TUTORIALS

Please note that all tutorials are unclassified. Separate registration is required to attend the tutorials.

MONDAY, 29 October 2007

UT-1

Factor Graphs for Advanced Algorithm Design in Wireless Communications

Monday 9:15 a.m.–12:15 p.m.
Osceola 1

Presenter: Mr. Henk Wymeersch

With the introduction of turbo codes in the early 1990s, a major leap forward was achieved in communications research, not only were practical capacity-approaching error-correcting codes finally developed, but the general idea behind turbo codes (the so-called turbo principle) was applied to a long list of applications. These include multiuser detection, channel estimation and MIMO systems. This has led to a myriad of algorithms, many of which are ad hoc, using different terminology, different notations, different implementations, and so forth. Any kind of coherent underlying mechanism was unclear. Only with the development of a type of graphical models, known as factor graphs, has it been recognized that there is in fact an underlying unifying theory for most, if not all, of these turbo algorithms. The factor graph framework is simple and elegant, and allows for a deep understanding of a wide variety of algorithms, based on a set of simple rules and a common notation. These insights are developed in detail in the upcoming book, *Iterative Receiver Design*, to be published by Cambridge University Press in the summer of 2007. The goal of this tutorial is to present these concepts in a rigorous yet understandable manner, and show how advanced algorithms can be understood and designed in a systematic fashion. The proposed tutorial will consist of six parts:

- Conceptual Background
  - Provides a description of the birth of iterative processing, tracing it back to Robert Gallager's Ph.D. thesis at MIT on Low Density Parity Check (LDPC) codes.
  - Shows how factor graphs came about, and how factor graphs have led to a paradigm shift in algorithm design.
- Practical Background
  - Review of the necessary mathematical tools required to solve inference problems.
  - Discuss the basic estimation algorithms and describe several classes of Monte Carlo methods.
- Factor Graphs
  - Presentation of the mathematical theory of factor graphs using a top-down approach to show the types of problems which can be solved by factor graphs using message-passing.
- Statistical Inference Using Factor Graphs
  - How factor graphs can be applied to estimation problems using the running example of a simple hidden Markov model to show how the factor graph framework easily gives rise to advanced algorithms such as the forward-backward algorithm, the Viterbi algorithm, and the Kalman filter.
- Turbo Processing
  - Demonstration of how soft decoding of turbo and LDPC codes and turbo detection for multiuser and multiantenna systems are nothing more than instantiations of the message passing algorithm on specific factor graphs.
- Open Issues
  - Discussion of a number of unsolved problems and the more advanced applications of factor graphs, including distributed processing.

UT-2

Multiple Antenna Systems for Interference Mitigation and Throughput Enhancement

Monday 9:15 a.m.–12:15 p.m.
Osceola 2

Presenters: Dr. Marco Chiani and Dr. Moe Win

Multiple antenna systems can exploit the spatial resource to mitigate multipath, to reduce multiuser interference, and to increase spectral efficiency. The use of multiple antennas (possibly at both transmitting and receiving ends) plays an increasingly important role in military wireless networks since it provides significant improvements in communication range, number of served users, data rate, interference mitigation, link reliability, etc.

This tutorial provides the basic principles and applications of multiple antenna systems, including MIMO and distributed MIMO, and their analysis based on random matrix theory. Recent results on the effect of space and time correlation on the capacity of MIMO systems will be discussed, as well as practical solutions for MIMO systems and their performance analysis. Finally, the tutorial illustrates applications of multiple antenna systems and MIMO in cellular systems, wireless LAN, WiMAX, and cooperative diversity for energy constrained wireless sensor networks. The tutorial will cover relevant topics including:

- Introduction to Multiple Antenna Systems: Diversity, Interference, Spectral Efficiency
- Basic Concepts in Random Matrices Theory
- Theoretical Limits: The Capacity of MIMO Systems
- Effects of Space and Time Correlation on MIMO Capacity
- Effects of Interference: Capacity of MIMO in a Multiuser Scenario
- Distributed MIMO
- Optimum Combining to Counteract Multipath and Interference
- MIMO-MMSE: Architecture and Analytical Performance Evaluation

- Application of Multiple Antenna to Cellular Systems, Wireless LAN, Wimax, and Energy-Constrained Wireless Networks

UT-3

Security of Information and Communication Networks

Monday 9:15 a.m.–12:15 p.m.
Osceola 3

Presenter: Dr. Stamatios Kartalopoulos

The delivery of private or secret messages has been an issue of concern regardless of method of transport. Since antiquity, it was risky to send a message with a messenger without compromise. As a result, certain methods were developed to assure unintelligibility of a message if in enemy hands or to indicate to the rightful recipient that the message has been compromised or not. In our modern era, most messages and private data are transported over the communications network, which unfortunately is not immune to eavesdroppers, malicious attackers, impersonators and in general to bad actors who, with sophisticated methods access the network and harvest or destroy electronic data. In recent years, government and private industry worldwide are witnessing with concern an alarming increase in such malicious acts.

