2pi Software

API as a Service (APIaaS) in the AWS Marketplace

Quantum Random Number Generator project for the Australian National University

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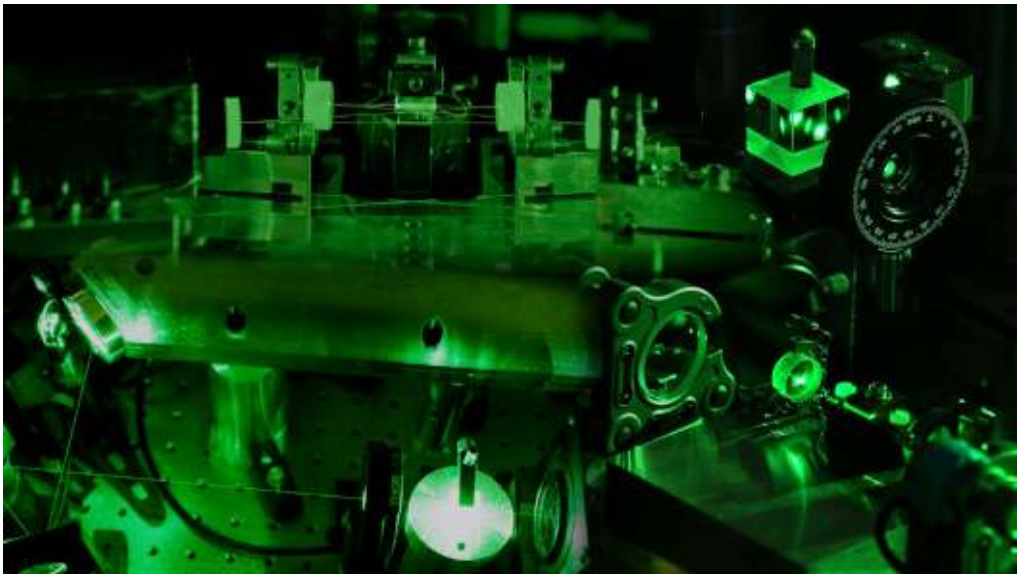
Quantum Random Number Generator project for the Australian National University

In 2021 the Australian National University (ANU) launched ANU Quantum Numbers (AQN), the world's fastest on demand quantum random number generator on AWS marketplace. By harnessing the quantum nature of lasers, high speed and truly random numbers are generated in real time creating a powerful tool for research students, academics, and IT specialists that need random numbers in their experiments.

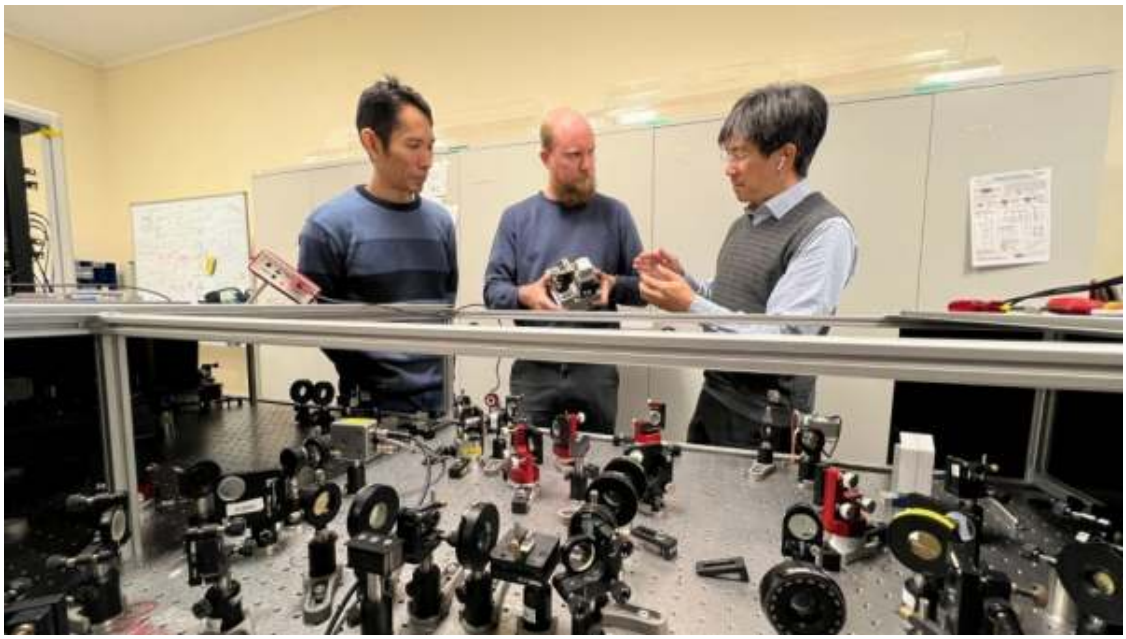
The service took a major maturation step in 2022 when a cloud-enabled version of the site, on the AWS platform, was brought to life by 2pi Software capitalising on the extensive serverless capabilities, and other scalability and security enablement features of AWS, in addition to offering it as purchasable service in the AWS marketplace.



