QuickBird-2 System Description and
Product Overview

presented by
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Revisit Times / GSD

Sample Target At 40° North Latitude, Over 1 Year

- Guaranteed GSD (m)
  - 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0

- Average Revisit
  - 0 10 20 30 40 50 60 70

- Off-Nadir Angle (°)
  - 0 10 20 30 40 50 60 70

- Off-Nadir Angle

- QuickBird Angle

- QuickBird Revisit

- Average Revisit

- Guaranteed GSD (m)
  - 0 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
Bands

• Pan band is determined by silicon response.
• MS bands designed to match nominal Landsat bands.
• Actual bands (average 50% response points) are as follows:
  - Pan 515 – 875 nm
  - Blue 448.5 – 512.3 nm
  - Green 498.8 – 594.1 nm
  - Red 622.6 – 688.9 nm
  - NIR 759.1 – 863.4 nm
Focal Plane Layout

- The QuickBird focal plane consists of
  - 6 staggered pan arrays, with 32 TDI stages each
  - 6 staggered MS arrays, with four linear arrays each
Measured Performance (MTF)

- Typical pan system MTF at the Nyquist frequency is approximately 0.17 along track, 0.21 cross-track, across field of view and over orbit, with focus optimized.
  - The average edge response slope is about 54% between \(-\frac{1}{2}\) pixel and \(+\frac{1}{2}\) pixel
- MTF for MS more difficult to measure on-orbit due to lack of large edge targets, but is expected to be between 0.25 and 0.40, based on modeling.
Geolocation

- Geolocation activities progressing on schedule
- Significant improvements in both absolute and relative geolocation on a weekly basis
- Continuing to improve camera model, attitude and ephemeris errors

<table>
<thead>
<tr>
<th></th>
<th>Including topo displacement &amp; view angle errors</th>
<th>Excluding topo displacement &amp; view angle errors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy Goal</strong></td>
<td>82m CE90</td>
<td>23m CE90</td>
</tr>
<tr>
<td><strong>Today's Performance</strong></td>
<td>100m CE90</td>
<td>TBD</td>
</tr>
</tbody>
</table>
QuickBird Basic Imagery

- Radiometric Corrections
- Sensor Corrections
- No Geometric Corrections
- Full scene delivery
- GSD varies with off-nadir angle
  - 61cm (nadir) to 72cm (25°) Pan
  - 2.44m (nadir) to 2.88m (25°) MS

<table>
<thead>
<tr>
<th></th>
<th>Panchromatic</th>
<th>Multispectral</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 bit</td>
<td>800MB</td>
<td>200MB</td>
</tr>
<tr>
<td>16 bit</td>
<td>1.6GB</td>
<td>400MB</td>
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</table>
Standard Imagery

- **Geometrically corrected**
- Radiometric & sensor corrections
- Resampled to a map projection
- 70cm pan, 2.8m MS
- Customer defined area
  - available by square kilometer with 64 km² minimum
- Accuracy – 82m CE90%
  - Includes terrain and view angle affects

<table>
<thead>
<tr>
<th></th>
<th>Panchromatic</th>
<th>Multispectral</th>
</tr>
</thead>
<tbody>
<tr>
<td>64km²</td>
<td>8 bit</td>
<td>136MB</td>
</tr>
<tr>
<td></td>
<td>16 bit</td>
<td>272MB</td>
</tr>
<tr>
<td>100km²</td>
<td>8 bit</td>
<td>212MB</td>
</tr>
<tr>
<td></td>
<td>16 bit</td>
<td>424MB</td>
</tr>
</tbody>
</table>
Orthorectified Imagery

- Ortho corrected/corrected for topographic distortions
- Radiometric & sensor corrections
- resampled to a map projection
- 70cm pan, 2.8m MS
- Customer defined area
  - available by square km with 64km² minimum

<table>
<thead>
<tr>
<th>Orthorectified Product Level</th>
<th>CE 90%</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:50,000</td>
<td>25.0 m</td>
<td>15.2 m</td>
</tr>
<tr>
<td>1:25,000</td>
<td>12.5 m</td>
<td>7.6 m</td>
</tr>
<tr>
<td>1:24,000</td>
<td>12.0 m</td>
<td>7.3 m</td>
</tr>
<tr>
<td>1:12,000</td>
<td>10.0 m</td>
<td>6.1 m</td>
</tr>
<tr>
<td>1:10,000</td>
<td>8.3 m</td>
<td>5.0 m</td>
</tr>
</tbody>
</table>
QuickBird Panchromatic Imagery

