Affordable High Volume Data Telemetry Using Iridium RUDICS

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Presentation Overview

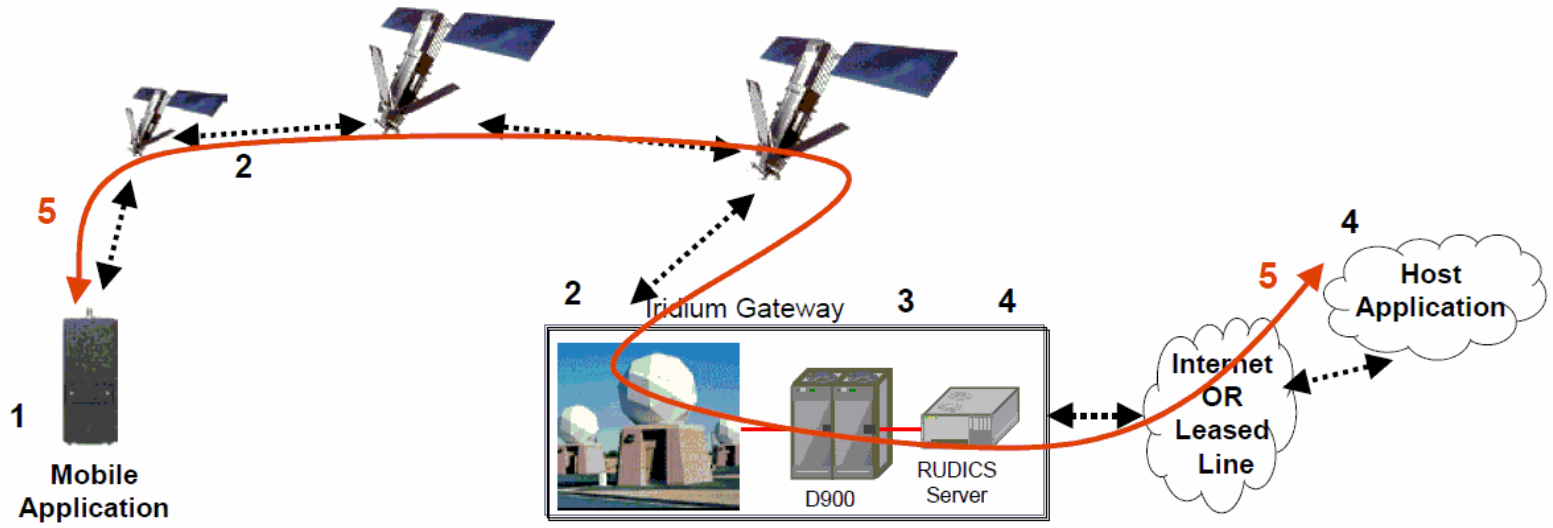
- What is RUDICS?
- How does RUDICS work?
- Considerations for Use
- Existing Applications
- Our Application & Improvements
- Results & Conclusions
- Brief Q&A

What is RUDICS?

- Router-based Unrestricted Digital Internetworking Connectivity Solution
- RUDICS provides a means to have an end-to-end bidirectional TCP/IP connection from the User Platform to a remote server.

Operational Flow Chart (Iridium Whitepaper)

Figure 5
A RUDICS Data Call from a remote application (ISU) to the central Host Application



Sequence of Events:

1. Mobile application places call to a custom RUDICS Server Number
2. Call request is routed over the constellation for user authentication and call set-up.
3. Switch connects to RUDICS Server, secondary authentication conducted
4. RUDICS Server terminates call to pre-configured IP Address
5. End-to-End IP connection established, over the constellation, between the Host Application and Mobile Application

Considerations for Use: Practical

- Data Volume
  - How much data do you intend to push, how often?
- Capital Investment
  - Considering volume, is it feasible to undertake the initial setup and development costs.
- Required Technical Resources
  - In-House Server
    - Requires 24-hour monitoring and up-time
  - Hosted Server
    - Additional expense

Considerations for Use: Functional

- Missing Pieces
  - What happens when the designated port is contacted?
  - Once you are connected
    - Authentication
    - Session management
    - How to transfer the data
    - Simultaneous connections
- Fortunately, servers are good at multitasking and the instruments only have one task to perform at a time.