THE OUTCOME

2pi Software successfully created a secure, scalable architecture in AWS that allowed for user authentication, user subscriptions and API key generators to turn an idea conceived in the ANU labs into a viable, scalable, robust and billable product available to anyone in the world. At its heart, the solution facilitated an interface to broker data between the quantum laboratory, physically located at the ANU in Canberra to consumers of the service connected to the AWS Marketplace.

The solution establishes a pathway for conventional User Interfaces and low-level code request architectures to interface, across the cloud, to quantum computing devices.



ANU REQUIREMENTS

ANU required a secure, scalable system to connect to their isolated quantum laboratory and serve unique feeds to authorised users. The system would require the following components:

- Broker data transfer from isolated quantum laboratory systems
- Distribute a data feed with high volume & availability
- Implement and enforce user access policies
- User authentication
- User subscription model

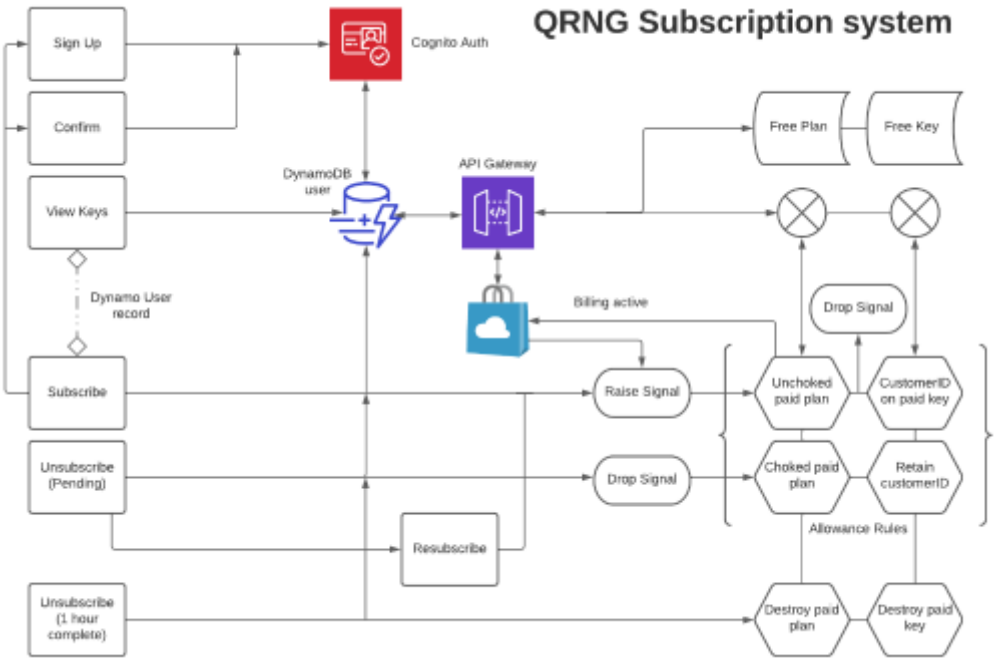
- Policy based service point exposure (API)
- Service point compute
- A cached data feed
- Guaranteed uniqueness of numbers consumed by purchasing parties

2PI SOFTWARE'S SOLUTION

The teams started by mapping out the various components required for the system. After reviewing the initial proof of concept code base provided by the ANU labs, additional layers for improved security and stability were added to the project scope.

