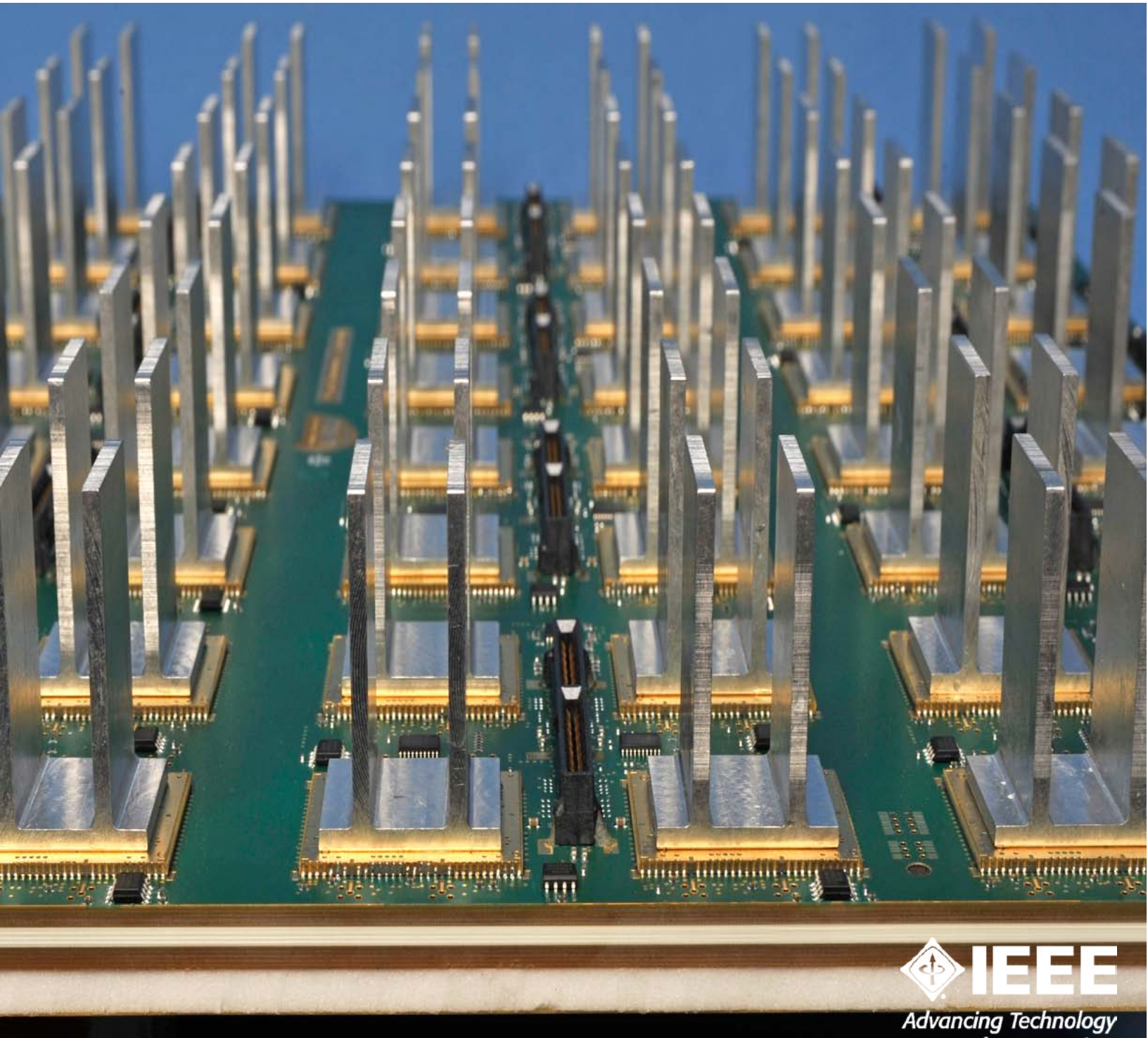
BOSTON

THE REFLECTOR

ISSUE #5
OCTOBER 2016



IEEE
Advancing Technology for Humanity

TABLE OF CONTENTS

IEEE Boston Section Online Courses:

Verilog101:Verilog Foundations CLASS DESCRIPTION: Verilog is IEEE standard 1364. It is a Hardware Description Language that is the corner stone of much of the simulation world. Verilog Foundations is a comprehensive introduction to the IEEE 1364 (Verilog). The Verilog Foundations class has a slightly different approach to learning Verilog than other methods. There is a lecture section for each main topic. This presents a basic foundation for the language. What makes Verilog Foundations exciting is the emphasis on labs/examples. There are nearly 100 labs/examples giving comprehensive "how to" examples of most Verilog language constructs. There are working solutions for each lab and the students can use the lab database for developing their own models later. The class is also self paced. All the work can be done independently by the engineers, at their own computer, and at their own pace.
(Register at http://www.ieeeboston.org) and click on course title

System Verilog 101: Design Constructs CLASS DESCRIPTION: SytemVerilog is an extensive set of language constructs to the IEEE 1364-2001 standard. It's meant to aid in the creation and verification of models. There are two parts to the language extension. The first part covered by this class, is new design constructs. The second part of SystemVerilog is verification constructs, covered by SystemVerilog102. There are over 100 labs/examples giving comprehensive "how to" examples of most SystemVerilog language constructs. There are working solutions for each lab and the students can use the lab database for developing their own models later. The class is also self paced. All the work can be done independently by the engineers, at their own computer, and at their own pace. There are self-grading quizzes for each chapter that allow the student to see if he/she is learning the material. The goals of this course are to make you familiar with the new part of the language. Students taking SystremVerilog101 will have a 90-day access to it. The lab database you will be able to download and is yours to keep. **(Register at http://www.ieeeboston.org) and click on course title**

System Verilog 102: Verification Constructs CLASS DESCRIPTION:SytemVerilog is an extensive set of language constructs to the IEEE 1364-2001 standard. It's meant to aid in the creation and verification of models. There are two parts to the language extension. The first part covered by SV101, is new design constructs. SV102, this class, covers verification constructs. SystemVerilog102, like all CBE classes, is lab based. There are over 30 verification labs/examples giving comprehensive "how to" examples of most SystemVerilog verification language constructs. There are working solutions for each lab and the students can use the lab database for developing their own assertions later. The class is also self paced. All the work can be done independently by the engineers, at their own computer, and at their own pace. **(Register at http://www.ieeeboston.org) and click on course title**

Introduction to Embedded Linux Part I CLASS DESCRIPTION: This first of a 2-part series introduces the Linux Operating System and the use of Embedded Linux Distributions. The course focuses on the development and creation of applications in an Embedded Linux context using the Eclipse IDE. The first part of the course focuses on acquiring an understanding of the basic Linux Operating System, highlighting areas of concern for Embedded Linux applications development using Eclipse. The latter part covers the methods for booting Embedded Linux distributions including embedded cross-development and target board considerations.

High Performance Project Managment CLASS DESCRIPTION: This12 hour course(broken into short 10 to 20 minute independent modules) provides the project methodology, concepts, and techniques that ensure successful completion (on time, on budget, with the quality required) of projects, large and small. Participants learn the steps to take before, during, and at the end of a project to hone planning and execution to a strategically built process that delivers project success when used. Additionally, the course provides the interpersonal and leadership techniques to ensure everyone involved with the project whether a team member, organization member, or outside of the organization commits to the success of the project—voluntarily—and provides the support and assistance to ensure its success. In addition to learning how to master the technical skills that have evolved over thousands of years of project implementation and practice, the course provides the advanced team building, leadership, and interpersonal skills that ensure the technical skills can be used, they way they are designed to be used, resulting in a process that delivers the on time, on or under budget, with the quality required completed project consistently.

The New Digitial Reflector

Fausto Molinet, Jr. Past Chair, Boston Section

The new Digital Reflector (let's just call it the dReflector for now) is now well established in our section. It's a new way of communicating with our members and helping members communicate with us.

The old paper version seemed to have outlived its usefulness. If you'd ever seen our Section manager Bob getting the old paper Reflector ready for publication … Well, it wasn't pretty. It was also afflicted with the usual long lead times associated with paper periodicals. Once finalized, printed and mailed we couldn't change anything in it. That's now in the past and while I not ready yet to say "Good Riddance", we have changed our way of doing business, for the better.

Of course we had the eReflector, which was our highly abbreviated version, emailed to members (and a relative few who subscribed) on a twice monthly schedule. I don't know about you, but I get enough email to easily lose something like that. We could simply use the section Website and upgrade and expand it. That was a good idea, but many people liked the paper Reflector and it had lots of history, so we decided to improve both. Magazines seem to be still quite popular, so why not convert the paper Reflector to an online magazine.

Take a look at the result. You can go to the Section website where you'll find a link to the Digital Reflector. It has lots of features to explore, but I want to focus here on content and utility. These are really the reasons we publish it.

All of the features of the old pReflector (I love these abbreviations, LOL) are still there; meeting announcements, course announcements, important section news, ads of interest to the members and of course my favorite, the editorial. The big difference is we get this done with less than half the lead time so the information is more current and if there is a critical change - easy to do. Obviously organizers of courses and meetings can't get careless here. It does take some work so we're insisting on completed content by a deadline, but it's not nearly as restrictive as before.

The neatest new concept for the dReflector is the opportunity to include some general interest content, such as an article this month by Bill Delaney on the History of Phased Arrays. We are looking for similar writings of general interest on technical and professional topics, probably with some relationship to a monthly magazine theme. This is an opportunity for you to write something a lot of people will read. It won't be peer reviewed and we don't want things that really belong in or have already been published in other sources such as IEEE Xplore. So keep it light, interesting to many different groups and original. We will accept articles based entirely on our judgment of suitability and space availability with priority to members of the Boston Section.

We are pretty proud of our new online magazine, but we also welcome suggestions to make it better. As we get more organized we'll have a good way for you to give us feedback. For now, enjoy ... and contribute.

From Vision to Reality

50+ Years of Phased Array Development

William Delaney, Director's Office Fellow, MIT Lincoln Laboratory

The following artilce covers the talk Bill will be presenting as the opening plenary speaker at the IEEE International Sympsoium on Phased Array Systems and Technology. The sympsoium is being held at the Westin Hotel , 70 Third Ave., Waltham, MA, October 18 - 21, 2016.
The url is www.array2016.org.

Abstract—Phased array radar systems, which emerged over 55 years ago, have continually evolved from the early 60s to present day. Over 55 years ago, U.S. phased array radar systems brought a new dimension or capability that is fully realized in today's all-solid-state arrays, such as those on the F-22 and F-35 military aircraft. This process of expanding phased array capability involved an evolutionary series of steps each decade. This paper cites the most prominent U.S.-deployed phased array radars as viewed by one phased-array radar advocate.

Key words: radar, antenna array, phased array, phased array radar, radar antennas, array

I. INTRODUCTION

I welcome the opportunity to talk with today's phased array engineers and scientists. I have always felt comfortable interacting with the phased array community, probably because I see myself as an early worker and advocate of the phased array art. I do not consider myself a "pioneer" or "founder" although I met a fair number of them along the way. I will offer you a commentary on our phased array situation in the 1960s era, some 55 years ago. Did we have a vision then and did we make it? Yes, we had a vision way back then and "yes", we made it, but it took over 40 years – much longer than we thought.

I will illustrate some prominent deployed phased array radars that evolved over the ensuing 50-plus years. I picked U.S. systems which I see as "stepping" stones – systems that brought some new dimension or capability to the art. I believe our 1960s "vision" is realized in today's all-solid-state arrays such as those on the F-22 and F-35 military aircraft. In the 60s, we wondered how we would cram all that X-band hardware into the one-half-inch spacing allowed, but it has been accomplished and is impressive to see! Not surprisingly, the "vision rolls on" and amazing phased arrays are now being developed and deployed.

I close with a return to the "vision" process and its important role in the careers of engineers and scientists. Persisting with a vision for a long duration is not easy but it is what we engineers/scientists do for the public at large. In our phased array case, this "vision" process has a happy ending.

II. THE 1960S

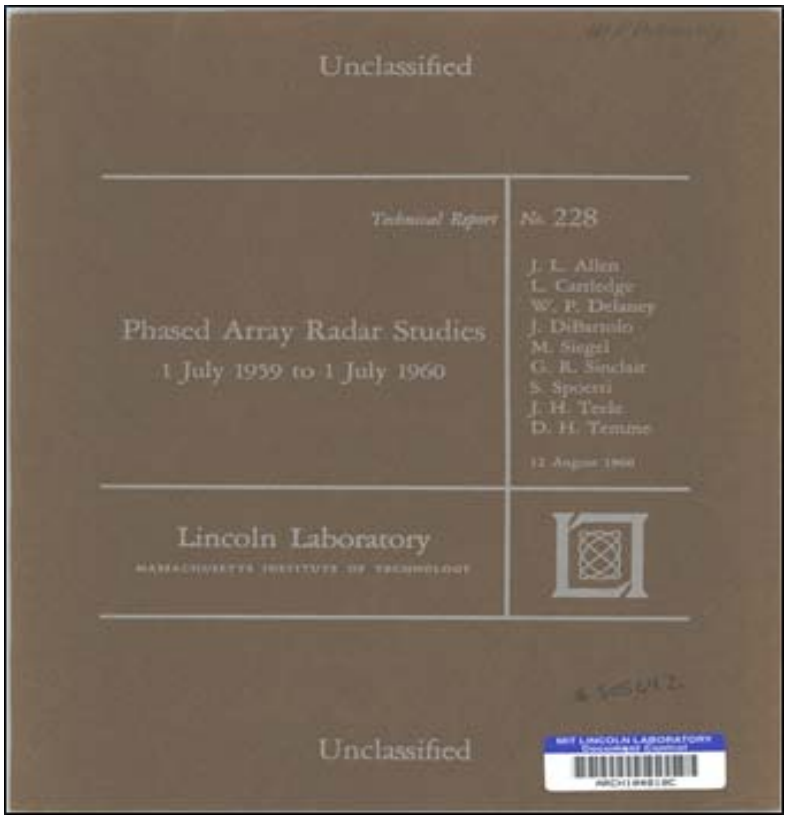
I joined Lincoln Laboratory in May of 1957 with a joint appointment to the Laboratory staff and the MIT Graduate School. 1957 became an exciting year on 4 October when the engineers and scientists of the Soviet Union launched the first artificial earth satellite. The "Space Age" had begun and it was obvious that our radar technology was inadequate to the task of space surveillance. A long-range aircraft surveillance radar of that era could detect a large jet aircraft at 200 miles, but the satellite detection job would require at least 2,000 miles! Early satellite radar returns would be smaller than jet aircraft so we were some 50 dB shy in radar power-aperture product. This huge deficiency in radar plus the need for very wide angle scanning turned our thoughts to phased arrays – big phased arrays! Also, the ability to put a satellite in orbit also conveyed the ability to send warheads to intercontinental distances so ballistic missile defense became a national concern. Missile defense would

demand radars of great power-aperture and very agile beam scanning for surveillance, tracking and fire-control.

I wanted to do a substantial experimental thesis at the MIT Graduate School and the topic that came my way was “Phase Stabilization of UHF Power Amplifiers”, a project funded by U.S. Air Force interest in phased array technology. So I joined the phased array business early in 1958.

I finished my graduate study in 1959 and joined a small Lincoln Laboratory group which was exploring phased array technology. This group had formed around a most talented individual, John Allen, who had great analytical skills and a creative, dynamic leadership style. He was a frequent writer of technical papers and his name is prominent in the phased array literature of the 1960s.

Lincoln Laboratory’s role as a Federally Funded Research Center prompted John to set a goal for our work that was “national” in scope. The goal was to make electronically steered arrays a practical option for the defense/military user. To achieve this goal, our program would have to foster tight coupling to the wide variety of industrial teams, laboratories, and academia around the nation who were investigating this technology. I can recall at least a dozen major electronic firms plus some six laboratories and a few universities, all with small teams, interested in phased array technology. We set out to collaborate with these some 20 teams around the nation. We invited them to our laboratory and briefed them on our work, visited their facilities, shared data with them and occasionally undertook joint investigations or hardware ventures with them. One important step we took was to publish a comprehensive technical report on our work each year and distribute that report widely to the community. Fig. 1 is a copy of the cover of our first such report, Lincoln Laboratory Technical Report, TR-228 with some 230 pages. Over the ensuing 5 years, we published TR-236, 299, and 381 plus a variety of other reports and papers. This publications process served our goal very well and I recall lots of feedback from the community on our work described in these publications.



