Telemetry Research at ITTC

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Background Information on Aeronautical Telemetry

The Test & Evaluation (T&E) Community consists of:
— Army (e.g., White Sands)

— Navy (e.g., Pt. Mugu)

— Air Force (e.g., Edwards)

— NASA (e.g., Dryden)

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

Background Information on Aeronautical Telemetry

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
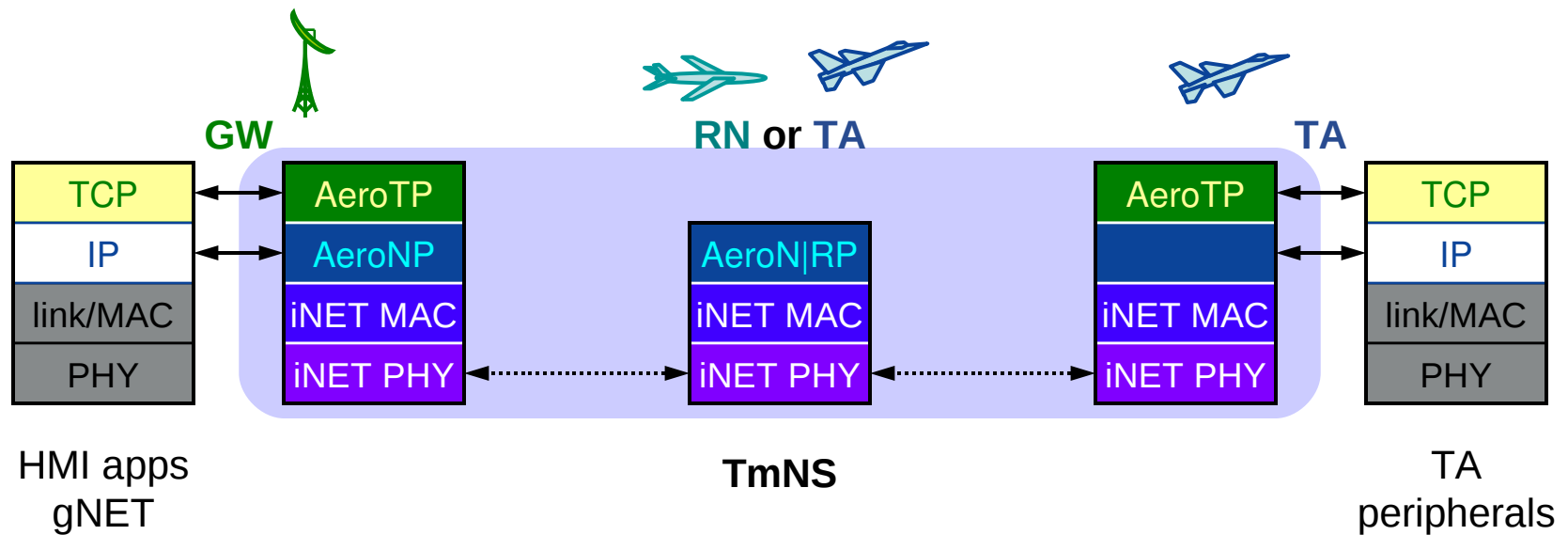
Aeronautical Network and Transport Protocols for iNET

