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DESIGN STUDY

Modular data-center pod for a utility control center, 20 racks, two full power paths

Complete design on current platforms

CAPABILITY	INDUSTRY	SETTING
Data Center	Utilities	Transmission operator
DOCUMENT	**VERSION**	**DATE**
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Document control

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CONVENTIONS

Source tags. [S] figure read from the vendor's own current page on Sep 18, 2026 · [S*] figure from the vendor's page summary where the page itself could not be opened · [A] design assumption, to be confirmed by the signing engineer · [T] design target: the record's outcome figure and anything derived from it. No figure comes from any engagement, file or asset. A row with more than one tag is counted once: as a published figure if any tag is [S] or [S*], otherwise as an assumption if any tag is [A], otherwise as a design target.

Table 1. Revision history

Date	Version	Change
Sep 18, 2026	1.0	First issue.
Sep 20, 2026	1.1	Public implementations added; figures reconciled with published sources.
Sep 27, 2026	1.2	Figures and platform details rechecked against published sources.
Oct 10, 2026	1.3	Approval line now reads: approved by the Founder, issued by Symbeeo. Steve Phillips remains the author.

1 · Scope

Who it is for. The head of operations technology of a transmission operator whose regulator requires a second control center, whose site has a slab and a substation feed but no building program that fits the deadline, and who will not energize a control-system host that depends on a single power path.

Typical buyer [A]. An electricity transmission operator building a second control center. Load: 20 racks; 6 racks of control-system hosts (SCADA/EMS front ends, historians, HMI servers), 10 racks of corporate and support systems, 2 racks of network, 2 racks of storage and backup. Design draw 6 kW per rack, 120 kW IT load. Site: concrete slab, two utility feeds from different substations, 400 m of fiber to the existing control center.

What is in. The prefabricated pod's performance specification (power, cooling, fire, access), the two power paths inside it, the compute and network fit-out, the 96-hour burn-in before energization, and the acceptance record. **What is out.** The pod's structural, civil and utility-feed engineering (the pod vendor's and the operator's civil engineer's, [A]); the SCADA application; the WAN to substations; the choice of pod vendor, which the operator's procurement makes; Dell's modular range (§1c) is one listed option.

Assumptions. Dell and HPE are the server vendors, Cisco the network vendor [A]. The pod is specified by performance and bought from a facilities vendor not named here [A]. Control-system hosts run on HPE, corporate hosts on Dell, so a firmware or supply fault in one line never touches both [A]. Both utility feeds are live before the burn-in starts [A].

Related documents, read Sep 18, 2026.

- Dell PowerEdge R7725 technical guide — https://www.delltechnologies.com/asset/en-us/products/servers/technical-support/poweredge-r7725-technical-guide.pdf
- Dell PowerEdge R7715 — https://www.dell.com/en-us/shop/ipovw/poweredge-r7715
- HPE ProLiant Compute DL380 Gen12 QuickSpecs — https://www.hpe.com/us/en/collaterals/collateral.a00073551enw.html
- Cisco Nexus 9300-FX3 series switches data sheet — https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/datasheet-c78-744052.html

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- Cisco Nexus 9300-GX2 series fixed switches data sheet — https://www.cisco.com/site/us/en/products/collateral/networking/switches/nexus-9000-series-switches/nexus-9300-gx2-series-fixed-switches-data-sheet.html
- Dell modular data center solutions (read Sep 20, 2026) — https://www.dell.com/en-us/lp/solutions-modular-data-centers
- NERC CIP-005-8, Cyber Security, Electronic Security Perimeter(s) (read Sep 20, 2026) — https://www.nerc.com/globalassets/standards/reliability-standards/cip/cip-005-8.pdf
- Cisco, control center virtualization for the Connected Pipeline, design guide, system design (read Sep 20, 2026) — https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/Oil_and_Gas/Pipeline/1_0/Control_Center_Virt/DG/CC-DG-v6/Ch3-SystemDesign.html
- A/B feed redundancy, dual-corded equipment and the role of automatic and static transfer switches (read Sep 20, 2026) — https://www.epistechnology.com/data-center-power-redundancy-ab-feeds-ats-and-ups/
- Uptime Institute Journal, "Dual-Corded Power and Fault Tolerance: Past, Present, and Future", Aug 18, 2014, updated Oct 24, 2016 (read Sep 27, 2026) — https://journal.uptimeinstitute.com/dual-corded-power-details-change-theme-remains/
- Uptime Institute Journal, "Myths and Misconceptions Regarding the Uptime Institute's Tier System", Jul 20, 2017 (read Sep 27, 2026) — https://journal.uptimeinstitute.com/myths-and-misconceptions-regarding-the-uptime-institutes-tier-certification-system/

1c · Public implementations this design follows

Deployment rows are real public deployments, each dated. Where no public deployment matches, the row is Vendor documentation: the vendor's document that this design, Symbeeo's own, is built on.

