**Progettazione e realizzazione di un sistema distribuito per il monitoraggio ambientale dei parchi comunali**

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1. INTRODUZIONE

Il monitoraggio delle condizioni ambientali dei parchi comunali è fondamentale per le amministrazioni locali che necessitano di dati aggiornati per ottimizzare la manutenzione e garantire la qualità degli spazi verdi urbani.

Il presente progetto sviluppa un sistema distribuito per il monitoraggio ambientale dei parchi comunali basato su un'architettura edge-cloud. Il sistema è composto da dispositivi edge dotati di sensori per il rilevamento delle condizioni climatiche (temperatura, umidità, luminosità e qualità dell’aria) che raccolgono periodicamente dati ambientali e li trasmettono a un server centralizzato per l'elaborazione e la visualizzazione.

Per garantire realismo nella simulazione, i dispositivi edge sono implementati come macchine virtuali con k3s per la gestione dei microservizi in Python. I dati raccolti vengono sottoposti a controlli di validità prima della trasmissione, evitando l'invio di informazioni ridondanti o errate. Il server è ospitato su un'istanza EC2 di AWS e utilizza Minikube per gestire un cluster Kubernetes che orchestrare i microservizi di back-end (sviluppati in Go) e front-end (HTML+JavaScript). La persistenza dei dati è gestita con un database relazione e la visualizzazione dei dati in tempo reale tramite un’interfaccia web.

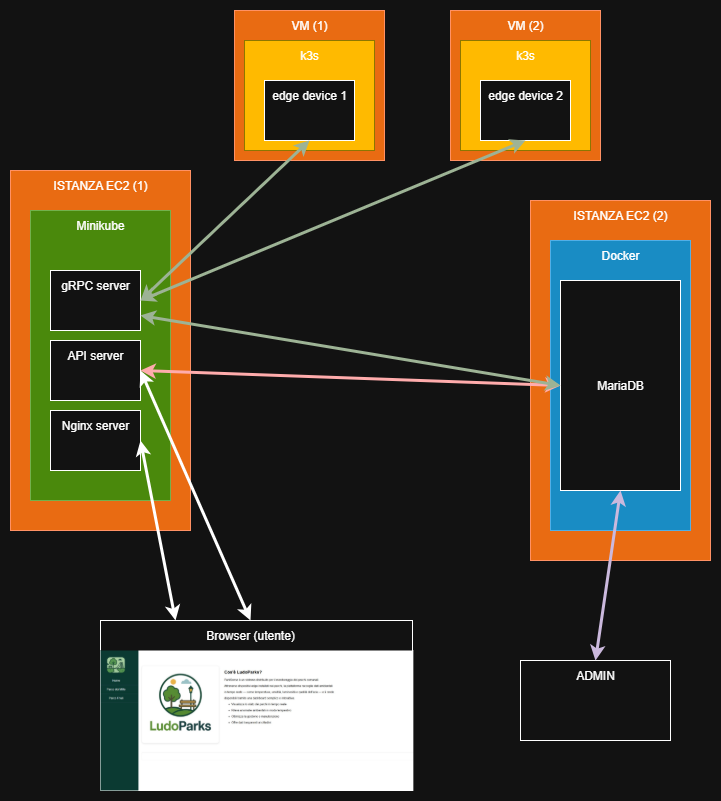
L'architettura adottata dimostra l'integrazione efficace di edge computing, containerizzazione e servizi cloud, applicando i principi fondamentali dei sistemi distribuiti per creare una soluzione scalabile e affidabile per il monitoraggio ambientale urbano.

1. ARCHITETTURA DEL SISTEMA

Il sistema è composto da cinque componenti :

1. *Edge device:* sui dispositivi edge è presente un cluster k3s per la gestione di un microservizio, sviluppato in Python, che simula i dati ambientali raccolti da un sensore. Ogni edge effettua un pre-processamento locale ed invia i dati al backend tramite gRPC. Nel pre-processamento avviene anche un controllo di validità dei dati e rilevamento di variazioni significative rispetto agli ultimi valori raccolti.
2. *Backend:* per il server cloud sono stati sviluppati 2 microservizi in Go, uno che consente di ricevere le misure raccolte dai dispositivi edge, tramite gRPC; l’altro microservizio serve per esporre delle API REST per il frontend, attraverso cui vengono fornite le misure aggiornate e i dati storici
3. *Frontend:* Il servizio per il frontend è stato realizzato a partire da un server Nginx, che restituisce le risorse web (HTML+Javascript). Comunica con il backend tramite richieste periodiche e mostra i dati in tempo reale, sia in forma testuale che tramite grafici.
4. *Database:* Il database si trova su un’istanza EC2 separata ed è basato su MariaDB che è un sistema di gestione di database relazionali.
5. *Admin:* l’amministratore del sistema avrà un programma dedicato con il quale può inserire, rimuovere parchi e sensori, oltre ad effettuare l’associazione e la dissociazione dei sensori dai parchi.

I componenti del backend e del frontend sono containerizzati e orchestrati all’interno di un cluster Minikube installato su un’istanza EC2, ed ogni microservizio è contenuto in un pod distinto.



1. IMPLEMENTAZIONE
2. *Dispositivi edge:* I dispositivi edge consistono in dei dispositivi con dei sensori che raccolgono i dati ambientali e li inviano al server. Tali dispositivi sono simulati, ovvero su una macchina

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