Agile Condor: Scalable High Performance Embedded Computing Architecture

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Integrity ★ Service ★ Excellence
AGILE CONDOR
Agenda

• CONOPS- Why Agile Condor?
• System Overview
• Pod and Chassis Design
• Scalability of the system
• AirWASP Processing Framework
• Future Work
• Summary
AGILE CONDOR
Operations Concept

1. Degraded or lost GPS and communications

2. RPA enables advanced navigation and target recognition algorithms

3. Agile Condor provides needed additional processing resources

4. RPA avoids threat using results from advanced algorithms processed on Agile Condor

5. Mission continues

Enabling autonomy in contested and degraded environments
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Capability Vision

**Vision:** Increase warfighter effectiveness by enhancing remotely piloted systems capabilities and expanding their capacity to create effects in the battlespace. The initial focus must be on onboard processing of data from sensors to reduce bandwidth required, further enabling human analysts to be more efficient and effective by focusing their efforts on key information.

**Goal 1:** Reduce Bandwidth Requirements
- High Data Transfer Rates
- Advanced Algorithms
- Command and Control
- On-Board Data Storage
- Real-Time Processing
- Pod-Based High Performance Embedded Computer

**Goal 2:** Enable ISR Missions in A2/AD environments
- Sensor Agnostic Interface
- Open Standards (VITA, 3U OpenVPX, IEEE)

**Goal 3:** Modular, Flexible, Scalable, Sensor Agnostic HPC Platform
- Reconfigurable Framework
- Next Generation Hardware
- Thermal Dissipation
- SWaP

**Goal 4:** Fast Technical Refresh Rate
- Flight Certified
- Airborne Environment
- Storage Environment

**Goal 5:** Compatibility with Group 3-Group 5 RPA’s
- Ground Environment

Legend
- Vision
- Goal
- Capability
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System Overview

3U VPX Backplane
- Design considerations for OpenVPX
- High speed PCIe data plane

Processing Pod
- Flight tested
- External Air for Cooling

Power Supply
- 800 Watts
- Smart Monitoring

Expansion Slots / Mezzanines
- 10Gbase-T
- 16Gbps Application Specific IO
- Support for fiber optic links
- FPGA option for pre-processing

SBC / GPU (x2) per slice
- Latest generation Intel i7
- Latest generation mobile ‘Kepler’ GPU
- 1096 GOps x2
- COTS Upgradable

PEX431
- PCIe switch base card

Processing Chassis
- Conduction Cooled 3U VPX
- Environmentally Sealed

Processing Slice (x3)

Agile Condor brings distributed high-performance computing closer to the sensor
• Existing pod baseline flight certified
• MIL-STD-8591 design for aircraft interface and aerodynamics
• Ambient air cooling thermal management

POD Air Inlet with filter

POD Air exhaust

Aircraft Mounting Interface

Aircraft I/O Interface

61.5 in
AGILE CONDOR
Chassis Details

14 slot backplane
VITA 62 power supplies
Cooling fins (forced air)
IO Card
38999 mil circular connectors

14 slot, 3U, VPX Conduction Cooled Chassis
Embedded HPC 2015 Flight Test

- Embedded real-time experiments
  - AirWASP
    - FY15 Flight tests (July 2015, Utah)
    - 18Tflops – 1400W
Embedded HPC
2015 Flight Test

Range-Doppler Plot – Flight 1, Orbit 4, Dwell 1609
Embedded HPC 2015 Flight Test

Preliminary SAR Image
0.5 m pixel spacing
Future Work

• Onboard embedded computing for Autonomous Sensing
  – FY16 Embedded HPC Pod
    • 5-10 Tflops ~ 400 W
    • October 2016 Planned Flight Test
  – FY18 Secure Processor & Bio-Inspired Computing

The Agile Condor form factor, power, weight, environmental, and thermal management capability will support Group 3 (e.g. RQ-7 Shadow) to Group 5 (e.g. MQ-9 Reaper) DoD UAS platforms.
Secure Bio-Inspired Computing

Challenges
- Degraded communication links
- Dynamic ISR situations
- Dynamic surface-to-air threats
- Targeted cyber attacks
- GPS jamming

R&D Needs
- Cognitive Exploitation
- Adaptive decision making
- Secured system and data
- Sensing-based self-guidance
- SWaP-efficient on-board comp.

Benefits
- Human-in-the-loop: high situational awareness and performance, reduced comm.
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Summary

• Leader in Embedded HPC technologies
  • First Embedded HPC POD based system (SRC-AFRL, Patent Pending)
  • 5-10 Tflops (400-500 Watts)
• Embedded HPC Flight Tests
  • Provide realistic environment and integration challenges
• Secure Bio-Inspired Computing CRDF
  • 17 TrueNorth small factor boards (Oct-Nov 2015)
  • Increased processing capability (100-1000x) in size, weight and power constrained applications
• Greater system resilience, adaptability, autonomy and intelligence
Questions?