

```
# OPMIG-05: Dynamic Routing & Bucket Management

> **Series:** OPMIG | **Notebook:** 5 of 9 | **Created:** December 2025

> **OpenPipeline Migration Series** | Notebook 5 of 9
> **Level:** Intermediate
> **Estimated Time:** 60 minutes

---

## Learning Objectives

By completing this notebook, you will:

1. Master dynamic routing strategies for different migration scenarios
2. Design multi-tier bucket architectures for cost optimization
3. ★ **NEW:** Calculate ROI and TCO for bucket optimization strategies
4. ★ **NEW:** Implement 3-tier and 5-tier bucket governance models
5. ★ **NEW:** Apply compliance-driven retention strategies
6. Configure multi-pipeline processing patterns
7. Analyze bucket usage and identify optimization opportunities

---

---

## Understanding Dynamic Routing

Dynamic routing is the mechanism that directs incoming data to specific pipelines based on matching conditions.

### How Routing Works

! [Dynamic Routing Flow]
()
```

XR50jEiIC8+CiAgICAgIDxzG9wIG9mZnNldD0iMTAwJSIgc3R5bGU9InN0b3AtY29sb3I6I2Q5Nz  
cwNjtzdG9wLW9wYWNPdHk6MSIgLz4KICAgIDwvbGluZWFFyR3JhZGllbnQ+CiAgICA8bGluZWFFyR3J  
hZGllbnQgaWQ9InJvdXRlQ0dyYWQiIHgxPSIwJSIgeTE9IjAlIIiB4Mj0iMTAwJSIgeTI9IjEwMCUi  
PgogICAgICA8c3RvcCBvZmZzZXQ9IjAlIIiBzdHlsZT0ic3RvcC1jb2xvcjojZWM00Dk503N0b3Atb  
3BhY2l0eToxIiAvPgogICAgICA8c3RvcCBvZmZzZXQ9IjEwMCUiIHN0eWx1PSJzdG9wLWNVbG9y0i  
NkYjI3Nzc7c3RvcC1vcGFjaXR50jEiIC8+CiAgICA8L2xpbmVhckdyYWRpZw50PgogICAgPGxpmbmV  
hckdyYWRpZw50IGlkPSJKZWZhWx0R3JhZC1geDE9IjAlIIiB5M0iMCUiIHgyPSIxMDALIIiB5Mj0i  
MTAwJSI+CiAgICAgIDxzG9wIG9mZnNldD0iMCUiIHN0eWx1PSJzdG9wLWNVbG9y0iM2NDc00GI7c  
3RvcC1vcGFjaXR50jEiIC8+CiAgICAgIDxzG9wIG9mZnNldD0iMTAwJSIgc3R5bGU9InN0b3AtY2  
9sb3I6IzQ3NTU20TtzdG9wLW9wYWNPdHk6MSIgLz4KICAgIDwvbGluZWFFyR3JhZGllbnQ+CiAgICA  
8ZmlsdGVyIGlkPSJkclNoYWVdyI+CiAgICAgIDxmZURyb3BTaGFkb3cgZHg9IjEiIGR5PSIxIiBz  
dGREZxPXRpb249IjIiIGZsb29kLW9wYWNPdHk9IjAuMTUiLz4KICAgIDwvZmlsdGVyPgogICAgP  
G1hcmtlcBpZD0iZHJBcnJvdyIgbWFya2VvV21kdGg9IjEwIiBtYXJrZXJIZWlnaHQ9IjciIHJlZl  
g9IjkiIHJlZlk9IjMuNSIgb3JpZW50PSJhdXRvIj4KICAgICAgPHBvbHlnb24gcG9pbnRzPSIxIDA  
sIDEwIDMuNSwgMCA3IiBmaWxsPSIjNjQ3NDhiIi8+CiAgICA8L21hcmtlcj4KICAgIDxtYXJrZXig  
aWQ9ImdyZWVuQXJyb3ciIG1hcmtlcldpZHRoPSIxMCiwbWFya2VvSGVpZ2h0PSI3IiByZWZyPSI5I  
iByZWZyPSIxLjUiIG9yaWVud0iYXV0byI+CiAgICAgIDxbw2x5Z29uIHBvaW50cz0iMCAwLCAxMC  
AzLjUsIDAgnYIgZmlsbD0iIzE2YTm0YSIVPgogICAgPC9tYXJrZXI+CiAgPC9kZWZzPgoKICA8IS0  
tIEjhY2tncm91bmQgLS0+CiAgPHJlY3Qgd21kdGg9IjgwMCiGaGVpZ2h0PSIxNDAiIGZpbGw9IjNm  
0GY5ZmEiIHJ4PSIxMCiVpgokICA8IS0tIFRpdx1C0tPgogIDx0Zxh0IHg9IjQwMCiGeT0iMjgiI  
GZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxOCiGZm9udC13ZWlnah  
Q9ImJvbGQiIGZpbGw9IiMzMzMiIHRleHQtYW5jaG9yPSJtaWRkbGUipkR5bmFtaWmgUm91dGluZyB  
GbG93PC90ZXh0PgogIDx0Zxh0IHg9IjQwMCiGeT0iNDgiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fu  
cy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZmlsbD0iIzY2NiIgdGV4dC1hbmnob3I9Im1pZGRsZSI+U  
mVjb3JkcyBjYW4gbWF0Y2ggbXVsdGlwbGUgcm91dGVzIchtYXggNSBwaXBlbGluZXmpC90ZXh0Pg  
oKICA8IS0tIEluY29taW5nIERhdGEgLS0+CiAgPHJlY3QgeD0iMzAiiHk9IjgwIiB3aWR0aD0iMTA  
wIiBoZWlnaHQ9IjUwIiByeD0i0CIgZmlsbD0idXjsKCNkYXRhR3JhZCkiIGZpbHRlcj0idXjsKCNk  
clNoYWVdykiLz4KICA8dGV4dCB4PSI4MCiGeT0iMTEwIiBmb250LWZhbWlseT0iQXJpYlwsiHNhb  
nMtc2VyaWYiIGZvbnQtc2l6ZT0iMTEiIGZvbnQtd2VpZ2h0PSJib2xkIiBmaWxsPSJ3aG10ZSIgdG  
V4dC1hbmnob3I9Im1pZGRsZSI+SW5jb21pbmc8L3RleHQ+CiAgPHRleHQgeD0iODAiIHk9IjEyNCI  
gZm9udC1mYW1pbhk9IkFyaWFsLCBzYW5zLXNlcmIiBmb250LXNpemU9IjEwIiBmaWxsPSJyZ2Jh  
KDI1NSwyNTUsMjU1LDAu0SkIiIHRleHQtYW5jaG9yPSJtaWRkbGUipLJlY29yZDwvdGV4d4KCiAgP  
CEtLSBBCnJvdyB0byBldmFsdWF0aW9uIC0tPgogIDxwYXRoIGQ9Ik0xMzAsMTA1IEwxNjAsMTA1Ii  
BzdHJva2U9IiM2NDc00GiIiIHN0cm9rZS13aWR0aD0iMiIgZmlsbD0ibm9uZSIgbWFya2VvLWVuZD0  
idXjsKCNkckFycm93KSIvpgokICA8IS0tIFJvdXRlIEV2Yw1YXRpb24gQm94IC0tPgogIDxyZWN0  
IHg9IjE3MCiGeT0iNjAiIHdpZHRoPSI0MDAiIGHlaWdodD0iMjIwIiByeD0i0CIgZmlsbD0iI2ZmZ  
iIgc3Ryb2tlPSIjZTJlOGYwIiBzdHJva2Utd21kdGg9IjIiLz4KICA8dGV4dCB4PSIxNzAiIHk9Ij  
g1IiBmb250LWZhbWlseT0iQXJpYlwsiHNhbnnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTIiIGZvbnQtd2V  
pZ2h0PSJib2xkIiBmaWxsPSIjMzMzIiB0Zxh0LWFuY2hvcj0ibWlkZGxlIj5ST1VURSBFkFMVUFU  
SU90PC90ZXh0PgogICAg8IS0tIFJvdXRlIDEgLS0+CiAgPHJlY3QgeD0iMTkwIiB5PSIxMDAiIHdpZ  
HRoPSIxNjAiIGHlaWdodD0iMzUiIHJ4PSI2IiBmaWxsPSIjZDFmYWU1IiBzdHJva2U9IiMyMmM1NW  
UiIHN0cm9rZS13aWR0aD0iMSIvPgogIDx0Zxh0IHg9IjI3MCiGeT0iMTE1IiBmb250LWZhbWlseT0  
iQXJpYlwsiHNhbnnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZvbnQtd2VpZ2h0PSJib2xkIiBmaWxs  
PSIjMDQ30DU3IiB0Zxh0LWFuY2hvcj0ibWlkZGxlIj5Sb3V0ZSAx0iBrOHMubmFtZXNwYWNLPC90Z  
Xh0PgogIDx0Zxh0IHg9IjI3MCiGeT0iMTI4IiBmb250LWZhbWlseT0iQXJpYlwsiHNhbnnMtc2VyaW  
YiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiMwNDc4NTciIHRleHQtYW5jaG9yPSJtaWRkbGUipj09ICJ  
wcm9kdWN0aW9uIjwvdGV4d4KCiAgPHRleHQgeD0iMzY1IiB5PSIxMjAiIGZvbnQtZmFtaWx5PSJB  
cmlhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZmlsbD0iIzE2YTm0YSI+WWVzIOKGkjwvd

