15th Annual
SCIENCE & ENGINEERING TECHNOLOGY CONFERENCE/DEFENSE TECH EXPOSITION
"Leveraging the DoD Science and Technology Program to Create Future Warfighting Capabilities Through Rapid Prototyping and Emerging Concept Demonstration"
APRIL 8 – 10, 2014 ▶ HYATTSVILLE, MD ▶ WWW.NDIA.ORG/MEETINGS/4720

Introduction to Poster Papers: Author Presentations

April 8, 2014

Potential Gains from Upstream Fusion of SIGINT and MOVINT Data

Gregory E. Bottomley, Tracy L. Fulghum, Michael A. Keegan, Ann M. Pitruzzello and Jamie M. Shorey

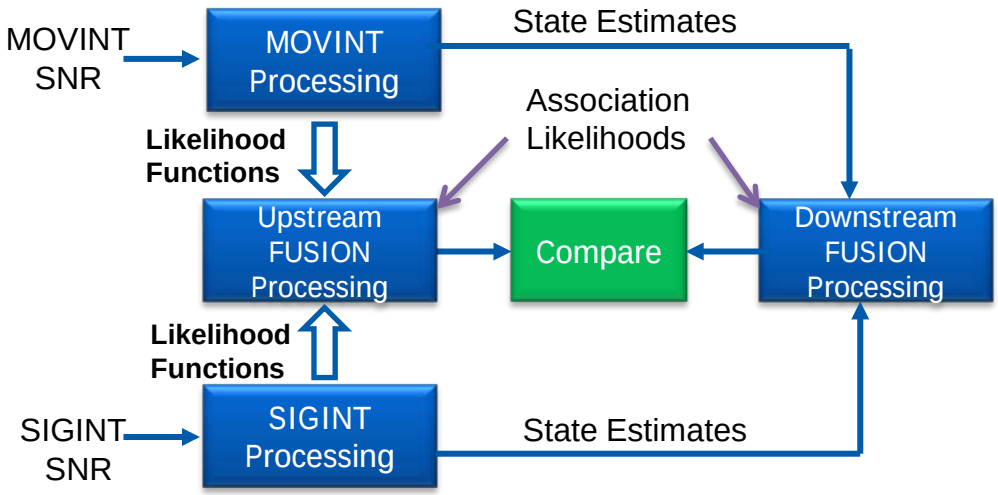
Research Objective(s)

Develop an **upstream** capability for MOVINT/ SIGINT fusion at the sensor that improves detection, tracking and identification of observed entities.

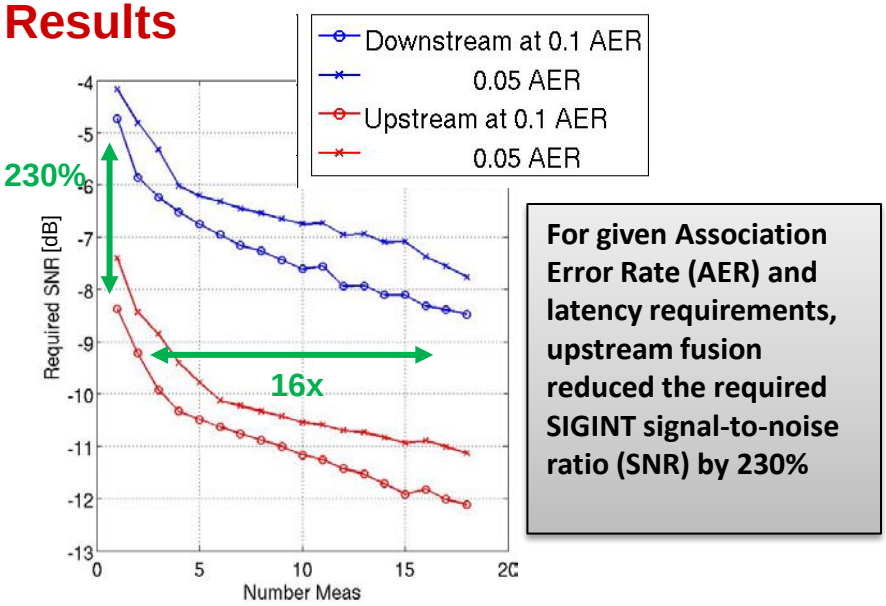
This research will determine the improvement in association error rate of upstream vs. downstream multi-INT fusion.

Through joint processing of raw data streams, upstream fusion provides improved detection and reduced latency.

Technical Approach



Results



For given Association Error Rate (AER) and latency requirements, upstream fusion reduced the required SIGINT signal-to-noise ratio (SNR) by 230%

DoD Relevance

- Traditionally, signals from different systems are processed separately and fused downstream.
- Processing prior to fusion results in information loss.
- Upstream is a **better way** to fuse information that:
  - does not require long term storage of sensor data feeds and processing sub-products,
  - can perform continuous/real-time detection for more **timely** reports, and
  - can exploit faint or obscured signatures using fewer SIGINT sensors.

Unique Number Generator: Port to IBM Process

Matt Casper (NSMC/KCP, mcasper@kcp.com)

Research Objective(s)

A critical component of trusted integrated circuits is the ability to quickly and non-destructively verify the component, to ensure its authenticity and mitigate the influx of counterfeit parts in to the supply chain.