How does RUDICS differ from other telemetry options?

- ARGOS 2/3
  - Low/No initial cost or monthly fees
  - Low bandwidth
  - No “Real-Time” reporting
- Iridium SBD
  - Nominal setup/activation costs and monthly fees. Charged by volume.
  - Decent bandwidth, Limited message size per session.
  - “Complete Constellation” – data can be delivered within a minute of collection.
- Iridium RUDICS
  - Moderately Expensive initial cost. Monthly similar to SBD. Charged by the minute of air-time.
  - Self-Selected protocol determines the % of 2400 baud band width usage.

How is RUDICS being used?

- Gliders
- ARGO floats
- Moored Tsunami Stations
- And now, Thermistor String and ADCP equipped ADOS.

Our Application: The Instrument

- Equipment
  - GPS
  - 20 Node thermistor string with pressure at each node.
  - 20 Level Nortek Aquadopp ADCP
- Sampling
  - Every 90 seconds
- Reporting
  - One session every half hour (293 bytes * 20 samples = 5,860 bytes)

Our Application: Initial Approach

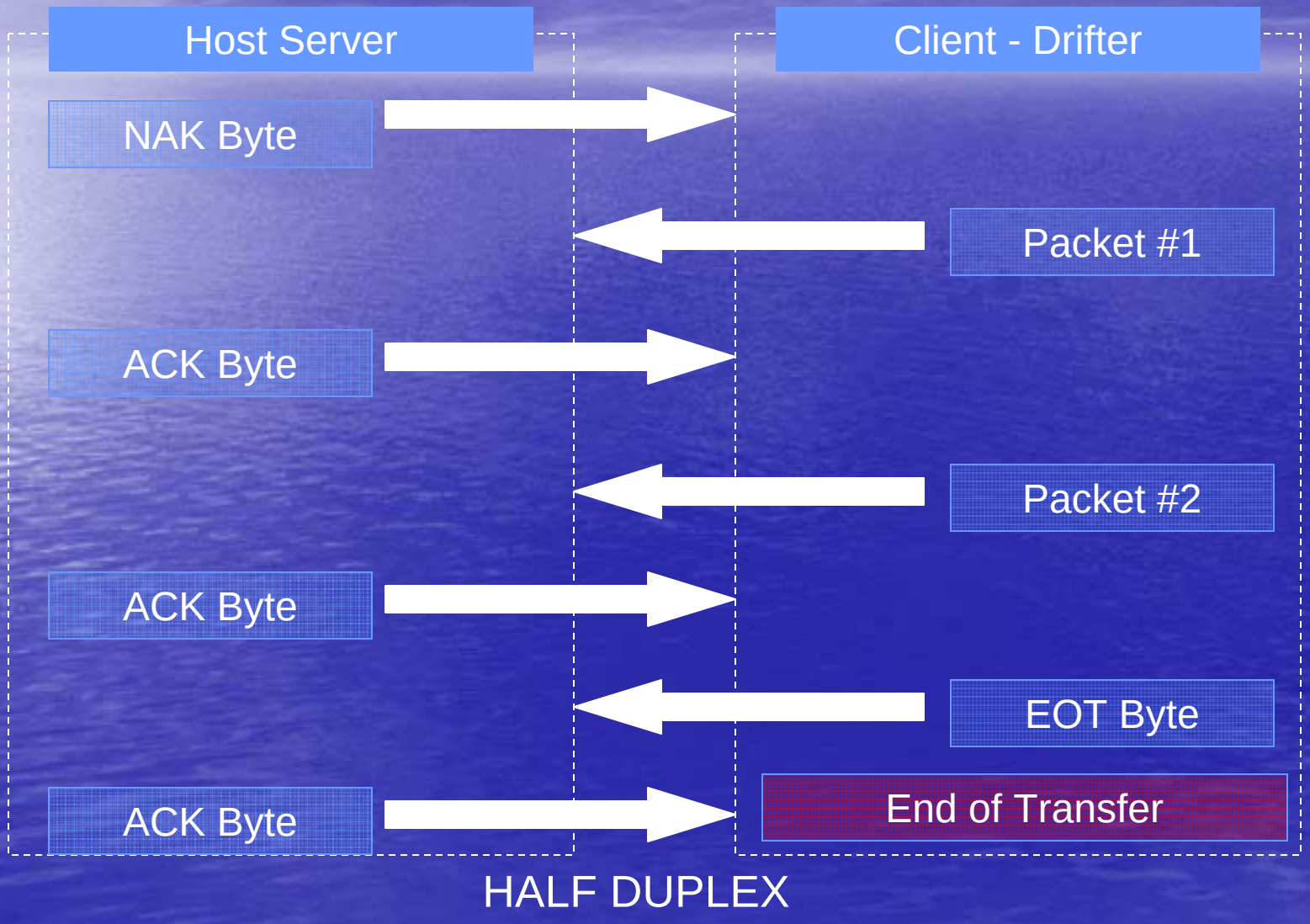
- Linux Server – Daemon Listening to incoming Port.
- telnet-style login authentication
- Commands issued by client
  - date - time synch
  - rx – XMODEM reception
- Client log-off with connection time-out

