Specification for the NEV file format (Rev. 2.0)

File Format Overview

This data format is designed to provide a method for encoding digitized extracellular electrode spike information for up to 255 electrodes (future revisions of the specification will provide higher counts). The format also includes methods for embedding low bandwidth, time-stamped experiment events. This format represents a balance between format flexibility to encode a variety of different event types, efficiency of encoding, and simplicity of organization for quick analysis.

A ***.NEV** file is composed of three sections:

1) **Header Basic Information**
   A series of fixed width fields containing the basic timing, creation, and comment information of the file.

2) **Header Extended Information**
   A variable number of fixed-width packets which can be used to embed data about the configuration of certain electrode channels and other important experiment information.

3) **Data Packets**
   A series of fixed width packets used to encode the electrode data stream.

All data stored in the file is in the form of packets that encapsulate information about certain events. For example, a spike on an electrode is considered to be an event, and the time of the spike, the channel number, and the waveform of the spike are stored in a data packet. Non-neural experiment events can also be embedded as data packets. Electrode channels in the file are numbered from 1 to 255.

In the section and field descriptions given below, Win32 data type designations are used. Since the data types can be confusing on different platforms, the designations are listed here for clarity. Caution is recommended as the names used here may be different under other compilers. Multi-byte types in this format are stored in little-endian format (LSB first, MSB last) in accord with MS-DOS convention.

char	8-bit ASCII character or signed value
unsigned char	8-bit unsigned value
word	16-bit unsigned value
short or *short int*	16-bit signed value
long or *int*	32-bit signed value
unsigned long	32-bit unsigned value

Section 1 - Header Basic Information

This section is placed at the beginning of the file and consists of the following fields in the order listed.

8 bytes (string) - File Type Identifier equal to "NEURALEV"

2 bytes (2 x unsigned char) - File Specification used to create the file
2 unsigned byte values which give the major and minor revision numbers of the NEV file specification used to create the file. For example, use 0x0200 for Spec 2.0.

2 bytes (word) - File format additional flags
Not used in this specification version. Use 0x0000.

4 bytes (unsigned long) - Number of bytes in the headers

The total number of bytes in both headers (Standard and Extended). This value can also be considered to be a zero-indexed pointer to the first data packet.

4 bytes (unsigned long) - Number of bytes per data packet

The length (in bytes) of the fixed width data packets in the data section of the file. The packet sizes must be between 12 and 256 bytes (see Data Section description). Packet sizes are required to be multiples of 4 so that the packets are well aligned for 32-bit file access.

4 bytes (unsigned long) - Time Resolution of Time Stamps

This value denotes the frequency (counts per second) of the global clock used to index the time stamps of the individual data packet entries.

4 bytes (unsigned long) - Time Resolution of Samples

This value denotes the sampling frequency (counts per second) used to digitize neural waveforms.

16 bytes (Windows SYSTEMTIME structure) - Time Origin

The Greenwich Mean Time at which the data in the file was collected. This also corresponds to time index zero for the time stamps in the file. The structure consists of eight 2-byte unsigned words defining the Year, Month, DayOfWeek, Day, Hour, Minute, Second, Milliseconds.

32 bytes (string) - Application used to create the file

A 32 character string labeling the program which created the file. Programs should also include their revision number in this label. The strings may be 32 bytes wide or have a null termination.

256 bytes (string) - Comment Field

A 256 character, null-terminated string used for embedding comments into the data field. Multi-line comments should ideally use no more than 80 characters per line and no more than 8 lines. If no null termination is present, the string is 256 characters.

4 bytes (unsigned long) - Number of Extended Headers

A long value indicating the number of extended header entries.

Section 2 - Header Extended Information

This section consists of a variable number of 32-byte,fixed length extended information entries. The exact number of entries in this section is specified at the end of the Header Basic Information section. These entries may be used to include additional configuration information and comments into the file.

Each 32-byte extended information entry consists of an **8 byte identifier** and a **24 byte information field**. These entries are not required to be of any registered type. For example, a program can add extended header entries to the NEV file that only the program or related programs can utilize. However, there are several standard entries and identifiers that are defined in the specification and listed below with the 8 character identifier and 24 byte information field.

"ARRAYNME": Name of the electrode array used, if special

+ char[24] = string name of the electrode array used, may be null-terminated

"ECOMMENT": Extra Comment string

+ char[24] = string name to be included, may be null-terminated

"CCOMMENT": Continued comment string

+ char[24] = string to be appended to previous comment, may be null-terminated

"MAPFILE ": Mapfile used in the creation of the data

+ char[24] = string for name of map file used, may be null-terminated

"NEUEVWAV": Standard neural event waveform

+ (word) Electrode ID number used in the data section of the file (1-255).
+ (unsigned char) Physical system connector or module connected to the electrode
+ (unsigned char) Physical system connector pin or channel connected to the electrode
+ (word) Digitization scaling factor (nV per LSB step)
+ (word) Energy threshold, 0 if none used
+ (short int) Amplitude high threshold used (in uV) 0 to 32767
+ (short int) Amplitude low threshold used (in uV) 0 to -32767
+ (unsigned char) number of sorted units in channel, set to 0 for no unit classification
+ (unsigned char) number of bytes per waveform sample, a value of 0 indicates 1 byte.

