Modular Programming in MPE

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MODULAR PROGRAMMING

— There is no final definition yet
— A module can be embedded into any environment knowing its interface but not the algorithm used.
example:

sin (×)

the user must know:
— x must be of type "REAL"
— sin (×) will be of type "REAL"
— sin (3.1415) = 0
— 1.2E−50 < × < 4.5E+55
— what happens in case of error

the user must not know:
— the method how sin (×) is calculated

SOME MORE ASPECTS

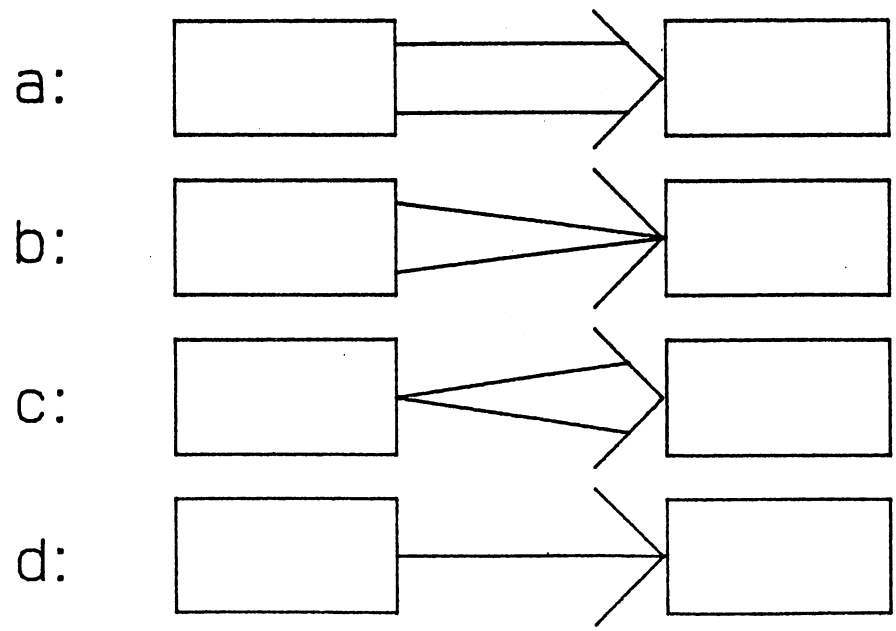
— A module can be constructed without knowing the environment it will be used in
— The module interfaces should be as simple as possible

WHAT MODULES CAN OFFER

— Procedures
e.g.: sin(×)
— Data
e.g.: INTEGER ARRAY A
— Files
e.g.: Data-base
— Any mixture of the three above

MODULE INTERFACES

— Information flow between modules
— Described by:
— The type of information (data, procedure, file)
— The access rights for each communication direction:



Examples for Module Interfaces

```
a:   BEGIN
       INTEGER I;
       ...
       PROCEDURE P1;
         BEGIN
           I:=0;
           WHILE (I:=I+1) < 10 DO
             BEGIN .... END;
         END;
       ...
       I: *EQL0;
       WHILE (I: =I+1) < 10 DO
         BEGIN
           ...
           P1;
         END;
       ...
     END;
c:         SUBROUTINE SUB
           ...
           INVAL=ITEMP (10)
           ...
           END
```

MODULE REQUIREMENTS

- — Control of information flow (specification of imported and exported objects)
- — Check of interfaces (some checking done by SEGMENTER, but not for all types)
- — Hidden information (to keep information within the module — problems with stack-structure, file-access)
- — More possibilities to restrict access on data, procedures and files
- — Comfortable to handle (library-problem)

Example: Own Data in SL-Routines

PROBLEM: The principle of hidden information requires that local data is not deleted between two procedure calls. This causes problems when procedure has to be put into a SL.

WHAT WE WANT: A module which stores local data into an extra data segment before exit and refreshes the data after call.

SPECIFICATION FOR MODULE "OWN DATA"

```
PROCEDURE INITDATA (BUFFER, LENGTH);
  INTEGER ARRAY BUFFER;
  VALUE LENGTH; INTEGER LENGTH;
  OPTION EXTERNAL;

  BEGIN
    IF `first time used'
      THEN `initialize BUFFER with 0'
      ELSE `refresh BUFFER with data
           stored in data segment';
  END;
```

```
PROCEDURE UPDATEDATA (BUFFER, LENGTH);
  INTEGER ARRAY BUFFER;
  VALUE LENGTH; INTEGER LENGTH;
  OPTION EXTERNAL;

  BEGIN
    `copy contents of BUFFER into
     data segment';
  END
```

Solution No. 1

```
PROCEDURE INITDATA (BUFFER, LENGTH);
  INTEGER ARRAY BUFFER;
  VALUE LENGTH; INTEGER LENGTH;

  BEGIN
    `allocate data segment';
    IF `data segment already exists'
      THEN `copy contents into BUFFER'
      ELSE `initialize BUFFER with 0';
  END;
```

```
PROCEDURE UPDATEDATA (BUFFER, LENGTH);
  INTEGER ARRAY BUFFER;
  VALUE LENGTH; INTEGER LENGTH;

  BEGIN
    `allocate data segment';
    `copy contents of BUFFER into
     data segment';
  END;
```

But

— Extra data segment has to be "global."

Therefore:

— Other users of module "OWN DATA" will use the same data segment

— Data segment is not automatically deallocated when program terminates. So no initialization will happen after the module has been used once.

Solution No. 2

```
PROCEDURE INITIALIZEDATE;
  OPTION PRELUDE;

  BEGIN
    `allocate extra data segment';
    `mark user within data segment';
    `initialize info part';
  END;
```

```
PROCEDURE INITDATA (BUFFER, LENGTH);
  INTEGER ARRAY BUFFER;
  VALUE LENGTH; INTEGER LENGTH;

  BEGIN
    `allocate extra data segment';
    IF `used first time (info part)'
       THEN
         BEGIN
           `initialize BUFFER with 0';
           `change info part';
         END
       ELSE `copy contents into BUFFER';
  END;


PROCEDURE UPDATEDATA (BUFFER, LENGTH);
  INTEGER ARRAY BUFFER;
  VALUE LENGTH; INTEGER LENGTH;

  BEGIN
    `allocate extra data segment';
    `copy contents of BUFFER into
    data segment';
  END;


PROCEDURE FREEDATA;
  OPTION POSTLUDE;

  BEGIN
    `allocate extra data segment';
    `delete module user from info
     part';
    `free extra data segment';
  END;
```