**N2679: Outer**

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**History**

N6257: Initial paper

N2679: Added the “double outward” rule for selection and iteration statements, to account for the fact that in C there are two nested blocks. Changed “scope” by “block” in the explanation of the semantics. Forbidden the appearance of _Outer in function parameter lists. It complicates the definition and it seems that it is of no use there. Added alternative nº. 2. Some minor changes.

**Problem**

It is very difficult, if not impossible, to declare an identifier to be used in a macro in such a way that it will surely not conflict with some existing identifier:

```c
#define copystr8(x, y) do { 
  char *px = x; const char *py = y; 
  while(*py != \0) *px++ = *py++; *px = \0; 
} while(0)

copystr8(s2, s1); // OK
copystr8(px, s1); // Wrong
```

This has always been a problem, and now that tools for generic programming are being proposed (e.g.: typeof, or the document N2638) a solution for it seems more necessary.

**Proposed solution**

To introduce the identifier-resolver _Outer. Its intended use is as in this example:

```c
#define copystr8(x, y) do { 
  char *px = _Outer (x); 
  const char *py = _Outer (y); 
  while(*py != \0) *px++ = *py++; *px = \0; 
} while(0)
```

So that after a call like copystr8(px, s1); the expansion of the line declaring px would be

```c
char *px = _Outer (px);
```

and the inner px gets initialized properly.

Because the arguments passed to macros can be more or less complicated text it is necessary that the syntax allows expression like _Outer (ptr + pos[n]), say, where the identifier resolver should apply to all identifiers within. Furthermore, constructions like _Outer _Outer (_Outer ptr + pos[n]), which may arise from nested macro invocations should also be valid.

The “Example 1” below uses the operator typeof(), though it is not part of the language yet, in the expectation that it will be added.
The additions to the current text of the standard appear in blue (except for the syntax highlighting of the examples). This document also incorporates a proposal for fixing the first paragraph in the “Semantics” section of 6.5.1. In order to keep the two proposals clearly apart, the additions because of the latter are written in green, and deletions in red. (The current proposal requires no deletions beyond a trivial one at the very end due to section renumbering).

Proposed wording

6.4.1. Primary expressions

Syntax

(Add _Outer to the list of keywords)

6.5.1. Primary expressions

Syntax

\[
\text{primary-expression:} \\
\text{\hspace{1cm} semantic-identifier} \\
\text{\hspace{1cm} identifier-resolver-selection} \\
\text{\hspace{1cm} constant} \\
\text{\hspace{1cm} string-literal} \\
\text{\hspace{1cm} ( expression )} \\
\text{\hspace{1cm} generic-selection}
\]

Semantics

A semantic identifier is a primary expression, provided it resolves to an identifier which has been declared as designating an enumeration constant (a case covered by the next paragraph), an object (in which case it is an lvalue) or a function (in which case it is a function designator). An undeclared identifier is a violation of the syntax.

[...]

\[\text{\textsuperscript{132}}\text{Thus, an undeclared identifier is a violation of the syntax.}\]

6.5.1.1. Semantic identifier and identifier resolver selections

Syntax

\[
\text{semantic-identifier:} \\
\text{\hspace{1cm} identifier-resolver-seq\text{\_opt} identifier} \\
\text{identifier-resolver-seq:} \\
\text{\hspace{1cm} _Outer identifier-resolver-seq\text{\_opt}} \\
\text{identifier-resolver-selection:} \\
\text{\hspace{1cm} identifier-resolver-seq ( expression )}
\]

Constraints

A semantic identifier in which the identifier-resolver sequence is not empty is a modified identifier. A modified identifier may appear in some of the places an ordinary identifier (6.2.3) may, but not in all. It may not appear in the list of parameters of a function, and when the appearance of an ordinary identifier at that place would constitute its declaration.

Semantics

In a construction of the form

\[\_\text{Outer sem-id}\]
the identifier resolver \_Outer may modify the entity the semantic identifier sem-id refers to. A modified identifier at file scope is considered an undeclared identifier. Otherwise it makes it refer to the entity it would have referred to at a prior point in the code. That point is just before the beginning of the innermost block sem_id is included in, where it is considered that nested blocks always begin at different points (therefore, that point is one level of blocks outwards), except that, if such innermost block is the body of a selection or iteration statement, then it is the point just before the beginning of that statement (thus, two blocks outwards instead of one). If sem-id still includes identifier resolvers the rule applies recursively.

As a result of this process the modified identifier is said to resolve to an identifier.

An identifier-resolver selection identifier-resolver-seq ( expression ) evaluates to ( expression2 ), where expression2 is the same as expression except that:

i) All identifier-resolver selections present in expression have identifier-resolver-seq prepended.

ii) All semantic identifiers in expression that appear at places where a modified identifier is allowed and which are not within the scope of an identifier-resolver selection have identifier-resolver-seq prepended.

**EXAMPLE 1**

```c
#define DIR_SEP '/
#define remove_filename(x) do{
    typeof(*x) *px = _Outer(x); while(*px != 0) px++;
    while(px != _Outer _Outer(x) && *px != DIR_SEP) px--;
    if(*px == DIR_SEP) px[1] = 0;
} while(0)
/* Suppose str points to a block of memory where several strings are stored, the first one at the position pointed to by str, another one at str+pos[px]. */
char *str;
size_t pos[100];
unsigned int px;
/* ... */
remove_filename(str);
remove_filename(str + pos[px]);
```

After the invocation remove_filename(str) is replaced by its expansion, the _Outer(x) tokens from the macro definition become _Outer(str). The first of these, the ones at the initialization of px, according to the rules for the evaluation of an identifier-resolver selection evaluate to (_Outer str ), which is itself a primary expression, for it matches the syntax ( expression ). Within it, expression is _Outer str, which according to the rules for the resolution of a modified identifier evaluates to a semantic identifier which refers to the object str would refer to just before the beginning of the do statement. This is just the only declared str, and _Outer would not have been necessary. A similar analysis applies to the _Outer _Outer(x) tokens.

