

# 2005 3D Laser Scanner Hardware Survey

MANUFACTURER	3rdTech	3rdTech	I-SITE Pty Ltd	iQvolution	Leica Geosystems HDS	Leica Geosystems HDS	Measurement Devices Limited	Optech
PRODUCT	DeltaSphere-3000	DeltaSphere-3000R	I-SITE 4400	iQsun 880	HDS3000	HDS4500 [62]	LaserAce Scanner	ILRIS-36D
<b>PERFORMANCE</b>								
Laser Wavelength (in nm)	670	780	905	785	532	690 mW	905	1500
Laser Power (in W, mW)	5 mW	8 mW	<10 mW	10 mW, 22 mW opt.	0.5 mW	14 mW - 23 mW		N/A
FDA Laser Classification (Class)	IIla	IIlb	3R	3R/3A	3R	3R	1M	Class 1
Beam Diameter at Specified Distance (0.Y ft at X ft/Ymm at X m)	[1]	[1]	600 mm at 300 m	[12]	6 mm at 50 m	8.5 mm at 25 m	300 mm at 100 m	27 mm at 100 m
Measurement Technique	Modulated beam, TOF	Modulated beam, TOF	TOF	Phase difference measurement	Pulsed laser; TOF	Phase shift	TOF	TOF
Average Data Acquisition Rate (pps)	15,466	15,466	4,400	120,000	1,400	180,000	250	2,000
Maximum Data Acquisition Rate (pps)	24,000	24,000	4,400	120,000	Up to 1,800	Up to 500,000	250	2,000
Distance Accuracy at Specified Distance (0.Y ft at X ft/Ymm at X m)	0.3 in at 40 ft	0.3 in at 54 ft	50 mm at 400 m	0.01 ft at 33 ft / 3 mm at 10 m	4 mm at 50 m	>3 mm at 25 m	10 cm at 600 m	7 mm at 100 m
Position Accuracy at Specified Distance (0.Y ft at X ft/Ymm at X m)	0.35 in at 40 ft	0.35 in at 40 ft	±35 mm at 100 m	0.012 ft at 33 ft / 3.5 mm at 10 m	6 mm at 50 m	>6 mm at 10 m	20 cm at 600 m	10 mm at 100 m
Angular Accuracy (degrees-min-sec)	0.015	0.015	0.02	0.007	.0034 (60 micro radians)	350 micro radians	0.02	0.003437747
Accuracy Certification Standard	Factory certified	Factory certified	Factory certified	Proprietary	ISO and NIST		ISO 9001:2000	Consult Optech
Minimum Range (feet/m)	1 ft	1 ft	2 m	0.66 ft / 0.2 m	<1 m	0.1 m	5 m	2 m
Maximum Range (feet/m)	40 ft [2]	54 ft [2]	400 m	250 ft / 76 m	100 m at 5% Albedo	25 m	700 m	1500 m at 80%
Field of View (vertical angle) (degrees-min-sec)	290°	290°	80°	320°	270°	310°	135° (-45 to 90)	360°
Field of View (horizontal angle) (degrees-min-sec)	360°	360°	360°	360°	360°	360°	360°	360°
Minimum Vertical Scan Increment (degrees-min-sec)	0.05	0.075	0.10	0.0011			0.01 degrees	0.0015
Minimum Horizontal Scan Increment (degrees-min-sec)	0.05	0.075	0.10	0.00076			0.01 degrees	0.0015
Surface Reflectivity Range (%)	5 - 99%	5 - 99%	5 - 95%	5 - 95%	[23]	[23]	0.1 - 100%	Consult Optech
On Board Camera (for aiming? Or for creating photomosaic? Etc.?)	Yes [3]	Yes [3]	[17]	Yes, optional	Yes	No	No	Yes, 6.6 Megapixel
Is hardware interoperable with optical total stations and GPS? If yes, how?	Yes [4]	Yes [4]	[18]	Georeferencing	Yes [24]	Yes [24]	Yes [32]	Yes
Is scanner effective when used to scan topography? (Y/N)	No	No	Yes	Yes	Yes	Yes, up to 15 m	Yes	Yes
Is software technology for processing data from scanner manufacturer?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Is hardware designed to enable "stitching" of scans that must be observed from different stations? (Y/N)	Yes	Yes	[19]	Yes	Yes	Yes	Yes	Yes

<b>ENVIRONMENTAL</b>								
Storage Temperature Range (degrees F/C)	32 to 113°F	32 to 113°F	-20 to 50°C	14 to 160°F	65 to -25°C	65 to -25°C	-20 to 45°C	-20 to 50°C
Operating Temperature Range (degrees F/C)	32 to 113°F	32 to 113°F	-10 to 50°C	32 to 113°F	40 to 0°C	40 to 0°C	-10 to 45°C	0 to 40°C [33]
Humidity (%)	Non-condensing	Non-condensing	<95% Non-condensing	Non-condensing	Non-condensing	Non-condensing	Non-condensing	No impact
Ambient Light	[5]	[5]	Any	[13]	Any light conditions	Any light conditions	Unaffected	No impact

