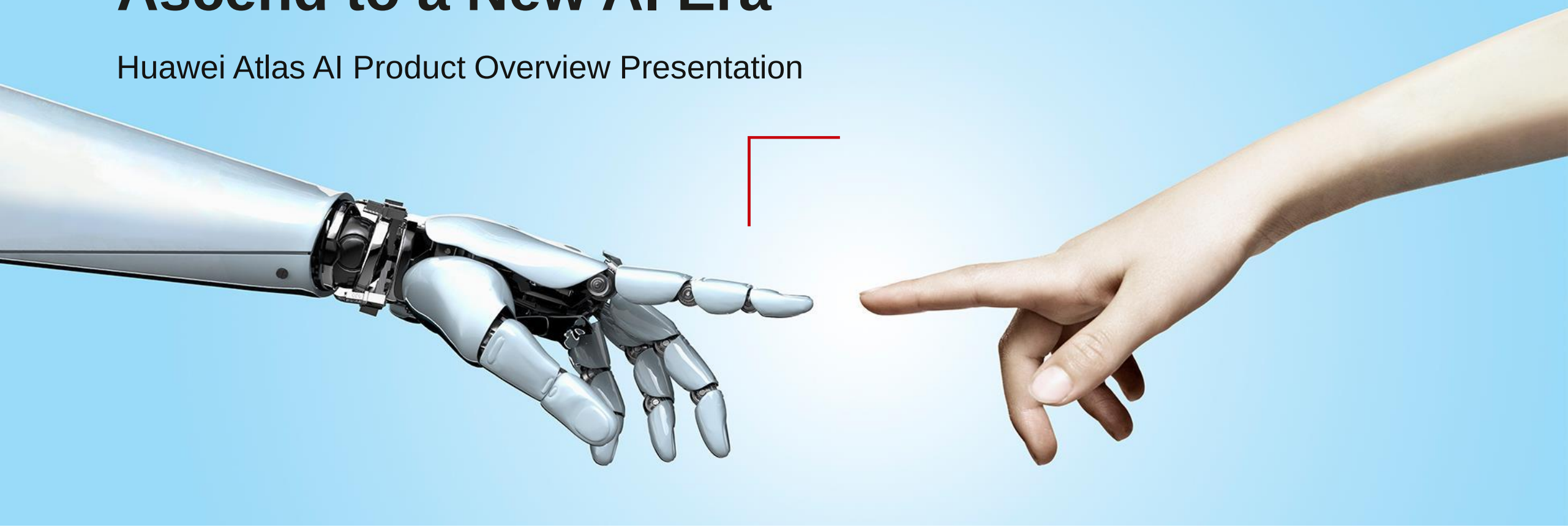
Ascend to a New AI Era

Huawei Atlas AI Product Overview Presentation



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Huawei: Leading Global Provider of ICT Infrastructure and Smart Devices

Bring digital to every person, home and organization for a fully connected, intelligent world

Huawei's end-to-end portfolio of products, solutions and services are both competitive and secure. Through open collaboration with ecosystem partners, we create lasting value for our customers, working to empower people, enrich home life, and inspire innovation in organizations of all shapes and sizes.

At Huawei, innovation focuses on customer needs. We invest heavily in basic research, concentrating on technological breakthroughs that drive the world forward.

188,000

Employees

80,000

R&D employees

170+

Countries and regions

No. 68 in

Interbrand's
Top 100
Best Global Brands

No. 61 in

Fortune Global 500

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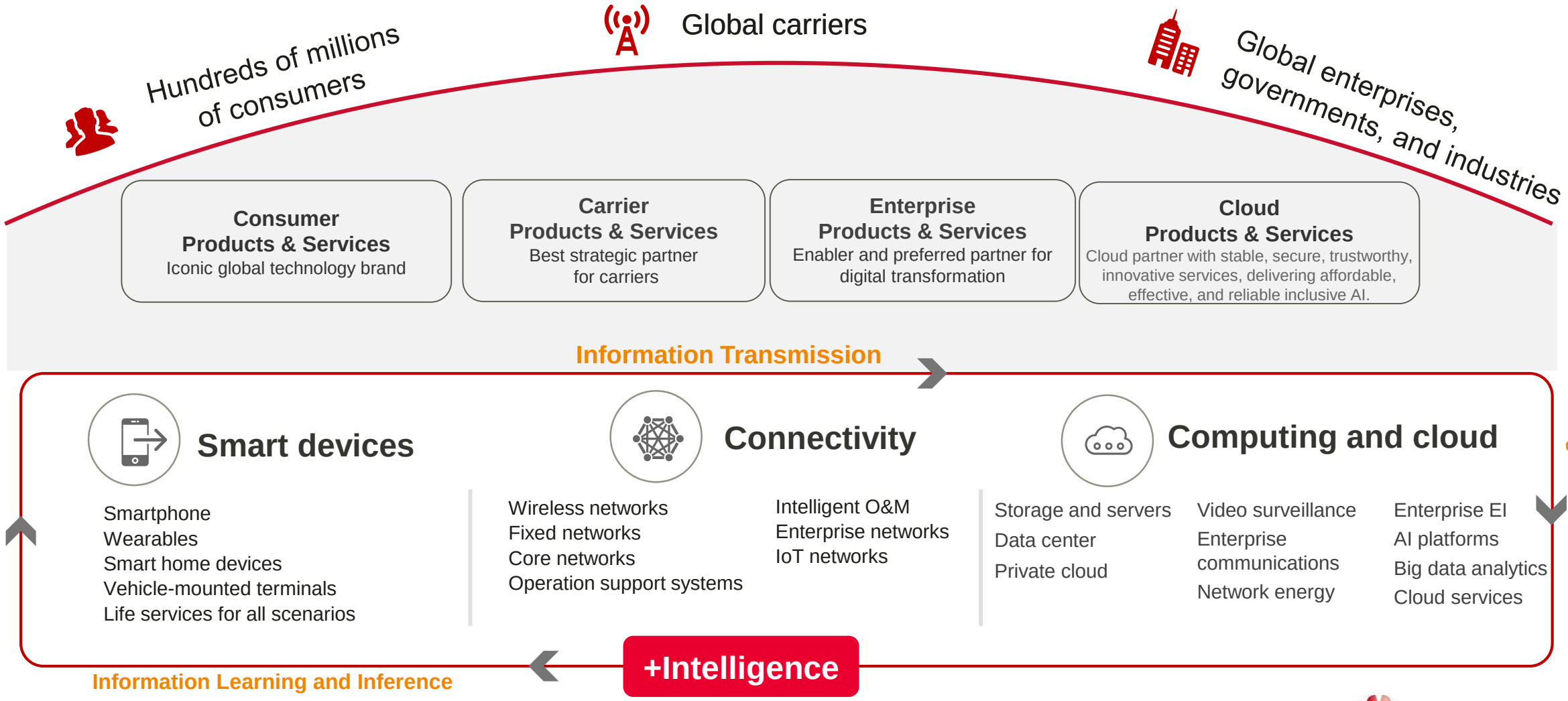
Focusing on Smart Devices, Connectivity, Computing, and Cloud; Providing Products and Solutions for Three Customer Groups



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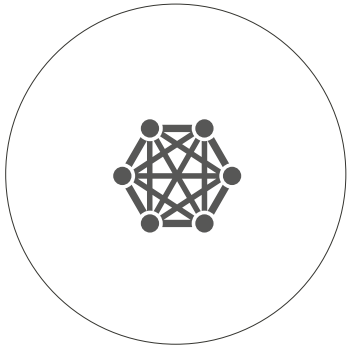
Huawei's Value Propositions

Building a fully connected, intelligent world

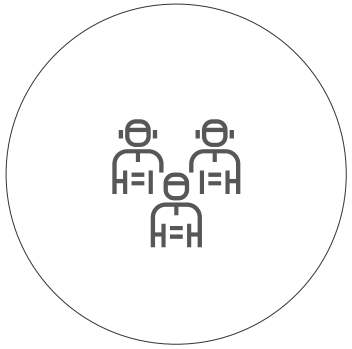


Ubiquitous Connectivity

- Wireless access
- Wired access
- Bearer network
- Core network
- Enterprise network

Pervasive Intelligence

- Mobile AI
- SoftCOM AI network
- Edge intelligence
- Enterprise intelligence (EI)
- Intelligent computing (servers + AI)
- Intelligent storage
- Intelligent security (management, analysis, and control platforms)



Personalized Experience

- Intelligent experience for all scenarios: Personal, car, home, and office scenarios
- Smart experience
- Chip-device-cloud synergy
- Intuitive interaction
- Multi-level security protection: Chips, devices, and cloud

