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9th Linux Driver Verification (LDV) Workshop
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Static Verification Results Visualization in the Context of SV-COMP

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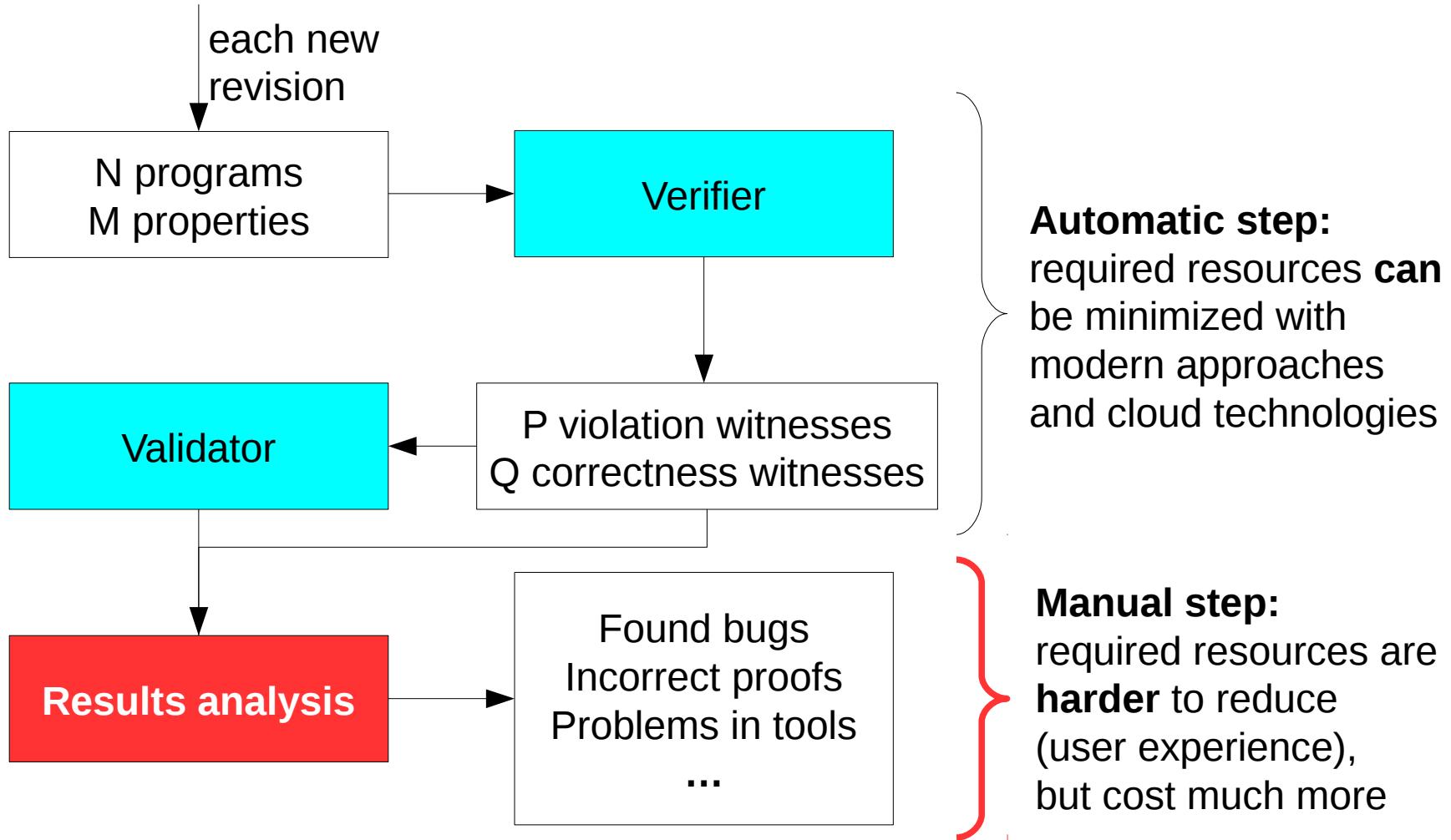


Static Verification State of the Art

- More than 31 tools*
- Improvements in effectiveness and efficiency*
- Validation of verification results*
 - Both property violations and correctness proofs*
- Different properties*
 - Potential for extensions (e.g., property automata)
- Verification of C and Java programs*

➡ What about results analysis?

Verification of Industry System



Related Work

- BenchExec* table-generator
 - Score (based on tasks definition)
 - Plots with consumed resources
 - Comparison tables
 - Witness validation results
 - Witnesses are not visualized
 - LDV Tools (Klever)**
 - Preset environment models for Linux/BusyBox/etc.
 - Violation witnesses visualization
 - Specific format
- Cannot visualize generic witness from SV-COMP tools
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- Presented in
machine-readable
format
- Not supported
by SV-COMP tools

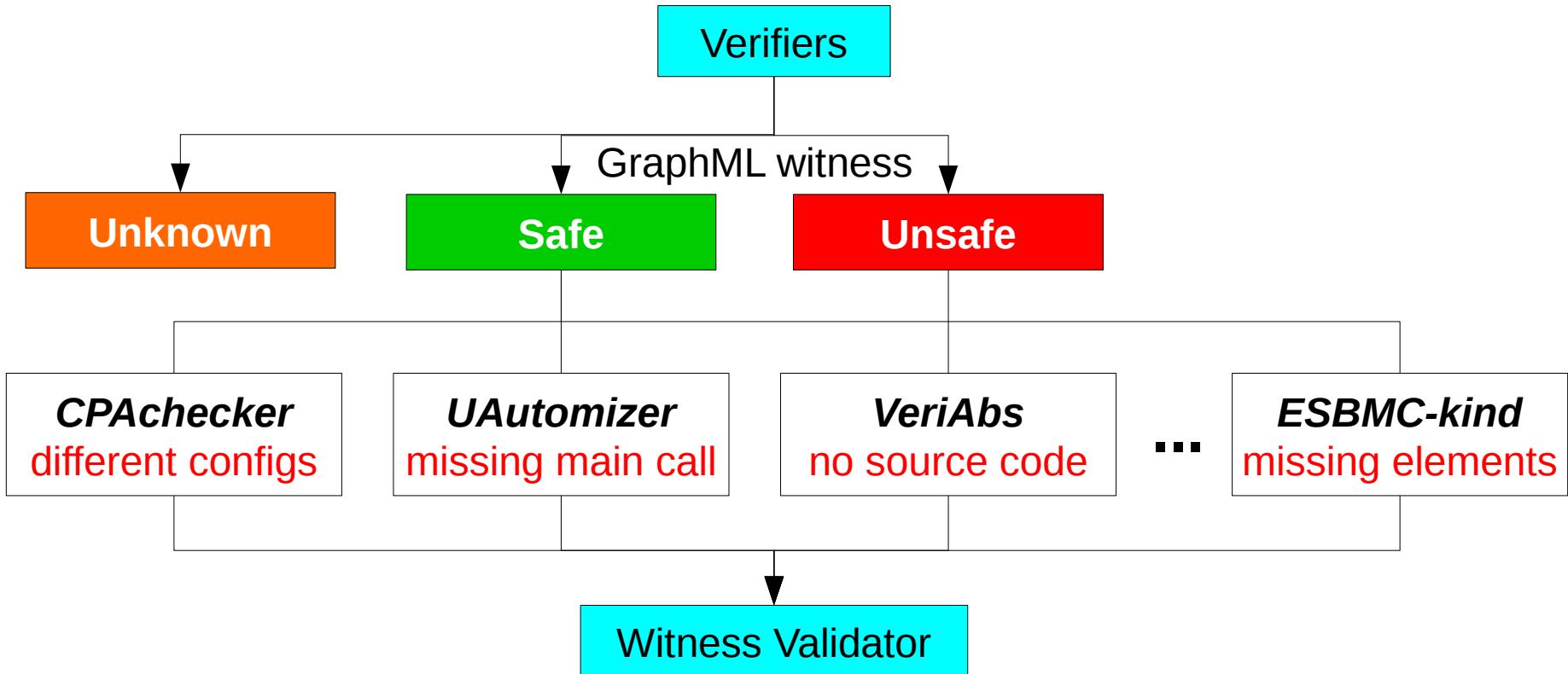
* <https://github.com/sosy-lab/benchexec>

