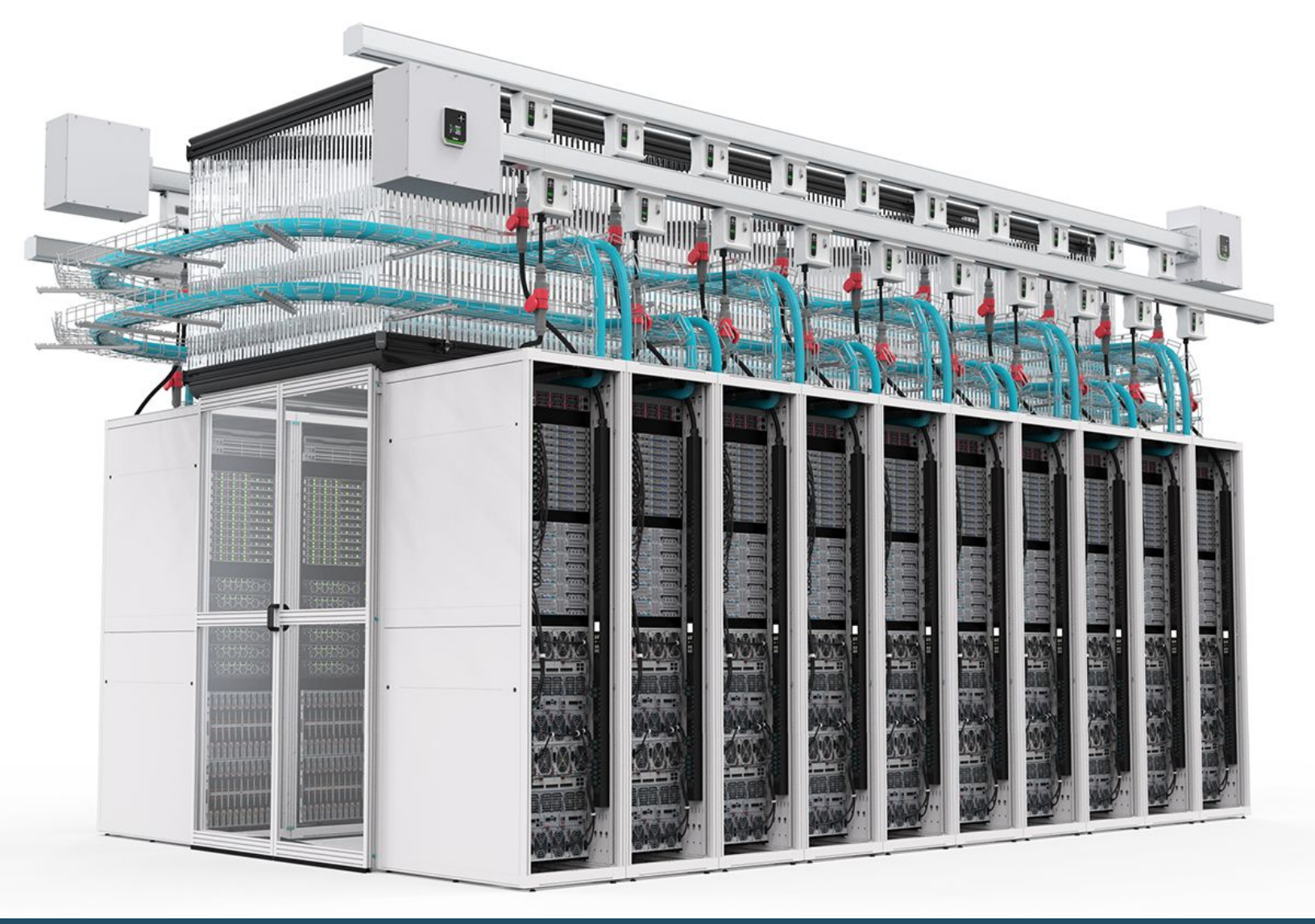


Solution Guide

zpe

Best Practices Guide for Managing PDUs in Data Centers & Remote Locations

Resilience and efficiency lessons learned from organizations managing critical power infrastructure

A brand of legrand

Executive Summary

Problem: Power Management is Manual, Costly, and Inefficient

Despite the use of DCIM and Out-of-Band (OOB) tools, managing Power Distribution Units (PDUs) still demands frequent on-site visits for tasks like firmware updates, outlet resets, and troubleshooting. This results in high operational costs, slow response times, and limited scalability, especially across distributed data centers and edge sites.

Gap: Existing Tools Lack Full PDU Control and Automation

DCIM platforms offer only basic PDU monitoring via SNMP and cannot perform critical functions like outlet-level control or remote firmware updates. OOB tools lack vendor flexibility, automation support, and resilience during network outages. This forces teams to manage devices manually, which increases errors and overhead.

