D4.4 - Modular Laboratory RRML Platform

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Abbreviations

Abbreviation	Description
RRML	Rapid Response Mobile Laboratory
CLF	Central Laboratory Facility
ICT	Information and Communication Technology
LAN	Local Area Network
WAN	Wide Area Network
PPE	Personal Protection Equipment
WHO	World Health Organization
FTX	Field Test Exercise
LIMS	Laboratory Information Management System
SPOF	Single Point Of Failure
WAP	Wireless Access Point

Executive Summary

This document provides comprehensive designs, technical drawings as well as details regarding the procedures followed for the Realization and Development of a Next Generation Self-contained Type IV RRML. The laboratory is based upon a modular, scalable Box-oriented approach according to which different Enclosures can be combined to meet the required throughput and conform with different operational conditions. Three Enclosure types are capable of aligning with the functional requirements described above:

- The Main Central Laboratory Facility (CLF1) Enclosure
- The Central Laboratory Facility Extension Enclosure (CLF2) and
- The Information and Communication Technology (ICT) Enclosure

The Laboratory modules may work either in combination or in standalone formation, providing enclosed laboratory workspace and throughput according to the field-testing requirements.

To tackle the challenges of highly contagious pathogen testing, CLF1 features a glovebox side via which sample collection is executed without direct tester-subject contact. This approach ensures minimum to zero exposure of the laboratory personnel. CLF2 may be used both as an individual laboratory practicing typical field testing, as well as an extension of the Main Facility. When attached, both Enclosures act as one cohesive field-testing laboratory. The ICT Enclosure may be deployed further apart from the laboratory Enclosures providing adequate separation from any sources of contamination. This Enclosure facilitates the information technology infrastructure that is essential for the data interconnection of ONELAB's modules and their communication with the outside world via Local Area Network (LAN), Wide Area Network (WAN) and Wireless Network (WiFi). The ICT module ensures both wired and wireless network communications for ONELAB. Internet access is available to all modules via wired Ethernet interconnections (on-site Data Drop), Satellite infrastructure and 4G/5G network. All three means of communication coexist in a firewall protected and fail-safe system that ensures network availability at all times provided one of the above technologies is accessible on-site. In the unlikely event of unavailability of all mentioned means of connection, the ICT module provides ample and redundant storage for the collected data that may be transmitted as soon as internet access is regained.

ONELAB's modules are allocated within the Enclosures. The deployment architecture may vary according to the scenario making the realization highly adaptable to the operational requirements that shall be met. An overview of the modules is presented below.

R	**Recruitment.** Patient reception, Information, shelter. Partitioning, Data-collection, consent, questions and answers, and welfare	T	**Triage** Spot temperature and symptomatic scoring.
ICT	**Information and Communication Technology.**Patient data collection, LIMS, Test Results and GIS services, Data uploads	VOC	Analysis of VOC, GC-IMS, sensor array.
S-VOC	Sampling for volatile organic compounds.	D	**Dispensary** Sampling kits, information
S-B	Dried blood spot sampling	CLF	**Central Laboratory Facility** for remote processing of samples
S-PCR	Nasal pharyngeal swab sample for PCR analysis.	DECON	**Biosecurity** Don PPE, Decontaminate, Doff PPE, Shower and change.

The correlation between the RRML realization, its attributes and the modules allocated within it, may be vividly described by the following graphic (Figure 1).

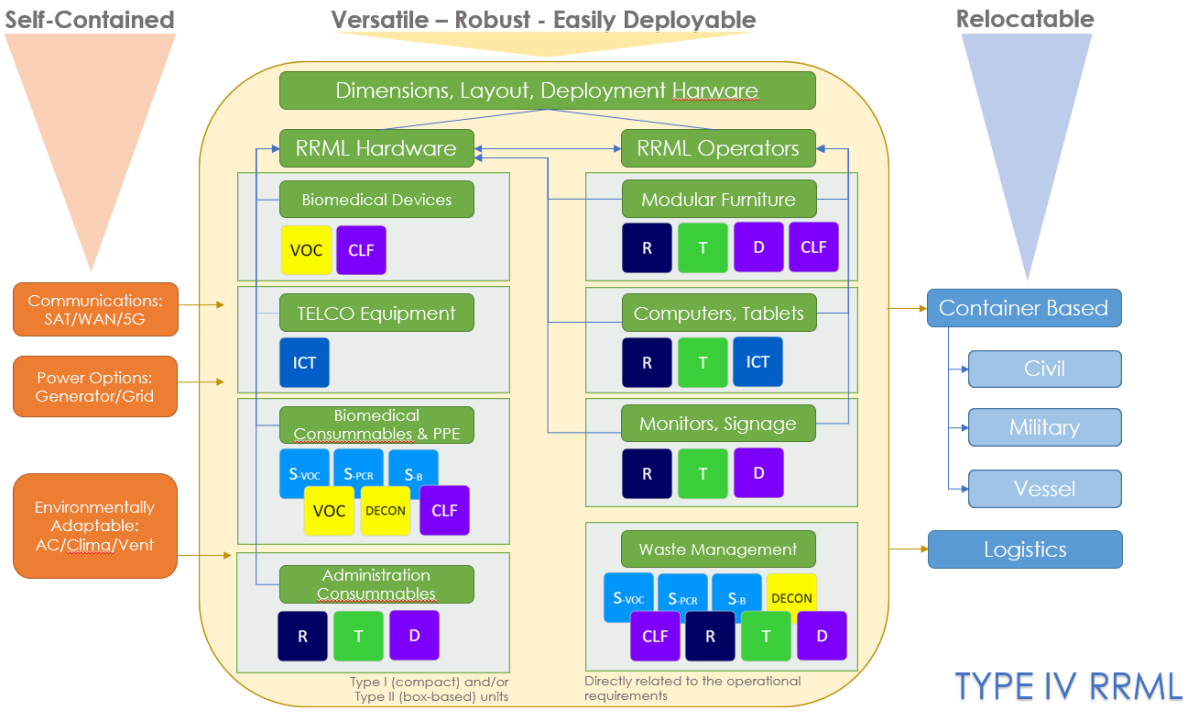


Figure 1 Modules allocation within the RRML & RRML attributes.

The RRML is self-contained in terms with Communications, Powering Options and Environmental Adaptability. Apart from ensuring robustness, the Enclosure based concept also adds to the versatility of the realization, as the Enclosures themselves possess modular attributes. The RRML may be deployed as a multi-purpose laboratory facility featuring different variations for testing and analyses, pre-configured and planned in detail according to the operational requirements of every scenario. The layout and footprint of the laboratory are directly linked to the required throughput, the quantities and types of equipment and technology that shall be used. These in turn indicate the personnel numbers, the consumables' quantities (PPE, Waste Management, perishables etc) and the decontamination procedures.

The ONELAB RRML is a small-volume, standard container-based solution relocatable via civil/military vehicles or vessels. The transportation and deployment logistics are governed by the international procedures of container transportation. Such an approach ensures worldwide familiarity that enhances the possibilities of ONELAB being an adopted RRML solution by various peers.

With respect to all aspects governing the design, deployment and utilization of the ONELAB RRML, the R&D process behind the described Enclosure approach, has focused in addressing key points governing the operation of similar realizations, involving the versatility, robustness, ease of relocation, setup, modularity and scalability. The demonstrated RRML aims to provide advancements for the next generation of mobile laboratories that shall feature sophisticated medical equipment for viral infection, detection and analyses. Apart from the Designs,

Technical/Drawings and the produced RMML prototype, the efforts of Task 4.3 during its allocated period, may be summarized under the following pillars:

- Exploration of the Principles & Standards governing contemporary Laboratory and Mobile Laboratory deployments
- Technical requirements analysis and integration aspects of the Equipment & Technology hosted in the RRML
- Exploration, clarification and alignment with End-User Specifications, Expectations and Feedback
- Logistics, Architecture, Requirements and Procedures that shall be followed during deployment and operation of the RRML
- Achievable Scalability and Modularity
- Power Requirements and Powering options.
- Communications options and communications resilience
- Accessibility and Inclusion
- Carbon footprint and Waste minimization
- Achievable Innovations
- Future Improvement / Further Development aspects

1. Introduction

ONELAB's Next Generation Self-contained Type IV RRML is a modular laboratory based upon a scalable enclosure-oriented approach that aims to provide advancements in Pandemic management. The RRML, apart from widely adopted contemporary methods, shall accommodate the latest, next-generation technology in test systems and exhibit increased effectiveness in mass community testing, essentially becoming an invaluable tool for health crises' management. The prototype documented herein (deliverable D4.4), provides the foundations to host this technology in terms of infrastructure, ergonomics and communications. Moreover, the modular RRML realization proposed by ONELAB features advancements in scalability and adaptability to various operational conditions, catering for increased personnel welfare, including the minimization of exposure to contamination sources and the resistance to demanding environmental conditions. ONELAB's RRML has been designed in close collaboration with technology providers, first-responders and end-users to pinpoint, address and solve as many operational challenges as possible.

2. Purpose of the document

This document stands as a comprehensive supportive report, documenting ONELAB's RRML research and development process. It describes the methodology employed during the development of the Prototype and the principles followed for its production. Moreover, it briefly presents the findings of earlier, conceptual versions of the RRML that were used to advance towards the demonstrated Prototype.

The design process is analytically broken down by Enclosure and addresses the key inputs incorporated such as the End-User Specifications and the technical details extracted for Communications, Power Requirements and Accessibility with respect to the modules.

The extent of customization and modularity of the RRML, as well as the logistics for its deployment, are demonstrated with respect to the "Hard Winter" FTX Scenario in the implementation section.

Conclusively, this report shall also provide a 'lessons learnt' section and insights for future improvements on the RRML prototype.

3. RRML Design Methodology

Prior to developing the RRML, a series of research tasks have been carried out to identify and address the challenges related to mobile laboratories and the new technology that ONELAB introduces to this concept.

Mobile Laboratories Characteristics and Classification

The World Health Organization (WHO) classifies Rapid Response Mobile Labs via a three-layer system which essentially addresses their Capability, Throughput, Biosafety, Mobility, Logistics Requirements and Capacity.[1]

Table 1 WHO Layer Classification System for RRMLs

LAYER 1 Common requirements and features that are consistent across all types of RRMLs	LAYER 2 Discriminatory variables across types of RRMLs	LAYER 3 Flexibility, interoperability and scalability to define capacity of the RRMLs
QMS and minimum quality standards	**Capability** to manage laboratory activities, perform sample management, conduct testing and analysis for routine and surge capacity, support public health investigations and report results	**Capacity** consists of output services completed over a defined period for each capability
LIMS and data exchange	**Troughput** with respect to the analysis, processing or testing of multiple samples	
	Biosafety and biosecurity, the ability to handle and/or inactivate pathogens of different risk groups	
	Mobility and logistic requirements	

With respect to the the classification system presented in Table 1, the RRMLs are discriminated into five types (I-V). The definition for each RRML type is listed below for reference [1][2].

- **RRML TYPE I**: “Highly mobile, compact laboratory units. Equipment can be expanded and composed of 1–3 individual units” - Backpack realizations
- **RRML TYPE II**: “Box-based mobile laboratory units. Equipment can be expanded and composed out of more than 3 individual units” - Box-based realizations
- **RRML TYPE III**: “Self-contained medium-scale laboratories in mobile vehicles that are generally single units” - Box-based realizations
- **RRML TYPE IV**: “Self-contained large mobile laboratories depending on mission needs and desired capacities”- Container-based realizations
- **RRML TYPE V**: “Full-scale self-contained laboratories for stationary or mobile diagnostics that can be expanded and composed of more than one laboratory”- Container-based realizations

In a next-generation scalable laboratory realization, such as ONELAB, various different diagnostic modules are facilitated to achieve a tailored response with respect to the mission. These modules are characterized by the equipment, the procedures, the consumables and the related operational expertise. Each module is in turn categorized accordingly with respect to its biosafety, the laboratory space needed, the logistics and its minimum standards. (Figure 2) [2]

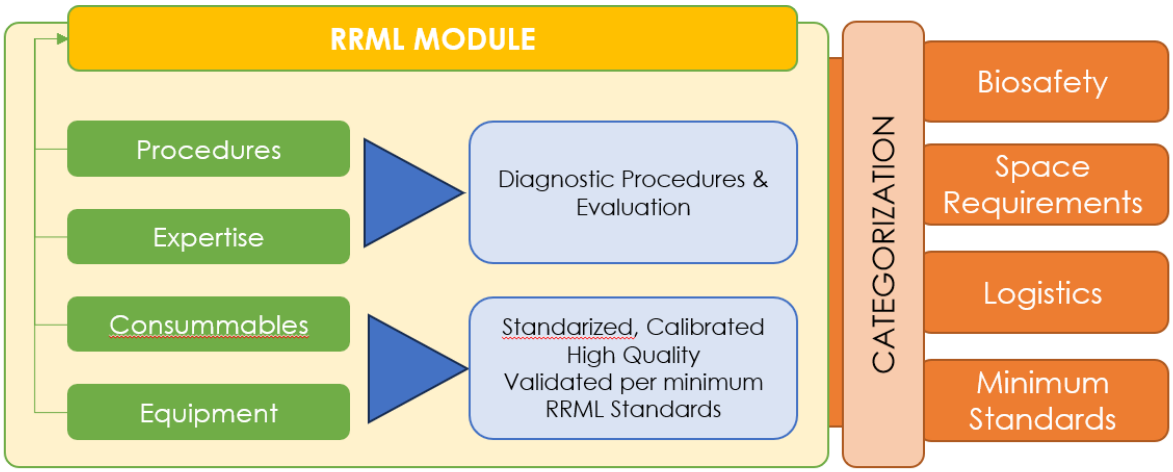


Figure 2 RRML Module Characterization and Categorization

RRML Equipment and Technology Categorization

Various types of different technologies coexist within the RRML, with each piece of equipment serving different operations. Apart from the medical devices and the procedures related with them, a considerable volume of hardware needs to be integrated in ONELAB to provide full functionality during operations. The relationship between every part has therefore been clarified and categorized during the integration process. The described correlations are efficiently depicted in Figure 3 below.