** <https://forge.ispras.ru/projects/klever>

Suggested Solutions

- Witness Visualizer (user-friendly witnesses)
 - Helps to locate bugs for the users
 - Helps to reveal problems in tools
- Correctness witnesses visualization (idea)
 - Shows main proof hints (for developers)
 - Presents source code coverage (for users)
- Benchmark Visualizer (continuous verification)
 - Visualizes BenchExec results
 - Groups witnesses for each benchmark

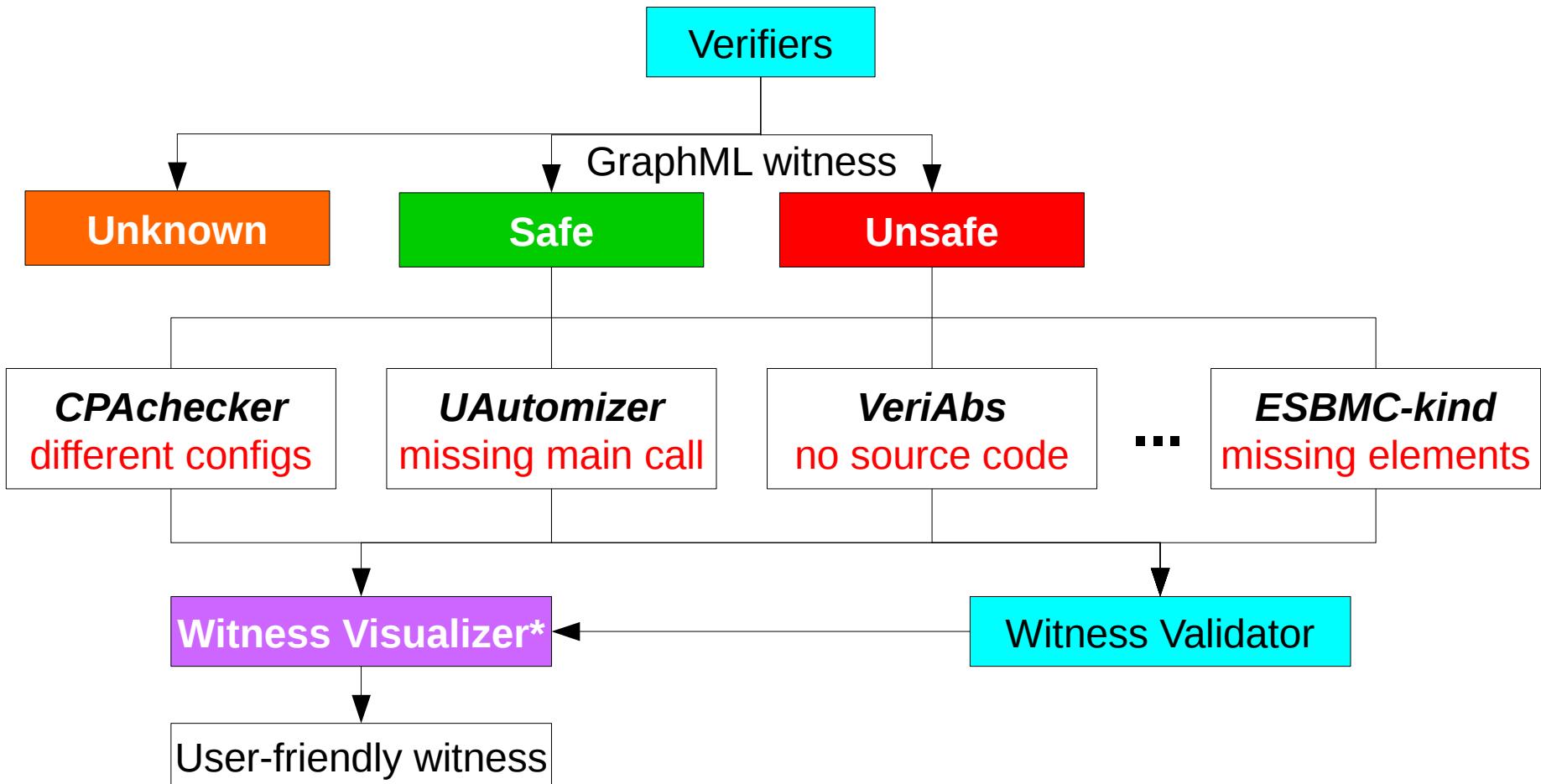
Common Witness Format*



- Machine-readable format
- There are still differences among tools

* D. Beyer, M. Dangl, D. Dietsch, M. Heizmann, A. Stahlbauer. *Witness validation and stepwise testification across software verifiers*. ACM, 2015.

Witness Visualizer



Requirements to the Witness Visualizer

- Fault tolerance (to the missing elements)
 - Support common witness format (GraphML)
- Quality control (for developers)
 - Provide feedback on the missing elements
- Support violation hints
 - Helps with large witnesses
- Provide operations with witnesses
 - Comparison
- Support both violation and correctness types

Fault Tolerance

- Cannot be tolerated
 - Parsing failures (wrong format)
 - Empty witnesses
- Restorable missing elements
 - Source code (program file + line/offset)
 - Entry point (based on property description)
 - Property violation (last edge)
- Elements, which cannot be restored
 - Call stack
 - Assumptions/controls

Quality Control

- Provide useful feedback to the developers
 - Source files do not exist
 - Call stack is missing
 - Conditions are missing
 - Entry point is missing
 - Produced warnings during visualization

- 
- 1) No call stack (enterFunction tag)
 - 2) No conditions (control tag)

Warning: some elements are missing

Violation Hints

- Core elements, which describe the given violation
- Reason – visualize large witnesses
 - Highlight violation hints
 - With call stack, source code link, thread id, etc.
 - Hide other elements
- Violation hints extraction
 - From witnesses (“note”, “warning”)
`<data key="note">Acquire mutex_lock</data>`*
 - From property
 - From source code**

```
OBSERVER AUTOMATON A  
...  
MATCH {func($?)} -> ...  
...
```

* Example is based on witnesses from CPA-Lockator tool.

