

Part V

Technical Specifications, Requirements & Scope of Work

Design and Realization of ICCT



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Chapter 1

Introduction

The Integrated Communication and Command Terminal (ICCT) shall consist of a Rigid wall relocatable structure (RWRS) which shall be a shelter with indoor equipment and working area for operators in its interior, as well as outdoor equipment appropriately mounted on the exterior. It is expected to be transported by road using a rigid body transporter truck or a semi-trailer platform. The transporter truck platforms also need to be realized as per the specifications outlined in this document. The ICCT also needs to be designed for air-transportation as per the requirements and specifications elaborated in this document.

While the present Request for proposal (RFP) mainly deals with necessary equipment mounted within and around a RWRS, there is a requirement to finalize a configuration that enables the ICCT to function from a static built-up structure which is nothing but a building. Only the configuration for the static ICCT needs to be prepared as part of the currently proposed work, and the actual realization shall be only for ICCT within an RWRS. In line with this, this document elaborates various requirements and specifications related to the shelter and its fitments/contents, road and air mobility requirements, specifications of systems and equipment to be integrated and various safety related requirements. The broad changes anticipated to adapt the transportable ICCT setup to a static installation are also highlighted to assist bidders in proposing the equipment and work required for a static installation. The techno-commercial proposals from bidders in this regard are meant to gain an understanding about the costs that are likely to be involved. All items related to static ICCT installation are categorized as optional items and Programme ‘AD’ (PGAD) reserves the right to either include or exclude optional items from the contract or supply order. Pricing of optional items will not be considered for commercial evaluation of bids.

While electrical, electronic and mechanical hardware are the building blocks of the proposed ICCT, the key ingredient that binds all the hardware elements together and transforms the ICCT effectively from an arrangement of hardware components to a coherent and reliably functioning network-centric system is the Network management system (NMS) software component. In this document the specifications and requirements related to NMS software are also elaborated. Because of the very important role of NMS software in the ICCT the development of NMS software is not allowed to be sub-contracted or outsourced and the industry partner is expected to carry out the NMS design, implementation and testing fully in-house using internal capability and manpower only.

In chapter 2, various technical specifications and requirements related to hardware components are elaborated. Towards the end of that chapter, the changes anticipated

for adapting the ICCT setup proposed around an RWRS to a static ICCT building are listed.

In chapter 3, the overall scope of work expected to be carried out by the industry partner is elaborated. The scope of work is in the form of key steps that the industry partner shall be expected to take in order to meet the objectives of the project. Various terms and conditions which shall govern the bidding by the bidders as well as the execution of the project by the industry partner are also elaborated.

Quality assurance (QA) and Quality control (QC) aspects play a key role in the design and realization of such systems. Accordingly, various QA and QC related requirements are elaborated in chapter 4.

In chapter 5, the specifications of the NMS software and the scope of work for the industry partner are elaborated.

In chapter 6, the scope of supply is described, essentially listing out the deliverable hardware items, software items and documentation items.

Chapter 2

Hardware specifications & requirements

2.1 Shelter

The ICCT is a system that is built around a non-expandable RWRS. In this section, the requirements and specifications of this shelter are outlined.

2.1.1 General requirements

Here, the general requirements that the shelter shall meet are enumerated.

- 2.1.1.1 The length of the shelter excluding overhanging equipment, and position of corner fittings shall be as per a 20-feet standard International Organization for Standardization (ISO) container (see [1]). The external width of the shelter shall not exceed 3,000 mm.
- 2.1.1.2 Corner and intermediate fittings of the shelter shall comply with ISO 1161 (see [2]).
- 2.1.1.3 Shelter construction and testing shall be carried out as per the requirements for an Electromagnetic interference (EMI)/Electromagnetic compatibility (EMC) shelter in JSS 5411-01 (see [3]). The shelter shall be constructed of Aluminium alloy faced structural sandwich panels with rigid polyurethane foam core.
- 2.1.1.4 The polyurethane foam core used shall have a density of at least 70 kg/m³.
- 2.1.1.5 The Aluminium alloy sheets used as facing of the panels shall conform to ASTM B209 (see [4]).
- 2.1.1.6 A suitable polyurethane adhesive shall be used to bond the core and facing by using vacuum bag bonding technique, as prescribed in JSS 5411-01 or using the hot-press bonding technique.
- 2.1.1.7 Walls, roof and floor of the shelter shall be made using a single sandwich panel each. No joining of sandwich panels shall be resorted to for this purpose.
- 2.1.1.8 Individual sandwich panels shall be joined by means of continuous seam welding on the outside as well as inside to form a double Faraday cage and thereby achieve the best possible weather sealing as well as attenuation of electromagnetic fields. Spot welding, screws or rivets shall not be used for this purpose.
- 2.1.1.9 Wherever dissimilar metals are in close contact, measures to prevent galvanic cor-

rosion shall be taken, in accordance with MIL-STD-889 (see [5]).

- 2.1.1.10 It shall be ensured that EMI attenuation is at least 60 dB, and shall be measured in accordance with ASTM E1851 (see [6]) and IEEE 299 (see [7]). Suitable EMI shielded connectors to be used to meet the requirement. Measurements shall be done after fabrication of shelter (including all connector panels, hatches, doors, air vents, etc), completion of all interior and exterior cabling (power, signal, network etc), mounting of all exterior and/or wall mounted equipment such as air-conditioners, masts, Very small aperture terminal (VSAT) outdoor systems etc but before installation of interior equipment racks, consoles etc. These measurements shall be carried out on one of the deliverable ICCTs.
- 2.1.1.11 The shelter shall be fabricated to ensure air-tight sealing. The sealing shall be adequate to maintain a consistent overpressure of at least 20 mm H₂O with all hatches being closed and fresh air being taken through the Nuclear, biological and chemical (NBC) filtration system.
- 2.1.1.12 The shelter shall be equipped with an overpressure valve which shall maintain a consistent overpressure of 20 mm H₂O with all hatches being closed and fresh air being taken through the NBC filtration system.
- 2.1.1.13 The design and engineering of the shelter shall be carried out in accordance with ASTM E1925 (see [8]). For qualification of the shelter design, all Qualification testing (QT) procedures shall be carried out at the vendor's expense on a separate shelter manufactured for the purpose. Verification and test procedures need to be performed and demonstrated, as per the following table.

Ref #	Performance requirement	Standard	Applicability
2.1.1.13.1	Adhesion shear test on panel	JSS 5411-01	Panel level test - QT
2.1.1.13.2	Flexural test on panel	JSS 5411-01	Panel level test - QT
2.1.1.13.3	Impact test on panel	ASTM E1925	Panel level test - QT
2.1.1.13.4	Floor loading test	ASTM E1925	On bare shelter - QT
2.1.1.13.5	Load test on door	ASTM E1925	On bare shelter - QT & AT
2.1.1.13.6	Roof loading test	ASTM E1925	On bare shelter - QT & AT
2.1.1.13.7	Shelter rigidity when supported on three points	JSS 5411-01	On bare shelter - QT & AT
2.1.1.13.8	Watertightness test	ASTM E1925	On bare shelter - QT
2.1.1.13.9	Lifting and towing provision strength test	ASTM E1925	On bare shelter - QT
2.1.1.13.10	Flat drop test without skids	ASTM E1925	On bare shelter - QT
2.1.1.13.11	Rotational drop test without skids	ASTM E1925	On bare shelter - QT
2.1.1.13.12	Flame resistance test	ASTM E1925	Panel level test - QT
2.1.1.13.13	Altitude test	ASTM E1925	Analysis only - QT
2.1.1.13.14	Air-tightness test	ASTM E1925	On bare shelter - QT & AT

Ref #	Performance requirement	Standard	Applicability
2.1.1.13.15	Leveling devices test	ASTM E1925	On bare shelter fitted with lifting-cum-leveling system - QT
2.1.1.13.16	Light tightness test	ASTM E1925	On bare shelter - QT
2.1.1.13.17	Humidity resistance test	ASTM E1925	On bare shelter - QT
2.1.1.13.18	Marine atmosphere test	ASTM E1925	On material samples - QT
2.1.1.13.19	Temperature test	ASTM E1925	On bare shelter - QT
2.1.1.13.20	Solar load test	ASTM E1925	On bare shelter - QT
2.1.1.13.21	Temperature shock test	ASTM E1925	Panel level test - QT
2.1.1.13.22	Heat transfer test	ASTM E1925	On bare shelter - QT
2.1.1.13.23	Fungus test	ASTM E1925	On test coupons - QT
2.1.1.13.24	RWRS squareness test	ASTM E1925	On bare shelter - QT & AT
2.1.1.13.25	Panel flatness test	ASTM E1925	On bare shelter - QT & AT
2.1.1.13.26	Panel attachment points test	ASTM E1925	On bare shelter - QT
2.1.1.13.27	Lift test (3.2 G)	ASTM E1925	On bare shelter - QT

- 2.1.1.14 Cable ducts in the shelter shall be provided with a suitable mechanism or arrangement to prevent entry and exit of rodents, small mammals, reptiles and other creatures. Such a mechanism or arrangement shall effectively prevent entry and exit of these creatures both at the outdoor opening as well as the indoor opening.
- 2.1.1.15 All cables used in the shelter shall be Low fire hazard (LFH) cables unless the same are not available to meet the necessary technical requirements. Cables used in cable ducts on the exterior of the shelter shall also be LFH cables as the ducts usually open in the interior of the shelter and any smoke generated within a duct is likely to be leaked into the interior of the shelter.
- 2.1.1.16 All indoor cables including Radio frequency (RF), power, network etc shall be chosen as per recommendation of equipment Original equipment manufacturer (OEM).
- 2.1.1.17 All outdoor connectors, whether panel mounted or mating type, shall be provided with a suitable protection cap which protects from dust and water ingress when the connector is not in mated condition.
- 2.1.1.18 All outdoor cables shall be water-tight and Ultra violet (UV) resistant. All outdoor connectors shall be IP-67 rated in mated condition or when closed using the protection cap.
- 2.1.1.19 Installation of cables in the interior and exterior of the ICCT shelter, interconnection of all ICCT equipment using the necessary cables, and establishing the full functionality of the system shall be the responsibility of the contractor.
- 2.1.1.20 The exterior of the shelter shall be painted using a color scheme or camouflage pattern provided by PGAD. Military grade primer, thinner and paints shall be used for the purpose.
- 2.1.1.21 The center of gravity of the fully equipped ICCT shelter shall be marked on all four walls of the shelter as per symbol 0627 in ISO 7000 (see [10]).

2.1.1.22 The center of gravity of a transporter truck platform loaded with a fully equipped ICCT shelter shall be separately marked on all four walls of the shelter as per symbol 0627 in ISO 7000. Clear text marking shall be made to identify this as the combined center of gravity of the shelter and the transporter truck platform and to distinguish it from the center of gravity of the fully equipped ICCT alone.

2.1.2 Accommodation and workspace

In this sub-section, requirements pertaining to accommodation for operators and equipment within the shelter are outlined.

2.1.2.1 The interior of the shelter shall be divided into two compartments, an operator compartment (or operator area) and an equipment compartment (or equipment area).

2.1.2.2 Both compartments shall be adequately air-conditioned. For this purpose, the ICCT shall be equipped with two or three military grade heating, ventilation and air-conditioning (Heating, ventilation and air conditioning (HVAC)) units.

2.1.2.3 There shall be space, seating arrangement and working arrangement for three operators in the operator area.

2.1.2.4 Equipment requiring frequent operator interaction, such as keyboards, mouse, Internet protocol (IP) phones, displays etc., shall be accommodated in the operator area.

2.1.2.5 Equipment housed in the equipment area shall be visible from the operator area. This may be accomplished by having a transparent door and/or a transparent partition between the operator and equipment areas.

2.1.2.6 The interior space of equipment and operator areas shall be at least 6 feet (1,830 mm) tall.

2.1.2.7 There shall be eight (8) 19" equipment racks in the equipment area of the ICCT. All racks shall be at least 32 Rack unit (RU) in height and shall be mounted on shock-cum-vibration isolators. External depth of four (4) of the racks shall not exceed 800 mm and that of the remaining four (4) racks shall not exceed 650 mm. Internal depth of at least 750 mm and 600 mm shall respectively be available to mount equipment in the two types of racks. An example layout of the racks can be seen in figure 2.1 on page 10.

2.1.2.8 The operator area shall be acoustically shielded from noise emanating in the equipment area. In the operator area, noise limit shall not exceed 65 dBA which is the noise limit for operational areas that require frequent telephone use or occasional direct communication up to 1.5 m as per MIL-STD-1472 (see [11]). This shall be verified by measurement in a fully equipped ICCT with all systems powered-on.

2.1.2.9 In other work-spaces outside operator area such as equipment area, roof-top and around the shelter, noise limits shall be within limits prescribed in MIL-STD-1474 (see [12]). If required, 4 sets of appropriate ear-protection equipment shall be provided, and appropriate visual indication shall be displayed to wear ear-protection equipment. Requirements pertaining to such ear protection equipment are given in paragraph 2.6.28.4.

2.1.2.10 Design of facilities in the equipment area, operator area as well as work spaces on

the roof and exterior of the shelter shall conform to human engineering requirements in MIL-STD-1472.

- 2.1.2.11 Adequate enclosed storage space shall be provided in the equipment area and/or operator area to store various loose ICCT related equipment such as inspection lamp, power extension boards, extractor cum vacuum cleaner, tool kit, drilling machine, soldering iron, crimping tools, optical fiber splicing kit, Ethernet tester, hand-held range finder, hand-held Global navigation satellite system (GNSS) receiver, inclinometer, microwave analyzer, multimeter, occupational safety equipment, manuals and related documents etc. Similarly, adequate enclosed and weather-proof storage space shall be provided on the exterior of the ICCT shelter to store the lifting lugs, lifting slings, earthing rods etc.

2.1.3 Ingress and egress requirements

The following is an enumeration of requirements related to ingress and egress of personnel and equipment.

- 2.1.3.1 To minimize the entry of dust and moisture into equipment area, entry and exit into equipment area shall be through the operator area.
- 2.1.3.2 All external ingress-egress doors including emergency exits shall be EMI shielding doors.
- 2.1.3.3 Doors, with the exception of emergency exits, shall be large enough to allow the largest piece of equipment, including 19" racks, to be moved in and out of the shelter.
- 2.1.3.4 There shall be at least one emergency door in the ICCT shelter.
- 2.1.3.5 Main door shall have a stay rod to keep it open so that free movement of personnel and equipment can be undertaken even in the presence of wind.

2.1.4 General fitments and accessories

In this sub-section, equipment that is required to be fitted in or contained in the ICCT shelter are listed, along with brief requirement or specification thereof.

- 2.1.4.1 Three (3) operator chairs shall be provided with casters appropriate for the nature of floor surface, waterfall front, swivel, tilt, adjustable lumbar support; pneumatic seat height adjustment, arm-rest height adjustment, and padded, contoured, upholstered seat and back-rest. The seat height range shall be from 16.5" to 20". Provision shall be made to arrest the movement of chairs during transportation of the shelter.
- 2.1.4.2 Copper strip for earthing, as per IS:613 (see [13]) shall be provided along all walls in the operator and equipment areas. This shall be mounted on insulated spacers along the walls. There shall be a terminal where this copper strip is connected and which can in turn be connected to an earthing pit.
- 2.1.4.3 Industrial grade wet and dry dust extractor cum vacuum cleaner, suitable for extraction of wood, masonry and metal-work dust as well as spillage liquids. It shall also be suitable for general cleaning of interior and exterior surfaces. It shall function as a blower also. Maximum suction air flow rate shall be at least 4,000 L/min. Dry dust capacity shall be at least 36 L. Wet fluid tank shall be at least 18 L. Weight

shall not exceed 17 kg. Shall be certified for M (medium) dust class (> 99.9% final filter efficiency for exposure limit 0.1 mg/m³). It shall have a power take-off facility allowing power tools to be powered directly through the extractor such that the suction is turned on whenever the power tool is switched on. Bosch® GAS 55 M AFC Professional Corded Dust Extractor or equivalent makes and models may be considered.

- 2.1.4.4 Portable dehumidifier system with at least 35 L/day of water extraction capability and an air flow of at least 250 m³/hour. It shall have a user selectable relative humidity setting between 40 % and 90 %. If the condensed water is stored in a water tank, such a tank shall hold at least 3 L of water and there shall be auto shut-off feature to prevent the water from overflowing.
- 2.1.4.5 Inspection lamp with a 10 m long power cord shall be provided
- 2.1.4.6 Two numbers of power extension boards shall be provided with 10 m long cable and four numbers of 5 A sockets
- 2.1.4.7 Two numbers of power extension boards shall be provided with 10 m long cable and two numbers of 15 A sockets
- 2.1.4.8 First-aid kit shall be provided as per IS 13115 (see [14]).
- 2.1.4.9 External water-proof Light emitting diode (LED) floodlights shall be provided on all four sides, IP-66 compliant as per IS/IEC 60529 (see [15]).
- 2.1.4.10 Foldable walk-way on the sides of the shelter along the roof-top, to provide working area around the VSAT antennas. The same walk-way, once folded, shall provide protection from tree-branches, vegetation etc. to the VSAT antennas during transportation. Walk-way surface shall be a perforated or grated, slip resistant surface with friction coefficient of at least 0.85 in dry condition. Friction coefficient shall be at least 0.6 in wet conditions with water or brake fluid. The walk way shall be designed to withstand a continuous load of 450 kg as well as the fall of a weight of 200 kg from a height of 1 m while it is loaded with a continuous load of 250 kg. The walk way surface need not be suitable for barefoot walking.
- 2.1.4.11 A tool-kit shall be provided with at least the following tools
 - (a) Double open-end (DOE) Spanner set as per DIN 3110 (see [16]) with 12 sizes. Hardened and tempered Chrome Vanadium 31CrV3 steel with mirror finish.
 - (b) Screw driver set. Steel collet handle and 8 interchangeable Nickel Chrome plated blades with hardened and magnetic tips. Non-inflammable, oil/grease/chemical resistant acetate cellulose handle.
 - (c) Allen key sets (British and metric)
 - (d) Socket wrench set with 1/2-inch 72T ratchet handle, 125 mm & 250 mm extension bars, 250 mm sliding T-bar, 75 mm universal joint and 18 numbers of 1/2-inch sq Hex sockets from 8 mm through 25 mm.
 - (e) Ball point hammer, 500 g. Phosphate polished hardened and tempered EN 9 steel head. Fungus resistant wooden handle.
 - (f) Adjustable wrench, 12-inch, with drop forged carbon steel construction.
 - (g) Long nose plier, 6-inch. Forged C-50 steel construction with thermo-plastic rubber sleeve certified for 1,000 V application.

- (h) Combination plier, 8-inch. Forged C-50 steel construction with thermo-plastic rubber sleeve certified for 1,000 V application.
 - (i) Wire stripper, 5-inch. EN 9 steel construction, with PVC insulated sleeves and spring loaded lock.
 - (j) 12" hacksaw with wing-nut blade fixing arrangement. Set of five (5) compatible blades of bi-metal type, with 18 teeth-per-inch.
- 2.1.4.12 A variable speed hand-held drilling machine shall be provided with drill bits suitable for Aluminium and mild steel
- 2.1.4.13 A 25 W soldering iron shall be provided.
- 2.1.4.14 Crimping or connectorization tools for various connectors used in the ICCT shall be provided.
- 2.1.4.15 Two (02) numbers each of torque wrenches suitable for SMA and other RF connectors in ICCT or its accompanying equipment shall be provided.
- 2.1.4.16 Two (02) numbers of fully loaded 48 port single mode optical fiber Line interface unit (LIU)s with Lucent® connector (LC) connectors, one indoor rack mounted unit and one outdoor wall mounted weather proof unit shall be provided with interconnections. All 48 ports of indoor LIU shall be connected to corresponding 48 ports of outdoor LIU.

2.1.5 Lifting, handling and in-site mobility

In this section, requirements related to necessary lifting and handling of a fully equipped ICCT shelter are enumerated.

- 2.1.5.1 Lifting lugs compliant with ISO 3874 (see [17]), designed for vertical lifting from top corner fittings of the ICCT shelter shall be provided.
- 2.1.5.2 Textile slings necessary for lifting, compliant with ISO 18264 (see [18]) shall be provided.
- 2.1.5.3 Load spreader beam or assembly required for lifting the fully equipped ICCT shelter using the corner fittings, as per ISO 3874, shall be provided. The load spreader may be modular in nature, so that it can be disassembled for transportation/storage and easily assembled for any lifting operation. Provision shall be made to transport the load spreader - in disassembled form in case of a modular load spreader - on the transporter truck platform along with the ICCT.

2.1.6 Example layout

An example layout of the ICCT shelter is shown in figure 2.1.

Racks 1 to 4 may be mounted on caster wheels and rails while racks 5 to 8 may be fixed in their position. The Uninterruptible power supply (UPS) and workstations may be housed in racks with 800 mm of external depth. RF related equipment may be housed in racks with 650 mm external depth and space available for accessing rear-panel RF connectors and RF cable routing. The layout shown in figure 2.1 does not contain full details and is meant to provide an example of a possible layout. Prospective contractors are free to make modifications, improvements or to propose fresh layouts.

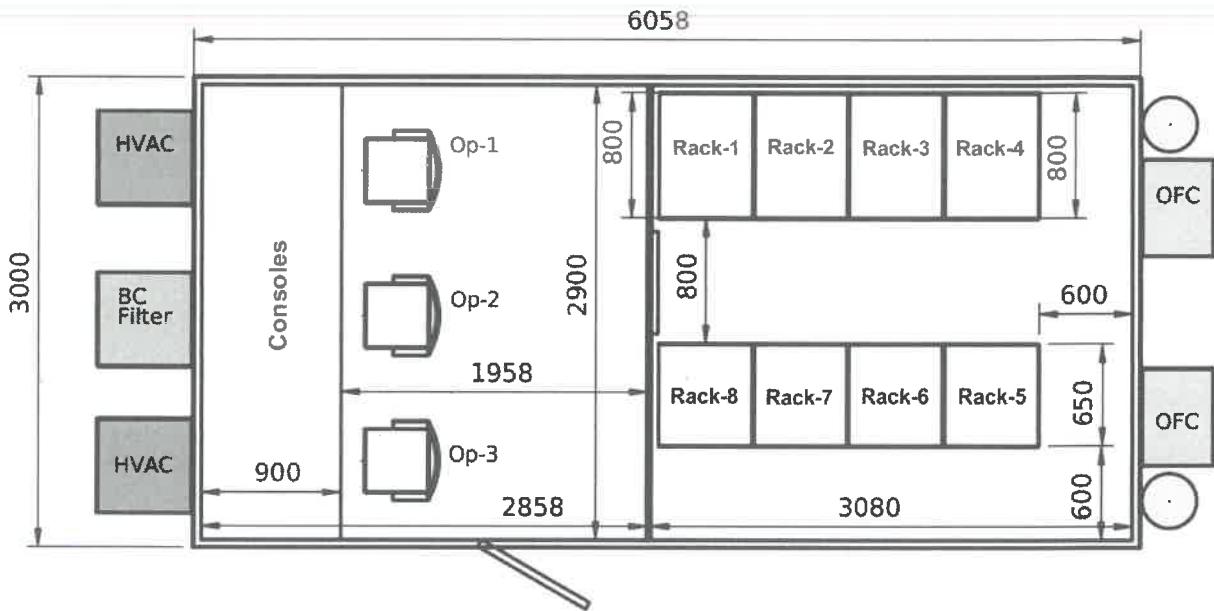


Figure 2.1: Example layout of the ICCT shelter

2.2 Power supply requirements

The following is an enumeration of power supply requirements of the ICCT.

- 2.2.1 The primary power supply input to the ICCT shall be 440 V, 50 Hz three-phase Alternating current (AC) mains supply, which is expected to be the common power supply to all systems at the deployment site.
- 2.2.2 The secondary power supply input to the ICCT shall be 440 V, 50 Hz three-phase AC mains supply, which is expected to be from a local power generator.
- 2.2.3 The ICCT shall be equipped with an Automatic transfer switch (ATS) which switches the entire electrical load of the ICCT to the secondary supply in the event of failure of or detection of irregularity in the primary supply.
- 2.2.4 In case of restoration of primary power supply, the ATS shall switch the electrical load back to the primary power supply.
- 2.2.5 The ATS shall have in-built communication features which allow the switch to be monitored by the NMS. Necessary arrangement for such monitoring, such as protocol conversion, hardware and software integration shall be carried out.
- 2.2.6 The ICCT shall be protected from lightning induced electrical surges on the primary power supply lines by Surge protection measures (SPM) provided in accordance with IEC 62305-4 (see [19]).
- 2.2.7 The ICCT shall be equipped with a UPS system to enable the critical systems to continue functioning during transition from primary to secondary power supply as well as for a certain duration of time in case of non-availability of both primary and secondary power supplies. Requirements related to the UPS system are enumerated in paragraph 2.6.4.

2.3 Road mobility requirements

The fully equipped ICCT shelter is required to be road-mobile. A transporter truck body needs to be built on an appropriate chassis for loading the ICCT and transportation to destination site by road. In this section, requirements pertaining to this road mobility mode are outlined.

2.3.1 Transporter truck

- 2.3.1.1 The height of the loading platform after loading with fully equipped ICCT shall not exceed 1,335 mm.
- 2.3.1.2 The width of the flat bed of the truck platform shall not exceed 3,000 mm to limit the folded length of the arms of lifting-cum-leveling system and to ensure safe reversing of the platform under the shelter.
- 2.3.1.3 The ground clearance of the truck shall be at least 245 mm.
- 2.3.1.4 Laden weight with fully equipped ICCT shall not exceed 80 % of the vehicle's Gross vehicle weight (GVW).
- 2.3.1.5 The fully equipped ICCT payload shall be positioned on the transporter truck platform such that no axle of the vehicle shall be loaded beyond 80 % of its maximum rated capacity.
- 2.3.1.6 The truck shall have adequate loading span for a fully equipped ICCT shelter with all overhanging equipment, the shoring formats and material necessary for loading it into the aircraft (see paragraph 2.4.1.4) as well as the load spreader beam or assembly (see paragraph 2.1.5.3).
- 2.3.1.7 The turning circle radius of the truck shall not exceed 12 m.
- 2.3.1.8 Length of the transporter truck loaded with a fully equipped ICCT shall not exceed the length limit (12 m) prescribed for transport vehicles with two or more axles in Central motor vehicles rules (CMVR) 1989 (see [20]).
- 2.3.1.9 To meet air mobility related requirements specified in paragraph 2.4.1.2, the overall height of the transporter truck loaded with a fully equipped ICCT shall not exceed 4000 mm.
- 2.3.1.10 The truck shall use diesel as fuel and shall be compliant with BS-VI emission norms.
- 2.3.1.11 The truck shall have a gross vehicle weight of at least 35,000 kg.
- 2.3.1.12 The truck shall have maximum engine power of at least 250 HP.
- 2.3.1.13 The truck shall have either four or five axles.
- 2.3.1.14 The truck shall have a sleeper cabin with HVAC, fully manufactured by the truck OEM.
- 2.3.1.15 The truck shall be equipped with suitable rear view mirrors which show clear rear view to the driver without obstruction when fully equipped ICCT is loaded on it.
- 2.3.1.16 The truck shall be equipped with a rear-view reversing/parking camera, reverse hooter, reverse flasher and reverse illumination lights for safe reversing in constrained spaces as well as during loading or unloading from aircraft.
- 2.3.1.17 Roadability test as per Procedure-1 or 2, test No. 29 of JSS-55555 shall be carried

out on one transporter truck loaded with a fully integrated ICCT system & any other payload (such as shoring formats, load spreader beam etc).

2.4 Air mobility requirements

The ICCT shelter shall be designed to be transported in C-17 transport aircraft while mounted on the transporter truck. Requirements pertaining to such transportation are listed in this section.

2.4.1 Air-transport of truck-mounted ICCT

- 2.4.1.1 It shall be possible to load and transport the fully equipped ICCT shelter, mounted on the transporter truck, directly into a C-17 transport aircraft.
- 2.4.1.2 The maximum height of 4,000 mm shall be allowed only in the rear 7,000 mm of the transporter truck loaded with the fully equipped ICCT shelter. In the remaining front portion of the vehicle, the height shall not exceed 3,500 mm. This is to allow aft-wing loading of the laden transporter truck in a C-17 aircraft.
- 2.4.1.3 Necessary shoring formats required for loading, unloading, rolling and parking the transporter truck either in unladen condition, or loaded with a fully equipped ICCT, for transportation using a C-17 aircraft, shall be provided. Such shoring formats shall be compliant with MIL-STD-1791.
- 2.4.1.4 During road transportation using transporter truck, the necessary shoring formats for ICCT shall be loaded on the transporter truck.
- 2.4.1.5 The ICCT shelter and the transporter truck shall have tie-down provisions compliant with MIL-STD-1791 so as to enable the transporter truck either in unladen condition, or loaded with a fully equipped ICCT to be tied down during transportation in a C-17 aircraft.

2.4.2 Approximate plan for air-transport of truck-mounted ICCT

The air transportation of truck-mounted ICCT needs careful design consideration. In view of this, in figure 2.2, an approximate and tentative plan for air-transportation of the truck-mounted ICCT is shown. This plan is not final and prospective contractors are free to make changes or propose a fresh plan.

2.4.3 Environmental aspects of air transportation

- 2.4.3.1 The ICCT and the transporter truck shall be capable of withstanding the vibration, shock and acceleration levels experienced by cargo during transportation by C-17 aircraft, during normal operation as well as hard-landing, as prescribed in MIL-STD-1791.
- 2.4.3.2 The ICCT, the transporter truck and their constituent equipment shall be designed to withstand rapid decompression caused by aircraft structural failure without endangering the aircraft or its crew. This shall be in compliance with MIL-STD-1791.

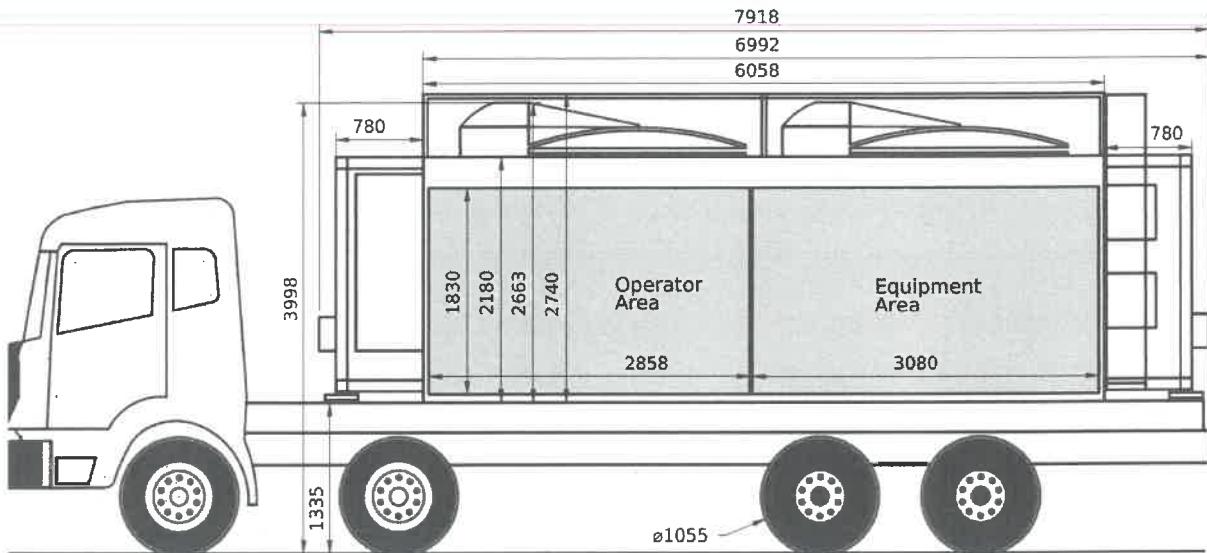


Figure 2.2: Example plan of a truck mounted ICCT for aircraft loading

2.4.3.3 Verification of compliance to environmental and other requirements related to air transportation shall be carried out as per MIL-STD-1791.

