Memory Based Dynamic Malware Analysis

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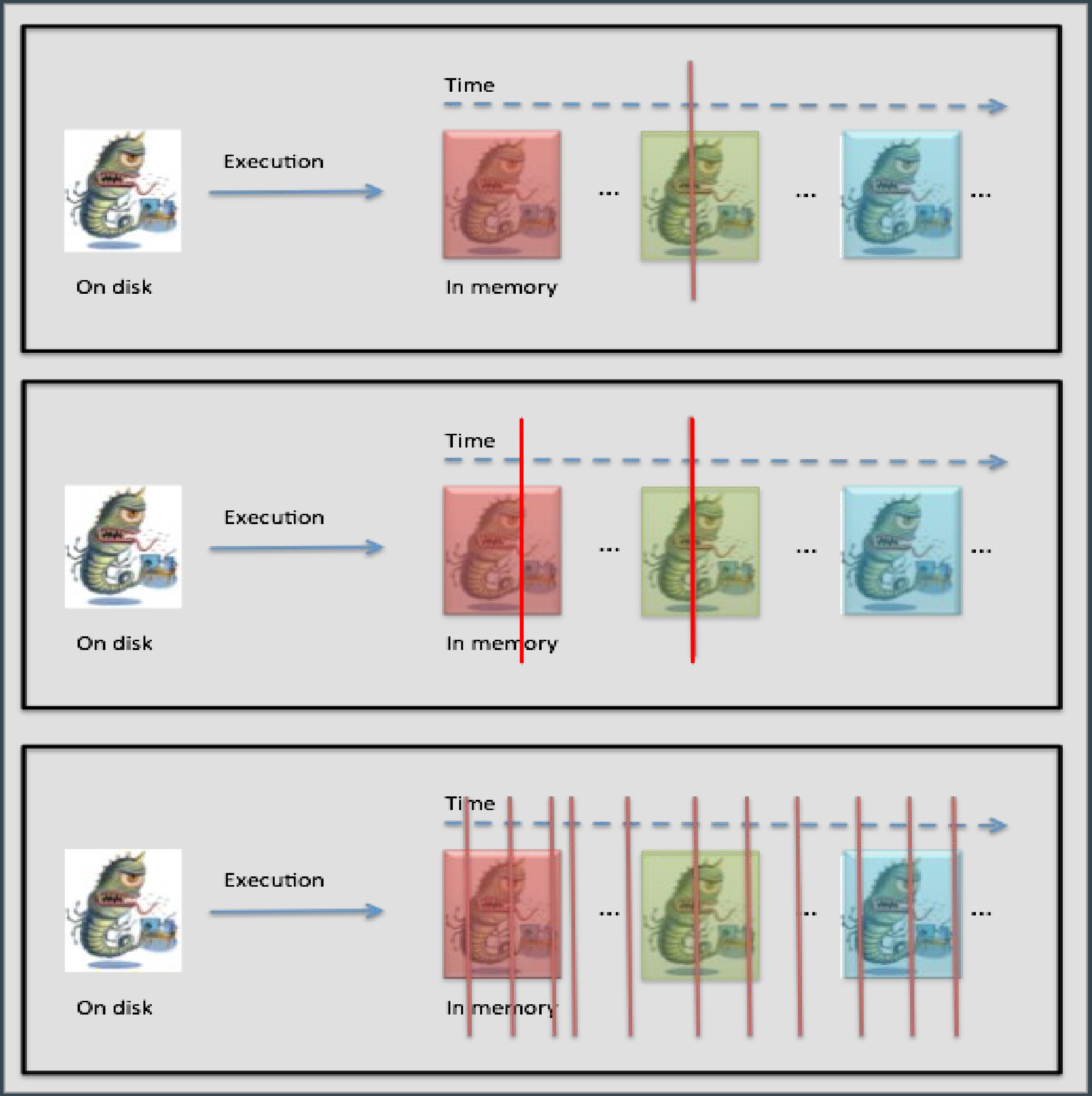
Memory forensics



