Dynamic Network Traffic Monitoring and Scaling Using eBPF

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Problem Statement

Traditional monitoring lacks flexibility for microservices

Need for real-time traffic-based scaling

Complex network policy management

Solution

eBPF-based network monitoring

Multi-metric scaling (traffic, CPU, memory)

Policy-driven traffic control

Real-time visualization

Architecture

Components

1. **Core Infrastructure**
   - Kubernetes 1.31 cluster (kind)
   - Cilium 1.16.3 with eBPF
   - Hubble for flow visibility

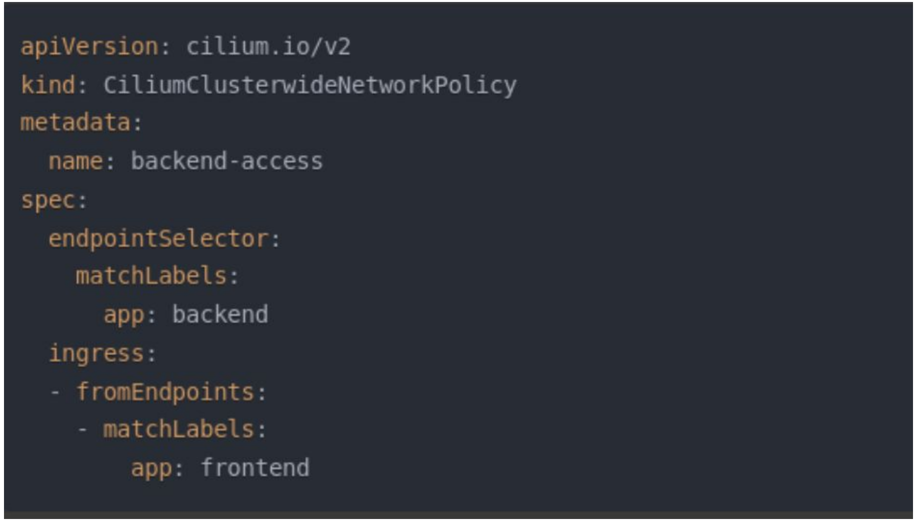
2. **Monitoring Stack**
   - Prometheus for metrics storage
   - Custom Prometheus Adapter
   - Hubble UI and Grafana for visualization

3. **Application Layer**
   - Frontend service
   - Backend service
   - Load testing suite

Implementation

1. Network Monitoring

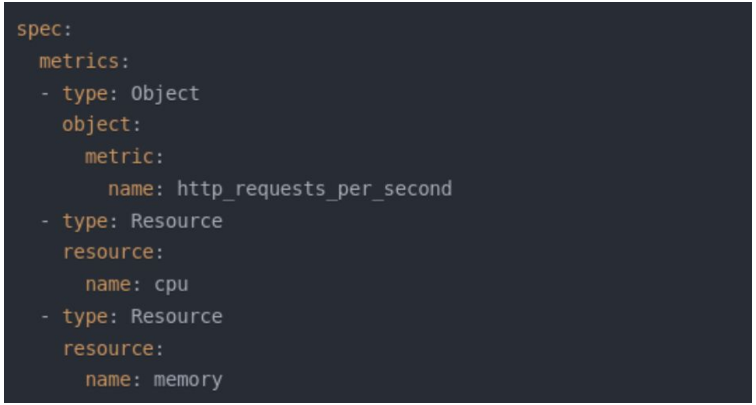
- Cilium eBPF programs for packet inspection
- Hubble flow monitoring



```yaml
apiVersion: cilium.io/v2
kind: CiliumClusterwideNetworkPolicy
metadata:
  name: backend-access
spec:
  endpointSelector:
    matchLabels:
      app: backend
  ingress:
  - fromEndpoints:
    - matchLabels:
        app: frontend
```

