

Invoking External Procedures

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External Procedures

- Oracle8 provides a method for calling a 3GL program from a PL/SQL program unit.
 - Currently, only C programs can be called from a PL/SQL program unit.
 - Future releases of Oracle will support Java and C++.
- An external procedure is simply a program unit that is not written in Oracle's SQL or PL/SQL and resides outside of the database.

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Executing External Procedures

- To execute external procedures, a process called *extproc* is spawned whenever a call to an external procedure is issued.
 - The extproc process loads the shared library (or libraries) that contain the C program and executes it.
 - The results are sent back to the shadow process, which in turn sends the results back to the client.

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Calling External Procedures

- External procedures must be stored as shared libraries at the operating system level.
 - In a Windows NT environment, the procedure would be compiled into a DLL.
 - In a Unix environment the procedure might be compiled into a shared object (.so) depending on the flavor of Unix.

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Calling External Procedures Contd.

- An extproc process will exist for each session that calls an external procedure.
- The extproc process is spawned by the SQL*Net (Net8) listener.
- The extproc process and listener process must reside on the same server as the database.

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Creating the External Procedure

- The following steps are required when creating an external procedure:
 - Create and compile the C program into a shared library.
 - Ensure that the SQL*Net listener process is configured and running on the database server machine.

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Creating the External Procedure Contd.

- Create a Library object in the Oracle database to represent the operating system library.
- Create a PL/SQL procedure to map PL/SQL parameters to the C parameters.

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Creating the C Procedure

- The first step in creating an external procedure is to write and compile the C program.
- There are two different versions of the C program - the one used to create the “.so” file in Unix and a second version used to create a DLL in Windows NT.

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The C Program (Unix Version)

```
#include <stdio.h>
writefile(char *path_in,
          char *message_in,
          char *message2_in,
          char *message3_in,
          char *message4_in)
{
    FILE *file_name;
    file_name = fopen(path_in, "a");
    fprintf(file_name, "\n%s", message_in);
    fprintf(file_name, "%s", message2_in);
    fprintf(file_name, "\n          %s", message3_in);
    fprintf(file_name, "\n          %s", message4_in);
    fclose(file_name);
}
```

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The C Program (DLL Version)

```
#include "stdafx.h"

BOOL APIENTRY DllMain(HANDLE hModule,
    DWORD ul_reason_for_call,
    LPVOID lpReserved);
__declspec(dllexport) int __cdecl writefile(char,
    char,
    char,
    char,
    char);

FILE *file_name;
__declspec(dllexport) writefile(char *path_in,
    char *message_in,
    char *message2_in,
    char *message3_in,
    char *message4_in)
```

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The C Program (DLL Version) Contd.

```
{
    file_name = fopen(path_in, "a");
    fprintf(file_name, "\n%s", message_in);
    fprintf(file_name, "%s", message2_in);
    fprintf(file_name, "\n          %s", message3_in);
    fprintf(file_name, "\n          %s", message4_in);
    fclose(file_name);
    return 1;
}
```

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The C Program

- The C program is creating a function named writefile which accepts five input arguments - path and four message lines.
- A file will be opened and the string in the message variables will be printed to the file.

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Compiling the C Program

- To compile and create the shared object library issue a command similar to the following:

```
cc -G -o writefile.so writefile.c
```
- The cc command compiles and creates the object code for a shared library named writefile.so.
- The file being compiled is named writefile.c.

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Compiling the C Program Contd.

- The shared library will be placed in the current directory, as there is no directory specification in the compile command.
 - The full path may be added in front of the shared object name.
- The DLL is compiled using the Microsoft Visual C++ “Build DLL” option.

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Configuring the SQL*Net Listener

- The tnsnames.ora and listener.ora files need to be modified to include information specific to the extproc process.
- The listener only needs to be configured one time for all future use of external procedures.
- The Net8 Configuration tool can be used to configure the extproc process.

