INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL
ISSN 1841-9836, 10(4):463-470, August, 2015.

Alleviation of Binding Update Re-registration Handoff Latency at Home Agent Failure in MIPv6 Network

A. Avelin Diana, K. Sundarakantham, S. Mercy Shalinie

A. Avelin Diana*, K. Sundarakantham, S. Mercy Shalinie
Department of Computer Science and Engineering
Thiagarajar College of Engineering, Madurai
dianaavelin@gmail.com, kskcse@tce.edu, shalinie@tce.edu
*Corresponding author: dianaavelin@gmail.com

Abstract: Home Agent (HA) is an indispensable entity for binding connectivity to route packets between Mobile Node (MN) and Correspondent Node (CN). MIPv6 allows the deployment of redundant HAs to overcome HA failure. Different approaches resolve this issue to recuperate binding association information. This paper compares the effect of handoff latency in various methods and proposes a Reliable HA delivery (RHAD) mechanism to mitigate the Binding Update (BU) registration latency in HA at the time of active HA failure. We use BGP domain in network architecture and apply IBGP protocol to transmit packets between Edge Router (ER) and HA. Both the theoretical evaluation and simulation results reveal that RHAD effectively reduces BU re-registration handoff latency and increases packet delivery ratio.
Keywords: MIPv6, home agent, binding update, IBGP, VHARP, Edge router.

1 Introduction

MIPv6 Networks are experiencing a rapid growth due to scarcity of IPv4 addresses and tremendous growth in portable communication devices, ubiquitous computing and mobile users. MIPv6 Network is a vital for evolving next generation internetworking systems. MIPv6 supports the mobility of Mobile Node (MN) to route packets transparently within the network [1]. MN ascertains its identity location with the Router Advertisement (RA) broadcasted from the router. HA is a router that maintains the mobility binding table to correlate the Home Address (HoA) with the Care-of-Address (CoA) of MN. Binding update list of MN maintains its binding information with HA and CN. The binding information lifetime is 420 seconds [2]. Similarly, CN contains Binding cache (BC) to store the MNs information and communicate with it directly by forming a tunnel via Route Optimization (RO) technique [1]. The RO is enhanced to tackle security, signaling overhead and handoff latency [3]. HA is responsible for the binding association of MN and CN. MN discovers HA with the secured Dynamic Home Agent Address Discovery mechanism (DHAAD) [4]. HA maintains the HA list which includes the link address of all the HAs within the network along with its preference value. MN selects the HA based on the higher preference value [5]. ICMP DHAAD message contains the preference value which gets decremented by one as it propagates along each router. HA list between HAs are sustained by different protocols like HARP [6], VHARP [7], HA-to-HA protocol [8]. HAs experience single point of failure and it results in bottleneck within the network [9]. A single HA failure causes loss of MNs binding association information. To overcome such problems, MIPv6 allows the deployment of multiple HAs with the redundant HA to backup the bindings at the time of failure [10]. This paper evaluates the BU registration handoff latency of various approaches during HA failure and proposes a RHAD mechanism to mitigate the registration delay of MN with the new active HA. This method reduces the BU re-registration handoff latency and improves Quality of Service (QoS) in MIPv6 network.

This paper is organized as follows: Section 2 discusses the related work in this area. Section 3 proposes the network architecture of RHAD mechanism with the theoretical evaluation. Section 4 provides the simulated results and finally we conclude this paper in Section 5.

2 Related Work

HA failure results in service connectivity breakdown. Redundant HA can avail uninterrupted service by the capture of BC contents from active HA. The standby HA detects the active HA failure with the periodic Hello messages [6]. Different solutions have been proposed to solve the HA failure issue. Secondary HAs from various home link takeover the service of primary HA and the registration delay is high in this approach [11]. In [12], the redundant HAs are in the same home link and backup the data of failed primary HA. Redundant HA of [13] and [14] follow the same approach as said in [12]and additionally it considers load balancing issues. Primary and Secondary HAs are synchronized with the transport layer connections and the registration delay is less in [13]. Efficient fault tolerant protocol provides a stable storage method in which the failure of a mobility agent is recovered by another mobility agent using check pointing and receiver based pessimistic message logging approach [15]. The mobility agent of this approach stores all the MNs binding.