GV4dD4KCiAgPHJlY3QgeD0iNDAwIiB5PSIxMDAiIHdpZHRoPSIxNTAiIGHlaWdodD0iMzUiIHJ4PSI2IiBmaWxsPSJ1cmwoI3JvdXRlQUdyYWQpIiBmaWx0ZXI9InVybCgjZHJTaGFkb3cpIi8+CiAgPHRleHQgeD0iNDc1IiB5PSIxMjIiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCigZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IndoaXRlIiB0ZXh0LWFuY2hvcj0ibWlkZGxlIj5wcm9kLw xvZ3MgcG1wZwpbmU8L3RleHQ+CgogIDwhLS0gUm91dGUgMiAtLT4KICA8cmVjdCB4PSIxOTAiIHk9IjE0NSIgd2lkdGg9IjE2MCigaGVpZ2h0PSIzNSIgcn9IjYiIGZpbGw9IiNmZWyZyZciIHn0cm9rZT0iI2Y10WUwYiIgc3Ryb2t1LXd pZHRoPSIxIi8+CiAgPHRleHQgeD0iMjcwIiB5PSIxNjAiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCigZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IiM5MjQwMGuIHRleHQtYw5jaG9yPSJtaWRkbGUiPlJvdXRlID16IGxvZy5zb3VY2U8L3RleHQ+CiAgPHRleHQgeD0iMjcwIiB5PSIxNzMiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCigZmlsbD0iIzkyNDAwZSIgdGV4dC1hbmNo b3I9Im1pZGRsZSI+PT0gIm5naW54IjwvdGV4dD4KCiAgPHRleHQgeD0iMzY1IiB5PSIxNjUiIGZvb nQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZmlsbD0iI2Q5NzcwNi I+WVzIOKGkjwvdGV4dD4KCiAgPHJlY3QgeD0iNDAwIiB5PSIxNDUiIHdpZHRoPSIxNTAiIGHlaWd odD0iMzUiIHJ4PSI2IiBmaWxsPSJ1cmwoI3JvdXRlQkdYwQpIiBmaWx0ZXI9InVybCgjZHJTaGFkb3cpIi8+CiAgPHRleHQgeD0iNDc1IiB5PSIxNjciIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZ XJpZiIgZm9udC1zaXplPSIxMCigZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IndoaXRlIiB0ZXh0LWFuY2hvcj0ibWlkZGxlIj5uZ2lueC1s b2dzIH BpcGVsaW51PC90ZXh0PgoKICA8IS0tIFJvdXRlIDM gLS0+CiAgPHJlY3QgeD0iMTkwIiB5PSIxOTAiIHdpZHRoPSIxNjAiIGHlaWdodD0iMzUiIHJ4PSI2IiBmaWxsPSIjZmNLN2YzIiBzdHJva2U9IiNlYzQ40TkIiHN0cm9rZS13aWR0aD0iMSIvPgogIDx0ZXh0IHg9IjI3MCi geT0iMjA1IiBmb250LWZhbWlseT0iQXjpYw wsIH NhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZvbnQtd2VpZ2h0PSJib2xkIiBmaWxsPSIjOWQxNzRkIiB0ZXh0LWFuY2hvcj0ibW lkZGxlIj5Sb3V0SAz0iBjb250YWluczwvdGV4dD4KICA8dGV4dCB4PSIyNzAiIHk9IjIx0CIgZm9udC1mYW1pbHk9I kFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjOWQxNzRkIiB0ZXh0LWFuY2hvcj0ibW lkZGxlIj4oY29udGVudCwgInBheW1lb nQkIT wvdGV4dD4KCiAgPHRleH QgeD0iMzY1IiB5PSIyMTAiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZmlsbD0iI2RiMjc3NyI+WVzIOKGkjwvdGV4dD4KCiAgPHJlY3QgeD0iNDAwIiB5PSIxOTAiIHdpZHRoPSIxNTAiIGHlaWdodD0iMzUiIHJ4PSI2IiBmaWxsPSJ1cmwoI3JvdXRlQ0dyYWQpIiBmaWx0ZXI9InVybCgjZHJTaGFkb3cpIi8+CiAgPHRleHQgeD0iNDc1IiB5PSIyMTIiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCigZm9udC13ZWlnaHQ9ImJvbGQ iIGZpbGw9IndoaXRlIiB0ZXh0LWFuY2hvcj0ibW lkZGxlIj5wYXltZw50LWxvZ3MgcG1wZwpbmU8L3RleHQ+CgogIDwhLS0gRGVmYXVsdCATLT4KICA8cmVjdCB4PSIxOTAiIHk9IjIzNSIgd2lkdGg9IjE2MCigaGVpZ2h0PSIzMCi gcn9IjYiIGZpbGw9IiNmWY1ZjkIiHN0cm9rZT0iIzY0NzQ4YiIgc3Ryb2t1LXd pZHRoPSIxIi8+CiAgPHRleHQgeD0iMjcwIiB5PSIyNTUiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCigZmlsbD0iIzQ3NTU20SIgdGV4dC1hbmNob3I9Im1pZGRsZSI+KG5vIG1hdGNoKT wvdGV4dD4KCiAgPHRleHQgeD0iMzY1IiB5PSIyNTIiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZmlsbD0iIzY0NzQ4YiI+4oaSPC90ZXh0PgoKICA8cmVjdCB4PSI0MDAiIHk9IjIzNSIgd2lkdGg9IjE1MCi gaGVpZ2h0PSIzMCi gcn9IjYiIGZpbGw9InVybCgjZGVmYXVsdEdyYWQpIiBmaWx0ZXI9InVybCgjZHJTaGFkb3cpIi8+CiAgPHRleHQgeD0iNDc1IiB5PSIyNTUiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCigZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IndoaXRlIiB0ZXh0LWFuY2hvcj0ibW lkZGxlIj5kZWZhdWx0IH BpcGVsaW51PC90ZXh0PgoKICA8IS0tIEt leSBq b2ludHmgLS0+CiAgPHJlY3QgeD0iNTkwIiB5PSI4MCi gd2lkdGg9IjE4MCi gaGVpZ2h0PSIyMDAiIHJ4PSI4IiBmaWxsPSIjZmZmIiBzdHJva2U9IiNlMmU4ZjAiIHn0cm9rZS13aWR0aD0iMiIvPgogIDx0ZXh0IHg9IjY4MCi geT0iMTA1IiBmb250LWZhbWlseT0iQXjpYw wsIH NhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTEiIGZvbnQtd2VpZ2h0PSJib2xkIiBmaWxsPSIjMzMzIiB0ZXh0LWFuY2hvcj0ibW lkZGxlIj5LZXkgQ29uY2VwdHM8L3RleHQ+CgogIDx0ZXh0IHg9IjYxMCi geT0iMTMwIiBmb250LWZhbWlseT0iQXjpYw wsIH NhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiMzMzMiPuKAoiBPcmRlcibtYXR0ZXJzP

```
C90ZXh0PgogIDx0ZXh0IHg9IjYxMCIGeT0iMTQ4IiBmb250LWZhbWlseT0iQXJpYWwsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiMzMzMiPuKAoiBNdWx0aS1tYXRjaCBhbGxvd2VkPC90ZXh0PgogIDx0ZXh0IHg9IjYxMCIGeT0iMTY2IiBmb250LWZhbWlseT0iQXJpYWwsIHNhbnMtc2VyawYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiMzMzMiPuKAoiBNYXggNSBwaXBlbGluZXM8L3RleHQ+CiAgPHRleHQgeD0iNjEwIiB5PSIx0DQiIGZvbnQtZmFtaWx5PSJBcmIhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCIGzmlsbD0iIzMyI+4oCiIERlZmF1bHQgY2F0Y2hlcyByZXN0PC90ZXh0PgoKICA8cmVjdCB4PSI2MTAiIHk9IjIwMCIGd2lkdGg9IjE0MCIGaGVpZ2h0PSI2MCIGcng9IjQiIGzbGw9IiNLMGYyZmUiLz4KICA8dGV4dCB4PSI20DAiIHk9IjIyMCIGzmnudC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmb250LXdlaWdodD0iYm9sZCIGzmlsbD0iIzAzNj1hMSIGdGV4dC1hbmnob3I9Im1pZGRsZSI+UHJvIFRpCdwdGV4dD4KICA8dGV4dCB4PSI20DAiIHk9IjIz0CIGzmnudC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIxMDM20WEixIiB0ZXh0LWFuY2hvcj0ibWlkZGxlIj5qbGFjZSBzcGVjaWZpYByb3V0ZXM8L3RleHQ+CiAgPHRleHQgeD0iNjgwIiB5PSIxNTAiIGZvbnQtZmFtaWx5PSJBcmIhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCIGzmlsbD0iIzAzNj1hMSIGdGV4dC1hbmnob3I9Im1pZGRsZSI+YmVmb3JlIGdlbmVyYWwgb25lczwvdGV4dD4KCIgPCEtLSBSZXN1bHQgTm90ZSATLT4KICA8cmVjdCB4PSIxMCIGeT0iMjk1IiB3aWR0aD0iNzQwIiBoZWlnaHQ9IjMwIiByeD0iNCIGzmlsbD0iI2zlzjNjNyIvPgogIDx0ZXh0IHg9IjQwMCIGeT0iMzE1IiBmb250LWZhbWlseT0iQXJpYWwsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiM5MjQwMGUiIHRleHQtYW5jaG9yPSJtaWRkbGUipk5vdGU6IEEgcmVjb3JkIGlzIHN0b3JlZCBPTkNFIGluIHRoZSBmaXJzdCBtYXRjaGluZyBwaXBlbGluZsdzIGJ1Y2tldCwgZXZlbiBpZiBwcm9jZXNzZWQgYnkgbXVsdlwbgUgcGlwZwpbmVzPC90ZXh0Pgo8L3N2zz4K)
```

### ### Key Routing Concepts

| Concept                | Description  |
|------------------------|--|
| **Matching Condition** | DQL expression that evaluates to true/false            |
| **Route Priority**     | Routes are evaluated in order (top to bottom)          |
| **Multi-match**        | One record can match multiple routes (max 5 pipelines) |
| **Default Pipeline**   | Catches all records not matching any route             |
| **Exclusive Routing**  | Use specific conditions to prevent multi-match         |

---

### ## Routing Strategies

#### ### Strategy 1: Source-Based Routing

Route based on data source or ingestion method:

| Condition                              | Target Pipeline | Use Case         |
|--|-----------------|------------------|
| `log.source == "nginx" `               | nginx-logs      | Web server logs  |
| `log.source == "application" `         | app-logs        | Application logs |
| `dt.openpipeline.source == "otlp" `    | otel-logs       | OpenTelemetry    |
| `dt.openpipeline.source == "generic" ` | api-logs        | API ingestion    |

```
### Strategy 2: Environment-Based Routing
```

Route based on environment or namespace:

| Condition                             | Target Pipeline | Bucket             |
|---------------------------------------|-----------------|--------------------|
| `k8s.namespace.name == "production"`  | prod-logs       | default_logs (35d) |
| `k8s.namespace.name == "staging"`     | staging-logs    | dev_logs (7d)      |
| `k8s.namespace.name == "development"` | dev-logs        | dev_logs (7d)      |

```
### Strategy 3: Content-Based Routing
```

Route based on log content patterns:

| Condition                       | Target Pipeline | Purpose         |
|---------------------------------|-----------------|-----------------|
| `contains(content, "payment")`  | payment-logs    | Financial logs  |
| `contains(content, "security")` | security-logs   | Security events |
| `contains(content, "audit")`    | audit-logs      | Compliance logs |

```
### Strategy 4: Severity-Based Routing
```

Route based on log level for tiered retention:

| Condition             | Target Pipeline | Bucket               |
|-----------------------|-----------------|----------------------|
| `loglevel == "ERROR"` | error-logs      | error_logs (90d)     |
| `loglevel == "WARN"`  | warning-logs    | default_logs (35d)   |
| `loglevel == "DEBUG"` | debug-logs      | short_retention (3d) |

```
### Strategy 5: Hybrid Routing
```

Combine multiple criteria for precise routing:

```

```
k8s.namespace.name == "production" AND log.source == "payment-service"
```

```

---

```
## Grail Buckets Explained
```

Grail buckets are storage containers with configurable retention and access policies.

```
### Default Buckets
```

| Bucket              | Data Type       | Default Retention |
|---------------------|-----------------|-------------------|
| `default_logs`      | Log records     | 35 days           |
| `default_spans`     | Span/trace data | 35 days           |
| `default_bizevents` | Business events | 35 days           |
| `default_events`    | Platform events | 35 days           |

### ### Custom Bucket Use Cases

| Use Case              | Bucket Strategy  | Retention |
|-----------------------|------------------|-----------|
| **Compliance/Audit**  | `audit_logs`     | 365+ days |
| **Financial Data**    | `financial_logs` | 90 days   |
| **Security Events**   | `security_logs`  | 180 days  |
| **Development Logs**  | `dev_logs`       | 7 days    |
| **Debug/Trace**       | `debug_logs`     | 3 days    |
| **High-Volume Noise** | `ephemeral_logs` | 1 day     |

### ### Bucket Benefits

- \*\*Cost Optimization\*\*: Shorter retention = lower storage costs
- \*\*Compliance\*\*: Longer retention for audit requirements
- \*\*Performance\*\*: Smaller buckets = faster queries
- \*\*Access Control\*\*: Bucket-level permissions
- \*\*Data Isolation\*\*: Separate buckets for different teams/purposes

---

## ## Bucket Routing Configuration

### ### Configuring Bucket Routing in Pipeline

Each pipeline can route data to a specific bucket:

- Open your pipeline in OpenPipeline settings
- Go to \*\*Storage\*\* tab
- Select target bucket from dropdown
- Save pipeline

### ### Bucket Routing Rules

| Rule                | Behavior                                      |
|---------------------|---|
| **Pipeline bucket** | Records go to pipeline's configured bucket    |
| **No bucket set**   | Records go to default bucket for data type    |
| **Multi-pipeline**  | Record stored once in first pipeline's bucket |

> **⚠ Important:** A record is stored only ONCE, even if processed by

multiple pipelines. It goes to the bucket of the FIRST matching pipeline.

