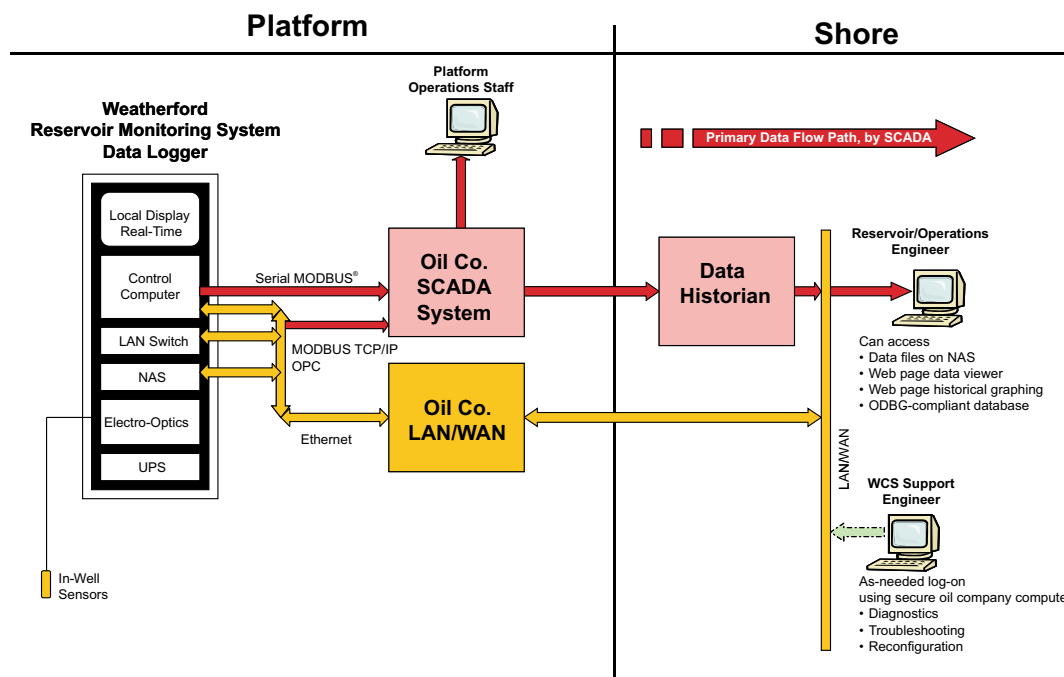




Optical-Sensor Data Handling

Those who rely on data produced by in-well optical sensors are typically well site production engineers, reservoir engineers, and other operations-related staff within an oil company. The needs of each differ slightly and can vary at different phases of a reservoir's lifetime. Therefore, the following information is compiled for the use of those concerned with the integration of data supplied by Weatherford optical sensing systems into oil company data access and management systems.

The diagram below shows a typical offshore platform arrangement:



Historically, MODBUS® protocols connected to supervisory control and data-acquisition (SCADA) systems or remote-terminal units (RTUs) have enabled platform production staff to correlate and combine production monitoring data. To maximize the benefit of the optical sensors, the reservoir engineer requires access to data stored at the highest data density possible. All of the Weatherford surface data systems compile data onto local storage media at high rates, ensuring easy access through local or wide-area networks (LAN/WAN).

The data-acquisition system software continually undergoes updates and improvement, based on input from the field. Maintenance and upgrade installation can be conveniently performed onshore if the systems are connected through a network, minimizing downtime and reducing the costs associated with transporting technicians to remote, offshore locations. In addition, connecting the systems to a network allows experts to support the software from locations around the world.

MODBUS is a registered trademark of Schneider Automation Inc.



Optical-Sensor Data Handling

Weatherford encourages operators to connect optical data-acquisition systems to both the platform SCADA as well as the business wide-area network. The benefits of connecting the optical surface systems to a LAN/WAN are as follows:

- Insurance that backup data on the logger can be readily accessed over network if the SCADA/data historian link fails
- Easy access of higher-density data on the data logger after unplanned events, such as well shut-ins
- One shared network for MODBUS TCP/IP and OPC
- Remote troubleshooting, reconfiguring, and upgrading through the network from onshore locations
- Access to the structured-query-language (SQL) database through standard open database connectivity (ODBC)

Connection to Platform Automation System

Several kinds of optical surface data-acquisition systems are available. Nearly all of the deployed systems are designed to complement a particular wellsite arrangement; however, the software guiding these systems is identical and is called the Reservoir Monitoring System (RMS).

