

Inside AdaCore

A woman with dark hair and glasses is shown in profile, looking towards the left. She is wearing a light-colored top. The background is a dark room with several computer monitors displaying code or data. The lighting is dim, with a strong blue and purple glow from the screens, creating a high-tech, focused atmosphere.

July–December 2020

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V21 Product Release

AdaCore's annual product release is taking place during Q1 2021; here are some highlights.

GNAT Pro Compiler

Compiler enhancements include an update of the back end (now incorporating GCC 9.4), support for 128-bit integers on 64-bit platforms, improved static resolution, and implementation of some of the new Ada 202x features.

GNAT Pro 21 supports the following new configurations:

- Bare Metal RISC-V 32-bits, hosted on Windows and Linux, for Ada and C
- Linux ARM 32-bits, hosted on Windows, for Ada, C and C++
- VxWorks 7 version 630+, on ARM, x86 and PowerPC, for C++ (in addition to Ada and C)
- Leon3v7, in bare Metal Leon3 products

For details please see https://www.adacore.com/gnat_21_release_notes.

GNAT Studio

The V21 release of GNAT Studio is focused on stability, performance enhancements, and improved source navigation, with additional features transitioned to the new engine in the Ada Language Server. (A summary of the upgrade to Microsoft's Language Server Protocol and the Ada Language Server appeared in the July–December 2019 issue of *Inside AdaCore*.) For details on the new GNAT Studio features, please see https://www.adacore.com/gnat_studio_21_release_notes.

CodePeer

CodePeer 21 includes a full reimplement of Level 0, based on Facebook's *Infer* technology. Among the improvements are significantly reduced analysis time, new diagnostics on array length and index checks, better precision from interprocedural analysis, and backtraces for messages resulting from a failed precondition. CodePeer 21 also adds improved support for pragma Annotate and file exclusion support for aggregate projects. For further details, please see https://www.adacore.com/codepeer_21_release_notes.

SPARK Pro

SPARK Pro 21 brings enhancements in several areas. Users will find extended language support, with the toolset now supporting *raise* expressions, forward *goto*, and several new Ada 202x features, while also performing data validity checks in new contexts and using ownership properties to detect potential memory leaks. SPARK Pro 21 has also enhanced its support for program specification and made improvements in tool usability and the overall user experience. For details, please see https://www.adacore.com/sparkpro_21_release_notes.

QGen

QGen 21 offers user experience improvements as well as additional functionality. Enhancements include support for parallel compilation and analysis, the detection and elimination of code coverage gaps, control over the handling of custom type headers, support for the trapezoidal integration method, improved handling of Unicode characters in models, and support for 3D data in ND Lookup blocks. For details on all of the new features, please download the text file at https://www.adacore.com/qgen_21_release_notes.pdf.

Product Videos

In conjunction with AdaCore's annual technology pre-release during Q4, which gives customers early access to upcoming products for evaluation purposes, a collection of product videos has been prepared and posted. These cover GNAT Pro, GNAT Studio, GNATcoverage, CodePeer and SPARK Pro, highlighting the enhancements and showing how to use the latest features. To view the videos, please visit <https://www.adacore.com/product-update-2020/> and, to learn more about any of these products, send an email to info@adacore.com. Customers can also inquire about further details via the standard ticket mechanism on GNATtracker or by contacting their dedicated account manager.

Ada 202x Support

The next revision of the Ada language, currently referred to as "Ada 202x", is nearing completion in accordance with international standardization procedures and is expected to be officially approved by ISO in late 2021 or early 2022. AdaCore has been actively participating in the evolution of the standard and, to help users who would like to gain early experience with the new language, the V21 release of GNAT Pro Ada is introducing initial Ada 202x support. Among the implemented features are the Jorvik tasking profile (an extension of the Ravenscar subset), improvements to the 'Image attribute, processor-specific atomic operations, "infinite precision" integer and real arithmetic, literals for user-defined types, support for importing variadic C functions, and improved expressiveness for contracts and expressions. For details on these features and AdaCore's roadmap for Ada 202x support, please see the blog post at <https://blog.adacore.com/ada-202x-support-in-gnat/>.

academic corner

GNAT Academic Program (GAP) Update

Ada and SPARK in courses

In May 2020 AdaCore surveyed its GAP membership and confirmed that more than one hundred academic institutions, in thirty-five countries, are actively teaching Ada and/or SPARK in their curricula. The courses go well beyond language syntax; they provide a solid background in software engineering principles and their realization in Ada and SPARK, preparing students for productive professional careers in the software industry. Sample course topics include:

- Real-time embedded systems programming,
- Software development for safe and secure systems,
- Concurrent programming and distributed systems,
- The Ravenscar profile and its runtime for embedded targets, and
- High Integrity Systems: porting system-level C code to Ada and SPARK.

