UTOPIACOMPRESSION

Intelligent Technologies & Innovative Solutions

UC

Leadership Statement

From the Research Desk to Integrated End-to-End Solutions:

UtopiaCompression Corporation (UC) is a rapidly growing, cutting-edge technology company providing mission critical solutions to various US Government Agencies and industry leaders. UC technologies and products focus on advancing the state-of-the-art in the areas of artificial intelligence, computational vision, autonomous systems, UAS Sense-and Avoid (SAA), wireless communications and networking, wireless network management and topology control, and medical decision support systems and diagnostics as well as a host of other vertical applications. UC's portfolio of automated and intelligence based technologies presents unique enablers for any value chain requiring intelligence-based processing, distillation and fusion of multi-modal data to empower actionable decision making.

To consistently achieve technological excellence and produce innovative products serving the needs of its clients, UC is committed to the following:

▸ Produce superior and innovative products with significant commercial potential and broad economic and societal benefits

▸ Deliver substantial return on investments

▸ Develop the highest levels of expertise in computational intelligence

▸ Create exceptional job opportunities and work environments to attract and retain technical and marketing talents

Core Competencies

Capitalizing on its distinguished researchers and engineers, UC brings together collective competencies and unique experiences to explore new technologies and create innovations in the military and homeland security systems, as well as the civil commercial markets. UC's core competencies include:

Intelligent Data/Image Processing and Computational Vision

▸ Pattern-driven multi-sensor visual data modeling and compression

▸ Panoramic imaging system

▸ Intelligent visual analytics for ship protection and port security

▸ Automated Target Recognition with incremental knowledge assimilation

▸ Affective computing

Intelligent Autonomous Systems

▸ Unmanned Aircraft Sense and Avoid Technology

▸ Collaborative task allocation and planning for unmanned systems

Wireless Ad Hoc and Sensor Networks

▸ Routing and topology management for tactical ad hoc networks

▸ Context Aware Routing and Network Management for the Airborne Network

▸ Generative programming architecture for tactical gateway design

▸ Autonomous fault detection, classification and self healing for tactical networks

▸ JTRS waveforms enhancements through cross layer optimization and adaptive diversity schemes

Medical Technologies

▸ Wireless Body Area Physiologic Monitoring System for Assessment of Health Status of the First Responders and the Warfighters

▸ Wireless Body Area Physiologic Monitoring System for Preventive Medicine within the Civil Applications

▸ Decision-support systems for diagnosis and monitoring of a host of diseases and injuries

UC's portfolio of automated and intelligence based products and solutions offer unique enablers for any value chain requiring creation, storage, processing, recognition, fusion, communication and/or distribution of data (still images, live combat video, 3D imaging, automated health status, etc.). Products/Solutions include:

### Intelligent Pattern-Driven Image Compression and Transmission

UC's suite of novel compression solutions addresses specific customer requirements. Included in this software solution suite are: pattern-driven image/video compression, 3D surface modeling and compression, synthetic aperture radar de-speckling and compression, and adaptive class-based compression technology for weapon seekers. Our intelligent pattern-driven image encoding/decoding software solutions offers superior subjective quality and highly efficient compression efficiency compared with the state-of-the-art compression standards.

### Video Analytics for Ship Protection and Port Security
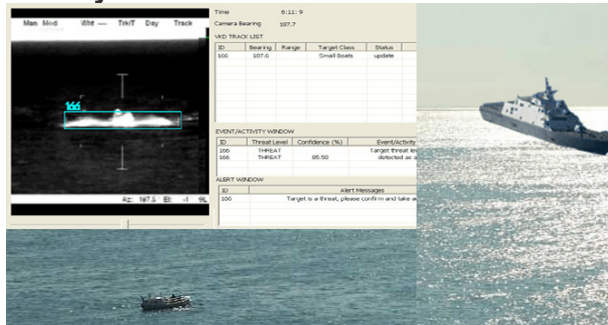
The UC innovative video analytic software named Visual Knowledge Discovery provides a robust and effective solution for maritime surveillance applications for ship protection as well as harbor security. The software performs automatic detection , tracking and classification of surface targets and generates automatic alerts of possible threats to operator. It also provides tools for analysts to perform video-based forensic analysis and rapidly search and query a video database by content (query by activities, query by example).

