This Month's Covers...

The IEEE AESS Pioneer Award for 2007 has been awarded to
Robert D. Briskman
For the development of commercial communications satellites over the past 40 years.

Formal presentation occurred at the Advanced Satellite Mobile Systems Conference
Bologna, Italy, in August 2008.

On the back:
The Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC)
was a joint US-China project designed to advance meteorology and space weather studies
by using GPS radio occultation receivers and other instruments on-board a constellation
of low-Earth orbit satellites. On April 14, 2006, six COSMIC satellites were delivered into
a low-Earth orbit of 500 to 600 km altitude and a 72° inclination angle by a single
launch vehicle launched from the Vandenberg Air Force Base in California. In the coming
19 months, these six satellites were raised, one by one, to an altitude of 800 kilometers
and separated into six different orbital planes with the same inclination angle
through the node drift effect of the gravitational pull by the Earth's equatorial bulge.

The six COSMIC satellites, labeled FM1 through FM6, have the same structure and functions.
Each carries an EGNOS GPS receiver, built by Broad Reach Engineering, derived from the NASA/NAIP's
four antenna BlackJack GPS receivers. Two antennas looking above the local horizon collect
GPS measurements for precise orbit determination (POD), and the two other antennas looking slightly below
the horizon collect GPS signals for radio occultation.

(From: Precise Orbit Determination for COSMIC Satellites Using GPS Data from Two Outward Antennas, ION 2008, 1-4244-1537-3, 2008)

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IEEE AESS MEETINGS & CONFERENCES

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<td>10-12 Dec</td>
<td>2008 2nd International Symposium on Systems and Control in Aerospace and Astronautics (ISSCAA)</td>
<td>Shenzhen, China</td>
<td>Changhong Wang, +86 451 8641891, <a href="mailto:changhong.wang@hit.edu.cn">changhong.wang@hit.edu.cn</a> <a href="http://www.isscaa.org/">http://www.isscaa.org/</a></td>
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<td>8-13 Feb</td>
<td>2009 International Waveform Diversity &amp; Design Conference</td>
<td>Kissimmee, FL</td>
<td>Patricia Woodard, <a href="mailto:cr@rifa.mil">cr@rifa.mil</a> <a href="http://waveformdiversity.org/">http://waveformdiversity.org/</a></td>
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<td>7-14 March</td>
<td>2009 IEEE Aerospace Conference</td>
<td>Big Sky, MT</td>
<td>D. Vooner, <a href="mailto:d.vooner@grf.nasa.gov">d.vooner@grf.nasa.gov</a> <a href="http://www.aerosconf.org/">http://www.aerosconf.org/</a></td>
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<td>4-5 May</td>
<td>2009 IEEE Radar Conference</td>
<td>Pasadena, CA</td>
<td>J. Berman, (818) 254-9433, <a href="mailto:jberman@jpl.nasa.gov">jberman@jpl.nasa.gov</a></td>
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<td>20-23 Apr</td>
<td>2009 3rd Annual IEEE Systems Conference</td>
<td>Vancouver, BC, Canada</td>
<td>C. Dyer, (785) 341-3583, <a href="mailto:cdyer@conferencetext.com">cdyer@conferencetext.com</a></td>
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Send all corrections and omissions to Barry C. Breen.
For latest information: http://www.eew.ieee.org/soc/AES/conferences.html
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Distinguished Tutorials Last Appeared April 2008, Back Cover

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Launching Astronauts: 50 Years of Electronic Checkout and Launch Systems at the Kennedy Space Center

When NASA was created in 1958 one of the elements incorporated into this new agency was the Army Ballistic Missile Agency (ABMA) in Huntsville, Alabama and its subordinate Missile Firing Laboratory (MFL) in Cape Canaveral. Under NASA, the MFL became the Launch Operations Directorate of the George C. Marshall Space Flight Center in Huntsville, but expanding operations in the build-up to Apollo dictated that it be given the status of a full-fledged center in July, 1962 [1]. The next year it was renamed the John F. Kennedy Space Center (KSC) after the president whose vision transformed its first decade of operation.

The ABMA was under the technical leadership of Dr. Wernher von Braun. The MFL was run by his deputy Dr. Kurt Debus, an electrical engineer whose training in the field began in the early days of V-2 testing in war-time Germany. In 1952, a group led by Debus arrived in Cape Canaveral to begin test launches of the new Redstone missile [2]. During the 1950s, the MFL built several launch complex and launched the Redstone, Jupiter, and Jupiter C missiles. This small experienced team of engineers and technicians formed the seed from which has grown the KSC team of today.

This briefly reviews the evolution, successes, and setbacks of KSC electronic technologies for integration, checkout, and launch of space vehicles and payloads. We show that this very successful technology development was driven by greater vehicle complexity and heavily influenced and constrained by the commercial state-of-the-art in electronics.

Ultraspectral Imaging: A New Contribution To Global Virtual Presence

A new technology, Ultraspectral Imaging (USI) offers the capability to extend spectral imaging to a level where molecular adsorption or emission line features can be presented in a two-dimensional display. With these capabilities, unambiguous identification and mapping of gaseous constituents or solid material by their spectral features becomes possible. One of the techniques that shows the potential to collect these type of data is a proposed USI-based on a Fourier transform ultraspectral imager operating in the 3 μm to 5 μm and 8 μm to 12 μm bands designed for installation in an aircraft. This proposed instrument will have a 15 degree field of view (FOV), with an instantaneous field of view (IFOV) of 1.0 mrad. The target spectral resolution is better than 1.5 cm⁻¹ over 2000 to 3000 cm⁻¹ and 0.4 cm⁻¹ over 850 to 1250 cm⁻¹ using 512 spectral channels. The device will use a variety of spectral enhancement techniques to achieve this unprecedented spectral resolution. Computer simulations of the optical systems demonstrate subwavenumber resolutions and signal to noise ratios of over 900.

Computer Course in the Applied Theory of Gyros

The fundamental methodical aspects and the gained practical experience of creating and using computer technologies in teaching the applied theory of gyroscopes are considered. Possible contents and the important features of the computer course are presented. The computer course is based on the papers dealing with various kinds of modern gyro sensors presented at the I-XIV International Conference on Integrated Navigating Systems.

Evaluating Aircraft Pilot – Navigational Equipment in Flight Tests

The specialists at M.M. Gromov Flight Research Institute (FRI) have developed special techniques and facilities to evaluate the aircraft pilot – navigational equipment for conformance to specified requirements. On-board trajectory measurement complex equipment is used for data recording and determination of actual values of trajectory parameters. The parameter values are obtained using the differential mode of the satellite navigation system. The flight test process is monitored at the flight test control center. The use of a test-bench and simulation complex allows reducing the scope and costs of flight tests. Flight test data are transmitted to the specialists for processing via local computer network on the day of flight tests. This covers the description of facilities used for testing pilot – navigational equipment of new aircraft at the M.M. Gromov Flight Research Institute.

Inertial Measurement Units on Micromechanical Sensors

This presents a micromechanical gyroscope (MMG), an inertial measurement unit (IMU) based on MMG and an integrated inertial-satellite attitude and navigation system (SANS) developed in CSRI Elektroripor. The evolution and prospects for the development of MMG main components and MMG-based systems is considered. The test results are given.

Product-Based Security Model for Smart Home Appliances

The idea of using existing electronics in smart home appliances and connecting them to the Internet is a new dimension along which technologies continue to grow. In Japan, electronics giants are selling various kinds of smart home appliances and have also joined hands to create standards for linking networked home appliances. While there is a huge potential market for such appliances, both in Japan and around the world, there are serious security challenges that have to be addressed in order to realize their true benefits. Herein, we examine a number of related security incidents that have occurred in Japan and identify existing challenges from technical, social, and practical aspects. We also discuss some countermeasures that can be used to prevent existing and projected security breaches.

NASA at 50: Some Electronic Connections Part 2
Our Salute to NASA!

This issue of *Systems* is our Salute to NASA on its fiftieth anniversary. Over one year in planning, we hope it helps explain what NASA is, where it originated, and what it has accomplished in the field of electronic systems, as well as aerospace, during the past 50 years. We hope that you find NASA at 50: *Some Electronic Connections* illustrative, informative, easy-to-read, and useful as a historical reference. It is but a small portion of what could be, but there are limits.

Our editorial objective is to continue to provide you with an “interesting read” — a balance between new innovations in the limitless field of electronic systems, technical items that will — hopefully — pique your interest, and provide access to items of historical interest. We are not a Transactions — and refer those who wish technical detail to seek them there.

Elsewhere in this issue is correspondence triggered in a reader’s mind by our recent article on Luis Alvarez. There is also data on the IEEE History Center’s newsletter, and its 2009 conference devoted to the history of technical societies — a look at our own ancestry, so to speak. There are more of our historical contributions for your interest.

Enjoy — and, as always, we welcome your comments.

— Evelyn Hirt

This issue is being sent to all IEEE Student Branches.
Part 2 of this issue is available in quantity for AESS functions.

Nominations Wanted

Nominations for the election of 8 members to the AESS Board of Governors and the office of Executive Vice President, are solicited. Nominations should be sent to the Chair of the N&A Committee, James V. Leonard, Jr. Past President. Those nominated will be submitted to the N&A Committee for consideration. Elections are planned for the Spring 2009 AESS Board of Governors meeting.

Women in Engineering (WIE) Conference

IEEE-USA is co-sponsoring the second annual Women in Engineering (WIE) Conference in Atlantic City, New Jersey, 3-5 October 2008. Hosted by the IEEE Women in Engineering Affinity Group, Southern New Jersey Section, this year’s conference will feature workshops on: Teambuilding and Chair Yoga; How to Stay Cutting Edge; Outsourcing Engineering; Personality Types; Listening and Communicating Effectively; and How to Survive in a Changing Market Place.

For more information, visit: http://bmsmail3.ieee.org/80/u/12119/85613.
Launching Astronauts:  
50 Years of Electronic Checkout and Launch Systems at the Kennedy Space Center

Stanley O. Starr  
NASA Kennedy Space Center

ABSTRACT

When NASA was created in 1958 one of the elements incorporated into this new agency was the Army Ballistic Missile Agency (ABMA) in Huntsville, Alabama and its subordinate Missile Firing Laboratory (MFL) in Cape Canaveral. Under NASA, the MFL became the Launch Operations Directorate of the George C. Marshall Space Flight Center in Huntsville, but expanding operations in the build-up to Apollo dictated that it be given the status of a full-fledged center in July, 1962 [1]. The next year it was renamed the John F. Kennedy Space Center (KSC) after the president whose vision transformed its first decade of operation.

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This briefly reviews the evolution, successes, and setbacks of KSC electronic technologies for integration, checkout, and launch of space vehicles and payloads. We show that this very successful technology development was driven by greater vehicle complexity and heavily influenced and constrained by the commercial state-of-the-art in electronics.

MERCUY AND SATURN I  
(1958-1963)

Debus’ first job under NASA was the adaptation of the Redstone missile facilities to support the sub-orbital flights in the Mercury program. Complex 5 was converted to the Mercury/Redstone (MR) facilities with relatively minor changes and during the Mercury Program the on-orbit operations were conducted in a nearby Cape facility (these were moved to the new Johnson Space Center for the Gemini and Apollo programs).

The centerpiece structure of the launch pad, the gantry (another name for any crane that straddles its payload) approached the vehicle from one side and provided access platforms including a small “white room” at the top for the egress of the astronaut. At ground level, on four sides of the “boat-tail” were pipes for the passage of cables and flex hoses into sub-pad conduits. The blockhouse, a hardened bunker capable of withstanding an exploding vehicle, was sufficiently close that signal wires, relay power circuits, and even pneumatic indicators could be routed directly from the vehicle to five “firing” consoles in the blockhouse (see Figure 1). Most of the vehicle servicing was performed manually including operating propellant valves, replacing batteries, setting inertial guidance systems, etc., so the consoles focused on vehicle systems more than ground support equipment (GSE). Console operators talked to missile technicians over an intercom system and could directly view their actions through large water-filled windows in the blockhouse.

The consoles contained about 100 readings including about 25 analog measurements. Additional analogs were recorded on a battery of strip chart recorders visible to the console operators. The MR telemetry was transmitted over 2 channels with 116 measurements. During launch preparation,
technicians at the vehicle coordinated activities with those on the consoles, after which the entire team retreated to the blockhouse for the final moments of the countdown.

As an example of the detailed operations, we review the first MR launch attempt: the unmanned MR-1. This was the only space vehicle launched twice (until Shuttle Columbia). During its first launch on November 21, 1960, the engine shut down shortly after lift-off when the primary electrical umbilical ejected at about 4 inches altitude. Loss of the electrical ground through the launch ring, and a longer than normal delay between ground disconnect and power disconnect, caused the engine activate relay to open shutting down the engine. The longer delay was due to the heavier vehicle and therefore slower rise off acceleration; an unforeseen effect. The vehicle settled back onto its launch ring with the rocket control timer merrily clicking along thinking the vehicle was flying. At specific times, the launch abort tower ignited carrying it away to crash 400 feet from the pad, the pyrotechnic bolts holding the capsule to the rocket blew, and the parachute deployed. The launch team stood helplessly staring at the vehicle through the blockhouse windows. After several hours, the batteries died and the telemetry stopped. This also meant that the armed command destruct pyrotechnic explosives were safe. Engineers left the blockhouse and manually drained the propellants. Luckily, winds were light so the parachute did not pull the rocket over. The remaining MR flights were very successful except for the loss of Gus Grissom's capsule in the Atlantic in a still mysterious firing of the hatch.

