



**INVOCON, INC.**

INNOVATIVE CONCEPTS IN  
SYSTEMS ENGINEERING



# Precision Instrumentation & Communication Solutions

for Unique Applications  
and Extreme Environments



## **MISSION**

Invocon provides turnkey solutions for demanding applications in extreme environments for the sensing and data acquisition communities. With a focus on wireless sensor networks, Invocon conducts research and development in topics related to data acquisition and communications, and manufactures precision instruments and sensors for use in aerospace, defense, civil structure monitoring, and other commercial markets.

Invocon intends to become the premier supplier of ideas and system designs to solve tomorrow's problems in the acquisition, communication, processing, and presentation of spatially distributed data.

## **COMPANY BACKGROUND**

Founded in 1986, Invocon, Inc. is a Veteran-owned Small Business, which has developed into a leader in data acquisition research and development. From inception, Invocon has continually introduced new innovations, ideas, and concepts to solve a myriad of technological challenges encountered in the sensing and acquisition industries.

Based in Conroe, Texas, 30 miles north of Houston, Invocon has aimed to provide high technology design and fabrication services for the U.S. Government, major corporations, and universities. Our staff consists of professional electrical, computer, and software engineers, and skilled technicians, whose skills and creativity successfully transform ideas into working products. Invocon has laboratory facilities for the prototyping, manufacturing, and testing of electronic products. We also team with university research groups, subcontractors, consultants, and other R&D companies to solve basic research problems and to bring the ideas from the laboratory to the marketplace.

## **CORE COMPETENCIES**

Invocon, Inc. has core competencies in the following areas:

- Precision Instrumentation System Design
- RF Communication System Design
- Underwater Acoustic Communication System Design
- Low-power, Battery-operated Electronics Design
- Electronics System Manufacture, Integration, and Testing
- Software Development

Invocon has developed a broad suite of technologies and systems for both government and commercial endeavors. Many of these systems can be directly applied to particular customer needs, or can be customized to provide an optimum solution.

## PRODUCTS AND SERVICES

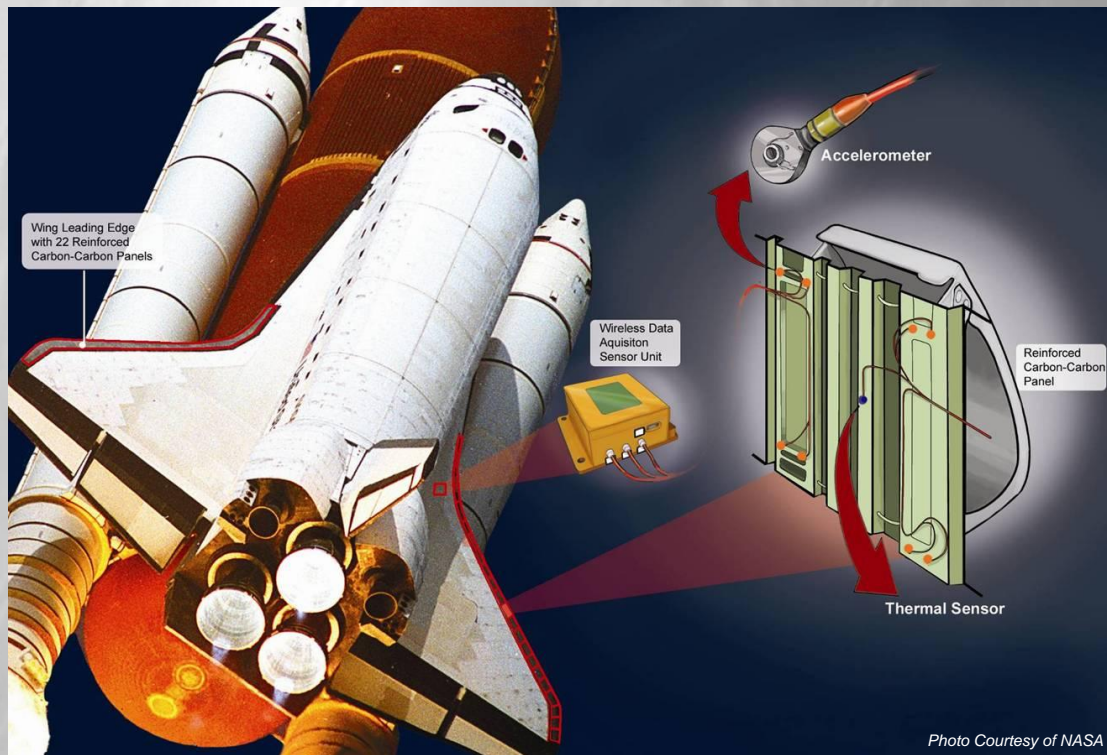
Invocon has developed electronic systems with a broad scope of applications—from underground to space, from military to commercial, from simple data recording to complex analysis, and from large-scale systems to miniature systems. The following application examples illustrate the effectiveness of Invocon produced technology:

### Space

Beginning in 1995, Invocon has successfully flown hardware on 22 Shuttle flights, and hardware is currently in use on the International Space Station (ISS). Invocon has provided NASA with unique instrumentation, data storage, and communication solutions for spacecraft structural and environment monitoring, particularly utilizing wireless communication, which satisfy their strict requirements for performance, reliability, and low-integration costs.

### Retrofit Instrumentation

The miniature wireless instrumentation and sensor products developed by Invocon for NASA have enabled a 10X reduction in the integration and installation costs for the Shuttle and ISS programs compared to traditional retrofit wired sensor approaches. Wireless, battery-operated intelligent sensors, some less than 1 cubic inch, are easily bonded to vehicle structure and monitor environmental parameters for up to 20 years without battery replacement. As a specific example, Invocon has provided NASA an instrumentation system called the Shuttle Wing Leading Edge Impact Detection System that is capable of detecting, recording, and transmitting data from an impact event from foam, ice, or ablator on the Shuttle wing RCC panels during ascent, and Micro-meteoroids during on-orbit phases.

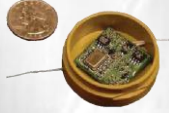





Now installed on all three remaining Space Shuttle Orbiters, the system is capable of high-speed data acquisition, local data processing and reduction algorithms for impact detection, sophisticated scheduling capabilities for maximizing battery life, and autonomous operation. Due to the existing technology base available and flexible architecture, this system was able to be designed, built, and flight certified for the Return to Flight mission of the Shuttle.

**Model Correlation**

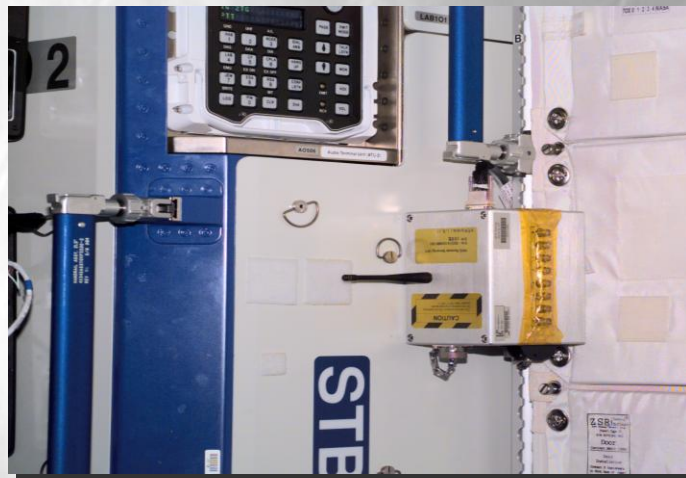
NASA has traditionally used models for predicting various spacecraft parameters, typically using high safety margins and assuming worst case conditions. Through the use of low-cost Invocon wireless sensors and data recorders, actual flight measurements have been made which have enabled NASA to refine models and reduce safety margins effectively. Invocon systems have been used to support an increase in the design life of the Shuttle Main Engine Struts, model correlation of Shuttle payload launch dynamics, verification of on-orbit plasma environment, and soon to monitor the Shuttle Main Engine flow-liners for high-cycle fatigue causing vibration.

These wireless sensors have enabled an entirely new paradigm in the way NASA acquires flight data for minimal cost and integration efforts. Capabilities and new sensor interfaces have been added as needed, producing a flexible, diverse set of technology elements that can be assembled easily to meet an ever increasing array of challenging data acquisition and transmission needs.

