BUS COMPARISON MATRIX

Item	*Profibus*	*AS-Interface*	*Interbus*	*Modbus-1*	*Ethernet*
General					
Abbreviation	Process Field Bus	Actuator Sensor Interface	-	Modicon Bus	-
Available since	Ca. 1990	Ca. 1995	Ca. 1988	Ca. 1979.	Ca. 1975
Developer	Profibus Consortium (Germany)	AS-Interface Consortium (Germany)	Phoenix (Germany)	Modicon / Gould / Groupe Schneider	Xerox (US)
Standards	DIN 19245, EN 13321/1 (FMS), EN 50254/2, EN 50170/2, IEC 61158 Type 3, SEMI E54.8 (DP)	EN 50295, IEC 62026/2, IEC 947	DIN 19258, EN 50254/1, IEC 61158 Type 8	No (inter)national standard.	IEEE 802.3
Website	www.profibus.com	www.as-interface.net	www.interbusclub.com	www.modbus.org	
Variants	FMS, PA, FDL, DP (with subversions DP/E, DP/V1 and DP/V2)	V1.0, V2.0, V2.10, V2.11 and higher	V1, V2, V3, V4 Interbus/Loop	ASCII, RTU (Remote Terminal Unit)	10Base2 (Coax) 10Base5 (Coax) 10BaseT (Twisted-pair) 100BaseTX (idem)
Other protocols which resemble it	MPI (Multipoint Interface) from Siemens (like FDL)	-	-	The French “Jbus” is not officially a Modbus-1 variant, but for 99% compatible.	-
Applicable for sensor/actuator I/O?	No (too complex, and hardware too large)	Yes (especially developed for it)	Yes (via Interbus/Loop)	No	No (hardware too large)
Applicable for remote I/O ?	Yes (DP only)	Limited (can only have 4 digital I/O channels or 2 analog channels per participant)	Yes	Yes	Yes
Applicable for communication between controllers and/or intelligent equipment?	Yes (FMS for communication between controllers, PA for field instruments)	No.	Limited.	Yes, but officially only for Modicon / Groupe Schneider controllers, although many other controller vendors also support Modbus.	Yes
Most often used variant at *this* moment	DP/V1	V2.0	V4	RTU	10BaseT, 100BaseTX
Variants that are not used anymore or are seldom used	FDL, FMS	V1.0	V1, V2	ASCII	10Base2 10Base5
Compatibility between	FMS and DP and FDL	Backwards compatible.	Backwards compatible.	Both variants have a	Compatible by using hubs or switches

variants	mutually incompatible, but can be connected to same cable.			similar command set, although different in transmission format.	that support multiple variants.
Application profiles	ProfiSafe, ProfiDrive, ProfiNet .	Analogue I/O, Safety	Drivecom, Encom, MMICOM, Safety	-	-
Application areas	Discrete industry (DP), Process industry (PA).	Discrete industry, Process industry partially.	Discrete industry	Discrete industry, process industry.	Office automation; higher levels of industrial automation
Intrinsically safe variant available?	Yes (PA).	No.	No.	No.	No
Stability of system	High.	High.	High.	High.	Ethernet is still in full development. No market leader able to set a standard.
Most important competitor	DP: Interbus, CAN. PA: Foundation Fieldbus	None	Profibus/DP		None at this moment; is still very much developing.
Availability of interface cards for PC's	Yes, several vendors.	Yes, several vendors.	Yes, via Phoenix.	Not needed when RS232 is used; for RS422/485 a converter can be used or a normal PC plug-in card.	Most modern PC's come with an Ethernet integrated on the motherboard.
Availability of driver software for PC's	Yes, comes with the PC card. For DP, a network configuration package is also needed.	Yes, comes with the PC card.	Yes, comes with the PC card.	In many cases the Windows or Linux support suffices.	Comes with Windows or Linux.
