



# Automatic License Plate Recognition System with Deep Learning

PM: Malcolm Chen

# Agenda

- AI Market Trends & Opportunities
- The Advantages of LPR Applications With AI
- IEI's Smart City Use Cases
- IEI AI Ready Embedded Systems
- The Advantages of Intel Solution

# AI Market Trends & Opportunities

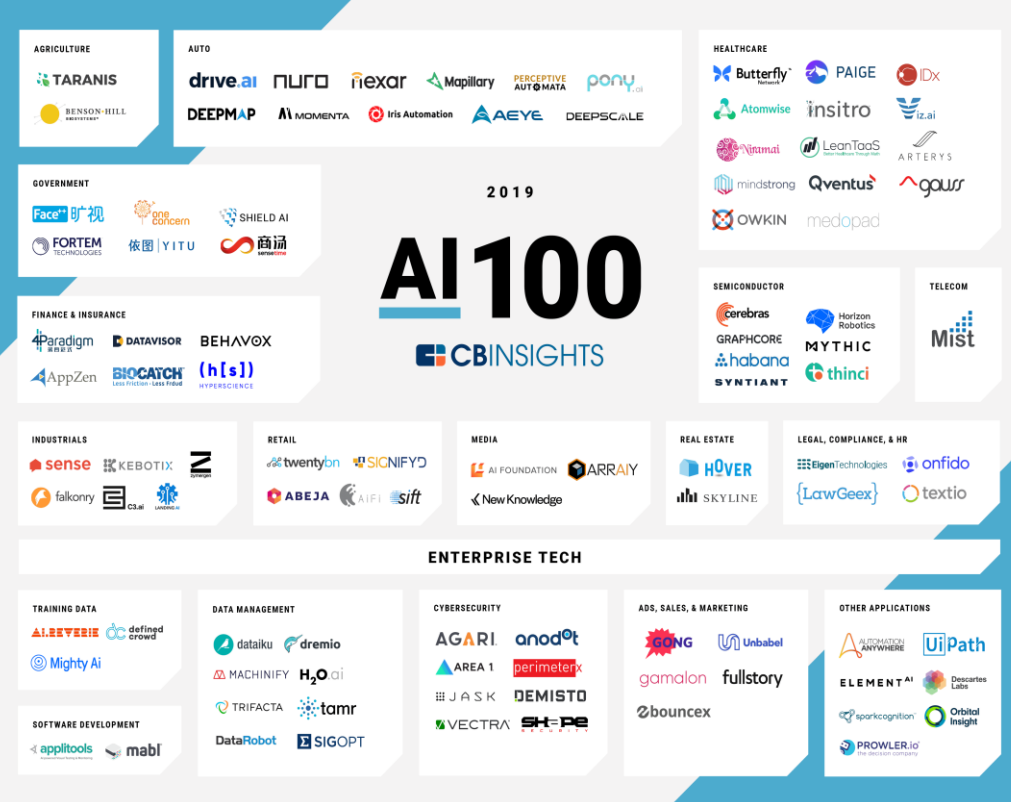
# AI Market Trend & Opportunities

The AI 100 is CB Insights' annual ranking of the 100 most promising AI startups in the world.

## 2020 AI 100



## 2019 AI 100

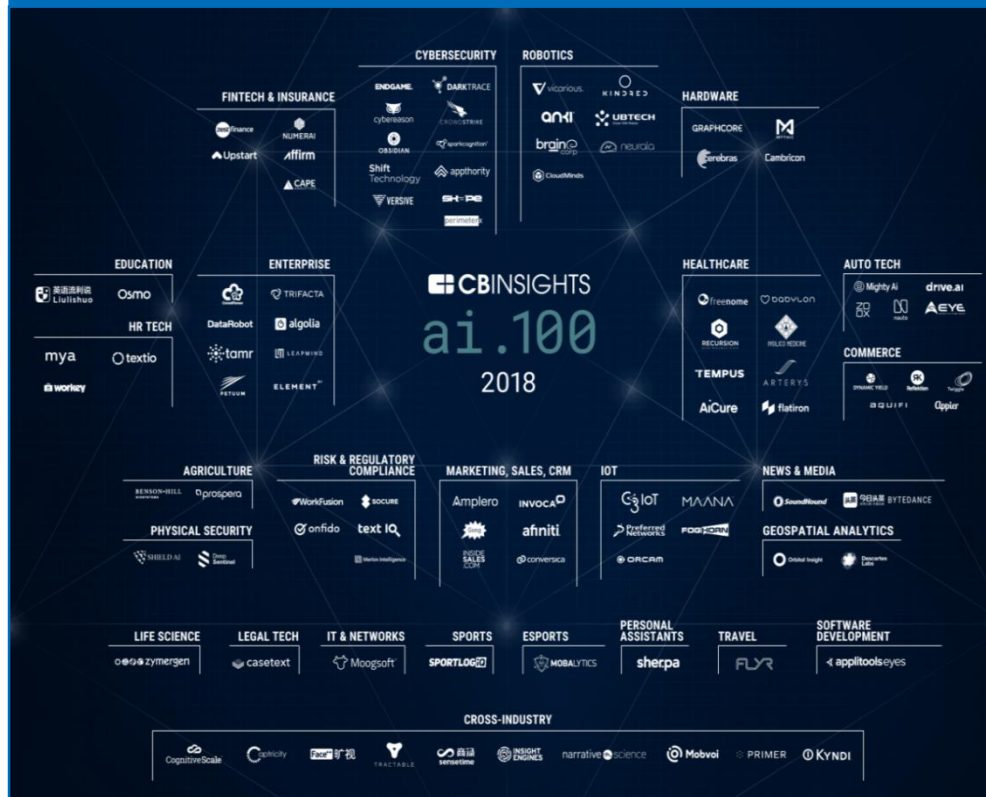


Source: <https://www.cbinsights.com/research/artificial-intelligence-top-startups/>

