

# Ranging-Piggyback Synchronization

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## What Ranging-Piggyback Synchronization Specifies

UWB and similar ranging modalities exchange precisely-timed signals to produce range estimates. The same exchanges produce time-offset information between the participating units.

Ranging-piggyback synchronization extracts the time-offset observations as credentialed time observations. The architecture integrates them with the ranging solution rather than treating them as separate.

## Why It Matters Structurally

Separate time and position synchronization paths impose architectural overhead and produce inconsistent solutions when the paths disagree.

Joint solution produces structural consistency. The same observations contribute to both position and time; the resulting estimates are jointly consistent by construction.

## How It Composes With Mesh Operation

Each ranging exchange records the round-trip timing, the per-unit transmit-receive offsets, and the resulting range and time-offset observations. Both observations carry credentialed lineage.

The joint solver integrates the observations into a spacetime estimate. Cross-checks operate structurally — when range and time observations from the same exchange disagree with the joint solution, the disagreement surfaces as a diagnostic event.

## **What This Enables for Resilient Timekeeping**

Operations requiring precise spatial-temporal correlation (formation flight, surgical robotics, defense engagement coordination) gain joint precision that separate paths cannot match.

The architecture also reduces overhead. Single exchanges produce both classes of observation; the bandwidth and processing efficiency improve relative to separate sync architectures.