Ontology-Based Knowledge Representation and Information Management in a Biological Light Fieldable Laboratory

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ABSTRACT

A comprehensive ontology has been developed to model the operational domain knowledge and provide information management for a light fieldable laboratory (LFL) performing molecular microbiological analyses. LFL is considered as a toolbox where all operational functions and tools used to execute these functions are incorporated into a single system. The ontology is used to facilitate the LFL mission preparation and management, to provide technical compatibility of sharable information between tools, and to align the terminology and definitions between tools while complying with standards, best practices and procedures. The LFL domain is a formalised and structured modelling the LFL concepts, procedures, functions, prescribing the necessary functions and delimiting those which are incompatible with the given mission or scenario. Such consistent logical modelling allows to efficiently plan and configure the LFL mission selecting only the necessary functions and tools from the whole collection and to activate them appropriately in due time.

Keywords

CBRN, crisis response, field diagnostics, field laboratory, infectious disease, information management, knowledge representation, molecular microbiology, ontology, outbreak response.

INTRODUCTION

This work presents an ontology-based information management approach that supports the whole cycle of operations required for the deployment of a field station for assessment (detection and identification) of biological threats, namely the Light fieldable laboratory (LFL). LFL is considered as a toolbox where all operational functions and tools used to execute these functions are incorporated into a single system, with the information flows between the LFL components defined by means of a comprehensive ontology. This is a new way to prepare and manage an LFL mission allowing to assemble the components of the LFL according to the data available on the biological crisis, and to efficiently operate the field laboratory during the mission.

Light Fieldable Laboratory (LFL), setting the context

The use of temporary field microbiology laboratory stations has found applications in Public Health policies since the first microbiology techniques have been implemented in the tropical medicine and environmental studies. More specifically, the concept of mobile, meaning on vehicle, laboratories has been developed as a main component of the preparedness for chemical, biological, radiological and nuclear (CBRN) defence and security.

An intervention study in tropical medicine was at the origin of the work discussed hereafter. This first experience [Dumont et al., 2014] succeeded in bringing into a Belgian military facility in Democratic Republic of Congo, geographically distant from expert laboratories, a temporary molecular microbiology field station performing accurate microbiological diagnostics on site. The mission allowed establishing a first prototype for the field laboratory with 4 main directions for improvements: biosafety, robustness, versatility, and autonomy.

The concept has received the name of light fieldable laboratory (LFL) - a lightweight, transportable, autonomous laboratory, rapidly deployable close to the sampling site in case of health crisis provoked by a B-agent. It is designed to be operated by a rapidly deployable staff as a complementary solution to the existing networks of biological reference laboratories. The time needed for transporting and deploying the LFL is short since the different components can be easily packaged and moved together with a limited staff of trained experts. The main advantage for deployment of the field laboratory results from the close geographical proximity between the laboratory where biological evidence is produced and the site where decisions made on the basis of these evidences have to be implemented. A typical example of such sites are the field hospital where probable, suspected and confirmed EBOLA cases are classified according to the rapid DNA-based diagnostics provided by the LFL, or extent of anthrax environmental contamination has to be assessed and properly delineated in order to isolate and decontaminate the area at risk according to the mapping of positive environmental samples identified by the LFL. In both cases geographical proximity accelerates the response time by avoiding delays resulting from long distance transportation of clinical or environmental samples. From an ethical point of view the LFL also participates in a more fair distribution of the best biomedical technologies developed in the North and needed in the South [Fonteyne et al., 2014].

The information management for CBRN mobile laboratories is quite a new area, it is only recently that significant effort has been applied for structuring the data, detailing all the components, specifying the information needs and gaps of users, defining information sharing processes between stakeholders, data analysis and processing in systematic way. The information content, terminology and the approach to data organisation and presentation aimed, among other aspects, at harmonisation of the concept of mobile laboratory structure, was validated with biological mobile laboratory operators from Belgium, Germany, the Netherlands and Norway [FP7-SECURITY-MIRACLE, 2013-2015].