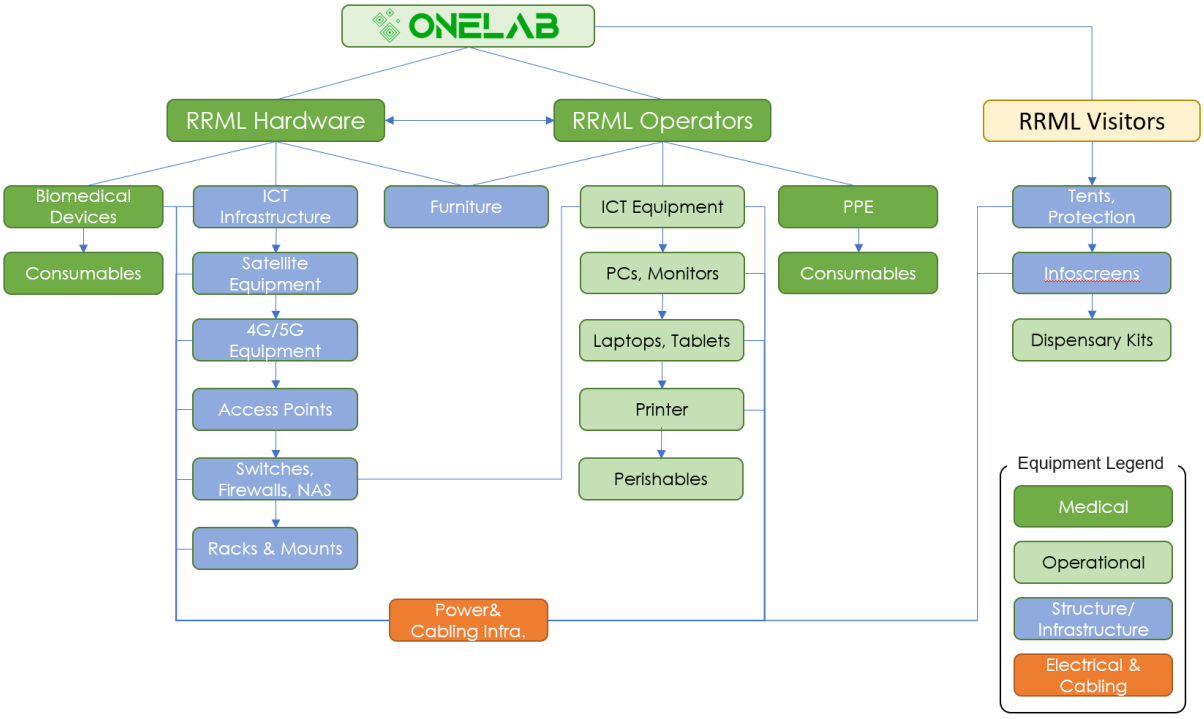


Figure 3 RRML Equipment Correlations

The throughput required from the RRML is essentially what defines the hardware to be deployed, the number of operators and the number of patients that shall be tested. These are three key variables that in turn affect the number of modules, each of them applicable to different core parts of the realization. The RRML hardware is split into three main categories:

- **Structural & Infrastructure Equipment**: ONELAB's permanent structure, Tents, Communications Core Equipment, Information Screens, Power and Network infrastructure, Racks and Furniture
- **Medical Equipment**: Medical Devices and peripherals, Personal Protection Equipment, Consumables, Decontamination Equipment and other perishables
- **Operations Equipment**: Equipment that is directly related to ONELAB's functionality but is not medical, such as PCs, Laptops, Monitors, Tablets, Printers, Office material, Dispensary Kits and any other perishables

RRML Equipment and Technology Integration Aspects

Apart from the main distinctions described previously, the equipment is subcategorized as **Integrated** or **Portable** to assist in its evaluation and extract efficient methods of allocating it within the RRML. Consequently, sensitive equipment (such as advanced technology, electronics etc) and insensitive equipment is approached differently regarding its integration, its storage and its transportation planning.

Additionally, both the equipment and the consumables have been listed by Module to distinguish key information such as quantity, size, weight, volume and energy consumption wherever applicable. The integration details for every part are then derived and successfully applied in the design and manufacturing of the RRML (Figure 4).

MODULE	EQUIPMENT	Quantity	Interior Dimensions	Exterior Dimensions	Weight
R + T			L x W x H/D	L x W x H/D	
	- Tablet Model: Samsung Galaxy Tap Active5 (**reference:** https://www.samsung.com/gr/business/tablets/galaxy-tab-active/galaxy-tab-active5-5g-enterprise-edition-128gb-sm-x306bzgaeee/)	1	126.8x213.8x10.1mm		433 g
1) Recruitment **2) Triage**	- Printer Model: (**reference**: https://www.canon.com.cy/printers/pixma-tr150-with-battery/specifications/) - A4 Paper Size: Width x Height (in mm): 210 x 297	1	Approx. 322x210x66mm		approx. 2.3 kg
COMMON EQUIPMENT FOR RECRUITMENT & TRIAGE **1) TABLET** **2) CASE FOR CONSUMABLES** **2) SANITIZER DISPENSER**	Zarges *(ORDER NUMBER : 45056)* (reference: https://www.zarges.com/en/products/y-case-and-sanpack) - For Consumables : Probably **ORDER NUMBER : 45052**	O.N. : 45056 -> 1 O.N. : 45052 -> 1	ZARGES **45056** 1.175×793×465mm ZARGES **45052** : 570×380×466 mm	ZARGES **45056** : 1.215×833×516 mm ZARGES **45052** : 615×420×516mm	ZARGES **45056** Empty: 22 kg ZARGES **45052** Empty: 7.6 kg
	- SAMSUNG MONITOR 43" (700 nit) | (**reference:** https://www.samsung.com/uk/business/smart-signage/uhd-4k-signage/crystal-uhd-signage-qhc-lh43qhce-bgcxen/)	1	Set: 969.5x557.8x28.5 mm		Set with Stand: 9.3 kg
	1 tent: **final option:** https://www.lanco-tents.com/arz-20	1	final option: Base area: 21.00 m² , 5.50x3.90x2.00m (Eaves) or x2.95m (Ridge)		final option: 82.00 kg
	sanitizer dispenser (**reference**: https://www.vaza.gr/en/automatic-hand-sanitizer-dispenser-with-floor-stand.html)	1	Height: 160 cm, Capacity: 1200 ml		

	- Alternative: Zarges *(ORDER NUMBER : 45050)* (**reference** https://www.zarges.com/en/products/y-case-and-sanpack)	1	ZARGES **45050** 570×380×220mm	ZARGES **45050** 615×420×270mm	ZARGES **45050** 6.4 kg
	- Thermal Camera: (Avigilon, Hikvision,Bosch) (**reference:** https://www.hikvision.com/en/products/Access-Control-Products/Face-Recognition-Terminals/Ultra-Series/ds-k1t671tm-3xf-/) - Oximeter: (**reference**: https://ihealthlabs.com/products/ihealth-air-pulse-oximeter) - Digital Ear Thermometer: (**reference**: https://ap.braunhealthcare.com/product/thermoscan-7-irt6520/) - Ear Thermometer Probe Covers: (**reference**: https://www.desertcart.com.cy/products/1136225-braun-thermo-scan-lens-filters-for-ear-thermometer-disposable-covers-lf-40-us-01-40-count) - Classic Forehead Thermometer: (**reference**: https://medical.gr/iatrikes-syskeyes-iatrika-ergaleia/epaggelmatika-thermometra/thermometro-anepafis-metrisis-jumper-fr202.html)	Thermal Camera -> 1 Oximeter -> 1 Digital Ear Thermometer -> 1 Ear Thermometer Probe Covers -> 1 pack Classic Forehead Thermometer: 1	Thermal Camera: 116.5x282.78x36.7mm , Screen 17.8 cm Oximeter: Machine size: 62x33x28mm Digital Ear Thermometer: 145x34.9x55.5mm		
	- Heater Inhag : **reference** : https://www.inhag-zelte.de/en/1861-2/oil-heater-type-thw-oeh-25-f/	1	1193x398x796 m (including exhaust)		72 kg

Figure 4 Research Table Example, during Equipment Categorization

Ref Nr	MODULE	ATTRIBUTES	DESCRIPTION	QTY	MAKE	MODEL
Recruitment & Triage Module						
1	Recruitment & Triage	Portable	Folding Rescue Tents - FRZ 33	1	Lanco	FRZ 33
1.1	Recruitment & Triage	Portable	Convectors	1	DeLonghi	HSX2320F
1.2	Recruitment & Triage	Portable	Lights for tent 1,20m LED	4	Drakakis	-
1.3	Recruitment & Triage	Portable	Ballast kit	4	Lanco	FRZ 33 Ballast kit
1.4	Recruitment & Triage	Portable	PLUG 3X16 MALE	4	Drakakis	
1.5	Recruitment & Triage	Portable	PLUG 3X16 FEMALE	4	Drakakis	
1.6	Recruitment & Triage	Portable	3X10 RUBBER CABLE	90	Drakakis	
1.7	Recruitment & Triage	Portable	SCHUKO SUPPLY 15m	4	Drakakis	
1.8	Recruitment & Triage	Portable	6 Pieces Motorola Talkabout T82 Extreme Wireless Transceivers	1	Motorola	T82
2	Recruitment & Triage	Portable	Galaxy Tab Active5 5G Enterprise Edition	1	Samsung	Tablet
3	Recruitment & Triage	Portable	Canon PIXMA TR150 with battery	1	Canon	PIXMA TR150

4	Recruitment & Triage	Portable	Aluminum storage case	1	Alubox	A 415
5	Recruitment & Triage	Portable	Aluminum storage case	1	Alubox	S 020
6	Recruitment & Triage	Portable	Aluminum storage case	1	Alubox	A 042
6.1	Recruitment & Triage	Portable	Clip-on castors (ZARGES - stable box wheels, with safety)	2	Zarges Hellas	40741
6.2	Recruitment & Triage	Portable	Clip-on castors (ZARGES - rotating box wheels, with safety)	2	Zarges Hellas	40742
7	Recruitment & Triage	Portable	Resolution : 3,840 x 2,160 (UHD) Brightness (Typ.) : 500 nit The carbon footprint of this product has been measured and certified. webOS Smart Platform, 24/7 Operation	1	LG	43UH5N-E
7.1	Recruitment & Triage	Portable	reflecta TV Stand 55DS	1	REFLECTA	23214
8	Recruitment & Triage	Portable	Hand disinfection & automatic temperature measuring device K9 Pro Plus + Stand	1	Digas	Sanitizer
9	Recruitment & Triage	Portable	KEDACOM KSCA120-ANW-TFC	2	LEXIS	
9.1	Recruitment & Triage	Portable	Siren for audible and visual alarm in case of high temperature detection	1	LEXIS	
10	Recruitment & Triage	Portable	iHealth Air Pulse Oximeter	2	iHealth	Oximeter
11	Recruitment & Triage	Portable	Digital Ear Thermometer	2	Braun	ThermoScan® 7 IRT6525
11.1	Recruitment & Triage	Portable	Braun ThermoScan Lens Filters, 40 pcs, Compatible with Braun ThermoScan Ear Thermometers, LF40	6	Braun	Ear Thermometer Probe Covers
12	Recruitment & Triage	Portable	Classic Forehead Thermometer	2	Jumper Medi-cal	JPD-FR202
CLF Enclosure						
13	CLF1	Custom Integration	Construction of main CLF container.	1	HCT	custom
13.1	CLF1	Custom Integration	Interior panel polyurethane 4cm white smooth	1	HCT	custom
13.2	CLF1	Custom Integration	Electrics	1	HCT	custom
13.3	CLF1	Custom Integration	1 Door	1	HCT	custom
13.4	CLF1	Custom Integration	1 Window	1	HCT	custom
13.5	CLF1	Custom Integration	Steel construction & Air condition	1	HCT	custom
13.6	CLF1	Custom Integration	vinyl floor	1	HCT	custom
14	CLF1	Custom Integration	Construction of extension CLF container .	1	HCT	custom
14.1	CLF1	Custom Integration	Interior panel polyurethane 4cm white smooth	1	HCT	custom
14.2	CLF1	Custom Integration	Electrics	1	HCT	custom
14.3	CLF1	Custom Integration	1 Door	1	HCT	custom
14.4	CLF1	Custom Integration	1 Window	1	HCT	custom
14.5	CLF1	Custom Integration	Steel construction & Air condition	1	HCT	custom
14.6	CLF1	Custom Integration	vinyl floor	1	HCT	custom
15	CLF1	Custom Integration	Glovebox construction for the main CLF container.	1	Vector Tech-nologies	custom
15.1	CLF1	Custom Integration	Gloveport feedthrough D=220mm, POM, Glove port for a diameter of 220mm (in-cluding threaded ring and o-rings). For mounting, our special tool (Art. 1515401) is required. (Original article number: 7070842)	4	Vector Tech-nologies	1515400
15.2	CLF1	Custom Integration	Gloves D=220mm,0.4 Butyl,anatomic,Size L,w/o T, Additionally included are 4 fixing rings and 1 pair of cotton gloves. Glove shape: Ana-tomical Diameter: 220mm . Material thick-ness: 0.4mm Length: 800mm (Original item number: 3000047)	2	Vector Tech-nologies	1515000-P
15.3	CLF1	Custom Integration	Gloves,D=220mm 0.4 Butyl,ambidex-trous,Size M,w/o T, This gloves are antistatic and without tal-cum. Additionally Included are 4 fixing rings and 1 pair of	1	Vector Tech-nologies	1515010-P

