



IVS - Software Solutions for Proven In Use Validation...





Context & Challenges



ADAS & AD Validation

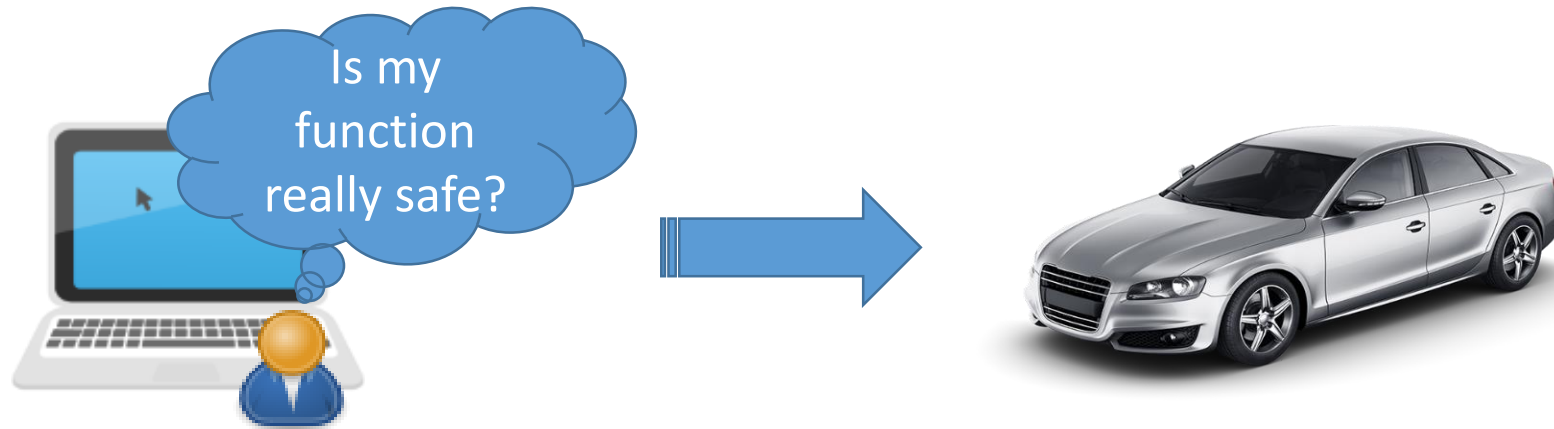
- ISO 26262 strongly constrain validation

ASIL	Observable Incident Rate
D	$<10^{-9}/h$
C	$<10^{-8}/h$
B	$<10^{-8}/h$
A	$<10^{-7}/h$

- Deterministic aspects
 - MISRA
 - Model analysis
 - Formal code analysis
 - Comprehensive testing
 - Deterministic scheduling
 - ...



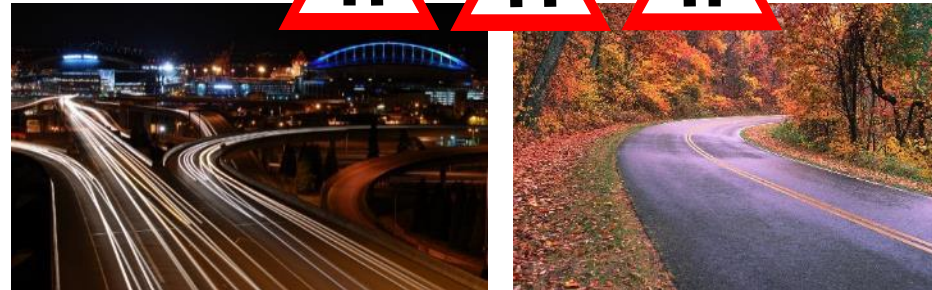
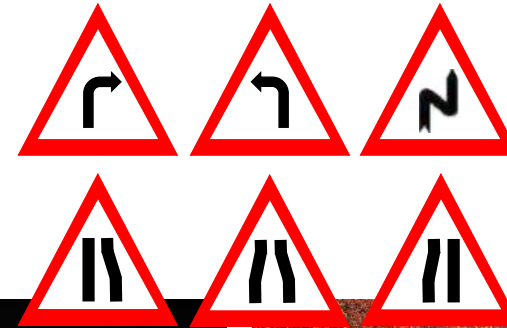
Beyond Design and Implementation Defects





Non-deterministic aspects

- Safety of the Intended Functionality (SOTIF) Validation
 - Deal with functions with statistically valid functionality





Non-deterministic aspects

- Necessity to setup statistical testing
 - A huge amount of kilometers are required
- Dual approach
 - Use of driving Tests
 - Real scenarios rather than modelled
 - Realistic sensor data
 - Use of simulation
 - Test dangerous situations
 - Accurately define scenario conditions
 - Spare equipment and time





