Assessing the Impact of Interface Vulnerabilities in Compartmentalized Software

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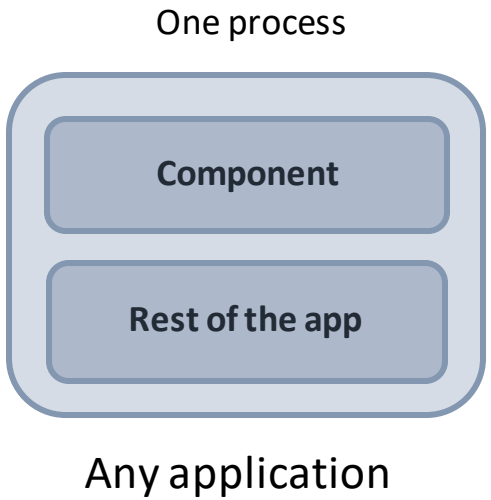

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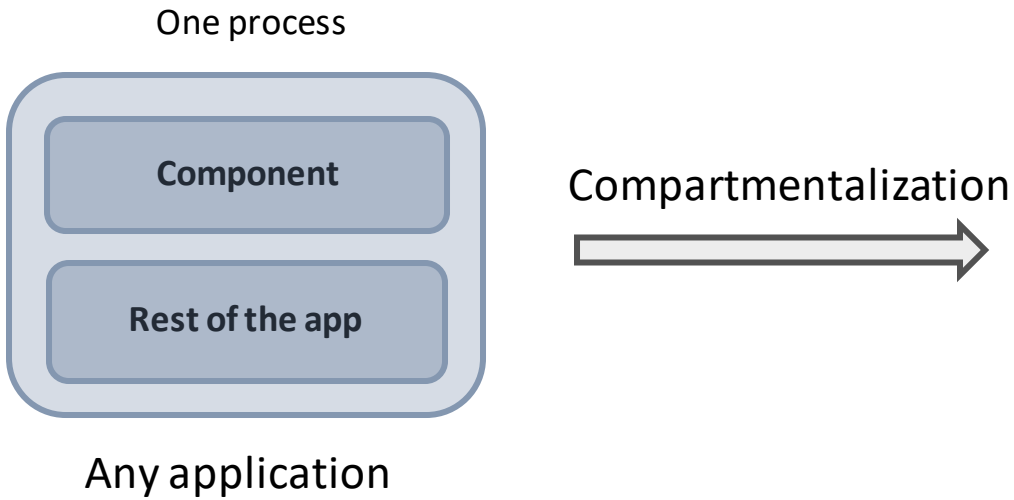

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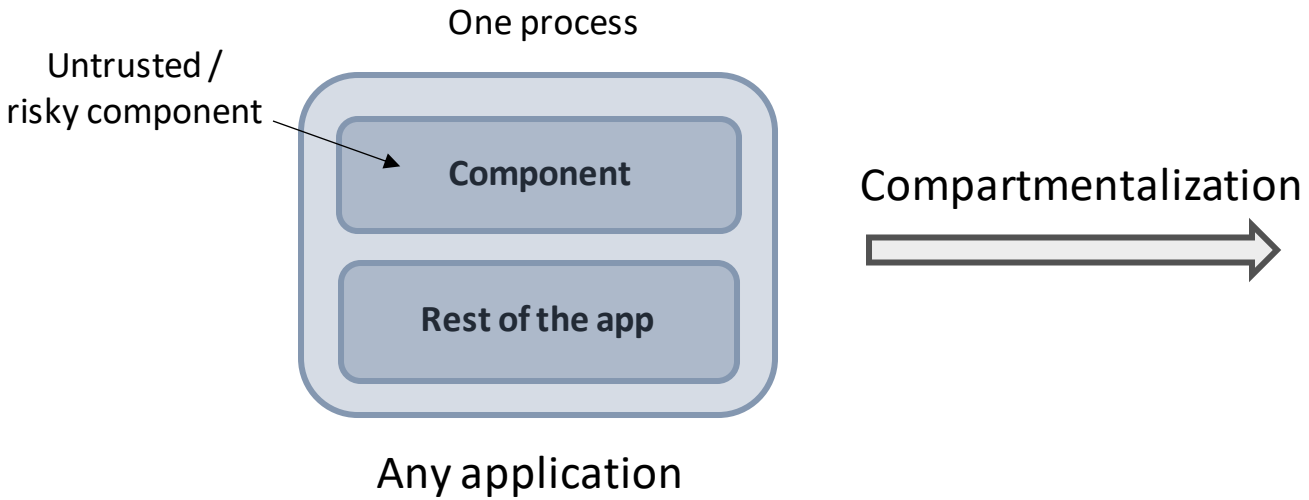

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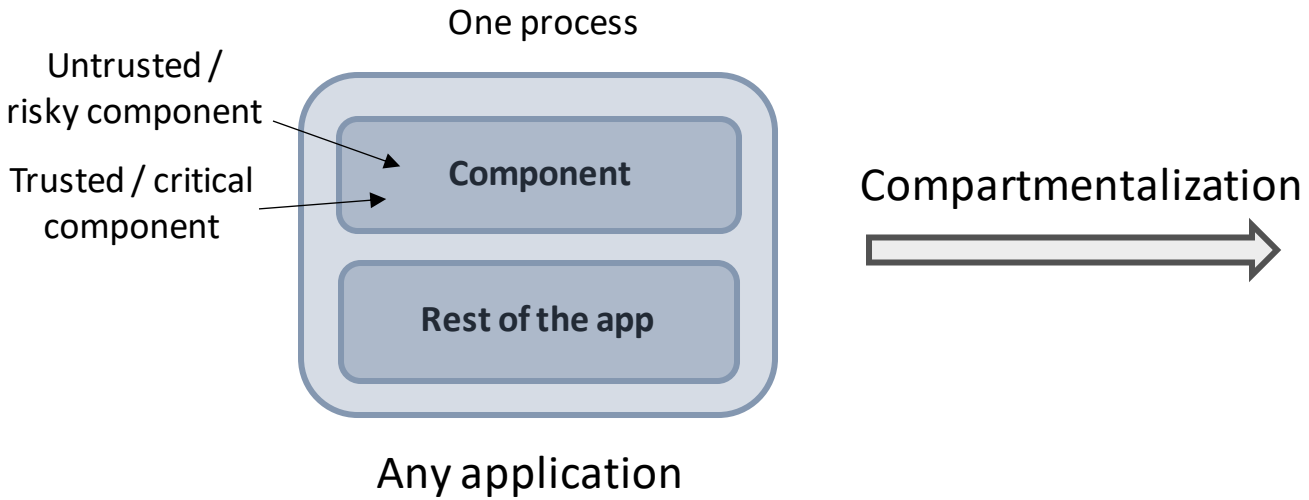

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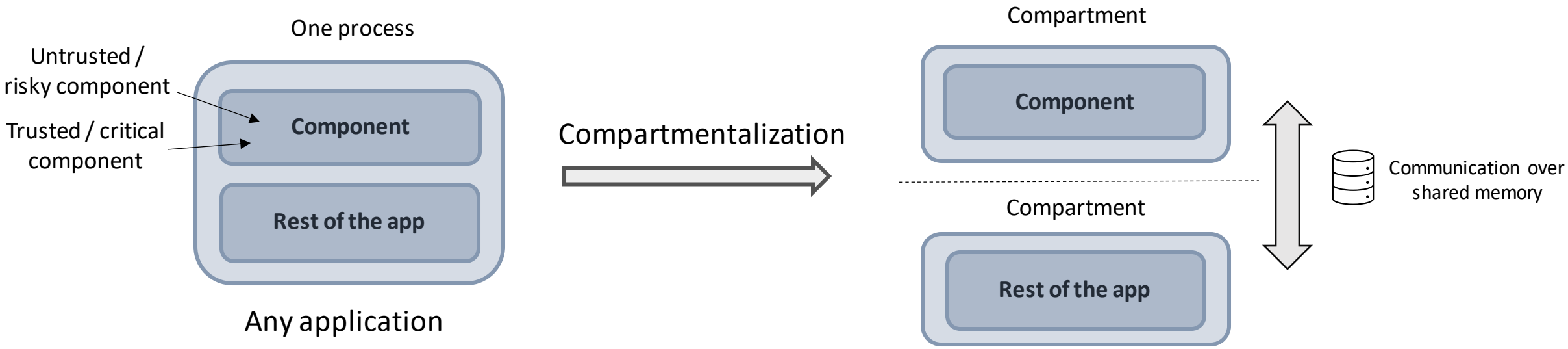

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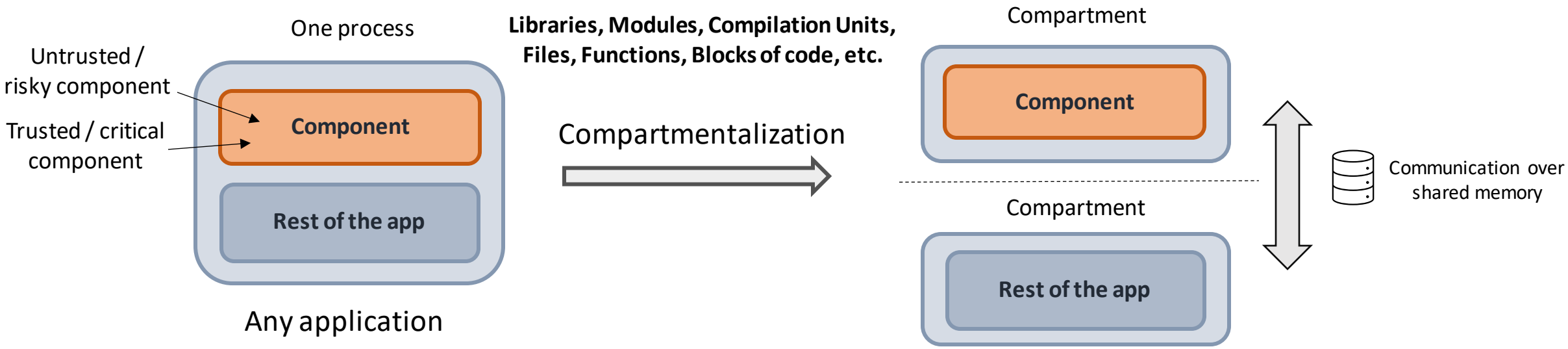

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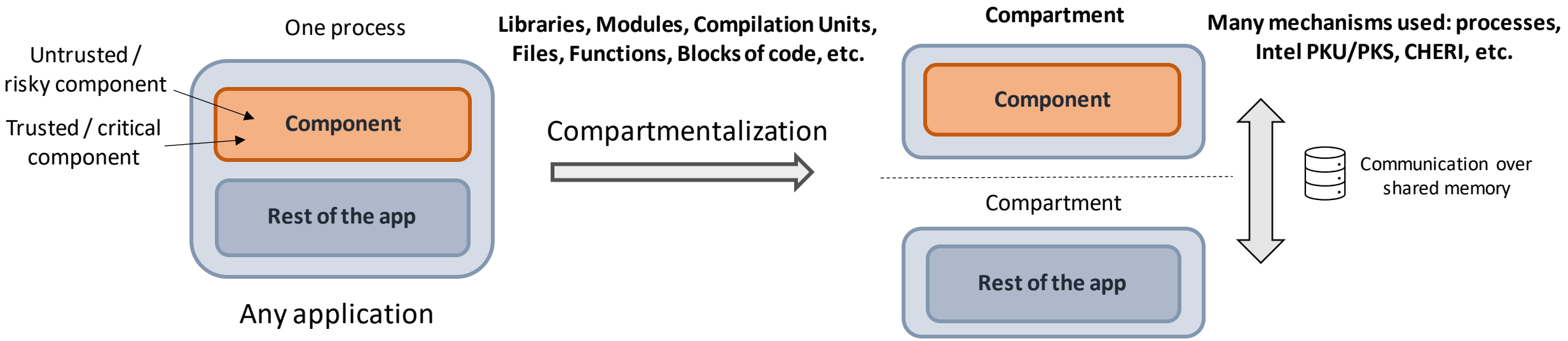

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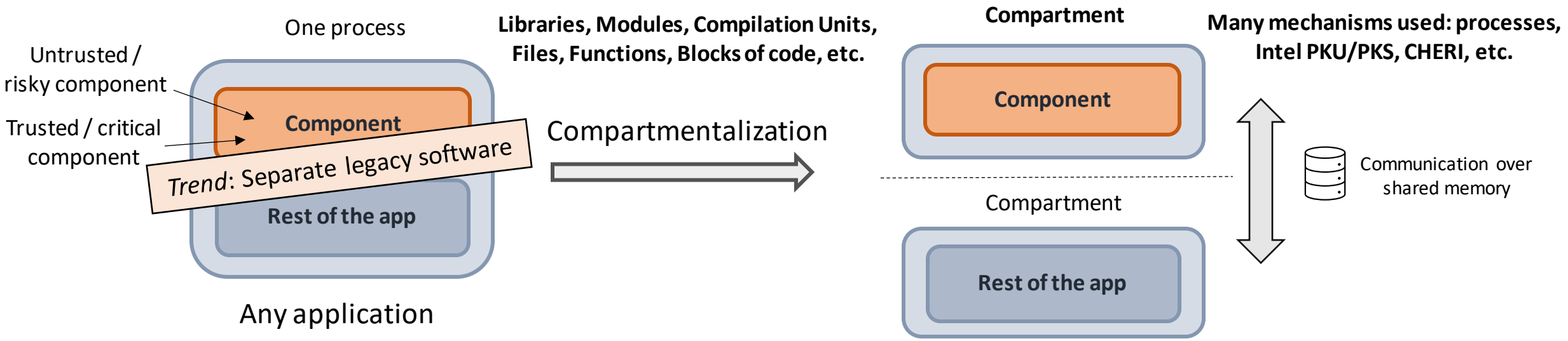

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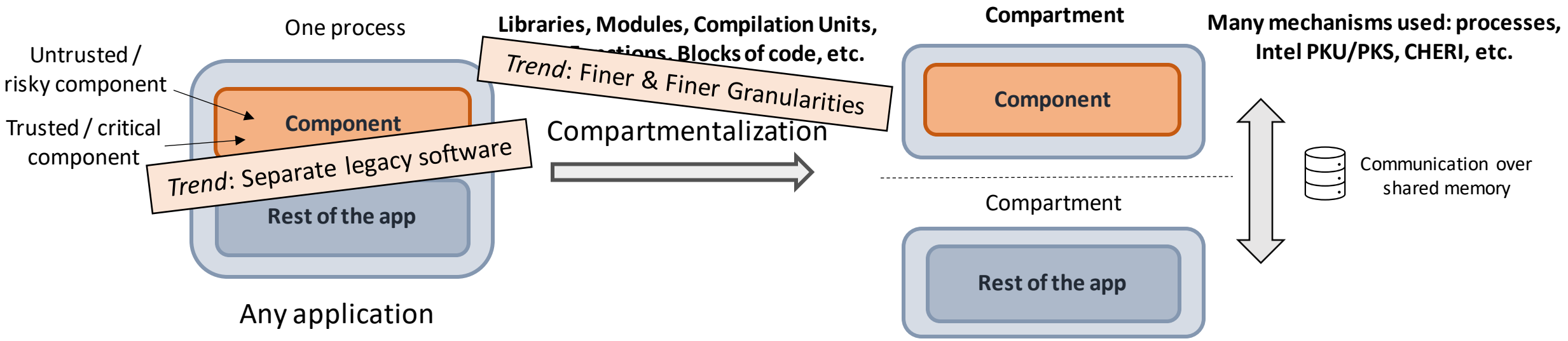