Investigation

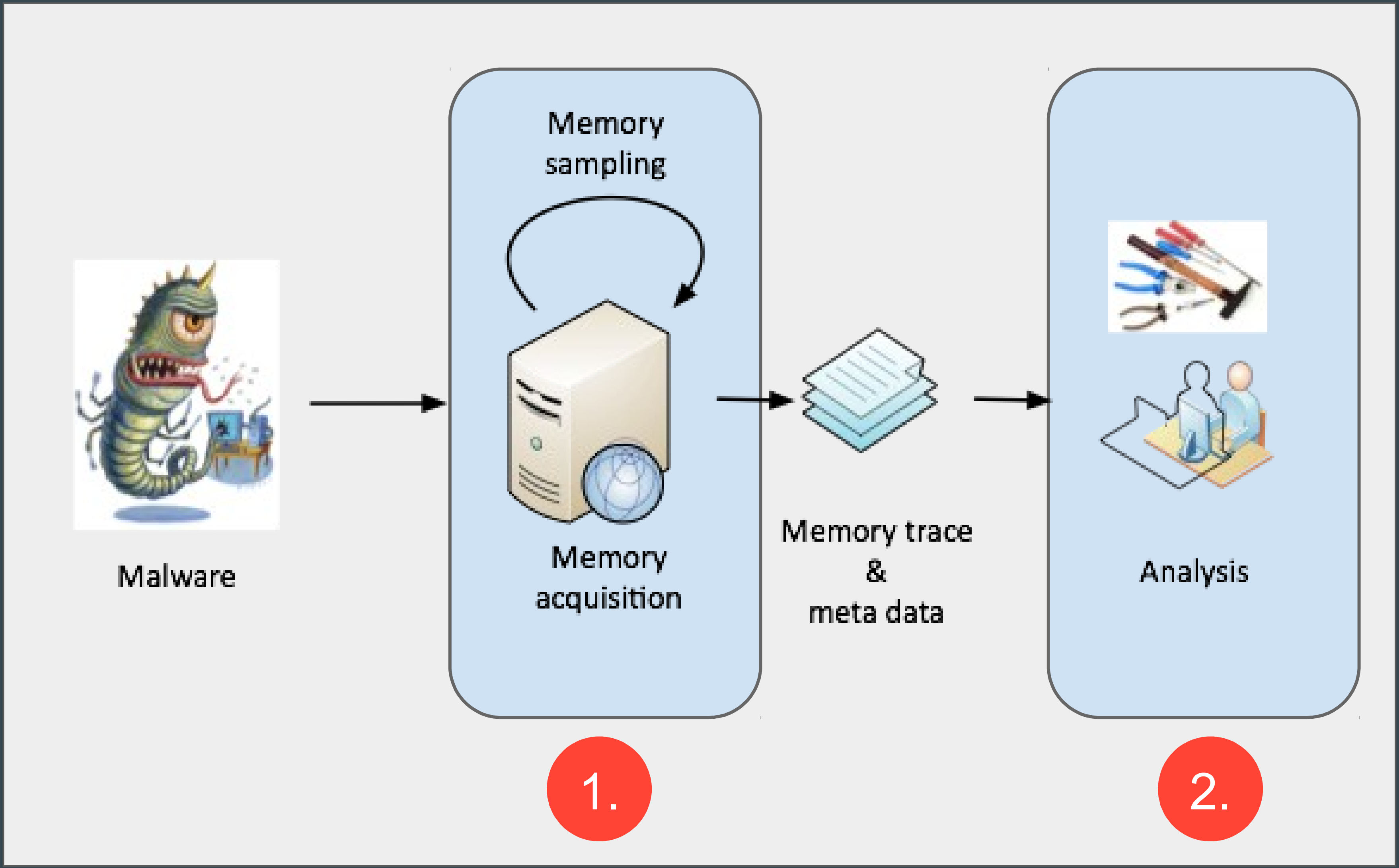
State Diffing

Memory tracing

Memory tracing

- Comprehensive capture of *full system behavior*, based on memory introspection
- May capture transient memory contents (i.e., short lived data & code)
- Hard to evade, reconstruction of system states from memory
- Novel techniques and algorithms to conduct dynamic malware analysis

System perspective



Memory acquisition

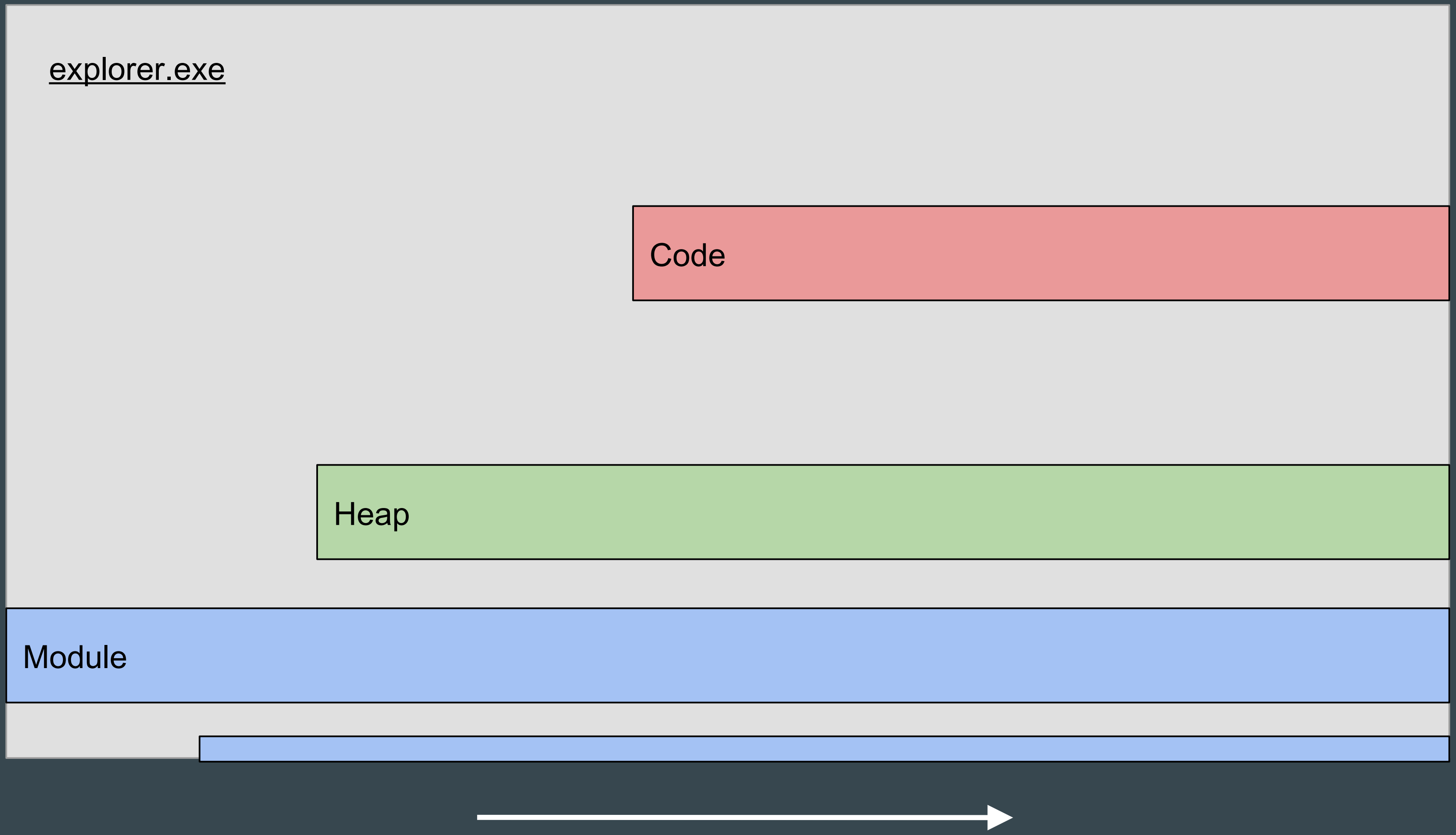
- Based on virtual machine introspection, e.g. hook KVM core functionalities
- Trigger a new snapshot on certain guest events, e.g. system calls
- Good performance, e.g. 100 snaps/sec while having an interactive VM
- Operating system independence and stealth