<b>GENERAL</b>								
Scanner Dimensions (LxWxH) (inches/cm)	14 x 14 x 4 in	14 x 14 x 4 in	43 x 25 x 36 cm (incl battery)	15.75 x 6.3 x 9.85 in / 40 x 16 x 25 cm	370 x 265 x 510 mm	300 x 180 x 350 mm	41 x 22 x 18 cm	32 x 32 x 22 cm
Scanner Weight (pounds/kg)	22 lbs	22 lbs	14 kg (incl battery)	30 lbs / 16 kg	16 kg	13 kg	8.1 kg	13 kg
Is scanner recommended for mounting on standard survey tripod? If no, what is recommended stand?	Yes [6]	Yes [6]	Yes	Yes	Yes	[30]	Yes	Yes
Power Supply Dimensions (LxWxH) (inches/cm)	5.75 x 3 x 1.75 in	5.75 x 3 x 1.75 in	Internal battery	5.9 x 2.75 x 1.4 in / 15 x 7 x 3.5 cm	236 x 165 x 215 mm	260 x 240 x 300 mm	16 x 12 x 8 cm	
Power Supply Weight (pounds/kg)	1.25 lbs	1.25 lbs	1 kg	1.3 lbs / 0.6 kg	12 kg	16 kg	2 kg	2.5 kg
AC Power Requirements (volts/watts)	100-240 V (40-65 W)	100-240 V (40-65 W)	N/A	100-240 V (100 W)		90-260 V (50-70 W)		24 VDC (75 W)
DC Power Requirements (volts/watts)	12 V (40-65 W)	12 V (40-65 W)	24 V DC	24 V (60 W)	[25]	24 V DC	12 V DC	24 VDC (75 W)
Batteries	Standard 12 V	Standard 12 V	NIMH rechargeable 24V	Standard 24 V	12V input [26]	[26]	12 V external	[34]
Battery Life (hours)	4 - 8	4 - 8	6	6-8	3 hours each	6 hours each	6	[35]
Computer Requirements (Control)	[7]	[7]	[20]	[14]	[27]	[31]	None	PDA, ethernet, wireless lan
Computer Requirements (data processing)	[8]	[8]	[21]	1 GB memory recommended	[28]	[28]	PC/laptop	PIII 500
Number of pieces of equipment/cases (complete system) when field-ready	[9]	[9]	1	1	5	4	2	1
Weight of complete field-ready system, in cases as described above (lbs/kg)	48 lbs [10]	48 lbs [10]	29 kg	60 lbs / 27.5 kg [15]	50 kg	35 kg	25 kg	40 lbs
Warranty	12 months	12 months	12 months	12 months (parts & labor)	12 months	12 months	12 months	12 months
Optional Accessories	[11]	[11]	[22]	[16]	[29]		Red dot pointing laser	Consult Optech
<b>READER SERVICE NUMBER</b>	1	2	3	4	5	6	7	8

N/A=Not Applicable Numbers in brackets refer to notes (see page 77).

# 2005 3D Laser Scanner Hardware Survey

MANUFACTURER	Riegl USA	Riegl USA	Riegl USA	Riegl USA	Trimble	Trimble	Visi Image	Zoller+Fröhlich GmbH (Z+F)
PRODUCT	LPM 800 HA	LMS Z210i	LMS Z360	LMS Z420	Trimble GS101	Trimble GS200	3Dguru	IMAGER 5003-53500
<b>PERFORMANCE</b>								
Laser Wavelength (in nm)	904	904	904	1550	532	532	650	780
Laser Power (in W, mW)	1 mW	1 mW	1 mW	1 mW	<1 mW	<1 mW	8 mW	32 mW
FDA Laser Classification (Class)	1	1	1	1	2 [36]	2 [36]	3R	3R [51]
Beam Diameter at Specified Distance (0.Y ft at X ft/Ymm at X m)	50 mm at 50 m	50 mm at 50 m	20 mm at 50 m	10 mm at 50 m	3 mm at 50 m	3 mm at 50 m	3 mm at 24 m	0.14 at 3.3 (3.5 mm at 1 m)
Measurement Technique	LiDAR	LiDAR	LiDAR	LiDAR	TOF	TOF	AMCW	Phase shift
Average Data Acquisition Rate (pps)	1,000	8,000	8,000	8,000	Dependent on scan conditions	Dependent on scan conditions	210,000	125,000
Maximum Data Acquisition Rate (pps)	2,000	12,000	12,000	10,000	5,000	5,000	210,000	500,000
Distance Accuracy at Specified Distance (0.Y ft at X ft/Ymm at X m)	15 mm at 800 m	15 mm at 400 m	6 mm at 200 m	5 mm at 800 m	7-8 mm at 100 m	7-8 mm at 100 m	1.8 mm at 36.5 m	< 0.2 in (1.3-175.5 ft) / < 5 mm (0.4-53.5 m)
Position Accuracy at Specified Distance (0.Y ft at X ft/Ymm at X m)	6.3 mm at 20 m	6 mm at 100 m	6 mm at 100 m	6 mm at 100 m	15 mm at 100 m	15 mm at 100 m	1.03 mm at 15 m	0.55 at 175.5 (14 mm at 53.5 m)
Angular Accuracy (degrees-min-sec)	0.01	0.005	0.002	0.002	±0.003	±0.003		±0.01
Accuracy Certification Standard	NIST Traceable	NIST Traceable	NIST Traceable	NIST Traceable	Trimble Test protocol	Trimble Test protocol		[52]
Minimum Range (feet/m)	10 m	4 m	1 m	2 m	1 m	1 m	.38 m	1.3 (0.4 m)
Maximum Range (feet/m)	1000 m	500 m	300 m	1000 m	Up to 200 m [37]	Up to 350 m [37]	36.5 m	175.5 (53.5 m)
Field of View (vertical angle) (degrees-min-sec)	160°	80°	90°	80°	60°	60°	260°	310°
Field of View (horizontal angle) (degrees-min-sec)	360°	360°	360°	360°	360°	360°	360°	360°
Minimum Vertical Scan Increment (degrees-min-sec)	0.01	0.005	0.002	0.002	0.0018	0.0018		0.018
Minimum Horizontal Scan Increment (degrees-min-sec)	0.01	0.005	0.002	0.002	0.0018	0.0018		0.01
Surface Reflectivity Range (%)	5 - 100%	5 - 100%	5 - 100%	5 - 100%	Albedo 2 - 99% [38]	Albedo 2 - 99% [38]	5 - 100% diffuse reflectivity	5 - 99%
On Board Camera (for aiming? Or for creating photomosaic? Etc.?)	6 Megapixel	6 Megapixel	6 Megapixel	6 Megapixel	Yes [39]	Yes [39]	No	No
Is hardware interoperable with optical total stations and GPS? If yes, how?	Yes	Yes	Yes	Yes	Yes [40]	Yes [40]	No	Yes [53]
Is scanner effective when used to scan topography? (Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	[54]
Is software technology for processing data from scanner manufacturer?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Is hardware designed to enable "stitching" of scans that must be observed from different stations? (Y/N)	Yes	Yes	Yes	Yes	Yes, fully automatic	Yes, fully automatic	No	Yes