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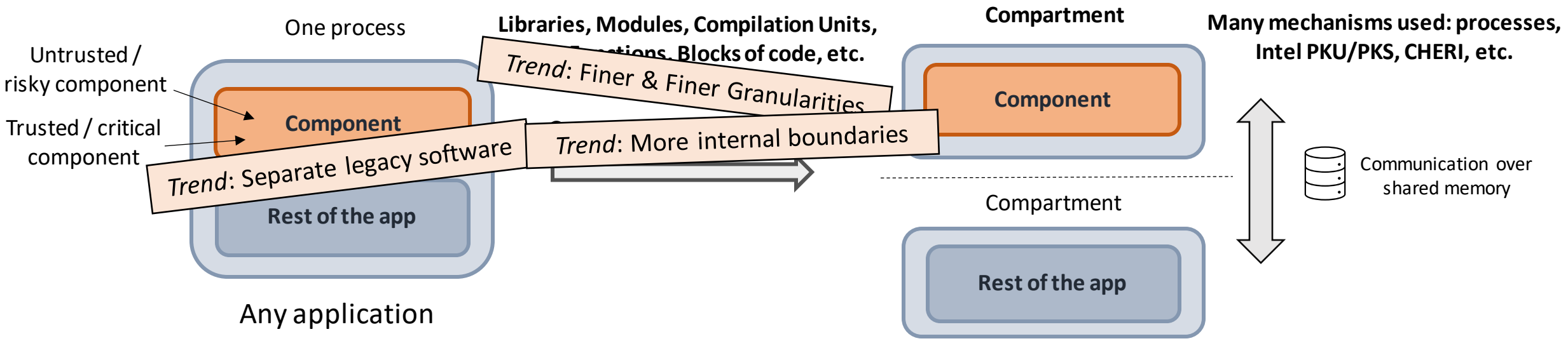

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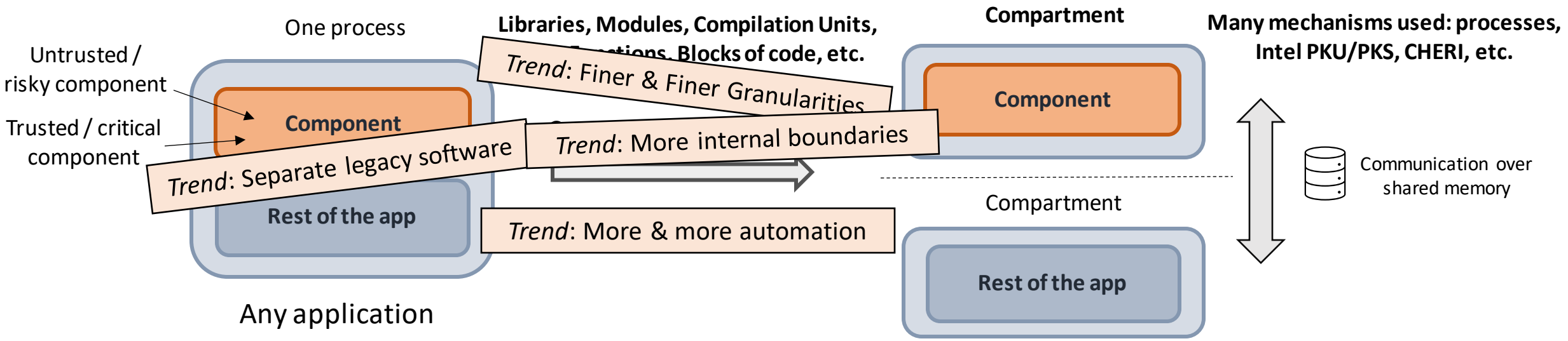

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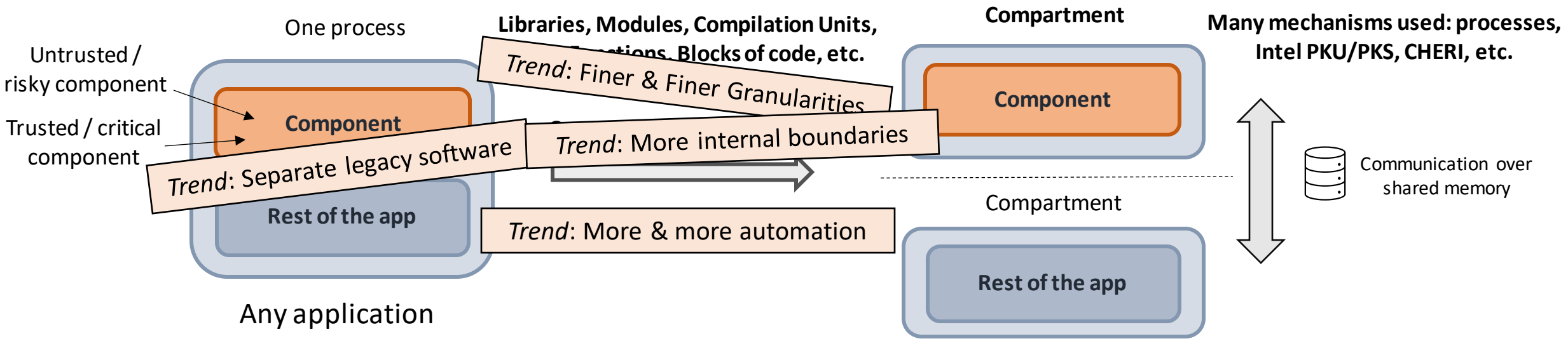

Goals of these works: compartmentalization of **legacy** software

… with a **low engineering effort** … at a **low performance cost**

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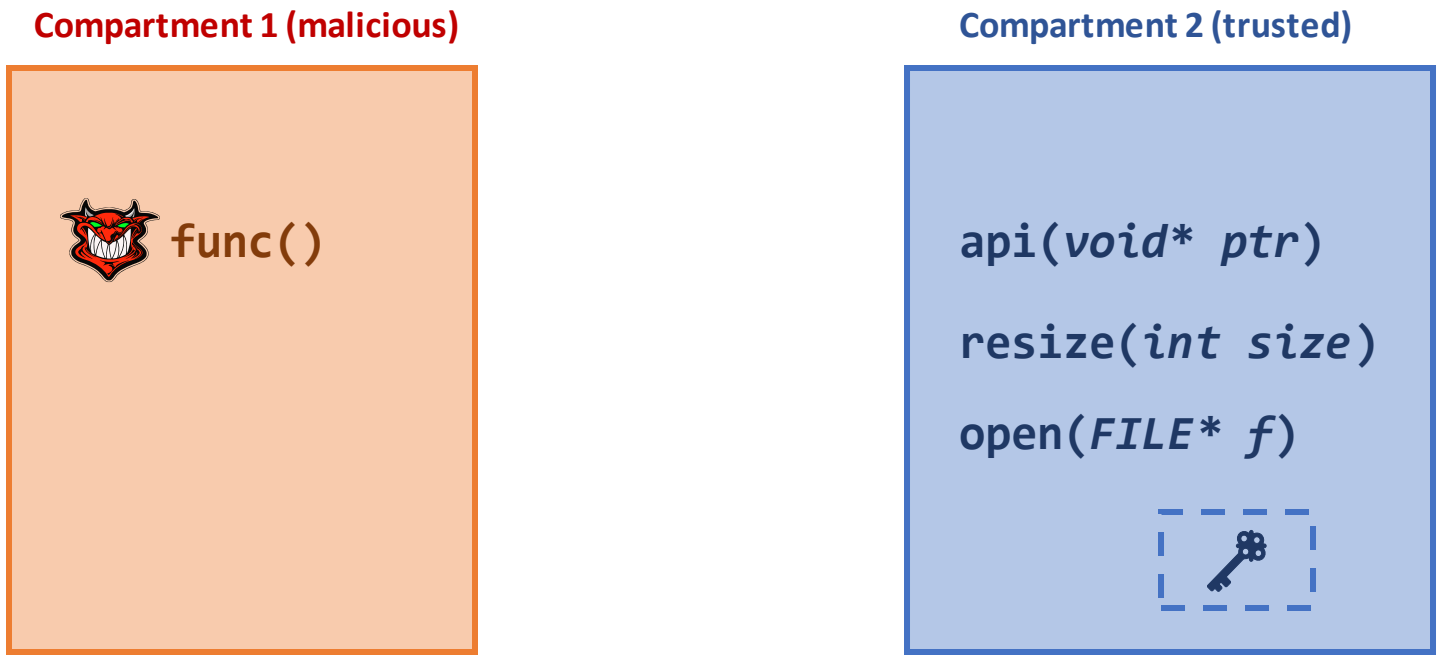

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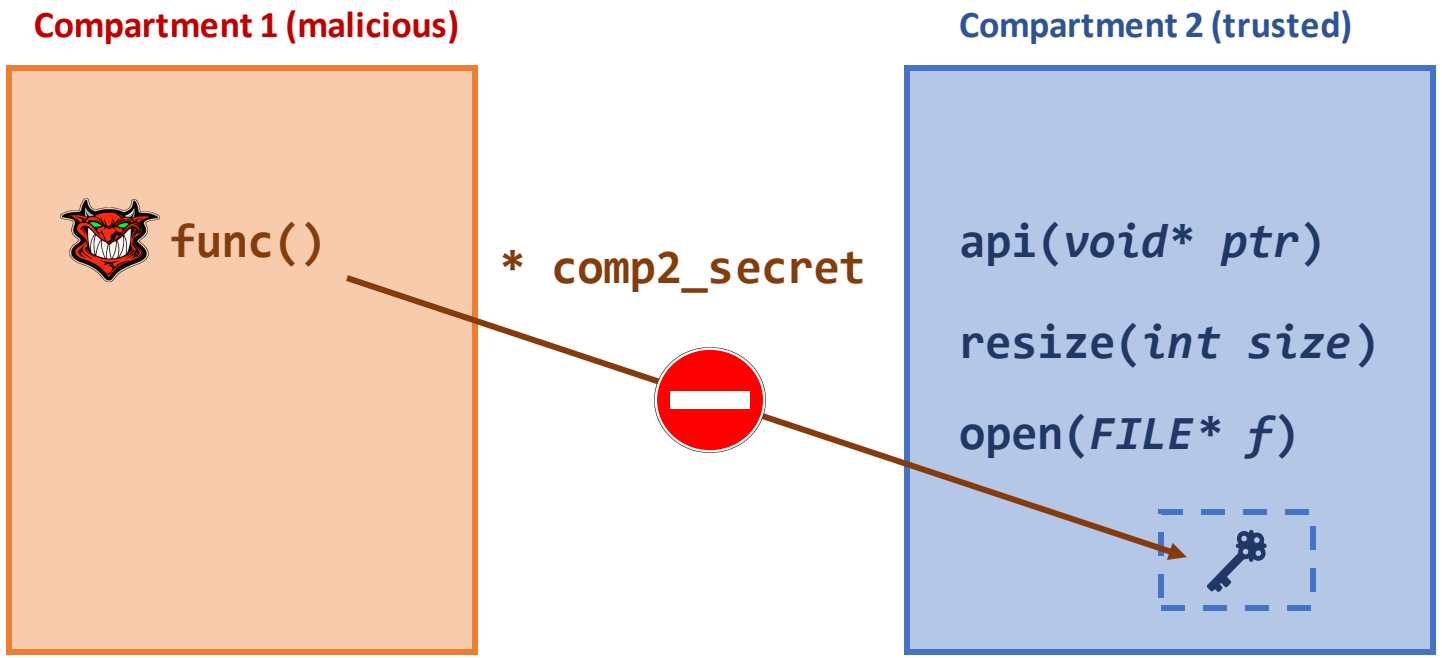

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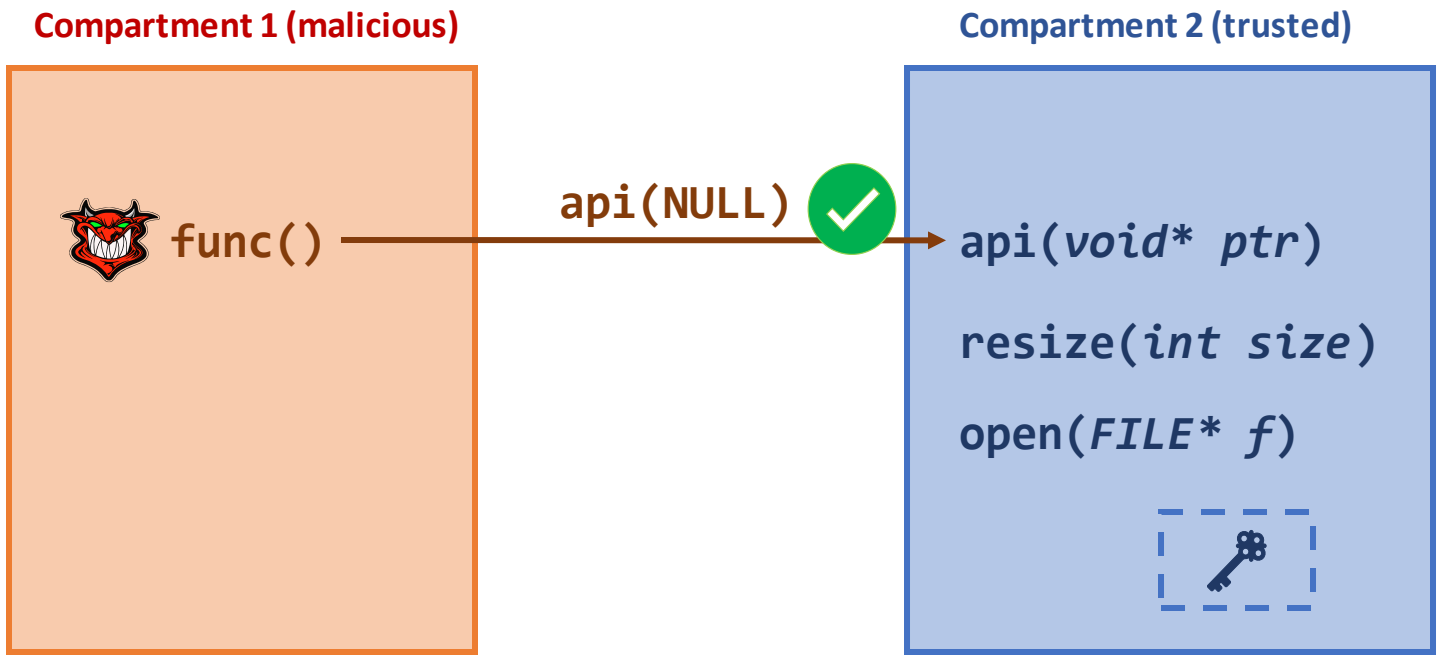