### ### Creating Custom Buckets

Custom buckets are created via Grail settings:

Settings → Data and storage → Grail buckets → + Create bucket

1

## Configure:

- **\*\*Name\*\*:** Descriptive bucket name
  - **\*\*Table\*\*:** Data type (logs, spans, etc.)
  - **\*\*Retention\*\*:** Days to retain data
  - **\*\*Description\*\*:** Purpose of bucket

10

## ## Cost Optimization Patterns

### ### Pattern 1: Tiered Retention by Severity

#### ! [Tiered Bucket Retention Strategy]

Igb3JpZW50PSJhdXRvIj4KICAgICAgPHBvbHlnb24gcG9pbnRzPSIwIDAisIDEwIDMuNSwgMCA3IiB  
maWxsPSIjNjQ3NDhiIi8+CiAgICA8L21hcmtlcj4KICA8L2R1ZnM+CgogIDwhLS0gQmFja2dyb3Vu  
ZCATLT4KICA8cmVjdCB3aWR0aD0iODAwIiBoZWlnaHQ9IjM0MCiGZmlsbD0iI2Y4ZjlmYSIgcng9I  
jEwIi8+CgogIDwhLS0gVG10bUGuLS0+CiAgPHRleHQgeD0iNDAwIiB5PSIy0C1gZm9udC1mYW1pbH  
k9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjE4IiBmb250LXdlaWdodD0iYm9sZCIgZml  
sbD0iIzMzMyIgdGV4dC1hbmNob3I9Im1pZGRsZSI+VGllcmVkIEJ1Y2tldCBSZXRLbnRpb24gU3Ry  
YXRlZ3k8L3RleHQ+CiAgPHRleHQgeD0iNDAwIiB5PSI00C1gZm9udC1mYW1pbHk9IkFyaWFsLCBzY  
W5zLXNlcmlmIiBmb250LXNpemU9IjExIiBmaWxsPSIjNjY2IiB0ZXh0LWFuY2hvcj0ibWlkZGxlij  
5PcHRpbWl6ZSBjb3N0cyB3aXRoIHJldGVudGlvbibiYXNlZCBvbiBkYXRhIHZhBHV1PC90ZXh0Pgo  
KICA8IS0tIEluY29taW5nIEvxZ3MgLs0+CiAgPHJ1Y3QgeD0iMzAiIHk9IjciIiB3aWR0aD0iMTIw  
IiBoZWlnaHQ9IjIwMCiGcng9IjgiIGZpbGw9IiNmZmYiIHn0cm9rZT0iI2UyZThmMCiGc3Ryb2tLL  
XdpZHRoPSIyIi8+CiAgPHRleHQgeD0i0TAiIHk9IjEwMCiGZm9udC1mYW1pbHk9IkFyaWFsLCBzY  
5zLXNlcmlmIiBmb250LXNpemU9IjExIiBmb250LXdlaWdodD0iYm9sZCIgZmlsbD0iIzMzMyIgdGV  
4dC1hbmNob3I9Im1pZGRsZSI+SW5jb21pbmcgTG9nczwvdGV4d4KICA8dGV4dCB4PSI5MCiGeT0i  
MTIwIiBmb250LWZhbwlsseT0iQXJpYwlsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiiIGZpbGw9I  
iM2NjYiIHRleHQtYw5jaG9yPSJtaWRkbGUipjewMCUgVm9sdW1lPC90ZXh0PgoKICA8cmVjdCB4PS  
I0NSIgeT0iMTM1IiB3aWR0aD0iOTAiIGHlaWdodD0iMjAiIHJ4PSIzIiBmaWxsPSIjZmVjYwNhIi8  
+CiAgPHRleHQgeD0i0TAiIHk9IjE00SiGZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBm  
b250LXNpemU9IjEwIiBmaWxsPSIjZGMyNjI2IiB0ZXh0LWFuY2hvcj0ibWlkZGxlij5FULJPUiAof  
jU1KTwdGV4d4KCiAgPHJ1Y3QgeD0iNDUiIHk9IjE2MCiGd2lkDg9IjkwIiBoZWlnaHQ9IjIwIi  
ByeD0iMyIgZmlsbD0iI2ZLzjNjNyIvPgogIDx0ZXh0IHg9IjkwiB5PSIxNzQjIGZvbnQtZmFtaWx  
5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZmlsbD0iI2Q5NzcwNiIgdGV4dC1h  
bmNob3I9Im1pZGRsZSI+V0FSTiAofjewJSk8L3RleHQ+CgogIDxyZWN0IHg9IjQ1IiB5PSIxODUiI  
HdpZHRoPSI5MCiGaGVpZ2h0PSIyMCiGcng9IjMiIGZpbGw9IiNkYmVhZmUiLz4KICA8dGV4dCB4PS  
I5MCiGeT0iMTk5IiBmb250LWZhbwlsseT0iQXJpYwlsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTA  
iiIGZpbGw9IiMyNTYzZWIIiHRleHQtYw5jaG9yPSJtaWRkbGUipklor8gKH41MCUpPC90ZXh0PgoK  
ICA8cmVjdCB4PSI0NSIgeT0iMjEwIiB3aWR0aD0iOTAiIGHlaWdodD0iMjAiIHJ4PSIzIiBmaWxsP  
SIjZDFmYWU1Ii8+CiAgPHRleHQgeD0i0TAiIHk9IjIyNCiGZm9udC1mYW1pbHk9IkFyaWFsLCBzY  
5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjMTZhMzRhIiB0ZXh0LWFuY2hvcj0ibWlkZGx  
lij5ERUJVRYAofjM1JSk8L3RleHQ+CgogIDwhLS0gQXJyb3dzIHRvIHRpZXJzIC0tPgogIDxwYXRo  
IGQ9Ik0xNTAsMTQ1IEwyMDAsOTUiIHn0cm9rZT0iI2RjMjYyNiIgc3Ryb2tLLXdpZHRoPSIyIiBma  
WxsPSJub25lIiBtYXJrZXItZw5kPSJ1cmwoI2J0QXJyb3cpIi8+CiAgPHBhdGggZD0iTT1MCwxNz  
AgTDIwMCwxNTUiIHn0cm9rZT0iI2Q5NzcwNiIgc3Ryb2tLLXdpZHRoPSIyIiBmaWxsPSJub25lIiB  
tYXJrZXItZw5kPSJ1cmwoI2J0QXJyb3cpIi8+CiAgPHBhdGggZD0iTT1MCwx0TUgTDIwMCwyMTUi  
IHn0cm9rZT0iIzI1NjNlYiIgc3Ryb2tLLXdpZHRoPSIyIiBmaWxsPSJub25lIiBtYXJrZXItZw5kP  
SJ1cmwoI2J0QXJyb3cpIi8+CiAgPHBhdGggZD0iTT1MCwyMjAgTDIwMCwyNzAiIHn0cm9rZT0iIz  
E2YTM0YSIgc3Ryb2tLLXdpZHRoPSIyIiBmaWxsPSJub25lIiBtYXJrZXItZw5kPSJ1cmwoI2J0QXJ  
yb3cpIi8+CgogIDwhLS0gVGllciAx0iBDcmloawNhbCATLT4KICA8cmVjdCB4PSIyMTAiIHk9Ijcw  
IiB3aWR0aD0iMzAwIiBoZWlnaHQ9IjUwIiByeD0i0C1gZmlsbD0idXjsKCN0aWVyMudyYWQpIiBma  
Wx0ZXi9InVybCgjYnRTaGFkb3cpIi8+CiAgPHRleHQgeD0iMzYwIiB5PSI5MiIgZm9udC1mYW1pbH  
k9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjExIiBmb250LXdlaWdodD0iYm9sZCIgZml  
sbD0id2hpGUiiHRleHQtYw5jaG9yPSJtaWRkbGUipLRpZXIgMToZJyb3JfbG9ncyAo0TAGZG5  
cyk8L3RleHQ+CiAgPHRleHQgeD0iMzYwIiB5PSIxMDgiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fuc  
y1zZXJpZiIgZm9udC1zaXplPSIxMCiGZmlsbD0icmdiYSgyNTUsMjU1LDI1NSwwLjkpiB0ZXh0LW  
FuY2hvcj0ibWlkZGxlij5Db21wbGlhbmNLICsgUm9vdCBDYXVzZSBBbmFseXNpczwvdGV4d4KciA  
gPCEtLSBUaWVyIDI6IFN0YW5kYXJkIC0tPgogIDxyZWN0IHg9IjIxMCiGeT0iMTMwIiB3aWR0aD0i  
MzAwIiBoZWlnaHQ9IjUwIiByeD0i0C1gZmlsbD0idXjsKCN0aWVyMkdyYWQpIiBmaWx0ZXi9InVyb  
CgjYnRTaGFkb3cpIi8+CiAgPHRleHQgeD0iMzYwIiB5PSIxNTIiIGZvbnQtZmFtaWx5PSJBcmhbC

wgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IndoaXRlIiB0ZXh0LWFuY2hvcj0ibWlkZGxlij5UaWVYIDI6IGRlZmF1bHRfbG9ncyAoMzUgZGF5cyk8L3R1eHQ+CiAgPHRleHQgeD0iMzYwIiB5PSIxNjgiIGZvbnQtZmFtaWx5PSJBcmlhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCigZmlsbD0icmdiYSgyNTUsMjU1LDI1NSwwLjkpIiB0ZXh0LWFuY2hvcj0ibWlkZGxlij5TdGFuZGFyZCBPcGVyYXRpb25zPC90ZXh0PgoKICA8IS0tIFRpZXIgMzogRGV2IC0tPgogIDxyZWN0IHg9IjIxMCiGeT0iMTkwIiB3aWR0aD0iMzAwIiBoZWlnaHQ9IjUwIiByeD0i0CIgZmlsbD0idXjsKCNoaWVyM0dyYWQpIiBmaWx0ZXI9InVybCgjYnRTaGFkb3cpIi8+CiAgPHRleHQgeD0iMzYwIiB5PSiyMTIiIGZvbnQtZmFtaWx5PSJBcmlhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IndoaXRlIiB0ZXh0LWFuY2hvcj0ibWlkZGxlij5UaWVYIDM6IGRldl9sb2dzICg3IGRheXMpPC90ZXh0PgogIDx0ZXh0IHg9IjM2MCiGeT0iMjI4IiBmb250LWZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9InJnYmEoMjU1LDI1NSwyNTUsMC45KSIgdGV4dC1hbmnob3I9Im1pZGRsZSI+RGV2ZWxvcG1lbnQgKyBTdGFnaW5nPC90ZXh0PgoKICA8IS0tIFRpZXIgNDogRHJvcCATLT4KICA8cmVjdCB4PSIyMTAiIHk9IjI1MCIgd2lkdGg9IjMwMCiGaGVpZ2h0PSI1MCiGcng9IjgiIGZpbGw9InVybCgjZHJvcEdyYWQpIiBmaWx0ZXI9InVybCgjYnRTaGFkb3cpIi8+CiAgPHRleHQgeD0iMzYwIiB5PSiyNzIiIGZvbnQtZmFtaWx5PSJBcmlhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IndoaXRlIiB0ZXh0LWFuY2hvcj0ibWlkZGxlij5Euk9QICgwIGRheXMpPC90ZXh0PgogIDx0ZXh0IHg9IjM2MCiGeT0iMjg4IiBmb250LWZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9InJnYmEoMjU1LDI1NSwyNTUsMC45KSIgdGV4dC1hbmnob3I9Im1pZGRsZSI+REVCVUcsIFRSQUNFLCBIZWFsdGggQ2h1Y2tzPC90ZXh0PgoKICA8IS0tIENvc3QgSW1wYW0N0IC0tPgogIDxyZWN0IHg9IjU0MCiGeT0iNzAiIHdpZHRoPSIyMzAiIGhlaWdodD0iMjMwIiByeD0i0CIgZmlsbD0iI2ZmZiIgc3Ryb2tlPSIjZTJl0GYwIiBzdHJva2Utd2lkdGg9IjIiLz4KICA8dGV4dCB4PSI2NTUiIHk9Ijk1IiBmb250LWZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTIiIGZvbnQtd2VpZ2h0PSJib2xkIiBmaWxsPSIjMzMzIiB0ZXh0LWFuY2hvcj0ibWlkZGxlij5Db3N0IEltcGFjdDwvdGV4d4KCiAgPHJlY3QgeD0iNTU1IiB5PSIxMTAiIHdpZHRoPSIyMDAiIGhlaWdodD0iNDAiIHJ4PSI0IiBmaWxsPSIjZmVjYwNhIi8+CiAgPHRleHQgeD0iNjU1IiB5PSIxMzAiIGZvbnQtZmFtaWx5PSJBcmlhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IiNKyZI2MjYiIHRleHQtYW5jaG9yPSJtaWRkbGUipjU1HZvbHVtZSDDlyA5MCBkYXlzPC90ZXh0PgogIDx0ZXh0IHg9IjY1NSIgeT0iMTQzIiBmb250LWZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiNkYzI2MjYiIHRleHQtYW5jaG9yPSJtaWRkbGUipkhpZ2hlcjBjb3N0IGJ1dCbjcmloaWNhbCBkYXRhPC90ZXh0PgogKICA8cmVjdCB4PSI1NTUiIHk9Ije1NSIgd2lkdGg9IjIwMCiGaGVpZ2h0PSI0MCiGcng9IjQiiIGZpbGw9IiNmZWYZzciLz4KICA8dGV4dCB4PSI2NTUiIHk9IjE3NSIgZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmb250LXdlaWdodD0iYm9sZCIgZmlsbD0iIzkyNDAwZSIgdGV4dC1hbmnob3I9Im1pZGRsZSI+NjAlHZvbHVtZSDDlyAzNSBkYXlzPC90ZXh0PgogIDx0ZXh0IHg9IjY1NSIgeT0iMTg4IiBmb250LWZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiM5MjqwMGUIIHRleHQtYW5jaG9yPSJtaWRkbGUipjL0N0YW5kYXjkIHJldGVudGbzbwvdGV4d4KCiAgPHJlY3QgeD0iNTU1IiB5PSIyMDAiIHdpZHRoPSIyMDAiIGhlaWdodD0iNDAiIHJ4PSI0IiBmaWxsPSIjZDFmYWU1Ii8+CiAgPHRleHQgeD0iNjU1IiB5PSIyMjAiIGZvbnQtZmFtaWx5PSJBcmlhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IiMwNDc4NTciIHReHQtYW5jaG9yPSJtaWRkbGUipjM1JSB2b2x1bWUgw5cgMCBkYXlzPC90ZXh0PgogIDx0ZXh0IHg9IjY1NSIgeT0iMjMzIiBmb250LWZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiMwNDc4NTciIHMTAiIGZpbGw9IiMwNDc4NTciIHRleHQtYW5jaG9yPSJtaWRkbGUipjLpFUk8gc3RvcmFnZSBjb3N0ITwvdGV4d4KCiAgPCEtLSBSZXN1bHQgLS0+CiAgPHJlY3QgeD0iNTU1IiB5PSIyNTAiIHdpZHRoPSIyMDAiIGhlaWdodD0iMzgiIHJ4PSI0IiBmaWxsPSIjZWRl0WZlIi8+CiAgPHRleHQgeD0iNjU1IiB5PSIyNzAiIGZvbnQtZmFtaWx5PSJBcmlhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IiM2ZDI4ZDkiIHRleHQtYW5jaG9yPSJtaWRkbGUipjRvdGFsIFNhdmLuZ3M6IH4zNS00MCU8L3R1eHQ+CiAgPHRleHQgeD0iNjU1IiB5PSIyODMiIGZvbnQtZmFtaW

```
x5PSJBcmhbCwg2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCIgZmlsbD0iIzZkMjhkOSIgdGV4dC1
hbmNob3I9Im1pZGRsZSI+dnMuIGFsbC1pbIBkZWZhWx0IGJ1Y2tldDwvdGV4dD4KPC9zdmc+Cg==
)
```

### ### Pattern 2: Environment-Based Retention

| Environment    | Bucket         | Retention | Cost Impact |
|----------------|----------------|-----------|-------------|
| Production     | `prod_logs`    | 35 days   | Standard    |
| Staging        | `staging_logs` | 14 days   | -60%        |
| Development    | `dev_logs`     | 7 days    | -80%        |
| Ephemeral/Test | `temp_logs`    | 3 days    | -90%        |

### ### Pattern 3: Drop + Sample

For extremely high-volume, low-value logs:

1. Drop 90% of health checks
2. Sample 10% to a short-retention bucket
3. Keep statistical visibility without full storage cost

### ### Pattern 4: Metric Extraction + Drop

For logs needed only for metrics:

1. Extract metrics (with dimensions) from logs
2. Drop the raw logs after extraction
3. Metrics persist for 10 years, logs dropped immediately

---

## ## Cost Optimization ROI Calculator ★ NEW

Understanding the financial impact of bucket strategies is critical for migration planning. This section provides detailed ROI calculations for common optimization patterns.

### ### DDU (Davis Data Units) Pricing Model

OpenPipeline storage is measured in \*\*Davis Data Units (DDUs)\*\*:

| Component             | DDU Calculation                    |
|-----------------------|------------------------------------|
| **Log Ingestion**     | 0.001 DDU per MB ingested          |
| **Storage (per day)** | 0.0001 DDU per MB per day retained |
| **DQL Query**         | 0.001 DDU per MB scanned           |

```

**Typical DDU Pricing:** ~$0.08 per DDU (varies by contract)

### Cost Formula

```
Total Cost = (Ingestion Cost) + (Storage Cost) + (Query Cost)
```

Where:
  Ingestion Cost = Volume (MB/day) × 0.001 DDU/MB × Price/DDU
  Storage Cost   = Volume (MB/day) × Retention (days) × 0.0001 DDU/MB/day ×
Price/DDU
  Query Cost     = Query Volume (MB) × 0.001 DDU/MB × Price/DDU
```
```

### Scenario 1: E-Commerce Platform – Tiered Retention

**Current State (No Optimization):**
```
Volume:          100 GB/day (100,000 MB/day)
Breakdown:
  - ERROR: 5% (5,000 MB/day)
  - WARN: 10% (10,000 MB/day)
  - INFO: 50% (50,000 MB/day)
  - DEBUG: 35% (35,000 MB/day)
Retention:       35 days (default_logs)
DDU Price:       $0.08 per DDU
```

**Current Monthly Cost:**
```
Ingestion: 100,000 MB/day × 30 days × 0.001 DDU/MB × $0.08 = $240/month
Storage:   100,000 MB/day × 35 days × 0.0001 DDU/MB/day × $0.08 =
$2,800/month
Query:      Estimate ~20% of stored data queried/month
            (100,000 × 30 × 0.2) × 0.001 × $0.08 = $48/month

TOTAL:        $3,088/month
```

**Optimized State (3-Tier + Drop):**
```
Tier 1 (ERROR): 5,000 MB/day → error_logs (90 days)
Tier 2 (WARN/INFO): 60,000 MB/day → default_logs (35 days)
Tier 3 (DEBUG): 35,000 MB/day → DROPPED (0 days)
```

**Optimized Monthly Cost:**
```
```

```

```
Ingestion (only non-dropped):  
65,000 MB/day × 30 days × 0.001 × $0.08 = $156/month
```

```
Storage:  
Tier 1: 5,000 × 90 × 0.0001 × $0.08 = $360/month  
Tier 2: 60,000 × 35 × 0.0001 × $0.08 = $1,680/month  
Total storage = $2,040/month
```

```
Query (20% of stored):  
(5,000 × 30 × 0.2 + 60,000 × 30 × 0.2) × 0.001 × $0.08 = $31.20/month
```

```
TOTAL: $2,227.20/month
```

```
```  
**ROI Analysis:**
```

```
Monthly Savings: $3,088 - $2,227 = $861/month  
Annual Savings: $861 × 12 = $10,332/year  
Savings Percentage: 27.9%  
Implementation Time: 4-8 hours  
Payback Period: Immediate (operational change only)
```

```
```  
### Scenario 2: SaaS Platform – Multi-Environment
```

```
**Current State:**
```

```
```  
Production: 50 GB/day × 35 days = $1,540/month  
Staging: 30 GB/day × 35 days = $924/month  
Development: 20 GB/day × 35 days = $616/month  
TOTAL: $3,080/month
```

```
```  
**Optimized State:**
```

```
```  
Production: 50 GB/day × 35 days = $1,540/month (no change)  
Staging: 30 GB/day × 14 days = $369.60/month (60% reduction)  
Development: 20 GB/day × 7 days = $154.40/month (75% reduction)  
TOTAL: $2,064/month
```

```
```  
**ROI Analysis:**
```

```
```  
Monthly Savings: $1,016/month  
Annual Savings: $12,192/year  
Savings Percentage: 33%
```

```
### Scenario 3: Global Retailer – Compliance + Cost
```

```
**Requirements:**
```

- Payment logs: PCI-DSS requires 90 days
- Audit logs: SOC 2 requires 365 days
- Application logs: 35 days standard
- Debug logs: Drop immediately