** Based on model comments (applied in LDV Tools).

Violation Hints Usage Example

Initial witness

```
main()
void *x = NULL;
int flags;
int size;
int i = 0;
f1(i)
assume(i < 10)
f2(i)
f3(i)
i := i + 1
...
x = alloc(size, flags)
return NULL
...
free(x)
```



Processed witness

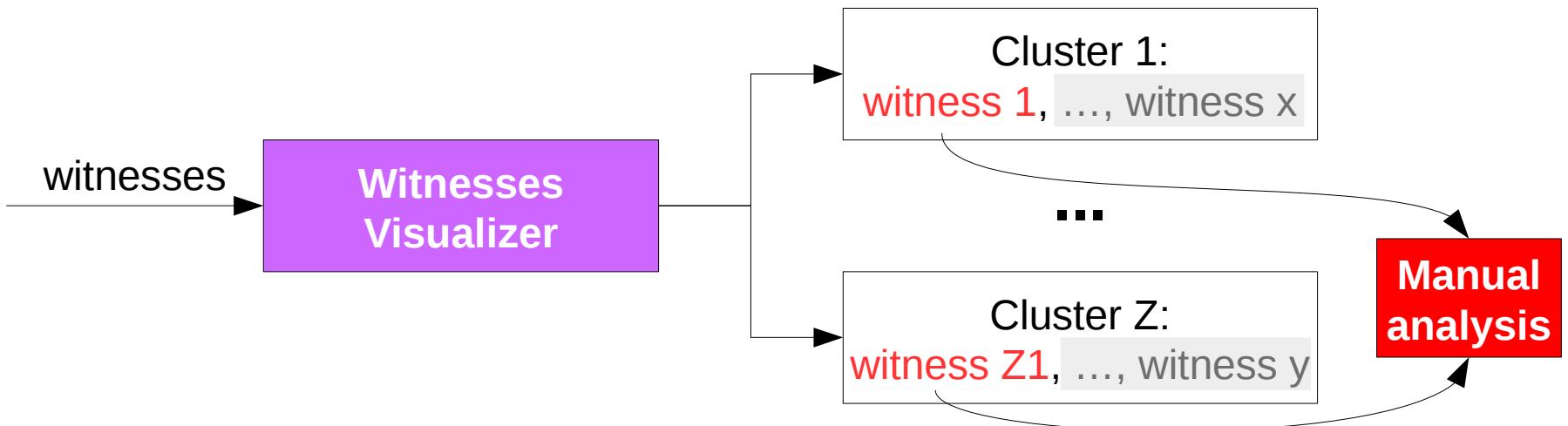
```
main()
void *x = NULL;
int flags;
int size;
int i = 0;
f1(i)
assume(i < 10)
f2(i)
f3(i)
i := i + 1
...
Allocate memory for x
Failed to allocate x
...
Null ptr dereference on x
```

Hidden elements

Violation hints

Operations with Witnesses

- Witnesses comparison
 - Distinguish different witnesses (error paths)
 - Filter several witnesses*
 - Can be done for validated witnesses only



* For example, SV-COMP tool *CPA-Lockator* can produce several witnesses for concurrency properties. 13/35

SV-COMP Tools Violation Witnesses

SV-COMP Tool	Witness elements			Source code				Violation Hints
	Call stack	Entry point	Assumptions/controls	String	Offset	Line number	File name	
2LS	-	-	+	-	-	+	+	-
AProVE	-	+	-	+	-	+	+	-
CBMC	-	-	+	-	-	+	+	-
CBMC-Path	-	-	+	-	-	+	+	-
CPA-BAM-BnB	+	+	+	+/-	+	+	+	+/-
CPA-Lockator	+	+	+	+/-	+	+	+	+/-
CPA-Seq	+	+	+	+/-	+	+	+	+/-
DepthK	-	+	+	-	-	+	+	-
DIVINE-explicit	+	+	-	-	-	+	+	-
DIVINE-SMT	+	+	-	-	-	+	+	-
ESBMC-kind	-	+	+	-	-	+	+	-
Lazy-CSeq	+	+	+	-	-	+	+	-
Map2Check	-	-	+	-	-	+	+	-
PeSCo	+	+	+	+/-	+	+	+	+/-
Pinaka	-	-	+	-	-	+	+	-
PredatorHP	-	-	-	-	-	+	+	-
Skink	-	-	+	-	-	+	+	-
SMACK	-	-	+	-	-	+	+	-
Symbiotic	-	-	+	-	-	+	+	-
UAutomizer	+	-	+	+	-	+	+	-
UKojak	+	-	+	+	-	+	+	-
UTaipan	+	-	+	+	-	+	+	-
VeriAbs	+	+	+	-	+	+	+	-
VeriFuzz	-	-	+	-	-	+	+	-
VIAP	+	+	-	+	-	+	+	-
Yogar-CBMC	+	+	-	-	-	+	+	-
Yogar-CBMC-Parallel	+	+	-	-	-	+	+	-

- * 4 verifiers for Java programs were excluded from this comparison, because they do not produce witnesses.

Example of a Witness with Violation Hints

- Input/output memory map operations: `ioremap`, `pci_ioremap_bar`, ...
 - Input/output memory unmap operation: `iounmap`

449 Generated entry point
479 * tmp = gxfb_probe(arg1, (struct pci_device_id const *)arg2);
376 * struct gxfb_par *par;
377 * struct fb_info *info;
378 * int ret;
379 * unsigned long val;
380 * struct fb_videomode *modedb_ptr;
381 * unsigned int modedb_size;
382 * int err;
383 * u64 tmp;
384 * int tmp_0;
385 * * info = gxfb_init_fbinfo(&pdev->dev);
386 * assume(((unsigned long)info) == ((unsigned long)((struct fb_info *)0)));
387 * assume(((unsigned long)info) != ((unsigned long)((struct fb_info *)0)));
388 * par = (struct gxfb_par *)info->par;
389 * * ret = gxfb_map_video_memory(info, pdev);
390 * assume(ret >= 0);
391 * dev_err((struct device const *)(&pdev->dev), "failed to map frame buffer or controller registers\\n");
392 * assume(__CPAChecker_TMP_2 == ((unsigned long)((char *)0)));
393 * iounmap
394 * * Unmapping io-memory without map-----
395 1299
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397 451
398 431 * iounmap
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400 1299 * Unmapping io-memory without map-----
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413 * Clear the frame buffer of garbage.
414 * * memset_io(info->screen_base, 0, info->fix.smem_len);
415
416 * gxfb_check_var(&info->var, info);
417 * gxfb_set_par(info);
418
419 * pm_set_vt_switch(vt_switch);
420
421 * if (register_framebuffer(info) < 0) {
422 * * ret = -EINVAL;
423 * * goto err;
424 * }
425 * pci_set_drvdata(pdev, info);
426 * fb_info(info, "ss frame buffer device\\n", info->fix.id);
427
428 * return 0;
429
430 * err:
431 * * if (info->screen_base) {
432 * * * iounmap(info->screen_base);
433 * * * pci_release_region(pdev, 0);
434 * * }
435 * * if (par->vid_regs) {
436 * * * iounmap(par->vid_regs);
437 * * * pci_release_region(pdev, 3);
438 * * }
439 * * if (par->dc_regs) {
440 * * * iounmap(par->dc_regs);
441 * * * pci_release_region(pdev, 2);
442 * * }
443 * * if (par->gp_regs) {
444 * * * iounmap(par->gp_regs);
445 * * * pci_release_region(pdev, 1);
446 * * }
447 * * fb_dealloc_cmap(&info->cmap);
448 * * framebuffer_release(info);
449 * * return ret;
450 * }
451
452 * static void gxfb_remove(struct pci_dev *pdev)
453 {
454 * * struct fb_info *info = pci_get_drvdata(pdev);
455 * * struct gxfb_par *par = info->par;
456
457 * * unregister_framebuffer(info);
458
459 * * iounmap((void __iomem *)info->screen_base);
460 * * pci_release_region(pdev, 0);
461
462 * * iounmap(par->vid_regs);
463 * * pci_release_region(pdev, 3);
464
465 * * iounmap(par->dc_regs);
466 * * pci_release_region(pdev, 2);
467
468 * * iounmap(par->gp_regs);
469 * * pci_release_region(pdev, 1);
470
471 * * fb_dealloc_cmap(&info->cmap);
472
473 * * framebuffer_release(info);
474 * }
475
476 * static struct pci_device_id gxfb_id_table[] = {
477 * { PCI_DEVICE(PCI_VENDOR_ID_NS, PCI_DEVICE_ID_NS_GX_VIDEO) },
478 * { 0, 0 }
479 }

