An explanation of the relation between Juliet & Romeo® and standard PLC programming in IEC 61131

This article explains how the IEC 61131 PLC environments and Juliet & Romeo® relate to each other, outlining their similarities, differences, and how to decide which to use for specific tasks. When comparing Juliet & Romeo® and the IEC 61131 PLC environments, the question isn't which one replaces the other; it's how they complement each other.

At a Glance: IEC 61131 vs Juliet & Romeo

- **IEC 61131** is a mature, stable international standard for programmable logic controllers (PLCs). It works well for traditional industrial automation, discrete logic, safety, etc.
  In particular, IEC 61131-3 defines multiple programming languages: graphical (Ladder Diagram (LD), Function Block Diagram (FBD)), textual (Structured Text (ST)), Sequential Function Chart (SFC), etc. With CODESYS as the leading manufacturer-independent IEC 61131-3 Software Suite, users and developers have access to well established tools for development of periodically executed application programs.

- **Juliet & Romeo** is designed specifically for modern automation and motion programming, also for flexible muti system applications. For this, real-time guarantees and safe, deterministic behaviors are a must. At the same time, to be able to write all sorts of components (sensor data processing, communication protocols, coordinated motion programs, process logic, AI, etc.), it comes with modern software concepts, an expressive language (Juliet) and libraries for code modeling and meta programming. This together with event driven execution, simplifies implementation and maintenance of more complex applications.
  Juliet & Romeo has functionality to emulate a PLC runtime, with libraries allowing quick implementation of periodically executed tasks. But it can just as well run in parallel to CODESYS and integrate through libraries that allow Juliet programs to exchange data with the CODESYS runtime.

Using an IEC 61131 language is an excellent choice for sequential logic and simple periodic tasks. Applications implemented in one of the IEC 61131 languages, can easily be extended

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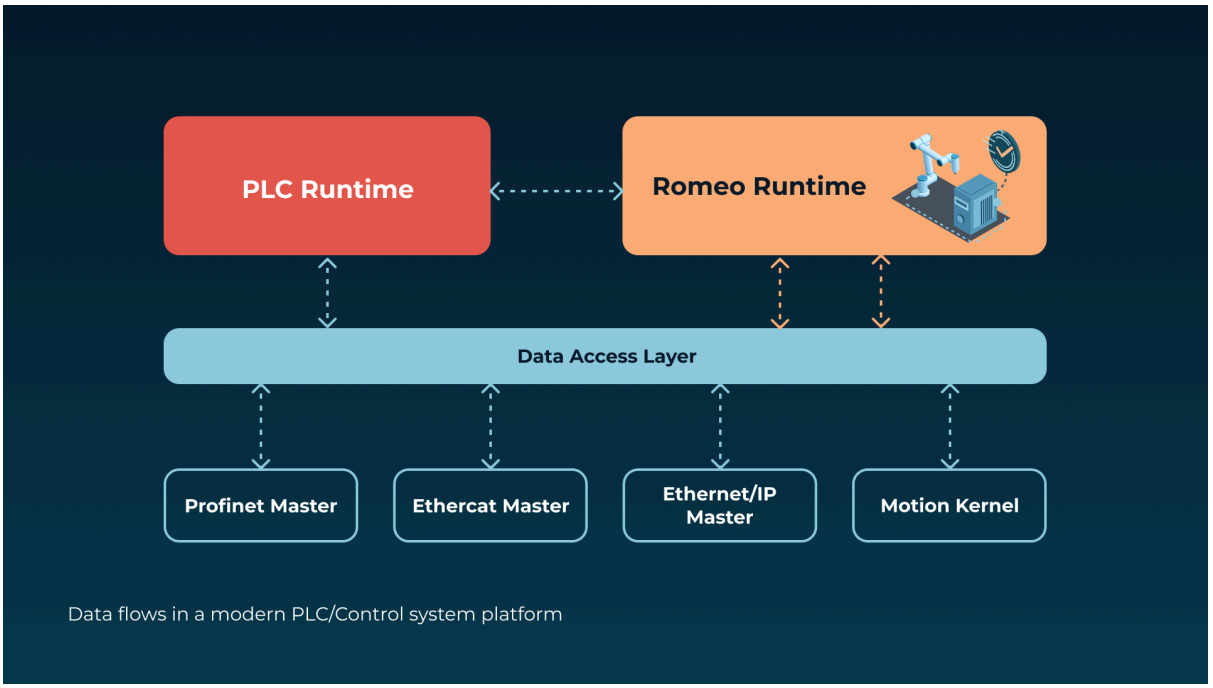
with new functionality or logic written in Juliet. This protects previous investments without compromising adaptability. Applications written in Juliet are mostly easier to maintain and keep track of due to the unified language that even higher-level code modeling and advanced algorithms can be efficiently expressed in. All while keeping low latency for instant reactiveness. With Juliet & Romeo, adaptations do not need to be costly headaches.



