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PRO-PMM: A PROACTIVE PRODUCER MOBILITY MANAGEMENT IN NAMED DATA NETWORKING

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Abstrak

Rangkaian Data Bernama (NDN) menggunakan seni bina berpusatkan data. Ini secara semula jadi menyokong mobiliti pengguna tetapi tidak menangani mobiliti pengeluar dengan secukupnya. Mekanisme sedia ada untuk mobiliti pengeluar menghadapi dua cabaran: meramal bila pengeluar akan meninggalkan penghala akses semasanya dan memaklumkan pengguna untuk mengambil tindakan pencegahan. Isu-isu ini boleh menyebabkan kehilangan paket Minat, yang seterusnya mengurangkan kepuasan Minat dan kecekapan penghantaran data. Bagi menangani cabaran ini, kajian ini mencadangkan Pengurusan Mobiliti Pengeluar Proaktif (Pro-PMM). Pro-PMM mengesan masa pelepasan pengeluar lebih awal dan memaklumkan pengguna sebelum proses penyerahan berlaku. Ia terdiri daripada dua skema bersepadu: Skema Pengesanan Pelepasan Proaktif (PDDS) dan Skema Makluman Proaktif (PNS). PDDS menganggarkan masa pelepasan menggunakan Petunjuk Kekuatan Isyarat Diterima (RSSI), kelajuan, dan koordinat. PNS pula memaklumkan pengguna untuk menggantung sementara penghantaran Minat, yang membantu mencegah kehilangan paket. Pendekatan ini membezakan Pro-PMM daripada kaedah proaktif sedia ada, yang hanya bergantung pada ramalan lokasi dan tidak memaklumkan pengguna. Apabila RSSI jatuh di bawah nilai ambang, PDDS akan menentukan masa penyerahan pengeluar dan mencetuskan makluman kepada penghala dan pengguna yang berkaitan. PNS kemudiannya memastikan pengguna berhenti menghantar Minat kepada pengeluar yang tidak tersedia itu. Pro-PMM telah dinilai menggunakan simulasi ndnSIM. Prestasinya telah dibandingkan dengan NDN tulen dan Skema Berasaskan Ramalan Lokasi (LPBS) proaktif di bawah lokasi pengeluar yang berbeza dan senario pelbagai pengguna. Hasil simulasi menunjukkan bahawa Pro-PMM mengurangkan kehilangan paket Minat secara signifikan. Ia meningkatkan kepuasan Minat masing-masing sebanyak 6.82% dan 10.53% berbanding LPBS dan NDN tulen. Pro-PMM juga menambah baik kadar penghantaran paket data sebanyak 5.69% dan 12.26%. Ini menunjukkan pengambilan data yang lebih stabil semasa mobiliti pengeluar berlaku. Dapatan ini mengukuhkan Pro-PMM sebagai penyelesaian yang cekap dan kebolehkalaan untuk mobiliti pengeluar yang lancar dalam NDN. Skema Pro-PMM, PDDS, dan PNS boleh digunakan untuk mengesan masa pelepasan, memaklumkan pengguna, serta mengurus penyerahan bagi Internet masa hadapan.

Kata Kunci: Rangkaian Data Bernama, Mobiliti pengeluar, Kaedah pengeluar.

