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Energy Saving xApp

Technical Specifications

Overview

The Energy Efficiency xApp (EE xApp) by Velinkx Ltd is a cutting-edge solution designed to address the growing energy demands of 5G networks while aligning with sustainability goals. Built specifically for Open Radio Access Network (O-RAN) architecture, this xApp intelligently manages power consumption across the disaggregated network components, including Radio Units (RUs), Distributed Units (DUs), and Centralized Units (CUs). By leveraging real-time traffic data and utilizing advanced resource allocation strategies, the EE xApp optimizes the operational states (active, idle, or sleep) of network elements, ensuring efficient energy usage without compromising on service quality.

The EE xApp overcomes this limitation by employing a dynamic, data-driven approach to selectively activate or deactivate Carrier Components (CCs) within RUs, virtual Distributed Units (vDUs), and CUs based on traffic load and user density.

The core functionality of the EE xApp includes monitoring key network metrics, such as user equipment (UE) density, reference signal received power (RSRP), and traffic load per CC, through interfaces like the E2 and fronthaul. These inputs are processed using sophisticated algorithms to make real-time decisions about resource allocation and power state transitions. For example, under low traffic conditions, the xApp consolidates traffic to minimize the number of active CCs and puts the remaining units into low-power or sleep modes, significantly reducing energy consumption.

Its dynamic optimization of resource allocation not only enhances energy efficiency but also aligns with the operational flexibility of O-RAN, supporting multi-vendor environments. This innovative solution positions Velinkx Ltd as a leader in sustainable 5G operations, offering network operators a scalable, intelligent, and eco-friendly energy management tool.

Technical Specification of EE xApp

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The Energy Efficiency xApp (EE xApp) is designed to optimize the power consumption of 5G O-RAN networks by dynamically managing the operational states of key components such as RUs, DUs, and CUs. Its functionality relies on monitoring real-time traffic patterns and leveraging open O-RAN interfaces to adapt resource utilization for maximum energy efficiency.

- **Functional Components Monitored**

- Radio Units (RUs): The xApp continuously tracks the traffic load distribution across Carrier Components (CCs) in the RUs. Based on real-time traffic data, it facilitates transitions between different power states, such as sleep, idle, and nominal. These transitions minimize energy consumption during low traffic periods while ensuring active CCs handle user demand effectively. The xApp also optimizes the activation and deactivation of CCs within macro and small cells, allowing unused RUs to enter low-power modes.

- Distributed Units (DUs): The xApp monitors virtual Distributed Units (vDUs) within each DU, scaling their power consumption according to CC traffic. It dynamically adjusts DU-RU mappings to consolidate traffic, reducing the number of active DUs and allowing the remaining units to enter sleep or idle modes.

The xApp tracks CC traffic loads and adjusts resource allocations accordingly. By enabling dynamic transitions between power states, the xApp ensures that CUs operate efficiently, processing traffic loads only when needed.

This dynamic, component-specific monitoring empowers the xApp to achieve significant energy savings while maintaining optimal network performance.

Input Parameters Monitored Through Interfaces– Inputs to EE xApp

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The EE xApp monitors key input parameters through O-RAN's standardized interfaces, enabling intelligent optimization of power consumption across RAN elements. These parameters provide real-time insights into network traffic, component states, and resource utilization, forming the basis for dynamic energy-saving decisions.

- **Input Parameters Monitored**

1. **Traffic Load (DRB Allocation):**
    1. Monitored via the E2 interface to evaluate traffic load and determine when to shut down or activate CCs. For example, low UE density, indicated by fewer DRBs in use, prompts the xApp to move users to another active CC and gradually shut down the 5G CC to save energy.
    2. Provides data for UE-RU mapping and RU traffic allocation.
2. **Reference Signal Received Power (RSRP):**
    1. Accessed through the E2 interface to evaluate signal strength for UE-RU association.
    2. Ensures UEs are connected to the most energy-efficient RU while maintaining quality of service.
3. **Active Carrier Components (CCs):**
    1. Managed via the fronthaul interface to determine the operational status of CCs in RUs.
4. **Power States of Components:**
    1. Data on sleep, idle, and nominal modes is monitored through the E2 interface for RUs, and DUs.
5. **Fronthaul Capacity:**
    1. Tracked via the E2 interface to ensure RU-DU and CU-DU mapping remain within capacity constraints.