New GAP representatives

In response to growing international interest, AdaCore is expanding its GAP support team. Native-speaking representatives are now available to facilitate communications with member institutions in the United States, the United Kingdom, France, Spain, and Central Europe (Germany, Austria, Switzerland, and The Netherlands).

For more information about the GAP program and its benefits, please contact gap-contact@adacore.com.

Support for Wind River Helix

In November 2020, AdaCore's GNAT Pro toolchains for Ada, C and C++ added support for the Wind River Helix Virtualization Platform, giving users a consistent development environment for consolidating applications at different criticality levels within a single multi-partition platform. Each GNAT Pro toolchain supports Wind River VxWorks 7, Wind River Linux, and Bare Metal processors. Through this bundling, users can choose the best option based on their applications' requirements while simplifying development efforts through common tools and a consistent user interface. As an example, developers of Ada and C applications with safety certification requirements such as DO-178C compliance can choose to use either a stripped-down, minimal environment with a Bare Metal partition, or a Wind River VxWorks Cert Edition partition with POSIX, ARINC 653 and real-time operating system (RTOS) capabilities. If a software component does not require safety certification, the developer can take full advantage of the general-purpose features of Ada, C and C++ on Wind River VxWorks 7 and Wind River Linux. For more information, please visit <https://www.adacore.com/press/windriver-helix-virtualization-platform/> or watch the webinar at <https://tinyurl.com/helix-webinar>.

AdaCore in Space — LASP and the CLARREO Pathfinder

The Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado Boulder has selected AdaCore's GNAT Pro Ada development environment targeted to a Bare Metal ARM Cortex M1 for a NASA-directed project: the *Climate Absolute Radiance and Refractivity Observatory* (CLARREO) Pathfinder mission. The primary goals for this mission are to perform high-accuracy measurements of solar energy that is reflected back from Earth, and to serve as an on-orbit inter-calibration reference to other orbiting sensors. CLARREO Pathfinder is part of an overall effort to improve scientific understanding of how the Earth's climate is evolving and is scheduled to be hosted on the International Space Station (ISS) in late 2022.

Space missions present unique system design challenges, with the harsh electromagnetic environment requiring radiation-hardened equipment as well as onboard software that can respond to and recover from any hardware malfunction. On the hardware side, LASP has selected an ARM Cortex M1 on a radiation-hardened FPGA as the control unit to interact with the sensor arrays. The software application is a high-frequency real-time control system that takes sensor readings and communicates with the ISS. This critical software requires high reliability, design simplicity, source code readability and maintainability, time and space efficiency, and tooling to aid developers in writing robust code.

To meet the software challenges, LASP has selected the Ada programming language and AdaCore's GNAT Pro Bare-Metal development environment for safety-critical, real-time systems, targeted to the ARM Cortex M series processor architecture. Language features such as strong typing, checks to prevent unwanted overlap in record fields, and automated endianness conversions have proved particularly helpful in meeting reliability requirements while also reducing development and verification effort. GNAT Pro's tailorable run-time libraries, coupled with Ada's simple Ravenscar concurrency model, have avoided design complexity and given the LASP engineers greater control over system behavior.

For an in-depth case study of the CLARREO Pathfinder project, please visit <https://tinyurl.com/CLARREO-case-study>.