In quorum based mechanism, mobility binding of MN is stored in the backup quorum of network segment [16]. Here, every HA finds a new HA as its standby HA. All the HAs of virtual home agent method share one global address and only one HA is set active [17]. Redundant HA set is a collection of active and standby HAs in which the failure recovery is maintained by HA-Virtual Switch (HA-V) and HA Hard Switch (HA-H). In HA-V the MN executes IKE exchange on standby HA with Home Address (HoA) assignment but in HA-H it exchanges without HoA. At the time of active HA failure, standby HA sends home agent switch message to all the registered MNs to redirect the BU messages [7]. In VHARP, the virtual home agent address is activated by standby HA and every state of MN is to be synchronized. The backup HAs are considered from different home links in VHAHA [18]. The home agents are arranged 2 in a chain and backup its binding to the adjacent home agent in [19].In Mobile IPv6 the message exchange is twice than that of HARP and VHARP since theMN does not involve in HA failure detection and recovery [10].

In all the above approaches, the MN should update its registration to the redundant HA at the time of active HA failure. Our RHAD technique reduces the registration delay since the MN is not essential for this registration process. The connectivity between MN to a router in the network is wireless, so the packet delivery ratio is also improved by RHAD.

3 RHAD Mechanism

3.1 RHAD Network Architecture

Our network entities include MN, HA, access router, access point, CN and Edge Router (ER) as in Figure 1. MN selects the nearest HA to reduce the probability of HA handoff failure. We create BGP domain and use IBGP to transfer the packets between MN and HA. It is noticed that the packets are never propagated to exterior network. ER is a boundary router that scrutinizes the BU message from MN and records it in router list. When the BU packet is routed to HA, first transmission occurs via ER that is nearer to MN. The stored BU information contains HoA, CoA and lifetime. It remains in the router list until the BU lifetime becomes zero. The BU is transmitted to active HA through edge router and access router. The active HA selects a standby HA from redundant HA set based on the highest preference value and back up its data. The

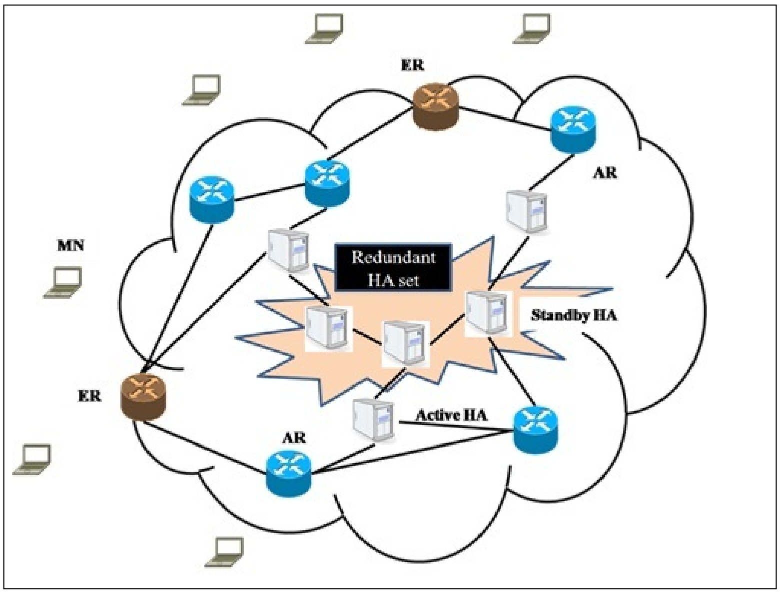

Figure 1: RHAD Network

redundant HA is provided with virtual HoA and it should be noticed that the binding should be synchronized between active and standby HA. In our approach we combine VHARP and BGP protocol to mitigate the failure recovery handoff latency. VHARP is transparent to MN and it maintains the HA list within the network. At the time of active HA failure, the edge router transmits BU information to the redundant HA.