```
**Volume Breakdown:**
```

```
```
```

```
Payment logs: 10 GB/day (10% of total)  
Audit logs: 5 GB/day (5% of total)  
App logs: 60 GB/day (60% of total)  
Debug logs: 25 GB/day (25% of total)  
TOTAL: 100 GB/day
```

```
```
```

```
**Cost Calculation:**
```

```
```
```

```
Payment (90d):  $10,000 \times 90 \times 0.0001 \times \$0.08 = \$720/\text{month}$   
Audit (365d):  $5,000 \times 365 \times 0.0001 \times \$0.08 = \$1,460/\text{month}$   
App (35d):  $60,000 \times 35 \times 0.0001 \times \$0.08 = \$1,680/\text{month}$   
Debug (drop): \$0/month  
Ingestion:  $75,000 \times 30 \times 0.001 \times \$0.08 = \$180/\text{month}$ 
```

```
TOTAL: $4,040/month
```

```
```
```

```
**vs. No Optimization (all 35 days):**
```

```
```
```

```
100 GB/day  $\times$  35 days = $3,080/month (but non-compliant!)
```

```
```
```

```
**Key Insight:** Sometimes optimization increases cost but ensures compliance. The cost of non-compliance (fines, audits) far exceeds storage costs.
```

```
---
```

```
---
```

```
## Analyzing Your Bucket Usage
```

```
Use these queries to understand your current bucket utilization and plan optimization.
```

```
```python
```

```

// Current bucket distribution for logs
// Shows where your logs are being stored
fetch logs, from: now() - 7d
| summarize {record_count = count()}, by: {dt.system.bucket}
| fieldsAdd daily_avg = round(record_count / 7, decimals: 0)
| sort record_count desc
```

```python
// Bucket usage by log source
// Identify which sources are consuming bucket capacity
fetch logs, from: now() - 7d
| summarize {record_count = count()}, by: {dt.system.bucket, log.source}
| sort record_count desc
| limit 30
```

```python
// Bucket usage by pipeline
// Shows which pipelines are routing to which buckets
fetch logs, from: now() - 7d
| filter isNotNull(dt.openpipeline.pipelines)
| summarize {record_count = count()}, by: {dt.openpipeline.pipelines,
dt.system.bucket}
| sort record_count desc
```

```python
// Bucket usage trend over time
fetch logs, from: now() - 7d
| makeTimeseries {record_count = count()}, by: {dt.system.bucket}, interval:
1d
```

```python
// Identify logs that could move to shorter retention buckets
// Debug and trace logs are prime candidates
fetch logs, from: now() - 7d
| filter dt.system.bucket == "default_logs"
| summarize {
    total = count(),
    debug = countIf(loglevel == "DEBUG" OR status == "DEBUG"),
    trace = countIf(loglevel == "TRACE" OR status == "TRACE"),
    info = countIf(loglevel == "INFO" OR status == "INFO")
}
| fieldsAdd debug_pct = round((toDouble(debug) / toDouble(total)) * 100,
decimals: 2)
| fieldsAdd trace_pct = round((toDouble(trace) / toDouble(total)) * 100,

```

```

decimals: 2)
| fieldsAdd optimization_potential = round((toDouble(debug + trace) /
toDouble(total)) * 100, decimals: 2)
```

```python
// Check span bucket distribution
// Spans also use buckets
fetch spans, from: now() - 7d
| summarize {span_count = count()}, by: {dt.system.bucket}
| sort span_count desc
```

```python
// Estimate storage reduction from tiered retention
// Shows potential savings from routing to different buckets
fetch logs, from: now() - 7d
| summarize {
    total = count(),
    error_warn = countIf(loglevel == "ERROR" OR loglevel == "WARN"),
    info = countIf(loglevel == "INFO"),
    debug_trace = countIf(loglevel == "DEBUG" OR loglevel == "TRACE")
}
| fieldsAdd tier1_90day = error_warn
| fieldsAdd tier2_35day = info
| fieldsAdd tier3_drop = debug_trace
| fieldsAdd current_cost_units = total * 35
| fieldsAdd optimized_cost_units = (tier1_90day * 90) + (tier2_35day * 35) +
(tier3_drop * 0)
| fieldsAdd savings_pct = round((1.0 - (toDouble(optimized_cost_units) /
toDouble(current_cost_units))) * 100, decimals: 1)
```

```

---

## ## Multi-Tier Bucket Strategies ★ NEW

Different organizations need different bucket architectures based on their scale, compliance requirements, and cost targets.

### ### 3-Tier Strategy (Small to Medium Organizations)

\*\*Recommended for:\*\* 10–500 GB/day, single or few environments

| Tier         | Bucket Name     | Retention | Use Case                | Volume % |
|--------------|-----------------|-----------|-------------------------|----------|
| ---          | ---             | ---       | ---                     | ---      |
| **Critical** | `critical_logs` | 90 days   | Errors, security, audit | 10–15%   |

```
| **Standard** | `default_logs` | 35 days | WARN, INFO, app logs | 60-70% |
| **Ephemeral** | `ephemeral_logs` | 7 days | DEBUG, health checks | 20-30% |
```

#### \*\*Routing Configuration:\*\*

```

##### Route 1 (Critical):

```
Condition: loglevel == "ERROR" OR
            contains(log.source, "security") OR
            contains(log.source, "audit") OR
            contains(content, "payment")
```

Pipeline: critical-logs

Bucket: critical\_logs (90 days)

##### Route 2 (Ephemeral):

```
Condition: loglevel == "DEBUG" OR
            loglevel == "TRACE" OR
            contains(content, "/health")
```

Pipeline: ephemeral-logs

Bucket: ephemeral\_logs (7 days)

##### Default Route:

```
Pipeline: standard-logs
Bucket: default_logs (35 days)
```

```

\*\*Expected Savings:\*\* 25–35% vs. single-bucket approach

### ### 5-Tier Strategy (Enterprise Organizations)

\*\*Recommended for:\*\* 500+ GB/day, multiple environments, strict compliance

| Tier            | Bucket Name       | Retention | Use Case                        | Volume % |
|-----------------|-------------------|-----------|---------------------------------|----------|
|                 |                   |           |                                 |          |
| **Compliance**  | `compliance_logs` | 365 days  | SOC 2, GDPR, HIPAA audit trails | 3–5%     |
| **Security**    | `security_logs`   | 180 days  | Security events, attacks, vulns | 2–5%     |
| **Production**  | `prod_logs`       | 90 days   | Production errors, warnings     | 10–15%   |
| **Standard**    | `default_logs`    | 35 days   | INFO logs, standard operations  | 40–50%   |
| **Development** | `dev_logs`        | 7 days    | Dev/staging, DEBUG, testing     | 30–40%   |

\*\*Expected Savings:\*\* 40–60% vs. single-bucket approach

### ### Hybrid Strategy (Compliance + Cost)

\*\*Best for:\*\* Organizations with compliance requirements AND cost constraints

! [Hybrid Bucket Strategy]

(

F0ZSgzMCwgMTkwKSI+CiAgICA8cmVjdCB3aWR0aD0iMTgwIiBoZWlnaHQ9Ij c1IIiByeD0iNCIgZml  
sbD0iI2ZlZjJmMiGc3Ryb2t1PSIjZmVjYWNhIiBzdHJva2Utd2lkdGg9IjEiLz4KICAgIDx0ZXh0  
IHg9IjE1IIiB5PSIyMCiGZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9I  
jEwIiBmaWxsPSIjOTkxYjFii5QYx1tZw50IGxvZ3Mg4oaSPC90ZXh0PgogICAgPHRleHQgeD0iMT  
EwIiB5PSIyMCiGZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiB  
maWxsPSIjZGMYnjI2IiBmb250LXdlaWdodD0iYm9sZCI+cGF5bWVudF9sb2dzICg5MGQpPC90ZXh0  
PgogICAgPHRleHQgeD0iMTQ1IiB5PSIzMyIgZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmI  
iBmb250LXNpemU9IjEwIiBmaWxsPSIjNjQ3NDhiIj5QQ0ktRFNTPC90ZXh0PgogKICAgIDx0ZXh0IH  
g9IjE1IIiB5PSI00CIgZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjE  
wIiBmaWxsPSIjOTkxYjFii5BdWRpdCBsb2dzI0KGkjwvdGV4d4KICAgIDx0ZXh0IHg9IjExMCiG  
eT0iNDgiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZmlsb  
D0iI2RjMjYyNiIgZm9udC13ZWlnaHQ9ImJvbGQiPmF1ZG10X2xvZ3MgKDM2NWQpPC90ZXh0PgogIC  
AgPHRleHQgeD0iMTUwIiB5PSI2MSIgZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb25  
0LXNpemU9IjEwIiBmaWxsPSIjNjQ3NDhiIj5TT0MgMjwvdGV4d4KCiAgICA8dGV4dCB4PSIxNSIg  
eT0iNzMiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZmlsb  
D0iIzk5MWIxYiI+SGVhbHRoY2FyZSDihpI8L3RleHQ+CiAgICA8dGV4dCB4PSIxMTAiIHK9IjczIi  
Bmb250LWZhbwLseT0iQXJpYwWsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiNkYzI  
2MjYiIGZvbnQtd2VpZ2h0PSJib2xkIj5waGfbG9ncyAoNyB5cnMpPC90ZXh0PgogIDwvZz4KCiAg  
PCEtLSBCcmFuY2ggMjogRW52aXJvbm1lbnQgQ2hLY2sgKENlbnRlcikgLS0+CiAgPHJ1Y3QgeD0iM  
jYwIiB5PSIxNDUiIhdZHRoPSIxODAiIGhlaWdodD0iMzUiIHK4PSI2IiBmaWxsPSJ1cmwoI2Vudk  
dyYWQpIiBmaWx0ZXi9InVybCgjaGJTaGFkb3cpIi8+CiAgPHRleHQgeD0iMzUwIiB5PSIxNjgiIGZ  
vbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIgZmlsbD0id2hdpu  
IHRleHQtYw5jaG9yPSJtaWRkbGUiIGZvbnQtd2VpZ2h0PSJib2xkIj4yLiBFbnZpcm9ubWVudCBda  
GVjazwvdGV4d4KCiAgPCEtLSFBnZpcm9ubWVudCBkZXN0aw5hdGlvbnMgLs0+CiAgPGcgdHJhbn  
Nmb3JtPSJ0cmFuc2xhdGUoMjYwLCAxOTApIj4KICAgIDxyZWN0IhdZHRoPSIxODAiIGhlaWdodD0  
iNzUiIHK4PSI0IiBmaWxsPSIjZwZmNmZmIiBzdHJva2U9IiNiZmRiZmUiIHN0cm9rZS13aWR0aD0i  
MSIvPgogICAgPHRleHQgeD0iMTUiIHK9IjIwIiBmb250LWZhbwLseT0iQXJpYwWsIHnhbnMtc2Vya  
WYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiMxZTQwYwYiPlByb2R1Y3Rp24g4oaSPC90ZXh0PgogIC  
AgPHRleHQgeD0iMTA1IiB5PSIyMCiGZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb25  
0LXNpemU9IjEwIiBmaWxsPSIjMjU2M2ViIiBmb250LXdlaWdodD0iYm9sZCI+cHJvZF9sb2dzICgz  
NWQpPC90ZXh0PgogKICAgIDx0ZXh0IHg9IjE1IIiB5PSI0NSIgZm9udC1mYW1pbHk9IkFyaWFsLCBzY  
W5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjMwU0MGFmIj5TdGFnaW5nI0KGkjwvdGV4dD  
4KICAgIDx0ZXh0IHg9IjEwNSIgeT0iNDUiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJpZiI  
gZm9udC1zaXplPSIxMCiGZmlsbD0iIzFlNDbhZiI+RGV2ZWvcG1lbn  
Qg4oaSPC90ZXh0PgogICAgPHRleHQgeD0iMTA1IiB5PSI3MCiGZm9udC1mYW1pbHk9IkFyaWFsLCB  
zYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjMjU2M2ViIiBmb250LXdlaWdodD0iYm9s  
ZCI+zGV2X2xvZ3MgKDdkKTwvdGV4d4D4KICA8L2c+CgogIDwhLS0gQnJhbmNoIDM6IFNldmVyaXR5I  
ENoZWRtChSaWdodCkgLS0+CiAgPHJ1Y3QgeD0iNDkwIiB5PSIxNDUiIhdZHRoPSIxODAiIGhlaW  
dodD0iMzUiIHK4PSI2IiBmaWxsPSJ1cmwoI3NldkdyYWQpIiBmaWx0ZXi9InVybCgjaGJTaGFkb3c  
pIi8+CiAgPHRleHQgeD0iNTgwIiB5PSIxNjgiIGZvbnQtZmFtaWx5PSJBcmhbCwgc2Fucy1zZXJp  
ZiIgZm9udC1zaXplPSIxMSIgZmlsbD0id2hdpuIHRleHQtYw5jaG9yPSJtaWRkbGUiIGZvbnQtd  
2VpZ2h0PSJib2xkIj4zLiBTZXZlcmloesBDAgVjazwvdGV4d4KCiAgPCEtLSBTZXZlcmloesBkZX  
N0aw5hdGlvbnMgLs0+CiAgPGcgdHJhbnNmb3JtPSJ0cmFuc2xhdGUoNDkwLCAxOTApIj4KICAgIDx  
yZWN0IhdZHRoPSIxODAiIGhlaWdodD0iNzUiIHK4PSI0IiBmaWxsPSIjZjBmZGY0IiBzdHJva2U9  
IiNiYmY3ZDAiIHN0cm9rZS13aWR0aD0iMSIvPgogICAgPHRleHQgeD0iMTUiIHK9IjIwIiBmb250L  
WZhbwLseT0iQXJpYwWsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiMxNjY1MzQiPk