XMODEM Protocol Explanation

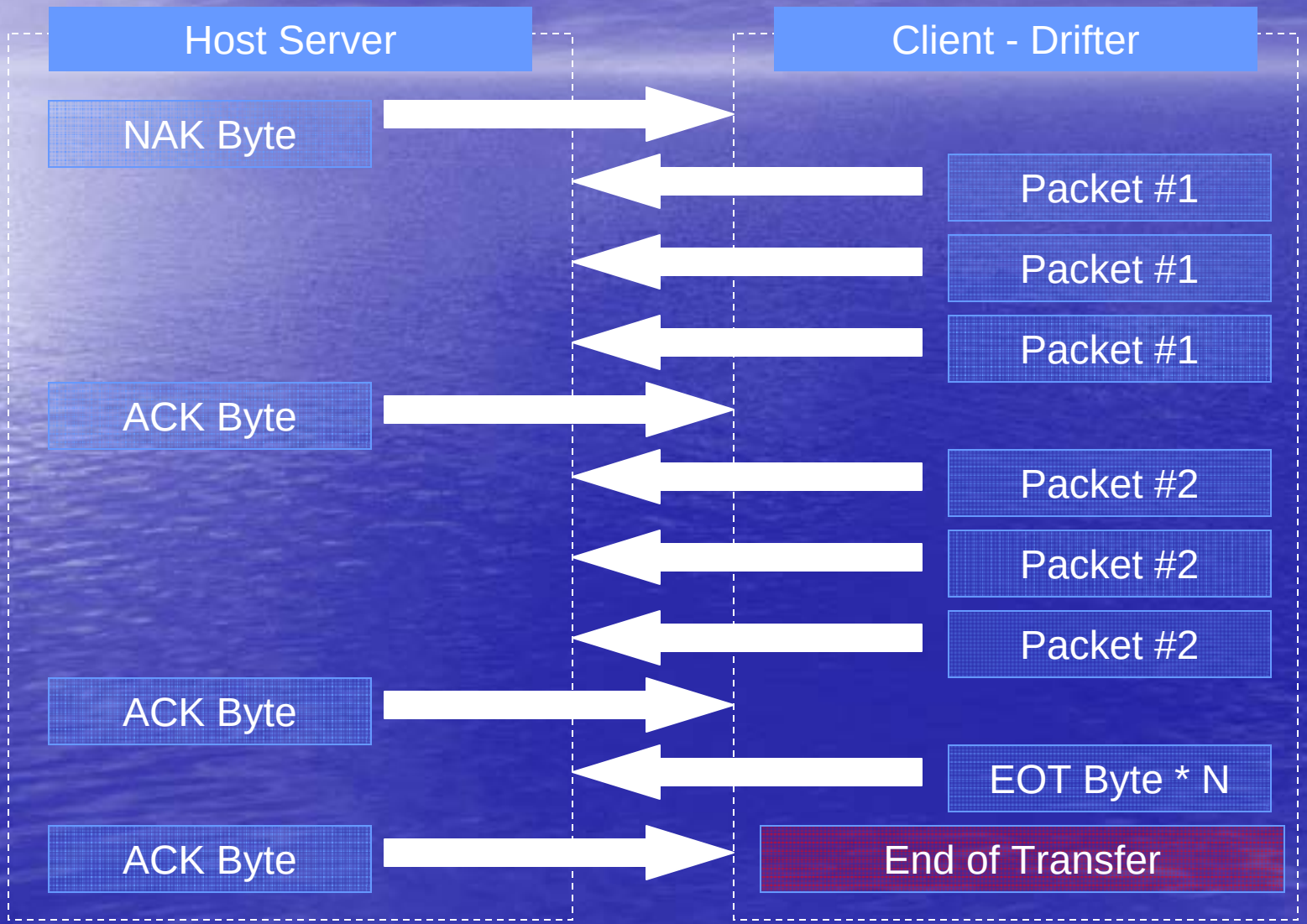
1) Client executes ‘rx’
2) Server sends NAK (Negative Acknowledgement)
3) Client sends a Packet
4) Server indicates reception with ACK (Acknowledgement) or NAK. Repeat 3+4
5) Client sent EOT (End of Transmission)
6) Server Acknowledges EOT

