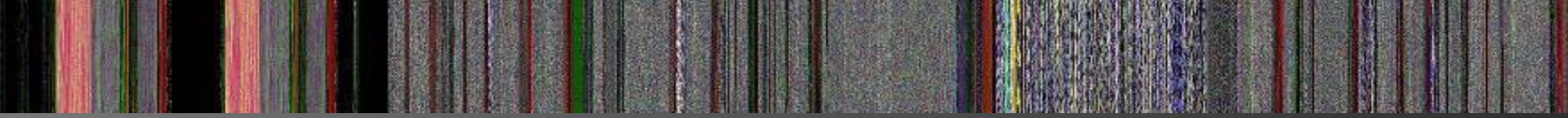


Malware Narratives

Introduction

Revised Version

Dmitry Vostokov
Software Diagnostics Services

Prerequisites

Interest in software diagnostics and malware analysis

Why?

- Communication language
- Malware diagnostics as software diagnostics
- Big DA+TA (Dump Artifacts + Trace Artifacts)

Software Diagnostics

A discipline studying signs of software structure and behavior in software execution artifacts (such as memory dumps, software and network traces and logs) using systemic and pattern-oriented analysis methodologies.

Diagnostics Pattern

> A common recurrent identifiable problem together with a set of recommendations and possible solutions to apply in a specific context.

Pattern Orientation

Pattern-driven

- Finding patterns in software artefacts
- Using checklists and pattern catalogs

Pattern-based

- Pattern catalog evolution
- Catalog packaging and delivery

Catalog Classification

- By abstraction

Meta-patterns

- By artifact type

Software Log* Memory Dump Network Trace*

- By story type

Problem Description Software Disruption UI Problem

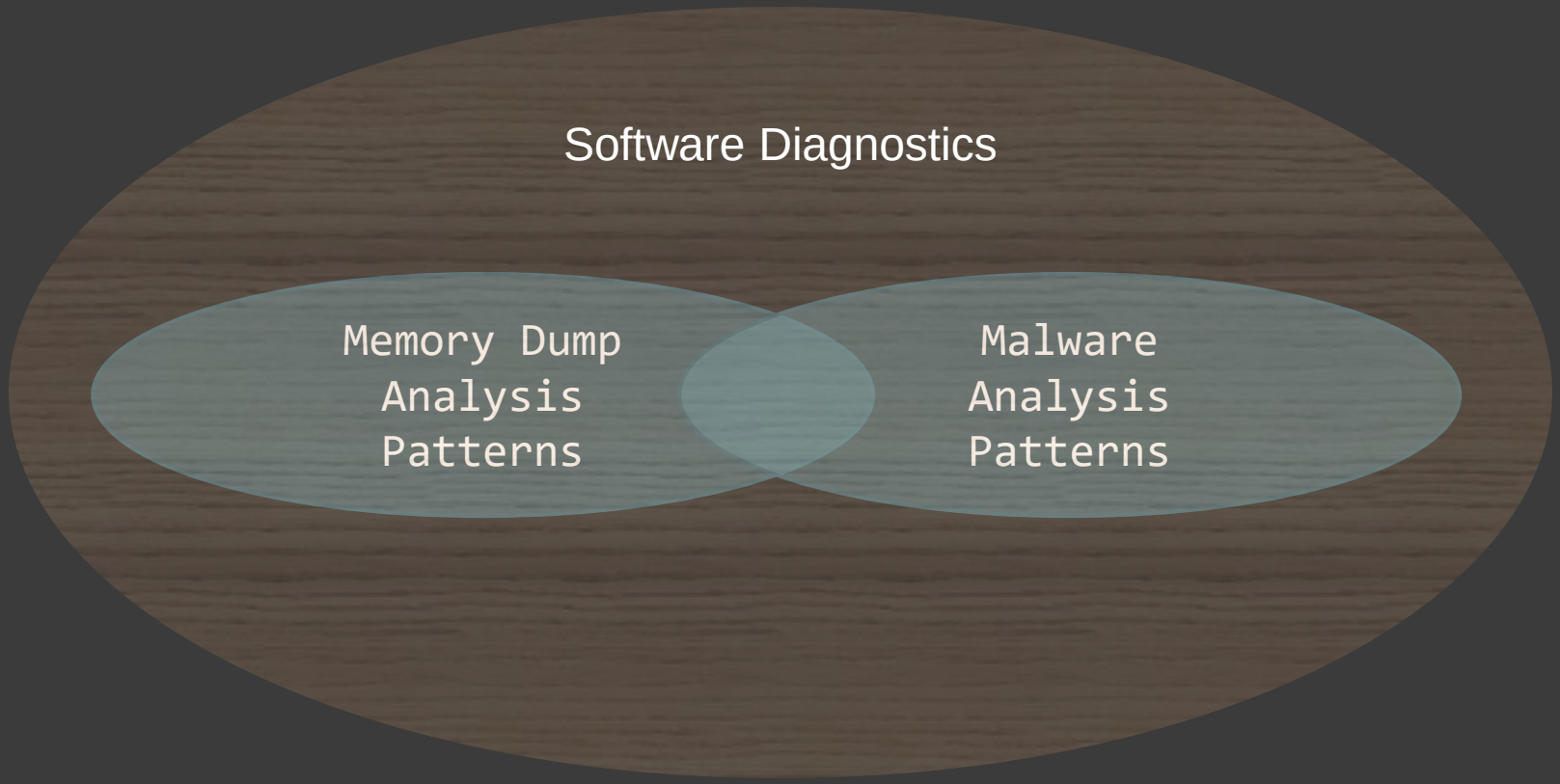
- By intention

Malware

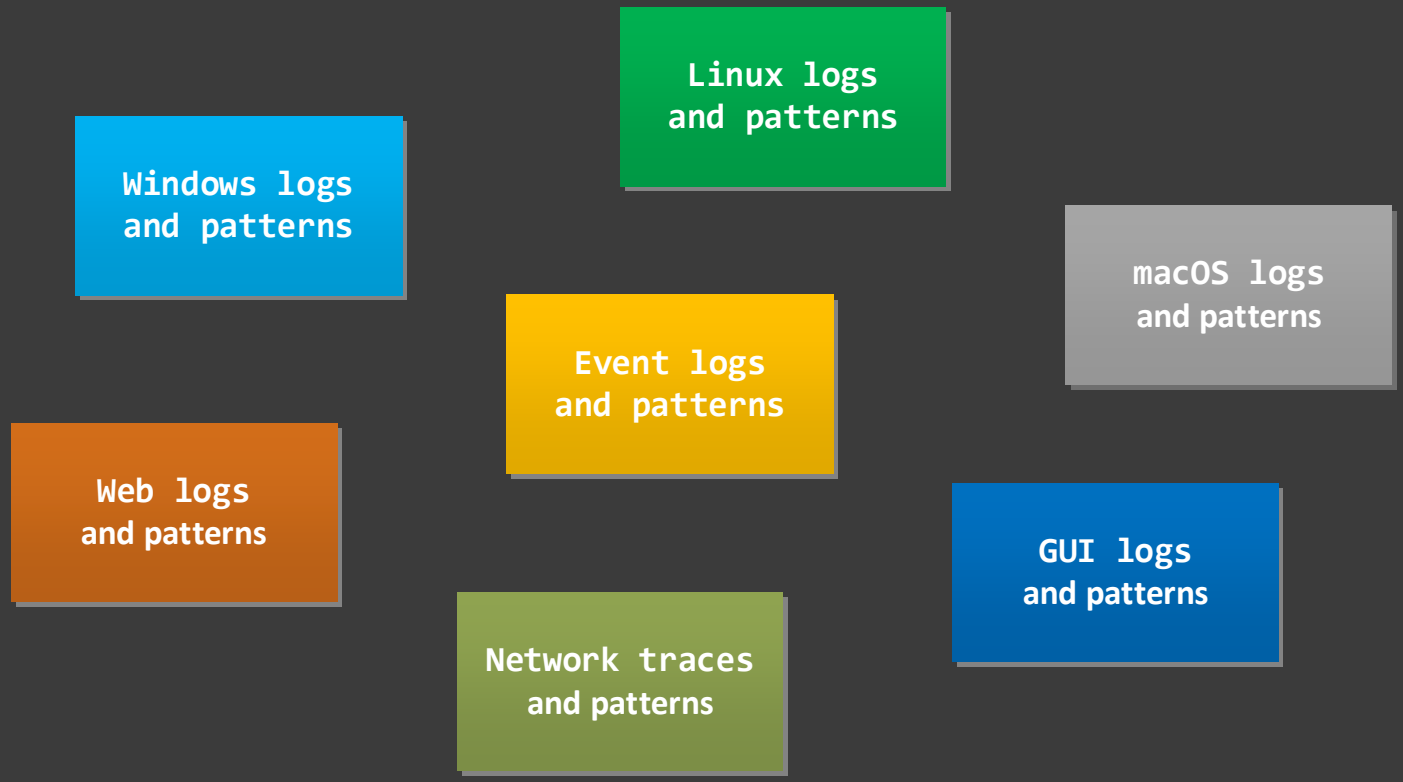
Malware

> Software that uses planned alteration of structure and behavior of software to serve malicious purposes.