3.2 Theoretical Evaluation

The BU re-registration handoff ow using RHAD approach is illustrated in Figure 2. The total message ow handoff time includes processing time and transmission time. Message retransmission is unnecessary in wired medium. Wireless link is least stable since message loss can occur at any instance and therefore message retransmission becomes indispensable. The transmission of BU message between MN and edge router is wireless. The additional signal processing time is evaluated below.

$$T^1_{BU} = \sum_{i=n}^{\infty} T_{BU}(n_f) \cdot prob(n_f \ failure \ and \ one \ success) \tag{1}$$

n_f represents the number of link failures. If the BA is not received after sending BU request we assume that message is lost and hence retransmitted. If n_f failure occurs then $T_{out}$and message retransmission takes n_f times. Usually, T_{out} is observed as 2 ms [13].

$$T_{BU}(n_f) = P_w + n_f \cdot (T_{out} + P_{wl}) \tag{2}$$

From (1) and (2),

$$T^1_{BU} = \Sigma^{\infty}_{n} \{P_{wl} + n_f \cdot (T_{out} + P_{wl})\} \cdot prob(n_f \ failure \ and \ one \ success) \tag{3}$$

$\Sigma^{\infty}_{n} n_f \cdot prob\,(n_f \ failure \ and \ one \ success)$ is obtained from infinite geometric progression.

$$\Sigma^{\infty}_{n} n_f \cdot prob\,(n_f \ failure \ and \ one \ success) = \frac{r}{r-1} \tag{4}$$

Here, r represents the link probability failure and it has the value 0.5 [13].

$$T_{BU}^{1} = P_{wl} + (T_{out} + P_{wl})\frac{0.5}{1-0.5} \tag{5}$$

$$T_{BU}^{1} = 2P_{wl} + T_{out} \tag{6}$$

Similarly, the BA received from edge router to MN is obtained as

$$T_{BA}^{2} = 2P_{wl} + T_{out} \tag{7}$$

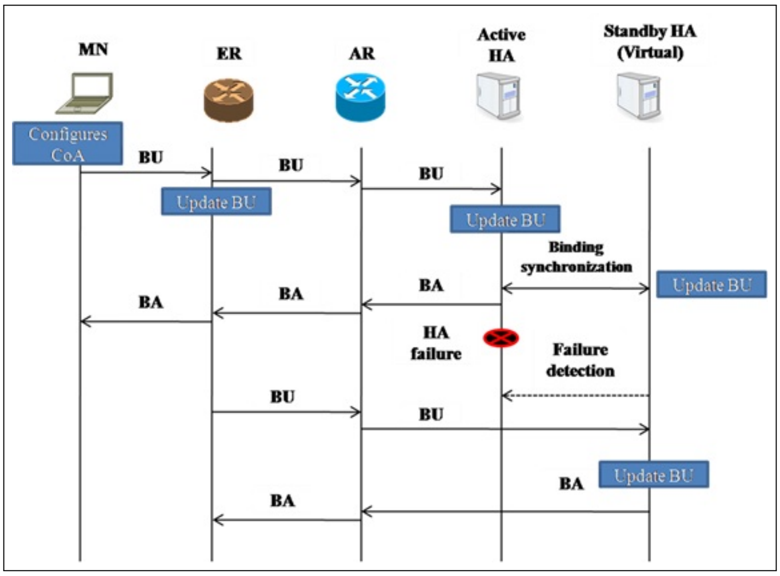

Figure 2: BU recovery registration handoff

Therefore total time for the message transmission in wireless medium is

$$T_{wl} = T_{BU}^{1} + T_{BA}^{2} \tag{8}$$

$$T_{wl} = 2\,(2P_{wl} + T_{out}) \tag{9}$$

The message transmission in wired medium includes the packet propagation between edge router and standby HA. The binding synchronization between active and standby home agent is achieved through VHARP protocol. The total message transmission time in wired medium is

$$T_{wi} = T_{ER-AR} + T_{AR-AHA} + T_{Bsync} + T_{AR-ER} + T_{AHA-AR} \tag{10}$$

$$T_{wi} = 2T_{ER-AR} + 2T_{AR-AHA} + T_{Bsync} \tag{11}$$

At the time of active HA failure, the total transmission time in HARP is obtained as

$$T_{HARP} = 2T_{wl} + T_{wi} + T_{ER-AR} + T_{AR-SHA} + T_{AR-ER} + T_{SHA-AR} \tag{12}$$

$$T_{HARP} = 2\,(T_{wl} + T_{ER-AR} + T_{AR-SHA}) + T_{wi} \tag{13}$$

Edge router contains the information of MNs BU and hence in RHAD method the standby virtual HA acquires the BU directly from edge router and sends BA after successful delivery. Therefore the transmission between edge router and MN is not necessary.

