



# AI and IoT Technology For Smart City and Sustainable Society

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# Background

Institute of Software, Chinese Academy Sciences (ISCAS) is established in March, 1985. It is located in Zhongguancun, Haidian District, Beijing. ISCAS is the only national research centre in China which specialize research on computer science and development of high-tech software. ISCAS has been the leader of the software developments in China. ISCAS set the foundation of many important benchmarks including the early operating system and high-level programming language. And, the Chinese name of software - **软件 “Ruan Jian” is also coined by ISCAS.** As the first completion unit, ISCAS has been awarded 39 National or Above-Provincial level Science and Technology Awards, 4(1 first level, 2 second level and 1 third level) National Natural Science Awards and 10 (8 second level and 2 third level) National Technology Progress Awards.

## Recent Achievements:

- Recruit world renowned M.S. Ying to join ISCAS. Ying is amongst the top league on quantum software. He is one of the pioneers of quantum programming theory and Methodology Emerging Technology.
- Significant progress on Natural Human-Computer Interaction, forming the ISO/IEC international standard on user interface for Affecting Computing. This is the first international standard led by a Chinese team.
- Award the AMC Gordon Bell Price because of achievements in HPC





## — Background

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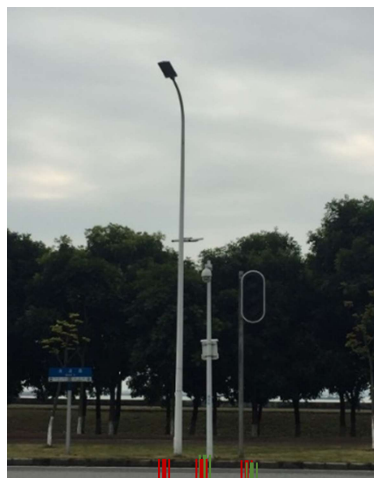
- Smart city has been included in China's National Strategic Planning in 2014, and viewed as a key strategy to promote industrialization, informatization, and urbanization
- There are 500+ domestic smart city pilot programs in China
- In China's 13th Five-Year Plan, China will further increase the information infrastructure investment, which has a huge boost for China's Smart City Strategy



# Problems in Smart City Construction

## ➤ Redundant Construction

- Pole Forest showing up along with the explosive growth of IoT devices and applications



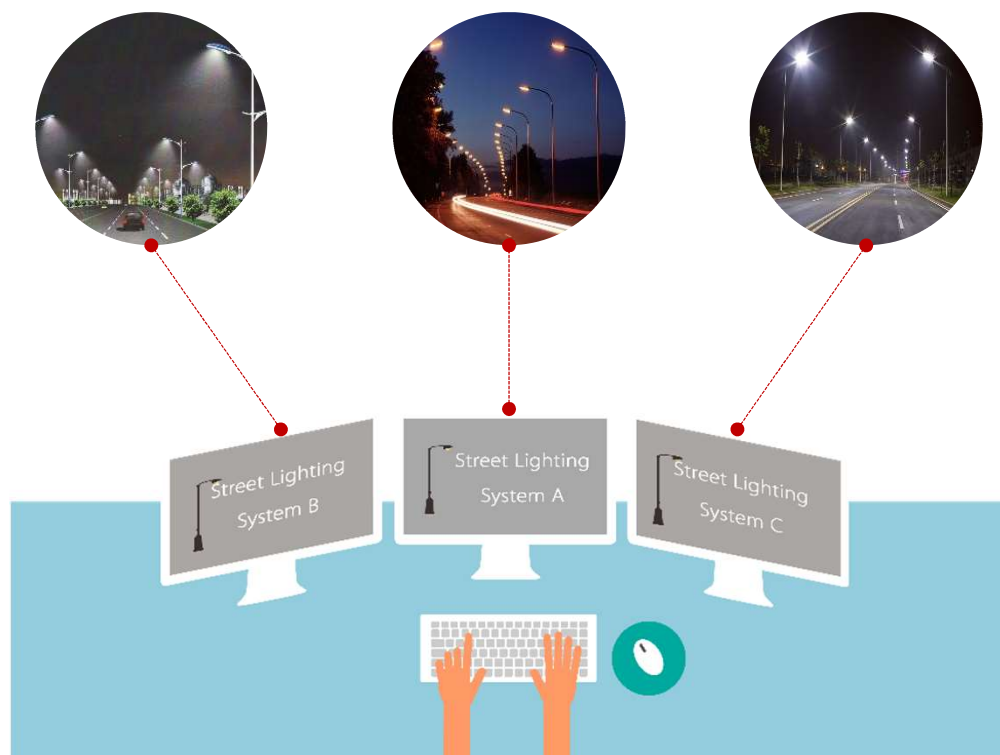
==== Cable  
==== Internet



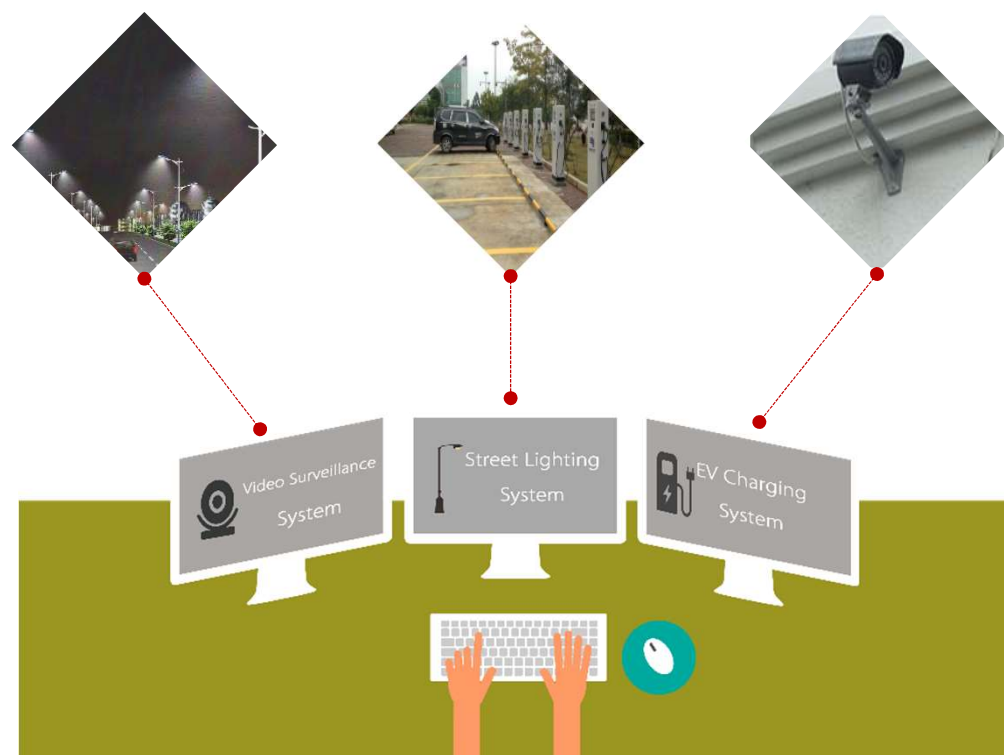


# Problems in Smart City Construction

## ➤ Information Isolated Island



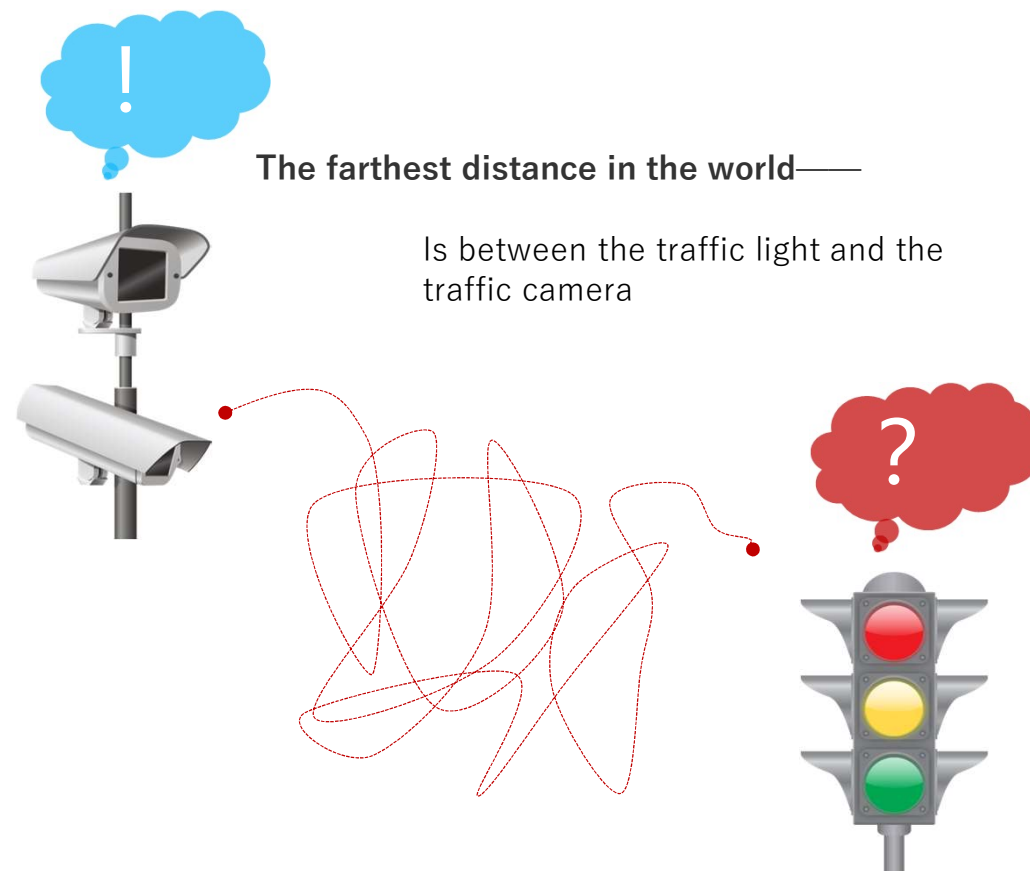
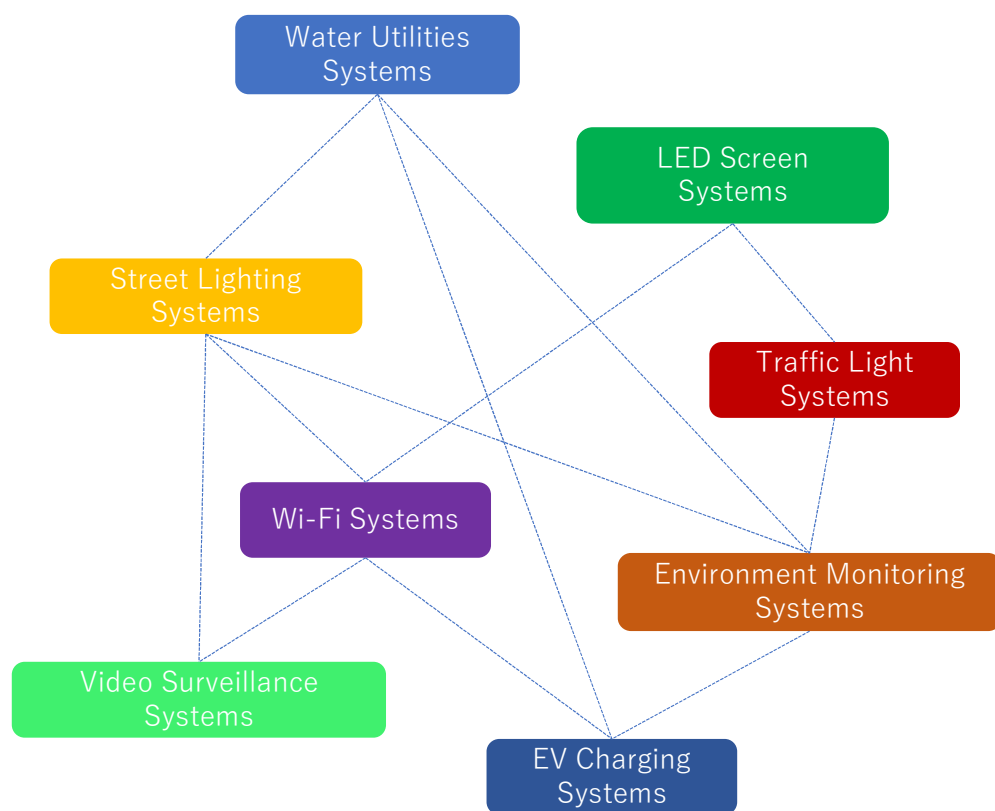
Different IoT systems existed for managing one application without data sharing