			cotton gloves. Glove shape: Ambidextrous Diameter: 220mm Material . Thickness: 0.4mm Length: 800mm (Original item number: 2604986-OT)			
15.4	CLF1	Custom Integration	Assembling tool gloveport feedthrough	1	Vector Technologies	1515401
15.5	CLF1	Custom Integration	Plexiglass	1	Plexiglass Center	custom
15.6	CLF1	Custom Integration	Glovebox intercom (LEM 1) .	2	Venieris Electronics	138-000000100
15.7	CLF1	Custom Integration	Intercom Glovebox (Substation LE A AIPHONE) .	2	Venieris Electronics	138-000000600
15.8	CLF1	Custom Integration	POWER SUPPLY	2	Venieris Electronics	027-000003900
15.9	CLF1	Portable	Portable 6U Rack Case (for main CLF container)	1	SKB	
15.10	CLF2	Portable	Portable 6U Rack Case (for Extention CLF container)	1	SKB	
15.11	CLF1	Integrated	Rack shelves			
15.12	CLF1	Custom Integration	Inox Sample drawers	2	InoxDimas	custom
16	CLF1		IT equipment for main CLF container	1		
16.1	CLF1	Integrated	UniFi Switch US-24-250W	1	Ubiquity	US-24-250W
16.2	CLF1	Integrated	Ubiquiti U7-Pro, UniFi 7 Pro Access Point	1	Ubiquity	UBI-00336
16.3	CLF1	Integrated	Ubiquiti U7-Pro, UniFi 7 Pro Access Point Pro Wall	1	Ubiquity	U7-Pro-Wall
16.4	CLF1	Integrated	Classic wall mounted rack 6U	1	Central	
16.5	CLF1	Integrated	POWER STRIP FOR RACK 8 POSITIONS	1	Central	
16.6	CLF1	Integrated	ADAPTER CORDSET 32A from 3-phase to single-phase	1	RATIO ELECTRIC	
16.7	CLF1	Consumables	Consumables - gloves	4	PLAISIO	
16.8	CLF1	Consumables	Consumables - masks FFP2	10	PLAISIO	
16.9	CLF1	Consumables	Consumables - Goggles	15	MediShop	
16.10	CLF1	Consumables	Consumables - Face protection - visor	12	medical.gr	SIG-69.65.002
16.11	CLF1	Consumables	FFP2 MASK	24	MediShop	ZH3310V
16.12	CLF1	Consumables	Consumables - Type IIR	5	PLAISIO	3824683
16.13	CLF1	Consumables	Consumables - gloves	4	PLAISIO	
16.14	CLF1	Consumables	Consumables - gloves	4	PLAISIO	
16.15	CLF1	Consumables	Consumables - Apron, disposable	1	MediShop	

Figure 5 Finalized Equipment Table Snapshots and Equipment Allocation

All non-integrated pieces of equipment such as info screens, monitors, consumables and auxiliary materials, are allocated for storage in aluminum stackable boxes that can be rigidly strapped and placed within the RMML enclosures ensuring safety during transportation. The transportation boxes are selected with respect to the volumes of the stored equipment and internally treated with shock absorbing, protective foam when necessary. Packing lists are attached under the lid of each box, and clear identification is used on the outer shells for allocation when re-packing the RRML. Detachable castor frames are foreseen to simplify the unloading and relocation procedures.

Figure 6 Aluminium Equipment Boxes and Castor set

To ensure successful integration of the RRML's Medical Equipment, the research team has evaluated the operating instructions, their mechanical characteristics, electrical requirements, ergonomics and best practices both through careful study of their operation manuals and specification sheets, as well as by interviewing the technology providers and end-users.

The information gathered has been stored -and is readily accessible- in the form of a list describing each Device, its Parts and Instructions per part, any highlighted issues, challenges or special requirements and the actions that shall be taken respectively.

Nr.	Device	Part/Instruction	Issue/Challenge/Requirement	Action/Comment
1	BreathSpec®	**Measures traces of volatile organic compounds in exhaled air of humans.** The device allows sampling of human breath directly by sucking in breath exhaled in a handheld breath sampler. The handheld sampler is equipped with disposable mouthpiece, sampling tube and sampling tip to minimize possible carry over of microbes. Furthermore, the device can be equipped with a Luer port to accept samples collected breath in a common disposable syringe. Sampling into a syringe - adside from the device. -. can be done using a full disposable breath sampling setup	–	–
2	BreathSpec®	BreathSpec® Device (1 piece)		Needs to be rack mounted
3	BreathSpec®	including connected Circular Gas Flow Unit (CGFU) (1 piece)	Is it also included? If yes, it needs to be rack mounted	
4	BreathSpec®	Power supply with power plug (1 piece)		Rack shelf
5	BreathSpec®	Mouthpiece Handheld holder arm with screws		Sturdy, transport-safe mounting
6	BreathSpec®	Mouthpiece Handheld with heatable Transferline		Sturdy, transport-safe mounting
7	BreathSpec®	BreathSpec® Gas tube Kit (installed) • Driftgas/Carriergas Adapter (1 piece)0 • 0,6 m 3mm PFA Tubes with 3 mm Swagelok-Connector (2 pieces)		Sturdy, transport-safe mounting
8	BreathSpec®	CGFU Connection cable (installed) (1 piece)		Sturdy, transport-safe mounting
9	BreathSpec®	LAN Cable (1 piece)		Sturdy, transport-safe mounting
10	BreathSpec®	Luer-Lock Adapter-Kit • Luer-Lock Adapter (1 piece) • Luer-Lock Adapter Heater (1 piece)		Sturdy, transport-safe mounting
11	BreathSpec®	Disposable Breath Reservoir Kit • Mouthpieces (100 pieces) • Reservoir tube (100 pieces) Inner		Holders, Drawers, safe disposal
12	BreathSpec®	Inner Syringe Body (2ml syringe) (50 pieces)		Holders, Drawers, safe disposal

Figure 7 *Snapshot of Medical Devices' Attributes Table*

End-User Involvement

A successful realization that shall be deployed on the field under demanding conditions, has to abide by certain functional requirements that essentially either simplify procedures or introduce characteristics that have not yet been available in similar approaches. Hence, thorough understanding of the related workflows, demystification of processes and assessment of operational pain-points have been key focal points throughout the research and development period.

End-User workshops were held regularly, providing valuable insights for the project and evaluating the engineering solutions suggested by ONELAB's team. Further progressing into the project, the End-Users were called to evaluate preliminary designs and layouts, help in the identification of flaws and provide detailed information about specific procedures formerly unknown to the engineering team through one-to-one interviews.

The retrieved information was broken down by module, listing the different End-User responses and suggestions, that in turn were merged into common responses reflected in every stage of the Design-Evaluation-Redesign circle. Both the workshops and the interview sessions proved very valuable in assessing the innovations ONELAB aims to introduce to the RRML realm.

MODULE	PROCESS/ ACTION	RELATED EQUIPMENT	FEEDBACK (HASS, GAS, HRC, JOAFG, BRK, SOL)	PANOU COMMENTS /ASSUMP-TIONS
R	Alternative 1: Online pre-regis-tered indi-viduals	QR code scanning with Tablet?	**Common**: - Scan pre-registered QR codes with Tablet (Android, App) - Laptop nice to have - Self scan/device is complicated **HRC:** May be possible **JOAFG:** Alternative with a lot of advantages (quick process, all of the data can be obtained beforehand); disadvantage: people who are not able to use online registration need someone on scene to obtain their in-formation. So pre-registration is not a solution for everyone **BRK:** there could be a scanning device installed in a holder where people can scan their predefined QR code autonomously	
Recruitment. Patient reception Information, shel-ter. partitioning Data-collection, consent, questions and answers, and, welfare	Alternative 2: On-Site registration	-Tablet or lap-top? -Is a registra-tion form ready (a sim-ple touchscreen-friedly pro-cess)? -Is a printer and paper necessary? -What is the process for equipment decon?	**Common:** - 1 Tablet used only by the personnel, Tablet & App - Registration form is being developed, needs patients to sign for GDPR ***Feature of the App** -Printer and paper provided - Decon regularly with wipes, not touched by the patients Samsung Galaxy 5 (military grade specs) **GAS:** Either choosing a tablet or laptop, patients need firstly to sign a form (for GDPR reasons). A printer will be needed to print the Barcode label so it will be hadled to Svoc,Sb,Spcr modules for the sample labeling. **HRC:** Tablet or laptop also can be used, has to be possible to easily desin-fect its surface. The registration form has to be developed according to international standards, but with the possibility to easily adjust to the lo-cal conditions. Paper and printer is necessary for the non-pre-registered patients, for the elderly or the patients with limited skills to use smart devices **JOAFG:** Tablet is preferred. A standardized registration form (similar to the one online, if pre-registration is provided) is filled out by user. Simple short questions and answers. No printer or paper necessary. A set of pre-printed QR-Codes is prepared, the user scans one code, fills out the form and the patient is registered. Please ask SOLGENIUM for further input re-garding the form/app etc.; Decontamination of the tablet from time to time - patient is not expected to touch the tablet; only the user does. Tablet needs to be useable with gloves. **BRK**: as gloves can hinder the use of touchscreens Laptops would be the better choice	All equip-ment shall be used with PPE and de-contami-nated after-wards
The reception mod-ule (R) is where par-ticipants register for their tests. It is	Personnel	-PPE, what type?, how many items	**Common:** - Gloves - FFP2 Masks - Goggles	2 desks , 1 person each suggested. One for the

where information about the disease outbreak is provided and the need for screening, tests and contact tracing explained. This is where epidemiologically relevant information for contact tracing is collected, and consent for tests obtained.		per individual?	- PPE suit & securing adhesive tape - Fiber glass barrier on the desk - Sanitizer - Number of items to be finalized (JOAFG) 2 hrs max worn per person **HAS:** PPE - Gloves, masks, alcohol gel, fiber glass barrier on the desk Personel - How many patients per hour will be tested? Capacity? How fast will the line go? **GAS**: Gloves, goggles **HRC:** at least FFP2 masks and gloves, regurarly changed (every 2-3 hours), safety googles and regular hand sanitizing possibility **JOAFG:** As users come into direct contact with patients, full PPE is required. D5.1 has examples for PPE in the hot zone. We cannot say yet how many sets per user, as it is not clear so far how often PPE needs to be changed. We need to discuss if there are really two physical lanes (fast and slow) or only one that allows pre-registered patients to (more or less) skip the recruitment module. **BRK**: depends on the nature of the suspected virus: transmission via air or droplet infection? Should be white infection control suits, gloves, masks, glasses; adhesive tape is needed to secure the suits, you always need two persons to put on infection suits correctly, max time for person working in full PPE is 2 hours	fast lane and one for the slow
	"It is where information about he disease outbreak is provided and the need for screening, tests and contact tracing explained."	-Orally by the personnel? Or - Digital signage (monitor)?	**Common:** - Banners with color scheme (prone to weather conditions) - optional/nice to have - Outdoor digital signage - yes - Printed handouts - yes - Orally by the personnel **HASS:** Digital Signage - OK Additional Idea, banners with matching colors and numbers with each desks (fast & slow lanes) *** REFERENCE , Vaccinatiecentrum Hasselt** **GAS:** Digital Signage - OK "It will be a good idea for each patient to be created a barcode. Each patient's barcode will be shown on the monitor and it would advice to which module/process will each patient move on" **HRC:** Can be done orally but the digital and also the printed out version is better **JOAFG:** For the waiting queue, a monitor could provide information. Pre-registered patients should already be informed about what is going on. Simple signs or graphs on the process for the patient: registration - sample taking - result. Maybe information on how long it will take. We have no preference regarding digital or analog information provision. **BRK**: monitor	Non-touch monitor to avoid cross-contamination!
	Fast lane and slow lane according to registration status, as mentioned	-Digital Signage to help people find the way - Clearly marked lanes' system with barriers that shall be deployed	**Common:** - Banners with color scheme (prone to weather conditions) - optional/nice to have - Outdoor digital signage - yes - Clearly distinguishable color scheme – yes **HRC :**Digital or printed signage for the clear pathway is necessary - the colour marks have to be chosen carefully (not to mix up with the triage colors) **JOAFG:** see above, we need to discuss the necessity of two physical lanes	Non-touch monitor to avoid cross-contamination!
	Next step admittance	How is the priority between fast and slow lanes handled?	**Common:** - Two lane system - **Possible, TBD** - Priority handled by the reception - Possible - via the QR codes – yes **HASS:** One person to welcome people and make the flow go easy (no need of priority lane) **GAS:** with barcode ticketing **HRC:** The succession can be arranged in the registration - for example as in the bank, the patients are sorted according to the order of registration	Suggestion is for the priority to be given by the person on the Triage desk (next module)

