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Kasahara, Yoshiaki
Kyushu University

Shimayoshi, Takao
Kyushu University

Miyaguchi, Tadayuki
Kyushu University

Fujimura, Naomi
Kyushu University

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Migrate Legacy Email Services in Kyushu University to Exchange Online

Yoshiaki Kasahara

Kyushu University

Fukuoka, Japan

kasahara.yoshiaki.820@m.kyushu-u.ac.jp

Tadayuki Miyaguchi

Kyushu University

Fukuoka, Japan

miyaguchi.tadayuki.773@m.kyushu-u.ac.jp

Takao Shimayoshi

Kyushu University

Fukuoka, Japan

simayosi@cc.kyushu-u.ac.jp

Naomi Fujimura

Kyushu University

Fukuoka, Japan

fujimura.naomi.274@m.kyushu-u.ac.jp

ABSTRACT

In Kyushu University, Information Infrastructure Initiative provides an email service for students and staff members, called “Primary Mail Service”. We had operated an on-premises system for this service, and the lifetime of this system would end in early 2019. We needed to reduce costs for replacing this system because our university had just finished a major campus migration. We compared some options such as building a yet another on-premise system and migrating to a cloud-based email service and finally gave up the on-premise option because we couldn’t afford replacement and operational costs of another on-premises system anymore. We selected Microsoft Exchange Online as the new service mainly because we already had a contract with Microsoft and been operating an Office 365 tenant. We had additional requirements for user provisioning and services which were not available in Exchange Online, so we had to implement and maintain additional systems on top of it. On December 18th, 2018, we successfully migrated the email service to Exchange Online. By coincidence, Kyushu University Administration Bureau decided to migrate their in-house Exchange server to Exchange Online. After some discussions, they concluded to migrate their domain to the same tenant with Primary Mail Service. Other than that, there are more than a hundred legacy email servers inside our campus network operated by various departments as subdomains of kyushu-u.ac.jp. We are designing a plan to consolidate them into our tenant of Exchange Online to reduce a budget and human resource costs, and to improve security. In this presentation, we share our experiences about migrating our campus-wide email services to Exchange Online. We also discuss why we want to consolidate other legacy email servers and how to implement the plan.

CCS CONCEPTS

• **Information systems** → **Email**; Enterprise applications; • **Social and professional topics** → *Software selection and adaptation*; Software maintenance; • **Software and its engineering** → *System administration*.

KEYWORDS

Cloud Migration, System Integration, Multiple Service Integration, Microsoft Office 365, Microsoft Azure

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1 INTRODUCTION

Email is still considered as one of the fundamental communication services on the Internet because there is no universal alternative which is supported by most personal digital devices. It is difficult to maintain secure and robust email service infrastructure in-house, because email is a major attacking vector to deliver malicious messages such as malware and phishing.

Kyushu University is one of the national university corporations in Japan, located in Fukuoka Prefecture, Kyushu Island. An organization called “Information Infrastructure Initiative” (to which the authors belong) provides network infrastructure and services (including email service) for staff members and students in Kyushu University. Our services support almost thirty thousand users, including ten thousand staff members and twenty thousand students in our university-wide system. In addition to the university email service provided by us, there are many legacy mail services in our campus network operated by various departments independently.

Our university email service is called “Primary Mail Service” [2–5]. We had operated an on-premise email system until 2018, when we decided to migrate to Microsoft Office 365 Exchange Online. For more details on the history of that decision and migration plan, see our previous publication [5]. We migrated our email service on December 18th, 2018, and terminated the old service at the end of March 2019. We consider the migration mostly successful. In this

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paper, we want to share our experience with the migration and discuss the remaining issues and future plans.

2 MIGRATION PREPARATION

2.1 Migration Decision

The preceding on-premise system for the Primary Mail Service was introduced in March 2014. We assigned email address for staff members based on their full name, and for students based on “Student ID”. The planned lifetime of the predecessor was five years with a five-year maintenance contract. We had to finish preparing the next system before the end of the predecessor’s lifetime. We had a couple of options, such as building a yet another on-premise system or migrating to a cloud-based email service such as Google G-Suite or Microsoft Office 365.