Data flows in a modern PLC/Control system platform

Brief introduction to Juliet & Romeo and IEC 61131

Juliet & Romeo

- Juliet is an expressive robotics & automation programming language: real-time, multitasking, with robustness features and automatic memory management.
- Romeo is a real-time virtual machine/runtime that executes Juliet (and any bytecode conforming to its format), designed for deterministic behavior, low latency, responsive to events, sensor feedback, etc.
- The goal of Juliet & Romeo is to unify motion control, process logic, sensor handling, AI, UI, etc. in one expressive language/runtime stack; to reduce development overhead, improve consistency, help scale automation systems and make them easier to evolve.

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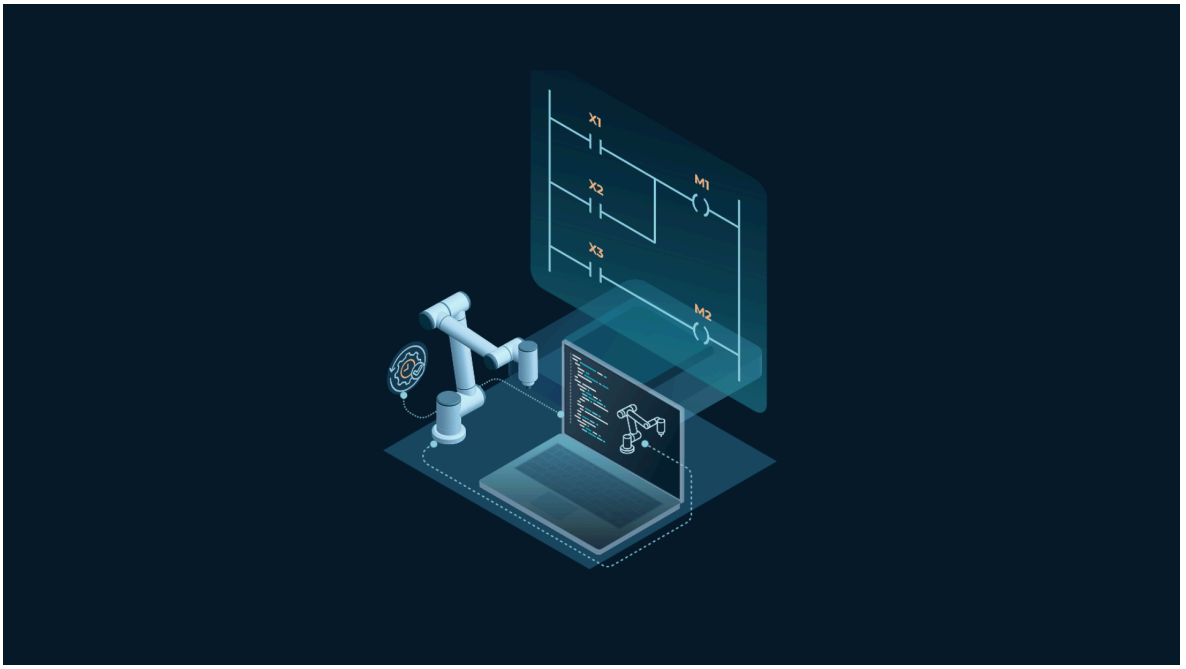
IEC 61131

- An international standard for programmable logic controllers (PLCs). In particular, IEC 61131-3 defines programming languages and software architecture for PLCs.
- Specifies multiple programming languages: graphical (Ladder Diagram (LD), Function Block Diagram (FBD)), textual (Structured Text (ST)), Sequential Function Chart (SFC), etc. The 2025 edition has updates.
- Also covers concepts such as program organization units (POUs), safety, communications, and requirements for hardware, among others.