2.5 Occupational safety requirements

The ICCT shall meet the following requirements related to occupational safety of operators.

- 2.5.1 Towards prevention of hazards caused by falling materials, the design shall incorporate compliance with IS 13416-1 (see [22]) to the extent possible.
- 2.5.2 Towards prevention of falls of operating personnel, the design shall incorporate compliance with IS 13416-2 (see [23]) to the extent possible
- 2.5.3 Ladder design and construction shall comply with code of safety prescribed in IS 3696-2 (see [24])
- 2.5.4 Safety related equipment listed in paragraph 2.6.28 shall be provided, ensuring that the pertinent standards or recommendations listed therein are met.
- 2.5.5 To the extent possible, flame-proof or fire-resistant lighting shall be used for illumination in the interior of ICCT.
- 2.5.6 To the extent possible, LFH cables and wires shall be used in ICCT. See 2.1.1.15 for more details.
- 2.5.7 Towards fire safety, it shall be ensured that all requirements of paragraph 2.6.3 are met.

2.6 Major systems and equipment

In this section, requirements related to all major systems and equipment expected to be integrated in the ICCT are discussed. For each major system or equipment, a sub-section is devoted.

2.6.1 Lifting and leveling system

There is a requirement of a lifting and leveling system to be fitted to the ICCT shelter. In this section, related requirements are enumerated.

- 2.6.1.1 The ICCT shelter shall be fitted with a lifting and leveling system which shall enable the fully equipped shelter to lift and level itself. This is meant to provide a reasonably leveled, rigid and stable platform for the operation of look-angle sensitive communication equipment such as VSAT, line of sight links, ground to air link etc.
- 2.6.1.2 It shall be possible to lift the fully equipped ICCT shelter using the lifting and leveling system and drive away the transporter truck or trailer from under the shelter. Similarly, it shall be possible to lift the fully equipped ICCT shelter and reverse the transporter truck or trailer under the shelter.
- 2.6.1.3 The lifting jacks shall be electromechanical type with individual lifting capacity of at least 10,000 kg. Two diagonally opposite jacks together shall be able to lift a total weight of at least 20,000 kg.
- 2.6.1.4 The lifting stroke shall be at least 1,700 mm.
- 2.6.1.5 Auto-leveling feature shall be available.
- 2.6.1.6 The leveling accuracy shall be within $\pm 0.5^\circ$.
- 2.6.1.7 Limit switches shall be provided to ensure that displacement limits of the system are not exceeded during operation.
- 2.6.1.8 It shall be possible to retract and fold the lifting-cum-levelling system so that there is no projection of the same beyond the shelter width during transportation.
- 2.6.1.9 Two inclinometers with manual readout shall be provided on two perpendicular sides of the ICCT shelter to assist in leveling.

2.6.2 Ethernet inclinometer

To measure and monitor the inclination angles of the ICCT shelter, it shall be equipped with one (1) dual axis Ethernet inclinometer instrument mounted such that it can measure the angles of inclination along the length and width dimensions of the ICCT shelter. It shall meet the following requirements.

Ref #	Parameter	Specification
2.6.2.1	Number of axes	2
2.6.2.2	Range of measurement	At least $\pm 20^\circ$
2.6.2.3	Accuracy	$\leq 0.025^\circ$ over full temperature range
2.6.2.4	Output at 0°	$\leq 0.05^\circ$
2.6.2.5	Temperature sensitivity of output at 0°	$\leq 0.005^\circ / ^\circ C$
2.6.2.6	3 dB measurement bandwidth	≥ 10 Hz
2.6.2.7	Transverse axis misalignment	$\leq 0.5^\circ$
2.6.2.8	Ethernet interface	10/100 base-T
2.6.2.9	Power supply	Power over Ethernet (PoE).

Ref #	Parameter	Specification
2.6.2.10	Ingress protection	At least IP-65 as per IS/IEC 60529

2.6.3 Fire prevention, detection and fighting systems

In this section, requirements pertaining to fire prevention, detection and fighting are listed.

2.6.3.1 Hydrogen gas detector

The ICCT shall be equipped with a hydrogen gas detection system to detect any accidental leakage from batteries. The following are the specifications and requirements.

Ref #	Parameter	Specification
2.6.3.1.1	Detection range	Up to 100 % Lower explosive level (LEL) of Hydrogen
2.6.3.1.2	Accuracy	Within $\pm 2\%$ of LEL
2.6.3.1.3	Response time	≤ 20 s
2.6.3.1.4	Alarm thresholds	Two thresholds, one at lower % of LEL and the other at higher % of LEL. Both thresholds shall be programmable
2.6.3.1.5	Relay contacts	Two contacts, one for each of the two alarm thresholds
2.6.3.1.6	Output	Standard 4-20 mA signal
2.6.3.1.7	Remote monitoring interface	Ethernet preferably with Simple network management protocol (SNMP) or RS-485/RS-422 converted to Ethernet
2.6.3.1.8	% of LEL indicator displays	Two (02) numbers of 7-segment red LED displays. 1-inch digit height. 4 digits
2.6.3.1.9	Audible alarm indication	Audible indications shall be provided for the two alarm levels
2.6.3.1.10	Visible alarm indication	Two distinct LED indicators for the two alarm levels
2.6.3.1.11	Flame-proof compliance	Ex Da, Group IIC, temperature class T5 or T6, EPL Ga as per IS/IEC 60079: Part 1 (see [25])
2.6.3.1.12	Intrinsic safety	Ex Ia, Group IIC, temperature class T5 or T6, EPL Ga as per IS/IEC 60079: Part 11 (see [26])
2.6.3.1.13	Dust-proof compliance	Ex Ta, Group IIIC, temperature class T85°C, EPL Da as per IS/IEC 60079: Part 31 (see [27])
2.6.3.1.14	Ingress protection	IP-66 as per IS/IEC 60529 (see [15])
2.6.3.1.15	EMC	EN-50270 (see [28])
2.6.3.1.16	EMI	IEC-61000-6-4 (see [29])

2.6.3.1.17 The Hydrogen gas detector shall be mounted within the battery compartment or rack, above all the rows of batteries.

- 2.6.3.1.18 The battery compartment shall be constructed such that Hydrogen gas emission from any row of batteries can freely travel upwards towards the Hydrogen gas detector.
- 2.6.3.1.19 The Hydrogen gas detector shall be insensitive to other gases as well as to variations in temperature, humidity or flow rate.
- 2.6.3.1.20 The hydrogen gas detector shall have Ethernet interface, preferably with SNMP. RS-485 or RS-422 converted to Ethernet interface is also acceptable. This shall be connected to the NMS for local and remote monitoring.
- 2.6.3.1.21 The two % of LEL indicator displays shall be mounted one each in the equipment and operator areas.
- 2.6.3.1.22 Visible alarm indicators (e.g. amber & red flashers), shall be mounted in the equipment as well as operator areas.
- 2.6.3.1.23 An audible alarm indicator shall be mounted in the operator area. An additional audible alarm indicator in the equipment area is preferable.
- 2.6.3.1.24 Devices such as hooters or buzzers used as audible alarm indicators shall be IP-66 compliant as per IS/IEC 60529.
- 2.6.3.1.25 One (01) number of gas calibration kit shall be provided.

2.6.3.2 Very early smoke detection apparatus (VESDA)

The ICCT shall be equipped with a Very early smoke detection apparatus (VESDA) to detect any internal fire in the very early stages so as to provide adequate response time for personnel to fight it, preventing harm to equipment or personnel to the maximum possible extent.

- 2.6.3.2.1 One (01) set of single-pipe aspirating smoke detector
- 2.6.3.2.2 Linear pipe length of at least 25 m. Branched pipe length of at least 30 m (2×15) m
- 2.6.3.2.3 Single pipe inlet
- 2.6.3.2.4 Shall support at least 6 holes per branch
- 2.6.3.2.5 Shall be suitable for up to 2,500 sq feet
- 2.6.3.2.6 Ethernet interface preferably with SNMP
- 2.6.3.2.7 Internal event log of up to 10,000 events
- 2.6.3.2.8 Audible alarm and visual indication
- 2.6.3.2.9 Settable alarm thresholds

2.6.3.3 Clean agent fire extinguisher

The ICCT shall be equipped with clean-agent fire-extinguishers which will allow the personnel to effectively fight and extinguish any fire within or around it without collateral damage to sensitive electronic equipment.

- 2.6.3.3.1 Three (3) canisters shall be provided, one (1) placed in operator area and two (2) in equipment area

- 2.6.3.3.2 Hydrochlorofluorocarbon (HCFC)-123 or Hydrofluorocarbon (HFC)-236fa residue-free clean agent
- 2.6.3.3.3 Shall be suitable for fire types A, B, C & electrically started fires
- 2.6.3.3.4 Minimum net weight of agent in each canister shall be 4 kg
- 2.6.3.3.5 Squeeze grip discharge mechanism
- 2.6.3.3.6 Range of at least 2 m
- 2.6.3.3.7 Discharge duration of at least 10 s
- 2.6.3.3.8 Shall be equipped with a pressure gauge, controllable discharge mechanism & flexible rubber hose pipe for directed agent delivery

2.6.4 Uninterruptible power supply (UPS)

The ICCT shall be equipped with an online UPS which meets the following requirements.

- 2.6.4.1 19-inch rack mountable, 20 kVA UPS with 1:1 load-sharing redundancy.
- 2.6.4.2 A rack mountable maintenance bypass cum output distribution unit shall be provided.
- 2.6.4.3 440 V, 50 Hz, three phase input and 440 V, 50 Hz, three phase output
- 2.6.4.4 Pure sinusoidal output waveform
- 2.6.4.5 At least 15 minutes of backup for a 20 kVA load shall be provided.
- 2.6.4.6 At least 40 minutes of backup for a 10 kVA load shall be provided.
- 2.6.4.7 Ethernet management interface, with SNMP
- 2.6.4.8 Rack-mountable battery modules from UPS OEM shall be provided to maximize backup duration and minimize rack-space required.
- 2.6.4.9 The UPS shall be mounted in a rack with 800 mm external depth described in 2.1.2.7. The battery modules shall fit in the same 19-inch rack as the UPS.
- 2.6.4.10 A power budget shall be carried out and submitted, to demonstrate that the 20 kVA UPS, with a derated capability of 18 kVA expected at 10,000 feet altitude, shall be able to meet the backup and load requirements.

2.6.5 Monitoring cameras & recording system

The ICCT shall be equipped with cameras and a rack-mounted Network video recorder (NVR) that meet the following requirements for monitoring & recording purposes.

- 2.6.5.1 There shall be at least two (2) indoor IP cameras in the ICCT, one (1) in the operator area, and one (1) in the equipment area.
- 2.6.5.2 The indoor cameras shall be mounted such that most of the operator and equipment areas shall be visible in the video captured.
- 2.6.5.3 There shall be at least two (2) outdoor IP cameras mounted on the roof of the ICCT.
- 2.6.5.4 The outdoor cameras shall be IP-66 compliant as per IS/IEC 60529.
- 2.6.5.5 The outdoor cameras shall be mounted at an extended height for improved cover-

- age. It shall be possible to retract, stow and secure the outdoor cameras during transportation.
- 2.6.5.6 The indoor and outdoor cameras shall be powered using PoE. No separate power cables shall be necessary.
- 2.6.5.7 The indoor and outdoor cameras shall be equipped with infrared illumination for night vision. This feature shall be automatically activated in case of absence or inadequacy of illumination.
- 2.6.5.8 The indoor and outdoor cameras shall be panoramic view cameras with $360^\circ \times 180^\circ$ coverage.
- 2.6.5.9 The indoor and outdoor cameras shall be based on a sensor which has a resolution of at least 6 MP.
- 2.6.5.10 The original view resolution of the cameras shall be at least 2000×2000 pixels.
- 2.6.5.11 The cameras shall support double panorama, single panorama (roof mounted), single panorama (wall mounted) and quad-views.
- 2.6.5.12 The cameras shall support on-board de-warping.
- 2.6.5.13 The cameras shall support a frame rate of at least 30 fps.
- 2.6.5.14 The cameras shall support High efficiency video coding (HEVC) as per the International Telecommunication Union (ITU) H.265 video compression standard (see [30]).
- 2.6.5.15 The cameras shall be vandal resistant and rated IK10 as per IEC 62262 (see [31]).
- 2.6.5.16 The cameras shall be suitable for usage on board a vehicle. Towards this, compliance to EN 50155 (see [32]) or IEC 60721-3-5 (either class 5M3 or class 5M2) (see [33]) shall be ensured.
- 2.6.5.17 The cameras shall support Open Network Video Interface Forum (ONVIF) profiles S, G & T.
- 2.6.5.18 The cameras shall support Wide dynamic range (WDR) with a dynamic range of at least 84 dB.
- 2.6.5.19 IEEE 802.1X authentication (see [34]) and Hypertext transfer protocol secure (HTTPS) security features shall be supported by the cameras.
- 2.6.5.20 The cameras shall support SNMP and web-based monitoring & control.
- 2.6.5.21 There shall be a single rack-mounted NVR in the ICCT to record the video output of all the cameras.
- 2.6.5.22 The NVR shall support at least 8 channels and shall be compatible with the four monitoring cameras of the ICCT.
- 2.6.5.23 The NVR shall supply power to the indoor and outdoor cameras through PoE.
- 2.6.5.24 The NVR shall support review or monitoring of the output of the cameras remotely over the network.
- 2.6.5.25 The NVR shall have adequate storage capacity to store at least twenty eight (28) full days of video from all the cameras at full resolution.
- 2.6.5.26 Necessary Solid state drive (SSD) or Hard disk drive (HDD) storage shall also be installed in the NVR.

2.6.6 Network equipment

Network equipment of the following nature shall be integrated in the ICCT. The OEM shall support the equipment for at least the next seven (07) years from the date of purchase. The equipment shall not have end-of-life announced by the OEM in the next three (03) years.

2.6.6.1 Core switch

Cisco® Catalyst® C9407R Chassis-K9, one (1) number, with the following modules or options

- 2.6.6.1.1 L-3 features support: Network address translation (NAT), Quality of service (QoS) and advanced L-3 features
- 2.6.6.1.2 Two (02) Supervisor engines, C9400x-SUP-2XL, with the latest software
- 2.6.6.1.3 Two (02) modules of 48-port 10/100/1000 Mbps (RJ-45) PoE+
- 2.6.6.1.4 Two (02) modules (line cards) of 24 port 10G Ethernet (Small form-factor pluggable (SFP)+) to be provided. Of these two modules/cards, one shall be loaded with 24×1G single mode SFP modules (LC connector, LX type) and the other shall be loaded with 24×10G single mode SFP+ modules (LC connector, LR type).
- 2.6.6.1.5 All SFP and SFP+ modules shall be Multi-Source Agreement (MSA) compliant
- 2.6.6.1.6 Input voltage range of 200 to 240 V, AC
- 2.6.6.1.7 Redundant power supply (1+1)
- 2.6.6.1.8 Cisco® Digital network architecture (DNA®) support
- 2.6.6.1.9 One (01) console cable with Universal serial bus (USB) interface

2.6.6.2 Edge router

Cisco® 8300 Series platform (C8300-2N2S-4T2X), five (5) numbers, with the following features or options

- 2.6.6.2.1 L-3 features support: NAT, QoS and advanced L-3 features
- 2.6.6.2.2 Modular architecture
- 2.6.6.2.3 Six (06) onboard Wide area network (WAN) ports: 4×1G Ethernet and 2×10G SFP loaded with 2×10G single mode SFP+ modules (LC connector, LR type).
- 2.6.6.2.4 Additional six (06) 1G WAN combo ports (3 × C-NIM-2T modules) loaded with 6×1G single mode SFP modules (LC connector, LX type).
- 2.6.6.2.5 All SFP and SFP+ modules shall be MSA compliant
- 2.6.6.2.6 Eight (08) clear channel data E1 ports
- 2.6.6.2.7 One (01) Cisco Catalyst NIM Module 2-port 1GE SFP with MACSec (Shall be stored as a spare module)
- 2.6.6.2.8 One (01) Cisco Catalyst SM to NIM Module Adaptor
- 2.6.6.2.9 Redundant power supply in 1+1 configuration with AC power cord (India)
- 2.6.6.2.10 One (01) console cable (5-pin mini USB Type-B-to-USB Type-A)

2.6.6.3 Node switch

Cisco® 9300 L-3 switch, twelve (12) numbers with the following features or options

- 2.6.6.3.1 Switching bandwidth of 208 Gbps
- 2.6.6.3.2 L-3 features support: NAT, QoS and advanced L-3 features
- 2.6.6.3.3 Forty eight (48) 10/100/1000 Mbps ports with PoE+
- 2.6.6.3.4 Four (04) 1G single mode SFP modules, LC connector, LX type and four (04) 10G single mode SFP modules, LC connector, LR type
- 2.6.6.3.5 All SFP and SFP+ modules shall be MSA compliant
- 2.6.6.3.6 Redundant power supply (1+1)
- 2.6.6.3.7 One (01) console cable with USB interface

2.6.7 Computer workstations

Fourteen (14) computer workstations shall be integrated in the ICCT, complying with the following requirements and specifications.

- 2.6.7.1 Rack mountable workstations, with depth suitable for installation in a 19-inch rack of depth 800 mm and height not exceeding 1 RU
- 2.6.7.2 Intel® Xeon® W7-2495X (2.5 GHz/24 core) Central processing unit (CPU)
- 2.6.7.3 Motherboard with Intel® W790 or equivalent Intel® chipset
- 2.6.7.4 96 GB dual rank Dual data rate, fourth generation (DDR4) 2933 MHz Error correcting code (ECC) memory
- 2.6.7.5 Internal storage, 2× 2 TB SSD with Redundant array of independent disks (RAID) 1
- 2.6.7.6 Built-in hardware RAID controller
- 2.6.7.7 Integrated graphics with one (01) on-board Video graphics array (VGA) port with support for 1920 × 1200@60 Hz, 32- Bits per pixel (bpp) resolution
- 2.6.7.8 2× Peripheral component interconnect - Express (PCIe) 3.0 bus slots (1 × 16, 3 × M.2 × 4)
- 2.6.7.9 4× 1 GbE ports with RJ-45 interface
- 2.6.7.10 4× USB 3.0
- 2.6.7.11 2× redundant hot-plug power supply modules
- 2.6.7.12 Hardware shall be certified for Red Hat® Enterprise Linux® 8.7 and above
- 2.6.7.13 Loaded with Red Hat® Enterprise Linux® (RHEL) 9.4 (64-bit) Workstation Operating system (OS) which shall be provided by PGAD, as per disk partitioning scheme and other relevant details also provided by PGAD
- 2.6.7.14 One license of Microsoft Windows 11 or higher version OS shall be provided per ICCT. It shall be installed as a virtual machine in one of the Linux Workstations to provide a platform for any OEM or third-party software that requires the Windows OS.
- 2.6.7.15 Workstations shall be suitable for switching OFF and ON, on a daily basis

2.6.8 Computer consoles

In the operator area of the ICCT three (3) computer consoles shall be provided as per the following specifications and requirements.

Ref #	Parameter	Specification
2.6.8.1	Computer platform	Thin client computers as per 2.6.9
2.6.8.2	Number of computer platforms	Two (2) per console (main and cold standby)
2.6.8.3	Computer display	As per 2.6.10
2.6.8.4	Number of computer displays	Two (2) per console
2.6.8.5	Keyboard	IP65 rated 105-key keyboard with shielded cable and type-A USB connector
2.6.8.6	Pointing device	IP65 rated 2+3 optical scroll mouse with shielded cable and type-A USB connector
2.6.8.7	Securing for transportation	Provision to secure keyboard & pointing device for transportation
2.6.8.8	Space below display, keyboard etc	IP44 enclosure with standard 19-inch rack of 10 RU height and 650 mm external depth
2.6.8.9	Material construction	Aluminium alloy with stainless steel stiffeners
2.6.8.10	Surface finish	Powder coated or polyurethane painted, with matte finish

2.6.9 Thin client computers

Six (6) thin client computers with adequate computation capacity shall be mounted in the computer consoles and shall be used to connect the displays to any of the computer workstations in the workstations rack.

Ref #	Parameter	Specification
2.6.9.1	Processor make, cores & speed	Intel 12th or later generation, i5 or i7, ≥ 6 cores & ≥ 2 GHz
2.6.9.2	Operating system	Loaded with RHEL 9.4 64-bit OS
2.6.9.3	Graphics	Integrated graphics
2.6.9.4	RAM	≥ 8 GB
2.6.9.5	I/O ports	2x Display ports, 1x serial port, 1x audio port, 4x USB 2.0, 1x RJ-45 Gigabit Ethernet

2.6.9.6 All software packages necessary to connect to the computer workstations in the workstations rack shall also be installed.

2.6.9.7 Each console shall have two thin client computers, one main and other kept as a cold standby. The main computer shall be connected to two displays in extended display mode and suitable graphics card shall be provided with each thin client computer.

2.6.10 Computer displays

Six (6) Military grade rugged computer displays shall be mounted in the computer consoles meeting the following requirements

Ref #	Parameter	Specification
2.6.10.1	Display size	24 inches
2.6.10.2	Display type	Flat Liquid crystal display (LCD)
2.6.10.3	Resolution	Full HD or higher
2.6.10.4	Colors	16.7 million
2.6.10.5	Brightness	≥ 300 nits
2.6.10.6	Contract ratio	$\geq 1000 : 1$
2.6.10.7	Viewing angle	$\geq 85^\circ$ in all directions
2.6.10.8	Anti-reflection & glare	Protective glass
2.6.10.9	EMI/EMC compliance	RE102, RS103, CS101, CE102, CS114 as per MIL-STD-461 (see [35])
2.6.10.10	Environmental compliance	Vibration, temperature & humidity as per MIL-STD-810E (see [36])
2.6.10.11	Power connector	MIL-DTL-38999 (see [37]) or MIL-DTL-26482 (see [38]) compliant
2.6.10.12	Display connector	Suitable to connect to thin-client computers described in 2.6.9 either directly or through suitable adaptor
2.6.10.13	Make & model	WINMATE® W24L100-RKS1ML, or equivalent

2.6.11 KVM over IP switch

One (1) number of Keyboard, video and mouse (KVM) over IP switch with console shall be provided in the workstations rack for easy maintenance access to any of the workstations in the ICCT from the rack itself. The KVM over IP switch shall meet the following requirements.

Ref #	Parameter	Specification
2.6.11.1	Computer connections	≥ 16
2.6.11.2	Sessions	1 local & ≥ 4 remote sessions
2.6.11.3	Local/Direct display port	1× DVI-D female
2.6.11.4	Computer port selection	Keyboard hot-keys, push buttons, Web-based Graphical user interface (GUI)
2.6.11.5	KVM ports	RJ-45 jacks
2.6.11.6	Network interface	2× 10/100/1000 Mbps NIC for dual IP or redundant Local area network (LAN) operation
2.6.11.7	Display adapters	16× USB + VGA to RJ-45 adapters
2.6.11.8	Power supply redundancy	2× power supply modules for hot redundant operation
2.6.11.9	Security	FIPS 140-2 level-1 compliant

Ref #	Parameter	Specification
2.6.11.10	Remote authentication and management	Support for RADIUS, LDAP, SNMP v2c and v3, Syslog
2.6.11.11	Display resolution	Full HD, 1920 × 1200 @ 60 Hz with 24-bit color depth at local console and remote sessions
2.6.11.12	Console	Separate rack mounted 19" single-rail LCD console of size $\geq 17"$, resolution of 1920×1080@60 Hz, PS/2 & USB mouse support, and with LED illumination for keyboard visibility in low light. 1× DVI-D female port, brightness ≥ 250 nits, contrast ratio $\geq 650 : 1$ and aspect ratio of 16:9. 24-bit color depth.
2.6.11.13	Virtual media (USB/Digital versatile disc (DVD))	For file applications, OS patching, software installation & diagnostic testing

2.6.12 VSAT systems

There shall be two VSAT systems in the ICCT for communication through geostationary satellites. These shall function in Ku-band and C-band. The OEM shall support the equipment for at least the next ten (10) years from the date of purchase. The equipment shall not have end-of-life announced by the OEM in the next three (03) years. Mandatory testing and certification of telecom equipment (MTCTE), Equipment type approval (ETA) and any other mandatory certification required for the equipment shall be completed prior to integration of the subsystems. Requirements pertaining to these VSAT systems are listed below.

2.6.12.1 C-band VSAT antenna

One (01) C-band mobile VSAT antenna system shall be provided as per the following specifications.

Ref #	Parameter	Specification
2.6.12.1.1	Diameter	1.8 m
2.6.12.1.2	Reflector construction material	Carbon fiber or glass fiber reinforced
2.6.12.1.3	Reflector operating bands	C-band
2.6.12.1.4	Feed type	Offset fed
2.6.12.1.5	Mount type	Elevation over azimuth
2.6.12.1.6	Azimuth travel	$\pm 180^\circ$ continuous
2.6.12.1.7	Elevation travel	5° to 90°
2.6.12.1.8	Polarization travel	$\pm 90^\circ$
2.6.12.1.9	Stowed height	≤ 470 mm
2.6.12.1.10	Overall weight	≤ 160 kg

Ref #	Parameter	Specification
2.6.12.1.11	Drive mechanism	Motorized for azimuth, elevation and polarization travel. Hand cranked manual drive for emergency or backup use, including manual adjustment provision for polarization travel.
2.6.12.1.12	Feed boom integration capacity	≥ 45 kg for Block up converter (BUC) integration
2.6.12.1.13	Operating frequency	5925 – 6425 MHz uplink 3700 – 4200 MHz downlink
2.6.12.1.14	Gain, mid-band	≥ 35.5 dBi receive ≥ 39.5 dBi transmit
2.6.12.1.15	3 dB beamwidth, mid-band	$\leq 3^\circ$ receive $\leq 2^\circ$ transmit
2.6.12.1.16	Antenna noise temperature	≤ 47 K at 10° elevation ≤ 43 K at 20° elevation ≤ 43 K at 40° elevation
2.6.12.1.17	Radiation pattern & side lobes	As per ITU-RS-580-6 (see [39])
2.6.12.1.18	Polarization	Linear, orthogonal in receive and transmit directions
2.6.12.1.19	VSWR	$\leq 1.5 : 1$ receive $\leq 1.35 : 1$ transmit
2.6.12.1.20	Feed port isolation	≥ 30 dB at receive frequency ≥ 70 dB at transmit frequency
2.6.12.1.21	Cross-pol isolation, on-axis	≥ 30 dB in receive path ≥ 30 dB in transmit path
2.6.12.1.22	Feed power handling capability	≥ 1 kW continuous wave
2.6.12.1.23	Automatic operation features	One-button auto-acquisition of selected satellite with peaking and cross-pol optimization
2.6.12.1.24	Automation accessories	Antenna control unit (ACU), Beacon tracking receiver (BTR), Global positioning system (GPS) receiver & Digital magnetic compass (DMC) as per 2.6.12.3, hand-held controller with azimuth, elevation and polarisation control feature
2.6.12.1.25	Wind speed, survival	≥ 120 kmph in any position ≥ 190 kmph in stowed condition
2.6.12.1.26	Wind speed, operational, with receive pointing loss ≤ 0.5 dB Root mean square (RMS)	≥ 45 kmph with gusting ≥ 70 kmph
2.6.12.1.27	Camouflaged reflector	The reflector shall be coated with a camouflage pattern provided by PGAD without altering the radiation pattern

- 2.6.12.1.28 The proposed C-band VSAT antenna shall be in production and shall not be developed specially to meet current requirement.
- 2.6.12.1.29 The OEM shall have at least one service and support center in India for the C-band VSAT antenna.

2.6.12.2 Ku-band VSAT antenna

One (01) Ku-band mobileVSAT antenna system shall be provided as per the following specifications.

Ref #	Parameter	Specification
2.6.12.2.1	Diameter	1.8 m
2.6.12.2.2	Reflector construction material	Carbon fiber or glass fiber reinforced
2.6.12.2.3	Reflector operating bands	Ku-band
2.6.12.2.4	Feed type	Offset fed
2.6.12.2.5	Mount type	Elevation over azimuth
2.6.12.2.6	Azimuth travel	$\pm 180^\circ$ continuous
2.6.12.2.7	Elevation travel	5° to 90°
2.6.12.2.8	Polarization travel	$\pm 90^\circ$
2.6.12.2.9	Stowed height	≤ 470 mm
2.6.12.2.10	Overall weight	≤ 160 kg
2.6.12.2.11	Drive mechanism	Motorized for azimuth, elevation and polarization travel. Hand cranked manual drive for emergency or backup use, including manual adjustment provision for polarization travel.
2.6.12.2.12	Feed boom integration capacity	≥ 45 kg for BUC integration
2.6.12.2.13	Operating frequency	13750 – 14500 MHz uplink 10950 – 12750 MHz downlink
2.6.12.2.14	Gain, mid-band	≥ 45 dBi receive ≥ 46 dBi transmit
2.6.12.2.15	3 dB beamwidth, mid-band	$\leq 1^\circ$ receive $\leq 0.8^\circ$ transmit
2.6.12.2.16	Antenna noise temperature	≤ 55 K at 10° elevation ≤ 45 K at 20° elevation ≤ 41 K at 40° elevation
2.6.12.2.17	Radiation pattern & side lobes	As per ITU-RS-580-6
2.6.12.2.18	Polarization	Linear, orthogonal in receive and transmit directions
2.6.12.2.19	VSWR	$\leq 1.5 : 1$ receive $\leq 1.4 : 1$ transmit
2.6.12.2.20	Feed port isolation	≥ 30 dB at receive frequency ≥ 85 dB at transmit frequency
2.6.12.2.21	Cross-pol isolation, on-axis	≥ 35 dB in receive path

Ref #	Parameter	Specification
		≥ 35 dB in transmit path
2.6.12.2.22	Feed power handling capability	≥ 1 kW continuous wave
2.6.12.2.23	Automatic operation features	One-button auto-acquisition of selected satellite with peaking and cross-pol optimization
2.6.12.2.24	Automation accessories	ACU, BTR, GPS receiver & DMC as per 2.6.12.3, hand-held controller with azimuth, elevation and polarisation control feature
2.6.12.2.25	Wind speed, survival	≥ 120 kmph in any position ≥ 190 kmph in stowed condition
2.6.12.2.26	Wind speed, operational, with receive pointing loss ≤ 0.5 dB RMS	≥ 45 kmph with gusting ≥ 70 kmph
2.6.12.2.27	Camouflaged reflector	The reflector shall be coated with a camouflage pattern provided by PGAD without altering the radiation pattern

2.6.12.2.28 The proposed Ku-band VSAT antenna shall be in production and shall not be developed specially to meet current requirement.

