

Data Center Physical Infrastructure - Overview

SEVEN NCPI ELEMENTS · FOUR KEY ENVIRONMENTS · BEST PRACTICES · AVAILABILITY & RELIABILITY · CHALLENGES

STUDY & REVIEW

01 MUST KNOW

if you remember five things, remember these

- 01 NCPI is the foundation:** **Network-Critical Physical Infrastructure (NCPI)** is the layer *below* the physical IT infrastructure — the servers, switches, and storage — that is essential to running a data center. Its **seven elements** are power, cooling, racks and physical structure, cabling, security and fire protection, management, and services. Together they form the base of the IT infrastructure pyramid, so failure of one or more can lead to potential failure of the data center.
- 02 Four key environments:** Every data center — small or large — must have four environments to operate: **power, cooling, IT connectivity, and space**. They require sufficient and redundant power, adequate cooling, proper connectivity, and enough space for the servers and switches.
- 03 Power ride-through order:** Utility grid feeds the data center through step-down transformers → on an outage the **UPS** supplies short-term battery power → the **backup generator** takes about 1 minute to start → the load transfers to the generator and the batteries recharge → the generator runs until utility power is confirmed stable.
- 04 Design, then maintain:** Design NCPI elements for **maximum availability, maximum reliability, reduced downtime, concurrent maintainability, and low cost**; maintain them regularly to **increase MTBF**. Availability is raised with standby redundancy; reliability is raised with better design, maintenance, and replacing worn parts before they fail.
- 05 Six modern challenges:** Managing an NCPI means constantly balancing six challenges: **data security, balance between cost control and efficiency, capacity planning, power management, IoT, and mobile enterprise** — several of which touch all seven NCPI elements at once.

02 KEY TERMS

TERM	DEFINITION
NCPI	Network-Critical Physical Infrastructure — the layer below the physical IT infrastructure that is essential to running a data center; made up of seven elements
UPS	Uninterruptible power supply — delivers short-term battery power during an intermittent power failure until the backup generator starts; batteries recharge once the generator carries the load
MDB	Main distribution board — houses fuses, circuit breakers, and ground leakage protection units, and distributes incoming low-voltage electricity to endpoints across the data center
2N redundancy	Two full independent sets of a component (for example, two sets of chillers, pumps, pipework, and CRAHs); if one set fails, the other takes over
Availability	The probability that a system is running and operational at a specific point of time; the readiness of systems to be accessible when needed
Reliability	The probability that a system will perform its required function at a specific point of time or over a period of time
MTBF	Mean time between failures — the average expected time between two failures of a system; raised through regular maintenance
MTTR	Mean time to repair — the average time required to repair a system
DCIM	Data Center Infrastructure Management — integrated tools that monitor, measure, and manage performance, identify unused cooling capacity and storage, and run the data center at full capacity while minimizing risk
ANSI/TIA-942	The Telecommunications Infrastructure Standard for Data Centers — the design standard for data center infrastructure, including generic cabling standards

03 THE SEVEN NCPI ELEMENTS

the base of the IT infrastructure pyramid

ELEMENT	WHAT IT COVERS	WATCH OUT FOR
Power	Grid or battery current via transformers, PDUs, distribution panels, UPS, and generators	Generator takes ~1 min to start — the UPS must bridge
Cooling	Chillers, cooling towers, CRACs and CRAHs, condensers, ductwork, pumps, piping	Hot zones and heat spillovers
Racks & physical structure	Steel-frame racks, raised floors, dropped ceilings, and cabling pathways	Open gaps recirculate hot air in the rack
Cabling	Data and power cables, cable trays, and management devices	Wrong plug-in (human error); overheating (power surge)
Security & fire protection	Biometrics, cameras, access cards; fire detection and suppression; firewalls	Water/chemical hazards, fire, and explosions
Management	BMS, NMS, and element managers monitoring the building and data center health	Frequent hardware failures if unmanaged
Services	The 24/7 availability expectation — consulting, monitoring, backup, and support	Human error without skilled, trained staff

