Was bringt die Behebung von technischen Schulden?

Ergebnisse einer retrospektiven Nutzenrechnung nach 10 Jahren

Dr. Elmar Jürgens

CQSE

Technische Universität München

Requirement Engineers

User

TreeAdministrationQuarterly.cs

```
93   /// </summary>
94   protected override bool DoLazyLoading(
         UltraTreeNode node)
95   {
96    // Some types of segments always have the
          expand icon
97    if ( node.Tag is GaSegment ||
98      node.Tag is MainSegment ||
99      node.Tag is GeneralMainSegment ||
100     node.Tag is Branch )
101    return true;
102   // All others only if there are child nodes
103   return false;
104  }

106  /// <summary>
107  /// Structure segments return only loss or
         premium segments according to
108  /// the mode.
109  /// </summary>
110  protected override IList GetChildSegments(
         ISegment parent, ref bool alreadySorted )
111  {
112   if ( parent is StructureSegment )
113   {
114    // Show either preminum or loss beyond
           structure segment
115    StructureSegment strucSeg = (StructureSegment
           )parent;
116    if ( (TypeOfSgmtEnum) GetFilterValue( typeof(
           TypeOfSgmtEnum) ) == TypeOfSgmtEnum.Loss
           )
117     return strucSeg.GetLossProcessingSegments();
118    else
119     return strucSeg.GetPremiumProcessingSegments
            ();
```

TreeAdministrationYearly.cs

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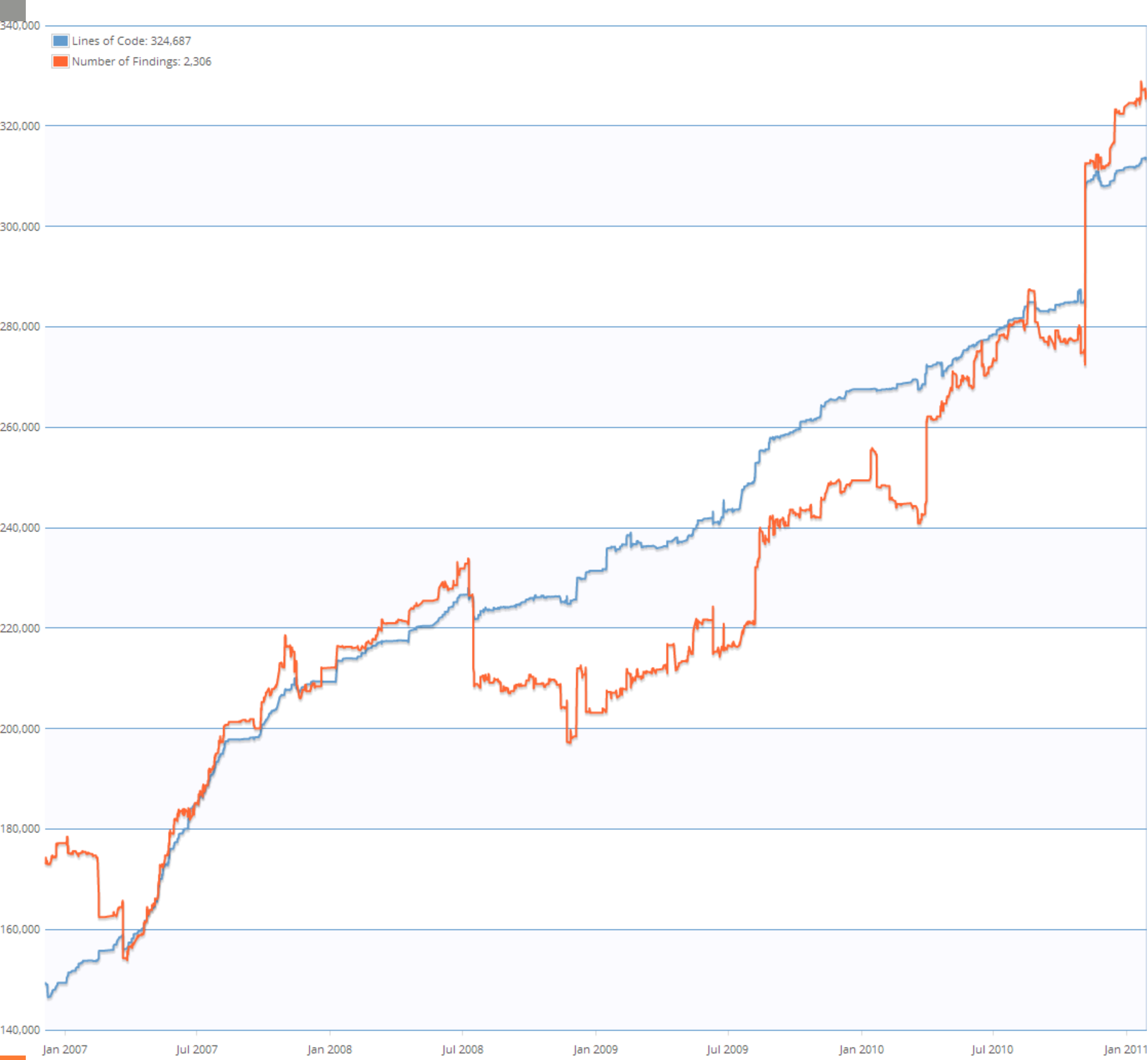