Analysis

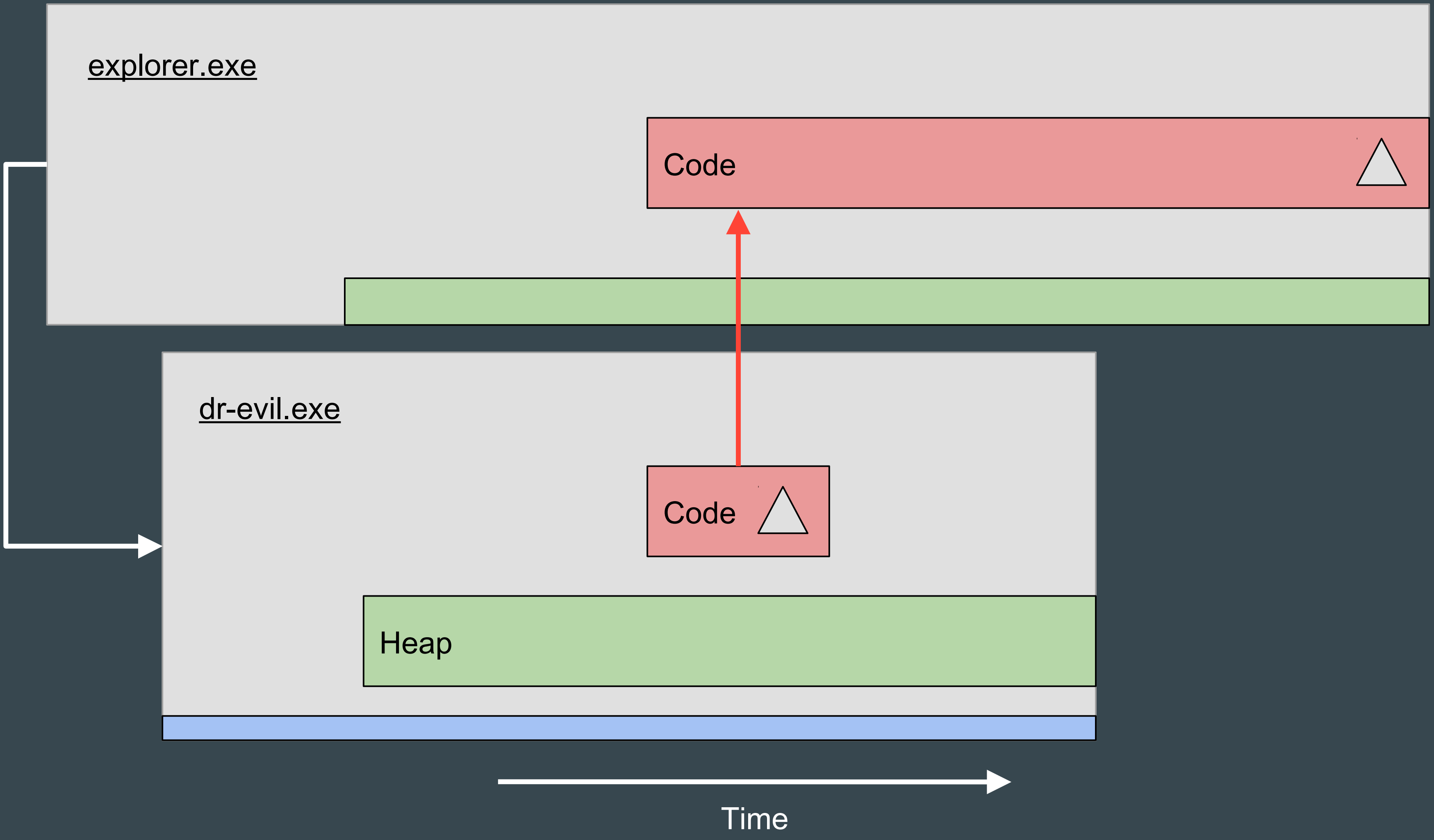
- Bridge the semantic gap

- Type 1: Data structure diffing
- Type 2: Content inspection
- Type 3: Temporal content inspection

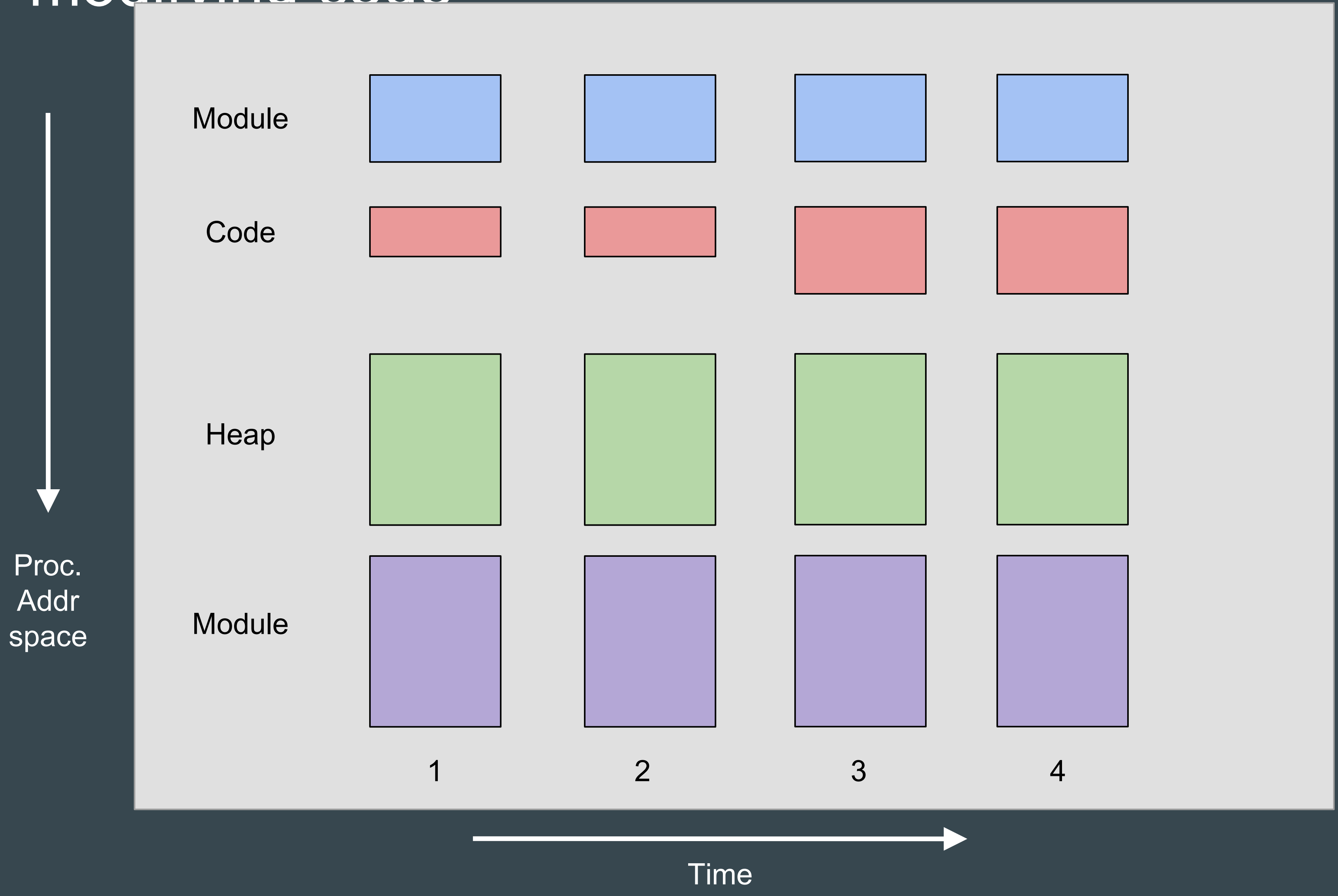
Type 1: Data structure diffing - Code injections



