Telemetry Research at ITTC

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The University of Kansas
Government Stakeholders in Telemetry

Army

Navy

NASA

Air Force
Telemetry and ITC/IFT

International Telemetering Conference (Oct)

Army
NASA
Navy
Air Force
IFT and Universities

• KU’s involvement at ITC since 2005:
  » 20+ student papers
  » 15+ student attendees
  » 3 EECS faculty advisors
  » Best Graduate Student Paper Awards, 2007, 2009
• I’ve been attending ITC since 1997
• Just last week, KU was announced as the IFT’s sixth officially sponsored university:
  » IFT announced a gift of $60k for 2010-11
  » EECS --> putting telemetry technology “on the shelf”
  » AeroE --> using “off the shelf” telemetry technology to test their aircraft prototypes
Spectrum Efficient Technology, Science & Technology (SET S&T), Department of Defense

The major program is called “iNET”: integrated Network Enhanced Telemetry

- 2006-2008, 2-year project, $155k, Basic FEC study
- 2009-2011, 2-year project, $800k, FEC hardware prototypes
- 2009-2012, 3-year project, $826k, Network and Transport Protocols for iNET
- 2009-2011, 2-year project, $550k ($350k to Nokia, $200k to KU), SC-FDMA for iNET
... More Background Information on Aeronautical Telemetry

- **Communication Challenges in Aeronautical Telemetry:**
  - Highly dynamic: test articles can have closing speeds up to Mach 7
  - Long range: test articles can be spread over thousands of square miles
  - Severe size, weight, and power (SWaP) constraints: T&E package (sensors + transmitter) must fit in confined spaces within test articles

- **The T&E Community has recently commenced the iNET Program (integrated Network Enhanced Telemetry):**
  - Replaces legacy telemetry system consisting of simple one-way comm links
  - Supports more elaborate test scenarios
  - Conserves spectrum

- **Three separate (but related) iNET projects were recently awarded to ITTC research teams**
Overview of Currently-Funded Projects
Addresses the following Test & Evaluation Gaps:

— Limited spectrum hinders ability to deliver telemetry data

— Current protocols do not support needed network functionality including, multhop, mission-based QoS, and multicast

— Existing protocols not suitable for highly-dynamic aeronautical environment: mobility and disruption tolerance
Aeronautical Network and Transport Protocols for iNET

- **AeroTP**: TCP-friendly transport
- **AeroNP**: IP-compatible forwarding
- **AeroRP**: routing
Aeronautical Network and Transport Protocols for iNET

Project Objectives: design, evaluate, simulate, & prototype:

— AeroTP: TCP-friendly domain-specific transport protocol for aeronautical telemetry with multiple reliability modes

— AeroNP: IP-compatible network protocol designed for a highly dynamic aeronautical environment that is also designed to be IP-compatible

— AeroRP location-based routing protocol that supports various stealth modes

— Cross-layer optimizations between the new protocols (AeroTP, AeroNP, AeroRP) and the lower layers in iNET

Three graduate research assistants work on the project, which has a three-year period of performance.
Forward Error Correction Architectures for Aeronautical Telemetry

Addresses the following Test & Evaluation Gaps:

— Forward error correction (FEC) codes are not currently part of telemetry standards; however, FEC can yield SNR gains of up to 8 dB (see figure next slide)

— FEC codes are an integral part of evolution path toward iNET

— High-performance, spectrum-efficient FEC prototype systems are needed for current/future telemetry use

Two faculty members, two technical staff and four graduate research assistants are funded on this project. The project has a two-year period of performance.
Project Objectives:

— Apply new hardware description language (HDL) technology to the problem of communications algorithm implementation
— Deliver a total of 8 FPGA prototype decoders and demodulators for
  • SCCC
  • LDPC
  • SOQPSK (coherent and noncoherent)
Block Diagrams of the FEC Prototypes

LDPC System

SCCC System
Hardware Platform

Annapolis Micro Systems Wildstar 5

RT Logic Tlemetrix 400 Telemetry Signal Simulator (RTL-T400TSS)
Future Work
(BAA to be released in June/July 2010)
Burst-Mode Synchronization for iNET

- Receiver synchronization is a fundamental research area in communication theory
- In general, the received burst must be:
  » Detected (!!!)
  » Frequency corrected
  » Phase corrected
  » Time aligned
- For iNET, a number of questions remain open:
  » What is the optimal format and length of the synchronization preamble?
  » What burst detection algorithm is optimal for the telemetry modulations at very low SNRs?
  » What frequency, phase, and timing estimation algorithms are optimal for iNET at very low SNRs?
- This will take the form of a multi-year, multi-student proposal to be submitted in Fall 2010.
The End