DigitalGlobe Incorporated
Civil Commercial Imagery Evaluation Workshop
Corporate and System Update
March 14, 2006
DigitalGlobe operates the world’s highest resolution commercial imaging satellite
QuickBird Specifications

- 60cm (2-foot) panchromatic resolution (at nadir)
  450-900 nm (grayscale)
- 2.44 meter multispectral resolution (at nadir)
  450-520 nm (blue)
  520-600 nm (green)
  630-690 nm (red)
  760-900 nm (near IR)
- 60cm (2-foot) digital color (natural or near-IR)
  - Image Detail Comparable to 1-foot film
- Collection capacity: 15 orbits/day; ~57 scenes/orbit;
  = ~27 million mi$^2$ (70 million km$^2$) per year
- Large 10.3 x 10.3 mi (16.5 x 16.5 km) scene/footprint
- 11 bit dynamic range
QuickBird Imagery Types

- Panchromatic
  - 60 Centimeter Resolution
  - 11-bit Dynamic Range
  - 450-900 nm Spectral Range

- Multispectral
  - 2.4 Meter Resolution
  - 11-bit Dynamic Range
  - 4 Spectral Bands
    - Blue: 450-520 nm
    - Green: 520-600 nm
    - Red: 630-690 nm
    - Near Infrared: 760-900 nm

- Pan-Sharpened (Fused)
  - 11-bit or 8-bit dynamic range
  - Natural Color (3 Bands)
  - Color Infrared (3 Bands)
  - 4 Bands

Forbidden City, Beijing, China
Port-au-Prince, Haiti
Abu Dhabi, UAE
Large Imaging Footprint

- More targets of interest per scene
- Builds Image Library faster
- Easier Image Mosaicking
- Fewer GCPs
- Faster large area collection
QuickBird Satellite Revisit

**Table: Revisit Days to a Point**

<table>
<thead>
<tr>
<th>Latitude</th>
<th>15 off-nadir</th>
<th>30 off-nadir</th>
<th>45 off-nadir</th>
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<td>0</td>
<td>9.8</td>
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<td>10</td>
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<tr>
<td>60</td>
<td>6.9</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>70</td>
<td>5.1</td>
<td>0.9</td>
<td>0.8</td>
</tr>
</tbody>
</table>
A Growing Imagery Library

• Currently Contains ~162,000,000 km² or ~596,000 QuickBird images
• Growing at a rate of 3,500 scenes per week
• 45 Percent Have Less Than 20 Percent Cloud Cover
The On-Line Search Tool
Aftermath of Hurricane Katrina: New Orleans, LA September 3, 2005

A Plea for Help: Downtown New Orleans

Louisiana Superdome

Metairie, LA: Rescue Staging Base at Zephyr Field
Rescue Operations Underway

Flooded Residential Area

Military Helicopters Parked on Interstate

QuickBird Natural Color Image September 3, 2005
17th Street Canal: Levee Repairs

QuickBird Natural Color Image
September 3, 2005

- Probable Sandbags For Levee Repair
- Storm Debris Piled up At Bridge
- Construction Equipment
- Levee Break
- Hammond Highway
- Flooded Residential Area
DigitalGlobe Data and Extracted Information:
Suitability for Many Civil Govt. Applications

- Base Mapping
  - For virtually ALL applications, rapid response and long term planning
- Environmental Assessment
  - Landcover III, Wetlands, Land Classification and Management, and Sensitive Areas
- Disaster and Emergency Response, Planning & Mitigation
- Water and Waste Water Management
- Watershed Master Planning and Management
- DOQQ Updating
- Environmental Monitoring
- Tax Assessment
- Parcel Mapping
- Transportation (Corridor Planning and Mapping, etc.) Apps
- Natural Resource (Forestry, Agriculture, etc.) Applications
Primary Forestry Applications

- Forested/non-forested classification
- Fire/Pest Damage Monitoring and Assessment
- Crown mapping
- Species identification
- Health assessment
- Individual Tree Count
- Inventory assessment
- Stem diameter (volume) estimates
- Timber density
- Canopy closure
- Open space measurements
- Stand delineation
- Commercial operation infrastructure
Crown Mapping

- Crown maps derived from high resolution imagery provide the basis for most automated and semi-automated forest assessment applications.

- 60 cm imagery represents an optimum resolution feature recognition as applied to forest resource assessment.

- Individual crowns may be derived from crown maps and classified according to size and species.

Source: Native Communities Development Corporation
Tree/Stem Diameter

- Tree diameter, or Diameter at Breast Height (DBH), is inferred from size of Crown area.

