

고가용성 인프라 구축

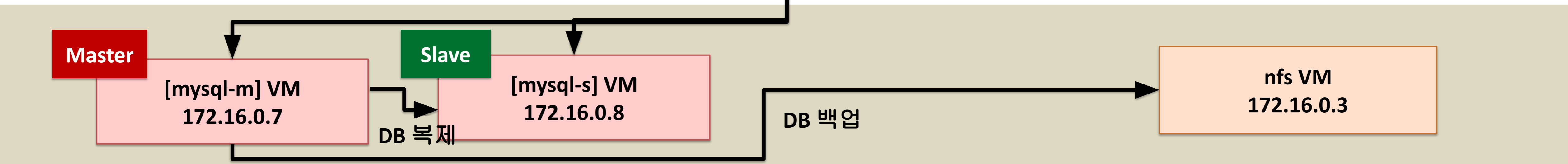
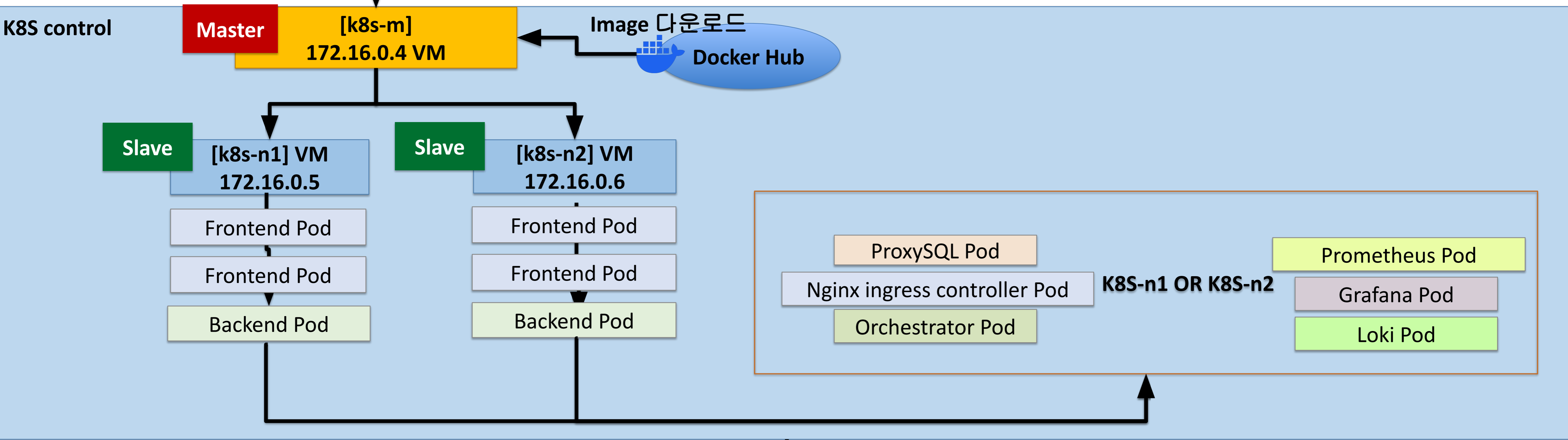
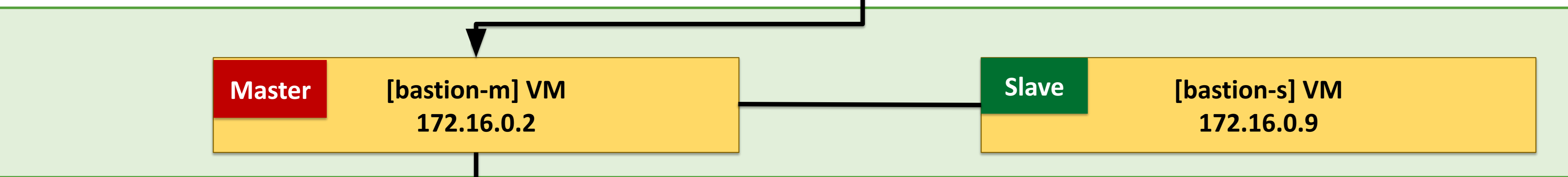
- Kubernetes 기반의 배관 수리 서비스 플랫폼

| 목차

 물리적 구성도	-----	4~7p
 논리적 구성도	-----	8~17p
 보완점	-----	18p

물리적 구성도

- bastionhost
- bastionhost-backup
- k8s-m
- k8s-n1
- k8s-n2
- mysql-m
- mysql-s
- nfs





장애 발생

Master

[bastion-m] VM
172.16.0.2

Slave

[bastion-s] VM
172.16.0.9

K8S control

Master

[k8s-m] VM
172.16.0.4

Image 다운로드

Docker Hub

Slave

[k8s-n1] VM
172.16.0.5

Slave

[k8s-n2] VM
172.16.0.6

Frontend Pod

Frontend Pod

Backend Pod

Frontend Pod

Frontend Pod

Backend Pod

ProxySQL Pod

Nginx ingress controller Pod

Orchestrator Pod

K8S-n1 OR K8S-n2

Prometheus Pod

Grafana Pod

Loki Pod

Master

[mysql-m] VM
172.16.0.7

Slave

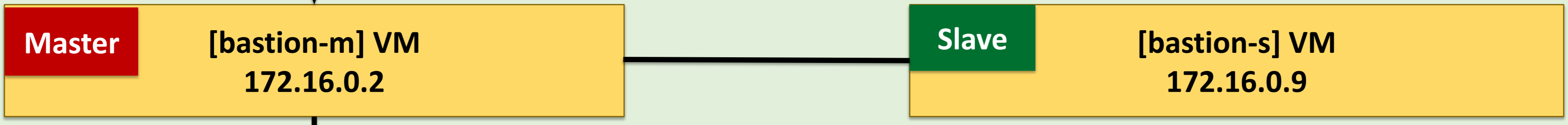
[mysql-s] VM
172.16.0.8

DB 복제

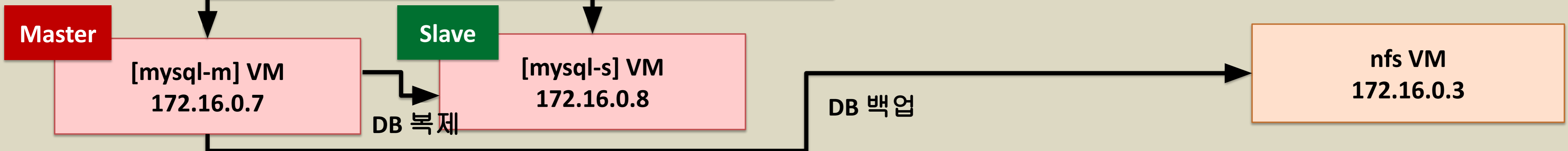
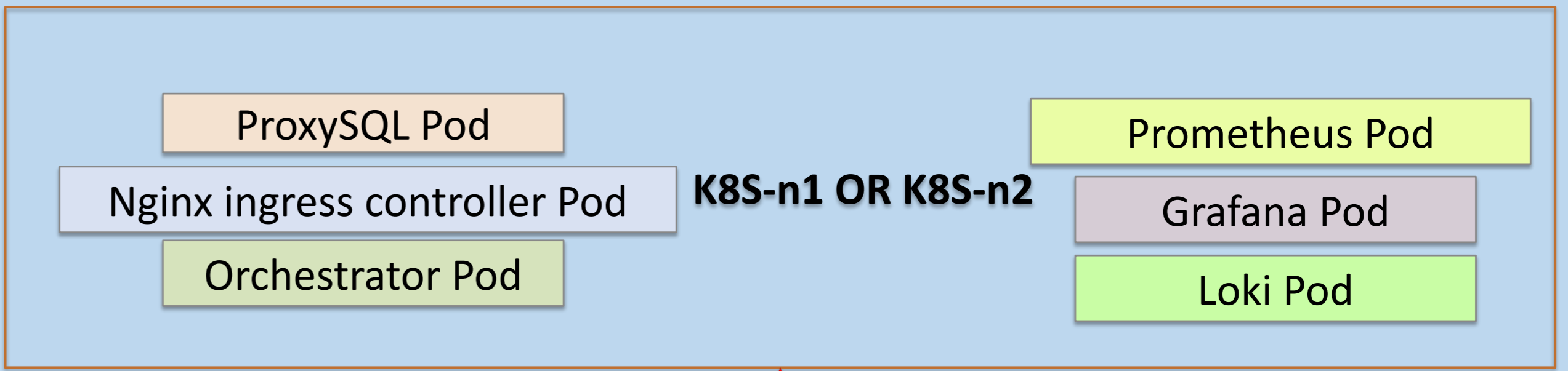
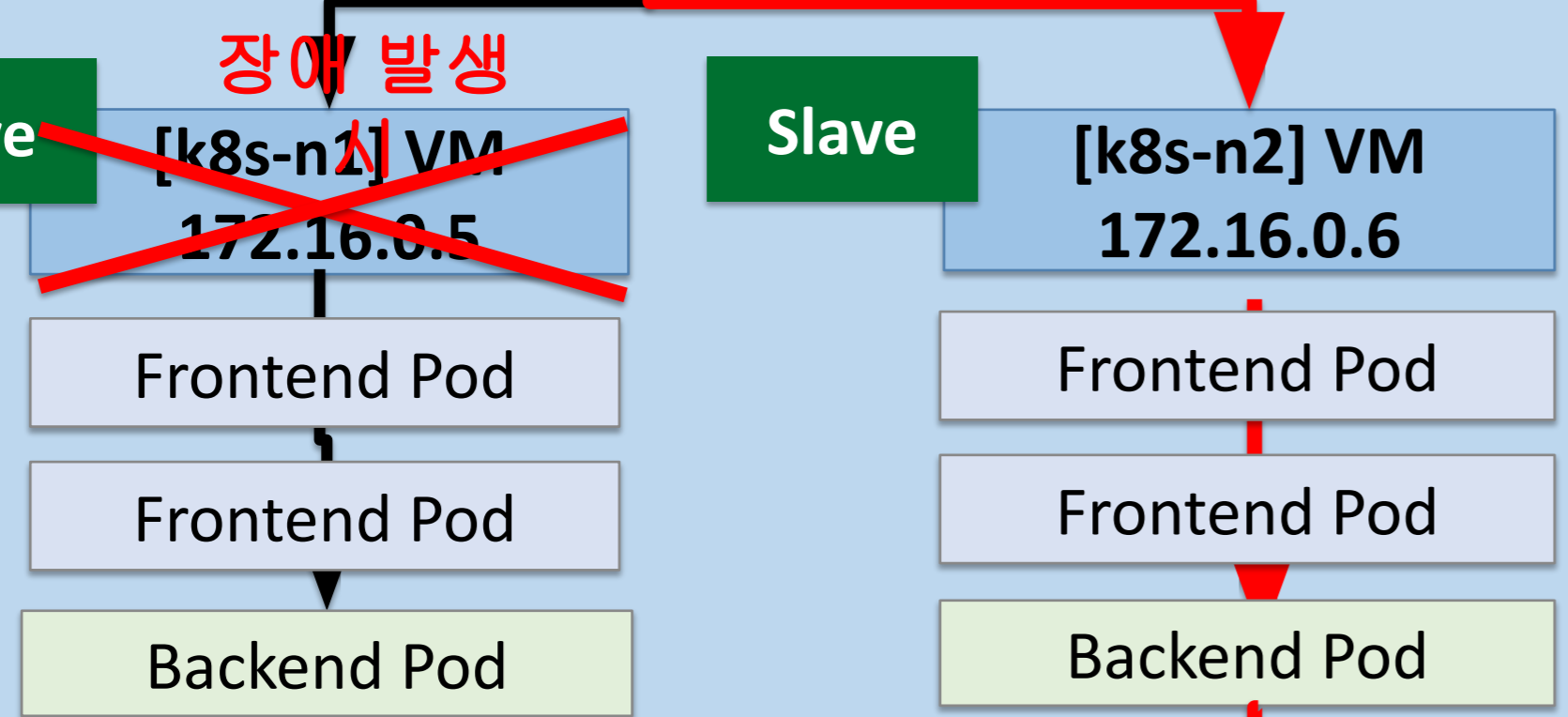
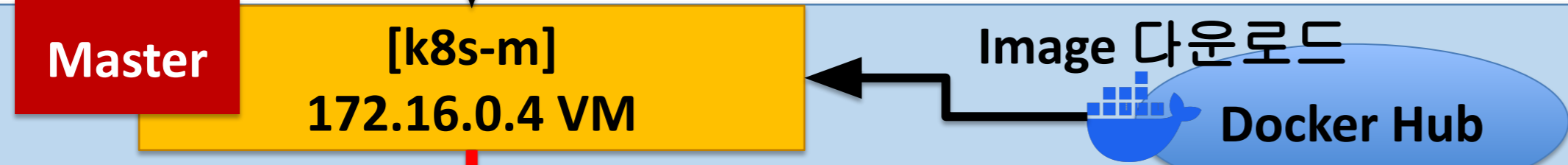
DB 백업

