Technical report · IF-TR-2026-05 · version 1.0

Falcon Autonomy: scenario simulation, a measured sim-to-real gap and a gated path to vehicle hardware on CARLA

Sherin Joseph Roy 10 November 2026 Falcon Autonomy v2.3.0 P4 · Sim to vehicle

Funded entirely by BluRabbit Mobility Private Limited.

Abstract

Falcon Autonomy is a desktop application that runs the loop of building and testing a driving model on the CARLA 0.9.16 simulator: worlds, recorded drives with labels, scenarios, model evaluation, training, closed-loop stack testing, hardware in the loop and deployment. This report describes release v2.3.0 with emphasis on the steps between simulation and a vehicle: repeatable scenarios, the measured gap between simulated and real camera images, a hardware-in-the-loop session and a gated deployment pipeline. The author counted the scenario library at the release tag: 15 built-in scenarios, 8 of them for Indian roads, where the README states eleven and four. All other figures are reported in the repository's documentation and were not reproduced, because they need a CARLA server with an NVIDIA GPU. The documentation states that nothing in the deployment pipeline has run on the target Jetson AGX Orin; the README and roadmap describe that step as done. The report states both.

1 Problem

Situations that decide whether a driving stack is safe on Indian roads (a two-wheeler filtering between lanes, cattle standing in the lane, a bus pulling out across traffic) are rare in recorded data and unsafe to stage on a public road, so most of the testing for them has to happen in simulation. Simulation raises three questions that this report addresses for one system. Can a simulated test be repeated exactly? How far are simulated camera images from real ones? What has to be checked before a model or stack tested in simulation runs on vehicle hardware?

Falcon Autonomy is the lab's application for that work. It is built around the CARLA 0.9.16 simulator [carla] and covers building or importing a world, recording labelled drives, scripting and searching scenarios, scoring and training models, closed-loop stack testing, a hardware-in-the-loop session and a deployment pipeline for the NVIDIA Jetson AGX Orin [repo]. This report describes release v2.3.0. It concentrates on the steps between simulation and a vehicle and leaves the data, training and policy tools to the repository's documentation.

2 System design

Falcon runs as two kinds of process that never share an interpreter. The PyQt6 application and its command line run in the system's Python and never import `carla`. Workers run in CARLA's own Python environment with the CARLA 0.9.16 wheel and never import Qt. The two talk over a documented JSON-lines protocol. Each worker writes a `run.json` and exits with a documented code. A machine-wide lock lets one CARLA job run at a time, and a memory guard queues jobs rather than overcommit the machine [repo]. Falcon starts its own headless CARLA server, capped in memory in a systemd scope, on its own ports, and leaves alone any server the user started.

A project is a JSON file with a published schema. Runs, logs and a SQLite catalogue live in a workspace folder beside it, and the catalogue can be rebuilt from the run folders, which are the record of truth. Every heavy action has a command-line form on the same code path as the GUI, including `falcon reproduce`, which re-runs a recorded run from its input and compares the result within stated pose and image tolerances.

Four subsystems carry the path from simulation to a vehicle:

- **Scenarios** (`core/scenarios.py`): a library of built-in scenarios with parameters drawn from distributions, criticality measures (time to collision, post-encroachment time, minimum distance, required deceleration), resumable sweeps, rare-case search and OpenSCENARIO import and export.
- **The sim-to-real gap** (`falcon gap`): statistics of image appearance and a distance in a fixed feature space between a set of simulated drives and a real image set.
- **Hardware in the loop** (`falcon hil`): one camera and one lidar of a CARLA session streamed to a device, a stack run there, and the control returned and applied at the next simulation step, with latency recorded per stage.
- **Deployment** (`falcon deploy`): a registered ONNX detector built into TensorRT engines on the device, profiled for latency and energy, checked for accuracy against the host's ONNX model, and passed or failed by a release gate.

3 Method

Scenario library and repeatability

The author read the scenario library in the source at the release tag and counted its entries (Section 4). The repeatability result is the repository's own. Each built-in scenario was run twice with the same seed on the same CARLA server and the trajectories were compared. Scenario runs default to kinematic motion: every scenario vehicle, the ego included, is integrated with a kinematic bicycle model and placed with physics off. The documentation reports that under CARLA's vehicle physics two runs with the same seed drift apart, which is why kinematic motion is the default [repo].