$$T_{RHAD} = 2\,(T_{ER-AR} + \ T_{AR-SHA}) \ + \ T_{wi} + T_{wl} \tag{14}$$

We have the fixed processing time to configure CoA and to update BU message at edge router, active HA and standby HA. The processing time is same for both HARP and RHAD method.

$$PT_{RHAD} = \ PT_{CoA} + \ 4\ PT_{BU} = 5\ PT \tag{15}$$

The total handoff failure is obtained by summing up the transmission and processing time.

$$T^{HO}_{HARP} = T_{HARP} + PT_{HARP} \tag{16}$$

$$T^{HO}_{HARP} = 2\,(T_{wl} + T_{ER-AR} + T_{AR-SHA}) + T_{wi} + 5PT \tag{17}$$

$$T^{HO}_{HARP} = T_{RHAD} + PT_{RHAD} \tag{18}$$

$$T^{HO}_{RHAD} = 2\,(T_{ER-AR} + T_{AR-SHA}) + T_{wi} + T_{wl} + 5PT \tag{19}$$

From (7) and (8), it is clear that the BU re-registration handoff in RHAD is fast and reliable.

4 Simulation results

The system parameter for the simulation of RHAD network is based on J. Mc Nair et al. [20] as depicted in Table 1. In this experiment we analyse the BU re-registration latency of different approach. Figure 3 depicts the number of recovery messages exchanged during BU registration at the new active HA. The number of recovery messages is high in MIPv6 and other methods when compared to our RHAD approach.

Table 1: System Parameter

System parameter	**Value**
Wired link message propagation time	0.5 ms
Wireless link message propagation time	2 ms
Link failure probability	0.5
Bit rate of wired link	155 Mbps
Bit rate of wireless link	144 Kbps
Message processing time	0.5 ms

After the recovery of new HA, the MN sends BU to confirm its binding registration with it. The BU re-registration latency over time is described in Figure 5. Since this process is not initiated by MN in RHAD, the registration latency is alleviated within 35 ms for the simulation time of about 300 sec as shown in figure. The fraction of packets that suffers due to different delays in various approaches at the time of re-registration is shown in figure 6.

Packet delivery ratio is evaluated as the number of packets received by the new active HA to the total number of packets sent by the mobile node. The packet delivery ratio of diverse