nfs VM
172.16.0.3

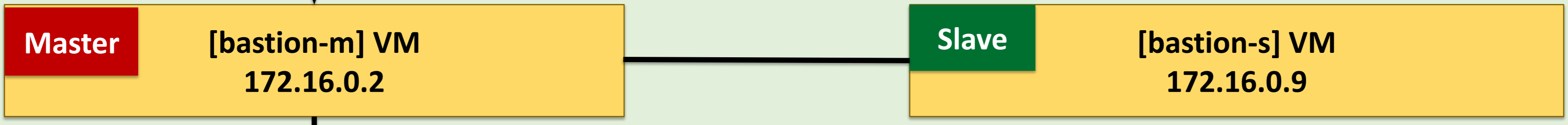
Bastion 서버 장애



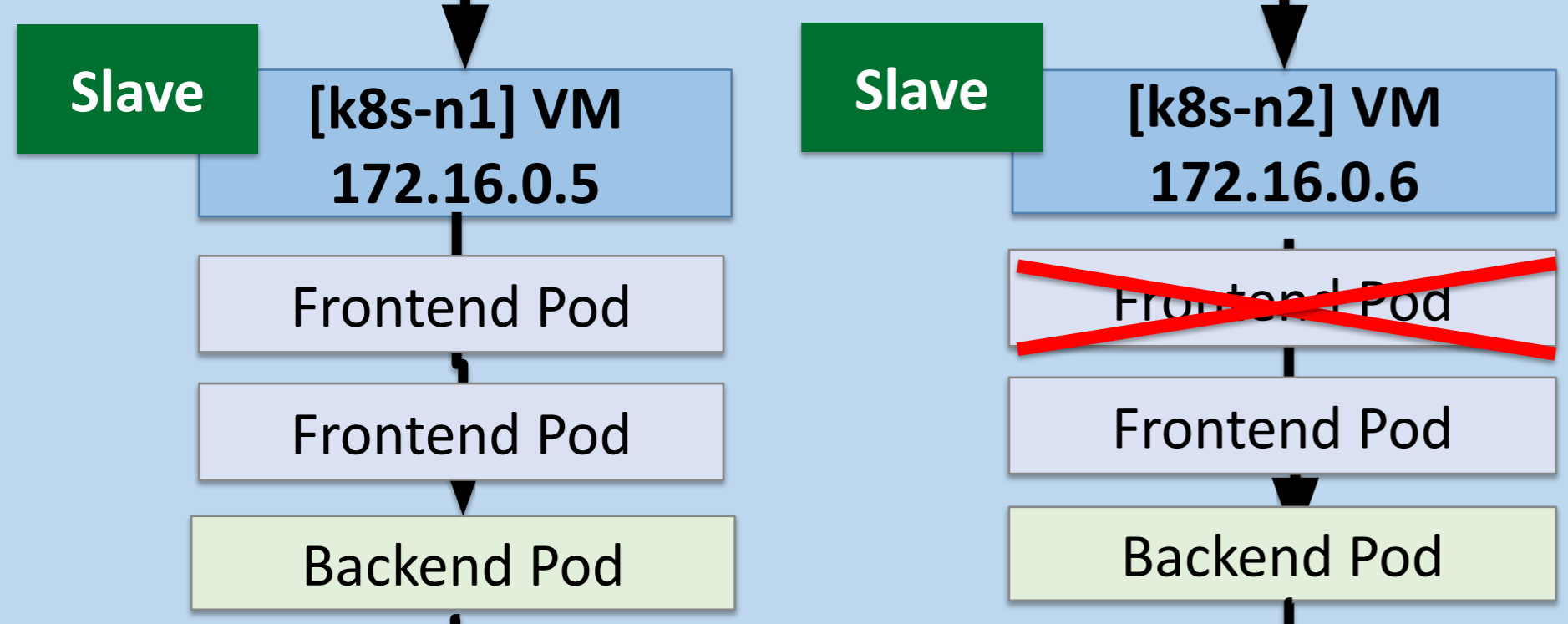
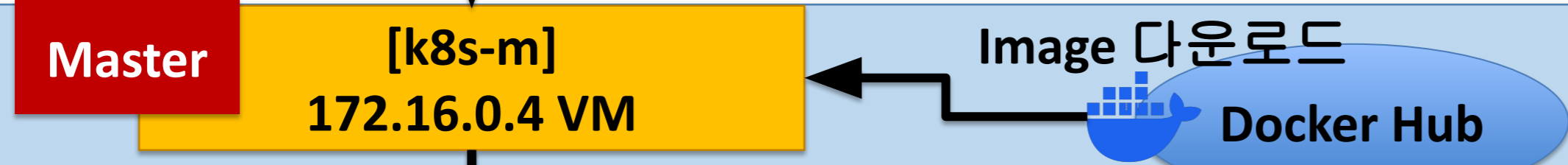
K8S control



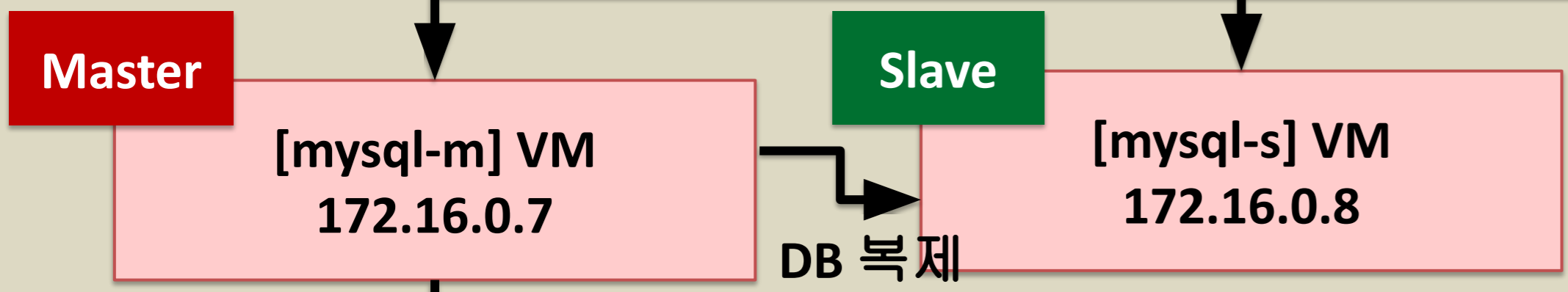
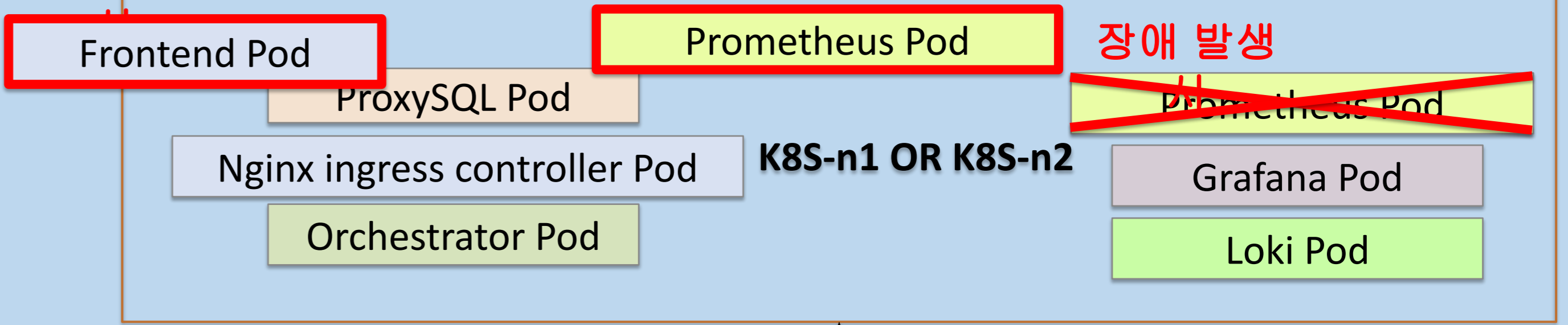
마스터 노드 장애