The proposed system architecture that was developed, after a number of iterations within the 2pi Software team, was accepted by the ANU team. The proposed solution included the following elements:

- Signup form hosted from a static S3 bucket
- Lambda functions for security model and service point access
- 'Backend logic' to coordinate authenticated users with AWS Marketplace subscriptions and adherence to a tiered pricing model
- Scripting all of the interactive processes into CDK for on-the-fly deployment to significantly cut ongoing AWS costs



CAPTION - Fig. Schematic view of the workflows and data transit path of the QRNG solution

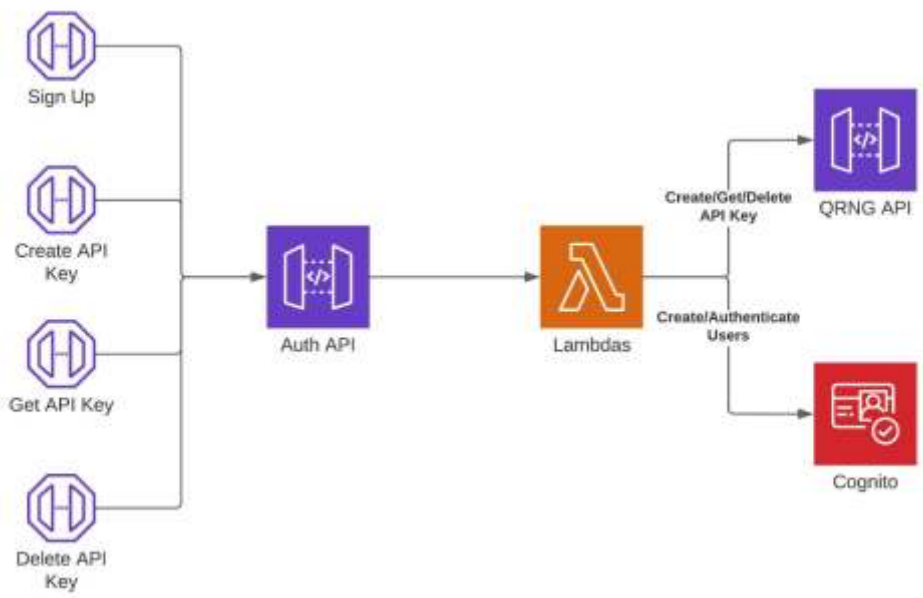
KEY COMPONENTS

The architecture supported brokering of the data feed from the ANU labs creating a high volume stream of unique quantum-generated random numbers, made available as an API-accessible feed via the AWS marketplace. The brokering functionality also enforced user access policies. User authentication was governed by linking DynamoDB and Cognito, to a static website hosted in an S3 bucket.

The user subscription system was hosted in the AWS Marketplace with policy based service point exposure being handled via API Gateway.

Data feeds coming out of the ANU labs were cached through S3 and SQS/SNS/CloudWatch services.

Service point compute processes were coded in various Lambdas.



CAPTION - Fig. Key API Gateway-served invocations to authenticate user access to the quantum random number cache

CHALLENGES

2pi Software guided the ANU labs team with migrating their existing interface code base to enterprise standards and reimplemented some layers for improved security and stability.