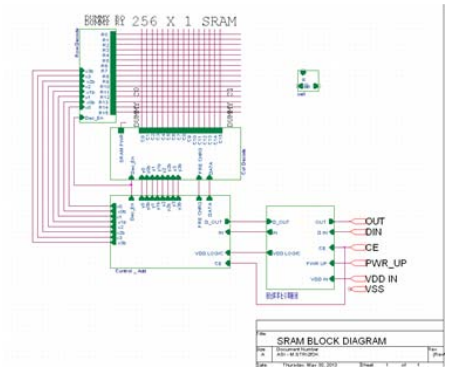
Porting this IP to IBM's 8HP process would make this function available to a wider customer base improving the security of fielded parts

Technical Approach

1. Derive schematic – Preliminary reverse engineering efforts have yielded a workable schematic
2. Simulate – Standard cells between NSC and IBM are similar
3. Layout
4. Fabricate
5. Test – Direct ports of some cells from original foundry process show no changes are needed
6. Improve

Significant Result

- Derived Schematic – valid starting point
- Isolated cells work similar to final National/TI product
- Early simulation work promising



DoD Relevance

The proposed, finished product would enable IC authenticity confirmation at any point in the IC lifecycle.

Fielded parts could be scanned and referenced to a master database to ensure products are not counterfeit.

Automated Test and Re-Test (ATRT)

Elfriede Dustin, IDT email: edustin@idtus.com

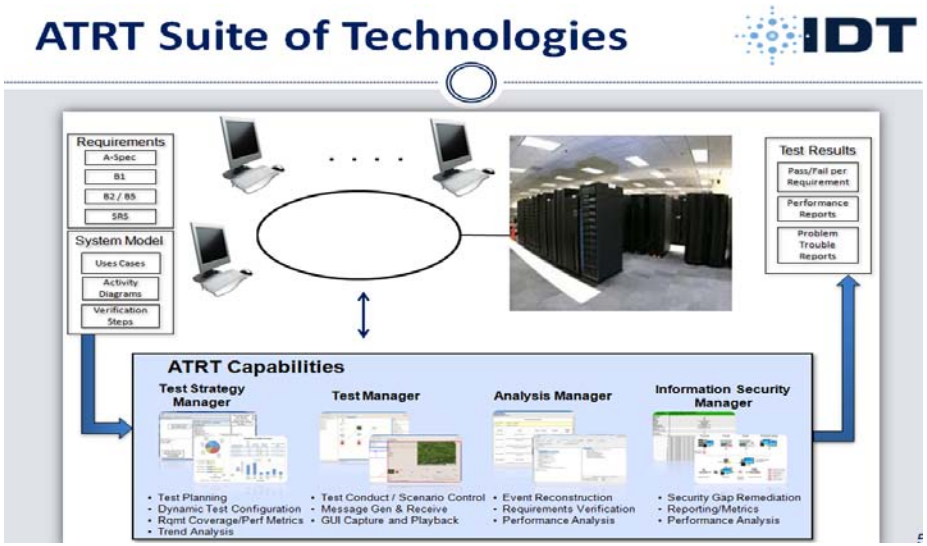
Research Objective(s)

Computer hardware and software technologies have continued to make significant advances throughout the past several decades, but testing these complex control systems has left much opportunity for increasing efficiency and test coverage.

Why is this project important?

Our ATRT solutions allow for testing of these complex systems in an automated fashion increasing coverage and reducing resource needs, improving software quality, and resulting in overall cost savings.

Technical Approach



Significant Results

Implementing ATRT on 50+ programs we have been able to increase testing productivity by an average of 75%

DoD Relevance

ATRT saves time and money

Improves software quality

Increases test coverage

Increases productivity

Overall DOD cost savings

Collaborative GPS Denied Navigation

Mr. William English TRX Systems, Inc. englishw@trxsystems.com

Research Objective(s)

- **Accurate 3D location** – critical for enabling improved navigation, situational awareness, targeting, and mapping.
- **Existing GPS receivers do not work** in triple canopy, urban canyons, indoors, and underground. Also, GPS receivers can be easily jammed or spoofed.
- **Low cost inertial navigation alternative** for dismounted warfighters that provide a "track through" capability when GPS is denied for any reason.
- **Collaborative navigation** achieved through TOF ranging and through exchange of detected building features (e.g., stairways, elevators).

Technical Approach

- Analysis and algorithm development for inertial navigation using **low cost MEMS sensors.**
- Two low SWAP-C configurations for the warfighter:
  1. **Android hand-held service with a small, wearable accessory** that includes high quality inertial and RF ranging sensors.
  2. **Android hand-held service** using only embedded mobile device sensors.
- **Android Location Service** providing GPS denied location for EUD applications when GPS is unavailable.
- **Peer-to-peer ranging and data exchange** enabling high relative team location that does not degrade over time in GPS denied operations; and enabling sharing location and tracking data for improved situational awareness.

Significant Results

- Initial version of sensor processing and navigation algorithms available as **NEON OTS product**.
- **Android-based prototype** of collaborative navigation delivered to ARL CERDEC.
- Recent completion of low SWAP-C waist-worn tracking accessory.