Weatherford's surface systems have a variety of connectivity options, all of which are easily configured at the time of installation. No programming or advanced, custom engineering is necessary. The chart below summarizes the options available:

Surface System	Environment			Sensor Options			Connectivity Options							Power Options			Local Media				
	Air conditioned control room	Desert outdoor	Subsea support	No. of PT gauges supported	No. of DTS channels supported	No. of flow meters supported	MODBUS RS232	MODBUS RS422	MODBUS RS485	MODBUS TCP/IP	OPC	Simple serial ASCII string	PROFIBUS	ODBC SQL database	Web viewer	24 V DC	110 V AC	220 V AC	CD burner	Floppy disk	USB
RMS-WH	✓	✓	N	6 ^a	0	0	✓	✓	✓	✓	✓	N	✓	✓	✓	N	N	N	N	N	N
RMS Lite	✓	N	✓	3 ^a	0	0	✓	✓	✓	✓	✓	N	✓	✓	✓	✓	✓	✓	✓	✓	N
RMS Lite with DTS	✓	N	✓	3 ^a	3 ^c	0	✓	✓	✓	✓	✓	N	✓	✓	N	✓	✓	✓	✓	✓	N
RMS	✓	N	✓	24 ^{+b}	0	0	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	✓	✓	✓	✓	✓
RMS with DTS	✓	N	✓	24 ^{+b}	9 ^{+c}	0	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	✓	✓	✓	✓	✓
RMS with flow and DTS	✓	N	✓	24 ^{+b}	9 ^{+c}	8 ^{+c}	✓	✓	✓	✓	✓	✓	✓	✓	N	✓	✓	✓	✓	✓	✓

^aGauge-type dependent
^bModular system allows expansion
^cOptical switch allows expansion
 ✓ = Included feature
 N = Not available



Optical-Sensor Data Handling

Weatherford surface systems can be connected to wellsite automation systems in the following ways:

- MODBUS
- OPC
- Database
- CSV ASCII string
- PROFIBUS
- Flat files

Following are descriptions of each of these means of connectivity.

MODBUS

Physical-Layer Interface Options Serial: RS232, RS485, RS422	
Connection	DB9
Speed	300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57.6K, 115.2K baud
Signals	RS-232: TxD, RxD, RTS, CTS, DTR, DSR, DCD, GND RS-422: TxD±, RxD±, RTS±, CTS±, GND-485: Data±, GND
Isolation	RS-232: N/A
	RS-422: 2 KV
	RS-485: 2 KV

Ethernet—TCP/IP (MODBUS Only)	
Connection	RJ45 Ethernet 10/100

MODBUS Interface Options	
Control	Master or slave
Device Address	1 to 247
Function Code	Read holding registers MODBUS function code 03)
	Allowable assignments 40001 to 49999
Data Format Options	Floating point (2 registers)
	Swapped floating point (2 registers)
	Double float (4 registers)
	Swapped dounge float (4 registers)
	Unsigned integer 16 bit

Three MODBUS message types are supported: ASCII framing, RTU framing, or TCP/IP.

CSV ASCII String

The CSV (comma-separated variable) string output format is not only useful for diagnostic and test purposes, but also for data transfer to third parties who do not support any of the SCADA-type formats. The protocol is simple enough for receiving programs to be expediently written.



Optical-Sensor Data Handling

Data format

Coding ASCII

Number of bits per character

Data 8

Parity None

Stop Bits 1

Message framing

Well Name<comma>Date<comma>Time<comma>Value 1<comma>Value 2<comma>.....

Value N<CR><LF>

Example

NewWell,6/13/2005, 14:43:26, 196.41786194, 75.53485870

NewWell,6/13/2005, 14:43:29, 196.26698303, 75.57905579

OPC

The RMS OLE for process control server (OPC) and client are fully compatible with the OPC Data Access 2.0 standard. Data transfer options include individual items or variable arrays.

Flow rate can be expressed in downhole conditions, separator conditions, or standard pressure and temperature conditions. The second pressure/temperature (PT) gauge is used to measure differential, from which density is derived.

Pressure Gauge			2-Phase Flow			3-Phase Flow		
Pressure Gauge	kPa	Quality	Pressure	kPa	Quality	Sound Speed, m/s, Quality	m/s	Quality
Temperature	Deg C	Quality	Temperature	Deg C	Quality	Bulk Velocity, m/s, Quality	m/s	Quality
			Bulk Velocity	m/s	Quality	Pressure	kPa	Quality
			Oil Flow Rate	cu.m/s	Quality	Temperature	Deg C	Quality
			Water Flow Rate	cu.m/s	Quality	Pressure Sensor 2	kPa	Quality
			Total Flow Rate	cu.m/s	Quality	Temperature Sensor 2	Deg C	Quality
			Oil Volume Fraction	%	Quality	Oil Flow Rate	cu.m/s	Quality
			Water Volume Fraction	%	Quality	Gas Flow Rate	cu.m/s	Quality
						Water Flow Rate	cu.m/s	Quality
						Pressure DH	kPa	Quality
						Temperature DH	Deg C	Quality
						Oil Flow Rate SEP	cu.m/s	Quality
						Gas Flow Rate SEP	cu.m/s	Quality
						Water Flow Rate SEP	cu.m/s	Quality
						Pressure SEP	kPa	Quality
						Temperature SEP	Deg C	Quality
						Oil Flow Rate STD	cu.m/s	Quality
						Gas Flow Rate STD	cu.m/s	Quality
						Water Flow Rate STD	cu.m/s	Quality
						Pressure STD	kPa	Quality
						Temperature STD	Deg C	Quality



