



NTN Deployment Archetypes — Field Validation Benchmark Map

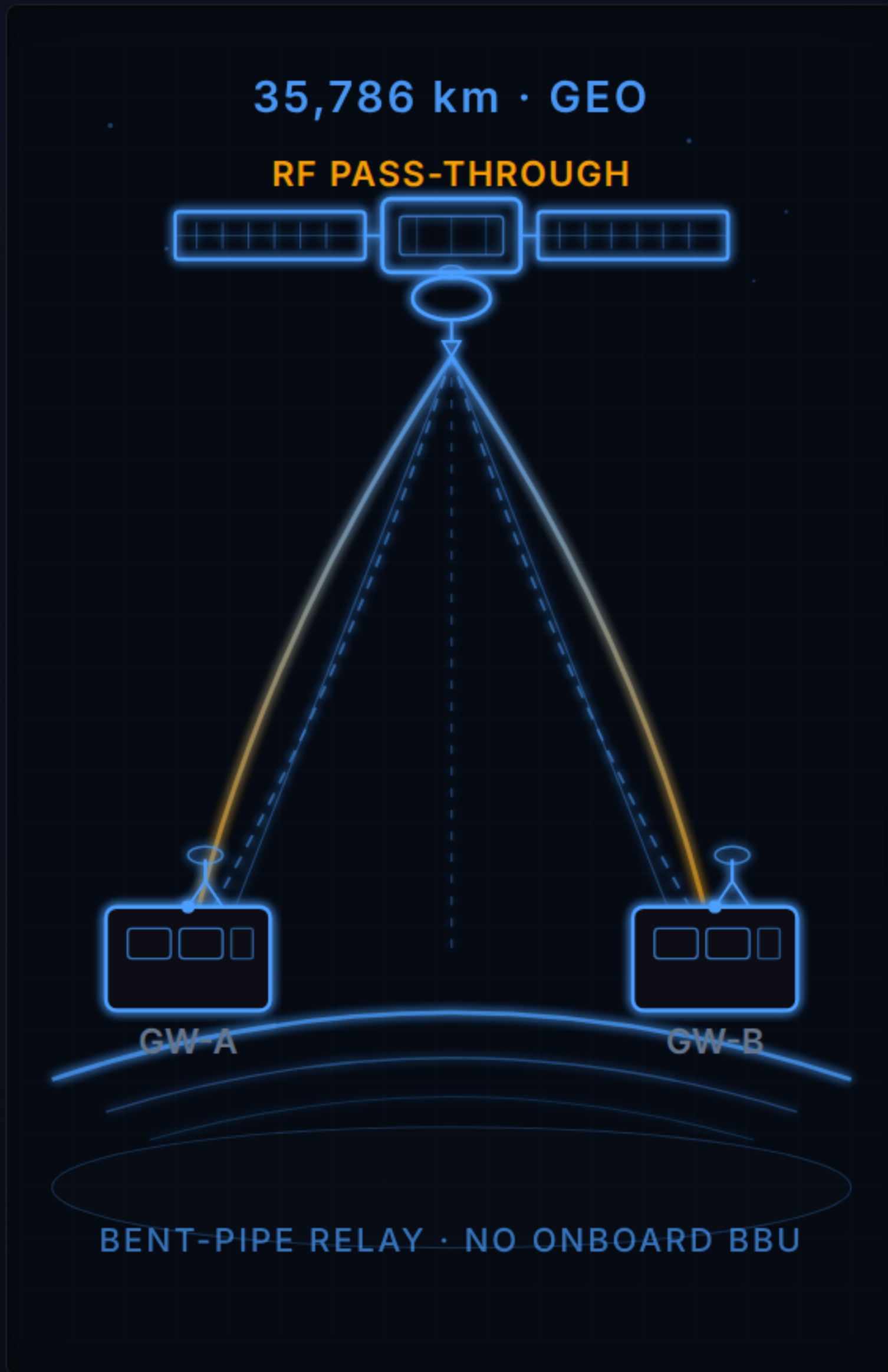
Six deployment models · validation stressors · where infrastructure must attach before pilots scale

- Post-TSG#112 · Rel-17 — Rel-21
- REL-17
- REL-18
- REL-19 PH.3
- REL-20
- REL-21