- * Violation witness visualization is based on LDV Tools (Klever):
<https://forge.ispras.ru/projects/klever>

Example of a Witness with Violation Hints

- Input/output memory map operations: `ioremap`, `pci_ioremap_bar`, ...
 - Input/output memory unmap operation: `iounmap`

Error trace

```
449 Generated entry point
479 * tmp = gxfb_probe(arg1, (struct pci_device_id const *)arg2);
376 struct gxfb_par *par;
377 struct fb_info *info;
378 int ret;
379 unsigned long val;
380 struct fb_videomode *modedb_ptr;
381 unsigned int modedb_size;
382 int _err;
383 u64 tmp;
384 int tmp__0;
385     > info = gxfb_init_fbinfo(&pdev->dev);
386 assume((unsigned long)info) == ((unsigned long)((struct fb_info *)0));
387 assume((unsigned long)info) != ((unsigned long)((struct fb_info *)0));
388 par = (struct gxfb_par *)info->par;
389     - ret = gxfb_map_video_memory(info, pdev);
390         struct gxfb_par *par;
391         int ret;
392         unsigned int tmp;
393         void *_tmp__0;
394         par = (struct gxfb_par *)info->par;
395         ret = pci_enable_device(dev);
396         assume(ret < 0);
397         assume(ret >= 0);
398         return ret;
399     +
400     assume(ret < 0);
401     assume(ret >= 0);
402 dev_err(&struct device const *)(&pdev->dev, "failed to map frame buffer or controller registers\n");
403 assume(_CPAchecker_TMP_2 == ((unsigned long)((char *)0)));
404 iounmap
405     & iounmap(void volatile *info->screen_base);
406     Unmapping io-memory without map
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```

Example of a Witness with Missing Elements

The screenshot shows a debugger interface with two panes. The left pane displays an "Error trace" with the following log entries:

```
0 entry point
3964 tmp_0 = 0;
6450 tmp_0 = 9215;
6451 ldvarg3 = 9215;
3964 tmp_0 = -1;
3964 tmp_0 = 0;
6465 ldvar3 = 4294967295;
6473 tmp_7 = 1;
6484 tmp_8 = 1;
6242 ldv_retval_0 = 0;
3964 tmp_0 = -1;
3964 tmp_0 = 1;
3964 tmp_0 = -1;
6473 tmp_7 = 3;
6717 tmp_10 = 1;
4070 return (struct max3421_hcd *)(& hcd->hcd_priv);
4281 return (struct max3421_hcd *)(& hcd->hcd_priv);
6117 max3421_hcd list = max3421_hcd;
6185 ldv_retval_2 = -12;
6473 tmp_0 = 2;
6727 tmp_0 = 0;
5720 max3421_ep = (struct max3421_ep *)(urb->ep)->hcpriv;
6794 flags = 4294967295;
4088 Property violation
```

The right pane shows assembly code from file /home/vitaly/ose/bl/esbmc/sv-benchmarks/c/ldv-linux-3.16-rc1/43_2a_bitvector_linux-3.16-rc1.tar.xz-43_2a-drivers--usb--host--max3421-hcd.ko-entry_point_false-unreach-call.cil.out.c, specifically the ldv_check_alloc_flags function:

