

Telenor Enables 5G Video Analytics for Norwegian Fish Farm

Video analytics solution from Telenor, Bluegrove, Nokia, and Intel provides remote Norwegian fish farm with fish traceability from feeding to distribution, improving efficiency, profitability, and sustainability

At a Glance

- Seafood popularity is growing
- Aquaculture requires real-time fish insights to minimize feed waste and monitor fish behavior and environmental conditions
- A remote island fish farm in Norway gets aquaculture video monitoring from Telenor, Bluegrove, Nokia, and Intel
- High-definition video analytics can enable cost savings, increased profitability in fish farms
- mmWave 5G needed for higher bandwidth video requirements

The Nokia logo, consisting of the word "NOKIA" in a bold, blue, sans-serif font.The Telenor logo, featuring a stylized blue flower-like icon to the left of the word "telenor" in a lowercase, blue, sans-serif font.The Bluegrove logo, featuring a stylized blue circular icon with concentric lines to the left of the word "BLUEGROVE" in a blue, sans-serif font.

Today, more than 3 billion people rely on fish for a large portion of their diet, and the European Commission reports that global seafood consumption has more than doubled over the past 50 years.¹ While worldwide demand for fish has seen a sharp increase, wild fishing simply cannot keep up with this demand, largely due to overfishing.

Aquaculture, the farming of freshwater and saltwater fish and other aquatic creatures and plants, is practiced globally by a wide variety of farmers, from one-person farms in developing countries to multinational corporations. The farming of fish provides an answer to the limited availability of wild fish, and the world now produces more farmed fish than farmed beef.

Aquaculture is a significant industry in Norway, where climate and natural conditions make it an ideal location for fish farming. The country is the world's largest producer of Atlantic salmon, but also farms rainbow trout, mussels, Atlantic halibut, and other aquatic species.

In Norway, a fish farm of 1 million salmon can be managed by just a few farmers who handle the daily feeding and ensure the overall well-being of the salmon. Most fish farmers in Norway operate a central feeding system with tubes to deliver feed to the fish in their cages. The farmers monitor the feed process via multiple cameras placed near the cages and look at the behavior of the fish to judge when to start, adjust, or stop feeding.

Unfortunately, lack of light, the water, and low-resolution cameras create poor camera visibility, a problem made worse by the lack of daylight in Norway in the winter. Farmers often have trouble getting a clear idea of what is happening during the feeding process.

A poorly managed feed process can lead to feed waste, and significant food spillage can pollute the seabed around the fish farm. On the other hand, poor visibility could lead to the potential for underfeeding the fish and reducing their biomass.

Better visibility of the fish would allow the fish farmers to optimally track behavior and estimate the appetite of the fish to feed more precisely, which, in turn, can lead to reduced feed costs, feed waste, and seabed pollution. Proper feeding also allows the fish to grow faster, meaning less time in the cages and less chance of disease.

The stakes are high: Without reliable technology to better track the fish and cage environment, hundreds of millions of fish are lost in Norway each year.

To achieve efficient, sustainable, and profitable fish farming, the farmers need real-time and historical insights into the behaviors and health of the fish, as well as data on the health of the salmon's environment.

For a Sinkaberg Hansen salmon farm on the remote Norwegian island of Gjerdinga, video analytics is enabling the visibility into the feeding process that the fish farmers need to better manage day-to-day operations. Intel® Network Builders partners Telenor and Nokia, along with Bluegrove, have provided the enabling connectivity and technologies to enable a high-resolution video analytics solution to address the challenges of modern fish farming.

Project Overview

The architecture for the Sinkaberg Hansen Gjerdinga fish farm analytics solution came from the European Union-funded 5G-HEART project in collaboration with the 5G-VINNI projects. The goal of 5G-HEART is to foster innovation around 5G technology to enable important applications in healthcare, transport, and aquaculture.

A similar EU-funded project is 5G-VINNI, which is more focused on 5G applications and has participation from Telenor and other communications service providers as well as infrastructure vendors like Nokia. The objective of the project is to validate the performance of new 5G applications by operating trials of advanced industry services such as those from 5G-HEART.

Sinkaberg Hansen Gjerdinga Fish Farm

For the Sinkaberg Hansen Gjerdinga island fish farm, a Bluegrove video monitoring system was set up (see Figure 1), using Nokia networks and servers that are powered by Intel® architecture CPUs. A Telenor 5G network was established to transmit the video to an analytics application for analysis and reporting.

