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Optimizing a Camera ISP to Automatically Improve Computer Vision Accuracy

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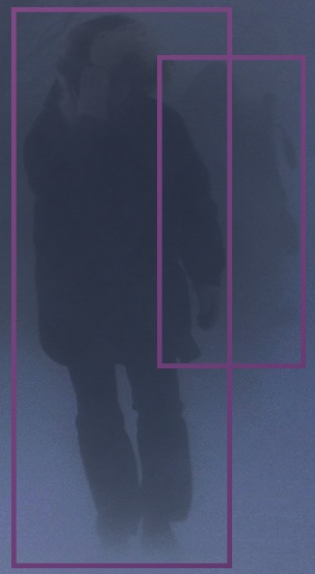

IDC Innovator

WEBINAR
March 30, 2021

Agenda

01 **Challenges**
Camera ISP Tuning

02 **Atlas**
Optimizing ISPs for Computer Vision at Scale

03 **Demo**
Atlas Cloud-Enabled Workflow

04 **Automotive Case Study**
Optimizing a Front-facing Camera for Computer Vision

Challenges with Camera ISP Tuning Today

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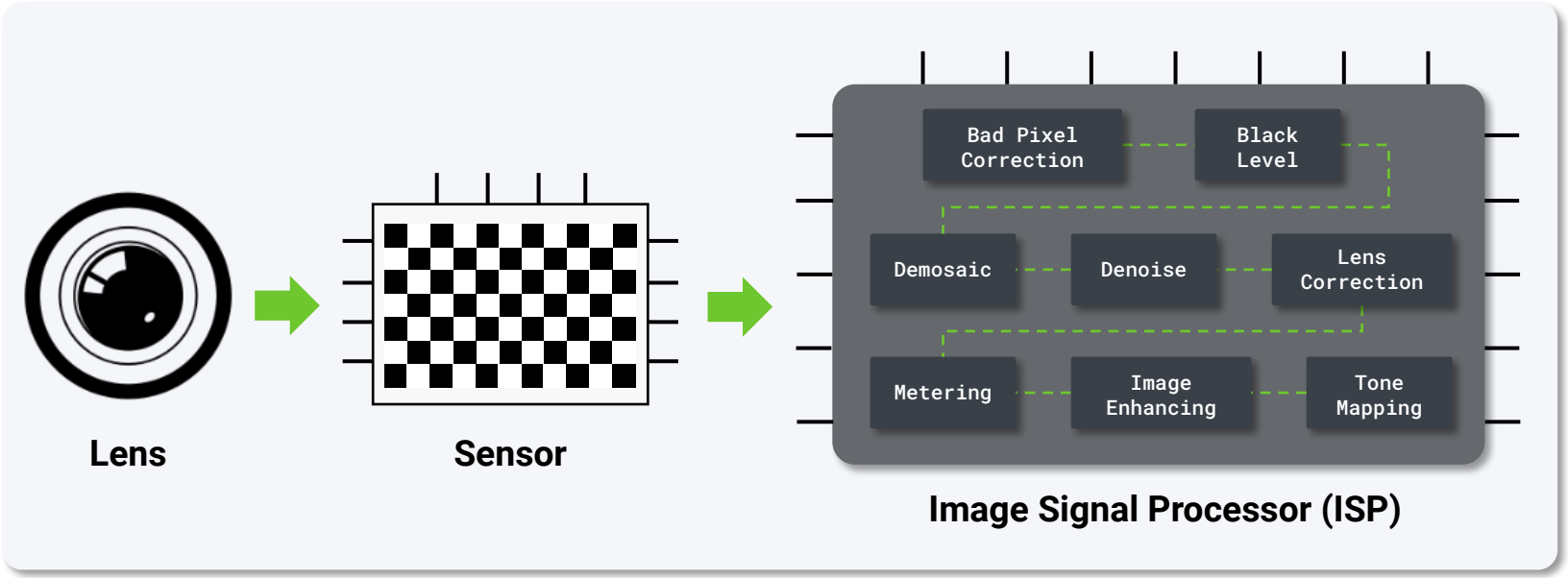
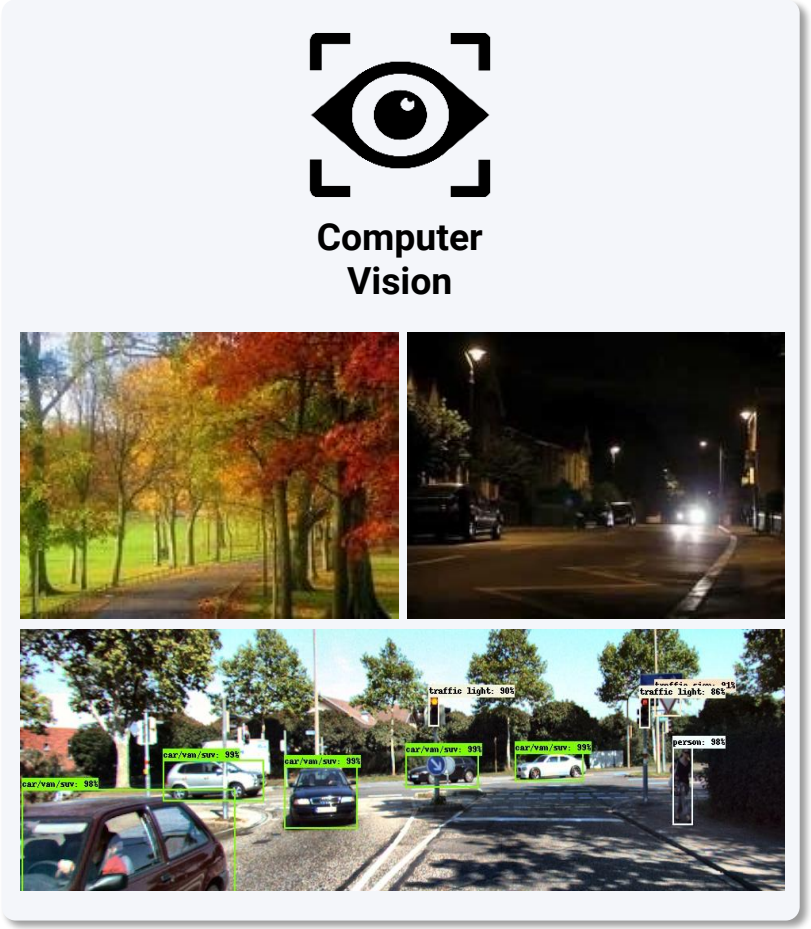
Typical Camera System