- DBH is an important component in determining timber volume in a given stand.
Species Classification

- QuickBird 2.4m, 4-band multispectral data provides the spectral depth necessary for species-level classification
Forest Composition Mapping

• Forest composition maps are derived from canopy density analyses

• Based on crown size and degree of canopy closure

• Direct application for mapping thinning projects or fire risk assessment zone maps

Timber Density Mapping

High density larger diameter stands in dark green and high density smaller diameter stands in red with moderate to low density timber illustrated in bright green as minimum tree units.

Source: Native Communities Development Corporation
Grand Prix Fire, California

QuickBird Natural Color Image

27 October 2003

Lytie Creek, California
Grand Prix Fire, California

Lytle Creek, California

QuickBird Color Near-Infrared Image

Clear delineation of fire lines

27 October 2003
1-Foot Resolution Traditional Orthophoto vs. 2-Foot Resolution QuickBird Orthoimage

1-Foot Traditional Orthophoto  2-Foot QuickBird Orthoimage
DigitalGlobe Dynamic DOQQ Product

QuickBird Dynamic DOQQ Specifications

- Same naming conventions and image footprint as USGS DOQQs
- Offered at 2-foot or 1m GSD
- B&W, Natural Color, CIR, 4-band options
- Overlap options of 0 & 300 meters
- Cloud-Free & Snow Free
- Edge matched as required
- Accurate to 1:12,000 scale (6.2m RMSE)
- FGDC Metadata Compliant
- 8 or 16 bit dynamic range
- State plane, geographic or UTM projections available
- As low as $399/DOQQ

DigitalGlobe Dynamic DOQQ
2-Foot Natural Color
DigitalGlobe ImageLibrary™ DOQQs

- 140 Million KM²
  ..... and counting

- 100 Counties
- 1500 Cities
USGS DOQQ, 1 meter, Pan
DigitalGlobe DOQQ, 2-foot, Color
CitySphere Overview

- **CitySphere™**
  - Current off-the-shelf orthomosaics of high resolution QuickBird imagery for 200 pre-selected cities worldwide
What is CitySphere™

• Pre-selected 200 Worldwide Cities
  – ~50 US and ~150 International
• GIS-ready imagery
  – High Resolution QuickBird data – 60 cm (2 foot) resolution
  – Accurate – 1:4800 orthomosaics
• Two Product Options
  – *Basemap GIS* - Color (RGB), 8 bit
  – *Basemap Advanced* – 4 band (NRGB), 16 bit
• Repeatable, Consistent Coverage
  – Each city will be updated every year
  – Imagery no older than 24 months
Currently Available CitySphere™ Cities

**International**

<table>
<thead>
<tr>
<th>City Name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amman</td>
<td>Jordan</td>
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<tr>
<td>Athens</td>
<td>Greece</td>
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<tr>
<td>Baghdad</td>
<td>Iraq</td>
</tr>
<tr>
<td>Barcelona</td>
<td>Spain</td>
</tr>
<tr>
<td>Basra</td>
<td>Iraq</td>
</tr>
<tr>
<td>Belgrade</td>
<td>Serbia and Montenegro</td>
</tr>
<tr>
<td>Belo Horizonte</td>
<td>Brazil</td>
</tr>
<tr>
<td>Brasilia</td>
<td>Brazil</td>
</tr>
<tr>
<td>Brisbane</td>
<td>Australia</td>
</tr>
<tr>
<td>Canberra</td>
<td>Australia</td>
</tr>
<tr>
<td>Cape Town</td>
<td>South Africa</td>
</tr>
<tr>
<td>Casablanca</td>
<td>Morocco</td>
</tr>
<tr>
<td>Durban</td>
<td>South Africa</td>
</tr>
<tr>
<td>Fortaleza</td>
<td>Brazil</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>Mexico</td>
</tr>
<tr>
<td>Istanbul</td>
<td>Turkey</td>
</tr>
<tr>
<td>Karachi</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Lima</td>
<td>Peru</td>
</tr>
<tr>
<td>Lisbon</td>
<td>Portugal</td>
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<tr>
<td>Madrid</td>
<td>Spain</td>
</tr>
<tr>
<td>Naples</td>
<td>Italy</td>
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<tr>
<td>Perth</td>
<td>Australia</td>
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<tr>
<td>Reval</td>
<td>Estonia</td>
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<td>Rio de Janeiro</td>
<td>Brazil</td>
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<tr>
<td>Rome</td>
<td>Italy</td>
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<tr>
<td>San Salvador</td>
<td>El Salvador</td>
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<tr>
<td>Santiago</td>
<td>Chile</td>
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<tr>
<td>Santo Domingo</td>
<td>Dominican Republic</td>
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<tr>
<td>Skopje</td>
<td>Macedonia</td>
</tr>
<tr>
<td>Tunis</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Windhoek</td>
<td>Namibia</td>
</tr>
</tbody>
</table>

