

# Using PCI Geomatics Software with Oracle 10g Spatial and GeoRaster



A PCI Geomatics Whitepaper

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## 1. Introduction

**Remote sensing images from satellites, aerial photography, and thematic mapping provide a wealth of earth information in every pixel.** Every day, earth imaging satellites deliver large volumes of critical information about our natural resources, our cities, our transportation, our climate, and more. In a way that traditional maps cannot, these images provide detail and context that is central to our understanding of our planet, our lives, and our future.

For this reason, progressive companies such as Oracle have put images – and all spatial data – right where they belong: inside the database.

Oracle Spatial is an option for Oracle's Enterprise Edition database that provides advanced spatial features to support high-end geographic solutions. Used by telecommunications, utilities, and government agencies around the world, Oracle Spatial helps organizations make better decisions about geography and location.

In Oracle 10g, Spatial now includes GeoRaster, a feature that lets users store, index, query, analyze and deliver raster data.

PCI Geomatics is an image-centric geospatial solutions company, with over 20 years experience making software that turns images into information. As an Oracle Partner, PCI began working with Oracle early in the 10g product development cycle and helped to define the GeoRaster feature requirements for raster data management.

This collaboration has led PCI Geomatics to develop support for Oracle 10g Spatial and GeoRaster in its software and solutions – technology that helps organizations make better decisions with spatial information.

*“PCI's GeoRaster ETL for Oracle product is a gateway to Oracle 10g. It provides access to many formats; that makes it an excellent supplemental tool for Oracle.”*

Joe Francica  
Editor, Directions Magazine  
Product review, July 21, 2004

## 2. How Geomatica adds value to Oracle 10g Spatial and GeoRaster

With GeoRaster, Oracle Database 10g is uniquely positioned to deliver enterprise-class support for storing and managing raster data in the context of a high-performance, scalable, secure environment. As a spatial data analysis and processing suite, PCI's Geomatica fits perfectly upon this raster-savvy Oracle 10g database architecture.

Though Oracle provides basic mechanisms for managing spatial and raster data in the database, PCI Geomatics software extends these capabilities in four key ways:

**Power tools for uploading and downloading data into Oracle.** Users can view, load, and manage spatial data using an easy-to-use GUI interface, or via programming languages like Java, Python and C++.

**Support for a broad variety of raster and vector file types.** Geomatica software supports data loading and conversion for more than 100 popular file formats and their associated metadata. These include imagery from satellites and aerial photos, plus scanned maps, thematic data, and most common vector file formats.

**Intuitive viewer for spatial data management and analysis.** Geomatica's viewing environment connects directly to the Oracle database for easy viewing of loaded and/or pre-loaded spatial data layers. This same graphical environment can perform value-added tasks, such as creating maps, performing GIS operations, or accessing a webserver.

**Cutting-edge functions for remote sensing, photogrammetry, GIS, and mapping.** The wealth of image-centric geospatial tools in Geomatica allows enterprises to extract more information from their imagery, saving time and money through automated processing and accurate results.

The potential applications of large-scale raster data management are varied. Images are used operationally in industries as diverse as defense, natural resources management, urban planning, agriculture, insurance, utilities, and more. However, all these applications face common challenges of data integration and conflation, challenges that PCI's Geomatica technology is built to address.

Many organizations have large volumes of imagery stored outside an Oracle 10g based enterprise infrastructure. These data repositories are often found in multiple formats and coordinate systems, and even on different media (e.g. on CD, on tape, on flat file disk systems). Loading, identifying and combining relevant image layers with other geospatial (and non-spatial) information can prove to be a time-intensive administrative task, using up valuable operator time.

By leveraging Oracle 10g and PCI Geomatica for automated image loading, querying, and processing, staff have more time to produce results.

### **3. Geomatica product family: support for Oracle 10g**

From their raster data expertise and collaboration with Oracle on the development of GeoRaster, PCI Geomatics has built support for Oracle Spatial and GeoRaster into the core of their software. This technology can be found in their enterprise, desktop, and developer products.

#### **3.1 Extract, Transform, and Load: GeoRaster ETL**

GeoRaster ETL is an Extract, Transform and Load tool for Oracle 10g Spatial and GeoRaster.

