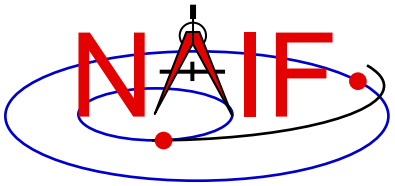
Exception Handling

April 2023



Topics

Navigation and Ancillary Information Facility

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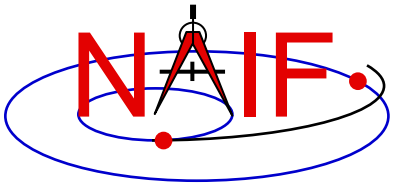
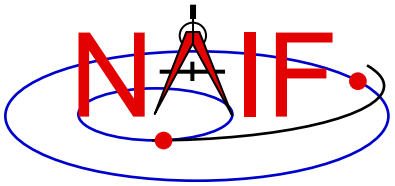


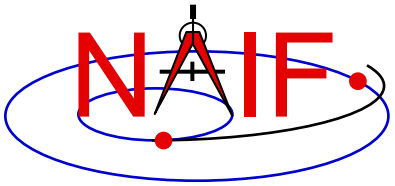
Exceptions Are… - 1

- **Run-time error conditions such as:**
  - **Files**
    - » **Required files not loaded**
    - » **Gaps in data**
    - » **Corrupted or malformed files (e.g. ftp'd in wrong mode)**
  - **Invalid subroutine/function arguments**
    - » **String values unrecognized**
    - » **Numeric values out of range**
    - » **Data type/dimension mismatch**
  - **Arithmetic errors**
    - » **Divide by zero, taking the square root of a negative number**
  - **Environment problems**
    - » **Insufficient disk space for output files**
    - » **Lack of required read/write permission/privileges**



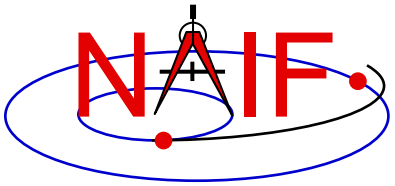
Exceptions Are… - 2

- **Valid but unusual conditions, such as:**
  - » **Normalize the zero vector**
  - » **Find the rotation axis of the identity matrix**
  - » **Find the boresight intercept lat/lon for a non-intercept case**
  - » **Find a substring where the end index precedes the start index**
  - – **Such cases are normally not SPICE "Error Conditions"**
  - – **Typically must be handled by a logical branch**
- **Errors found by analysis tools, such as:**
  - » **Invalid SQL query**
  - » **Invalid string representing a number**
  - – **Such cases are normally not SPICE "Error Conditions"**
  - – **However, if a SPICE parsing routine failed because it couldn't open a scratch file, that would be an "error condition"**



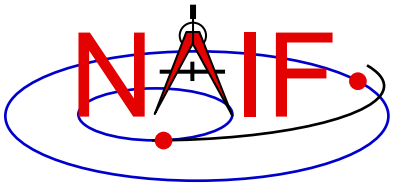
SPICE "Errors"

- Most "errors" made while using SPICE result from a mistake in how you are trying to use SPICE code, or in how you are trying to use SPICE files
  - It's rare that a SPICE user finds an error within SPICE Toolkit code
- The SPICE "exception handling subsystem" helps detect user's errors
- All "errors" detected by SPICE result in a SPICE error message
  - Such errors will not make your program crash
- A program crash indicates an error in your own code, a corrupted SPICE kernel, or (rarely) a SPICE bug



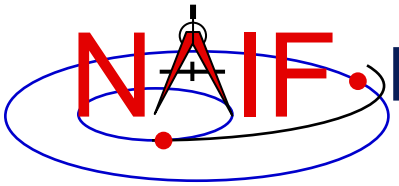
Language Dependencies

- SPICELIB and CSPICE provide essentially identical error handling capabilities.
- Icy and Mice provide similar error handling functionality; this functionality is quite different from that of CSPICE.
  - These systems do rely on CSPICE for most error detection.
  - Icy and Mice provide no API for customizing underlying CSPICE error handling behavior.
  - Short, long, and traceback error messages are merged into a single, parsable, message.
  - Use IDL or MATLAB features to customize error handling…
    - » to prevent your program from stopping.
    - » to capture SPICE error messages.
- Most of this tutorial deals with SPICELIB and CSPICE error handling.
  - There is a bit on Icy and Mice near the end.



