# Telemetry Research at ITTC

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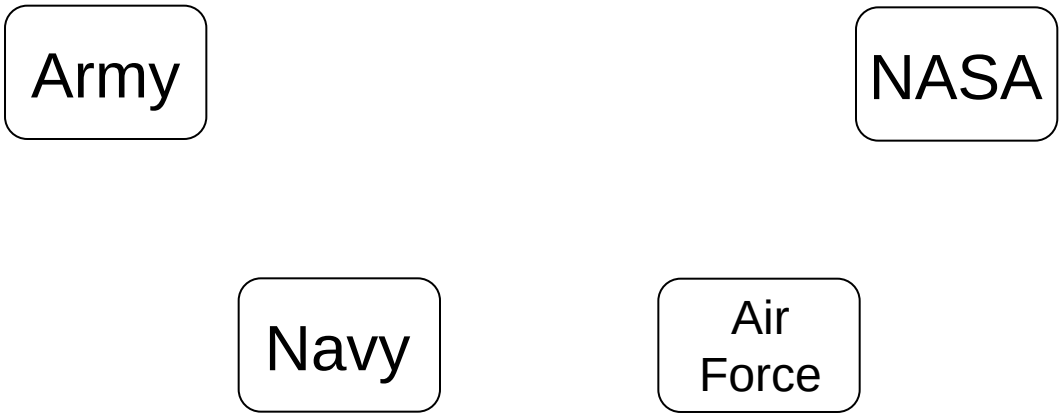
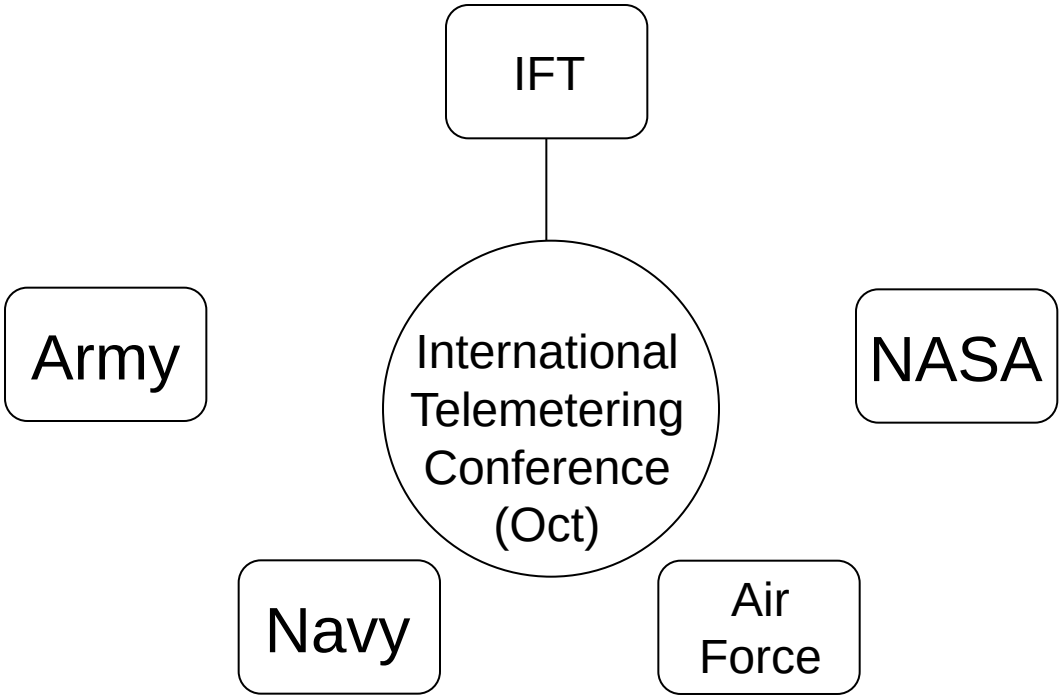
*Department of Electrical Engineering & Computer Science*