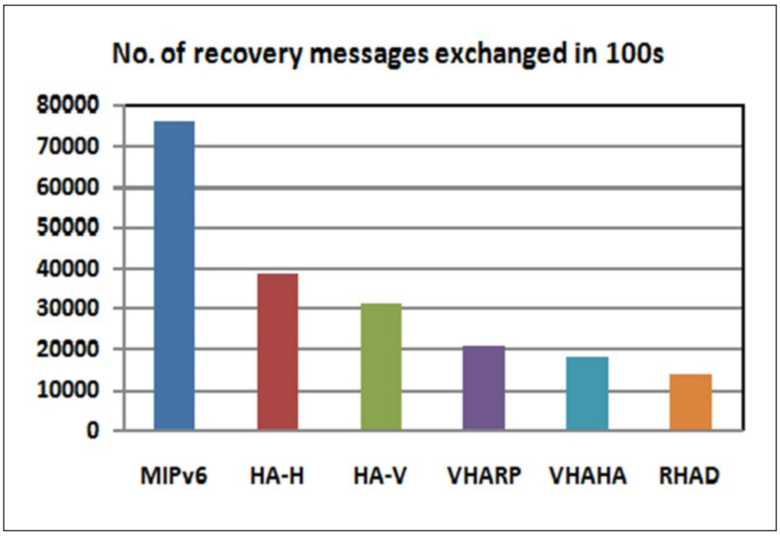

Figure 3: No of recovery messages of different approach

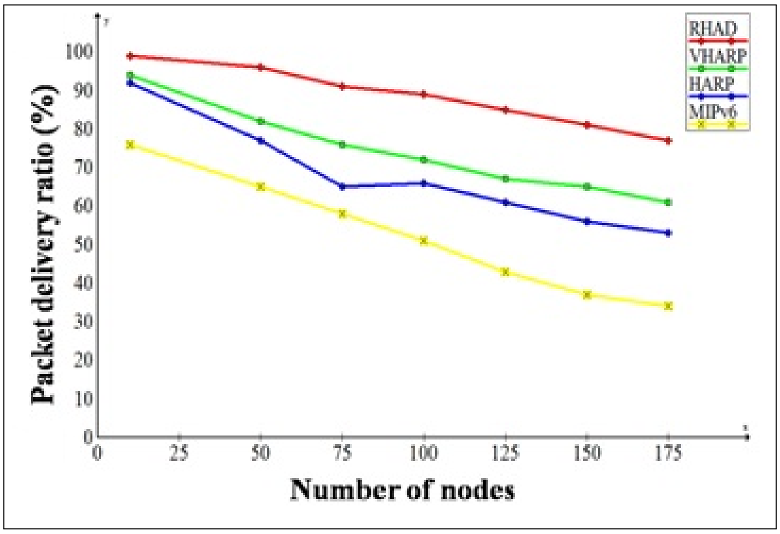

Figure 4: Active HA packet delivery ratio

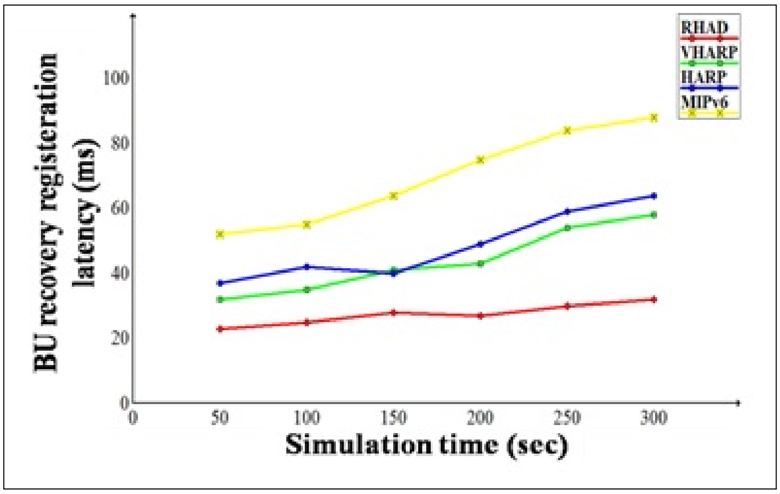

Figure 5: BU recovery registration latency

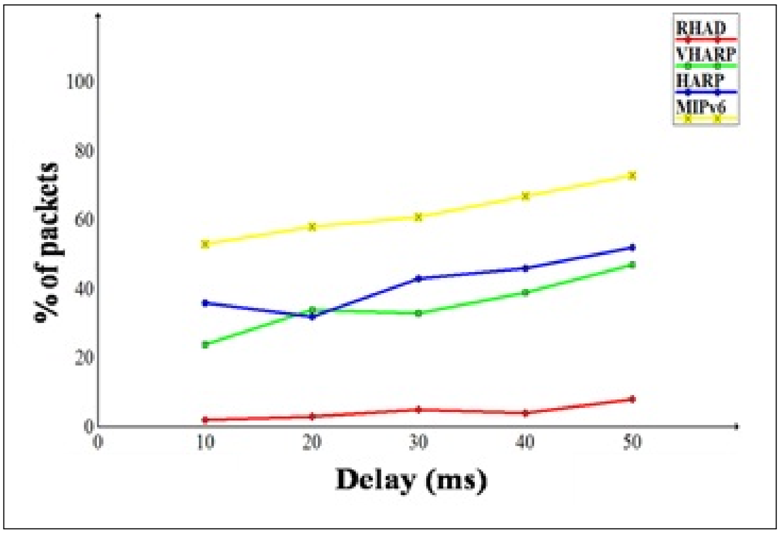

Figure 6: Suffered packets at delay

approaches is illustrated in figure 4. For 175 nodes, the percentage of packet delivery ratio in RHAD is 81% whereas for VHARP, HARP and MIPv6, it is 61%, 53% and 34% respectively. The successful packet delivery is comparatively large in our technique.

5 Conclusion

RHAD network is simulated and its handoff latency is examined. Comparatively this method mitigates the registration latency of BU after the HA failure. Our approach outperforms all the other approaches with the enlarged packet delivery ratio at HA. Currently we are analysing the HA fault tolerant mechanism and failure recovery. In future work we would like to include an efficient HA fault tolerant method to recuperate the registered BU without any loss of service connectivity.