Concurrent with the Mercury program, the Launch Operations Directorate began the construction of the largest launch facility to date; Complex 34 (CX34) for the gigantic Saturn 1. This vehicle had two stages with multiple engines per stage, and would ultimately (as the Saturn 1B) carry the Apollo spacecraft for orbital testing. The Saturn was 3 times the height of Redstone and produced 10 times the thrust (Figure 2). The first Saturn rockets had dummy second stages filled with water. Later, shots carried the S-IV stage, a large hydrogen/oxygen restart stage; a prototype of the stage that would propel the Apollo tandem spacecraft into trans-lunar injection. This later second stage, called the S-IVB, differentiated the Saturn 1 from the Saturn 1B.

Multiple engines meant complex engine sequencing and the need for a first stage hold-down and release system. The larger exhaust volume meant the small launch ring was replaced by a very large flame deflector structure. The height of the vehicle required a tall umbilical tower with long umbilical swing arms positioned far enough from the vehicle.
Fig. 2. Launching the Saturn rocket with its multiple stages and much more complex Apollo spacecraft introduced huge challenges in check-out and launch technologies.

to avoid contact during a windy launch. The Saturn blockhouse required 21 consoles, many for the increasing complex ground support systems that required remote manual control. The telemetry stream for the first Saturn grew to 505 measurements in 8 links. As the Saturn program progressed, the data rates and bandwidth continued to expand. The dome-shaped blockhouse eliminated windows, the Saturn had far too high a blast potential. Instead submarine periscopes (a USAF innovation) were used for test conductors and closed-circuit television allowed console operators views of critical operations. For example, when an operator started filling a liquid oxygen tank, he could verify that vapors were streaming out the vent.

CX34 started as the big brother of Redstone’s Complex 5. Controls and indications were still point-to-point with a great increase in remote control versus hands-on actions. As the vehicle matured and became more complex, increasing levels of automation were introduced. Marshall Space Flight Center introduced automation in Saturn checkout systems with the RCA 110 computer in test operations in Huntsville, and later installed them at CX34. The RCA was the first priority interrupt computer, which assigns different inputs as stacked priorities and stops the operations of low priority operations to service higher priorities. By the beginning of the Saturn IB program in 1966, CX34 and the new dual launch pad CX37 check-out activities were highly computerized, although it was nearly entirely remote manual controls. Issues faced by CX34 engineers continue to be debated today, especially how to design for computer failures and manual safing of the vehicle. Having a live Saturn vehicle on the pad like the MR experience was unthinkable. Test data was transmitted from hardwire interfaces to ground support systems and the vehicle through 600 kHz pulse code modulated FM links to dual RCA 110 computers, one for running the test and the other for controlling displays. The telemetry link for Saturn 1 would grow to 1183 measurements [1].

The Saturn 1 experience with automation showed that computers were essential to complete the increasingly complex series of tests required to verify all vehicle and ground systems. This project also created a local team of experts that, in the future, would lead the development of major KSC automation systems.

Complex 34 was the site for one of NASA’s greatest tragedies, the Apollo 204 fire which killed three astronauts in January 1967. Although the specific cause was not ascertained, the contributing factors included a high pressure pure oxygen environment for ground testing, excessive use of flammable materials in the cabin, a hatch that could not be opened quickly, and the possibility of frayed wiring bundles at a small access hatch. Post-fire investigations revealed many electrical problems in the spacecraft, which were subsequently corrected. On October 11, 1968, Apollo 7 lifted off CX34. This was the first and last manned flight from CX34 and no manned launches were conducted from CX37.

SATURN V (1963-1975)

The Saturn V and Apollo spacecraft represented a major increase in check-out test requirements. The Launch Control Center (LCC) was several miles from the launch pad which necessitated several changes. The data handling computers were mounted underneath the vehicle in the mobile launcher, called the Launch Umbilical Tower, so that tests could take place in the Vehicle Assembly Building, adjacent to the LCC as well as on the launch pad. The RCA 110A in the LCC could transmit 2,016 discrete signals to its brother in the LUT which could transmit 1,512 discrete signals back [3]. The LCC contained 4 firing rooms so that four vehicle “flows” could be handled in parallel. Each firing room contained about 400 consoles (Figure 3). A new feature added to the previous architecture was an alert monitor system where out-of-tolerance measurements were picked up and displayed at a central location.

Programming for the RCA 110A computers was performed in machine language. A higher language process called “Acceptance Test Or Launch Language” (ATOLL) was used to translate procedural steps into machine code. Another innovation was the testing of code against process simulators. This overall process improved procedures but
inevitable conflicts arose between systems engineers and software engineers over the extent to which processes should be automated, i.e., how many contingencies can be hard coded into a flow chart versus the response of a knowledgeable systems engineer. The compromise was often that only simple processes were fully automated (e.g., turn on a pump, verify that the pump has started, and a nominal flow indication has occurred).

The Firing Rooms also contained a DDP 224 display computer which controlled 20 data display CRT's. This innovation, a precursor to future displays, allowed a significant increase in the density of data available on a console.

The Saturn vehicles contained their own computers and were very much separate vehicles from the Apollo spacecraft. The astronauts did not "fly" the Saturn — they rode it, so that the Command Module simply displayed status indicators of the launch vehicle. While the stages of the Saturn vehicles were checked-out and integrated together on the LUT, the Apollo Command and Lunar Modules were checked-out in a facility called the Manned Spaceflight Operations Building. Later, the acronym was softened a bit with its new name Operations and Checkout (O&C). The Apollo Command/Service Module and Lunar Module spacecraft were processed in the O&C high bay. Adjacent rooms housed a system called ACE, Apollo Checkout Equipment. KSC developed the concept and architecture for the ACE system. Approved for development in 1962, ACE paralleled ground and flight telemetry and proved itself in prototype phases as early as Cooper's Mercury flight.

This early start enabled concurrent development as the Apollo hardware was designed but also considerable evolution of hardware before configuration was frozen. General Electric (GE) became involved in ACE as part of their overall GSE development responsibilities. GE added to the knowledge base but also introduced conflicts of ideas. The system team weathered these and other storms and ACE became operational in 1964 in support of Apollo 009 build-up in Downey, California, the first unmanned Apollo spacecraft to fly. One key feature of ACE was that the same hardware and software systems were used at the manufacturing facilities (Downey and Bethpage, New York) and at KSC. The ACE system was not only interfacing with systems on the spacecraft and GSE but was also interfacing.
with flight computers. ACE could enter a command to an on-board computer then verify that the internal spacecraft system responded.

**SPACE TRANSPORTATION SYSTEM**
**(1976-PRESENT)**

The Space Transportation System was envisioned to provide “assured and routine access to space.” The concept of the Space Shuttle as a space truck capable of 60 launches per year with 5 vehicles [4] and minimum turn-around time of 10 working days, 2 shifts per day, today seems shockingly aggressive. Plans also included the phasing out of all other heavy launch vehicles, Delta, Atlas, and Titan. These turn-around requirements called for a quantum leap in check-out and launch technology. The central player in this feat would be a new Launch Processing System (LPS) capable of highly automated testing and distributed in the facilities requiring check-out activities, the Orbiter Processing Facility, the Hypergol Maintenance Facility, the VAB, and the Pads. The LPS computers were installed in the Launch Control Center (LCC) where Firings Rooms 1 and 2 were converted for Shuttle operations.

LPS architecture and capabilities were very advanced for the early 1970s when it was conceived. There would be roughly 40,000 inputs and outputs [5]. This I/O is handled by Hardware Interface Modules (HIM) operating (O) or sensing (I) relay contacts and digitizing analog measurements. The data sampling rate was programmable up to 50 kHz per channel. The data streams from each HIM were fed into Front End Processor computers which time-tagged, bundled, and converted data into engineering units. The FEP’s pushed the data into the massive Common Data Buffer (CDBFR) which contained the latest value of all of the LPS discrete and analog measurements and commands. Consoles in each firing room were driven by Modcomp Classic minicomputers, which were architecture based on interrupt programming. The Modcomps consisted of a series of programs which the console operator could activate for displaying data or conducting an operation. The Modcomps fetched the data from the CDBFR for display, and pushed changes to the CDBFR for control. Data was displayed on color CRTs using graphic “skeletons” representing the schematic of the particular system. Consoles were in clusters, each containing a Master Console capable of performing the operations of any of the other consoles for back-up. For example, a console operator could conduct a system test on an Orbiter system in the OIF then switch to testing another Orbiter at the Pad. Programs were written in a new language called Ground Operations Aerospace Language (GOAL). Test sequences were written as a series of near-English spoken language statements and GOAL translated these into machine language.

LPS also handled the complex timing issues associated with interfacing with the 5 Shuttle on-board computers. The Saturn vehicles had primitive sequential operation computers which could handle complex tasks like sequencing the start of multiple rocket engines, but the Shuttle was extremely automated and flown entirely via its computers. Launch preparations are mainly handled by LPS, but the actual launch is controlled by the Shuttle computers requiring a hand-off to the on-board system with sub-millisecond timing precision. This synchronization was a major accomplishment at the time.

The early years of the Shuttle program proved the worth of LPS as each mission showed a declining number of days for process flow (landing to launch). Although schedule pressures were high, the original Shuttle vision appeared to be on track. The Challenger disaster of January 1986 showed that schedule pressure had resulted in a culture of unresolved problems. Before return to flight, every system at KSC, including LPS and instrumentation systems was carefully scrutinized and failure modes re-evaluated. Safe operations, not schedule, would now be the driver at KSC.

Post-Challenger reviews of LPS identified new failure modes and improvements were implemented under a project called LPS Survivability. LPS became a stronger system but unlike cranes, cryogenics, and other ground systems, LPS was fast becoming technically obsolete. The advances in computers and controls over the preceding decade were staggering, including the introduction of micro-computer-based industrial controls and desktop PCs. Obsolescence is measured in many ways, ranging from “how you would design the system today” to the inability to get spare parts. LPS was rapidly becoming obsolete by all these measures. Yet it continued to successfully process the Shuttle and does so to this day. This success is due to many factors, but is, in part, due to significant efforts made to reproduce boards, cards, and components using modern technology; even to the point of proposing to reduce a Modcomp computer to a custom chip! The costs of replacing LPS would be enormous. It pervades all aspects of Shuttle processing at KSC and even if the hardware and software were free, the changes to procedures, verification of each process, and all of the other systems engineering required would be difficult and expensive. A recent project called Extended LPS Survivability has resulted in a new Firing Room 4 where nearly all of the hardware has been replaced with modern, high-reliability equipment.

Two major attempts have been made to replace LPS. In 1989, a contract with Harris Corp. called Core Electronics Contract was initiated then subsequently (1994) cancelled due to Shuttle budget pressure [6]. Harris’ concept was to replace the primary LPS components with custom-built replacements and use custom operating software, although the plan called for porting the existing GOAL application software. Their study concluded that network architectures for large-scale real-time control were not sufficiently mature. However, the largest project to replace LPS was the network-based CLCS (Checkout and Launch Control System), initiated as an “in-house” project. CLCS was to produce a state-of-the-art critical control and monitoring system with an architecture that would allow incremental upgrades and adaptation as technology creates new opportunities, thereby avoiding obsolescence. CLCS took
advantage of significant technology improvements in the three years since Core to base its architecture on secure networks. After making significant progress, this project, too, was cancelled in October 2002. CLCSC was the largest development project taken on by KSC in the Shuttle operations era and its cancellation was, in many ways, regrettable. Since CLCSC, no serious effort has been made to replace LPS, nor would it make sense in the current reality of the phase-out of Shuttle in 2010.

Other limitations of LPS deserve mention. LPS is capable only of discrete control outputs although, in a few cases, ungainly pseudo-analog control was implemented. Needed upgrades to GSE systems and the availability of reliable Programmable Logic Controllers (PLC) increased pressure to add local closed-loop controls. This led to a proposed Integrated Network Control System (INCS) in the mid-1990s. INCS would have implemented PLCs with LPS being relegated to supervisory control and alarm function. The high costs for the system and the competition with CLCSC for funds kept INCS on the back-burner. The catch phrase at the time was “CLCSC without INCS was like a digital dash-board in a Pinto.” The INCS concept has been partially implemented since key aspects can be implemented piece-meal and is expected to play a significant role in the architecture of Constellation GSE controls.

SHUTTLE PAYLOADS AND INTERNATIONAL SPACE STATION
(1991-PRESENT)

To meet tight schedules, payloads had to be fully tested against a Shuttle emulator before transport to the Orbiter Processing Facility or Pad for integration into the Shuttle. Spacelab modules and other cargo were processed in the O&C (horizontal payloads) or the Vertical Processing Facility (vertical payloads) using the Cargo Integration and Testing (CITE) system. CITE, actually part of the LPS, verifies that the GOAL software written for that particular payload was verified so that when the cargo left the processing facility it had been fully checked-out and operated, as if installed on the vehicle.

In the post-Challenger era, the Partial Payload Checkout System (PPCU) was developed as a sophisticated, flexible, and distributed check-out system for Space Shuttle’s widely diverse assortment of payloads. PPCU was first installed in 1989 and primarily consists of off-the-shelf hardware and software. The first version of PPCU was based on VME and Ethernet technology. PPCU was network-based which allowed it to be more easily upgraded to keep pace with changing computer technology and payloads technologies.