Compatibility between Juliet & Romeo and IEC 61131

From the description above, it should be easy to understand that there is no competition between the two technologies. IEC 61131 is a standard, and Juliet & Romeo are a real-time development platform. Most IEC 61131 functionality is or can be supported in Juliet, but Juliet & Romeo also offers great integration possibilities with CODESYS runtime, making Co-existence the obvious choice to extend previous investments with new functionality. For new robotics-heavy automation projects, Juliet & Romeo offer richer functionality; for traditional PLC tasks, IEC 61131 remains very strong.



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Detailed Feature-by-Feature Comparison

Here are the key dimensions along which they differ, overlap, or complement each other:

Dimension	IEC 61131-3 / IEC 61131	Juliet & Romeo	Comments & Gaps
Language Types & Expressiveness	Good for expressing discrete logic, state machines, and standard process control. More limited in expressively combining complex motion, AI, sensor fusion in one coherent program.	Juliet is a high-level language that aims to unify motion, logic, sensors, UI, AI in one expressive syntax. Includes support for event-driven programming, multitasking, execution safety, and modularity.	IEC 61131 tends to be more rigid and domain-specific (PLC control, process logic). Juliet gives more freedom and modern software language features.
Real-Time / Determinism	IEC 61131 is designed for industrial control, which often has real-time constraints. But the standard itself does not always guarantee hard real-time behavior; that depends a lot on the PLC implementation, hardware, execution cycle (“scan” cycle), etc. It tends to be scan-based.	Romeo is built for deterministic real-time execution, low latency, event driven responses to application events, with guarantees around motion and safe execution. Low latency is always given but hard real time guarantees are dependent on support from the target operation system and correct integration as provided via automation platforms.	Juliet/Romeo likely exceed what IEC 61131 typical PLCs do in strict real-time behavior, especially in motion control and event driven responsiveness.

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Dimension	IEC 61131-3 / IEC 61131	Juliet & Romeo	Comments & Gaps
Task / Motion Control, Robotics	Traditionally, IEC 61131 is strong in process automation, discrete control, and safety logic. Some PLCs support motion control, but often via specific motion modules and vendor-specific extensions. Robotics and high-speed motion blending is typically missing.	Juliet & Romeo explicitly target robotics, motion control, sensor handling, dynamic behaviors. Robotics is a core domain. Including intuitive coordination and programming of multiple motion units.	For applications involving complex robotics/motion, Juliet has more built-in capability or less reliance on external vendor-specific motion modules. IEC 61131 might need additional hardware or vendor-specific extensions.
Modularity, Abstraction, Reuse	IEC 61131-3 defines POUs (Program Organization Units: programs, function blocks, functions), modularization of code, reuse of function blocks etc.	Juliet supports modules / libraries, abstracts logic, supports reuse, version control, modern software engineering practices. Deterministic behaviour and automatic memory management assures consistent module behaviours in various integration contexts.	IEC 61131 is more established, but some of its tooling is older or vendor-locked. Juliet provides more modern tooling (e.g. better support for version control, continuous integration, test frameworks etc.).

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Dimension	IEC 61131-3 / IEC 61131	Juliet & Romeo	Comments & Gaps
Safety, Reliability, Memory / Resource Management	Safety is an important part of the standard (functional safety, etc.), hardware requirements, some determinism. But memory management, dynamic constructs, and modern safety features depend on the vendor. IEC 61131 languages often don't include automatic safe memory management or garbage collection as part of standard.	Juliet & Romeo include automatic memory management, safety, deterministic execution, responsiveness to events etc. Designed to minimize unsafe behavior, handle dynamic tasks etc.	Juliet & Romeo give stronger guarantees "built in," whereas IEC-61131 compliance depends on implementation and hardware.
Tooling, Ecosystem, Maturity	Very mature. Tons of vendor support, many PLCs worldwide, many engineers trained in IEC 61131 languages, existing libraries, safety certified modules. The standard is widely adopted.	Juliet & Romeo are newer; market launch (2025) in selected partner platforms. Ecosystem growing. Some demo integrations (Bosch Rexroth, KEBA, etc.).	If needing existing mature libraries, broad certified support, IEC 61131 has the advantage. Juliet & Romeo may catch up and offer modern features.