2.6.12.2.29 The OEM shall have at least one service and support center in India for the Ku-band VSAT antenna.

2.6.12.3 VSAT antenna control unit

Two (02) numbers of rack-mountable indoor ACU with integrated BTR, GPS receiver and DMC shall be provided, one each for the C-band and Ku-band VSAT antennas. They shall meet the following specifications.

Ref #	Parameter	Specification
2.6.12.3.1	Operating modes	Manual, automatic
2.6.12.3.2	Automatic functions	Home/stow, Go-to/point
2.6.12.3.3	Monitoring and control interface	Ethernet with SNMP
2.6.12.3.4	Control movements	Azimuth, elevation & polarization
2.6.12.3.5	Mount type	Elevation over azimuth
2.6.12.3.6	BTR input frequency range	Fully covering the output frequency range of the corresponding Low noise block (LNB)

2.6.12.3.7 The proposed VSAT antenna control unit shall be in production and shall not be developed specially to meet current requirement.

2.6.12.3.8 The OEM shall have at least one service and support center in India for the VSAT antenna control unit.

2.6.12.4 C-band BUC system with 1:1 hot-standby

There shall be an C-band BUC system with 1:1 hot-standby, meeting the following specifications.

Ref #	Parameter	Specification
2.6.12.4.1	Input frequency range	Within the L-band frequency range of modem as defined in 2.6.12.8
2.6.12.4.2	Output frequency range	5925 to 6425 MHz
2.6.12.4.3	Amplification technology	GaAs or GaN
2.6.12.4.4	RF output power	$P_{\text{sat}} \geq 49 \text{ dBm}$, $\text{IMD3} \leq -25 \text{ dBc}$ with 2 equal carriers, 5 MHz apart, at a total power level of +45 dBm
2.6.12.4.5	Gain	$\geq 65 \text{ dB}$ with attenuation at 0 dB
2.6.12.4.6	Gain flatness	$\leq 2 \text{ dB}$ peak to peak over 36 MHz
2.6.12.4.7	Internal reference	10 MHz with stability better than 10^{-6} over rated temperature range
2.6.12.4.8	Gain variation over temperature	Within $\pm 2 \text{ dB}$
2.6.12.4.9	Gain adjustment range	$\geq 15 \text{ dB}$ in 1.0 dB steps
2.6.12.4.10	Input VSWR	$\leq 1.5 : 1$
2.6.12.4.11	Output VSWR	$\leq 1.5 : 1$
2.6.12.4.12	Phase noise	$\leq -60 \text{ dBc/Hz}$ at 100 Hz $\leq -70 \text{ dBc/Hz}$ at 1 kHz $\leq -80 \text{ dBc/Hz}$ at 10 kHz $\leq -90 \text{ dBc/Hz}$ at 100 kHz $\leq -100 \text{ dBc/Hz}$ at 1 MHz
2.6.12.4.13	Harmonics output	$\leq 50 \text{ dBc}$
2.6.12.4.14	Spurious output at $P_{1\text{dB}}$ or P_{linear}	$\leq 50 \text{ dBc}$
2.6.12.4.15	Input connector	Type N(F), 50Ω , waterproof
2.6.12.4.16	Output connector	CPR-137G, waterproof
2.6.12.4.17	Power supply input	AC, 100-240 V, 50 Hz
2.6.12.4.18	Weight	$\leq 45 \text{ kg}$ total, for two BUCs and redundancy controller
2.6.12.4.19	Ingress protection	IP-66 compliant as per IS/IEC 60529
2.6.12.4.20	Monitor and control	Individual BUC shall have provision for hand-held terminal, Ethernet port, RS-232, RS-485, SNMP agent, Web-interface. RF output sample port & reflected power monitoring feature are desirable. In each ICCT, one (01) hand-held terminal is required to be provided along with C-band BUCs

Ref #	Parameter	Specification
2.6.12.4.21	1:1 switchover events	At least the following events shall be considered: Temperature alarm, input threshold low, input threshold high, output threshold low, output threshold high, power supply voltage, 10 MHz reference fault
2.6.12.4.22	Redundancy control	Individual BUC shall have in-built redundancy controller with Ethernet interface module & interconnecting cables for switching
2.6.12.4.23	10 MHz external reference pass-through	Shall support distribution of 10 MHz external reference signal to both BUCs
2.6.12.4.24	Independence of uplink & downlink chains	1:1 redundancy control system for BUC shall be independent from that for LNB

- 2.6.12.4.25 The proposed C-band BUC system with 1:1 hot standby shall be in production, and shall not be developed specially to meet the current requirement.
- 2.6.12.4.26 The OEM shall have at least one service and support center for the BUC, redundancy controller etc in India.

2.6.12.5 C-band LNB system with 1:1 hot standby

There shall be one C-band LNB system with and 1:1 hot-standby, meeting the following specifications.

Ref #	Parameter	Specification
2.6.12.5.1	Input frequency range	Not beyond the range 3900 to 4200 MHz but including 4000 to 4200 MHz
2.6.12.5.2	5G-rejection	Effective rejection of 5G/International mobile telecommunications (IMT) band of 3.3-3.67 GHz shall be provided. LNB shall function satisfactorily in the presence of nearby 5G base stations
2.6.12.5.3	Output frequency range	Within the L-band frequency range of modem as defined in 2.6.12.8
2.6.12.5.4	Type	Phase locked loop (PLL) based
2.6.12.5.5	Noise temperature	≤ 40 K
2.6.12.5.6	Local oscillator (LO) stability	Within ± 15 kHz
2.6.12.5.7	Internal reference	10 MHz with stability better than 10^{-6} over rated temperature range
2.6.12.5.8	Gain	≥ 55 dB
2.6.12.5.9	Current drain	≤ 300 mA
2.6.12.5.10	Input VSWR	$\leq 2.3 : 1$
2.6.12.5.11	Output VSWR	$\leq 2.5 : 1$
2.6.12.5.12	Phase noise	≤ -75 dBc/Hz at 1 kHz ≤ -80 dBc/Hz at 10 kHz

Ref #	Parameter	Specification
2.6.12.5.13	Input connector	CPR 229G, waterproof
2.6.12.5.14	Output connector	N (F), 50 Ω, waterproof
2.6.12.5.15	Power supply input to individual LNBs	Direct current (DC), +15 to +24 V
2.6.12.5.16	Power supply input to 1:1 redundancy controller	AC, 100 to 240 V, 50 Hz
2.6.12.5.17	Ingress protection	LNB & redundancy controller to be IP-66 compliant as per IS/IEC 60529
2.6.12.5.18	Monitor and control	LNB 1:1 redundancy controller shall have provision for RS-232, RS-485, SNMP agent, Web-interface.
2.6.12.5.19	1:1 switchover events	At least the following events shall be considered: Temperature alarm, input threshold low, input threshold high, output threshold low, output threshold high, power supply voltage, 10 MHz reference fault
2.6.12.5.20	10 MHz external reference pass-through in 1:1 redundancy controller	Shall support distribution of 10 MHz external reference signal to both LNBs
2.6.12.5.21	LNB power supply support from 1:1 redundancy controller	Shall supply DC power to both LNBs
2.6.12.5.22	Independence of uplink & downlink chains	1:1 redundancy control system for LNB shall be independent from that for BUC

2.6.12.6 Ku-band BUC system with 1:1 hot-standby

There shall be one Ku band BUC system with 1:1 hot-standby, meeting the following specifications.

Ref #	Parameter	Specification
2.6.12.6.1	Input frequency range	Within the L-band frequency range of modem as defined in 2.6.12.8
2.6.12.6.2	Output frequency range	13750 to 14500 MHz
2.6.12.6.3	Amplification technology	GaAs or GaN
2.6.12.6.4	RF output power	$P_{\text{sat}} \geq 49 \text{ dBm}$, $\text{IMD3} \leq -25 \text{ dBc}$ with 2 equal carriers, 5 MHz apart, at a total power level of +45 dBm
2.6.12.6.5	Gain	$\geq 65 \text{ dB}$ with attenuation at 0 dB
2.6.12.6.6	Gain flatness	$\leq 2 \text{ dB}$ peak to peak over 36 MHz
2.6.12.6.7	Internal reference	10 MHz with stability better than 10^{-6} over rated temperature range
2.6.12.6.8	Gain variation over temperature	Within $\pm 2 \text{ dB}$
2.6.12.6.9	Gain adjustment range	$\geq 15 \text{ dB}$ in 1.0 dB steps

Ref #	Parameter	Specification
2.6.12.6.10	Input VSWR	$\leq 1.5 : 1$
2.6.12.6.11	Output VSWR	$\leq 1.5 : 1$
2.6.12.6.12	Phase noise	$\leq -60 \text{ dBc/Hz}$ at 100 Hz $\leq -70 \text{ dBc/Hz}$ at 1 kHz $\leq -80 \text{ dBc/Hz}$ at 10 kHz $\leq -90 \text{ dBc/Hz}$ at 100 kHz $\leq -100 \text{ dBc/Hz}$ at 1 MHz
2.6.12.6.13	Harmonics output	$\leq 50 \text{ dBc}$
2.6.12.6.14	Spurious output at $P_{1\text{dB}}$ or P_{linear}	$\leq 50 \text{ dBc}$
2.6.12.6.15	Input connector	Type N(F), 50 Ω , waterproof
2.6.12.6.16	Output connector	WR-75, waterproof
2.6.12.6.17	Power supply input	AC, 100-240 V, 50 Hz
2.6.12.6.18	Weight	$\leq 30 \text{ kg}$ total, for two BUCs and redundancy controller
2.6.12.6.19	Ingress protection	IP-66 compliant as per IS/IEC 60529
2.6.12.6.20	Monitor and control	Individual BUC shall have provision for hand-held terminal, Ethernet port, RS-232, RS-485, SNMP agent, Web-interface. RF output sample port & reflected power monitoring feature are desirable. In each ICCT, one (01) hand-held terminal is required to be provided along with Ku-band BUCs
2.6.12.6.21	1:1 switchover events	At least the following events shall be considered: Temperature alarm, input threshold low, input threshold high, output threshold low, output threshold high, power supply voltage, 10 MHz reference fault
2.6.12.6.22	Redundancy control	Individual BUC shall have in-built redundancy controller with interface module & interconnecting cables for switching
2.6.12.6.23	10 MHz external reference pass-through	Shall support distribution of 10 MHz external reference signal to both BUCs
2.6.12.6.24	Independence of uplink & downlink chains	1:1 redundancy control system for BUC shall be independent from that for LNB

- 2.6.12.6.25 The proposed Ku-band BUC system with 1:1 hot standby shall be in production and shall not be developed specially to meet current requirement.
- 2.6.12.6.26 The OEM shall have at least one service and support center for the BUC, redundancy controller etc in India.

2.6.12.7 Ku-band LNB system with 1:1 hot-standby

There shall be one Ku-band LNB system with 1:1 hot-standby, meeting the following specifications.

Ref #	Parameter	Specification
2.6.12.7.1	Input frequency range	10950 to 11700 MHz
2.6.12.7.2	Output frequency range	Within the L-band frequency range of modem as defined in 2.6.12.8
2.6.12.7.3	Type	PLL based
2.6.12.7.4	Noise figure	≤ 1.0 dB
2.6.12.7.5	LO stability	Within ± 15 kHz
2.6.12.7.6	Internal reference	10 MHz with stability better than 10^{-6} over rated temperature range
2.6.12.7.7	Gain	≥ 55 dB
2.6.12.7.8	Current drain	≤ 300 mA
2.6.12.7.9	Input VSWR	$\leq 2.5 : 1$
2.6.12.7.10	Output VSWR	$\leq 2.2 : 1$
2.6.12.7.11	Phase noise	≤ -70 dBc/Hz at 1 kHz ≤ -75 dBc/Hz at 10 kHz ≤ -90 dBc/Hz at 100 kHz
2.6.12.7.12	Input connector	WR 75, waterproof
2.6.12.7.13	Output connector	N, 50Ω , waterproof
2.6.12.7.14	Power supply input to individual LNBs	DC, +15 to +24 V
2.6.12.7.15	Power supply input to 1:1 redundancy controller	AC, 100 to 240 V, 50 Hz
2.6.12.7.16	Ingress protection	IP-66 compliant as per IS/IEC 60529
2.6.12.7.17	Monitor and control	LNB 1:1 redundancy controller shall have provision for RS-232, RS-485, SNMP agent, Web-interface.
2.6.12.7.18	1:1 switchover events	At least the following events shall be considered: Temperature alarm, input threshold low, input threshold high, output threshold low, output threshold high, power supply voltage, 10 MHz reference fault
2.6.12.7.19	10 MHz external reference pass-through in 1:1 redundancy controller	Shall support distribution of 10 MHz external reference signal to both LNBs
2.6.12.7.20	LNB power supply support from 1:1 redundancy controller	Shall supply DC power to both LNBs
2.6.12.7.21	Independence of uplink & downlink chains	1:1 redundancy control system for LNB shall be independent from that for BUC

2.6.12.8 SCPC-PAMA modems

2.6.12.8.1 Multi-demodulator Single channel per carrier (SCPC)-Pre-assigned multiple access or Permanent assignment multiple access (PAMA) satellite modems in 1:1 hot-standby configuration shall be provided.

2.6.12.8.2 Make shall be Datum Systems®, model M7L modems shall be provided.

2.6.12.8.3 There shall be one (1) pair of modems with 1:1 hot standby for the C-band VSAT and one (1) such pair for the Ku-band VSAT. The total number of 1:1 hot standby pairs shall be two (2). The modems shall meet the following specifications.

Ref #	Parameter	Specification
2.6.12.8.4	L-band frequency range	950 to 2150 MHz, tunable in 1 Hz steps
2.6.12.8.5	Modulation	Binary phase shift keying (BPSK), Quadrature phase shift keying (QPSK), 8-Amplitude and phase shift keying (APSK), 16-Quadrature amplitude modulation (QAM)
2.6.12.8.6	Forward error correction (FEC)	Low density parity check (LDPC) with block size 2 k, 4 k, 8 k and 16 k bits
2.6.12.8.7	FEC rates	$\frac{1}{2}, \frac{8}{15}, \frac{4}{7}, \frac{8}{13}, \frac{2}{3}, \frac{16}{23}, \frac{8}{11}, \frac{16}{21}, \frac{4}{5}, \frac{16}{19}, \frac{8}{9}$
2.6.12.8.8	Scrambler & descrambler	Synchronous and asynchronous
2.6.12.8.9	Symbol rate support	≥ 14 Msps per demodulator or modulator ≥ 68 Msps aggregate for demodulators
2.6.12.8.10	Data rate support	≥ 16 Mbps per demodulator or modulator ≥ 68 Mbps aggregate for demodulators
2.6.12.8.11	L-band transmit power level	0 to -30 dBm with a tolerance of ± 0.5 dB over frequency and temperature range
2.6.12.8.12	Output connector	SMA (F) or N(F), $50\ \Omega$
2.6.12.8.13	Output return loss	≥ 15 dB
2.6.12.8.14	Output spurious	≤ -60 dBc/4 kHz
2.6.12.8.15	Output isolation	≥ 60 dB
2.6.12.8.16	Phase noise	≤ -70 dBc/Hz at 100 Hz ≤ -80 dBc/Hz at 1 kHz ≤ -90 dBc/Hz at 10 kHz ≤ -100 dBc/Hz at 100 kHz ≤ -110 dBc/Hz at 1 MHz
2.6.12.8.17	External reference frequency	10 MHz
2.6.12.8.18	External reference power level	-10 dBm to +10 dBm
2.6.12.8.19	Input bandwidth	72 MHz
2.6.12.8.20	Transmit & receive channels	1 transmit & 16 receive channels
2.6.12.8.21	Input connector	SMA (F) or N(F), $50\ \Omega$
2.6.12.8.22	Input return loss	≥ 15 dB
2.6.12.8.23	Receive acquisition mode	Auto detection of modulation and FEC
2.6.12.8.24	Maximum total input power	≥ 10 dBm
2.6.12.8.25	Minimum input power	$10 \log_{10}(R_S) - 125$ dBm, where R_S is the symbol rate
2.6.12.8.26	Maximum input power	$10 \log_{10}(R_S) - 80$ dBm, where R_S is the symbol rate
2.6.12.8.27	Data interface	Ethernet bridge interface, 10/100/1000 base-T with 4 RJ-45 ports and 1 optical fiber SFP port

Ref #	Parameter	Specification
2.6.12.8.28	Data protocol	Layer-2 switched bridge, QoS, Virtual LAN (VLAN)
2.6.12.8.29	Monitoring and control	Ethernet, SNMP, Web interface
2.6.12.8.30	Size	2 units in 1 RU
2.6.12.8.31	Power supply input	AC, 100 to 240 V, 50 Hz

The modems shall meet the following Bit error ratio (BER) performance requirements.

Ref #	FEC	E_b/N_0 , in dB, for BER of 1×10^{-8}		
		BPSK/ QPSK	8-APSK	16-QAM
2.6.12.8.32	LDPC, 1/2 rate, 2 kb depth	≤ 2.20	-	≤ 4.60
2.6.12.8.33	LDPC, 1/2 rate, 16 kb depth	≤ 1.50	-	≤ 3.90
2.6.12.8.34	LDPC, 2/3 rate, 2 kb depth	≤ 2.90	≤ 4.80	≤ 6.00
2.6.12.8.35	LDPC, 2/3 rate, 16 kb depth	≤ 2.20	≤ 4.10	≤ 5.20
2.6.12.8.36	LDPC, 16/23 rate, 2 kb depth	≤ 3.30	≤ 5.30	-
2.6.12.8.37	LDPC, 16/23 rate, 16 kb depth	≤ 2.50	≤ 4.40	-
2.6.12.8.38	LDPC, 8/11 rate, 2 kb depth	≤ 3.70	-	-
2.6.12.8.39	LDPC, 8/11 rate, 16 kb depth	≤ 2.90	-	-
2.6.12.8.40	LDPC, 4/5 rate, 2 kb depth	-	-	≤ 7.80
2.6.12.8.41	LDPC, 4/5 rate, 16 kb depth	-	-	≤ 6.80
2.6.12.8.42	LDPC, 8/9 rate, 2 kb depth	≤ 5.80	-	≤ 9.50
2.6.12.8.43	LDPC, 8/9 rate, 16 kb depth	≤ 4.60	-	≤ 8.10
2.6.12.8.44	LDPC, 16/17 rate, 2 kb depth	-	-	≤ 10.2
2.6.12.8.45	LDPC, 16/17 rate, 16 kb depth	-	-	≤ 8.70

2.6.12.9 Active RF splitters & combiners

Three (3) numbers of active RF splitters with one L-band input and eight L-band outputs shall be integrated, one each for the Ku-band and C-band VSAT systems and a third splitter to be kept as a spare. Also, three (3) numbers of active RF combiners with eight L-band inputs and one L-band output shall be provided, one each for the Ku-band and C-band VSAT systems and a third combiner to be kept as a spare.

The following shall be the requirements pertaining to active splitters.

Ref #	Parameter	Specification
2.6.12.9.1	Splitting capacity	8-way
2.6.12.9.2	Operational frequency	950 - 2150 MHz
2.6.12.9.3	Connectors	SMA, 50Ω
2.6.12.9.4	Gain	0 ± 1.0 dB
2.6.12.9.5	Gain flatness over operational bandwidth	± 0.8 dB
2.6.12.9.6	Gain flatness over any 36 MHz	± 0.25 dB
2.6.12.9.7	Input return loss	≥ 14 dB

Ref #	Parameter	Specification
2.6.12.9.8	Output return loss	≥ 14 dB
2.6.12.9.9	Isolation	≥ 24 dB
2.6.12.9.10	Noise figure	≤ 12 dB
2.6.12.9.11	In-band spurious	≤ -70 dBm
2.6.12.9.12	Local monitoring	Front panel LEDs
2.6.12.9.13	Remote control	RJ45 port with Ethernet & SNMP
2.6.12.9.14	LNB power	13 V or 18 V DC, 500 mA via RF input port with over-current protection.
2.6.12.9.15	Power supply redundancy	Dual redundant, hot standby, alarmed, diode-ORed power supply modules
2.6.12.9.16	Amplifier redundancy	Dual redundant, hot standby with auto switch-over
2.6.12.9.17	Monitoring port	Single port, with -20 dB output
2.6.12.9.18	Form factor	19-inch rack mountable, 1 RU height

The following shall be the requirements pertaining to active combiners.

Ref #	Parameter	Specification
2.6.12.9.19	Combining capacity	8-way
2.6.12.9.20	Operational frequency	950 - 2150 MHz
2.6.12.9.21	Connectors	SMA, 50Ω
2.6.12.9.22	Gain	0 ± 1.0 dB
2.6.12.9.23	Gain flatness over operational bandwidth	± 0.8 dB
2.6.12.9.24	Gain flatness over any 36 MHz	± 0.25 dB
2.6.12.9.25	Input return loss	≥ 14 dB
2.6.12.9.26	Output return loss	≥ 14 dB
2.6.12.9.27	Isolation	≥ 24 dB
2.6.12.9.28	Noise figure	≤ 24 dB
2.6.12.9.29	In-band spurious	≤ -70 dBm
2.6.12.9.30	Local monitoring	Front panel LEDs
2.6.12.9.31	Remote control & monitoring	RJ45 port with Ethernet & SNMP
2.6.12.9.32	Power supply redundancy	Dual redundant, hot standby, alarmed, diode-ORed power supply modules
2.6.12.9.33	Amplifier redundancy	Dual redundant, hot standby with auto switch-over
2.6.12.9.34	Form factor	19-inch rack mountable, 1 U high

2.6.13 Point to multipoint LOS link

One (01) Point to multi-point (PTMP) Line of sight (LOS) link is required to be integrated in the ICCT for communication with certain other nodes. PGAD shall provide PTMP LOS link hardware to carry out integration and demonstrate functionality. The electrical & mechanical details as well as NMS interface details of the base unit shall be

provided to the successful bidder(s) who shall be responsible to incorporate necessary design features and to integrate the PTMP LOS link.

2.6.14 Antenna masts

Two (2) antenna masts are required to be integrated in the ICCT, one of which shall be used for the line of sight link, and the other for a ground to air link. Relevant requirements are as follows.

- 2.6.14.1 Erected height shall be at least 12 m to meet 5 km range of link coverage in L-band with adequate Fresnel zone clearance.
- 2.6.14.2 Retracted height shall not exceed the sum of external shelter height and VSAT antenna stowed height.
- 2.6.14.3 Payload shall be at least 75 kg. This may include LOS link radio, beam switching antenna etc.
- 2.6.14.4 The mast-mounted hardware may be unmounted and stowed securely in the ICCT shelter during transportation. Necessary provisions to be made in the design.
- 2.6.14.5 Survival wind speed shall be at least 100 kmph.
- 2.6.14.6 Operational wind speed shall be at least 80 kmph.
- 2.6.14.7 Deflection shall not exceed 5° at all operational wind and load conditions.
- 2.6.14.8 The mast shall be capable of self supported operation, without guy wires or ropes, at all operational wind and load conditions.
- 2.6.14.9 The mast shall be capable of operation at any height up to the maximum erected height.
- 2.6.14.10 The tare weight of the mast shall not exceed 400 kg.
- 2.6.14.11 Outdoor equipment, together with necessary pan/tilt units, shall be within the height limits of mast head load, with a safety factor of at least 1.333.
- 2.6.14.12 The lifting mechanism shall be a motorized electro-mechanical system powered by AC mains with manual option in case of power failure.
- 2.6.14.13 The mast shall be provided with a low intensity type-A aviation obstacle light in accordance with ICAO Annex-14 (see [21]). The aviation obstacle light shall be supplied with power from the UPS.

2.6.15 Antenna positioning units (pan/tilt units)

Three (3) pan/tilt antenna positioning units shall be provided, which meet the following requirements.

- 2.6.15.1 Make Moog® Quickset®, model MPT-50 RF
- 2.6.15.2 The unit shall have a single RF channel.
- 2.6.15.3 RF interfaces shall be N(F) type.
- 2.6.15.4 The single channel shall support the radio frequency range of DC to 12 GHz.
- 2.6.15.5 VSWR of the RF channel shall not exceed 1.5.
- 2.6.15.6 Insertion loss shall not exceed 0.3 dB throughout the band of operation.

- 2.6.15.7 Peak power handling capacity shall be at least 3 kW.
- 2.6.15.8 Average power handling capacity shall be at least 400 W at 2 GHz.
- 2.6.15.9 The communication interface for monitoring and control shall be Ethernet.
- 2.6.15.10 The load capacity shall be at least 50 lb-ft (68 N-m).
- 2.6.15.11 Heater shall be installed to enable the system to function in low temperature conditions.
- 2.6.15.12 Pan movement range shall be continuous rotation.
- 2.6.15.13 Tilt movement range shall be at least $\pm 90^\circ$.
- 2.6.15.14 Pan speeds up to $50^\circ/\text{s}$ shall be supported.
- 2.6.15.15 Tilt speeds up to $12^\circ/\text{s}$ shall be supported.
- 2.6.15.16 The antenna positioning units shall be IP-66 compliant as per IS/IEC 60529.
- 2.6.15.17 Since AC power shall be available from the ICCT shelter, a suitable DC power supply shall be mounted at an appropriate location. The DC power supply shall be connected to Ethernet to allow monitoring of status and parameters such as output voltage, load current etc through the NMS.
- 2.6.15.18 While two (02) antenna positioning units shall be mounted on the mast meant for data link, the third unit shall be kept as cold-standby or spare within the ICCT.

2.6.16 HVAC sets

Two (02) or three (03) numbers of heating, ventilation and air-conditioning units shall be integrated in the ICCT meeting the following requirements.

- 2.6.16.1 The HVAC units shall be military grade, slip-on type.
- 2.6.16.2 If two HVAC sets are planned, each shall be of adequate capacity to continuously maintain the mass and volume of the ICCT shelter, with all sub-systems powered on and functional, at $+22^\circ\text{C}$ within an external ambient temperature range of -20 to $+55^\circ\text{C}$ and with Relative humidity (RH) of up to 98 %. If three HVAC sets are planned, any two of them together shall have the same cooling capacity. Necessary heat-load related calculations, considering the occupants of the shelter and heat generated by equipment need to be carried out before deciding the number and cooling capacity of the units.
- 2.6.16.3 The HVAC shall also be capable of maintaining interior temperature of $+22^\circ\text{C}$ for two hours at an external ambient temperature of 57°C .
- 2.6.16.4 The HVAC shall be equipped with a heater of at least 3 kW.
- 2.6.16.5 The HVAC set shall be capable of maintaining the interior RH within 60 % irrespective of the outdoor RH level.
- 2.6.16.6 The interior noise level without fresh air supply shall not exceed 66 dB(A) at 3 m.
- 2.6.16.7 The interior noise level with fresh air supply shall not exceed 63 dB(A) at 1 m.
- 2.6.16.8 The HVAC sets shall have a NBC mode of operation and shall be compatible with the provided NBC filtration system. In the NBC mode of operation, fresh air from the NBC filtration system only shall be supplied by the HVAC sets.
- 2.6.16.9 During normal operation, with NBC mode disabled, the HVAC sets shall deliver

fresh air directly from outside. The rate of fresh air delivered shall be sufficient for the volume of space in the shelter, considering full occupancy of three operators and two additional personnel, as per MIL-STD-1472G.

- 2.6.16.10 If two HVAC sets are planned, they shall serve as redundant to each other, with only one unit working at a time. If three HVAC sets are planned, any two of them shall work at a time, with the third unit serving as the redundant unit.
- 2.6.16.11 Remote control panel shall be provided in the operator area.
- 2.6.16.12 Remote control panel shall have an Ethernet interface with SNMP support. If not possible or feasible, Ethernet interface without SNMP is acceptable provided a well-defined Interface control document (ICD) is available to integrate with the NMS. If that is also not possible, RS-422/485 interface is also acceptable provided it is suitably interfaced with the NMS.
- 2.6.16.13 Interface document, containing the message formats and other details of the interface shall be provided.
- 2.6.16.14 Outdoor units shall meet ingress protection criteria of IP56 as per IS/IEC 60529.
- 2.6.16.15 The HVAC outdoor units shall be coated or painted using a color scheme or camouflage pattern provided by PGAD. Military grade primer, thinner and paints shall be used for the purpose.

2.6.17 Nuclear, biological and chemical filtration system

For protecting the ICCT shelter occupants from the effects of a nuclear, biological or chemical contamination environment, there shall be a provision of a nuclear, biological and chemical filtration system. Related requirements are as follows.

- 2.6.17.1 The NBC filtration system shall maintain a consistent over pressure between 10 to 15 mmH₂O in the interior of the shelter.
- 2.6.17.2 The NBC filtration system shall have two modes of operation. In *normal mode* of operation, external air shall be passed through pre-filter and fine-filter before being allowed into the shelter. In *NBC mode* of operation, the external air shall be passed through pre-filter, fine filter and NBC filter stages before being allowed into the shelter.
- 2.6.17.3 The changeover between normal and NBC modes shall be through a 100 % leak proof solenoid valve actuated through the control panel with a switching time not exceeding 20 seconds.
- 2.6.17.4 The NBC filter shall consist of the following main components or parts

Ref #	Component	Specification/ Remarks
2.6.17.4.1	Anti-blast valve	Pneumatically actuated
2.6.17.4.2	Pre-filter	Filtration efficiency $\geq 96\%$ down to 10 μm
2.6.17.4.3	Blower	
2.6.17.4.4	Fine filter	Filtration efficiency $\geq 99\%$ down to 2 μm
2.6.17.4.5	NBC filter	Filtration efficiency $\geq 99.97\%$ down to 0.3 μm . Protection duration ≥ 5 days. Compliant with North Atlantic Treaty Organization (NATO) AEP-54 (see [40])

Ref #	Component	Specification/ Remarks
2.6.17.4.6	Bypass valve	
2.6.17.4.7	Flexible ducts	
2.6.17.4.8	Outlet duct	
2.6.17.4.9	Mounting frame assembly	
2.6.17.4.10	Vibration mounting pads	
2.6.17.4.11	Electrical panel and remote control panel	

2.6.17.5 The system shall be able to deliver fresh air at least at the rate of 100 m³/hour.

2.6.18 Bulk encryption units & Data diodes

For communication security of data transmitted over the WAN and over wireless communication links, twelve (12) Bulk encryption unit (BEU)s and two (2) data diodes need to be integrated in the ICCT. While BEUs shall be integrated by the contractor in the ICCT, data diode units shall be separately procured and integrated by PGAD after final delivery.

- 2.6.18.1 BEUs shall be of make Bharat Electronics Limited (BEL), Panchkula and model SMILE Mk-II with Ethernet interface modules for clear and crypt.
- 2.6.18.2 230 V AC power supply input from UPS shall be provided for each BEU
- 2.6.18.3 Three (3) Ethernet interfaces per BEU shall be provided.
- 2.6.18.4 1 RU height shall be provided per data diode.
- 2.6.18.5 230 V AC power supply input from UPS, with peak power consumption of 23 W per data diode shall be provided.
- 2.6.18.6 Four (4) Ethernet interfaces per data diode shall be provided.
- 2.6.18.7 BEUs shall be supplied with trial algorithm only.
- 2.6.18.8 BEUs shall be supplied with carrying case provided by OEM.
- 2.6.18.9 Accessories such as fill guns, algorithm loading devices etc need not be supplied.

