Basis of Estimate

1. WBS ID

1.3.4

$67,798.17 total burdened cost for this WBS

2. WBS Name

Ice Comms Module (ICM)

3. Estimated by

Timo Karg (DESY)

4. WBS Dictionary Description

Common to all 3 sensor types, may be implemented completely on the main board or as a standalone module that can be fitted onto all 3 sensor main boards. Will also be used in Standalone Calibration devices. Directly 'talks' to the Surface Comms Module that is located in the FieldHub. This element includes the firmware running on the ICM, including the golden image with boot loader and firmware update functionality, communications and error detection, and device addressing, and RapCal functionality.

5. Assumptions and Related Documents

The estimates described in this document rely on the following assumptions, which are consistent with the Project's "Key Assumptions" document" (1) and the "Cost Estimating Plan" (2).

- The cost estimate technique classifications (A-L) follow the US Government Accountability Office (GAO) best practices. These are summarized in the Project's Key Assumptions document (1). The techniques are: A=Analogy; C=Engineering build-up; D=Expert opinion; E=Extrapolation from actuals; F=Parametric; L=Learning Curves.
- Contingency codes are assigned to each item: C1—C8. These reflect the estimated uncertainty in the estimate. The meanings of the contingency codes and the percentage of contingency in each case are described in the Key Assumptions document (1).

6. Scope

The scope of this BOE covers the support of the ICM firmware during the final acceptance testing of the two main sensor types, mDOM and D-Egg, and during the development, testing, and design verification of the standalone calibration devices and the Special Devices (WBS 1.3.5).

7. Materials, Supplies, Equipment, Travel

7.1. Procurement of Materials, Supplies, Equipment

No materials will be purchased. Systems for firmware development are available and test systems for the different Upgrade modules are provided by the module developers.

7.2. Summary of Materials, Supplies, and Equipment Resources

WBS	M&S/Equipment Activity	FY22	FY23	FY24	FY25	Institution	GAO Estimation Technique	Base Year of Estimate	Unit Cost ($)	Qty	Direct Cost	Contingency Code

7.3. Travel

No travel is foreseen in this WBS element.

WBS	Travel Activity	FY22	FY23	FY24	FY25	Institution	GAO Estimation Technique	Base Year of Estimate	Unit Cost ($)	Contingency Code

8. Labor

8.1. Labor Estimate

The ICM firmware has been developed and tested in PY1 to PY3. However, a full system integration test has not been possible so far. Final acceptance testing of the sensor modules mDOM and D-Egg will be a stress test of the communication firmware under more realistic conditions. Developers of standalone calibration devices and Special Devices will require some minimal support to integrate their systems into the communication framework. Firmware support is also needed during system integration and commissioning of the IceCube Upgrade detector. A level-of-effort type supports from a firmware engineer is required for these activities. This work will be carried out by a person already hired, S. Griffin (WIPAC)x, and for the costing labor escalation rates according to the Key Assumptions Document will be applied.

- 0.15 FTE during the D-Egg final acceptance testing
- 0.15 FTE during the mDOM final acceptance testing
- 0.05 FTE until the end of project for development of standalone calibration devices and Special Devices until they pass their deployment readiness review, system integration, and detector commissioning

8.2. Summary of Labor Resources

WBS	Labor Activity	FY23	FY24	FY25	FY26	Institution	GAO Estimation Technique	Labor Type	Effort (hours)	Contingency Code
1.3.4.2	Support during D-Egg FAT execution	176	0	0	0	UW	D	LoE	176	C1
1.3.4.2	Support during mDOM FAT execution	198	0	0	0	UW	D	LoE	198	C1
1.3.4.2	Support for calibration and special devices,	84	84	84	49	UW	D	LoE	301	C1

	integration, commissioning									

9. References

[Ref-1] 1. **IceCube Upgrade Project.** *Key Assumptions for the IceCube Upgrade Project.*

[Ref-2] 2. —. *Cost Estimating Plan.*

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Revision History

Date	Revised by	Summary of changes
2022-01-27	Timo Karg	First version created
2022-02-25	Timo Karg	v1 for review
2022-03-07	Timo Karg	Removed FY22
2022-03-23	V. O'Dell	Did some cleanup; used fully burdened cost