



Building Superior Embedded Systems

EMBEDDED**ARTISTRY**

<https://embeddedartistry.com>
contact@embeddedartistry.com

CPF Project Setup Proposal

Embedded Artistry will dedicate two to four 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. However, there are issues getting the code for these prototypes to work properly when they are combined into a single system. Rather than burning time to debug these issues, 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 2-4 weeks to creating the initial version of the foundational project structure. Our primary goal is to merge the two existing prototype applications into a single system, set up minimal on-target testing support, and create sample unit tests to demonstrate the testing framework. Because there have already been difficulties in merging these applications, a fallback plan has been provided in case we determine this effort is not feasible within the allotted timeframe. As we are creating the project structure, we will review the existing code and provide design feedback to the MBARI team upon completion of this initial project.

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. The target outcome is to produce a combination of the existing prototype software into a single application. If that cannot be achieved within the project timeline, then a minimum viable application for the STM32H7A3 Nucleo board will be created.

The secondary objective of this engagement is to review the existing CPF source code and design to determine its long-term viability for the redesigned system.

Because this engagement is time-bounded, there is an opportunity to also achieve a number of tertiary objectives *if execution of the primary objective can be completed early*.

Tertiary objectives will be accomplished as-able, with the following priority:

1. Implement static analysis support with one tool
2. UART loopback testing support
3. (If fallback plan is executed) Incorporate state machines and other constructs from the CPF C++ prototype
4. Real-Time Clock driver, which synchronizes time from the GPS
5. I2C interface, with DMA and Interrupt support
6. GPS driver implementation using the I2C interface
7. Redesign of the existing UART driver to generalize it so it works with any available processor UART port
8. Address static analysis tool feedback
9. Expand test coverage
10. Implement support for additional static analysis tools

Work Products

The following work products will be delivered to MBARI:

1. Source code for the resulting project skeleton
2. Design review document containing recommended changes to the prototype software and the build environment

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 skeleton will include minimum support for:

- Executing on the STM32H7A3 Nucleo board
- Reading from the GPS receiver over UART using DMA
- Writing files to a micro-SD card that supports FatFs
- Unit testing (with sample tests)

If Embedded Artistry determines that merging the existing GPS and SD card prototype applications cannot be achieved within 7 business days of our effort, we will execute the fallback plan to produce a minimum viable skeleton which performs the following actions:

- Initialize the system
- Read GPS positions over UART (via DMA/interrupts)
- Log the message to a file on the SD card

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 improve the existing code
- Design and code guidelines that can be applied to the project
- In the event that we need to switch to the fallback plan, we will include in our review a discussion of the difficulties we encountered and explain how that might drive future development.

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. RAI 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 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 17 January. This project will run for either two weeks (ending 28 January) or four weeks (ending 11 February).

Fee

Two options are provided for this project:

- Two Week
- Four Week

Two Week

The fixed fee for the two-week option is \$6750. Payments are due on the following schedule (invoices will be provided):

- \$750 deposit due to start the engagement
- \$6000 due 4 February

We offer a 10% discount on the total fee if the full project fee is paid up-front (total of \$6075).

Four Week

The fixed fee for the four-week option 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 18 February

We offer a 10% discount on the total fee if the full project fee is paid up-front (total of \$12,150).

Payment Method

Embedded Artistry prefers payment via direct transfer but will also accept payment via check or credit card. Payment remittance information is provided on the invoice. Please provide instructions if invoices are to be sent to an accounting team.

Late Payments

A 3% monthly interest charge will be applied to late payments starting the business day following the invoice due date. 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 \$250. 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 once the deposit and required materials are received.

Please indicate desired option: ☐ Two-week ☐ Four-week

This proposal is valid through **31 December 2021**.

CONSULTANT:

CLIENT:

MBARI



Phillip Johnston
Embedded Artistry LLC

Date: 19 December 2021

Name: _____

Title: _____

Date: _____