**North America**

<table>
<thead>
<tr>
<th>City Name</th>
<th>Country</th>
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<tbody>
<tr>
<td>Aguas Calientes</td>
<td>Mexico</td>
</tr>
<tr>
<td>Albuquerque</td>
<td>USA</td>
</tr>
<tr>
<td>Anchorage</td>
<td>USA</td>
</tr>
<tr>
<td>Atlanta</td>
<td>USA</td>
</tr>
<tr>
<td>Austin</td>
<td>USA</td>
</tr>
<tr>
<td>Boise</td>
<td>USA</td>
</tr>
<tr>
<td>Charlotte</td>
<td>USA</td>
</tr>
<tr>
<td>Colorado Springs</td>
<td>USA</td>
</tr>
<tr>
<td>Fairbanks</td>
<td>USA</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>Mexico</td>
</tr>
<tr>
<td>Halifax</td>
<td>Canada</td>
</tr>
<tr>
<td>Helena</td>
<td>USA</td>
</tr>
<tr>
<td>Honolulu</td>
<td>USA</td>
</tr>
<tr>
<td>Las Vegas</td>
<td>USA</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>USA</td>
</tr>
<tr>
<td>Oakland</td>
<td>USA</td>
</tr>
<tr>
<td>Oklahoma City</td>
<td>USA</td>
</tr>
<tr>
<td>Orlando</td>
<td>USA</td>
</tr>
<tr>
<td>Portland</td>
<td>USA</td>
</tr>
<tr>
<td>Quebec</td>
<td>Canada</td>
</tr>
<tr>
<td>Regina</td>
<td>Canada</td>
</tr>
<tr>
<td>San Antonio</td>
<td>USA</td>
</tr>
<tr>
<td>San Francisco</td>
<td>USA</td>
</tr>
<tr>
<td>San Jose, California</td>
<td>USA</td>
</tr>
<tr>
<td>Saskatoon</td>
<td>Canada</td>
</tr>
<tr>
<td>Spokane</td>
<td>USA</td>
</tr>
<tr>
<td>Tucson</td>
<td>USA</td>
</tr>
<tr>
<td>Vancouver</td>
<td>Canada</td>
</tr>
<tr>
<td>Winnipeg</td>
<td>Canada</td>
</tr>
</tbody>
</table>

- Most cities currently available
- All 200 cities will be available by May 2006
- New cities will be released every month
- See [www.digitalglobe.com](http://www.digitalglobe.com) for updates
CitySphere Product Example

Downtown San Francisco
WorldView

DigitalGlobe’s Next Generation Satellite System
## DigitalGlobe Satellite Comparison

<table>
<thead>
<tr>
<th>Feature</th>
<th>QuickBird</th>
<th>WorldView-60</th>
<th>WorldView-110</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Altitude</td>
<td>450 km</td>
<td>450 km</td>
<td>770 km</td>
</tr>
<tr>
<td>Weight Class</td>
<td>2000 lbs</td>
<td>5700 lbs</td>
<td>5700 lbs</td>
</tr>
<tr>
<td>Pan / MS GSD (nadir)</td>
<td>0.6 / 2.4 m</td>
<td>0.5 / 2.0 m</td>
<td>0.5 / 2.0 m</td>
</tr>
<tr>
<td>Standalone CE90 (avg / max)</td>
<td>13 m / 23 m</td>
<td>7 m / 9 m</td>
<td>11 m / 14 m</td>
</tr>
<tr>
<td>Avg revisit at 1m resolution (40 deg latitude target)</td>
<td>2.5 days</td>
<td>1.7 days</td>
<td>1 day</td>
</tr>
<tr>
<td>Swath width</td>
<td>16.5 km</td>
<td>16 km</td>
<td>16 km</td>
</tr>
<tr>
<td>Monoscopic area capacity</td>
<td>1 X</td>
<td>&gt; 3.5 X</td>
<td></td>
</tr>
<tr>
<td>Single-Pass Mono Area Coverage (scenes)</td>
<td>1 x 10 (&lt; 30 deg off nadir)</td>
<td>4 x 4 (&lt; 40 deg off nadir)</td>
<td>1 x 10 (&lt; 40 deg off nadir)</td>
</tr>
<tr>
<td>Single-Pass Stereo Area Coverage (scenes)</td>
<td>1 x 1 (&lt; 10 deg off nadir)</td>
<td>2 x 2 (&lt; 30 deg off nadir)</td>
<td>1 x 10 (&lt; 30 deg off nadir)</td>
</tr>
<tr>
<td>Attitude Control</td>
<td>Reaction Wheels</td>
<td>Control Moment Gyros</td>
<td></td>
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<tr>
<td>Onboard Storage</td>
<td>128 Gbits</td>
<td>1600 Gbits</td>
<td></td>
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<tr>
<td>Wideband Link Rate</td>
<td>320 Mbps</td>
<td>800 Mbps</td>
<td></td>
</tr>
</tbody>
</table>
QuickBird Geolocation Accuracy