```
6768 }
6769 inline static void *kmalloc(size_t size , gfp_t flags )
6770 {
6771
6772
6773 {
6774 ldv_check_alloc_flags(flags);
6775 ldv_kmalloc_12(size, flags);
6776 return ((void *)0);
6777 }
6778 void *ldv_kmem_cache_alloc_16(struct kmem_cache *ldv_func_arg1 , gfp_t flags )
6779 {
6780
6781
6782
6783
6784 ldv_check_alloc_flags(flags);
6785 kmem_cache_alloc(ldv_func_arg1, flags);
6786 return ((void *)0);
6787 }
6788
6789 inline static void *kzalloc(size_t size , gfp_t flags )
6790 {
6791
6792
6793
6794 ldv_check_alloc_flags(flags);
6795 return ((void *)0);
6796 }
6797
6798 inline static int ldv_request_irq_19(unsigned int irq , irqreturn_t (*handler)(int void *),
6799 unsigned long flags , char const *name ,
6800 void *dev )
6801 {
6802 ldv_func_ret_type__2 ldv_func_res ;
6803 int tmp ;
6804 int tmp_0 ;
6805
6806
6807
6808 tmp = request_irq(irq, handler, flags, name, dev);
6809 ldv_func_res = tmp;
6810 tmp_0 = req_check_l(handler);
6811 if (tmp_0 != 0 && ldv_func_res == 0) {
6812 activate_suitable_irq_l((int)irq, dev);
6813 } else {
6814
6815 }
6816 return (ldv_func_res);
6817 }
6818 void ldv_free_irq_20(unsigned int ldv_func_arg1 , void *ldv_func_arg2 )
6819 {
6820
6821
6822
6823 free_irq(ldv_func_arg1, ldv_func_arg2);
6824 disable_suitable_irq_l((int)ldv_func_arg1, ldv_func_arg2);
6825 return;
6826 }
6827
6828 inline static void ldv_error(void);
6829 int ldv_spin = 0;
6830 void ldv_check_alloc_flags(gfp_t flags )
6831 {
6832
6833
6834
6835 if (ldv_spin == 0 || ! (flags & 16U)) {
6836 } else {
6837 ldv_error();
6838 }
6839 return;
6840 }
6841
6842 extern struct page __0 *ldv_some_page(void);
6843 struct page __0 *ldv_check_alloc_flags_and_return_some_page(gfp_t flags )
6844 {
6845 struct page __0 *tmp ;
6846
6847 if (ldv_spin == 0 || ! (flags & 16U)) {
6848 } else {
6849 ldv_error();
6850 }
```

Warning: some elements are missing

- 1 No call stack (please add tags "enterFunction" and "returnFrom" to improve visualization)
- 2 No conditions (please add tags "control" to improve visualization)

Witness was produced by ESBMC-kind tool.

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Witness Visualizer Application Area

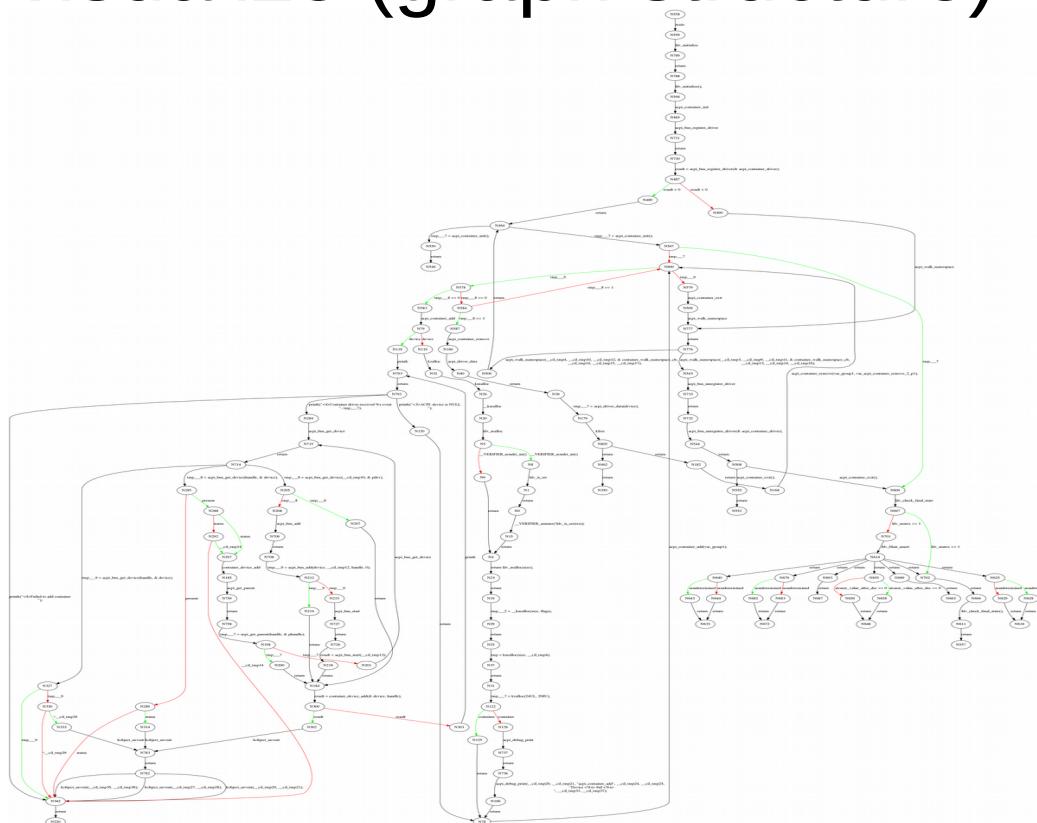
- Demonstration of a generic witness
 - Supports any SV-COMP tool
- Feedback to the developers
 - Missing elements, warnings, etc.
- Large witnesses visualization
 - Based on extracted violation hints
- Comparison of witnesses
 - Required for several witnesses

Suggested Solutions

- Witness Visualizer (user-friendly witnesses)
 - Helps to locate bugs for the users
 - Helps to reveal problems in tools
- Correctness witnesses visualization (idea)
 - Shows main proof hints (for developers)
 - Presents source code coverage (for users)
- Benchmark Visualizer (continuous verification)
 - Visualizes BenchExec results
 - Groups witnesses for each benchmark

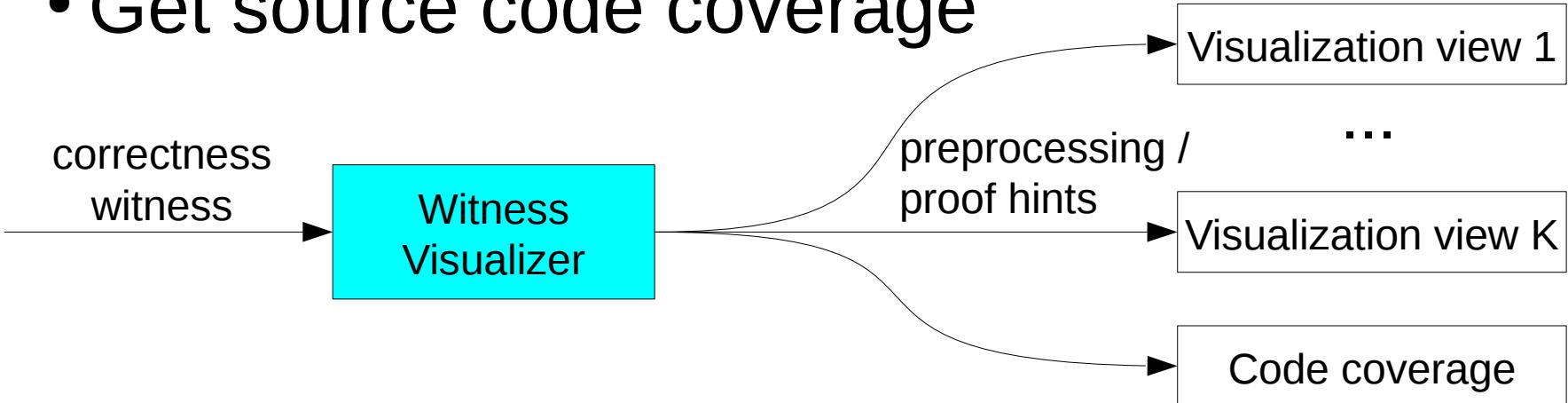
Correctness Witnesses

- Present main verification result (proof)
 - Ensure the absence of missed bugs
 - Hard to visualize (graph structure)



General Ideas of the Visualization

- Support of common format* (GraphML)
- Witness preprocessing
 - Convert to the plain structure
- Extract main proof hints
 - Conditions, invariants, etc.
- Get source code coverage



* D. Beyer, M. Dangl, D. Dietsch, M. Heizmann. *Correctness witnesses: exchanging verification results between verifiers*. ACM, 2016.

Implementation of the Suggested Ideas

- Proof hints
 - Conditions
 - Invariants (common and local)
- Witness preprocessing
 - Sort all elements by line/thread/source file
 - Combine all assumptions for conditions
 - Extract common invariants
- Witness comparison
 - Is not supported (only 1 (?) witness is expected)

Correctness Witness Model Example

“Developer” view

Main proof hints

Conditions

condition(cond1)
condition(cond2)

...

Common invariants

invariant(inv1)

...

Invariants

Multiple invariants

invariant(inv2)
invariant(inv3)

...

All branches
are covered

“User” view

Source code coverage

Line 1 - covered condition
Line 2 - covered line
Line 3 - uncovered

...

Condition line

Invariant scope

Some
branches were
not covered

Correctness Witness Example

UAutomizer correctness witness visualization*

Correctness witness

