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The JSON Data Interchange Format
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Abstract

JavaScript Object Notation (JSON) is a lightweight, text-based, language-independent data interchange format. It was derived from the ECMAScript Programming Language Standard. JSON defines a small set of formatting rules for the portable representation of structured data.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

JavaScript Object Notation (JSON) is a text format for the serialization of structured data. It is derived from the object literals of JavaScript, as defined in the ECMAScript Programming Language Standard, Third Edition [ECMA].

JSON can represent four primitive types (strings, numbers, booleans, and null) and two structured types (objects and arrays).

A string is a sequence of zero or more Unicode characters [UNICODE].

An object is an unordered collection of zero or more name/value pairs, where a name is a string and a value is a string, number, boolean, null, object, or array.

An array is an ordered sequence of zero or more values.

The terms "object" and "array" come from the conventions of JavaScript.

JSON's design goals were for it to be minimal, portable, textual, and a subset of JavaScript.

1.1. Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

The grammatical rules in this document are to be interpreted as described in [RFC4234].

1.2. Introduction to This Revision

In the years since the publication of RFC 4627, JSON has found very wide use. This experience has revealed certain patterns which, while allowed by the RFC, have caused interoperability problems.

Also, a small number of errata have been reported.

This revision does not change any of the rules of the specification; all texts which were legal JSON remain so, and none which were not JSON become JSON. The revision's goal is to fix the errata and highlight practices which can lead to interoperability problems.

1.3. Changes from RFC 4627

This section lists all changes between this document and the text in RFC 4627.

- Changed Working Group attribution to JSON Working Group.
- Changed title of doc per consensus call at http://www.ietf.org/mail-archive/web/json/current/msg00736.html
- Applied erratum #607 from RFC 4627 to correctly align the artwork for the definition of "object".
- Change the reference to [UNICODE] to be be non-version-specific.
- Applied erratum #3607 from RFC 4627 by removing the security consideration that begins "A JSON text can be safely passed" and the JavaScript code that went with that consideration.
- Added Tim Bray as editor.
- Added an "Introduction to this Revision" section.

- Added language about duplicate object member names and interoperability.

- Added language about number interoperability as a function of IEEE754. Also added IEEE754 reference.

- Added language about interoperability and Unicode characters, and about string comparisons. To do this, turned the old "Encoding" section into a "Character Model" section, with three subsections: The old "Encoding" material, and two new sections for "Unicode Characters" and "String Comparison".

- Made a real "Security Considerations" section, and lifted the text out of the existing "IANA Considerations" section.

- Removed the language "Interoperability considerations: n/a" from the "IANA Considerations" section.

- Added "Contributors" section crediting Douglas Crockford.

- Changed "as sequences of digits" to "in the grammar below" in "Numbers" section.

2. JSON Grammar

A JSON text is a sequence of tokens. The set of tokens includes six structural characters, strings, numbers, and three literal names.

A JSON text is a serialized object or array.

```
JSON-text = object / array
```

These are the six structural characters:

```
   begin-array     = ws %x5B ws  ; [ left square bracket

   begin-object    = ws %x7B ws  ; { left curly bracket

   end-array       = ws %x5D ws  ; ] right square bracket

   end-object      = ws %x7D ws  ; } right curly bracket

   name-separator  = ws %x3A ws  ; : colon

   value-separator = ws %x2C ws  ; , comma
```

Insignificant whitespace is allowed before or after any of the six structural characters.

```
ws = *(
        %x20 /              ; Space
        %x09 /              ; Horizontal tab
        %x0A /              ; Line feed or New line
        %x0D                ; Carriage return
    )
```

3. Values

A JSON value MUST be an object, array, number, or string, or one of the following three literal names:

```
false null true
```

The literal names MUST be lowercase. No other literal names are allowed.

```
value = false / null / true / object / array / number / string

false = %x66.61.6c.73.65   ; false

null  = %x6e.75.6c.6c      ; null

true  = %x74.72.75.65      ; true
```

4. Objects

An object structure is represented as a pair of curly brackets surrounding zero or more name/value pairs (or members). A name is a string. A single colon comes after each name, separating the name from the value. A single comma separates a value from a following name. The names within an object SHOULD be unique.

```
object = begin-object [ member *( value-separator member ) ]
         end-object

member = string name-separator value
```

An object whose names are all unique is interoperable in the sense that all software implementations which receive that object will agree on the name-value mappings. When the names within an object

are not unique, the behavior of software that receives such an object is unpredictable. Many implementations report the last name/value pair only; other implementations report an error or fail to parse the object; other implementations report all of the name/value pairs, including duplicates.

5. Arrays

An array structure is represented as square brackets surrounding zero or more values (or elements). Elements are separated by commas.

array = begin-array [value *(value-separator value)] end-array

6. Numbers

The representation of numbers is similar to that used in most programming languages. A number contains an integer component that may be prefixed with an optional minus sign, which may be followed by a fraction part and/or an exponent part.

