N1358

AFNOR proposal on object orientation in Fortran 2000

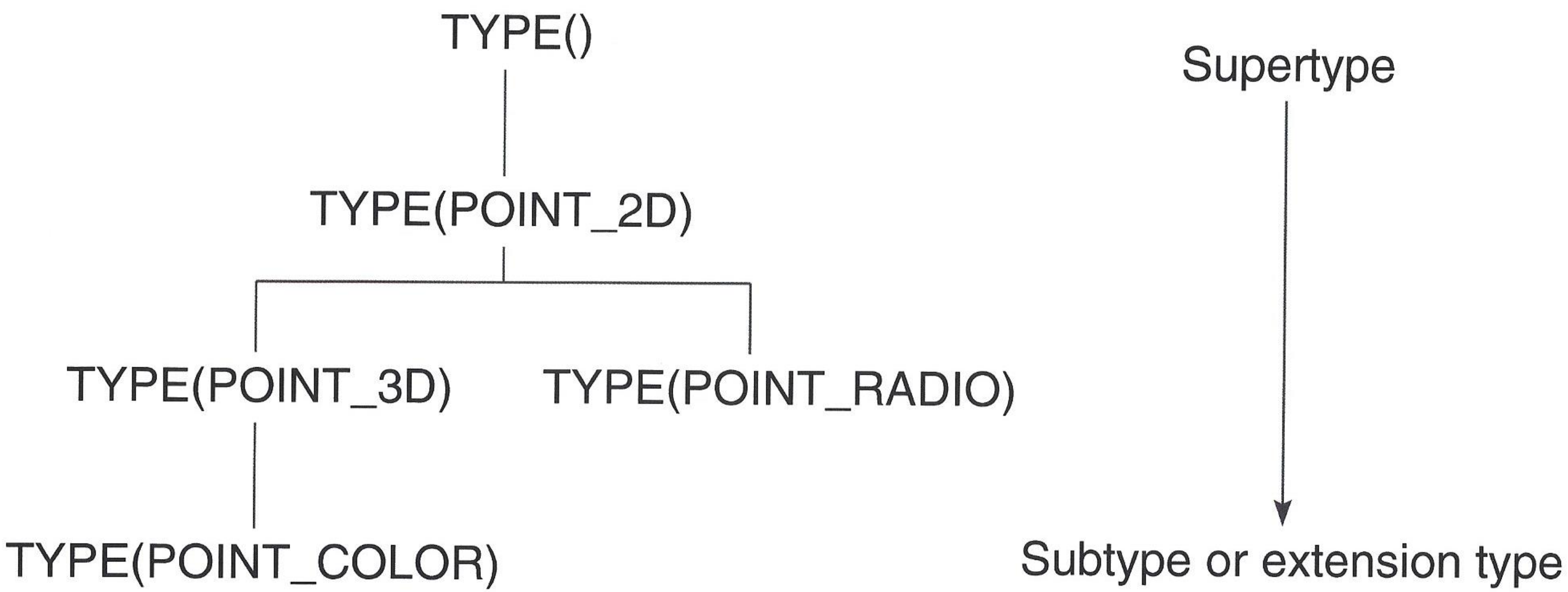
N 1358

Type extension

Extend an existing derived type by adding zero or more additional components

```
TYPE,EXTENDS() :: POINT_2D
   REAL :: X,Y
END TYPE POINT_2D
TYPE,EXTENDS(POINT_2D) :: POINT_3D
   REAL :: Z
END TYPE POINT_3D
TYPE,EXTENDS(POINT_3D) :: POINT_COLOR
   INTEGER :: COLOR
END TYPE POINT_COLOR
TYPE,EXTENDS(POINT_2D) :: POINT_RADIO
   REAL :: FREQUENCY
END TYPE POINT_RADIO
```

Extension type hierarchy



Supertype cast operation (1)

Consider a subroutine operating on POINT_2D types:

```
SUBROUTINE POLAR(POINT)
   TYPE(POINT_2D),INTENT(IN) :: POINT
   PRINT *,’polar angle=’,ATAN(POINT%Y/POINT%X)
   PRINT *,’modulus=’,SQRT(POINT%X**2 + POINT%Y**2)
END SUBROUTINE POLAR
```

Consider now using this subroutine on a variable of type POINT_COLOR:

```
TYPE(POINT_COLOR) :: A
...
CALL POLAR(A) ! Compile-time error
CALL POLAR(A%POINT_3D%POINT_2D) ! Legal, X3J3 syntax
CALL POLAR(POINT_2D@A) ! Legal, AFNOR supertype cast
```

Supertype cast operation (2)

Comparison of AFNOR and X3J3 syntax:

```
TYPE(POINT_COLOR) :: A
```

Afnor	X3J3
`POINT_3D@A`	`A%POINT_3D`
`POINT_2D@A`	`A%POINT_3D%POINT_2D`
`POINT_2D@A%X`	`A%POINT_3D%POINT_2D%X`
`A%X`	`A%X`

Restriction on X3J3 syntax:

«A component or type parameter declared in an extended type shall not have the same name as the parent type.» **page 56, line 23**

Polymorphic variable

Ability for a variable declared with the CLASS keyword to assume differing dynamic types during program execution:

```
CLASS(POINT_2D) :: A ! The dynamic type of A is
                     ! POINT_2D, POINT_3D, POINT_RADIO
                     ! or POINT_COLOR
CLASS() :: B ! The dynamic type of B is any
             ! extensible type
CLASS(POINT_3D) :: C ! The dynamic type of C is
                     ! POINT_3D or POINT_COLOR
```

A polymorphic variable gets its dynamic type via argument association, pointer assignment, NULLIFY, or execution of ALLOCATE or DEALLOCATE statement.