Measuring the gap to real images

The gap measure applies the method of the Fréchet inception distance [fid] and the kernel inception distance [kid] to the 2048 pooled features of torchvision's ResNet-50 with ImageNet-1k weights. These values are not comparable with published FID, which uses a different network, and they depend on the number of images. Each distance is therefore reported next to its floor: the same distance between two random halves of the real set at the same set sizes. The day comparison uses three KITTI raw drives [kitti]. The night comparison uses held-out night frames from a single dashcam, which are not published. An optional appearance matching applies a fixed, non-learned transform to the simulated images before the distance is taken.

Hardware in the loop

The session worker steps the world synchronously at 20 Hz. It hands the camera image and lidar sweep of each step to a gateway, which encodes the camera as H.264, frames the lidar and sends both to the device agent. The agent decodes, pairs the camera and lidar of each step, runs the stack and returns the control with its timestamps. The simulation never waits for the device. A control that arrives after the next step has started is applied one step later and counted as late. If no control arrives for 0.5 s, the ego brakes. A ping exchange estimates the device's clock offset, and camera jitter follows RFC 3550 [rfc3550]. The device was simulated on the host for every measurement reported here.

Deployment gate

The gate judges three quantities measured on the device: accuracy relative to the host's ONNX reference, with bootstrap intervals; latency; and energy per frame. Because the development machine has no Jetson and no TensorRT, the pipeline was exercised with onnxruntime on the host CPU standing in for the engine [repo].

4 Validation

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> 1. "Reproduced" marks a value the author obtained itself at the release tag; "Reported" marks a value taken from the repository's documentation. The evidence appendix gives the source of each.

Scenarios

At the release tag the scenario library holds `15 scenarios`, of which `8 scenarios` are written for Indian roads: two-wheeler filtering, a jaywalker from behind a bus, a wrong-way scooter, a bus pulling out, stray cattle, a handcart in the kerb lane, an autorickshaw cutting in, and a lead vehicle braking on a waterlogged road. The README at the same tag states eleven built-ins, four of them for Indian roads. The repository reports that `11 scenarios` repeat bit for bit under kinematic motion. That measurement covers eleven scenarios, so the four added since are not covered by it.

Gap to real images

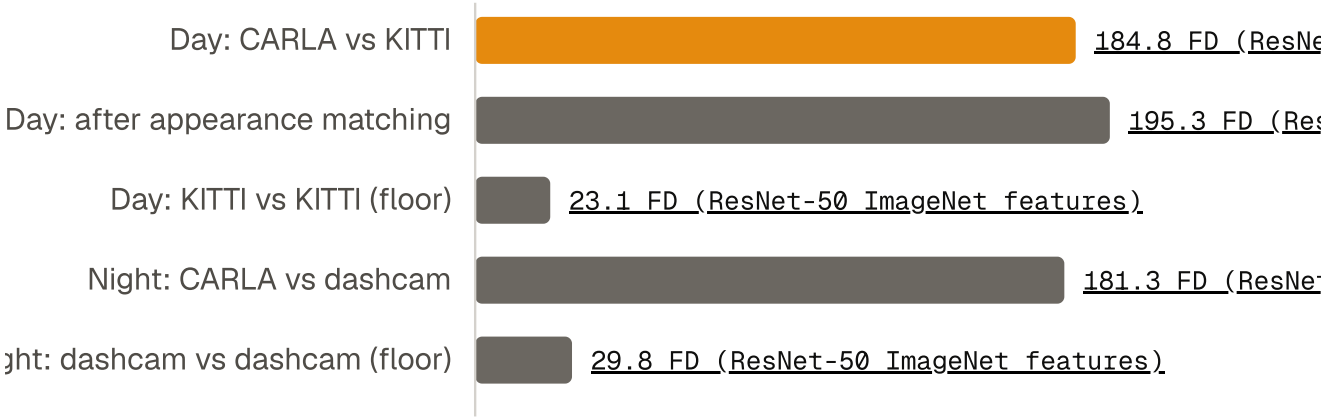


Figure 1. Fréchet distance on ResNet-50 ImageNet features between simulated and real images, with the real-vs-real floor at the same set sizes. Day: two CARLA 0.9.16 drives (Town10HD and an imported OpenStreetMap world) against three KITTI raw drives. Night: two CARLA night drives against held-out dashcam night frames. Reported in the repository, docs/sim-to-real.md.

