

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, reduce cost, and improve the operational efficiency of airborne science missions while enabling 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

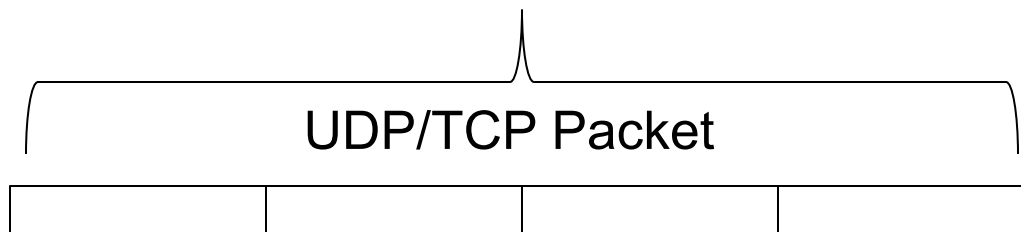
- Current solution to the channel multiplexing problem.
- Hypothesis: PPP-MP fragments UDP/TCP over multiple channels. Thus, when one modem fails, UDP/TCP protocol is heavily effected.
 - TCP more so due to TCP backoff and congestion control mechanisms.
- Characterizing Iridium modems, simulation and 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

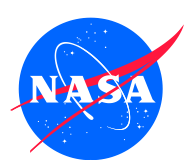
The NASDAT serves as a rate limiting, packet forwarding proxy server for all always-on low rate traffic (Iridium ~ 9600 bps for four channels)

- IP Address: 10.3.1.x (static address assigned for each instrument)
- Housekeeping Data: UDP from: broadcast/5000
- Status Packets: UDP to: broadcast/5100
- Iridium SatCom: UDP from/to: NASDAT/[assigned]
- Wide Band SatCom: TCP/IP via: Router
- Message Logging: UDP to: NASDAT/5200

