Intel Cloud Orchestration Networking Design Document

Abstract

This document outlines the design considerations for the implementation of Open vSwitch and other networking technologies in the Cloud Integrated Advanced Orchestrator (Ciao), Intel Corporation's advanced cloud orchestration software. It describes the various techniques, structure, and technology choices that will be used in the execution of our project.

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CONTENTS

I. Introduction

Our project is to first switch the Linux-created GRE tunnel implementation in Ciao to use GRE tunnels created by Open vSwitch. From that point we will switch the actual tunneling implementation from GRE to VxLAN/nvGRE based on performance measurements of each on data center networking cards. After this is completed, a stretch goal is to replace Linux bridges with Open vSwitch switch instances. This document outlines the steps, techniques, and methodology we will utilize to achieve each goal.

A. Purpose

The current implementation of Ciao tightly integrates software defined networking principles to leverage a limited local awareness of just enough of the global cloud's state. Tenant overlay networks are used to overcome traditional hardware networking challenges by using a distributed, stateless, self-configuring network topology running over dedicated network software appliances. This design is achieved using Linux-native Global Routing Encapsulation (GRE) tunnels and Linux bridges and scales well in an environment of a few hundred nodes.

While this initial network implementation in Ciao satisfies current simple networking needs in Ciao, all innovation around software defined networks has shifted to the Open vSwtich (OVS) framework. Moving Ciao to OVS will allow leverage of packet acceleration frameworks like the Data Plane Development Kit (DPDK) as well as provide support for multiple tunneling protocols such as VxLAN and nvGRE. VxLAN and nvGRE are equal cost multipath routing (ECMP) friendly, which could increase network performance overall.

B. Scope

Ciao exists as a cloud orchestrator for cloud clusters. It is inherently Ciao exists as a cloud orchestrator for cloud clusters. It is inherently necessary for the separate nodes in the cloud cluster to be able to talk to each other. Without a reliable and secure software defined network Ciao would have little purpose. Utilization of Open VSwitch GRE tunnels allows Ciao to become more scalable and enables the inclusion of packet-acceleration technology such as the Data Plane Development Kit (DPDK).

C. Context

Our network mode will exist within Ciao, a cloud orchestrator designed to be fast and easy to deploy. Ciao is sectioned into three parts, each with distinctive purposes [1].

Controller Responsible for policy choices around tenant workloads [1].

Scheduler The Scheduler implements a ”push/pull” scheduling algorithm. In response to a controller approved workload instance arriving at the scheduler, it finds a first fit among cluster compute nodes currently requesting work [1].

Launcher The Launcher abstracts the specific launching details for the different workload types (eg: virtual machine, container, bare metal). Launcher reports compute node statistics to the scheduler and controller. It also reports per-instance statistics up to controller [1].

Our networking mode must facilitate the communication of packets between all three levels of Ciao, as well as individual compute and network nodes and the Compute Node Concentrator (CNCI) [2].

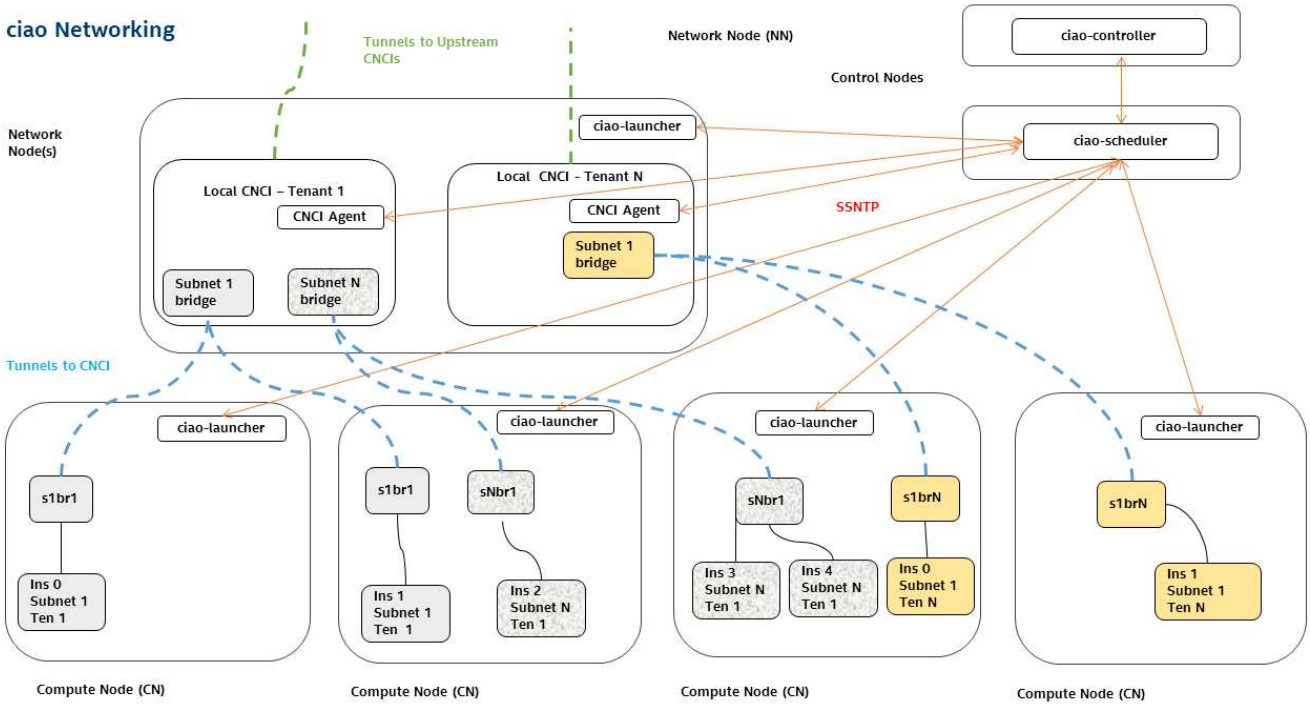
Compute Node A compute node typically runs VM and Container workloads for multiple tenants [2].

