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DevOps Innovation in Practice: New Lifecycle Processes, New Applications

JUNE 2023

RECOMMENDATION REPORT

Introduction

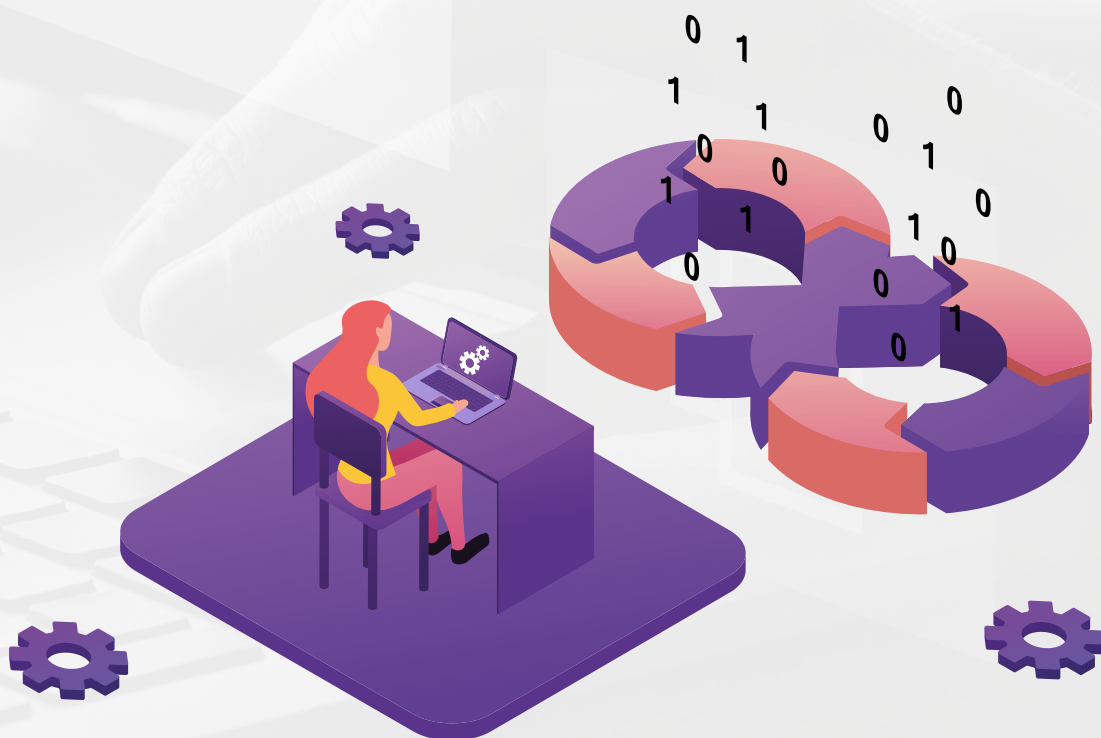
DevOps, born from the agile movement, has become a key driver of continuous software engineering. It combines software development and IT operations to automate workflows and enable fast feedback. As applications become more ambitious, new demands arise, leading to innovation in DevOps practices and lifecycles.

SWForum.eu successfully organised its third webinar series, centred around the theme “**DevOps Innovation in Practice: New Lifecycle Processes, New Applications.**” Held on 20 April 2023, the webinar focused on showcasing the latest advancements in DevOps for advanced software systems, with a particular emphasis on the outcomes of EU-funded projects.

During the webinar, experts from four prominent EU-funded projects, namely COSMOS, DESTINI, VeriDevOps, and PIACERE, shared their valuable insights and provided an overview of the innovative practices and outcomes in DevOps. The session offered participants a comprehensive understanding of the practical applications and benefits of DevOps in software development.

Access the complete speaker presentations and unlock valuable insights from our recent event. Also, a video recording of the full session is available at the [SWForum.eu page](#).

The objective of this webinar is to showcase innovation in DevOps lifecycle processes, practices, and culture in response to the evolving demands of software development. It aims to highlight the advancements in DevOps for advanced software systems and present exciting results from R&D projects. The target participants include the software technology and digital infrastructure communities, EC-funded projects, policymakers, decision-makers, software engineering experts, SMEs, and large industries. The webinar provides an opportunity for knowledge exchange and exploration of the latest developments in the field of DevOps.



Results of the interactive live poll session

This webinar managed to gather 35 live participants from 12 countries across the globe: 9 EU Member States and 3 Non-EU/global. The majority of them were from EC-funded H2020 and Horizon Europe projects with interest in standardisation (44%), followed by Software Engineering Experts (25%), SME and Large enterprises (16%), Software technology and digital infrastructure communities (13%) and Policy and decision makers (3%).

Key recommendations emerging from the session are also provided in the next pages.

