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See the world with different eyes

51st Photogrammetric Week

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Performance improvements of digital photogrammetric systems

- Review
- Changes in computing performance
- Parallel/distributed processing/computing
- Example
- Prospects

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Review - project size

Number of photos in production per company

- **1997 10000 – 20000 photos**
- **2007 200000 photos**

- **example for large project in 2006:**

Los Angeles County 3 DMC cameras 60500 images + LIDAR

final products: 10 cm pixel orthos , 2 foot contours

(see: ASPRS 2007, G. Sehnalek, N. Franchino)

Increase in productivity

main contribution:

- **new digital sensors (large and medium format)**
- **direct Georeferencing (GPS and IMU)**
- **Changes in computing performance (storage and processing)**

images on the Internet

www.virtualearth.com

www.google.com

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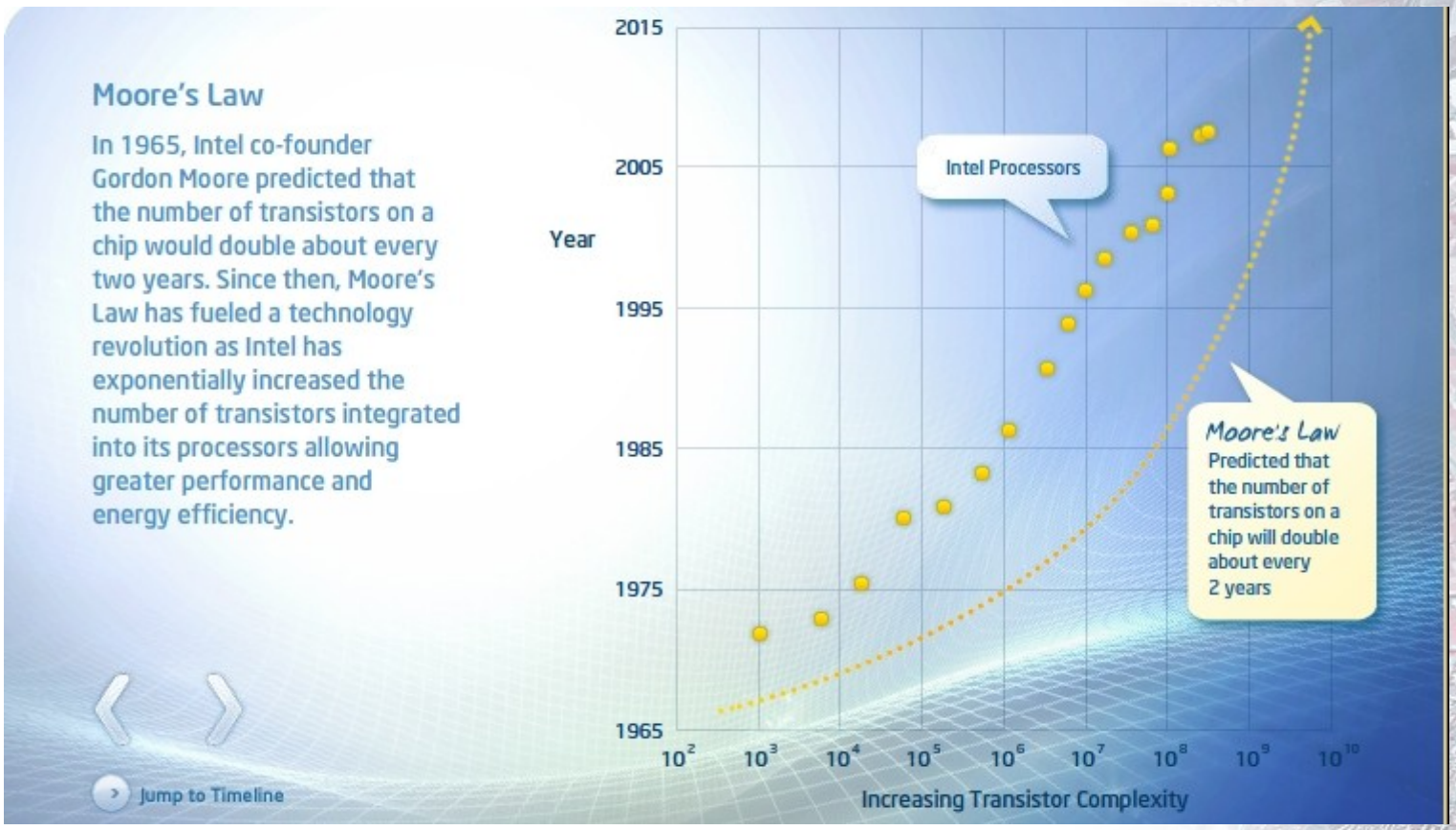
Moore´s Law



Ref: www.intel.com

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Intel

1981 - 6 Mhz 134 000 Transistors	Intel 286
1989 - 25 Mhz 1,2 Mio.	Intel 486
2000 - 1,5 Ghz 42 Mio.	Intel Pentium IV
2007 - 2,6 Ghz 582 Mio.	Intel Core 2 Quad Processor

