Technical Specification for

Signal Validation Engine (SiVa)

Preamble

SiVa is a software platform to facilitate validation/reconciliation of thermal power plant process data. SiVa's high level architecture consists of a Core engine and GUI. Core engine shall be based on VDI 2048 standard as well as Artificial Neural Networks; both running parallel. SiVa shall focus on thermal power plants having Boilers, Turbines, Heat exchangers, Pumps, Condenser etc. typically found in large fossil fuel fired plants. SiVa shall obtain real time data from plant DCS historian at pre configured intervals and validate all signals configured in its scope. SiVa shall typically consider measurements like mass flows, pressures, temperatures etc., and also consider non-measured process variables wherever applicable. SiVa shall operate on data when plant is in steady state operation and its range applies to 60% to 100% of rated conditions.

Scope of Development

Development includes architecture, design, implementation, testing, and training at clients place. The following clauses apply to development.

Part A: Core Engine

Core Engine shall consist of two modules.

Specs for development of Module I

1. Module I of Core engine shall be designed based on VDI 2048 applicable to thermal power plants of 210 / 250 / 500 MW capacity.
2. Systems like turbines, heaters, pumps, condensers, mills, fans, economizer, superheater, reheater, furnace and heating sections of boiler shall be modeled to suit the VDI formulation. The exact list of subsystems shall be selected during the course of development and the list shall be selected in such way that complete process cycle is covered. Exact process modeling and formulation of constraints for VDI 2048 shall be arrived at mutually.
3. Core engine shall be capable of applying heat and mass balances to various sub systems.
4. Algorithms discussed in VDI 2048 shall be suitably modified based on BHEL's recommendations.
5. List of parameters considered for validation/reconciliation can consist of both measured and non-measured variables.
6. Validation/reconciliation algorithm should consider redundancy in measured variables.
7. Use of Principal Component method shall also be explored, if required; details shall be worked out during detail design and BHEL shall take final decision on its usage during implementation.

8. Power plant process modeling should be considered to predict the ideal / design values for any given load for all configured set of measured parameters from the design data available at 60%, 80% and 100% rated conditions.
9. Probability distribution function for arriving at relevant requirements in VDI 2048, to be determined from historical data given by BHEL or any other formulation acceptable to BHEL.
10. Determine constraints equations for various sub systems, as well as overall cycle.
11. Time line for Module I is six months.

Acceptance Criterion for Module I of Part A

1. Sub systems considered in VDI 2048 formulations should be as per BHEL approval.
2. Formulation of constraint equations for overall system should be as per BHEL approval.
3. Accuracy of Module 1 for data reconciliation/validation algorithms shall be checked with design test cases provided by BHEL and this accuracy shall be within a range 0.1% to 0.75% for ideal data, depending on the choice of measurement. The accuracy tolerance for results shall be adjusted by instrument / measurement calibration where applicable.
4. Acceptance test shall be carried out using CSV file inputs.
5. The above is gross criterion for Acceptance criterion; however detailed Acceptance Test Protocol shall be worked out after detail design is finalized and approved by BHEL.

Specs for development of Module II

1. Module II of Core engine shall be designed based on Artificial Neural Nets as applicable to thermal power plants of 210 / 250 / 500 MW capacity.
2. Systems like turbines, low / high pressure heaters, pumps, condensers, mills, fans, economizer, superheater, reheater, furnace and heating sections of boiler shall be considered. The exact list of subsystems shall be selected during the course of development and BHEL shall finalize the list.
3. Algorithms shall be based on pattern recognition techniques like Support Vector machines / Adaboost / Self Organizing Maps/ or any other suitable self leaning techniques. Both supervised and unsupervised learning techniques shall be considered. BHEL shall finalize the algorithms during detail design.
4. Vendor should submit a detail technical proposal on the algorithms suggested above and their applicability to identify frequently occurring patterns in a set of historical data for approval by BHEL.
5. List of parameters considered for validation / reconciliation shall consist of both measured and non-measured variables.
6. Validation/reconciliation algorithm should consider redundancy in measured variables.
7. Multiple nets should run simultaneously and each net shall have different set of inputs which are configured.
8. Provision should be there to configure network type / topology for different sub-systems.
9. Training of nets shall be carried out using both on-line and off-line data.
10. Time line for Module II shall be six months.

Acceptance Criterion for Module II of Part A

1. For each network configured for a process boundary, the network predicted value shall be within a tolerance limits provided by BHEL.
2. Simultaneous functioning of different networks shall be checked by configuring different networks with design inputs and trained with off-line data and by choosing a different design case. The different networks shall predict the outputs within close tolerance which shall be fixed during detail design phase.
3. Type of networks to be provided in this module shall be as per BHEL approval.
4. Acceptance test shall be carried out using CSV file inputs.
5. For the purpose of testing on-line training facility, a skeletal application shall be developed which writes data to a pipe and Core engine shall read data for training.
6. The above is gross criterion for Acceptance criterion; however detailed Acceptance Test Protocol shall be worked out after detail design is finalized and approved by BHEL.

Common to Module I and II of Core engine.

1. The list of measured variables shall be configurable; typically 1000.
2. Data inputs to core engine shall be through a file / pipe.
3. Core engine shall receive field signals along with any design inputs.
4. Core engine shall be capable of calculating non measurable parameters from measured parameters.
5. The reconciled data should be saved to the data base (File / MS SQL).
6. Deterioration of sensor failure condition to be detected.
7. BHEL reserves the right to finalize detail design / algorithms during the time of development.