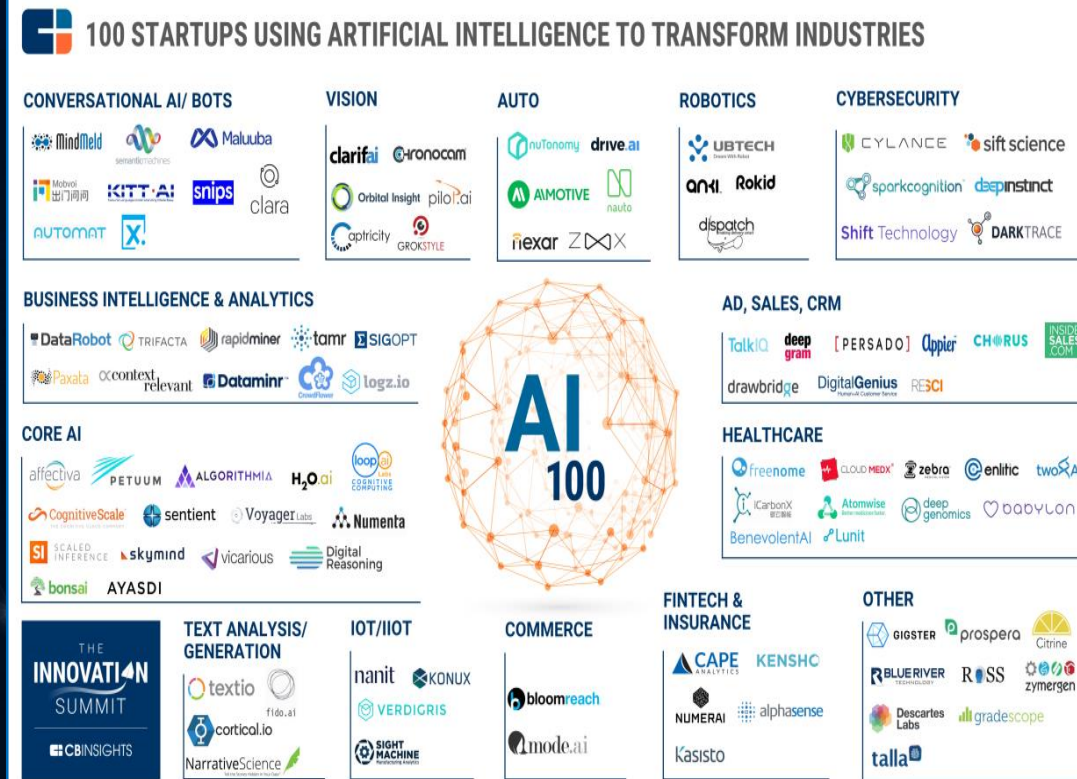
# AI Market Trend & Opportunities

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## 2018 AI 100

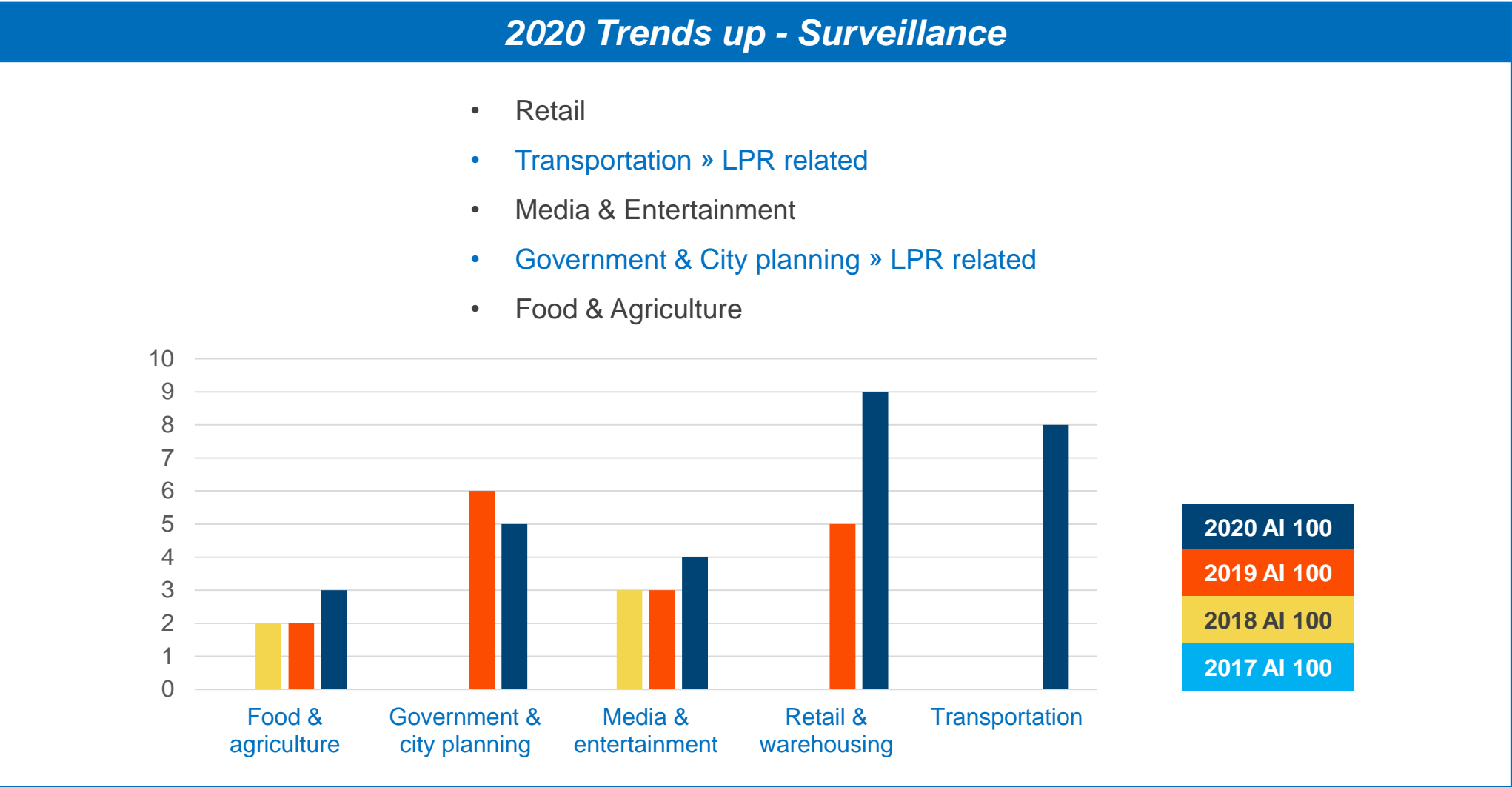


## 2017 AI 100



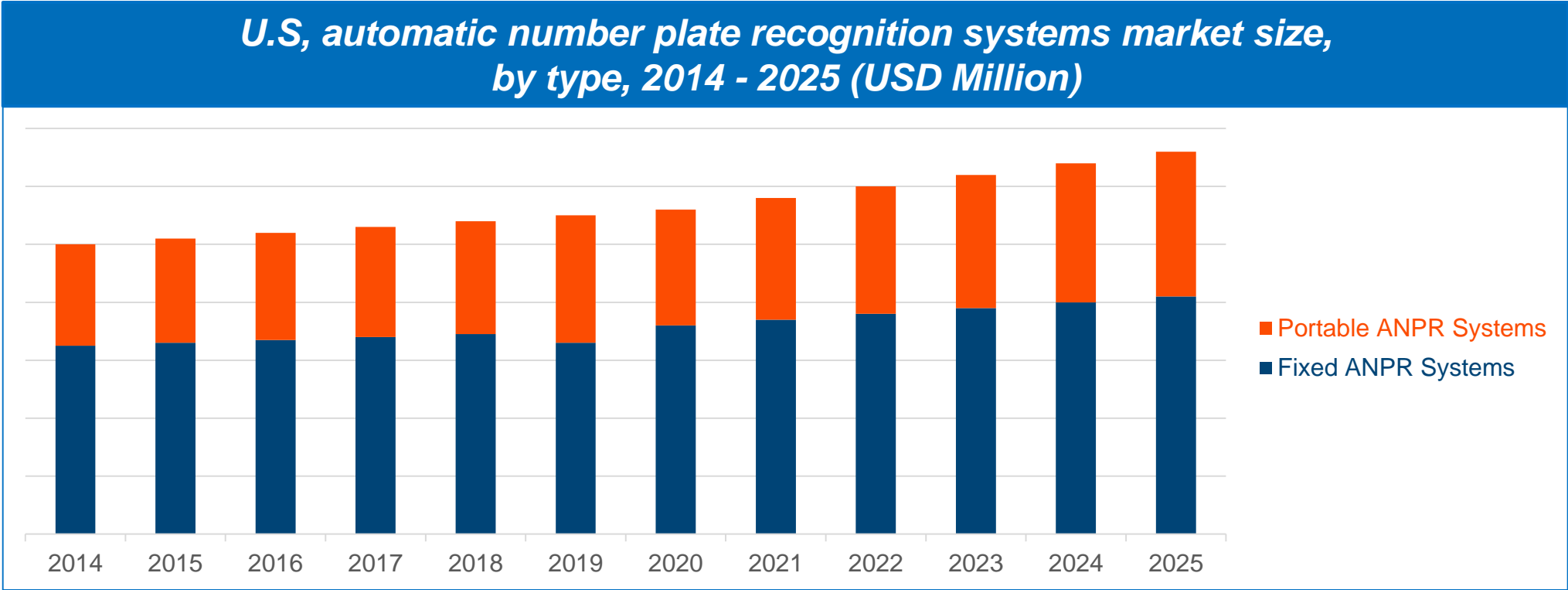
Source: <https://www.cbinsights.com/research/artificial-intelligence-top-startups/>

# AI Market Trend & Opportunities



# AI Market Trend & Opportunities

The global automatic number plate recognition system market size was estimated at USD 1.9 billion in 2018 and is expected to exhibit a CAGR of 6.8% from 2019 to 2025.