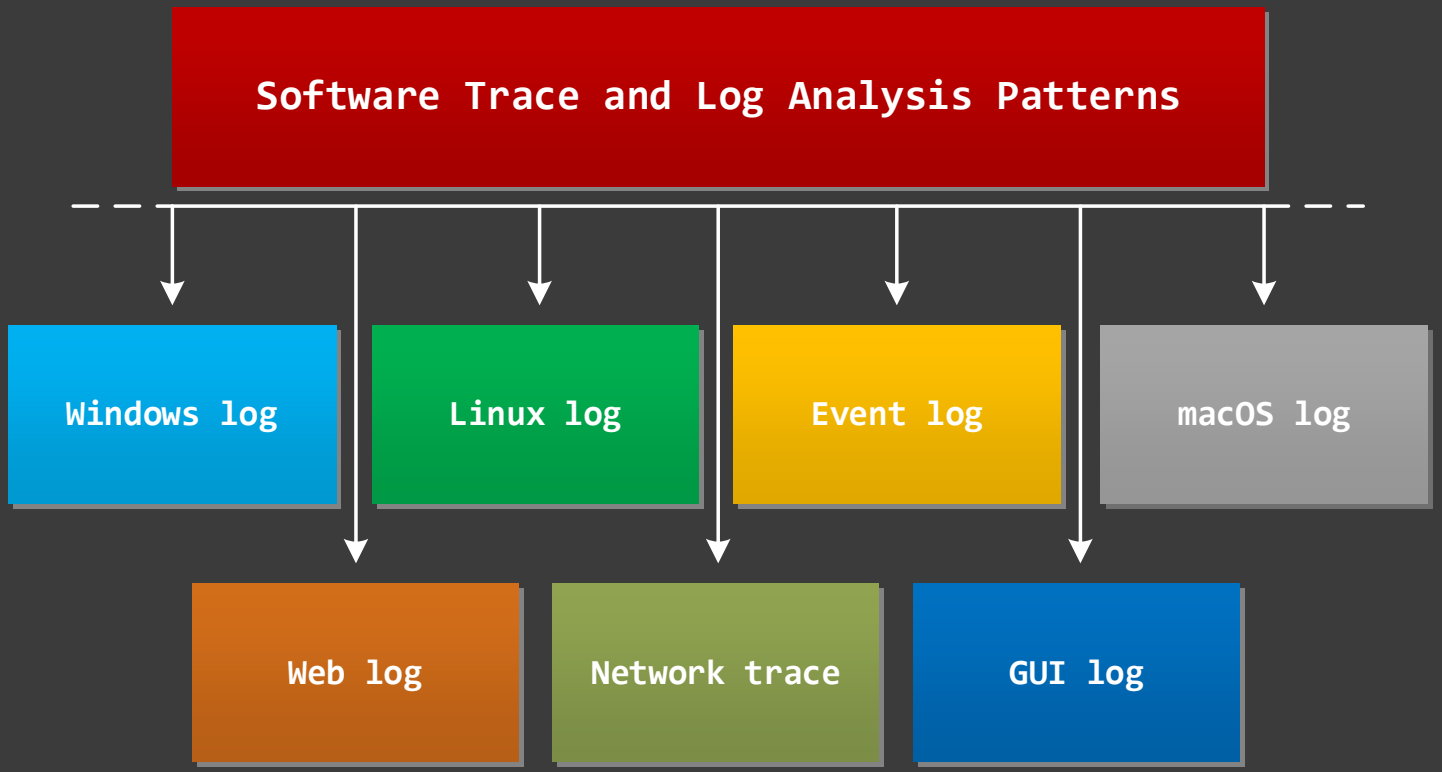
Memory Analysis Patterns



Traces and Logs



Trace and Log Patterns



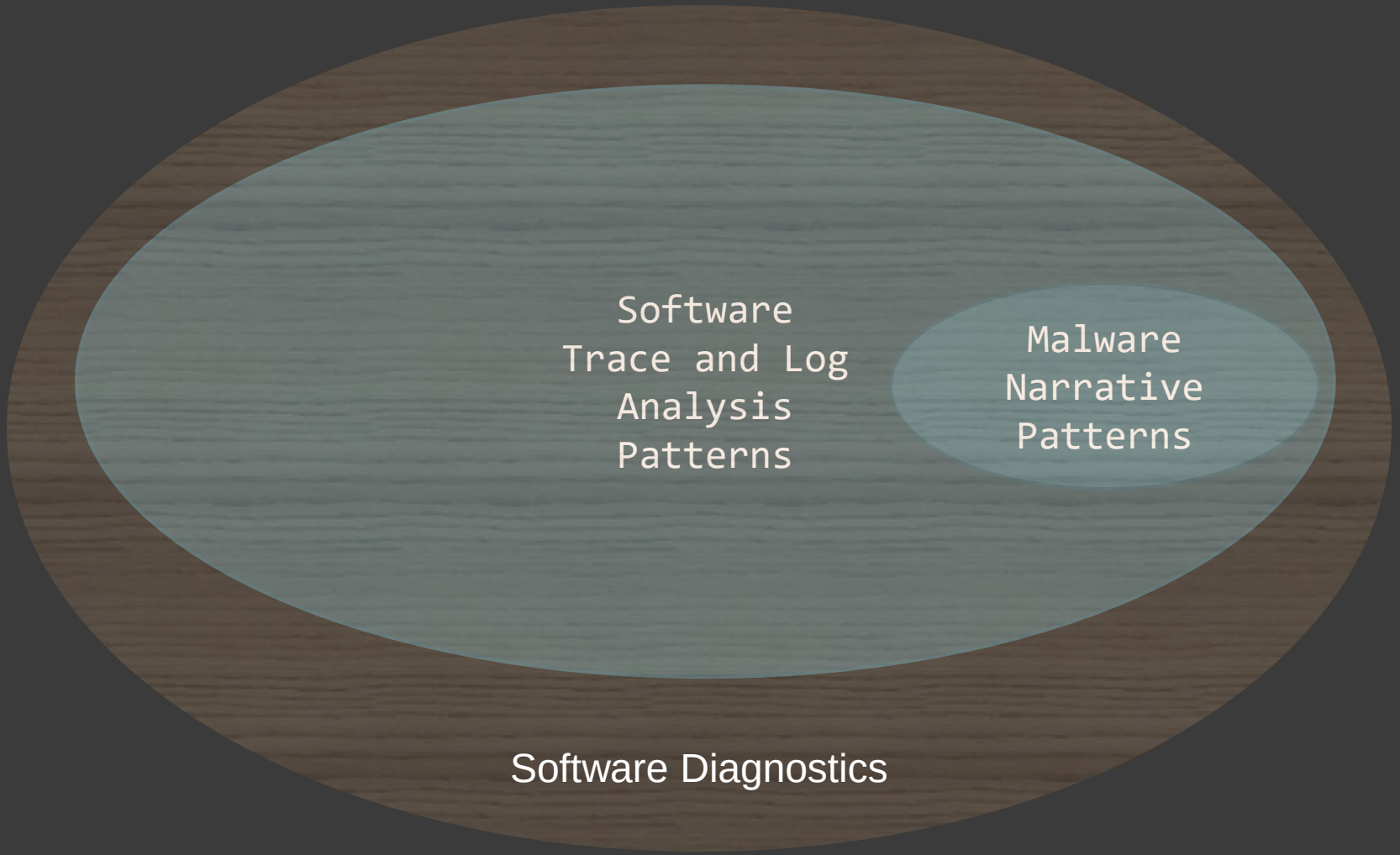
Software Narrative

> A temporal sequence of events related to software execution.