```
10596 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->resume != (unsigned long )((int *)(struct device
10605 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->freeze != (unsigned long )((int *)(struct device
10615 condition(tmp__2 != 0);
10616 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->freeze_late != (unsigned long )((int *)(struct device
10623 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->have_early != (unsigned long )((int *)(struct device
10631 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->freeze_noirq != (unsigned long )((int *)(struct device
10639 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->have_noirq != (unsigned long )((int *)(struct device
10647 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->haw != (unsigned long )((int *)(struct device *
10656 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->poweroff != (unsigned long )((int *)(struct device
10666 condition(tmp__3 != 0);
10667 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->poweroff_late != (unsigned long )((int *)(struct
10675 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->restore_early != (unsigned long )((int *)(struct
10684 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->poweroff_noirq != (unsigned long )((int *)(struct
10692 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->restore_noirq != (unsigned long )((int *)(struct
10701 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->restore != (unsigned long )((int *)(struct device
10716 condition((unsigned long )ldv_6_pm_ops.dev_pm_ops->complete != (unsigned long )((void *)(struct devi
11010 condition(tmp__2 != 0);
11016 condition(tmp__1 != 0);
11064 condition(tmp__2 != 0);
11070 condition(tmp__1 != 0);
11117 condition(tmp__1 == 1);
11122 condition(tmp__2 == 2);
11127 condition(tmp__3 == 3);
11132 condition(tmp__4 == 4);
11137 condition(tmp__5 == 5);
11167 condition(\read(tmp));
11685 condition(ldv_linux_alloc_usb_lock.lock == 2);
13017 condition(ldv_linux_net_register_probe_state == 1);
13517 condition(ldv_linux_usb_register_probe_state == 1);
13586 condition(expression == 0);
13669 condition(tmp__1 != 0);
15378 condition(! expr);
15439 condition(! expr);
15484 condition(! expr);
15545 condition(! expr);
15592 condition(! expr);
15638 condition(! expr);
15684 condition(! expr);
15715 condition(! expr);
15823 condition(! expr);
15854 condition(! expr);
15900 condition(! expr);
15916 condition(! expr);
15977 condition(! expr);
16054 condition(! expr);
16084 condition(! expr);
16205 condition(! expr);
16221 condition(! expr);
16282 condition(! expr);
16298 condition(! expr);
16359 condition(! expr);
16405 condition(! expr);
16481 condition(! expr);
16512 condition(! expr);
16528 condition(! expr);
16559 condition(! expr);
16651 condition(! expr);
16697 condition(! expr);
5248 * invariants
4804   -> multiple invariants
4882   -> multiple invariants
4882     invariant!{0 == ldv_linux_fs_char_dev_usb_gadget_chrdev} || !(0 == ldv_linux_block_request_blk_
4882       invariant!{0 == ldv_linux_fs_char_dev_usb_gadget_chrdev} || !(1 == LDV_LINUX_KERNEL_LOCKING_MUTE
4882
  
```

ome/vitaly/ose/bl/UAutomizer-linux/sv-benchmarks/c/ldv-linux-4.0-rc1-mav/linux-4.0-rc1---drivers--mtd--devices--docg3.ko_true-unreach-call.cil.c