The nature and volume of Shuttle payloads associated with the construction and logistics of the International Space Station stimulated a new era of growth in KSC engineering and operational requirements. These included building the Space Station Processing Facility (SSPF) and its myriad of specialized ground support systems. The challenge was to process and check-out some of the most complex

Fig. 4. Artist’s conception of the launch of Ares 1 carrying the Orion crew vehicle
(Image Courtesy of ASRC, KSC)

system was activated in the mid-1990s. Originally, the Program envisioned that ISS elements would arrive at KSC requiring minimal processing. Since there would be very little interfacing to the Orbiter, minimal pre-launch check-out would satisfy reliability requirements (“ship and shoot”). The KSC payloads community dissuaded the Program of that notion and showed that a check-out system was required that would verify the near-perfect functionality of ISS modules as they were mated in orbit. TCMS answers this need and has.
identified many discrepancies that would have required hardware to be returned from orbit for repair, and landing a fully-loaded Orbiter is not something that is particularly desirable.

CONSTELLATION
(PRESENT AND FUTURE)

Large-scale, secure, real-time control systems can now be implemented using primarily commercially-available equipment and software platforms. This is expected to significantly reduce the cost of processing the Orion spacecraft and Aries I booster (Figure 4). KSC is currently designing these systems.

The Shuttle ground systems were implemented by a team that had, in 15 short years, designed and activated ground architectures for Mercury/Redstone, Saturn, and Saturn V. With few exceptions, members of today's KSC workforce have spent their entire careers enhancing existing Shuttle and payload operations. Today, we face the challenge and opportunity of developing completely new processing architectures for new vehicles. The next several years promise to be very exciting as the post-Apollo generation grapples with these big issues and confronts the kind of challenges successfully overcome by our predecessors, but in a completely different digital age.

ACKNOWLEDGEMENTS

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Ultraspectral Imaging:  
A New Contribution to Global Virtual Presence

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ABSTRACT

A new technology, Ultraspectral Imaging (USI) offers the capability to extend spectral imaging to a level where molecular adsorption or emission line features can be presented in a two-dimensional display. With these capabilities, unambiguous identification and mapping of gaseous constituents or solid material by their spectral features becomes possible. One of the techniques that shows the potential to collect these type of data is a proposed USI-based on a Fourier transform ultraspectral imager operating in the 3 μm to 5 μm and 8 μm to 12 μm bands designed for installation in an aircraft. This proposed instrument will have a 15 degree field of view (FOV), with an instantaneous field of view (IFOV) of 1.0 mrad. The target spectral resolution is better than 1.5 cm⁻¹ over 2000 to 3000 cm⁻¹ and 0.4 cm⁻¹ over 850 to 1250 cm⁻¹ using 512 spectral channels. The device will use a variety of spectral enhancement techniques to achieve this unprecedented spectral resolution. Computer simulations of the optical systems demonstrate subwavenumber resolutions and signal to noise ratios of over 900.

INTRODUCTION

As current hyperspectral imagers become accepted tools for the remote sensing community, a small but growing portion of the community is seeking finer spectral resolution [1]. Current hyperspectral imagers typically have hundreds (50 to 500 bands) of 5 to 10 nm spectral bandwidths. A new generation of hyperspectral instruments called ultraspectral imagers is now being developed to satisfy this growing demand for increased spectral resolution. These devices have sufficient spectral resolution to allow molecular absorption or emission bands to be imaged in two dimensions from moving platforms.

Today, no technology offers medium wave infrared (MWIR) and long wave infrared (LWIR) ultra high resolution passive spectral imaging from a moving platform or observation of a time changing scene [2]. Kestrel Corporation has started developing infrared (IR) ultraspectral imagers based on the advantages of Fourier transform imaging spectrometry (FTHSI) technology. We are currently investigating techniques to create wavenumber spectral resolution over a broad spectral band with milliradian spatial resolution, in a passive sensor that is not sensitive to temporal changes or observation platform motion.

As an example of what can be resolved, Figure 1 illustrates the spectral resolution required to identify specific lines of a typical hydrocarbon gas, benzene. The limits of current instruments represented by a grating type hyperspectral sensor (HSI) [3], and a 100 cm⁻¹ hyperspectral device such as Kestrel’s FTHSI are noted [4]. As this figure illustrates, a sensor with better than 2 cm⁻¹ resolution is required to positively identify this specific molecule. Coarser spectral resolutions are not capable of unambiguous typing.

With an ultraspectral imaging capability, unique material identification mapping could be conducted rapidly over a wide search area. This capability would reduce the dependence on multiple data sources, simplifying data fusion. Improvements in target detection, target typing, and discrimination against backgrounds increase rapidly as the spectral bandwidth is decreased to the width of molecular lines. The reasons for these improvements are two-fold. First, with molecular feature resolution, an ultraspectral imager can isolate a specific material’s signature, replacing cross-correlation search techniques with a simple fitting algorithm [5]. Second, for highly mixed backgrounds and targets that are spatially smaller than a pixel, more and better defined end members can be determined to improve sub-pixel unmixing [6].

These advantages are well-known and documented using non-imaging sensors, such as Bomen’s Michelson spectrometers, and form the basis for all laboratory level spectrometry. The difficulty with these sensors is their lack
BACKGROUND

Use of spatially modulated Fourier transform spectrometers (FTS) for airborne remote sensing provides several advantages, optical efficiency and decoupling of spatial and spectral resolution being two of the most important [7]. Another advantage of FTS systems is that they are constant wavenumber devices that create data over the light full spectrum. However, this advantage implies that there is data that correspond to frequencies of light that the sensor cannot detect. A spectral slice, shown in Figure 2, from our FTHSI instrument operating in the ultra-violet to near-infrared (UV/NIR) illustrates this problem. Spectral bins between 0 and 65 correspond to infrared wavelengths which the silicon detector cannot sense. Also, with the configuration shown, some spectral resolution is lost because the Nyquist cut-off frequency was not properly matched to the UV cut-off of the detector. By properly setting up the interferometer, the spectral bins on the right in Figure 2 can be utilized, improving the spectral resolution of the system, but the spectral bins on the left can never be utilized in traditional FTS systems.

Okamoto, et al. [8] investigated an approach to improve the spectral resolution by recovering the spectral range from zero wavenumber to the IR limit of the detector. They introduced a dispersive block that allowed the amount of shear in the interferometer to be a function of wavenumber. A drawback of the dispersive block enhancement technique is that the system no longer operates with constant wavenumber increments. Thus, blue wavelengths have a much smaller bin size than red wavelengths. The underlying principle being used is the wavelength dependent dispersion in the block that spread the apparent sources coming out of the interferometer. Properly set-up, the distance between the red sources coming out of the interferometer is zero or near zero, while the blue sources have a distance that maximizes the source separation. By adjusting the angle, mirror offset, and the thickness of the block, the range of wavelengths covered can be optimized for the visible wavelengths.

The ability to tailor the bins in which the shortest and longest wavelengths reside allows us to apply the Nyquist criteria to only the band of interest. This characteristic is a significant improvement over conventional FTS that must apply the Nyquist criteria from the blue cut-off to zero wavenumber. In addition, by tailoring the upper and lower
Regions lost due to not being able to tailor the sampling over a specific band.

Fig. 2. Example of lost resolution in a conventional FTHSI

To demonstrate the effectiveness of the modeled dispersive block spectral stretching technique, laboratory measurements using a glass block of Schott SF11 inserted between the two mirrors of the interferometer (the hypotenuse) were made. A 1.1 cm thick block with parallel sides was used with the block being inserted at various angles (1° to 45°) to change the amount of dispersion. A sketch of the interferometer and a picture of the laboratory set-up is shown in Figure 3.

The experimental spectral resolution was determined by measuring the number of bins between five separate spectral peaks obtained by looking at the green helium neon (HeNe), red HeNe and the three most dominant lines from a Krypton discharge lamp. The general conclusion is that the dispersive block works as anticipated. Spectral resolutions improved as the dispersive angle was increased and showed the expected dependence on wavelength. We observed a spectral resolution increase from 512 cm⁻¹ to 92 cm⁻¹ in the blue/green, over a factor of five improvement, Figure 4.

While the dispersive block clearly improved the spectral resolution of the system, several major drawbacks are associated with the approach. The instrument is no longer constant in wavenumber, but instead follows a quadratic relationship between spectral channel and wavenumber. In addition, this technique would be difficult to implement in an imaging device, because the dispersive block introduces unwanted chromatic dispersion in the spatial dimension. This effect can be corrected in other optical elements, but if the user wants to adjust the instrument to operate over other spectral ranges, then the optical system would need to be re-optimized.

We have adapted Okamoto et. al.'s spectral resolution enhancement technique to correct for the two drawbacks noted above. A sample of the increase in spectral resolution that can be obtained is shown in Figures 5, 6 and 7. This design approximates that which would be used in an actual ultraviolet design. The array size was assumed to be 512, 30μm x 30μm, detectors. The minimum and maximum wavenumber were assumed to be 800 cm⁻¹ (12 μm) and 1250 cm⁻¹ (8 μm) for Figure 5, 950 cm⁻¹ (10.5 μm) and 1000 cm⁻¹ (10 μm) for Figure 6, and 2000 cm⁻¹ (5 μm) and 3300 cm⁻¹ (3 μm) for Figure 7. The relationship between wavenumber resolution and bin number is non-linear as illustrated in Figure 6, where it follows roughly a quadratic relationship. However, by re-optimizing the design, the non-linear nature can be virtually eliminated, as shown in Figures 6 and 7. All the bins have a better spectral resolution than a system without any spectral improvement (Δσ = 6.4 cm⁻¹ for the MWIR case and 2.4 cm⁻¹ for the LWIR sample). Note that a slight variation occurs in the resolution increase; for the
Fig. 4. Measured increase in spectral resolution as a function of the amount of dispersion added in the long leg of the interferometer.

Fig. 5. The spectral resolution as a function of the wavenumber for an LWIR design. The horizontal line represents an equal division of the spectral band by the number of available bins, which is the best resolution possible given the number of spectral channels. Longer wavelengths (smaller wavenumber) the enhancement is greater than for shorter wavelengths.

These plots illustrate the spectral performance that can be expected. The systems modeled in Figures 5 through 7 can be adjusted to operate in any spectral region that the detector supports, without needing to re-optimize the optical train. This technique allows the existing optics design envelope to be retained and maintains the large chromatic band of the sensors. This technique is significant in our concept for an ultraspectral design.

CONCEPTUAL DESIGN

Conceptual designs for a MWIR and LWIR ultraspectral sensor have been completed using the spectral enhancement technique discussed earlier. The designs were carried through optical raytrace, mechanical packaging, and performance estimates. Our approach uses a custom design based on both reflecting and refractive optics. Note that we expect to be able to make most of the MWIR optics out of refractive material while the LWIR portion of the sensor will be a reflective design. These preliminary designs do not include second order effects, specific material emissive properties, chromatic effects, beamsplitter polarization splits efficiencies, and diffraction effects from finite element optics or the various optical stops employed. A conceptual design of the mechanical configuration is shown in shown in Figure 8. The overall size is governed by the commercial electronics and liquid nitrogen dewar. The compact size of the optical system makes this an ideal package for a small satellite.

At the system level, our concept design retains the same general arrangement as our existing hyperspectral [9] and multispectral [10] data managers, supporting data sources and controller functions. This concept has been implemented several times and has proven to be both effective and robust.
that the expected spectral resolution of the two sensors is very good and exceeds the performance goals.

To estimate the radiometric performance and signal to noise for the two proposed designs we have used HIMP modified for IR and ultraspectral capability. We used a baseline scenario of the sensors operating at an altitude of 2.0 km observing in a nadir direction. MODTRAN3, with a 1976 US Standard day, rural, 5 km visibility, no clouds or rain, and a surface albedo of 0.40 was used to generate the radiometric input. Note that this baseline configuration has not been optimized or tailored to a specific set of requirements.

Three types of output were generated. The first was used to determine how well the sensor performed optically by looking at the predicted interference pattern. Next, the ability of the sensor to replicate the input spectra was checked by comparing the input to the output spectra. Last, the predicted signal to noise was calculated.

The results of this performance analysis for the proposed 3µm to 5µm and 8µm to 12µm sensors, respectively, are shown in Figures 9 through 11. The predicted interference patterns are shown in Figure 9, the input versus measured spectra in Figure 10, and the predicted signal to noise in Figure 11. Several conclusions can be drawn from these data. The optical performance is as expected with a symmetric well-defined interference pattern and minimum aliasing, and the spectral resolution and reproduction of the input spectra is very good for both sensors. Last, the signal to noise varies from being acceptable in the MWIR to being excellent in the LWIR. The lower signal to noise in the MWIR is the result of a very reduced input signal. These MWIR data also show the strength of having the HIMP model to tailor a design. In this case, the HIMP analysis suggests that the MWIR sensor should be set up to have a 3.3µm to 5.0µm operating band to improve overall performance by avoiding the lower signal to noise (SNR) data in the 3.0µm to 3.3µm band. The lower SNR for the MWIR is the result of our selection of detectors and the low amounts of light flux in this band. The SNR can, unlike diffraction systems, be increased dramatically by opening the field stop in the system without changing the spectral resolution.