04 POWER RIDE-THROUGH SEQUENCE

what happens when the utility grid fails

01 Utility grid feeds the data center through step-down transformers → **02** Grid outage — the UPS supplies short-term battery power → **03** Backup generator starts (about 1 minute) → **04** Load transfers to the generator; batteries recharge → **05** Generator runs until utility power is confirmed stable

05 AVAILABILITY VS. RELIABILITY

improved in different ways

AVAILABILITY

probability a system is operational right now

- Readiness of systems to be accessible when needed
- Raised by a standby redundant system or resource
- Power: backup generator plus extra backup fuel
- Cooling: 2N capacity and fast-start equipment
- Cables: follow ANSI, TIA-942, and IEEE standards

RELIABILITY

probability a system performs its function over time

- Probability a system performs its required function at a time or over a period
- Improve the design of the products and equipment
- Regular maintenance; replace worn parts early
- Keep operational load within the specified limit
- Redundant components lower whole-system failure

- × “NCPI is the servers and switches.” — No. NCPI is the layer *below* the physical IT infrastructure; the servers, switches, and storage are the IT infrastructure that sits on top of NCPI.
- × “The backup generator carries the load the instant the grid fails.” — It takes about 1 minute to start. The UPS bridges that gap on battery power, and only after the generator starts does the load transfer and the batteries recharge.
- × “The seven elements and the four key environments are the same list.” — Different framings. Seven elements: power, cooling, racks/physical structure, cabling, security & fire protection, management, services. Four environments: power, cooling, IT connectivity, space.
- × “Packing racks or leaving them wide open — either is fine.” — Excessive open spaces let hot air recirculate inside the rack, raising heat and cutting performance. Organize equipment without excessive gaps and monitor rack loads for hot pockets.
- × “Availability and reliability mean the same thing.” — Availability is the probability a system is operational **now** (raised by standby redundancy). Reliability is the probability it performs its required function over **time** (raised by design, maintenance, and replacing worn parts).
- × “Virtualization and server consolidation always cut power use.” — They optimize hardware but can **increase** power consumption; modern blade servers can draw four to five times the energy of previous-generation storage devices.
- × “Firewalls belong to the cabling element.” — Firewalls and data security applications are part of the **security and fire protection** element, which covers both cyber protection and physical fire detection and suppression.
- × “Fire suppression just needs correct installation once.” — Its availability depends on **regular maintenance** and checking that devices work, and compliance must be met at the system, component, and installation levels.

07 SELF-QUIZ

answers are upside-down below

Q1 How many elements make up NCPI, and what layer of the data center does NCPI occupy?

Q2 Name the four key environments a data center needs to operate.

Q3 During a utility outage, what bridges power until the backup generator starts, and roughly how long does that take?

Q4 What three things does a main distribution board (MDB) house?

Q5 Two data center cabling problems come up repeatedly — name them.

Q6 What does 2N cooling capacity provide?

Q7 State the difference between availability and reliability.

Q8 Which two metrics describe, respectively, average time between failures and average time to repair?

Q9 Which system helps administrators find unused cooling capacity and storage so the data center runs at full capacity while minimizing risk?

Q10 List the six common challenges of NCPI implementation.

ANSWER KEY (rotate the page)

Q1 Seven elements: the physical IT infrastructure (servers, switches, storage) **Q2** Power, cooling, IT connectivity, and space **Q3** The UPS supplies short-term battery power; the generator takes about 1 minute to start **Q4** Fuses, circuit breakers, and ground leakage protection units **Q5** Wrong plug-in of cables (human error) and overheating of cables (a sudden power surge) **Q6** Two full independent sets of components (chillers, pumps, pipework, CRAHs) so a backup set takes over if one fails **Q7** Availability is the probability a system is operational at a given time; reliability is the probability it performs its required function at a time or over a period **Q8** MTBF (mean time between failures) and MTR (mean time to repair) **Q9** DCIM (Data Center Infrastructure Management) **Q10** Data security, balance between cost control and efficiency, capacity planning, power management, IoT, and mobile enterprise