

Jens Peter Alfke
11 October 1993
AppleScript Team
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Introduction

OK, What Is It?

Even with the helpful Object Support Library routines that assemble common Apple event object descriptors, building descriptors and events is still a pain. I've written a library of two functions that make it quick and easy to build or display Apple event descriptors and the Apple events themselves.

The AEBuild function takes a format string — a description in a very simple language of an Apple event descriptor — and generates a real descriptor (which could be a record or list or event) out of it. The AEPrint function does the reverse: given an Apple event descriptor, list or record, it prettyprints it to a string. (The resulting string, if sent to AEBuild, would reproduce the original AEDesc structure.)

AEBuild can plug variable parameters into the structures it generates — as with printf, all you do is put marker characters in the format string and supply the parameter values as extra function arguments.

The benefits of using this library are fourfold:

- i It's easier for you to write the code to build Apple event structures. You only have to remember one function call and a few simple syntax rules. Your resulting code is also easier to understand.

- ii As of version 1.2, your code is even faster: AEBuild is three to four times as fast as the regular Apple Event Manager routines at constructing complex structures. (Your mileage may vary.)

- iii Your code is smaller: the code for AEBuild and the AESTream library is about 6k in size, and the overhead for each call is minimal. (Most of the descriptor string consists of the same four-letter codes you'd be using in your program code anyway, and the strings can even be stored in resources for more code savings.)

i AEPrint helps in debugging programs, by turning mysterious AEDesc structures into human-readable text.

What's New?

In version 1.3:

- A new function, AEPrintSize, computes how long the string built by AEPrint would be, without actually creating it. This is useful if you want to allocate storage for the string dynamically.
- AEPrint no longer truncates hex dumps (of unknown descriptors) after 32 bytes.

And in version 1.3.2:

- AEPrint no longer uses the stdio library. This should help reduce code size (and eliminate some problems in code resources) but to do it I had to cripple floating-point display. Floating-point descriptors now print as the integer part followed by ".XXXX".

And in version 1.3.3:

- After a brilliant suggestion by Rob Dye, AEPrint now uses the built in float-to-text coercion to display floating-point descriptors.
- Fixed a possible problem with AEBuild input strings containing Return characters, in the MPW version of the library.

How To Call the Functions

These are all C functions. They all take variable number s of arguments, so they'd be difficult or impossible to call from Pascal, anyway. (And remember, kids: there are no Pascal compilers for the PowerPC chip...)

AEBuild

OSErr

```
AEBuild( AEDesc *desc, const char *descriptorStr, ... ),  
vAEBuild( AEDesc *desc, const char *descriptorStr, void *args );
```

AEBuild reads a null-terminated descriptor string (usually a constant, although it could come from anywhere), parses it and builds a corresponding AEDesc structure. (Don't worry, I'll describe the syntax of the descriptor string in the next section.) If the descriptor string contains magic parameter-substitution characters ("@") then corresponding values of the correct type must be supplied as function arguments, just as with printf.

(vAEBuild is analogous to vprintf: Instead of passing the parameters along with the function, you supply a va_list, as defined in <stdarg.h>, that points to the parameter list. It's otherwise identical.)

AEBuild returns an OSErr. Any errors returned by Apple Event Manager routines while building the descriptor will be sent back to you. The most likely results are memFullErr and errAECoercionFail. Also likely is aeBuildSyntaxErr, resulting from an incorrect descriptor string. (Make sure to debug your descriptor strings, perhaps using the demo application, before you put them in programs!)

The basic version of AEBuild just reports that a syntax error occurred, without giving any additional information. If you want to know more (perhaps the string came from a user, to whom you'd like to report a helpful error message) you can use the other version of the library. This version includes a wee bit of extra code, and two global variables that will contain useful information after a syntax error:

```
extern AEBuild_SyntaxErrType  
      AEBuild_ErrCode;  
extern long  
      AEBuild_ErrPos;
```

AEBuild_ErrCode is an enumerated value that will contain a specific error code. The error codes are defined in AEBuild.h. AEBuild_ErrPos will contain the index into the descriptor string at which the error occurred: usually one character past the end of the offending token.

