

## Augmented BNF for Syntax Specifications: ABNF

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## 1. INTRODUCTION

Internet technical specifications often need to define a format syntax and are free to employ whatever notation their authors deem useful. Over the years, a modified version of Backus-Naur Form (BNF), called Augmented BNF (ABNF), has been popular among many Internet specifications. It balances compactness and simplicity, with reasonable representational power. In the early days of the Arpanet, each specification contained its own definition of ABNF. This included the email specifications, RFC733 and then RFC822 which have come to be the common citations for defining ABNF. The current document separates out that definition, to permit selective reference. Predictably, it also provides some modifications and enhancements.

The differences between standard BNF and ABNF involve naming rules, repetition, alternatives, order-independence, and value ranges. Appendix A (Core) supplies rule definitions and encoding for a core lexical analyzer of the type common to several Internet specifications. It is provided as a convenience and is otherwise separate from the meta language defined in the body of this document, and separate from its formal status.

## 2. RULE DEFINITION

### 2.1 Rule Naming

The name of a rule is simply the name itself; that is, a sequence of characters, beginning with an alphabetic character, and followed by a combination of alphabetics, digits and hyphens (dashes).

**NOTE:** Rule names are case-insensitive

The names <rulename>, <Rulename>, <RULENAME> and <rULENameE> all refer to the same rule.

Unlike original BNF, angle brackets ("**<**", "**>**") are not required. However, angle brackets may be used around a rule name whenever their presence will facilitate discerning the use of a rule name. This is typically restricted to rule name references in free-form prose, or to distinguish partial rules that combine into a string not separated by white space, such as shown in the discussion about repetition, below.

## 2.2 Rule Form

A rule is defined by the following sequence:

```
name = elements crlf
```

where **<name>** is the name of the rule, **<elements>** is one or more rule names or terminal specifications and **<crlf>** is the end-of-line indicator, carriage return followed by line feed. The equal sign separates the name from the definition of the rule. The elements form a sequence of one or more rule names and/or value definitions, combined according to the various operators, defined in this document, such as alternative and repetition.

For visual ease, rule definitions are left aligned. When a rule requires multiple lines, the continuation lines are indented. The left alignment and indentation are relative to the first lines of the ABNF rules and need not match the left margin of the document.

## 2.3 Terminal Values

Rules resolve into a string of terminal values, sometimes called characters. In ABNF a character is merely a non-negative integer. In certain contexts a specific mapping (encoding) of values into a character set (such as ASCII) will be specified.

Terminals are specified by one or more numeric characters with the base interpretation of those characters indicated explicitly. The following bases are currently defined:

b	=	binary
d	=	decimal
x	=	hexadecimal

Hence:

CR = %d13

CR = %x0D

respectively specify the decimal and hexadecimal representation of [US-ASCII] for carriage return.

A concatenated string of such values is specified compactly, using a period (".") to indicate separation of characters within that value. Hence:

CRLF = %d13.10

ABNF permits specifying literal text string directly, enclosed in quotation-marks. Hence:

command = "command string"

Literal text strings are interpreted as a concatenated set of printable characters.

NOTE: ABNF strings are case-insensitive and the character set for these strings is us-ascii.

Hence:

rulename = "abc"

and:

rulename = "aBc"

will match "abc", "Abc", "aBc", "abC", "ABc", "aBC", "AbC" and "ABC".

To specify a rule which IS case SENSITIVE, specify the characters individually.

For example:

rulename = %d97 %d98 %d99

or

rulename = %d97.98.99

will match only the string which comprises only lowercased characters, abc.

## 2.4 External Encodings

External representations of terminal value characters will vary according to constraints in the storage or transmission environment. Hence, the same ABNF-based grammar may have multiple external encodings, such as one for a 7-bit US-ASCII environment, another for a binary octet environment and still a different one when 16-bit Unicode is used. Encoding details are beyond the scope of ABNF, although Appendix A (Core) provides definitions for a 7-bit US-ASCII environment as has been common to much of the Internet.

By separating external encoding from the syntax, it is intended that alternate encoding environments can be used for the same syntax.

## 3. OPERATORS

### 3.1 Concatenation

Rule1 Rule2

A rule can define a simple, ordered string of values -- i.e., a concatenation of contiguous characters -- by listing a sequence of rule names. For example:

```
foo          = %x61          ; a
bar          = %x62          ; b
mumble      = foo bar foo
```

So that the rule <mumble> matches the lowercase string "aba".