Making the Marketplace subscriptions work with API GateWay billing and access policies presented some challenges including :-

- The number of edge cases in signing up for API GateWay billing via the MarketPlace Subscription system complicated the user sign-up process.
- Serving APIs via the AWS Marketplace at the time of solution implementation was a relatively new AWS feature-set and in cases where the documentation may have lagged, the AWS support team were quick to resolve issue

SOLUTIONS

2pi Software were greatly assisted by AWS personnel toward better understanding the available documentation on the AWS Marketplace API as a Service feature - 2pi Software's empirical observations were instrumental in identifying areas requiring clarification and the AWS support team collaborated enthusiastically in ensuring successful adoption of the technology.

2pi Software's architectural and platform implementation resulted in a functionally secure subscription system, rather than being reliant on security ‘by assumption’.

CODE EXAMPLES

The AQN JSON API supports three parameters. These are:

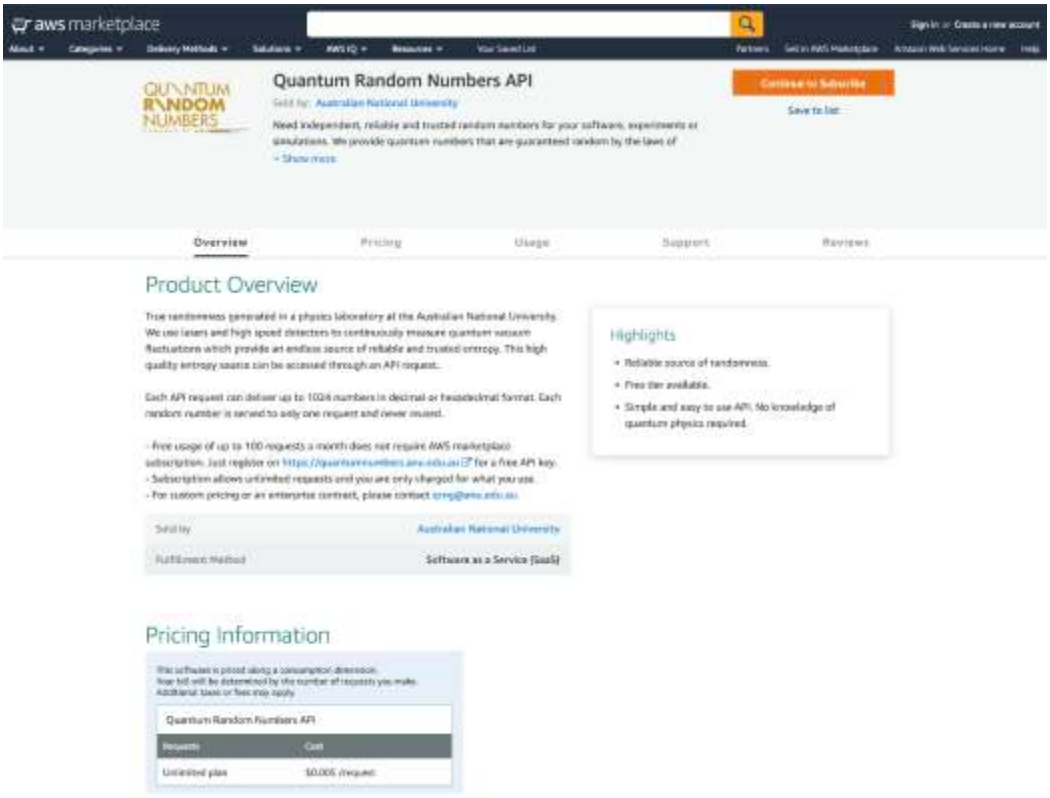
- Data type, the data type must be 'uint8' (returns integers between 0-255), 'uint16' (returns integers between 0-65535), 'hex8' (returns hexadecimal characters between 00-ff) or 'hex16' (returns hexadecimal characters between 0000-ffff).
- Array length, the length of the array to return. Must be between 1-1024.
- Block size, only needed for 'hex8' and 'hex16' data types. Sets the length of each block. Must be between 1-10.

