | 44 | 42 | 4C | 41 | SIZE........DBLA |
| 00000190 | 00 | 00 | 00 | 10 | 47 | EF | FF | FF | E0 | 00 | 00 | 00 | 47 | EF | FF | FF | ....Gïÿÿà...Gïÿÿ |
| 000001A0 | E0 | 00 | 00 | 00 | 43 | 48 | 4E | 4D | 00 | 00 | 00 | 20 | 6E | 50 | 61 | 72 | à...CHNM... nPar |
| 000001B0 | 74 | 69 | 63 | 6C | 65 | 53 | 68 | 61 | 70 | 65 | 31 | 5F | 66 | 69 | 6E | 61 | ticleShape1_fina |
| 000001C0 | 6C | 4C | 69 | 66 | 65 | 73 | 70 | 61 | 6E | 50 | 50 | 00 | 53 | 49 | 5A | 45 | lLifespanPP.SIZE |
| 000001D0 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 02 | 44 | 42 | 4C | 41 | 00 | 00 | 00 | 10 | ........DBLA.... |
| 000001E0 | 47 | EF | FF | FF | E0 | 00 | 00 | 00 | 47 | EF | FF | FF | E0 | 00 | 00 | 00 | Gïÿÿà...Gïÿÿà... |
| 000001F0 | 43 | 48 | 4E | 4D | 00 | 00 | 00 | 19 | 6E | 50 | 61 | 72 | 74 | 69 | 63 | 6C | CHNM....nParticl |
| 00000200 | 65 | 53 | 68 | 61 | 70 | 65 | 31 | 5F | 76 | 65 | 6C | 6F | 63 | 69 | 74 | 79 | eShape1_velocity |
| 00000210 | 00 | 00 | 00 | 00 | 53 | 49 | 5A | 45 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 02 | ....SIZE........ |
| 00000220 | 46 | 56 | 43 | 41 | 00 | 00 | 00 | 18 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | FVCA............ |
| 00000230 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | ................ |
| 00000240 | 46 | 4F | 52 | 34 | 00 | 00 | 02 | 08 | 4D | 59 | 43 | 48 | 54 | 49 | 4D | 45 | FOR4....MYCHTIME |
| 00000250 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | FA | 43 | 48 | 4E | 4D | 00 | 00 | 00 | 13 | .......úCHNM.... |
| 00000260 | 6E | 50 | 61 | 72 | 74 | 69 | 63 | 6C | 65 | 53 | 68 | 61 | 70 | 65 | 31 | 5F | nParticleShape1_ |
| 00000270 | 69 | 64 | 00 | 00 | 53 | 49 | 5A | 45 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 02 | id..SIZE..... |
| 00000280 | 44 | 42 | 4C | 41 | 00 | 00 | 00 | 10 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | DBLA......... |
| 00000290 | 3F | F0 | 00 | 00 | 00 | 00 | 00 | 00 | 43 | 48 | 4E | 4D | 00 | 00 | 00 | 16 | ?ð......CHNM. |

**BLOCK** #2

# nParticles cache description (one file)

by S. Cieri, C. D'Angelis

## HEADER — 48 bytes

| | | | | |
|---|---|---|---|---|
| **cache format** | 4 bytes | "FOR4" | char* | cache format |
| **header length** | 4 bytes | .. .. .. .. | (hex) unsigned int | header data length (bytes) |
| **cache version** | 8 bytes | "CACHVRSN" | char* | tag for cache version |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | cache version data length (bytes) |
| | 4 bytes | "30 2E 31 00" | (hex) | cache version |
| **start time** | 4 bytes | "STIM" | char* | tag for start time |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | start time data length (bytes) |
| | 4 bytes | "00 00 00 00" | (hex) unsigned int | start value** |
| **end time** | 4 bytes | "ETIM" | char* | tag for end time |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | end time data length (bytes) |
| | 4 bytes | "00 00 00 01" | (hex) unsigned int | end value** |

## BLOCK — 24 + n bytes

| | | | | |
|---|---|---|---|---|
| **cache format** | 4 bytes | "FOR4" | char* | cache format |
| **block length** | 4 bytes | .. .. .. .. | (hex) unsigned int | block data length (bytes) |
| **block tag** | 4 bytes | "MYCH" | char* | tag for channels' block |
| **current time** | 4 bytes | "TIME" | char* | tag for current time |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | time data length (bytes) |
| | 4 bytes | .. .. .. .. | (hex) int | current time (ticks) |
| | n bytes | | | [channels' data, as explained below] |