*The University of Kansas*

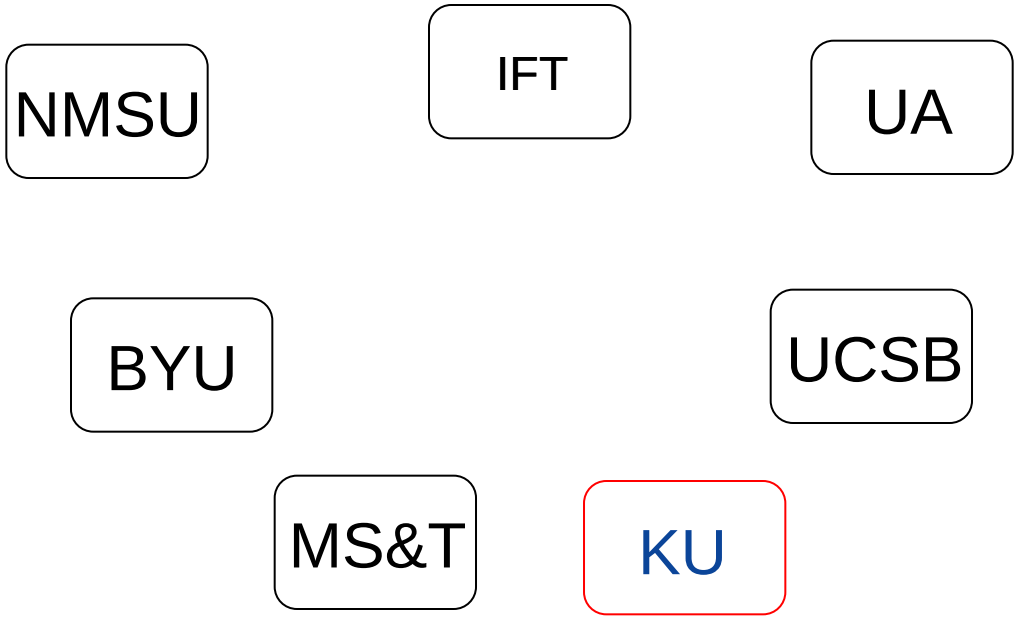
# Government Stakeholders in Telemetry



# Telemetry and ITC/IFT

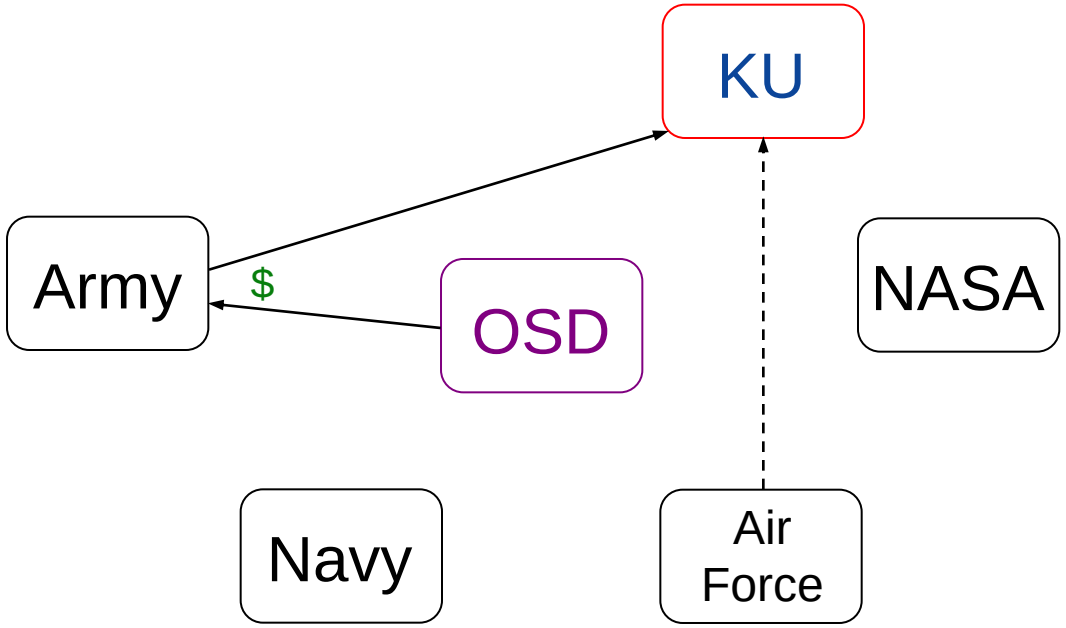


# IFT and Universities




- KU's involvement at ITC since 2005:
  - 20+ student papers
  - 15+ student attendees
  - 3 EECS faculty advisors
  - Best Graduate Student Paper Awards, 2007, 2009
  - Best Paper Awards, 2005, 2008
- 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