CONCLUSIONS

Herein, we have presented a new class of imagers that have extremely high spectral resolution. We have dubbed these new imagers ultraspectral, since they allow sub-wavenumber spectral resolution, while maintaining two-dimensional imaging. Both of these imagers have impressive spectral characteristics and excellent signal to noise ratios, exhibiting improvements of over a factor of five. These imagers can also be adjusted to provide tenth wavenumber resolution over smaller spectral ranges. With these ultraspectral imagers, individual molecular absorption or emission characteristics are observable, improving target identification.
Fig. 9. Predicted interference pattern for the proposed MWIR (left) and LWIR (right) ultraspectral imager

A sensor with these capabilities has several implications to global virtual presence. First, the scope of what can be presented to a virtual situation display can be increased to include airborne compounds, the spread of pollutants, and hazardous materials mapping. Second, USI offers an opportunity to improve classification through a more precise representation of the spectral signature. USI also illustrates the need to be able to convert vast amounts of data into usable information quality. The sensors described herein produce data at very high and detailed rates. While these data contain a wide breadth of information, they also have imbedded an equally large amount of data that is not relevant to a particular scenario.

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Fig. 10. Predicted spectra compared to the input spectra for the proposed MWIR (top) and LWIR (bottom) ultraspectral imager

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Computer Course in the Applied Theory of Gyros

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ABSTRACT

The fundamental methodical aspects and the gained practical experience of creating and using computer technologies in teaching the applied theory of gyroscopes are considered. Possible contents and the important features of the computer course are presented. The computer course is based on the papers dealing with various kinds of modern gyro sensors presented at the I-XIV International Conference on Integrated Navigating Systems.

INTRODUCTION

Modern requirements are extremely high for research and educational courses connected with the exact sciences (theoretical mechanics, the theory of gyroscopes and accelerometers, mathematical simulation in instrument engineering, etc.). Both the subject matter and the form of the presentation of theoretical theses and practical examples in such courses are rather complicated.

On the other hand, the available conventional and specialized software and tools provide sufficient means for training not only by using "chalk and blackboard," but also a computer, a multimedia projector and a screen.

The purpose of this work is:

- to provide training of scientifically educated, highly-qualified experts, designers, and creators of modern gyroscopic and navigation devices.

Key problems are:

- to essentially improve the training effectiveness and optimization of time and the quality of mastering the complicated scientific and training materials of the applied theory of gyroscopes;

- to develop a new approach and technique of using of the theoretical and practical tools, computer technologies; and

- to create the necessary multimedia software.

The Proceedings of the I-XIV International Conference on Integrated Navigating Systems, in particular, the papers dealing with modern gyro sensors of various modes of functioning were used as a basis for the creation of the computer course in the applied theory of gyroscopes [1,2]. This considers the content of a possible computer course, the main methodical aspects and the practical experience in using computer technologies for teaching this course to students of Electronic Engineering and Instruments Making Faculty of Saratov State Technical University.

The computer course in the applied theory of gyroscopes is about 34 hours long. The course consists of three parts:

1. Fundamental theses, theorems and equations of theoretical mechanics, the theory of heat transfer, the theories of elasticity and thermal elasticity, acromechanics, hydromechanics and optics used in the applied theory of modern gyroscopes.

2. The essential physical principles of functioning of the main types of gyroscopes (gimbaled, floated, dynamically-tuned,
Electrostatic, hemispherical resonator, micromechanical, fiber-optical gyroscopes).

3. Special problems of the theory of disturbed gyroscopic sensors.

Part I (~6 hours) provides the fundamental definitions of theoretical mechanics, such as the angular momentum and kinetic energy of a solid body at spherical motion, Resale’s theorem, Euler’s dynamic equations, Lagrange equations, etc., as well as the application of these definitions to the conclusion of gyro motion equations.

Part 2 (~24 hours) considers all main types of gyroscopes following the same procedure: mode of functioning, design, mathematical models, and research problems.

Part 3 (~4 hours) presents some modern special problems of the theory of gyroscopes; for example, problems of the occurrence of the determined chaos phenomenon in non-linear
Fig. 3. Examples of presentations to be printed and handed out

temperatures – disturbed dynamic systems containing measuring and damping gyros.

The basic features of the suggested techniques of training are as follows (Figure 1):

1. *The material of the course* is presented as the set of PowerPoint presentations.

2. *The course allows for computer mathematical simulation and three-dimensional dynamic visualization of principles of operation and the equations of motion for all basic types of gyroscopes* (Figure 2).

The special software was developed for dynamic visualization with the use of Borland C++ Builder integrated development environment and the graphic interface library-Open GL. The special software can be run directly from PowerPoint presentations by means of hyperlinks.

It is mathematical simulation and three-dimensional dynamic visualization that allow demonstrating the operation of the gyroscopes under consideration and studying the effects of gyro parameters, and exterior and interior actions on their functioning.

3. *Complicated pictures, formulas, photos, graphs, tables, homework, the curriculum of the lecture course, can be printed out and produced to students in the class as handouts* (Figure 3).

4. *A laptop and a multimedia projector with sufficient image brightness are used for presentation.*

**ADVANTAGES OF THE OFFERED APPROACH**

Flexible and effective management of the scientific and teaching content of the course which allows any component to be added, changed, or removed from the course.
The possibility of demonstrating (in the form of photos, movies, presentations, etc.), practical constructions of gyroscopes, and the process of their operation, documents, historical, and other materials.

The possibility of connecting to the Internet in on-line or off-line modes to obtain the necessary remote electronic data; for example, conference Proceedings.

Application of the developed techniques and software for training allows solving the following important pedagogical tasks.

- **For students** –
  it is the profound learning, comprehension and mastering of complicated material, increase of interest to the object of research and the possibility to become aware of the latest achievements in the applied gyroscopic theory.

- **For the lecturer** –
  it is the optimization and increase of training efficiency, the support of the material visualization.

On the whole, application of the described method is supposed to help solve the important task of training scientifically educated and highly-qualified experts, designers, and creators for modern gyroscopic and navigation devices.

**DIFFICULTIES AND REQUIREMENTS**

The main difficulties are high intellectual and labor-intensiveness long time needed to develop the scripts for the course, design and create presentation slides, develop specialized software for dynamic visualization. It is necessary and desirable to limit the number of students in a group (<15-20).

The main hardware requirements are:

- A multimedia computer (preferably a laptop) must be powerful enough to show photos, movies, presentations, etc., the one that can be connected to the Internet;

- A screen should be large enough to be in view from any point of the lecture room; and

- A multimedia projector should have sufficient image brightness and contrast even in bright daylight.

**FUTURE**

Development of new theoretical, methodical, and software-based materials for training and realization of practical, computer graphic and research laboratory works for basic and special contemporary courses in the theoretical mechanics, mathematical simulation in instrument-making, the general theory of gyroscopes and accelerometers, methods of maintenance of the thermal invariance of micro-electromechanical systems.
Evaluating Aircraft Pilot – Navigational Equipment in Flight Tests

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ABSTRACT

The specialists at M.M. Gromov Flight Research Institute (FRI) have developed special techniques and facilities to evaluate the aircraft pilot – navigational equipment for conformance to specified requirements. On-board trajectory measurement complex equipment is used for data recording and determination of actual values of trajectory parameters. The parameter values are obtained using the differential mode of the satellite navigation system. The flight test process is monitored at the flight test control center. The use of a test-bench and simulation complex allows reducing the scope and costs of flight tests. Flight test data are transmitted to the specialists for processing via local computer network on the day of flight tests. This covers the description of facilities used for testing pilot – navigational equipment of new aircraft at the M.M. Gromov Flight Research Institute.

FLIGHT TESTS AS A FINAL STAGE OF PILOT – NAVIGATIONAL COMPLEX DEVELOPMENT

Pilot-navigational equipment (PNE) of an aircraft is continuously upgraded to meet the enhanced requirements for course line tracking accuracy, increased flight safety, and improved comfort during flight. Generally the pilot – navigational equipment forms a Pilot – Navigational Complex (PNC). The number of tasks set for the pilot – navigational complex as well as requirements for the execution of each task are constantly increasing. The pilot – navigational complex of a modern aircraft is composed of a variety of instruments and systems. A Satellite Navigation System (SNS) receiver integrated into the complex has supported a significant increase of navigation accuracy, and therefore, expanded a range of tasks to be executed.

The development of the pilot – navigational complex for a new aircraft, which meets all the requirements, is a long-continued process. Flight tests are the final stage of the complex development. During this stage, the complex is checked for conformance to the specified requirements.

OTMC IS AN INSTRUMENT FOR RECORDING AND DETERMINING TRAJECTORY PARAMETERS DURING FLIGHT TESTS

In order to test the pilot – navigational equipment the specialists at M.M. Gromov FRI employ special facilities and instruments. In recent years, a versatile On-board Trajectory Measurements Complex (OTMC) [1] has been widely adopted for aircraft flight tests. The complex is designed to execute the following tasks:

- Determination of actual values of trajectory parameters;
- Recording of data from on-board systems;
- Synchronization of the trajectory parameters and data from on-board systems; synchronization error is < 3 ms; and
- Evaluation of operation and determination of accuracy characteristics of on-board systems in the real-time mode and by post-flight processing.

For flight test purposes, a Base Reference Monitoring Station (BRMS) is mounted in the test airfield area and its SNS receiver’s antenna is positioned at the point with known geodetic coordinates. Post-flight processing of the OTMC
Fig. 1. Scheme of the OTMC instruments application for flight tests, MCU – Laptop-based Monitoring and Control Unit

data gathered during the flight from a built-in SNS card and the BRMS data generates high-accuracy parameter values provided by differential SNS based on code and phase measurements [2]. The values of trajectory parameters adopted as true ones when evaluating the on-board flight and navigation instruments and systems, are calculated at a required frequency by integrated processing of differential SNS data and on-board INS data recorded by OTMC. The scheme of the OTMC instruments application for flight tests is given in Figure 1.

FLIGHT TEST MONITORING AND CONTROL

The flight Test Control Station (FTCS) has been developed at FRI to monitor the process of flight tests. Data from the on-board systems and trajectory data related to an object under test are delivered to FTCS from the measuring system via telemeter data communication channels. The FTCS computer system is composed of a local network of personal computers which serve as workstations for the specialists of a control group. FTCS executes the following tasks:

- Measurement data processing;
- Computer-aided control of data quality;
- Control of aircraft status and status of its instruments and systems;
- Control of test conditions; and
- Data display in a format convenient for online analysis and decision-making.

The analysis of current information on a status of aircraft and operation of its main systems made by the specialists at FTCS as well as a possibility of efficient intervention in the flight process ensure a significant improvement of the flight test efficiency while maintaining a high level of safety, and the reduction of the test time period.

APPLICATION OF AUXILIARY SIMULATION, FLYING AND DYNAMIC TEST BENCHES

In order to reduce the scope of flight tests, to practice and analyze separate phases of flight and to gather statistical data an auxiliary simulation is applied. One of the facilities available at the FRI test center is the pilotage and landing test-bench and simulation system which is used for practicing pilotage tasks related to landing in poor weather conditions, for designing and testing indication and control systems, and for training the flight personnel.

In order to reduce the flight test time period, flying test benches laboratories are employed. The flying test benches may be based on various types of aircraft modified and adjusted for testing. For instance, the flying test benches at FRI, based on the Tupolev TU-154 and Sukhoi SU-30
aircraft, are employed to perform a variety of comprehensive studies and tests of high-accuracy radio, satellite, inertial, and inertial/satellite systems.

A car-based mobile test bench allows reducing the costs of testing new navigation facilities. A specially equipped car (MBCS) is employed at FRI to perform preliminary tests of satellites, inertial and inertial/satellite navigation systems. A laboratory compartment of the car accommodates the instruments and systems under test and OTMC which records parameters of the instruments and systems under test and provides high accuracy determination of trajectory parameters [3].

POST-FLIGHT PROCESSING OF TEST DATA

Immediately after each test flight, the OTMC database is transmitted to the local computer network server by means of the laptop. A file containing the SNS receiver data gathered during the flight by the ground BCS is transmitted to the server, too. Using specially developed software, the server provides the generation of differential SNS data, integrated data processing, and the conversion of the aircraft trajectory parameters into topocentric coordinate systems.

Fig. 2. Scheme of flight test data processing:

APC - Aircraft Performance Characteristics
PCS - Pilotage Computer System
RE - Radio Equipment

TLC - Takeoff and Landing Characteristics
ASP - Airspeed Parameters
ACS - Automatic Control System

The specialists who perform data processing for each system of the aircraft PNE receive the flight data file via the local network. Each frame of the file contains the following information:

- Greenwich time;
- Required aircraft trajectory parameters; and
- Required parameters of on-board systems.

Special methodology support and software have been developed for the evaluation of each system. The processing results for each system are transmitted to the server from the specialists' workstations, discussed with the supervisor and included in the report upon approval.

The general scheme for flight test data processing of the aircraft PNE is given in Figure 2.

Over the past 10 years, the above-stated technique has been employed to test the pilot navigation equipment of various types of aircraft such as Ilyushin IL-96-300, IL-114, Tupolev TU-204-300, TU-214, Beriev BE-200, Sukhoi SU-30 MKI, Mikoyan MiG-29 SMT.
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History

The 2009 IEEE Conference on the History of Technical Societies

5-7 August 2009  •  Philadelphia, PA, USA

In 2009, the IEEE History Committee and the IEEE History Center held the eighth in a series of historical conferences. The 2009 IEEE Conference on the History of Technical Societies took place in Philadelphia, Wednesday, 5 August through Friday, 7 August 2009. The conference theme was The History of Professional Technical Associations, a theme chosen because 2009 is the 125th anniversary of the IEEE. The location is appropriate because the IEEE, the American Institute of Electrical Engineers, was founded in Philadelphia.

