Annexure – I
Technical Specification

Summary of Requirements

RFQ No.	Description	Quantity	Page No	Preferred Brand
1	**Computer Hardware and Networking**			
1 (A)	Rack Server	1	3	Dell / HP / Lenovo
1 (B)	Tower Workstation (16 Core)	9	3	Dell / HP / Lenovo
1 (C)	Tower Workstation (12 Core)	12	3	Dell / HP / Lenovo
1 (D)	24 Port Giga Unmanaged Switch	1	4	D Link / Cisco / TP Link
1 (E)	Firewall	1	4	
1 (F)	WIFI Access Point (100 MBPS)	1	4	Cisco / D Link
1 (G)	Server Rack	1	4	
2	**Other Infrastructure and Peripherals**			
2 (A)	Projector	1	4	
2 (B)	Laser Printer (Black and White)	1	5	
2 (C)	Inkjet (Tank)	1	5	
2 (D)	Smart TV	1	5	Acer / LG / Samsung
3	**CAD / CAM Softwares**			
3 (A)	CAD Product Design	1	5	Siemens
3 (B)	CAD – CAD / CAM 3 Axis Milling	1	10	Siemens
3 (C)	CAD – Industrial Design	1	12	Siemens
3 (D)	PCB Schematic, Layout and Basic Analysis	2	19	Siemens
3 (E)	Software for Complete Integrated Suit for CAD / CAM / CAE	2	86	Siemens
4	**CAE Softwares**			
4 (A)	Software for EMI Mitigation in Modern Electronics	1	20	Ansys
4 (B)	Software for Thermal Management for Equipment	1	31	Ansys
4 (C)	Software for Reliability of Electronic Hardware	1	34	Ansys
4 (D)	Software for Embedded Systems and Software Development	1	37	Ansys
4 (E)	Software Model Based Development Environment	1	39	Ansys
4 (F)	Software for Electromagnetic Simulation of Cable Harness	1	43	Ansys
4 (G)	Software for Cyber Safety and Security Solution	1	47	Ansys
4 (H)	Software for FEA and Fluids Simulation	1	49	Ansys
4 (I)	Software for CAD Design Tool	1	70	Ansys
4 (J)	Software for Motor Design Solution	1	73	Ansys
4 (K)	Software for Material Solution	1	75	Ansys

4 (L)	Software for High Performance Computing Solutions	1	78	Ansys
4 (M)	Software for Technical Specifications for Optical Solutions	1	80	Ansys
4 (N)	Software for Optics Design Studio	1	81	Ansys
4 (O)	Software for High Frequency Structural Solver (Academic License)	1 (25 Tasks)	84	Ansys
4 (P)	Software for Electromagnetics (Academic License)	1 (25 Tasks)	85	Ansys
4 (Q)	Software for FEA and CFD (Academic License)	1 (5 Tasks)	85	Ansys
4 (R)	Software for Teaching Optics (Academic License)	1 (5 Tasks)	86	Ansys

Note :

MECF intent to have perpetual License for the softwares mentioned above except for PCB Schematic, Layout and Basic Analysis

RFQ 1 - Computer Hardware & Networking Specifications

RFQ 1 (A) Specification for Rack Server

	General Specifications	
Sr No	**Parameters**	**Specification**
1	Processor	Latest Xeon Processor with 64 Core
2	RAM	1TB DDR5 RAM
3	Primary Storage	1 TB, M.2, PCIe NVMe, SSD, Class 40
4	Additional Storage	50 TB, 5400 RPM, 3.5-inch, SATA, HDD
5	Network Connectivity	RJ45 Ethernet port
6	Graphics Card	NVIDIA® Quadro Series Graphic Card 16GB
7	Operating System	Linux
8	Monitor	24 inches Full HD IPS Panel

RFQ 1 (B) Specification for Tower Workstation – 16 Core

	General Specifications	
Sr No	**Parameters**	**Specification**
1	Processor	13th Gen Intel® Core™ i7-13700 (30 MB cache, 16 cores, 24 threads, 2.10 GHz to 5.20 GHz Turbo, 65 W)
2	RAM	64 GB, 2 x 32 GB, DDR5, 4400 MT/s, V2
3	Primary Storage	1 TB, M.2, PCIe NVMe, SSD, Class 40
4	Additional Storage	4 TB, 5400 RPM, 3.5-inch, SATA, HDD
5	Network Connectivity	RJ45 Ethernet port
6	Power Supply	500W
6	Graphics Card	NVIDIA® T1000 8GB, 8 GB GDDR6, 4 mDP to DP adapters
7	Operating System	Windows 10 Pro
8	Monitor	24 inches Full HD IPS Pannel

RFQ – 1 (C) Specification for Tower Workstation – 12 Core

	General Specifications	
Sr No	**Parameters**	**Specification**
1	Processor	12th Gen Intel® Core™ i7-12700 (25 MB cache, 12 cores, 20 threads, 2.10 GHz to 4.90 GHz Turbo, 65 W)
2	RAM	64 GB, 2 x 32 GB, DDR5, 4400 MT/s, V2
3	Primary Storage	1 TB, M.2, PCIe NVMe, SSD, Class 40
4	Additional Storage	4 TB, 5400 RPM, 3.5-inch, SATA, HDD
5	Network Connectivity	RJ45 Ethernet port
6	Power Supply	500W
6	Graphics Card	NVIDIA® T1000 8GB, 8 GB GDDR6, 4 mDP to DP adapters
7	Operating System	Windows 10 Pro
8	Monitor	24 inches Full HD IPS Pannel

RFQ – 1 (D) Specification for 24 PORT GIGA UNMANAGED SWITCH

General Specification		
Sr No	**Parameters**	**Specification**
1	Port Standards	IEEE 802.3 10BASE-T
2	Data Transfer Rates	100 Mbps Half-Duplex , • 200 Mbps Full-Duplex
3	LED Indicators	• Link/Activity Per device: • Power
4	Transmission Method	Store-and-forward
5	Network Connectivity	RJ45 Ethernet port
6	Number of Ports	24 10/100Mbps Fast Ethernet ports
7	24 Port	24 Port patch Pannel Loaded

RFQ – 1 (E) Specification for Firewall

General Specification		
Sr No	**Parameters**	**Specification**
1	Firewall throughput	YES
2	Threat Protection	YES
3	SSL VPN concurrent tunnels	YES
4	SSL/TLS concurrent connections	YES
5	IPsec VPN concurrent tunnels	YES

RFQ – 1 (F) Specification for Wifi Access Point

General Specification		
Sr No	**Parameters**	**Specification**
1	Connectivity	100 Mbps

RFQ – 1 (G) Specification for Server Rack

General Specification		
Sr No	**Parameters**	**Specification**
1	Specification	23U Usable

RFQ – 2 Other Infrastructure and Peripherals

RFQ – 2 (A) Specification for Projector

General Specification		
Sr No	**Parameters**	**Specification**
1	Brightness	3800
2	Resolution	1080P (1920x1080)
3	Native Aspect Ratio	16:09
4	Contrast Ratio	20,000:1
5	Display Color	30-bit (1.07 billion colors)

6	Picture Modes	3D, Bright, Infographic, Presentation, Spreadsheet, sRGB, User 1, User 2

RFQ – 2 (B) Specification for Laser Printer (Black & White)

General Specification		
Sr No	**Parameters**	**Specification**
1	Functions	Print, copy, scan, fax
2	Paper Size	A4
3	Print Quality	Black: Up to 600 x 600 dpi Color
4	Processor speed	600 MHz
5	Print Cartridges	1 (black)
6	Memory	128 MB

RFQ – 2 (C) Specification for Inkjet (Tank)

General Specification		
Sr No	**Parameters**	**Specification**
1	Functions	Print, copy, scan, fax
2	Paper Size	A4
3	Print quality	Black: Up to 600 x 600 dpi Color
4	Printer Output	Colour
5	Printing Technology	Inkjet

RFQ – 2 (D) Specification for Smart TV

General Specifications		
Sr No	**Parameters**	**Specification**
1	Size	32 Inches
2	Resolution	Full HD
3	Connectivity	HDMI
4	Wall Mount	YES

RFQ – 3 CAD / CAM Softwares

RFQ – 3 (A) Specification for CAD – Product Design

General Specification (NX Mach 1)

General Capabilities

- Should support master-model concept of 3D modeling and other downstream application providing complete integration between modeling, drafting, assembly, manufacturing, and finite element analysis environments in the same gateway.
- Should support OS viz., Microsoft Windows (Win10, Win11), RedHat Linux and Suse Linux operating systems.
- There should be no reason to believe that any specialized "migration service" would be required for bringing data into the latest version from any of the preceding 5 versions of the software.
- The software should support history-based and history-free ways of modeling in the same environment. Users should be able to toggle between history-based modeling and history free (direct) modeling while in the part modeling or assembly modeling environment. This toggle should happen without closing of the working session.

Specifications for Basic CAD software

The following are required in addition to all the features described as "General Capabilities" above.

Sketching

- Capability to create 2D sketch on a Plane, a planar face or on a Path
- Dynamic preview during creation of Sketch-curve
- Help-lines while creating sketch-curves for horizontal & vertical alignment with end-points and mid-points of existing entities
- Option to create a sketch internal to a specific modeling feature or to keep it external to child-feature
- Dynamic update of color of individual sketch-entities based on their constraint-status (under-constrained, fully-constrained, over-constrained)
- Capability for Auto-constraining and auto-dimensioning while creating sketch-curves
- Continuous on-screen display of degrees of freedom of sketch-curves
- Capability to re-attach dimensions from one entity to another entity
- Capability to re-attach a complete sketch from one plane to another
- Option to delay the evaluation of the changes made in a sketch to avoid drastic & partial modifications affecting the sketch adversely
- Ability to project existing curves including curves imported from DWG or DXF and edges
- Patterning of sketch curves, creating regular polygons, chamfers and fillets in sketches.

Math-engine & Expressions

- Capability to create user-defined formulae, rules and expressions within part files to drive part-dimensions and attributes. These expressions can return numbers, strings, points, vectors, Booleans
- Ability to link one expression with another within the same part or even between two separate parts or assemblies
- Provides a comprehensive set of in-built mathematical / trigonometrical functions

- Part-expressions to support nested loops and conditionals like if-then-else statements and for-loops
- Built-in standard mechanical engineering functions and formulae. For example, standard formulas for stresses, displacements, bending-moments for beams and plates under various loading conditions; spur-gear-calculations, material-modulus calculations, spring calculations, vibrations calculations etc.

Solid Modeling

- Ability to create features from open as well as closed sketches
- Ability to create features from sketches irrespective of its constraint status (under-, fully- or over-constrained)
- Ability to extrude & revolve solid features from open sketches using offset option
- Ability to create conic fillets, edge-based fillets, face-blends on 3D models
- Create curves derived from mathematical equations
- Create helical curve along curved path
- Ability to extract curves associatively or un-associatively from existing edges & other curves that may even belong to other parts in an assembly
- Capability to emboss sections on complex faces with multiple draft and end-cap options
- Ability to create symbolic or actual thread-features on cylindrical faces. Multiple types of threads - Metric, UNJ, Unified, Trapezoidal, ACME, stub acme, Lowenherz, Buttress, NPT, etc.
- Ability to shell solids or regions of solids and offset surfaces with uniform or variable thicknesses. Should automatically handle minimum bend-radius violations and provide partial results if necessary.
- Ability to Trim, divide and split faces and solids associatively
- Allow filtering of features in the model's feature-tree based on specified criteria like name (using wildcards), attributes (based on type-value pair), feature category or type, features' state (failed, suppressed, out-of-date, warnings, etc), timestamp, model-views & alerts. Allow negative filtering of selected criteria. Allow saving of selected criteria for future use.
- Undo/Redo capability.
- Capability to import/export 3D data to/from various standard formats like STL, IGES, STEP, Parasolid and JT.

Re-use Library

- Capability to define parametric template parts & assemblies driven by their own customized dialog-boxes that can be built using a completely code-free environment.
- Capability to build a hierarchy of libraries containing such re-usable templates of parts and assemblies
- Option to include bitmap image in the dialog-box, pull-down values and upper-lower limits for part-sizes.

Direct editing of 3D models

- Capability to edit parts that do not have any feature history. This should be provided in the same environment as solid modeling.

- Possibility of directly editing by selecting faces or groups of faces and either by dynamically dragging these or by attaching dimensions
- Intelligence in the software to preserve design intent of 3D parts while such changes are made.
- Intelligence in the software to automatically select groups of faces that appear as generic engineering features like bosses, ribs, holes, pockets, slots, etc.
- On selection of one face, software should have built-in intelligence to automatically select all tangential, coaxial, coplanar, symmetric or offset faces so that all can be edited in unison
- Ability to create geometrical constraints between faces
- Provision to create driving dimensions directly on features or faces.

Assembly Modeling

- Capability for creating 3D assemblies using both top-down and bottom-up approaches
- Capability to provide geometric constraints between components like touch & align, concentric, parallel, perpendicular and centered constraints.
- Capability to provide positional constraints between components like linear distances between faces, edges or points and & angular deviation between faces or edges.
- Support for handling very large assemblies by allowing the user to selectively control loading and display of components – segregation of information stored in a part-file – e.g. lightweight data, graphical data, detailed CAD-information and inter-part data – should help in optimally loading and displaying a large assembly. These data should be loaded on demand to enhance performance without compromising user-experience.
- Capability to dynamically move a component in space, with options to honor / dishonor its constraints and with options to detect and even stop when a collision occurs.
- Ability to create reference sets – user-defined sets of entities that can be displayed in a higher level assembly instead of the complete part.
- Ability to create arrays of components. The arrays should be associative if they are constrained to arrayed features
- Capability to set minimum clearance-requirements in an assembly, set zones or pairs that are allowed to violate such requirements, validate the assembly against these rules, study the hard and soft interferences in details, isolate the solids of hard-interference and save the results as a report.
- Capability to define assembly/disassembly or motion sequences by defining components' start and end positions. Should be capable of reporting any collision with other bodies during such motion.

Freeform Modeling, Basic

- All surfacing commands must be history-supported and should not result in any deletion of the model's history.
- Capability to create lofted surface through non-intersecting sections, each section containing contiguous curves with option to preserve. Option to control position-, tangent- or curvature-continuity at end-sections with adjoining surfaces. Option to re-parameterize the lofted surface to enhance smoothness. Provision to select the iso-lines of the lofted surface based on arc-length of the sections, connecting points, by distance along a vector,

by a template curve or by segments. Capability to create either single-patch or multi-patch lofted surface.
- Capability to create to create a body through a mesh of sections in one direction, and guides in another direction. Option to define continuity with adjacent surfaces.
- Capability to create a multi-sided surface by defining the boundaries of the patch.
- Capability to sweep an open or a closed section along guide curves with option for lateral or uniform scaling when there are only 2 guides.

Drafting

- Capability to create 2D engineering-drawings completely associative to a 3D model with options for view-selection and placement (both first-angle and third-angle projections), hidden-line processing, section-views, inheritance of feature-dimensions and 3D annotations, creation of part-lists / BOM of assemblies with associative ballooning, creation of additional dimensions and annotations and company-standard title-blocks.
- Capability to add multiple sheets of different sizes to a drawing
- Capability to select from a list of metric and English standard sheet-sizes while creating sheets or later
- Arrow-head types and sizes can be defined during creation by user or later during editing.
- Capability to create dual dimensions, tolerances, reference and inspection dimensions.
- Capability to add annotations on any of the 4 sides of a dimension and associatively link their positions to the parent dimension.
- Support of a library of industry standard drafting and GD&T symbols
- Capability to add cross-hatch by selecting a point in a closed area or a set of curves that define a boundary.
- Capability to create broken views with simple, saw-tooth, tubular, rod and solid tubular break-ends.
- Capability to import raster images (JPEG, PNG, TIFF) in to drawing.
- Capability to associatively add existing expressions or attributes in the part to an annotation.
- Capability to create user-defined character and line fonts
- Capability to use layers for hiding and showing entities in drafting views

Straight Brake Sheet Metal

- Capability to create basic sheet-metal features like tabs, flanges, lofted flanges, contour flanges, hem flanges, jogs, bends.
- In-built functions to create form-features like beads, louvers, dimples, gussets and drawn cutouts on a base sheet-metal feature.
- Capability to define a solid body as a punch to create sheet-metal feature.
- Capability to treat sheet-metal corners using in-built features like closed-corners, open-corners, circular / U-shaped / V-shaped cutouts and three-bend corners.
- Ability to flat solid from a sheet-metal part with cylindrical or conical bends
- Ability to create flat-pattern drawings with annotations for bending, punching or cutting manufacturing instructions in automated or semi-automated fashion. Ability to create formed and unformed (flattened) views of the part in the same 2D drawing

- Ability to incorporate annotations / callouts for Tool ID information in manufacturing or process planning drawings.

Collaborative Design and Data Management

- Capability to work in a managed environment with facilities for version-controlling, check-in check-out, data-vaulting using industry-standard database systems.
- Ability to create light-weight package file of CAD parts and assemblies that can be shared over internet and e-mail (depending on the size) more efficiently than the original data. Ability to open and review the package file on a freely downloadable viewer.

UDF (User-defined features)

- Capability to define a library of re-usable groups of modeling features
- Capability to define the driving dimensions while creating the feature group.
- No need to define the driven dimensions and the hard-coded ones while defining the reusable feature-group.

Product Validation

- Provide a set of standard tools to check compliance of modeling, drafting and assembly against well-known industry CAD-practices.
- Capability of software to save the results of the checks in the part-files
- Among others, checks should include consistency of assembly inter-part links, whether clearance analysis has been run or not, consistency of model geometry, feature positioning and tolerances, chamfer and blend feature too early in the model history, sheet body offset thickness, un-parameterized features, whether all sketches are fully constrained, drafting with false dimensions, drawings with overlapping views, whether all drawings are up-to-date, spell-check on drawing notes, VDA 4955 compliance.
- Single command to make an edge planar and curvature-symmetric so that a subsequent mirror would be curvature-continuous.
- Option to create a styled-blend between two surfaces by controlling the depth of the blend, its skew and the chordal distances
- Capability to snip-back surfaces based on a curve and re-parametrize these so that the trim-edge is converted to a natural edge.
- Capability to fit existing surfaces by wrapping them on facets.

RFQ – 3 (B) Specification for CAD – CAD/CAM 3 Axis Milling

CAD/CAM 3 Axis Milling Software Specification

General Specification

1. Integrated and Parametric CAD/CAM software should be from single software vendor and not from multiple or third party vendor. Also should have capability to add CAE/CMM in the same integrated interface.

2. There should be no disruption of work due to license expiry after the completion of the standard support / warranty period. Only Perpetual licensing in real sense should be proposed and will only be considered. After the expiry of the standard warranty, the software licensing should be valid and should be working even if the warranty or AMC is not extended by us. The vendor should not propose any annual lease licensing, nor annual key licensing.
3. Integrated and Parametric CAD/CAM/CMM software should be based on single underlying base kernel and have single user-interface across all applications.
4. CAD/CAM software supplied should support Microsoft Windows (Win10), MAC OS and Suse/REDHAT Linux operating systems.
5. CAD software should be able to import standard data translation formats like (STEP, STP, IGES, Parasolid, JT, STL etc.
6. Integrated Software should have CAD functions for Parametric Solid Modeling, Direct & Synchronous Modeling and Advanced Surfacing capability. CAD software should be able to create assembly models for Fixture design and Drafting for shop drawing.
7. CAM software should be integrated or associated with CAD software such that any changes in CAD model will reflect in CAM software and re-importing of CAD geometry is not required. Also for change in CAD model, CAM software should notify programmer that programs are out of date with CAD model and allow for Automatic Regeneration of programs.
8. CAM Software should be able to analyze Draft, Minimum Radius, and Undercuts from model and be able to remove undercuts within the CAM software. CAM software should be able to patch or delete holes within a single function.
9. CAM software should be able to program Turning, Feature Based Machining, Milling of 3axis, Complex 5axis and Advanced Mill-turn machines in single software and User Interface.
10. CAM software should be able to machine on Solid, Surface and STL (polygon) data models.
11. CAM Software should support On Machine Inspection program generation using Renishaw or similar Probes within the same Software & User interface. CAM software should be able to program 5axis inspection.
12. CAM Software should have Feature Based Machining which automatically identifies features & Creates Complete programs with appropriate tool selection from Library, also within the same software and User Interface.
13. CAM software should be able to output Siemens & Fanuc standard Turning & Drilling output.
14. CAM Software should be able to copy/paste machining operations from one file to another for easy repeatability of programming strategy.
15. CAM Software should support consideration of Product Manufacturing Information (PMI) tolerances during generation of CAM programs.