GEO · 35,786 KM

GEO Bent-Pipe

Rel-17 IoT & backhaul



- LINK & TIMING STRESSORS**
- ~250 ms RTT & TA budget limits
 - Ephemeris vs. station-keeping drift
 - Sub-5 MHz IoT-NTN on MSS bands (Rel-19 RF)
 - Feeder-link rain-fade margin headroom
 - Transparent payload gain stability
 - GEO IoT power-saving DRX cycles

- VALIDATION & TEST ECOSYSTEM**
- UXM / CMX500 — RF (stateless) · 38.521-5 PCT (stateful)
 - MT8000A NTN IoT · SATCOM emulators (stateless)
 - Amarisoft NB-IoT NTN (stateful) · Gatehouse NEMU — R&S Apr '26

- USE CASES**
- Maritime IoT asset tracking
 - Remote site backhaul
 - MSS narrowband IoT telemetry

Examples: Inmarsat, Eutelsat

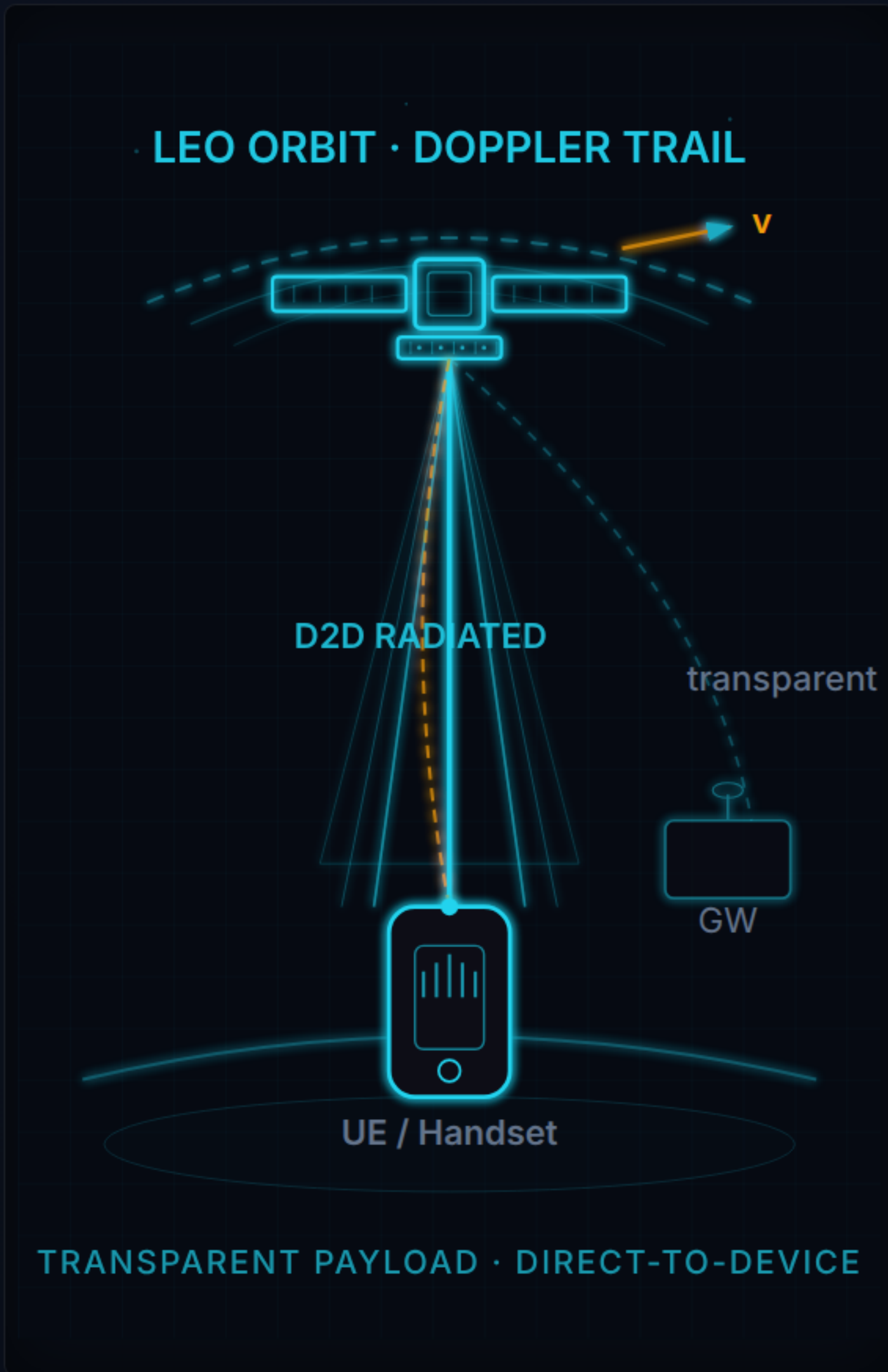
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Deterministic long-RTT impairment replay with ephemeris-tagged SoS evidence.