Various IoT application systems existed in the city without data sharing

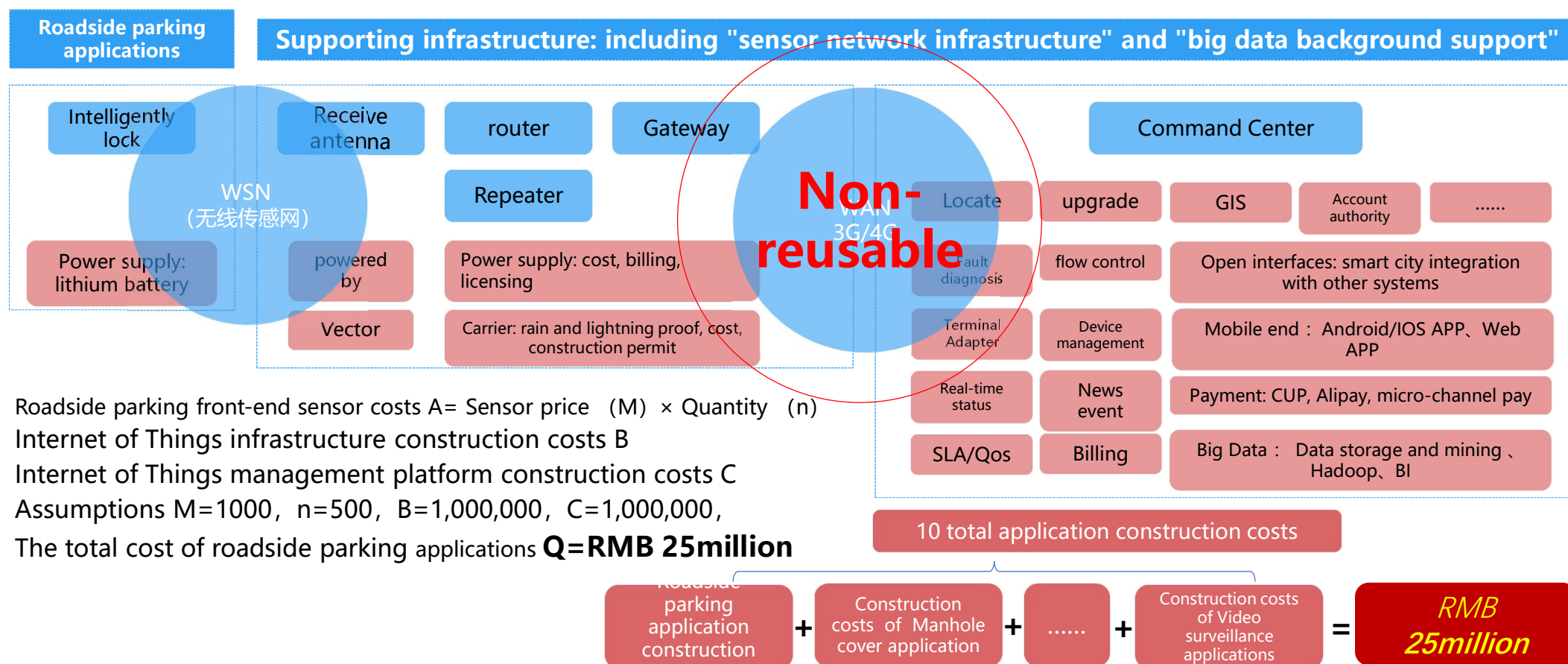
# Problems in Smart City Construction

- IoT Systems without Linkage and Interaction



IoT devices and smart city applications explosive growth

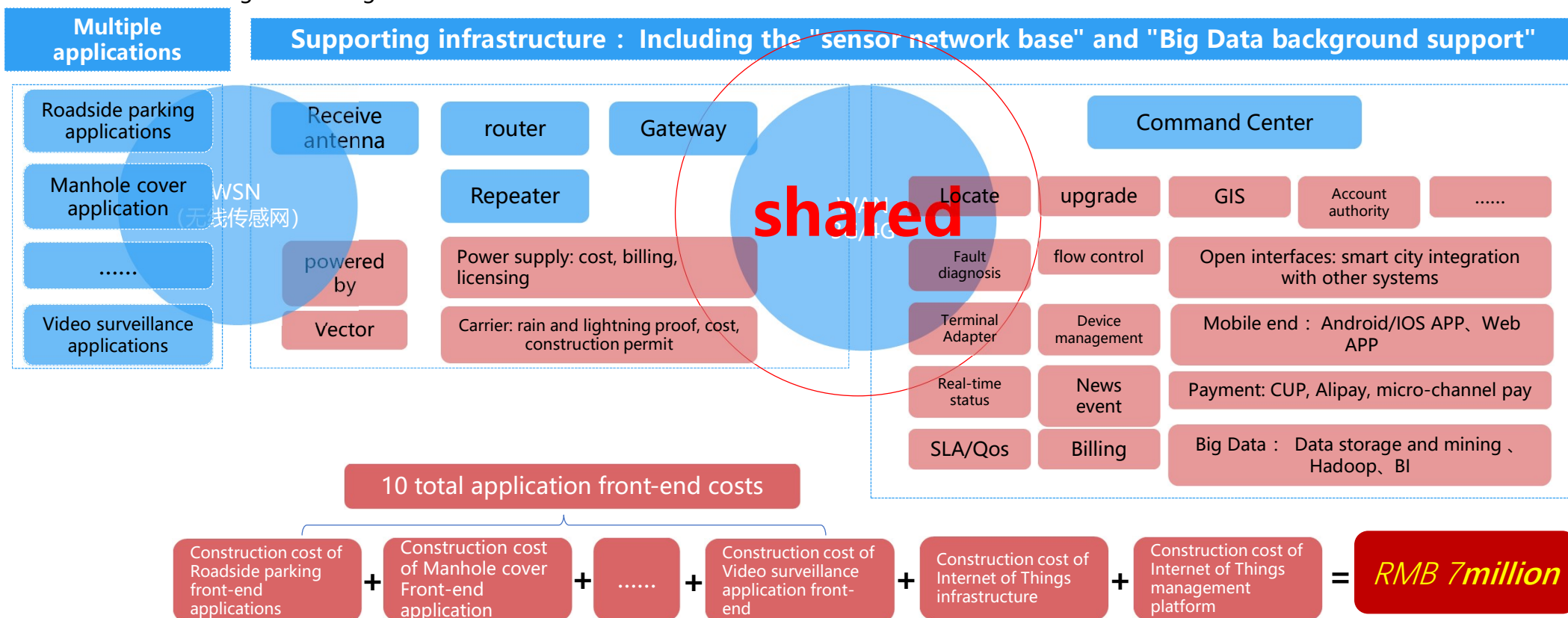
## ● The traditional method of construction——Small horse drawn cart





# Construction of urban Internet of Things shared infrastructure

- Replaces the construction model of a mini-horse-drawn carriage and significantly reduces the construction cost of a single application ;
- Data collection, to avoid information silos: things big data to support early warning based on big data analysis and urban intelligence management.



# Advantages of building an urban IoT shared infrastructure

- **save costs: share infrastructure and avoid duplication**

- ✓ *Construction costs : RMB 25million → RMB 7 million*

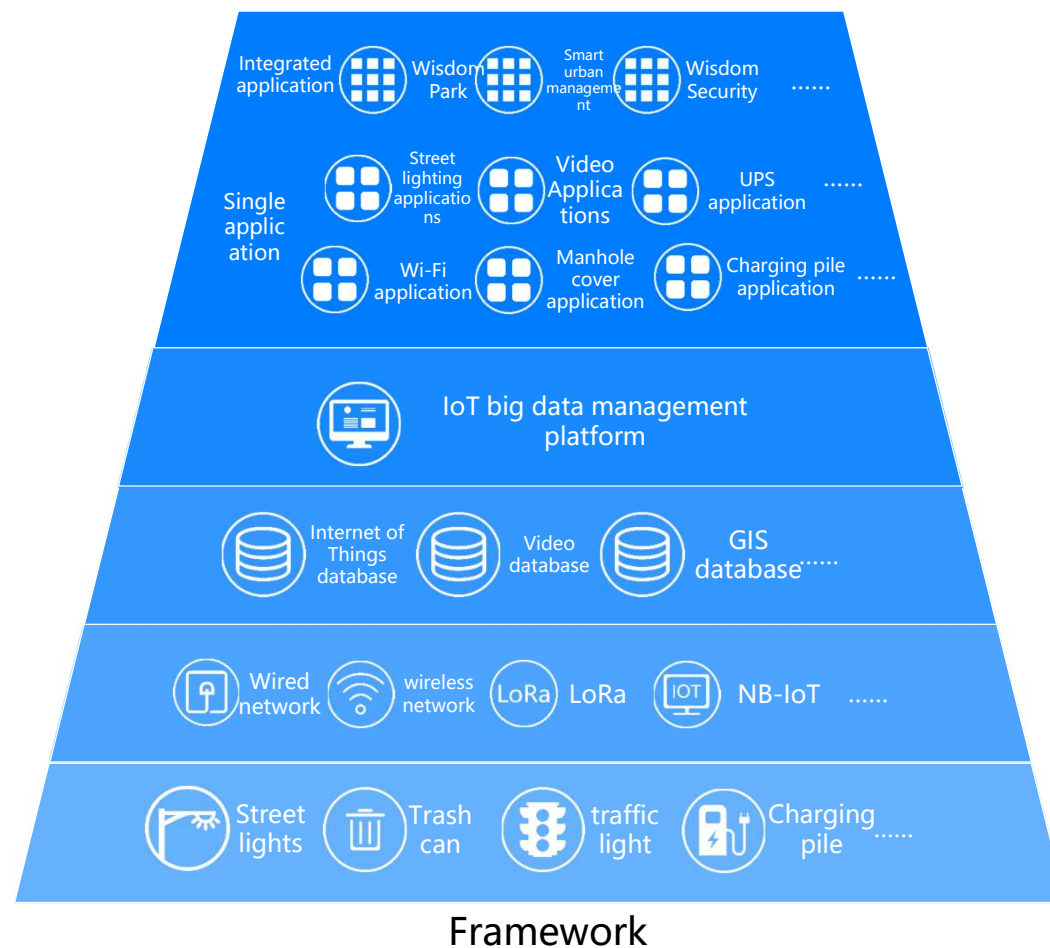
- **Clean, tidy, safe and orderly**

- ✓ *Tongzhou, Xiong'an District.....*

- **Information interoperability, unlimited support possible**

- ✓ *City-level IFTTT (software link everything)*

- ✓ *Platform + Applications: Low cost, fast support for rich applications*



# Street lights——The best candidate for building a city's IoT



- Street lights cover every corner of the city (Project scope)

- **Electricity**

- ✓ Solve the electricity bill calculation problem through EMC / PPP mode

- **Pole**

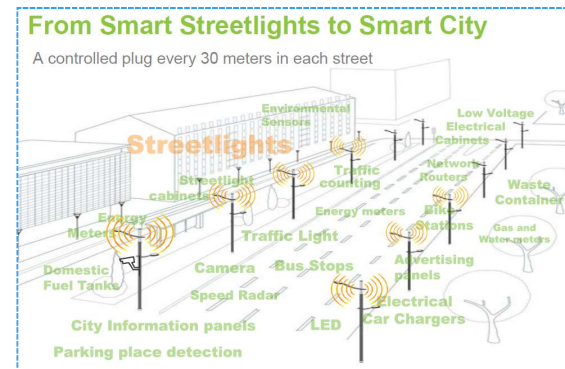
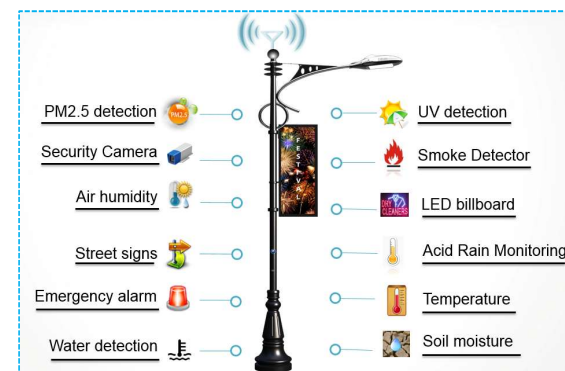
- ✓ Carrier, Cost, Construction Permit