Digital Platform

- Open, reliable cloud platform (Public cloud and private cloud)
- Open hybrid cloud architecture
- ICT infrastructure platform with device-network-cloud synergy

Globalized Positioning, Localized Operations

- Operations in 170+ countries; approximately 188,000+ employees of 160+ nationalities; 70% of staff hired locally
- Huawei is increasing its "glocalization", delegating more end-to-end business responsibility and authority to local teams
- We aim to develop a healthy industry in which every player can succeed, and we pride ourselves on being a responsible local corporate citizen

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With the Advent of the 4th Industrial Revolution, AI Is Driving Global Development

1st

Steam engine

2nd

Electric power

3rd

Information technology

4th Industrial Revolution

Artificial intelligence

Global macro trends

- Sustainability
- New growth of digital economy
- Upgrade to smart city
- Digital transformation of industries
- Better consumer experience
- Scenario-specific solutions

Two Key Technologies in the Intelligent World

Building a fully connected, intelligent world

Connectivity

100 billion connections

Computing

$2 trillion computing market

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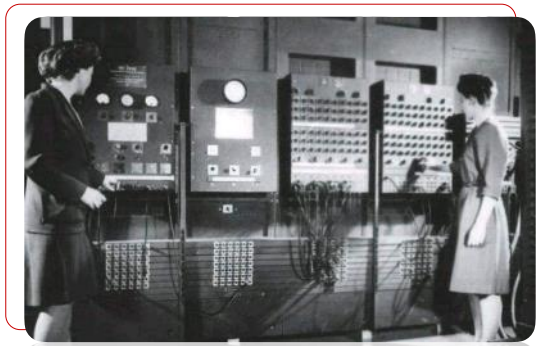
Computing Extends Human Capabilities



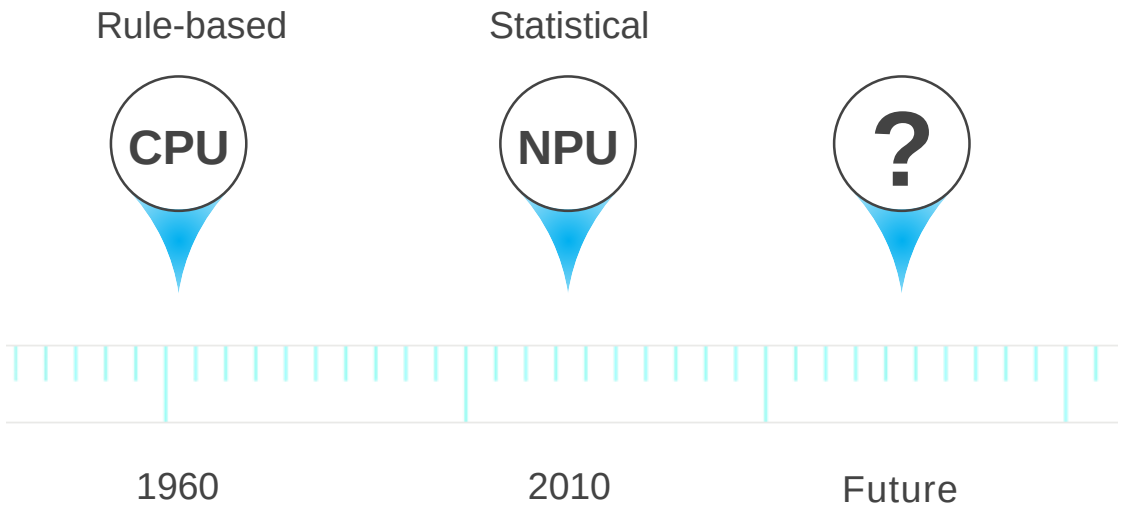
Mainframe computers

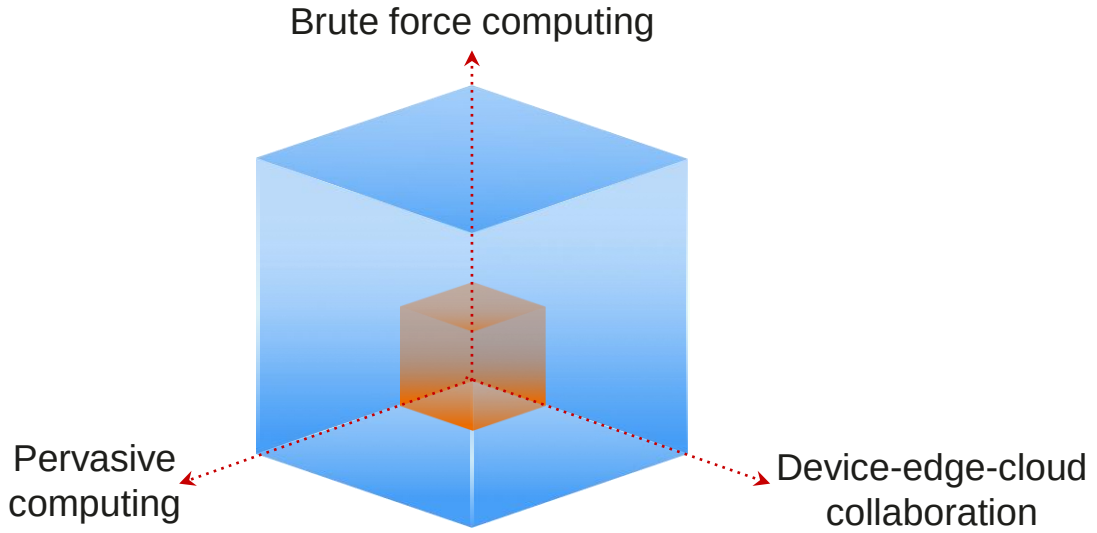
PCs

Mobile phones

Wearables

Computing Modes Constantly Evolve, Propelling the Industry into the Intelligent Era





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Many Countries Have Released AI Strategies

2019: "Smart +" was reported on the work of the governments, highlighting smart manufacturing, intelligent transformation of industries, and deepened big data application
2018: Artificial Intelligence Innovation Action Plan for Higher Schools; 2019: AI included in the compulsory courses of primary and secondary schools
2017: Three-Year Action Plan for Promoting Development of a New Generation Artificial Intelligence Industry
2017: Next Generation Artificial Intelligence Development Plan
2016: Internet + Artificial Intelligence Three-Year Action Plan

2019: The President signed the "AI Initiative" (the federal government increases investment and protects the US leading edge)
2017: National Robotics Initiative 2.0, NRI-2.0
2016: National AI Research and Development Strategic Plan Preparing for the Future of AI
2013: Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative
2010: US's DARPA started to support AI application in various fields

2019: South Korea released the Dataset AI Development Plan, announcing the increase in AI investment and becoming the leader of global data and AI by 2030
2017: Society 5.0, Artificial Intelligence Technology Strategy
2015: Japan's Robot Strategy

2019: Germany released Germany’s Industrial Strategy 2030 in February, emphasizing the use of AI technology to maintain the global industrial position.
2018: France – French Intelligence Artificielle
2018: UK – Industrial Strategy: Artificial Intelligence Sector Deal
2018: EU – intends to release an AI strategy and coordination plan; Germany – Key points for a Federal Government Strategy on Artificial Intelligence, AI development strategy to be released by the end of the year
2013: EU – Human Brain Project (HBP)

Source: Huawei EBG New ICT, 2019

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Huawei's AI Strategy

Invest in basic research

Develop fundamental capabilities for data & power-efficient (i.e., less data, computing, and power needed), secure & trusted, automated/autonomous machine learning in computer vision, natural language processing, decision/inference, etc.

Build a full-stack AI portfolio

Deliver abundant and affordable computing power.

Provide an efficient and easy-to-use AI platform with full-pipeline services.

Adaptive to all scenarios, both standalone and cooperative scenarios between cloud, edge, and device.

Develop open ecosystem and talents

Collaborate widely with global academia, industries, and partners.

