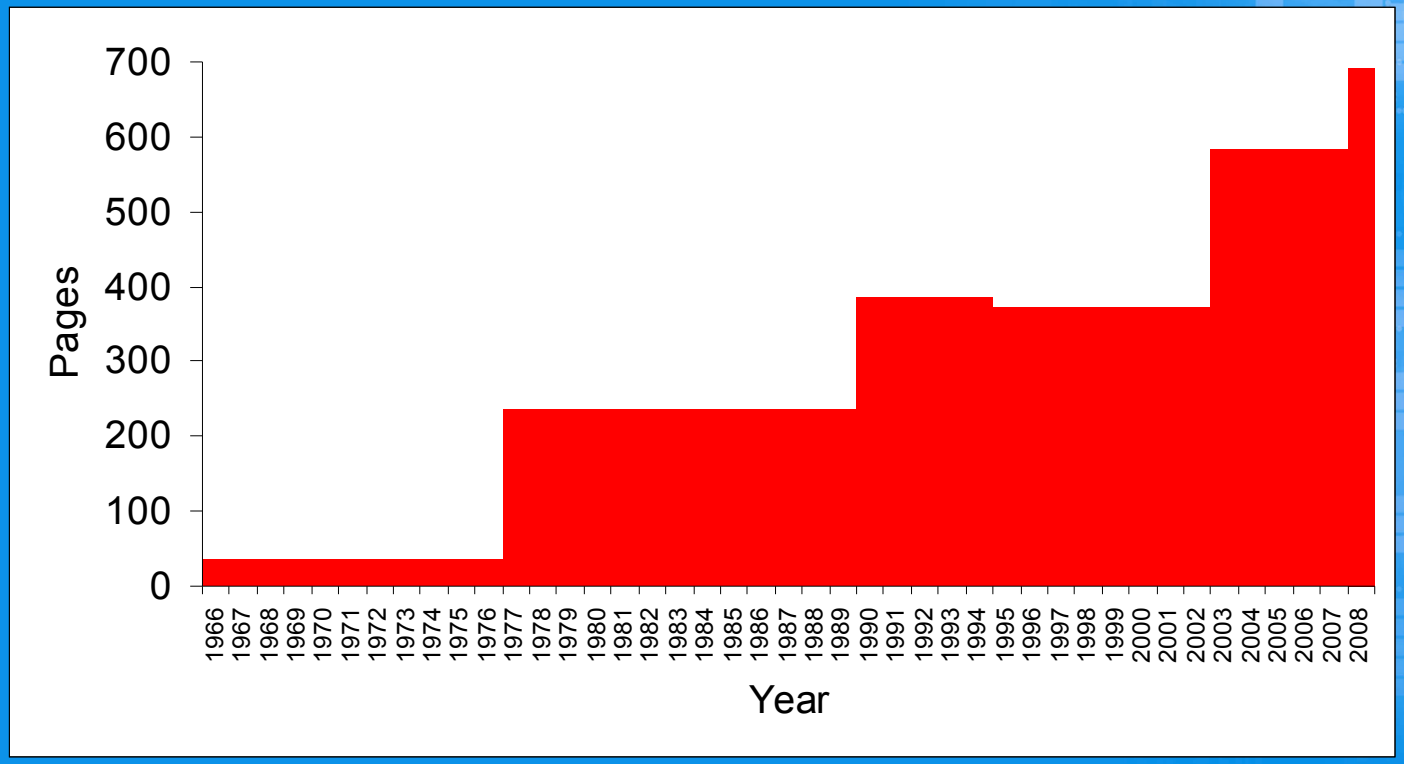
The new features of Fortran 2003

David Muxworthy
BSI Fortran Convenor

Pages in Fortran Standards



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Major extensions

- Standardized interoperability with C
- Object-oriented support
- Derived-type enhancements
- IEEE 754 support
- Numerous data manipulation enhancements
- Numerous input/output enhancements

Minor incompatibilities with Fortran 95

- carriage control for printer output has been removed from the standard
- list-directed and namelist output of real zeros is changed

  output of real zeros in these contexts always uses F rather than E format
- if the processor can distinguish +0.0 and -0.0, use is made of this by ATAN2 and by LOG, SQRT if they have complex arguments

  e.g. result of ATAN2 or LOG may be $-\pi$ rather than π

Characters and source form

- the default character set is extended to include:

  ~ | \ [ ] { } @ # grave accent, circumflex accent (but not acute accent)

  only [and] are used and are synonyms for (/ and /)

- variable names may be to 63 characters

- statements may be up to 256 lines

'International' (non-anglophone) usage

- explicit accommodation of 10646 characters (but not necessary for processors to support 10646)
- ability to specify decimal separator in internal or external files as POINT or COMMA

Data types and specifications

Many new facilities, including:

- deferred type parameters

  length type parameters of certain entities may be changed during execution

- VOLATILE attribute

  for interacting with non-Fortran processes

- ASYNCHRONOUS attribute

  for specifying that a variable may be subject to asynchronous input/output

- type specification for array constructors, e.g.

