TERMS OF REFERENCE FOR THE R&D PROJECT

1. **Title:** Classification Framework in Underwater IoT Networks.

2. **Background:**

a) The project is related to existing standards of ISO/IEC JTC 1/SC 41, not limited to, the following;

- ISO/IEC 30140-1:2018 Underwater acoustic sensor network (UWASN) - Part 1: Overview and requirements
- ISO/IEC 30140-2:2017 Underwater acoustic sensor network (UWASN) - Part 2: Reference architecture
- ISO/IEC 30140-3:2018 Underwater acoustic sensor network (UWASN)- Part 3: Entities and interfaces
- ISO/IEC 30140-4:2018 Underwater acoustic sensor network (UWASN)- Part 4: Interoperability

b) In the literature of Underwater networks or Underwater IoT, the generic term of network "Node" is used. Node here may refer to statically deployed sensor nodes or a mobile entity such as UUV (Unmanned Underwater Vehicle), AUV (Autonomous Underwater Vehicle), ROV (Remotely Operated Vehicle) and so on. Sensor node usually consists of sensors along with processors, batteries/power supply, and underwater modems. Modems also might be of Acoustic, Optics, RF or hybrid -i.e. supporting multimodal communication. Networks may have passive entities or active entities performing sensing tasks.

A standard classification of these nodes is currently not available in any of the national or international standards/literature. Classification of networks as per the depth of operation is required to be standardized. Providing classification of vehicles as per depth of operation can help in uniformity here. For example, Shallow Water (up to 200 meters) vs. Mid-Water (200 to 1000 meters) vs. Deep Water (over 1000 meters). Based on Autonomy, it can be autonomous vs. Remotely Operated etc. Similarly, the vehicle classification as micro, mini, and large is not well differentiated in the literature. For example, for Industry it will be important to quantify the classification based on the sizes such as Micro (less than 1 meter) vs. Mini vs. Large (over 5 meters).

Such aspects are also required for the underwater modem as well. A classification of these modems from rate, range and power usage point of view is required. The modems can be differentiated based on the frequency range of operation, conversion efficiency, mode of operation and power levels of emission. The report of this study will be utilized in developing a new standard on '**Classification Framework in Underwater IoT Networks'.**

3. Scope:

The scope of this R&D project is to document the classification of components of the underwater networks or Underwater IoT. The classification aspects will cover, but not limited to, the following:

1. **Network Nodes:** Including static sensor nodes and mobile entities such as UUVs, AUVs, and ROVs, considering their deployment environment, capabilities, and communication protocols.

2. **Vehicles:** Classifying vehicles based on their depth of operation (shallow, mid-water, deep-water), size (micro, mini, large), endurance (Short, Medium, and Long duration) and capabilities (Survey, profiling, and Intervention) providing clear distinctions to streamline communication.

3. **Modems:** Categorizing underwater modems based on performance metrics such as data rate, communication range, and power consumption. This classification will consider factors like frequency range, conversion efficiency, and emission power levels.

4. Expected Deliverables:

The following are the minimum expected deliverables from the R&D project:

1. Classification criteria for underwater network nodes, vehicles, and modems.
2. Technical documentation detailing the classification criteria
3. Recommendations for adoption of standard usage of terminology related to classification of underwater nodes across industry, manufacturers, network designers, researchers, academia etc,..
4. Information on publicly accessible resources to promote awareness and facilitate implementation of the standardized classification.

5. Research Methodology:

1. **Literature Review:** Conduct an extensive review of existing literature and industry standards to identify current practices and gaps in classification.

2. **Expert Consultation:** Engage with domain experts, researchers from civil and military, and industry stakeholders to gather insights and refine the classification criteria.

3. **Classification criteria development:** Develop a classification criterion for nodes, vehicles, and modems, considering depth of operation, size, and performance metrics.

4. **Review:** Review the proposed framework by circulations among the experts.

Work would majorly involve the literature review and access to standard journals and conference proceedings would be required. Visit to research organizations, manufacturing industries in India (at least 2) for data collection.

6. Timeline and Method of Progress Review :(6 months)

- Literature Review: 1.5 months
- Expert Consultation: 1 month
- Framework Development: 1.5 months
- **Mid-term Review: 3 months from date of allotment**
- First Draft : 1 month
- Documentation and Recommendations: 1 month.

Pert chart

Tasks	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**
Literature Review						
Expert Consultation						
Framework Development			Mid-term Review			
Documentation and Recommendations						
Submission of FPR						

7. Support BIS will provide:

BIS will provide access to the latest available editions of Indian standards and/ or international standards relevant to the project, on request.

8. Nodal Contact Point:

Mr Priyanshu Sharma, Scientist-C & Member Secretary (LITD 27), litd27@bis.gov.in

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