The product can load a wide range of image types and file formats – over 100 commonly used raster and vector types. GeoRaster ETL also includes a scripting environment for customized or command line loading, and a visual workflow builder to build process flows which incorporate transformations in the loading process. In addition, a metadata mapping wizard allows users to build associations between metadata and fields in the Oracle destination table.

The tool is designed to be multi-session, enabling access to multiple servers in a distributed environment.

An easy-to-use viewer rapidly displays data that have been loaded into the Oracle database, as well as layers that have yet to be loaded.

The GeoRaster ETL tools provide full control of the GeoRaster object created as part of the loading process. Specifically, users can:

- Specify settings for blocking (tiling) the GeoRaster object. The image tiling is indicated for row, column and band dimensions.
- Generate reduced resolution datasets with control of how the resampling operation is to be performed.
- Calculate image statistics for storage within the GeoRaster object.
- Set the interleaving type for images with multiple bands.
- Set the image footprint, from either the spatial reference of the raster, or based on the raster footprint re-projected to a different spatial reference system.

## 3.2 Geospatial analysis and processing suite: Geomatica

Geomatica, PCI Geomatics' suite of image-centric geospatial tools, is now enabled for GeoRaster loading, transformation, and data processing.

With a library of cutting-edge tools for remote sensing, GIS, photogrammetry and mapping, Geomatica includes more than 250 transformations in an easy-to-use GUI environment, a powerful scripting language, or a GUI workflow builder.

### Key Features

- Advanced processing and transformation of spatial data
- Data Loader for Oracle 10g Spatial and GeoRaster
- Geomatica Focus, an intuitive viewspace for spatial data viewing, mapping, and analysis
- Over 250 powerful raster and vector processing transformations for:
  - image mosaicking
  - orthorectification
  - image classification
  - pansharpening
  - atmospheric correction
  - digital elevation model (DEM) extraction
  - 3D analysis

Geomatica is useful for enterprises that are preparing and extracting information from imagery, integrating imagery and GIS vector layers, or managing large raster datasets.

*"Earth Satellite customers demand high accuracy from our image products. We have consistently been able to deliver high-accuracy orthos and mosaics using Geomatica OrthoEngine technology. The PCI models support a wide variety of sensors, and save us considerable time and expense through automation. We're very happy with our investment in PCI Geomatics software."*

Chris Peterson  
VP of Information Technology and CTO,  
MDA Federal Inc. (Formerly Earth Satellite)

### **3.3 Components for developers: GeoRaster ETL ProPack**

The Loading of raster and vector data is available as an embeddable / scriptable object from PCI Geomatics.

The GeoRaster ETL ProPack contains a set of pluggable functions for loading raster and vector data into Oracle 10g. Using PCI's software development kit, users can integrate PCI's Spatial and GeoRaster loading engines into their own applications. The software development kit supports Python, Java, and C/C++ programming languages.

The ProPack's raster loading algorithm includes the same options for GeoRaster object control as the ETL product. In addition to loading, Geomatica's 250+ image and vector processing algorithms are also available as other components.

Documentation and examples are provided for a smooth implementation, and consultation services are also available.

The GeoRaster ETL ProPack will help enterprises that want to custom-integrate raster and vector data loading into their own application built on Oracle 10g. The ProPack also allows software vendors / integrators to build GeoRaster ETL's capabilities into their products via OEM agreements.

### **3.4 Enterprise-scale solutions**

PCI's Professional Services department can work with the client to produce automated information-extraction, analysis and storage applications. Designed for the client's specific requirements, these solutions are built upon an Oracle 10g Spatial and GeoRaster architecture.

With a commitment to open standards and interoperability, customized systems can incorporate PCI's webserver technology, imaging and mapping programs, and interface with other vendors' software applications.

## **4. Oracle Spatial and GeoRaster technology**

### **4.1 Oracle Spatial**

Oracle Spatial is an option for the Enterprise Edition database that provides a robust foundation for GIS applications. Its features manage vector data and location information, such as lines, points, polygons and their associated tables. Because Spatial is an integral part of the Oracle

database – as opposed to a GIS application atop it – it affords users all the advantages of a relational database: multi-user access, indexing, integrity checking, access to data via standard SQL queries, centralized management, security, backup and recovery.

