Today's Orthophoto Production - The Business Model

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Images Courtesy of Stereocarto, Spain; PhotoScience, USA; AAM Hatch PTY Ltd., Australia

INTERGRAPH

Presentation Outline

ZI IMAGING

- Background
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- Orthophoto Production
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  - PixelQue
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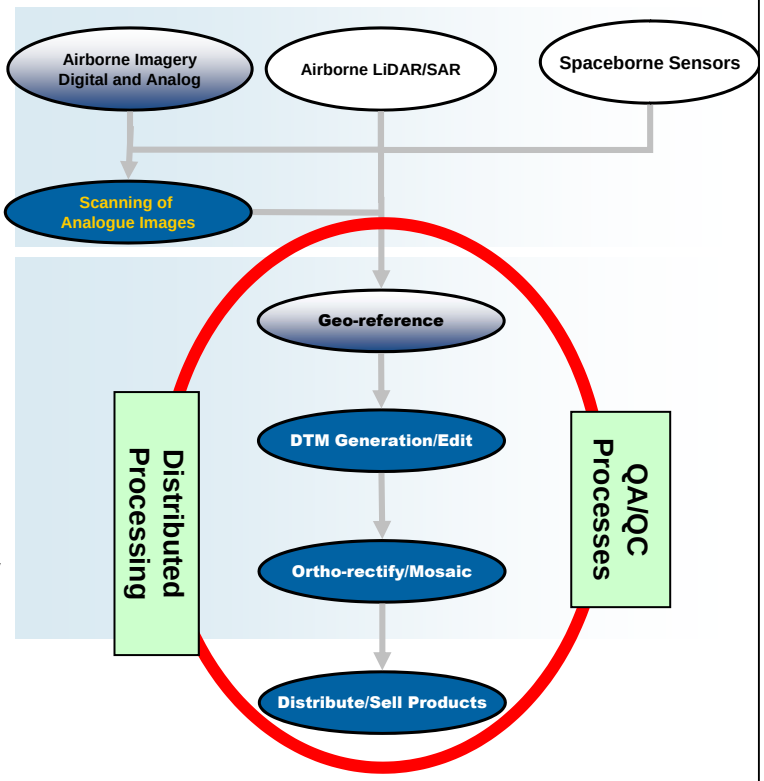
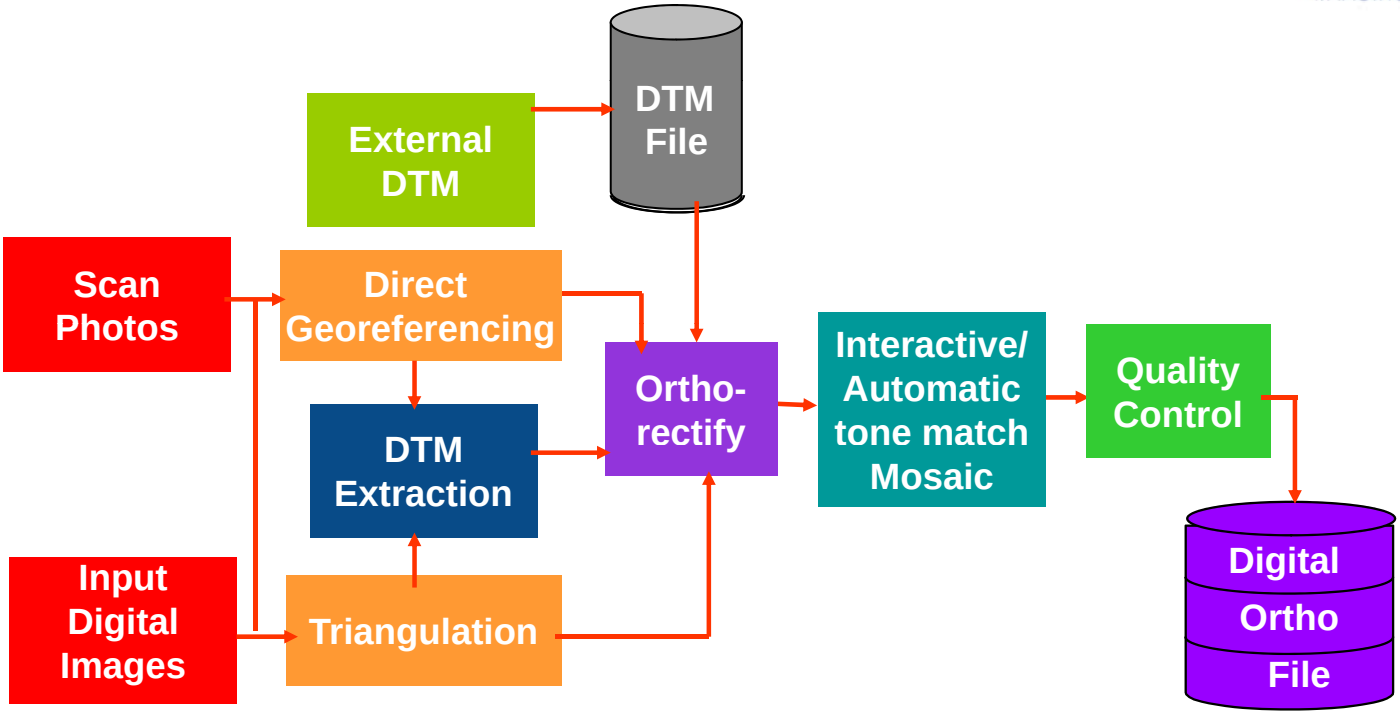
- Enterprise Photogrammetry
  - PixelPipe
- Summary



