Troubleshooting and Baselining the Environment

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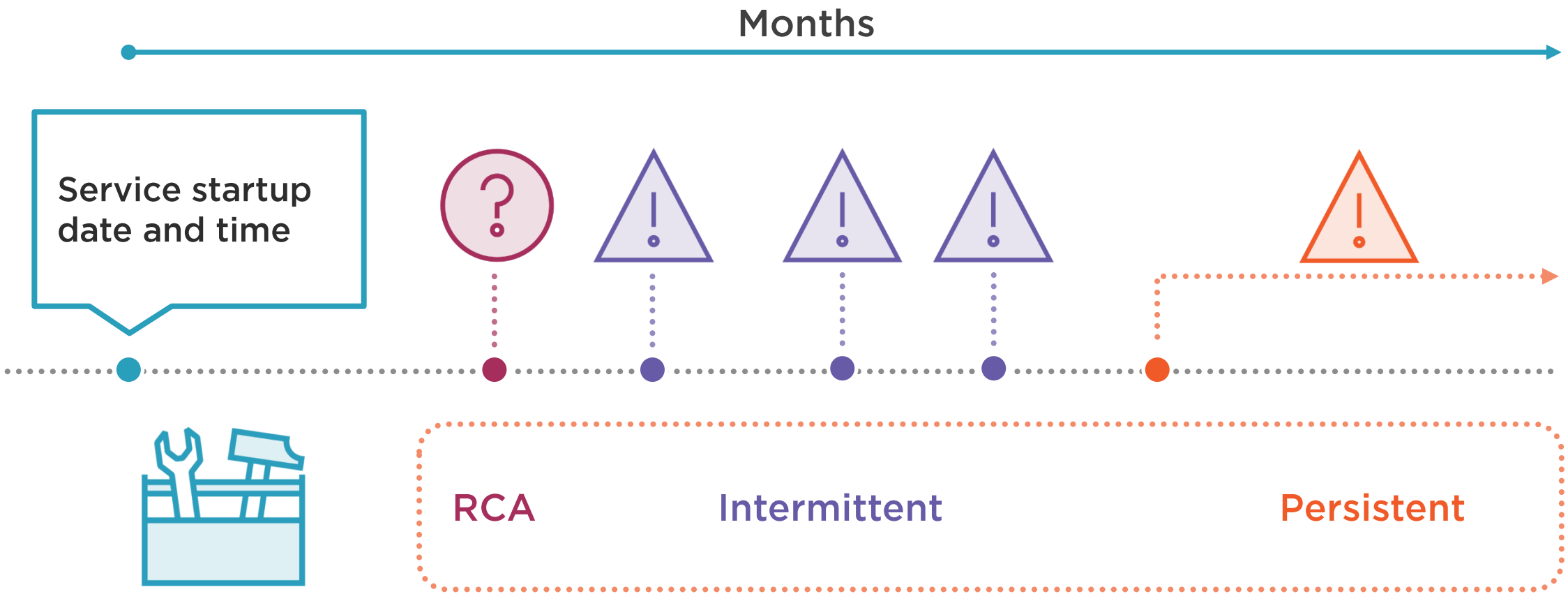
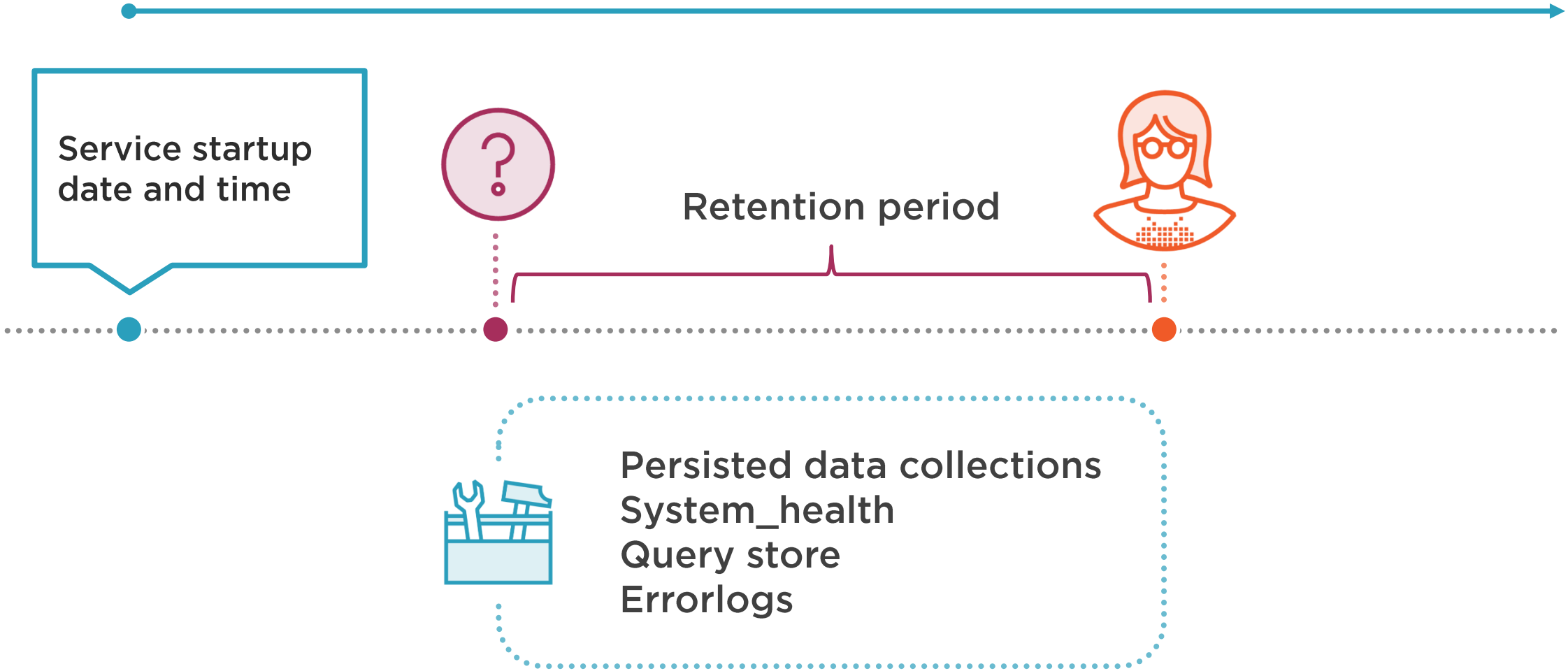
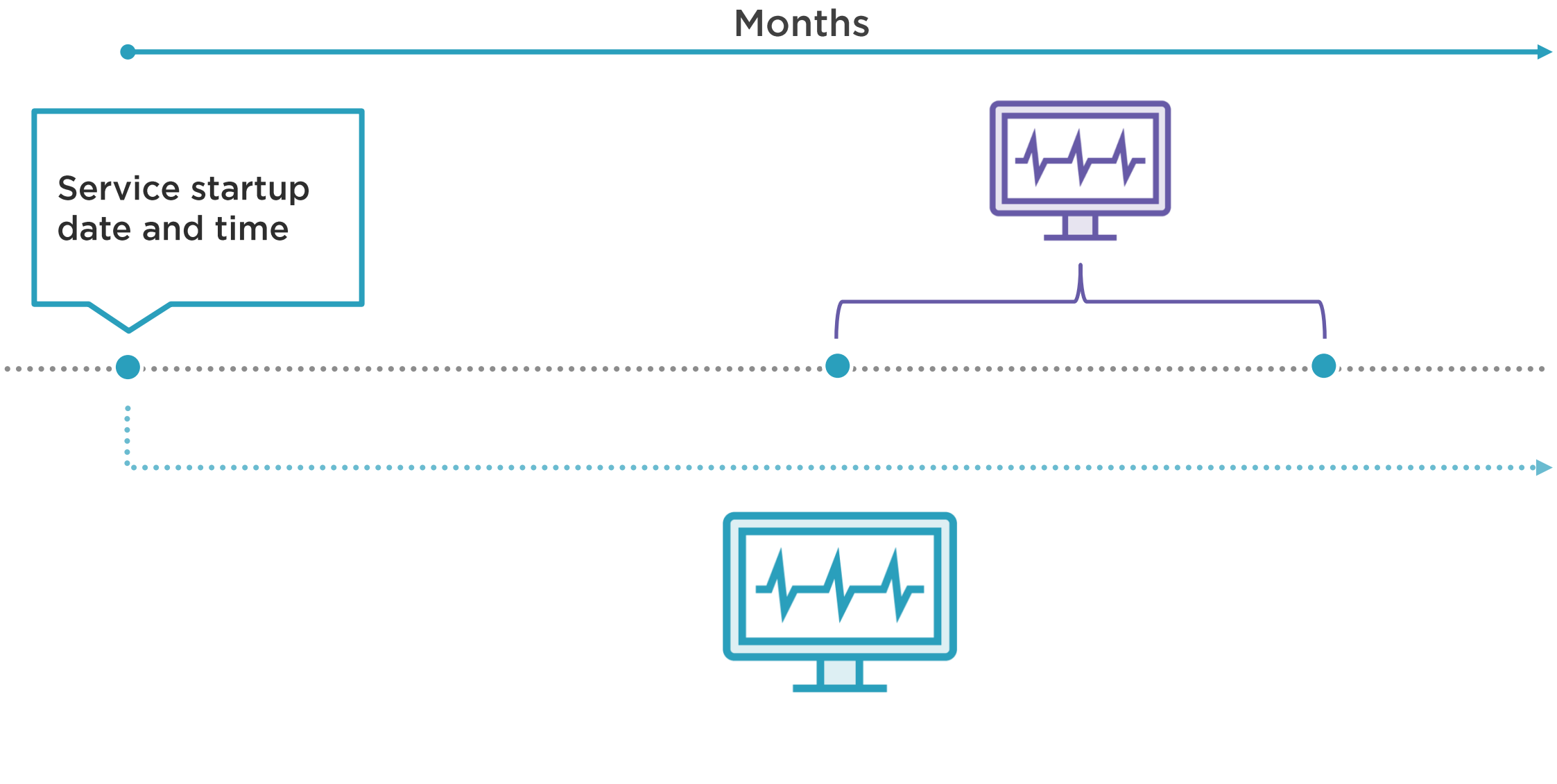
Performance Problems Timeline