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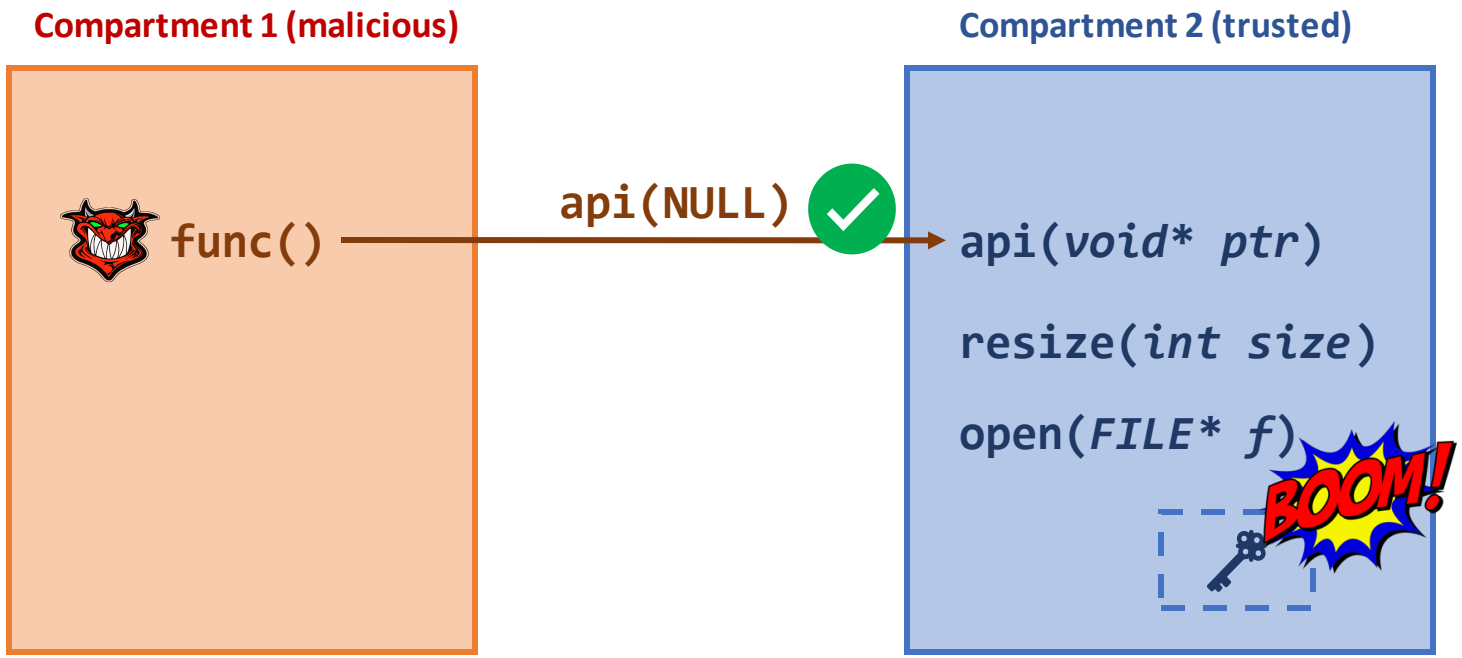

- Dereference of corrupted pointer

```
void api(void* ptr) {
  // …
  * (char *) ptr = '\0';
  // …
}
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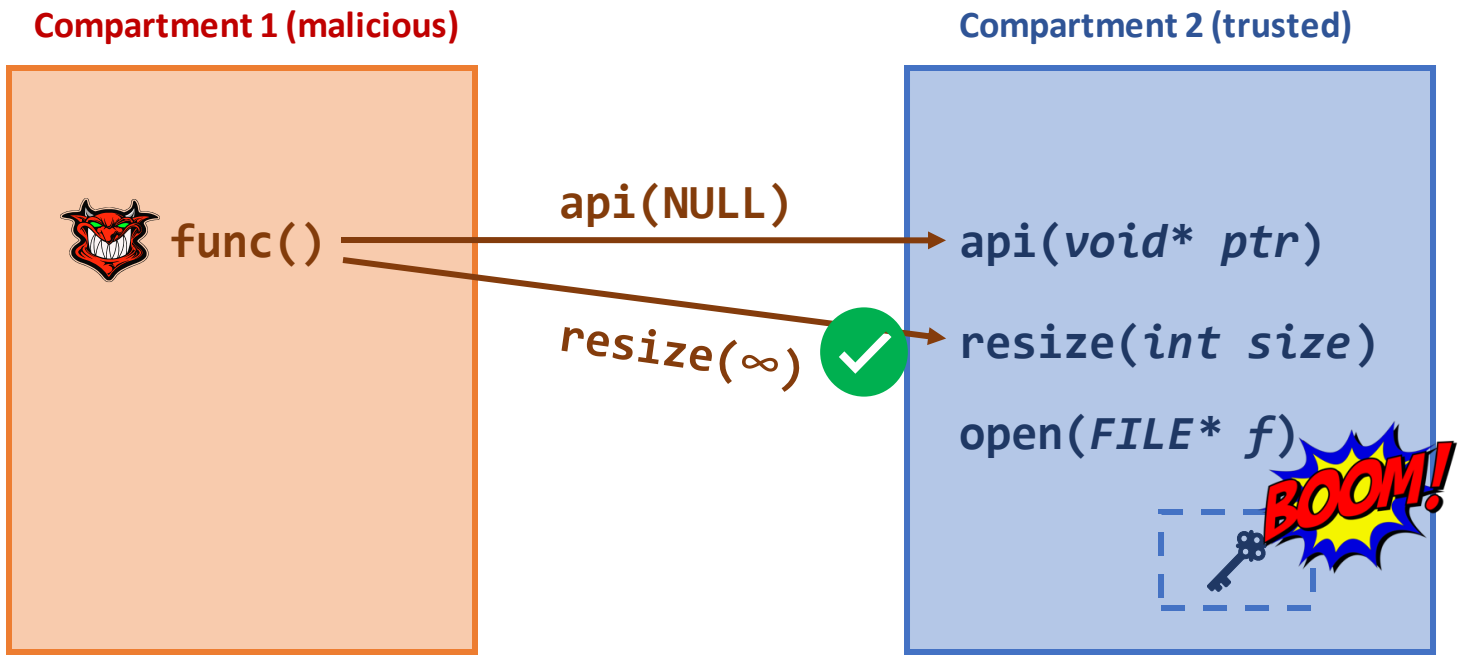

- Dereference of corrupted pointer
- Usage of corrupted indexing information