16. CAM Software should be able to dynamically check remaining material after program generation and give color coded representation or plot with respect to original model.
17. CAM Software should have Tool Library which can store Tool information such as Tool Type Tool Geometric Definition, Tool Material, Tool Feed & Speed based on Part Material Machined & Tool Feed & Speed based on Process (Roughing, Semi-finishing, Finishing)
18. CAM Software should be able to verify Programs through Gouge check, Holder collision Check, 3D Simulation & Machine Simulation within the same User Interface.
19. CAM Software should have Integrated Verification and Machine Simulation and not use any external third party software for the same. Integrated Verification and Machine simulation should be capable of handling turning machines, 3 axis milling machines (orthogonal & Non-orthogonal machines) & Mill-turn machines with multi channels.
20. Machine Simulation should be based on G-code simulation and not internal toolpath. i.e. it should Simulate G-Code of programs.
21. Machine simulation within CAM software should also be able to simulate programs created externally or manually using controller MDI.
22. Cam Software should support time based program operation Synchronization of machining channels in Mill-Turn machines.
23. CAM Software should also support Tombstone Machining within the same User Interface.
24. CAM Software should be easy to use and be able to adjust User Interface based on level of user, such that it improves productivity of beginner and advanced user.
25. CAM Software should be able to create Templates or Macros for automation of milling and Turning Programming.
26. CAM Software should be able to create Shop Documentation for machining programs with all relevant machining information like Tool Definition, Holder Definition, Feeds & Speeds Cutting and Non Cutting Air time etc.

RFQ – 3 (C) Specification for CAD – Industrial Design

General Specification
General Capabilities • Should support master-model concept of 3D modeling and other downstream application providing complete integration between modeling, drafting, assembly, manufacturing and finite element analysis environments in the same gateway. • Should support OS viz., Microsoft Windows (Win10, Win11), RedHat Linux and Suse Linux operating systems. • There should be no reason to believe that any specialized “migration service” would be required for bringing data in to the latest version from any of the preceding 5 versions of the software. • The software should support history-based and history-free ways of modeling in the same environment. User should be able to toggle between history based modeling and history

free (direct) modeling while in the part modeling or assembly modeling environment. This toggle should happen with our closing of the working session.

Specifications for Basic CAD software

The following are required in addition to all the features described as “General Capabilities” above.

Sketching

- Capability to create 2D sketch on a Plane, a planar face or on a Path
- Dynamic preview during creation of Sketch-curve
- Help-lines while creating sketch-curves for horizontal & vertical alignment with end-points and mid-points of existing entities
- Option to create a sketch internal to a specific modeling feature or to keep it external to child-feature
- Dynamic update of color of individual sketch-entities based on their constraint-status (under-constrained, fully-constrained, over-constrained)
- Capability for Auto-constraining and auto-dimensioning while creating sketch-curves
- Continuous on-screen display of degrees of freedom of sketch-curves
- Capability to re-attach dimensions from one entity to another entity
- Capability to re-attach a complete sketch from one plane to another
- Option to delay the evaluation of the changes made in a sketch to avoid drastic & partial modifications affecting the sketch adversely
- Ability to project existing curves including curves imported from AutoCAD and edges
- Patterning of sketch curves, creating regular polygons, chamfers and fillets in sketches

Math-engine & Expressions

- Capability to create user-defined formulae, rules and expressions within part files to drive part-dimensions and attributes. These expressions can return numbers, strings, points, vectors, Booleans
- Ability to link one expression with another within the same part or even between two separate parts or assemblies
- Provides a comprehensive set of in-built mathematical / trigonometrical functions
- Part-expressions to support nested loops and conditionals like if-then-else statements and for-loops
- Built-in standard mechanical engineering functions and formulae. For example, standard formulas for stresses, displacements, bending-moments for beams and plates under various loading conditions; spur-gear-calculations, material-modulus calculations, spring calculations, vibrations calculations etc.

Solid Modeling

- Ability to create features from open as well as closed sketches
- Ability to create features from sketches irrespective of its constraint status (under-, fully- or over-constrained)
- Ability to extrude & revolve solid features from open sketches using offset option
- Ability to create conic fillets, edge-based fillets, face-blends on 3D models
- Create curves derived from mathematical equations

- Create helical curve along curved path
- Ability to extract curves associatively or un-associatively from existing edges & other curves that may even belong to other parts in an assembly
- Capability to emboss sections on complex faces with multiple draft and end-cap options
- Ability to create symbolic or actual thread-features on cylindrical faces. Multiple types of threads - Metric, UNJ, Unified, Trapezoidal, ACME, stub acme, Lowenherz, Buttress, NPT, etc.
- Ability to shell solids or regions of solids and offset surfaces with uniform or variable thicknesses. Should automatically handle minimum bend-radius violations and provide partial results if necessary.
- Ability to Trim, divide and split faces and solids associatively
- Allow filtering of features in the model's feature-tree based on specified criteria like name (using wildcards), attributes (based on type-value pair), feature category or type, features' state (failed, suppressed, out-of-date, warnings, etc), timestamp, model-views & alerts. Allow negative filtering of selected criteria. Allow saving of selected criteria for future use.
- Undo/Redo capability.
- Capability to import/export 3D data to/from various standard formats like STL, IGES, STEP, Parasolid and JT.

Re-use Library

- Capability to define parametric template parts & assemblies driven by their own customized dialog-boxes that can be built using a completely code-free environment.
- Capability to build a hierarchy of libraries containing such re-usable templates of parts and assemblies
- Option to include bitmap image in the dialog-box, pull-down values and upper-lower limits for part-sizes.

Direct Editing of 3D Models

- Capability to edit parts that do not have any feature history. This should be provided in the same environment as solid modeling.
- Possibility of directly editing by selecting faces or groups of faces and either by dynamically dragging these or by attaching dimensions
- Intelligence in the software to preserve design intent of 3D parts while such changes are made.
- Intelligence in the software to automatically select groups of faces that appear as generic engineering features like bosses, ribs, holes, pockets, slots, etc.
- On selection of one face, software should have built-in intelligence to automatically select all tangential, coaxial, coplanar, symmetric or offset faces so that all can be edited in unison
- Ability to create geometrical constraints between faces
- Provision to create driving dimensions directly on features or faces

Assembly Modeling

- Capability for creating 3D assemblies using both top-down and bottom-up approaches

- Capability to provide geometric constraints between components like touch & align, concentric, parallel, perpendicular and centered constraints.
- Capability to provide positional constraints between components like linear distances between faces, edges or points and & angular deviation between faces or edges.
- Support for handling very large assemblies by allowing the user to selectively control loading and display of components – segregation of information stored in a part-file – e.g. lightweight data, graphical data, detailed CAD-information and inter-part data – should help in optimally loading and displaying a large assembly. These data should be loaded on demand to enhance performance without compromising user-experience.
- Capability to dynamically move a component in space, with options to honor / dishonor its constraints and with options to detect and even stop when a collision occurs.
- Ability to create reference sets – user-defined sets of entities that can be displayed in a higher level assembly instead of the complete part.
- Ability to create arrays of components. The arrays should be associative if they are constrained to arrayed features
- Capability to set minimum clearance-requirements in an assembly, set zones or pairs that are allowed to violate such requirements, validate the assembly against these rules, study the hard and soft interferences in details, isolate the solids of hard-interference and save the results as a report.
- Capability to define assembly/disassembly or motion sequences by defining components' start and end positions. Should be capable of reporting any collision with other bodies during such motion.

Freeform Modeling, Basic

- All surfacing commands must be history-supported and should not result in any deletion of the model's history.
- Capability to create lofted surface through non-intersecting sections, each section containing contiguous curves with option to preserve. Option to control position-, tangent- or curvature-continuity at end-sections with adjoining surfaces. Option to re-parameterize the lofted surface to enhance smoothness. Provision to select the iso-lines of the lofted surface based on arc-length of the sections, connecting points, by distance along a vector, by a template curve or by segments. Capability to create either single-patch or multi-patch lofted surface.
- Capability to create to create a body through a mesh of sections in one direction, and guides in another direction. Option to define continuity with adjacent surfaces.
- Capability to create a multi-sided surface by defining the boundaries of the patch.
- Capability to sweep an open or a closed section along guide curves with option for lateral or uniform scaling when there are only 2 guides.

Drafting

- Capability to create 2D engineering-drawings completely associative to a 3D model with options for view-selection and placement (both first-angle and third-angle projections), hidden-line processing, section-views, inheritance of feature-dimensions and 3D annotations, creation of part-lists / BOM of assemblies with associative ballooning, creation of additional dimensions and annotations and company-standard title-blocks.

- Capability to add multiple sheets of different sizes to a drawing
- Capability to select from a list of metric and English standard sheet-sizes while creating sheets or later
- Arrow-head types and sizes can be defined during creation by user or later during editing.
- Capability to create dual dimensions, tolerances, reference and inspection dimensions.
- Capability to add annotations on any of the 4 sides of a dimension and associatively link their positions to the parent dimension.
- Support of a library of industry standard drafting and GD&T symbols
- Capability to add cross-hatch by selecting a point in a closed area or a set of curves that define a boundary.
- Capability to create broken views with simple, saw-tooth, tubular, rod and solid tubular break-ends.
- Capability to import raster images (JPEG, PNG, TIFF) in to drawing.
- Capability to associatively add existing expressions or attributes in the part to an annotation.
- Capability to create user-defined character and line fonts
- Capability to use layers for hiding and showing entities in drafting views

Straight Brake Sheet Metal

- Capability to create basic sheet-metal features like tabs, flanges, lofted flanges, contour flanges, hem flanges, jogs, bends.
- In-built functions to create form-features like beads, louvers, dimples, gussets and drawn cutouts on a base sheet-metal feature.
- Capability to define a solid body as a punch to create sheet-metal feature.
- Capability to treat sheet-metal corners using in-built features like closed-corners, open-corners, circular / U-shaped / V-shaped cutouts and three-bend corners.
- Ability to flat solid from a sheet-metal part with cylindrical or conical bends
- Ability to create flat-pattern drawings with annotations for bending, punching or cutting manufacturing instructions in automated or semi-automated fashion. Ability to create formed and unformed (flattened) views of the part in the same 2D drawing
- Ability to incorporate annotations / callouts for Tool ID information in manufacturing or process planning drawings

Collaborative Design and Data Management

- Capability to work in a managed environment with facilities for version-controlling, check-in check-out, data-vaulting using industry-standard database systems.
- Ability to create light-weight package file of CAD parts and assemblies that can be shared over internet and e-mail (depending on the size) more efficiently than the original data. Ability to open and review the package file on a freely downloadable viewer.
- UDF (User-defined features)
- Capability to define a library of re-usable groups of modeling features
- Capability to define the driving dimensions while creating the feature group.
- No need to define the driven dimensions and the hard-coded ones while defining the reusable feature-group.
- Product Validation

- Provide a set of standard tools to check compliance of modeling, drafting and assembly against well-known industry CAD-practices.
- Capability of software to run a selected set of model-checks in either batch or interactive mode and recurse through a complete folder.
- Capability of software to save the results of the checks in the part-files
- Among others, checks should include consistency of assembly inter-part links, whether clearance analysis has been run or not, consistency of model geometry, feature positioning and tolerances, chamfer and blend feature too early in the model history, sheet body offset thickness, un-parameterized features, whether all sketches are fully constrained, drafting with false dimensions, drawings with overlapping views, whether all drawings are up-to-date, spell-check on drawing notes, VDA 4955 compliance.
- 3D Annotation (GD & T, PMI)
- Capability to create 3D annotation PMI (Product Manufacturing Information) directly over a model. Annotations include various types of dimensions on model entities, surface finish symbols, locator and weld symbols, datum symbols, feature-control frames, notes, geometric-tolerancing (GD&T) symbols, pre-set company-proprietary or government-security symbols, etc.
- Capability to select and associate auxiliary objects for a PMI to communicate multiple entities in the model that have to be considered during manufacturing for that PMI.
- Provision to create report of all the PMIs in a model
- Capability to define different views in the model and associate and display of various PMIs in such views to reduce clutter and to segregate PMIs according to interest-areas.
- Freeform Modeling, advanced
- Capability to enlarge or contract a surface by using drag-handles and keep the edit as a feature (history-supported)
- Capability to edit a surface by changing either its degree/order, or its number of segments/knots, or its stiffness and keep the edit as a feature (history-supported)
- Capability to edit a surface by fitting it to a target geometry or faceted point data by providing a user-controlled checking distance and an optional direction for fitting. Keep the edit as a feature (history-supported)
- Capability to edit a surface by modifying the locations of its defining points and keep the edit as a feature (history-supported)
- Capability to edit a surface by modifying the locations of its control points and keep the edit as a feature (history-supported)
- Advanced Assemblies
- Capability to analyze weights data of a complete assembly by simple click of a button and report it in textual format or in a spreadsheet.
- Capability to store all weights data of all components as a default and automatic operation during file-save
- Capability to simplify a large assembly for easier visualization – using either wrapping techniques, selective display of faces, defining zones of interest or faceted representations,
- Capability to create component-groups based on interest areas (for example, those related to manufacturing teams, design teams, reviewers, etc.)
- WAVE Control

- Software should provide a framework for creating and managing multiple levels of interpart dependencies and control-structures to streamline the design-process of large assemblies in a team-environment where hierarchical decision-making results complex inter-dependencies in the product-structure.
- Capability in software to review, modify and update all interpart relations including geometrical links or links between driving / driven dimensions or expressions.
- Capability to display the inter-part links, their parent-child-relationships, their update status and load status of a specific assembly in a graphical manner
- Capability to display the inter-part links, their parent-child-relationships, their update status and load status of all parts of a session in a graphical manner
- Freeform Shape / High-class surfacing
- Capability to create curves to remain exactly on surfaces and to constrain these with adjoining geometries using C0, C1 or C2 continuity
- Capability to edit an existing surface by fitting it to a target geometry or faceted point data by providing a user-controlled checking distance with an optional direction for fitting. Software must keep such a modification as a feature in the part's history.
- Capability to edit a surface by modifying the locations of its defining points and preserve the changes as a feature (history-supported)
- Capability to smoothen the distribution of pole / control-points of a surface with respect to its surrounding data and keep the edit as a feature (history-supported)
- Capability to snip-back surfaces based on a curve and re-paramterize these so that the trim-edge is converted to a natural edge.
- Single command to build surfaces by lofting or sweeping, depending on the selection of any number of section curves and guide curves. Option to preserve up to curvature-continuity with adjoining surfaces, if any.
- Single command to edit b-surfaces or spline curves by dynamically manipulating the locations of control-points by selecting these individually or in groups and at the same time increase/decrease the number of control points by changing the order or number of patches of the free-form entity. Command should also provide options to maintain upto G3 continuity at selected ends, and/or lock selected control-points and/or to move adjacent control points proportionally.
- Advanced Surface Analysis
- Capability to provide a framework of analysis results that must be dynamic, i.e. should update immediately when the underlying objects are modified
- Capability to display deviation data between target objects and one or more reference objects. Target and reference objects may include any of the various types like Curves, faces, edges, and facet bodies. Labels, needles, color mapping, and a color legend should identify maximum and minimum deviation, and where deviation exceeds inner and outer tolerances. Option to provide feedback of deviation in 3D space, along a vector or by projecting objects onto the work view plane or any other reference plane.

RFQ – 3 (D) Specification for PCB Schematic, Layout and Basic Analysis

General Specification
Description
Integrated, correct-by-construction component library, ensuring that once a part is defined, the symbol, cell and part mappings will be in sync.
Support for Import and export of parts.
Should provide a starter library with current manufacturer's part numbers and include a wide variety of device types, well-defined partitions for easy navigation and IPC-7351B compliant.
Design Definition (Schematic Entry) Schematic or table-driven design entry of digital, analog/mixed signal circuits.
Unlimited hierarchy for easy design reuse.
Support for Variant management and cross probing with the layout.
Support for object alignment functionality to help align objects as and when they are placed on the schematic.
GRC functionality to find Off-grid components, text placed away from object-owner, etc.
Constraint Management A fully integrated unified constraint-driven design methodology to automate design rule communication.
Support for direct integration with schematic, layout and built-in analysis SI Analysis
Analog/Mixed-Signal Simulation Advanced circuit simulation with comprehensive analysis for analog, mixed-signal, and mixed-technology PCB circuits.
Support for simulation using spice and VHDL models
PCB Layout: It should provide powerful data measurements, waveform viewers, and post-processing calculators
Multilayer PCB editing and routing, Integrated Constraint Manager, Semi auto Routing, Dynamic high-performance healing of planes and thermal reliefs.
Support for Hierarchical group placement in 2D/3D layout. Should include a fully integrated true parametric 3D layout with placement, constraints, DRC checking, and photorealistic visualization. It should have use the same selection, planning and placement functionality as PCB layout. 3D mechanical kernel should use complete set of 3D constraints with dynamic collision detection and batch verification. It should support full photorealistic visualization of board elements, like traces, components, silkscreen, solder mask, and vias, is provided with transparency, z-axis scaling, view/rotation control, and x/y/z cut planes. It should allow import of mechanical items like chassis and heat sinks, and even sub-assemblies of other PCB designs into 3D.
Support for Auto fan-out, Sketch routing, multi-flow routing.
Support for design of most complex boards that include complex, constrained topologies and power distribution, differential pairs, wide busses, and large fine-pitch BGAs. Should optimize the escapes from components like BGAs so they are optimal for routing
Support for dynamic glossing of traces, should reduce segments, prevent acute angles and obey pad entry rules.

Support for MCAD Collaboration tool to pass information to popular industry mechanical design systems.
Support for export of 3D to industry standard formats and a 3D PDF file.
Basic features Signal Integrity Analysis To identify signal degradation issues including over/undershoot, ringing, crosstalk problems. It should help in defining stackup and routing constraints for layout.
Thermal Analysis Support for both Pre-layout and post-layout analysis.
Analyze board-level thermal problems on placed, partially routed, or fully routed PCB designs. It should provide Temperature profiles, gradients, and excess temperature maps. Ability to produce desired outputs for System-level Thermal analysis capability in future.
PCB Manufacturing Documentation Support for Manufacturing documentation, Panel documentation and outputs to be created from the layout environment. The Panel documentation, fabrication drawings should be easily created using pre-set templates.
Data Migration Ability to migrate existing Classic PADS Flow Libraries & Projects into the new flow.
Subscription model licensing should be supported.

RFQ – 4 CAE Softwares

RFQ – 4 (A) Specification for Software for EMI Mitigation in Modern Electronics

General Specifications

Software should have a comprehensive simulation suite designed for the design, analysis, and optimization of electronic systems. It includes electromagnetic field solvers, circuit and system simulators, and various tools for modeling, simulating, and analyzing RF, microwave, antenna, EMI/EMC, signal integrity, and power integrity designs. The suite integrates multiple solvers for mechanical, thermal, and fluid analysis, providing a complete solution for electronic product development.

Technical requirements:

Features
Modules to be included The package should has the capability to simulate any arbitrary 2D or 3D model for EM simulation from DC to THz frequency and can also extend the solution to Multiphysics Thermal Analysis. Moreover, Circuit simulation tool allow user to integrate multiple electromagnetically analyzed models to carry out a system-level analysis.
Numerical Solver Technology required • HFSS (High Frequency 3D Electromagnetic Field simulation) • 3D full-wave Frequency Domain-based electromagnetic field solver based on the Finite Element Method (FEM). • 3D full-wave Frequency Domain-based electromagnetic field solver based on Integral Equation Method (MoM). • 3D full-wave Time Domain-based electromagnetic field solver based on Discontinuous Galerkin (DG) and FEM Time Domain Methods.

