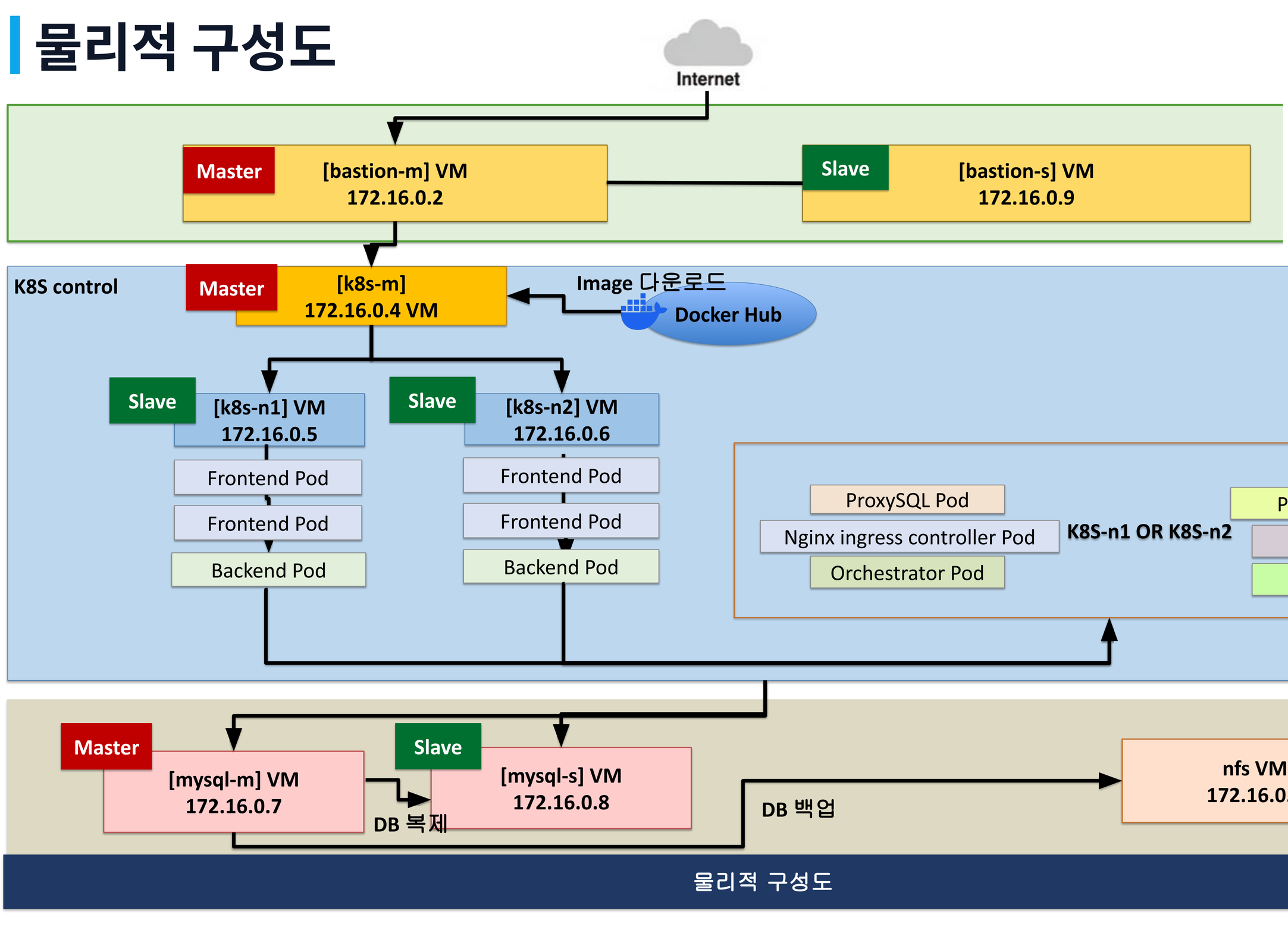
고가용성 인프라 구축

- Kubernetes 기반의 배관 수리 서비스 플랫폼

2026.03.25 김다정

목차

물리적 구성도



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

Internet

장애 발생

Master [bastion-m] VM 172.16.0.2

Slave [bastion-s] VM 172.16.0.9

K8S control

Master [k8s-m] 172.16.0.4 VM

Image 다운로드 Docker Hub

Slave [k8s-n1] VM 172.16.0.5

Frontend Pod

Frontend Pod

Backend Pod

Slave [k8s-n2] VM 172.16.0.6

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

Internet

Master [bastion-m] VM 172.16.0.2

Slave [bastion-s] VM 172.16.0.9

K8S control

Master [k8s-m] 172.16.0.4 VM

Image 다운로드

Docker Hub

장애 발생

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

마스터 노드 장애

Internet

Master [bastion-m] VM 172.16.0.2

Slave [bastion-s] VM 172.16.0.9

K8S control

Master [k8s-m] 172.16.0.4 VM

Image 다운로드 Docker Hub

Slave [k8s-n1] VM 172.16.0.5

- Frontend Pod
- Frontend Pod
- Backend Pod

Slave [k8s-n2] VM 172.16.0.6

- ~~Frontend Pod~~
- Frontend Pod
- Backend Pod

장애 발생

Frontend Pod

- ProxySQL Pod
- Nginx ingress controller Pod
- Orchestrator Pod

Prometheus Pod

장애 발생

~~Prometheus Pod~~

K8S-n1 OR K8S-n2

- 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

파드 장애

Internet

Master [bastion-m] VM 172.16.0.2