Type 2: Content inspection - Code injection behavior

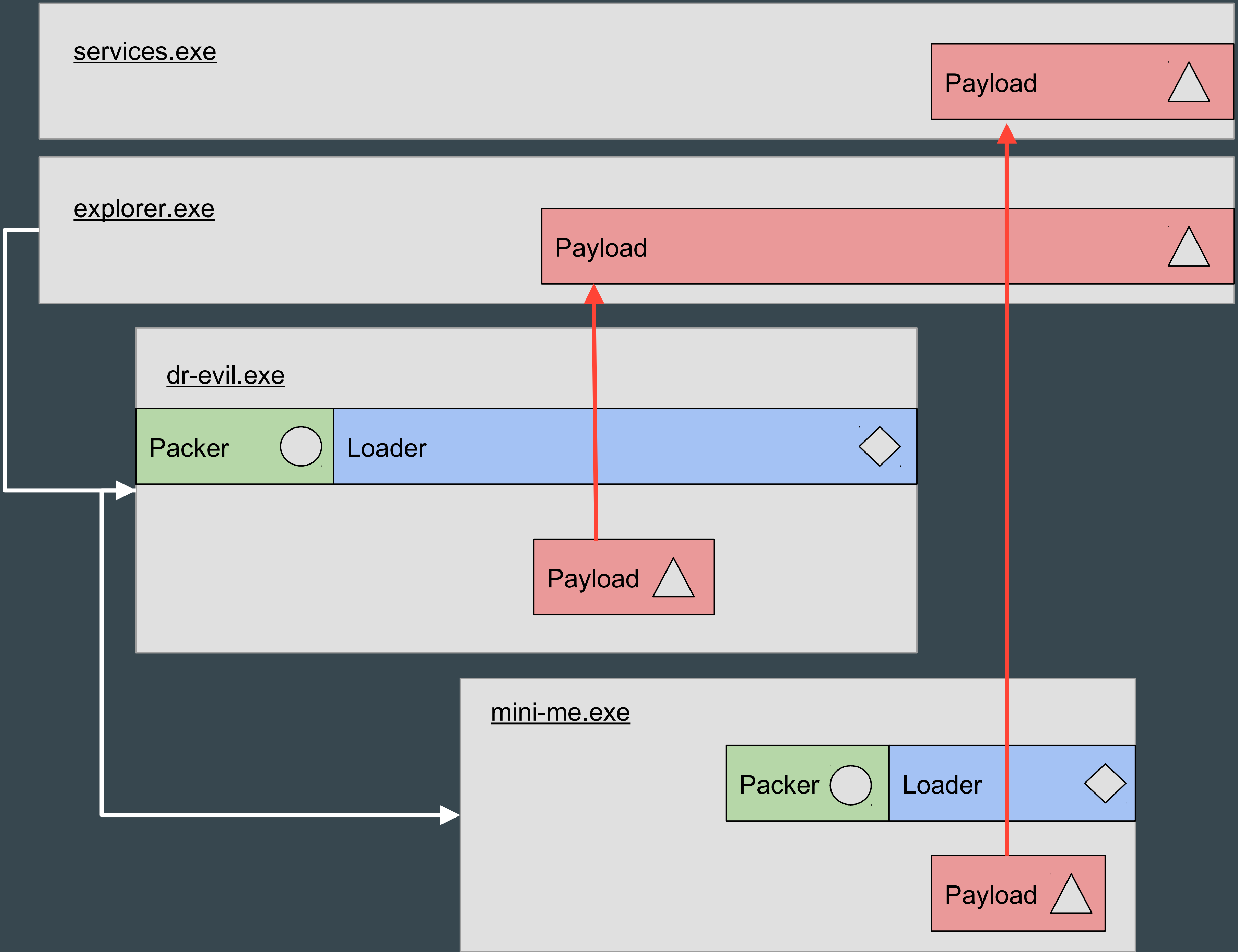


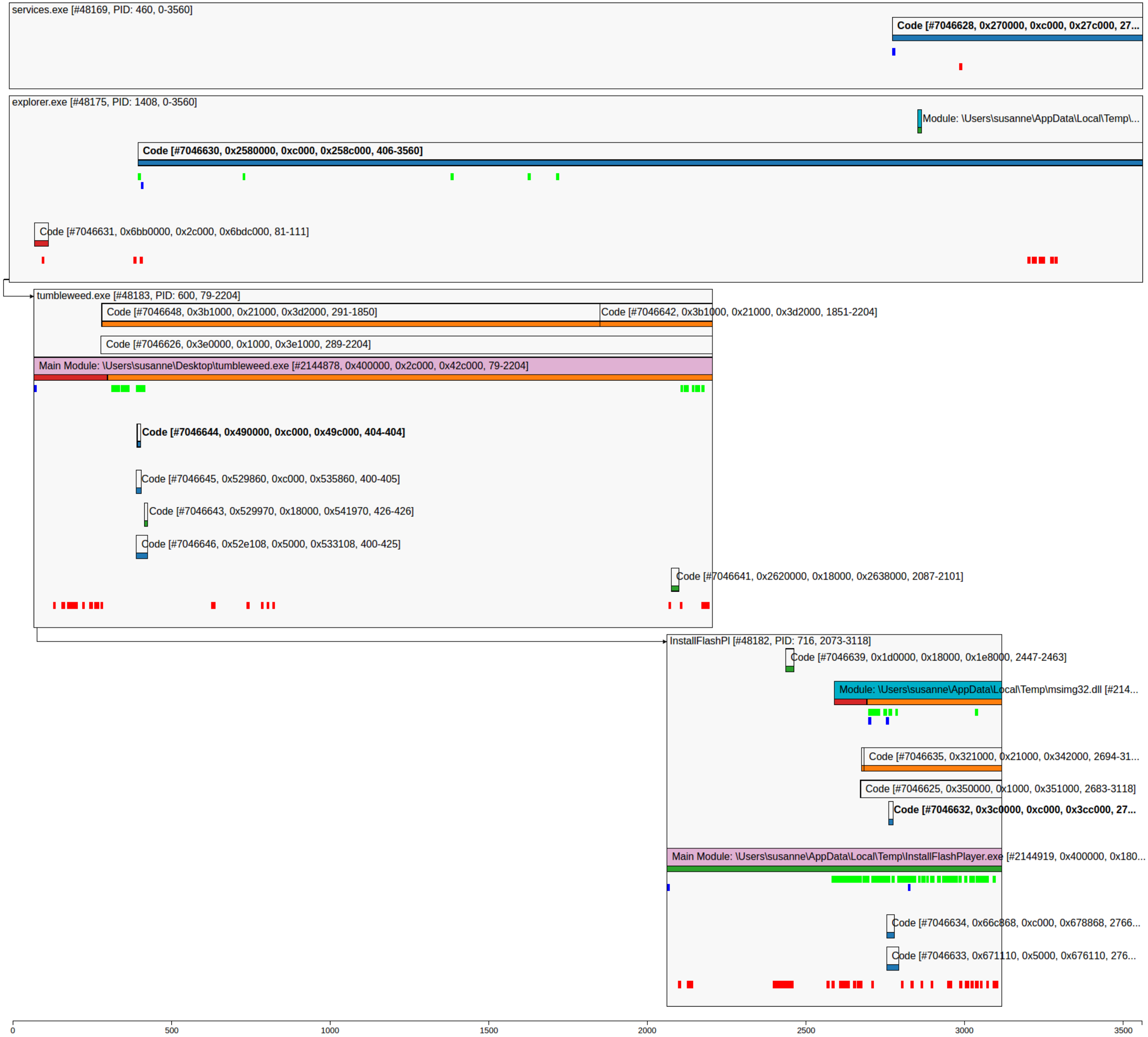
Type 3: Temporal content inspection - Self-modifying code



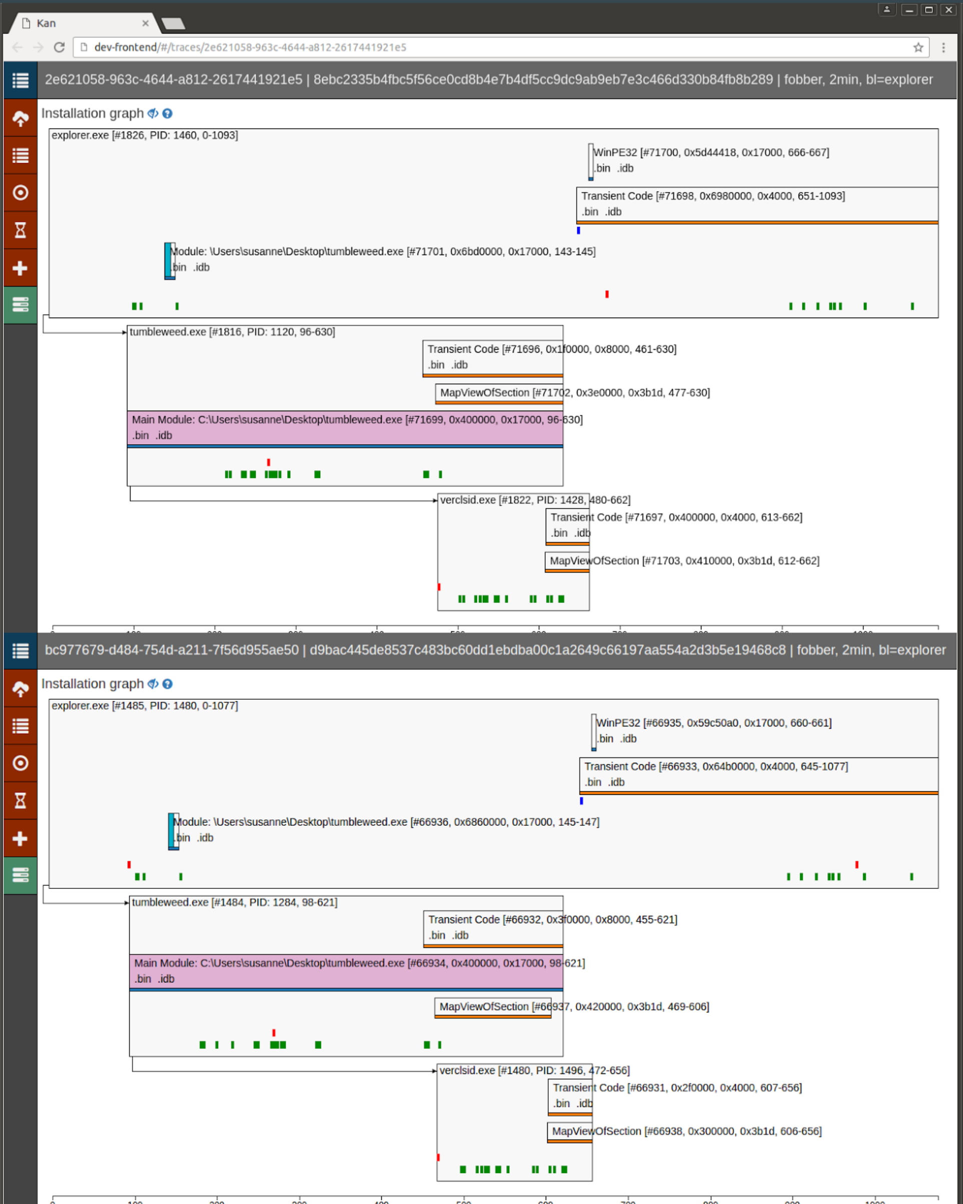
Type 1-3: Detecting code phases

- Characterize code phases: packer, loader, payload, etc. based on their lifetime in memory
- Detection of points in time where code is stable
- Remove redundancies through pattern matching


services.exe
Payload
explorer.exe
Payload
dr-evil.exe
Packer
Loader
Payload
mini-me.exe
Packer
Loader
Payload