AdaCore and the FACE™ Approach

During this past year, AdaCore continued its active involvement in the Future Airborne Capabilities Environment (FACE) effort, a standards-based technical and business approach to reducing development and deployment costs for airborne defense systems through component reuse. Among the highlights:

- In June 2020 Dr. Benjamin Brosgol, a member of AdaCore's senior technical staff, was elected Vice-Chair of the FACE Consortium's Technical Working Group;
- On July 29 Dr. Brosgol gave an *Aviation Week* Tech Talk podcast, explaining how the Ada language and AdaCore's products can help FACE software developers meet requirements for reliability, safety, and security (see <https://tinyurl.com/FACE-podcast-2020>);
- AdaCore was the Premier Sponsor of The Open Group FACE and SOSA Consortia Technical Interchange Meeting on September 21, and AdaCore CEO Dr. Franco Gasperoni delivered the Welcome Address. In a follow-up Q&A, Dr. Gasperoni examined how AdaCore views the role of the FACE standards in its business and more generally in the software industry. Please see <https://www.adacore.com/Franco-FACE-QandA.pdf>;
- On December 10, AdaCore participated in an Open Systems Media webinar, *Accelerating Avionics Design & Testing Through FACE Conformance: An Integrated Model by Boeing, US Army & Aerospace Leaders*. The webinar featured a demo of Boeing's AvionX Flight Deck system, in which Boeing used AdaCore's GNAT Pro Ada toolsuite to develop the Geospatial Embedded Mapping Software (GEMS).

AdaCore is a Principal Member of the FACE Consortium, and company representatives actively participate in both the Technical and Business Working Groups. With its emphasis on component reuse and source code level portability, the FACE approach fits in well with both the Ada language and AdaCore's mission of helping people "build software that matters." The company is committed to supporting the FACE effort, both by contributing to the evolution of the FACE standards and by supplying products that can help developers produce FACE conformant software. Certifiable run-time libraries that have been part of airborne systems at DO-178C Level A, and static analysis tools to assist verification and enforce the FACE Technical Standard's safety and security capability set restrictions, are helping FACE software developers meet requirements of reliability, safety and security.

For further information about AdaCore and its role in the FACE community, please see <https://www.adacore.com/industries/defense/face/>.

Fifth Annual Make with Ada Programming Competition

AdaCore's fifth annual *Make with Ada* contest launched on July 31, 2020, and runs through January 31, 2021, offering over \$9000 (US) in total prizes. Geared to both experienced and new Ada and/or SPARK users, the competition has as its objective the design and implementation of an innovative embedded software project using Ada and/or SPARK as the primary language. Entrants must demonstrate that their system meets all requirements and uses sound software engineering practices. Submissions from previous years have included an IoT adjustable bed, an electrocardiogram detection device, a high integrity sumobot, a Swiss Army smart watch, an automated plant sprinkler and many others. For more information, please visit <https://www.hackster.io/contests/adacore3/>.

GNATcoverage Extends Source-Based Instrumentation for Ada

GNATcoverage 21, AdaCore's code coverage analysis and reporting tool, supports source-based instrumentation for Ada on all GNAT Pro platforms, native and cross, giving users additional flexibility in implementing a code coverage strategy for dynamic analysis.

GNATcoverage computes its results from *trace files* that show which program constructs have been exercised by a given test campaign; the granularity of the analysis is based on the coverage criterion chosen by the user. The tool works with two kinds of traces, based on an instrumentation option that is also chosen by the user:

- *Binary traces*, produced by an instrumented execution environment running the object code from an unmodified version of the program. Such traces contain low-level information about executed blocks of machine instructions, with instrumentation through an emulator or a hardware probe. GNATcoverage uses debugger information to map the trace data to source program constructs.
- *Source traces*, produced by executing an alternative version of the program, built from source code instrumented to populate coverage-related data structures.

To perform coverage tests on the source code, the user can choose to generate either binary or source traces. Both support analysis with respect to any of the criteria defined in DO-178C: statement coverage, decision coverage, or Modified Condition / Decision Coverage (MC/DC).

For object code coverage, binary traces can be used. GNATcoverage can compute two kinds of coverage data for the machine-level instructions that the compiler generated from the original source code:

- *Instruction Coverage*, where each machine instruction is marked as either executed (at least once) or unexecuted; and
- *Branch Coverage*, where each executed conditional branch instruction is marked to be in one of three states: only executed with the branch taken, only executed with fall-through, or executed with both behaviors.

With GNATcoverage providing two options for traces—non-instrumented sources (binary traces) and instrumented sources (source traces)—the user can select which one best meets their needs.