Source: <https://www.grandviewresearch.com/industry-analysis/automatic-number-plate-recognition-systems-market>

# The Advantages of LPR Applications With AI

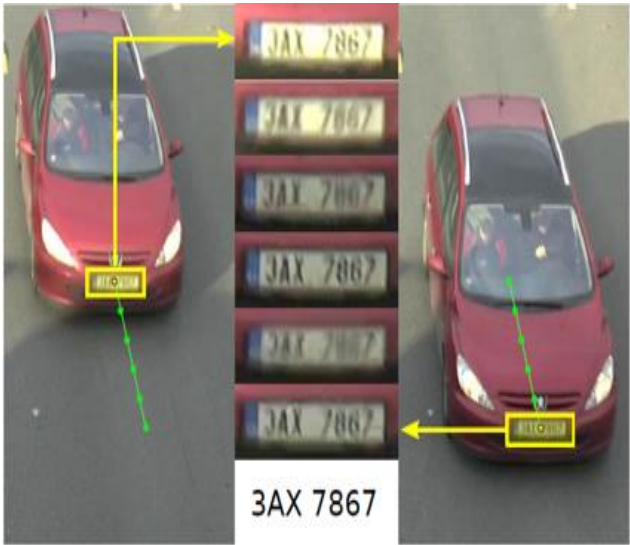


# How AI Improve LPR Applications

AI can solve the problem of waiting in line at the entrance and exit by overcome the problem caused by weather or lighting due to the limitations of the traditional recognition system.



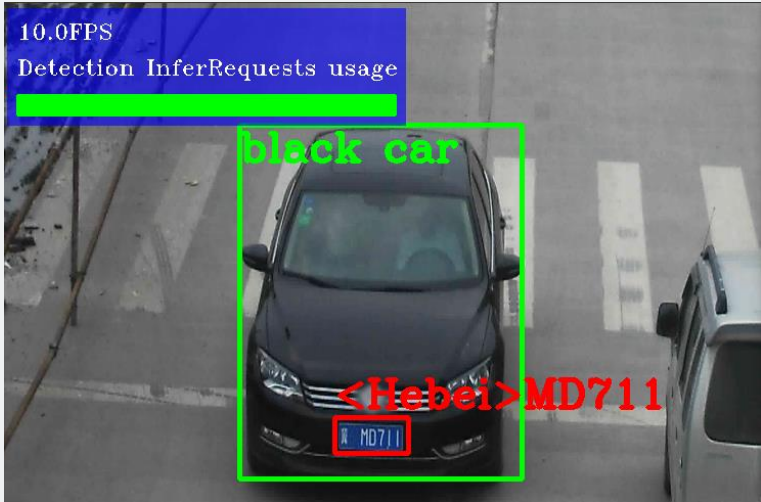
Fig. 9. Examples of car license plate detection.



