OSS Tools
for System Management

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Agenda

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- Current State of System Management on IBM i
- Operational Monitoring with Prometheus
- Data Visualization with Grafana
- Event Monitoring with Manzan
- Manzan + AI

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Current State of System Management on IBM i

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What tools are you using for monitoring your IBM i systems?

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Choose up to 3:

1. Dynatrace
2. Nagios
3. Instana
4. DataDog
5. Control4i
6. Syslog Reporting Manager (SRM)
7. Created your own
8. Other

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Specialty is a collective disadvantage

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1. Dynatrace
2. Nagios
3. Instana
4. DataDog
5. Control4i
6. Syslog Reporting Manager (SRM)
7. Created your own
8. Other

Each solutions has their own…

- Configuration
- Host installation requirements
- Monitoring capabilities
  - Collect system metrics (active jobs, ASP consumption)
  - View sub system information
  - Identify long-running SQL
  - View job queue

Can you integrate with other tools?

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Do you use Grafana?

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Choose 1:

1. Yes, with IBM i
2. Yes, but not with IBM i
3. No, but we want to
4. No, we don’t want to
5. No, don’t know what it is

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Operational Monitoring with Prometheus

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Prometheus Overview

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What is it?

- Leading open-source systems monitoring and alerting toolkit
- Collects and stores metrics as timeseries data

Features

- Multi-dimensional data model with time series data identified by metric name and labels
- Provides a functional query language called PromQL
- No reliance on distributed storage
- Has an alert manager built-in
- Easily paired with Grafana and other monitoring solutions

Prometheus

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Prometheus Architecture

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What do exporters do?

Collection of exporters: https://prometheus.io/docs/instrumenting/exporters/

1. Fetch metrics
2. Convert them to Prometheus format
3. Expose data via an HTTP endpoint for it to be scraped

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Data Model for TSDB

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- All data is stored as a time series: `(timestamp, value)`

Ordered by timestamp

Integer or fractional value

- Each time series has a name (metric name)
  - General feature of a system that is measured
- Each time series can have key/value pairs (metric labels)
  - Identifies a particular dimension of the metric
- Notation: `<metric name>{<label name>=<label value>, ...}`
  - `api_http_requests_total{method="POST", endpoint="/messages"}`
- Time series is uniquely identified by metric name + metric label
  - `temperature{city="Toronto"}`
  - `temperature{city="Rochester"}`

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PromQL (Prometheus Query Language)

Functional query language that lets the user select and aggregate time series data in real time

Usage

- Get/filter metrics we are interested in
- Aggregate metrics
- Build dashboards
- Setup alerts

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PromQL Basics

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SQL	PromQL
select * from http_server_request_count	http_server_request_count
select * from http_server_request_count where uri="/api/people"	http_server_request_count{uri="/api/people"}
select * from http_server_request_count where uri="/api/people" and method="GET"	http_server_request_count{uri="/api/people", method="GET"}
select * from http_server_request_count where status like '2%' or status like '3%' or status like '4%'	http_server_request_count{status=~"2..|3..|4.."}

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More PromQL Basics

Data Type	Expression	Example
Scalar	sum(http_server_request_count)	20
Instant Vector	http_server_request_count	20@1708759057
Range Vector	http_server_request_count[3m]	20@1609746001 20@1609746041 20@1609746121

💡 `rate()` function can then be used to calculates the average rate of increase on a range vector

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How to use Prometheus with IBM i

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IBM i Prometheus Exporter

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- JDBC-based exporter that leverages SQL to export IBM i metrics
- Exports hundreds of metrics including:
  - System activity levels (such as CPU usage)
  - Memory pool information
  - Apache HTTP server metrics
  - Number of remote TCP connections
- User customizable metrics with SQL

