2011 International Business & Technology Summit

International Business and Technology Summit

Thermal Management of Electronics

Emerging Technologies for Advanced Cooling of Electronic Systems

coolingZONE

October 5 - 6, 2011 | Cambridge, MA

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Overview

coolingZONE presents the 11th International Business and Technology Summit in Thermal Management of Electronics in Cambridge MA, USA on October 5-6, 2011. This event will feature world renown experts in thermal management to share their latest developments and research, and discuss emerging technologies for advanced cooling of electronic systems.

Engineers across the globe attend the Summit to learn what new cooling challenges will confront them, where the solutions will be found, and who can help them with effective products and services to manage today's thermal challenges.

The Summit's agenda includes two full days of technical presentations from leading experts in industry and academia. Short technical sessions will be provided by corporations who are advancing the thermal management community with innovative and practical thermal solutions.

Topics to be presented in Summit 2011 include:

- Thermal and Energy Management Technologies for the Next Decade: Challenges and Opportunities
- Challenges and Innovations in Avionics and Military Electronics Thermal Management
- An Overview of the Challenges in Thermal Testing
- Challenges of Thermal Management and Design of Compact 3-D Microsystems: An integrated System Level Approach with Focus on Discrete Technologies
- Thermal Design and Management of High Power LEDs
- The Future of Solid State Lighting is Bright but "Why is it Taking so Long?"
- Design of Liquid Cooled Heat Sinks and Cold Plates: Some Fundamental Concepts for Transitioning from Air Cooled Solutions
- Thermal Engineering Challenges at the Device and Microprocessor Levels
- Thermal Design of Telecommunications Equipment: Challenges and Requirements
- Perspectives on Electronics Thermal Management from Academia to Industry

Who Should Attend?

Engineers, engineering managers and executives, chief technical officers, project managers, professors, students and others who want insight into the thermal design issues that affect product performance and the latest advancements in solving these critical thermal challenges

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Summit Program

Wednesday, October 5, 2011

7:30AM — **Registration Opens/Continental Breakfast**

8:20 — **Welcome**

8:30 — **Keynote Address**

Thermal and Energy Management Technologies for the Next Decade: Challenges and Opportunities

Suresh V. Garimella, Ph.D
Director, NSF Cooling Technologies Research Center
School of Mechanical Engineering and Birck Nanotechnology Center
Purdue University

From health care to education to security, almost every aspect of life has benefited from the Silicon Revolution. Integrated circuits serve as the "brains" of nearly all engineered entities that require rapid acquisition, transfer, and interpretation of information. The continued evolution of electronics for the 21st Century, however, requires a fundamental shift in perspective, coupled with major technical innovations at all scales, to manage the power generated by carrier transport and dissipated in the form of heat. On the other end of the spectrum, large computing systems such as data centers are facing an energy crisis caused by this increasing power demand, which is aggravated by the cooling systems requiring levels of energy that are comparable to that consumed for computing. Tens of megawatts of power consumed by data centers stress the energy supply infrastructure and cause environmental concerns as well. Integrating ongoing advances at the micro- and nano-scales with system-level considerations is critical for achieving the desired performance and reliability, while at the same time supporting significant improvements in energy efficiency. Approaches such as dynamic reconfiguration of computing jobs and on-demand, site-specific heat removal, supported by distributed sensing and control, are necessary. This talk will briefly review the current state of this field, and then discuss challenges and opportunities for the next decade, supported by examples of emerging solutions from work being conducted by the speaker's group under the framework of the Cooling Technologies Research Center, a National Science Foundation Industry/University Cooperative Research Center (https://engineering.purdue.edu/CTRC).

9:40 — **Technical Presentations**

10:50

Challenges and Innovations in Avionics and Military Electronics Thermal Management

Jim Wilson, Ph.D
Engineering Fellow, Raytheon Space and Airborne Systems
Mechanical Analysis Section Manager, Raytheon's Advanced Product Center

Avionic and defense electronic systems are continuing to add functionality and features resulting in thermal design engineers being tasked to devise efficient thermal management approaches with minimum weight, volume, and cost. While adding the latest high performance devices often increases dissipated heat loads, the ambient environment is still at the mercy of nature. Difficulties in thermal management cause constraints on system performance, especially in harsh environments. Continuing research in innovative thermal solutions is easily justified by the need to reduce system operating temperatures. Challenges faced by the thermal design community in the avionics and defense industry are mostly familiar to their commercial counterparts. Designing packaging for the latest high performance semiconductor is similar to the task performed in the commercial sector but complicated by requirements demanded by the avionics and defense electronics sector. These requirements include harsh environmental temperature extremes, dirty and humid air, and long operating life. This presentation will review current thermal design considerations for avionics and defense electronics and describe some of the specific concerns that must be addressed. The time required for new thermal management technology to be designed into avionics and defense electronics can be extensive. Some of the reasons why this process is lengthy will be discussed. Advances in thermal management for the avionics and defense industry are requiring research at the nano and micro scales. This presentation will cover some current research at these small scales. The goals of this research are ultimately more efficient thermal packaging as well as the ability to manage high heat flux levels. Challenges and opportunities for innovative research related to the avionics and defense thermal management field will also be described.

12:00PM

Lunch

12:50

Exhibit Hall Open

1:25

Technical Presentations

1:50

An Overview of the Challenges in Thermal Testing

Robert J. Moffat, Ph.D.
President, Moffat Thermosciences
Professor, Stanford University

Today's engineers require skilled knowledge to effectively plan and respond to the many challenges faced in the thermal testing of electronics. In this lecture, we will focus on temperature measurements in air-cooled systems (surface and coolant) in a reasonably well-equipped lab. We will discuss the application and error characteristics of thermocouples, RTDs, thermistors, IR cameras, and liquid crystals. We will then discuss how to effectively plan and execute a set of measurements that will answer the question that sent you into the lab and give you an estimate of the measurement uncertainty. In experiment planning, we will discuss the various parameters to consider, such as identifying the specific questions you are trying to answer; the degree of accuracy required; type of sensors and lab equipment available for thermal testing; and applicable budget constraints. Finally, we will review specific challenges in measurement accuracy and uncertainty, including measurement errors most commonly encountered and the impact of your overall result.