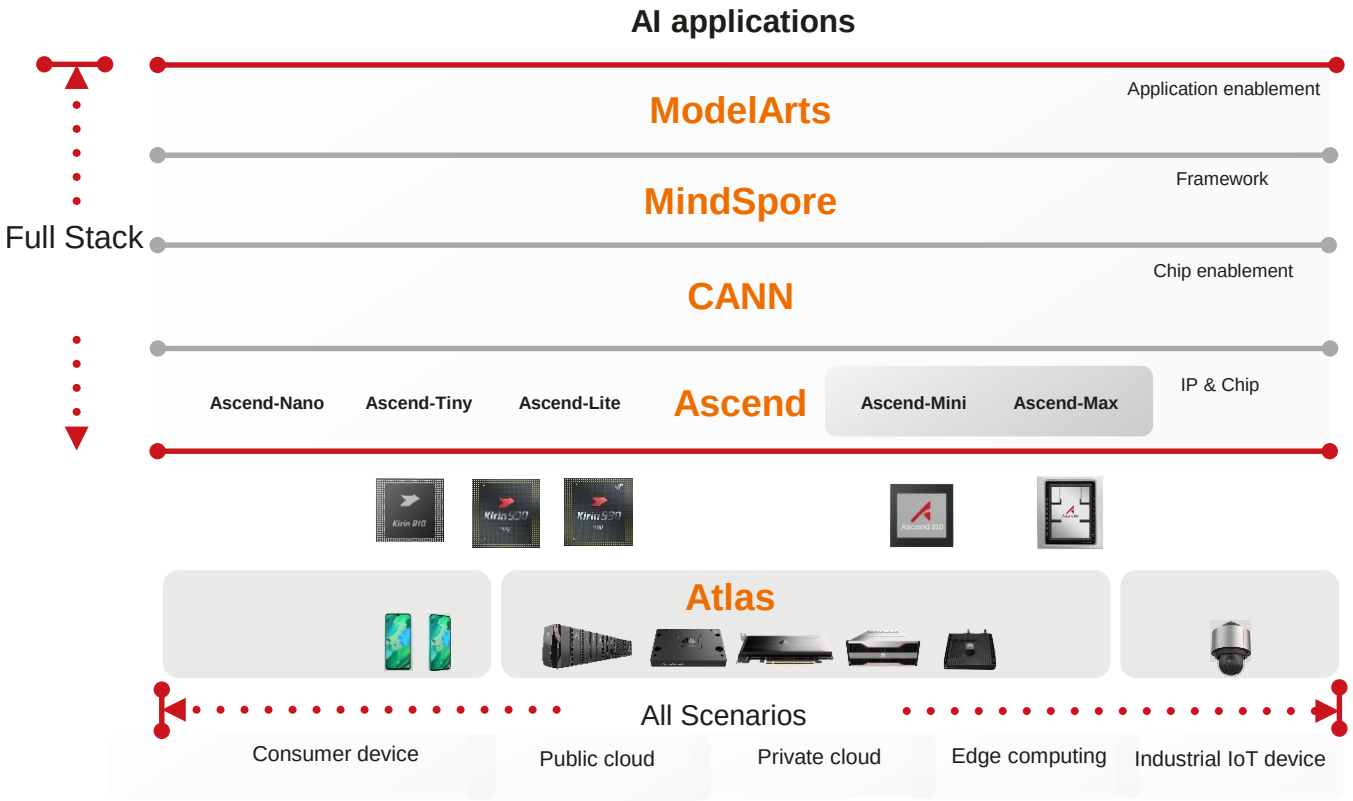
Strengthen existing portfolio

Bring an AI mindset and techniques into existing products and solutions to create larger value and enhance competitive strengths.

Drive operational efficiency

Apply AI to massive volumes of routine business activities for better efficiency and quality.

Huawei Full-Stack, All-Scenario AI Solution



Application enablement: provides E2E services (ModelArts), layered APIs, and pre-integrated solutions

MindSpore: a unified training and inference framework for independent and collaborated operation across the device-edge-cloud

CANN: chip operator libraries and highly automated operator development tools

Ascend: unified and scalable AI IPs and chips

Atlas: an all-scenario AI infrastructure solution for the device-edge-cloud based on the Ascend series AI processors and various product form factors

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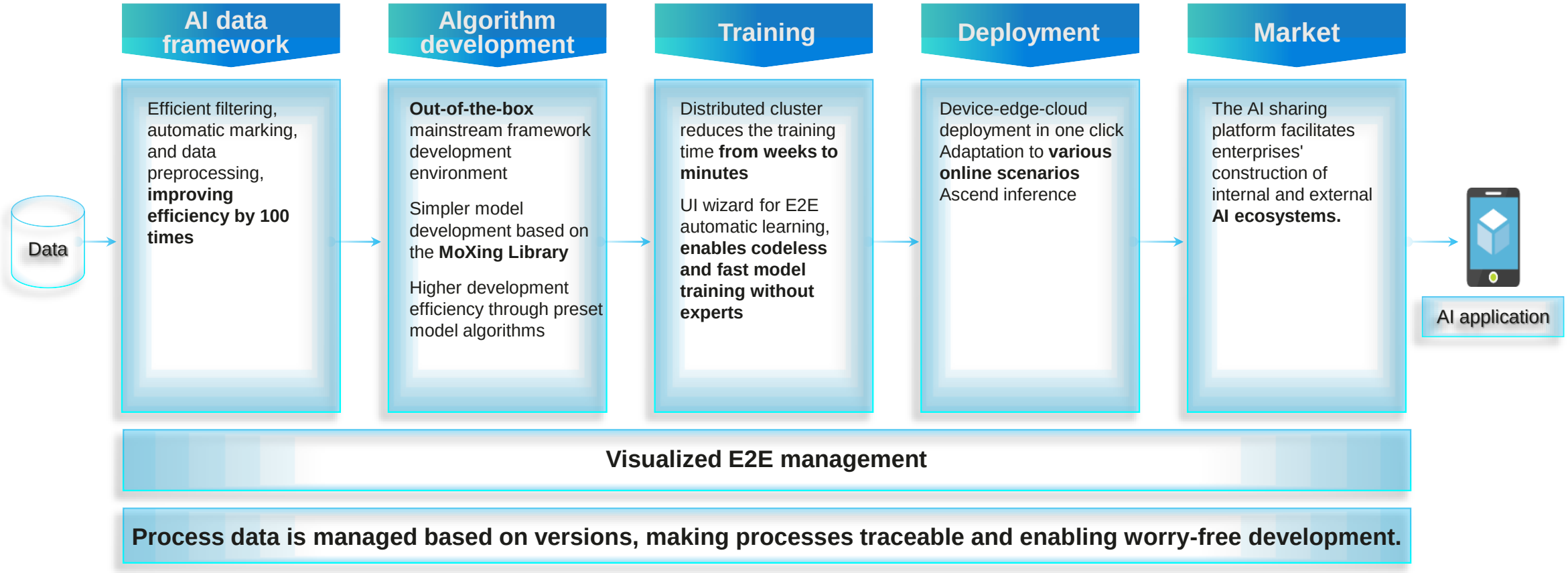
ModelArts: A Faster, Inclusive AI Development Platform

- A developer-centric and full-lifecycle platform covering data preparation, model training, and inference execution
- Facilitating AI adoption by enabling developers of different needs with hierarchical APIs and pre-integrated solutions



In the latest training ranking of Stanford DAWNBench, Huawei cloud ModelArts takes 10 minutes and 28 seconds, making ModelArts the world's fastest, which is 8 minutes faster than the Amazon cloud.

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MindSpore: All-Scenario AI Computing Framework

All-scenario AI application ecosystem

MindSpore

All-scenario unified APIs

Automatic differentiation	Automatic parallelism	Automatic optimization

MindSpore IR computational graph expression

On-device execution	Pipeline parallelism	Deep graph optimization

Device-edge-cloud, collaborative, distributed architecture (deployment, scheduling, communication, etc.)