This Security of Information and Communication Networks tutorial covers:

- Overview of Encryption and Securing Messages
- Modern Network Security Issues, Network Security Levels, and Security Layers in Communication Networks (Information, MAC, Link layers)
- A Mathematical Foundation for Security, PN, Mod Arithmetic, GCD, Groups, Rings and Fields
- Ciphers (Symmetric, Asymmetric, RSC, DES, AES, RC4, Elliptic Curve, RSA)
- Key Distribution Algorithms (Merkley, Shamir, Diffie-Hellman, ECC, Digital Signature, Key Escrow)
- Quantum Cryptography and QKD (Polarization, Entangled-States, Teleportation)
- Vulnerabilities and Countermeasures in QC
- Biometrics in Communication Networks
- Security in the Next Generation Optical Networks

Intended Audience:

This course is designed for a general audience and is attractive to those that have to understand what security is in communications, what has been done about it, why security is an open issue and why very advanced topics such as Quantum Mechanics are incorporated. It is expected that it will attract researchers in the field of security, information and communications engineers and managers.

UT-4

Software-Defined and Cognitive Radio

Monday 2:15–5:15 p.m.
Osceola 1

Presenter: Dr. T. Charles Clancy

This tutorial will provide a survey of software-defined radio and cognitive radio technologies. The Software-Defined and Cognitive Radio tutorial will familiarize attendees with:

- Basic components of a software-defined radio
- How software-defined radios interoperate
- How a cognitive engine can control software-defined radios

A variety of applications will be discussed, including adaptive waveforms and dynamic spectrum access. Relationships to JTRS, the SCA, and DARPA XG will also be covered.

UT-5

Elements of Cross-Layer System and Network Design for QoS-Enabled WiMAX Networks

Monday 2:15–5:15 p.m.
Osceola 2

Presenters: Dr. Vishal Sharma and Dr. Abhay Karandikar

The main theme of this workshop/tutorial will be to elucidate Medium Access Control (MAC) layer operation and cross-layer system and network design techniques for providing Quality of Service (QoS) in wireless broadband networks, and to put it in the context of military communications. We will use the IEEE 802.16 standard as an example for two important reasons:

- The rich feature set it presents and the flexibility it provides for the system/network designer in choosing various schemes for scheduling traffic and coordinating user transmission (via Orthogonal Frequency Division Multiple Access (OFDMA) for instance), while accounting for interactions between an advanced PHY (physical layer) and the corresponding MAC (datalink).
- Growing interest from operators and vendors worldwide in this emerging technology, due to the prospects of using it in a variety of applications, such as wireless data backhaul or in regions of the world where there is little or no wired infrastructure, which could have significant value for military applications. The specific topics to be addressed include:
  - Quick introduction to the IEEE 802.16 standard—protocol stack and its relevance for offering QoS-based services

- Key design aspects of the PHY and MAC layer; their interactions as they pertain to QoS
- Scheduling services (or traffic classes) in 802.16: relation to QoS; mapping higher layer (IP) QoS to the MAC; design implications of choices
- System architectures for providing QoS guarantees in 802.16-based networks—system-level view: canonical node architectures of the BS and SS
- Scheduling algorithms for QoS service guarantees in 802.16-based networks—scheduler-level view, implications for system/network design; performance results
- Status of proposed/reviewed algorithms and approaches for QoS, and their applicability—what is expected to work, what may not
- Overview of potential implementation issues in the defined interfaces and protocol standards
- WiMAX in the context of military communications—what prospects does WiMAX offer, what (military) systems and applications may benefit from it? Some speculation on WiMAX as a JTRS (Joint Tactical Radio System) replacement?

UT-6

Challenges and Potentials of All-IP Converged/Integrated GIG and Broadband Satellite/Wireless Services for the Warfighter

Monday 2:15–5:15 p.m.

