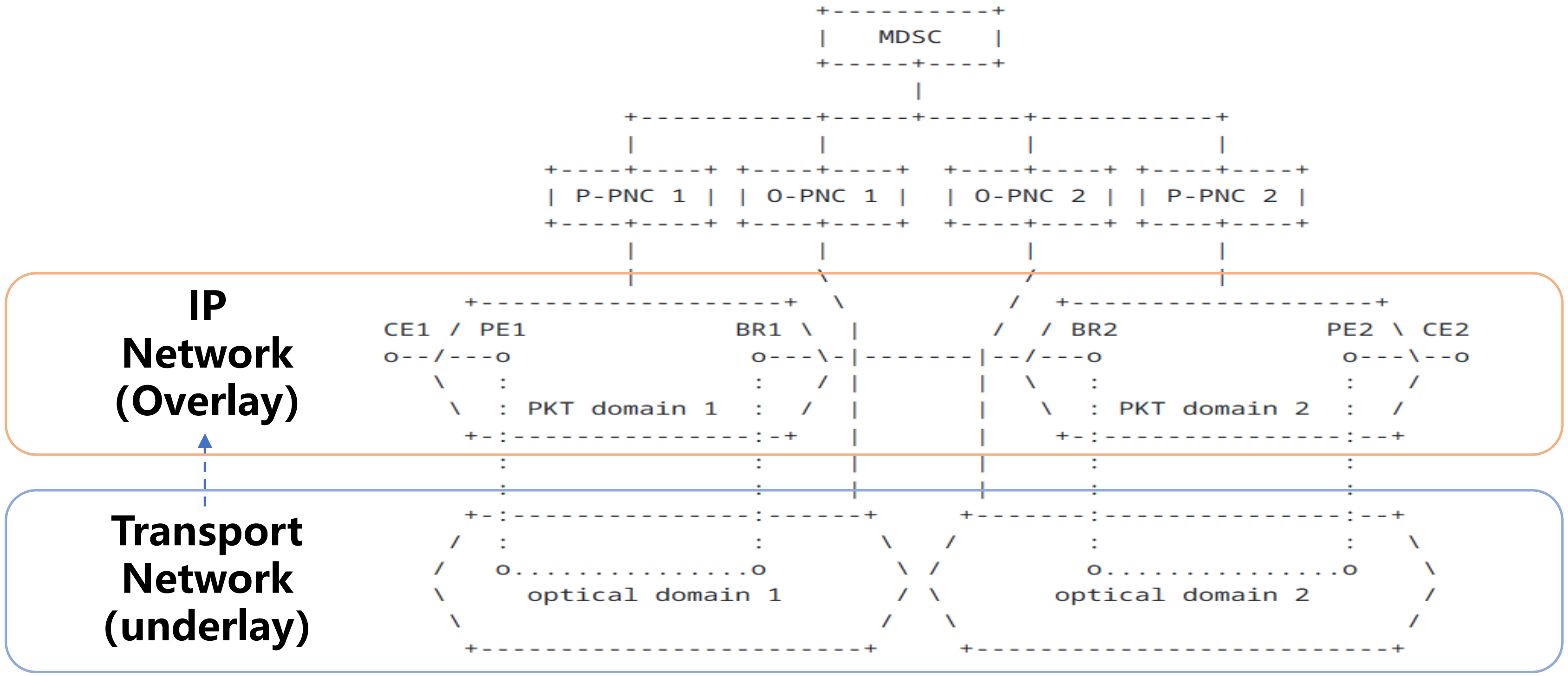
Transport Network Level Use Case for GREEN

draft-chen-green-transport-network-ucs-00

X. Chen (*CMCC)* , M. Wang (*CMCC)* , J.Zhou (*ZTE*) , J.Yan (*ZTE*)

July,2025

The necessity of transport network use cases for GREEN



Note: According to statistics, transport aggregation sites consume 3.16 billion kw·h of power, accounting for 12% of CMCC's power consumption.