Solution: Isolated Management Infrastructure (IMI)

An Isolated Management Infrastructure (IMI) enables secure remote management of PDUs. ZPE Systems' Nodegrid platform extends this with:

- Dual connectivity (Ethernet + serial) for full visibility and control
- Broad PDU vendor support with outlet-level automation
- RESTful APIs and scripting (Python, Ansible) for automated updates
- Resilient access via redundant WAN (LTE, 5G, Starlink)

Benefits and ROI: Lower Costs, Fast Scaling, and More Uptime

Deploying Nodegrid within an IMI framework allows organizations to:

- Cut site visit costs by enabling full remote PDU lifecycle management
- Accelerate deployments and ongoing operations using automation
- Improve uptime and responsiveness through reliable OOB access
- Centralize and standardize power management across locations

This guide outlines best practices for remote configuration, automation, and centralized management of PDUs using an IMI approach.

The Problem: Managing and Scaling Power Distribution Systems

Even With DCIM and OOB Solutions, Three Problems Persist

Large organizations may employ DCIM or OOB solutions. However, DCIM tools are designed to only provide PDU monitoring and basic software upgrade capabilities, while traditional OOB solutions lack comprehensive PDU integration and granular remote control. For troubleshooting, scaling, and managing PDUs, teams still struggle with three problems:

1. Too Much Time On-Site: When firmware updates crash PDUs, SNMP interfaces become unresponsive, or specific outlets must be rebooted, teams need to physically connect their crash cart or USB stick. Without granular remote configuration and troubleshooting capabilities, teams are forced to perform tasks on-site, which increases costs, strains IT resources, and delays issue resolution.

Image: Traditional solutions force technicians to be on-site to configure and troubleshoot PDUs.

2. Too Much Manual Work: PDUs lack flexible support for automation, forcing teams to perform repetitive tasks across their PDU fleet. This increases the risk of errors and misconfigurations, and slows down scaling as teams must perform tedious jobs for each new deployment.

3. Too Much Overhead: Enterprises using hundreds or thousands of distributed PDUs need to track and manage each one individually. There's too much administrative overhead just to keep the lights on (literally).

Solving the overarching problem requires addressing three questions:

1. **How can we eliminate on-site work and enable remote power management?**
2. **How can we accelerate scaling and automate PDU management?**
3. **How can we reduce overhead and centralize administration of PDUs?**

The Solution: Isolated Management Infrastructure

1. How Can We Eliminate On-Site Work and Enable Remote Power Management?

Problem:

Enterprises commonly connect PDUs to DCIM systems using Ethernet and SNMP. This provides basic visibility into PDU status and may allow for software updates. However, few organizations leverage a robust OOB solution for PDU management. As a result, IT teams are often forced to dispatch personnel for tasks like configuration, troubleshooting, or recovery, especially when PDUs become unresponsive. This reliance on on-site intervention drives up operational costs and delays resolution times.

Gap:

DCIM platforms rely on SNMP, which is limited to monitoring, not management. DCIM tools cannot perform critical tasks like configuration changes or power cycling. Traditional OOB solutions offer partial coverage by connecting to PDU serial ports, but most lack broad vendor support, fine-grained per-outlet control, and reliable connectivity. Worse, they typically depend on a single WAN link, which becomes a point of failure. When firmware updates fail or remote links drop, teams have no option but to go on-site.

