TECHNISCHE UNIVERSITÄT WIEN

Vienna University of Technology

Introducing Context Awareness in Unmodified, Context-unaware Software

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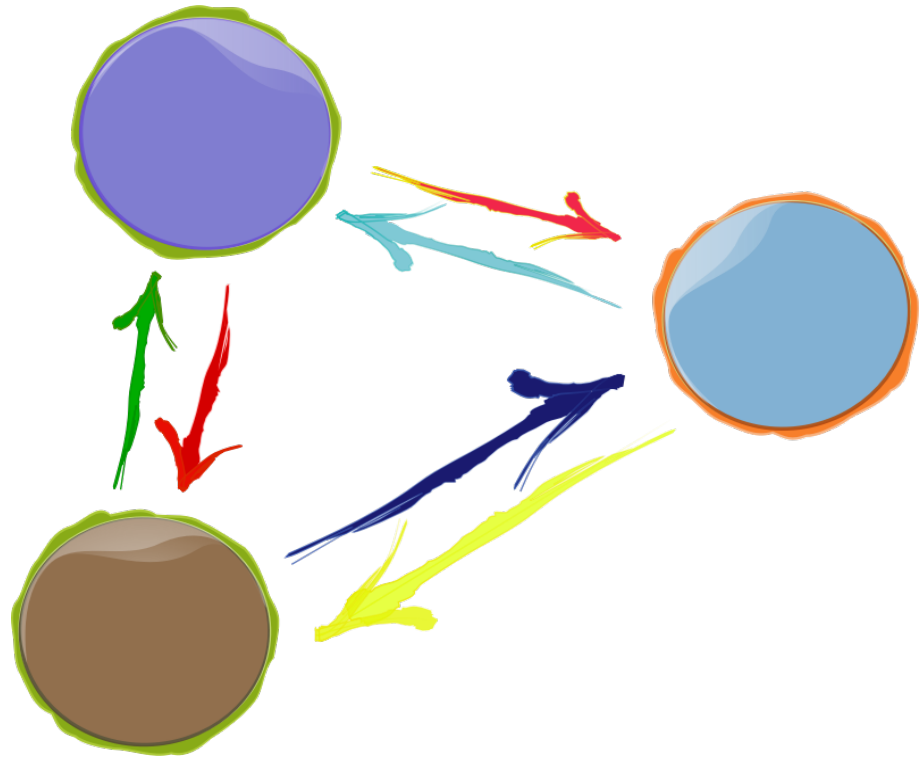
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Goals

- **Context-aware**
  e.g. battery status

- **Customizable**
  adapt to user

- **Unmodified**
  use applications as they are

Problem

- run-time configuration accesses such as
  getenv (specified in C89, POSIX)
  cannot be updated from outside processes

```
for_each (download){
    if ((proxy = getenv("http_proxy")) !=NULL)
        lynx_cfg_file = strdup(cp);
}
```

wrong proxy!

change work place

proxy1

proxy1

Contextual Values

- "Trivial generalization of thread-local values"
- using layers (context-oriented programming)
- applied to **getenv**

many layers
can be active

```
for_each (download){
    if ((proxy = getenv("http_proxy")) !=NULL)
        lynx_cfg_file = strdup(cp);
}
```

change work place

proxy1

proxy2

Contextual Configuration&Specification

- both persisted in Configuration Files
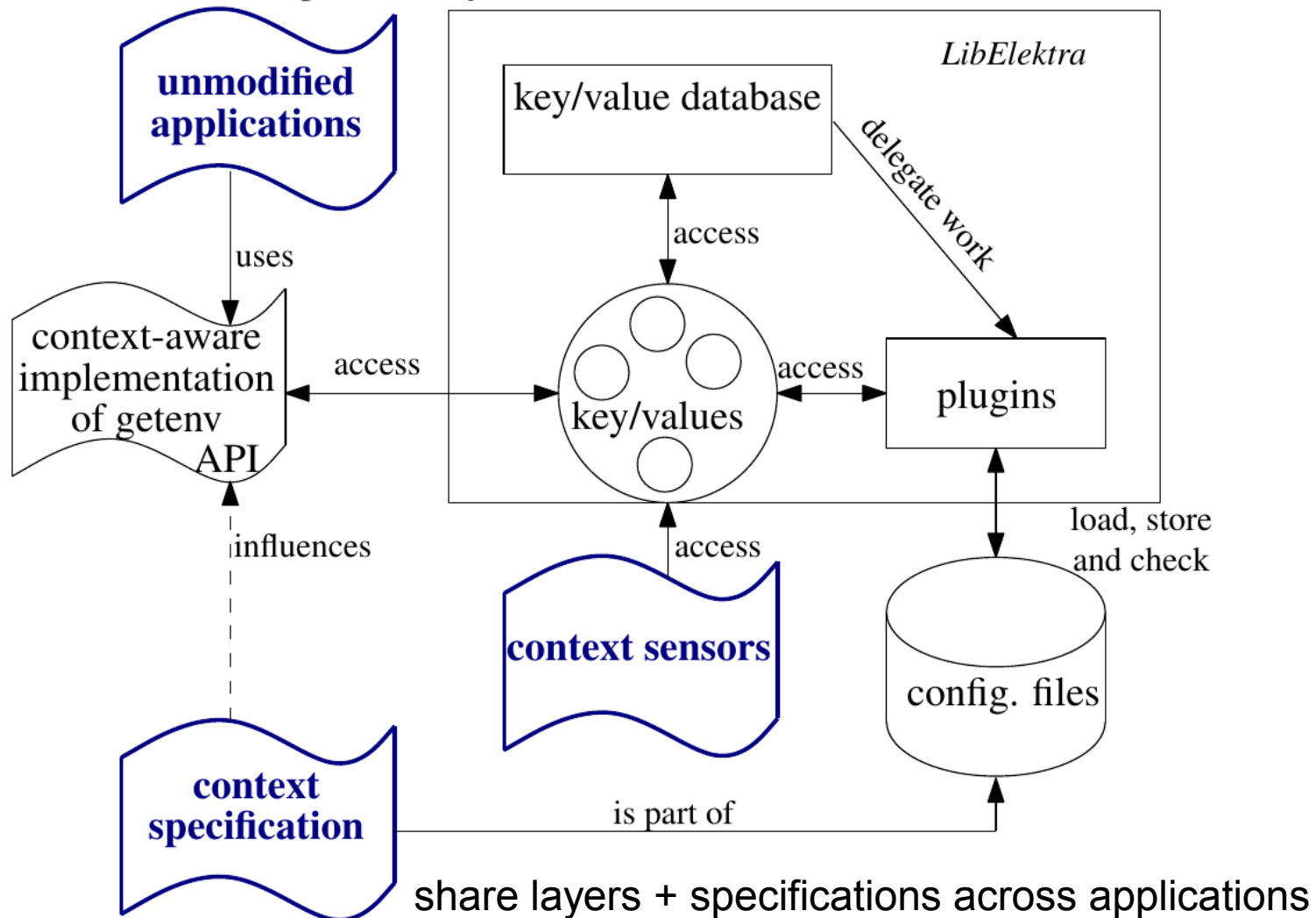- Contextual **Specification**

```
[getenv/http_proxy]
  context=/proxies/%network%
```