# How AI Improve LPR Applications

## AI LPR System Including:

- Attribute  
(mini van, sedan...etc.)
- Color
- License plate



Vehicle  
Recognition

Vehicle  
Classification

License  
Plate  
Recognition

Video Decode

Image Pre  
processing

OpenVINO™ toolkit

OS: Linux / Windows

Image Post  
processing

Video Encode

CPU

iGPU

VPU

FPGA

# AI LPR Applications in Parking Lot

Parking Lot AI LPR System Including:

- IP Camera
- AI LPR Edge BOX PC

- LED Digital Sign
- Gate

- LED Guidance Sign
- Toll machine

## Parking space monitoring

- Browser-based available parking spots display

## Automatic payment system (vehicle)

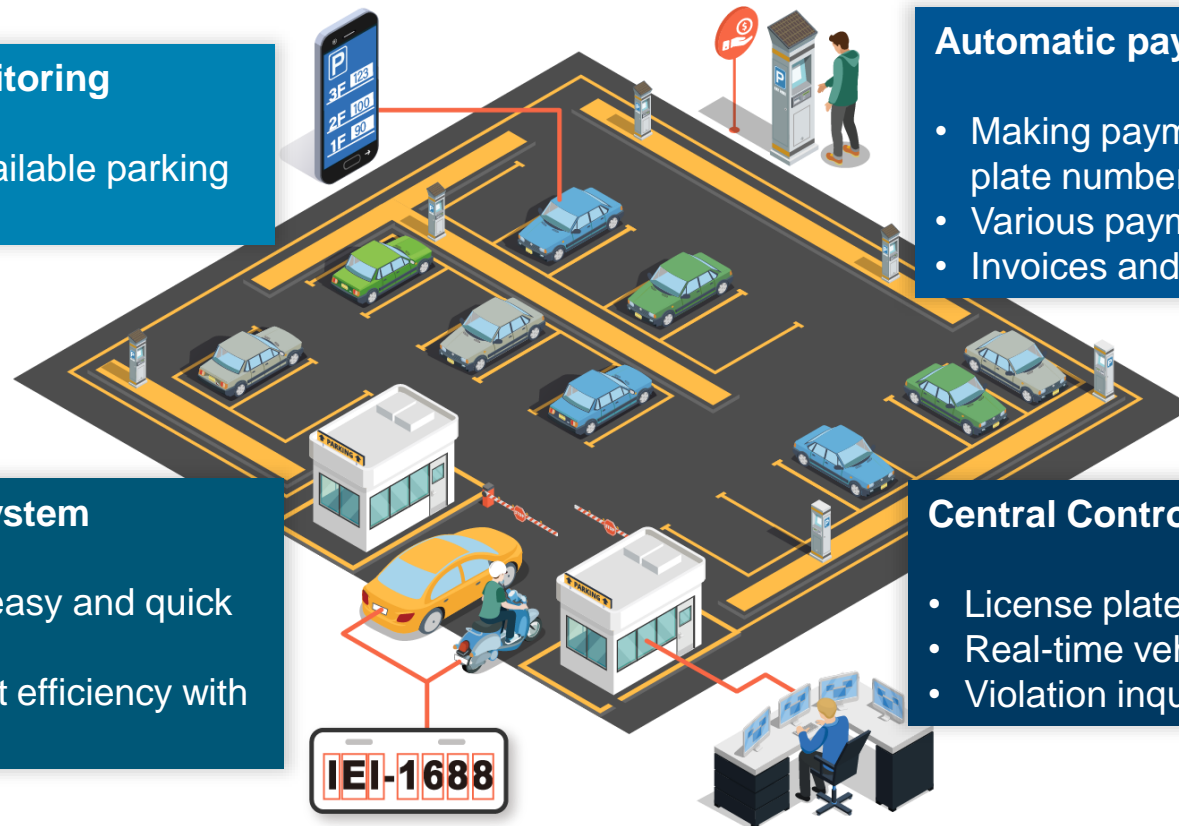
- Making payment on touch screen with license plate number
- Various payment methods
- Invoices and reports

## ALPR access control system

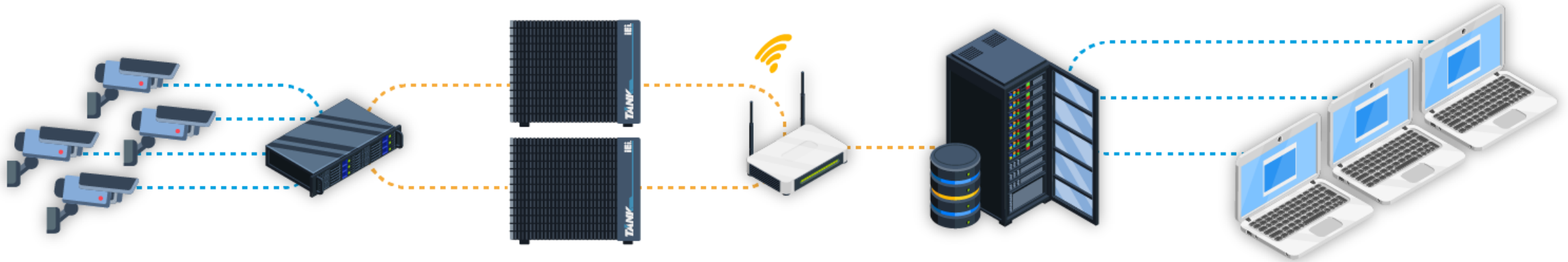
- Token-free system for easy and quick access
- Improving management efficiency with ALPR

## Central Control & Management System

- License plate management
- Real-time vehicle access records
- Violation inquiry & report



# AI LPR Applications in Parking Lot



Parking Lot AI LPR system help to:

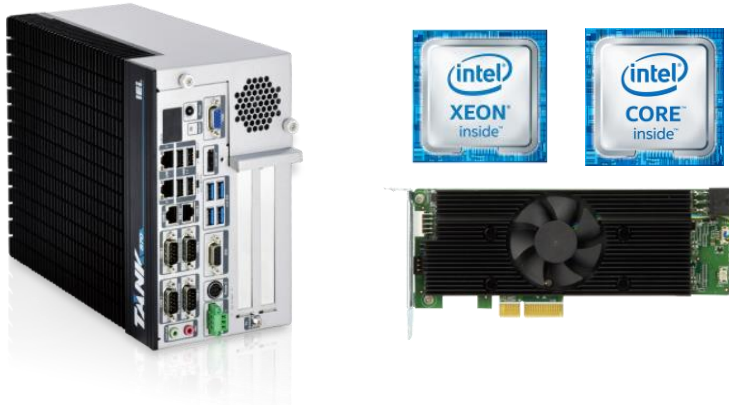
- Reduce long queue in entrance & exit
- Low error rate
- Token-free (missing issue)