End of 2007 Intel 8 core systems

Need: Support of multi core architecture

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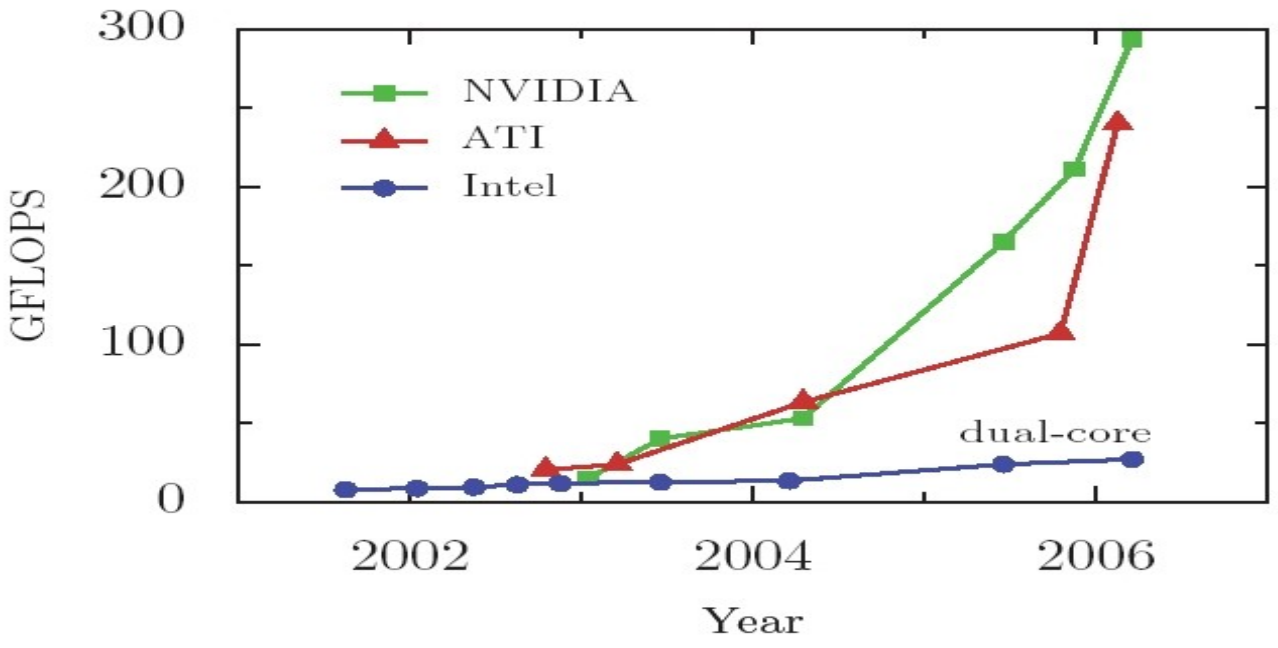
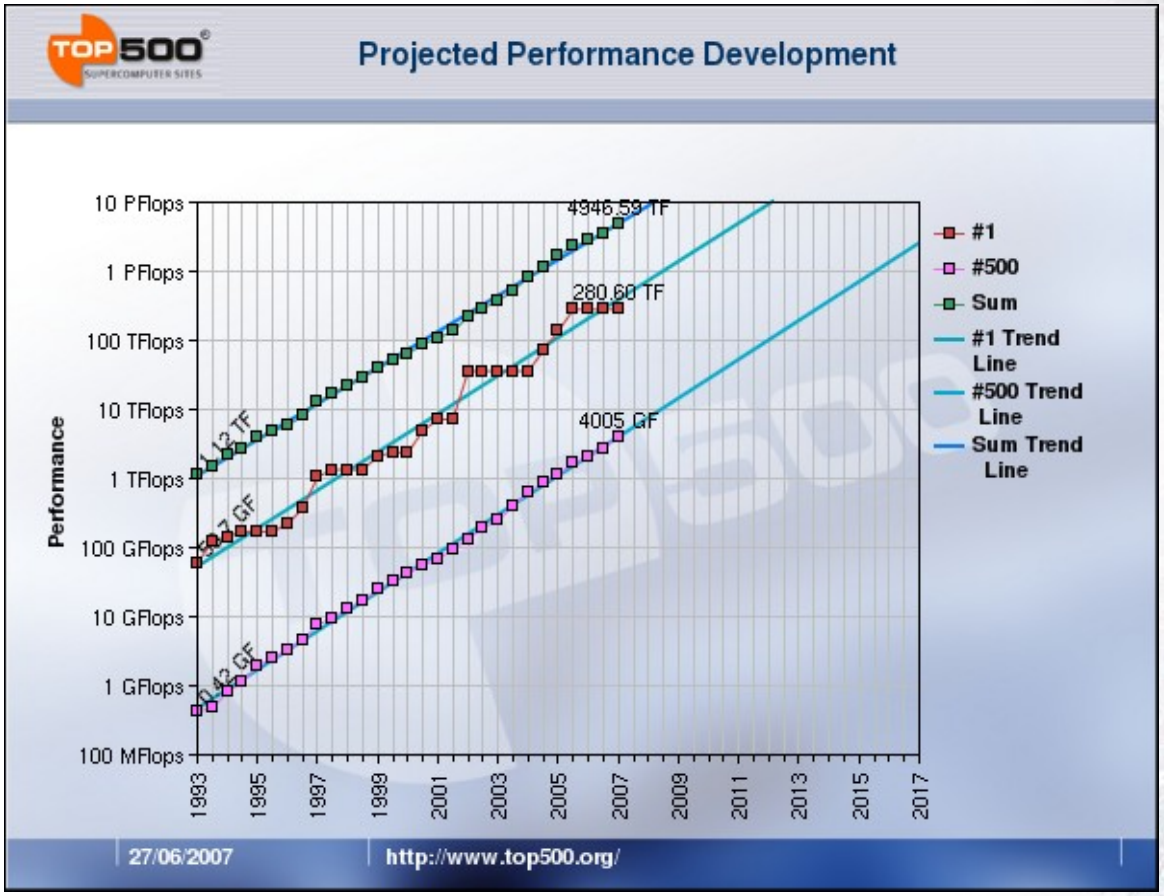
GP-GPU

- General –Purpose computation on Graphics Processing Units



Ref:Owens, Luebke,Govindariju,Harris,Krüger,Lefohn,Purcell, A Survey of General Purpose Computation on Graphics Hardware Computer Graphics Forum, Volume 26 (2007), number 1 pp. 80 - 113