https://github.com/ThePrez/prometheus-exporter-jdbc

{} config.json ×

home > SANJULA > jar > prometheus > {} config.json > ...

```
1  {
2    "port": 9853,
3
4    "queries": [{
5        "name": "System Statistics",
6        "interval": 60,
7        "enabled": true,
8        "prefix": "STATS",
9        "sql": "SELECT * FROM TABLE(QSYS2.SYSTEM_STATUS(RESET_STATISTICS=>'YES',DETAILED_INFO=>'ALL')) X"
10     },
11     {
12       "name": "System Activity",
13       "interval": 20,
14       "prefix": "SYSACT",
15       "enabled": true,
16       "sql": "SELECT * FROM TABLE(QSYS2.SYSTEM_ACTIVITY_INFO())"
17     },
18     {
19       "name": "number of remote connections",
20       "interval": 30,
21       "enabled": true,
22       "sql": "select COUNT(REMOTE_ADDRESS) as REMOTE_CONNECTIONS from qsys2.netstat_info where TCP_STATE = 'ESTABLISHED'
         AND REMOTE_ADDRESS != '::1' AND REMOTE_ADDRESS != '127.0.0.1'"
23     },
24     {
25       "name": "Memory Pool Info",
26       "interval": 100,
27       "enabled": true,
28       "multi_row": true,
29       "prefix": "MEMPOOL",
30       "sql": "SELECT POOL_NAME,CURRENT_SIZE,DEFINED_SIZE,MAXIMUM_ACTIVE_THREADS,CURRENT_THREADS,RESERVED_SIZE FROM TABLE
         (QSYS2.MEMORY_POOL(RESET_STATISTICS=>'YES')) X"
31     }
32   ]
33 }
```


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Deploying the IBM i Prometheus Exporter

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1. Download latest .jar file from release page and store in the IFS:

```
wget https://github.com/ThePrez/prometheus-exporter-jdbc/releases/latest/download/prom-client-ibmi.jar
```

2. If this is your first time, create a default configuration file (config.json):

```
java -jar prom-client-ibmi.jar
```

3. Respond with y for the following message:

```
Configuration file config.json not found. Would you like to initialize one with defaults? [y]
```

4. Confirm the Prometheus client has started:

```
==============================================================
Successfully started Prometheus client on port 9853
==============================================================
```

5. Create a service commander configuration file (prometheus.yml) and start it:

```
java -jar prom-client-ibmi.jar sc
sc start prometheus.yml
```


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Deploying the Prometheus Instance

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1. Download the Prometheus-provided image from Docker Hub to some central location:

```
docker pull prom/prometheus
```

or

```
podman pull docker.io/prom/prometheus
```

2. Create a Prometheus configuration file (prometheus.yml):

prometheus.yml U

prometheus.yml

```yml
scrape_configs:
  - job_name: 'prometheus'
    static_configs:
      - targets: ['9.5.12.241:9853']
```

3. Launch the image in a container named “prometheus”:

```
docker run -d --name=prometheus -v /path/to/prometheus.yml:/etc/prometheus/prometheus.yml -p 9090:9090
prom/prometheus
```

or

```
podman run -d --name=prometheus -v /path/to/prometheus.yml:/etc/prometheus/prometheus.yml -p 9090:9090
prom/prometheus
```

4. Navigate to Prometheus web UI at http://<container_ip>:9090

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Prometheus Web UI

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Graphing Historical Metric Data

Target System Status

Blog post by Jesse Gorzinski: "Monitoring IBM i with Prometheus"
https://techchannel.com/open-source-on-ibm-i/monitoring-ibm-i-with-prometheus/

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Prometheus can be the bridge to other solutions

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Data Visualization with Grafana

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Grafana Overview

- Open-source analytics, visualization, and monitoring solution
- Driven by Grafana Labs. Plenty of open-source components. See https://grafana.com/
- Over 300 plugins available

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Grafana Data Sources

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Time series databases

Prometheus
Open source time series database & alerting
Core

Graphite
Open source time series database
Core

InfluxDB
Open source time series database
Core

OpenTSDB
Open source time series database
Core

SQL

MySQL
Data source for MySQL databases
Core

Microsoft SQL Server
Data source for Microsoft SQL Server compatible databases
Core

PostgreSQL
Data source for PostgreSQL and compatible databases
Core

Cloud

Azure Monitor
Data source for Microsoft Azure Monitor & Application Insights
Core

CloudWatch
Data source for Amazon AWS monitoring service
Core

Logging & document databases

Loki
Like Prometheus but for logs. OSS logging solution from Grafana Labs
Core

Elasticsearch
Open source logging & analytics database
Core

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Prometheus Visualization with Grafana

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Grafana Backend (Without Prometheus)