Lines of Code: 324,687
Number of Findings: 2,306
340,000
320,000
300,000
280,000
260,000
240,000
220,000
200,000
180,000
160,000
140,000
Jan 2007
Jul 2007
Jan 2008
Jul 2008
Jan 2009
Jul 2009
Jan 2010
Jul 2010
Jan 2011

Studie

Munich Re LV 1871

- Über 100 Fehler in produktiver Software

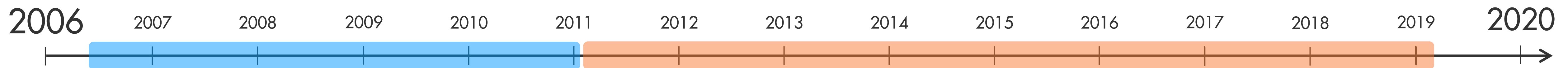
17	44	46
Kritisch	Nutzersichtbar	Nicht nutzersichtbar

Juergens, Deissenboeck et al. *Do Code Clones Matter?* ICSE 2009

Technische Universität München

Requirement Engineers

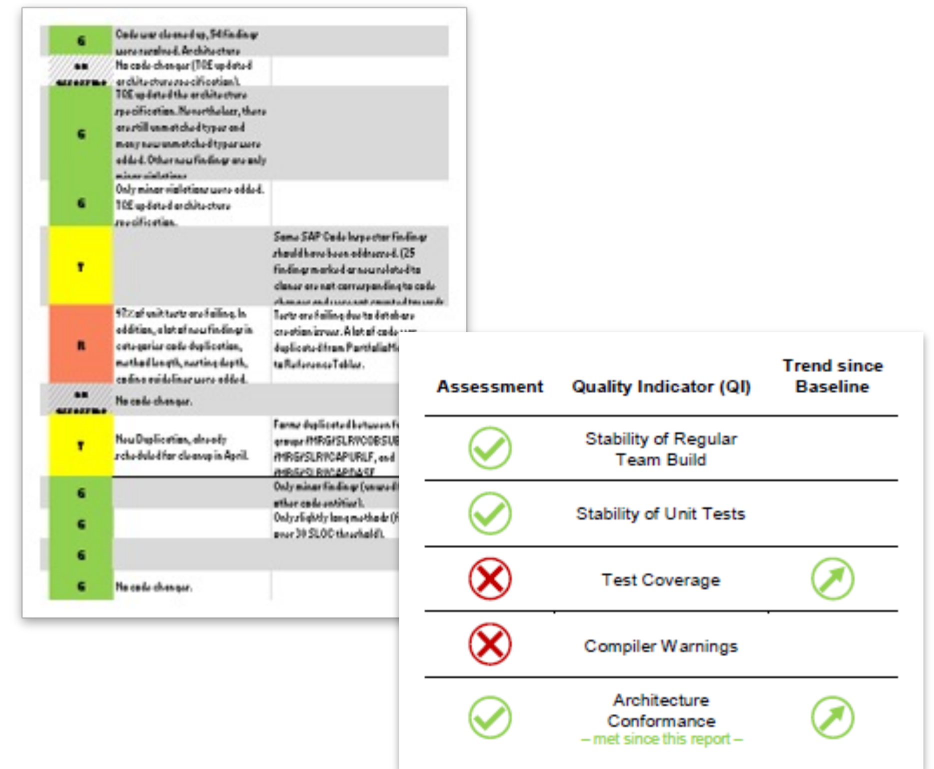
User

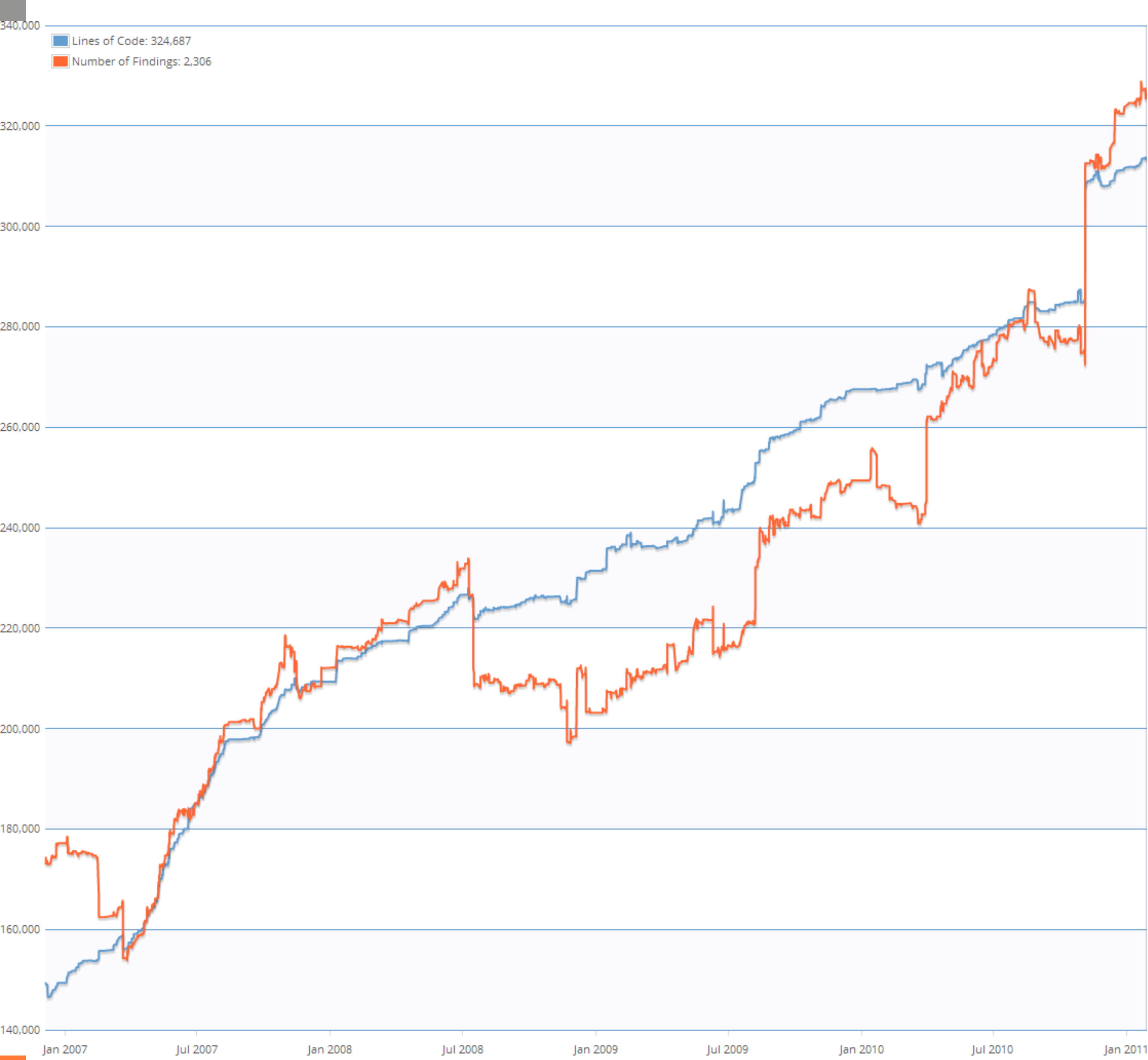


Munich Re Internal Services

Dashboards, IDE Plugin, Azure DevOps

Monthly Assessments, Reports





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Project	QG	Assessment	Comment	Detailed Comment	QG-relevant Findings
	2	Y	Four new security relevant findings should have been reviewed.	Missing authorization checks (1) at the beginning of report _GOODSRECEIPT. (2) before CALL TRANSACTION ycl_p2p_invoice=>gc_ta_f90 in method create_post_values in class FIXEDASSET (3) before CALL TRANSACTION gc_ta_fbd1 in method start_recurring_entry in class INVOICE	4

Di 29.10.2019 18:01

Munich-MR

AW: Security Code Scan - Monthly Assessment

To IT TQE-TGA (Pool) - Munich-MR;

Cc Proft Uwe - Munich-MR

You replied to this message on 30.10.2019 15:06.

Hi all,

the findings down below has been fixed, next assessment status should be green again.

Best regards

Wie können wir den
Nutzen quantifizieren?

```java
// Utilities for arrays of elements
public String showElements(ModelElement[] elements, String nomsg) {
    boolean found = false;
    StringBuffer res = new StringBuffer();
    if (elements != null) {
        Index.getInstance().setCurrentRenderer(
                FlatReferenceRenderer.getInstance());
        for (int i = 0; i < elements.length; i++) {
            ModelElement el = elements[i];
            res.append(showElementLink(el)).append(HTML.LINE_BREAK);
            found = true;
        }
        Index.getInstance().resetCurrentRenderer();
    }
    if (!found && nomsg != null && nomsg.length() > 0) {
        res.append(HTML.italics(nomsg));
    }
    return res.toString();
}
```

