TRINITY Q

Whitepaper

TRINITYQ Platform

Clearing, finance, inventory management,
blockchain and AI on one platform

TRINITYQ GmbH · Science Park Kiel
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01 Introduction

TRINITYQ develops quantum-safe software for financial and business processes, digital assets and AI-assisted development. The applications are built on a single software platform and broken down into small software building blocks that can be combined flexibly.

Technologically, the software is based throughout on Kotlin and Kotlin Multiplatform, with post-quantum cryptography as its security foundation. This whitepaper outlines the product lines and presents QUANTUM CLEARING, a central building block of the platform, in detail.

Alongside our own products we develop software on behalf of our customers: bespoke developments and complete software products.

Software Asset Base

The software building blocks form an application platform from which product lines are derived. Development largely follows the product line engineering model developed by the SEI at Carnegie Mellon University.

Assembly instead of new development:

Customer applications are created largely by using finished components directly, by configuring, adapting and extending existing services, and only to a lesser extent by developing new services.

Tailor-made in a short project:

This makes tailor-made applications affordable and quick to deliver. The final product is best understood as a bespoke suit, produced flexibly from the platform's software assets in a short project.

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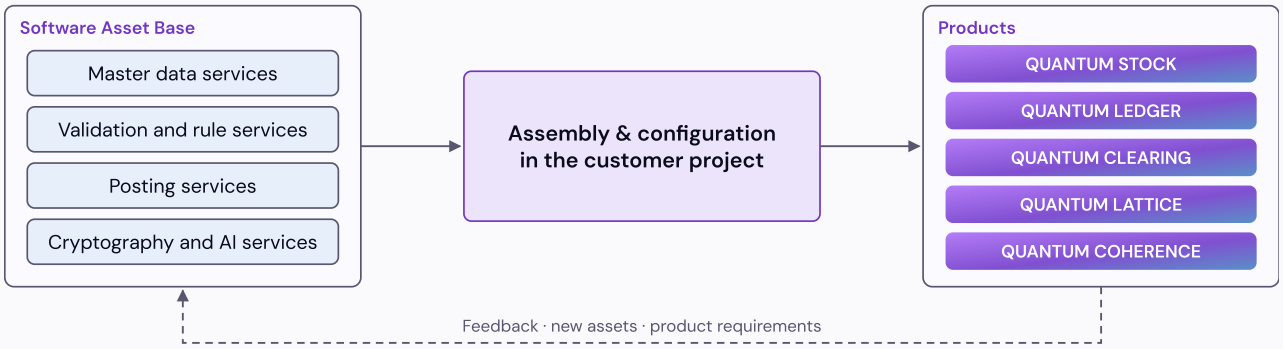
From asset base to product

Services are assembled and configured in the customer project. Feedback and new requirements flow back into the platform as new assets.



One name, one rule

All products carry QUANTUM in their name. The second part says what the product does and is sufficient as a short name in everyday use.

Product lines:

- QUANTUM STOCK: inventory and materials management
- QUANTUM LEDGER: invoicing, finance and accounting
- QUANTUM CLEARING: central clearing
- QUANTUM LATTICE: quantum-safe multi-chain wallet
- QUANTUM COHERENCE: development system for AI

Platform services:

- QUANTUM MESH: the platform's mesh network
- QUANTUM BRAIN: AI core with self-hosted models
- QUANTUM COHERENCE OS: hardened operating system

Short names: STOCK, LEDGER, CLEARING, LATTICE, COHERENCE, MESH and BRAIN.

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02 Custom Development

We deliver both bespoke developments tailored to the specific requirements of our customers and complete software products for payroll accounting on behalf of our customers.

The products are used predominantly in Windows environments, on workstations as well as in client/server configurations or on web servers.

Concepts and prototypes

Together with our customers we develop innovative concepts for implementing their requirements.

Staying in dialogue:

By providing prototypes early, we remain in dialogue with our customers throughout the implementation phase and come as close as possible to what they have in mind.

Reducing risk:

At the same time we reduce risk, because problem areas are identified earlier.

Experience and components

We are familiar with current technologies, have many years of experience in numerous areas of software development and pass this know-how on to our customers.

Object-oriented software engineering:

Through consistently object-oriented software engineering, the high reusability of the components we develop allows even complex applications to be designed quickly and cost-effectively.

Proven components:

We draw on a broad range of proven, stable components, some developed by us and some sourced from third-party vendors. This gives our customers high added value for the functionality and user interfaces of their products.