Root Cause Analysis



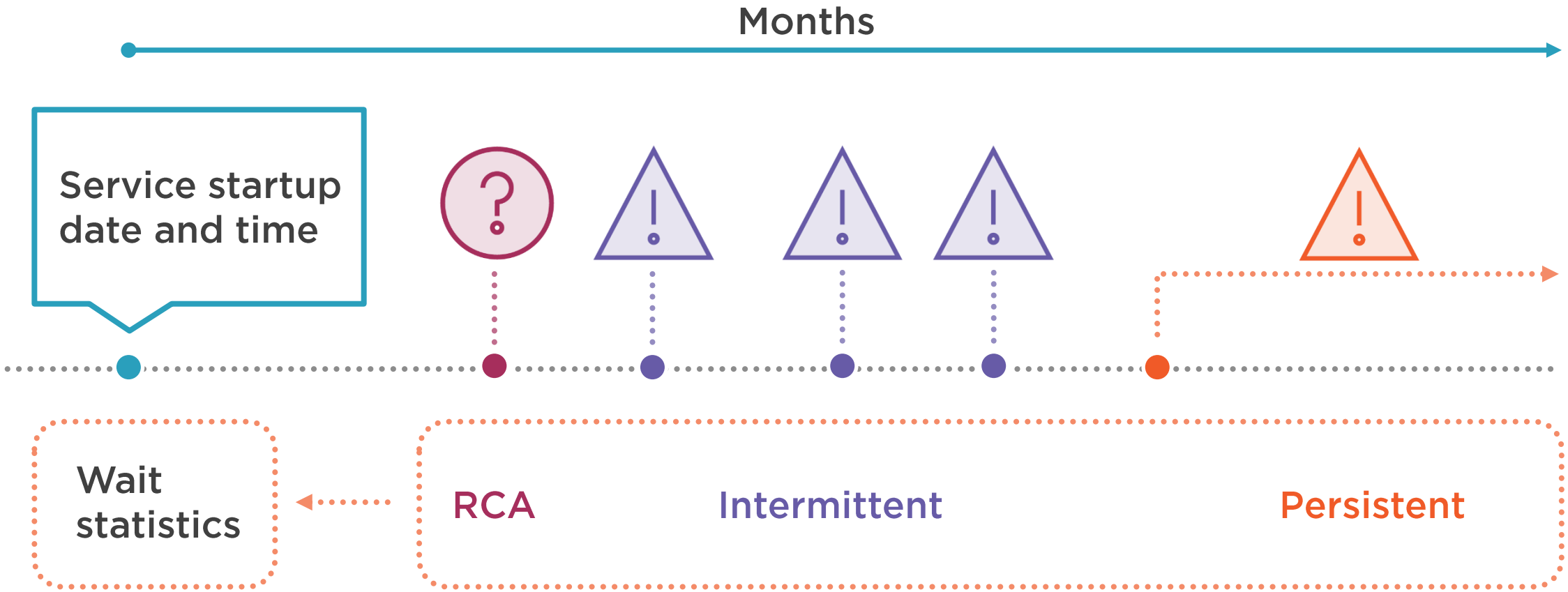
Performance Baselining



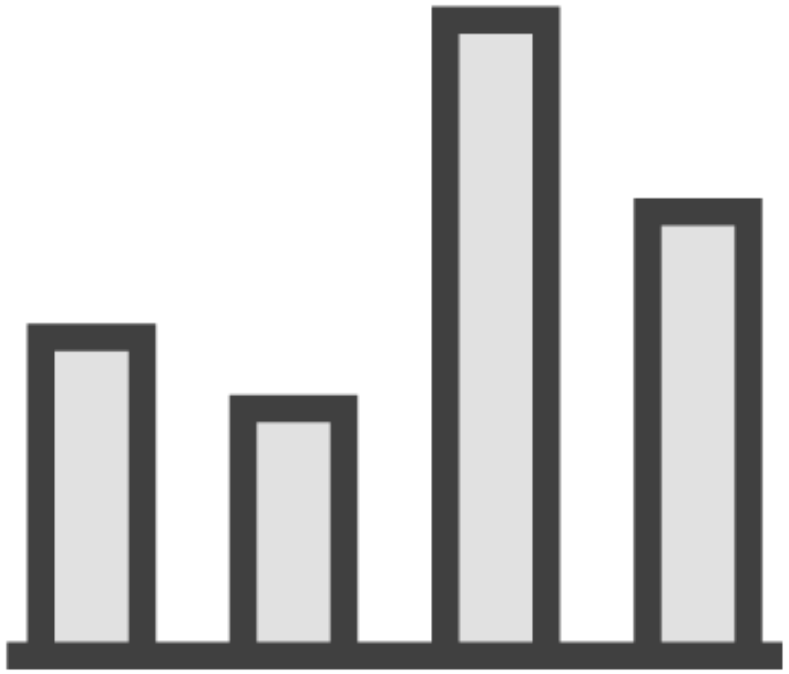
- Wait statistics
- Dynamic management views (DMVs)
- Query store
- System_health session trace
- Performance Monitor (Perfmon) trace