# IEI's Smart City Use Cases

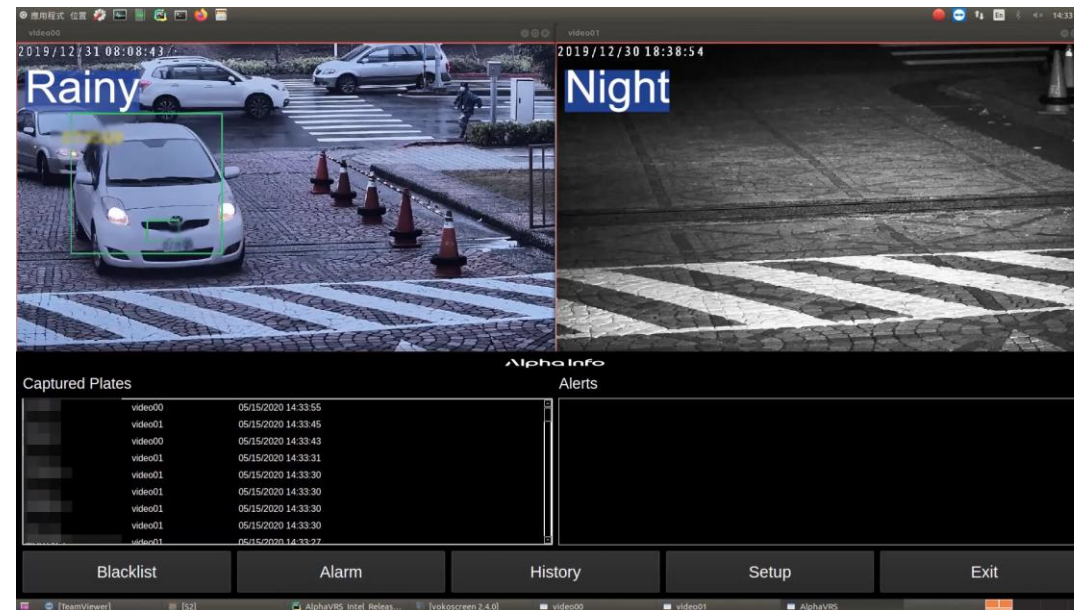
# Smart City Use Cases

## Smart City



IEI TANK AIoT Dev. Kit

- Up to 2 x [Mustang-V100-MX8](#)
- [OpenVINO Toolkit](#)
- Application: LPR
- SW Partner: [AlphaInfo](#)





# Smart City Use Cases

## Smart City



IEI FLEX-BX200 8th & 9th Gen Core

- Up to 4 x [Mustang-V100-MX8](#)
- [OpenVINO Toolkit](#)
- Application: LPR
- SW Partner: [LILIN](#)



# Smart City Use Cases

## Smart City



IEI FLEX-BX200 8th & 9th Gen Core

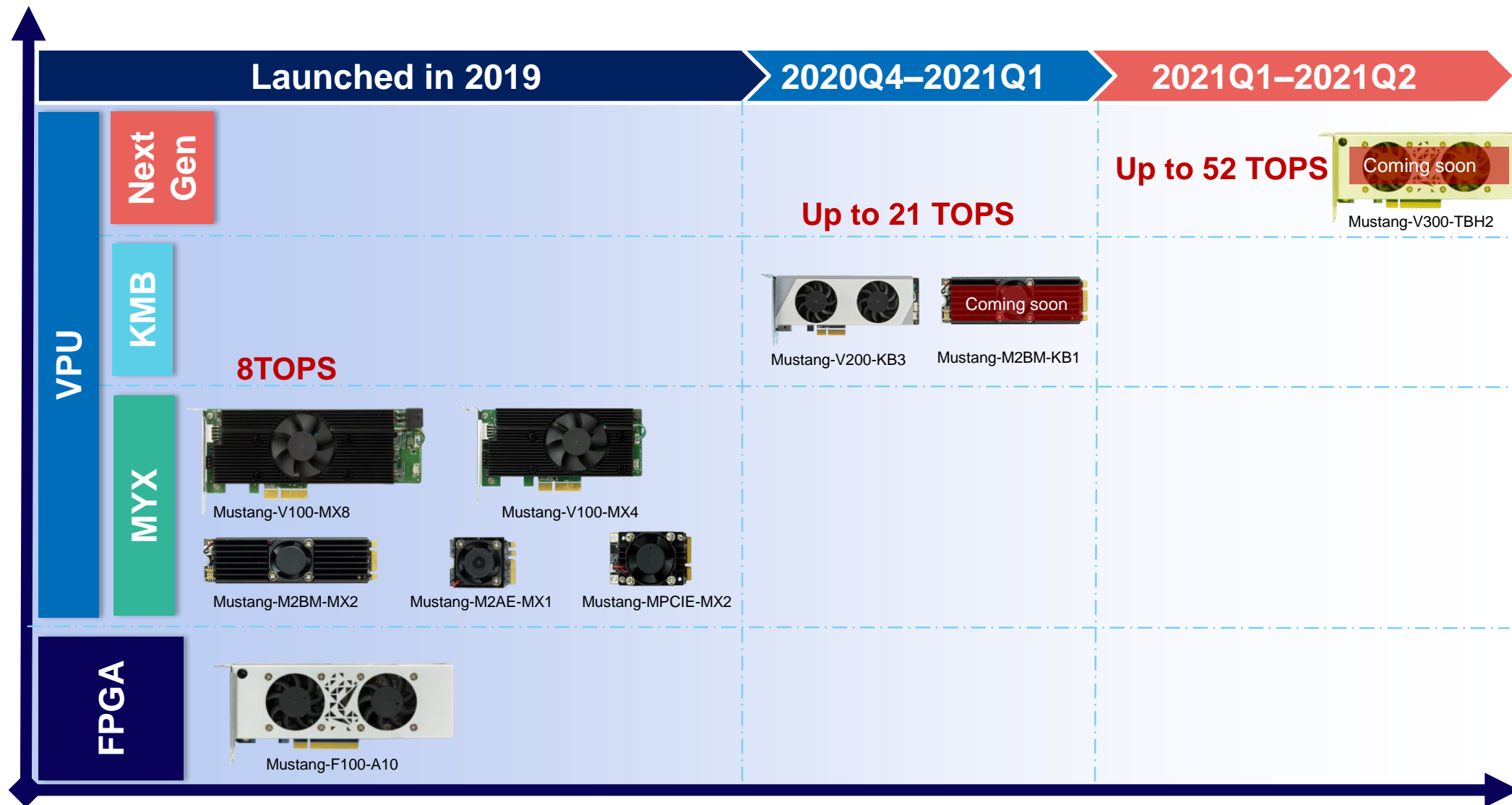
- Up to 4 x [Mustang-V100-MX8](#)
- [OpenVINO Toolkit](#)
- Application: Pedestrian, vehicle violation,
- SW Partner: [Geovision](#)