The estimated five-year cost of a new on-premise system was almost the same as the old system, but Kyushu University had just finished a major campus migration and we needed to reduce costs. We concluded that we couldn’t afford a new on-premise system anymore. We decided to migrate to Office 365[5], mainly because we already had an Enrollment for Education Solution contract with Microsoft and been operating an Office 365 tenant[6].

2.2 Migration Schedule

After we decided to migrate our email service to Exchange Online, we needed to decide the detailed migration schedule.

The system maintenance support contract of the old system would be till the end of March 2019, however, the license of the spam and virus filter appliance would be terminated at the end of January 2019 because it had to cover the preparation of the system before the start of the operation in 2014. The on-premise system could not receive email messages after the license of the spam and virus filter had been expired, so we had to migrate from the old on-premise server to the Exchange Online server before that.

We lagged behind in the preparation of additional systems (explained in 2.4), so we wanted to set the cutover date (changing email message delivery to Exchange Online) as late as possible. In January and February, staff members and students are very busy due to the preparation of graduation in March, so we needed to avoid the cutover during these months. We expected to handle a lot of inquiries from users after the cutover, and we couldn’t handle inquiries during holidays, so we set the cutover date to December 18th, ten days before the start of new year holidays.

One of our concerns was that we would receive a lot of inquiries from users because they stopped receiving new messages after the cutover. To reduce the number of inquiries, we decided to request users to try using “Outlook on the web” (the web mail of Exchange Online) before the cutover date to get used to it. They would not see any message in their mailbox before cutover, so we decided to place a test message in every mailbox of Exchange Online in advance.

If we terminated the SMTP service of the on-premise server as soon as the cutover, users who had trouble using Exchange Online would not be able to send a help message to us. We decided to keep the old SMTP service running for a month to help users migrating to Exchange Online.

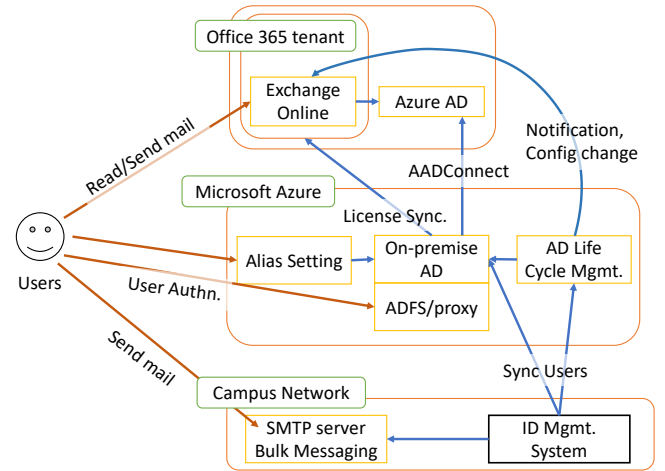


Figure 1: System Overview after migration

We decided not to migrate users’ mailbox contents from the on-premise server to Exchange Online. We were not confident about the migration tool of Office 365 to migrate nearly 30,000 users’ data, and we couldn’t afford to outsource the task. Instead, we chose to prepare user manuals instructing users how to migrate their own mailbox using email software including Microsoft Outlook and Mozilla Thunderbird.

We set the user-visible migration event schedule as shown in Table 1.

Table 1: The migration event schedule

| | |
|----------------------|---|
| During November 2018 | Ask users to access Exchange Online prior to cutover |
| December 18th, 2018 | Cutover from the on-premise server to Exchange Online |
| January 23rd, 2019 | Terminate SMTP service of the on-premise server |
| End of March 2019 | Shutdown the entire on-premise system |

2.3 Tenant Preparation

Figure 1 shows the system overview including our Office 365 tenant, servers in Microsoft Azure, and servers in our campus network. We decided to use Kyushu University’s network addresses for Microsoft Azure VMs and handled them as same as servers in our campus network, so we called them “on-premise servers” even though they were in the cloud infrastructure. We explain the details in 2.3 and 2.4.