Narrative Taxonomy

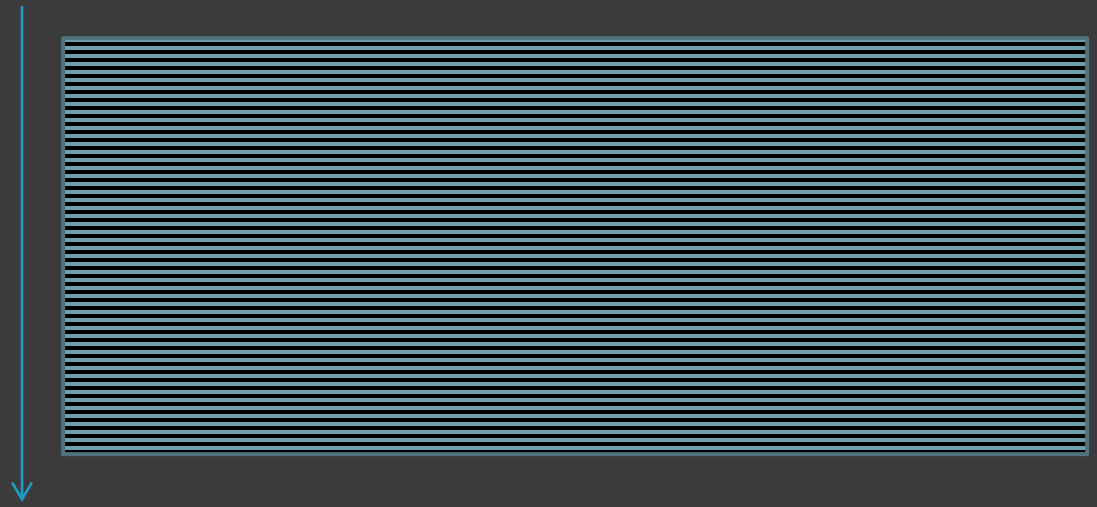
- Incident stories
- Software traces and logs
- Malware analysis stories

Malware Narrative Patterns

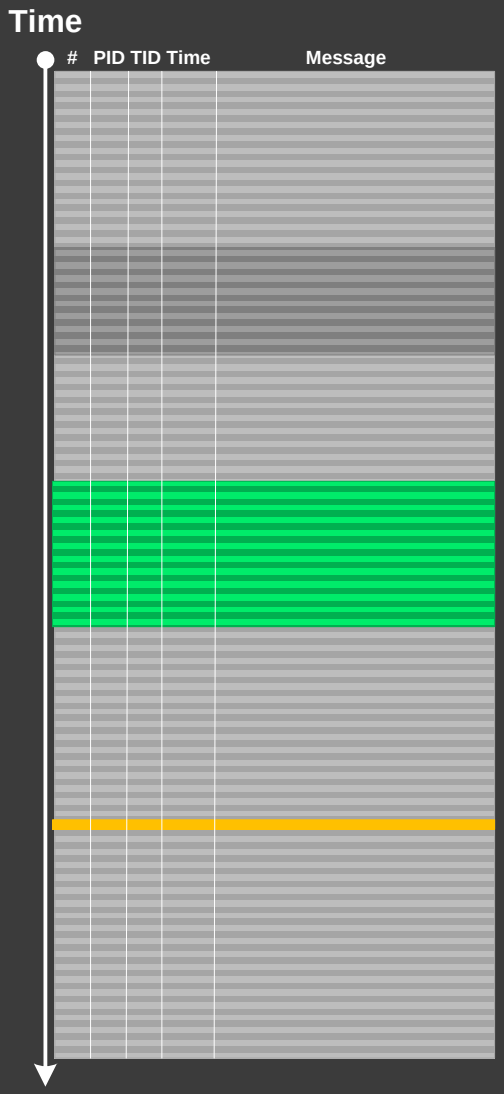


Software Log

- A sequence of formatted messages
- Arranged by time
- A narrative story



Minimal Trace Graphs




```
No Module  PID  TID  Date      Time         Message
-----------------------------------------------------------
1  ModuleA 4280 1736 5/28/2012 08:53:50.496 Trace message 1
2  ModuleB 6212 6216 5/28/2012 08:53:52.876 Trace message 2
[…]
```

Pattern-Driven Analysis

Diagnostic Pattern: a common recurrent identifiable problem together with a set of recommendations and possible solutions to apply in a specific context.

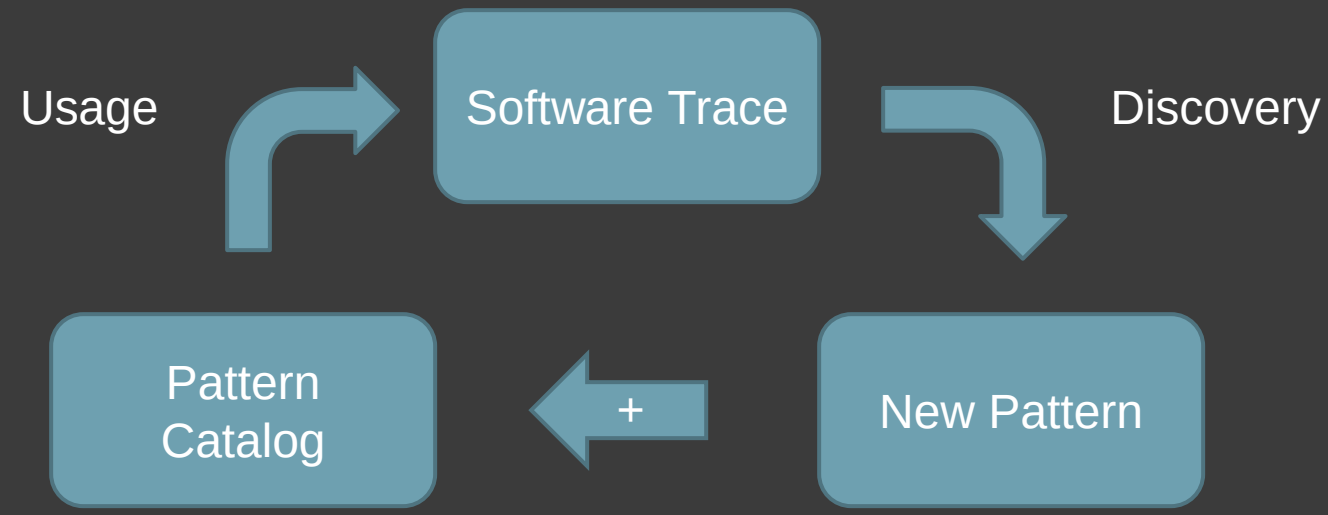
Diagnostic Problem: a set of indicators (symptoms, signs) describing a problem.

Diagnostic Analysis Pattern: a common recurrent analysis technique and method of diagnostic pattern identification in a specific context.

Diagnostics Pattern Language: common names of diagnostic and diagnostic analysis patterns. The same language for any operating system: Windows, macOS, Linux, ...

Checklist: http://www.dumpanalysis.org/blog/index.php/2011/03/10/software-trace-analysis-checklist/
Patterns: http://www.dumpanalysis.org/blog/index.php/trace-analysis-patterns/

Pattern-Based Analysis



Pattern Classification

- Vocabulary
- Error
- Trace as a Whole
- Large Scale
- Activity
- Message
- Block
- Trace Set

Reference and Course

- Catalog

Software Trace and Log Analysis Patterns

- Free reference graphical slides

Accelerated-Software-Trace-Analysis-Part1-Public.pdf

- Training course

Accelerated Software Trace Analysis

Vocabulary Patterns

- Basic Facts*
- Vocabulary Index

* patterns marked with yellow color are most likely to be useful for malware detection and analysis

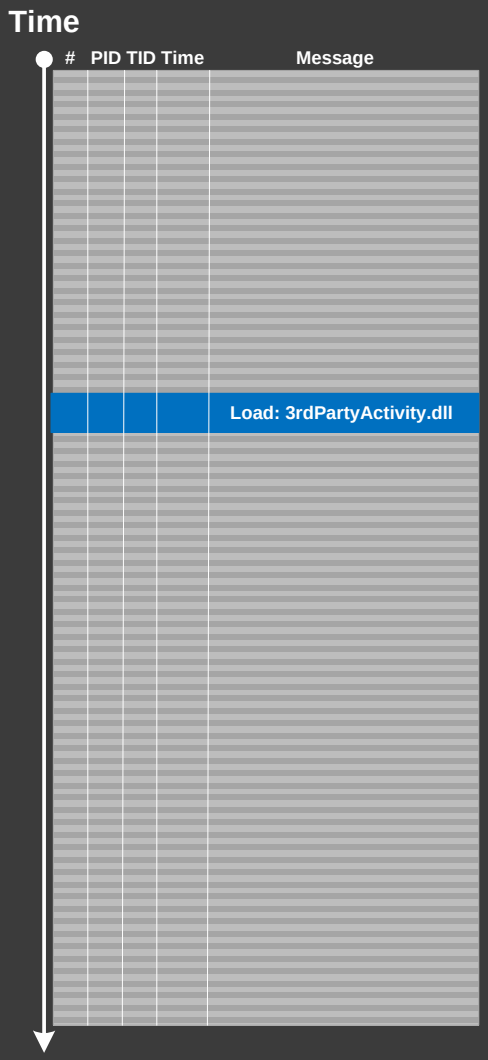
Error Patterns

- Error Message
- Exception Stack Trace
- False Positive Error
- Periodic Error
- Error Distribution

Trace as a Whole

- Partition
- Circular Trace
- Message Density
- Message Current
- Trace Acceleration
- No Trace Metafile
- Empty Trace
- Missing Module
- Guest Module
- Truncated Trace
- Visibility Limit
- Sparse Trace