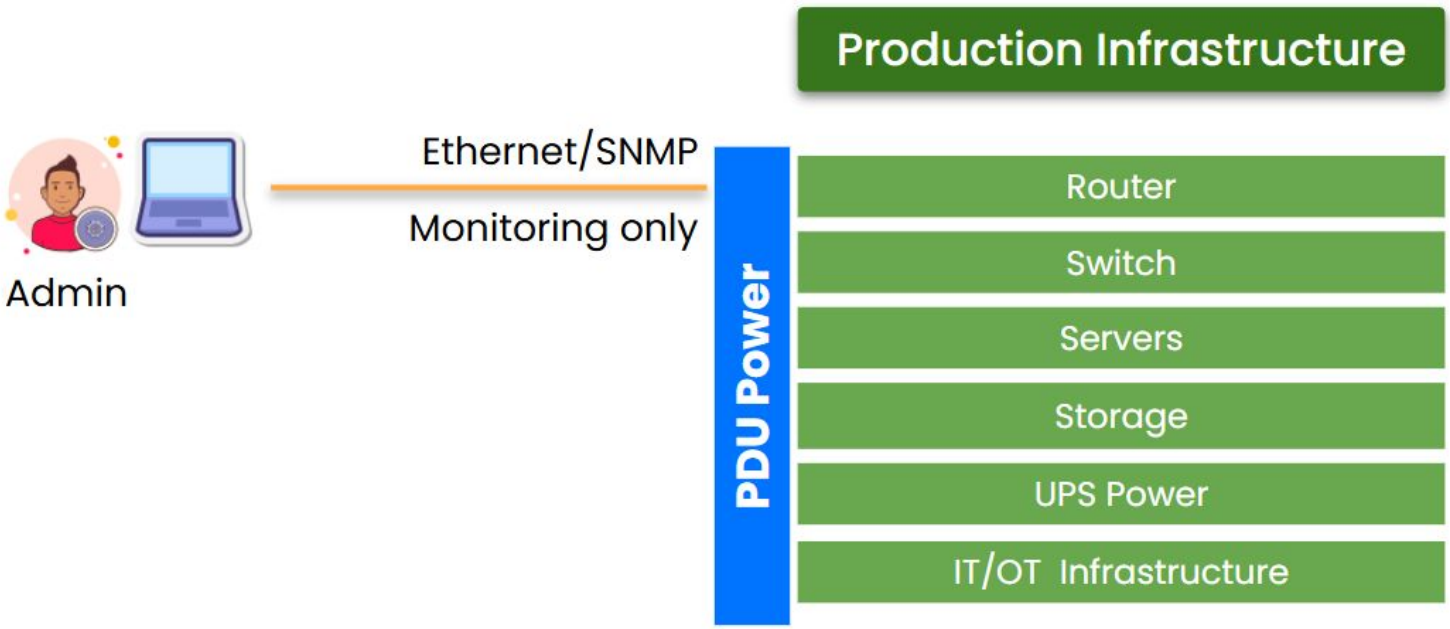


Diagram: *Ethernet-connected PDUs use SNMP to transmit data to DCIM solutions, but these interfaces are used only for monitoring PDU usage and health and cannot be used for remotely configuring or troubleshooting PDUs.*

Best Practice:

An Isolated Management Infrastructure (IMI) is a dedicated management network built to support remote operations. IMI best practices call for connecting PDUs to both Ethernet (for monitoring) and serial (for full OOB access). This dual-connection model allows remote teams to manage PDUs in real time, from updating configurations and firmware, to cycling device power – all without visiting the site.

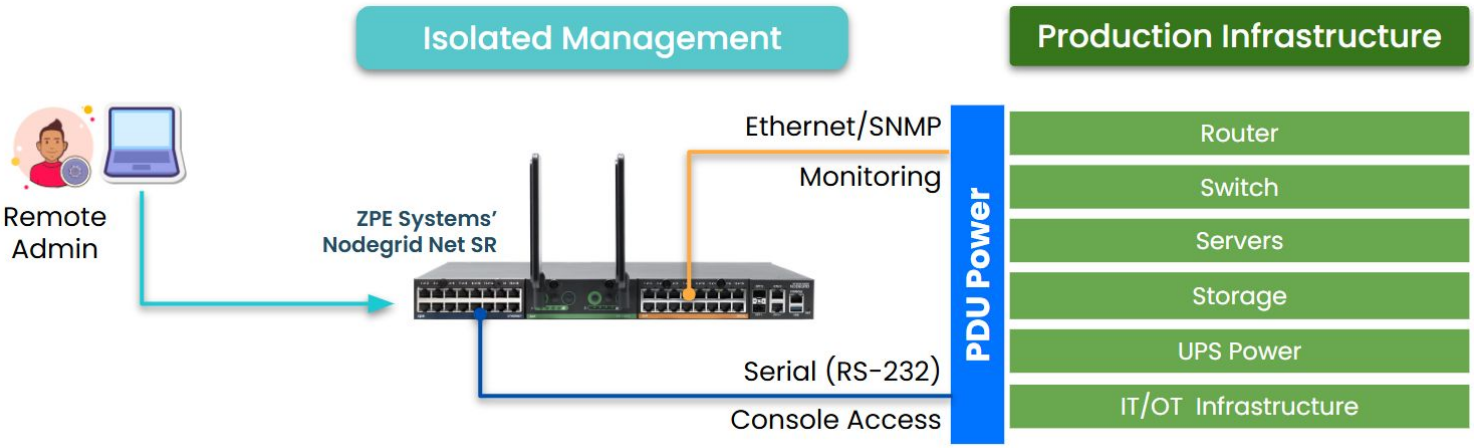


Diagram: *IMI best practices use both Ethernet and serial connections to provide remote monitoring of and console access to PDUs. ZPE Systems' Nodegrid improves upon IMI by fully integrating with a wide range of vendor PDUs and interface types, allowing remote admins to configure, troubleshoot, and recover PDUs as if they were on-site.*

How ZPE Improves Best Practices:

- **Broad Vendor Compatibility:** Nodegrid supports more than a dozen PDU vendors out of the box, which eliminates vendor lock-in or the need for custom integrations.
- **Comprehensive Access Options:** Access PDUs via serial, SNMP, REST API, or secure web interface to allow for full remote control over PDUs.
- **Granular Outlet Control:** Gain precise control at the outlet level for power cycling, monitoring, and automation, so teams don't have to be on-site to flip a switch or gather data.
- **Reliable Out-of-Band Connectivity:** Nodegrid appliances offer redundant WAN links (LTE, 5G, Starlink), ensuring remote access even during network outages.
- **Comprehensive Security Framework:** Nodegrid enforces strong role-based access controls, zero-trust architecture, secure boot, and encrypted communications to protect critical power infrastructure from unauthorized access and cyber threats.

2. How Can We Accelerate Scaling and Automate PDU Management?

Problem:

Many PDUs lack native support for APIs, scripting interfaces, or integration with infrastructure-as-code platforms. This means IT teams are forced to manage PDUs manually and configure each unit individually through web GUIs or vendor-specific tools. As deployments grow, these manual processes become a bottleneck that increases the likelihood of human error and delays.