- **Network**

- ✓ information channel, information transmission cost / 100

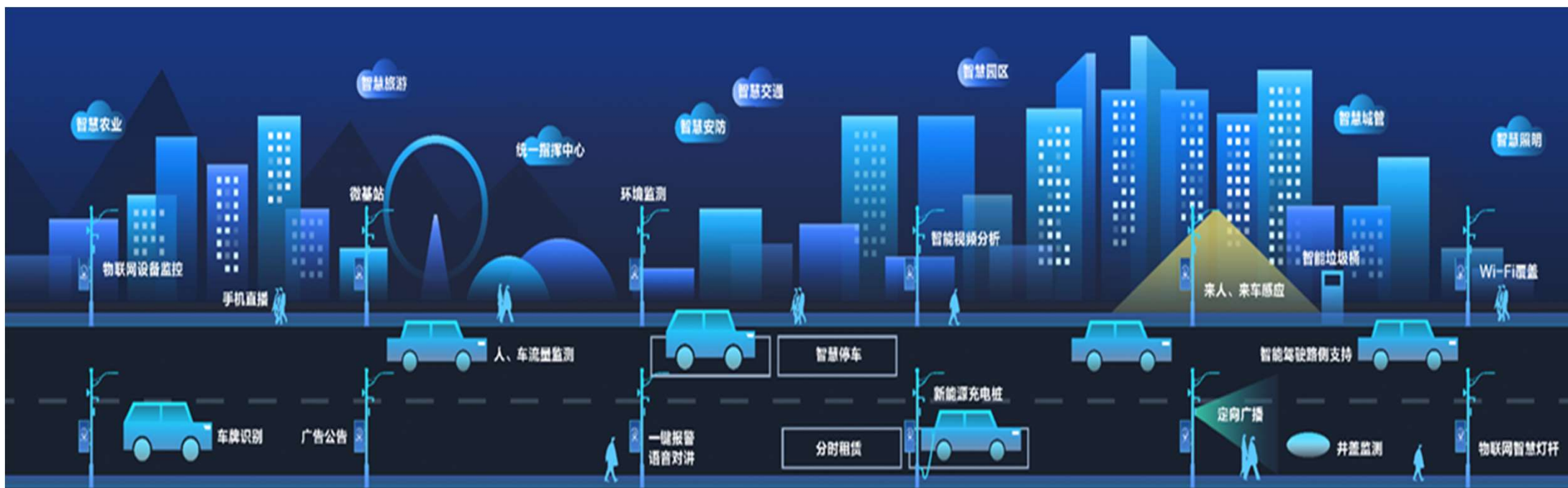
- **Platform**

- ✓ Support for complex management of big data and cloud computing background



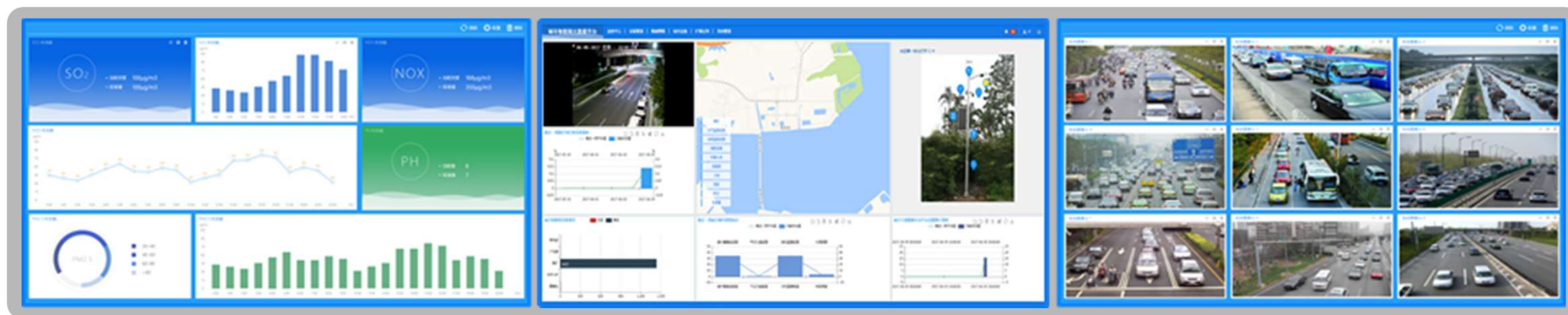


# Smart City Total Solution



# Smart City IoT Big Data Management Platform

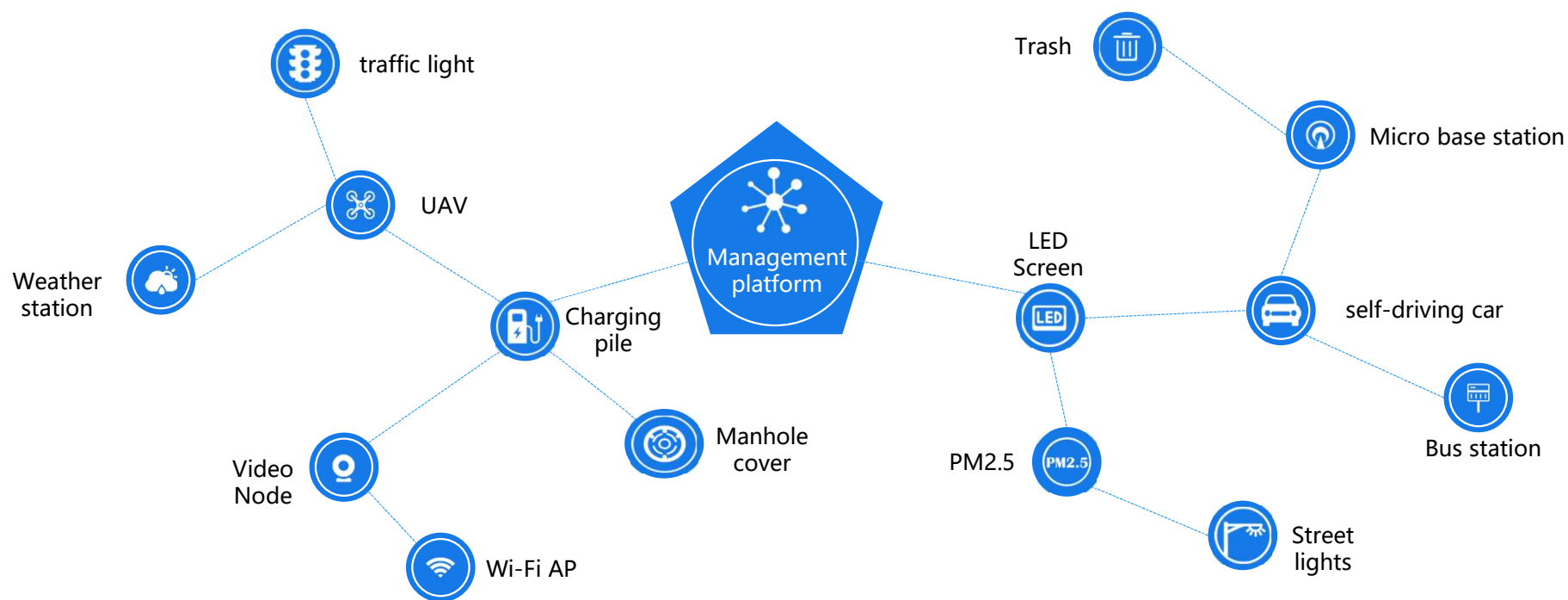
**Build smart city neural network and brain**



# Smart City IoT Big Data Management Platform

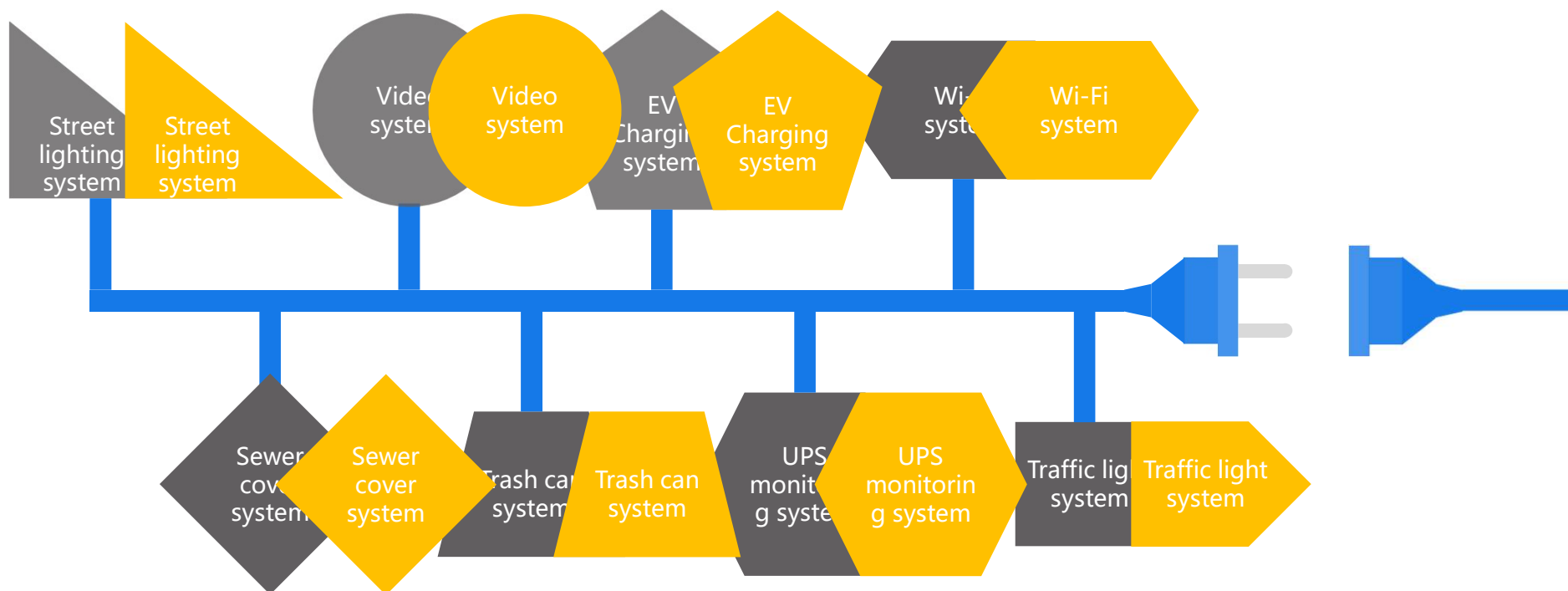
## Build a smart city neural network

Access and control of massive heterogeneous city IoT devices / systems





# Smart City IoT Big Data Management Platform

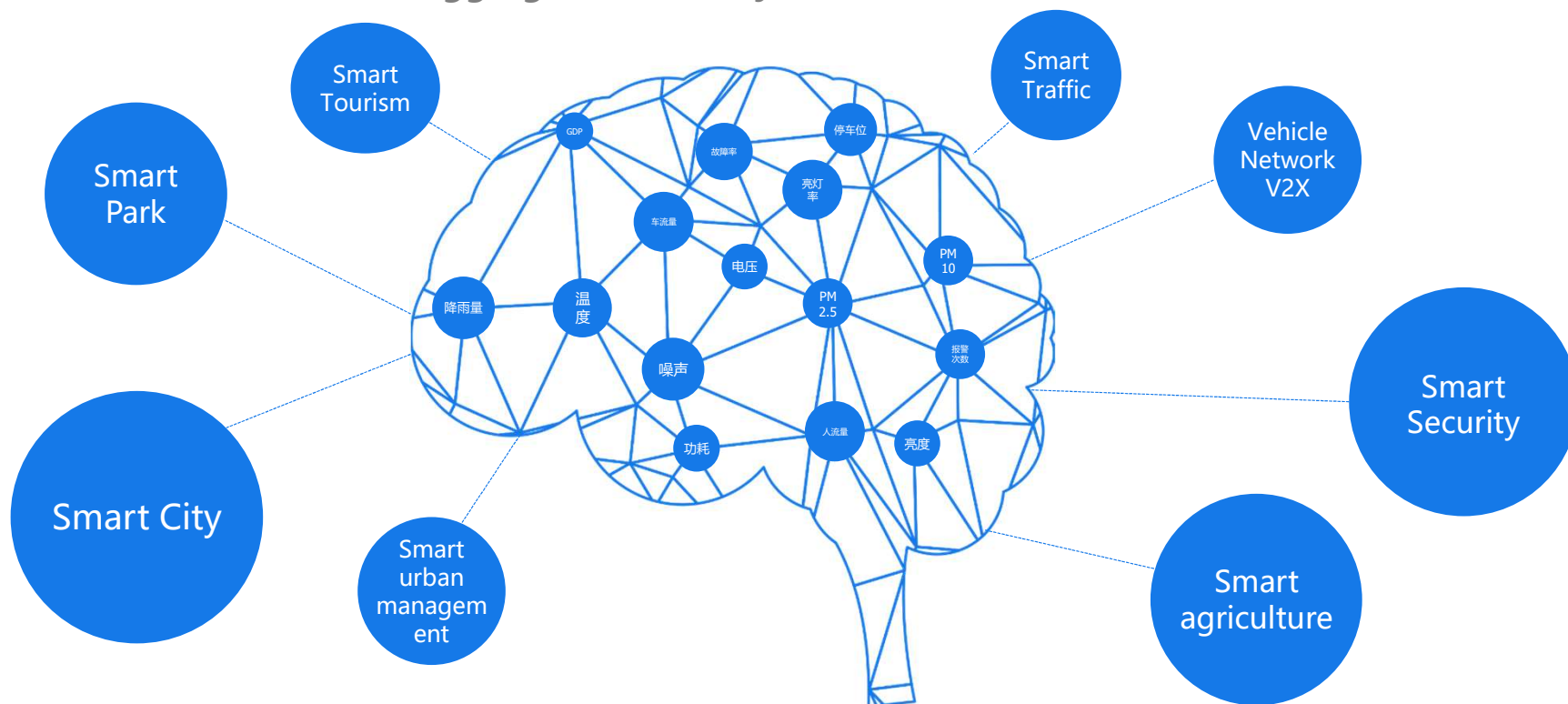


Access is simple and convenient

# Smart City IoT Big Data Management Platform

Build a smart city brain

Aggregate and analyze massive multi-source data



# Smart City IoT Big Data Management Platform

## ➤ Support Various Applications Running on the Platform

- Smart Street Lighting
- Video Surveillance
- Smart Parking
- EV Charging Station
- Public Wi-Fi
- Environmental Monitoring
- Vehicle Rental
- V2X
- .....