```

VSUK9SL0ZBVEFMI0KGkjwvdGV4dD4KICAgIDX0ZXh0IHg9IjEwNSIgeT0iMjAiIGZvbnQtZmFtaWx
5PSJBcmhbCwg2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZmlsbD0iIzA10TY20SIgZm9udC13
ZWlnaHQ9ImJvbGQiPktxZXAgaw4gYnVja2V0PC90ZXh0PgoKICAgIDX0ZXh0IHg9IjE1IiB5PSI0N
SIgZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjMT
Y2NTM0Ij5XQVJ0l0Rk8g4oaSPC90ZXh0PgogICAgPHRleHQgeD0iMTA1IiB5PSI0NSIgZm9udC1
mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjMDU5NjY5IiBm
b250LXdlaWdodD0iYm9sZCI+S2VlcCBpbibidWnrZXQ8L3RleHQ+CgogICAgPHRleHQgeD0iMTUiI
Hk9IjcwIiBmb250LWZhbWlseT0iQXJpYWwsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbG
w9IiMxNjY1MzQiPkRFQ1VHL1RSQUNFI0KGkjwvdGV4dD4KICAgIDX0ZXh0IHg9IjEwNSIgeT0iNzA
iIGZvbnQtZmFtaWx5PSJBcmhbCwg2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiGZmlsbD0iI2Y1
OWUwYiIgZm9udC13ZWlnaHQ9ImJvbGQiPkRST1AgLyAzLWRheTwvdGV4dD4KICA8L2c+CgogIDwhL
S0gUHJpb3JpdHgbm90ZSBhdCBib3R0b20gLS0+CiAgPHJ1Y3QgeD0iMTIwIiB5PSIzMADaiIHdpZH
RoPSI0NjAiIGhlaWdodD0iNDAiIHJ4PSI2IiBmaWxsPSIjZmVmM2M3IiBzdHjva2U9IiNmY2QzNGQ
iIHNOcm9rZS13aWR0aD0iMSIvPgogIDX0ZXh0IHg9IjM1MCIgeT0iMzE4IiBmb250LWZhbWlseT0i
QXJpYWwsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTEiIGZpbGw9IiM5MjQwMGUiIHRleHQtYW5ja
G9yPSJtaWRkbGUIIGZvbnQtd2VpZ2h0PSJib2xkJ5QcmIvcml0eSBPcmRlcjo8L3RleHQ+CiAgPH
RleHQgeD0iMzUwIiB5PSIzMzMiIGZvbnQtZmFtaWx5PSJBcmhbCwg2Fucy1zZXJpZiIgZm9udC1
zaXplPSIxMCiGZmlsbD0iIz4MzUwZiIgdGV4dC1hbmnob3I9Im1pZGRsZSI+Q29tcGxpYW5jZSAo
MXN0KSDihpIgRW52aXJvbm1lbnQgKDJuZCkg4oaSIFNldmVyaXR5ICzcmQpPC90ZXh0PgoKICA8I
S0tIEtleSBpbnNpZ2h0IC0tPgogIDxnIHRyYW5zZm9ybT0idHjhbnNsYXR1KDEyMCwgMzU1KSI+Ci
AgICA8cmVjdCB3aWR0aD0iNDYwIiBoZWLnaHQ9IjUwIiByeD0iNiIgZmlsbD0id2hpdGUiiHN0cm9
rZT0iI2UyZThmMCiGc3Ryb2t1LXdpZHRoPSIxIi8+CiAgICA8dGV4dCB4PSIyMzAiIHk9IjIwIiBm
b250LWZhbWlseT0iQXJpYWwsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IiM2NDc00
GIiIHRleHQtYW5jaG9yPSJtaWRkbGUIPvCfkqEgS2V5IEluc2lnaHQ6IENvbXBsaWFuY2Ugcm91dG
VzIG11c3QgYmUgZXZhbHVhdGVkIEZJUlnUPC90ZXh0PgogICAgPHRleHQgeD0iMjMwIiB5PSIz0CI
gZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjNjQ3
NDhiIiB0ZXh0LWFuY2hvcj0ibWlkZGxlIj50byBlbnN1cmUgcmVndWxhdG9yeSBkYXRhIGlzIG5ld
mVyIGRyb3BwZWQgb3IgdW5kZXItcmV0YWluZWQ8L3RleHQ+CiAgPC9nPgo8L3N2Zz4K)

```

**\*\*Key Principle:\*\*** Compliance routes must be FIRST to ensure regulatory data isn't accidentally dropped or under-retained.

---

---

## ## Multi-Pipeline Processing

A single record can be processed by multiple pipelines (up to 5). This enables powerful patterns:

### ### Use Case: Extraction + Storage Pipeline