The LFL provides a flexible and affordable working area for integrated equipment and systems that combine the advantages of current miniaturised and portable technologies. The challenge here is to take these instruments and methods out of the laboratory facilities into a more challenging operational environment. To achieve this, tools, materials, and methods have to be selected, ruggedised, compacted and tested against field conditions where the main limitations will be biosafety, with the main optimisation criterion based on mobility. In order to select the right set of tools to perform the appropriate set of operational functions (OF) necessary in a particular type of mission, an information management tool would help combining all the information, and support the decision making process.

Light Fieldable Laboratory (LFL) is a toolbox

LFL comprises various interlinked components such as the laboratory staff performing the tasks; the shelter and the lab equipment; the small and/or disposable materials and the reagents; the ICT, satellite communication and Earth observation tools; the procedures, guidelines, standards prescribing execution of every task, proper manipulation of all the components, communication inside and outside the LFL, and the resources to perform every task.

All the technologies and processes constituting the LFL components are considered as tools, and the whole LFL is thus seen as a toolbox that offers to the LFL operators a large diversity of tools with the key challenge of making it effective, simple and easy to use.

The LFL as a toolbox is part of the FP7-SEC PRACTICE project [Fonteyne et al., 2014] toolbox aiming at strengthening the users' operational capabilities in disaster response improving the exchange of critical information, bridge the gap between various tools and users, increase the flexibility, provide situational awareness and support better decision making of the actors involved. The focus of the LFL is on drawing together the integrated technology solutions in B agent detection, identification, analysis and communication technologies.

This concept of a toolbox allows a high degree of interoperability between the LFL users and other stakeholders at the differing levels of capability, pulling together heterogeneous multidisciplinary tools that serve the same LFL mission in crisis management. As it is impossible to foresee all potential situations in a crisis management mission, the LFL tool is designed as generic, scalable and adaptable to different crisis scenarios and changing conditions allowing flexibility during the mission.

The general scheme of LFL as a toolbox is shown in Figure 1.

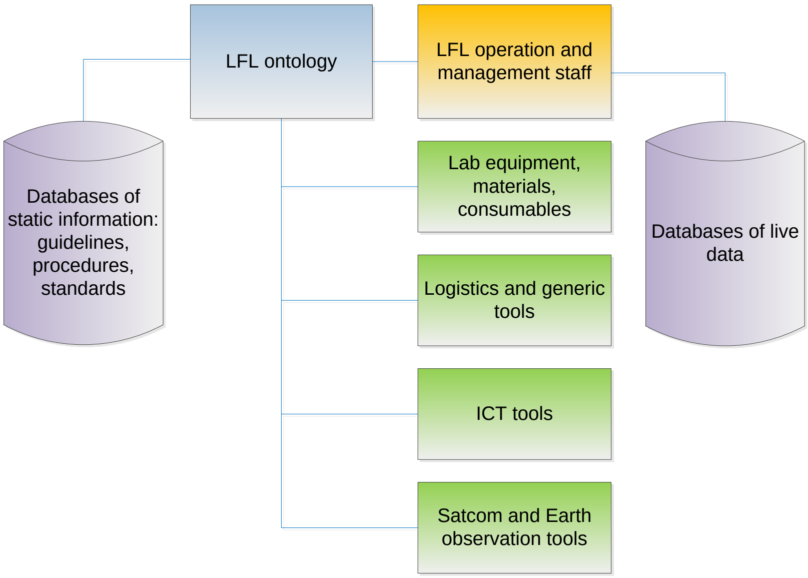

Figure 1. LFL Toolbox

In the LFL toolbox, different tools – technologies and processes - are associated to different functions. In FP7-SEC PRACTICE, *operational functions* are defined as activities (tasks) that need to be performed to identify and to actively counter CBRN threats, to be prepared for, to respond to and to recover from CBRN incidents/attacks [Fonteyne et al., 2014]. There are several conditions stipulating the operational functions implementation:

- By performing an operational function a particular goal/effect should be achieved.
- Particular resources will be needed to successfully perform a specific operational function.
- Each operational function is linked to other operational functions serving as pre-conditions, triggers, being part of, used in, linked to, influencing, informing or referring to the given function.
- Thus advanced input/information is needed to start a function and to successfully perform a function.