Practical Wait Statistics

Performance Problems Timeline



Wait Statistics Toolset

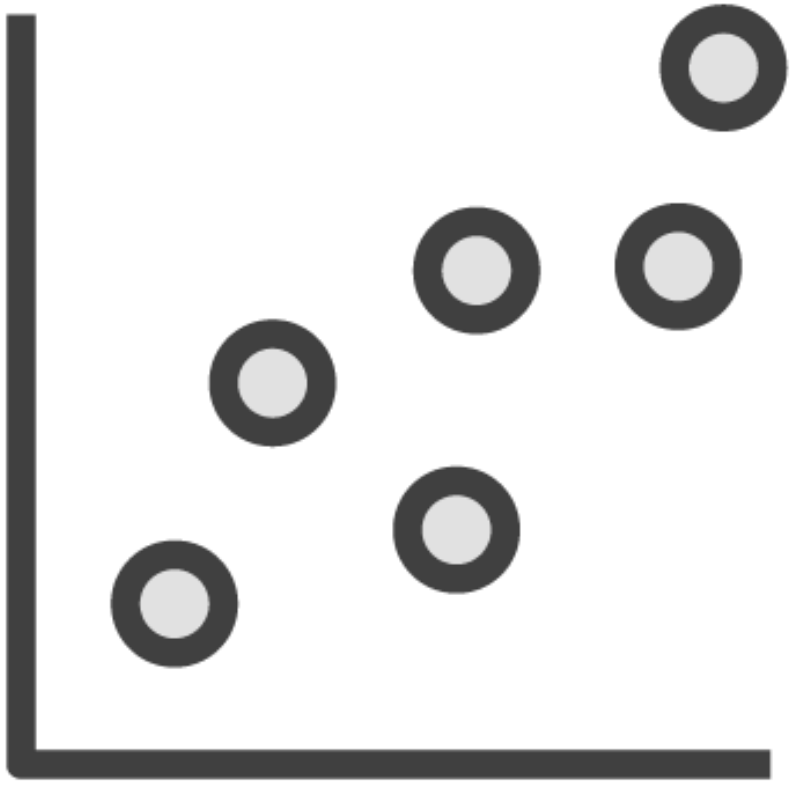


- Sys.dm_os_wait_stats
- Sys.dm_db_wait_stats
- Sys.dm_exec_session_wait_stats
- Query store
- Custom trace

Multi-level Wait Statistics

Level	Method
Server instance	Sys.dm_os_wait_stats
Database (Azure SQL Database)	Sys.dm_db_wait_stats
Session	Sys.dm_exec_session_wait_stats
	Custom trace
Query	Query store
	Custom trace

Server-level Wait Statistics



Sys.dm_os_wait_stats

- Cumulative since last restart of server
- Can be cleared manually too

Good for

- Overall server health-check
- Collecting server baselines
- Identifying problem patterns and troubleshooting entry points

Use custom query to collect and analyze

A Widely Used Wait Statistics Query

Used for server level waits analysis

It should be part of your toolset every time!

Source

- www.sqlskills.com
- https://bit.ly/2wsQHQE

What it does

- Shows the prevalent waits only
- Calculates average wait times
- Excludes benign waits