	Reception of pre-registered individuals	1 tent and a desk with stool/chair	**Common:** - 1 tent , easy to setup and weather resistant - yes - One desk with 2 stools/chairs - yes - A bench/stools/chairs for patients waiting - yes ***number of patients** **HASS/GAS:** 1 tent and a desk with stool/chair **HRC:** at least 1 desk and 2 chairs for the personnel doing the registration, also a chair or a bench for the patients in a weather-proof environment **JOAFG:** tents should be available anyway. Consider storms or other weather conditions when planning the tents. Easy set-up is required. Tents should be left out over night. Furniture will need to be put inside over night/when lab is closed. **BRK:** when they do have an QR code, is an extra tent needed or can they just pass via the scanner	Weather conditions: weather-proof folding tent
	Reception of non-registered individuals	-is an extra tent and a desk with stool/chair needed? -Shall the 2-lane system start from this point	**Common:** - 1 tent , easy to setup and weather resistant - yes - One desk with 2 stools/chairs - yes - A bench/stools/chairs for patients waiting – yes **HASS:** Amount of people that need to be handled? **JOAFG:** see above regarding discussion about physical lanes	Weather conditions: weather-proof folding tent
	Sanitization	-Is a sanitizer dispensary needed for the visitors?	**Common:** - Automatic sanitizer dispenser - yes - Wipes for the personnel/equipment - yes **- Masks inventory for the patients – yes** **HASS/GAS:** Sanitizer dispensary is needed **HRC:** it is needed for the patients, also for the workers, and regular disinfection of the surfaces is also necessary **JOAFG:**hand/gloves sanitizer should be available at least at every step of the process for users and/or patients. No-touch technology (sensor) **BRK:** yes, and additional masks for those who forgot to bring any	
T	Personnel	-1 or 2 persons? -PPE, what type?, how many items per individual?	**Common:** - 1 person - Gloves - FFP2 Masks - Goggles - PPE suit & securing adhesive tape - Fiber glass barrier on the desk - Sanitizer auto - ***Number of items to be finalized (JOAFG)** **2 hrs max worn per person** **HASS/GAS:** 1 person probably **HRC:** at least 1 person with FF2/FFP3 mask, gloves, safety googles **JOAFG:** One person per patient. Hot zone PPE (see above) **BRK**: See above	

** Many more rows after this, but it is just an example of collected feedback.*

Figure 8 *Snapshot of End-User Response and Common Feedback Data*

Complementary Development Activities

During the Research & Development process, knowledge was also acquired through complementary activities such as FTX observation visits and co-operation with local peers involved in Laboratory Management. Such activities helped the engineering team to address procedural challenges, evaluate ergonomical aspects and material sourcing contacts.




Figure 9 (Top Left) Internal view of tent arrangement, Joint German EMT Exercise 2024, Ahr Valley
Figure 10 (Top Right) Field Deployment, Joint German EMT Exercise 2024, Ahr Valley
Figure 11 (Bottom Left) Stackable equipment storage and transportation boxes, Joint German EMT Exercise 2024, Ahr Valley
Figure 12 (Bottom Right) Container enclosures daisy-chain powering system, Joint German EMT Exercise 2024, Ahr Valley

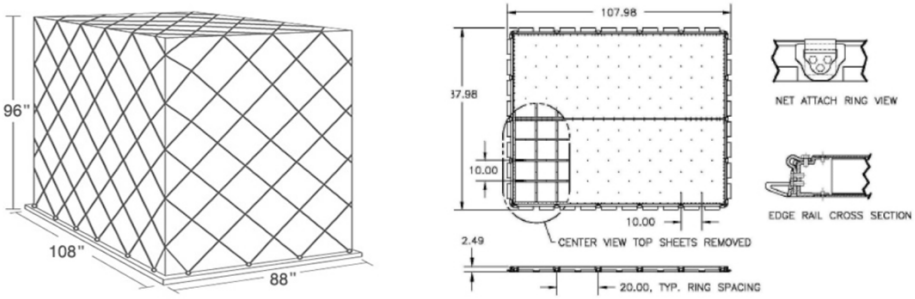

Figure 13 (Top Left) Glovebox ring detail, NUA Medical School Laboratory
Figure 14 (Top Right) Laboratory floor detail, NUA Medical School Laboratory

4. The Enclosure Based Approach

An Enclosure-based solution for ONELAB has from an early stage been identified as one that would provide adequate, well-organized and safe storage space during transportation by all available means. Moreover, upon deployment the available volume could be used as working space for the personnel, providing shelter and substantial immunity to the various weather conditions that ONELAB would possibly encounter when operational. Consequently, significant research was conducted with respect to the available enclosure systems, the level of internal customization and their capacity to be used in the intended multifunctional manner.

Earlier Conceptual Version

The early version of the RRML (v.0, rev.00) had been envisioned as a modular set of two or three enclosures of substantial internal volume to host working personnel and the footprint of a pallet according to the international transportation standards in order to achieve relocation by all available means (Typical Pallets, Military & Civil, HCU-6/e, “SS-463L Pallet Cargo Handling System” [3]).



Code	Dimension (LxWxH, cm)	Usable Dimensions (LxWxH, cm)	Volume (cbm)	Estimate Max Gross Weight (Kg)	Estimate Tare Weight (Kg)	Note
HCU-6E	274x224x244	263x213x233	13	4,530	150	Military Pallet

Figure 15 Military Pallets Dimensions and tare weight

Such a system would allow for practical allocation of ONELAB’s modules per enclosure type and its intendent field use, as well as the formation of a greater laboratory area when fully deployed. The enclosures could be placed sufficiently apart from one another and allocated within the different zones (hot, warm, cold), minimizing cross-contamination risks and further simplifying deployment and dismantling procedures. This early realization concept employed two main enclosures and one auxiliary enclosure.

The Operations-Administration & Communications Enclosure would be used to host the ICT module, and the administrative parts related to the Recruitment and Triage modules. It would be optimized to host up to four persons working on desk and information technology roles with the respective hardware and modular furniture.

The Main Equipment & Testing Enclosure would act as the Central Laboratory Facility (CLF) and would host the VOC module. The respective devices would be rack-mounted and accessible through a fully exposed front side protected by two do rotating doors (270°). A decontamination tent was foreseen on the back side separating the laboratory facility from contamination agents.

The third enclosure would be employed for storage of all the auxiliary equipment required for operation, such as furniture, consumables, power generators, cables and PPE.

All enclosures would be interconnected via external cabling running in a protective management system. Each Enclosure would fit IP rated plugs on the side panel, clearly marked to prevent false interconnections.

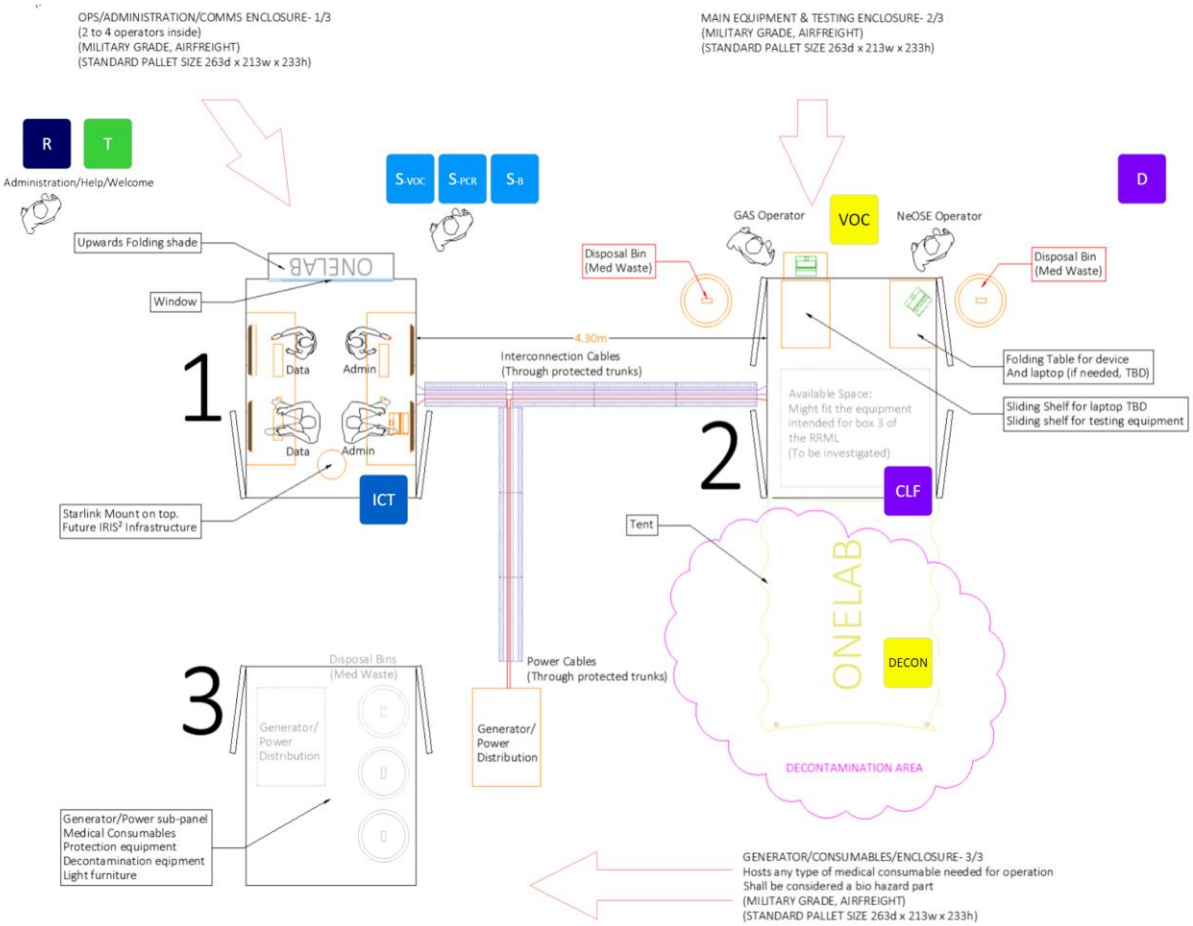


Figure 16 Early ONELAB Conceptual Deployment

Despite its promising attributes, especially in terms of size and transportation flexibility, this early envisionment of the deployment exhibits certain flaws related to the everyday operations, the personnel's well-being and the ergonomics of the testing procedures.

The setup implies a straight testing route from the Reception and Triage modules to the sampling and VOC analyses ones. This line would require most of the personnel to be in contact with possibly infectious individuals in the red zone, imposing the use of higher-level PPE while operating in open air conditions, varying from extreme heat to extreme cold, moisture or rain. Providing adequate protection in the form of overlaying tents would require considerable amounts of time to be spent setting up the facility. Consequently, the extra protection equipment would reserve significant storage space within the Enclosures during transportation. Moreover, the size limitations imposed by the air-freight containers (see Fig.15) would make them marginally acceptable as working spaces. Those net internal dimensions would be reduced further after the application of any standard type of shell insulation and wall finishing as well as the fitting of lights, air-conditioning and cable trunking systems.