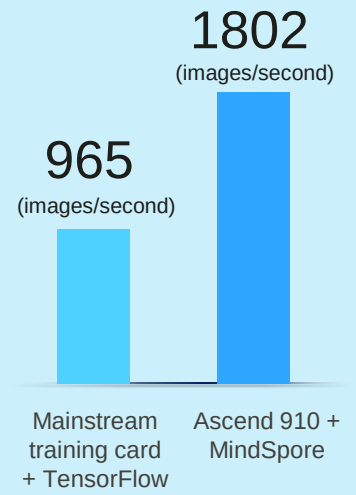
Processors: Ascend, GPU, and CPU

MindSpore

User-friendly development: AI algorithm as code

Runtime-efficient: optimized for Ascend and GPU

Flexible deployment: all-scenario on-demand collaboration



- ResNet 50 V1.5
- ImageNet 2012
- Based on the respective best batch size

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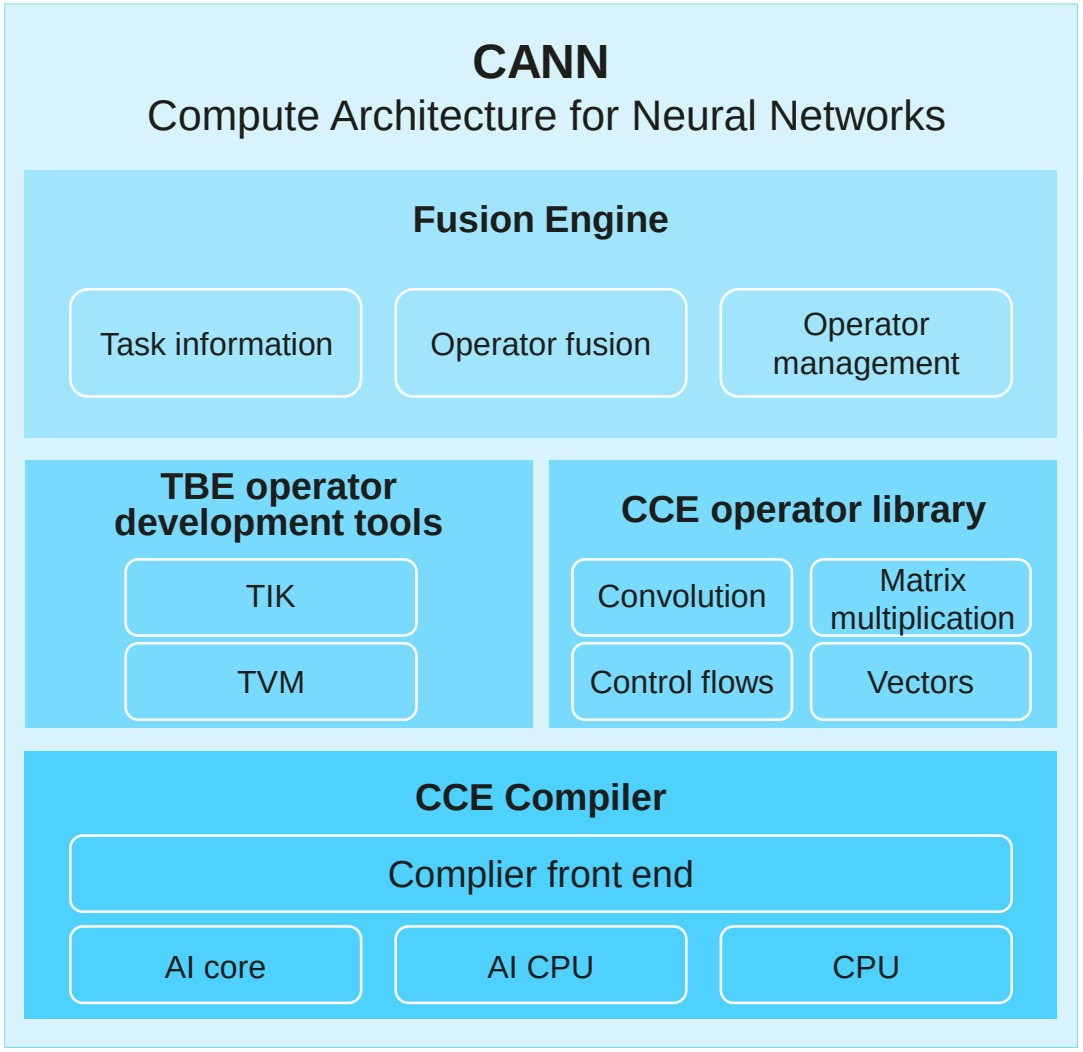
CANN: High-Performance Chip Operator Library and Automated Operator Development Tools



CANN: Includes the chip operator library and highly automated operator development tools for optimal development efficiency and Ascend performance matching

Fusion Engine: Ascend-based memory architecture implements operator fusion, reduces operator memory data transfer, and improves performance by 17%

Tensor Boost Engine (TBE) operator development tools: various preset APIs for custom operator development and automatic optimization, **shortening project cycle by 53% and reducing labor by 42%**

CCE operator library: high-performance operator library based on in-depth collaborative optimization of the Ascend chip, **for 10% performance boost**

CCE compiler: compiler and binary tool set using heterogeneous hybrid programming language (C/C++ extension) to optimize performance and programming, enabling Ascend to support all scenarios

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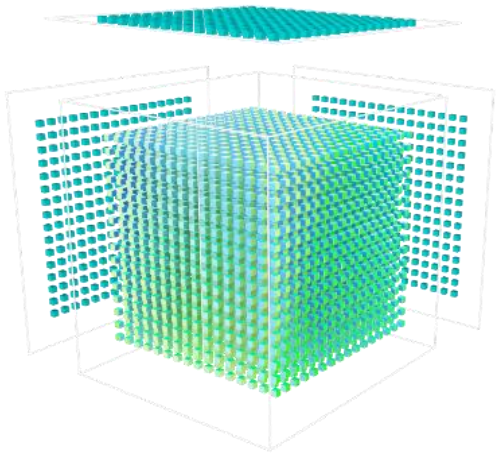
Da Vinci Architecture, for Tensor Computing



3D Cube: Made for AI Matrix Operation

Human Intelligence
Obtain complete semantics from holographic information input

Artificial Intelligence
Data, computing power, and algorithms

3D Cube:
16*16*16 3D Elastic Cube

- High computing power: 4096 FP16 MAC operations completed within a clock cycle
- Efficiency: from IP modules of dozens of mW to chips of hundreds of watts, adapting to the smoothly scalable architecture of device-edge-cloud

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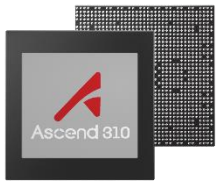
Ascend AI Processors Infuse Superior Intelligence into Computing



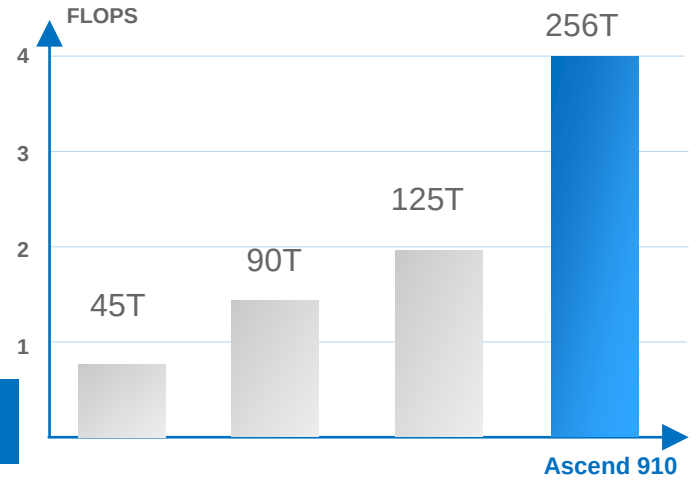
Ascend 310

AI SoC with Ultimate Perf./Watt

- Ascend-Mini
  Architecture: Da Vinci
- **Half precision (FP16): 8 TFLOPS**
- **Integer precision (INT8): 16 TOPS**
- **16-channel full-HD video decoder: H.264/265**
- 1-channel full-HD video encoder: H.264/265
- **Max. power consumption: 8 W**

Ascend 910

World's Most Powerful AI Processor



* Normalized to 16-bit

- Ascend-Max
  Architecture: Da Vinci
- **Half precision (FP16): 256 TFLOPS**
- **Integer precision (INT8): 512 TOPS**
- **128-channel full-HD video decoder: H.264/265**
- Max. power consumption: 310 W

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Atlas AI Computing Platform Portfolio

Superior computing power | **All-scenario deployment** | **Cloud-edge-device collaboration**

Atlas 900 AI cluster

Atlas 800 AI server
Model: 9000/9010

Atlas 800 AI server
Model: 3000/3010

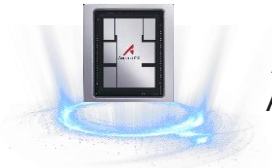
Atlas 300 AI accelerator card
Model: 3000/9000

Atlas 500 AI
edge station

Atlas 200 AI
accelerator module

Cloud — **Edge** — **Device**

Ascend 310
AI processor



Ascend 910
AI processor

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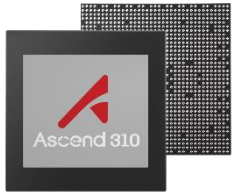
Atlas Accelerates AI Inference



Ascend 310
AI processor

Intelligence into terminal devices
7x higher performance

Atlas 200 AI accelerator module

Model: 3000

64-channel video inference
Industry's highest density

Atlas 300 AI accelerator card

Model: 3000

Edge intelligence and cloud-edge collaboration

Atlas 500 AI edge station

Model: 3000

AI inference platform with ultimate computing power

Atlas 800 AI server

Model: 3000/3010

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Atlas 200: Smartening up Terminal Devices, with a 7x Performance Leap

Cameras Drones Robots

- **16 TOPS INT8, 9.5 W**
- **16-channel HD video real-time analytics, and JPEG decoding**
- **4 GB/8 GB memory, PCIe 3.0 x4 interface**
- **Operating temperature: -25°C to +80°C**

30 → 200

Number of faces in a single frame

AI camera

Run multiple algorithms in parallel

Pixel-level image segmentation
+ Facial recognition
+ Posture recognition
+ Vehicle recognition

Models in the demo are Huawei employees.

