INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

MATERIALS MANAGEMENT DIVISION

Powai, Mumbai 400076.

Reference No. (PR No. 1000020941) **RFx No. 6100000927**

TECHNICAL SPECIFICATIONS

Software-In-Loop Simulation (SILS) facility

The Software-In-Loop Simulation (SILS) facility provides a complete real-time computer-based system to carry out all the Software-In-Loop Simulation tests that are required for the testing of the performance of the Controller/ Unit Under Test (UUT) hardware and software. These can be broadly classified into the following two categories:

a) Hardware/Software Integration Tests

b) Verification and Validation Tests

Scope of Work:

The works involved in the Supply and Services of Real-time Model based SILS Facility (Hardware, Software and Services) are listed below.

The purpose of the SILS is to provide hardware interfaces with the various subsystems of the Controller/UUT and some other interconnected subsystems that are identical to what the subsystems interface in the vehicle as well as interfaces for some of the ground support equipment that are required for the operation of the Controller/UUT. In order to meet these requirements, the resources of the SILS has to contain computers with various Input/ Output (I/O) interfaces, connection methods for connecting the Controller/UUT and other Line Replaceable Units (LRUs) to the hardware resources of the SILS, peripherals, etc.

Number	Specification	Specification in Details	QTY
1	**Simulator Chassis**	Simulator Chassis shall be rack mountable	1
		Powerful target computer, with Multi Core Processor, Minimum Quad core	
		Minimum supported speed 3.0Ghz	
		Supported HDD, Minimum 512 GB	
		Supported DDR RAM, minimum 16GB	
		4U, Xeon E5, 4 Cores, 10M cache	
		RCP/HIL Artix 7 FPGA-based Real-Time Simulator	
		PCIe slots to support third party cards/custom made cards	
		High Speed duplex multi-mode SFP optical fibre 1 to 5Gbps	
		Should have the LED indicators for synchronization status, target computer status etc.,	
		Should have standard ATX computer connectors like USB ports, monitor, network ports etc.,	

		Should support Lab grade environmental conditions	
		Integrated Patch panels for 16 Channels of I/O for monitoring parameters	
		One Artix -7 FPGA to drive the I/O cards	
		I/O expansion chassis with the required process capabilities, the integrated patch panels for signal monitoring, the Aritix-7 FPGA and the required software license.	
		A suitable rack should be provided to mount all these.	
2	**Analog Input**	2x16 Ch with 16 bits	1
		400kS/s /ch simultaneous sampling	
		Minimum 2.5 µs conversion time	
		All channels simultaneously captured	
		Voltage range configurable up to ±20 V true differential input	
		400 kOhms input impedance	
		Conversion time should be directly controlled by the FPGA	
3	**Analog Output**	2x16 Ch with 16 bits	1
		1 MS/s/ch simultaneous output	
		1 µs update time	
		15mA (35 mA with fast driver)	
		All channels simultaneously generated	
		Short circuit protected	
		Voltage range configurable up to ±5V, ±10V, ±16V	
4	**Digital Input**	2x32 channels	1
		Push pull type	
		40 ns propagation delay	
		All inputs are sampled simultaneously, at up to 10 MSPS	
		4.5 V to 50 V, same module can be used up to 50 V	
		Short circuit protected, Galvanic isolation with Op to coupler transition delay of 50 ns	

5	**Digital Output**	2x32 channel	1
		Push pull type	
		50 ns propagation delay	
		5 V to 30 V	
		Short circuit protected	
		Galvanic isolation	
		All outputs are simultaneously generated with a maximum transition delay of 50 ns	
		Adjustable via user-supplied external voltage	
		50 mA max	
		Same module should be used for PWM generation, software configurable	
6	**Serial RS232/RS422/RS485**	Two, Four or eight asynchronous serial ports, in various electrical interface configuration	2
		Support full duplex (4 wire) with RTS/CTS flow control, half duplex (2 wire) with auto TxD echo cancellation and multi-drop (4 wire) full duplex communication modes in RS-422/485	
		Maximum data speeds of 921kbps (RS-232) and 1.8432Mbps (RS-422/485)	
		Multi-strike surge suppression: IEC 1000-4 compatible on all signals, all port	
7	**Target License**	Target software allows the offline Simulink model to run in Real-Time, and should allow the model to interact with real world signals, through Analog voltages and currents, also through means of communication protocol	2
		Real Time Operating System should be used dedicatedly for the real time simulation. RTOS used will be COTS based	
		Hard Real Time scheduler	
		TCP/IP Host target communication	
		IO Management	