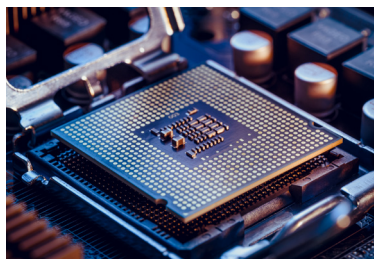
For the non-instrumented source approach, a major benefit is the opportunity to use the same executable for both coverage analysis and final delivery; this can simplify certification under a standard such as DO-178C. Additionally, the developer can obtain both source and object code coverage information and, by using a target emulator on the host platform, can perform coverage analysis without needing the target hardware. However, the instrumented execution environment approach is not feasible on embedded targets lacking an emulator or an ability to obtain hardware trace data. Additionally, the trace files can be large and, on native platforms, there is a performance penalty in execution speed and an inability to analyze shared libraries.

Source-based instrumentation overcomes these issues. Since this option is available on all platforms, GNATcoverage is now a practical verification tool for any Ada project. Additional benefits include significant speedup (especially on native platforms), compact-size source trace files independent of execution duration, and support for shared libraries. The main issue with source-based instrumentation is the additional effort needed in a certification context, since the coverage tests would have to be performed twice, once with source instrumentation and once without.

Earlier versions of GNATcoverage only worked with binary traces. Based on customer requirements, AdaCore introduced an initial implementation of source traces in GNATcoverage 20, and has now extended these capabilities in V21. With its provision of both kinds of traces, and its support for source-based instrumentation on all platforms, GNATcoverage 21 offers users complementary, flexible and comprehensive approaches to coverage analysis and reporting. Although the use of the two kinds of traces cannot be combined within the same GNAT Studio project, workflow differences between the two approaches have been minimized in order to facilitate transitions from one to the other. GNATcoverage 21 handles all versions of the Ada standard; support for C is on the roadmap for 2022. Also on the roadmap, AdaCore will be merging GNATcoverage into a new, full-scale toolsuite that will include GNATtest and other dynamic analysis support.

A video/demo showing the new GNATcoverage capabilities is available at <https://www.adacore.com/product-update-2020/gnatcoverage-update/>; for additional information on GNATcoverage please see <https://www.adacore.com/gnatcoverage/> or contact info@adacore.com.

Ada for the Embedded C Developer



AdaCore has added a new interactive course, *Ada for the Embedded C Developer*, to its education website <https://learn.adacore.com>. With an emphasis on producing reliable, safe and secure code, the course teaches the essentials of embedded systems programming in Ada through a comparison with the C

language. Specific lessons are devoted to topics such as concurrency and real-time, enhancing verification with SPARK and Ada, and C-to-Ada translation patterns. To view the course or download the content as a pdf file, please visit https://learn.adacore.com/courses/Ada_For_The_Embedded_C_Developer/.

HIS 2020 Virtual Conference

The seventh annual High Integrity Software (HIS) conference took place as a webinar on November 17, 2020, chaired by Emma Adby from AdaCore. Subtitled *Continuing innovation in the face of global challenge*, the virtual conference opened with keynote presentations from Simon Creak (Rolls-Royce) on *Modernising control systems development in the aviation industry*, Matt Jones (Wind River) on *Digital transformations and disruptors in the future connected autonomous world*, and Walid Negm (Altran) on *How to emerge stronger and more resilient from the COVID-19 crisis*. The event also featured a panel session in which the speakers discussed the lessons learned and how the challenges they highlighted are likely to resolve.

HIS has historically been conducted as a live conference held in Bristol, UK. Although Covid-19 ruled out an in-person event in 2020, the webinar proved to be hugely popular and attracted more than four hundred registrants. The webinar sessions are available for on-demand access at <https://www.his-conference.co.uk/>.

AdaCore acquiring Componolit GmbH

In response to the rapid growth in the German market for high-assurance software, and to help enhance its cybersecurity offer, AdaCore will be acquiring the German company Componolit on February 1, 2021. Headquartered in Dresden under the direction of Alexander Senier, Componolit has expertise in cybersecurity, SPARK/Ada, and formal methods. Its flagship product, RecordFlux, is an advanced technology for formally specifying, testing, and implementing binary communication protocols and as such will bring new capabilities to AdaCore's suite of automated testing and static analysis tools.