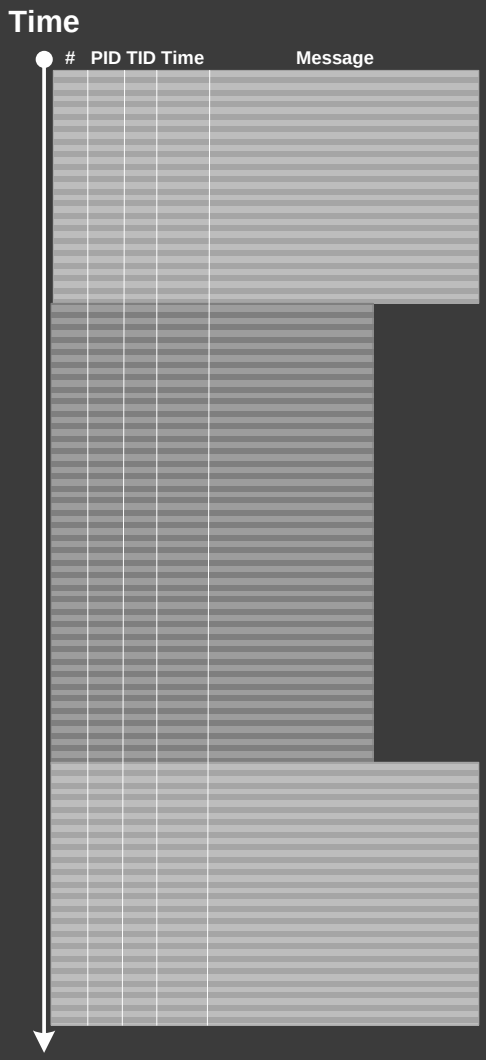
Guest Component



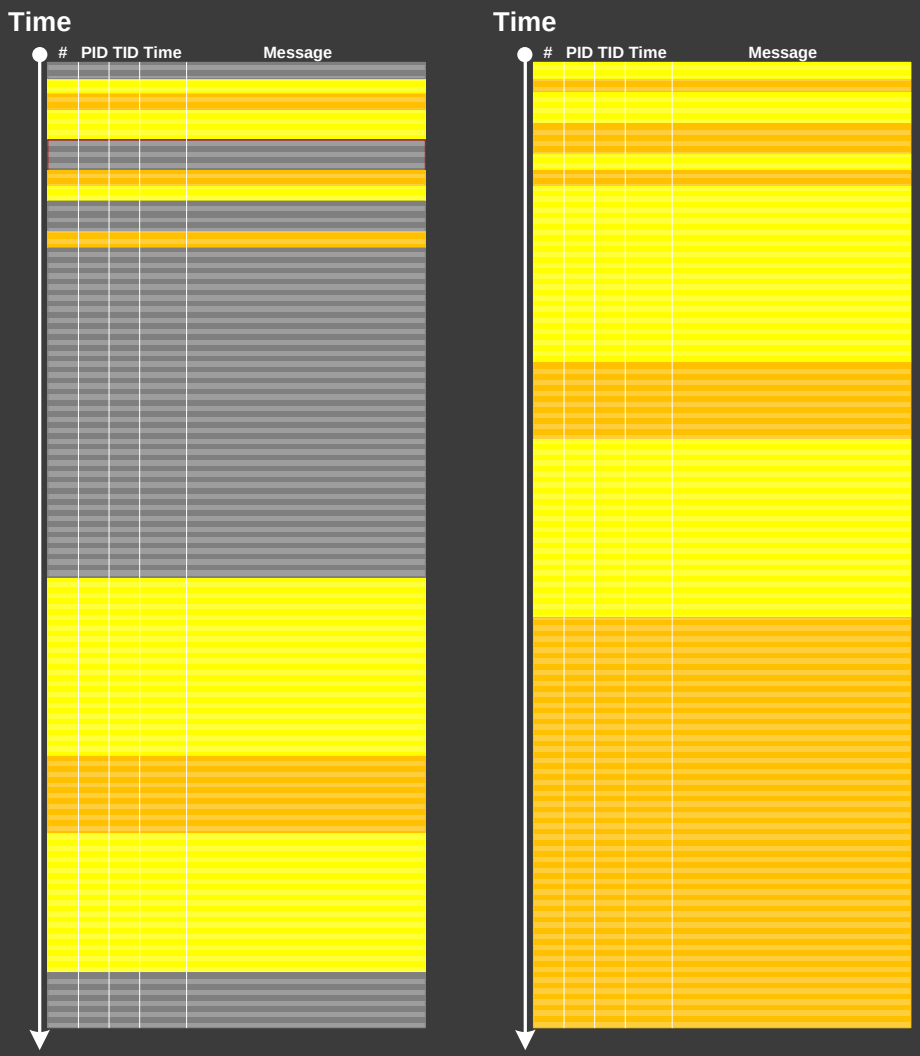
Large Scale Patterns

- Characteristic Message Block
- Background Components
- Foreground Components
- Layered Periodization
- Focus of Tracing
- Event Sequence Order
- Trace Frames