```
12997 {
12998   return (nodeet);
12999 } else {
13000   return (0);
13001 }
13002 }
13003 void ldv_linux_net_register_reset_error_counter(void)
13004 {
13005
13006
13007 {
13008   ldv_linux_net_register_probe_state = 0;
13009   return;
13010 }
13011 }
13012 void ldv_linux_net_register_check_return_value_probe(int retval )
13013 {
13014
13015
13016
13017 if (ldv_linux_net_register_probe_state == 1) {
13018 {
13019   ldv_assert_linux_net_register_wrong_return_value(retval != 0);
13020 }
13021 } else {
13022
13023 }
13024 {
13025   ldv_linux_net_register_reset_error_counter();
13026 }
13027
13028 }
13029
13030 void ldv_assert_linux_net_rtinetlink_double_lock(int expr );
13031 void ldv_assert_linux_net_rtinetlink_double_unlock(int expr );
13032 void ldv_assert_linux_net_rtinetlink_lock_on_exit(int expr );
13033 int rtnllocknumber = 0;
13034 void ldv_linux_net_rtinetlink_past_rtnl_unlock(void)
13035 {
13036
13037
13038 {
13039 {
13040   ldv_assert_linux_net_rtinetlink_double_unlock(rtnllocknumber == 1);
13041   rtnllocknumber = 0;
13042 }
13043
13044 }
13045
13046 void ldv_linux_net_rtinetlink_past_rtnl_lock(void)
13047 {
13048
13049
13050
13051 {
13052   ldv_assert_linux_net_rtinetlink_double_lock(rtnllocknumber == 0);
13053   rtnllocknumber = 1;
13054 }
13055
13056 }
13057
13058 void ldv_linux_net_rtinetlink_before_ieee80211_unregister_hw(void)
13059 {
13060
13061
  
```

- * Sometimes SV-COMP tools may produce empty correctness witnesses.

Correctness Witnesses Visualization

- Suggested general ideas of the visualization
 - Based on plain structure and proof hints
- Suggested implementation of the ideas
 - Based on conditions and invariants
 - Other implementations can be suggested
- Idea to extract source code coverage
- Can be useful for both developers and users

Suggested Solutions

- Witness Visualizer (user-friendly witnesses)
 - Helps to locate bugs for the users
 - Helps to reveal problems in tools
- Correctness witnesses visualization (idea)
 - Shows main proof hints (for developers)
 - Presents source code coverage (for users)
- Benchmark Visualizer (continuous verification)
 - Visualizes BenchExec results
 - Groups witnesses for each benchmark

Benchmark Visualizer*

- Web-interface** for verification results visualization
 - Easy to setup and use
- Database
 - Benchmark verification results
 - User marks: bugs, incorrect proofs, etc.

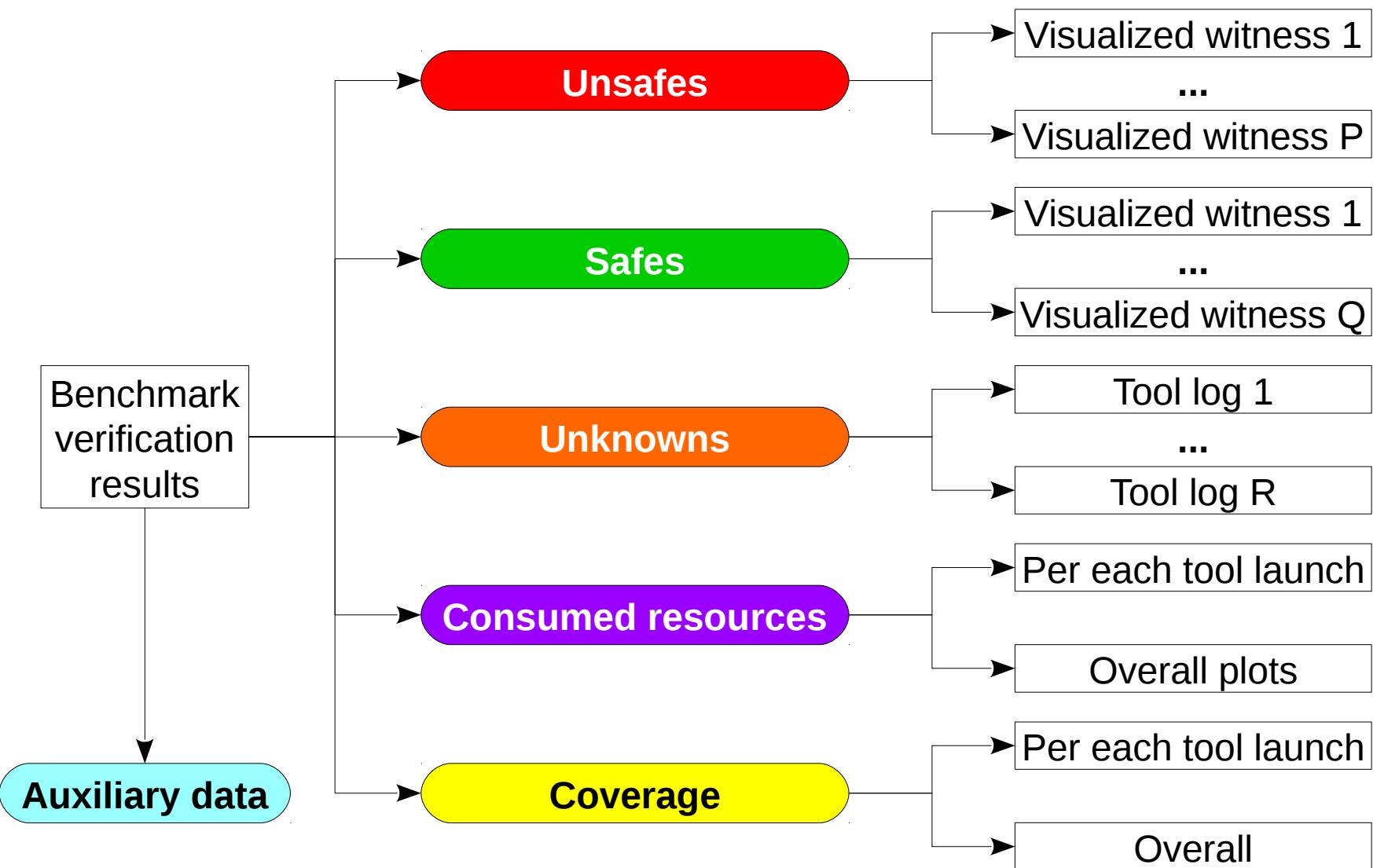
→ Differences with BenchExec table-generator

- Witnesses in user-friendly format
- Means for manual results analysis
- Coverage (if presented)

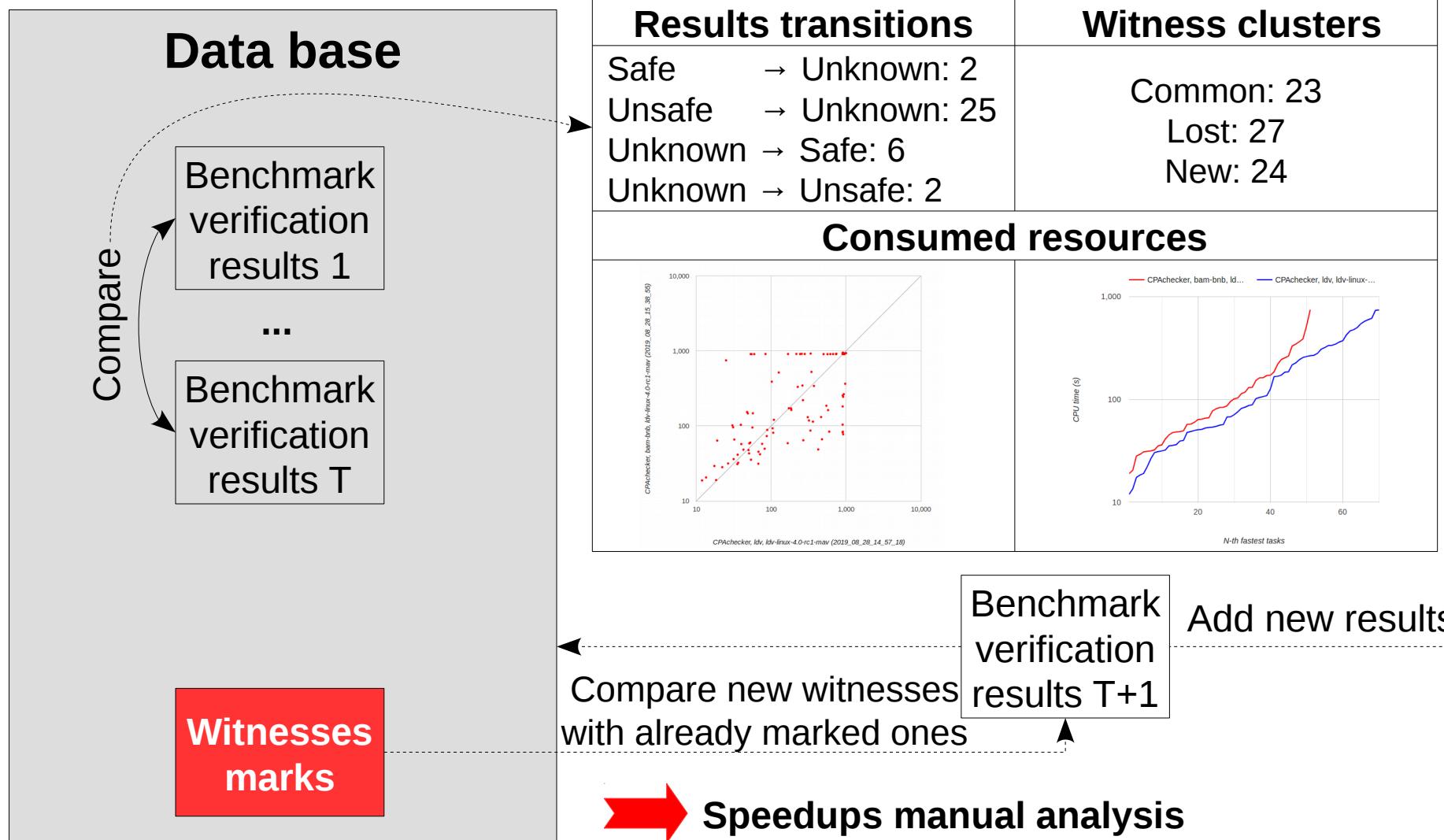
* <https://github.com/ispras/cv>

** <https://github.com/mutilin/klever> (branch cv-v2.0)

Benchmark Verification Results Visualization



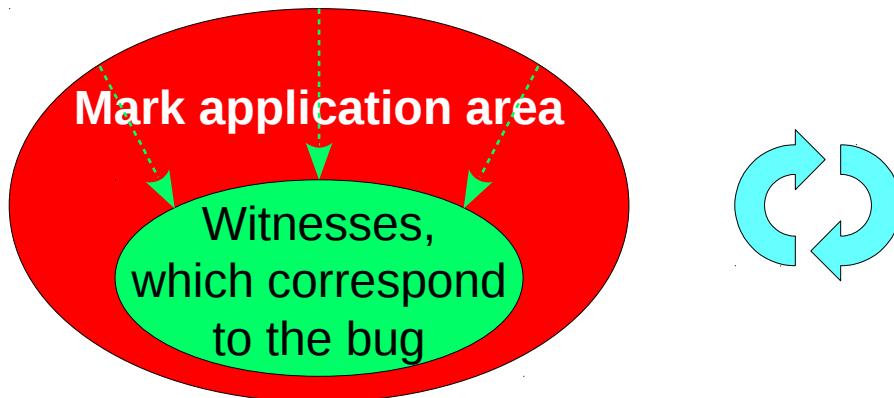
Benchmark Visualizer Database



