



Multi-channel combining for Airborne Flight Research

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Outline

- Motivation
- Point-to-Point Protocol Multilink Protocol (PPP-MP)
- Multi-Path TCP (MP-TCP)
- Approach
- Testbeds



Motivation

- Improve the reliability of channel bonding and thereby eliminate problems associated with communications dropouts and improve the operational efficiency of airborne science missions
- Enable newer technologies (radios) to be easily integrated into the NASA Airborne Science Data Acquisition and Transmission unit (*NASDAT*)
- Use of TCP (remote login, file transfers, etc...) over current system is problematic due to modem dropouts.





Point-to-Point Protocol Multilink Protocol

- Current solution to the channel multiplexing problem.
- Hypothesis: PPP-MP fragments UDP/TCP over multiple channels. Thus, when one modem fails, UDP/TCP protocol is heavily effected.
 - TCP more so due to TCP backoff and congestion control mechanisms.
- Characterizing Iridium modems, simulation and emulation in the research testbed will validate (or invalidate) this hypothesis.

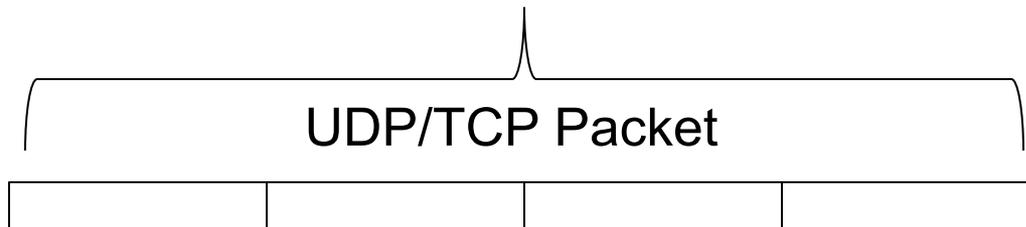




PPP-MP

Problem

- Nothing gets through while any modem is down for UDP or TCP
- TCP Congestion Control:
 - Lost Sub-Packet = lost packet
 - Half rate (not really a problem at super low rates)
 - Backoff retransmission timer
 - generally exponential backoff with some limit (e.g. 64 seconds)



Channel 1

Channel 2

Channel 3

Channel 4





NASDAT Global Hawk Network

- IP Address: 10.3.1.x (static address assigned for each instrument)
- Wide Band SatCom: TCP/IP via: Router (KuBand satellite below 65 degrees latitude)
- Iridium Satcom 4 channels at 2.4 kbps (9600 bps total) above 65 degrees latitude
 - Housekeeping Data: UDP from: broadcast/5000
 - Status Packets: UDP to: broadcast/5100
 - Iridium SatCom: UDP from/to: NASDAT/[assigned]
 - Message Logging: UDP to: NASDAT/5200



MP-TCP

- Multipath TCP (MPTCP) is a set of extensions to regular TCP to provide a Multipath TCP service, which enables a transport connection to operate across multiple paths simultaneously
- Provides a bidirectional byte stream between two hosts communicating like normal TCP, and, thus, does not require any change to the applications.
- Enables the hosts to use different paths with different IP addresses to exchange packets belonging to the MPTCP connection.
- The number of subflows that are managed within a Multipath TCP connection is not fixed and it can fluctuate during the lifetime of the Multipath TCP connection.

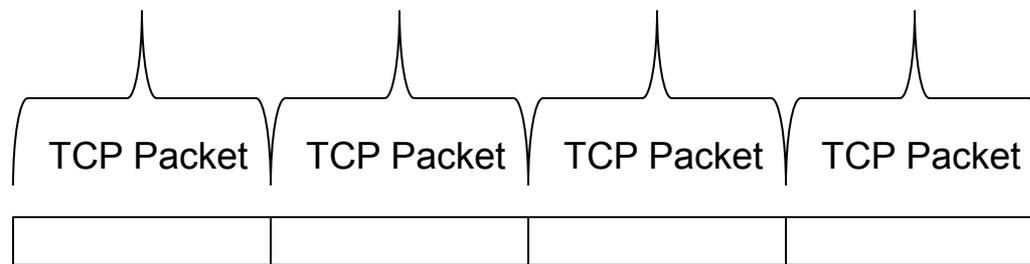




MPTCP

Solution

- MPTCP creates 4 subflows, one per channel
- Channels 1,3 and 4 get through even if modem 2 has drops.