Top 500


TOP500
SUPERCOMPUTER SITES
Projected Performance Development
10 PFlops
1 PFlops
100 TFlops
10 TFlops
1 TFlops
100 GFlops
10 GFlops
1 GFlops
100 MFlops
Performance
4946.59 TF
280.60 TF
4005 GF
1.13 TF
59.7 GF
0.42 GF
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
#1
#500
Sum
#1 Trend Line
#500 Trend Line
Sum Trend Line
27/06/2007
http://www.top500.org/

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better performance

how to get there at customer's production:

…it runs twice as fast every 18 months with no change of code…

Enhance software to take advantage of new hardware

- **Better utilization of available customer's hardware**
- **Use complete potential of multi-core architecture**

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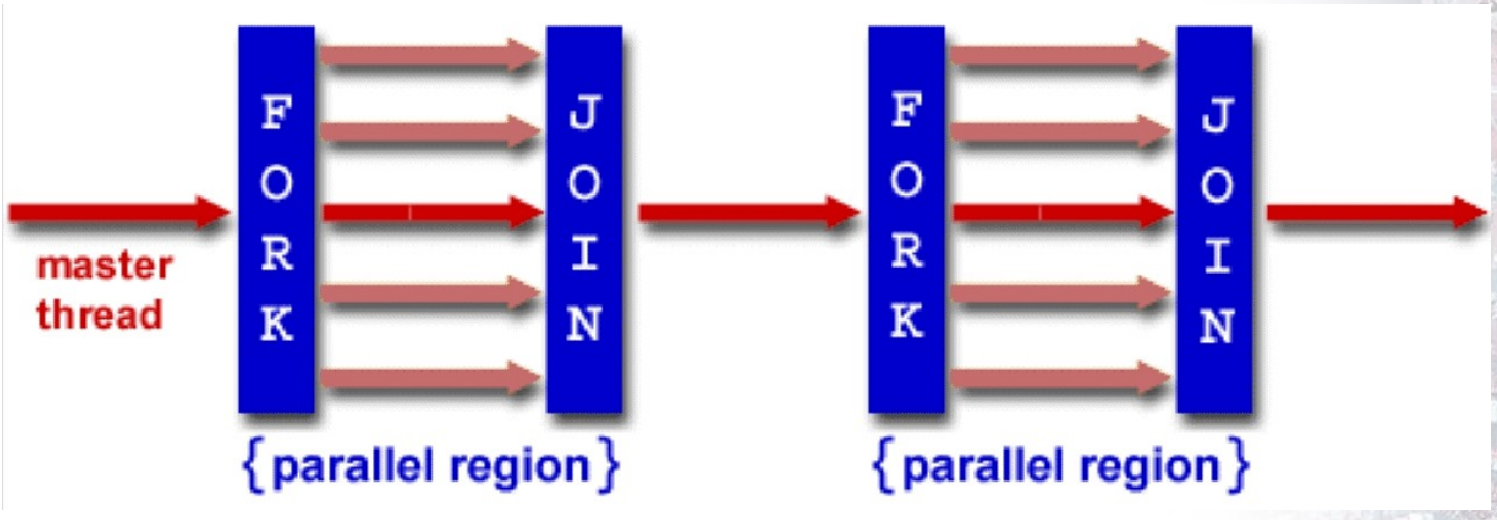
Parallel execution in software

usage of multi core hardware:

- **OpenMP for shared memory (SMP) systems:**
- **fork / join model**



http://www.openmp.org

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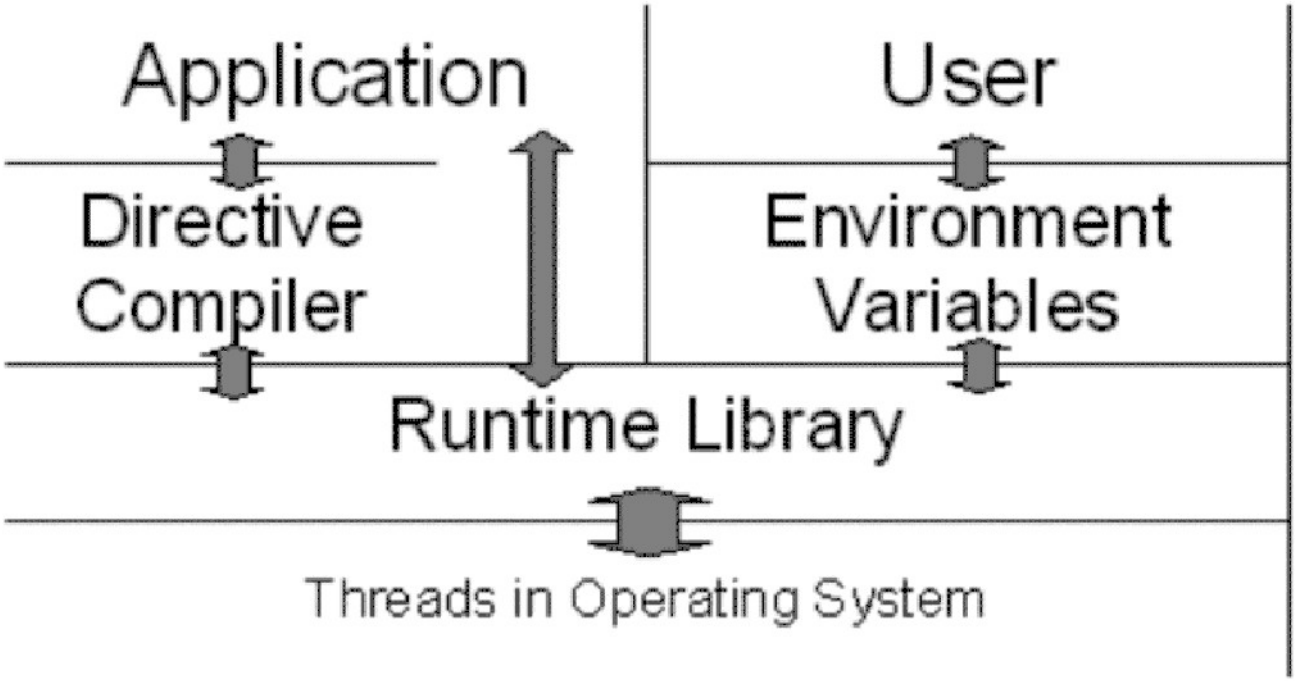
Open_MP Architecture