Part B: GUI

GUI of SiVa facilitates the following features

1. Display of Process descriptions showing measured and calculated data in its context.
2. GUI should facilitate display of multiple process descriptions.
3. Configuration of field Sensor List to Core engine.
4. Input Parameter list shown using a Tree View.
5. Add / delete a parameter to the configuration list.
6. Configure Sensor/parameter Properties.
7. Add / delete / update sensor/parameter properties
8. Configuration should be stored in a file / database.
9. Properties of each signal/parameter should be shown upon user selection in Tree View.
10. Graph plots like trend / pie / bar/ surface should be provided; list of actual graph plots shall be finalized during detail design.

11. Y1,Y2 vs. X style Trend Graph to study the trend of any parameter in SiVa application.
12. Plane graph showing classification of patterns in case of Neural nets.
13. Any desired Signal using its ID available in Tree View of shown process view can be dragged and dropped onto trend graph and the graph starts plotting the trend from the instant it is dropped.
14. A single trend graph should accommodate more than one signal ID for trending using different colors for trend plots.
15. Multiple trend graphs can be opened simultaneously.
16. Trend graph should highlight raw, validated / reconciled and invalid portions of signals.
17. Presentation of signal statistics as applicable to VDI 2048 and as finalized by BHEL; signal statistics shall be presented in tabular form / graphic format. Exact format shall be detailed in design phase.
18. Grouping of signals as per user configuration; details shall be worked out during design along with BHEL.
19. Graphic representation of system components with measured and calculated parameters updated periodically. List of system components shall be provided during detail design.
20. Integration of Module I and Module II of Core engine.
21. Interfaces to external data files and applications shall also be developed. Data from external sources can be in the form of either a CSV file or MS Excel Spread sheet.
22. Validate data should be saved in a CSV file for use by down stream applications.
23. Any mutually agreed design alterations shall be incorporated during the development phase.
24. BHEL reserves the right to finalize the details for User Interface screens during development.
25. Time line for Part B shall be seven months.

Common to Part A and Part B

1. Language of implementation shall be VC++ / VC# / Java / Qt; shall be decided during detail design.
2. Coding should be as per BHEL guidelines.
3. OS is MS Windows XP Prof. / Windows 7.
4. Data store shall be File / MS Access/Oracle/MS SQL.
5. Security in terms of authorization to run and stop core engine. Only one instance of engine should be permitted to run.
6. Total time of development for Part A and Part B shall not be more than eleven months.
7. Implementation at every stage should be approved by BHEL both for Part A & B.
8. Part A and Part B shall be integrated and the results of Part A shall be shown in Part B. Integration details shall be finalized during detail design.
9. Part A can also run as independent application, in which case it shall save the results in CSV files.
10. Data sets for Module I and module II shall be provide by BHEL and testing should be carried out with these data sets.

Deliverables

1. Architecture and Design documentation showing class diagrams, Sequence/Collaborative Diagrams, Flow Charts, data structure details etc. separately for Module 1 and 2 of Part A and Part B.
2. Fully commented Total source code for both Module I and II of Part A and Part B separately.
3. Test Protocols / reports for Module I and II of Part A and Part B separately.
4. Special tools and their usage, if any used.
5. Full Executable Modules for both Module I and II of Part A and Part B
6. Executable modules shall also be supplied as installable versions using self extracting feature.
7. Full on-site training on usage and maintenance for Module I and II of Part A and Part B separately.

General

1. Vendor should submit techno-commercial quotes separately for Module I and Module II of Part A (Core Engine) and Part B (GUI) without which offer shall not be considered. This offer should spell out time lines explicitly for each module in Core Engine and also GUI.
2. Technical Offers for Module I and Module II of Part A and Part B should contain detailed methodologies of development without which offer shall not be entertained.
3. Quotation for only a part of either Part A or Part B shall not be entertained.
4. BHEL reserves the right to award only part of the scope i.e. either Module I or Module II of Part A or Part B or the total scope. Payment shall be for the parts developed.
5. Vendor should have been in existence for at least four years carrying out similar assignments. Proof of business activity for the last four years should be attached without which offer shall not be entertained.
6. The company must have successfully executed S/W development projects for any Central Government Establishments / PSUs. Proof to be provided without which the offer shall not be entertained.
7. Vendor should have expertise either by previously executed contracts or in terms of human resources in developing process modeling for thermal power plant applications like performance monitoring / optimization / diagnostics etc., and expertise in developing Artificial Neural Network based applications. The vendor company should have human resources with a minimum experience of 10 years in the S/W development for thermal power plant S/W applications using process modeling of turbines / boilers / condensers / .heat exchangers / pumps etc. Vendor should provide proof of the above competence without which the offer shall not be entertained.
8. Vendor must be willing to execute NDA at the time of Ordering.
9. Vendor must provide on-site development / testing support; time period of support shall be total duration of development.
10. Warranty / Guarantee should be provided for not less than one year from the date of delivery.

11. Bug fixes during the warranty period shall be carried out free of cost.
12. Vendor shall be penalized / black listed in the event of abandoning the development in the middle of the project.
13. Vendor should submit tentative Quality Test plan for Part A and Part B without which offer shall not be entertained.
14. Vendor shall obtain approval of Design/Architecture/Coding from BHEL during various phases of development; failure to do so shall result in cancellation of contract at any stage without any obligations from BHEL.
15. The developed modules will be solely the property of BHEL. BHEL reserves the exclusive IPR rights. Vendor can not publish any information connected with this development without written permission of BHEL.
16. Payments shall be based on Module wise delivery and satisfactory clearance of functionally.

For any Technical Clarifications please contact –

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