Intempora Validation Suite Overview

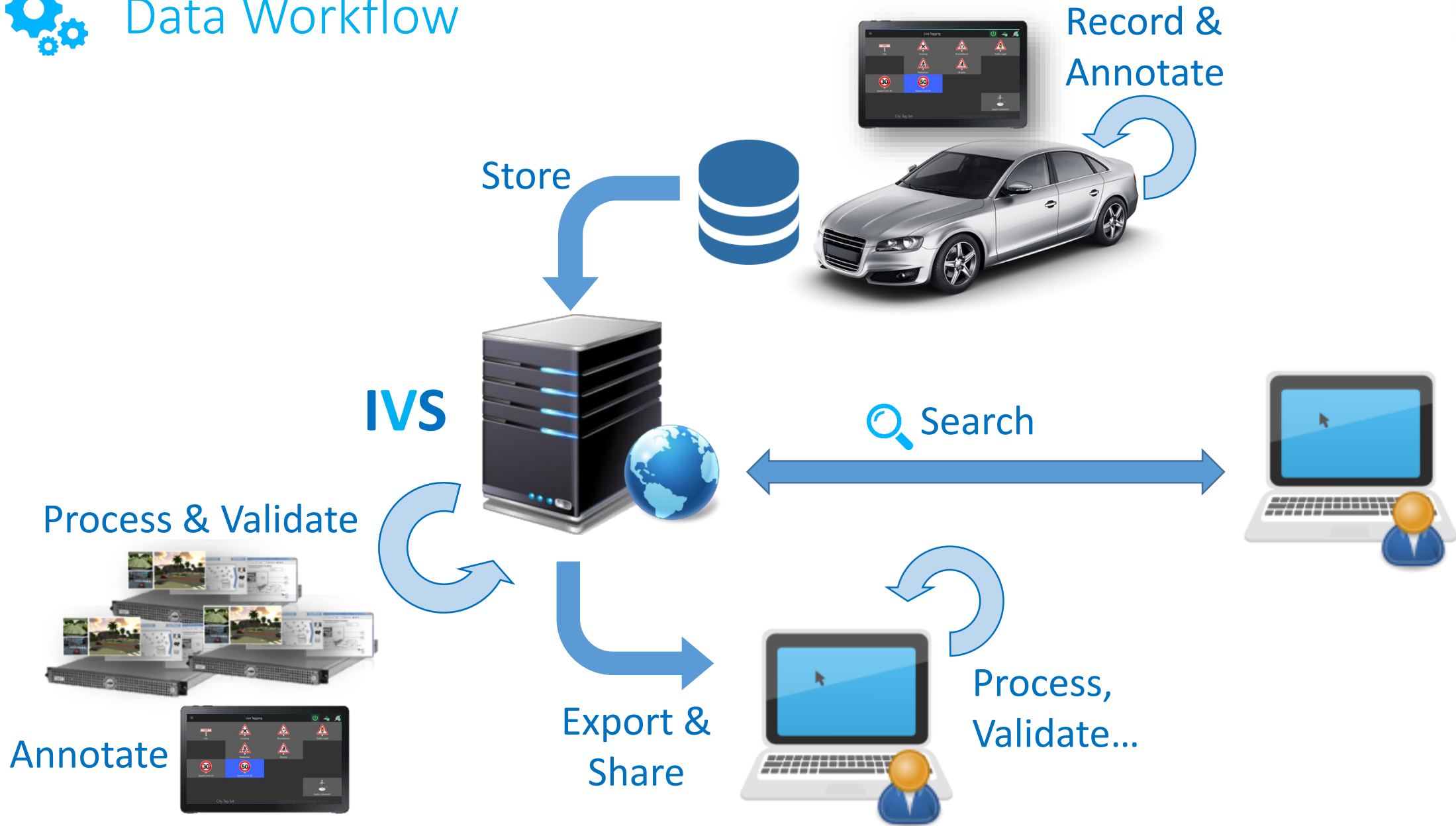


Annotations, Labels and Tags

- Few words about Annotations, Labels and Tags
- An *Annotation* is a searchable information describing a recording content (for a given time range or the full recording)
 - *Tags*: macroscopic information such as “there is a car during this period” or “outside temperature is 20°C”
 - *Labels*: refined information giving more details about the current situation such as *pixel wise segmentation*



