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Research Article

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Research on heterogeneous network architecture between the next-generation internet and internet of things (IOT)

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ABSTRACT

At present, the internet has developed into the next-generation internet time, some organizations have proposed to integrate the internet architecture about the internet of things (IOT), but as for the continuous development of the next-generation internet and wireless network, there has no systematic research on heterogeneous network between the next-generation internet and the IOT. Thus for the IOT and the next-generation network's development issue, firstly divide the core network development into four stages, design to the partial newly-build IPv6 network mode, dual-stack core network mode, IPv6 core network mode and IPv6-only network mode. Propose the architecture plan including sensor network from non-IP to IP mode, IOT access sub-network from IPv4 to IPv6, the core network from IPv4 to IPv6 integration development architecture scheme, and finally design the next-generation internet and IOT network integration comprehensive architecture mode, resolve the network constant change and the integration architecture problems under different application contexts.

Key words: Next-generation internet; IOT; IPv6; integration architecture

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INTRODUCTION

The IOT [1] is the high ground of future network information technology and industry competition, which has attracted governments around the world to pay attention to in recent years. Many countries introduce policies to encourage IOT technology and industry development, develop various demonstration applications, cultivate and develop the IOT industry. However, during the short-term, the IOT industry is still in starting stage, the key technology research and commercial model exploration becomes the priority issue.

As the extension of communication network and internet network, the IOT network makes use of the perceptive technology and intelligent settings to make perception and identification for the objects and settings, makes transmission and interconnection through network, by calculation, processing and knowledge discovery to realize the information interaction and network interconnection between person to thing and thing to thing, including the sensor network, internet and other networks, the sensor network includes the wireless sensor network, wired sensor network, RFID system, WLAN, Zigbee network, Bluetooth and other heterogeneous networks. As the internet's network extension, The IOT development meets a lot of problems such as the non-unified standard of the systematic structure, the diversification of IOT network terminal device, the exhaustion of IP address and lack of mobility, etc. However, the internet technology progresses to the next-generation internet [2] provides the application platform and technology support for IOT. The various network applications including IOT needs abundant internet addresses, with the depletion of IPv4 address, the IPv6 starts to enter into the substantive deployment stage. At present, it has been on the schedule about the IPv4's whole transfer to IPv6, thus it is a very urgent task to accelerate the development research of next-generation internet and IOT. The proposal of IPv6 in the next-generation internet network can provide light-weighted IPv6 address for each IOT node; can solve the inter-connection between the IOT heterogeneous network and internet. Therefore, it is the essential process of network development to research the network integration between the next-generation network and IOT, which has great practical significance [3].

It has proposed multiple architectures to integrate the IOT at present, but they are all incomplete or are short of the research on the internet's succession and the different circumstances' compatibility and commonality. For the above problems, this paper points out the IOT network integrated architecture model which integrates the internet and has compatibility, expansibility, adaptability and comprehensiveness at different stages, through the close combination of the IOT and the internet, to realize the heterogeneous IOT and internet's integrated architecture.

THE IOT NETWORK INTEGRATION PLAN TO THE IP SYSTEM DEVELOPMENT

2.1 The partial newly-built IPv6 IOT integration model

The partial newly-built IPv6 network model takes the IPv4 network as the core, and newly builds the partial IPv6 network on the basis of the original network. At present, most of the core network still uses IPv4 protocol, LAN as IOT access networks, the wireless device in a wireless network using IPv4 protocol, IPv6 protocol or dual-stack protocol, wired network retains the use of the original equipment. In the IOT accesses subnet, the wireless devices use IPv4 protocol or IPv6 protocol, and the subnet existing wireless Mesh network. The IPv4 network transmits the data to IPv4 core network by Security Gateway; IPv6 network transmits the data to IPv4 core network by Translation Gateway; if it is the double stack network, it directly selectively transmits the data to IPv4 core network through Dual-stack Gateway.