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SERVER_NAME	HTTP_FUNCTION	SERVER_NORMAL_CONNECT	SERVER_ACTIVE_THREADS	SERVER_IDLE_THREADS	BYTES_RECEIVED	BYTES_SENT	NONCACHE_PROCESSING_T	CACHE_PROCESSING_TIME
ADMIN	SERVER HANDLED	1520	0	5	1086170	868072	3.72	0
ADMIN	CGI	1520	0	5	42008	3612	1.63	0
ADMIN	WEBSPHERE	1520	0	5	4129509	28220366	0	3071

Blog post by Jesse Gorzinski: "How to Deploy a Simple Grafana Dashboard“
https://techchannel.com/performance/how-to-deploy-a-simple-grafana-dashboard/

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Grafana with or without Prometheus

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	With Prometheus	Straight to Grafana
Persistent storage	Prometheus	Grafana
Persistent storage of unused metrics	Prometheus	--
Metric type	Numerics	Numerics/strings/other
Ecosystem	Extremely Broad	There
Scalability	Excellent	Good
IBM i requisites	None	Node.js
Initial setup	Easier	Easy

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Event Monitoring with Manzan

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Manzan Overview

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- Open-source event handling tool designed to simplify handling of system events
- Serves as a gateway for publishing IBM i events to a variety of endpoints:
  - User applications
  - External resources
  - Open-source technologies
- Example use cases:
  - Monitor system events with a third-party open source or proprietary tool
  - Consolidate logs for auditing/reporting + query for system events
  - Feed real-time system event data into stream processing systems (ie. Apache Kafka)
  - Send alerts for system events

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Understanding the Architecture

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What are inputs?

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Inputs: Sources of your data

- Stream file
- System watch facility (STRWCH)
  - MSGQ
  - LIC logs
  - PAL logs
- System exit points (*coming soon*)
- Audit journals (*coming soon*)

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So practically what can Manzan monitor?

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Application crashes	Log data	Specific entries in log data	System Limits alerts
History Log entries	Problem log entries	*SYSOPR messages	Specific job log messages
Audit journal events (future)	PAL entries	VLOGs	Fishy TCP connections (future)

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What are destinations?

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Destinations: Locations to send data

- Built-in supported destinations:
  - HTTP/HTTPS endpoints (REST, etc)
  - Email (SMTP/SMTPS)
  - SMS (via Twilio)
  - Slack
  - FluentD
  - Kafka
  - Sentry
  - Grafana Loki
  - Google Pub/Sub
  - ActiveMQ

- Custom ILE Code

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Can Manzan send data anywhere?

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- Many desitnations are already working, but there are more to come
- Track supported destinations: https://theprez.github.io/Manzan/#/?id=where-can-i-send-these-events
- Desired target not on the list? Please open an issue to the repository and let us know!

- ActiveMQ ⏳
- AWS Simple Email Service (SES) ⏳
- AWS Simple Notification System (SNS) ⏳
- ElasticSearch ⏳
- Email (SMTP/SMTPS) ✅
- FluentD ✅
- Google Drive ⏳
- Google Pub/Sub ✅
- Grafana Loki ✅
- HTTP endpoints (REST, etc) ✅
- HTTPS endpoints (REST, etc) ✅
- Internet of Things (mqtt) ⏳
- Kafka ✅
- Mezmo ⏳
- Microsoft Teams ⏳
- PagerDuty ⏳
- Sentry ✅
- Slack ✅
- SMS (via Twilio) ✅
- Splunk ⏳

✅ = implemented 🌗 = partially implemented ⏳ = future

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Understanding the Architecture: Handler and Distributor

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WIP

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Configuring Inputs and Destinations

Configuration files are located in /QOpenSys/etc/manzan

app.ini

Used for general Manzan configuration
(you can leave the default contents)

```
[install]
library=MANZAN
```

data.ini

Used for configuring different data sources (inputs)

```
[<id>]
# where the data is coming from
type=<type>
# as defined in dests.ini
destinations=<destinations>

# other properties for <id> here..
```

dests.ini

Used for configuring different destinations

```
[<id>]
# the type of destination the data is going to
type=<type>

# other properties for <id> below (specific
# to each destination)...
```


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Simple data.init configuration