2.6.19 NTP clock display

There shall be one (1) wall mounted Network time protocol (NTP) clock display, mounted in the operator area. It shall meet the following requirements.

- 2.6.19.1 Network interface shall be 10/100 Base-T Ethernet with RJ-45 jack connector.
- 2.6.19.2 Power supply shall be over the network cable, using PoE.
- 2.6.19.3 The display shall be a bright red/green/white LED 7-segment numeral display.
- 2.6.19.4 The hours and minutes numerals shall be at least 2.5 inches in height.
- 2.6.19.5 The seconds numerals shall be at least 1.8 inches in height.
- 2.6.19.6 There shall be an option of configurable time zone and daylight saving settings.
- 2.6.19.7 IP settings shall be selectable between static or Dynamic host configuration protocol (DHCP).

2.6.19.8 The configuration interface shall be Secure shell (SSH) session, Telnet session or web-page.

2.6.19.9 Time display format shall be *hh:mm:ss*.

2.6.20 Ethernet hygro-thermometer units

There shall be two (2) Ethernet hygro-thermometer units, one mounted in the operator area, and the other mounted in the equipment area. These shall meet the following requirements.

2.6.20.1 Network interface shall be 10/100 Base-T Ethernet with RJ-45 jack connector.

2.6.20.2 Power supply shall be over the network cable, using PoE. External DC power adapter shall be provided for standalone testing.

2.6.20.3 The unit shall have a front panel display for locally displaying the measured temperature and relative humidity.

2.6.20.4 There shall be a provision for setting upper and lower threshold limits with configurable hysteresis at each threshold crossing.

2.6.20.5 The unit shall support SNMP protocol for communication with NMS.

2.6.20.6 Temperature units shall be configurable between degrees Celsius and degrees Fahrenheit.

2.6.20.7 IP settings shall be selectable between static or DHCP.

2.6.20.8 The configuration interface shall be SSH session, Telnet session or web-page.

2.6.20.9 Temperature sensor measurement range shall be at least -20 to +60°C.

2.6.20.10 Temperature sensor accuracy shall be within ±0.6°C.

2.6.20.11 Temperature display and measurement resolution be 0.1°C

2.6.20.12 Hygrometer range shall be 0 to 100% RH.

2.6.20.13 Hygrometer accuracy shall be ±2.5% RH.

2.6.20.14 Hygrometer display and measurement resolution be 0.1% RH.

2.6.21 Ethernet carbon-dioxide concentration monitoring units

There shall be two (2) CO₂ monitoring units, one mounted in the operator area, and the other mounted in the equipment area, to monitor the quality of breathed air and ventilation. These shall meet the following requirements.

2.6.21.1 Network interface shall be 10/100 Base-T Ethernet with RJ-45 jack connector.

2.6.21.2 Power supply shall be over the network cable, using PoE. External DC power adapter shall be provided for standalone testing.

2.6.21.3 The unit shall have a front panel display for locally displaying the CO₂ concentration.

2.6.21.4 There shall be a provision for setting upper and lower threshold limits with configurable hysteresis at each threshold crossing.

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- 2.6.21.5 The unit shall support SNMP protocol for communication with NMS.
 - 2.6.21.6 IP settings shall be selectable between static or DHCP.
 - 2.6.21.7 The configuration interface shall be SSH session, Telnet session or web-page.
 - 2.6.21.8 CO₂ concentration measurement range shall be at least 0 to 10,000 Parts per million (ppm).
 - 2.6.21.9 Sensor accuracy shall be within ± (100 ppm + 5 %) of measurement.
 - 2.6.21.10 Display and measurement resolution shall be 1 ppm.
 - 2.6.21.11 Measurement repetition interval shall not exceed 30 seconds.
 - 2.6.21.12 Operating temperature range shall be at least 0 to +55°C.

2.6.22 Differential pressure monitoring unit

There shall be one (1) differential pressure monitoring unit, which will measure and display the differential pressure between the interior and the exterior of the ICCT shelter. If a differential pressure monitor cum display is included as a part of the NBC filtration system, it need not be separately provided. The unit shall meet the following requirements.

- 2.6.22.1 The unit shall have a front panel display for locally displaying the differential pressure.
- 2.6.22.2 Differential pressure measurement range shall be at least -100 to +100 mm H₂O.
- 2.6.22.3 Operating temperature range shall be at least -20 to +55°C.

2.6.23 VoIP system

Six (6) Voice over Internet protocol (VoIP) phones as per the following specification shall be provided in the ICCT shelter. Of the six phones, three shall be suitably mounted in the operator area for use by the operators, one shall be mounted in the operator area for use by the officer, one shall be mounted in the equipment area and one phone shall be kept as a spare.

- 2.6.23.1 The make shall be GrandStream®
- 2.6.23.2 The model shall be GXV3350
- 2.6.23.3 The VoIP phones shall be powered using PoE.
- 2.6.23.4 Compatible RJ9 over-the-ear headset with microphone shall be provided. Conventional cradle handset also shall be provided. Either handset or cradle shall be connected by the user, depending on requirement.
- 2.6.23.5 Compatible cable for connecting headset or cradle to VoIP phone shall be supplied.
- 2.6.23.6 There shall be a provision on the roof-top of the ICCT to connect the spare VoIP phone for communication with indoor personnel during integration or maintenance activities. The connectivity port on the roof-top shall be IP-67 compliant as per IS/IEC 60529 when mated with a cable, or when closed with a protective cap. The protective cap for the roof-top port shall also be provided.

- 2.6.23.7 Latest stable version of Asterisk® open source VoIP server based VoIP solution along with corresponding web based management system shall be installed by the contractor in one of the workstations described in section 2.6.7. PGAD shall provide necessary VoIP multi-party voice conference software module with dependencies, if any.
- 2.6.23.8 Intellectual property rights (IPR) of the conference module shall continue to rest with PGAD.

2.6.24 Power distribution and monitoring

- 2.6.24.1 A Power distribution panel (PDP) with Ethernet monitoring and the following local displays and controls shall be provided.
- (a) 3-phase input voltage and current
 - (b) 3-phase output voltage and current
 - (c) Phase-sequence testing
 - (d) Hour meter
 - (e) Volt, Ampere, frequency (VAF) meter for incoming and load parameters

2.6.24.2 The PDP shall have the feature of monitoring 3-phase input voltages, currents & frequency, 3-phase output voltages, currents & frequency, hour count, individual Miniature circuit breaker (MCB) status over Ethernet interface using NMS

2.6.24.3 For each rack in the equipment area, rack Power distribution unit (PDU)s shall be provided with SNMP feature to monitor the load across each PDU and overall status. These shall be monitored using the NMS.

2.6.25 Vehicle mounted Ethernet weather station

For remote monitoring of weather at any ICCT site, and to aid in weather related decisions such as erection or retraction of masts, deployment or stowage of VSAT antennas etc, a vehicle/shelter mounted weather monitoring station shall be provided. The following are the requirements.

- 2.6.25.1 There shall be a single integrated weather sensor with ultrasonic wind measurement, without any moving parts. Rain measurement shall be integrated within the same sensor and shall not use tipping bucket rain gauge. The integrated weather sensor shall not be affected by clogging and evaporation.
- 2.6.25.2 A lightning surge arrester shall be provided for differential and common mode protection from up to 10 kA surge currents.
- 2.6.25.3 There shall be a provision to mount the weather sensor and the lightning surge arrester on any of the electromechanical masts integrated with the ICCT shelter.
- 2.6.25.4 There shall also be a retractable detachable mast of at least 9 feet height, on which the weather sensor and the surge arrester can be mounted. There shall be a provision to mount this mast on the ICCT shelter.
- 2.6.25.5 The mast and surge arrester shall be provided from the same OEM as the weather sensor.

2.6.25.6 Sensor shall have adequate protection against damage caused by birds. If necessary, a bird spike kit shall be provided which prevents birds from landing, pecking or nesting on the weather sensor.

2.6.25.7 The following weather parameters shall be monitored

- (a) Wind speed in the range 0 to 210 kmph
- (b) Wind direction between 0 and 360°
- (c) Rainfall
- (d) Barometric pressure in the range 600 to 1,100 millibars
- (e) Temperature in the range -30 to +60°C
- (f) Relative humidity in the range 0 to 100 %

2.6.25.8 Measurement of solar radiation is preferable, and may be provided, if possible.

2.6.25.9 All outdoor hardware shall be IP-66 compliant as per IS/IEC 60529.

2.6.25.10 An OEM-supplied indoor weather server shall be provided to interface with the outdoor weather sensor and related hardware, and to provide weather data to the NMS, other computers or software applications.

2.6.25.11 The weather data shall be available in the following data formats or standards from the weather server

- (a) SNMP
- (b) File transfer protocol (FTP)
- (c) Extensible markup language (XML) web service
- (d) Web-browser interface
- (e) Serial port

2.6.25.12 A water-tight, air-tight, un-breakable protective case shall be provided for storing the weather sensor and accessories when they are not installed.

2.6.26 Lightning warning system

ICCT shall be equipped with one (01) lightning warning system that provides early warning about storm build-up around the deployment site as well as lightning warning throughout the life-cycle of a thunderstorm. The storm warning is expected to provide time to take preventive action such as retraction or securing of antennas, masts etc. It shall meet the following requirements.

2.6.26.1 The lightning warning system shall be a Class-A detector as per IEC 62793 (see [41]). It shall be capable of warning about storm build-up throughout the life-cycle of a thunderstorm.

2.6.26.2 The unit shall be able to effectively provide warning on storm build-up up to at least 20 km from the site of installation.

2.6.26.3 Preferably, the unit shall have an interface to connect to the NMS, preferably Ethernet interface with SNMP or an appropriate serial port.

2.6.26.4 The lightning warning unit shall be mounted externally, as per the recommendations

of the OEM.

2.6.27 Engineering & measurement instruments

The engineering and measurement instruments enumerated here are required to be provided with the ICCT.

2.6.27.1 OTDR

One (01) number of Optical time-domain reflectometer (OTDR) shall be provided meeting the following specifications.

Ref #	Parameter	Specification
2.6.27.1.1	Fiber compatibility	Single mode & multi-mode
2.6.27.1.2	Central wavelength	1,310 nm & 1,550 nm for single mode 850 nm & 1,300 nm for multi-mode
2.6.27.1.3	Wavelength tolerance	1,310 nm ± 25 nm 1,550 nm ± 30 nm 850 nm ± 10 nm 1,300 nm ± 15 nm
2.6.27.1.4	Dynamic range at maximum wavelength	≥ 32 dB at 1,310 nm ≥ 30 dB at 1,550 nm ≥ 28 dB at 850 nm ≥ 30 dB at 1,300 nm
2.6.27.1.5	Event dead zone, maximum	≤ 0.6 m at 1,310 nm ≤ 0.6 m at 1,550 nm ≤ 0.5 m at 850 nm ≤ 0.7 m at 1,300 nm
2.6.27.1.6	Attenuation dead zone, maximum	≤ 3.6 m at 1,310 nm ≤ 3.7 m at 1,550 nm ≤ 2.5 m at 850 nm ≤ 4.5 m at 1,300 nm
2.6.27.1.7	Distance measurement range	≥ 80 km at 1,310 nm ≥ 130 km at 1,550 nm ≥ 9 km at 850 nm ≥ 35 km at 1,300 nm
2.6.27.1.8	Sample resolution	3 cm to 400 cm
2.6.27.1.9	Maximum distance range setting	≥ 130 km for single mode ≥ 40 km for multi-mode

2.6.27.2 Optical fiber splicing kit

One (01) number of optical fiber splicing machine with accessories shall be provided meeting the following specification.

Ref #	Parameter	Specification
2.6.27.2.1	Type	Single fiber fusion splicer
2.6.27.2.2	Splicing method	Arc splicing
2.6.27.2.3	Splicing mode	Auto

Ref #	Parameter	Specification
2.6.27.2.4	Alignment mode	Core to core alignment: Profile alignment system - Profile alignment system (PAS)
2.6.27.2.5	Applicable filters	Single mode (SM) Multi-mode (MM) Dispersion shifted (DS) Non-zero dispersion shifted (NZDS)
2.6.27.2.6	Fiber count	One (01)
2.6.27.2.7	Type of display	Color LCD
2.6.27.2.8	Connectivity interfaces	USB, Bluetooth
2.6.27.2.9	Power source	Rechargeable battery
2.6.27.2.10	Accessories	Fiber cleaver, fiber stripper, diamond cutter, isopropyl alcohol spray canister (1 liter), fiber sleeves 60 mm (200 numbers) & carrying case etc

2.6.27.3 Optical power meter

One (01) number of optical power meter shall be provided meeting the following specification.

Ref #	Parameter	Specification
2.6.27.3.1	Wavelength measurement range	780 to 1,650 nm
2.6.27.3.2	Auto-wavelength recognition	Yes
2.6.27.3.3	Tone detection	270 Hz, 330 Hz, 1 kHz, 2 kHz
2.6.27.3.4	Display size	≥ 2.8 inch
2.6.27.3.5	Display & screen type	Color display, with capacitive touch-screen
2.6.27.3.6	Reporting	Transfer result to a computer via USB cable. Necessary dedicated software to be included.
2.6.27.3.7	Data logging/storage	At least 1,000 test results for local recall & viewing
2.6.27.3.8	Battery autonomy	≥ 8 hours of continuous use

2.6.27.4 Optical fiber visual fault locator

One (01) number of visual fault locator for optical fiber shall be provided meeting the following specification.

Ref #	Parameter	Specification
2.6.27.4.1	Fiber compatibility	SM & MM
2.6.27.4.2	Wavelength	650 nm (visible length)
2.6.27.4.3	Laser safety rating	Class IIIB
2.6.27.4.4	Output power	< 10 mW

Ref #	Parameter	Specification
2.6.27.4.5	Range	≥ 12 km for SM fiber

2.6.27.5 1 GE/10 GE Ethernet tester

One (01) number of 1 Gigabit Ethernet (GE)/10 GE Ethernet tester (LAN tester) shall be provided meeting the following specification.

Ref #	Parameter	Specification
2.6.27.5.1	Traffic generation support	1 GE & 10 GE
2.6.27.5.2	Support for terminate & loop-back modes	Yes
2.6.27.5.3	Alarm injection	1 GE & 10 GE
2.6.27.5.4	Network layer protocol support	Internet protocol version 4 (IPv4) & Internet protocol version 6 (IPv6) traffic generation
2.6.27.5.5	Transmission layer verification support	Layer 2, 3 & 4 BER test (BERT) with standard Pseudo-random binary sequence (PRBS) patterns
2.6.27.5.6	Ping & Traceroute support	Yes
2.6.27.5.7	Layer-4 Transmission control protocol (TCP) throughput test as per Request for comments (RFC) 6349 (see [42])	Yes

2.6.27.6 Fiber optic connector cleaning and inspection kit

one (01) fiber optic connector cleaning and inspection kit with 400 \times fiber inspection microscope shall be provided with the following specifications.

Ref #	Parameter	Specification
2.6.27.6.1	Fiber connector cleaners	1.25 mm, 2.5 mm & universal
2.6.27.6.2	Fiber connector tool	For LC and SC simplex and duplex connectors. Spring loaded arms.
2.6.27.6.3	Fiber inspection microscope	400 \times magnification, with achromatic lens compatible with 2.5 mm and 1.25 mm adaptors
2.6.27.6.4	Single-use fiber wipes	Residue-free isopropyl alcohol wipes, made of lint-free non-abrasive material for cleaning optical surfaces, bare fiber and connector ends. Each wipe at least 3" \times 3". Pack of 50 or more.

Ref #	Parameter	Specification
2.6.27.6.5	LED torch/flashlight	At least 120 lumen LED with zoom lens for spot focus or area illumination. Clip-on lanyard to secure the flashlight.
2.6.27.6.6	Carrying case	Rugged multi-pocket tool case

2.6.27.7 Hand-held laser based range finder

One (01) number of hand held laser based range finder instrument shall be provided to aid in distance estimation for various activities such as estimation of cable length requirements, erected height of mast etc. The following are the specifications for the range finder.

- 2.6.27.7.1 The measurement range of the instrument shall be 5 cm to 200 m.
- 2.6.27.7.2 Typical measurement accuracy shall be ± 1 mm.
- 2.6.27.7.3 It shall have an integrated viewfinder for viewing the laser point up to maximum range.
- 2.6.27.7.4 Provision for inclination measurement shall be present.
- 2.6.27.7.5 It shall have a back-lit display.
- 2.6.27.7.6 It shall be IP-54 compliant as per IS/IEC 60529.
- 2.6.27.7.7 It shall be powered using AA or AAA batteries.
- 2.6.27.7.8 It shall have 1/4" tripod threads for mounting on a tripod, if necessary.
- 2.6.27.7.9 Weight shall not exceed 0.25 kg.
- 2.6.27.7.10 Protective bag, carrying strap, compatible tripod and one set of batteries shall be provided.

2.6.27.8 Hand-held GNSS receiver

One (01) number of hand held GNSS receiver shall be provided with the following specifications.

- 2.6.27.8.1 Shall support Indian Regional Navigation Satellite System (IRNSS)/Navigation with Indian Constellation (NavIC), GPS & Global Navigation Satellite System (GLONASS) constellations
- 2.6.27.8.2 Shall have in-built electronic compass for North-finding.
- 2.6.27.8.3 Shall be pre-loaded with maps of India
- 2.6.27.8.4 Shall be powered by rechargeable battery/batteries

2.6.27.9 Hand-held inclinometer

One (01) number of hand held inclinometer shall be provided to measure tilt or bank angles of surfaces during operations.

2.6.27.10 Hand-held lensatic sighting compass

A hand-held lensatic sighting compass shall be provided as per the following specifications

- 2.6.27.10.1 $\pm 0.5^\circ$ of accuracy
- 2.6.27.10.2 Foldable cover with sighting window
- 2.6.27.10.3 Liquid filled dial
- 2.6.27.10.4 Built-in bubble level
- 2.6.27.10.5 Luminous dial that glows in the dark

2.6.27.11 Hand-held microwave analyzer

One (01) number of hand held microwave analyzer shall be provided for carrying out RF power measurements as well as to test RF cables, waveguides, antennas, feeds etc.

- 2.6.27.11.1 The microwave analyzer shall have spectrum analyzer, 2-port network analyzer and 1-port cable & antenna test modes of operation.
- 2.6.27.11.2 The frequency range shall be at least 9 kHz to 18 GHz
- 2.6.27.11.3 Necessary kit for mechanical calibration of the instrument shall be provided
- 2.6.27.11.4 Make Keysight® FieldFox®, or equivalent

2.6.27.12 Digital multimeter cum clamp-meter

One (01) number of digital multimeter cum clamp-meter shall be provided with the following features

- 2.6.27.12.1 Contact-less and lead-based voltage and current measurement
- 2.6.27.12.2 True RMS AC readout
- 2.6.27.12.3 AC & DC voltage measurement up to 1,000 V
- 2.6.27.12.4 AC & DC current measurement up to 10 A
- 2.6.27.12.5 Resistance measurement up to 50 M Ω
- 2.6.27.12.6 Frequency measurement up to 200 kHz
- 2.6.27.12.7 Capacitance measurement up to 10,000 μ F
- 2.6.27.12.8 Diode testing
- 2.6.27.12.9 Continuity testing with audible indication
- 2.6.27.12.10 Backlit LCD display
- 2.6.27.12.11 IP-65 compliant as per IS/IEC 60529

2.6.28 Occupational safety equipment

The following occupational safety equipment shall be provided with each ICCT.

2.6.28.1 Industrial helmets

Four (04) numbers of industrial helmets as per the following specifications shall be provided.

- 2.6.28.1.1 Compliant with IS 2925, EN-397 or ANSI/International Safety Equipment Association (ISEA) Z89.1 (see [43, 44, 45]).

2.6.28.1.2 Three (3) medium size & one (1) large size helmet shall be provided.

2.6.28.2 Safety gloves

Four (4) pairs of safety gloves as per the following specifications shall be provided.

2.6.28.2.1 Compliant with IS 13774 or IEC 60903 (see [46], [47]).

2.6.28.2.2 Two (2) pair of class 0, category H, 270 mm length

2.6.28.2.3 Two (2) pair of class 0, category H, 360 mm length

2.6.28.3 Eye protection

2.6.28.3.1 Two (2) numbers of safety glasses for eye protection shall be provided, compliant with ISO 16321-1 or ANSI/ISEA Z87.1, suitable for protection against flying particles and fragments in occupational environments such as metal-shop, carpentry and construction work (see [48], [49]).

2.6.28.3.2 Two (Two) numbers of laser safety glasses suitable for work with the class of laser present in the the optical fiber related test equipment and laser based range finder provided with ICCT. Such laser safety glasses shall comply with ANSI Z136.1 and ANSI Z136.2 (see [50] & [51]).

2.6.28.4 Ear protection equipment

As per paragraph 2.1.2.9, four (4) sets of ear protection equipment shall be provided if required, as per MIL-STD-1474. Such ear protection equipment, if provided, shall meet the following requirements.

2.6.28.4.1 The ear-protectors shall be in the form of ear muffs compliant with IS:9167 (see [52]).

2.6.28.4.2 The ear muffs shall have an extendable headband.

2.6.28.4.3 A compliance report with sound attenuation in dB at 125, 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz shall be provided.

2.6.28.4.4 The compliance report shall also contain the test tension of headband, overall mass (weight), temperature range, lower pressure severity, instructions for cleaning and instructions for use for the ear muffs.

2.6.28.4.5 Ear protectors compliant with EN 352-1 are also acceptable (see [53]).

2.6.28.5 Wearable head-lamp

2.6.28.5.1 Two (2) numbers of head lamps shall be provided

2.6.28.5.2 Shall be wearable with or without helmet

2.6.28.5.3 IP-65 as per IS/IEC 60529

2.6.28.6 Safety harness for ladder climbing

2.6.28.6.1 Two (2) numbers of full body safety harness shall be provided

2.6.28.6.2 Compliant with IS 3521 (see [54]), class L

2.6.28.6.3 Full body safety harness compliant with EN 361 shall also be acceptable (see [55])

2.6.29 Surge protection device with in-built grounding device

For effective grounding of power supply and signals in the ICCT, a digital earthing device, also known as surge protection device with in-built grounding, shall be provided.

2.6.29.1 The make of the device shall be Ground Co. Ltd®

2.6.29.2 The model shall be eca3G®, TM-series, TM-34-40.

2.6.30 Fiber optic cable drums

For connectivity to local nodes, four (4) fiber optic cable drums meeting the following specifications shall be provided.

Ref #	Parameter	Specification
2.6.30.1	Length	$\geq 1 \text{ km}$
2.6.30.2	Number of cores	4
2.6.30.3	Cable type	Each core & cable shall comply with ITU-T G.652 (see [56])
2.6.30.4	Attenuation	$\leq 0.36 \text{ dB/km}$, for wavelength 1310 nm $\leq 0.25 \text{ dB/km}$, for wavelength 1550 nm
2.6.30.5	Loose tube material	Stainless steel
2.6.30.6	Water ingress protection	Loose tube to be filled with a thixotropic gel to prevent water ingress
2.6.30.7	Armor	Stainless steel wire
2.6.30.8	Outer sheath	Appropriate UV stabilized thermoplastic material
2.6.30.9	Short term tensile strength	$\geq 3000 \text{ N}$
2.6.30.10	Long term tensile strength	$\geq 1600 \text{ N}$
2.6.30.11	Short term bending radius	$\leq 40 \text{ mm}$
2.6.30.12	Long term bending radius	$\leq 60 \text{ mm}$
2.6.30.13	Outer diameter	$\leq 4 \text{ mm}$
2.6.30.14	Weight	$\leq 30 \text{ kg/km}$
2.6.30.15	Breaking load	$\geq 3500 \text{ N}$
2.6.30.16	Crush resistance	$\geq 1000 \text{ N/cm}$
2.6.30.17	Impact resistance	$\geq 100 \text{ impacts, } 1 \text{ J/impact}$
2.6.30.18	Torsion range	$\pm 180^\circ$
2.6.30.19	Temperature range	-55°C to $+70^\circ\text{C}$ or wider
2.6.30.20	Connectors & plugs	Expanded Pro Beam "Junior" connectors
2.6.30.21	Mating connectors for both ends with fan-out of 4 LC connectors, 2 pairs	to be provided
2.6.30.22	Spooling & unspooling	Manually operated mechanism suitable for field use shall be provided

2.6.30.23 Two (2) smaller optical fiber drums with 200 m of optical fiber cable shall be provided with expanded Pro Beam "Junior" connectors at both ends. Mating con-

nectors for both ends with fan-out of 4 LC connectors, 4 pairs. Manually operated spooling & unspooling mechanism suitable for field use shall be provided.

2.6.30.24 Provision shall be made to mount all optical fiber drums externally on the ICCT shelter such that they can be spooled or unspooled from the mounting location without the need for unloading and carrying the drums.

2.6.31 Two-way satellite time and frequency transfer system

For GNSS independent time synchronization, the ICCT shall need one (01) Two-way satellite time and frequency transfer (TWSTFT) system. It has already been designed and developed to meet PGAD specifications. Related requirements are listed here.

2.6.31.1 The system shall be of make Accord Software & Systems Pvt Ltd, Bengaluru, model NGS-T20, Part No. 1400900

2.6.31.2 Tri-band AIV GNSS antenna make Thiagarajar Telekom Solutions Ltd, model TTSLIGGN17 or equivalent

2.6.31.3 30 m long low-loss RF cable of model LMR-400-DB or equivalent, for GNSS antenna

2.6.31.4 Antenna mounting stand of height 1 foot and other necessary accessories.

2.6.32 Multi-GNSS location sensing & compass system

One (01) multi-GNSS compass system shall be integrated in the ICCT to enable accurate determination of the coordinates and azimuth angle of placement of the shelter with respect to geographical north, even in the presence of external magnetic fields and magnetic materials. Related requirements are as follows.

Ref #	Parameter	Specification
2.6.32.1	GNSS constellations support	IRNSS, GPS, GLONASS
2.6.32.2	Heading accuracy	within $\pm 0.5^\circ$
2.6.32.3	Position accuracy	within ± 5 m
2.6.32.4	Cold start time	≤ 60 s
2.6.32.5	Communication	Ethernet 10/100 Mbit
2.6.32.6	Outdoor unit power supply	PoE or indoor unit generated DC over coaxial cable. Indoor unit shall provide DC over antenna port, if required.
2.6.32.7	Indoor unit power supply	AC mains
2.6.32.8	Output	NMEA 0183 compatible sentences (see [57]) placed in UDP datagrams. One sentence per packet.
2.6.32.9	Ingress protection	IP-67 as per IS/IEC 60529 for outdoor unit
2.6.32.10	Antennas	OEM supplied integrated two-antenna outdoor unit, with 50Ω input impedance

2.6.32.11 Provision shall be made to mount the location sensing & compass system on the roof of the shelter within $\pm 0.5^\circ$ of the length dimension of the shelter.

2.6.33 Transportation data logger

Two (2) transportation data logging systems shall be provided to record key data during in-site mobilization, lifting, loading, unloading, road-transportation, air-transportation etc. Necessary software for visualization and analysis of the recorded data shall also be supplied. These shall meet the following specifications.

Ref #	Parameter	Specification
2.6.33.1	Recording type	Curve recording triggered by user-programmed events and at periodic intervals
2.6.33.2	Measurements supported	3-axes acceleration & shock, inclination, temperature, air pressure, GNSS position, date, time
2.6.33.3	Acceleration & shock measurement range	at least ± 16 g, 3 axes
2.6.33.4	Acceleration & shock tolerance	within ± 0.35 g
2.6.33.5	Acceleration & shock sampling rate	$\geq 2,000$ Hz
2.6.33.6	Acceleration & shock recording duration	≥ 1 s
2.6.33.7	Acceleration recording threshold	≤ 0.5 g
2.6.33.8	Inclination tolerance	within $\pm 3^\circ$
2.6.33.9	Temperature measurement range	-40 to $+85^\circ\text{C}$
2.6.33.10	Temperature tolerance	within $\pm 0.5^\circ\text{C}$
2.6.33.11	Air pressure measurement range	260 - 1,260 mbar
2.6.33.12	Air pressure tolerance	within ± 2 mbar
2.6.33.13	Programmable parameters	Registration thresholds for shock, inclination, temperature & air pressure. Periodicity of GPS position, inclination, temperature & pressure recording. Data recording start & stop times
2.6.33.14	Data interface	USB 2.0
2.6.33.15	GNSS antenna interface	SMA (F) connector, 50Ω
2.6.33.16	GNSS antenna	Compatible active antenna to be integrated
2.6.33.17	Power supply	Commercial Lithium ion or alkaline batteries
2.6.33.18	In-use battery life	At least 1 year, with all options enabled
2.6.33.19	Internal memory	≥ 32 MB, non-volatile
2.6.33.20	Data retention	≥ 10 years, even after battery discharge
2.6.33.21	Time	User settable date-time. GNSS time to be used if antenna is connected.
2.6.33.22	Ingress protection	IP-67 as per IS/IEC 60529
2.6.33.23	Weight	≤ 1 kg including batteries

Ref #	Parameter	Specification
2.6.33.24	Data analysis & visualization software	OEM supplied license free software to be provided. Linux-based software is preferable. Windows® OS based software is acceptable
2.6.33.25	Firmware update	To be supported through USB

2.6.33.26 Necessary GPS antennas shall be provided, with provision to connect the antennas and mount them on shelter roof during mobilization and transportation operations.

2.6.33.27 Provision shall be made to install the transportation data loggers at various locations in ICCT. These locations may be finalized during the design review stage.

2.6.33.28 If the units use rechargeable batteries, provision shall be made to charge the batteries within the ICCT shelter.

2.6.34 Serial device server

One (1) serial device server meeting the following specifications shall be provided in the ICCT.

Ref #	Parameter	Specification
2.6.34.1	Supported serial interface standards	RS-232, RS-422 & RS-485
2.6.34.2	Number of serial ports	16
2.6.34.3	Serial port connectors	Eight-pin RJ45
2.6.34.4	Number of serial ports	16
2.6.34.5	Power supply	100-240 V AC, 50 Hz
2.6.34.6	Number of power supply inputs	2 inputs in dual-redundant configuration
2.6.34.7	Ethernet interface	10/100BaseT(X) ports
2.6.34.8	Ethernet port connectors	RJ45
2.6.34.9	Number of LAN cards	Dual LAN cards with independent MAC addresses & IP addresses
2.6.34.10	Host redundancy	Should support dual host redundancy.
2.6.34.11	Communication redundancy	Should support dual redundant Ethernet communication with the same host.
2.6.34.12	Remote configuration interfaces	Serial console (RS-232 with 8-pin RJ45) port, Telnet, Web interface
2.6.34.13	Human interface	LCD panel and keypad on front panel for configuration
2.6.34.14	Management interface	SNMP v1/v2c/v3
2.6.34.15	Driver availability	Linux kernel versions 2.6.x, 3.x, 4.x & 5.x Windows 7, Windows 8, Windows 8.1 & Windows 10
2.6.34.16	Baud rate	50 bps to 921.6 kbps
2.6.34.17	Mechanical installation	19" rack mountable

2.6.35 Earth ground measurement kit

One (01) set of earth ground measurement kit shall be provided with the following specifications and features.