DOD Relevance

- **Improved command and control, situational awareness, and mission coordination** in GPS-denied environments such as urban environments, indoors, underground, and whenever GPS is jammed or spoofed.
- Improved situational awareness through **detection of inferred building structure features** such as stairwells, elevators, hallways.
- **Soldier status** reporting of gait, heading, posture (on-back, standing, walking, etc.) and alarm conditions (e.g., high-impact).

Developed with support and funding from US Army, DARPA, NSF, DHS, TSWG, and others.

Pulse: Connecting the Disconnected on the Edge

Christina S. Kang, IST Research (christina.kang@istresearch.com)

Research Objective(s)

- **PROBLEM:** Difficult to efficiently and effective launch campaigns and collect data from dynamic and evolving environments with limited connectivity, little infrastructure, low stability, and high conflict.
- **PROBLEM:** Need agile information methods and tools to fulfill information needs: holding conversations, stating questions, and administering data collection.
- **IMPORTANCE:** Effective two-way information sharing relationships with disconnected populations in developing nations and conflict zones can better support decision making in monitoring and evaluation, program design, needs assessments, and information campaigns, leading to more effective outcomes of conflict, crisis and development efforts.

Technical Approach

- Integrated and optimized information platform featuring six input (getting information/data) modalities and 8 output (sending information/data) modalities: local third party monitors, paper to digital technology, radio, tv, SMS, IVR, social media, web forms, smart phone apps
- Seamless integration of modalities enabling simultaneous collection and consolidation across modalities
- Microtasking capability for human in the loop to rapidly inspect, clean, and synthesize data

Significant Results

- Utilized SMS and IVR to track and measure penetration of CJPOTF information products
- Deployed SMS gateway to Colombia in support of MIST operations
- Monitored and evaluated the adoption of new medical techniques to improve neonatal care in Zambia using SMS, Android app, and field paper technologies
- Developed mobile payment system for teacher pay in Afghanistan, replacing manual system
- Tested effectiveness of narratives in influencing action and behavior through multiple modes

DoD Relevance

- Communicate two-ways with disconnected populations and within units in austere environments with limited connectivity/resources
- Streamline campaign design and information output/input for maximum return on investment
- Examples include:
  - **Information operations**: Design, launch, and consolidate responses through multiple modes in 1 common interface
  - **Monitor/Evaluate**: Collect data to track/measure progress
  - **Mobile Payment:** Set up mobile payment system
  - **Communication Gateway**: Support operations through reliable, multimodal communication platform

Integrated Bridge System an Example of Information Dominance

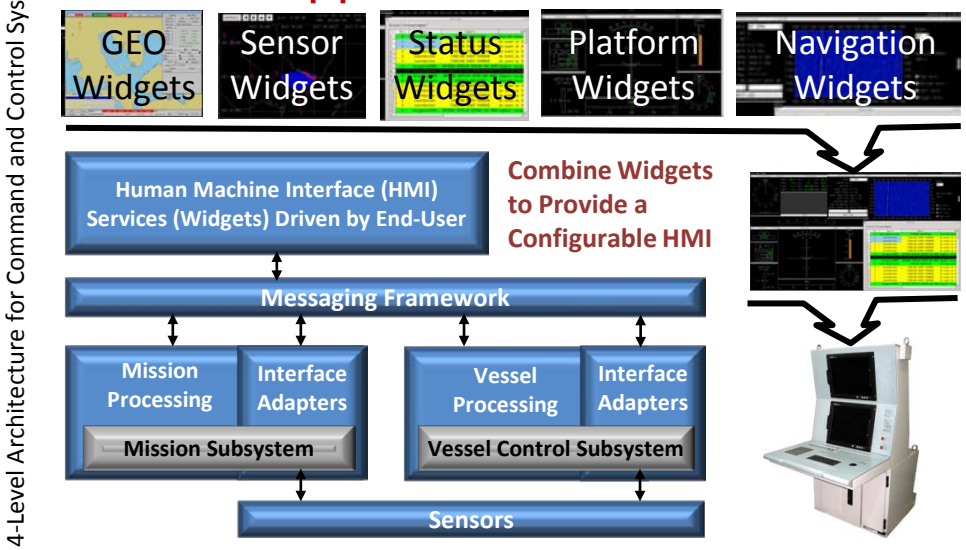
Robert L McCaig; ASSETT, Inc. bob.mccaig@assett.net

Research Objective(s)

Problem: Is it possible to provide a vehicle-independent mission-driven, command and control system that minimizes cost and maximizes expandability?

Importance: Build Once Use Many: This project provides an innovative approach for vehicle adaptability and Human Machine Interface that is built on a common software base (e.g., minimizes software support costs) while providing the end-user with the information and level of detail necessary for accurate rapid decision making.