<b>ENVIRONMENTAL</b>								
Storage Temperature Range (degrees F/C)	-20 to 70°	-20 to 60°	-20 to 60°	-10 to 50°	-20 to 50°C	-20 to 50°C	-25 to 85°C	32 to 158°F (0 to 70°C)
Operating Temperature Range (degrees F/C)	0 to 50°	-10 to 50°	-10 to 50°	0 to 40°	0 to 40°C	0 to 40°C	0 to 50°C	32 to 104°F (0 to 40°C)
Humidity (%)	Non-condensing	Non-condensing	Non-condensing	Non-condensing	Non-condensing	Non-condensing	[43]	Non-condensing
Ambient Light	Not affected	Not affected	Not affected	Not affected	No influence	No influence	[44]	[55]

<b>GENERAL</b>								
Scanner Dimensions (LxWxH) (inches/cm)	28 x 30 x 32	44 x 21	49 x 21	47 x 21	34 x 27 x 42 cm	34 x 27 x 42 cm	19 x 8 x 7 in / 19 x 16 x 49 cm	11.9 x 13.8 x 7.1 in / 30 x 35 x 18 cm
Scanner Weight (pounds/kg)	15	13	13	15	13.6 kg	13.6 kg	15 lbs / 7.7 kg	28.7 lbs / 13 kg
Is scanner recommended for mounting on standard survey tripod? If no, what is recommended stand?	Yes	Tripod or vehicle	Tripod or vehicle	Tripod or vehicle	Yes	Yes	Yes	Yes
Power Supply Dimensions (LxWxH) (inches/cm)	12 x 11 x 8	12 x 11 x 8	12 x 11 x 8	12 x 11 x 8	10.5 x 20 x 6.5 cm	10.5 x 20 x 6.5 cm	[45]	[56]
Power Supply Weight (pounds/kg)	19	19	19	19	1.5 kg	1.5 kg	16 lbs / 7.25 kg	[57]
AC Power Requirements (volts/watts)	No	No	No	No	90-240 VAC, 50-60 Hz	90-240 VAC, 50-60 Hz	80-265 VAC	120 V/230 V (80 W)
DC Power Requirements (volts/watts)	12-28 VDC	12-28 VDC	12-28 VDC	12-28 VDC	24 V, nominal	24 V, nominal	18 V DC	24 V (80 W)
Batteries	Marine battery	Marine battery	Marine battery	Marine battery	Standard or premium available	Standard or premium available	Li-ion gellpack [46]	Sealed lead acid battery
Battery Life (hours)	14	14	14	14	3	3	8-10	8
Computer Requirements (Control)	1024 MB RAM	1024 MB RAM	1024 MB RAM	1024 MB RAM	[41]	[41]	[47]	[58]
Computer Requirements (data processing)	1024 MB RAM	1024 MB RAM	1024 MB RAM	1024 MB RAM	[42]	[42]	1G RAM; 2G CPU	IEEE 1394-interface (FireWire)
Number of pieces of equipment/cases (complete system) when field-ready	2	2	2	2	2	2	3 [48]	[59]
Weight of complete field-ready system, in cases as described above (lbs/kg)	70 lbs	70 lbs	70 lbs	70 lbs	37 kg	37 kg	45 lbs / 99 kg	[60]
Warranty	12 months	12 months	12 months	12 months	12 months	12 months	[49]	Limited 12 months
Optional Accessories	Yes	Yes	Yes	Yes	Yes	Yes	[50]	[61]
READER SERVICE NUMBER	9	10	11	12	13	14	15	16

N/A=Not Applicable Numbers in brackets refer to notes (see page 77).

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MANUFACTURER/DISTRIBUTOR	3rd Tech	BitWise Solutions Inc.	InnovMetric Software	iQvolution	iQvolution	I-SITE Pty Ltd
NAME/FUNCTIONALITY OF MODULES OR COMPONENTS OF SUITE	SceneVision-3D	Existing Conditions Suite	PolyWorks	iQscene	iQscout point cloud viewer	I-SITE Studio2.4
Price (list by modules or components)	[1]	Varies	On demand	\$11,499	\$1,250	Consult I-SITE
Laser scanner brands and models from which data can be imported directly	[2]	[6]	[10]	[15]	[15]	All
Operating systems supported (if one is preferred, please state)	Win 2000/XP	Windows	Win XP/2000/NT	Win XP/NT	Win XP/NT	Win 2000/XP
Minimum CPU requirement	Pentium 4	600	2 GH	Pentium, 1GHz	Pentium, 1GHz	[17]
Minimum RAM required	512 MB (1GB recommended)	125	512 MB (2GB recommended)	1GB	768 MB	512 MB
Space required on hard disk to properly run application, including swap space, etc. (list in Mb)	50 MB (512 MB swap)	Depends on project	3000 MB	25	25	[18]
Other hardware requirements	3D graphics card recommended		[11]			[19]