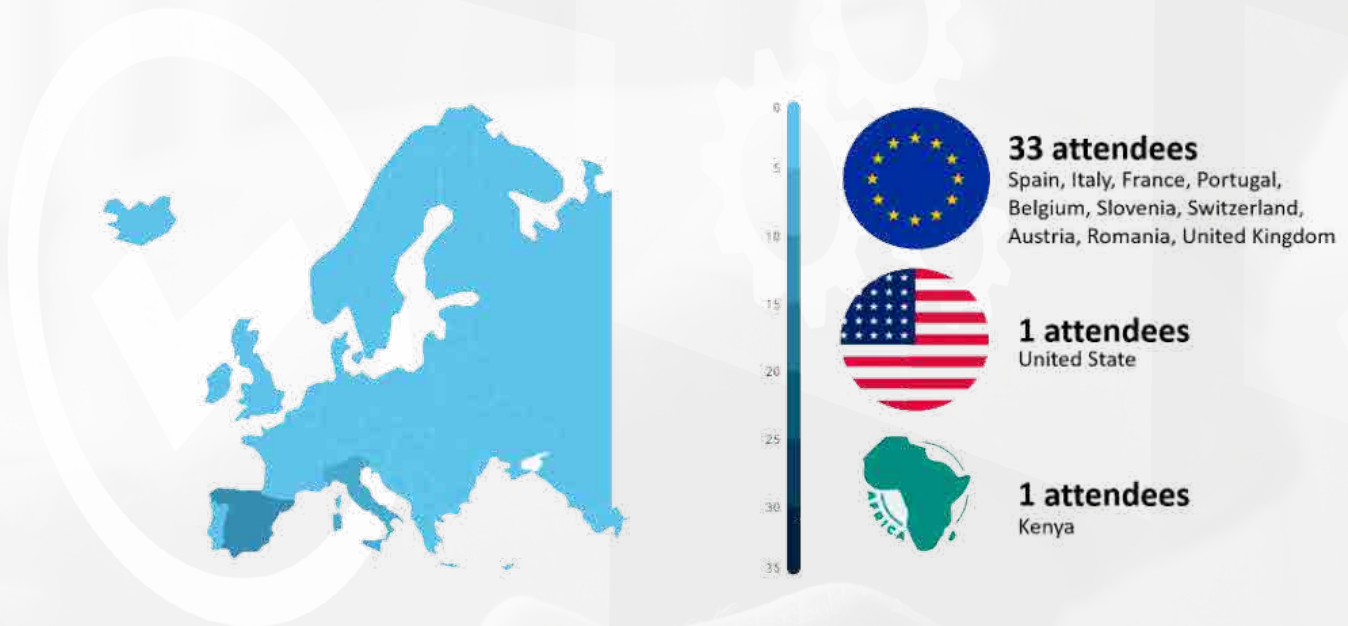


Figure 1: Attendees by regions

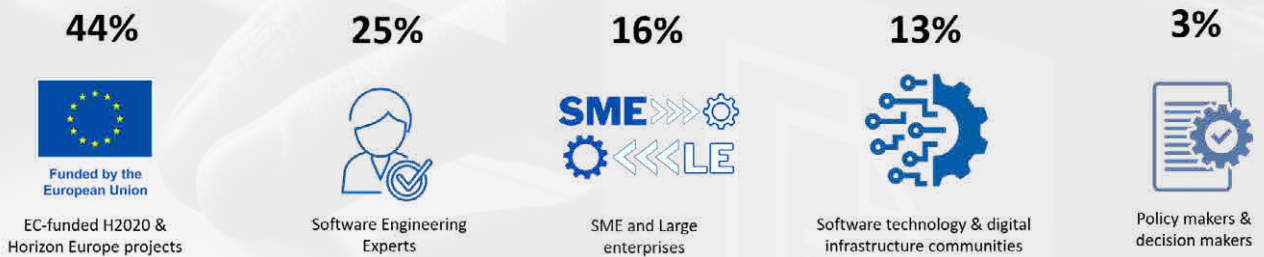


Figure 2: Attendees by groups

During the webinar, we conducted a live polling session to gauge the understanding of our attendees regarding the barriers that hinder the implementation of DevOps. Here is the result:



These findings underscore the shared challenges that organizations encounter when adopting DevOps and underscore the significance of addressing cultural, communication, and automation issues to facilitate successful implementation. In the following section, we will present the viewpoints of our key speakers on this matter, providing further insights and recommendations for overcoming these barriers.