Osceola 3

Presenter: Dr. Syed A. Shah

The warfighter's need for anytime, anywhere, and reliable two-way broadband real-time access to networks for accomplishing strategic, operational, and tactical missions and operations is growing. At the same time, there is a fundamental shift within DoD from a platform centric focus to a network centric focus. This has significantly increased the demands for communications transport technologies to support an increasingly mobile warfighter. Satellites provide a convenient way to create communication networks for hard-to-reach regions of the world. The critical Military needs can be met with MILSATCOM while augmenting with the most cost-effective plan for meeting unplanned and surge needs by employing commercial SATCOM infrastructure. Integration of broadband satellite and wireless technologies with Global Information Grid (GIG) can provide that capability in a seamless manner. The use of Internet Protocol (IP) as a common protocol language facilitates the convergence of voice, data, and video services to provide ubiquitous communication. It has now become possible to offer this capability by integrating the latest Satellite and Wireless technologies with GIG/DISN on an All-IP platform.

The proposed All-IP converged future architecture includes provisions for meeting surge and unplanned demands with commercial broadband satellite-based communications systems and services. At the GIG/DISN core, there is a reliable, secure and cost-optimized transport network. Satellites/wireless technologies are particularly essential for military missions, in which Internet Protocols (IP) provide the basis for integrating voice, video and data into a single, cost-effective network. Currently, access for satellites, gateways, and terrestrial networks is provisioned separately without a common focal point. In the new approach, various access technologies will be integrated with the core at the multiaccess edge such as Teleports and SATCOM/wireless-terrestrial gateways, which will provide network interfaces, internetworking functions, protocol conversion, and network security services. It is based on open standards and combines converged fixed and mobile network architectures. The new evolved architecture is designed to meet the warfighter's needs across tactical and strategic boundaries. The services on this converged network will be seamlessly accessible across all devices and networks. In DoD, there are several current satellite and terminal programs of record including MUOS, WGS, AEHF, WIN-T, and TCA, leading to this direction.

However, there are myriads of issues. Satellite propagation delays and bit errors can impact performance; there are choices regarding earth stations; satellite links must be integrated with terrestrial networks; space segment is expensive; security is a concern; quality of service must be provided. This 3-hour tutorial will help participants understand the technology needed to resolve these issues. This tutorial also addresses the potentials for an integrated architecture that will overcome the technology synchronization challenges of RF SATCOM Gateways, information technologies, network management, information assurance, technical regulatory compliance, user interfaces, mobility, terminal design, packaging, and integration, interoperability, and more.

Who Should Attend?

Engineers and managers who wish to gain a better understanding of the design, development, specification and deployment of military IP networks in mission-critical environments.

Outline of the Tutorial:

- Key Challenges and Drivers: Why do we need a new vision of the network and the services?
  - Anytime and anywhere communication (warfighter/user convenience)
  - Platform agnostic multiaccess edge
  - Flexible and integrated transport
  - Interactive and personalized access
- Communication Architecture: A snapshot of networks and capabilities
  - GIG/DISN CORE (Optical fiber network)
  - Military Satellite Communication Networking Architectures
  - DoD Gateways/Ground station architectures
  - Commercial Leased services (BGAN…)
  - Overview of Integrated Satellite and Terrestrial networks incorporating satellites/wireless, wide area networks such as the GIG/DISN, Local Area Networks (LAN), and tactical mobile networks

- Evolving and New Broadband Integration for Seamless Connectivity: New hardware and software technologies combined with the latest open standards enable new architectures and paradigms
- Broadband Satellite Network based on Digital Video Broadcast – Return Channel via Satellite (DVB-S2 & DVB-RCS) technology
  - Broadband Wireless Network based on IEEE 802.16e or Mobile WiMAX technology
  - Integrated DVB-RCS and WiMAX Architecture
  - Fixed and mobile convergence
  - Multiaccess capability: GPON, 3G, VDSL2, Broadband access terminal, Ground segment for satellites
- New Services and Applications: IP-converged network-based capabilities in the hands of the warfighter
  - Interfaces: open and standardized User-Network and Network-Network Interfaces (UNI & NNI)
  - IP Multimedia System (IMS) based services framework (key enabler), Mobile IP, Location management
- End-to-end performance and Quality-of-Service (QoS) provisioning for voice and video in All-IP networks, call admissions control, Seamless handover, SLA and resource management
  - Service and network performance and reliability parameters measurements, monitoring & control, analyzing, SLA management and reporting and review under actual service conditions and loads
  - Security issues and their impact on QoS
- A View of the Future and Case Studies from Joint Capabilities Technology Demonstration (JCTD): The JCTD programs are very convenient vehicles for introducing a cutting edge technology in the Warfighter's environment. They can also be used for improving or modifying an existing system
  - Next generation military and commercial satellites
  - IP Router In Space (IRIS)
  - Tactical Service Provider (TSP)

TUESDAY, 30 October 2007

UT-7

Reconfigurable Technology for MIMO-OFDM Systems

Tuesday 9:15 a.m.–12:15 p.m.
Osceola 1

Presenters: Dr. Raghu Mysore Rao and Dr. Chris Dick

High data rate applications are driving the need for high throughput and spectrally efficient broadband communication systems. Efficient modulation schemes and multiple antenna techniques are being explored for such applications. MIMO-OFDM is one such promising technology. OFDM modulation has been adopted by almost all of the major broadband wireless standards, such as 802.11a/g, DVB-T/DVB-H, 802.16, UWB, etc. MIMO-OFDM is also finding its way into some of the newer standards, such as 802.11n and 802.16e. The key aspects of all of these standards are reliability and high throughput. Mobility is also a key factor in some of these standards.

