Open Plug-N-Play Modular Architecture for Signal Processing, Tracking, and Exploitation Research (MASTER)

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Focus of MASTER Case Study on Developing a Framework for a Sensor Exploitation Testbed

- Open and extensible architecture
- The relationship of an architecture and the Agile development methodology
- How an architecture enables multi-mission data processing
- Leveraging existing sensor exploitation
- Evolution through re-factored code
- Move towards community standards
SMC/XRF built a Joint Architecture for More Unified Operations Through Community Interaction

• Managing Multiple Stakeholders with proven Agile process
  – Capability driven specifically designed to be responsive within fixed budgets
  – Emphasizes the need for ongoing iterative development with completed, demonstrable functionality
  – Periodic and frequent stakeholder interaction/involvement

• Utilizing Cross-program synergy “Enterprise Approach”
  – Cross-project opportunities, leveraging across multiple DOD programs
  – Look for the best of the best (BoB) algorithm-software-hardware

• Experiencing broad OPIR Community Involvement
  – Aerospace Corporation, Space Dynamics Laboratory, AF Research Labs, MITRE, Sandia National Labs, and Aerospace Fusion Center
  – Multiple Industry Non-disclosure agreements used throughout development

Proven Agile business process provides responsive solutions to War-fighter needs within cost and schedule constraints
Agile Development Process and Modular Architecture Evolves System in a User Environment

A Key is to Have a Real User Involved in Development
System Development Overview

• Coding for the Algorithm Development Lab (ADL) Started January 2008
  – Algorithm development, refinement and characterization
  – Delivered ADL Oct 2008 within 4 software spirals
    • Start to major milestone in 7 months
  – ADL Ribbon Cutting on 29 May 2009

• Initial Engineer Ops Baseline delivered January 2010
  – Performing ground signal and mission data processing to support R&D sensor demonstration
  – Leveraged existing mission processing and client visualization suite tools
Modular Architecture for Signal/Mission-Processing Tracking and Exploitation Research (MASTER)

- **Advanced Open System Architecture**
  - Flexible 64 bit Linux OS, Platform Independent
  - Parallel Algorithm processing
  - API-driven plug & play facilitates 3rd Party
  - Unified Design Standards (UML & MOSA)

- **Mature Algorithmic Processing Suite**
  - ~50+ algorithmic plug-ins
  - Extensive Set of Analysis Tools
  - Leveraged existing active DOD program assets
  - OPIR Community Involvement

- **Sensor Agnostic Processing**
  - Multiple data sources – Chamber, Sims & Live
  - Sensors currently in Ops & other R&D sensors
  - XML/HDF5 data format for Web Services
  - SOA Services as Needed, Enterprise Ready

**From R&D to operations – continual support of risk reduction & enhanced capabilities**

MASTER Provides a Collaborative OPIR Enterprise With Advanced Multi-Source Exploitation
MASTER Architecture has Mature Algorithm Processing Suite

Developed an Open Architecture that provides users Sensor Agnostic Ground Processing

- Quickly adaptable to new sensors, missions and alternative algorithms
- ~150+ plug-ins exist today
What Is MASTER/SPRTE Architecture?

- Frontend/Signal Processing Plug-ins:
  - Comply with “SPRiTE” API
  - Common Startup & Shutdown
  - Common Argument & Logging
  - Common Queue configuration and access methods
  - Allows for algorithm alternatives
  - Each configuration recorded in XML
  - Plug-in’s auto restart capability at runtime
- Implemented in 64 bit Red Hat Linux

- Leveraged Existing Components
  - Missile Tracker Suite Plug-inized
  - Multi Source Correlator (MSC) plug-inized
  - Tactical Parameter Estimator (TPE) plug-inized
- Plug-ins comparable with Executable versions

Delivered SDK, including API and test-harness, enables 3rd-party development of algorithms
Analysis Portal Tools Automate Quick Algorithm Evaluation and Provide for Auto-Regression

- Inspired by statistical process control
- Provides standardized performance metrics
Multiple Parallel Algorithm Architecture Using Split and Merge Functionality

- Can create parallel processing chains, each customized
- Methodology to spatially partition moveable windows
- Supports subsequent plug-ins
- Merger plug-ins, with rule-sets

Architecture Supports Parallel Processing Data to Exploit Optimum Target Extraction
MASTER/SPRTE Provides Flexibility to Span Processing Across Distributed Machines

- Network plug-in type provides input and output interface to other machines

- Flexibility allows scaling same processing chain onto different hardware environments
  - Maximize utility of legacy hardware
  - Flexibility to optimize processing across servers
Having Completely Specified Configuration is Key to Rapid Integration and Test

Single database of plug-in libraries made available for a specific deployment to be used as needed.

Each plug-in has specific parameters that have defaults and can be modified for a specific run-time configuration.

Each instance of a run-time configuration is automatically logged with a unique identifier.
An Open Architecture Delivers Multiple Benefits

**Collaboration and efficient responsiveness to changing mission and geopolitical needs**

- **Low Risk Evolutionary path, Tech Readiness Assessment**
  - Development → Engineering Ops → Real-time Data Services → Military OPS
- **High TRL, Flexible and Scalable Enterprise Solutions**
  - Processing Multiple data sources (on-orbit, chamber or simulated)
- **API-driven plug & play architecture facilitates:**
  - Sensor Agnostic data processing and exploitation
  - 3rd party development and Fly-off of alternative algorithms
  - Ability to effectively react to sensor/mission changes
- **Open COTS H/W and S/W**
  - Helps contain long-term O&M cost
  - Modern COTS software with 64-bit architecture removes key growth constraints

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*Government Investment has produced a non-proprietary, flexible architecture to process Multi-Source, Multi-Int data*
Plans desired for MASTER

- Add system entry points for existing and emerging data interface standards
- Add other 3rd party plug-ins
- Standard data sets
- Pluginize legacy systems
- Interface to other existing systems