Chairs and Speakers

The graphic is a purple-themed promotional poster for a webinar. At the top left is the SWForum.eu logo. Below it, a yellow 'WEBINAR' badge is followed by the date and time: '20 April 2023 11:00 CEST'. The main title is 'DevOps Innovation in Practice: New lifecycle processes, new applications.' Below the title is an illustration of a person working at a laptop with various DevOps icons like gears, a code editor, and a server. At the bottom left is the 'Funded by the European Union' logo. The central part of the graphic is a purple box labeled 'SPEAKERS' containing six circular portraits of the speakers, arranged in two rows of three. To the right of this box is a smaller purple box labeled 'MODERATOR' containing one circular portrait of John Favaro.

SWForum.eu

WEBINAR

20 April 2023 11:00 CEST

DevOps Innovation in Practice: New lifecycle processes, new applications.

SPEAKERS

- Juncal Alonso**
TECNALIA, SWForum.eu
Project Coordinator
- Radosław Piliszek**
Senior IT Architect
at 7bulls.com
- Sebastiano Panichella**
ZHAW, COSMOS
Technical Director
- Damian Tamburri**
TU/e, JADS/
POLIMI, DESTINI
- Andrey Sadovykh**
SOFTEAM, VeriDevOps
Technical Coordinator
- Matija Cankar**
XLAB d.o.o., PIACERE
Technical Coordinator

MODERATOR

- John Favaro**
Senior Research
Analyst at Trust-
IT Services

Funded by the European Union

John Favaro - Senior Research Analyst at Trust-IT Services, SWForum.eu Communications and Dissemination Officer

John Favaro is a Senior Research Analyst at Trust-IT, where he is responsible for tracking cutting-edge technologies and trends. He has experience in numerous technologies ranging from 5G to automotive engineering, and is currently also an Assistant Editor of IEEE Software Magazine and a member of its Advisory Board. John has degrees in computer science from Yale University and the University of California at Berkeley.



Keynote speakers

Juncal Alonso, PhD - R&D Engineer at Tecnalía, SWForum.eu Project Coordinator

Juncal is a senior researcher working in the Cloud Technologies projects area of TECNALIA (since 2007). She received her diploma of Master Telecommunication Engineering (BSc) from the University of the Basque Country (Escuela Técnica Superior de Ingeniería - UPV) in 2006. She also obtained a Master's diploma in Local ICT administration (UNED) and the ITIL certification in IT services management and also holds a PhD in Telecommunications, in the Cloud Computing domain. Currently, Juncal belongs to the High-Performance Architecture group in TECNALIA as a specialised researcher on Cloud-based architecture, DevOps and multi-cloud. Her research interests include software engineering for the cloud continuum, secure cloud federation and multi-cloud-enabled software applications. She is currently the coordinator of the PIACERE H2020 RIA action and SWForum H2020 CSA.



Radosław Piliszek - Senior IT Architect at 7bulls.com

Radek's background is in computer systems and networks, with particular emphasis on automation and cloud-native technologies. He is responsible for projects involving IT systems and integrations between them. Certification-wise, he holds several exam-proven Red Hat and CNCF certifications. Radek is an experienced contributor to various open-source projects, primarily OpenStack. In his scientific career, he has an open doctoral dissertation in which he deals with the issue of feature selection.



Speakers

Matija Cankar - Researcher and Project Manager at XLAB d.o.o., and PIACERE project's Technical Coordinator

Matija is a researcher and project manager at XLAB d.o.o., Slovenia. He received the Ph.D. degree in 2014 at the University of Ljubljana for his work on efficient resource allocation in grid and cloud computing systems. His current research interests are cloud automation, orchestration, infrastructure as code inspection, applying open standards or open-source technologies, and delivering high-end deployment automation solutions to end-users. Lately, he has been leading the development of Gaia-X (GXFS) Orchestrator.



Andrey Sadovykh - Project Manager, Researcher in Software Engineering at SOFTEAM, VeriDevOps project's Technical Coordinator

In Softeam, Dr. Sadovykh leads projects on model-driven methods and tools for software engineering in various domains such as cyber-security, cloud computing and cyber-physical systems. His current research interests are Natural Language Processing for Requirements engineering and security testing with Requirements as Code methods. Dr. Sadovykh holds PhD and MBA degrees.



Damian Tamburri - Associate Professor at Eindhoven Univ. of Technology - JADS / Politecnico di Milano, DESTINI Project Research Coordinator

Damian is an Associate Professor at the Eindhoven University of Technology, the Jheronimus Academy of Data Science, in s'Hertogenbosch, The Netherlands with a double-affiliation at Politecnico di Milano as well. At JADS he lectures the Big Data Engineering and Deep Learning courses, while lending a hand in the Machine-Learning pre-master course. His research interests rotate around Data-Intensive Services DevOps/ DataOps, Social Software Engineering, and Artificial-Intelligence Software Engineering. Damian has published over 150+ papers in either top Journals or conferences in Software Engineering, Information Systems, as well as Services and AI Computing. Also, Damian has been an active contributor and lead research in many EU FP6, FP7, H2020, and HorizonEurope projects, such as S-Cube, MODAClouds, SeaClouds, DICE, ANITA, DossierCLOUD, ProTECT, RADON, SODALITE, DESTINI, and more. In addition, Damian is ACM TOSEM editorial board member, secretary of the OASIS TOSCA Standardisation TC as well as secretary of the IFIP TC2, TC6, and TC8 WG on "Service-Oriented Computing".