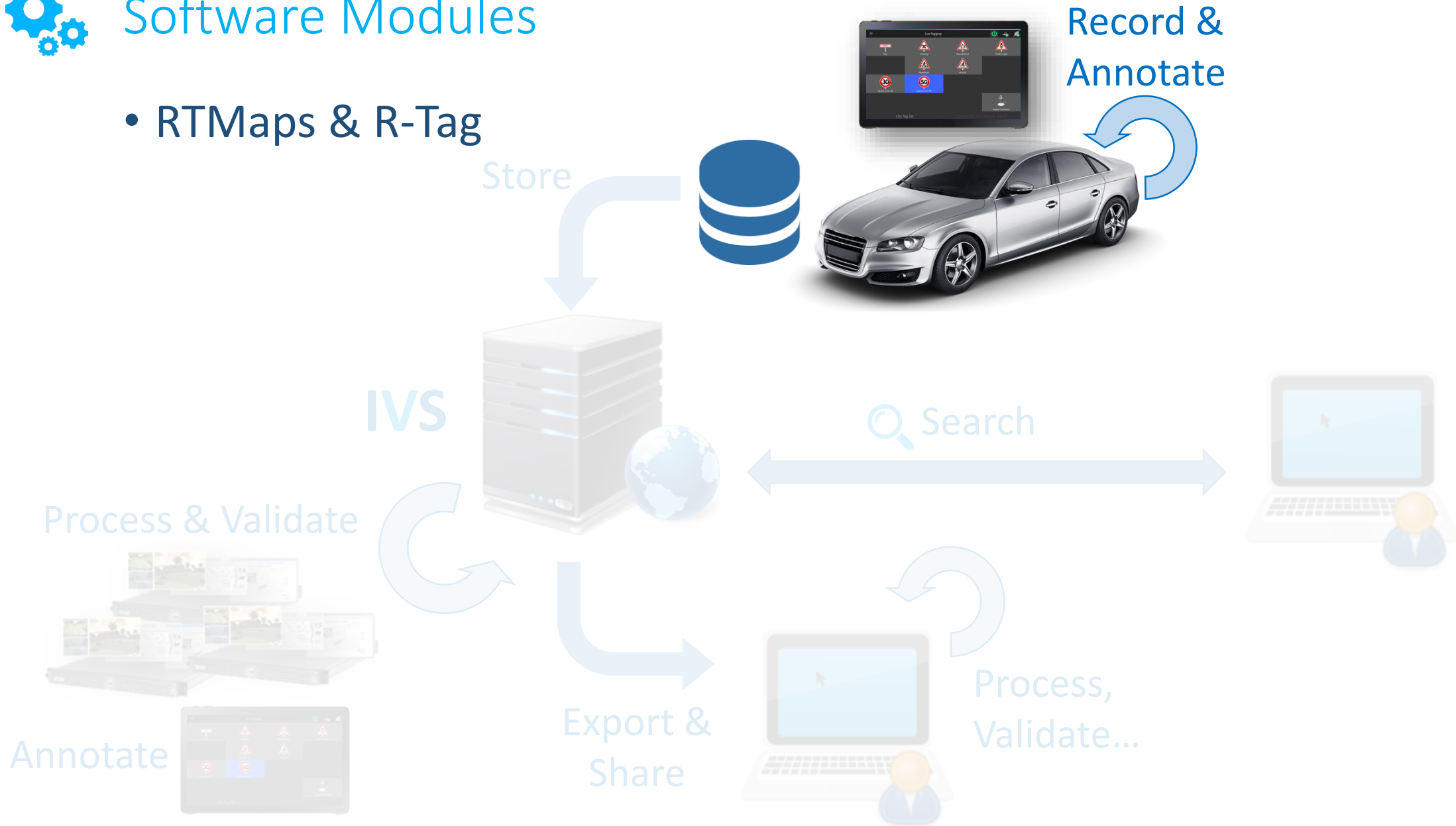
Data Workflow





Software Modules

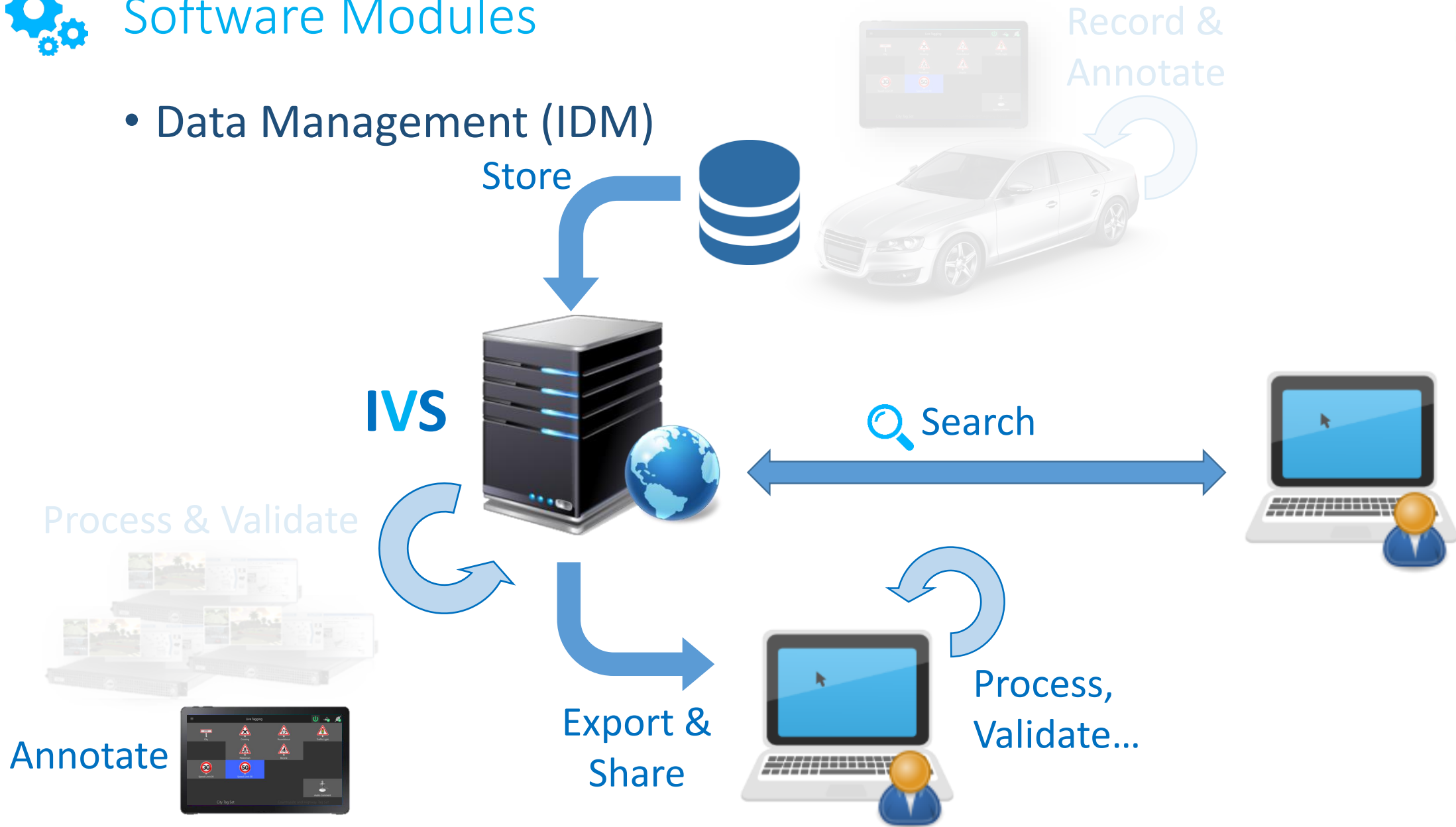
- RTMaps & R-Tag





Software Modules

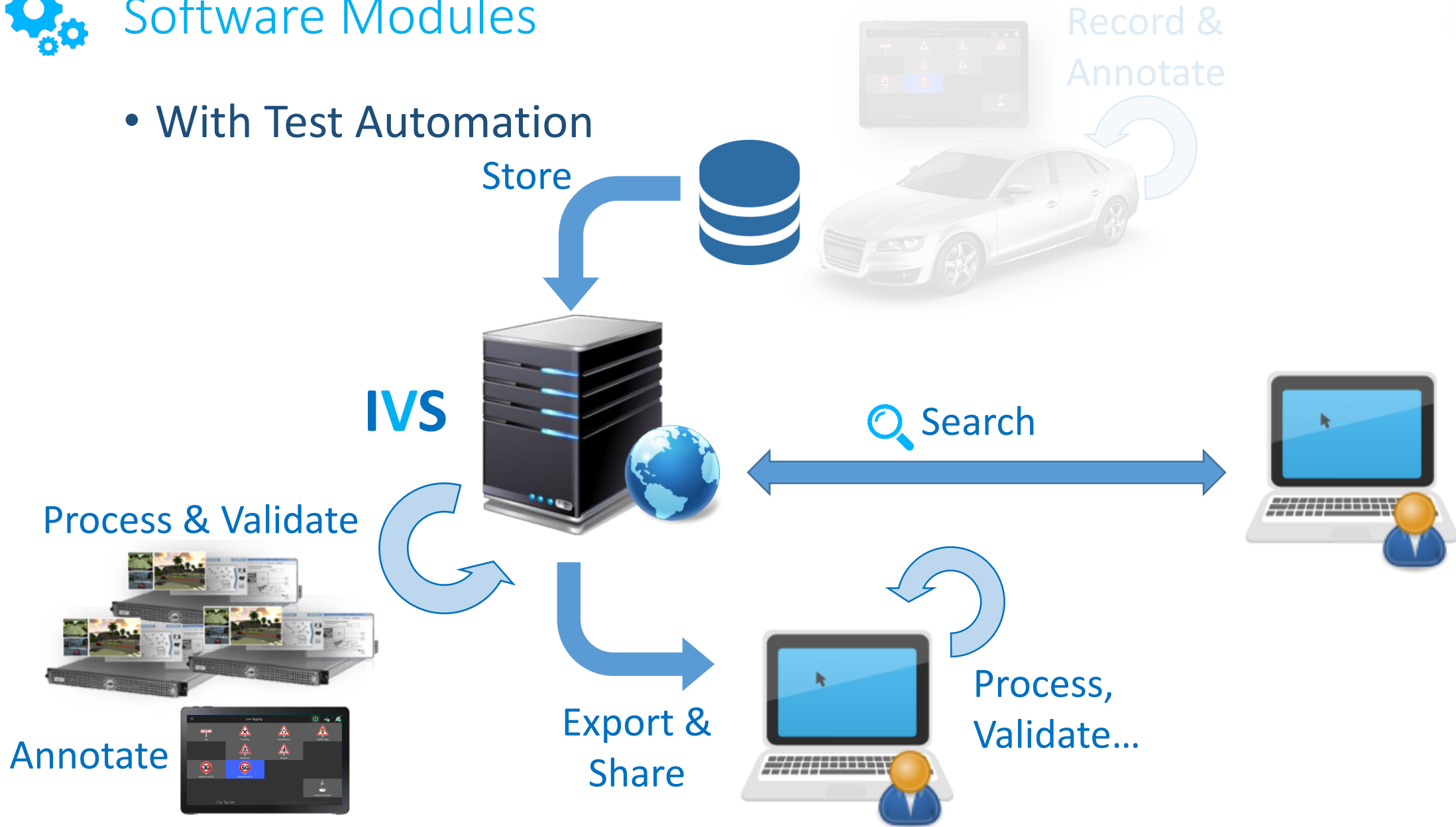
- Data Management (IDM)





Software Modules

- With Test Automation





Deployment

- Designed to be deployed on various Big Data infrastructures
- On-premise installation to keep your data on your in-house hardware
- Cloud provider such as Microsoft Azure, Amazon Web Services or Google Cloud



Data Recording & Live Annotation In-Vehicle



Large Range of Data Recorders

The extreme scalability of RTMaps allows to provide a large range of data recorders



Raspberry PI

- GPS
- CAN bus
- IMU
- Communication



R-Car H3

- Video
- GPS
- CAN bus
- IMU
- Communication



Embedded SPU + Data Logging Unit

- Up to 6 videos
- CAN bus
- GPS
- IMU
- Communication



Rack

- 6 uncompressed HD videos
- Real-time tagging (incl. Voice)
- 360° laser scanners, radars, ...
- **> 1.4 GB/s bandwidth**
- GPS / IMU, CAN bus



Distributed architecture with synchronization

- Remote data loggers
- Stacks to increase resources and I/Os



High performance data logger for ADAS Validation

- Sensors
 - 6 x uncompressed color HD video cameras (USB 3.0)
 - 360° laser scanners (IBEO fusion system – Ethernet)
 - 360° radars: 1 LRR, 4 MRR – XCP over Ethernet
 - OxTS INS (GPS + IMU)
 - 2 x CAN bus
- Extractible storage disks
- 8 TB storage ~ 2h recording





Live (Manual) Annotation

- Touch screen (tablet) HMI
- Manual annotation:
 - Recording wide annotations
 - Live annotation about driving condition, special events
- Remote recorder control
 - Start/Stop recording
 - Sensors status monitoring





Recorder Setup & Status Monitoring

 Sensors Configuration & Monitoring   

RecFile_1

Front Camera 

☒ Enable ☒ Record

Rear Camera 

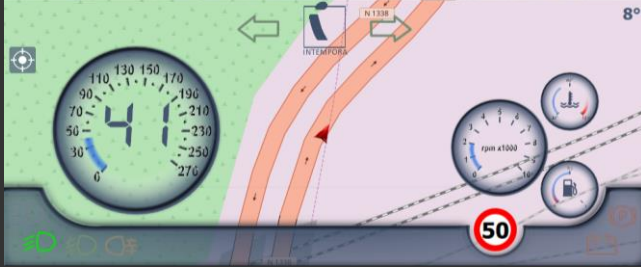
☒ Enable ☒ Record

360° LIDAR 

☒ Enable ☒ Record

Front Radar (Long Range) 

☒ Enable ☒ Record



 Sensor Data Recording



Manual Tagging Interface

New Recording...