Bibliography

[1] Johnson, D.; Perkins, C.; Arkko, T. (2004); Mobility support in IPv6, *IETF RFC 3775*, https://www.ietf.org/rfc/rfc3775.txt.

[2] http://www.kame.net

[3] Arkko, J.; Vogt, C.; Haddad, W.(2007); Enhanced Route Optimization for Mobile IPv6, Network Working Group, *RFC 4866*, https://www.rfc-editor.org/rfc/rfc4866.txt.

[4] Qian Sun et al (2004); Security Issues in Dynamic Home Agent Address Discovery, *draft-sun-mipv6-dhaadsecurity-00.txt.*

[5] http://www.cisco.com/en/US/docs/ios/ipv6/command/reference/ipv6_07.html

[6] Wakikawa, R. (2009); Home Agent Reliability Protocol, MEXT Working Group, *draft-ietf-mip6-hareliability-05.txt.*

[7] Wakikawa, R.(2011); Home Agent Reliability Protocol, MEXT Working Group, *draft-ietf-mip6-hareliability-09.txt.*

[8] Devarapalli, V.; Wakikawa, R.; Thubert, P. (2006); Local HA to HA protocol, *draft-devearapalli-mip6-nemo-local-haha-01.txt.*

[9] Ng, C.; Thubert, P.; Watari, M.; Zhao, F. (2007); Network Mobility Route Opti-mization Problem Statement, Network Working Group, *RFC 4888.*

[10] SeungSun Hong (2004); Multihoming Scenarios with Multiple Home Agents in Mobile IPv6, *draft-hong-mip6-multihoming-scenarios-00.txt.*

[11] Wakikawa, R.; Devarapalli, V.; Thubert, P. (2003); Inter Home Agents Protocol (HAHA), IETF Draft, *draft-wakikawamip6- nemo-haha-00.txt.*

[12] Deng (2003); Load balance for Distributed HAs in Mobile IPv6, IETF Draft, *draft-wakikawamip6-nemo-haha-00.txt.*

[13] Heissenhuber, F.; Fritsche, W.; Riedl, A. (1999); Home Agent Redundancy and Load Balancing in Mobile IPv6, *5th International Conference Broadband Communications*, 235-244.

[14] Faizan, J.; El-Rewini, H.; Khalil, M. (2005); VHARP: Virtual Home Agent Reli-ability Protocol for Mobile IPv6 based Networks, *Int. conf. on Wireless Networks, Communications, and Mobile Computing*, DOI:10.1109/WIRLES.2005.1549599, 1295-1300.

[15] Ahn, J.H.; Hwang, C.S. (2011); Efficient Fault-Tolerant Protocol for Mobility Agentsin Mobile IP, *International Parallel and Distributed Processing Symposium*, DOI:10.1109/IPDPS.2001.925103, 1273-1280.

[16] Chen, Y.S.; Chen, C.H.; Fang, H.Y. (2008); An Efficient Quorum-Based Fault-Tolerant Approach for Mobility Agents in Wireless Mobile Networks, *IEEE International Conference on Sensor Networks, Ubiquitous and Trustworthy Computing (SUTC)*, 373-378.

[17] Faizan, J.; Rewini, H.E. et al (2006); Introducing Reliability and Load Balancing in Mobile IPv6 Based Networks, *Journal of Wireless Communications and Mobile Computing*, 6:1-19.

[18] Rathi, S.; Thanushkodi, K. (2006); Design and Performance Evaluation of anEffcient Home Agent Reliability Protocol, *International Journal of Recent Trends in Engineering*, 2(1):26-32.

[19] Yujun Zhang; Hanwen Zhang (2011); A Mobile Agent Fault-Tolerant Method Based on the Ring Detection Backup Chain for Mobile IPv6 Networks, *IEEE Int. Conf. on Communications*, DOI: 10.1109/icc.2011.5962677, 1-5.

[20] McNair, J.; Akyildiz, I.F.; Bender, M.D. (2001); Handoffs for real-time traffc in mobile IP version 6 networks, *IEEE GLOBECOM*, DOI:10.1109/GLOCOM.2001.966325, 6: 3463-3467.