Orthophoto Workflow



Digital Imagery

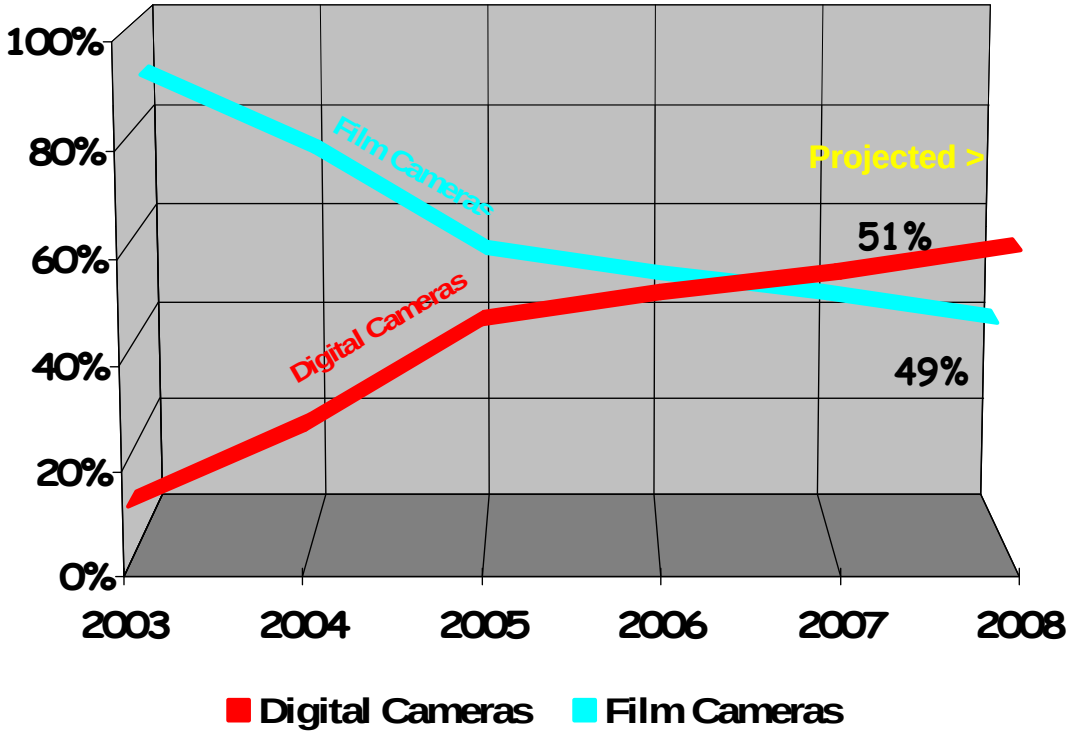
Facts

- 150,000 or more frames per year are acquired by digital camera owners
- Request for higher resolution and multi spectral imagery will increase
- Request for rapid response on natural disasters
- Teaming of photo flyers
- Large image programs will go fully digital during the next 3 years
  - National Agricultural Image Program and Imagery for the Nation
  - Microsoft, Google

Issues

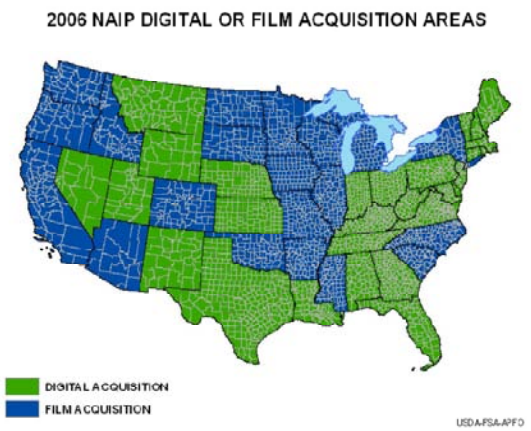
- Downstream processing of imagery is a bottleneck
- How to manage, store, view, archive and distribute the data?
- Reduce cost / project time
- Improve QA/QC processes, less rework
- Need for automated and efficient production tools
- Demand for instant access to enterprise data through intranet as well as internet

Industry Trends: Digital vs. Film Cameras



Industry Trends

- A trend to larger orthophoto projects and shorter project times
  - USDA National Agriculture Imagery Program (NAIP)
    - Collect 1 and 2 meter natural color and color infrared imagery for the entire continental United States on a 1-year refresh cycle
    - 20% 1 meter and 80% 2 meter
    - Deliver imagery in the year of acquisition
  - Ordnance Survey, GB
    - 25cm national orthophotos
    - 3 to 5 year refresh cycle
  - IGN Spain
    - National orthophoto program

