

Timing budget

Wi-Fi will never be deterministic, so prove the worst-case gap fits inside what the tightest timeout leaves for the radio.

Where each timeout comes from

Connection	Timeout	Example
CIP Safety input connection	RPI x (timeout multiplier + network delay multiplier)	40 ms at Input RPI 10 ms, Timeout multiplier 2, Network delay multiplier 200 %
CIP Safety output connection	safety task period x (timeout multiplier + network delay multiplier - 1)	60 ms at Safety task period 20 ms, Timeout multiplier 2, Network delay multiplier 200 %
EtherNet/IP standard I/O	RPI x connection timeout multiplier, but never less than the minimum timeout	100 ms at RPI 20 ms, Connection timeout multiplier 4 x, Minimum timeout 100 ms
PROFINET IO	update time x accepted update cycles without IO data	12 ms at Update time 4 ms, Accepted update cycles without IO data 3
PROFIsafe	F-monitoring time, entered directly	100 ms at F-monitoring time (F_WD_Time) 100 ms

How to use the budget

1. List every connection on the link: safety, standard I/O, fleet traffic.
2. Take the tightest timeout configured in the project, not the default.
3. Example: CIP Safety input at defaults is 10 ms x (2 + 2) = 40 ms.
4. Subtract what the wired path and endpoints spend. Measure it; do not guess.
5. What remains is the outage budget: the longest gap Wi-Fi may ever cause.
6. Measure the worst-case roam on the real vehicle, client, and security.
7. Pass only if the worst gap fits. One gap over the budget faults the connection.
8. Raising a timeout is the machine builder's call. It lengthens the worst case.
9. Time is distance: at 30 mph (13.41 m/s), each 100 ms is about 1.3 m.

Published roam interruption ranges (typical, measure your own)

Roam	Typical interruption
Full 802.1X reauthentication	No published range: measure yours
PSK four-way handshake (no fast roaming)	55 to 520 ms
PMK caching and opportunistic key caching	No published range: measure yours
802.11r fast BSS transition	15 to 90 ms
Vendor fast-roam and make-before-break schemes (vendor claim)	63 to 150 ms
Wi-Fi 7 multi-link operation	No published range: measure yours
802.11bn seamless mobility domain	No published range: measure yours