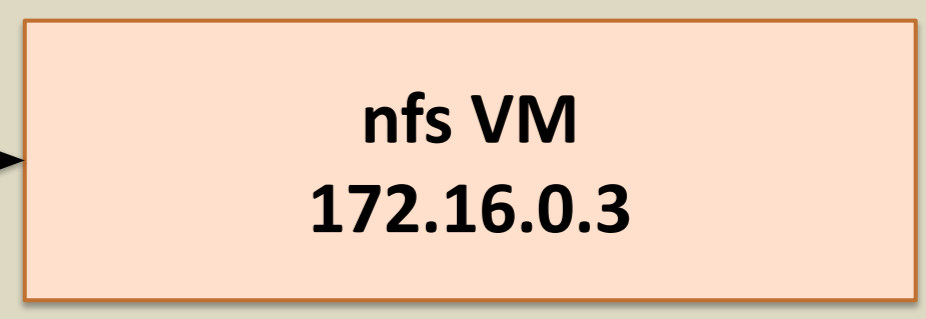
K8S control



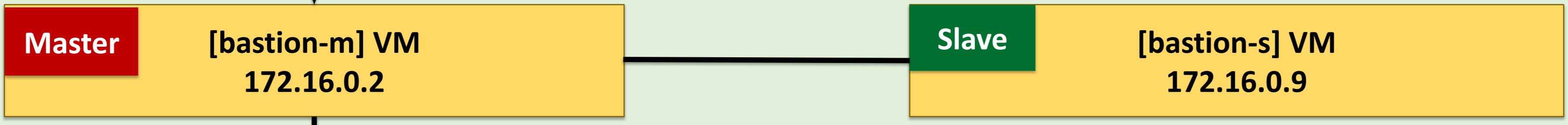
장애 발생



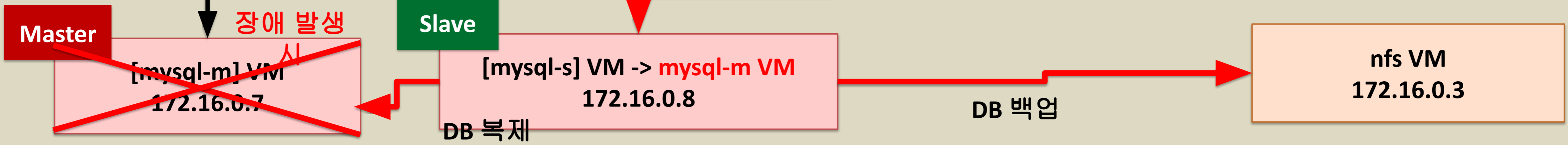
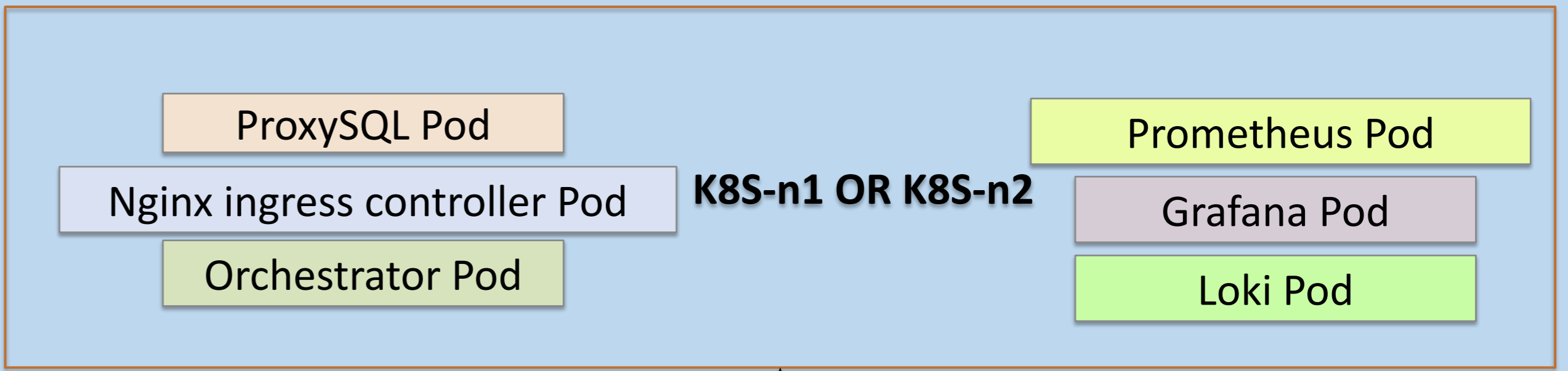
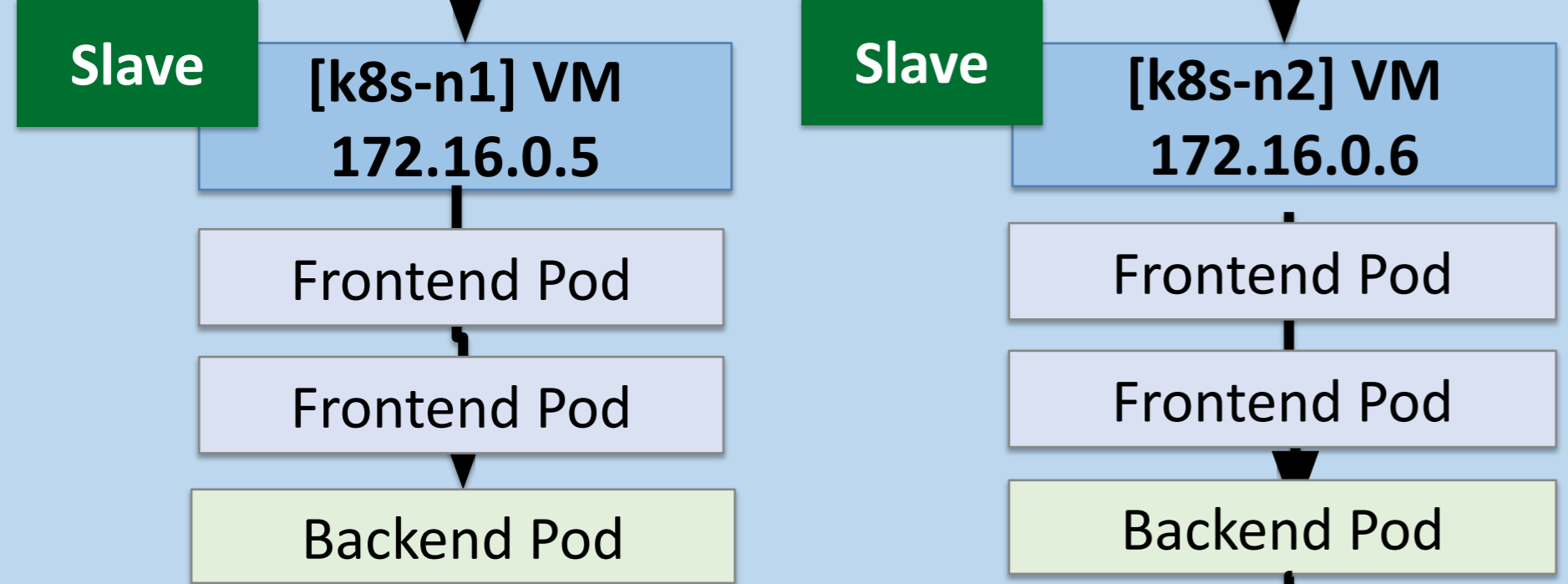
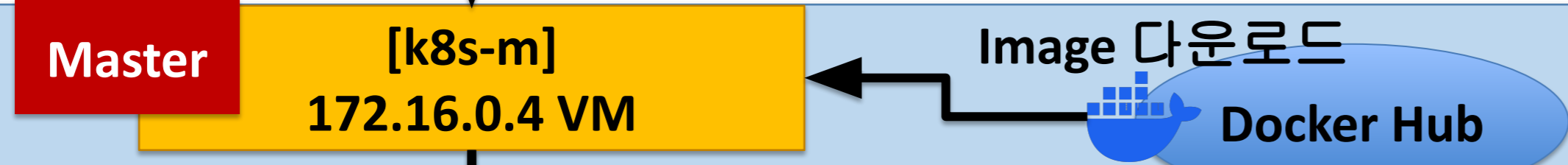
DB 백업