In the stub network, sensor or the wireless device makes the data collection through AP node (WIFI protocol), Zigbee node or 433 frequency range node, Bluetooth etc. node or 433 frequency range node etc. posts the data back to the multi-protocol gateway or the wireless net-bridge, and then transmits the data to the network; the data collected by Zigbee node is posted back to the network through Zigbee gateway, the network can be the IPv4 network or IPv6 network [4]. This moment's sensor or the wireless device only partly allocates the IP address, for the sensor network's wireless device or sensor which only partly has IP or has no IP; the network still makes networking communication by means of gateway. As shown in Fig.1.

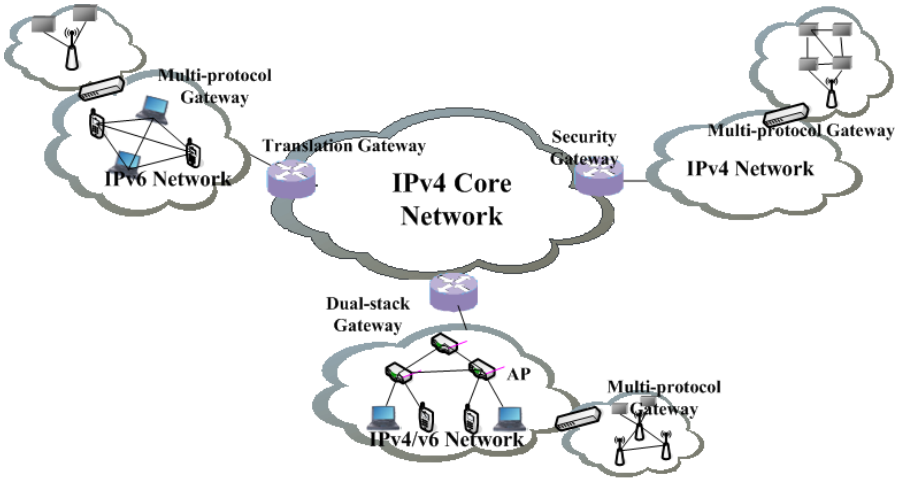

Fig. 1: the partial newly-built IPv6 IOT integration model

2.2 Dual-stack core IOT integration model

With the constant development of network, the network becomes the IPv4/IPv6 dual core model. In the IOT accesses subnet, exists wireless Mesh network which include planar mesh network, layered mesh network, hybrid mesh network. Because hybrid mesh network can realize wireless broadband access, also can achieve the direct communications with other users, and also can be used as routing to forward the data. So hybrid mesh network will become the most common access sub-network structure. When the network of access sub-network is IPv4 or IPv6 network, it transmits to the double core network through the original protocol, or translates into the corresponding protocol through Translation Gateway, and then makes the communication in double core network; if the network has different IP protocol at one side of the double stack gateway, the network will choose protocol by itself to make data communication according to the need.

The stub network changes into AP node and transmits to the multi-protocol gateway or the wireless net bridge through LTE base station, forms the wireless network in the model of intelligent wireless switch and the intelligent access point, and then transmits the data to the network. What's more, the Zigbee node or 433 frequency range node also transmits the data to the network through Zigbee gateway. At this time, the stub network's sensors and wireless devices also partly have IP address. As shown in Fig.2.