- 3D full-wave Frequency Domain-based Asymptotical electromagnetic field solver based on Shooting and Bouncing Ray + (SBR+) method.
- 3D full-wave Frequency Domain, Eigen Mode Solver, based on FEM.
- 3D Full-wave Frequency Domain Characteristic Mode Analysis Solver based on MoM.
- 3D Multifaction solver for finding RF breakdown inside High Power RF components
- 3D simulation tools support Hybridization FEM, IE and SBR+/PO solver in a single design.
- SBR+ solver should automatically combine following asymptotic methods to arrive at an accurate solution.
- Physical Optic (PO),
- Geometrical Optic (GO),
- Physical Theory of Diffraction (PTD),
- Uniform Theory of Diffraction (UTD),
- Creeping Wave (CW)
- Maxwell (Low-frequency electromagnetic field simulation for 3D/2D structures)
- Transient - nonlinear analysis with:
- Motion—rotation, translational, non-cylindrical rotation
- External circuit coupling
- Permanent magnet demagnetization analysis
- Core loss computation
- Lamination modelling for 3D
- AC Electromagnetic—Analysis of devices influenced by skin/proximity effects, eddy/displacement currents
- Magneto static—Nonlinear analysis with automated equivalent circuit model generation
- Electric Field—Transient, Electrostatic/Current flow analysis with automated equivalent circuit model generation
- 2D low-frequency electromagnetic solver should be able to
- Extract Torque, Power, current variations
- Capability to do the demagnetization study, help to extract Torque Speed characteristics
- Inbuilt circuit solver to a model electronic circuit like inverters, rectifiers, etc and connect with 2D Electromagnetic model
- Extract losses as output for CFD (Thermal) Analysis
- Q3D (Quasi-static electromagnetic field simulation for 2D/3D RLGC extraction)
- 3D EM Solver for RLGC Extraction of Busbar, PCB, IC Packages
- Quasi-static 3D electromagnetic field analysis using Method of Moments accelerated by Fast Multipole Method
- DCRL, ACRL & CG Solver
- Quasi-static 2D electromagnetic field analysis using Finite Element Method
- There should be a capability to solve just the 2D cross-section of transmission lines to extract its characteristic impedance.
- AEDT ICEPAK (CFD - Thermal Analysis)
- 3D CFD solver for Transient and Static Thermal Analysis
- Capable to handle types of heat transfer: Conduction, Convention and radiation: Combination of all modes of heat transfer.
- 3D Static Solver for Transient and Static Thermal Analysis

- 3D FEA solver Mechanical Stress Analysis
- SIwave(2.5D Electromagnetic solver for PCB, Planar structures)
- 2.5D Hybrid (FEM + MOM) solver for PCB, Package
- EMI Scanner - Capable
- Able to model and simulate following SI and PI effects:
- resonance frequencies of complete power and ground structures,
- power and ground bounce,
- simultaneous switching noise,
- impedance discontinuities due to changes in signal layers or split supply planes,
- noise coupling between signal lines and supply planes,
- time-domain effects such as propagation delay, rise and fall times, reflections and ringing,
- frequency-domain phenomena such as resonant modes and S, Y, and Z-parameters.
- DC IR analysis to compute DC voltage drop and current density.
- Near and far field analysis, automatically from circuit simulation waveforms for accurate source modeling and thus accurate emissions analysis (EMI/EMC).
- Circuit simulation (Designer, Simplorer and EMIT)
- ID circuit simulation capability for following RF simulations
- Linear analysis
- DC analysis
- Oscillator Analysis
- Harmonic Balance Analysis (1-Tone and N-Tone)
- Transient Analysis
- Time Varying noise Analysis
- Phase noise Analysis
- Multi-tone harmonic balance analysis
- Envelope analysis
- Load pull analysis and model support.
- Periodic transfer function analysis
- Circuit System solver should have.
- Build power electronic circuits using IGBT, BJT, MOSFET, etc.
- Capability to characterize semiconductor switches from manufacturer datasheet.
- Capability to do time and frequency domain simulations.
- Capability to co-simulate with physics-based models.
- Capability to import Reduced-Order Models generated for Physics-based simulations.
- 1D Power Spectral Based solver for finding RF interference between different Microwaves system
- System-level solver for Integrating physics-based model with multi-domain-based components, Power Electronic circuits, etc.
- Power Spectral solver should provide following RFI matrics across multiple Transmitter and Receiver platform: EMI Margin, Sensitivity, Availability, Desense, Noise In-Band EMI Margin
- Power Spectral solver should provide RF interference of Mulitple Transmitter to the single receiver.

- Power Spectral solver should support Non-Linear Interference Effects in RF interference analysis.

Graphical User Interface for EM analysis

- The software package should have the following features:
- Tools should have an option or toolkit to automatically setup simulations for following RCS/Radar simulation: Range Profile, ISAR, Range Doppler Processing and waterfall.
- The tool should have an option to encrypt the 3D component, which a user can share with others without revealing the IP.
- The tool should have an option to import/export encrypted/unencrypted 3D component models for simulation.
- The tool should have templates for setting up EMI EMC simulation like Radiated Emission, Conducted Emission, ESD, BCI
- The tool should have the capability to model and parameterize any arbitrary 3D model.
- The tool should have the capability to do operations such as unite, subtract, intersect different objects to create a model.
- There should be a provision for creating equation-based curves/surfaces for creating more complex models.
- There should be provision for wrapping sheets onto curved surfaces.
- The software should have the ability to import, edit, simplify and parameterize 3D CAD models from third-party tools.
- The capability to clean up 3D CAD and detection tools for Short Edges, Overlap Faces, Corrupt Faces
- The tool should allow users to edit STL files directly and leverage automatic repair tools.
- Options for cleaning imported 3D models
- Options for analyzing individual objects of the complete 3D model to locate any faults in the modelling.
- Possibility to find inter-object misalignments.
- There should option for healing the geometry.
- There should be provision to model layouts into a stackup based environment and simulate in the same environment.
- Layout interface should have options to change the stackup, trace widths, via and padstack.
- PCB Trace modelling options in the Layout interface
- Surface roughness – Huray and Groisse
- Options for Etching

Import ECAD/MCAD

- Integrated design flow that allows user to easily import design geometry from commercial layout packages such as:
- Cadence Allegro and APD,
- Sigrity UDP,
- Zuken CR5000, CR8000,
- Mentor BoardStation, Expedition, and PADS Layout,
- Altium Designer,
- DXF and GDSII files.
- Ability to import circuit component models of various types like,

- HSPICE and spectre models
- IBIS models, including IBIS-AMI
- W-element
- S-parameters, as Touchtone, CITI files
- X-parameters
- Verilog libraries
- Ability to import Chip Power Model (CPM) for the die/IC, to perform accurate power integrity analyses.
- The tool should support the import of following 3D DATA: ACIS, Acrobat 3D, 2D PDF, AMF, AutoCAD, CATIA, Creo Elements/Direct Modeling, Design Modeler, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER
- The tool should support the export of following 3D DATA: ACIS, Acrobat PDF 3D, Acrobat 2D PDF, AMF, AutoCAD, CATIA, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER, Rhino, SketchUp, SolidWorks, STEP, STL

Mesh Options

- Use tetrahedron element for 3D models and triangles for sheet structures
- Option to have curvilinear mesh elements for accurately solving curved geometries
- Mesh Control
- Options to specify surface deviation, normal deviation and aspect ratio to control mesh density
- Ability to restrict the amount of elements/size of the elements within an object or just on the surface of the object
- Skin-depth based seeding capability
- Advanced capability like Assembly Meshing: Independent component meshing allows mesh reuse, no re-meshing in parametric variations, independent mesh settings for different components and more robust meshing for models with a significant difference in scale. Especially useful for Antenna Placement and scattering problems where mesh reuse can be done
- Phi mesher (Prism elements) for faster meshing of the planar structures .
- Provision of automatic & manual meshing to be available
- Automatic meshing for fluid & solid regions to be available
- Different type of mesh models like body fitted Cartesian mesh etc. to be available to represent complain shapes in the electronic model
- Ability to import external mesh in addition to native mesh

Advanced Material Library which should include

- A comprehensive materials database containing permittivity, permeability, electric and magnetic loss tangents for common substances.
- Users must be able to include anisotropic materials, ferrites, temperature and frequency-dependent material properties. Frequency-dependent material models like Debye and Djordjevic-Sarkar models to ensure that the material satisfies causality conditions.

- Provision for Spatially dependent material properties and boundary conditions.
- Data base of interface materials like thermal components (manufactures like 3M, Aavid, etc).
- Heat sinks: Standard heat sinks of different manufactures like Aavid, Thermshield etc to be provided. Minimum of 500 No's of heat sink database.

Excitation and Boundary Condition

- Excitation and Boundary Condition
- Excitation for Ports SYZ parameter excitation
- Arbitrary internal and external ports – Waveport and Lumped Port
- Ability to solve all ports in one solution and not port-by-port.
- Floquet ports for antenna arrays, frequency selective surfaces (FSS) and other periodic structures
- The software should have a provision for extracting fields/active S parameter as per user specified excitation magnitude and phase.
- Option to provide voltage source and current source.
- Magnetic bias for ferrite models
- Incident wave excitations available from following wave types:
- Plane Wave, Hertzian dipole wave, cylindrical wave, Gaussian Beam Wave
- Linear Antenna wave, Far Field Wave, Near Field Wave
- Far-field wave and near field wave can be from another design or the measurement.
- Boundary conditions available:
- Radiating, perfectly matched layers and FEBI
- Impedance boundary
- Layered Impedance with shell elements which can account for thickness even when modelled as sheets.
- Lumped RLC boundary
- Symmetry boundary for reducing the problem size.
- Period boundary condition for solving arrays.
- Finite conductivity boundary with the capability to include metal roughness using Huray or Groisse algorithm.
- Fresnel Boundary

General Solver Options

- Direct or Iterative approach for solving the matrices.
- Hybrid solver with Integral equation solver should support matrix solving with ACA (Adaptive Cross Approximation) or MLFMM (multilevel fast multipole method).
- Basis functions are available as zero, first, second and mixed order for simulation of various class of problems.
- Import mesh to design from other similar design.
- Frequency sweep options
- Interpolation sweep
- Discrete sweep
- Fast sweep
- Broadband frequency sweeps with the capability to consider dispersive ports, materials and skin effect.
- Enforce passivity / enforce causality for the broadband sweep.

- DC point solver option for PCBs for accurate DC point characterization
- The asymptotic solver should enable all SBR solver like PTD, UTD, and CW in a single simulation.
- PO and SBR+ asymptotic solver should support lossy dielectrics.
- SBR solver should support multilayer dielectrics.
- FEM frequency-domain solver should have the capability to simulate even in THz region for applications such as metamaterials, FSS etc.
- There should be an option of using 2.5D MOM or FEM solver to analyze planar layouts.
- Solution convergence and control:
  1. Convergence based on S parameter, field quantities or user-defined expressions
- The software should have the capability for adaptive meshing across different frequencies of broadband structures.
- Eigenmode solver should be able to find the natural resonances and quality factor of the lossy structure.
- The solver (FEM) should have an option to
- physically divide the simulation model into the different sections
- Enable parallel meshing and solving for each section individually.
- Solver has the capability for solving a single unit cell of an array for Active Element Patterns using Periodic Boundary Conditions
- The solver should have the ability to create and solve Finite Array Simulation by combining different types of unit cells.
- Finite Array simulation should support features like Array Mask creation for arbitrary sparse array configuration.
- Scattered field simulation for solving RCS problems. Provision for both bistatic and monostatic RCS along with incident field excitations.
- RCS calculation should be able to conduct with FEM, IE and SBR+ solvers.
- RCS simulation using SBR solver should automatically combine additional solvers like PTD, UTD and CW in a single design.
- Broadband frequency sweeps with the capability to take into account dispersive ports, materials and skin effect.
- The IE and SBR should have an option to create an ISAR image, Near Filed Radar ROM (Waterfall plot) of the Radar target.
- SBR+ Radar simulation should support Pulsed Radar and FMCW Radar
- Capability to generate raw IQ data from Radar simulation (FMCW)
- Multifaction solver should support multiple port simultaneous excitations for RF breakdown analysis.
- Basic Solver should enable 4 cores HPC (High Performance Computation) capability.
- Built-in Antenna model for RF interference and SBR+ simulation: Short Dipole, Half-wave dipole, Quarter wave Monopole, Pyramidal Horn, Small Loop, Parametric Beam Antenna, Wire Monopole
- SBR solver should have the ability to simulate Radar Simulation
- Able to incorporate multiple transmitting and receiving antenna.
- Able to create Radar simulation scenarios.
- Scenario simulation with respect to time
- Calculate Range, Velocity and Angle of Arrival

- Types of flow for thermal analysis:
- Laminar, transition & turbulent flows
- Ability to model multiple fluids.
- Transient, steady state and parametric analysis (Thermal)
- Joule heating in objects with temperature dependent properties supported.
- In case of transient simulation, ability to model variables as a function of time (Thermal).
- Bi-directional coupling with Q3D, Maxwell, HFSS for node-to-node EM loss mapping and coupled electro-thermal simulation
- Bi-directional coupling with SIwave for electro-thermal analysis with automatic transfer of power dissipation on PCB along with temperature dependency on material properties
- Importing of Chip Thermal model powermap from Apache Redhawk for accurate power dissipation from chip level tool

Pre-Processing Options

- Pre-Processing Options
- Ability to perform package merge with PCB.
- Advanced and easy-to-use layout-based GUI allowing users to easily manipulate layouts, with features as follows:
- trace drawing utilities,
- layer stackup editor,
- padstack editors,
- add bondwire - standard JEDEC bondwire, non-standard bondwire,
- solderball and bump creation utilities,
- generate 3D models of selected nets, areas or both.
- pin grouping
- Ability to import Chip Power Model (CPM) for the die/IC, to perform accurate power integrity analyses.
- Feature to perform optimization of decoupling capacitor scheme on the PDN of PCB/package design, based on constraints like target impedance, number and types of capacitors, cost etc.
- Built-in Circuit and system components library including wide range of active, passive, and distributed device models from transistors to transmission lines, including sources and probes.
- Should be able to identify electronics objects from the imported CAD geometry and convert them automatically in native objects (Icepak)
- Import power maps in form of X, Y, Z, P. X, Y and Z are the coordinates and P is the heat flux

Post-Processing Options-

- Post-processing options-
- The output from the tool should be.
- Network parameters like SYZ
- Characteristic port impedances and propagation constants
- Capability to observe near field and far-field radiations.
- Far field antenna parameters like
- Gain
- Directivity

- Radiation efficiency
- Axial ratio
- Capability to observe co-pol and x-pol antenna patterns.
- Observe antenna array patterns based on array factor and pattern multiplication.
- Characterize RCS of structure
- Monostatic RCS and Bistatic RCS
- SAR plot
- Capability to dynamically link electromagnetic models to circuit simulator for further system analysis. There should be an option to push excitation back from circuit to the electromagnetic solver to observe fields based on actual excitation.
- Feature to perform optimization of decoupling capacitor scheme on the PDN of PCB/package design, based on constraints like target impedance, number and types of capacitors, cost etc.
- The electromagnetic solver should have the option to export s parameter data in touchstone format, generate equivalent RLGC models, export W element model, export equivalent spice models.
- Field Animation
- Capability to animate E-field/H-field and Current density.
- User Defined Field Calculations using Field Calculator
- RF Link Budget analysis: using simulation or measured data.
- Option to add rain and atmospheric attenuation in RF interference and Link budget calculation.
- Wireless Propagation Models support for RF interference and Link Budget calculation: Hata model, S parameter model, Path loss coupling, two ray path loss coupling, Log distance coupling, Walfisch-Ikegami model, Erceg Coupling, Indoor propagation model, Two-ray ground-reflection model.
- The tool should have option or toolkit to automatically post process and display the following RCS/Radar outputs: Range, Range Doppler, ISAR, Waterfall
- The tool should have option or toolkit to automatically calculate Power Density and Cumulate derivative Function from phased array or antenna simulations.
- Ability to get a quick idea of characteristic impedance by generating an impedance delay plot for each trace path selected and to rapidly generate transient voltage waveforms of pin-to-pin signal propagation.
- Ability to simulate for TDR and TDT for specified nets in design.
- Provide impedance scan feature to quickly examine trace impedance profiles and identify any viola-tions according to user chosen criteria.
- Provides two-way coupling with thermal or electronics cooling solver to solve for joule heating.
- Perform QuickEye analysis, a pattern-dependent convolution-based approach to calculate eye diagram from transient analysis of single transitions.
- Perform VerifEye analysis using a fully statistical approach to calculate the BER directly.
- Perform IBIS-AMI analysis allowing time-domain simulation of a linear channel using customer-supplied models for the transmitter and receiver.
- Direct integration with HSPICE simulation software, allowing transient simulations with HSPICE and also plot results directly from HSPICE output data files.

Advanced Analysis Features and Parallel Solve

- Advanced analysis features and parallel solve.
- Analytical derivatives to find output sensitivity to design parameters without resolving structure.
- Capability for simulation of very large models across a network of machines using all the available memory using Domain Decomposition.
- Data link for field-to-field 3D electromagnetic linking – Enabling fields from one simulation to be used as source in another simulation.
- Dynamic link for circuit and EM co-simulation with smith tool capability for matching circuit design.
- The capability of tools to integrate with other application such as Thermal, Mechanical for Multiphysics Problems
- Should be capable of doing:
- Queuing the projects for solving
- Support for remote analysis with client and server each on any supported platforms
- 64-Bit Support:
- The software should be able to support 64-bit CPU architecture on Windows and Unix Operating system for both solver and user interface.
- Should support unbounded 64-bit Solver Memory allocation.

Optimetrics – For Optimizing Designs

- Optimetrics – For optimizing designs.
- Integrated optimization capability including:
- Parametric analysis
- Optimization analysis
- Sensitivity analysis
- Statistical analysis
- Optimizer should have these algorithms:
- Pattern search algorithm
- Quasi-Newton search algorithm
- Sequential Non-Linear Programming (SNLP) Optimizer
- Genetic optimization algorithm
- Link to Matlab for custom optimization codes
- Screening (Shifted Hammersley)
- MOGA (Multi-Objective Genetic Algorithm)
- NLPQL (Non-linear Programming by Quadratic Lagrangian)
- MISQP (Mixed-Integer Sequential Quadratic Programming Method)
- Adaptive Single-Objective
- Adaptive Multiple-Objective
- Analytical derivatives to find output sensitivity to design parameters without resolving structure.
- Capability to solve parametric variations of a design in parallel using processor cores in a single machine or spread over networks.

Automation and Distributed Computing

- Automation and distributed computing

- Scripting options for model creations, plotting, exporting results thus providing automation.
- Scripting languages
- VB script
- Iron python script
- Java script
- Able to use multiple cores in simulation for faster simulations.
- Multiple cores can be a single machine or across the network.
- Domain Decomposition Method for solving electrically large model.
- Automatically break the large problem into smaller domains and solve them in parallel.
- Distribute frequency points and solve in parallel.
- Should be capable to Queue the projects for solving.

Tool should be capable to model following topologies of filter.

- Lumped topology filter
- Distributed topology filter
- Active topology filter
- Switched Capacitor topology filter.
- Digital topology filter
- Filter Topology should support the following types of filters.
- Low Pass
- High pass
- Band Pass
- Band stop
- Filter design with above topology should support.
- Bessel filters
- Butterworth filter
- Legendre filter
- Chebyshev Type I filter
- Chebyshev Type II filter
- Elliptic filter
- Raised cosine Filters.
- Delay filters
- The tool should have the option to plot the following parameters.
- Pole Zero plot
- Time Domain plot
- Reflection and Impedance plot
- S-Parameter plot
- Smit and Polar Plots
- Lumped Schematic Display
- Distributed Schematic Display
- Tool should have capability to create Impedance Matching circuit.
- Single point impedance matching
- Multiple point impedance matching
- Broadband impedance matching

- Lumped matching circuit
- Distributed impedance matching
- The tool should have the capability to run sensitivity analyses
- Monte Carlo Analysis
- Element sensitivity analysis
- Distributed type filter should support RLGC, Microstrip line, stripline and suspended substrate
- Distributed type filter topology should minimum support
- Open and short stub
- Stepped impedance resonator
- Hairpin resonator
- Ring resonator
- Series Quadruplet resonators
- Interdigital filters
- The tool should have the capability to export Lumped and distribute type of filter to Circuit simulator.

RFQ – 4 (B) Specification for Software for Thermal Management for Equipment

General Specification

Technical Specifications for Thermal Management for Equipment

Advanced software specifically designed for the simulation of thermal management in electronic and industrial equipment. Software should provide solutions for electronics cooling and thermal analysis, covering a wide range of applications such as consumer electronics, automotive electronics, telecommunication systems, power electronics, and data centers. It allows engineers to model and analyze heat transfer, fluid flow, and thermal performance with high accuracy.

Technical requirements:

Features
Required Thermal Analysis Types • Conduction, convection, and radiation heat transfer. • Transient and steady-state thermal simulations. • Joule heating effects due to current flow in electronic components.
Required Flow Simulation: • Forced and natural convection modeling. • Simulation of airflow patterns around components. • Analysis of fan and blower performance in cooling systems. • Airflow management in enclosed and open environments.
Multiscale Modeling: • Thermal analysis at both system and component levels, ranging from individual chips to electronic assemblies.
PCB and Package-Level Analysis:

- Dedicated modules for simulating PCB designs, component packages, and heat sink configurati
- Prediction of temperature gradients across multi-layer boards and electronic packages.

Power and Heat Dissipation:

- Comprehensive modeling of heat dissipation across electronic devices, including semicondu junctions, components, and boards.
- Support for high-power electronics, LED arrays, and other power-dense systems.

Must have Material Properties:

- Built-in library of thermal properties for standard materials such as copper, aluminum, sili thermal interface materials, and more.
- Custom material definition for advanced composites, phase-change materials, and heat spreac

Thermal Coupling with Electromagnetics for Multiphysics:

- Integration with high frequency for thermal analysis of electromagnetic effects in high-freque electronics, such as antennas and microwave circuits Sub-laminates: an assembly of fabrics laminates (with orientations), orientation-based properties (an-isotropy) Define the elem orientation (to properly orient materials).

Software Integration and Compatibility

- Supports full integration into the FEA environment, enabling streamlined workflows for m domain simulation tasks, such as structural, fluid, and electromagnetic analysis.

PCB Design Import:

- Direct import of electronic design files from leading PCB design software (Altium, Cadence, Mer etc.) for quick setup of thermal simulations.

Support for Industry Standards:

- Meets industry standards for electronics cooling, including JEDEC standards for thermal analys semiconductor packages.

Automation & Scripting:

- Extensive automation capabilities through Python scripting and batch processing, allowing parametric studies and optimization tasks.

