A Vision of IoT: Applications, Challenges, and Opportunities With China Perspective

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Definitions of IoT from Different Organizations:

<table>
<thead>
<tr>
<th>Organizations</th>
<th>DEFINITIONS</th>
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<tbody>
<tr>
<td>CCSA</td>
<td>A network, which can collect information from the physical world or control the physical world objects through various deployed devices with capability of perception, computation, execution and communication, and support communication between human and things or between things by transmitting, classifying and processing information.</td>
</tr>
<tr>
<td>ITU-T</td>
<td>A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.</td>
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<tr>
<td>EU FP7 CASAGRAS</td>
<td>A global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities.</td>
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<tr>
<td>IETF</td>
<td>A world-wide network of interconnected objects uniquely addressable based on standard communication protocols.</td>
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Characteristics of IoT:

1. **Comprehensive Perception**: Using RFID, sensors, and two-dimensional barcode to obtain the object information at anytime and anywhere, it will be a new opportunity.

2. **Reliable Transmission**: Through a variety of available radio networks, telecommunication networks, and Internet, objects information can be available in any time.

3. **Intelligent Processing**: By collecting IoT data into databases, various intelligent computing technologies including cloud computing will be able to support IoT data applications.

Opportunity of IoT:

1. The IoT will create a huge network of billions or trillions of “Things” communicating each other.

2. The IoT blends the virtual world and the physical world by bringing different concepts and technical components together.

3. In IoT, applications, services, middleware components, networks, and end nodes will be structurally organized and used in entire new ways.
Capability of the IoT Application:

1. Location Sensing and Sharing of Location Info including:
   a. Mobile asset tracking
   b. Fleet management
   c. Traffic information system

2. Environment Sensing including:
   a. Environment detection
   b. Remote medical monitoring

3. Remote Controlling:
   a. Appliance control.
   b. Disaster recovery.


5. Secure Communication.

### Summary of IoT Applications

<table>
<thead>
<tr>
<th></th>
<th>Location sensing and sharing</th>
<th>Environment sensing</th>
<th>Remote controlling</th>
<th>Ad hoc networking</th>
<th>Secure communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-health</td>
<td>Monitoring</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
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<tr>
<td></td>
<td>Home care</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
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<tr>
<td>ITS</td>
<td>Smart fleet</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>Automotive</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Smart city</td>
<td>Environment monitoring</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td>√</td>
<td>√</td>
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<td></td>
<td>Food traceability</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Smart agriculture</td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Industry</td>
<td>Process monitoring</td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
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<tr>
<td></td>
<td>Logistic management</td>
<td>√</td>
<td></td>
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<td>√</td>
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IoT in China:

1. Action Plan of IoT Development in China:
   1. Top-layer design.
   2. Standards development.
   3. Technology development.
   4. Application promotion.
   5. Industry support.
   8. Government support.
   9. Laws and regulations guarantee.

2. National R&D plans in IoT in China:
3. Standardization

The IoT standard system contains:
- The architecture standards
- The application requirements standards
- The communication protocol standards
- The identification standards
- The security standards
- The application standards
- The data standards
- The information processing standards
- The public service platform standards.

Motivation and General Description:

Characteristics of an open and generic IoT architecture:

1. **Standard Interface and Protocol**: By comparing various private IoT systems, a generic IoT infrastructure has the same hardware and software interfaces, and protocols.

2. **Public and Operating**: A general IoT architecture is deployed to take over public IoT applications with open-operating capability. A public IoT system can thus integrate multiple IoT applications into one architecture.

3. **Open, Scalable, and Flexible**: An open IoT architecture with open resources, open standards, and open interfaces can easily extend its functionality and the scale of performance. It can thus adapt to different requirements including technical developments flexibly.
CCSA proposed open and general architecture of IoT.

Open and General IoT Architecture:

The architecture includes three functional platforms:

1. **Sensing and Gateway Platform**: This platform connects sensors, controllers, RFID readers, and location sensing device (e.g., GPS) to IoT network layer.

2. **Resource and Administration Platform**: Network and service layer includes backbone networks and resource administration platforms.