The cameras, transmitting multiple streams of high-resolution video, required extreme bandwidth from the 5G link between the cameras and the analytics application. The fish farm's existing 4G network did not have enough bandwidth to transfer livestream video from the farm to a central location, a requirement for operating and navigating underwater cameras in real time. In some other fish farm applications, fiber and/or point-to-point wireless networks can be used to provide this connection. However, the use of fiber cables is challenging as they can be exposed to breakage and damage. This can lead to downtime of the camera system, which is critical for several daily farming activities, particularly feeding.

5G meets the bandwidth requirements of the camera network, offering enough bandwidth to also replace local area networks.

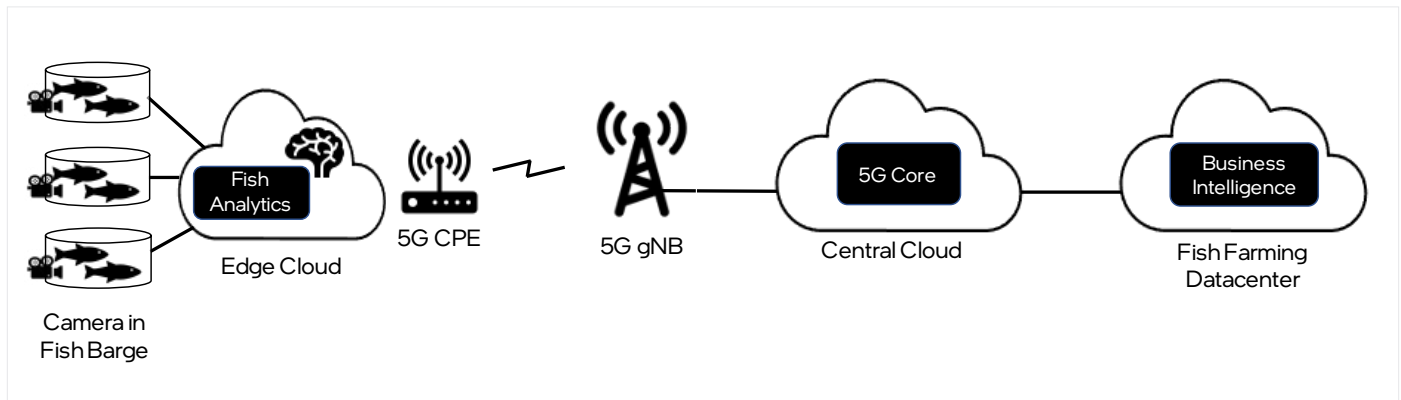


Figure 1. End-to-end architecture.

The analytics applications at the Sinkaberg Hansen Gjerdinga island fish farm were deployed in an onsite, on-premises edge cloud at the fish farm. After analytics processing in the edge cloud, the results are available locally at the fish farm so that immediate action can be taken with minimal latency. Furthermore, only the analytics results are transmitted to a central Intel® processor-based cloud infrastructure for processing in a business intelligence tool—reducing backbone bandwidth requirements.

With the video analytics solution, the Gjerdinga fish farmers can have a clearer view of the feeding process, fish behavior, and the environmental status of the cages.

Enabling Technologies

The technologies utilized in the solution for the Gjerdinga farm include the following.

5G Network Services

Telenor built a 5G fixed wireless access (FWA) service utilizing an enhanced mobile broadband (eMBB) 5G network slice type. Two 5G base stations were deployed to provide coverage and

capacity to the fish farm, one using an 80 MHz channel in the C-band (3.6 GHz) and the other using an 800 MHz channel in the mmWave band (26 GHz). The mobile core was initially based on non-standalone (NSA), which overlays 5G technology on the existing 4G network to offer a high bandwidth eMBB service. The anchor band for this network was a 10 MHz channel in the 2.1 GHz band. The NSA-enabled mobile core software was provided by Ericsson running on a network functions virtualization (NFV) platform provided by Nokia. The Nokia NFV infrastructure is based on AirFrame Open Edge servers using Intel® Xeon® Scalable processors. The 5G system and service is part of the 5G-VINNI and 5G-HEART projects.