The software enhances performance of traditional video security systems both in terms of enhanced accuracy and reduced manpower. The system can process multiple video feed and can be deployed in both stationary and mobile camera platforms (such as ones mounted on ship, boat or buoy).
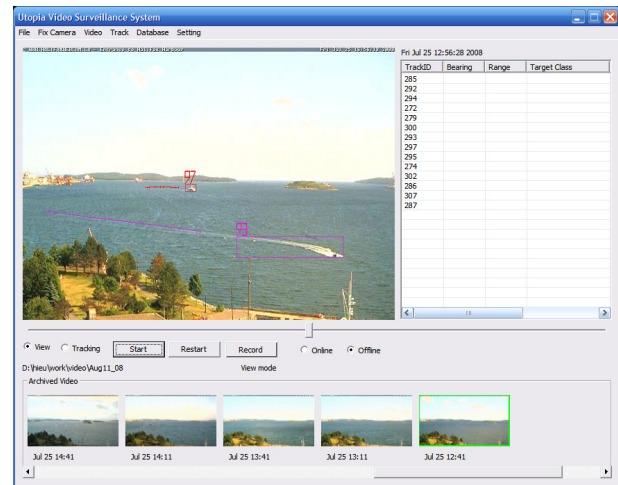
### High-Resolution Hemi-spherical Camera
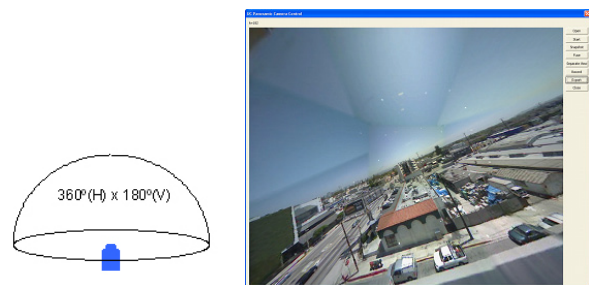
The UC-designed panoramic camera captures a hemispherical field of view (360ox180o) with uniform high-resolution (~0.4mrad/pixel) at video rate. The panoramic image has a single viewpoint and no distortion. Having a low form factor, weight and power consumption, the camera provides an exciting new opprtunity for large area surveillance as well as any application that requires imaging of large-field-of-view scenes. The camera operates in both indoor and outdoor environments.
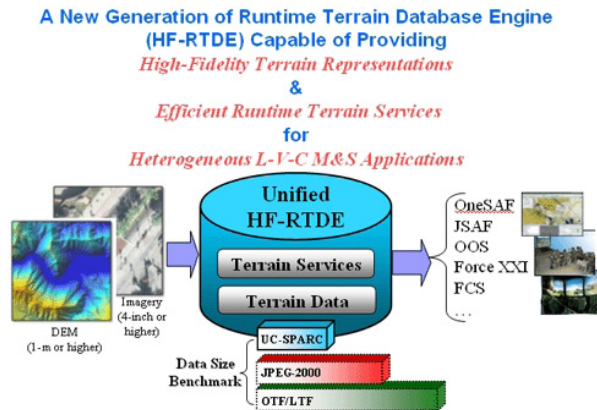
Automatic Target Recognition

The existing ATR systems require retraining whenever the operational environment changes or new classes of targets needs to be added. Such offline retraining usually causes operational downtime. Sponsored by the US Navy, UC has developed an Incremental Knowledge Assimilation (IKAS) system as a novel automatic target recognition (ATR) software tool kit for detecting and classifying underwater mines from sonar images of the sea floor. Capitalizing on its unique capability of self-adapting to varying operational environments and online updation of new data, our IKAS system brings the following benefits:

▸ Eliminates the operational downtime while training

▸ Improves the efficiency and effectiveness of the mine hunting operational process

▸ Minimizes the human intervention and the associated cost while maintaining the same or better recognition performance
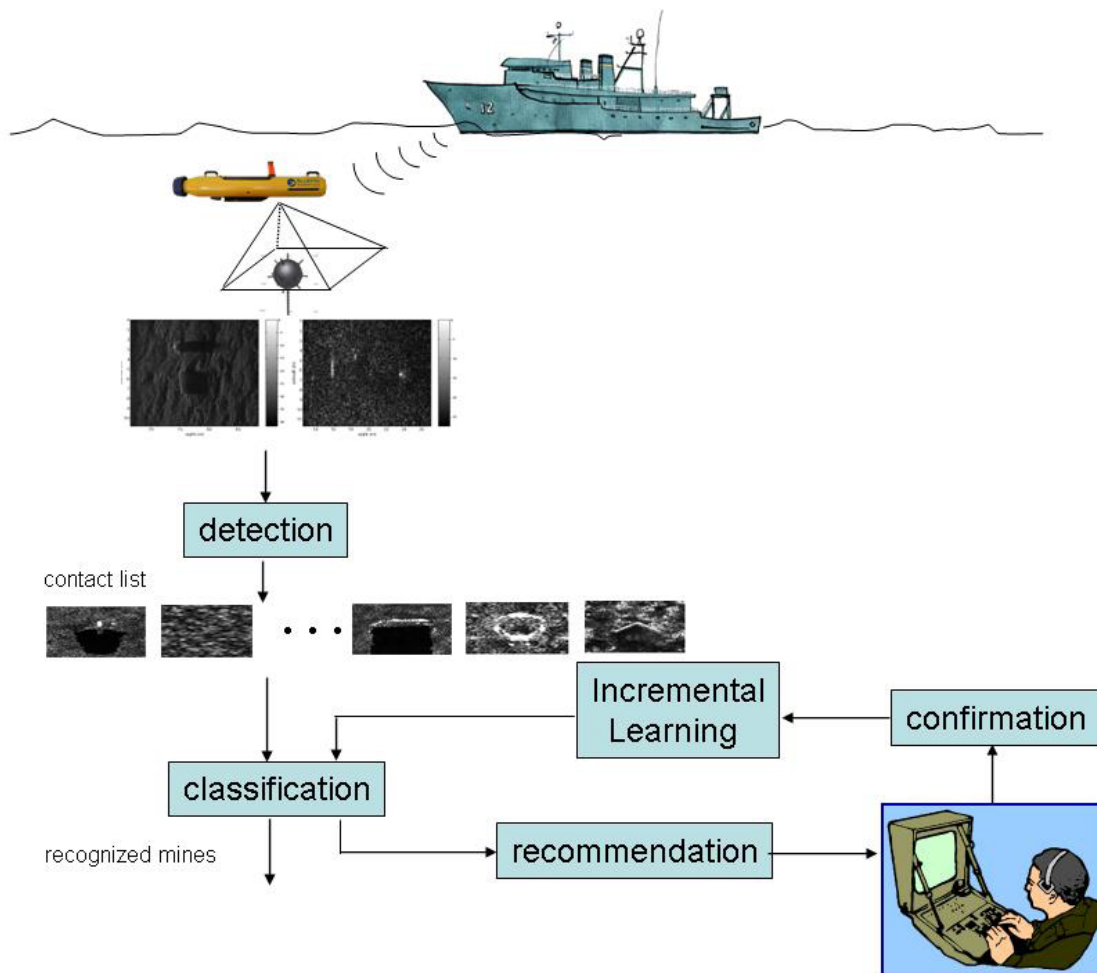
Novel Solutions for Modeling and Simulation Applications