Common Wait Types and Patterns - IO

PAGEIOLATCH_XX

IO wait when reading pages from disk in SH or EX mode

WRITELOG

IO wait when writing the transaction log

Common Wait Types and Patterns - CPU

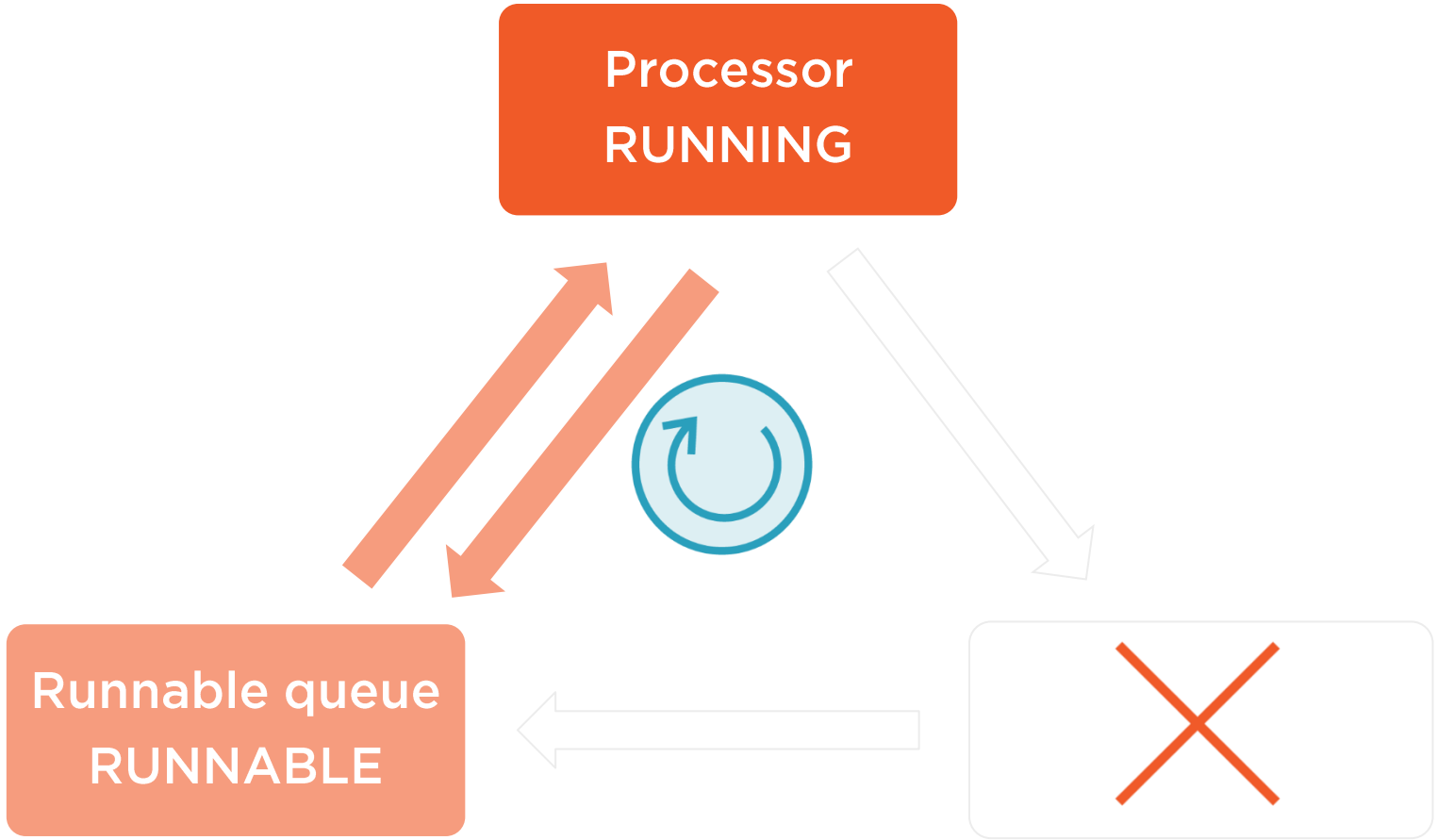
CXPACKET

Parallelism is present

SOS_SCHEDULER_YIELD

Persistent CPU utilization

SOS_SCHEDULER_YIELD



Common Wait Types and Patterns - OS

PREEMPTIVE_OS_WRITEFILEGATHER

NTFS zero file initialization

PREEMPTIVE_OS_AUTHENTICATIONOPS

DC authentication

Common Wait Types and Patterns - Locking

LCK_M_S

Waiting to acquire shared locks

LCK_M_X, LCK_M_IX

Waiting to acquire exclusive locks

Common Wait Types and Patterns – Data Page

PAGELATCH_SH

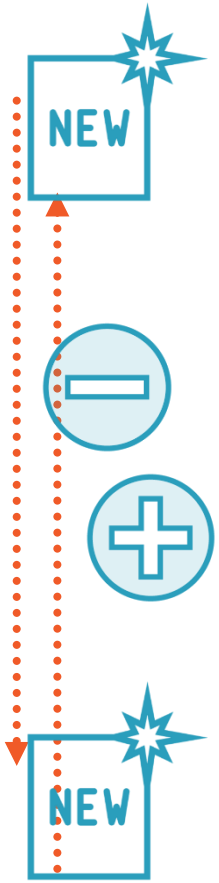
Waiting to access data pages in-memory for read

PAGELATCH_EX, PAGELATCH_UP

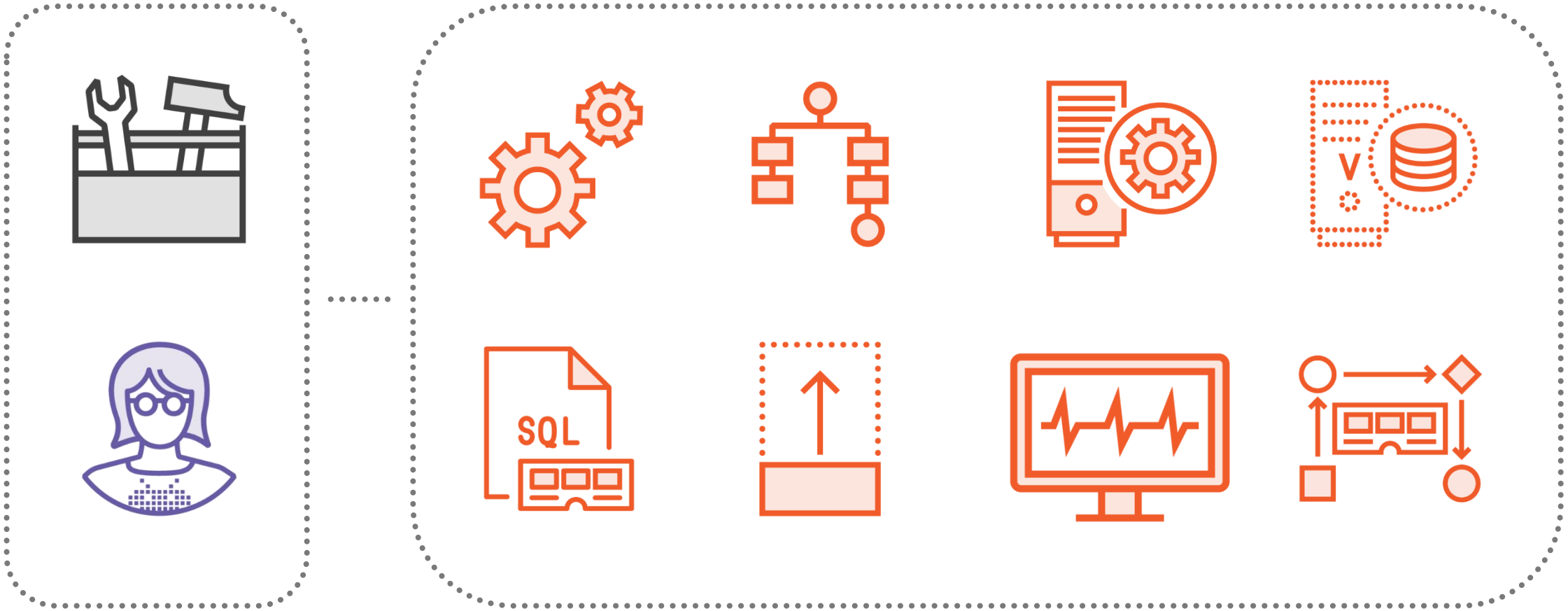
Waiting to access data pages in-memory for modification

Pattern Changes Example

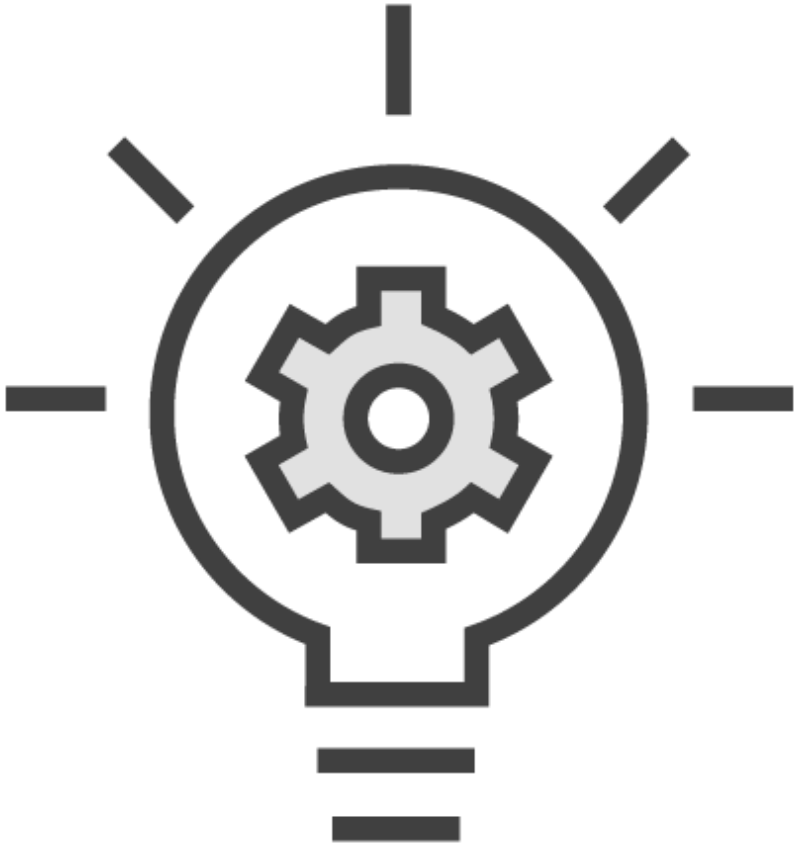
Before	After
CXPACKET	SOS_SCHEDULER_YIELD
WRITELOG	LCK_M_S
PAGELATCH_EX	WRITELOG
BACKUPIO	LCK_M_IX
OLEDB	PAGELATCH_EX
ASYNC_NETWORK_IO	ASYNC_NETWORK_IO
LCK_M_S	CXPACKET
LCK_M_IX	PAGEIOLATCH_SH