Ref #	Parameter	Specification
2.6.35.1	Ground measurement types	Soil resistivity measurement, 3-pole fall of potential measurement, 4-pole fall of potential measurement, selective measurement, stake-less measurement & 2-pole measurement
2.6.35.2	Accessories	All necessary accessories such as stakes, clamps, probes etc shall be included in the kit

2.6.36 Portable two-way radio set

A portable two-way radio set consisting of three (3) transceivers shall be provided with the following features.

- 2.6.36.1 Kenwood TK-3501 or equivalent 16-channel, IP-54 rated, PMR446 license-free radio is required with belt clip and battery
- 2.6.36.2 Compatible behind the head or over the head Voice operated exchange (VOX) capable headset for hands-free operation
- 2.6.36.3 It shall be possible to use the transceivers either in speaker mode or in headset mode.
- 2.6.36.4 Suitable battery chargers shall be provided with suitable battery charging arrangement in the ICCT shelter.

2.6.37 Miscellaneous items for RF and networking

2.6.37.1 RF items

- 2.6.37.1.1 RF cables with the following specification as per quantities mentioned in the table below shall be provided:
Impedance of 50Ω , operating frequency range 0 - 3 GHz, minimum bending radius (repeated) $\leq 2"$, minimum bending radius (installation) $\leq 0.5"$, attenuation $\leq 20\text{dB}/100\text{ feet}$ at 3 GHz, continuous power $\geq 50\text{ W}$, VSWR $\leq 1.5\text{ dB}$, temperature range -20 to +85°C.
- 2.6.37.1.2 Adaptors with the following specification as per quantities mentioned in the table below shall be provided:
Impedance of 50Ω , operating frequency range 0 - 3 GHz, insertion loss $\leq 0.6\text{ dB}$ at 3 GHz, VSWR ≤ 1.5 at 3 GHz, temperature range -20 to +85°C.

Ref #	Item	Quantity
2.6.37.1.3	N(M) to N(M) RF cables, 2 m length	5
2.6.37.1.4	N(M) to N(M) RF cables, 5 m length	5
2.6.37.1.5	SMA(M) to SMA(M) RF cables, 2 m length	5

Ref #	Item	Quantity
2.6.37.1.6	SMA(M) to SMA(M) RF cables, 5 m length	5
2.6.37.1.7	N(M) to SMA(M) RF cables, 2 m length	5
2.6.37.1.8	N(M) to SMA(F) adaptors	5
2.6.37.1.9	N(F) to SMA(M) adaptors	5
2.6.37.1.10	SMA(F) to SMA(F) adaptors	5
2.6.37.1.11	N(F) to N(F) adaptors	5
2.6.37.1.12	1:4 SMA passive splitter/combiner	3
2.6.37.1.13	1:2 N-type passive splitter/combiner	3

2.6.37.2 Networking items

Ref #	Item	Quantity
2.6.37.2.1	Single mode patch cord, SC-LC, duplex, 5 m length	10
2.6.37.2.2	Single mode patch cord, SC-LC, duplex, 10 m length	10
2.6.37.2.3	Single mode patch cord, SC-LC, duplex, 20 m length	10
2.6.37.2.4	Single mode patch cord, LC-LC, duplex, 5 m length	10
2.6.37.2.5	Single mode patch cord, LC-LC, duplex, 10 m length	10
2.6.37.2.6	Single mode patch cord, LC-LC, duplex, 20 m length	10
2.6.37.2.7	Single mode patch cord, SC-SC, duplex, 5 m length	10
2.6.37.2.8	Single mode patch cord, SC-SC, duplex, 10 m length	10
2.6.37.2.9	Single mode patch cord, SC-SC, duplex, 20 m length	10
2.6.37.2.10	SC-LC couplers, duplex type, with metal body	10
2.6.37.2.11	LC-LC couplers, duplex type, with metal body	10
2.6.37.2.12	SC-SC couplers, duplex type, with metal body	10
2.6.37.2.13	Single core single mode media convertor, fiber to RJ-45 (Gigabit) with chassis and Gigabit SFP modules of LC type	10
2.6.37.2.14	RJ45 crimping tool for cat6a cable	2
2.6.37.2.15	RJ45 jacks for cat6a cable, packet of 100	2

2.6.38 Data-link sub-systems

Data-link related sub-systems, as per the following numbers and requirements, shall be supplied and integrated in the ICCT.

Ref #	Item	Qty	Make, model
2.6.38.1	Spread spectrum transmitter unit (SSTU)	4	BEL, Bengaluru - MIL-COM Strategic business unit (SBU), part No. 110005427387 (or) Accord Software and Systems Pvt Ltd, Bengaluru, part No. 1100920

Ref #	Item	Qty	Make, model
2.6.38.2	200 W Solid state power amplifier (SSPA)	4	BEL, Bengaluru - MIL-COM SBU, part No. 110005434856 (or) Accord Software and Systems Pvt Ltd, Bengaluru, part No. 1100930
2.6.38.3	Airborne receiver system (ARS)	2	BEL, Bengaluru - MIL-COM SBU, part No. 110005427484 (or) Accord Software and Systems Pvt Ltd, Bengaluru, part No. 1100950
2.6.38.4	6 GHz (Spectrum analyzer + 2-port network analyzer + cable tester + power meter)	1	Keysight® Fieldfox® N9915A
2.6.38.5	Dual channel, 0-32 V, rack-mounted DC power supply with at least 2 A of current per channel,	2	Rohde & Schwarz® (or) Keysight® (or) TDK Lambda®
2.6.38.6	20 m, high-power RF cable with 500 W power handling at 2 GHz, N(M) straight - N(M) right angle connectors	3	Times Microwave® LMR600-DB or equivalent
2.6.38.7	2 m, high-power RF cable with 500 W power handling at 2 GHz, N(M) straight - N(M) right angle connectors	6	Times Microwave® LMR400-DB or equivalent
2.6.38.8	High power ground antenna	3	Excel RF Technologies, Hyderabad, part No. ANH0700205050
2.6.38.9	20 m low power RF cable with 10 W power handling at 2 GHz, TNC(M) straight - TNC(M) right angle connectors	3	Times Microwave® LMR200-DB or equivalent
2.6.38.10	2 m low power RF cable with 10 W power handling at 2 GHz, TNC(M) straight - TNC(M) right angle connectors	6	Times Microwave® LMR200-DB or equivalent
2.6.38.11	DMC with RS-422, RS-485 or Ethernet interface. Ethernet interface is preferable.	2	Aeron® GLO DMC 300® or equivalent
2.6.38.12	Step variable attenuator, 0-100 dB, 10 dB step	3	Fairview Microwave®, SA37100SMA or equivalent
2.6.38.13	Step variable attenuator, 0-10 dB, 1 dB step	3	Fairview Microwave®, FMAT1025 or equivalent
2.6.38.14	USB MIL-STD-1553 single node, single function module, with one pair of cables	2	Ballard Technology®, part No. UA1120 & part No. 16065

Ref #	Item	Qty	Make, model
2.6.38.15	4-node MIL-STD-1553 bus coupler with one pair of terminations	2	Ballard Technology® (or) DDC® (or) Compu Power® or equivalent
2.6.38.16	2-port RF power combiner with RF cables. Maximum power handling capability = 1 W at 2 GHz & SMA(F) connectors	2	Mini Circuits® or equivalent

- 2.6.38.17 Preferably SSTU, SSPA and ARS systems shall be from the same OEM.
- 2.6.38.18 For SSTU, 200 W SSPA, ARS and high power ground antenna, acceptance testing as per approved Qualification test procedure (QTP)/Acceptance test procedure (ATP) document for the respective system shall be carried out at the contractor's expense in the presence of inspection authority's representative. Cleared acceptance test reports shall be submitted at the time of delivery.
- 2.6.38.19 Downlink receiver which is an indoor system and downlink active antennas which are outdoor units shall be integrated later. Necessary mechanical and electrical interfaces for these systems shall be incorporated in the ICCT systems.
- 2.6.38.20 Fabrication of necessary mounting interfaces for DMC, antennas etc shall be the contractor's responsibility.
- 2.6.38.21 Integration of above systems, including connectors and cables necessary for their integration, shall be the responsibility of the contractor.

2.7 Feasibility of static setup

- 2.7.1 Though the current RFP is about a truck mounted ICCT shelter, design feasibility of a static ICCT setup shall also be established as a part of the current work. The static setup feasibility shall be established in an available built-up structure with minimal equipment changes.
- 2.7.2 In the available built-up structure, a single room of approximate size 324 square feet shall be available to plan the operator area and equipment area. The height shall be 8-12 feet.
- 2.7.3 In the static ICCT room, there shall be an equipment area and an operator area separated by a transparent partition.
- 2.7.4 In such a static setup, the HVAC system (which is elaborated in paragraph 2.6.16) needs to be appropriately substituted by a set of air-conditioners and provision of room-heaters (if required, depending on climatic conditions at the site).
- 2.7.5 A set of two or three air-conditioners shall be planned for the equipment area. Similarly, another set of two or three air-conditioners shall be planned for the operator area.
- 2.7.6 If two air-conditioners each are planned for the equipment and operator areas, each shall be of adequate capacity to continuously cool the mass and volume of the equipment/operator area, with all sub-systems powered on and functional, to +22 °C within an external ambient temperature range of -20 to +55°C and with RH of

up to 98 %. If three air conditioners are planned, any two of them together shall have the same cooling capacity. Necessary heat-load related calculations, considering the occupants of the shelter and heat generated by equipment need to be carried out before deciding the number and cooling capacity of the units.

- 2.7.7 The mobile C-band and Ku-band VSAT antennas (which are elaborated respectively in paragraphs 2.6.12.1 and 2.6.12.2) are to be appropriately substituted by static antennas either mounted at the same location or at a stand-off distance. The static antennas shall have motorized drive for azimuth and elevation movement.
- 2.7.8 Should stand-off installation of antennas be required, the site of installation of the VSAT antennas shall be such that appropriately routed fiber optic cable of length not exceeding 1,000 meters can be used to connect the antenna installation site to the static ICCT building.
- 2.7.9 The two antenna masts (which are elaborated in paragraph 2.6.14), together with antenna positioning units (which are elaborated in 2.6.15) and their payload, shall be co-located with the VSAT antennas.
- 2.7.10 At the antenna installation site, a one-room built-up structure, referred as the antenna room, shall be available for housing the necessary indoor equipment.
- 2.7.11 The antenna room shall have an available area of approximately 162 square feet to plan the installation of necessary equipment. The height shall be 8-12 feet.
- 2.7.12 A set of two or three air-conditioners shall be planned for the antenna room.
- 2.7.13 If two air-conditioners are planned for the antenna room, each shall be of adequate capacity to continuously cool the mass and volume of the antenna room, with all sub-systems powered on and functional, to +22 °C within an external ambient temperature range of -20 to + 55°C and with RH of up to 98 %. If three air-conditioners are planned, any two of them together shall have the same cooling capacity. Necessary heat-load related calculations, considering the occupants of the shelter and heat generated by equipment need to be carried out before deciding the number and cooling capacity of the units.
- 2.7.14 One node switch, (elaborated in paragraph 2.6.6.3) shall be planned in the antenna room for connecting all outdoor equipment or payloads requiring network connectivity to the static ICCT building.
- 2.7.15 The connectivity between the LNBs/BUCs at the antenna installation site and the modems in the static ICCT building, shall be over an appropriate bi-directional RF-over-fiber system.
- 2.7.16 The antenna room and antenna installation site shall contain all necessary hardware for the masts, antenna positioning units, their payloads, and the VSAT antennas.
- 2.7.17 One 42 RU 19-inch rack shall be provided in the antenna room for mounting any rack-mountable equipment.
- 2.7.18 Two (02) 19-inch rack mountable 10 kVA pure-sinusoidal output UPS systems in 1:1 load-sharing redundancy configuration shall be planned in the antenna room, together with necessary batteries for at least 15-minutes of backup time at full 10 kVA load. The power budget shall be worked out and included in the Preliminary design review (PDR) document.
- 2.7.19 If stand-off antenna installation is not required, all antennas may be co-located

at the static ICCT building, and all indoor hardware shall be installed in the ICCT room. In this case, the antenna room and associated hardware such as antenna room air-conditioners, RF-over-fiber system etc shall not be required.

- 2.7.20 The additional equipment required for making the static setup as described in this section, shall be considered as optional items. Pricing for static ICCT setup related items with and without stand-off installation of antennas shall be included.
- 2.7.21 The optional items considered shall include four/six split air-conditioner units for the static ICCT building, two/three split air-conditioner units for the antenna room, three room heaters, static C-band VSAT antenna, static Ku-band VSAT antenna, node switch, RF-over-fiber system, 10 kVA 1:1 load-sharing UPS system and any other additional items that may be necessary to achieve the objectives highlighted in this section.
- 2.7.22 The optional items considered shall include four/six split air-conditioner units for the static ICCT building, two/three split air-conditioner units for the antenna room, three room heaters, static C-band VSAT antenna, static Ku-band VSAT antenna, node switch, RF-over-fiber system, 10 kVA 1:1 load-sharing UPS system and any other additional items that may be necessary to achieve the objectives highlighted in this section.

Chapter 3

Scope of work, terms and conditions

In this chapter, details of work and supply in the contractor's scope as well as associated terms and conditions are summarized.

3.1 Quantity requirement

- 3.1.1 The present scope of work and supply is for six (6) / eight (8) fully equipped ICCT systems with three (3) transporter truck platforms.
- 3.1.2 Apportionment of quantity shall be applicable with quantity of ICCTs apportioned in the ratio as per the table below as described in paragraph titled "Apportionment of quantity" in part-III (special terms and conditions) of this RFP.

Quantities of supply		Apportionment ratio (L1 : non-L1)	
ICCTs	Transporter trucks	ICCTs	Transporter trucks
6	3	4:2	2:1
8	3	5:3	2:1

- 3.1.3 In case of apportionment among two industry partners, the L1 industry partner shall be expected to supply both the Local NMS (LNMS) and Central NMS (CNMS) software while the other industry partner shall be expected to supply only the LNMS software.
- 3.1.4 In case the entire required quantity is awarded to the L1 industry partner, both the LNMS and CNMS software shall be supplied by the L1 industry partner.

3.2 Delivery schedule

- 3.2.1 All items and services deliverable within the scope of the contract shall be delivered within eighteen (18) months from the date of formalization of contract or placement of supply order.
- 3.2.2 In case of apportionment of quantity among two industry partners, the L1 industry partner shall be expected to carry out all supplies within the maximum number of lots as follows.

6 ICCTs + 3 transporter trucks		8 ICCTs + 3 transporter trucks	
Lot	Deliverable items	Lot	Deliverable items
1	One (1) ICCT including all subsystems which need QT, along with one (1) transporter truck & NMS software	1	ICCT including all subsystems which need QT, along with one (1) transporter truck & NMS software
2	One (1) ICCT along with one (1) transporter truck	2	One (1) ICCT along with one (1) transporter truck
3	One (1) ICCT	3	One (1) ICCT
4	One (1) ICCT	4	One (1) ICCT
-	-	5	One (1) ICCT

3.2.3 In case of apportionment of quantity among two industry partners, the non-L1 industry partner shall be expected to carry out all supplies within the maximum number of lots as follows.

6 ICCTs + 3 transporter trucks		8 ICCTs + 3 transporter trucks	
Lot	Deliverable items	Lot	Deliverable items
1	One (1) ICCT including all subsystems which need QT, along with one (1) transporter truck & NMS software	1	ICCT including all subsystems which need QT, along with one (1) transporter truck & NMS software
2	One (1) ICCT	2	One (1) ICCT
-	-	3	One (1) ICCT

3.2.4 In case entire required quantity is awarded to the L1 industry partner, the industry partner shall be expected to carry out all supplies within the maximum number of lots as follows.

6 ICCTs + 3 transporter trucks		8 ICCTs + 3 transporter trucks	
Lot	Deliverable items	Lot	Deliverable items
1	One (1) ICCT including all subsystems which need QT, along with one (1) transporter truck & NMS software	1	ICCT including all subsystems which need QT, along with one (1) transporter truck & NMS software
2	One (1) ICCT along with one (1) transporter truck	2	One (1) ICCT along with one (1) transporter truck
3	One (1) ICCT along with one (1) transporter truck	3	One (1) ICCT along with one (1) transporter truck
4	One (1) ICCT	4	One (1) ICCT
5	One (1) ICCT	5	One (1) ICCT
6	One (1) ICCT	6	One (1) ICCT
-	-	7	One (1) ICCT
-	-	8	One (1) ICCT

3.3 Safe storage of systems prior to dispatch & delivery

- 3.3.1 If required, PGAD shall ask that ICCT systems be safely stored at industry partner's premises for a period not exceeding six (6) months after completion of Factory acceptance testing (FAT) but prior to dispatch, delivery, Site acceptance testing (SAT), installation & commissioning.
- 3.3.2 The safe storage period shall be reckoned in months with a month being considered as a period of 30-days. A remainder period shorter than 15-days at the end of reckoning shall be neglected. A remainder period of 15 to 29 days at the end of reckoning shall be counted as a month.
- 3.3.3 The industry partner shall include the safe storage charges as flat rates in the commercial bid on a per-ICCT per-month & per-truck per-month basis.
- 3.3.4 L-1 computation shall be carried out including safe storage charges as applicable for six (6) months of storage for all 6/8 ICCTs and 3 transporter truck platforms.
- 3.3.5 Safe storage charges shall be paid on an actual basis.
- 3.3.6 During safe storage period, the industry partner shall take full responsibility for any damages to the stored systems and for rectification of the same at their own expense.
- 3.3.7 In case of systems which are stored by the industry partner at PGAD request, a pre-dispatch inspection of the systems shall be carried out prior to their dispatch for delivery. The test procedure for the same shall be included in the test-procedures document and shall be reviewed during PDR.
- 3.3.8 After successful completion of pre-dispatch inspection, the items shall be dispatched within fifteen (15) days.
- 3.3.9 Warranty commitments of the industry partner shall commence on successful completion of SAT, installation & commissioning and final acceptance of the system by PGAD.

3.4 Payment schedule

- 3.4.1 90 % of a lot's price shall be paid after completion of FAT.
- 3.4.2 Balance 10 % of a lots price, with safe storage charges (if any) shall be paid after completion of SAT, installation and commissioning.

3.5 Scope of work

The following work and supply actions shall be in the contractor's scope.

- 3.5.1 Within seven (07) days of placement of order or formalization of contract, to prepare and forward a role identification document identifying individuals who shall be responsible for various activities to be carried out under the order or contract. Among other roles, this document shall identify a project manager who shall be responsible for the overall progress and completion of work under the order or

contract, a hardware design manager who shall be responsible for proposing and finalizing the hardware design details, selection of sub-systems etc, a hardware QC manager who shall be responsible for all hardware quality related aspects of realization of the ICCT systems and a software development manager who shall be responsible for all activities required for the development and testing of NMS software. The role identification document shall include the contact details of all identified managers or individuals.

- 3.5.2 During the execution of the contract, if any of the responsible individuals identified in the role identification document need to be replaced for any reason whatsoever, the same shall be communicated in writing within a week of such replacement.
- 3.5.3 To thoroughly study the final scope of work, scope of supply and related documents, to discuss with PGAD wherever necessary, and to capture all relevant requirements in the form of a requirements document. The requirements document shall be approved by the contractor's project manager.
- 3.5.4 To capture all relevant NMS requirements and to prepare a Software requirement specification (SRS) document, signed by the designated software development manager and project manager.
- 3.5.5 To prepare a configuration document, showing the proposed make and part numbers of various subsystems, subsystems which are proposed to be custom-developed, the broad equipment layout, top-level road & air transportation plan etc. This document shall be approved by the designated design manager and project manager.
- 3.5.6 To forward the requirements document, SRS document and configuration document for review and approval to PGAD.
- 3.5.7 To participate in configuration review meetings, present the proposed configuration, and to seek approval thereof.
- 3.5.8 To prepare and forward a preliminary design document (or PDR document) with necessary details about the proposed engineering approach, fabrication or integration plan, quality assurance plan of each part or sub-system, quality assurance plan for the overall system etc. The proposed mechanical, electrical, communication and software design aspects shall be adequately described. This document shall be approved by the designated design manager, hardware QC manager and project manager and forwarded for review and approval to PGAD.
- 3.5.9 To include in the preliminary design document, details of necessary equipment and the engineering approach to make a static ICCT setup as described in section 2.7. To establish the feasibility of making a static setup and the equipment and work required for that purpose.
- 3.5.10 To prepare and forward, along with the preliminary design document, a QA plan document (see para 4.1), a test procedures document (see para 4.3), a maintenance plan document (see para 3.7.1.10), an installation & commissioning document and a SAT document for review and approval. These documents shall be approved by the designated design manager, hardware QC manager and project manager and forwarded for review and approval to PGAD.
- 3.5.11 To participate in preliminary design review meetings, present the proposed design and other details, and to seek approval thereof.
- 3.5.12 To take action on recommendations made during preliminary design review meet-

ings, to appropriately modify the submitted documents and to re-submit for approval. To ensure that all necessary actions, corrections or modifications are complete and to obtain approval.

- 3.5.13 To carry out a detailed design on the lines of the approved preliminary design. To carry out necessary analyses such as thermal analysis under various scenarios, structural analysis under various static and dynamical structural loads or scenarios, vibration analysis, shielding effectiveness analysis etc.
- 3.5.14 To prepare and forward a detailed design document with exhaustive details of the design and analysis results. This document shall be approved by the designated design manager, hardware QC manager and project manager and forwarded for review and approval to PGAD.
- 3.5.15 To participate in detailed design review meetings, present the detailed design, and to seek approval thereof.
- 3.5.16 To take action on recommendations made during detailed design review meetings, to appropriately modify the detailed design document and other documents, and to re-submit for approval. To ensure that all necessary actions, corrections or modifications are complete and to obtain approval.
- 3.5.17 To prepare and forward an Interface requirement specification (IRS) document, a Software design document (SDD), a Software test plan (STP) and a Software test document (STD) for the NMS software. These documents shall be approved by the designated software development manager and project manager and forwarded for review and approval to PGAD.
- 3.5.18 To participate in software design review meetings for NMS, present the IRS, SDD, STP and STD. To seek approval thereof.
- 3.5.19 To take action on recommendations made during software design review meetings, to appropriately modify the software design document and to re-submit for approval. To ensure that all necessary actions, corrections or modifications are complete and to obtain approval.
- 3.5.20 To fabricate and integrate ICCTs as per the approved detailed design and quality assurance plan.
- 3.5.21 To offer the ICCTs for qualification and acceptance testing as per the approved test procedure document. To participate in qualification and acceptance testing of the ICCTs as per the test procedure document.
- 3.5.22 In case of any failures during testing, to constructively participate in any failure analysis proceedings called by PGAD (see para 3.7.3).
- 3.5.23 To prepare and forward qualification and acceptance test reports duly approved by the designated QC manager and to seek PGAD approval.
- 3.5.24 To develop NMS software as per the approved SRS, IRS and SDD. To offer for testing as per the approved STP and STD.
- 3.5.25 To participate in software testing as per approved STP and STD. To prepare Software test report (STR) and forward for approval.
- 3.5.26 To prepare a multimedia based Computer based training (CBT) covering installation, operation and maintenance of ICCT and to finalize the same as per review and suggestions from PGAD

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- 3.5.27 To deliver the ICCTs, transporter trucks, all necessary hardware as per contract or supply order, all necessary software, CBT module and documents as per necessary formats which shall be provided by PGAD. The delivery shall be carried out either at sites in and around National Capital Region (NCR) within a radius of 300 km or within Hyderabad. The list of sites shall be communicated to the successful bidder(s) by PGAD.
 - 3.5.28 To carry out installation and commissioning of the delivered ICCTs as per the approved installation & commissioning document. Adequately prepared site for ICCT installation, with hard-stand, power supply, earthing pit(s), leased-line connectivity etc shall be provided by PGAD. Any expense for hiring of crane for unloading ICCT or related hardware at site shall be borne by the industry partner.
 - 3.5.29 To offer the installed and commissioned ICCTs for SAT as per the approved SAT document at the respective installation sites. To participate in SAT.
 - 3.5.30 To address any observations made during SAT and ensure satisfactory completion of SAT.
 - 3.5.31 To prepare and forward SAT reports duly approved by the designated QC manager and to seek PGAD approval.

3.6 Terms & conditions for submission of bids

3.6.1 Authorization for signatory in bid document

All bid documents shall be signed by an authorized signatory under the bidder's common seal. The following proof of authorization in favor of the signatory shall be submitted.

- 3.6.1.1 Power of attorney executed on non-judicial stamp paper of requisite value duly notarized, in favor of the individual signing the documents on behalf of the bidder. This shall be submitted in original.
- 3.6.1.2 True copy of resolution of board of Directors, extract of charter documents, power of attorney or similar set of documents of the bidder unambiguously establishing delegation of power in favor of the individual executing the power of attorney in paragraph 3.6.1.1. True copies and extracts of these documents shall be attested by a notary public.

3.6.2 Inclusion of proposed subsystem details in bid

The bidder shall include in the technical bid, proposed makes and model numbers of Commercial off-the-shelf (COTS) subsystems and proposed manufacturers of custom-made subsystems. These details shall be tentative and shall only be used to evaluate and compare the technical bids. Responsibility for meeting all requirements shall rest with the successful industry partner and mere declaration of a bid as technically compliant based on information and data supplied during bidding shall not be interpreted as the proposed subsystems or manufacturers being acceptable for ICCT design or realization. After contract formalization the vendor shall present ICCT design using the proposed subsystems in the design review meeting. The decision of the design review committee shall be final and binding in respect of selection of subsystems.

3.6.3 Manufacturer's Authorization Form

The bidder shall submit Manufacturer's authorization form (MAF) for all sub-systems proposed to be procured from third-parties or OEMs along with the techno-commercial bid.

3.6.4 Details of outsourced work

The bidder shall include details of work which is proposed to be outsourced to third-parties in the techno-commercial bid. Details of the third parties such as name, address etc to whom the said work is proposed to be outsourced shall also be included.

3.6.5 Optional items

- 3.6.5.1 Bidder shall quote the cost of optional items required for static ICCT setup described in section 2.7 in the commercial bid.
- 3.6.5.2 Bidder shall include the cost of post-warranty Annual maintenance contract (AMC) as described in paragraph 3.7.1.12 as an optional item.
- 3.6.5.3 Bidder may also include the cost of any other optional items offered in the commercial bid.
- 3.6.5.4 The cost of optional items shall be for information only, and shall not be considered for commercial comparison of bids.

3.6.6 Statement of compliance

Bidder shall indicate compliance or non-compliance with each and every enumerated paragraph and point in the technical specifications, requirements and scope of work document. The same shall be provided in tabular form as a statement of compliance in the technical bid. If compliance to any requirement or specification is partial, the same shall be mentioned and adequately elaborated in the technical bid. If compliance or non-compliance to any requirement or specification is conditional, then such conditions shall be clearly specified in the technical bid.

3.6.7 Technical evaluation of bids

The techno-commercial bid submitted by the bidder shall be evaluated by a committee formed for the purpose. The bidder shall promptly respond to queries from the committee and provide information sought. The committee may, if deemed necessary, visit the bidder's premises and/or seek the demonstration of relevant capabilities. The Programme reserves the right to reject bids of those bidders who fail to provide information or demonstration sought by the committee.

3.6.8 Submission of un-priced bid

An unpriced bid, which is identical to the commercial bid submitted by the bidder but without showing any of the costs therein, shall be submitted as a part of the technical bid.

3.6.9 Indication of cost break-up

Bidders shall indicate the cost break-up as applicable in the commercial bid. The break-up cost shall include at least the following details as per the following indicative format. The price bid format provided at part-VII of the RFP shall be used for preparation of commercial bid. Separate pricing details shall be provided clearly for 6 ICCTs and 8 ICCTs.

S.No.	Item	UoM	Unit cost (Rs)	Qty	Item cost (Rs)	Remarks (if any)
1	BoM item 1	No.	u_1	N_1	$c_1 = u_1 \times N_1$	
2	BoM item 2	Sets	u_2	N_2	$c_2 = u_2 \times N_2$	
⋮	⋮	⋮	⋮	⋮	⋮	
BoM cost per ICCT						$C_{BoM} = c_1 + c_2 + c_3 + \dots$
Hardware cost for 6 (or 8) ICCTs						$C_{ICCTs} = 6 \text{ (or 8)} \times C_{BoM}$
⋮	Transporter truck	Sets	t	3	$C_{Truck} = 3 \times t$	
⋮	LNMS software				C_{LNMS}	
⋮	CNMS software				C_{CNMS}	
⋮	Documentation				C_{Doc}	
⋮	Qualification testing				C_{QT}	
⋮	Acceptance testing				C_{AT}	
⋮	Freight & transportation				C_{Tpt}	
⋮	Hardware integration & manpower				C_{Int}	
⋮	Installation & commissioning				C_{Inst}	
⋮	Training				C_{Train}	
⋮	Warranty & support				C_{Warr}	
⋮	6 months of safe storage for ICCTs				$C_{Store-ICCT}$	
⋮	6 months of safe storage for trucks				$C_{Store-Truck}$	
⋮	Development cost & other NRE				C_{Dev}	
⋮	Any other costs				C_{Others}	
Total cost exclusive of taxes						$C = C_{ICCTs} + C_{Truck} + C_{LNMS} + C_{CNMS} + C_{Doc} + C_{QT} + C_{AT} + C_{Tpt} + C_{Int} + C_{Inst} + C_{Train} + C_{Warr} + C_{Store-ICCT} + C_{Store-Truck} + C_{Dev} + C_{Others} + \dots$

S.No.	Item	UoM	Unit cost (Rs)	Qty	Item cost (Rs)	Remarks (if any)
	GST, other taxes, levies & duties				T	
	Total cost, including of all taxes				C + T	
:	Optional item 1	
:	Optional item 2	
:	

3.7 Terms and conditions for work under the contract

3.7.1 Warranty & maintenance

- 3.7.1.1 For ICCT and all its subsystems, a warranty of thirty-six (36) months shall be provided against manufacturing defects, defective workmanship and defective materials.
- 3.7.1.2 The warranty period shall commence from the date of delivery and acceptance of the ICCT at PGAD.
- 3.7.1.3 The date of commencement of warranty and the period of warranty, together with the identification of items covered by the warranty shall be documented as a warranty certificate. It shall be signed by the contractor's project manager and forwarded to PGAD.
- 3.7.1.4 Unless it is mutually agreed otherwise, warranty of all subsystems shall be provided by the respective OEM.
- 3.7.1.5 For core switch, edge router and node switch, Next business day (NBD) warranty shall be provided from the OEM.
- 3.7.1.6 For shelter, lifting & leveling system, UPS, VESDA, monitoring cameras, antenna masts, NBC filtration system, UPS, HVAC, C-band VSAT antenna, Ku-band VSAT antenna and computer workstations, comprehensive on-site warranty shall be provided from the OEM. For such systems, the OEM or the contractor shall be responsible for shipping of defective equipment from the deployment site to the OEM workshop or service facility as well as shipping of the repaired or replacement equipment back to the deployment site.
- 3.7.1.7 For systems or instruments that require periodic calibration, warranty shall include periodic calibration service at OEM recommended periodicity.
- 3.7.1.8 For systems without on-site warranty, contractor shall be responsible for collection of the defective item from the site of deployment, shipping it to the workshop or service facility, collection of repaired or replacement item from workshop or service facility, fitment of the repaired or replacement item at the site of deployment, and verification of ICCT functionality after the fitment.
- 3.7.1.9 During the warranty period, the contractor shall also be responsible for routine maintenance of ICCT and its subsystems as per OEM recommendations, apart from break-down maintenance.