After the invocation remove_filename(str + pos[px]) the replacement is _Outer(str + pos[px]), which evaluates to

_Outer str + _Outer pos[Outer px]

and the _Outer that precedes px is necessary. There, _Outer px resolves to an identifier which designates the unsigned int from the declaration unsigned int px.

The px within the typeof operator does not need to be preceded by _Outer because after expansion:

typeof(*px) *px = _Outer(px)

by the time the first px is seen the scope of the px being declared has not yet begun (6.2.1 - 7, 6.7.6).
EXAMPLE 2

```c
int i; // 1st
int main(void){
    enum A{a, e, i = 6}; // 2nd
    {
        int i, j; // 3rd
        j = _Outer _Outer _Outer i; // The innermost _Outer i is to be resolved at file scope: undecl. identifier
        i = _Outer j; // Undeclared_identifier
        _Outer (int k[i]); // OK. k is not affected by _Outer because it is a declarator. VLA having 6 elements.
    }
}
```

EXAMPLE 3

```c
int i;
typedef unsigned int uint;
_Outer i = 2; // Error. _Outer at file scope

int h(int n);
int f(int _Outer i); // Constrain violations: _Outer in a function parameter list and i is a declarator
int g(void){
    int _Outer i; // Constrain violation: i is a declarator
    uint f;
    int k = _Outer uint; // Constrain violation, equivalent to int k = unsigned int;

    f = _Outer f(f); // OK
    f = _Outer (f)(f); // The same as previous line
    f = h(f) + _Outer h(f); // OK
    f = _Outer (f(i)); // Uses file-scope i
    {
        goto _Outer a; // Constrain violation. An ordinary identifier is not allowed here
    }
    a;
}
```

EXAMPLE 4

```c
_Outer (int a = _Outer _Outer (x + _Outer y) + z)
```

Evaluates to

```c
int a = _Outer _Outer _Outer (x + _Outer y) + _Outer z
```

which in turn evaluates to

```c
int a = _Outer _Outer _Outer x + _Outer _Outer _Outer _Outer _Outer y + _Outer z
```

Forward references: selection statements (6.8.4), iteration statements (6.8.5).

6.5.1.12 Generic selection

Alternatives

1. To introduce a construction that would defer the beginning of the scope of an identifier being declared to the end of the instruction or to the next sequence point. For example:

```c
char * _Deferred px = px; // The second px does not refer to the object the declared px will refer to
// because the latter's scope has not yet begun.
```

This has the advantage that it does not require the translator to go one (or two) blocks outwards in
order to find the object px refers to. But it has the disadvantage that the outer object cannot be re-
f
deferred to beyond the initialization of the inner one. Example 1 featured a case of that use.

2. Not to allow multiple _Outer to apply to an identifier. This way the main use of _Outer will still be
covered, and it avoids counting multiple blocks outwards, about which some concerns have been ex-
pressed that it would be fragile. I do not believe it fragile because the appearances of _Outer will be in
macros, written there by the programmer, and it is easy by looking at the code to know how many
_Outer are necessary. In most cases it will be just one as in {int x = _Outer x; ... }.

A possible advantage of not allowing multiple _Outer could be that it might be easier to implement.

Comments

• Two _Outer may be needed if the macro opens another block. This was the case in Example 1 above and
also here (suppose uint is unsigned int):

```c
#define mmul_vectorn(A,B,x,a,c) if(a){
    memset(A, 0, a * sizeof(double)) \ 
    const double *pB = _Outer B, *pC = _Outer v; \ 
    double *pA = _Outer A; \ 
    uint ic = _Outer(c); \ 
    while(ic){ ic--; \ 
        double aux = *pC++; \ 
        uint ia = _Outer _Outer (a); do ia--, *pA++ += *pB++ * aux; while(ia >= 1); \ 
        pA -= _Outer _Outer (a); \ 
    }
}
```

The reason two _Outer are needed here in the initialization of ia is not that the argument passed as a
may be literally ia (one _Outer would suffice for that) but that it may be ic (or pA or pB).

• The previous example also serves to illustrate the need of the _Outer(x) syntax versus _Outer x in
same cases. The arguments passed to the macro in place of a and c could be constants. Suppose for in-
stance c to be 6. The two syntax would yield, respectively,

```c
uint ic = _Outer(6);
uint ic = _Outer 6;
```

The second one is not valid, since 6 is not an identifier. The existence of the _Outer(x) variant relieves
the definition of semantic-identifier from the need to deal with those cases. It would be a little messy
since the same sequence of tokens can match both _Outer identifier and _Outer constant. This happens
when the identifier is an enumeration constant. Also, _Outer 6 looks weird. There being no need for it,
it seemed better not to permit _Outer to precede constants like this. It is the most superfluous since
macro parameters are most often enclosed in parentheses in its replacement text.

• The syntax has been defined with the care that

```
_Outer1 ( _Outer2 ( expr ) + _Outer3 x)
```

expands to

```
_Outer1 _Outer2 ( expr ) + _Outer3 _Outer1 x
```

While it wouldn’t make any difference if the order of the _Outer identifier resolvers were reversed, it
would in the (unlikely) event that other identifier resolvers were added to the syntax, and in any case
the present expansion is what would be expected.

• In “Example 1”, the declaration is typeof(*x)) *px and not typeof(x) px because x could be an array.