(MIT Lincoln Laboratory)

Figure 1. Reprinted from “Phased Array Radar Studies: 1 July 1959 to 1 July 1960”, by J. L. Allen, L, Cartledge, W.P Delaney, J. Dibartolo, M. Siegel, G. R. Sinclair, S. Spoerri, J. H. Teele and D. H. Temme, 1960, Lincoln Laboratory Technical Report, cover. 1960

The electronic technology situation in 1960 was such that many knowledgeable technical people considered the vision of an affordable, high-powered 5,000-element array with all elements acting reliably and in complete amplitude and phase coherence an “impossible dream.” The cost, complexity, and reliability of such arrays were substantial concerns to those knowledgeable engineers. Our early experimental arrays certainly were a complex assembly of disparate hardware pieces. One 16-element test array I assembled must have had 100 pounds of cables to connect the elements to the receivers, beam formers, etc.

Clearly, an all-solid-state configuration would be the solution, but there were no appropriate high-frequency or high-powered solid-state devices available in the early 1960s! Thus, a high-frequency,

high-power solid-state array became our "vision." In the mid-1960s, the nation undertook focused solid-state array device work at L band, and that work by a variety of industry teams and national laboratories carried us some 50 years later to today's fine X-band, all-solid-state transceiver modules and the realization of the "vision." In response to an urgent need for high frequency solid-state devices at low cost and high reliability, the Defense Advanced Research Projects Agency (DARPA) initiated the MIMIC program in 1988 and continued it with sustained investments through 1995. The program established robust, controllable manufacturing processes for gallium arsenide (GaAs) integrated-circuit chips, multichip ceramic packages, accurate computer-aided device and circuit modeling tools, automated on-wafer testing techniques, and advanced fabrication methods. The technologies developed in the MIMIC program established a mature manufacturing base for the production of active phased arrays at lower cost, improved reliability, and higher performance.

We told our sponsors it might take 10 to 15 years to "realize the vision," but we were very optimistic. It has taken closer to 50 years, and today we have all-solid-state radars, such as the active electronically scanned arrays in the F-22 and F-35 fighters, and the realization of even more advanced arrays which will be discussed in the next section.

A. "STEPPING STONES"

I can describe the migration from vacuum-tube arrays to today's all-solid-state configuration by pointing to a time-ordered sequence of deployed phased arrays. Each one of the more than dozen cited arrays in this quick review is in my view considered a "stepping stone", with each bringing something important or new to the phased array art. The phased array systems cited offer my perspective on the more important developments; a different author might pick different systems. I limited my selection to phased array radar system (vs. communications systems and to radars that were actually deployed. All are U.S. systems which are the only arrays I am familiar with in detail. I order my list in time sequence of their Initial Operational Capability (IOC) dates, starting with the earliest.

B. 1962: AN/SPS 32/33 RADARS

I select these two radars because I believe they were the first substantial phased arrays deployed. They were sponsored by the U.S. Navy for ship defense and were built by the Hughes Company of Fullerton, CA. They are shown in Fig. 2, deployed on the forward superstructure of the cruiser "Long Beach" (they were also deployed on the aircraft carrier "Enterprise"). The SPS-32 was a UHF radar with long-range surveillance and tracking capability. The SPS-33 was an S-band array with fine resolution tracking capability. The SPS-32 was a phase-scan aperture and the SPS-33 utilized a phase-frequency scan. Both were large arrays. I visited their test site in Fullerton, CA in the mid-1960s and was impressed by the size of the antennas. Eight apertures were deployed on each ship to provide 360-degree azimuth coverage.

Figure 2. AN/SPS-32/33 Radars

C. 1969: THE FPS-85

This large UHF phased array, shown in Fig. 3, was built for Air Force satellite surveillance purposes by the Bandix Corporation of Maryland. It is located at Eglin Air Force Base in Florida and is still operating today. It represented to me a classical realization of the early phased array art. The square

aperture is the 5,000-element transmitter radiating some 175 kilowatts of average power. The larger aperture is the 4,700 element receiver with many dummy elements to form an effective amplitude taper across the array.

This phased array provides an example of the reliability concerns about these early arrays. Each transmitter element was originally driven by three high-power vacuum tubes: a tetrode final amplifier of 10 kW peak power and two triode amplifiers as drivers; thus, the transmitter features some 15,000 high-power tubes (plus a multitude of low-power tubes). These high-power amplifiers operated 24 hours a day and if one operated them conservatively, a 10,000-hour service life was achievable. A simple calculation of 10,000 hours life for 15,000 tubes has 12,000 tubes replaced each year which calculates to 33 replacements per day. I visited this radar in 1974 and the Air Force sergeant who monitored the transmitter told me that on a "good day" he replaced 10 tubes, on a "bad day" 35 tubes, and on the day of my visit 17 tubes. So there was a substantial burden in maintenance with arrays with high-power vacuum tubes (the receivers of the FPS-85 featured transistor circuits).

Figure 3. FPS-85

D. 1975: MSR, PAR

These two radars are noteworthy since they were the main sensing elements of the United States first national missile defense system. They were located at Grand Forks, ND near the ICBM Minuteman missile deployment at Grant Forks Air Force Base.

The massive concrete structures that house the arrays are testimony to the nuclear environment in which they were designed to operate.

Figure 4. Missile Site Radar (MSR)

The Missile Site Radar (MSR), shown in Fig. 4, was designed for medium-range surveillance, tracking, fire control and missile guidance. It was built for the Army's missile defense program by the Raytheon Company of Massachusetts. The Bell Telephone Laboratory was heavily involved in its design and testing. It contained four S-band array faces, each with 5,000 elements (the array is the smaller circular aperture in the figure, the larger ring was for future expansion).

The array features a lens feed with diode phase shifters and the transmitter was a very high-power klystron pair. The average radiated power was some 225 kW (the futuristic appearance of this radar building has resulted in the building being used in television science fiction programs representing various kinds of alien structures).

The Perimeter Acquisition Radar (PAR), shown in Fig. 5, was built for the Army missile defense program by the General Electric Company of Syracuse, NY. The radar, which still operates today for satellite surveillance, has been renamed PARCS and sometimes is referred to as the "Cardinal" radar. It is located several miles from the MSR site.

Figure 5. Perimeter Acquisition Radar (PAR)

The PAR's role in missile defense was long-range surveillance and tracking. It operates at UHF and contains some 6,000 elements in its 100-foot aperture. It features a corporate feed with traveling wave tubes providing the 700-plus kW of average radiated power.

E. 1977: COBRA DANE RADAR

The COBRA DANE radar, shown in Fig. 6, was built for the U.S. Air Force by the Raytheon Company of Massachusetts and it still operates today. The radar is located on the Shemya Island in the Aleutian Islands archipelago southwest of Alaska. Its site and its long-range capability allow it to track satellites and to monitor ballistic missile flights in the Pacific Ocean area.

Figure 6. COBRA DANE Radar

The COBRA DANE development featured a strong emphasis on reducing the cost of large phased arrays. The array operates at L-band and has some 15,000 active elements in its 95-foot diameter aperture. The array is corporate-fed with travelling wave tube transmitters providing some 900 kW of average radiated power.

I recall that the goal of lowering the cost of arrays was achieved and COBRA DANE became the prominent example of a high-performance, lower-cost array.

F. 1980: PAVE PAWS

The PAVE PAWS array radar (Fig. 7) development is noteworthy since it was the world's first high-powered all-solid-state array. PAVE PAWS' mission was warning of ballistic missile attack. It was built for the U.S. Air Force by the Raytheon Company of Massachusetts. The first two PAVE

Figure 7. PAVE PAWS

PAWS radars were located at Cape Cod in Massachusetts and Beale Air Force Base in California. These UHF radars had two 100-foot diameter array faces with some 1800 active elements per face. Each antenna element was driven by a 325 watt peak-power solid-state module.

One can argue that PAVE PAWS realizes our vision of an all-solid-state array. It did certainly validate the solid-state array potential but at the time of its development the military interest was focused on arrays at higher frequency than UHF. That interest extended to L, S, C and X-band so I argue PAVE PAWS was a significant step in answering the vision but was not the final step.

The architecture of a large all-solid-state UHF surveillance radar became a popular construct and the PAVE PAWS approach was used in a major upgrade of the Ballistic Missile Early Warning System (BMEWS), with improved versions of the PAVE PAWS UHF array faces installed at Clear, Alaska; Thule, Greenland; and Fylingdales, UK.

G. 1981: PATRIOT

The PATRIOT array radar, shown in Fig. 8, was built for the U.S. Army by the Raytheon Company of Massachusetts. The PATRIOT system role/mission was a surface-to-air missile system (SAM) for defense of Army assets against aircraft and missile attack. The PATRIOT SAM was an early tactical user of a phased array for surveillance, tracking, and missile guidance.

The radar featured a C-band lens-fed array of 5,000 elements with diode phase shifter. Traveling wave tubes provided the RF power.

Figure 8. PATRIOT Surface-to-Missile (SAM) System

The lens feed of PATRIOT was a favorable choice for a field mobile system like PATRIOT since the radiating aperture could be folded flat onto the top of the vehicle for transport. This type of lens feed has become popular and Russia and now China are producing tactical SAMs with this style of array. Over 200 PATRIOT SAMS have been produced and used by a number of nations. The PATRIOT system has been used in combat a number of times.

H. 1983: AEGIS SPY-1 RADAR

The AEGIS SPY-1 radar, shown in Fig. 9, was built for the Navy by the Lockheed Martin Corporation of Moorestown, NJ. The array face can be seen on the forward superstructure of the ship. The AEGIS system's role is air and missile defense of the surface fleet. The system has seen combat a number of times.

The SPY-1 radar is an S-band, 4,000-element ar-

ray that uses cross-field amplifiers for transmitters in a corporate feed arrangement. Average radiated power is some 60 kW.

Four array faces are used on each AEGIS cruiser or destroyer to provide 360 azimuth coverage. Some 77 major ships carry the AEGIS system, which adds up to some 300 array faces deployed – probably a record number of arrays in the U.S. inventory. An advanced version of AEGIS is in development.

I. 1983: COBRA JUDY RADAR

The COBRA JUDY radar system, shown in Fig. 10, was built for the U.S. Air Force by the Raytheon Company of Massachusetts. Its mission was data collection on ballistic missile flights. COBRA JUDY is my favorite array radar system since I had a lot to do with its specification and development during my tour in the Department of Justice Defense (DoD) in the 1973-76 time frame. The COBRA JUDY system served for 31 years and was recently retired. The COBRA JUDY ship, the "Observation Island", is one of a long line of range instrumentation ships that collect data on a wide variety of missile testing. The "Observation Island" was preceded by the "Arnold" and "Vanderberg" ships and is succeeded by the "Howard O. Lorenzen", which will be described shortly.

The COBRA JUDY radar is a 12,000-element S-band array with a 20-foot diameter. Its transmitters are travelling wave tubes in a corporate feed structure. The array is mounted on an azimuth pedestal.

Figure 9. AEGIS SPY-1 Radar

Figure 10. COBRA JUDY Radar

J. 1987: JSTARS

JSTARS, shown in Fig. 11, is the first airborne array on my list of prominent phased arrays. It was built for a joint Air Force-Army program by the Northrop Grumman Corporation of Florida. The JSTARS mission is wide area surveillance of ground targets, both moving targets and fixed targets. The 24-foot X-band array is mounted on the forward fuselage of a 707 aircraft. The array is scanned in azimuth and has a limited mechanical scan in elevation. Sixteen JSTARS aircraft are operational and the system has been used in combat. A current program is investigating a JSTARS-like capability on a smaller air frame, such as a business jet.

K. 2005, 2012: APG-77, APG-81 (ALSO APG-79)

In 2005, the APG-77 radar, shown in Fig. 12, fully answered our 1960's vision of an all-solid-state radar operating at the higher microwave frequencies. This X-band radar was built for the Air Force for installation in the F-22 fighter (187 F-22s have been produced), by the Northrop Grumman Corporation of Baltimore, MD.

Northrop Grumman also built the APG-81 X-band all-solid-state array, shown in Fig. 13, for the Air Force for use in the F-35 fighter. Raytheon Company of Massachusetts also produced a similar array for the F/A-18 fighter called the APG-79.

Figure 11. JSTARS

Figure 12. APG-77 Radar

These three programs alone will produce more than 1,000 of these modern airborne arrays. They all feature more than 1,000 array elements and many of the "bells and whistles" enabled by modem solid-state microwave components and modern digital engineering.

In 1960, we had a hard job considering how one might cram all the hardware into the one-half inch space allowed for an X-band array. The nation's steady and long-lasting MIMIC program produced this amazing capability.

L. 2008: TPY-2 RADAR

As we celebrated the realization of our all-solid-state vision by the APG-77 radar, we received a reminder that "the vision marches on" when the TPY-2 radar, shown in Fig. 14, appeared in the scene somewhere around 2005 (prior to its declared operational date of 2008). I was shocked to see the 25,000-element X-band array in development at the Raytheon Company. This development was testimony that the solid-state array technology had taken hold.

Figure 13. APG-81 Radar

The TPY-2 radar was developed for the Missile Defense Agency by Raytheon Company of Massachusetts. Its mission was to be the principal sensor in a medium-range missile defense system. It also has found use as a surveillance-tracking sensor around the world. My recollection is that some 12 of the radars are operating around the world.

Figure 14. TPY-2 Radar

(United States Missile Defense Agency)

Figure 15. SBX Radar

M. 2005: SBX RADAR

Whatever surprise I had at 25,000-element TPY-2 was exceeded when I witnessed the SBX seaborne X-band array, shown in Fig. 15, built for the Missile Defense Agency by Raytheon Company of Massachusetts. This huge radar in a unique sea-going platform features a world-record 45,000 elements on an azimuth-elevation pedestal. It is part of our current missile defense capability, operating from various locations in the Pacific.

N. 2014: COBRA KING RADARS

The Cobra King radars on the new ship, the "Howard O. Lorenzen", are the range instrumentation ship radar replacement for the COBRA JUDY system. The ship, shown in Fig. 16, was developed for the Air Force with radars by Northrop Grumman Corporation of Maryland and Raytheon Company of Massachusetts. The upper radar is an S-band all-solid-state array by Northrop Grumman and the lower radar is an X-band system by Raytheon. Both of these modern all-solid-state arrays feature thousands of elements and substantial average radiated power.

Figure 16. COBRA KING Radars

O. 2018 IOC: SPACE FENCE RADAR

Further testimony that the "vision marches on" is offered by the Space Fence Radar, shown in an artistic concept in Fig. 15, currently being installed on Kwajalein Atoll in the Marshall Islands in the Pacific. The radar is being built for the Air Force by the Lockheed Martin Corporation of Moorestown, NJ. A second site for this type of radar is planned for Australia.

The S-band Kwajalein array features a transmitter array of some 36,000 elements and average radiated power of some 810 kW. The separate receiver array has some 86,000 receiver elements. The role of this radar is surveillance with an ability to see even very small objects in orbit (a following paper in this plenary session by Joseph Haimerl gives details on this fantastic evolution in array technology).

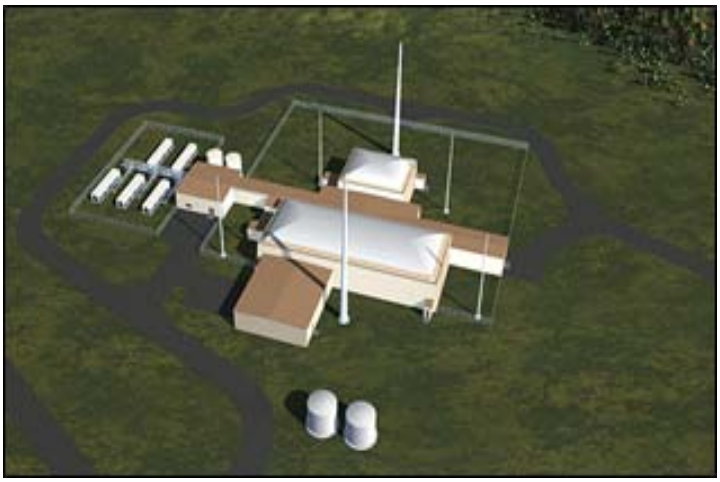


Figure 17. Space Fence Radar

III. ENGINEERS AND VISIONS

Our development of truly amazing array technology over the past 50-plus years is testimony to the vision of engineers and scientists. We are the "keepers of visions" and the public at large has grown accustomed to this march of visions which provides an ever increasing supply of devices and systems that benefit mankind.