General Capabilities of Pre-Processing Tools

- The preprocessors (geometry modeling tool & the mesh generator) should have the follov capabilities
- Design mode options, 3D parametric Modeling,3D concept Modeling
- Other Advanced Features such as solid extension, surface extensions, Freeze\ Unfreeze, volume enclosure etc.
- Other Advanced Tools such as merge/slice bodies, surface flip, surface patch, symmetry extract body operation, analysis tools, Repair tools etc.
- Bidirectional CAD connections e.g. PRO-E, CATIA V5, SolidWorks, Solid Edge etc. (additional lice required)
- Data import options: IGES, Parasolid, STEP, STL etc.
- Data export option: Parasolid, IGES, and STEP etc.

- Tetrahedral meshing methods-patch confirming and patch independent.
- Hexahedral meshing methods-General sweep, thin sweep, Multizone, Hex Dominant.
- Surface meshing.

Import File Formats:

Thermal Management for Equipment should supports a wide range of file formats for importing d ensuring compatibility with various CAD and ECAD systems

- CAD Formats:
- IGES (.iges, .igs)
- STEP (.stp, .step)
- Parasolid (.x_t, .x_b)
- ACIS (.sat)
- STL (.stl)
- SolidWorks (.sldprt, .sldasm)
- Pro/ENGINEER (.prt, .asm)
- CATIA (.catpart, .catproduct)
- NX (.prt)
- Creo (.prt, .asm)
- ECAD/PCB Design Formats:
- IDF (.emn, .emp)
- ODB++ (.tgz, .tar.gz)
- IPC-2581 (.xml)
- Ansys EDB (.aedb)
- Gerber (.gbr)
- Ansys Workbench Project (.wbpj)
- Ansys Geometry (.agdb)
- Mesh Files:
- Ansys Fluent Mesh (.msh)
- Ansys Mechanical APDL (.cdb)
- CGNS Mesh (.cgns)
- Mesh Import Formats (.msh, .uns, .dat)

Supported File Format (Export)

Thermal Management for Equipment should allows exporting results and models in multiple format integrate with other simulation or design tools.

- Mesh Files:
- Ansys Fluent Mesh (.msh)
- CGNS Mesh (.cgns)
- CAD Export Formats:
- IGES (.iges, .igs)
- Parasolid (.x_t, .x_b)

- STL (.stl)
- Thermal Results Export:
- Text Files (.txt, .csv)
- Images:
- PNG (.png)
- JPEG (.jpg)
- TIFF (.tif)
- Custom Export Scripts:
- Python (.py)
- Batch Script Export for customized post-processing.

RFQ – 4 (C) Specification for Software for Reliability of Electronic Hardware

General Specification

Technical Specifications for Reliability Of Electronic Hardware (Sherlock)

Automated Design Analysis software should enable engineers to accurately predict the reliability of electronic hardware by modeling and analyzing how products will respond to real-world conditions. Reliability of electronic hardware transforms data directly into 3D models, applying industry-leading algorithms to simulate the operational and environmental stresses that electronic components will encounter throughout their lifecycle.

Technical Requirements:

Features
Key Capabilities • Automated PCB Reliability Analysis • Prognostics for Lifecycle Prediction • Comprehensive Failure Modes Assessment • Material Selection & Optimization • Component Modeling & Library Integration
Solver Features Reliability of electronic hardware should include robust solvers capable of performing various simulations necessary for predicting the reliability of electronics: • Thermal Cycling Solver: Calculates solder fatigue and creep using the Coffin-Manson, Darveaux, and Anand models for solder joint failure prediction. • Vibration and Shock Solver: Analyzes harmonic vibration and random vibration (Power Spectral Density - PSD) using sophisticated algorithms. • Mechanical Shock Solver: Provides drop and impact analysis to determine the likelihood of failures in response to sudden mechanical loads. • Finite Element Solver Integration: Seamlessly works with FEA Mechanical and other FEA tools for advanced structural analysis.

- Solder Fatigue Solver: Predicts solder joint fatigue life using advanced thermomechanical fatigue analysis methods.
- Thermo-mechanical Solver: Includes creep, stress relaxation, and thermal shock for evaluating time-dependent material behavior.

Import and Export Data Formats

Reliability of electronic hardware should support a wide range of data formats for both import and e to ensure seamless integration with various ECAD, FEA, and simulation tools:

Import Formats

- ECAD Formats:
- ODB++
- IPC-2581
- Gerber
- Altium Designer
- Cadence Allegro and OrCAD
- Mentor Graphics PADS, Xpedition
- Zuken CR-5000, CR-8000
- DXF (AutoCAD)
- BOM Formats:
- CSV
- XML
- Excel (.xls, .xlsx)
- Component Libraries:
- Custom libraries with material properties, packaging types, and solder types.

Export Formats

- Finite Element Model Export:
- ANSYS Workbench (.wbpj)
- Abaqus
- Nastran
- LS-DYNA
- SolidWorks
- CAD Export:
- STEP (.stp)
- IGES (.igs)
- 3D PDF

Advanced Analysis Techniques

Reliability of electronic hardware should be equipped with advanced analysis techniques designed to enhance prediction accuracy for complex electronics:

- Thermal Cycling and Fatigue Life: Models the effects of thermal cycling and temperature fluctuations on PCBs, solder joints, and components to predict time to failure.

- Vibration Fatigue: Uses random vibration analysis (PSD) and harmonic vibration simulations to predict fatigue life under vibrational stress.
- Mechanical Shock Analysis: Determines component and system survivability under mechanical shock, using drop test simulations and acceleration loading.
- Accelerated Life Testing (ALT): Enables predictive testing under accelerated conditions to anticipate product failures and improve design robustness.
- Multi-Physics Coupling: Works with Icepak, Fluent, and Mechanical for coupled thermal-structural and fluid-thermal simulations for advanced multi-physics analysis.
- Stress Relaxation & Creep Analysis: Models the long-term behavior of materials under mechanical and thermal loads, simulating time-dependent failures in components.
- Lead-Free Solder Analysis: Provides specific models for lead-free solders, which have different mechanical properties compared to traditional lead-based solders

Boundary Conditions

Reliability of electronic hardware should provide a wide range of boundary condition setups for simulations:

- Thermal Boundaries: Thermal loads can be defined for individual components, PCB layers, and solder joints. Boundary conditions include fixed temperature, convection, and thermal radiation.
- Mechanical Boundaries: Constraints for displacement, rotation, and forces can be applied to simulate realistic operating conditions or boundary fixities.
- Environmental Loads: Include the ability to input vibration profiles, mechanical shock impacts, and other operational or environmental conditions that reflect real-world use.
- Power Dissipation: Allows for the definition of power dissipation profiles across components to simulate heat generation and propagation through the system.
- Mission Profile Integration: Users can specify detailed mission profiles for lifecycle analysis, including operational temperature ranges, vibration spectra, and thermal cycling profiles.

Post-Processing Features

Reliability of electronic hardware provides advanced post-processing tools for interpreting results and making data-driven decisions:

- Reliability Prediction Reports: Automatically generates detailed reports with failure predictions, time-to-failure, and component risk rankings.
- Component Life Expectancy Maps: Visual representation of the expected life of individual components on the PCB based on analysis results.
- Thermal Mapping: Detailed thermal maps that show temperature distribution across PCBs and components after thermal cycling or heat dissipation analysis.
- Fatigue Life Visualization: Displays fatigue life prediction results across solder joints and components for easy identification of high-risk areas.
- 3D Stress and Strain Visualization: Allows for detailed visualization of stress and strain across components and PCBs, enabling users to identify failure-prone zones.

- Data Export: Results can be exported in various formats, including CSV, Excel, and PDF, for further analysis and documentation.

General Capabilities of Pre-Processing Tools:

Reliability of electronic hardware should have pre-processing tools that automate much of the setup process and reduce the time needed for analysis:

- Automated 3D PCB Model Generation: Converts 2D ECAD layouts into 3D finite element models, automatically assigning materials, component properties, and boundary conditions.
- Component Library: A built-in, extensible library of over 150,000 components with detailed material properties, package types, and failure models.
- Material Library: A comprehensive database of PCB materials, solder types, and substrate materials with predefined mechanical and thermal properties.
- Material Property Editor: Allows users to edit or create custom materials with user-defined mechanical, electrical, and thermal properties.
- Mission Profile Editor: Provides an intuitive interface for defining operational conditions like temperature, vibration, and humidity over time for lifecycle prediction.
- BOM (Bill of Materials) Integration: Automatically imports BOM data and maps components to the Reliability of electronic hardware library, significantly reducing model setup time.

Automated Mesh Generation: Ensures that FEA meshes are automatically created with optimal element sizes and types for each component and PCB region.

Standards Compliance

Complies with industry and military standards, including:

- MIL-STD-810G (Environmental engineering considerations and laboratory tests)
- IPC-9701A (Performance Test Methods and Qualification Requirements for Surface Mount Solder Attachments)
- JEDEC JESD22-A113 (Preconditioning of non-hermetic surface mount devices prior to reliability testing)
- Telcordia (GR-468-CORE) for reliability of optoelectronic devices

RFQ – 4 (D) Specification for Software for Embedded Systems and Software Development

General Specification

Technical Specifications for Embedded Systems and Software Development

Embedded Systems and Software development, part of the Model-based development environment, is a model-based development environment dedicated to the creation of critical embedded software. It enables automatic generation of DO-178C Level A certified source code for aviation systems. The DO-178C Level A Certification Kit provides the necessary tools and documents for certifying the software developed using MODEL-BASED DEVELOPMENT ENVIRONMENT for the most stringent safety levels in aviation.

Technical requirements:

Features
Modules to be Included: Model-based development environment Modeler: Provides the model-based design environment for safety-critical applications.

• Model-based development environment Code Generator: Certified automatic code generation for embedded systems adhering to DO-178C Level A. • Model-based development environment test: Module for automatic test case generation, execution, and coverage analysis. • Model-based development environment Display: For the development of critical embedded displays (if required for HMI). • DO-178C Level A Certification Kit: Provides the certification documents needed for compliance with aviation safety standards.
Advanced Analysis Techniques • Model-Based Simulation: Enables real-time simulation and debugging of the embedded application models. • Code Verification: Allows verification and validation of the automatically generated code against the design models. • Coverage Analysis: Ensures high coverage for DO-178C Level A compliance, including MC/DC (Modified Condition/Decision Coverage). • Deadlock and Livelock Analysis: Identifies potential deadlock and livelock conditions in the software, ensuring safe state management. • Timing and Performance Analysis: Conducts detailed analysis on the timing behavior of the system to ensure performance under all operating conditions. • Formal Verification: Automated proof-based analysis to verify the safety and correctness of the software logic.
Post-Processing • Automatic Test Report Generation: Generates detailed reports for testing and verification tasks. • Traceability Reports: Maintains traceability from requirements to design models, code, and test cases, critical for certification audits. • Code Coverage Reports: Detailed reports showing the extent of test case coverage for DO-178C compliance.
Automation Customization : • Customizable Workflows: Enables the development of customized workflows for specific project needs, improving efficiency and reducing manual effort. • API Access for Automation: Provides APIs for automating repetitive tasks such as code generation, verification, and report generation. • Continuous Integration/Continuous Deployment (CI/CD): Can be integrated into CI/CD pipelines for automated builds and testing, enhancing software delivery speed. • Scripting Support: Offers scripting interfaces (e.g., Python, TCL) for custom automation in toolchains and workflows
Capabilities of Pre-Processing Tools • Model Import and Export: Supports import/export of models from/to industry-standard formats (e.g., Simulink, Stateflow). • Design Rule Checking (DRC): Automated checks to ensure the design adheres to specific industry or project standards. • Consistency Checking: Ensures consistency across all models, requirements, and generated code.

- Graphical and Textual Editors: Provides user-friendly editors to define control logic, state machines, and data flow diagrams.
- Real-Time Simulation and Debugging: Interactive simulation capabilities for real-time debugging of embedded systems designs.

Standards Compliance

- Embedded Systems and Software development and its DO-178C Level A Certification Kit are fully compliant with the following standards:
- **DO-178C / ED-12C**: Software Considerations in Airborne Systems and Equipment Certification.
- **DO-331**: Model-Based Development and Verification Supplement.
- **DO-330**: Tool Qualification for airborne systems, ensuring that tools meet required safety and quality levels.
- **ISO 26262**: Automotive safety standard for functional safety, if required for automotive applications in addition to aviation.
- **ARP 4754A / ARP 4761**: Guidelines for civil aviation systems and equipment development, for safety and certification.

Certification Support Required

- Tool Qualification Data Package: Includes all necessary tool qualification documents for certification with authorities.
- Verification Plans and Procedures: Documentation and guidelines for ensuring that the generated code complies with safety-critical standards.
- Safety Compliance Reports: Detailed reports that demonstrate how the software design and code meet DO-178C Level A requirements.
- Traceability Matrices: Provides complete traceability from system requirements to test results, critical for audits and certifications.

Additional Capabilities

- Modular and Scalable Architecture: Supports large-scale projects with modular system designs and scalable integration capabilities.
- High-Fidelity Simulations: Accurate simulations of system behavior under various conditions, enabling rigorous testing and analysis.
- Fault Injection and Safety Analysis: Performs fault injection for assessing system behavior under failure conditions.
- Human-Machine Interface (HMI) Design: Includes tools for designing safety-critical user interfaces, if required.

RFQ – 4 (E) Specification for Software Model-based Development Environment

General Specification

3.9 Technical Specifications for Model-based development environment

Advanced Modeler Suite for model-based development environment for the design, simulation, and automatic code generation of critical embedded software. It provides a robust, high-integrity design framework used in various industries, including aerospace, automotive, rail, and energy, to ensure software reliability and compliance with stringent safety standards such as DO-178C, ISO 26262, and IEC 61508. This tool supports the entire development lifecycle, from early design and formal verification to certified code generation and integration.

Technical requirements:

Features
Modules to be Included: • MODEL-BASED DEVELOPMENT ENVIRONMENT Suite Modeler Core graphical model-based development environment for critical embedded software design using synchronous programming language principles (Lustre-based). It allows for safe and efficient modeling of system functionalities. • MODEL-BASED DEVELOPMENT ENVIRONMENT Suite Design Verifier Automated formal verification tool that performs design property verification, ensuring consistency and completeness early in the development process. Helps in detecting logical errors like deadlocks, division by zero, or overflows. • MODEL-BASED DEVELOPMENT ENVIRONMENT Suite KCG Code Generator Certified automatic code generator producing highly optimized, readable, and traceable C code directly from models. The code generation is compliant with several safety standards (DO-178C, ISO 26262). • MODEL-BASED DEVELOPMENT ENVIRONMENT Suite Model Coverage Offers model-based coverage analysis tools, enabling the generation of test cases based on model structure and behavior. This ensures complete model coverage and supports certification objectives. • MODEL-BASED DEVELOPMENT ENVIRONMENT Suite Timing Verifier This module provides timing analysis of models. It allows you to verify whether the designed system meets timing constraints early in the development process.
General Features Required • Model-Based Development (MBD) MODEL-BASED DEVELOPMENT ENVIRONMENT Suite uses a Model-Based Development approach that facilitates the design, simulation, and verification of embedded systems. It reduces design complexity and enhances collaboration across multidisciplinary teams. • Lustre-Based Language The underlying formal language of MODEL-BASED DEVELOPMENT ENVIRONMENT, based on Lustre, is specifically tailored for the development of deterministic, safety-critical systems. This ensures predictability and rigor in design execution. • Modular and Scalable Architecture Supports the creation of modular and hierarchical system models, enabling scalability for small to large complex systems. This architecture is useful for designing reusable components and managing large-scale projects effectively. • Data Consistency and Integrity MODEL-BASED DEVELOPMENT ENVIRONMENT's model repository ensures that data across the model is always consistent and integrated, reducing the chance of errors and ensuring the integrity of design artifacts throughout the development process. • Integrated Requirements Management Integrates with industry-standard requirements management tools like IBM DOORS and Polarion, providing direct linkage between model elements and requirements, improving traceability, and ensuring design compliance with specified needs.

- Collaborative Environment with Version Control
  Supports team collaboration by offering integration with version control systems (e.g., Git, SVN) for model versioning, branching, and merging. This allows multiple teams to work together efficiently and manage changes in large projects.
- Cross-Platform Support
  MODEL-BASED DEVELOPMENT ENVIRONMENT Suite supports multiple platforms, enabling users to deploy their designs across various target environments like Windows, Linux, and real-time operating systems (RTOS).
- Support for Multicore Systems
  Provides capabilities to develop and verify software for multicore processors, ensuring the system's optimal performance on modern hardware architectures.
- Efficient Resource Management
  Optimizes memory footprint and CPU utilization of the generated code to meet the constraints of embedded systems with limited resources.
- High-Performance Code Generation
  The KCG (Qualified Code Generator) produces efficient and optimized C code that is designed to meet the stringent performance requirements of embedded systems, especially those in safety-critical applications.
- Graphical Debugger
  An integrated graphical debugger allows step-by-step simulation of models and detailed insight into system behavior, enabling developers to easily locate and fix bugs in the model.
- Extensive Testing and Validation Tools
  Includes tools for system testing, validation, and certification. It also supports both model-in-the-loop (MiL) and hardware-in-the-loop (HiL) simulations, ensuring system performance in real-world scenarios.
- Real-Time Simulation Support
  Offers support for real-time simulation and testing, enabling users to validate the embedded system's performance against real-time constraints and environments.
- Multi-Domain System Integration
  Seamlessly integrates with other tools like Digital Twin, CFD, and Mechanical for multi-domain simulation (thermal, fluid, structural, and electrical) when embedded systems interact with the physical environment.
- Predefined Libraries for Embedded System Design
  MODEL-BASED DEVELOPMENT ENVIRONMENT Suite includes a rich set of predefined and customizable libraries (e.g., logic blocks, state machines) to speed up embedded system design.
- Graphical and Textual Code Inspection
  Provides mechanisms for inspecting generated code both in graphical and textual forms, enabling engineers to ensure that the code meets project standards and functional specifications.
- Safety and Security Considerations
  Built-in safety mechanisms such as the use of formal methods, timing analysis, and support for partitioning (for ARINC 653 and IMA) help ensure that the software is not only safe but also secure from external threats.

Advanced Analysis Techniques:

- Formal Verification
  MODEL-BASED DEVELOPMENT ENVIRONMENT Suite Design Verifier performs exhaustive formal verification of embedded software models, identifying hidden design flaws and logical errors without executing the model.
- Worst-Case Execution Time (WCET) Analysis
  Embedded systems often have stringent timing constraints, and MODEL-BASED DEVELOPMENT ENVIRONMENT Suite Timing Verifier performs automated timing analysis on the generated code or model, ensuring that the system meets WCET requirements.
- Model Simulation and Behavioral Analysis
  Interactive model-in-the-loop simulation and debugging provide real-time insights into model behavior, enabling early error detection and ensuring proper system functionality.
- Back-to-Back Testing
  Automates the validation process by testing model behavior against its generated code, ensuring no discrepancies between the two.

General Capabilities of Pre-Processing Tools:

- Graphical Design Environment
  A powerful and intuitive graphical interface that supports modular and hierarchical modeling, helping users build complex systems from reusable components.
- Requirement Traceability Integration
  Seamless integration with requirements management tools like DOORS, enabling direct linkage between requirements and design elements.
- Static and Dynamic Model Checking
  Ensures that design rules and constraints are respected, highlighting potential inconsistencies before the generation of code or simulation.
- Interactive Simulation
  Real-time, step-by-step model simulations help developers verify that their design meets functional specifications early in the process.

Post-Processing:

- Traceability Reports
  MODEL-BASED DEVELOPMENT ENVIRONMENT generates comprehensive traceability reports that link requirements, models, and generated code, assisting in certification and compliance.
- Code Performance Metrics
  After code generation, performance metrics like memory usage, execution time, and resource constraints are provided to evaluate the efficiency of generated code.
- Simulation Logs and Graphs
  The suite offers advanced logging and graphical post-processing of simulation data, allowing users to visualize system performance and pinpoint potential issues.
- Coverage Analysis Reports
  Provides detailed model and code coverage reports based on test scenarios, enabling thorough validation for certification processes.

Automation and Customization:

- MODEL-BASED DEVELOPMENT ENVIRONMENT Suite API for Toolchain Integration
  MODEL-BASED DEVELOPMENT ENVIRONMENT Suite offers an open API to integrate custom tools into the toolchain or to automate repetitive tasks, including batch processing of model verifications or code generation.