Availability of specifications for users	Free only for members of the user group; otherwise only available for a fee.	Only for members of the user group; otherwise only available for a fee.	Can be downloaded from www.interbusclub.com	Can be downloaded from Groupe Schneider website (www.modicon.com) or from the Modbus User group (www.modbus.org).	Can be downloaded from www.ieee.org .
Books about this system	12 About FMS the only book is sold out..	1	8	None known.	1 Many other books, but mainly meant for office automation applications.
Cabling					
Cable	2-wire.	2- wire (yellow AS-i cable), possibly power-supply via extra 2-wire cable (black).	4- wire.	Commonly use either RS232 or RS422/485, although this is not formally specified.	Coax (10Base2/5) 4- wire Twisted pair (10BaseT, 100BaseTx)
Cable color	Purple (DP), blue(PA).	Yellow (network + power), black (power 24V), red (power 220V).	Green.	Not specified.	Yellow (coax 10Base5), black (coax 10Base2), usually gray for other variants.
Redundant cabling possible	Not yet (only specification for redundant slaves is available)	No.	Not yet.	Depends on vendor.	Yes .
Fiber optic possible	Yes (via repeaters).	No.	Yes.	Yes, depends on vendor.	Yes.
Power supply for nodes on network	Via separate connection (FMS, DP). With PA via network itself.	Via network itself (30V/8A), extra power via 24V cable (black).	Via separate connection.	Not specified.	Via separate connection.
Connector	9-pins sub-D connector	Via vampire taps (most	9-pins sub-D connector.	Not specified (often 9-pin	15-pins sub-D (10Base5)

	(most common), other connectors possible.	common) or screw connector.		sub-D, but the pinning is always different).	BNC (10Base2) RJ45 (10BaseT, 100BaseTX).
Topology	Bus (FMS, DP, PA) Chicken feet(PA).	Tree, bus, star.	Bus, tree, star.	Bus.	Bus (10Base2/5) Star (10BaseT, 100BaseTX).
Termination	3 resistors at both ends of cable (FMS, DP). With PA combination of R and C.	Not necessary.	Not necessary (integrated in equipment).	Not specified; probably one or three resistors when RS422/RS485 is used.	1 resistor at both ends of cable (10Base2 and 10Base5 only).
Vulnerability for incorrect termination	Nodes with terminators may not be switched off or be removed from the network.	None.	None.	Nodes with terminators may not be switched of or be removed from the network.	None.
Signal transmission	According RS485 (FMS, DP) or IEC 61158/2 (PA).	AS-Interface specific.	According RS485.	According RS232, RS422/485, or Ethernet.	Ethernet specific.
Maximum length (without repeaters)	1200 m.	100 m.	Not applicable (every node is automatically a repeater).	According RS232 (15..60 m) or RS422/485 (1200m).	500m (10Base5) 200m (10Base2) 100m (10BaseT, 100BaseTx).
Speed (bit rate)	9.6 / 19.2 / 93.75 / 187.5 / 500 Kbit/s (FMS); DP like FMS but also supports 45.45 Kbit/s and 1.5 / 3 / 6 and 12 Mbit/s; PA only 31.25 Kbit/s.	Always 167 Kbit/s.	500 Kbaud/s or 2 Mbit/s with the new version.	Not specified; usually not higher than 38,4 Kbit/s and most often 19,2 or 9,6 Kbit/s (lower speeds also possible).	10 Mbit/s (10Base2/5/T) 100 Mbit/s (100BaseTX).
Stubs possible	Yes, with limitations (up to 1,5 Mbit/s).	Yes (because of tree topology).	Yes.	Yes.	Yes (only 10Base5)
Repeaters possible	Yes, maximum 3 according standard, but more (up to 10) possible in practice (supplier-dependant).	Yes, maximum 2.	Not applicable (every node is automatically a repeater).	Yes, according to RS485 specification.	Yes, but nowadays usually hubs or switches are used
Maximum length	10 km (copper) 90 km (fiber optic).	300m.	13 km (copper).	Not known.	Not applicable.