Channel 1

Channel 2

Channel 3

Channel 4





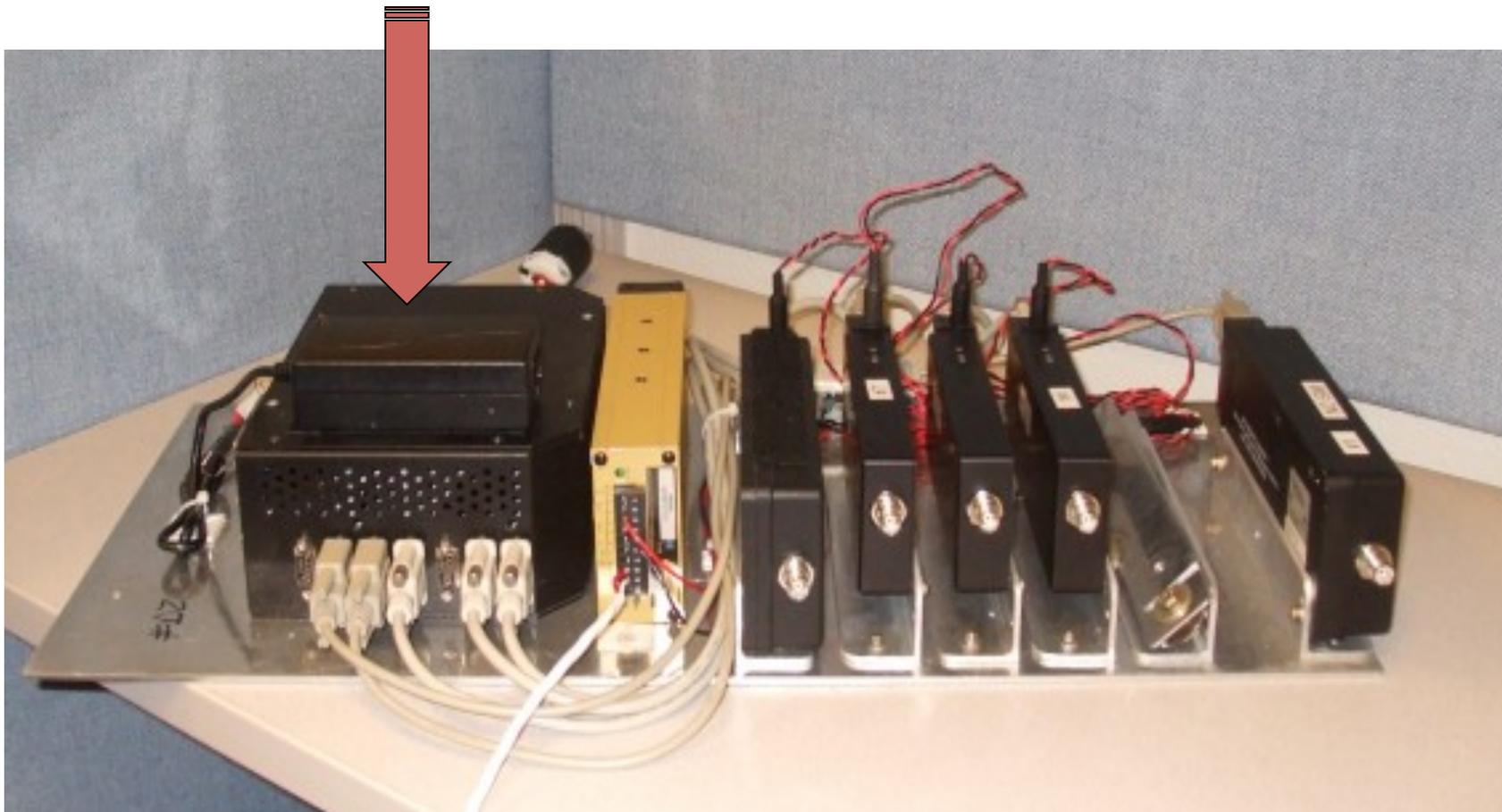
Approach

- GRC performs protocol research effort
- Ames provides expertise and code of existing system and integration into flight systems
- Tasks
 - Characterize the existing Iridium channels
 - Develop Laboratory Testbed (Research Testbed)
 - Develop Engineering Model (Relevant Environment Testing)