If you would like to be one of our satisfied customers, get in touch with us today.

info@trinityq.de

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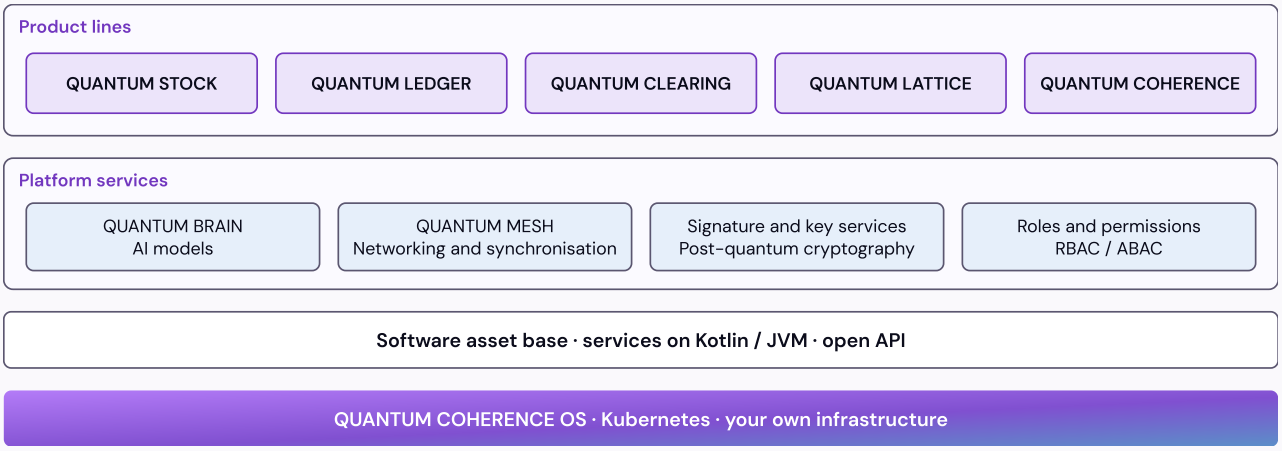
03 Product Lines

The platform at a glance

All product lines use the same platform services and the same software asset base.



QUANTUM STOCK

QUANTUM STOCK is the platform's inventory management system and connects materials management with a company's finance side. It carries a materials management system with many years of use into a new technical generation.

Functional areas:

- Item and supplier master data
- Warehouse and stock management
- Purchasing and goods receipt
- Consumption and withdrawal postings
- Stocktaking
- Reports and dashboards
- Tenant and site management
- Hand-over to finance and accounting systems

Multi-tenant and industry-neutral:

STOCK is designed as a multi-tenant cloud platform, is not tied to one industry and can also be operated in regulated environments. Tenants are separated down to the level of the database row. Information security according to ISO/IEC 27001 and the requirements of NIS2 are guiding principles of development.

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QUANTUM LEDGER

QUANTUM LEDGER bundles everything a company needs for invoicing, finance and accounting: from the single document to the balance sheet.

From document to balance sheet:

- Quotes, invoices and credit notes
- Document capture and archive
- Contacts: customers and suppliers
- Open items and payments
- Bookkeeping and account assignment
- Closings up to the balance sheet
- Dashboards and reports

AI-assisted document recognition:

Incoming documents are read by the company's own self-hosted AI models. Invoice number, company, address and amounts are available as structured data. LEDGER is the natural counterpart to CLEARING: validated documents and journal entries are taken over without any media break.

QUANTUM LATTICE

QUANTUM LATTICE is a multi-chain wallet for digital assets whose keys and signatures are designed for post-quantum algorithms.

Post-quantum algorithms:

Classical signature schemes are considered vulnerable to powerful quantum computers. LATTICE therefore relies on the lattice-based algorithms standardised by NIST:

- ML-DSA (FIPS 204) for digital signatures
- ML-KEM (FIPS 203) for key exchange

Further features:

- Multi-chain management in one application
- One codebase for mobile and desktop
- Support for hardware keys
- Swapping assets across chains
- Automatic rebalancing
- AI assistant with graduated autonomy levels: from information only to approved execution

QUANTUM COHERENCE

QUANTUM COHERENCE is a development system for AI applications and a development environment for distributed collaboration.

Distributed collaboration:

Teams work together on software across sites, regardless of where the individual machines are located. Collaboration runs over MESH, the platform's network, and entirely on the team's own infrastructure.