- Transport network is the underlay compared to IP router's overlay role, designed for *guaranteed connectivity* with relatively rigid resource allocation.
- Transport network is the carrier of *integrated services* (TDM/IP) based on *physical infrastructures* (optical fiber, optical wavelengths), facing the challenges of *"dynamic traffic vs. static infrastructure"*.
- Transport network is the key enabler for GREEN multi-layer optimization.

GREEN challenges for transport network

- Fundamental Connectivity vs. Dynamic Traffic:

Unlike dynamic routing in IP, baseline transmission paths must be pre-configured to guarantee fundamental connectivity for basic assurance, idle resources caused by tidal traffic fluctuation are unavoidable.

- Ring topology： Transport network is ring-based topology where energy saving provision is different from that in IP tree/mesh network

✓ Ring ports must remain active for protection switching.

✓ Node resources (e.g., line cards) can be dynamically powered down.

- Cross-Layer Impact, Unified Control:

✓ Any change in the transport layer impacts the L3 IP overlay.

✓ A unified YANG management framework to ensure coherent, cross-layer configuration is required.

Transport network GREEN framework covers multi-layer energy saving management from transport layer (L0/L1/L2) to L3

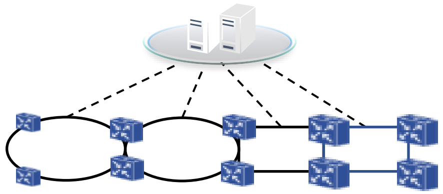
Transport network level use case

Use Case 1 – Network-Level Optimization

•Use case description:

Traditional Statistic Energy-saving Scheme

① Query for disabled boards/ports



②Automatic power down for the disabled boards/ports

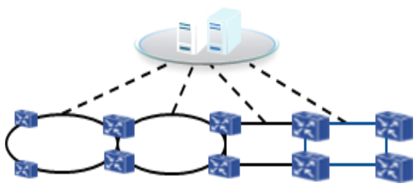
③If needed, port enabled, wake up port and board for the increased demand

Multi-layer energy saving management

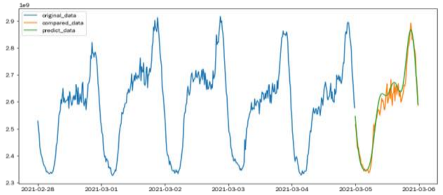
Network-level dynamically adjust with the change of traffic load, reducing the actual energy consumption of the device

Dynamic Energy-saving Scheme

① Learn and analyze current network traffic data

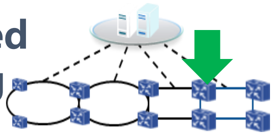


②Tidal traffic tracking and forecasting



③Risk assessment & Energy-saving simulation

④Issue energy-saving solutions based on comprehensive decision-making



Transport network level use case

Use Case 1 – Network-Level Optimization

- **GREEN specifics:**
  - Network level monitoring (**real-time data of energy consumption, traffic volume, temperature**, etc. to the management and control system)
  - Energy saving strategy generation (AI/ML traffic prediction+adaptive device power state)
  - Global scheduling and coordination