LEO · 500–1,200 KM

LEO Transparent Direct-to-Device

Direct-to-device · RedCap NTN



- RADIATED PATH KPIS**
- Body loss & antenna orientation
 - Doppler rate-of-change at pass edge
 - RedCap duty-cycle & wake windows
 - Elevation-dependent path loss
 - NTN cell reselection at pass edge
 - Open-loop UL timing advance errors

- VALIDATION & TEST ECOSYSTEM**
- ETS-Lindgren / octoScope — radiated (field)
 - UXM / CMX500 + Prosim — RF (stateless) · RedCap PCT (stateful)
 - Amarisoft UE Simbox (stateful) · NI USRP radiated capture (field)

- USE CASES**
- Smartphone emergency SOS
 - Off-grid messaging
 - RedCap sensor telemetry

Examples: Apple/Globalstar, AST

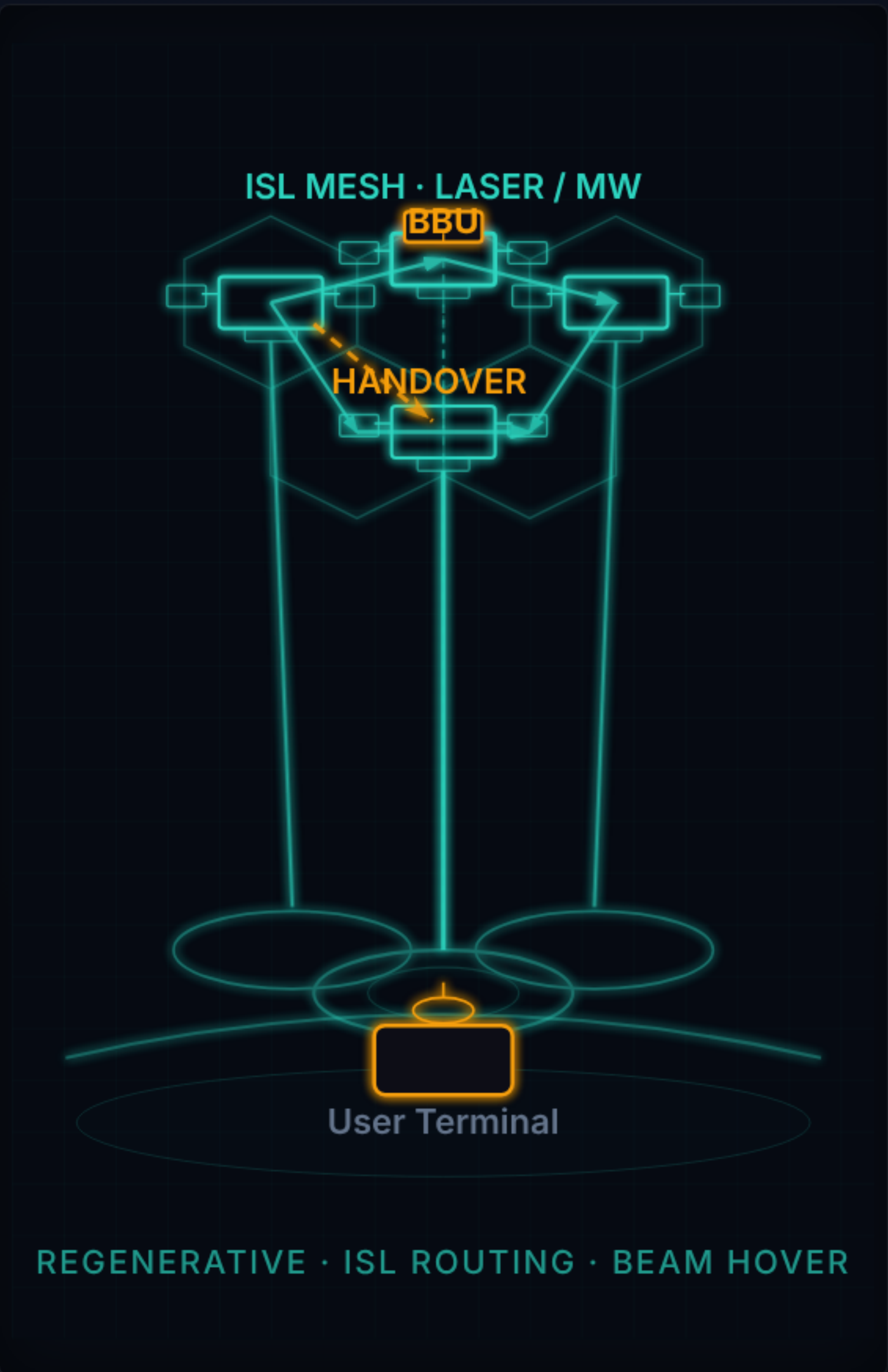
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Radiated capture with geometry labels for conducted-vs-field KPI gap closure.