AI development:

AI models are an integral part of the development process. COHERENCE is used to develop and operate AI applications and is also the tool with which the services of the TRINITYQ platform themselves are built.

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QUANTUM MESH

QUANTUM MESH is the platform's mesh network and connects sites, servers and work-stations directly with one another, without a central relay.

Part of the application:

Networking is part of the applications themselves. No additional VPN software or external services are required.

- Direct, encrypted connections between nodes
- Automatic discovery of peers
- Quantum-safe key exchange (ML-KEM)

Synchronisation:

Data is reconciled between sites. Work continues when a connection is interrupted and is synchronised once it is restored.

MESH is the shared transport layer of the platform: for COHERENCE, for distributed installations and for connecting submitters to CLEARING.

QUANTUM BRAIN

QUANTUM BRAIN is the AI core of the platform and provides self-hosted AI models to all applications.

Your own models:

- Operation of multiple models on your own hardware
- Pooling of several GPU servers into one cluster
- Data stays within your own infrastructure

With BRAIN, AI remains part of your own infrastructure rather than an external service to which documents and source code have to be entrusted.

One interface:

The product lines access BRAIN through a uniform interface, for example for document recognition, for assistant functions or for development with COHERENCE.

Further building blocks

The platform also includes its own operating system, its own cryptocurrency in design, and operations services.

QUANTUM COHERENCE OS:

A hardened Linux operating system for desktop and server on which COHERENCE, BRAIN and the other applications run preconfigured.

TRINITYQ COIN (TRQ):

The design of a quantum-resistant proof-of-work cryptocurrency with hybrid post-quantum signatures.

DevOps services:

Building and operating infrastructure, with a focus on the financial sector.

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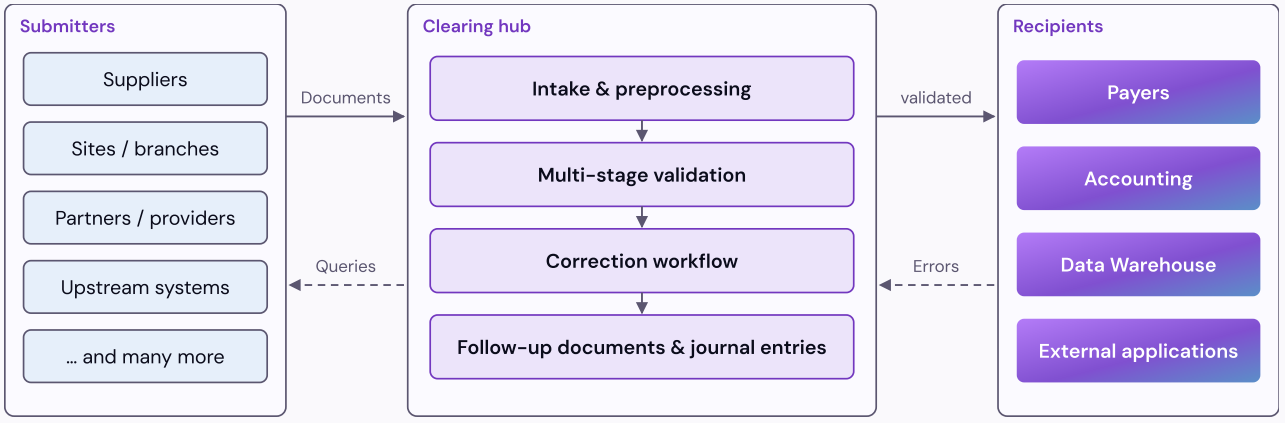
04 QUANTUM CLEARING

Where a very large number of submitters deliver documents to one central point, the quality of clearing determines cost, speed and trust.

A large number of submitters send billing-relevant data to a central hub. The hub checks, creates or validates and corrects the documents and forwards them to a payer, an accounting department or another receiving party.

Scenario

Validation runs through several stages, from syntactic to semantic. Rejected documents are fed back into a correction workflow.



Mass data under control

CLEARING is optimised for the mass processing of data from very many submitters to one central hub and is industry-neutral by design. Billing of medical services is not part of the TRINITYQ platform.

Fine-grained validation:

Codes, services and contract parameters are differentiated in great detail in the master data. This ensures that even the most complex validation routines can be implemented across several stages. The data structures are optimised for mass data processing.

Correction in dialogue:

Rejected documents enter a correction workflow that is handled in interaction with the submitters concerned. This interaction follows the idea of a “customer success service” and is based on help desk and adviser desk functions.