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- 3.7.1.10 The contractor shall prepare a maintenance plan document with details of warranty service for each subsystem, periodic and preventive maintenance tasks for each subsystem and formats of maintenance checklists, maintenance reports etc. Draft maintenance plan document shall be submitted along with the preliminary design document and shall be reviewed and approved by the design review committee.
 - 3.7.1.11 During the warranty period, the contractor shall present an annual report with details of warranty repairs undertaken, maintenance actions undertaken, problem areas etc. The report shall be presented before the progress review committee (see para 3.7.2).
 - 3.7.1.12 Bidders submitting bids shall also include the indicative cost of post-warranty comprehensive AMC of thirty-six (36) months from the date of completion of warranty period as an optional item. This indicative cost shall serve as a reference for future work and shall not be considered for determination of L-1 bidder.

3.7.2 Progress review committee

- 3.7.2.1 PGAD shall constitute a Progress review committee (PRC) to review the progress of work carried out under the contract. Unless otherwise notified, PRC meetings shall be held at PGAD premises.
- 3.7.2.2 From the commencement of contract to the end of warranty period, the contractor shall constructively participate in PRC meetings whenever they are called for.

3.7.3 Failure analysis

- 3.7.3.1 In case any failures are encountered during the testing process, the contractor shall participate in any Failure analysis board (FAB) proceedings called by PGAD. Unless otherwise notified, FAB meetings shall be held at PGAD premises.
- 3.7.3.2 During FAB meetings, the contractor shall effectively present details of failure encountered, analysis carried out, inferences drawn, corrective action proposed etc.
- 3.7.3.3 PGAD may also refer any failures during warranty & maintenance phase to FAB, in order to obtain corrective recommendations.
- 3.7.3.4 Decisions and recommendations of FAB shall be binding on PGAD and the contractor.

3.7.4 Design ownership

- 3.7.4.1 The design of the complete ICCT including electrical design, mechanical design, and software design shall be owned by PGAD.
- 3.7.4.2 The contractor is required to provide design files in source format to PGAD, including mechanical drawings (2-D & 3-D), electrical drawings, schematic drawings, bill of materials, assembly instructions, software source code and executable code.
- 3.7.4.3 Final or approved versions of all documents prepared during the execution of the contract shall also be provided to PGAD in source format.
- 3.7.4.4 All documents, drawings etc provided by subsystem OEMs shall be provided to PGAD unaltered.

3.7.4.5 The contractor shall not include any of their own distinguishing marks, such as name, logo etc, on any of the documents or drawings submitted under this contract, without written consent for the same from PGAD.

3.7.5 Formats and templates of documents

PGAD shall provide the templates and formats for documents and drawings expected to be prepared and submitted under the contract. The contractor shall prepare documents and drawings as per relevant templates or formats provided.

3.7.6 Confidentiality

- 3.7.6.1 The contractor shall treat the data and information provided in the scope of work, contents of design review proceedings, minutes of meetings/discussions, and any other data or information that may be supplied from time to time for the purpose of executing the work specified in this document, or is related to such execution of work, as confidential. The vendor shall also treat all designs, algorithms, concepts, methods, techniques, programs, patterns, formulas, technology, processes, procedures, specifications, data, inventions, discoveries, ideas, documents, manuals and know-how that the vendor might prepare, acquire, develop or apply towards the design, development, fabrication, testing, and maintenance of the system as confidential.
- 3.7.6.2 The contractor shall ensure that appropriate and adequate operational procedures are established and adequate security measures are taken to prevent inadvertent release or disclosure of such confidential data or information to unauthorized third-parties.
- 3.7.6.3 The contractor shall not, without express permission from PGAD, disclose, release, or display such confidential information to any person(s) other than contractors/suppliers or prospective contractors/suppliers who require such confidential information to submit offers/ proposals or to execute contracts/ orders for the vendor as part of the design, development, fabrication or maintenance of the system. The contractor shall require their contractors/suppliers or prospective contractors/suppliers to sign a confidentiality agreement consistent with the confidentiality requirements in this scope of work and supply, prior to disclosing, releasing or displaying such data or information. The contractor shall promptly communicate the details of any such agreements entered into, to the Director, Contracts and Material Management (DCMM), PGAD, Kanchanbagh, Hyderabad - 500058.
- 3.7.6.4 If the contractor, the contractor's contractor/ supplier or the contractor's prospective contractor/ supplier is a public authority as per the provisions of Right to Information (RTI) Act 2005, and are therefore bound by the provisions and contents of the RTI Act, such public authority shall treat all such data or information as confidential information relating to or supplied by a third party. PGAD, Kanchanbagh, Hyderabad - 500058, shall be considered as the third party owner of the information. Relevant provisions of the RTI Act relating to the disclosure of such third party information shall invariably be followed when dealing with RTI requests made for such information.

3.7.7 Tasks that shall not be outsourced

- 3.7.7.1 Because of the very important role of NMS software in the ICCT, the development of NMS software shall not be sub-contracted or outsourced. The industry partner shall carry out NMS design, implementation and testing fully in-house using internal capability and manpower only.
- 3.7.7.2 Because of the central role of integration activities, electrical and mechanical integration of all key electrical and electronic systems such as UPS, VSAT systems, network equipment, computer workstations, displays, consoles, LOS link, antenna positioning units, bulk encryption units, NTP clock displays, hygro-thermometer units, Ethernet weather station, lightning warning system, TWSTFT system, multi-GNSS location sensing & compass system, transportation data logger, serial device server, portable two-way radio set, data link subsystems etc shall be carried out by the industry partner in-house using internal capability and manpower only.

3.7.8 Identification of authority

- 3.7.8.1 Programme Director ‘AD’ shall be the acceptance authority.
- 3.7.8.2 Reliability and Quality Assurance (R&QA), PGAD or Strategic Systems Quality Assurance Group (SSQAG) or an agency nominated by Programme Director ‘AD’ shall be the inspection authority.
- 3.7.8.3 DCMM, PGAD shall be the contract manager for PGAD.

Chapter 4

Quality assurance and testing requirements

In this chapter, the QA and testing related requirements are outlined. These aspects necessarily revolve around two key documents, namely the QA plan document and the test procedures document. For each subsystem of the ICCT, there shall be a QC plan which shall be an appendix to the QA plan document.

4.1 QA plan document for ICCT

- 4.1.1 The contractor shall prepare a detailed quality assurance plan document for the entire ICCT along with the preliminary design document.
- 4.1.2 The proposed QA plan once reviewed and approved by PGAD, shall be the basis of QA activities during the realization of the ICCT.
- 4.1.3 The proposed QA plan document shall include an overview of all the steps involved in realizing the ICCT, including procurement of various raw materials, procurement of finished sub-systems, processes involved in fabrication, realization of electrical or mechanical sub-assemblies, integration of various sub-assemblies and subsystems etc.
- 4.1.4 At each of the steps involved, there shall be a formal inspection with an inspection report.
- 4.1.5 The proposed QA plan document shall summarize the involvement of contractors quality department and PGAD representatives during every inspection step.

4.2 Quality control plans for subsystems

- 4.2.1 Some of the subsystems may be manufactured by the respective manufacturers specifically to the specifications required for ICCT. In the case of such custom-made subsystems, the respective manufacturer shall prepare and forward a detailed QC plan identifying the various processes and steps that constitute manufacturing of that subsystem and the proposed QC approach at each of them.
- 4.2.2 One such QC plan for each relevant subsystem shall be included as an annexure to the QA plan document when submitting the same for review and approval.

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- 4.2.3 The QC plan shall also assign various QC roles and responsibilities within the manufacturing organization and include related details.
 - 4.2.4 During critical inspection steps, for the sake of quality assurance, contractor's representatives and/or PGAD representatives shall be required to be present.
 - 4.2.5 The QC plan shall also contain the formats of all QC reports to be prepared at various stages of the manufacturing.
 - 4.2.6 In the case of subsystems which are available off the shelf from their manufacturers and are made without any customization of any process or parameter, the respective manufacturer shall provide a detailed Certificate of compliance (CoC). In the case of such subsystems, the process to be followed by the contractor for acceptance at their end shall constitute the QC plan.

4.3 Test procedures document

- 4.3.1 The contractor shall prepare a test procedures document for entire ICCT and its subsystems after approval of the QA plan document.
- 4.3.2 The proposed test procedures document, once reviewed and approved by PGAD, shall be the basis of testing activities during QT, Acceptance testing (AT), FAT, SAT and pre-dispatch inspection.
- 4.3.3 The document shall include the detailed test procedures proposed to be followed during various testing phases.
- 4.3.4 For each test proposed to be carried out, the test setup diagram, sequence of steps constituting the test procedure, test report formats to be filled, parameters to be noted in the test reports and pass-fail criteria shall be defined.
- 4.3.5 Custom-made subsystems (either Built to print (BTP) or Built to specification (BTS) subsystems) shall be subjected to acceptance testing as per the approved qualification and acceptance testing document for the respective subsystem.
- 4.3.6 In case any custom-made subsystem does not have an approved QT-AT document, then the contractor shall prepare and forward a draft document for review and approval by PGAD.

4.4 Qualification & acceptance testing

- 4.4.1 On custom-developed subsystems of ICCT, QT procedures shall be carried out on an additional unit meant for this purpose. This unit shall be in addition to the quantity required for the ordered number of ICCTs.
- 4.4.2 On the following custom-developed subsystems of ICCT, since they have been qualified earlier against PGAD specifications, QT need not be carried out.
 - (a) BEUs
 - (b) TWSTFT system
 - (c) Data-link sub-system: SSTU
 - (d) Data-link sub-system: 200 W SSPA
 - (e) Data-link sub-system: ARS

(f) Data-link sub-system: High power ground antenna

- 4.4.3 If any custom-developed subsystem is already qualified for usage in another Project or Programme of Defence Research and Development Organisation (DRDO), full qualification with PGAD specifications shall be carried out.
- 4.4.4 AT shall be carried out on all units of custom-developed sub-systems except the unit on which QT is carried out.
- 4.4.5 COTS subsystems shall be accepted based on OEM CoC and functional testing. QT and AT shall not be applicable for such sub-systems.
- 4.4.6 It shall be ensured that subsystems required to be installed prior to EMI attenuation measurement as per paragraph 2.1.1.10 have been qualified and accepted as per requirements listed herein.
- 4.4.7 It shall also be ensured that qualification and acceptance of all subsystems is completed prior to final integration and roadability testing of fully integrated ICCT as per paragraph 2.1.1.13.

4.5 QA plan and testing of shelter

According to the design of the shelter, the contractor shall propose a QA plan and test plan for the shelter which shall be reviewed and approved during the preliminary and detailed design review phases. The decision of the design review committee shall be final and binding. General and testing requirements in paragraph 2.1.1 shall be considered for preparation of the initial proposals.

4.6 Environmental test specifications for electrical & electronic subsystems

In this section, environmental test specifications for custom-developed electrical and electronic subsystems are elaborated. Both AT and QT specifications are listed.

4.6.1 Custom-developed subsystems

4.6.1.1 Acceptance testing

Ref #	Test	Specification	Remarks
4.6.1.1.1	Burn-in	+65°C for 168 hours with all Printed circuit board (PCB)s and modules in power ON condition	Voltage & Current to be monitored once in 24 hours. If the test set-up permits, then limited functional tests to be carried out
4.6.1.1.2	Environmental stress screening (ESS)	As per MIL-HDBK-344 (see [59])	

Ref #	Test	Specification	Remarks
(a)	Pre random vibration	20 to 100 Hz, +6db/Octave 100 to 1000 Hz, 0.02 g ² /Hz 1000 to 2000 Hz, -6 db/octave 5 min/axis on all 3 axes. (Fig 4.2)	In-situ environmental test (INSET) applicable for each axis
(b)	Temperature cycling	Thermal cycling: 6 cycles Dwell: 1 hr each at -20 °C & +55/ + 65 °C Temp gradient: 10 °C/min (Fig 4.1)	+55 °C for indoor systems and +65 °C for outdoor systems. INSET applicable during 1st, 2nd, 4th & 6th cycles
(c)	Post random vibration	20 to 100 Hz, +6db/octave 100 to 1000 Hz, 0.02 g ² /Hz 1000 to 2000 Hz, -6 db/octave 5 min/axis on all 3 axes. (Fig 4.2)	INSET applicable for each axis
4.6.1.1.3	EMI/EMC: RS-103	10 V/m from 2 MHz to 1 GHz and 50 V/m from 1 GHz to 18 GHz as per MIL-STD-461E (see [35])	As per ground, Air Force category. Applicable for one unit in a batch of size 20
4.6.1.1.4	EMI/EMC: CS-115	$I_{\max} = 5 \text{ A}$, as per Fig CS-116-2 of MIL-STD-461E (see [35])	As per ground, Air Force category. Individual cable injection (on connector set) & all positive lines. Applicable for one unit in a batch of size 20
4.6.1.1.5	EMI/EMC: HESD	20 kV pulses	2 pulses on each connector and on each face of chassis/ enclosure. Applicable for one unit in a batch of size 20

4.6.1.1.6 Pre-environmental (functional) test (PREET) and Post environmental (functional) test (POET) shall be carried out for each environmental test.

4.6.1.2 Qualification testing

Ref #	Test	Specification	Remarks
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Ref #	Test	Specification	Remarks
4.6.1.2.1	Burn-in	+65 °C for 168 hours with all PCBs and modules in power ON condition	Voltage & Current to be monitored once in 24 hours. If the test set-up permits, then limited functional tests to be carried out
4.6.1.2.2	ESS	As per MIL-HDBK-344 (see [59])	
(a)	Pre random vibration	20 to 100 Hz, +6db/Octave 100 to 1000 Hz, 0.03 g ² /Hz 1000 to 2000 Hz, -6 db/octave 5 min/axis on all 3 axes. (Fig 4.2)	INSET applicable for each axis
(b)	Temperature cycling	Thermal cycling: 10 cycles Dwell: 1 hrs each at -20 °C & +55/ +65 °C Temp gradient: 10 °C/min (Fig 4.1)	+55 °C for indoor systems and +65 °C for outdoor systems. INSET applicable during 1st, 2nd, 5th, 7th & 10th cycles
(c)	Post random vibration	20 to 100 Hz, +6db/octave 100 to 1000 Hz, 0.03 g ² /Hz 1000 to 2000 Hz, -6 db/octave 5 min/axis on all 3 axes. (Fig 4.2)	INSET applicable for each axis
4.6.1.2.3	High temperature	Unit under test (UUT) to be maintained at high temperature as follows $+55 \pm 3$ °C for 6 hours, $+65 \pm 3$ °C for 4 hours, $+55 \pm 3$ °C for 6 hours; as per test No. 17 of JSS-55555 (see [58])	INSET to be conducted during last 30 minutes
4.6.1.2.4	Low temperature	UUT to be maintained at low temperature as follows -20 ± 3 °C for 6 hrs, -30 ± 3 °C for 4 hrs, -20 ± 3 °C for 6 hrs; as per test No. 20 of JSS-55555 (see [58])	INSET to be conducted during last 30 minutes
4.6.1.2.5	High altitude	4 km (0.58 bar pressure), -10 °C for 4 hours (as per test No. 3 of JSS-55555 (see [58]))	INSET applicable

Ref #	Test	Specification	Remarks
4.6.1.2.6	Transportation simulation	5 to 20 Hz: 6 dB /octave 20 to 50 Hz: 0.02 g ² /Hz 50 to 500 Hz: roll-off to 0.001 g ² /Hz 40 minutes along mounting axis only as per test No. 28 of JSS-55555 (see [58])	INSET applicable
4.6.1.2.7	Tropical exposure	Introduce UUT into a chamber whose temperature is maintained at $+20 \pm 5^\circ\text{C}$ & follow the below sequence 1. Ramp up to $+45^\circ\text{C}$ in 3 hours & RH $\geq 95\%$, 2. Maintain at $+45^\circ\text{C}$ for 12 hours, 3. Ramp down to $+20 \pm 5^\circ\text{C}$ in 3 hours, 4. Maintain at $+20 \pm 5^\circ\text{C}$ for 6 hours. This constitutes one cycle (24 hrs). Perform 14 cycles. Test No.27 of JSS-55555 (see [58])	INSET during 7th & 14th cycles, during last 30 minutes of $+45^\circ\text{C}$
4.6.1.2.8	Bump	4,000 bumps, 40 g, 3 to 6 ms, 2 to 3 bumps per second. To be conducted on containerized unit. If container is not available, test may be conducted on unpacked unit. Test No. 5 of JSS-55555 (see [58])	INSET not applicable
4.6.1.2.9	Drop	UUT to be dropped from a height of 25 mm in unpacked and switched-off condition. Test No. 13 of JSS-55555 (see [58])	INSET not applicable
4.6.1.2.10	Mould growth	Test coupons, rubber seals, gaskets etc to be subjected to $+29 \pm 1^\circ\text{C}$, RH $\geq 90\%$ for 28 days. Test No. 21 of JSS-55555 (see [58])	INSET not applicable

Ref #	Test	Specification	Remarks
4.6.1.2.11	Salt corrosion	Salt to be sprayed for 2 hours at $+35 \pm 2^\circ\text{C}$ & RH between 90-95 % for 7 days. This constitutes a single cycle. To be subjected to four cycles. Test coupons (metallic plates of unit) to be subjected to this test. Test No. 9 of JSS-55555 (see [58])	INSET not applicable
4.6.1.2.12	Driving rain	UUT to be sprayed with water from shower heads at a static pressure of $200 \text{ kPa} \pm 15\%$ for a period of 1 hour. After completion of test, UUT to be wiped and POET to be conducted. Test No. 12 of JSS-55555 (see [58])	Applicable for outdoor subsystems only. INSET not applicable
4.6.1.2.13	Dust	UUT to be introduced in unpacked and switched off condition into the test chamber and subjected to stream of dust laden air for 1 hour at $+40 \pm 3^\circ\text{C}$ and RH $\leq 50\%$. POET to be conducted after a recovery period of 2 to 4 hours. Test No. 14 of JSS-55555 (see [58])	Applicable for outdoor subsystems only. INSET not applicable
4.6.1.2.14	Solar radiation	UUT to be tested in a chamber which simulates solar radiation with irradiance of $1.2 \pm 0.1 \text{ kW/m}^2$. Test procedure 1 of test No. 25 of JSS-55555 (see [58])	Applicable for outdoor subsystems only. INSET not applicable
4.6.1.2.15	EMI/EMC: CE-102	Basic curve as per Fig CE-102-1 of MIL-STD-461E (see [35])	As per ground, Air Force category. On high and low power leads on +28 V
4.6.1.2.16	EMI/EMC: CS-101	Curve in Fig CS-101 of MIL-STD-461E (see [35])	As per ground, Air Force category. On high line only
4.6.1.2.17	EMI/EMC: CS-114	Curve from 10 kHz to 200 MHz in Fig CS-114-1 of MIL-STD-461E (see [35])	As per ground, Air Force category. In flight configuration, with shielded cable, bulk cable injection

Ref #	Test	Specification	Remarks
4.6.1.2.18	EMI/EMC: CS-115	$I_{\max} = 5 \text{ A}$, as per Fig CS-116-2 of MIL-STD-461E (see [35])	As per ground, Air Force category. Individual cable injection (on connector set) & all positive lines
4.6.1.2.19	EMI/EMC: RE-102	Navy fixed and Air Force curve as per Fig RE-102-1 of MIL-STD-461E (see [35])	As per ground, Air Force category. 10 kHz - 1 GHz
4.6.1.2.20	EMI/EMC: RS-103	10 V/m from 2 MHz to 1 GHz and 50 V/m from 1 GHz to 18 GHz as per MIL-STD-461E (see [35])	As per ground, Air Force category
4.6.1.2.21	EMI/EMC: HESD	20 kV pulses	2 pulses on each connector and on each face of chassis/ enclosure
4.6.1.2.22	EMI/EMC: CS-103	15 kHz - 10 GHz	as per MIL-STD-461E (see [35]). Applicable only for antenna port of transceivers and amplifiers
4.6.1.2.23	EMI/EMC: CS-104	30 Hz - 20 GHz	as per MIL-STD-461E (see [35]). Applicable only for antenna port of transceivers and amplifiers
4.6.1.2.24	EMI/EMC: CS-106	10 kHz - 40 GHz	as per MIL-STD-461E (see [35]). Applicable only for antenna port of transceivers and amplifiers

4.6.1.2.25 PREET and POET shall be carried out for each environmental test.

4.7 Environmental specifications for COTS indoor & outdoor systems

4.7.1 For COTS indoor systems except computer workstations & thin client computers, operating temperature shall be 0 to 40 °C and RH shall be 90 %. For computer workstations and thin client computers, operating temperature shall be 5 to 35 °C and RH shall be 90 %.

4.7.2 For COTS outdoor systems, operating temperature shall be -10 to 55 °C , RH 95 %.

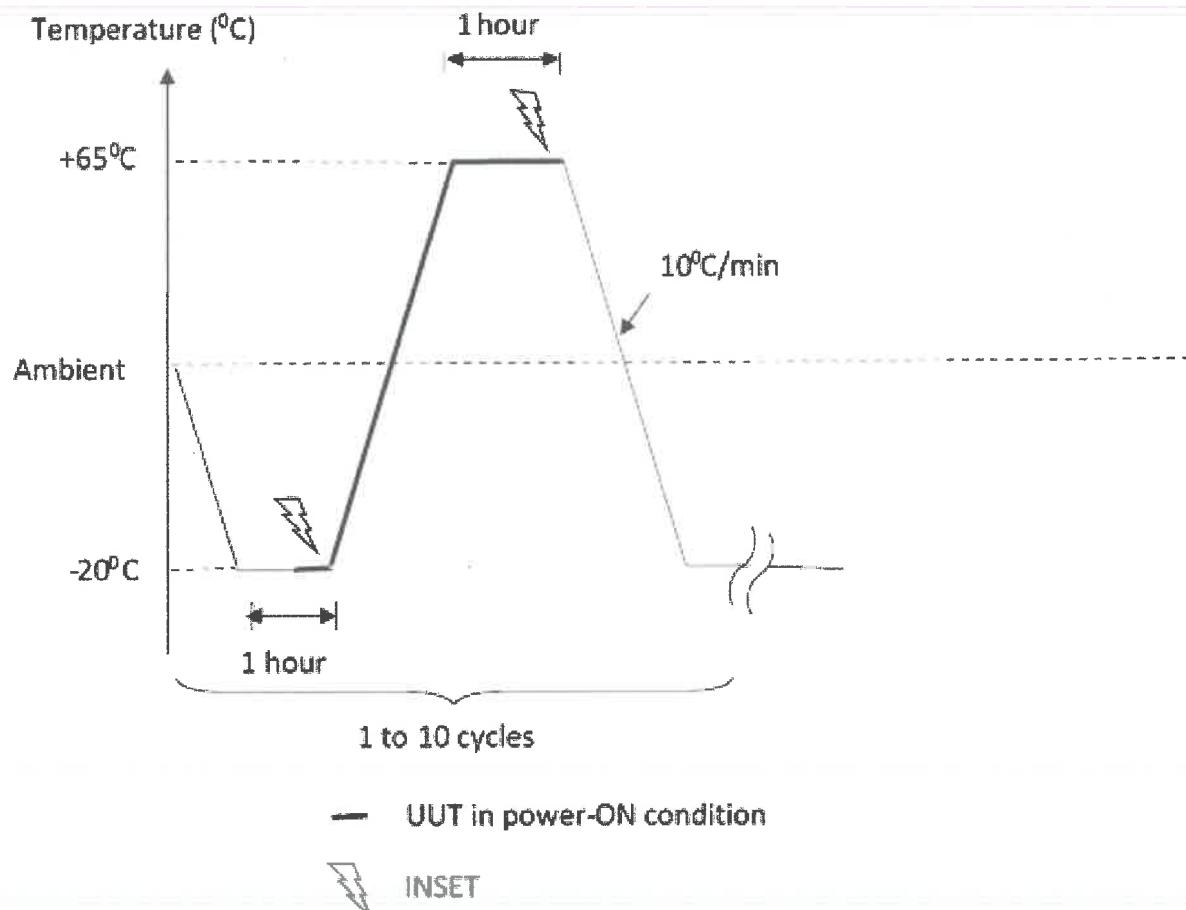


Figure 4.1: Thermal cycling profile

4.8 Testing of mechanical systems & sub-systems

Test specifications and procedures pertaining to mechanical systems and sub-systems of ICCT shall be proposed in the test procedures document for review and approval by PGAD. Testing shall be carried out as per approved test procedures document.

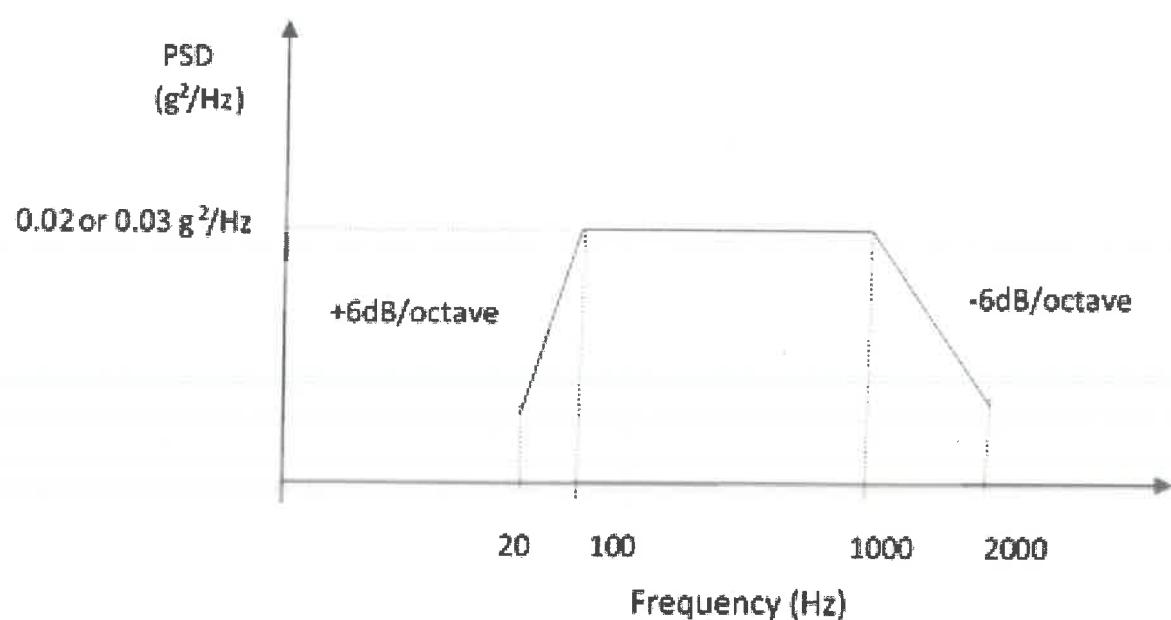


Fig.1 Random Vibration profile

Figure 4.2: Random vibration profile

Chapter 5

Specifications & scope of work for NMS software

5.1 Introduction

ICCT is a shelter based communication terminal which provides reliable and secure data & voice communication among weapon system elements across LAN and WAN. Typical deployment configuration consisting of multiple sites connected through ICCT over VSAT and leased-line links, is shown in figure 5.1. Each site has one or more local nodes, which are connected to ICCT over dedicated optical link and/or line-of-sight link.

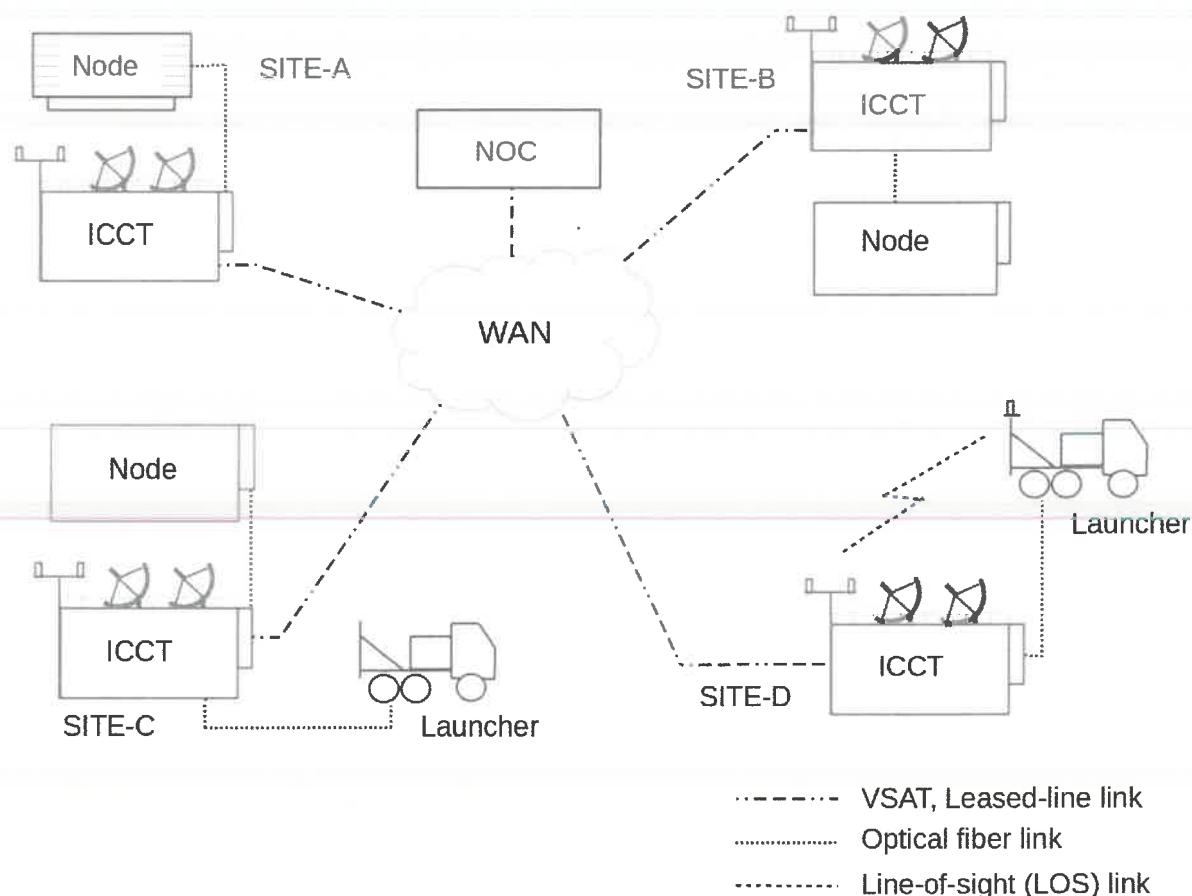


Figure 5.1: ICCT network

ICCT comprises of various communication devices such as edge routers, core switches, access switches, satellite modems etc. The connectivity over WAN is provided by VSAT and leased-line network.

This chapter is intended to bring out the key requirements of the both the LNMS to be used in each ICCT and the CNMS to be used at Network operations centre (NOC).

5.2 ICCT NMS requirements

5.2.1 NMS for ICCT shall have a two-tier architecture with LNMS in each ICCT and a CNMS at NOC. This section covers high-level requirements of both the LNMS and the CNMS.