High Speed Video Transfer and Analytics

The system was designed to deliver the high uplink speeds required to transfer the fish farm's video streams to the edge server with very low latency. Telenor's mmWave connection provided a 1 Gbps uplink, which is a significant improvement compared to 4G, which delivered a maximum 20 Mbps uplink. Achieving the required bitrates is essential as the number of connected cameras grows, increasing bandwidth demand.

Edge Servers Powered by Intel® Xeon® Scalable Processors

The edge network servers for the Sinkaberg Hansen salmon farm project are based on 2nd generation Intel® Xeon® Scalable processors. Intel Xeon Scalable processors are the foundation for powerful edge platforms that deliver compute agility and scalability. Disruptive by design, they benefit from decades of innovation for the most in-demand workload requirements and are part of a complete set of network technologies from Intel.

The latest 3rd generation Intel Xeon Scalable processors enhance edge server solutions with a balanced architecture that supports artificial intelligence with built-in acceleration and hardware-based security features. These CPUs are also engineered for modern network workloads, targeting low latency, high throughput, deterministic performance, and high performance per watt.² The Nokia AirFrame Open Edge Server OE 20 benefits from this processor technology.



Bluegrove Video Analytics

Bluegrove has developed an underwater fish monitoring system, complete with light and camera vision technology along with acoustic underwater sensor technology.

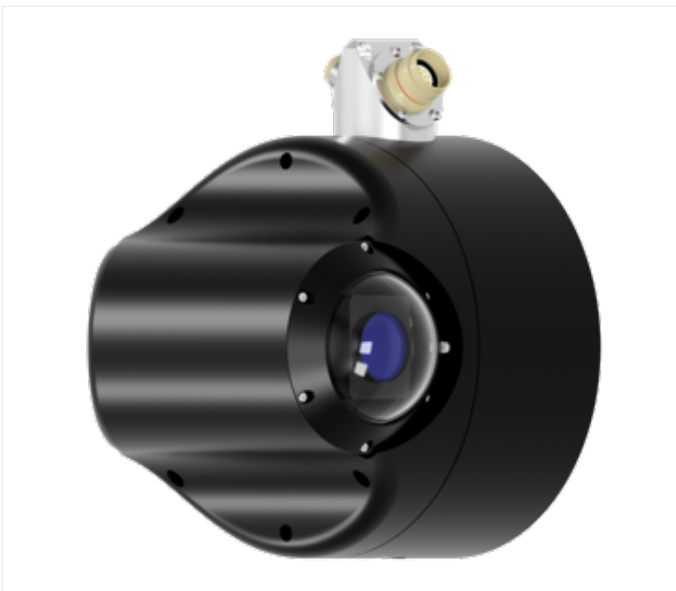


Figure 2. Bluegrove underwater camera.

For the Gjerdinga fish farm, Bluegrove's subsea cameras enable observation to improve feeding strategies, view abnormal fish behavior, and detect wounds or bites or other fish health issues. The cameras also feature a pellet detector to identify feed pellet droppings. This optimizes the feeding process, reduces waste, and reduces the environmental impact.

The cameras film in full HD resolution and provide high quality video streams suitable for AI applications. The cameras have

auto-focus and auto-adjusted color balance and can be moved both vertically and horizontally in the cage by using the winch and graphical user interface. The cameras are round to ensure that the nets won't get damaged if they should come into contact with each other. Bluegrove's topside cameras can also provide surface monitoring to watch for unwanted fish or predators.

Subsea lights provide dimmable LED light to avoid stressing the fish, while making it possible to capture high-quality images below the surface, even at night.

The cameras are physically connected to a central switch and data can be transferred to the edge or directly to the core. For the Gjerdinga fish farm, an edge server was set up to process the huge bandwidth from the camera network, which includes eight cage installations, each sending data at a rate of up to 200 Mbps; it was decided that data would be processed in edge servers. By transferring data to the edge, this reduces transport time and latency, enabling analysis locally.

Bluegrove sensors also measure oxygen, salinity, and sea temperature. With Bluegrove's unique camera and sensor technology, the fish farm receives high-quality surveillance images into its control room to provide a crystal-clear view of what is going on in the cages and on the surface.

The Bluegrove analytics platform collects, processes, and analyzes data from aquaculture installations and utilizes a wide range of analytic tools and methods, including statistics, artificial intelligence, and machine learning to further improve the algorithms and insights. The platform also hosts a range of user interfaces and reporting capabilities for the end-users.