In this tutorial, the audience is introduced to the key concepts of OFDM and MIMO-OFDM systems. The discussion will include:

- Consideration of the practical issues related to OFDM systems such as peak-to-average power (PAPR).
- Various receiver algorithms and how they can be mapped to FPGAs.
- The 802.16/802.16e physical layer will be used to exemplify the various aspects of OFDM and MIMO-OFDM technology.
- Architectural aspects of FPGAs that make them a popular choice for developing wireless communication systems at the basestation, given their configurability and time to market advantages.
- Newer-generation FPGAs which have dedicated fabric for efficient implementation of DSP and communication systems.
- Newer, higher-level design methodologies (such as AccelDSP-MATLAB to hardware), which further improve this time to market advantage of FPGAs. We will briefly discuss these methodologies and also introduce some of the DSP and communication centric features of popular FPGAs.

UT-8

WiMAX for the Warfighter

Tuesday 9:15 a.m.–12:15 p.m.
Osceola 2

Presenter: Mr. Jim Orr

The WiMAX topic covers several areas. We have found that breaking it down into four core parts works best.

WiMAX Overview

This segment will present the history of WiMAX up to the time of the publication of the tutorial later this year. The intent of this section is to describe how 802.16 has developed from the original intent of the standard to the versions passed by IEEE. We will discuss the evolution of the WiMAX Forum and its operations and goals.

- What is WiMAX?
- Technology and market status
- Spectrum availability and trade-offs
- 802.16e-2005 vs. 802.16-2004
- What are the differences?
- Co-existence
- Emergence of single standard
- 802.16j relay service
- PHY and MAC definitions
- QoS
- WiMAX Forum
- What is it?
- How can you participate?
- Why should you participate?
- Working groups
- Certification (fixed and mobile system/network profiles)
- Other key projects

WiMAX Applications, Commercial and Direct Translation to the Military

This segment will describe the real and targeted applications for WiMAX. This includes the varieties of Broadband Wireless Access (BWA) for residential and business use and the translation to Military applications. The significant benefits to using WiMAX as the BWA technology for Military-applications security, large scale market volume, global acceptance, native IP, etc., will be discussed.

- Benefits of leveraging commercial WiMAX economies of scale
- Services
- Broadband data services
- VoIP
- VLAN
- Video
- Stationary broadband access
- Consumer
- Business
- Portable and mobile broadband services
- Consumer
- Business
- IP/Ethernet backhaul
- Military parallel applications

Theory of Operation

In this more in-depth section, we will describe the actual operation of the WiMAX product set to back up the supposition in the prior section. We will describe the operational characteristics of the technology and why this supports the movement to an All-IP operational model.

- Ranging and Network Access Negotiation
- Authentication and Registration
- Connection Setup and IP Access
- Service Flows

Key Technology Assessment

There are many technologies that make up the operational structure of a WiMAX system. We will describe the various technologies and the trade-offs inherent to each technology. The impact to performance and service implementation will be discussed.

- FDD and TDD
- MIMO vs. AAS
- Adaptive Modulation, OFDMA Modes and Management of Cell Edge Capacity
- Channel Structures and Network/Cell Site Engineering
- Security
- Network Management

UT-9

Evaluation Frameworks for Net-Centric Operations

Tuesday 9:15 a.m.–12:15 p.m.
Osceola 3

Presenter: Dr. Rajive Bagrodia

The tutorial is intended to familiarize the audience with the state-of-the-art innovations in the evaluation techniques for net-centric applications and services that operate on heterogeneous, next generation networks. The wireless networks that exist today and those envisaged for the future are quite unlike the modest considerations of the recent past. The network size is expanding, from WLAN with few clients to city-wide mesh networks or even sensor networks with multiple thousands of nodes. The network architecture itself is transforming into a more heterogeneous nature incorporating cellular, MANET, mesh, satellite, and sensor networks to name a few. With the emergence of diverse hardware and software technologies, applications are being conceived and developed that span across hybrid networks. Applications themselves are bringing forth a new direction in the network research—cross-layer interactions and evaluation of user-perceived performance. Finally, as the research ideas begin to mature, there is a need for an evaluation platform that can ease the transition of these prototypes into commercial deployment.