3:00

Break - Exhibit Hall Open

3:20

Challenges of Thermal Management and Design of Compact 3-D Microsystems: An integrated System Level Approach with Focus on Discrete Technologies

Ihab Andre Ali, Ph.D.
President and Co-Founder, Deeia Systems

The lecture provides an overview of thermal design performance limitations and thermal management techniques covering 3-D Microsystems. Thermal challenges are discussed including a key thermal design parameter concerning outer skin temperature limits based on natural convection and radiation with the ambient. The lecture covers an overview on internal IC's thermal performance enhancements utilizing advanced thermal management techniques including single- and two-phase liquid cooling. The discussion walks through an application introducing a microchannel pumped liquid cooled system for compact electronic form factors. The performance of the liquid cooled system is discussed at length and compared to conventional heat pipe based thermal architecture. Tradeoffs of various system related parameters are discussed in details. System parameters included microchannel effects and pump scaling and heat exchange scaling effects. Other die level parameters are considered including die silicon thinning, TIM characteristics and effects of CPU heat flux non-uniformity. It is shown that while pumped liquid cooled system offers a performance increase over conventional heat pipe based architecture, system design ought to consider other important parameters for enhancing performance. These parameters include the die-to-cold plate TIM performance, die thickness and heat exchanger performance.

4:30

Thermal Design and Management of High Power LEDs

Norbert Engelberts
Director, ATS-Europe

Light emitting diodes (LED) used to have a strong presence in instrumentation and computer as visual indicator for signal integrity and device operations status. In these applications, LEDs were ideal since they are highly reliable, low power while requiring little to no maintenance. The latter features of LEDs piqued the market interest for their use not only as indicator but also as lighting devices. Since illumination has become the focus, the power consumption of LEDs has gone up dramatically with device heat fluxes rivalling CPU and other semiconductor packages. As the result, thermal management of LED applications has taken the centre stage for their successful implementation. It's important to remember that an LED is not a high temperature, filament-type light source. Most LEDs are designed in SMT (surface mount technology) or COB (chip-on-board) packages. But, while a single LED is a cold and efficient light source, high-power LED applications, including arrays of LEDs, need thermal management similar to other semiconductor devices. High temperatures not only degrade an LED's lifetime, but also results in lower light or non-uniform output – effects that can significantly affect the application In this presentation we will demonstrate the required approach for thermal management of LEDs that will enable the designer to select the appropriate cooling solution based on the LED's junction temperature, and not on the total power dissipation.

5:30 - 7:30

Networking Reception

Summit Program

Thursday, October 6, 2011

7:30AM Registration Opens/Continental Breakfast

8:20 Welcome

8:30 Keynote Address

The Future of Solid State Lighting is Bright but "Why is it Taking so Long?"

Victor Zaderej, M.S.
Manager of Advanced Development, Molex Solid State Lighting Group
Molex

We have all heard about the benefits of Solid State Lighting (SSL), a revolutionary source of light that will dramatically reduce energy requirements, allow us to shine light onto any surface from a "rainbow" of colors, and will virtually last our entire lives. Although all of these benefits are technically achievable today, we do not see them in our daily lives because either the products are not available or they are too expensive. Several new technologies within the electronics, electromechanical packaging (Molded Interconnect Device; MID), LED array design, and thermal management fields along with an increase in LED manufacturing capacity are quickly changing the dynamics of the industry. These new technologies and manufacturing methods and how they can be integrated into a unique and cost effective Solid State Light source will be discussed in depth. Within the next several years, the products that will make SSL fun, easy to use, and affordable will be part of our lives. The timing of this next generation of products will nicely coincide with the end of the incandescent bulb and possibly the CFL that is currently proliferating in use on the market.

9:40 Technical Presentations

10:25

Design of Liquid Cooled Heat Sinks and Cold Plates: Some Fundamental Concepts for Transitioning from Air Cooled Solutions

Alfonso Ortega, Ph.D.
James R. Birle Professor of Energy Technology
Associate Dean for Graduate Studies and Research
Director, Laboratory for Advanced Thermal and Fluid Systems
College of Engineering
Villanova University

For decades electronics thermal management has relied primarily on air-cooled solutions, but indirect liquid cooling via cold plates and liquid cooled heat sinks has become a necessary part of the potential design space as the thermal margin for air cooling vanishes. Just as in the early days of air cooling, the design of liquid cooled heat sinks and cold plates has not always followed a rigorous engineering process. As liquid cooled solutions start to seriously contend for implementation, understanding their behavior will lead to better design processes, tools, and ultimately optimized solutions. This lecture will focus on understanding the basic behavior of liquid cooled heat sinks and cold plates, primarily in single phase flow, but with some attention also to two-phase flow. We will compare the various metrics that can be used to assess their performance, including the overall thermal resistance and the heat exchanger effectiveness, and we will compare the performance of liquid cooled heat sinks to air-cooled solutions using these metrics. Finally, we will discuss the use of analysis tools in their design in particular to show the value of simple modeling approaches compared to full CFD approaches.

11:35

Technical Presentations

12:00PM

Lunch

12:50

Exhibit Hall Open

1:25

Technical Presentations

1:50

Thermal Engineering Challenges at the Device and Microprocessor Levels

Mehdi Asheghi, Ph.D.
Associate Professor, Mechanical Engineering Department
Stanford University

The power distribution non-uniformities across chips results in sharp temperature gradients and multiple temperature peaks across a microprocessor or chip, which can adversely impact reliability and performance. Therefore, microprocessor packaging and cooling solutions should not only consider the worst case senario but must also take into account the imapct and ramifiactions of the non-uniformities in power and temperature distributions. Device and package levels thermal design and modeling cover length- and timescales that span over many many orders of magnitude. Often time, the corrolation and connection between the thermal design at the device and package levels

are poorly understood. The thermal cooling solutions not only impact the average chip temperature but also impact the peak temperatures and the extent of the heat spreading. This presentation implements the Spatial Frequency Domain (SFD) analyses of heat transfer in microprocessors to establish a clear relationship between the device and packaging levels thermal design and modeling. I also report on recent advances in the thermal interface material and microprocessor cooling technologies.