A New Generation of Runtime Terrain Database Engine (HF-RTDE) Capable of Providing
High-Fidelity Terrain Representations
&
Efficient Runtime Terrain Services
for
Heterogeneous L-V-C M&S Applications

High-Fidelity Runtime Terrain Database Engine: Utilizing an innovative Scalable Pattern-driven Region-adaptive Compression (UC-SPARC), UC has developed a new generation High-Fidelity Runtime Terrain Database Engine (HF-RTDE). The UC-SPARC HF-RTDE software solution is capable of optimizing both real-world accuracy and simulation performance on platforms with limited disk, CPU, and memory resources. The software and services will provide compact storage of high-fidelity (4-inch or better) terrain geometry and imagery, >10x greater accuracy, and rapid runtime performance to support interoperable Live-Virtual-Constructive Modeling & Simulation applications as well as dynamic terrain updates and modifications. Specifically, our UC-SPARC HF-RTDE software libraries have been ported to a typical Android mobile device to demonstrate the applicability and potential transition to Force XXI Battle Command Brigade and Below (FBCB2) blue force tracker (BFT).

3-D Situational Awareness Visualization for Emergency Response: For assisting emergency response applications, UC's 3-D situational awareness visualization technologies automatically provide decision makers with 3-D information about building exteriors, interiors, utilities, and facilities. Our technology enables real-time 3-D visualization for identifying, localizing, and tracking people and resources within the multi-story incident buildings in urban environments. Such 3-D situational awareness software will enhance the decision making capabilities of incident-commanders and increase the effectiveness and speed of emergency response.


Scalable Urban Warfare and Destruction Simulation Models: UC has developed a physics-based simulation system to simulate detonation damage events in urban environments with a high fidelity. UC's developed system has the following capabilities: realistically simulates both the static and dynamic status of building rubble; high-fidelity scalable rubble representation; high resolution multi-component based representation for scene objects (such as buildings, pedestrians, and vehicles); novel accurate spherical and non-spherical blast models (of multi-material/composed structures) and their derivatives; sequential and parallel events simulation with automated scalable level of details.

SENSEI: Sensing Emotion Non-invasively for Software-based Educational Instruction
UC is developing a multi-modal emotion recognition system that has the capability of estimating human subjects' emotional state using a number of non-invasive external cues, including facial expression, body posture, voice intonation, etc. UC's solution includes a set of innovative feature extraction and analysis modules for various sensory data and a novel probabilistic multi-modal information fusion framework that incorporates heterogeneous cues to aid in estimation of the human subject's emotional state efficiently and robustly. The major advantages of UC's SENSEI technology include: 1) Capable of sensing the subject's emotional state in real-time; 2) Integrating multiple cues in a systematic and probabilistic way; and 3) Flexible and extensible to add any additional modalities.
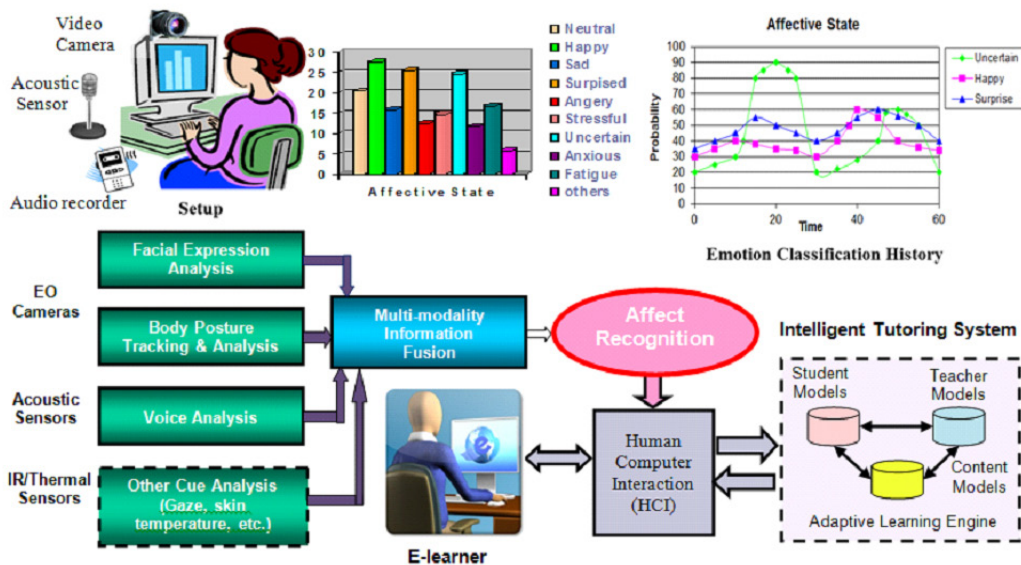
**Solutions for Safe Operations of Unmanned Aircraft Systems**
Passive sensor based end-to-end solution for air traffic detection and avoidance: UC offers embedded software solution to enable UAS to detect, track and avoid non-cooperative air traffic using passive electro-optical/infra-red sensors alone. The software leverages a number of recent algorithmic breakthroughs at UC such as novel image processing techniques to detect small targets characterized by low signal-to-noise ratios, patent pending approach to maneuverless passive range estimation and statistical decision theoretic approaches to collision prediction. The passive-only end-to-end solution is ideal for small to medium UAS with strict payload size, weight and power (SWAP) constraints.
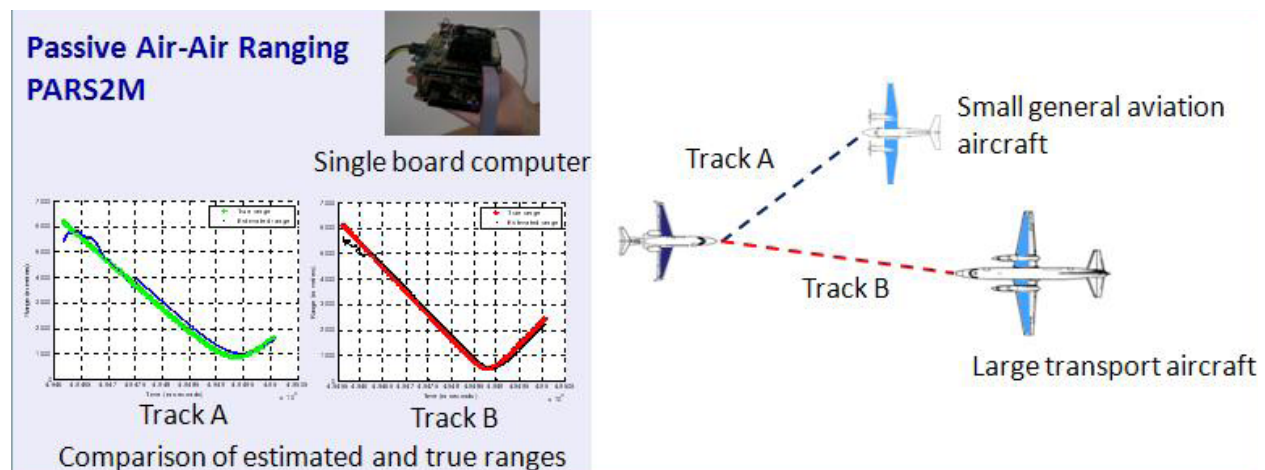
Sense and Avoid ladar: UC's sense and avoid ladar provides UAS the capability to autonomously detect, track and avoid other non-cooperative air traffic. The ladar operates in conjunction with passive EO/IR sensors to provide increased track accuracy and low false alarm rates. For low altitude operations, the SAA ladar can perform the dual function of obstacle and terrain detection. Size, weight and power requirements of the SAA ladar make it attractive for use on medium to large UAS.