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Dimension	IEC 61131-3 / IEC 61131	Juliet & Romeo	Comments & Gaps
Graphical vs Textual	IEC 61131 gives both: graphical (LD, FBD, SFC) and textual (ST). Good for users who prefer rail-logic or function block diagrams or visual representation.	Juliet is described more as a textual, expressive programming language (influenced by Julia ideas) plus support for libraries and modern dev tools. Juliet supports graphical programming through graphical code modeling, like Finite State Machines and Behaviour Trees. The actual code is however always Juliet and text based.	Depending on the user base, graphical tools are an advantage IEC 61131 has in traditional PLC / OT environments. Juliet may appeal more to software developers.
Interoperability & Vendor Independence	IEC 61131 aims for standardization across PLC vendors; programs in standard languages can be ported (with caveats) between compliant controllers; reduced vendor lock-in. However, vendor specific extensions, performance, module availability vary so in reality this is not complete.	Juliet & Romeo aim to be vendor agnostic; support integrating legacy + new, modular updates, broader developer pool; likely less vendor-lock in (depending on adoption and how the runtime is offered) – supporting platforms such as ctrlX etc.	Juliet may have more flexibility, but for migration from IEC 61131 environments, one will have to consider how to interoperate or port.

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Dimension	IEC 61131-3 / IEC 61131	Juliet & Romeo	Comments & Gaps
Ease of Learning / Adoption	Because IEC 61131 is well established, many engineers and technicians are familiar with its graphical languages; many PLC tool chains are designed for ease of adoption in industrial settings.	Juliet is newer; learning curve for a new language, real-time VM, possibly different development practices. But reports say “enable software developers to contribute, broaden recruitment” meaning ease of adoption is part of design. Graphical programming can be supported via Juliet libraries.	IEC 61131 may still be easier for plant engineers familiar with PLCs. Juliet has strong benefits for developers with a software engineering background. Juliet brings gains in maintainability and flexibility.

Strengths & Trade-Offs

Here are some of the trade-offs if you are considering using one or the other:

IEC 61131 Strengths:

- Proven, widely adopted in industry. Good support, lots of hardware, many PLCs, safety certifications, large base of trained engineers.
- Graphical languages often make logic easier to visualise for discrete control, simple sequence control, on/off logic, etc.
- Standardization helps portability, maintainability in traditional PLC-only environments.

But its limitations include:

- Less built-in support for high-speed motion control, robotics, AI, sensor fusion, asynchronous / event-driven behavior (though vendor extensions sometimes exist).
- The programming languages (especially graphical ones) can be less expressive for complex tasks, less modern tooling (version control, code reuse, software

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engineering practices) in some vendor ecosystems.

- Real-time guarantees depend strongly on hardware, scan cycle times; less guarantee of deterministic execution in some cases.

- Interoperability between different implementations of the standard is suffering which doesn't allow simple porting of code, like merely a recompile and hampers reusability.

Juliet & Romeo Strengths:

- Designed for modern automation: expressive language, support for motion, sensors, AI, real-time, library modularity, modern dev tools.

- Provides a runtime with deterministic behavior, automatic memory management, execution safety, event-driven tasks, etc.

- Aimed at bridging legacy and new systems, integrating robotics and automation tasks more flexibly.

Trade-offs/things to watch out for:

- **Ecosystem Maturity:** Being a younger platform, there are fewer readily available off-the-shelf libraries, mature tools, or widespread vendor support in certain domains compared to the decades-old IEC 61131 standard.

- **Certification and Trust:** User adoption, vendor support, and system certification in critical safety domains may lag behind the widely-trusted and certified IEC standards, posing an early adoption risk in highly regulated industries.

- **Steeper Learning Curve:** Engineers familiar with traditional IEC 61131 languages (like Ladder Diagram) and established PLC toolchains will face a learning curve when adapting to Juliet's expressive, high-level language and modern software development practices.

- **Higher Resource Requirements:** The advanced runtime (Romeo VM) requires more capable hardware (CPU, memory) compared to simple PLCs in constrained environments. This is necessary to deliver the deterministic execution and modern software features that Juliet & Romeo provide.