As young engineers, most of us found ourselves working to implement somebody else's idea or vision. Most of us took a good while to realize we are entitled or, rather, we are somewhat obligated to be visionaries.

The visionary role is not easy. A really great vision will create a lot of upset and even hostility in the community of folks doing things the "old way". If one has a great idea that does not upset a lot of folks, maybe it is not so great an idea! Many years ago, the Navy folks who added steam engine drive to a Navy sailing ship were not welcome in Navy circles. It seems that coal for the steam boilers got the white uniforms of the crew sooty and the test ship for steam drive was allowed to rot at its dock! So be prepared for rough road as you pursue your vision.

Some great individuals offer encouragement to the visionary. Famous aerodynamicist, Professor Theodore von Kármán of Caltech explains the engineer's role:

"The scientist seeks to understand what is. The engineer seeks to create what never was."

Prolific author, Mark Twain points to the need for self-confidence:

"If you think you can or if you think you can't, you're probably right."

And finally, some anonymous wise individual offers you encouragement if you consider your expertise to be inadequate:

"The Titanic was built by professionals: The Ark was built by amateurs."

Good luck to you in pursuit of your visions and congratulations to the phased array community, past and present, for the realization of a 1960's vision for phased arrays.

REFERENCES

Images in this paper were taken from the "public domain" web sites listed below:
Fig. 2. AN/SPS-32/33 Radars
http://militaryhistory.x10.mx/shippictures/uss%20long%20beach/uss%20long%20beach%2002.jpg
Fig. 3. FPS-85
https://en.wikipedia.org/wiki/Eglin_AFB_Site_C-6#/media/File:2008_Eglin_AFB_Site_C-6_phased_array_building.jpg
Fig. 4. Missile Site Radar (MSR)
https://en.wikipedia.org/wiki/Safeguard_Program#/media/File:Safeguard_Missile_Site_Radar.png
Fig. 5. Perimeter Acquisition Radar (PAR)
https://en.wikipedia.org/wiki/Safeguard_Program#/media/File:Cavalierairforcestation-parcs.jpg
Fig. 6. COBRA DANE Radar
https://en.wikipedia.org/wiki/Cobra_Dane#/media/File:Cobradane.jpg
Fig. 7. PAVE PAWS
https://en.wikipedia.org/wiki/PAVE_PAWS#/media/File:PAVE_PAWS_Radar_Clear_AFS_Alaska.jpg
Fig. 8. PATRIOT Surface-to-Missile (SAM) System
http://data3.primeportal.net/artillery/ulrich_wrede/nl_patriot/images/nl_patriot_03_of_87.jpg
Fig. 9. AEGIS SPY-1 Radar
http://www.seaforces.org/marint/Japan-Maritime-Self-Defense-Force/Destroyer/Atago-class-Dateien/image082.jpg
Fig. 10. COBRA JUDY Radar
Figure 1. USNS Observation Island. The Cobra Judy S- band radar array.. https://www.researchgate.net/figure/4242838_fig1_Figure-1-USNS-Observation-Island-The-Cobra-Judy-S-band-radar-array-is-located-aft-of [accessed Aug 8, 2016]
Fig. 11. JSTARS
http://www.airforce-technology.com/projects/jstars/jstars1.html
https://en.wikipedia.org/wiki/Northrop_Grumman_E-8_Joint_STARS#/media/File:Usaf.e8.750pix.jpg
https://en.wikipedia.org/wiki/Northrop_Grumman_E-8_Joint_STARS#/media/File:T-3_with_JT8D-219_engines.JPG
Fig. 12. APG-77 Radar
http://www.globalsecurity.org/military/systems/aircraft/systems/images/an-apg-77-image1.jpg
Fig. 13. APG-81 Radar
http://www.northropgrumman.com/Photos/pgM_AN-10137_001.jpg
Fig. 14. TPY-2 Radar
http://www.defenseindustrydaily.com/antpy-2-ground-radar-07533/
Fig. 15. SBX Radar
https://en.wikipedia.org/wiki/Sea-based_X-band_Radar#/media/File:Sbx_050701_001.jpg
Fig. 16. COBRA KING Radars
http://www.raytheon.com/capabilities/rtnwcm/groups/ids/documents/image/rtn_241433.jpg
Fig. 17. Space Fence Radar
http://www.lockheedmartin.com/us/news/press-releases/2015/september/150928-mst-space-fence-program-completes-critical-design-review.html

Entrepreneurs' Network - 6:30PM, Tuesday, 4 October

The Government as a Customer

Meeting Location – Constant Contact, 3rd Floor Great Room, 1601 Trapelo Road, Waltham, MA PRE-MEETING DINNER at 5:15 PM (sharp) at Bertucci's, Waltham.

US federal, state, and municipal government organizations represent an extremely large and diverse market segment. They are friendly to innovation, have large resources and a good reputation for paying on time. They also have fairly stringent processes for identifying and procuring what they want.

Early stage companies often face significant barriers to entry from established suppliers, daunting business processes, and unfamiliarity with missions and needs. How can you overcome them and profit from a relationship with government? And when you have achieved that fantastic order, what's next?

On October 4, our panelists will address these issues and more. Kristina Camerota from the Procurement Technical Assistance Center, will speak to the processes for identifying and responding to government requests (SBIRs, BAAs, RFPs, RFQs, etc) and how to conduct business. Erin Fopiano of the Raytheon Small Business and Innovation Office will tell us about teaming and working with already established government suppliers. Chris Whalen with New Technology Ventures will discuss transitioning from government business to the commercial sector. Venkatesh Chari of Orbit Research will describe how his company worked with the US Bureau of Engraving and Printing to establish a long term relationship that eventually led to a significant contract win. The discussion and a Question and Answer session will be moderated by Fausto Molinet of Matrix Internationale.

If you are seeking to develop or increase your revenue through government business, this is a must attend event. You will leave with information and contacts that can give you opportunities to "get you foot in the door" and develop strong resources for growth.

PANELIST: KRISTINA CAMEROTA, PROCUREMENT TECHNICAL ASSISTANCE CENTER (PTAC), KCAMEROTA@MSBDC.UMASS.EDU

Prior to joining PTAC, Kristina had worked closely with small businesses and individuals. She is an active member of the Association of Procurement Technical Assistance Centers (APTAC) and National Contract Management Association (NCMA).

PTAC provides many forms of service are provided to its clients. The most valuable of these services is one-on-one business assistance, both during the proposal process and the subsequent contract period. Client firms receive an understanding of contracting requirements and the know-how to obtain and successfully perform federal, state and local government contracts. PTAC provides a wide range of assistance, such as: guidance on initial registrations and small business certifications, researching procurement histories, small business matchmaking conferences, proposal guidance and review, contract performance issues and much more.

PTAC is funded from the U.S. Department of Defense and the Massachusetts Department of Business Development, through the University of Massachusetts Amherst, Isenberg School of Management,.

PANELIST: ERIN FOPIANO, RAYTHEON SMALL BUSINESS AND INNOVATION OFFICE, ERIN.J.

FOPIANO@RAYTHEON.COM

Erin Fopiano, is the SBIR and Small Business Innovation Research (SBIR) Coordinator and a member of the Supplier Innovation team at Raytheon Integrated Defense Systems (IDS). During her tenure in Supplier Innovation, Erin improved collaboration and information sharing among Integrated Supply Chain, Suppliers, Advanced Technology Programs and Engineering across the four Raytheon Business Units. She was also pivotal in the creation of the Front-End of the Business Web site for IDS.

Erin joined Raytheon in October 2009 as a Process Engineer for Patriot. In 2015, Erin received a Supplier Diversity Award in 2015 for enabling cross business unit collaboration and was honored with Raytheon at the Navy Opportunity Forum with the People's Choice Award in recognition of the assistance provided in the Transition Assistance Program.

She earned a Master's Degree in Technical and Professional Writing, with a concentration in computer documentation, from Northeastern University in and a Bachelor of Arts Degree in Journalism from the University of Rhode Island.

PANELIST: CHRISTOPHER WHALEN, MANAGING DIRECTOR, NEW TECHNOLOGY VENTURES, CWHALEN@NEWTECHVC.COM

Chris Whalen has over two decades of professional experience starting, building, advising, and working with successful technology firms. He has founded and/or served in leadership, executive, and corporate development roles in multiple early and growth stage companies, with primary responsibility for overall revenue generation, raising capital for operations and growth, partnering, strategic transactions, and mergers and acquisitions, with a particular focus on enterprise technology and monetizing intellectual property from larger institutions.

Chris has been a part of early stage companies such as Links2Go, Continuum Software and a variety of other entities worldwide, and has worked with firms such as Guggenheim Ventures, Bain Capital, Eastward Capital, Draper Fischer Jurvetson, Kistefoss, and other leading private equity and venture capital firms.

Prior to NTV, Chris served for 6 years as a merchant banker working with early and growth stage companies to raise capital, complete acquisitions, and structure and arrange debt and lines of credit. Early in his career, Chris was responsible for monetizing intellectual property for NEC Labs inNorth America, the $2B research and development arm of NEC Corporation in Japan.There Chris successfully spun-out technologies in the areas of enterprise applications, as well as bioinformatics.

Chris earned his BA from Assumption College and his MBA from Babson College (FW Olin School of Business).

PANELIST: VENKATESH CHARI, ORBIT RESEARCH VENKATESH.CHARI@GMAIL.COM

At Orbit Research, a company specializing in the development, marketing and manufacture of affordable electronic products for people with special needs, he is responsible for technology, product definition and strategic direction. His efforts there led to a significant contract win with the US Bureau of Engraving and Printing for iBill, a currency reader for the blind.

His first job was at a small Boston startup, developing electronic products for blind people where he developed a talking blood-glucose meter and blood pressure monitor and the first handheld PC with a

speech synthesizer. He subsequently joined another small startup in Lexington where he developed a method to improve the quality of speech for laryngectomees, obtaining a patent for this. In 1996, Venkatesh joined the wireless handset group at Analog Devices, Inc., where he spent the next 14 years in roles spanning engineering, management and strategic technical marketing and led the development of mobile phone hardware, software and architecture.

Chari obtained a BE degree in Electronics from MS University, Baroda, India and an MSEE from Boston University, with a focus on speech and signal processing.

MODERATOR: FAUSTO MOLINET,
www.matrixinternationale.com
Fausto Molinet, IEEE Representative, ENET Founder
Fausto co-founded the Entrepreneurs' Network, and is president of Matrix Internationale, a business development group with associates in Boston, Chicago, Melbourne, Florida and Metzingen, Germany. www.matrixinternationale.com

Meeting Location: Constant Contact, Inc., Reservoir Place, 3rd Floor Great Room, 1601 Trapelo Rd., Waltham, MA (Exit 28B, I-95/Route 128)

Pre-meeting Dinner at 5:15 PM (sharp) at Bertucci's, Waltham, (Exit 27B, Route 128)

Check for Updates at: Boston Entrepreneurs' Network Website at http://www.boston-enet.org

Directions: http://www.constantcontact.com/about-constant-contact/office-location-waltham.jsp

Reservations: ENET Constant Contact meetings are free to ENET members and $20 for non-members. No reservations are needed for the dinner. To expedite sign-in for the meeting, we ask that everyone -- members as well as non-members -- pre-register for the meeting online. Pre-registration is available until midnight the day before the meeting. If you cannot pre-register, you are welcome to register at the door.

Nuclear and Plasma Science, and Photonics Societies – 2:00PM, Thursday, 6 October

Ultra-Miniature Lensless Computational Imagers and Sensors Using Optics for Computing and Computing For Optics

David G. Stork, Rambus Labs

Hosted by Professor Lei Tian, leitian@bu.edu, Department of Electrical & Computer Engineering (ECE), Boston University
Sponsored by Professor Min-Chang Lee mclee@bu.edu of ECE Boston University, IEEE Boston NPSS Chapter Chair.

We describe a new class of computational optical sensors and imagers that do not rely on traditional refractive or reflective focusing but instead on special diffractive optical elements integrated with CMOS photodiode arrays. The diffractive elements have provably optimal optical properties essential for imaging, and act as a visual chirp and preserve

full Fourier image information on the photodiode arrays. Images are not captured, as in traditional imaging systems, but rather computed from raw photodiode signals. Because such imagers forgo the use of lenses, they can be made unprecedentedly small—as small as the cross-section of a human hair. Such imagers have extended depth of field, from roughly 1mm to infinity, and should find use in numerous applications, from endoscopy to infra-red and surveillance imaging and more. Furthermore, the gratings and signal processing can be tailored to specific applications from visual motion estimation to barcode reading and others.

David G. Stork is Rambus Fellow and leads research in the Computational Sensing and Imaging Group at Rambus Labs in Sunnyvale, CA. A graduate in physics from MIT and the University of Maryland, Dr. Stork has published eight books/proceedings volumes, including Pattern classification (2nd ed.) and Seeing the Light: Optics in nature, photography, color, vision and holography and has held faculty appointments in eight disciplines variously at Wellesley and Swarthmore Colleges and Clark, Boston and Stanford Universities.

He co-created the PBS television documentary 2001: HAL›s Legacy,based on his book HAL›s legacy: 2001›s computer as dream and reality, analyzing the computer science in the feature film 2001: A Space Odyssey. He holds 48 issued patents and is a Fellow of the Optical Society of America (OSA), the Society for Photographic Instrumentation and Engineering (SPIE), the International Association for Pattern Recognition (IAPR), and the International Academy, Research and Industry Association (IARIA) and is a Senior Member of the Association for Computing Machinery (ACM) and IEEE.

Meeting Location: Photonics Building Room PHO 339, Boston University, 8 St. Mary›s Street, Boston, MA 02215.

To assist us in planning this meeting, please pre-register at http://www.ieeeboston.org/Register/.

Photonics, and Nuclear and Plasma Sciences Societies – 6:00PM, Thursday, 13 October

Photonic Properties and Applications of Hybrid Lead Halide Perovskites

Riccardo Comin - MIT

In recent years light-harvesting devices based on a new class of organometallic lead iodide perovskites (CH3NH3PbI3) were demonstrated to exhibit power conversion efficiencies beyond 20%, rapidly approaching the performance of commercial silicon-based modules. Besides photovoltaics, lead halide perovskites and quantum-dot/perovskite hybrids were recently discovered to possess remarkable electro- and photo-luminescent properties, highlighting them as a promising materials platform for photonic applications, such as LEDs and lasers.

In this talk I will first discuss a series of fundamental studies of single-crystalline perovskite materials, including investigations of their electronic structure, carrier dynamics, and photophysical properties. I will then present some recent developments of new highly-luminescent perovskite compounds and per-

ovskite-based composite materials and hierarchical structures, and provide a few examples of how they can be tailored and functionalized for specific optoelectronic applications, and in particular for light emission technologies.

Riccardo Comin joined MIT as an Assistant Professor of Physics in July 2016. He completed his undergraduate studies at the Universita' degli Studi di Trieste in Italy, where he also earned a M.Sc. in Physics in 2009. Later, he pursued doctoral studies at the University of British Columbia, Canada, earning a PhD in 2013. Prior to MIT, Comin was an NSERC postdoctoral fellow at the University of Toronto.

For his work using synchrotron-based X-ray scattering methods on oxide-based quantum materials and halide-based optoelectronic materials, Comin received the Bancroft Thesis Award (2014), Fonda-Fasella Award (2014), John Charles Polanyi Prize in Physics (2015), McMillan Award (2015), and Coles prize (2016).

Professor Comin's research couples the design of new materials possessing novel, technologically-relevant quantum properties, with the fundamental study of the driving force behind new phases of matter or unconventional functionalities. Examples include both systems with exquisitely quantum behavior, such as high-temperature superconductors or multiferroics, and systems with non-trivial and tunable structure-property-function relationships such as halide-based perovskite semiconductors. The Comin group engages in the synthesis of single-crystalline materials, as well as thin films and heterointerfaces, and uses photonic probes such as X-ray or Raman scattering to unearth the fundamental and often elusive properties of new quantum materials.

Directions to Forbes Rd Lincoln Laboratory: (from interstate I-95/Route 128)

- **Take Exit 30B onto Marrett Rd in Lexington – Merge into left lane**
- **Make the first Left onto Forbes Rd.**
- **Proceed straight through the small rotary and enter the parking lot.**
- **The entrance is on your right.**

To assist us in planning this meeting, please pre-register at http://www.ieeeboston.org/Register/.