Slave [bastion-s] VM 172.16.0.9

K8S control

Master [k8s-m] 172.16.0.4 VM

Image 다운로드 Docker Hub

Slave [k8s-n1] VM 172.16.0.5

Frontend Pod

Frontend Pod

Backend Pod

Slave [k8s-n2] VM 172.16.0.6

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 장애 발생 시

[mysql-m] VM 172.16.0.7

Slave [mysql-s] VM -> mysql-m VM 172.16.0.8

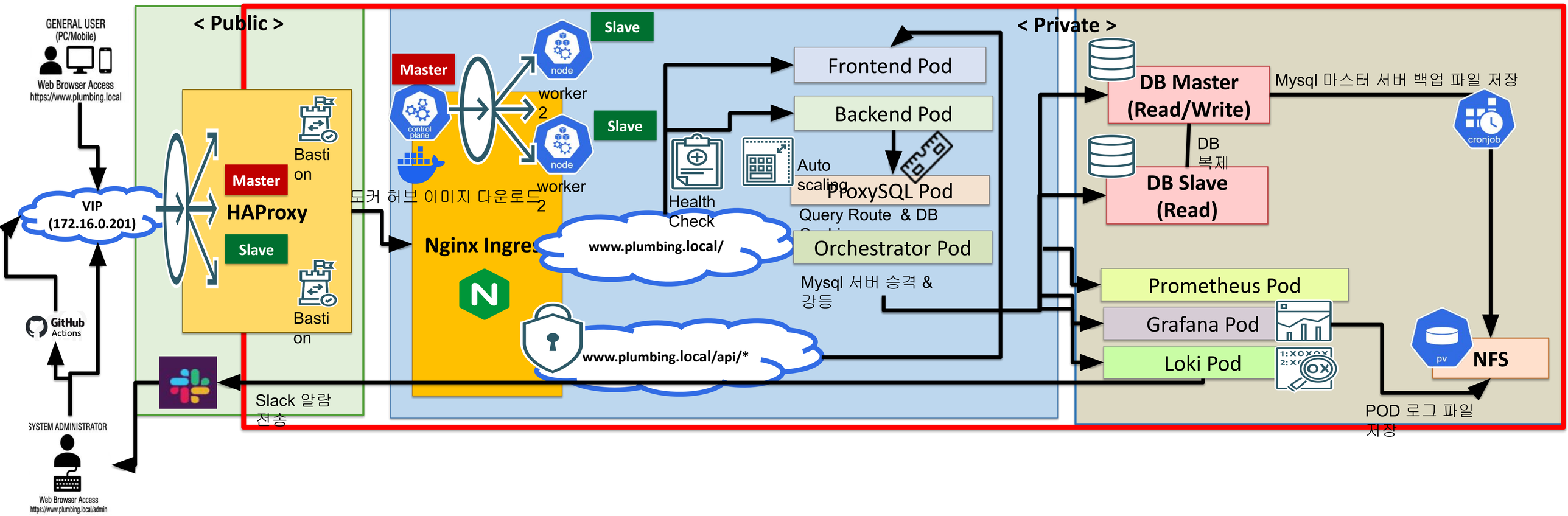
DB 복제

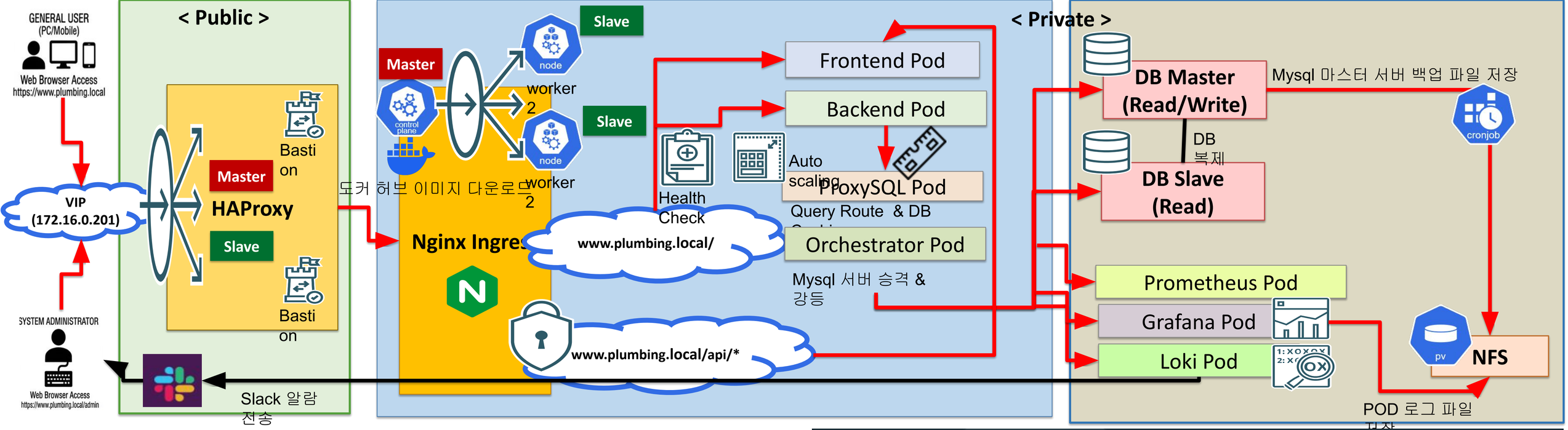
DB 백업

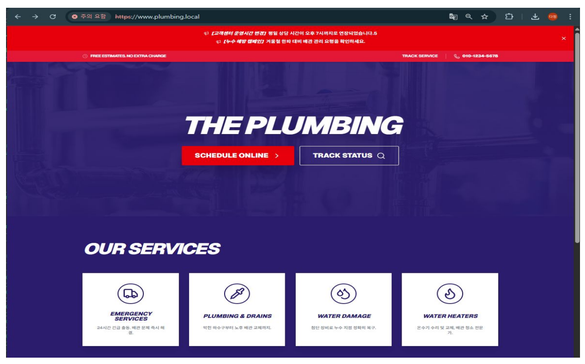
nfs VM 172.16.0.3

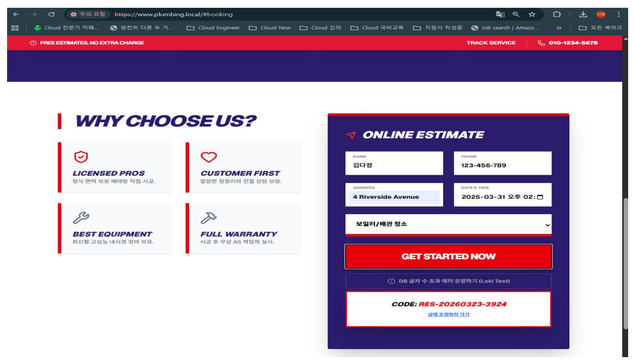
DB 서버 장애

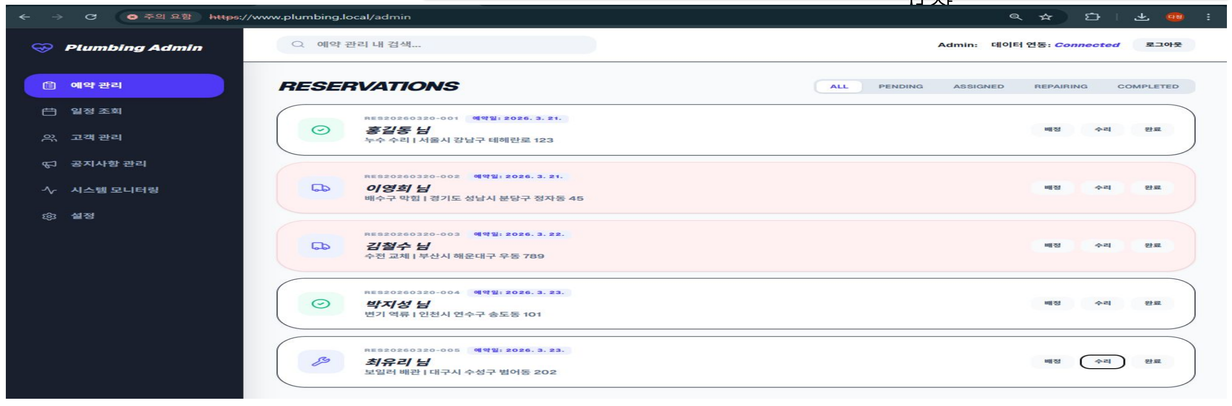
논리적 구성도

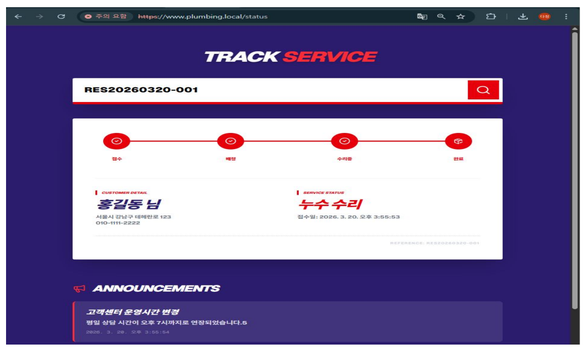

GENERAL USER
(PC/Mobile)
Web Browser Access
https://www.plumbing.local
VIP
(172.16.0.201)
GitHub
Actions
SYSTEM ADMINISTRATOR
Web Browser Access
https://www.plumbing.local/admin
< Public >
Master
HAProxy
Slave
Basti
on
Basti
on
Slack 알람
전송
도커 허브 이미지 다운로드
Master
Slave
Slave
node
worker
2
node
worker
2
Nginx Ingres
www.plumbing.local/
www.plumbing.local/api/*
Health
Check
Auto
scaling
< Private >
Frontend Pod
Backend Pod
ProxySQL Pod
Query Route & DB
Orchestrator Pod
Mysql 서버 승격 &
강등
DB Master
(Read/Write)
Mysql 마스터 서버 백업 파일 저장
DB
복제
DB Slave
(Read)
cronjob
Prometheus Pod
Grafana Pod
Loki Pod
pv
NFS
POD 로그 파일
저장