AEBuildParameters

```
OSErr AEBuildParameters( AppleEvent *event, const char *descriptorStr, ... );
```

AEBuildParameters adds parameters and/or attributes to an existing Apple event. descriptorStr specifies the parameters (required and optional) and attributes. Its syntax is described below (see especially the Apple Event

Descriptor Strings subsection); it's almost the same as the syntax for AEBuild, with a few additions and modifications. (vAEBuildParameters is analogous to vprintf: Instead of passing the parameters along with the function, you supply a va_list, as defined in <stdarg.h>, that points to the parameter list. It's otherwise identical.)
AEBuildAppleEvent

```
AEBuildAppleEvent( AEventClass theClass, AEventID theID,
                  DescType addressType, void *addressData, long addressLength,
                  short returnID, long transactionID,
                  AppleEvent *event,
                  const char *descriptorStr, ... );
```

AEBuildAppleEvent is like AEBuild but builds an Apple event, including parameters and attributes. Or, you could say that it's like AEBuildParameters but creates the event from scratch.

Most of the parameters are just like the parameters to AECreatAppleEvent, although you pass the target address data directly, instead of via a pre-built descriptor. The resulting Apple event will appear in the event parameter. descriptorStr specifies the parameters (required and optional) and attributes. The syntax is described below (see especially the Apple Event Descriptor Strings subsection); it's almost the same as the syntax for AEBuild, with a few additions and modifications.

(vAEBuildAppleEvent is analogous to vprintf: Instead of passing the parameters along with the function, you supply a va_list, as defined in <stdarg.h>, that points to the parameter list. It's otherwise identical.)
AEPrint

```
OSErr AEPrint( AEDesc *desc, char *bufStr, long bufSize );
```

AEPrint reads the Apple event descriptor desc and writes a corresponding descriptor string into the string pointed to by bufStr. It will write no more than bufSize characters, including the trailing null character. Any errors returned by Apple Event Manager routines will be returned to the caller; this isn't very likely unless the AEDesc structure is somehow corrupt.

The descriptor string produced, if sent to AEBuild, will build a descriptor identical to the original one. AEPrint tries to detect AERecords that have been coerced to other types and print them as coerced records. Structures of unknown type that can't be coerced to AERecords are dumped as hex data.

AEPrint can also print complete Apple events as well as regular descriptors. The syntax of the resulting string for an event is like that used by AEBuildParameters and AEBuildAppleEvent, except that:

- The string begins with the event class and ID separated by a backslash.
- the parameter list is surrounded by curly braces.
- Attributes are also displayed; they look like parameters but are preceded by "&"s.

The builder functions do not accept this event syntax yet. u
AEPrintSize

```
OSErr AEPrintSize( AEDesc *desc, long *bufSizeNeeded );
```

AEPrintSize computes the buffer size that AEPrint would require if given the same descriptor. (The size is equal to the string length, plus 1 byte for the trailing null.) This is handy for pre-fighting AEPrint, if you want to allocate the buffer dynamically instead of relying on one of fixed size .

Descriptor-String Syntax

The real meat of all this, of course, is the syntax of the descriptor strings. It's pretty simple: basic data types like numbers and strings can be described directly, and then built up into lists and records. I've even provided a pseudo-BNF grammar (next section) for those of you who actually enjoy reading those things.