Entrepreneurs' Network Cambridge Meeting - 6:00PM, Tuesday, 18 October

How to Find, Select and Build your Co-Founding Team

NEW Meeting Location – WorkBar Cambridge, 45 Prospect Street, Cambridge, MA

Most successful start-ups have more than one founder, actually an average of 2.4. Since the year 2000 more than ninety percent of the billion-dollar start-up companies began with co-founders. Our Boston ENET meeting on October 18, 2016, will help entrepreneurs find, select and build their co-founding teams. It is essential that the importance of having co-founders is understood as it is critical to growing your company to a huge success.

Our panelists for the meeting include successful founders and early stage company investors. Kent Plunkett, the CEO and founder of Salary.com, Gerry Wilson, the CEO and Founder of Yoonew and Steve Hubermas, Founder and CEO of VeriLync Capital Solutions are the panelists.

Speaker: Kent Plunkett, CEO and President, CCP
A serial entrepreneur with deep experience in starting and growing companies, Kent is thrilled to be back at the helm of the company he founded in 1999. During his tenure as its Chairman and CEO for eleven years, Salary.com grew from a start-up through its successful initial public offering in 2007; was acquired by Kenexa in 2010 and subsequently, by IBM. Before acquiring the company back in January 2016, Kent was the CEO of Intronis, another SaaS leader.

Kent holds an MBA from Harvard Business School and A.B. in Economics and Government from Georgetown University. He is a three time Inc. 500 CEO, a six-time Deloitte Fast 50 awardee and recipient of the 2007 Ernst & Young Entrepreneur of Year Award for business services. Kent is accredited by WorldatWork as a Certified Compensation Professional (CCP®)

Speaker: Gerry Wilson, Partner, OmniAnalytics, NY.

Mr. Gerry Wilson is currently a partner with OmniAnalystics. He has produced data monetization strategies for an online media conglomerate, conducted data management platform evaluations and participated in business plan and go-to-market strategies for customers in the B2B marketing data space. Prior to OminAnalystics, he was the Vice President, Data and Technology Solutions for MediaLink, LLC. Previously, he was a cofounder and Managing Director at Verto Media, LLC., an advertising technology company specializing in programmatic solutions for the digital audio industry. He has also held positions with Appnexus, inc., Do It Media, LLC. and YooNew, Inc.

Gerry has a Master of Business Administration in Financial Management and Entrepreneurship from the MIT Sloan School of Management as well as a Bachelor of Science and Engineering in Mechanical and Aerospace Engineering from Princeton University.

Speaker: Steve Habermas, Founder and CEO, VeriLync Capital Solutions, www.VeriLyncCapital.com

Steve Habermas is the founder and CTO of VeriLync Capital Solutions. VeriLync provides alternate lending solutions to business owners with a mission to make it easy for businesses to quickly obtain the optimal financing solution for growing their companies so that they can focus their time and resources on running their businesses rather than financing them. Steve has 20 plus years of diverse leadership and operational execution experience that fuel his desire to fulfill VeriLync Capital Solutions mission.

Steve then worked in the high-tech software product industry as a senior executive. He was the VP of Engineering for several successful software product companies in the Boston area including Tele Atlas (acquired by TomTom), Axeda (acquired by PTC), and Verivo Software (assets acquired by Appery). Steve is recognized as an expert in applying Agile processes and bringing innovative products to market. As a business executive, Steve became frustrated that the customers he served were routinely limited in their ability to expand due to capital constraints. So, he launched VeriLync Capital Solutions to address this challenge.

He began his career as a submarine officer in the United Stated Navy, where he was responsible for the daily operation of the 165-person, $1.8 billion USS Nebraska submarine. Steve graduated with distinction from the United States Naval Academy with a BS in electrical engineering. He also earned a MS in electrical engineering from Georgia Tech and an MBA from the University of California, Berkeley, Haas School of Business. He and his wife reside in

the Boston area with their five children.

Moderator: Brigid Oliveri Siegel, Partner, Ward Howell International, Inc., http://www.ward-howell.com

Brigid Siegel is a partner and management consultant at Ward Howell, Inc. where she conducts retained executive searches. In this capacity, she focuses on finding and developing leaders as well as building effective managing teams which will guarantee success in any technology, life sciences or biotech field.

Brigid began her career in the high technology industry over 30 years ago and in executive search, 20 years ago. She was a principal at Brigid Siegel Associates, a partner at Polachi, a Managing Director with The Onstott Group, a Senior Partner at Heidrick & Struggles and a Vice President with Fenwick Partners. Throughout her retained executive search career Brigid has successfully completed numerous senior executive search assignments for clients ranging from emerging growth companies to multi-billion dollar corporations.
Brigid studied at Polytechnic Institute of Brooklyn and holds a Bachelor of Science Degree in Electrical Engineering from Lowell Technological Institute. Her executive search industry expertise has been cited in the Boston Business Journal, the New York Post, as well as Hunt Scanlon's Executive Recruiting Industry Newswire. She was also a member of the Executive Board of the WPI (Worcester Polytechnic Institute) Venture Forum for seven years and is currently a Boston ENET Vice Chairperson and an Executive Board member.

Where: Workbar Cambridge is less than a block away from the MBTA Red Line (Central stop). There are on-street, 2-hour metered parking spaces throughout the surrounding area, as well as affordable parking garages/lots. For detailed information see: http://boston.workbar.com/neighborhood/cambridge-office-space/

Admission: General admission is $10. Free to ENET members. Free Pizza and soft drinks will be served. Advanced registration is requested but not necessary.

For more information and for updates, visit www.boston-enet.org

Reliability Society (co-sponsored by NE-ESDA) – 5:30PM, Wednesday, 19 October

The Design Engineer: Weak link or Warrior in the ESD Battle?

Ginger Hansel, Director of ESD Program Management, Dangelmayer Associates LLC

Ginger Hansel, Director of ESD Program Management, Dangelmayer Associates LLC, joint meeting with NE-ESDA at MIT Lincoln Lab, Lexington, MA.

Agenda:
5:30-6:00 Sign In, Networking, Light Dinner & Refreshments
6:00-6:10 Chapter Chair Greetings & Announcements
6:10-8:00 Ginger Hansel, Director of ESD Program Management, Dangelmayer

Associates LLC
8:00-8:15 Q&A session, meeting adjourns

Design Engineers strive to incorporate ESD protection into chip designs, but they are often unclear about the best way to handle the physical devices. The Industry Council on ESD Targets documented a need to lower both the HBM and CDM thresholds with the confidence that factories already had the appropriate ESD control programs in place. However, many engineering labs do not understand or follow industry ESD guidelines and are unaware of the potential jeopardy created by these lower thresholds. Anyone doing device testing, characterization, TLP stress testing, board level analysis or upgrading their own computer should know basic ESD control techniques. This seminar will include practical ESD control tips for engineering labs as well as how to set up and monitor a comprehensive ESD control program. Real world examples will show the increased ESD risk of Charged Board Events (CBE), the surprising damage due to hand tools and how to use event detectors to identify ESD threats. You've spent a lot of effort doing careful designs – now take good care of your valuable test chips and prototype engineering samples.

Ginger Hansel joined Motorola's Semiconductor Products Sector in 1981 as a Test Process/Equipment Engineer to analyze and improve manufacturing operations. She founded and led the manufacturing ESD control team that trained, audited, qualified materials, and established innovative solutions throughout the semiconductor sector. Under her leadership, the team reduced a 40% failure rate in one test operation to almost zero through the targeted introduction of specific ESD control materials and ESD Awareness training. Ginger brought ESD awareness to her other roles as Engineering Section Leader, Technical Training Manager, QA Engineer, Business Metrics Engineer, Data and Document Control Manager, Program Manager and Technical Product Marketing Manager. Ginger retired from Motorola/Freescale in 2004.

She has published numerous magazine articles and technical papers on effective ESD control programs and awareness training; examples include "The Production Operator: Weak Link or Warrior in the ESD Battle" and "Cost Effective Failure Analysis Method for Detecting Failure Site Associated with Extremely Small Leakage". She has taught seminars and workshops around the country and abroad. For over 20 years, Ginger has held leadership positions in the International ESD Association such as President, Board of Directors, Chairman of the Association Council on Education and has served on the Steering, Technical Program, Standards, and other committees.

Ginger initiated the NARTE ESD Certification in 1992 and is a certified ESD control engineer. She is currently on the board of directors for the Texas ESD Association.

Ms. Hansel received a BS in Natural Sciences (Psychology) and a BS in Electrical Engineering Technology, both from the University of Houston. She received her MBA (Executive Option II program) from the University of Texas.

Meeting Location: 3 Forbes Rd, MIT Lincoln Laboratory -- Forbes Rd, Lexington, Massachusetts
To assist us in planning this meeting, please pre-register at
http://www.ieeeboston.org/Register/.

Education, and Aerospace and Electronic Systems Societies, and Women In Engineering - 6:00PM, Thursday, 20 October

Singing Whales, Deep-Rumbling Elephants

What Do Their Calls Tell Us about Who They Are?

This lecture, illustrated with sound and video, will sample Katy Payne's 30 years of research into the acoustic behavior of whales and elephants.

For reasons that remain incompletely understood, humpback whales continually, progressively, and communally change their long complex songs amongst many populations. Meanwhile on land, elephants use infrasound and audible sound to organize social behavior over relatively large distances. What do their uses of sound suggest about these animals' minds, and why should we listen to these huge, intelligent, long-lived mammals?

Streaming live at …. RSVP at tinyurl.com/TuftsWomeninSTEM

Doctor Katy Payne is affiliated with the Cornell Lab of Ornithology's Bioacoustics Research Program, founder of the lab's Elephant Listening Project, and author of *Silent Thunder: in the Presence of Elephants*. Although officially retired from Cornell she continues to ponder the mysteries of nature ...

Dinner: 6:00 – 6:30PM

Lecture and Questions: 6:30 – 8:30PM

Meeting Location: Tufts University, Coolidge Room Ballou Hall

To assist us in planning this meeting, please pre-register at http://www.ieeeboston.org/Register/.

Consultants Network and co-sponsoring Women In Engineering - 6:30PM, Tuesday, 25 October

Seven Tips for Technical Presenters

Norman Daoust

What percentage of presentations by technical presenters that you have attended can you say you really enjoyed? Technical presenters are typically extremely knowledgeable in their field, but all too frequently do not have good presentation skills. This presentation provides you with seven tips for technical presentations that will easily improve their quality and improve your audience's enjoyment. Just by following these simple tips, you will improve your next presentation. And, if you practice these tips, you can become a good technical presenter!

Attendees will learn:
• Tips to make your technical presentations stand out from the rest of the pack
•Typical blunders that you can easily avoid

Norman Daoust founded his consulting company Daoust Associates, www.DaoustAssociates.com, in 2001. His clients have included the Centers for Disease Control and Prevention (CDC), the Canadian Institute for Health Information, the Veterans Health Administration, a Fortune 500 software company, and several healthcare provider organizations. In his consulting practice Norman specializes in helping organizations with their data management challenges using analysis and data modeling. He was one of the contributor to the healthcare industry standard data model, the HL7 Reference Information Model.

He serves on the Board of Directors of the New England Chapter of the Data Managements Association and has given more than forty presentations at local, regional and national conferences including the DAMA Symposium and Wilshire Meta-Data Conference and the Data Modeling Zone.

Norman is an engaging speaker who enjoys making complex topics easy and enjoyable.

PLEASE NOTE: The meeting is open to the public. No charge for Consultants Network members or employees of Constant Contact; $5 entrance fee for all others. Casual dress.

The Consultants Network meeting starts at 6:30 PM. The meeting will take place at Constant Contact, Reservoir Place - 1601 Trapelo Road, Waltham, MA 02451, in the Great Room on the First Floor. A no-host, *PRE-MEETING DINNER will take place at 5:15 PM (sharp) at Bertucci's, 475 Winter Street, Waltham, MA 02451 (exit 27B, Rte 128).*

Driving Directions: Follow I-95/route 128 to Trapelo Rd in North Waltham, Waltham. Take exit 28 from I-95/route 128. (https://goo.gl/maps/tvn3l)

Consultants Network meetings generally take place on the **fourth Tuesday** of each month, but are not held during the summer months. Check the Consultants Network website for meeting details and last-minute information.
http://www.boston-consult.com/calendar.php

For more information, e-mail
cn.boston@ieee.org or chairman@boston-com
To assist us in planning this meeting, please pre-register at http://www.ieeeboston.org/Register/.

Computer Society and GBC/ACM – 7:00PM, Tuesday, 25 October

Database Decay and What To Do About It

Michael Stonebraker, M.I.T. Computer Science and Artificial Intelligence Laboratory

The traditional wisdom for designing database schemas is to use a design tool (typically based on a UML or ER model) to construct an initial data model for one›s data and its instantiation as a collection of relational tables. Then applications are coded against this relational schema. When business circumstances change (as they do frequently) one should run the tool to produce a new data model and a new collection of tables. The new schema is populated from the old schema, and the applications are altered to work on the new schema, using relational views whenever possible to ease the migration. In this way, the database remains in 3rd normal form, which represents a «good» schema, as defined by DBMS researchers.

In a survey of 20 DBAs at three large companies in the Boston area, we found that this traditional wisdom is rarely-to-never followed for large, multi-department applications. Instead DBAs try very hard not to change the schema when business conditions change, preferring to «make things work» without schema changes. If they must change the schema, they work directly from the relational tables in place. Using these tactics, the ER or UML model (if it ever existed) diverges quickly from reality. Moreover, over time, the actual semantics of the data tend to drift farther and farther from a 3rd normal form data model.

We term this divergence of reality from 3rd normal form principles database decay. This talk explains why database decay occurs in large applications and presents a collection of ideas on how to fight it. These include defensive schemas, defensive applications, and a non-traditional model for application development.

Dr. Stonebraker has been a pioneer of data base research and technology for more than forty years. He was the main architect of the INGRES relational DBMS, and the object-relational DBMS, POSTGRES. These prototypes were developed at the University of California at Berkeley where Stonebraker was a Professor of Computer Science for twenty five years. More recently at M.I.T. he was a co-architect of the Aurora/Borealis stream processing engine, the C-Store column-oriented DBMS, the H-Store transaction processing engine, the SciDB array DBMS, and the Data Tamer data curation system. Presently he serves as Chief Technology Officer of Paradigm4 and Tamr, Inc.

Professor Stonebraker was awarded the ACM System Software Award in 1992 for his work on INGRES. Additionally, he was awarded the first annual SIGMOD Innovation award in 1994, and was elected to the National Academy of Engineering in 1997. He was awarded the IEEE John Von Neumann award in 2005 and the 2014 Turing Award, and is presently an Adjunct Professor of Computer Science at M.I.T, where he is co-director of the Intel Science and Technology Center focused on big data.

See http://amturing.acm.org/award_winners/stonebraker_1172121.cfm for more biographical details.

This joint meeting of the Boston Chapter of the IEEE Computer Society and GBC/ACM will be held in the Broad Institute Auditorium (MIT building NE-30). The Broad Institute is on Main St between Vassar and Ames streets. You can see it on a map at this location. The auditorium is on the ground floor near the entrance. **Broad Institute Auditorium (MIT building NE-30)**

Up-to-date information about this and other talks is available online at http://ewh.ieee.org/r1/boston/computer/.

You can sign up to receive updated status information about this talk and informational emails about future talks at http://mailman.mit.edu/mailman/listinfo/ieee-cs, our self-administered mailing list.

For more information contact Peter Mager p.mager at computer.org

To assist us in planning this meeting, please pre-register at http://www.ieeeboston.org/Register/.

IEEE Constitutional Amendment Q&A

Some IEEE Members have raised questions on the proposed amendment to the IEEE Constitution, which is on the current IEEE ballot. I wanted to share answers to those key concerns.

The Board is taking control of IEEE away from the members; the amendment transfers power from over 400,000 members to a small group of insiders.

A. Just the opposite. The amendment allows for all members to vote for all director positions. This is democracy in action. *Read more*.

Members in many regions will lose representation because the amendment removes regional representation from the Board of Directors, thereby making it possible that representatives from only a few select regions will be on the Board of Directors.

A. Quite the opposite. Members in many geographic regions are currently under-represented. *Read more*.

Removing technical activities representation from the Board of Directors diminishes the voice of the societies in steering IEEE's future.