Speed configuration	Via local switches or software-configuration; DP-slaves sometimes have autobaud. PA only has 1 speed.	Not necessary.	Not necessary.	Via local switches or software-configuration.	Not possible.
Nodes					
Maximum number of nodes without using repeaters	32 (limitation RS485).	31 (V2.0) of 62 (V2.1), but less when analogue or safety I/O is used.	512.	2 (with RS232), 10 (RS422) or 32 (RS485)	Practically no limits.
Maximum number of nodes with use of repeaters	126 (= maximum 125 slaves).	31 (V2.0) of 62 (V2.1), but less when analogue or safety I/O is used.	512.	2 (with RS232), 250 (RS422/485).	Practically no limits.
Network address	Via local switches, or	Via network itself or via	Not necessary.	Via local switches or	Not necessary.

configuration	sometimes via the network itself (DP).	configuration tool. Limited automatic reconfiguration after swap of defective node by similar node.		software.	
Network address configured "out of the box"	None (FMS) 126 (DP,PA) in case no local switches are available.	0 (zero).	Not necessary.	Not specified.	Every Ethernet-node as a worldwide unique 48-bit address (MAC-address).
Communication relations between nodes	Multi-master (FMS) Master/slave (DP, PA) Producer/consumer as of DP/V2.	Master/slave.	Master/slave.	Master/slave.	Multi-master, but higher protocol layers can limit this.
Message destination	Point-to-point, multicast and broadcast possible.	Point-to-point (between master and slave).	Point-to-point.	Point-to-point, broadcast.	Point-to-point, multicast and broadcast possible.
Broadcast implementation	Use network address 127.	Not possible.	Not possible.	Use network address 0. Note: very often this is not implemented in a slave!	Via MAC-address FFFFFF.
Network management	Via token-ring between masters, otherwise master/slave.	Master/slave.	Master/slave.	Master/slave.	CSMA/CD for 10Base5 and 10Base2 and 10BaseT with hubs. Software may determine additional management strategies (such as token-bus, master/slave, etc.).
Maximum number of masters	No limitation (in practice usually no more than 1).	1.	1.	1.	No limitation.
Messaging					
Maximum data in one message	241 bytes (FMS), 244 bytes (DP,PA) but sometimes limited to 32.	4 bits for inputs; 4 bits for outputs (V2.0), as of V2.1 3 bits outputs.	8192 bits.	250 bytes (= 125 registers or 2000 single bits).	1500 bytes.
Minimum data in one message	0 bytes.	4 bits.	4 bits.	0 bytes.	46 bytes.
Overhead per message	9 bytes, plus 3 bits per byte. Also short transmit pause between messages.	24 bits minus number of inputs (max. 4) and minus number of outputs (max. 4).	48 bits, plus 5 bits per byte.		38 bytes, plus minimal 46 bytes in the data field. For small amounts of data a minimum message is thus 672 bits long.
Number of messages needed for handling 'n' remote I/O modules	2 * n (for inputs and for outputs).	2 * n (for inputs and for outputs).	1 (all inputs and all outputs are handled simultaneously).	4 * n (for inpuits and for outputs, which must be handled via two separate commands since Modbus has no combined read/write command).	2 * n (for inputs and for outputs).
Fault detection	Balanced transmission per bit, parity bit per byte, 8 bits checksum per message, Hamming distance 4 coding on first	Manchester coding per bit, parity bit per message.	Balanced transmission, 16 bit CRC per message.	Paritybit per byte (optional), 8 bit checksum per message (ASCII), or 16 bit CRC per message (RTU).	32 bit CRC per message.

	and last byte per message.				
Number of retries after fault detected	Configurable 1..8.	2.	3.	Not specified; vendor specific (usually 0, meaning that the application software must handle the retries itself).	None (to be handled by higher protocol layers).