파드 장애

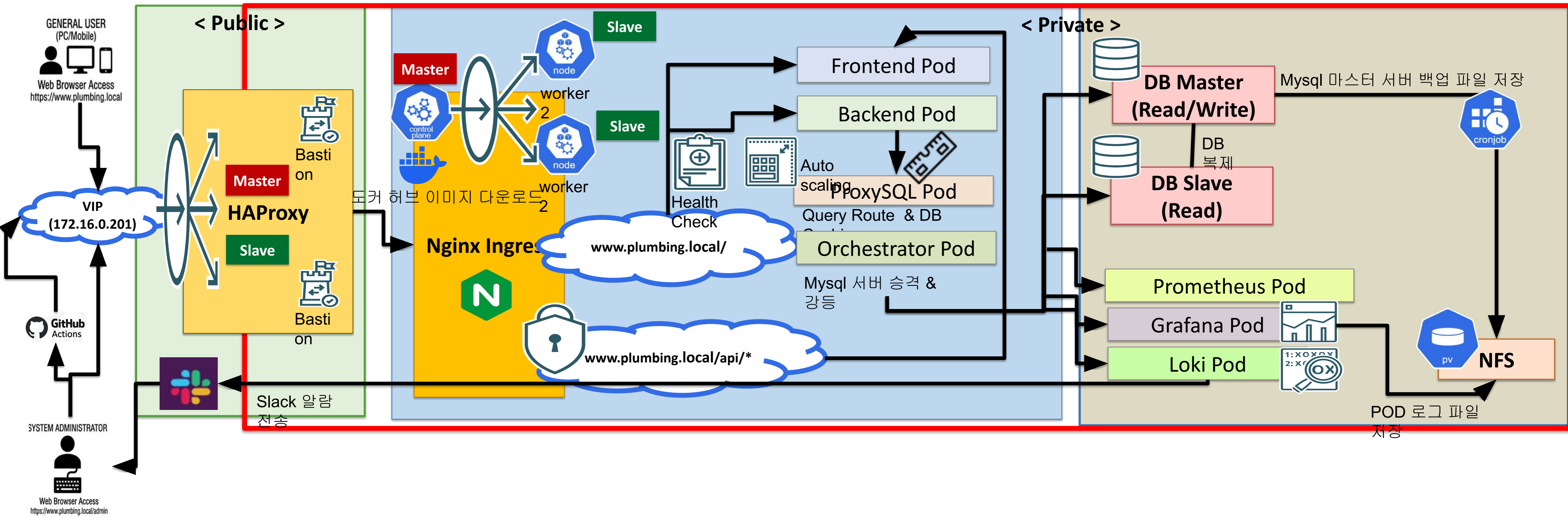


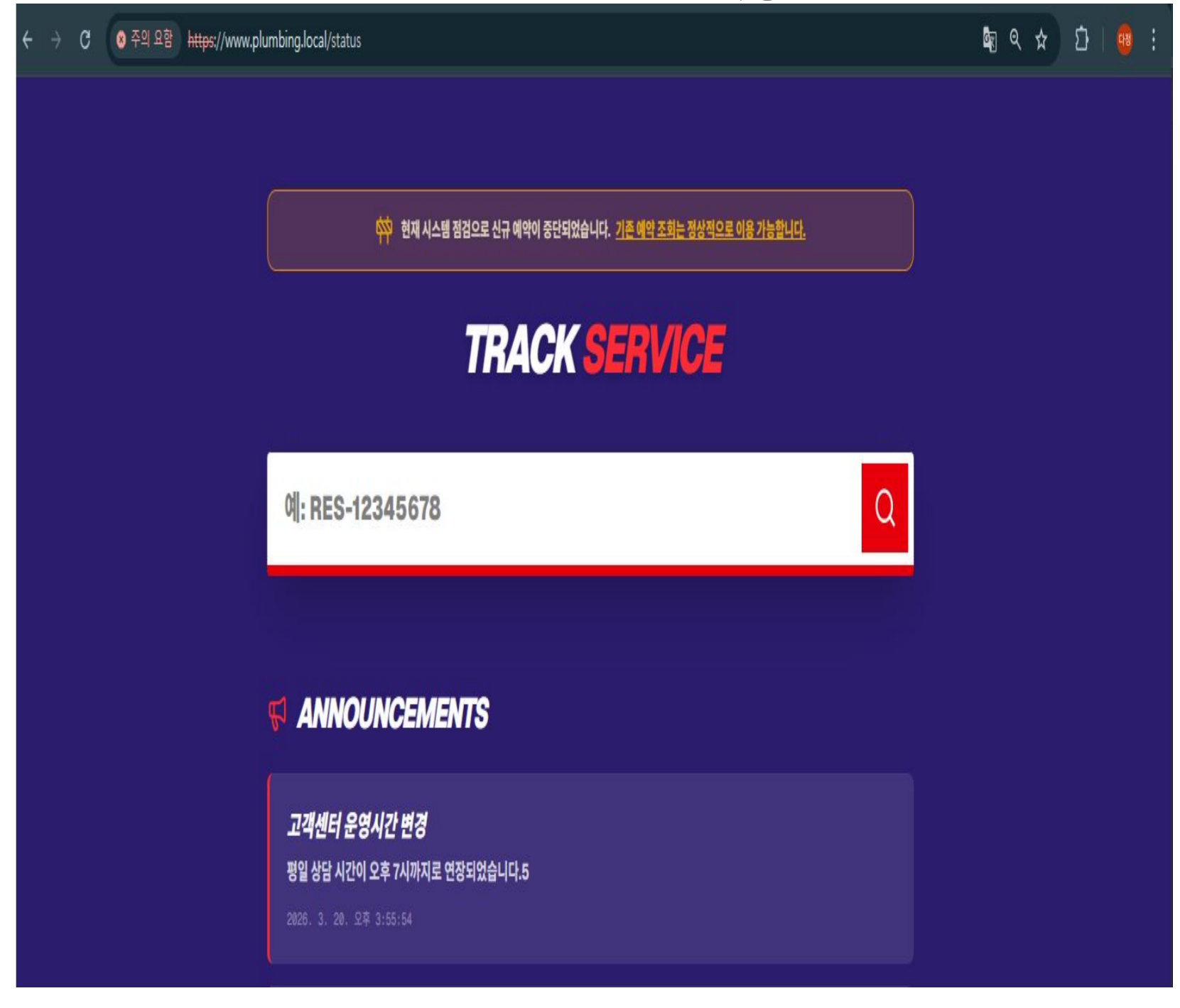
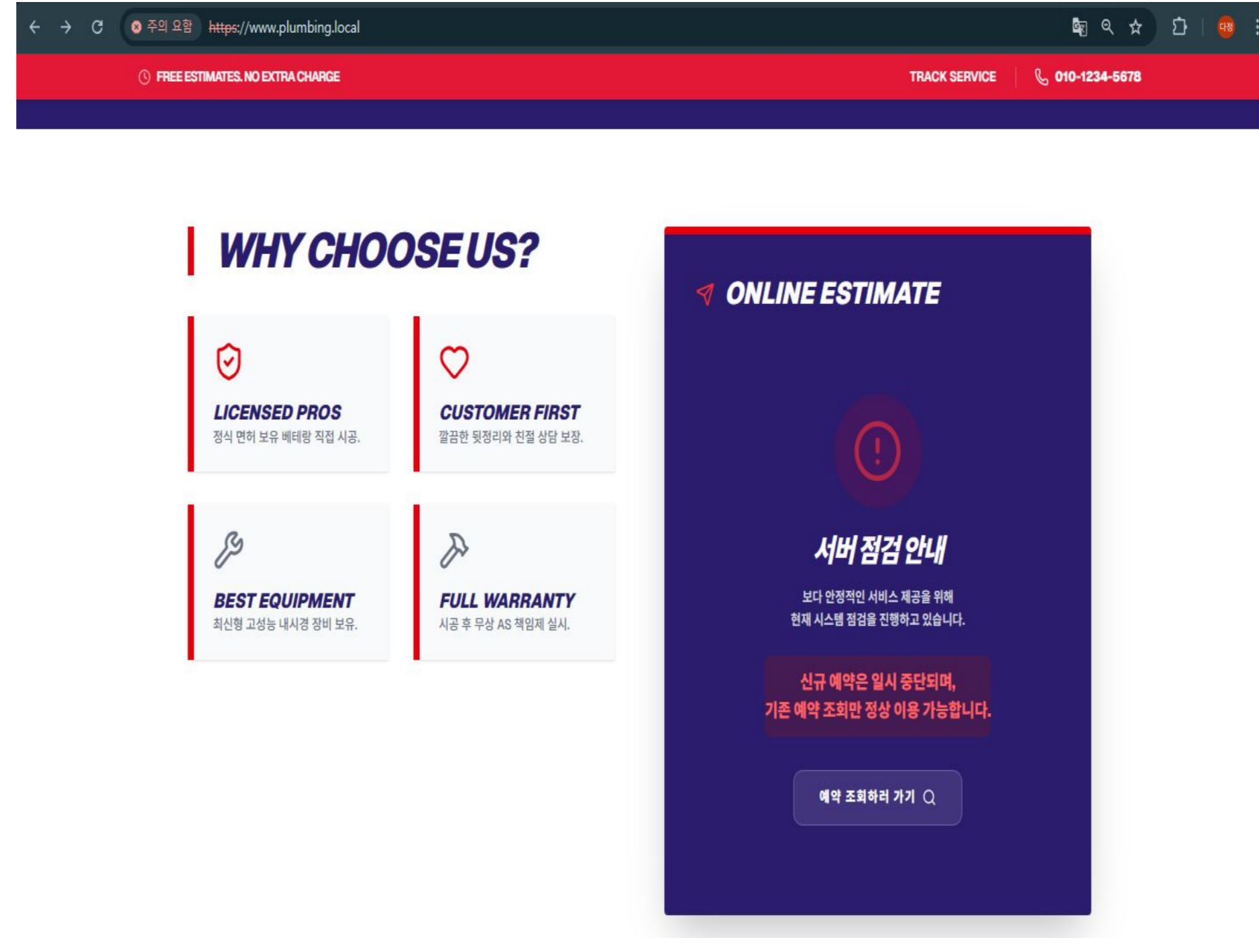
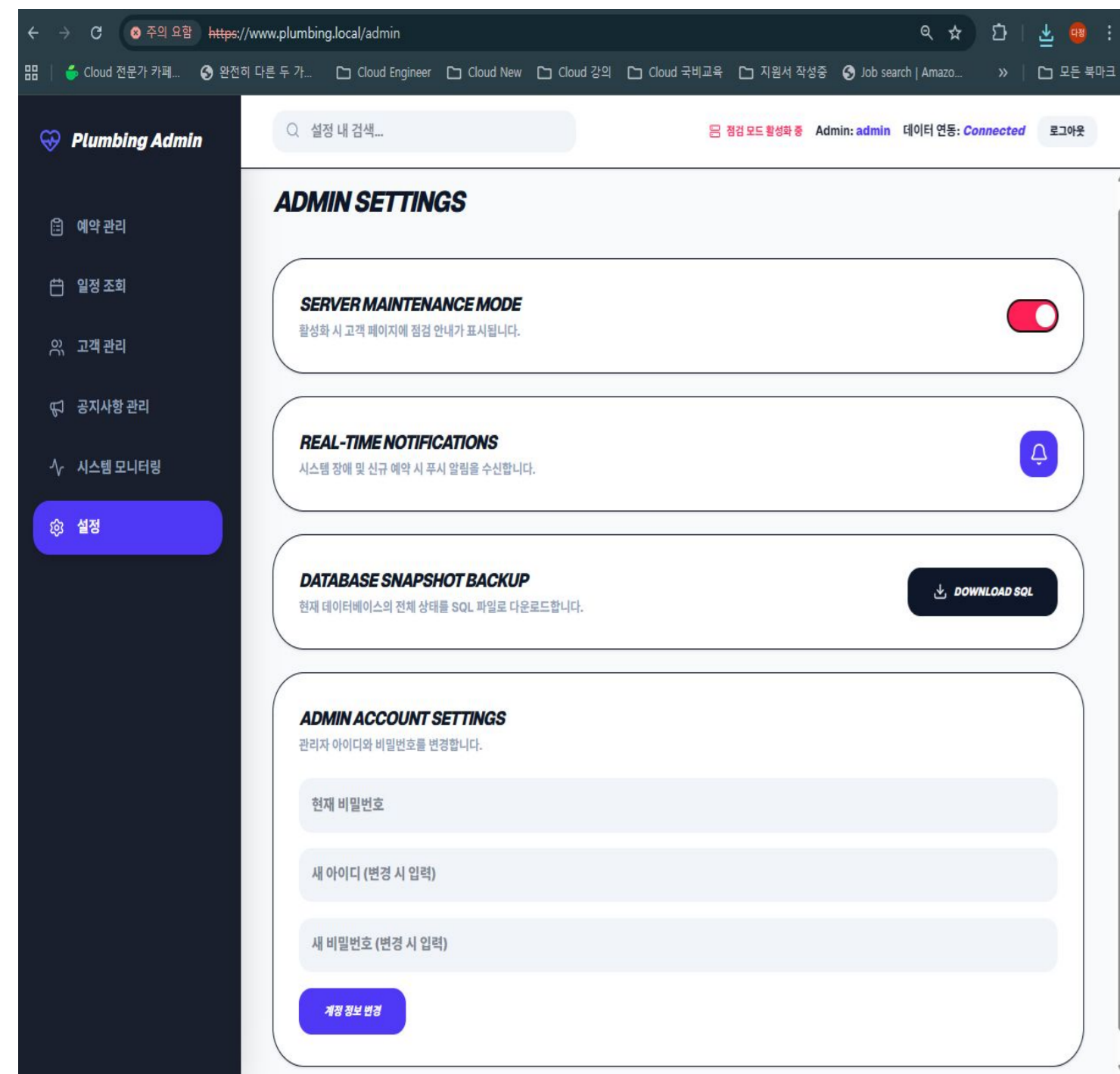
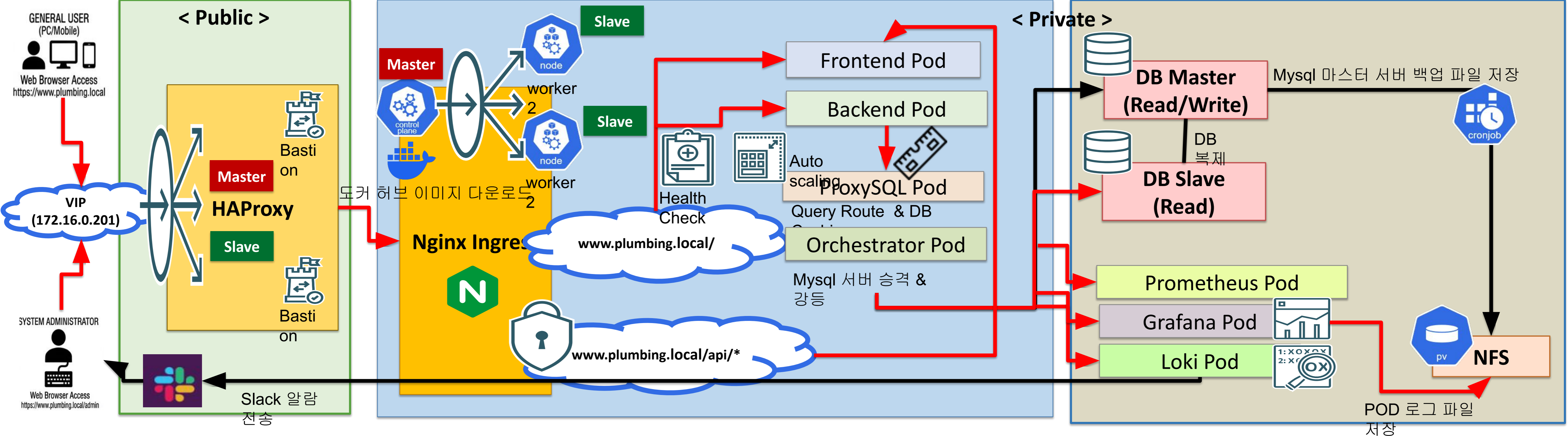
K8S control