• Custom Code Integration Allows users to customize or extend the generated code using specific templates or external code, making it flexible for project-specific needs. • Scriptable Workflow Automation Using Python and other scripting tools, users can automate repetitive modeling tasks, batch simulations, formal analysis runs, or code generation. • Customizable User Interface MODEL-BASED DEVELOPMENT ENVIRONMENT Suite's interface can be customized according to project needs, improving user experience and development productivity.
Standards Compliance: • DO-178C (Software Considerations in Airborne Systems and Equipment Certification) MODEL-BASED DEVELOPMENT ENVIRONMENT Suite has been certified up to DO-178C Level A, the highest certification level required for airborne systems. It covers automatic code generation, verification, and traceability to support certification objectives. • ISO 26262 (Functional Safety for Road Vehicles) MODEL-BASED DEVELOPMENT ENVIRONMENT Suite is ISO 26262 ASIL D compliant, supporting automotive industry safety standards for developing safety-critical software, from modeling through code generation. • EN 50128 (Railway Applications) MODEL-BASED DEVELOPMENT ENVIRONMENT Suite complies with EN 50128, providing a framework for developing and verifying safety-related software for railway control and protection systems. • IEC 61508 (Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems) MODEL-BASED DEVELOPMENT ENVIRONMENT supports functional safety requirements across various industries by providing compliance with IEC 61508. • ARINC 653 and DO-297 (Avionics Applications) Supports the development of Integrated Modular Avionics (IMA) systems, with specific focus on partitioning and integration.

RFQ – 4 (F) Specification for Software for Electromagnetic Simulation of Cable Harness

General Specification

Technical Specifications for Electromagnetic Simulation of Cable harness

Electromagnetic Simulation of Cable harness is required for simulation of electromagnetic analysis of cable systems.

Technical requirements:

Features
Pre-Processing Modules: • Geometry Import: Capability to import and handle 3D geometry from multiple CAD formats (e.g., STEP, IGES, Parasolid) and directly from electrical design tools like AutoCAD and EPLAN.

- Cable Definition: Specialized tools for defining and modeling cables, including twisted-pair, coaxial, and multi-conductor cables. Users can assign cable properties like resistance, inductance, capacitance, and dielectric materials.
- Cable Routing and Assembly: Tools to define the routing of cables within a system, including connections, bends, and twists. Ability to simulate realistic cable layouts within enclosures or structures.

Analysis Modules Required

- Electromagnetic Field Simulation: 3D full-wave solvers for accurate analysis of cable electromagnetic behavior under operating conditions. Uses methods such as Finite Element Method (FEM), Method of Moments (MoM), and Finite Difference Time Domain (FDTD).
- Cable Coupling and Crosstalk: Simulation of crosstalk and electromagnetic interference (EMI) between multiple cables and cable bundles, including signal coupling, shielding effects, and noise propagation.
- Electromagnetic Compatibility (EMC) Analysis: Tools to assess the EMC performance of cables and their interaction with other system components, including electromagnetic shielding effectiveness and susceptibility to external noise.
- Signal Integrity: Analysis of signal degradation due to cable properties, such as attenuation, reflection, and dispersion. Includes support for high-speed signal integrity for modern communication systems.
- Power and Ground Integrity: Simulation of current flow through cables and power delivery networks to ensure stable operation and to prevent grounding issues or power noise interference.
- Lightning and Surge Protection: Modeling of the cable system's response to high-voltage surges and lightning strikes, including transient analysis.

Post-Processing Modules:

- Voltage and Current Distributions: Visualization of the electric and magnetic fields within cables and the surrounding environment to identify high-stress areas and possible failure points.
- Signal Integrity Analysis: Post-processing capabilities to examine the waveform of signals traveling through the cables, assess impedance matching, and detect issues such as reflections or losses.
- Radiated Emissions: Analysis of the radiated electromagnetic fields from cables, important for ensuring compliance with EMI and EMC standards.
- Time and Frequency Domain Analysis: Visualization and analysis in both time and frequency domains for transient events (e.g., lightning strikes) and steady-state conditions (e.g., normal cable operation).
- Heat Generation and Thermal Effects: Simulation results that show heat buildup due to current flow, helping to identify potential overheating or failure risks in cables.

Advanced Analysis Techniques

Software should Cable incorporates advanced analysis techniques tailored to high-performance cable simulations:

- **Full-3D Electromagnetic Simulation**: High-fidelity 3D electromagnetic analysis, including full-wave modeling of cable systems and their interactions with nearby structures or components.
- **Time-Domain and Frequency-Domain Simulations**: The tool allows simulations in both the time-domain (for transient events like surges or lightning strikes) and the frequency-domain (for steady-state conditions like continuous signal transmission).
- **Coupled Electro-Thermal Modeling**: Coupled analysis that integrates electrical heating effects in cables with the thermal response of the cable system, essential for assessing safety and performance under high-current conditions.
- **Multi-Scale Modeling**: Capability to simulate cable systems from the micro-level (individual wire strands and insulation) to the macro-level (entire cable bundles and their interaction with the environment).
- **Signal Integrity and Crosstalk Analysis**: Advanced techniques for modeling high-speed signal integrity and evaluating the impact of crosstalk between adjacent cables, crucial for communication and power applications.
- **Transient Simulation**: Modeling of transient events, such as lightning strikes, power surges, or other electromagnetic disturbances, to ensure cables and systems can withstand these extreme conditions.
- **Lightning and Electrostatic Discharge (ESD) Simulation**: Simulation of lightning strikes and electrostatic discharge effects, including their potential to damage cables or cause failure in sensitive systems.

Post-Processing

Post-processing in Cable software analysis should have following reporting:

- **3D Field Visualization**: Advanced visualization tools for displaying electric and magnetic field distributions along cables, including 3D color mapping, streamlines, and vector plots to highlight areas of high field intensity or potential failures.
- **Time and Frequency Domain Analysis**: The ability to visualize and interpret simulation results in both the time and frequency domains, providing a complete picture of transient and steady-state behavior.
- **Signal Integrity Visualization**: Post-processing for signal integrity analysis, including reflection coefficients, impedance mismatches, and waveform analysis to detect performance bottlenecks or integrity issues.
- **Radiation Pattern Analysis**: Ability to evaluate the radiation patterns of electromagnetic emissions from cable systems, ensuring compliance with regulatory EMI standards.
- **Impedance and S-Parameter Plots**: Capability to generate impedance plots, S-parameters, and other key metrics that are essential for evaluating cable performance in high-frequency applications.

- **Simulation History and Comparison**: Tools to compare results across multiple simulations (e.g., different cable configurations or routing scenarios) for optimal design decisions.

Automation and Customization

Cable should includes features for automation and customization, which enable users to improve simulation efficiency and tailor analyses to specific needs:

- **Scripting and Batch Processing**: Support for Python scripting and automation to run batch simulations, parameter sweeps, and optimization tasks, significantly reducing manual intervention and increasing productivity.
- **Custom Cable and Material Properties**: The ability to define custom materials (e.g., insulation, shielding materials) and cable geometries for simulation, including advanced properties like frequency-dependent conductivity or permittivity.
- **Custom Solvers and Modeling Options**: Option to develop and integrate custom solvers or specialized models, providing the flexibility needed for unique or proprietary cable systems.
- **Design Parameterization**: Users can set up parameterized designs to automatically adjust cable configurations, routing, and materials during optimization studies.
- **Optimization**: Built-in optimization tools for automatically improving cable system designs to meet performance goals, such as minimizing crosstalk, maximizing signal integrity, or improving heat dissipation.
- **CAD and Electrical Design Tool Integration**: Direct integration with CAD software and electrical design tools such as **AutoCAD**, **EPLAN**, and **Altium** for seamless data exchange and design collaboration.

Capabilities of Pre-Processing Tools Required

Cable solution should have pre-processing tools for preparing and modeling cable systems:

- **Cable Geometry Setup**: Tools for defining complex cable geometries, including twisted-pair cables, multi-conductor cables, coaxial cables, and cable bundles. Users can set cable dimensions, material properties, and insulation characteristics.
- **CAD Integration**: Seamless integration with major CAD platforms, enabling the import of complex cable assemblies and geometric models directly from electrical system designs.
- **Mesh Control**: Advanced meshing capabilities to automatically generate fine meshes in regions of high field variation, such as near cable conductors, and coarser meshes in areas with less field variation.
- **Multi-Layered Mesh Generation**: Ability to create multi-layered meshes for cables with various materials (e.g., conductors, insulations, shielding), which allows for accurate simulation of electromagnetic behavior.
- **Design Space Exploration**: Tools for exploring and defining different cable configurations (e.g., bending, twisting, bundling) to evaluate their impact on EMC and signal integrity.

Standards Compliance

Cable solution should complie with several important international standards to ensure that its simulations meet industry regulations and requirements:

- **MIL-STD-461**: Military standard for electromagnetic interference (EMI) and electromagnetic compatibility (EMC), ensuring cables are designed to meet stringent defense and aerospace requirements.
- **IEC 61000**: International standard for electromagnetic compatibility (EMC) in electrical and electronic equipment, including immunity and emissions testing.
- **CISPR 25**: Standard for electromagnetic interference (EMI) testing of automotive electronics, ensuring cable designs meet automotive EMI requirements.
- **IEEE 802.3**: Standards for Ethernet cables and networking, ensuring signal integrity for high-speed data transmission.
- **ISO 11452**: Standard for electromagnetic immunity testing of components in vehicles, ensuring compliance with automotive EMC standards.
- **FCC Part 15**: U.S. Federal Communications Commission (FCC) regulations governing EMI from electronic devices, ensuring that cables meet required EMI limits for communications equipment.

RFQ – 4 (G) Specification for Software for Cyber Safety and Security Solution

General Specification

Technical Specifications for Cyber Safety and Security Solution

Technical requirements:

Features
Modules to be included (Scade Suite) • Cyber Safety analyze: should Provide a comprehensive framework for safety analysis across different systems. This module includes tools for Functional Safety (ISO 26262), System Safety (ARP4761, ARP4754), and Process Safety. • Cyber Safety analyze for Cybersecurity: should Focuses on identifying and managing cybersecurity risks in systems, particularly in line with ISO/SAE 21434. • Cyber Safety analyze for Reliability: Supports analysis methods for system reliability such as Fault Tree Analysis (FTA), Reliability Block Diagrams (RBD), and Failure Modes and Effects Analysis (FMEA). • Cyber Safety analyze for Compliance: Must manage compliance checks across various standards, ensuring regulatory adherence for automotive, aerospace, defense, and industrial applications. • Cyber Safety traceability: Should enable efficient management of traceability across safety, reliability, and cybersecurity analysis, ensuring alignment with requirements, system design, and risk analysis.
Advanced Analysis Techniques required • FTA (Fault Tree Analysis): Cyber Safety (Scade Suite) enables qualitative and quantitative fault tree analysis to evaluate the risks associated with failures in the system. • FMEA (Failure Mode and Effects Analysis): Supports Design and Process FMEA, with advanced tools for automatically identifying potential failure points and consequences across complex systems.

- FMEDA (Failure Modes, Effects, and Diagnostic Analysis): Facilitates the calculation of hardware fault metrics for safety-critical systems.
- Cybersecurity Threat Analysis and Risk Assessment (TARA): Provides a structured methodology for assessing potential cyber threats, vulnerabilities, and their impact.
- Safety Integrity Level (SIL) Analysis: Supports the analysis of Safety Integrity Levels (SIL) according to IEC 61508 for determining safety performance requirements.
- Diagnostic Coverage and Hardware Metrics: Automatic generation of diagnostic coverage reports and hardware safety metrics as per ISO 26262.

Capabilities of Pre-Processing Tools

- Data Import: Directly import data from other systems like requirements management tools, system architecture tools, and external databases.
- System Model Support: Seamless integration with model-based system engineering (MBSE) tools, allowing analysis directly from system models like SysML or UML.
- Consistency Checks: Cyber Safety 's pre-processing tools include consistency checks to ensure that the analysis inputs (such as system models or design data) are aligned with the required safety, reliability, and cybersecurity frameworks.
- Library of Failure Modes and Threats: Cyber Safety provides an extensive library of common failure modes and cybersecurity threats that can be customized based on the project.
- Collaboration Tools: Multiple team members can collaborate within the tool through real-time data sharing and version control, ensuring all stakeholders have access to up-to-date information.

Post-Processing Capabilities

- Automated Reporting: Comprehensive reporting templates that generate detailed documents, including analysis results for FMEA, FTA, FMEDA, and cybersecurity risk assessments.
- Customizable Report Formats: Allows customization of report formats to meet specific project or regulatory requirements.
- Visualization Tools: Cyber Safety offers graphical tools such as system dependency diagrams, fault trees, and risk analysis charts to facilitate understanding of the system behavior post-analysis.
- Data Export: Export analysis results in multiple formats, including XML, CSV, and Excel, for integration with other tools or regulatory documentation.

Automation & Customization

- Custom Workflows: Cyber Safety supports customization of analysis workflows to align with specific project needs or industry standards.
- Scripting Support: Users can automate repetitive tasks through Python scripting, enabling advanced customization and integration with other tools.
- API Integration: Provides an open API to integrate with other PLM (Product Lifecycle Management) tools, simulation software, or data management systems.
- Automation of Standard Compliance Checks: Built-in automation for conducting compliance assessments as per industry-specific regulations like ISO 26262, ARP4761, or IEC 61508, reducing manual effort.

Standards Compliance

- ISO 26262 (Automotive Functional Safety): Full support for functional safety analysis including FMEA, FTA, and FMEDA.

• IEC 61508 (Functional Safety): Ensures compliance with functional safety standards for industrial applications, providing support for SIL (Safety Integrity Levels) determination. • ARP4761 / ARP4754A (Aerospace Safety): Fully compliant with the standards for civil aircraft and system safety analysis in the aerospace industry. • ISO/SAE 21434 (Automotive Cybersecurity): Supports risk assessment, threat analysis, and cybersecurity assurance for automotive systems. • MIL-STD-882E (Military System Safety): Facilitates safety analysis aligned with military standards. • DO-178C and DO-254 (Aerospace Systems and Software): Provides tools for safety-critical system and software verification and validation for aerospace applications. • Custom Compliance Frameworks: Users can define custom compliance checks for company-specific regulations or frameworks.
Additional Features Required • Scalability: Cyber Safety is designed to handle projects of various sizes, from small component-level analysis to large system-level analysis, making it suitable for complex government and defense projects. • Multi-Domain Support: Cyber Safety allows for cross-domain analysis (e.g., combining safety and cybersecurity risks), ensuring comprehensive risk management for systems. • Real-Time Collaboration and Cloud Support: Cyber Safety supports cloud deployment, enabling geographically distributed teams to work on the same project and share results seamlessly.

RFQ – 4 (H) Specification for Software for FEA and Fluids Simulations

General Specification

Technical Specifications for FEA & Fluids Simulations.

Mechanical FEM analysis tool is required to carry out structural, thermal and coupled structural-thermal along with bidirectional CFD coupling for FEA having pre-and post-processor capabilities.

Technical requirements:

Features
Number of Modules • The software should have following modules: • FEM Enterprise Module • 3-D Design Modeler with direct modeling features Module
Structural Analysis • Static analysis, Modal analysis, • Pre-stress effects, Complex Eigen value extraction, Buckling - linear & nonlinear, Transient analysis, Spectrum & Harmonic analysis, Random vibration, Sub-structuring, Shape & Topology Optimization, Geometric Nonlinearity, small/ large strains, • Material Models for Structural analysis, • Linear material models (Hyperelasticity, Viscoelasticity),

- -Non-linear material models (Rate-dependent plasticity, Rate-independent plasticity, Visco-plasticity, creep, von-Mises and Hills plasticity models including kinematic (linear and segmented non-linear (Chaboche's model), isotropic and mixed hardening behavior, Prandtl-Reuss flow rule). Gurson plasticity with isotropic/ Chaboche Kinematic Hardening; Drucker-Prager Yield Surfaces model
- Gasket material models
- nonlinear elasticity models
- Concrete material models
- Cohesive Zone Material (CZM) Model
- There shall be user defined material model. This requires accessibility of material parameters/ variables by user to integrate a new model with existing set-up. The user defined model shall be based on python scripts.
- Cast Iron plasticity, Multi scale modeling, Curve fitting tools, Isotropic, Orthotropic & Anisotropic material considerations.
- The software shall be capable of carrying out cyclic plasticity calculations using the material considerations as given in Sr. No. 3 and 4 (above) of clause 3.2.1.
- Geometric non-linear capabilities: large strain, large rotation, and stress stiffening. These can be used with above rate dependent and rate independent plasticity models
- Advance Material Modeling and configuration for material assignment

Contact Modeling features

- Automatic Contact Detection for Assemblies with different following contact schemes,
- Pure penalty, Augmented Lagrange, Normal Lagrange with contact detection algorithms to obtain better convergence capabilities. The options shall be existing to specify penetration tolerance by value or factor.
- No slip condition, slip conditions with friction coefficient etc.

Thermal Analysis

- Steady State analysis, transient analysis
- Phenomenon such as Conduction, Convection & Radiation.
- Temperature dependent thermal material properties (isotropic/ anisotropic) for non-linear thermal problems such as specific heat, thermal conductivity, heat transfer coefficient, emissivity, absorptivity, transmittivity etc.
- boundary conditions and load inputs includes convections and radiation heat fluxes, heat generation rates, and temperatures
- Solution schemes: Explicit, Implicit, Crack-Nicolson schemes with consistent and lumped formulations of capacitance matrix.
- User shall be able to access the FE parameters and can make changes based on user defined subroutines.
- Modelling thermal contact conductance, frictional heating
- Thermal module shall be capable of coupling to mechanical module for coupled thermal-mechanical analyses to evaluate thermal stresses and strains.

Advanced Analysis Techniques

- Adaptive Meshing
- Sub-modeling (including Solid-Shell)
- Element birth and death
- Fracture mechanics (Evaluation of stress intensity factor and J-integral for 2D and 3D geometries) & Crack Propagation by XFEM
- Rigid & Flexible Multi-body dynamics

Meshing Features

- Beam and Link elements
- Pipe elements
- Shell elements (plane and curved shell)
- Solid elements (linear, quadratic or higher order)
- Planar elements
- Plane Stress
- Plane Strain
- Axisymmetric
- Linear/ Nonlinear Spring elements
- All elements shall be conforming elements and capable of carrying out:
- All types of Structural nonlinear analyses
- Buckling and collapse
- All types of Dynamic analysis
- Special Purpose elements like:
- Gasket elements
- Kinematic Joints
- Interface elements
- Mass elements
- Integrated Environment CAD connectivity, geometry clean-up, automatic meshing, a comprehensive materials library, use of parameters, and design exploration
- Automatic pop-up warning messages for missing element, distorted elements, unconstrained nodes etc.

Solver Features

- Direct Sparse Solver, Distributed sparse direct solver
- Iterative Solvers (Preconditioned Conjugate Gradient (PCG) & Jacobi Conjugate Gradient (JCG), PCG Lanczos eigensolver
- High Performance Computing (HPC) enabled (Both SMPS and Distributed Parallel Processing)
- HPC for GPGPU (General Purpose Graphical Processing Unit)
- Special Solvers for Large Number of Modal Extraction
- MBD for Motion design and simulation

- Flex body Dynamics

Boundary Conditions

- Solid model loads and boundary conditions, point load, line traction, pressure, body force etc.
- Tabular loads and boundary conditions
- Function loads and boundary conditions
- Apply temperature loads/ boundary conditions in terms of flux and temperature, heat source/ sink etc.
- Application of boundary condition in different coordinate systems (Cartesian, cylindrical, spherical, user defined)

Post Processing

- Report generator (in HTML or MS Word formats)
- Contour displays: Iso-stress, Isotherms, Iso-strains contours, invariants based
- Vector displays
- Ability to display result Summaries (Max & Min, invariants, specified range)
- Slicing planes
- Path Plots, path action
- Time History Plots & Data Output
- Derived quantitative calculations (Including Differentiation Integration, Statistical Quantities, etc.)
- Animation (Including over Time History)
- Output (Images, Text format & Excel data)
- Stress linearization for membrane and bending stress/ strain, peak stress components

Automation Customization

- Solver scripting language
- Automatic Capture and Reuse data through Parameters
- Enable Building of Vertical Applications
- Restarting the solution with Restart command to read the previous stress/ strain history.