FEATURE	3rd Tech	BitWise Solutions Inc.	InnovMetric Software	iQvolution	iQvolution	I-SITE Pty Ltd
<b>CLOUD EDITING/ANALYSIS</b>						
Can features be defined with user-created code libraries?	No	Yes	Yes	Yes	Yes	Yes
Feature codes exportable to CAD software? (specify which software )	Triangle mesh, lines	AutoCAD, MicroStation	MicroStation, AutoCAD	Microstation, AutoCAD	No	Yes, txt, DGD, DXF
Can user compare cloud or shapes fitted to clouds to "plan," or perform theoretical shape and interference checking? (State which, "all" or "none.")	None	Yes	All	Yes	No	Yes
Ability to make measurements such as distances, angles, areas, volumes, of lines, planes, shapes and other surfaces from cloud? (State which, "all" or "none.")	[3]	All	All	Yes	Yes	Yes, all
Can user overlay or drape photograph on cloud or elements extracted from cloud?	Yes	Yes	No	Yes	No	Yes
Ability to match common points from different scans and create merged ("stitched") cloud?	Yes	Yes	Yes	Yes	No	Yes
Ability to place several clouds from different scans in coordinated 3D space using total station or GPS survey data that has been used to determine positions of scanner and alignment of scans?	No	Yes	Yes	Yes	Yes	Yes
Analyze points in a cloud representing shapes such as planes, cylinders and spheres to detect measurement outliers?	Planes only	Yes	Yes	Yes	Yes	Yes
Ability to integrate scans with floor plans, engineering drawings of objects and surveyed information? (State which, "all" or "none.")	None	Yes	[12]	Yes	Yes	Yes, all
Automate decimation of points in selectable areas to make data files as compact as possible?	Some	[7]	Yes	Yes	Yes	Yes
Is fitting of lines, planes and shapes to cloud done manually or automatically, or both?	Automatic plane fitting	Both	Both	Both		Yes, both
- For automatic and manual fitting, what techniques are used or available (e.g. least squares, taking average, etc.)?	Least squares	Least squares	[13]	Mixed		Least squares
Ability to automatically track lines or limits of areas by color or texture discrimination?	No	Yes	Yes	Yes	No	Yes
Ability to automatically calculate and list alignment of center line of shapes (such as a pipe) containing straight and curved segments such as elbows?	No	Yes	Yes	Yes	No	No

FEATURE	3rd Tech	BitWise Solutions Inc.	InnovMetric Software	iQvolution	iQvolution	I-SITE Pty Ltd
<b>RENDERING/CAD MODEL GENERATION/VIEWING</b>						
Does software automatically or manually generate or create CAD models or model segments from point clouds and other known information? (Specify level of automation and intelligence.)	[4]	Yes [8]	FA, SA & INT methods	Yes	No	Yes [20]
Perform automatic generation of CAD models from point clouds?	[4]	No	FA, SA & INT methods	Yes	No	Yes
Automatically compute, without user interaction, a full 3D polygonal mesh (not view-based) from a point cloud?	Yes	[9]	Yes	Yes	Yes	Yes
Perform contour generation?	No	Yes	Yes	No	No	Yes
Perform volume calculation capabilities?	No	Yes	Yes	Yes	No	Yes [21]
Perform solid modeling (volume generation) based on user-defined lines, planes and other surfaces as bounds?	No	No	No	Yes	No	Yes
Perform profile and cross-section generation along any cutting plane or family of planes?	Yes	Yes	Yes	Yes	Yes	Yes
Have edge detection technology to determine boundaries of solids, planes and other shapes?	No	Yes	Yes	No	No	Yes
Perform automatic extraction of standard shapes from cloud (e.g. pipe fittings, structural steel members, etc.)?	No	Yes	Pipe center lines	Yes	Yes	No
Can user view cloud or generated shapes or models from any viewpoint in 3D?	Yes	Yes	Yes	Yes	Yes	Yes
Are fly-throughs or walk-throughs supported?	Yes	Yes	Yes (video generation)	Yes	Yes	Yes
Have intelligent display of detail depending on scale of the view?	No	Yes	No	Yes	Yes	Not required
Can user select transparent/opaque surface for cloud and CAD shapes?	Yes	Yes	Yes	Yes	Yes	Yes
Can software display scanner's color detection capabilities?	Yes	Yes	Yes	Yes		Yes
Which export formats are supported?	RTP1, ASCII XYZ, VRML, PIF	All industry standard formats	[14]	[16]		[22]

FEATURE	3rd Tech	BitWise Solutions Inc.	InnovMetric Software	iQvolution	iQvolution	I-SITE Pty Ltd
<b>MISCELLANEOUS</b>						
Provide high-speed thumbnail views of scans, clouds, photographic images and generated shapes?	No	Yes	No	Yes	Yes	Yes
Can client/server system support multiple users?	No	Yes	No	Yes (iQworks)	No	Yes
Is client/server system supported to enable several clients contributing to a single project?	No	Yes	No	Yes (iQworks)	No	No
<b>OTHER FEATURES</b>						
Describe	[5]					[23]
<b>READER SERVICE NUMBER</b>	17	18	19	20	21	22

N/A=Not Applicable Numbers in brackets refer to notes (see page 77).

