Rateless FEC for Lossy Mesh Media

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What Rateless FEC Specifies

The transmitter encodes the message into a stream of fragments such that any sufficient subset enables full reconstruction. The encoding is rateless — the transmitter can produce arbitrarily many distinct fragments without coordinating with receivers. The receiver collects fragments until reconstruction succeeds.

Fountain codes (Luby Transform), Raptor codes, and related rateless erasure codes provide this property. The architecture treats them as a structural element of the wire format: the FEC descriptor tells receivers how to combine fragments.

Why Retransmission-Based Protocols Fail in Lossy Mesh

TCP and similar retransmission-based protocols depend on round-trip negotiation. In deeply-lossy mesh environments, the round-trip negotiation itself fails — acknowledgments don't arrive, retransmission requests don't propagate, the protocol stalls. Defense mesh, satellite-link mesh, expeditionary mesh, and dense-urban mesh all face this pattern.

Rateless FEC eliminates the round-trip dependency. The sender produces fragments; receivers anywhere collect what they can; reconstruction succeeds when enough

fragments arrive. No retransmission negotiation is needed.

How Rateless FEC Composes With Mesh Routing

Each fragment travels through the mesh independently. Relays can forward fragments without reassembling the message; multiple paths can carry different fragments simultaneously; receivers anywhere in the mesh can begin reconstruction as soon as they have enough fragments.

The architecture composes naturally with hop-history. Each fragment carries its own hop history; the reconstructed message's hop history reflects the diversity of paths the fragments traveled.

What This Enables for Lossy Operation

Defense mesh radios in jammed conditions, satellite-link mesh in deep-fade conditions, dense-urban mesh through structural attenuation, and indoor mesh through wall-loss conditions all benefit. The protocol-level resilience reduces the need for application-level retry logic that current architectures depend on.

The patent positions the primitive at the layer where current mesh deployment encounters the loss-pattern frontier that retransmission-based protocols cannot effectively address.