**Rællic Systems**
Advanced Information Systems / HPC
+1 (415) 261-8527 / CAGE: 9DZ94

555 Twin Dolphin Dr., Ste. 135
Redwood City, CA 94065
andrew@raellic.com

July 20, 2024

Via Email

U.S. Missile Defense Agency
unsolicited.proposals@mda.mil

RE: Unsolicited Proposal: Infinity Stone

Dear MDA,

Thank you for your continued work on your critical mission in the Department of Defense. I write with an unsolicited proposal that I think is relevant to your mission in the areas of algorithms, probability, decision theory, and Artificial Intelligence.

**Abstract**

INFINITY STONE is a proposed suite of software applications written in C++ and x86 Assembly language that are intended to (1) rapidly compute the predicted trajectory and targets of hypersonic glide vehicles (HGVs) using a fusion of high resolution sensor data and dynamic Bayesian networks, assisted by Artificial Intelligence when possible; and (2) determine the correct timing of, and issue, missile launch orders to position enough kinetic kill vehicles in the predicted flight path so as to enable intercept of incoming HGVs with an acceptable level of confidence. The system is supplemented by an opportunistic automatic queueing algorithm that assigns the nearest Joint Warfighting Cloud Capability (JWCC) supercomputing asset an A.I.-assisted trajectory inference task, so that each defensive missile battery has essentially unlimited computation available to it with the smallest Round Trip Time (RTT) possible. A proof of concept is proposed using a commercially available civilian A.I. platform that has a substantial cloud-based capability, followed by a prototype in C++ and/or x86 Assembly for testing.

**Executive Summary**

Infinity Stone is intended to rapidly compute the predicted trajectory and targets of midcourse-to-terminal Hypersonic Glide Vehicles until a user-specified target confidence level is reached, at which point the system directs the launch of defensive missiles into the anticipated area of intercept. Millimeter-wave software-defined radar is proposed to detect the extremely minor turning, change in speed, and other maneuvers of HGVs, which are believed to be an earlier sign of their intention to turn toward the actual target than actual distance and bearing. The early signal returns feed into the A.I. system to update Bayesian probabilities.

The system envisions local and remote computation; the local missile batteries have a classical approach, while the out-of-band remote supercomputing asset has an A.I. inference element that refines the local computations and reports back with a more precise track, and/or more accurate launch orders. In this solution, multiple defensive missile batteries and radars send trajectory data and computation tasks to the nearest JWCC supercomputing asset to offload the most computing-intensive tasks while retaining normal local capabilities. In this way, they have a reasonably accurate local track and a tentative launch decision, but also have a super-refined remotely computed track in high resolution, with added target probabilities and better launch decisions.

Centralizing the supercomputing in the JWCC also enables sensitive data such as "blue team" target lists and target weights to be restricted from the local missile batteries for security reasons or otherwise. Additionally, the connection of multiple missile batteries to JWCC will facilitate the gathering of data necessary to train a neural network on HGV tracking and interception.

The targeting and defense algorithms were prepared in consultation with the desired software engineer, who is an expert in C++ and x86 Assembly. The offeror believes that after an initial three seconds of tracking from the point of HGV detection, the system can manage a continuous 2 Hz to 3 Hz target refresh on the operator display, even allowing for significant latency in data transmission and cloud computation. With the JWCC system expected to offer a near-instantaneous and automatically load-balanced supercomputing capacity, it makes sense to opportunistically supplement the local computations with JWCC compute results. The offeror believes the current system does not exist, which renders HGV track and target prediction in the midcourse-to-terminal phase difficult-to-impossible with current publicly known technology. The collaboration of the chair of aerospace engineering at a global university is possible following their potential interest in the system, and this and other consultants' involvement will ensure that the basic science behind the system is sound.

Infinity Stone can be accomplished at the proof of concept level in approximately twelve months for $100,000.00 with the involvement of subcontractor Wolfram Research, Inc., which is the creator of the technical computation program Mathematica (used for computation and technical diagrams), and also the creator of the Wolfram|Alpha cloud computation system that stands in for an actual JWCC supercomputing asset. The proof of concept incorporates a commercially available Bayesian A.I. package and its underlying libraries to save money and effort; its authors are also consulting on this program. The proposed prototype can be accomplished in approximately twenty-four months with subcontractor Jerry Cai, a prominent C++/Assembly programmer in Silicon Valley with substantial A.I. experience, working full-time on a solo basis or optionally with a small team if faster results are desired.

Much of the legwork has been done on the dynamic Bayesian network side in the aforementioned COTS Bayesian modeling package, which may be possible to compile as an extremely fast, extremely lean library for an onboard missile guidance computer such as on the Patriot missile.