Basic Types

The fundamental data types are:

Type	Examples	Type-code	Description
------	----------	-----------	-------------

Integer 1234
 -5678 'long' or
 'shor' A sequence of decimal digits,
 optionally preceded by a minus
 sign.
 Enum/Type
 Code whos
 longint
 'long'
 <=
 '8-)'
 'ZQ 5'
 m 'enum'
 (Use coercion
 to change to
 'type') A magic four-letter code. Will be
 truncated or padded with spaces
 to exactly four characters. If you
 put straight or curly single-
 quotes around it, it can contain
 any characters. If not, it can't
 contain any of: @'"":~,{ }])
 and can't begin with a digit.
 String "A String."
 "Multiple lines
 are okay." 'TEXT' Any sequence of characters
 within open and close curly
 quotes. Won't be null-terminated.
 Hex Data «4170706C65»
 «0102 03ff
 e b 6 c» ??
 (Must be
 coerced to
 some type) An even number of hex digits
 between French quotes (Option-
 \, Option-Shift-\). Whitespace is
 ignored.

u Yes, you have to use the actual four-letter codes for enums, type codes,
 keywords and object types, instead of the mnemonic constants. Luckily the
 codes are semi-mnemonic anyway. I did it this way to avoid the massive
 overhead, both in code size and execution speed, of a symbol table. You can
 find the definitions of the constants in the text file "AEOObjects.p", which is
 part of the Apple Events Object Support Library. u

Coercion
 Any basic element (except a hex string) by itself is a descriptor, whose
 descriptorType is as given in the table. You can coerce a basic element to a
 different type by putting it in parentheses with a type-code placed before it. Here
 are some examples:

```

sing(1234)
type(line)
long(CODE)
hexd("A String")
'blob'(«4170706C65»)

```

u Coercions of numeric values are effected by calling AECOerceDesc; if the
 coercion fails, you'll get an errAECOercionFail error returned to you.

Coercions of other types just replace the descriptorType field of the AEDesc. u

u Hex strings must be coerced to something, since they have no intrinsic type. u
 You can also coerce nothing, to get a descriptor with zero-length data:

```

empty()

```

Even the type can be omitted, leaving just (), in which case the type is 'null'.

Lists

To make an AEDesclList, just enclose a comma-separated list of descriptors in square brackets. For example:

```
[123, -456, "et cetera"]
[sing(1234), long(CODE),
 ["wheels", "within wheels"]]
[]
```

The elements of a list can be of different types, and a list can contain other lists or records (see below) as elements.

Lists cannot be coerced to other types; the type of a list is always 'list'.

Records

An AERecord is indicated by a comma-separated list of elements enclosed in curly braces. Each element of a record consists of a keyword (a type-code, as described under Basic Types) followed by a ":", followed by a value, which can be any descriptor: a basic type, a list or another record. For example:

```
{x:100, y:-100}
{'origin': {x:100, y:-100}, extent: {x:500, y:500},
 cont: [1, 5, 25]}
{}
```

The default type of a record is 'reco'. Many of the Apple Events Object Model structures are AERecords that have been coerced to some other data type, like 'indx' or 'whos'. You can coerce a record structure to any type by preceding it with a type code. For example:

```
rang{ star: 5, stop: 6}
```

s Warning Coercing to an existing type, such as 'bool' or 'TEXT', is a bad idea. Anyone parsing the descriptor (including AEPrint) will recognize the type and assume that the data has the normal interpretation, which in this case it wouldn't. Bad to awful things would happen. Don't do it.

Apple Events

The syntax of the formatting string for an entire Apple event (as passed to AEBuildAppleEvent) is almost identical to that of a record. Each keyed element specified in the string becomes a parameter or attribute of the event. The differences are:

- There are no curly-braces at the beginning and end of the string.
- The character "~" before a parameter keyword makes it optional.

Here's an example of how to construct an Open Selection event for the Finder:

```
AliasHandle parent, itemToOpen;
const OSType finderSignature = 'MACS';
AppleEvent event;
OSErr err;

// Construct the aliases here (not shown)

err= AEBuildAppleEvent(
    'FNDR', 'SOPE',
    typeAppSignature, @finderSignature, sizeof(finderSignature),
    kAutoGenerateReturnID, kAnyTransactionID,
    &event,
    // Event to be created
    "----: alis(@@), fsel: [alis(@@)]", // Format string
    parent,
    // param for 1st @@
    itemToOpen
    // param for 2nd @@
);
```

Substituting Parameters

To plug your own values into the midst of a descriptor, use the magic "@" character. You can use "@" anywhere you can put a basic element like an integer.