The LFL components do not act in isolation, they are unavoidably linked together by means of corresponding operational functions to be executed within a single system (the LFL toolbox) in order to achieve the desired result of LFL work – to provide evidence-based decision support for the decision making authorities.

All operational functions are grouped to perform certain LFL mission cycles as described in Figure 1 below, every function is linked by its properties to other functions, and is associated to the list of tools used to execute this function. Such a system creates a single information space where all the components, operational functions, tools must be described in a consistent way excluding redundancies and overlapping in order to be easily manageable. The LFL toolbox can be represented as a model consisting of a hierarchy of the classes, subclasses and individual concepts, and even more importantly the links between all the elements providing their usability within the toolbox.

In order to develop the LFL as an operational toolbox integrating technologies and processes, the following sub-objectives were pursued:

- to establish a mechanism allowing continuous improvement of the LFL structure and configuration;
- to identify a mission statement for the LFL as a service;
- to identify and describe the OFs required for the execution of the mission;

- to identify and describe the technologies and processes (tools) required for the execution of the functions;
- to develop the ontology to be applied to the LFL missions preparation, description of the relationship between operational functions and tools;
- to test the performances of the LFL toolbox and the added value of the ontology as the information management and decision support tool in field exercises.

The information management cycle in LFL corresponds to the principles described in [The Operational Guidance Note on Information Management, 2012]: the collected information about the operational functions, tasks, procedures, tools and actors form the body of data that is structured, processed and analysed using the ontological approach that facilitates the use of the data by the LFL operators, and by decision makers, providing complete, consistent, reliable and easily accessible data.

The LFL configuration can be designed for different missions requiring the deployment of a laboratory station in the field. Missions participate in response capacity as well as capacity building with the following five main categories of scenarios:

(1) CBRN scenarios: Field assessment of the distribution of environmental and human contamination resulting from a deliberate contamination of an indoor or an outdoor environment. Mission of the LFL is to provide evidence for accurate mapping of the contaminated area and contaminated persons. Main constraints are identified as emergency and the biohazard resulting from the handling of the agent

(2) Response to outbreaks scenario: typically outbreaks caused by life threatening, highly contagious agents in a remote area with insufficient local laboratory capacity. Mission of the LFL is to provide excellent microbiological diagnostics. The main constraints are identified as emergency and the maintenance of the full LFL capacity in a remote area with limited resources

(3) Public Health scenarios: typically support for difficult diagnosis in large geographical areas with none or low density of expert laboratories. The LFL mission is to cover a large territory with a single laboratory capacity. Main constraints are identified as mobility and robustness of equipment, and duration of the mission.

(4) Validation of new technologies: such as validation of field or point of care detection and identification tests vs. reference methods. The LFL mission is to validate new technologies in field conditions vs reference methods in reach back lab conditions, using identical samples. The main constraint is identified as the quality management of analytical procedures and results.

(5) Training: of local staffs and/or quality control of local capacities. The LFL mission is to contribute to the capacity rebuilding typically in a post disaster situation affecting laboratory infrastructure and staff. The main constraint is to adapt to the specificities of multicultural audiences.

Each category of LFL mission presumes execution of a range of operational functions and particular set of tools associated to the functions. Most operational functions are activated for all types of missions, while the set of tools corresponding to the certain operational functions have to be applied only to a particular mission. For example in the function `PowerSupply`, the tool `Generator6,5kVa` may not be required if the mission customer provides electricity.

The generalized LFL mission is represented as a cycle with 5 phases in 13 steps as described hereafter and illustrated by the Figure 2.