This new generation of networks, many of which have substantial application in multiple Defense programs include the U.S. Army's Future Combat Systems (FCS) program, the U.S. Navy's ForceNet programs, and the all-encompassing Global Information Grid (GIG), impose a number of novel requirements on the evaluation framework:

- The framework should be scalable to a large network size
- Flexible to model heterogeneous, wireless networks
- Have the ability to predict performance of real (operational) multimedia applications that operate in diverse environments including urban and rural terrain
- Have a high-enough fidelity of evaluation such that the interactions with operating systems and hardware should be effectively addressed
- Promote a convergence between the analysis and development platforms

The tutorial enumerates various evaluation methodologies, identifies their pros and cons and suitability for specific analysis requirements. The tutorial is divided in four parts: the first part discusses the familiar simulation and physical testbed approaches of evaluation, second part explores the recent advances in software emulation-based testbeds that overcome some of the shortcomings of the preceding approaches, the third part introduces the novel hybrid paradigm of evaluation that combines simulation, emulation, and physical subnets in a single unifying framework, and the last part presents case studies in the use of the hybrid models for protocol design as well as net-centric test and evaluation.

UT-10

Design Methodologies for FPGA-Based Software-Defined Radios

Tuesday 2:15–5:15 p.m.
Osceola 1

Presenter: Mr. Joshua Noseworthy

The need for Software-Defined Radio systems that are capable of delivering the computational power and I/O throughput necessary to service wideband waveforms has forced many system designers to consider the use of Field Programmable Gate Arrays (FPGAs). Standardized techniques for deploying Software Communications Architecture (SCA) applications on FPGAs are still forthcoming. This tutorial provides an introduction to creating FPGA-based components that are reusable, portable and compliant with the SCA. The techniques presented are based on industry standards, such as the Open Core Protocol (OCP) and SPIRIT. The tutorial examines four openly licensed OCP interfaces that are extensions of those specified by Change Proposal 289. In addition, it examines the overhead that may be introduced into a system through the use of OCP-based design techniques. Following is an outline of the content that will be presented:

Introduction

- Field Programmable Gate Arrays (FPGAs)
- Common FPGA Design Challenges
- SCA Support for FPGAs

Component-Based Design Concepts for FPGAs

- Traditional Component-Based Design Approaches for FPGAs
- Reusability
- Portability
- Verification Techniques
- Impact on EDA Tools

- Xilinx's System Generator
- Altera's DSP Builder
- State-of-the-Art Component-Based Design Approaches for FPGAs
- Open Core Protocol (OCP)
- Spirit
- Improved Reusability, Portability
- Better Verification
- Impact on EDA Tools
- Xilinx's System Generator
- Altera's DSP Builder
- Mentor's Platform Express

An OCP-Based Approach to Component Design for FPGAs

- Standardized Interfaces Through OC
- Signals
- Behavior
- Configurability
- Verification—OCP's System C TLM
- Transaction Layer 0
- Transaction Layer 1
- Advantages/Disadvantages of OCP-Based Approach
- Example OCP Interfaces
- Worker Control Interface
- Worker Streaming Interface
- Worker Message Interface
- Worker Memory Interface

Example OCP-Based Component

- Steps to Creation
- Highlighting the Steps That Are Specific to This Approach
- Steps to Reuse
- Verification
- High Level Modeling
- Overhead Introduced Through OCP
- Test Cases Using Example OCP-Based Component
- Analysis of Results

Conclusion

UT-11

Throughput Enhancement and Fundamentals of UWB Systems

Tuesday 2:15–5:15 p.m.
Osceola 2

Presenter: Dr. Moe Win

Ultra-Wide Bandwidth (UWB) transmission systems have gained interest in the scientific, commercial and military sectors. Wide bandwidth provides fine delay resolution, making UWB a viable candidate for communications in dense multipath environments, such as short-range or indoor wireless communications. Currently, UWB transmission systems are under consideration for communications and sensor networks because they potentially allow low-cost production and reuse of (already occupied) spectrum. UWB also has applications for military operations because it provides low probability of detection as well as anti-jam capabilities. Recent ruling concerning UWB emission masks, by the U.S. Federal Communications Commission (FCC), opens the way for coexistence with traditional and protected radio services and allows the potential use of UWB transmission without allocated spectrum.