(Remaining bytes reserved, write as zero)

"NSASEXEV": Configuration of NSAS experiment information channels

+ (word) frequency of periodic packet generation, 0 if none
+ (unsigned char) Digital Input Port configuration
  bit 0 = 0 if digital input port changes are ingnored
  bit 0 = 1 if digital input port changes cause experiment information events
  bits 1-7 are reserved
+ (unsigned char) External Analog Channel 1 Configuration
  bit 0 = Low to High edge triggers experiment information event (0 = no, 1 = yes)
  bit 1 = High to Low edge triggers experiment information event (0 = no, 1 = yes)
+ (short int) Analog Channel 1 edge detect value in mV (-5000 to 5000)
+ (unsigned char) External Analog Channel 2 Configuration
  bit 0 = Low to High edge triggers experiment information event (0 = no, 1 = yes)
  bit 1 = High to Low edge triggers experiment information event (0 = no, 1 = yes)
+ (short int) Analog Channel 2 edge detect value in mV (-5000 to 5000)
+ (unsigned char) External Analog Channel 3 Configuration
  bit 0 = Low to High edge triggers experiment information event (0 = no, 1 = yes)
  bit 1 = High to Low edge triggers experiment information event (0 = no, 1 = yes)
+ (short int) Analog Channel 3 edge detect value in mV (-5000 to 5000)
+ (unsigned char) External Analog Channel 4 Configuration
  bit 0 = Low to High edge triggers experiment information event (0 = no, 1 = yes)
  bit 1 = High to Low edge triggers experiment information event (0 = no, 1 = yes)
+ (short int) Analog Channel 4 edge detect value in mV (-5000 to 5000)
+ (unsigned char) External Analog Channel 5 Configuration
  bit 0 = Low to High edge triggers experiment information event (0 = no, 1 = yes)
  bit 1 = High to Low edge triggers experiment information event (0 = no, 1 = yes)
+ (short int) Analog Channel 5 edge detect value in mV (-5000 to 5000)

(remaining bytes reserved, write as zero)

Section 3 - Data Packets

This section contains an unspecified number of fixed length data packets (length defined in the Basic Header Section). Extracellular spike events and external experiment channel updates are stored in these packets.

Each packet begins with a **4 byte (unsigned long) Time Stamp** and a **2 byte (word) Packet Identifier**. The remaining bytes of the packet are defined according to the packet type.

The 4 byte (unsigned long) Time Stamp of the packet gives the time at which the event contained in the packet occurred. A time stamp of zero corresponds to the beginning of the data acquisition cycle and the

beginning of the file. The frequency of the time stamp clock and the time of the file creation are stored in the Header Basic Information section.

The 2 byte (word) Packet Identifier determines the information stored in the remainder of the packet. The different IDs correspond to system events or events on certain electrodes. In this revision of the specification, only packet IDs from 0 to 255 are valid. The upper 8 bits of this value are reserved as 0.

The contents of the different packet types are listed below.

Packet Identifier 0

Represent packets that give the state of non-neural experiment information channels. These packets can be inserted whenever a periodic sampling timer expires, the value of the digital input port changes, or when an analog edge threshold is crossed.

This revision provides for digital values up to 16 bits, and 5 analog inputs to be logged for each experiment information entry. An event trigger on any one of the experiment information channels is assumed to log the instantaneous state of all of the experiment information channels.

The data fields of packets with Packet ID 0 are (in order):

4 byte (unsigned long) Timestamp.
2 byte (word) Packet ID equal to zero.
1 byte (unsigned char) bit flag field detailing why this packet was inserted
    bit 0 set if digital channel changed
    bit 1 set if analog channel 1 crossed threshold
    bit 2 set if analog channel 2 crossed threshold
    bit 3 set if analog channel 3 crossed threshold
    bit 4 set if analog channel 4 crossed threshold
    bit 5 set if analog channel 5 crossed threshold
    bit 6 set if periodic sampling event
    bit 7 is reserved as 0
    (multiple bits may be set).
1 byte (reserved as 0)
2 bytes (word) value of the digital input port
2 bytes (short int) Analog Input Channel 1 Value in mV (± 5000)
2 bytes (short int) Analog Input Channel 2 Value in mV (± 5000)
2 bytes (short int) Analog Input Channel 3 Value in mV (± 5000)
2 bytes (short int) Analog Input Channel 4 Value in mV (± 5000)
2 bytes (short int) Analog Input Channel 5 Value in mV (± 5000)

Packet Identifiers to 1 through 255

Represent a spike event on the electrode number given by the packet ID number. For example, a data packet with ID 25 indicates that a spike occurred on electrode 25 at the time of the time stamp. The data fields of packets with Packet ID 1-25 are (in order):

4 byte (unsigned long) Timestamp
2 byte (word) Packet ID equal to the electrode number (1-255)
1 byte (unsigned char) Unit classification number for the spike (0=unclassified, 255="noise")
1 byte (unsigned char) Reserved for future unit information (use 0)
[packet_width – 8] bytes (signed char) the sampled waveform of the spike

Continuation Packets

If the time stamp of the packet is 0xFFFFFFFF, the remaining bytes of the packet are a continuation of the previous packet and should be appended to that packet. This is to provide support for future

revisions in which the packet size may be allowed to shrink to 8 characters wide (no event waveform storage). In this case, the continuation packets would be used to squeeze packets (such as external info packets) which would not fit into an 8 character wide format.

Revision History

Version 2.0 First major revision to the file format. The X-Y channel notation system was scrapped in favor of a 1-255 straight linear numbering scheme. It is recommended that newer NEV programs only use this format and older NEV files be converted to NEV version 2.0 files. The types of packets have also been simplified into the 2 most commonly used entries in this format, neural events and external events. NSASEXEV and external events were also change to mV representation.