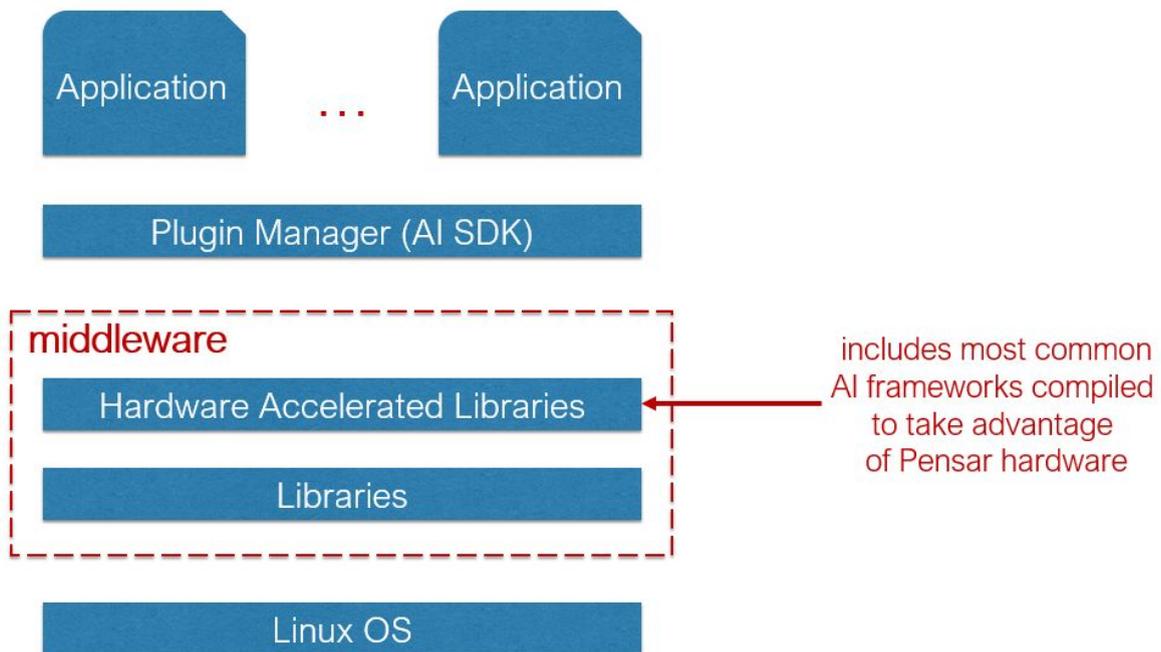


## Pensar software stack

Pensar is provided with: standard Linux OS, middleware of hardware optimized libraries, proprietary AI SDK (Plugin Manager) and several ready-to-use AI applications. In general the **software stack** provided with Pensar is:



### Linux OS and Middleware

Operative system currently used is Ubuntu 16.04, it includes CUDA 9.0 accelerated drivers for NVIDIA GPU. Middleware is constituted by a large set of libraries, all available as open source, a big effort has been spent to integrate them on Pensar taking maximum advantage from hardware acceleration.

**AI hardware accelerated libraries** provided with Pensar middleware include:

- NVIDIA cuDnn 7
- NVIDIA TensorRT 4
- NVIDIA Caffe
- OpenCV 3.4.5 (CUDA and ARM Neon acceleration supported)
- DLIB (CUDA and ARM Neon acceleration supported)
- GStreamer with NVIDIA proprietary CUDA accelerated plugins
- Darknet (CUDA accelerated)

TensorRT, Caffè, OpenCV, DLIB and Darknet make possible to load and run the most common AI neural network model formats that include:

- TensorFlow
- Caffe
- ONNX
- Darknet networks (like for instance YOLO neural networks)

**Other libraries** provided with Pensar middleware include:

- Keras
- Theano
- TensorFlow
- SciKit
- SciPy
- Numpy
- Matplotlib
- ZMQ
- Mavlink
- Kivy (used for Graphical User Interfaces)
- Docker-ce
- Visual Studio Code

Python bindings have been included for all C++/C libraries (if exist), so in general the middleware make possible to write hardware accelerated applications in C++ and Python.

## **App Manager**

On top of that there is **App Manager**. App Manager is a multiplatform software entirely designed in Aerialtronics, written in C++ and Python, it is not an application but an AI and Computer Vision environment to build and run generic applications.

App Manager includes following functionalities:

- basic Pensar control and Graphical User Interface to handle sensors (visible camera, thermal camera, IMU etc.) and other Pensar hardware
- basic functionalities (take snapshots, record video, etc.)
- capability to communicate and control all other hardware connected to Pensar (operate Gimbal to track targets, talk to fly computer, etc.) making use of Mavlink, IP and USB connections
- capability to run generic applications that have their own Graphical User Interface, fully integrated into Plugin Manager GUI (Kivy is used to get OpenGL accelerated GUIs)

Applications can be written in Python, are made of a sequence of plugins (that we call **plugin pipeline**) and, thanks to Plugin Manager, can easily access to AI neural networks running in C++, making use of hardware accelerated middleware libraries. Some neural network models are provided with Plugin Manager, others can be loaded since Plugin Manager supports most common neural network standards.