services.exe [#48169, PID: 460, 0-3560]
Code [#7046628, 0x270000, 0xc000, 0x27c000, 27...
explorer.exe [#48175, PID: 1408, 0-3560]
Module: \Users\susanne\AppData\Local\Temp\...
Code [#7046630, 0x2580000, 0xc000, 0x258c000, 406-3560]
Code [#7046631, 0x6bb0000, 0x2c000, 0x6bdc000, 81-111]
tumbleweed.exe [#48183, PID: 600, 79-2204]
Code [#7046648, 0x3b1000, 0x21000, 0x3d2000, 291-1850]
Code [#7046642, 0x3b1000, 0x21000, 0x3d2000, 1851-2204]
Code [#7046626, 0x3e0000, 0x1000, 0x3e1000, 289-2204]
Main Module: \Users\susanne\Desktop\tumbleweed.exe [#2144878, 0x400000, 0x2c000, 0x42c000, 79-2204]
Code [#7046644, 0x490000, 0xc000, 0x49c000, 404-404]
Code [#7046645, 0x529860, 0xc000, 0x535860, 400-405]
Code [#7046643, 0x529970, 0x18000, 0x541970, 426-426]
Code [#7046646, 0x52e108, 0x5000, 0x533108, 400-425]
Code [#7046641, 0x2620000, 0x18000, 0x2638000, 2087-2101]
InstallFlashPl [#48182, PID: 716, 2073-3118]
Code [#7046639, 0x1d0000, 0x18000, 0x1e8000, 2447-2463]
Module: \Users\susanne\AppData\Local\Temp\msimg32.dll [#214...
Code [#7046635, 0x321000, 0x21000, 0x342000, 2694-31...
Code [#7046625, 0x350000, 0x1000, 0x351000, 2683-3118]
Code [#7046632, 0x3c0000, 0xc000, 0x3cc000, 27...
Main Module: \Users\susanne\AppData\Local\Temp\InstallFlashPlayer.exe [#2144919, 0x400000, 0x180...
Code [#7046634, 0x66c868, 0xc000, 0x678868, 2766...
Code [#7046633, 0x671110, 0x5000, 0x676110, 276...
0
500
1000
1500
2000
2500
3000
3500

Finding correlations between samples



Kan

dev-frontend/#/traces/2e621058-963c-4644-a812-2617441921e5

2e621058-963c-4644-a812-2617441921e5 | 8ebc2335b4fbc5f56ce0cd8b4e7b4df5cc9dc9ab9eb7e3c466d330b84fb8b289 | fobber, 2min, bl=explorer

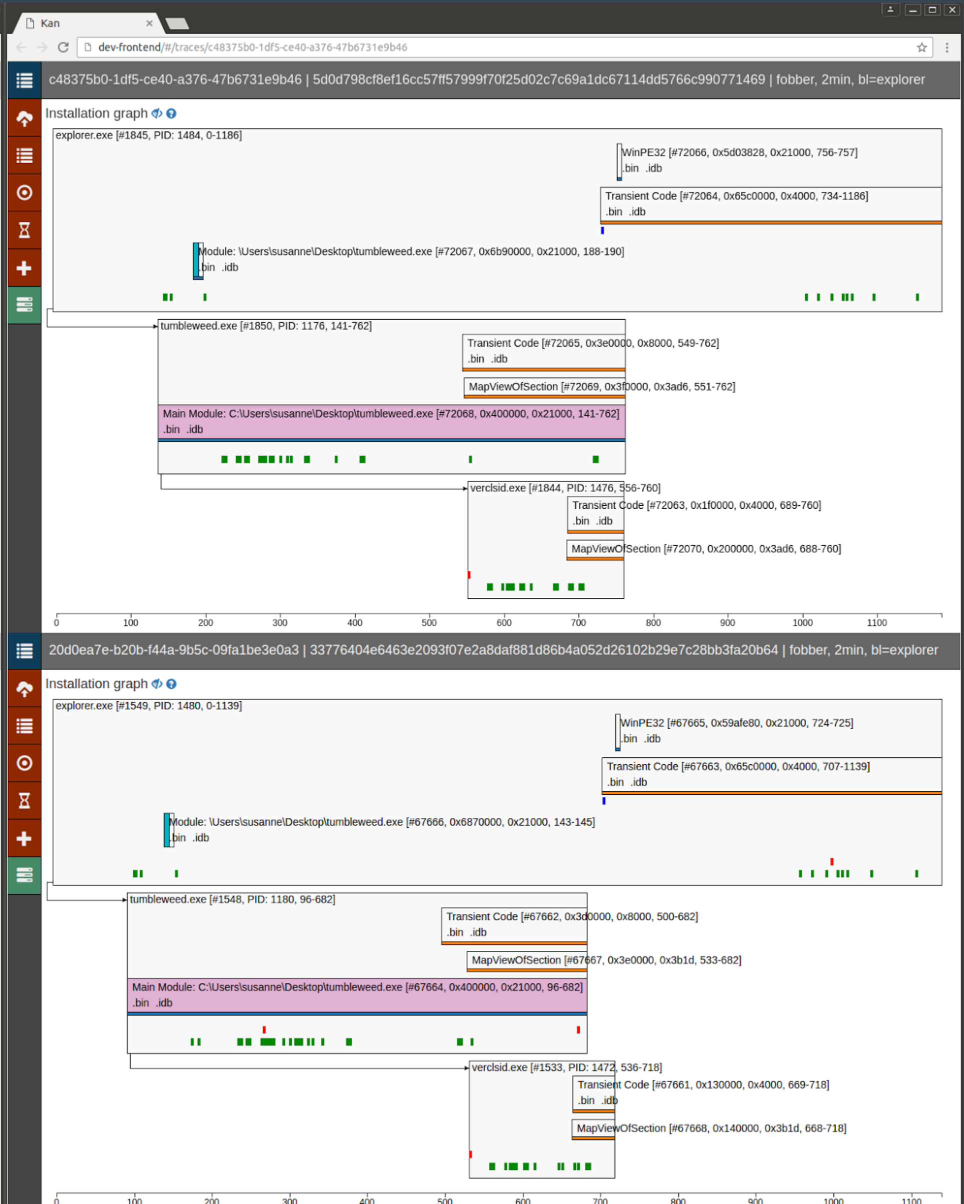
Installation graph

explorer.exe [#1826, PID: 1460, 0-1093]
WinPE32 [#71700, 0x5d44418, 0x17000, 666-667]
.bin .idb
Transient Code [#71698, 0x6980000, 0x4000, 651-1093]
.bin .idb
Module: \Users\susanne\Desktop\tumbleweed.exe [#71701, 0x6bd0000, 0x17000, 143-145]
.bin .idb
tumbleweed.exe [#1816, PID: 1120, 96-630]
Transient Code [#71696, 0x1f0000, 0x8000, 461-630]
.bin .idb
MapViewOfSection [#71702, 0x3e0000, 0x3b1d, 477-630]
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#71699, 0x400000, 0x17000, 96-630]
.bin .idb
verclsid.exe [#1822, PID: 1428, 480-662]
Transient Code [#71697, 0x400000, 0x4000, 613-662]
.bin .idb
MapViewOfSection [#71703, 0x410000, 0x3b1d, 612-662]

bc977679-d484-754d-a211-7f56d955ae50 | d9bac445de8537c483bc60dd1ebdba00c1a2649c66197aa554a2d3b5e19468c8 | fobber, 2min, bl=explorer