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Stream file

- Watch application log file (test.txt) and only take action when a line written to the file contains the string "error"

```
[logfile1]
type=file
file=test.txt
destinations=email_it, test_out
filter=error
format=$FILE_DATA$
```

System Watch

- Manage information from watch session with id "jesse"

```
[watcher1]
type=watch
id=jesse
destinations=test_out, slackme
enabled=false
```


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Advanced data.init configuration

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System Watch

- Manage information from watch session with id "jesse", which is configured to watch all messages in the IBM i history log
- Format the message into a human-sensible format
- Automatically start the watch when Manzan is started

```
[watchout]
type=watch
id=jesse
destinations=test_out, slackme
format=$MESSAGE_ID$ (severity $SEVERITY$): $MESSAGE$
strwch=WCHMSG((*ALL)) WCHMSGQ((*HSTLOG))
```


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Example dests.ini configuration

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Send an email

```
[email_b]
type=smtp
format=Hey, check out this information!! \n\n$FILE_DATA$
  server = my.smtpserver.com
  subject = Testemail
  from=me@mycompany.com
  to=me@mycompany.com
```

Send to Sentry

```
[sentry_out]
type=sentry
dsn=<slackdsn>
```


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What does it look like in Sentry?

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sentry.io

IBM
Liam

Projects
Issues
Performance
Profiling beta
Releases
Crons beta
User Feedback
Alerts
Discover
Dashboards

Quick Start
5 Remaining tasks

Upgrade Now
Help
What's new

Collapse

Issues

Saved Searches

All Unresolved 12 | For Review | Ignored

manzan | All Envs | 14D | is:unresolved

Resolve | Ignore | Last Seen | GRAPH: 24h 14d | EVENTS | USERS | ASSIGNEE

	EVENTS	USERS
MCH3601: Pointer not set for location referenced.Cause . . . . . : A pointer w 24946 MANZAN-C 1wk ago | 2wk old	385	1
MCH4421: Invalid operation for program.Cause . . . . . : The operation reque 26669 MANZAN-7 1wk ago | 2wk old	47	1
MCH1401: Receiving context contains duplicate object.Cause . . . . . : An at 25195 MANZAN-5 1wk ago | 2wk old	233	2
MCH3601: Pointer not set for location referenced.Cause . . . . . : A pointe 26742 MANZAN-G 1wk ago | 1wk old	1	1
MCH3401: Cannot resolve to object QTMSTRCSVR. Type and Subtype X'19 26987 MANZAN-A 1wk ago | 2wk old	29	1
MCH5801: Dequeue operation not satisfied in 15 seconds for queue &1C		

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What does it look like in Sentry?

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sentry.io

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- Projects
- Issues
- Performance
- Profiling beta
- Releases
- Crons beta
- User Feedback
- Alerts
- Discover
- Dashboards

Quick Start
5 Remaining tasks

- Upgrade Now
- Help
- What's new
- Collapse

Additional Data

Formatted | Raw

HANDLED_TIMESTAMP	2022-12-12T17:21:17.996Z
JOB	293151/QUSER/QZDASOINIT
MESSAGE	Invalid operation for program.Cause . . . . . : The operation requested is not supported for program &1. The system supports distinct "models" of program objects. Not all operations are supported for all models of programs. For example, some program objects cannot be deactivated.
MESSAGE_ID	MCH4421
MESSAGE_TIMESTAMP	2022-12-12T17:21:17.936Z
MESSAGE_TYPE	*ESCAPE
ORDINAL_POSITION	25197
SENDING_MODULE_NAME	QSQRINZ
SENDING_PROCEDURE_NAME	QSQRINZ
SENDING_PROGRAM_NAME	QSQRINZ
SENDING_USRPRF	QUSER
SESSION_ID	JESSE
SEVERITY	40

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More example dests.ini configuration

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Send SMS message with Twilio

```
[twilio_sms]
type=twilio
sid=[redacted]
token=[redacted]
to=+[redacted]
from=+[redacted]
```

Send to Slack

```
[slackme]
type=slack
channel=open-source-system-status
webhook=https://hooks.slack.com/services/TA3EF58G4...
```


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Putting it together

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dests.ini

```
[slackme]
type=slack
channel=open-source-system-status
webhook=https://hooks.slack.com/services/TA3EF58G4...
```

data.ini

```
[watchout]
type=watch
id=jesse
destinations=slackme
format=$MESSAGE_ID$ (severity $SEVERITY$): $MESSAGE$
strwch=WCHMSG((*ALL)) WCHMSGQ((*HSTLOG))
```


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What does it look like in Slack?