# IEI AI Ready Embedded Systems

# IEI Mustang Accelerator Roadmap

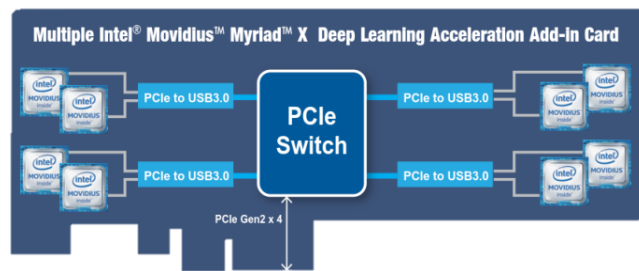


# IEI 2020 AIoT Dev Kit RoadMap

Schedule	2019		2020				2021	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Intel® Vision Accelerator Design Integrated Systems	TANK AIoT Dev. Kit With Mustang-V100-MX8							
				FLEX AIoT Dev. Kit With Mustang-V100-MX8				
						FLEX AIoT Dev. Kit With Mustang-V200-KB3		



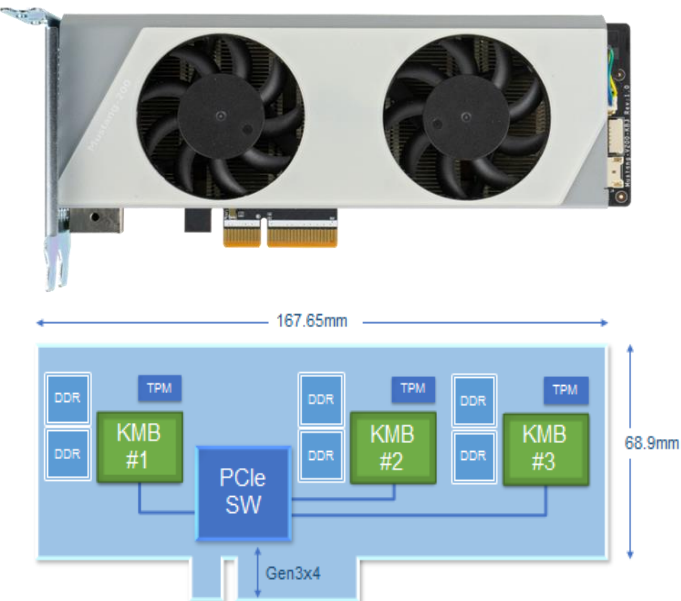
# Mustang Accelerator – Intel Myriad X VPU



Components	Mustang-V100-MX8
Chipset	Intel® Movidius™ Myriad X™ x8
CPU	-
Memory	512MB each VPU
Storage	-
TPM data protection	-
Form Factor	Standard Half-Height, Half-length <167x69mm>
Interface	PCIe Gen2 x 4
Operating Temperature	-20 ~ 60 degree C
Power Consumption	25W
Cooling	Active(single slot with Fan) / Passive(single slot)
External Power	Preserved power connector
Computation Capability	8 TOPS (1 TOPS per MA2485)

2nd Generation of Intel® Movidius™ VPU Target to Edge Computing

# Mustang Accelerator – Intel Keem Bay VPU



Components	Mustang-V200-KB3
Chipset	Intel® Movidius™ Keem Bay™ x3
CPU	4*ARM A53 1.5GHz
Memory	12GB LPDDR4
Storage	24GB eMMC
TPM data protection	Yes
Form Factor	Standard Half-Height, Half-length <167x69mm>
Interface	PCIe Gen3 x 4
Operating Temperature	-20 ~ 60 degree C
Power Consumption	50W
Cooling	Active(single slot with Fan) / Passive(single slot)
External Power	Preserved power connector
Computation Capability	15 TOPS (5 TOPS per 3400 VE), 21 TOPS (7 TOPS per 3700 VE)