Mechanical design of SAA Ladar packaged inside a gimbal
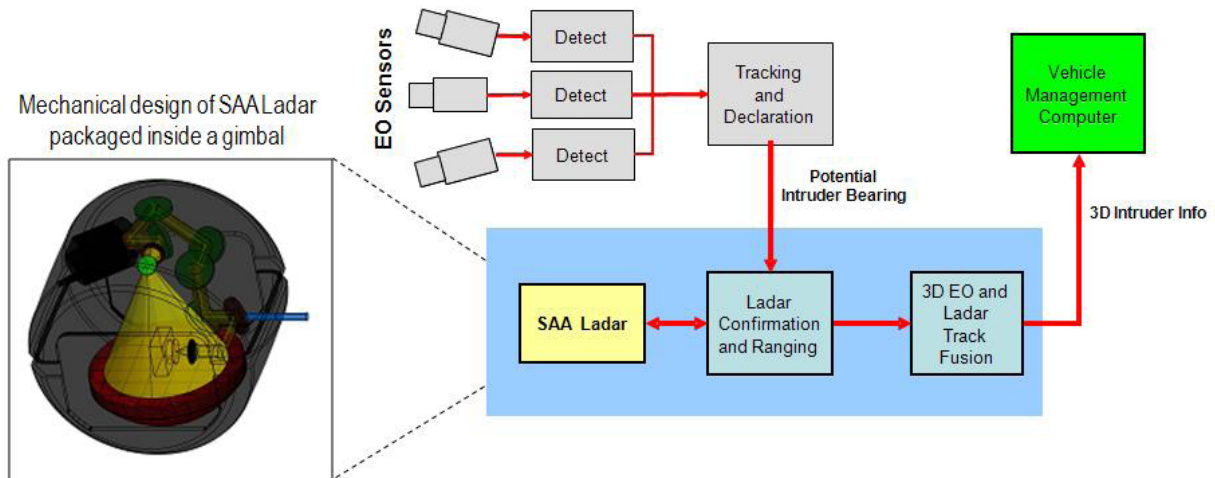
Cloud detection and avoidance: UC offers an embedded automatic cloud detection and avoidance capability based on passive electro-optical sensors. UC's software automatically detects clouds in live EO video feed, computes the range from UAS to clouds, estimates the size of clouds and performs path planning to avoid clouds and keep the UAS in Visual Meteorological Conditions, all in real-time.
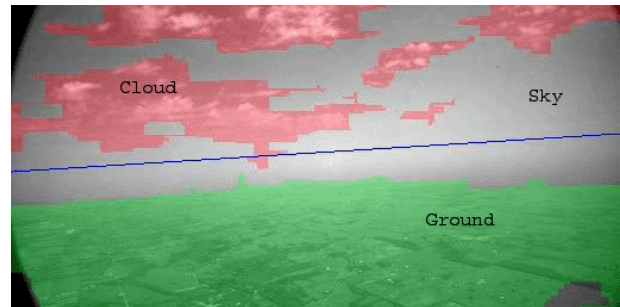

Integrity management for mixed critical UAS: UC's integrity management software tools enable rapid fault detection and identification in UAS sensors where hardware redundancy is not possible due to SWAP constraints. Example applications where the technology has been demonstrated include Sense and Avoid and obstacle avoidance.
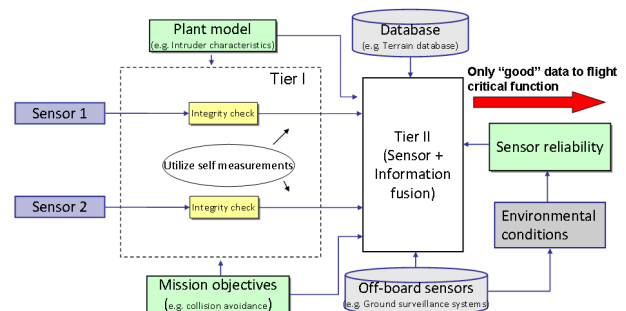
**Routing, Topology Control and Mission Planning for Airborne Networks**

Airborne Network (AN) is a critical component to realize DoD's vision of Network Centric Warfare and to achieve ubiquitous war-fighter connectivity through the Global Information Grid. UC's Mobility Aware Routing Protocol and Mobility Dissemination Protocol suite (MARP/MDP) performs significantly better than existing reactive and proactive Mobile Ad-Hoc Network protocols for the dynamic airborne network scenarios. The Mission Aware Topology Control (MAToC) protocol maximizes the Signal-to-Interference-plus-Noise Ratio of high capacity directional links in the Airborne Network topology and reactively repairs links which have a high packet-loss.