3:00 ## Break - Exhibit Hall Open

3:20 ## Thermal Design of Telecommunications Equipment: Challenges and Requirements

Majid Safavi
Distinguished Member of Technical Staff, Alcatel-Lucent Technologies
ALU Representative at North American Telecom Standards, Telcordia and ATIS

Thermal design of telecommunications equipment poses challenges that are unique to the industry. In addition to common electronic thermal design considerations, telecommunications equipment has to be designed to specific and more stringent mechanical, thermal, fire, efficiency, reliability requirements which are defined by the service providers, standard bodies, and regulatory agencies such as FCC. A combination of increased thermal densities and the extreme thermal operational environment of telecom equipment leave very small margins of error in the design and analysis. A slight miscalculation in the design phase could cause result in costly re-designs or termination of the project. To successfully design a new telecommunications product, thermal engineers must work closely with other disciplines throughout the design cycle to ensure that the final product will meet the requirements and pass the compliance/qualification tests. This presentation will provide an overview of the industry requirements and an evaluation of their impact on the equipment design and the cooling strategies of environments such as central offices and data centers.

4:30 ## Perspectives on Electronics Thermal Management from Academia to Industry

Open panel discussion with industry leaders and prominent authorities in electronic cooling. Moderated by Kaveh Azar, Ph.D.

5:30 ## Conclusion of Summit 2011

About the Speakers

Suresh Garimella , Ph.D. - KEYNOTE

Professor Suresh Garimella is the R. Eugene and Susie E. Goodson Distinguished Professor of Mechanical Engineering at Purdue University where he is Director of the NSF Cooling Technologies Research Center. He received his Ph.D. from the University of California at Berkeley in 1989, his MS from The Ohio State University in 1986, and his Bachelor's degree from IIT Madras, in 1985. His research interests include energy efficiency in computing and electronics, renewable and sustainable energy systems, micro- and nano-scale engineering, and materials processing. Dr. Garimella has worked with over 70 Ph.D. and M.S. students and 32 visiting scholars and post-docs, and has co-authored over 450 refereed journal and conference publications and 13 patents/patent applications, besides editing or contributing to a number of books. Twelve alumni from his research group are now faculty members in prestigious universities around the world. Dr. Garimella is a Fellow of the Center for Smart Interfaces at the Technical University of Darmstadt, and an Honorary Guest Professor at Xi'an JiaoTong University in China, and was Honorary Visiting Fellow at the University of New South Wales in 1995.

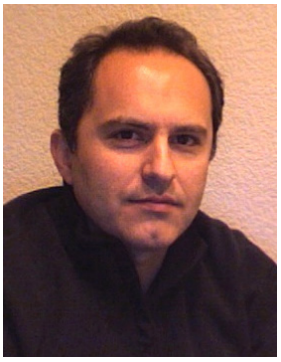
Dr. Garimella serves in editorial roles with Applied Energy, ASME Thermal Science and Engineering Applications, International Journal of Micro and Nanoscale Transport, and Experimental Heat Transfer, and previously served with ASME Journal of Heat Transfer, Experimental Thermal and Fluid Science, and Heat Transfer-Recent Contents. He is a Fellow of the ASME. His efforts in research and engineering education have been recognized with the 2011 NSF Alexander Schwarzkopf Prize for Technological Innovation, the 2010 ASME Heat Transfer Memorial Award, the 2010 Distinguished Alumnus Award from IIT Madras, the 2009 ASME Allan Kraus Thermal Management Award, the 2009 Harvey Rosten Award for Excellence, the 2004 ASME Gustus L. Larson Memorial Award, the 2011 College of Engineering Mentoring Award, the 2009 Purdue University Distance Teaching Award, the 1995 Graduate School/UWM Foundation Research Award for Outstanding Research and Creative Activity, the 1997 UWM Distinguished Teaching Award, and the 1992 Society of Automotive Engineers' Ralph R. Teetor Educational Award, among others. He is currently serving as a Jefferson Science Fellow at the U.S. State Department, in the International Energy and Commodity Policy office of the Economic Bureau. This program offers his services as a science advisor to the State Department for a period of six years.

Victor Zaderej, M.S., MBA - KEYNOTE

Victor Zaderej is the Manager of Advanced Development for Molex's Solid State Lighting Group where he provides strategic direction for the group as well as is responsible for the next generation of solid state lighting products. Victor joined Molex in 2000 when Molex purchased his and a business partner's company, Three Dimensional Interconnects Incorporated (3Di). The antenna business unit which was started as a result of the 3Di purchase now generates over $110,000,000 in revenue for Molex. Victor began his work in the area of applying circuitry to three dimensional plastic components in 1987 while working for IBM's personal computer division where he was the lead engineer for the IBM PS/2 Model 50. He left IBM in 1989 for a joint venture between GE Plastics and Circuit Wise, specializing in the design and manufacture of MIDs (Molded Interconnect Devices).Working with both domestic and international customers to develop new applications as well as perfecting the technology to manufacture MIDs, Victor has been exposed to all aspects of using the technology to provide solutions to challenging electromechanical packaging applications.

Victor received his B.S. and M.S. in Mechanical Engineering from MIT. He completed his MBA in 1995 from Quinnipiac University. He holds 33 patents within the fields of electrical packaging, thermal management, energy conservation, and solid state lighting. He lives in St. Charles, Illinois. His interests include tennis, scuba, chess, and training architects, homeowners, and builders on the design of super energy efficient homes.

About the Speakers



Ihab Andre Ali, Ph.D.

Dr. Ali is currently a President and co-founder of Deeia Systems, an energy efficiency and renewable energy company. Andre is also a founder of Rola Technologies, a technical, market and product strategy consulting company in electronics thermal design and energy efficiency. He is a former chief thermal architect at Apple where he is credited for leading and innovating thermal technologies and design architectures for Apple's Macbook, Macbook Pro, MacBook Air, iPhone, |iPad and other platforms. He is a former thermal technologist at Intel's mobile product group. His interests and research focus are in electronics and buildings thermal management and control, energy efficiency, renewable energy and environmental impact. Dr. Ali is an inventor of over 20 patents and applications and publisher of numerous papers in the field of thermal management, CFD and heat transfer. He also served as keynote speaker, panelist and chair at various conferences and forums worldwide. He has a BS in Civil Engineering from Damascus University, MS in Mechanical Engineering from WPI and PhD in Mechanical Engineering from University of Maryland.

Mehdi Asheghi, Ph.D.

