

DMC System – Features & Benefits

JAICE Workshop, Fairfax, Virginia, March 25-28, 2008

Dr. Mostafa Madani

Chief Photogrammetrist & Product Manager



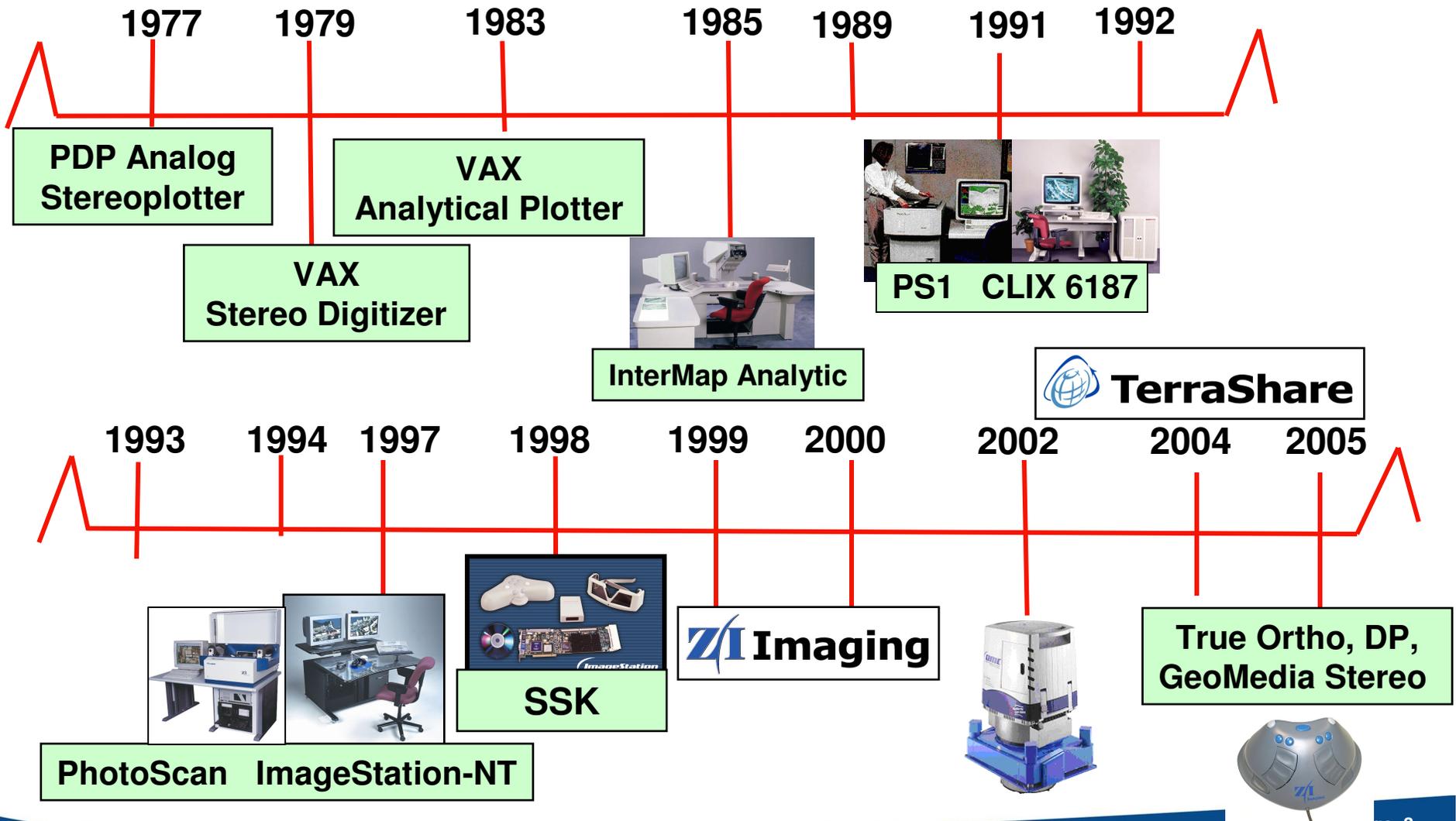
INTERGRAPH

Overview

- Background
- Digital Imagery Trends
- What Do We Offer?
 - DMC
 - Airborne system configuration
 - Z/I Mission
 - Z/I InFlight
- Photo Flight Workflow
- Image Data Post Processing
- Applications
- Summary

Photogrammetry Timeline...

Z+I = More Than 150 Years of Experience



Intergraph – Z/I Locations



**Hardware Development Center
Aalen, Germany**



**Headquarter/Software Development
Center
Huntsville (AL), USA**

Large Customer Base



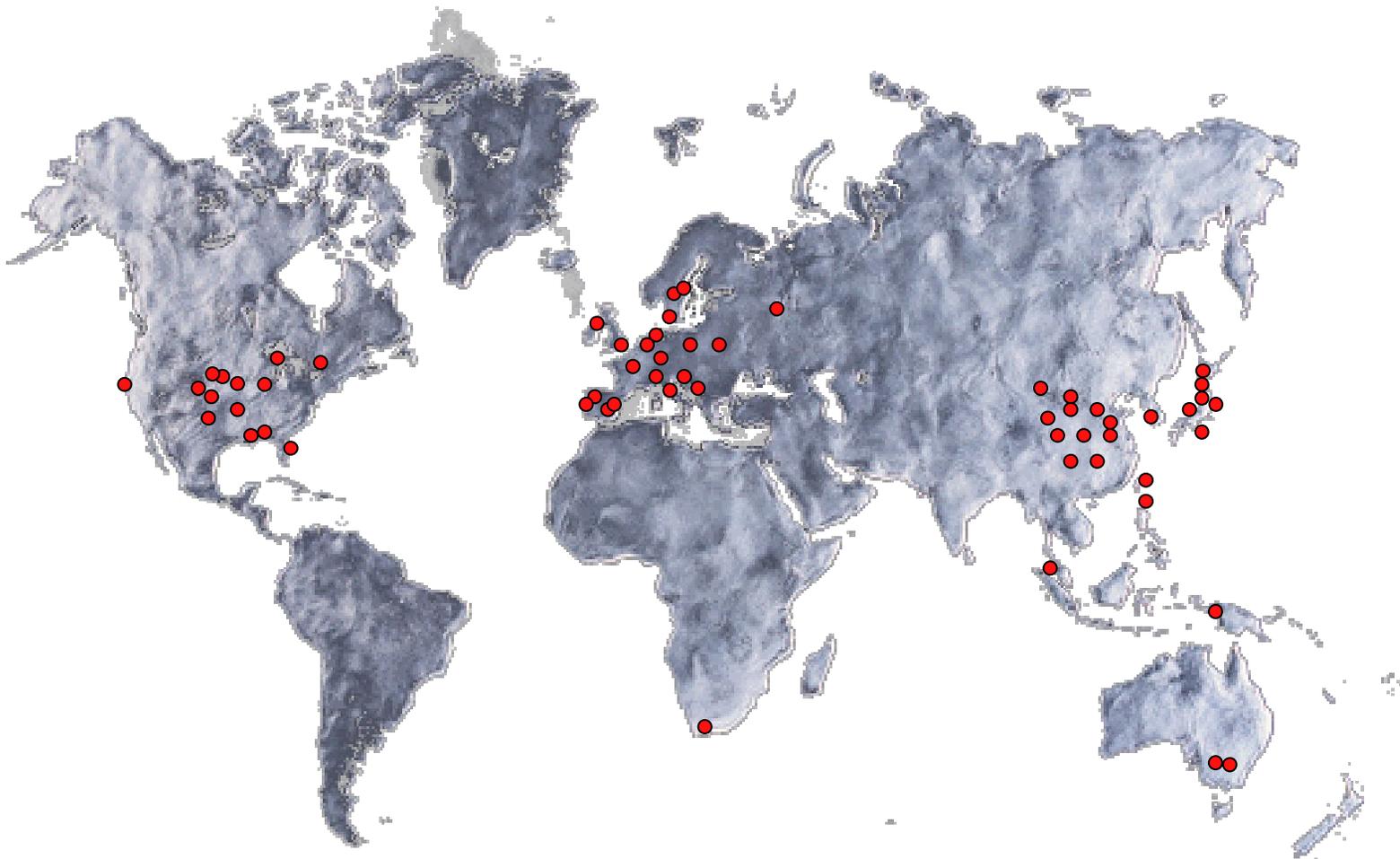
“Largest Customer Base in the Market!”



- More than 1000 RMK/LMK
- More than 450 Scanner Systems
- 79 DMC's delivered
- 1300 Analytic Instruments (Planicom, IMA)
- More than 5000 Softcopy Systems
- End-to-end earth imaging solutions



79 DMC Sales Worldwide



Why Digital Imaging?

- It is simple!
 - no photo lab, no scanning, no reconstruction of interior orientation
- Quantitative Measures
 - grey values (primary)
 - travel, time, phase, polarization (secondary)
 - Arbitrary spectral resolution, extended spectrum
 - Panchromatic & Multi-spectral
- Better radiometry (dynamic range, resolution, SNR)
- Unlimited copies of equal quality
- Telemetry for data transfer
- Potential for real-time processing via automation

Digital Imagery

Facts

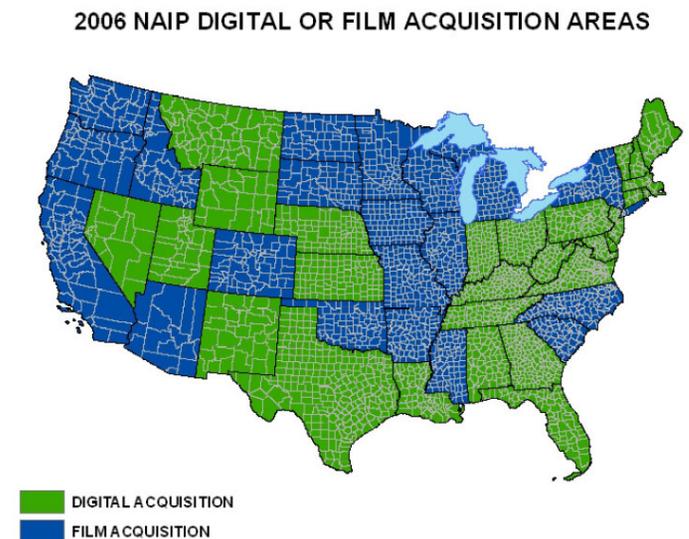
- 150,000 or more frames per year are acquired by digital camera owners
- Request for higher resolution and multi spectral imagery will increase
- Request for rapid response on natural disasters
- Teaming of photo flyers
- Large image programs will go fully digital during the next 3 years
 - National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