Table 2. Public implementations this design follows

Implementation	Who published it · date	What it settles for this design	URL
Vendor documentation. Prefabricated modules on the market: "Click" at 5 to 20 racks of 48RU and 5 to 115 kW per rack; "Flex" at 5 to 100 racks; a custom line to 24 racks under UL 2755	Dell · Sep 14, 2026 (page metadata, read Sep 27, 2026)	R1 and R2: a 20-rack, 6 kW-per-rack pod on a slab is inside a listed vendor's standard range; §1 keeps the pod performance-specified and unnamed	https://www.dell.com/en-us/lp/solutions-modular-data-centers
Vendor documentation. Electronic Security Perimeter rule for control systems: "Applicable Systems connected to a network via a routable protocol must be protected by an ESP"; only needed routable communications permitted through it, all others denied	NERC · CIP-005-8, approved by the NERC Board of Trustees May 9, 2024	R10 and §4.4: a physically separate control-system network is a stricter form of the perimeter the regulator requires	https://www.nerc.com/globalassets/standards/reliability-standards/cip/cip-005-8.pdf
Vendor documentation. A virtualized control center design: production, test, development and training in separate zones, an industrial DMZ between enterprise and process networks, servers in pairs across two chassis, dual storage controllers, dual firewalls active/standby	Cisco · Oct 1, 2018, design guide v6	§4.4 and §5: pairs of everything on the control side and a DMZ rather than a shared network to the corporate fabric	https://www.cisco.com/c/en/us/td/docs/solutions/Verticals/Oil_and_Gas/Pipeline/1_0/Control_Center_Virt/DG/CC-DG-v6/Ch3-SystemDesign.html

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2 · Requirements register

Table 3. Requirements register

#	Requirement	Value	Source
R1	Racks and load	20 racks · 6 kW each · 120 kW IT	[A]
R2	Form	one prefabricated pod on the existing slab, 20 × 42U or larger	[T]
R3	Power	two independent paths, each sized for the full 120 kW IT load (2N between paths); N+1 UPS modules within each path; two utility feeds; one generator per path, the other path being its backup	[T] N+1 and 2N; [A] feeds
R4	Cooling	N+1 in-row or rear-door units, 120 kW plus 20 %	[T] N+1; [A] margin
R5	Control-system power path	**every control-system host dual-corded to independent path A and path B distribution, with no transfer switch in front of any dual-corded device. A single-corded device, if any, takes a rack-mounted automatic transfer switch fed from both paths**	[S] Uptime Institute, dual-corded power and rack-mounted transfer switches; [T] path separation
R6	Burn-in	96 hours at design load before any host is energized	[T]
R7	Control-system host	2U, 2 × Intel Xeon 6, 32 DIMM slots, iLO 7, PSU redundancy	[S] DL380 Gen12
R8	Corporate host	2U, 2 × AMD EPYC 9005, 24 DIMM slots, 800–3200 W Titanium PSUs	[S] PowerEdge R7725
R9	Historian host	2U, 1 × AMD EPYC 9005 to 160 cores, up to 40 × E3.S NVMe	[S] PowerEdge R7715
R10	Control-system network	1G copper access, separate from corporate; 48 × 1G + 4 × 25G + 2 × 100G, 226 W typical	[S] Nexus 9348GC-FX3
R11	Corporate network	25G leaf, 48 × 1/10/25G + 6 × 40/100G, 325 W typical	[S] Nexus 93180YC-FX3
R12	Spine	32 × 400G QSFP-DD, 25.6 Tbps, 1RU	[S] Nexus 9332D-GX2B
R13	Fire and access	gas suppression, two-person access to control-system racks	[A]
R14	Acceptance	every N+1 element failed one at a time under load during burn-in, each recorded	[T]

Fourteen rows; seven carry a vendor or published figure, four are design assumptions, three are design targets.