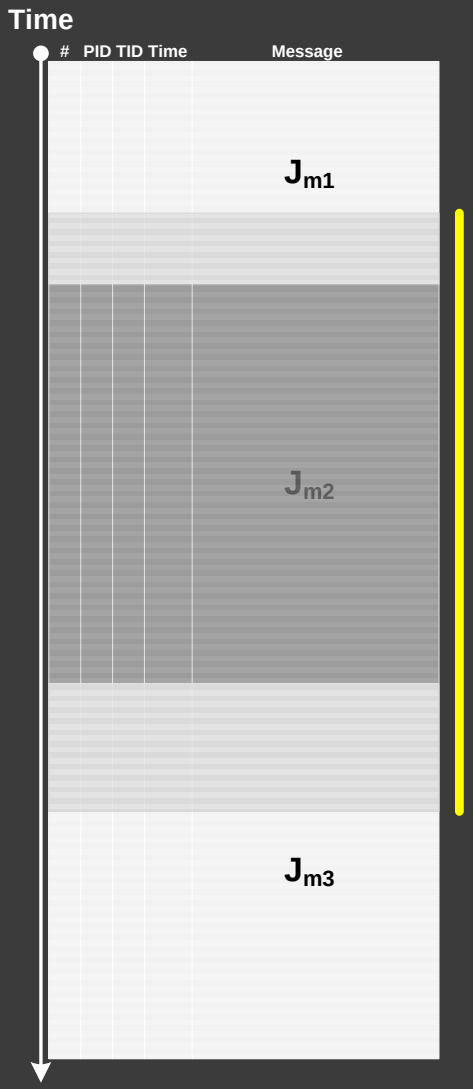
Characteristic Message Block



Foreground Components



Focus of Tracing

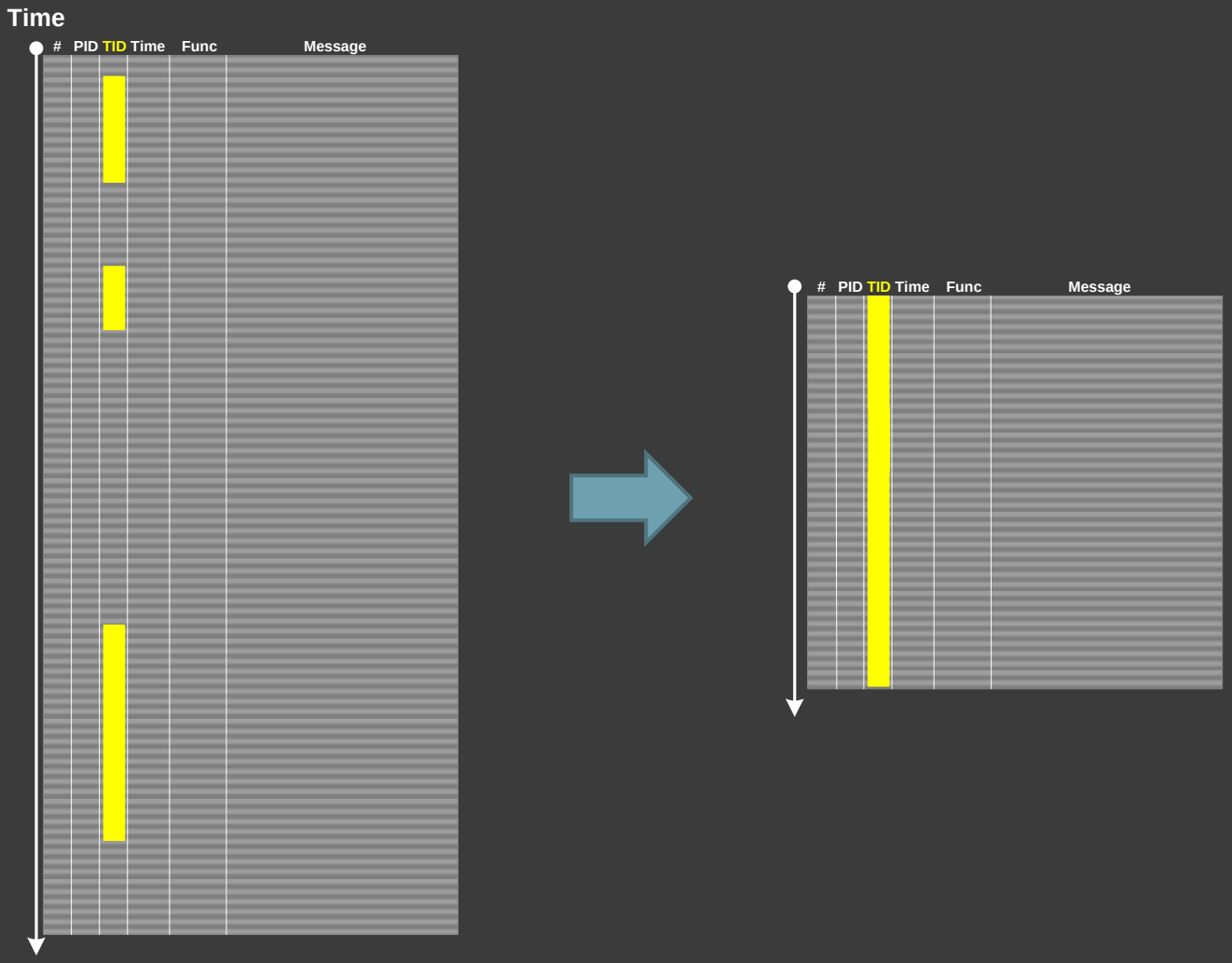


Activity regions: J_{m1}, J_{m2}, J_{m3}

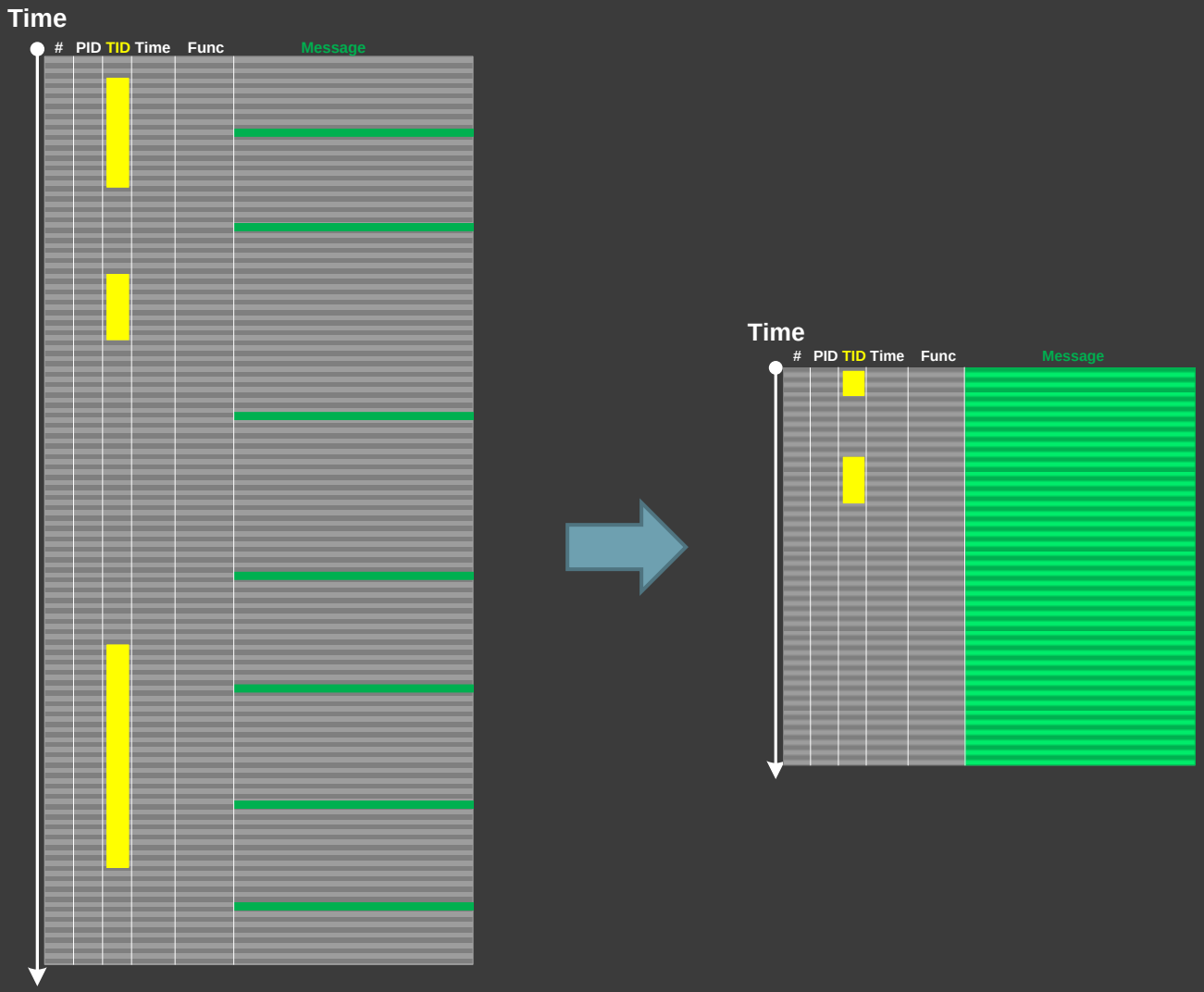
Activity Patterns

- Thread of Activity
- Adjoint Thread of Activity
- No Activity
- Activity Region
- Discontinuity
- Time Delta
- Glued Activity
- Break-in Activity
- Resume Activity
- Data Flow