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   }
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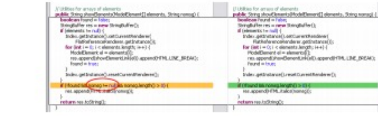
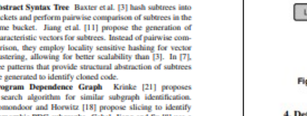
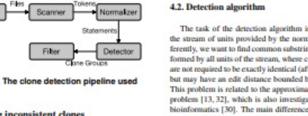
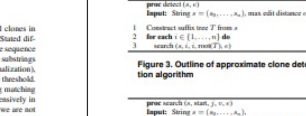
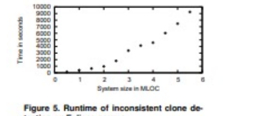
```











Studie

Munich Re LV 1871

- Über 100 Fehler in produktiver Software

17	44	46
Kritisch	Nutzersichtbar	Nicht nutzersichtbar

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$$\text{Anzahl}\ \frac{Fehler}{Jahr} \times \text{Fehlerfolgekosten}\ \frac{PT}{Fehler}$$

$$\text{Anzahl}\ \frac{Fehler}{Jahr} \times \text{Fehlerfolgekosten}\ \frac{PT}{Fehler}$$

#Fehler durch inkonsistente Klone @ Munich Re

Daten aus Studie

- 3 Systeme von Munich Re analysiert
- 79 Fehler gefunden (Impact auf Funktionalität, nicht nur Wartbarkeit o.ä.)
- System waren produktiv, einzelne Fehler schon durch Anwender als Tickets reportet
- 1 Produktionsfehler durch inkonsistente Klone / 17k SLOC

Bedeutung heute

- Betrachtetes Portfolio der Munich Re umfasst ca. 8,25 Millionen SLOC
- Konservative Annahme: Clone Management spart 1 Produktionsfehler pro 50k SLOC pro Jahr
- 8,25 Millionen SLOC / 50k = 165

$$\text{Anzahl}\ \frac{Fehler}{Jahr} \times \text{Fehlerfolgekosten}\ \frac{PT}{Fehler}$$

$$165\ \frac{Fehler}{Jahr} \times \text{Fehlerfolgekosten}\ \frac{PT}{Fehler}$$

$$165\,\frac{Fehler}{Jahr} \times \text{Fehlerfolgekosten}\,\frac{PT}{Fehler}$$

ØFehlerfolgekosten von Fehlern in Produktion

Mögliche Auswirkungen fehlerhafter Software

- Nutzer bekommen falsche Ergebnisse
- Anwendung stürzt ab
- Daten gehen verloren
- Frustration bei Nutzern (Kunden und Mitarbeiter)

? PT

Aufwand für Reparatur

- Nutzer schreibt Ticket für Fehler
- Debugging (Nachstellen, Diagnose, …)
- Fixing
- Test
- Ggf. Deployment

? PT

ØFehlerfolgekosten von Fehlern in Produktion

Mögliche Auswirkungen fehlerhafter Software

- Nutzer bekommen falsche Ergebnisse
- Anwendung stürzt ab
- Daten gehen verloren
- Frustration bei Nutzern (Kunden und Mitarbeiter)

0 PT: bewusste Unterschätzung

Aufwand für Reparatur

- Nutzer schreibt Ticket für Fehler
- Debugging (Nachstellen, Diagnose, …)
- Fixing
- Test
- Ggf. Deployment

3 PT

$$165\,\frac{Fehler}{Jahr} \times \text{Fehlerfolgekosten}\,\frac{PT}{Fehler}$$

$$165 \, \frac{Fehler}{Jahr} \times 3 \, \frac{PT}{Fehler}$$

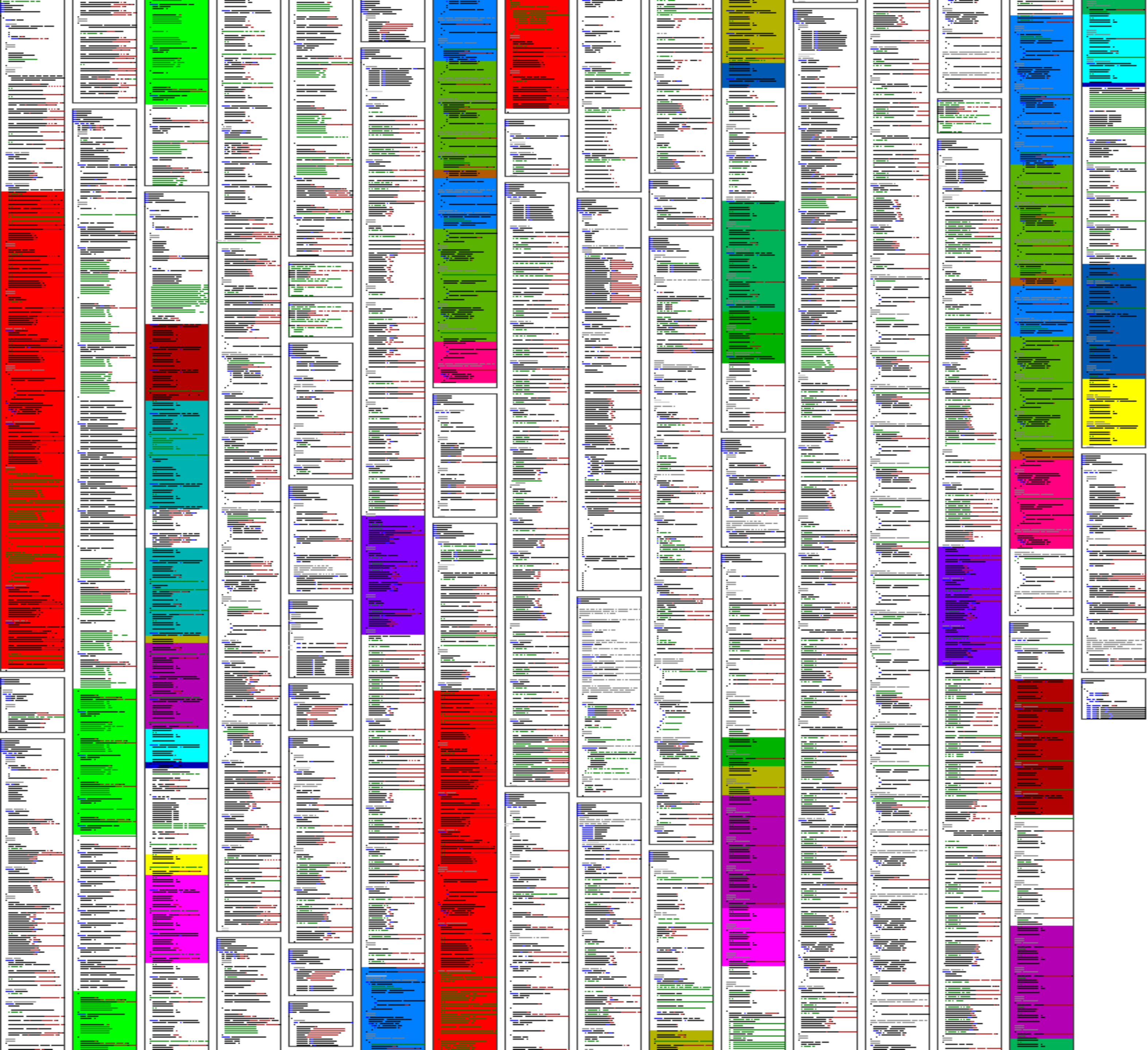
$$495 \frac{PT}{Jahr}$$

$$500 \frac{PT}{Jahr}$$

Munich Re spart durch Einsatz von Clone Management jährlich ca. 500 PT Aufwand für Fehlerbehebung

Komponente A

Komponente B



Juergens, Deissenboeck: *How Much is a Clone?* WoSQ 2010

$$\Delta \text{Aufwand} = \%\text{BlowUp} \times \%\text{CloneAffectedEffort}$$

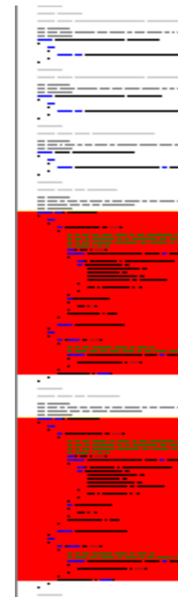
$$\Delta \text{Aufwand} = \%\textbf{BlowUp} \times \%\text{CloneAffectedEffort}$$

Blow-Up: 0%

20 Lines

20 Lines

Blow-Up: 50%



20 Lines

20 Lines

20 Lines

$$\Delta\text{Aufwand} = \%\mathbf{12} \times \%\text{CloneAffectedEffort}$$

$$\Delta \text{Aufwand} = \%12 \times \textbf{\%CloneAffectedEffort}$$