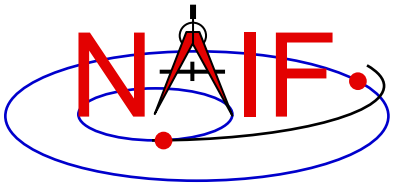
Fortran and C Error Handling Features - 1

- **Error handling in SPICE: safety first**
  - Trap errors where they occur; don't let them propagate.
    - » Don't let errors "fall through" to the operating system.
  - Supply meaningful diagnostic messages.
    - » Incorporate relevant run-time data.
    - » Supply context in human-readable form.
  - Don't depend on callers to handle errors.
    - » Normally, "error flags" are not returned to callers.
  - Stop unless told not to.
    - » Don't try to continue by making "smart guesses."
- **Subroutine interface for error handling**
  - Interface routines called within SPICE may be called by users' application programs



Fortran and C Error Handling Features - 2

- **Signal errors**
  - Create descriptive messages when and where an error is detected
    - » Short message, long message, (explanation), traceback
  - "Signal" the error: set error status, output messages
    - » By default, CSPICE error output goes to stdout (not stderr)
- **Retrieve error information**
  - Get status and error messages via subroutine calls
- **Customize error response---actions taken when an error occurs.**
  - Set error handling mode ("action")
  - Set error output device
  - Set message selection
- **Inhibit tracing**
  - To improve run-time performance (only for thoroughly debugged code)



Error Messages

- **Short message**
  - Up to 25 characters.
  - Can easily be compared with expected value.
    - » Example: SPICE(FILEOPENFAILED).
- **Long message**
  - Up to 1840 characters.
  - Can contain values supplied at run time.
    - » Example: 'The file <sat077.bsp> was not found.'
- **Traceback**
  - Shows call tree above routine where error was signaled.
    - » Not dependent on system tracing capability.
    - » Don’t need a “crash” to obtain a traceback.

Error Handling Actions - 1

- **ABORT**
  - Designed for safety.
    - » Output messages and traceback to your screen or stdout.
    - » Stop program; return status code if possible.
- **RETURN**
  - For use in programs that must keep running.
  - Attempts to return control to the calling application.
  - Preserves error information so calling application can respond.
    - » Output messages to current error device.
    - » Set error status to “true”: FAILED() will return “true.”
    - » Set “return” status to “true”: RETURN() will return “true.”
    - » Most SPICE routines will return on entry. Very simple routines will generally execute anyway.

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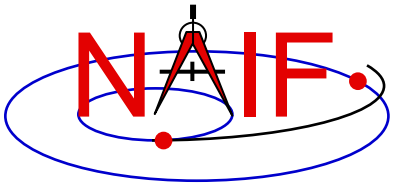


Error Handling Actions - 2

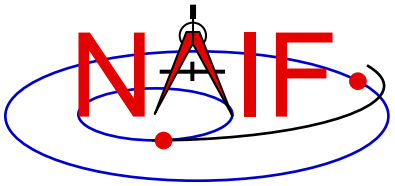
- Capture traceback at point where error was signaled.
- Inhibit error message writing and error signaling.
- Must call RESET to resume normal error handling.

Error Device

- **Destination of error messages**
  - **Screen/stdout (default)**
  - **Designated file**
    - » **Error diagnostics are appended to the file as errors are encountered.**
  - **“NULL” --- suppress output**
    - » **When the NULL device is specified, error messages can still be retrieved using API calls.**
- **Limitations**
  - **In C, cannot send messages to stderr.**
  - **In C, writing to a file opened by means other than calling errdev_c is possible only if CSPICE routines were used to open the file.**
    - » **These limitations may be removed in a later version of CSPICE.**

Customize Error Handling - 1

- **Set error action**
  - CALL ERRACT ('SET', 'RETURN')
  - erract_c ("set", LEN, "return");
    - » Length argument is ignored when action is “set”; when action is “get”, LEN should be set to the available room in the output string, for example:
    - » erract_c ("get", ACTLEN, action);
- **Set error device**
  - CALL ERRDEV ('SET', 'errlog.txt')
  - errdev_c ("set", LEN, "errlog.txt");
- **Select error messages**
  - CALL ERRPRT ('SET', 'NONE, SHORT, TRACEBACK')
    - » If tracing is disabled (see next page), selecting TRACEBACK has no effect.
  - errprt_c ("set", LEN, "none, short, traceback");



Customize Error Handling - 2

- **Disable tracing**
  - Normally done to speed up execution by a few percent
  - Benefit is highly dependent on application
  - NAIF normally recommends users not turn tracing off
  - Use TRCOFF:
    - » CALL TRCOFF or trcoff_c();
      - Do this at the beginning of your program.
      - Once disabled you cannot re-enable tracing during a program run.