UC also offers a Mission Planning Toolbox (MPT) for the Airborne Network deployment. MPT helps designing airborne node trajectories such that their coverage provided to ground nodes is maximized while maintaining inter-airborne node connectivity. MPT can be used to design trajectories of close air support assets (Small UAS etc.) to maximize the radio contact opportunities between the close air support and the ground troops.
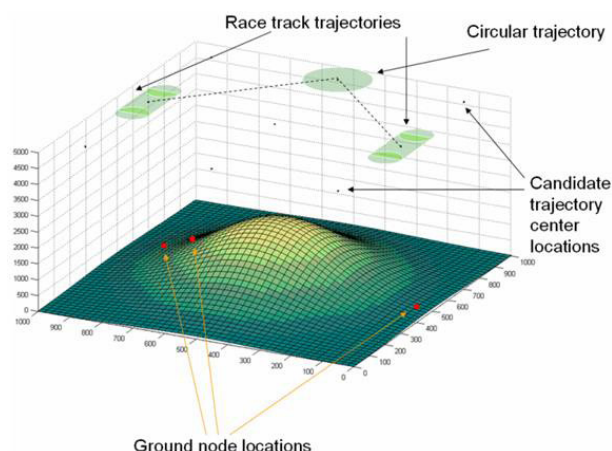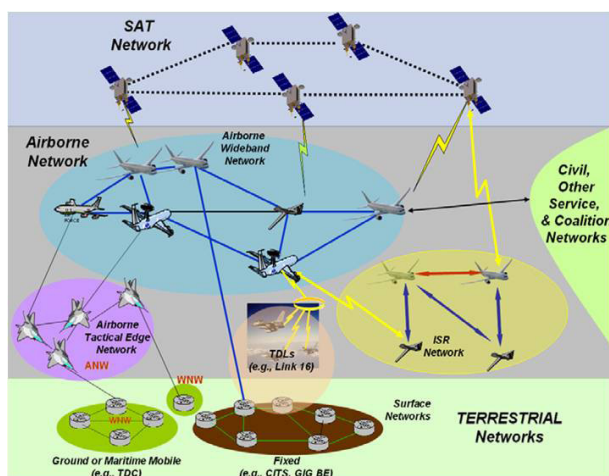
Thin Layer Approach to Increase Reliability in Ad Hoc Networks

Radio communication in warfare faces several formidable challenges, e.g., high mobility, scalability, external interference, etc. These problems make network protocols unreliable. We solve these problems through exploitation of diversity mechanisms, multi-path routing, packet coding schemes, and multi-channel communication within the networking structure. To support the wide range of situations that occur in the battlefield, UC's "thin" software layer transparently interacts with other layers to leverage diversity mechanisms provided by each layer. Thin Layer turns on and off diversity mechanisms adapting to varying network environments and link conditions. Thin Layer technology has been successfully demonstrated to enhance the reliability of the Wideband Networking Waveform (WNW).
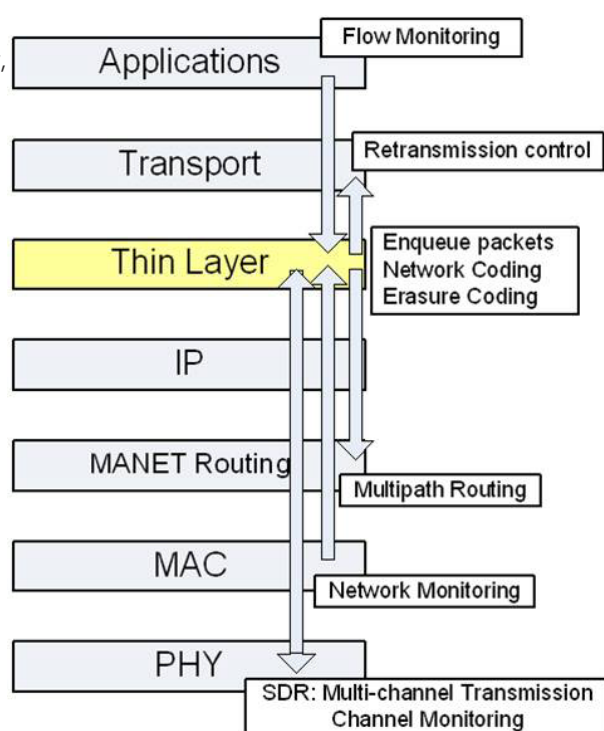
Proactive Fault and Healing Management for Mobile Ad Hoc Networks

UtopiaCompression's proactive fault and healing management solution enables predictive identification of hard and soft network failures and automated response in mobile ad hoc networks. The core of UC's network fault detection and classification capability is our novel biologically inspired network detectors for anomaly detection.