  [CHARACTER(LEN=8) :: 'Fortran', 'C', 'Algol 68']

More data manipulation enhancements

- specification and initialization expressions are extended by removal of some restrictions
- complex literals are extended to accept named constants, e.g.

  (0., PI) where PI is a previously declared real constant
- MIN and MAX extended to accept character arguments

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Derived type enhancements

- the kind, length and shape of derived type components may be specified when the type is used
- different components may have different accessibility
- improved structure constructors
- finalizers
- derived-type input/output
- components may be allocatable

ASSOCIATE construct

This allows a complex expression or object to be denoted by a simple symbol

Examples:

```
associate ( z => exp(-(x**2+y**2)) * cos(theta) )
   print *, a+z, a-z
end associate

associate ( array => ax%b(i,:)%c )
   array(n)%ev = array(n-1)%ev
end associate
```

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Enumerators

Enumerators are provided to interoperate with the corresponding C enumeration type

Example:

```
enum, bind(c)
    enumerator :: red = 4, blue = 9
    enumerator yellow
end enum
```

Procedure pointers

Pointers are extended to point to procedures, as well as variables, using a new PROCEDURE statement.

Example:

```
procedure (real_func), pointer :: p=> null()
where the interface to real_func has already been
   defined
...
p => bessel
write (*, *) p(2.5)          !-- bessel(2.5)
```

Input/output enhancements

There are many detailed enhancements, including:

- asynchronous transfer
- stream, rather than record, access
- named constants for preconnected units
- FLUSH statement
- access to error messages
- derived-type i/o
- control over rounding mode at internal to external real number conversion

IEEE support

If the processor supports some or all of IEC 60559 (IEEE 754) arithmetic, the standard provides facilities to:

- query which IEEE facilities are provided
- access the facilities for IEEE arithmetic, exception handling, rounding, use of certain IEEE functions, etc.

Enhanced access to system environment

new procedures, including

- GET_COMMAND
- GET_COMMAND_ARGUMENT
- GET_ENVIRONMENT_VARIABLE
- COMMAND_ARGUMENT_COUNT

IOMSG=*character-variable* specifier in OPEN, CLOSE, READ, WRITE

Interoperability with C

Uses intrinsic module ISO_C_BINDING to define named constants and derived types

allows for interoperability of:

- intrinsic types
- pointer types
- derived types
- scalars and arrays
- procedures and procedure interfaces
- C global variables
- C functions

but not (yet):

- procedures with data pointer, allocatable, assumed-shape array or optional dummy arguments

Interoperability with C example part 1

C Function Prototype:

```
int C_Library_Function(void* sendbuf, int sendcount, int
 *recvcounts);
```

Fortran Module:

```
module ftn_c
   interface
      integer (c_int) function C_Library_Function &
        (sendbuf, sendcount, recvcounts),    &
   bind(c,name='C_Library_Function')
        use iso_c_binding
        implicit none
        type (c_ptr), value :: sendbuf
        integer (c_int), value :: sendcount
        type (c_ptr), value :: recvcounts
      end function C_Library_Function
   end interface
end module ftn_c
```

Interoperability with C example part 2

Fortran Calling Sequence:

```
use iso_c_binding, only: c_int, c_float, c_loc
use ftn_c
...
real (c_float), target :: send(100)
integer (c_int)        :: sendcount
integer (c_int), allocatable, target ::
   recvcounts(100)
...
allocate( recvcounts(100) )
...
call C_Library_Function(c_loc(send), sendcount, &
   c_loc(recvcounts))
```

Object-oriented support

- enhanced data abstraction

  one type may extend the definition of another

- polymorphism

  allows type of a variable to vary at run time

- dynamic type allocation

- SELECT TYPE construct

- type-bound procedures

Further information

For a far more detailed (38 page) overview of the new features in Fortran 2003 relative to Fortran 95 see "The New Features of Fortran 2003" by John Reid, at

ftp://ftp.nag.co.uk/sc22wg5/N1601-N1650/N1648.pdf