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Technical Solutions

A university project harnesses Arm and Raspberry Pi to channel the Internet of Things data tsunami

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Researchers at the University of Melbourne are tackling one of the biggest challenges ahead in the next decade of computing: Making sense of the tsunami of data generated by Internet of Things devices coming online.

The volume of data threatens to overwhelm networks and computing resources, making it impossible to extract useful insights. With a project it calls FogBus2, a team at the University of Melbourne is looking to fix that.

“With all these billions and billions of IoT devices pushing data to the cloud, the latency would be very high,” says Rajkumar Buyya, distinguished professor and the director of the university’s Cloud Computing and Distributed Systems Lab. “That is where we start moving toward this model of fog computing, where we can harness the resources at the edge of the network and the cloud.”

FogBus2 is an open source, container-based distributed framework to collect data from cameras, ECG devices, laptops, smartphones, or most any other IoT devices. In cases where fast results are needed—for example, taking action on readings from a medical sensor—edge servers near the IoT device that run Raspberry Pi and Jetson processors analyze that data quickly. In cases where more compute is needed but response time is less important, the data goes to the cloud for analytics.

The team recently started running FogBus2 on Oracle Cloud Infrastructure (OCI), using services including Oracle Autonomous Data Warehouse, Oracle Machine Learning Cloud Services, and Identity and Access Management, to build a service that’s multicloud, widely available, and secure. It’s also tapping the OCI Arm Accelerator program, which provides a one-year free trial to select open source developers, research universities, industry partners, and private companies to run workloads on OCI Ampere A1 Compute and other OCI services.

FogBus2 uses Oracle Machine Learning to allocate networking and compute resources for data analytics. It uses Oracle Autonomous Database to compile network information, such as latency, data rate between devices, availability of hardware resources such as CPU and RAM utilization, and software information such as response time and which containers are running on which devices. The

achieve and how.

Putting IoT to work

Video image recognition, such as assessing surveillance cameras for criminal activity, is a kind of application FogBus2 is built to facilitate.

“If you look at a citywide deployment, with cameras in multiple places, there could be thousands and thousands of data points, and if each computation takes just two minutes to analyze, that can take several hours on a single virtual machine,” says Mohammad Goudarzi, graduate researcher at the University of Melbourne’s CLOUDS Lab, in the School of Computing and Information Systems.

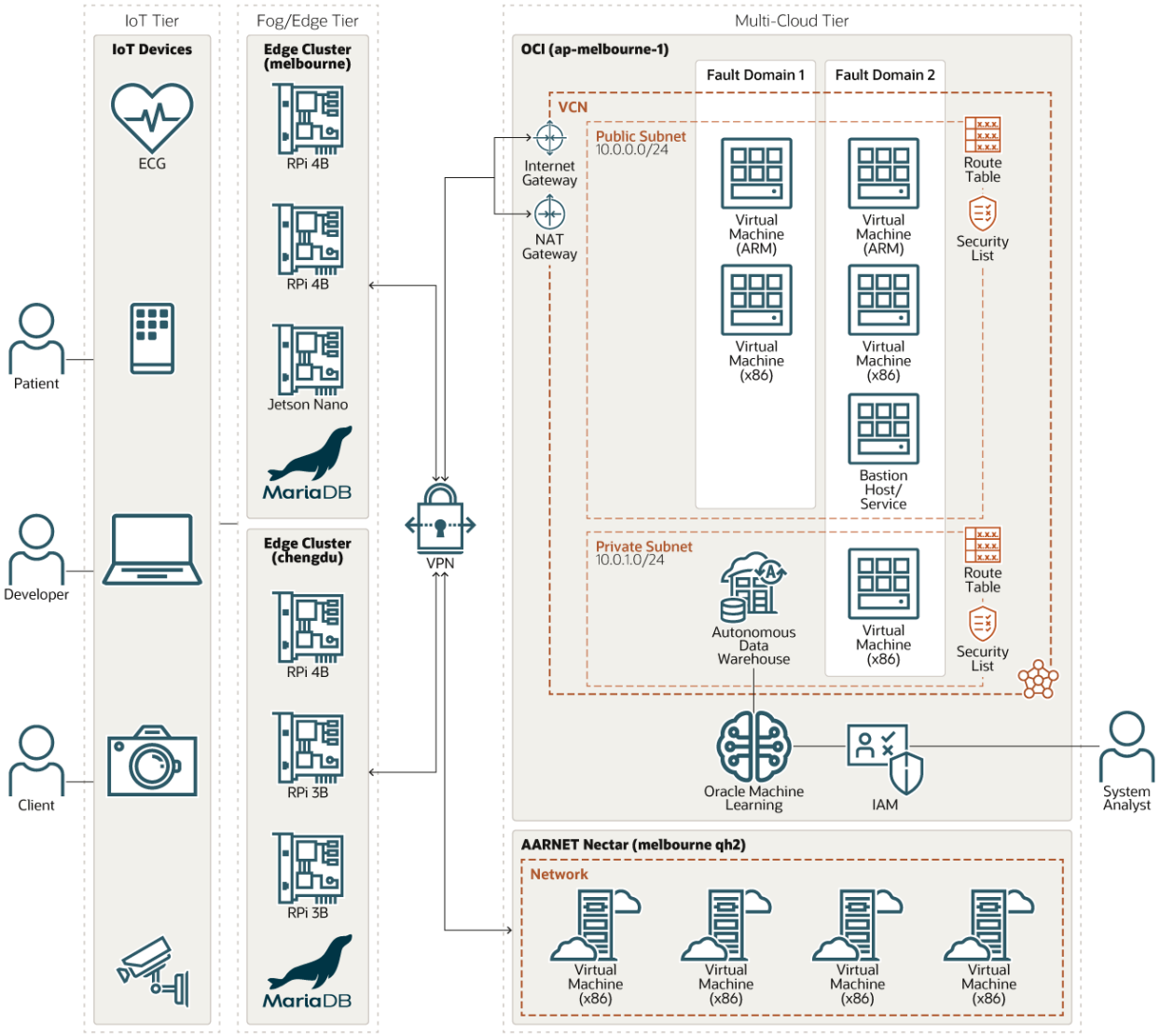
A typical video camera captures information at 30 or 60 frames per second. Sending all that information to the network might congest the system. So instead FogBus2 uses algorithms to analyze frames on the edge servers, so that only frames that are sequentially different from each other are transmitted to the cloud for further processing.