 - Model the existing PPP Implementation
 - Develop PPP, MPTCP and MPUUDP real time test tools in Linux
 - Implement multipath-TCP
 - Proof-of-Concept in Testbed then Integration into flight systems
 - Implement multipath-UDP
 - Proof-of-Concept in Testbed then Integration into flight systems



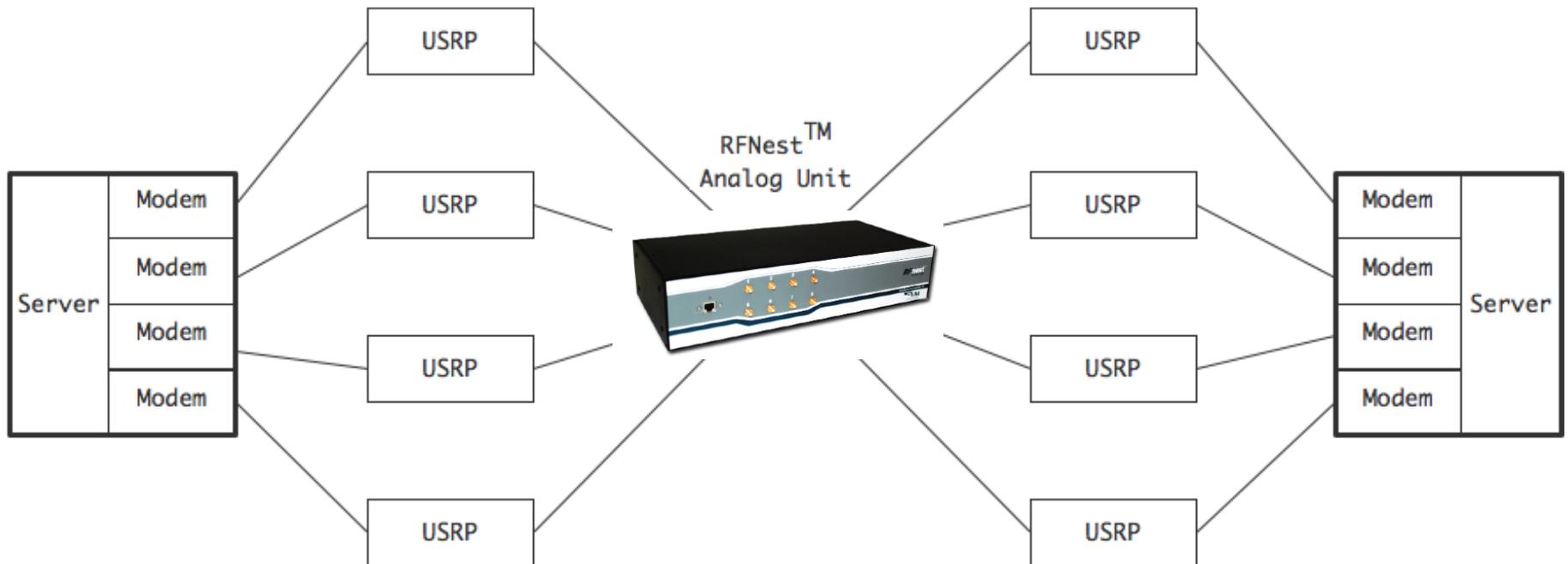
Channel Bonding 4 Iridium Modems

Change Software, not Hardware!



