IoT-NDN: An IoT Architecture via Named Data Networking (NDN)

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Introduction

- The Internet of Things (IoT) is a network of mainly small devices that collect and share data.
- IoT modeled in IP isn't scalable enough.
- The main problems are data aggregation, naming scalability, and the handling of IoT devices.
- IoT devices are limited in energy and memory.
- Named Data Networking (NDN) is a model that searches for data via names instead of its location. Importantly, it allows cached packets to be sent out again [1].
- This paper introduces IoT-NDN, which solves the problems of IP and mitigates issues of IoT devices in NDN [2].

Analysis of IoT and NDN

Problems of IoT in IP:

- Each device needs its own IP address.
- Too many packets will put a strain on the Network and its devices.
- The overhead of packages reduces the efficiency of transferred data.
- No mechanism to enhance data aggregation.
- IoT devices aren't reliably connected.

Integrating IoT into NDN:

- NDN wasn't designed with resource-limited devices in mind.
- Packets are small, so their overhead needs to be too.
- Packages don't have a fixed length, allowing future edits to the protocol.
- Devices are too small to cache data, but IoT allows In-Network caching.
- Similar interest packets need to be requested separately; that excludes received data packets.
- Names in NDN are human-friendly, which is too long.

Architecture of IoT-NDN System

As seen in Fig. 1, IoT-NDN has three main components: **Naming**, **Management/Control Plane**, and the **Data Plane**.

- **Naming:**
  - Similar to IP, NDN addresses are hierarchical, as shown in Fig. 2.
  - IoT-NDN introduces a fifth naming component (marker component) that contains information on the application, service, or device resources.
- **Management and Control Plane:**
  - Similar data can be combined into one data packet to reduce bandwidth and energy consumption [3].
  - Flooding with timer-based packet suppression ensures robustness and reduces bandwidth (compared to Flooding).
  - A gateway ensures a smooth transition between wired and wireless devices. It uses a name alias service to shorten the human-friendly names.
- **Data Plane:**
  - The Content Store (CS) caches fulfilled interest packets and is able to send them out again if requested.
  - LRU is the standard replacement strategy, but the CAching STrategy (pCASTING) considers data freshness, the charge, and the storage of devices, which makes it more viable.
  - Based on performance characteristics like delay or throughput, the path of the interest packets can be selected from the FIB.