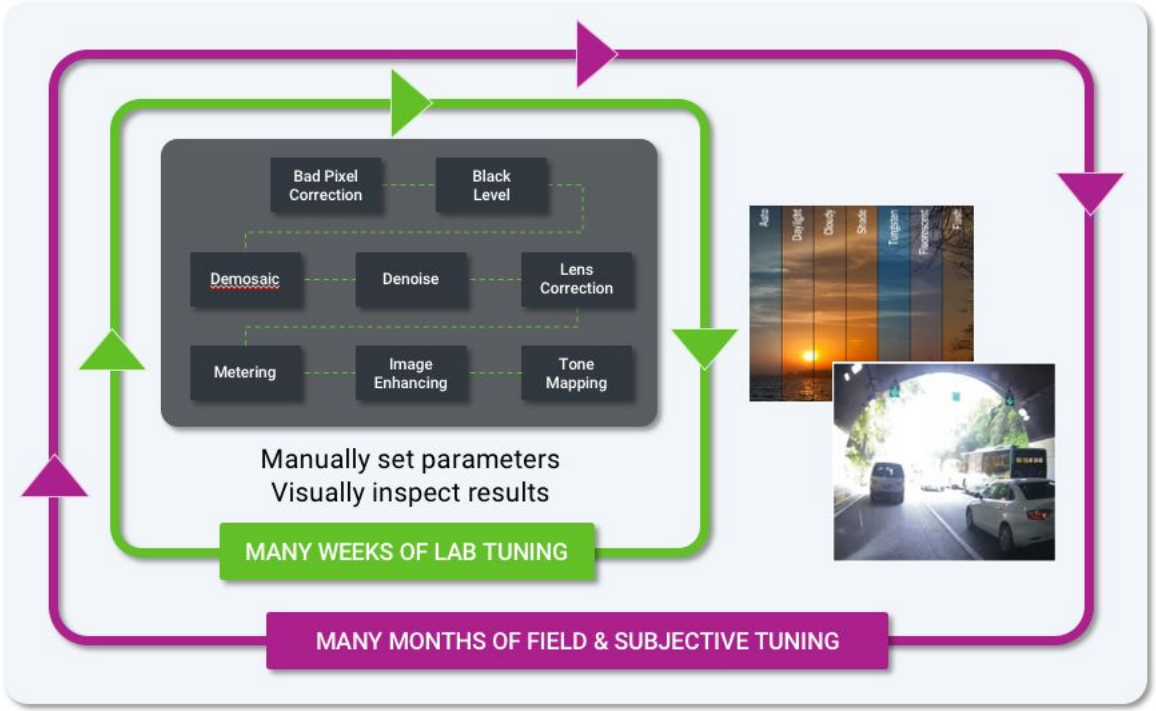
Lens parameters

Sensor parameters

ISP parameters

Massive parameter space controls the image quality for each camera configuration

Challenges With Manual ISP Tuning



Resource-Intensive

"Too much cost & time"

Inefficient

"It doesn't scale to my projects"

Limited

"Manual tuning does **NOT** work for computer vision"

Uncertain

"Good enough?"
"How do I know?"

Atlas Camera Optimization Suite

Optimize Camera Architectures to Improve Computer Vision

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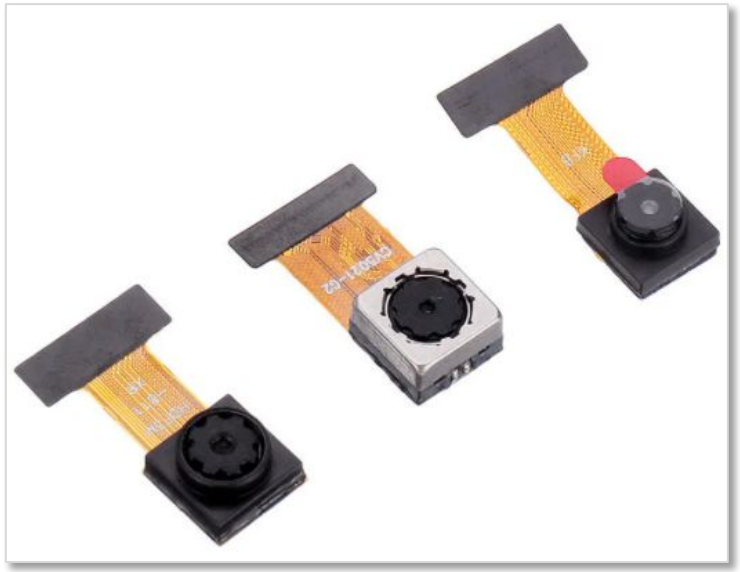
Atlas Automated Workflows

Sensor Module Qualification

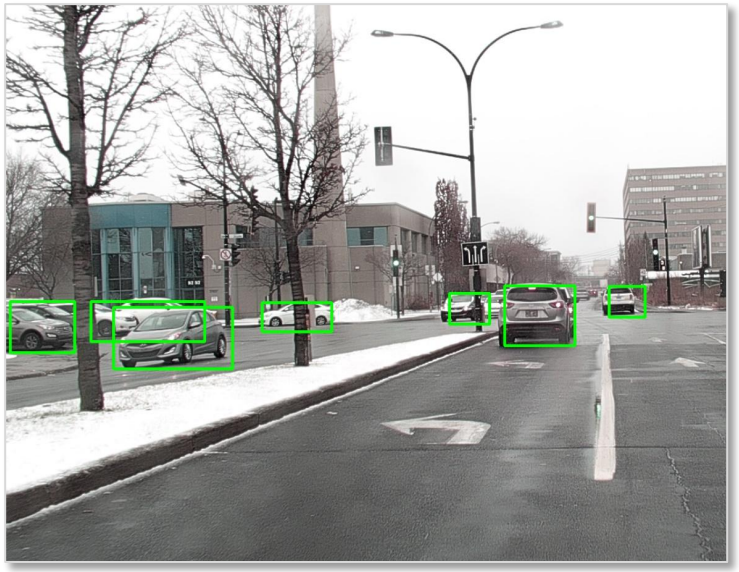


- Reduce lab setup and effort
- Ensure system reqs are met

Image Quality Optimization / Certification

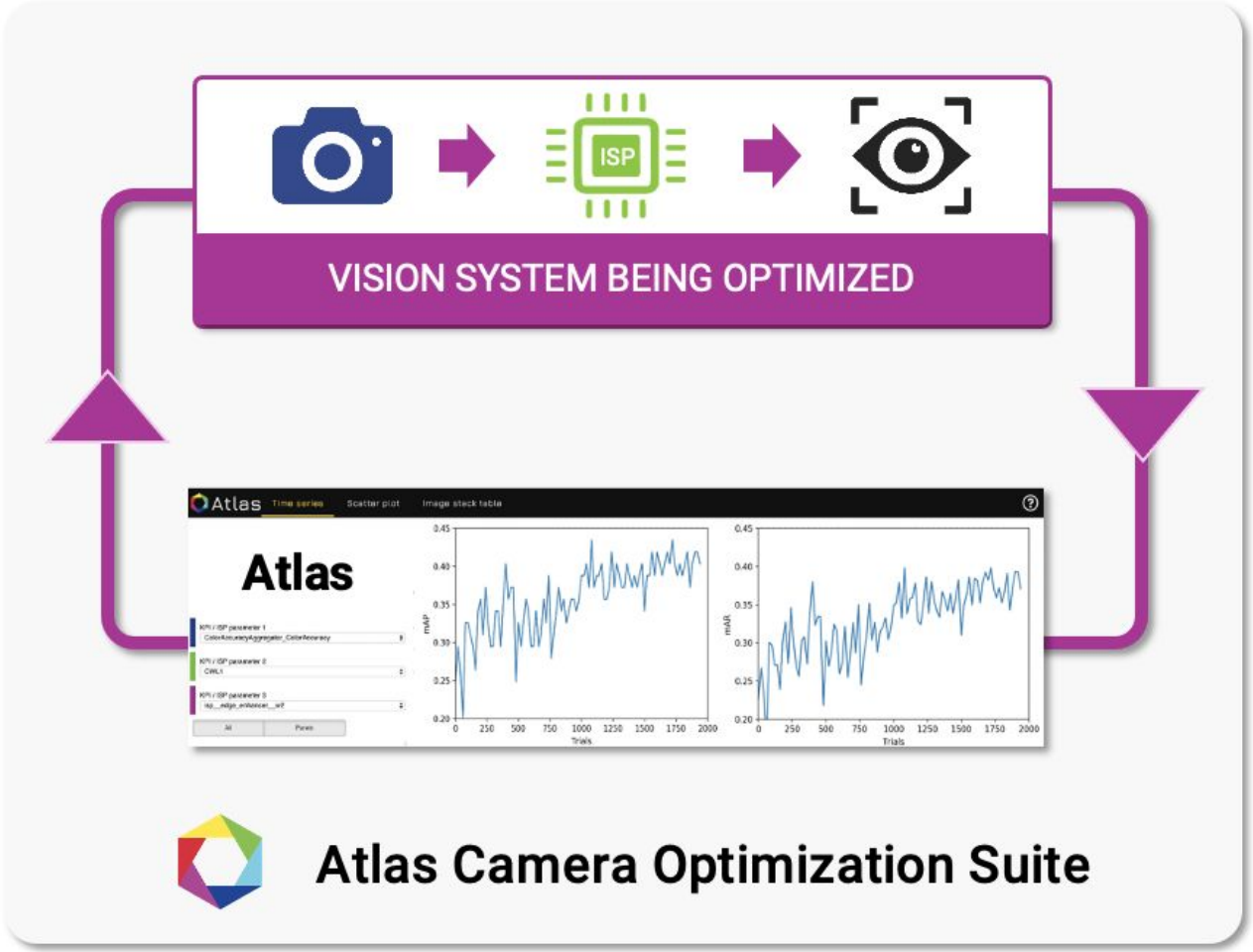
- Optimize camera IQ in days
- Establish IQ pass/fail “bar”