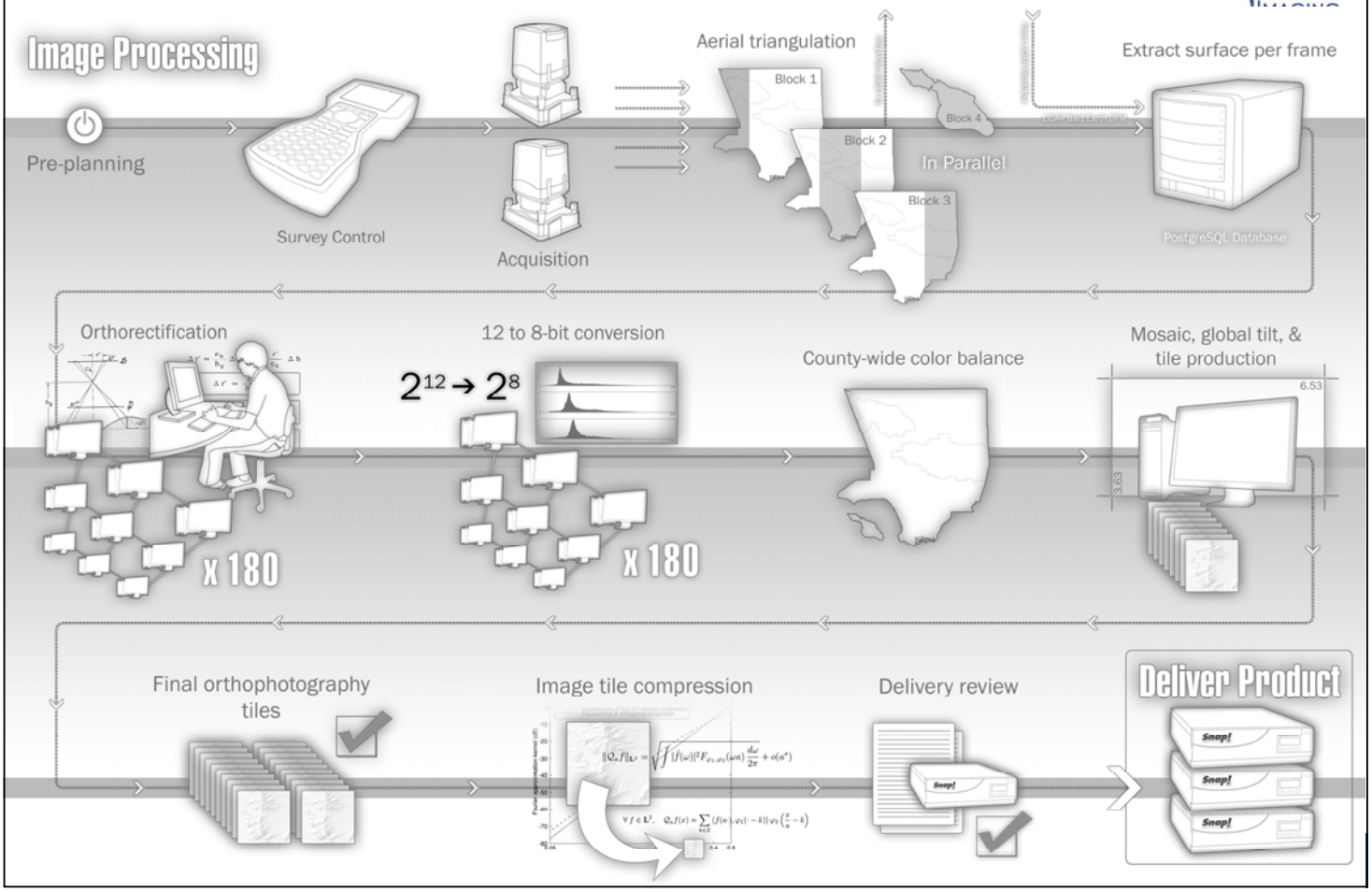


Industry Trends - Imagery for the Nation

- **Vision –** Provide sustainable and flexible digital imagery program that meets the needs of local, state, regional, tribal and federal agencies.
- **Program Cost –** Approximately $111 million per year or $333 million during the first 3-year.

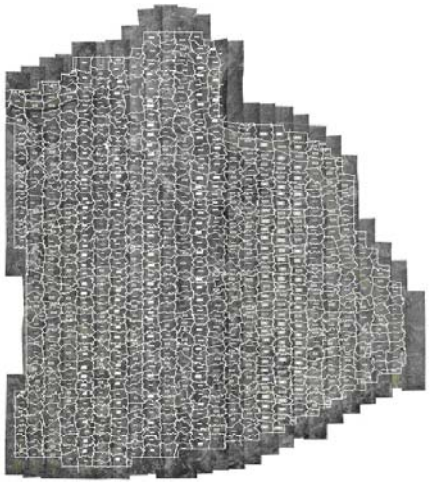
Ground Resolution	6-inch	1-foot	1-meter
Image Type	Natural Color	Natural Color	Natural Color
Leaf On or Off	On	On	Off
Cloud Cover	0%	0%	10%
Horizontal Accuracy	2.5' @ 95% NSSDA	5' @ 95% NSSDA	25' @ 95% NSSDA
Frequency	Every 3 ears	Every 3 Years	▪ Every Year in 48 States ▪ Every 5 Years in Alaska & Hawaii
Federal Program Steward	USGS	USGS	US Dept. of Agriculture except Alaska (USGS)

County-wide Ortho Production Workflow



Orthophoto Production

- **County-wide Jobs**
  - Typical size about 2,000 images
  - Usually 8-bit color (RGB)
  - Various type of DTMs (stereo compiled, filtered LiDAR, auto-correlated points, or a combination of these)
  - 0.5 or 1.0 foot pixel resolution
  - 2000 to 4000 tiles output delivery
  - Final products 250 to 400 megabytes
- **Required Storage for Each Project**
  - 2.0 to 3.0 terabytes per ortho project
    - 0.5 to 1.0 terabytes for raw imagery
    - 1.0 to 1.5 terabytes for the ortho-rectified imagery
    - 0.5 terabytes for product tiles
  - 6.0 to 8.0 terabytes for 3 or 4 simultaneous projects



Orthophoto Production

- **Data Preparation**
  - Project setup
  - Different DTMs (format, coordinate systems, accuracy, etc)
  - Seamline generation
- **Overall Performance**
  - 6 to 8 hours rectifying 1500 color exposures to 0.5 foot pixel resolution using 28 processing nodes
  - 2 days dividing jobs to 3 to 4 parts for seamline editing and collection
  - 4-8 hours to produce large mosaics with overviews (batch processing)
  - 2 to 3 days - Quality control (manual)
  - Complete county-wide project with 1500 exposures within two weeks
- **Generally, as many as 6 to 8 different projects working at various stages of completion**