Issues

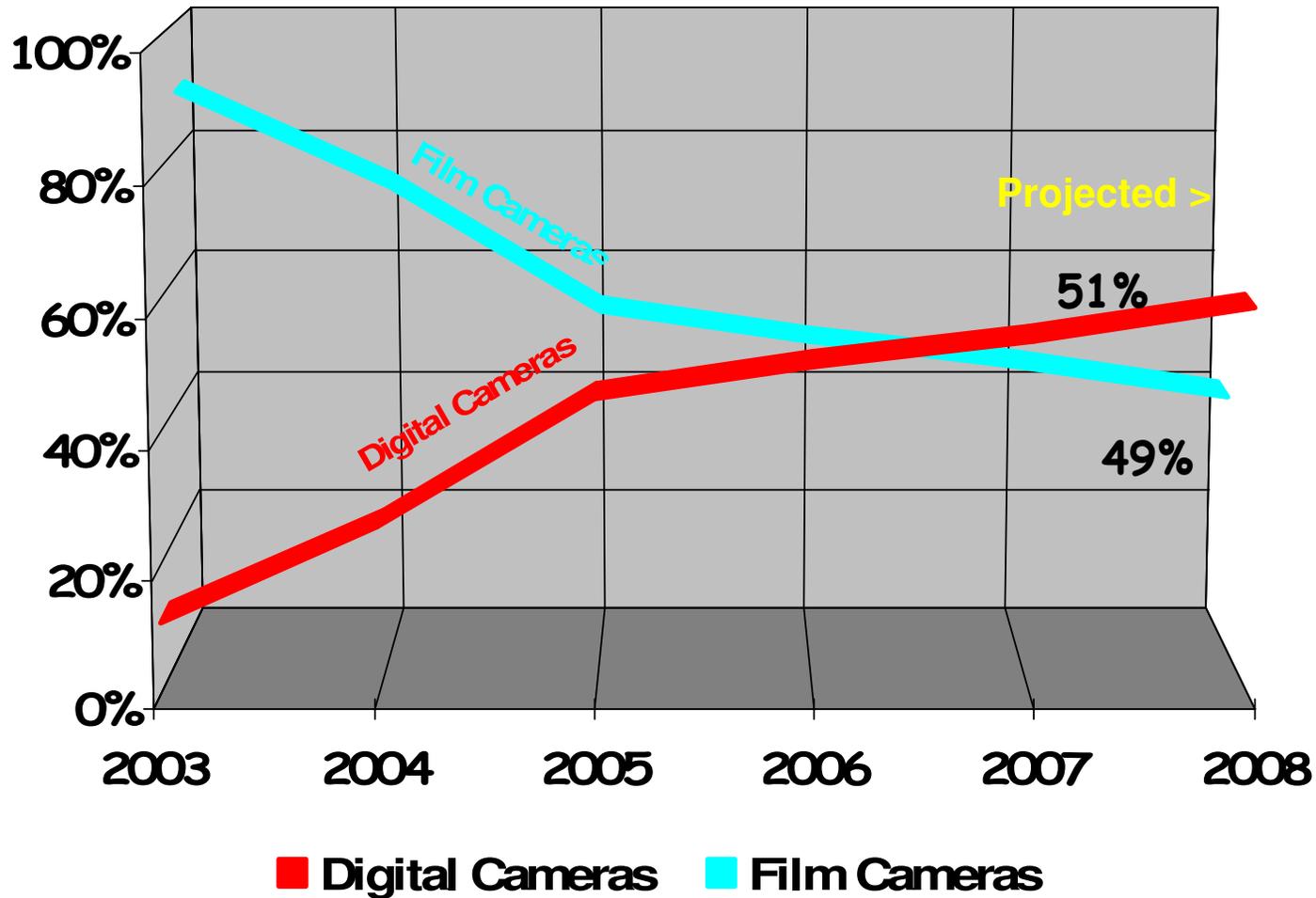
- Downstream processing of imagery is a bottleneck
- How to manage, store, view, archive and distribute the data?
- Reduce cost / project time
- Improve QA/QC processes, less rework
- Need for automated and efficient production tools
- Demand for instant access to enterprise data through intranet as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

Industry Trends.. - Examples

- 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, England
 - 25cm national orthophotos
 - 3 to 5 year refresh cycle
 - IGN Spain
 - National orthophoto program

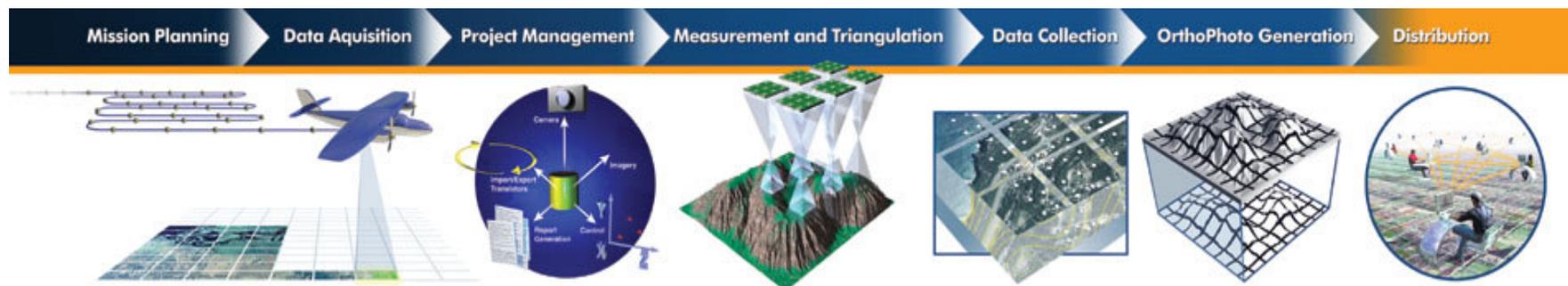


Industry Trends: Digital vs. Film Cameras



What Do We Offer?

- DMC - large format & high productive digital camera system
- Higher integration level for system components
- More automation for workflow
- Increased throughput for image data post processing
- New flexible onboard storage concept
- End-to-end earth imaging applications



DMC Technical Overview

- Large format CCD digital aerial camera
- Metric camera for photogrammetry
- High spatial resolution
- 12-bit radiometric resolution
- Pan and 4-Band multispectral imagery
- Forward Motion Compensation
- Onboard data storage (SSD)
- Airborne system management
- Post-processing ground station



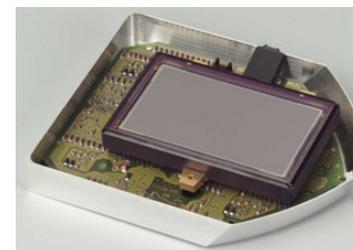
Solid State Disk Storage (SSD)



Four Pan Cameras
7k x 4k
F = 120mm



Four Multi-Spectral Cameras
3k x 2k
F = 25mm

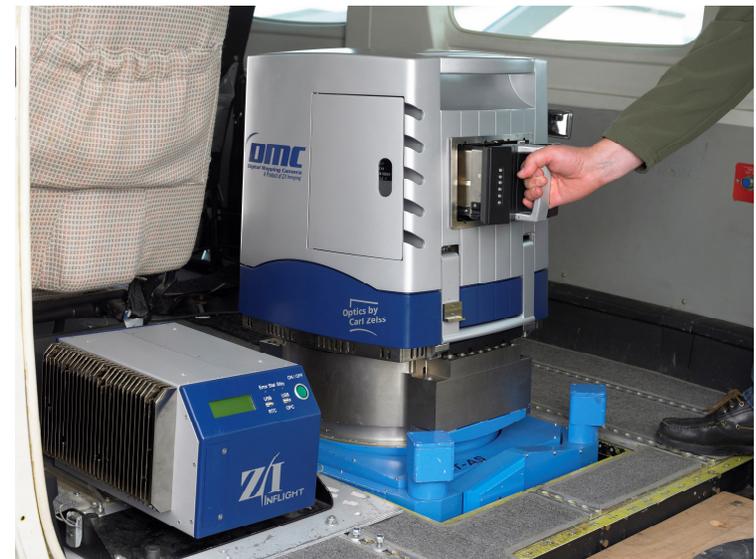


7k x 4k CCD by DALSA
Pixel size = 12 μ m
12 bit radiometric resolution

Solid State Disk (SSD)

- **Replaces Disk Drives**

- Smaller system footprint
- Drastically reduces weight (eliminates 87kg of FDS!)
- Reduces power consumption
- Allows DMC to fit into Small, Single Engine Aircraft (ex. Cessna 206) without Power Modifications
- High reliability
- Plugs directly into side of DMC
- Can be exchanged in flight
- First version with 1000 images capacity
- Higher cost per GByte comparing to FDS
- Future enhancements planned