Gap:

Traditional PDU management solutions are designed to scale in terms of providing power, not network capabilities. Most provide only basic SNMP or CLI access with limited or no support for modern automation frameworks like Ansible, Python, or Terraform. These systems lack robust APIs and have limited vendor ecosystems, with inconsistent capabilities across models. IT staff must log into each device separately to perform configuration, power cycling, or firmware updates. This slows down site provisioning, complicates remote operations, and makes automation nearly impossible in multi-vendor environments.

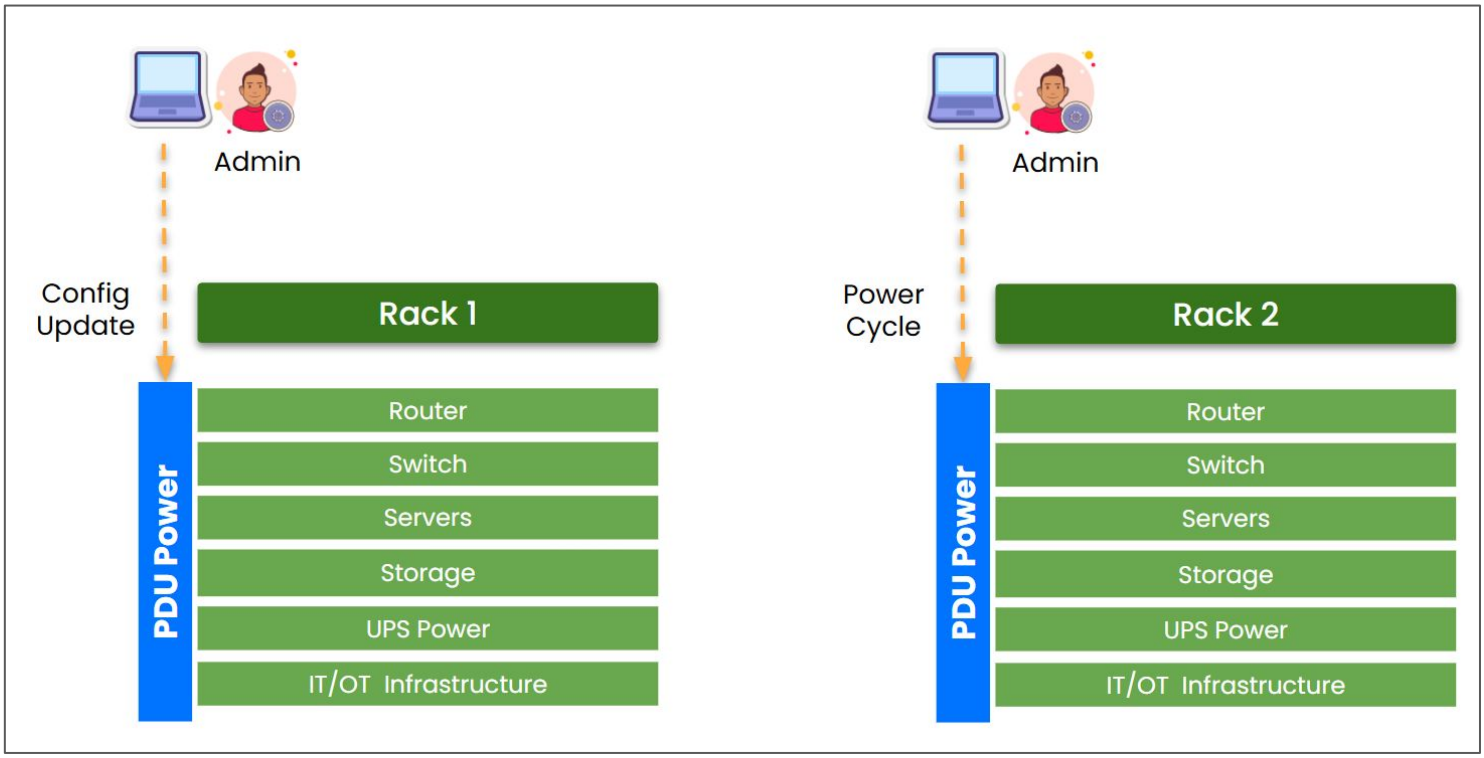


Diagram: PDUs lack support for modern automation solutions, forcing admins to connect to each device individually to perform manual configuration updates, power cycling, and firmware updates.

Best Practice:

As part of IMI, a vendor-neutral management platform can abstract complexity and enable centralized automation across all PDUs, regardless of make or model. The best practice is to deploy a platform that integrates easily with existing automation tools and pipelines, supports script-based configurations, and allows remote power control workflows to be triggered automatically.