Bluegrove uses the Intel® Distribution of OpenVINO™ toolkit to enable video analytics. The OpenVINO toolkit is based on convolutional neural networks (CNN). The toolkit extends workloads across Intel architecture hardware (including accelerators) and optimizes inferencing performance.

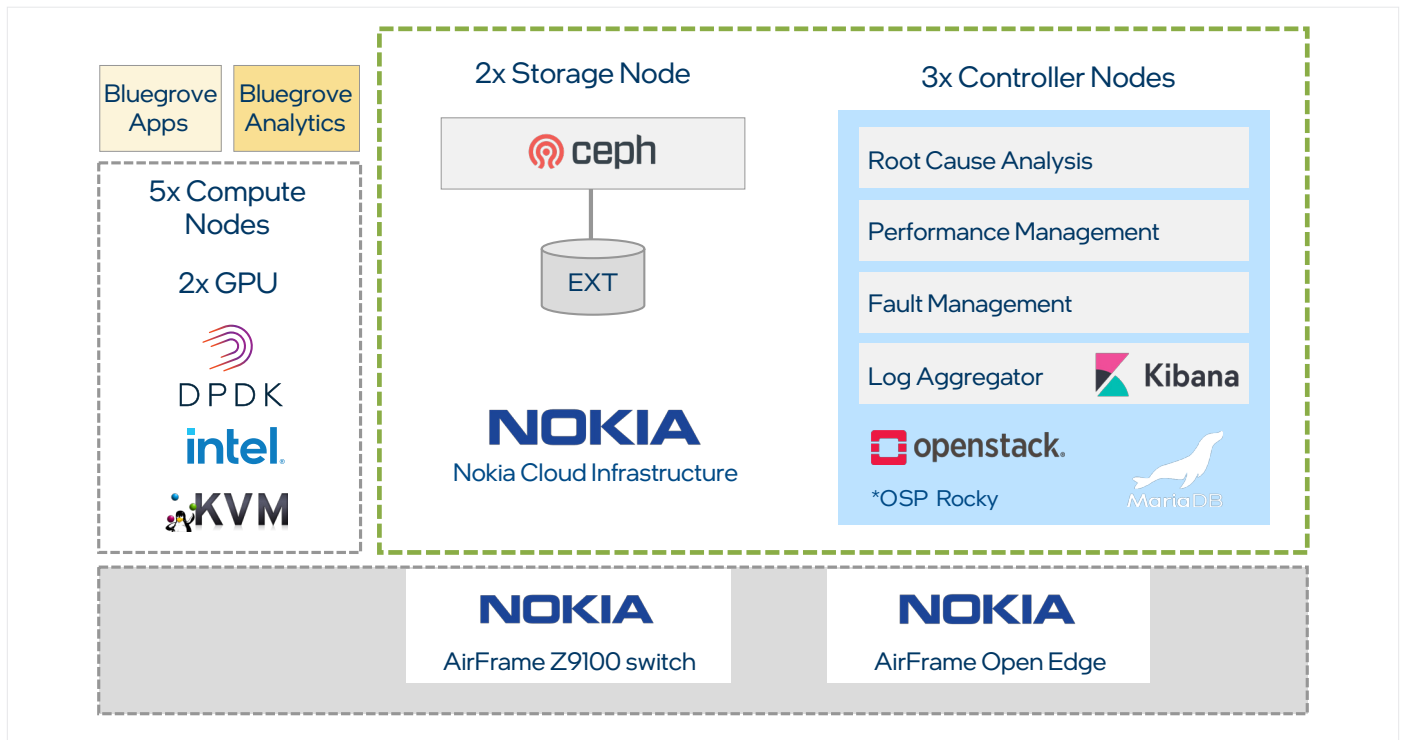


Figure 3. Telenor 5G-VINNI edge site solution.

Nokia Edge Cloud Infrastructure

The edge cloud infrastructure was provided by Nokia, whose edge cloud solution supports the ETSI reference model (see Figure 3).

The fish farm edge site utilizes the Nokia AirFrame Open Edge OE 19 for computing and storage, with networking provided by the AirFrame Z9100 (see Figure 4) with 32 x 100 Gb ports. Nokia's Cloud Infrastructure provides the virtualization layer.