Computer Vision Optimization



- Optimize cameras to maximize computer vision accuracy

Atlas Optimizes Cameras for IQ and Computer Vision



Efficient

Get results in just days

Scalable

Any CV task and camera

Optimal

Maximize CV results

Objective

Results driven by clear metrics

Atlas Camera Optimization Suite
Cloud-Enabled Workflow

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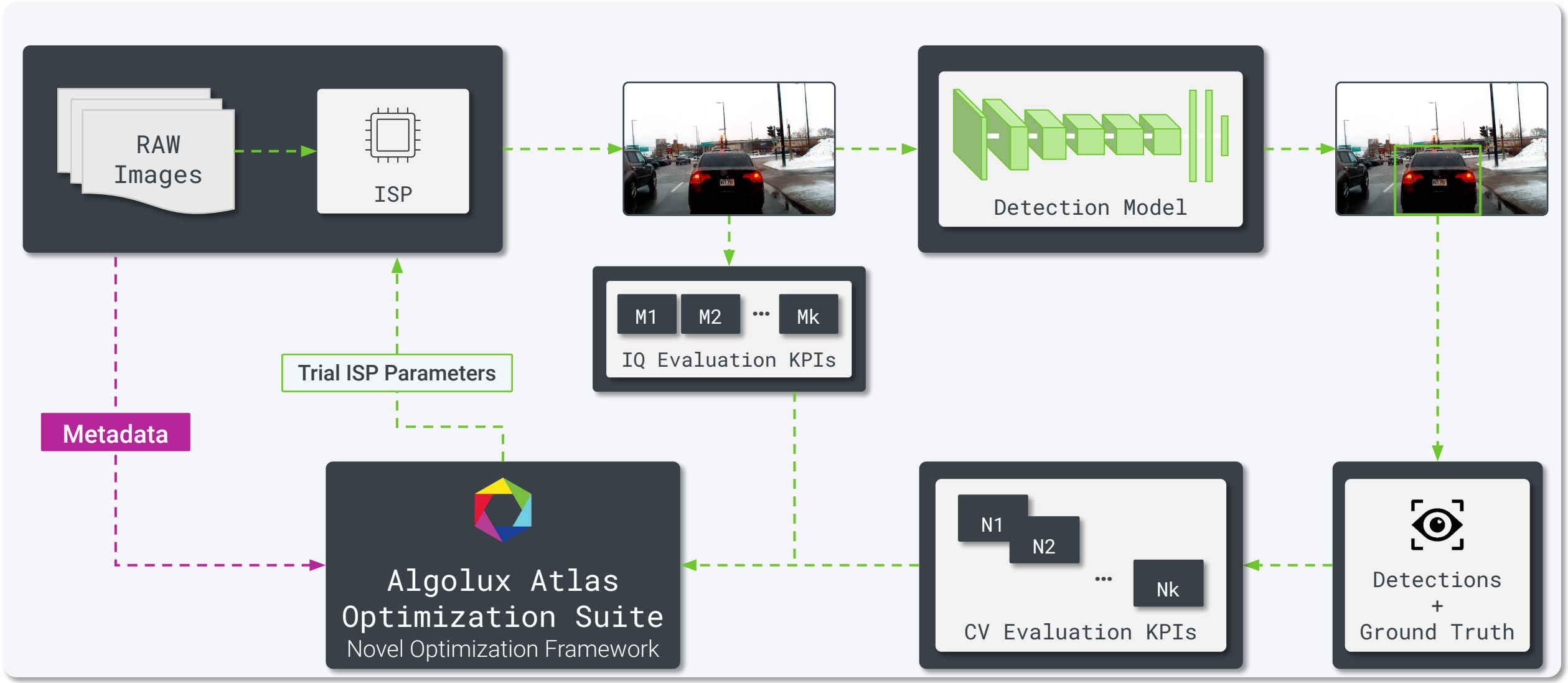
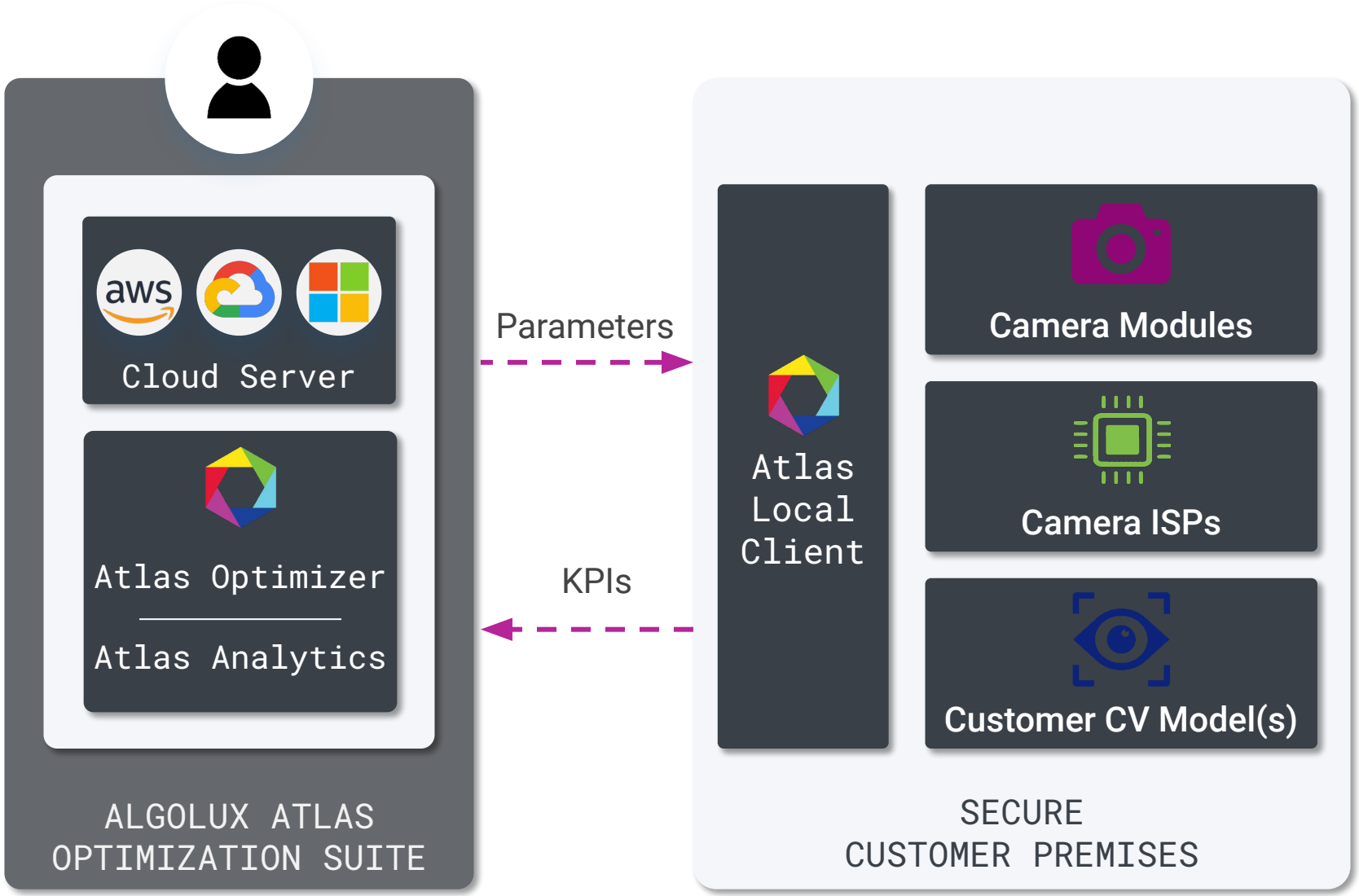
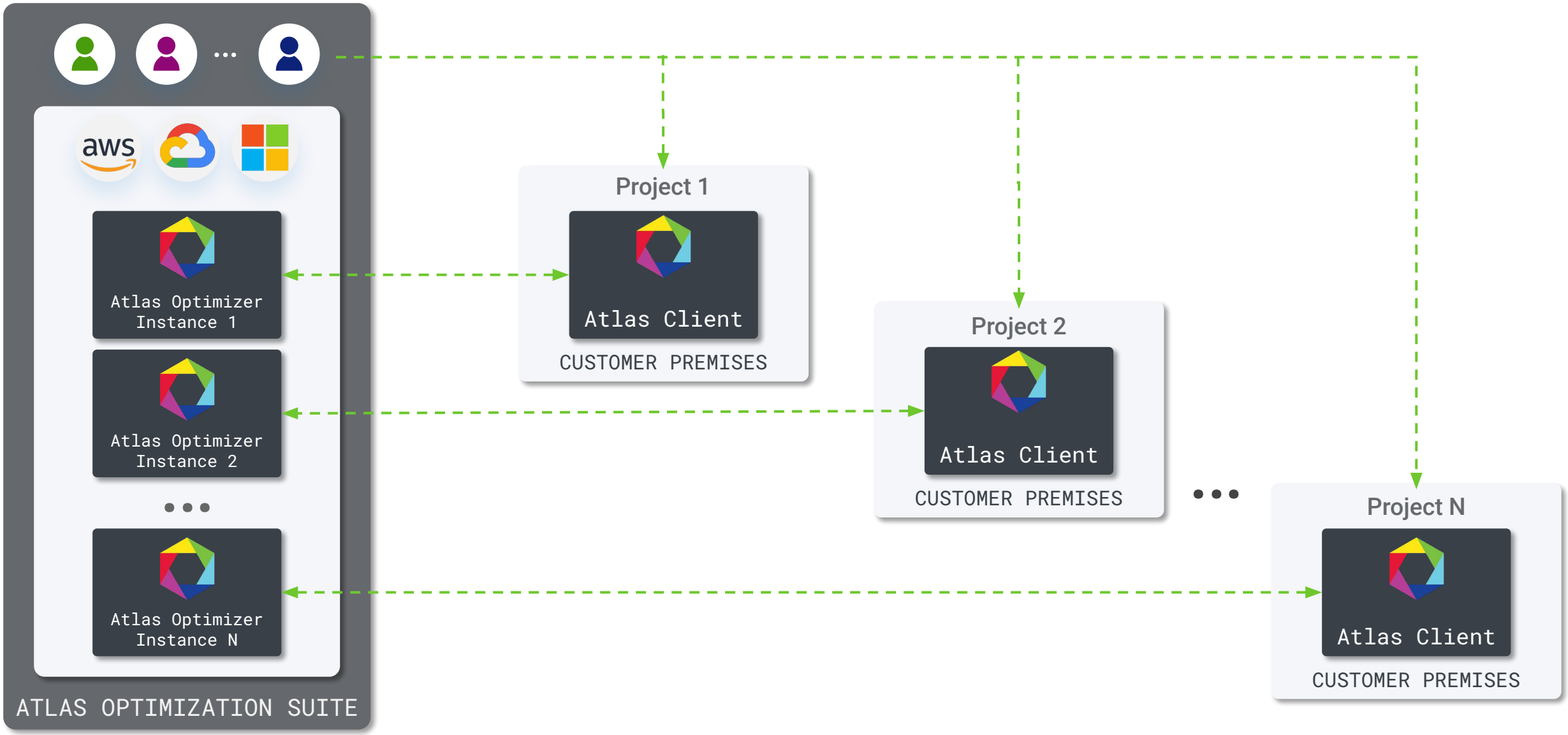
Atlas Workflow for Image Quality and Computer Vision