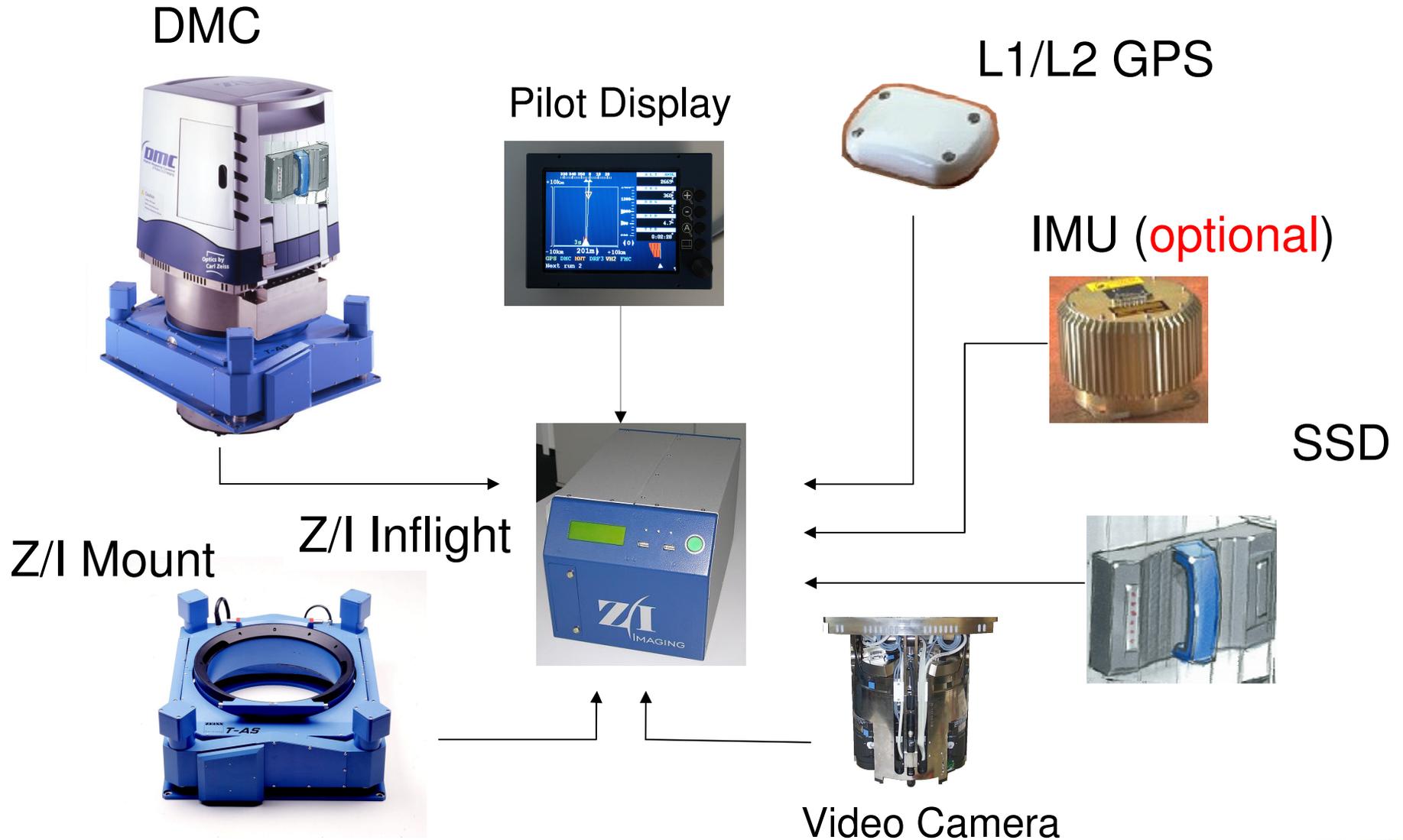
In-field Data Copy Workflow



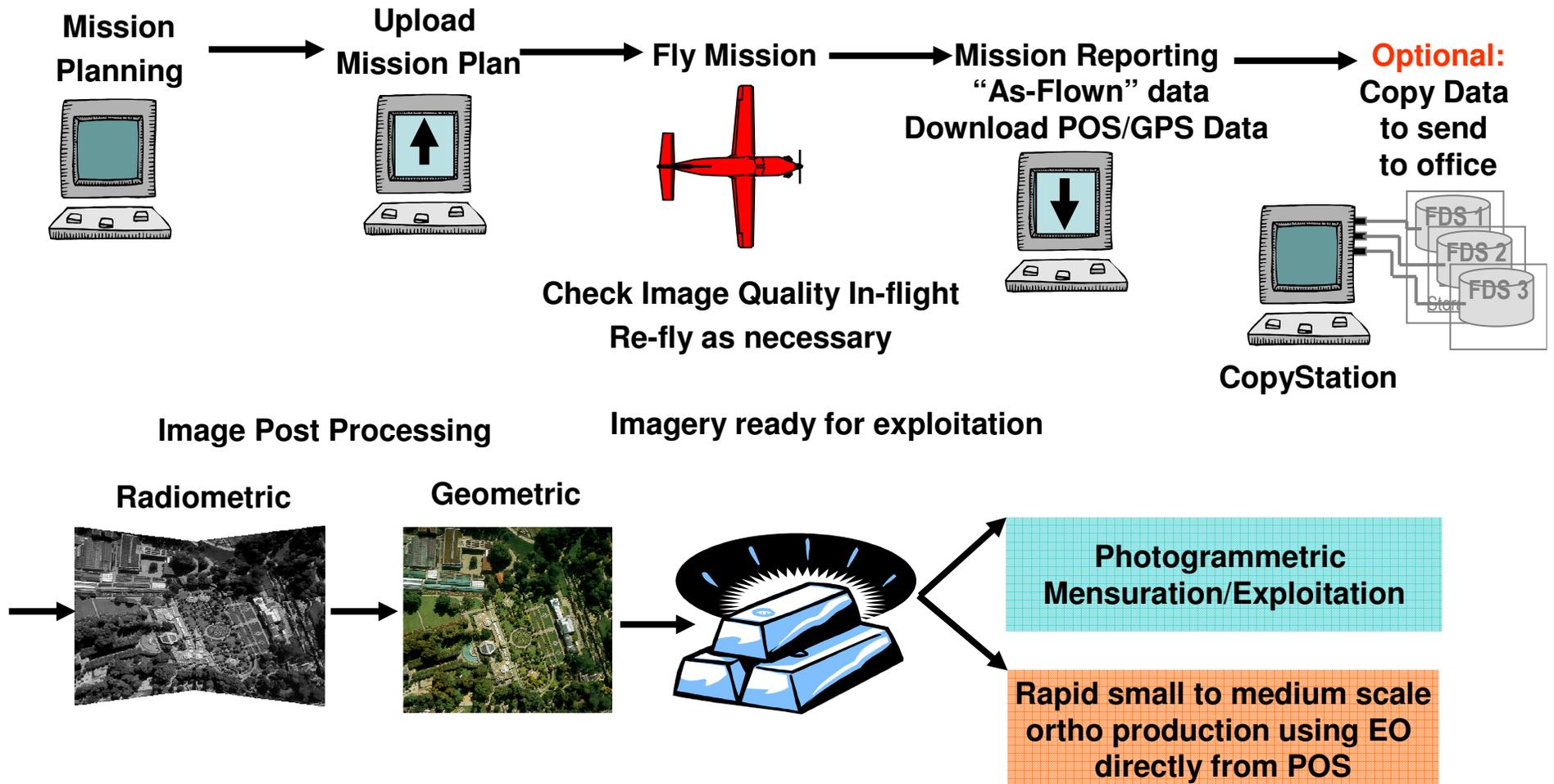
Readout Station

- Ruggedized mobile computer for field data copy slot for SSD cartridge
- LTO 4 tape drive dual 1 GBit Ethernet
- USB 2.0 and external SATA interface

Airborne System Configuration



DMC Workflow



Z/I Mission planning software



- Comes with predefined sensor types for DMC and RMK Top
- Definition of properties for Aircraft and any type of frame Camera

2D Mission Planning

Set up photo requirements

Input units and formats are here Height, Distance and Angle. Side and End Lap can be defined in % at time. Photo orientation is without restriction in projected coordinate system only.

Dependence of Resolution

Ground Sampled Dist. 1.000 ft

Height over Ground 10000.00 ft

Photo Scale 1 : 25400

Photo Frame Flight Dir. 7680.000 Tolerance (+-) 200.000 ft

Photo Frame Across Flight Dir. 13824.042 Tolerance (+-) 200.000 ft

Photo Relation Along Flight Direction

End Lap 60

Base Length 3072.000 ft Tolerance (+-) 3 %

Photo Relation Across Flight Direction

Side Lap 30

Run Spacing 9676.829 ft Tolerance (+-) 3 %

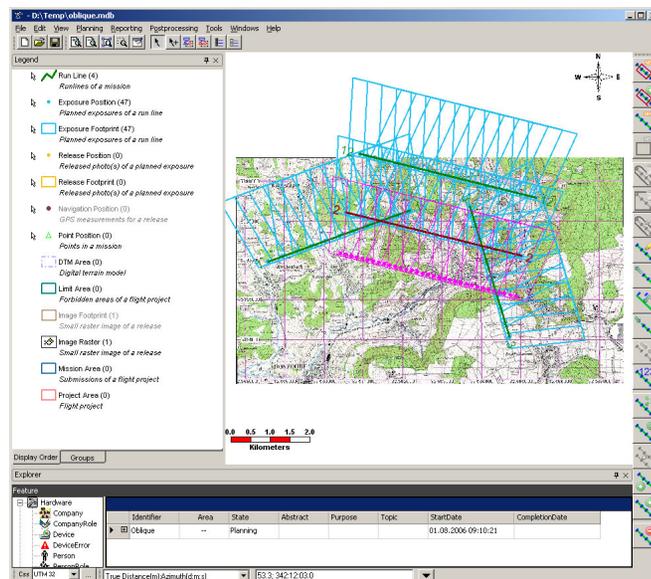
Reference Ground Height 5000.00 ft

Photo Orientation 90:00:00.0 d:m:s

Trigger Limit 300.000 ft

DOP Maximum 3

< Back Next > Cancel



Camera Editor DMC

Camera Digital View Default IO

Phi 0.00 deg

Omega 30.00 deg

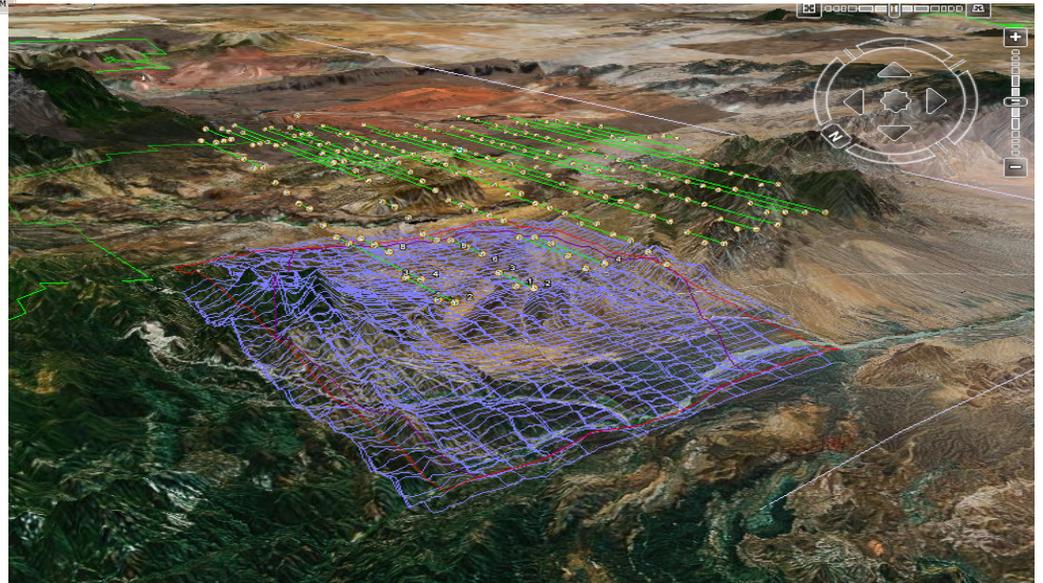
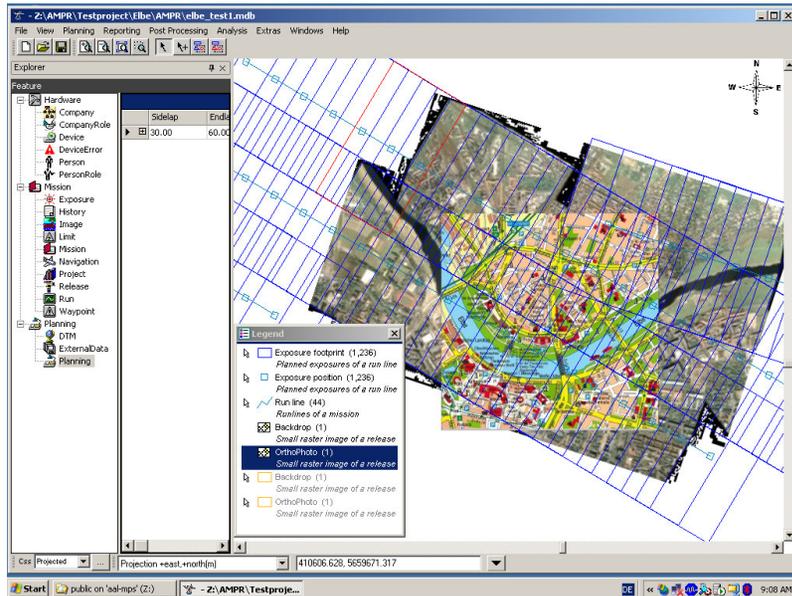
Phi: Rotation around axis perpendicular to flight direction. Positive: looking backward. Negative: looking forward.