This tutorial provides a basic understanding and a technical overview that encompass the fundamentals of UWB system design and analysis. It will cover relevant topics including:

- Transmitted-Reference Systems
- Rake Reception
- Effect of Narrowband Interference
- Distribution-Invariant Monotonicity Theorems
- Fundamental Limits on Wide Bandwidth Signal Acquisition
- Ranging and Localization

UT-12

Security Vulnerabilities and Preventive Measures in Wireless Mesh Networks

Tuesday 2:15–5:15 p.m.
Osceola 3

Presenters: Dr. Dharma P. Agrawal (Presenter), Ms. Lakshmi Santhanam, and Dr. Nagesh S.P. Nandiraju

Within the short span of a decade, WiFi hotspots have revolutionized the Internet service provisioning. With the increasing popularity and growing demand for more public WiFi hotspots, network service providers are facing a daunting task. WiFi hotspots typically require extensive wired infrastructure to access the backhaul network, which is often expensive and time consuming to provide. Wireless Mesh Networks (WMNs) obviate the need for extensive wired infrastructure at every MR by connecting only a subset of MRs known as Internet Gateways (IGWs) to the wired Internet. The underlying paradigm of WMNs is similar to multihop MANETs (Mobile Ad Hoc Networks). Besides broadband internet connectivity, WMN encompasses numerous applications such as building automation, VoIP over wireless, video delivery, home networking, etc.

The plug-and-play architecture of WMN, however, paves the way for malicious intruders. It is a very common misconception that MRs are managed by a single trusted entity. This may not be always true in a WMN, which offers various kinds of flexible management styles such as semi-managed networks (operated partly by ISPs) and unmanned networks (operated by a group of users). Hence, it is critical to protect the open architecture of WMN from the various possible attacks such as Denial of Service (DoS) attacks, selfish node attacks, route disruption attacks, etc. Unfortunately, the current thrust of research in WMNs is primarily focused on developing multipath routing protocols; security is very much in its infancy.

The Security Vulnerabilities and Preventive Measures in Wireless Mesh Networks tutorial provides a comprehensive coverage of the various security issues pertinent to WMNs, including:

- An introduction to the concepts of WMNs and the multitude of applications envisioned for this upcoming technology.
- A systematic exploration of the vulnerabilities that can be exploited by the attackers to conduct various attacks on the network.
- A detailed description of the important security designs/proposals from industry and academia that will capture the current start-of-the-art solutions such as DoS attack regulators, traceback, selfish node detection, Intrusion Detection Systems, etc.
- Key results from our research and other active researchers that have a great impact on the design of a secure WMN. This will help attendees to quickly grasp the tutorial material more clearly and can also help in catalyzing new research ideas by the attendees.
- Finally, we conclude the tutorial by outlining and describing various open challenges which can serve as a catalyst for new research efforts by attendees.

After attending this tutorial, attendees will have a clear understanding of the mesh technology, the various security issues that can arise and some elegant ways to deal with them.

WEDNESDAY, 31 October 2007

UT-13

Waveform Development and Deployment With the Software Communication Architecture (SCA)

Wednesday 9:15 a.m.–12:15 p.m.
Osceola 1

Presenters: Mr. Aaron Kaiway, Dr. Vincent Kovarik, and Mr. Mark Hermeling

For the uninitiated, developing waveforms to operate on an SCA-enabled radio platform can be a daunting task, forcing the waveform development team to satisfy not only the functional requirements of the specified waveform, but also the deployment requirements imposed by the SCA software operating environment. This workshop will explore these issues in detail, providing the participant with a working knowledge of SCA-based waveform development and illustrating the use of a number of tools that accelerate the overall development effort. Topics that will be covered in this workshop include:

Part 1—SCA Foundation

- Introduction to the SCA:
  - Core Framework Components and Services
  - Resources, Devices, and Applications
- Exploration of the SCA Domain Profile and XML Descriptor Files

Part 2—Creating the Waveform

- Creating a waveform component model and the Software Component Descriptor
- Transitioning from the waveform functional Block Diagram to the SCA Software Assembly Descriptor

Part 3—Deploying the Waveform on an SCA-Enabled Platform

- Modeling the radio platform and creating the device descriptors
- Partitioning the waveform and deploying on the target devices
- Support for specialized hardware (FPGA, DSP) through hardware abstraction layers
- Integration with radio services
- Run-time monitoring and real-time debugging

Throughout this workshop, a simple "representative waveform" will be utilized to illustrate the design concepts, with the developed waveform deployed on a representative black-side transceiver system.