Although rejected, this concept clearly grasps a few major positive attributes that were inherited in the current realization. All three enclosures are autonomous to a considerable extent, allowing the deployment of any combination according to the increased requirements for throughput. More Laboratory and Auxiliary Enclosures could be allocated and supported from the same Administration centre. Those enclosures could also be independent in terms of equipment according to the operations that they would be required to carry trough, but still providing and exchanging valuable data through the same LIMS platform.

Thorough examination of the functional characteristics exposed through this exercise has successfully revealed key points for further development and adaptations that were essential for the RRML.

Modularity

An enclosure-based approach provides extended modularity while preserving rigid and protected working space. Concluding to a design that allows for flexible allocation of the different modules in ONELAB would essentially make it a highly evaluated solution for pandemic testing. The term should not only refer to the equipment hosted within the RRML, but also apply to the RRML itself, allowing for higher degrees of customization according to the operational requirements. Concluding to a design with maximized working space and universal infrastructure would help provide tailor-made versions of the RRML.

Scalability

The concept of scalability while preserving autonomous operation of different modules is also crucial for a successful realization. Different technologies can be evoked within each Enclosure, while at the same time Enclosures may vary in configurations and quantities on the field with respect to the desirable throughput of the laboratory facility. Decentralizing as many attributes as possible and transferring them to the core structure of the Enclosures would be highly beneficial in eliminating a considerable amount of SPOFs in the realization and mitigating risks as the correlation between the modules of the RRML is preserved to the bare minimum. Maximum achievable scalability is therefore achieved without compromising the whole facility in case of standalone malfunctions.

Innovative Aspects

The innovations explored in the realization are listed below and are products of the careful examination of the preliminary designs, the creative collaboration between the members of the Consortium and the transferred knowledge from the field.

- **Extended Modularity & Scalability**: The RRML is a built-to-order, scalable solution
- **Sturdiness & Safety**: The facility provides better and safer working conditions compared to the tent-based RRML realizations
- **Autonomy:** Each Enclosure is designed with autonomous power and network infrastructures that allow deployment with minimum prerequisites, provided that the portable ICT module is allocated within it. External power (grid, generator or battery) is attached to the Enclosure's power board
- **Minimum Exposure to Pathogens**: ONELAB introduces a glovebox inspired sampling system that allows for maximum separation between the personnel and the patients.
- **Enclosure Combination:** Enclosures can be attached together in pairs to create more laboratory space.
- **Connectivity:** ONELAB's ICT module supports uninterrupted connectivity.

5. Design

The proposed designs for the RRML are based on the principles of maximizing space while preserving safe and controlled environmental conditions for the End-Users. Inherited knowledge from the earlier concepts has led to the decision of employing customized Enclosures to host ONELAB's modules with respect to the differentiation between the possible use scenarios. Relocation of those enclosures shall abide by the international transportation rules, procedures and best practices to allow for the minimization of transportation times from place to place.

As the spatial limitations of the initial HCU-6/E (ICU) concept addressed it as a non-viable solution, 10ft Standard Dry Van Containers (ISO/TC-104) were qualified as the structural basis for the RRML. These enclosures allow for a high degree of customization while preserving the properties of carriage of general cargo by marine, road, and rail. 10ft containers are designed to maintain their structural and weathertight integrity within a temperature range of -30ºC to 70ºC and conform to ISO standards (ISO 830: Freight containers-Terminology, ISO 668: Series 1 Freight containers Classification, external dimensions and ratings, ISO 1894: Minimum internal dimension, ISO 6346: Freight containers Coding, identification and marking, ISO 1161: Series 1 Freight containers-Corner castings specification, ISO 1496-1: Series 1 Freight containers Specification and testing-Part 1: General cargo containers) [4]

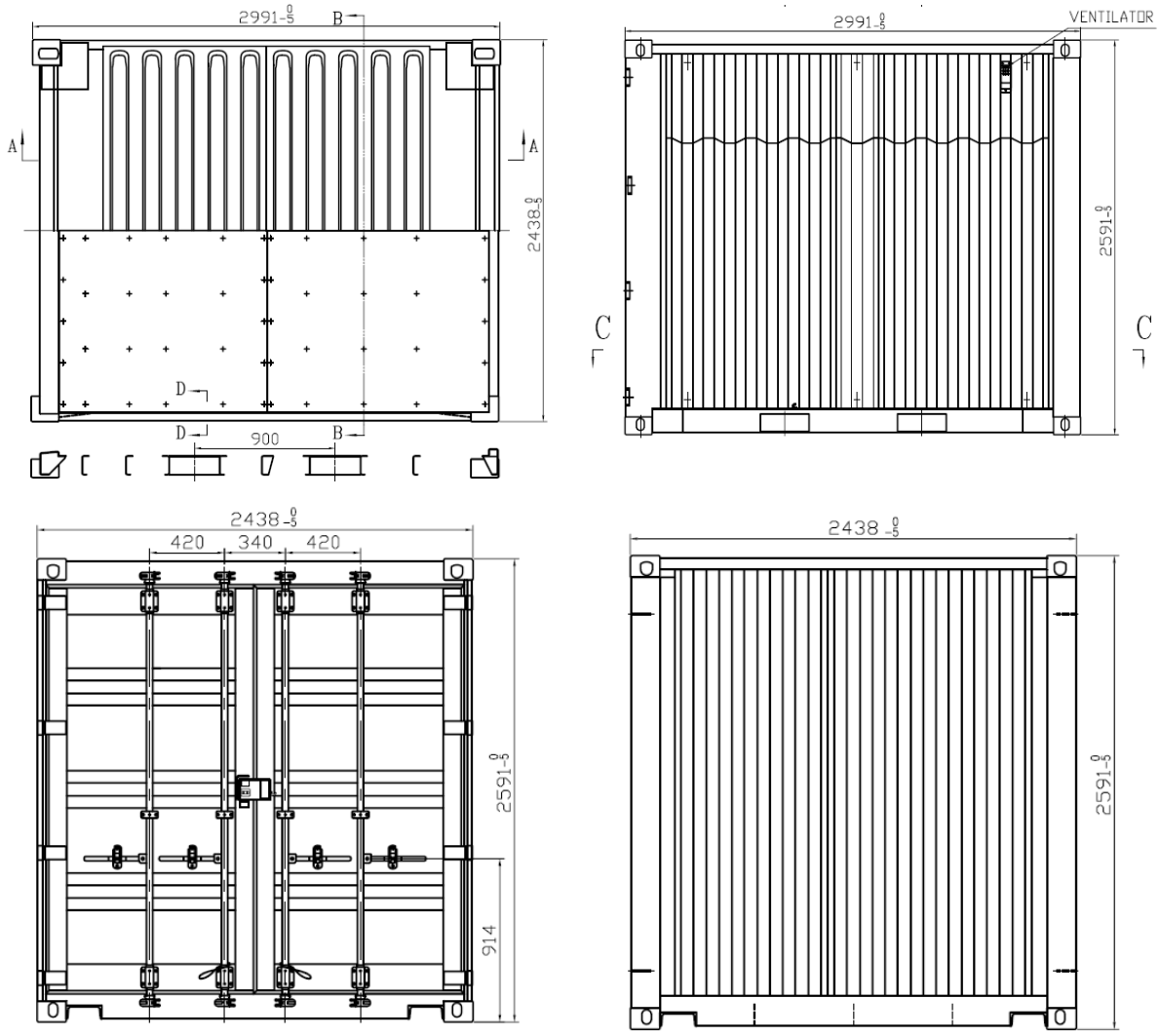


Figure 17 Standard 10ft Container views and measurements ISO/TC-104

Main CLF Enclosure (CLF1)

The main Enclosure of the RRML is the CLF1. The module has been designed under the concept of maximizing protection from the surrounding environment when necessary. Based on the 10ft container standard architecture, according to which each narrow side features dual doors that can freely rotate around their axes, the Enclosure features one fixed side and a one side that can be opened if needed. Both sides look identical when the doors are closed.

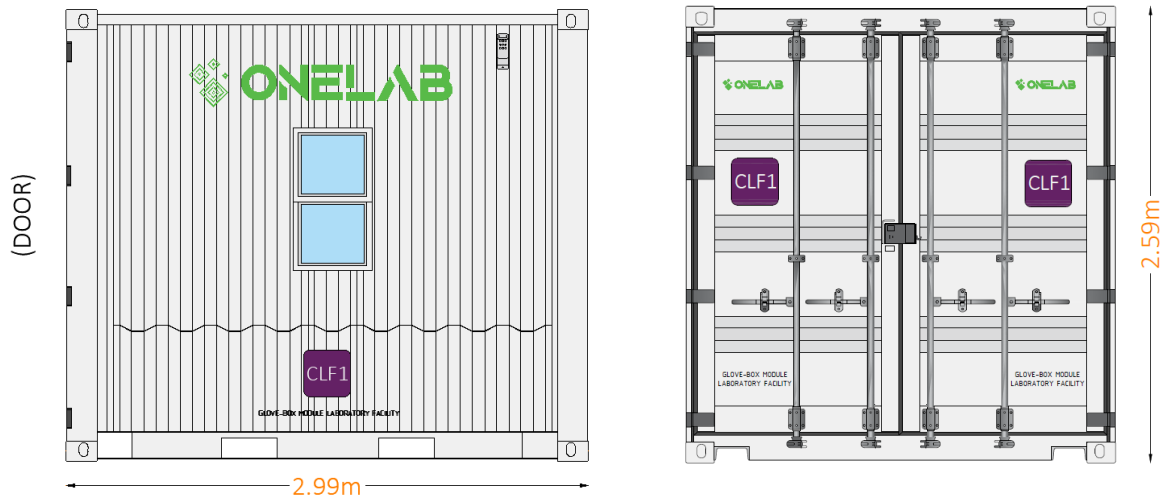


Figure 18 CLF1 Container side, front and back

CLF1 is intended for use in highly contagious environments and aims to minimize contamination risks by separating the sample collection personnel from the visiting test subjects. The glovebox-inspired side features two sample collection posts, one seated and one standing, ensuring accessibility for all individuals on the outside. It features two sealed 10mm thick, plexiglass windows on which the gloves are attached as well as an intercom for bi-directional communication. The collected samples are transferred into the lab for analysis via a two-way inox drawer handled by the sample collector.

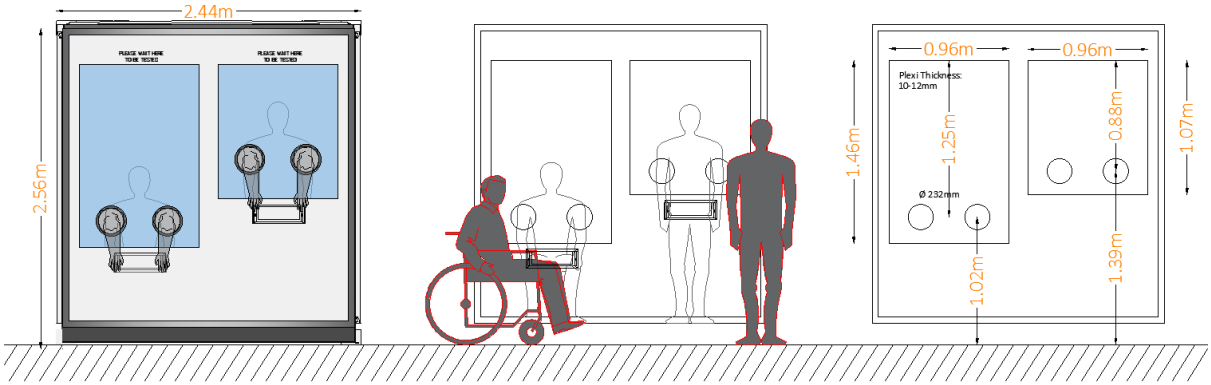


Figure 19 Measurements and accessibility features of CLF1

The Enclosure can host up to tree people, one post in sample analysis and up to two sample collectors if required. It features insulation around all its sides and the ceiling, air-conditioning, structural cabling for internal power and network connectivity, lights, storage space with 215L capacity, a folding 1.4m x 0.7m inox working surface, as well as a small sliding window for natural light and fresh air source if required directly over the working surface. The net internal dimensions allow for 5.2m² of free space. Access inside the enclosure is available through a 90cm wide lockable door.