Omega: Rotation around axis in flight direction. Positive: looking left. Negative: looking right.

Nadir: Phi and Omega are zero.

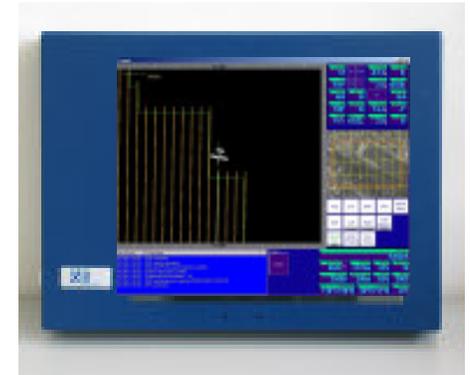
Save Delete OK Cancel

Z/I Mission offers various interfaces!



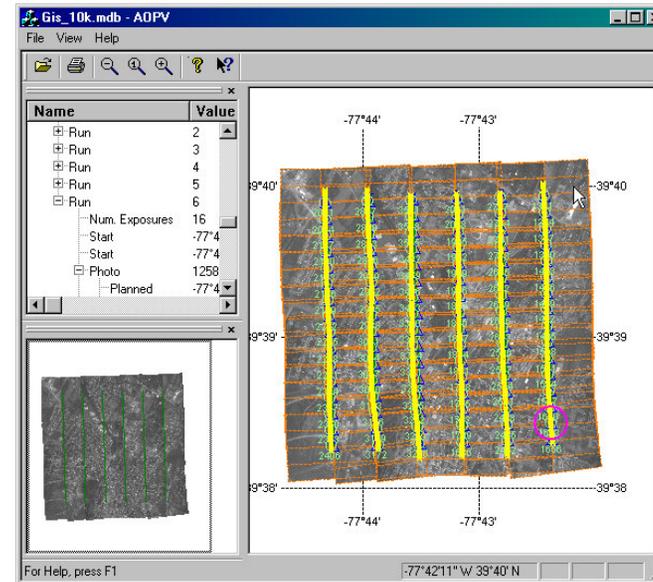
Z/I Inflight

- Eliminates the need for a separate laptop
- High Reliability
- Touch Screen Controls for operator and pilot
- Integrated computers
 - RTC running LINUX
 - Computer running Windows XP
- High Speed Data Hub (1Gb) on-board
- Interface to RMK-TOP

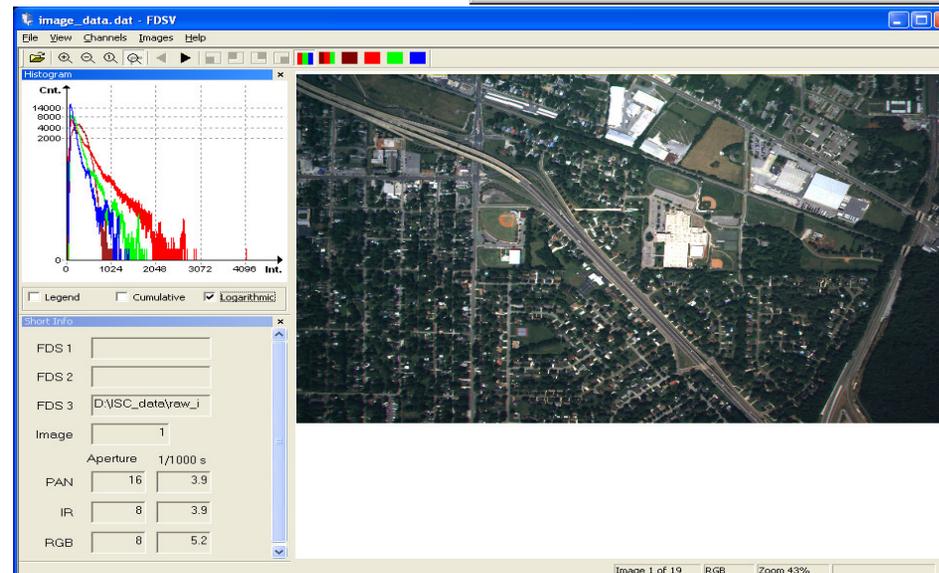


In-Flight QC

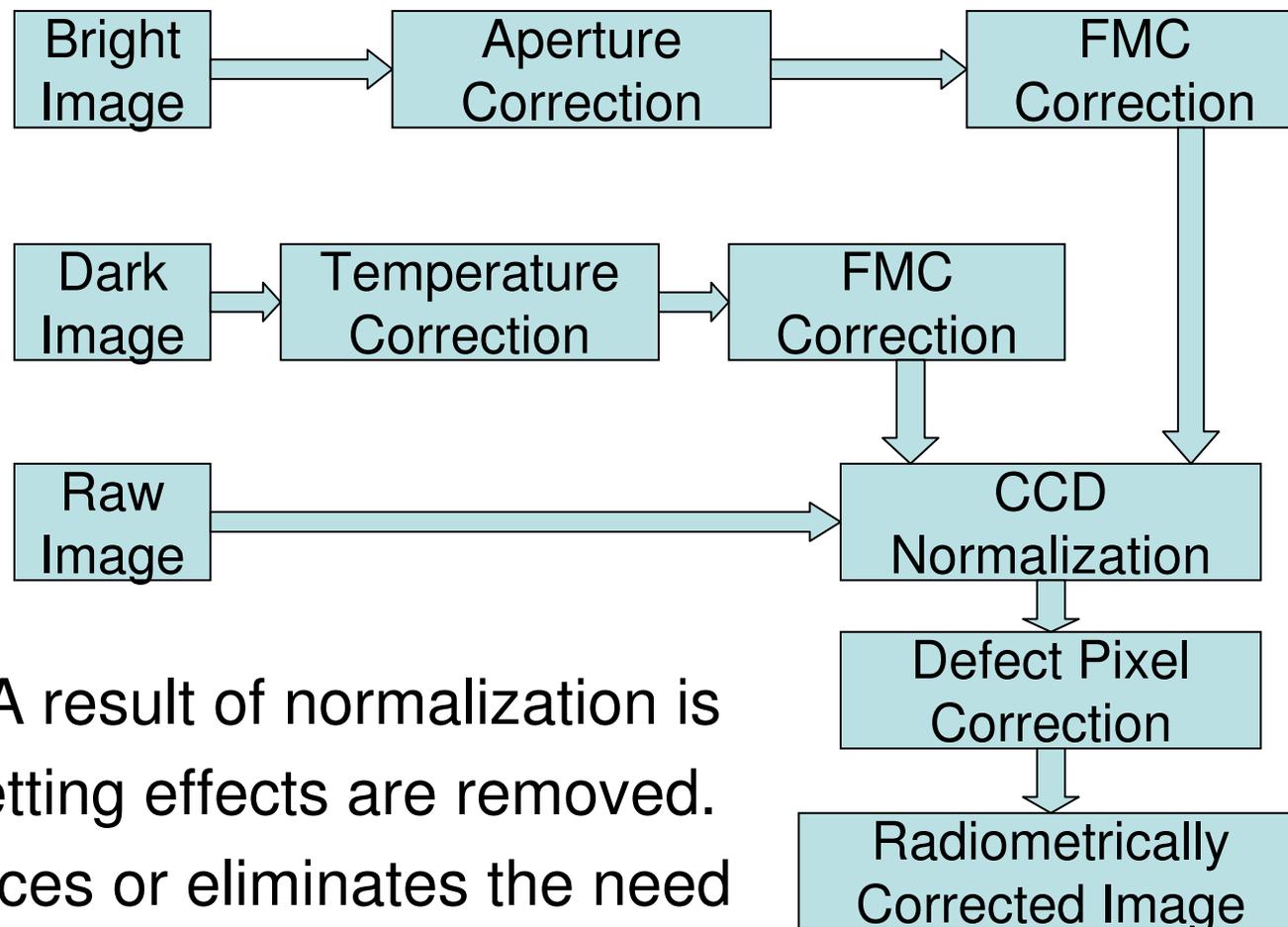
- Real time video information
- Real time project status
- Real time project overview
- Mosaic of mission area



Z/I ImageView

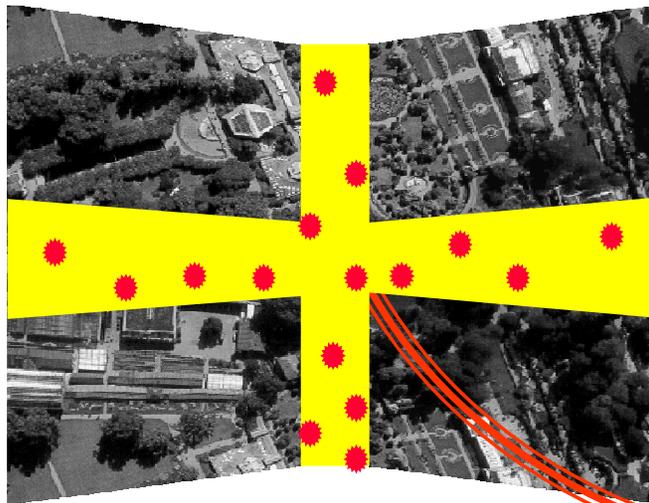


DMC Radiometric Processing



Benefit. A result of normalization is that vignetting effects are removed. This reduces or eliminates the need for a ‘downstream’ dodging step.