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MANUFACTURER/DISTRIBUTOR	Kubit GmbH	Leica Geosystems HDS	Leica Geosystems HDS	Optech Inc.	RiegI USA	RiegI USA
<b>NAME/FUNCTIONALITY OF MODULES OR COMPONENTS OF SUITE</b>	<b>PointCloud</b>	<b>Cyclone [24]</b>	<b>CloudWorx (Pro, Basic)</b>	<b>PolyWorks [40]</b>	<b>Phidias</b>	<b>RiScan Pro</b>
Price (list by modules or components)	\$1,000-\$1,700	[25]	[35]	Consult Optech	\$15,000	N/C
Laser scanner brands and models from which data can be imported directly	All [52]	[26]	Cyclone IMP file [26]	Many, consult Optech	All	RiegI
Operating systems supported (if one is preferred, please state)	AutoCAD/AutoCAD LT [53]	Win 2000/XP	Win 2000/XP	Win 2000/XP	Microsoft	Microsoft
Minimum CPU requirement	Like AutoCAD	Pentium 4.2 GH	Pentium 4.2 GH	PIII 1.5 GH		
Minimum RAM required	Like AutoCAD	512 MB	512 MB	500 MB	1024 MB	1024 MB
Space required on hard disk to properly run application, including swap space, etc. (list in Mb)	Like AutoCAD	[27]	[27]	Consult Optech	5 GB	5 GB
Other hardware requirements	Like AutoCAD	[28]	[36]	[41]		

LOUD EDITING/ANALYSIS						
Can features be defined with user-created code libraries?	Yes [54]	Yes	Yes [37]	SA	Yes	No
Feature codes exportable to CAD software? (specify which software )	N/A (already in CAD)	Yes [29]	No, runs on CAD	SA	Microstation	No
Can user compare cloud or shapes fitted to clouds to "plan," or perform theoretical shape and interference checking? (State which, "all" or "none.")	Yes	Yes, all	Yes, all	All	Yes	Yes
Ability to make measurements such as distances, angles, areas, volumes, of lines, planes, shapes and other surfaces from cloud? (State which, "all" or "none.")	Yes [55]	Yes, all	Yes [37]	All	All	Yes
Can user overlay or drape photograph on cloud or elements extracted from cloud?	No	Yes [30]	Yes [30]	Yes	Yes	Yes
Ability to match common points from different scans and create merged ("stitched") cloud?	Yes	Yes	No	Yes, SA	No	Yes
Ability to place several clouds from different scans in coordinated 3D space using total station or GPS survey data that has been used to determine positions of scanner and alignment of scans?	Yes	Yes	No	Yes, SA	No	Yes
Analyze points in a cloud representing shapes such as planes, cylinders and spheres to detect measurement outliers?	No	Yes	Yes (planes, cylinders)	Yes	Yes	Yes
Ability to integrate scans with floor plans, engineering drawings of objects and surveyed information? (State which, "all" or "none.")	Yes	Yes, all	Yes, all	All	All	No
Automate decimation of points in selectable areas to make data files as compact as possible?	No	Yes	No	Yes, FA	Yes	Yes
Is fitting of lines, planes and shapes to cloud done manually or automatically, or both?	Both	Yes, both	Yes, both	FA	Both	Manually
- For automatic and manual fitting, what techniques are used or available (e.g. least squares, taking average, etc.)?	Least squares	Yes, least squares	Yes, least squares	Least squares	Multiple	Multiple
Ability to automatically track lines or limits of areas by color or texture discrimination?	No	Yes, segment by intensity	No	Yes	Yes	Yes
Ability to automatically calculate and list alignment of center line of shapes (such as a pipe) containing straight and curved segments such as elbows?	No	Yes, calculate	No	Yes	Yes	No

RENDERING/CAD MODEL GENERATION/VIEWING						
Does software automatically or manually generate or create CAD models or model segments from point clouds and other known information? (Specify level of automation and intelligence.)	SA	Yes [31]	Yes [38]	Yes, SA	Yes	No
Perform automatic generation of CAD models from point clouds?	SA	Yes, Automatic Region Grow	Yes, Automatic Region Grow	Yes	Yes	No
Automatically compute, without user interaction, a full 3D polygonal mesh (not view-based) from a point cloud?	No	No	No	Yes	Yes	Yes
Perform contour generation?	No	Yes	No	Yes	Yes	No
Perform volume calculation capabilities?	No	Yes	No	Yes	Yes	Yes
Perform solid modeling (volume generation) based on user-defined lines, planes and other surfaces as bounds?	Yes	No	No	Yes	Yes	No
Perform profile and cross-section generation along any cutting plane or family of planes?	No	Yes	No	Yes	Yes	No
Have edge detection technology to determine boundaries of solids, planes and other shapes?	Yes	Yes	No	Yes	Yes	No
Perform automatic extraction of standard shapes from cloud (e.g. pipe fittings, structural steel members, etc.)?	Yes	Yes [32]	Yes [39]	Yes	Yes	No
Can user view cloud or generated shapes or models from any view-point in 3D?	Yes	Yes	Yes	Yes	Yes	Yes
Are fly-throughs or walk-throughs supported?	Yes	Yes	Yes	Yes	Yes	Yes
Have intelligent display of detail depending on scale of the view?	Yes	Yes	Yes	Yes	Yes	Yes
Can user select transparent/opaque surface for cloud and CAD shapes?	No	Yes	No	Yes	Yes	No
Can software display scanner's color detection capabilities?	Yes	Yes	Yes	Yes	Yes	Yes
Which export formats are supported?	Like AutoCAD	[33]	Runs on CAD	Many, consult Optech	Multiple	Multiple

MISCELLANEOUS						
Provide high-speed thumbnail views of scans, clouds, photographic images and generated shapes?	No	No	No	Yes	Yes	Yes
Can client/server system support multiple users?	Yes	Yes	Yes	Yes	No	Yes
Is client/server system supported to enable several clients contributing to a single project?	Yes	Yes	Yes	Yes	No	No
<b>OTHER FEATURES</b>						
Describe	[56]	[34]	[34]			
<b>READER SERVICE NUMBER</b>	23	24	25	26	27	28

N/A=Not Applicable Numbers in brackets refer to notes (see page 77).