For day images, CARLA drives sit at `184.8 FD (ResNet-50 ImageNet features)` from KITTI, against a floor of `23.1 FD (ResNet-50 ImageNet features)`. The kernel distance is `0.113 KD (ResNet-50 ImageNet features)`. Appearance matching moves brightness, contrast, colour spread and noise towards the real set, but the feature distance rises to `195.3 FD (ResNet-50 ImageNet features)`. The documentation reads this as a gap of content and rendering rather than of global colour. It also notes that the scenes differ: Karlsruhe in 2011 on one side, a CARLA town and an imported city on the other. At night the distance is `181.3 FD (ResNet-50 ImageNet features)` against a floor of `29.8 FD (ResNet-50 ImageNet features)`. The simulated night is far darker than the camera's auto-exposed frames, has rendering noise in the shadows, and has few light sources with halos.

Hardware in the loop on a simulated device

Quantity	Value	Conditions	Basis
Hardware-in-the-loop step start to control at the simulation, x264 transport (median)	`23.67 ms`	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; x264 transport; p95 47.13 ms; load average 9–15 on the host during these sessions (other projects' test suites); network stages are loopback	Reported 2026-10-29
Hardware-in-the-loop step start to control at the simulation, NVENC transport (median)	`27.97 ms`	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; NVENC transport; p95 73.50 ms (session ran during a load peak, real-time factor 0.985); load average 9–15 on the host during these sessions (other projects' test suites); network stages are loopback	Reported 2026-10-29
Hardware-in-the-loop controls on time, x264 transport	`1143 controls`	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; x264 transport; of 1199 (95.3 %); 14 late, 42 superseded, 0 missing; load average 9–15 on the host during these sessions (other projects' test suites); network stages are loopback	Reported 2026-10-29
Device clock-offset estimate error against the known truth	`5.2-7.0 µs`	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; simulated device clock offset 1500 ms drifting 20 ppm; range over the five sessions; stated bounds ±24–30 µs; drift recovered 19.97–20.05 ppm	Reported 2026-10-29

Table 1. Hardware-in-the-loop sessions with a simulated device on the host: CARLA 0.9.16, Town10HD, 60 s at 20 Hz, a 1280 × 720 camera as H.264 and a 32-channel lidar over loopback, on a shared machine. Reported in the repository, docs/hardware.md. "Reproduced" rows were run by the author; "Reported" rows are quoted from the repository at the commit shown.

With the x264 transport the control is back at the simulation `23.67 ms` after its step began (median), and `1143 controls` arrived on time. The NVENC session's median is `27.97 ms`. The documentation notes that this session ran during a load peak on the host and that NVENC's single-slice stream decodes more slowly in software. The clock-offset estimate falls within `5.2-7.0 µs` of a known simulated offset. These figures describe the session machinery on a desktop. They say nothing about latency on the Jetson.

Deployment pipeline on a simulated device

On the repository's synthetic test drives, the INT8 engine scores `0.935 ratio (AP / reference AP)` of the reference accuracy, and the gate fails it because the interval lies below its threshold. On real CARLA recordings, the simulated device reports a median latency of `20.47 ms` for FP32 and `19.38 ms` for INT8 on the host CPU. The detector used there does not detect Town10 objects (its reference accuracy is near zero), so the accuracy criterion is reported as not measured. The run shows that the pipeline works end to end, not that a model is ready.

Models and training

The evaluation harness, given a synthetic detector with a deliberate size weakness on the fake simulator's drives, scores `0.111 COCO AP`, falling with range as the planted weakness predicts. Detector fine-tuning runs at `126-139 images/s` on the stated GPU.