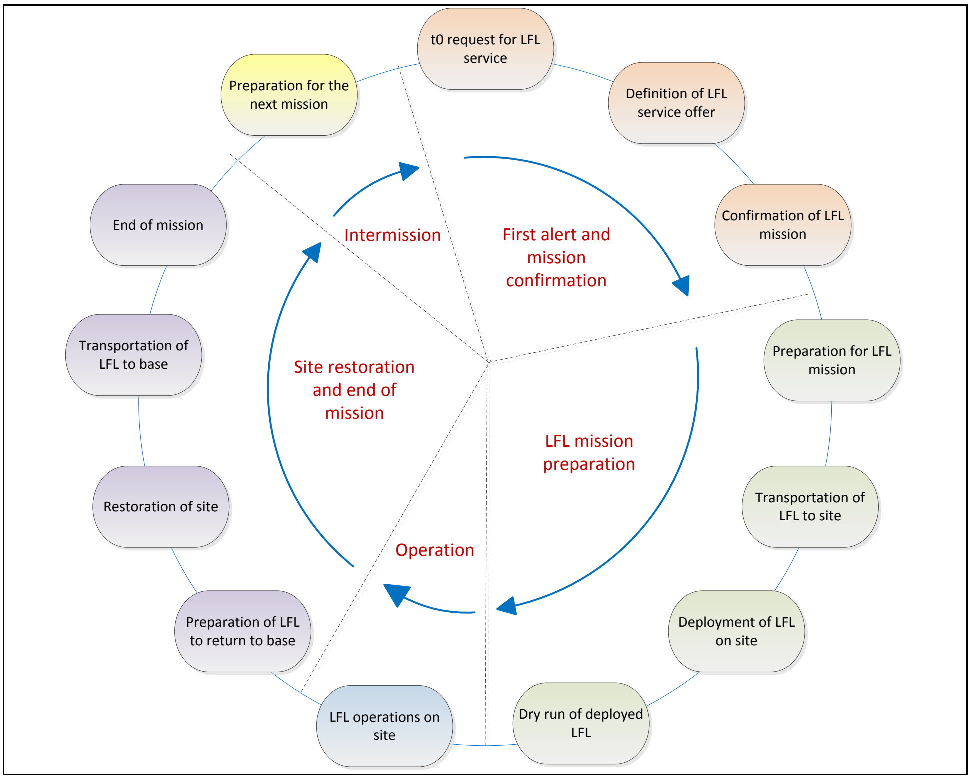

Figure 2. LFL Mission Cycles

Phase 1: First alert and mission confirmation starts at t0 with the record of a request for the mission by the manager of the LFL service. The LFL manager needs a short time to evaluate the request for service, check for feasibility and propose a service offer. The ontology based information management system has a major role to play in accelerating the process. The mission is confirmed as soon as the service offer is accepted by the customer.

Phase 2: Preparation of LFL mission. The LFL manager and staff prepare the mission for deployment. At the preparation and planning phase the LFL mission is defined, the LFL capacity is built according to the requirements of the mission - the plan for the access and installation on the site are established, all authorisations and clearance required for staff and materials are collected, it is ensured that the host nation authorities are correctly informed about the mission, and provide their agreement, it is evaluated which services and tools can be supplied locally and which of them must be brought, the costs of the mission are estimated and agreed with the stakeholders; the short list of volunteers to participate in the mission is confirmed, the staff is comprehensively informed about the conditions for LFL deployment. In addition to routine training during the intermission phase, complementary training is organised for specificities of the mission (e.g. operation of communication equipment, field security recommendations, physical training). All medical formalities, including the preparation and vaccination are accomplished; the guarantee of medical support and medical evacuation conditions is arranged with the stakeholders. In case clinical samples are foreseen to be collected during the mission, the required forms and approvals are proactively obtained in order to comply with and solve all the ethical issues and guarantee personal data protection. The LFL configuration is estimated and the list of tools to be involved in the particular mission is established, then the necessary tools are purchased, packed and prepared for deployment. As materials and volunteers are in a standby mode, the duration of the preparation phase mainly depends on the administrative and logistic constraints associated with transportation to the site of deployment. Staff and LFL hardware are then transported to the site. LFL is deployed and a dry run allows to test that the capacity is fully operational.

Phase 3: Operations on site is the core of the LFL mission and therefore deserves a more detailed description. Generally speaking, the LFL in operation can be seen as a box where samples and information related to these samples are processed in order to produce evidence to the attention of decision makers. The operations on site are described in 5 steps from notification of the arrival of samples to the follow-up interaction with customers after reporting.