Installation graph

explorer.exe [#1485, PID: 1480, 0-1077]
WinPE32 [#66935, 0x59c50a0, 0x17000, 660-661]
.bin .idb
Transient Code [#66933, 0x64b0000, 0x4000, 645-1077]
.bin .idb
Module: \Users\susanne\Desktop\tumbleweed.exe [#66936, 0x6860000, 0x17000, 145-147]
.bin .idb
tumbleweed.exe [#1484, PID: 1284, 98-621]
Transient Code [#66932, 0x3f0000, 0x8000, 455-621]
.bin .idb
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#66934, 0x400000, 0x17000, 98-621]
.bin .idb
MapViewOfSection [#66937, 0x420000, 0x3b1d, 469-606]
verclsid.exe [#1480, PID: 1496, 472-656]
Transient Code [#66931, 0x2f0000, 0x4000, 607-656]
.bin .idb
MapViewOfSection [#66938, 0x300000, 0x3b1d, 606-656]



Kan

dev-frontend/#/traces/c48375b0-1df5-ce40-a376-47b6731e9b46

c48375b0-1df5-ce40-a376-47b6731e9b46 | 5d0d798cf8ef16cc57ff57999f70f25d02c7c69a1dc67114dd5766c990771469 | fobber, 2min, bl=explorer

Installation graph

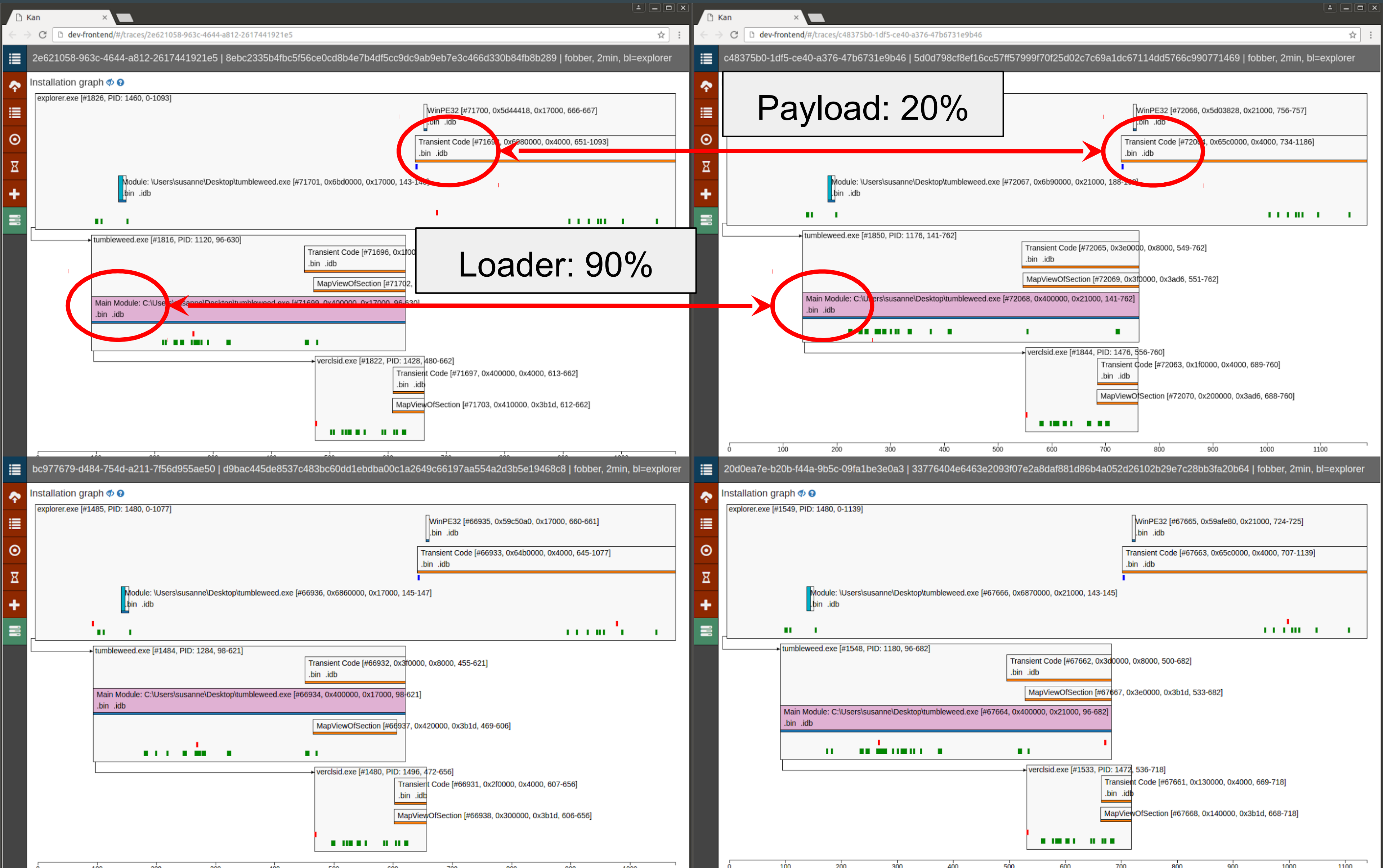
explorer.exe [#1845, PID: 1484, 0-1186]
WinPE32 [#72066, 0x5d03828, 0x21000, 756-757]
.bin .idb
Transient Code [#72064, 0x65c0000, 0x4000, 734-1186]
.bin .idb
Module: \Users\susanne\Desktop\tumbleweed.exe [#72067, 0x6b90000, 0x21000, 188-190]
.bin .idb
tumbleweed.exe [#1850, PID: 1176, 141-762]
Transient Code [#72065, 0x3e0000, 0x8000, 549-762]
.bin .idb
MapViewOfSection [#72069, 0x3f0000, 0x3ad6, 551-762]
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#72068, 0x400000, 0x21000, 141-762]
.bin .idb
verclsid.exe [#1844, PID: 1476, 556-760]
Transient Code [#72063, 0x1f0000, 0x4000, 689-760]
.bin .idb
MapViewOfSection [#72070, 0x200000, 0x3ad6, 688-760]
0
100
200
300
400
500
600
700
800
900
1000
1100