Self-developed EV Charging Station App



## Integrated Smart City IoT Management Center



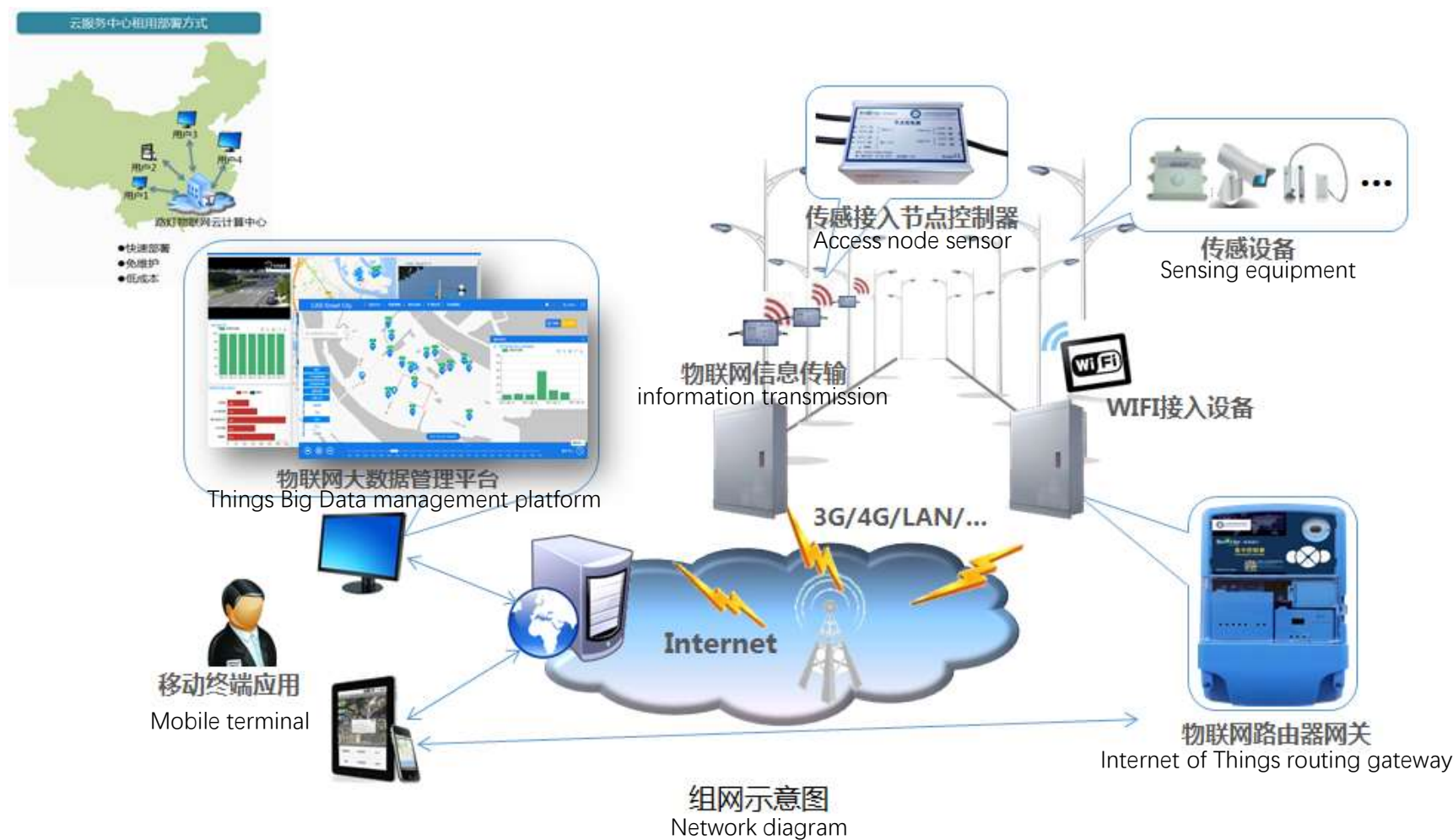
City Internet of Things big data management center implementation

## Smart City / Internet of Things Based on Street Lighting

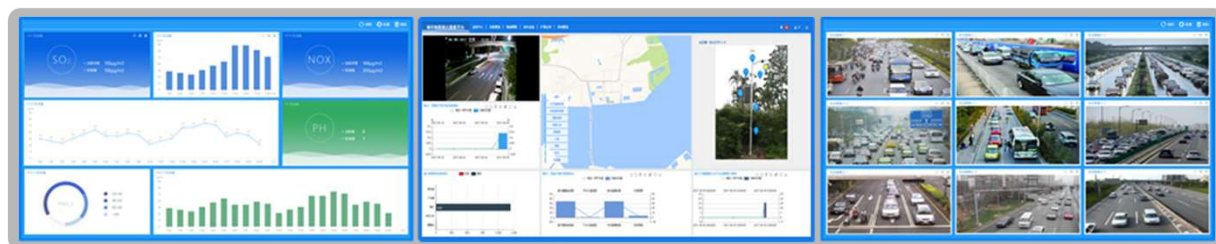




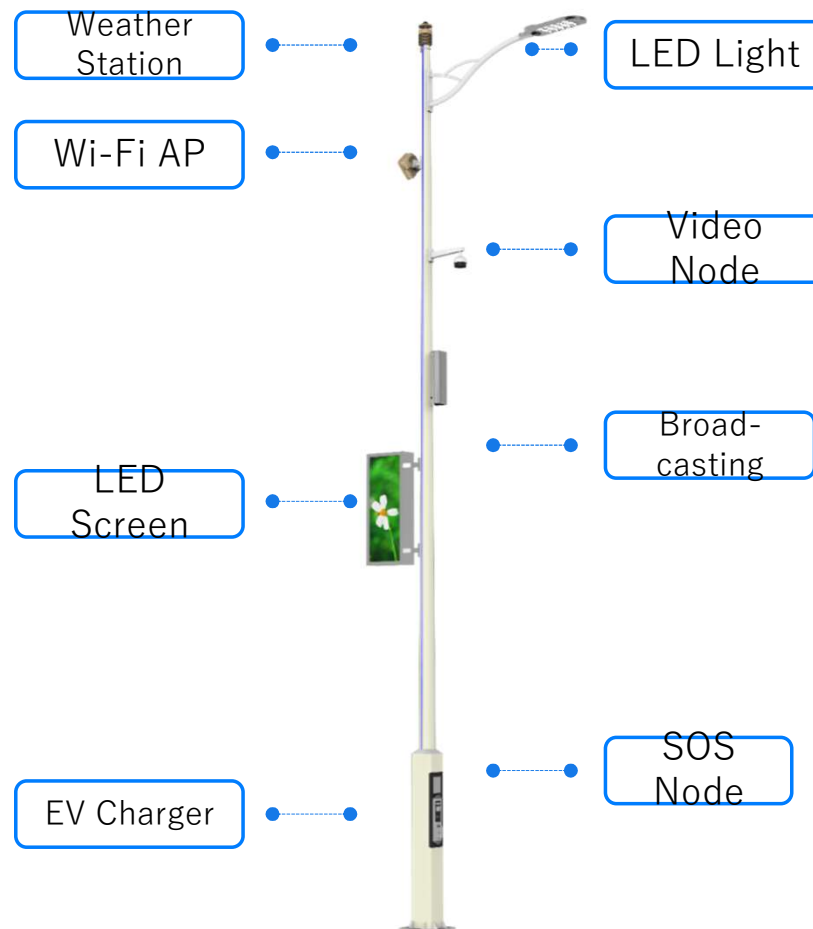
# Networks



# Hardware & Software implementations



Smart City IoT big data management platform



Internet of Things smart light pole



# Platform + Applications

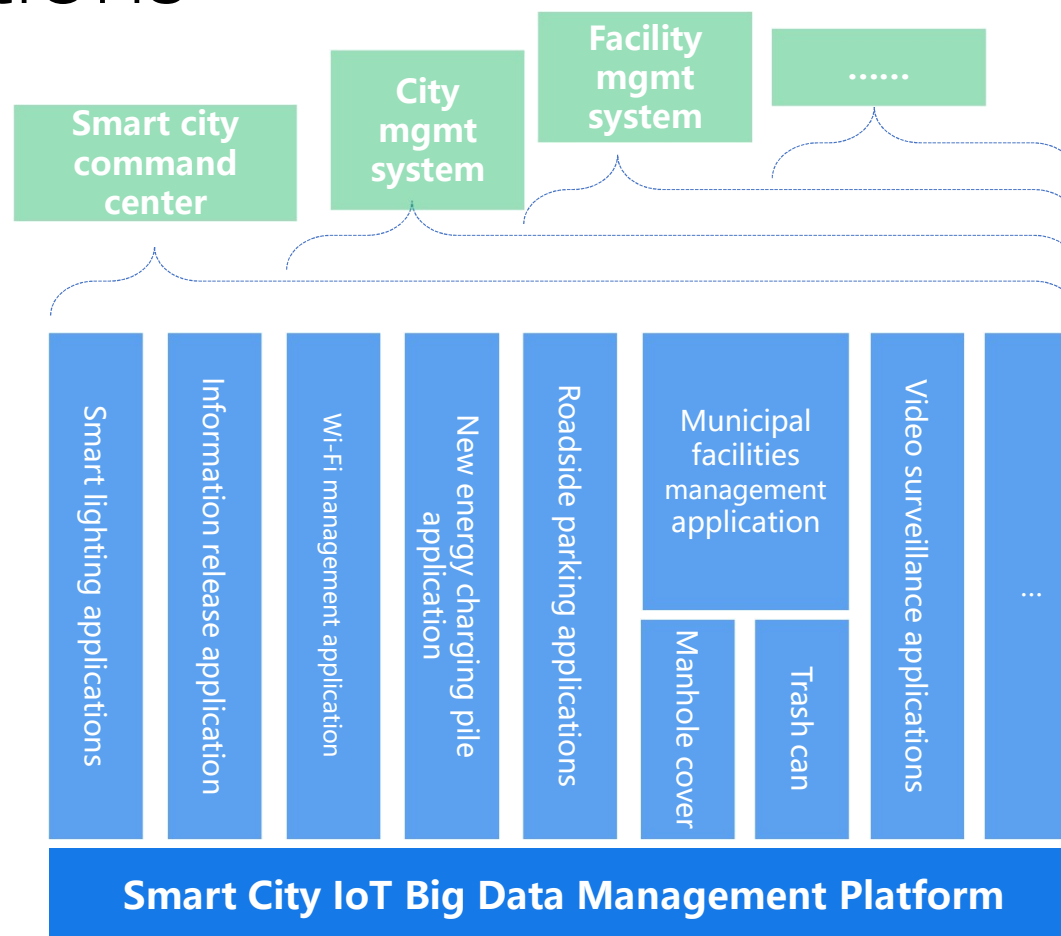
- Urban Internet of Things Big Data Cloud Platform

- Vertical applications

- ✓ *Smart lighting application*
- ✓ *Information release application*
- ✓ *Wi-Fi management application*
- ✓ *EV charging / roadside parking application*
- ✓ *LPWAN-based application: sewer covers, trash cans*
- ✓ *Video surveillance application*
- ...

- Comprehensive applications

- ✓ *Smart city command center*
- ✓ *City management system*
- ✓ *Facility management system*
- ...



# Researchers



WuJun



YanKai



LiTeng



PangYu

Core team

◇Jun Wu graduated from the University of Tokyo and was a co-researcher at the Institute National for Research in Computer Science and Automation, France(INRIA) and a researcher at Waseda University in Japan. Dr Wu is proudly awarded Expert Grant by State Council in 2018. During his master degree, he received the highest level BK scholarship in Korea. During his Ph.D., he was responsible for the cooperation between the University of Tokyo and the Institute National for Research in Computer Science and Automation, France(INRIA), which was supported by the Japanese and the French governments. He is quadrilingual (Chinese, English, Japanese and Korean) and hence has been active and proficient in organizing international academic exchanges.

◇Li TENG: Ph.D. KAIST, IEEE member, ACM member, Member of CCF CV, He has served as a senior researcher at the Central Research Institute of Alibaba and Huawei. He has also been visiting fellow at the National University of Singapore and Microsoft Research Asia conducting various research.

◇Yan Kai: Ph.D., University of Tokyo, Japan. He was also a researcher at Stanford University and the National Institute of Intelligence, Japan. He is the deputy director of the Intelligent Video Research Center of the Institute of Intelligent Software, Guangzhou and the founder of the OpenKAI framework.

◇Pang Yu: Ph.D., McGill University, He presided over 2 National Natural Science Foundations, 1 Ministry of Education's Artificial Intelligence Key Project, 1 Chongqing Key Natural Science Fund, 3 Provincial and Ministerial Projects, and SCI/EI Academic Papers 70 so far. He owns 13 National Invention patents now.

Core Technology

Core Products

- 1、Face recognition:** a biometric recognition technology based on human facial feature information for identification;
- 2、Object recognition and scene application:** The computer compares the image content with the data in the database to identify the recognition technology of the object and the scene;
- 3、Unmanned Machine Intelligent Control:** Unmanned Machine Control System Based on Deep Neural Network Algorithm.

