UNIVERSITÉ DE RENNES 1

Direction de la Recherche et de l'Innovation

Appel à projets - Année 2023

Contrats doctoraux «Ordinaires»

ECOLE DOCTORALE : MATHSTIC **POLE DE RECHERCHE : IRISA**

Unité de recherche d'accueil

Unité de Recherche : UMR6074

Equipe : WIDE

Encadrement

Directeur de thèse : Yerom-David Bromberg **Unité de recherche** : UMR6074

Employeur/Établissement d'origine : Université de Rennes 1

HDR : ☒ oui ☐ non **Nb de thèses en cours** : 1

Mail : david.bromberg@irisa.fr **Tél.** :

Co-directeur de thèse : Djob Mvondo **Unité de recherche** : UMR6074

Employeur/Établissement d'origine : Université de Rennes 1

HDR : ☐ oui ☒ non **Nb de thèses en cours** : 1

Mail : barbe-thystere.mvondodjob@univ-rennes1.fr **Tél.** : 0695396684

Sujet

Titre : FASTSYNC : Efficient clock synchronization in a datacenter

Mots clés : System, Datacenter, Time synchronization protocols, Linux Kernel, Hardware

Cotutelle internationale (~~oui~~/non) : **Si oui, préciser l'établissement et le pays de rattachement** :

Descriptif (15-30 lignes) :
Contexte socioéconomique et scientifique ; Les hypothèses et questions posées ; Les grandes étapes de la thèse et démarche ; Approches méthodologiques et techniques envisagées

Context

Clock synchronization is of utmost importance for applications running in a datacenter. It becomes critical for large scale distributed systems (e.g., databases--- RocksDB, Spanner, etc.), where each server epoch will determine the validity of a transaction. Additionally, clock synchronization is critical for fault tolerance protocols such as SMR (state machine replication) that relies on heartbeats to determine the health situation of a state. However, for servers in a datacenter, sources of clock inconsistency are numerous.

The principal source of inconsistency originates from the network devices (mainly switches) that interconnect the different servers. Indeed, a switch performs several tasks and its load continuously vary. Thus, network packet processing can be delayed within a non-determinist interval and lead to the delay of network packets delivery, necessary to ensure clock synchronization. Another source of inconsistency is the kernel network stack, which introduces significant delays for user-space applications that need to process the network packet to synchronize. Despite existing techniques such as NTP (Network Time Protocol) or PTP (Precision Time Protocol), it is hard to achieve a determinist protocol that ensures micro-second level and fault-tolerant clock synchronization.

Objective

The main aim of the PhD is to propose a low-cost, micro-second level, determinist, and fault-tolerant clock synchronization protocol for servers in a datacenter. Our key insight is to use a different path than the network path to be free from loads on network devices. Thus, our starting point is the state-of-the-art of the different usable paths such as Bluetooth. The output of the state-of-the-art phase will be the different parameters of each alternative path such as the additional hardware required, the cost, and operating system support. Based on the state-of-the-art result, we will proceed to design a synchronization protocol relying on the alternative path. Then, we will implement a prototype of the protocol, with an emphasis on efficient kernel drivers to leverage the new hardware and alternate path. We intend to test the resulting prototypes on simulated and real datacenter testbeds.