



Building Superior Embedded Systems

EMBEDDEDARTISTRY

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CPF Project Setup Proposal, v2

Embedded Artistry will dedicate five weeks to helping MBARI create a foundational project structure for developing the STM32-based CPF system.

Situation Appraisal

MBARI has developed an autonomous oceanographic coastal profiling float (CPF) that has been in operation for several years. The existing implementation is designed around a GHI G400S SOM and the code is written in C# using the .NET Micro Framework. The existing SOM has reached end-of-life, and there are general concerns with the greater oceanographic research community's willingness to adopt a C# codebase due to a general familiarity with and preference for C/C++. These two factors are driving a redesign of the CPF system.

The current effort is focusing on a custom SOM based on the STM32H7A3 processor with an implementation in C and C++. Prototyping efforts have been completed which demonstrate general viability of the processor with existing CPF peripheral hardware. MBARI has also created a prototype application to demonstrate some of the desired behavior of the device. MBARI is interested in engaging with an experienced embedded systems firm to implement a foundational project structure that can be extended to continue the development of the redesigned CPF system. Success of this effort will determine whether additional funding can be secured for the CPF redesign effort.

Embedded Artistry will dedicate 5 weeks to creating the initial version of the foundational project structure. We will use the provided prototype source code as a starting point, using the time available to us to refactor, redesign, and generally improve the code base with respect to maintainability and supporting future expansion. Since this initial project is time-bound, we will focus on big wins. Any improvement opportunities which cannot be addressed during the initial effort will be documented and discussed with MBARI.

Objectives

The primary objective of this engagement is to produce a foundational project skeleton that can be used for further development of the new CPF system. This skeleton will provide equivalent behavior to the existing prototype software, with improvements made to support long-term maintainability and future development.

While developing the new project structure, Embedded Artistry will note additional improvement opportunities that can be made to the existing source code.

Because this engagement is time-bounded, there is an opportunity to also achieve a number of secondary objectives *if execution of the primary objective can be completed early*. Secondary objectives will be accomplished as-able, with the following priority:

1. Integrate a unit testing framework
2. Implement static analysis support with one tool
3. Redesign of the existing UART driver to generalize it and support DMA transfers
4. Address static analysis tool feedback
5. Improve test coverage
6. Implement support for additional static analysis tools

Work Products

The following work products will be delivered to MBARI:

1. Source code for the foundational project structure
2. Design review document containing recommended changes to the prototype software and the build environment
3. Time permitting: secondary objectives as noted above

Delivery Metrics

Embedded Artistry will provide a weekly status report on Friday. The report will provide a summary of work performed that week, planned work for the following week, and relevant service announcements.

MBARI has identified Visual Studio and VisualGDB as the primary development environment for this project. The solution provided will work with VisualGDB.

The foundational project structure will execute on the STM32H7A3. It will have behavioral equivalency with the provided prototype code.

Embedded Artistry will concurrently review the existing system to provide feedback in the following areas:

- Long-term viability and extensibility of the design
- Ways to further improve the existing code
- Design and code guidelines that can be applied to the project

Smaller points of feedback will be fixed as we work (based on our professional judgment). We will track recommended architectural/design feedback in a shared document that will be reviewed with Gene Massion at the conclusion of the project.

Embedded Artistry provided source code will meet the following design criteria:

1. Object-oriented wherever sensible and possible
2. Code will not require an expert understanding of C++.
3. Interfaces will be designed to work in an asynchronous, non-blocking manner
4. Descriptive names will be used
 1. Method names will include verbs which describe the action being performed
5. RAII will be used wherever it makes sense
6. Dynamic memory allocation will only happen during initialization
7. The ETL will be used in place of dynamic-memory STL types where appropriate
8. `std::array` and containers will be preferred to C-style arrays

9. Separation of concerns, information hiding, and encapsulation will be employed wherever possible (for example, peripheral drivers should not care which processor device instance they are connected to)

Joint Resource Commitments

MBARI has already provided source code read access for the project. Embedded Artistry will require write access to the C++ CPF prototype software repository so that we may submit our modified code to the servers. Alternatively, a new empty project can be created by MBARI to house our code.

MBARI will provide Embedded Artistry with the following hardware:

- STM32H7A3 Nucleo board
- Arduino uSD shield we built with a jumper to loop back the UART TX and RX
- uBlox GPS Receiver

Hardware will be returned at the end of this project if no further work is anticipated, or as requested by MBARI.

Embedded Artistry will acquire Windows 10, Visual Studio, and Visual GDB licenses for use on this project.

Timing

Embedded Artistry is available to begin working with MBARI starting 6 September. This project will run for five weeks (ending 7 October).

We are unavailable on 5 September and 16-19 September. Phillip will be unavailable between 11-17 October (immediately following the project's completion).

Fee

The fixed fee for this five-week engagement is \$13,500. Payments are due on the following schedule (invoices will be provided):

- \$1,350 deposit due to start the engagement
- \$12,150 due 22 October

We offer a 10% discount on the total fee if the full project fee is paid up-front (total of \$12,150). Please indicate if you will be taking advantage of this discount upon returning this signed proposal.

Late Payments

Work will be halted until payment has been made.

Expenses

Any project-related expenses that are incurred will be billed at the end of each month with Net15 payment terms. Approval will be requested in advance for any anticipated expenses and receipts will be provided with the expense invoice.

We do not anticipate any expenses for this engagement.

Out-of-Scope Requests

Embedded Artistry is willing to support requests that are outside of the primary engagement objectives, subject to our approval. Any such requests will be billed in increments of 15-minutes at our standard hourly rate of \$325. We will notify MBARI of any subsequent delays that will be incurred on the primary scope of work.

We will send a summary of billable hours worked in the weekly status report. An invoice for hourly support will be issued every two weeks with Net15 payment terms.

Acceptance

Your signature below indicates acceptance of this proposal. Work will begin according to the proposed schedule provided the deposit and required materials are received.

This proposal is valid through **26 August 2022**.

CONSULTANT:

CLIENT:

MBARI

A handwritten signature in black ink, appearing to read 'P Johnston', with a long horizontal flourish extending to the right.

Phillip Johnston
Embedded Artistry LLC

Date: 25 July 2022

Name: _____

Title: _____

Date: _____