Contextualized Information-Centric Home Network

Trisha Biswas†, Asit Chakraborti‡, Ravishankar Ravindran‡,
Xinwen Zhang‡, and Guoqiang Wang‡

†North Carolina State University, Raleigh, NC, USA. tbiswas@ncsu.edu
‡Huawei Research Center, Santa Clara, CA, USA.
{asit.chakraborti, ravi.ravindran, xinwen.zhang, gq.wang}@huawei.com

ABSTRACT

We deploy information-centric networks (ICN) to serve several applications including content distribution, vehicle-to-vehicle communication (V2V), home networks (homenet), and sensor networks. These applications require policy and context-based interaction between service producers and consumers. We visualize the ICN service layer as a contextualized information-centric bus (CIBUS), over which diverse sets of service producers and consumers co-exist. We develop a prototype and demonstrate several desirable features of ICN for homenets such as contextual service publishing and subscription, zero-configuration based node and service discovery, policy based routing and forwarding with name-based firewall, and device-to-device communication. Furthermore the prototype is applicable to both ad hoc and infrastructure settings, and can deal with diverse devices and services.

1. INTRODUCTION

Several features provided by information-centric networks (ICN) [2] make it suitable for diverse application environments such as home network (homenet), vehicle-to-vehicle (V2V), and Internet-of-things (IoT), including receiver-oriented communication, enforcing security policies at service, device, and content levels, and naming entities according to application requirements. These features make ICN suitable not only for existing applications such as content distribution, but also for emerging applications such as sensor or ad hoc networks.

We envision ICN as a contextual information-centric bus (CIBUS) spanning diverse applications, over which context-aware interaction is enabled among service producers and consumers. Such interaction requires service framework over ICN to discover, publish, and subscribe resources, which differ with the types of applications and contexts. This paper discusses CIBUS in homenet scenario. Among our contributions, we design and develop light-weight name-based node and service discovery protocols overlaying ICN, which allows policy and context based interaction between distributed service producers and consumers.

2. CIBUS BASED HOME NETWORK

A high level view of ICN based homenet architecture is shown in Figure 1(a). ICN supports primitives to request name-based services and content, name-based routing, in-network content caching, multi-homing and multi-path routing. We propose a service management layer allowing contextual auto-node and service discovery, and policy-based service publishing and subscription. ICN-based homenet provides the following novel features: (1) Being a name-based networking architecture, ICN-based homenet requires no configuration for local communication among producers and consumers, within and crossing router boundary, and service access over Internet through ISP support; (2) The service management layer allows consumers to discover services based on their contexts. A home gateway learns services through the discovery process, manages service policies, and composes rich new services; (3) With its configuration-less nature and support for various communication modes such as 1:M and M:1, ICN can be used for various situations including sensor networks, achieving the objective of single network layer protocol in homenet; (4) Being receiver-oriented, ICN allows consumers to express contexts, and producers to generate appropriate responses, therefore enabling contextual communication; (5) ICN integrates security with data requests and responses, which can be bound at service, device, or content level.