Octal and hex forms are not allowed. Leading zeros are not allowed.

A fraction part is a decimal point followed by one or more digits.

An exponent part begins with the letter E in upper or lowercase, which may be followed by a plus or minus sign. The E and optional sign are followed by one or more digits.

Numeric values that cannot be represented in the grammar below (such as Infinity and NaN) are not permitted.

```
number = [ minus ] int [ frac ] [ exp ]

decimal-point = %x2E       ; .

digit1-9 = %x31-39         ; 1-9

e = %x65 / %x45            ; e E

exp = e [ minus / plus ] 1*DIGIT

frac = decimal-point 1*DIGIT

int = zero / ( digit1-9 *DIGIT )

minus = %x2D               ; -

plus = %x2B                ; +

zero = %x30                ; 0
```

This specification allows implementations to set limits on the range of numbers accepted. Since software which implements IEEE 754-2008 [IEEE754] is generally available and widely used, good interoperability can be achieved by implementations which expect no more precision or range than provided by an IEEE 754 binary64 (double precision) number, in the sense that implementations will approximate JSON numbers within the expected precision. A JSON number which is outside those bounds, such as 1E400 or 3.14159265358979323846264338327 9, may indicate potential interoperability problems since it suggests that the software which created it it expected greater magnitude or precision than is widely available.

Note that when such software is used, numbers which are integers, are in the range [-(2**53)+1, (2**53)-1], and are represented without "frac" or "exp" parts (for example as 3 not 3.0), are interoperable in the sense that implementations will agree exactly on the numeric values.

Numbers which represent zero without a sign, for example as 0 or 0.0 not -0 or -0.0, are interoperable in the sense that software implementations will agree on the zero value. Signed zeros are significant in some numerically-intensive applications, but implementations which read JSON texts cannot be relied upon to preserve that distinction.

7. Strings

The representation of strings is similar to conventions used in the C family of programming languages. A string begins and ends with quotation marks. All Unicode characters may be placed within the quotation marks except for the characters that must be escaped: quotation mark, reverse solidus, and the control characters (U+0000 through U+001F).

Any character may be escaped. If the character is in the Basic Multilingual Plane (U+0000 through U+FFFF), then it may be represented as a six-character sequence: a reverse solidus, followed by the lowercase letter u, followed by four hexadecimal digits that encode the character's code point. The hexadecimal letters A though F can be upper or lowercase. So, for example, a string containing only a single reverse solidus character may be represented as "\u005C".

Alternatively, there are two-character sequence escape representations of some popular characters. So, for example, a string containing only a single reverse solidus character may be represented more compactly as "\\".

To escape an extended character that is not in the Basic Multilingual Plane, the character is represented as a twelve-character sequence, encoding the UTF-16 surrogate pair. So, for example, a string containing only the G clef character (U+1D11E) may be represented as "\uD834\uDD1E".

```
   string = quotation-mark *char quotation-mark

   char = unescaped /
       escape (
           %x22 /          ; "    quotation mark  U+0022
           %x5C /          ; \    reverse solidus U+005C
           %x2F /          ; /    solidus         U+002F
           %x62 /          ; b    backspace       U+0008
           %x66 /          ; f    form feed       U+000C
           %x6E /          ; n    line feed       U+000A
           %x72 /          ; r    carriage return U+000D
           %x74 /          ; t    tab             U+0009
           %x75 4HEXDIG )  ; uXXXX                U+XXXX

   escape = %x5C              ; \

   quotation-mark = %x22      ; "

   unescaped = %x20-21 / %x23-5B / %x5D-10FFFF
```

8. Character Model

8.1. Encoding and Detection

JSON text SHALL be encoded in Unicode. The default encoding is UTF-8.

Since the first two characters of a JSON text will always be ASCII characters [RFC0020], it is possible to determine whether an octet stream is UTF-8, UTF-16 (BE or LE), or UTF-32 (BE or LE) by looking at the pattern of nulls in the first four octets.

```
00 00 00 xx  UTF-32BE
00 xx 00 xx  UTF-16BE
xx 00 00 00  UTF-32LE
xx 00 xx 00  UTF-16LE
xx xx xx xx  UTF-8
```

8.2. Unicode Characters

When all the strings represented in a JSON text are composed entirely of Unicode characters [UNICODE] (however escaped), then that JSON text is interoperable in the sense that all software implementations which parse it will agree on the contents of names and of string values in objects and arrays.

However, the ABNF in this specification allows member names and string values to contain bit sequences which cannot encode Unicode characters, for example "\uDEAD" (a single unpaired UTF-16 surrogate). Instances of this have been observed, for example when a library truncates a UTF-16 string without checking whether the truncation split a surrogate pair. The behavior of software which receives JSON texts containing such values is unpredictable; for example, implementations might return different values for the length of a string value, or even suffer fatal runtime exceptions.