The prototype would optionally use millimeter-wave software defined radio (SDR) chips from vendor mmTron, Inc. in a phased array to evaluate whether an ultra high resolution (n = 64 billion samples/sec) SDR-based radar would enhance the accuracy of the system and detect small indications of HGV intention. The ultimate goal is, of course, testing Infinity Stone at White Sands Missile Range or a comparable facility with a simulated HGV and actual Patriot missile batteries connected to the system. Success is defined as completing Milestone One (proof of concept); Milestone Two (prototype); Milestone Three (test of prototype in simulation environment); and Milestone Four (test of prototype on actual missile range).

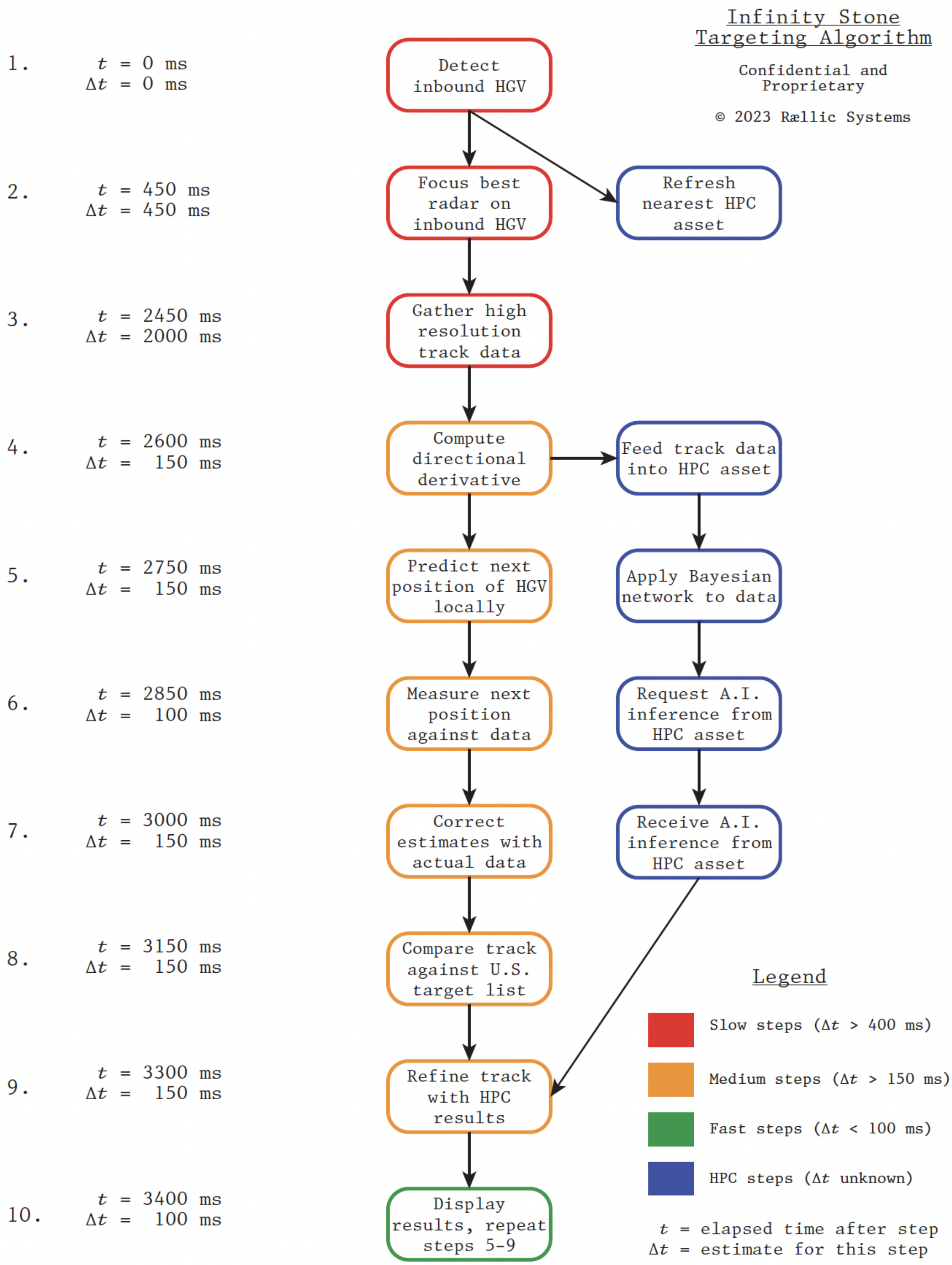
The system is relevant to the MDA mission in the area of hypersonic defense, which is an important field considering that opposing nations such as Russia and China have announced and/or demonstrated hypersonic missiles and HGVs. With enough optimization, the offeror suggests as a "reach" goal providing an efficient means of defense against "carrier killer" hypersonic missiles in a naval setting by using a compact GPU-based supercomputing system that could be installed on a Navy ship such as AEGIS cruisers, or aircract carriers themselves, to make up for the latency that would be expected when computing the same tasks in JWCC on a typical satellite connection.

Government support is required if the Government wishes to share classified information with the offeror, as none of the participants have clearances, and their work is normally done in an office-type setting with no access to SCIFs. There are no foreign persons. The proposal does not appear to require access to much, if any, classified information, as the proposal focuses on novel science and algorithms rather than actual data in the possession of the Government.