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+---------------------------------------------------------------+
|                  Transport Network Controller                 |
|                                                               |
|   Traffic Prediction  -> Network Optimization -> Evaluation   |
+---------------------------------------------------------------+
              ^                                   |
              |                                   |
          Monitoring                    Energy-Saving Strategy
              |                                   |
              |                                   v
+---------------------------------------------------------------+
|                                                               |
|                    Transport Network Element                  |
|                                                               |
+---------------------------------------------------------------+
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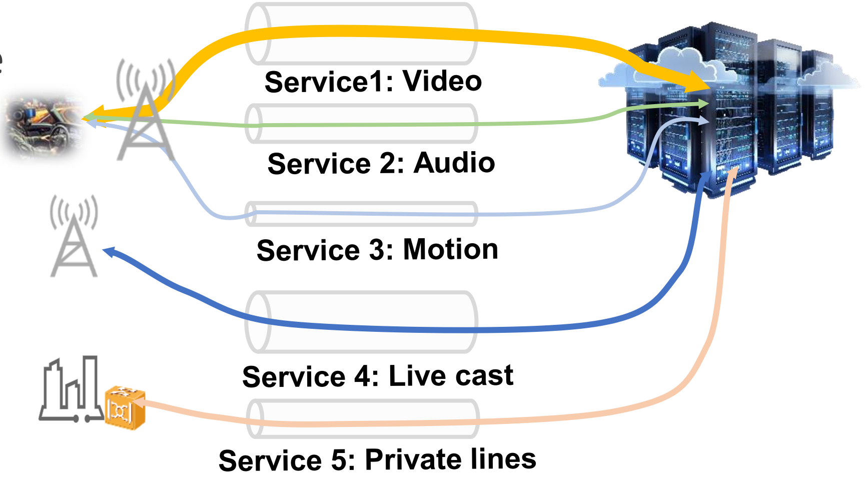
- **Requirements for GREEN:**
  - The controller has the ability to display energy consumption per transport network element at specified time granularity.
  - **The controller has the ability to manage the reserved resources of the devices based on the ring logical connection**.
  - The controller has the ability to perform accurate network-level traffic prediction, capturing both long-term regularities and short-term bursts, using historical traffic data.
  - The controller has the capability to generate GREEN optimization strategies including the traffic migration methods based on traffic forecasts, operating on defined planning cycles.
  - The device has the ability to switch the power state of components according to the traffic load dynamically.