```

! [Multi-Pipeline Processing]
(
ciIHZpZXdCb3g9IjAgMCA2MDAgMzAwIj4KICA8ZGVmcz4KICAgIDxsaw5LYXJHcmFkaWVudCBpZD0

```

ibXBJBjB1dEdyYWQiIHgxPSIwJSIgeTE9IjAlIiB4Mj0iMTAwJSIgeTI9IjAlIj4KICAgICAgPHN0b3Agb2Zmc2V0PSIwJSIgc3R5bGU9InN0b3AtY29sb3I6IzMzNDE1NTtzdG9wLW9wYwNpdHk6MSlglz4KICAgICAgPHN0b3Agb2Zmc2V0PSIxMDAlIiBzdHlsZT0ic3RvcC1jb2xvcjojNDc1NTY503N0b3Atb3BhY2l0eToxIiAvPgogICAgPC9saW5LYXJHcmFkaWVudD4KICAgIDxsaw5LYXJHcmFkaWVudCBpZD0ibXBQaXB1MUdyYWQiIHgxPSIwJSIgeTE9IjAlIiB4Mj0iMTAwJSIgeTI9IjAlIj4KICAgICAgPHN0b3Agb2Zmc2V0PSIxMDAlIiBzdHlsZT0ic3RvcC1jb2xvcjojYTg1NWY303N0b3Atb3BhY2l0eToxIiAvPgogICAgPC9saW5LYXJHcmFkaWVudD4KICAgIDxsaw5LYXJHcmFkaWVudCBpZD0ibXBQaXB1MkdyYWQiIHgxPSIwJSIgeTE9IjAlIiB4Mj0iMTAwJSIgeTI9IjAlIj4KICAgICAgPHN0b3Agb2Zmc2V0PSIxMDAlIiBzdHlsZT0ic3RvcC1jb2xvcjojNjBhNWZh03N0b3Atb3BhY2l0eToxIiAvPgogICAgPC9saW5LYXJHcmFkaWVudD4KICAgIDxmaWx0ZXIgaWQ9Im1wU2hhZG93Ij4KICAgICAgPGZlRHJvcFNoYWRvdyBkeD0iMSlglzHk9IjEiIHN0ZERldmlhdGlvbj0iMiIgZmxvb2Qtb3BhY2l0eT0iMC4xNSIvPgogICAgPC9maWx0ZXI+CiAgICA8bWFya2VyIGlkPSJtcEFycm93IiBtYXJrZXJXaWR0aD0iMTAiIG1hcmtlckhlaWdodD0iNyIgcmVmW0i0SIgcmVmWT0iMy41IiBvcmlbnQ9ImF1dG8iPgogICAgICA8cG9seWdvbiBwb2ludHM9IjAgMCwgMTAgMy41LCawIDciIGZpbGw9IiM2NDc00GIiLz4KICAgIDwvbfWFya2VypgogIDwvZGVmcz4KCIagPCETLSBCYWNrZ3JvdW5kIC0tPgogIDxyZwN0IHdpZHRoPSI2MDaiIGHlaWdodD0iMzAwIiBmaWxsPSIjZjh0WzhIiByeD0iMTAiLz4KCIagPCETLSBUaXRsZSAtLT4KICA8dGV4dCB4PSIzMdaIiHk9IjI1IiBmb250LWZhbwlseT0iQXJpYWwsIHnbmMtc2VyaWYiIGZvbnQtc2l6ZT0iMTQlIGZvbnQtd2VpZ2h0PSJib2xkIiBmaWxsPSIjMWUyOTNiIiB0ZXh0LWFuY2hvcj0ibwlkZgxlij5Ndwx0aS1qaXB1bGluzTogTvw0cmIjcyBFerHRYwN0aW9uICsgTG9nIFN0b3JhZ2U8L3R1eHQ+CgogIDwhlS0gSw5jb21pbmcgTG9nIC0tPgogIDxyZwN0IHg9IjMwiB5PSIxMTAiIHdpZHRoPSIxMTAiIGHlaWdodD0iNTaiIHJ4PSI2IiBmaWxsPSJ1cmwoI21wSW5wdXRHcmFkKSIgZmlsdGvyPSJ1cmwoI21wU2hhZG93KSIvPgogIDx0ZXh0IHg9Ijg1IiB5PSIxMzUiIGZvbnQtZmfatwX5PSJBcmhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSlgb0id2hpduiIHR1eHQtYw5jaG9yPSJtaWRkbGUIGZvbnQtd2VpZ2h0PSJib2xkij5JbmNvbwlzYbMb2c8L3R1eHQ+CiAgPHR1eHQgeD0i0DuIiHk9IjE1MCigZm9udC1mYw1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSIjOTRhM2I4IiB0ZXh0LWFuY2hvcj0ibwlkZgxlij5wYXltZW50IHJlcXVlc3Q8L3R1eHQ+CgogIDwhlS0gU3BsaXQgYXJyb3cgLS0+CiAgPGxpbmUgeDE9IjE0MCiGeTE9IjEzNSIgeDI9IjE3NSIgeTI9IjEzNSIgC3Ryb2tlPSIjNjQ3NDhiIiBzdHJva2Utd2lkdg9IjIiLz4KICA8bGluZSB4MT0iMTc1IiB5MT0iMTM1IiB4Mj0iMTc1IiB5Mj0iNzUiIHN0cm9rZT0iIzY0NzQ4YiIgc3Ryb2tlLXdpZHRoPSIyIi8+CiAgPGxpbmUgeDE9IjE3NSIgeTE9IjEzNSIgeDI9IjE3NSIgeTI9IjE5NSIgC3Ryb2tlPSIjNjQ3NDhiIiBzdHJva2Utd2lkdg9IjIiLz4KICA8bGluZSB4MT0iMTc1IiB5MT0iNzUiIhgypsiX0TuIiHkyPSI3NSIgC3Ryb2tlPSIjNjQ3NDhiIiBzdHJva2Utd2lkdg9IjIiLz4KICA8bGluZSB4MT0iMTk1IiB4Mj0iMTk1IiB5Mj0iMTk1IiBzdHJva2U9IiM2NDc00GIiIHN0cm9rZS13aWR0aD0iMiIgbWFya2VylWVuZD0idXjsKCntcEFycm93KSIvPgoKICA8IS0tIFBpcGVsaW5lIDE6IE1ldHjpY3MgRXh0cmFjdGlvbiAtLT4KICA8cmVjdCB4PSIyMDuiIHK9IjUwIiB3aWR0aD0iMTcwIiBoZwlnaHQ9IjUwIiByeD0iNiIgZmlsbD0idXjsKCntcFBpcGuXr3JhZCkiIGZpbHRLcj0idXjsKCntcFNoYWRvdykiLz4KICA8dGV4dCB4PSIyOTAiIHK9IjcyIiBmb250LWZhbwlseT0iQXJpYWwsIHnbmMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9IndoaXrlIiB0ZXh0LWFuY2hvcj0ibwlkZgxliiBmb250LXdlaWdodD0iYm9sZCI+UGlwZwxbmUgMTo8L3R1eHQ+CiAgPHR1eHQgeD0iMjkwiB5PSI40CigZm9udC1mYw1pbHk9IkFyaWFsLCBzYW5zLXNlcmlmIiBmb250LXNpemU9IjEwIiBmaWxsPSJyZ2JhKDI1NSwyNTUsMjU1LDAuOSkiIHR1eHQtYw5jaG9yPSJtaWRkbGUipm1ldHjpY3MtZXh0cmFjdGlvbjwvdGV4d4KCIagPCETLSBQaXB1bGluZSAxIGFjdGlvbnMgLs0+CiAgPGcgdHJhbnNmb3JtPSJ0cmFuc2xhdGuomjA1LCaxMDUpIj4KICAgIDxyZwN0IHdpZHRoPSIxNzAiIghlaWdodD0iNDUiIHK4PSI0IiBmaWxsPSIjZWR10WZLiiBzdHJva2U9IiNjNGI1ZmQ1IHN0cm9rZS13aWR0aD0iMSIVPgogICAgPHR1eHQgeD0iMTAiIHK9IjE4IiBmb250LWZhbwlseT0iQXJpYWwsIHnbm

tc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9iM2ZDI4ZDkiPuKAoiBQYXJzZSBzZXNwb25zZV90  
aW1lPC90ZXh0PgogICAgPHRleHQgeD0iMTAiIHk9iJm1IiBmb250LWZhbWlseT0iQXJpYWwsIHnhb  
nMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9iM2ZDI4ZDkiPuKAoiBFeHRYYWN0IG1ldHjpYZ  
ogZHVyYXRpb248L3RleHQ+CiAgPC9nPgoKICA8IS0tIFBpcGVsaW5lIDeB3V0cHV0IGFycm93IC0  
tPgogIDxsaw5lIHgxPSIzNzUiIHkxPSIxMjciIHgyPSIzOTUiIHkyPSIxMjciIHn0cm9rZT0iIzY0  
NzQ4YiIgc3Ryb2t1LXdPzHroPSIyIiBtYXJrZXItZw5kPSJ1cmwoI21wQXJyB3cpIi8+CgogIDwhL  
S0gTW0cmIjIE91dHB1dCATLT4KICA8cmVjdCB4PSI0MDuiIHk9iJewNSIgd2lkGg9iJewMCiagG  
VpZ2h0PSI0NSIgcng9iJyIIGZpbGw9iMxMGI50DEiIGZpbHRlcj0idXjsKCntcFNoYWrvdykiLz4  
KICA8dGV4dCB4PSI0NTUiIHk9iJeyMyIgZm9udC1mYW1pbhk9iKfyaWFsLCBzYW5zLXNlcmlmIiBm  
b250LXNpemU9iJewIiBmaWxsPSJ3aG10ZSIgdGV4dC1hbmnob3I9Im1pZGRsZSIgZm9udC13ZWlna  
HQ9ImJvbGQiPvcfk4ogTUVUuk1DPC90ZXh0PgogIDx0ZXh0IHg9iJq1NSIgeT0iMTQwIiBmb250LW  
ZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9InJnYmEoMjU1LDI  
1NSwyNTUsMC45KSIgdGV4dC1hbmnob3I9Im1pZGRsZSI+cmVxdWVzdF9kdXJhdGlvbjwvdGV4dD4K  
CiAgPCEtLSBQaXB1bGluzSAy0iBmb2cgU3RvcmFnzsAtLT4KICA8cmVjdCB4PSIyMDUiIHk9iJyE3M  
CIgd2lkGg9iJyE3MCiagGVpZ2h0PSI1MCiagcng9iJyIIGZpbGw9InVybCgjXBQaXB1mkdyYWQpII  
BmaWx0Zxi9InVybCgjXBtaGFkb3cpIi8+CiAgPHRleHQgeD0iMjkwiB5PSIxOTIiIGZvbnQtZmF  
taWx5PSJBcmhbCwg2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiagZmlsbD0id2hpdGUiiHrleHQt  
Yw5jaG9yPSJtaWRkbGUIIGZvbnQtd2VpZ2h0PSJib2xkIj5QaXB1bGluzSAy0jwvdGV4dD4KICA8d  
GV4dCB4PSIyOTAiIHk9iJiw0CIgZm9udC1mYW1pbhk9iKfyaWFsLCBzYW5zLXNlcmlmIiBmb250LX  
NpemU9iJewIiBmaWxsPSJyZ2JhKDI1NSwyNTUsMjU1LDAu0SkiiHrleHQtYw5jaG9yPSJtaWRkbGU  
iPmxvZy1zdG9yYwd1PC90ZXh0PgokICA8IS0tIFBpcGVsaW5lIDigYwN0aW9ucyAtLT4KICA8zyB0  
cmFuc2Zvcm09InRyYw5zbGF0ZSgyMDUsIDiyNSkiPgogICAgPHJyY3Qgd2lkGg9iJyE3MCiagGVpZ  
2h0PSI0NSIgcng9iJyIiIGZpbGw9iNkYmVhZmUiIHn0cm9rZT0iIzkzYzVmZCIgc3Ryb2t1LXdPzH  
RoPSIxIi8+CiAgICA8dGV4dCB4PSIxMCigeT0iMTgiIGZvbnQtZmFtaWx5PSJBcmhbCwg2Fucy1  
zZXJpZiIgZm9udC1zaXplPSIxMCiagZmlsbD0iIzFkNGVk0CI+40CiIFBhcnNlIGFkZG10aW9uYw  
ZmllbGRzPC90ZXh0PgogICAgPHRleHQgeD0iMTAiIHk9iJm1IiBmb250LWZhbWlseT0iQXJpYWwsI  
HNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9iMxZDR1ZDgiPuKAoiBsb3V0ZSB0byBidW  
NrZXQ8L3RleHQ+CiAgPC9nPgoKICA8IS0tIFBpcGVsaW5lIDigb3V0cHV0IGFycm93IC0tPgogIDx  
saW5lIHgxPSIzNzUiIHkxPSIyNDciIHgyPSIzOTUiIHkyPSIyNDciIHn0cm9rZT0iIzY0NzQ4YiIg  
c3Ryb2t1LXdPzHroPSIyIiBtYXJrZXItZw5kPSJ1cmwoI21wQXJyB3cpIi8+CgogIDwhLS0gTG9nI  
FN0b3JhZ2UgT3V0cHV0IC0tPgogIDxyZwN0IHg9iJqwnsiGeT0iMjI1IiB3aWR0aD0iMTAwIiBoZW  
lnaHQ9iJyQ1IiByeD0iNiIgZmlsbD0iIzN10DjmNiIgZmlsdGVyPSJ1cmwoI21wU2hhZG93KSiVPG  
gIDx0ZXh0IHg9iJyQ1NSIgeT0iMjQzIiBmb250LWZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZv  
bnQtc2l6ZT0iMTAiIGZpbGw9IndoaXrlIiB0ZXh0LWFuY2hvcj0ibWlkZGxlIiBmb250LXdlaWdod  
D0iYm9sZCI+8J+TiyBMT0c8L3RleHQ+CiAgPHRleHQgeD0iNDU1IiB5PSIyNjAiIGZvbnQtZmFtaW  
x5PSJBcmhbCwg2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiagZmlsbD0icmdiYsgyNTUsMjU1LDI  
1NSwwLjkpiIiB0ZXh0LWFuY2hvcj0ibWlkZGxlIj5wYXltZw50X2xvZ3M8L3RleHQ+CgogIDwhLS0g  
UmVzdWx0IGJveCatLT4KICA8cmVjdCB4PSI1MTAiIHk9iJyE1NSIgd2lkGg9iJgwIiBoZwlnaHQ9i  
jYwIiByeD0iNCIgZmlsbD0iI2YwZmRmNCIg3Ryb2t1PSIjMTBi0TgxIiBzdHJva2Utd2lkGg9iJ  
IiLz4KICA8dGV4dCB4PSI1NTAiIHk9iJyE3NSIgZm9udC1mYW1pbhk9iKfyaWFsLCBzYW5zLXNlcml  
mIiBmb250LXNpemU9iJewIiBmaWxsPSIjMTY2NTM0IiB0ZXh0LWFuY2hvcj0ibWlkZGxlIiBmb250  
LXdlaWdodD0iYm9sZCI+UkVTVuXUPC90ZXh0PgogIDx0ZXh0IHg9iJyU1MCiGeT0iMTkyIiBmb250L  
WZhbWlseT0iQXJpYWwsIHnhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9iMxNjY1MzQiiH  
RleHQtYw5jaG9yPSJtaWRkbGUIpk1ldHjpYyDinJM8L3RleHQ+CiAgPHRleHQgeD0iNTUwIiB5PSI  
yMDUiIGZvbnQtZmFtaWx5PSJBcmhbCwg2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMCiagZmlsbD0i  
IzE2NjUzNCIgdGV4dC1hbmnob3I9Im1pZGRsZSI+TG9nI0KckzwvdGV4dD4KPC9zdmC+Cg==)