For example, if a store manager wants to assess COVID-19 mask compliance by shoppers, she can set up cameras to capture images of people coming into a shopping center, and analyze faces to see which shoppers are not wearing masks. An application like that needs to be fast, with results available in real time, and analyzed on the network edge, Goudarzi says. Store managers could then direct staff to ask those shoppers to wear masks.

Analysis of protective face covering requirements is more compute-intensive, and can be processed at the edge or in the cloud.

“Our framework can support applications that are computationally intensive or latency sensitive. That

MariaDB database, managing local analytics for applications requiring low latency. Servers can scale up with additional processors to meet demand.



Why in Melbourne and Chengdu? The FogBus2 frameworks support distributed multiregional edge computing, so the edge clusters are currently deployed at researchers' homes to enable ongoing testing and development. Researchers moved the servers from university facilities to ensure access during COVID-19 lockdowns.

The University of Melbourne team chose to split services between OCI and AARNet Nectar for performance and cost reasons. The FogBus2 software uses OCI to take advantage of technology such as Arm processors, an Autonomous Data Warehouse, and machine learning software. Where those resources are unnecessary, using the Nectar services reduces cost, because it's free for Australian researchers.

Additionally, a goal for FogBus2 is to provide multicloud support. The researchers have already begun work on getting the software running on other clouds to take advantage of each cloud's specialized strengths.

The applications and MariaDB database that make up the FogBus2 software framework run in Docker containers, while the Autonomous Database runs in Oracle Cloud. The university plans to deploy Oracle Container Engine for Kubernetes for orchestration, but for now uses homegrown software for the job.

Why Oracle?

The University of Melbourne chose to partner with Oracle because of Oracle's Arm Accelerator program, Autonomous Data Warehouse with built-in artificial intelligence, containerized software and microservices, and edge computing.

"As a research laboratory, it is exciting to show that our effort is not just functional in our own controlled lab infrastructure, but that it works in the real world," Buyya says. "Working with Oracle helps us demonstrate that capability."

The FogBus2 team also tapped the Oracle Cloud Free Tier, which provides free services developers can use to experiment and find the best architecture to support applications, before deploying in the field.

Why Arm?

FogBus2 takes advantage of the Arm processor's support for virtual machines running on CPUs with hundreds of cores, providing opportunity to massively scale parallel operations within each virtual

and storage that Oracle Autonomous Data Warehouse delivers. And FogBus2 benefits from Autonomous Data Warehouse's support for integrated machine learning, reducing the need for developers to build and manage ML capabilities in applications. Oracle Autonomous Data Warehouse's automation also helps increase developer productivity, allowing the university to develop FogBus2 over the course of one year.

Managing infrastructure with machine learning

Oracle Machine Learning allows researchers to visualize data in a database very quickly, "with a few clicks and lines of code," and without the need to build a separate back-end service, says Qifan Deng, contributing researcher to the university's CLOUDS Lab in the School of Computing and Information Systems.

Using Oracle Machine Learning offers an alternative to university researchers building their own machine learning algorithms. With Oracle Machine Learning, researchers can tap Oracle Cloud Identity and Access Management for security.

"It saves us weeks of development and gives us more time to try out more research and more ideas," Deng says.

Looking ahead

Following successful tests of FogBus2, the University of Melbourne research team hopes to see interest in real-world IoT deployments of the open source software.

"We have reached our first and most important goal: setting up the framework, deploying it in a real environment, supporting multicloud, and offering IoT applications on top of that," Goudarzi says.

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