# DoD Telemetry Funding and Universities




- 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

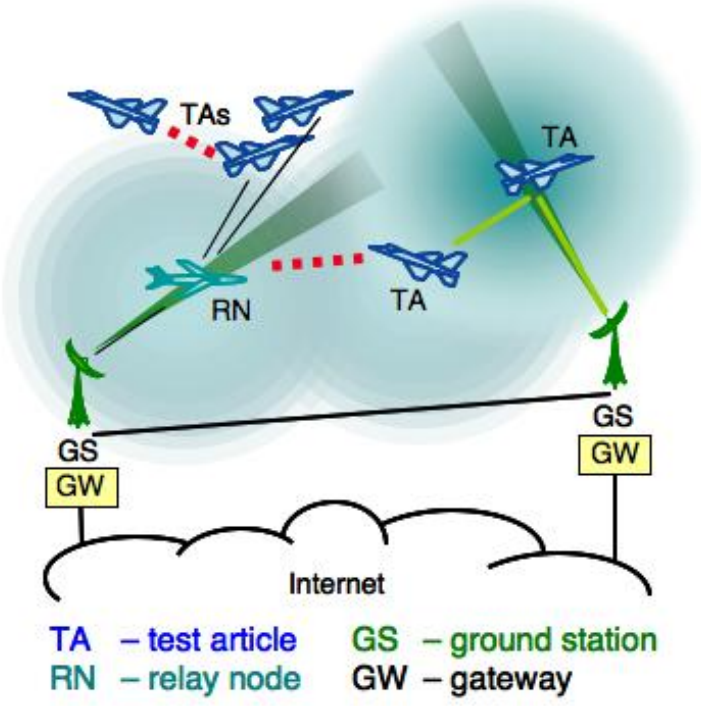
# Overview of Currently-Funded Projects

*PI: Prof. James P.G Sterbenz; Co-PI: Prof. Erik Perrins*

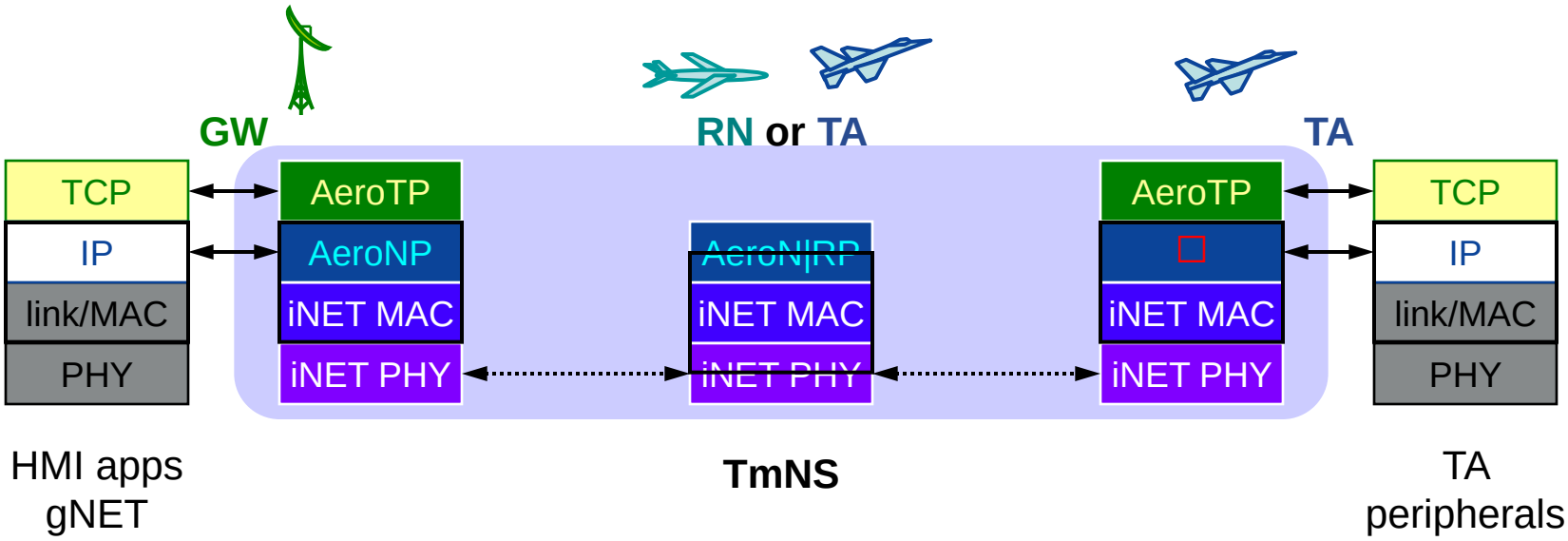
# Aeronautical Network and Transport Protocols for iNET

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, AeriRP) and the lower layers in iNET

*Three graduate research assistants work on the project, which has a three-year period of performance.*