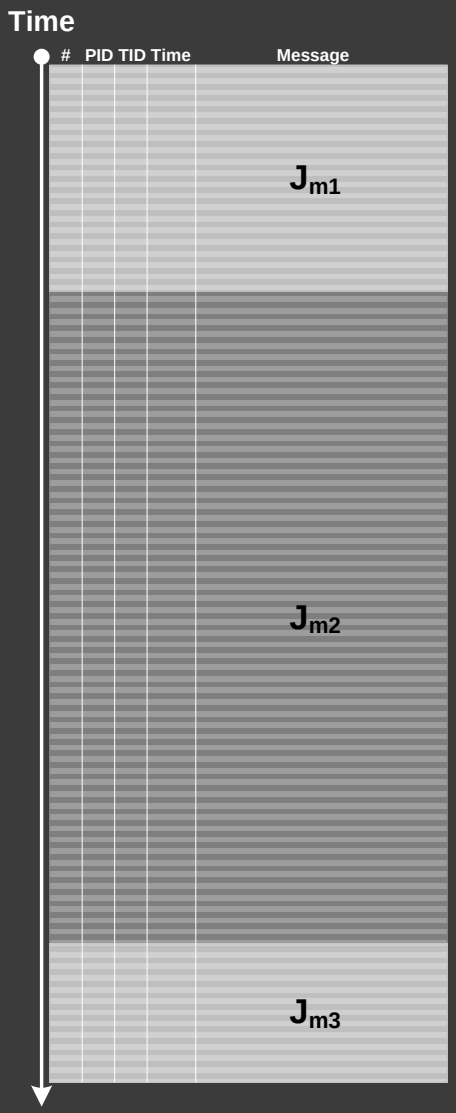
Thread of Activity



Adjoint Thread of Activity

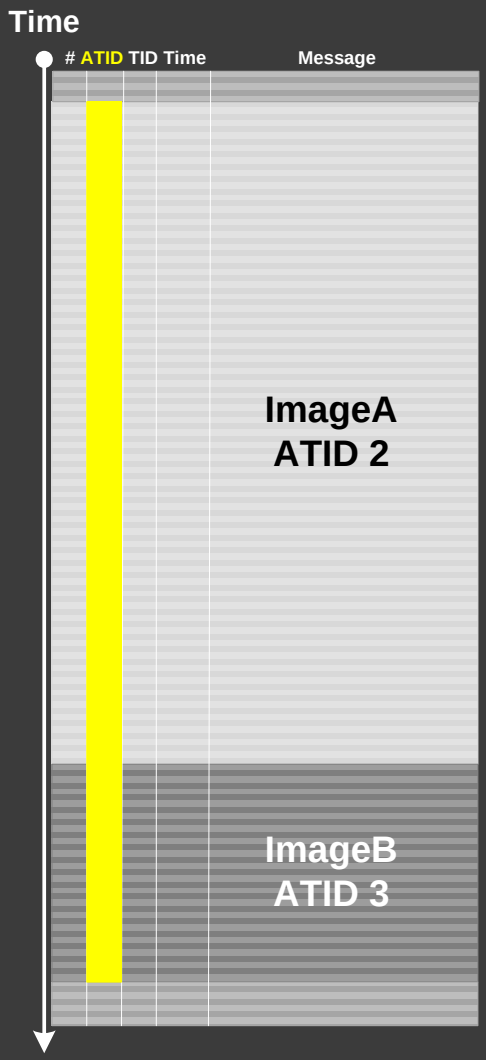


Activity Region

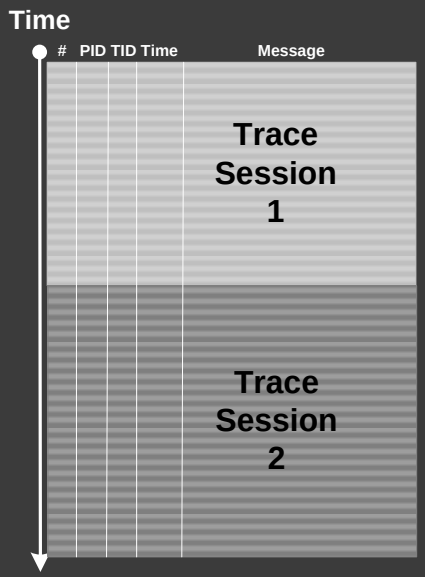


Message current : $J_{m2} > \max(J_{m1}, J_{m3})$

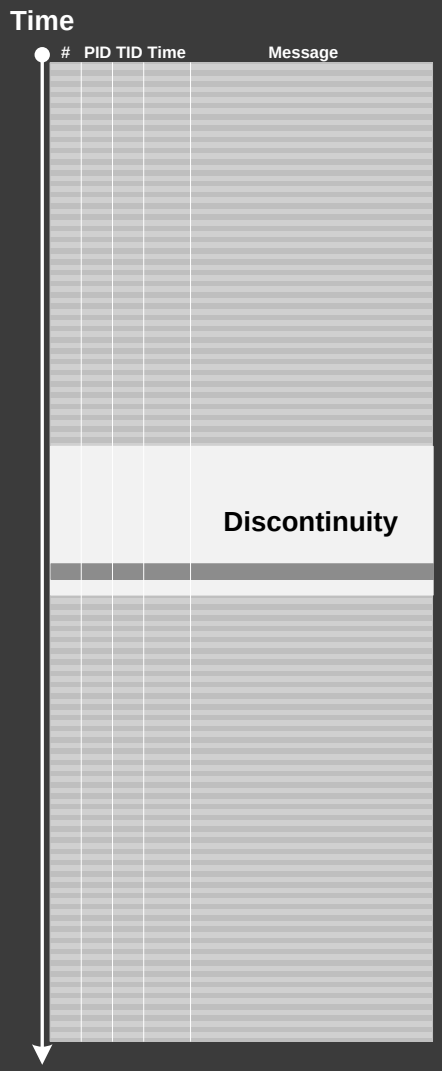
Glued Activity



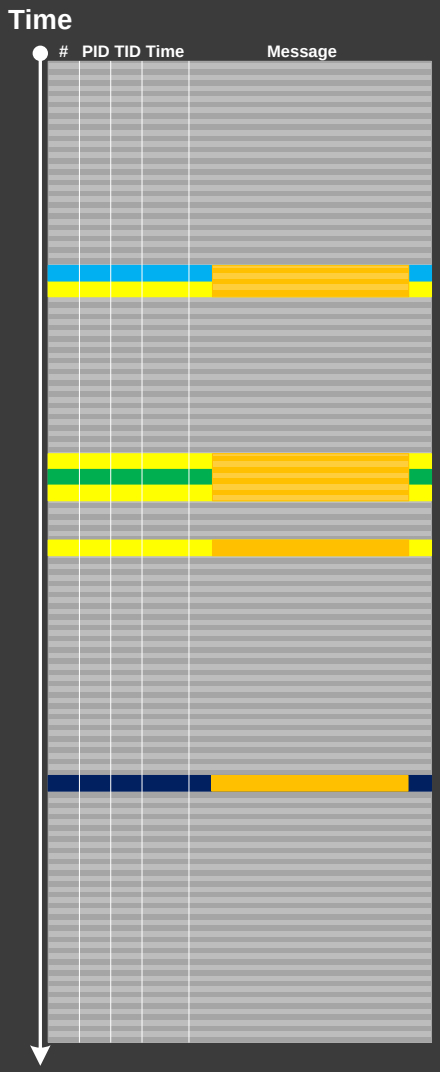
ATID: Adjoint Thread ID



Break-in Activity



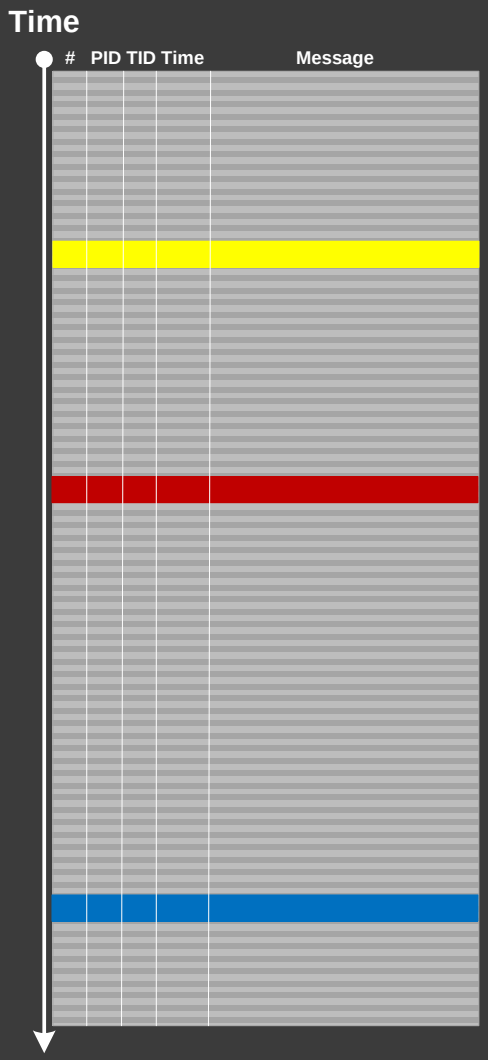
Data Flow



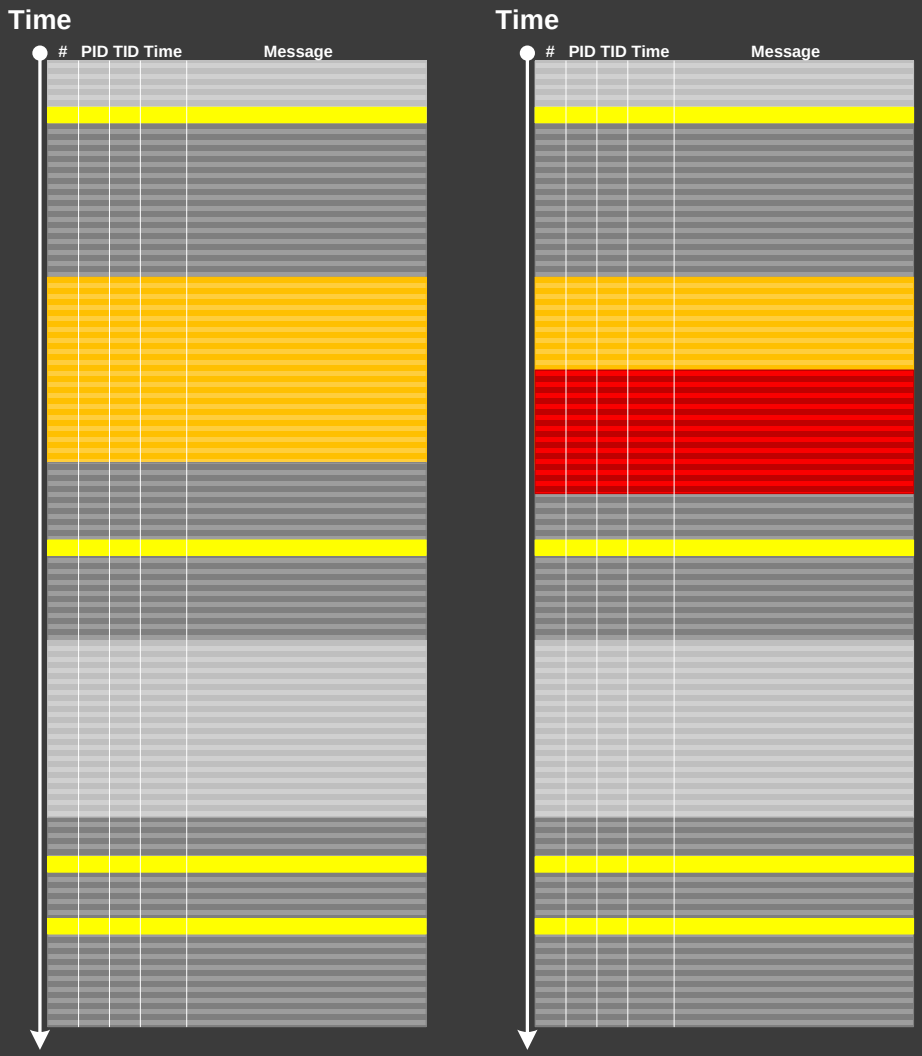
Message Patterns

- Significant Event
- Defamiliarizing Effect
- Anchor Messages
- Diegetic Messages
- Message Change
- Message Invariant
- UI Message
- Original Message
- Implementation Discourse
- Opposition Messages
- Linked Messages
- Gossip
- Counter Value
- Abnormal Value
- Message Context
- Marked Messages
- Incomplete History
- Message Interleave
- Fiber Bundle