%CloneAffectedEffort

Aktivitäten	Aufwändiger durch Cloning
▪ Analysis	-
▪ Location	Location
▪ Design	-
▪ Impact Analysis	Impact Analysis
▪ Implementation	Implementation
▪ Quality Assurance	Quality Assurance
▪ Other	-

Detaillierte Herleitung und Berechnung im Paper.

Wert für Berechnung: 50%.

$$\Delta \text{Aufwand} = \%12 \times \mathbf{\%50}$$

$$\Delta \text{Aufwand} = \%12 \times \%50 = \mathbf{6\%}$$

Die Munich Re setzt
Clone Detection seit ca.
10 Jahren ein.

Wie sähe es ohne aus?

Continuous Software Quality Control in Practice

Daniela Steidl*, Florian Deissenboeck*, Martin Poehlmann*, Robert Heinke[†], Bärbel Uhink-Mergenthaler[†]
* CQSE GmbH, Garching b. München, Germany
[†] Munich RE, München, Germany

Abstract—**Many companies struggle with unexpectedly high maintenance costs for their software development which are often caused by insufficient code quality. Although companies often use static analyses tools, they do not derive consequences from the metric results and, hence, the code quality does not actually improve. We provide an experience report of the quality consulting company CQSE, and show how code quality can be improved in practice: we revise our former expectations on quality control from [1] and propose an enhanced continuous quality control process which requires the combination of metrics, manual action, and a close cooperation between quality engineers, developers, and managers. We show the applicability of our approach with a case study on 41 systems of Munich RE and demonstrate its impact.**

I. Introduction

Software systems evolve over time and are often maintained for decades. Without effective counter measures, the quality of software systems gradually decays [2], [3] and maintenance costs increase. To avoid quality decay, *continuous quality control* is necessary during development and later maintenance [1]: for us, quality control comprises all activities to monitor the system's current quality status and to ensure that the quality meets the quality goal (defined by the principal who outsourced the software development or the development team itself).

Research has proposed various metrics to assess software quality, including structural metrics[1] or code duplication, and has led to a massive development of analysis tools [4]. Much of current research focuses on better metrics and better tools [1], and mature tools such as ConQAT [5], Teamscale [6], or Sonar[2] have been available for several years.

In [1], we briefly illustrated how tools should be combined with manual reviews to improve software quality continuously, see Figure 1: We perceived quality control as a simple, continuous feedback loop in which metric results and manual reviews are used to assess software quality. A quality engineer – a representative of the quality control group – provides feedback to the developers based on the differences between the current and the desired quality. However, we underestimated the amount of required manual action to create an impact. Within five years of experience as software quality consultants in different domains (insurance companies, automotive manufacturers, or engineering companies), we frequently experienced that tool