Technical Approach



Significant Results

1. End-user has immediate access to a hierarchy of information from command decision level to detailed analysis
2. Quickly incorporate new missions and requirements – create a new widget not an entire display
3. Rapid integration of third party sensors/products
4. Low cost software maintenance
5. Common training

DoD Relevance

1. Concept is scalable from unmanned UUVs to major combat systems which leads to greater commonality
2. Facilitates changes in CONOPS commensurate with new technologies and automation
3. Provides an alternative method for addressing the operator data overload issue by presenting the end-user with the information needed and augment with details if required

Forward Repair Capability Provides a Shot Peening Solution for the Warfighter

Kelly McClurg, Avion Solutions, Inc. (Email: Kelly.McClurg@AvionInc.com)

Research Objective(s)

- Provide a portable, ruggedized system that brings shot peening TO the Warfighter
- Create Shot Peening Solutions for Critical Safety Items
- Allow for peening to occur during assembly and sub-assembly

Technical Approach

- Tested 3 common aviation materials: 4340 Steel, 7075 Aluminum, 6Al4V Titanium
- Tested both low and mid intensities: 5N – 11N and 8A -12A
- Saturation Curves and Coverage Charts
- Compared to Conventional Shot Peening:
  - Surface Roughness
  - Residual Stress Profiles
  - Fatigue Testing

Significant Results

- Ultrasonic Shot Peening Residual Stress Profiles closely followed those of Conventional Shot Peening
- Fatigue results provided authorization to use Ultrasonic Shot Peening on Critical Safety Items
- Localized repair solutions eliminate FOD during In-Situ repair capability

DoD Relevance

- Will bring the complex procedure of Shot Peening to the field
  - Eliminates need to ship components
- Creates Shot Peening solutions which save time and money from conventional methods
- Army at a TRL 9, easily transitioned into other DoD areas

Adaptive Compression To Tackle Spectrum Constraints

Tejbir Phool, MiMoCloud, Tejbir@MiMoCloud.com

Research Objective(s)

- Develop a compression tool that adapts to multiple sensor data

What problem are you trying to solve?

- Growing ISR & T&E Spectrum Crunch

Why is this project important?

- The growing complexity and number of sensors is leading to an explosion in wireless bandwidth demand as available spectrum declines

Technical Approach

Combine the most current compression and compressive sensing algorithms with modular high performance computing processors to develop a scalable tool that is reconfigurable for a wide range of applications.

Significant Results

- Compelling bandwidth reduction
  - Lossless compression 3:1 – 45:1
  - Sensor Sensitivity Based Lossless: 60:1
  - Visually Lossless up to 100:1
- Consistently better than standard tools

DoD Relevance

- **ISR:** Camera, Infrared, Sonar, Radar
- **S&T:** Real time Big-Data sharing
- **T&E Centers:** Flight Testing, Wind Tunnels

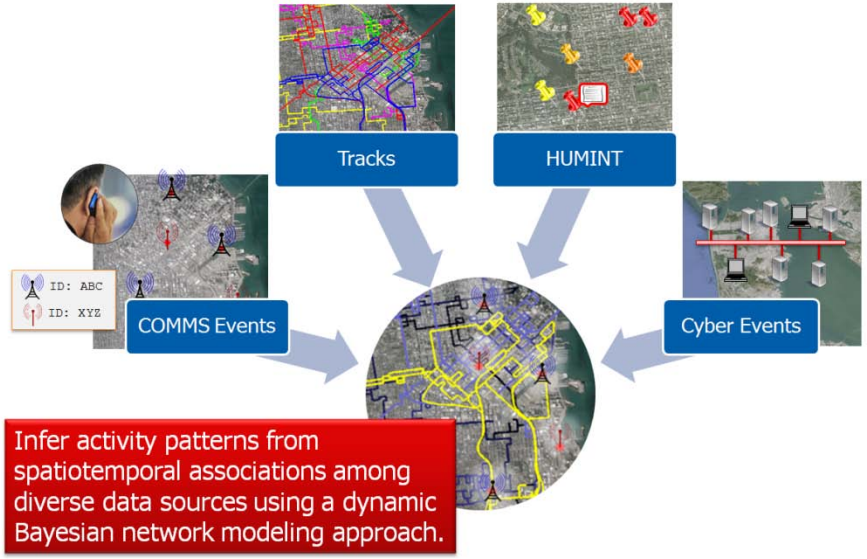
Multi-INT Data Fusion for Sparse, Asynchronous, and Low Spatial Resolution Data

Dr. Michael A. Keegan, Northrop Grumman (Michael.Keegan@ngc.com)

Research Objective

- Communications event data (e.g. cellular comms) contains valuable target information, but the data is often of limited utility due to low spatial resolution and limited amount of data available.
- The research objective was to develop a multi-INT fusion algorithm to associate discrete comms event data with additional data sources, in order to significantly increase the intelligence value of the data.

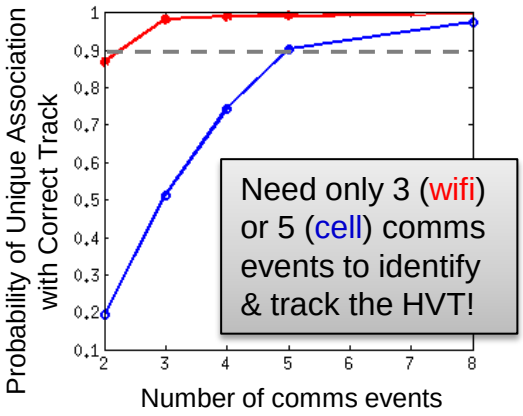
Technical Approach



Significant Results

Demonstrated ability to track a HVT by associating comms events with MOVINT tracks.

With comms alone, geolocation is poor (3km for cellular, 200m for Wi-Fi).