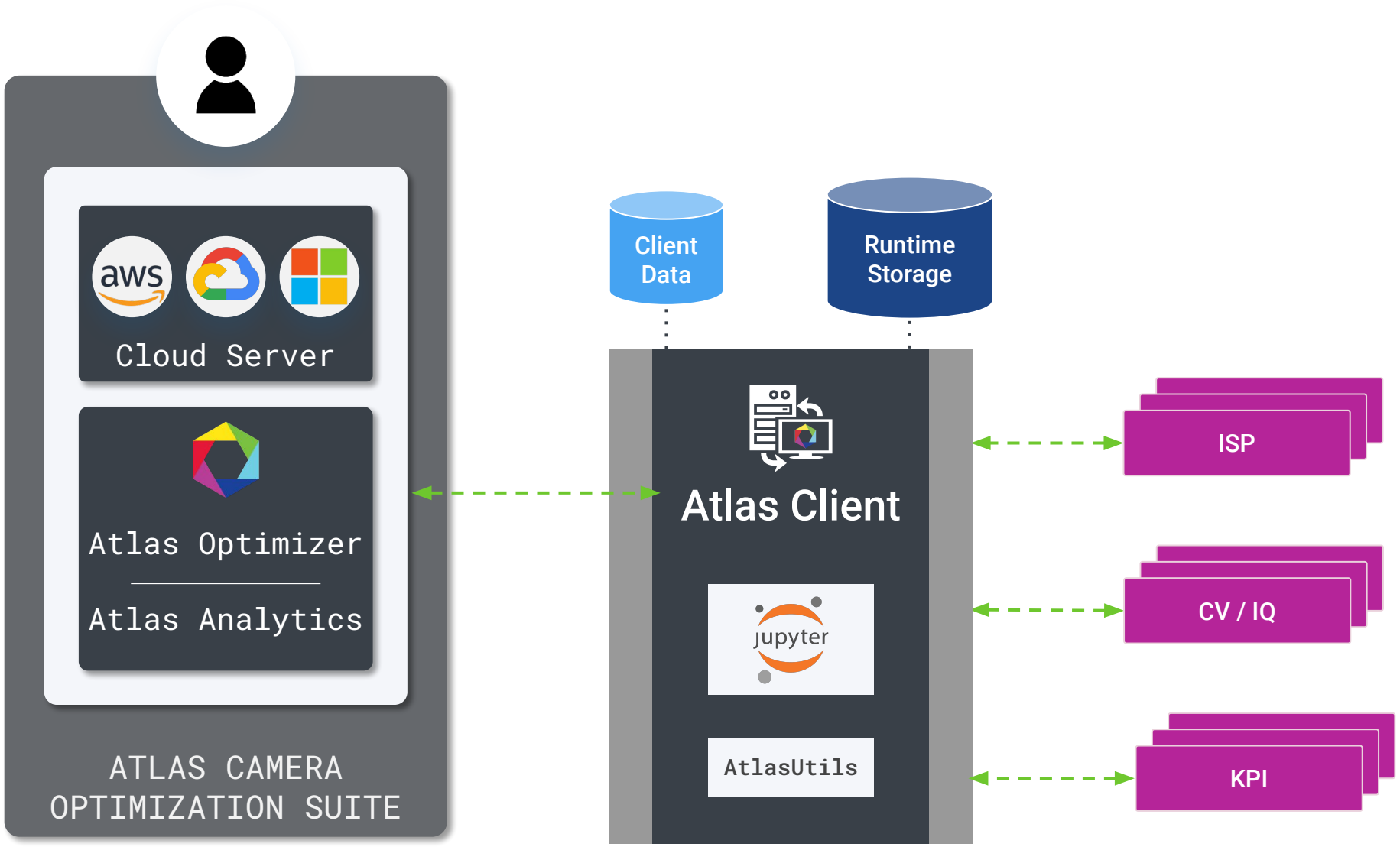
Atlas Automates Manual Camera ISP Tuning