Sebastiano Panichella - Senior Computer Science Researcher at Zurich University of Applied Sciences (ZHAW), COSMOS Project Coordinator

Sebastiano Panichella is a Computer Science Researcher at Zurich University of Applied Sciences (ZHAW). His main research goal is to conduct industrial research, involving both industrial and academic collaborations, to sustain the Internet of Things (IoT) vision. His research interests are in the domain of Software Engineering (SE), cloud computing (CC), and Data Science (DS). Currently, he is the technical coordinator of H2020 and Innosuisse projects concerning DevOps for Complex Cyber-physical Systems. He authored or co-authored more than eighty papers that appeared in International Conferences and Journals. He serves and has served as a program committee member of various international conferences and as a reviewer for various international journals in the field of software engineering. Home page: <https://spanichella.github.io/>



Questions and Answers

During the webinar, we invited speakers to share their unique perspectives on various software and DevOps concerns. Participants had the opportunity to gain insights from industry experts on a wide range of topics, including software development practices, DevOps methodologies, workflow automation, and addressing the challenges posed by ambitious applications. The diverse perspectives offered during the webinar provided attendees with valuable insights and a well-rounded understanding of the software and DevOps landscape.

? 1 Question: What are the cultural issues in the transition to DevOps?



Andrey Sadovykh (VeriDevOps)

Answer: DevOps, a field deeply rooted in technology, has today become increasingly complex, with a multitude of platforms and specific tools. This forces developers to engage in continuous learning, even if the immediate benefits are not necessarily visible straight away. The challenge is to simplify the deployment and maintenance of DevOps practices, while clearly justifying the costs and benefits associated with the transition to DevOps.



Sebastiano Panichella

Answer: While there is a need for DevOps for CPS development and evolution, there are resistances and risks in moving to DevOps for CPS, and more and more projects have to investigate ways to standardise practices, processes, and technologies (as done in the projects in this meeting). Complementary, there is still a lack of large educational efforts to create profiles that can fill such a gap in expertise.



Damian Tamburri

Answer: The transition to DevOps can raise several cultural issues that can affect the success of the implementation. Some of these cultural issues include: (1) Resistance to change: DevOps involves significant changes to the way people work, which can cause resistance from employees who are used to working in a different way. (2) Silos and lack of collaboration: DevOps requires teams to work together more closely than traditional IT organisations. However, many companies have siloed teams that are used to working independently, which can lead to a lack of collaboration. (3) Blame culture: Traditional IT organisations often have a blame culture where individuals are held accountable for any issues that arise. This can create a hostile environment where people are hesitant to take risks or share information. (4) Lack of communication: Communication is critical in DevOps, as teams need to work closely together to ensure that everything runs smoothly. However, communication breakdowns can occur, leading to delays and errors. (5) Limited ownership: DevOps requires individuals to take ownership of their work and be accountable for its success. However, some employees may be used to a more hierarchical structure where decision-making is left to management. To address these cultural issues, companies may need to invest in training and development programs to help employees adjust to the new ways of working. They may also need to implement new communication channels and processes to improve collaboration and reduce silos. Additionally, companies can encourage a culture of learning and experimentation where employees are encouraged to take risks and learn from their mistakes rather than being punished for them.



Matija Cankar (PIACERE)

Answer: All transformations are hard for teams and individuals, and applying DevOps is definitely not just a technical thing. I guess that the biggest issue with a cultural shift lies in the size of the impact that it has on product development and management. Shifting to DevOps is not only an upgrade of the IT team but also increases the role of developers, leaders, product owners, and business in the whole process. Everyone is more involved and shares more responsibility for success, which can be an issue for individuals at the start, but later, the team is more connected and more active in problem resolution.



Radoslaw Piliszek

Answer: The biggest issue seems to be the lack of awareness or understanding that DevOps's effectiveness does not lie in the tools themselves but in the synergy achieved by employing the right tools and adjusting the company culture, e.g., by adapting relevant processes and procedures. For many companies, this is trickier than it looks because of responsibility chains and the natural human desire to avoid responsibility if possible. This is further augmented by the blame culture and the resulting lack of acceptance of mistakes, while DevOps embraces the fact that mistakes happen and will happen. The goal is to catch them sooner rather than later and learn from them the easy way rather than the hard way. The remedy is not obvious because these negative practices are well-rooted in the functioning of these companies, and their acceptance actually often begins in schools. Thus, it would be best if the general education system was adapted to penalise the blame culture and focus more on collaboration.