The accuracy of the network fault detection and classification engine is further enhanced through interaction with mission planning systems. In response to the detected network faults, UC's solution automatically activates local/global network self-healing mechanisms and processes for protection and recovery from undesirable network states. UC's solution will enable improved and efficient management of large scale complex dynamic tactical networks.
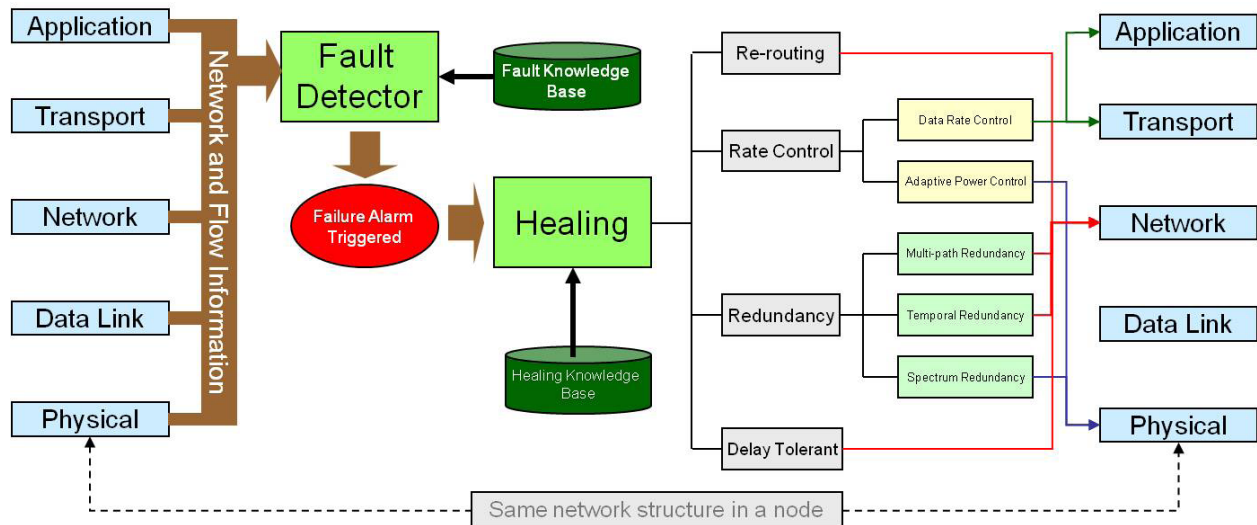
## Generative Waveform Agnostic Gateway (GENWAG)

The GENWAG framework simplifies the tedious and immensely costly process involved in creating gateways between heterogeneous communication waveforms. A large number of gateways will be required by the Department of Defense (DoD) for integration of fielded legacy radios using legacy waveforms with the new radios and new IP waveforms currently under development.

