TECHNICAL NOTE

How can we optimise and secure power supplies in Data Centres?

The essential role of Static Transfer Systems (STS)

When **energy** matters | socomec Innovative Power Solutions

Introduction

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Over the last thirty years, Data Centres have become the mainstay of an increasingly digital economy. The exponential increase in data volumes has led to a growing need for storage and processing infrastructures. Furthermore, forecasts leave no doubt that the Data Centre industry will continue to experience strong growth over the next few years: data traffic is set to increase by between 25% and 30% each year between now and 2033[1]. In order to meet this demand, Data Centre operators are looking to accelerate time-to-market while optimising investment and operating costs.

This quest for competitiveness must be achieved without compromising the continuity of the power supply and servers. Outages are costly, but 80% of them could be avoided with an improved power supply. Ensuring maximum availability of power is, therefore, **the number one challenge for Data Centres.**

To meet these challenges of competitiveness, efficiency and resilience, Socomec has been designing and installing high-performance electrical equipment on behalf of Data Centres for over 50 years.

By reading this White Paper, you can learn more about the various architectures and optimum strategies for your Data Centres.

** France Data Center survey.*

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Part 1

Data Centres electrical architecture: an overview of the issues, opportunities and constraints

Server availability: a critical issue

**Within Data Centres, servers are extremely sensitive to any load interruption greater than 20 milliseconds, according to the ITIC curve *(Information Technology Industry Council)*.
This curve defines the tolerance of loads to voltage drops and helps users to determine the power supply conditions for IT loads.**

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Causes of electrical interruptions

There are many causes of electrical interruptions:
- **Human error:** this can be linked to mishandling during maintenance operations and accounts for 22% of unplanned outages.
- **Bad weather:** this can lead to equipment failure and interruptions.
- **Abnormal rises in temperature:** these can cause an electric arc or an electrical fire.
- **Electrical overloads:** these can occur when energy demand exceeds the capacity of the Data Centre's power supply system.
- **Fluctuations in power quality:** voltage or frequency variations, transients and short power cuts can also affect sensitive equipment.
- **Cyber attacks:** cyber attacks on Data Centre Infrastructure Management (DCIM) systems can lead to interruptions if the attackers manage to control or disable the electrical systems.

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Major risks

When network outages do occur, across any territory, they are much longer than the 20 milliseconds deemed acceptable by the ITIC curve. **Power supply problems are the main cause of downtime in Data Centres**, ahead of system errors (22%) and network problems (17%)[2].

Whether in server rooms or infrastructure rooms, Data Centre architecture must be designed to react quickly to any risk of loss of load, power surge or short-circuit. Otherwise, Data Centre operators are exposed to three major risks:
- **Hardware:** servers and other Data Centre equipment may be lost.
- **Economic:** every minute of downtime in a Data Centre results in massive loss of revenue. According to estimates, poor quality electricity costs European businesses more than €150 billion a year.
- **Competitive:** any interruption of service and/or loss of data is detrimental to the brand image of Data Centre operators.

** Uptime Institute study (2020).*

Four examples of power cuts that have cost Data Centres dearly

A number of electrical incidents in recent years have demonstrated the significant cost that these can represent for Data Centres.

As Frost & Sullivan points out (see table no.), a breakdown in Delta's Data Centre grounded around 2,000 flights in the space of three days at a cost of 150 million US dollars.
At British Airways, a similar incident caused the cancellation of 400 flights and blocked the movements of 75,000 passengers.
At Southwest Airlines, the impact of a power cut to the Data Centre responsible for its data was even worse: the reservation system remained unavailable and aircraft were grounded for 3 days, resulting in an estimated loss of 177 million euros for the company.

Company	Issue	Financial impact	Root Cause
DELTA	Data Centre Outage grounded about 2.000 flights over the span of three days	Cost to the company $150 million	**HUMAN/ ACCIDENTAL ERROR** Mainly Pertaining to Critical Infrastructure Related Issues
Southwest	Knocked reservations systems offline and grounded its planes nationwide. Flights cancelled for 3 days.	Estimated cost of outage $177 million	
BRITISH AIRWAYS	Outage resulting in the cancellation of over 400 flights, leaving 75.000 passengers stranded	Cost to the company $112 million	
amazon	Issue with debugging a billing system caused inadvertent shut down of numerous servers	Cost of outage is Undisclosed	

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One of the main reasons why outages are so costly for Data Centres is **the unpredictability of** the majority of potential failures in the electrical infrastructure. What's more, the negative impact of outages goes far beyond the costs of repair or replacement equipment.
The indirect costs can be even greater: loss of business opportunities and customers, loss of productivity and IT efficiency, even overexposure to cyber-risks.