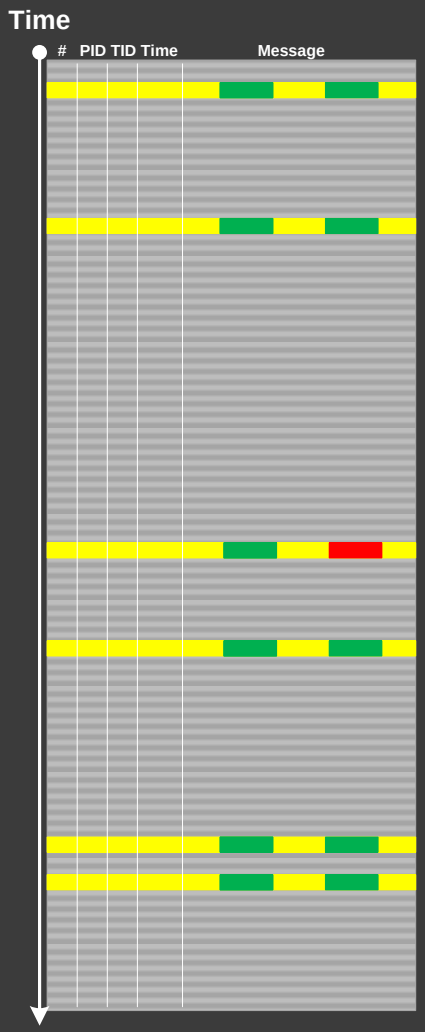
Significant Event



Defamiliarizing Effect



Abnormal Value



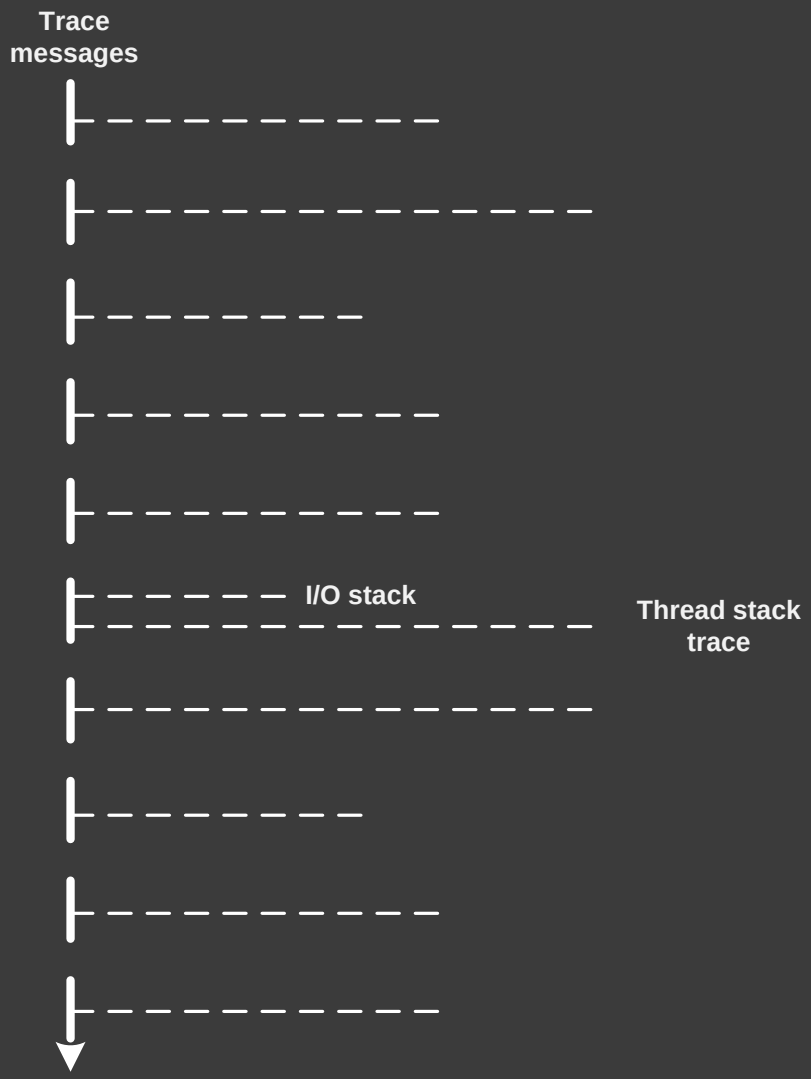
Marked Messages

Annotated messages:

```
network activity [+]
process A launched [+]
process B launched [-]
process A exited [-]
```