5 Limitations

- **No target-hardware result.** The documentation states that nothing in the deployment pipeline has run on an Orin, that the TensorRT backend has never executed, and that the hardware-in-the-loop acceptance run on the Jetson is pending. The README describes deployment as engines "built, profiled and accuracy-checked on the Jetson AGX Orin", and the roadmap marks that milestone done. The documentation and the README conflict on this point. This report follows the documentation.
- **Not reproduced by the author.** Apart from the scenario count, every figure here is reported in the repository. The CARLA-server measurements need an NVIDIA GPU with its Vulkan driver, and the night gap uses footage that is not published. The author's attempt to run the repository's test suite on a shared CPU host did not finish within its time limit, so no test totals are reported.
- **Counts in the README are behind the code.** The README states eleven built-ins and four for Indian roads; the library at the tag holds `15 scenarios` and `8 scenarios`. The bit-for-bit result covers eleven scenarios.
- **Kinematic scenarios.** Bit-for-bit repetition holds under kinematic motion, which has no wheel, tyre, suspension or collision dynamics. Under CARLA's vehicle physics, runs do not repeat exactly.
- **The gap measure is narrow.** It covers camera appearance only, with no lidar or radar gap. It uses one ImageNet network's feature space. The night comparison uses one camera's footage, and its thresholds are fixed choices rather than fitted ones.
- **Shared-machine timing.** The hardware-in-the-loop and simulated-device latencies were measured on a desktop shared with other jobs. The documentation records an earlier session, during a heavier load peak, that could not hold the 20 Hz loop.

6 Reproducibility

The report describes Falcon Autonomy release v2.3.0, commit 5d73101 [repo]. The application needs Linux x86_64, an NVIDIA GPU with its Vulkan driver, systemd user scopes, and CARLA 0.9.16 with a Python environment beside it holding `carla==0.9.16`, `numpy` and `opencv-python-headless`. The application itself needs Python 3.12 or later with PyQt6.

The author's scenario count was taken on an AMD Ryzen 9 9900X with Python 3.12.13, CPU only, by parsing `falcon_autonomy/core/scenarios.py` at the tag. The command is in the evidence appendix. The repository's measurements use these commands: `falcon gap --features --match` for the gap, `falcon hil` for the hardware-in-the-loop sessions, `falcon deploy` for the deployment pipeline, and two runs per built-in scenario for repeatability. Each needs a CARLA server and was not run by the author.

The repository's test suite runs against a fake `carla` package without a GPU or server. On the shared host it did not complete within 1800 s (the raw log is kept). The Orin acceptance runs (`falcon hil acceptance`, `falcon deploy all --device orin`) need the device's address and an SSH key, and have not been run.

References

1. Sherin Joseph Roy. Falcon Autonomy, release v2.3.0 (commit 5d73101). Source code, GPL-3.0-or-later. github.com/Sherin-SEF-AI/Falcon-Autonomy/tree/v2.3.0
2. A. Dosovitskiy, G. Ros, F. Codevilla, A. López, V. Koltun. CARLA: An Open Urban Driving Simulator. Proceedings of the 1st Annual Conference on Robot Learning, PMLR 78:1–16, 2017. proceedings.mlr.press/v78/dosovitskiy17a.html
3. A. Geiger, P. Lenz, C. Stiller, R. Urtasun. Vision meets robotics: The KITTI dataset. The International Journal of Robotics Research 32(11):1231–1237, 2013. doi:10.1177/0278364913491297
4. M. Heusel, H. Ramsauer, T. Unterthiner, B. Nessler, S. Hochreiter. GANs trained by a two time-scale update rule converge to a local Nash equilibrium. NeurIPS 2017. arxiv.org/abs/1706.08500
5. M. Bińkowski, D. J. Sutherland, M. Arbel, A. Gretton. Demystifying MMD GANs. ICLR 2018. arxiv.org/abs/1801.01401
6. H. Schulzrinne, S. Casner, R. Frederick, V. Jacobson. RTP: A Transport Protocol for Real-Time Applications. RFC 3550, 2003. doi:10.17487/RFC3550