In order to migrate our email system, we needed to create a new tenant of Office 365 to match its UPN (User Principal Name) with the email address of “Primary Mail Service”. We also decided to change the UPN and the primary email address of students to be based on their real names instead of their “Student ID”. The major reason for the change was that we provide e-learning material

to student candidates before admission, including how to use Microsoft Office. Until last year we used the volume license versions of Office applications, but this year we switched to Office 365 ProPlus. We had to assign UPN and create Office 365 accounts for these candidates in order to provide Office applications, but they didn't have a "Student ID" assigned before admission. We had already assigned email addresses for staff members based on full name, so we decided to do the same for student email addresses. It would also solve an issue that a student's email address would change because the "Student ID" would change when he or she would proceed to a graduate school. Historically "Student ID" had long been used for the student's email addresses by various information service in Kyushu University, so we decided to keep the address as an alias of the primary email address.

In addition to email addressing, we needed to determine how IDs and passwords would be handled. In the old tenant, we used IDs and passwords different from our central Identity Management System (IDM), but we wanted to use credential information provided by our IDM to provide a consistent user experience with other information systems. We had an on-premise Active Directory (AD) which held user information synchronized from our IDM. The information could be synchronized via Microsoft Azure AD Connect to Azure AD of our tenant. The security policy of the IDM did not allow us to export users' passwords in the IDM to an entity outside our university, so we couldn't synchronize users' passwords to Azure AD. Instead, we configured our tenant to redirect user authentication requests to be processed through our on-premise AD Federation Service (AD FS). The details of the transition is discussed separately in [7]. Though we did not use Exchange Online at the time, the new tenant was ready in April 2018 and started providing other major Office 365 services including Office Online, Office 365 ProPlus, OneDrive for Business, Skype for Business, and OneNote.

2.4 Logistical Preparation

In addition to the tenant preparation, we had additional requirements for user provisioning and services as follows:

- (1) Sending event-triggered notify messages to users
- (2) Selecting additional alias addresses by user
- (3) Bulk messaging to all or selected users
- (4) Changing the sender address of messages

These functions were not available in Exchange Online, so we had to implement and maintain additional systems on top of it.

2.4.1 Event-triggered Messages. Throughout the lifetime of an account, there are several events for which we want to notify the owner of the account, such as creation and termination of an account, change of its UPN due to the name change, and so on. This feature was implemented as a part of "Active Directory Life Cycle Management System" in a virtual machine of Microsoft Azure[7].

2.4.2 Alias Address Setting Service. As discussed in [3] and [2], we provide "Alias Address Setting Service" for email users. The initial idea was to create a name-based persistent email address for students in addition to their "Student ID" based address. Since "Student ID" would change when the student proceeded to a graduate school or change his or her department, and the email address would change too. The service became relatively popular with more

than 2,500 users, so we decided to implement a similar service for Exchange Online.

As explained in 2.3, we changed student's primary email address to being based on their real name, so the initial issue was solved, but the system was also useful to shorten an inconveniently long email address based on the full name.

To implement the service, we built a separate web server in Microsoft Azure which allowed a user to select an alias address from several candidates (generated based on the user's name) and added the selection to "proxyAddresses" attribute of the on-premise AD. User authentication was processed via AD FS using SAML protocol.

2.4.3 Bulk Messaging. One of the important purposes of "Primary Mail Service" was to provide an official channel to reach every member of Kyushu University in case of emergency. To achieve that, we needed a bulk messaging system. We'd like to include the recipient's name in each message, so we couldn't use distribution groups in Exchange Online. The previous bulk messaging system had been outdated, so we decided to ask a company to implement a new system. For this service, we decided to purchase real hardware and placed it on our campus, because we had some concerns about sending a lot of messages from a cloud VM. The system was collocated with the SMTP server described in 2.4.4.

2.4.4 Changing the Sender Address. Exchange Online doesn't allow a user to change the sender address of a message from the "primary" email address defined in the "proxyAddresses" AD attribute. We didn't have such a restriction in our previous email service, and users were accustomed to changing their sender addresses when needed, such as using an alias address (discussed in 2.4.2) or a subdomain address (discussed in 4.2) as the main address. Though there were some security concerns with this practice, the demand was high.

In Exchange Online, a user can change the sender address when the domain of the address is registered to the tenant and the address is configured as a distribution group. You can add the user to the group and grant "send-as" permission to the user. We realized this method after we wrote the specification of the alias address setting service and ordered a company to implement the system, so it was too late to implement this method. We also couldn't register domains of other mail servers to our tenant without coordination. So we decided to build another SMTP server to allow an authenticated user to send a message with any sender address.