5.2.2 LNMS requirements

5.2.2.1 LNMS shall possess the capability to perform various network management functions as per Fault, Configuration, Accounting, Performance & Security (FCAPS) reference model (see [60]).

5.2.2.2 LNMS shall be developed on Linux, Apache®, MySQL® & PHP (LAMP) stack using Cacti® monitoring software and its plug-in architecture (see www.cacti.net).

5.2.2.3 LNMS shall support industry standard protocols including SNMP v1/v2c/v3, Syslog, Telnet, SSH, Cisco® discovery protocol (CDP), Link layer discovery protocol (LLDP), Trivial file transfer protocol (TFTP), FTP, NTP, Terminal access control access control system (TACACS)+, Cisco® NetFlow & Internet Protocol Flow Information Export (IPFIX).

5.2.2.4 LNMS shall have provision to communicate local status to LNMS of remote ICCTs.

5.2.2.5 LNMS shall have an North bound interface (NBI) for interacting with CNMS. It shall periodically update the CNMS with ICCT status and shall post critical events/alarms on occurrence.

5.2.2.6 LNMS shall have a web based User interface (UI) to provide monitoring and control functions.

5.2.3 CNMS requirements

5.2.3.1 CNMS shall monitor and present consolidated status of all ICCTs and operational status of various communication links between them.

5.2.3.2 CNMS shall have all the features of LNMS along with the following additional requirements.

5.2.3.2.1 CNMS shall have a South bound interface (SBI) for listening to status updates and events from each ICCT through its LNMS.

5.2.3.2.2 CNMS shall have provision for cross-launching local NMS of any ICCT.

5.2.3.2.3 CNMS shall also have a web based UI to provide necessary monitoring and control functions.

5.2.3.2.4 It shall have a high availability architecture (1+1 including database replication) with support for both co-located and geographically redundant configuration.

5.2.4 Overall architecture

The ICCT NMS interfaces and high-level architecture are shown in figure 5.2.

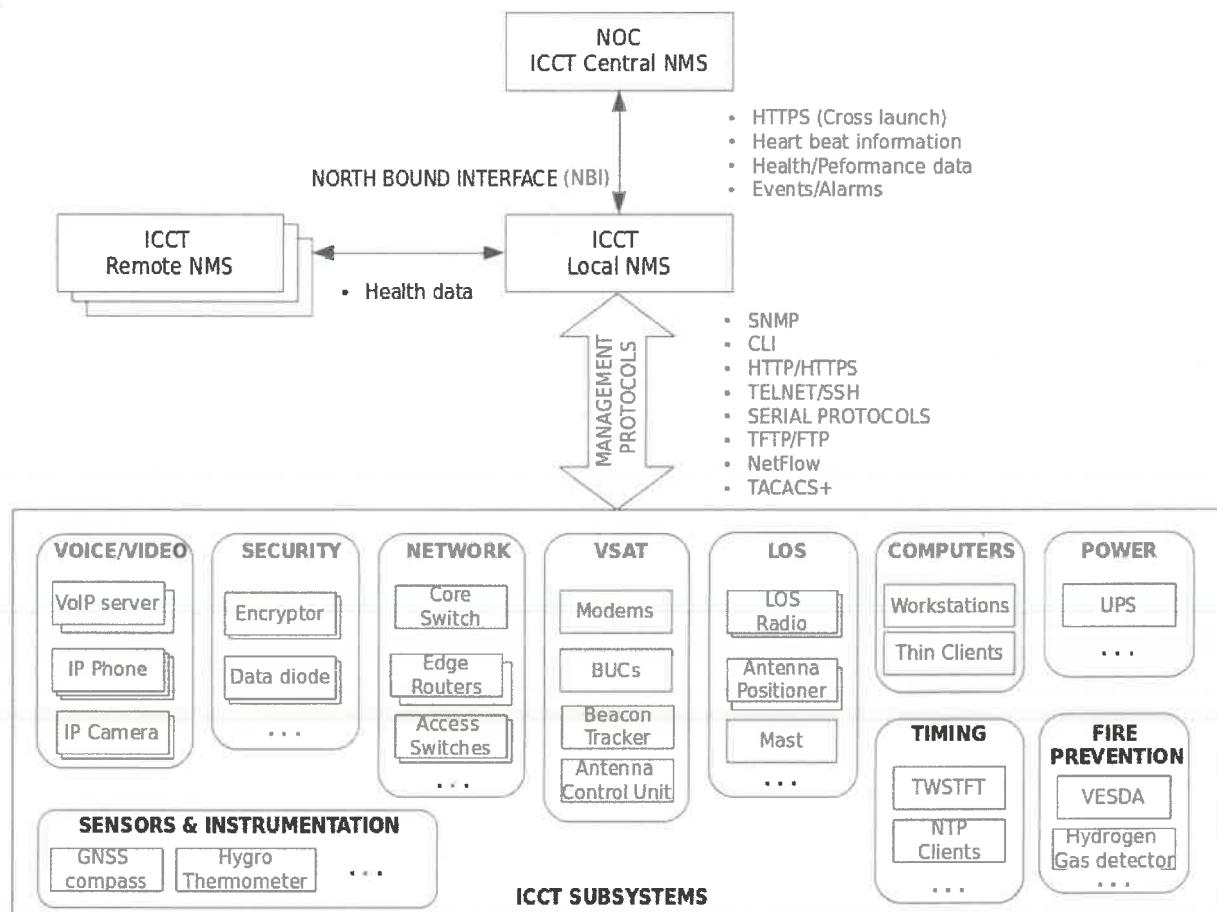


Figure 5.2: NMS interfaces

5.3 Scope of work for LNMS

This section addresses the scope of work of LNMS with detailed specification and requirements. The ICCT LNMS design shall follow FCAPS reference management model, the details of which are provided in the following subsections.

5.3.1 Fault management

Fault management involves detection, isolation, correction and logging of events/faults at system and subsystem level. The ICCT LNMS shall have the feature to perform both passive and active fault management.

5.3.1.1 Passive fault management

- 5.3.1.1.1 ICCT LNMS shall be capable of receiving, decoding and displaying the following set of protocols: SNMP traps (v1,v2), SNMP notifications, Syslog, vendor-specific protocols
- 5.3.1.1.2 For non-SNMP (serial) devices the SNMP adaptors/proxies must be capable of generating SNMP traps and/or Syslog events based on the configuration.
- 5.3.1.1.3 The adaptor/proxy must poll the user-defined parameters and generate an event or alarm in the form of standard SNMP trap/Syslog.
- 5.3.1.1.4 The ICCT LNMS must be capable of receiving and processing a minimum of 1000 traps/s.

5.3.1.2 Active fault management

- 5.3.1.2.1 ICCT LNMS shall have the capability to monitor standard and user-defined parameters for both SNMP and non-SNMP subsystems.
- 5.3.1.2.2 Standard parameters shall consist of management variables under Management information base (MIB)-II (see [61]) which are applicable for Layer-2 and Layer-3 devices.
- 5.3.1.2.3 User-defined parameters consist of management variables selected/configured by the user that are defined in the MIBs of the respective devices.
- 5.3.1.2.4 Default and customized templates of critical parameters must be provided for ICCT elements.
- 5.3.1.2.5 Upon selecting the device the corresponding templates with parameters list must be displayed. The user selects the parameters to be monitored.
- 5.3.1.2.6 In summary the user must be able to perform following activities
 - (a) Creation and modification of templates for managed devices and its parameters
 - (b) Selection of managed device and parameters to be monitored
 - (c) Defining the minimum, maximum thresholds and rate of poll
 - (d) Define the severity-level to be reported in case of exceeding the minimum and/or maximum threshold values

5.3.1.3 Fault management console

- 5.3.1.3.1 Events captured as part of passive fault management and events generated as part of active fault management, irrespective of the native protocol (Syslog, SNMP trap, vendor-specific message) shall be converted to a common event message format before storing in the NMS data base.
- 5.3.1.3.2 The processed and stored events shall be presented to the user in near real-time on a unified fault management console with relevant details as mentioned below.
 - (a) Source (Name, IP Address for IP enabled devices, Type of network element, model number and serial number)
 - (b) Date and time-stamp
 - (c) Severity with appropriate color code

- (d) Generic and detailed description specific to the event/alarm/trap
- (e) Possible help information describing corrective action to be taken by the user
- (f) User acknowledgment status
- (g) Event count

5.3.1.3.3 The console shall have provision to filter through the events based on a combination of one or more of the following parameters

- (a) Single or multiple sources
- (b) Data and time window
- (c) One of more severity levels
- (d) User acknowledgment status

5.3.1.3.4 The user must be able to navigate from the source to its detailed view from the fault console.

5.3.1.4 Actions

The ICCT LNMS, apart from displaying the fault should support the following actions when an event/fault occurs

5.3.1.4.1 **Audio:** A unique tune or sound file can be configured which can be played based on the severity of the event

5.3.1.4.2 **Email:** Provision to send an email to a one or more of email ids as configured by the user. Email server and related services shall be provided by PGAD.

5.3.1.5 Escalation

The ICCT LNMS shall have the ability to escalate the faults based on several criteria similar to those mentioned with reference to filters. The user shall be able to configure the escalation policies wherein he/she can select and save the criteria along with the associated actions to be executed as described in paragraph 5.3.1.4.

5.3.1.6 Views/graphs

5.3.1.6.1 There shall be a provision to select and view the statistical graphs of the faults based on the selection criteria similar to the filters such as

- (a) Source
- (b) Severity
- (c) User acknowledgment status
- (d) Time window: defined, daily, weekly, monthly and quarterly
- (e) Range of IP addresses

5.3.1.6.2 Following views/graphs must be generated

- (a) Pie-chart

- (b) Histograms (bar charts)
- (c) Point/line plots (showing the trends)

5.3.1.7 Report generation

The ICCT LNMS shall have the provision for generating reports and exporting the same as a Portable document format (PDF) document. The report generation shall be based on similar search and filtering criteria as mentioned in paragraph 5.3.1.6.

5.3.1.8 Diagnostic tools

ICCT LNMS shall have integrated user-interface to execute commonly used diagnostic tools such as

- 5.3.1.8.1 Traceroute
- 5.3.1.8.2 Ping
- 5.3.1.8.3 Address resolution protocol (ARP)
- 5.3.1.8.4 Tools for bandwidth testing (iperf, pathchar, netperf etc)

5.3.1.9 Chatting

- 5.3.1.9.1 The ICCT LNMS shall have a chat utility for the users so that they can exchange text messages during operations or while troubleshooting specific problems.
- 5.3.1.9.2 Network/system administrators located at NOC can establish chat sessions with the ICCT operators for providing appropriate instructions for troubleshooting and carrying out system diagnostics.

5.3.2 Configuration management

The ICCT LNMS shall support configuration of both SNMP and non-SNMP devices (serial devices). As a part of configuration management the ICCT LNMS shall have the capabilities enumerated in this subsection.

5.3.2.1 Device and network discovery

ICCT LNMS shall be capable of performing discovery of devices and network through multiple methods described in the following sections.

5.3.2.1.1 Auto-discovery via

- (a) IP address and port scanning
- (b) CDP
- (c) LLDP
- (d) Internet control message protocol (ICMP)
- (e) SNMP
- (f) Combination of these methods as selected by the user.

- 5.3.2.1.2 An interactive wizard shall be provided to the user to select and define the discovery techniques and related parameters. Editable topological view shall be presented with various network elements and the interconnections. Appropriate symbols/icons shall be used for network elements and links. These icons can be user-configurable.
- 5.3.2.1.3 Provision for manual discovery shall be provided where the user selects the type of device and defines the related parameters needed.
- 5.3.2.1.4 For SNMP enabled devices, the LNMS shall automatically discover the device type and shall present the list of associated templates for performance monitoring. The user shall select the required templates/parameters to be monitored.

5.3.2.2 Device inventory

- 5.3.2.2.1 The devices discovered shall be stored and maintained as an inventory.
- 5.3.2.2.2 The status of all the devices present in the inventory shall be tracked for any changes and updated accordingly.
- 5.3.2.2.3 Events shall be generated on any changes to the devices to notify the user.

5.3.2.3 Configuration backup and restore

- 5.3.2.3.1 Backup of devices' configuration shall be supported automatically (on a scheduled basis) as well as manually with user intervention.
- 5.3.2.3.2 Automatic back up and restoration need to be developed using SNMP or any other suitable protocol as supported by the devices.
- 5.3.2.3.3 The stored configuration can be restored onto the device either from the database or from a user supplied file.
- 5.3.2.3.4 A common format, preferably in XML, shall be defined for storing the configuration files.
- 5.3.2.3.5 Further, the user shall be provided with an interface for generation and uploading the configuration files for all the devices.

5.3.2.4 Configuration interface/console

- 5.3.2.4.1 The user shall be provided with an intuitive and easy-to-use interface for device configuration. This interface shall abstract the underlying protocol being used for the configuration.
- 5.3.2.4.2 The user interface must have the following features
 - (a) Confirmation for changing critical parameters
 - (b) Display of valid range of the parameters
 - (c) Warning on entering values beyond the defined thresholds
 - (d) Invalid values should not be accepted by the fields
 - (e) Acknowledgment after successful configuration of parameters

5.3.2.5 Configuration protocols

5.3.2.5.1 The ICCT LNMS shall support the following protocols for configuration.

- (a) SNMP v1/v2c/v3
- (b) Telnet
- (c) SSH
- (d) TFTP, FTP, Secure file transfer protocol (SFTP)
- (e) Vendor specific protocols

5.3.2.5.2 A web-based interface shall be provided emulating the SSH or Telnet sessions for configuration of switches and routers.

5.3.2.6 Cross-launch facility

Certain devices in the ICCT may support web-based management interface. To leverage such interfaces, ICCT LNMS shall have provision for configuration and cross-launching of element management consoles over Hypertext transfer protocol (http)/Hypertext transfer protocol secure (https).

5.3.2.7 Audit

ICCT LNMS shall have the provision to log configuration activities performed by the user. Following parameters shall be included in the log data.

5.3.2.7.1 User-name

5.3.2.7.2 Device Id

5.3.2.7.3 Parameter(s) configured

5.3.2.7.4 Date and time of activity

5.3.3 Performance management

The ICCT LNMS shall have capability to poll, process, store, present and generate reports about the performance parameters of various subsystems and about the system as a whole. A set of generic and specific parameters will be defined and selected for monitoring as described in the following sub-sections.

5.3.3.1 General parameters

5.3.3.1.1 **Availability:** The availability status of all the devices shall be monitored based on its response to a combination of one or more protocols including ICMP, UDP, TCP and SNMP. The user shall be notified about any change in the state as an event. In case of orderly shut down of the ICCT system, the ICCT LNMS shall have the provision to send shut down event to ICCT CNMS and remote ICCT LNMS. This condition may prevail when the ICCT is non-operational or under storage condition or on the move for an impending deployment.

5.3.3.1.2 **MIB-2 (iso.org.dod.internet.mgmt.mib-2):** Management variables under the MIB-II definition must be monitored for layer-2 and layer-3 SNMP enabled devices which include

- (a) Interface statistics
- (b) Protocol statistics

5.3.3.1.3 MIBs defined under MIB-2, which are applicable to any system or subsystem in ICCT such as UPS (UPS-MIB) shall be supported by ICCT LNMS for monitoring purpose. Standard templates for polling and graph generation for such MIBs shall be preloaded in the LNMS.

5.3.3.2 Specific parameters

5.3.3.2.1 The ICCT LNMS shall have the provision to create polling and graph templates for specific parameters for each type of device based on their MIBs.

5.3.3.2.2 By default, the templates associated with a type of device shall be listed whenever such a device is added into LNMS.

5.3.3.2.3 During adding or while editing the device details, the user shall have the provision to select one or more parameters for monitoring.

5.3.3.2.4 In summary the user shall be able to perform the following activities

- (a) Creation and modification of templates for managed devices and its parameters
- (b) Selection of managed device
- (c) Selection of performance parameters

5.3.3.3 Network time protocol (NTP)

ICCT LNMS shall support monitoring of NTP status of selected nodes and store the statistical information for further analysis. Minimum statistical information consists of sync status, sync source, offset, jitter and delay.

5.3.3.4 Netflow and IPFIX

ICCT LNMS shall support processing and visualization of Netflow protocol and statistics with the following capabilities

5.3.3.4.1 Support for various Netflow versions: v5, v7 and v9 and IPFIX.

5.3.3.4.2 Provide historical trends for WAN and LAN bandwidth usage

5.3.3.4.3 Persistent storage of Netflow data for analysis

5.3.3.4.4 Generation of extensive graphs and reports based on user selected criteria such as

- (a) Top hosts
- (b) Protocols
- (c) Applications
- (d) Conversations

5.3.3.4.5 Ability to detect and locate anomalies in the network traffic such as

- (a) Various network attacks
- (b) Denial of service (DoS) attacks
- (c) Infected by worms and virus

5.3.3.4.6 Pinpointing the cause of network over-utilization and highlighting the IP addresses of the top talkers on the network

5.3.3.5 Reports

The ICCT LNMS as a part of performance management functionality shall be capable of generating reports about the above discussed parameters.

5.3.4 Security management

5.3.4.1 User authentication and authorization

5.3.4.1.1 The ICCT LNMS shall provide creation, modification and deletion of users and associated privileges/roles with following features

- (a) Fine grained and extensible authorization including support for users, groups, roles, operations and views
- (b) Secure authentication and access control including time limited passwords
- (c) Auditing capabilities including log in time, source IP and operations performed shall be logged.

5.3.4.1.2 **User groups:** A default set of user groups shall be configured as shown below.

Group	Privileges/roles					
	Add/delete elements	Configura-tion of elements	Monito-ring	User manage-ment	Backup	Restore
System administrator	Y	Y	Y	Y	Y	Y
Network administrator	N	Y	Y	N	Y	Y
Network operator	N	N	Y	N	Y	Y

5.3.4.1.3 **Network device groups:** Provision for creating network device groups shall be present through which the user creates different groups and adds devices to them based on certain criteria. A probable list of groups is shown below.

Group	Description	Devices
LAN	Consists of elements comprising the LAN segment of ICCT	Core routers, access switches etc

Group	Description	Devices
WAN	Consists of elements comprising the WAN segment of ICCT	Edge routers, satellite subsystems, LOS link subsystems etc
Security	Consists of elements that provide network security	Intrusion protection system (IPS), bulk encryptor etc
Power	Consists of elements related to power-supply	UPS etc

5.3.4.2 Accounts and password management

5.3.4.2.1 Only the system administrator shall be allowed to manage user groups, device groups and associated parameters. Any other user can only change their own password.

5.3.4.2.2 At least, the following user parameters shall be managed

- (a) User name
- (b) Password
- (c) Associated groups
- (d) Per group privileges
- (e) Password expiry period

5.3.4.3 Monitoring and logging

The ICCT LNMS shall have full auditing capabilities which shall include at least the following events.

5.3.4.3.1 Changes done by users

5.3.4.3.2 Log in and log out times

5.3.4.3.3 Login failures

5.3.5 WebUI layout and views

The ICCT LNMS shall have a web-based UI with the sample layouts as shown in figures 5.3 and 5.4.

5.3.5.1 Menus and main console

This shall include various sub-menus specific to each management function and related operations.

5.3.5.2 Inventory

This shall be a tree based view showing the inventory of the ICCT which includes the devices, interfaces etc. The user shall be able to select a device or an interface and drill down to the lowest possible level.

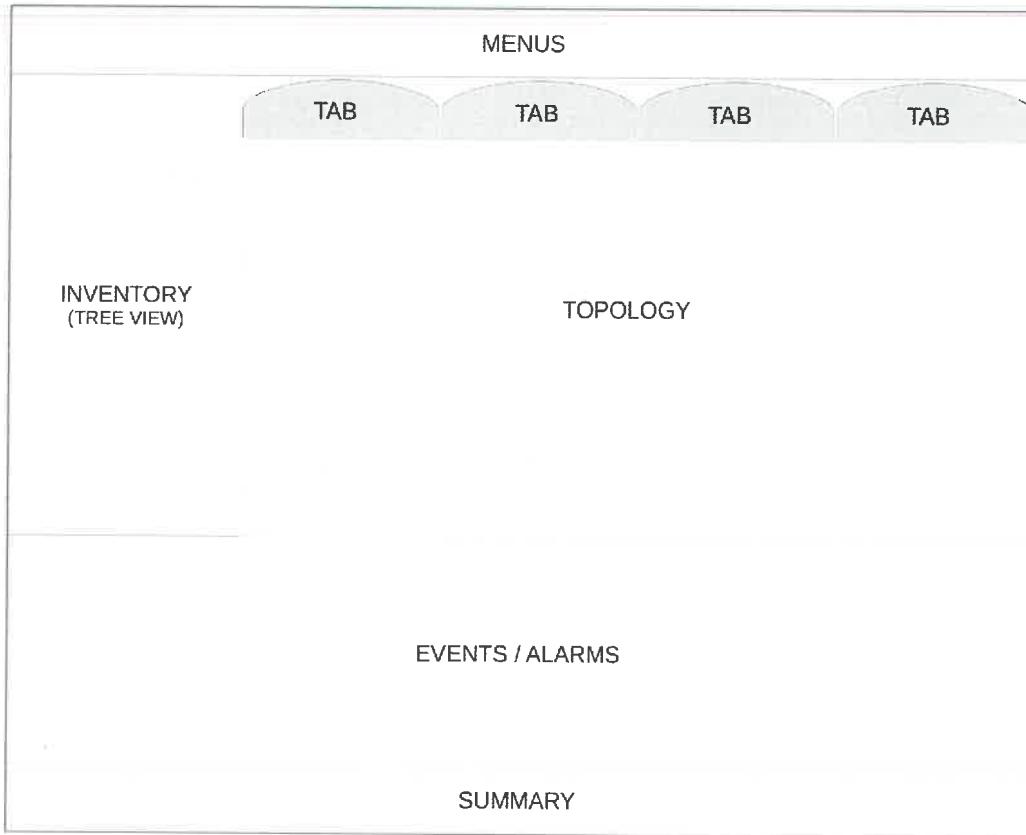


Figure 5.3: ICCT LNMS WebUI sample layout

5.3.5.3 Topology

This portion of the layout shall support presentation of various forms of topology as listed below.

5.3.5.3.1 **Physical network topology:** Provides visual representation of the network as discovered by the ICCT LNMS comprising of layer-2, layer-3 switches, edge routers, end-points and interface details. The topology shall be updated in real-time showing the availability and reachability of all the nodes in the topology. The update rate shall be user configurable.

5.3.5.3.2 **Rack view topology:** Provides visual representation of the racks and the status of respective devices installed in them.

5.3.5.3.3 **ICCTs network topology:** Provides visual representation of various communication links among ICCTs and their current operational status in real-time. ICCT shall be represented using appropriate color codes based on the health and link availability.

5.3.5.3.4 **Geographical topology:** ICCTs network topology shall be overlayed on a digital map indicating the current location and operational status of ICCTs. The position at each ICCT shall be fetched from the GNSS clock located in the ICCT and the same shall be reported to remote ICCT LNMS for display on the map.

5.3.5.4 Events and alarms

Critical events/alarms shall be summarized and presented in this area.

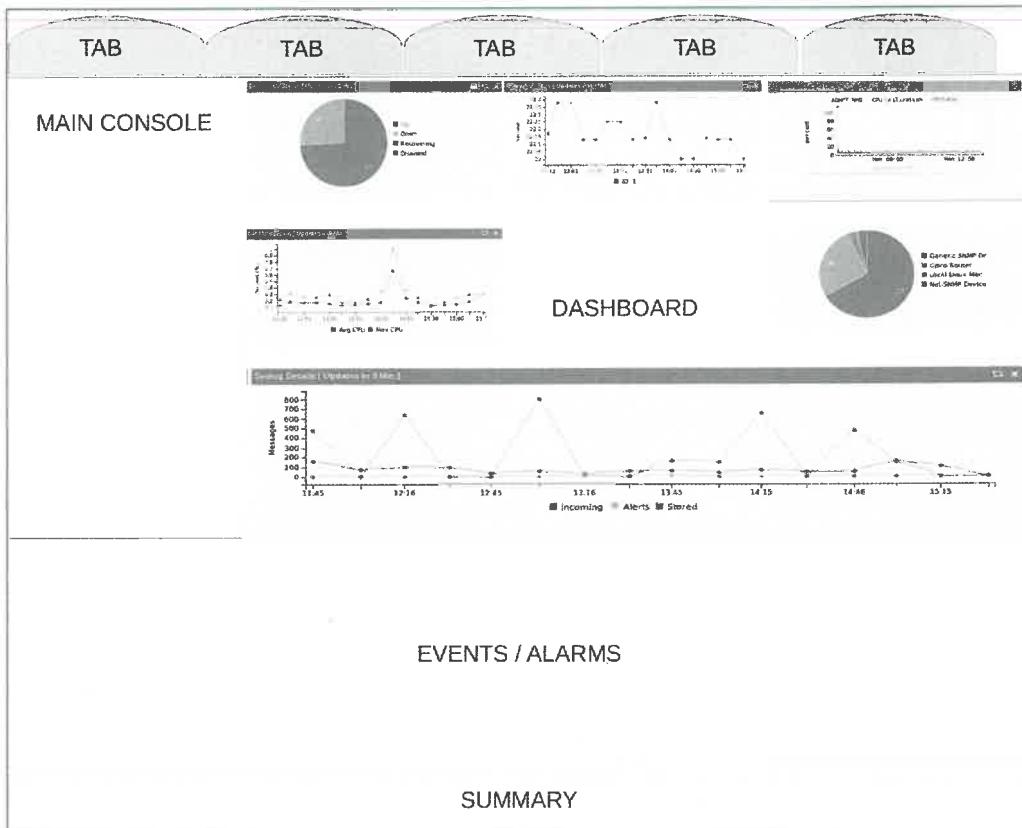


Figure 5.4: ICCT LNMS WebUI sample layout

5.3.5.5 Summary

This shall display the brief information regarding the following parameters

- 5.3.5.5.1 System status: Resources utilized including Random access memory (RAM), CPU and disk space
- 5.3.5.5.2 Current active link with the NOC(s)
- 5.3.5.5.3 Current logged in user(s)

5.3.5.6 Dashboard

The ICCT LNMS shall have provision of a customizable dashboard, which presents a bird's-eye view of the overall network health with customizable widgets providing real-time statistics of critical parameters/metrics such as CPU load, availability, real-time utilization graphs of critical network resources, list of critical alarms/events, rate of events/alarms reported/processed by LNMS, inventory, top-talkers and any other Service level agreement (SLA) widgets.

5.3.6 Reports and Logging

The details of events and related information have been discussed in the respective management function.

5.3.6.1 Reporting methodology

- 5.3.6.1.1 The reporting of events and other information from ICCT LNMS to CNMS at NOC should be configurable by the administrators.
- 5.3.6.1.2 Administrators can configure either the main or the alternate method of reporting or parallel reporting as explained below.
 - (a) **Parallel mode:** In this mode ICCT LNMS shall send the status information to main and standby CNMS located at different NOCs.
 - (b) **Main/Standby mode:** In this mode ICCT LNMS shall send the status information to only the main CNMS (at one of the NOCs). In case of failure of the main NOC, the ICCT LNMS shall send the status information to the standby CNMS at another NOC. The ICCT LNMS shall detect the availability of the main and standby links to the NOCs through periodic polling.
- 5.3.6.1.3 The ICCT LNMS shall have the feature of scheduling automatic generation of the reports based on user defined periodicity and features.

5.3.6.2 Interaction with CNMS

- 5.3.6.2.1 The CNMS, as discussed earlier, primarily monitors the health of remote ICCTs presenting the current status, alarms and topological view showing the connectivity between remote ICCTs. Both push and pull techniques shall be used for exchanging information between CNMS and various LNMS.
 - (a) Push-model shall be used for forwarding of SNMP Traps, alarm and events (configurable using filters)
 - (b) Pull-model (On demand) shall be used for consolidated health status of ICCT, inventory, configuration information of ICCT and its subsystems etc.
- 5.3.6.2.2 The information shall be exchanged using SNMP, XML or JavaScript object notation (JSON). If SNMP is used a new MIB shall be written defining the ICCT health status and custom traps for monitoring and notification.

5.3.6.3 Interaction with remote ICCT LNMS

- 5.3.6.3.1 The ICCT LNMS shall share its health status with LNMS at remote ICCTs. This shall enable availability of consolidated health status of all ICCTs at each LNMS.
- 5.3.6.3.2 The health information shall be shared efficiently among ICCTs either through multicast or broadcast to a unique virtual IP address, which shall be translated appropriately and forwarded to respective ICCT LNMS upon reception.
- 5.3.6.3.3 The message format for exchange of health status between LNMS of various ICCTs shall be proposed by the contractor for review and approval by PGAD.

5.4 Scope of work for CNMS

This section addresses the scope of work for the CNMS with detailed specification of the requirements. The CNMS design shall follow FCAPS management model, the details of

which are provided in the following subsections.

5.4.1 Fault management

The CNMS shall receive the events such as SNMP traps, alarms, consolidated health status from multiple ICCT LNMS and display detailed information associated with them. A standard message format shall be proposed by the contractor for review and approval by PGAD. The approved message format shall be used for reporting and polling of such events between ICCT LNMS and CNMS. It shall be capable of receiving and processing a minimum of 2500 events/s.

5.4.1.1 Fault management console

5.4.1.1.1 Fault management console shall be comprehensive and configurable as per the user requirements. It shall allow the user to view events in real time providing an interface for acknowledging, servicing and annotating them.

5.4.1.1.2 Detailed information about event must be displayed in real time including

- (a) ICCT identity and description
- (b) Source information including IP Address for IP enabled devices and/or name as well as type of network element/model/serial number
- (c) Date and time-stamp
- (d) Severity with configurable color code
- (e) Generic and detailed description specific to the event
- (f) Possible help information describing corrective action to be taken by the user
- (g) User acknowledgment status

5.4.1.1.3 There shall be a provision for configuring the filters for alarms display based on the combination of one or more of the following parameters

- (a) ICCT ID
- (b) Source (as mentioned above)
- (c) Time window
- (d) Severity
- (e) User acknowledgment status

5.4.1.2 Actions

5.4.1.2.1 The CNMS, apart from displaying the fault shall support the following actions when a fault occurs

- (a) **Audio:** A unique tune or sound file can be configured which can be played based on the fault
- (b) **Email:** An email must be sent to the administrator/operator
- (c) **SMS:** A short message may be sent to the administrator/operator's mobile phone via Short message service (SMS)

5.4.1.2.2 The user shall be able to configure the above actions as per the requirements.

5.4.1.3 Escalation

5.4.1.3.1 The ICCT CNMS shall have the ability to escalate the faults based on several criteria similar to those mentioned about filters.

5.4.1.3.2 The user shall be able to configure the escalation policies wherein he can select and save the criteria and the associated actions described in the above section.

5.4.1.4 Views and graphs

5.4.1.4.1 There shall be a provision to select and view the statistical graphs of the faults based on the selection criteria similar to the filters such as

- (a) ICCT
- (b) Source
- (c) Severity
- (d) User acknowledgment status
- (e) Time window: defined, daily, weekly, monthly and quarterly
- (f) Range of IP addresses

5.4.1.4.2 Following views/graphs shall be generated:

- (a) Pie-chart
- (b) Histograms (Bar charts)
- (c) Point/line plots (showing the trends)

5.4.1.5 Report generation

5.4.1.5.1 The CNMS shall have the capability of generating various reports based on several criteria as selected by the user.