- Multi-Platform shared-memory parallel programming
- Specification 2.5 May 2005
- Supported by all major compiler



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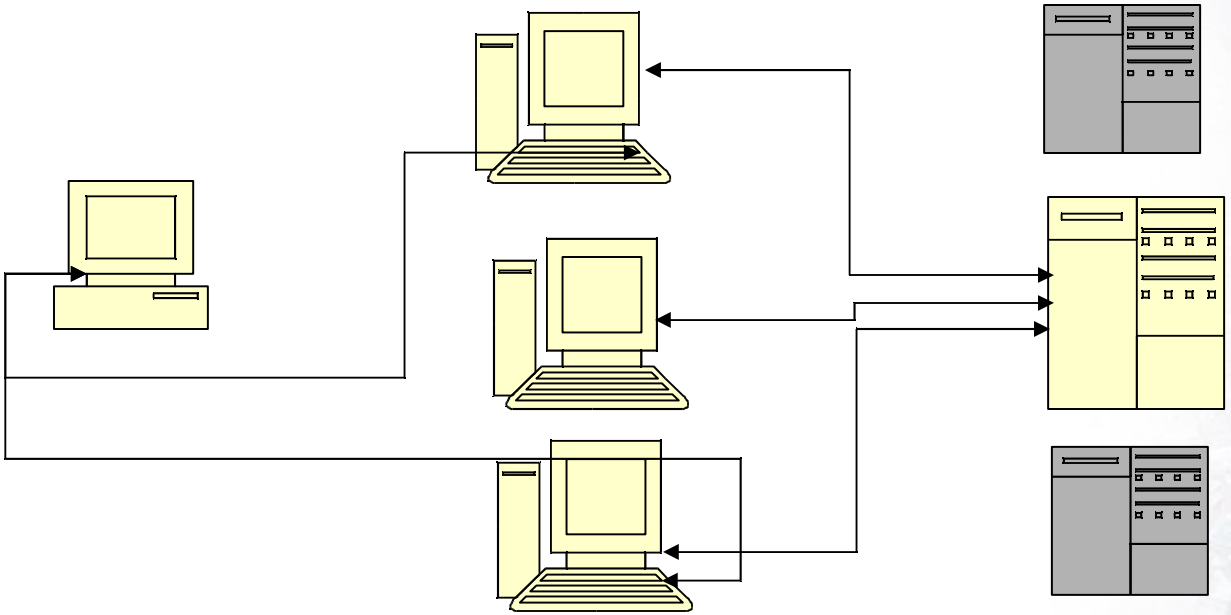
better workload on customer‘s IT

better utilization ratio of available hardware:

→ distribute/share tasks to/with different computer



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Work load management systems

Open source:

Portable Batch System (or simply PBS)

- **OpenPBS — the unsupported original opensource version**
- **TORQUE Resource Manager (Terascale Open-Source Resource and QUEue Manager) an open source fork of OpenPBS version 2.3.12 maintained by Cluster Resources.**
- **Sun Grid Engine (SGE), previously known as CODINE (COmputing in DIstributed Networked Environments) or GRD (Global Resource Director), an open source batch-queuing system, supported by Sun Microsystems.**
- **Condor is a software framework for coarse-grained distributed parallelization of computationally intensive tasks**

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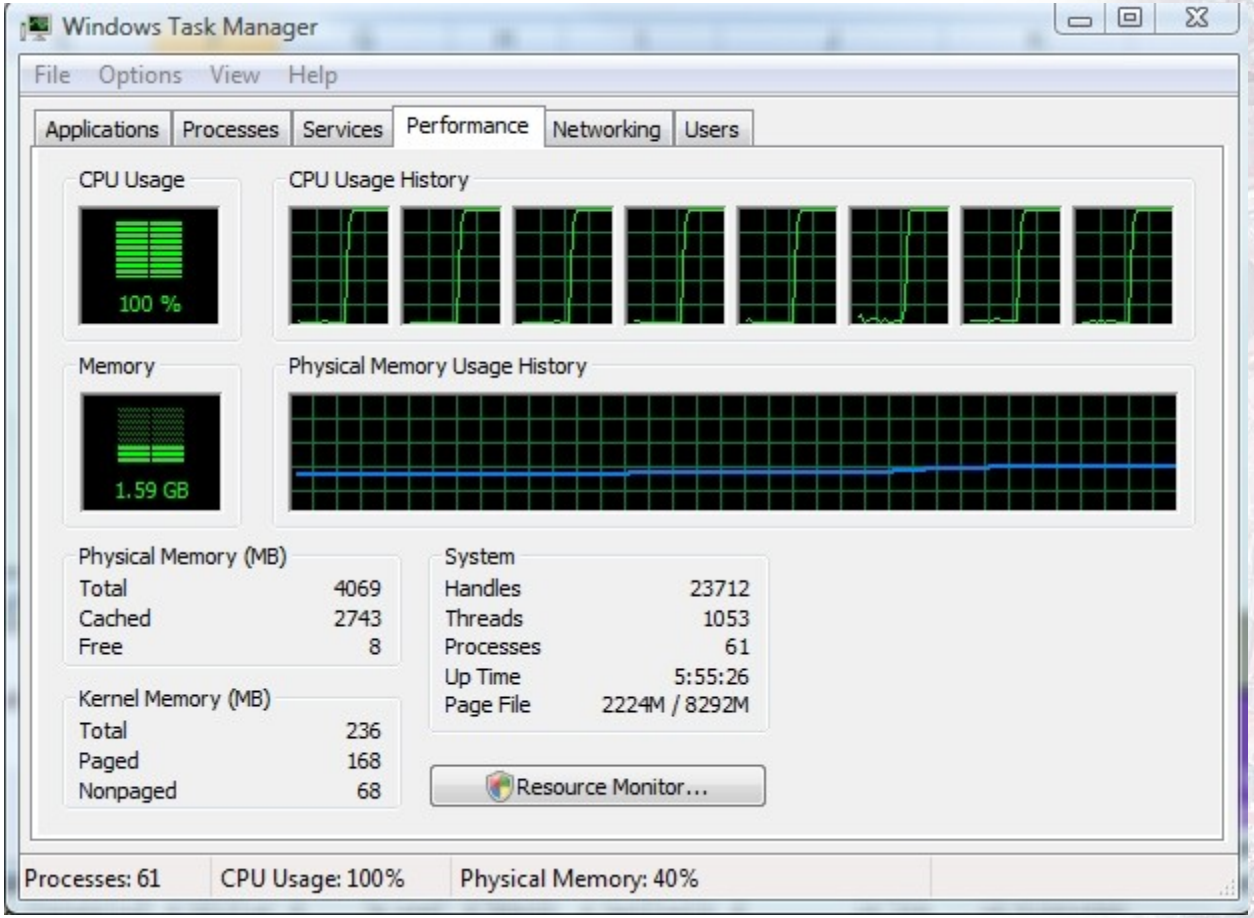
Commercial systems