Evidence

Quantity	Value	Conditions	Basis	Source and
Built-in scenarios in the scenario library	15 scenarios	keys of LIBRARY in falcon_autonomy/core/scenarios.py at the release tag: lead_brake, cut_in, pedestrian_crossing, cyclist_crossing, door_opening, stalled_vehicle, unprotected_turn and the eight Indian-road scenarios Differs from another source; both are listed.	Reproduced 2026-11-10	falcon_auto commit 5d7 9900X (12 c 7.0.0-42-ge 3.12.13, CPU `git clone https://git AI/Falcon-A Autonomy && python3 -c t=ast.parse ore/scenari print([len( t.body if i and getattr == 'LIBRARY`
Built-in scenarios for Indian roads	8 scenarios	the INDIAN tuple in falcon_autonomy/core/scenarios.py at the release tag, all present in LIBRARY: two-wheeler filtering, jaywalker behind a bus, wrong-way scooter, bus pulling out, stray cattle, handcart in the kerb lane, autorickshaw cut-in, monsoon waterlogged road Differs from another source; both are listed.	Reproduced 2026-11-10	falcon_auto commit 5d7 9900X (12 c 7.0.0-42-ge 3.12.13, CPU `git clone https://git AI/Falcon-A Autonomy && python3 -c t=ast.parse ore/scenari print([len( t.body if i and getattr == 'LIBRARY`
Built-in scenarios that repeat bit for bit with kinematic motion	11 scenarios	of 11 built-ins, each run twice with the same seed on the same CARLA 0.9.16 server (Town10HD_Opt); every trajectory identical; with CARLA vehicle physics instead the ego drifted 3 cm (no controller) to 0.4 m (lane follower) within 12 s Differs from another source; both are listed.	Reported 2026-10-29	docs/scenar commit 647 ("the referen `not documen`
Sim-to-real Fréchet distance, CARLA day vs KITTI	184.8 FD (ResNet-50 ImageNet features)	Two Falcon drives on a real CARLA 0.9.16 server (Town10HD and an imported OpenStreetMap world, 1280 × 720, ClearNoon; 240 images in all) against 240 images of three KITTI raw drives (left colour camera); seed 0; measured 2026-10-28 per the doc; real-vs-real floor 23.1 (120 against 120 images); not comparable with published FID	Reported 2026-10-30	docs/sim-to commit 5d7 real CARLA `git clone https://git AI/Falcon-A Autonomy && pip install fetch --wor -sim RUN... -out DIR -- -match`
Real-vs-real Fréchet distance floor, KITTI against KITTI (day comparison)	23.1 FD (ResNet-50 ImageNet features)	the same distance between two random halves of the real set at the same set sizes (120 against 120 images); the doc reports each FD next to this floor because the values are not comparable with published FID; Two Falcon drives on a real CARLA 0.9.16 server (Town10HD and an imported OpenStreetMap world, 1280 × 720,	Reported 2026-10-30	docs/sim-to commit 5d7 real CARLA `git clone https://git AI/Falcon-A Autonomy && pip install fetch --wor -sim RUN...`