Recording Description

Test drive

Recording Driver Name

Driver 1

q w e r t y u i

a s d f g h j k

↑ z x c v b n m

&123  British English

Live Tagging


City


Crossing


Roundabout


Traffic Light


Pedestrian


Bicycle


Speed Limit 30


Speed Limit 50


Audio Comment

City Tag Set

Countryside and Highway Tag Set



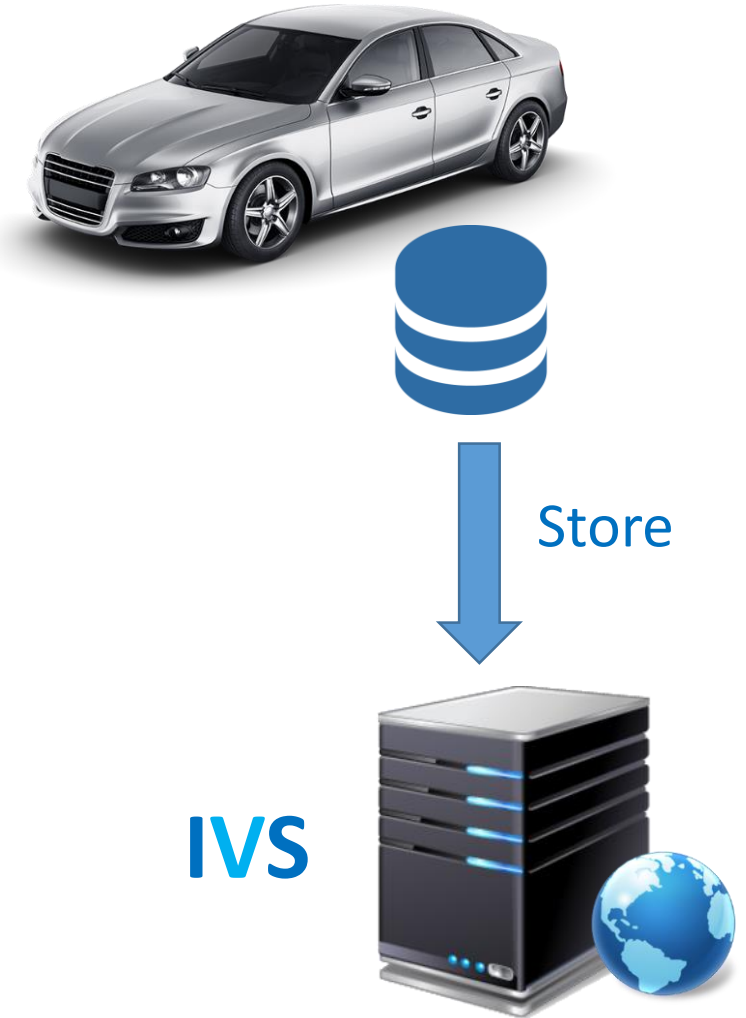
Data Storage & Indexing

Leverage recorded data within cloud infrastructure



Store Recorded Data

- Import in-vehicle recording
 - Raw sensors data
 - Metadata (data stream types, format...)
 - Live annotations
- Import process overview
 - Data upload (on premise or cloud storage)
 - Trigger processing
 - Index recording





Annotation & Preview Generation

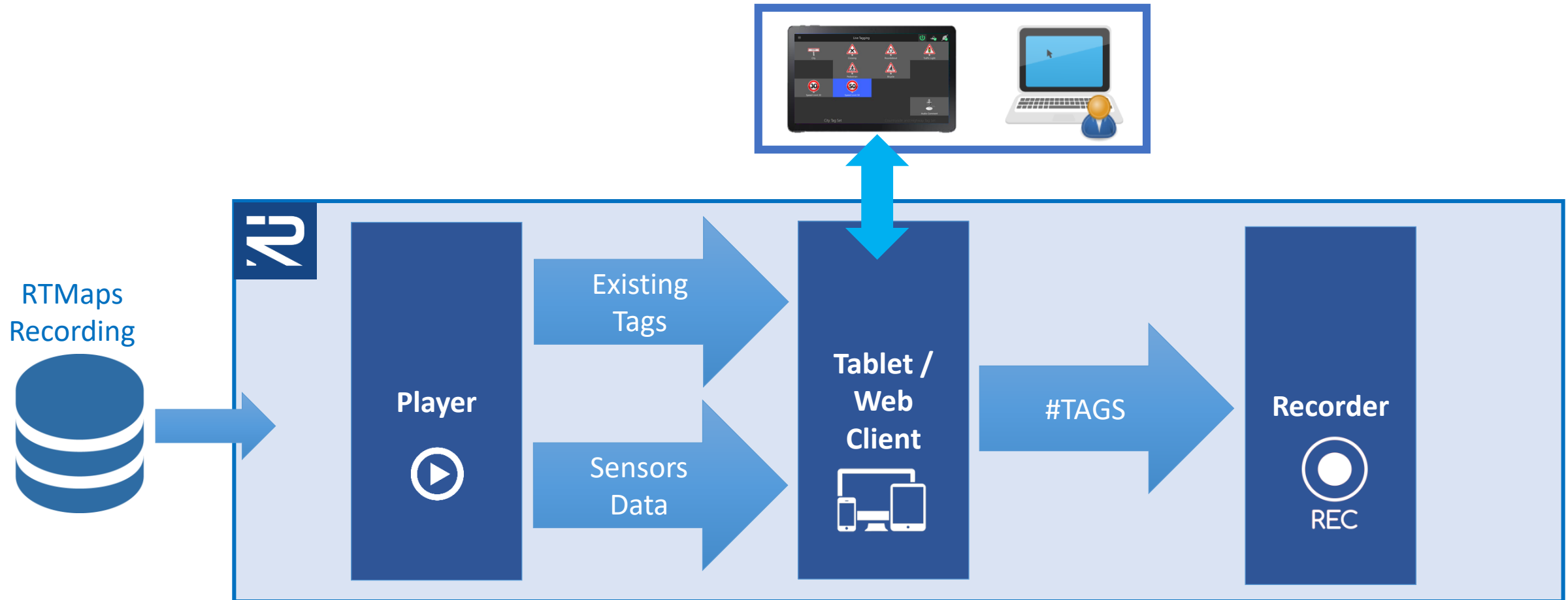
- Why ?
 - Make stored data searchable
 - Visualize data (from a web browser)
- Annotation & Preview Generation Features
 - Predefined annotation and preview extractors
 - Plugin based
 - Extendable by end-users
 - Triggered on data upload (based on recording metadata)