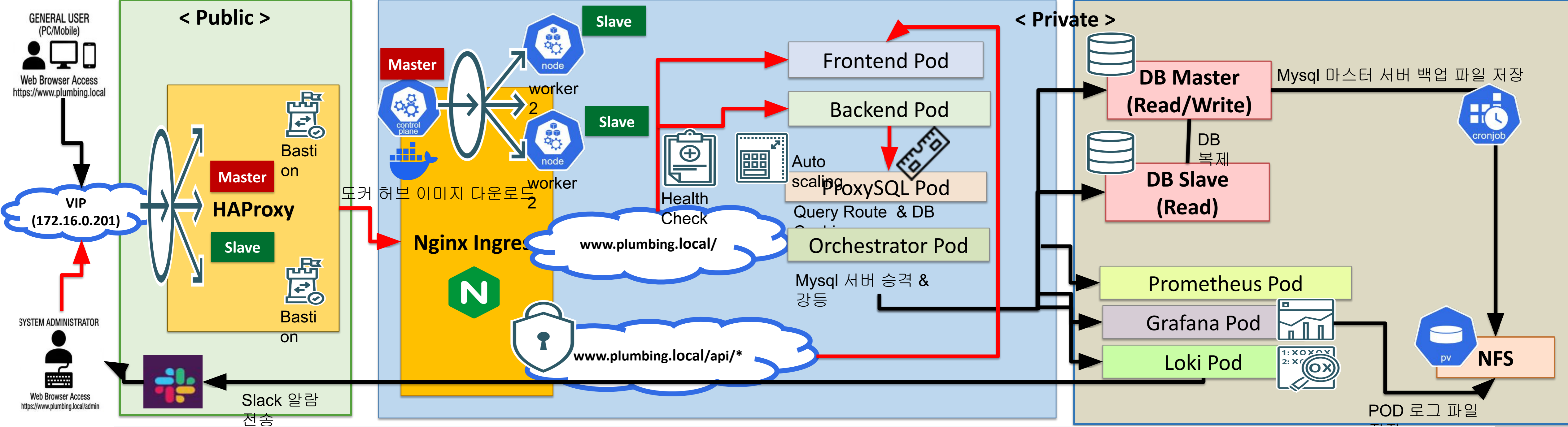
DB 서버 장애

논리적 구성도





요구사항 2. 사이트 점검 시(DB 오류로 인한 긴급 중단 또는 정기 점검 시) 새로운 예약은 받지 못하도록, 예약 조회는 가능하도록



990402DAJEONGKIM / VMware-3Tier-HighAvailability

Code Issues Pull requests Actions Projects Security Insights Settings

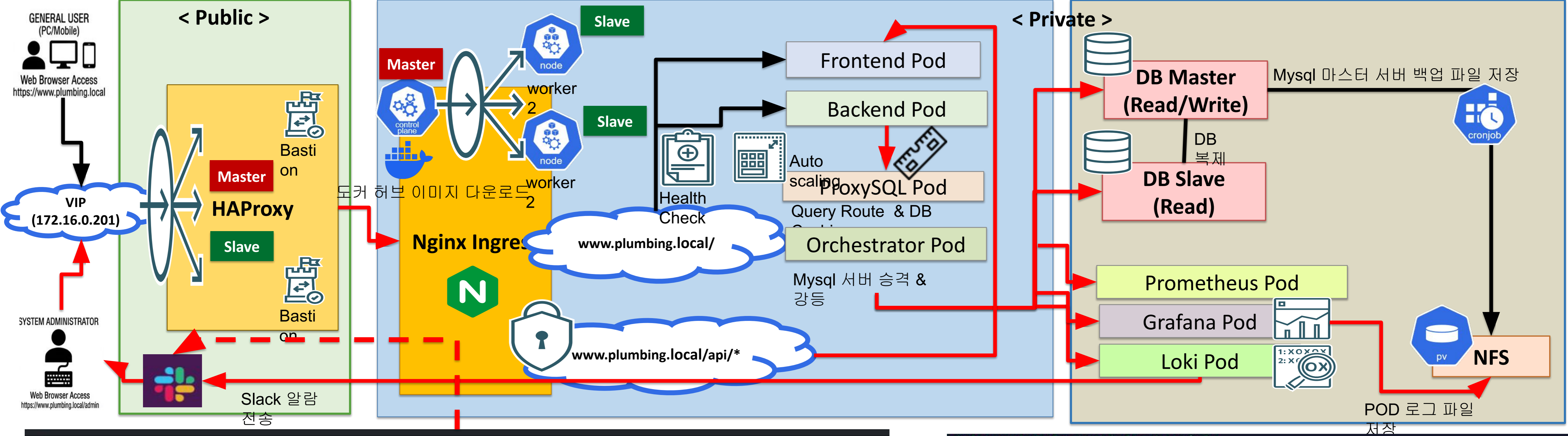
Actions New workflow

All workflows Showing runs from all workflows

123 workflow runs

Event	Status	Branch	Actor
fix: 관리자페이지에서 백엔드 로그 볼 수 있도록 추가	Success	main	990402DAJEONGKIM
fix: 관리자페이지 'Database HA Status (ProxySQL) 기능 삭제 및 loki 확인 완료	Success	main	990402DAJEONGKIM
feat: 그라파나에 loki 로그수집기 오류 수정	Success	main	990402DAJEONGKIM
feat: 그라파나에 loki 로그수집기 추가	Success	main	990402DAJEONGKIM
fix: proxysql의 runtime_mysql_servers 의 default 테이블 수정	Success	main	990402DAJEONGKIM
배포 오류 수정	Warning	main	990402DAJEONGKIM

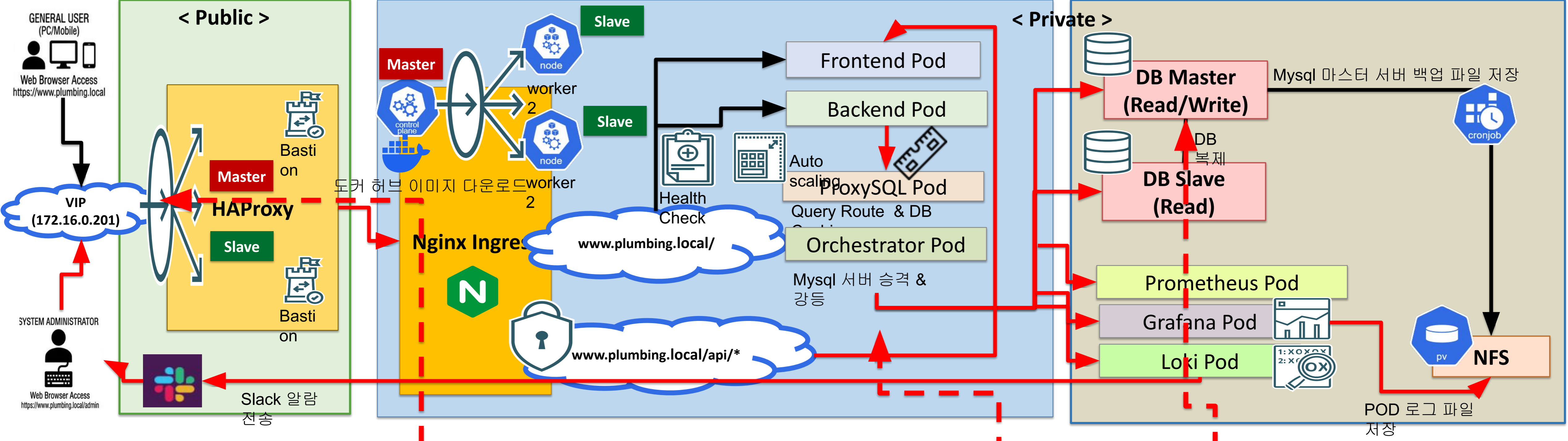
요구사항 3. 인프라 삭제될 시 최소한의 노력으로 ci/cd로 간편하게 재구축 가능하도록



[FATAL ERROR] AlertmanagerClusterDown
 상세 내용: 100% of Alertmanager instances within the cluster have been up for less than half of the last 5m.
 대상 서버:
 Infra admin APP 8:50 PM
[RESOLVED] InstanceDown
 상세 내용: ● 시스템이 정상 상태로 복구되었습니다.
 대상 서버: 172.16.0.9:9100
 관리자 대시보드 접속

```
dajeongkim@nfs:/mnt/nfs_share$ ls
archived-default-orchestrator-pvc-pvc-f2465b12-9c99-42ac-9ac6-b96c754951f2
archived-default-proxysql-pvc-pvc-e2ec4b23-4694-41c1b-aa23-04082f6a6166
default-db-backup-pvc-pvc-c0512072-c365-420d-a419-cce04d83aa9f
default-orchestrator-pvc-pvc-1245ee59-018e-498d-a240-36c1042a3531
default-proxysql-pvc-pvc-706b1d67-a745-4dab-b5e8-e079bb8c568c
monitoring-storage-loki-0-pvc-ff0d1dbc-322b-4926-a349-56a292f19265
dajeongkim@nfs:/mnt/nfs_share$ ^C
dajeongkim@nfs:/mnt/nfs_share$
```

```
dajeongkim@k8s-m:/var/log/containers$ ls
calico-apiserver-6b76cb9444-khtml_calico-apiserver_calico-apiserver-2f284546013423a3569a65136a7dbac2d415
61e268b39f530553201424095a73.log
calico-apiserver-6b76cb9444-khtml_calico-apiserver_calico-apiserver-9ec2e9ee4a2525c366df29de794ba8ffc374
65b74a8a727c4330954ce857aa7a.log
calico-apiserver-6b76cb9444-rl7mx_calico-apiserver_calico-apiserver-336433b512dea4aa9647dcf7de077b6fef50
28fe041860516b8d856e2ee1318e.log
calico-apiserver-6b76cb9444-rl7mx_calico-apiserver_calico-apiserver-a2aee794afd680ff24f7727e15c711d0e778
57220225333cd1351d30e2d07507.log
calico-kube-controllers-688ccc4c6b-nz8s8_calico-system_calico-kube-controllers-396770cd60d74c399eacc0d88
2979cc0c0c47704144b3ce28258db2eafa35340.log
calico-kube-controllers-688ccc4c6b-nz8s8_calico-system_calico-kube-controllers-82a3b43d1cb002788e67d8706
c308c1ddda9e26b0d8c82f42cecc4cbab8cf7e4.log
calico-node-kgtpk_calico-system_calico-node-15e88d2d13d558c65936360cfed8be29b0e1b02813db27a36c092b32b757
d4ea.log
calico-node-kgtpk_calico-system_calico-node-48baeaad797a7789df5344767c2043cb719d209935ab9199f5b903f4585a
56fd.log
calico-node-kgtpk_calico-system_flexvol-driver-d2b653141c6fa154e9a912c8c18d50614ffb59cce9c3f847065b166b1
3d8917d.log
calico-node-kgtpk_calico-system_install-cni-cbab2faf2c4aa38bceea49c963aee342569342660d24fb344a454f0ca42
a6a8.log
calico-typha-858cbdcbff-j764q_calico-system_calico-typha-346c3d4c02e6dd47754652add3f0b4d452a27b98e52838e
65c6474236c1dd180.log
calico-typha-858cbdcbff-j764q_calico-system_calico-typha-477f7931ba5a34580491eb730ea51218653692c182928a5
82b4ffb4eba906134.log
coredns-55cb58b774-f27cx_kube-system_coredns-9394963294204eefc6e957c78cf173cdf3eec16ca810a1e7f35fa4cb9e0
7867a.log
coredns-55cb58b774-f27cx_kube-system_coredns-9f07a4fea81cfc8410f3bc23362ff52863c6d153a3d2282a6b269db7d7f
9acff.log
```