commercial :

- **Load Sharing Facility (or simply LSF) is a commercial computer software job scheduler sold by Platform Computing**
- **Sun also sells a commercial product based on SGE, known as N1 Grid Engine (N1GE).**
- **PBS Professional (PBS Pro) — an enterprise-quality professional version maintained and sold commercially by Altair Engineering**
- **others**

Ideal workload on 8 core system



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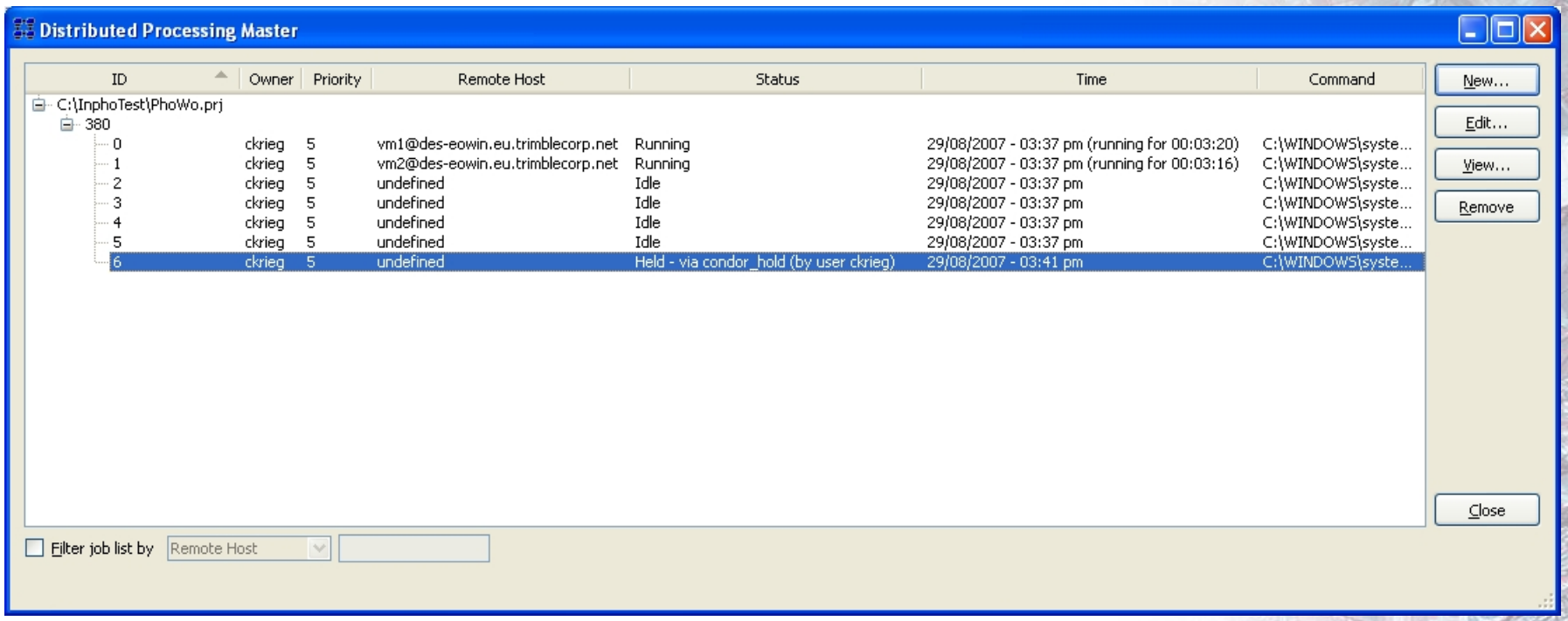
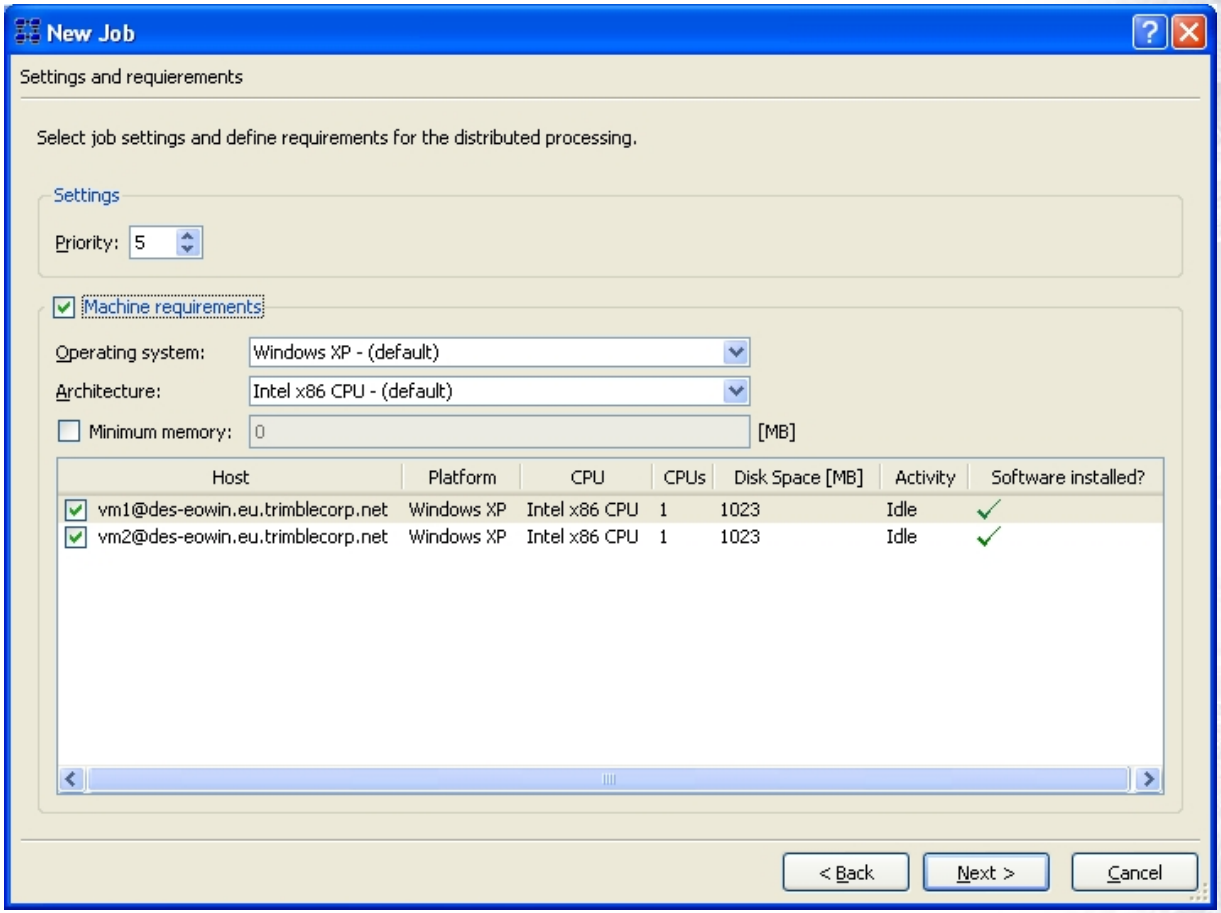
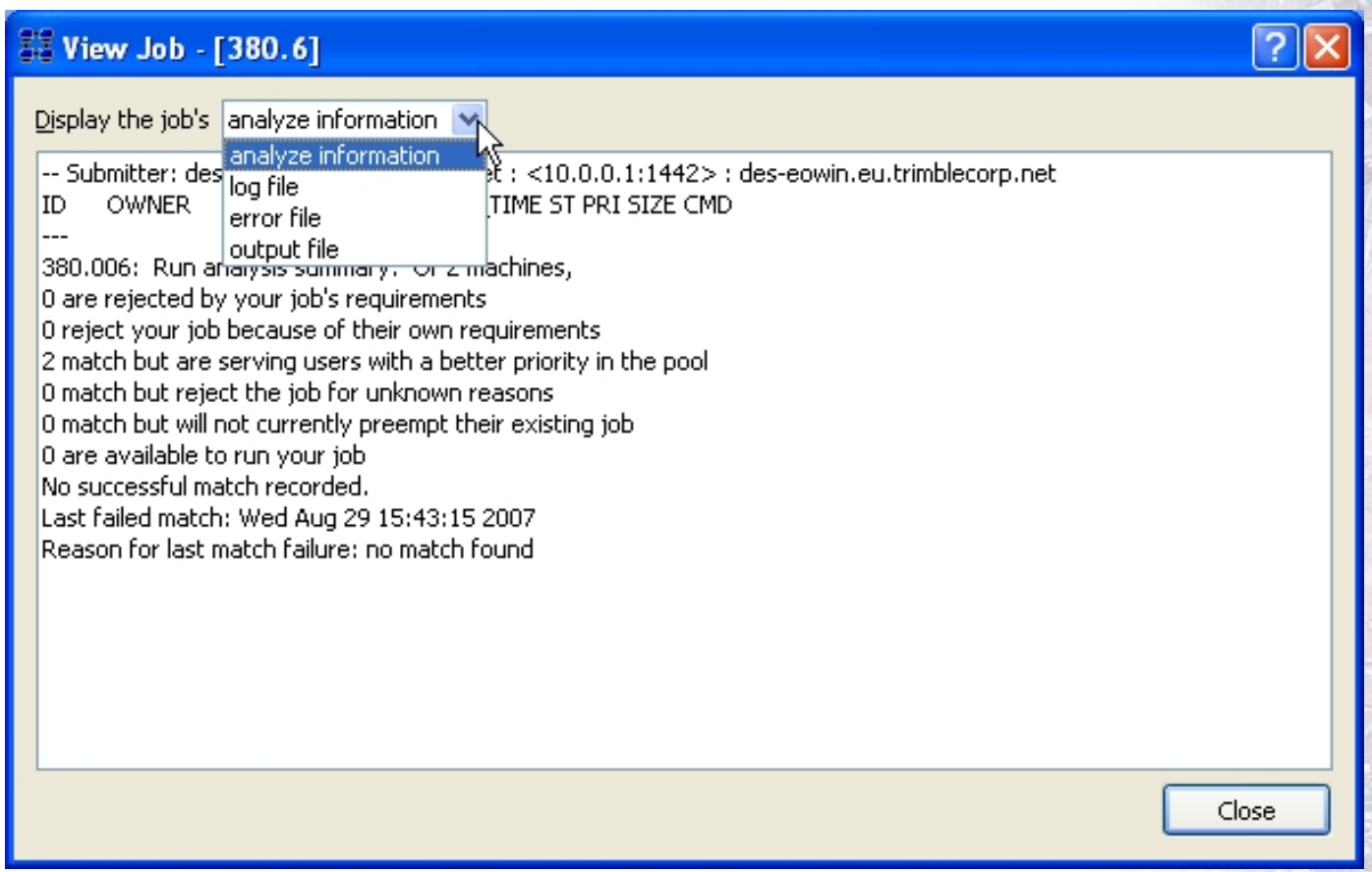
Example 1a: OrthoMaster - DPMaster