Nokia's extremely efficient, compact AirFrame Open Edge Server is built and optimized to fully support edge and far-edge cloud deployments. The AirFrame Open Edge Server chassis is only 3U high, enabling its installation on indoor or outdoor base station sites. The system features single-socket server nodes in 1U- and 2U-high form factors, supporting the 2nd generation Intel Xeon Scalable processor family. A small graphics processing unit (GPU) fits in the 1U server sled to aid in the video analytics. One open edge chassis supports five servers, each having a 24-core Intel Xeon Scalable processor.

- 1 x Nokia AirFrame Open Edge chassis
- 5 x Nokia Open Edge servers (24c, 1 x Intel® Xeon® 6212U CPU, 192GB RAM)
- 2 x GPUs NVIDIA T4 16GB
- 4 x 1.92TB SSD disks (Ceph OSD)
- 1 x Z9100 leaf switch (32x100Gb ports)

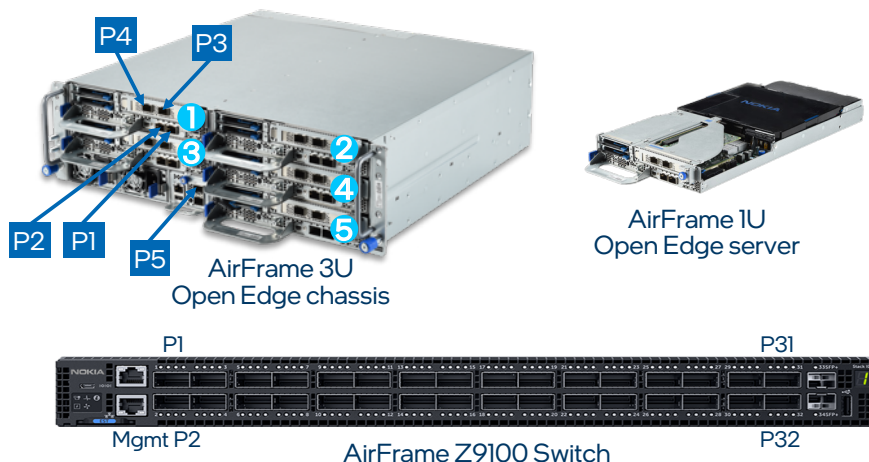


Figure 4. Nokia's edge server and networking system.

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The AirFrame Z9100 fixed switch is used for networking and virtualization, with the Nokia cloud infrastructure delivering the real-time applications and NFV cloud solution. The Nokia cloud infrastructure is based on OpenStack Rocky and leverages the open-source Data Plane Development Kit (DPDK) software libraries for high-performance packet processing. This infrastructure software is OPNFV-verified as a telco-grade solution that meets the requirements of high bandwidth and low latency edge data center applications.

Nokia also supports the automation of application onboarding at the edge cloud and 5G CPE service provisioning with its central office-based Nokia FlowOne service orchestrator, Nokia CBND NFV orchestrator, and Nokia CBAM generic VNF manager.

A user or a BSS system can initiate the service deployment via the service orchestrator, which will trigger the network service deployment in the NFV orchestrator (NFVO) using the exposed SOL005 API. The orchestrator will then create the provider networks in the physical switch and also in OpenStack Neutron so the virtual machines can access external networks via Nokia's AirFrame Z9100 switch.

The Gjerdinga fish farm uses five Nokia servers that are powered by 2nd generation Intel Xeon Gold processors. This innovative processor delivers significant improvements in agility and scalability and sets a new level of platform convergence and capabilities across compute, storage, memory, network, and security.³