We invited papers on the history of the engineering profession, particularly on the role of professional societies in engineering, with emphasis on the technical fields served by IEEE. The historical papers were presented in focused sessions over the two-and-a-half days in two tracks, though there were one or more plenary sessions. The papers written for the conference were a valuable contribution to researching the history of engineering organizations, a topic that deserves more attention than it has received. In connection with the conference, there was an IEEE anniversary celebration at the Franklin Institute on Thursday, 6 August from 6:00 pm until 11:00 pm.

IEEE History Center Newsletter Available Online

The latest issue of the IEEE History Center newsletter is available online at:

The issue includes the following stories:

• IEEE Global History Network
• 2009 Conference Announcement on the History of Technical Societies
• Adaptive Reuse of Old Power Generating Plants (Things to See and Do)
• Relic Hunting – artifacts and infrastructure from Edison’s Pearl Street System
• Reminiscence – First Photolithographic Transistor Fabrication

To receive a free paper copy of this and future editions of the newsletter, e-mail your name and address to: ieee-history@ieee.org.

The IEEE History Center Newsletter welcomes submissions of Letters to the Editor as well as articles for its Reminiscences and Relic Hunting Departments.

Reminiscences are accounts of history as a technology from the point of view of one who worked in the technical areas or was closely connected to someone who did. They may be narrated in first- or third-person.

Relic Hunting are accounts of finding or tracking down tangible pieces of electrical history in interesting or unsuspected places (in-situ and still operating is of particular interest).

Length 500-1200 words. Submit to: ieee-history@ieee.org.
Articles and Letters to the Editor may be edited for style or length.
Inertial Measurement Units on Micromechanical Sensors

State Research Center of Russia - CSRI Elektropribor

ABSTRACT

This presents a micromechanical gyroscope (MMG), an inertial measurement unit (IMU) based on MMG and an integrated inertial-satellite attitude and navigation system (IANS) developed in CSRI Elektropribor. The evolution and prospects for the development of MMG main components and MMG-based systems is considered. The test results are given.

INTRODUCTION

A micromechanical gyroscope (MMG) with a disc-shaped inertial mass has been developed in the CSRI Elektropribor jointly with TRONIC'S Microsystems (France) since 2001. The key achievements of the first three years are as follows: the process for manufacturing MMG micromechanical silicon sensors, sealed in a high-vacuumed ceramic case was elaborated and special breadboard electronics was developed which provided experimental verification of the sensor serviceability and its conformance to the design accuracy [1]. In recent years, the designers have focused on elaboration of both the electrical and mechanical parts of MMG, on creation of an MMG-based inertial measurement unit (IMU) and integrated inertial satellite attitude and navigation system (IANS). The development of MMG is aimed at designing an unpackaged micromechanical sensor, special capacity-voltage converter, and microcontroller, all implemented on a single microchip. On the way to this chip some new modifications of MMG have been designed which comply with the requirements of different applications and are suitable for batch production. The existing MMG modifications were used in IMU and IANS with a built-in SNS receiver, which are intended for broad application on land vehicles, small vessels and boats, airplanes, and unmanned aerial vehicles. IMU and IANS design and software are considered. The results of the laboratory and car tests are given.

Fig. 1. MMG principal diagram:
первичные колебания
systema разгонна
диск

secondary колебания
systema съема

C_f

C_t

f_1

f_2

Ω

MICROMECHANICAL GYROSCOPE

MMG comprises a vacuumed silicon module (VSM) containing a micromechanical silicon sensitive element (MSE), and microelectronic systems that read out the measured parameters and control the motion of the gyroscope proof mass. MSE is built on the principle of a vibrating RR-type gyro with a disc-shaped inertial mass in internal torsion suspension, electrostatic excitation of primary oscillations, and capacitive pick-off (Figure 1).

The micromechanical element is packaged in a high-vacuumed sealed case (Figure 2).
MSE design implements the Silicon-on-Insulator (SOI) technology. More than one-thousand VSM were manufactured by TRONIC’s in accordance with Elektroproibor’s specifications in 2005. The tests showed that 96% complied with the requirements in all the checked parameters. The tests repeated in March 2008 proved that 136 of 150 checked VSM (more than 90%) were serviceable.

By now, two MMG modifications, both based on VSM but with different electronic parts and case structure have been developed and have passed the tests (Figures 3 and 4). Electronic components of the first MMG modification are arranged on three rectangular electronic boards; 21 × 35 mm in size. The major functions are divided between the microcontroller and the functional nodes on analog electrical elements. Electronics of the second MMG modification together with VSM is arranged on a round board 50 mm in diameter. All of the operations except the capacity-voltage conversion are realized in the digital form, which makes the MMG design more compact and reduces its power consumption up to 0.6 W. Interface range for communication with the users is extended: apart from RS-232, there is an output via CAN interface provided and an analog voltage output. MMG-2 is installed in a solid metal case. The device is connected to the external mains via plug connection.

Specifications of both modifications are presented in Table 1 for the measurement ranges ± 100°/s and ± 1000°/s.

The development of MMG-1 and MMG-2 is completed. The gyros are ready to be produced in small batches. The further research is intended to improve MMG performance and enable large-scale and mass production. The research involves the development of the MMG electronic part mostly, but also refers to MSE. One of the key MSE improvements is the change of rotor elastic suspension (Figure 5). The elastic elements in the suspension have a zig-zag shape, and the leg of the elastic element enclosed in the inertial body (disc) is located non-radially [2]. It makes the suspension equally rigid in the plane OX₀, X₁. The axis OX₀ is an axis of secondary oscillations. The turn angle γ of the segment of the elastic element can be changed to precisely adjust the suspension according to the translational rigidities and relevant frequencies.

With γ = 7°, the suspension parameters provide high resistance to translational vibration. The elastic response non-linearity of this suspension is 200 times less as compared to that of the suspension with straight elastic elements applied in the first MSE [1].

Well-known is the problem of reduction and compensation for the “zero signal” at the MMG output on an immobile base. The zero signal can be presented by two components.

The first is in phase with the signal caused by the base rotation; the second, called the quadrature error, is phase-shifted by 90° relative to the previous. As a rule, it is this component that prevails and can exceed the range of the measured angular rate. To solve this problem, a new 6-electrode MSE structure was offered. Due to the new design, under the rotor oscillations about the axis OX₀, the moment in phase with the quadrature error is generated to reduce the error. The method is based on using the MMG rotor itself as a modulator. This idea as applied to RR-type MMG was proposed in [3], but it was realized using the additional electrodes arranged beyond the rotor periphery, which enlarged the area occupied on the chip by more than 2 times. Arranging the electrodes above the rotor tooth zone [4] allows the quadrature error to be reduced down to 300%/s without enlarging the occupied area. The results of the experiment on quadrature error reduction performed on two VSM are presented in Figure 6. It shows, in particular, the change of the zero signal amplitude of each VSM vs. control voltage. The quadrature error is totally suppressed with the...
Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MMG-1</th>
<th>MMG-2</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>±100 / ±1000</td>
<td></td>
<td>°/s</td>
</tr>
<tr>
<td>Conversion factor</td>
<td>10/1</td>
<td></td>
<td>mV/°/s</td>
</tr>
<tr>
<td>Noise density</td>
<td>&lt;0.1 / &lt;0.3</td>
<td></td>
<td>°/s√VHz</td>
</tr>
<tr>
<td>Scale factor nonlinearity</td>
<td>&lt;0.5</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Bandwidth (-3 dB)</td>
<td>40</td>
<td></td>
<td>Hz</td>
</tr>
<tr>
<td>Output</td>
<td>Digital</td>
<td>Digital Analog</td>
<td></td>
</tr>
</tbody>
</table>

control voltage 3.5 V in the first VSM and with 4.0 V in the other. In both VSM further increase of control voltage causes the error phase to change to the opposite and its amplitude to grow.

The improvements introduced in the experimental MMG made it possible to achieve the sensitivity threshold of 0.01-0.02°/s, as it is presented in Figure 7, which shows the responses of the experimental MMG and Analog Devices gyroscope ADXR5 150 to the stepwise (0.05°/s) change of the test table rotation rate.

The development of procedures and techniques for production of the “wafer-level” vacuum micromechanical silicon element which does not need any ceramic case, like the one used in VSM, is coming to completion. At the same time, work on creation of a specialized ASIC to replace the existing electronics is in progress. The work is aimed at creation of MMG about 1 cm³ in volume, featuring 0.01°/s accuracy class and minimum power consumption, suitable for mass production.

INTEGRATED ATTITUDE AND NAVIGATION SYSTEM

The achievements in the MMG development made it possible to create an IANS-based on MMG. This stage was preceded by the development of an experimental IMU on micromechanical accelerometers ADXL 105 and Analog Devices gyro ADXR5 150 and further development of the experimental IANS. The latter comprises an experimental IMU and an electronic board (Figures 8A and 8B). The electronic board is built on the Texas Instruments signal processor TMS320F2810. It is intended for integrated processing of data from inertial sensors and SNS receivers to provide the users with attitude and navigation parameters. The board receives analog signals from the IANS inertial sensors and digital signals from the external SNS receiver. The error of analog signal conversion is about 0.03% with the sampling frequency of 1 kHz. IANS is fed from 5V dc power supply. Power consumption is 2 W. With the data received

Fig. 5. Equally rigid planar elastic suspension

Fig. 6. Quadrature error reduction
In the car tests, a FOG-based IANS was installed as a reference on the platform with the MMG-based experimental IANS. Both systems used the data from the satellite receiver Ashtech GG-24. Apart from direct comparison of output data from two IANS in real-time, raw data from the micromechanical inertial sensors and from the SNS receiver obtained during the tests were post-processed jointly in the office. It allowed the developers to elaborate the parameters of stationary filters used in the IANS experimental software and estimate the possibility and expediency of employing more complicated Kalman-type algorithms for the tightly-coupled integrated systems.

Figure 10 shows the readings of the experimental IANS (continuous line) and the reference IANS (dotted line) car pitch (top) and roll (bottom) angles during the motion along the route shown in Figure 11. RMS deviation of the readings for the motion along the route shown in Figure 11 has made 0.3° in pitch and roll angles, 2.0 m in position, 0.25 m/s in speed components.

from SNS receivers at a rate of 1-2 Hz, IANS outputs the navigation and attitude parameters to the users at a frequency of up to 500 Hz.

The developed real-time software, based on Elektropribor’s recent experience, realizes the algorithms of loosely-coupled integrated systems with stationary filters borrowed from the FOG-based IANS. Post-processing of raw inertial and satellite data involved the simulation of on-board algorithms, along with the algorithms of Kalman filter for the tightly-coupled systems.

The experimental IANS was tested on dynamic test beds and on the car.

Figure 9 presents the results obtained in testing the experimental IANS on the oscillation test bed. The upper diagram shows the current values of oscillation angles from the test bed pickoff (dotted line) and from IANS (continuous line). The lower diagram shows the difference of these values. The laboratory tests have shown that the leveling errors did not exceed 0.5° for the case of the stationary base and the base coning motion with amplitude up to 10°. The error in keeping the azimuth direction did not exceed 0.05°/s.
Fig. 10. Car pitch and roll angles measured by the model and reference IANS

The micromechanical IMU was also tested on a car using SNS receiver Kotlin 201M developed by the JSC Russian Institute of Radionavigation and Time (RIRT). During the tests, radial ranges and speed values, as well as the ephemeris of each observed navigation satellites were registered at a frequency of 10 Hz, apart from inertial data, current position and speed values from the SNS receiver. The obtained data arrays were used for debugging IANS algorithms based on the Kalman filter for the tightly-coupled systems. It should be noted that the route was chosen so that the observed satellites were frequently shadowed for a rather long time.

Figure 12 shows the results of the IANS performance simulation using data from the micromechanical IMU and the SNS receiver with a limited number of visible satellites. Figure 12A presents the motion path obtained at 10 Hz from the SNS receiver Kotlin-201M when less than 4 satellites were visible simultaneously for a long time. In these conditions some position spikes exceed several kilometers, which can be seen in the diagram. The same paths obtained with the same raw data in tightly-coupled IANS are given in Figure 12B. The maximum deviations from the map are 30 m (in the left lower corner) and can be explained by the absence of visible satellites during the motion to this point in both directions for 4-6 s. Except for the mentioned 4-6 s interval, SNS data were continuously supplied to the inputs of the current navigation and IMU correction problems, which would be impossible in a loosely-coupled system. Also, a tightly-coupled scheme made it possible to more efficiently reject the errors in the initial SNS data. When SNS data were received at a frequency of 10 Hz, the rejection of a significant number of measurements would not have caused drastic degradation of the data quality, if at least three satellites on the average had been visible.

The performed tests made it possible to elaborate the error models, determine the achieved IANS characteristics, considerably develop the existing software for the strapdown integrated systems and start developing IANS using an in-house MMG. IANS prototype is shown in Figure 13.

Unlike the experimental IANS, the prototype is implemented as a single cylindrical unit 100 mm in diameter.

Fig. 12A. Motion paths by the data from the SNS receiver Kotlin 201M; and
Fig. 12B. By the data from the tightly-coupled IANS
and 55 mm high. The device comprises three electronic boards. The first comprises micromechanical inertial sensors and electronics for them. The second board comprises a Texas Instruments signal processor TMS320F2812 and a miniature 16-channel GPS receiver RGPSM202. The third board is a secondary power supply which converts the voltage +27V from the board mains to the voltages required for the internal boards.