UT-14

Tactical Wireless Networking Army's Requirements and Current/Future Force Capability Gaps

Wednesday 9:15 a.m.–12:15 p.m.
Osceola 2

Presenter: Major Bryon K. Hartzog

This tutorial provides commercial vendors and DoD contractors with an understanding and appreciation of the Army's tactical wireless communication/networking requirements, identifying areas that wireless COTS technology can potentially address current force capability gaps with modifications. Discuss current DoD efforts to leverage wireless COTS through technology assessments and live experimentation. Identify critical issues discovered to date with wireless COTS technologies such as transmission security, susceptibility to jamming due to probability of detection.

The Army and Joint forces have increasingly leveraged commercial information technology in recent years to satisfy military requirements. Recent and growing commercial investments in wireless communication systems using IEEE 802.xx and other wireless protocols present new opportunities for the Army to leverage commercial technologies for the network. The Army Science Board has and continues to conduct studies on the applicability of adopting wireless COTS technologies, identifying interoperability and security issues. Numerous academia and government agencies are assessing and conducting live experimentation of emerging wireless technologies to determine how they can address current capability gaps.

Introduction

- Purpose
- Scope
- Objectives/Take Away of Tutorial

Background

- Rapid growth of wireless technologies—both commercial and government
- Army's interest in Commercial-Off-the-Shelf
- Findings of past and current studies on leveraging wireless COTS

Validated Wireless Communications/Networking Requirements

- Bridge to Future Networks (BFN) Capabilities
- Future Combat System (FCS) and Warrior Information Network-Tactical (WIN-T) Capabilities

Identified Wireless Capability Gaps

- Scalable/deployable command posts
- Mobile narrowband and wideband on-the-move communications

- Integrated network management tool for both wireless and wired networks
- Ability to communicate in complex terrain down to dismounted/unmounted soldiers over extended ranges
- Broadband wireless communications supporting streaming video, IP telephony
- LPI/LPD wireless communications capable of operating in a jamming enriched environment
- Secure, long range, beyond LOS communications
- Power and bandwidth efficient wireless communication protocols
- Ability to dynamically change operating frequency band

Limitations of Current Wireless COTS Technologies

Capability Gaps in Which the Army Needs Commercial Industry and Academia Assistance

Venues for Assessing/Evaluating Applicability of Wireless COTS Technologies

- TRADOC Battle Labs
- TRADOC Experimentation
- CERDEC Experimentation

Conclusion

UT-15

Next Generation Optical Communication Networks and Protocols

Wednesday 9:15 a.m.–12:15 p.m.
Osceola 3

Presenter: Dr. Stamatios Kartalopoulos

As communication needs evolve, the current network requires a humongous bandwidth deliverability of both synchronous and asynchronous traffic with enhanced efficiency, scalability, protection, reliability, and cost-performance objectives.

The next generation optical network is based on DWDM technology and is designed on new standard protocols to efficiently address the aforementioned requirements. This network may be viewed as an amalgamation of the best features that combine both legacy synchronous and asynchronous data networks, and adding to it new features that enhance network attributes including efficiency cost.

The Next Generation Optical Communication Networks & Protocols tutorial will cover:

- Optical Networks
- SONET/SDH and the DWDM Technology
- Next Generation SONET/SDH
- Data-Over-SONET/SDH
- Packet-Over-SONET/SDH
- Error Handling
- Protection Switching
- Link Capacity Adjustment Scheme (LCAS)
- Generalized Framing Procedure (GFP)
- Link Access Procedure for SDH (LAPS)
- Internet and Ethernet Over SONET/SDH
- Virtual Concatenation (VC)
- Multi-Service Switching Platform (MSSP)
- Multi-Service Provisioning Platform (MSPP)
- Next Generation SONET/SDH Over DWDM
- Optical Transport Network (OTN)

Intended Audience:

This course is designed for a general audience. It provides a synopsis of the protocols needed to understand the next generation optical network, including managers, communications engineers, communications management and control, and network modeling.

UT-16

SDR Infrastructures: The SCA and Beyond

Wednesday 2:15–5:15 p.m.
Osceola 1

Presenter: Dr. Vincent Kovarik and John Bard

Providing a software infrastructure is a foundational component of software radio architecture. The infrastructure provides common interfaces and services for the underlying hardware platform and waveforms. This tutorial begins with an overview and analysis of the Software Communications Architecture (SCA). The SCA will be used as a foundation for comparing and contrasting other deployment domains, such as space, other application domains, such as dynamic deployment of distributed applications, and constraints that must be considered, such as Size, Weight, and Power (SWaP), when developing the infrastructure architecture. The aspects of waveform portability and the degree to which the infrastructure promotes portability and interoperability will be discussed. Finally, emerging cognitive radio technologies and their impact on the evolution of software radio architectures will be presented.