				
	<b>MicroWIS-based</b>	<b>Extended Life MicroWIS-based</b>	<b>MicroTAU-based</b>	<b>Wideband MicroTAU-based</b>
<b>Sample Rate</b>	Up to 1 Hz	Up to 1 Hz	Up to 500 Hz	Up to 20,000 Hz
<b>Data Storage</b>	Real-time Transmission to PC Only	2 Mbytes & Real-time Transmission	1 Mbyte	256 Mbytes
<b>Local Data Processing</b>	No	No	Yes 8 bit micro-controller	Yes High-speed DSP
<b>Battery Life</b>	9 months	10+ years	50 hours of data acq. 1 year sleep mode	80 hours of data acq. 5 years sleep mode
<b>Sensors</b>	Resistive sensors including Temperature, Strain, Accelerometer, Pressure	Resistive sensors including Temperature, Strain, Accelerometer, Pressure	Resistive or Voltage sensors including Strain, Accelerometer, Pressure	Piezoelectric, Voltage, or Resistive, including Temperature, Strain, Accelerometer Pressure
<b>Flight History</b>	8 Shuttle Flights	Flight Certified – awaiting first flight on Shuttle Orbital Maneuvering System	9 Shuttle Flights	5 Shuttle Flights

### **Modal Analysis**

Invocon has produced a highly synchronized, wireless instrumentation system for NASA which is currently being used to assist in the performance of on-orbit modal analysis of the ISS throughout assembly operations. The Wireless Instrumentation System (WIS) is a powerful, laboratory grade instrumentation system with wireless network connectivity capabilities and multiple node synchronization down to  $\pm 300\text{ns}$ . Versions have been developed for the ISS Truss Elements and Pressurized Modules for temperature, strain, and micro-g accelerometer measurements. The Internal WIS system, shown below, is currently onboard the ISS and has been used repeatedly for measuring structural responses to various excitations, and for troubleshooting various exercise equipment failures. A similar system has been delivered to the Japanese Aerospace Exploration Agency for use in the JEM module on the ISS, and an extension of the system has recently launched that will include the outboard solar array truss elements.



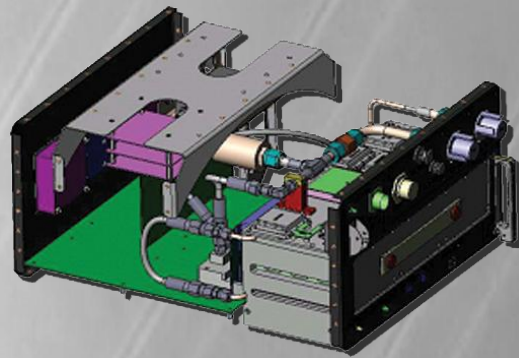
**IWIS Unit Onboard the ISS**

*Photo Courteously NASA*

The same basic platform, with a high-speed, direct sequence spread spectrum radio link, modular bussed architecture, and extremely high resolution data conversion ( $\sim 16\text{bits}$ ), has been used for a variety of applications including a Navy flight test data acquisition system and a NASA Dryden “Fly by Wireless” demonstration program. Both systems were shown to be capable of direct wire replacement in demanding, latency critical applications. The Fly by Wireless system was able to control an aileron based on inputs from the flight control computer, and passed the normal ground acceptance tests for an F-18 aileron.

### **Payload Electrical Integration**

Invocon performed ISS payload design, manufacturing, and testing services for the HDMAX Quad-HD video payload. Functions included system controller design, power supply design, cable design, ISS payload communications, embedded software design for system control, and system integration.



### **Missile Defense**

Invocon has produced an innovative lethality and effects tracking and communication system as part of a U.S. Navy Standard Missile program. The target missile system is capable of detecting the initial impact point of a killer missile to within 1 cm, as well as track collateral damage to the target at rates greater than 32,000 feet per second. Data is collected and transmitted directly to ground station facilities with extremely low latency for maximum data collection prior to destruction. In addition, Invocon has recently designed and delivered a low-mass, low-cost version of this system for the smaller, lower cost ARAV target missiles.



The system allows engineers to reconstruct the final moments of a collision when the target missile (simulating a military threat) is intercepted by a defensive missile. Precision measurement is necessary in order to understand the accuracy of the intercept and the angles at which the intercept takes place. The lethality information from these missile defense tests will help the designers of the intercept missiles insure the complete neutralization of the threat missile warhead.