Get Error Status - 1

- **Use FAILED to determine whether an error has been signaled**
  - `IF ( FAILED() ) THEN …`
  - `if ( failed_c() ) { …`
- **Use FAILED after calling one or more SPICE routines in a sequence**
  - **Normally, it's safe to call a series of SPICE routines without testing FAILED after each call**
- **Use GETMSG to retrieve short or long error messages**
  - `CALL GETMSG ( 'SHORT', SMSG )`
  - `getmsg_c ( "short", LEN, smsg );`

Get Error Status - 2

- Use QCKTRC or TRCDEP and TRCNAM to retrieve traceback message
- Test value of RETURN() to determine whether routines should return on entry
  - Only relevant if user code is designed to support RETURN mode
- Handle error condition, then reset error status:
  - `CALL RESET`
  - `reset_c();`
  - In Icy-based applications you only need handle the error condition; a reset is automatically performed by Icy

Signal Errors - 1

- **Create long error message**
  - Up to 1840 characters
  - Use SETMSG
    - `CALL SETMSG ( 'File <#> was not found.' )`
    - `setmsg_c    ( "File <#> was not found." );`
- **Substitute string, integer, or d.p. values at run time**
  - Use ERRCH
    - `CALL ERRCH ( '#', 'cassini.bsp' )`
    - `errch_c    ( "#", "cassini.bsp" );`
  - Also can use ERRINT, ERRDP
  - In Fortran, can refer to files by logical unit numbers: ERRFNM

Signal Errors - 2

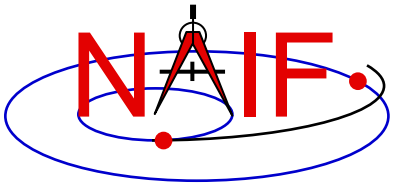
- **Signal error**
  - Use SIGERR to signal error. Supply short error message as input to SIGERR.
    - `CALL SIGERR ( 'FILE OPEN FAILED' )`
    - `sigerr_c ( "FILE OPEN FAILED" );`
  - "Signaling" error causes SPICE error response to occur
    - Output messages, if enabled
    - Set error status
    - Set return status, if error action is RETURN
    - Inhibit further error signaling if in RETURN mode
    - Stop program if in abort mode
- **Reset error status after handling error**
  - CALL RESET()
  - reset_c()

Icy Error Handling

Navigation and Ancillary Information Facility

- **Error action:**
  - By default, a SPICE error signal stops execution of IDL scripts; a SPICE error message is displayed; control returns to the execution level (normally the command prompt).
  - Icy sets the CSPICE shared object library's error handling system to RETURN mode. No other modes are used.
    - » The CSPICE error state is reset after detecting an error.
  - Use the IDL CATCH feature to respond to error condition.
- **Error status**
  - Value of !error_state.name
    - » ICY_M_BAD_IDL_ARGS - indicates invalid argument list.
    - » ICY_M_SPICE_ERROR - indicates occurrence of a SPICE error.
- **Error message**
  - CSPICE short, long, and traceback error messages are merged into a single, parsable, message.
    - » The merged error message is contained in the variable !error_state.msg.
    - » Example:

```
CSPICE_ET2UTC: SPICE(MISSINGTIMEINFO): [et2utc->ET2UTC->UNITIM]
               The following, needed to convert between the
               uniform time scales, could not be found in the
               kernel pool: DELTET/DELTA_T_A, DELTET/K,
               DELTET/EB, DELTET/M. Your program may have failed to load…
```



Mice Error Handling

Navigation and Ancillary Information Facility

- **Error action**
  - By default, a SPICE error signal stops execution of MATLAB scripts; a SPICE error message is displayed; control returns to the execution level.
  - Mice sets the CSPICE shared object library's error handling system to RETURN mode. No other modes are used.
    - » The CSPICE error state is reset after detecting an error.
  - Use the MATLAB try/catch construct to respond to error condition.
- **Error message**
  - CSPICE short, long, and traceback error messages are merged into a single, parsable, message.
    - » Example:

```
??? SPICE(MISSINGTIMEINFO): [et2utc->ET2UTC->UNITIM]
The following, needed to convert between the
uniform time scales, could not be found in the
kernel pool: DELTET/DELTA_T_A, DELTET/K,
DELTET/EB, DELTET/M. Your program may have failed to load…
```

- **Use the MATLAB function lasterror to retrieve SPICE error diagnostics. When a SPICE error occurs:**
  - the "message" field of the structure returned by lasterror contains the SPICE error message.
  - the "stack" field of this structure refers to the location in the m-file from which the Mice wrapper was called (and so is generally not useful).
  - the "identifier" field of this structure currently is not set.

Recommendations

- **For easier problem solving**
  - **Leave tracing enabled when debugging.**
  - **Always test FAILED after a sequence of one or more consecutive calls to SPICE routines.**
  - **Don't throw away error output. It may be the only useful clue as to what's going wrong.**
    - » **Programs that must suppress SPICE error output should trap it and provide a means for retrieving it.**
      - **Test FAILED to see whether an error occurred.**
      - **Use GETMSG to retrieve error messages**
      - **Use RESET to clear the error condition**
  - **Use SPICE error handling in your own code where appropriate.**
  - **When reporting errors to NAIF, have SPICE error message output available**
    - » **Note whether error output is actually from SPICE routines, from non-SPICE code, or was generated at the system level.**