AI+Platform service

- Face Recognition Platform
- Face Attendance Device
- Face gate
- Posture Recognition Platform
- Food Recognition Electronic Scale

AI+ system integration

- Safe-Campus Management System
- Target Identification System
- Smart Park Security System

AI+robot

- Auto Driving
- Drone
- Robotic Arm

AI+Industry application

- Garbage Smart Mgt Sys
- Intelligent Site Supervision System
- Foot Traffic Statistic Analysis Instrument



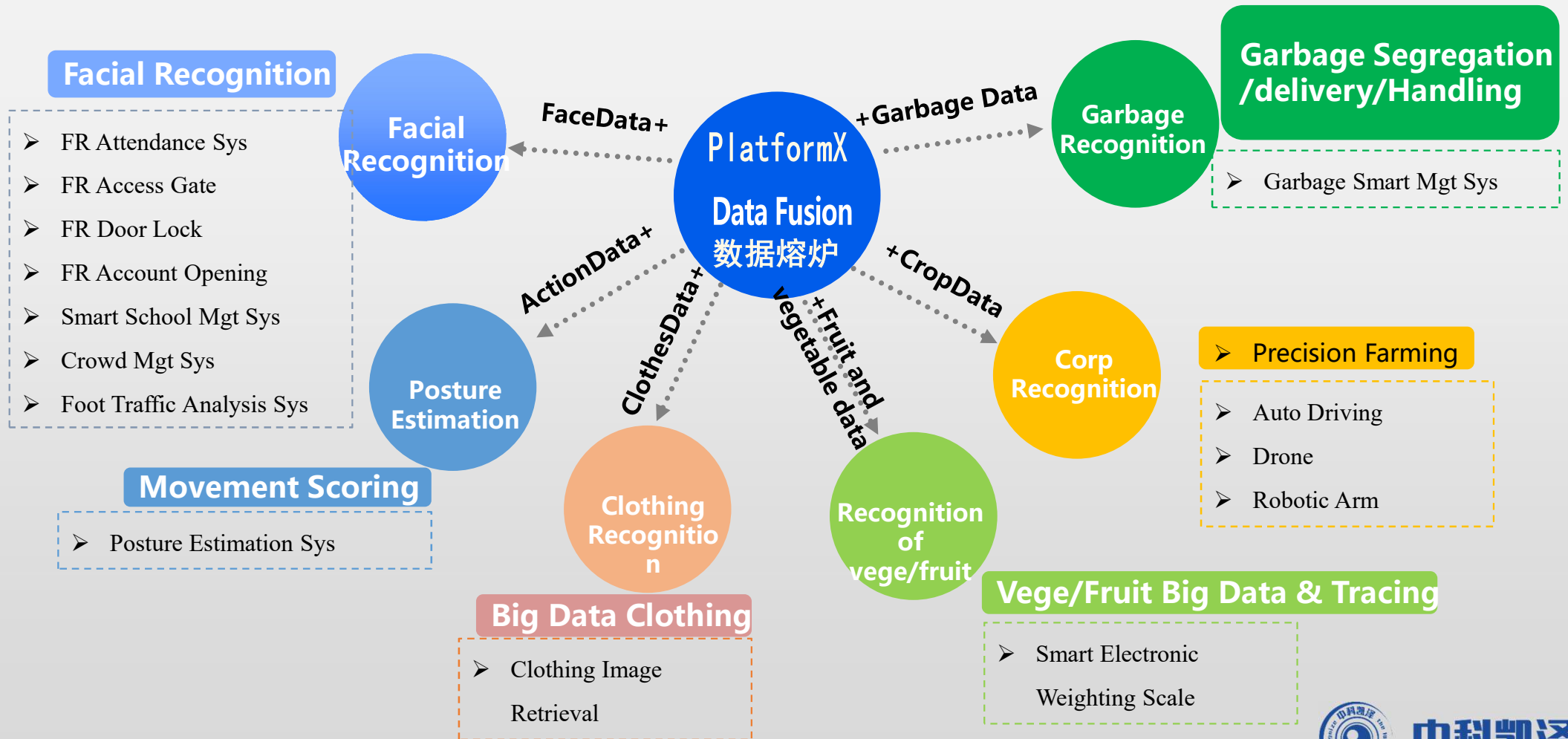
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# Institute of Software, Chinese Academy Sciences (ISCAS)





# Technology Platform Architecture: PlatformX-DataFusion

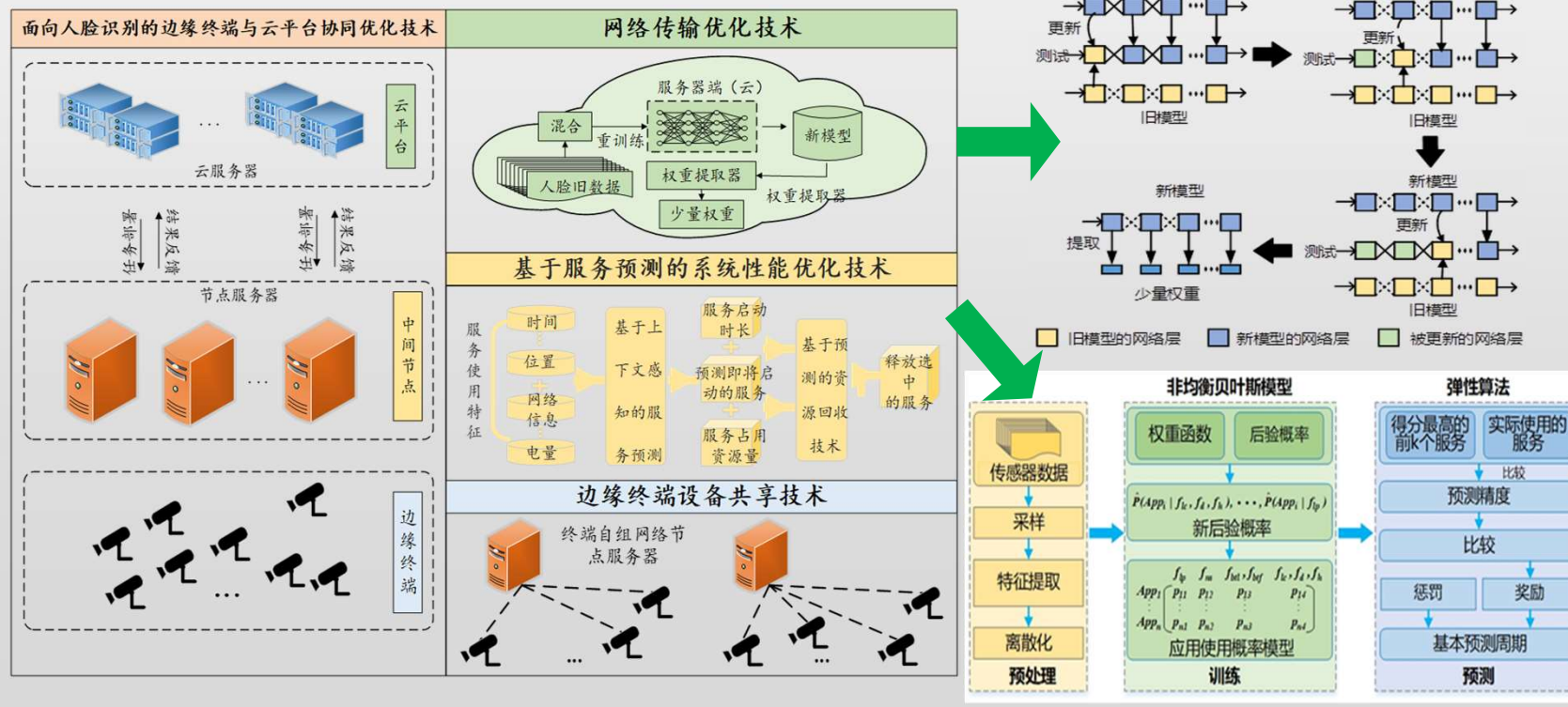


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# Core Technology of the Platform: Edge computing and cloud platform collaborative optimization technology for Deep Learning

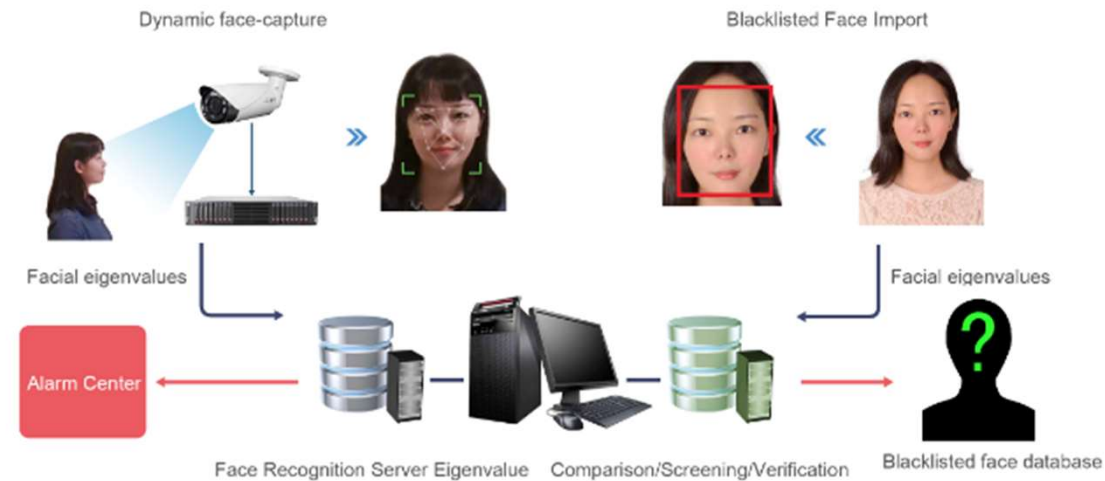
- Research on optimizing method of network transmission with weight updating. Improve the data collection and reduce network transmit cost. **Reduce network transmission overhead in edge terminals and cloud platforms**
- Reduce the burden on Cloud platform. Improve job allocation at the terminals. Design edge terminal identification task sharing system
- Research resource recovery technology based on service prediction. **To improve resource management of edge terminals and cloud platforms and reduce service startup delays**



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# Target Identification System

Target Identification System is a system empowered to work on dynamic video images as well as static face images. Face recognition record of target persons can be installed at airports, railway stations, bus stations, metro, office buildings, and city business districts. The system can automatically identify, track and capture the faces of target people. The real-time comparison and recognition between the collected facial feature data and the target face in the database completes in split second. Once a match with target/blacklist person is found, alarm would be triggered and the respective static face image will be retrieved. The target person would be tracked continuously. Through linkage of different platforms, the system can also perform forecasting and early warning. The system is widely used in public security, frontier defense, customs criminal investigation case tracking, personnel control, terrorist tracking, and other places.





# Foot Traffic Statistic Analysis

## Crowd Counting

Foot traffic is the key data to support management of shopping malls, chain stores, airports, train stations, museums, exhibition centers and other public places. It can provide Customer Thermal Map, Customer behavior tracking analysis and overall foot traffic analysis.

## Gender Statistics

Gender is an essential marketing factor in almost all consumer products/services. Facial and Posture Recognition can effectively tell the gender of a target.

## Age Statistics

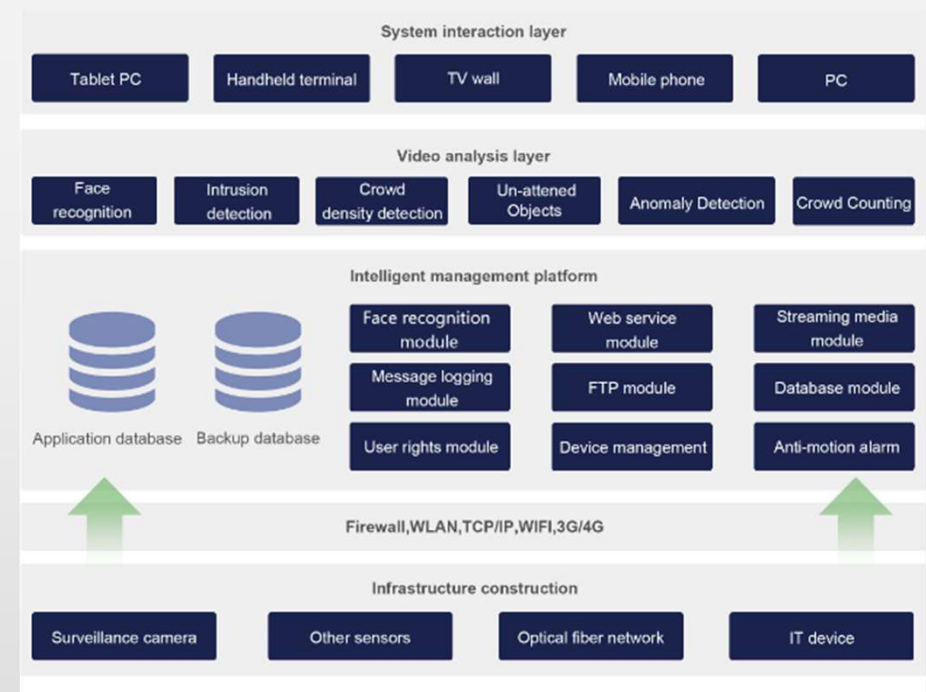
Facial and Posture Recognition can effectively suggest the age of a target. Age grouping is one of the most important tools in the consumer market.



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# Safe-Campus Management System

Safe-Campus Management System is a large integrated security system with video surveillance, intelligence analysis, intrusion alarm. “Sunshine” campus is the core value of our System. Advanced high-definition intelligent monitoring technology is used to monitor the campus comprehensively, to minimize all kinds of potential safety hazards, to strengthen the safety management and is able to be used to improve the behavior of students. Through the centralized network management platform, a command and dispatch system with multi-level, multi-function, rapid response and information sharing can be constructed. It allows emergency alarm and help-seeking alert to work all day long. It is an effective platform for management to grasp the dynamic situation of campus at any time and handle all kinds of complex emergencies in an efficient manner.