DoD Relevance

- Analysts can get more utility out of sparse comms event data by fusing with additional data sources, even when geolocation is poor and there are few comms events available.
- The fused data may be used to increase situational awareness and enable activity-based intelligence.

Development of a Passive, Single-Camera 3D Imaging System Using Light Field Technology

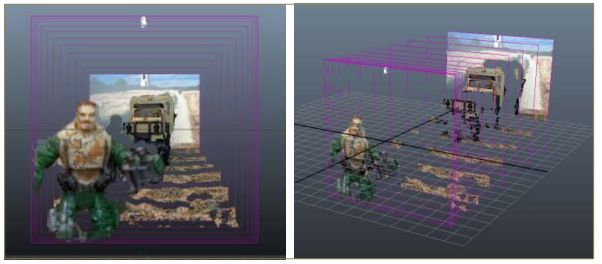
Dr. Michael A. Keegan, Northrop Grumman (Michael.Keegan@ngc.com)

Research Objective

- Light field (LF) cameras are an emerging technology for passive 3D imaging with a single optical sensor.
- The research objective was to develop a light field camera system and image processing capabilities for passive ranging and 3D imaging.

Technical Approach

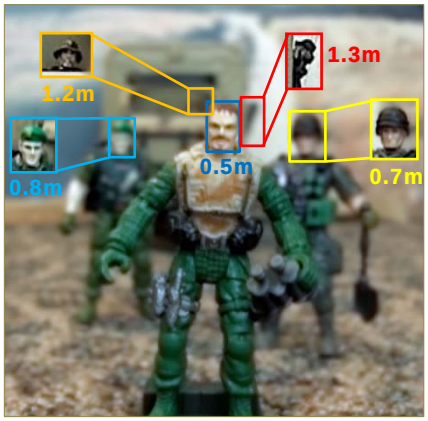
- Developed 3D imaging system using a commercial LF camera and custom image processing algorithms.
- Demonstrated system capabilities, including digital refocusing, automated range finding, face detection, and 3D scene reconstruction (shown below).



Significant Results

System was successfully developed and demonstrated for surveillance and threat detection applications.

Significant improvement in 3D scene understanding over conventional surveillance systems.



Digital refocusing & range finding from a single LF image.

DoD Relevance

- Light field imaging technology may be an enabling technology for surveillance and threat detection applications.
- Potentially replace dual-sensor systems, reducing size, weight, cost, and complexity.
- Example applications: enhanced surveillance video with automated tagging and refocusing, automated object detection and tracking, quantitative biometrics.

Highly Conductive Carbon Nanotube Films

Colin Preston, University of Maryland (Email: cpreston@umd.edu)

Research Objective(s)

What problem are you trying to solve?

- Carbon nanotube (CNT) inks agglomerate unless disruptive surfactants or damaging chemical processes are used

Why is this project important?

- Tuning CNT structure and processing conditions optimize printed film conductivity

Technical Approach

- Chemical vapor deposition to grow CNTs with specific wall number
- Surface functionalization of CNTs to enable dispersion in solution
- Raman, TEM, and FTIR determine CNT properties; SEM visualized film homogeneity; and ink stability extrapolated from zeta-potential

Significant Results

- As-grown CNTs are of high purity
- CNTs may form stable dispersions in alcohol-based solvents with no surfactants
- Stable dispersions form highly electrically conductive spray coated CNT networks with no post-treatments

DoD Relevance

- Spray-coated conductive CNT films may be applied in light-weight and flexible thin film batteries or supercapacitors

Silicon Carbide Semiconductor Switch for Pulsed High Power Systems

Stanislav Soloviev, GE Global Research (soloviev@ge.com)

Research Objectives

Develop advanced Silicon Carbide (SiC) semiconductor opening switch (SOS) for high pulse power generators enabling output power peak up to ~2GW with pulse width <50 ns. Benefits vs. Silicon & GaAs approaches

- **20x faster switching** speed with the same operating voltage
- **10x higher** pulse repetition frequency
- **70x size reduction** of pulse generator

Technical Approach

	SiC	GaAs	Si
Breakdown electric field , MV/cm	~3-6	0.4	0.3
Saturation carrier-drift velocity, x10^7 cm/s	2.2	0.8	1.1
Thermal conductivity, W/cm K	5	0.55	1.3
Bandgap, eV	3.26	1.42	1.1

- High Electric Field Edge Termination with GE's Innovative Technologies
- Leverage 20 years GE expertise in SiC technology in DoD & commercial applications

Significant Results

- SiC SOS devices interrupting current density of **25 kA/cm²** in a time less than **0.3 ns** [Mater. Sci. Forum, 2013]

- GE high voltage SiC power devices MOSFETs, Thyristors, TVS, PIN diodes and Avalanche diodes with **robust edge termination technique**

.

DoD Relevance

Robust, compact device design solution supports integration of high-power electronics into wider array of operational systems

Extended operational effects for compact or airborne pulsed power systems

A2/AD, including point defense with increased range (Ranets-E, Vigilant Eagle, etc.)

