Ontario Realty Corporation - Multi-Resolution Imagery Service - Imagery for Ontario

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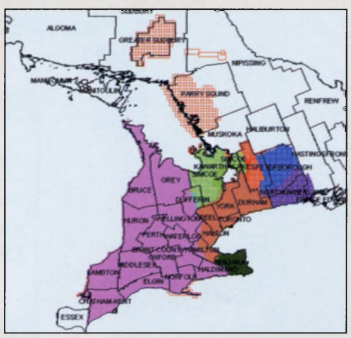
Background

The Ontario Realty Corporation (ORC) provides the Government of Ontario useful and usable access to large and growing amounts of aerial and satellite imagery through its GeoPortal application. ORC's new technology – called the "Multi-Resolution Imagery Service" – efficiently processes and publishes very large volumes of aerial and satellite imagery. Now at over a dozen terabytes of data, this service was recognized recently with an *Innovation Award* from the Urban and Regional Information Systems Association's Ontario Chapter (URISA-OC).

The Challenge

The ORC, through the Government of Ontario and other sources is acquiring massive amounts of aerial and satellite imagery for use in mapping. The Southwestern Ontario Ortho-photography, Golden Horseshoe Imagery, GTA imagery, QuickBird imagery for SE Ontario, municipal imagery data sets, and others are making the government's image holdings balloon in size and complexity. The graphic *(right)* shows different sources of coverage for UTM Zone 17 in Southern Ontario.



High-resolution imagery provides extremely powerful and useful information, particularly when used with vector data mapped features as a backdrop or as classified thematic maps. However, the sheer volume of data presents a significant challenge for Ontario government organizations to store, publish and access this valuable information source. "The data are there, we invested large sums of dollars – but we don't have the right tools to access and use them!"

Traditional solutions include:

- Merging image scenes into a mosaic and compressing the data into proprietary formats, such as Mr. SID. This works reasonably well when the geographic area is not too large; it does not span multiple coordinate systems/UTM Zones; the imagery is homogeneous; and the user has appropriate GIS tools to view the data. For organizations like ORC that need to view data from multiple jurisdictions, simultaneously accessing multiple mosaics presents a further challenge as the image coverage in each mosaic often stops at the administrative boundary. Anything outside of the boundary appeared as a "null" black area. Having multiple null-areas in different mosaics can interfere with the display of other data and can make the map look cluttered and unusable.
- An alternative to an individual mosaic is to create an image catalogue. An image catalogue provides a geographic index to the individual image files that make up an area of coverage. By having an index, the GIS viewing tool first identifies which image files it needs for its view. This can significantly enhance access times to the imagery. A further refinement of this method is to compress the individual image files into Mr. SID or another similar type of compressed format. However, there are drawbacks such as: the image catalogues are often tied to a specific coordinate system and cannot be dynamically projected or the processing effort of projecting on the fly is too high; the index structure is technology/vendor specific; there is no control with overlapping imagery as to which images get displayed first; there can be significant manual effort expended in preparing multiple source imagery to be used in a single image catalogue; and, sheer volumes of image files could make the image catalogue index become very large and inefficient to search through. A further refinement to having tens of thousands of individual compressed image files that make up an image catalogue is to store the compressed image data into relational database management systems (DBMS) as binary objects. This minimizes the challenge of managing thousands of individual files, but balloons the database to very a large size and that can create DBMS performance challenges.

The Scale Issue: One of the biggest drawbacks to all of these methods is that GIS image viewing is very dynamic and can span multiple viewing scales. Accessing imagery at full resolution, even if compressed, means that for small viewing scales that cover large areas (i.e. many image files), the GIS has to read *all of the data* but only display a small portion of it. In other words, the system must re-sample the source imagery to compose a view appropriate for the map scale and the output display device of the computer. This is very *processing intensive* and very inefficient in a multi-user, web-based GIS environment, such as ORC's GeoPortal, which must respond to user requests in fraction of a second.

Multi-Resolution (MR) Imagery Service

Handling multiple sources of imagery at different viewing scales, of different quality, source and vintage; that span all of Ontario, and requiring *dozens of terabytes* of storage space,

forced ORC and its GIS implementation partner, SKE Inc. to re-evaluate how to manage and publish imagery.