2. Dynamic Scaling

- Multiple HPA metrics combined:



```
spec:
  metrics:
  - type: Object
    object:
      metric:
        name: http_requests_per_second
  - type: Resource
    resource:
      name: cpu
  - type: Resource
    resource:
      name: memory
```

3. Load Testing Suite

- Traffic generation
- CPU stress testing
- Real-time monitoring
- Automated reporting

Features

Monitoring

- Network flows
- Resource utilization
- Policy enforcement

Scaling

- Traffic-based scaling
- Resource-based scaling
- Combined metric approach

Security and Control

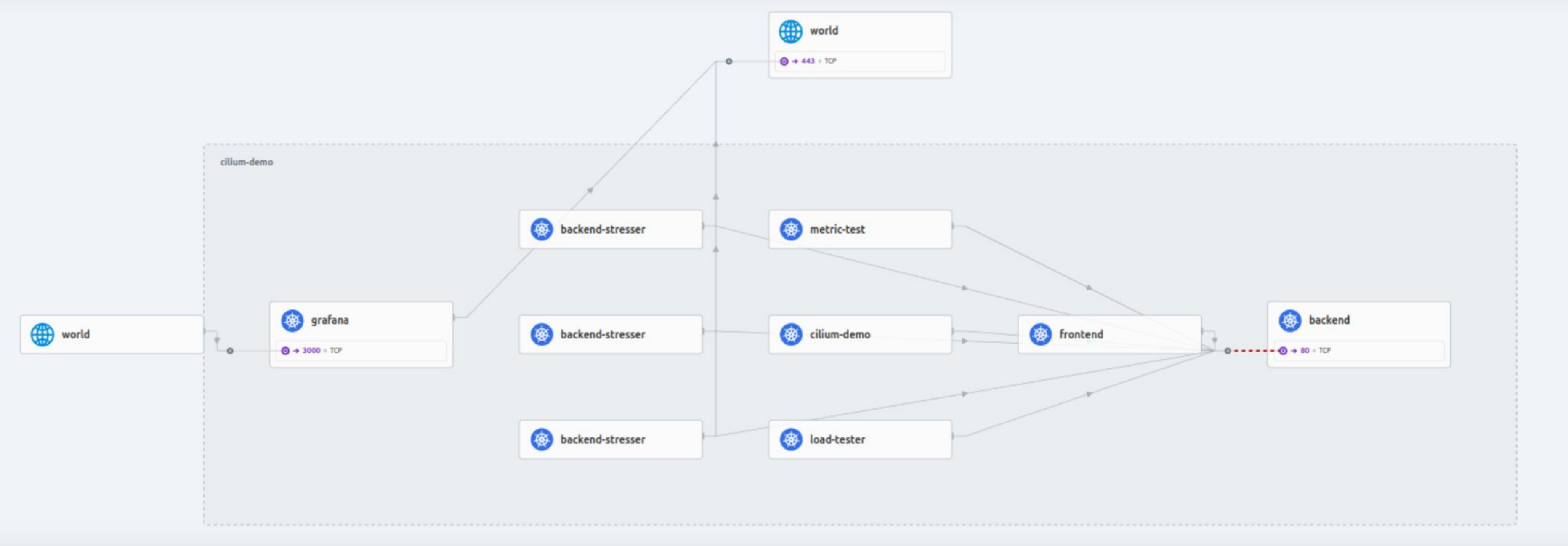
- L3/L4/L7 policies
- Rate limiting
- Flow visibility

Testing and Validation

- Automated load testing
- Multi-metric validation
- Comprehensive reporting

Results

- Hubble UI
- Traffic Monitoring Report



Future Enhancements

Advanced Analytics

- Machine learning for predictive scaling
- Pattern recognition
- Anomaly detection

Enhanced Policies

- Dynamic policy adjustment
- Context-aware rules
- Advanced rate limiting

Optimization

- Performance tuning
- Resource efficiency
- Scaling algorithms

Questions?

References

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