- 61 – 72-centimeter
  - Basic Imagery
- 70-centimeter
  - Standard
  - Orthorectified Imagery
- 11-bit dynamic range
  - 16 bit file
  - 8 bit file (linear transformation)
- 450-900 nm spectral
QuickBird Multispectral Imagery

• 2.44 – 2.88-meter
  - Basic Imagery

• 2.8-meter
  - Standard
  - Orthorectified Imagery

• 11-bit Dynamic Range

• Blue: 450-520 nm
• Green: 520-600 nm
• Red: 630-690 nm
• NIR: 760-900 nm
Product Metadata

- Defines image collection and product processing information
- Contains the End User License Agreement
- Defines satellite collection and telemetry information
- Defines Rational Polynomial Coefficients (RPCs)

<table>
<thead>
<tr>
<th>File Type</th>
<th>Extension</th>
<th>Basic Imagery</th>
<th>Standard Imagery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td>.att</td>
<td>XX</td>
<td></td>
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<tr>
<td>Ephemeris</td>
<td>.eph</td>
<td>XX</td>
<td></td>
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<tr>
<td>Geometric Calibration File</td>
<td>.geo</td>
<td>XX</td>
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<tr>
<td>Image Metadata File</td>
<td>.imd</td>
<td>XX</td>
<td>XX</td>
</tr>
<tr>
<td>License File</td>
<td>.txt</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>README file</td>
<td>.txt</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>RPC00B File</td>
<td>.rpb</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>Tile Map File</td>
<td>.til</td>
<td>XX</td>
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</table>
## Standard QuickBird Product Pricing

### Product Base Price

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Description</th>
<th>Base Price panchromatic or multispectral km(^2) (USD)</th>
<th>Base Price panchromatic or multispectral mi(^2) (USD)</th>
<th>Product Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Imagery</td>
<td>Radiometric &amp; sensor correction only. Minimum order is 1 scene (272km(^2)).</td>
<td>$30</td>
<td>$80</td>
<td>+ 50%</td>
</tr>
<tr>
<td>Standard Imagery</td>
<td>Radiometric, sensor &amp; geometric correction. Minimum order is 64km(^2)/25mi(^2).</td>
<td>$30</td>
<td>$80</td>
<td>+ 50%</td>
</tr>
<tr>
<td>Orthorectified Imagery</td>
<td>Radiometric, sensor &amp; orthographic correction to meet specified accuracy. Minimum order 64km(^2)/25mi(^2).</td>
<td>$35</td>
<td>$93</td>
<td>+ 50%</td>
</tr>
<tr>
<td>1:50,000(^1)</td>
<td></td>
<td>$45</td>
<td>$119</td>
<td>+ 50%</td>
</tr>
<tr>
<td>1:25,000(^1)</td>
<td></td>
<td>$45</td>
<td>$119</td>
<td>+ 50%</td>
</tr>
<tr>
<td>1:24,000(^1)</td>
<td></td>
<td>$45</td>
<td>$119</td>
<td>+ 50%</td>
</tr>
<tr>
<td>1:12,000(^1)</td>
<td></td>
<td>$60</td>
<td>$159</td>
<td>+ 50%</td>
</tr>
<tr>
<td>1:10,000(^1)</td>
<td></td>
<td>$70</td>
<td>$185</td>
<td>+ 50%</td>
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</tbody>
</table>

\(^1\)Subject to availability of appropriate DEMs and GCPs

Prices for Basic and Standard Imagery, panchromatic and multispectral available today. Other products and options available soon.
## End User License Agreements

<table>
<thead>
<tr>
<th>License Type</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Site</td>
<td>Included</td>
</tr>
<tr>
<td>Single Organization</td>
<td>+ 25%</td>
</tr>
<tr>
<td><strong>Multiple Organization</strong></td>
<td></td>
</tr>
<tr>
<td>2 Organizations</td>
<td>+ 50%</td>
</tr>
<tr>
<td>3 - 5 Organizations</td>
<td>+ 100%</td>
</tr>
<tr>
<td>6 - 10 Organizations</td>
<td>+ 150%</td>
</tr>
<tr>
<td>11 or more Organizations</td>
<td>as negotiated</td>
</tr>
</tbody>
</table>
Standard QuickBird Product Delivery

Order Priority

<table>
<thead>
<tr>
<th>Order Priority</th>
<th>Fee</th>
<th>Time between order placement and start collection date</th>
<th>Image Acquisition Window</th>
<th>Minimum order size</th>
<th>Maximum order size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Included</td>
<td>5 days</td>
<td>&gt; 14 days</td>
<td>Standard</td>
<td>10,000km²</td>
</tr>
<tr>
<td>Priority</td>
<td>+ 50%</td>
<td>5 days</td>
<td>≤ 14 days</td>
<td>Standard</td>
<td>2 scenes</td>
</tr>
</tbody>
</table>