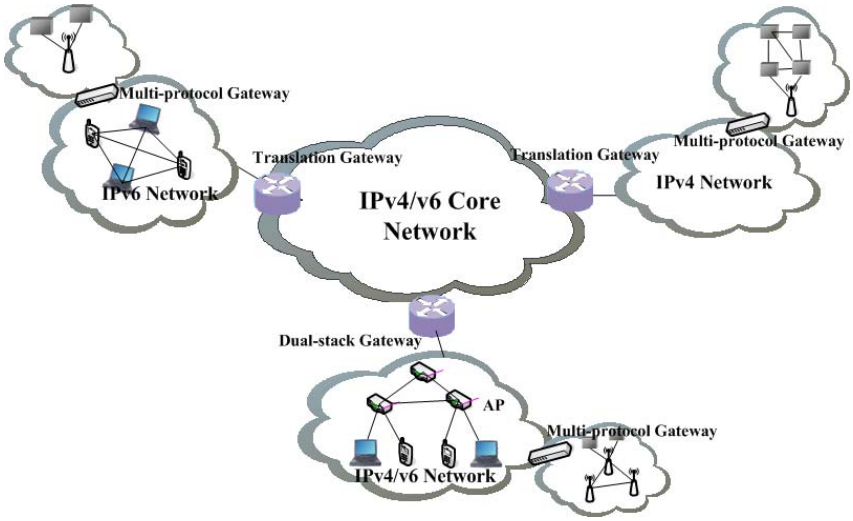

Fig. 2: Dual-stack core IOT integration model

2.3 The IPv6 core IOT integration model

With the constant evolution of network, the core network will evolve into IPv6 core network. In the access network, it communicates through Security Gateway with IPv6 core network; when the access network is IPv4 network, it communicates through Translation Gateway with IPv6 core network; when the access network is double stack network, it communicates through Dual-stack Gateway with IPv6 core network, and selects protocol by itself according to the need.

For this new-generation internet of integrates IOT, the sensor or the wireless device of IOT stub-network also collects the data through LTE base station, Zigbee node or 433 frequency range node. The LTE base station posts the data back to the multi-protocol gateway, that time's gateway evolution can be the intelligent wireless control gateway with convergent type and large capacity, this kind of gateway converges the data in IOT stub-network and then transmits the data to the access network; the data collected by Zigbee node or 433 frequency range node is posted back to the access network through Zigbee gateway or 433 frequency range node. Most of the sensor devices and wireless devices in stub-network can be automatically assigned a lightweight IPv6 address [5], if the access subnet is IPv4 network, it can partly retain IPv4 address; the sensors and wireless devices in IOT access network are also mostly automatically assigned a lightweight IPv6 address, partly for IPv4 address. As shown in Fig.3.

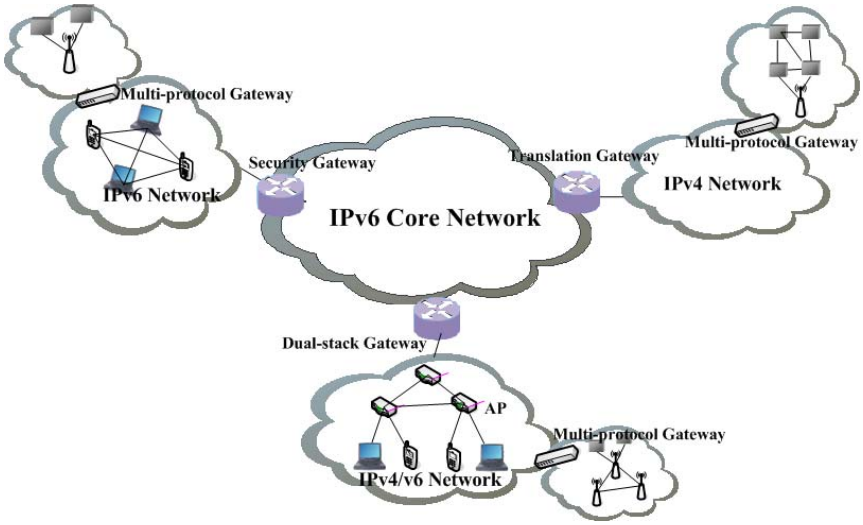

Fig. 3: IPv6 core IOT integration model

2.4 IPv6-only IOT integration model

The IOT access subnet and IOT network will be finally developed to the IPv6-only network, at this time, all access objects and devices will be transmitted in network by IPv6 protocol and be automatically assigned the lightweight IPv6 address. At this moment, the sensor devices and wireless devices in stub network and access network are all automatically assigned IP, they can organize network by themselves, and these ad hoc networks upload the data

through wireless gateway or intelligent wireless switcher to the upper network, and then make communication with other IPv6 networks through security gateway. The objects and devices in access network and sensor network all have control function, which can directly upload the data to the wireless gateway and wireless switcher. As shown in Fig. 4.