## Key Features

- Support for basic geometric forms – points, lines, polygons, arcs and circles
- Layer representation, e.g. themes for roads, buildings, vegetation, etc – each layer can contain both vectors and their associated thematic metadata
- Spatial indexing, allowing for effective queries on area of interest from layers that can contain millions of shapes
- Support for multiple coordinate systems – Oracle 10g includes more than 1000 coordinate systems, and also allows user-defined coordinate systems
- A wealth of practical spatial operators and functions – examples include comparison operators (contain, intersect) to find relations between shapes, coordinate system transformations, geometry calculations, searching for related objects
- Geocoding – the process of associating location coordinates with addresses; e.g. postal codes, telephone area codes, and more

## 4.2 Oracle GeoRaster

GeoRaster is a feature of Oracle 10g Spatial that lets users store, index, query, analyze and deliver raster data, along with associated metadata.

### Key Features

- Storing raster data with its metadata directly inside the database, enabling all of the advantages of Oracle’s relational database system – scalability, security, integrity
- Robust enough for very large applications: can manage tens of terabytes of raster data
- Georeferencing – associating raster data with a coordinate system and projection information; essentially, indexing the earth position of each raster cell
- Blocking (tiling) – storing raster data in divided blocks, for faster retrieval and image processing
- Pyramiding – creating and storing in the database smaller representations of a raster for faster viewing operations
- Simple, practical image processing – e.g. file translation, subsetting (cropping), scaling

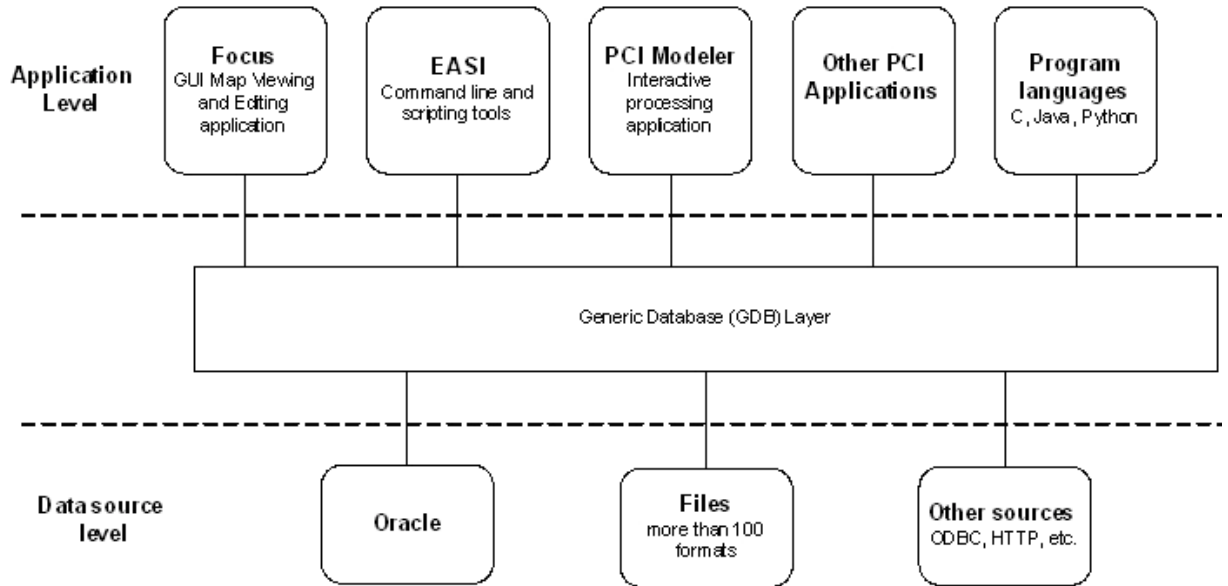
As of Oracle 10g Release 2, GeoRaster will also support the compression and decompression of raster data, using both JPEG and DEFLATE (ZLIB) compression algorithms. PCI Geomatics software will fully support this new capability.