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Master data

Managing a large number of submitters requires extensive master data. The list shows an excerpt of what is managed as standard. Master data is extended in the project as required.

Managed as standard:

- Document types
- Authorisation status
- Bank details
- Submitters and submitter groups
- Recipients and payers
- Error codes
- Deadlines
- Business partners
- Terms and price lists
- Charts of accounts
- Account assignment rules
- Cost centres and cost objects
- Country codes
- Service and item catalogues
- Tenants
- Units of measure
- Groups of persons
- Postal codes
- Validation rules and stages
- Sites
- Tax rates
- Contract types
- Contract data
- Currencies
- Payment terms
- Surcharges and discounts
- And more

Core functions

The following functions form the standard scope of CLEARING. Some of them are very complex components that can be extended further in the project.

Standard scope:

- Work list management
- Auditing
- Reports
- Automated workflows
- Backup
- Document data management
- Difference analysis after import
- Real-time plausibility checks
- Generation of journal entries
- Versioning and history
- Internal work distribution / document review
- AI-assisted document recognition
- Corrections after error messages
- Online provision of documents
- Validation routines in several stages
- Data protection through logging
- Data protection through encryption
- Pseudonymisation during processing
- Quantum-safe signing of documents
- Invoice corrections
- Invoice management
- Invoice blocks
- Guided invoice runs
- Interfaces to accounting systems
- Status management
- Cancellation of invoices
- And more

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Data protection and evidence

Particular attention is paid to data protection and to the long-term evidential value of the documents processed.

Pseudonymisation:

During processing, personal data transmitted by the submitters can be concealed from staff to such an extent that identification is not possible.

Quantum-safe signature:

Documents and validation logs are signed using post-quantum algorithms. The origin and integrity of a document therefore remain verifiable even when today's signature schemes are no longer considered secure.

Roles and permissions

TRINITYQ implements a role-based access control (RBAC) model on all platforms. Access rights are assigned to roles, and roles are assigned to users and user groups.

Sign-in methods:

- Microsoft Active Directory
- LDAP
- Linux PAM
- Integrated authentication server

An access rule consists of a triple (object, user, role) or (object, group, role).

Inheritance rules:

- Individual user rights override group rights.
- The rights of the group to which a user is assigned apply.
- Directly assigned rights override rights inherited from higher levels.

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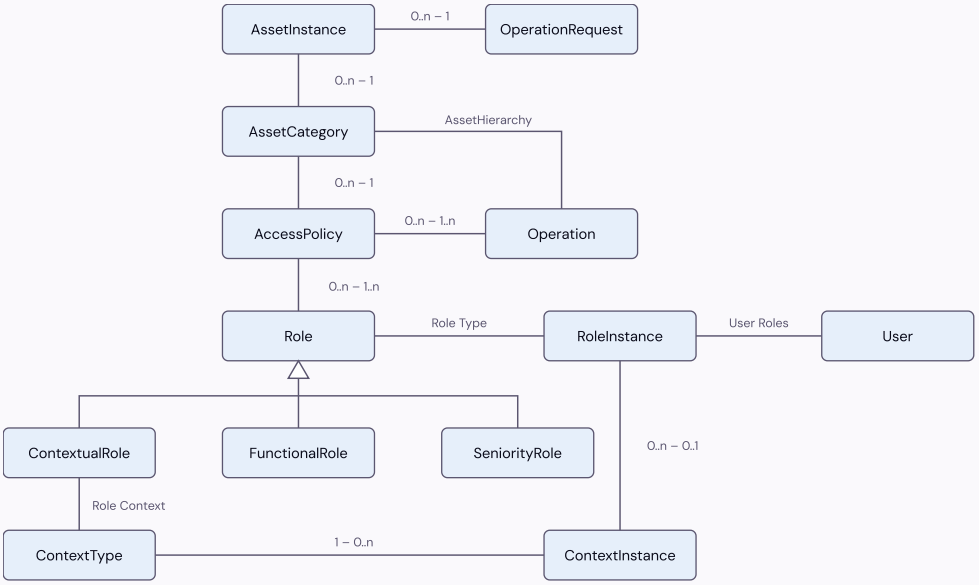
Role model

The figure shows the conceptual structure of the system.



From RBAC to ABAC:

The standard model is being extended to an attribute-based access control model (ABAC). It enables dynamic access control and greatly streamlines the administration of rights.