The signal processor TMS320F2812 (32-bit fixed-point format, frequency 120 MHz, RAM 36 KB, ROM 128 KB) realizes the computations in integer data representation and performs the program emulation of the floating-point data format. It enables multi-threaded data processing using the interrupt mechanism without real-time operating systems. The software realizes the algorithm for calculation of the vehicle translational and rotational motion and the algorithm of the generalized 18th order Kalman filter for a loosely-coupled system with feedbacks for the whole state vector. Now the software debugging is nearly completed. The developed hardware and software are able to compute the navigation data and attitude parameters and output them to the users at a frequency of 100 Hz via serial interfaces RS-232C and CAN, and SNS data are received at a frequency of 1-2 Hz. Then the background flow is organized, which involves the main resource-intensive computations of the filtering task. In the future, it is planned to build an IANS with the tightly-coupled scheme based on the processor TMS320F2835 supporting the floating-point computations. It would increase the system informational autonomy, and, in addition, solve the problem of rejecting invalid measurements at a qualitatively new level.

CONCLUSIONS

The CSRI Elektroibir in cooperation with TRONIC's Microsystems (France) have created a micromechanical gyrooscope of 0.1°/s performance class suitable for small-batch production. The obtained experimental data verify the possibility to achieve 0.01°/s accuracy level.

Now the work is in progress on the development of a gyro micromechanical sensor in the form of a vacuumed silicon element which does not require a special ceramic case for maintaining the vacuum, and on the development of a special ASIC to replace the analog microelectronics currently used in the gyro. The development is aimed at creation of an MMG about 1 cm² in volume, featuring 0.01°/s accuracy class and minimum power consumption, and suitable for mass production.

The experimental IANS-based on Analog Devices micromechanical inertial sensors was tested in the laboratory and on a car. Simulation of tightly- and loosely-coupled IANS using in-situ data was carried out. As a result, the efficient up-to-date IANS software has been created, which is intended for low accuracy gyros and can be realized in a single-board on-board computer built on a signal processor of TMS320F2812 class.

At the moment, a prototype IANS based on Elektroibir's micromechanical gyros, a signal processor TMS320F2812 and a 16-channel miniature GPS receiver RGPSM202, has been manufactured and is in preparation for testing.

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Product-Based Security Model for Smart Home Appliances

Davar Pishva & Keiji Takeda
Carnegie Mellon CyLab Japan

ABSTRACT

The idea of using existing electronics in smart home appliances and connecting them to the Internet is a new dimension along which technologies continue to grow. In Japan, electronics giants are selling various kinds of smart home appliances and have also joined hands to create standards for linking networked home appliances. While there is a huge potential market for such appliances, both in Japan and around the world, there are serious security challenges that have to be addressed in order to realize their true benefits. Herein, we examine a number of related security incidents that have occurred in Japan and identify existing challenges from technical, social, and practical aspects. We also discuss some countermeasures that can be used to prevent existing and projected security breaches.

INTRODUCTION

The 21st century has been regarded by many as the information era and the penetration of Internet connection into home appliances is a new dimension along which technologies continue to grow. We are surrounded by technologies and there are computer technologies in our cars, phones, entertainment systems, and home appliances. The idea is to make use of existing electronics in the devices and, in conjunction with specialized software, create an intelligent network with access to the Internet.

In Japan, many audio visual equipments can already be connected to the Internet, enabling people to enjoy network-based services, such as Video on Demand (VOD), Music on Demand (MOD), remote update; e-commerce, remote control, and other similar services. Network connectivity is likely to be equipped in all AV equipments in the near future. Furthermore, researchers around the world have come up with an abundance of resourceful ideas on how to effectively use microprocessors and the Internet in other everyday household appliances. “Smart” is the new buzzword that we can hear these days, for example, in “smart” homes, “smart” kitchens, “smart” ovens, “smart” refrigerators, etc. [1]. A refrigerator can keep track of the food stock and automatically order replenishment, an alarm clock can turn off the electric blanket and turn on the coffee maker, a microwave oven knows how to cook the potatoes, or a dishwasher can be turned on from the office.

NEED FOR SECURITY

There is a huge potential market for smart home appliances. A survey shows that 42% of American single family homeowners - 26.1 million households – are interested in new technologies in a connected home [2]. There is a tremendous business potential for smart home appliances for elderly people, where the number of people over the age of 65 is expected to double to 70 million by 2030 [3]. LG Electronics, one of Korea’s largest firms estimates that the total market value of the industry is about US $360 billion [4].

Connecting smart home appliances to the Internet, however, makes us vulnerable to malicious attacks. An intruder can steal private information such as contact information, shopping or eating preferences, lifestyle and relaxation habits, or credit card information used to pay for such services. They can also use smart appliances as launching pads to carry out malicious attacks into other systems. For instance, a DVD/HDD video recorder in Japan, which implemented a proxy server and was accessible without authentication under its default configuration, was used as an open proxy server base for spamming [5], as shown in Figure 1.

In another incident, a music player, infected with a virus in the factory, corrupted its user’s computer upon connection [6], as depicted in Figure 2.

In an example of privacy violation, a poorly implemented "referer" feature in a cellular phone constantly transmitted...
Previously accessed page information even when the page was reached via direct addressing (i.e., non-hyperlink access). The browser flaw caused private information, which may have been required to access a previous page (e.g., user name, password), to be revealed to the next link. It also revealed the user's favorite sites by transmitting information on a previously accessed page [7]. A Japanese researcher has also successfully exploited buffer overflow vulnerabilities in embedded home routers and managed to remotely gain complete access to peripheral devices [8].

Thus it is essential to equip such devices with security features. In fact, security and especially the concept of privacy are vital for users' acceptance of new technologies. Bill Gates noted in his visionary speech at Telecom '99 about future “Intelligent Appliances: "[...each of these devices will connect up to the Internet and get rich services. Authentication is the first one that's necessary." In addition to authentication, a number of additional services like payments, non-repudiation, etc., for all of which a security infrastructure is essential, will be required.

IMPLEMENTATION CHALLENGES

Continuous growth of diverse smart home appliances and development of numerous networking technologies make management of home network security and associated services complex to both users and service providers, as seen in Figure 3.

Implementing security on these devices also presents more challenges than traditional computer security due to the limited resources (e.g., toy CPUs that cannot handle computationally expensive cryptographic computations and battery power that prohibits long-lasting or high-peak computations). Furthermore, because security of a network depends on its weakest link, security of networked smart home appliances would rely on the security of its most primitive home appliance, e.g., a coffee maker or toaster. The problem is further aggravated by the fact that home appliance users cannot be considered as "skilled" administrators, but are instead technology-unaware people in many cases.

SECURITY MODEL

To come up with a model that can deal with the security requirements of smart appliances, we first develop a classification of smart home appliances, categorizing them into eight different functional groups, as shown in Table 1. Next we consider possible threats that any internet-enabled device may encounter (Table 2). We then examine countermeasures that can be taken against such threats (Table 3).

Correlation of our classification with an analysis of present and past security-related incidents yields a taxonomy of threats to smart home appliance as shown in Table 4, where H, M, and L indicate high, medium, and low level threat likelihood, respectively, and there was no supporting data for "<" entries.
Table 1. Functional Classification of Smart Home Appliances

<table>
<thead>
<tr>
<th>No.</th>
<th>Function</th>
<th>Example of Produce or Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Content Retrieval</td>
<td>Broadband TV, Microwave Oven, HDD Recorder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(for TV programs, etc.)</td>
</tr>
<tr>
<td>2</td>
<td>Content Storage / Usage</td>
<td>HDD Recorder (for TV programs, etc.), MP3 Player</td>
</tr>
<tr>
<td>3</td>
<td>Communication / Messaging</td>
<td>VoIP, IP-TV Phone, All kinds of E-mail Systems,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Healthcare Systems</td>
</tr>
<tr>
<td>4</td>
<td>Remote Surveillance</td>
<td>Security Camera, Gas/Fire Sensors, Refrigerator,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lighting Fixture, Door Lock</td>
</tr>
<tr>
<td>5</td>
<td>Remote Control</td>
<td>Air Conditioner, Lighting Fixture, TV, TV Program Recording</td>
</tr>
<tr>
<td>6</td>
<td>Remote Maintenance</td>
<td>Firmware Update, Trouble Report</td>
</tr>
<tr>
<td>7</td>
<td>Instrument Linkage</td>
<td>Networked AV Equipments</td>
</tr>
<tr>
<td>8</td>
<td>Networked Game</td>
<td>Family Type Game Machine</td>
</tr>
</tbody>
</table>

Table 2. A List of Common Attacks

<table>
<thead>
<tr>
<th>No.</th>
<th>Common Threat</th>
<th>Example of an Attack</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User Impersonation</td>
<td>Impersonation using password</td>
</tr>
<tr>
<td>2</td>
<td>Device Impersonation</td>
<td>Impersonation of a device using its faulty certificate</td>
</tr>
<tr>
<td>3</td>
<td>Service Interruption</td>
<td>Distributed Denial of Service (DDOS)</td>
</tr>
<tr>
<td>4</td>
<td>Data Alteration</td>
<td>Data alteration of transmitted or stored data</td>
</tr>
<tr>
<td>5</td>
<td>Worm/Virus Infection</td>
<td>Infiltration and/or damaging of a computer system</td>
</tr>
<tr>
<td>6</td>
<td>Phishing / Pharming</td>
<td>Impersonation of users’ destination</td>
</tr>
<tr>
<td>7</td>
<td>Data Wiretapping</td>
<td>Information leakage through wiretapping</td>
</tr>
<tr>
<td>8</td>
<td>Firmware Alteration</td>
<td>Replacing of firmware at will</td>
</tr>
<tr>
<td>9</td>
<td>OS / Software Vulnerability</td>
<td>Launching of worms and attacks using such vulnerabilities</td>
</tr>
</tbody>
</table>

As can be observed from Table 4, except for content storage/usage appliances, the likelihood of user or device impersonation attacks is high (H). On the other hand, threats of phishing / pharming, data wiretapping, and OS / software vulnerability are low (L), and the likelihood of the remaining threats fall somewhere in between for the smart appliances.

COUNTERMEASURES

This section examines in detail some of the countermeasures listed in Table 3 and recommends how to tailor them for smart appliances.

User/Device Impersonation

In this scenario, a malicious attacker tries to make an unauthorized access to the appliance and possibly perform some configuration changes on the system. Since the risk level of such an attack is high for smart appliances, a certification mechanism based on standard and public-key infrastructures (PKI) must be used among the entities involved as shown in Figure 4.

Following is a list of required certification mechanisms:

- A standard certification mechanism between user and server.
Table 3. Summary of Proposed Countermeasures

<table>
<thead>
<tr>
<th>No.</th>
<th>Common Threat</th>
<th>Proposed Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User Impersonation</td>
<td>Introduce a certificate mechanism through memory card-like devices</td>
</tr>
<tr>
<td>2</td>
<td>Device Impersonation</td>
<td>Introduce a certificate mechanism through memory card-like devices</td>
</tr>
<tr>
<td>3</td>
<td>Service Interruption</td>
<td>Control through network and access mechanism to outside world</td>
</tr>
<tr>
<td>4</td>
<td>Data Alteration</td>
<td>Introduce access control and certificate mechanism</td>
</tr>
<tr>
<td>5</td>
<td>Worm/Virus Infection</td>
<td>Use virus protection software and prepare to handle new vulnerabilities</td>
</tr>
<tr>
<td>6</td>
<td>Phishing/Pharming</td>
<td>Consider using SSL to assure genuineness of displayed sites</td>
</tr>
<tr>
<td>7</td>
<td>Data Wiretapping</td>
<td>Protect communication via IPSEC/SSL/TLS</td>
</tr>
<tr>
<td>8</td>
<td>Firmware Alteration</td>
<td>Use physical access control for update procedure</td>
</tr>
<tr>
<td>9</td>
<td>OS/Software Vulnerability</td>
<td>Educate R&amp;D people on security and conduct product test</td>
</tr>
</tbody>
</table>

Table 4. Threat Likelihood Level of a Given Smart Home Appliance for a Particular Attack

<table>
<thead>
<tr>
<th>No.</th>
<th>Common Threat Function</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Content Retrieval</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>-</td>
<td>L</td>
</tr>
<tr>
<td>2</td>
<td>Content Storage/Usage</td>
<td>-</td>
<td>-</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>-</td>
<td>L</td>
<td>-</td>
<td>L</td>
</tr>
<tr>
<td>3</td>
<td>Communication</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>-</td>
<td>L</td>
</tr>
<tr>
<td>4</td>
<td>Remote Surveillance</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
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Table 4: Threat Likelihood Level of a Given Smart Home Appliance for a Particular Attack

- An easy-to-use certification mechanism (e.g., through a memory card-like device, a built-in speech recognizer, or biometrics recognition method) between the following entities:
  
  Appliance ↔ User
  
  Appliance ↔ PC
  
  Appliance ↔ Server
  
  Appliance ↔ Appliance

- An SSL server certificate between the appliance and server.

**Service Interruption**

Smart home appliances can also be used as a launching pad for a distributed denial of service (DDOS) attack. The risk posed by this threat is medium to high across the various types of appliances and the following methods are recommended as countermeasures:

- Provide a suitable access control for external accesses based on an authentication mechanism.
Fig. 4. Use of Certification Mechanism

- The appliance should neither implement redirection nor allow internet access via user input. It should also thoroughly examine the input.

- To prevent attack against a currently accessed site, the appliance should not hard code access address and should make it easily changeable.