## CHANNEL — 28 + n bytes

| | | | | |
|---|---|---|---|---|
| **channel name** | 4 bytes | "CHNM" | char* | tag for channel name |
| | 4 bytes | .. .. .. .. | int (hex) | channel name data length (name length + 1) |
| | n bytes | | char* | channel name, padded with modulus of 4<br>padding = 4 - len(name)%4 |
| **array size** | 4 bytes | "SIZE" | char* | tag for channel's array size |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | array size data length (bytes) |
| | 4 bytes | .. .. .. .. | (hex) unsigned int | array size (number of elements) |
| **data type** | 4 bytes | | char* | tag for data type |
| | | "DBLA" | | double array |
| | | "FVCA" | | float vector array (Maya 8.5 and later) |
| | | "DVCA" | | double vector array (Maya 8.0 and earlier)*** |
| **data array** | 4 bytes | .. .. .. .. | (hex) int | array size (bytes) |
| | n bytes | | (hex) float | double | array data |

**     this is only in *one file* caches

***     DVCA is not supported by *Maya Cache DLL Project* (the library is compatible only with Maya 8.5 and later)

# nParticles cache description (one file per frame)

by S. Cieri, C. D'Angelis

## Format Specification for nParticles, in one .mc file per frame

The single-frame .mc file format for nParticles consists of:

• A header for general file information. Please note that (only in the *one file per frame* version) the start and end time value to specify is the current frame cached.
• A single block, reporting its own length in bytes (such length includes all the channels included in the block).
• A section, containing a number of channels, which is equal to the number of attributes you want to cache per frame; each channel defines the channel-wise data regarding the particles.

**HEADER**
- cache format
- header length
- cache version
- start (current) time
- end (current) time

**BLOCK**
- cache format
- block length
- block tag

**CHANNEL** #1
- channel name
- array size
- data type
- data array

**CHANNEL** #2

**CHANNEL** #3

**CHANNEL** #n

```
Offset(h)  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
00000000   46 4F 52 34 00 00 00 28 43 41 43 48 56 52 53 4E   FOR4...(CACHVRSN
00000010   00 00 00 04 30 2E 31 00 53 54 49 4D 00 00 00 04   ....0.1.STIM....
00000020   00 00 00 00 45 54 49 4D 00 00 00 04 00 00 00 00   ....ETIM........
00000030   46 4F 52 34 00 00 01 FC 4D 59 43 48 43 48 4E 4D   FOR4...üMYCHCHNM
00000040   00 00 00 13 6E 50 61 72 74 69 63 6C 65 53 68 61   ....nParticleSha
00000050   70 65 31 5F 69 64 00 00 53 49 5A 45 00 00 00 04   pe1_id..SIZE....
00000060   00 00 00 02 44 42 4C 41 00 00 00 10 00 00 00 00   ....DBLA........
00000070   00 00 00 00 3F F0 00 00 00 00 00 00 43 48 4E 4D   ....?ð......CHNM
00000080   00 00 00 16 6E 50 61 72 74 69 63 6C 65 53 68 61   ....nParticleSha
00000090   70 65 31 5F 63 6F 75 6E 74 00 00 00 53 49 5A 45   pe1_count...SIZE
000000A0   00 00 00 04 00 00 00 01 44 42 4C 41 00 00 00 08   ........DBLA....
000000B0   40 00 00 00 00 00 00 00 43 48 4E 4D 00 00 00 1A   @.......CHNM....
000000C0   6E 50 61 72 74 69 63 6C 65 53 68 61 70 65 31 5F   nParticleShape1_
000000D0   62 69 72 74 68 54 69 6D 65 00 00 00 53 49 5A 45   birthTime...SIZE
000000E0   00 00 00 04 00 00 00 02 44 42 4C 41 00 00 00 10   ........DBLA....
000000F0   BF A5 55 55 55 55 55 55 BF A5 55 55 55 55 55 55   ¿¥UUUUUU¿¥UUUUUU
00000100   43 48 4E 4D 00 00 00 19 6E 50 61 72 74 69 63 6C   CHNM....nParticl
00000110   65 53 68 61 70 65 31 5F 70 6F 73 69 74 69 6F 6E   eShape1_position
00000120   00 00 00 00 53 49 5A 45 00 00 00 04 00 00 00 02   ....SIZE........
00000130   46 56 43 41 00 00 00 18 00 00 00 00 00 00 00 00   FVCA............
00000140   40 A0 00 00 40 DF FF FB 00 00 00 00 3B B6 A8 82   @ ..@ßÿû....;¶¨‚
00000150   43 48 4E 4D 00 00 00 1B 6E 50 61 72 74 69 63 6C   CHNM....nParticl
00000160   65 53 68 61 70 65 31 5F 6C 69 66 65 73 70 61 6E   eShape1_lifespan
00000170   50 50 00 00 53 49 5A 45 00 00 00 04 00 00 00 02   PP..SIZE........
00000180   44 42 4C 41 00 00 00 10 47 EF FF FF E0 00 00 00   DBLA....Gïÿÿà...
00000190   47 EF FF FF E0 00 00 00 43 48 4E 4D 00 00 00 20   Gïÿÿà...CHNM...
000001A0   6E 50 61 72 74 69 63 6C 65 53 68 61 70 65 31 5F   nParticleShape1_
000001B0   66 69 6E 61 6C 4C 69 66 65 73 70 61 6E 50 50 00   finalLifespanPP.
000001C0   53 49 5A 45 00 00 00 04 00 00 00 02 44 42 4C 41   SIZE........DBLA
000001D0   00 00 00 10 47 EF FF FF E0 00 00 00 47 EF FF FF   ....Gïÿÿà...Gïÿÿ
000001E0   E0 00 00 00 43 48 4E 4D 00 00 00 19 6E 50 61 72   à...CHNM....nPar
000001F0   74 69 63 6C 65 53 68 61 70 65 31 5F 76 65 6C 6F   ticleShape1_velo
00000200   63 69 74 79 00 00 00 00 53 49 5A 45 00 00 00 04   city....SIZE....
00000210   00 00 00 02 46 56 43 41 00 00 00 18 00 00 00 00   ....FVCA........
00000220   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
00000230   00 00 00 00                                       ....
```