Reshaping the Costs of Department of Defense Systems Through Full Interoperability

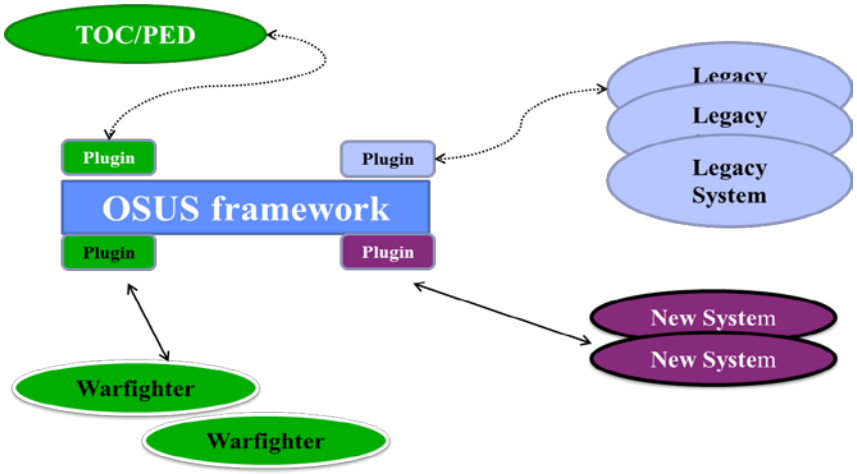
Larrell Walters, Sensor Systems Division – UDRI (larrell.walters@udri.udayton.edu)

DIA Goal: Move away from proprietary designs and stove-piped systems in the Unmanned Ground Systems (UGS) arena. Utilize a model that is not platform dependent and not constrained by Sensor performance.

Current Challenges ~

- Government locked into one vendor so that any follow-on integration, technology insertion, or reconfiguration requires going back to the original vendor
- Integration time exceeding operational mission timelines, complicating integration efforts when multiple vendors have to work together in near real time

RESULT ⇨ ***Open Standard for Unattended Sensors (OSUS):***
Developed an open, integrated battlefield Unattended Ground Sensors (UGS) architecture ensuring interoperability among disparate legacy and new UGS components and systems.



- **Fundamental framework plug and play Data, Control and Missions: all with standardized internal and external interfaces**
- **Deliver all OSUS documentation to Forge.mil for government/3rd party availability**
- **Government/Industry collaborate to establish a workable architecture, standards, and interfaces**

OSUS has been used in two major DoD Spring demonstrations.

2012/2013 Demonstration(s):

- OSUS deployed the following building blocks in 2012:
  - 22 types of sensor systems, 6 types of radio systems, 5 types of controller platforms, and 2 algorithms

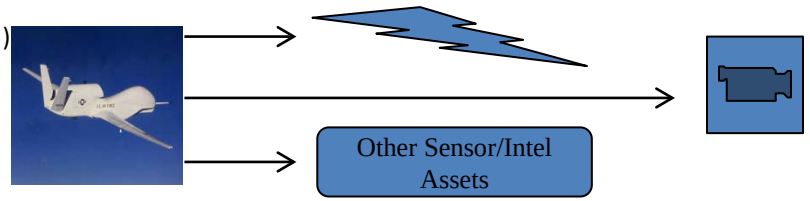
2012/2013 Accomplishment(s):

Demonstrating, assessing, validating intelligence, surveillance, and reconnaissance assets in an operational setting as well as responding to changing mission profiles in near real time. These demonstrations provided technology Focus Groups feedback from "users" in operational setting.

OSUS has been validated via field tests in 2012, 2013 and 2014 AND SUCCESSFUL …..

- **Fielding of OSUS-R, PM ITS systems (BETSS-C) (2013) includes C&A (ATO)**
- **Fielding of OSUS-R, multi-int, airborne application, integrate sensors (2013-2014)**

- **OSUS objectives include enhanced operational flexibility, improved interoperability, and reduced integration time and costs.**
- **Replaces inflexible systems with affordable systems** that permit field adjustments, quick integration, or reconfiguration
- **Other acquisition programs can take advantage of the OSUS open architecture** to meet their own challenging mission requirements for sensor integration.
- **The OSUS architecture can *benefit* Data to Decisions developments** and extend into commercial applications related to law enforcement, emergency response and other areas of interest.



Quad Chart Example: Technology as a Dialectic

John Watts, Noetic Group (Email: john.watts@us.noeticgroup.com)

Research Objective(s)

What problem are you trying to solve?

Defense needs a new way to examine the potential impact and implications of potentially 'game-changing' technology.

Why is this project important?

It examines the potential, and potential risks, of emerging technologies from a holistic perspective

Technical Approach

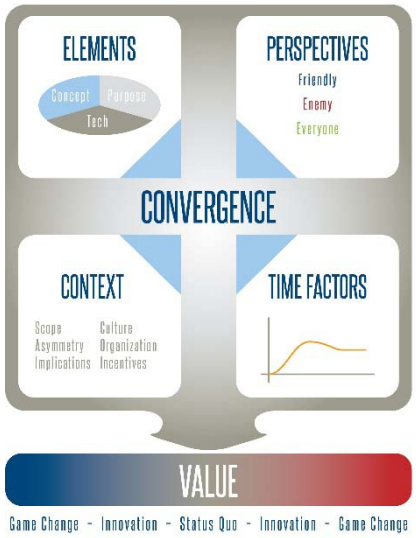
+ Review of existing literature and studies

+ Engagement with broad range of subject matter experts

+ Series of war-games examining different facets of 'game-changing' technology on future warfare:
  - Defining 'game-changing
  - Blue Force Perspective
  - Red Force Perspective
  - Exploring ethical/ legal/ policy implications

Significant Results

+ Non-technology factors
+ Multiple Domains
+ Change to symmetry of Power
+ Dynamic convergence
+ Values vs Technology
+ Necessity and true potential



DoD Relevance

+ Provides a new way to understand the complex, dynamic and changing factors that determine a technologies importance and impact.