Quantity	Value	Conditions	Basis	Source and
		ClearNoon; 240 images in all) against 240 images of three KITTI raw drives (left colour camera); seed 0; measured 2026-10-28 per the doc; real-vs-real floor 23.1 (120 against 120 images); not comparable with published FID		`-out DIR -- -match`
Sim-to-real Fréchet distance after appearance matching, CARLA day vs KITTI	`195.3 FD (ResNet-50 ImageNet features)`	Two Falcon drives on a real CARLA 0.9.16 server (Town10HD and an imported OpenStreetMap world, 1280 × 720, ClearNoon; 240 images in all) against 240 images of three KITTI raw drives (left colour camera); seed 0; measured 2026-10-28 per the doc; after the fixed colour/blur/noise appearance matching (FD before: 184.8; KD after: 0.124)	Reported 2026-10-30	docs/sim-to commit 5d7 real CARLA `git clone https://git AI/Falcon-A Autonomy && pip install fetch --wor -sim RUN... -out DIR -- -match`
Sim-to-real kernel distance, CARLA day vs KITTI	`0.113 KD (ResNet-50 ImageNet features)`	Two Falcon drives on a real CARLA 0.9.16 server (Town10HD and an imported OpenStreetMap world, 1280 × 720, ClearNoon; 240 images in all) against 240 images of three KITTI raw drives (left colour camera); seed 0; measured 2026-10-28 per the doc; ± 0.009 (spread over subsets); real-vs-real floor −0.001 (120 against 120 images)	Reported 2026-10-30	docs/sim-to commit 5d7 real CARLA `git clone https://git AI/Falcon-A Autonomy && pip install fetch --wor -sim RUN... -out DIR -- -match`
Sim-to-real Fréchet distance, CARLA night vs the owner's night dashcam frames	`181.3 FD (ResNet-50 ImageNet features)`	Two CARLA 0.9.16 night drives (ClearNight, 60 s at 10 frames/s, 640 × 360, vehicle lights on; Town10HD and an imported OpenStreetMap world) against held-out night frames of the owner's own dashcam (sun below −6°); 300 images a side, seed 0; real-vs-real floor 29.8; KD 0.117 ± 0.004 against −0.001 (150 against 150 images); measured 2026-10-29 per the doc	Reported 2026-10-30	docs/sim-to commit 5d7 real CARLA `git clone https://git AI/Falcon-A Autonomy && pip install sim RUN... out DIR --f`
Real-vs-real Fréchet distance floor, dashcam night frames against themselves (night comparison)	`29.8 FD (ResNet-50 ImageNet features)`	the same distance between two random halves of the real set at the same set sizes (150 against 150 images); the doc reports each FD next to this floor because the values are not comparable with published FID; Two CARLA 0.9.16 night drives (ClearNight, 60 s at 10 frames/s, 640 × 360, vehicle lights on; Town10HD and an imported OpenStreetMap world) against held-out night frames of the owner's own dashcam (sun below −6°); 300 images a side, seed 0; real-vs-real floor 29.8; KD 0.117 ± 0.004 against −0.001 (150 against 150 images); measured 2026-10-29 per the doc	Reported 2026-10-30	docs/sim-to commit 5d7 real CARLA `git clone https://git AI/Falcon-A Autonomy && pip install sim RUN... out DIR --f`

Quantity	Value	Conditions	Basis	Source and
Hardware-in-the-loop step start to control at the simulation, x264 transport (median)	23.67 ms	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; x264 transport; p95 47.13 ms; load average 9–15 on the host during these sessions (other projects' test suites); network stages are loopback	Reported 2026-10-29	docs/hardw commit 6b0 (24 threads) 595.99), GSt device on th network); m load average git clone https://git AI/Falcon-A Autonomy && pip install session PRO exact flags not documen
Hardware-in-the-loop step start to control at the simulation, NVENC transport (median)	27.97 ms	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; NVENC transport; p95 73.50 ms (session ran during a load peak, real-time factor 0.985); load average 9–15 on the host during these sessions (other projects' test suites); network stages are loopback	Reported 2026-10-29	docs/hardw commit 6b0 (24 threads) 595.99), GSt device on th network); m load average git clone https://git AI/Falcon-A Autonomy && pip install session PRO exact flags not documen
Hardware-in-the-loop controls on time, x264 transport	1143 controls	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; x264 transport; of 1199 (95.3 %); 14 late, 42 superseded, 0 missing; load average 9–15 on the host during these sessions (other projects' test suites); network stages are loopback	Reported 2026-10-29	docs/hardw commit 6b0 (24 threads) 595.99), GSt device on th network); m load average git clone https://git AI/Falcon-A Autonomy && pip install session PRO exact flags not documen
Device clock-offset estimate error against the known truth	5.2–7.0 µs	Falcon's own CARLA 0.9.16 server (8 GB cap, Epic), Town10HD, 10 traffic vehicles, seed 7, 60 s at 20 Hz (1200 steps), camera 1280 × 720 H.264 at 8 Mbit/s, 32-channel lidar over TCP, agent decoding with avdec_h264 on CPU; 2026-10-28; simulated device clock offset 1500 ms drifting 20 ppm; range over the five sessions; stated bounds ±24–30 µs; drift recovered 19.97–20.05 ppm	Reported 2026-10-29	docs/hardw commit 6b0 (24 threads) 595.99), GSt device on th network); m load average git clone https://git AI/Falcon-A Autonomy && pip install session PRO exact flags not documen
FP32 engine median latency (simulated device, CPU)	20.47 ms	Real Town10HD recordings (an 8 s drive and a lead-brake scenario run, 1280 × 720); fasterrcnn_mobilenet_v3_small_fpn	Reported 2026-10-29	docs/deploy commit 036 unchanged 9900X CPU