3. **Open Application Platform**: Modularization design in this application platform provides common function and open application programming interface (API).
Main Application Fields in China:

<table>
<thead>
<tr>
<th>Fields</th>
<th>Typical applications</th>
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<tbody>
<tr>
<td>Industry</td>
<td>Production process control, industrial environmental monitoring, manufacturing supply chain tracking, product lifecycle monitoring (PLM), safety in manufacturing, and energy saving and pollution control.</td>
</tr>
<tr>
<td>Smart agriculture</td>
<td>Agricultural resources utilization, quantitative management in agricultural production process, production and cultivation of environmental monitoring, management of quality, safety and traceability of agricultural product.</td>
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<tr>
<td>Smart logistics</td>
<td>Inventory control, distribution management, traceability and other modern logistic system, public logistics service platform covering different zones and domains, with Smart e-commerce and smart logistics.</td>
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<tr>
<td>Intelligent transportation</td>
<td>Traffic state perception and notification, traffic guidance and Intelligent control, vehicle positioning and scheduling, remote vehicle monitoring and service, vehicle and road coordination, and integrated smart transportation platform.</td>
</tr>
<tr>
<td>Smart grid</td>
<td>Monitoring of power facilities, smart substation, automatic power dispatch, smart power, smart scheduling, Remote meter reading.</td>
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<tr>
<td>Smart environmental protection</td>
<td>Pollution source monitoring, water quality monitoring, air quality monitoring, environmental information collection network and its information platform.</td>
</tr>
<tr>
<td>Smart safety</td>
<td>Social security monitoring, monitoring of dangerous and chemicals cargo transportation, food safety monitoring, early warning and emergency response for infrastructures such as Important bridges, buildings, rail transit, public water supply/drainage, and the municipal pipe network.</td>
</tr>
<tr>
<td>Smart medical</td>
<td>Intelligent drug/medicine control, hospital management, collection and analysis of Human physiology and medicine parameters, and remote medical service for family and community.</td>
</tr>
<tr>
<td>Smart home</td>
<td>Home area network, home security, smart control of household appliances, smart metering, energy saving and low carbon, and distance learning.</td>
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IoT development from Three Major Operators:

<table>
<thead>
<tr>
<th>China Mobile</th>
<th>China Telecom</th>
<th>China Unicom</th>
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<tbody>
<tr>
<td>Status of development</td>
<td>M2M services have been available in 51 provinces</td>
<td>M2M services have been available in more than 20 provinces</td>
</tr>
<tr>
<td>Range of the number Platform</td>
<td>10648xxxxxx.</td>
<td>10649xxxxxx.</td>
</tr>
<tr>
<td>Service scope</td>
<td>Focusing on industry, agriculture, electricity, health care, economy, ITS, logistics, etc., especially on electricity and ITS</td>
<td>Focusing on ITS, smart home, smart metering, healthcare, etc.</td>
</tr>
<tr>
<td>Operation</td>
<td>The branch for IoT was established in Chongqing in 2012.</td>
<td>The branch for IoT was established in Wuxi in 2014.</td>
</tr>
</tbody>
</table>
Deployment of Typical Applications:

1. **Smart City**: Smart city development plans are divided into three stages:
   - The stage for initial infrastructure construction
   - The stage for data-processing facility construction
   - The stage for end-phase service platform construction.

2. **Intelligent Transportation** Including: electronic police, intelligent traffic signal control, traffic video monitoring, intelligent Taxi service management, urban public transport information technology, and ETC.

Challenge of IoT:

1. Architecture Challenge
2. Technical Challenge
3. Hardware Challenge
4. Privacy and Security Challenge
5. Standard Challenge
6. Business Challenge
Prospect of IoT:

IoT systems will make intelligent sensing widely available through information sharing and collaboration.

IoT applications will expand the scale in the different industries like:

1. Interoperability
2. Intelligent System
3. Energy Sustainability

CONCLUSION:

The IoT encompasses several technologies such as information technology, cognitive sciences, communication technology, and low-power electronics.

The development of IoT will depend on technological advances in silicon scaling and energy-efficient devices, in getting the information from heterogeneous sources, in reducing costs, and in improving efficiencies.

The development of the IoT exposed many new challenges including the lack of fundamental theory supporting, unclear architecture, and immature standards.

Thus, the developments of IoT as an intelligent system can be proceeding with interoperability, energy sustainability, privacy, and security.

IoT have become an inevitable trend of development of information industry, which bound to bring new changes to our lives.