QGen wins 2020 Technology Innovators Award for Aerospace and Defense achievement

AdaCore's QGen Model-Based Development Toolsuite received a Platinum Honoree award from *Military & Aerospace Electronics* magazine, in recognition of the product's "superb innovation, characterized by a groundbreaking approach to meeting a need, and/or a new level of performance, efficiency, ease-of-use, or other beneficial quality." QGen's qualifiable code generator for a safe subset of MathWorks Simulink® and Stateflow® models generates tailorable MISRA-C or SPARK/Ada source code, without human intervention. Formal qualification for the QGen code generator at Tool Qualification Level 1 (TQL-1) is scheduled for completion in late 2021 or early 2022. TQL-1 is the highest level defined in the *Tool Qualification Considerations* standard (DO-330) accompanying DO-178C and is the analog of a development tool in DO-178B. For further information about QGen please visit <https://www.adacore.com/qgen/>.

Airbus Helicopters selects GNAT Pro Ada for unmanned aerial system

Airbus Helicopters (France) has selected GNAT Pro Ada, targeted to Wind River's VxWorks 6.x Cert RTOS on PowerPC, to develop new software components for the VSR700 tactical unmanned aerial system (UAS) prototype project. The choice was based on several factors, including the ability to increase the maintainability and quality of the software, ease of integration into the existing development infrastructure, the capacity to help certify the software up to DO-178C Design Assurance Level B, and the quality of AdaCore's support. For further information please visit <https://www.adacore.com/press/airbus-selects-gnatpro-for-vs700-prototype/>.

AdaCore article in "Top 10" stories of the year in *Military Embedded Systems*

The technical journal *Military Embedded Systems* has named *DO-178C meets the FACE Technical Standard: High assurance and reusability for airborne software*, an article written by Ben Brosgol, as one of the Top 10 military electronics stories of 2020. The article shows how developers of FACE conformant software can meet requirements for high assurance by following the guidance from the DO-178C standard for airborne software, even if they do not undertake the formal certification process specified by DO-178C. The page with the list is <https://tinyurl.com/MES-top-10-2020> and the article, published in March 2020, is <https://tinyurl.com/FACE-and-DO-178C>.

Consafe Logistics chooses GNAT Pro for warehouse control system

Consafe Logistics, a Sweden-based supplier of warehouse management solutions, has selected GNAT Pro Ada to implement mission-critical firmware within its innovative Warehouse Control Systems. The selection of GNAT Pro Ada enables Consafe Logistics to meet stringent assurance requirements, helping ensure that its systems operate reliably, safely and securely at its customers' large and complex warehouse sites. Ada's strong typing and other compile-time checks catch errors even before the code is run, and the language's run-time checks will detect errors such as buffer overrun during testing, thereby helping to keep the fielded system free from vulnerabilities. Maintenance and change control is easier, allowing Consafe Logistics to manage with a small Ada development team even though its solution consists of millions of lines of code and handles very complex automation equipment and warehouses. For further information, please visit <https://www.adacore.com/press/consafe-gnat-pro-warehouse-control-system-firmware/>.

QinetiQ selects AdaCore's Mentorship service for technology modernization

The security and defense company QinetiQ in the UK has selected AdaCore's Mentorship program—a custom service in which an AdaCore expert works directly with the customer to help them adopt a new technology—in upgrading to the latest version of the SPARK Pro toolset. QinetiQ is making use of the Mentorship service in modernizing the development environment for their Trials Control System (TCS), a command and control system that handles training and military equipment test and evaluation. The upgrade of the SPARK technology was central to sustaining the safety-critical software development capability required by TCS, allowing QinetiQ to leverage their existing critical software platform investment and avoid software tool obsolescence. For further information, please visit <https://www.adacore.com/press/qinetiq-selects-mentorship-service-spark/>.