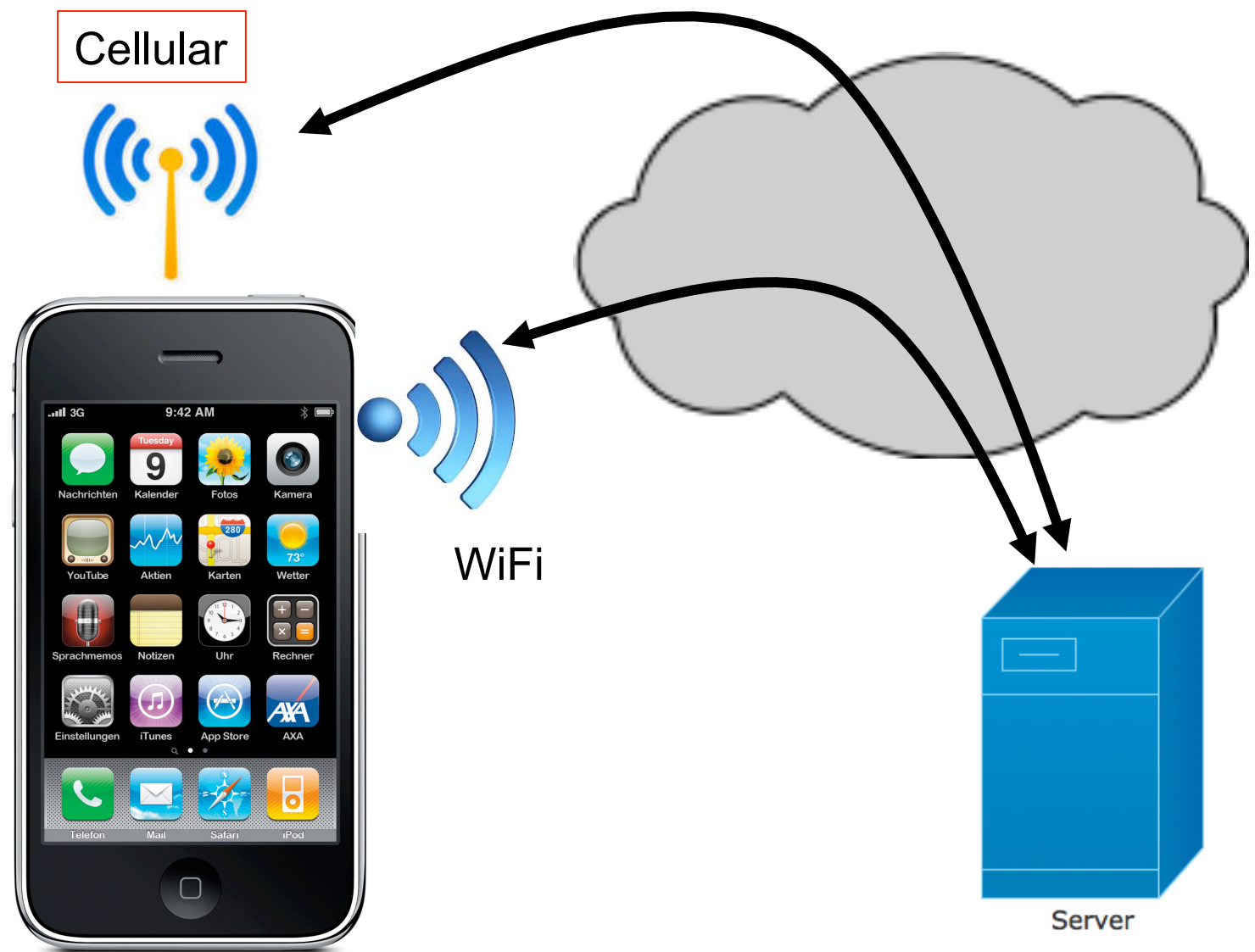


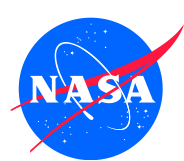
MP-TCP

- 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 Use Case

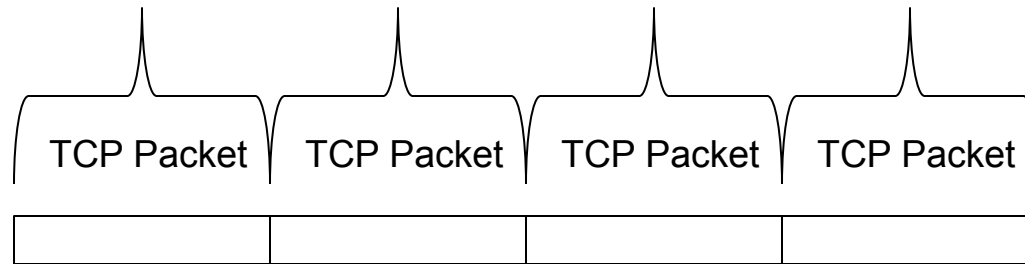




MPTCP

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

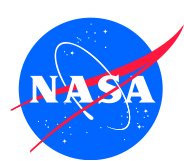
Channel 3

Channel 4



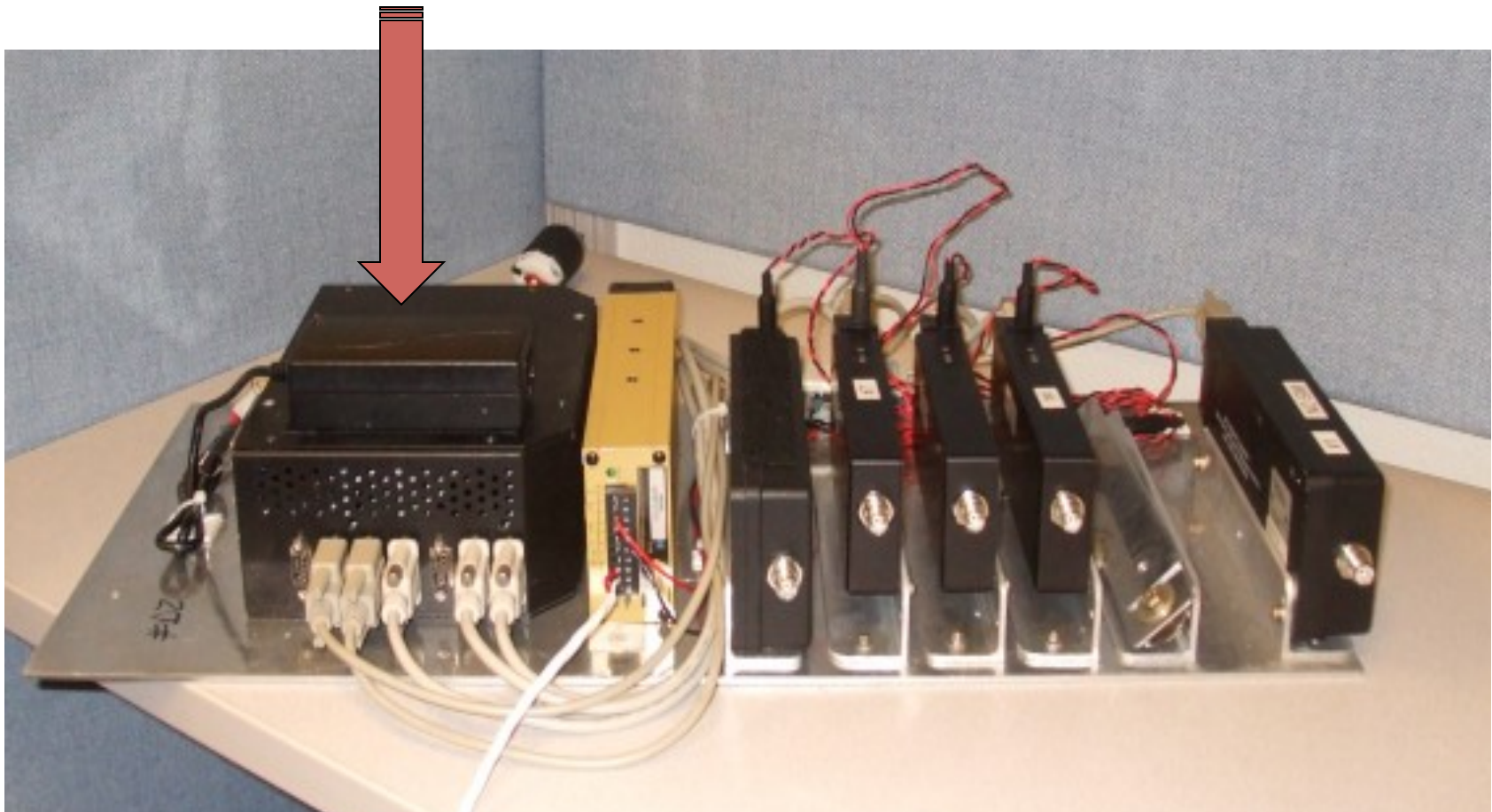
Approach

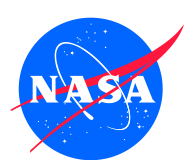
- GRC performs protocol research effort
- Ames provides expertise and code of existing system and integration into flight systems