**LINEAR WHITE SPACE:** Concatenation is at the core of the ABNF parsing model. A string of contiguous characters (values) is parsed according to the rules defined in ABNF. For Internet specifications, there is some history of permitting linear white space (space and horizontal tab) to be freely and implicitly interspersed around major constructs, such as delimiting special characters or atomic strings.

**NOTE:** This specification for ABNF does not provide for implicit specification of linear white space.

Any grammar which wishes to permit linear white space around delimiters or string segments must specify it explicitly. It is often useful to provide for such white space in "core" rules that are

then used variously among higher-level rules. The "core" rules might be formed into a lexical analyzer or simply be part of the main ruleset.

### 3.2 Alternatives

Rule1 / Rule2

Elements separated by forward slash ("/") are alternatives. Therefore,

foo / bar

will accept <foo> or <bar>.

NOTE: A quoted string containing alphabetic characters is special form for specifying alternative characters and is interpreted as a non-terminal representing the set of combinatorial strings with the contained characters, in the specified order but with any mixture of upper and lower case..

### 3.3 Incremental Alternatives

Rule1 /= Rule2

It is sometimes convenient to specify a list of alternatives in fragments. That is, an initial rule may match one or more alternatives, with later rule definitions adding to the set of alternatives. This is particularly useful for otherwise- independent specifications which derive from the same parent rule set, such as often occurs with parameter lists. ABNF permits this incremental definition through the construct:

oldrule /= additional-alternatives

So that the rule set

ruleset = alt1 / alt2

ruleset /= alt3

ruleset /= alt4 / alt5

is the same as specifying

ruleset = alt1 / alt2 / alt3 / alt4 / alt5

### 3.4 Value Range Alternatives

%C##-##

A range of alternative numeric values can be specified compactly, using dash ("-") to indicate the range of alternative values. Hence:

DIGIT = %x30-39

is equivalent to:

DIGIT = "0" / "1" / "2" / "3" / "4" / "5" / "6" /  
"7" / "8" / "9"

Concatenated numeric values and numeric value ranges can not be specified in the same string. A numeric value may use the dotted notation for concatenation or it may use the dash notation to specify one value range. Hence, to specify one printable character, between end of line sequences, the specification could be:

char-line = %x0D.0A %x20-7E %x0D.0A

### 3.5 Sequence Group

(Rule1 Rule2)

Elements enclosed in parentheses are treated as a single element, whose contents are STRICTLY ORDERED. Thus,

elem (foo / bar) blat

which matches (elem foo blat) or (elem bar blat).

elem foo / bar blat

matches (elem foo) or (bar blat).

NOTE: It is strongly advised to use grouping notation, rather than to rely on proper reading of "bare" alternations, when alternatives consist of multiple rule names or literals.

Hence it is recommended that instead of the above form, the form:

(elem foo) / (bar blat)

be used. It will avoid misinterpretation by casual readers.

The sequence group notation is also used within free text to set off an element sequence from the prose.

### 3.6 Variable Repetition

\*Rule

The operator "\*" preceding an element indicates repetition. The full form is:

`<a>*<b>element`

where `<a>` and `<b>` are optional decimal values, indicating at least `<a>` and at most `<b>` occurrences of element.

Default values are 0 and infinity so that `*<element>` allows any number, including zero; `1*<element>` requires at least one; `3*3<element>` allows exactly 3 and `1*2<element>` allows one or two.

### 3.7 Specific Repetition

nRule

A rule of the form:

`<n>element`

is equivalent to

`<n>*<n>element`

That is, exactly `<N>` occurrences of `<element>`. Thus 2DIGIT is a 2-digit number, and 3ALPHA is a string of three alphabetic characters.

### 3.8 Optional Sequence

[RULE]

Square brackets enclose an optional element sequence:

`[foo bar]`

is equivalent to

`*1(foo bar).`

### 3.9 ; Comment

A semi-colon starts a comment that continues to the end of line. This is a simple way of including useful notes in parallel with the specifications.



### 3.10 Operator Precedence

The various mechanisms described above have the following precedence, from highest (binding tightest) at the top, to lowest and loosest at the bottom:

```
Strings, Names formation
Comment
Value range
Repetition
Grouping, Optional
Concatenation
Alternative
```

Use of the alternative operator, freely mixed with concatenations can be confusing.

Again, it is recommended that the grouping operator be used to make explicit concatenation groups.