Example 1b: New job



Example 1c: view job



Example 2a: ADS On the fly L1

- original L0

Example 2b: ADS On the fly L1

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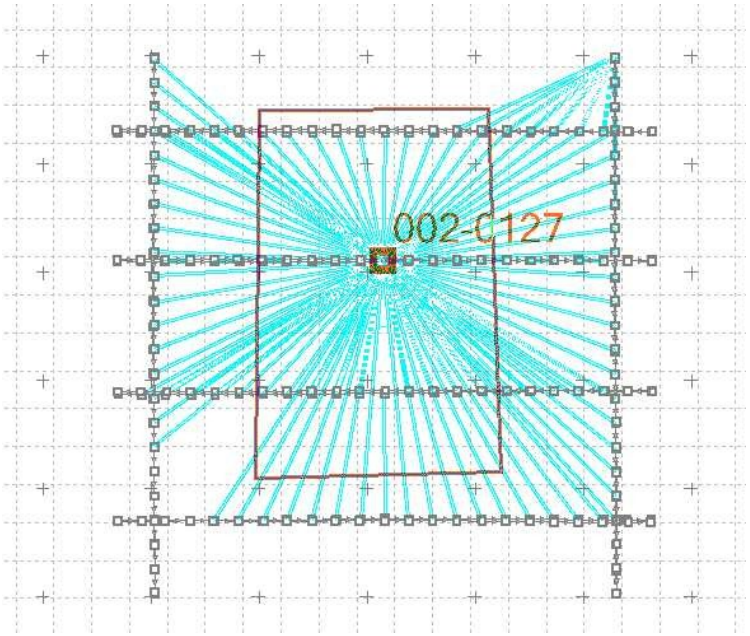
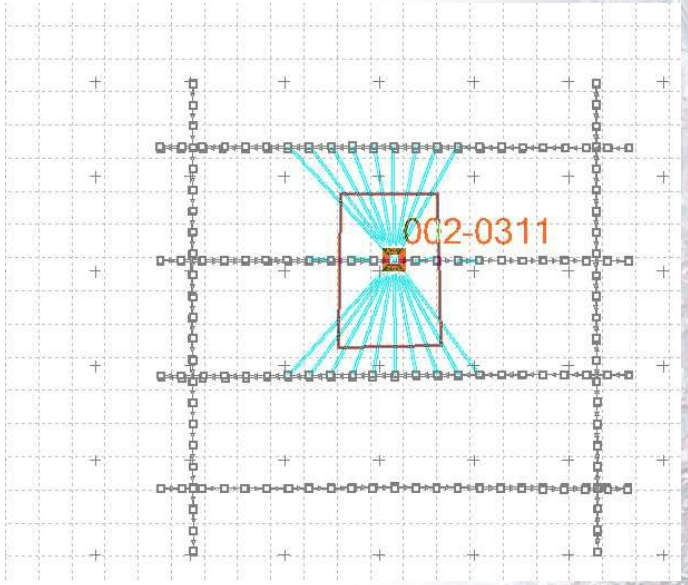
Example 3: Automatic Triangulation

- Simulated data, large block size
- 10000 images 50 strips, 200 images each
- 225 image observations, per image
- 10000 GPS + IMU
- 2.5 Mill. image points
- 1,5 Mill. unknowns
- ca. 0,5 Mio. block points
- Adjustment MATCH-AT: 17 minutes / iteration
- → need for parallel processing of matching