Manual Annotation

- Enhance and modify existing annotations





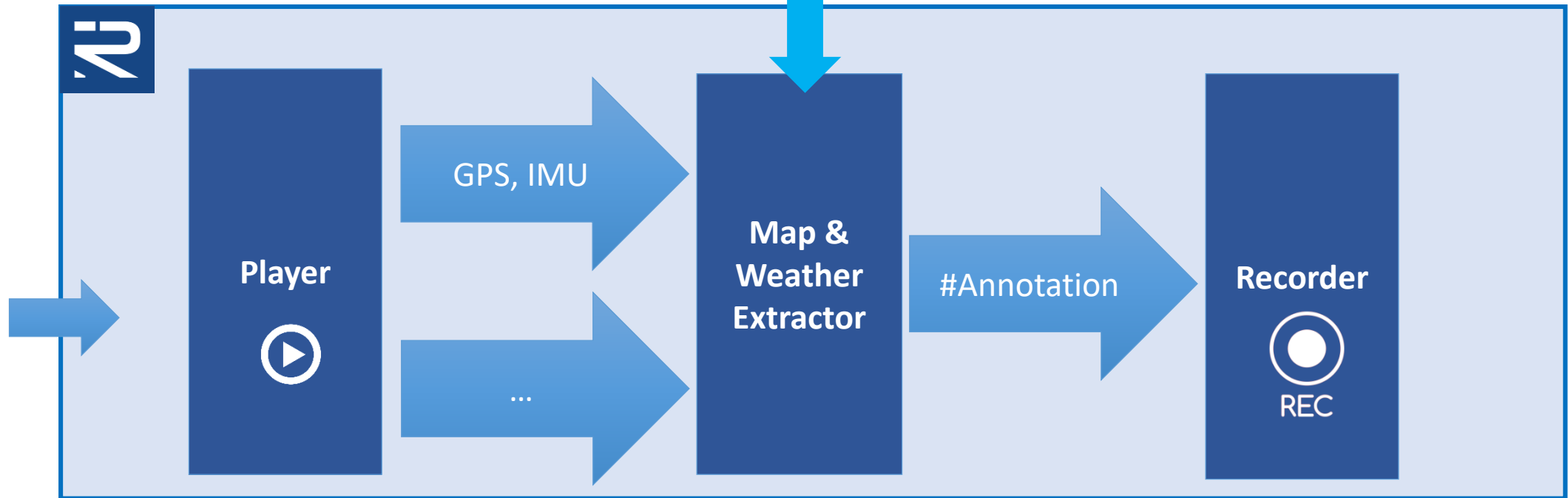
Automatic Annotation Examples 1/3

- Annotations from GPS, IMU DATA
 - Road type, traffic signs, city, ...
 - Weather data

Map & weather data providers



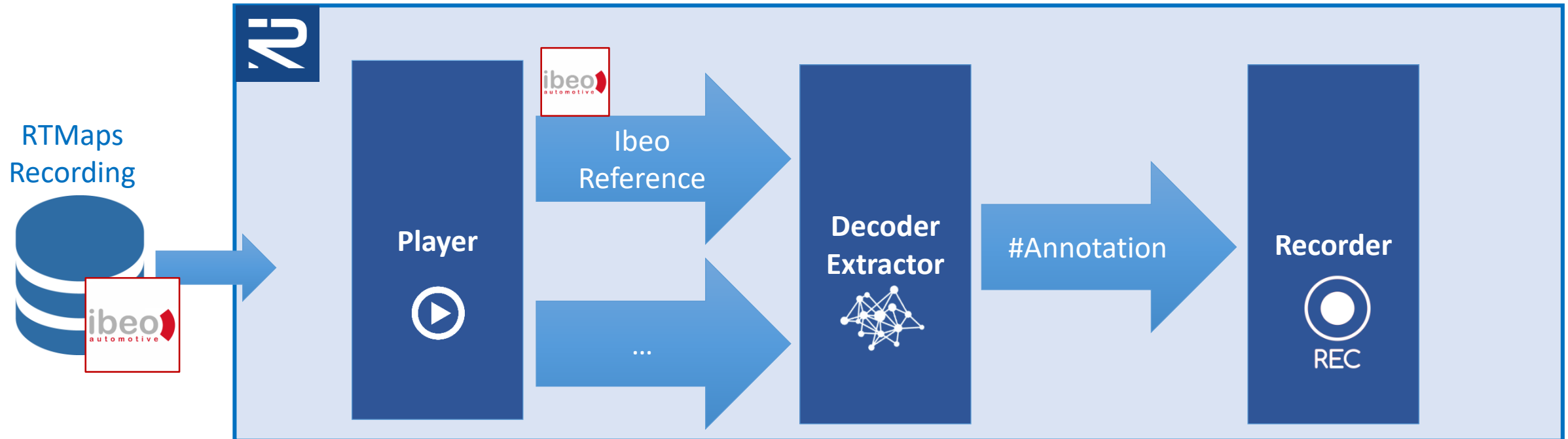
RTMaps
Recording





Automatic Annotation Examples 2/3

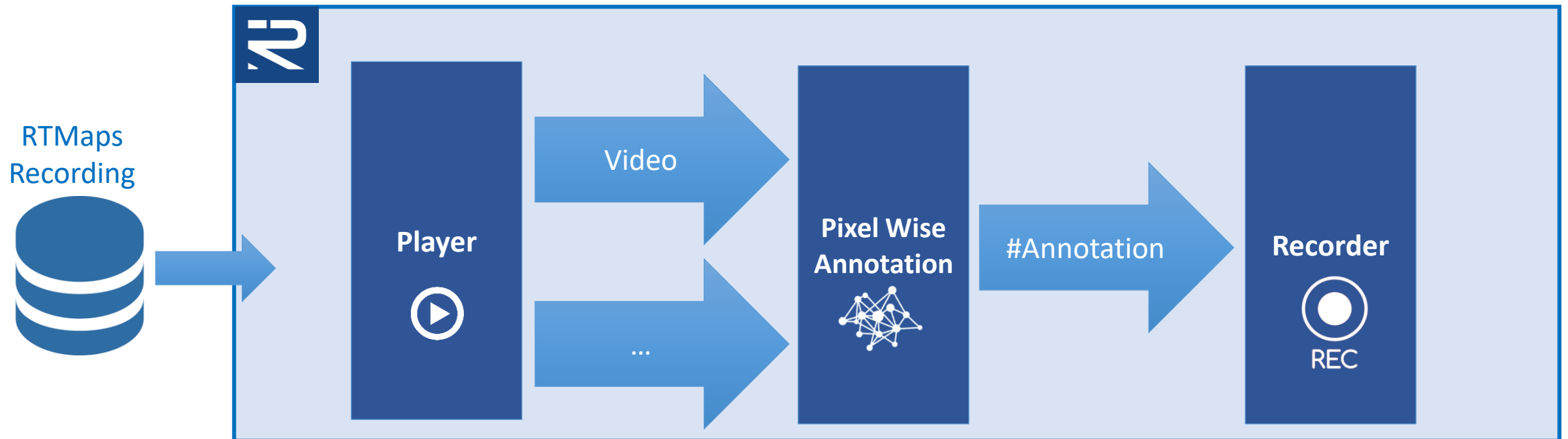
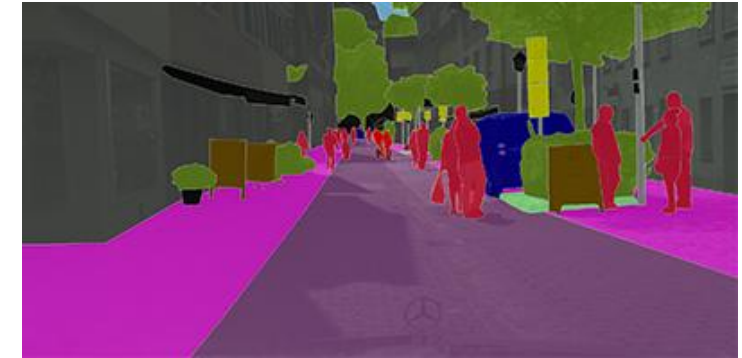
- Traffic participants annotation from IBEO reference data
 - Vehicles, pedestrians, ...
 - Relative position, speed
 - ...