Abstract

Named Data Networking (NDN) uses a data-centric architecture. This naturally supports consumer mobility but does not adequately address producer mobility. Existing mechanisms for producer mobility face two challenges: predicting when a producer will leave its current access router and notifying consumers to take preventive action. These issues can cause Interest packet loss, which reduces Interest satisfaction and data delivery efficiency. To address these challenges, this study proposes Proactive Producer Mobility Management (Pro-PMM). Pro-PMM detects producer departure times in advance and notifies consumers before handover. It consists of two integrated schemes: the Proactive Departure Detection Scheme (PDDS) and the Proactive Notification Scheme (PNS). PDDS estimates departure time using Received Signal Strength Indicator (RSSI), speed, and coordinates. PNS informs consumers to suspend Interest transmissions, which helps prevent packet loss. This approach differentiates Pro-PMM from existing proactive methods, which rely only on location prediction and do not notify consumers. When the RSSI falls below a threshold, the PDDS determines the producer's handover time and triggers notifications to relevant routers and consumers. PNS then ensures consumers stop sending Interest to the unavailable producer. Pro-PMM was evaluated using ndnSIM simulations. Its performance was compared with pure NDN and the proactive Location-Prediction-Based Scheme (LPBS) under different producer locations and multiple consumer scenarios. Simulation results show that Pro-PMM significantly reduces Interest packet loss. It increases Interest satisfaction by 6.82% and 10.53% compared to LPBS and pure NDN, respectively. Pro-PMM also improves the data packet delivery rate by 5.69% and 12.26%. This indicates more stable data retrieval during producer mobility. These findings establish Pro-PMM as an efficient and scalable solution for seamless producer mobility in NDN. The Pro-PMM, PDDS, and PNS schemes can be used to detect departure time, notify consumers, and manage handovers for the Internet of the future.

Keywords: Named data networking, Producer mobility, Proactive approach.

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List of Abbreviations

AR	Access Router
AP	Access Point
BIT	Bind Information Table
CB-DMM	Cluster-Based Device Mobility Management
CCN	Content-Centric Networking
CS	Content Store
DONA	Data Oriented Network Architectural
FIB	Forwarding Information Base
GETT	GET Trendiness
HA	Home Agent
HIM	Hybrid Indirection Method
HyNeMo	Hybrid Network Mobility Support
IBM	Indirection Based Mobility
ICN	Information-Centric Network
IN	Interest Notification
IP	Internet Protocol
IU	Interest Update
LFBL	Listen First Broadcast Later
MAP-Me	Managing Anchor-Less Producer Mobility
MI	Mobility Interest
MNN	Mobile Network Node
MR	Mobile Routers
nAP	new Access Point
NDN	Named Data Networks
ndnSIM	NDN Simulator
NetInf	Network Information
NFD	NDN forwarding daemon
NLSR	Named-data Link State Routing Protocol
N-NAR	New NDN Access Router
NS-3	Network Simulator Version 3
OMNeT++	Objective Modular Network Test Bed in C++
OPMSS	Optimal Producer mobility support solution
PD	Producer Discovery
PIT	Pending Interest Table
PDDS	Proactive Departure Detection Scheme
PMLS	Producer Mobility Link Service
PMSS	Producer Mobility Support Scheme
P-NAR	Previous-NDN Access Router
PNS	Proactive Notification Scheme
PoA	Point of Attachment

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Pro-PMM	Proactive Producer Mobility Management
PURSUIT	Publish-Subscribe Internet Technology
QoS	Quality of Service
RDR	Restricted Domain Router
RSS	Received Signal Strength
RSSI	Received Signal Strength Indicator
RSU	Road Side Unit
SCaN-Mob	Shared Caching in Named Data Networking Mobile

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CHAPTER ONE
INTRODUCTION

In recent years, the Named Data Networking (NDN) paradigm has emerged as a promising candidate for future Internet architecture. Underpinned by the notion of a data-centric forwarding philosophy, NDN is purported to offer seamless network communication for mobile users. While NDN inherently supports consumer mobility, handling producer mobility remains an unresolved challenge, leading to inefficiencies in data retrieval and network performance. Producer mobility presents a distinct challenge, as the relocation of the content provider disrupts the availability of content, complicating the retrieval process for consumers. Therefore, this research seeks to address the issue of producer mobility support in NDN by proposing a novel mechanism.

The structure of this chapter is as follows: Section 1.1 introduces the research background, and Section 1.2 outlines the study's motivation. The problem statement is detailed in Section 1.3. Sections 1.4 and 1.5 present the research questions and objectives, respectively. Section 1.6 describes the significance of the research, while Section 1.7 defines its scope. Finally, Section 1.8 provides an overview of the thesis organization.

1.1 Introduction to Named Data Network (NDN) and Mobility

The rapid advancements of mobile devices and applications increase the Internet traffic demand. This evolution has prompted the current Internet framework to emphasize service access and data retrieval, thereby generating new requirements for enhanced security, effective content distribution, and mobility assistance. Such

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