GENWAG architecture includes a high-level Domain Specific Language (DSL) to describe waveform specifications, protocol behaviors, message structures and the gateway logic. A corresponding high level compiler validates and verifies the gateway logic against the desired inter-waveform interactions. The adoption of GENWAG architecture by the DoD would ensure radio and waveform interoperability at a significant reduction in cost.
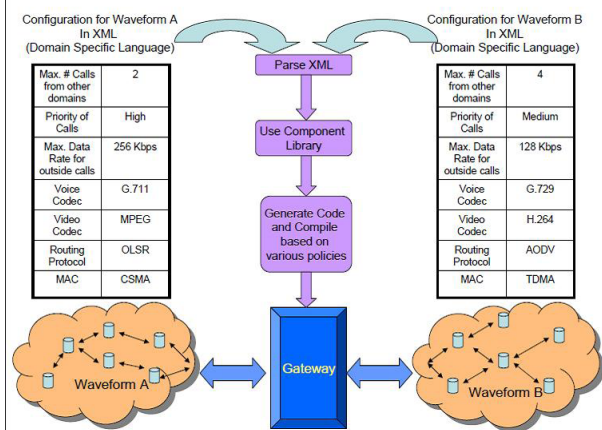
Context Aware Routing and Network Management Architecture (CARMA) for the Airborne Network
Airborne networks have several serious disadvantages for wireless communications such as extremely high mobility, unstable link conditions, channel jamming and congestion, etc. To mitigate those disadvantages, UtopicaCompression collaborating with Air Force Institute of Technology proposes Context Aware Routing and Management Architecture (CARMA) that exploits multiple network metrics and contextual information to establish shortest end-to-end delay paths. Furthermore, CARMA employs a prediction algorithm that uses Kalman filter for seamless route updating and parameter adaptation to dynamic network and topology changes of the airborne network. Our experimental results indicate that CARMA achieves superior performance gain compared to baseline MANET routing protocols.
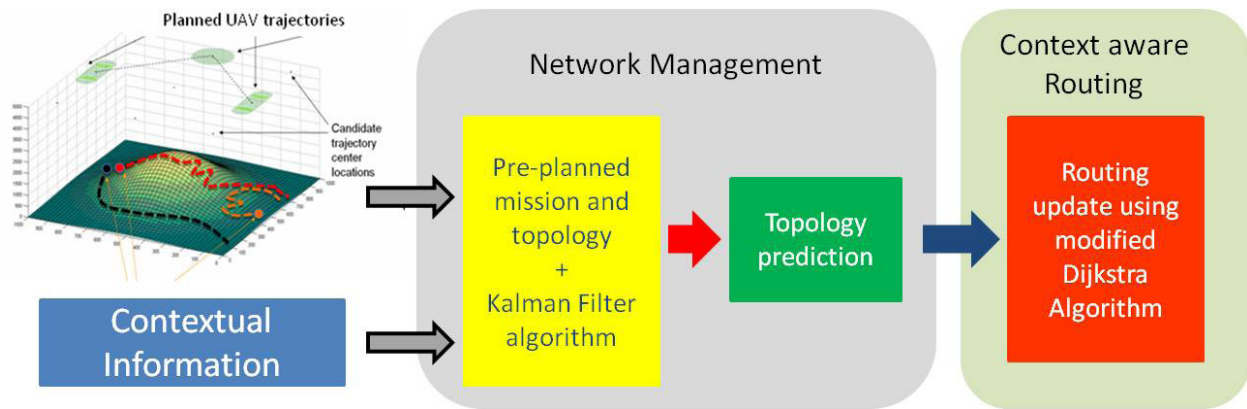
Mobility-Aware Disruption-Tolerant Opportunistic Routing (MADOR)
Effective autonomous routing and management for dynamic SUAS networks can result in reliable data delivery, lower congestion, higher communication capacity, energy conservation, and fault-tolerance capability. For those desirable network features, UtopiaCompression (UC) creates Mobility-Aware Disruption-Tolerant Opportunistic Routing (MADOR). We consider the communication and networking problem from the mission planning stage up to operational deployment. Mobility aware routing for SUAS is the basis for providing proactive and reactive solutions that use the knowledge of mission and mobility information of the aerial platforms. MADOR proactively determines the available mobility information, routing tables, packet storage, and connectivity while reducing energy usage due to overhead and excessive traffic usage. UC provides an integrated solution to both routing and disruption tolerant networking using the mobility knowledge about the network nodes by combining the overall routing and disruption tolerant networking suites under one unified umbrella protocol. Our research on energy-efficient routing ensured that the packet relaying load is distributed more evenly to the whole network so that some of the nodes' batteries are not depleted due to excessive information relaying before they complete the mission.
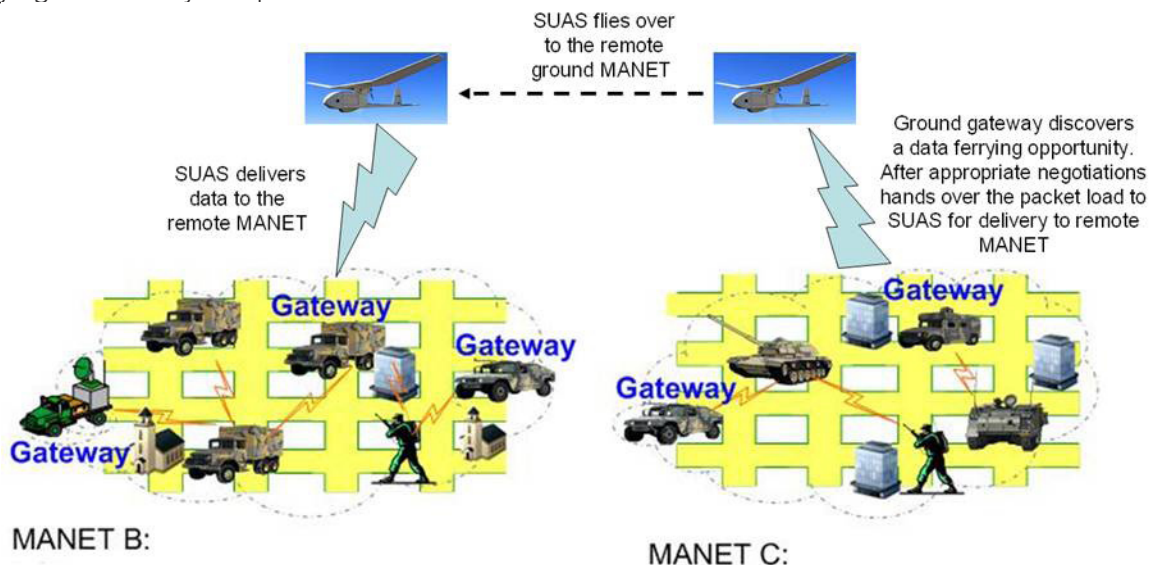
Smart Physiological Sensor Vest for First Responders

UC is developing a smart physiological vest capable of monitoring in real time the physiological status of first responders during in-field operations. The physiological vest consists of a suite of wireless sensors integrated with the clothing. A personal server located on the body of the first responder fuses the sensor measurements and uses advanced artificial intelligence concepts to accurately infer the health status of the first responder. The decision support software can handle any number or combination of relevant physiological sensors and can also be tuned to a given responder's individual body and fitness traits for highly accurate health status reports.
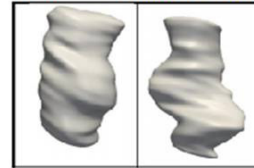

Biomarkers for Traumatic Brain Injury Detection (TBI)

Current state-of-the-art includes imaging technologies which are not portable and very expensive to be used as a screening and monitoring tool for TBI. Researchers in TBI have not fully explored the benefits of using ultrasound imaging which offers considerable advantages over other modalities such as CT and MRI in terms of cost, portability and with no risk of radiation. These advantages come with minimal loss of diagnostic accuracy when compared to gold standard techniques of CT and MRI. UC has developed novel TBI biomarkers using ultrasound imaging of the optic nerve sheath (ONS). ONS is an anatomical structure (it lies 5 mm behind the optic globe (eye)) and its dilation is affected by changes in the intracranial pressure (ICP) a clinical indicator of TBI. UC has also developed the necessary image processing and data analytics modules to allow for a rapid visualization of the captured structure for medics and clinicians. As TBI affects several system pathways, we have adopted a multimodal approach of using auxiliary and off the shelf sensors which can further improve the diagnostic sensitivity offered by ultrasound. A pilot study on trauma patients showed encouraging results with our markers providing a diagnostic correlation of 90% compared to invasive indicators such as ICP, thereby, promising our proposed prototype to be a reliable tool for rapid diagnosis of TBI.
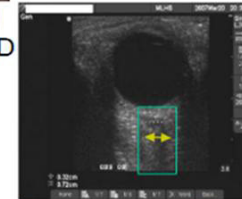