Atlas Scales to Your Needs



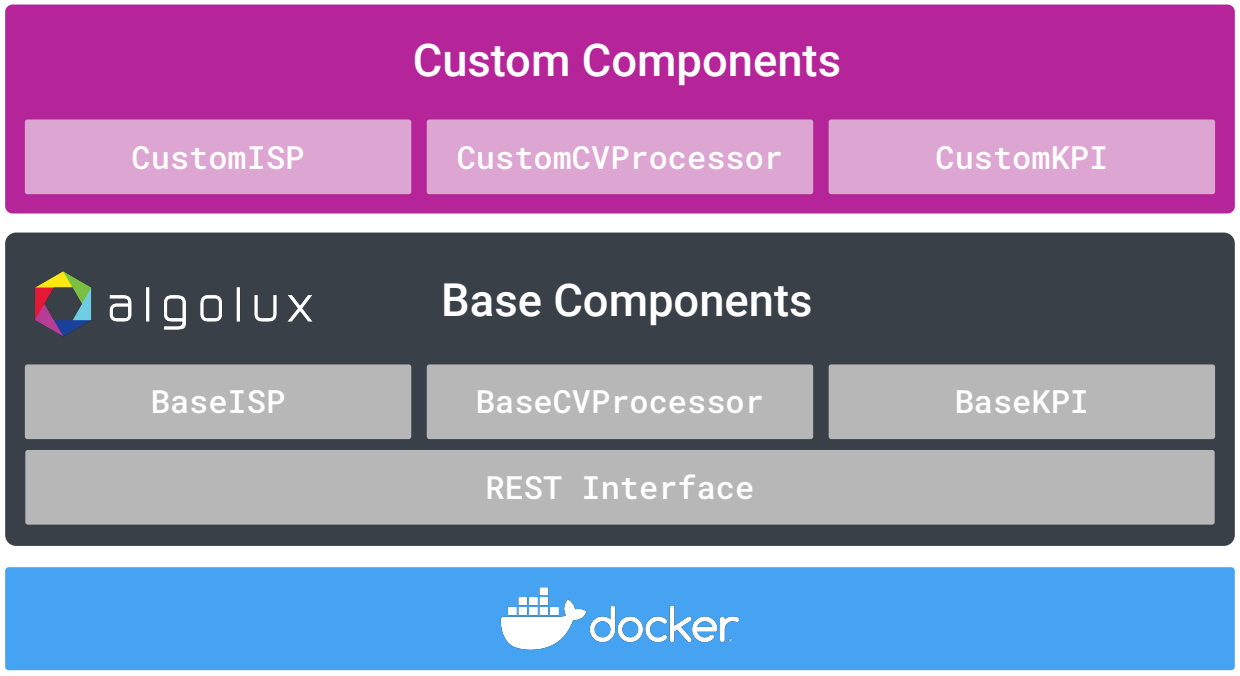
Atlas and User Components



Components:

- Atlas Optimization Server
- Atlas Client
- Client Data Docker
- Atlas Runtime Storage
- ISP instances
- CV Algos / IQ Processors
- KPIs Evaluators

Atlas Client Components: ISP, CV/IQ Processor, KPI



Use HTTP to call Component methods

- Use Docker to deploy
- REST APIs throughout
- Native and custom KPIs (supported

[CASE STUDY] Automotive Tier 1 Front-facing Camera Optimized for Computer Vision

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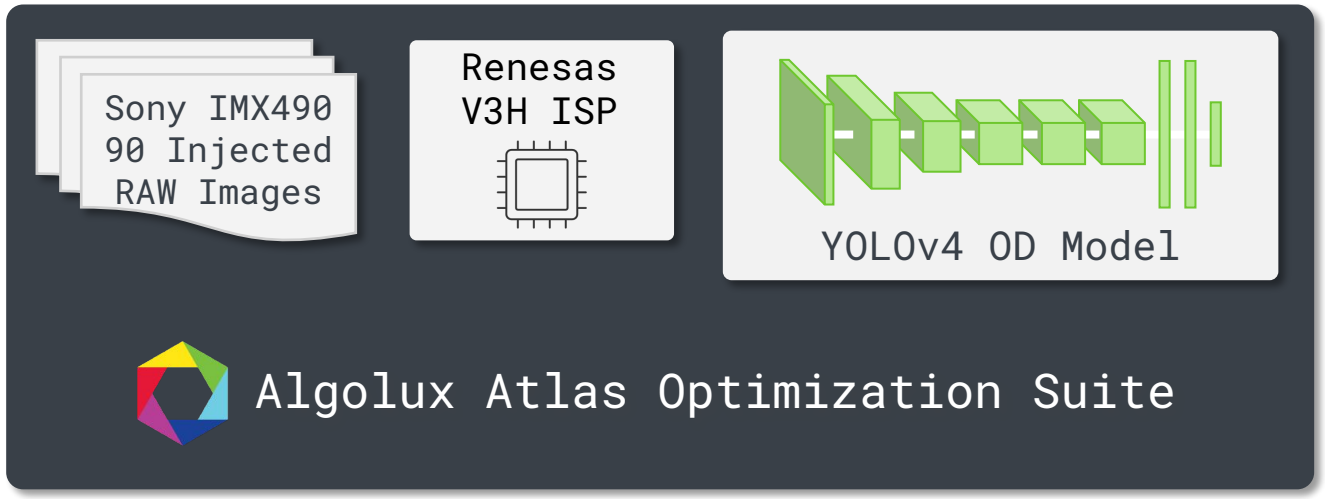
Front-Facing System: V3H ISP Atlas-Optimized for YOLOv4



- ISP optimization for YOLOv4 object detector
- 2500 images total, 90 used for the optimization set
  - → Remaining images were used for validation
  - → Selection balanced lighting, class and object size distribution
- Dataset built from 4 captures during:
  1. Midday: Bright daytime images
  2. Afternoon: Bright daytime to afternoon
  3. Dusk: Afternoon to dusk
  4. Night: Night low light