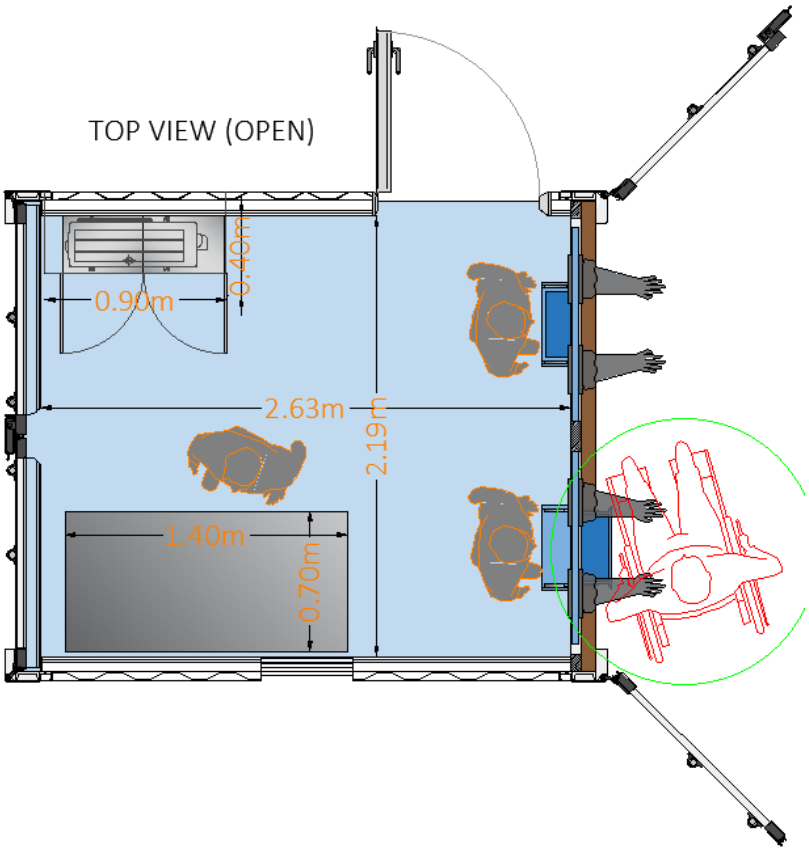


Figure 20 Top view of the CLF1 Enclosure

To ensure compliance with transportation standards, under which nothing must protrude out the shell of the container, a custom cavity is built to host the aircondition's external unit. This cavity also hosts an IP protected power receptor as well as interconnection cabling passages. The occupied internal space is used as the foundation for the storage cabinet. The wall directly above it allows for the installation of small IT rack, mandatory for the structural network cabling around the module and its WAP. The aircondition is mounted on top of the wall (Fig.21)

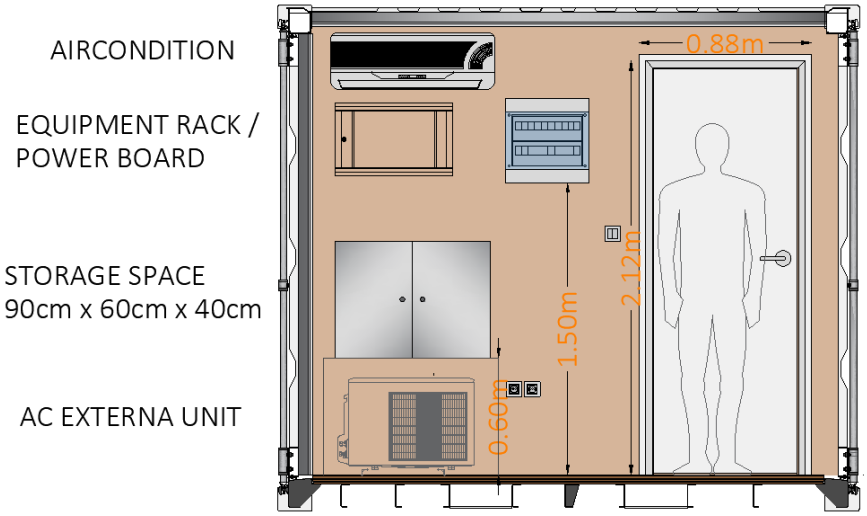


Figure 21 Entrance side internal view of the CLF1 Enclosure

A light switch is installed at standard height and is accessible upon entering the enclosure to activate the led lighting fixture mounted on the ceiling. Additionally, two European Power

outlets are installed at lower height to provide power for auxiliary equipment if required. (Fig.21)

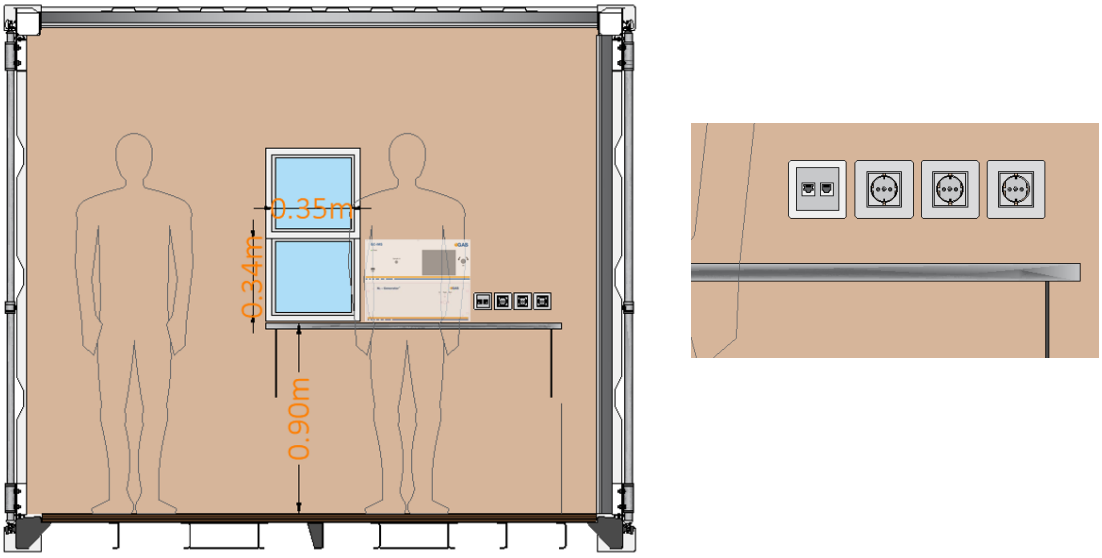


Figure 22 Working surface side internal view of the CLF1 Enclosure & Outlets Detail

The folding inox working surface (1.40m x 0.7m) is rigidly supported by steel hollow sections concealed in the back of the finished wall to support the weight of the instruments required for the sample analysis. It is mounted at a height of 90cm to allow both seated and standing operations and ensure clear visibility of the spectrograph monitor that is centred at approximately 1.2m – the standard seated person eye level. Three European power outlets (Schucko) and a dual network outlet (RJ45) are installed directly above the working surface on the right-hand side (Figure 22).

CLF Extension Enclosure (CLF2)

The CLF2 Enclosure is a laboratory enclosure that may either operate in standalone mode or attach to CLF1 to provide extra working space when higher throughputs are required from ONELAB. This enclosure is oriented for work with external sample collection and variable analyses operations internally. For this reason, more working space and is provided, as well as a wider window for air and natural light.

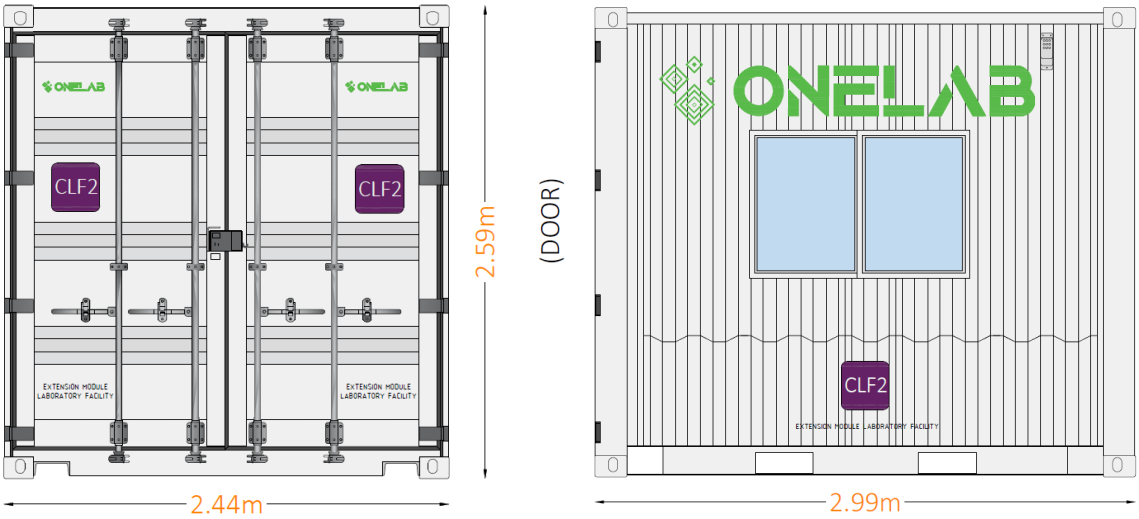


Figure 23 CLF2 Container front, back and side

The Enclosure features a recessed entrance wall, concealed behind the container doors. The space created between the outer shell and the entrance facade is used to rigidly install the external AC unit, an IP protected power receptor as well as interconnection cabling passages. Sample handover may take place via the side sliding window, or traditionally through the entrance door.

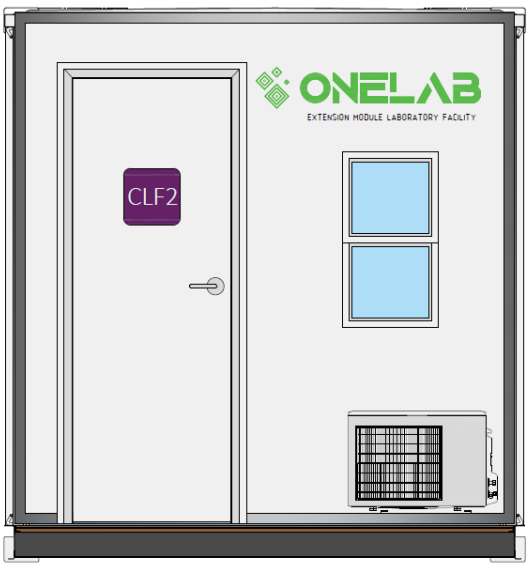


Figure 24 CLF2 Entrance Facade

The Enclosure can host two people performing sample analysis. It features insulation around all its sides and the ceiling, air-conditioning, structural cabling for internal power and network connectivity, lights, three storage cabinets with a combined capacity of 280L and two folding 1.1m x 0.7m inox working surfaces. The sliding window is installed directly over the working surface. The net internal dimensions allow for 3.5m² of free space. Access inside the enclosure is given through a 90cm wide locking door.

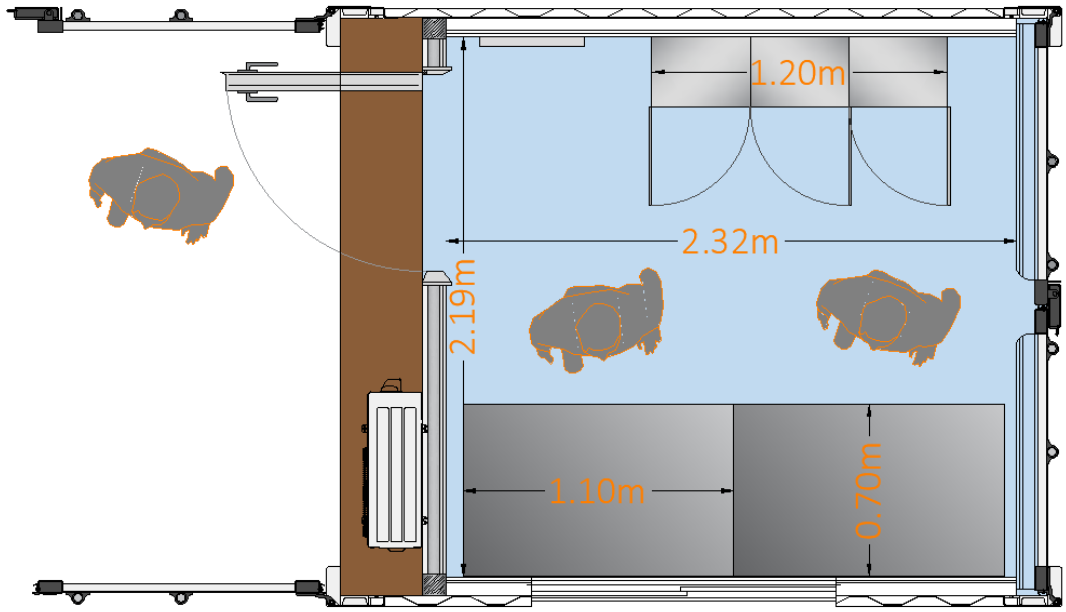


Figure 25 CLF2 Top view

A light switch is installed at standard height and is accessible upon entering the enclosure to activate the led lighting fixture mounted on the ceiling. The power panel, rack and cabinet system are mounted on the back wall in a similar fashion to CLF1 (Fig.26).