*PI: Prof. Erik Perrins; Co-PI: Prof. Andy Gill*

# 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.*

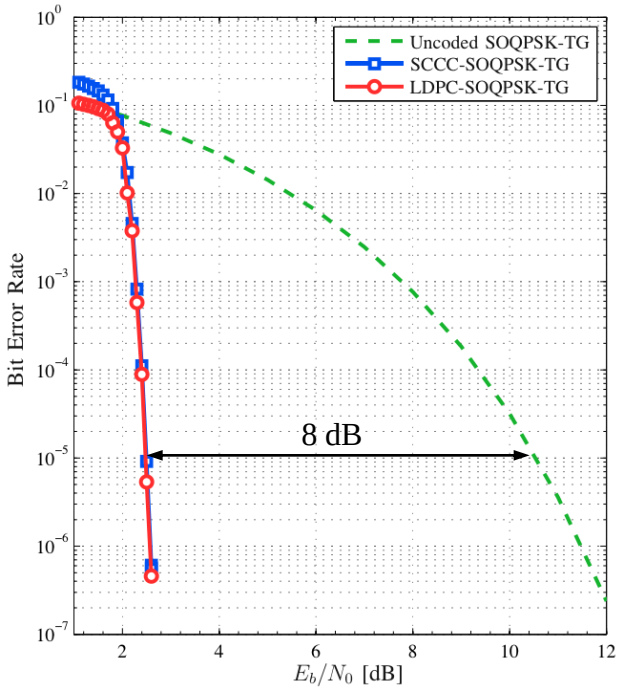
# Forward Error Correction Architectures for Aeronautical Telemetry

Project Objectives:

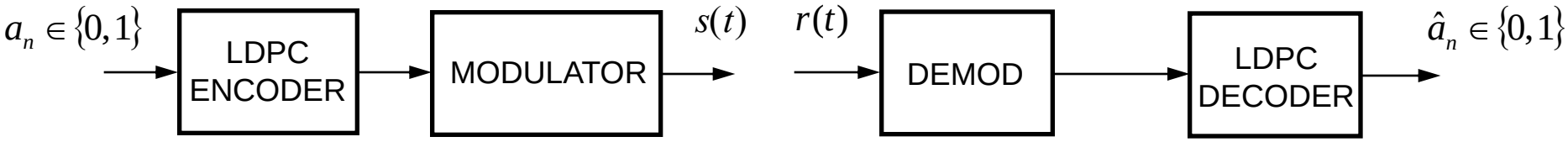
—Apply new hardware description language (HDL) technology to the problem of communications algorithm implementation

—Deliver a total of 8 FPGA prototype decoders and demodulators for

- SCCC
- LDPC
- SOQPSK (coherent and noncoherent)