NOTE: The Server and Client are required to each have time-outs on their portion of the transmission cycle!!!

XMODEM Protocol Explanation



XMODEM Latency Issues



Initial Approach Results

- Most Importantly, It worked.
- Reliability of the In-House server proved problematic.
  - ISP downtime primarily
- Post Deployment Analysis
  - Far more dropped connections than expected
  - Additional air time for reattempt overhead.
  - But data were ultimately received.
  - Latency seem

Our 2nd Application: The Instrument

- Equipment
  - GPS
  - 30 Node thermistor string with pressure at each node.
  - 2 - 20 Level Nortek Aquadopp ADCP
- Sampling
  - Every 900 seconds
- Reporting
  - One session every 6 hours (535 bytes * 24 samples = 12,840 bytes)

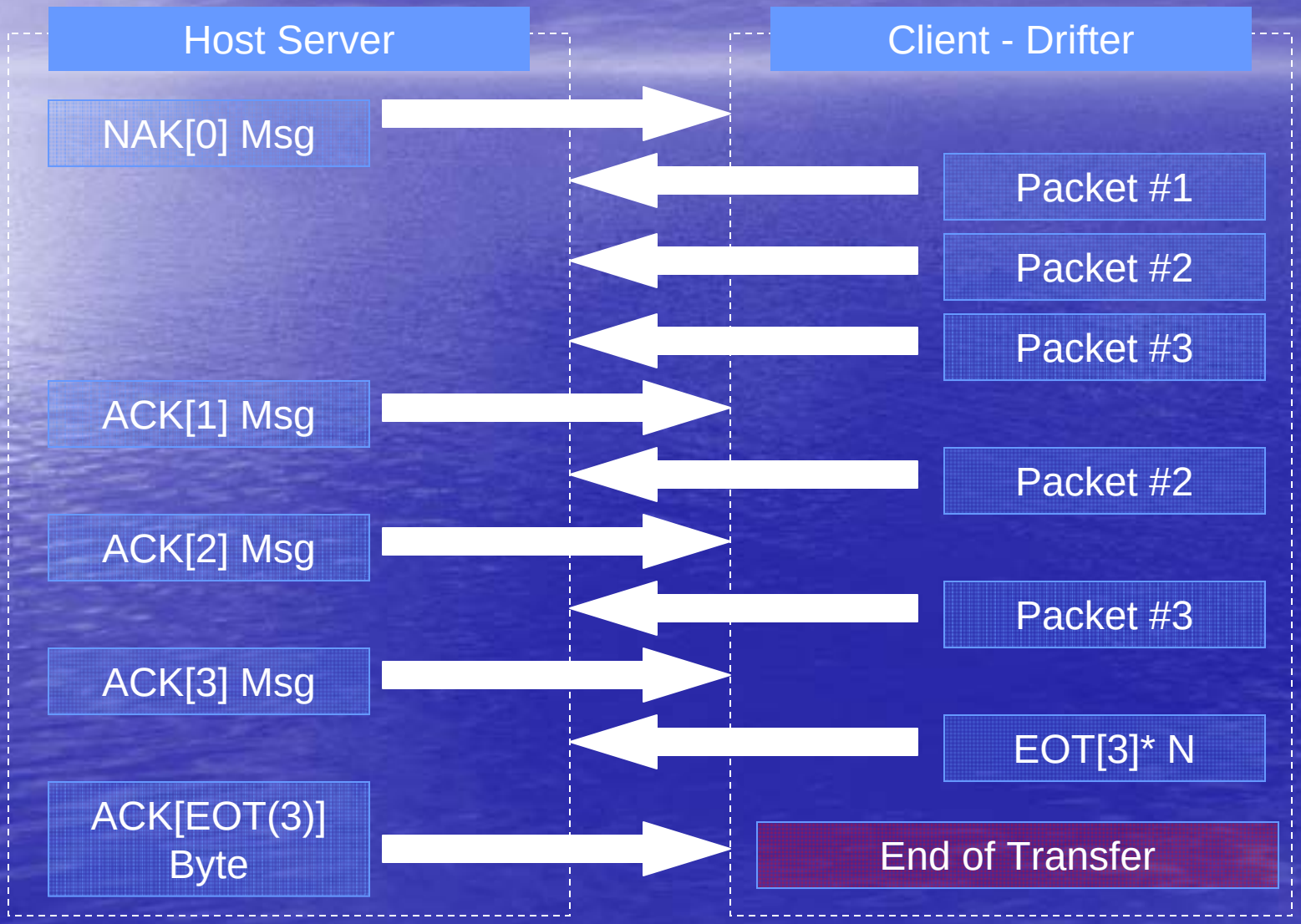
Our 2nd Application: Improvements

- XMODEM Shortcomings were costing valuable time and bandwidth.
- Looked into other protocols
  - YMODEM
  - ZMODEM
  - SEALink
- Infeasible to implement the require intricacies for any of those protocols in entirety, but walked away with a few key ideas
- Common feature of these is streaming, via “signed” Acknowledgement Packets

Our 2nd Application: New Protocol

- Implement a “Streaming” Protocol, to take advantage of Full Duplex connection and available processing.
- Connection overhead is reduced and bandwidth is better utilized if the user pushes data for the entire session without waiting for “round trip” responses.