2.1 Prototype

The prototype setup is shown in Figure 1(b), where multiple internal routers (IRs) are rooted to a home gateway (HGw), each is deployed with CCNx [1]. The HGw connects to an ISP's provider gateway (PGw). The IRs provide gateway support to connected resource-constrained sensors. The prototype demonstrates the following functionalities: (1) home-wide zero-configuration through name-based neighbor and service discovery protocols across router boundary; (2) context and policy based routing and forwarding at the HGw/IRs, where routing tables are set as the result of the service dis-
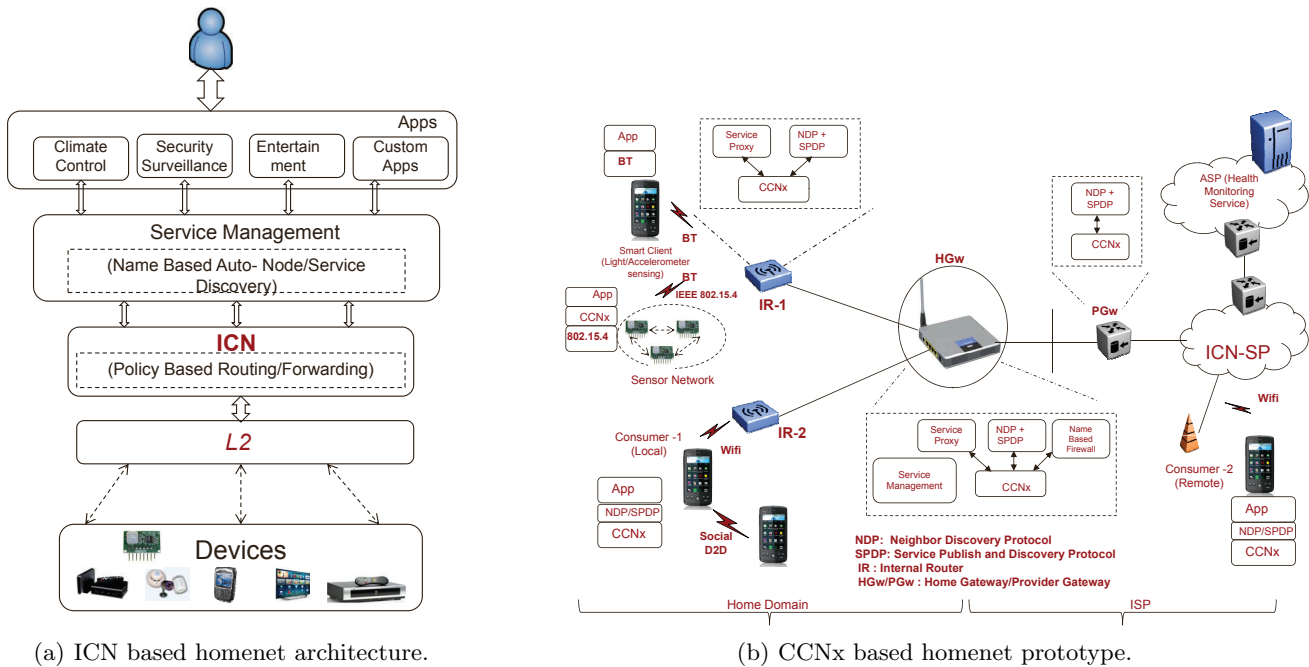
(a) ICN based homenet architecture. (b) CCNx based homenet prototype.

Figure 1: ICN based homenet architecture and prototype.

covery protocol; (3) name-based firewall at the HGw, where flows are inspected based on service names rather than ports and IP addresses; (4) layer-2 agnostic operations realizing end-to-end ICN operations over any L2 technology.

Zero-configure discovery protocol: We develop two name-based CCN protocols, namely, neighbor discovery protocol (NDP) and service publishing and discovery protocol (SPDP). The objective of NDP is contextual association of devices, while SPDP allows efficient discovery of services over ICN. Further details on these protocols can be found in [3].

Policy-based routing: ICN-based homenet uses policy based routing and forwarding, wherein service entries in the FIB of a node are the result of service discovery requested by consuming applications. In the HGw, a name-based firewall is realized by extending CCNx's FIB logic to subject incoming requests to policies associated with services. For example, if a service is marked for private access, i.e. valid only within the homenet scope, any interest from outside is dropped by the HGw.

Device-to-device communication: While demonstrating the applicability of ICN towards different scenarios, our prototype supports location based service publishing and social-aware device-to-device (D2D) interaction.

2.2 Demonstration Scenarios

Health monitoring service: In this scenario, a consumer discovers a health monitoring service through the HGw. The user then subscribes to this service. The interaction between the consumer and the service results another service instantiation on the consumer device, which makes the health monitoring data accessible to a healthcare service provider. The consumer device service is published for public access.

Sensor service: A set of wireless sensor motes are deployed which generate data of temperature, light, and humidity. These data are made accessible through a sensor service. The service is proxied by the internal router (IR-1) as shown in Figure 1(b), and published for public access.

Trusted D2D interaction: This application demonstrates ICN-based ad hoc trusted and social device-to-device interaction. Two devices discover each other and their services through the neighbor and service discovery protocols. Data access is restricted through group-ID based access control, and data confidentiality is enforced using a group key.

3. REFERENCES

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