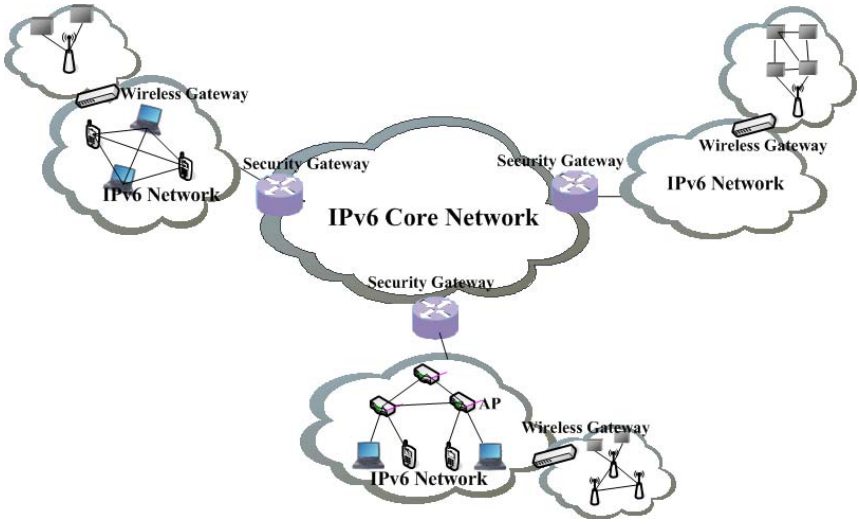

Fig. 4: IPv6-only IOT integration model

THE COMPREHENSIVE ARCHITECTURE PLAN OF IOT NETWORK INTEGRATION

Based on the IP heterogeneous network, make the lightweight to IPv6 protocol, deploy the IOT protocol stack, internet stack and other relevant protocols on the IOT gateway, and realize the adaptation between light weight IPv6 and standard IPv6 and the deployment of multi-protocol gateways. The heterogeneous network which is composed of various objects networking, the IOT node accesses the internet through multi-protocol gateway by wireless way, the IOT access network makes the communication with the multi-protocol gateway by wireless or wired way, and finally use the security tunnel model, gateway translation model and double stack gateway model to realize the interconnection between heterogeneous network and internet. During the process of communication, the network layer uses IPv6 protocol, uses RPL and 6LoWPAN protocol for the low-power network routes that don't support IPv6, the application layer uses CoAP [6] protocol. As shown in Fig. 5.

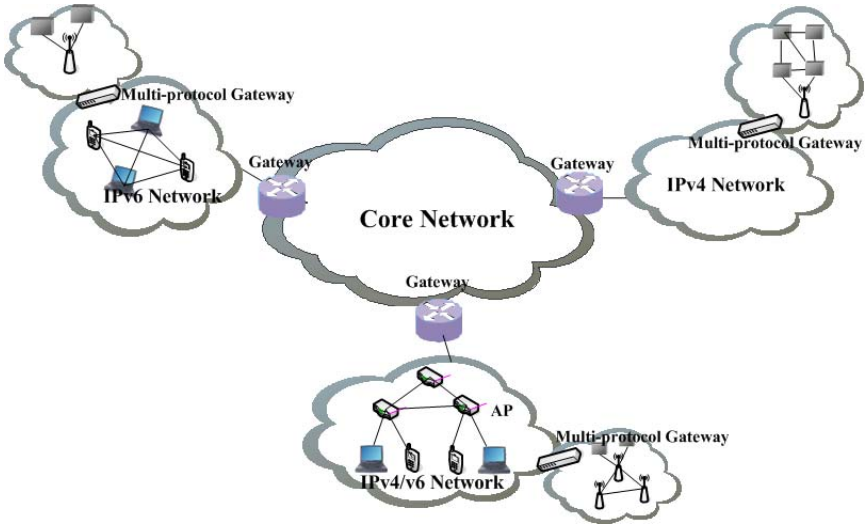

Fig. 5: the IOT network integration architecture

It can be known from the above figure, the IOT core network is IPv6 core network, and the sensor node in IOT realizes the communication with terminal host through Dual-stack Gateway, tunnel mechanism and Translation Gateway. As the sensor nodes and route nodes in IOT use the lightweight IPv6 protocol or IPv4 protocol, during the internet communication process, use multi-protocol gateway and stub network to make wireless communication, and then makes connection with the upper internet through wired or wireless way, the multi-protocol needs to finish the work of completing IP address and removing the prefix and the function of protocol bilateral translation, and takes

charge of the protocol transition and information transmission; the multi-protocol gateway transmits the stub network's information to the intelligent convergent gateway and then transmits to the internet network. The geographic position and network environment that the objects locate in IOT heterogeneous network is not all same, which can make the data in heterogeneous network access to the upper integrated network through several effective links. For the IOT heterogeneous network which supports IP address, take the distributed source address [7] to verify and guarantee the authenticity of sensor node IP address.