## 5. Using PCI Geomatics software with Oracle

### 5.1 PCI data access technology: GDB

A unique feature underlying all PCI Geomatics technologies is the Generic Database Access Layer (GDB). GDB acts as a transparent interface between PCI applications and a wide variety of data sources, reading, writing and transforming more than 100 raster and vector file formats.

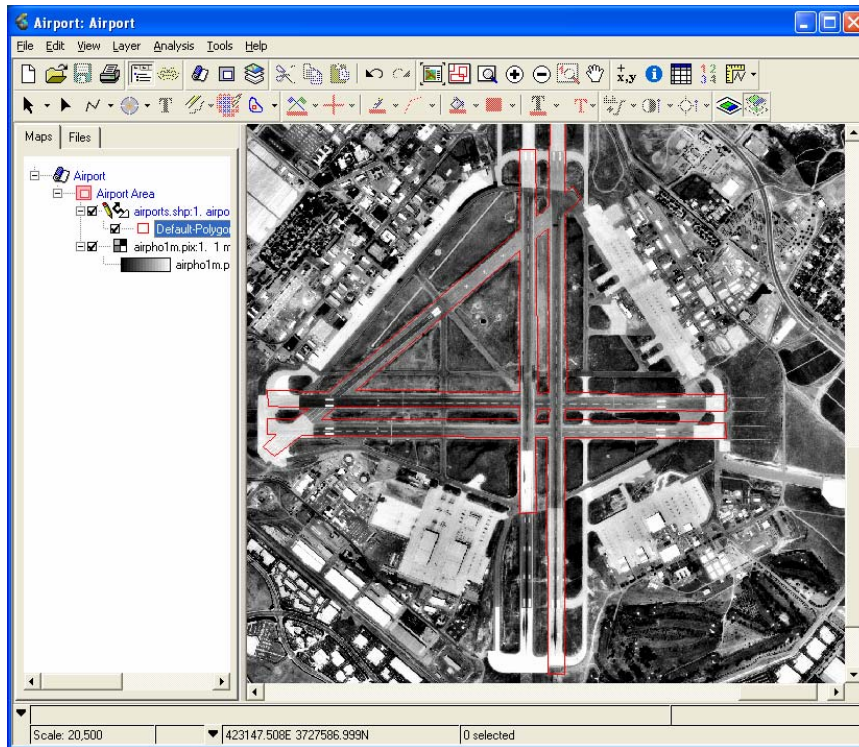
Because support for Oracle Spatial and GeoRaster is at the GDB level, *all* PCI applications can interface with Oracle for reading, viewing, and transforming data in the database.



*PCI's Generic DataBase Access Layer (GDB) architecture model*

## 5.2 Viewing and project management: Geomatica Focus

Focus is PCI Geomatics' interactive data viewing and editing environment.



*Geomatica Focus*

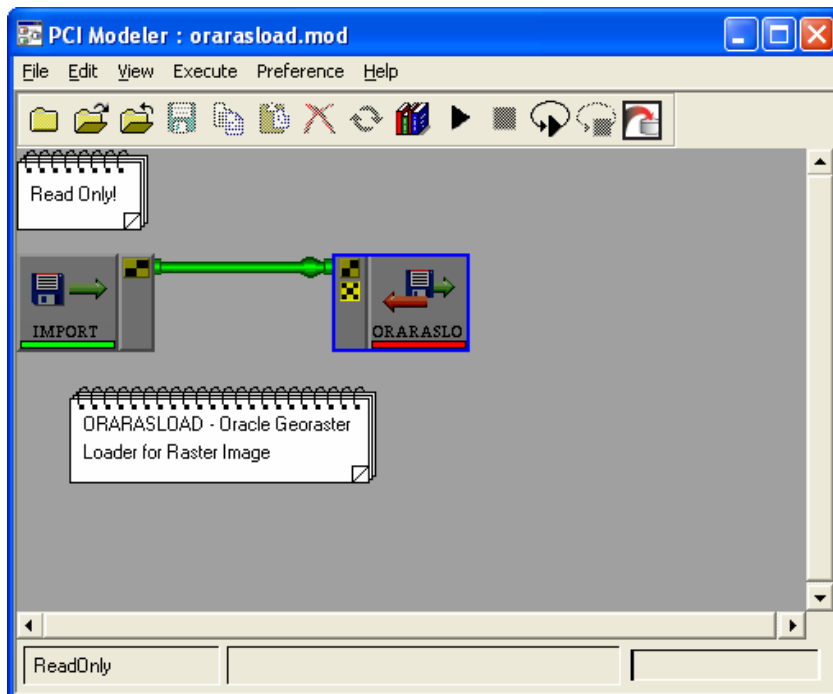
Geomatica Focus is fully integrated with Oracle Spatial and GeoRaster:

- open and view vector and raster data from the database
- analyze / edit / transform vector and raster data
- save the edited data back into Oracle database
- export data into an external file – e.g. open an image from the database, save it to disk
- create and export maps – e.g. open rasters and/or vectors from the database, prepare a map for printing or exporting
- Save your project session in a project file (creates dynamic links to layers in the database)

### 5.3 Flexible visual modeling: Geomatica Modeler

Modeler is a graphical tool for running over 250 powerful raster and vector processing transformations, including data import / export, image classification, overlays and statistical analyses, and advanced spatial data processing.

Its intuitive canvas allows users to build processing models by connecting the programs together with pipes. During the execution of the model, graphical progress monitors follow the data flow through the process, and provide status reports.



*Geomatica Modeler interactive scripting environment*

Modeler allows a process flow to culminate with populating an Oracle database. For example, the user could perform a classification of images on the local disk, inspect the results, and perform a batch ingest of the classified rasters to the Oracle database.

Conversely, processes in Modeler can read data from the Oracle database, perform operations on it locally, and either re-save to the database or export to a local file.

Each geospatial function accessed by Modeler has input and output file parameters. When connecting Modeler to the Oracle database, either the file name or the Oracle connect string can be used to define the source and destination ports for each program.

The format of the Oracle connection string is as follows:

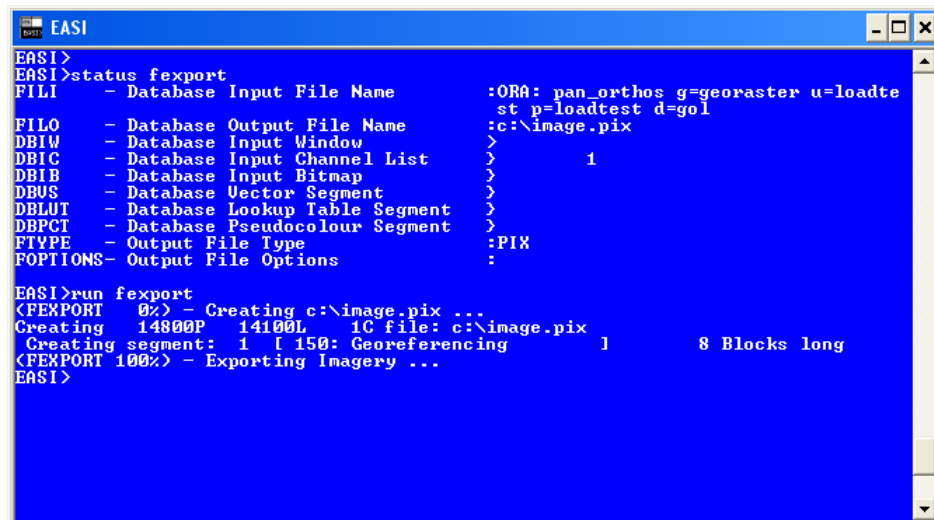
```
ORA: <table_name> g=<georaster field name> s=<spatial field name> u=<oracle user name> p=<oracle password> d=<database name> w=<where clause>
```

Some common functions for uploading and downloading raster and vector data to the Oracle database are:

- ORARASLOAD – procedure for loading raster data, its associated metadata, and ancillary information into the Oracle GeoRaster table. The procedure loads data into an existing Oracle table (which is predefined in Oracle through scripts readily-available from PCI). Allows control of blocking size, pyramid level, list of raster channels, and several other parameters of the GeoRaster object type.
- ORAVECLOAD – procedure for reading vector information from source file, creating a new table in the database, and loading vector data and associated metadata into this table.
- VECAPPEND – procedure for loading vector and associated metadata into an existing Oracle table.