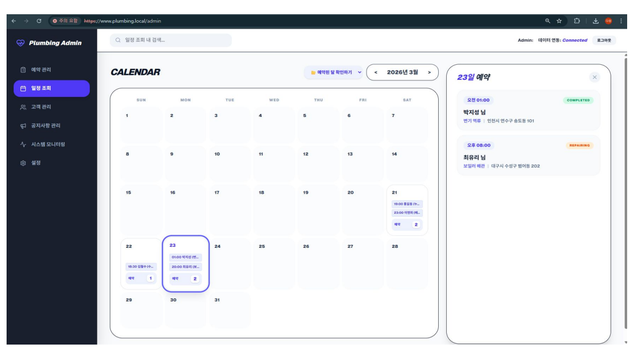


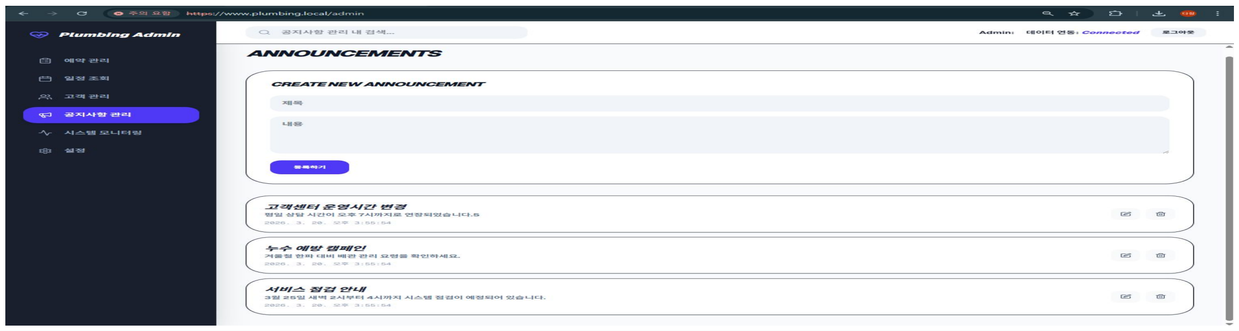




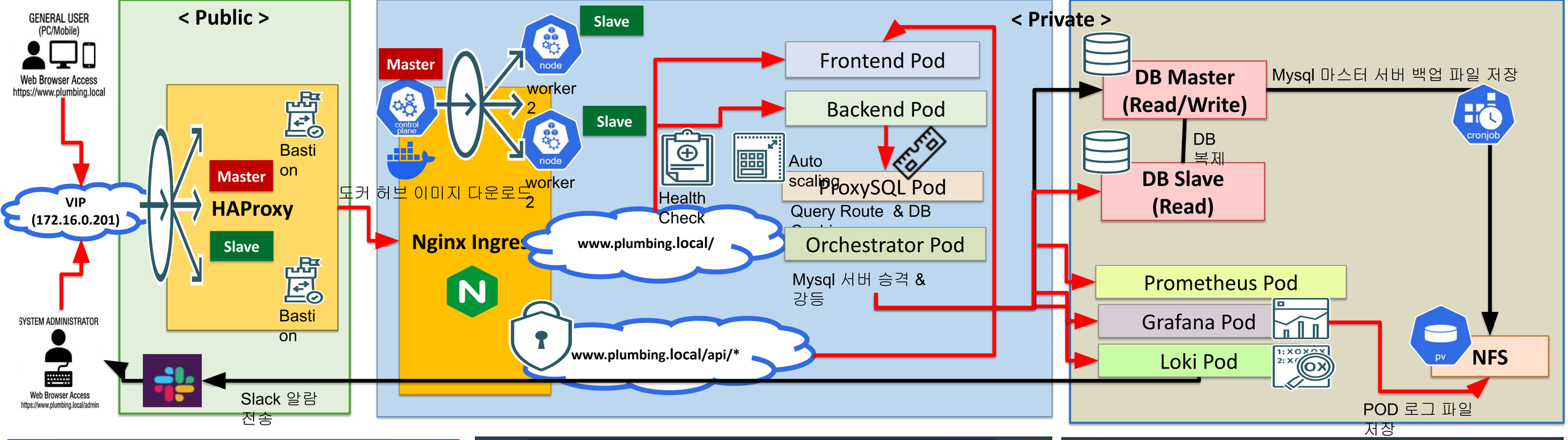


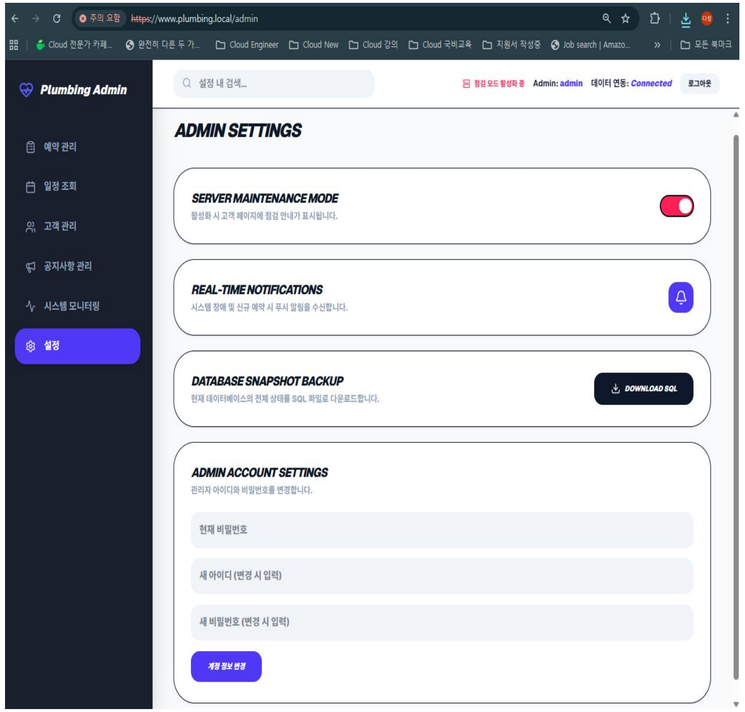