Face  
recognition

Intrusion  
warning

Un-attended  
Objects

Crowd  
Counting

Crowd density  
detection

Early Warning  
of Fighting



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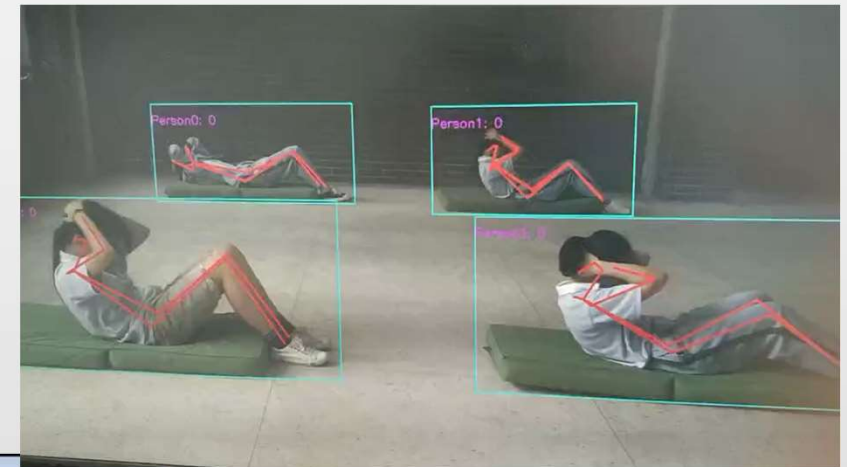
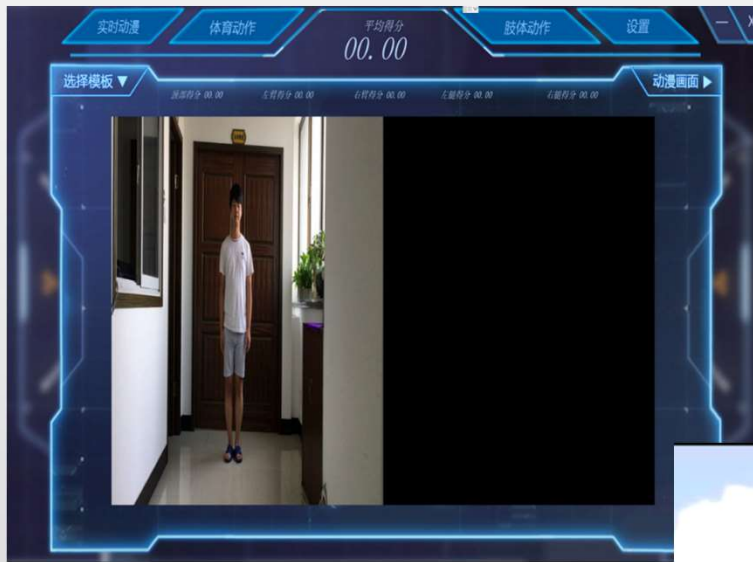
# Kindergarten Guarding System





# Posture Recognition Platform

The human Posture Recognition has a wide range of applications. It can be used to develop scoring systems for dance, martial arts and numerous sports. Posture recognition can help computer better recognize human body movements and more precisely define the action content.



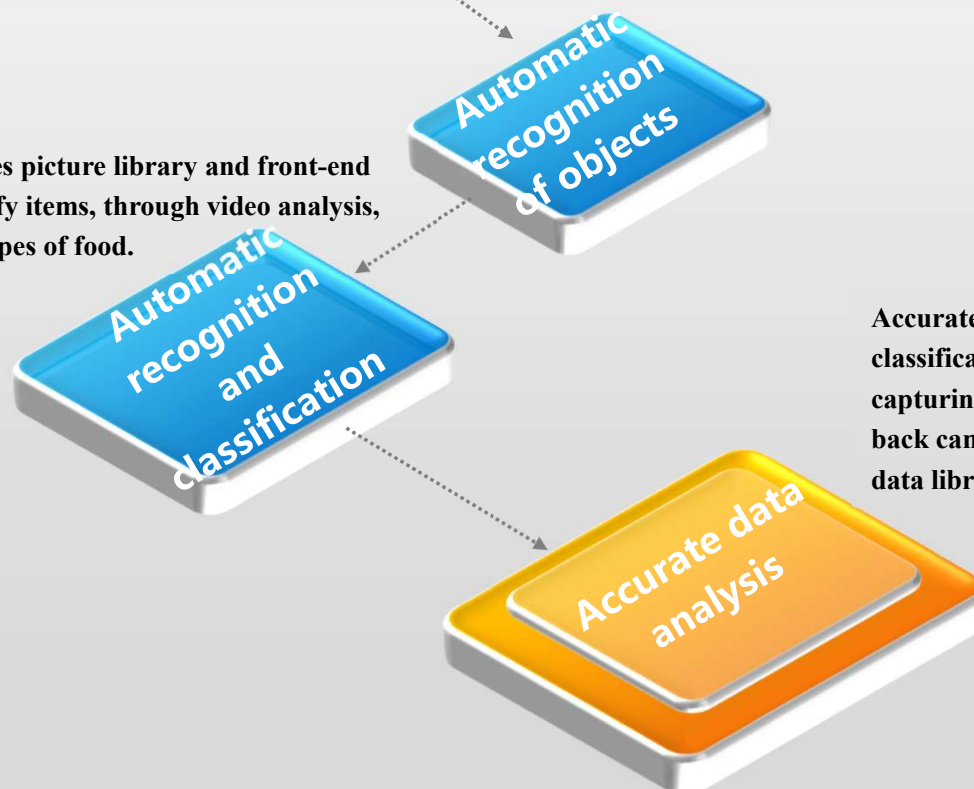
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# Food Recognition Electronic Scale

The application of the new intelligent electronic scale realizes automatic recognition, accurate classification and accurate data analysis of vegetables and fruits.

Self-developed object recognition algorithm, first of all, meat and vegetable varieties for modeling and learning, and then through the electronic scale camera to collect and locate items, extract product characteristics.

Item categories picture library and front-end camera identify items, through video analysis, identify the types of food.



Accurate identification and accurate classification is achieved by capturing images from front and back camera and match with the data library.



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# Garbage identification algorithm – garbage classification feature value extraction

We carry out classification by verifying the overall and specialized characteristics. Overall characteristics : appearance, shape, type. Specialized Characteristics: material, content and attribute etc.

## Overall Characteristics

### Extraction process:

**1. Integral garbage area detection**  
Deep Learning Target Detection Algorithms

**2. Fast Detection of Garbage Location**  
Deep learning detection method based on yolov3-tiny

**3. Detecting image position and extracting image**  
The data is divided into three parts: training set, test set and verification set, and then the in-depth learning detection model is trained.

**4. Training model**  
The region images detected are deeply learned and classified by RESNET (residual network structure) algorithm.

**5. Image feature extraction**  
The method of calculating similarity is the cosine value of the angle between two image feature vectors. The larger the value, the higher the similarity.

Appearance

Shape

Type

## Specialized Characteristics

Material

Content

Attribute

The extraction process is basically the same as the Overall Characteristics extraction

### Differences between overall and specialized characteristics extraction

- (1) The detection network structure yolov3-tiny detection effect is not ideal, the local feature extraction uses a deeper network structure detection, the detection effect meets the customer's requirements.
- (2) The feature extraction network structure also adopts a deep network structure, which can extract local features better and the retrieval effect meets the requirements.



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# Hurdles in implementing Garbage Recognition

More the types of garbage you set, the less differentiations you will allow between types. The segregation process will also be harder to process. More the number and various sizes of pictures would also affect the expandability of the algorithm. How to process the vast data swiftly in limited time and carry out segregation accurately are the major tasks.

## Problem

### Surface appearance of similar objects vary greatly 01

The difference in the apparent characteristics of the same type of garbage is relatively large, and the reasons are the changes in the various instance levels mentioned above, but the emphasis here is on the differences between different instances within the class.

### Type class gap-blur 02

Different types of garbage have certain similarities, such as the difference between a wolf and a dog, but we are difficult to separate the two from the appearance.

### Background interference 03

In the actual scene, garbage can't appear in a very clean background. On the contrary, the background may be very complicated and interfere with the objects we are interested in, which makes the identification problem more difficult.

## Solution

### 01 Design a Reasonable Network Structure

- 1. Focus on accuracy:** Designing deep network structure can extract garbage features well, but this process will lose some speed;
- 2. Pay attention to speed:** Designing lightweight network structure, but the accuracy will be downloaded, but generally not more than a few percentage points.
- 3. Compatibility Accuracy and Speed:** Through a large number of data and combined with scenarios to design a reasonable speed and accuracy of the network structure, through training and testing.

### 02 Loss function design

The selection of loss function is very helpful to improve the accuracy, and it has little effect on the speed.

### 03 Increase background complexity

Increase the background complexity of garbage, improve the angle of the object (rotation, clipping, etc.), brightness of the background, add noise, so as to increase the amount of garbage to better learn the characteristics of garbage.



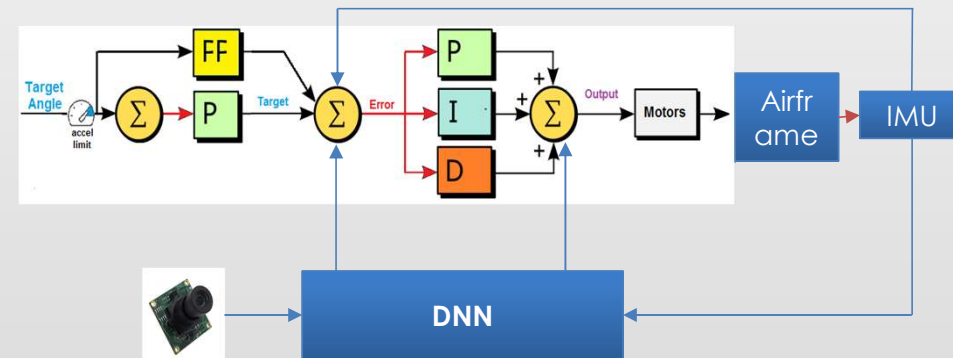
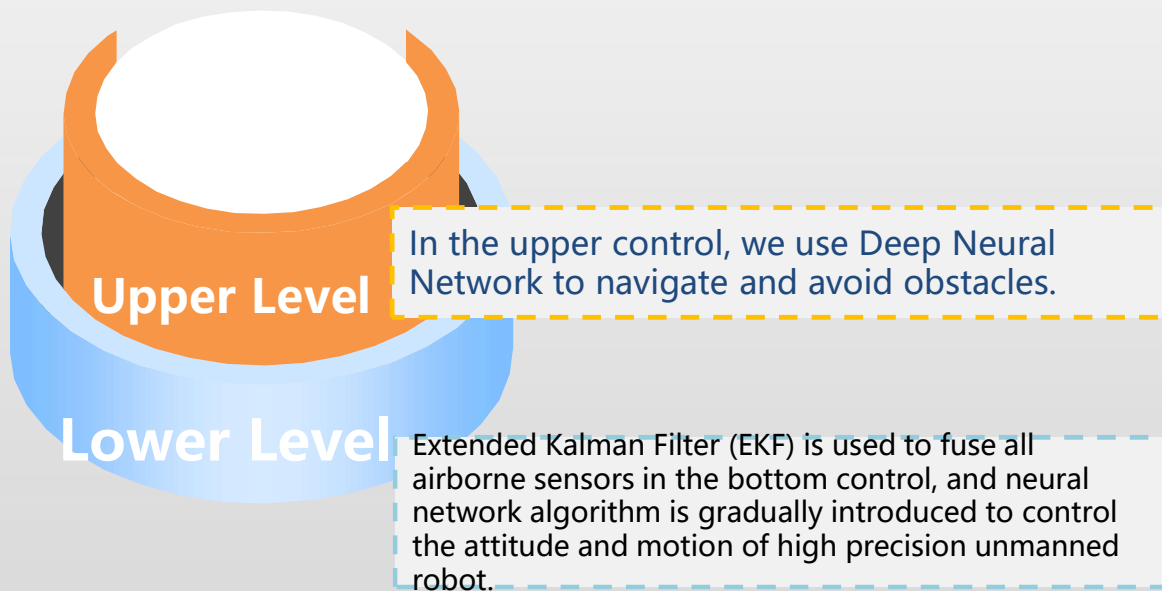
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# Key Technology in Monitoring/Delivery of Garbage

## Smart Precise Positioning and Controlling System on ground

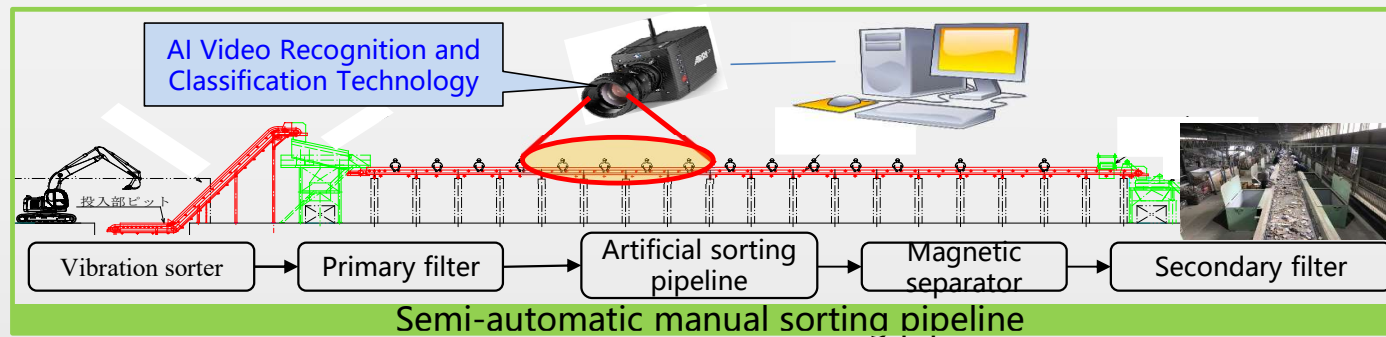
Accuracy is as high as within +/- **1.0cm**. Our Robotic Controlling System is built on the most commonly used algorithm of controlling system. There are over 5000 highly automated industrial enterprises using this and the number keeps growing.