Protected objects:

- Virtual machines and containers
- Data stores and their resources
- Operations on data objects
- Applications and their resources

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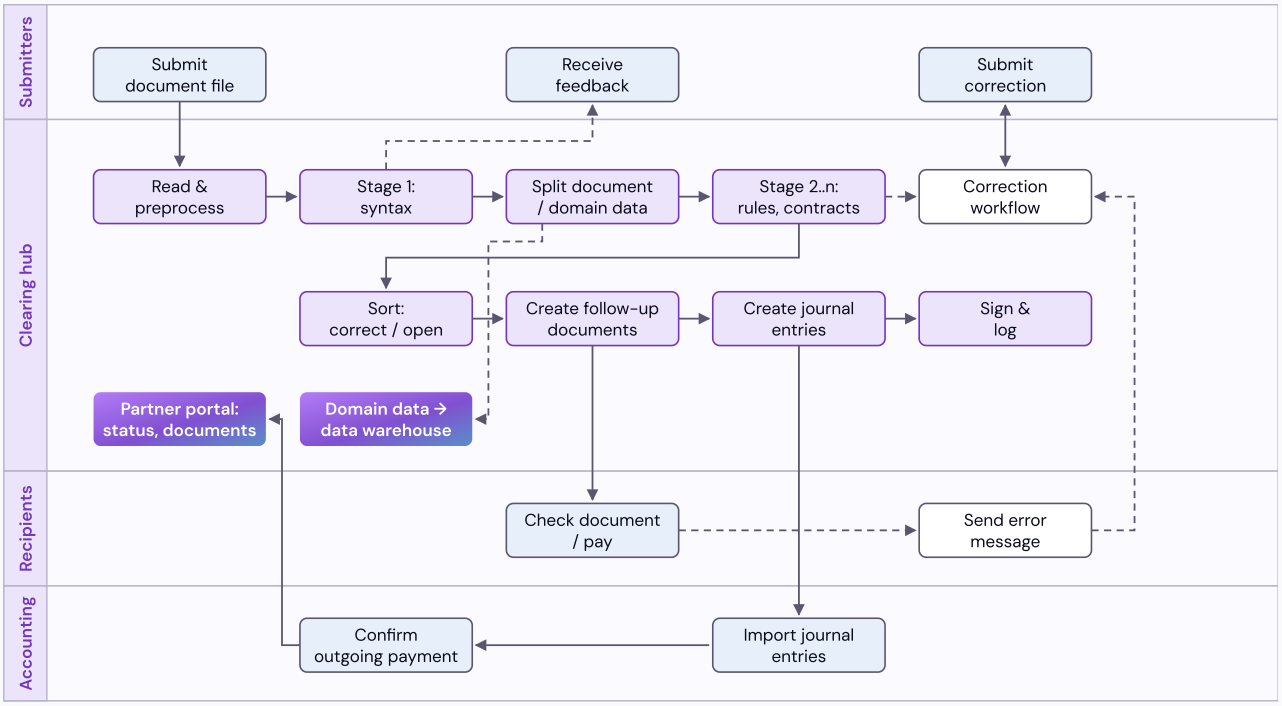
Processes

CLEARING is not a fixed product but allows processes to be configured flexibly. The figure shows the typical flow from receipt of a document file to confirmation of the outgoing payment.



The flow in eleven steps

Processes carried out with the standard components of CLEARING generally follow this pattern.

01 Very many submitters transmit data.

02 The data is preprocessed and checked syntactically.

03 The submitters receive feedback with individually defined information.

04 Correct submissions are split into document data and domain data.

05 The clearing-relevant data enters the clearing workflow.

06 Further validation stages take legal and contractual parameters into account.

07 The results are sorted into correct documents, documents needing rework and documents to be rejected.

08 Follow-up documents such as payment orders and credit notes are created for correct documents.

09 Journal entries are generated according to defined account assignment rules and passed to LEDGER or another system.

10 Documents and validation results are signed and logged.

11 The domain data goes to a data warehouse or to an external application.

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Interplay of the product lines

CLEARING does not stand alone but works together with the other product lines. The result is a continuous chain from goods receipt to balance sheet.

STOCK and LEDGER:

Purchase orders and goods receipts from STOCK provide the basis for checking incoming invoices. Validated documents and journal entries are handed over to LEDGER.

LATTICE, MESH and BRAIN:

The signature and key services that also underlie LATTICE secure documents and logs. Distributed submitters and sites are connected via MESH, and document recognition uses the models provided by BRAIN.