5.4.1.5.2 The generated reports can be exported to either PDF or Open document format (ODF).

5.4.1.6 Diagnostic tools

5.4.1.6.1 Diagnostic and testing tools must be provided with integrated user-interface to help user carryout specific tests on the devices and/or the network.

5.4.1.6.2 At least the following tools shall be supported

- (a) Traceroute
- (b) Ping
- (c) ARP
- (d) Tools for bandwidth testing (iperf, pathchar, netperf etc)

5.4.2 Configuration management

5.4.2.1 Cross-launching for configuration activities

The CNMS shall cross-launch the ICCT LNMS for any configuration activities.

5.4.2.2 ICCT inventory

- 5.4.2.2.1 The CNMS shall maintain the list of available ICCTs and their inventory.
- 5.4.2.2.2 The status of all the ICCTs and respective inventories shall be tracked for any changes and updated accordingly.
- 5.4.2.2.3 Events shall be generated on any changes in ICCT inventory to notify the user.

5.4.2.3 Configuration backup and restore

- 5.4.2.3.1 Provision for taking backup of ICCT configuration comprising the devices configuration must be provided at the CNMS. This can be carried out either automatically on a scheduled basis or manually with the user intervention.
- 5.4.2.3.2 The stored configuration can be restored onto the ICCT either from the database or from a user supplied file. A common configuration template either in XML or JSON format has to be defined for storing the configuration files. The user must be provided with an interface for generation and uploading the configuration files for all the ICCTs. The configuration file format shall be proposed by the contractor for review and approval by PGAD.

5.4.2.4 Configuration interface/console

The user shall be provided with an intuitive and easy-to-use interface for ICCT configuration. On selecting the ICCT, the respective ICCT LNMS shall be cross-launched through which the user can view and carry out the configuration changes.

5.4.2.5 Audit

All the configuration activity performed by the user must be logged for further analysis and report generation.

5.4.3 Performance management

- 5.4.3.1 The CNMS shall receive the performance reports from all the ICCTs through their respective LNMS either on-demand or on a scheduled basis.
- 5.4.3.2 The received performance reports shall be exported to the a central database or storage facility for further analysis.
- 5.4.3.3 The CNMS shall be capable of presenting and generating reports on the performance parameters of ICCTs and its subsystems.

5.4.4 Security management

5.4.4.1 User authentication and authorization

5.4.4.1.1 The CNMS shall have security features similar to the ICCT LNMS. It must provide creation, modification and deletion of users and associated privileges/roles with following features.

- (a) Fine grained and extensible authorization including support for users, groups, roles, operations and object views
- (b) Secure authentication and access control including time-limited passwords
- (c) Full auditing capabilities including changes, log in times etc.

5.4.4.1.2 **User Groups:** A default set of user groups shall be configured as shown below.

Group	Privileges/roles					
	Add/ delete ICCT	Configura- tion of ICCT	Monito- ring	User manage- ment	Backup	Restore
System administrator	Y	Y	Y	Y	Y	Y
Network administrator	N	Y	Y	N	Y	Y
Network operator	N	N	Y	N	Y	Y

5.4.4.2 Account and password management

5.4.4.2.1 Only the system administrator shall be allowed to manage user groups, device groups and associated parameters.

5.4.4.2.2 Individual users shall only be allowed to change their own password which shall expire after a predefined time period.

5.4.4.2.3 At least, the following user parameters shall be managed

- (a) User name
- (b) Password
- (c) Associated groups
- (d) Per group privileges
- (e) Password expiry period

5.4.4.3 Monitoring and logging

The CNMS shall have full auditing capabilities which shall include at least the following events.

- (a) Changes done by users

- (b) Log in and log out times
- (c) Login failures

5.4.5 WebUI layout and views

The Central NMS shall have a webUI similar to ICCT LNMS.

5.4.5.1 Menus

This shall include various sub-menus specific to each management function and related operations.

5.4.5.2 Inventory

5.4.5.2.1 This shall be a tree based view showing the inventory of the ICCTs which include the list of available ICCTs, its devices, interfaces etc.

5.4.5.2.2 The user shall be able to drill down to the lowest level possible with facility to cross-launch respective OEM tools for configuration and monitoring of the device.

5.4.5.3 Topology

This portion of the layout supports presentation of various forms of topology as listed below.

5.4.5.3.1 **Geographical topology:** The CNMS shall provide network view indicating the current location and operational status of ICCTs over an India map. The position of each ICCT shall be fetched from the GNSS clock located in that ICCT and the same shall be reported to CNMS for display on the map. The representation shall be done on a digital map with ICCT icons in different colors based on the health and availability of communication links.

5.4.5.3.2 **Logical topology:** The CNMS shall provide a visual representation of the links, inter-dependencies and relationships among ICCTs.

5.4.5.4 Fault console

A fault console shall be provided, as discussed in the fault management section.

5.4.5.5 Summary

The CNMS shall have a fault console that shall display the brief information regarding the following parameters

5.4.5.5.1 **System status:** Resources utilized including RAM, CPU and disk space

5.4.5.5.2 Availability of ICCTs and their status

5.4.5.5.3 User currently logged in

5.4.5.5.4 High availability status (main/standby)

5.5 Software design features

In this section, various software-design related requirements of the ICCT LNMS and CNMS are enumerated.

5.5.1 Development platform

LNMS and CNMS software shall be developed on LAMP stack using Cacti® network monitoring software and its plug-in architecture (see www.cacti.net). Cacti® is being used by PGAD along with in-house developed plug-ins to monitor and manage existing communication terminals and internal networks. The same is required to be used in ICCT LNMS and CNMS in order to have uniformity and also to leverage the existing expertise and experience available with PGAD in using Cacti®.

Cacti® has several distinct advantages as summarized below

- **Ease of installation:** It is based on the popular LAMP stack, which is available as a set of standard packages for most of the popular Linux distributions including RHEL.
- **Minimal dependencies:** It has minimal dependencies and pre-requisites as most of the required tools are available as a part of the operating system.
- **Highly scalable:** It has the provision to use either the built-in poller written in PHP: Hypertext processor (PHP), which is suitable for small to medium installations or spine poller written in C, which is faster and multi-threaded as it utilizes multi-tasking capabilities of modern operating systems and hardware and is suitable for large installations.
- **Highly extendable:** Using in-built plug-in architecture, Cacti®'s functionality can be extended and/or existing applications and modules can be integrated into it with minimal effort.
- **Sophisticated user management:** It has in-built provision for configuring fine-grained access control and management of users and groups. It offers two levels of permission control: realm permissions and graph permissions, which allows the administrator to control what the user can access, see and change.
- **Availability of templates and plug-ins:** It has plenty of existing templates and plug-ins for popular network devices and management functions.
- **Flexible web interface:** The WebUI of Cacti® is built on PHP/MySQL®, which is flexible and customizable. It also offers re-usability of the WebUI framework through Application programming interface (API) for seamless design, development and integration of custom user interface modules.

5.5.1.1 Development environment

The ICCT LNMS and the CNMS shall be designed and developed using the following development environment.

Ref #	Parameter	Specification or description
5.5.1.1.1	OS	Portable with out-of-the-box support for RHEL v7.8 (64-bit) or latest stable version as on date.
5.5.1.1.2	NMS framework	Cacti® (www.cacti.net)
5.5.1.1.3	Programming language	Server side: PHP, C/C++ Client side: JavaScript
5.5.1.1.4	Technologies	AJAX for interactive and responsive interface
5.5.1.1.5	Database	MySQL® / MariaDB®
5.5.1.1.6	Browser support	Mozilla® Firefox®, Google® Chrome®

5.5.1.2 Design features

The ICCT LNMS and CNMS software shall be designed and developed with the following features.

5.5.1.2.1 **Robust design:** The NMS software shall be designed to provide carrier class performance with high availability and high degree of fault-tolerance. The developed modules shall have extensive debug and notification capabilities, when enabled by the user, shall log events at various checkpoints to help in carrying out diagnosis and troubleshooting.

5.5.1.2.2 **Interactivity and responsiveness** The software shall be used 24x7 round the clock for months together. Hence the software shall be designed to be responsive and reliable under these continuous operating conditions. The events shall be updated both at LNMS and at CNMS with minimum delay. The user-interface shall not take more than a few seconds to respond to user-actions.

5.5.1.2.3 **Self-diagnostic capability** The NMS software shall be capable of monitoring its own resources including

- (a) CPU utilization
- (b) Memory utilization
- (c) Database connectivity and its utilization
- (d) Disk space
- (e) Network interfaces and connectivity
- (f) Required modules and services (HTTP server, database server etc)

5.5.1.3 Scalability

The NMS software architecture shall enable high scalability to cater to multiple clients and multiple processes. The design shall be modular enough for easy maintenance and high durability.

5.6 ICCT NMS deliverables

The deliverables for ICCT NMS and CNMS shall include the following

5.6.1 Documentation

The complete documentation of the software shall follow MIL-STD-498 (see [62]). The following documents shall be prepared and delivered after review and approval by PGAD for both ICCT LNMS and CNMS

5.6.1.1 SRS

5.6.1.2 IRS

5.6.1.3 SDD

5.6.1.4 STP including Integration test plan (ITP)

5.6.1.5 STD

5.6.1.6 STR

5.6.1.7 Software installation manual

5.6.1.8 Software user manual

5.6.2 Software

The application software including the following, shall be delivered

5.6.2.1 Source code of the software, inclusive of all pre-requisite libraries and tools

5.6.2.2 User-friendly installation utility

5.7 Other terms and conditions

5.7.1 Only software and platforms with valid and legitimate license shall be used for development and testing of ICCT LNMS and CNMS.

5.7.2 PGAD shall nominate an Independent verification and validation (IV&V) team, which shall be DRDO's internal agency. Along with NMS source code, all necessary libraries and packages, if any, used for development of NMS shall be provided for IV&V. During initial phase, IV&V shall be carried out at vendor place. IV&V for the final version shall be carried at Hyderabad after integration with ICCT systems. Schedule for IV&V to be proposed by the vendor considering the delivery timelines.

5.7.3 PGAD shall have unrestricted license to install and use the ICCT LNMS and CNMS software. There shall be no restriction on the number of installations and on the number of ICCTs managed by the CNMS.

5.7.4 All IPR related to the software shall rest with PGAD.

5.7.5 The contractor shall carry out installation and commissioning of the LNMS software in all ICCTs and of the CNMS at one location. LNMS and CNMS shall be loaded in different workstations. Existing workstations in ICCT only shall be used for the installation.

5.7.6 Comprehensive training of the users shall be provided with relevant subject material and presentation.

5.7.7 The software shall also be included in the warranty of the ICCT. During the warranty period, bug-fixes, enhancements and upgrades shall be provided free of cost.

This shall also include upgrades of Cacti as and when released by the Cacti community.

Chapter 6

Scope of supply

6.1 ICCT systems and subsystems

ICCTs shall be supplied as per quantity mentioned in the contract or supply order, each ICCT system consisting of items or subsystems including but not limited to the items enumerated in the following BoM.

Ref #	Item	Quantity	Remarks
6.1.1	Shelter with constituent items, subsystems, fitments and accessories as per subsection 2.1	1 Set	
6.1.2	Operator chairs	3 Nos	
6.1.3	19" equipment racks	8 Nos	4 Nos with 800 mm external depth & 4 Nos with 650 mm external depth
6.1.4	Industrial grade wet & dry dust extractor cum vacuum cleaner	1 Set	
6.1.5	Portable dehumidifier	1 Set	
6.1.6	Inspection lamp with 10 m long power cord	1 Set	
6.1.7	Power extension board with 10 m long cable and 4× 5 A sockets	2 Sets	
6.1.8	First-aid kit	1 Set	
6.1.9	LED floodlights	4 Sets	
6.1.10	Power extension board with 10 m long cable and 2× 15 A sockets	2 Sets	
6.1.11	Tool kit as per basic tools specified in 2.1.4.11	1 Set	
6.1.12	Variable speed hand-held drilling machine with drill bits	1 Set	
6.1.13	Soldering iron, 25 W	1 Set	

Ref #	Item	Quantity	Remarks
6.1.14	Crimping & connectorization tools for various connectors used	1 Set	
6.1.15	Indoor rack mounted 48 port single mode optical fiber LIU with LC connectors	1 No.	
6.1.16	Outdoor weather proof wall mounted 48 port single mode optical fiber LIU with LC connectors	1 No.	
6.1.17	Torque wrenches for SMA and other RF connectors used	2 Sets	
6.1.18	Lifting equipment and accessories (Load spreader beam, lifting lugs, textile slings etc)	1 Set	
6.1.19	Shoring formats for air transportation of truck-mounted ICCT	1	1 set of shoring formats is required for each transporter truck supplied
6.1.20	Lifting and leveling system	1 Set	
6.1.21	Ethernet inclinometer	1 Set	
6.1.22	Fire prevention, detection and fighting systems - Hydrogen gas detection system	1 Set	
6.1.23	Fire prevention, detection and fighting systems - VESDA	1 Set	
6.1.24	Fire prevention, detection and fighting systems - Clean agent fire extinguisher	3 No.	
6.1.25	UPS	1 Set	
6.1.26	Monitoring cameras and recording system	1 Set	2 indoor cameras, 2 outdoor camera, 1 NVR with storage & related accessories
6.1.27	Network equipment - Core switch	1 No.	
6.1.28	Network equipment - Edge router	5 No.	
6.1.29	Network equipment - Node switch	12 No.	
6.1.30	Computer workstation with accessories and OS	14 Sets	
6.1.31	Computer consoles, each with 2 displays, 2 thin client computers, keyboard and pointing device	3 Sets	
6.1.32	KVM over IP switch	1 Set	

Ref #	Item	Quantity	Remarks
6.1.33	VSAT systems - C-band VSAT antenna system	1 Set	
6.1.34	VSAT systems - Ku-band VSAT antenna system	1 Set	
6.1.35	VSAT systems - VSAT ACU	2 Sets	1 set each for C-band & Ku-band VSAT antennas
6.1.36	VSAT systems - C-band BUC system with 1:1 hot-standby	1 Set	
6.1.37	VSAT systems - C-band LNB system with 1:1 hot-standby	1 Set	
6.1.38	VSAT systems - Ku-band BUC system with 1:1 hot-standby	1 Set	
6.1.39	VSAT systems - Ku-band LNB system with 1:1 hot-standby	1 Set	
6.1.40	VSAT systems - SCPC PAMA modems with 1:1 hot standby	2 Pairs	1 pair for C-band & 1 pair for Ku-band VSAT systems
6.1.41	VSAT systems - Active RF splitters	3 Sets	
6.1.42	VSAT systems - Active RF combiners	3 Sets	
6.1.43	Point to multipoint LOS link	Nil	Provision to be made for installation and integration of 1 base unit, which shall be provided by PGAD
6.1.44	Antenna mast	2 Sets	
6.1.45	Antenna positioning unit (pan/tilt units)	3 Sets	
6.1.46	HVAC sets	2/3 Sets	Either 2 or 3 sets may be proposed based on HVAC capacity and thermal calculations and finalized during design review
6.1.47	NBC filtration system	1 Set	
6.1.48	BEUs	12 Sets	
6.1.49	Data diodes	Nil	Units not to be supplied. Provision to be made for installation of 2 units by PGAD
6.1.50	NTP clock display	1 Sets	
6.1.51	Ethernet hygro-thermometer unit	2 Sets	
6.1.52	Ethernet carbon-dioxide concentration monitoring unit	2 Sets	

Ref #	Item	Quantity	Remarks
6.1.53	Differential pressure monitoring unit	1 Set	Required only if not included as a part of NBC filtration system
6.1.54	VoIP system - VoIP phone	6 Sets	
6.1.55	Power distribution and monitoring panel	1 Set	
6.1.56	Vehicle mounted Ethernet weather station	1 Set	
6.1.57	Lightning warning system	1 Set	
6.1.58	OTDR	1 Set	
6.1.59	Optical fiber splicing kit	1 Set	
6.1.60	Optical power meter	1 Set	
6.1.61	Optical fiber visual fault locator	1 Set	
6.1.62	1 GE/10 GE Ethernet tester	1 Set	
6.1.63	Fiber optic connector cleaning and inspection kit	1 set	
6.1.64	Hand-held laser based range finder	1 Set	
6.1.65	Hand-held GNSS receiver	1 Set	
6.1.66	Hand-held inclinometer	1 No.	
6.1.67	Hand-held lensatic sighting compass	1 No.	
6.1.68	Hand-held microwave analyzer	1 Set	
6.1.69	Digital multimeter cum clamp-meter	1 Set	
6.1.70	Occupational safety - Industrial helmets	4 Sets	3 medium & 1 large size
6.1.71	Occupational safety - Safety gloves	4 Pairs	2 pairs of 270 mm length, 2 pairs of 360 mm length
6.1.72	Occupational safety - Eye protection - Safety glasses	2 Pairs	
6.1.73	Occupational safety - Eye protection - Laser safety glasses	2 Pairs	
6.1.74	Occupational safety - Ear protection equipment	4 Sets	To be supplied if necessary as per MIL-STD-1474
6.1.75	Occupational safety - Wearable head-lamp	2 Sets	
6.1.76	Occupational safety - Safety harness for ladder climbing	2 Sets	
6.1.77	Surge protection device with in-built grounding device	1 Set	

Ref #	Item	Quantity	Remarks
6.1.78	Fiber optic cable drum	6 Sets	4 sets with at least 1 km fiber length and 2 sets with at least 200 m fiber length
6.1.79	TWSTFT system	1 Set	
6.1.80	Multi-GNSS location sensing & compass system	1 Set	
6.1.81	Transportation data logger	2 Sets	
6.1.82	Serial device server	1 Set	
6.1.83	Earth ground measurement kit	1 Set	
6.1.84	Portable two-way radio set	1 Set	Each set consisting of 3 transceivers
6.1.85	Miscellaneous RF items	Assorted	As per paragraph 2.6.37.1
6.1.86	Miscellaneous networking items	Assorted	As per paragraph 2.6.37.2
6.1.87	Data-link subsystems	Assorted	As per paragraph 2.6.38
6.1.88	Air-conditioner sets for static ICCT building	Nil	Optional items as per para 2.7
6.1.89	Air-conditioner sets for antenna room	Nil	
6.1.90	Room heaters for static ICCT building and antenna room	Nil	
6.1.91	Static C-band VSAT antenna system	Nil	
6.1.92	Static Ku-band VSAT antenna system	Nil	
6.1.93	Node switch for antenna room	Nil	
6.1.94	5 kVA UPS with 1:1 load sharing redundancy for antenna room	Nil	
6.1.95	19-inch rack for antenna room	Nil	
6.1.96	RF-over-fiber system for connectivity between antenna room and staticICCT building	Nil	

6.1.97 Any other items necessary to meet essential requirements but not explicitly mentioned in the BoM above shall be deemed to be implicit parts of the scope of supply. Requirement of mechanical or electrical tools required for day to day operation or user-level maintenance of the equipment in ICCT shall be considered as an implicit requirement. Itemized cost of such items shall be shown separately in the commercial bid.

6.1.98 Transporter trucks meeting requirements enumerated in this document, as per quantity mentioned in the contract or supply order shall be supplied.

6.2 Documentation and software

The following documents and software shall be delivered at various stages of work under the contract. Documents, unless otherwise mentioned, shall be delivered in printed-and-bound format as well as soft-copies in source format and PDF.

- 6.2.1 Role identification document with amendments, if any
- 6.2.2 Duly approved requirements document
- 6.2.3 Duly approved preliminary design document
- 6.2.4 Duly approved QA plan document
- 6.2.5 Duly approved test procedures document
- 6.2.6 Duly approved maintenance plan document
- 6.2.7 Duly approved detailed design document
- 6.2.8 Duly approved qualification and acceptance test reports for ICCT
- 6.2.9 Warranty certificates including details of all items covered by warranty
- 6.2.10 Annual reports with details of warranty repairs, maintenance actions, problem areas etc for the duration of warranty
- 6.2.11 Mechanical drawings, electrical drawings, schematic drawings, BoM, assembly instructions etc for ICCT mechanical assemblies and electrical circuits in printed and bound format as well as in source format
- 6.2.12 Operator's manuals & installation manuals for all subsystems
- 6.2.13 Command interface or NMS interface definition for subsystems wherever applicable
- 6.2.14 OEM provided software and utilities related to all subsystems
- 6.2.15 ICCT NMS deliverables as per section 5.6.
- 6.2.16 CBT package

Glossary of abbreviations

AC	Alternating current.
ACU	Antenna control unit.
AEP	Allied engineering publication.
AJAX	Asynchronous JavaScript and XML.
AMC	Annual maintenance contract.
ANSI	American National Standards Institute.
API	Application programming interface.
APSK	Amplitude and phase shift keying.
ARP	Address resolution protocol.
ARS	Airborne receiver system.
ASTM	American Society for Testing and Materials.
AT	Acceptance testing.
ATP	Acceptance test procedure.
ATS	Automatic transfer switch.
BEL	Bharat Electronics Limited.
BER	Bit error ratio.
BERT	BER test.
BEU	Bulk encryption unit.
BoM	Bill of materials.
bpp	Bits per pixel.
BPSK	Binary phase shift keying.
BTP	Built to print.
BTR	Beacon tracking receiver.
BTS	Built to specification.
BUC	Block up converter.
CBRN	Chemical, biological, radiological and nuclear.
CBT	Computer based training.
CDP	Cisco® discovery protocol.
CMVR	Central motor vehicles rules.
CNMS	Central NMS.
CoC	Certificate of compliance.
COLPRO	Collective protection.
COTS	Commercial off-the-shelf.
CPU	Central processing unit.
DC	Direct current.
DCMM	Director, Contracts and Material Management.
DDR4	Dual data rate, fourth generation.
DHCP	Dynamic host configuration protocol.

DMC	Digital magnetic compass.
DNA®	Digital network architecture.
DOE	Double open-end.
DoS	Denial of service.
DRDO	Defence Research and Development Organisation.
DS	Dispersion shifted.
DVD	Digital versatile disc.
ECC	Error correcting code.
EMC	Electromagnetic compatibility.
EMI	Electromagnetic interference.
EPL	Equipment protection level.
ESS	Environmental stress screening.
ETA	Equipment type approval.
FAB	Failure analysis board.
FAT	Factory acceptance testing.
FCAPS	Fault, Configuration, Accounting, Performance & Security.
FEC	Forward error correction.
FTP	File transfer protocol.
GE	Gigabit Ethernet.
GLONASS	Global Navigation Satellite System.
GNSS	Global navigation satellite system.
GPS	Global positioning system.
GST	Goods and services tax.
GUI	Graphical user interface.
GVW	Gross vehicle weight.
HCFC	Hydrochlorofluorocarbon.
HD	High definition.
HDD	Hard disk drive.
HEVC	High efficiency video coding.
HFC	Hydrofluorocarbon.
HTTP	Hypertext transfer protocol.
http	Hypertext transfer protocol.
HTTPS	Hypertext transfer protocol secure.
https	Hypertext transfer protocol secure.
HVAC	Heating, ventilation and air conditioning.
ICAO	International Civil Aviation Organization.
ICCT	Integrated Communication and Command Terminal.
ICD	Interface control document.
ICMP	Internet control message protocol.
IEC	International Electrotechnical Commission.
IEEE	Institute of Electrical and Electronics Engineers.
IMT	International mobile telecommunications.
INSET	In-situ environmental test.
IP	Ingress protection.
IP	Internet protocol.
IPFIX	Internet Protocol Flow Information Export.
IPR	Intellectual property rights.
IPS	Intrusion protection system.

IPv4	Internet protocol version 4.
IPv6	Internet protocol version 6.
IRNSS	Indian Regional Navigation Satellite System.
IRS	Interface requirement specification.
IS	Indian standard.
ISEA	International Safety Equipment Association.
ISO	International Organization for Standardization.
ITP	Integration test plan.
ITU	International Telecommunication Union.
IV&V	Independent verification and validation.
JSON	JavaScript object notation.
JSS	Joint Services standard.
kmph	Kilometers per hour.
KVM	Keyboard, video and mouse.
LAMP	Linux, Apache®, MySQL® & PHP.
LAN	Local area network.
LC	Lucent® connector.
LCD	Liquid crystal display.
LDPC	Low density parity check.
LED	Light emitting diode.
LEL	Lower explosive level.
LFH	Low fire hazard.
LIU	Line interface unit.
LLDP	Link layer discovery protocol.
LNB	Low noise block.
LNMS	Local NMS.
LO	Local oscillator.
LOS	Line of sight.
MAF	Manufacturer's authorization form.
MCB	Miniature circuit breaker.
MIB	Management information base.
MM	Multi-mode.
MSA	Multi-Source Agreement.
MTCTE	Mandatory testing and certification of telecom equipment.
NAT	Network address translation.
NATO	North Atlantic Treaty Organization.
NavIC	Navigation with Indian Constellation.
NBC	Nuclear, biological and chemical.
NBD	Next business day.
NBI	North bound interface.
NCR	National Capital Region.
NIC	Network interface card.
NMEA	National Marine Electronics Association.
NMS	Network management system.
NOC	Network operations centre.
NRE	Non-recurring expenditure.
NTP	Network time protocol.
NVR	Network video recorder.

NZDS	Non-zero dispersion shifted.
ODF	Open document format.
OEM	Original equipment manufacturer.
ONVIF	Open Network Video Interface Forum.
OS	Operating system.
OTDR	Optical time-domain reflectometer.
PAMA	Pre-assigned multiple access or Permanent assignment multiple access.
PAS	Profile alignment system.
PCB	Printed circuit board.
PCIe	Peripheral component interconnect - Express.
PDF	Portable document format.
PDP	Power distribution panel.
PDR	Preliminary design review.
PDU	Power distribution unit.
PGAD	Programme 'AD'.
PHP	PHP: Hypertext processor.
PLL	Phase locked loop.
PoE	Power over Ethernet.
POET	Post environmental (functional) test.
ppm	Parts per million.
PRBS	Pseudo-random binary sequence.
PRC	Progress review committee.
PREET	Pre-environmental (functional) test.
PTMP	Point to multi-point.
QA	Quality assurance.
QAM	Quadrature amplitude modulation.
QC	Quality control.
QoS	Quality of service.
QPSK	Quadrature phase shift keying.
QT	Qualification testing.
QTP	Qualification test procedure.
R&QA	Reliability and Quality Assurance.
RAID	Redundant array of independent disks.
RAM	Random access memory.
RCI	Research Centre Imarat.
RF	Radio frequency.
RFC	Request for comments.
RFP	Request for proposal.
RH	Relative humidity.
RHEL	Red Hat® Enterprise Linux®.
RMS	Root mean square.
RTI	Right to Information.
RU	Rack unit.
RWRS	Rigid wall relocatable structure.
SAT	Site acceptance testing.
SBI	South bound interface.
SBU	Strategic business unit.
SCPC	Single channel per carrier.

SDD	Software design document.
SFP	Small form-factor pluggable.
SFTP	Secure file transfer protocol.
SLA	Service level agreement.
SM	Single mode.
SMA	Sub miniature version A.
SMS	Short message service.
SNMP	Simple network management protocol.
SPM	Surge protection measures.
SRS	Software requirement specification.
SSD	Solid state drive.
SSH	Secure shell.
SSPA	Solid state power amplifier.
SSQAG	Strategic Systems Quality Assurance Group.
SSTU	Spread spectrum transmitter unit.
STD	Software test document.
STP	Software test plan.
STR	Software test report.
TACACS	Terminal access control access control system.
TCP	Transmission control protocol.
TFTP	Trivial file transfer protocol.
TMN	Telecommunication management network.
TNC	Threaded Neill-Concelman.
TWSTFT	Two-way satellite time and frequency transfer.
UDP	User Datagram Protocol.
UI	User interface.
UoM	Unit of measure.
UPS	Uninterruptible power supply.
USB	Universal serial bus.
UUT	Unit under test.
UV	Ultra violet.
VAF	Volt, Ampere, frequency.
VESDA	Very early smoke detection apparatus.
VGA	Video graphics array.
VLAN	Virtual LAN.
VoIP	Voice over Internet protocol.
VOX	Voice operated exchange.
VSAT	Very small aperture terminal.
VSWR	Voltage standing wave ratio.
WAN	Wide area network.
WDR	Wide dynamic range.
XML	Extensible markup language.

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Earnest Money Deposit (EMD) cum Pre-Contract Integrity Bond (PCIB)

To,
The Programme Director,
Programme – AD (PGAD),
Dr. A P J Abdul Kalam Missile Complex,
Kanchanbagh (P.O), Hyderabad – 500 058.

Whereas M/s _____ (hereinafter called the "Bidder") has submitted their offer dated _____ for the supply of DESIGN AND REALIZATION OF ICCT (hereinafter called the "Bid") against the Buyer's Request for Proposal (RFP) No. _____ dtd. _____ Know all men by these presents that we (Banker) _____ of M/s _____ having our registered office at _____ are bound unto The Director, Research Centre Imarat (RCI), Vignyana Kancha, Hyderabad – 500 069 (hereinafter called the "Buyer") in the sum of Rs. 5,72,61,270/- for which payment will and truly to be made to the said Buyer. The Bank binds itself. Its successors and assigns by these presents.

Sealed with the Common Seal of the said Bank this xxth day of _____ 2025.

The conditions of obligations are: -

1. If the Bidder withdraws or amends, impairs or derogates from the bid in any respect within the period of validity of this Bid.
2. If the Bidder having been notified of the acceptance of his Bid by the Buyer during the period of its validity.
 - a. If the Bidder fails to furnish the required Performance Bond/ Performance-cum-Warranty Bond for the due performance of the contract.
 - b. Fails or refuses to accept/execute the contract.
3. If the bidder violates the provisions of Pre-Contract Integrity Pact (PCIP).

We hereby expressly, irrevocably and unconditionally undertake to pay the Buyer up to the above amount upon receipt of its first written demand, without the Buyer having to substantiate its demand, provided that in its demand the Buyer will note that the amount claimed by it is due to it owing to the occurrence of one or more of the conditions, specifying the occurred condition(s).

We further agree that any change in the constitution of the bank or the constitution of the Seller shall not discharge our liability hereunder.

This guarantee will remain in force till (One year from the date of BG), and any demand in respect thereof should reach the Bank not later than the above date. This guarantee (EMD) would be extended from time to time as required by the Buyer and agreed by the Bidder.

NOTWITHSTANDING ANYTHING CONTAINED THEREIN

- a. Our liability under this Bank Guarantee shall not exceed INR 5,72,61,270/- (Rupees five crore seventy two lakh sixty one thousand two hundred seventy).
- b. This Bank Guarantee shall remain in force up to (One year from BG date).
- c. We are liable to pay the guaranteed amount or any part thereof under this bank guarantee only and only if a written claim or demand, served by you in accordance with the terms of this bank guarantee, is received by us on or before 5 P.M on or before <date> at _____ <Branch Address>. Thereafter, your right to claim under this bank guarantee shall be forfeited once and forever and we shall be relieved from all our liabilities hereunder irrespective of whether the original bank guarantee has been returned to us or not

(Signature with Date of the authorized officer(s) of the Bank)	
Name and designation of the officer(s)	
Seal, name & address of the Bank and address of the Branch	

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To,
The Programme Director,
Programme – AD (PGAD),
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(Signature with Date of the authorized officer(s) of the Bank)	
Name and designation of the officer(s)	
Seal, name & address of the Bank and address of the Branch	