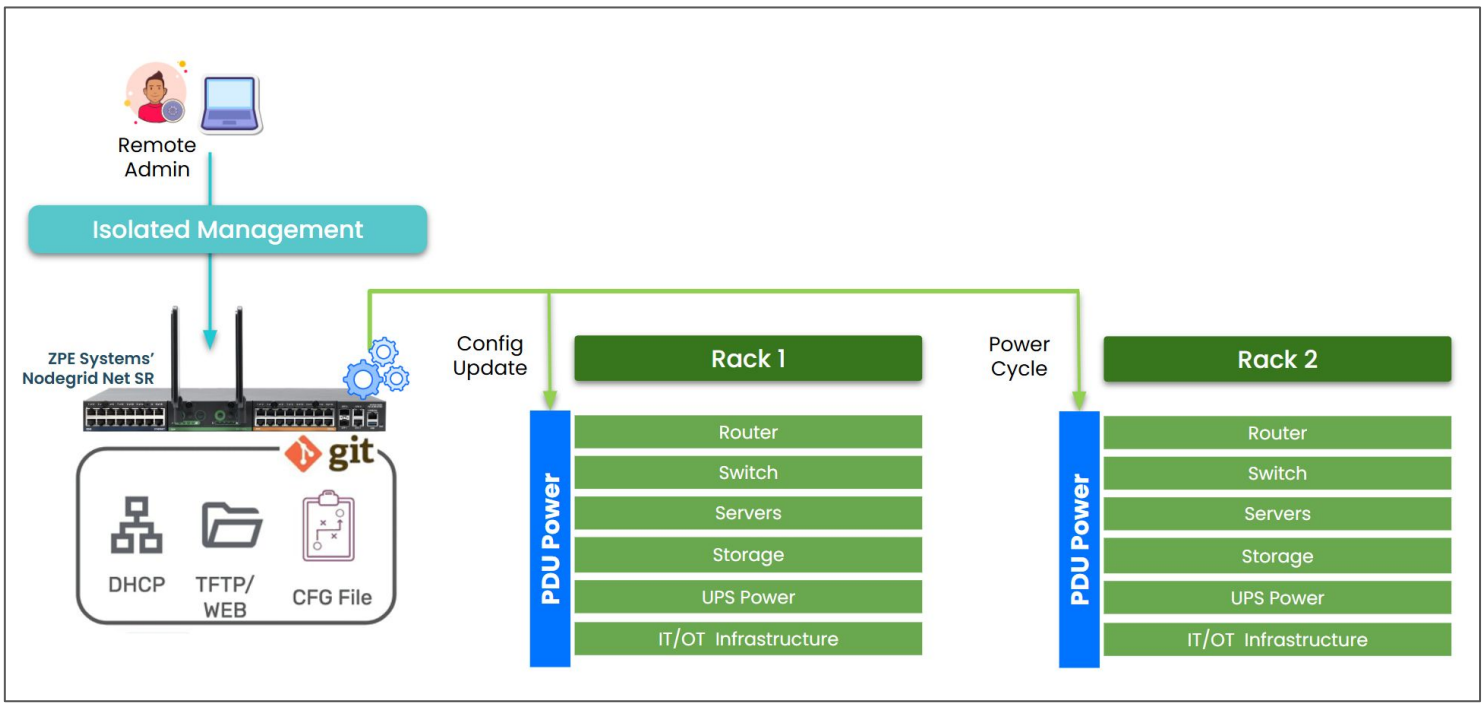


Diagram: IMI serves as a dedicated environment for running automation tools and pipelines. Nodegrid improves on IMI by allowing teams to automate configuration and troubleshooting of PDUs and the entire rack via DHCP or TFTP, which eliminates the need for separate servers or manual configurations.

How ZPE Improves Best Practices:

- **Scriptable Automation Framework:** Nodegrid supports infrastructure-as-code approaches with RESTful APIs, CLI tools, and native integrations with Ansible, Python, and other automation platforms, to enable repeatable, hands-off deployments.
- **Zero-Touch Provisioning (ZTP):** Nodegrid enables fully automated PDU onboarding through ZTP, allowing new units to configure themselves upon connection to support rapid edge, colocation, and data center rollouts.
- **Automated Monitoring and Firmware Management:** Nodegrid appliances can host the required TFTP and DHCP services for PDU firmware upgrades. Nodegrid can execute scripted updates or automatically upgrade PDUs using DHCP-based workflows. This eliminates the need for separate servers or manual intervention, keeping PDUs secure and up-to-date across all sites.

3. How Can We Reduce Overhead and Centralize Administration of PDUs?

Problem:

Managing hundreds or thousands of PDUs manually is time-consuming and error-prone. Each device may require its own login, update schedule, and configuration process, often spread across different vendor platforms and interfaces. This creates a significant administrative burden and increases the risk of misconfigurations, overlooked updates, and inconsistent security policies.

Gap:

Traditional PDU management solutions were never designed to operate at the scale or complexity demanded by modern enterprise and edge environments. Most lack multi-vendor support, centralized visibility, and native integration with automation frameworks or orchestration tools. IT teams are forced to manually log into each device to monitor health, apply firmware updates, or adjust outlet settings. These legacy approaches not only slow down daily operations but also hinder strategic initiatives like rapid site rollouts, power optimization, and compliance enforcement.