# nParticles cache description (one file per frame)

by S. Cieri, C. D'Angelis

## HEADER — 48 bytes

| | | | | |
|---|---|---|---|---|
| cache format | 4 bytes | "FOR4" | char* | cache format |
| header length | 4 bytes | .. .. .. .. | (hex) unsigned int | header data length (bytes) |
| cache version | 8 bytes | "CACHVRSN" | char* | tag for cache version |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | cache version data length (bytes) |
| | 4 bytes | "30 2E 31 00" | (hex) | cache version |
| start time | 4 bytes | "STIM" | char* | tag for start time |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | start time data length (bytes) |
| | 4 bytes | .. .. .. .. | (hex) unsigned int | current frame** |
| end time | 4 bytes | "ETIM" | char* | tag for end time |
| | 4 bytes | "00 00 00 04" | (hex) unsigned int | end time data length (bytes) |
| | 4 bytes | .. .. .. .. | (hex) unsigned int | current frame** |

## BLOCK — 12 + n bytes

| | | | | |
|---|---|---|---|---|
| cache format | 4 bytes | "FOR4" | char* | cache format |
| block length | 4 bytes | .. .. .. .. | (hex) unsigned int | block data length (bytes) |
| block tag | 4 bytes | "MYCH" | char* | tag for channels' block |
| | n bytes | | | [channels' data, as explained below] |

## CHANNEL — 28 + n bytes

| | | | | |
|---|---|---|---|---|
| channel name | 4 bytes | "CHNM" | char* | tag for channel name |
| | 4 bytes | .. .. .. .. | int (hex) | channel name data length (name length + 1) |
| | n bytes | | char* | channel name, padded with modulus of 4 <br> padding = 4 - len(name)%4 |
| array size | 4 bytes | "SIZE" | char* | tag for channel's array size |
| | 4 bytes | "00 00 00 04" | (he x) unsigned int | array size data length (bytes) |
| | 4 bytes | .. .. .. .. | (hex) unsigned int | array size (number of elements) |
| data type | 4 bytes | | char* | tag for data type |
| | | "DBLA" | | double array |
| | | "FVCA" | | float vector array (Maya 8.5 and later) |
| | | "DVCA" | | double vector array (Maya 8.0 and earlier)*** |
| data array | 4 bytes | .. .. .. .. | (hex) int | array size (bytes) |
| | n bytes | | (hex) float \| double | array data |

**    this is only in *one file* per frame caches

***    DVCA is not supported by *Maya Cache DLL Project* (the library is compatible only with Maya 8.5 and later)