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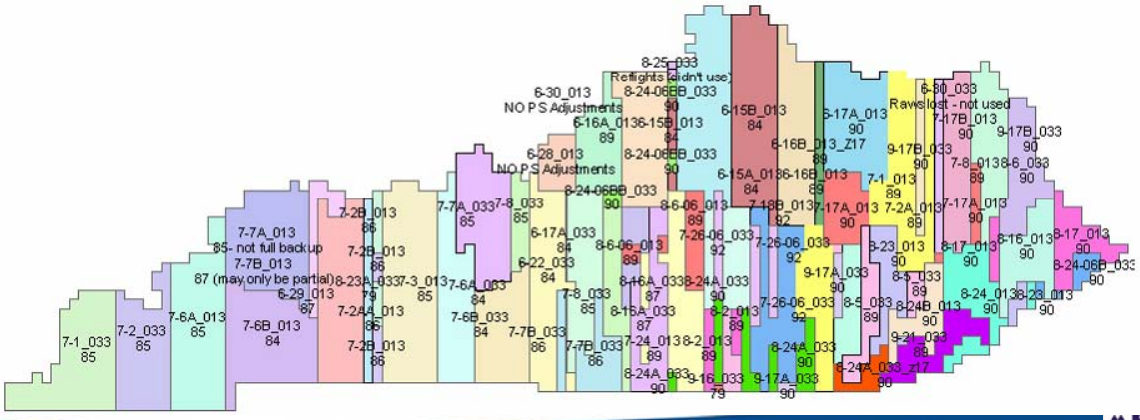
Orthophoto Production

State of Kentucky for NAIP

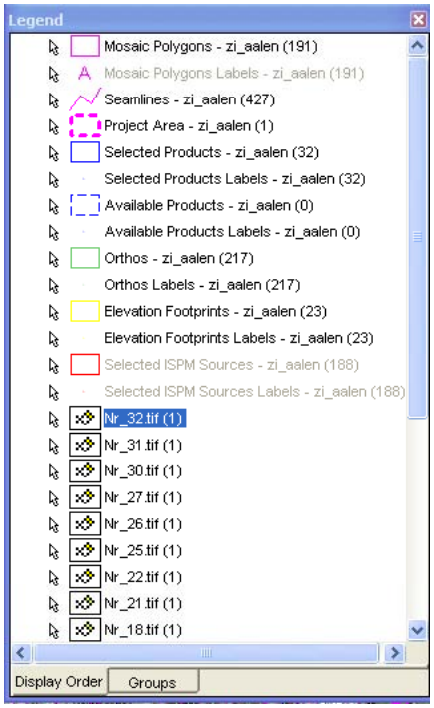
- Flights with two DMCs (from June 15 to September 21, 2006)
- 13,000 frames of photography flown at 20,000 ft
- DTMs (USGS) – 1280 files
- Automatic seamline, mosaicking, and tonal balancing on multiple computers
- 2,730 DOQQs tiled sheets @ 0.2 m pixel size
- Multiple computers (2Ghz, 2 GB RAM or higher) were used



ImageStation OrthoPro

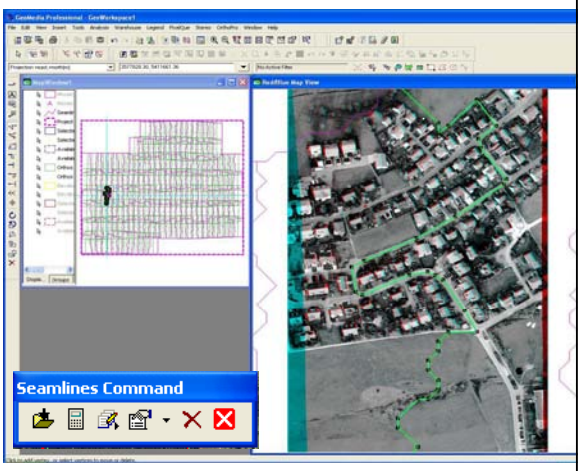
Included functions:

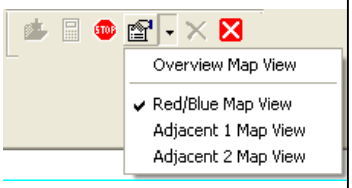
- Project definition
- Rectification
- Seamlines
  - Manual
  - Automatic
  - Editing
- Mosaicking
- Dodging
- True Orthophoto
- Auto-Ortho Production



OrthoPro Features…

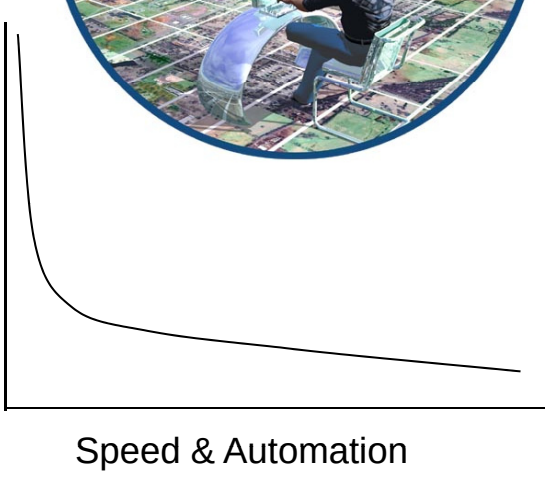
- Use different DTM formats/coordinate systems
- Different seamline generation methods
- Red/Blue Image display tool for drawing seams
- Perform digital dodging (4-band files, and full 16-bit files)
- Apply LUT during rectify and mosaic
- Tone match and radiometric balance
- Mosaic along user-defined seam lines
- Graphic product selection through quad boundaries
- Create multiple output products in a single run
- Build for NDOP (DOQ & DOQQ) and NAIP productions