+ Generated a range of findings and observations on specific technologies, including: cyber, robotics, energy, 3D printing and bio

+ Repeatable and ongoing forum to examine many more in the future

Commercial Turbomachinery Applications of Digital Thread Principles

Felipe Viana (viana@ge.com), Genghis Khan, Liping Wang, Jordan Fitzpatrick, Marlee Rust

Research Objective(s)

What problem are you trying to solve?

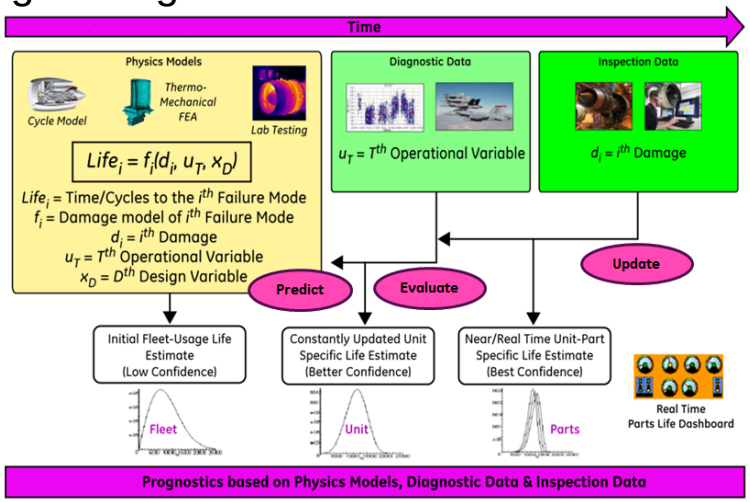
Flow of information upstream and downstream in all phases of a product's lifecycle.

Why is this project important?

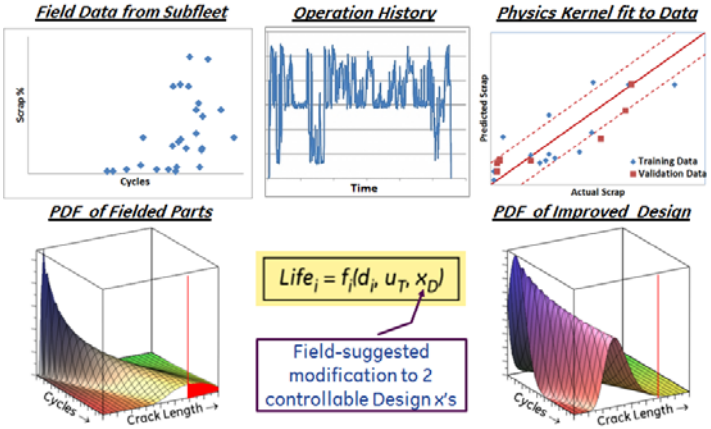
Information generated during the design phase of a product can be leveraged for determining the in-service maintenance plan. Conversely, information generated during the in-service phase, or at a maintenance event can be leveraged for design improvements.

Technical Approach

Leverage Design for Services



Significant Results



DoD Relevance

Systems modeling framework where digital surrogates can be used to assess and quantify the effects of design geometry, materials and manufacturing on the durability and capability of products.

Verification and Validation of Unmanned Autonomous Systems

Lorenzo Lo Monte, Michael O'Connor, Larrell Walters, UDRI Sensor Systems Division
Michael C. Wicks, mwicks1@udayton.edu University of Dayton, Dayton OH, USA

Research Objective(s)

- To develop rigorous validation techniques for Models and Simulations that Verify and Validate (V&V) autonomous systems.
- Without V&V of emerging autonomous systems permeating the battle space, a serious threat to national security and public safety could emerge.

Technical Approach

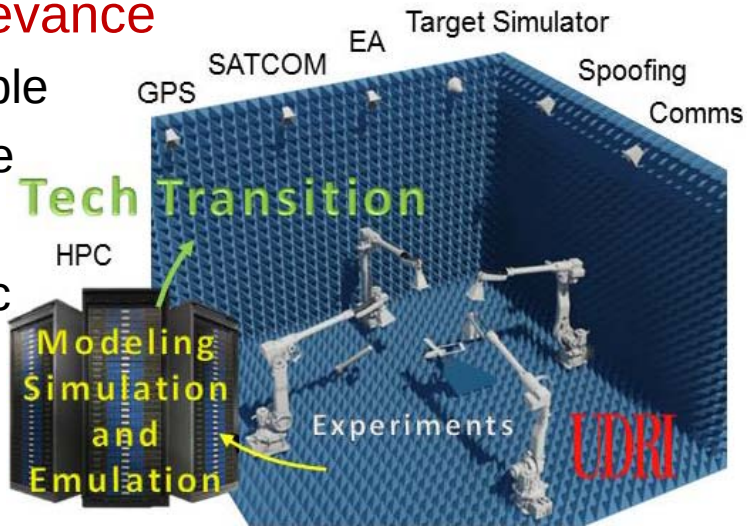
- Comprehensive V&V boundary testing of autonomous systems and autonomous technology for model validation.
- Real-time systems level data emulated via embedded HPC technology.
- Benchmark testing of autonomous systems under realistic conditions.
- Methodology applicable to variety of emerging autonomous technologies.