```

### Use Case: Security + Operational Logs

```
Pipeline 1: security-analysis
  - Extract security events
  - Generate security alerts

Pipeline 2: operational-logs
  - Standard parsing
  - Normal storage
```

### Configuring Multi-Pipeline Routes

Create overlapping route conditions:

```
Route 1: log.source == "auth-service" → security-logs
Route 2: log.source == "auth-service" → app-logs

Both pipelines process the same record
```

> ⚠ **Limit:** A record can be processed by maximum 5 pipelines. Beyond this, extraction stops.

```python
// Identify records processed by multiple pipelines
fetch logs, from: now() - 1h
| filter isNotNull(dt.openpipeline.pipelines)
| filter arraySize(dt.openpipeline.pipelines) > 1
| summarize {multi_pipeline_count = count()}, by: {dt.openpipeline.pipelines}
| sort multi_pipeline_count desc
| limit 20
```

```python
// Count of logs by number of pipelines processing them
fetch logs, from: now() - 1h
| filter isNotNull(dt.openpipeline.pipelines)
| fieldsAdd pipeline_count = arraySize(dt.openpipeline.pipelines)
| summarize {record_count = count()}, by: {pipeline_count}
| sort pipeline_count asc
```

---
```

## ## Bucket Governance & Access Control ★ NEW

Proper bucket governance ensures compliance, security, and operational efficiency.

### ### Access Control Patterns

#### #### Pattern 1: Role-Based Bucket Access

| Role              | Bucket Access     | Permissions           |
|-------------------|-------------------|-----------------------|
| **Developers**    | `dev_logs`        | Read/Write            |
|                   | `staging_logs`    | Read/Write            |
|                   | `prod_logs`       | Read-only             |
| **SRE/Platform**  | All buckets       | Read/Write            |
| **Security Team** | `security_logs`   | Read/Write            |
|                   | `audit_logs`      | Read-only (immutable) |
|                   | `compliance_logs` | Read-only (immutable) |
| **Auditors**      | `audit_logs`      | Read-only             |
|                   | `compliance_logs` | Read-only             |
| **Finance**       | `payment_logs`    | Read-only             |

#### #### Pattern 2: Least Privilege by Environment

```

##### Development Team:

- FULL access to dev\_logs
- READ access to staging\_logs
- NO access to prod\_logs

##### QA Team:

- FULL access to staging\_logs
- READ access to dev\_logs
- READ access to prod\_logs (for troubleshooting only)

##### Production SRE:

- FULL access to prod\_logs, error\_logs, security\_logs
- READ access to all other buckets

```

### ### Retention Policy Enforcement

| Bucket         | Min Retention | Max Retention | Enforcement           |
|----------------|---------------|---------------|-----------------------|
| `dev_logs`     | 1 day         | 14 days       | Auto-delete after max |
| `staging_logs` | 7 days        | 30 days       | Auto-delete after max |
| `default_logs` | 35 days       | 35 days       | Standard retention    |
| `prod_logs`    | 90 days       | 90 days       | Protected             |

```
| `audit_logs` | 365 days | 2555 days | Immutable after 30d |
| `payment_logs` | 90 days | 2555 days | PCI-DSS compliant |
| `phi_logs` | 2555 days | 2555 days | HIPAA 7-year rule |

**Enforcement Methods:**
1. Automated: Grail automatically purges data after retention period
2. Immutability: Compliance buckets can be configured as write-once
   (after grace period)
3. Audit Trail: All retention changes logged in audit_logs
```

#### ### Compliance Audit Trail Requirements

##### #### SOC 2 Compliance

**Required Logs (365 days minimum):**

- Authentication events (login, logout, MFA)
- Authorization changes (role assignments, permission changes)
- Data access (who accessed what, when)
- Configuration changes (pipeline edits, bucket changes)
- Security events (failed auth, suspicious activity)

**Bucket Configuration:**

```

Bucket: soc2\_audit\_logs

Retention: 365 days (minimum)

Immutability: Write-once after 30-day grace period

Access: Security team + auditors only

Encryption: At-rest encryption enforced

```

##### #### PCI-DSS Compliance

**Required Logs (90 days minimum, 12 months recommended):**

- Payment transaction logs (amounts MASKED, card numbers REDACTED)
- Access to cardholder data environments
- Authentication to payment systems
- Database queries touching payment data

**Bucket Configuration:**

```

Bucket: pci\_payment\_logs

Retention: 365 days (exceeds 90-day minimum)

Processing: MASK credit card numbers, CVV codes

Access: Payment team + security + auditors

Encryption: TLS 1.2+ in transit, AES-256 at rest

Monitoring: Alert on access attempts

```

#### #### HIPAA Compliance

\*\*Required Logs (6 years minimum, 7 years recommended):\*\*

- PHI access logs (who viewed which patient records)
- Authentication to healthcare systems
- Prescription and medical record changes
- Breach detection events

\*\*Bucket Configuration:\*\*

```

Bucket: hipaa\_phi\_logs

Retention: 2555 days (7 years)

Processing: MASK patient IDs, SSNs, dates of birth

          HASH medical record numbers

Access: Healthcare IT + compliance officers only

Encryption: FIPS 140-2 compliant

Audit: All bucket access logged to separate audit bucket

```

#### #### GDPR Compliance

\*\*Special Considerations:\*\*

- \*\*Right to Erasure:\*\* Logs with EU citizen PII must be deletable on request
- \*\*Data Minimization:\*\* Only collect necessary personal data
- \*\*Retention Limits:\*\* Cannot retain personal data longer than necessary

\*\*Bucket Strategy:\*\*

```

Bucket: eu\_customer\_logs

Retention: 90 days (balancing security and data minimization)

Processing: MASK email addresses, IP addresses

          ADD customer\_id\_hash (for erasure lookup)

Deletion API: Integrate with GDPR erasure requests

Data Residency: EU-only bucket (if required)

```

#### ## Bucket Naming Conventions

\*\*Recommended Pattern:\*\* `\_\_logs`

Examples:

```

prod\_app\_logs

prod\_error\_logs

prod\_security\_logs

staging\_app\_logs

dev\_debug\_logs

compliance\_audit\_logs

```

compliance_soc2_logs
compliance_pci_logs
compliance_hipaa_logs
ephemeral_healthcheck_logs
```

**Benefits:**

- Clear ownership and purpose
- Easy to identify in DQL queries
- Simplifies access control rules
- Supports automated governance checks



### Bucket Lifecycle Management

**Quarterly Review Checklist:**

- [ ] Review bucket usage and growth trends
- [ ] Validate retention periods still match requirements
- [ ] Check for unused or abandoned buckets
- [ ] Audit access control list changes
- [ ] Verify compliance bucket configurations
- [ ] Analyze query patterns for optimization opportunities
- [ ] Review storage costs vs. budget

**Annual Compliance Audit:**

- [ ] Verify all compliance buckets meet regulatory retention
- [ ] Confirm masking/redaction rules are working
- [ ] Test data erasure procedures (GDPR)
- [ ] Review audit trail completeness
- [ ] Validate encryption standards
- [ ] Document bucket governance changes



---



---


## Best Practices

### Routing Best Practices



| Practice  | Description |
|---|-------------|
| **Specific first**   Place specific routes before general ones      |             |
| **Test conditions**   Validate matching conditions with sample data |             |
| **Avoid overlap**   Unless intentional multi-pipeline is needed     |             |
| **Document routes**   Keep a map of route → pipeline → bucket       |             |
| **Monitor default**   High default pipeline volume = missing routes |             |


```

```
### Bucket Best Practices

| Practice | Description |
|-----|-----|
| **Meaningful names** | Use descriptive bucket names |
| **Match retention to value** | Critical data = longer retention |
| **Consider query patterns** | Frequently queried data in main bucket |
| **Plan for compliance** | Audit logs may need 365+ days |
| **Review regularly** | Re-evaluate bucket strategy quarterly |
```

```
### Cost Optimization Best Practices
```

| Practice                   | Impact                          |
|----------------------------|---------------------------------|
| Drop DEBUG/TRACE           | 30–50% volume reduction         |
| Drop health checks         | 5–20% volume reduction          |
| Short retention for dev    | 70–80% cost reduction           |
| Extract metrics, drop logs | Metrics persist, logs don't     |
| Sample high-volume noise   | Keep visibility, reduce storage |

```
---
```

```
## Routing Configuration Examples
```

```
### Example 1: Environment-Based Routing
```

```
**Route 1: Production Logs**  
```
```

```
Condition: k8s.namespace.name == "production" OR k8s.namespace.name == "prod"  
Pipeline: production-logs  
Bucket: production_logs (35 days)  
```
```

```
**Route 2: Development Logs**  
```
```

```
Condition: k8s.namespace.name == "development" OR k8s.namespace.name == "dev"  
Pipeline: development-logs  
Bucket: dev_logs (7 days)  
```
```

```
### Example 2: Severity-Based Routing
```

```
**Route 1: Error Logs (high value)**  
```
```

```
Condition: loglevel == "ERROR"  
Pipeline: error-logs  
Bucket: error_logs (90 days)  
Processing: Parse stack traces, enrich with service info
```

```
```
**Route 2: Debug Logs (low value)**
```
Condition: loglevel == "DEBUG" OR loglevel == "TRACE"
Pipeline: debug-logs
Processing: DROP all (or route to 3-day bucket)
```

### Example 3: Compliance Routing

**Route 1: Audit Logs**
```
Condition: contains(log.source, "audit") OR contains(content,
"authentication")
Pipeline: audit-logs
Bucket: audit_logs (365 days)
Processing: Mask PII, add compliance tags
```
---
```

## ## Next Steps

Now that you understand routing and buckets, continue with:

|                                                     |
|-----------------------------------------------------|
| Notebook   Focus Area                               |
| ----- -----                                         |
| **OPMIG-06**   Processing, Parsing & Transformation |
| **OPMIG-07**   Metric & Event Extraction            |
| **OPMIG-08**   Security, Masking & Compliance       |
| **OPMIG-09**   Troubleshooting & Validation         |

---

## ## References

- [OpenPipeline Data Flow](<https://docs.dynatrace.com/docs/discover-dynatrace/platform/openpipeline/concepts/data-flow>)
- [Grail Buckets](<https://docs.dynatrace.com/docs/platform/grail/data-model/buckets>)
- [OpenPipeline Limits](<https://docs.dynatrace.com/docs/discover-dynatrace/platform/openpipeline/reference/limits>)

---

\*Last Updated: December 12, 2025\*