Network Node A Network Node is used to aggregate network traffic for all tenants while still keeping individual tenant traffic isolated from all other the tenants using special virtual machines called Compute Node Concentrators (CNCIs) [2].

Compute Node Concentrator (CNCI)
CNCIs are Virtual Machines automatically configured by the ciao-controller, scheduled by the ciao-scheduler on a need basis, when tenant workloads are created [2].

Specifically, the Ciao network components must communicate securely using the Simple and Secure Node Transfer Protocol (SSNTP). The network node aggregates traffic between compute nodes while keeping the tenant traffic isolated from other tenants in the cluster. Network nodes achieve this with CNCIs. A graphic of the lowest-level of this network configuration shows their relation to each other.

Fig. 1. Ciao Network Topology [3]



D. Summary

We will implement an Open vSwitch Generic Routing Encapsulation (OVS-GRE) mode in Ciao in order to leverage DPDK and other software defined networking technology innovations which are dependent on OVS. This document will outline our design strategy, design views, and design viewpoints for each component of our solution.

II. References

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III. Glossary

Bridge — Software or hardware that connects two or more network segments.

Ciao — Ciao is a cloud orchestrator that provides an easy to deploy, secure, scalable cloud orchestration system which handles virtual machines, containers, and bare metal apps agnostically as generic workloads. Implemented in the Go language, it separates logic into ”controller”, ”scheduler” and ”launcher” components which communicate over the ”Simple and Secure Node Transfer Protocol (SSNTP)” [1].

Cloud — A huge, amorphous network of servers somewhere [4].

Cloud Orchestration A networking tool designed to aid in the deployment of multiple virtual machines, containers, or bare-metal applications [1].

Compute Node Concentrator (CNCI)
Virtual Machines automatically configured by the ciao-controller, scheduled by the ciao-scheduler on a need basis, when tenant workloads are created [2].

Data Plane Developement Kit (DPDK)
DPDK is a set of libraries and drivers for fast packet processing. It was designed to run on any processors. The first supported CPU was Intel x86 and it is now extended to IBM Power 8, EZchip TILE-Gx and ARM. It runs mostly in Linux userland [5].

Equal Cost Multipath Routing (ECMP)
Equal cost multipath routing is a routing strategy in which next path routing for a packet can occur along one of several equal-cost paths to the destination [6].

Generic Routing Encapsulation (GRE)
Encapsulation of an arbitrary network layer protocol so it can be sent over another arbitrary network layer protocol [7].

Linux Bridge Configurable software bridge built into the Linux kernel [8].

Network Node (NN) A Network Node is used to aggregate network traffic for all tenants while still keeping individual tenant traffic isolated from all other the tenants using special virtual machines called Compute Node Concentrators (CNCIs) [2].

nvGRE Network Virtualization using Generic Routing Encapsulation [9].

Open vSwitch Open source multilayer software switch with support for distribution across multiple physical devices [10].

OVS Open vSwitch [10].

Packet Acceleration Increasing the speed of the processing and transfer of network packets.

Packet Encapsulation Attaching the headers for a network protocol to a packet so it can be transmitted using that protocol [11].

SSNTP The Simple and Secure Node Transfer Protocol (SSNTP) is a custom, fully asynchronous and TLS based application layer protocol. All Ciao components communicate with each others over SSNTP [12].

Tunnel Point to point network connection that encapsulates traffic between points [11].

VxLAN Virtual Extensible Local Area Network [13].

IV. Body

A. Design Stakeholders

B. Design Concerns

C. Design Viewpoint 1

D. Design View 1

E. Design Viewpoints 2

F. Design View 2

G. Design Rationale

V. High-level considerations

Our software defined network will be written in the Go programming language and fully integrated in to the Cloud Integrated Advanced Orchestrator (Ciao) [1]. The Go programming language was selected for several reasons, including the efficiency of the language regarding both speed and memory, the concurrency capabilities, and the ease of implementation. Go was compared against C and Python as alternatives, and prevailed in every criteria except for availability of the language.

This network mode will be written as a standalone networking mode for Ciao as an additional option to the standard Linux bridges available now. For this reason it must be fully integrated with the Ciao networking framework as it currently exists [2].

VI. Summary

We have outlined the steps and design strategy we will take for each goal. Our design methodology is incremental design, starting with the first goal (Open vSwitch-created GRE tunnels) and incrementing through each feature until all goals are achieved.

VII. Signatures

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