- Redundancy and other usual prevention methods against service interruption should be implemented.

Data Alteration
This threat involves misuse of the link between the appliance and PC to alter data or system configuration in an unauthorized manner. The risk posed by this threat is high for remote-controlled appliances, medium for networked games and remotely maintained appliances, and low for the remaining items. We can cope with these threats by:

- Implementing certification mechanisms for all appliances.

- Implementing access control based on the authentication method.

Presently most of the network media players that are available in the market do not have an authentication and access control system.

Infection by Worm or Virus
Worm / virus infected appliances can become a secondary source of damage for external access and poses a low to medium risk. We can employ the following methods to safeguard against these infections:

- Virus protection software, which is practical even from resource and operational points of view.

- Use of firewall or intrusion detection systems (IDS) to deter infection.

- Use of distributed patch programs for established vulnerability information.

Phishing / Pharming
In this scenario, a malicious entity tries to guide the appliance user into a different server for either marketing purposes or try to deceive the user to steal his/her personal information. Except for the Communication/Messaging appliance, the risk of such an attack is relatively low. Nonetheless an SSL certificate mechanism can be used to prevent its occurrence. For server certificate verification, however, a mechanism wherein the user could clearly verify would be necessary. Furthermore, a design which prevents user information from being sent to the server is required.

Data Wiretapping
Wiretapping is a covert means of monitoring communication, the risk of which is quite low for smart appliances. The following methods can be considered as countermeasures:

- Use IPSEC, TLS, or SSL for the communication.

- Use server certification mechanism from access points to the appliance. Or, facilitate the router's VPN or NAPT settings.

Overwriting Firmware
This involves unauthorized external access to the appliance and overwriting of its firmware. Appliances which are remotely maintained are susceptible to this attack. In order to prevent the risk of such attack, the appliance should require some form of direct user operation for its firmware update.

OS / Software Vulnerabilities
In this attack, a malicious user takes advantage of OS / software vulnerabilities and freely executes any code externally. The attacker can also misuse back doors that are left open for R&D and maintenance purposes for their malicious purpose. Although the risk of such an attack is relatively low for the smart appliances, the following methods can be employed to counteract the threat:
- Educate system designers and R&D people on secure development systems.

- Familiarize R&D people on the vulnerabilities of back doors that are left open.

- Conduct an exhaustive test on projected vulnerable components during test phase of the product.

**DISCUSSION**

As can be observed from the above, security requirements of smart appliances depend on their functions. To address such functionally-dependent security requirements, one has to consider whether a given smart appliance is to be utilized on a stand-alone basis, or several of them are to be used in an interconnected manner in a family area network (FAN) environment. Although it is simpler to meet the security requirements of a single appliance, in reality however, several appliances will be used in an interconnected manner. Therefore, security of the FAN and its underlying technologies, e.g., dedicated wiring, existing power or phone wiring, or wireless, must also be considered. Similarly, while it is ideal to address security requirements of smart appliances by local means and without any need for a background online system, it is not clear what such a security infrastructure will look like at present. Hence, it becomes essential to also employ PKI in this field. Furthermore, because appliance users are technology-unaware people, network operators appear to be in an excellent position to offer the required security services. They handle various network technologies, have experience with PKI and direct access to the users, and are capable of managing large-scale infrastructures.

**IMPLEMENTATION GUIDELINES**

It seems that no single vendor / manufacturer may be able to solve the problems faced. Nevertheless, the best way to proceed is to develop the security model around smart home appliances and network components that conform to certain standards. There are standards bodies which specify how to build these devices and meet their various requirements. It is essential to conform to these standards when building, managing, and providing services for smart home appliances in the future. Such an approach will encourage more vendors/manufacturers to conform to these standards, and the standards themselves will evolve as needs arise.

In the following sections, we briefly explain some of the existing standards that define how to build and manage universally-deployable smart home appliances. We also specify implementation guidelines to set up a prototype system using an open architecture and a modular development scheme.

**Association of Home Appliance Manufacturers**

The Association of Home Appliance Manufacturers (AHAM) [9] has completed an ANSI standard for generic object models for all of the major white goods in the home, including refrigerators, washing machines, dryers, dishwashers, microwave ovens, room air conditioners, and ranges. The ANAM Standard for Connected Home Appliances-Object Modeling (CHA-1) was also created to provide interoperability with higher-level protocols such as Universal Plug and Play (UPnP), Versatile Home Network (VHN), and others. It enables both appliance manufacturers and third-party developers to create new value-added services and features that will allow remote operation and monitoring of appliances from anywhere in the home or even when you are away from home.

**ECHONET Consortium**

ECHONET develops specifications of home network for networked household appliances, facilities, and sensors. ECHONET Consortium [10] has formulated the ECHONET Specification, which can be used to centrally monitor and control smart home appliances that are connected through an ECHONET compatible network interface and a controller. The ECHONET specifications can ensure interoperability between devices of different vendors and realize easy home network at low cost. Also, ECHONET promotes the development of attractive service and application systems using the ECHONET™ specifications.

ECHONET routers have conversion functions to accommodate home appliances that use different transmission media. The ECHONET, which had previously only supported transmission media such as power lines, low-power radio frequency, and infrared radiation, has come to support other transmission media such as Bluetooth and Ethernet with the release of its version 3.00. Therefore, when there are multiple transmission media in the same domain, the installation of an ECHONET router specified by the ECHONET Specification will allow seamless connection between different types of transmission media.

The ECHONET consortium has over 100 members and its major sponsors are “Hitachi, Ltd.” “Matsushita Electric Industrial Co., Ltd.” “Mitsubishi Electric Corporation,” “Sharp A Corporation,” “Tokyo Electric Power Company, Inc.” and “Toshiba Corporation.” Smart home appliances built by the major Japanese companies are ECHONET-compliant.

**Open Services Gateway Initiative Alliance**

The OSGi Alliance is an open forum. Their mission is to specify, create, advance, and promote an open service platform for the delivery and management of multiple applications and services to many types of networked devices. Their specifications were initially targeted at residential gateways for the connection of home devices to an external network or for interconnections between the different protocols that are used in devices at home but have
recently been extended to accommodate vehicle, mobile, and other environments.

About one-half of its members are based in North America, one-third are based in Europe, and the rest are based in the Asia/Pacific region. A number of products developed by member companies are based on the OSGi Service Platform specification [11].

The OSGi specification is not a new protocol technology that replaces existing ones; but rather assumes that multiple protocols could be used within the target device. Its relationship to other standards is schematically shown in Figure 5, where OSGi maps existing local network standards to broadband networks and provides portal services.

Figure 6 shows OSGi architecture which consists of OSGi Framework and a set of bundles [12].

The OSGi Framework provides the basic functionality for executing OSGi bundles which are software components that contain algorithms and protocols for controlling a device. When a bundle is required, it can be downloaded from a server on the network and then executed. This feature makes it possible to download and use the latest and most optimal bundles and allows customization of gateway functions for each user. Since only the bundles that are needed are downloaded and stored, little memory space is required.

**Next Generation Gateways**

Even with the existence of standardized smart home appliances and standard specifications on how to network them together, a major challenge still falls on capabilities of gateways that connect all of these devices to the network, control the devices, and provide portal capability for using services offered by the external networks, including the Internet. The OSGi specification can be used to implement such gateway capabilities through software component technologies that use the Java language.

There are vendors like ProSyst Software AG [13] that use OSGi specification in their modular and open service platform. Companies like Motorola integrate ProSyst’s Service Gateway software in their advanced residential products and there are forums like Home Gateway Initiative (HGI) [14] which define the next generation of residential gateway. There are also forums like UPnP [15] which provides the architectural framework for self-configuring, self-describing devices.

The next logical step is to develop an experimental, secured service application for a home network consisting of open standard compliant home appliances and network components that are manufactured by different vendors. Although when using off-the-shelf products, one may need to employ several gateways and a computer as a service gateway, the above described OSGi specification maybe used to answer such problems. The next generation gateway should enable adoption of a uniform approach regardless of underlying technology and manufacturer.

**A NEW SECURITY ARCHITECTURE**

Considering the above-mentioned security requirements and the various associated challenges, the most effective way to address security issues of the smart appliances are to:

1. Engage a network operator to build dedicated but non-proprietary home gateways and become

   ![](image)

   **Fig. 6. Structure of OSGi Gateway**

   the preferred trusted third party.

2. Motivate Internet-enabled smart appliance manufacturers to develop device drivers and application software that can run on such universal home gateways to control and operate the appliances.

This idea is schematically shown in Figure 7, where a universal home gateway, managed by a network operator, functions as an entry point to the networked appliances. In this architecture, all transactions with the smart appliances,
whether local or remote, are done via universal home gateways.

Basic Usage Scenarios
There are three basic usage scenarios;

- One is access of local services by a user from within a FAN
  (e.g., watch a movie using a video recorder located in another room);

- Another is downloading remote services;
  and

- The third is control of smart appliances interconnected in a FAN environment,
  by a remote user (e.g., turn on air conditioner from the office).

From within the FAN, users can be authenticated through a common-password-based, log-on approach. Each user’s access control information (e.g., no adult movies for kids below 17, or no movies for school-going children after 11 p.m., etc.), which is stored in the universal home gateway, can be used for access granting. To access a remote service site from within the FAN, the universal home gateway authenticates the user through an authentication server, establishes the user’s access control privilege, and initiates a secure communication between the remote service provider and the user for the transfer of the requested service. Remotely accessing home appliances is the counterpart of remote service access where the universal home gateway checks and validates a remote user’s access control privileges and allows secure communication for legitimate data transfer.

Desired Features of the Universal Home Gateway
In general, universal home gateways, in addition to having the general functions of supporting the underlying FAN technology, and acting as a gateway between a telecom operator’s network and the FAN and as an access point to the smart appliances for digital service providers and remote users, are envisioned to have the following security functions:

1. Authenticate a user from within FAN through either a common-password-based log-on approach or by the plugging of a memory card-like device, containing user’s access control information, into the system. A more user-friendly approach would require a built-in speech recognizer or biometrics recognition method.

2. Act as a security server and maintain each user’s access control information (security attributes and the basic key for communication with remote services).

3. Provide secure communication and deal with security issues on behalf of appliance users. Enable remote management services through providers, intermediaries, and network operators. Allow network operators to use universal home gateways to authenticate their users, or bill them on behalf of a third party, e.g., service providers.

4. Detect connection of a new appliance to the FAN and prompt users to insert its manufacturer supplied driver / application software. Such a plug and play-type auto configuration mode, however, should be manually selectable (i.e., be enabled when needed) in order to provide an added security for wireless FAN and prevent arbitrary connection from the neighborhood.

5. Automatically disable, via software selectable functions, an appliance when it is detached from the FAN and auto configure when a previously detached appliance is re-connected.
6. Be equipped with firewall and virus protection software.

Such functionalities could meet security measures which were discussed above. Moreover, because security requirements are handled via central universal home gateways, it could offset resource limitations of individual smart appliances.

Existing and Envisioned Technologies

Although at present there are some vendors who market their own brand of smart appliances, which are equipped with a central controller that links the appliances together in a FAN environment and offer limited security and exclusive digital services [16, 17], history shows that such propriety approaches are prone to fail. Similarly, while some researchers, e.g., those at the University of Illinois [18], have done ingenious work in coming up with protocols and schemes that could provide security for smart home appliances, a universally-deployable, user-friendly system, which is acceptable to a wide range of users, is the key issue.

Therefore, design and development of an open system and involvement of big and experienced players like network operators are vital to the successful adoption of the technologies. This will allow appliance users to enjoy security without having to be aware of the underlying mechanisms. Universal home gateways may even be provided free of charge, in a manner similar to the way that cell phone sets and broadband modems are being given away by their respective service providers in Japan. Security pricing may also be implemented on a product (functional group)-based scheme.

CONCLUSION

Herein, we have examined a number of security incidents in Japan and identified existing challenges and showed that the security requirements of smart appliances depend on their functions. The security requirements of each functional type appliance were identified. Appropriate solutions were proposed. PKI was identified as an essential security component and easy-to-use authentication mechanisms were recommended. It considered compliance with existing standards and liaise with appropriate fora to downstream new requirements important when trying to address security requirements of smart home appliances. It argued that successive security implementation involves cooperation of manufacturers, network operators, and service providers. An architecture wherein security issues are managed through universal home gateways by network operators in a product-based fashion is proposed and manufacturers and service providers are recommended to adopt the technology, in order to offset resource limitations of individual smart appliances and make their security issues straightforward to ordinary users.

ACKNOWLEDGMENTS

The authors thank Dr. Shizuo Asogawa and Dr. Nicolas Christin for their useful suggestions and valuable comments. Special thanks are due to Hyogo Institute of Information Education Foundation for supporting this work.

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Letter to the Editor

Dear Editor:

Amazing things occur!

After reading Systems Magazine, May 2008, that included the article Rad Lab, Luie Alvarez, and the Development of the GCA Radar Landing System: A Memoir by C.A. Fowler, I was clearing out some packing boxes in the garage and came across an album of photos and memorabilia that my Mother saved from my Army Air Force service in Germany from 1946 to 1948. Included was a Munich Air Base newspaper published in February 1947, showing photos of the Munich GCA and an explanation of the Airways and Air Communications Service (AACS) that included the GCA installation! I have enclosed a photocopy of the newspaper. Would you be kind enough to send this to Mr. Fowler? [We have. – Editors]

I entered the Army Air Corps in October 1945 (age 17) and was trained as a Ground Maintenance Mechanic for Airborne and Ground Radio equipment. I served in the AACS from July 1946 to July 1948. In September 1946, I was assigned to Bremerhaven, Germany Air Base in the AACS Detachment and took care of Control Tower Radios (UHF) and Ground-to-Ground (HF) Air Traffic Control transmitters from September to December 1946.