Computer Vision Optimization: YOLOv4

Optimization Loss Function

A single loss function was used to maximise Mean Average Precision of the object detections.

loss = 1 - mAP(IoU>.5)

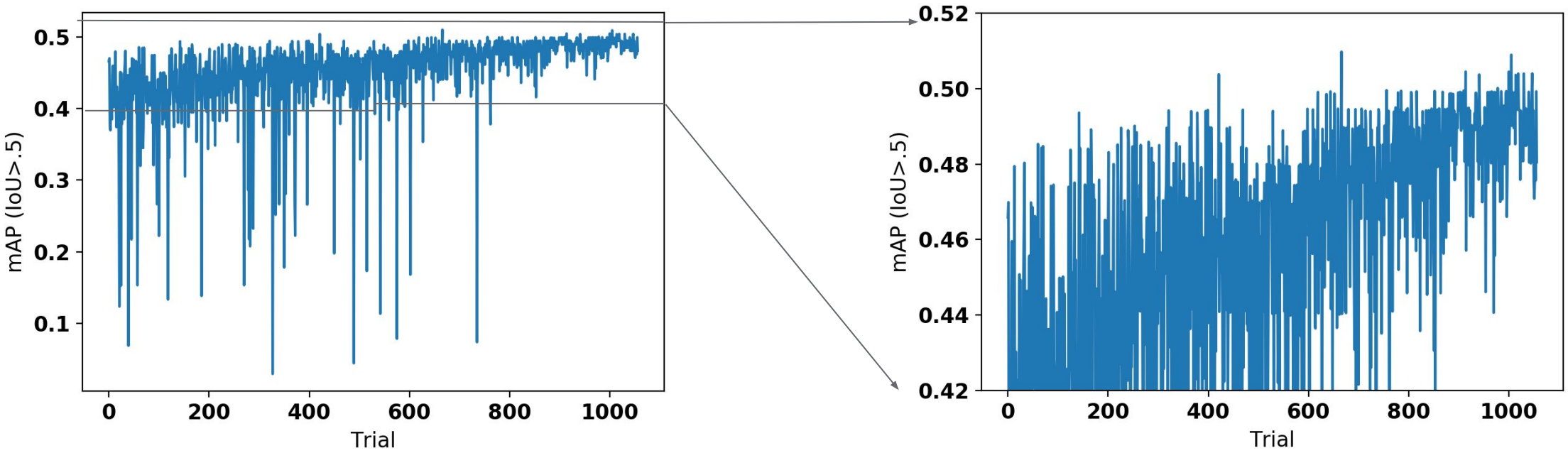


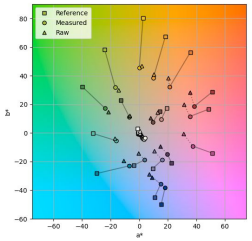
Image Quality Tracking

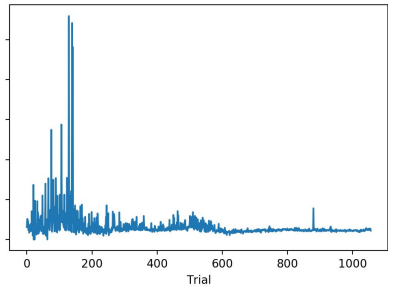
Charts and test patterns included in dataset for each trialed configuration to measure...

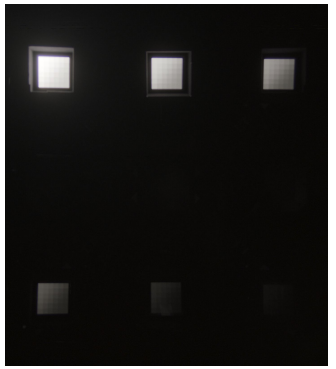
- Color Accuracy / Saturation
- Tonal Response
- SNR
- MTF
- Overshoot / Undershoot
- etc….

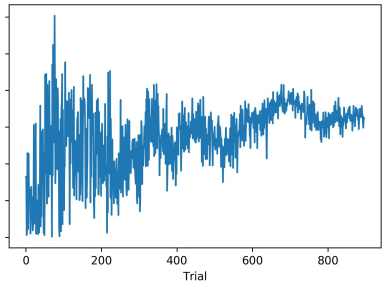
While ISP was optimized for CV accuracy...

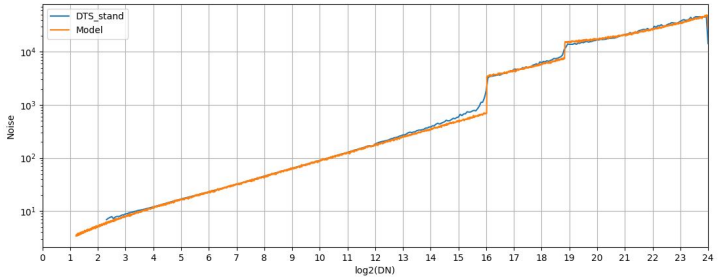
IQ factors are also tracked through the optimization runs