`[+]` activity is present in a trace
`[-]` activity is undetected or not present

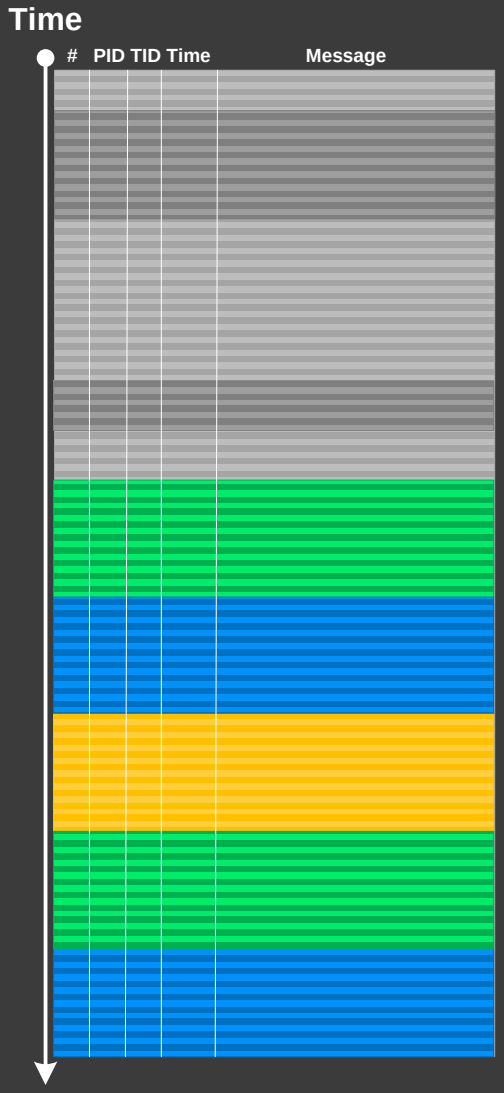
Fiber Bundle



Block Patterns

- Macrofunction
- Periodic Message Block
- Intra-Correlation

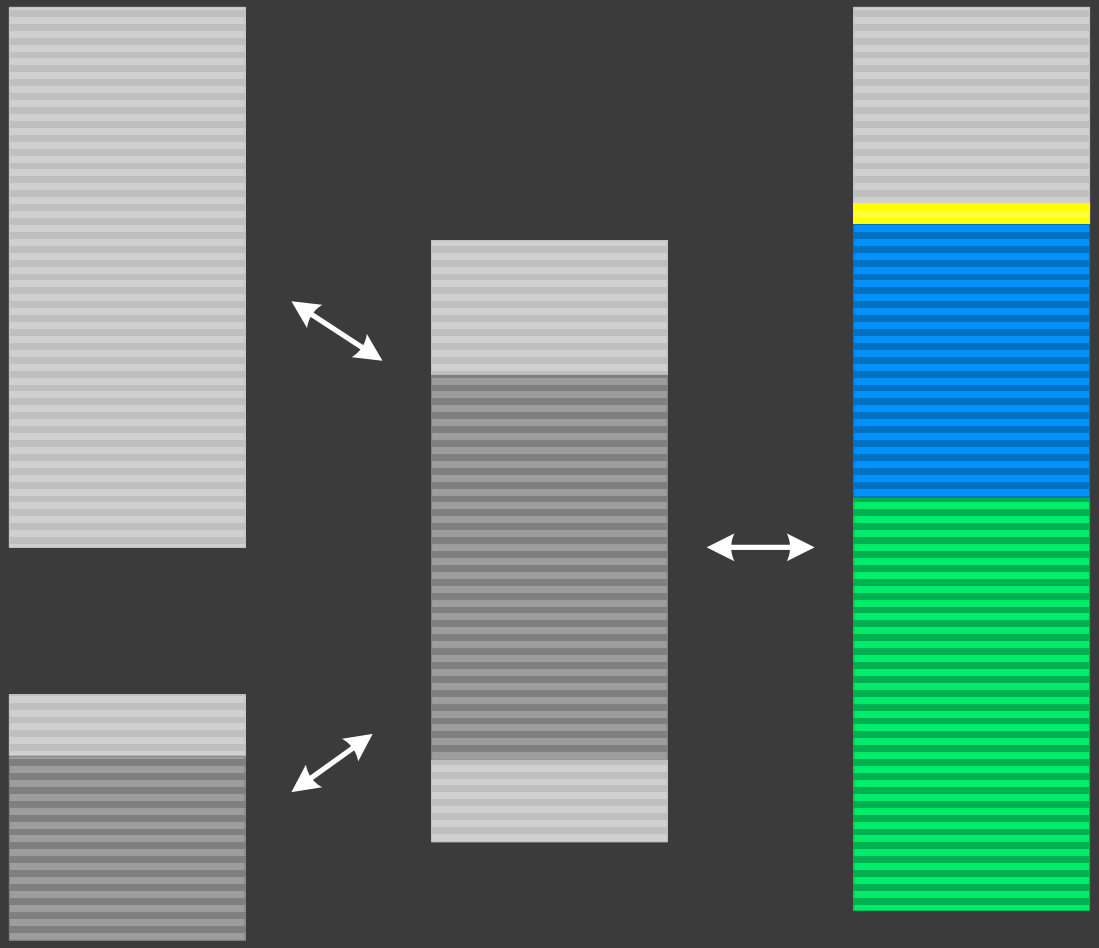
Periodic Message Block



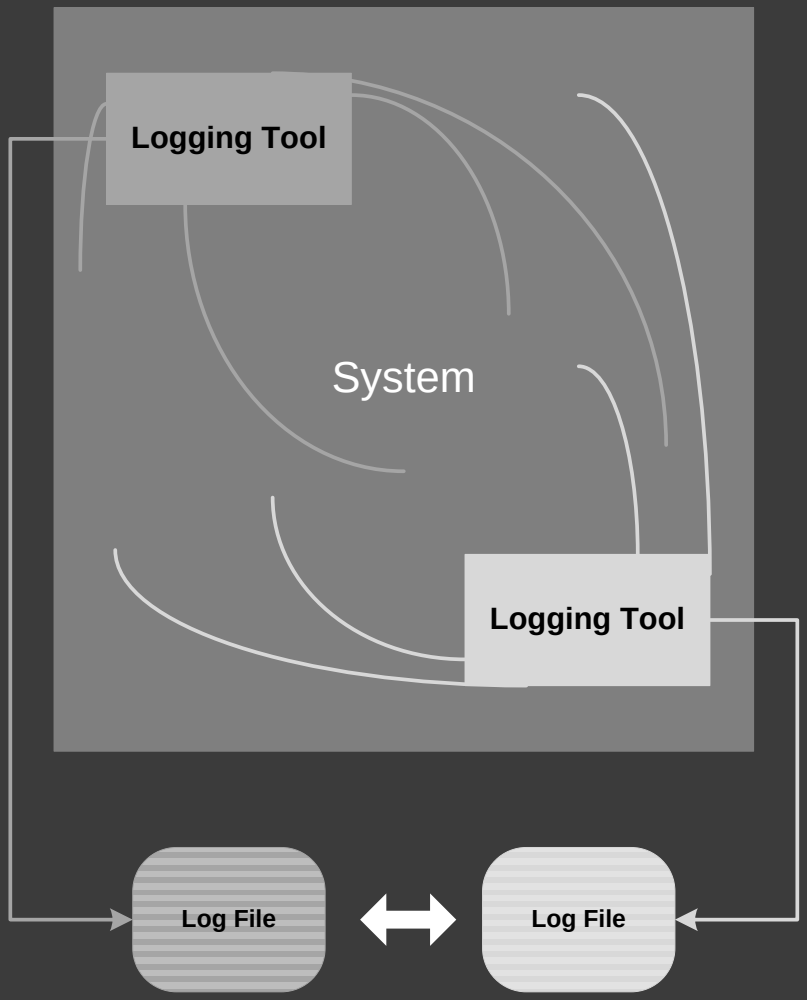
Trace Set Patterns

- Master Trace
- Bifurcation Point
- Inter-Correlation
- Relative Density
- News Value
- Impossible Trace
- Split Trace

Master Trace



Inter-Correlation



Impossible Trace

```
#    Module  PID TID Message
-------------------------------
[…]
1001 ModuleA 202 404 foo: start
1002 ModuleA 202 404 foo: end
[…]
```

```
void foo()
{
  TRACE("foo: start");
  bar();
  TRACE("foo: end");
}

void bar()
{
  TRACE("bar: start");
  // some code ...
  TRACE("bar: end");
}
```

Grand Unification

- Narrative and Trace

$N: T \rightarrow M$

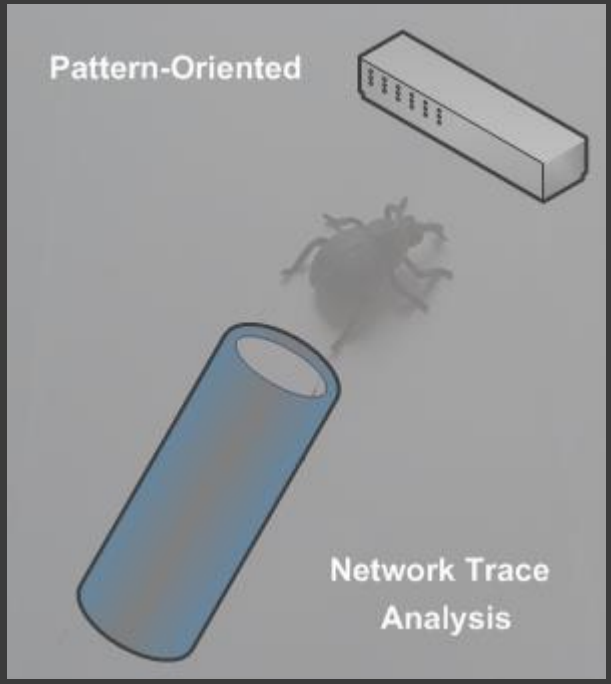
- Generalized Narrative and Trace

GN: A -> M

$GN_3 \circ GN_2 \circ GN_1: M \rightarrow M \rightarrow M$

Further Reading

- Software Diagnostics Institute
- Debugging.TV / YouTube.com/DebuggingTV / YouTube.com/PatternDiagnostics
- Software Trace and Memory Dump Analysis
- Pattern-Driven Software Diagnostics
- Systemic Software Diagnostics
- Pattern-Based Software Diagnostics
- Philosophy of Software Diagnostics
- Theoretical Software Diagnostics
- Software Narratology
- Malnarratives
- Pattern-Oriented Network Trace Analysis
- Accelerated Software Trace Analysis



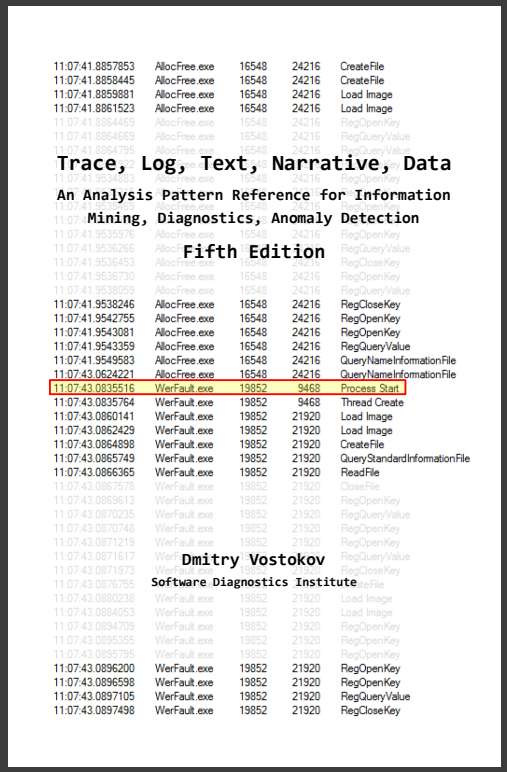
Historical Reference

Memory Dump Analysis Anthology (Diagnomicon): 14 volumes

Volume 15 is planned for 2023

Alphabetical Reference

Trace, Log, Text, Narrative, Data: An Analysis Pattern Reference for Information Mining, Diagnostics, Anomaly Detection, Fifth Edition



A Guide to Learning Software Trace and Log Analysis Patterns

Q&A

Please send your feedback using the contact form on PatternDiagnostics.com

Thank you for attendance!