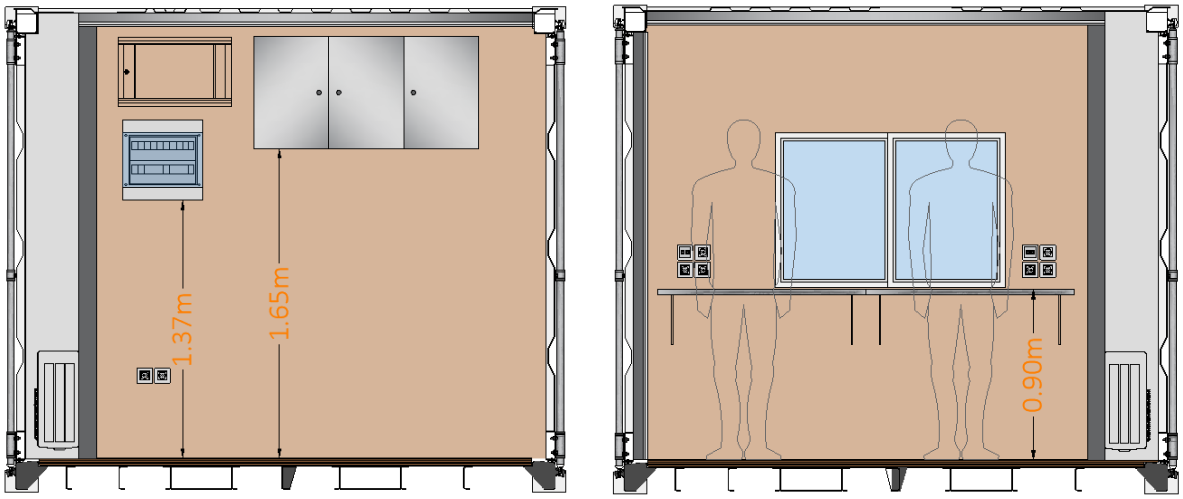


Figure 26 CLF2 Internal Side Views

The folding inox working surface (combined 2.20m x 0.7m) is rigidly supported by steel hollow sections concealed in the back of the finished wall to handle the weight of the instruments. The mounting height is 90cm to allow both seated and standing operations and ensure clear visibility of the instruments. Three European power outlets (Schucko) and a dual network outlet (RJ45) are installed directly above the working surface on both sides (Fig.26).

Combined Laboratory Space

The combination of CLF1 and CLF2 Enclosures is able to host a fully featured field laboratory that can operate with minimal risks of external contamination when sample collection is performed from the glovebox side. The gaps in between the attached frames are sealed with rubber to preserve isolation (Figure 27).

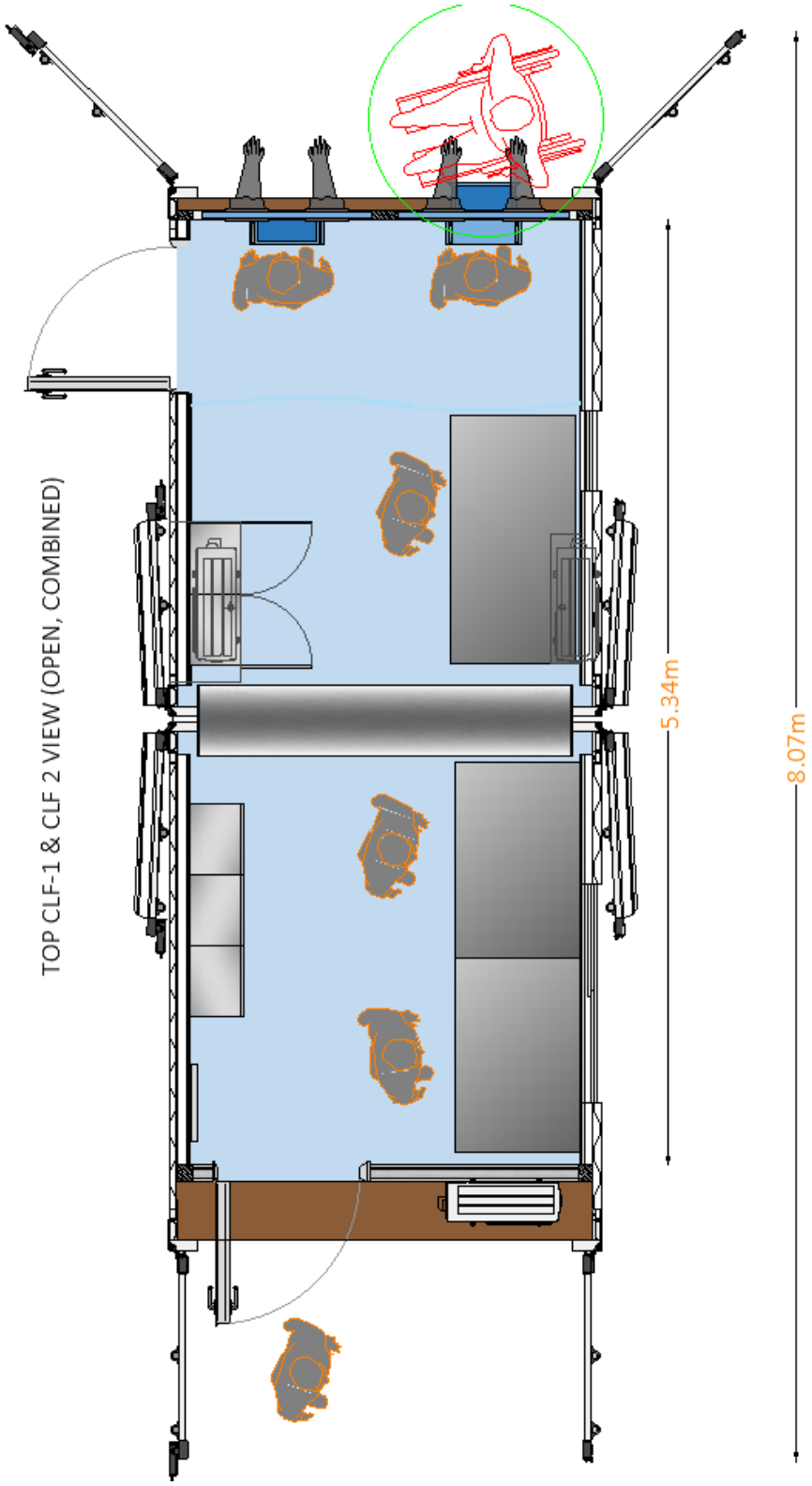


Figure 27 CLF2 Internal Side Views

ICT Enclosure

The ICT enclosure is used as administration and resting space that may be deployed further apart from the operational red zone if needed, at a radius of approx. 60m to ensure that network communications are not interrupted by long interconnection cable runs. Additionally, its ample internal space can be used for storage during transportation. It shall be noted that the ICT Enclosure and the ICT Module may be used separately as the ICT module is portable to allow small scale operations. Although, under moderate circumstances, the Enclosure serves as valuable space for auxiliary functionalities. The enclosure's architecture is very similar to the architecture of the CLF2 enclosure. It features a recessed entrance wall, concealed behind the container doors.The external AC unit, the IP protected power receptor and the interconnection cabling passages are located on the façade in the same fashion.

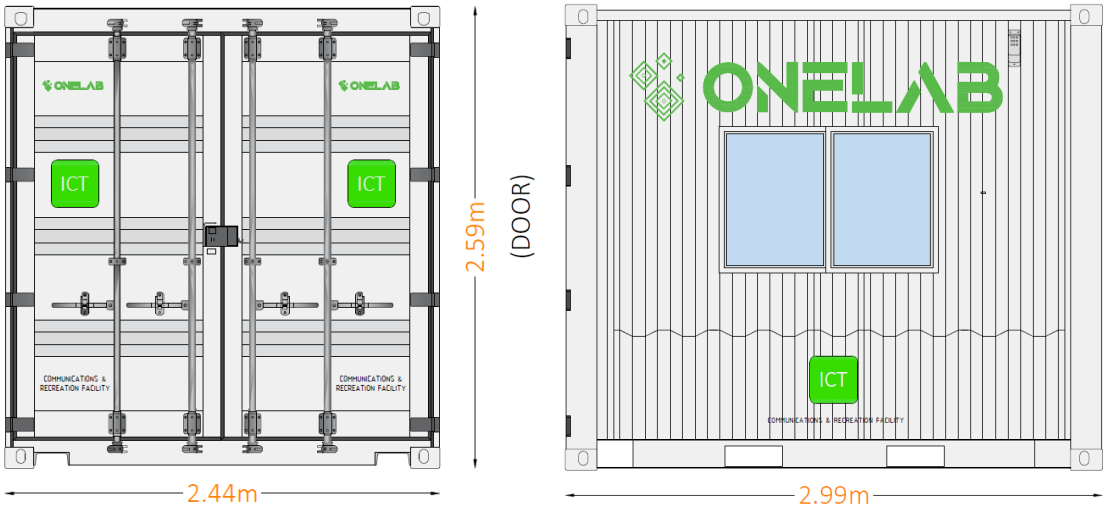


Figure 28 ICT Container front, back and side

The ICT Enclosure can host up to two operators. It features insulation around all its sides and ceiling, air-conditioning, structural cabling for internal power and network connectivity, lights, three storage cabinets with a combined capacity of 280L and one standard desk 1.6m x 0.7m. A sliding window is installed directly over the working surface. The net internal dimensions allow for approximately 4m² of free space. Access inside is given through a 90cm wide locking door (Fig.29)

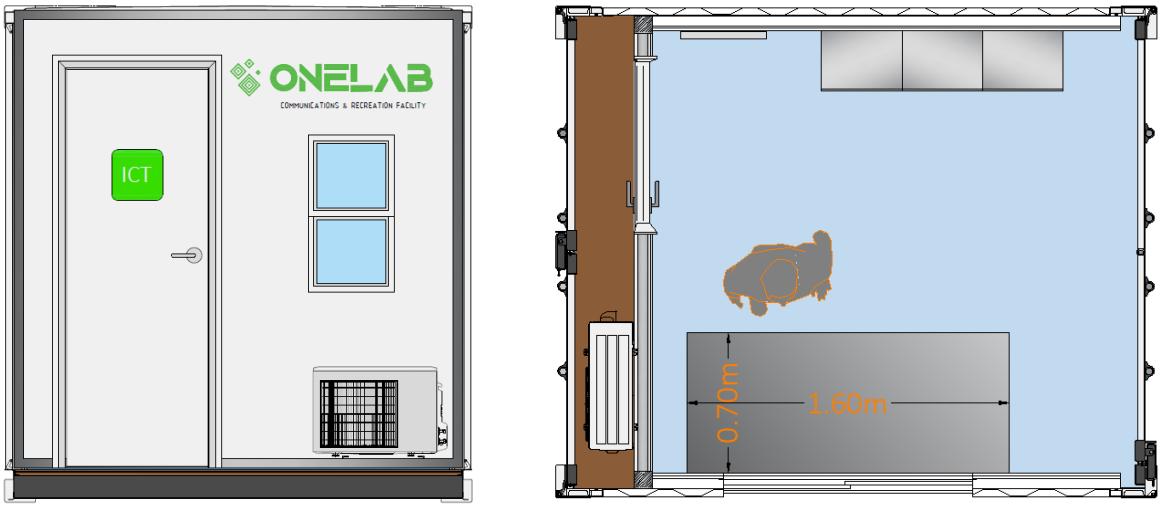


Figure 29 ICT Enclosure Façade and Top View

To protect the appealing technology hosted inside the enclosure, its window features a roller shade that may be closed in between operations.

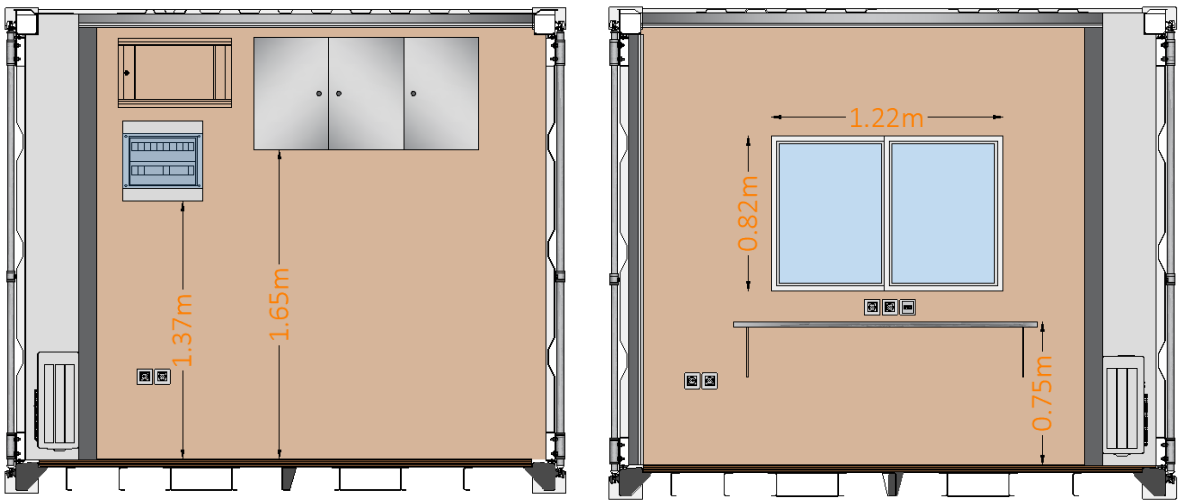


Figure 30 ICT Enclosure Internal Side Views

A light switch is installed at standard height and is accessible upon entering the enclosure to activate the led lighting fixture mounted on the ceiling. The power panel, rack and cabinet system are mounted on the back wall

The desk is rigidly supported by steel hollow sections concealed in the back of the finished wall to handle the weight of the equipment. The mounting height of the desk is 75cm to allow seated operations. Two European power outlets (Schucko) and a dual network outlet (RJ45) are installed directly above the working surface, and a second set of power outlets is located at a lower height to the left for auxiliary devices if required (Figure 30).