```
void resize(int size) {
  // …
  var = matrix[size];
  // …
}
```

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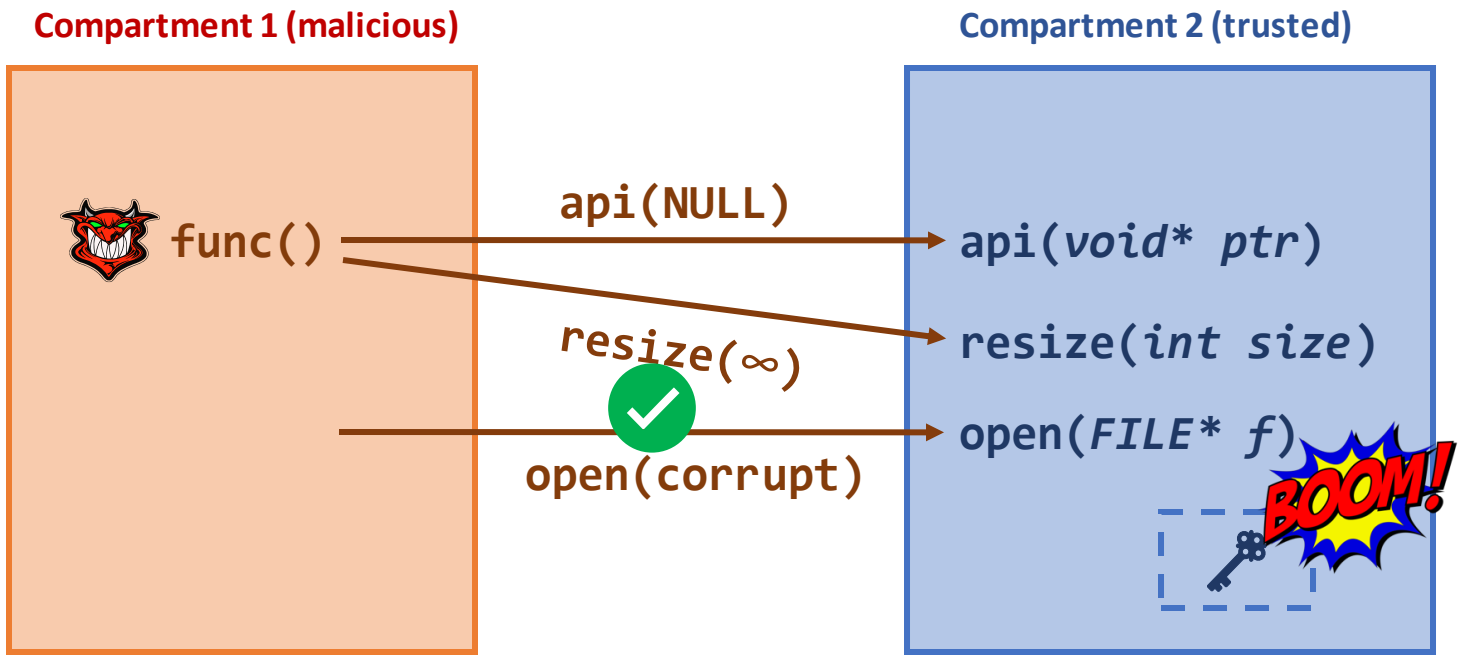

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void open(FILE* f) {
  // …
  close(f);
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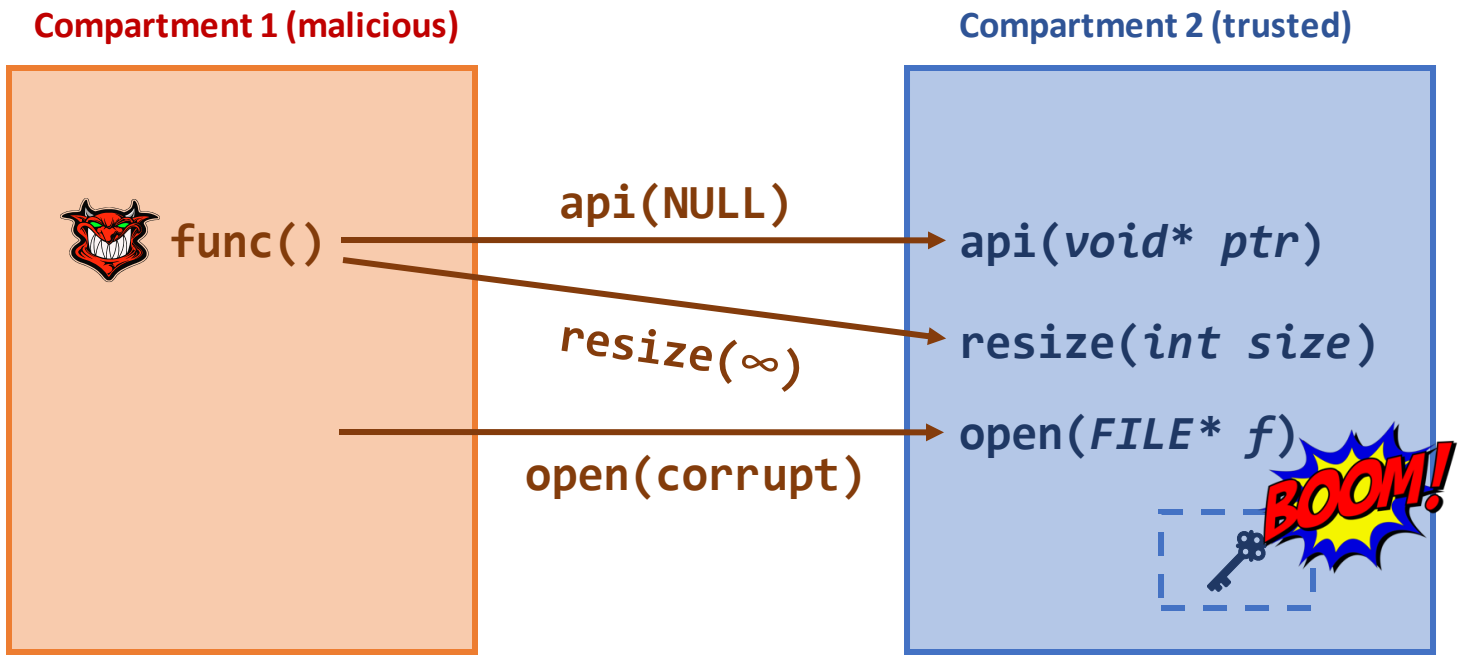

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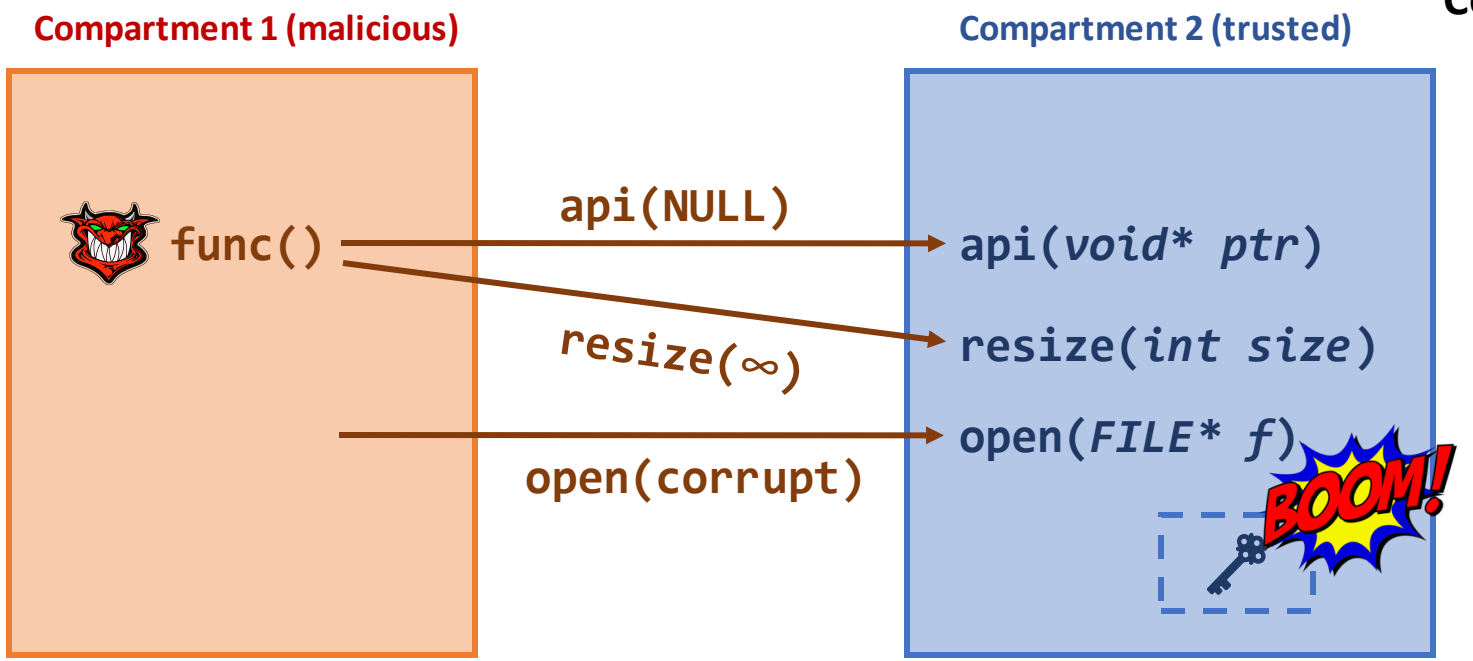

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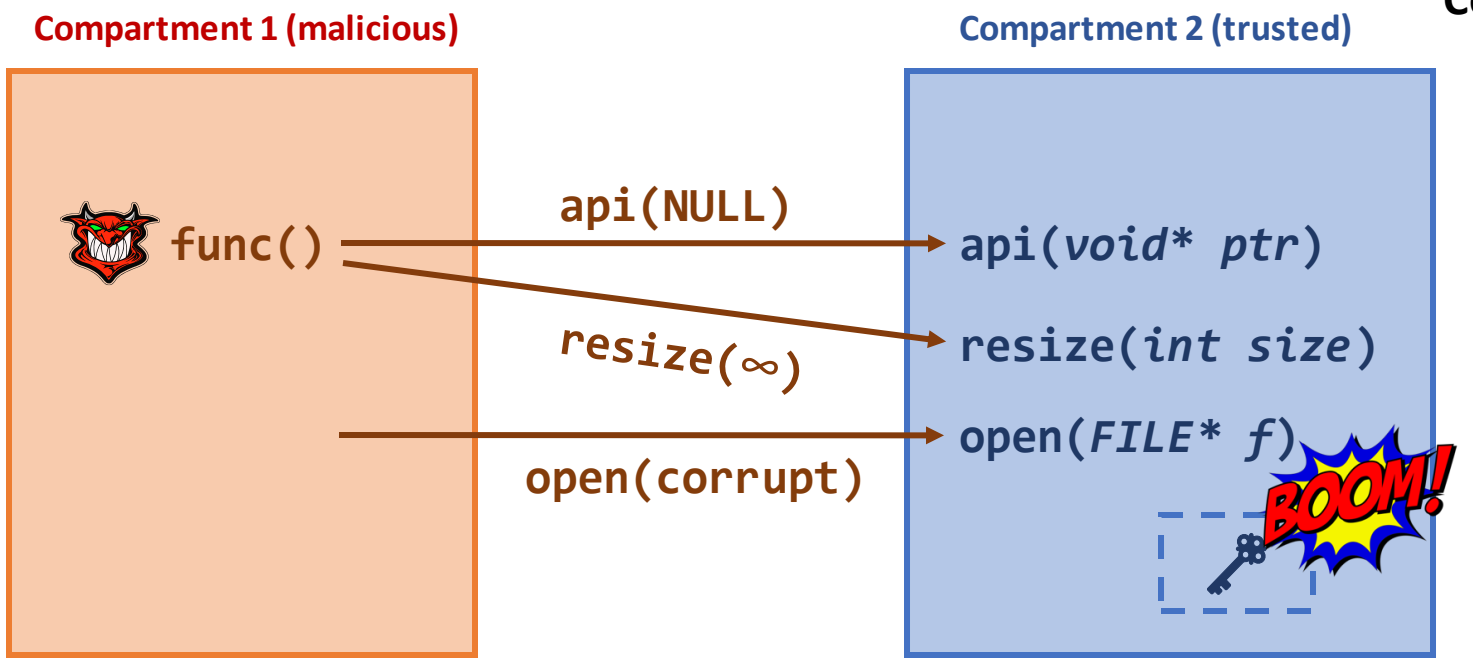

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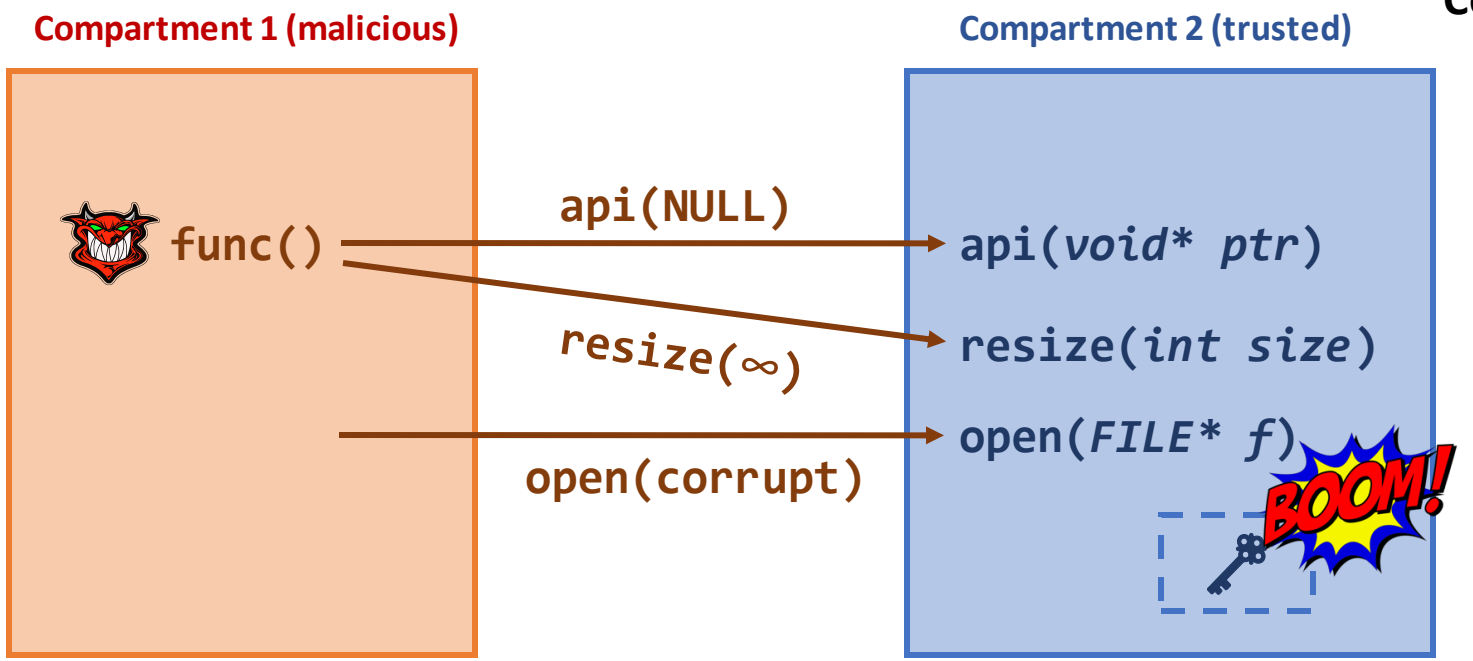

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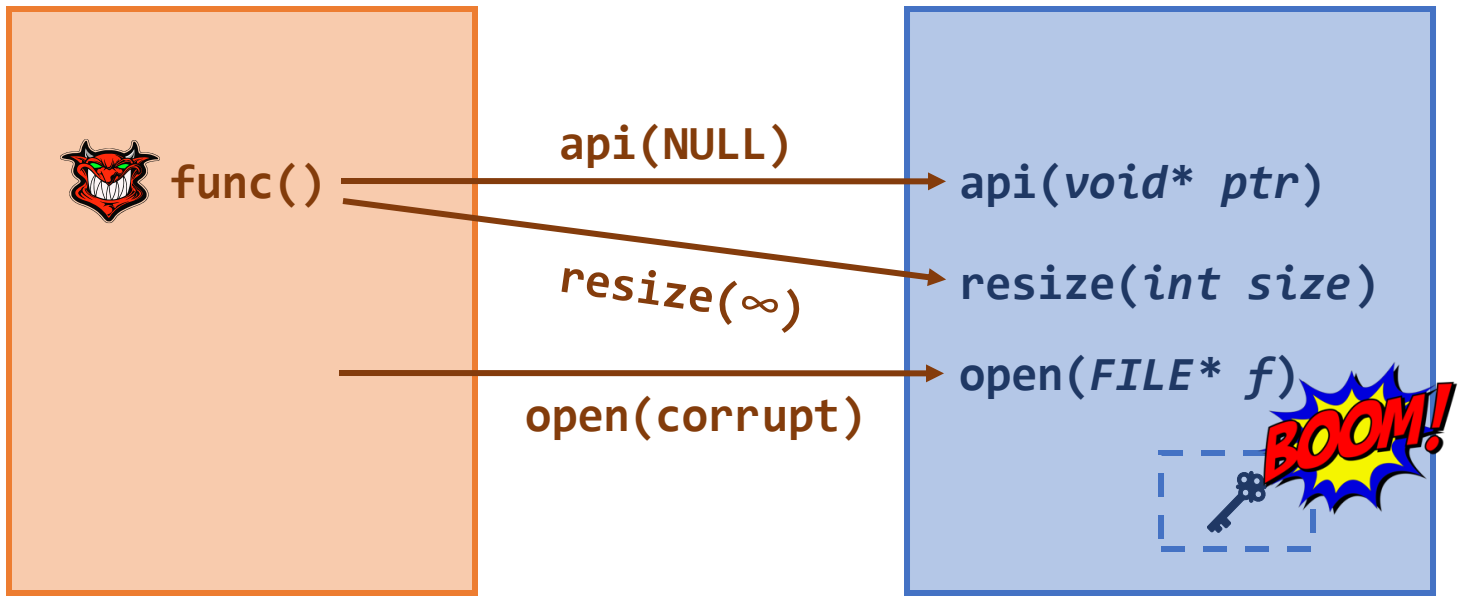

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Full taxonomy of CIVs in our paper!

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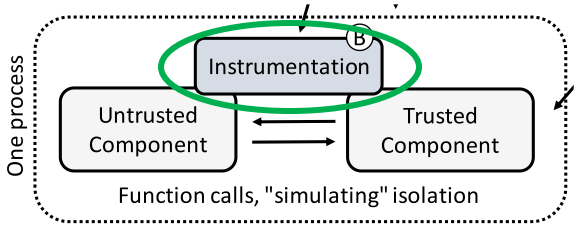

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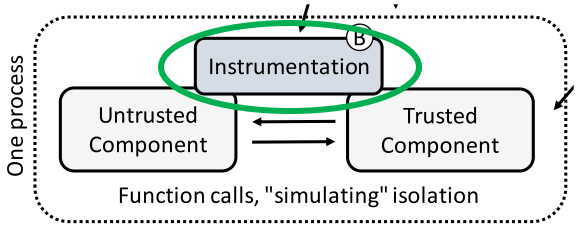

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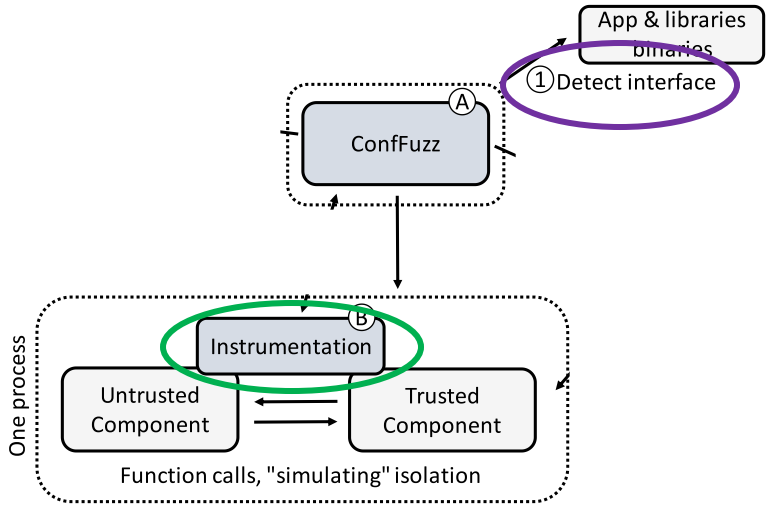

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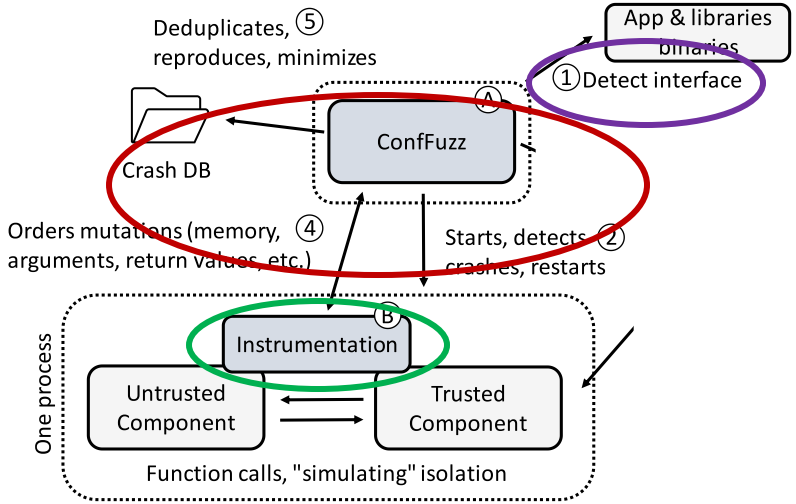

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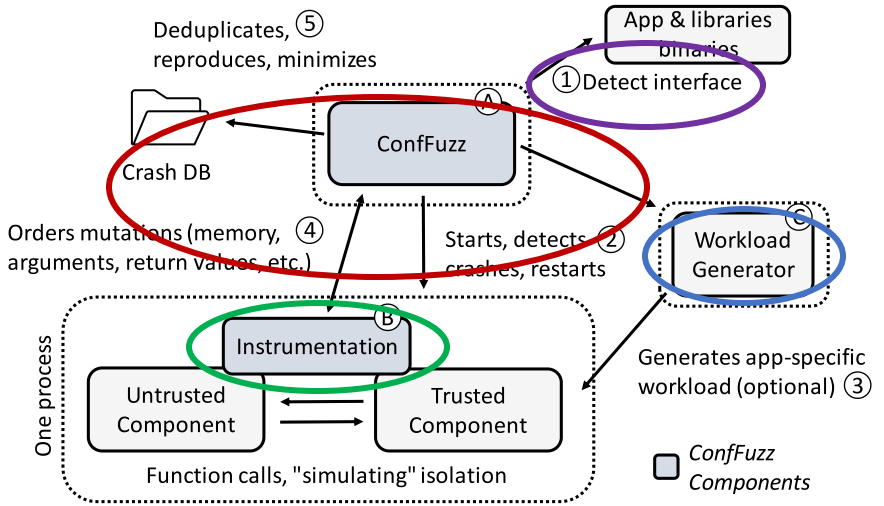

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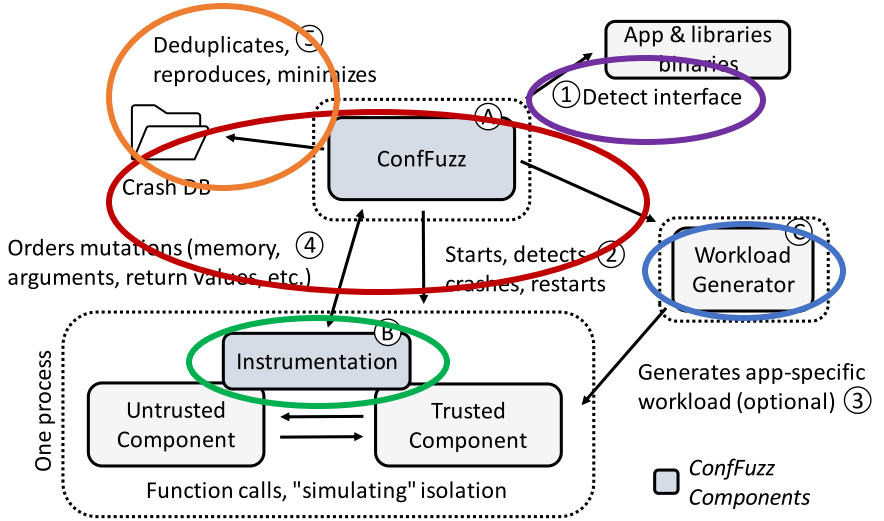
- The fuzzing monitor automatically triages and stores crash reports



Study results: Overview

Using ConfFuzz we gathered a substantial data set

TM	Application	Compartment API	References	Crashes		Victims	API Coverage		Impact (of which arbitrary)				
				Raw	*Dedup.*		*Callers*	*Coverage*	*Read*	*Write*	*Exec*	*Alloc*	*Null*
Sandbox	HTTPd	libmarkdown	[42]	192	13	3	1	100% (4/4)	10 (8)	7 (7)	0 (0)	1	4
		mod_markdown		381	71	5	1	100% (1/1)	62 (52)	17 (14)	2 (1)	0	30
	aspell	libaspell		278	8	1	1	34% (48/141)	7 (7)	7 (7)	2 (1)	0	3
	bind9	libxml2 (write API)		0	0	0	1	86% (13/15)	0 (0)	0 (0)	0 (0)	0	0
	bzip2	libbz2	[67], [5]	16	5	1	1	62% (5/8)	5 (2)	1 (0)	0 (0)	0	0
	cURL	libnghttp2		61	7	2	1	50% (18/36)	3 (3)	5 (5)	0 (0)	1	3
	exif	libexif		400	7	1	1	10% (13/129)	3 (3)	0 (0)	0 (0)	0	5
	FFmpeg	libavcodec		316	20	3	4	31% (19/60)	13 (12)	12 (12)	0 (0)	3	7
		libavfilter		51	1	1	2	12% (2/16)	1 (1)	0 (0)	0 (0)	0	1
		libavformat		217	9	2	3	52% (10/19)	8 (7)	1 (1)	0 (0)	0	7
	file	libmagic		150	5	1	1	63% (7/11)	5 (2)	1 (1)	0 (0)	0	4
	git	libcurl	[22]	13	4	2	1	90% (18/20)	2 (2)	2 (2)	0 (0)	1	1
		libpcre		81	2	1	1	44% (8/18)	2 (2)	0 (0)	0 (0)	2	0
	Inkscape	libpng	[67]	66	3	1	1	46% (14/30)	2 (1)	2 (2)	0 (0)	0	1
		libpoppler	[16]	81	4	2	1	100% (9/9)	4 (3)	4 (4)	0 (0)	0	2
	libxml2-tests	libxml2 (write API)		0	0	0	1	100% (47/47)	0 (0)	0 (0)	0 (0)	0	0
	lighttpd	mod_deflate		117	26	2	1	100% (6/6)	16 (11)	5 (0)	1 (1)	2	9
	Image Magick	libghostscript	[5]	67	14	2	1	100% (11/11)	4 (2)	1 (1)	0 (0)	3	9
		libpng	[67]	778	44	1	2	22% (17/77)	2 (2)	9 (9)	2 (0)	2	39
		libtiff	[67]	197	14	2	1	30% (13/43)	3 (3)	6 (6)	0 (0)	0	13
	Nginx	libpcre		144	10	1	1	93% (14/15)	8 (7)	3 (3)	0 (0)	6	2
		mod_geoip	[52]	276	25	2	1	35% (5/14)	21 (17)	4 (1)	1 (1)	1	10
	Okular	libmarkdown	[42]	64	5	3	1	100% (4/4)	3 (1)	0 (0)	0 (0)	1	2
		libpoppler	[16]	195	9	1	1	6% (24/379)	8 (6)	7 (7)	0 (0)	1	4
	Redis	mod_redisbloom		389	23	1	1	42% (8/19)	18 (13)	6 (4)	0 (0)	0	13
		mod_redisearch		381	21	1	1	54% (18/33)	15 (14)	14 (11)	0 (0)	0	12
	rsync	libpopt		167	8	1	1	90% (9/10)	4 (3)	2 (0)	0 (0)	0	5
	squid	libxml2		226	12	1	1	70% (7/10)	9 (5)	3 (3)	4 (1)	0	4
	su	libaudit		0	0	0	1	66% (2/3)	0 (0)	0 (0)	0 (0)	0	0
	Wireshark	libpcap		162	8	2	1	50% (20/40)	8 (3)	5 (5)	0 (0)	0	4
		libzlib		42	1	1	1	85% (6/7)	0 (0)	0 (0)	0 (0)	0	1
	Total:			5508	379	47	38	N/A	246 (192)	124 (105)	12 (5)	24	195
Safebox	cURL	libssl	[5]	198	27	1	1	25% (14/56)	18 (10)	5 (4)	1 (1)	0	17
	GPA	libgpgme		174	9	1	1	4% (3/72)	7 (2)	0 (0)	0 (0)	0	6
	GPG	libgcrypt	[5]	4221	105	1	1	15% (15/95)	64 (60)	4 (0)	0 (0)	77	20
	Memcached	internal_hashtable	[45]	4037	16	1	1	50% (6/12)	10 (5)	2 (0)	0 (0)	1	6
	Nginx	internal_libssl-keys	[45], [60], [15], [34]	599	46	1	1	50% (2/4)	32 (1)	28 (0)	0 (0)	0	22
		libssl	[5], [1], [22], [51]	346	39	2	1	11% (11/96)	16 (13)	19 (13)	2 (1)	0	26