Atlas 200 Empowers Robotic Arms for Garbage Sorting

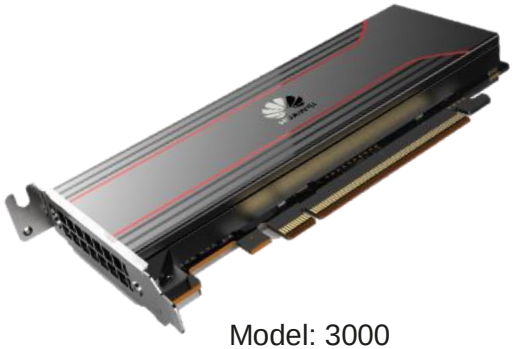
Challenges

- China has to deal with more than 400 million tons of domestic waste every year. Garbage sorting involves intensive workload and labor, and endangers the health of the workers.

Solution

- Huawei provides a solution composed of the Atlas 200 AI accelerator module, development interface, and HUAWEI CLOUD resources, and works with ABB to develop a vision-enabled robotic arm solution for garbage sorting.
- Atlas 200 is integrated into the robotic arm control board to identify garbage types and control the robotic arm, which boosts sorting efficiency and frees up human labor.
- Atlas 200 delivers the leap from programming to learning in industrial robotic arms, bridging the "last mile" in industrial automation. Robotic arms now act with real-time decision making instead of moving as programmed in advance.

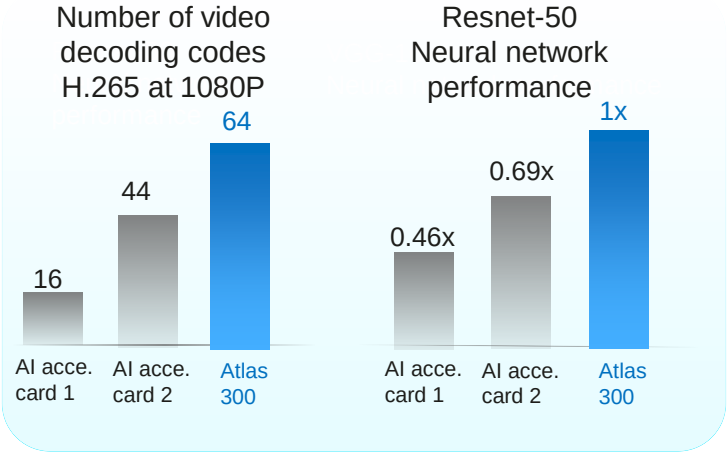
Atlas 300: Industry's Highest-Density AI Accelerator Card, Supporting 64-Channel Video Inference



Model: 3000

- **64 TOPS of INT8, 67 W**
- **32 GB memory**
- **64-channel HD video real-time analytics**

Video Analytics | OCR | Speech Recognition | Precision Marketing | Medical Image Analysis



Industry-leading performance

Demo video

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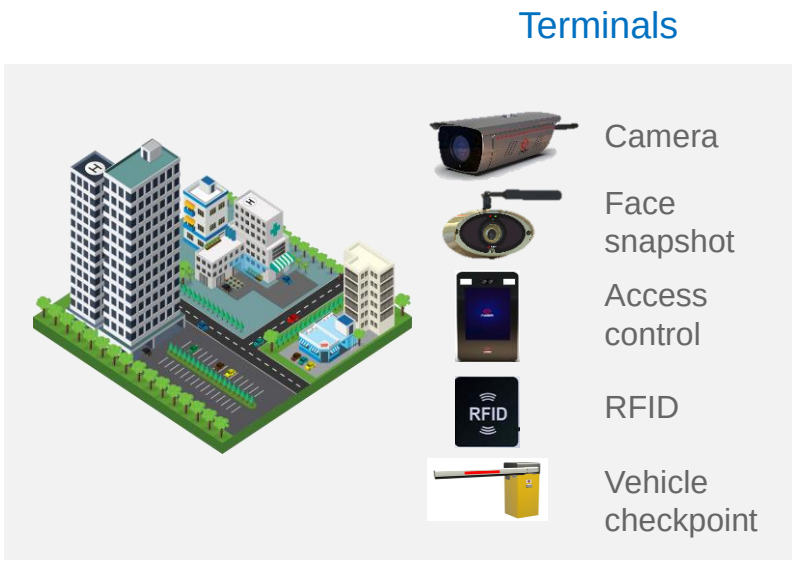
Atlas 300 Helps Build a Safe Smart Community

Challenges

- Community information collection is slow and difficult, especially in real population management and basic information collection.
- Data resources are isolated, making it impossible to apply digitalized statistics or big data methods to the population information of most communities.
- Current methods cannot manage floating population in time or based on networks.

Solution

- The smart community solution based on the Atlas 300 AI inference accelerator card automatically identifies community residents, facilitates community residents' access, and helps communities deploy security warnings for suspicious persons, improving community security.
- The web interface supports facial retrieval, frequency analysis, statistics report, resource management, and system management. The statistics data can be uploaded to the management platform for display.



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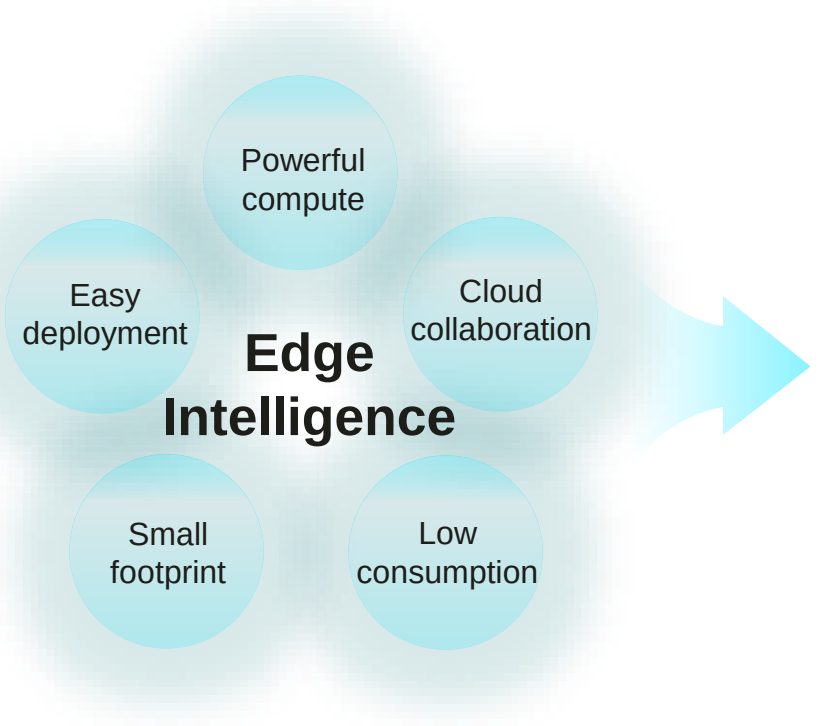
Atlas 500 AI Edge Station



- **16 TOPS INT8**
- **25–40 W**
- **Wi-Fi & LTE**
- **16-channel HD video real-time analytics**
- **Fanless, stable at -40°C to +70°C**