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open-source-system-status – Dec 20th, 2022

ibm i system monitor APP 9:01 PM

CPIAD09 (severity 0): User LINUX from client 9.163.40.192 connected to job 492988/QUSER/QZDASOINIT in subsystem QUSRWRK in QSYS on 12/20/22 20:17:06.

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Ingest Logs into Grafana Loki

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WIP

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More examples…Grafana loki!

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Explore - grafanacloud-sanjulag

sanjulaganepola.grafana.net/explore?schemaVersion=1&panes=%7B"ei5":%7B"datasource":"grafanacloud-logs","queries":%5B%7B"refId":"A","expr":"%7Bapp%3D%5C"manzan%5C"...

Search or jump to... ctrl+k

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Application
Frontend
Connections
Add new connection
Collector
Data sources
Integrations
Private data source connect
Apps
Administration

Outline | grafanacloud-sanjulaganepol | Split | Add | Live

Queries
Logs

Manzan (grafanacloud-sanjulaganepola-logs) {app="manzan"} |= ``

Add query | Query history | Query inspector

Logs volume

Logs | Logs | Table

Time | Unique labels | Wrap lines | Prettify JSON | Deduplication: None | Exact | Numbers | Signature

Display results: Newest first | Oldest first

Common labels: SENDING_MODULE_NAME= app=manzan service_name=manzan

Download

Line limit: 1000 reached, received logs cover 25.42% (15min 15sec) of your selected time range (1h)

Total bytes processed: 4.99 MB

```
2024-10-01 13:44:14.042  JOB=465707/QUSER/QZSOSIGN
                         MESSAGE_ID=CPIAD0B
                         MESSAGE_TYPE=*INFO
                         SENDING_PROGRAM_NAME=QZSOSIGN
                         SENDING_USRPRF=QUSER
                         SESSION_ID=sanjula
                         SEVERITY=0
                         CPIAD0B (severity 0): *SIGNON server job 465707/QUSER/QZSOSIGN processing re
                         quest for user SANJULA on 10/01/24 13:44:14 in subsystem QUSRWRK in QSYS.Cau
                         se . . . . . :   The *SIGNON server is processing request 1 for user SANJUL
                         A.  The types of requests supported are as follows: 1 -- Retrieve Signon Inf
                         ormation 2 -- Change Password 3 -- Generate Authentication Token 4 -- Genera
                         te Authentication Token on Behalf of Another User 5 -- Start Server
2024-10-01 13:44:14.024  JOB=465707/QUSER/QZSOSIGN
                         MESSAGE_ID=CPIAD0B
                         MESSAGE_TYPE=*INFO
                         SENDING_PROGRAM_NAME=QZSOSIGN
                         SENDING_USRPRF=QUSER
                         SESSION_ID=sanjula
                         SEVERITY=0
                         CPIAD0B (severity 0): *SIGNON server job 465707/QUSER/QZSOSIGN processing re
                         quest for user SANJULA on 10/01/24 13:44:14 in subsystem QUSRWRK in QSYS.Cau
                         se . . . . . :   The *SIGNON server is processing request 1 for user SANJUL
                         A.  The types of requests supported are as follows: 1 -- Retrieve Signon Inf
                         ormation 2 -- Change Password 3 -- Generate Authentication Token 4 -- Genera
                         te Authentication Token on Behalf of Another User 5 -- Start Server
2024-10-01 13:44:14.022  JOB=465708/QUSER/QZSOSIGN
                         MESSAGE_ID=CPIAD0B
                         MESSAGE_TYPE=*INFO
                         SENDING_PROGRAM_NAME=QZSOSIGN
                         CPIAD0B (severity 0): *SIGNON server job 465708/QUSER/QZSOSIGN
                         quest for user SANJULA on 10/01/24 13:44:14 in subsystem QUSRWR
                         se . . . . . :   The *SIGNON server is processing request 1 for user SANJUL
                         A.  The types of requests supported are as follows: 1 -- Retrieve Signon Inf
```