- So, if the client is always pushing data, the server needs to intelligently inform the client what has been received and what was corrupted or lost.

CS-MODEM Approach



Improved Protocol Results

- Session lengths shortened.
- Scalability
  - The more packets in your message, the more efficient. Less falsely repeated packets.
- Partial message recovery
  - Each packet received as part of a contiguous set can be accurately removed from the queue (This is the only context sensitive part)
- Reliability
  - In our experience, a connection with very little “silence” has a better chance of sustaining.

Comparison of Applications

- 6144 bytes every 30 minutes.
- ~6 min per session.
- ~1 min per KB.

- 13,312 bytes every six hours.
- ~2 min per session
- ~0.154 min per KB

Well over a 500% improvement, with a change in transfer protocol.

Conclusions

- For the correct high-volume, data applications, RUDICS can provide a low cost per byte, low latency means of data delivery.
- Challenges
  - Initial Investments
    - Program set up with Iridium
    - Server setup
    - Client-Server Protocol Development

Future Work

- Explore further improvements in protocol.
- Discuss existing applications with other users.
- Look into the feasibility of data compression algorithms that are microcontroller friendly.

Thanks

- Dana Swift, University of Washington
  - Initial Server setup information
  - Advised on the implementation of protocols
- Paul Hill, JouBeh Technologies
  - Iridium VAR
  - Initial testing supplies and support
  - On going technical support

Question and Answer