Built for Harsh Edge Environments

Extreme cold | Extreme hot | Heavy dust

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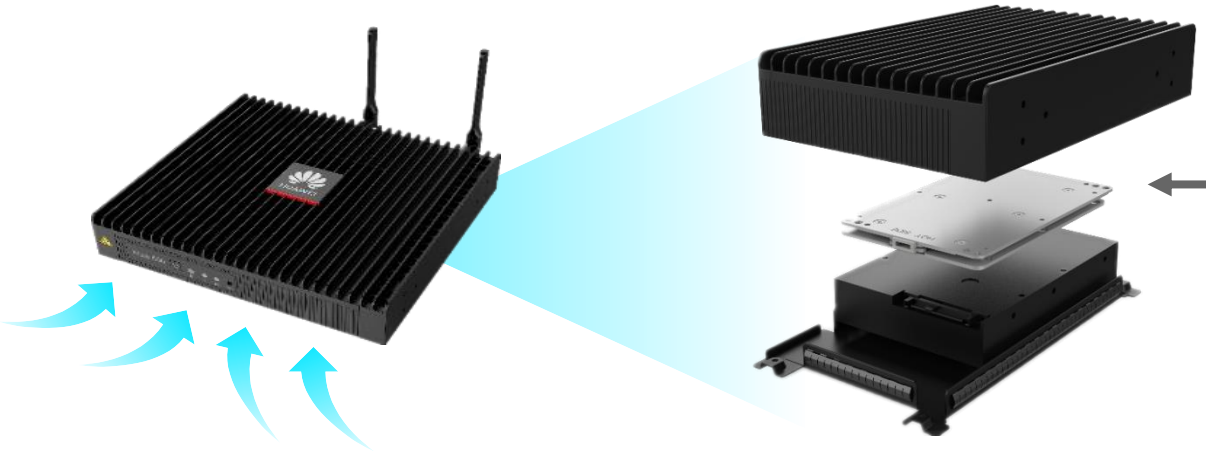
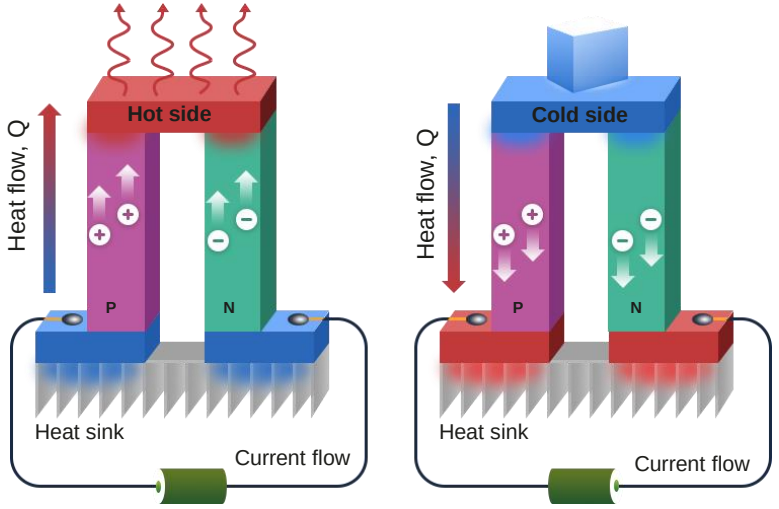
TEC Semiconductor Cooling Technology

Atlas 500



Thermoelectric cooling (TEC) semiconductor

Peltier Effect, Semiconductor Cooling



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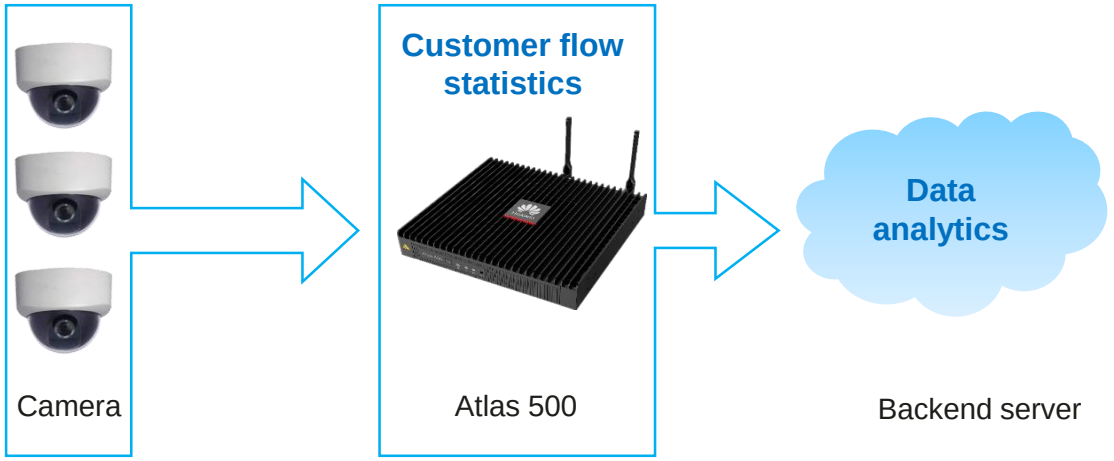
AI Edge Station Enables Accurate Customer Flow Analysis for Smart Shopping Malls

Challenges

Shopping mall companies cannot quantify customer turnover, and therefore fail to analyze the direct cause of sales fluctuation. They cannot adapt agilely to customer needs.

Solution

- Atlas 500 smart shopping mall solution: Uses AI algorithms to analyze crowd characteristics such as human bodies, postures, and traffic, and uses big data analytics to obtain operation status and identify customer interest.
- Quantify and visualize operation data, and clearly display business operation problems.
- Identify VIP customers and recommend products based on customer interest to improve the sales success rate.
- Adjust the rent based on the passenger flow data to ensure shop owners' rights and interests.



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Atlas 800 AI Server – 3000 Model: Efficient Inference Platform Powered by Kunpeng

- 2 Kunpeng 920 processors in a 2U space
- 8 PCIe slots, supporting up to 8 Atlas 300 AI accelerator cards
- Up to 512-channel real-time HD video analytics
- Air-cooled, stable in 5°C to 40°C environments

Powerful Real-Time Inference

- Supports **8 Atlas 300 AI accelerator cards**, industry-leading 64 TeraOPS per card; **512-channel real-time HD video analytics** per system
- Runs on 2 **Kunpeng 920 processors**, unlocking supreme performance and compute power; leverages a multi-core architecture for application acceleration

Efficient Computing

- Provides an AI computing platform with high efficiency, low consumption for inference scenarios, fully leveraging the multi-core and energy-efficient advantages of Kunpeng
- Atlas 300 runs at an ultra-low power of 67 W, fueling the AI server with faster computing and **higher performance per watt**

Atlas 800 AI Server – 3010 Model: Flexible Inference Platform Based on Intel Processors

- 2 Intel® Xeon® SP Skylake or Cascade Lake processors in a 2U space
- 8 PCIe slots, supporting up to 7 Atlas 300/NVIDIA T4 AI accelerator cards
- Up to 448-channel real-time HD video analytics
- Air-cooled, stable in 5°C to 35°C environments

Flexible Configuration, Workload-Adaptive

- Supports flexible combinations of **SAS/SATA/NVMe/M.2 SSD hard drives**
- Supports **LAN on motherboard (LOM) and FlexIO cards**, providing rich network interface options

Intelligent Video Analytics

- Supports **7 AI accelerator cards**, adapting to various video and image analytics scenarios
- Uses the Atlas 300 dedicated decoding engine for transcoding and inference of up to 448-channel HD video streams

Atlas 200 DK AI Developer Kit: Superb Computing and Ease of Use

Full-stack AI development on and off the cloud

- **16 TOPS INT8, 24 W**
- **1 USB type-C, 2 camera interfaces, 1 GE port, 1 SD card slot**
- **8 GB memory**
- **Operating temperature: 0°C to 45°C**
- **Dimensions: 24 mm x 125 mm x 80 mm**

Developers

Set up a dev environment with 1 laptop
Ultra low cost for local independent environment, with multiple functions and interfaces to meet basic requirements

Researchers

Local dev + Cloud training collaboration
The Developer Kit and HUAWEI CLOUD use the same protocol stack, allowing for training on the cloud and local deployment without any modification

Startups

Code-level demo
Based on the reference architecture, algorithm functions are completed with only 10% code modification; support developer community interaction; seamless porting for commercial products

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Atlas Accelerates AI Training

Ascend 910
AI processor

The ultimate training card

Atlas 300 AI accelerator card

Model: 9000

World's most powerful training server

Atlas 800 AI server

Model: 9000/9010

World's fastest AI training cluster

Atlas 900 AI cluster

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Atlas 300 AI Accelerator Card: Industry's Most Powerful Training Card

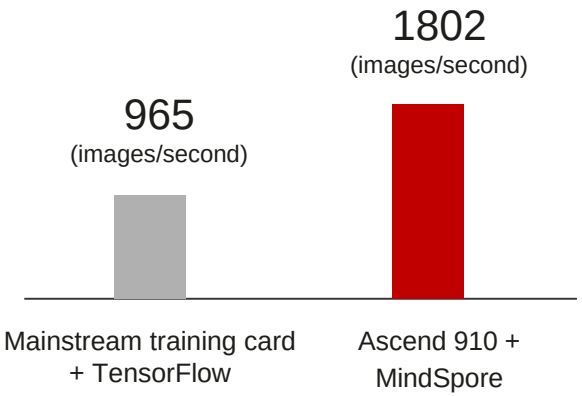
Atlas 300

Model: 9000

2x ↑

Computing power per card

256T FLOPS at FP16



Test benchmark:
- ResNet 50 V1.5
- ImageNet 2012
- Optimal batch size respectively