Each “@” is replaced by a value taken from the parameter list sent to the AEBuild function. The type of value created depends on the context in which the “@” is used: in particular, how it’s coerced.

Type Coerced to:	Type of fn parameter read:	Comments:
No coercion	AEDesc*	A plain “@” will be replaced with a descriptor parameter.
Numeric (bool, shor, long, sing, doub, exte)	short, short, long, float, short double, double	Remember that THINK C’s double corresponds to type 'exte'!
TEXT	char*	Pointer to a null-terminated C string.
Any other type	long followed by void*	Expects a length parameter followed by a pointer to the descriptor data.
s	Important	Note particularly: that TEXT parameters must be null-terminated strings, although the resulting descriptor data will not be null-terminated; and that the general case expects two parameters: the data’s size and location. s

In addition, you can substitute data from a handle by using two @ signs. An “@@” parameter will read a single handle from the parameter list and use the data pointed to by that handle as the value of the descriptor. The “@@” must be coerced so that AEBuild will know what type to make the descriptor; however, the type coerced to can be anything (the table above is ignored.) This mechanism is still a bit limited, and may well be improved in the future.

Descriptor-String Grammar

Since no language, however small, can be taken seriously unless it comes fully equipped with a formidable-looking BNF grammar specification, I here present one. No attempt has been made to prevent Messrs. Backus and/or Naur from rolling over in their respective graves.

Character Classification:

```

whitespace  ' ', '\r', '\n', '\t'
digit       0 ... 9
paren, bracket,
braces     (, ), [, ], {, }
single-quote  '
double quotes  " , "
hex quotes    «, »
colon       :
comma      ,
at-sign     @
identchar   any other printable character

```

Tokens:

```

ident ::= identchar (identchar | digit)*  —Padded/truncated
        'character*' to exactly 4 chars
integer ::= [ - ] digit+  —Just as in C
string ::= " (character)* "
hexstring ::= « (hexdigit | whitespace)* »  —Even no. of digits, please

```

Grammar Rules for AEBuild:

```

formatstring ::= obj  —This is the top level of syntax
obj ::= data  —Single AEDesc; shortcut for (data)
      structure  —Un-coerced structure
      ident structure  —Coerced to some other type
structure ::= ( data ) —Single AEDesc
            [ objectlist ]  —AEList type
            { keywordlist } —AERecord type
objectlist ::= «blank» —Comma-separated list of things
            obj [ , obj ]*
keywordpair ::= ident : obj  —Keyword/value pair
keywordlist ::= «blank» —List of said pairs
            keywordpair [ , keywordpair ]*
data ::= @  —Gets appropriate data from fn param
       integer  —'shor' or 'long' unless coerced
       ident  —A 4-char type code ('type') unless coerced
       string  —Unterminated text; 'TEXT' type unless coerced
       hexstring  —Raw hex data; must be coerced to some type!

```

Grammar Rules for AEBuildAppleEvent:

```
eventstring ::= evtkeywordlist —Top level syntax for AEBuildAppleEvent
evtkeywordpair ::= [~] ident : obj —Keyword/value pair
evtkeywordlist ::= «blank»—List of said pairs
                 evtkeywordpair [ , evtkeywordpair ]*
```

There. Now it's all crystal-clear, right?

An Example & Timing Comparison

As an example, I'll take a C function to generate an object descriptor (taken from a Pascal example in the Object Model ERS, fleshed out and with gobs of error checking added) and turn it into a call to AEBuild. The object descriptor we want to generate is:

First line of document 'Spinnaker' whose first word is 'April'
and whose second word is 'is'

Then I'll execute both functions and compare their execution times.