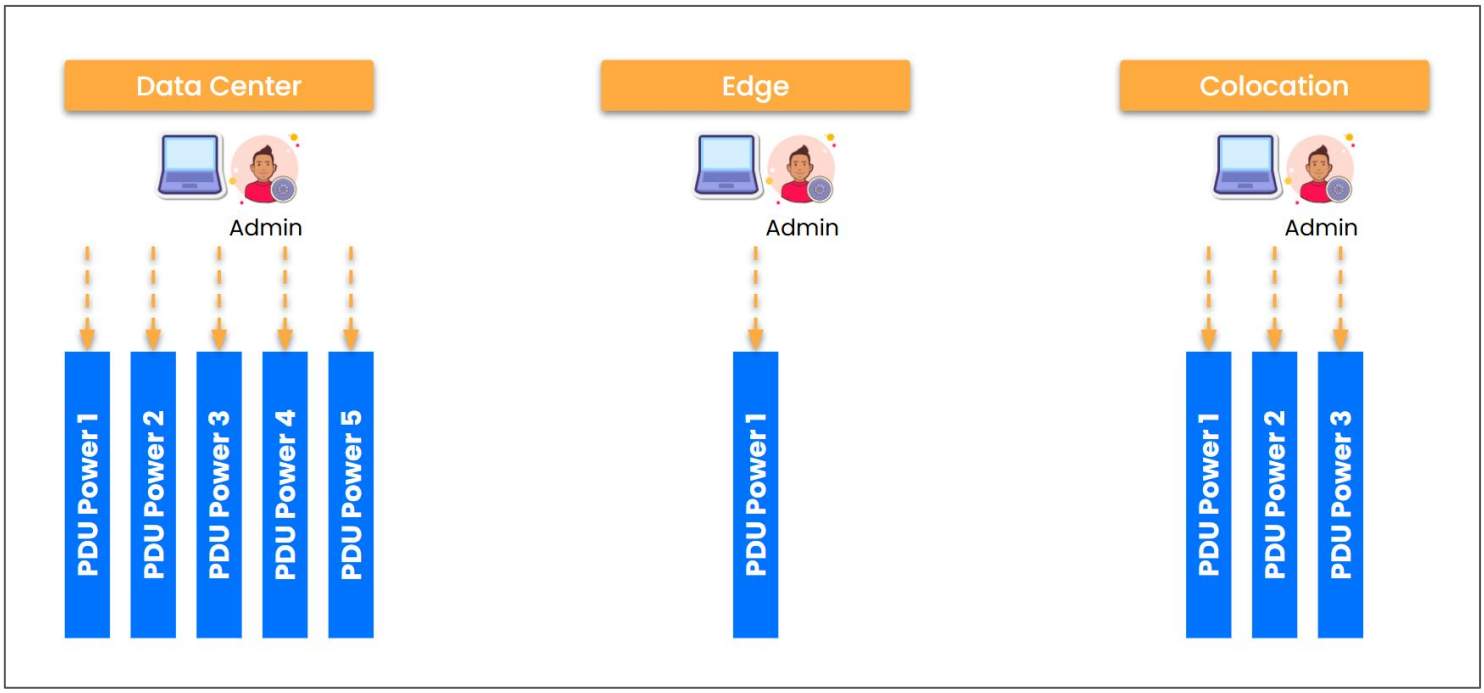


Diagram: PDU management solutions were not designed to scale or integrate with automation and infrastructure-as-code solutions. This creates a lot of administrative overhead, forcing admins to visit each site and log into each PDU, which consumes large chunks of time and valuable resources.

Best Practice:

The best practice for centralizing power management is to use an open-architecture platform capable of supporting multi-vendor devices, remote administration, and automation. This platform should reside on a dedicated IMI to ensure secure, uninterrupted access for management tasks. Integration with third-party power management tools, DCIM platforms, and scripting engines allows organizations to standardize operations and automate routine workflows across all sites.