Automatic Annotation Examples 3/3

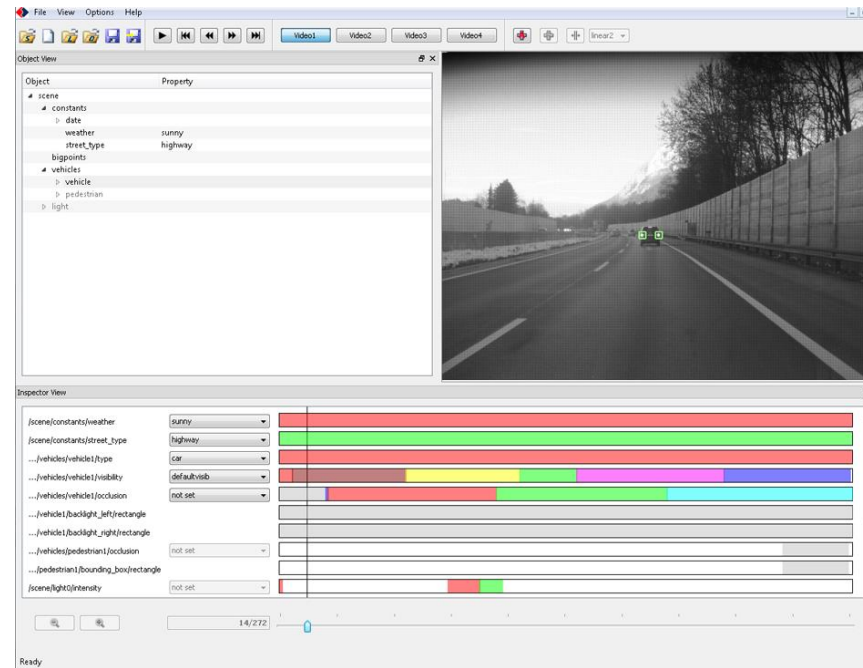
- Pixel wise annotation from any video stream
 - Vehicles, pedestrians, ...
 - Road, Sidewalk, ...
 - ...





Other Annotation Sources

- Import tags/labels from external tools such as:
 - Philosys Ground Truth Annotator 2018

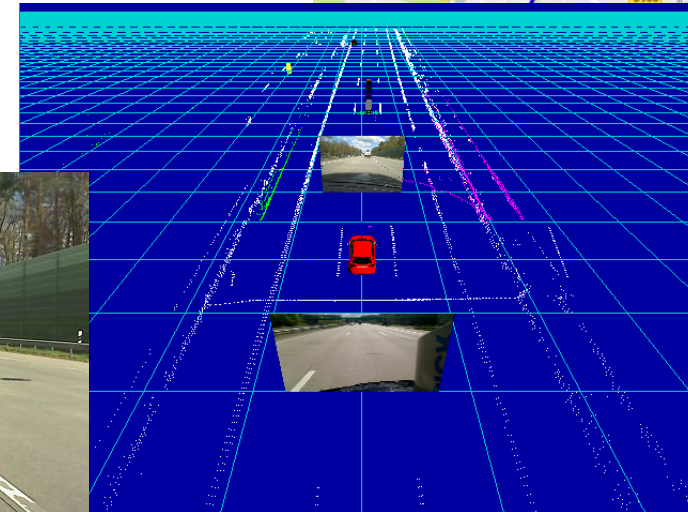


- Tag format is open and can be generated by any custom tool



Preview Generation

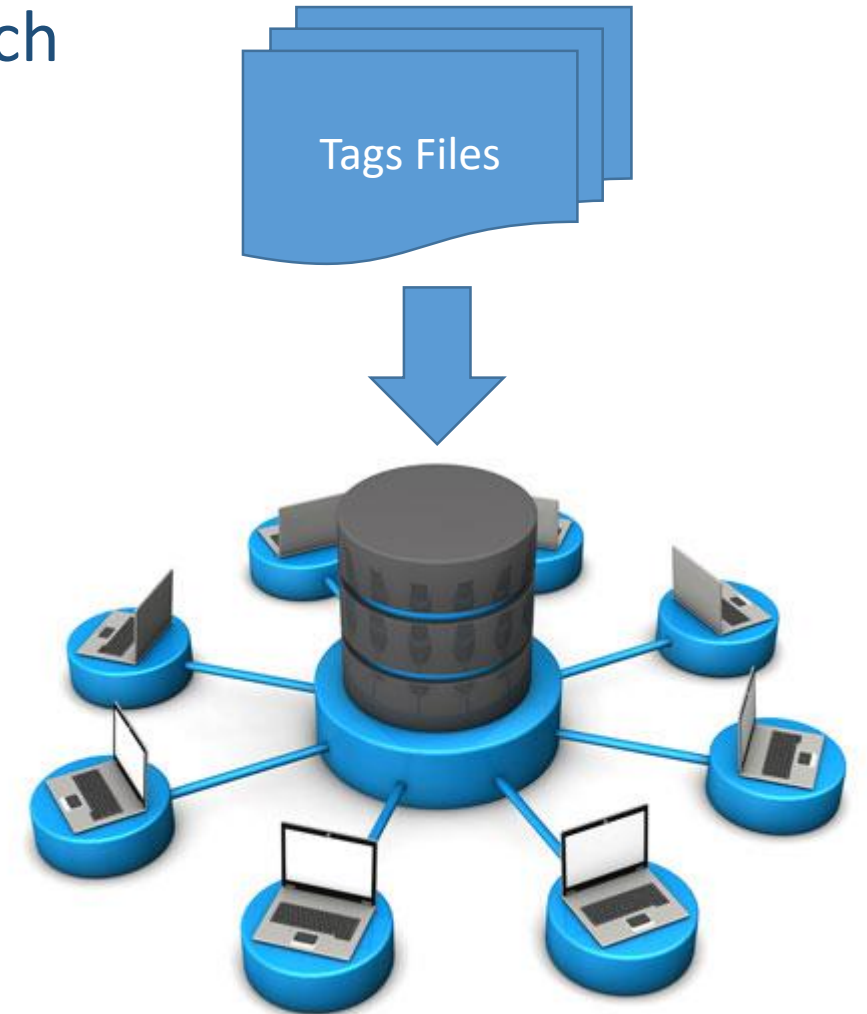
- Generate previews from data streams
 - MAP view from GPS/IMU streams
 - 3D view video from LIDAR/Radar streams
 - Thumbnails/video previews from Camera streams
 - ...





Data Indexation

- Upload tags to the database for future search
- Big-data
 - **Volume**
 - Thousand hours of recordings
 - Billions of tags
 - **Velocity**
 - Handle query on billions of tags as fast as possible
 - **Variety**
 - Heterogeneous tags content





Data Management



Search

- Search against
 - Large amount of data (tags)
 - Various kind of tags
 - Recording wide data (car type, available sensors, ...)
 - Geospatial data
 - Dynamic values (traffic participants, traffic signs, ...)
 - Continuous values (speed, ...)
- Various kinds of queries
 - “Emergency braking on highway”
 - “Pedestrian crossing with rain”
 - ...