70% ↓

Gradient synchronization latency

Direct 100G RoCE

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Atlas 800 AI Server: World's Most Powerful AI Training Server

Atlas 800

Model: 9000

2.5x ↑

Computing density

2P FLOPS/4U

25x ↑

Hardware decoder

16384 images/second

(1080P decoding capability)

1.8x ↑

Energy efficiency

2P FLOPS/5.6 kW

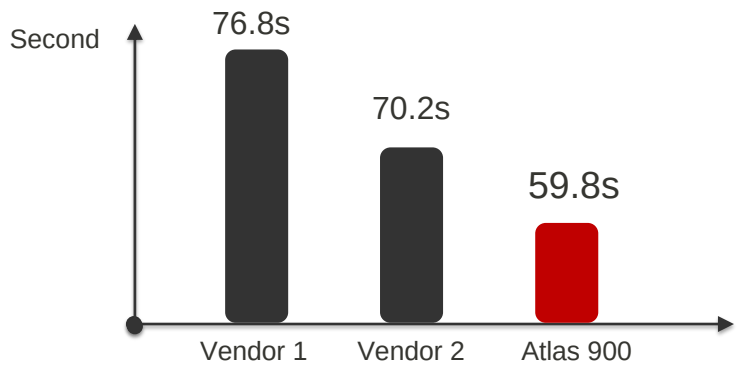
Atlas 900 AI Cluster: World's Fastest AI Training Cluster

Atlas 900

256–1024 PFLOPS at FP16

Leading computing power | Best cluster network | Ultimate heat dissipation

World's #1: 59.8s



Test benchmark:

- Benchmark: ResNet-50 V1.5 model, ImageNet-1k dataset
- Cluster: 1024 Ascend 910 AI processors
- Accuracy: 75.9%

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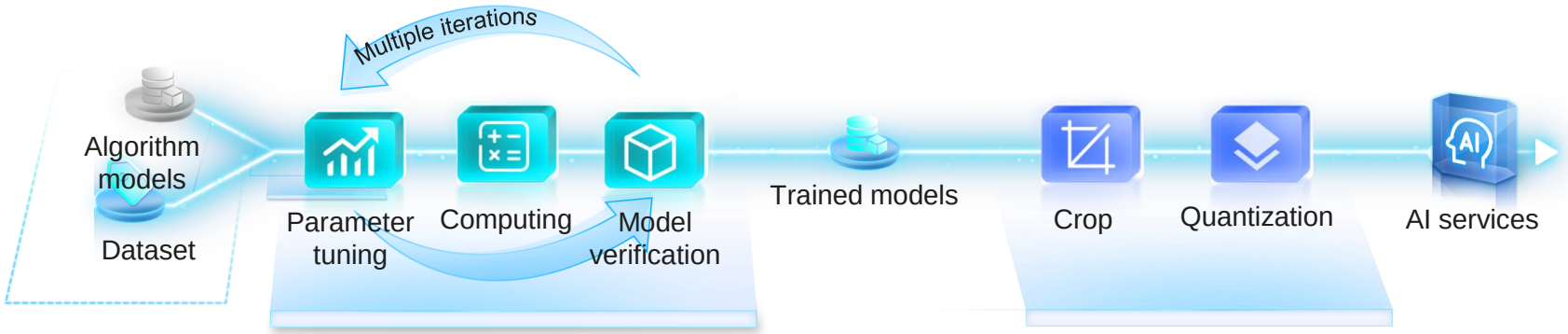
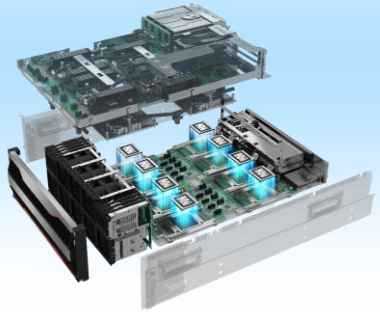
Atlas Accelerates AI Model Training for Various Applications



Atlas 300 AI accelerator card
Model: 9000



Atlas 800 AI server
Model: 9000

Atlas 900 AI cluster

Video analytics

Gene research

Autonomous driving

Weather forecast

Oil exploration

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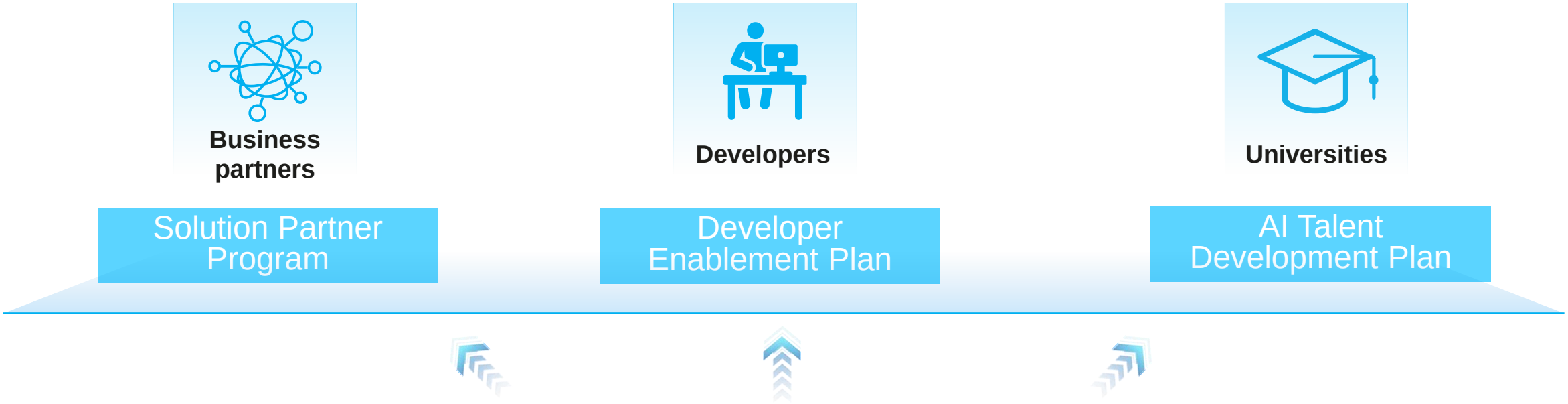
1 Platform + 3 Plans Support Ascend Industry Partners and Developers

2000 partners, 1 million developers in 5 years



Work Closely with Industry Organizations to Incubate Industry Standards

Huawei tasked with building China's Next-Generation AI Open Innovation Platform for basic software and hardware

Industry organization

Serves as the governing unit in 10+ AI industry organizations

- AIIA governing unit
- AITISA governing unit
- Governing unit of the Information Technology and Application Innovation Committee

Research institute

Strategic cooperation with 20+ research institutes

- Peng Cheng Laboratory
- Shanghai Astronomical Observatory
- National Natural Science Foundation of China

Industry association

In-depth participation and technical cooperation in global industry associations

- National Smart City Standardization & Integration Team
- Smart Security Industry Association of Shenzhen
- China Intelligent Transportation Systems Association

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Open the CANN Toolchain to Fully Unleash the Potential of Ascend

Fully Open CANN Toolchain

TBE: custom operator development tools, enabling optimal development efficiency and allowing operators to best match the performance of Ascend

CCE: optimal performance and programming efficiency for all scenarios

CANN
Compute Architecture for Neural Networks

- Fusion Engine
- TBE operator development tools
- CCE operator library
- CCE Compiler

Full Promotion of Operator Development

Initiate the operator development plan and cooperate with universities, research institutes, and partners to fully unlock the potential of Ascend processors

Q4 2019

Tool release

Q1 2020

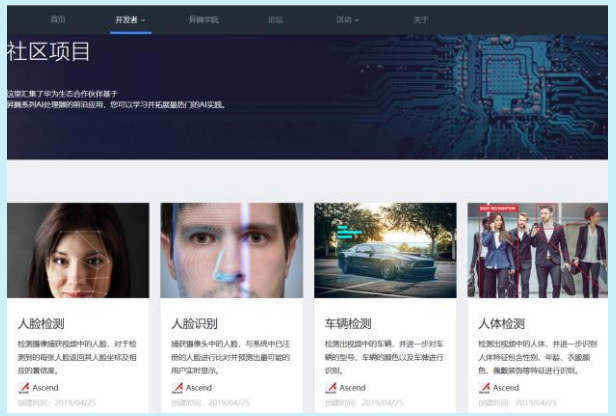
Operator Development Contest

Fully Open Mature Operators & Models

Open-source mature operators

GitHub

Open network models in the developer community



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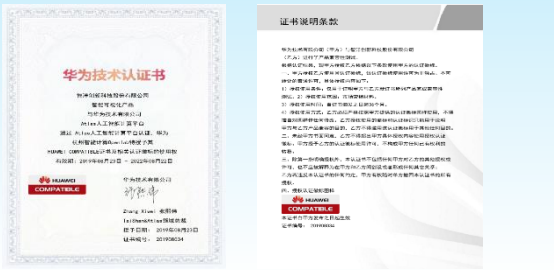
Work with Partners to Develop Scenario-Specific Solutions

Work with partners to develop 20+ joint solutions in 2019. The annual plan is 50+.

