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Quantum-Safe Satellite Backhaul for the Unconnected

Post-Quantum IPsec over a GEO Link in a Private 5G Network

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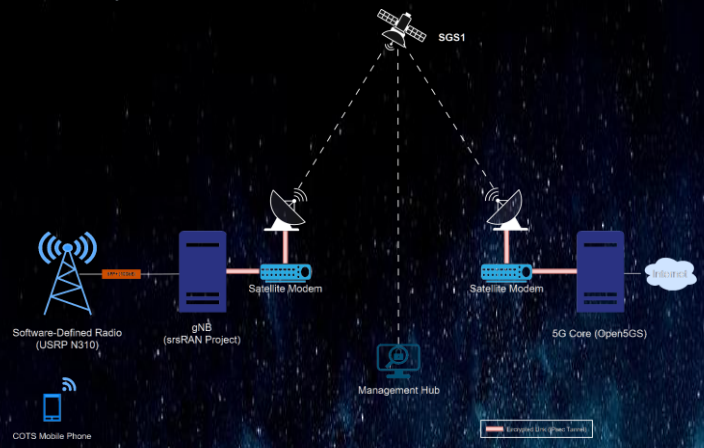
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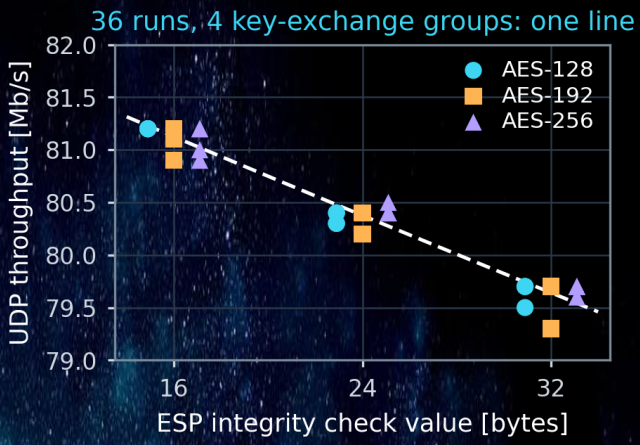
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Bytes, not compute.

Post-quantum security over a real GEO backhaul costs packet framing, not cryptography.

THE INNOVATION post-quantum cost on satellite backhaul is a framing problem, not a compute problem. A 36-configuration sweep separates the one-off key exchange from per-packet framing, and an operational GEO link shows where that framing meets the MTU ceiling — which delay emulation cannot reveal.





THE RESULT the cryptography is not the cost; bytes on the wire are.

0.1 Mb/s

largest difference in mean throughput between ML-KEM and classical MODP-8192 across 36 terrestrial configurations, on 80 Mb/s — inside the run-to-run scatter. Memory: 7.9–8.0 MB.

97%

of throughput variance across 36 configurations explained by integrity-check-value length alone. A 16-byte ICV carries 1.9% more payload than a 32-byte one.

4.5%

of a 1200-byte MTU is ESP framing over the GEO link — about a sixth of the 26% bitrate drop seen against an untunnelled baseline, and recoverable by MSS clamping.

THE SUSTAINABILITY CASE what the measurements mean for hardware, spacecraft capacity and reach.

Software upgrade, not hardware replacement

Deployed gNBs, gateways and cores become quantum-safe without new silicon, an accelerator refresh or a replacement cycle.

More users per spacecraft

Recovering framing overhead returns capacity that is already launched, on shared, finite GEO carriers with a fixed embodied energy cost.

Connectivity where fibre never reaches

Earth station to earth station, no third-party terrestrial segment: mines, farms and disaster areas served from day one, immune to fibre cuts.

THE OPPORTUNITY a market that needs this, and a place to build for it

Private 5G where fibre never reaches

Mining and energy sites, agricultural districts, disaster response: sovereign networks, satellite-backhauled from day one, quantum-safe with no hardware line item.

A sandbox on a real GEO link — open to partners

Open-source O-RAN 5G, live satellite backhaul, post-quantum security: trial applications, xApps and security migrations in the real environment, not an emulator.

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