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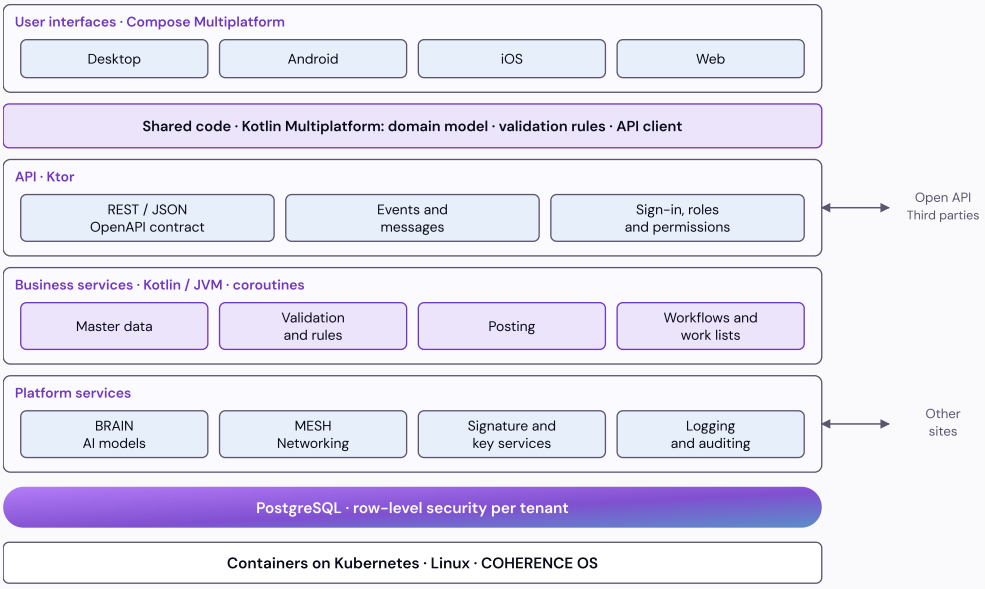
05 Architecture

The TRINITYQ platform is developed in Kotlin throughout: server, business logic and user interfaces speak the same language.

Business services run on the JVM, the user interfaces are built with Compose Multiplatform, and both sides share the same business code through Kotlin Multiplatform.

Technology base

The applications are organised in clearly separated layers and follow a clean architec-ture with a clearly directed data flow from the user interface down to data storage.



One language, one rule set:

The architecture protects your investment: one language, one data model and one set of rules for all devices.

Shared services:

Tenant separation is enforced in the database itself. AI, networking and cryptography are available to all services as shared platform services.

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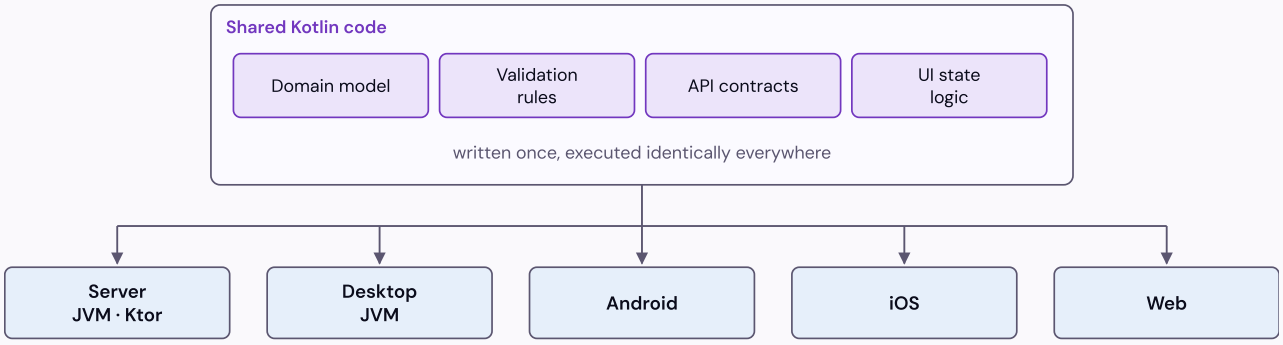
Kotlin Multiplatform

Business logic is written once in Kotlin and runs unchanged on the server, on the desktop, on mobile devices and in the browser.



Write once, validate everywhere

Data model, validation rules and API contracts live in shared code. Platform-specific code is added only where a device really behaves differently, such as access to a hardware key.

What this means for CLEARING:

The same validation rule that decides on a document on the server already checks the input for plausibility in the submitter's user interface.