LEO · ISL MESH

LEO Regenerative Broadband

ISL handover · Starlink-class KPIs



- HANDOVER & THROUGHPUT KPIS**
- Beam handover every 2–4 min
 - ISL routing & ground-station visibility
 - Throughput vs. elevation angle
 - On-board BBU processing latency
 - Ground-station feeder congestion
 - Multi-beam interference & ISL handover loss

- VALIDATION & TEST ECOSYSTEM**
- Spirent Landslide — core/UPF sim (stateful)
 - OAI / srsRAN gNB lab stack (OSS lab) · Gatehouse regen (stateful)
 - ISL routing — gap (no commercial PCT)

- USE CASES**
- Residential broadband
 - Mobility backhaul
 - Government connectivity programs

Examples: Starlink, OneWeb

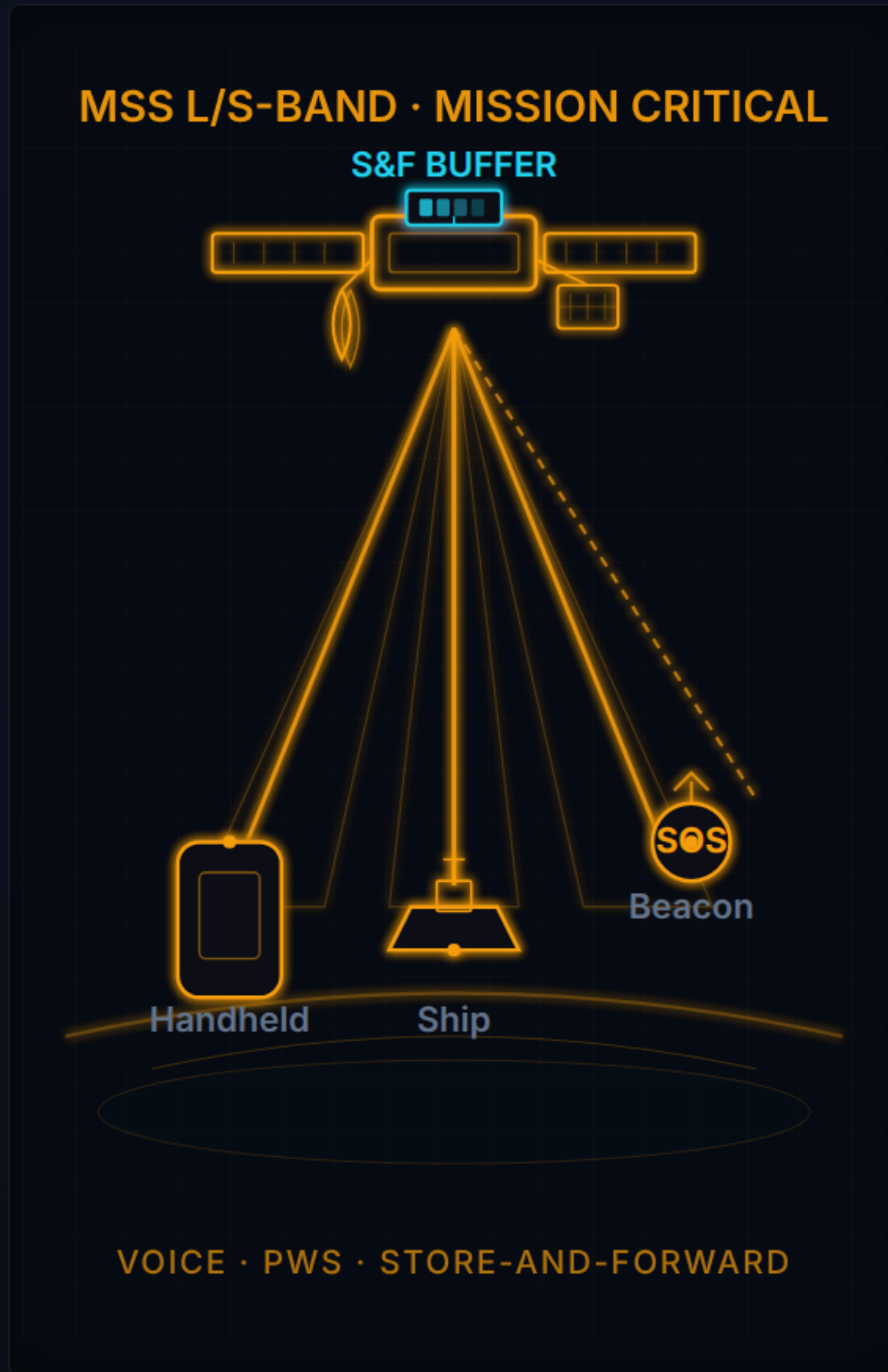
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Orbit-anchored replay twin for handover windows — KPI capture across multi-satellite transitions.