We wanted to send messages from the SMTP server through Exchange Online Protection to mitigate possible abuse. To achieve that, we needed to configure an inbound connector in Exchange Online. To authenticate our SMTP server, we needed to configure a valid SMTP client certificate to the SMTP server. Without the certificate, Exchange Online couldn't validate the server, consider the message as third party relay, and rejected it.

To reduce user's confusion, we decided to inform users to use IMAP and SMTP to access Exchange Online instead of the Exchange protocol, because a user couldn't select another SMTP server when using Exchange protocol. We would lose some Exchange-specific features such as calendar and meeting reservation, but we don't have a plan to utilize these features for now.

3 ACTUAL MIGRATION

3.1 Delays and Mitigation

In 2018, we prepared to migrate “Primary Mail Service” to Exchange Online. We secured a budget and started to implement systems described in 2.4. We couldn’t prepare the specification earlier enough because we needed to rewrite some specification to simplify and reduce more costs. Due to the delay, we couldn’t finish preparing the new AD life cycle management system and the alias setting service before the cutover date. The delay was not critical to the migration because we had some workarounds. We had to inform users that some feature would be missing for a while after the cutover.

Until the new life cycle management system was ready in February 2019, we needed another way to modify user’s UPN and email address when their name or “Student ID” was changed. We had to write some Powershell scripts which looked up and updated AD attributes accordingly, and made them run periodically using the server’s task scheduler. We also couldn’t send event-triggered messages to the users, but it was not a serious issue because these messages were just informational.

We closed the old alias setting service before the cutover date, and migrated user’s alias addresses to the on-premise Active Directory manually in order to receive messages to these addresses by Exchange Online. Users couldn’t configure a new alias address until the new system was up in February.

3.2 Training and Communication

In addition to sending announcement messages via email and posting to the student web portal, we had nine briefing sessions for staff members during October and November of 2018 in various departments to explain the migration of the mail system. Approximately ten percent of all staff members attended these sessions. We counted on these participants to share their knowledge about the migration to other staff members and students.

We prepared instruction manuals on how to log in and use Exchange Online via web browsers and email clients. We encouraged users to try using Exchange Online before the cutover date. We placed a sample message in every user’s mailbox of Exchange Online so a user could ensure the access was successful.

3.3 Transition Details

On December 18th, 2018, we changed the DNS MX records of “Primary Mail Service” to Exchange Online and we changed the on-premise server to redirect received messages to Exchange Online for the immediate cutover. The cutover was relatively successful except for one operational failure. Due to a miscommunication with a DNS administrator, the MX entry of student email (s.kyushu-u.ac.jp domain) disappeared from the authoritative DNS server. The configuration was immediately remedied, but it took up to one hour to be effective because that zone’s negative caching TTL (how long “the domain didn’t exist” would be remembered by DNS cache servers) was 3,600 seconds. We couldn’t estimate the actual impact, but we were sure that some messages were bounced to the sender.

After the cutover, we received various inquiries such as how to configure email clients, how to properly configure email forwarding to another email address, and so on. There were some inquiries

from users who suddenly stopped receiving new messages because they didn’t realize the cutover happened. We informed them about the cutover and introduced the instruction manual we prepared. We prepared an FAQ page about service migration to avoid answering the same question multiple times. We didn’t have a ticket management system, so I cannot show the exact number and kind of inquiries here.

On January 23rd, 2019, we stopped SMTP service of the old on-premise server. Even one month had passed after the cutover, there were several inquiries from unaware users who couldn’t send messages from the old service anymore. Due to the fact that some users still didn’t notice the cutover, we felt that we needed to increase the awareness of migration. We found a way to directly place a message to the old server’s mailbox using LMTP instead of SMTP, and placed a warning message about the termination of the old service in every user’s mailbox of the old service. We also encouraged users to migrate their messages from the old service to Exchange Online before the end of March 2019.