Use-Case Comparison: Where Each Shines

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Scenario	IEC 61131 likely enough / preferable	Juliet & Romeo likely superior
Discrete process control, simple sequencing, safety logic, basic I/O, where users are PLC programmers	IEC 61131 fits well; minimal overhead; many vendors, tools, support.	Could still be used, but maybe overkill; unless motion, AI, sensor fusion, or more dynamic behavior is required.
Motion-heavy robotics, combining high-speed trajectories, sensor input, asynchronous events, AI, needing modular updates, close integration between robot + automation + UI	IEC 61131 may need vendor extensions or external components; hard to build a fully integrated system. Costly to maintain and modify solutions.	Juliet & Romeo are built for this kind of scenario.
Environments where safety certification, hardware determinism are required, and regulatory compliance is critical, and where risk must be minimized	IEC 61131's maturity, certification history may make compliance easier.	Juliet & Romeo may need to prove compliance/certification in domain; risk for early adopters.
Existing PLC-based plants, with many legacy systems, and staff experienced in ladder logic, function blocks etc	IEC 61131 offers continuity; lower retraining, lower migration risk.	Using Juliet & Romeo may require more retraining, migration effort; but potential long-term gains in flexibility.

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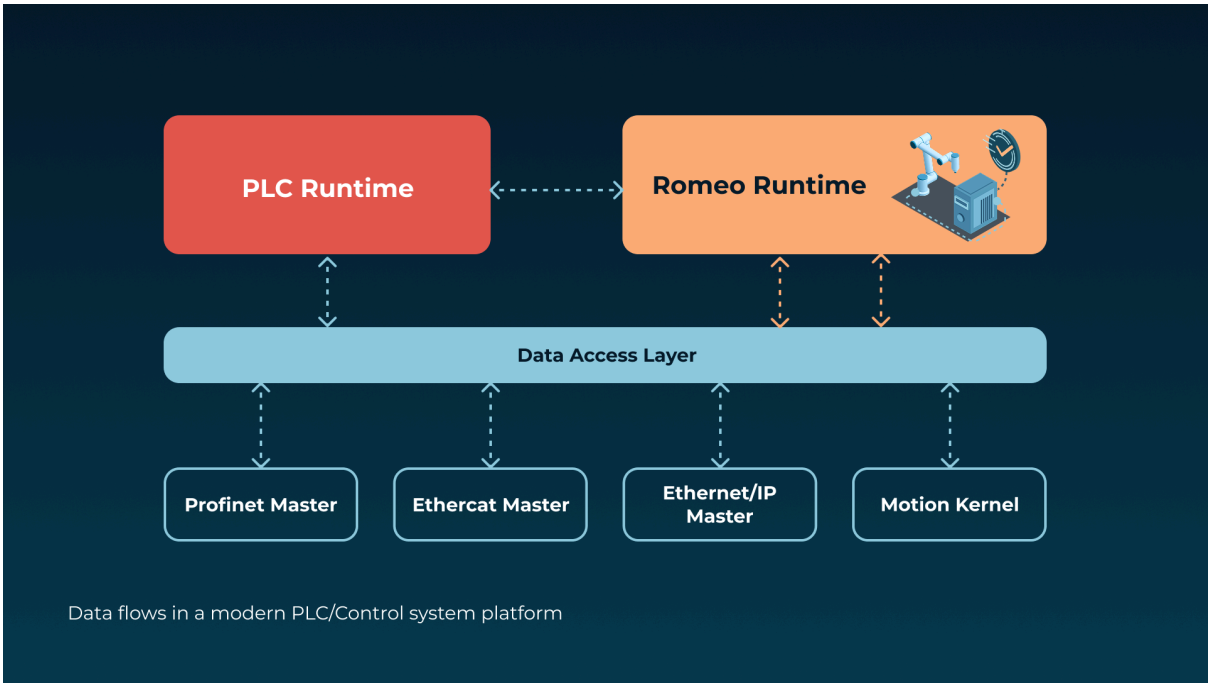
Summary

- IEC 61131 is a mature, stable standard that works well for traditional industrial automation, discrete logic, safety, etc.
- Juliet & Romeo bring a more modern, unified, expressive, and real-time capable programming and runtime environment. Especially strong for robotics, sensor fusion, AI, motion, and systems that need to evolve.
- For new robotics-heavy automation projects, Juliet & Romeo offer richer functionality; for traditional PLC tasks, IEC 61131 remains very strong.



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