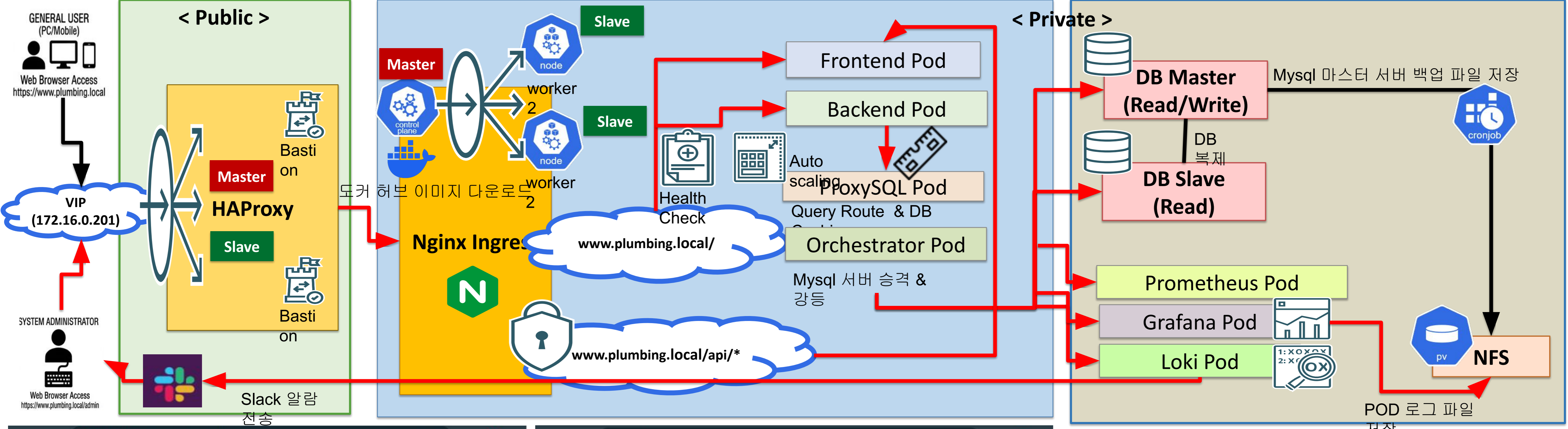


```
dajeongkim@bastion-backup:~$ systemctl status keepalived
• keepalived.service - Keepalive Daemon (LVS and VRRP)
  Loaded: loaded (/usr/lib/systemd/system/keepalived.service; enabled; preset: enabled)
  Active: active (running) since Mon 2026-03-23 20:49:47 KST; 5min ago
  Docs: man:keepalived(8)
        man:keepalived.conf(5)
        man:genhash(1)
        https://keepalived.org
  Main PID: 1058 (keepalived)
  Tasks: 2 (limit: 998)
  Memory: 4.7M (peak: 4.9M)
  CPU: 73ms
  CGroup: /system.slice/keepalived.service
          └─1058 /usr/sbin/keepalived --dont-fork
            └─1118 /usr/sbin/keepalived --dont-fork
```

```
dajeongkim@k8s-m:~$ kubectl get pod -w
NAME                                READY   STATUS    RESTARTS   AGE
plumbing-backend-745799f459-4cbzf    1/1    Running   0           21m
plumbing-backend-745799f459-s8gs9    1/1    Running   0           21m
plumbing-frontend-554b759d48-7nxgd   1/1    Running   0           43s
plumbing-frontend-554b759d48-95stc   1/1    Running   0           20m
plumbing-frontend-554b759d48-bcp2p   1/1    Running   0           28s
plumbing-frontend-554b759d48-hm2xz   1/1    Running   0           43s
plumbing-frontend-554b759d48-qj96l   1/1    Running   0           28s
plumbing-frontend-554b759d48-vcmjr   1/1    Running   0           21m
plumbing-orchestrator-7f6594d6f7-sxcqc 1/1    Running   0           21m
plumbing-proxysql-677886db77-7gbn7    1/1    Running   0           21m
```

```
MySQL [(none)]> SELECT hostgroup_id, hostname, status FROM runtime_mysql_servers;
+-----+-----+-----+
| hostgroup_id | hostname | status |
+-----+-----+-----+
| 10           | 172.16.0.7 | ONLINE |
| 20           | 172.16.0.7 | ONLINE |
| 20           | 172.16.0.8 | ONLINE |
+-----+-----+-----+
```

요구사항 5. 장애 시 대응 방안이 있어야 함 (Mysql, bastion 서버, K8S 클러스터, CPU/MEM 등의 자원들에 대한 장애)



Plumbing Admin

Admin: 데이터 연동: **Connected** | 로그아웃

시스템 모니터링 내 검색...

INFRA STATUS

- INFRASTRUCTURE**: CPU / Mem 12.0% / 41.0%, Disk / Net 49.4% / 3.88 MB/s
- KUBERNETES**: Pod Health 96%, Nodes Available 3 / 3
- MYSQL (PROMETHEUS)**: QPS / Conn 9 q/s / 15, Slow / Rep. Lag 0.29 /s / 0 sec
- VIP ENTRYPOINT**: VIP MASTER Status (Active), Uptime 99.99%
- WEB / INGRESS**: Latency 34ms, HTTP Status 200 OK
- ERROR LOGS**: 5