DMC Image Post Processing

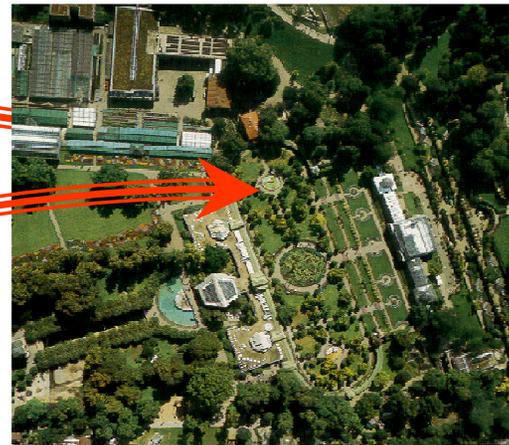


 tie point area



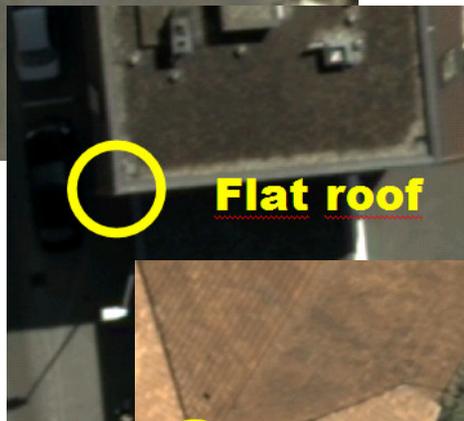
Image Mosaicking

- DMC calibrated camera heads
- Geometric and radiometric correction
- Check calibration with tie points
- Mosaicking
- Fusion with color composite

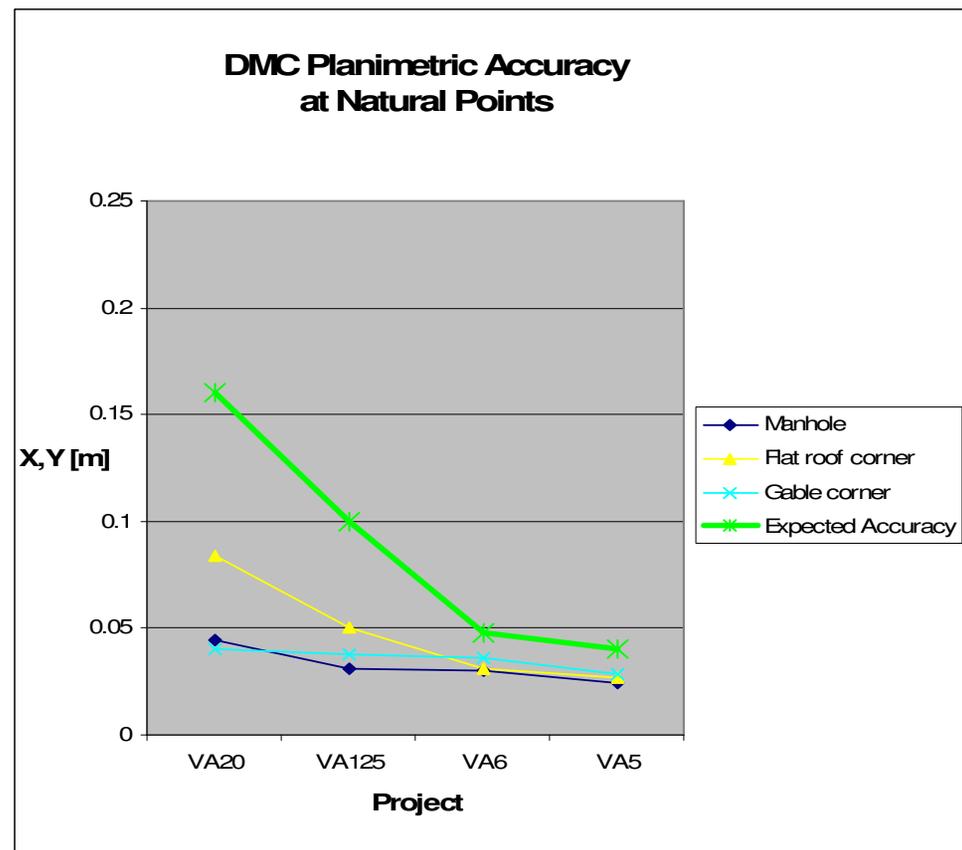


Bundle orientation
using tie points:
sigma = $\sim 0.80\mu\text{m}$
(0.07 pixels)
of observations:
 ~ 1000

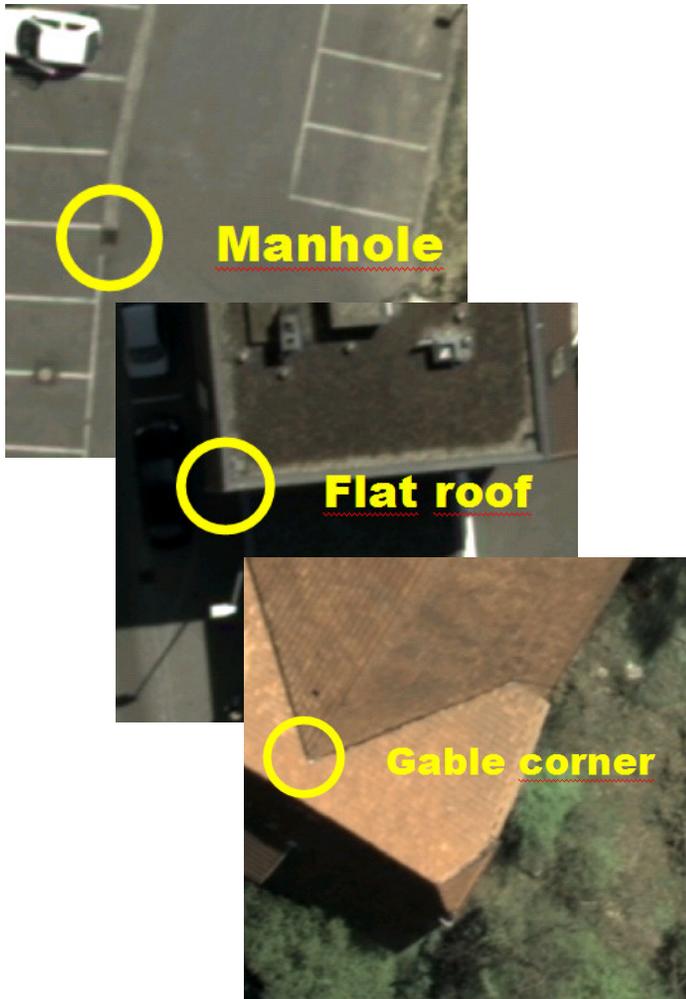
Planimetric Accuracy



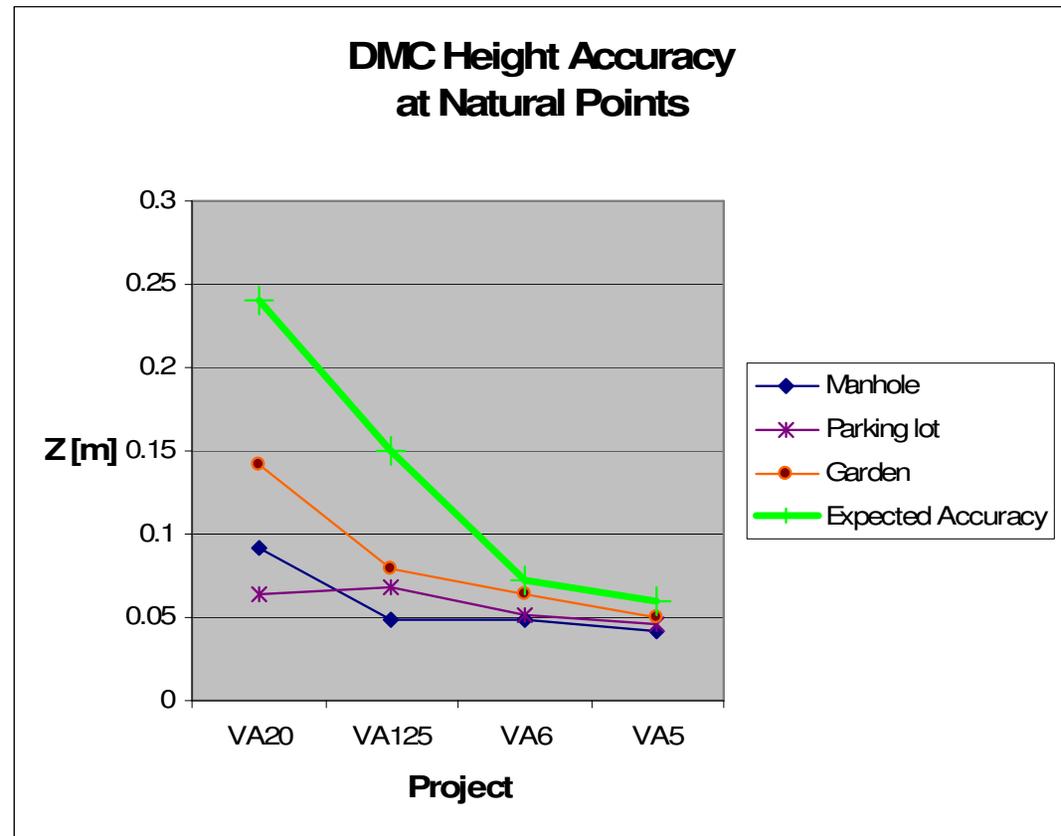
Horizontal Accuracy: $< \pm 3 \text{ } [\mu\text{m}] \text{ * image scale}$