	sudo	internal_auth-api		191	5	1	1	100% (5/5)	5 (4)	0 (0)	0 (0)	0	4
		libapparmor		97	3	1	1	100% (2/2)	2 (2)	2 (0)	0 (0)	0	2
	Total:			9863	250	9	8	N/A	154 (97)	60 (17)	3 (2)	78	103

TM	Application	Compartment API	References	Crashes		Victims	API Coverage		Impact (of which arbitrary)				
				Raw	*Dedup.*		*Callers*	*Coverage*	*Read*	*Write*	*Exec*	*Alloc*	*Null*
Sandbox	HTTPd	libmarkdown	[42]	192	13	3	1	100% (4/4)	10 (8)	7 (7)	0 (0)	1	4
		mod_markdown		381	71	5	1	100% (1/1)	62 (52)	17 (14)	2 (1)	0	30
	aspell	libaspell		278	8	1	1	34% (48/141)	7 (7)	7 (7)	2 (1)	0	3
	bind9	libxml2 (write API)		0	0	0	1	86% (13/15)	0 (0)	0 (0)	0 (0)	0	0
	bzip2	libbz2	[67], [5]	16	5	1	1	62% (5/8)	5 (2)	1 (0)	0 (0)	0	0
	cURL	libnghttp2		61	7	2	1	50% (18/36)	3 (3)	5 (5)	0 (0)	1	3
	exif	libexif		400	7	1	1	10% (13/129)	3 (3)	0 (0)	0 (0)	0	5
	FFmpeg	libavcodec		316	20	3	4	31% (19/60)	13 (12)	12 (12)	0 (0)	3	7
		libavfilter		51	1	1	2	12% (2/16)	1 (1)	0 (0)	0 (0)	0	1
		libavformat		217	9	2	3	52% (10/19)	8 (7)	1 (1)	0 (0)	0	7
	file	libmagic		150	5	1	1	63% (7/11)	5 (2)	1 (1)	0 (0)	0	4
	git	libcurl	[22]	13	4	2	1	90% (18/20)	2 (2)	2 (2)	0 (0)	1	1
		libpcre		81	2	1	1	44% (8/18)	2 (2)	0 (0)	0 (0)	2	0
	Inkscape	libpng	[67]	66	3	1	1	46% (14/30)	2 (1)	2 (2)	0 (0)	0	1
		libpoppler	[16]	81	4	2	1	100% (9/9)	4 (3)	4 (4)	0 (0)	0	2
	libxml2-tests	libxml2 (write API)		0	0	0	1	100% (47/47)	0 (0)	0 (0)	0 (0)	0	0
	lighttpd	mod_deflate		117	26	2	1	100% (6/6)	16 (11)	5 (0)	1 (1)	2	9
	Image Magick	libghostscript	[5]	67	14	2	1	100% (11/11)	4 (2)	1 (1)	0 (0)	3	9
		libpng	[67]	778	44	1	2	22% (17/77)	2 (2)	9 (9)	2 (0)	2	39
		libtiff	[67]	197	14	2	1	30% (13/43)	3 (3)	6 (6)	0 (0)	0	13
	Nginx	libpcre		144	10	1	1	93% (14/15)	8 (7)	3 (3)	0 (0)	6	2
		mod_geoip	[52]	276	25	2	1	35% (5/14)	21 (17)	4 (1)	1 (1)	1	10
	Okular	libmarkdown	[42]	64	5	3	1	100% (4/4)	3 (1)	0 (0)	0 (0)	1	2
		libpoppler	[16]	195	9	1	1	6% (24/379)	8 (6)	7 (7)	0 (0)	1	4
	Redis	mod_redisbloom		389	23	1	1	42% (8/19)	18 (13)	6 (4)	0 (0)	0	13
		mod_redisearch		381	21	1	1	54% (18/33)	15 (14)	14 (11)	0 (0)	0	12
	rsync	libpopt		167	8	1	1	90% (9/10)	4 (3)	2 (0)	0 (0)	0	5
	squid	libxml2		226	12	1	1	70% (7/10)	9 (5)	3 (3)	4 (1)	0	4
	su	libaudit		0	0	0	1	66% (2/3)	0 (0)	0 (0)	0 (0)	0	0
	Wireshark	libpcap		162	8	2	1	50% (20/40)	8 (3)	5 (5)	0 (0)	0	4
		libzlib		42	1	1	1	85% (6/7)	0 (0)	0 (0)	0 (0)	0	1
	Total:			5508	379	47	38	N/A	246 (192)	124 (105)	12 (5)	24	195
Safebox	cURL	libssl	[5]	198	27	1	1	25% (14/56)	18 (10)	5 (4)	1 (1)	0	17
	GPA	libgpgme		174	9	1	1	4% (3/72)	7 (2)	0 (0)	0 (0)	0	6
	GPG	libgcrypt	[5]	4221	105	1	1	15% (15/95)	64 (60)	4 (0)	0 (0)	77	20
	Memcached	internal_hashtable	[45]	4037	16	1	1	50% (6/12)	10 (5)	2 (0)	0 (0)	1	6
	Nginx	internal_libssl-keys	[45], [60], [15], [34]	599	46	1	1	50% (2/4)	32 (1)	28 (0)	0 (0)	0	22
		libssl	[5], [1], [22], [51]	346	39	2	1	11% (11/96)	16 (13)	19 (13)	2 (1)	0	26
	sudo	internal_auth-api		191	5	1	1	100% (5/5)	5 (4)	0 (0)	0 (0)	0	4
		libapparmor		97	3	1	1	100% (2/2)	2 (2)	2 (0)	0 (0)	0	2
	Total:			9863	250	9	8	N/A	154 (97)	60 (17)	3 (2)	78	103

25 applications

36 APIs in total

TM	Application	Compartment API	References	Crashes		Victims	API Coverage		Impact (of which arbitrary)				
				Raw	*Dedup.*		*Callers*	*Coverage*	*Read*	*Write*	*Exec*	*Alloc*	*Null*
Sandbox	HTTPd	libmarkdown	[42]	192	13	3	1	100% (4/4)	10 (8)	7 (7)	0 (0)	1	4
		mod_markdown		381	71	5	1	100% (1/1)	62 (52)	17 (14)	2 (1)	0	30
	aspell	libaspell		278	8	1	1	34% (48/141)	7 (7)	7 (7)	2 (1)	0	3
	bind9	libxml2 (write API)		0	0	0	1	86% (13/15)	0 (0)	0 (0)	0 (0)	0	0
	bzip2	libbz2	[67], [5]	16	5	1	1	62% (5/8)	5 (2)	1 (0)	0 (0)	0	0
	cURL	libnghttp2		61	7	2	1	50% (18/36)	3 (3)	5 (5)	0 (0)	1	3
	exif	libexif		400	7	1	1	10% (13/129)	3 (3)	0 (0)	0 (0)	0	5
	FFmpeg	libavcodec		316	20	3	4	31% (19/60)	13 (12)	12 (12)	0 (0)	3	7
		libavfilter		51	1	1	2	12% (2/16)	1 (1)	0 (0)	0 (0)	0	1
		libavformat		217	9	2	3	52% (10/19)	8 (7)	1 (1)	0 (0)	0	7
	file	libmagic		150	5	1	1	63% (7/11)	5 (2)	1 (1)	0 (0)	0	4
	git	libcurl	[22]	13	4	2	1	90% (18/20)	2 (2)	2 (2)	0 (0)	1	1
		libpcre		81	2	1	1	44% (8/18)	2 (2)	0 (0)	0 (0)	2	0
	Inkscape	libpng	[67]	66	3	1	1	46% (14/30)	2 (1)	2 (2)	0 (0)	0	1
		libpoppler	[16]	81	4	2	1	100% (9/9)	4 (3)	4 (4)	0 (0)	0	2