Communications

Communications in ONELAB are available via a carefully designed decentralized network. Each enclosure uses dedicated IT infrastructure to provide standard wired Ethernet to its local wall outlets according to its internal architecture, as well as seamless WiFi connectivity. The structural cabling is terminated in the local wall mounted rack that hosts a standard termination panel, the local Ethernet switch, the wireless access point and any other auxiliary piece of network equipment.

Interconnection between the modules is achieved through external EtherCON plugs that incorporate a locking system ensuring accidental disconnections never occur during operations.

The heart of the communications system though, lies within the portable rack of the ICT Module. As an integral part of the RRML, the modules is responsible for the reception and allocation of Network connectivity via Satellite (Starlink), 4G/5G mobile network and standard Ethernet Internet cable. Failover is seamless between the tree technologies and is managed through a redundant firewall system that enhances ONELAB's cyber security features.

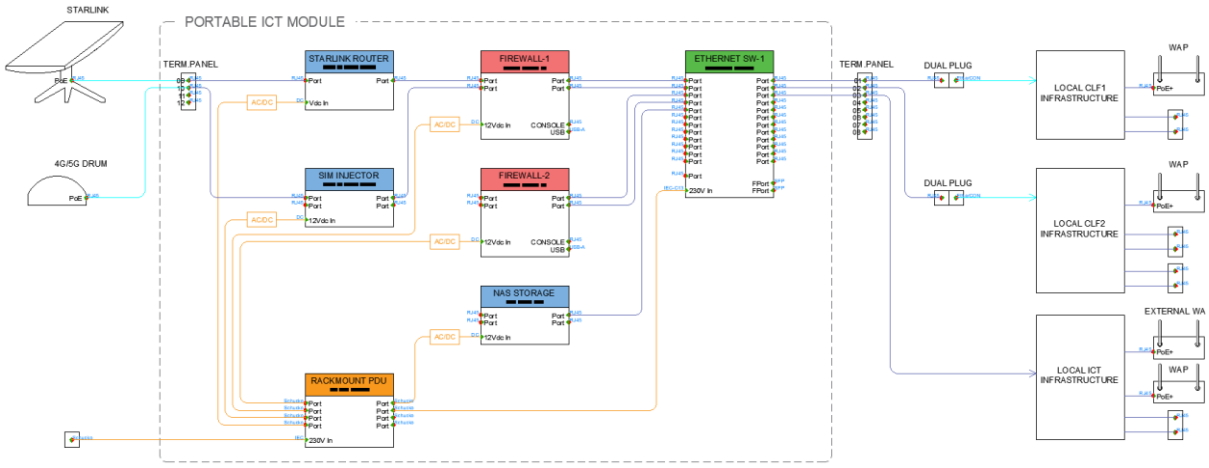


Figure 31 ICT Module Schematic Diagram

The ICT module is, under normal circumstances, allocated within the ICT enclosure where monitoring and troubleshooting can easily be performed without disrupting the laboratory's everyday procedures. Therefore, the ICT enclosure features pole mounts on which the mobile network antenna and the Starlink satellite receiver are mounted during the deployment of the RRML. The ICT enclosure also hosts an external IP rated WAP that provides wireless connectivity around the RRML site. All the external devices can be mounted in alternative ways if the operational requirements change or in case very compact versions of the RRML need to be deployed on the field.

The end-users are able to work under a standard, familiar connectivity scheme irrelevant of the Internet source that is available at each site.

6. Implementation

FTX Oriented Deployment Scenario

As a highly modular solution, the RRML is built-to-order in line with the operational requirements that need to be fulfilled in every mission. With respect to the “Hard Winter” FTX, the RRML shall consist of all three core enclosures to demonstrate the full extent of the technology it brings to the realm of field laboratories. An overview of the potential deployment in Vienna is given in the below image.

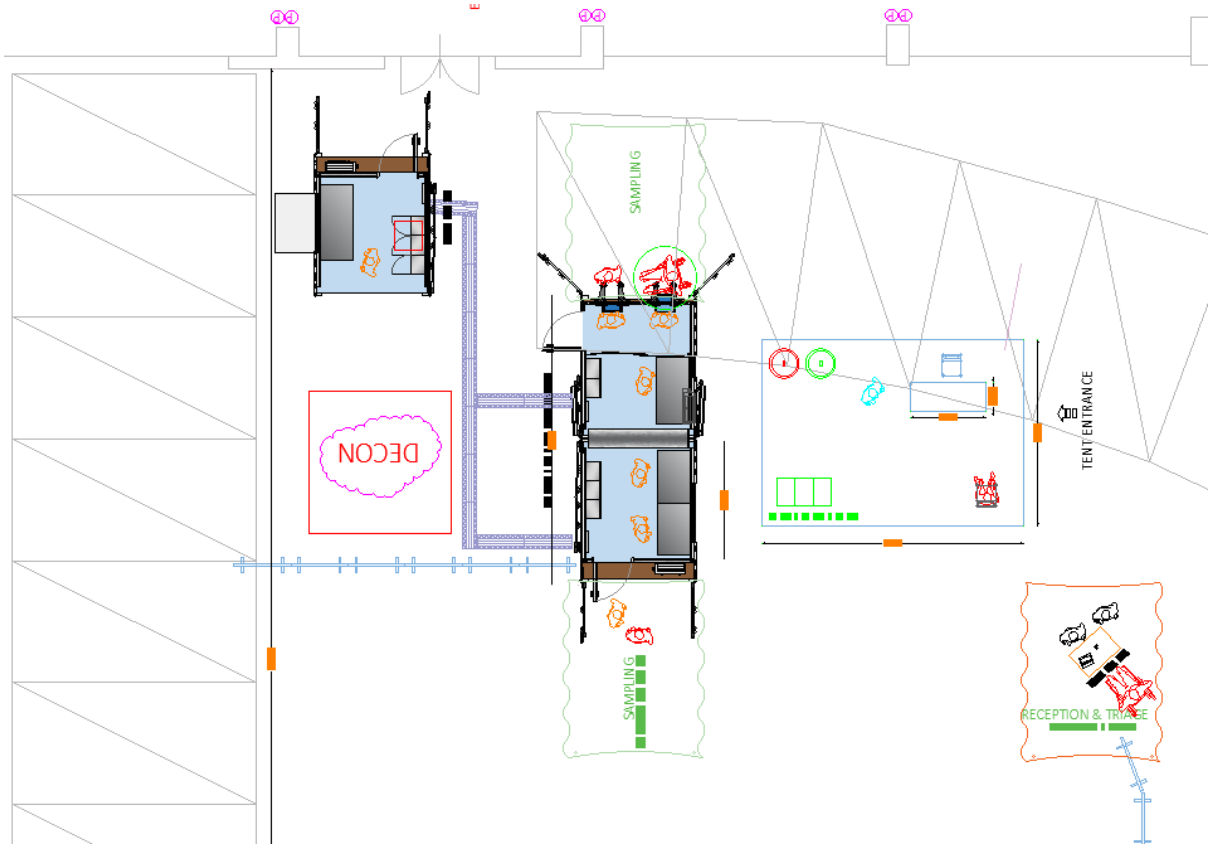


Figure 32 Top View of Potential RRML Deployment

Logistics Aspects

As a container-based realization, the RRML enclosures must abide by the international transportation rules that indicate transportation by commercial rail networks, road networks or vessels [4].

- **Rail Transportation:** On flat or container car secured at its bottom corner castings
- **Road Transportation:** On flat or chassis secured at its bottom corner castings
- **Marine Transportation:** On deck or in cell guided by vertical or diagonal lashings

Up to three 10ft containers can safely be transported via trucks that feature onboard cranes for loading and unloading. The containers are also forklift compatible provided that the forklifts are rated for the gross weight of each enclosure. Lifting may be executed as follows:

- Lifting full by its top corner castings by means of spreaders
- Lifting full by its bottom corner castings by means of fitting at a sling angle of 60 degrees.
- Lifting full or empty by forklift at its forklift pocket.

7. Conclusions

ONELAB introduces a considerable number of advancements related to RRML realizations for field operation, focusing on the following core functionality characteristics:

- **Robustness:** The RRML is based on sturdy constructions that allow safe working conditions for the End-Users. Upon careful planning and deployment, the Enclosures provide sufficient immunity to external weather conditions and are able to withstand cold, heat or rain. The RRML is designed as an season-agnostic solution
- **Scalability:** As a modular realization, the RRML can consist of as little as one CLF1 or CLF2 Enclosures depending on the availability of power on site. The integral communications ICT module's portability makes it easy to integrate within the laboratory modules resulting in mobile laboratory with a very small footprint. At the same time, if higher throuput is required, multiple enclosures may be deployed on a single or on multiple sites in different combinations as all the RRMLs retain uninterrupted communications.
- **Customization:** The shape and size of the Enclosures allow for different testing and analyses technologies allocation with respect to the incidents that they are called to adress. These attributes allow ONELAB to stand out as a future proof solution in pandemic control. The RRML Enclosures have the ability to be built-to-order and modified internally to host various types of laboratory equipment.
- **Inclusion:** The RRML CLF1 Enclosure, designed for minimal contact between the personnel and the public, is accessible by all individuals. Moreover, the laboratory modules and the ICT enclosure provide sufficient internal working and movement space.

Future Improvements Exploration

As a newly introduced solution, the RRML shall undergo a series of field tests to address and improve any potential flaws that may only be revealed in practice. Prior to the field deployment tests, aspects of power autonomy and network independence have been examined and already addressed as key future improvement points.

Energy-wise, the RRML may be power self-sufficient using traditional contemporary sources like generators and batteries, apart from its direct connection to the power grid. Though, as these technologies are either more harmful to the environment or exhibit limited energy capacity, the research shall focus in the adoption of alternative green power sources as these advance over time. Currently the power requirements of ONELAB can not be covered entirely by alternative sources as these require a sufficient amount of capacitors to travel with the lab making relocation logistics more demanding.

ONELAB shall also benefit from the advancements of European alternatives to the Strarling satellite technology currently employed for its communications. Anticipated is the IRIS² Satellite Constellation, the European Union's answer to pressing challenges of tomorrow. IRIS² offers highly secure. enhanced communication capacities to governmental users and businesses, while ensuring high-speed internet broadband to cope with connectivity dead zones. According to the timeline presented for IRIS², the network shall be available in the next few years (2024-2029 and onwards), with full service is expected from mid-2027. [5]

8. FTX “Hard Winter” RRML Deployment

The FTX “Hard Winter” has taken place between 18-20 November 2024 in Vienna, Austria. During this exercise, the RRML was fully deployed and operationaly tested for the first time. The following photos present the preparations and the modules for demonstration purposes.

Figure 33 Transportation of the RRML Modules

Figure 34 CLF1-Glovebox, Equipment and Operations views

Figure 35 CLF2-Internal, Operations and External views

Figure 36 Deployed RRML:CLF1 and CLF2 Combined & ICT

Figure 37 Deployed ICT Enclosure and ICT Module

Figure 38 FTX RRML Deployment views

9. References

[1] Guidance for rapid response mobile laboratory (RRML) classification. Copenhagen: WHO RegionalOffice for Europe; 2021. Licence: CC BY-NC-SA 3.0 IGO.

[2] Rapid Response Mobile Laboratories (RRMLs): What's in a mobile laboratory?. Copenhagen: WHO Regional Office for Europe; 2023. Licence: CC BY-NC-SA 3.0 IGO.

[3] 2022 Products & Services Catalog, AAR Corporation, Public Document

[4] 10' X 8' X 8'6" TYPE STEEL DRY CARGO CONTAINER, Specification No:JS-10, Jingsheng Container Manufacturing Co.Ltd, 2012

[5] IRIS²: Infrastructure For Resilience, Interconnectivity and Security by Satellite, European Union, 2023