Search & Visualize Stored Data

- Intuitive search interface and data visualization

IVS Recordings Jobs & Requests Taxonomy Dashboard Logout

Roundabout x



ADACCESS
2018/09/04 - 09:32:06
Start @ 12m 12s
Duration: 17s
Last updated 3 mins ago



ADACCESS
2018/09/04 - 13:06:30
Start @ 3m 3s
Duration: 17s
Last updated 3 mins ago



ADACCESS
2018/09/04 - 13:06:30
Start @ 4m 9s
Duration: 33s
Last updated 3 mins ago



ADACCESS
2018/09/04 - 13:06:30
Start @ 58m 44s
Duration: 16s
Last updated 3 mins ago



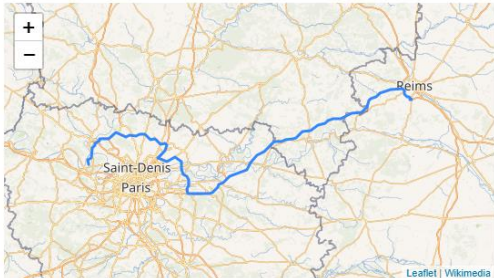
IVS Recordings Jobs & Requests Taxonomy Dashboard Logout

ADACCESS 2018/09/04 - 09:32:06

Duration: 2h 34m 15s

First recording on ADACCESS's Ampera E

Autonomous Vehicle Electric Vehicle



Matching Time Interval(s)

Roundabout

Appuyez sur  pour quitter le mode plein écran.

rl

I



Sun

environment > weather > sun

Storm

environment > weather > storm

Rain

environment > weather > rain

Snow

environment > weather > snow

Accident

road_conditions > traffic > accident

ADACCESS 2018/09/04 - 09:32:06

Start @ Begining

Duration: 2h 34m 15s

Last updated 3 mins ago



ADACCESS 2018/09/04 - 13:06:30

Start @ Begining

Duration: 3h 13m 32s

Last updated 3 mins ago





Export or Process Data

- Select recording sub-sequences
 - Time sub-sequence
 - Stream sub-set
- Export or process them in IVS