	libxml2-tests	libxml2 (write API)		0	0	0	1	100% (47/47)	0 (0)	0 (0)	0 (0)	0	0
	lighttpd	mod_deflate		117	26	2	1	100% (6/6)	16 (11)	5 (0)	1 (1)	2	9
	Image Magick	libghostscript	[5]	67	14	2	1	100% (11/11)	4 (2)	1 (1)	0 (0)	3	9
		libpng	[67]	778	44	1	2	22% (17/77)	2 (2)	9 (9)	2 (0)	2	39
		libtiff	[67]	197	14	2	1	30% (13/43)	3 (3)	6 (6)	0 (0)	0	13
	Nginx	libpcre		144	10	1	1	93% (14/15)	8 (7)	3 (3)	0 (0)	6	2
		mod_geoip	[52]	276	25	2	1	35% (5/14)	21 (17)	4 (1)	1 (1)	1	10
	Okular	libmarkdown	[42]	64	5	3	1	100% (4/4)	3 (1)	0 (0)	0 (0)	1	2
		libpoppler	[16]	195	9	1	1	6% (24/379)	8 (6)	7 (7)	0 (0)	1	4
	Redis	mod_redisbloom		389	23	1	1	42% (8/19)	18 (13)	6 (4)	0 (0)	0	13
		mod_redisearch		381	21	1	1	54% (18/33)	15 (14)	14 (11)	0 (0)	0	12
	rsync	libpopt		167	8	1	1	90% (9/10)	4 (3)	2 (0)	0 (0)	0	5
	squid	libxml2		226	12	1	1	70% (7/10)	9 (5)	3 (3)	4 (1)	0	4
	su	libaudit		0	0	0	1	66% (2/3)	0 (0)	0 (0)	0 (0)	0	0
	Wireshark	libpcap		162	8	2	1	50% (20/40)	8 (3)	5 (5)	0 (0)	0	4
		libzlib		42	1	1	1	85% (6/7)	0 (0)	0 (0)	0 (0)	0	1
	Total:			5508	379	47	38	N/A	246 (192)	124 (105)	12 (5)	24	195
Safebox	cURL	libssl	[5]	198	27	1	1	25% (14/56)	18 (10)	5 (4)	1 (1)	0	17
	GPA	libgpgme		174	9	1	1	4% (3/72)	7 (2)	0 (0)	0 (0)	0	6
	GPG	libgcrypt	[5]	4221	105	1	1	15% (15/95)	64 (60)	4 (0)	0 (0)	77	20
	Memcached	internal_hashtable	[45]	4037	16	1	1	50% (6/12)	10 (5)	2 (0)	0 (0)	1	6
	Nginx	internal_libssl-keys	[45], [60], [15], [34]	599	46	1	1	50% (2/4)	32 (1)	28 (0)	0 (0)	0	22
		libssl	[5], [1], [22], [51]	346	39	2	1	11% (11/96)	16 (13)	19 (13)	2 (1)	0	26
	sudo	internal_auth-api		191	5	1	1	100% (5/5)	5 (4)	0 (0)	0 (0)	0	4
		libapparmor		97	3	1	1	100% (2/2)	2 (2)	2 (0)	0 (0)	0	2
	Total:			9863	250	9	8	N/A	154 (97)	60 (17)	3 (2)	78	103

Library APIs Module APIs Internal APIs

25 applications

36 APIs in total

TM	Application	Compartment API	References	Crashes		Victims	API Coverage		Impact (of which arbitrary)				
				Raw	*Dedup.*		*Callers*	*Coverage*	*Read*	*Write*	*Exec*	*Alloc*	*Null*
Sandbox	HTTPd	libmarkdown	[42]	192	13	3	1	100% (4/4)	10 (8)	7 (7)	0 (0)	1	4
		mod_markdown		381	71	5	1	100% (1/1)	62 (52)	17 (14)	2 (1)	0	30
	aspell	libaspell		278	8	1	1	34% (48/141)	7 (7)	7 (7)	2 (1)	0	3
	bind9	libxml2 (write API)		0	0	0	1	86% (13/15)	0 (0)	0 (0)	0 (0)	0	0
	bzip2	libbz2	[67], [5]	16	5	1	1	62% (5/8)	5 (2)	1 (0)	0 (0)	0	0
	cURL	libnghttp2		61	7	2	1	50% (18/36)	3 (3)	5 (5)	0 (0)	1	3
	exif	libexif		400	7	1	1	10% (13/129)	3 (3)	0 (0)	0 (0)	0	5
	FFmpeg	libavcodec		316	20	3	4	31% (19/60)	13 (12)	12 (12)	0 (0)	3	7
		libavfilter		51	1	1	2	12% (2/16)	1 (1)	0 (0)	0 (0)	0	1
		libavformat		217	9	2	3	52% (10/19)	8 (7)	1 (1)	0 (0)	0	7
	file	libmagic		150	5	1	1	63% (7/11)	5 (2)	1 (1)	0 (0)	0	4
	git	libcurl	[22]	13	4	2	1	90% (18/20)	2 (2)	2 (2)	0 (0)	1	1
		libpcre		81	2	1	1	44% (8/18)	2 (2)	0 (0)	0 (0)	2	0
	Inkscape	libpng	[67]	66	3	1	1	46% (14/30)	2 (1)	2 (2)	0 (0)	0	1
		libpoppler	[16]	81	4	2	1	100% (9/9)	4 (3)	4 (4)	0 (0)	0	2
	libxml2-tests	libxml2 (write API)		0	0	0	1	100% (47/47)	0 (0)	0 (0)	0 (0)	0	0
	lighttpd	mod_deflate		117	26	2	1	100% (6/6)	16 (11)	5 (0)	1 (1)	2	9
	Image Magick	libghostscript	[5]	67	14	2	1	100% (11/11)	4 (2)	1 (1)	0 (0)	3	9
		libpng	[67]	778	44	1	2	22% (17/77)	2 (2)	9 (9)	2 (0)	2	39
		libtiff	[67]	197	14	2	1	30% (13/43)	3 (3)	6 (6)	0 (0)	0	13
	Nginx	libpcre		144	10	1	1	93% (14/15)	8 (7)	3 (3)	0 (0)	6	2
		mod_geoip	[52]	276	25	2	1	35% (5/14)	21 (17)	4 (1)	1 (1)	1	10
	Okular	libmarkdown	[42]	64	5	3	1	100% (4/4)	3 (1)	0 (0)	0 (0)	1	2
		libpoppler	[16]	195	9	1	1	6% (24/379)	8 (6)	7 (7)	0 (0)	1	4
	Redis	mod_redisbloom		389	23	1	1	42% (8/19)	18 (13)	6 (4)	0 (0)	0	13
		mod_redisearch		381	21	1	1	54% (18/33)	15 (14)	14 (11)	0 (0)	0	12
	rsync	libpopt		167	8	1	1	90% (9/10)	4 (3)	2 (0)	0 (0)	0	5
	squid	libxml2		226	12	1	1	70% (7/10)	9 (5)	3 (3)	4 (1)	0	4
	su	libaudit		0	0	0	1	66% (2/3)	0 (0)	0 (0)	0 (0)	0	0
	Wireshark	libpcap		162	8	2	1	50% (20/40)	8 (3)	5 (5)	0 (0)	0	4
		libzlib		42	1	1	1	85% (6/7)	0 (0)	0 (0)	0 (0)	0	1
	Total:			5508	379	47	38	N/A	246 (192)	124 (105)	12 (5)	24	195
Safebox	cURL	libssl	[5]	198	27	1	1	25% (14/56)	18 (10)	5 (4)	1 (1)	0	17
	GPA	libgpgme		174	9	1	1	4% (3/72)	7 (2)	0 (0)	0 (0)	0	6
	GPG	libgcrypt	[5]	4221	105	1	1	15% (15/95)	64 (60)	4 (0)	0 (0)	77	20