Troubleshooting Plan



Understanding Wait Statistics Results



Waits are normal, filter out good waits

Focus on the prevalent wait types, wait counts and average wait times

There are hundreds of wait types, only a dozen or two will show up as prevalent

Look for changes in patterns

Look for red flag or poison waits

- THREADPOOL
- RESOURCE_SEMAPHORE

Wait Statistics Library References

Comprehensive wait type libraries

- https://bit.ly/2UZG7tm
- http://www.sqlskills.com/help/waits/

Get production samples and get familiar with patterns

- Do not focus on memorizing all the wait types

Demo

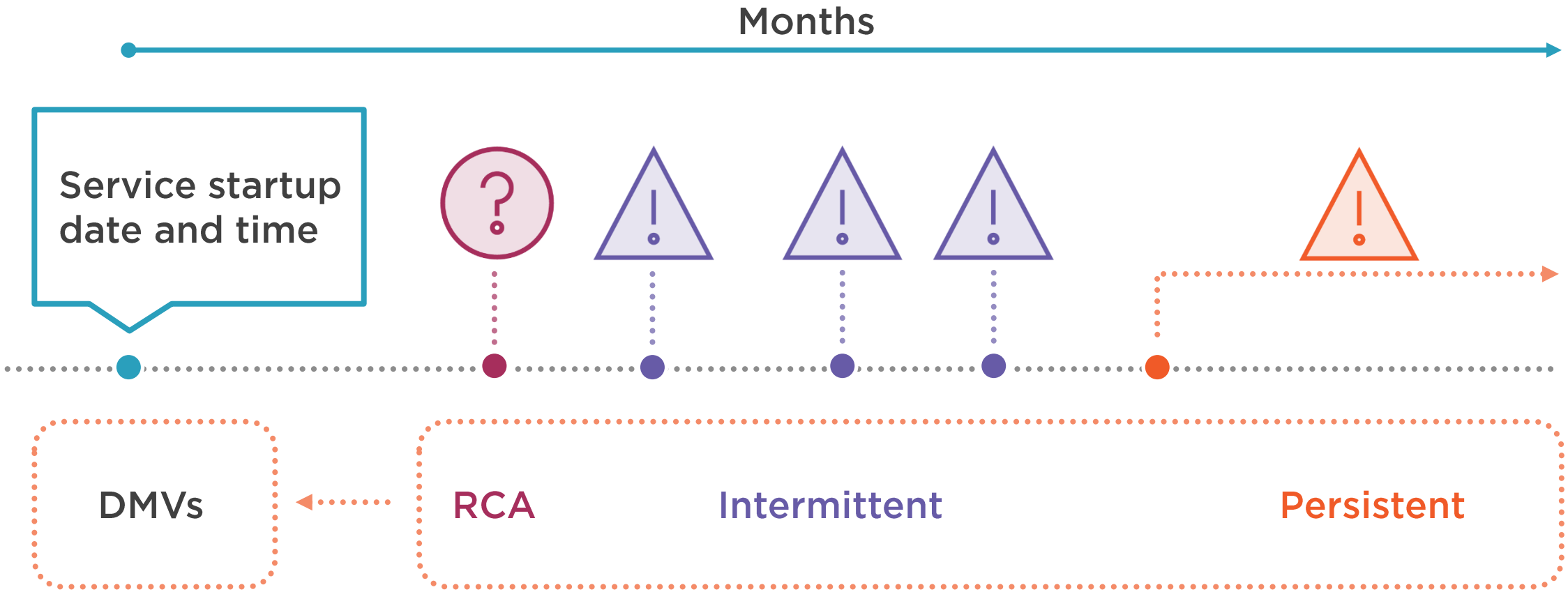
Analyzing server wait statistics with an on-premise SQL Server instance

Analyzing database wait statistics with Azure SQL Database

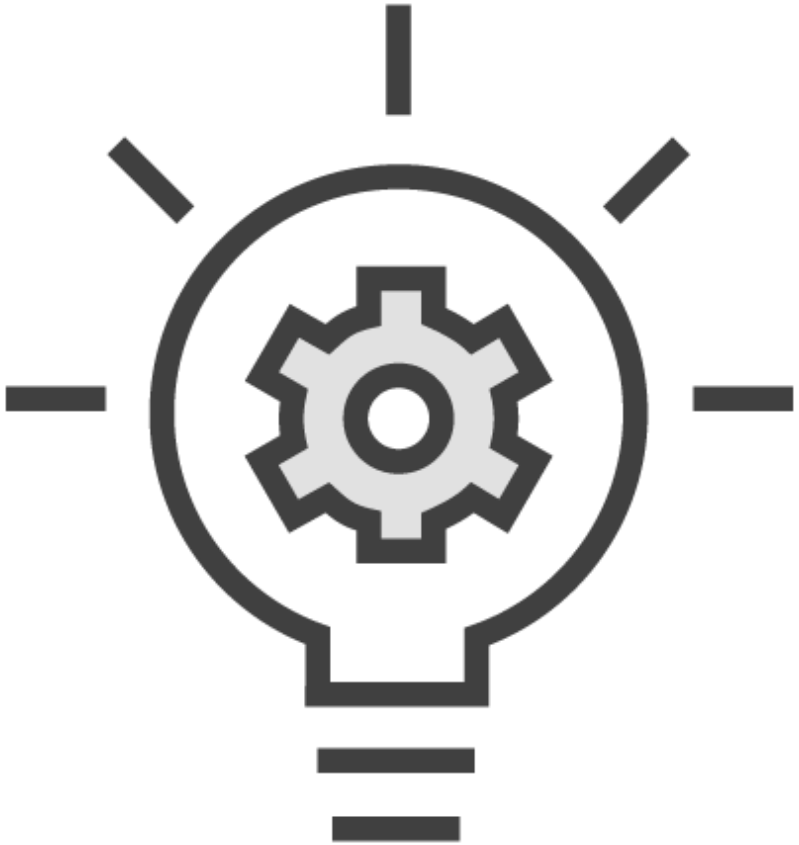
Using custom script for wait statistics data collection and analysis

Dynamic Management Views (DMVs)

Performance Problems Timeline



Dynamic Management Views



Provide internal version specific (diagnostic) data

DMVs for many areas

- SQLOS: sys.dm_os_wait_stats
- IO: sys.dm_io_virtual_file_stats
- Databases
- Indexes
- Server instance
- Transactions

A Widely Used IO Statistics Query

Used for database file level IO statistics

It should be part of your toolset every time!