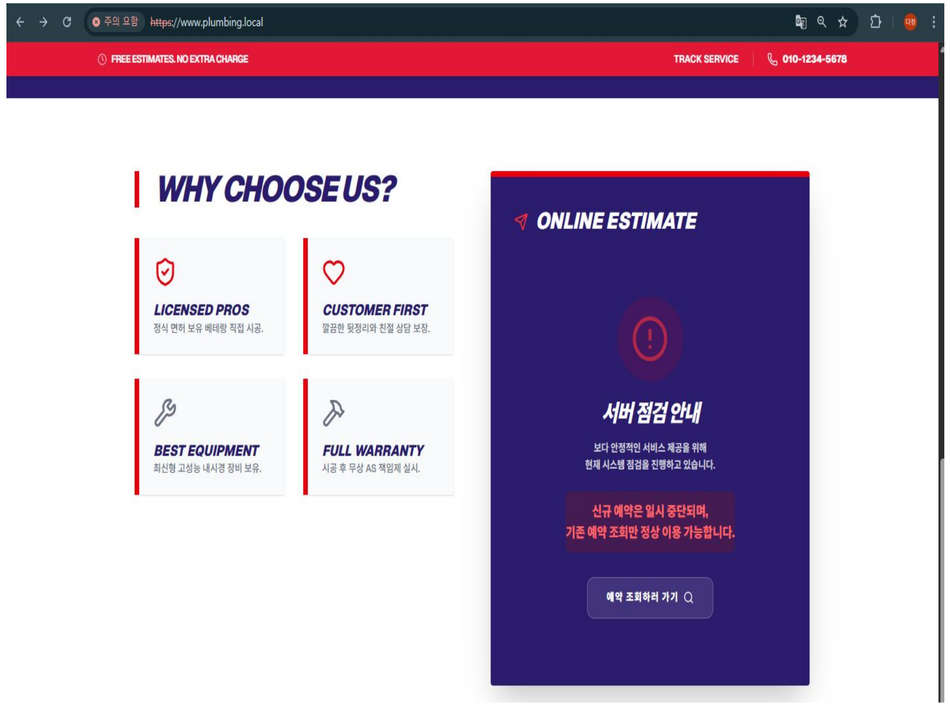


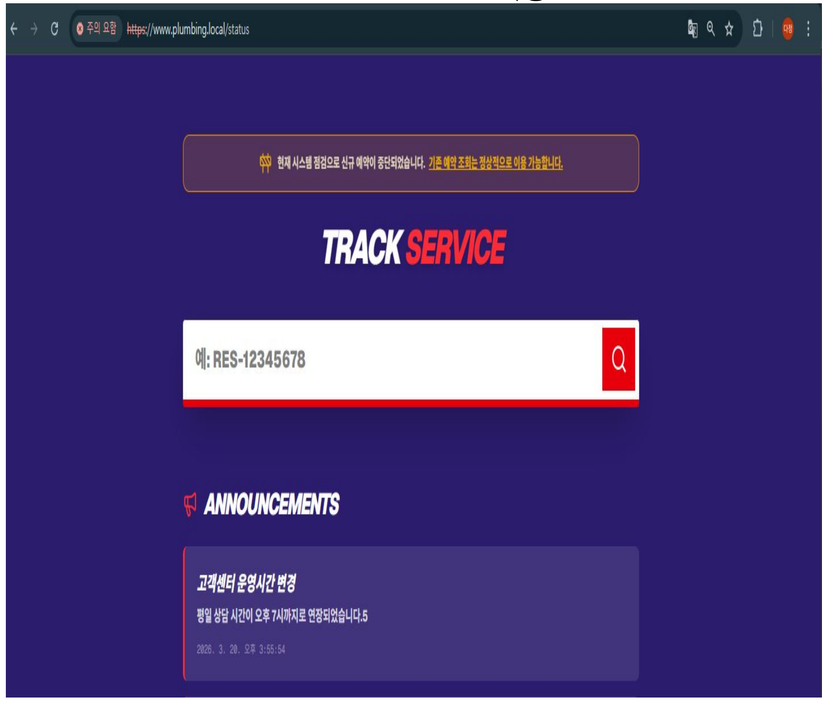


요구사항 1. 웹 백엔드, 프론트엔드 , DB 무중단 상태 유지

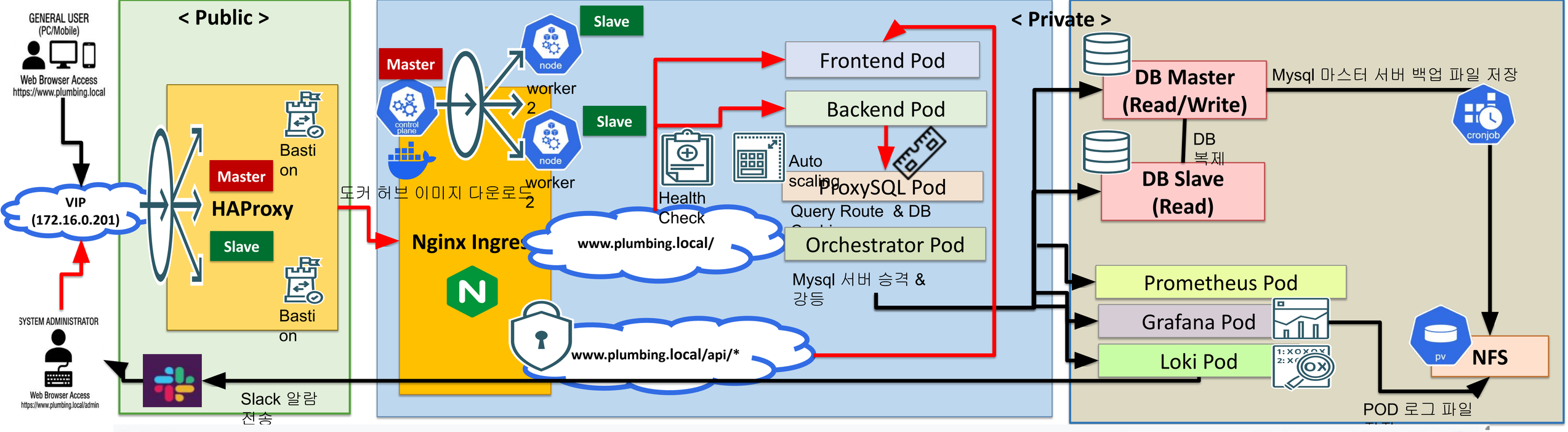


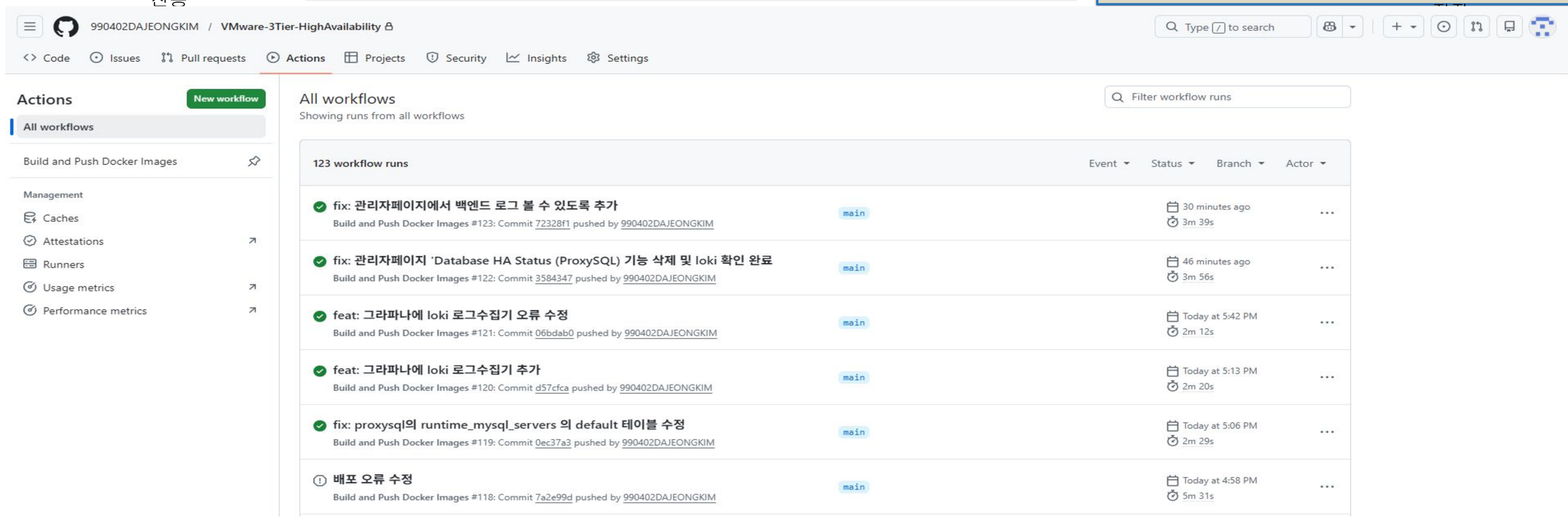