- The 1st Step consists in the notification of a request for service and interaction with the customer.. Interaction is required in order to agree on specific needs of the customer, provide guidelines for the handling of samples and interpretation of results, and to plan the execution of the tests.
- Step 2 is "reception of samples" including data recording and validation of the samples packaging according to pre-established validation criteria and instructions provided to the customer and/or transporter.
- The tests are performed in the 3rd step including formal validation of the results and analysis of the raw data.
- At Step 4, results are reported in an unambiguous format that is fully informative for the customer according to the European standards for confidentiality, security and privacy of data..
- The 5th step ensures follow up including availability of the staff for further information upon request and preparation of the LFL for the next round.

In Phase 4 deployment ends with site restoration and end of mission. Staff will prepare the LFL for return to the basis. Important steps are the restoration of the site, cleaning, decontamination and waste management in order to avoid any side effect on the local population and environment. Staff and materials return to the base and after return and final debriefing, the end of the mission is declared.

The mission cycle ends with Phase 5 "Intermission" in which LFL is improved and prepared for a next run. All stocks of tools are ensured to be refilled and maintained. The new sources of funding are identified for dedicated research and next mission, and the staff undergoes routine training.

Development of an ontology-based description of the relationships between operational functions and tools

LFL toolbox employs a knowledge base that is represented in a comprehensive ontology combining the tools, modelling patterns and a priori background knowledge about the mission's parameters. The ontological approach to LFL description and mission's preparation serves a multifold purpose:

- to formalize and structure the domain of biological mobile laboratory operation in disaster response and preparedness to such response, thus ensuring the continuous improvement of performance;
- to provide easy access to all the information, and make the information reusable;
- to align the terminology, definitions between the tools and to provide a shared vocabulary of concepts to comply with the commonly recognized standards, best practices and procedures to facilitate common ground establishment between internal LFL operators and external decision makers;
- to provide technical and conceptual compatibility of sharable information between the heterogeneous tools.

The ontology here is a formal, explicit specification of a shared conceptualization describing the LFL as operational domain. It describes concepts, their properties, relationships and constraints on relationships between them, providing consistent and unambiguous modelling of the certain LFL concepts, procedures, functions, and/or delimiting others which are incompatible with the given task or scenario. This allows to follow the desired sequence and set of actions in a mission, and following the desired procedure associated with a certain scenario, allows to efficiently select the necessary tools from the whole collection and to activate them appropriately in due time.

1. The LFL ontology is developed with the help of the open-source Protégé environment [http://protege.stanford.edu/]. In the current version the ontology comprises:

- 359 classes (including subclasses) describing the LFM mission cycles, steps, operational functions, sub-functions, 10 categories of 117 tools used for each function implementation
- 58 individuals as members of classes denoting specific tools and materials used in the operational functions
- 27 object properties that determine the relationships between functions, such as: one function triggering (an)other function(s), providing information and expertise, influenced by (an)other function(s), included, being part of and used in (an)other function(s), having particular parameters, e.g. type, time, source or location, etc.
- 4 types of data properties that determine particular values of class members. These are specific values attributing to certain classes, such as values of temperature to be kept by the freezer, or predefined length of extension cords used in LFL,

The logical consistency of the entire model of the LFL operation domain is ensured by 1500 axioms (rules) and filters delimiting the restrictions for all the relationships between all kinds of ontology entries.

The tools used in the LFL for execution of various operational functions constitute ten groups with 117 categories:

- Lab equipment (11 categories)
- Lab consumables (22 categories)
- Polymerase chain reaction (PCR) equipment (3 categories)
- Personal protective equipment (PPE) (5 categories)
- Storage devices (1 category)
- Waste management tools (5 categories)
- Devices to record data (3 categories)
- Logistic tools (34 categories)
- Communication tools (8 categories)
- Generic tools (25 categories)

The ontology major classes describe the types of missions that can be executed by LFL, the LFL operational functions that are performed during the missions confirmation, preparation, execution, after mission site restoration, between the missions and transversal functions present in all cycles of LFL missions, as well as tools used in functions.