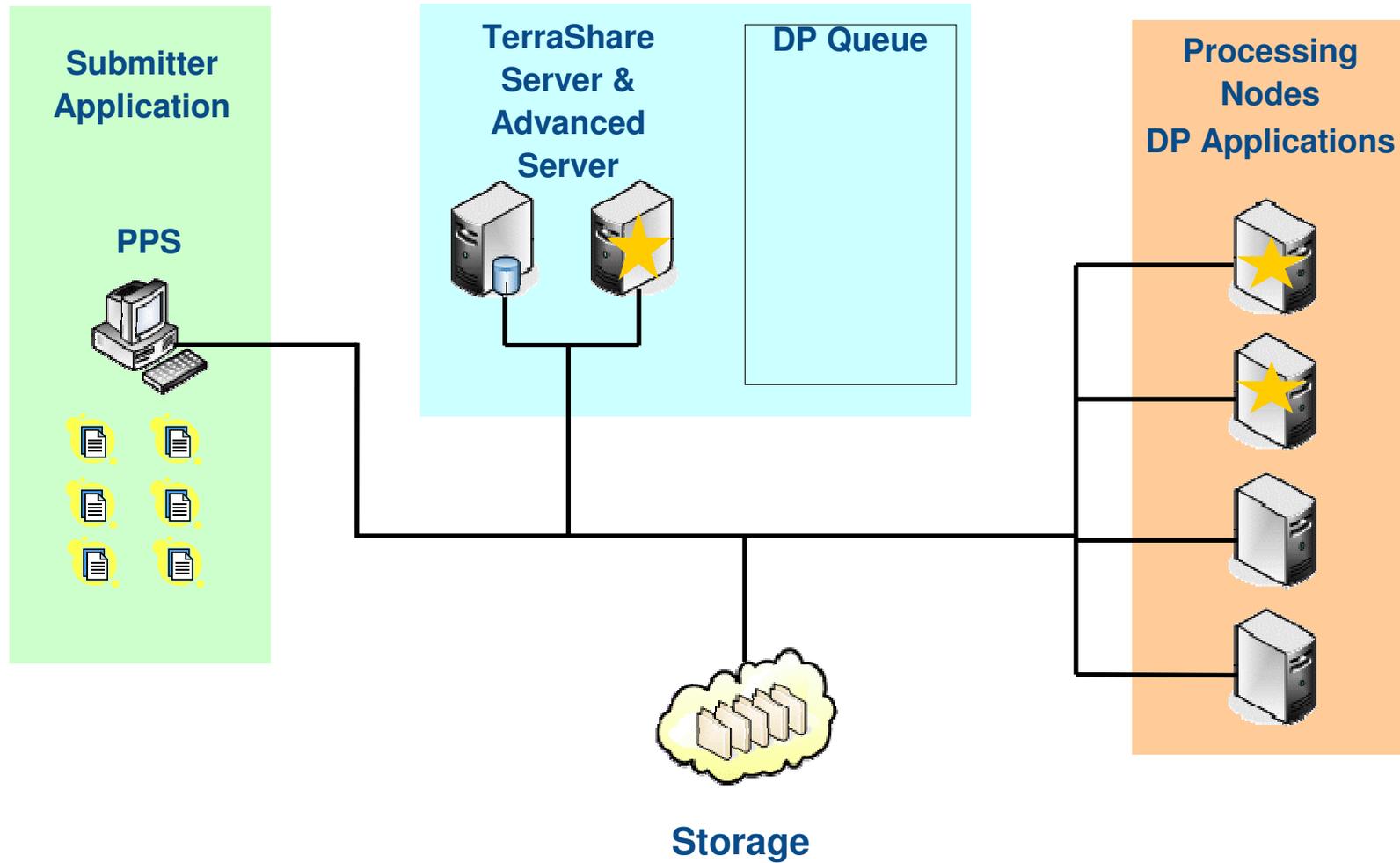
Height Accuracy



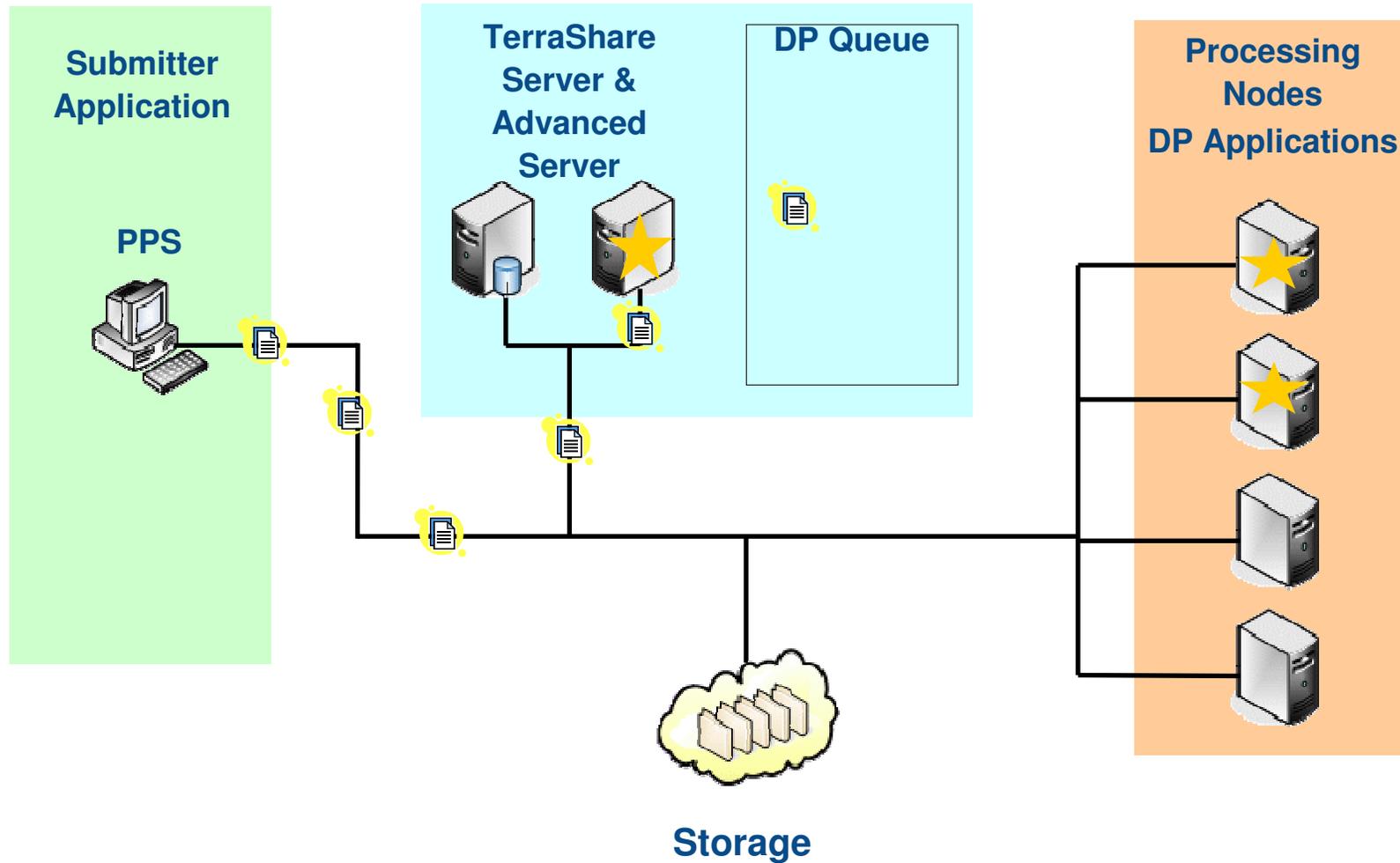
Vertical Accuracy: $\pm 0.05\%$ of flying height