There is sensor network based on IP and sensor network based on non-IP in the IOT network sensor network, between the sensor net and IOT user based on IP, they realize networking through IP address, the sensor node can be directly connected to the internet through tunnel mechanism and communicate with IP terminal host. In the sensor network based on non-IP, the sensor node has no IP address, the IOT user and sensor network realizes networking through sensor gateway. During the process of network integration, for the sensor node whether supports IP or non-IP, wireless or wired, the sensor net must be connected to the original internet network, the each heterogeneous sensor network's transmission data is integrated in IP network through integration and is communicated in IP network.

This plan realizes adaptation between light weight IPv6 and standard IPv6 in IOT gateway, completes the end-to-end communication between sensor terminal and application host, and finally realizes the seamless integration between sensor network and traditional core network. Complete the heterogeneous node internetwork's end-to-end communication, which further verifies the IP architecture's validity and accuracy in IOT network integration.

In autonomous domain, the IPv6 backbone network of operating BGP route protocol takes use of inter-domain source address to verify SMA plan; within autonomous domain, the network operates route protocol such as OSFP, RIP, IS-IS and so on, takes use of intra-domain source address to verify SAVT [8] plan; within the user access subnet, takes use of SAVI exchange board technology to guarantee the user status and host's authenticity and reliability; within the IOT access subnet, the routable node operates RPL and other route protocols, takes use of distributed source address to verify plan, guarantees IP address authenticity and reliability for the IOT sensor node and achieves the sensor node granularity's verification level.

The stub network node needs corresponding extensible route algorithm to match up, divide the stub network into three kinds: single-hop network, node transmission network and scale level network according to the network scale and node density, and for the different kinds of network, propose the corresponding gateway setup and new-type extensible level route design plan. The singled network refers to that all sensor node data can reach to the multi-protocol gateway just through no more than one routable node; the multi-hop network refers to that some of sensor nodes can't directly communicate with routable node, and must continue to relay transmission through sensor inter-node, and communicate with internet node under the transition of one or multi-routable nodes; the scale level network is the extension of single-hop network, which refers to that all sensor nodes can directly communicate with their covered routable nodes, but it should need at least one routable node to make relay transmission that the data can be reached to the multi-protocol gateway. The sensor or the wireless device in single-hop network directly transmits to the multi-protocol gateway, intelligent wireless switcher or the convergent gateway through an AP, LTE base station or Zigbee gateway, the route protocol adopts the RPL protocol; the sensor or the wireless device in node transmission network uploads to AP, LTE base station or Zigbee node through many sensors or wireless devices, and then transmits to the network through gateway and intelligent switcher; while the level network is that the AP, LTE base station or Zigbee node transmits by level way, and transmits the data to the network through gateway and intelligent switcher.

It has been designed in network architecture's deployment plan schemes at various stages. In architecture, according to the difference of communication terminals, access internet types and ways, the inter-connection and inter-communication problems include models such as security tunnel model, gateway translation model and double stack gateway model, etc., their solutions include the route mechanism design, protocol translation plan, capability negotiation mechanism, communication role definition, domain name analytic method and data analysis technology, etc.

CONCLUSION

The IOT heterogeneous network integration is one of the key technologies of IOT research, The IP network architecture becomes current IOT heterogeneous network integration research hot spot because of its advantages such as extensibility, universality and mature infrastructure, etc. For the current research, this paper is just the IOT integration research in next-generation internet, it researches the integrated architecture model of IOT which develops from current IPv4 core network to IPv6-only core network [9], it systematically proposes the network integrated architecture models at different stages with the internet core network development and stub network change, and it

will lay the foundation for further research on IOT inter-connection and inter-communication.

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