Explicit Capabilities

- Interactive interface for pre- and post-processing with instant feedback.
- The solver shall automatically switch from explicit to implicit whenever the results are not converging.
- Transition to explicit, user interface should be same as for Mechanical, enabling easy transition to an explicit solution when an implicit solution is impractical.
- Automatically adjusting the load/ time steps for convergence of results4. Override default setting for all parameters when needed to provide maximum flexibility to improve calculation accuracy and speed.
- Problems involving short-duration severe impact loading, large material deformation and material failure

• Response of materials from impacts, high pressures, and other forms of loading that result in deformation, failure and fragmentation • Short-duration problems with complex material response • To be used for simulating fracture, cutting, machining operation, buckling, impact, drop etc. as well as highly nonlinear quasi-static simulations where the implicit solvers would struggle to converge
Composite Feature • Define composite properties of specific parts — for both implicit and explicit solutions • Materials: basic materials defining the fabrics. • Fabric: material properties and a thickness. • Laminate: an assembly of fabrics (with orientations). • Sub-laminates: an assembly of fabrics and laminates (with orientations), orientation based properties (an-isotropy)Define the element orientation (so as to properly orient materials). • Define the ply sequence for groups of elements (usually corresponding to faces of the geometry). • Draping: Ability to compute accurate orientation changes due to geometry curvature • 3D modeling: By extrusion of shell models, 3D models can be created. 3D models are useful for bulky areas • CAD support: STEP and IGES geometries can be imported to define thick cores or use as guides for 3D extrusions. • Improved usability to define composite models, especially for complex shapes • More detailed analysis with more failure criteria. • Automation of composite modeling through Python or fortran scripting
• Load application with cyclic waveforms such as sine, trapezoidal, triangular, asymmetric triangular with or without mean stress (and strain) components • The user shall be able to write the post-processing scripts on the derived parameters obtained from finite element solution. • Rainflow-algorithms for cycle counting or evaluation of cumulative damage fraction
Graphical Tools • Fitting schemes • Full Second-Order Polynomial • Kriging (with manual or automated refinement) • Non-Parametric Regression • Graphical tools • Sensitivity plots • Correlation matrices • Curves and surface • Trade-off plots
Additional Features

Multi Analysis Capabilities, Optimization analysis, Geometric idealization, fluid structure interaction, Low Frequency shall support file formats such as IGES, STEP, Parasolid®, SAT, STL

Geometry Modeling and Preprocessing

MODELER CAPABILITIES

Direct Modeling Technology

- Feature Based Modeling Technology
- Open Data from All Major CAD Systems
- Export Data to Neutral File Formats
- Modify Imported Geometry
- Defeaturing and Simplification Tools
- Model Repair
- Add Parameters for Design Exploration
- Extract Mid-Surfaces/Shells and Beams
- Extract Volumes & Create Inner Fluid Domains
- Extract Outer Air Enclosures
- Shared Topology for Conformal Meshing
- Booleans and Slicing
- Create Weld Bodies
- Boundary Condition Mapping
- Scripting
- Sketching and Editing Tools
- 3D Comparison Tools
- Repair and Edit Faceted Data
- Reverse Engineering Faceted Data
- Raster to vector conversion
- New Imprint and Wrap tools for easier simulation edits between parts and solid geometry
- New simulation cleanup and detection tools: Short Edges, Overlap Faces, Corrupt Faces
- Power selection and update of mid-surfaces to geometry changes
- Driving dimensions from Pull tool edge pivot, as well as imports of layer contents into selection sets.
- MODELER: CONCEPT DESIGN
- Custom shortcuts that personalize Direct Modeler tools to your needs
- Pivoting of surface edges and vertices
- Reverse engineering improvements, such as a dedicated mesh curve fitting tool and snap to point
- Blend improvements — blend to point capability
- Automatic Clip Volume for Repair tool options
- Tangent/natural extensions for curves and surfaces

- Variable radius rounds, re-ordering of overlapping round chains, and projected linked points
- Mirror depression/protrusion, min/max curvature points shown, and ability to scale points/axes
- “Paste Independent” and replace component commands, support multiple components
- The ability to 3D Printing module, which allows users to edit STL files directly and leverage automatic repair tools in order to ensure a successful print.
- 3-D MODELING
- Extrude
- Revolve
- Sweep
- Skin/loft
- Surface
- Blend
- Chamfer
- Share topology
- 2-D SKETCHING
- Drawing tools
- Line modifications
- Dimensions and constraints
- Parameter Manager
- 1-D MODELING
- Beams from lines/edges
- Plates from lines/sketches
- cross-section types
- Parametric cross sections
- FEATURES AND TOOLS
- Merge/slice bodies
- Surface extraction
- Surface extension
- Surface patch
- Surface flip
- Join surfaces
- Freeze/unfreeze
- Volume enclosure
- Volume fill
- Face delete
- Edge delete
- Named selection

- Attribute
- Symmetry extraction
- Mid-surfacing
- Connect
- Projection
- Pattern
- Boolean
- Repair tools
- Analysis tools
- SUPPORTED FILE FORMAT(IMPORT)
- ACIS, Acrobat 3D, 2D PDF, AMF, AutoCAD, CATIA, Creo Elements/Direct Modeling, Design Modeler, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER,
- SUPPORTED FILE FORMAT(EXPORT)
- ACIS, Acrobat PDF 3D,Acrobat 2D PDF, AMF, AutoCAD, CATIA, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER, Rhino, SketchUp, SolidWorks, STEP, STL,
- Meshing : capabilities
- Meshing tool intended for creating structured hexahedral (brick) mesh for non-trivial geometries, also to support free tetrahedral or hex dominant mesh, Blocking of geometry, Meshing Workflow transfer from SpaceClaim to Mechanical

Explicit Solver

- Interactive prep/post and solution
- Remapping in space
- Remapping solution methods
- Mass scaling
- Dezoning
- Part activation and deactivation
- Part addition/removal during
- a simulation
- Erosion based on multiple criteria
- Natural fragmentation
- Euler solver
- 2-D solver
- Fluid–structure interaction (FSI)
- Implicit–explicit deformations
- Implicit–explicit material states

- Variety of inlet and outlet B.C.
- Steady-state flow
- Transient flow
- 2-D flow (dedicated solver option)
- 2-D flow (using thin 3-D segment)
- 3-D flow
- Conjugate heat transfer
- Non-Newtonian viscosity
- Viscoelasticity
- Turbulence (isotropic)
- Turbulence (anisotropic/RSM/LES)
- Dynamic/moving-deforming mesh
- Immersed-solid/MST method
- for moving parts
- Flow-driven solid motion (6DOF)
- Internal radiation
- (participating media)
- Species modeling
- Flow pathlines (massless)
- Particle tracking (with mass)
- Acoustics (source export)
- Acoustics (noise prediction)
- Chemical reaction
- Cavitation
- Multiphase (Eulerian)
- Multiphase (free surface)
- Fluid–structure interaction option
- Internal optimization for flow
- Specialty extrusion models
- Specialty blow molding models
- Specialty fuel cell models

Features

- Shall support scripting features
- Direct Modeling technology supported with 3-D comparison tools
- Repair & edit faceted data support

HPC /High Performance Computing

- Default Number of Cores - 4 (DMP + SMP)

Features / Capabilities Required

General Capabilities of pre-processing tools

- The preprocessors (geometry modeling tool & the mesh generator) should have the following capabilities
- Design mode options, 3D parametric Modeling,3D concept Modeling
- Other Advanced Features such as solid extension, surface extensions, Freeze\ Unfreeze, volume fill, enclosure etc.
- Other Advanced Tools such as merge/slice bodies, surface flip, surface patch, symmetry extraction, body operation, analysis tools, Repair tools etc.
- Bidirectional CAD connections e.g. PRO-E, CATIA V5, SolidWorks, Solid Edge etc. (additional license required)
- Data import options: IGES, Parasolid, STEP, STL etc.
- Data export option: Parasolid, IGES, and STEP etc.
- Tetrahedral meshing methods-patch confirming and patch independent.
- Hexahedral meshing methods-General sweep, thin sweep, Multizone, Hex Dominant.
- Surface meshing.

Mesh Controls Global Controls

- Physics preference settings
- Relevance settings
- Inflation settings
- Curvature-based refinement settings Proximity-based refinement settings
- Smoothing settings
- Transition/growth settings
- Pinch (defeaturing) settings
- Quality settings
- Element mid-side node settings
- Rigid-body behavior settings
- Automatic contact detection
- Contact sizing
- Body mesh method controls
- Body, face, edge, vertex sizing
- Body, face, edge, vertex sphere of influence
- Body, face, edge curvature-based refinement
- Body of influence
- Solver-based refinement controls
- Mapped-face meshing controls
- Match mesh controls

Meshing Solutions Features

- Virtual topologies
- Pinch controls
- Inflation controls
- Gap tool
- Winding-body meshing
- Wire-body meshing

- Rigid-body meshing
- Gasket meshing
- CAD instances meshing

Post Processing

- Species Transport
- Non-Premixed Combustion
- Premixed Combustion
- Fully interactive graphical and text-based user interfaces
- Grid checking (validity, quality, size) and reordering utilities
- Flexible unit specification (SI units. British units, custom/mixed units) in post process
- Computation, reporting, and monitoring of surface/volume integrals and averages
- Calculator utility for user-defined (custom) field functions
- Calculation of gradients (vector and scalar) and derived quantities
- Histogram/graphs of geometric and solution data
- Vector plots for velocity field and user-defined vector fields
- Contour plots on boundary surfaces and user-specified surfaces
- Pathlines (streamlines)
- XY-plots
- Phase-specific post processing for multiphase flows
- Graphical probing of data
- Interactive sweeping of planes through the solution domain
- Automated animation creation tools
- On-screen mouse-based view manipulation (rotation, translation, magnification)
- Extensive hardcopy options
- Automated report generation option with turbo specific report generation option
- Export to 3-D viewer option
- Turbo specific Post processing

Geometry Modeling capabilities required

PRE AND POST PROCESSING

- Photo Realistic Rendering
- SpaceClaim Direct Modeler
- Compare Multiple Runs, Datasets, Physics, Graphs in a Single Window

- Direct Modeling Technology
- Feature Based Modeling Technology
- Open Data from All Major CAD Systems
- Export Data to Neutral File Formats
- Modify Imported Geometry
- Defeaturing and Simplification Tools
- Model Repair
- Add Parameters for Design Exploration
- Extract Mid-Surfaces/Shells and Beams
- Extract Volumes & Create Inner Fluid Domains
- Extract Outer Air Enclosures
- Shared Topology for Conformal Meshing

- Booleans and Slicing
- Create Weld Bodies
- Boundary Condition Mapping
- Scripting
- Sketching and Editing Tools
- 3D Comparison Tools
- Repair and Edit Faceted Data
- Reverse Engineering Faceted Data
- Raster to vector conversion
- New Imprint and Wrap tools for easier simulation edits between parts and solid geometry
- New simulation cleanup and detection tools: Short Edges, Overlap Faces, Corrupt Faces
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- Driving dimensions from Pull tool edge pivot, as well as imports of layer contents into selection sets.
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- Automatic Clip Volume for Repair tool options
- Tangent/natural extensions for curves and surfaces
- Variable radius rounds, re-ordering of overlapping round chains, and projected linked points
- Mirror depression/protrusion, min/max curvature points shown, and ability to scale points/axes
- "Paste Independent" and replace component commands, support multiple components
- The ability to 3D Printing module, which allows users to edit STL files directly and leverage automatic repair tools in order to ensure a successful print.

Supported File Format (Import)

- ACIS, Acrobat 3D, 2D PDF, AMF, AutoCAD, CATIA, Creo Elements/Direct Modeling, Design Modeler, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER,

Modeler: Supported File Format (Export)

- ACIS, Acrobat PDF 3D, Acrobat 2D PDF, AMF, AutoCAD, CATIA, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER, Rhino, SketchUp, SolidWorks, STEP, STL,

Meshing: Capabilities

- Meshing tool intended for creating structured hexahedral (brick) mesh for non-trivial geometries, also to support free tetrahedral or hex dominant mesh, Blocking of geometry, Meshing Workflow, transfer from SpaceClaim to Mechanical

General Capabilities of pre-processing tools

- The preprocessors (geometry modeling tool and the mesh generator) should have the following capabilities
- The tool should have the design mode options , 3D parametric Modeling,3D concept Modeling
- Other Advanced Features such as solid extension, surface extensions, Freeze\ Unfreeze, volume fill, enclosure etc
- Other Advanced Tools such as merge/slice bodies, surface flip, surface patch, symmetry extraction , body operation, analysis tools, Repair tools etc
- Bidirectional CAD connections e.g. PRO-E, CATIA V5, SolidWorks, Solid Edge etc. (additional license required)
- Data import options: IGES, Parasolid, STEP, STL etc.
- Data export option: Parasolid, IGES, and STEP etc.
- Tetrahedral meshing methods-patch confirming and patch independent.
- Hexahedral meshing methods-General sweep, thin sweep, MultiZone, Hex Dominant.
- Surface meshing.

Mesh Controls

- Global Controls
- Physics preference settings
- Relevance settings
- Inflation settings
- Curvature-based refinement settings
- Proximity-based refinement settings
- Smoothing settings
- Transition/growth settings
- Pinch (defeaturing) settings
- Quality settings
- Element midside node settings
- Rigid-body behavior settings
- Automatic contact detection
- Contact sizing
- Body mesh method controls
- Body, face, edge, vertex sizings
- Body, face, edge, vertex sphere of influence
- Body, face, edge curvature based refinement
- Body of influence
- Solver-based refinement controls
- Mapped-face meshing controls
- Match mesh controls
- Meshing Solutions Features
- Virtual topologies
- Pinch controls
- Inflation controls
- Gap tool
- Winding-body meshing

- Wire-body meshing
- Rigid-body meshing
- Gasket meshing
- CAD instances meshing

General Modeling Capabilities/ Configuration CFD Software

The CFD Solver should have the following capabilities:

- 2D and 3D flows
- Steady-state and transient flows
- All speed regimes (low subsonic, transonic, supersonic, and hypersonic flows)
- Laminar, turbulent and transitional flows
- Full range of turbulence models with predictive transition model and also Turbulence transition model for rough walls
- Spalart-Allmaras
- K-epsilon including Standard, Realizable and RNG
- SST k-w
- RSM
- Transition k-kl-w
- Transition SST
- DES
- SAS
- LES
- E-LES
- Near Wall Treatment (including Standard, Non-equilibrium, scalable Wall Functions;, Enhanced Wall Treatment and User Defined wall Function)
- Heat transfer
- Conduction
- Conjugate heat transfer can be modeled
- Convection
- Forced
- Natural
- Radiation modeling capability including
- Discrete Ordinate (Unlimited number of gray bands modeling)
- P1 (Multi-band modeling also available)
- Discrete Transfer
- View factor based approach like S2S
- Monte Carlo
- Particle effect on radiation
- Effect of Soot on radiation
- Effect of gaseous species on radiation (WSGGM approach)
- Solar load modeling
- Phase change heat transfer
- condensation
- Evaporation
- Boiling

- Solidification/melting
- Multiphase modeling capabilities
- Cavitation
- Mixture model
- Eulerian model
- Lagrangian Dispersed phase model
- Volume of Fluid model
- Eulerian Wall Film Model
- Species modeling
- Porous media modeling
- Ability to model heat transfer in porous media without the assumption of thermal equilibrium between the media and the fluid flow, via a dual cell approach
- Combustion modeling
- Fast Chemistry
- Eddy dissipation model
- Premixed combustion model
- Non-premixed equilibrium model
- Partially pre-mixed model
- Finite rate chemistry
- Laminar Flamelet model
- Laminar finite-rate model
- Eddy-dissipation concept model (EDC)
- Composite PDF transport model
- Pollutant formulation model
- NOx formulation model
- Thermal NOx
- Prompt NOx
- Fuel NOx
- NOx reburning model
- Selective Non-catalytic Reduction (SCNR) model
- Soot formulation model
- Moos-Brookes model
- One step and Two step models
- Soot affects and radiation absorption
- SOx formulation model
- Discrete phase combustion (Reacting particles)
- Heating/cooling of the discrete phase
- Vaporization and boiling of liquid droplets
- Volatile evolution and char combustion for combusting particles
- Droplet breakup and coalescence using spray models
- Erosion/Accretion
- Gas phase, Surface Reactions, Particle Surface reactions
- Multiple spark model
- Veynante extended coherent flame model (ECFM)

- Secondary Droplet breakup models (TAB, WAVE, KHRT and SSD)
- Characteristic time model, G-equation model, Thickened flame model
- Ability to Import CHEMKIN Chemistry file for easier and faster reactions set-up
- Ability to model stiff chemistry (both for homogeneous and heterogeneous reactions)
- Speed-up in computation due to reactions using ISAT algorithm for faster turnaround
- Viscosity treatment
- Newtonian fluid
- Non-Newtonian fluid
- Viscoelasticity
- Solid body motion
- Rotation & translation
- Multi-reference frame
- Mixing Plane
- Sliding mesh
- Dynamic mesh
- Re-meshing
- 2.5D
- Smoothing
- Ability to remesh 3D wedge/prism cells in a boundary layer mesh as part of cell zone and face region remeshing methods
- Ability to detect if the computed mesh motion will result in contact with other surfaces in dynamic mesh simulations
- Flow driven solid motion
- 6DOF (Fully parallelized)
- Adjoint Solver for shape optimization
- Acoustics modeling
- Broadband noise model
- FWH model
- CAA model

Mesh Capabilities

- Unstructured mesh (tetrahedral, hexahedral, prism and pyramid elements, polyhedral elements)
- Non-conformal (non-matching) mesh interfaces including fluid/solid interfaces.
- Mesh smoothing, improvement & manipulation tools.
- Transportation equation-based (diffusion-based) mesh smoothing
- Hybrid mesh generation utilities
- Grid-to-grid solution interpolation capability
- Key frame mesh swapping
- Mesh morpher and optimizer
- Cartesian re-meshing

Numerical Method

- Solution for Navier Stokes equation using pressure based and density-based solvers
- Finite-volume method based on fully unstructured meshes
- Adaptive time stepping option for implicit schemes
- Dynamic memory allocation

- Non-iterative (NITA) transient solution options
- Pseudo-transient relaxation method
- Conservation of rothalpy transport equation
- Second-order time discretization for simulations using the deforming mesh
- Pressure based and Density Based solvers
- Pressure Based Segregated Solver
- Decoupled solution for all mean flow qualities
- First-order and second-order implicit time discretization schemes
- Pressure Based Coupled Solver
- Coupled solution for all mean flow qualities
- Decoupled (segregate) solution of turbulence and user-defined scalar transport equations
- Coupled or segregated solution for VOF.
- First-order and second-order implicit time discretization schemes
- Density Based Coupled Solver
- Coupled solution for Flow, Energy and Species
- Decoupled (segregated) solution for turbulence and user-defined scalar transport equations
- First-order and second-order implicit time discretization scheme
- Solution steering to navigate the flow solution from a starting initial guess to a converged solution with minimum user interaction
- Use monitors to determine solution convergence

Boundary Conditions

- Inlets (Pressure, Mass or Velocity), outlets (Pressure, Mass or Velocity) , Reverse Flow at inlet/outlet
- Non-Reflecting Boundary Conditions
- Walls
- Symmetries
- Periodic (Rotational and Translational)
- Porous Media modeling (cell based and face element based approaches)
- Transient boundary condition

Material Properties

- Constant or variable fluid properties including temperature and composition dependence
- Comprehensive database containing material properties for standard fluids and solids (user-modifiable), including:
- Custom database creation for storing material properties

Parallel Processing

User-Defined Functions

- Capability to modify solver to incorporate user physical models using User Defined Functions or User Fortran, Expressions
- Interpreted (compiled at runtime) or compiled (compiled in advance and linked at runtime)
- Access to memory for user-defined functions
- Specification of volumetric sources in continuity, momentum, energy, turbulence, specifies, mixture fraction, and volume fraction transport equations
- Definition of custom physical properties
- User-defined density for compressible liquid modeling
- Customized boundary/initial conditions

- User-defined scalar transport equations
- Creation of custom post processing variables

- Parallel processing on shared and distributed memory systems
- Ability to scale linearly for 1000 cores or more
- Faster File I/O in parallel
- Truly Parallel file writing capability
- Automatic load balancing between cores based on mesh count or physical models (e.g. Multiphase, DPM, etc.)