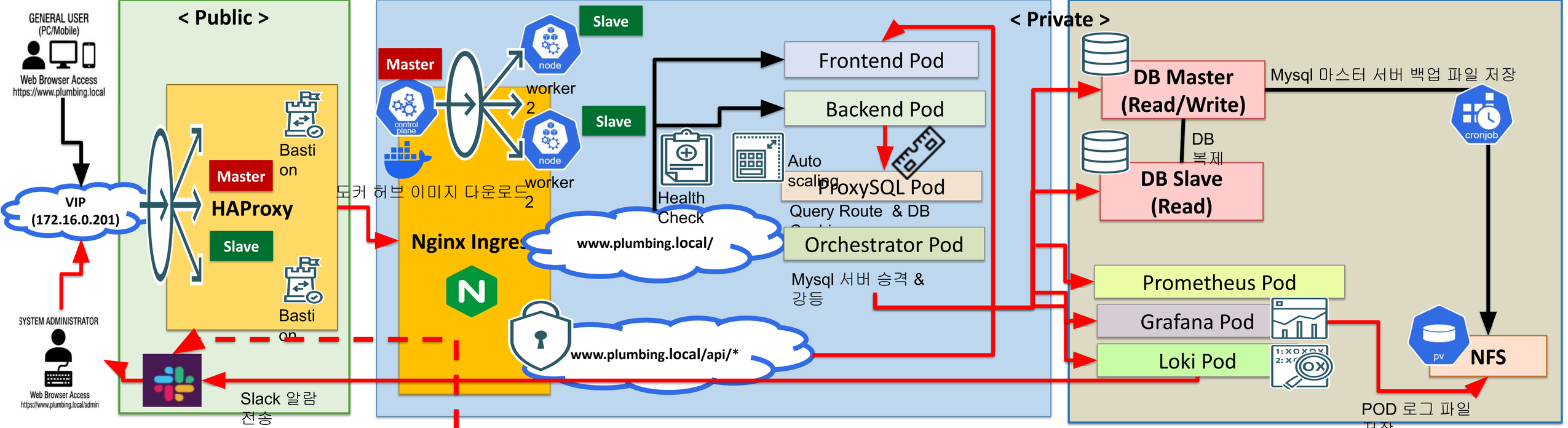


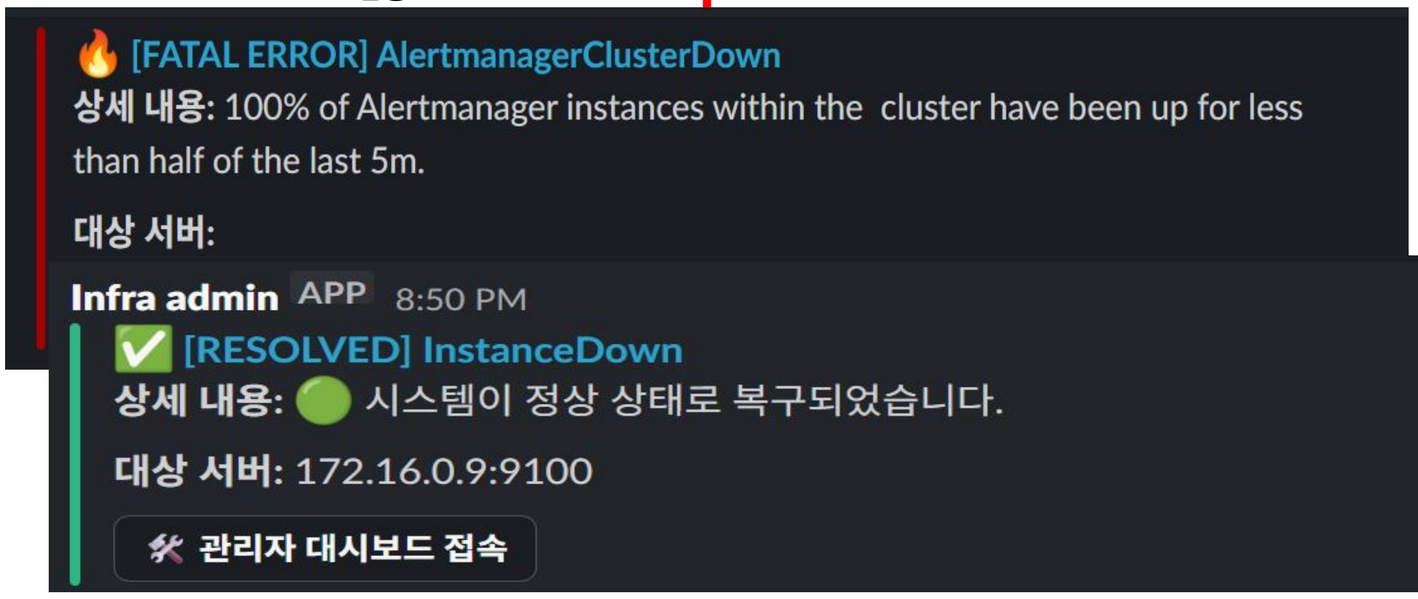
요구사항 2. 사이트 점검 시(DB 오류로 인한 긴급 중단 또는 정기 점검 시) 새로운 예약은 받지 못하도록, 예약 조회는 가능하도록