Transport network level use case

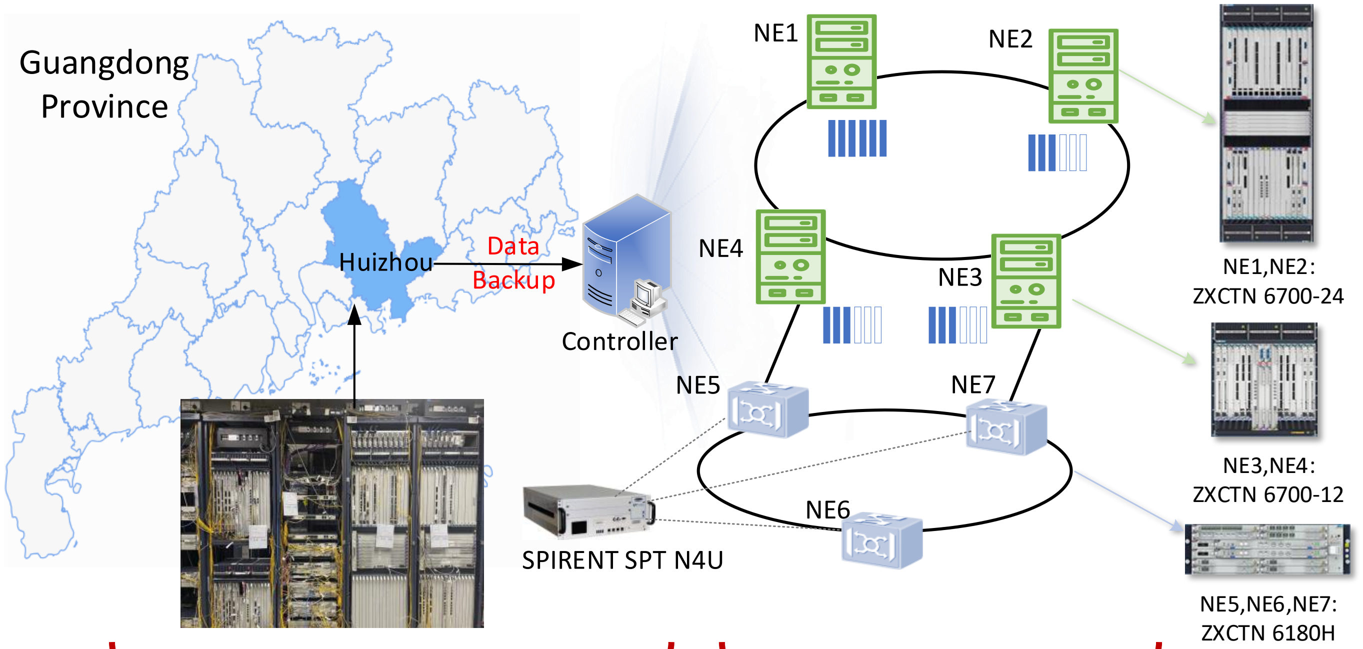
Use Case 2 – SLA-Aware Energy Saving

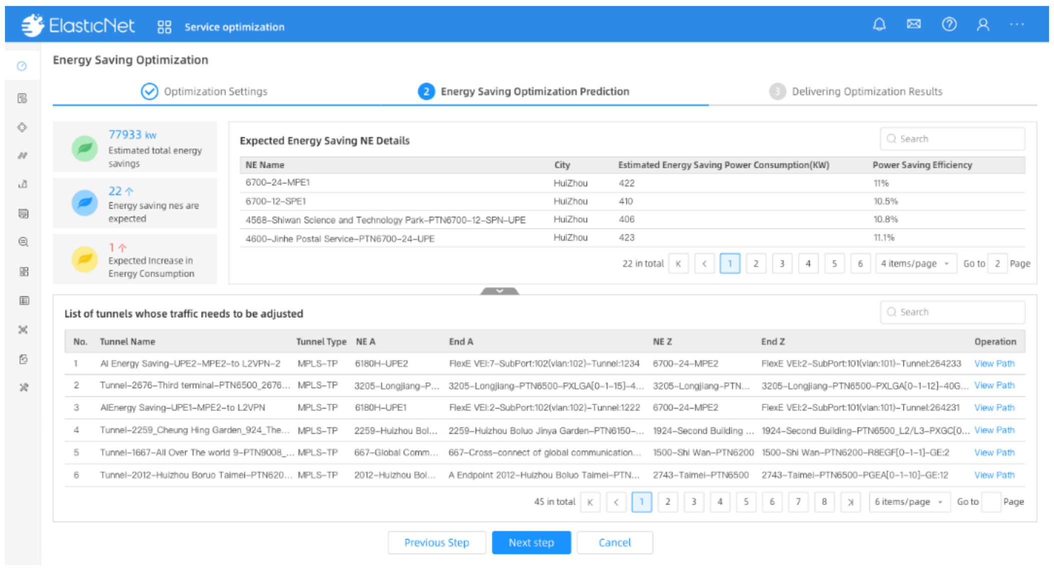
- **Use case description:**
  - Integrating energy saving factors into service assurance, aiming to achieve differentiated energy saving without affecting the quality of service.
  - For general-grade services, energy-saving strategies can allow devices to enter **deep sleep mode** (maximizing power reduction). For high-reliability premium services, strategies should prioritize stability by using **light sleep mode** (ensuring instant wake-up with zero service impact).



- **GREEN specifics:**
  - Network level monitoring (real-time data of energy consumption, traffic volume, temperature, **service SLA** etc. to the management and control system)
  - **Service assurance with energy efficiency: Energy efficiency factors can be taken into account in processes during service provisioning, in combination with the client's SLA and available underlying hard isolation resources**.
  - Control and management:Local automatic energy saving can be processed on the network element, if enabled.
- **Requirements for GREEN**:
  - The controller has the capability **to consider energy efficiency factor in the multi-layer resource allocation** during service assurance lifecycle.
  - The network element capability interacted between controller and transport network element must be considered.

Deployment considerations





Traffic data collected from Huizhou's commercial network involving 1966 NEs for prediction

Test network for energy-saving verification

Two service routes through NE1 and NE4 can be adjusted for energy saving, each with a traffic flow of 18Gbps.

- Route1: from NE6-NE5-NE4-NE1-NE2 to NE6-NE7-NE3-NE2
- Route2: from NE5-NE4-NE1-NE2 to NE5-NE7-NE3-NE2

- **NE1 and NE4 reveals 20.8% and 10.6% energy-saving benefits.**
- **For the whole network, network-level energy-saving strategy provides benefit of 7.7%.**

Open discussion & Next steps

Proposal & Discussion:

- **Transport network level use case and associated requirements not covered in the exsisting use cases draft (draft-stephan-green-use-cases-00).**
- **Use case and requirments for transport network to be included in GREEN WG.**

Next steps:

- **YANG model for data collection/aggregation/processing for transport network level green work, in terms of inventory and transport network model.**