Short Paper: IoT-NDN: An IoT Architecture via Named Data Netwoking (NDN)

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***Abstract*—The Internet of Things (IoT) is gaining importance in everyday life, science, and industry. Although current IoT systems can be modeled in IP, future systems with over a billion devices will face great challenges. Data aggregation, naming scalability, and the handling of resource-restrained devices are problems that need to be solved. Named Data Networking (NDN) addresses many issues by using named data. IoT based on NDN (IoT-NDN) is used to solve many of the mentioned issues in this work.**

I. Introduction

This short paper is based on [1]. Currently, IoT is based on the Internet Protocol (IP) which lacks scalability, robustness, and efficiency. Mobility is not supported in location-based IP; protocols are needed for support. Named Data Network (NDN) is data-focused and not location-focused; it allows devices to request data using unique, location-independent names. NDN offers scalability, lightweight configuration, and simplified communications, making NDN a solution for IoT systems [2].

II. Analysis of IoT and NDN

This section will discuss the limitations of IoT devices and the challenges of the current Internet architecture.

A. Challanges of the IoT

1) **The connectivity of IoT devices:** Currently, IoT devices use a server-client or host-to-host connection, neither is scalable enough for a billion devices. In the host-host architecture, every host has to communicate with every other host, resulting in exponential resource consumption.

2) **Technological Standards:** The current standards are inadequate for network protocols, communication protocols, and data aggregation. They lead to inefficient caching and aggregation. In addition, mobility protocols are needed to mitigate the effect of a connection loss.

3) **Mobility:** IoT systems that use mobile devices need to note, that devices are numerous and technologically diverse, and consumer reliance is increasing.

4) **Complexity and Integration Issues:** IoT systems comprise many unique Application Programming Interfaces (APIs), protocols, and platforms. The integration of technologies into the system is very complicated due to all the different combinations. This system should consider the resource limitation of its components.

B. NDN for the IoT

1) **NDN Packet Length:** Packages in NDN are not bound to a specific length, which allows the expansion of further protocols by adding or subtracting from the overhead. IoT devices are limited in memory, resulting in small packages with a need for small overheads.

2) **Caching in IoT/NDN:** IoT devices have too little memory for efficient caching, resulting in increased unnecessary package flow and reduced data availability. The solution is in-network caching, a feature of NDN.

3) **Data Aggregation in Wireless Networks:** Interest packets are requests for data that are name-based. Data packets are their counterpart. Multiple but very similar Data packets have to be requested separately (excluding the others). This results in a greater overhead and more unnecessary package flow. The new system should fix the request problem.

4) **Naming Problems in Wireless Networks:** NDN supports name-centric services, which facilitate access without knowing their location. Data is addressed by names that should be kept short to minimize storage usage [5].

5) **Routing Scalability in NDN:** The Pending Interest Table (PIT) tracks Interest packets until satisfaction. The Content Store (CS) is a cache that stores the Data packets. Routing scalability is important to facilitate a large network [6].

III. Architecture of IoT-NDN System

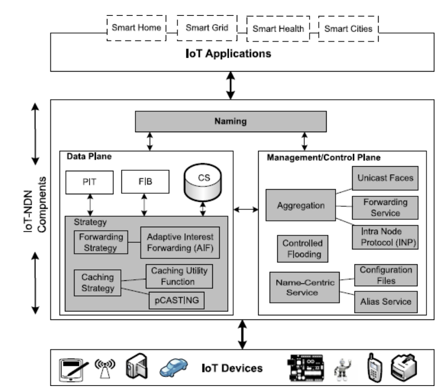

Fig. 1: IoT-NDN System architecture and its components

The IoT-NDN has three main components that are responsible for packages, caching, strategies, and others. The **naming** component, the **Management and control plane**, and the **dataplan** component. All three interact with each other, as seen in Fig. 1.

Devices in the IoT-NDN architecture have three tables: CS, PIT, and Forwarding Information Base (FIB).

A. Naming

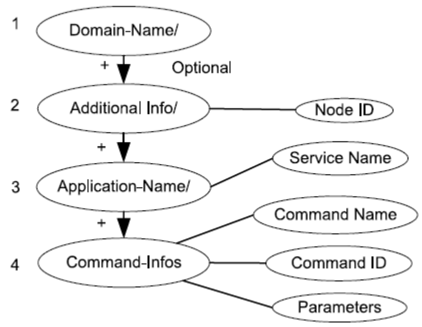

Fig. 2: Name Structure of the suggested Approach

In IoT-NDN the structure in which data are addressed is hierarchical, as shown in Fig. 2. The marker component is the additional fifth component of the name, specific to IoT-NDN. It contains information on the application, service, or device resources.

B. Managment and Control Plane

1) **Aggregation:** Combining similar information into one package will reduce the memory stress and energy consumption of the CS [3]. Three components achieve Data aggregation. The components are: Forwarding Service, Unicast Faces, and Intra Node Protocol (INP). They are explained in greater detail in [3].

Unicast Face needs every package (in the radio layer) to include the source and destination address. When a device receives a package, it will build a connection to the sender of the package. If a connection is lost, for this connection allocated resources will be released.

2) **Controlled Flooding:** IoT devices aren't reliable in power or connectivity; as a result, the FIB tables are usually insufficiently populated in advance by routing information. Controlled flooding is selected for its robustness. Expanding it with timer-based package suppression can reduce overhead. Packages won't be sent out while the timer is running, if the same package is received it will only be sent out once.

3) **Name-Centric Services:** The usage of a gateway enables IoT devices to be reachable from any internet device. The gateway allows wireless and wired connections, via protocol conversion. It provides all important configurations of names and IoT-NDN devices. Services on the gateway can be developed as IoT-NDN applications, enabling communication to each other threw the IoT-NDN daemon and face. To reduce the workload on the IoT devices the gateway will use aliases (that are shorter) to reduce the size of the packages. Names received from the internet will be mapped to names used in the IoT-NDN network.

C. Data Plane

1) **Strategy-In-Network Caching:** The CS differs from routers in IP by the ability to send cached packages more than once. If a device receives a package request, it will first check the CS by checking for matching prefixes because the same data will probably be requested many times in IoT-NDN networks. The standard replacement strategy is LRU, but others can be implemented. IoT-NDN devices have a special probabilistic CAching STrategy (pCASTING) that considers data freshness and the charge and storage of devices. This strategy is used when a device receives a data package with a matching PIT.

2) **Strategy-Forwarding:** The forwarding strategy component selects the forwarding path from the FIB to send the Interest packets. Remembering the number of unsatisfied interests, the forwarding strategy could be used to control the traffic. The forwarding component is the path of the Interest packet using data such as delay and throughput. Forwarding steps on devices are supported by IoT-NDN and the forwarding strategy allows the request of lost packages in a network by using its metrics. These metrics can be used to study the performance of every face. Finding missing packages can also be achieved with the InterestLifeTime parameter. For more information, see [4]

IV. Conclusion

First, the paper highlights the problems of IoT if implemented in IP. NDN isn't built with resource-constrained devices in mind. This paper names the problems and solutions to integrate NDN into IoT. The result Iot-NDN is a new type of network that includes communication and data access, based on names.

References

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