LEO · MSS L/S-BAND

LEO MSS Safety & Voice

Mission-critical · store-and-forward



- SAFETY & VOICE KPIS**
- Voice codec under variable latency
 - PWS delivery during visibility gaps
 - Polar & maritime link budgets
 - SOS beacon acquisition time
 - Store-and-forward queue depth
 - L/S-band duplexer isolation & rain-fade QoS

- VALIDATION & TEST ECOSYSTEM**
- Iridium / MSS voice suites (proprietary cert) · VoNR-NTN (emerging)
 - PWS delivery — field/sat sim (field), not standard PCT
 - Amarisoft voice demos — lab only (stateful)

- USE CASES**
- Aviation safety comms
 - Maritime GMDSS distress
 - Remote expedition voice

Examples: Iridium, Globalstar

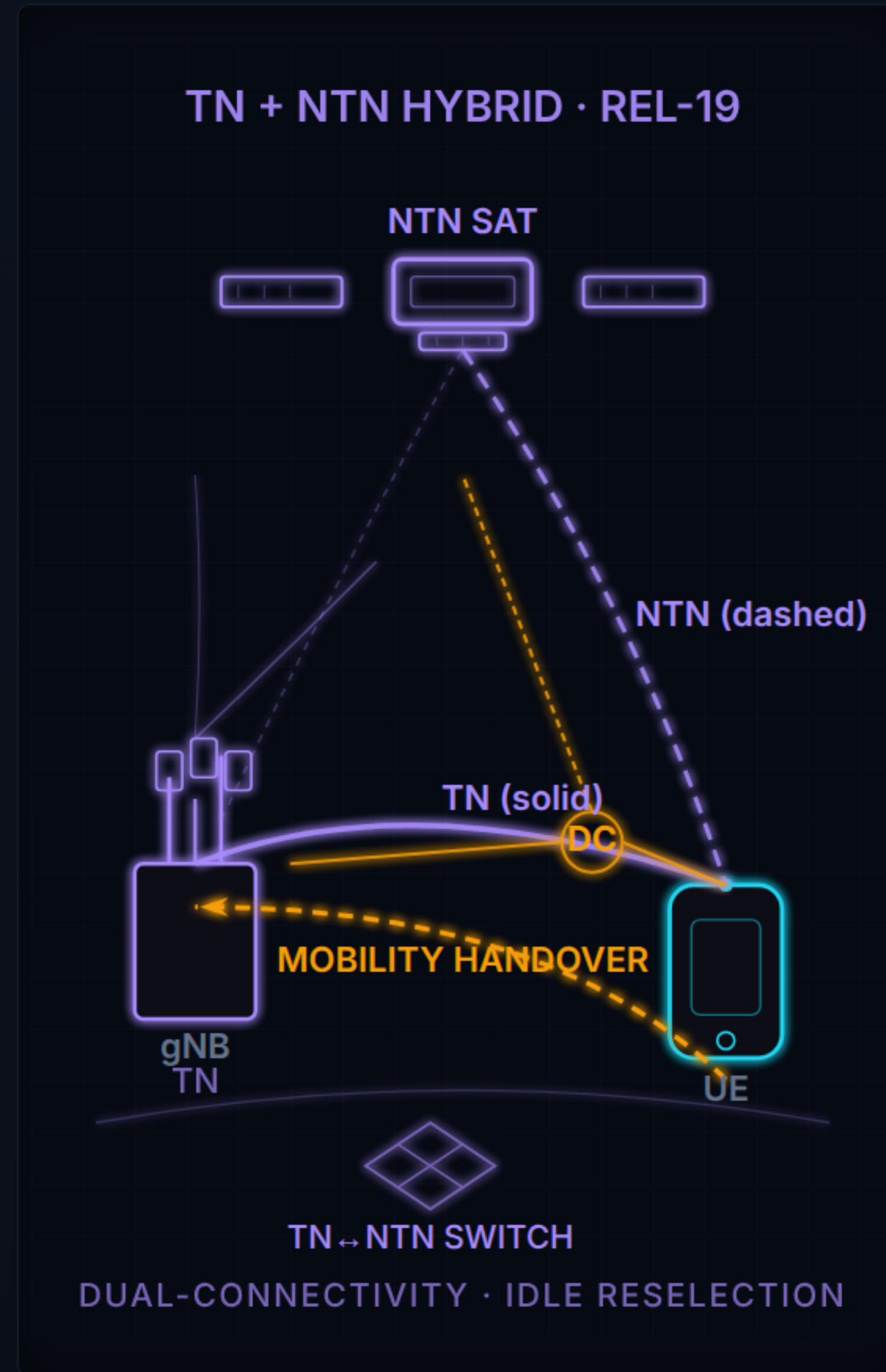
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Store-and-forward buffer traces with deterministic visibility-gap replay.

TN + NTN HYBRID

3GPP NR-NTN Integrated

TN → NTN mobility · Rel-19 Ph.3



- MOBILITY & STEERING KPIS**
- Idle-mode TN → NR-NTN mobility (Rel-19 W1)
 - PDU session continuity across TN → NTN switch
 - TN/NTN traffic steering & slice policies
 - Cross-release Rel-17/18/19 stacks
 - Slice-aware admission under TN/NTN split
 - RRC release with redirection & meas. gaps

- VALIDATION & TEST ECOSYSTEM**
- CMX500 / UXM — RF (stateless) · TN+NTN PCT (stateful)
 - Viavi TEMS (field) · Square Peg RLS — Viavi Jun '26 (stateless)
 - Amarisoft TN+NTN live demos (stateful) · ESA/Telesat LEO

- USE CASES**
- Seamless rural coverage
 - Automotive always-on connectivity
 - Enterprise TN → NTN fallback