3rd Generation of Intel® Movidius™ VPU Target to Edge Computing

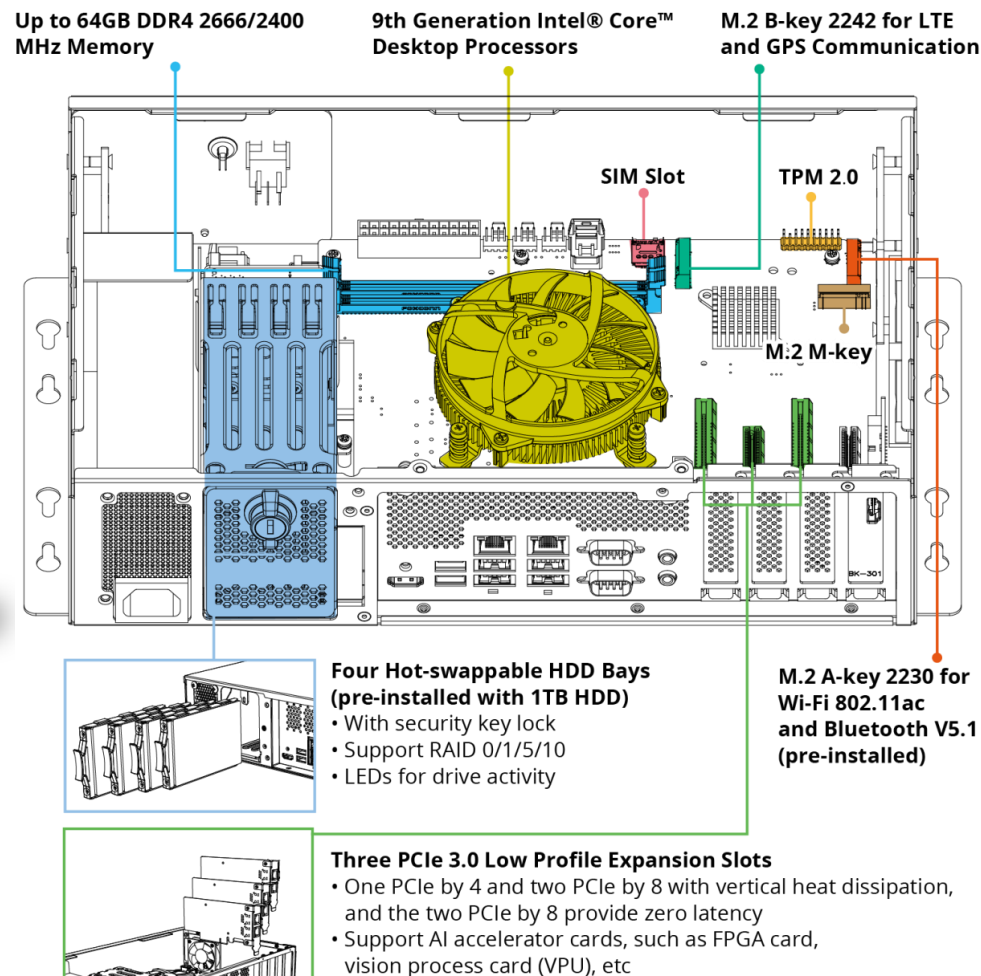
# TANK AIoT Developer Kit Features



## TANK AIoT Developer Kit

- 6th/7th Gen Intel® Core™/Xeon® processor platform with Intel® Q170/C236 chipset and DDR4 memory
- Rich high-speed I/O interfaces on one side for easy installation
- Pre-installed Ubuntu 16.04 LTS
- Pre-installed Intel® Distribution of Open Visual Inference & Neural Network Optimization (OpenVINO™) toolkit, Intel® Media SDK, Intel® System Studio and Arduino® Create


# IEI 2020 AIoT Dev Kit - FLEX-BX200



Source: <https://www.ieiworld.com/flex-bx200-aiot-development-kit/en/>



# IEI AI Ready Embedded Systems

	VPUx8 PCIe Gen2x4	VPUx4 PCIe Gen2x2	VPUx2 minipcie	VPUx2 M.2 B+M	VPUx1 M.2 A+E	Retail applications	Attendance System	LPR
FLEX-BX-200-Q370 Intel® Coffee Lake AI Modular Box PC						Up to 32 CH	Up to 16 CH	Up to 16 CH
TANK AIoT Dev. Kit Intel® SkyLake AI Dev. Kit						Up to 16 CH	Up to 8 CH	Up to 8 CH
RACK-500AI Intel® Coffee Lake AI Modular PC						Up to 16 CH	Up to 8 CH	Up to 8 CH
PAC-400AI Intel® SkyLake AI Modular PC						Up to 16 CH	Up to 8 CH	Up to 8 CH
DRPC-230 Intel® Whiskey Lake Core™ i5-8265U						Up to 8 CH	Up to 4 CH	Up to 4 CH
ITG-100AI Intel® Atom™ x5-E3930						Up to 2 CH	Testing Estimated 1~2CH	Testing Estimated 1~2CH



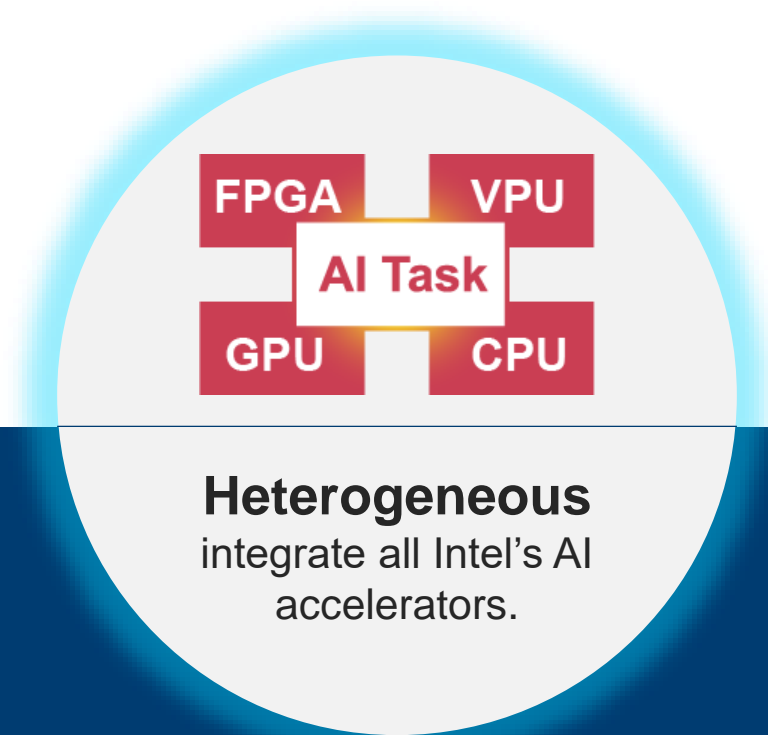
# The Advantages of Intel solution

# Why Intel & IEI Mustang Solution



**Cross Platform**  
Support both  
Windows & Linux OS

# Why Intel & IEI Mustang Solution



OpenVINO™

intel® FPGA

Movidius  
an Intel company



# Why Intel & Iei Mustang Solution



Mustang-F100-A10 (45W)



Mustang-V100-MX8  
(25W, single slot)



Mustang-V100-MX4  
(15W, single slot)

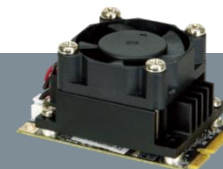


## Compact Size

IEI provided full portfolios  
of form factors



Mustang-M2BM-MX2(7.5W)



Mustang-MPCIE-MX2(7.5W)



Mustang-M2AE-MX1(5W)