❓ 2 Can DevOps ever be completely automated or will we always need the human element?



Andrey Sadovykh (VeriDevOps)

Answer: Until now, full automation has remained an elusive goal, as the complex nature of the problems to be solved requires individualised approaches and human intervention for analysis and supervision. Nevertheless, we aspire to streamline routine tasks through automation, while equipping humans with invaluable knowledge, warning signals, and sound advice. Our vision is to push back the frontiers of automation in hitherto unexplored areas, such as requirements analysis and task prioritisation.



Sebastiano Panichella

Answer: DevOps can and has to be automated, with adaptation for different domains or application scenarios. At the same time, we need automated ways to validate results and put humans into the loop of relevant evaluations of CPS behaviours in a cost-effective manner.



Damian Tamburri

Answer: Never completely automated without the need for the human element. This is because DevOps involves collaboration and communication between different teams and requires creativity, critical thinking, and decision-making skills that are difficult to automate. While some routine and repetitive tasks can be automated through the use of tools and scripts, there are certain aspects of DevOps that require human intervention. For example, resolving complex technical issues, making strategic decisions, and collaboration.



Name: Matija Cankar (PIACERE)

Answer: The DevOps approach is a way for the team to better collaborate in the process of product development and delivery. There will always be an opportunity to automate some parts or rely on new tools to improve the DevOps process and ease the work of technicians. However, the DevOps team members share the responsibility, and they need to make decisions on how to resolve daily issues. When the product is running, the decisions may be driven by business and cannot be automated.



Radoslaw Piliszek

Answer: The short answer is: no, it cannot. The long answer is that DevOps is about empowering humans to do their jobs better, not replacing them. Sure, if DevOps is misconceived as tooling only, then automating "everything DevOps" sounds plausible. However, this is not true, as proper DevOps has the human element, which manifests largely in this cultural aspect discussed in the previous question. It is still humans making the final decisions. The more feedback and extra information we can provide automatically, the better it is for humans to make informed decisions. DevOps is for humans, not machines.

③ What do you see as the future trends of DevOps? How can it be enhanced?



Andrey Sadovykh (VeriDevOps)

Answer: In a broader context, DevOps is becoming the norm in various project areas. The current trend involves increasing automation of tasks such as requirements analysis and the provision of recommendations and information. While DevOps remains a technically oriented domain that can quickly become complex, it also requires a user-friendly framework to support developers and facilitate the adoption of streamlined practices for continuous integration and deployment (CI/CD). What's more, DevOps will extend its reach into areas that were previously unaddressed and constrained by unique characteristics and limited resources.



Sebastiano Panichella

Answer: There will be more and more emphasis on AI-based CPS and their ability to evolve and cope with the needs of dynamic environments. So more trends will go into understanding AI and AI effects and decisions in CPS, as well as the ability to leverage DevOps to evolve such systems.



Damian Tamburri

Answer: The future trends of DevOps are likely to focus on further automation, improving collaboration, and enabling more efficient and secure software delivery. Here are some specific areas where we can expect to see growth and development in the coming years: (a) Artificial intelligence (AI) and machine learning (ML) will be integrated into DevOps tools and processes to enable more automated decision-making and to identify patterns and trends in software delivery. (b) Security will become an even more critical focus of DevOps, with increased emphasis on integrating security throughout the software development and delivery process. (c) DevOps will expand beyond just software development and delivery to include other areas of the business, such as operations, finance, and marketing, leading to a more holistic approach to organisational transformation. (d) DevOps will continue to embrace cloud-native technologies and containers, enabling more flexibility, scalability, and portability for software applications. (e) Collaboration will be further enhanced through the use of social tools, chatbots, and other communication technologies, enabling more real-time feedback and information sharing. To enhance DevOps, organisations can take several steps, including:

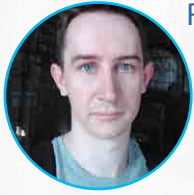
- ➔ Investing in training and development programs to improve the skills and knowledge of DevOps teams and stakeholders
- ➔ Adopting a culture of continuous improvement where feedback and experimentation are encouraged and valued
- ➔ Fostering collaboration between different teams and departments and breaking down silos to enable better communication and collaboration
- ➔ Implementing automation wherever possible to free up time for more strategic work and reduce the risk of errors and delays
- ➔ Emphasising security as a first-class citizen throughout the software development and delivery process and adopting best practices for security testing and validation.

By staying abreast of these trends and investing in the right tools, processes, and culture, organisations can improve their DevOps capabilities and stay competitive in an increasingly fast-paced and complex software delivery landscape.