Optical-Sensor Data Handling

PROFIBUS

PROFIBUS is offered as an optional add-on for control room RMS systems only. The RMS system uses PROFIBUS interface cards and software drivers supplied by Softing, Inc. The PROFIBUS option offers several benefits:

- Provides an intelligent PC interface card for integrating a PC in a PROFIBUS network (1-channel)
- Provides master/slave functionality with a separate micro-controller for the protocol software
- Delivers a transfer rate of up to 12 mbit/s
- Supports all PROFIBUS protocols (multi-protocol support)

PROFIBUS	
DP Options	FMS Options
Master	Client
Slave	Server
Slave address configurable	
Slave type DP_Slave_Softing_b205	

Database

Weatherford’s RMS software contains an SQL database. In addition, an ODBC driver is available for direct interconnection to other databases.

Well Sensor History Table

Table name: WellSensor_History

Description: This table has information about all sensor tables.

Table layout:

Date Time Stamp	Well Name	Sensor Name	Sensor Type	Depth	Date Table Name	Status	Age

Well Sensor Current Table

Table name: WellSensor_Current

Description: This table has information about the sensor tables for the current configuration.

Table layout:

Date Time Stamp	Well Name	Sensor Name	Sensor Type	Depth	Date Table Name



Optical-Sensor Data Handling

Pressure Sensor Data Table

Table name: WellName_SensorName_Date_Time

Description: This table stores the data for this pressure sensor.

Table layout:

Date Time Stamp	PRS	PRS Status	TMP	TMP Status

Flow Sensor Data Table

Table name: WellName_SensorName_Date_Time

Description: This table stores the data for this flow sensor.

Table layout:

Date Time Stamp	PRS	PRS Status	TMP	TMP Status	BV	BV Status	SS	SS Status

continued ...

Oil FR	Oil FR Status	Water FR	Water FR Status	Oil PF	Oil PF Status	Water PF	Water PF Status

Three-Phase Flow Sensor Data Table

Table name: WellName_SensorName_Date_Time

Description: This table stores the data for this three-phase flow sensor.

Table layout:

Date Time Stamp	PRS 1	PRS 1 Status	TMP 1	TMP 1 Status	PRS 2	PRS 2 Status

continued ...

TMP 2	TMP 2 Status	PRS_DH	PRS_DH Status	TMP_DH	TMP_DH Status

continued ...

PRS_STD	PRS_STD Status	TMP_STD	TMP_STD Status	PRS_STD	PRS_STD Status

continued ...

TMP_SEP	TMP_SEP Status	BV	BV Status	SS	SS Status

continued ...

Oil FR_STD	Oil FR_STD Status	Water FR_DH	Water FR_DH Status	Gas FR_DH	Gas FR_DH Status



Optical-Sensor Data Handling

continued ...

Oil FR_STD	Oil FR_STD Status	Water FR_STD	Water FR_STD Status	Gas FR_STD	Gas FR_STD Status

continued ...

Oil FR_SEP	Oil FR_SEP Status	Water FR_SEP	Water FR_SEP Status	Gas FR_SEP	Gas FR_SEP Status

VeISOS (Velocity and Speed of Sound) Sensor Table

Table name: WellName_SensorName_Date_Time

Description: This table stores the data for this VeISOS sensor

Table layout:

Date Time Stamp	BV	BV Status	SS	SS Status	Total FR	Total FR Status

DTS Sensor Table

Tablename: WellName_SensorName_Date_Time

Description: This table stores the data for this DTS sensor

Table layout:

Date TimeStamp	DTS Data	Zone Alarms

Flat Files

If the RMS system is not configured to use a database and is directly connected to a network through the control computer or through a network-attached storage (NAS) server, the data can be accessed through flat files. For each PT gauge and each flowmeter, an ASCII data file is created every 24 hours, at midnight. The file is tab delimited, and the units of measure are in SI units.