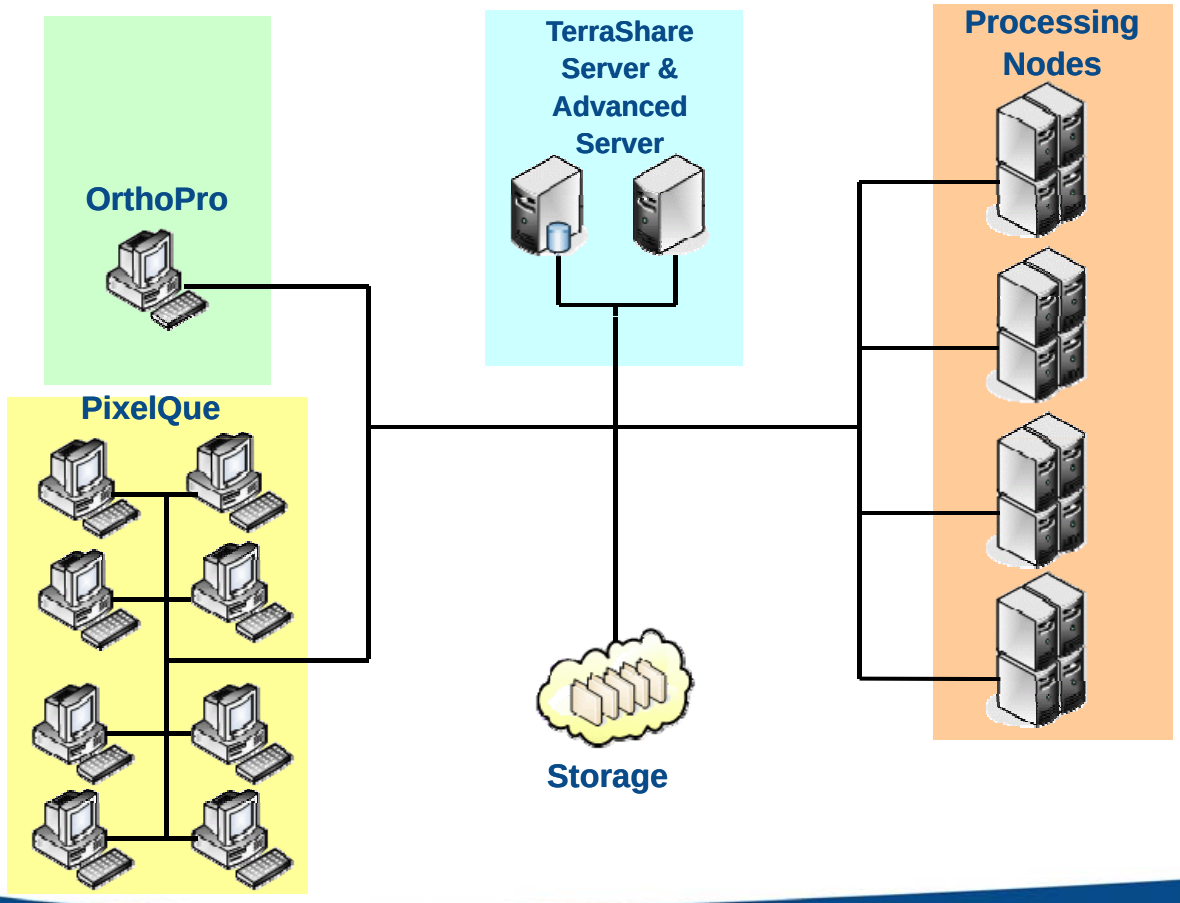


Why Distributed Processing?

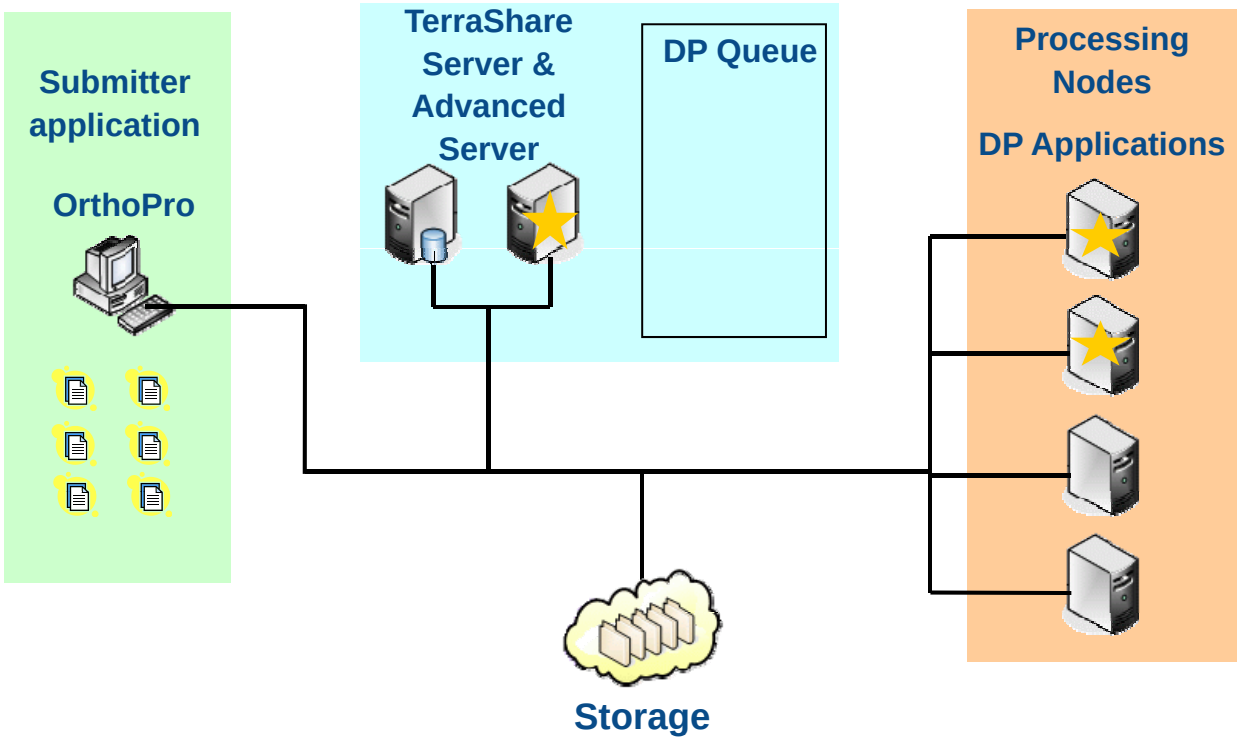
- **Reduce processing times linearly**
  - Shorten project turn around times
  - Full quality control
- **Use existing COTS TerraShare technology**
  - Plugs easily into existing TS installations
- **Easy to operate**
  - System distributes jobs automatically
- **Performance will depend on IO, Disk & network speed, etc.**



System Configuration



How Distributed Processing Works?