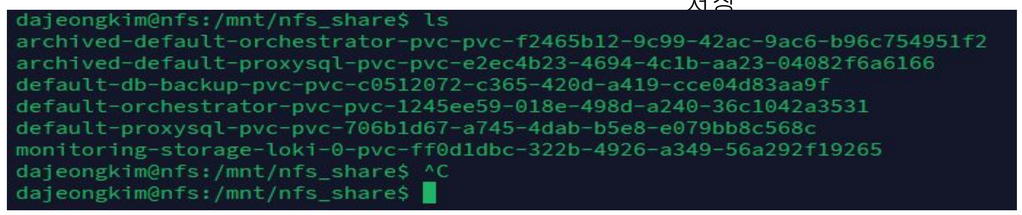


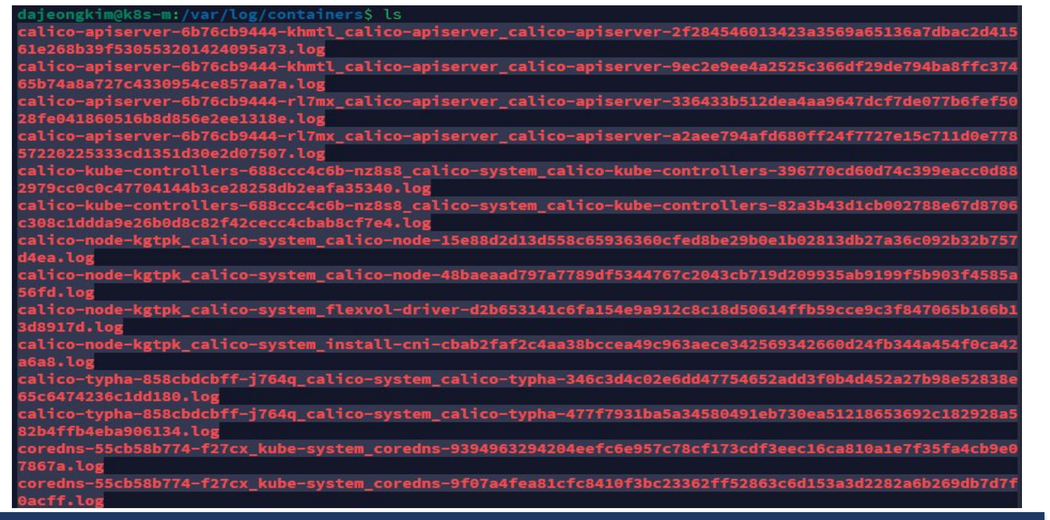


요구사항 3. 인프라 삭제될 시 최소한의 노력으로 CI/CD로 간편하게 재구축 가능하도록

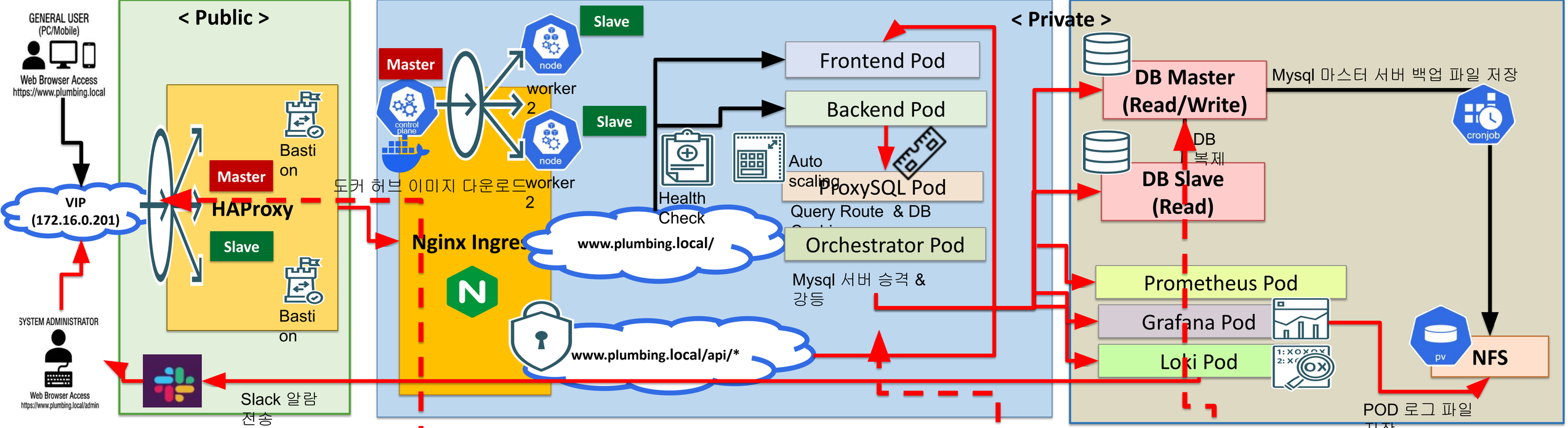








요구사항 4. 로그를 NFS에 저장하고 로그를 읽어 장애 내용을 실시간으로 알 수 있도록

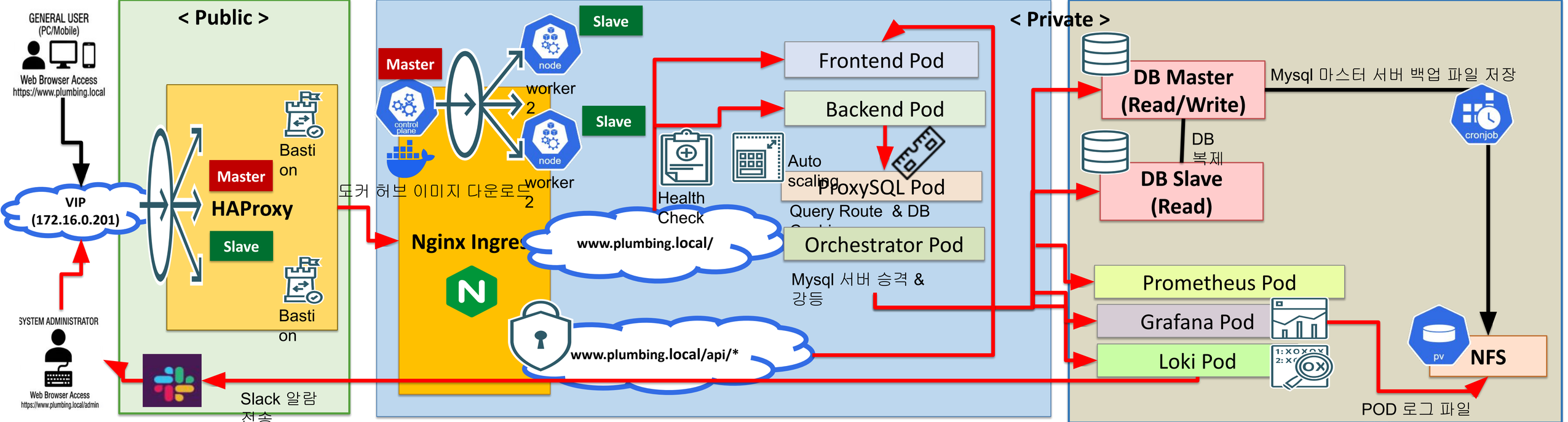


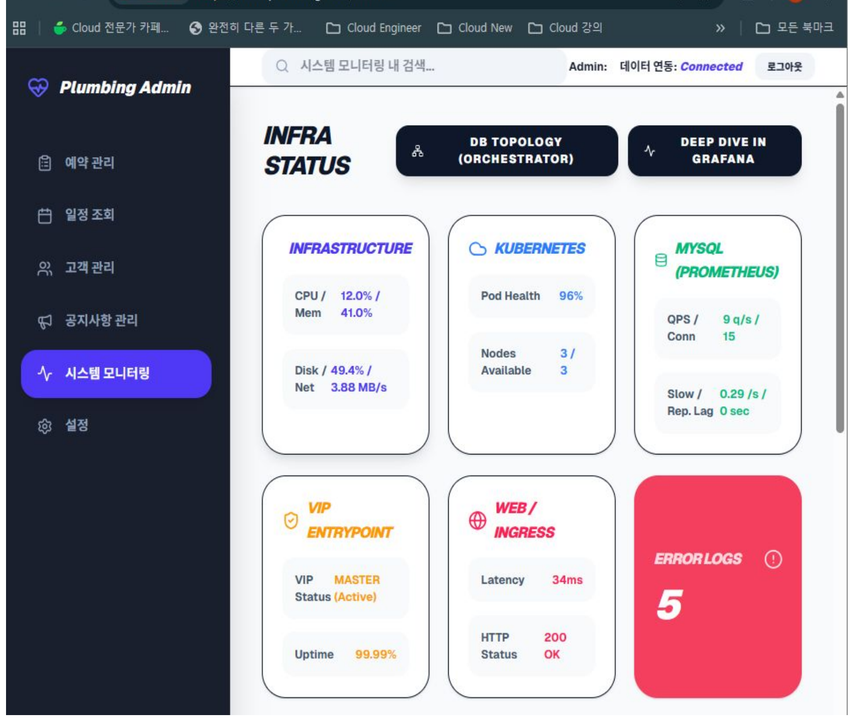

```
dajeongkim@bastion-backup:~$ systemctl status keepalived
● keepalived.service - Keepalive Daemon (LVS and VRRP)
     Loaded: loaded (/usr/lib/systemd/system/keepalived.service; enabled; preset: enabled)
     Active: active (running) since Mon 2026-03-23 20:49:47 KST; 5min ago
       Docs: man:keepalived(8)
             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
```

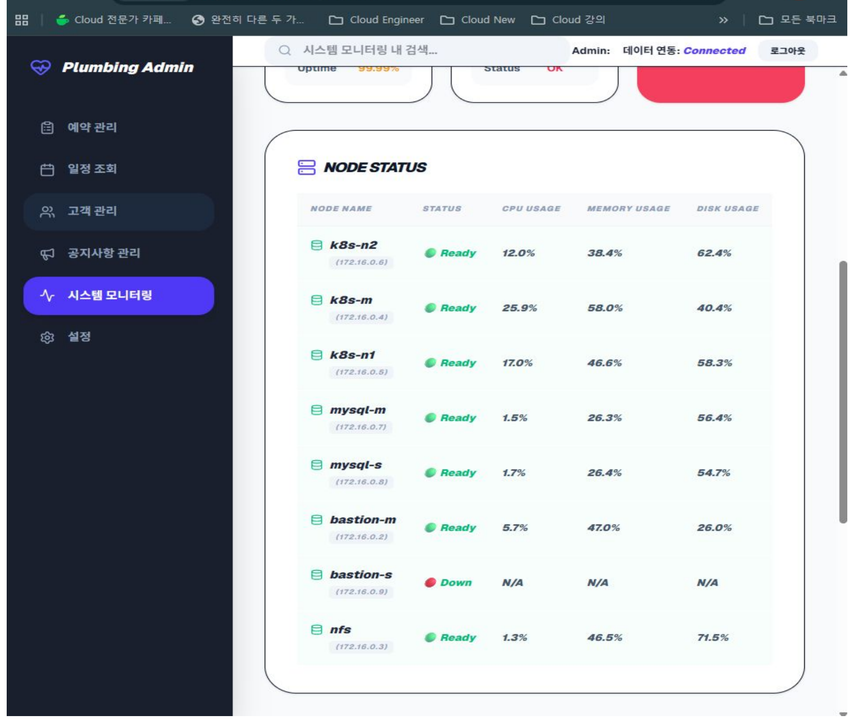
```
dajeongkim@k8s-m:~$ kubectl get pod -w
NAME                                      READY   STATUS    RESTARTS   AGE
plumbing-backend-745799f459-4cbzf         1/1     Running   0          21m
plumbing-backend-745799f459-s8gs9         1/1     Running   0          21m
plumbing-frontend-554b759d48-7nxgd        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
```