# Why Intel & IEI Mustang Solution



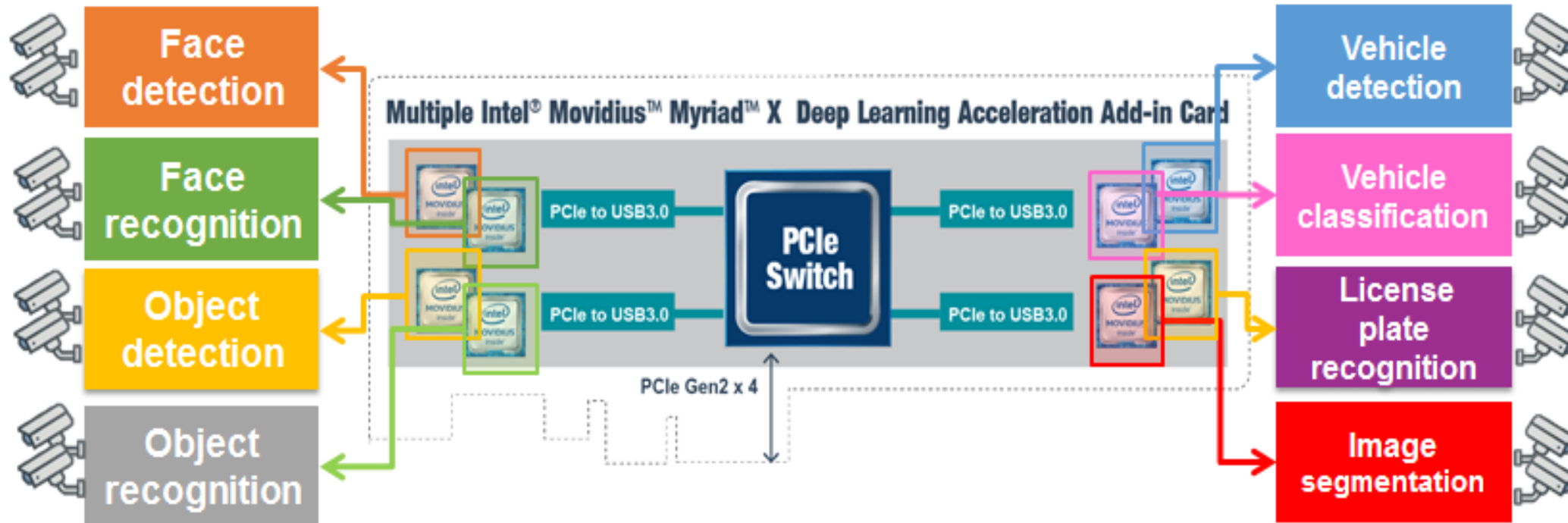
**Multi-Task**

**Distributed Computing**

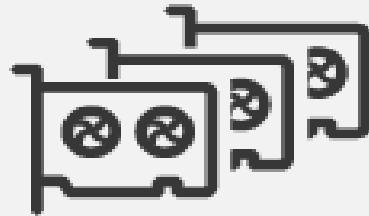
Multi-threads

Multi-tasks

# Why Intel & IEI Mustang Solution



# Why Intel & Iei Mustang Solution



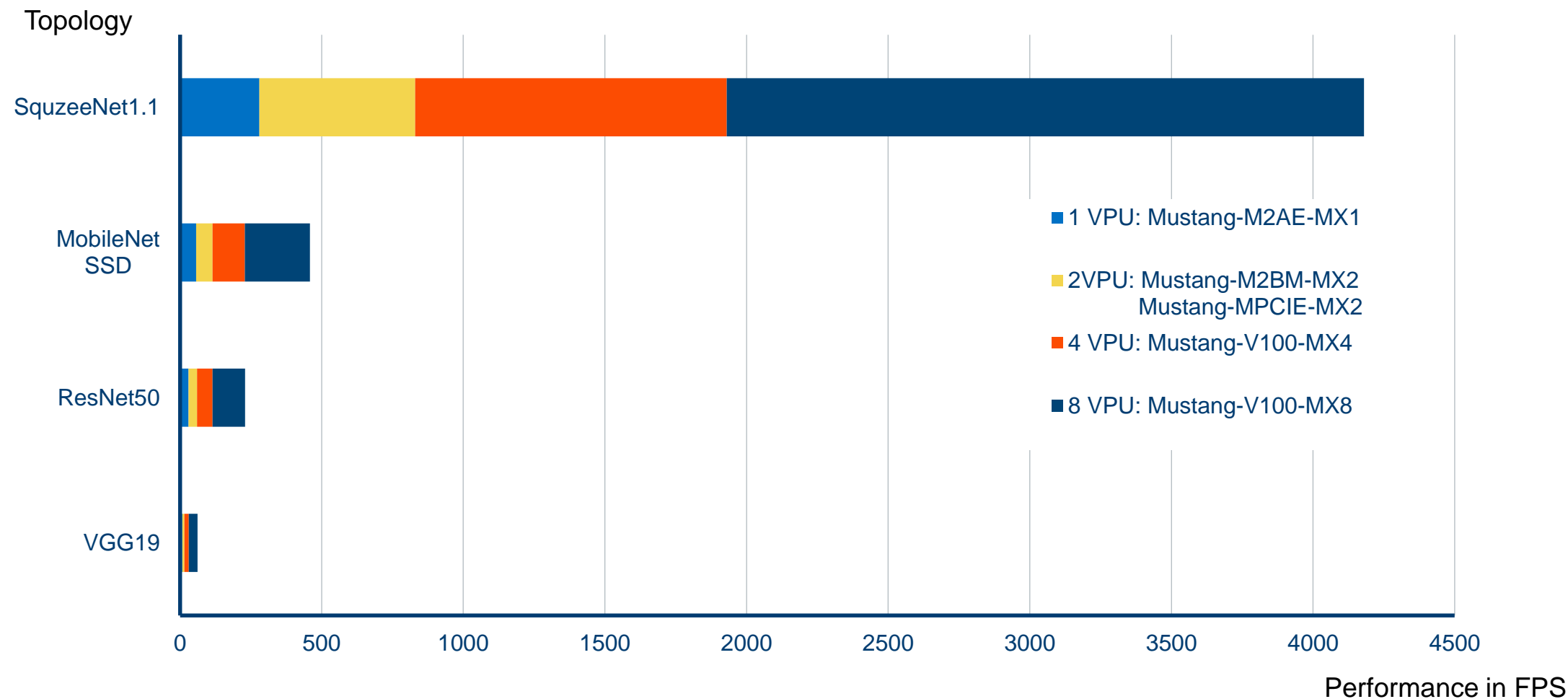
**Multiple Cards**

## **Scalable**

Performance increases  
by the factor of VPU  
quantity

# Why Intel & IEI Mustang Solution

Performance increases by the factor of VPU quantity.



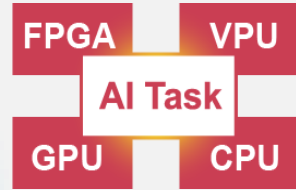


# Why Intel & Iei Mustang Solution



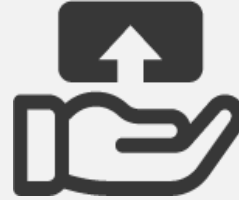
## Cross Platform

Support both  
Windows & Linux OS



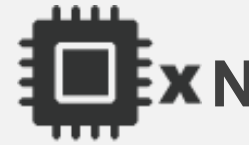
## Heterogeneous

integrate all Intel's AI  
accelerators.



## Compact Size

IEI provided full  
portfolios of form factors



Multi-Task

## Distributed computing

Multi-threads  
Multi-tasks



Multiple Cards

## Scalable

Performance  
increases by the  
factor of VPU  
quantity

OpenVINO™

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