A. Not true. As fiduciaries of the organization, directors are required to act in the best interests of the entire IEEE, not just the division or region that elected them. *Read more*.

Moving vital provisions of the constitution to the bylaws could subject them to be changed by a small group of Board members on short notice.

A. IEEE is and always has been a member-driven organization. Currently the Bylaws can be changed by the Board of Directors on notice as required by law. *Read more*.

The executive director and/or other professional staff will become voting members of the Board.

A. This is simply incorrect. The executive director would **not** become a voting member of the Board of Directors, nor would any other member of the professional staff. *Read more*.

The Board will be taken over by non-IEEE members.

A. This is an impossibility. To even be considered as a candidate for a seat on the Board, the individual must be an IEEE senior member or higher grade. *Read more*.

Read more about the proposed amendment to the IEEE Constitution.

If you have not yet voted, please remember to do so by 3 October. Your voice matters. If you have already voted, thank you.

Thank you for your time, consideration, and your commitment to IEEE.

Sincerely,

Barry L. Shoop, Ph.D, P.E.
2016 IEEE President and CEO

New Course Listing!

Practical RF PCB Design: Wireless Networks, Products and Telecommunications

Date & Time: Thursday & Friday, December 15 & 16; 9AM - 4:30PM

Location: Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA

Speaker: Henry Lau, Lexiwave Technology

Overview: One of the most demanding consumer products in the market is the wireless telecommunication product. A well-designed Radio Frequency Printed Circuit Board (RF PCB) contributes significantly to the success of any wireless product as the layout of the PCB greatly affects the performance, stability and reliability of the product. In today's highly competitive wireless products market with increasingly compressed development time-frame, there is a strong demand for RF professionals who possess the knowledge and experience to design top-performing RF PCBs in less number of iterations. What matters is whether your level of competence is up to the required standard to meet such demand.

Audience: RF Designers, Wireless Product Designers, Field Application Engineers, Design Managers and related professionals.

Benefits: This course aims to provide participants with an insightful training on RF PCB design from a practical, industrial perspective. Participants will be led through a systematic, theoretical presentation with case studies on commercial products in the training. The course will be conducted by an RF expert with rich industrial experience. It is suitable for RF professionals who want to keep up-to-date their skills and knowledge in RF PCB design and stay competitive.

OUTLINE

1. Printed circuit board design for RF circuits
From product design, circuit design to PCB design
Layer stack-up assignment
Grounding methods and techniques
Interconnects and I/O
Bypassing and decoupling
Partitioning methods

2. Printed circuits board design for other circuits
Clock circuits
Base-band circuits
Audio circuits
Power supplies
Impedance-controlled circuits

3. PCB design for EMC/EMI compliance
EMC/EMI compliance
Grounding methods
Decoupling methods
Shielding methods

4. Additional Design Techniques
Production concerns
Systematic product design approach
RF Modules
Evaluation boards
Other RF concerns
Casing design

5. Case studies

Expertise:

Henry Lau received his M.Sc. and MBA degrees from UK and USA respectively. He has more than 25 years of experience in designing RF systems, products and RFICs in both Hong Kong and US. He worked for Motorola and Conexant in US as Principal Engineer on developing RFICs for cellular phone and silicon tuner applications. Mr Lau holds five patents all in RF designs. He is currently running Lexiwave Technology, a fables semiconductor company in Hong Kong and US designing and selling RFICs, RF modules and RF solutions. He has also been teaching numerous RF-related courses internationally.

Decision (Run/Cancel) Date for this Courses is Friday, December 9, 2016

Payment received by December 5
IEEE Members $405
Non-members $435

Payment received after December 5
IEEE Members $435
Non-members $455

http://ieeeboston.org/practical-RF-PCB-Design/

ANSYS New England Innovation Conference

October 6, 2016 8:30 AM - 4:30 PM (EDT)

Free-to-attend one day conference at UMass Lowell Innovation Hub. Learn how simulation-driven product development can help engineers rapidly innovate new products.

In addition to our keynote presentation, we have a packed agenda featuring technical presentations including:

- Computational Dynamics for Human Body Modeling
- 5G (the next generation wireless network)
- Multiphysics Simulations of an Energy Efficient IoT-Based Smart Home
- Cloud-Based Simulation; HPC with Elasticity for Variable Workloads
- Structural Analysis of an Aerostat and Ground Station
- Printed Electronics Research for DoD and IoT Applications

Networking Reception and Raffle immediately following

Register Now!

LAST NOTICE BEFORE COURSE BEGINS, PLEASE REGISTER NOW!!

Digital Signal Processing (DSP) for Wireless Communications - Under the Hood

Time and Dates: 6 - 9PM, Wednesdays, October 19, 25, November 2, 9, 16 (10/25 is a Tuesday)

Location: Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA

Speaker: Dan Boschen, Microsemi

Course Summary:

This course is a fresh view of the fundamental concepts of digital signal processing most applicable to practical real world problems and applications in radio communication systems. This course will build an intuitive understanding of the underlying mathematics through the use of graphics, visual demonstrations, and real world applications in GPS and mixed signal (analog/digital) modern transceivers. This course is applicable to DSP algorithm development with a focus on meeting practical hardware development challenges in both the analog and digital domains, and not a tutorial on working with specific DSP processor hardware.

Target Audience:

All engineers involved in or interested in signal processing applications. Engineers with significant experience with DSP will also appreciate this opportunity for an in depth review of the fundamental DSP concepts from a different perspective than that given in a traditional introductory DSP course.

Benefits of Attending/ Goals of Course:

Attendees will build a stronger intuitive understanding of the fundamental signal processing concepts involved with digital filtering and mixed signal communications system design. With this, attendees will be able to implement more creative and efficient signal processing architectures in both the analog and digital domains

Topics / Schedule:

Class 1:
Correlation
Fourier Transform
Laplace Transform

Class 2:
Sampling and A/D Conversion
Z –transform
D/A Conversion

Class 3:
IIR and FIR Digital filters
Direct Fourier Transform

Class 4:
Windowing, Digital Filter Design
Fixed Point vs Floating Point

Class 5:
Fast Fourier Transform
Multirate Signal Processing
Multi-rate Filters

Speaker's Bio:

Dan Boschen has a MS in Communications and Signal Processing from Northeastern University, with over 20 years of experience in system and hardware design for radio transceivers and modems. He has held various positions at Signal Technologies, MITRE, Airvana and Hittite Microwave de-

signing and developing transceiver hardware from baseband to antenna for wireless communications systems. Dan is currently at Microsemi (formerly Symmetricom) leading design efforts for advanced frequency and time solutions.

For more background information, please view Dan's Linked-In page at: http://www.linkedin.com/in/danboschen

Decision (Run/Cancel) Date for this Courses is Tuesday, October 11, 2016

Payment received by October 5
IEEE Members $325
Non-members $360

Payment received after October 5
IEEE Members $360
Non-members $425

http://ieeeboston.org/digital-signal-processing-dsp-wireless-communications/

Making You a Leader - Fast Track

Date & Time: **Wednesday, November 30; 8:30AM - 5:00PM**

Location: **Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA**

Speaker: **Robin Goldsmith, President, GoPro Management**

We do projects to make change. Yet, change will not occur without leadership, and leaders are rare. Leaders make others want to do what the leader wants done. Leaders cause ordinary people to achieve extraordinary things. Managing is not the same as leading, and titles do not make leaders. Seminars can teach you to manage, but they cannot teach you to be a leader. Rather, making a leader takes special techniques—such as our personal development clinics—that can change deep-seated behaviors learned over a lifetime.

However, since clinics usually last about ten weeks, this mini-clinic was devised as a more convenient alternative. This format places responsibility upon the participant to carry out an extended informal follow-on program after completion of the formal seminar workshop session.

During the follow-on period, the participant uses time-condensed methods that simulate the lifetime learning which makes a leader. Therefore, commitment to carrying out these exercises is essential for successful transformation.

Participants will learn:

- Leadership characteristics and practices that are essential for project and personal success.
- Differences between management and leadership, how they conflict, and why leaders are so rare.
- Behaviors leaders use to influence others, up and down, to want to do what the leader wants them to do
- Special techniques personal development clinics use to change lifetime learning and make leaders.
- How to employ those special techniques in a follow-on mini-clinic to develop the leadership skills they need to make their projects successful.

WHO SHOULD ATTEND: This course has been designed for business and systems professionals who want to improve their ability to lead and influence other people.

LEADERSHIP CHARACTERISTICS & ROLE
How leadership looks and feels
Management vs. leadership
Leadership components of project success
Basic leadership practices; power sources
Real change leaders in organizations

TEAMS AND LEADERSHIP
Everyone feels leadership is lacking
Everyone thinks s/he is a leader
Results, not actions or intent
Workgroups, teams, and leaders
Situational leadership styles
Coaching and sports analogies to projects

INSPIRING AND MOTIVATING
Gaining commitment to project success
Communicating that influences others
Addressing negativism and groupthink
Conscious and unconscious messages
Greatest management principle
Hierarchy of needs effects on projects
Hygiene factors vs. motivators

Helping project players get their rewards
Influencing up and down without authority
Inspiring the extra efforts projects need
Energizing the project team

SHARED VISIONS
Relating values and vision to projects
Getting others to embrace one's vision
Developing a motivating project vision

WHERE AND HOW LEADERS ARE MADE
Born or made? How do we know?
Habits of thought that affect project success
Overcoming self-limiting lifetime learning
Leader's critical success factors
Traditional education doesn't make leaders
Special way—personal development clinics

SETTING AND ACCOMPLISHING GOALS
S.M.A.R.T. goals for self and project
Action plans to achieve your goals
Visualizing and emotionalizing

DEFINING THE FOLLOW-ON PROGRAM
Clarifying project leadership objectives
Breaking into prioritized subgoals
Establishing rewarding daily achievements
Special techniques to change habits

CARRYING OUT THE MINI-CLINIC
Working with a follow-up support structure
Mapping results regularly to goals
Objectively recording leadership changes
Self-leadership through the process

Speaker's Bio: Robin F. Goldsmith, JD is an internationally recognized authority on software development and acquisition methodology and management. He has more than 30 years of experience in requirements definition, quality and testing, development, project management, and process improvement. A frequent featured speaker at leading professional conferences and author of the recent Artech House book, Discovering REAL Business Requirements for Software Project Success, he regularly works with and trains business and systems professionals.

Decision (Run/Cancel) Date for this Courses is Friday, November 18, 2016

Payment received by November 11
IEEE Members $220
Non-members $245

Payment received after November 11
IEEE Members $245
Non-members $265

http://ieeeboston.org/making-leader-fast-track/

IEEE Boston Section Social Media Links:

Twitter: https://twitter.com/ieeeboston

Facebook: https://www.facebook.com/IEEEBoston

YouTube: https://www.youtube.com/user/IEEEBostonSection

Google+: https://plus.google.com/107894868975229024384/

LinkedIn: https://www.linkedin.com/groups/IEEE-Boston-Section-3763694/about

Defining and Writing Business Requirements

Date & Time: **Monday & Tuesday, December 5 & 6; 8:30AM - 5:00PM**

Location: **Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA**

Speaker: **Robin Goldsmith, President, GoPro Management**

Discovering and documenting business requirements for projects always has been the weakest link in systems development. Up to 67 percent of maintenance and 40 percent of development is wasted rework and creep attributable to inadequately defined business requirements. Too often projects proceed based on something other than what the business people really need; and traditional methodologies commonly focus mainly on the format for writing requirements. This interactive workshop also emphasizes how to discover content, why to build it and what it must do to produce value for the customer/user. Using a real case, participants practice discovering, understanding, and writing clear and complete business/user requirements that can cut creep, speed project delivery, reduce maintenance, and delight customers

Participants will learn:
Avoiding creep--role and importance of defining business requirements accurately and completely.
Distinctions between the user's (business) requirements and the system's (design) requirements.
How to gather data, spot the important things, and interpret them meaningfully.
Using the Problem Pyramid™ tool to define clearly problems, causes, and real requirements.
Formats for analyzing, documenting, and communicating business requirements.
Techniques and automated tools to manage requirements changes and traceability.

WHO SHOULD ATTEND: This course has been designed for systems and business managers, project leaders, analysts, programmer analysts, quality/testing professionals, auditors, and others responsible for assuring business requirements are defined adequately.

REQUIREMENTS ROLE AND IMPORTANCE
Sources and economics of system errors
How requirements produce value
Business vs. system requirements
Survey on improving requirements quality
Software packages and outsourcing
How we do it now vs. what we should do

DISCOVERING "REAL" REQUIREMENTS
Do users really not know what they want?
How the "real" requirements may differ
Aligning strategy, management, operations
Technology requirements vs. design
Problem Pyramid™ tool to get on track
Understanding the business needs/purposes
Horizontal processes and vertical silos
Customer-focused business processes
Who should do it: business or systems?
Joint Application Development (JAD) limits
Management/supervisor vs. worker views

DATA GATHERING AND ANALYSIS
Surveys and questionnaires

Research and existing documentation
Observing/participating in operations
Prototyping and proofs of concept
Planning an effective interview
Controlling with suitable questions
FORMATS TO AID UNDERSTANDING
Business rules, structured English
E-R, data flow,flow, organization diagrams
Data models, process maps
performance, volume, frequency statistics
Sample forms, reports, screens menus

DOCUMENTATION FORMATS
IEEE standard for software requirements
Use cases, strengths and warnings
7 guidelines for documenting requirements
Requirements vs. implementation scope
Iterating to avoid analysis paralysis
Conceptual system design solutions
Detailing for clarity, clarifying quality

GETTING MORE CLEAR AND COMPLETE
Stakeholders and Quality Dimensions
Addressing relevant quality factor levels
Standards, guidelines, and conventions
Detailing Engineered Deliverable Quality
Simulation and prototyping
Defining acceptance criteria

MANAGING THE REQUIREMENTS
Supporting, controlling, tracing changes
Automated requirements management tools
Measuring the “proof of the pudding”

Speaker’s Bio:
Robin F. Goldsmith, JD is an internationally recognized authority on software development and acquisition methodology and management. He has more than 30 years of experience in requirements definition, quality and testing, development, project management, and process improvement. A frequent featured speaker at leading professional conferences and author of the recent Artech House book, Discovering REAL Business Requirements for Software Project Success, he regularly works with and trains business and systems professionals.

Decision (Run/Cancel) Date for this Courses is Friday, November 18, 2016

Payment received by November 11
IEEE Members $415
Non-members $430

Payment received after November 11
IEEE Members $430
Non-members $455

http://ieeeboston.org/defining-writing-business-requirements/

IEEE Boston Section Social Media Links:

Twitter: https://twitter.com/ieeeboston

Facebook: https://www.facebook.com/IEEEBoston

YouTube: https://www.youtube.com/user/IEEEBostonSection

Google+: https://plus.google.com/107894868975229024384/

LinkedIn: https://www.linkedin.com/groups/IEEE-Boston-Section-3763694/about

Credibly Managing Agile and Other Projects

Skills, Approaches and Methods Needed to Make any Project Succeed!

Date & Time: Monday & Tuesday, November 28 & 29; 8:30AM - 5:00PM

Location: Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA

Speaker: Robin Goldsmith, President, GoPro Management

Despite claims to the contrary, even Agile projects need to be managed in order to succeed. That doesn't—and never did—mean the project manager dictates every little action; but every project must know what to do, how to do it, what it takes, and how to make sure it gets done well. Agile methods help but are not sufficient and can create challenges.

This intensive interactive seminar workshop shows how to manage projects to deliver the results their customers want, on time and in budget. This course helps improve project teams' credibility by better knowing what they're doing so they deliver as promised. Each section of the course shows how to make sure that an additional Critical Success Factor is present and addresses both Agile and other project formats. Case study exercises provide practice applying the techniques and learning how to avoid common pitfalls.

Participants who attend this course may also want to attend "Making You a Leader."

* How lack of credibility often unknowingly affects project success and ways to earn credibility.
* Recognizing and avoiding common, often overlooked pitfalls to on-time, in-budget, quality projects.
* Using Agile and other development life cycles to jumpstart projects confidently and quickly.
* Defining scope so it doesn't creep and building essential transitions to the workplan for achieving it.
* Methods for reliably estimating the time, effort, costs, and resources required.
* Controlling risks and balancing conflicts in the real world of both task and resource constraints.
* Tools and techniques to catch and correct problems early so project promises are kept.

WHO SHOULD ATTEND: This course has been designed for business and development specialists, product owners, scrum masters, managers, analysts, and other project participants.

