Department of the Navy SBIR/STTR Transition Program
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NAVAIR 2018-833

Topic # N152-096
FlexDuo - An FPGA Accelerated, Flexible Execution Mission Processing
QuickFlex, Inc.

WHO

SYSCOM: NAVAIR

Sponsoring Program: PMA 275 V22 Osprey Program and PMA 276 H-1 Helicopter Program

Transition Target: V22 Osprey, AH-1Z and UH-1Y Helicopters

TPOC:
(301)342-5690

Other transition opportunities: The FlexDuo distributed mission computing technology is ideal for other new or retrofitted Navy and DoD (attack) rotorcraft and fixed wing aircraft, as well as civil air systems. The architecture could also potentially be utilized for securing systems, radar applications, and/or basically anywhere Field Programmable Gate Arrays (FPGAs) that need to be secured or networked are installed.

Notes: FlexDuo's versatile multi-node design will enable it to be scaled for use on a variety of aircraft and other systems, providing further cost savings and enhancing its commercialization potential. The state-of-the-art FlexDuo approach helps future-proof systems, while providing a more cost effective, high performance, fault tolerant architecture designed for next generation, increasingly computationally intensive algorithms.

US Navy Image 180204-N-XK809-047, available at https://www.navy.mil/management/photodb/photos/180204-N-XK809-047.JPG

WHAT

Operational Need and Improvement: To replace centralized mission computer/processing, the Navy needs a more cost effective, flexible, distributed architecture supporting current/future high speed/high power hardware and more video intensive processing with increased mission computing fault tolerance. As a team member of three companies, QuickFlex is performing offload of Central Processing Unit (CPU)/Graphics Processing Unit (GPU) functions and dynamic securing of the network.

Specifications Required: Overall team goals: maintain full situational awareness (S/A) across 4 Extended Graphics Array/High Definition (XGA/HD) (720 & 1080p) displays & processing maps, digital video, & sensor data, even if loose up to 50% of Processing Nodes. Architecture should have singular nodal processing system of at least 3 nodes with documented expandability limit, reduced unit cost 20% or less, & include new, higher speed systems (i.e., Ethernet). QuickFlex goal: provide secure, flexible high-performance distributed processing architecture.

Technology Developed: FlexDuo's defining feature is the ability to sub-divide a software (SW) workload between groups of SW processors & hardware (HW) acceleration components and at runtime dynamically allocate these tasks between constituent components, taking into account possibility of HW being destroyed, lost, or compromised when making the dynamic allocation. FlexDuo implementation will consist of a collection of FPGA-accelerated Processing Nodes (PNs) with capability to react to lost PNs & automatically restore their associated functionality. Lost or failing PNs are detected by SW developed by another team member. To accommodate various functions, FlexDuo provides a flexible execution model: functions may run on CPU or be implemented on FPGA & GPU resources for HW acceleration. FlexDuo uses compliant Real Time Operating System (RTOS) to guarantee functions will not interfere with each other when running on CPU. FlexDuo uses innovative techniques to compartmentalize functions for individual unit testing, increasing overall system reliability while removing need to exhaustively test & certify every possible permutation of simultaneous process allocations.

Warfighter Value: Supports mission success/safety: provides operators with full system functionally even in event of node failure while providing increased S/A, more real-time comprehensive video & other feeds. Reduces costs: minimizes use of aviation specific chips, provides SW portability, integration & upgrades via standards-based interfaces, miniaturization, & performance hedge against obsolescence.

WHEN

Contract Number: N68335-17-C-0388   **Ending on:** June 20, 2018

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Phase II Base	N/A	Submitted Architecture and Design Documentation Version 1, including unclassified analysis of FlexDuo architecture security requirements.	4+	June 2018
Phase II Base	N/A	Submitted User Guide and Read Me First Version 1 for implementation of the FlexDuo technologies.	4+	June 2018
Phase II Base	N/A	Finalized FlexDuo initial infrastructure software using selected board, operating system, and necessary driver(s) for communication; submitted FlexDuo Software Code Version 1 and software video demonstration.	3+	June 2018
Phase II Option I	N/A	Demonstrate FlexDuo Architecture on Processing Node demonstration and development platform incorporating Key FPGA technology, Fault Tolerance, Security, Networking, and other aspects of software and firmware design	6+	December 2019
Phase II Option II	Med	If Option II exercised, finalize Testing and Integration, finalize Demonstration and Development Platform, provide higher fidelity prototype and technical readiness level (TRL).	7+	December 2020

HOW

Projected Business Model: QuickFlex expects to use the direct sales model, with profits derived from product licensing sales, training, maintenance agreements, and engineering services contracts. Agreements are expected to include standard, yet customized, software licensing and maintenance agreements, with engineering research and development (R&D) and other services at industry rates. Depending upon customer needs, FlexDuo technologies can be customized for various environments using QuickFlex engineering R&D services.

Company Objectives: QuickFlex is proud to support our valued U.S. Federal Government (e.g., DoD, NASA, DoE, and others), DoD contractor, and other customers. QuickFlex and its experts have a proven record of successful product development from concept generation through deployment, supporting all phases of the product life cycle including: Qualifications (Flight), Certifications, Radiation Testing, Manufacturing, Support, and Upgrades. QuickFlex provides products and services in the development and support of high-performance, state-of-the-art, reconfigurable systems and circuit solutions, novel security protections, fault tolerant solutions, and sophisticated decision engines for embedded, desktop, and networking technologies. With current focus on leveraging QuickFlex's technologies and expertise to create secure, fault tolerant distributed mission computing, secure mobile-ad-hoc network (MANET)/fixed network technologies, and Cyber Security and Anti-Tamper solutions, QuickFlex's innovations are applicable for systems of all sizes. QuickFlex is continuing its long term goals of providing more standardized, broadly applicable, readily customizable technologies to help deliver lower non-recurring engineering (NRE), faster-time-to-deployment, reduced risks to programs, and increased product life.

Potential Commercial Applications: Beyond the DoD, FlexDuo can bring value to various National Critical Infrastructure (NCI) industries, such as the energy sector. Other sectors include oil and gas drilling and "smart factory" manufacturing where FlexDuo's capabilities make it a first-rate choice for more harsh manufacturing environments.

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