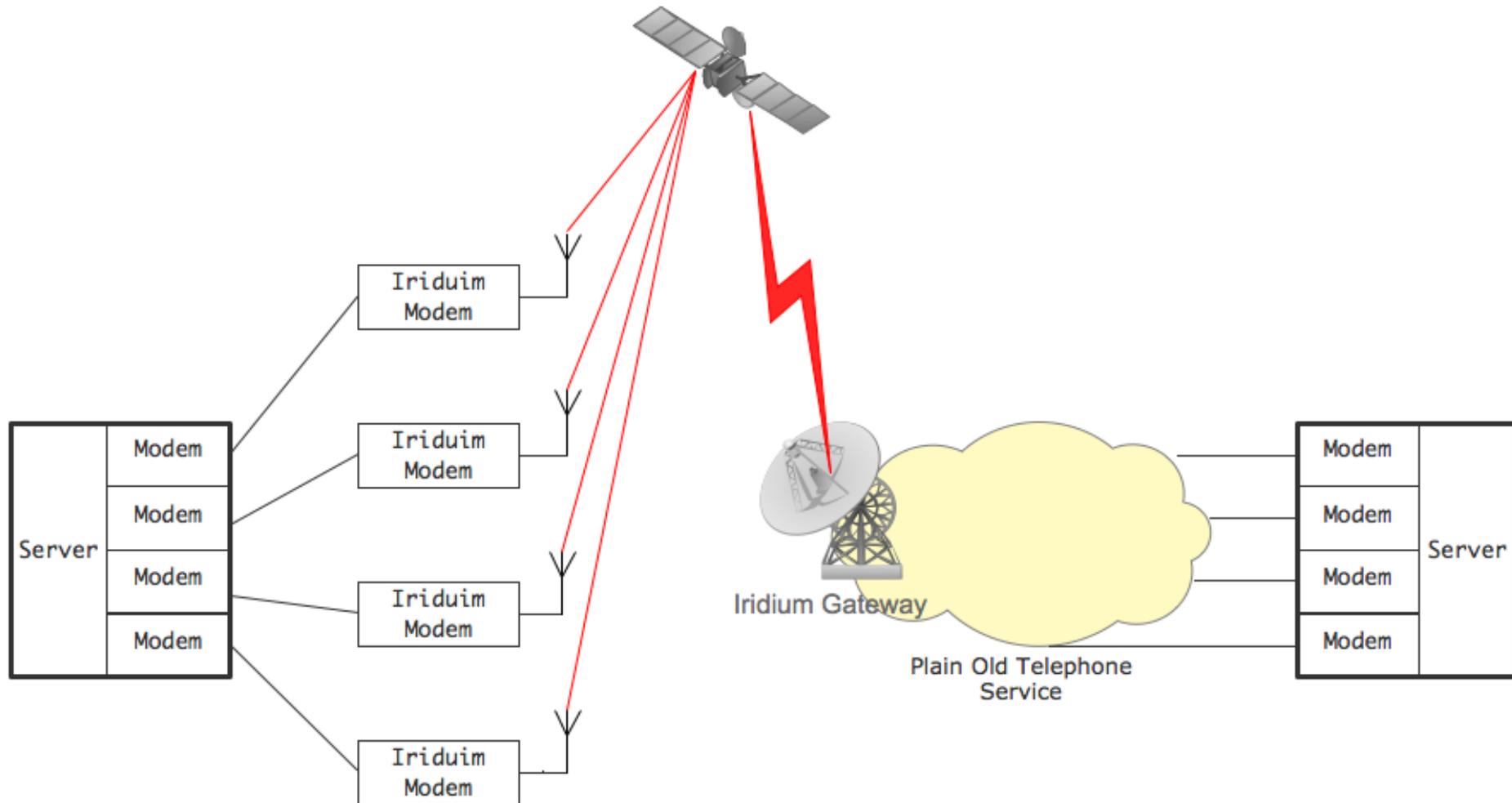


Laboratory Testbed





Engineering Model





DRYDEN FLIGHT RESEARCH CENTER



NORTHROP GRUMMAN