An API key which you can be granted for free at sign up, is required

```
API_URL=https://api.quantumnumbers.anu.edu.au

API_KEY=your_secret_api_key

curl -X GET -H x-api-key:${API_KEY}
${API_URL}?length=[array length]&type=[data
type]&size=[block size]
```



THE 2PI SOFTWARE DIFFERENCE

2pi Software has many years experience in cloud and AWS infrastructure design and deployment. 2pi Software's dedicated AWS team work closely with 2pi Software's software development teams.

2pi Software's AWS expertise allowed systemised linking of the ANU's pre-existing codebase (focussed mainly at the Quantum Device and associated computing resources level) to the normal AWS Lambda release update cycle, for much improved stepwise migration/ upgrade of the workflows & algorithms.

2pi Software's experience with AWS CDK (and non-standard projects in general) enabled the project to successfully progress from locally-based toolchains to a fully 'infrastructure as code' cloud environment to a production-grade quality level. When it became necessary to move the entire project out of a specific AWS region – a very late stage development – that process was straightforward and was a clear illustration of the power of AWS CDK and Infrastructure as Code.

ABOUT THE ANU QRNG

In 2021 ANU launched ANU Quantum Numbers (AQN), the world's fastest on demand quantum random number generator on AWS marketplace. By harnessing the quantum nature of lasers, high speed and truly random numbers are generated in real time. This is be useful for research students, academics, and IT specialists that need random numbers in their experiments.

Random numbers are needed in many applications in IT, data science, arts, gaming industry and research. A poor source of randomness will lead to biased or unreliable results. Generating a provably random string of numbers is hard–every algorithmic random number generator by definition can be computed.

Quantum physics literally provides an infinite source of truly random numbers. These quantum random numbers are guaranteed by the laws of physics to be unpredictable and unbiased. The Australian National University Quantum Optics Group has made this source of randomness easily accessible through the QRNG service. Customers now have access to reliable high speed quantum random numbers for their applications without having to deal with messy hardware or complicated algorithms.

AQN can be integrated into any application or experiment that have access to the internet. The service is hosted on AWS and offers 24 hours reliable operation and high speed connection anywhere around the globe. ANU's service uses simple API and different usage plans to allow everyone, from hobbyist to data scientists, to use quantum random numbers in their projects with effortless ease.

For more information on go to https://quantumnumbers.anu.edu.au

ABOUT 2PI SOFTWARE

2pi Software was formed in 2012 by Carsten Eckelmann and Liam O'Duibhir.

The company headquarters are located on the Sapphire Coast (Bega and Merimbula) of NSW, and with over 25 years of IT experience across software development and cloud deployment, the founders have created a unique business and technology consulting programme.

Since 2019, 2pi Software has focused on extending the company's existing expertise in cloud (AWS) and traditional software engineering to better serve the Artificial Intelligence (AI) and Machine Learning (ML) needs of our clients. And in more recent times the organisation has worked to embrace the compelling world of Quantum computing (Q) with exciting results.

2pi Software's diverse skill set has allowed the organisation to leverage these abilities to the benefit of 2pi Software's clients and the community.

Tech Vision - *Enablement of Artificial Intelligence (AI), Machine Learning (ML) and Quantum computing (Q) capabilities*

2pi Software's mission statement is to provide businesses and organisations with state of the art Workflow Enablement and Data Husbandry for AI/ML and Quantum solutions in addition to architecting secure, cloud infrastructure and big data support systems.

CORE COMPETENCIES

At its core, 2pi Software is a software engineering company. 2pi Software's problem-solving and solution development capabilities are well-honed over many years, and the company passionately pursues excellence in the software engineering craft, and applies the intellectual rig2pi Software's needed to build long-lasting, supportable and well-documented systems.

In summary, 2pi Software's skills and experience cover :-

- High-end software engineering
- Promotion and adoption of Open Source and Open Standards
- AWS Cloud System implementation and interconnectivity
- Support for Artificial Intelligence (AI), Machine Learning (ML) and Quantum Computing (QC) applications
- B2B communication and automation - ERP/CRM/Workflow
- Interconnectivity of disparate systems – 2pi Software provides the 'glue' between systems

2pi Software

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