This work was partially funded by the German Federal Ministry of Education and Research (BMBF), grant EvoCon, 01IS12034A. The responsibility for this article lies with the authors.

[1] *e. g.*, file size, method length, or nesting depth

[2] http://www.sonarqube.org/

Fig. 1. The former understanding of a quality control process

support alone is not sufficient for successful quality control in practice. We have seen that most companies cannot create an impact on their code quality although they employ tools for quality measurements because the pressure to implement new features does not allow time for quality assurance: often, newly introduced tools get attention only for a short period of time, and are then forgotten. Based on our experience, quality control requires actions beyond tool support.

In this paper, we revise our view on quality control from [1] and propose an enhanced quality control process. The enhanced process combines automatic static analyses with a significantly larger amount of manual action than previously assumed to be necessary: Metrics constitute the basis but quality engineers must manually interpret metric results within their context and turn them into actionable refactoring tasks for the developers. We demonstrate the success and practicability of our process with a running case study with Munich RE which contains 32 .NET and 9 SAP systems.

II. Terms And Definitions

- A *quality criterion* comprises a metric and a threshold to evaluate the metric. A criterion can be, *e. g.*, to have a clone coverage below 10% or to have at most 30% code in long methods (*e. g.*, methods with more than 40 LoC).
- *(Quality) Findings* result from a violation of a metric threshold (*e. g.*, a long method) or from the result of a static code analysis (*e. g.*, a code clone).
- *Quality goals* describe the abstract goal of the process and provide a strategy how to deal with new and existing findings during further development: The highest goal is to have no findings at all, *i. e.*, all findings must be removed immediately. Another goal is to avoid new findings, *i. e.*, existing findings are tolerated but new findings must not be introduced. (III-B will provide more information).

III. The Enhanced Quality Control Process

Our quality control process is designed to be *transparent* (all stakeholders involved agree on the goal and consequences

...must ... cient ... ecify ... ither ... pany. ... eam- ... eing ... ess's ... but ... QSE ... site. ... pers ... bone ... the ... eeds. ... ality ... sting ... lings ... ly). ... de – ... hout ... ment ... outs ... ways ... [7]). ... lings ... nder ... gies ... com- ... ding ... ment. ... teria ... code ... ngth, ... cture ... lines ... teria ... ancy, ... and ... ized ... ality ... (see

...evelopers
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5
4
2