- Tasks
 - Characterize the existing Iridium channels
 - Develop Laboratory Testbed (Research Testbed)
 - Develop Engineering Model (Relevant Environment Testing)
 - Model the existing PPP Implementation
 - Develop PPP, MPTCP and MPUDP 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



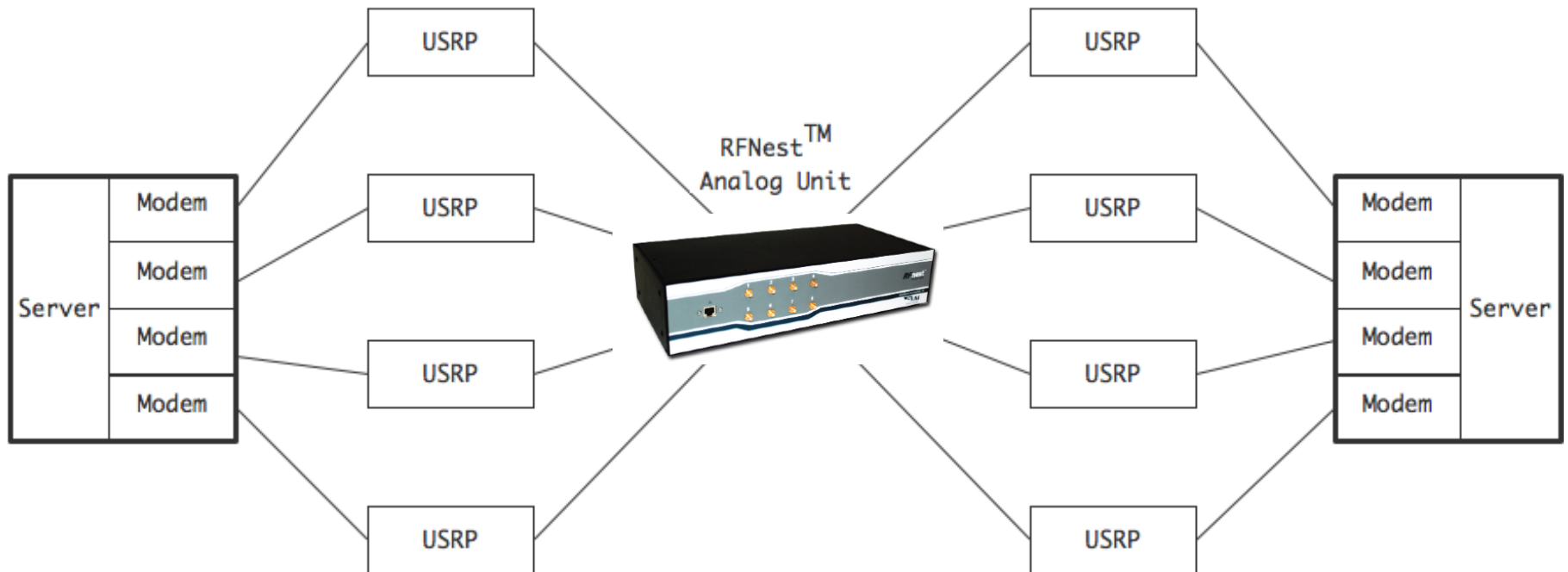
Channel Bonding 4 Iridium Modems

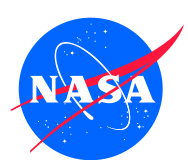
Change Software, not Hardware!





Laboratory Testbed





Engineering Model