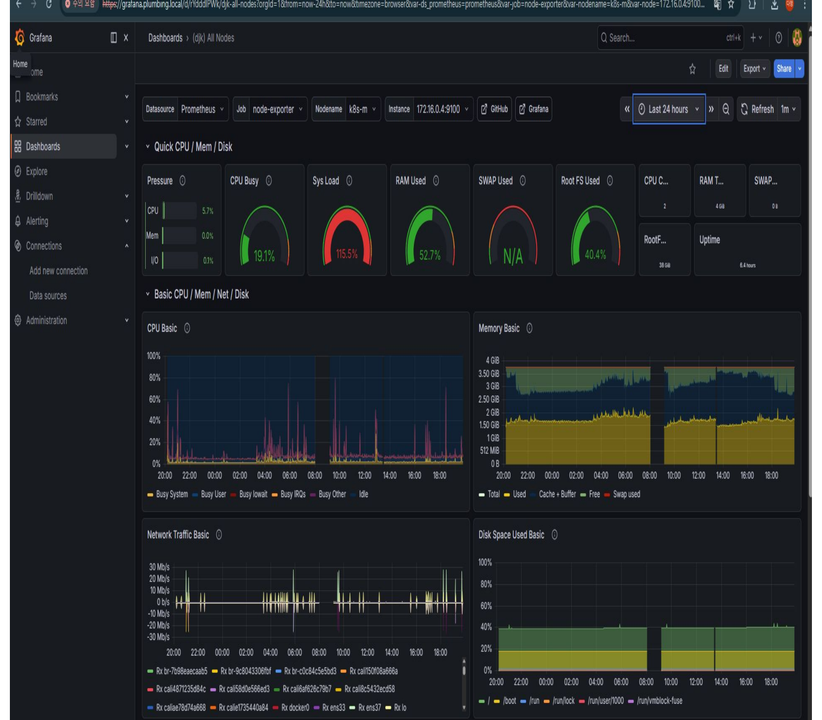
```
MySQL [(none)]> SELECT hostgroup_id, hostname, status FROM runtime_mysql_servers;
+--------------+-----------+--------+
| hostgroup_id | hostname  | status |
+--------------+-----------+--------+
| 10           | 172.16.0.7 | ONLINE |
| 20           | 172.16.0.7 | ONLINE |
| 20           | 172.16.0.8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

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

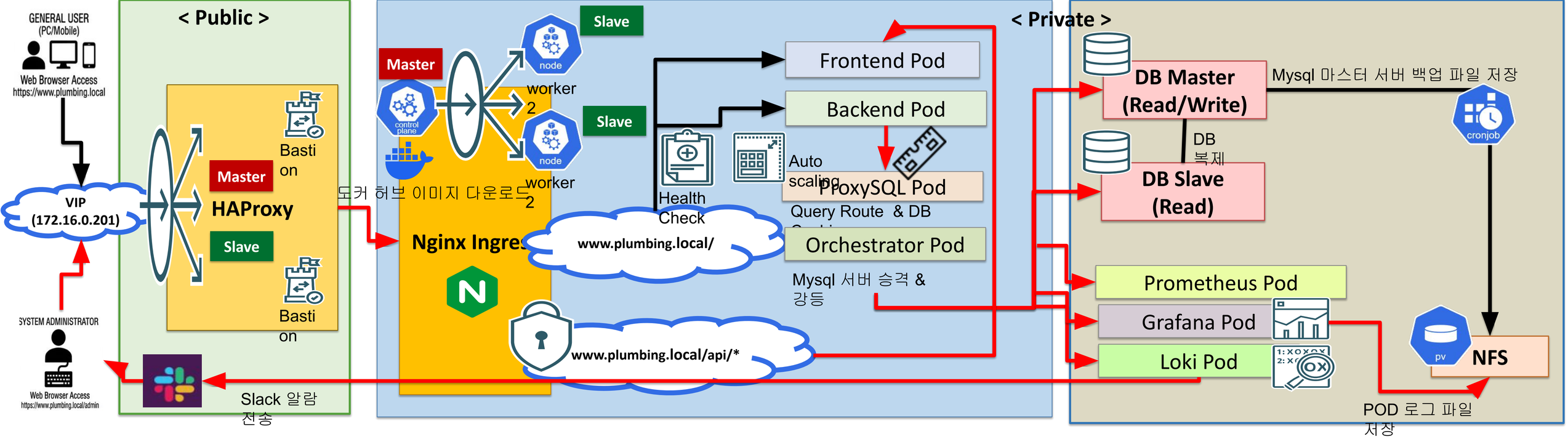