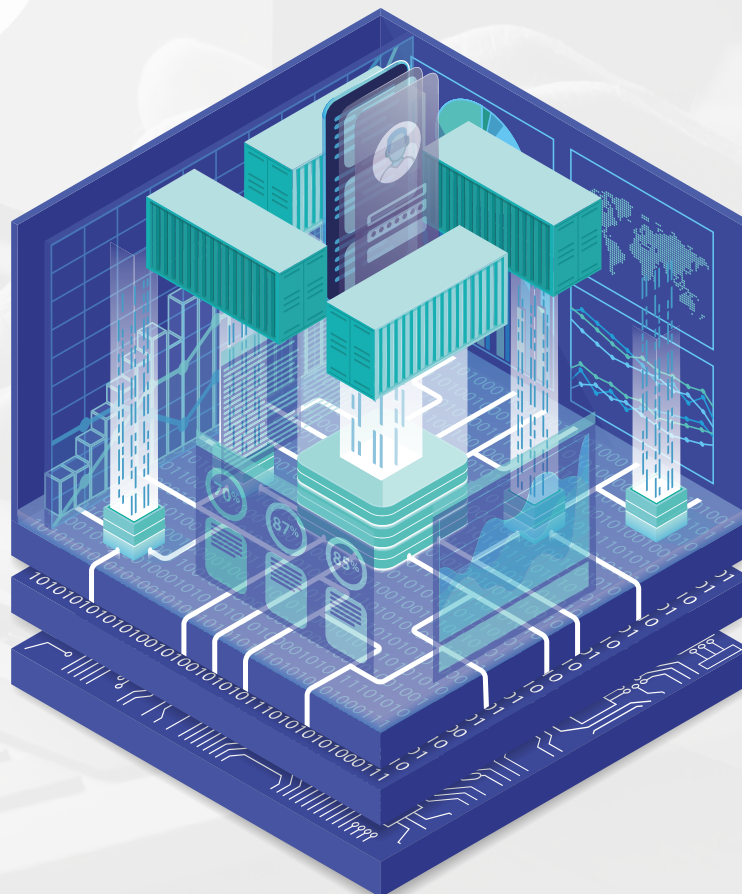
Matija Cankar (PIACERE)

Answer: The future of DevOps goes in the direction of automation and security. With more automation we try to bring in, better plans for process automation will be created, and more inspection of the plans can be applied. This presents an opportunity to empower the processes of DevOps automation design with inspection tools, including a focus on security, and with the help of machine learning. Note that DevOps will also expand, involving more and more technologies that will be mastered in that way. I believe that from cloud infrastructure and application delivery, we will soon be able to move to the bare-metal provisioning and management of daily routines navigating robots and drones. While DevOps is also a cultural thing, I guess that it is possible to apply this approach to other industrial domains focusing on product delivery.



Radoslaw Piliszek

Answer: The future of DevOps or DevOps-like movements is bright. In the typical, traditional sense of DevOps, the current trends focus on improving the tooling with Artificial Intelligence (AI) capabilities, usually revolving around Machine Learning (ML) for inferring or predicting outcomes before they happen based on historical data. This is considered both for static (i.e., before the system is put into production) and dynamic (i.e., when the system is already in place and doing its job) analysis. The goal with these is to enhance the completeness of tooling beyond what humans have already conceived. In a more general sense, DevOps is being adapted to apply in other areas beyond the original development and deployment cycle of software. This is a promising “family of trends” that picks solutions relevant for DevOps and amends them so that they make sense in broader or simply independent topics. I see these two aspects continuing in the future, enhancing our perception of DevOps and what it really means to apply it to our work.



Recommendations

Representatives from each of the projects involved in this webinar have offered a set of recommendations for DevOps practitioners to improve their state of practice and look forward to the future of DevOps within their organisational processes. The reader will find them in the following sections.

Much of the increasing complexity of ICT systems is being driven by the more distributed and heterogeneous nature of these systems, with Cyber Physical Systems accounting for an increasing portion of Software Ecosystems. This basic premise underpins the COSMOS proposal, which focuses on blending best practices in DevOps solutions with the development processes used in the CPS context. This will enable the CPS world to deliver software more rapidly and result in more secure and trustworthy systems.



COSMOS is a collaborative project aiming to enhance DevOps pipelines for Cyber Physical Systems (CPS) software. It brings together industry, SMEs, and academics to integrate advanced validation and verification techniques, such as static code analysis, automated test case generation, runtime verification, HiL testing, and field device feedback. The project will employ machine learning, model-based testing, and search-based test generation. Techniques to prioritise and schedule testing for improved efficacy and reduced security threats will also be developed.