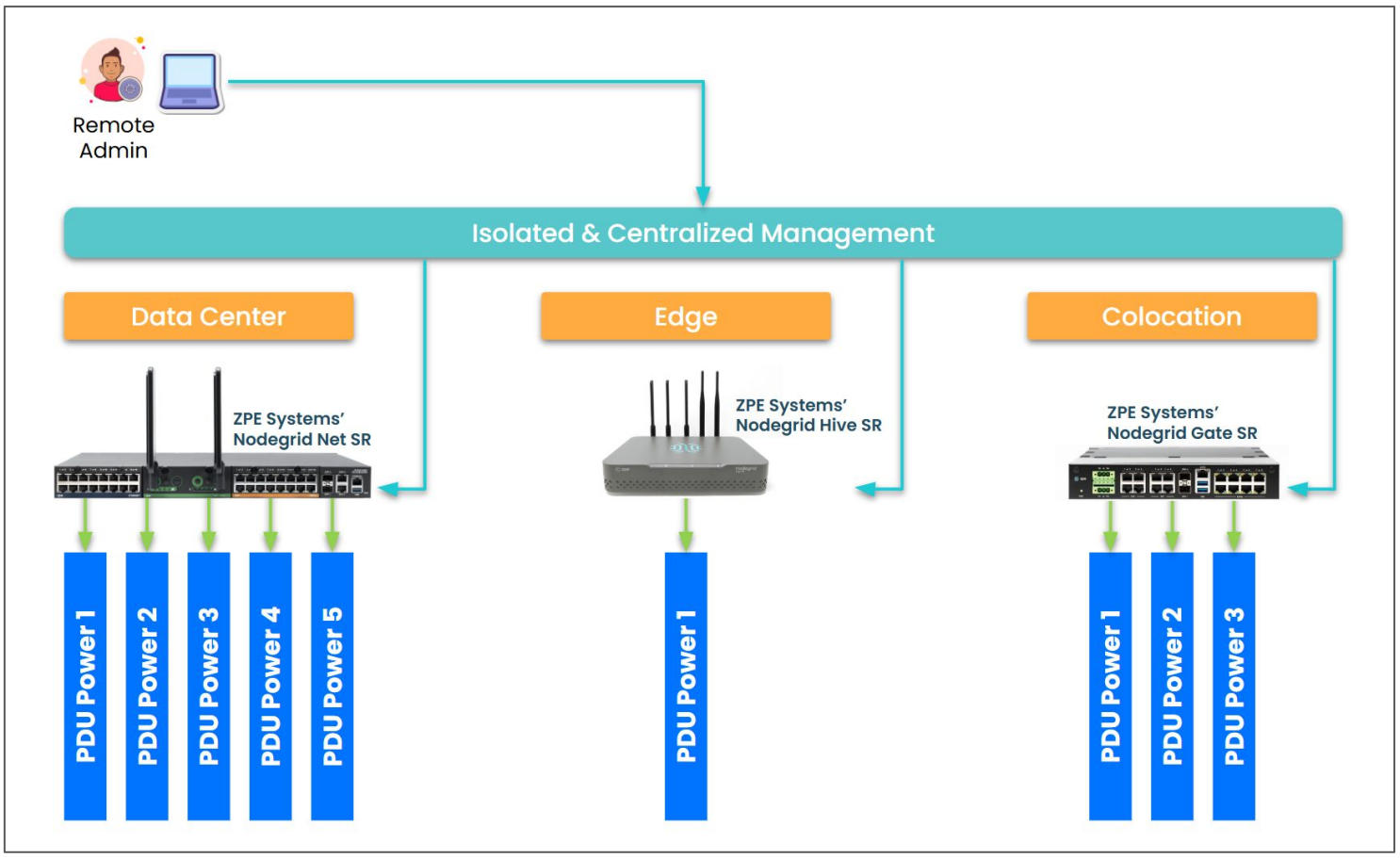
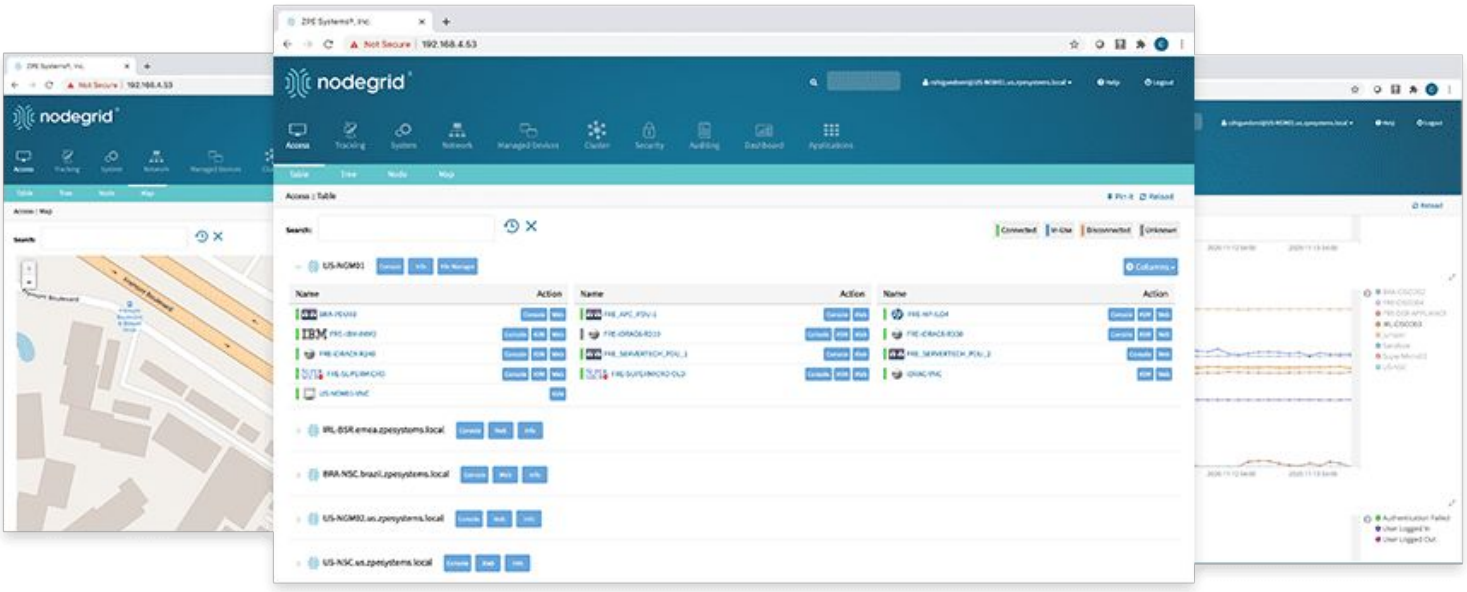


Diagram: IMI best practices call for using an open-architecture platform that integrates with a variety of vendor PDUs. Nodegrid improves on IMI by using an abstraction layer that normalizes commands across vendor PDUs, provides one secure login for remote access, and centralizes global PDU fleet management under one screen.