## 5.4 Command-line scripting: Geomatica EASI

Another way to access and process geospatial data in Oracle is using PCI's traditional command line tool, EASI. An easy-to-use scripting environment, EASI provides a scripting portal to the same raster and vector processing transformations as Modeler. These functions can be run in single executions or through the use of a script in the EASI scripting language.



```
EASI
EASI>
EASI>status fexport
FILE - Database Input File Name      :ORA: pan_orthos g=georaster u=loadte
      st p=loadtest d=gol
FILE - Database Output File Name     :c:\image.pix
DBIW - Database Input Window         >
DBIC - Database Input Channel List   >      1
DBIB - Database Input Bitmap         >
DBUS - Database Vector Segment       >
DBLUT - Database Lookup Table Segment >
DBPCT - Database Pseudocolour Segment >
FTYPE - Output File Type             :PIX
FOPTIONS - Output File Options       :

EASI>run fexport
<FEXPORT 0%> - Creating c:\image.pix ...
Creating 14800P 14100L 1C file: c:\image.pix
Creating segment: 1 | 150: Georeferencing 1      8 Blocks long
<FEXPORT 100%> - Exporting Imagery ...
EASI>
```

*Geomatica EASI scripting / command line environment*

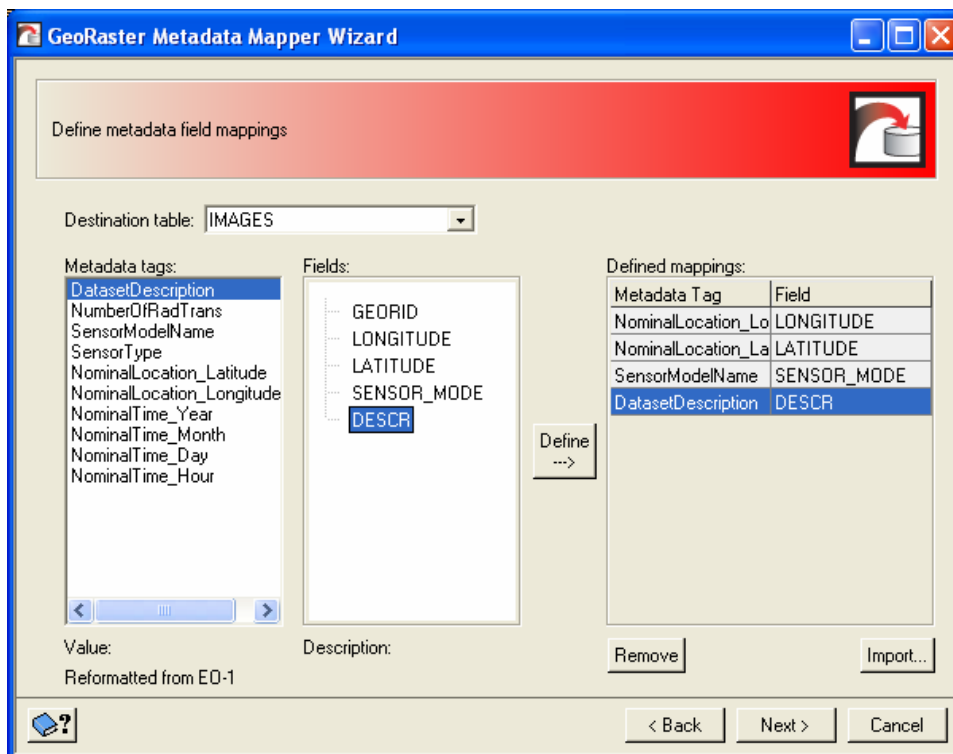
As with Modeler, either the file name or the Oracle connect string can be used to define the source and destination ports for each program.

## 5.5 Metadata mapping

Raster images are often associated with metadata information, such as the orbit parameters of a satellite image, or the contextual color information of a thematic map. This information is often crucial in the accurate processing and integrity of the raster data itself.

To help with the efficient loading of such metadata, PCI Geomatics has created a simple Metadata Mapper Wizard for GeoRaster loading. The wizard essentially defines the relationships between metadata tags in a source file, and their corresponding fields in the Oracle GeoRaster table.