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3 · Architecture overview

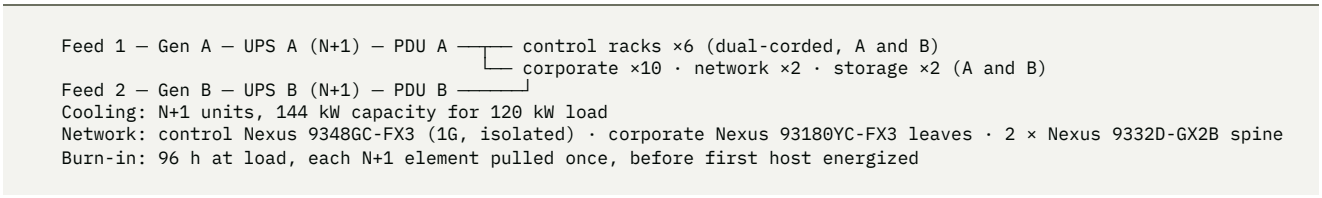


Figure 1. Pod power paths, cooling and network

One pod, two power paths, each able to carry the whole 120 kW (2N between paths), N+1 inside each. **Every control-system host is dual-corded into both paths**; one path with a manual transfer is below the practice for a critical load (§4.2). The network for control systems is physically separate, on its own switches.

Table 4. Architecture overview

Role	Product (exact model)	Qty	Capacity used	Why this unit
Pod	prefabricated data-center pod, performance-specified (vendor outside list)	1	20 racks, 120 kW [A]	fits slab and deadline [A]
Control-system host	HPE ProLiant Compute DL380 Gen12	36 (6 per rack, 6 racks)	2 × 32 P-cores, 512 GB [A]	Xeon 6, 32 DIMMs, iLO 7 [S]
Historian host	Dell PowerEdge R7715	4	1 × 64 cores, 24 × 7.68 TB NVMe [A]	single socket, up to 40 E3.S NVMe [S]
Corporate host	Dell PowerEdge R7725	80 (8 per rack, 10 racks)	2 × 64 cores, 768 GB [A]	2 × EPYC 9005, 24 DIMMs [S]
Control-system switch	Cisco Nexus 9348GC-FX3	12 (pair per control rack)	12 of 48 × 1G ports per switch (6 hosts × 4 × 1G over the pair) [A]	1G copper access, 226 W [S]
Corporate leaf	Cisco Nexus 93180YC-FX3	28 (pair per corporate, storage and network rack)	8 of 48 × 25G ports per leaf in a corporate rack (8 hosts, one 25G to each leaf) [A]	48 × 25G, 6 × 100G [S]
Spine	Cisco Nexus 9332D-GX2B	2	28 leaves × 100G = 7 of 32 ports at 4 × 100G breakout [S][A]	25.6 Tbps, 638 W [S]

4 · Design by subsystem

4.1 The pod.

Specified by performance, not by brand: 20 rack positions at 42U or more, 120 kW IT load, two independent power rooms, N+1 UPS per room, N+1 cooling, gas suppression, two-door vestibule, 96-hour factory and site burn-in in the contract **[A][T]**. The vendor is chosen by the operator's procurement from the facilities market; this document does not name one. Rejected: a conventional building — the deadline set by the regulator arrives before a building permit would [A].

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4.2 Power paths.

Path A: feed 1, generator A, UPS A in N+1 modules, PDU A. Path B: the same from feed 2 [A]. Corporate, network and storage racks take A and B into dual PSUs; every R7725 is ordered with redundant Titanium PSUs from the 800–3200 W range [S]. Control-system racks take **both paths into dual PSUs, exactly as the corporate racks do**: Uptime Institute's Tier Standard: Topology requires dual-corded IT devices for its Tier III and Tier IV objectives [S] (Uptime Institute Journal, Aug 18, 2014, updated Oct 24, 2016, read Sep 27, 2026). No Tier rating is claimed for the pod; the practice is followed, not certified. Each path is sized for the full 120 kW, so either path alone carries every rack (R3) [A]. **Why not one path.** The alternative puts the control racks on path A alone with a manual transfer to B, on the reasoning that an automatic transfer switch could drop them into a fault carried on the corporate side. That reasoning answers the wrong question: a dual-corded host needs no transfer switch at all — each PSU sits on its own path, and the loss of a path is absorbed by the surviving supply with no transfer event, no switching transient and no operator [S]. Single-path with manual transfer means the control system is dark from the loss of path A until two people reach the pod, which is minutes of a utility control center being blind, and that is not a trade a design makes on purpose. Rejected: manual transfer for the control racks — it is the failure mode, not the protection. Any single-corded device that cannot be ordered with two supplies takes its own **rack-mounted automatic transfer switch** fed from path A and path B: Uptime Institute's Tier Standard accommodates single-corded equipment with a local, rack-mounted or point-of-use transfer switch, and a rack-based ATS meets the dual-path requirement for that device [S] (Uptime Institute Journal, Aug 18, 2014 and Jul 20, 2017, read Sep 27, 2026). Only that device sees a transfer event; its rack's dual-corded hosts do not. Rejected: a large static transfer switch or STS-fed PDU in front of several racks, which Uptime Institute records as not meeting Tier III or Tier IV criteria [S], and a manual transfer switch, for the reason above.