Example of a PT gauge file:

12/7/2001	10:16:39	PRS	33832.94	TMP	110.082
12/7/2001	10:16:42	PRS	33832.29	TMP	110.077
12/7/2001	10:16:45	PRS	33833.82	TMP	110.089
12/7/2001	10:16:48	PRS	33834.44	TMP	110.090
12/7/2001	10:16:51	PRS	33833.17	TMP	110.085



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Example of a two-phase flowmeter file:

12/27/2001	14:41:05	PRS	120.240347	TMP	127.330997	SS	4597.636138	BV	3.423553	OilPF	0.001764	WaterPF	0.998236	OilFR	0.000026	WaterFR	0.014785
12/27/2001	14:42:35	PRS	143.142929	TMP	126.334707	SS	4603.990606	BV	3.414589	OilPF	0.001849	WaterPF	0.998151	OilFR	0.000027	WaterFR	0.014745
12/27/2001	14:44:05	PRS	139.685703	TMP	126.244007	SS	4596.178620	BV	3.412020	OilPF	0.002147	WaterPF	0.997853	OilFR	0.000032	WaterFR	0.014730
12/27/2001	14:45:35	PRS	117.066904	TMP	129.337863	SS	4605.759725	BV	3.441207	OilPF	0.000946	WaterPF	0.999054	OilFR	0.000014	WaterFR	0.014874
12/27/2001	14:47:05	PRS	128.955536	TMP	127.445628	SS	4589.666501	BV	3.489948	OilPF	0.001996	WaterPF	0.998004	OilFR	0.000030	WaterFR	0.015068

Each file name is appended with the date, for example: *Psensor 1-22Oct2001.dat*

DTS data are depth based rather than time based. Therefore, they are formatted differently. DTS files adhere to the Canadian Well Logging ASCII Standard (LAS). Both LAS 2.0 and 3.0 standards are supported. The depth data are referenced to the wellhead, negative depths indicate surface cable, and positive depth numbers indicate in-well data. A typical file name is "DTS Sensor-08Apr2003-1104.las." A sample LAS file is shown at right.

```
# Las ver 3.0 per CWLS June 6, 2000

~Version
VERS.      3.0      : CWLS LOG ASCII STANDARD VERSION 3.0
WRAP.      NO      : ONE LINE PER DEPTH STEP
DLM.       COMMA   : DELIMITING CHARACTER (SPACE TAB OR COMMA)

~Well
#MNEM.UNIT      DATA      DESCRIPTION
#-----
STRT .M         1010.01      : First Index Value
STOP .M         1020.05      : Last index Value
STEP .M         0          : STEP
NULL .          -999.25     : NULL VALUE

COMP .          ANY OIL COMPANY INC.      : COMPANY
WELL .          ANY ET AL 01-02-03-04     : WELL
FLD .           WILDCAT                   : FIELD
LOC .           1-2-3-4W5M                 : LOCATION
SRVC .          WEATHERFORD               : SERVICE COMPANY
DATE .          13/12/2002                : Service Date {DD/MM/YYYY}

CTRY .          AU                        : COUNTRY {WWW CODING}

~Parameter
#MNEM.UNIT      DATA      DESCRIPTION
#-----
#Required Parameters
PDAT .          GL          : Permanent Data
APD .M         4.2         : Above Permanent Data
DREF .          KB         : Depth Reference (KB,DF,CB)
EREF .M        234.5       : Elevation of Depth Reference
RUN .          1          : Run Number
RUNT .         10:21       : Run Time

#DTS Parameters
SMTH .          2          : Smoothing interval
AVGT .SEC       60         : Averaging Time
PWDTH.NS       30         : Pulse Width
RANGE.KM       6          : Instrument Range
QF .           10         : Quality Factor

~Curve
#MNEM.UNIT      LOG CODES      CURVE DESCRIPTION
#-----
DEPT .M         123 456 789      : DEPTH {F}
TEMP .DEGC     123 456 789      : Temperature {F}

~ASCII
1010.01,77.234
1011.01,77.235
1012.02,77.235
1013.03,77.236
1014.03,77.236
1015.04,77.237
1016.04,77.239
1017.04,77.240
1018.05,77.241
1019.05,77.244
1020.05,77.249
```



Optical-Sensor Data Handling

Network-Attached Storage

NAS servers are self-contained, intelligent devices that attach directly to an existing LAN. A file system is located and managed on the NAS device, and data is transferred to users over standard network protocols such as TCP/IP. Weatherford uses Quantum's Snap NAS devices.

NAS drives offer larger data storage capacity than local hard drives and protect the investment made in acquiring the data. The SNAP servers are RAID 5 striping with parity (factory default), and RAID 1 monitoring. Another advantage of storing data files on a NAS device is no executable files are running on these servers. Therefore, network corruption is minimized, while control and communication to the computer is restricted from casual users on the network.