Improved Layer 2 Protocol

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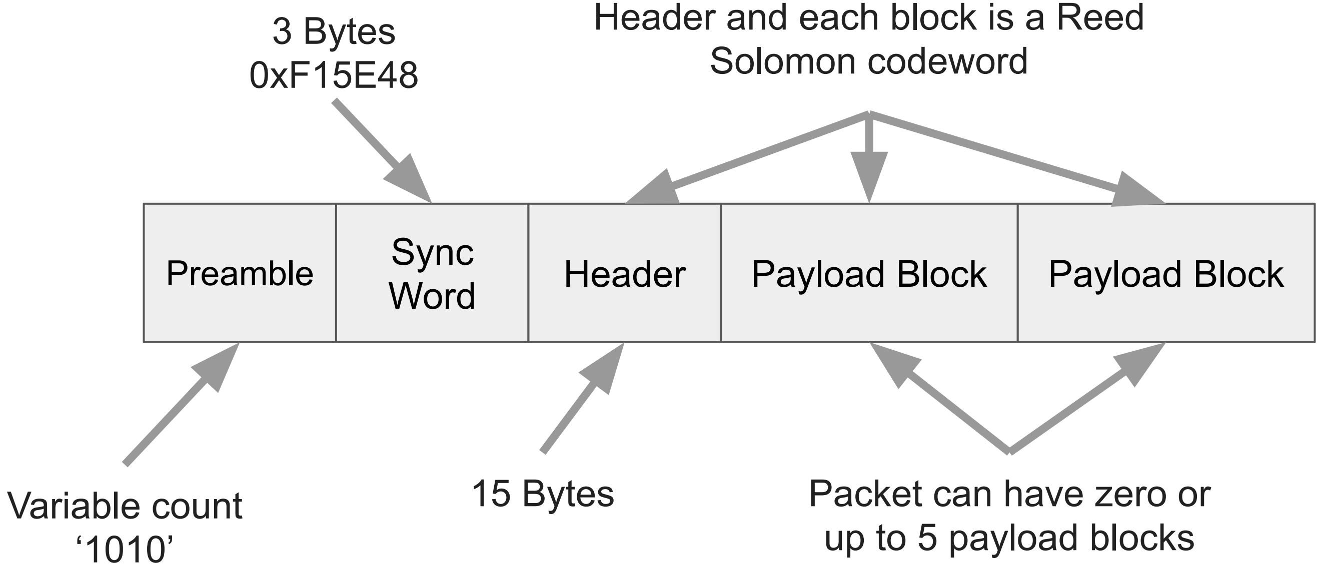
Overview

- Motivation for Development
- Packet Structure
- Reed Solomon Basics
- Header Encoding
- Payload Encoding
- Cost of FEC
- Practical Experience and Further Work

Motivation for Development of IL2P

- Make a more robust link layer for narrowband packet radio
- AX.25 Lacks Forward Error Correction (FEC)
    - Packet will be rejected with single bit error
- FX.25 adds FEC, but less efficient and not widely adopted
    - Cost of backwards-compatibility with legacy hardware
- Integrate bit-scrambling to support non-AFSK modes
- Improve packet-start detection (24 bit Sync Word)
    - Assist data-carrier-detection
    - 8-bit 0x7E flag occurs frequently in sliced random noise
- Move away from bit-stuffing
    - An effective packet delimiter in high-SNR situations, but cumbersome
- Integrate with existing host packet software (ie “KISS” interfaces)

IL2P Packet Structure



Reed Solomon Error Correction

- “Block Code”
  - Each block is a complete codeword
  - Decoder requires knowledge of block length
- Composed of symbols, chosen to be 8-bit bytes for IL2P
- Maximum block size based on size of symbol (Galois Fields)
  - For an 8-bit field, codeword can be up to 255 symbols (bytes) long
- Error correction capability depends on number of parity symbols
  - Can correct a fixed number of erroneous symbols in the block or codeword
  - Error correction capability = ½ number of parity symbols
- Decoder can make erroneous decode decision if errors exceed capability

Header Encoding

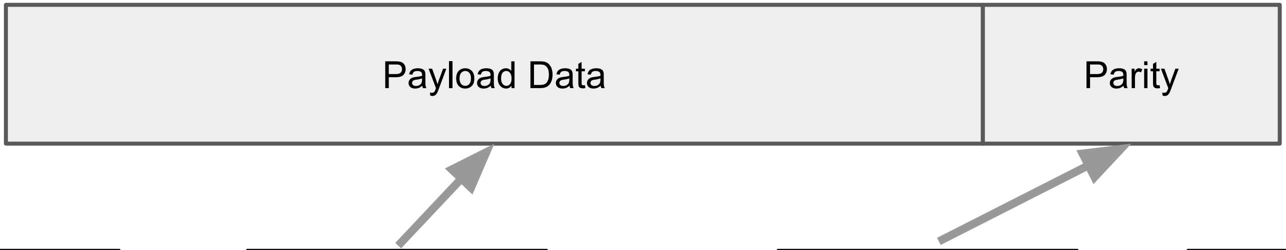
Control and Addressing Field Map for IL2P Type 1 Header														FEC	
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	Byte 12	Byte 13	Byte 14
Bit 0	DEST C/S 1	DEST C/S 2	DEST C/S 3	DEST C/S 4	DEST C/S 5	DEST C/S 6	SRC C/S 1	SRC C/S 2	SRC C/S 3	SRC C/S 4	SRC C/S 5	SRC C/S 6	SRC SSID	Parity	Parity
Bit 1															
Bit 2															
Bit 3															
Bit 4													DEST SSID		
Bit 5															
Bit 6	UI	PID				CONTROL									
Bit 7	FEC LEVEL	HDR TYPE	PAYLOAD BYTE COUNT												
Subfields spanning Bit 6 and Bit 7 have MSB on the left. SSID are four-bit subfields. Callsigns are packed in DEC SIXBIT encoding.															