Significant Results

- Integrated system performance measurements of hardware/human-in-the-loop, high fidelity simulation testing in A2AD environments.
- Novel methodology for systems level modeling and simulation, controlled experiments, and V&V analysis.

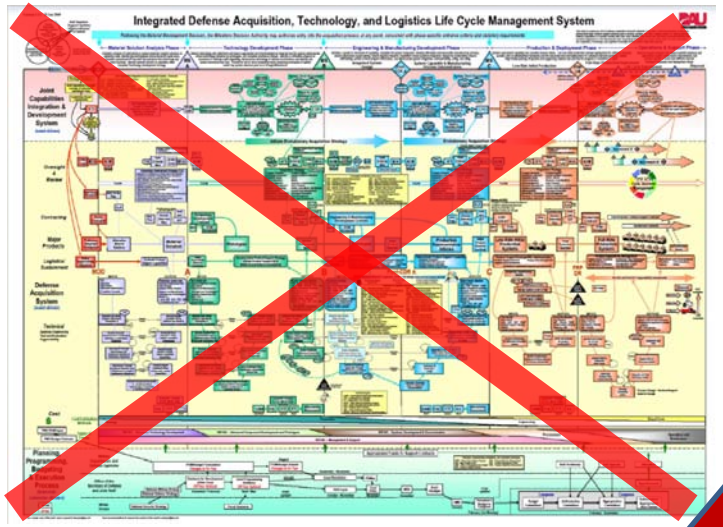
DOD Relevance

- Affordable
- Effective
- Flexible
- Realistic
- Secure
- Safe
- Timely



Rethinking DoD Acquisition

Jeff Windham Email: james.j.windham.civ@mail.mil



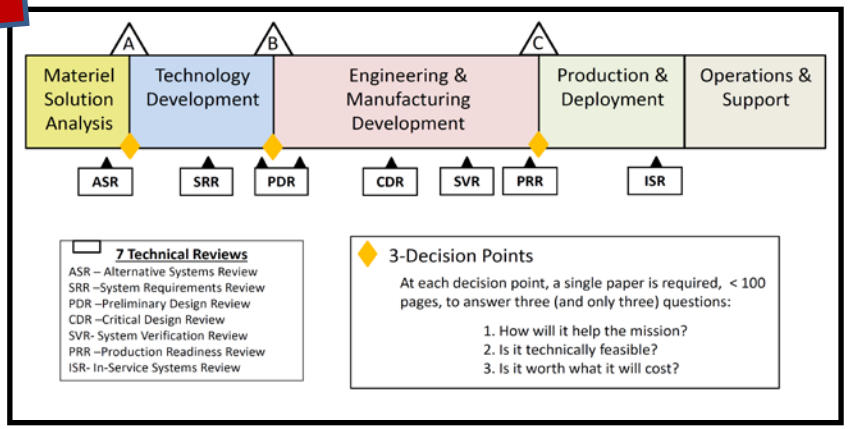
DOD's acquisition process exists for one reason:

To provide technologically advanced tools to the war-fighter.

The Acquisition Paradox

As our weapon systems get more complex, the processes and organizations to manage those systems must get simpler.

RADICALLY SIMPLER



War-fighters deserve an acquisition system backing them up that looks like it was designed on purpose.

Transparent paper for Flexible Electronics

Hongil Zhu, University of Maryland (Email: hongli@umd.edu)

Research Objective(s)

What problem are you trying to solve?

The transition from rigid glass to flexible plastic substrates enabled flexible and transparent devices that are currently mass produced using established roll-to-roll printing methods. Plastic substrates, however, are not produced from sustainable materials nor are recyclable.

Why is this project important?

Green electronics continue to gaining more commercial interests and research due to their flexibility, cost efficiency, light weight, and renewability.

Technical Approach

Nanopaper made from the nanocellulose is emerging as the new generation for green substrates used in flexible electronics because of its tunable optical properties and strong mechanical stability. This nanopaper retains all of the desirable properties of plastic substrates, yet possesses the advantage of being recyclable, renewable, and inexpensive.

We also reported a novel nanocomposite with layered boron nitride nanosheets wired by nanofibrillated cellulose that have a much higher thermal conductivity and mechanical strength compared with other reported nanocomposites.

Significant Results

The nanopaper electronics have excellent flexibility due to the layered structure of nanopaper.

One-dimensional nanofibrillated cellulose fiber provides mechanical strength and two-dimensional (2D) flakes provide percolative thermal transport. Compared with previous nanocomposites with randomly distributed boron nitride nanosheets, the films with layered 2D nanosheets have a much lower percolation threshold and higher performance. It pave the way for thermal dissipation in compressive cockpit electronics.

DoD Relevance