How ZPE Improves Best Practices:

- **Open Architecture with Third-Party Integrations:** Nodegrid integrates with a wide range of power management software, automation frameworks (e.g., Ansible, Python), and monitoring tools, for orchestrating and standardizing workflows across environments.
- **Scalable Power Management:** Nodegrid centralizes administration of thousands of PDUs from a single interface, streamlining updates, configuration changes, and monitoring without the need for per-device interaction.
- **Operational Efficiency:** By automating routine tasks like firmware upgrades, outlet control, and power policy enforcement, Nodegrid reduces manual workloads and frees up IT teams to focus on higher-value strategic initiatives such as capacity planning, performance optimization, and infrastructure expansion.
- **Comprehensive Remote Power Controls:** With Nodegrid, teams can remotely control and monitor power at the outlet level, schedule power actions, execute batch changes across groups of PDUs, and enforce power governance policies, regardless of location or vendor.



Screenshot: Nodegrid gives remote admins a centralized view of their global PDU and device fleet, all from their web browser. Users can monitor individual devices, perform updates, cycle power at the outlet level, and roll out automation scripts across their global fleet.

Blueprint for Isolated Management Infrastructure

To ensure reliable and scalable power distribution, organizations should implement IMI as follows:

1. **Physically connect all PDUs to the IMI:**
   Use Ethernet and serial/USB interfaces to connect PDUs to the IMI and enable remote configuration, updates, and troubleshooting.

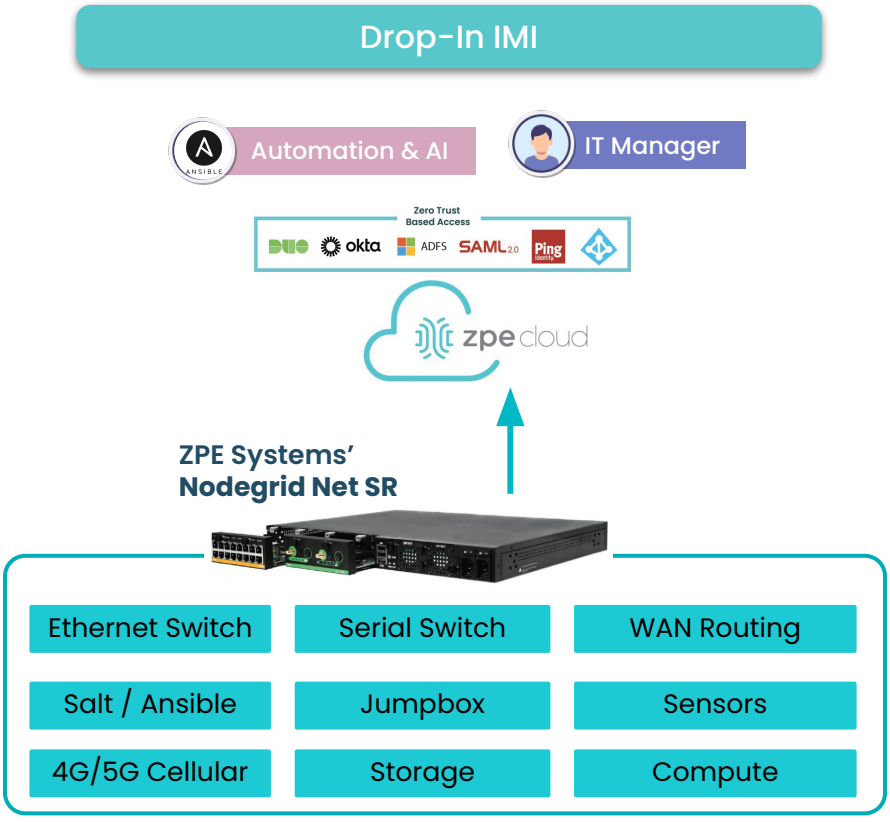
2. **Integrate automation and third-party tools:**
   Use an open-architecture solution that supports third-party automation and integrates with management solutions from any vendor.

3. **Deploy a centralized power management platform:**
   Consolidate PDU monitoring and administration using an open, vendor-neutral management platform.

Contact ZPE Systems for Drop-In IMI

ZPE Systems developed these best practices working with hyperscalers. The **modular Nodegrid Net SR** provides a scalable, secure platform for managing power infrastructure remotely.

ZPE also offers **professional services for installation and configuration,** ensuring seamless deployment and integration into existing IT workflows.



Get in touch for a demo!

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