CRITICAL PROJECT SUCCESS FACTORS
Importance of credibility to project success
Characteristics of successful projects
- Factors that really cause projects to fail
- Agile's view, why no project manager
- Superworker to supervisor to superfluous
- Establishing credibility, managing by facts
- Overcoming Parkinson's Law
- Projects succeed/fail in the first 15 minutes

PROJECT LIFE CYCLE
- Mapping project management/development
- Why we get impossible deadlines/budgets
- Traditional and iterative, Agile models
- Project management deliverables
- System development deliverables
- Proactive Testing□ developer's advantage

ANALYST/DESIGNER ROLE
- Establishing achievable project scope
- Internal & external customers/stakeholders
- Strategic and management alignment
- Identifying project risks
- Requirements, design, user stories, ATDD
- Make vs. buy
- JAD, facilitation, and customer partnering

High-level conceptual design roadmap

ESTIMATING TIME, EFFORT, RESOURCES
- Understanding causes of poor estimates
- Applying multiple estimating strategies
- Work breakdown structure, controlling risk
- Measuring deliverables, function points
- User story sizing, backlog grooming
- PERT and weighted averages risk reduction
- Cost/benefit analysis and communication

SCHEDULING TO MEET DEADLINES
- Productive time scheduling practicalities
- Time management techniques
- Dependency networking and CPM
- Coordinating multiple projects/resources
- Sprints, releases, strengths and issues
- Managing resource-constrained projects
- Working within Brooks' Law
- Negotiating commitments and resources

CONTROLLING PROJECT COMPLETIONS
- Monitoring against budget and schedule
- Time boxing, burn down charts
- Earned value measure of completion
- Assuring quality and preventing errors
- Automated tools, Kanban boards
- Reporting to stakeholders, management
- Key to advancement

Speaker's Bio:

Robin F. Goldsmith, JD is an internationally recognized authority on software development and acquisition methodology and management. He has more than 30 years of experience in requirements definition, quality and testing, development, project management, and process improvement. A frequent featured speaker at leading professional conferences and author of the recent Artech House book, Discovering REAL Business Requirements for Software Project Success, he regularly works with and trains business and systems pro-

Decision (Run/Cancel) Date for this Courses is Friday, November 18, 2016

Payment received by November 11	
IEEE Members	**$415**
Non-members	**$430**
Payment received after November 11	
IEEE Members	**$430**
Non-members	**$455**

http://ieeeboston.org/managing-agile-projects-skills-approaches-methods/

IEEE Boston Section goes Online!!!'

The IEEE Boston Section is in the process of creating an comprehensive online course presence. We are working to populate our online course offerings with several courses. Our time line is to have the online curriculum operational by September 2017.

• Intro to Embedded Linux • Linux Optimization • Making you a Leader • DSP for Wireless Comm

• Forensics • S/W for Medical Devices • Verilog • Project Management • Linux Android

Please check our website, e-reflector and this Digital Reflector for details moving forward

Introduction to Embedded Linux

Time & Date: 6 - 9PM; Thursdays, Nov. 10, 17, Wednesdays, Nov. 30, Dec. 7

Location: Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA

Speaker: Mike McCullough, RTETC, LLC

Overview - This 4 day course introduces the Linux Operating System and Embedded Linux Distributions. The course focuses on the development and creation of applications in an Embedded Linux context using the Eclipse IDE. The first part of the course focuses on acquiring an understanding of the basic Linux Operating System, highlighting areas of concern for Embedded Linux applications development using Eclipse. The latter part of the course covers testing, booting and configuring of Embedded Linux systems including embedded cross-development and target board considerations.

Who Should Attend – The course is designed for real-time engineers who are building Embedded Linux solutions. It is also targeted at experienced developers requiring a refresher course on Embedded Linux. This course will clearly demonstrate both the strengths and weaknesses of the Linux Operating System in Embedded Systems.

Course Objectives

• To provide a basic understanding of the Linux OS and the Eclipse IDE framework.
• To understand the complexities of Embedded Linux Distributions in embedded systems.
• To learn how to configure, boot and test Embedded Linux distributions and applications running on Embedded Linux target systems.
• To give students the confidence to apply these concepts to their next Embedded Linux project

Hardware and Software Requirements – The student should have a working Linux desktop environment either directly installed or in a virtualization environment. The desktop Linux should have the GNU compiler and binary utilities (binutils) already installed. A working Eclipse C/C++ installation or prior knowledge of C-based Makefiles is useful for completion of lab exercises. Lab solutions are also provided with the course. An Embedded Linux target hardware platform is useful but not absolutely required for this course.

Additional Reference Materials

• Linux Kernel Development by Robert Love
• Linux System Programming by Robert Love
• Embedded Linux Primer by Christopher Hallinan
• Pro Linux Embedded Systems by Gene Sally
• Embedded Linux Development Using Eclipse by Doug Abbott
• Linux Device Drivers by Jonathan Corbet et al
• Essential Linux Device Drivers by Sreekrishnan Venkateswaran

Lecturer – Mike McCullough is President and CEO of RTETC, LLC. Mike has a BS in Computer Engineering and an MS in Systems Engineering from Boston University. A 20-year electronics veteran, he has held various positions at LynuxWorks, Tilera, Embedded Planet, Wind River Systems, Lockheed Sanders, Stratus Computer and Apollo Computer. RTETC, LLC is a provider of Eclipse-based development tools, training and consulting for the embedded systems market.

OUTLINE

Course Schedule Day 1

The Basics
Linux Terminology, History and Versioning

The Linux Community: Desktop & Embedded
Linux and the GPL
Linux References (Books and Online)
Getting Started
Building the Kernel Source Code
Embedded Linux Kernels
Linux 2.6 and 3.x
Basic Kernel Capabilities
Process and Threads Management
Signals and System Calls
Synchronization, IPC and Error Handling
Timing and Timers
Memory Management and Paging
The I/O Subsystem: A Tale of Two Models
Modularization
Debugging
Process-Level and System-Level Debug
GDB, GDB Server and the GDB Server Debugger
Other Debug and Test Tools
An Eclipse Remote Debug Example
Advanced Debug with printk, syslogd and LTTng
System-Level Debug
System-Level Debug Tools
The /proc Filesystem
Advanced Logging Methods
KGDB and KDB
Crash and Core Dumps

Course Schedule Day 2
Process & Threads Management
What are Processes and Threads?
Virtual Memory Mapping
Creating and Managing Processes and Threads
Thread-Specific Data (TSD)
POSIX
The Native POSIX Threading Library (NPTL)
Kernel Threads
Signals
System Calls
Scheduling
Linux 2.4 and 2.6 Scheduling Models
The O(1) Scheduler
The Completely Fair Scheduler (CFS)
Synchronization
Via Global Data
Via Semaphores, Files and Signals
Condition and Completion Variables
Mutexes and Futexes
Inter-Process Communications (IPC)
Message Queues
Semaphores Revisited
Shared Memory
Pipes and FIFOs
Remote Procedure Calls
Networking

Course Schedule Day 3
Memory Management and Paging
Demand Paging and Virtual Memory
Allocating User and Kernel Memory
Mapping Device Memory
The Slab Allocator
The OOM Killer
Memory in Embedded Systems
Advanced Memory Operations
Linux and Memory
Managing Aligned Memory
Anonymous Memory Mappings
Debugging Memory Allocations
Locking and Reserving Memory
Error Handling
errno and perror
strerror and strerror_r
oops, panics and Segmentation Faults
Timing
How Linux Tells Time
Kernel, POSIX and Interval Timers
High-Resolution Timers (HRTs)
Modularization
Creating a Module and Module Loading
Dependency Issues
In Embedded Systems
Shared Libraries
A Shared Library Example
Static and Dynamic Libraries
The I/O Subsystem: A Tale of Two Models
The Original Device Driver Model
The Standard I/O Interface
Major and Minor Numbers
Configuring the Device Driver

The Evolution of the New Device Driver Model
The Initial Object-Oriented Approach
Platform Devices, Busses, Adapters and Drivers
Comparing the Two Driver Models

Course Schedule Day 4
Advanced I/O Operations
Standard I/O Operations
Scatter-Gather and Asynchronous I/O
Poll, Select and Epoll
Memory-Mapped I/O
File Advice
I/O Schedulers
Interrupt and Exception Handling
Bottom Halves and Deferring Work
The Linux Boot Process
The Root Filesystem
Desktop Linux Boot
Bootloaders and U-Boot
Embedded Linux Boot Methods
Building and Booting from SD Cards
Managing Embedded Linux Builds
Configuring and menuconfig
Building Custom Linux Images
Target Image Builders
LTIB and Yocto
System Architecture Design Approaches
Deploying Embedded Linux
Choosing and Building the Root Filesystem
Useful Embedded Filesystems
Module Decisions
Final IT Work
Embedded Linux Trends
Some Final Recommendations

Decision (Run/Cancel) Date for this Courses is Monday, October 24, 2016

Payment received by October 20
IEEE Members $400
Non-members $430

Payment received after October 20
IEEE Members $430
Non-members $455

http://ieeeboston.org/introduction-embedded-linux/

IEEE Boston Section goes Online!!!'

The IEEE Boston Section is in the process of creating an comprehensive online course presence. We are working to populate our online course offerings with several courses. Our time line is to have the online curriculum operational by September 2017.

• Intro to Embedded Linux • Linux Optimization • Making you a Leader • DSP for Wireless Comm

• Forensics • S/W for Medical Devices • Verilog • Project Management • Linux Android

Please check our website, e-reflector and this Digital Reflector for details moving forward

IEEE Advancing Technology for Humanity

2016 IEEE International Symposium on Phased Array Systems and Technology

Revolutionary Developments in Phased Arrays

BOSTON 2016

18–21 October 2016

Westin Waltham Hotel, Greater Boston, Massachusetts, USA

www.array2016.org

About the Symposium

Phased array systems continue to be a rapidly evolving technology with steady advances motivated by the challenges presented to modern military and commercial applications. This symposium will present the most recent advances in phased array technology and provide a unique opportunity for members of the international community to interact with colleagues in the field of Phased Array Systems and Technology.

Plenary Session Speakers

- **William Delaney** – MIT Lincoln Laboratory
- **Troy Olsson** – DARPA
- **Israel Lupa** – IAI ELTA, Israel
- **Gordon Frazer** – DSTO Australia
- **Joseph Haimerl** – Lockheed Martin
- **Tony Fischetti** – Northrop Grumman Corp.

SESSIONS

Plenary
European Phased Array Systems and Technology*
Array Design I, II, III
T/R Modules
Radar I, II
Beamforming and Calibration I, II, III
Emerging Technologies for Wideband Arrays*
Communications Arrays
Array Measurements
Signal Processing and Architectures
Dual Polarization Weather Radar Arrays
Multifunction Arrays
Millimeter Wave and Terahertz Arrays*
Metamaterial Phased Arrays*
MIMO Arrays
Conformal Arrays
Poster Sessions I & II

*Special Session

Tutorials

- Phased Arrays for MIMO Radar
  Dr. Vito Mecca, MIT Lincoln Laboratory
- T/R Modules for Phased Arrays
  Dr. William H. Weedon, Applied Radar
- Phased Array Antenna Measurements
  Dr. Alan J. Fenn, MIT LL
- Advances in SiGe BiCMOS Technology with Chip Scale Phased Array Applications
  – Dr. Gabriel Rebeiz, UCSD
- Phased Arrays for Imaging Applications
  Dr. Carey Rappaport, Northeastern University
- Microwave Array Beamforming: Analog, Digital, and Photonic
  Dr. Jeffrey Herd, MIT Lincoln Laboratory
- Phased Arrays: Basics, Breakthroughs & Future Trends
  Dr. Eli Brookner, Raytheon (Retired)

Sponsors

Platinum

Raytheon

Gold

Georgia Tech Research Institute

Northrop Grumman

Silver

SRC

Lincoln Laboratory, Massachusetts Institute of Technology

MITRE

ARRC, The University of Oklahoma, Advanced Radar Research Center

HUMATICS

Banquet Sponsor

Rockwell Collins

Other Sponsors

Lockheed Martin

Applied Radar

STR Systems & Technology Research

MACOM

SI2

Technical Co-Sponsors

MTT-S

AES

AESS

Our Blog

Conference Committee

Conference Chair:
Jeffrey S. Herd, (MIT LL)

Vice Chair:
William Weedon, Applied Radar

Honorary Chair:
Eli Brookner, Raytheon (retired)

Technical Program Chair:
Alan J. Fenn, MIT LL

Technical Program Vice Chair:
Wajih Elsallal, MITRE

Special Sessions Chair:
Sean Duffy, MIT LL

Plenary Session Chairs:
David Mooradd, MIT LL
Eli Brookner, Raytheon (retired)

Tutorials Chairs:
Jonathan Williams, STR
Jonathan Doane, MIT LL

Student Program Chairs:
Bradley T. Perry, MIT LL
Justin Kasemodel, Raytheon

Secretary:
Duane J. Matthiesen, Technia

International Liaison:
Alfonso Farina, Selex (retired)

Exhibits Chair:
Dan Culkin, NGC

Publicity Chairs:
Glenn Meurer, MITRE
Don McPherson, SRC, Inc.

Social Media Chair:
Gregory Charvat, Humatics, Inc.

Publications Chairs:
Raoul Ouedraogo, MIT LL
Will Moulder, MIT LL

Poster Sessions Chairs:
Greg Arlow, Lockheed Martin
Mark McClure, STR

Local Arrangements/Finance:
Robert Alongi, IEEE Boston

Website:
Kathleen Ballos, Ballos Associates

Advisors:
Ellen Ferraro, Raytheon
Robert J. Mailloux, Arcon
Hans Steyskal, Arcon
Chris McCarroll, Raytheon

v.19

Advanced Embedded Linux Optimization

Time & Date: **6 - 9PM, Mondays, January 9, 16, 23, 30, 2017**

Location: **Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA**

Speaker: **Mike McCullough, RTETC, LLC**

Course Summary - This 4-day technical training course provides advanced training in the debugging, testing, profiling and performance optimization of Embedded Linux software. The first part of the course focuses on advanced debugging, testing and profiling in an Embedded Linux context with a focus on using Eclipse, Backend Debuggers, JTAG and In-Circuit Emulators as well as Kernel Logging capabilities and Kernel Hacking. The latter part of the course covers performance measurement and optimization affecting boot, memory, I/O and CPU performance and key performance optimization tools for Embedded Linux software including the perf tool, advanced cache usage and compiler-based optimization.

Who Should Attend - The course is designed for real-time engineers who are developing high-performance Linux applications and device drivers using Embedded Linux distributions. It is also targeted at experienced developers requiring a refresher course on Advanced Embedded Linux optimization.

Course Objectives

- To understand methods for debugging, profiling and testing Embedded Linux software.
- To provide an overview of Linux application performance measurement and optimization.
- To understand the tools used for performance optimization of Embedded Linux software.
- To give students the confidence to apply these concepts to their next Embedded Linux project.