If the Government wishes to proceed to Milestone Three (testing of prototype in simulation environment), presumably TS/SCI clearances will be required for the offeror and the principal software engineer (two clearances total). The offeror suggests deferring clearances until the conclusion of the proof of concept at Milestone One.

## Program Description

There are two algorithms proposed: (1) targeting, and (2) defense. The defense algorithm will be completed as part of the proof of concept. A process diagram is provided showing the targeting algorithm, followed by a narrative description of each step:


Infinity Stone
Targeting Algorithm
Confidential and Proprietary
© 2023 Rællic Systems
1. t = 0 ms
Δt = 0 ms
Detect inbound HGV
2. t = 450 ms
Δt = 450 ms
Focus best radar on inbound HGV
Refresh nearest HPC asset
3. t = 2450 ms
Δt = 2000 ms
Gather high resolution track data
4. t = 2600 ms
Δt = 150 ms
Compute directional derivative
Feed track data into HPC asset
5. t = 2750 ms
Δt = 150 ms
Predict next position of HGV locally
Apply Bayesian network to data
6. t = 2850 ms
Δt = 100 ms
Measure next position against data
Request A.I. inference from HPC asset
7. t = 3000 ms
Δt = 150 ms
Correct estimates with actual data
Receive A.I. inference from HPC asset
8. t = 3150 ms
Δt = 150 ms
Compare track against U.S. target list
9. t = 3300 ms
Δt = 150 ms
Refine track with HPC results
10. t = 3400 ms
Δt = 100 ms
Display results, repeat steps 5-9
Legend
Slow steps (Δt > 400 ms)
Medium steps (Δt > 150 ms)
Fast steps (Δt < 100 ms)
HPC steps (Δt unknown)
t = elapsed time after step
Δt = estimate for this step

1. Detect incoming HGV from existing sensor data (t = 0).
2a. Focus best available phased array radar on incoming HGV (t = 200 ms, t$\Delta$ = 200 ms).
2b. If not already cached, determine nearest available supercomputing asset from Joint Warfighting Cloud Capbility (t = 200 ms, t$\Delta$ = 150 ms).
2c. Initiate secure connection to nearest supercomputing asset identified in step 2b (t = 450 ms, t$\Delta$ = 250 ms).
3a. Track HGV with high resolution sampling of trajectory (n > 32 billion samples per second) (t = 2450 ms, t$\Delta$ = 2000 ms).
3b. Feed track data into supercomputing asset if available (t = 2500 ms, t$\Delta$ = 10-50 ms).
3c. Apply high resolution Kalman filter to track (t = 2550 ms, t$\Delta$ = 50 ms).
4a. Compute directional derivative/gradient of Kalman-filtered track on a continuous basis (t = 2600 ms, t$\Delta$ = 50 ms).
4b. Request A.I. inference from neural network in supercomputer connected in step 2c (t = 2650 ms, t$\Delta$ = 10-50 ms).
4c. Predict next position of HGV locally from the directional derivative of the Kalman-filtered track (t = 2660 ms, t$\Delta$ = 10 ms).
5. Measure next predicted position of HGV against actual sensor data (t = 2710 ms, t$\Delta$ = 50 ms).
6. Correct estimates with deviation between actual versus predicted position and re-compute step 4c (t = 2810 ms, t$\Delta$ = 100 ms).
7. Compare step 4c with blue team's target list. If there is a match within theater/area, report circular error probability (CEP) of impact on likely targets in predicted HGV path (t = 2910 ms, t$\Delta$ = 100 ms).
8. Receive predicted track from supercomputing asset and update local data and CEP (t = 2960 ms, t$\Delta$ = 50 ms).
9. Display results on screen and update operator display with 3 Hz refresh (t = 2980 ms, t$\Delta$ = 20 ms). Repeat steps 4a-9 at 3 Hz until CEP reaches 80%, after which initiate step 10.
10. Launch defensive missile into HGV path.
11. Communicate with missile and continuously update trajectory with local and remote data until missile acquires target with onboard active seeker.

The system is believed to be able to contribute to the MDA mission, and the offeror invites contact to discuss the proposal further. The proof of concept can be accomplished for $100,000.00 within 12 months, which represents a half-of-full-time software engineer programming C++ and Assembly for 7 months ($70,000.00), plus the estimated cost of cloud computing credits from Wolfram|Alpha ($10,000.00), 3 months of additional programming in Wolfram|Alpha by the offeror ($0.00), and 2 months of final testing with the software engineer ($20,000.00) before presenting the results to the Government. The offeror may be required to essentially donate his services in Milestone One in order to maximize the amount of programming that can be done by the indicated professional software engineer. In addition, the offeror will be investing at least $100,000.00 of his own money in the project. Your response is respectfully requested, either indicating interest or no interest.

Sincerely,

Andrew G. Watters
Owner