JTEKT selects SPARK Pro for safety-critical automotive software

JTEKT, an international automotive electric power steering system manufacturing company headquartered in Japan, has adopted AdaCore's SPARK Pro toolsuite and the GNAT Pro Common Code Generator (CCG) to aid in the development of safety-critical power steering system software. This software is classified as Automotive Safety Integrity Level (ASIL) D—the most stringent classification of initial hazard (injury risk) defined within the ISO 26262 standard. Taking advantage of AdaCore's Mentorship Program to help bring them up to speed quickly with the SPARK technology, JTEKT demonstrated how to leverage the SPARK Ada language subset and formal methods to facilitate unit testing and verification of the system's C code to ensure that it was correct. JTEKT believes that AdaCore's tools will enable them to save money on testing of safety-critical software and will eventually help them to mass-produce safe, secure code. For further information please visit <https://www.adacore.com/press/jtekt-spark-pro-automotive/>.

New AdaCore Blogs

AdaCore's blog site offers an informative and personal perspective on Ada and related technologies, from both AdaCore staff and external contributors. Blog topics from the second half of 2020 include *Make with Ada 2020* project summaries; data initialization in SPARK; source code instrumentation in GNATcoverage; the FACE™ open systems strategy; using Ada for the BBC micro:bit; code of conduct for AdaCore-maintained community spaces; code obfuscation for Ada using Libadalang and SPARK; the Alire package manager for Ada/SPARK; and finding vulnerabilities using advanced fuzz testing and AFLplusplus v3.0. For these and other blogs, please visit <https://blog.adacore.com/>.

calendar highlights / July–December 2020

AdaCore participated in a number of meetings and conferences, all of which were conducted as virtual events rather than live because of COVID-19.

RISC-V Global Forum 2020 September 3, 2020

AdaCore was a sponsor and provided a virtual booth, including a corporate video and a slack chat room.

<https://events.linuxfoundation.org/riscv-global-forum/>

The Open Group FACE™ AND SOSA™ Consortia Technical Interchange Meeting September 21, 2020

AdaCore was the Premier Sponsor, and CEO Franco Gasperoni delivered the Welcome Address.

<https://meet.opengroup.org/event/virtual-event>

RTI ConnexCon 2020 October 28–29, 2020

AdaCore had a virtual booth at this partner event hosted by RTI.

<https://www.rti.com/company/events/virtual-connex-con>

RISC-V Day November 5–6, 2020

AdaCore was a Silver Sponsor for this virtual event and partnered with IT Access Co. (Japan) for a presentation on AdaCore's Ada and C technologies for RISC-V.

<https://riscv-association.jp/en/riscv-day-tokyo-2020-en/>

ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE 2020)

November 6–16, 2020

Ben Brosgol from AdaCore delivered a presentation “How to Succeed in the Software Business While Giving Away the Source Code”, based on his article in the November–December 2019 issue of *IEEE Software*.

<https://2020.esec-fse.org/>

ACM SIGAda High-Integrity Language Technology (HILT) 2020 Workshop on Safe Languages and Technologies for Structured and Efficient Parallel and Distributed/Cloud Computing November 16–17, 2020

Tucker Taft from AdaCore was one of the workshop organizers and the moderator of a panel session on Language Support for Parallel and Distributed Computing.

<https://tinyurl.com/HILT-2020>

High Integrity Software (HIS) November 17, 2020

AdaCore co-hosted this virtual event with Altran. Emma Adby, Managing Director of AdaCore Ltd, chaired the program.

<https://www.his-conference.co.uk/>

Military Embedded Systems Webcast: How to Enable the Intelligent Edge for Critical Avionics Software December 1, 2020

In this webinar, subject matter experts from Wind River and AdaCore demonstrated how to map an existing architecture to guest operating systems on hypervisors, by using Wind River's Helix Virtualization Platforms and software development tools from AdaCore.

<https://tinyurl.com/MES-webinar-2020-12-01>

RISC-V Summit December 8–10, 2020

AdaCore was a sponsor and had a virtual booth at this event.

<https://tinyurl.com/risc-v-summit>

Military Embedded Systems Webcast: Accelerating Avionics Design & Testing through FACE Conformance December 10, 2020

In this webinar, Boeing, in partnership with the US Army, AdaCore, CoreAVI, Presagis and Real-Time Innovations (RTI), demonstrated an integrated FACE Commercial-off-the-Shelf (COTS) solution stack covering cockpit displays, graphics systems and data transport connectivity.

<https://tinyurl.com/MES-webcast-2020-12-10>

contact us!

Please contact us at info@adacore.com with questions/comments or to get further information about any of the items in this newsletter.

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