8	**Driver Block Set**	Driver block should be a Simulink based blockset and should be user configurable for the following parameter: BC Receive Block : To receive the data from a specific remote terminal (RT)/ Sub-Address (SA) of an MIL-1553B card. Ability to switch between the buses BC send Block : To send the data from a specific remote terminal (RT)/ Sub-Address (SA) of an MIL-1553B card. Ability to switch between the buses. Should support different bus control operations. Like RT-RT, RT-BC, BC-RT and broadcast Control Block : Should define general configuration setting of the 1553B board. Ability to set status word and bus controller. Monitor Block : This block performs monitoring of messages received by a specific MIL-1553B RT/SA couple. Mode Codes can also be monitored with this block. The data width must be large enough to accommodate the largest packet. Enable Block : This block allows the user to activate or deactivate simulation of a MIL-1553B Remote Terminal at run-time RT Receive Block : This block is used to return messages received by a specific MIL-1553B Remote Terminal/ Sub Address. Option to set maximum number of data words. RT- Send Block : This block is used to prepare data sent by one simulated RT/SA of a MIL-1553B card. Block should also support triggered transmission of data. Serial Controller Block : Block defines the asynchronous serial communication parameters, like a. Controller ID b. Comm Port Number c. Baud Rate d. Parity e. Data Size f. Stop Bits g. Flow Control etc. Serial Send & Receive Block : Sperate blocks for transmission and reception, block should be to do triggered based transmission. Should be able to parameterized the data.	2

9	**MIL 1553B**	Multi-Function and should be easily configurable to operate simultaneously as Bus controller, 31 Remote Terminal and BUS Monitor with variable voltage transceivers. Specifications are; ➢ Dual Channel, Dual-redundant MIL-STD-1553 A/B Notice I channels ➢ Simultaneous Bus Controller, 31 Remote Terminals and Bus Monitor ➢ High-level API for Windows XP, Linux, RTOS ➢ Card should be PCI based ➢ Bus Controller a. Programmable control over: b. Major and minor frame content and timing c. Intermessage gap times d. Response time-out and late response e. Multiple BC retry f. Modify messages, data or setup while card is running g. Insert aperiodic messages into a running BC list h. "Oneshot" mode for simplified BC operation i. Conditional message sequencing based on real-time message data or status j. Selectable interrupt generation and status messages i. Full range of system conditions ii. All detected errors ➢ Remote Terminal a. Multiple RT simulation (up to 31 RTs) b. Modify data, status words or setup while card is running c. Programmable message content d. Interrupts can be generated on a per message basis upon End of Message and error conditions e. RT Map Monitoring ➢ Bus Monitor a. Capture 100% fully loaded bus traffic with: i. Time-tagging ii. Error status iii. Word status iv. Message status v. RT response time b. Interrupts can be selected by RT/SA/WC c. Real-time bus playback with RT edit mode d. 45-bit, microsecond resolution time tagging e. IRIG-B Receiver (AM or DC/TTL)/Generator (DC/TTL) ➢ Accessories : Mating connectors with mating backshell. Stub with transformed couple with terminators- 1Set	2