- Governments
- Finance
- Energy
- Transportation
- Education
- Internet

Create a joint solution display platform to demonstrate certification solutions.

Solution Certificate



Solution Demonstration Platform

In 2020, Huawei will further enhance partners' rights and provide 1000+ training cards.

Sample Device Support

• 1000+ AI training cards • 1000+ Developer Kits • Cloud training service

Joint Innovation Technical Support

• Onsite technical support • Special technical training • Global OpenLabs

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Develop 1M Developers Based on the Ascend Developer Community

Developer-Centric enablement platform

https://ascend.huawei.com/home

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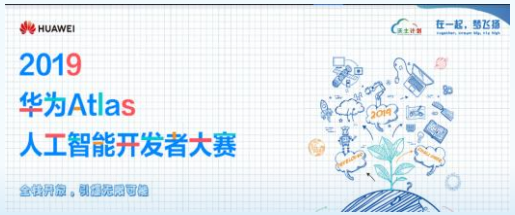
Annual technical salon

- Held in **10+** cities
- 20+ senior trainers
- Dozens of speeches

Developer Challenge



- **1500+** teams
- Over CNY1 million annual prize
- Equal opportunities for enterprises and universities

Developer support

- Public cloud vouchers
- Free certification course tickets
- Free Atlas Developer Kits

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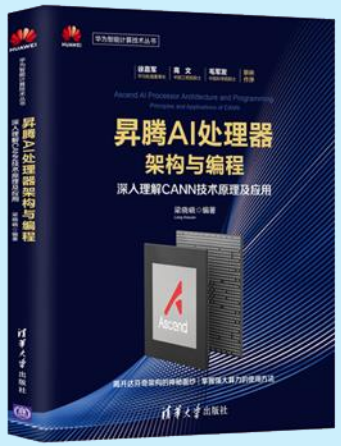
Huawei Developer Program for AI Talent, Covering 100 Colleges and Universities

Joint university curriculum development & lab building



- New generation of AI textbooks of the Department of Higher Education
- Authored by professor Liang Xiaoyao, Shanghai Jiao Tong University
- Published by Tsinghua University Press

Teaching & Training	University Contest	Research & Joint Innovation
Joint development of teaching materials Practice platform construction	University developer contest Incubation and innovation	Scientific research cooperation Industry-education joint innovation

Joint curriculum development with 30+ universities in 2019

First universities for joint course development

- Shanghai Jiao Tong University
- Zhejiang University
- Tsinghua University
- Peking University
- Tianjin University
- Renmin University of China
- Beijing University of Posts and Telecommunications
- Huazhong University of Science and Technology
- Southern University of Science and Technology
- Xidian University

Cooperation with Training Partners

- Tech Education
- Open Education
- Simple Education
- Xunfang Technology

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Strengthen Cooperation with Universities and Support the Implementation of Advanced Technologies with Ascend

The first 15+ partner universities have achieved many innovations in robotics, machine vision, and image processing.

南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY
華東師範大學 EAST CHINA NORMAL UNIVERSITY
哈爾濱工業大學 HARBIN INSTITUTE OF TECHNOLOGY
東南大學 SOUTHEAST UNIVERSITY
浙江大學 ZHEJIANG UNIVERSITY
上海交通大學 Shanghai Jiao Tong University
南開大學 Nankai University

- Fundus retinal vessel segmentation
- Humanoid
- Thmart
- Protein subcellular localization prediction
- Super-resolution image algorithm based on deep learning
- Age recognition
- Intelligent robot cluster for desert restoration
- Handwritten Chinese character recognition
- Single-image facial expression animation based on image warping and GAN

Expand cooperation and build Ascend into an innovative platform for AI research in universities

- **Natural language processing**
  - Natural language generation
  - Information extraction
  - Knowledge management
  - Machine translation
  - Natural language expression
  - Speech recognition
  - Conversational system
  - Q&A system
- **Graphics**
  - 3D body segmentation
  - 3D reconstruction
- **Medical image**
  - Segmentation of tissue and organs
  - Lesion location identification

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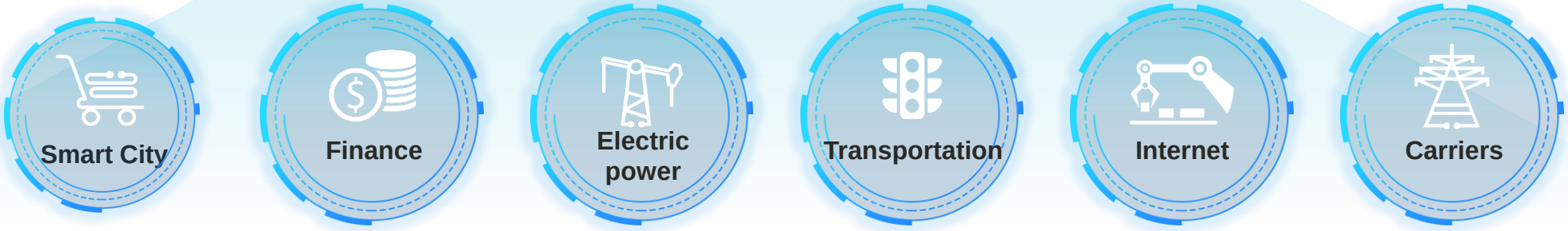
Atlas Products: Built on Ascend 310 and Serving Many Industries

50+ Atlas industry solutions



Safe city	Smart branch	Unmanned inspection of high-voltage lines	Free flow at province toll stations	Intelligent recommendations	Smart customer service center	...

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Joint Innovation in Segmented Scenarios to Facilitate Intelligent Transformation of Industries

Smart City


Facial recognition


Video structurization

Transportation


Vehicle identification


Highway toll collection

Finance


Smart branch


OCR

Electric power


Line monitoring


Device status monitoring

Carriers


Family cloud album


AI training platform

Internet


New retail
Smart community


Ads recommendation

Governments and corporations


Archive identification


Logistics & new retail

Contents

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Atlas Intelligent Computing Platform Recognition

Spearhead China's Next-Generation AI Open Innovation Platform

Two-Time Winner of the Best of Show Award at Interop Tokyo

Winner of Two Red Dot Awards 2019

China International Industry Fair Award

World Leading Internet Scientific and Technological Achievements Award

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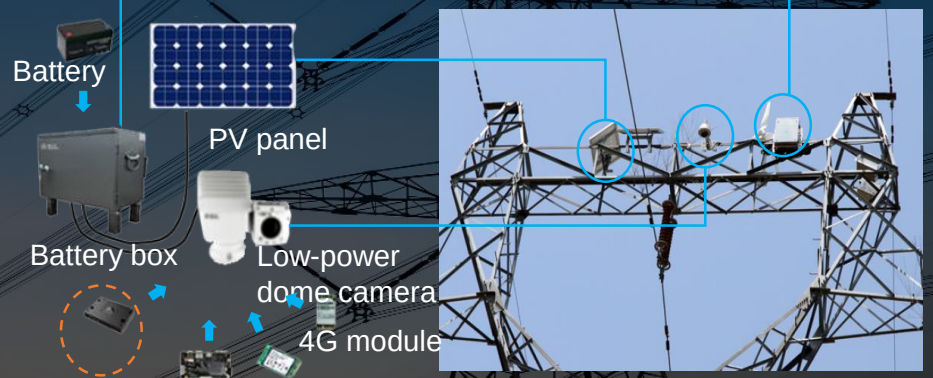
Huawei Atlas Enables Intelligent Inspection of Power Transmission Lines

- The Atlas 200 AI accelerator module is embedded into traditional tower cameras. Atlas 200 uses AI inference algorithms to **analyze images and videos locally, and reports alarms in a timely manner, implementing unattended power line inspection.**
- The Atlas deep learning solution and Atlas 300 AI accelerator card are deployed at the master station to implement cloud-based training and inference, remotely deliver and deploy models using management software.
- Atlas 200 has a low-power design. The entire camera consumes 8 W, **runs on solar power**, and is maintenance-free throughout its lifecycle.




Intrusion detection


Foreign object identification


Smoke and fire detection

Thank you.

Bring digital to every person, home, and organization for a fully connected, intelligent world.