C Code Using Object-Packing Library

OSErr

```
BuildByHand( AEDesc *dDocument, AEDesc *theResultObj )
```

```
{
    OSErr err;
    AEDesc dObjectExamined, dNum, dWord1, dWord2, dAprilText, dIsText,
          dComparison1, dComparison2, dLogicalTerms, dTheTest, dLineOne, dTestedLines;

    dObjectExamined.dataHandle =      /* Zero things to start out with so we can safely */
    dNum.dataHandle =                  /* execute our fail code if things don't
work out */
    dWord1.dataHandle =
    dWord2.dataHandle =
    dAprilText.dataHandle =
    dIsText.dataHandle =
    dComparison1.dataHandle =
    dComparison2.dataHandle =
    dLogicalTerms.dataHandle =
    dTheTest.dataHandle =
    dLineOne.dataHandle =
    dTestedLines.dataHandle =
        NIL;

    if( err= AECreatDesc( 'exmn', NIL, 0, &dObjectExamined ) )
        goto fail;

    if( err= MakeIndexDescriptor(1,&dNum) )
        goto fail;
    if( err= MakeObjDescriptor( 'word', &dObjectExamined, formIndex, &dNum,
                               false, &dWord1 ) )
        goto fail;
    if( err= AECreatDesc( 'TEXT', "April", 5, &dAprilText ) )
        goto fail;

    AEDisposeDesc(&dNum);
    if( err= MakeIndexDescriptor(2,&dNum) )
        goto fail;
    if( err= MakeObjDescriptor( 'word', &dObjectExamined, formIndex, &dNum,
                               true, &dWord2 ) )
        goto fail;
    if( err= AECreatDesc( 'TEXT', "is", 2, &dIsText ) )
        goto fail;

    if( err= MakeCompDescriptor( '= ', &dAprilText, &dWord1, true, &dComparison1 ) )
        goto fail;
    if( err= MakeCompDescriptor( '= ', &dIsText, &dWord2, true, &dComparison2 ) )
        goto fail;

    if( err= AECreatList( NIL, 0, false, &dLogicalTerms ) )
        goto fail;
    if( err= AEPutDesc( dLogicalTerms, 1, dComparison1 ) )
```

```

        goto fail;
    if( err= AEPutDesc( dLogicalTerms, 2, dComparison2 ) )
        goto fail;

    AEDisposeDesc(&dComparison1);
    AEDisposeDesc(&dComparison2);

    if( err= MakeLogicalDescriptor( &dLogicalTerms, 'AND ', true, &dTheTest ) )
        goto fail;

    if( err= MakeObjDescriptor(classLine,&dDocument,formTest,&dTheTest,true,
                                &dTestedLines) )
        goto fail;

    if( err= MakeIndexDescriptor(1,&dLineOne) )
        goto fail;
    if( err= MakeObjDescriptor( classLine, &dTestedLines, formIndex, &dLineOne,
                                true, theResultObj ) )
        goto fail;
    return noErr;

fail:
case we couldn't build it */
AEDisposeDesc(theResultObj);
AEDisposeDesc(&dObjectExamined);
AEDisposeDesc(&dNum);
AEDisposeDesc(&dWord1);
AEDisposeDesc(&dWord2);
AEDisposeDesc(&dAprilText);
AEDisposeDesc(&dIsText);
AEDisposeDesc(&dComparison1);
AEDisposeDesc(&dComparison2);
AEDisposeDesc(&dLogicalTerms);
AEDisposeDesc(&dTheTest);
AEDisposeDesc(&dLineOne);
AEDisposeDesc(&dTestedLines);

return err;
}

```

MPW 3.2b5 C compiled this into 816 bytes of object code.

I found that the average time to execute this function was 0.0188 seconds (Quadra 700) or 0.0113 seconds (IIfx).† Use this figure for comparison only; your times may vary. The timing is especially dependent on the number of blocks in the heap, since so many block allocations and disposals are happening.

