**Supplemental Material: Cost Estimate**

The anticipated costs to enable widespread use of SMART cables have been calculated based on known costs for submarine cable systems and sensor sets combined with estimates for development and operational costs. Assumptions regarding the number of cable systems and number of SMART enabled repeaters are a significant factor in establishing the overall costs. To achieve global coverage of 2,000 SMART repeaters, 200 repeaters must be deployed each year. We estimate it will take ten years to achieve the widespread acceptance necessary to support this deployment rate. Full global deployment is projected to be achieved after eighteen years at which time the rate of retirement will equal the rate of new deployments. Costs are separated into three broad categories: development; deployment; and operations.

Development costs include the cost of a demonstration system, the cost to develop a reference design, and non-recurring costs to support the first deliveries of SMART repeaters from cable system suppliers. The demonstration system consists of three prototype sensor sets and up to 300 km of cable. These sensor sets will be installed either as an independent system or as the branching unit off a commercial telecom cable. In either case, the incremental cost associated with the science functionality will be supported by science funding. The reference design is envisioned as an open-source project to develop circuit board schematics, digital signal processing methods, communications protocols and related micro-code which can be reused by each repeater supplier. Some professional input is expected to be required to complete this design, although a large portion of the work should be performed by academia. The final aspect of development costs are non-recurring costs incurred by the cable system suppliers. The first system delivered by each supplier will incur non-recurring development costs. We anticipate that funding will have to be allocated to the first three suppliers that participate in the SMART cable program for this purpose. Any further participating suppliers will need to bear their own development costs. Development costs are the smallest portion of the overall budget and are incurred only during the first five years.

Deployment of fully developed SMART repeaters begins in year three. Deployment costs are calculated based on the number of SMART repeaters deployed times a unit cost, plus some costs for each cable system. We estimate a cost of US$207,000 per repeater, which includes an allowance for additional fiber in the cable. The cost model assumes this target price will be achieved in the fifth year. For prior and subsequent years, a 10 percent inflation/deflation factor is applied on the basis that lower volumes will incur higher costs but as delivery volumes and experience increase, the cost will decline to $175,000 per repeater. Deployment costs ramp from $6M in year three to a steady state of $36.5M in year nine. Deployment costs are the largest portion of the overall budget.

The final cost area is operational costs. Operations costs include program administration, data transmission, and data processing costs. Operational costs are about 10 percent of annual deployment costs but are an essential aspect of the overall program. Table 1 shows the projected approximate system cost. Note the large initial development cost that decreases after approximately year 5, with deployment volume and costs increasing year over year until a steady state in approximately year 10.

For comparison, the US NOAA DART program budget is $27M/year, comparable to the incremental cost for a SMART cable that spans the Pacific region where most of the US DART buoys are located. The Argo program, with 4000 expendable floats, costs about $32M per year to maintain. The NSF funded Ocean Observatories Initiative (OOI) cost approximately $400M for the fabrication phase, with operating costs of approximately $44M annually. NOAA estimates it spends approximately $430M annually to operate and maintain its ocean, coastal, and Great Lakes observing systems.

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|  | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 | Year 25 |
| Units Deployed |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Number of SMART repeaters deployed |  | 3 | 20 | 25 | 30 | 50 | 75 | 125 | 150 | 175 | 200 | 200 | 200 |
| Cumulative SMART repeaters in service |  | 3 | 23 | 48 | 78 | 128 | 203 | 328 | 478 | 653 | 1570 | 1995 | 2000 |
| Number of systems entering service |  | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| Cumulative systems in operation |  | 1 | 2 | 3 | 4 | 6 | 8 | 10 | 12 | 15 | 26 | 30 | 30 |
| Development Costs |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Demonstration system | $5,000 | $5,000 |  |  |  |  |  |  |  |  |  |  |  |
| Reference design |  | $2,000 |  |  |  |  |  |  |  |  |  |  |  |
| Non-recurring supplier costs |  |  | $3,000 | $3,000 | $3,000 |  |  |  |  |  |  |  |  |
| Total development costs | $5,000 | $7,000 | $3,000 | $3,000 | $3,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Deployment Costs |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SMART repeater deployments |  |  | $5,000 | $5,700 | $6,210 | $9,850 | $14,025 | $22,250 | $26,250 | $30,625 | $35,000 | $35,000 | $35,000 |
| Shore end equipment |  |  | $1,000 | $900 | $800 | $1,400 | $1,200 | $1,000 | $1,000 | $1,500 | $1,500 | $1,500 | $1,500 |
| Total Deployment Costs | $0 | $0 | $6,000 | $6,600 | $7,010 | $11,250 | $15,225 | $23,250 | $27,250 | $32,125 | $36,500 | $36,500 | $36,500 |
| Operations Costs |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Program office |  | $350 | $400 | $450 | $500 | $550 | $600 | $600 | $600 | $600 | $600 | $600 | $600 |
| Data management |  | $53 | $123 | $198 | $278 | $428 | $603 | $828 | $1,078 | $1,403 | $2,870 | $3,495 | $3,500 |
| Total Operations Costs |  | $403 | $523 | $648 | $778 | $978 | $1,203 | $1,428 | $1,678 | $2,003 | $3,470 | $4,095 | $4,100 |
| Total Annual Expenditure | $5,000 | $7,403 | $9,523 | $10,248 | $10,788 | $12,228 | $16,428 | $24,678 | $28,928 | $34,128 | $39,970 | $40,595 | $40,600 |
| Cumulative Expenditure | $5,000 | $12,403 | $21,926 | $32,174 | $42,962 | $55,190 | $71,618 | $96,296 | $125,224 | $159,352 | $355,565 | $557,715 | $760,715 |
| All figures in 2018 US$ '000s |  |  |  |  |  |  |  |  |  |  |  |  |  |

Table 1: Projected roll-out of SMART cable systems showing ramp-up to 30 operational systems, each with an average of 75 SMART repeaters and an operating life of 10 years, with estimated costs for deployment and operations in 2018 US$ ‘000s.