OUTLINE

Course Schedule Day 1

Getting Started with Embedded Linux
Linux and the GPL
Building the Kernel Source Code
Embedded Linux Kernels
BSPs and SDKs
Linux References (Books and Online)
Basic Debugging Review
Embedded Applications Debugging
GDB, GDB Server and the GDB Server Debugger
An Eclipse Remote Debug Example
Debugging with printk and LTTng
System Logs
Other Debuggers
System-Level Debug
System-Level Debug Tools
The /proc and /sys Filesystems
Basic Logging
KGDB and KDB
Crash Dumps and Post-Mortem Debugging
Debugging Embedded Linux Systems
Backend Debuggers
JTAG and In-Circuit Emulators
Hardware Simulators
Analyzers
Debugging Device Drivers
Kernel Probes
Kexec and Kdump
Kernel Profiling

Course Schedule Day 2

Testing
Design for Test
Agile Software Design
Unit-Level Testing
System-Level Testing
Code Coverage Tools
gcov
Automated Testing
DebugFS
Configuring DebugFS
DebugFS Capabilities
Advanced Logging
LogFS
Using Logwatch and Swatch
Using syslogd and syslog-ng

Kernel Hacking
Configuring Kernel Hacking
Kernel Hacking Capabilities
Tracing
ptrace and strace
New Tracing Methods
SystemTap
Ftrace, Tracepoints and Event Tracing
Tracehooks and utrace

Course Schedule Day 3
Profiling
Basic Profiling
gprof and Oprofile
Performance Counters
LTTng
Another DDD Example
Manual Profiling
Instrumenting Code
Output Profiling
Timestamping
Measuring Embedded Linux Performance
Some Ideas on Performance Measurement
Common Considerations
Uncommon Considerations
Using JTAG Methods
BootLoader Optimizations
Boot Time Measurements
Effective Memory and Flash Usage
Filesystem Choices
Addressing Performance Problems
Types of Performance Problems
Using Performance Tools to Find Areas for Improvement
Application and System Optimization
Device Driver Optimization
CPU Usage Optimization
Memory Usage Optimization
Disk I/O and Filesystem Usage Optimization
The Perf Tool
Improving Boot Performance
Boot Time Optimization
The Linux Fastboot Capability
Building a Smaller Linux
Building a Smaller Application
Filesystem Tips and Tricks
Some Notes on Library Usage
Performance Tool Assistance
Recording Commands and Performance
System Error Messages and Event Logging
Dynamic Probes
User Mode Linux and Virtualization

Course Schedule Day 4
Improving CPU Performance
Run Queue Statistics
Context Switches and Interrupts
CPU Utilization
Linux Performance Tools for CPU
Process-Specific CPU Performance Tools
Stupid Cache Tricks
Improving System Memory Performance
Memory Performance Statistics
Linux Performance Tools for Memory
Process-Specific Memory Performance Tools
More Stupid Cache Tricks
Improving I/O and Device Driver Performance
Disk, Flash and General File I/O
Improving Overall Performance Using the Compiler
Basic Compiler Optimizations
Architecture-Dependent and Independent Optimization
Code Modification Optimizations
Feedback Based Optimization
Application Resource Optimization
The Hazard of Trust
An Iterative Process for Optimization
Improving Development Efficiency
The Future of Linux Performance Tools
Some Final Recommendations

Decision (Run/Cancel) Date for this Courses is Friday, December, 30, 2016

Payment received by December 27
IEEE Members $395
Non-members $415

Payment received after December 27
IEEE Members $415
Non-members $435

http://ieeeboston.org/advanced-embedded-linux-optimization/

Embedded Linux Board Support Packages and Device Drivers

Date & Time: 6 - 9PM; Mondays, Nov. 28, Dec. 5, 12, 19

Location: Crowne Plaza Hotel, 15 Middlesex Canal Park Road, Woburn, MA

Speaker: Mike McCullough, RTETC, LLC

Course Summary - This 4-day technical training course provides advanced training in the development of Embedded Linux Board Support Packages (BSPs), Device Drivers and Distributions. The first part of the course focuses on BSP and Software Development Kit (SDK) development in an Embedded Linux context with a focus on application performance measurement and improvement. The latter part of the course covers Embedded Linux Device Driver development including key device driver decisions and deployment considerations for Embedded Linux BSPs.

Who Should Attend - The course is designed for real-time engineers who are developing Embedded Linux BSPs and Device Drivers for Embedded Linux distributions. It is also targeted at experienced developers requiring a refresher course on Linux BSP and Device Driver development.

Course Objectives

- To gain an understanding of the complexities of BSP and SDK development and their uses in Embedded Linux systems.
- To provide a basic understanding of the Linux I/O Subsystem and the Device Driver Models provided with Embedded Linux distributions.
- To gain an in-depth understanding of character-based device drivers in Embedded Linux
- To understand key device driver subsystems including relatively slow I/O interconnects such as I2C, SPI and USB as well as high-speed interfaces such as USB 3.0 and PCIe
- To give students the confidence to apply these concepts to their next Embedded Linux project.

Course Schedule Day 1

Getting Started with Embedded Linux
Linux and the GPL
Building the Kernel Source Code
Embedded Linux Kernels
BSPs and SDKs
Linux References (Books and Online)

Embedded Linux BSP Development Basics
BSP Requirements
U-Boot and Bootloader Development
Basic BSP Development
Files and Filesystem Support
The I/O Subsystem: Talking to Hardware
Memory Management and Paging
Error Handling in Embedded Linux BSPs
Timing and Timers
Interrupt Handling in BSPs
BSP Deployment Issues and Practices

Embedded Linux SDK Basics
The 3 Pieces of an SDK
Embedded Linux Distributions
The GNU Compiler Collection (GCC)
Other Embedded Linux Development Tools
Library Support
Glibc and Alternatives
SDK Deployment and Support
Debugging
GDB, GDB Server and the GDB Server Debugger
Other Debug Tools
An Abatron Board Bring-Up Example
An Eclipse Remote Debug Example
Advanced Debug with printk, syslogd and LTTng

System-Level Debug
System-Level Debug Tools
The /proc Filesystem
Advanced Logging Methods
KGDB and KDB
Crash Dumps

Course Schedule Day 2

Configuring Embedded Linux
Config Methods
Config Syntax
Adding Code to the Linux Kernel

Booting Embedded Linux
The Linux Boot Process

NFS and RAMdisk Booting
Root and Flash File System Development
Building the RAMdisk
Busybox Development
Testing and Debug of Embedded Linux BSPs
Kernel Debug and Kernel Probes
Kexec and Kdump
The Linux Test Project (LTP)
Performance Tuning Embedded Linux BSPs
User Mode Linux and Virtualization
Measuring Embedded Linux BSP Performance
Common Considerations
Uncommon Considerations
BootLoader Optimizations
Boot Time Measurements
Effective Memory and Flash Usage
Filesystem Performance Issues
Some Ideas on Performance Measurement

Course Schedule Day 3
The Original Device Driver Model
The fops struct and Char Drivers
The inode and dentry structs
Major and Minor Numbers
Embedding Channel Information
Deferring Work
The /proc Filesystem

Configuring the Device Driver
Modularization Revisited
The New Device Driver Model
An Object-Oriented Approach
Platform Devices and Drivers
Subsystem Registration
The Probe and Init Functions
The Show and Store Functions
The /sys Filesystem
Configuring the New Device Driver
Comparing the Two Driver Models
The Flattened Device Tree (FDT)
openBoot and its Effect on Embedded Linux
The Device Tree Script (dts) File
The Device Tree Compiler (dtc)
The Device Tree Blob (dtb) File
Building a dtb File
Hybrid Device Drivers
Other fops Functions
The Need for Ioctl
A Simulated Char Device Driver
The SIM Device Driver
Initialization
Open and Close
Read and Write
The /proc Driver Interface
MMAP Support

Course Schedule Day 4
Linux Device Driver Subsystems
Serial Drivers
The RTC Subsystem
Watchdogs
I2C & SPI
Block Devices
PCI
USB
VME
Video
Sound
What's Missing?
Memory Technology Devices
What is an MTD?
NAND vs NOR Flash Interfaces
The Common Flash Interface (CFI)
Driver and User Modules
Flash Filesystems
Drivers in User Space
Accessing I/O Regions
Accessing Memory Regions
User Mode SCSI, USB and I2C
UIO
High-Speed Interconnects
PCIe
GigE
iSCSI
Infiniband
FibreChannel
Serial RapidIO
Debugging Device Drivers
kdb, kgdb and JTAG
Kernel Probes
Kexec and Kdump
Kernel Profiling
User Mode Linux and Kernel Hacking
Performance Tuning Device Drivers
Some Final Recommendations

Decision (Run/Cancel) Date for this Courses is Friday, November 18 2016

Payment received by November 15
IEEE Members $395
Non-members $415

Payment received after November 15
IEEE Members $415
Non-members $435

http://ieeeboston.org/embedded-linux-bsp-device-drivers/

MIT IEEE Student Branch & IEEE Boston Section Present

NOVEMEBER 4-6 | STATA CENTER & BUILDING 34

MEET INNOVATIVE TECHNOLOGY

MIT IEEE UNDERGRADUATE RESEARCH TECHNOLOGY CONFERENCE

ieee.scripts.mit.edu/conference

Nov 4-6

Focus technical tracks:

1. Machine Learning, Cloud Computing
2. Biological and Biomedical Engineering and Technology
3. Robotics and Automation Technology
4. Comunications and Security
5. Wearable Technology
6. Innovative Technologies X-Track

KEYNOTE SPEECHES

RESEARCH PRESENTATIONS

NETWORKING OPPORTUNITIES

REGISTER TODAY

ieee.scripts.mit.edu/conference

Questions? Email conference chairs
ieee-ucc-chairs@mit.edu

Call for Course Speakers/Organizers

IEEE's core purpose is to foster technological innovation and excellence for the benefit of humanity. The IEEE Boston Section, its dedicated volunteers, and over 8,500 members are committed to fulfilling this core purpose to the local technology community through chapter meetings, conferences, continuing education short courses, and professional and educational activities.

Twice each year a committee of local IEEE volunteers meet to consider course topics for its continuing education program. This committee is comprised of practicing engineers in various technical disciplines. In an effort to expand these course topics for our members and the local technical community at large, the committee is publicizing this CALL FOR COURSE SPEAKERS AND ORGANIZERS.

The Boston Section is one of the largest and most technically divers sections of the IEEE. We have over 20 active chapters and affinity groups.

If you have an expertise that you feel might be of interest to our members, please submit that to our online course proposal form on the section's website (www.ieeeboston.org) and click on the course proposal link (direct course proposal form link is http://ieeeboston.org/course-proposals/ . Alternatively, you may contact the IEEE Boston Section office at sec.boston@ieee.org or 781 245 5405.

- Honoraria can be considered for course lecturers
- Applications oriented, practical focused courses are best (all courses should help attendees expand their knowledge based and help them do their job better after completing a course
- Courses should be no more than 2 full days, or 18 hours for a multi-evening course
- Your course will be publicized to over 10,000 local engineers
- You will be providing a valuable service to your profession
- Previous lecturers include: Dr. Eli Brookner, Dr. Steven Best, Colin Brench, to name a few.

Note: Submission Deadline Is October 17, 2016

Call for Papers, Posters & Tutorials

The 16th annual IEEE Symposium on Technologies for Homeland Security (HST '17), will be held 25-26 April 2017, in the Greater Boston, Massachusetts area. This symposium brings together innovators from leading academic, industry, business, Homeland Security Centers of Excellence, and government programs to provide a forum to discuss ideas, concepts, and experimental results.

Produced by IEEE with technical support from DHS S&T, IEEE, IEEE Boston Section, and IEEE-USA and organizational support from MIT Lincoln Laboratory, Raytheon, Battelle, and MITRE, this year's event will once again showcase selected technical paper and posters highlighting emerging technologies in the areas of:

- **Cyber Security**
- **Biometrics & Forensics**
- **Land and Maritime Border Security**
- **Disaster and Attack Preparedness, Mitigation, Recovery, and Response**

We are currently seeking technical paper, poster and tutorial session submissions in each of the areas noted above. Papers examining the feasibility of transition to practice will also be considered. Submissions should focus on technologies with applications available for implementation within about five years. All areas will cover the following common topics:

- Strategy and threat characterization, CONOPs, risk analysis,
- Modeling, simulation, experimentation, and exercises & training, and
- Testbeds, standards, performance and evaluations.

Contact Information

For more detailed information on the Call for Papers, Posters & Tutorials, as well as Sponsorship and Exhibit Opportunities, visit the website http://ieee-hst.org/ or email: information@ieee-hst.org. Submissions should be made at the following website: https://cmt3.research.microsoft.com/HST2017/

Important Dates

Paper Abstract Deadline:	October 17, 2016
Paper, Poster and Tutorial Acceptance Notification	December 1, 2016
Final Paper Submission Deadline:	March 1, 2017

All deadlines are by midnight Eastern Time.

Organizing Committee

General Chair:	James Flavin, MIT Lincoln Laboratory
Deputy Chair:	Fausto Molinet, Matrix Internationale
Technical Chair:	Gerald Larocque MIT Lincoln Laboratory
Tutorials Chair:	Anthony Serino, Raytheon
Business Program Chair:	Andrea Marsh, Battelle
Local Arrangement Chair:	Bob Alongi, IEEE Boston
Marketing Chair:	Jessica Patel, Raytheon
Publications Chair:	Adam Norige, MIT Lincoln Laboratory
Sponsorship/Exhibits Chair:	Fausto Molinet, Matrix Internationale
Special Advisor to the Chair:	Lennart Long, EMC Consultant
Registration Chair:	Karen Safina, IEEE Boston

Technical Program Committee Chairs

Disaster and Attack Preparedness, Mitigation, Recovery, and Response
Lance Fiondella, UMass, Dartmouth Kenneth Crowther, MITRE

Biometrics & Forensics
Eric Schwoebel, MIT Lincoln Laboratory James L. Wayman, San Jose State University

Land and Maritime Border Security Karen Panetta, Tufts University Rich Moro, Raytheon John Aldridge, MIT Lincoln Laboratory

Cyber Security
Claire Applegarth, Mark Peters, MITRE

LAST NOTICE BEFORE COURSE BEGINS, PLEASE REGISTER NOW!!

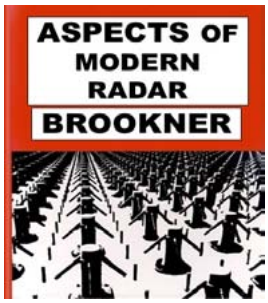
Radar Basics and Amazing Recent Advances

Time & Dates : **6:00 - 9:00 PM, Mondays, Oct. 24, 31, Nov. 7, 14, 21, 28, Dec. 5, 12, 19 2016, Jan. 9, 2017 (If needed, Snow/make up days Jan. 23, 30, Feb. 6)**

Location: **MITRE Corporation, 202 Bedford Rd., Burlington**

Speaker: **Dr. Eli Brookner, Raytheon Company (Retired)**

All Attendees of the class will receive a trial license of MATLAB, Phased Array System Toolbox, and Antenna Toolbox from MathWorks in addition to a set of examples which help demonstrate the key radar concepts covered in the course material.



The following book plus over ten paper reprints are provided FREE with your registration:

1. “Aspects of Modern Radar”, Dr. Eli Brookner (Editor), Artech House, Hardcover, 432 pages, 1988, List price: $159. The 1st chapter gives the best easy to read introduction to radar. It covers all aspects of radar: transmitters, receiver, antennas, signal processing, tracking, clutter derivation of radar equation in easy terms and definition of dB. The 2nd chapter gives detailed descriptions of different radar systems like: Cobra Dane, Pave Paws, BMEWS, Series 320 3D radar, OTH radars and dome antenna. The book has a catalog giving the detailed parameters for over 200 radars from around the world. The remaining chapters cover AEGIS SPY-1, Hybrid and MMIC circuits, ultra low sidelobe antennas (ULSA), mmw, radar cross section and Doppler weather radars. The material in the book is easy to access and as a result the text serves as a handy reference book.

This course is an updated version of the Radar Technology course given previously. Those who have taken the Radar Technology previously should find it worthwhile taking this revised version. New material includes latest on solid state devices and transmitters including GaN, SiC, SiGe; Breakthroughs in Radar — $10 T/R module, Digital Beam Forming (DBF), Packaging, Disruptive Technology, Metamaterials, radar on a chip, 32 element phased array on a chip, Memristors, Graphene. Also covered are radar height-range coverage diagram using the powerful SPAWAR’s AREPS program. AREPS provides coverage for arbitrary propagation conditions (ducts [evaporation, surface, or elevated], subrefraction and superrefraction) and terrain conditions based on DTED map data. AREPS now accounts for surface roughness scattering and evaluates sea and land clutter backscatter versus range. Attendees will be told how to obtain AREPS FREE. Valued at over $7,000. Also new is coverage of Anomalous Propagation and what to do about it. Finally also covered is the new Multiple-Input Multiple-Output (MIMO) explained in simple physical terms.

Updated course is framed around FREE book described above. Also given ot free are supplementary notes consisting of copies of >800 vugraphs plus over 15 paper reprints by Dr. Brookner.

For the beginner, basics such as the radar equation, MTI (Moving Target Indicator), pulse doppler processing, antenna-scanning techniques, pulse compression, CFAR, RAC and SAW devices, dome antenna, CCDs, BBDs, SAW, SAW monolithic convolvers, microstrip antennas, ultra-low antenna sidelobes (<-40 dB), stacked beam and phased array systems, (1-D, 2-D, Limited Field of View [LFOV]),

Moving Target Detection (MTD) are all explained in simple terms. For both the novice and experienced covered are tracking, prediction and smoothing in simple terms (mystery taken out of GH, GHK and Kalman filters); the latest developments and future trend in solid state, tube and digital processing technologies; synthetic aperture radar (SAR); Displaced Phase Center Antenna (DPCA); Space-Time Adaptive Processing (STAP) ; digital beam forming (DBF); Adaptive-Adaptive Array Processing for jammer suppression with orders of magnitude reduction in computation; RECENT AMAZING RADAR BREAKTHROUGHS.