Post Processing

- Fully interactive graphical and text-based user interfaces
- Grid checking (validity, quality, size) and reordering utilities
- Flexible units specification (SI units, British units, custom/mixed units) in post process
- Computation, reporting, and monitoring of surface/volume integrals and averages
- Calculator utility for user-defined (custom) field functions
- Calculation of gradients (vector and scalar) and derived quantities
- Histogram/graphs of geometric and solution data
- Vector plots for velocity field and user-defined vector fields
- Contour plots on boundary surfaces and user-specified surfaces
- Pathlines (streamlines)
- XY-plots
- Phase-specific post processing for multiphase flows
- Graphical probing of data
- Interactive sweeping of planes through the solution domain
- Automated animation creation tools
- On-screen mouse-based view manipulation (rotation, translation, magnification)
- Extensive hardcopy options
- Automated report generation option with turbo specific report generation option
- Export to 3-D viewer option
- Turbo specific Post processing

Interface, Graphics and Reporting

- Summary reports of solver and physical model settings
- Dynamic interrupt and restart of calculations & modification
- Residual reporting and display
- Reporting and monitoring minimum and maximum values
- Reporting and monitoring of fluxes of mass, heat, and chemical species
- Reporting and monitoring of forces and moments
- Time-average and RMS statistics

Export / Import

- Export of solution data dynamically to CFD SOFTWARE Mechanical package
- Data export in ASCII format (CSV and space-delimited)
- Data import from the various existing standard formats like CGNS format etc.
- Seamless bi-directional coupling with existing Mechanical software with same platform / GUI
- Connectivity with BladeModeler, Turbogriad, VSITA TF and RBF Morph module

CFD Software ICEM CFD

- It should have Modernized and Integrated GUI
- It should support Wide CAD tools (Pro/ENGINEER®, UGS™ NX™, SolidWorks®, CFD SOFTWARE ® DesignModeler™ • Geometry readers: CATIA®, Parasolid®, ACIS®, CAPRI, DXF/DWG, I-DEAS® Viewer XML (IDI), IGES, STEP, Plot3D, Rhino3D, CFD SOFTWARE ® Workbench™ readers and more • Faceted geometry: STL, VRML, formatted point data, third-party mesh formats.
- Geometry Creation/Repair/Simplification
- Including Mid-Plane Extractions/Extensions
- Powerful Meshing tools
- Tetra from CAD and/or existing surface mesh
- Shell meshing: patch dependent, patch independent, mapped, structured/unstructured
- Unstructured hexa, structured hexa, hex-dominant extruded quads, Cartesian
- It should have Advanced mesh editing feature
- Solver Setup
- It should have features of Output to 100+ Solvers
- It should be Completely Scriptable
- It should Mesh from dirty CAD and/or faceted geometry (STL, etc.)
- It should Efficiently mesh large, complex models
- It should have features of Hexa mesh (structured or unstructured) with advanced control
- It should have the feature of Extended mesh diagnostics and advanced, interactive mesh editing
- It should output to a wide variety of computational fluid dynamics (CFD) and finite element analysis (FEA) solvers and neutral formats
- It should be Robust algorithms for creating a wide variety of mesh types: hexa, tetra, prism, pyramid, quad, tri or bar elements (linear or quadratic) for use with a range of physics and solvers
- It should be Extended, parametric and persistent mesh controls can be applied globally or specifically as needed
- Should Tolerant of imperfect CAD data containing sliver surfaces, gaps, holes and overlaps
- Tool should use a primarily top-down blocking approach to efficiently hex mesh complex models without the need to subdivide the geometry

CFD Software Process Simulation

- Comprehensive Inlet and Outlet, Conditions, Steady-State Flow
- Transient Flow, 2-D and 3-D Flow, Time Dependent Boundary Conditions
- Periodic domains, Dynamic/moving-deforming mesh, Overset Mesh, Immersed-solid/MST method for moving parts, Flow-driven solid motion (6DOF), Pressure-based coupled solver
- Incompressible Flow, Non-Newtonian Viscosity, Flow Pathlines (Massless), Internal Radiation - Participating Media, Implicit And Explicit VOF
- High Rheology Material, Viscoelasticity, Specialty Extrusion Models, Specialty Blow Molding Models, Specialty Fiber Spinning Models, Drag-n-Drop Multiphysics

Technical Capability Features with Description Technical Specifications Direct Modeler
Direct Modeler • New Imprint and Wrap tools for easier simulation edits between parts and solid geometry • New simulation cleanup and detection tools: Short Edges, Overlap Faces, Corrupt Faces • Power selection and update of mid-surfaces to geometry changes • Driving dimensions from Pull tool edge pivot, as well as imports of layer contents into selection sets. **Concept Design and General Modeling Improvements:** • Custom shortcuts that personalize SpaceClaim Direct Modeler tools to your needs • Pivoting of surface edges and vertices • Reverse engineering improvements, such as a dedicated mesh curve fitting tool and snap to point • Blend improvements — blend to point capability • Automatic Clip Volume for Repair tool options • Tangent/natural extensions for curves and surfaces • Variable radius rounds, re-ordering of overlapping round chains, and projected linked points • Plugin for Makerbot Upload • Mirror depression/protrusion, min/max curvature points shown, and ability to scale points/axes • "Paste Independent" and replace component commands, support multiple components **Detailing:** • BOM display controls: include and collapse properties • Highlight selected point dimension, leader underline control, and 45° chamfer note • Overall usability improvements, including option to hide annotations behind bodies • The ability to 3D Printing module, which allows users to edit STL files directly and leverage automatic repair tools in order to ensure a successful print.
3-D Parametric Modeling • Extrude • Revolve

- Sweep
- Skin/loft
- Surface
- Blend
- Chamfer
- Welds
- Share topolog

Primitive Shapes

- Sphere
- Box
- Parallel piped
- Cylinder
- Cone
- Prism
- Pyramid
- Torus
- Rectangular bend

Advanced Features and Tools

- Merge/slice bodies
- Surface extraction
- Surface extension
- Surface patch
- Surface flip
- Join surfaces
- Freeze/unfreeze
- Volume enclosure
- Volume fill
- Face delete
- Edge delete
- Named selection
- Attribute
- Symmetry extraction
- Mid-surfacing
- Connect
- Projection
- Pattern
- Boolean
- Repair tools
- Analysis tools

Body operation

3-D Concept Modeling

- Beams from lines/edges
- Plates from lines/sketches
- 11 cross-section types
- Parametric cross sections

2-D Sketching

• Drawing tools • Line modifications • Dimensions and constraints **Others** • Parameter Manager

RFQ – 4 (I) Specification for Software for CAD Design Tool

General Specification

Technical Specifications for CAD Design tool

Technical requirements:

Features
Modules to be included The software should have following modules: • Should be able to launch modeling applications such as 3-D Parametric Modeling and direct modeling capabilities along with geometry cleanup and STL editing. • Should have Meshing capability for hexahedral ,2D and 1D meshing.
Geometric Direct Modeler Capabilities • 3D cad modeling should have, Direct Modeling Technology, Feature Based Modelling Technology, Open Data from All Major CAD Systems, Export Data to Neutral File Formats, Modify Imported Geometry, Defeaturing and Simplification Tools, Model Repair, Add Parameters for Design Exploration, Extract Mid-Surfaces/Shells and Beams, Extract Volumes & Create Inner Fluid Domains, Extract Outer Air Enclosures, Shared Topology for Conformal Meshing, Booleans and Slicing, Create Weld Bodies, Boundary Condition Mapping, Scripting, Sketching and Editing Tools, 3D Comparison Tools, Repair and Edit Faceted Data, Icepak Integration, Reverse Engineering Faceted Data, Raster to vector conversion, New Imprint and Wrap tools for easier simulation edits between parts and solid geometry. New simulation clean-up and detection tools: Short Edges, Overlap Faces, Corrupt Faces, Power selection and update of mid-surfaces to geometry changes, Driving dimensions from Pull tool edge pivot, as well as imports of layer contents into selection sets.
Concept Design and General Modelling Improvements • 3D cad modeling should have provision to customize shortcuts that personalize Space Claim Direct Modeler tools to user needs. It should give tools for pivoting of surface edges and vertices, Reverse engineering improvements, such as a dedicated mesh curve fitting tool and snap to point, Blend improvement i.e. blend to point capability, Automatic Clip Volume for Repair options, Tangent/natural extensions for curves and surfaces, Variable radius rounds, re-ordering of overlapping round chains, and projected linked points, Mirror depression/protrusion, min/max curvature points shown, and ability to scale points/axes, “Paste Independent” and replace component commands, support multiple components. The ability to 3D Printing module, which allows users to edit STL files directly and leverage automatic repair tools in order to ensure a successful print with plugin for Makerbot Upload.
Boundary Conditions

- Solid model loads and boundary conditions, point load, line traction, pressure, body force etc.
- Tabular loads and boundary conditions
- Function loads and boundary conditions
- Apply temperature loads/ boundary conditions in terms of flux and temperature, heat source/ sink etc.
- Application of boundary condition in different coordinate systems (Cartesian, cylindrical, spherical, user defined)

Advanced Features and Tools

- It should have advanced CAD tools such as Merge/slice bodies, Surface extraction, Surface extension, Surface patch, Surface flip, Join surfaces, Freeze/unfreeze, Volume enclosure, Volume fill, Face delete, Edge delete, Named selection, Attribute, Symmetry extraction, Mid-surfacing, Connect, Projection, Pattern, Boolean, Repair tools, Analysis tools, Body operation.

Geometry Modeling Features

- Modify Imported Geometry
- Defeaturing and Simplification Tools
- Model Repair
- Add Parameters for Design Exploration
- Extract Mid-Surfaces/Shells and Beams
- Extract Volumes & Create Inner Fluid Domains
- Extract Outer Air Enclosures
- Shared Topology for Conformal Meshing
- Booleans and Slicing
- Create Weld Bodies
- Boundary Condition Mapping
- Scripting
- Sketching and Editing Tools
- 3D Comparison Tools s
- Repair and Edit Faceted Data
- Reverse Engineering Faceted Data
- Raster to vector conversion
- New Imprint and Wrap tools for easier simulation edits between parts and solid geometry
- New simulation cleanup and detection tools: Short Edges, Overlap Faces, Corrupt Faces
- Power selection and update of mid-surfaces to geometry changes
- Driving dimensions from Pull tool edge pivot, as well as imports of layer contents into selection sets.
- Custom shortcuts that personalize Direct Modeler tools to your needs
- Pivoting of surface edges and vertices
- Reverse engineering improvements, such as a dedicated mesh curve fitting tool and snap to point
- Blend improvements — blend to point capability
- Automatic Clip Volume for Repair tool options
- Tangent/natural extensions for curves and surfaces

- Variable radius rounds, re-ordering of overlapping round chains, and projected linked points
- Mirror depression/protrusion, min/max curvature points shown, and ability to scale points/axes
- "Paste Independent" and replace component commands, support multiple components
- The ability to 3D Printing module, which allows users to edit STL files directly and leverage automatic repair tools in order to ensure a successful print.
- Advance Geometry editing features like, Sweep, blend etc. should be available
- Imprint and Wrap tools for easier simulation edits between parts and solid geometry
- Simulation cleanup and detection tools: Short Edges, Overlap Faces, Corrupt Faces
- Power selection and update of mid-surfaces to geometry changes
- Driving dimensions from Pull tool edge pivot, as well as imports of layer contents into selection sets.
- Concept Design and General Modeling Improvements:
- Custom shortcuts that personalize direct Modeler tools to your needs
- Pivoting of surface edges and vertices
- Boolean operations
- Addition, edition and deletion of geometries
- Reverse engineering improvements, such as a dedicated mesh curve fitting tool and snap to point
- Blend to point capability
- Automatic Clip Volume for Repair tool options
- Tangent/natural extensions for curves and surfaces
- 3-D Parametric Modeling: Extrude, Revolve, Sweep, Skin/loft, Surface, Blend, Chamfer, Welds, Share Topology
- Primitive Shapes: Sphere, Box, Parallel piped, Cylinder, Cone etc.
- Advanced feature & tools: Surface extraction, surface patch, Surface flip, volume fill, Edge delete, face delete etc.
- 3-D Concept Modeling & 3D sketching features shall be available
- Should have customization /automation and modeling using python.

1-D Modeling

- Beams from lines/edges, Plates from lines/sketches, cross-section types, Parametric cross sections

2-D Sketching

- Drawing tools, Line modifications, Dimensions and constraints, Parameter Manager

Provides access to the following formats

- Import and Export: Supported File Types ACIS, Acrobat 3D, 2D PDF, AMF, AutoCAD®, CATIA®, Creo Elements/Direct Modeling (CoCreate), Design Modeler, ECAD IDF IGES Image Files, Inventor®, JT Open, Keyshot, Excel, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER, Rhino, SketchUp, SolidWorks, STEP, STL, VDA-FS, VRML, Video files, Wavefront, XAML, XPS

Capabilities in Geometric Idealization

- Mass Shell - Thin 3D Solids

Meshing: Capabilities

• Meshing tool intended for creating structured hexahedral (brick) mesh for non-trivial geometries, also to support free tetrahedral or hex dominant mesh, Blocking of geometry, Meshing Workflow, transfer from design to Mechanical
Features • Should support scripting features, Python scripting • Direct Modeling technology supported with 3-D comparison tools • Repair & edit faceted data support
Supported File Format (Import) • ACIS, Acrobat 3D, 2D PDF, AMF, AutoCAD, CATIA, Creo Elements/Direct Modeling, Design Modeler, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER,
Modeler: Supported File Format (Export) • ACIS, Acrobat PDF 3D,Acrobat 2D PDF, AMF, AutoCAD, CATIA, ECAD IDF, IGES, Image Files, Inventor, JT Open, Keyshot, Acrobat PDF 2D, AMF, AutoCAD, CATIA, Excel, ECAD IDF, IGES, Image files, NX, Parasolid, Point curve text, POV-Ray, Microsoft PowerPoint, Pro/ENGINEER, Rhino, SketchUp, SolidWorks, STEP, STL,
Required Meshing: Capabilities • Meshing tool intended for creating structured hexahedral (brick) mesh for non-trivial geometries, also to support free tetrahedral or hex dominant mesh, Blocking of geometry, Meshing Workflow, transfer from design to Mechanical

RFQ – 4 (J) Specification for Software for Motor Design Solution

General Specification

Technical Specifications for Motor design solution

Motor design software suite required for electric machine design and analysis, encompassing a wide range of capabilities from electromagnetic to thermal and efficiency analysis. The software enables rapid and accurate multi-physics simulations to optimize motor performance across various applications. It is well-suited for high-fidelity design verification and optimization, with comprehensive pre-processing, advanced analysis, and post-processing tools.

Technical requirements:

Features
Modules to be included • Electromagnetic (EM) Module: • Conducts electromagnetic analysis of electric machines (motors and generators) using finite element analysis (FEA). • Simulates performance characteristics like torque, flux density, losses, and back EMF. • Thermal Module: • Evaluates the thermal behavior of motors and components, including heat generation and cooling systems. • Supports both transient and steady-state thermal analysis. • Mechanical Module:

- Provides structural analysis for evaluating deformations, stress, and vibrations in motor components.
- Handles rotor dynamics and mechanical resonance analysis.
- Efficiency Mapping (Drive Cycle) Module:
- Offers efficiency prediction for electric machines under different operating conditions.
- Generates efficiency maps and drive cycle analysis to predict real-world performance.

Advanced Analysis Techniques Required

- Multi-Physics Simulation:
- Coupling of electromagnetic, thermal, and mechanical analyses for holistic machine performance evaluation.
- Enables the assessment of interactions between different physics domains, e.g., electromagnetic forces and thermal stresses.
- Time-Stepping Analysis:
- Allows dynamic time-domain simulations for transient behavior in motors, capturing dynamic torque and speed variations.
- Harmonic Analysis:
- Conducts detailed harmonic analysis for identifying vibrations, noise sources, and potential electromagnetic interference (EMI).
- Loss Prediction and Efficiency Optimization:
- Models losses due to core, copper, and magnetics and assists in improving the overall efficiency of the motor design.
- Design Optimization Algorithms:
- Leverages optimization solvers to improve motor performance parameters such as torque, efficiency, and thermal behavior based on constraints.

Capabilities of Pre-Processing Tools

- Geometry Import and Parameterization:
- Import CAD geometries from popular formats such as IGES, STEP, and STL.
- Provides robust geometry cleanup tools to fix gaps, overlaps, and other common geometry issues.
- Parametric modeling to easily modify design geometry for optimization and design variation studies.
- Material Database:
- Built-in comprehensive material library, including properties for electromagnetic, thermal, and mechanical materials.
- Supports custom material definitions and anisotropic material properties for advanced simulations.
- Mesh Generation:
- Automatic and manual mesh generation capabilities tailored for different physics (EM, thermal, mechanical).
- Adaptive mesh refinement for capturing fine details in regions of interest.
- Boundary Conditions and Excitations:
- Provides a wide range of predefined boundary conditions and excitations, including load scenarios for electromagnetic, thermal, and structural simulations.
- Allows custom load profiles and boundary conditions for specific operating scenarios.

Visualization Tools:

- Post-Processing Capabilities
- Provides graphical visualization for motor performance parameters including flux, torque curves, efficiency maps, and temperature distributions.
- Custom Report Generation:
- Generates detailed, customizable reports that include 2D and 3D charts, summaries of key performance indicators (KPIs), and efficiency breakdowns.
- Comparison and Benchmarking:
- Allows comparison of different motor designs, plotting their performance side-by-side across key metrics like efficiency, losses, and operating temperatures.
- Thermal and Structural Safety Margins:
- Calculates safety margins for thermal performance and structural integrity under various operating conditions.

Automation & Customization

- Scripting and API Access:
- Supports Python scripting and API access for automating repetitive design and analysis tasks.
- Customizable workflows that enable batch simulations and parametric sweeps.
- Integration with Other Simulation Tools:
- Seamlessly integrates with other simulation tools like Fluent and Ansys Mechanical, Maxwell, and Workbench for Multiphysics.
- Supports co-simulation with Twin Builder for system-level simulations and digital twin creation.

Standards Compliance

- ISO Compliance:
- Compliant with international standards such as ISO 9001 for quality management systems.
- IEC Standards:
- Supports analysis based on IEC 60034 (Rotating Electrical Machines), IEC 60076 (Power Transformers), and IEC 61972 (Rotating Machine Efficiency).
- Automotive and Aerospace Standards:
- Supports simulations in line with automotive and aerospace standards such as ISO 26262 for functional safety, MIL-STD-810 for environmental testing, and AS9100 for quality assurance in aerospace design.
- Custom Standards and Testing Protocols:
- Provides flexibility to customize simulations based on industry-specific standards or internal testing protocols.

RFQ – 4 (K) Specification for Software for Material Solution

General Specification

Technical Specifications for Material solution

Technical requirements:

Features
Modules to be included

- Material solution should offer a variety of databases and tools for material exploration, comparison, and selection.

Materials Data Module (Granta)

- Access to comprehensive materials data libraries (MaterialUniverse, MMPDS, CAMPUS Plastics, SteelSpec, ASME data, etc.).
- Materials Property Module: Coverage of mechanical, thermal, electrical, environmental, and physical performance properties, including advanced data like fatigue, creep, and corrosion resistance.
- Eco Audit Tool: Evaluate environmental impacts, such as CO2 footprint, through Life Cycle Assessment (LCA) tools.
- Material Comparison Module: Enables comparison of multiple materials side by side, including property charts and cost-performance analysis.
- Materials Selection Algorithms: Multi-attribute optimization tools for selecting materials based on customizable criteria like weight, cost, or performance.

Advanced Analysis Techniques

- Material Selector should support sophisticated analytical techniques to optimize material selection:
- Performance Index Calculations: Built-in algorithms calculate material performance indices for objectives like stiffness, strength, and lightweighting.
- Risk Assessment & Material Substitution: Identify high-risk materials due to supply chain, cost, or regulatory concerns and find alternatives that maintain performance.
- Finite Element Data Support: Provides FEA-compatible material data for accurate simulations.

Material Comparison

- Material Selector should enable in-depth material comparison through various tools and graphical methods:
- Material Comparison Tables:
    1. Side-by-side comparison of material properties across a range of categories such as strength, thermal conductivity, electrical properties, cost, and environmental impact.
- Material Performance Indices:
    1. Allows comparison based on performance objectives (e.g., strength-to-weight ratio, cost vs. strength) using performance indices derived from user-defined criteria.
- Cost vs. Performance Charts:
- Charts plotting cost alongside key performance indicators (e.g., cost vs. yield strength or cost vs. thermal expansion) to evaluate material options in terms of both performance and economic efficiency.

Graphs Available for Material Property Analysis

Material Selector should provide several types of graphical tools to visualize and compare material properties, helping engineers and researchers make informed decisions:

- Ashby Material Property Charts:
- 2D scatter plots used to compare materials based on two selected properties, such as:
- Strength vs. Density
- Young's Modulus vs. Density

- Thermal Conductivity vs. Electrical Resistivity
- Strength vs. Cost
- These charts help in visualizing trade-offs and understanding which materials excel in particular areas of performance.

Bubble Charts:

- These are specialized Ashby charts where each material is represented by a bubble. The size of the bubble can be used to represent a third variable, such as material cost or environmental impact.

Property Histograms:

- Histograms that show the distribution of a specific property (e.g., yield strength, elongation, or thermal conductivity) across a range of materials, helping users quickly identify outliers or groups of materials with specific characteristics.

Pareto Frontier Analysis:

- Graphical method to identify the optimal set of materials based on multiple competing objectives (e.g., minimizing cost while maximizing strength). This helps highlight materials that offer the best balance across various design criteria.

Trade-off Plots:

- Two-variable graphs that demonstrate the trade-offs between competing material properties, such as weight vs. strength or stiffness vs. thermal expansion. This assists in selecting materials that meet specific design trade-offs.

Radar/Spider Charts:

- Radar charts can be used to compare multiple materials across various dimensions simultaneously. For instance, a chart can plot strength, weight, corrosion resistance, and cost for three materials, giving a holistic view of their overall performance.

Capabilities of Pre-Processing Tools

Pre-processing tools should support material selection, analysis, and management workflows:

Data Filtering:

- Narrow down material choices quickly by applying filters based on properties, regulatory compliance, or performance requirements.
- Material Comparison Setup:
- Interactive GUI for setting constraints and objectives (e.g., minimizing weight while maintaining strength).
- Material Data Customization:
- Users can modify material records to incorporate custom properties or proprietary data.

Post-Processing

- The post-processing capabilities allow users to summarize and report material selection findings:

Reporting Tools:

- Automated generation of detailed reports, including charts and tables, for regulatory and technical documentation.