8.3. String Comparison

Software implementations are typically required to test names of object members for equality. Implementations which transform the textual representation into sequences of Unicode code units, and then perform the comparison numerically, code unit by code unit, are interoperable in the sense that implementations will agree in all cases on equality or inequality of two strings. For example, implementations which compare strings with escaped characters unconverted may incorrectly find that "a\b" and "a\u005Cb" are not equal.

9. Parsers

A JSON parser transforms a JSON text into another representation. A JSON parser MUST accept all texts that conform to the JSON grammar. A JSON parser MAY accept non-JSON forms or extensions.

An implementation may set limits on the size of texts that it accepts. An implementation may set limits on the maximum depth of nesting. An implementation may set limits on the range of numbers. An implementation may set limits on the length and character contents of strings.

10. Generators

A JSON generator produces JSON text. The resulting text MUST strictly conform to the JSON grammar.

11. IANA Considerations

The MIME media type for JSON text is application/json.

Type name: application

Subtype name: json

Required parameters: n/a

Optional parameters: n/a

Encoding considerations: 8bit if UTF-8; binary if UTF-16 or UTF-32

JSON may be represented using UTF-8, UTF-16, or UTF-32. When JSON is written in UTF-8, JSON is 8bit compatible. When JSON is written in UTF-16 or UTF-32, the binary content-transfer-encoding must be used.

Published specification: RFC 4627

Applications that use this media type:

JSON has been used to exchange data between applications written in all of these programming languages: ActionScript, C, C#, ColdFusion, Common Lisp, E, Erlang, Java, JavaScript, Lua, Objective CAML, Perl, PHP, Python, Rebol, Ruby, and Scheme.

Additional information:

Magic number(s): n/a
File extension(s): .json
Macintosh file type code(s): TEXT

Person & email address to contact for further information:
Douglas Crockford
douglas@crockford.com

Intended usage: COMMON

Restrictions on usage: none

Author:
Douglas Crockford
douglas@crockford.com

Change controller:
Douglas Crockford
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12. Security Considerations

Generally there are security issues with scripting languages. JSON is a subset of JavaScript, but excludes assignment and invocation.

13. Examples

This is a JSON object:

```
{
  "Image": {
      "Width":  800,
      "Height": 600,
      "Title":  "View from 15th Floor",
      "Thumbnail": {
          "Url":    "http://www.example.com/image/481989943",
          "Height": 125,
          "Width":  "100"
      },
      "IDs": [116, 943, 234, 38793]
    }
}
```

Its Image member is an object whose Thumbnail member is an object and whose IDs member is an array of numbers.

This is a JSON array containing two objects:

```
[
  {
     "precision": "zip",
     "Latitude":  37.7668,
     "Longitude": -122.3959,
     "Address":   "",
     "City":      "SAN FRANCISCO",
     "State":     "CA",
     "Zip":       "94107",
     "Country":   "US"
  },
  {
     "precision": "zip",
     "Latitude":  37.371991,
     "Longitude": -122.026020,
     "Address":   "",
     "City":      "SUNNYVALE",
     "State":     "CA",
     "Zip":       "94085",
     "Country":   "US"
  }
]
```

14. Contributors

RFC 4627 was written by Douglas Crockford. This document was constructed by making a relatively small number of additions to and subtractions from that document; thus the vast majority of the text here is his.

15. Normative References

[ECMA] European Computer Manufacturers Association, "ECMAScript Language Specification 3rd Edition ", December 1999, <http://www.ecma-international.org/publications/files/ecma-st/ECMA-262.pdf>.

[IEEE754] IEEE, "IEEE Standard for Floating-Point Arithmetic", 2008, <http://grouper.ieee.org/groups/754/>.

[RFC0020] Cerf, V., "ASCII format for network interchange", RFC 20, October 1969.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC4234] Crocker, D., Ed. and P. Overell, "Augmented BNF for Syntax Specifications: ABNF", RFC 4234, October 2005.

[UNICODE] The Unicode Consortium, "The Unicode Standard, Version 4.0 ", 2003, <http://www.unicode.org/versions/latest/>.

Appendix A. Changes in -04

- Reworded Section 8.2 to talk about strings that are represented in the JSON text, rather than the actual text itself. Also fine-tuned the "will agree on" clause in the interoperability description.

- Changed "20008" to "2008".

- Reworded numeric-interoperability language following on WG discussion, notably referring to availability of software that does IEEE754 and "approximate JSON numbers within the expected precision". Also took out duplicate language about NaN and Inf.

- Changed "as sequences of digits" to "in the grammar below" in "Numbers" section.

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