COSMOS will leverage existing prototype technologies from its partners, refining them throughout the project. The effectiveness of CPS pipelines will be validated using five use cases in the healthcare, avionics, automotive, utility, and railway sectors. These use cases will serve as references when promoting the technology to the open-source and standardisation communities. The project aims to engage with the open-source community and leverage the standards expertise of the coordinator and partners to promote COSMOS technologies in regulated sectors requiring well-defined software V&V solutions.

URL: <https://www.cosmos-devops.org/>

1 Adopt the technologies developed in the COSMOS project and their benefits for specific domains.

Sebastiano recommends the following technologies developed in the COSMOS project:

1. **SURREALIST: Simulation-based Test Case Generation for UAVs in the Neighborhood of Real Flights Simulation-based testing** (<https://github.com/skhatiri/Surrealist>) represents a fundamental testing practice for Unmanned aerial vehicles (UAVs), but the testing scenarios considered in software-in-the-loop testing may not be representative of the actual scenarios experienced in the field. Here, we propose Surrealist (teSting Uavs in the neighboRhood of REAL fLIghtS), a novel search-based approach that analyses logs of real UAV flights and automatically generates simulation-based tests in the neighbourhood of such real flights, thereby improving the realism and representativeness of the simulation-based tests. This is done in two steps: first, Surrealist faithfully replicates the given UAV flight in the simulation environment, generating a simulation-based test that mirrors a pre-logged real-world behaviour. Then, it smoothly manipulates the replicated flight conditions to discover slightly modified flight scenarios that are challenging or trigger misbehaviors of the UAV under test in simulation. Surrealist internally uses Aerialist, A UAV test bench developed on top of PX4, to evaluate the UAV test cases in the simulation environment.

Related paper:

➔ *Sajad Khatiri, Sebastiano Panichella, Paolo Tonella: Simulation-based Test Case Generation for Unmanned Aerial Vehicles in the Neighborhood of Real Flights. International Conference on Software Testing, Verification and Validation.*

2. **SDC-Scissor** (<https://github.com/christianbirchler-org/sdc-scissor>) is a tool that lets you test self-driving cars more efficiently in simulation. It uses a machine-learning approach to select only relevant test scenarios so that the testing process is faster. Furthermore, the selected tests are diverse and try to challenge the car with corner cases. Furthermore, this repository contains also code for test multi-objective test case prioritisation with an evolutionary genetic search algorithm.

Related papers:

- ➔ Christian Birchler, Sajad Khatiri, Bill Bosshard, Alessio Gambi, Sebastiano Panichella: "Machine Learning-based Test Selection for Simulation-based Testing of Self-driving Cars Software". *Empirical Software Engineering*.
- ➔ Christian Birchler, Nicolas Ganz, Sajad Khatiri, Alessio Gambi, Sebastiano Panichella: Cost-effective Simulation-based Test Selection in Self-driving Cars Software. *Science of Computer Programming*.
- ➔ Christian Birchler, Sajad Khatiri, Pouria Derakhshanfar; Sebastiano Panichella, and Annibale Panichella: Single and Multi-objective Test Cases Prioritisation for Self-driving Cars in Virtual Environments. *ACM Transactions on Software Engineering and Methodology (TOSEM)*.
- ➔ Christian Birchler, Nicolas Ganz, Sajad Khatiri, Alessio Gambi and Sebastiano Panichella: Cost-effective Simulation-based Test Selection in Self-driving Cars Software with SDC-Scissor. *The 29th IEEE International Conference on Software Analysis, Evolution, and Reengineering*.

Smart data is Big Data transformed into actionable data for a variety of business outcomes. It's data that is well-defined and contains meaningful information. The processing of smart data is big business. The EU-funded DESTINI project will bring together two scientific groups from Tilburg University in the Netherlands and Sapienza Università di Roma in Italy to collaborate with the Cyprus University of Technology (CUT). The aim is to boost CUT's international standing in the research community. CUT will investigate a series of timely topics in the field of smart data processing systems and smart data-centric services and applications. The project expects a number of high-quality research results to be delivered.



URL: <https://destini2020.eu/>

2 Adopt the RADON methodology for cloud-native design, maintenance, and evolution in serverless and hybrid cloud environments.

Going serverless is by no means a simple endeavour. Indeed, it assumes the concerted involvement of many users, (automated) tools, and feedback loops. The RADON methodology offers a workflow-driven ALM designed explicitly for cloud-native design, maintenance, and evolution around serverless and hybrid cloud-native computing. We offer a high-level overview of the methodology, including its main workflows and tool support. First, we distilled the RADON methodology lifecycle model, corroborated by three industrial partners via 11 focus groups and semistructured interviews as part of our method engineering campaign. The preceding lifecycle model comprises an abstract representation for the high-level phases and six lower-level workflows, which describe how RADON users can exploit the RADON tools to design, develop, and operate RADON applications.