Benefits:

- One data model instead of separate models per device
- Identical validation rules on client and server
- Type-safe interfaces from server to user interface
- New functions are available on all devices at the same time

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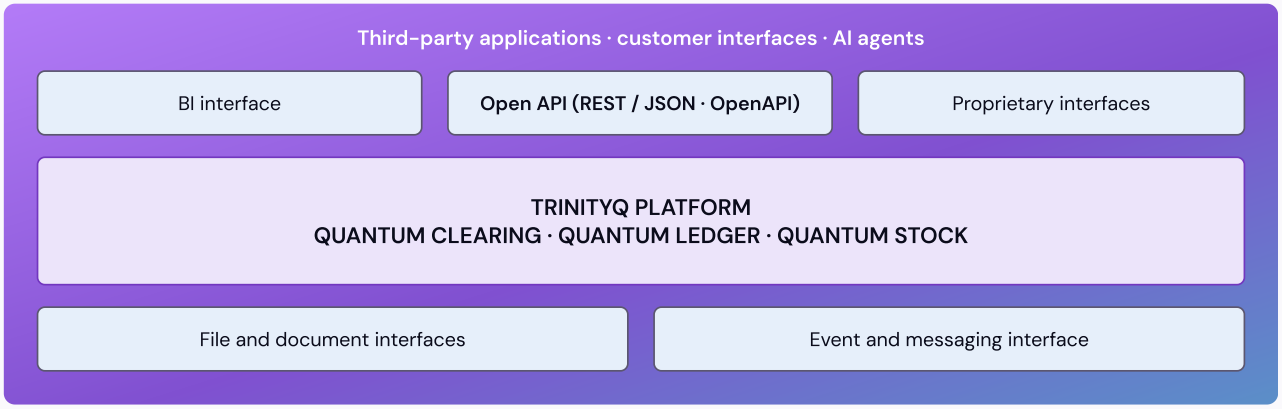
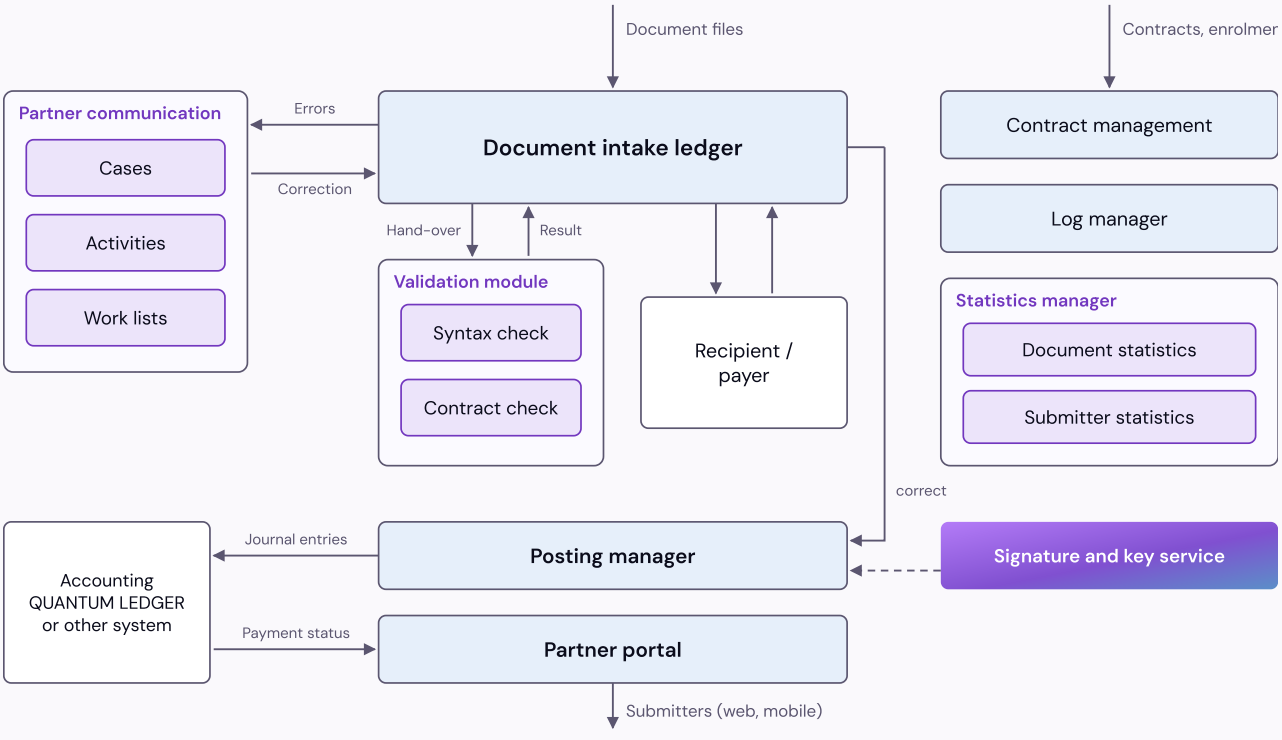
Open API

An open API for the most important functions and data access, provided with Ktor and described by an OpenAPI contract. TRINITYQ's own user interfaces use the same interfaces as third-party applications.