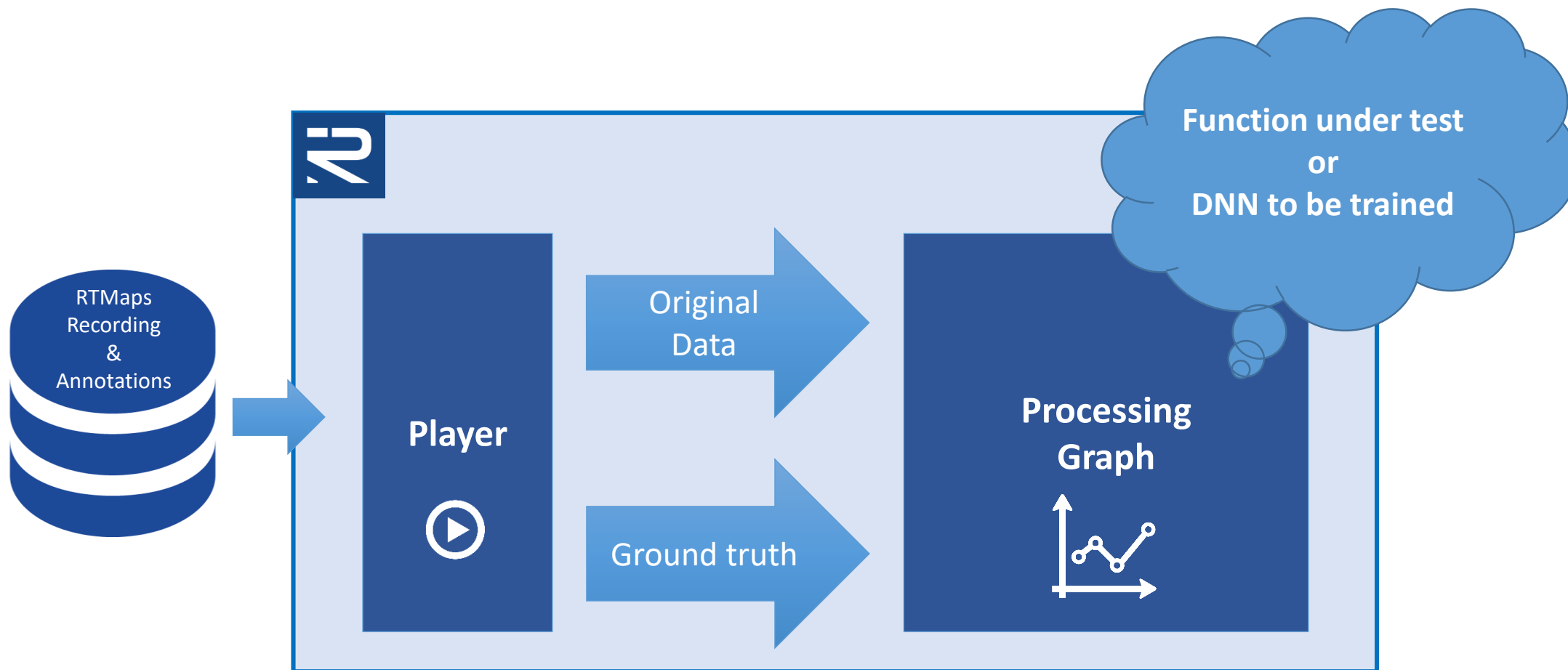
Test Automation

DNN Training, Continuous Integration & Validation



Batch execution against recorded data

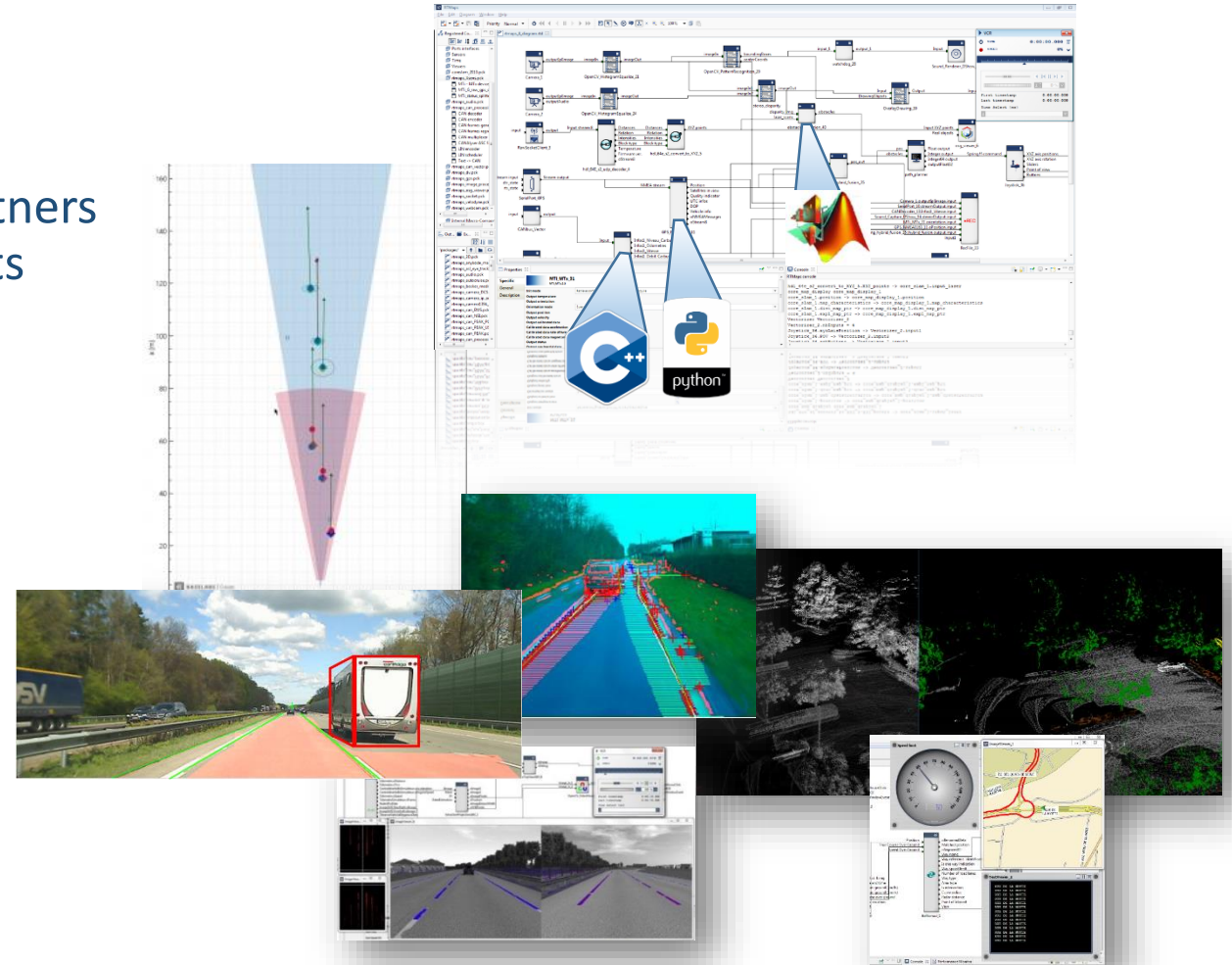
- Data & Annotation synchronized replay





Integrate Functions in RTMaps

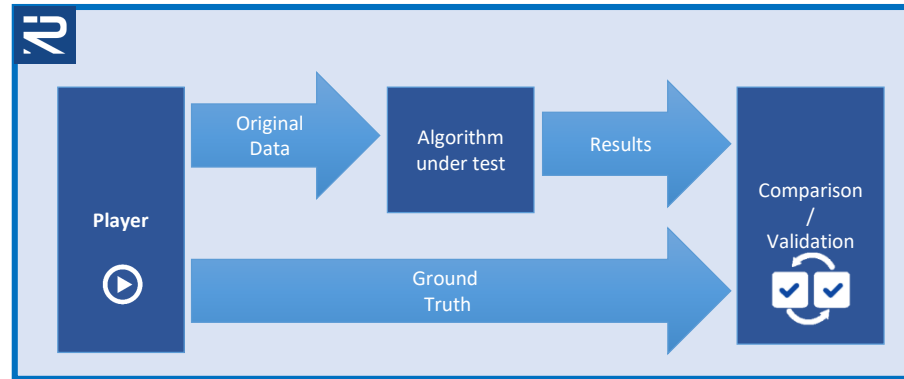
- RTMaps SDK allows to integrate algorithms in RTMaps SDK
 - C/C++
 - Python
 - Simulink
- Pick algorithms from techno-provider partners already wrapped into RTMaps components
 - Nexyad
 - Dibotics
 - NVidia DriveWorks
 - Benomad
 - Sherpa Engineering
 - Mines-ParisTech
 - INRIA
 - LIVIC
 - BaseLabs
 - Google TensorFlow
 - ...





Test Automation

- DNN Training, Continuous Integration & Validation



IVS



Automated execution

Search data and
Define jobs

IVS



Results





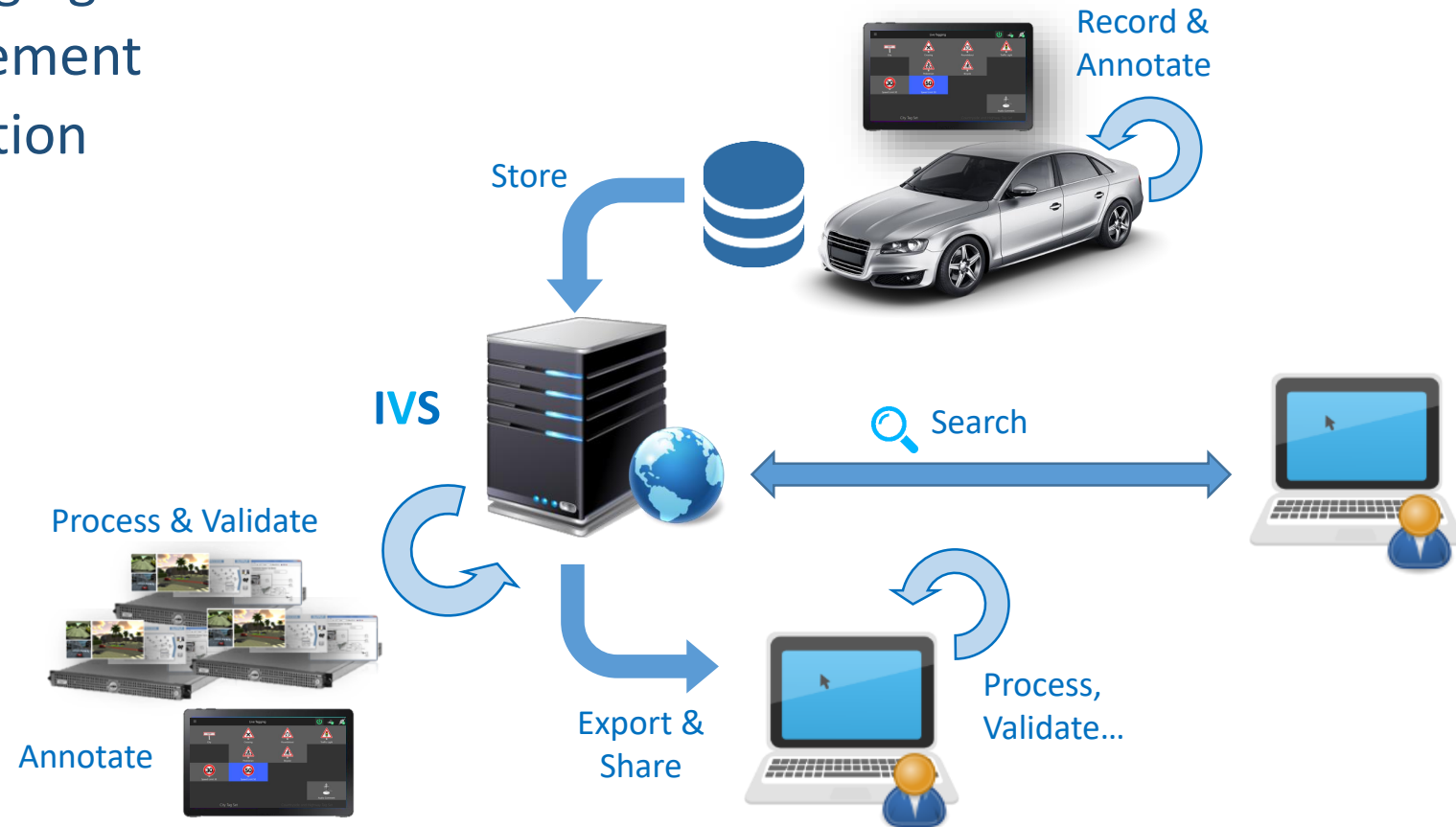
Conclusion



Conclusion

- Intempora Validation Suite key features

- Live data tagging
- Data Management
- Test Automation



Thanks for your attention – Q&A ?

www.intempora.com

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