Mehdi Asheghi is currently a consulting associate professor at the Stanford University focusing on further development of PCRAM technology. He completed his Ph.D. (1999) and postdoctoral (2000) at the Stanford university conducting research in the area of nanoscale thermal engineering of microelctronic devices. He is also with the iCONA Technology, which is a Palo Alto based research and development firm focusing on smart energy and thermal managements of residential buildings. He led a well-known and funded research program (2000-2006) at the Carnegie Mellon University that focused on nanoscale thermal phenomena in semiconductor and data storage devices. He is the author of more that 110 book chapters, journal publications and fully-reviewed conference papers.

Kaveh Azar, Ph.D.

Dr. Kaveh Azar is the President and CEO of Advanced Thermal Solutions, Inc. (ATS), a leading edge thermal management company involved in developing liquid and air cooling solutions for the telecomm and computing market sectors. Under Dr. Azar's leadership, ATS has expanded globally with offices in Europe and Asia, and has become the leading supplier of cooling solutions and thermal management consulting to the telecomm market sector. Prior to ATS, Dr. Azar was the founder and manager of Lucent Technologies thermal management center, responsible for developing the next generation of cooling systems. In addition, Dr. Azar has authored Lucent's thermal roadmap and served as the corporate thermal consultant. While at Lucent, he developed a state-of-the- art thermal/fluids laboratory for simulation of components, boards and systems. Since 1985, Dr. Azar has been an active participant in electronics thermal community and has served as the organizer, general chair and the keynote speaker at the national and international conferences sponsored by ASME, IEEE and AIAA. He has also been an invitee to national bodies such as NSF, NIST and NEMI for organizing government and industry research goals in electronics cooling. Dr. Azar has been an adjunct professor at a number of universities in the USA, and lecturers worldwide on different facets of electronics cooling. He holds more than 31 national and international patents, has published more than 73 articles, 3 book chapters and a book entitled, "Thermal Measurements in Electronics Cooling" and has edited a 5 book series, "Qpedia – Electronics Thermal Management." In addition, he served as the Editor-in-Chief of Electronics Cooling Magazine for eleven years, and is currently the publisher of Qpedia, a monthly publication dedicated to thermal management of electronic systems. Dr. Azar has received several recognitions within Bell Labs and other entities that include Bell Labs' President Silver Award, Strathmore's Who's Who, The Uptime Institute for Visionary Leadership and IEEE SEMITHERM Significant Contributor Award in thermal management of electronics systems.

About the Speakers

Norbert P. Engeleberts

Norbert P. Engelberts is the director of Advanced Thermal Solutions Europe and has been actively involved in electronics cooling since 1992. Prior to ATS, Engelberts headed the Thermal Design and Environmental Testing Group for Bell Labs, Lucent Technologies (now Alcatel-Lucent). During his 11 year tenure at Bell Labs, he was responsible for the thermal management and environmental testing (indoor and outdoor) of all telecommunications system equipment developed by the company in the Netherlands. In addition, Engelberts also brings with him expertise in HVAC system design, particularly those that house telecommunications and networking equipment. He works as a senior consultant for marked leading companies in the area of semiconductor, telecom, military, automotive and lighting. He has an extensive experience in the thermal management of LED based lighting solutions for a variety of applications, including automotive, street lighting, led replacement lamps.

Robert J. Moffat, Ph.D.

Dr. Robert J. Moffat is a Professor at Stanford University and President of Moffat Thermosciences, Inc. Prof. Moffat started his professional career at the General Motors Research Laboratories on graduation from the University of Michigan (1952) in the Gas Turbine Laboratory. He assumed responsibility in 1958 for the testing of periodic-flow heat exchangers for regenerative gas turbines and the development of seals for these devices. He completed requirements for the degree of Master of Science, Engineering Mechanics, at Wayne State University in 1961, with a thesis on the behavior of ground effect machines (i.e., hover-craft) having thick curtain jets. He then enrolled in Stanford University in 1962 and completed the requirements for Master of Science (Mechanical Engineering), Engineer (Mechanical), and Ph.D. in Mechanical Engineering. He was appointed Acting Associate Professor, 1966, Associate Professor, 1967, and Professor of Mechanical Engineering, 1972, and served as the Director of the Thermosciences Industrial Affiliates Program from 1967 to 1986 and as Chairman of the Thermosciences Division from1973 to 1986. His research efforts have involved three areas: convective heat transfer in engineering systems, experimental methods in heat transfer and fluid mechanics, and biomedical thermal issues. The largest body of work concerns convective heat transfer. The first program, begun in 1967 and continued until 2002, focused on gas turbine blade and vane heat transfer. The second program, begun in 1980 and continuing to the present, is aimed at convective cooling of electronic components. Early work focused on measuring heat transfer coefficients in a coherent sequence of experiments covering forced convection, free convection and mixed convection. From these data, a clear physical picture of the mechanisms was extracted. The behavior of finned heat sinks was studied analytically and experimentally, to explain the effect of the local pressure gradient on the heat sink behavior. In its broadest terms, the Stanford work was the first to capitalize on the linearity of the heat transfer process and use superposition to deal with heat transfer from arrays of objects that are non-uniformly heated. Several significant contributions came out of these programs: (1) a demonstration of the importance of developing invariant descriptors of heat transfer, (2) a new definition of the heat transfer coefficient for electronics cooling (the concept of hadiabatic) and (3) the development of a simple correlation for predicting had with useful accuracy based on an estimate of the turbulence intensity. The second area of research concerned experimental methods in the thermosciences. The pioneering work of S. J.Kline was extended and developed into a tool useful in planning experimental programs of provable accuracy. A good deal of work was done on the use of thermocouples for point-wise temperature measurements and full-field imaging techniques for temperature, heat flux, and heat transfer coefficient measurement using thermochromic liquid crystals and digital image handling. The experimental methods program contributed regularly to the theory of uncertainty analysis through presentations and publications. Professor Moffat was an invited lecturer for 40 consecutive years in the Measurement Engineering Series (originally through Arizona State University), for more than 20 years in the Instrument Society of America Test Measurements Division Professional Development Program and, for ten years, in the ASME Professional Development program. There was been a continuing, small scale effort on biomedical engineering problems, in particular the thermal protection of newborn infants. A self-contained, portable incubator was developed which provided a neutral thermal environment for the infant while allowing free access by the attending physicians. It has been used on almost every continent where cold-weather transport is needed and resulted in the award of the ASME Holley Medal Award, 1987. Moffat Thermosciences, Inc. was incorporated in 1984 as a vehicle for consulting, research, and teaching in Heat Transfer and Experimental Methods. The corporation has been active in preparing and delivering short courses in the area of Electronics Cooling, Experimental Methods, and Uncertainty Analysis, as well as problem solving. Dr. Moffat hold nine patents related to heat transfer, fluid mechanics, and instrumentation and has authored over 230 publications on heat transfer, experimental methods, biomedical issues and teaching.