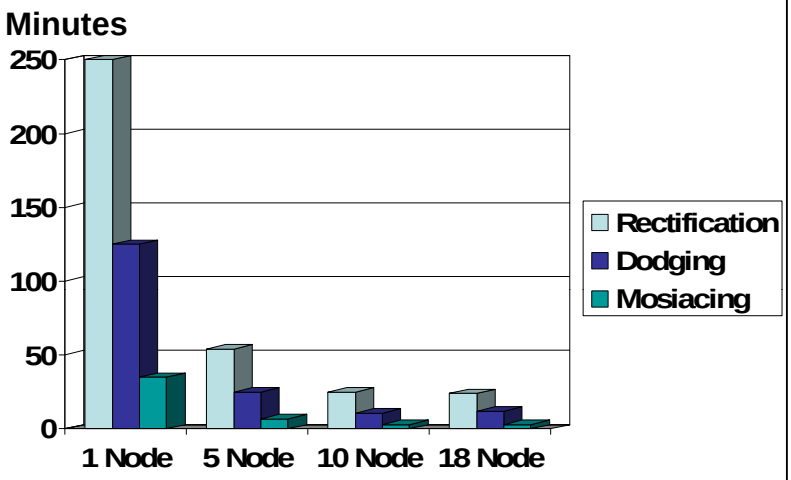
Performance of Distributed Processing

Project Area

- Number of Photos: 145
- Number of Products: 35
- Imagery: 8 bit RGB, ~1ft GSD
- 80% Forward Lap, 10% Side Lap

Workstation (HP xw9300)

- Dual AMD x86 2.4GHz Processors
- 4 GB RAM
- IDE 80 GB Drives
- Gbit network
- WinXP SP 2

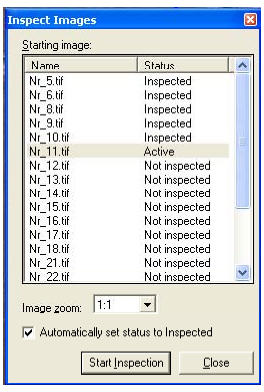


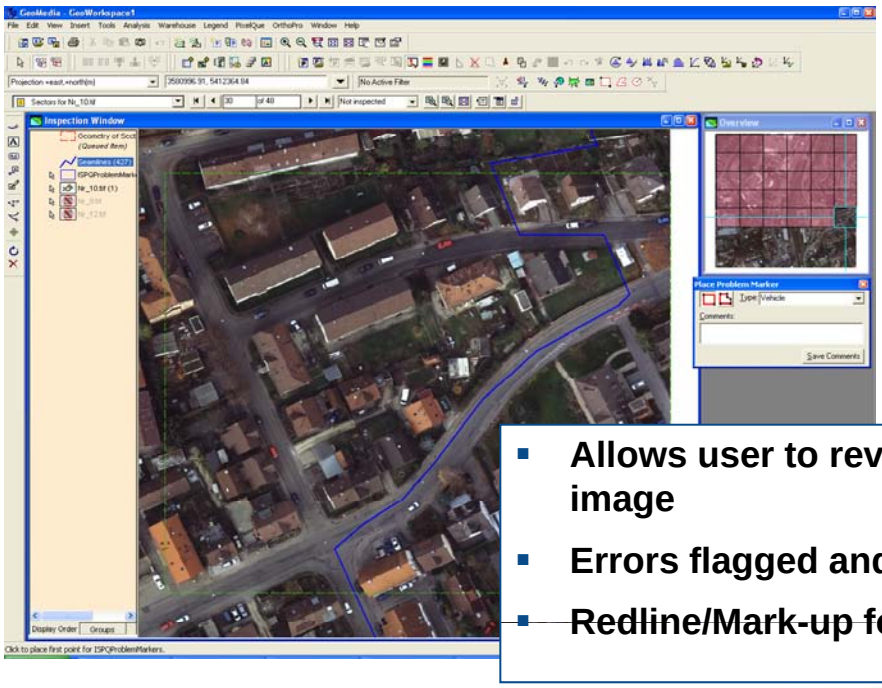
- Performance depends on IO, Disk & network speed, etc
- Typically encounter I/O bottlenecks with > 15-20 DP nodes
- Optimum configuration for OrthoPro is 10-15 nodes

ImageStation PixelQue

Finishing tools needed in orthophoto production

Highest cost in ortho production is QA/QC





- **Allows user to review entire image**
- **Errors flagged and queued**
- **Redline/Mark-up for rework**

ImageStation PixelQue

1. Allows user to review all images in project
   - User selects zoom factor
   - Then driven sector by sector to review entire image
   - Automatically advances to next image
2. Mark up errors and problem areas
   - Problems found may be fixed or marked up for later rework
   - User may define attribution of markers

3. Review of inspected image
   - Queued edit of problem markers
   - User corrects problems
   - User sets attribution to “fixed” after rework
4. Supports 4 band and 16bit images

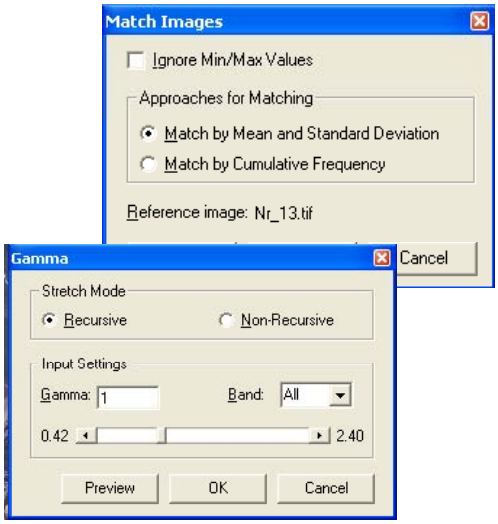
PixelQue Commands...