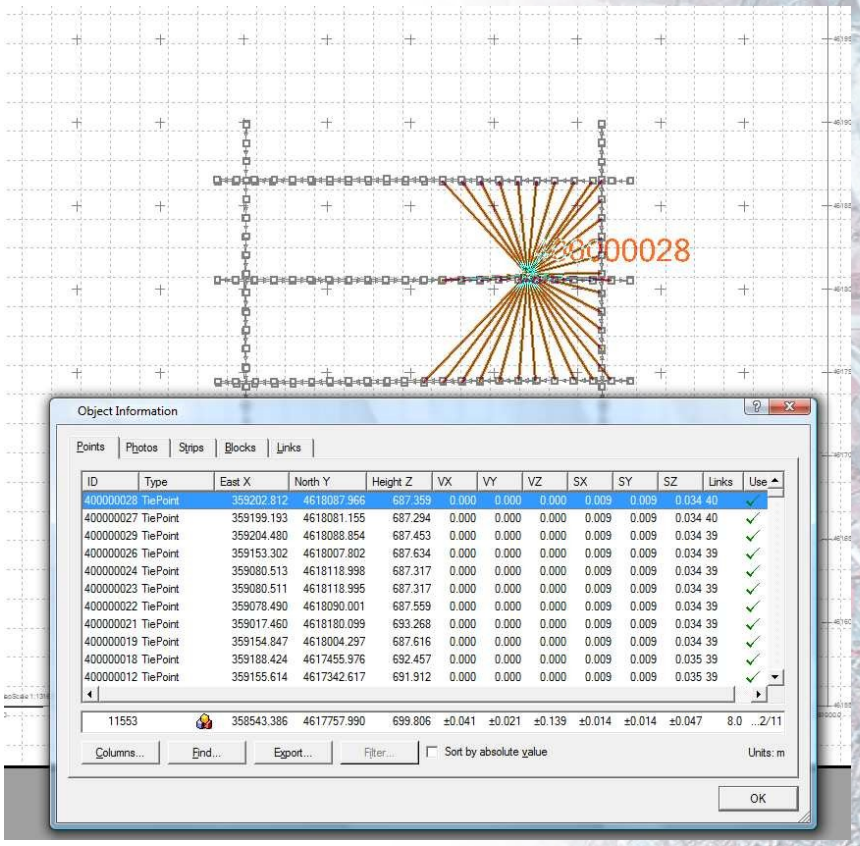
Example 4a: block with extreme overlap





Example 4b: block with extreme overlap

- points in up to 40 images:

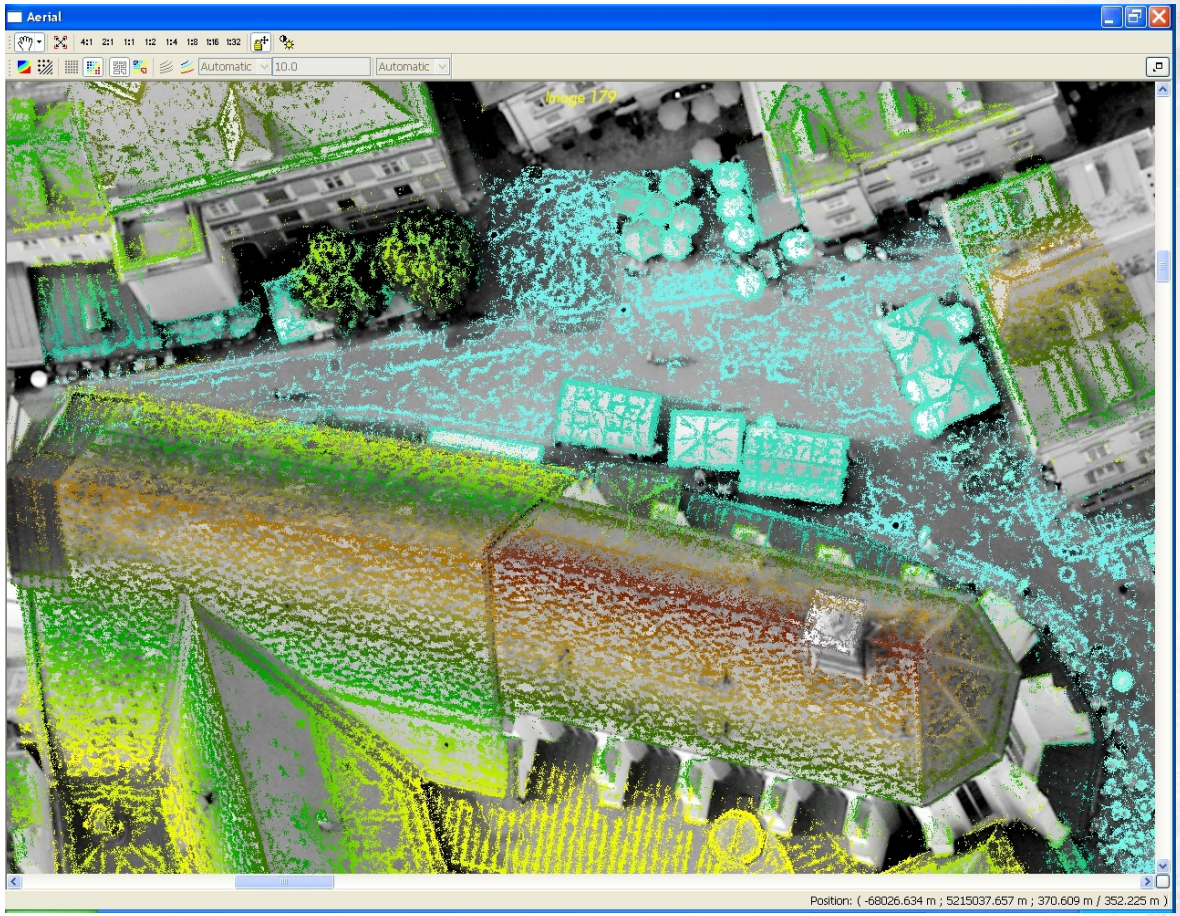


Example 5a : MATCH-T DSM

- Creation of DSM point cloud with UltraCam images
- 80/60 overlap
- 10 cm GSD

Example 5b : DSM point cloud

Example 5c : DSM colored point cloud



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- Distributed processing
  - Already in use at customer‘s productions shops
  - INPHO introduces **DPMaster** for OrthoMaster and MATCH-T
- Need for adapted algorithms to run on parallel (multi-core hardware)
  - Different technologies for implementation, Open_MP platform independent
  - Multi core architecture will evolve in next years
- additional source processing power: GPU (graphic process. unit)
  - GPU development faster then CPUs in last 3 years
  - Different programming model - only special task can run on GPU

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For further information, please visit INPHO‘s demo in room E and F