- **/:** denotes hierarchy of contextual values
- **%:** placeholders for layers

- Contextual **Configuration** needed for **customization**
  - initialize and persist every contextual value

```
proxies/wlan = proxy1
proxies/lan = proxy2
proxies/guestwlan = proxy3
```

share layers + specifications across applications
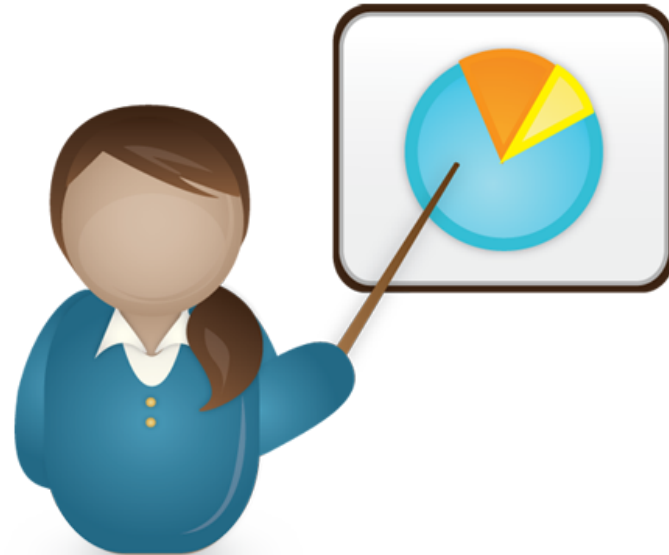
Evaluation

Evaluated Software

- applied Elektra on 16 applications/systems
- 50 million LOC
- very different applications and domains
- no source-code modifications

application	version	application	version
0ad	0.0.17	Gimp	2.8.14
Akonadi	1.13.0	Inkscape	0.48.5
Chromium	45.0.2454.85	Ipe	7.1.4
Curl	7.38.0	Libreoffice	4.3.3
Eclipse	3.8.1	Lynx	2.8.9dev1
Evolution	3.12.9	Man	2.7.0.2
Firefox	38.3.0esr	Smplayer	14.9.0 ds0
Gcc	4.9.2	Wget	1.16

Case Studies

- works very well if:
  - `getenv` is called often (also indirectly), **or**
  - configuration can be reloaded (`open` interception), **or**
  - external applications are executed
- needs restart otherwise
- works perfectly for:
  - proxy for browsers/wget/curl
  - Firefox with 1,957 options
  - gimp open/help
  - UNIX man utiliy
  - printer dialogs
  - ...

Further Results

- we found 2,683 useful `getenv` invocations
- one `getenv` occurrence in 18,470 LOC
- results for browsers:

application	getenv all	all uniq	later uniq	later config	context aware
Chromium	2,723	1,056	73	≥ 24	≥ 1
Curl	87	14	9	6	6
Firefox	8,185	273	210	118	≥ 15
Lynx	1,428	45	23	19	16
Wget	13	7	1	1	1

Overhead

- Lynx
  - overhead: 18.5%
  - no layer: 24.51%
  - two layers: 25.27%

- Firefox http-proxy-transition
  - dynamic reload, below 1%

Source Code

- Source Code released as free software within Elektra
  - ~80 predefined plugins
  - `getenv` and `open` interception
  - support for hundreds kinds of configuration files
  - integrate standard software
  - specification is configuration (e.g. in XML, JSON)
- http://www.libelektra.org
  - version 0.8.19 released 2016-11-22

Conclusion

- combination of unmodified software, context awareness and customization

- layers and specifications are **shared** across applications

- implementation is **free software** and can be downloaded from http://www.libelektra.org

- `getenv` and `open` interception is used to improve unmodified software

- case study with 16 real-world applications

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Thank you for your attention!

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Benchmark Setup

- hp ® EliteBook 8570w ™
  - CPU Intel ® Core i7-3740QM @ 2.70GHz
  - 7939 MB Ram
- GNU/Linux Debian Jessy 8.4
- gcc compiler Debian 4.9.2-10
  - with the options -std=c++11, -O2
- measured the time using `gettimeofday`
- median of eleven executions