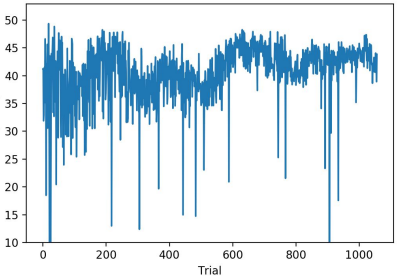






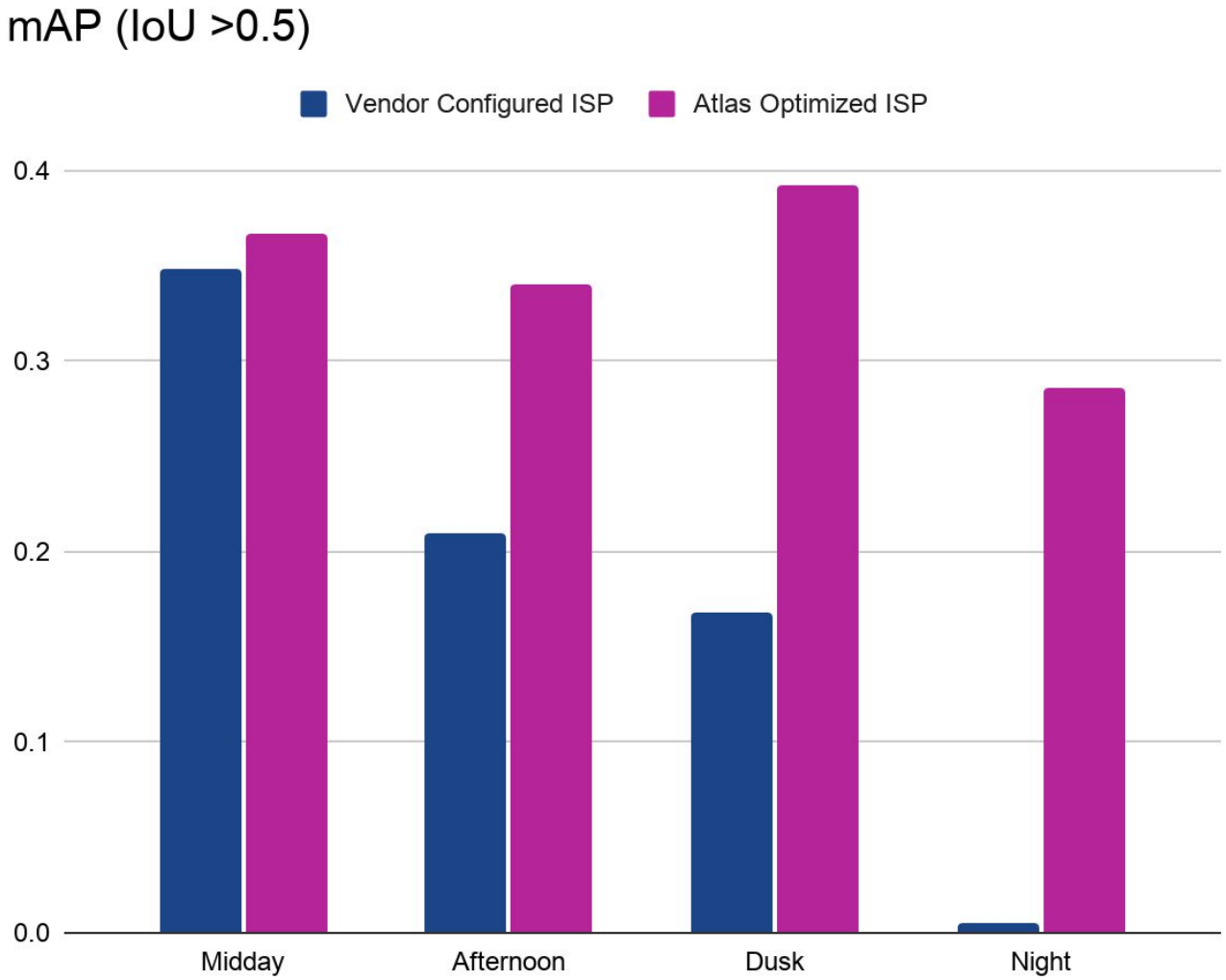






Accuracy Results for YOLOv4 Detector vs. IQ Tuned Baseline

mAP (IoU>.5)	Vendor Tuned ISP	Atlas Optimized ISP
Midday	0.348	**0.367**
Afternoon	0.210	**0.341**
Dusk	0.168	**0.393**
Night	0.005	**0.286**

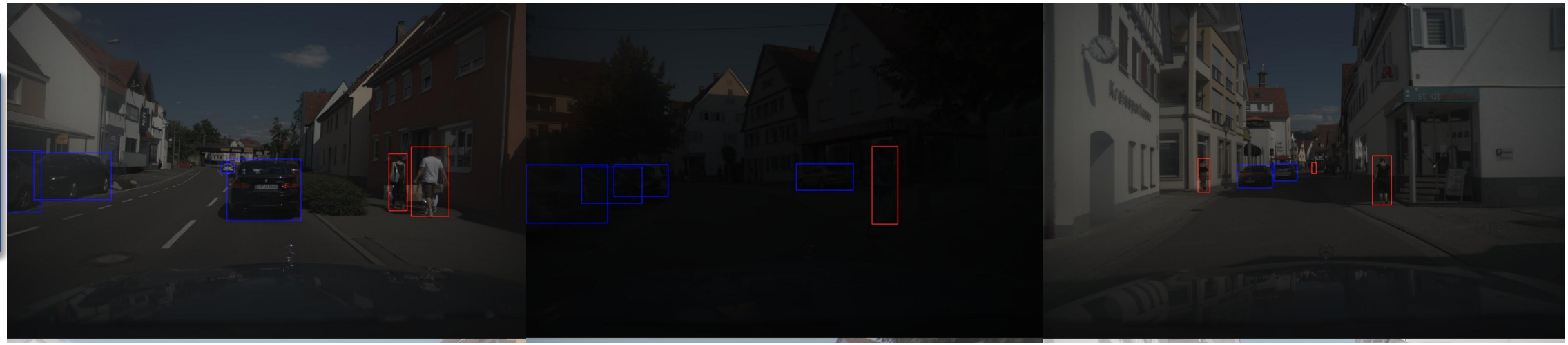


Atlas Optimization Summary

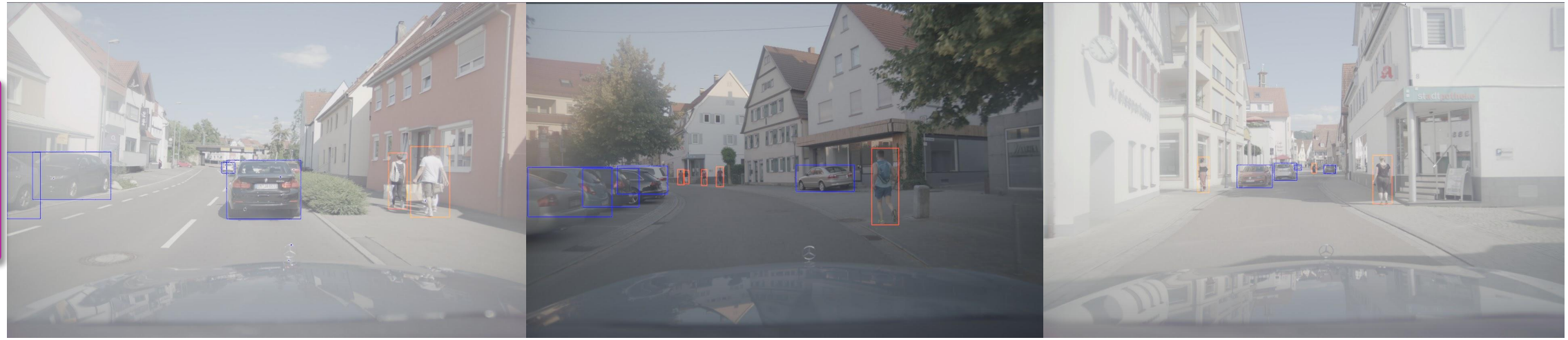
- 2% - 28% mAP Improvement vs. Baseline
- Final optimization: 1000 Trials in ~36hrs