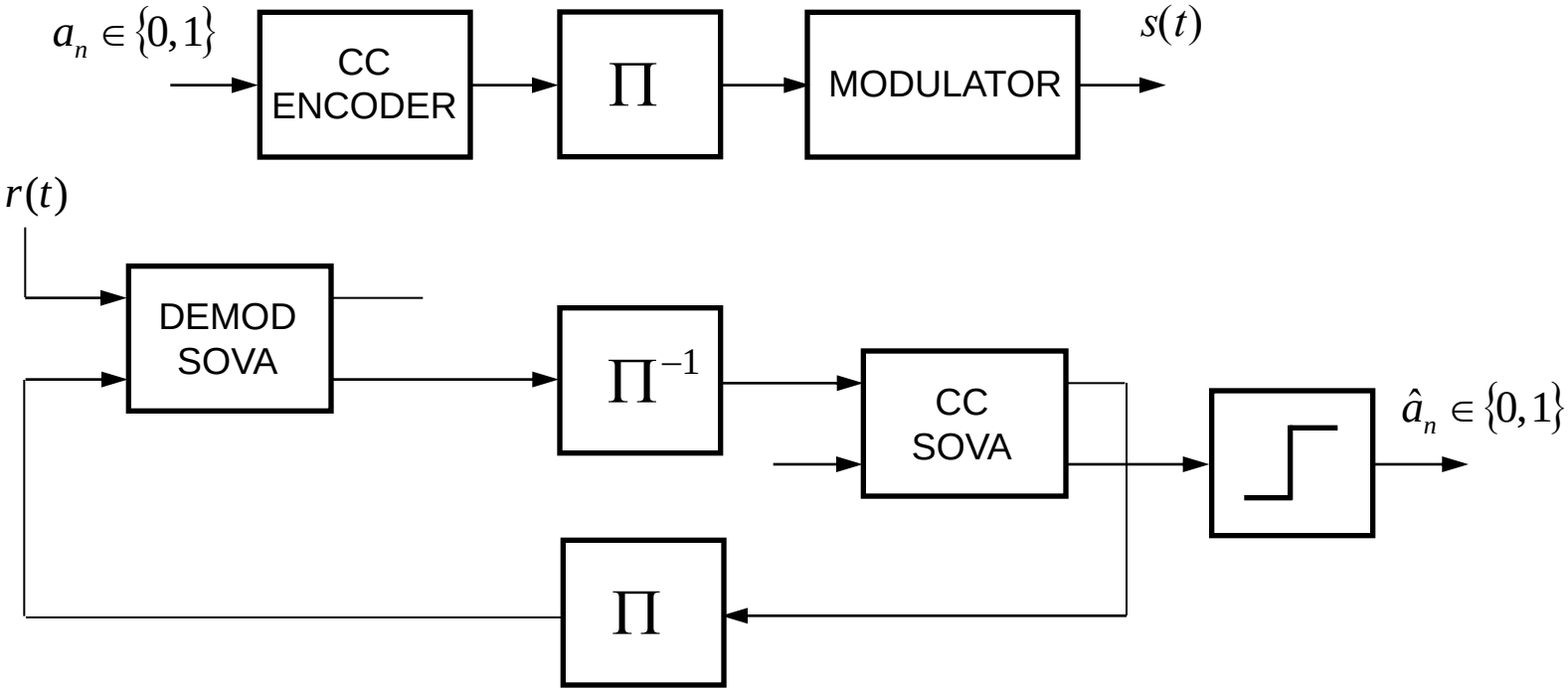


# Block Diagrams of the FEC Prototypes

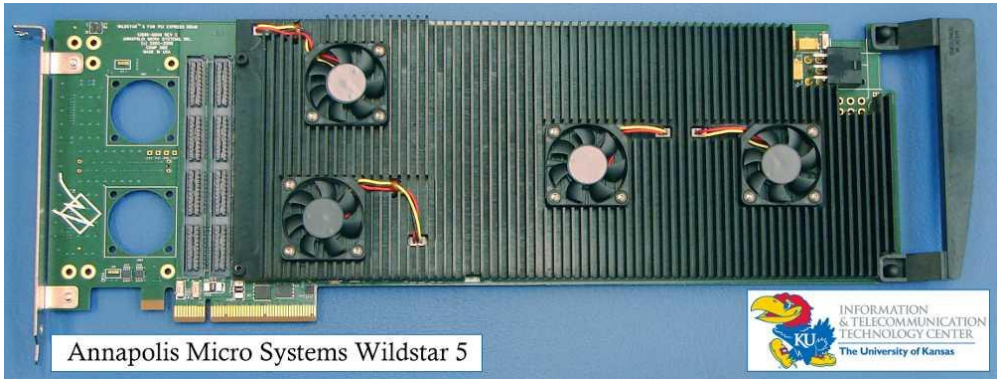


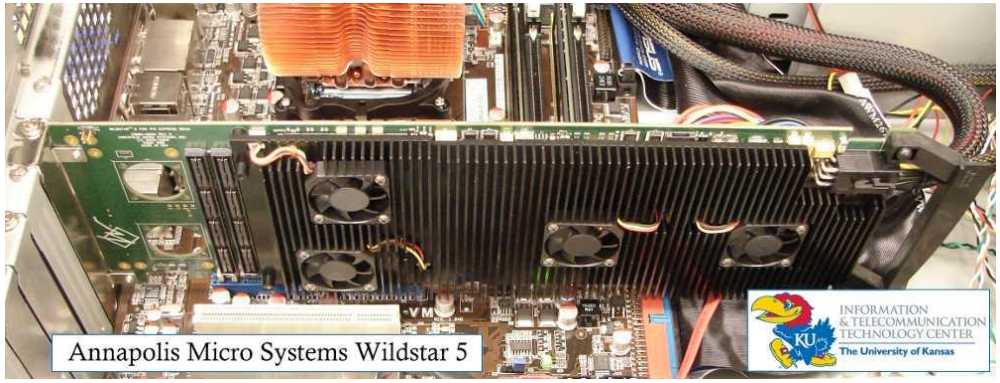

LDPC System

SCCC System



# Hardware Platform



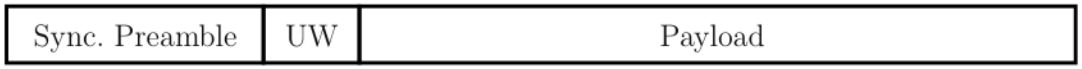


**RT Logic Tlemetrix 400 Telemetry Signal Simulator (RTL-T400TSS)**

# 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