4.3 Cooling.

N+1 units sized to 144 kW against a 120 kW load, as six units of 24 kW, so any five carry 120 kW [A]; hot-aisle containment across the 20 racks [A]; one unit pulled for one hour under full load during burn-in (R14).

4.4 Control-system hosts and network.

DL380 Gen12: 2U, up to two Xeon 6 processors of up to 86 P-cores, 32 DIMM slots to 8 TB, up to eight PCIe Gen5 slots, iLO 7 [S]. Specified build: 2 × 32 P-cores, 512 GB, redundant PSUs, 4 × 1G copper [A]. Historians on PowerEdge R7715: single EPYC 9005 to 160 cores, up to 40 × E3.S NVMe [S], built with 24 × 7.68 TB [A]. Network: Nexus 9348GC-FX3 pairs, 48 × 1G BASE-T, 4 × 25G, 2 × 100G, 226 W typical [S], on their own fiber to the existing control center and never to the corporate spine [A]. Rejected: shared leaves with VLAN separation — fails the physical-separation intent of R10.

4.5 Corporate hosts and fabric.

PowerEdge R7725: 2U, two EPYC 9005 of up to 192 cores, 24 DIMMs, two OCP 3.0 slots [S]; specified build 2 × 64 cores, 768 GB, dual 25 GbE [A]. Leaves 93180YC-FX3, 48 × 25G and 6 × 100G, 325 W [S]; spines 9332D-GX2B, 32 × 400G with 4 × 100G breakout, 25.6 Tbps, 638 W [S]. Fourteen leaf pairs at 2 × 100G each use 7 ports per spine [A].

4.6 Burn-in and acceptance.

96 hours at 120 kW of resistive load banks in the racks, before any server is racked [T]. During the 96 hours, one at a time and each recorded with a start time, end time and observed effect: one UPS module per path, one generator start on loss of feed, one cooling unit, one PDU breaker, one fire-panel test **[T][A]**. Only after the record is complete are the hosts energized, control racks last [A].

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5 · Failure behavior

Table 5. Failure behavior

Failure	Behavior	Source
Feed 1 lost	generator A carries path A; UPS A rides through the start; control racks unaffected	[T] R3; [A]
UPS module on path A fails	N+1 module absorbs the load; alarm	[T] N+1
Path B lost entirely	every dual-corded device, control included, runs on path A through its second supply with no transfer event; a single-corded device, if any, moves to path A through its rack-mounted ATS; path A carries the full 120 kW	[S] dual-cord, rack ATS; [T] R3
Path A lost entirely	every dual-corded device, control included, runs on path B through its second supply with no transfer event and no operator; a single-corded device, if any, moves to path B through its rack-mounted ATS; path B carries the full 120 kW	[S] dual-cord, rack ATS; [T] R3
One cooling unit fails	N+1 unit carries; 144 kW minus one 24 kW unit = 120 kW	[A] R4
One control-system switch fails	hosts stay up on the second switch of the pair	[A] dual-homed

6 · Limits

- The pod vendor is chosen by the operator's procurement (Dell's modular range, §1c, is one listed option); its performance specification is the operator's to enforce in contract.
- Every control-system host is dual-corded across paths A and B; the loss of either path is carried by the other with no transfer event for those hosts. A single-corded device, if any, takes a rack-mounted automatic transfer switch and sees one transfer; an outage of that switch itself takes that device down, which is why every host is dual-corded.
- 6 kW per rack is a design assumption; the burn-in load banks are set to it, and any rack above it after fit-out needs a cooling re-check.
- Two utility feeds from different substations are assumed available; where only one exists, path B runs on generator alone.
- Historian storage and control host counts are placeholders until the SCADA vendor's sizing arrives.

7 · Lessons learned

None yet — this is a design study; populated after the first build against it.

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8 · The author

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SYMBEEO

Each vendor's tool shows you their option. We show you all of them against one requirement.

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Figures are as published by their sources on the dates given in this document; figures marked [A] are assumptions.

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