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MANUFACTURER/DISTRIBUTOR	Trimble	Trimble	Visi Image	Z+F	Z+F	Z+F
NAME/FUNCTIONALITY OF MODULES OR COMPONENTS OF SUITE	Mensi RealWorks Survey	Mensi 3Dipos	SEL [46]	LFM Modeller	LFM Server	LFM Viewer
Price (list by modules or components)	Consult Trimble	Consult Trimble	All inclusive	\$12,000	\$5,000	\$3,000
Laser scanner brands and models from which data can be imported directly	All	All	3Dguru	Z+F, Cyra	Z+F, Cyra	Z+F, Cyra
Operating systems supported (if one is preferred, please state)	Win 2000Pro/NT4/XP	Win 2000Pro/NT4/XP	Win XP	Windows, Linux	Windows, Linux	Windows, Linux
Minimum CPU requirement	1.2 GH	1.2 GH	1 G, 2 G preferred	1 GH	1 GH	1 GH
Minimum RAM required	512 MB	512 MB	1 G	512 MB		
Space required on hard disk to properly run application, including swap space, etc. (list in Mb)	25 (35 w/ samples)	25	20 G [47]	20 MB		
Other hardware requirements			None	[49]	[49]	[49]

LOUD EDITING/ANALYSIS						
Can features be defined with user-created code libraries?	Yes	N/A	No	No	No	No
Feature codes exportable to CAD software? (specify which software )	AutoCAD, Microstation	N/A	No	No	No	No
Can user compare cloud or shapes fitted to clouds to "plan," or perform theoretical shape and interference checking? (State which, "all" or "none.")	Yes, all	Yes, all	No	All	All	All
Ability to make measurements such as distances, angles, areas, volumes, of lines, planes, shapes and other surfaces from cloud? (State which, "all" or "none.")	Yes, all	Yes, all	No	All	All	All
Can user overlay or drape photograph on cloud or elements extracted from cloud?	Yes	Yes	No	No	No	No
Ability to match common points from different scans and create merged ("stitched") cloud?	Yes	Yes	No	Yes	Yes	Yes
Ability to place several clouds from different scans in coordinated 3D space using total station or GPS survey data that has been used to determine positions of scanner and alignment of scans?	Yes	Yes	No	Yes	Yes	Yes
Analyze points in a cloud representing shapes such as planes, cylinders and spheres to detect measurement outliers?	No	Yes	No	Yes	No	No
Ability to integrate scans with floor plans, engineering drawings of objects and surveyed information? (State which, "all" or "none.")	Yes, all	Yes, all	No	All	All	None
Automate decimation of points in selectable areas to make data files as compact as possible?	Yes, FA	Yes, FA	Yes	Yes	Yes	Yes
Is fitting of lines, planes and shapes to cloud done manually or automatically, or both?	Both	Both	N/A	Both	Both	Both
- For automatic and manual fitting, what techniques are used or available (e.g. least squares, taking average, etc.)?	Least squares, auto-tracking	Least squares, auto-tracking	N/A	Least squares	Least squares	Least squares
Ability to automatically track lines or limits of areas by color or texture discrimination?	Yes	No	N/A	No	N/A	N/A
Ability to automatically calculate and list alignment of center line of shapes (such as a pipe) containing straight and curved segments such as elbows?	No	Yes, FA	N/A	Yes	N/A	N/A

RENDERING/CAD MODEL GENERATION/VIEWING						
Does software automatically or manually generate or create CAD models or model segments from point clouds and other known information? (Specify level of automation and intelligence.)	No	Yes (FA, SA, INT)	No	SA	No	No
Perform automatic generation of CAD models from point clouds?	No	Yes	No	SA	No	No
Automatically compute, without user interaction, a full 3D polygonal mesh (not view-based) from a point cloud?	Yes, FA	Yes, FA	No	FA	No	No
Perform contour generation?	Yes, FA	N/A	No	Yes	Yes	Yes
Perform volume calculation capabilities?	Yes, FA	N/A	No	Yes	No	No
Perform solid modeling (volume generation) based on user-defined lines, planes and other surfaces as bounds?	N/A	N/A	No	Yes	No	No
Perform profile and cross-section generation along any cutting plane or family of planes?	Yes, FA	N/A	No	Yes	Yes	Yes
Have edge detection technology to determine boundaries of solids, planes and other shapes?	Yes, FA	No	Yes	Yes	No	No
Perform automatic extraction of standard shapes from cloud (e.g. pipe fittings, structural steel members, etc.)?	No	Yes, FA	No	SA	No	No
Can user view cloud or generated shapes or models from any viewpoint in 3D?	Yes	Yes	Yes	Yes	Yes	Yes
Are fly-throughs or walk-throughs supported?	Yes	No	No	Yes	Yes	Yes
Have intelligent display of detail depending on scale of the view?	Yes	Yes	Yes	Yes	Yes	Yes
Can user select transparent/opaque surface for cloud and CAD shapes?	No	No	No	Yes	Yes	Yes
Can software display scanner's color detection capabilities?	Yes	Yes	No	N/A	N/A	N/A
Which export formats are supported?	[42]	[44]	[48]	[50]	AutoCAD, Microstation	ZFC