Agenda:

Software Radio Aspects

- Hardware
- Waveforms
- Infrastructure
- User

Infrastructure Architectures

- Software Communications Architecture (SCA)
- OMG Software Radio
- NASA Space Telecommunications Architecture
- Others

Waveform Portability

- The impact of the infrastructure
- Other factors

- Evaluating waveform porting effort

Technology Trends and Their Impact on SDR Architecture

- Cognitive Radio
- Digital Processing

Summary

- Current SDR landscape
- Emerging technologies and trends
- The next generation

UT-17

Satellite-Based IP Networks for Mission-Critical Applications

Wednesday 2:15–5:15 p.m.
Osceola 2

Presenter: Mr. Burt H. Liebowitz

Satellites provide a convenient way to create communication networks for hard-to-reach regions of the world. Satellites are particularly useful for military missions in which Internet Protocols (IP) provide the basis for integrating voice, video and data into a single, cost-effective network. However, there are issues. Satellite delay and bit errors can impact performance; there are choices regarding earth stations; satellite links must be integrated with terrestrial networks; space segment is expensive; security is a concern; quality of service must be provided. This 3-hour tutorial will help participants understand the technology needed to resolve these issues.

Who Should Attend

Engineers and managers who wish to gain a better understanding of how to specify and deploy satellite-based, IP networks in mission-critical environments.

Course Outline:

- Hybrid Satellite and Terrestrial Networks

  Overview of end-to-end networks incorporating satellites, Wide Area Networks (WAN) such as the GIG, Local Area Networks (LAN), and mobile networks
- Communication Satellite Technology
  - LEOs, MEOs and GEOs. Converting bandwidth (Megahertz) to data channels (bits per second)
  - Satellite coverage area, frequency bands, impact of rain
- Packet-Based Data Networking

  Seven-Layer Model (ISO). Layer 2 networks such as Frame Relay, ATM, Aloha, Digital Video Broadcasting (DVB), and Ethernet
- The Internet and its Protocols
  - Higher layer networks using IP protocols
  - Routing between and within networks
  - Use of the Transmission Control Protocol (TCP) for reliable file transfer
  - Impact of bit errors and propagation delay on TCP-based applications
  - User Datagram Protocol (UDP) for IP multicasting, voice transmission (VoIP) and video streams
  - Introduction to Intranets—private networks that use IP protocols
- Satellite Data Networking Architectures
  - Ground station architectures for data networking.
  - Shared outbound carriers incorporating Frame Relay, DVB
  - Dynamically shared return channels: SCPC DAMA, TDMA/DAMA
  - Full mesh network technology, impact of mobile terminals
- Quality-of-Service (QoS) Issues in Intranets
  - Definition of quality factors for streams and files
  - Performance of voice and video in IP networks
  - Methods for improving QoS in Intranets, including differentiated services, caching and TCP protocol enhancement
  - Security issues and the impact on QoS
- A View of the Future
  - Next generation military and commercial satellites.
  - Impact of on-board processing
  - What's ahead in low-cost ground station technology

UT-18

Challenges in Building and Scaling Large Red IP Services Architectures

Wednesday 2:15–5:15 p.m.
Osceola 3

Presenter: Mr. Craig Hill

As Black architectures roll out within the Department of Defense, the Red services architecture is the key component to delivering the mission-critical applications for the agencies. This tutorial will focus on IP architecture design approaches that address the IP scaling challenges and solution options, when building large Red IP Services networks. This discussion will also include technology "primers" (such as MPLS, IP Tunneling, Type I, advanced routing techniques) and will provide example approaches and solutions for integrating current and newly available COTS routing features into large-scale "Red" IP Service capable networks when Type I encryption technologies are required.

Outline of Tutorial:

- Current Network Architecture Approaches in the DoD/IC
  - Relevance of the IP Core Networks Today
  - How the Network Is Changing
- The "Red vs. Black" Concept in Today's IC Network Models
  - Overview of Current Encryption Technologies
  - Explanation and Benefits of Each Concept
  - Where Each Model Applies
- Red IP Services Approach
  - Relevance
  - Foundation for Next Generation Service Offering
  - Why and How Black Services are Still Critical
- Red Services Architecture Description
  - Service Model Approaches—Tiered vs. Flat
  - Maximizing Commercial Services in Metro Areas
- Applying Encryption Technology to Specific Places in the Network
  - Where and Why Various Encryption Technologies Fit Into Certain Architecture Layers
  - Breakdown of Each Layer in the Reference Architecture
- Next Generation Network Model for Red Services
  - Components
  - Architecture Description
  - Service Capabilities
- Optional Deployment Model—Case Study