

Subject: Coroutines
From: Van Snyder
Reference: 03-258r1, section 1.1

1 **1 Number**

2 TBD

3 **2 Title**

4 Coroutines.

5 **3 Submitted By**

6 J3

7 **4 Status**

8 For consideration.

9 **5 Basic Functionality**

10 Provide for coroutines.

11 **6 Rationale**

12 In many cases when a “library” procedure needs access to user-provided code, the user-provided code
13 needs access to entities of which the library procedure is unaware. There are at least four ways by which
14 the user-provided code can gain access to these entities:

- 15 • The user-provided code can be implemented as a procedure that is invoked either directly or by
16 way of a dummy procedure, the extra entities can be made public entities of some module, and
17 accessed in the user-provided procedure by use association.
- 18 • The user-provided code can be implemented as a procedure that is invoked either directly or by
19 way of a dummy procedure, and the extra entities can be put into common if they’re data objects.
- 20 • The user-provided code can be implemented as a procedure that takes a dummy argument of
21 extensible type, which procedure is invoked either directly or by way of a dummy procedure, and
22 the extra entities can be put into an extension of that type.
- 23 • The library procedure can provide for *reverse communication*, that is, when it needs access to user-
24 provided code it returns instead of calling a procedure. When the user-provided code reinvokes
25 the library procedure, it somehow finds its way back to the appropriate place.

26 Each of these solutions has drawbacks. Entities that are needlessly public increase maintenance expense.
27 The maintenance expense of common is well known. If the user-provided procedure expects to find its
28 extra information in an extension of the type of an argument passed through the library procedure, the
29 dummy argument has to be polymorphic, and the user-provided code has to execute a SELECT TYPE
30 construct to access the extension. Reverse communication causes a mess that requires GO TO statements
31 to resume the library procedure where it left off, which compromises the ability to use well-structure
32 control constructs.

33 Reverse communication is, however, a blunt-force simulation of a well-behaved control structure that
34 has been well-known to computer scientists for decades: The *coroutine*. Coroutines would allow user-
35 provided code needed by library procedures more easily to gain access to entities of which the library

1 procedure is unaware, without causing the disruption of the control structure of the library procedure
2 that reverse communication now causes.
3 Coroutines are also useful to implement *iterators*, which are procedures that can be used both to enu-
4 merate the elements of a data structure and to control iteration of a loop that is processing those
5 elements.

6 **7 Estimated Impact**

7 Small. Minor additions to Section 12.

8 **8 Detailed Specification**

9 Provide two new statements, which we shall here call SUSPEND and RESUME,

10 If a subroutine suspends its execution by executing a SUSPEND statement, and its execution is subse-
11 quently resumed by executing a RESUME statement, execution resumes after the SUSPEND statement.
12 Otherwise (either execution of the subroutine was terminated by execution of a RETURN or END state-
13 ment, or it was invoked by a CALL statement), execution continues with the first executable statement
14 of the invoked subroutine.

15 It would be reasonable to restrict coroutines to be nonrecursive, and to prohibit a SUSPEND and
16 ENTRY statement to appear in the same subroutine.

17 A third statement, *viz.* COROUTINE could replace the SUBROUTINE statement, indicating that the
18 program unit could contain a SUSPEND statement and could not contain an ENTRY statement. This
19 would add some complication, as all references to the terms “subroutine” and “procedure” would need
20 to be examined to determine whether it is necessary to add the term “coroutine” to the discussion. This
21 may be necessary in order for implementations to make dummy coroutines work.

22 The RESUME statement need not appear in the same subprogram as the CALL statement that initiated
23 execution of the coroutine.

24 It is not necessary or useful to prohibit internal subroutines to be coroutines.

25 Coroutines should be allowed to be actual arguments and procedure pointer targets.

26 The question whether the entire instance of the procedure survives execution of a SUSPEND statement,
27 or only those data entities that have the SAVE attribute survive, can be decided later. Similarly, the
28 question whether modules and common blocks accessed from the coroutine survive can be decided later.

29 Fortran already has a limited form of coroutine: The relation between an input/output item list and a
30 format is a coroutine relation.

31 **8.1 Inferior alternative**

32 An inferior alternative is to allow an ENTRY statement within a construct other than WHERE, FORALL
33 or DO with *loop-control* consisting of *do-variable = scalar-int-expr, scalar-int-expr [, scalar-int-expr]*.
34 This is inferior because it puts the onus on the user to return to the correct place in the library code. It
35 is a step forward from the current situation because it doesn't require to disrupt the control structure
36 to implement reverse communication. All in all, it's a relatively crappy solution.

37 **9 History**

38 This proposal was discussed and eventually rejected at meeting 166. The argument that led to its
39 rejection was that one could always put the extra information for user-defined code into an extensible
40 type. It was not considered at the time, however, that this requires the dummy argument of the
41 user-provided subprogram to be polymorphic, and that the user-provided subprogram must execute a
42 SELECT TYPE construct to gain access to the extra information. This overhead would not be necessary
43 in a coroutine interaction. Furthermore, type extension cannot be applied to iterator construction.