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Visualize logs in custom Grafana dashboard

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Manzan Dashboard - Dashboar

sanjulaganepola.grafana.net/d/cdz6l0myytywwf/manzan-dashboard?from=2024-10-01T17:42:55.000Z&to=2024-10-01T17:46:05.000Z&timezone=browser

Search or jump to... ctrl+k

Home › Dashboards › Manzan Dashboard

Share Edit

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- Infrastructure
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- Frontend
- Connections
  - Add new connection
  - Collector
  - Data sources
  - Integrations
  - Private data source connect
- Apps
- Administration

2024-10-01 13:42:55 to 2024-10-01 13:46:05 Refresh

Message Frequency

Log Count By Level

Critical Logs

Common labels: MESSAGE_ID=*IMMED MESSAGE_TYPE=*INFO SENDING_MODULE_NAME= SENDING_PROGRAM_NAME=QCAPCMD SENDING_USRPRF=SANJULA SESSION_ID=sanjula1 SEVERITY=80 app=manzan service_name=manzan

```
  2024-10-01 13:45:59.924 *IMMED (severity 80): Invalid operation for pro
                          gram
  2024-10-01 13:45:40.884 *IMMED (severity 80): Pointer not set
  2024-10-01 13:45:27.173 *IMMED (severity 80): Error in program
2x 2024-10-01 13:45:19.860 *IMMED (severity 80): Pointer exception
```

All Logs

Common labels: SENDING_MODULE_NAME= app=manzan service_name=manzan

```
  2024-10-01 13:45:59.924 *IMMED (severity 80): Invalid operation for pro
                          gram
  2024-10-01 13:45:40.884 *IMMED (severity 80): Pointer not set
  2024-10-01 13:45:27.173 *IMMED (severity 80): Error in program
2x 2024-10-01 13:45:19.860 *IMMED (severity 80): Pointer exception
  2024-10-01 13:44:14.045 CPIAD09 (severity 0): User SANJULA from client
                          127.0.0.1 connected to job 463761/QUSER/QZDASOI
                          NIT in subsystem QUSRWRK in QSYS on 10/01/24 1
                          3:44:14.
  2024-10-01 13:44:14.043 CPIAD09 (severity 0): User SANJULA from client
                          127.0.0.1 connected to job 463291/QUSER/QZDASOI
                          NIT in subsystem QUSRWRK in QSYS on 10/01/24 1
                          3:44:14.
  2024-10-01 13:44:14.042 CPIAD09 (severity 0): User SANJULA from client
                          127.0.0.1 connected to job 463530/QUSER/QZDASOI
```


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Future Enhancements to Manzan

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- Trigger events based on audit journals

- Exit point processing (currently this is completely unimplemented)

- Metrics exported to Prometheus, for instance:
  - How many MCH exceptions have happened in production applications?
  - How many severity 40+ history log entries?
  - How many errors showing in web server logs?
  - How many PASE vlogs have been created?

- Ability to trigger events from Prometheus exporter, for instance:
  - Memory pool usage anomalies
  - Increased HTTP server traffic
  - Unexpected amount of remote connections
  - Operational data beyond thresholds

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Manzan + AI

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AI-Based System Monitoring: Failure Prediction System

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AI-Based System Monitoring: Intrusion Detection System

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AI-Based System Monitoring: Health and Performance Assistant

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Takeaways

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01

Grafana is a must-have technology

02

Prometheus is a great way to enable ongoing monitoring

03

Manzan is a great way to handle various events and integrate with tons of solutions

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Any Questions?

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Important Links

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For more information

IBM Sites:

IBM i Home Page	https://www.ibm.com/it-infrastructure/power/os/ibm-i
IBM Strategy Whitepaper	https://www.ibm.com/it-infrastructure/us-en/resources/power/i-strategy-roadmap/
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For more information:

Blogs to follow

- TechChannel You and i (Steve Will)
- TechChanneli-Can (Dawn May)
- TechChannel: iTalk with Tuohy
- TechChannel: OpenYour i with Jesse Gorzinski
- IBM Db2 for i (Kent Milligian)
- IBM i Analyitics Blog (Jon Westcott Jr)
- iSee with Scott and Tim

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