20d0ea7e-b20b-f44a-9b5c-09fa1be3e0a3 | 33776404e6463e2093f07e2a8daf881d86b4a052d26102b29e7c28bb3fa20b64 | fobber, 2min, bl=explorer

Installation graph

explorer.exe [#1549, PID: 1480, 0-1139]
WinPE32 [#67665, 0x59afe80, 0x21000, 724-725]
.bin .idb
Transient Code [#67663, 0x65c0000, 0x4000, 707-1139]
.bin .idb
Module: \Users\susanne\Desktop\tumbleweed.exe [#67666, 0x6870000, 0x21000, 143-145]
.bin .idb
tumbleweed.exe [#1548, PID: 1180, 96-682]
Transient Code [#67662, 0x3d0000, 0x8000, 500-682]
.bin .idb
MapViewOfSection [#67667, 0x3e0000, 0x3b1d, 533-682]
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#67664, 0x400000, 0x21000, 96-682]
.bin .idb
verclsid.exe [#1533, PID: 1472, 536-718]
Transient Code [#67661, 0x130000, 0x4000, 669-718]
.bin .idb
MapViewOfSection [#67668, 0x140000, 0x3b1d, 668-718]

Finding correlations between samples



Payload: 20%

Loader: 90%

dev-frontend/#/traces/2e621058-963c-4644-a812-2617441921e5

2e621058-963c-4644-a812-2617441921e5 | 8ebc2335b4fbc5f56ce0cd8b4e7b4df5cc9dc9ab9eb7e3c466d330b84fb8b289 | fobber, 2min, bl=explorer

dev-frontend/#/traces/c48375b0-1df5-ce40-a376-47b6731e9b46

c48375b0-1df5-ce40-a376-47b6731e9b46 | 5d0d798cf8ef16cc57ff57999f70f25d02c7c69a1dc67114dd5766c990771469 | fobber, 2min, bl=explorer

bc977679-d484-754d-a211-7f56d955ae50 | d9bac445de8537c483bc60dd1ebdba00c1a2649c66197aa554a2d3b5e19468c8 | fobber, 2min, bl=explorer

20d0ea7e-b20b-f44a-9b5c-09fa1be3e0a3 | 33776404e6463e2093f07e2a8daf881d86b4a052d26102b29e7c28bb3fa20b64 | fobber, 2min, bl=explorer

Kan
Installation graph
explorer.exe [#1826, PID: 1460, 0-1093]
WinPE32 [#71700, 0x5d44418, 0x17000, 666-667]
Transient Code [#71699, 0x6880000, 0x4000, 651-1093]
Module: \Users\susanne\Desktop\tumbleweed.exe [#71701, 0x6bd0000, 0x17000, 143-145]
tumbleweed.exe [#1816, PID: 1120, 96-630]
Transient Code [#71696, 0x1f00
MapViewOfSection [#71702,
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#71698, 0x400000, 0x17000, 96-630]
verclsid.exe [#1822, PID: 1428, 480-662]
Transient Code [#71697, 0x400000, 0x4000, 613-662]
MapViewOfSection [#71703, 0x410000, 0x3b1d, 612-662]
WinPE32 [#72066, 0x5d03828, 0x21000, 756-757]
Transient Code [#72064, 0x65c0000, 0x4000, 734-1186]
Module: \Users\susanne\Desktop\tumbleweed.exe [#72067, 0x6b90000, 0x21000, 188-190]
tumbleweed.exe [#1850, PID: 1176, 141-762]
Transient Code [#72065, 0x3e0000, 0x8000, 549-762]
MapViewOfSection [#72069, 0x3f0000, 0x3ad6, 551-762]
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#72068, 0x400000, 0x21000, 141-762]
verclsid.exe [#1844, PID: 1476, 556-760]
Transient Code [#72063, 0x1f0000, 0x4000, 689-760]
MapViewOfSection [#72070, 0x200000, 0x3ad6, 688-760]
explorer.exe [#1485, PID: 1480, 0-1077]
WinPE32 [#66935, 0x59c50a0, 0x17000, 660-661]
Transient Code [#66933, 0x64b0000, 0x4000, 645-1077]
Module: \Users\susanne\Desktop\tumbleweed.exe [#66936, 0x6860000, 0x17000, 145-147]
tumbleweed.exe [#1484, PID: 1284, 98-621]
Transient Code [#66932, 0x3f0000, 0x8000, 455-621]
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#66934, 0x400000, 0x17000, 98-621]
MapViewOfSection [#66937, 0x420000, 0x3b1d, 469-606]
verclsid.exe [#1480, PID: 1496, 472-656]
Transient Code [#66931, 0x2f0000, 0x4000, 607-656]
MapViewOfSection [#66938, 0x300000, 0x3b1d, 606-656]
explorer.exe [#1549, PID: 1480, 0-1139]
WinPE32 [#67665, 0x59afe80, 0x21000, 724-725]
Transient Code [#67663, 0x65c0000, 0x4000, 707-1139]
Module: \Users\susanne\Desktop\tumbleweed.exe [#67666, 0x6870000, 0x21000, 143-145]
tumbleweed.exe [#1548, PID: 1180, 96-682]
Transient Code [#67662, 0x3d0000, 0x8000, 500-682]
MapViewOfSection [#67667, 0x3e0000, 0x3b1d, 533-682]
Main Module: C:\Users\susanne\Desktop\tumbleweed.exe [#67664, 0x400000, 0x21000, 96-682]
verclsid.exe [#1533, PID: 1472, 536-718]
Transient Code [#67661, 0x130000, 0x4000, 669-718]
MapViewOfSection [#67668, 0x140000, 0x3b1d, 668-718]
.bin .idb
0
100
200
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700
800
900
1000
1100

Conclusion

- Novel memory acquisition technique
- Memory inspection based analysis
- Automate some aspects of reverse engineering
- Provide entry points for further analysis
- Delivers relevant artifacts for malware correlations

Questions?

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