Export Capabilities:

- Seamless export of material data to CAD, CAE tools, and other enterprise systems.

Material Customization:

- Custom materials can be created or modified, validated, and saved for future use.

Automation & Customization

Material Selector should allow for workflow automation and tool customization:

Batch Processing: • Automation of material selection processes for large datasets or multiple projects at once. Integration with Enterprise Systems: • API support for integration with PLM, ERP, and other systems for data consistency. Custom Attribute Definitions: • Define and incorporate custom properties for project-specific needs. Scriptable Workflows: • Automation using Python scripting for repetitive or complex tasks, allowing for increased efficiency.
Standards Compliance Material Selector should provide access to materials compliant with international standards: Industry Standards Databases: • Access to material standards like ISO, ASME, ASTM, MIL-SPEC, and others. Regulatory Compliance: Tools for tracking compliance with REACH, RoHS, and other regulatory requirements. Material Traceability: • Ensures traceability for quality management systems and compliance with certification bodies like FAA, DoD, and ISO. Export Control Management: • Manage materials subject to export controls (e.g., ITAR) with features to handle restricted materials data.

RFQ – 4 (L) Specification for Software for High Performance Computing Solutions

General Specification

Technical Specifications for High Performance computing solutions

The High-performance computing Workgroup 64 to accelerate and optimize engineering simulations, allowing teams to leverage up to 64 cores in parallel. This enables efficient handling of complex, high-fidelity simulations while reducing time-to-solution. The platform should be suitable for applications across various industries, including aerospace, defense, automotive, and energy, with support for advanced physics and large-scale models. Remote Solve Manager to enhance the efficiency of simulation job submission, monitoring, and management across distributed computing resources.

Technical requirements:

Features
Modules to be included • Should support FEA Comprehensive structural analysis, including nonlinear, static, dynamic, and thermal simulations solvers. • Should support Complete fluid dynamics simulations, covering turbulence, heat transfer, multiphase, and combustion phenomena solvers. • Should support Advanced fluid simulation software with meshing, turbulence, and multiphysics capabilities solvers. • Should support Electromagnetic simulation for RF, microwave, and high-frequency components solvers.

- Should support Dynamic analysis for crash, blast, and impact simulations solvers.
- Should support Fatigue life analysis for time- and frequency-domain fatigue predictions solvers.

Advanced Analysis Techniques

- Multiphysics Simulations: Fully coupled fluid-structure interaction (FSI), thermal-fluid, and electromagnetic-thermal analysis capabilities.
- Nonlinear and Dynamic Analysis: Large deformation, nonlinear material behavior, and contact simulations for real-world applications.
- High-Cycle and Low-Cycle Fatigue: Integrated fatigue life prediction using nCode DesignLife for structural components.
- Optimization and Parametric Analysis: Topology optimization, shape optimization, and parametric sweeps for improved design performance.
- Electromagnetic Analysis: Advanced electromagnetic solutions for antennas, radar, and signal integrity.
- Transient Dynamic Simulations: Includes dynamic impact and crash simulations with LS-Dyna for automotive and aerospace applications.

Remote Solve Manager Functionality

Job Submission Management: should provide centralized management for submitting, queuing, and executing simulation jobs across multiple compute resources, maximizing the utilization of all available cores.

- Distributed Solving: Supports the distribution of simulation tasks across 64 cores, managing workloads efficiently while ensuring reliable completion of tasks.
- Job Prioritization: Users can assign priorities to different jobs, enabling more critical simulations to be prioritized and completed faster.
- Remote Monitoring: Provides the ability to monitor the progress of simulation jobs remotely, with real-time updates on job status and resource allocation.
- Error Recovery: Automatic job recovery features, allowing for resumption of interrupted simulations without data loss.
- Data Handling: Automatically transfers input data to remote servers and retrieves results, reducing manual data management tasks.
- Scalability: Easily scalable to manage larger HPC clusters or additional cores as they are added to the infrastructure.
- Multi-User Collaboration: Facilitates collaboration across teams, allowing multiple users to submit and manage jobs from various locations.

Post-Processing

Parallel Post-Processing: Supports parallel post-processing of large datasets across multiple cores for faster results analysis.

High-Fidelity Visualization: Advanced 3D visualization tools for stress, temperature, deformation, and flow field data.

Customizable Reports: Automated report generation with detailed graphical outputs, animations, and contour plots.

- Data Export: Results can be exported in multiple formats (Excel, CSV, STL, Parasolid) for further analysis or documentation.

Automation and Customization

Python Scripting: Python-based scripting support for workflow automation and custom simulation setup.

Custom GUIs: Users can create custom graphical user interfaces (GUIs) to streamline specific workflows. Batch Processing and Scheduling: Supports batch processing with job scheduling, allowing automated submission and execution of simulations without manual intervention. Process Integration: Integrates with third-party optimization tools and design environments, enhancing automation and workflow customization. • API and Macros: APIs for advanced automation and customization, with support for macros to simplify repetitive tasks.
Scalability and Performance Parallel and Distributed Solving: Capable of distributing simulations across 64 cores for faster solutions of large, complex models. Scalability: Easily scalable by adding more compute cores or nodes to expand simulation capabilities. Memory Management: Optimized for handling large memory requirements, ensuring high performance for complex models with intricate geometries. • High-Efficiency Solvers: Solvers optimized for multi-core execution, providing rapid convergence and significantly reducing computation time.

RFQ – 4 (M) Specification for Software for Technical Specifications for Optical Solution

Technical Specifications for Optical Solution

Optical solution should simulate and help to optimize behavior of light in complex systems, ranging from automotive lighting, aerospace, defense sensors, camera systems, to human vision perception. It allows for precise and realistic modeling of optical components and systems, enabling engineers to analyze and enhance performance across a wide variety of industries, including government and defense sectors.

Technical requirements:

Features
Modules to be included SPEOS solution should offer several key modules to support comprehensive optical simulation and design for government and industrial applications. These modules include: • **Optical Design**: For the design and optimization of optical systems, including lenses, reflectors. • **Lighting**: Simulates and validates lighting systems, considering photometric and colorimetric properties for accurate illumination.
Advanced Analysis Techniques SPEOS should support the following advanced optical simulation techniques: • Ray Tracing Algorithms: High-precision optical ray tracing for accurate light propagation, reflection, refraction, scattering, and diffraction modeling. • Monte Carlo Simulation: Used for analyzing complex light behavior in diffuse and scattering materials. • Spectral Analysis: Supports full spectral analysis for designing lighting systems with specific wavelength-dependent characteristics.

- Thermal-Optical Coupling: Integration with thermal simulations to analyze the impact of temperature on optical performance.

Capabilities of Pre-Processing Tools

Pre-processing tools in optical solution to streamline model setup for large and complex optical simulations:

- CAD Integration: Seamless integration with leading CAD software (e.g., CATIA, NX, SolidWorks) for importing and preparing 3D models.
- Geometry Simplification: Advanced simplification tools to reduce simulation complexity while preserving essential optical features.
- Material Library: Extensive optical material libraries, including refractive indices, absorptivity, and scatter properties, customizable for specific project needs.
- Automatic Meshing: Automated mesh generation for lenses, light guides, and reflective surfaces, ensuring high accuracy in optical simulations.
- Optical Source Setup: Ability to define light sources with various properties (e.g., spectral distributions, emission profiles).

Post-Processing

Optical Solution should provide powerful post-processing tools for analyzing and interpreting optical simulation results:

- Photometric and Radiometric Analysis: Tools to evaluate illuminance, luminance, and radiance at any point in the system.
- ISO and CIE Compliance: Post-processing compliant with international standards for lighting and visibility assessments.
- Image Quality Assessment: Visualize and quantify optical effects such as glare, or contrast in displays and camera systems.
- 3D Visualization: Realistic 3D rendering of optical phenomena for easy understanding and reporting of results.

Automation and Customization

Automation and customization features in optical solution should enable efficient workflows and tailored solutions for specialized government needs:

- Scripting and API: Supports Python scripting and APIs for automating repetitive tasks, parameter sweeps, and optimization studies.
- Batch Processing: Capability to run multiple simulations in parallel or sequentially to save time and compute resources.
- Custom Optical Libraries: Ability to define and store custom material, surface, and light source properties for reuse across projects.
- Macro Recording: Records and automates repetitive tasks with custom macros, enhancing productivity for large-scale government projects.

RFQ – 4 (N) Specification for Software for Optics Design Studio

General Specification

Technical Specifications for Optics Design Studio

Optics design solution is required for optical design and simulation platform tailored for advanced optical systems, enabling the design, optimization, and validation of optical components and systems

in various industries, including defense, aerospace, telecommunications, and biomedical sectors. It provides tools for lens design, stray light analysis, illumination system design, and imaging system performance evaluation.

Technical requirements:

Features
Modules to be included • Optical Design Module (ZEMAX): Lens and imaging system design Sequential ray tracing for precise imaging system analysis Advanced lens optimization techniques Support for multi-configuration systems for different field of views or wavelengths • Non-Sequential Mode Module: Simulation of complex optical systems with scattering, reflection, refraction, and transmission effects Supports stray light analysis and thermal effects in optical systems Design of optical systems with LEDs, lasers, fiber optics, and photonic components • Optomechanical Design Module: Integration of mechanical tolerances with optical performance Ability to model flexures, supports, and mount effects on system alignment Includes ghost image analysis for optical components • Illumination Design Module: Tools for lighting systems, including uniformity, brightness, and power efficiency Simulate complex lighting systems for automotive, LED, and architectural applications Analyze the performance of lighting guides, diffusers, and reflectors • Stray Light Analysis Module: Simulation and mitigation of stray light in optical systems Monte Carlo analysis for accurate scattering and ghost imaging evaluation • Optimization and Tolerancing Module: Advanced optimization algorithms for design optimization across multiple variables Tolerancing tools for robust design accounting for manufacturing errors and environmental conditions
Advanced Analysis Techniques • Wavefront Analysis: Ability to simulate wavefront propagation through optical systems Zernike polynomial fitting for aberration analysis Support for interferometric data integration for precise surface and wavefront measurement • Polarization and Coherence Analysis: Modeling of polarized light in optical systems Support for partial coherence analysis, crucial in imaging and laser systems • Thermal and Structural Analysis:

Simulation of thermally induced changes in optical systems using thermal data
Analyze structural deformation of optical components and its impact on optical performance

- Diffractive Optics and Holography:

Supports diffractive optics and holographic elements modeling
Fourier optics and beam propagation methods for diffractive systems

Capabilities of Pre-Processing Tools

- Geometrical Model Building:

Import CAD files for seamless integration of mechanical and optical designs
Generate parametric models for lenses, mirrors, and optical assemblies
Integration with Mechanical for coupled thermal and structural simulations

- Material Database and Coating Libraries:

Comprehensive library of optical materials (glass, plastics, metals, etc.)
Support for custom refractive indices and dispersion data
Predefined and customizable thin-film coating models for anti-reflection, dichroic filters, and mirror coatings

- Surface Fitting Tools:

Tools for aspherical, freeform, and diffractive optical surfaces
Direct integration of manufacturing data, such as interferometry, into the optical design process

- Interface to CAD/CAE:

Support for exporting optical geometries and surfaces into mechanical CAD/CAE systems
Integration with FEA simulation tools for multiphysics analysis (thermal, structural, and fluid dynamics)

Post-Processing

- Image Quality Analysis:

Point Spread Function (PSF), Modulation Transfer Function (MTF), and Encircled Energy calculations for assessing image performance
Analyze field curvature, distortion, and vignetting in complex optical systems

- Beam Propagation and Far-Field Analysis:

Tools for evaluating near and far-field beam profiles
Evaluate beam divergence, spot size, and intensity distributions

- Tolerance Sensitivity Analysis:

Evaluate the sensitivity of optical systems to manufacturing and alignment errors
Perform Monte Carlo simulations to determine system robustness

- Customizable Reporting:

Generation of detailed simulation reports including graphs, data tables, and visualizations
Support for automated post-processing scripts and custom outputs

Automation and Customization

- Scripting and API:

Fully scriptable environment using Python, MATLAB, or C# for automating tasks

Create custom functions, optimization routines, and analyses using the API
Integration with third-party software via COM (Component Object Model) interface

- Batch Processing:

Automate large-scale simulations and optimizations across multiple configurations or designs
Support for cloud-based processing and high-performance computing clusters for large datasets

- Custom GUI and Plugins:

Build custom graphical user interfaces (GUIs) for frequently used workflows
Develop plugins to extend software capabilities for specific tasks or industry needs

RFQ – 4 (O) Specification for Software for High Frequency Structural Solver

General Specification

Academic training/teaching licenses for High frequency Simulations (Qty. 25 Task)

Software for designing and simulating high-frequency electronic products such as antennas, antenna arrays, RF or microwave components, high-speed interconnects, filters, connectors, IC packages and printed circuit boards. Software to design high-frequency, high-speed electronics found in communications systems, advanced driver assistance systems (ADAS), satellites, and internet-of-things (IoT) products.

- Component-to-System EM Workflow
- Coupled EM System Solver
- Encrypted 3D Design Share
- Automatic Adaptive Meshing

RFQ – 4 (P) Specification for Software for Electromagnetics

General Specification

Academia Training /Teaching license for Electromagnetics Simulations (Qty. 25 Task)

Low-Frequency Electromagnetic Simulation

With Maxwell, you can precisely characterize the nonlinear, transient motion of electromechanical components and their effects on the drive circuit and control system design. By leveraging Maxwell's advanced electromagnetic field solvers and seamlessly linking them to the integrated circuit and systems simulation technology, you can understand the performance of electromechanical systems long before building a prototype in hardware.

- Advanced Magnetic Modeling
- Multiphysics Couplings
- ISO 26262 Compliant
- Bi-Directional CAD Integration
- Electric Drive Modeling

RFQ – 4 (Q) Specification for Software for FEA & CFD

General Specification

Academic Training /Teaching License for Structure and Fluid Solutions (Qty. 5 Task)

A software which enable us to solve complex structural engineering problems and make better, faster design decisions. With the finite element analysis (FEA) solvers available in the suite, which can be customized and automate solutions for your structural mechanics problems and parameterize them to analyze multiple design scenarios.

- Easy to Use, Multi-Purpose Tool
- Dynamic, Integrated Platform
- Persistent, Dependable, Accurate Solver Technology
- Powerful Nonlinear and Linear Solvers

A computational fluid dynamics (CFD) products which enables to make better, faster decisions.

RFQ – 4 (R) Specification for Software for Teaching Optics

A software which enables the standard for optical, illumination, and laser system design

- Analyze, optimize, tolerance
- Global userbase
- Leading industry standard
- Built-in STOP analysis available

RFQ – 3 (E) Specification for Software for A complete integrated suite of CAD/CAM/CAE

General Specification

A complete integrated suite of CAD/CAM/CAE software (Solid Edge)

Description:

A complete integrated suite of CAD/CAM/CAE software, including all the core design, simulation and manufacturing functionality required for an engineering course.
- Design: Design: 2D and 3D geometry creation including wireframe, surface, solid and synchronous modeling. Drafting and PMI for 3D annotation, full assembly modeling capabilities.

General Capabilities

- Should support master-model concept of 3D modeling and other downstream application providing complete integration between modeling, drafting, assembly, manufacturing, and finite element analysis environments in the same gateway.
- Should support both Microsoft Windows (Win10), Win11

Math-engine & Expressions

- Capability to create user-defined formulae, rules and expressions within part files to drive part-dimensions and attributes. These expressions can return numbers, strings, points, vectors, Booleans.
- Ability to link one expression with another within the same part or even between two separate parts or assemblies.
- Provides a comprehensive set of in-built mathematical / trigonometrical functions.

Part Modeling:

- Availability of both History Based and History free design methodologies in single environments for parts and assemblies both.
- Capability to transfer dimensions from imported 2d geometry while creating 3d and then using the same dimension {from 2d} drive the 3d model with directional control. Capability to write formulas between these imported dimensions.
- Super Features: Lip, Mounting Boss, Cooling Vent, Web network

- Surface design with history independent curve editing.
- Ability to define draft and crown during extrusion operation.
- Surface shape editing using blue dot and blue surf technology.
- In-built Stress and Modal analysis of parts and sheet metal components in assembly context.

- 3D Product manufacturing information (PMI) on parts and assemblies for collaboration as per ASME 14.41
- Design Sensors to monitor design criteria for dimensions, mass, surface area etc.
- Dynamic Edit of components without suppressing later designed features.
- Direct Editing of imported data without concern for history. Software should be able to put 3d dimensions anywhere on the imported geometry and change model with directional control.
- JT Import and Export of parts and assemblies with full modification capabilities.

Direct editing of 3D models

- Capability to edit parts that do not have any feature history. This should be provided in the same environment as solid modeling.
- Possibility of directly editing by selecting faces or groups of faces and either by dynamically dragging these or by attaching dimensions
- Intelligence in the software to preserve design intent of 3D parts while such changes are made.
- Intelligence in the software to automatically select groups of faces that appear as generic engineering features like bosses, ribs, holes, pockets, slots, etc.

Freeform modeling, basic

- All surfacing commands must be history-supported and should not result in any deletion of the model's history.
- Capability to create lofted surface through non-intersecting sections, each section containing contiguous curves with option to preserve. Option to control position-, tangent- or curvature-continuity at end-sections with adjoining surfaces. Option to re-parameterize the lofted surface to enhance smoothness. Provision to select the iso-lines of the lofted surface based on arc-length of the sections, connecting points, by distance along a vector, by a template curve or by segments. Capability to create either single-patch or multi-patch lofted surface.

Drafting:

- Stand alone drafting and 3D generative drafting in a unified interface.
- Advanced production drawing capabilities.
- Draft Quality views.

- Design review mode with capability to detail views, without loading parts into memory.
- Quick-sheet Template creation with section views, detail views, Part list etc.
- Dynamic Detail views, section of section views, auxiliary views etc
- Capability to define any face of a part or an assembly as a new principal view. Eg a chamfered edge to be defined as front view.
- 2D Diagramming tools to create schematics and P&IDs
- Efficient Block technology in 2D with the capability to directly read AutoCAD blocks without the need to open .dwg file.
- Readymade library of Industry standard symbols in the form of blocks like Piping/Hydraulic/Mechanical and Electrical symbols.

Sheet Metal Design:

- Availability of Process Specific Features like Louvers, Dimples, Gussets with patterning capability within the command. No use of forming tools.
- Contour Flange on curved edges.
- Manufacturing Support
    - Blank cut-size in Sheet metal.
    - Fully annotated Bend table with easy manipulation of bend sequence
    - Cross Brake support for stiffening large sheet metal parts.
    - Save Flat Pattern as part or dxf.
- Availability of Etch command on Sheet Metal parts. Once Etch is done, it should remain on the same face once the model is flattened.
- Mid surface extraction for Stress or modal analysis in a single command.
- Tab creation on flattened models without transferring to part environment.
- Direct Editing of imported sheet metal parts without concern for history. Software should recognize imported part as sheet metal {maintains thickness and bend radius throughout} Direct editing of Sheet Metal as stated in {Part Modeling, point 10} should be available.

Assembly Modeling:

- Assembly Auto Constraining {Adding Intelligence to Imported assemblies}
- Goal Seek – Ability to put a goal to a variable in both 2d and 3d and let the software change geometry accordingly.
- Assembly Engineering Manager
- Interference Check with Interfering volume creation and report generation.
- Flexible Assemblies using Flexible parts.
- True Top down Assembly layout definition using *Virtual Structure Editor {Zero D}*
- Engineering Reference for Design Calculation and Creation of Gears / Shafts / springs / Columns /pulleys , Rack & Pinions etc.
- Weldment – capability to define welding between various assembly components.
- Surface Preparation
- Weld bead creation – Fillet weld, Groove Weld, Stitch weld etc. with support for mirroring.
- Support for Weld annotations as per various standards in 3d.
- Frame Design
    - Design in the context of the assembly
    - Automatic trimming and coping of frame members.

- Frame design using spline path.
- BOM of frames in Draft environment should show weight of individual members, quantity and whole frame assembly.

Translators:
Support for neutral data translators: IGES, STEP, DWG, DXF, PARASOLID, JT,ACIS etc.
Support for Native CAD data translators: NX, I-DEAS, Pro/E, Solid Edge, SolidWorks, Inventor, MDT, Catia V4 and V5 (optional), EMS, DGN etc.

3D Annotation (GD & T, PMI)

- Capability to create 3D annotation PMI (Product Manufacturing Information) directly over a model. Annotations include various types of dimensions on model entities, surface finish symbols, locator and weld symbols, datum symbols, feature-control frames, notes, geometric-tolerancing (GD&T) symbols, pre-set company-proprietary or government-security symbols, etc.
- Capability to select and associate auxiliary objects for a PMI to communicate multiple entities in the model that have to be considered during manufacturing for that PMI.

Built-in Simulation

- Software should have Automated, high-quality mesh generation controls mesh without need for parameters, allowing linear structural simulations to be run on mesh bodies.
- Should support Automatic finite element model creation with optional manual override.
- Software should perform simulation on convergent models without the need for conversion to b-rep.