Figure 1

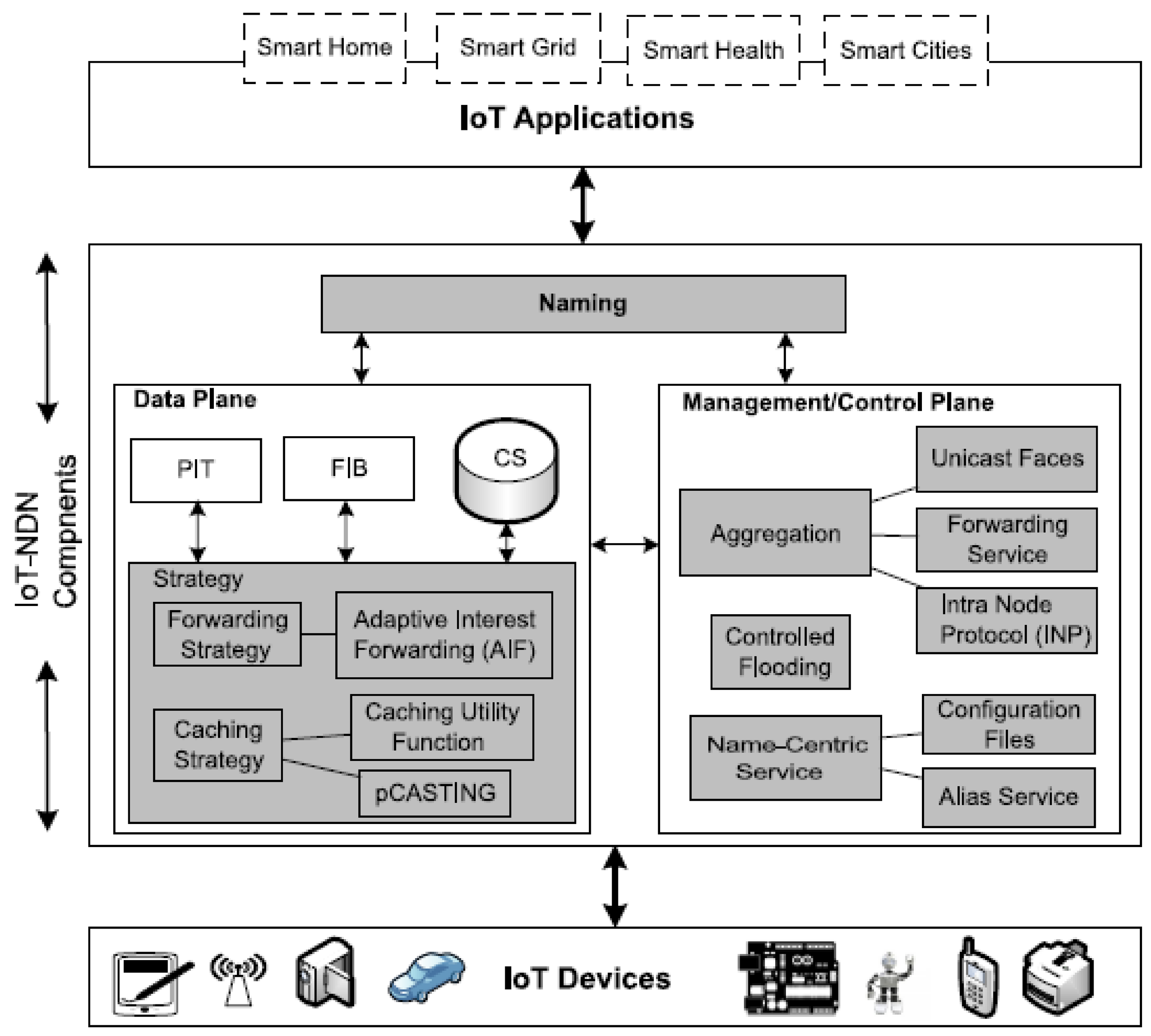
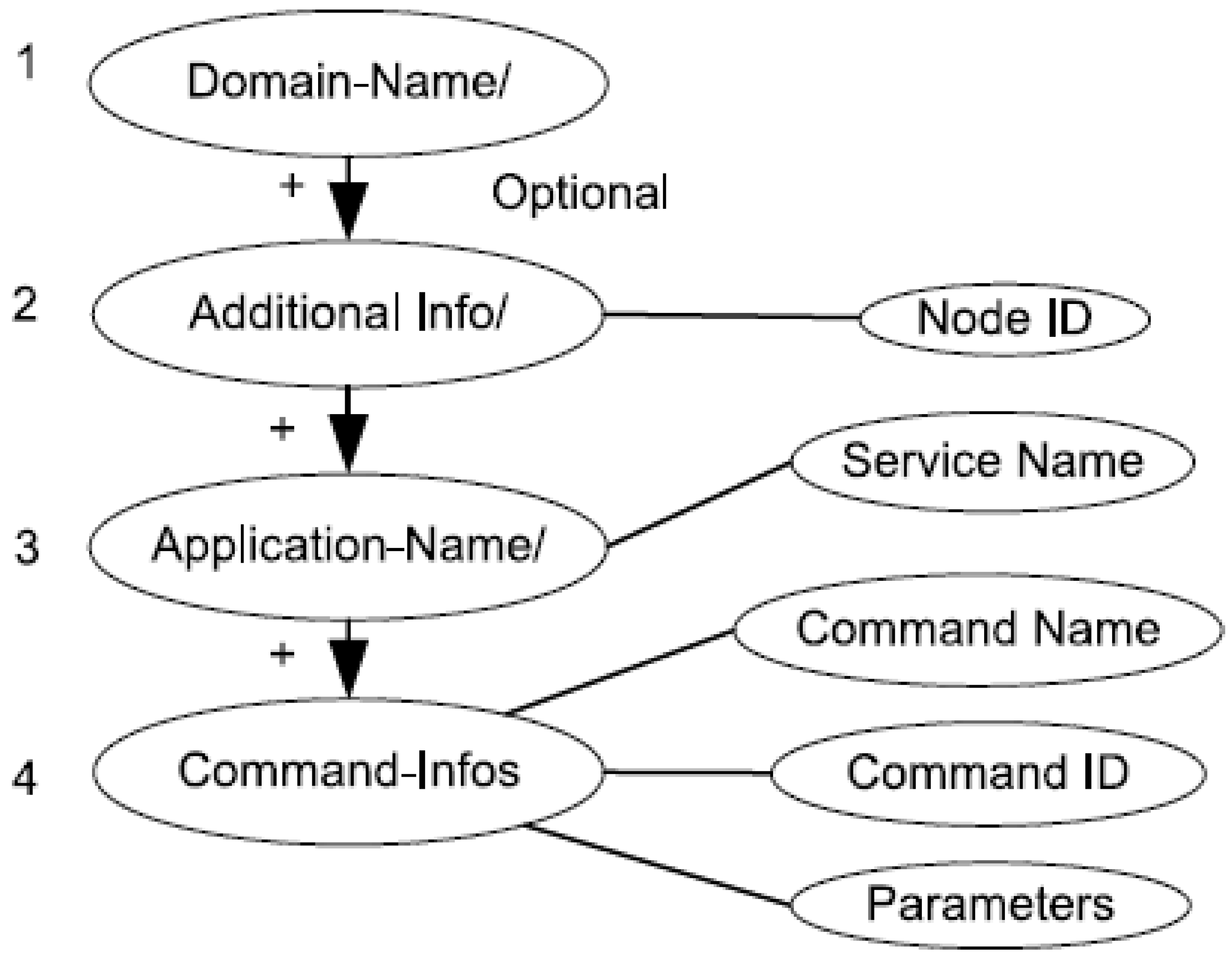


Figure 2



Conclusion

IoT-NDN solves the problems of data aggregation, naming scalability, and the handling of IoT devices.

- Data aggregation: by combining similar data, data aggregation is achieved.
- Naming scalability: devices don't need IP addresses because the data is addressed, not the device.
- Resource-constrained devices: having smart in-network caching, a reduced overhead, and robust pathfinding mitigate the device's shortcomings.

References

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[2] M. A. Heil, ÏoT-NDN: An IoT Architecture via Named Data Netwoking (NDN)inSSoft-ware Embedded System Department Euroimmun AG, a PerkinElmer Company

[3] T. Teubler, M. A. M. Hail, and H. Hellbr¨uck, "Efficient Data Aggregation with CCNx in Wireless Sensor Networks," in 19th EUNICE Workshop on Advances in Communication Networking (EUNICE 2013), Germany.