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

TA – test article   GS – ground station
RN – relay node   GW – gateway
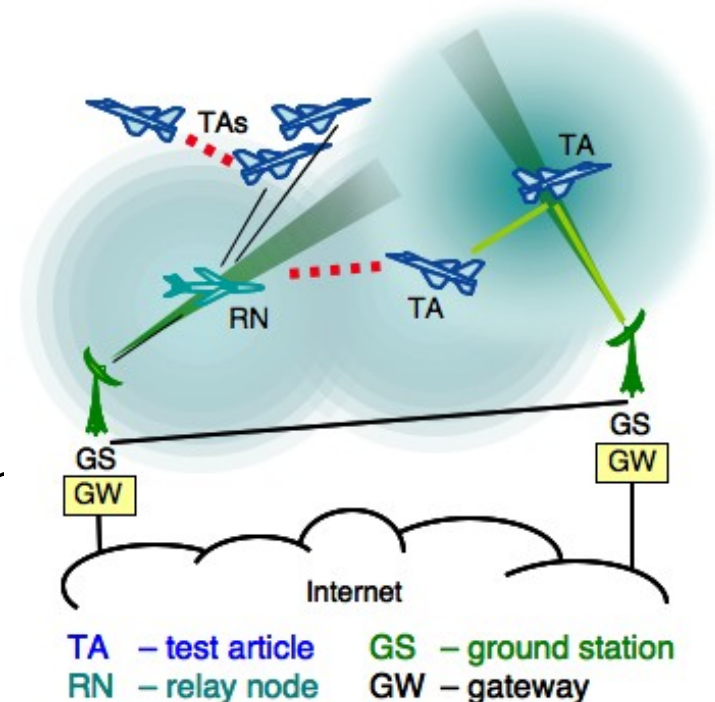
Aeronautical Network and Transport Protocols for iNET

- 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.

Forward Error Correction Architectures for Aeronautical Telemetry
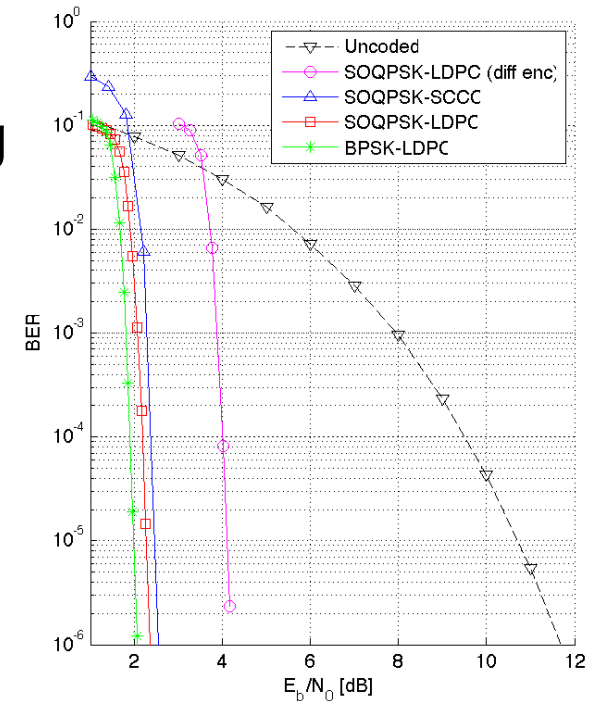
Addresses the following Test & Evaluation Gaps:

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

— 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 ITTC technical staff and four graduate research assistants will be funded on this project. The project has a two-year performance period.

Forward Error Correction Architectures for Aeronautical Telemetry

Project Objectives:

— Apply simple-yet-powerful programming

paradigms, such as functional

programming languages, to the

problem of communications

of communications algorithm

implementation

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

• serially concatenated convolutional codes (SCCC)

• low density parity check (LDPC) codes

• SOQPSK (coherent and noncoherent)

PI: Dr. Marilynn Green (Nokia); Co-PI: Prof. Erik Perrins

CPM-OFDMA Aeronautical Telemetry Applications

Addresses the following Test & Evaluation Gaps:

— Current Telemetry modulations are all based on continuous phase modulation (CPM):

- CPM permits the use of nonlinear power amplifiers
- Nonlinear power amplifiers are power efficient and generate little waste heat
- Therefore, CPM is essential to meet severe SWaP constraints

—However:

- CPM is not robust in wireless (multipath) channels
- CPM is less flexible in a multi-user, sophisticated network, such as iNET

CPM-OFDMA Aeronautical Telemetry Applications

Project Objectives:

— Combine CPM technology with OFDMA technology (orthogonal frequency division multiple access) to achieve a system with combined advantages of both:

- CPM permits the use of nonlinear power amplifiers
- OFDM is robust in wireless multipath interference and is easily equalized
- OFDMA delivers a flexible multi-user system that is easily scalable

One graduate research assistant will be funded on this project. It has a two-year period of performance.

CPM-OFDMA Aeronautical Telemetry Applications