...ifficult for ... history of ... ny reliable ... ms in case ... quently, we ... le systems ... ather than ... For these ... before and ... g methods, ... ese quality ... contrast to, ... tomatically. ... d. Second, ... both trends ... All trends ... stems with ... long-term ... m size (to ... he behavior ... ll QG3, we ... igures 3–6 ... dings trend ... e coverage ... he quality ... e for each ... ort date. ... reat impact ... size grows ... control, the ... s declines ... m of 5%. ... measurably ... However, ... cooperation ... e 2006, in ... erage had ... e decreases ... e the history ... ce, although ... Teamscale to

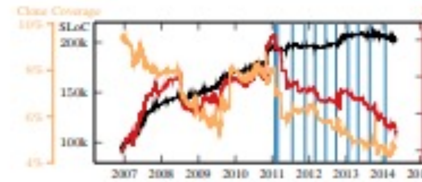


Fig. 3. System *A*

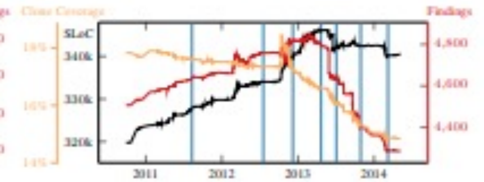


Fig. 5. System *C*

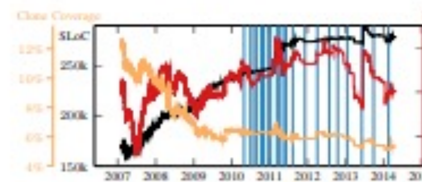


Fig. 4. System *B*

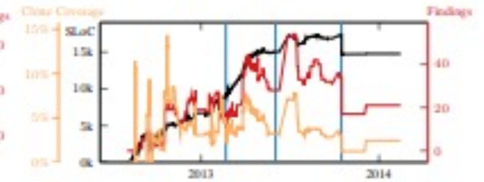


Fig. 6. System *D*

continuously in the available history (Figure 4). The number of findings, however, increases until mid 2012. In 2012, the project switched from QG2 to QG3. After this change, the number of findings decreases and the clone coverage settles around 6%, which is a success of the quality control. The major increase in the number of findings in 2013 is only due to an automated code refactoring introducing braces that led to threshold violations of few hundred methods. After this increase, the number of findings start decreasing again, showing the manual effort of the developers to remove findings.

For System C (Figure 5), the quality control process shows a significant impact after two years: Since the end of 2012, when the project also switched from QG2 to QG3, both the clone coverage and the overall number of findings decline. In the year before, the project transitioned between development teams and, hence, we only wrote two reports (July 2011 and July 2012).

System *D* (Figure 6) almost fulfills QG4 as after 1 year of development, it has only 21 findings in total and a clone coverage of 2.5%. Technically, under QG4, the system should have zero findings. However, in practice, exactly zero findings is not feasible as there are always some findings (*e. g.*, a long method to create UI objects or clones in test code) that are not a major threat to maintainability. Only a human can judge based on manual inspection of the findings whether a system still fulfills QG4, if it does not have exactly zero findings. In the case of System D, we consider 21 findings to be few and minor enough to fulfill QG4.

To summarize, our trends show that our process leads to actual measurable quality improvement. Those trends go beyond anecdotal evidence but are not sufficient to scientifically proof our method. However, Munich RE decided only recently to extend our quality control from the .NET area to all SAP development. As Munich RE develops mainly in the .NET and SAP area, most application development is now supported by quality control. The decision to extend the scope of quality control confirms that Munich Re is convinced by the benefit of quality control. Since the process has been established, maintainability issues like code cloning are now an integral part of discussions among developers and management.