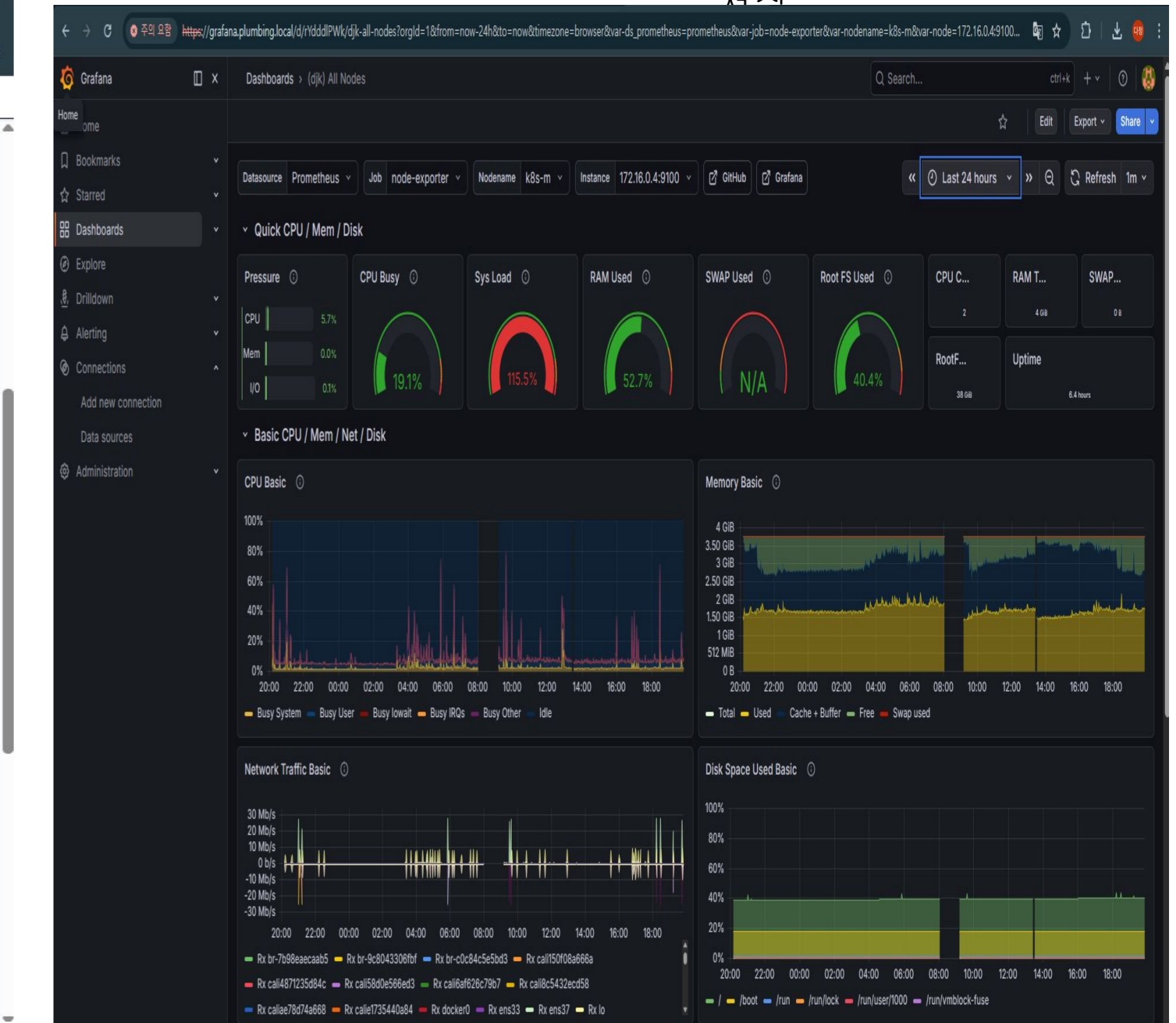
Plumbing Admin

Admin: 데이터 연동: **Connected** | 로그아웃

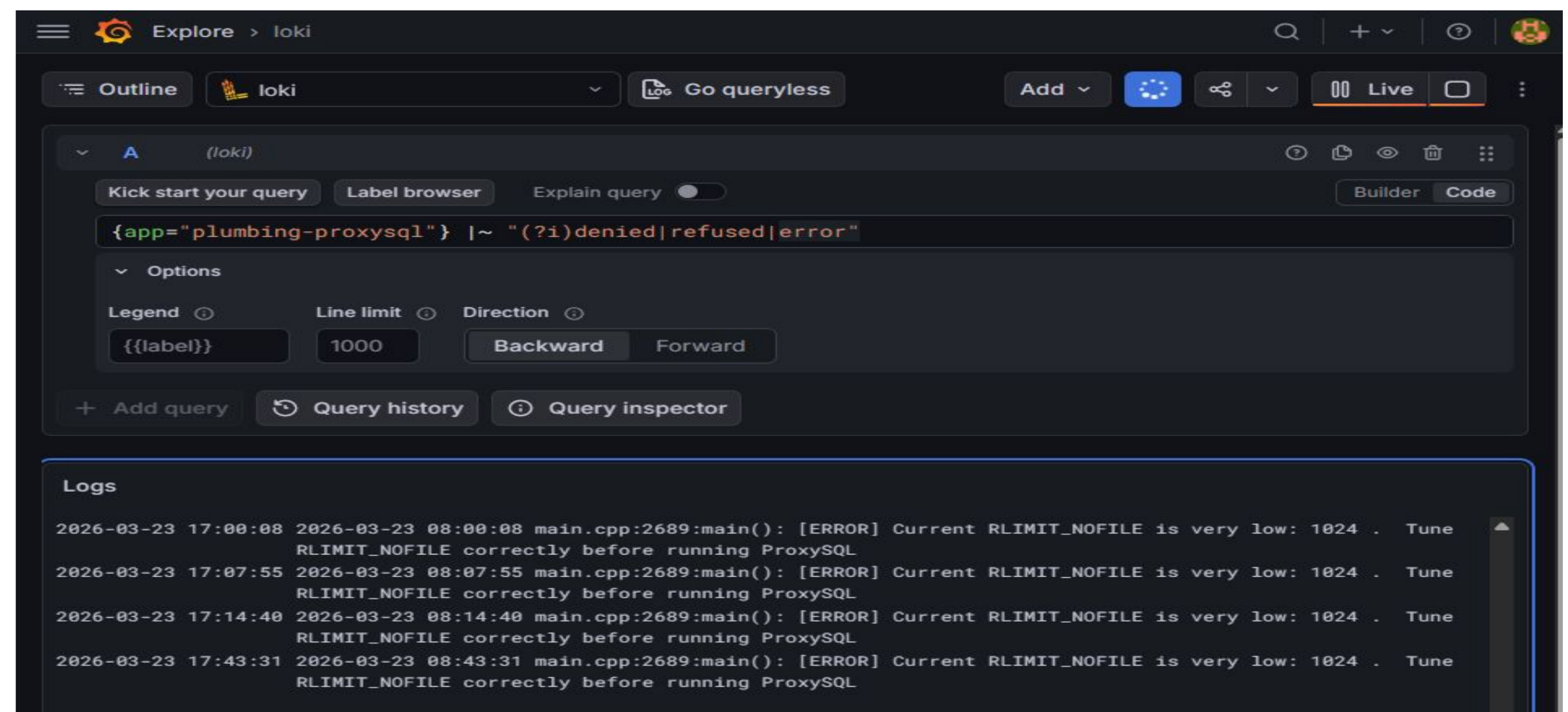
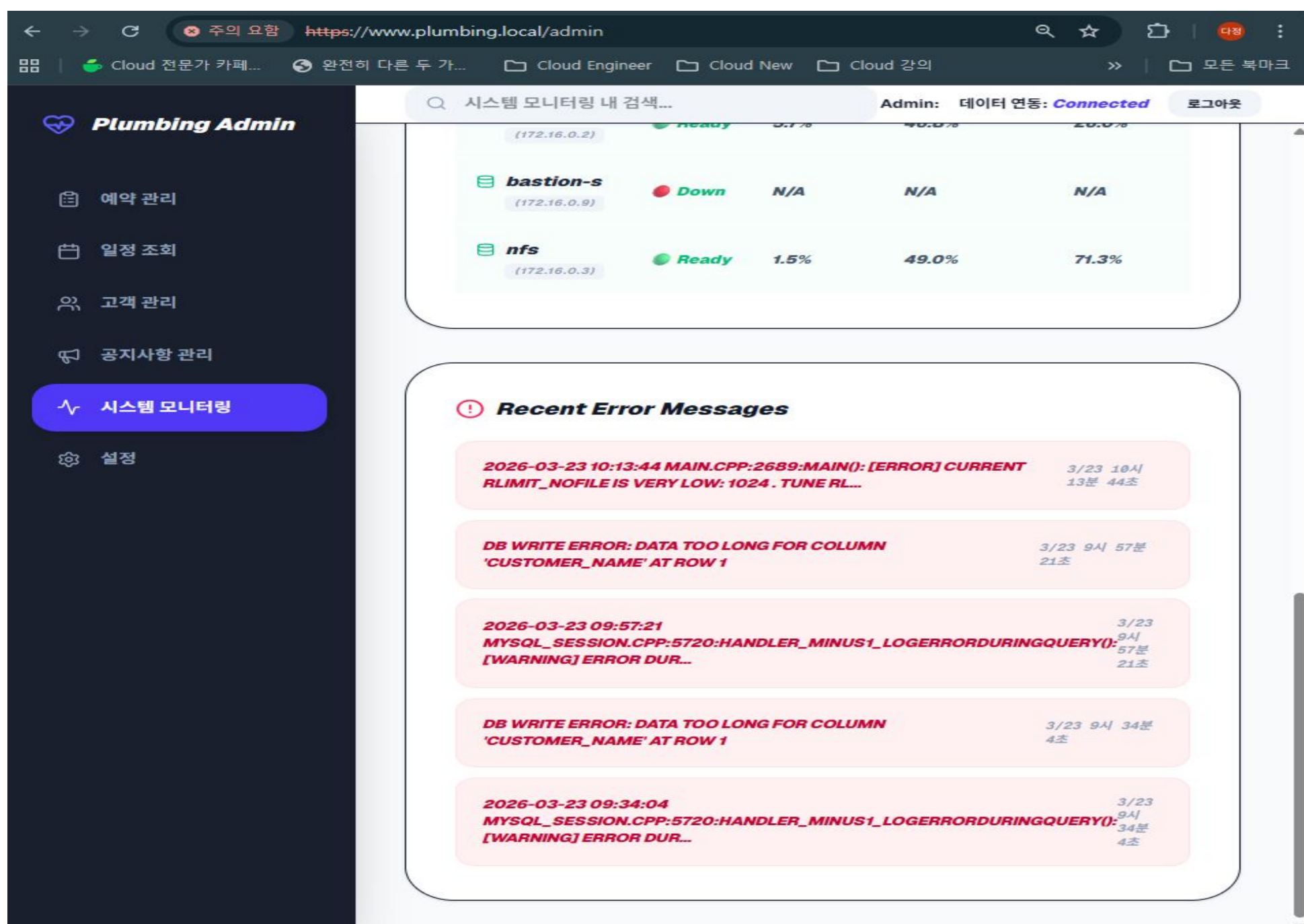
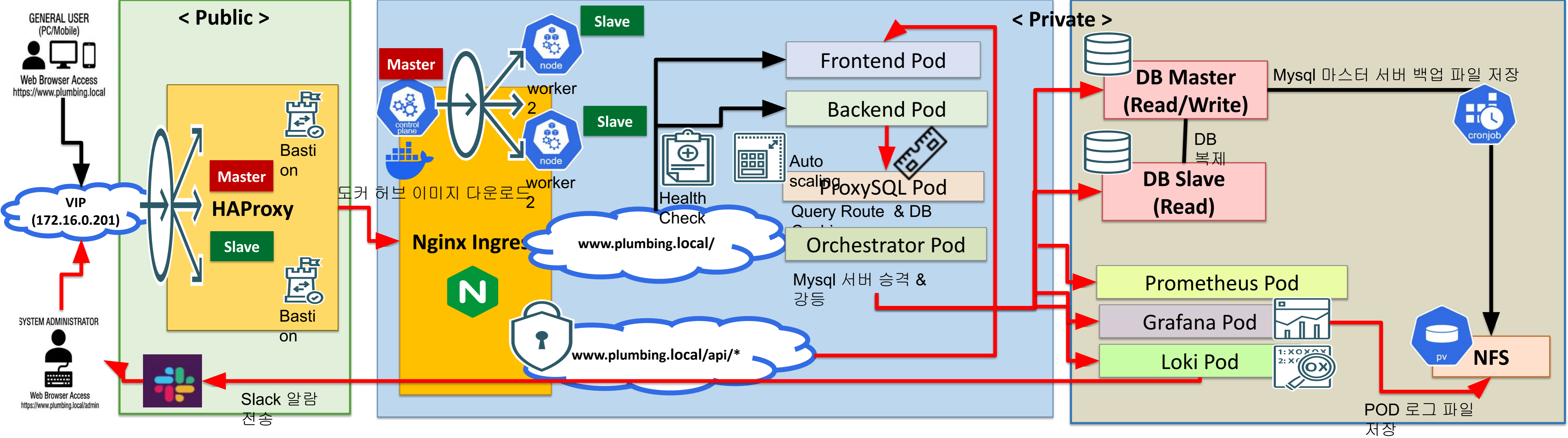
시스템 모니터링 내 검색...

NODE STATUS

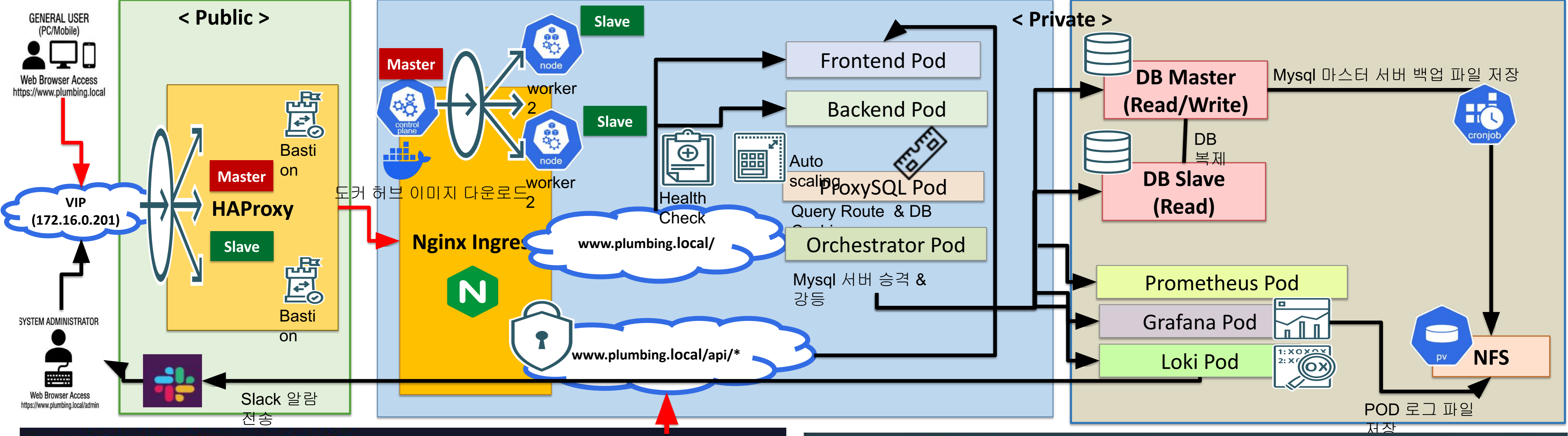
NODE NAME	STATUS	CPU USAGE	MEMORY USAGE	DISK USAGE
k8s-n2 (172.16.0.6)	Ready	12.0%	38.4%	62.4%
k8s-m (172.16.0.4)	Ready	25.9%	58.0%	40.4%
k8s-n1 (172.16.0.5)	Ready	17.0%	46.6%	58.3%
mysql-m (172.16.0.7)	Ready	1.5%	26.3%	56.4%
mysql-s (172.16.0.8)	Ready	1.7%	26.4%	54.7%
bastion-m (172.16.0.2)	Ready	5.7%	47.0%	26.0%
bastion-s (172.16.0.9)	Down	N/A	N/A	N/A
nfs (172.16.0.3)	Ready	1.3%	46.5%	71.5%