Source

- www.sqlskills.com
- https://bit.ly/2JaX2bH

What it does

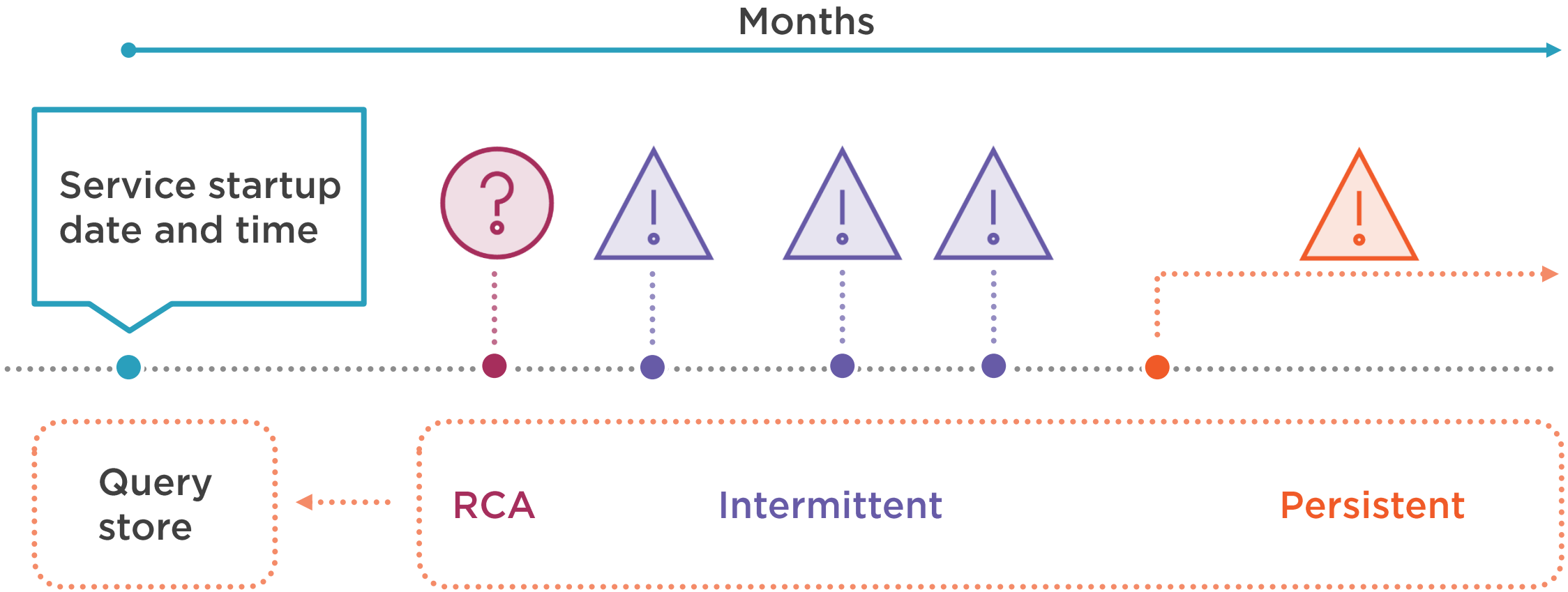
- Uses sys.dm_io_virtual_file_stats
- Calculates latency values and averages