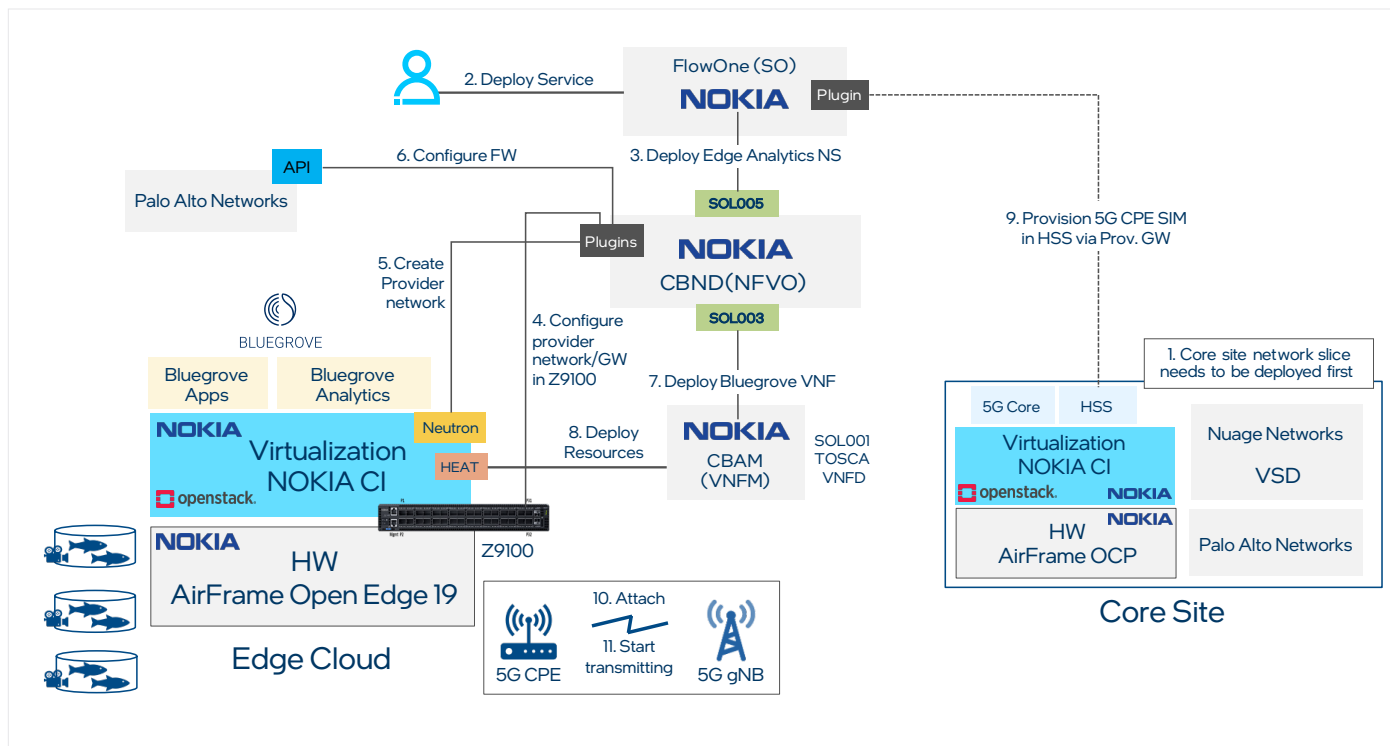


Figure 5. Service orchestration for Edge cloud and 5G CPE provisioning.



Conclusion

By implementing the Bluegrove video fish analytics system, with 5G connectivity and edge computing provided by Telenor, Nokia, and Intel, the Sinkaberg Hansen Gjerdinga island fish farm can utilize high-quality video streams from each fish farm to provide fish farmers with the video and analytics they need to better understand what is happening with the fish they are raising. Specifically, the high-quality video allows better feed process management that reduces feed waste significantly. This cuts down on pollution and improves sustainability. The potential cost savings for a fish farmer like Sinkaberg Hansen could be up to 50 million NOK per year.⁴

The application is enabled by emerging 5G and edge networking technology. Telenor's 5G service provided bandwidth needed for real-time data transfers from the fish cages to the edge server, where Nokia's edge compute and networking technology processed the data providing analytics with no lag time. Intel architecture processor technology plays a key role in delivering the compute density needed to enable the edge computing. This Sinkaberg Hansen Gjerdinga island fish farm case study is just one example of how edge innovations are enabling exciting 5G vertical use cases and new business opportunities.

Learn More

Intel® Network Builders

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¹ <https://link.springer.com/article/10.1007/s13280-018-1060-9>

² <https://www.intel.com/content/www/us/en/products/docs/processors/xeon/3rd-gen-xeon-scalable-processors-brief.html>

³ <https://www.intel.com/content/www/us/en/products/docs/processors/xeon/2nd-gen-xeon-scalable-processors-brief.html>

⁴ Estimate provided by Bluegrove, May 2021.

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