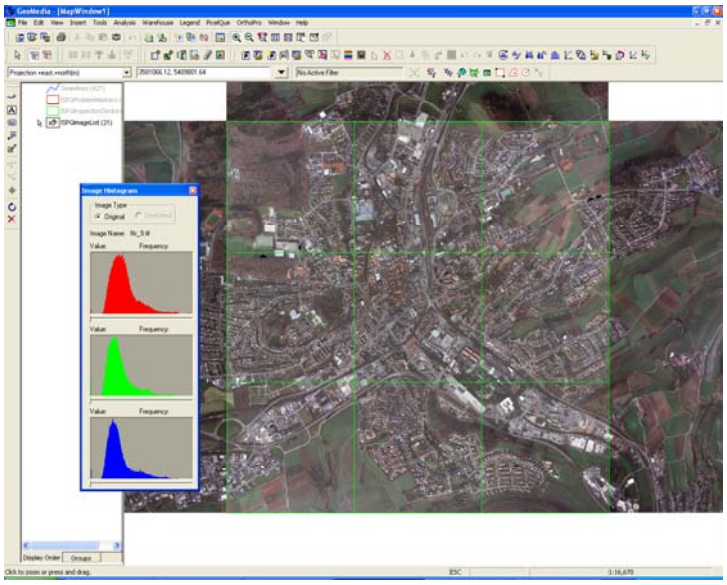
- Raster Fill
  - Fill user selected area
- Raster Splice
  - Copy and paste user selected area
  - From one image to another
- Pixel Clone
  - User selects source
    - Brush shape and size
    - Feathering and Opacity
  - Copies to target
- Local Warp
  - Remove small distortions in orthophotos due to minor DTM errors

- **Raster Enhance (gradient)**
- **Raster Undo Brush (history brush)**

PixelQue Commands

- **Enhance Contrast**
  - **Linear Percent**
  - **Linear Clip**
  - **Equalize**
  - **Gamma**
- **Histogram**
  - **Collect**
  - **Display**
- **Look up tables**
  - **Load, Save, Reset, Apply**
- **Match Images**



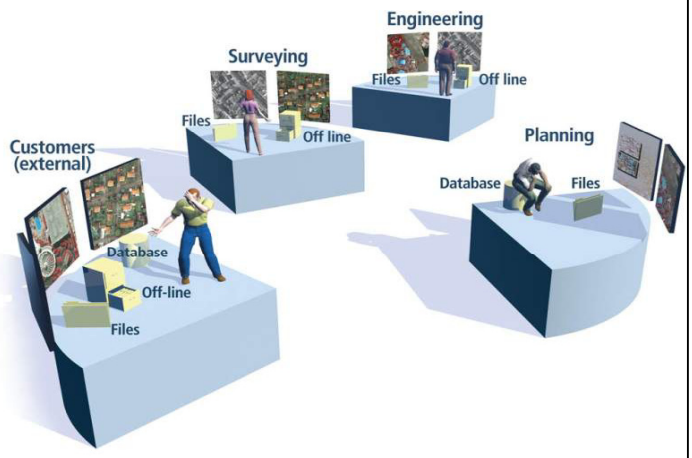


PixelQue - Summary Key Features

- Georeferencing maintained
- Fast image loads
- Systematic inspection process helps eliminate gaps in coverage
- Apply edits to all 4 bands at the same time
- Apply Image Enhancement to MANY images at the same time
- Match many images to a single, source image
- Fast saves of images after raster editing
- Multi-user access to PixelQue Warehouse

Production Issues

- Typical production workflow comprises a number of different software tools from different vendors
- Software/tools typically have low to no level of integration
- Processes are workstation-centric
- Big projects with large volume of data
- Mixed data (formats, resolutions, coordinate systems)
- Multiple offices and outsourcing



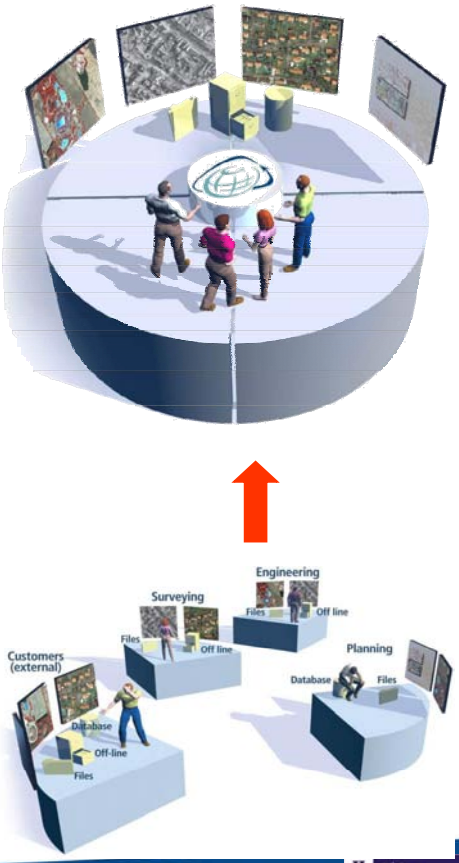
Hundreds of Terabytes and Thousands of Files

Production Management Issues

- Is very manual (status reporting)
- Operators rely on paper tracking charts or make entries into Excel or Access tracking systems
- Operators use “file directory” to organize work
- Cannot view project status
- Inefficient - “home grown” tools and procedures to interface operations (input/output)
- Is very inefficient and error prone
- Production may stop if someone calls in sick!