V. Conclusion

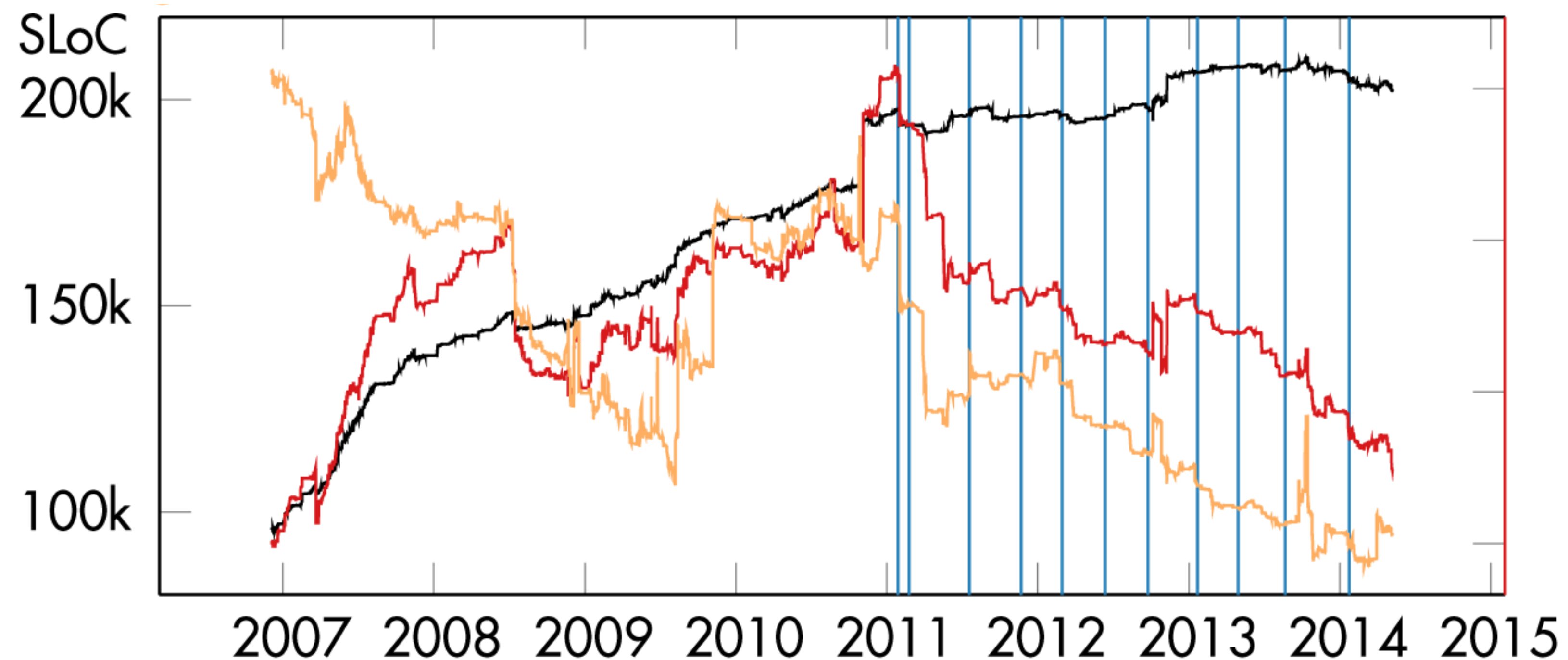
Quality analyses must not be solely based on automated measurements, but need to be combined with a significant amount of human evaluation and interaction. Based on our experience, we proposed a new quality control process for which we provided a running case study of 41 industry projects. With a qualitative impact analysis at Munich RE we showed measurable, long-term quality improvements. Our process has led to measurable quality improvement and an increased maintenance awareness up to management level at Munich Re.

References

[1] F. Deissenboeck, E. Juergens, B. Hummel, S. Wagner, B. M. y Parareda, and M. Pizka, "Tool support for continuous quality control," in *IEEE Software*, 2008.
[2] D. L. Parnas, "Software aging," in *ICSE '94*.
[3] S. G. Eick, T. L. Graves, A. F. Karr, J. S. Marron, and A. Mockus, "Does code decay? Assessing the evidence from change management data," *IEEE Trans. Software Eng.*, 2001.
[4] P. Johnson, "Requirement and design trade-offs in hackystat: An in-process software engineering mea- surement and analysis system," in *ESEM'07*.
[5] F. Deissenboeck, M. Pizka, and T. Seifert, "Tool support for continuous quality assessment," in *STEP'05*.
[6] L. Heinemann, B. Hummel, and D. Steidl, "Teamscale: Software quality control in real-time," in *ICSE'14*.
[7] R. C. Martin, *Clean Code: A Handbook of Agile Software Craftsmanship*, 2008.

Steidl, Heinke, Uhink: Continuous Software Quality Control in Practice? *ICSME* 2014

Einsparung durch Clone Detection



Menge an geklontem Code hat sich seit der Einführung von Clone Detection halbiert.
Ohne Clone Detection wäre der Clone Blow-Up daher vorr. doppelt so groß.

$$\text{Ersparnis Aufwand} = \mathbf{6\%}$$

Munich Re spart durch Einsatz von Clone Detection jährlich 6% Aufwand durch vermiedene Redundanz ein.

Findings

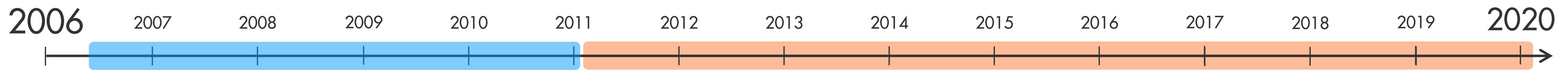
Category	Count
All	**6793**
Architecture	**1**
Architecture Conformance	1
Code Anomalies	**1344**
Bad practice	971
Correctness	2
Exception Handling	62
General checks (built-in)	120
Null pointer dereference	13
Performance	36
Unused code	93
Unused variable or parameter	47
Code Duplication	**988**
Cloning	101
Redundant Literals	887
Documentation	**3378**
Comment completeness	3236
Task tags	142
Formatting	**6**
Code formatting	6
Naming	**110**
Java naming conventions	110
Structure	**966**
File Size	38
Method Length	278
Nesting Depth	650

$$500 \frac{PT}{Jahr}$$

Munich Re spart durch Einsatz von Clone Management jährlich ca. 500 PT Aufwand für Fehlerbehebung

$$\text{Ersparnis Aufwand} = \mathbf{6\%}$$

Munich Re spart durch Einsatz von Clone Detection jährlich 6% Aufwand durch vermiedene Redundanz ein.


2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

Kontakt – Ich freue mich auf Fragen ☺

Dr. Elmar Jürgens juergens@cqse.eu +49 179 675 3863

CQSE GmbH
Centa-Hafenbrädl-Str 59
81249 München
www.cqse.eu