# ARISTA

Netnod choose Arista Networks for World's first FPGA implementation of Network Time Security (NTS), improving performance and predictability whilst streamlining operational cost and complexity

# Highlights

# CHALLENGE

Delivering accurate, secure and reliable time data services to its users is a critical task for Netnod, a neutral and independent provider of critical infrastructure in the Nordics and beyond. However, the initial software implementation of the new Network Time Security (NTS) standard offered limited scalability with a significant operational burden. Using data center grade FPGA- based switches from Arista Networks, Netnod has created a reliable, scalable and high- performance time data service with robust security controls whilst reducing operational running costs and complexity.

# SOLUTION

- Arista 7130L Series Layer 1+ FPGA Switch 7130L optimised for FPGAbased network applications
- Arista FPGA development kit with full IP core access for custom application development

# RESULT

- Standardised layer 1+ network switches and open FPGA platform simplifies operational support
- Open standards-based approach to allow continual development and optimisation of NTS services
- Predictable and robust delivery of secure time data with option to scaleout as needed

Accurate and secure time data is vital for society, enabling everything from air traffic control, bank transactions and computer log files to applications for legal, medical and manufacturing processes. For over 25 years, Netnod has provided critical infrastructure support including Network Time Protocol (NTP) services as well as being instrumental in the development of Network Time Security (NTS) – a new protocol that adds much needed secure authentication to time data services. Having built a development prototype on Field Programmable Gate Array (FPGA) technology, Netnod chose Arista Networks as the data center grade FPGA switch platform to deploy its full-scale public service. Netnod gained significant improvements in reliability and scalability whilst reducing operational running costs, power and space requirements.



### **Company Background**

Netnod provides critical infrastructure support ranging from interconnection services and Internet Exchanges to time services, DNS services and root server operations. With a worldwide reputation for its services and the expertise of its staff, Netnod ensures a stable and secure Internet for the Nordics and beyond. Established in 1996 as a neutral and independent Internet infrastructure organisation, Netnod is fully owned by the nonprofit foundation TU-stiftelsen (Stiftelsen för Telematikens utveckling).

#### Challenge

Accurate and universally agreed time is essential for the operation of everything from mobile networks to websites, energy and financial sectors and even factory production lines. 400 highly precise atomic clocks along with calculations for the rotation of the earth are used to establish Coordinated Universal Time (UTC). These atomic clocks in various locations around the world makes UTC universally available, for example by Internet connectivity. However, this accessibility has also resulted in potential for cyber-attacks that manipulate UTC data to possibly disrupt a wide range of applications and critical processes. Until recently there was no way to ensure that the time data received over the Internet was being fed from a malicious or trusted source as the underlying Network Time Protocol (NTP), created in 1985, had limited security controls.

Over the years, a range of security flaws and some high-profile attacks have shown that NTP needed significantly improved security. After several years in development, a Network Time Security (NTS, RFC8915) standard was ratified in 2020 that aims to address these security limitations.

As one of the leading figures in NTS, Netnod has worked on all stages of concept development from the IETF standard, to software and hardware implementations at client and server levels. Netnod provides NTP, NTS and Precision Time Protocol (PTP) services offering a robust, reliable and highly accurate source for time and frequency that are freely available to anyone. Netnod's time service, funded by the Swedish Post and Telecom Authority (PTS), uses a distributed architecture at multiple, autonomous sites throughout Sweden to provide a time service available over IPv4 and IPv6.

Netnod launched one of the first software based NTS-enabled NTP services in the world in 2019. The focus moving forward was how to scale up this implementation. As Christer Weinigel, Senior Embedded Software Engineer for Netnod, explains, "We had previously built and maintained very specialist servers linked to atomic clocks that serve NTP requests for time data. This method worked well, but the new NTS standard uses more computational resources for encryption processes. This reduced the number of requests we could serve from our existing clusters and made it difficult to scale up."

"Although we are a very technical organisation, it was not an efficient use of our resources to have to build and maintain lots more of these servers," explains Weinigel." So instead, we wanted an 'off-the-shelf' solution using Field Programmable Gate Array (FPGA) technology that would not only deliver more reliability and better performance, but also allow us to replace hardware quickly and scale as needed." ARISTA

In addition to improved efficiency and scalability, deploying NTS at a hardware level has two important benefits: it makes the service much more robust and secure; and it enables a more deterministic processing improving both the quality of the time synchronisation provided and the security of the service by reducing the ability for side-channel attacks.

### **Solution**

For the development phase, an expert team from Netnod used Xilinx VCU118 FPGA Evaluation Boards to create an implementation of NTS on the programmable hardware architecture. The system takes advantage of parallel processing to handle the cryptographic operations and removes the need for multiple servers and load balancers. This improves predictability and reliability, while using less equipment and reduces power consumption. In production, this integrated approach leads to lower operational costs compared to using clusters of servers.

"We looked at full-scale deployment options during the prototyping stage and our goal was to find a partner that offered an open environment for porting our code onto an industrial grade FPGA solution," explains Weinigel. "The Arista 7130 ticked all the boxes from a technical standpoint and has an extensible operating system (EoS) that makes it easier to create a highly integrated implementation. Arista is also well known for its support for open standards and welcoming third-party development using its platforms which matches our own ethos – so overall, it was a really good fit for us."

The Arista 7130L Series FPGA-enabled devices leverage FPGA technology to enable the development and deployment of cutting-edge network applications. Available in 32, 48 or 96 SFP+ port options, the 7130L Series combines multiple devices in one, performing layer 1+ switching in only 5 nanoseconds, enabling unrestricted access to an onboard FPGA along with an x86\_64 server. Arista and third parties have been developing applications for the 7130L for several years and NTS joins a growing library of networking functions such as packet replication, multiplexing, filtering, timestamping, Layer 2 switching, aggregation and capture that are typically used in ultra-low latency use cases such as financial services and network security.

"The Arista 7130 does provide a lot of infrastructure that we could use for the NTS implementation," says Weinigel, "For example, the NTS implementation needs a stable clock synchronised to a PPS pulse to be able to provide accurate time. With the 7130, Arista provides a FDK which contains software and an IP block which does that, which means that we didn't have to write something like it ourselves."

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## Conclusion

Using the Arista FPGA development kit, the Netnod team ported its prototype from its Xilinx development board into Arista 7130L series switches at the end of 2020, before deployment as high availability pairs at a data center in Sweden. Netnod is planning to roll it out at more sites over the coming year.

"This is the first time that NTS has been deployed as an FPGA-based service and we are very proud of what our team has achieved and how it will improve the accuracy, security and reliability of our NTP services used by hundreds of thousands of users across the world," says Weinigel. "We have also released our initial FPGA implementation of an NTP/NTS server to the Arista 7130-48LB FPGA switch onto GitHub. This is still a work in progress, but we hope that the operational benefits that we have gained can be utilised by others that work in the field of NTP across the world," he concludes.

Netnod formally launched the new NTS services running on Arista switches in February of 2022 and initial testing validates all existing NTP functionality while ensuring access to time data is securely authenticated in an efficient and predictable manner. All the hardware elements are under maintenance contracts to simplify support and the initial Arista 7130-48 port switch resides within a family scaling up to 96 ports giving Netnod effective options for future service expansion.



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