About the Speakers

Alfonso Ortega, Ph.D.

Alfonso Ortega is the James R. Birle Professor of Energy Technology at Villanova University and Associate Dean for Graduate Studies and Research for the College of Engineering. He received his B.S. in 1976 from The University of Texas-El Paso, and his M.S. and Ph.D. from Stanford University in 1978 and 1986 respectively, all in Mechanical Engineering. He was on the faculty of Aerospace and Mechanical engineering at The University of Arizona from 1988 to 2005 where he founded and directed the Experimental and Computational Heat Transfer Laboratory. From 2004 to 2006, Dr. Ortega was the Program Director for Thermal Transport and Thermal Processing in the Chemical and Transport Systems Division of The National Science Foundation in Arlington, Virginia. He joined the faculty of Mechanical Engineering at Villanova University in 2005. Dr. Ortega directs the Laboratory for Advanced Thermal and Fluid Systems conducting research in the heat transfer and fluid mechanics fundamentals of convective heat transfer in single and two phase flow, especially in problems that arise from the technology of electronics thermal management, gas turbine cooling, and alternative energy technologies. He has supervised nearly 40 M.S. and Ph.D. candidates to degree completion and is the author of over 300 journal and symposia papers. Dr. Ortega is a Fellow of the ASME and is currently Associate Editor of the ASME Journal of Heat Transfer.

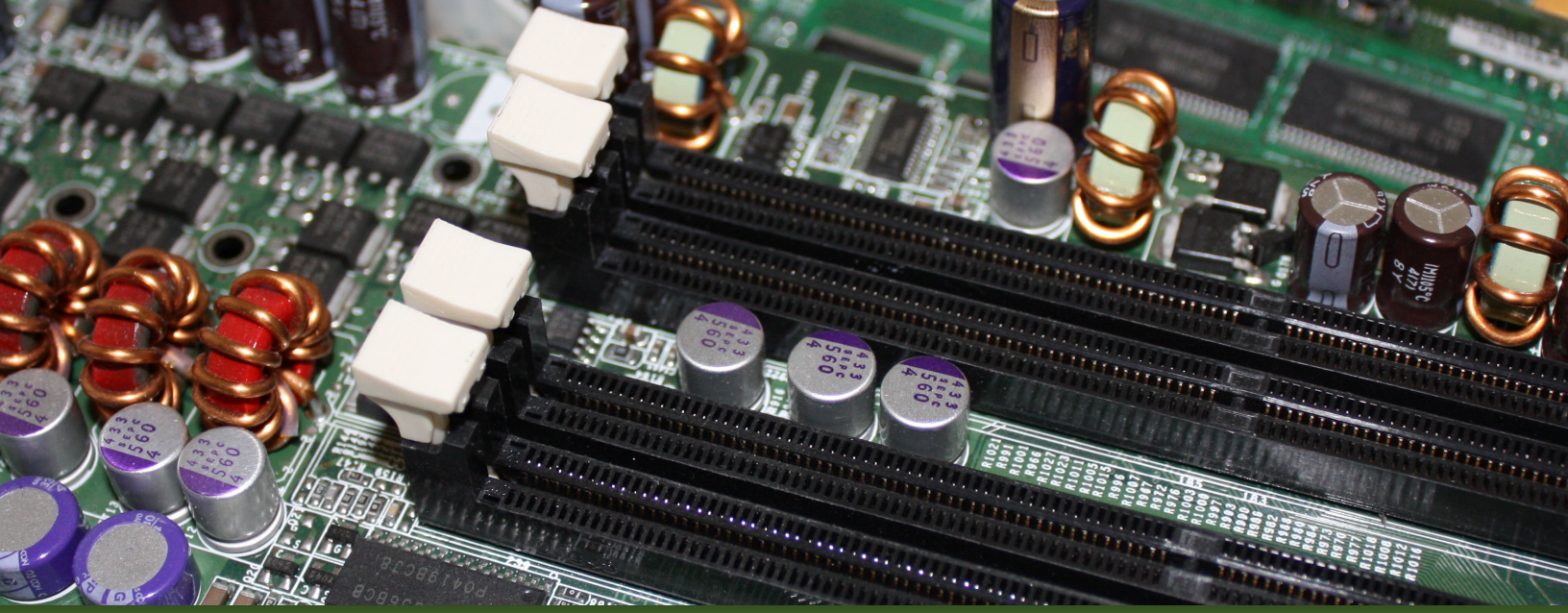
Majid Safavi

Majid Safavi, Distinguished Member of Technical Staff at Bell Laboratories and Alcatel Lucent Technical Academy member has over 25 years of experience in thermal/mechanical R&D of telecom equipments. He is the principle thermal designer for the land line and wireless switching products at the Naperville campus and has been involved in the successful design of more than 100 products currently in the field. Mr. Safavi represents Alcatel Lucent in the North American Telecom Standards bodies, Telcordia and ATIS, working on standards related to energy efficiency and thermal management of Telecom equipments and environments. In addition to thermal design he has also been working on, process improvement, seismic analysis and testing, project management, and system engineering.

Jim Wilson, Ph.D.

Dr. Jim Wilson is currently an Engineering Fellow with Raytheon Space and Airborne Systems in Dallas, Texas and the section manager for the mechanical analysis section of Raytheon's Advanced Product Center. Jim has 26 years experience in electronics cooling of microwave systems and other military electronic products. He has spent a substantial portion of his career responsible for phased array radar thermal management with topics ranging from thermal design at the microwave integrated circuit level, directed research for advanced thermal interface materials, engineered material for enhanced thermal conduction, as well as overall cooling system design. The challenges of cooling radar systems have included a large portion of the electronics cooling heat transfer spectrum; conduction with advanced materials, liquid cooling, radiation cooling of satellite systems, and the challenges represented by the need to manage both maximum temperatures and the temperature distribution.