Lecture 1, Oct. 24

FUNDAMENTALS OF Radar: Part 1: Very brief history of radar, major achievements since WWII: PHASED ARRAYS: Principles explained with COBRA DANE used as example. Near and Far Field Defined, Phased Steering, Time Delay Steering,

(G.KLARI,, ET AL, "SINGLE CHIP MM RADAR", MICROWAVE J., 1-14-15;
R. J. Evans et al., "Consumer Radar," *Int. Radar Conf.*,Adelaide, 9/2013, pp. 21–26)

Subarraying, Array Weighting, Monopulse, Duplexing, Array Thinning, embedded element, COBRA DANE slide tour (6 stories building). Radar equation derived.

Lecture 2, Oct. 31

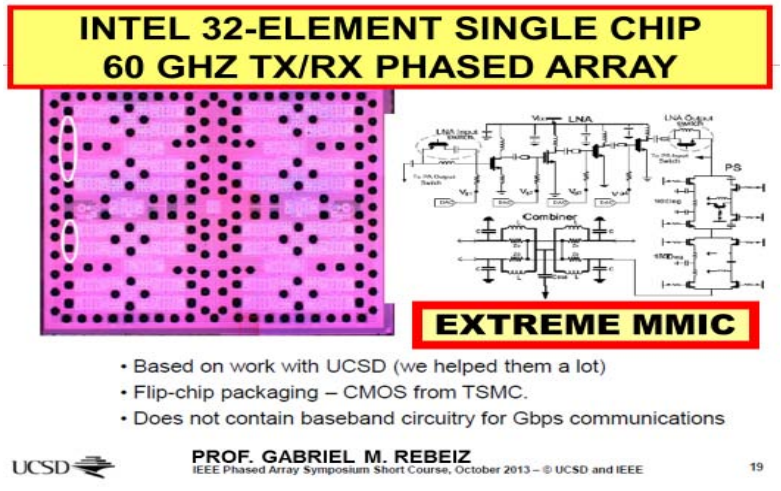
FUNDAMENTALS OF Radar: Part 2: FREQUENCY TRADEOFFS: Search vs Track, Range and Doppler Ambiguities, Detection in Clutter. Blind Velocity

http://spendergast.blogspot.com/2016/05/googles-project-soli-demos-mmw-micro.html
http://www.theverge.com/2016/5/20/11720876/google-soli-smart-watch-radar-atap-io-2016

region, range eclipsing, Environmental Factors, Dependence of clutter model on grazing angle and size radar resolution cell discussed, Weibull clutter: Polarization Choice, Detection of Low Flying Low Cross-Section Targets, Antenna Pattern Lobing in Elevation due to multipath, Ground Multipath Elevation Angle Error Problem and ways to cope with it, e.g., use of an even difference pattern Off-Axis Monopulse, Complex Monopulse,Two Frequency Radar Systems: Marconi L- and S-band S631, Signaal/ Thales (Holland),Flycatcher X and Ka System; Tube and Solid State OTH. Radars

Lecture 3, Nov. 7

FUNDAMENTALS of Radar: Part 3: PROPAGATION: standard, superrefraction, subrefraction, sur-



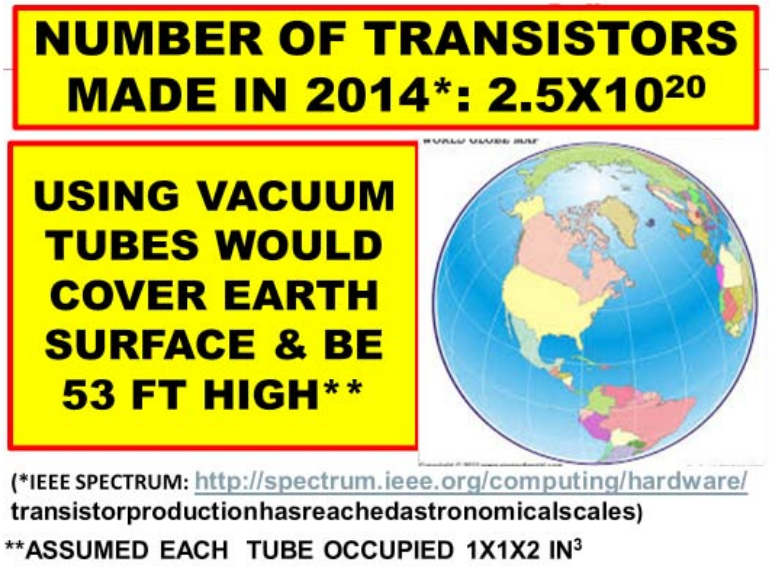
face-based ducts, evaporation ducts. Determination of radar coverage using new AREPS program. ANTENNA SCANNING SYSTEMS: Fixed Beam System: Wake Measurement Radar; 2-D Radars, 3-D Radars: Stacked Beam: Marconi Martello, Smart-L, SMARTELLO, ARSR-4; 1-D Frequency Scanning: ITT Series 320; 1-D Phased Scanning: TPS-59, GE-592, RAT-31DL; Phased-Frequency Scanners: Raytheon Fire Finder and Plessey AR320; Limited and Hemispherical Scanning (Dome Antenna) related and explained in simple terms.

Lecture 4, Nov. 14

FUNDAMENTALS of Radar: Part 4: ULTRA LOW ANTENNA SIDELOBES (40 dB down or more). MOVING TARGET INDICATORS (MTI): Two-Pulse Canceller, Pulse Doppler Processing; MOVING TARGET DETECTOR (MTD); Optimum Clutter Canceller, STAP, AMTI, DPCA.

Lecture 5, Nov. 21

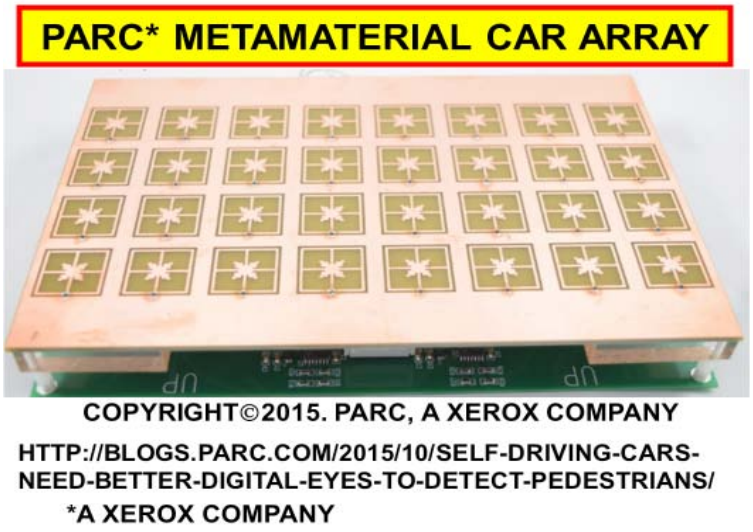
SIGNAL PROCESSING: Part 1: What is PULSE COMPRESSION? Matched Filters; Chirp Waveform



Defined; ANALOG PROCESSING: Surface Acoustic Wave (SAW) Devices: Reflective Array Compressor (RAC), Delay Lines, Bandpass Filters, Oscillators, Resonators; IMCON Devices; Analog Programmable Monolithic SAW Convolver; BBD/CCD. What are they?

Lecture 6, Nov. 28

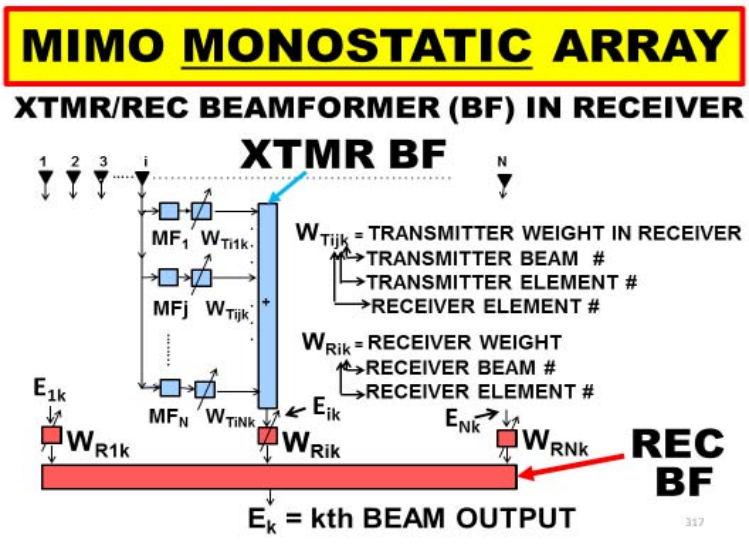
SIGNAL PROCESSING: Part 2: DIGITAL PROCESSING: Fast Fourier Transform (FFT); Butterfly, Pipeline and In-Place Computation explaine in simple terms; Maximum Entropy Method (MEM)



Spectral Estimate; State-of-the-art of A/Ds, FPGAs and Memory; Signal Processor Architectures: Pipeline FFT, Distributed, Systolic; Digital Beam Forming (DBF). Future Trends.

Lecture 7, Dec. 5

SYNTHETIC APERTURE RADAR (SAR): Strip and Spotlight SAR explained in simple terms.
TUBES: Basics given of Magnetron, Cross Field



Amplifiers, Klystrons, Traveling Wave Tubes, Gyro Tubes.
TREND TOWARD SOLID STATE PHASED-ARRAY TRANSMITTERS: Discrete All Solid State PAVE PAWS and BMEWS radars; advantages over tube radars; MMIC (Monolithic Microwave Integrated Circuitry; integrated circuitry applied to microwaves components): THAAD, SPY-3, IRIDIUM, XBR, JLENS. Solid State 'Bottle' Transmitters: ASR -11/ DASR, ASR-23SS, ASDE-X. Extreme MMIC.

Lecture 8, Dec. 12
Breakthroughs and Trends in Phased-Arrays and Radars

Systems: 3, 4, 6 face "Aegis" systems developed by China, Japan, Australia, Netherlands, USA; Patriot

now has GaN AESA providing 360o coverage without having to rotate; S/X-band AMDR provides 30 times the sensitivity and number of tracks as SPY-1D(V). Low Cost Packaging: Raytheon funding development of low cost flat panel X-band array using COTS type printed circuit boards (PCBs); Lincoln-Lab./MACOM developing low cost S-band flat panel array using PCBs, overlapped subarrays and a T/R switch instead of a circulator; Extreme MMIC: 4 T/R modules on single chip at X-band costing ~$10 per T/R module ; full phased array on wafer at 110 GHz; on-chip built-in-self-test (BIST); Digital Beam Forming (DBF): Israel, Thales and Australia AESAs have an A/D for every element channel; Raytheon developing mixer-less direct RF A/D having >400 MHz instantaneous bandwidth, reconfigurable between S and X-band; Lincoln Lab increases spurious free dynamic range of receiver plus A/D by 40 dB; Radio Astronomers looking at using arrays with DBF. Materials: GaN can now put 5X to 10X the power of GaAs in same footprint, 38% less costly, 100 million hr MTBF; SiGe for backend, GaN for front end of T/R module. Metamaterials: Material custom man made (not found in nature): electronically steered antenna at 20 and 30 GHz demonstrated (with goal of $1K per antenna) remains to prove low cost and reliability); 2-20GHz stealthing by absorption simulated using <1 mm coating; target made invisible over 50% bandwidth at L-band; Focus 6X beyond diffraction limit at 0.38 μm; 40X diffraction limit, λ/80, at 375 MHz; In cell phones provides antennas 5X smaller (1/10th λ) having 700 MHz-2.7 GHz bandwidth; Provides isolation between antennas having 2.5 cm separation equivalent to 1m separation; used for phased array WAIM; n-doped graphene has negative index of refraction, first such material found in nature. Very Low Cost Systems: Valeo Raytheon (now Valeo Radar) developed low cost, $100s, car 25 GHz 7 beam phased array radar; about 2 million sold already, more than all the radars ever built up to a very few years ago; Commercial ultra low cost 77 GHz Roach radar on 72mm2 chip, uses >8 bits 1 GS/s A/D and 16 element array; Low cost 240GHz 4.2x3.2x0.15 cm3 5 gm radar for bird inspired robots and crawler robots, Frequency scans 2ox8o beam ±25o. SAR/ISAR: Principal Components of matrix formed from prominent scatterers track history used to determine target unknown motion and thus compensate for it to provide focused ISAR image. Technology and Algorithms: Lincoln Lab increases spurious free dynamic range of receiver plus A/D by 40 dB; MEMS: reliability reaches 300 billion cycles without failure; Has potential to reduce the T/R module count in an array by a factor of 2 to 4; Provides microwave filters like 200 MHz wide tuneable from 8-12 GHz; MEMS Piezoelectric Material = piezoMEMS: Enables flying insect robots; Printed

Electronics: Low cost printing of RF and digital circuits using metal-insulator-metal (MIM) diodes, 2D MoS2 ink and 1.6 diodes GHz (goal 2.4 GHz) made with Si and NbSi2 particles,; Electrical and Optical Signals on Same Chip: Electricity and light can be simultaneously transmitted over a silver nanowire combined with single layer 2D MoS2, could be a step towards transporting on computer chips digital information at the speed of light; COSMOS: DARPA revolutionary program: Allow integration of III-V, CMOS and opto-electronics on one chip without bonded wires leading to higher performance, lower power, smaller size, components; MIMO (Multiple Input Multiple Output): Where it makes sense; contrary to what is claimed MIMO array radars do not provide 1, 2 or 3 orders of magnitude better resolution and accuracy than conventional array radars; MIMO does not provide better barrage-noise-jammer, repeater-jammer or hot-clutter rejection than conventional array radars; should not be better for detecting low velocity targets in airborne STAP radar; Graphene and Carbon Nanotube (CNT): Potential for Terahertz transistor clock speeds, manufacture on CMOS demo'd, could allow Moore's law to march forward using present day manufacturing techniques; potential for non-volatile memory, flexible displays and camouflage clothing, self-cooling, IBM producing 200 mm wafers with RF devices; Electron spin: For memory; Atomic Memory: 12 iron atoms for 1 bit of memory; could provide hard drive with 100X density; Revolutionary 3-D Micromachining: integrated circuitry for microwave components, like 16 element Ka-band array with Butler beamformer on 13X2 cm2 chip; Superconductivity: We may still achieve superconductivity at room temperature; Superconductivity recently obtained for first time with iron compounds; DARPA UHPC (Ubiquitous High Performance Computing) Program): Goal: Reduce signal processing power consumption by factor of 75; Biodegradable Array of Transistors or LEDs: Imbedded for detecting cancer or low glucose; can then dispense chemotherapy or insulin; Quantum Radar: See stealth targets; New polarizations: OAMs, (Orbital Angular Momentum) unlimited data rate over finite band using new polarizations??

Lecture 9, Dec. 19

TRACKING, PREDICTION AND SMOOTHING: Simple Algebra and Physical explanation. Mystery taken out of αβ (GH) Filter; Errors of; Fading Memory; Benedict-Bordner; Example Designs; Stability; Tracking Initiation; αβγ (GHK) Filter; Kalman Filter Explained in simple physical terms; Why Kalman Filter?; Relationship to GH and GHK Filters; Matrix Notation; Simple Derivation.

Lecture 10, Jan. 9

HOW TO LOOK LIKE A GENIUS IN DETECTION WITHOUT REALLY TRYING: Simple procedure for determining detection using Meyer Plots, MATLAB, Excel and MATHCAD is presented. No detailed mathematics used, emphasis on physical understanding of target models (non-fluctuating, Marcum, Swerling, Weinstock, Chi-Square, Rayleigh, Lognormal, Rice and YGIAGAM) and performance results. Also covered are beam shape, CFAR, mismatch losses.

The Following is Included in Your Registration:

	Value
Textbook	**$159**
Reprints	**$150**
Over 800 Vugraphs	**$120**

Decision (Run/Cancel) Date for this Courses is Monday, October 17, 2016

Payment received by October 12

IEEE Members	**$300**
Non-members	**$340**

Payment received after October 12

IEEE Members	**$340**
Non-members	**$370**

http://ieeeboston.org/radar-basics-recent-amazing-advances/