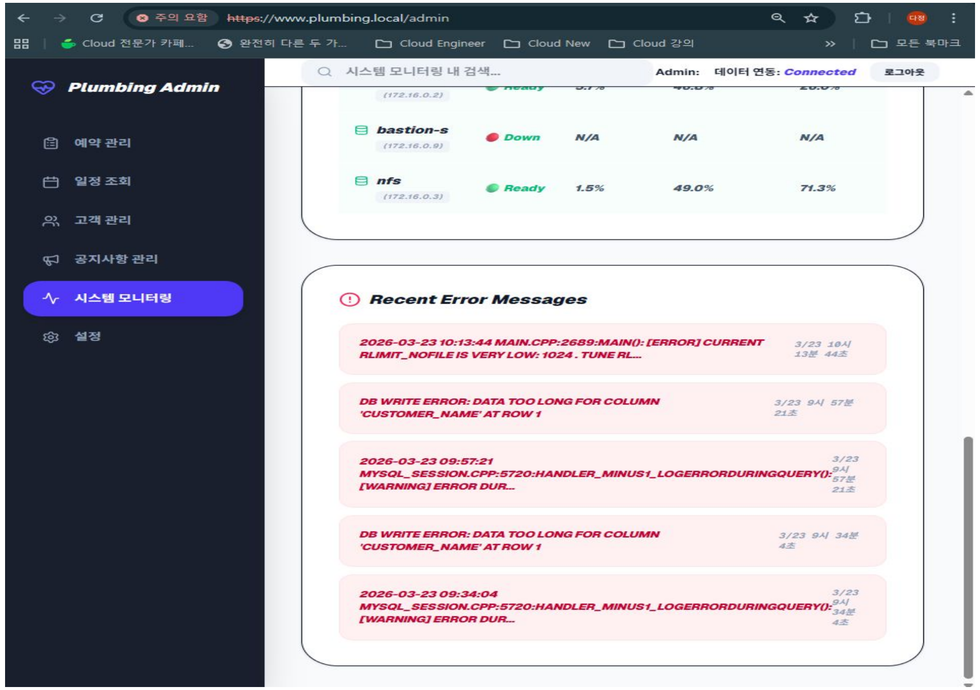


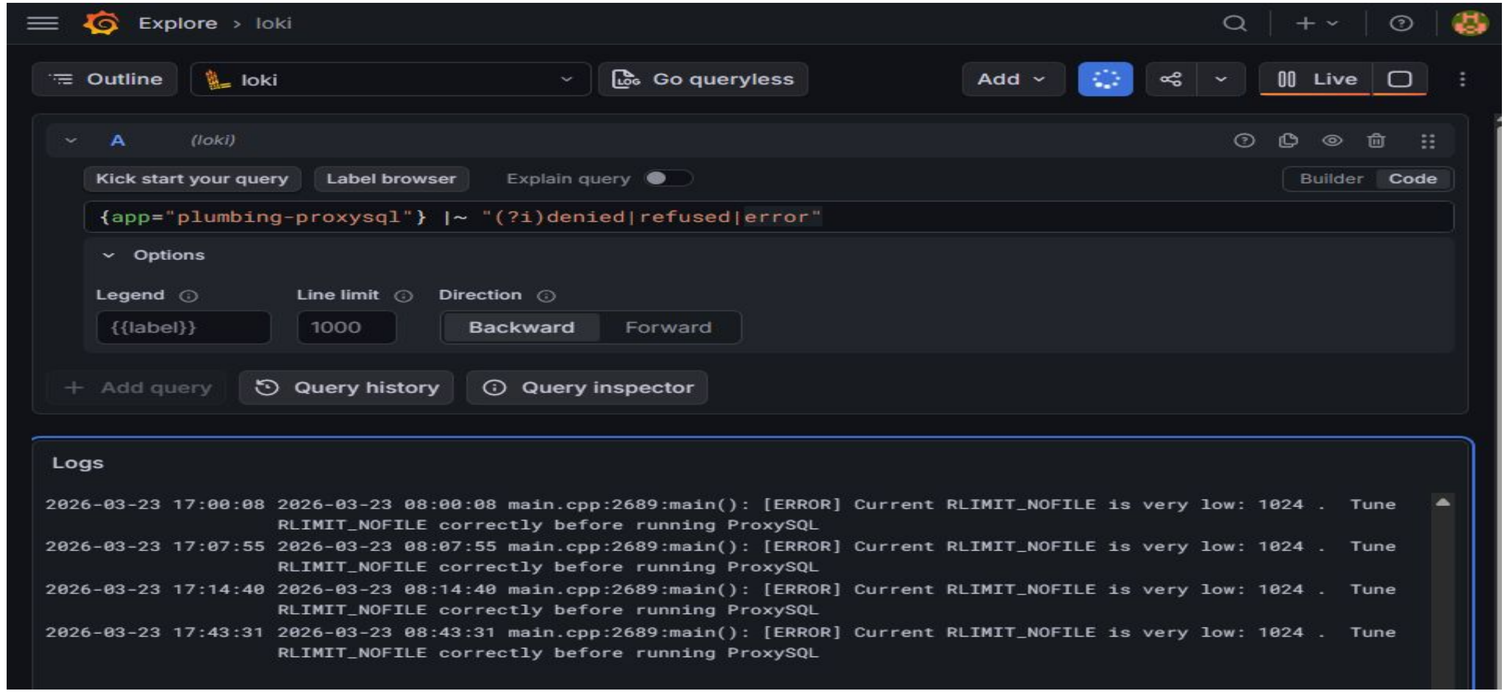




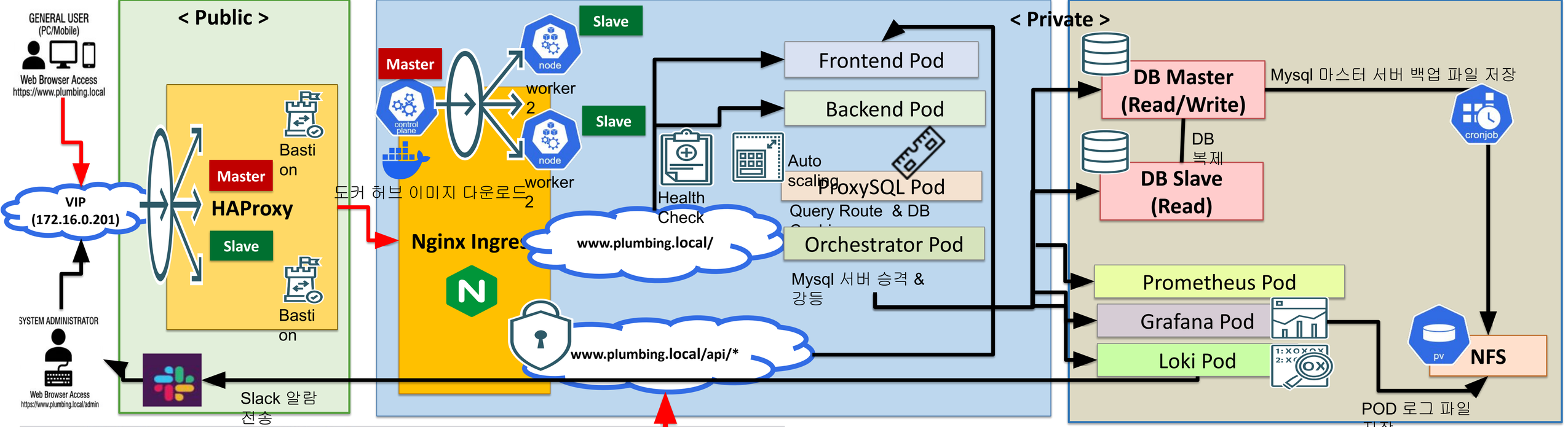
요구사항 6. 관리자 페이지에서 시스템을 한눈에 모니터링하고 그라파나 접속 페이지를 링크로 걸어 상세 내역도 확인 할 수 있도록



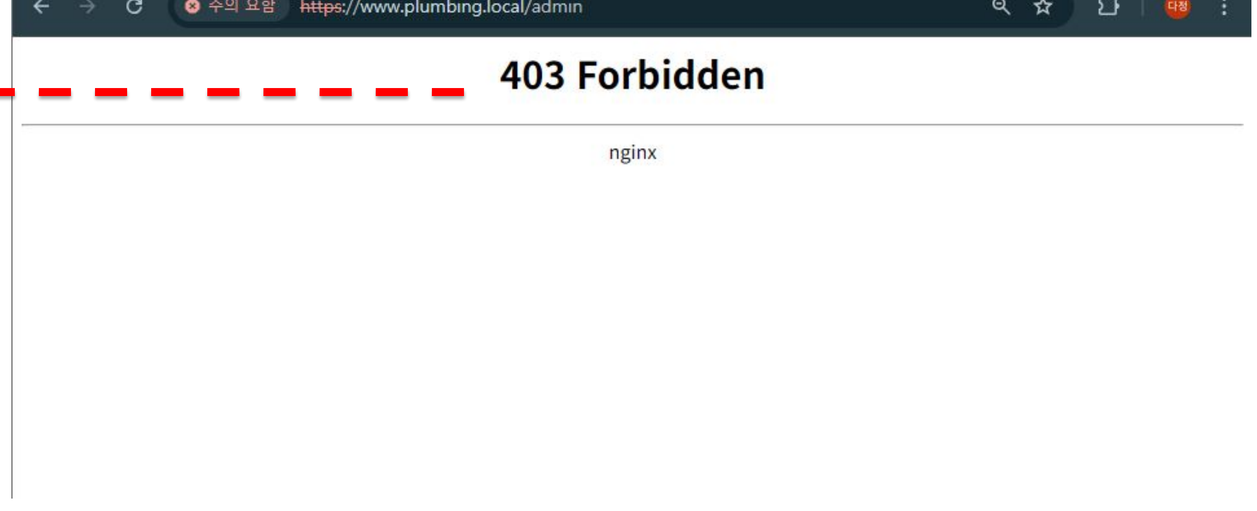




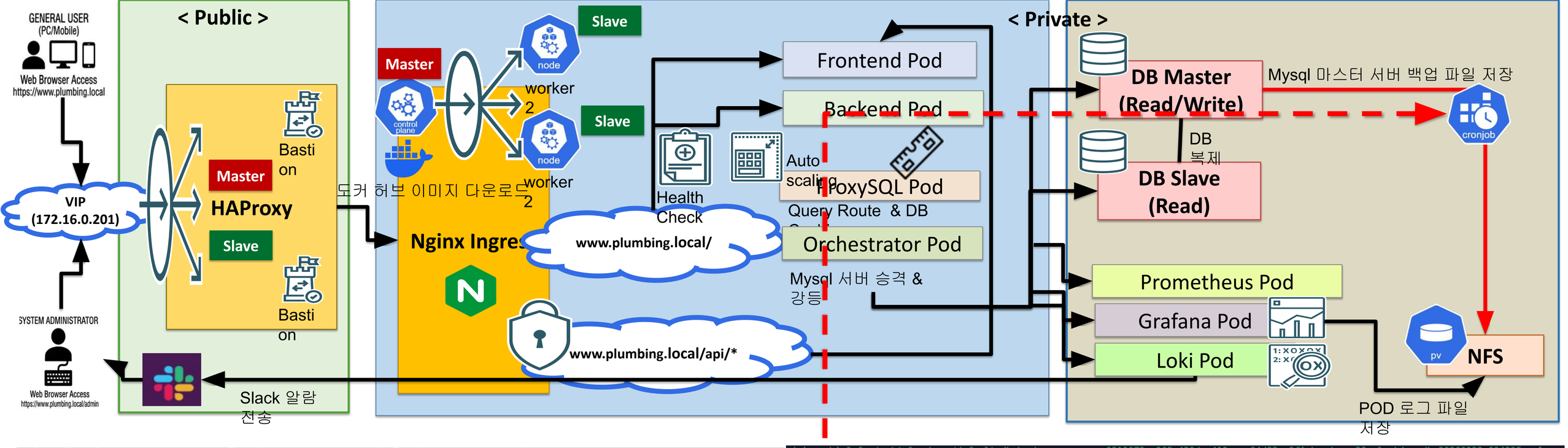
요구사항 7. 장애가 발생한 로그를 실시간으로 확인하고 싶음,




```yaml
# 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' */;
/*!40111 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 벡엔드 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.