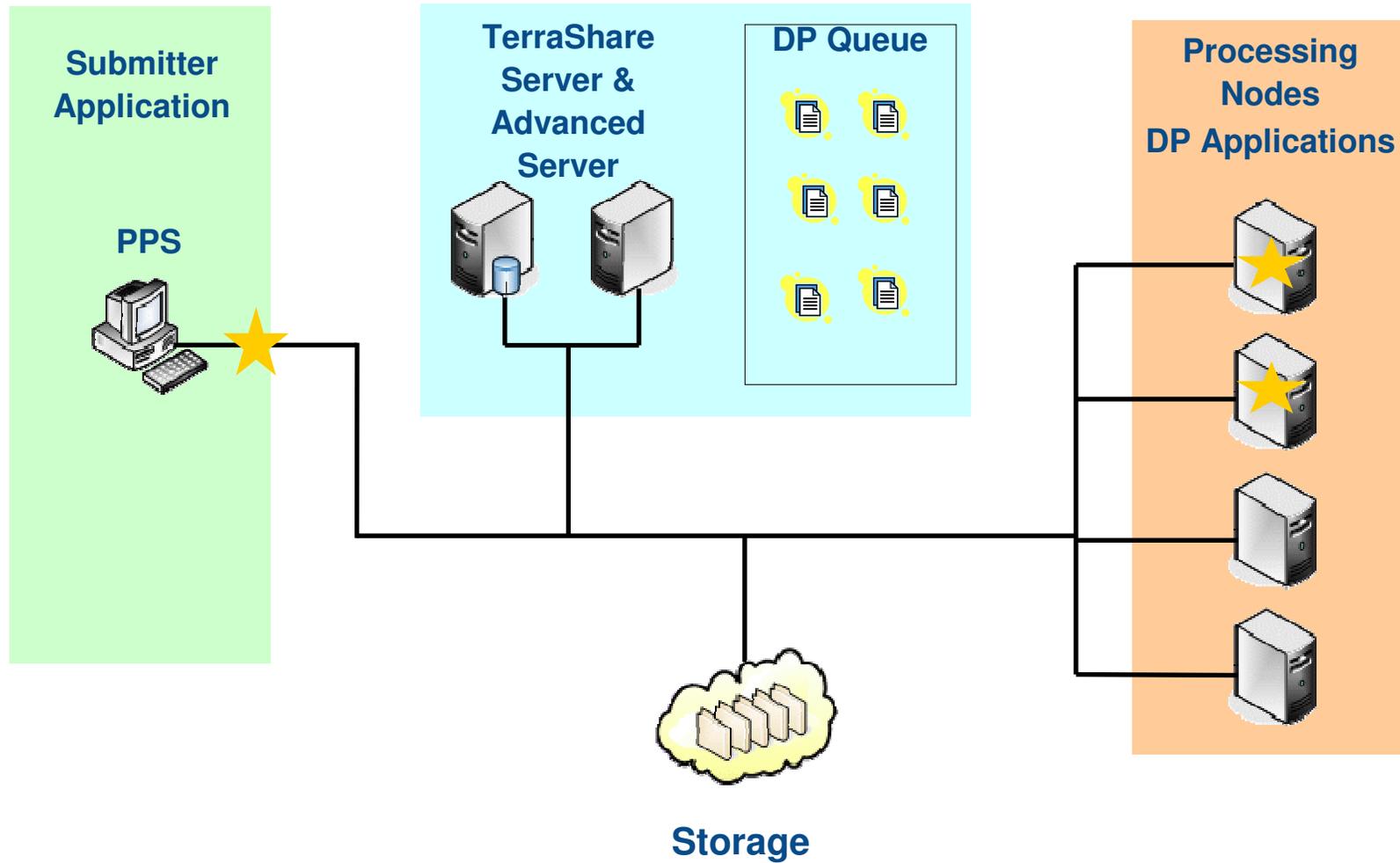
Distributed Processing



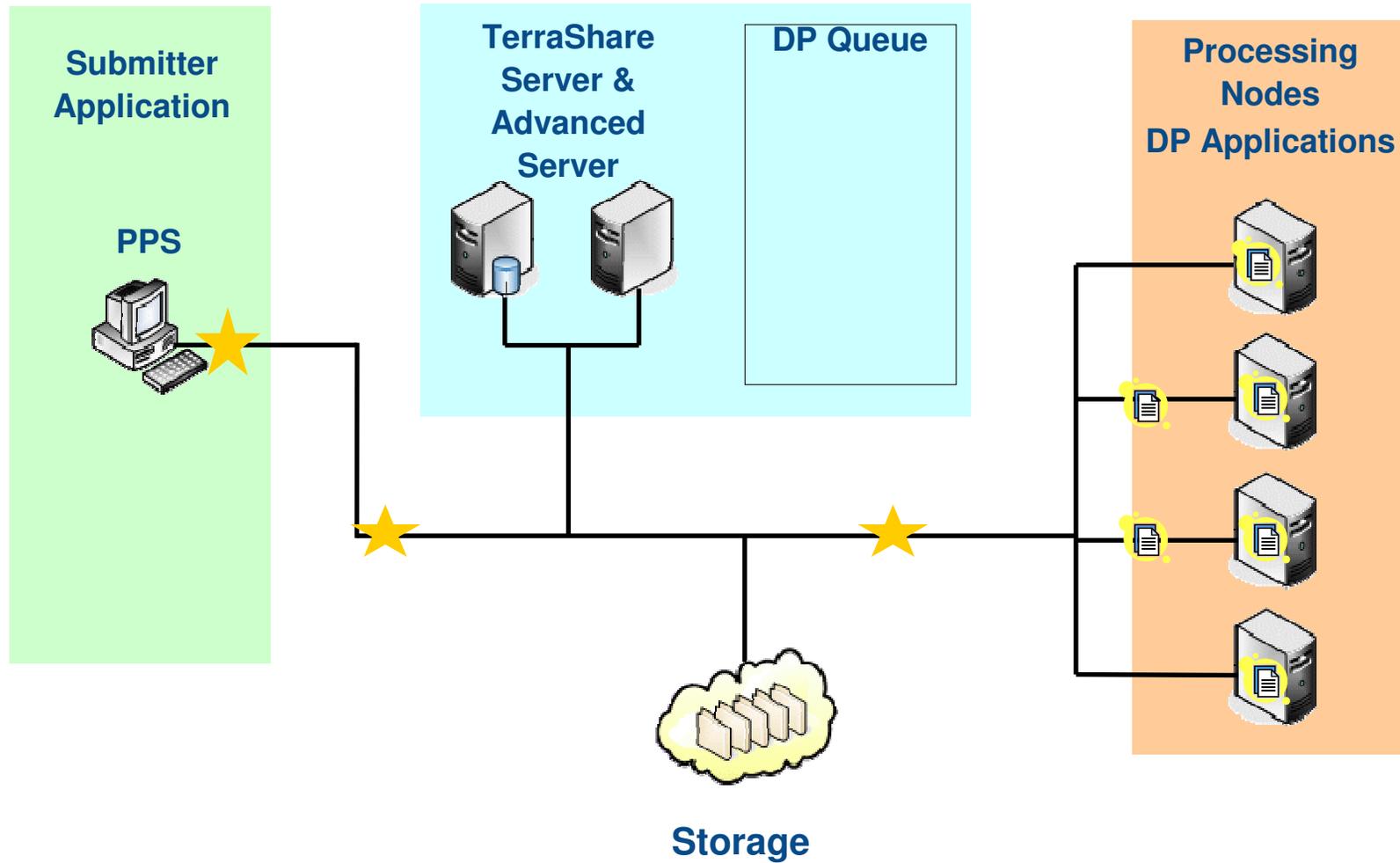
Distributed Processing



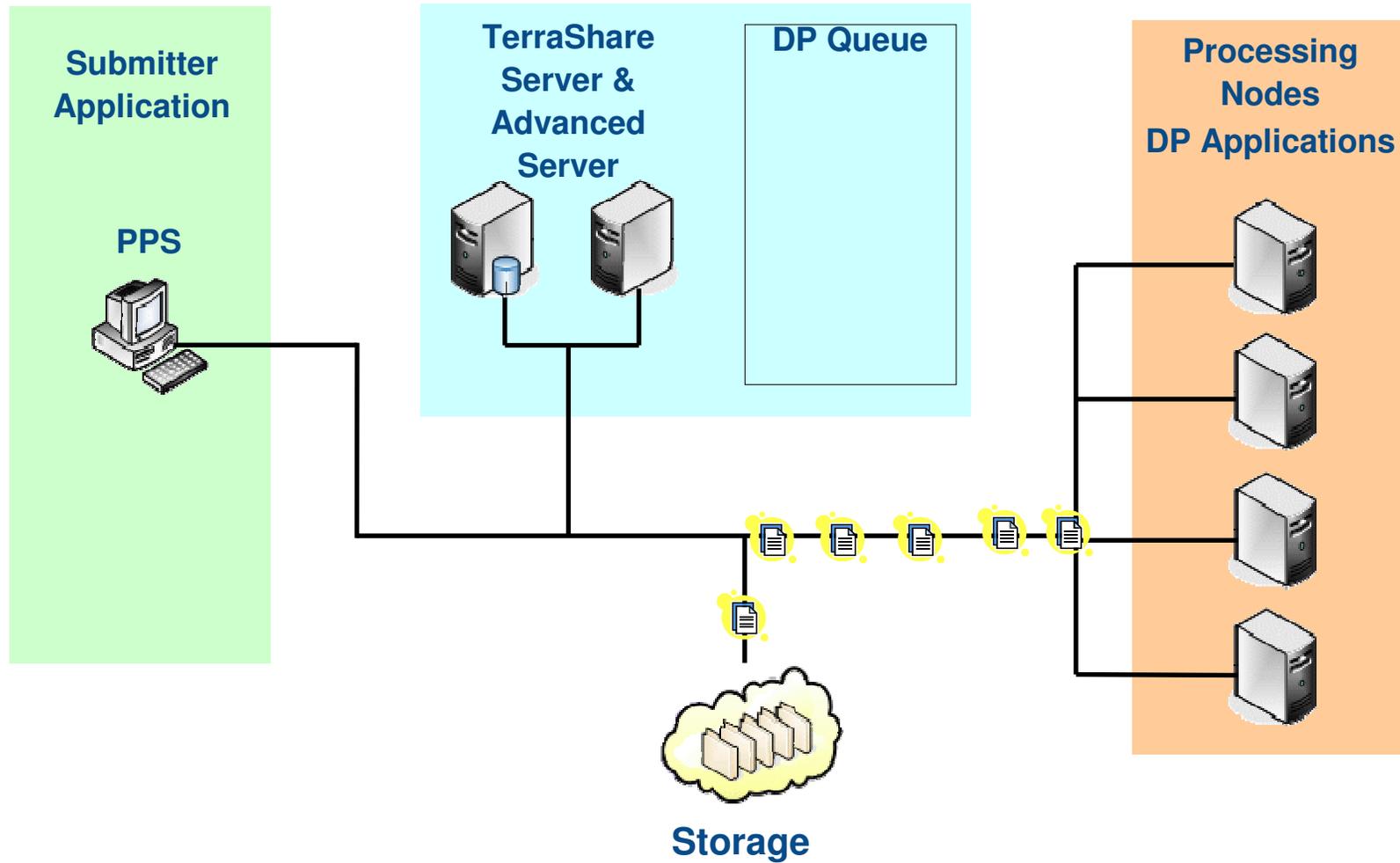
Distributed Processing



Distributed Processing



Distributed Processing



PPS Distributed Processing Experience

Intergraph Test	# of Strips	# of Images	Total Time (hrs)	Time per Image (mines)	Throughput Performance
One PPS	7	472	16.07	2.04	
3 PPS DP Nodes	7	472	6.25	0.79	158 %

Customer Test		# of Strips	# of Images	Total Time (hrs)	Time per Image (mines)	Throughput Performance
Test 1	One PPS	6	127	4.81	2.27	
	4 PPS DP Nodes	6	127	1.97	0.93	144 %
Test 2	One PPS	15	272	10.73	2.37	
	4 PPS DP Nodes	15	272	3.00	0.66	259 %
Test 3	One PPS	63	1224	45.9	2.25	
	4 PPS DP Nodes	63	1224	12.24	0.60	275 %

PPS Distributed Processing Experience

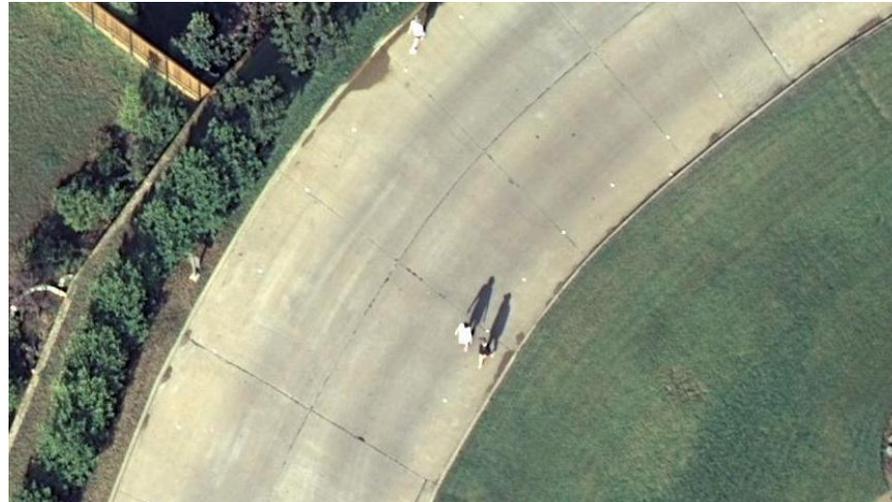
- Image I/O is most significant bottleneck
- More than 4 processing nodes encounters I/O bottleneck, resulting in diminishing performance of each node
- Optimal cost/benefit configuration:
 - Fastest network between storage & processing nodes
 - Isolate DP network from office network!
 - High-performance RAID storage for input/output
 - 4 (virtual) CPUs per processing node
 - Local attached RAID at each node for intermediate file storage
- **150 sec/image/node * 4 nodes => 45 sec/image can be expected**

DMC Application Range

DMC covers a wide range of applications from large scale engineering to remote sensing