Examples: T-Mobile/SpaceX, Vodafone/AST

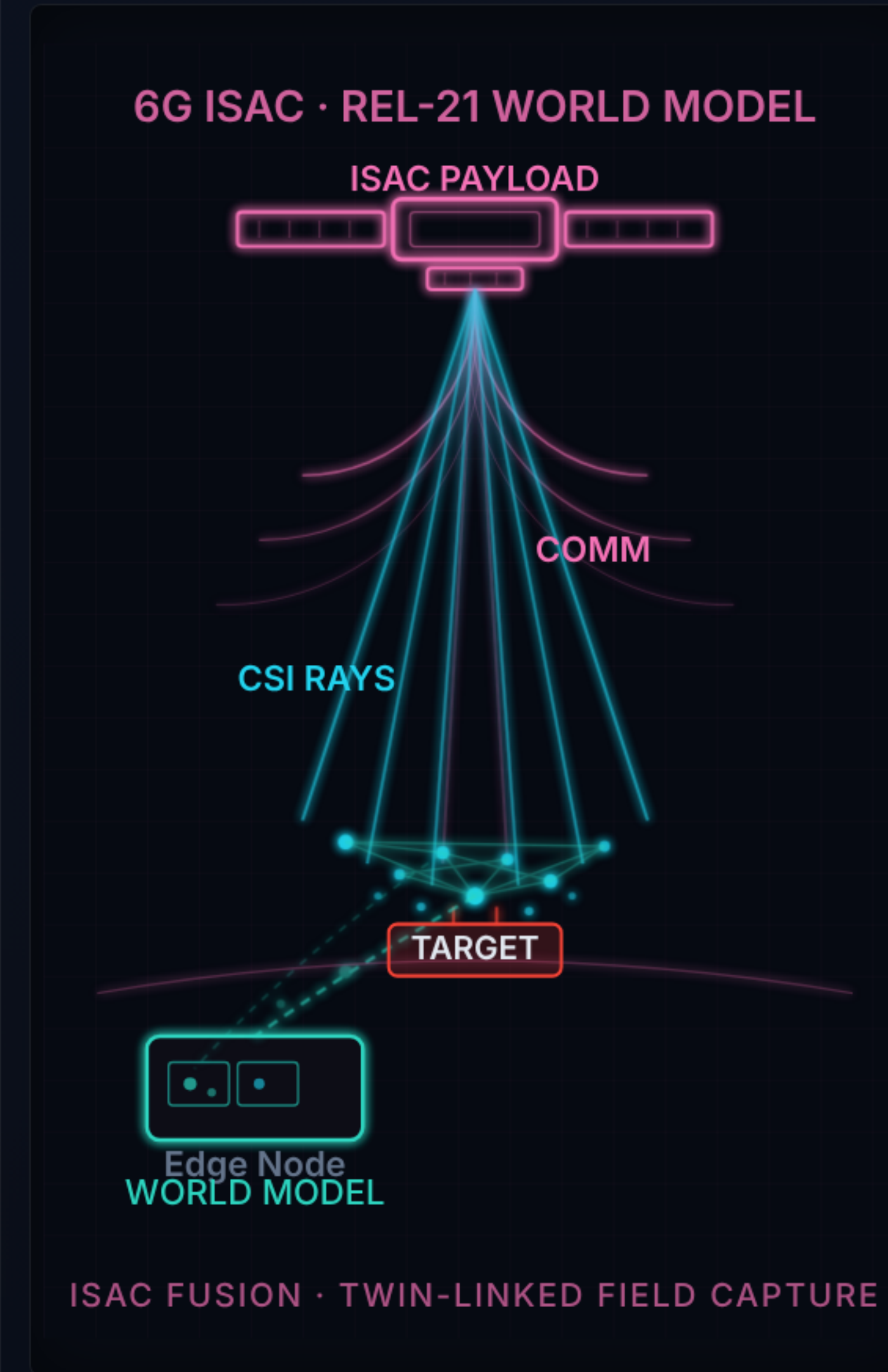
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Mobility-window twin for TN → NTN reselection evidence — release-tagged protocol + RF joint capture.

REL-21 · 6G BAND

6G NTN + ISAC Sensing

World-model lens · NEXUS edge plane



- ISAC & WORLD-MODEL KPIS**
- ISAC point-cloud → CSI fusion
 - AI-native RAN studies under orbital geometry
 - Rel-21 study-to-spec falsification (Stage-2 ~Jun 2028)
 - Sensing-comm mutual interference
 - Digital twin: world-model sync latency
 - CSI feedback under orbital Doppler

- VALIDATION & TEST ECOSYSTEM**
- R&S / NI ISAC sensing test beds (emerging)
 - NI USRP + CHES — SDR replay (stateless) · OAI/OpenISAC (OSS lab)
 - World-model twin validation — gap

- USE CASES**
- Disaster sensing & response
 - Border & perimeter monitoring
 - Autonomous vehicle world-model

Examples: TR 38.914, TSG#112 6G SI

NEXUS · DIGITAL TWIN

Twin-linked ISAC world-model: fuse point-cloud + CSI capture → SDR replay for Rel-21 falsification.