The result is a new and innovative approach for creating publishable imagery called the "Multi-Resolution (MR) Imagery Service." ORC is using this new approach and technology to re-process all of its image holdings and make them available to others in the Ontario government through its GeoPortal service.

The Multi-Resolution Imagery Service consists of two main components:

1. The MR Imagery Build process.
2. The MR Imagery Publish process.

1. The MR Imagery Build process:

- Creates multiple image catalogues using homogeneous source imagery that is geo-referenced in the same coordinate system.
- Creates an MR Index scheme. There can be multiple indexes created for a coordinate system or one big index that covers the entire imagery area. An MR Index identifies all of the output image tile names, extents, and location by quad-level. A quad-level is like a map layer in that it contains MR images at a specific resolution for a specific display scale. For example ORC will display high-resolution aerial imagery from a scale of 1000 to 128,000. Therefore, quad-levels are created for: 1000, 2000, 4000, 8000, 16000, 32000, 64000 and 128000 scales with image resolution decreasing by a factor of two for each quad-level.
- Processes the source imagery using the MR Indexes as "cookie cutters" by bringing together the source imagery for each MR Index tile and re-sampling them to the pre-defined resolution associated with the specific quad-level, and then outputting that image to the pre-defined MR Image indexed storage structure.

As part of the processing, the system incorporates a number of capabilities including:

- **Image Masking:** Combining imagery from multiple and different sources usually can leave a lot of null imagery or black areas. This issue is resolved by defining masks and then making these areas transparent. No more black areas!
- **An Efficient Indexing Scheme:** An indexing scheme is created that maps directly to the system storage, thus enabling very rapid and direct access to each index tile. For example, high-resolution imagery in UTM Zone 17 covering viewing scales from 1,000 to 128,000 contains *over 65,000,000 multi-resolution files and corresponding folders!* Navigating this structure would be impossible without an efficient indexing scheme.
- **Flexible Processing:** ORC continues to acquire new imagery so the processing scheme has to allow for these additions and changes over time. The MR Build process allows for parts of an MR Index tile to be processed or re-processed at any time without any system downtime to any of the in-production imagery. The MR image files are simply replaced with the updates as they are processed.
- **Multiple MR Image Layers:** ORC's imagery comes from a variety of sources with various viewing scales to view

anywhere from a street corner to the entire province. The imagery can be updated at different times. It is therefore necessary to use different image layers. The MR Image Service supports the concept of different MR imagery layers that can be used to segregate different types of image data. In fact, this concept is being extended to process static "tombstone" vector map data (such as topographic map layers like the OBM) into the MR imagery format. The display performance gains are significant compared to accessing the same data in a dynamic vector file/database.

2. The MR Imagery Publish process:

The MR imagery is published through two methods:

1. ORC's GeoPortal technology can access the imagery directly. This enables users with the GeoViewer tool to efficiently access imagery for any part of Ontario. Vector map data is then dynamically displayed on this imagery backdrop.
2. An Open GIS Consortium (OGC) – Web Map Service (WMS) enables any WMS compliant client (e.g. ArcGIS, AutoCAD, Microstation, GeoMedia) to efficiently use the MR image source.

The MR Imagery Build and MR Imagery Publish processes are shown in the schematic below.

Impact and Results

Imagery supports multiple business applications by greatly enhancing our understanding of the landscape and any related vector map layers shown on top. Having readily available imagery is further enhancing ORC's enterprise GIS – GeoPortal. By taking a new approach, ORC and SKE have developed a solution that is dramatically improving ORC's ability to process, manage and serve huge volumes of imagery. Some of the key benefits include:

- Rapid "Google Earth"-like access and display of the best imagery available in the province.
- Support for web and desktop GIS clients through standards-based geo-publishing technologies.
- Ability to efficiently handle very large amounts of imagery and tombstone vector data.
- Ability to update specific areas of an image coverage using multiple sources and image types.
- Ability to integrate multi-resolution image sources providing a seamless view to end-users.

ORC is now making all of the aerial and satellite imagery of Ontario more accessible to the government and its ministries and agencies because of the capabilities of the new MR Imagery Service. What would otherwise have been impossible for most government organizations for both technical and economic reasons is now simply there and available through ORC's GeoPortal services. This is further enabling ORC to take a GIS information publishing leadership role in the Ontario government that is transforming how the government utilizes its information resources.

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