요구사항 6. 관리자 페이지에서 시스템을 한눈에 모니터링하고 그라파나 접속 페이지를 링크로 걸어 상세 내역도 확인 할 수 있도록

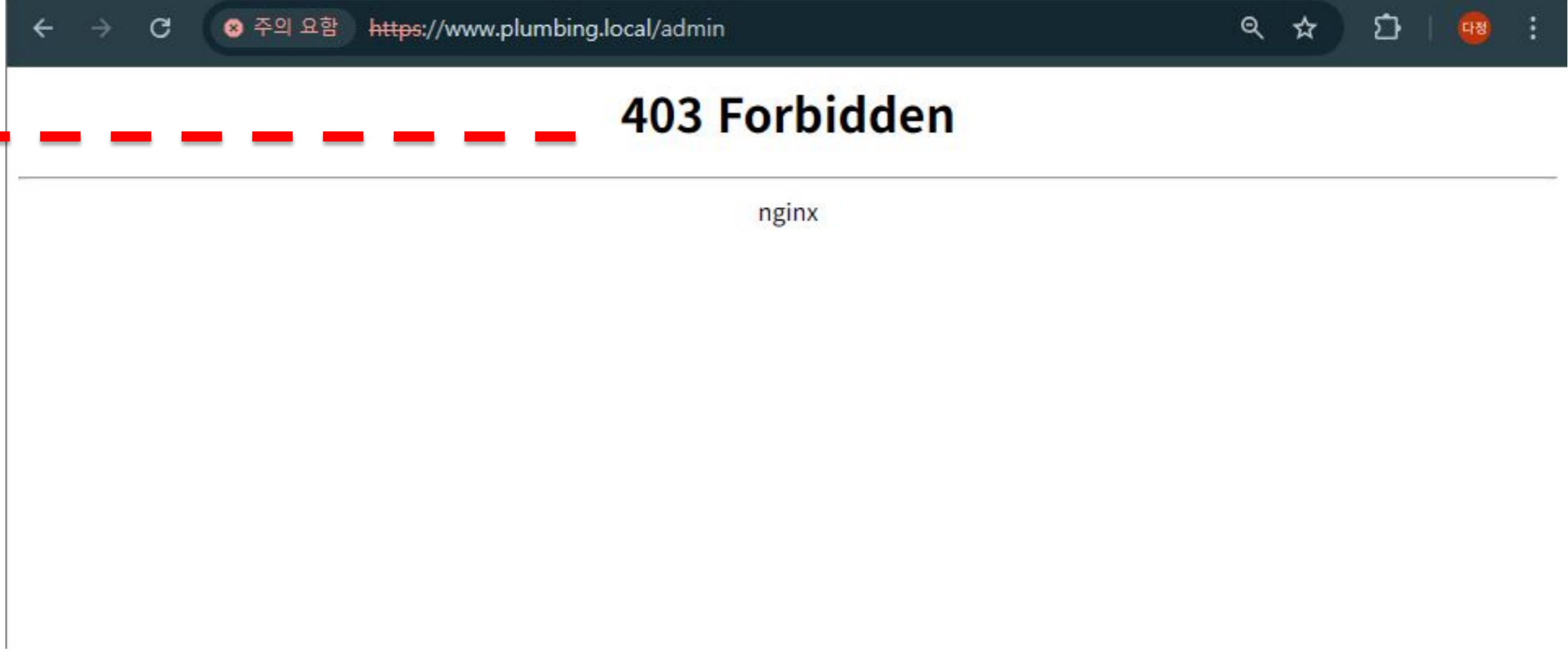


요구사항 7. 장애가 발생한 로그를 실시간으로 확인하고 싶음,

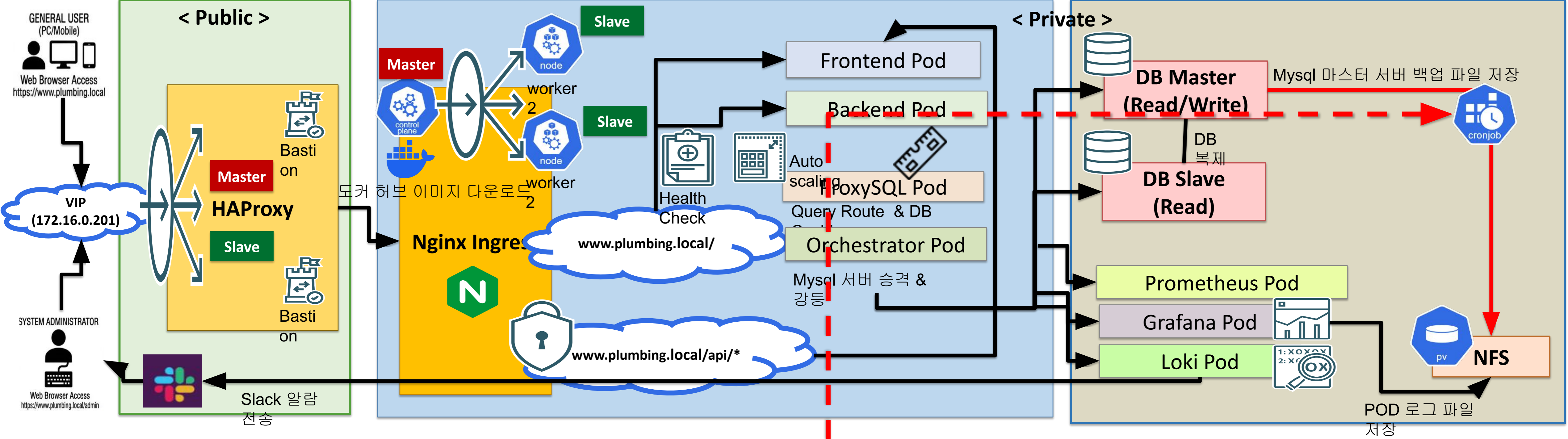


```

# 4.5 관리자 전용 Ingress (IP 제한 적용)
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: admin-ingress
  annotations:
    nginx.ingress.kubernetes.io/ssl-redirect: "true"
    # 💡 기존 PC IP 뒤에 쉼표(,)를 찍고 확인된 휴대폰 IP를 추가합니다.
    nginx.ingress.kubernetes.io/whitelist-source-range: "1.1.1.1/32, 10.0.255.13/32"
spec:
  ingressClassName: nginx
  
```



요구사항 8. 관리자 페이지는 외부에서 접속하지 못하도록 하며 관리자 전용 계정으로 페이지로그인을 해야 접속할 수 있도록 함



```

dajeongkim@k8s-m:~$ kubectl get cronjob -n default
NAME          SCHEDULE   TIMEZONE   SUSPEND   ACTIVE   LAST SCHEDULE   AGE
db-backup-cronjob  0 19 * * * <none>   False    0          <none>      14h
dajeongkim@k8s-m:~$ kubectl create job --from=cronjob/db-backup-cronjob manual-backup-test -n default
job.batch/manual-backup-test created
dajeongkim@k8s-m:~$ kubectl get pods -n default | grep manual-backup-test
manual-backup-test-gfzx7          0/1    Completed 0          10s
dajeongkim@k8s-m:~$ kubectl logs -n default -l job-name=manual-backup-test
데이터베이스 백업 시작...
mysqldump: [Warning] Using a password on the command line interface can be insecure.
백업 완료: /mnt/nfs_backup/plumbing_db_20260323_094325.sql
7일이 지난 오래된 백업 파일 정리 완료.
dajeongkim@k8s-m:~$

```

```

dajeongkim@nfs:/mnt/nfs_share/default-db-backup-pvc-pvc-c0512072-c365-420d-a419-cce04d83aa9f$ head -n 50 plumbing_db_20260323_094325.sql
-- MySQL dump 10.13  Distrib 8.0.45, for Linux (x86_64)
--
-- Host: 172.16.0.7    Database: plumbing_db
-- Server version      8.0.45-0ubuntu0.24.04.1

/*!40101 SET @OLD_CHARACTER_SET_CLIENT=@CHARACTER_SET_CLIENT */;
/*!40101 SET @OLD_CHARACTER_SET_RESULTS=@CHARACTER_SET_RESULTS */;
/*!40101 SET @OLD_COLLATION_CONNECTION=@COLLATION_CONNECTION */;
/*!50503 SET NAMES utf8mb4 */;
/*!40103 SET @OLD_TIME_ZONE=@TIME_ZONE */;
/*!40103 SET TIME_ZONE='+00:00' */;
/*!40014 SET @OLD_UNIQUE_CHECKS=@UNIQUE_CHECKS, UNIQUE_CHECKS=0 */;
/*!40014 SET @OLD_FOREIGN_KEY_CHECKS=@FOREIGN_KEY_CHECKS, FOREIGN_KEY_CHECKS=0 */;
/*!40101 SET @OLD_SQL_MODE=@SQL_MODE, SQL_MODE='NO_AUTO_VALUE_ON_ZERO' */;
/*!40101 SET @OLD_SQL_NOTES=@SQL_NOTES, SQL_NOTES=0 */;

--
-- Table structure for table `admin_users`
--
DROP TABLE IF EXISTS `admin_users`;
/*!40101 SET @saved_cs_client      = @@character_set_client */;
/*!50503 SET character_set_client = utf8mb4 */;
CREATE TABLE `admin_users` (
  `id` int NOT NULL AUTO_INCREMENT,
  `username` varchar(50) NOT NULL,
  `password` varchar(255) NOT NULL,
  PRIMARY KEY (`id`)
) ENGINE=InnoDB AUTO_INCREMENT=7 DEFAULT CHARSET=utf8mb4 COLLATE=utf8mb4_0900_ai_ci;
/*!40101 SET character_set_client = @saved_cs_client */;

```

요구사항 9. DB 장애 시 복구를 위해 백업 파일을 자동으로 NFS 서버에 저장하도록

보완점

단일 장애점 존재

클러스터에서 가장 중요한 역할을 하는 마스터 노드(k8s-m)가 단 한 대뿐이며 이에 대한 대응 방안이 없음.

Mysql 자동 복구 실패

자동 복구 시스템인 orchestrator 의 미작동.
마스터가 죽을 시 슬레이브 서버가 마스터로 자동 승격이 되지 않아 관리자가 수동으로 슬레이브를 마스터로 승격시키고 죽은 마스터는 살려낸 뒤 슬레이브로 만들어야 함.

내부 서버에 대한 보안 약함

클러스터 내부의 파드들끼리는 자유롭게 통신할 수 있음.
만약 백엔드 파드가 해킹이 된다면 다른 파드들에 쉽게 옮겨갈 수 있고 이 파드가 proxSQL 파드로 넘어가 Mysql 서버와도 연결될 가능성이 있음.

시스템 계정 관리 문제

mysql 에서 복제를 위한 계정, proxySQL 에서 모니터링 계정, DB 백업 계정 등 모두 root 계정을 사용하였음.
계정을 생성하고 계정별 어떠한 권한이 필요한지 알아볼 필요가 있음.