Biomarkers for Traumatic Brain Injury

Cognitive Rehabilitation for PTSD and Mild TBI Subjects

More than 10% of returning soldiers from Iraq and Afghanistan suffer from post-traumatic stress disorder (PTSD) and/or mild traumatic brain injury (Mtbi). The symptoms of both PTSD and Mtbi make it extremely difficult for veterans to join normal work force due to poor functioning of various cognitive skills such as memory loss and problems in spatio-temporal representation. At UC, we have developed an analysis tool using functional magnetic resonance imaging (fMRI) to map the cognitive functions and capabilities of warfighters. The analysis tool uses neural signatures captured from fMRI and applies machine learning techniques to automatically classify the affected brain regions which lead to poor functioning of certain cognitive functions. Based on this mapping, we can recommend a set of games that veterans can play to re-train their cognitive skills. We have also developed cognitive tutors which can be loaded along with the gaming software on a cell phone for veterans to practice the recommended games at regular intervals. These tutors can track the performance of subjects and provide feedback.
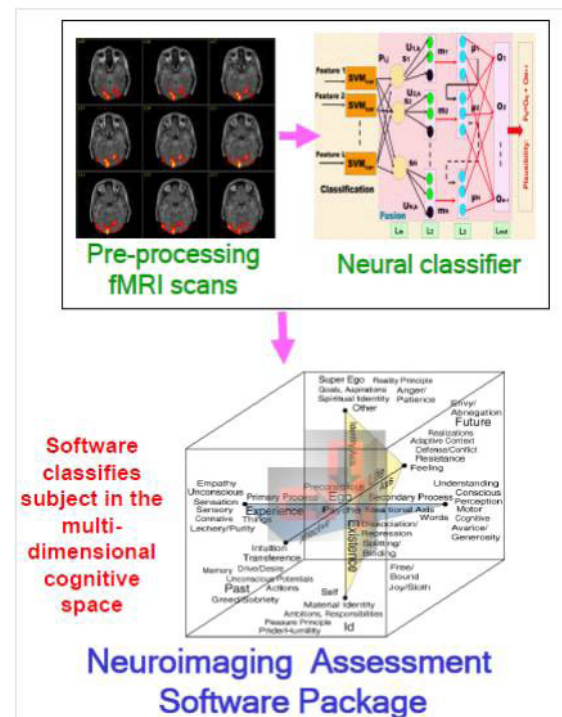
RECREATE: Real-time Cognitive Readiness Assessment Tools

UC is developing an integrated sensor and data analysis solution which contains a suite of innovative and substantial intelligent analysis tools and is capable of quickly, accurately, and reliably estimating Cognitive Readiness (CR) level of individuals/teams through sensing, analyzing and fusing a number of non-invasive external cues. The major advantages of UC's RECREATE technology include: 1) A set of innovative data analysis algorithms for heterogeneous sensory data, (including neurophysiological fMRI and EEG data, multi-modal physiological data, physical behavior data, etc.); 2) A flexible and extensible probabilistic multi-modal fusion model capable of optimally/robustly estimating CR of individuals and teams based on available resources and expanding to handle any number and type of external cues; 3) The proposed system can also naturally integrate domain expert assessment and be applied in both static/dynamic environments.

Customers

UC is proud to serve the following organizations and agencies:

- US Air Force
- US Navy
- US Army
- Department of Homeland Security
- US Missile Defense Agency

- Department of Energy
- National Aeronautics and Space Administration
- National Institute of Standards and Technology
- National Science Foundation
- Defense Advanced Research Projects Agency

Partnerships

UC actively pursues and welcomes collaboration with government prime contractors, peer companies and generally high-tech organizations with complementary solutions. Currently UC has, and is developing business relationships with a number of prime contractors including Lockheed Martin. For instance, with Lockheed Martin, UC is developing maritime surveillance and security solutions and 3-D urban visualization capabilities to assist first responders on duty in disaster areas.

Company profile

UtopiaCompression Corporation (UC) was formed in Los Angeles, CA in 2002 to harness the scientific vision, innovation and entrepreneurial spirit of its founders. Within its first year of operation, UC's technology was recognized by the National Institute of Standards and Technology (NIST) as one of the nation's top emerging technologies. Since that time, UC has developed into a rapidly growing, cutting-edge technology company, focused on pushing the limits of the state-of-the-art intelligent technologies. During its eight years lifespan, the UC team has won numerous US Government awards and contracts providing innovative technologies and solutions. UC technologies for image compression, visual knowledge discovery, and sense-and-avoid are currently on the transition pathway to our DoD customers and US War fighters. Some of the company highlights include:

▸ A team of World-Class Scientists/Engineers and highly qualified Business Professionals.

▸ A solid track-record of consistently exceptional performance with various government customers.

▸ Streamlined management processes developed over 8 years to bring high-tech ideas from concept to transition-ready solutions.

▸ Well established partnership with a slew of prime contractors and academic collaborators.

Core Advantage

Computing and high tech systems are increasingly taking over the processes that control the conduct of modern society. They are used in such diverse areas as industry, finance, corporate world, health care, education, governmental services, the military, and the homeland security. The strongly human driven paradigm of computing that tightly relies on software developers monitoring, debugging, revising and updating software solutions is progressively becoming more expensive and will ultimately be untenable. This is due to human bounded rationality and the continual ascension of the order of complexity of the software solutions.

The pressures of modern networked society thus demand a paradigm shift in our conception of computing. We are posed with the tall task of building systems that:

▸ Have proprioceptive and introspective capabilities to self-heal, grow and adapt themselves vis-à-vis the dynamically changing environment in which they are immersed.

▸ Continually learn the nuances of their environment and reason about the world in order to act proficiently with minimal human involvement.

Although the design and construction of self-healing adaptive systems is a very tall task, it is the framework and the vision UtopiaCompression considers worthy of pursuing. Cognitive computing (alternatively computational intelligence) has the potential and promise of delivering the above paradigm. As a small company, we take pride in being one of the early leaders in developing expertise in cognitive computing and heralding the new era of intelligent adaptive solutions and systems.

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