The LFL operators described in detail the contents of operational functions, the particular tasks within each function, the sequence of operational functions within each mission cycle. Based on this knowledge, the relationships between operational functions were defined in the ontology. Thus it was observed that actually all operational functions cannot be performed in isolation, but they all are related to other functions. For instance, the function `ReceptionOfSamples` (in the `Operation` cycle), at the high level cannot be executed unless LFL is deployed on the site with all the corresponding functions related to LFL preparation to operation, and at the direct level it cannot be executed unless the `DecisionToSample` has been made, thus `ReceptionOfSamples` function is triggered by several functions preceding it. In its turn, `ReceptionOfSamples` is linked to the function `TransportationOfSamplesToLFL`, triggers execution of the function `ValidationOfPackagingAndInformation`. By nature, `ReceptionOfSamples` is linked to `RecordingData` function, since data of every sample must be recorded to ensure the correct procedure of samples treatment. `ReceptionOfSamples` function can be executed with the use of several tools, which are associated to this function by means of property employs `Tool`.

In the ontology we manually denote only direct links between operational functions which impact the close “neighbours”. Each function in its turn invokes other functions and contains new parameters. The links between far distanced operational functions are generated automatically by the system reasoner following the intrinsic logic of properties inheritance and extrapolation within and between classes of functions.

The whole map of all the multiple links between all operational functions is created automatically and can be visualized together or fragment by fragment for every function neighbourhood. One such generalized fragment is illustrated below, showing a few links between operational functions of `FirstAlertAndMission Confirmation` cycle and `LFLMissionPreparation` cycle and other cycles. Note that only major links are shown on the visualisation, and secondary links are hidden for the sake of readability of the picture.

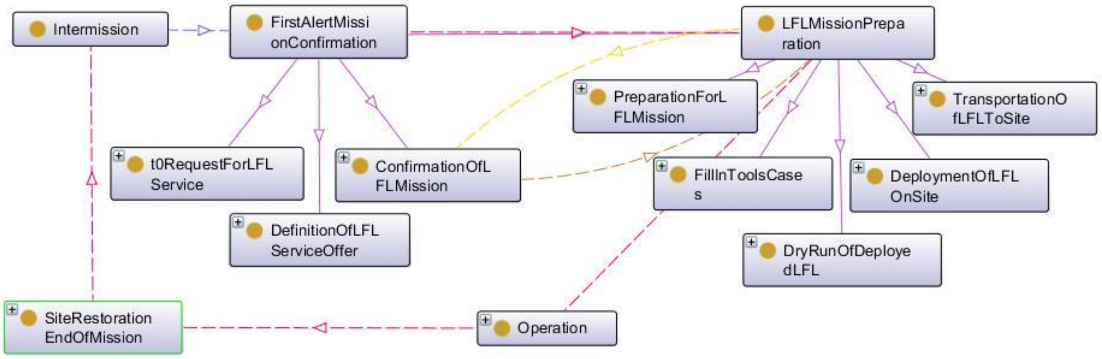

Figure 3. Fragment of ontology showing a few links between operational functions in the cycle FirstAlertAndMissionConfirmation**, and** LFLMissionPreparation.

------▶------ - hasSubclass link

------▶------ - isFollowedBy property

------▶------ - triggers property

------▶------ - isTriggeredBy property

"+" – the node has other linked nodes

Depending on the B threat at hand, a type of mission to be executed is defined in all detail to be better prepared for the mission and make sure that all components are taken into consideration correctly according to the mission type parameters. The set of the tools, the configuration of the mobile lab for a particular mission are stipulated by the Mission Parameters modelled in the ontology:

MissionLocation: Inside/Outside EU. If the mission is Outside EU, there are two further options – Country With a Developed Infrastructure, or Low Income Country. This parameter is linked to the MissionDuration parameter and LevelOfAutonomy parameter that prescribe requirements for the amount and categories of equipment to be taken for the mission, like autonomous power supply, autonomous communication means, etc.

MissionDuration: Short/MidTerm/Long. This parameter is obviously important for the lab configuration depending on the amount of various tools – materials, reagents, logistic tools, generic tools to be included and the shifts of staff. This parameter is linked to the Materials and Equipment, Logistics, Shelter, Communication.

NatureOfBiologicalAgent: this parameter is one of the most important as it defines the specific set of Tests required for diagnostics of a specific disease, the level of biosafety constraints, and possibly the need for specific Training of LFL staff.