Then I was transferred to Munich-Reim Air Base, AACS Detachment in December 1946 and took care of Control Tower Radios, Ground to Ground HF Transmitters and Motor Generators that provided proper power for them. Also at Munich was a GCA Installation set up along the main runway, as shown in the newspaper article. The Control Tower and HF Radio transmitters where I worked were on the same side of the runway as the GCA, so I saw many GCA landings there at Munich – some in snow storms! So I was very pleased to read the Systems article about GCA in the May issue.

In June 1947, I was assigned as AACS Detachment Leader to set up and operate a new Control Tower, non-directional Radio Beacon, weather monitoring Radio receivers, weather network teletype equipment and the AACS HF air traffic control radio at Erding Air Base. Erding is located about 35 miles northeast of Munich. This was set up so P-47’s could be flown into Erding for disassembly and salvage.

We got the Tower and other equipment operational in less than a month, since most of the radio equipment needed was dumped there in a field by US and UK at the end of WW II. This had been a German Army base and did not have a runway until the US Corps of Engineers planted a pierced metal runway, and the Control Tower building in the spring of 1947. So I served at Erding from June 1947 until July 1948, when my active duty enlistment ended.

Subsequently in 1950, I was recalled to active duty until July 1952. Then I enrolled at Purdue University in the Electrical Engineering school. In 1955, I became a Student Member of the IRE. After graduating with a BSEE in 1956, I have spent most of my career in the design, installation, flight testing, and mandatory certification of avionics systems in several commercial aircraft in several countries, as well as avionics systems for several military aircraft.

And I continued my membership in the IRE (subsequently IEEE) and have become a Life Senior Member.

I retired from active design work in 2003 – after over 50 years of great technical pleasure and travel around the world. I continue to travel with my wife and have enjoyed travel and the review of technical journals such as the Systems Magazine, the IEEE Spectrum, IEEE Proceedings, and others.

Thank you in advance for assisting me with this information.

Sincerely,

William R. Beckman
Corona Del Mar, CA 92625
Guards Caught Looting 11th TCS Ops.

Five Polish Guards from the 409th Labor Supervision Co. at Munich Air Base were arrested today for the looting of the 11th TCS Operations and destroying an MP. The five Poles entered the base just before midnight and were апп�п (approx.) into the "office" and "room" by the 11th TCS Operations officers. They then robbed the office and overpowered the MP guard. The guards then found the old of a 25-cal. pistol, Pfc. Cooledge and caught four of the men looting the confidential files from the same office. The fifth Polish officer then fled from the base.

Charged with illegal possession of firearms, possession of Government property, armed assault and murder, the five refugees were given an army post, the five men were turned over to the police by Maj. Lewis, Marshall, Lt. Robert L. Carr.

Para. 6

Now It's Fish in Beer.
The menu said "Fish in beer." Everyone thought it was a joke, but that was some time after some gastronomical experts at the MAJ officers' mess have to admit it's not a joke but a swell way to eat fish.
The idea was developed by Sg.t. Clarence Price who has been cooking for almost a year. Here's how to do it: Take regular pancake batter and use beer instead. The regular evaporated milk called for in the recipe was replaced with beer and then heat up eggs. Dip the fish into the eggs then into the batter and fry in deep grease.

"We have to displace the fish somewhat, but it's an easy recipe to cook and a week as we do," said Sgt. Price.

AOA Announces Flights to US.

Commercial reservations are now available for those traveling by air, on leave or business to the United States or points in Europe. A.O.A. Flight is operated five times weekly from Frankfurt for London and Paris, York and all points in the United States.


There is also a speedy carriage of Air Express Service for personnel desiring to send packages home. Shipping is at special handling to any point in the United States.

Para. 10

RAF Chief Visits MABS

Munich, Germany, February 1, 1947

West Point Point Brings Films of Army Team to MAB

Col. William "Babe" Bolinsky, West Point's all-around football coach, is coming to MAB next Tuesday with motion pictures of the great Army team in action. The Col. brings three films with him showing Doc Blanchard, Glenn Davis and other Point stars in action. He will also answer any questions about the team before the show. The films are "Point," "Babe" takes his film to the Pentagon in Washington, where he shows them four times per day to take care of enthusiastic football fans.

Col. Bolinsky is making a tour of the Army with the membership of Stars and Stripes and Special Services. He will be at the Troops' Coop at 1400 on Tuesday, Feb. 4.

G.I.'s Pay Old Rates.

(Washington, C.N.)—Service men and women will begin paying full pay in January. A cent per mile will be paid on buses and trains on January 31st. The Relocation Finance Corporation has ruled that the reduced mileage rate of one cent per mile will go to the full civilian level on that date.

Railroads and bus lines operating east of the Mississippi river proposed cancellation of the reduced rates effective December 31. On protest of the military branches of the government, the RFC suspended the schedules until January 30. The RFC also said that no reasonable document could be expected for investigating the fares and issuing an order discontinuing the present proceedings. Thus, higher civilian rates will be charged on the rails and bus lines. It was also announced that the rates on trains and trolleys will be made up by the time the situation is cleared up.

When the application is approved, the rate will be placed by the Army by any time during his last thirty days in the theater. The only privilege granted these marrying Germans while this theater is a one-year honeymoon. When the German wins reaches the point for her status becomes the same as other American dependents.

Para. 20

Swiss—Rome Tour Quota

FRANKFURT, GERMANY—Since temporary quotas for participants and their guests have not been established, to by some of the major commands, it has become necessary to authorize the Commanding Officer at the Oswe Leave Center in Rome, France, to direct the return to the station of all personnel arriving on the quota for their commands. The daily Special Services announces that the Air Force will host a six-day tour every Monday, Wednesday and Friday. 

PX Writing Today

Drawings were made today at the base PX on $10,000 worth of equipment, including cameras to Parker F1 sets, according to Lt. Colonel Harold Cral, assistant PX officer.

Remained articles on sale are sold at 69.50 cents for $5.00, as 50 cents for 0.5 cents for $2.50 to $122, 54 Parkers at 1.00, 1.00 r, one enlarger, one 35mm slide projector, and an electric train.

Persons may sign for three tickets, each ticket, one camera, one electric watch, one ladies of men, and one miscellaneous item.

An other added requirement in the men is a box of ration free chips that may be purchased by any one who has been promoted after January 15, 1947.
Munich's GCA Best in Europe

By Nick Furneaux

The Munich Air Base - GCA installation was the first of its kind in Europe. It was installed here in September of 1943. For many months in the States and abroad the GCA (Ground Control Approach) was a hush-hush operation. People would stand at planes, making low approaches on the field and then climb up to do it all over again. The pilots were only practicing blind approaches on GCA.


The purpose of GCA is to land airplanes when the conditions are below minimums. GCA comes into operation after the pilot has contacted the radio range and has informed the radar men of his position. By aural signs the men on the ground are able to tell the pilot when he is in position so he will be able to line up on the runway in order to make a contact landing. There are only five GCA outfits in the Theater all of them run by EADS. The Munich outfit is considered by many to be the best. During the months of November and December Munich GCA made over one hundred PPI's.

The MAB outfit has nine men, most of them MSGs, and former AAF pilots. Chief engineers in civilian, Don Mancuso. The other civilian is the 14th AACS Squadron in GCA technician, Ed Malvarca.

Pilot's Third Hand - AACS

By LIL H. WOOD

While you're reading this, there is a plane landing at Munich Air Base. The pilot of this plane has at his fingertips all the necessary information to leave him of safe landing.

Wind direction and velocity altimeter setting, landing instructions have all been radiated to him who is approximately three miles from the field. All this information and the control of the airfield is being handled by a group of men in a glass house perched high above Munich Air Base. These men at the Munich Air Base and at bases in various parts of the world are all part of the Airway and Air Communications Service.

AROUND THE GLOBE

How this was accomplished, and in what time is now history to the airman, yet the story of the Airways and Air Communications Service for AACS has spread like its tentacle fashioned air control, completely around the globe. The Pacific ocean holds no fears for the army pilot, nor does he hesitate to fly over the ice-covered regions. He knows that as AACS planned high frequency transcontinental眇uals contact with all planes flying between it and all the stations in the north, south, east, and west. He can fly a work at his fingertips, and his headphones will resound with a constant radio beam from an AACS operated radio station which will guide him to a safe landing.

BLIND LANDINGS

The pilot does not fear blind landings as he did in the past, for AACS developed equipment for this weather condition. Yet there are people outside those lives are dependent on the equipment of the Airways and Air Communications Service for AACS, General intelligence are measured by standard army task. These men have a very important job that of controlling the skies, a job well done.

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Dual Use Technologies and Applications: A Key-Topic in a Key-Agreement

Signature of Agreement

Did you know that since September 2007 AESS and AFCEA (Armed Forces Communications & Electronics Association) are formally "connected"?

AFCEA is an international non-profit membership association, established in 1946, serving military, government, industry, and academia as an ethical forum for advancing professional knowledge and relationships in the fields of communications, IT, intelligence, and global security [1]. The organization, headquartered in Fairfax, Virginia, USA, similar to IEEE is structured into Regions and Chapters.

The AFCEA Rome Chapter (Italy), that manages all AFCEA Italian activities, under the dynamic presidency of Lt. Gen Pietro Finocchio (Italian Air Force, TELEDIF), received multiple awards in the last years for its initiatives, member recruiting capabilities and personal merit of President [2].

As announced in [3], September 12-14, 2007, the AFCEA Rome Chapter organized an International Symposium on Aerospace Technologies and Applications for Dual Use, gathering key people from civil and military institutions, industries and universities. Moving from the main results of the International Symposium, derived from the keynote speeches, invited lectures, panel discussions and conclusions, a book on Aerospace Technologies and Applications for Dual Use - A New World of Defense and Commerce in 21st Century Security - the first on the topic - will be published in 2008 by River Publishers (P. Finocchio, R. Prasad and M. Ruggieri, Eds.).

During the Symposium, technically co-sponsored by AESS and the IEEE Systems Council, a Memorandum of Agreement (MoA) was signed between AESS and the AFCEA Rome Chapter to create a cooperation frame in the area of Aerospace Technologies and Applications for Dual Use. In particular, through the MoA the two parties intend to cooperate for the development and promotion of the topic in dedicated events (workshops, seminars, conferences) or in dedicated sessions/palettes/tutorials of existing conferences and events regularly (or occasionally) organized by each institution. The cooperation will also involve development and promotion of the topic in educational activities, already developed by each institution or to be conceived jointly, as well as in dedicated sessions or issues of the publications of each institution.

A common interest has been recognized by AESS and the AFCEA Rome Chapter in a key area that, being clearly within the scope of each party, can provide large benefits from a harmonized joint action.

On May 5, 2008 the President and CEO of AFCEA International, Kent R. Schneider, visited the AFCEA Rome Chapter. Cooperation points and initiatives were discussed. Two points of particular interest to AESS:

AFCEA President Visits Rome Chapter

A possible extension of the Memorandum of Agreement on Dual Use, already existing between AESS and the AFCEA Rome Chapter, to AESS and AFCEA International;

A community-oriented model that the AFCEA Rome Chapter is developing to enhance the potential of the industrial and academic participants to the Chapter.

In particular, the latter model is based on MindSh@re methodology, the unconventional engine for value innovation that is producing great results inside Finmeccanica Group. MindSh@re is a process to enhance common knowledge capital, designed with the aim of connecting people in a knowledge network which multiplies the possibility of generating new ideas, products and talents, and is the engine for a real innovation of value through "communities", a model focusing and sharing experience on subjects considered to be of top priority for AFCEA, Rome Chapter, main stakeholders.

— Arturo Di Giovanni
Marina Ruggieri

REFERENCES
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Please send corrections or omissions for this page to AESS Executive Assistant, Judy Scharmann, j.scharmann@ieee.org

Dated: October 2008
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- Graduate Student Rep –Open
- Executive Assistant – Judy Scharmann

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**1. NAME AS IT SHOULD APPEAR ON IEEE MAILINGS:** SEND MAIL TO:  
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**2. Are you now or were you ever a member of IEEE?**  
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If yes, please provide, if known:

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**DEMOGRAPHIC INFORMATION — ALL APPLICANTS —**

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<th>Day</th>
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- Male  
- Female

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**3. BUSINESS / PROFESSIONAL INFORMATION**

Company Name: 

Department / Division: 

Title / Position: 

Years in Current Position: 

Years in the Profession Since Graduation: 

PE: State / Province

Street Address: 

City: 

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**4. EDUCATION** A baccalaureate degree from an IEEE reference list of programs assures assignment of "Member" grade. For others, additional information and references may be necessary for grade assignment.

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**5. SIGNATURE OF APPLICANT**

I hereby make application for IEEE membership and agree to be governed by IEEE's Constitution, Bylaws, Statements of Policies and Procedures and Code of Ethics.

Full signature of applicant: 

Date: 

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Office Phone: 

Home Phone: 

Office Fax: 

Home Fax: 

Office E-mail: 

Home E-mail: 

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- United States: $165.00  
- Canada (includes GST): $152.50  
- Canada (includes HST): $162.64  
- Africa, Europe, Middle East: $137.00  
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Aerospace and Electronic Systems Society Membership Fee:  
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