MISCELLANEOUS						
Provide high-speed thumbnail views of scans, clouds, photographic images and generated shapes?	Yes	Yes	Yes (.bmp)	No	No	No
Can client/server system support multiple users?	N/A	Yes	Yes	Yes	Yes	Yes
Is client/server system supported to enable several clients contributing to a single project?	N/A	Yes	Yes	Yes	Yes	Yes
<b>OTHER FEATURES</b>						
Describe	[43]	[45]			[51]	
<b>READER SERVICE NUMBER</b>	29	30	31	32	33	34

N/A=Not Applicable Numbers in brackets refer to notes (see page 77).

# 2005 3D Laser Scanner Survey Notes

**POB does not assume responsibility for any errors or omissions that may be contained within the survey.**

## HARDWARE

1. 0.1 in at 0 ft, 0.28 in at 30 ft.
2. Longer for reflective surfaces.
3. Optional; for creating full color, texture-mapped, computer graphics models.
4. Compatible; aligned with tribrach mount.
5. Interior lighting or shade to total darkness. Direct sunlight reduces the range.
6. Or photographic tripod.
7. Standard PC/laptop, Windows 2000/XP, Ethernet, IEEE 1394 (Firewire) for color option.
8. Standard PC/laptop, Windows 2000/XP, 512mb memory, 3D graphics card for display performance, 3-button mouse.
9. One airline-checkable, ruggedized case (supplied) for scanner and power supply. Laptop, tripod, color camera option, battery are separate.
10. Instrument and power supply in case.
11. Calibrated professional digital camera, mount and software.
12. 0.01 ft at exit/3 mm at exit, circular.
13. Clouded sky does not harm, but full sun on target object will disturb measurement.
14. No PC required (internal hard disk).
15. Depending on case.
16. Traveling case, additional hard drives, custom spheres.
17. Yes, integrated 67 mega pixel panoramic digital camera for set up & high resolution texture mapping.
18. Yes, field setup & software integration to use GPS & total station. Attachment for GPS antenna.
19. Yes, by utilizing on-board tilt compensator & motorized survey telescope. Direct link of scan data to survey control via HHC.
20. Touch screen Tablet Data Recorder & I-SITE HHC Software.
21. Min. PIV, 1.2 GHz, 512 Mb RAM, 128 Mb Graphics, Win XP, NT, W2K.
22. GPS attachment, extra batteries (2 incl).
23. Surface diffuse reflectivity 1 - 100%.
24. Via direct read of ASCII coordinates.
25. 12 V input, less than 80 W average power consumption.
26. 2 SLA batteries with system.
27. 1.4 GHz Pentium M or similar, 512MB SDRAM, Ethernet Card, SXGA+, Windows XP (Pro or Home Edition), Windows 2000.
28. 2.0 GHz Pentium 4, 512 MB SDRAM, Ethernet Card, SXGA+, Windows XP (Pro or Home Edition), Windows 2000.
29. HDS3000 scan targets and target accessories, Service Agreement for HDS3000.
30. Scanner can be mounted on standard surveying tripod or onto scanner stand.
31. 1.7 GHz Pentium M or similar, 1024 MB SDRAM, Ethernet Card, FireWire, SXGA+, Windows XP (Pro or Home Edition), Windows 2000.
32. Standard survey control observations can be made in conjunction with scans by a simple coding system.
33. Extended ranges available.
34. Wide variety available, consult Optech Incorporated.
35. Minimum 5 hours/hot swappable, continuous operation.
36. US standard 21 CFR \$1041.10.
37. Maximum range using OverScan capability.
38. (depending on distance).
39. Real time for RGB scanning and Photomosaic.
40. Top adaptor feature or GPS, targets.
41. Recon, PocketPC or NotebookPC.
42. Recommended configuration: Pentium P4, 2.0 GHz, 1 GB RAM, 128 MB Video RAM, Windows 2000pro or Windows XP.
43. Operable in high humidity conditions (non-condensing).

44. Operable in conditions with high levels of ambient light.
45. Integrated transport case 21 x 13 x 8 in.
46. Integrated into transport case.
47. Windows XP; DirectX 9.0b; Microsoft .NET Framework 1.1 or later.
48. Scanner, tripod, transport case/battery pack.
49. One year full coverage on hardware with software upgrades (optional extension).
50. Additional tripods, mounting brackets, pipe clamps, targets.
51. (d>6.6ft/2m) DIN EN 60825-1.
52. Factory certified to EU standards.
53. Z+F scans are tied to a control survey.
54. Conventional instrumentation: yes; GPS: no.
55. All conditions from darkness to daylight.
56. AC: 5.1 x 7.5 x 6.3 in (13 x 19 x 16 cm) / DC: 12.6 x 9.4 x 10.2 in (32 x 24 x 26 cm).
57. AC: 2.2 (1 kg) / DC: 35.3 (16 kg).
58. 1.2 GHz, 512 MB RAM (Win2000, XP).
59. Scanner (including base), laptop, tripod, battery.
60. 35.3 / 8.8 / 19.8 / 35.3 (16 kg / 4 kg / 9 kg / 16 kg).
61. Dolly, tripod, laptop tray for tripod.
62. 25 m ambiguity Range Model.