Dr. Wilson has been active in professional thermal management societies and is currently an associate editor of Electronics Cooling magazine. Jim is an active member of the steering committee for the annual IEEE Semitherm conference. He has six thermal design patents and has authored or co-authored over 25 papers in the field of electronics thermal management including invited papers at government workshops sponsored by NASA and the Office of Naval Research. He received his BSME from Texas Tech, MSME from Stanford, and Ph.D. from Southern Methodist University. As part of his dissertation, he developed numerical techniques to rapidly simulate transient temperatures in GaAs MMICs.



Pre-Summit Short Course

Thermal Management of Electronics –
Calculations, Measurements, Simulation, Review and Selection of Cooling Options

October 4, 2011
Cambridge, MA

Design engineers are dealing with more heat problems than ever before and the task of mitigating those thermal issues within cost and time constraints have never been more challenging. Please join Dr. Kaveh Azar, a global electronics cooling expert and the President and CEO of Advanced Thermal Solutions, Inc. in a full day thermal management presentation that will provide an introduction to electronics thermal management for current and next-generation electronics.

Goal
To provide the audience with the fundamentals of thermal management and explore the salient features and the benefits/short-falls of varied cooling options - from simple air cooling to high capacity refrigeration.

Who Should Attend?
"Thermal Management of Electronics – Calculations, Measurements, Simulation, Review and Selection of Cooling Options" is specifically tailored for engineers who require a principal understanding of electronics thermal management and need practical, focused methods for identifying optimal cooling solutions. This seminar is also suited to project managers, chief technical officers and other who want insight into the thermal design issues that affect product performance.

How to Register
The cost to attend the day-long short course program on October 4, 2011 is $795.00, with a discounted rate of $695.00 if registered by September 9, 2011. Space is limited and advanced registration is required.

To register for the short course, please visit www.coolingzone.com
For more information, please contact Debbie at 508-329-2021 or registration@coolingzone.com

Course Agenda

The seminar runs from 8:00 a.m. to 6:00 p.m. and includes a continental breakfast, lunch, and afternoon refreshments.

Morning Session - 4 hours

Attendees will be taken from the basic definition of electronics cooling and why thermal management is required; to how to calculate certain parameters; to how to accurately measure them; and to where and how to use simulation tools like CFD, for effective thermal management. These include:

- **Fundamentals of Electronics Cooling**
  What it is; why it needs to be considered; how it is approached and what needs to be considered.
- **Required Calculations in Thermal Management**
  A set of calculations and respective procedures for analytical modeling of components, boards and systems.
- **Effective Characterization – The Role of Measurement in Thermal Management**
  Basic principles of measurement are examined and proper practices for temperature, velocity, pressure and heat flux are reviewed.
- **The Role of Software in Thermal Management—CFD Simulation**
  Understanding the fundamentals of CFD simulation and reviewing the best practices in modeling electronic components, boards and systems.

Afternoon Session - 5 hours

This session is designed to provide the attendees with features, selection and salient characteristics of different cooling systems. These include: selection and design of heat sinks and thermal interface materials, fan selection and characterization, and their role in electronics cooling. The use of vapor chambers and jet impingement for cooling of high power components and boards will also be reviewed. The session ends with an extensive review of cooling solutions that has been developed from vacuum tube to modern high power electronics. These include:

- **Heat Sink Design and Thermal Interface Selection**
  This topic will feature a review of the process of heat sink design and selection and the role of thermal interface material in cooling of electronic components.
- **Fan Characterization and Its Deployment in Electronic Systems**
  This session will involve a review of fan types, their characteristics and best deployment practices. This will include an examination of how fan characterization is done and how to use fan curves for fan selection.
- **Vapor Chamber and Jet Impingement For Thermal Management of High Power Electronics**
  A review of the design and operations of vapor chambers and how they are deployed in electronics components will be conducted. Also included will be a look at jet impingement characteristics and its heat transfer benefits/shortfalls in tough-to-cool electronics.
- **Review of Salient Features of Market-Developed Cooling Solutions**
  In this period, an exhaustive review of cooling solutions that have been developed across the electronics industry will be presented. The review starts at the vacuum tube era and continues through to today's sophisticated electronics. This presentation will encompass all market sectors: from LEDs and consumer electronics to space and military applications.

About the Speaker

Kaveh Azar, Ph.D.

Dr. Kaveh Azar is the President and CEO of Advanced Thermal Solutions, Inc. (ATS), a leading edge thermal management company involved in developing liquid and air cooling solutions for the telecomm and computing market sectors. Under Dr. Azar's leadership, ATS has expanded globally with offices in Europe and Asia, and has become the leading supplier of cooling solutions and thermal management consulting to the telecomm market sector. Prior to ATS, Dr. Azar was the founder and manager of Lucent Technologies thermal management center, responsible for developing the next generation of cooling systems. In addition, Dr. Azar has authored Lucent's thermal roadmap and served as the corporate thermal consultant. While at Lucent, he developed a state-of-the- art thermal/fluids laboratory for simulation of components, boards and systems. Since 1985, Dr. Azar has been an active participant in electronics thermal community and has served as the organizer, general chair and the keynote speaker at the national and international conferences sponsored by ASME, IEEE and AIAA. He has also been an invitee to national bodies such as NSF, NIST and NEMI for organizing government and industry research goals in electronics cooling. Dr. Azar has been an adjunct professor at a number of universities in the USA, and lecturers worldwide on different facets of electronics cooling. He holds more than 31 national and international patents, has published more than 73 articles, 3 book chapters and a book entitled, "Thermal Measurements in Electronics Cooling" and has edited a 5 book series, "Qpedia – Electronics Thermal Management." In addition, he served as the Editor-in-Chief of Electronics Cooling Magazine for eleven years, and is currently the publisher of Qpedia, a monthly publication dedicated to thermal management of electronic systems. Dr. Azar has received several recognitions within Bell Labs and other entities that include Bell Labs' President Silver Award, Strathmore's Who's Who, The Uptime Institute for Visionary Leadership and IEEE SEMITHERM Significant Contributor Award in thermal management of electronics systems.