Images courtesy of Asia Air Survey

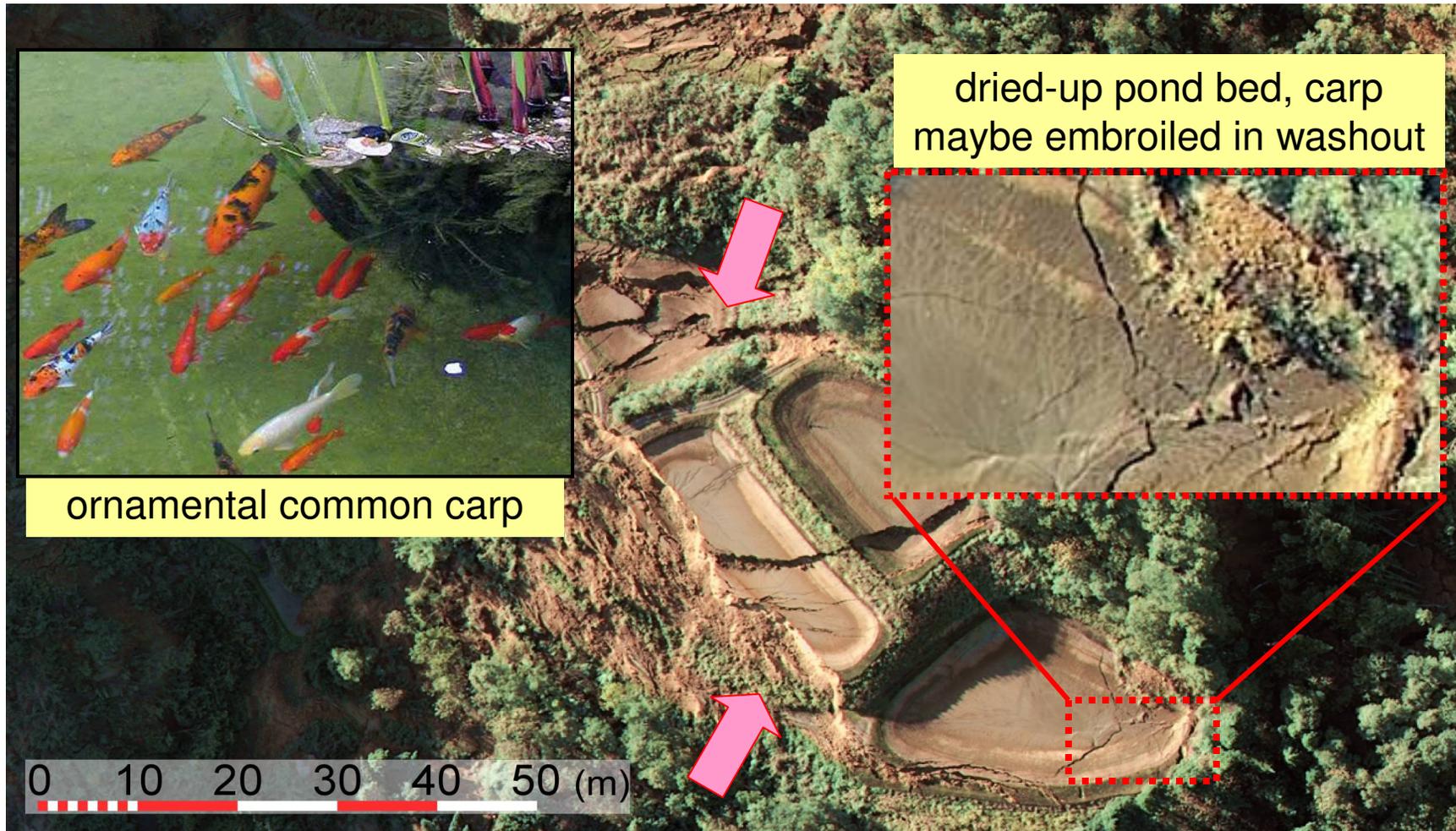


Images courtesy of Kokusai Kogyo

DMC Images



Better Definition: Ruins of Breeding Pond



GSD=12.0cm: Yamakoshi Village (now part of Nagaoka city), at Oct. 24

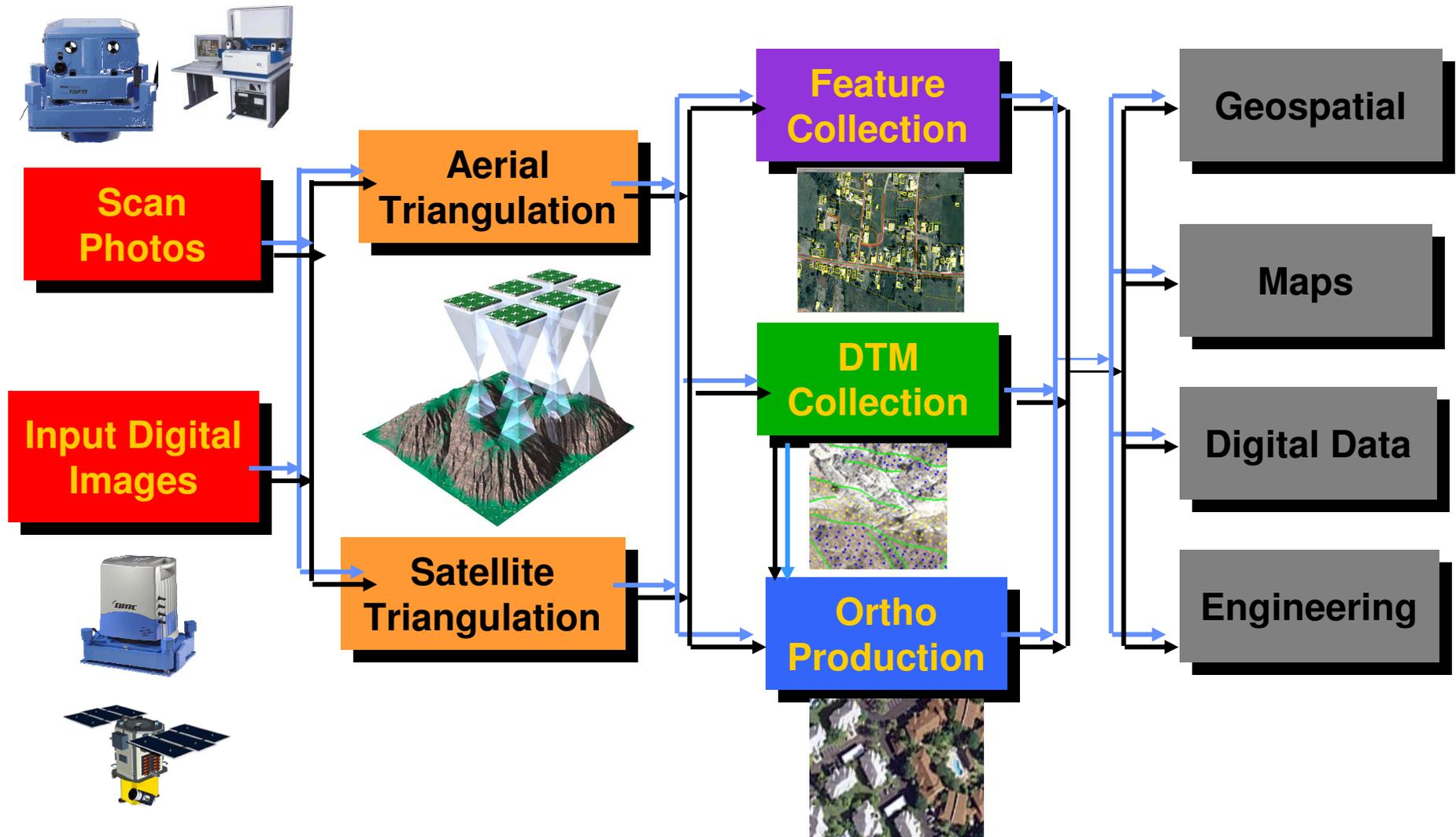
Image courtesy of Asia Air Survey

DMC Benefits

- Frame sensor based camera, stable geometry
- Central perspective geometry
- IMU or GPS system not essential
- Wide application range for stereo coverage
5cm to 1m GSD at 140 knots airspeed or faster
- 3.8cm possible at lower air speed
- Large ground coverage, 13824 x 7680 pixels
- Pan, RGB and CIR images from one flight
- Fast image post processing - < 1 minute per image possible
- Field serviceable, all parts can be exchanged onsite
- USGS certified



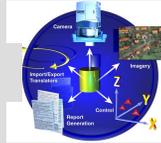
Digital Photogrammetry Workflow



ImageStation provide solutions across the whole range of Earth Imaging requirements

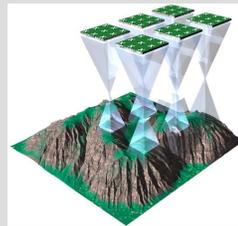


Project Management



ImageStation Photogrammetric Manager

Orientation & Triangulation



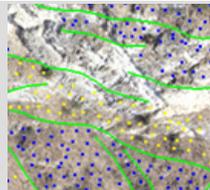
ImageStation Model Setup
ImageStation Digital Mensuration
ImageStation Automatic Triangulation
ImageStation Satellite Triangulation

Stereo 3D Feature Capture



ImageStation Stereo Display
ImageStation Feature Collection-MicroStation
ImageStation Stereo for GeoMedia
ImageStation Stereo Viewer - GeoMedia

DTM Collection & Edit



ImageStation DTM Collection
ImageStation Automatic Elevations

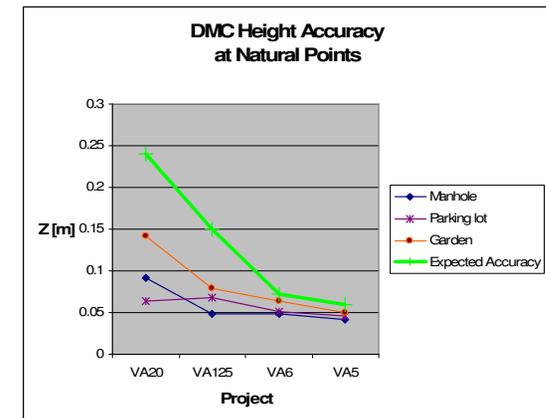
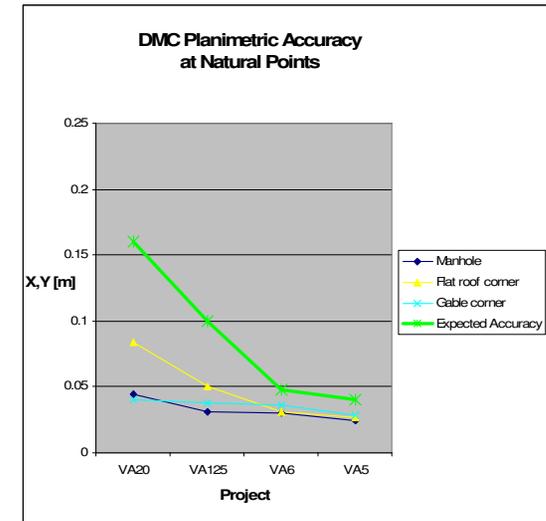
Orthophoto Production



ImageStation Base Rectifier
ImageStation OrthoPro
ImageStation PixelQue

Summary

- Geometric accuracy better than analog camera
 - Aerial triangulation accuracy:
 - Planimetry: $< \pm 3 [\mu\text{m}] * \text{image scale}$
 - Height : $< \pm 0.05\%$ of flying height
 - Stereo measurement accuracy:
 - Planimetry: $< \pm 4 [\mu\text{m}] * \text{image scale}$
 - Height : $< \pm 0.07\%$ of flying height
- Outstanding image quality
- Multiple image products (all with 12-bit radiometry)
- Potential to fly at higher altitudes (less strips)
- Rapid acquisition and in-flight QC of image content
- More reliable image matching
- Superior 3-D viewing of stereo models





**Thank you for listening
Questions and Comments?**



Mostafa Madani

Cheif Photogrammetrist & Product Manager
Intergraph – Z/I Imaging

P (256) 730 - 1814

M (256) 617 - 2236

F (256) 730 - 2096

mostafa.madani@intergraph.com

<http://www.intergraph.com/photogrammetry>