- These inputs enable the EE xApp to make data-driven adjustments, achieving significant energy savings while maintaining network reliability.

Outputs from EE xApp

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The EE xApp provides critical outputs that enable network optimization and energy savings in 5G O-RAN systems. Below are the key outputs from the xApp:

- **Cell Power State Adjustments:**
  1. Shut Down/Activate 5G Cells: Based on traffic load (monitored through DRB allocation), the xApp outputs commands to turn off 5G cells during low traffic periods or activate them when LTE cells experience increased connection requests.
  2. Graceful Shutdown: The xApp ensures that 5G cells are gradually powered down, allowing users to be reassociated with alternative active 4G or 5G cells before complete shutdown.
- **UE-RU Mapping:**
  1. Optimal UE-RU Mapping: The xApp outputs instructions to map users to the most energy-efficient RUs based on the traffic load, RSRP, and available capacity. This mapping minimizes the number of active RUs, reducing power consumption by consolidating users into fewer active RUs during low traffic conditions.
  2. User Reassociation: In the event of cell shutdown, the xApp outputs the new RU mapping to ensure users are reassigned to another active cell with minimal impact on their service experience.
- **RU-DU Mapping:**
  1. Dynamic RU-DU Mapping: The xApp optimizes the mapping between RUs and DUs, ensuring that RUs are efficiently assigned to available DUs based on their traffic load and capacity. This helps balance the load across DUs and ensures that energy consumption is minimized.
  2. Traffic Balancing: The xApp dynamically adjusts the RU-DU mapping to balance the load between RUs and DUs, ensuring efficient resource utilization and reducing the overall energy consumption of the DU.

Prerequisites for Installing the EE xApp

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- **System Requirements**
- **Software Requirements**:
  - **Open-Source RIC Platform**: Installed and configured (e.g., O-RAN Software Community RIC).
  - **Kubernetes**: For container orchestration (v1.20 or higher recommended).
  - **Docker**: For EE xApp deployment (v20.10 or higher).
  - **Helm**: For managing the xApp deployment (v3).
- **Other Tools**:
  - Git for downloading xApp source code or images.
  - E2 Termination in the RIC for handling E2 messages.
- **Preparation Steps**

1. **Set Up RIC**:
   1. Install and configure the RIC platform on the host machine using O-RAN Software Community documentation.
   2. Verify RIC services are active (e.g., RIC Manager, E2 Termination).
2. **Configure RAN Components**:
   1. Ensure the open-source RAN (e.g., srsRAN) is operational and connected to the RIC.
   2. Configure the RAN for E2 interface communication with proper Service Models (SMs) like RC and RSM.

Installation Instructions for EE xApp

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- **Download EE xApp:**
  - Clone the repository or download the EE xApp docker image.
- **Prepare Kubernetes Cluster:**
  - Deploy the RIC platform on Kubernetes.
- **Deploy EE xApp:**
  - Using Helm.
- **Connect to RIC Platform:**
  - Ensure the EE xApp connects to the RIC E2 termination by configuring the config.json file of the xApp with proper E2 SMs and endpoints.
- **Validate Deployment:**
  - Confirm logs to ensure successful deployment.
- **Testing and Integration:**
  - Ensure the EE xApp exchanges E2 messages with the RAN nodes.
  - Test functionality by simulating low and high traffic loads.

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About us

VelinkX Ltd. specializes in creating xApps leveraging Open RAN technology, focusing on enhancing connectivity for autonomous and urban mobility. Our solutions are designed to bring efficiency, reliability, and real-time performance in dynamic wireless environments.

Our Services in the Open-RAN area include:

- xApp and rApp development for the RAN Intelligent Controller.
- Dedicated simulations and algorithm design.
- Consultancy services.
- Whitepapers and technical articles deliver.

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