Quantity	Value	Conditions	Basis	Source and
		at 160 × 96 (reference AP 0.0001: it does not detect Town10 objects); 50 evaluation frames; 300 timed runs after a 1 s warm-up, 4 onnxruntime threads, load average 4–7; p95 24.48 ms, p99 29.25 ms; throughput 47.3 qps; engine 14.3 MiB Differs from another source; both are listed.		onnxruntime device: not T Orin `git clone https://git AI/Falcon-A Autonomy && pip install all PROJECT --run RUN.. out DIR`
INT8 (QDQ, entropy) engine median latency (simulated device, CPU)	`19.38 ms`	Real Town10HD recordings (an 8 s drive and a lead-brake scenario run, 1280 × 720); fasterrcnn_mobilenet_v3_small_fpn at 160 × 96 (reference AP 0.0001: it does not detect Town10 objects); 50 evaluation frames; 300 timed runs after a 1 s warm-up, 4 onnxruntime threads, load average 4–7; p95 22.57 ms, p99 25.15 ms; throughput 50.2 qps; engine 4.1 MiB; AP/reference ratio 0.013 [0.006, 0.013]	Reported 2026-10-29	docs/deploy commit 036 unchanged a 9900X CPU onnxruntime device: not T Orin `git clone https://git AI/Falcon-A Autonomy && pip install all PROJECT --run RUN.. out DIR`
INT8 engine AP relative to the ONNX reference (simulated device, synthetic drives)	`0.935 ratio (AP / reference AP)`	Synthetic drives from the tests (five drives of six 128 × 96 frames, a 4-node ONNX detector); 30 evaluation frames, 10 calibration frames; entropy-calibrated QDQ int8; 95 % interval [0.898, 0.967]; 300 bootstrap resamples, seed 0; reference AP 0.925 [0.898, 0.970]; the release gate fails it on accuracy (interval below 0.98)	Reported 2026-10-29	docs/deploy commit 036 unchanged a 9900X CPU onnxruntime device: not T Orin `git clone https://git AI/Falcon-A Autonomy && pip install pytest test doc attribu tests; the`
Planted-weakness synthetic detector AP on fake-CARLA drives	`0.111 COCO AP`	Three 1 s drives against the fake CARLA (tests); 95 % interval [0.077, 0.152]; falls to 0.027 at 40–60 m and 0 beyond 60 m; the ground truth as a detector scores 1.000 [1.000, 1.000]	Reported 2026-10-29	docs/model commit bebu `not documen it to the t`
Detector fine-tuning throughput, fasterrcnn_mobilenet_v3_large_fpn, epoch 2	`126-139 images/s`	Fine-tuning from COCO at 640 × 384, batch 8, AMP, four data-loader workers decoding 1280 × 720 PNGs (720 training images, 2 epochs); two runs; peak GPU memory 1123 MiB allocated (1994 reserved); images were fake-CARLA frames scaled up	Reported 2026-10-28	docs/trainin commit 4d7 GB; torch 2.5 `git clone https://git AI/Falcon-A Autonomy && pip install train SRC.. fasterrcnn_ -init coco size 640x38`

Table 2. Every measured quantity in this report, with its source, commit, hardware and the command that reproduces it. “Reproduced” rows were run by the author; “Reported” rows are quoted from the repository at the commit shown.

Cite this report

APA

Roy, S. J. (2026). Falcon Autonomy: scenario simulation, a measured sim-to-real gap and a gated path to vehicle hardware on CARLA (Technical Report IF-TR-2026-05, Version 1.0). IsoFrames. https://isoframes.io/reports/if-tr-2026-05/

BibTeX

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@techreport{isoframes_if_tr_2026_05,
  author      = {Roy, Sherin Joseph},
  title       = {Falcon Autonomy: scenario simulation, a measured sim-to-real gap and a gated path to vehicle hardware on
CARLA},
  institution = {IsoFrames, BluRabbit Mobility},
  number      = {IF-TR-2026-05},
  type        = {Technical Report},
  year        = {2026},
  month       = nov,
  note        = {Version 1.0},
  url         = {https://isoframes.io/reports/if-tr-2026-05/}
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