Related article:

➔ <https://ieeexplore.ieee.org/abstract/document/9763068>

3 Leverage the RADON framework to support DevOps teams in the development of serverless applications

According to interviews and final focus groups with the project stakeholders and teams, RADON provides valuable support to the DevOps team for developing serverless applications. Furthermore, we learned some lessons, which enable future research in the field. More studies are needed to understand serverless development. From a more qualitative perspective, RADON should enact content, root cause, and a strengths, weaknesses, opportunities, and threats analysis in a data-driven fashion to further elaborate on each challenge. RADON practitioners embarking on DevOps migration/adoption exercises should determine how every organisational and sociotechnical challenge is born and evolves and whether it is eventually reduced, solved, or even made worse.

Related article:

➔ <https://ieeexplore.ieee.org/document/9712241>

The role of software in infrastructure management has grown significantly in the last few years as software developers joined forces with infrastructure operators to shorten the development life cycle and provide continuous delivery (DevOps). Infrastructure as a Code (IaC) programmatically defines the infrastructure, application deployment, and management, enabling the automation of repeatable tasks, significantly saving time, and enabling the code to be reused or adapted whenever needed. The big challenge to be solved is trust—trust in automation, IaC, and the so-deployed infrastructure and automation.

PIACERE works on a framework solution and an integrated set of tools to help organisations develop and operate IaC through DevOps practices exactly the way they would with traditional code, with an additional focus on security (DevSecOps). This leads to increased productivity in operations, security, and the overall quality and reliability of deployed infrastructure.



URL: <https://piacere-project.eu/>

4 Gain a thorough understanding of the DevOps philosophy and the challenges associated with implementing it in infrastructure-as-code development

The first recommendation focuses on understanding the DevOps philosophy and challenges, when you apply this approach on the development of infrastructure as a code. If you would need such support, you can find some useful material in the following article.

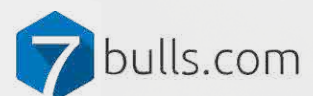
Related article:

➔ <https://ieeexplore.ieee.org/document/9915031>

5 Explore and try out tools that can enhance your infrastructure-as-code (IaC) development.

The second recommendation would be to try the tools that can make your IaC better. We invite you to check the PIACERE framework as a whole or only individual tools that can provide you a good overview of what users require and how we were able to tackle this in design and runtime. More of our material is available on the web page (<https://piacere-project.eu/>) and GitLab (<https://git.code.tecnalia.com/piacere/public/the-platform>). For those that are more interested in the security design tools for infrastructure as a code, I recommend you to try the IaC Scan Runner, which is an open-source solution for IaC inspection (<https://xlab-si.github.io/iac-scanner-docs/>).

7bull.com is an SME from Poland with more than 20 years of experience in the Polish and international IT market. The company has the status of a Research and Development Center in Poland and France. Their expertise revolves around automation and productivity in areas such as cloud, AI and robotics. 7bull.com is heavily involved in modern DevOps practices for the integration of complex systems. They participated and participate in H2020 and Horizon Europe projects related to AI, cloud, security and big data.



URL: <https://www.7bulls.com/en>

6 Reflect on how DevOps is currently implemented in your company or project and consider improvements based on understanding the human aspects of DevOps.

My main recommendation is to take a few minutes to think how DevOps in your company or general undertaking is realised currently and how it could be improved after learning of the human aspects of it. There are lots of tools out there that help companies on their DevOps journey but their effectiveness will be limited by the policies governing the relations built inside.

About the projects



[SWForum.eu](https://swforum.eu) is the European forum of the software research community, promoting best practices and technology transfer opportunities to cross-synergise European excellence.



[COSMOS](#) is designing and developing novel DevOps methodologies, techniques, and tools that will enable effective, continuous development and evolution of cyber-physical systems.



The [DESTINI H2020 Twinning Project](#) aims to promote research in the area of Smart Data by facilitating collaboration between internationally recognised scientific groups from the Netherlands, Italy, and Cyprus. The project's goal is to strengthen the research and scientific profile of the Cyprus University of Technology (CUT) by transferring knowledge, expertise, and best research practices from leading institutions. The focus is on enhancing CUT's research capacity in Smart Data Processing and Systems of Deep Insight through the investigation of significant and current topics in the field.



[VeriDevOps](#) aims to provide faster feedback and verification of security requirements in large-scale cyber-physical systems. It focuses on creating security models, generating tests, and developing intelligent security monitors. The goal is to enhance feedback mechanisms and deliver secure systems in a fast-paced DevOps environment.



[PIACERE](#) aims to increase the productivity of DevOps teams in the development and operation of IaC through the provisioning of an integrated DevSecOps framework. DevOps teams can program IaC as if they were programming any software application.

DevOps Innovation in Practice: New lifecycle processes, new applications

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