Allocation of a polymorphic variable

Consider a polymorphic variable A:

```
CLASS(POINT_2D) :: A
```

Default allocation:

```
ALLOCATE(A) ! The dynamic type of A is POINT_2D
```

Casted allocation, X3J3 syntax:

```
ALLOCATE(TYPE(COLOR_POINT) :: A) ! The dynamic type of
                                 ! A is COLOR_POINT
```

Casted allocation, AFNOR syntax:

```
ALLOCATE(COLOR_POINT@A) ! The dynamic type of A is
                        ! COLOR_POINT
ALLOCATE(A,CAST=B) ! The dynamic type of A is the same
                     as the dynamic type of B
```

The second form of AFNOR casted allocation is not possible with the X3J3 syntax

Dynamic Dispatch

To be able to make a procedure reference where the specific procedure that is called depends on the dynamic type of a polymorphic variable.

```
CLASS(POINT_2D),POINTER :: A
TYPE(POINT_3D) :: B
A => B ! The dynamic type of A is POINT_3D
CALL METHOD(A,other parameters) ! Dynamic dispatch
```

Here, a run-time analysis of this request is made:

- If `CALL METHOD` can operate on objects of type POINT_3D (the dynamic type of A), the run-time system replace the call with

  ```
  CALL METHOD(POINT_3D@A,other parameters)
  ```

- If `CALL METHOD` can operate on objects of type POINT_2D (the parent type of the dynamic type of A) , the run-time system replace the call with

  ```
  CALL METHOD(POINT_2D@A,other parameters)
  ```

- Else, run-time error

Subtype cast operation on a polymorphic variable

«Only components of the declared type of a polymorphic object may be designated by component selection». Page 77, line 2

```
CLASS(POINT_2D) :: A
TYPE(POINT_COLOR) :: B
A => B ! The dynamic type of A is B
X = A%COLOR ! Compile-time error
X = POINT_COLOR@A%COLOR ! Legal, AFNOR subtype cast

SELECT TYPE(A) ASSOCIATE(point) ! Legal, X3J3 syntax
TYPE IS(POINT_COLOR)
   X=point%COLOR                !
END SELECT                      ! End of X3J3 syntax
```

The AFNOR syntax is type-unsafe (a run-time error may occurs); the X3J3 syntax is type-safe (a run-type error cannot occurs).

Unresolved issues with type cast

- Should type cast be available in Fortran2000
  - X3J3: Supertype cast is type safe, but it can be replaced with %-operations with restrictions; subtype cast is type unsafe and should not be available
  - AFNOR: Both supertype cast and subtype cast operations should be available
- Should casted-allocation be available in Fortran2000
  - Two forms of casted allocation are required.
    - → `ALLOCATE(TYPE(COLOR_POINT) :: A) or ALLOCATE(COLOR_POINT@A)`
    - → `ALLOCATE(A,CAST=B)`

Unresolved issues with dynamic dispatch

- Should dynamic dispatch be available only for type-bound procedures?

  →AFNOR: Should be available also to ordinary procedures.

- What happens if a procedure is called with many polymorphic variables:

```
CLASS(POINT_2D) :: A,B
CALL METHOD(A,B,other parameters)
```

  →AFNOR: The order of resolution should follow some rules.

- Can dynamic dispatch be made type-safe without loosing flexibility?

  →AFNOR: No. Exception handling may be added to deal with the type-unsafe characteristic of dynamic dispatch.

CONSTRUCTOR and DESTRUCTOR capabilities (1)

We propose to supplement the ALLOCATE statement with a «CONSTRUCTOR» capability and to supplement the DEALLOCATE statement with a «DESTRUCTOR» capability.

Defined as a type bound procedure with name CONSTRUCTOR or DESTRUCTOR:

```
TYPE CHAR_OBJ
   INTEGER :: NTABLE = 0
   CHARACTER(LEN=1),POINTER,DIMENSION(:) :: PTEXT
CONTAINS
   PROCEDURE,PASS_OBJ :: CONSTRUCTOR => SUB00
   PROCEDURE,PASS_OBJ :: DESTRUCTOR => SUB11
END TYPE CHAR_OBJ
```

CONSTRUCTOR and DESTRUCTOR capabilities (2)

The constructor/destructors are implemented as elemental subroutines:

```
ELEMENTAL SUBROUTINE SUB00(AA,LENGT)
   TYPE(CHAR_OBJ) :: AA
   AA%NTABLE = LENGT
   ALLOCATE(AA%PNEXT(LENGT))
   AA%PTEXT = ' '
END SUBROUTINE SUB00
ELEMENTAL SUBROUTINE SUB11(AA)
   IF(AA%NTABLE > 0) DEALLOCATE(AA%PNEXT)
END SUBROUTINE SUB11
```

In the calling procedure, we write:

```
TYPE(CHAR_OBJ),DIMENSION(:),ALLOCATABLE :: STRING
ALLOCATE(STRING(10),LENGT=5)
...
DEALLOCATE(STRING)
```