Demo

Using custom script for file level IO statistics data collection and analysis

Query Store

Performance Problems Timeline



Query Store Availability

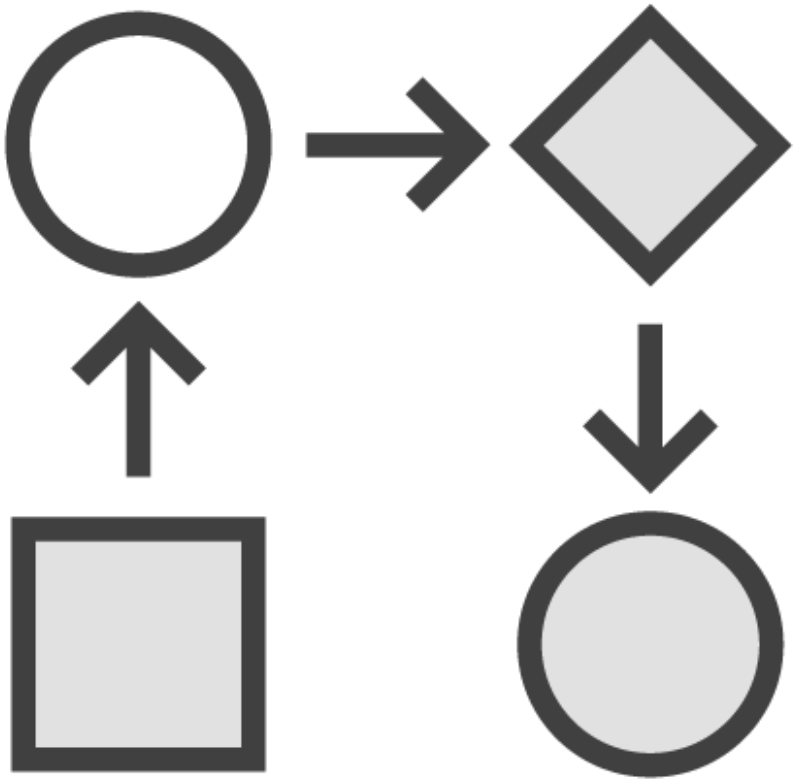
On-premise or IaaS

Turned off by default

Azure SQL Database

Turned on by default

Query Store



Persistent store at database level

Flight-recorder of query plans and runtime statistics

Query wait statistics added in SQL2017

Used for

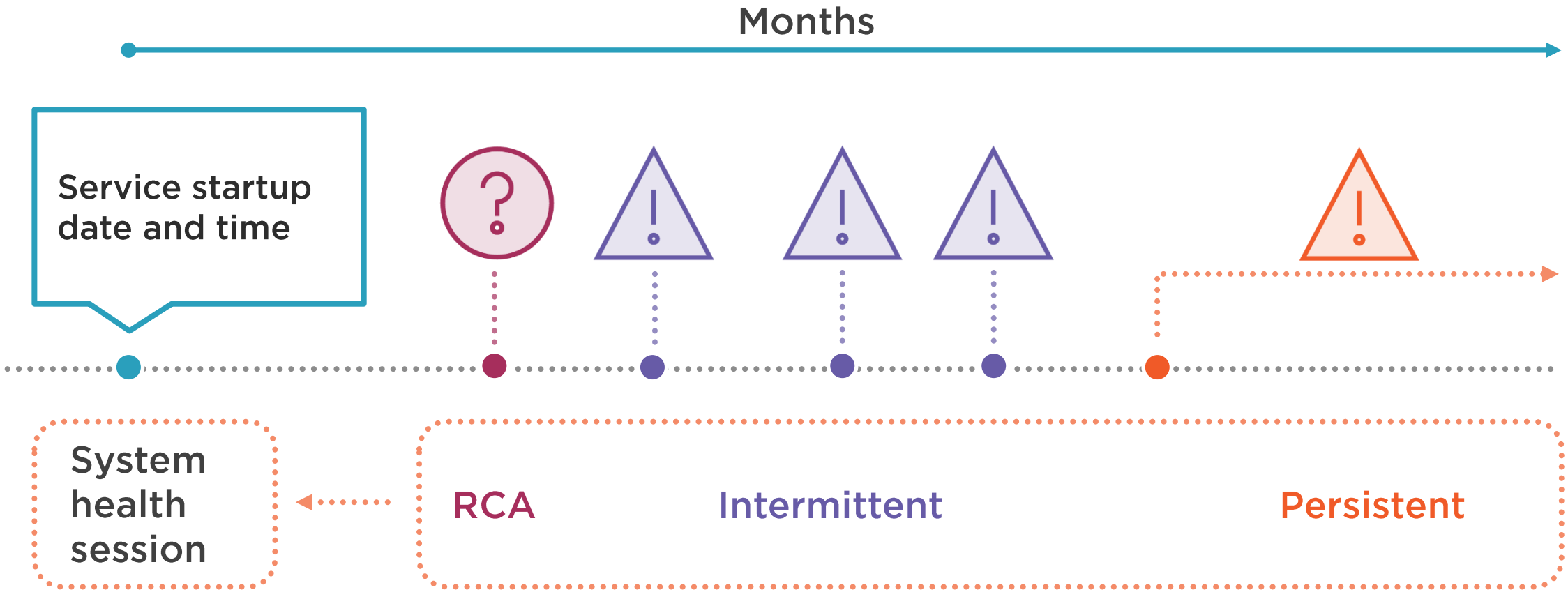
- Tracking query performance over time
- Tracking query plan changes over time
- Addressing query plan regressions
- Helping developers in query optimization

Demo

Using the Query Store in Azure SQL Database to track query performance

System_health Session Trace

Performance Problems Timeline



System_health Session Trace

Built-in extended event trace session

Trace files in the SQL Server log folder

- System_health.xel

Collects for example

- Selected error numbers
- CPU and memory related errors and problems
- Sp_server_diagnostics outputs
- Deadlock graphs

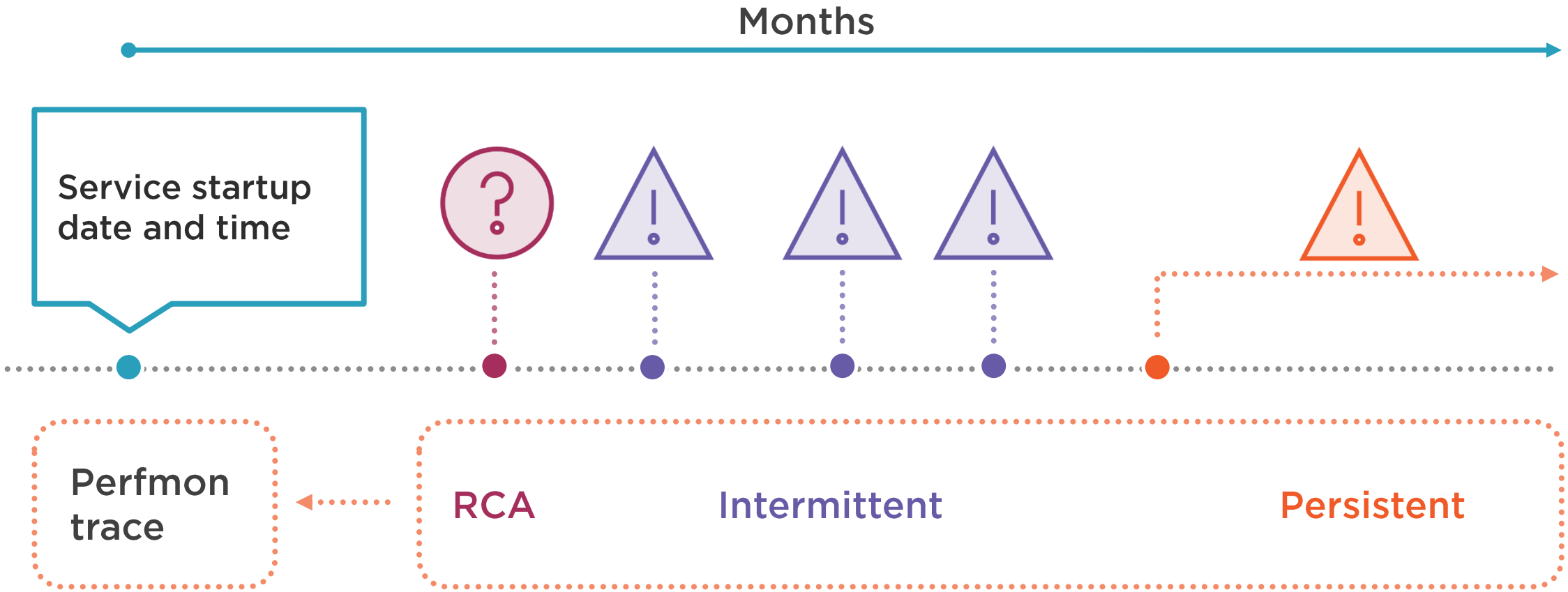
Demo

Using the system_health session trace with an on-premise SQL Server instance

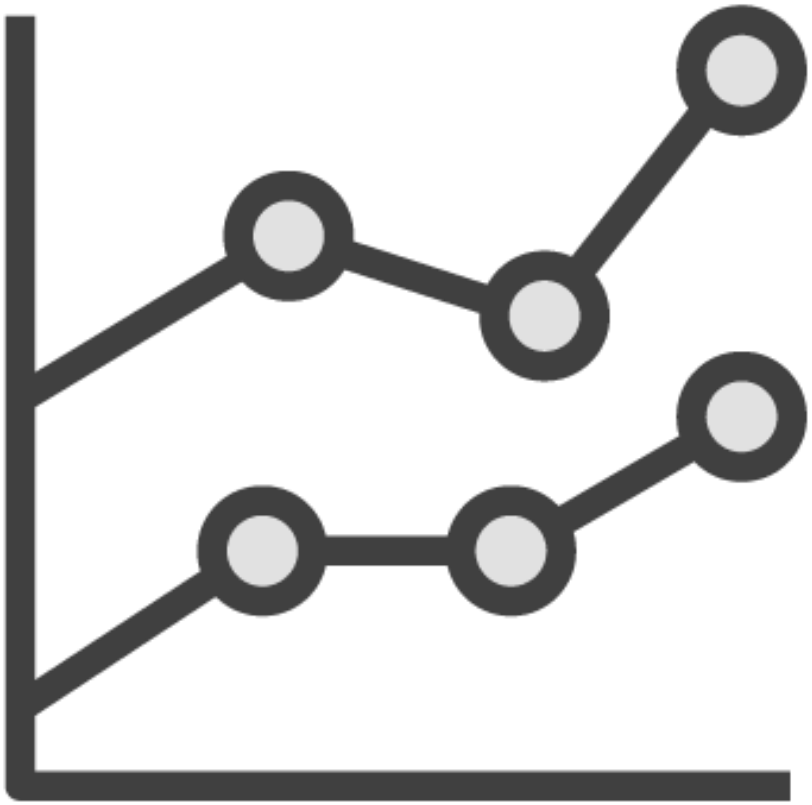
Using SSMS for trace analysis

Perfmon Traces

Performance Problems Timeline



Perfmon Trace



System and SQL Server object counters

Used for trend analysis and to see the details in context

Collect when the problem occurs or for baselining

Collect with

- Windows Performance Monitor (all counters)
- Sys.dm_os_performance_counters view (SQL Server cached counters)

What to Collect in a Perfmon Trace?