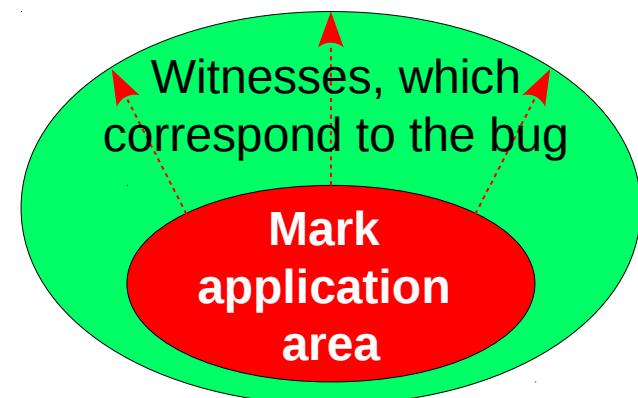
Manual Results Analysis*

- User analyses a witness to determine a bug
- User creates a mark for a bug
 - Witness + comparison criteria + description
- User adjusts the created mark

The mark is applied to a witness, which corresponds to other bugs



There is a witness, which corresponds to the same bug, but the mark was not applied to it



* Based on violation witnesses.

Benchmark Visualizer Example

Violation witnesses

Unsafes: 59
▼ Details
+ Bugs: 1
- False positives: 13
- Rule: 5
- EnvironmentModel: 8
+ Unknown: 3
+ Without marks: 42

Coverage: 56.61% by functions / 20.81% by lines

▼ Details		
Coverage type	Function coverage	Line coverage
Covered by all properties	56.61%	20.81%
Property 'unreach-call'	56.61%	20.81%

Correctness witnesses

Safes: 11
▼ Details
- Unknown: 7
- Low coverage: 7
+ Without marks: 4

Verifier logs

Unknowns: 28
▼ Components
CPAchecker: 28
- Assertion: 19
- Parsing: 1
- Soft time limit: 23
- Time limit: 23

Coverage per property

Consumed resources: 35 835 s / 15 GB			
▼ Details			
Component	CPU time	Memory	Wall time
CPAchecker	35 789 s	15 GB	8.1 h
Coverage	8 s	52 MB	16 s
Exporter	0 s	21 MB	290 ms
Launcher	1 s	20 MB	15 s
MEA	36 s	91 MB	37 s
Overall	35 835 s	15 GB	15 s

Consumed resources plots

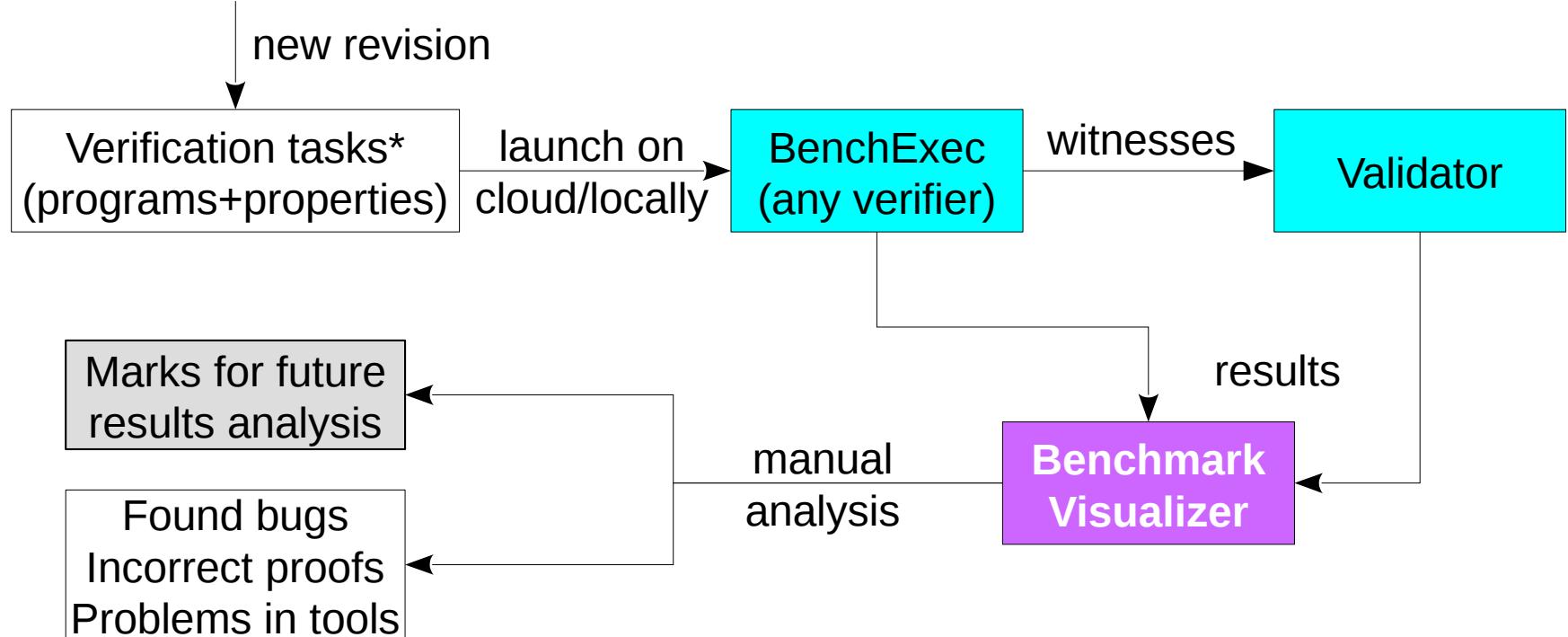
CPAchecker, ldv, ldv-linux-4.0-rc1-mav (2019_08_28_14_57_18)

Description	SV-COMP benchmarks results
Last change	2 weeks, 5 days ago (uploader uploader)
Status	Solved (components tree)
Attributes filters ◆ Apply	
Rule specification	<input checked="" type="checkbox"/> unreach-call
Verification object	▶ 98 elements
Configuration	
CPU cores limit	2
CPU time limit	900s
Memory limit	16000000000
Options	▶ Show

Auxiliary data / filters

Benchmark Visualizer Application Area

- Continuous verification of industry systems



- SV-COMP tasks
 - Similar work-flow with the given verification tasks

* May require additional preparation by the user or other tool.

Conclusion

- Witness Visualizer
 - Converts witnesses to user-friendly format
- Correctness witnesses visualization
 - New ideas of visualization
 - A simple implementation of the ideas
- Benchmark Visualizer
 - Successfully applied to continuous verification
 - Can be applied for SV-COMP tasks

Future Plans

- Witness Visualizer improvements
 - Restore missing elements where possible
 - Improve feedback to the developers
- Correctness witnesses visualization
 - Suggest other views based on proof hints
 - Implement automatic coverage extraction
- Benchmark Visualizer improvements
 - Regression verification
 - Verification tasks preparation

The joint 4rd International Workshop on CPAchecker (CPA'19) and
9th Linux Driver Verification (LDV) Workshop
October 2, 2019, Frauenchiemsee, Germany

Thank you

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