	Memcached	internal_hashtable	[45]	4037	16	1	1	50% (6/12)	10 (5)	2 (0)	0 (0)	1	6
	Nginx	internal_libssl-keys	[45], [60], [15], [34]	599	46	1	1	50% (2/4)	32 (1)	28 (0)	0 (0)	0	22
		libssl	[5], [1], [22], [51]	346	39	2	1	11% (11/96)	16 (13)	19 (13)	2 (1)	0	26
	sudo	internal_auth-api		191	5	1	1	100% (5/5)	5 (4)	0 (0)	0 (0)	0	4
		libapparmor		97	3	1	1	100% (2/2)	2 (2)	2 (0)	0 (0)	0	2
	Total:			9863	250	9	8	N/A	154 (97)	60 (17)	3 (2)	78	103

Library APIs | Module APIs | Internal APIs

25 applications

36 APIs in total

16 of which taken from the literature

TM	Application	Compartment API	References	Crashes		Victims	API Coverage		Impact (of which arbitrary)				
				Raw	*Dedup.*		*Callers*	*Coverage*	*Read*	*Write*	*Exec*	*Alloc*	*Null*
Sandbox	HTTPd	libmarkdown	[42]	192	13	3	1	100% (4/4)	10 (8)	7 (7)	0 (0)	1	4
		mod_markdown		381	71	5	1	100% (1/1)	62 (52)	17 (14)	2 (1)	0	30
	aspell	libaspell		278	8	1	1	34% (48/141)	7 (7)	7 (7)	2 (1)	0	3
	bind9	libxml2 (write API)		0	0	0	1	86% (13/15)	0 (0)	0 (0)	0 (0)	0	0
	bzip2	libbz2	[67], [5]	16	5	1	1	62% (5/8)	5 (2)	1 (0)	0 (0)	0	0
	cURL	libnghttp2		61	7	2	1	50% (18/36)	3 (3)	5 (5)	0 (0)	1	3
	exif	libexif		400	7	1	1	10% (13/129)	3 (3)	0 (0)	0 (0)	0	5
	FFmpeg	libavcodec		316	20	3	4	31% (19/60)	13 (12)	12 (12)	0 (0)	3	7
		libavfilter		51	1	1	2	12% (2/16)	1 (1)	0 (0)	0 (0)	0	1
		libavformat		217	9	2	3	52% (10/19)	8 (7)	1 (1)	0 (0)	0	7
	file	libmagic		150	5	1	1	63% (7/11)	5 (2)	1 (1)	0 (0)	0	4
	git	libcurl	[22]	13	4	2	1	90% (18/20)	2 (2)	2 (2)	0 (0)	1	1
		libpcre		81	2	1	1	44% (8/18)	2 (2)	0 (0)	0 (0)	2	0
	Inkscape	libpng	[67]	66	3	1	1	46% (14/30)	2 (1)	2 (2)	0 (0)	0	1
		libpoppler	[16]	81	4	2	1	100% (9/9)	4 (3)	4 (4)	0 (0)	0	2
	libxml2-tests	libxml2 (write API)		0	0	0	1	100% (47/47)	0 (0)	0 (0)	0 (0)	0	0
	lighttpd	mod_deflate		117	26	2	1	100% (6/6)	16 (11)	5 (0)	1 (1)	2	9
	Image Magick	libghostscript	[5]	67	14	2	1	100% (11/11)	4 (2)	1 (1)	0 (0)	3	9
		libpng	[67]	778	44	1	2	22% (17/77)	2 (2)	9 (9)	2 (0)	2	39
		libtiff	[67]	197	14	2	1	30% (13/43)	3 (3)	6 (6)	0 (0)	0	13
	Nginx	libpcre		144	10	1	1	93% (14/15)	8 (7)	3 (3)	0 (0)	6	2
		mod_geoip	[52]	276	25	2	1	35% (5/14)	21 (17)	4 (1)	1 (1)	1	10
	Okular	libmarkdown	[42]	64	5	3	1	100% (4/4)	3 (1)	0 (0)	0 (0)	1	2
		libpoppler	[16]	195	9	1	1	6% (24/379)	8 (6)	7 (7)	0 (0)	1	4
	Redis	mod_redisbloom		389	23	1	1	42% (8/19)	18 (13)	6 (4)	0 (0)	0	13
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	sudo	internal_auth-api		191	5	1	1	100% (5/5)	5 (4)	0 (0)	0 (0)	0	4
		libapparmor		97	3	1	1	100% (2/2)	2 (2)	2 (0)	0 (0)	0	2
	Total:			9863	250	9	8	N/A	154 (97)	60 (17)	3 (2)	78	103

Library APIs | Module APIs | Internal APIs

25 applications

36 APIs in total

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	bind9	libxml2 (write API)		0	0	0	1	86% (13/15)	0 (0)	0 (0)	0 (0)	0	0
	bzip2	libbz2	[67], [5]	16	5	1	1	62% (5/8)	5 (2)	1 (0)	0 (0)	0	0
	cURL	libnghttp2		61	7	2	1	50% (18/36)	3 (3)	5 (5)	0 (0)	1	3
	exif	libexif		400	7	1	1	10% (13/129)	3 (3)	0 (0)	0 (0)	0	5
	FFmpeg	libavcodec		316	20	3	4	31% (19/60)	13 (12)	12 (12)	0 (0)	3	7
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		libavformat		217	9	2	3	52% (10/19)	8 (7)	1 (1)	0 (0)	0	7
	file	libmagic		150	5	1	1	63% (7/11)	5 (2)	1 (1)	0 (0)	0	4
	git	libcurl	[22]	13	4	2	1	90% (18/20)	2 (2)	2 (2)	0 (0)	1	1
		libpcre		81	2	1	1	44% (8/18)	2 (2)	0 (0)	0 (0)	2	0
	Inkscape	libpng	[67]	66	3	1	1	46% (14/30)	2 (1)	2 (2)	0 (0)	0	1
		libpoppler	[16]	81	4	2	1	100% (9/9)	4 (3)	4 (4)	0 (0)	0	2
	libxml2-tests	libxml2 (write API)		0	0	0	1	100% (47/47)	0 (0)	0 (0)	0 (0)	0	0
	lighttpd	mod_deflate		117	26	2	1	100% (6/6)	16 (11)	5 (0)	1 (1)	2	9
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	Redis	mod_redisbloom		389	23	1	1	42% (8/19)	18 (13)	6 (4)	0 (0)	0	13
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	rsync	libpopt		167	8	1	1	90% (9/10)	4 (3)	2 (0)	0 (0)	0	5
	squid	libxml2		226	12	1	1	70% (7/10)	9 (5)	3 (3)	4 (1)	0	4
	su	libaudit		0	0	0	1	66% (2/3)	0 (0)	0 (0)	0 (0)	0	0
	Wireshark	libpcap		162	8	2	1	50% (20/40)	8 (3)	5 (5)	0 (0)	0	4
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	sudo	internal_auth-api		191	5	1	1	100% (5/5)	5 (4)	0 (0)	0 (0)	0	4
		libapparmor		97	3	1	1	100% (2/2)	2 (2)	2 (0)	0 (0)	0	2
	Total:			9863	250	9	8	N/A	154 (97)	60 (17)	3 (2)	78	103