Register Now

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International Business and Technology Summit

Thermal Management of Electronics

Emerging Technologies for Advanced Cooling of Electronic Systems

October 5 - 6, 2011 | Cambridge, MA

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Registration Information

How to register for the Summit and Pre-Conference Short Course:

- **Register online at www.coolingzone.com through our secure online processing**
- **Complete and FAX the registration form to coolingZONE at 508-898-2796**

2-Day Summit Fee: (Oct. 5-6, 2011)	**Before September 9, 2011**	**$995 per person**
	After September 9, 2011	**$1395 per person**
	Includes: Conference Proceedings, Breakfast and Lunch each day, Exhibit Hall admission and Networking Reception.	
1-Day Course Fee: (Oct. 4, 2011)	**Before September 9, 2011**	**$695 per person**
	After September 9, 2011	**$795 per person**
	Includes: Lecture Notes, Breakfast and Lunch. Discounted day parking rate at the hotel is applcable for short course participants.	
2-Day Summit and Short Course Fee: (Oct. 4-6, 2011)	**Before September 9, 2011**	**$1495 per person**
	After September 9, 2011	**$1995 per person**
	Includes: Lecture Notes, Conference Proceedings, Breakfast and Lunch each day, Exhibit Hall admission and Networking Reception.	

No refund is provided for cancellation after August 26, 2011. However, you may transfer your registration to another person to attend in your place.

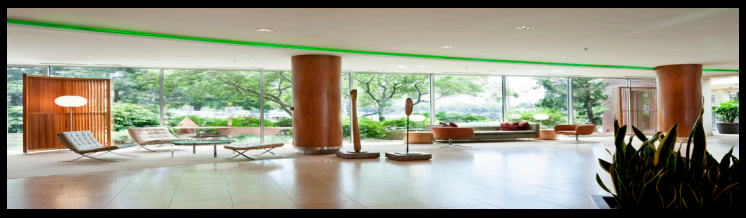
Questions? Contact coolingZONE at 508-329-2021 or registration@coolingzone.com

Hotel and Area Information

The Royal Sonesta Hotel

40 Edwin Land Boulevard
Cambridge, MA 02142
617-806-4200
www.sonesta.com

The 11th International Business & Technology Summit will be held at the Royal Sonesta Hotel in Cambridge, MA located on the banks of the scenic Charles River. Offering views of the Boston skyline and less than one mile from MIT, Harvard University, high-tech, bio-tech and financial centers of both Cambridge and Boston, the Royal Sonesta Hotel affords a perfect venue for coolingZONE Summit attendees to participate in our industry-leading conference and network with academic and industry leaders in the area.



Above: Hotel Lobby
Below: Art Bar (Left) , Pool & Spa (Right)

A special room rate of $189 per night is offered for attendees. Reserve your preferred accommodation by:

1) Reserving on-line at www.coolingzone.com . Go to EVENTS and select the REGISTRATION tab. Select the HOTELS AND AREA INFORMATION tab and link directly to the hotel URL dedicated for coolingZONE, LLC with discounted room rates Oct. 3-6, 2011.

2) Calling the Hotel directly at 617-806-4200 and asking for Reservations. Reference GROUP CODE #COOJ11A to receive your discounted room rate; or

3) Emailing the Hotel directly at reservations@sonesta-boston.com. Reference GROUP CODE # COOJ11A to receive your discounted room rate.

You must identify yourself as part of the coolingZONE Group to take advantage of the discounted group rate. Note: standard room rate without the discount during this time period is $399 per night. Rooms reserved at the special rate of $189 are limited, so call today to reserve your room and enjoy all the benefits Royal Sonesta, Cambridge and Boston have to offer!

Transportation

Airport Transfers and Parking

Logan International Airport is just 3 miles from the Royal Sonesta Hotel. Taxi Service is available to and from Logan Airport. Travel from Logan Airport to the Royal Sonesta Hotel is provided by Boston taxi companies. Fares are a metered rate and can range from $25 to $30 depending upon traffic conditions and the time of arrival. Return travel from the Royal Sonesta back to Logan Airport is provided by Cambridge taxi companies. Fares are flat rates, inclusive of all tolls, taxes and driver gratuities.

Hotel Courtesy Vans

Daily routes provide scheduled stop to MIT, Kendall Square, Quincy Market/Faneuil Hall Marketplace and the Prudential Center/Copley. Shuttle service is FREE to all registered guests of the Royal Sonesta Hotel, however reservations are required. Please contact Guest Services at 617-806-4250 to receive a current schedule of departure and arrival times available and confirm your reservation. NOTE: Shuttle service is not available to Logan International Airport (3 miles away), however, taxis are available on-site for your convenience.

Public Transportation

Logan International Airport is accessible by subway using the Green MBTA line (0.7 miles from Airport): Take the Green Line MBTA trolley/bus to Lechmere Station. Exit and follow signs to Cambridge Street. Cross to First Street and walk along the CambridgeSide Galleria to Charles Street/CambridgeSide Place. Turn left and the Hotel will be at the end of the block.

Garage Parking

Guest Services can reserve a vehicle from any of the major car rental companies.

Directions

From the Logan International Airport:

Take the main airport roadway (one-way) out of the airport and follow signs for "Route 1A / Sumner Tunnel, Boston/ I 93" Enter the tunnel and stay in the right lane. As you exit the Summer Tunnel, veer right into the tunnel for Storrow Drive. As you exit this tunnel, make a left following signs for "Leverett Circle / North Station.' At the second light, make a left and follow 28 North (McGrath / O'Brien highway). You will pass the Museum of Science on your left. After two traffic lights, turn left onto Edwin H. Land Boulevard (sign will say Memorial Drive) follow to first traffic light and turn left into the Royal Sonesta's driveway.

From the North (Route 93S):

Take Route 93 South to Exit 26 (not accessible from carpool lane), "Storrow Drive/Cambridge/Route 28N/ Route 3N." Stay to the right, moving to the middle lane, following signs for "Route 28 North/Cambridge/ North Station." At the traffic signal, turn left onto Nashua Street. Take the first right onto Route 28 North/Msgr O'Brien Highway. Pass the Museum of Science on your left. Proceed to the second traffic light and turn left onto Edwin Land Boulevard. The hotel is on the left at the next traffic signal, across from the CambridgeSide Galleria.

From the South (Route 93N):

Take Route 93 North to the Liberty Tunnel (move to the right lane after Exit 23). Take Exit 26, "Storrow Drive". Stay to the right moving onto Storrow Drive. Take immediate left exit "Government Center/Kendall Square" and turn right at the top of the ramp, onto the Longfellow Bridge. Proceed to the traffic signal and turn right onto Third Street. Proceed to the traffic signal and turn right onto Binney Street and proceed to the end. At the traffic signal, turn left onto Edwin Land Boulevard. The hotel entrance and garage are located on the right at the next traffic signal, across from the CambridgeSide Galleria.