In Kyushu University, students have to bring their own PC since 2013[1]. Every April, PC training hands-on sessions for all the fresh students were held by Information Infrastructure Initiative. In 2019, the sessions were scheduled on April 1st and 2nd. Many staff members of Information Infrastructure Initiative would be occupied to handle these sessions, so we wanted to avoid terminating the old system just before the sessions, and we did not fully shut down the old system until April 3rd, 2019. Personally I was afraid of many inquiries from users who couldn’t access the old messages anymore after the shutdown, but actually, it was surprisingly calm. We considered that the migration was successful.

4 OTHER EMAIL SERVICES

In this section, we introduce a couple of other email services in our university and discuss the actual or possible migration or integration with Exchange Online.

4.1 Administration Bureau

In Kyushu University, the Administration Bureau operates an individual network separate from campus-wide education and research network. They operated an in-house Microsoft Exchange server to provide email addresses corresponding to positions and groups of each department, division, section, and so on. By coincidence with the migration of “Primary Mail Service”, they decided to migrate their email service to Exchange Online at the end of 2018, too. After some discussions, we decided to integrate their service with our existing Office 365 tenant, instead of building a separate tenant for their domain. We added their domain in our tenant, and they created each email address as a shared mailbox and registered relevant Office 365 accounts as members.

The migration plan was designed by the Administration Bureau and it included migration of messages from the old Exchange server. The actual migration task was outsourced, but there were several complications and they needed a couple of months to find the bottleneck and finish migrating the data. One of the major issues was the in-house Exchange server didn’t meet the requirement specifications of the Office 365 migration tool. Due to the insufficient performance of the server, the migration batch jobs tended to fail

easily with the default configuration. It took time to find the appropriate parameters for successful migration batch jobs. After finding the right parameters, all messages of 934 mailboxes were successfully migrated in 19 days.

4.2 Subdomains

There are more than 200 subdomains in the kyushu-u.ac.jp domain. We delegated the operation of the network for each department and organization under their control, and naturally, each sub-network wanted to have its own sub-domain name. Many of them had implemented their own email services independently. From 2008, we started web, DNS, and mail-hosting service for such subdomains. Because running email servers is difficult, many subdomains have migrated their services to our hosting service. Currently 100 subdomains are running their email services on our hosting service. There are hundreds of email servers still running in our campus.

Security incidents related to email service are becoming more and more common. Many messages with malware and phishing flow into email servers and it becomes harder to filter them out properly. If someone becomes a victim of a phishing message, the email account will be abused to send out more malicious messages, causing the email server to be overburdened to interfere with the delivery of other messages. Even the mail service is running on our hosting service, the account management is done by the domain's administrator and users. Due to poorer account and password management, email services of subdomains tend to cause more security incidents than our "Primary Mail Service". On the other hand, one's email address is a sort of "identity" on the Internet, so it is hard to convince users to abandon using subdomain's email addresses and to use "Primary Mail Service" instead.

We are discussing whether it is feasible to integrate email address of subdomains with "Primary Mail Service" using some features of Exchange Online. One idea is to prepare a distribution group for each email address in a subdomain, register the owner's Office 365 account as the only member, and allow the user to send the message as the name of the distribution group. By doing so, the user can continue to receive and send messages using the subdomain email address. We realized this method after designing our Alias Address Setting Service discussed in 2.4.2, and it seems better than using "proxyAddresses" to define alias address because a user can change the sender address using the standard Exchange Online interface.

In order to implement and deploy the idea, we need to prepare an interface for subdomain admins to add, delete, and modify distribution groups for subdomain's email addresses. Exchange Online itself doesn't have a way to grant admin permission for a specific domain only, so we need to build a web service which accepts orders from subdomain admins and modify the configuration of Exchange Online accordingly. We also need to support mailing lists on such subdomains. A simple mailing list can be implemented using a distribution group, but we need a mailing list manager such as GNU Mailman in order to support advanced features such as header rewriting and sequence numbering.

5 CONCLUSION

At the writing of this paper, two months have passed since the termination of the old "Primary Mail Service" system, and we are confident that the migration had been successful. Our users are now using Exchange Online and the number of inquiries about email service has returned to normal levels. However, we still have a lot of mail servers in our campus network, and ultimately we want to consolidate most of them under our control to secure the entire email ecosystem in our university.

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