- Standard delivery (2 day USA; 5 day International) on media or ftp is included in product price
- An additional charge will be assessed for
  - Additional copies of products
  - Rush delivery
Quality Assurance & Control Background

• To ensure products meet DigitalGlobe’s established quality standards, image and product quality are monitored at various stages of:
  - image ingest,
  - product formation, and,
  - delivery

• DigitalGlobe assesses the quality of each product according to internal procedures; some procedures are automated while some are manual.
Quality Control Background

• DigitalGlobe products are evaluated for four types of anomalies;
  - radiometric
  - geometric
  - image
  - processing
• Initial qualitative assessment is performed upon receipt of imagery at the Longmont facility from the Remote Ground Terminals. Initial qualitative image assessment consists of:
  - cloud cover assessment and,
  - image quality based on environmental factors such as:
    • Haze, fog
    • Smoke
    • Shadows
Initial Image Quality Assessment

• Analyses:
  - Conduct analysis of data following collection
  - Assess usability of imagery against order requirements
  - Characterize cloud cover estimates for future use
  - Ensure usability of imagery to fulfill customer orders
  - Detect and resolve problems related to cloud cover assessment
  - Conduct review of initial problem reports
  - Early detection of image anomalies
Radiometric Quality Assessment

- Imagery assessed for the following radiometric anomalies:
  - Apparent Bit Error
  - Banding
  - Bright Object Anomaly
  - Compression Artifact(s)
  - Excessive Saturation
  - Over Exposure
  - Under Exposure
  - Low SNR
  - Spectral Banding
  - Streaking
  - Wrong TDI
  - Other Radiometric error
Geometric Quality Assessment

- Imagery assessed for the following Geometric anomalies:
  - Band misregistration
  - DCA stitch error
  - Drift
  - Excessive absolute geolocation error
  - Excessive relative geolocation error
  - Excessive pointing error
  - GCP geolocation error
  - GCP obscured
  - Inadequate overlap of order
  - Seam or Break
  - Skew
  - Other Geometric Anomaly
Image Quality Assessment

- Imagery assessed for the following technical anomalies:
  - ACS problem
  - Dropouts or gaps in imagery
  - Incorrect calibration params applied
  - Jitter
  - Missing or incorrect support data
  - Out of focus
  - Spatially uniform smear
  - Spatially varying smear
  - Wrong image or area of interest
  - Other image quality anomaly
Image and Product Quality Assessment

- Imagery assessed for proper processing:
  - **Metadata Checks for Basic 1A:**
    - DDD Date incorrect
    - License Type incorrect
    - Cloud Cover incorrect
    - Off Nadir Angle incorrect
    - Band ID incorrect
    - Output Format incorrect
    - NRD Fill incorrect
    - Radiometric Correction incorrect
    - Delivery Media incorrect
    - Geolocation coordinates incorrect
  - **Metadata Checks for Basic 1B = Basic 1A +:**
    - Dynamic Range incorrect
    - Resampling Kernel incorrect
Image and Product Quality Assessment

• Imagery assessed for proper processing:
  
    - Metadata Checks for 2A = 1B +:
      • Pan Sharpening per order incorrect
      • Tiling per order incorrect
      • Pixel Spacing incorrect
      • Map Projection per order incorrect
      • Datum per order incorrect
      • Area of Interest per order incorrect
  
    - Product Checks per order:
      • Verify all metadata params above are applied to product, plus:
        • MBR for AOI orders incorrect
        • Delivery media flaws (open data)
        • Other processing anomaly
Quantifying Quality

- Procedure quantifies a repeatable qualitative assessment process
- QC Assessment uses two forms:
  - Existing Product QC Checklist used to record **Product and Processing Anomalies** (order parameters & metadata)
  - Product Anomaly Severity Matrix
    - Quantifies severity of anomalies identified in the “Image and Product Anomaly Table”, including:
      - Radiometric, Geometric, Image Quality, Product Processing
      - Environmental anomalies are not addressed at this time
- Severities are compiled for products & pass/fail determined by a threshold depending on product size (anomaly density)
Product Pass/Fail

- Forms for Quality Controlled products are stored in the appropriate pass/fail directory
- Product that pass QC are packaged, shipped and invoiced
- Products that do not pass QC are sent to Customer Service to confirm that the client wants the product
  - If Customer rejects product, the order is cancelled and/or portion not meeting QC retasked
  - If the Customer wants the product, the order is packaged, shipped and invoiced
  - Customer has two weeks to accept or reject the order