NumberOfTests: this parameter is triggered by the MissionType to be performed – to know what shall be the LFL capacity, how many tests shall be done, and thus what Materials and Equipment shall be there, NumberOfStaffNeededForMission with reference to the MissionLocation which is linked to the Sampling area and sampling strategy to be implemented – thus linked to the corresponding operational functions in Operation cycle.

NumberOfStaffNeededForMission: this parameter is clearly related to the MissionType to be performed, and the MissionDuration parameter. A minimum of 3 staff members can participate in a short mission focusing on the analytical duties. Longer missions or missions requiring additional expertise will require additional staffs depending on the mission requirements for the job profiles necessary to execute the corresponding set of operational functions.

MaterialsAndEquipmentNeeds: this parameter is informed by the MissionType, MissionLocation, MissionDuration, LevelOfAutonomy, and is directly related to Logistics parameter and various categories of Tools that have to be collected in preparing a particular mission.

LevelOfAutonomy: FullIndependency/UseOfLocalFacilities. This parameter options are informed by MissionLocation, MissionDuration and MissionType, as well as Materials and Equipment to understand what facilities and equipment can be used when provided locally at the mission site, and what shall be brought with to provide full independency from local facilities or the absence thereof, and for how long (according to the host nation support conditions).

PreparationTime: Urgent/Middle/Planned. This is a parameter of MissionType denoting the necessity of urgent response in case of a CBRN incident, mid-term response in case of response to an outbreak, or planned intervention or training mission. This parameter is related to the operational function PreparationForLFLMission,

Logistics: this parameter options for AccommodationOfStaff/Food/Transportation depends on the MissionLocation, MissionDuration and LevelOfAutonomy to set up the requirements for Definition and Negotiation of LFLServiceOffer.

CommunicationNeeds: this parameter is informed by the LevelOfAutonomy, and is linked to

`Communication Tools` required for the `TypeOfMission` according to the `DefinitionOfLFLServiceOffer`.

`Users`: Public (Governmental, professional associations, …) / Private (PharmaCompany, Diagnostic Test Manufacturer, NGOs…) - the users responsible for `RequestForLFLService` can be customers funding the mission, and those actors involved in the `Negotiation and Confirmation of LFLServiceOffer`, as well as those influencing the `Operation` cycle of the mission. Exact `Users` for a particular mission can be instantiated as individual members of the predefined categories, together with the names, organisations and contact details.

Figure 4 hereafter illustrate the fragment of ontology linking LFL mission and service parameters:

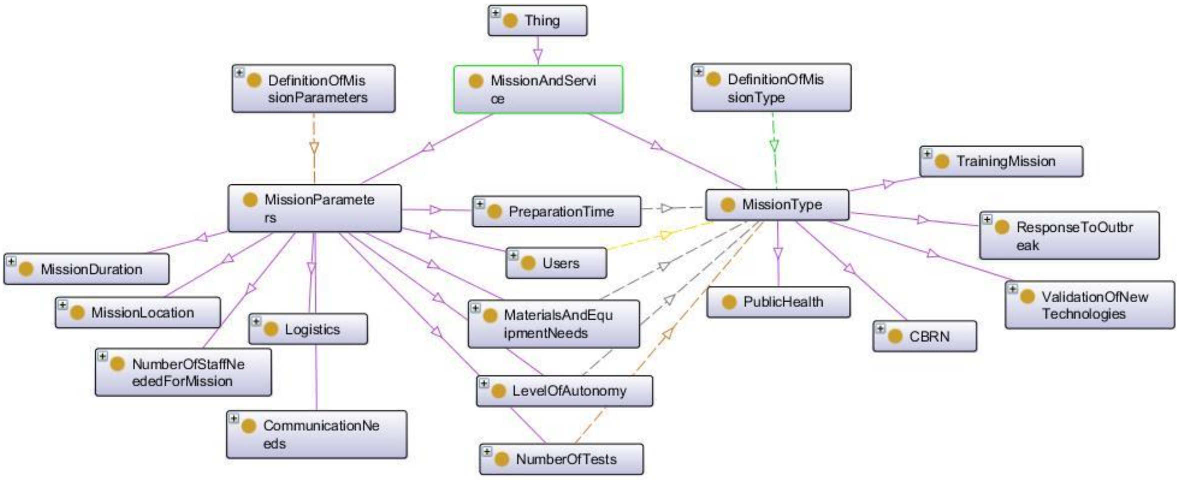

Figure 4. Fragment of the ontology linking LFL Mission and Service parameters.