Specification in the project

To assemble the software services into application modules, an easily understandable application map is created together with the customer. The figure shows an excerpt from the map of a clearing system.



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From prototype to product

TRINITYQ maintains ready-made process models and application maps that can be adapted. Prototypes are then developed that move seamlessly into the production application.

Prototypes:

Prototyping is coordinated closely with the customer in sessions held at short intervals. In an incremental and agile process the customer continuously influences the final product. Thick requirements specifications are not needed.

Assembling existing services:

In this process, mostly existing services are assembled and shown in use. Individual extensions are relatively easy to add and fit the system exactly to the customer's requirements.

User interfaces

The user interfaces of TRINITYQ products are built with Compose Multiplatform from a shared codebase.

One application, all devices:

The same application is available on the desktop, on Android and iOS and in the browser, with the responsiveness familiar from desktop applications.

Shared design system:

The applications are platform-independent and multilingual. A shared design system ensures a consistent look across all product lines.

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06 Private Cloud Installations

TRINITYQ applications run as containers and can be installed entirely on your own infrastructure.

Central clearing houses or data processing service providers can thus build a private cloud infrastructure for CLEARING and the other product lines behind their firewall.

Your own infrastructure

- Operation on Kubernetes, in your own data centre or with a European hosting provider
- Based on open source and Linux throughout
- Distributed, fault-tolerant storage
- Self-hosted AI models via BRAIN
- Distributed sites connected via MESH
- GDPR-compliant architecture

QUANTUM COHERENCE OS

COHERENCE OS provides a hardened, preconfigured operating system.

It sets up cluster operation, storage and the TRINITYQ applications through a single graphical installer.

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07 Fields of Application

The TRINITYQ platform is built for organisations in which many parties deliver to one central hub, for example:

Central clearing houses:

Checking, correcting and forwarding large volumes of documents from many submitters.

Purchasing and buying groups:

Central handling of invoices between suppliers and members.

Shared service centres:

Bundled document and accounting processes for several companies.

Branch and franchise organisations:

Uniform inventory management and settlement across many sites.

08 Conclusion

The TRINITYQ platform brings inventory management, accounting, clearing, digital assets and AI development together on one technical foundation: one language, one data model, one set of rules.

Post-quantum cryptography, self-hosted AI models and operation on your own infrastructure make it a solution for organisations that want to keep their data and processes in their own hands for the long term.

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09 Appendix

This whitepaper provides an overview of the TRINITYQ platform and its technologies. For further information, please visit our website or get in touch with us.

Technology overview:

Language	Kotlin, from server to user interface
Shared code	Kotlin Multiplatform
User interfaces	Compose Multiplatform for desktop, Android, iOS and web
Server and API	Ktor, REST / JSON with OpenAPI contract
Data storage	PostgreSQL with row-level security per tenant
Cryptography	ML-DSA (FIPS 204) and ML-KEM (FIPS 203)
AI	QUANTUM BRAIN with self-hosted models
Networking	QUANTUM MESH, the integrated mesh network
Operation	Containers on Kubernetes, Linux, QUANTUM COHERENCE OS

Contact:

TRINITYQ GmbH
Bahnhofstraße 5
96199 Zapfendorf
Germany

TRINITYQ GmbH
Science Park Kiel
Alexander Behm House,
2nd floor
Neufeldtstraße 6
24118 Kiel, Germany

Local court of Bamberg:
HRB 8091
VAT ID: DE299395414

info@trinityq.de
www.trinityq.de

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TRINITYQ GmbH
Bahnhofstraße 5
96199 Zapfendorf
Germany

TRINITYQ GmbH
Science Park Kiel
Alexander Behm House, 2nd floor
Neufeldtstraße 6
24118 Kiel
Germany

Local court of Bamberg: HRB 8091 · VAT ID: DE299395414
info@trinityq.de · www.trinityq.de