Remote I/O					
Cycle time calculation	Calculate number of bits transmission for inputs of slave, and also for the outputs. Add overhead: twice 9 bytes, and master + slave pause which are bit rate dependent. Note: Profibus has 11 bits per byte! Do this for all slaves, sum the totals. Divide by the bit rate. This is the theoretical best cycle time.	Per slave it takes 0,15 msec. Multiply this with (amount of slaves + 2).	Calculate size of the only message, which depends on the number of nodes and the I/O per node. Divide this by the bit rate.	Modbus has no standard for it, therefore it is impossible to calculate in advance. Basically one can cycle I/O with separate commands for read and write of I/O, or with one command for combined reading and writing. This can either be done in ASCII or RTU, giving 4 different ways of calculating the cycle time.	Per remote I/O node this costs 672 bits per message. Multiply this by twice the number of slaves, divide by 10 or 100 Mbit/s. This is the theoretical best cycle time. In practice software can cause much slower cycle times.
Analogue I/O possible	Yes.	Yes. As of V2.1 standard, but about 8 times as slow as digital I/O. As of V2.0 and earlier analogue I/O must be programmed in the application, and the speed is thus application-dependent.	Yes.	Yes.	Yes.
Maximum I/O per node	244 bytes for inputs and 244 bytes for outputs in any combination analogue / digital.	4 bits digital inputs en 4 bits digital outputs (V2.0), as of V2.1 only 3 bits digital outputs. Maximum 2 analogue channels per slave.	16 bytes for inputs and 16 bytes for outputs, in any combination analogue / digital.	250 bytes for inputs and 250 bytes for outputs in any combination analogue / digital.	1500 bytes for inputs en 1500 bytes for outputs, in any combination analogue / digital.
Configuration	FMS is not standardized. DP via “GSD” files and network configurator. PA idem.	Via hand-held configurator or master. Master can automatically detect defect slaves, and its replacement which does not have to be configured.	Via “CMD” software-package.	No standard known.	No standard known.
Diagnostics at the network level	Which nodes are present, and of what type (master or slave). Counters for transmission errors etc.	Which nodes are present, and are they configured or not.	Several bus errors, and their physical location.	Not specified (vendor specific).	None (handled by higher protocol layers).

Diagnostics at the node level	Part standard diagnostics bits (specified by DP), remainder is supplier-specific or profile-specific.	Presence; configured; in use.	Periphery error.	A diagnostic command is specified, although very often it is not implemented.	None (handled by higher protocol layers).
Vulnerabilities	Nodes with terminators that are removed or switched off; short-circuit on the bus; dual use of network addresses.	Failure power-supply; dual use of network addresses (especially address 0).	Ring broken.	Nodes with terminators that are removed or switched off; short-circuit on the bus; dual use of network addresses.	Failure of hub/switch (10BaseT, 100BaseTX). Failure of power supply of hub/switch.
Can I/O nodes be removed from running network?	Yes; this is detected.	Yes; this is detected.	Yes; after switching off node.	Yes; this is detected if the master regularly communicates with that node (a timeout is the result).	Yes. Detection depends on capabilities of higher protocol layers.
Can I/O nodes be connected to a running system?	Yes. If node was configured earlier, it is activated again.	Yes. If node was configured earlier, it is activated again.	Yes. If node was configured earlier, it is activated again.	Yes.	Is possible when supported by higher protocol layers.
What happens when a node is connected that is not configured?	Ignored.	Ignored, after being reported to application.	Reported to application.	Ignored.	Depends on higher protocol layers.
Synchronous reading of inputs possible?	Yes; but only if supported by supplier (is an option in DP, not possible in FMS).	No.	Yes (standard).	-	Is possible when supported by higher protocol layers
Synchronous activation of outputs possible?	Yes; but only if supported by supplier (is an option in DP, not possible in FMS).	No.	Yes (standard).	-	Is possible when supported by higher protocol layers