Example Frames

Vendor Configured

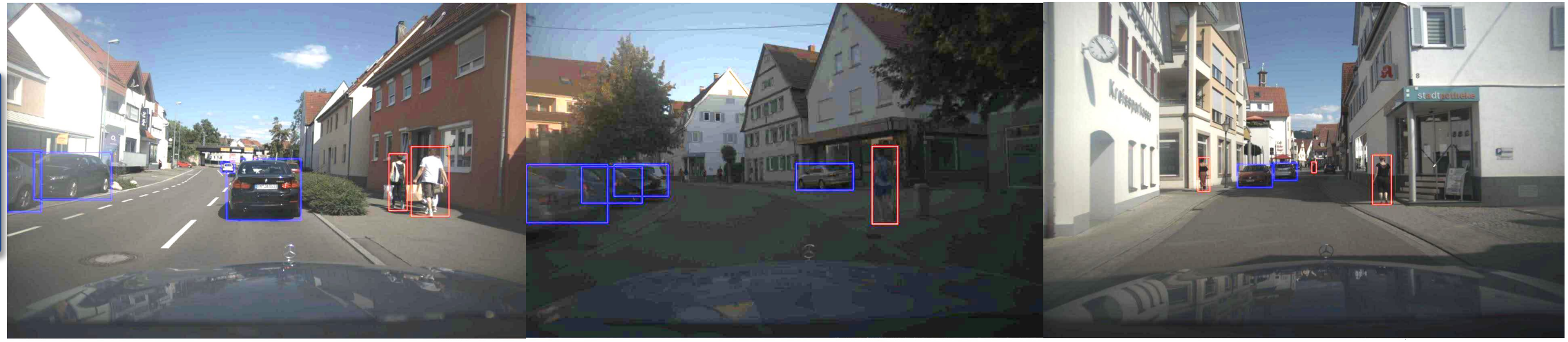


Atlas Optimized

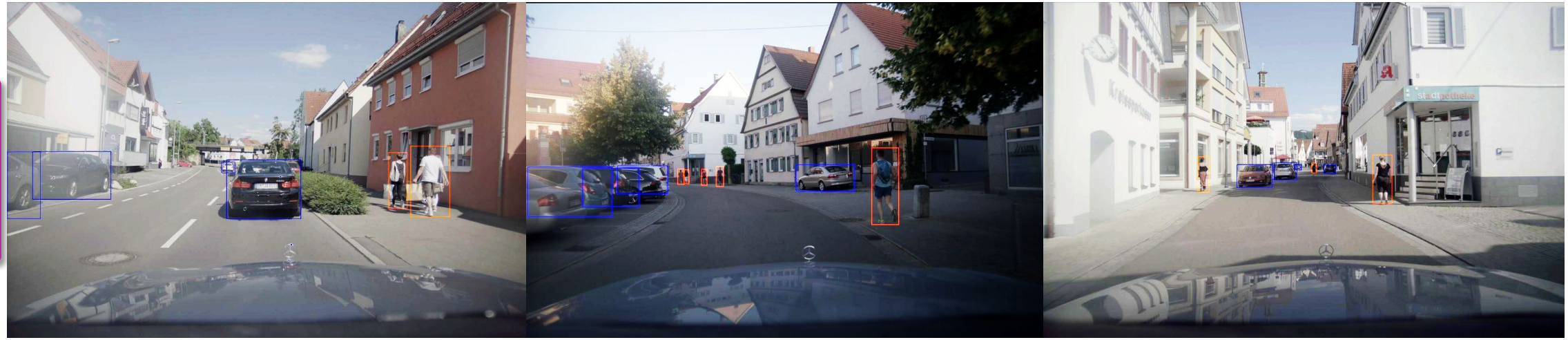


Example Frames

Vendor Tuned



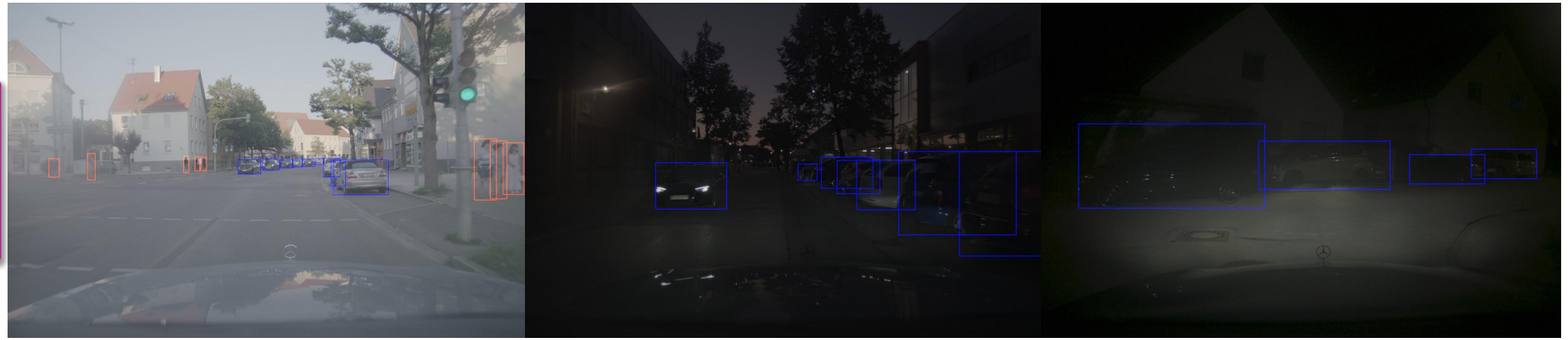
Atlas Optimized



Example Frames

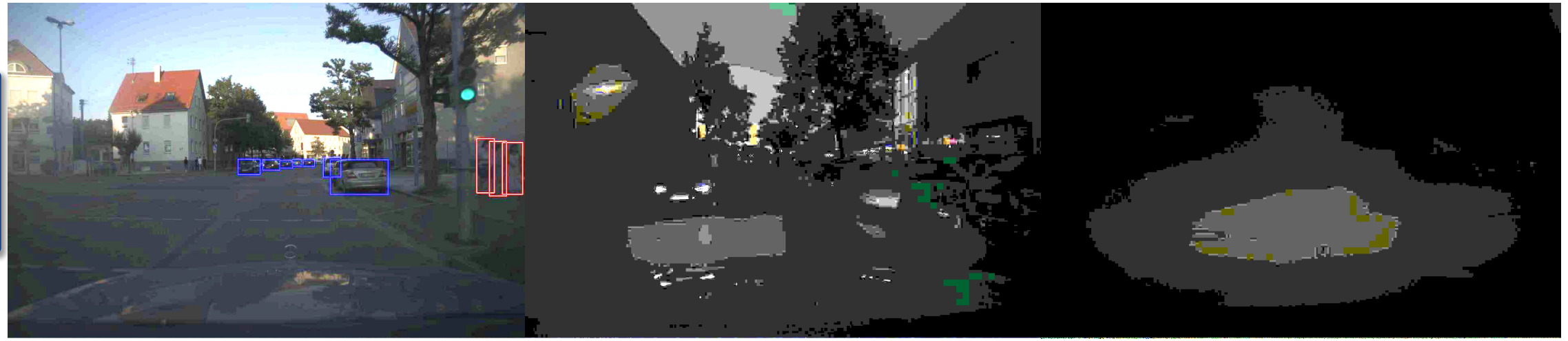
Vendor Configured

Atlas Optimized

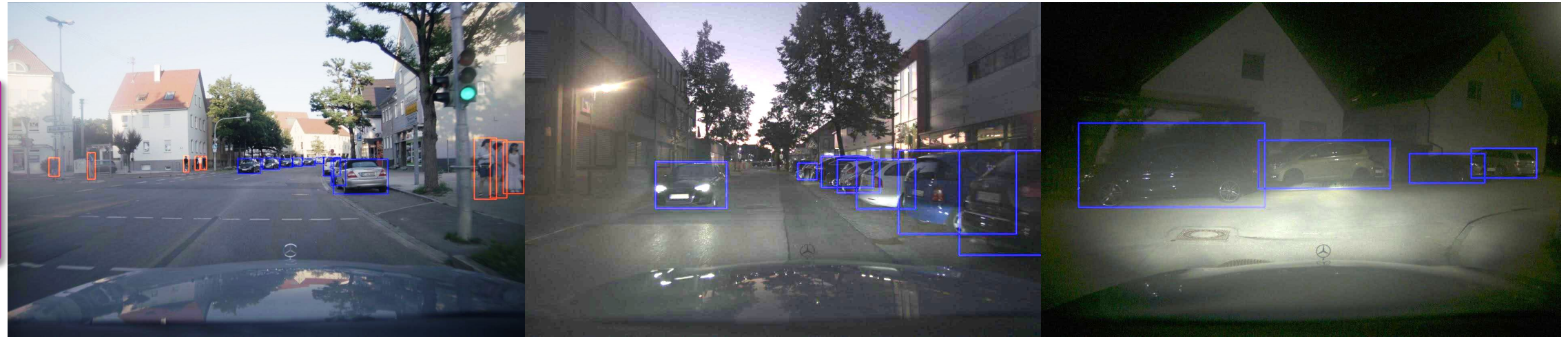


Example Frames

Vendor Configured



Atlas Optimized



Immediately Improve Your Vision System

Optimize your Vision System

From impossible to days

- **Optimize CV Performance**
- **Empower your Resources**
- **Repeatable & Predictable**
- **Reduce Time & Cost Risks**

Questions? Thank You!

To learn more, contact us at
www.algolux.com or info@algolux.com

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