System objects and counters

- Processor and memory
- LogicalDisk
  - Avg. disk sec/read
  - Avg. disk sec/write

SQL Server objects and counters

- Buffer Manager and Memory Manager
- Access methods
- Databases
- General statistics and SQL statistics

Analyzing Perfmon Traces

Windows Performance Monitor UI

- Manual analysis, to see all the details

PAL utility

- https://github.com/clinthuffman/PAL

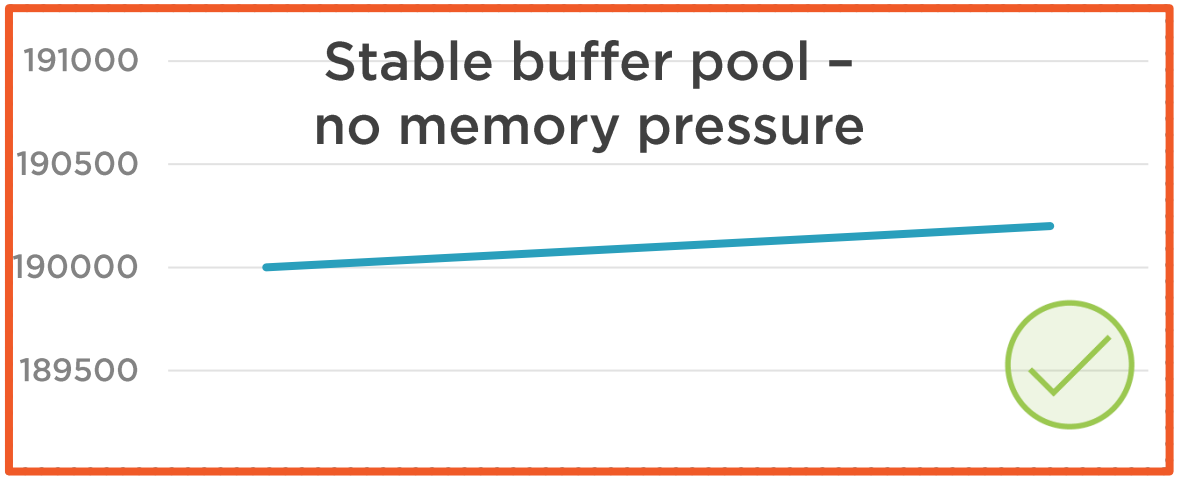
PAL is very good for

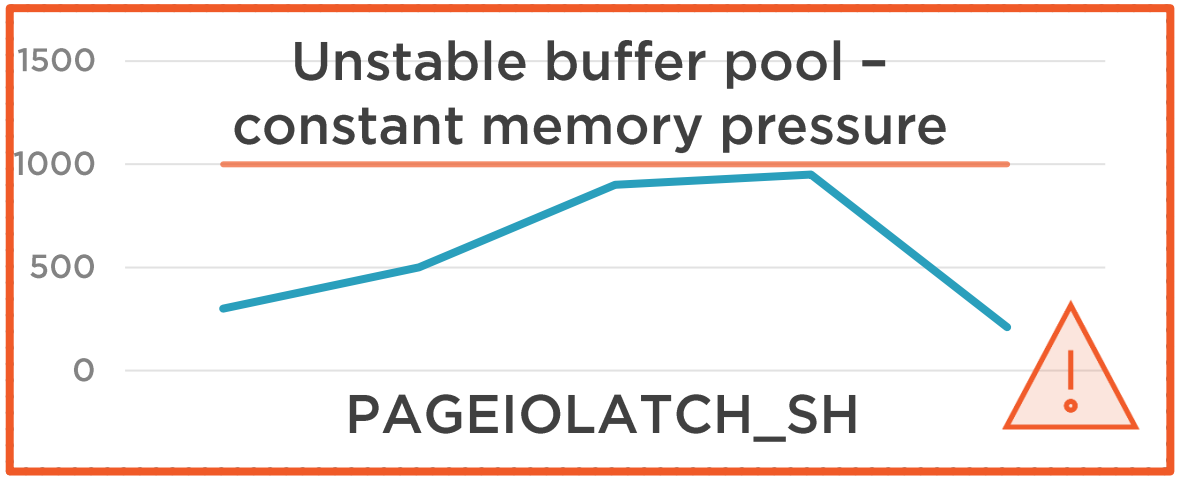
- Quick analysis and overview
- Providing nice report with charts, explanations and thresholds

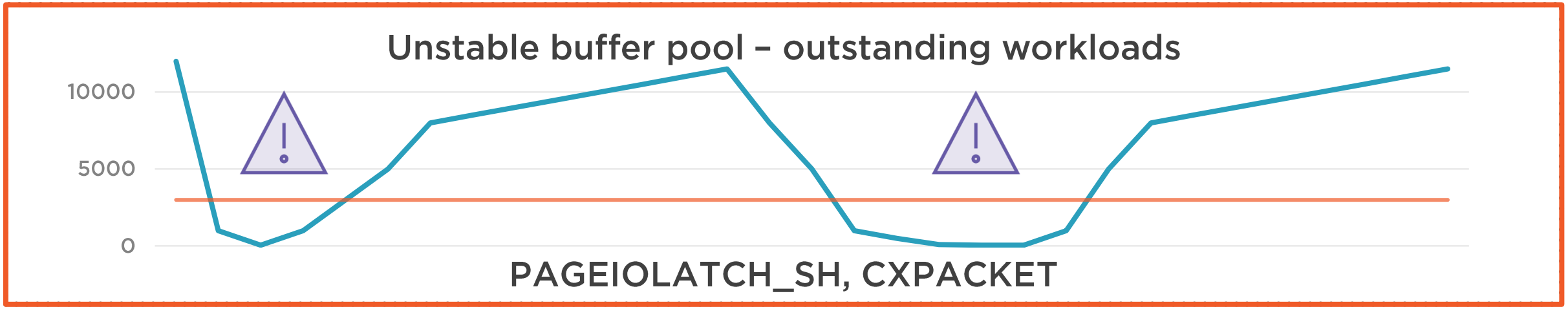
Interesting SQL Server Counters

Buffer Manager: Page life expectancy	SQL Statistics: Batch requests/sec	Access Methods: Full scans/sec
General Statistics: Processes blocked	SQL Statistics: SQL attention rate	Memory Manager: Total server memory

Page Life Expectancy (PLE) Patterns







Demo

Creating a SQL Server Perfmon trace with Windows Performance Monitor

Using the PAL tool to analyze the Perfmon trace

Querying the cached counters view

- Sys.dm_os_performance_counters

Using relog.exe to export the binary trace into a database for custom reporting

Summary

- Types of performance problems
- Practical wait statistics
- Using DMVs for IO performance troubleshooting
- Query Store
- System_health session trace
- Perfmon traces