For efficient batch loading of many rasters, the Metadata Mapping Wizard can output a schema file, mapping the fields for a series of images.



*Matching metadata from a source image with fields in the Oracle GeoRaster table*

## 5.6 Custom development: accessing PCI and Oracle with Python, Java, and C/C++

To support the creation of customized systems, the same functions for processing, analyzing, and loading data into Oracle 10g are available from PCI Geomatics ProPacks.

The GeoRaster ETL ProPack contains a set of pluggable functions for loading raster and vector data into Oracle 10g. The software development kit supports the following programming languages:

- Python – for creating scripts that can support complex spatial data processing
- Java – for using PCI algorithms in an enterprise environment
- C/C++ – for building high performance systems

In all cases above, the same steps for connecting to Oracle apply as described for Modeler and EASI.

Oracle users might find such interactions to be powerful: users can write their own processing scripts in Python, and these scripts can access images and vectors inside the Oracle database as easily as they would local files.

## 5.7 Using Geomatica Focus as a Map Generating Server

Using prepared map templates, maps can be generated automatically from vector and image layers – even from specified regions within / across data layers – stored inside the Oracle database. Focus makes this possible by acting as an XML-RPC server.

XML-RPC is a remote procedure call, using HTTP as the transport mechanism and XML for encoding. XML-RPC is designed to be as simple as possible, while allowing complex data structures to be transmitted, processed and returned.

There are several implementations of XML-RPC clients for Java, Python, C/C++, PHP, Visual Basic and other popular languages. More information about XML-RPC can be found at <http://www.xmlrpc.com>.

## 6. Summary

The growing number of enterprises leveraging raster images will benefit greatly from using Oracle 10g GeoRaster for storing and managing raster data in the database infrastructure.

Though Oracle provides basic mechanisms for managing spatial and raster data in the database, PCI Geomatics software extends these capabilities significantly through automated uploading and downloading of data to Oracle, support for a broad variety of raster and vector file types, and advanced functions for remote sensing, photogrammetry, GIS, and mapping.

## Appendix: Loading and viewing performance statistics

To aid potential users in estimating their loading and viewing performance, the following estimations for a) loading vector and raster data into Oracle, and b) reading vectors data from Oracle, were made.

Note that the figures below are approximations, and that performance is dependent upon several factors:

- Hardware configuration
- Server Disc subsystem
- Database configuration parameters
- Loading parameters (e.g. blocking size and pyramid level)
- Server loading
- The amount of data in various caches (operating system, Oracle, Geomatica Focus)
- The particular data tested (e.g. the number of channels in a raster image file)

All tests were performed on a system with the following components:

- PC with dual processors @ 3.4 GHz
- Oracle SGA size 1.5Gb
- 2 SATA RAID arrays with 16x300Gb SATA hard drives
- Windows 2003 server (Standard Edition)
- Oracle 10g Enterprise Edition 10.1.0.3

### A. Loading rasters

In this test, two different raster files were loaded into Oracle by the ORARASLOAD procedure in the EASI interface.

Size	16600x16200 pixels
Bits per pixel	8
Number of channels	1
Format	Geomatica .pix
Size on disk	301 Mb
Block size in Oracle	1024 x 1024 pixels
Loading time	55 sec
Building 6 levels of the pyramid	105 sec

Size	8550x8000 pixels
Bits per pixel	8
Number of channels	6
Format	Geomatica .pix
Size on disk	456 Mb
Block size in Oracle	1024 x 1024 pixels
Loading time	100 sec
Building 6 levels of pyramid	170 sec

## B. Loading and reading vectors

In this test, two different vector shape files were loaded into Oracle. The loaded layers were then opened for viewing in Geomatica Focus.

Number of vectors	1761
Shape type	Polygons
Format	Arc/Info .shp
Size on disk .shp file (vectors)	894 Kb
Size on disk .dbf file (metadata)	466 Kb
Loading time	6 sec
Opening in Focus	1 sec

Number of vectors	3597
Shape type	Lines
Format	Arc/Info .shp
Size on disk .shp file (vectors)	3.16 Mb
Size on disk .dbf file (metadata)	0.85 Mb
Loading time	12 sec
Opening in Focus	3 sec



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