## 4. ABNF DEFINITION OF ABNF

This syntax uses the rules provided in Appendix A (Core).

```
rulelist      = 1*( rule / (*c-wsp c-nl) )
rule          = rulename defined-as elements c-nl
               ; continues if next line starts
               ; with white space
rulename      = ALPHA *(ALPHA / DIGIT / "-")
defined-as    = *c-wsp ("=" / "=/") *c-wsp
               ; basic rules definition and
               ; incremental alternatives
elements      = alternation *c-wsp
c-wsp         = WSP / (c-nl WSP)
c-nl          = comment / CRLF
               ; comment or newline
comment       = ";" *(WSP / VCHAR) CRLF
alternation   = concatenation
               *(*c-wsp "/" *c-wsp concatenation)
```

```

concatenation = repetition *(1*c-wsp repetition)
repetition    = [repeat] element
repeat        = 1*DIGIT / (*DIGIT "*" *DIGIT)
element       = rulename / group / option /
               char-val / num-val / prose-val
group         = "(" *c-wsp alternation *c-wsp ")"
option        = "[" *c-wsp alternation *c-wsp "]"
char-val      = DQUOTE *(%x20-21 / %x23-7E) DQUOTE
               ; quoted string of SP and VCHAR
               without DQUOTE
num-val       = "%" (bin-val / dec-val / hex-val)
bin-val       = "b" 1*BIT
               [ 1*("." 1*BIT) / ("-" 1*BIT) ]
               ; series of concatenated bit values
               ; or single ONEOF range
dec-val       = "d" 1*DIGIT
               [ 1*("." 1*DIGIT) / ("-" 1*DIGIT) ]
hex-val       = "x" 1*HEXDIG
               [ 1*("." 1*HEXDIG) / ("-" 1*HEXDIG) ]
prose-val     = "<" *(%x20-3D / %x3F-7E) ">"
               ; bracketed string of SP and VCHAR
               without angles
               ; prose description, to be used as
               last resort

```

## 5. SECURITY CONSIDERATIONS

Security is truly believed to be irrelevant to this document.

## 6. APPENDIX A - CORE

This Appendix is provided as a convenient core for specific grammars. The definitions may be used as a core set of rules.

### 6.1 Core Rules

Certain basic rules are in uppercase, such as SP, HTAB, CRLF, DIGIT, ALPHA, etc.

ALPHA	=	%x41-5A / %x61-7A	; A-Z / a-z
BIT	=	"0" / "1"	
CHAR	=	%x01-7F	; any 7-bit US-ASCII character, excluding NUL
CR	=	%x0D	; carriage return
CRLF	=	CR LF	; Internet standard newline
CTL	=	%x00-1F / %x7F	; controls
DIGIT	=	%x30-39	; 0-9
DQUOTE	=	%x22	; " (Double Quote)
HEXDIG	=	DIGIT / "A" / "B" / "C" / "D" / "E" / "F"	
HTAB	=	%x09	; horizontal tab
LF	=	%x0A	; linefeed
LWSP	=	*(WSP / CRLF WSP)	; linear white space (past newline)
OCTET	=	%x00-FF	; 8 bits of data
SP	=	%x20	

```
                ; space  
VCHAR          = %x21-7E  
                ; visible (printing) characters  
WSP            = SP / HTAB  
                ; white space
```

## 6.2 Common Encoding

Externally, data are represented as "network virtual ASCII", namely 7-bit US-ASCII in an 8-bit field, with the high (8th) bit set to zero. A string of values is in "network byte order" with the higher-valued bytes represented on the left-hand side and being sent over the network first.

## 7. ACKNOWLEDGMENTS

The syntax for ABNF was originally specified in RFC 733. Ken L. Harrenstien, of SRI International, was responsible for re-coding the BNF into an augmented BNF that makes the representation smaller and easier to understand.

This recent project began as a simple effort to cull out the portion of RFC 822 which has been repeatedly cited by non-email specification writers, namely the description of augmented BNF. Rather than simply and blindly converting the existing text into a separate document, the working group chose to give careful consideration to the deficiencies, as well as benefits, of the existing specification and related specifications available over the last 15 years and therefore to pursue enhancement. This turned the project into something rather more ambitious than first intended. Interestingly the result is not massively different from that original, although decisions such as removing the list notation came as a surprise.

The current round of specification was part of the DRUMS working group, with significant contributions from Jerome Abela, Harald Alvestrand, Robert Elz, Roger Fajman, Aviva Garrett, Tom Harsch, Dan Kohn, Bill McQuillan, Keith Moore, Chris Newman, Pete Resnick and Henning Schulzrinne.

## 8. REFERENCES

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