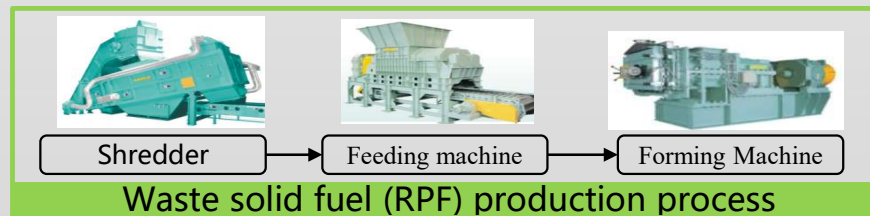
Bottom Flight Control Based on Practical Neural Network Algorithms



# Garbage Handling



Classification of  
Construction  
Waste Recycling



< product > Recycling rate above 95%

- Gravel
- Wood fuel
- Scrap iron
- Waste paper
- Soil improver
- Waste solid fuel

Renewable  
resource  
utilization

→ Inorganic matter

< Residue >

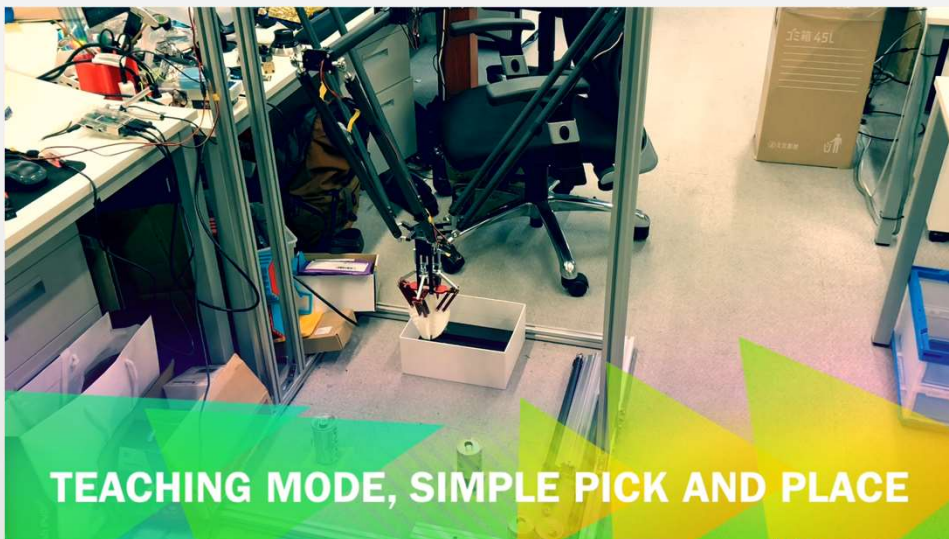
Less than 5%

Landfill



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# Garbage Collection - Pilot Test



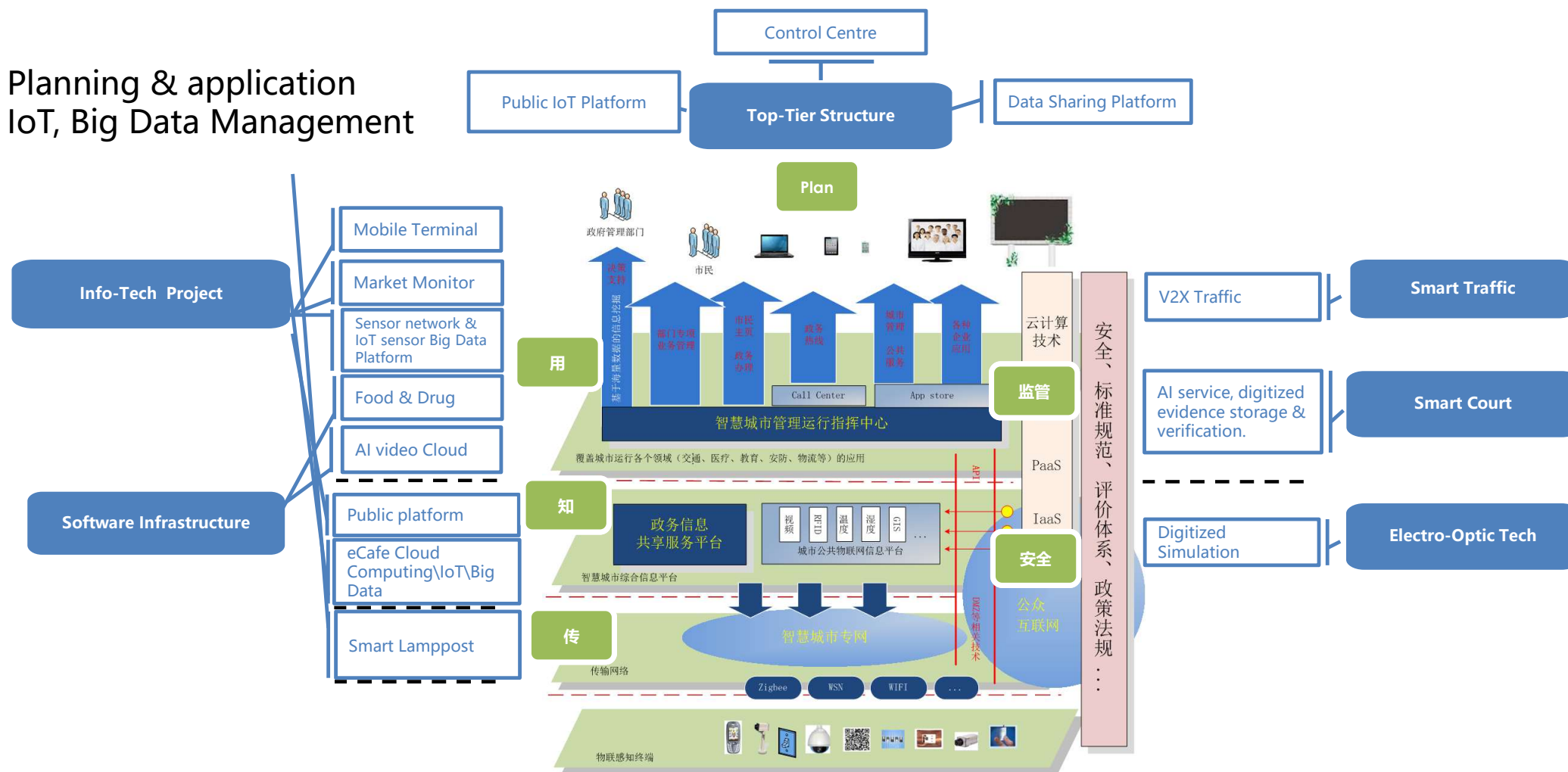
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# AI Community : Smart City



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Planning & application  
IoT, Big Data Management







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# Smart Hospital

## Registration Hall

## Medication Room



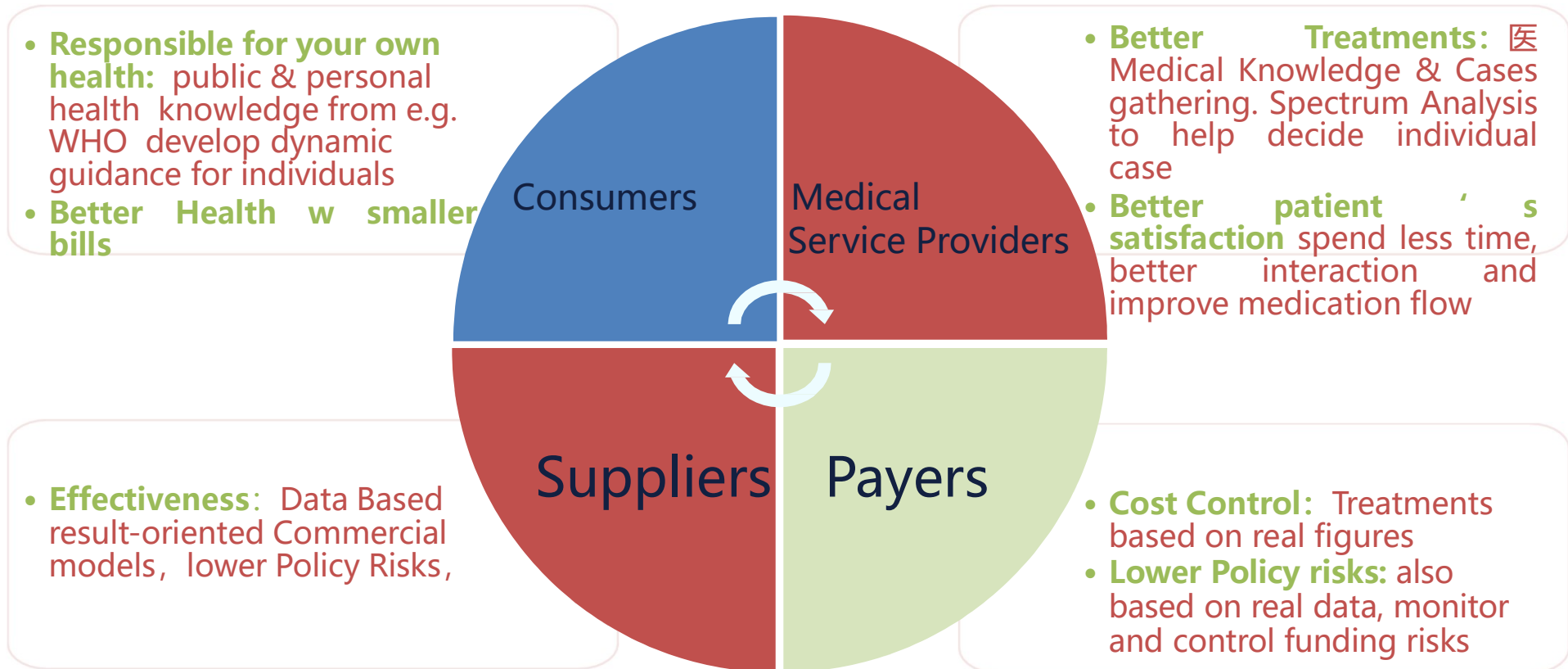


# AI Value-based Hospital & Medic System



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AI Lowering Costs, Better Health

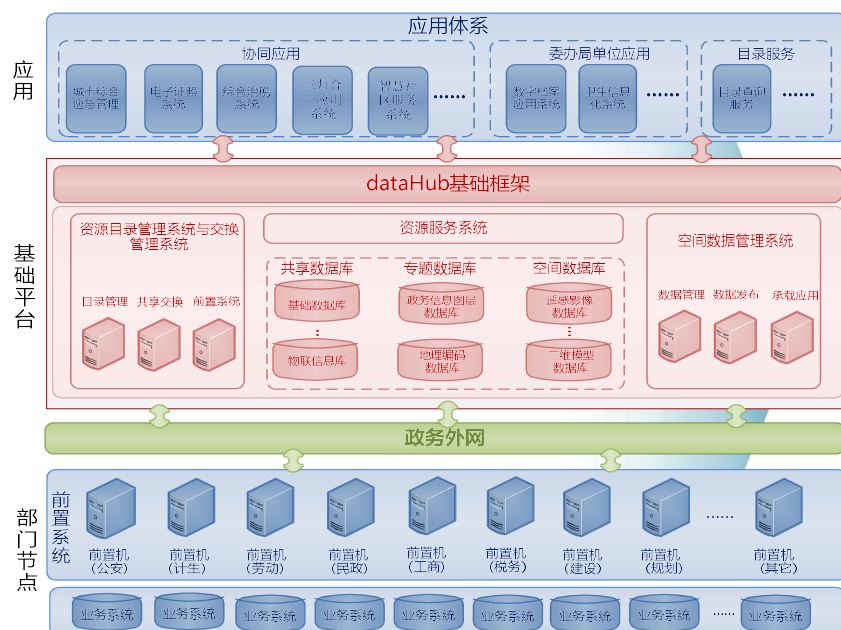




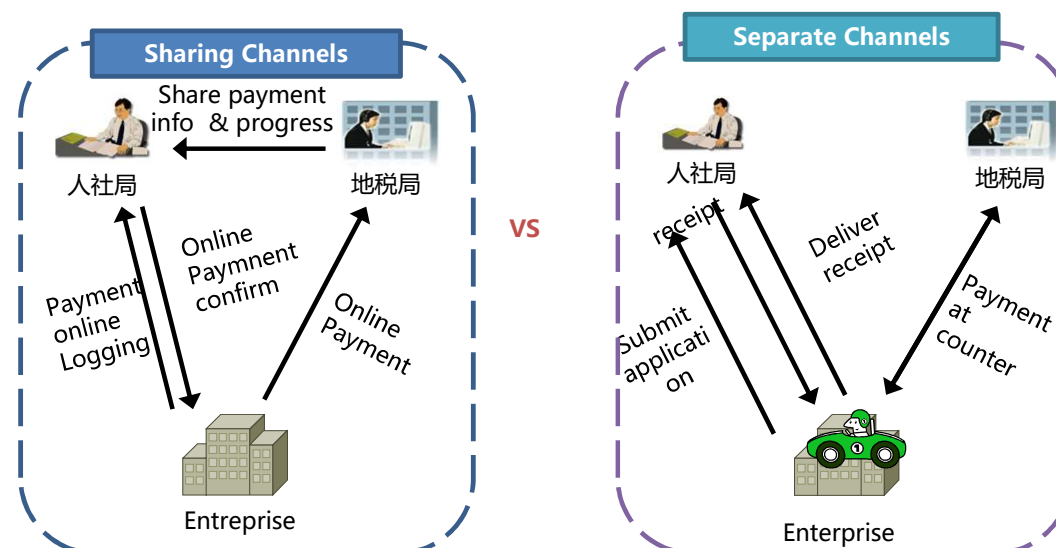
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# Smart Government – Public Information Sharing