Descriptor String

```

obj{ want:type('line'),
  from: obj{ want: type('line'), from: @, form: 'test',
    seld: logi{
      term: [comp{ relo:=, obj1:"April",
        obj2:
          obj{ want:type('word'), from:exmn(), form:indx, seld:1 }},
        comp{ relo:=, obj1:"is",
          obj2:
            obj{ want:type('word'), from:exmn(), form:indx, seld:2 }},
          1,
        logc:AND
      ]
    }
  },
  form: 'indx',
  seld: 1
}

```

AEBuild Call

```
char descriptor[] =
```

```
/* Same descriptor string as above. Note clever */
```



```

        aeBuildSyntaxBadToken,                /* Illegal character */
        aeBuildSyntaxBadEOF,                 /* Unexpected end of
format string */
        aeBuildSyntaxNoEOF,                  /* Unexpected extra
stuff past end */
        aeBuildSyntaxBadNegative,           /* "-" not followed by digits */
        aeBuildSyntaxMissingQuote,         /* Missing close "" */
        aeBuildSyntaxBadHex,                /* Non-digit in hex
string */
        aeBuildSyntaxOddHex,                /* Odd # of hex digits */
        aeBuildSyntaxNoCloseHex,           /* Missing ">" */
        aeBuildSyntaxUncoercedHex,         /* Hex string must be coerced
to a type */
        aeBuildSyntaxNoCloseString,        /* Missing "" */
        aeBuildSyntaxBadDesc,              /* Illegal descriptor */
        aeBuildSyntaxBadData,              /* Bad data value inside (...) */
        aeBuildSyntaxNoCloseParen,         /* Missing ")" after data value */
        aeBuildSyntaxNoCloseBracket,      /* Expected "," or "]" */
        aeBuildSyntaxNoCloseBrace,        /* Expected "{" or "}" */
        aeBuildSyntaxNoKey,                /* Missing keyword in
record */
        aeBuildSyntaxNoColon,              /* Missing ":" after keyword in
record */
        aeBuildSyntaxCoercedList,          /* Cannot coerce a list */
        aeBuildSyntaxUncoercedDoubleAt    /* "@@" substitution must be
coerced */
} AEBuild_SyntaxErrType;

```

```

// In all the "v..." functions, the "args" parameter is really a va_list.
// It's listed as void* here to avoid having to #include stdarg.h.

```

```

// Building a descriptor:

```

```

OSErr
    AEBuild( AEDesc *dst, const char *src, ... ),
    vAEBuild( AEDesc *dst, const char *src, const void *args );

```

```

// Adding a parameter to an Apple event:

```

```

OSErr
    AEBuildParameters( AppleEvent *event, const char *format, ... ),
    vAEBuildParameters( AppleEvent *event, const char *format, const void *args );

```

```

// Building an entire Apple event:

```

```

OSErr
    AEBuildAppleEvent( AEEEventClass theClass, AEEEventID theID,
                      DescType addressType, const void *addressData, long
addressLength,
                      short returnID, long transactionID, AppleEvent *result,
                      const char *paramsFmt, ... ),
    vAEBuildAppleEvent( AEEEventClass theClass, AEEEventID theID,
                      DescType addressType, const void *addressData, long
addressLength,
                      short returnID, long transactionID, AppleEvent
*resultEvt,
                      const char *paramsFmt, const void *args );

```

```

AEBuildGlobals.h

```

```

/*

```

```

*   AEBuildGlobals.h
*   Computer, Inc.

```

```

*/

```

```

Copyright ©1991 Apple

```

```

extern AEBuild_SyntaxErrType

```

```
        AEBuild_ErrCode;                /* Examine after AEBuild returns a
syntax error */
extern long
        AEBuild_ErrPos;                /* Index of error in format string */
AEPrint.h
/*
 *      AEPrint.h
 *      Copyright ©1991 Apple Computer, Inc.
 */

OSErr AEPrint( AEDesc *desc, char *bufStr, long bufSize );
```

† Yes, it really took half again as long on a Quadra! I think that cache flushing during the PACK call is responsible. (It barely slows down at all when you disable the caches.)