The CE90s of recent QB imagery have gotten uncomfortably close to our 23 meter spec.

some absolute geolocation accuracy statistics:
QuickBird Geolocation Accuracy

What kills the geolocation accuracy?

If star catalog is perfect, then star trackers provide excellent data for attitude solution.

Bad Stars!
QuickBird Geolocation Accuracy

What kills the geolocation accuracy?

But a biased star in the catalog skews the attitude solution.
QuickBird Geolocation Accuracy

Can it be fixed? Absolutely! Just reprocess the attitude...

Port Hedland, Australia
4 Aug 2005 02:37 UTM

adp216, current

CE90: 16.97 meters

adp40, experimental

CE90: 3.53 meters
What Do WV Satellite Enhancements Mean?

• Accuracy
  – Standalone max CE90 roughly twice as good as QuickBird
  – Accuracy Transfer improves standalone accuracy significantly (demonstrated better than 6 meter CE90 in testing with QuickBird; WorldView will be better given higher quality gyros)

• Revisit
  – Daily revisit at 1 meter resolution or better
  – Much better chance of collection in high cloud regions

• Area collection capacity + storage + downlink data rate
  – Over 3.5x the total capacity of QuickBird, so faster collection

• Agility (10x QuickBird) + altitude (1.7x QuickBird)
  – MUCH greater local collection capacity
  – MUCH greater capacity to collect competing orders within the same region
  – MUCH faster collection of orders in high competition areas
WorldView’s CMGs Greatly Reduce Slewing Time

WorldView-1

WV-60 Telescope (60cm Aperture)
Pan only, Dual Direction FPA
2 Terabit Recorder
800 Mpbs Downlink

Control Moment Gyros
Large Propulsion System (>7 yrs fuel)
2 Single Axis Solar Array Wings
Large Ni-H Battery
Star Tracker, SIRU, GPS

For typical target separations, WorldView slew time is 2 to 3 times faster than the next highest performing system.
WorldView Constellation (QB, WV-1, WV-2) Offers Many Same-Day Imaging Opportunities For A Variety Of Scenarios

Fraction Of Passes Target Is Visible From Multiple Satellites
Constellation includes: QB, WV-1, WV-2

- **NoDong Missile Site**
  - Point
  - At least 1 satellite
  - At least 2 satellites
  - 3 satellites
  - Image *twice a day on average*

- **Tsunami Coast**
  - Strip
  - At least 2 satellites
  - Image *1.4 times a day on average (either one or two times a day)*

- **Afghanistan**
  - Small Area
  - At least 2 satellites
  - Image *once every two days on average*

Does not include cloud cover, since this varies by region & season
Efficient Constellation Tasking Means Quicker Order Fulfillment

QB2 Alone (today)
- 10 collects per pass
- mono / stereo
- pan / msi
- direct / archive

Time to complete Whole 1° Cells ~ 25 days

QB2 + WV-1 (2006)
- 20 collects per pass
- mono (mostly)
- pan / msi
- archive (mostly)

WV60
- 40 collects per pass
- mono / stereo
- pan only
- direct / archive

Time to complete Whole 1° Cells ~ 6 days

QB2 + WV-1 + WV-2 (2008)
- 40 collects per pass
- mono / stereo
- pan + msi
- direct / archive

WV110
- 40 collects per pass
- mono / stereo
- pan only
- direct / archive

Time to complete Whole 1° Cells ~ 2 days

vicinity of 1° cell
Summary

- WorldView will offer dramatic improvements over current commercial satellite capability in:
  - Timeliness
  - Capacity
  - Agility
  - Accuracy
  - Multisourcing
  - Product Diversity
  - Integration with NGA Systems
  - Cost-effectiveness: a better product for a dramatically lower price

- The program is on schedule to support:
  - WorldView-60 launch by late-2006
  - WorldView-110 launch 12-18 months following WV1
Thank You
Thank You
For Additional Information:

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(228) 688-1607

www.digitalglobe.com