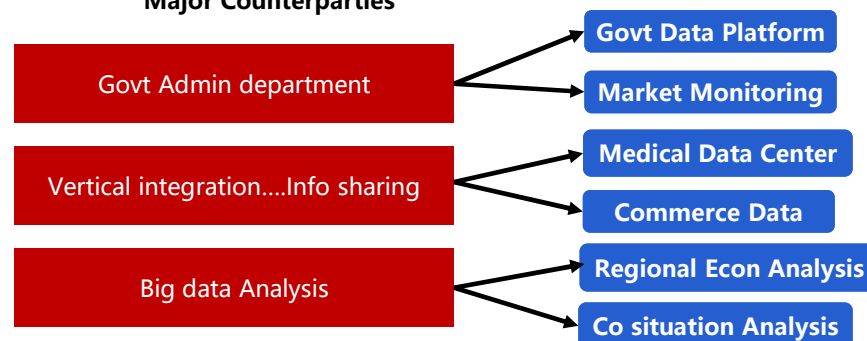
**Information platform** using advanced data sharing /exchange technology and geographical/location info-tech, help to achieve an inter-departmental, an inter-ranking, an inter-network information platform.



Social Security application & payment, Time & Efforts Saving



Major Counterparties

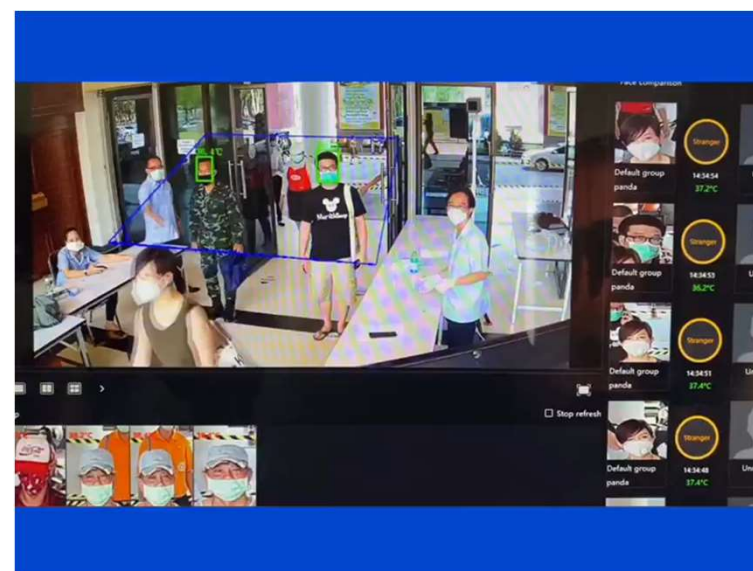




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× เชียงใหม่ วางมาตรการเข้มป้องกันโรค

วันนี้ (25 มี.ค. 63) วิทยาลัยศิลปะ สื่อ และเทคโนโลยี มหาวิทยาลัยเชียงใหม่ ร่วมกับ Institute of Software Chinese Academy of Sciences ประเทศจีน ได้ติดตั้งเครื่องวัดอุณหภูมิร่างกายของข้าราชการ เจ้าหน้าที่ และประชาชนที่เข้ามาภายในบริเวณอาคารอำนวยการ ศาลากลางจังหวัดเชียงใหม่ ซึ่งเป็นเครื่องวัดอุณหภูมิร่างกายระบบ AI Body Temperature System มีความแม่นยำ  $\pm 0.3$  องศาเซลเซียส เรียลไทม์ และแจ้งเตือนทุก 30 วินาที เป็นระบบการทำงานร่วมกันระหว่าง AI Facial Recognition, Infrared Thermal Camera และ Blackbody เครื่องกำหนดค่ากลางอุณหภูมิ (เพิ่มความแม่นยำ) มี Data display/Dashboard แสดงข้อมูลทางสถิติ เช่น อุณหภูมิ เพศ อายุ เป็นต้น



เพื่อช่วยในการตัดสินใจ มีฟังก์ชัน Human Resources Record Management ด้วยระบบ Learning Face Recognition และมี Target Health Record ด้วย ซึ่งหากบุคคลใดตรวจวัดครั้งที่ 1 อุณหภูมิร่างกายมากกว่า 37.5 องศาเซลเซียส เจ้าหน้าที่จะแนะนำให้นั่งพักประมาณ 5-10 นาที และทำการวัดอุณหภูมิร่างกายซ้ำอีกครั้ง หากอุณหภูมิ > 37.5 องศาเซลเซียส จะให้เข้าในอาคารตรวจวัดซ้ำได้ แต่หาก



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- Infrared Thermal Imaging
- Temperature Detecting
- Facial Recognition



**Dual-Camera Real-time Detection matching visible light and thermal-imaging**

- High-precision body temperature checking, Accuracy  $\leq 0.3^{\circ}\text{C}$ , built-in temperature sensor for compensated measurement to reduce the effect of environment temperature fluctuations, long-term stable operations
- Real time, Multi-target, Simultaneous checking.
- Alert in 30 sec
- Temperature of individual also displays next to its face

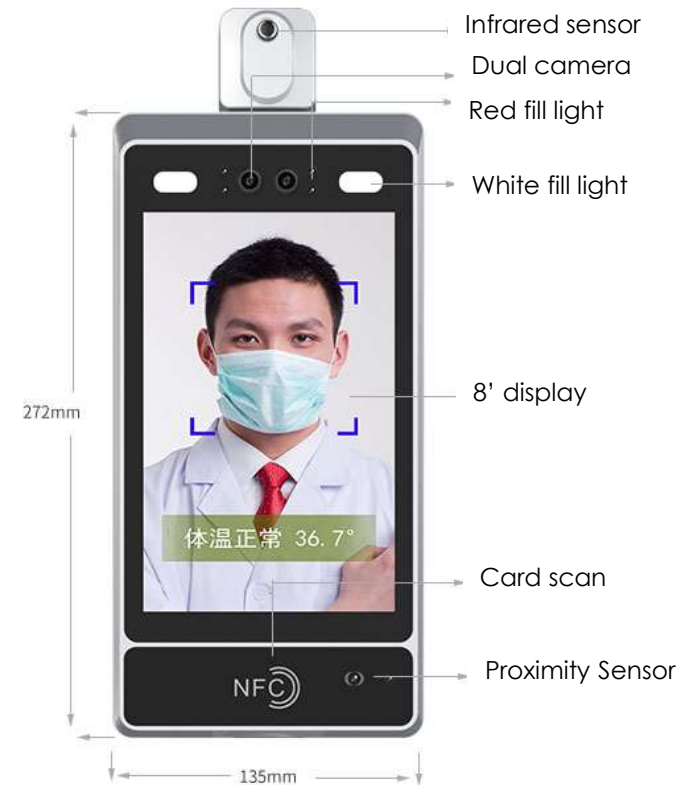
## Body Temperature Checking + Access Management Terminal



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KZ-T980 is our latest model of access management terminal featured with body temperature measuring.

- Same as our previous models; its dual-camera verification ensure genuine Facial Recognition
- The new thermographic camera provides accurate gauge of temperature which will show on the display screen.
- Alert will be activated once the target has above normal temperature
- Combine access management with body temperature recording
- Support 4G and Wifi
- Display 8 inches 1280 x 800
- Operate well under sunlight.





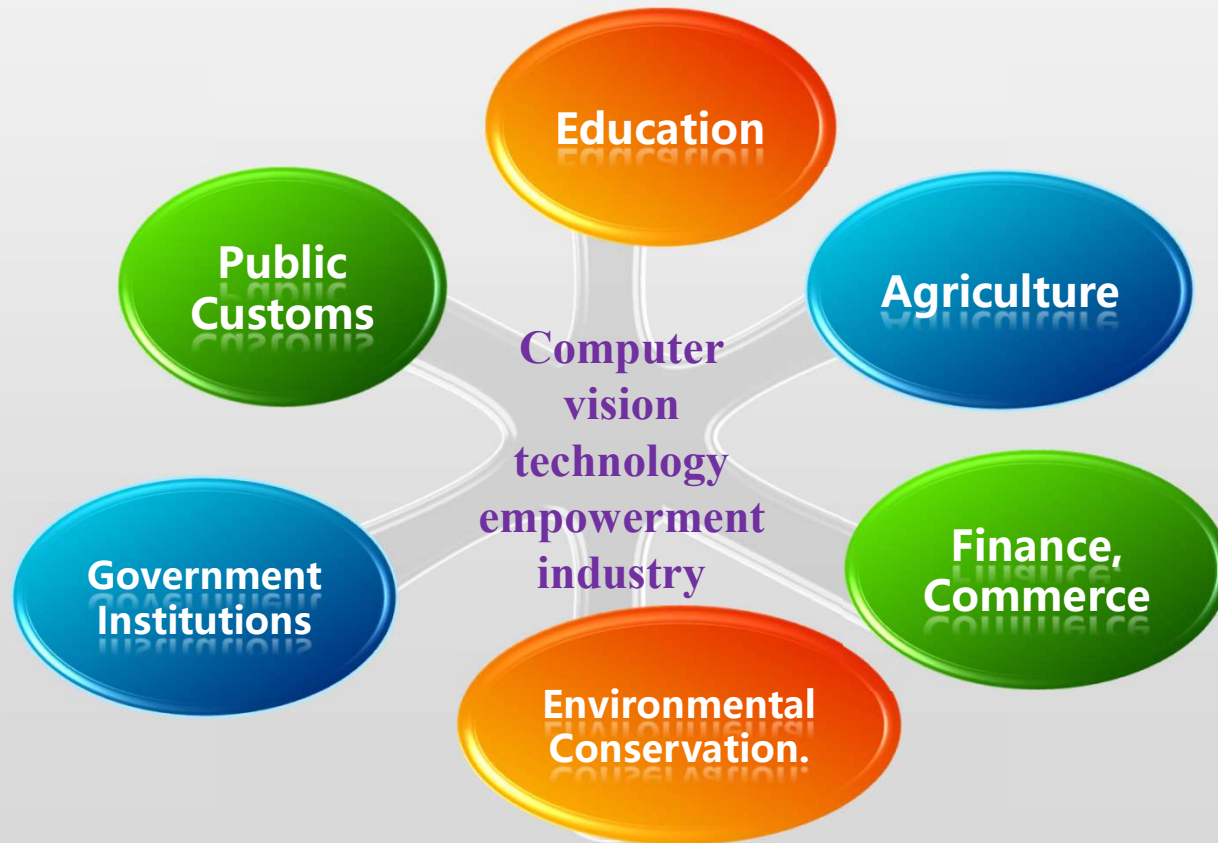
## AI fitness



中科凯泽

# Mission—Computer Vision Empowered Applications

Our Startegy is applying Computer Vision Technology into every corner of our daily life like education, public security, customs and other government bodies, finance, commerce, agriculture, environmental conservation. Our Mission is **promoting the whole society into AI stage and improve everybody livelihood**.



# Reference——Cases

Dynamic Face Recognition System of Qinjiang Criminal Investigation Brigade  
Dynamic Face Recognition System of Chongqing Criminal Investigation Corps  
Rongchang public security bayonet Face Recognition Distribution Control System  
Nanning Metro Face Recognition Distribution and Control System  
Nanning Metro Face Recognition Distribution and Control System  
Facial Recognition Distribution and Control System of Kakou in Wusu City  
Chongqing Yunyang Back Street Lane Project  
Wisdom Town Project of Guangpu Town in Bishan District  
Kunming Entertainment Place Face Recognition Project  
Yunnan Frontier Defense Face Recognition and Authentication Project  
Xichang Special Industry Management Platform Project  
AB Gate of Chongqing Jiangbei Detention House  
AB Gate of Chongqing Dadukou Detention Center  
Chongqing Reservist Face Access Control Project  
Ningbo Ping'an Campus Project  
Taizhou Intelligent Medical Project  
Facial Distribution Control Project in Nanjiang County, Sichuan Province  
Beijing Second Intermediate People's Court Video Intelligent Analysis System  
Face Recognition Project of smuggle in Gongbei Customs, Zhuhai  
On-line Escape Project for Detainees in Changzhou Detention Center  
Changzhou Public Security Smartphone Face Recognition System  
ATM Intelligent Analysis System of Chongqing Industrial and Commercial Bank  
Mianyang City Yanting County Complex Project  
Guangdong Maritime Safety Administration Face Recognition Platform Project

## Contact

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THANKS

谢谢聆听