Library APIs | Module APIs | Internal APIs

5 security impact types

25 applications

36 APIs in total

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	bzip2	libbz2	[67], [5]	16	5	1	1	62% (5/8)	5 (2)	1 (0)	0 (0)	0	0
	cURL	libnghttp2		61	7	2	1	50% (18/36)	3 (3)	5 (5)	0 (0)	1	3
	exif	libexif		400	7	1	1	10% (13/129)	3 (3)	0 (0)	0 (0)	0	5
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Study results: CIV prevalence

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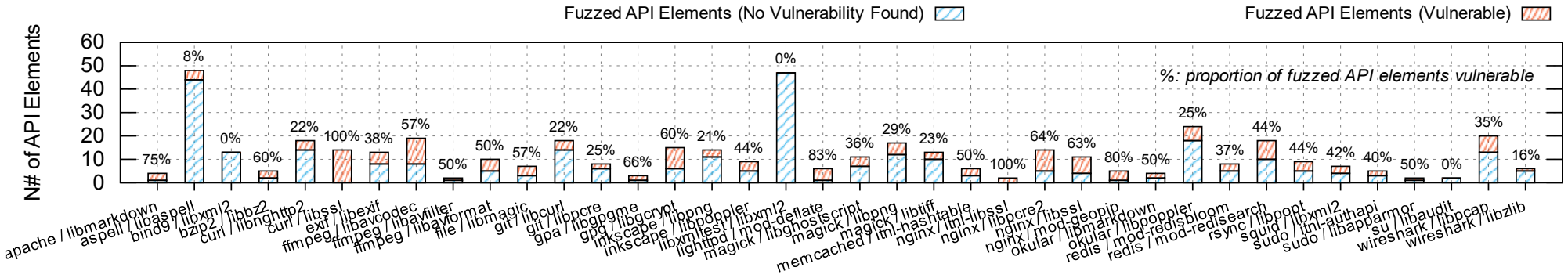

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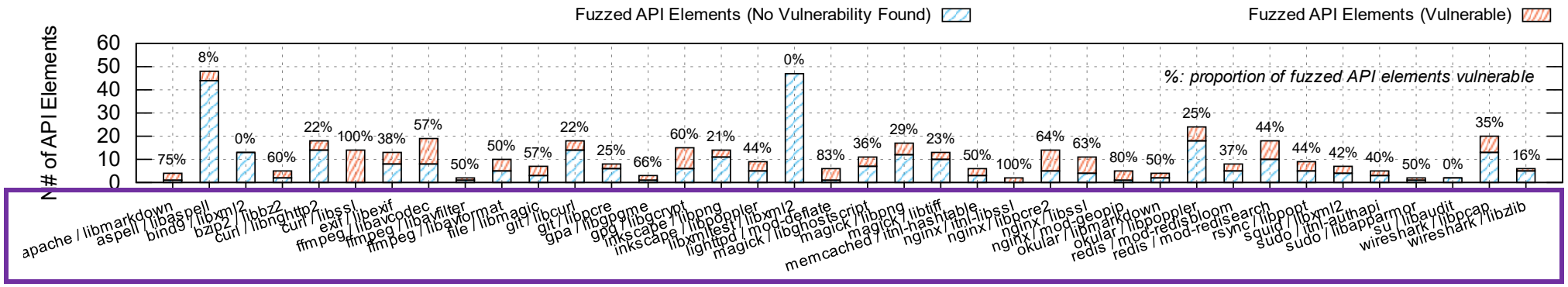

For each scenario

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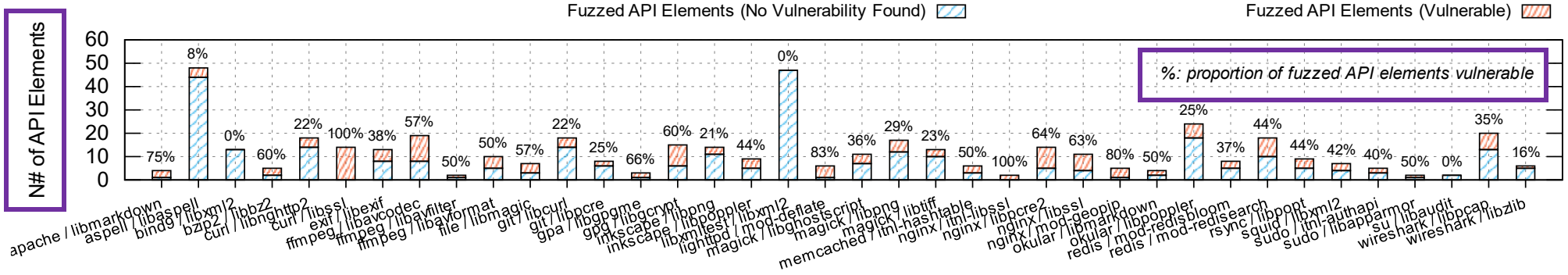

Number of vulnerable API endpoints (= has CIVs) versus non-vulnerable

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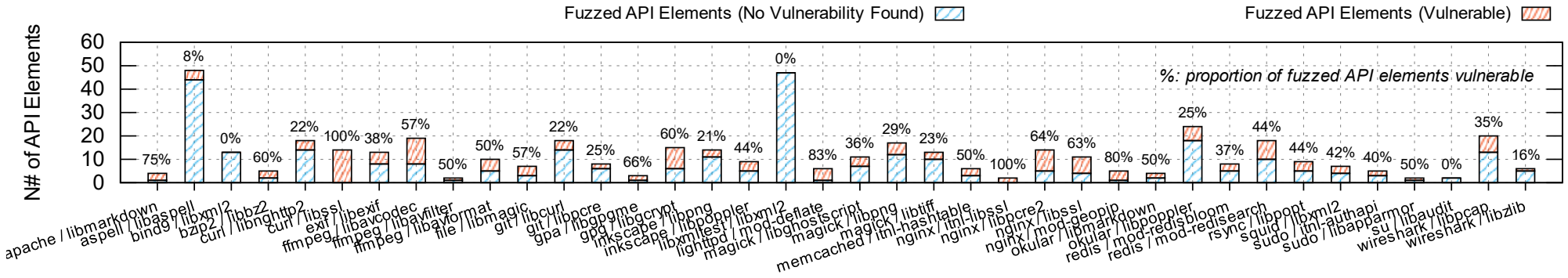

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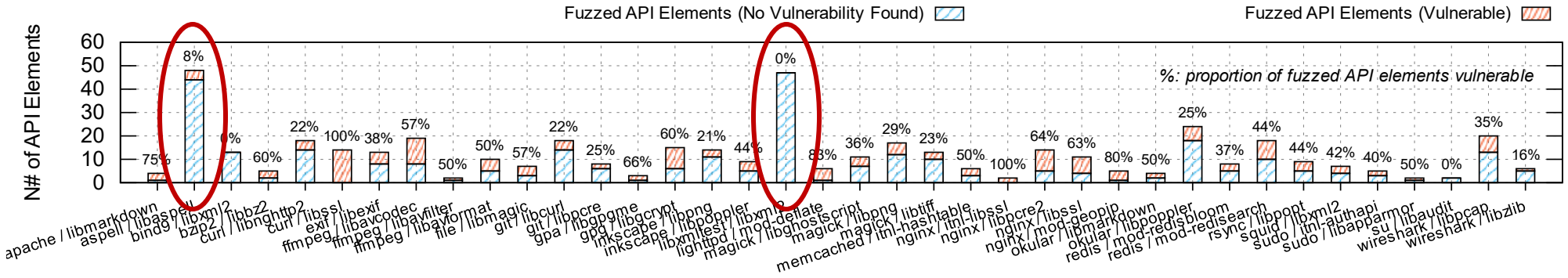

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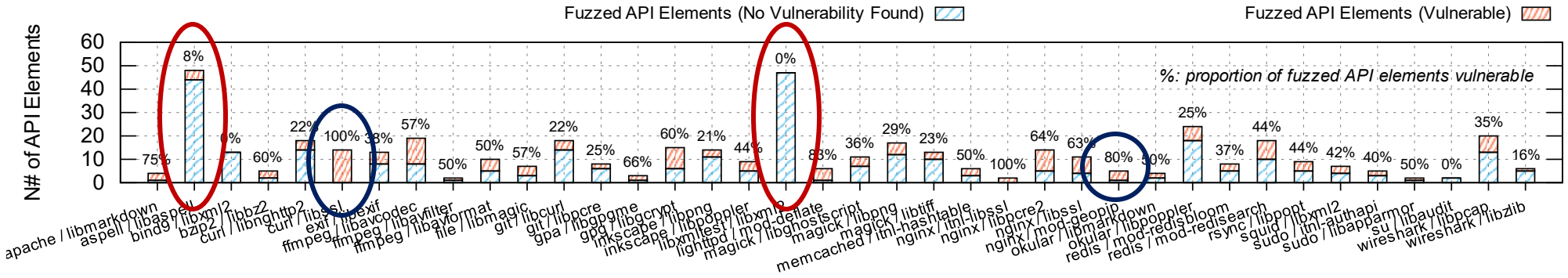

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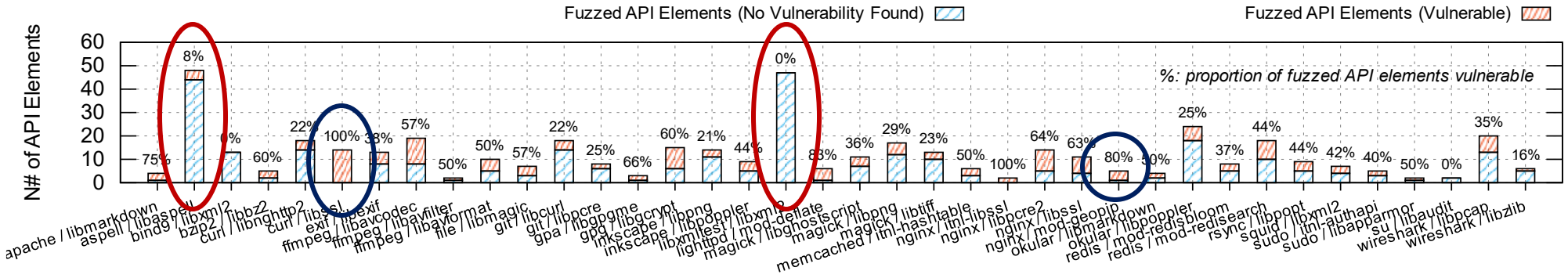

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No correlation between API size and CIV count!

Study results: CIV Patterns

"Are all APIs similarly affected? How hard are they to fix?"

- We observe recurring API design patterns that lead to CIVs

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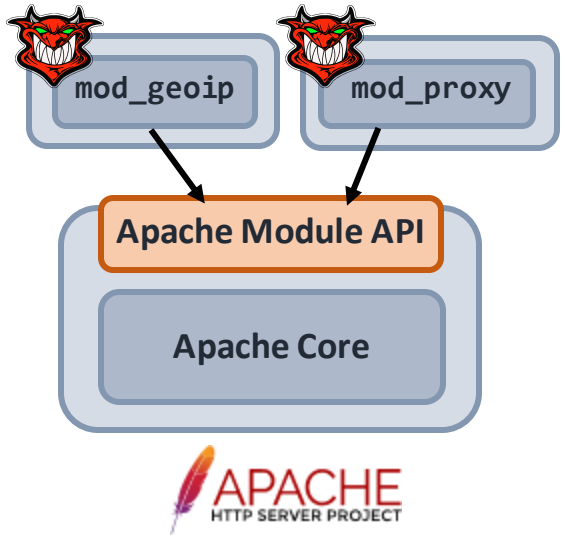
"Are all APIs similarly affected? How hard are they to fix?"

- We observe recurring API design patterns that lead to CIVs
- These reinforce the idea that **the presence of CIVs is influenced by structural properties** rather than API size or quantity of shared data
- Highlight one of these patterns here
- Many more in the paper!

CIV Pattern: Modular APIs

- Module APIs are the most CIV-vulnerable APIs in the study (HTTPd, Nginx, Redis, lighttpd, etc.)



CIV Pattern: Modular APIs

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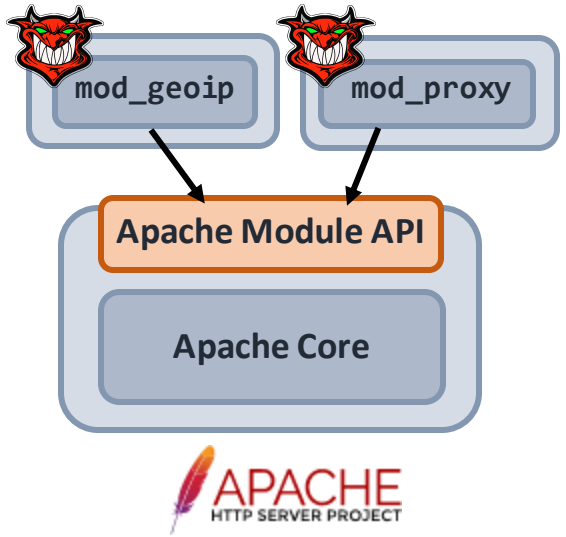

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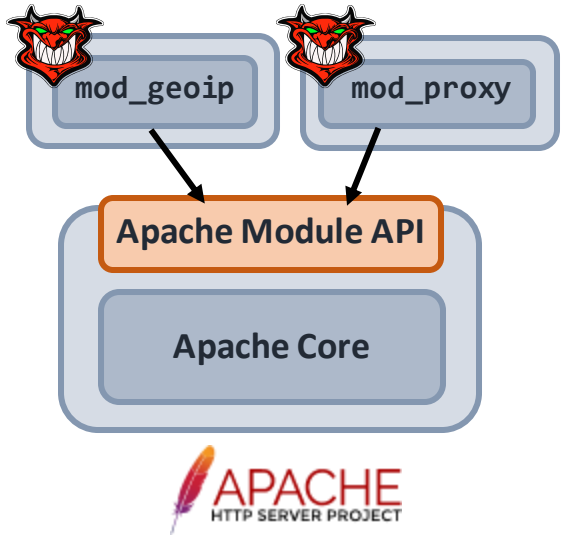

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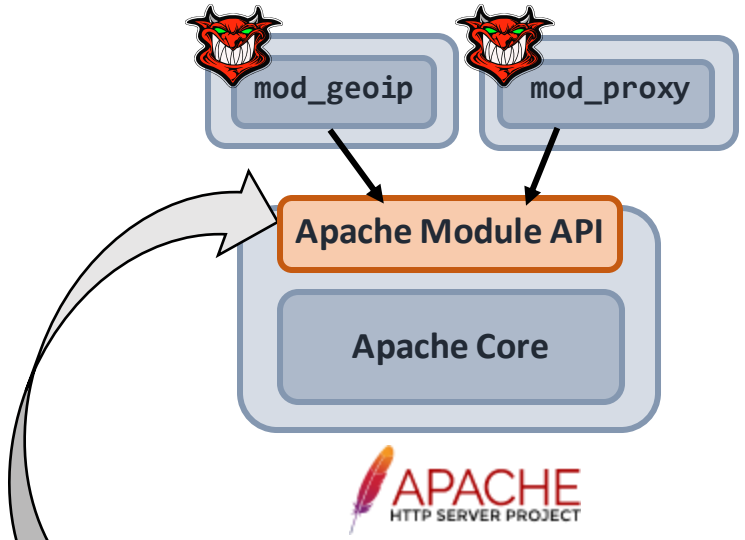

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// A structure that represents the current request
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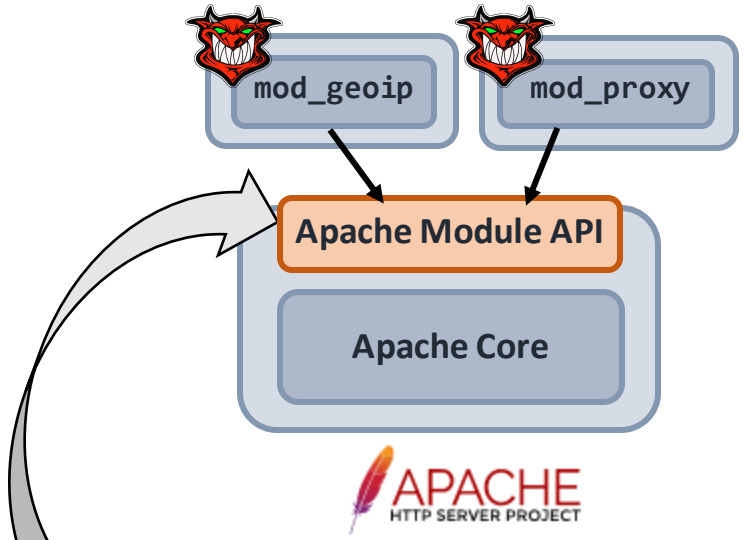

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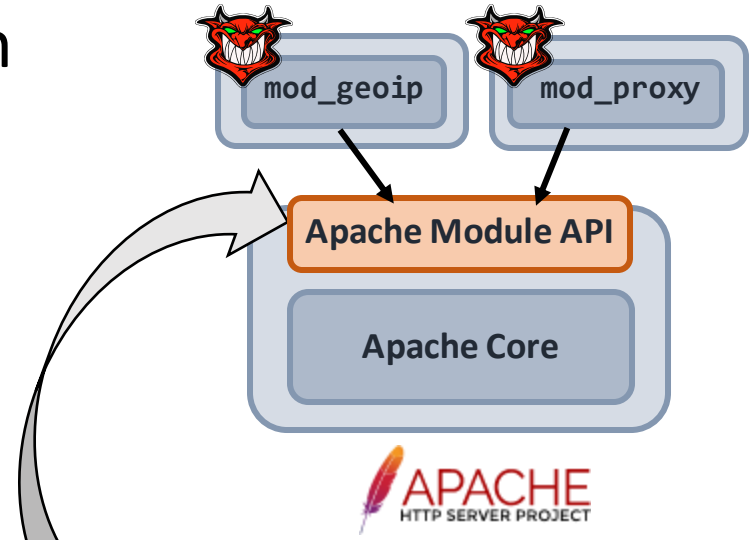

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Somewhat counter-intuitive: modularity does not imply low compartmentalization complexity

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- Here: illustrate security impact with a concrete scenario
  - Key extraction in OpenSSL safebox
- More in the paper

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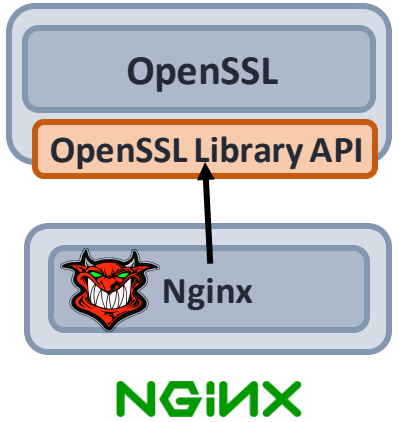

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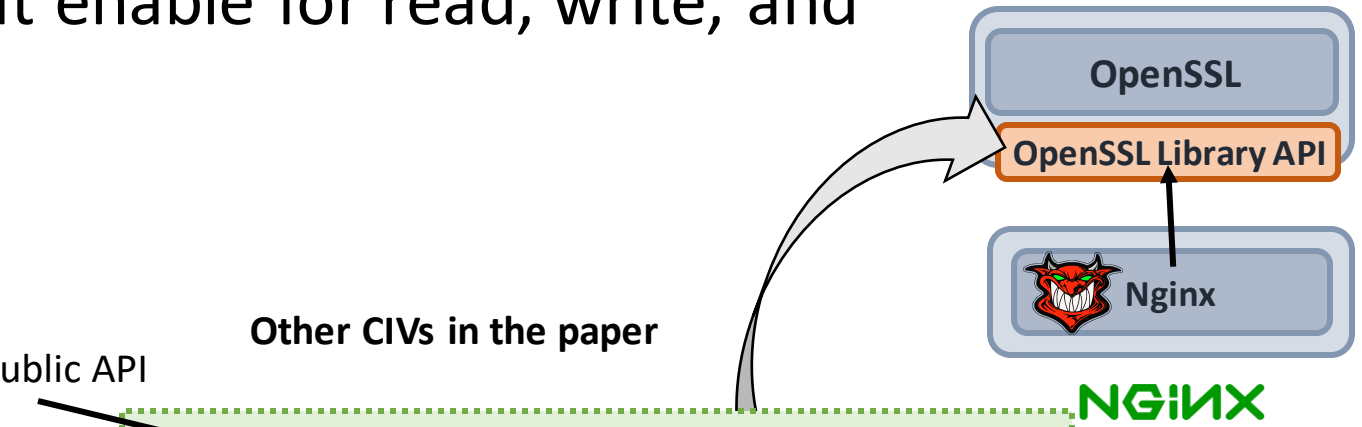

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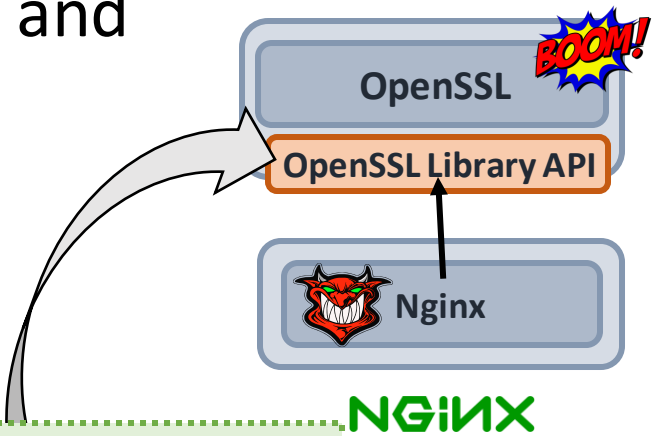

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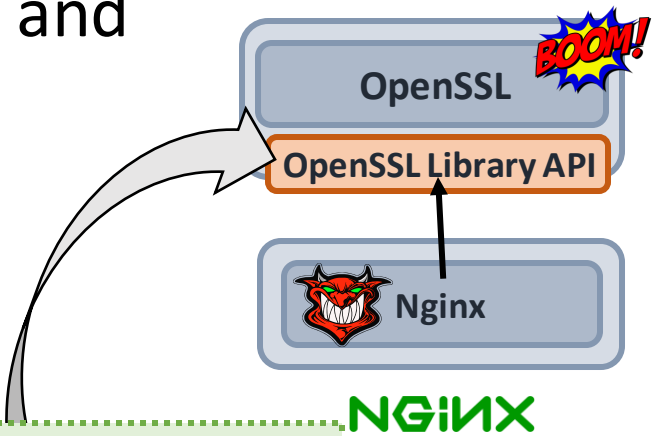

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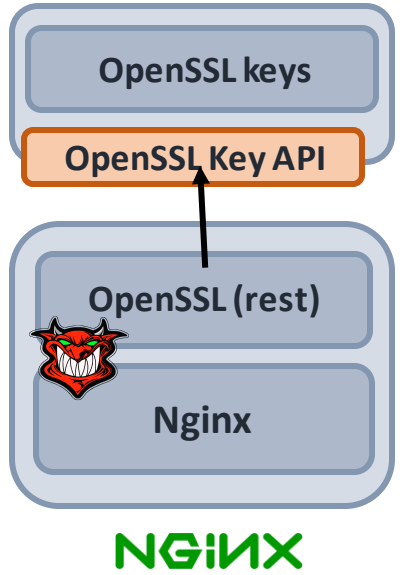

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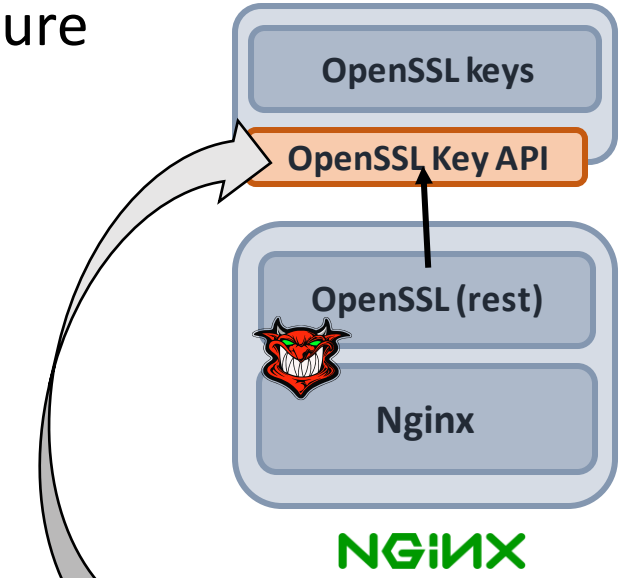

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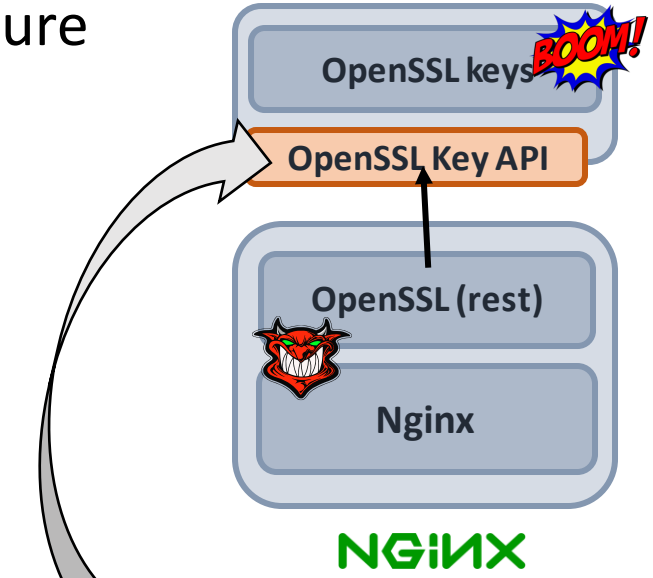

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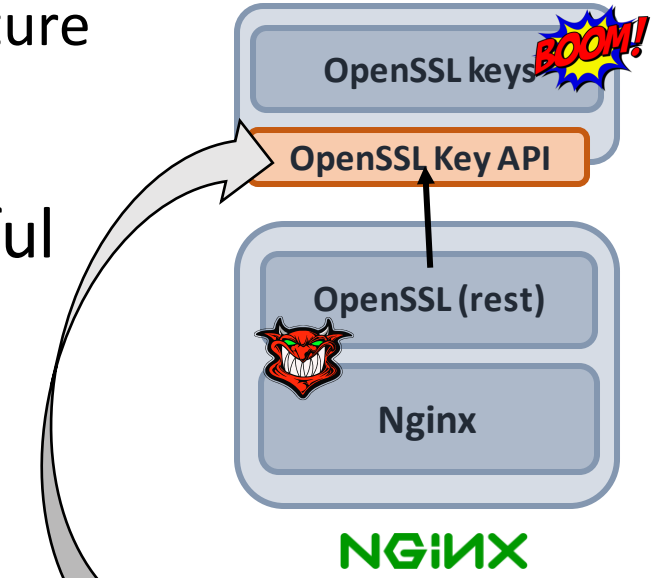

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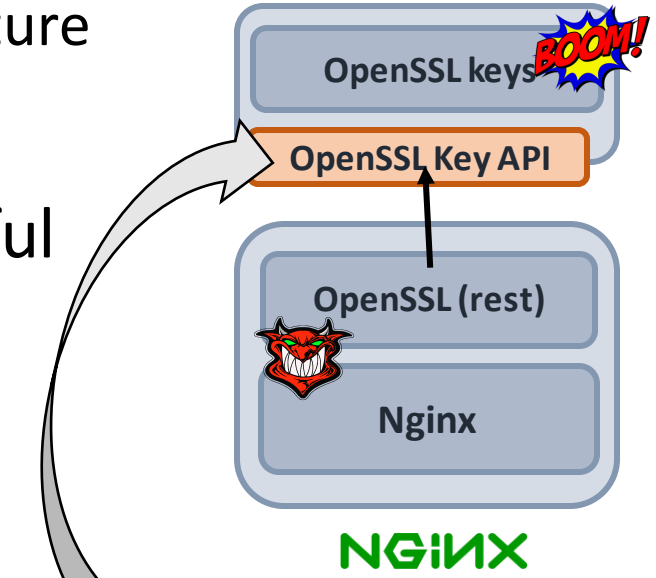
Because of CIVs, all OpenSSL isolation use-cases from the literature are pointless & fixes are non-trivial



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Fundamentally hard: need to understand API semantics

Both approaches are complimentary

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NDSS'23 Paper: https://arxiv.org/abs/2212.12904
Project website: https://conffuzz.github.io Code & Dataset under BSD-3 & CC-BY