### **Military Aircraft Test and Evaluation**

Through a successful SBIR contracts with the U.S. Air Force and U.S. Navy, Invocon has developed and delivered extremely versatile RF wireless data acquisition systems for military aircraft test and evaluation support. The systems replace the wires between various test sensors and existing analog telemetry equipment on rotary and fixed wing aircraft. This tightly synchronous, wireless link greatly reduces test preparation time and extends analog sensor placements on rotor hubs or other extreme locations.

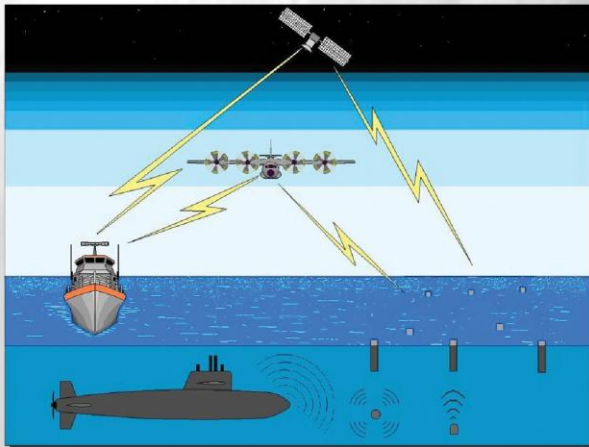
Invocon has also developed systems to perform remote machinery diagnostics and prognostics on engine components or bearings, as well as structural failure monitoring of aircraft based on Neural Network analysis of the dynamic response of the structure during flight maneuvers.

### **Non-lethal Weapons**

Invocon is currently performing research for the U.S. Navy relating to a non-destructive, stand-off weapon that can render a human powerless to effectively resist arrest or subjugation. The Electromagnetic-based technology is anticipated to be capable of working through walls to cause a temporary, non-lethal physiological effect on the target.

### **Underwater Sensors and Acoustic Communications**

Under a U.S. Navy-sponsored project, Invocon has developed the Un-tethered Velocity of Sound Profiling Sensor. The system creates a map of temperature vs. depth in a water column, allowing the Navy to obtain a profile of sound velocity.



The system consists of a series of probes stored onboard sonobuoys. The system periodically releases these probes, which take measurements of water temperature and pressure as they descend through the water column. The probes transmit this data acoustically to a receiver integrated into the sonobuoy. Multiple probes are stored in a single sonobuoy, allowing the buoy to gather sound velocity profiles over time.

### **Civil Structures Monitoring**

Invocon's micro-wireless instrumentation systems are being used by universities and commercial companies to perform research on bridge monitoring, as well as to monitor underground tunnels under construction in Europe. Remote data analysis algorithms based on the ASTM Rainflow calculation has been implemented in the miniature remote unit, greatly decreasing the volume of data that must be stored, transmitted, and post-processed.



## **CUSTOMERS**

Invocon's customer list includes the following entities and organizations within the government and commercial sectors:

- The Boeing Company
- Endeveco
- Federal Aviation Administration
- Ford Motor Company
- JAXA (Japan Aerospace Exploration Agency)
- Jet Propulsion Laboratory
- NASA (JSC, KSC, DFRC, GRC, MSFC, SSC)
- Northrop Grumman Corporation
- Penn State Applied Research Laboratory
- University of Houston
- University of Texas
- U.S. Air Force
- U.S. Coast Guard
- U.S. Navy
- U.S. Department of Energy
- U.S. Department of Transportation

## **MANAGEMENT TEAM**

Invocon's Management Team has the experience and vision to effectively apply cutting edge technology to solve complex systems engineering problems. President and CEO Karl Kiefer founded Invocon in 1986 to service the niche market related to government-supported R&D into newly emerging wireless communication technologies. Through his leadership and the support of his Program Directors, Invocon has developed into a market leader in providing reliable instrumentation and communication solutions. With an average of over 12 years of experience, Invocon Program Directors are uniquely qualified to manage government and commercial research and development projects across an unusually broad range of technologies.

## **CORE ADVANTAGE**

As a world leader in developing solutions for unique challenges in difficult environments from sub-surface to space, Invocon can provide the precision instrumentation and communication products and services needed to address the technological challenges encountered in the sensing and acquisition fields.

***For more information, please contact:***

Invocon, Inc.  
19221 I-45 South, Suite 530  
Conroe, TX 77385  
281-292-9903 (voice)  
281-298-1717 (fax)  
[www.invocon.com](http://www.invocon.com)  
[applications@invocon.com](mailto:applications@invocon.com)