Header is composed, then scrambled, then FEC parity is calculated and appended.

Header fields are analogous to those defined in AX.25.

Payload Encoding

Each payload block is one RS codeword including payload and parity.

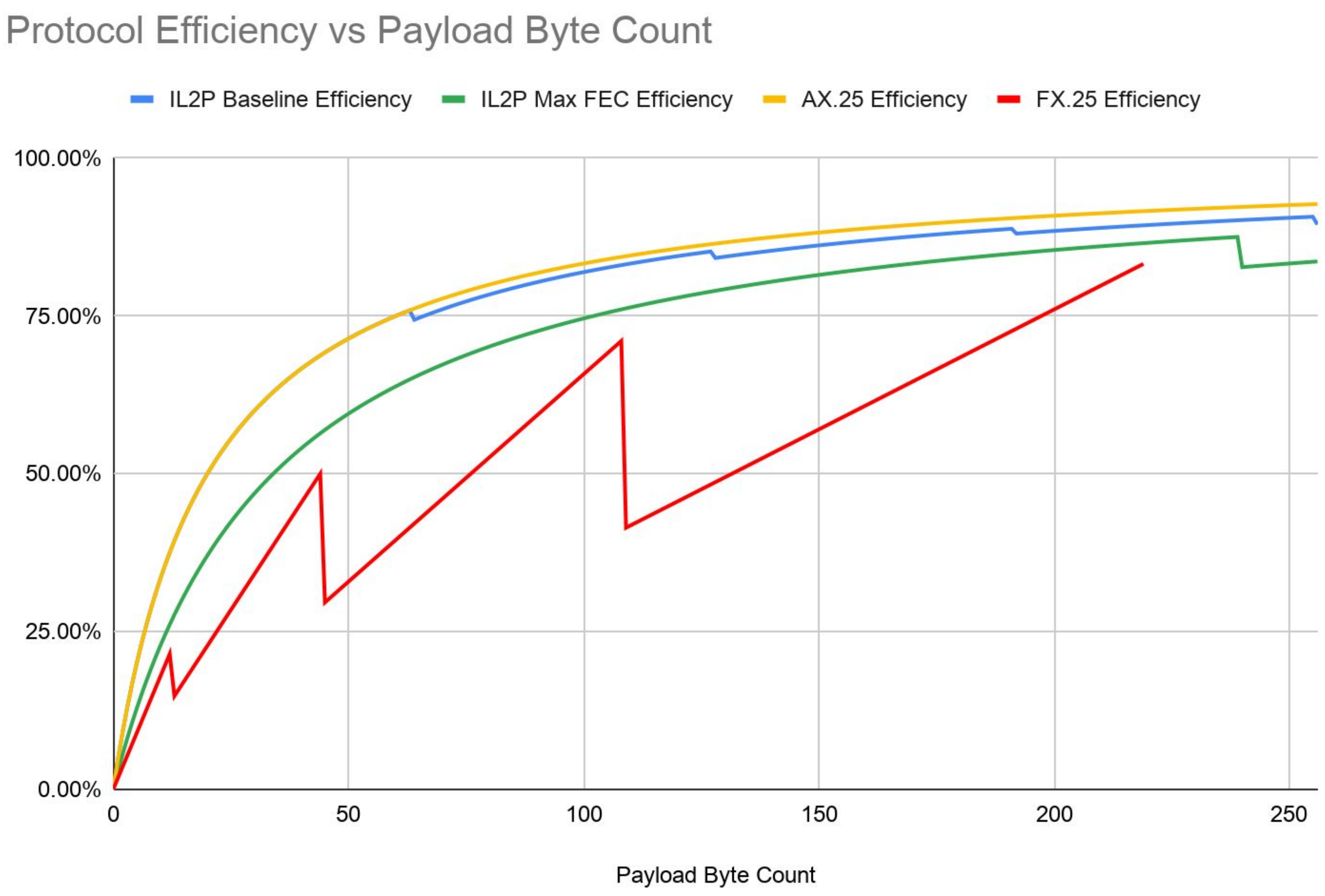


Payload block is composed, then scrambled, then FEC parity is calculated and appended.

“Baseline” payload up to 247 bytes, “Max” up to 239 bytes.

Number of parity symbols depends on FEC level and block length.

“Baseline” uses up to 8 parity symbols per block. “Max” uses 16 parity symbols regardless of block length.


Protocol Efficiency vs Payload Byte Count
IL2P Baseline Efficiency
IL2P Max FEC Efficiency
AX.25 Efficiency
FX.25 Efficiency
100.00%
75.00%
50.00%
25.00%
0.00%
0
50
100
150
200
250
Payload Byte Count

Real World Experience, Work Left to Do

- IL2P-capable TNCs fielded on 20 VHF links in TARPN network
- “Baseline” FEC limitations - false decodes on marginal links
  - Driver for “Max” FEC with additional parity
- Need to validate performance cost/benefit
  - Simulation
  - Measured noise injection
- Experiment with broadcast/beacon applications

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