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Sample Listener.ora File

- The following excerpt from the listener.ora file is a sample that can be modified to fit your site.

```
SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (GLOBAL_DBNAME = inv.us.company.com)
      (SID_NAME = ORCL)
    )
    (SID_DESC =
      (SID_NAME = extproc)
      (PROGRAM = extproc)
    )
  )
```

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Sample Tnsnames.ora File

- The following excerpt from the tnsnames.ora file is a sample that can be modified to fit your site.

```
extproc_connection_data.world =
  (DESCRIPTION =
    (ADDRESS =
      (PROTOCOL = IPC)
      (KEY = EXTPROC0)
    )
    (CONNECT_DATA = (SID = extproc)
  )
)
```

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Starting the Listener Process

- After the tnsnames.ora and listener.ora files have been successfully modified the listener process needs to be restarted.
- From a Unix operating system prompt, issue the following command:
\$ lsnrctl start

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Creating a Database Library Object

- A database library object that maps to the operating system shared library needs to be created.
- The CREATE LIBRARY command is used to create a library object in the database.
- The basic syntax for the CREATE LIBRARY command is:

```
CREATE LIBRARY library_name is  
'fullpath_file_name';
```

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Creating a Database Library Object Contd.

- The *library_name* is the user-defined name for the library database object and must be 30 characters or less in length.
- The *fullpath_file_name* is the full path and file name of the operating system shared library.
- The path and file name are case sensitive and must be enclosed in single quotes.

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Database Library Object Example

- The following example creates a library named writefile in the database.

```
SQL> create or replace library writefile  
is 'e:\eab.dll';  
/
```
- The CREATE LIBRARY privilege is required to create a database library.
- The full path and file name for the operating system library is not verified when the CREATE LIBRARY command is issued.

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Database Library Object Example Contd.

- When a program is executed that calls the database library the path specified for the operating system library will be verified.
- To determine what library objects have been created, query the data dictionary table `user_libraries` or `dba_libraries`.

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Library Privileges

- The GRANT command can be used to grant other users access to a database library object.

```
SQL> GRANT EXECUTE ON writefile  
      TO student1;
```

- Only the owner of an object may grant privileges on the object.

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Creating the PL/SQL Wrapper Procedure

- The next step is to create a PL/SQL wrapper procedure that will be used to call the external procedure.
- The PL/SQL procedure will be used to map PL/SQL parameters to the C parameters.
- The PL/SQL procedure will also be used to identify the name of the external procedure to PL/SQL

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Creating the PL/SQL Wrapper Procedure Contd.

- The basic syntax for creating a wrapper procedure is:

```
CREATE OR REPLACE PROCEDURE proc_name
[parameter_list]
AS EXTERNAL LIBRARY library_name
[NAME external_name]
[LANGUAGE language_name]
[CALLING STANDARD {C|PASCAL}]
[WITH CONTEXT]
[PARAMETERS (external_parameter_list)];
```

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Creating the PL/SQL Wrapper Procedure Contd.

- The *proc_name* is the user-defined name for the procedure.
 - The *parameter_list* is the list of input/output arguments required by the procedure.
 - The *library_name* is the database library object name that represents the operating system library. (This is the only required clause)
- Note: You must own the library or have execute privileges on the library.

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Creating the PL/SQL Wrapper Procedure Contd.

- The *external_name* specifies the name of the external procedure and defaults to the name of the PL/SQL wrapper procedure.
- Remember that the database stores object names as upper case - if the C procedure name is lower case, double quotes are required around the name.
- The *language_name* identifies the language that the external procedure is written in.

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Creating the PL/SQL Wrapper Procedure Contd.

- The default language is C.
- C is currently the only language supported.
- The *calling standard* determines the order that parameters are placed on the stack. The default is C.
- The *with context* is used with OCI for database callbacks.
- The *external_parameter_list* is used to specify how the PL/SQL parameters should be mapped to the C parameters.