The developed ontology has been evaluated by the LFL microbiology staff members according to the following performance parameters:

Clarity – the transparent knowledge representation is important to avoid misinterpretation, confusion, contradiction.

Completeness – the ontology shall cover all the relevant concepts in the domain of interest without gaps in knowledge

Consistency – the ontology shall be free from any logical contradictions in the internal and external rules, definition of classes, subclasses, categories, concepts, terms, instances, their properties and relationships.

Acceptability - both by developers and users – the ontology shall consistently use the commonly accepted and recognized terminology, precisely and truly describe the concepts, their attributes and relationships between the concepts relevant to the domain of interest.

These parameters have been evaluated, and the whole developed ontology validated through testing of the relevance for the users (the LFL microbiology staff) and performance on CBRN scenario at FP7-PRACTICE Full Scale International exercise PIONEX that took place in Pionki, Poland, in April 2014, where the LFL concept was tested in real operational conditions [2].

A good usable ontology shall not be a closed finite structure, it shall be possible to update it and enrich by introducing new classes, categories, concepts, terms, instances, properties and their relationships when necessary. The future work will include evaluation of the ontology performance, evolution and expandability on a further variety of application scenarios for the five categories of missions described above. Scenarios will be manually developed and agreed with users. Solutions provided by the ontology will be compared with solutions provided by users without using the ontology. In particular, the ontology is currently under evaluation for the outbreak scenario in the context of the planned LFL mission in December, 2014 to Guinea in response to the Ebola outbreak crisis. Then it will be further evaluated on the scenarios for public health – related missions on exploration of large geographical areas for diagnosis and assessment of risks related to monkeypox. An interesting challenge will be testing the performance, possible update and enrichment of the ontology, like adding new concepts or whole new modules as parts of ontology structuring various blocks of information, for instance, in case of a combined occurrence of biological agents to be tested for in a certain region, or a possible conflict of national vs. European regulations in the region where the mission should take place. The formalised ontology-based missions preparation will also provide a solid basis for the development of a quality assurance manual. It also supports the systematic continuous improvement of LFL configuration and whole system performance.

CONCLUSION

The ontology developed to structure the domain of a biological light fieldable laboratory operation in five categories of missions helps managing information of large diversity, which must be processed, interpreted, filtered and transformed into action as a result of decisions made. Integrating the LFL operational functions with all their parameters and tools into a single information space aims at strengthening the responders' operational and strategic capabilities by better preparedness and training for the biological crisis response, improving the exchange of critical information, making informed decisions and early monitoring of potential risks.

An important improvement for the usability of the ontology for users is foreseen by development of web-based interface for querying the ontology, The ontology has been developed keeping in mind the information needs of the users, so that it can provide answers to such questions as, for example - Given an incident, what tools shall be activated, at what time and in what sequence? Given a type of mission and having selected the relevant mission parameters, what operational functions shall be executed, when and in what sequence? By whom – who is responsible and involved in this particular operational function execution in the given region of the mission? How to contact this organization/person? What facilities and equipment can be used for the given operational function execution? What is the commonly accepted and internationally recognized denotation of the given operational function/facility/equipment/actor? What are the logistic facilities in the crisis area? What are the legal regulations valid in the mission area? etc.

Harmonising a concept of mobile laboratories that assemble many different elements from a spectrum of light field deployable capacities addressing a wide diversity of CBRN disciplines across many EU countries requires an ontological approach and is pursued in FP7-SEC MIRACLE project [FP7-SECURITY-MIRACLE, 2013-2015]. Sharing and reuse of information shall be enabled for interoperability of laboratories staff required by initiatives such as the European Mobile Laboratory Project (EMLab) for extensive staff training and joint operation [http://www.emlab.eu/].

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