Enterprise Production System Key Features

- Disparate input data
- Unified Database & Data Management
- Multi-user Transaction Control
- Workflow Guidance
- Distributed Processing Engine
- Production Logging/Reporting Tools
- Helper Functions
- Workflow Builder Tools
- Customizable and Scaleable
- Interoperability
- Flexibility
- Ease of use
- Accuracy



Benefits for Production Automation

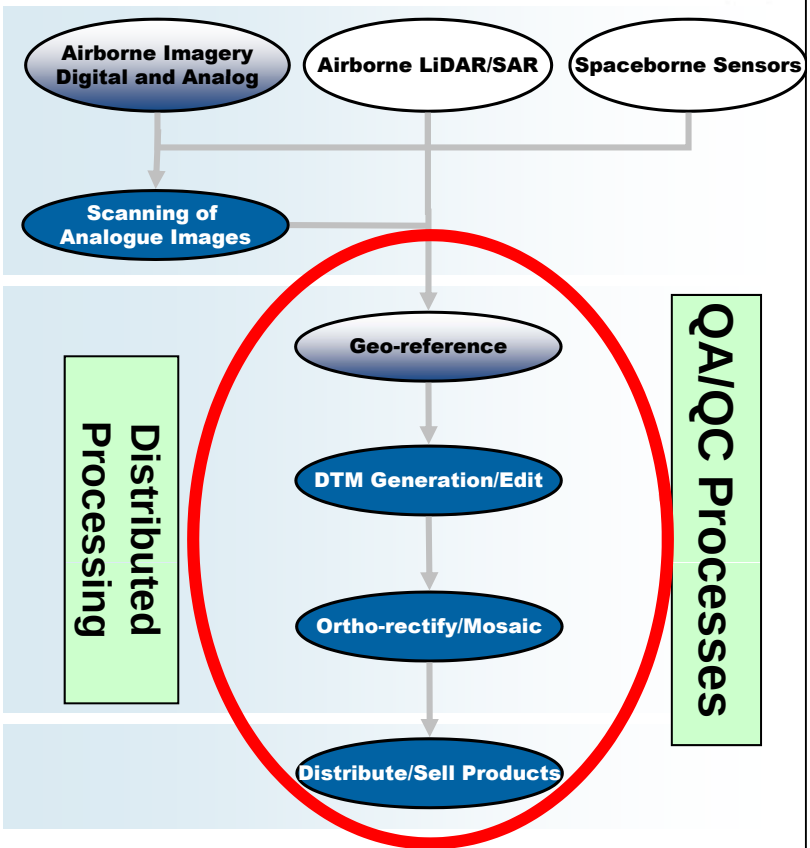
- **Throughput optimization:**
  - Seamless production tracking based on on-line product generation status
  - Operators can browse the information assets via a logical folder structure, footprints, or through metadata
- **Timely feedback:**
  - Production status is almost near- to real-time (no longer reflects the past)
  - Production planning, control and reporting can be greatly simplified; and occur almost in real-time
  - Distributed processing eliminates bottlenecks in computing intensive tasks
- **Production Intelligence:**
  - Metrics from old projects can be used to optimize process, find bottlenecks

PixelPipe - Solution Vision

"A highly automated ortho production process"

PixelPipe Overview

- **Highly Automated**
- **Production management and status review**
- **Distributed processing**
- **Scaleable, adapts to workload**
- **Automated radiometry/color balancing**
- **QA/QC Capability**
  - Errors flagged for operator attention
  - Redline/Mark-up for rework
- **Licensing**
  - By node/CPU/Metered or token usage



Stepwise Implementation

"A highly automated ortho production process"

Workflow/Production Management

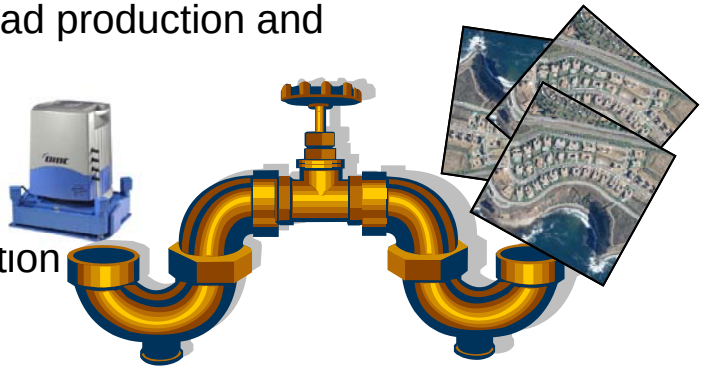
DMC PPS	AT & QC/QA	DTM Extraction	DTM Edit QA/QC	DTM Prep	Rectification	Mosaic	Ortho QA/QC

Distributed Processing

Content Management

Summary

- Demand for orthophotos is very high
- PixelPipe is specifically being developed for high volume and throughput orthorectification/mosaicking production
- Directly supports the USGS orthoquad production and NAIP programs
- Highly Automated
  - Minimal operator intervention
  - Errors flagged for operator attention
- Distributed processing
  - Flexible and scalable
- Automated radiometry/color balancing
- QA/QC
  - Redline/Mark-up for rework
  - Queue for rework



Thank you for your attention.

Questions and Comments?

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Performance of Distributed processing

Rectification process

- 819 Images
- 294 DTMs