From the Massachusetts Turnpike:

Take exit 18, Allston/Cambridge (left exit) Bear Right, after toll booth bear right towards Cambridge. Go straight through 3 sets of lights (this will bring you on to River Street). Continue straight down River Street until you come to Massachusetts Avenue (approx. .6 mile) get into right lane to turn on Mass. Ave. Go straight down Massachusetts Ave for .2 mile and turn/bear left onto Main Street (not clearly marked). Continue on Main Street .4 Mile through 3 sets of lights and turn left onto Galileo Way and take it all the way to the end. Turn left onto Edwin Land Blvd, getting in the right lane, The Royal Sonesta will be on the right at the next light

Cambridge, MA

Stroll the cobble-stone streets of Cambridge where world-class educational institutions coexist with our nation's history. Packed with an international flair and youthful vitality, Boston is a leader for economic, political, and social change. Home to Harvard and MIT, Cambridge is a heady mix of students, scholars, and visitors from around the world. It's a cosmopolitan college town with an eclectic array of bookstores, coffee houses, blues clubs, street musicians, repertory theaters, and mouthwatering ethnic restaurants. With a picturesque riverfront and breathtaking skyline, you will soon discover why the charm of the Charles River is contagious. Boston and Cambridge are a perfect blend of stylish sophistication and historic New England charm.

Harvard

Take a stroll through the ivy-covered Harvard Yard and see the famous "Statue of Three Lies", and you will walk the same path as some of the greatest minds in history. Curl up with a book at the world-famous Harvard COOP Bookstore or grab something to eat at any of the hip, ethnic resteraunts of Harvard Square.

Harvard University / The Harvard Coop Bookstore
1400 Massachusetts Avenue
18 Palmer Street | Cambridge, MA 02238
617.499.2800 | www.harvardcoopbooks.com
Open Mon - Sat 9am – 9pm | Sun 10am - 7pm

MIT

Join MIT in celebrating its 150th anniversary of rich history and revolutionary ideas. Visit the MIT Museum to view the The MIT +150 Exhibition, the most expansive exhibition ever developed. This unique exhibition is made up of stories and objects that members of the MIT community helped to select, collect and make available to the public, many for the first time.

Massachusetts Institute of Technology/ MIT Museum
Building N51 | 265 Massachusetts Avenue | Cambridge, MA 02139
617.253.5927 | www.mit.edu
Open Daily 10am – 5pm

Museum of Science

The Museum of Science, located 100 yards from the hotel, has remained on the cutting edge of science education by developing over 400 innovative and interactive exhibits and programs that both entertain and educate. In addition to the exhibits, there is the Mugar Omni Theater, the Charles Hayden Planetarium and the Butterfly Garden.

Science Park | Boston, MA 02114
617.723.2500 | www.mos.org
Open Sat - Thurs 9am – 5pm | Friday 9am - 9pm

Museum of Fine Arts

The Museum of Fine Arts is one of the most comprehensive art museums in the world with nearly 450,000 works of art. Each year, more than one million visitors experience the museum's spectacular exhibits, from ancient Egyptian to contemporary works, as well as special exhibitions and innovative educational programs.

465 Huntington Avenue | Boston, MA 02115
617.267.9300 | www.mfa.org
Open Mon & Tues 10 am - 4:45 pm | Wed - Fri 10am - 9:45pm
Sat & Sun 10 am - 4:45pm

Boston Symphony Orchestra

The Boston Symphony Orchestra and Boston Pops are two renowned musical institutions. The Symphony offers youth and family nights, guest conductors and virtuoso performers. The BSO will be performing "Britten, Prokofiev and Sibelius" the evening of Thursday October 6, 2011.

Symphony Hall
301 Massachusetts Ave. | Boston 02115
617.266.1492 | www.bso.org

New England Aquarium

The New England Aquarium is home to the 200,000-gallon tank known as the Caribbean Coral Reef Exhibit. The reef accommodates not only sharks, sea turtles, barracuda and moray, but also hundreds of smaller exotic tropical fish, and it is one of the most detailed and scientifically accurate presentations of its kind.

Central Wharf | Boston, MA 02110
617.973.5200 | www.neaq.org
Open Mon - Fri 9am – 5pm | Sat & Sun 9am - 6pm

Boston Common

Stroll through the infamous Boston Common, America's first park, and the Public Garden, its first public botanical garden. Admire the rich and unusual plants, the Lagoon, monuments and fountain. Take a graceful ride on the Swan boats and enjoy the natural beauty of its 24 acres.

Boston Public Garden
Arlington Street | Boston, MA 02130
www.swanboats.com

Fanuiel Hall

Faneuil Hall, often referred to as the "Cradle of Liberty," comes alive as festive street performers wow you with magic, acrobatics, music, and dancing. Shop for one-of-a-kind gifts and specialty items. Dine at 5-star restaurants, historic Irish pubs, or Cheers "where everyone know youre name." In addition, you'll find over 36 international food vendors inside of the Quincy Market Colonnade, the largest food hall in New England. Whatever you're looking for, Fanuiel Hall has it all.

Fanuiel Hall Marketplace
State Street | Boston, MA 02130
www.faneuilhallmarketplace.com

Fenway Park

Visit one of America's most beloved ballpark, home to the 2004 and 2007 World Champion Boston Red Sox. Take a tour of fenway as it celebrates its 100th year to soak up baseball history, hear echoes of the past, and touch the Green Monster of this iconic ballpark. Not just for the sports fan, Lansdowne street is a popular local and tourist attraction for fun restaurants and night life.

4 Yawkey Way | Boston, MA 02215
617.226.6666 | www.redsox.com

Boston Duck Tours

You haven't toured Boston until you've taken a Boston Duck Tour! The fun begins as soon as you board your "DUCK", an authentic, renovated World War II amphibious landing vehicle. View all the historic landmarks in a way you've never experienced and take a cruise throuh the city streets and harbor.

Tours depart from the Museum of Science
Science Park | Boston, MA 02114
617.267.DUCK| www.bostonducktours.com

Contact Us

For personalized assistance with questions or registration, please contact us at 508-329-2021 or email coolingZONE, LLC at:

Registration:	registration@coolingzone.com
Exhibit/Sponsorship:	registration@coolingzone.com
Program Information:	cz-info@coolingzone.com

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