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Example PL/SQL Wrapper Procedure

- The following example creates a wrapper procedure for the writefile C procedure:

```
SQL> create or replace procedure writeit
(path_in varchar2,
 message_in varchar2,
 message2_in varchar2,
 message3_in varchar2,
 message4_in varchar2)
as external library writefile
name "?writefile@@YAHPAD0000@Z"
```

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PL/SQL Wrapper Procedure Contd.

```
parameters(path_in string,
 message_in string,
 message2_in string,
 message3_in string,
 message4_in string);
/
```

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Calling the External Procedure

- The writefile procedure can be called from any PL/SQL program unit.

```
create or replace procedure printinv
(path_in varchar2,
 id varchar2) is
cursor customer_cursor(id char) is
select customer_id,
       first_name||' '||last_name
name
from customer
where customer_id = id;
```

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Calling the External Procedure Contd.

```
cursor invoice_cursor(id char) is
select to_char(depart_date,'DD MON')depart,
       substr(to_char(depart_date,'DAY'),1,3)day,
       rpad(airline_name,20)airline_name,
       rpad(invoice.flight_no,5) flt,
       substr(fare_basis,1,1)fare_basis,
       rpad(depart_city,19)depart_city,
       to_char(depart_time,'HH:MI AM')depart_time,
       rpad(arrive_city,19)arrive_city,
       to_char(arrive_time,'HH:MI AM')arrive_time
from invoice,
     flight_schedule,
     airline
```

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Calling the External Procedure Contd.

```
where invoice.flight_no =
       flight_schedule.flight_no
and invoice.airline_id = airline.airline_id
and cust_id = id
order by depart_date;
begin
for customer_rec in customer_cursor(id) loop
writeit(path_in,customer_rec.name,',','');
for invoice_rec in invoice_cursor
(customer_rec.customer_id) loop
```

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Calling the External Procedure Contd.

```
writeit(path_in, ' ', invoice_rec.depart||'-'||  
invoice_rec.day||' '||  
invoice_rec.airline_name||' FLIGHT: '||  
invoice_rec.flt||' CLASS: '||  
invoice_rec.fare_basis,  
invoice_rec.depart_city||' '||  
' DEPART: '||invoice_rec.depart_time,  
invoice_rec.arrive_city||' '||  
' ARRIVE: '||invoice_rec.arrive_time);  
end loop;  
end loop;  
end printinv;  
/  

```

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Calling the External Procedure Contd.

- In this example, the file name will be passed in to the printinv procedure from the end-user Oracle Forms application.
- The form will also be used to provide input for the id input argument.

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The Oracle Form

- An Oracle Form has been created that will call the PL/SQL procedure printinv.
- The purpose of the form is to allow the end-user a method of selecting a customer and then printing the invoice information for the customer.
- The invoice information is being written to a flat text file in the location specified by the user.

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Sample Output

- The following example is the text file produced by the external procedure writeit.

Melinda Johnson

```
21 MAR-SUN Continental Airlines FLIGHT: 516 CLASS: Q
ATL DEPART: 07:20 PM
DEN ARRIVE: 10:58 PM
21 MAR-SUN Transworld Airlines FLIGHT: 908 CLASS: Q
STL DEPART: 04:45 PM
DEN ARRIVE: 05:13 PM
04 JUL-SUN Continental Airlines FLIGHT: 517 CLASS: K
ATL DEPART: 06:20 PM
DEN ARRIVE: 08:48 PM
12 JUL-MON Continental Airlines FLIGHT: 617 CLASS: K
DEN DEPART: 01:00 PM
ATL ARRIVE: 06:34 PM
```

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Conclusion

- An external procedure is simply a program unit that is written in a 3GL and resides outside of the database.
- Currently, the only 3GL supported by Oracle 8.0.5 is the C programming language.
- After the C program has been compiled, a database library object needs to be created that maps to the C shared library.

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Conclusion Contd.

- A wrapper procedure is used to map the PL/SQL arguments to the C arguments.
- The PL/SQL procedure can be called from any other PL/SQL program unit.

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