10	**Real-Time Communication Link**	Link Speed : 40 GBPS PCI Express : Base Spec 2.1 Cable Connection : x8 PCI Express Connection Drivers : Required drivers Interface between the two systems with minimum 2 meters cable	1
11	**Integrated Development Environment (IDE) Software**	a. IDE software must be installed on the user provided system. b. The IDE software must provide development of scalable real-time platform for mathematical models of dynamic system built using RT-LAB/ MATLAB/ Simulink for simulation and control testing. c. Should provide High-fidelity Plant Simulation of i. Real-Time Simulation for System Integration ii. Physical Components Testing with Virtual Systems iii. Operator Training iv. Controller Development d. Control System Prototyping i. Prototyping Controller Connected to virtual Plant ii. Control Testing with Real Plant iii. Hardware-in-the-Loop with Real Controller e. Embedded Data Acquisition and Control i. Should be able to run the models in embedded Mode. Once the controller is flashed on the system it should be able to work like controller ever system is rebooted multiple times in embedded mode option. ii. High-Speed Signal Capture and Data Logging f. Should Run Simulink models in real time on HILS platform g. Must work with industry standard I/O h. Should offer fast execution, small fixed-step sizes i. Must support SMP or distributed targets for faster execution j. Run on a reliable, industrial-grade RTOS k. Must provide Integrated Signal Visualization and control Panel l. Should provide High-Fidelity Plant Simulation m. Support for 3DVirtual Reality Visualization Tools	1

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Additional Terms and Conditions

1. **The party to provide the following in the bid:**

a) The vendor/manufacturer should be direct presence in India or should be an exclusive agent of an International equipment manufacturer for minimum 5 years in India. Proof of this relationship should be included along with the technical bid.

b) Undertaking for support of hardware and spare for a minimum period of 10 years after installation and commissioning.

c) Undertaking for guarantee and warranty of the product for a minimum of 3 years from the date of commissioning.

d) Details of installed SILS facilities over the last 10 years of at least 5 users of similar or higher capabilities in India (specifically in reputed institutions/organizations like IIT's, IISc, NIT's and reputed national labs like DRDO, NAL, ISRO, HAL, etc.) or abroad from reputed institutions/organizations for getting first hand feedback from them about the product and service experience.

e) If the SILS facility fails to meet the specified requirements, the vendor/manufacturer will be held liable to take the SILS facility back at their own cost. IIT Bombay will not be responsible for any damage to the SILS facility until it is handed over to the user.

f) The firm should be equipped with well-trained engineers to offer post warranty maintenance and service support. Number of service engineers employed in this region by manufacturer should be mentioned, along with their qualifications and experience.

g) Details of service support in India that the firm can offer should be given along with the NABL calibration facility.

h) Nearest service centre to Mumbai is to be mentioned.

i) Well-trained engineer should install the complete setup and it should not be carried out by the agent.

2. **Installation & Commissioning:** The SILS facility shall be installed in full functionality and handed over in full functional condition to IITB at the location designated for delivery. Instantiation and Commissioning by the supplier at no additional cost.

3. **Training, Development Program, Technical Literature, Deliverable:** The supplier should carry out extensive training program, which is to be conducted at IITB, as part of the delivery and should support future recurrent training programs on request as and when needed by IITB to train faculty members, staffs and students on various aspects of the SILS facility including software and hardware interfacing, experimentation and development of components and adding them to the simulation. For the user, the delivery of training material / documents, maintenance and usage shall be included. All Software manual used in the hardware shall be handed over. Detailed specifications of components utilized in making the hardware also required to be covered.

4. **Maintenance:** IITB Unit will nominate few people for a thorough training by the vendor/manufacturer to carry out necessary maintenance and troubleshooting. They will also work with the vendor/manufacturer as a point of contact for remote diagnostics using the internet and minor fixes and repair activities.

5. **Warranty:** A minimum of THREE-year warranty on site from the date of commissioning. During the warranty period, any un-serviceability in the SILS facility has to be attended and rectified by the seller at the installation site. All Repair/Replacement/Spares cost during warranty period will be fully borne by the seller.

6. **Please specify the following**
    a. Power requirements
    b. Drives are all electric or not. If not, which drives are electric?
    c. training period and method of training
    d. Integration of hardware plus software
        i. The time required for installation and commissioning
        ii. The requirement of civil, electrical, plumbing work etc. to be carried out by IIT for the SILS facility
        iii. Other, if any

7. The SILS facility software and interface should be capable of supporting and also interfacing with PC desktop and 3-Axis Angular Motion Simulator.

8. Detailed manuals of hardware and software in English along with electronic copies.

9. Upgradation of software should be free for first 5 years, which will be compatible to any higher version of windows operating system.

10. **Safety:** At all times, the SILS facility should ensure the operator's safely. Please specify in the technical bid the safety features, precautions and capabilities of hardware and software of your SILS facility.