## SOFTWARE

- A. For questions pertaining to automation and to allow richer descriptions of features, applicable questions should/may be answered with FA (Fully Automatic); SA (Semi-automatic); INT (Interactive), or "Yes," "No" and "None."
  - B. Fully automatic: User may specify some parameters and/or interact with the 3D data for a short time, such as clicking on three points to begin process of best-fitting points to a plane, press 'Start,' and everything is computed without any additional user-intervention.
  - C. Semi-automatic: Some significant portion of the operation is done automatically, but user needs to interact with the 3D data for more than a short time, such as confirming each individual segment or element of step.
  - D. Interactive: Done manually, applying CAD techniques and mathematical functions.
1. Included with system; contact 3rdTech for separate pricing.
  2. 3rdTech, Polhemus, iQvolution.
  3. Distances between points, lines, planes; angles between lines and planes.
  4. Automatic VRML models from point clouds.
  5. Create full-color, texture-mapped, CG models. Measure between aligned scan windows. Create hi-res, photorealistic close-ups. Intersect planes and lines.
  6. 3rd Tech, Leica HDS 2500 & HDS 3000 - PTX & PTS Only, Leica HDS4500 Direct, Optech, Quantapoint, iQvolution, Riegl, Trimble, Mensi, Visi Image, Z+F, Callidus.
  7. When needed yes, but Bitwise technology allows the user to manage the un-decimated data in the CAD environment.
  8. Models that can be referenced into the CAD environment.
  9. Does not use polygonal meshes, but does create a full 3d model of the points.
  10. Optech, Riegl, Callidus, Cyrax, Mensi, Z&F, iQvolution and several others.
  11. Open GL graphics accelerator, 3-button mouse.
  12. Engineering drawings & surveyed information.
  13. Least squares, minimum circumscribed, maximum circumscribing, orientation-constrained, position-constrained.
  14. TXT, IGES, DXF, STL, OBJ, VRML. Microstation plug-ins available for importing projects directly.
  15. iQsun 880, Riegl, Cyra pts, all others via ASCII.
  16. Microstation, AutoCAD, .dxf, IGES, ASCII, PTS, PTX, propri-

- etary, VRML, others.
17. Min. PIV, 1.2 GHz, 128 MB Graphics.
18. 180 MB application (1 GB swap).
19. 128 MB Graphics Card Open GL.
20. Both automatic and manual methods.
21. Solid, Surface & Solid differential.
22. 3DP, 3di, 3DD, DXF, Obj, Maya, txt, DGD, .00t, VRML.
23. High resolution photo rendering of panoramic photo from 4400 scanner. Generation of survey points directly from point cloud, intelligent automatic surface registration of any data, automatic geo-location of scans from 4400, target/reflector registration.
24. Scan, Register, Model, Survey, Server.
25. Cyclone - Scan: \$3750, Register: \$7500, Model: \$12500, Survey: \$7500, Server: \$2000 one concurrent user, \$1000 each additional user.
26. Leica HDS - HDS2500/HDS3000/HDS4500; Z+F - Imager 5003 (ZFS, ZFC); Riegl (3DD).
27. 130 MB static footprint; swap dependent on size of point cloud and operation.
28. Ethernet adapter for licensing, remote client/server, scanning with HDS2500/HDS3000; IEEE1394 (FireWire) for HDS4500; keyboard; mouse or other pointing device.
29. To all software that accepts ASCII.
30. Image from HDS scanner onto point cloud.
31. Automatic: Region Grow modeling tools; manual modeling tools; ability to apply attributes to modeled elements.
32. Semi-automatic; structural steel members, etc.
33. DXF, COE (DWG, DGN), ASCII (XYZ, SVY, PTS, PTX, TXT, Customized format).
34. Clouds are not confined/restricted on a per-scan basis. Engine supports billions of points in a single dataset with interactive performance. Limit box can be changed on-the-fly. Supports multiple windows. Multi-threaded; supports multiple processors. Has 64-bit data engine and virtual 64-bit graphics engine. Data stored in databases.
35. CloudWorx - Pro: \$3,500, Basic: \$995.
36. Ethernet adapter for licensing; keyboard; mouse or other pointing device.
37. Using CAD symbology tools directly with point clouds.
38. Automatic: Region Grow modeling tools; manual modeling tools; ability to use intelligent CAD tools.
39. Semi-automatic; cylinders, planes.
40. Polyworks v.9 by Innovmetric, ImAlign, ImInspect, ImEdit. Other solutions also available.
41. Minimum 32 MB graphics card recommended.
42. ASCII, txt, dgn, dxf, bmp.
43. Simultaneous station alignment. Topographic filtering. Inspection Map generation. OrthoPhoto generation. Multi-OrthoPhoto management. Profile tracking etc. Consult Trimble.
44. ASCII, txt, dgn, dxf, PDS, PDMS, rf, stl, vrml, sat, acis, iges, ps, obj, arc+, jpg, rgb.
45. Intelligent modeling. Complex equipment generation. User defined macros, etc. Consult Trimble.
46. User interface only. Registration and modeling available from 3rd party bundle.
47. Free hard disk space.
48. ptx, pts, dxf, xyz, ptb.
49. Nvidia GForce Graphics card recommended.
50. SAT, VRML, ASCII, ZFC, PTX
51. Point Cloud Server to AutoCad or Microstation. Supports up to 6 billion points.
52. The ASCII import for works for any model. It exists special imports for Riegl, Mensi and Optech.
53. PointCloud is an AutoCAD Application. AutoCAD or AutoCAD LT 2000 or later are supported.
54. Using CAD feature code or symbol tools and picking point.
55. Using CAD feature code and picking point.
56. Combined analysis of point clouds and orthophotos.