"Availability is at the heart of the service provided by a Data Centre. Any power interruption, even for a few seconds, can have an impact on customers and therefore on the operator's profitability"

Xavier Mercier
EMEA Marketing Director at Socomec

Guaranteeing availability through optimum redundancy

Ensuring 100% power availability for critical loads is one of the top priorities for any Data Centre. That's why redundancy is a key solution for achieving optimum levels of resilience and energy availability in critical applications.

Definition

In a redundant power supply, network equipment will be able to operate using two or more physical power supplies, each of which is capable of operating the device independently.
More generally, in any redundant system, if one component fails, another takes over to ensure that it operates correctly.
This basic level of redundancy can be reinforced by additional architectural measures, increasing the robustness of the system.

Implementing effective redundancy radically transforms cost management, as it minimises the risk of costly downtime. This guide explores the various redundancy configurations used in electrical infrastructures, examining their benefits as well as their limitations.

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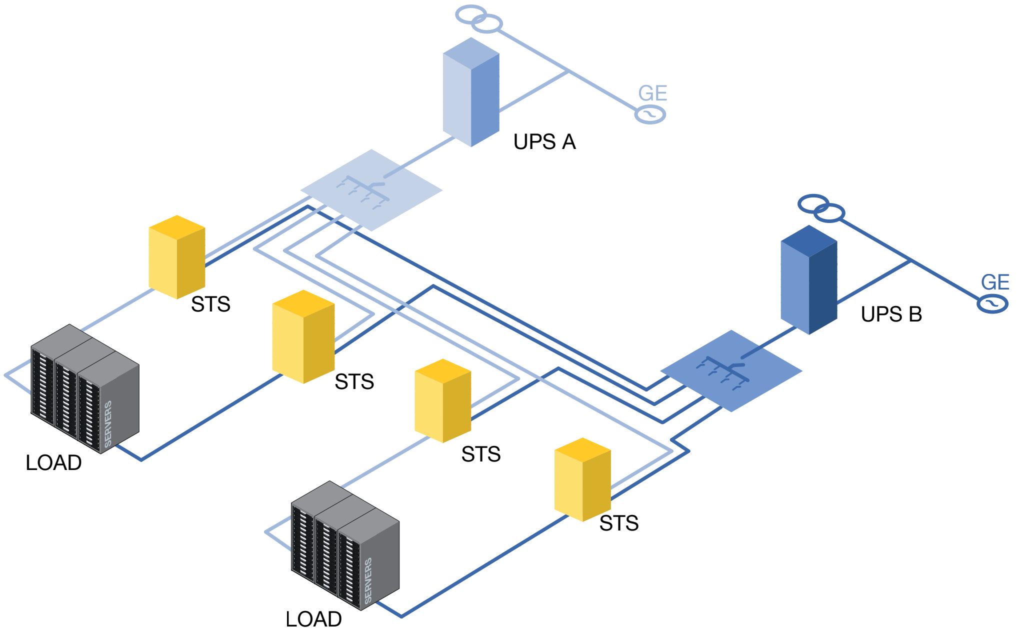
Classic architecture for applications where downtime can have costly consequences

The advantages and disadvantages of the architectures most widely used today

The 2N architecture

Definition
The 2N architecture, also known as "redundant architecture", consists of two complete and independent systems, each capable of supporting the total load autonomously. In other words, each system has an exact replica, ready to take over in the event of failure.



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The 2N architecture, once considered the reference for redundancy in electrical systems, is gradually being replaced. This is mainly due to the high costs associated with its implementation and maintenance, which involve the complete duplication of every component in the system.

The use of STS in a 2N architecture is a major advantage

Objectives of the architecture 2N
Despite its **high cost**, it offers high **reliability** and availability, which are essential for critical systems. The use of STS in a 2N architecture is a major advantage for Data Centres because it adds an extra level of protection. High availability is particularly sought after in critical applications managing banking transactions, where every second of unavailability can result in significant financial penalties.

Benefits:
- **Ultra-secure:** this architecture is particularly suitable for Data Centres in applications where the cost of interruption is higher than average.

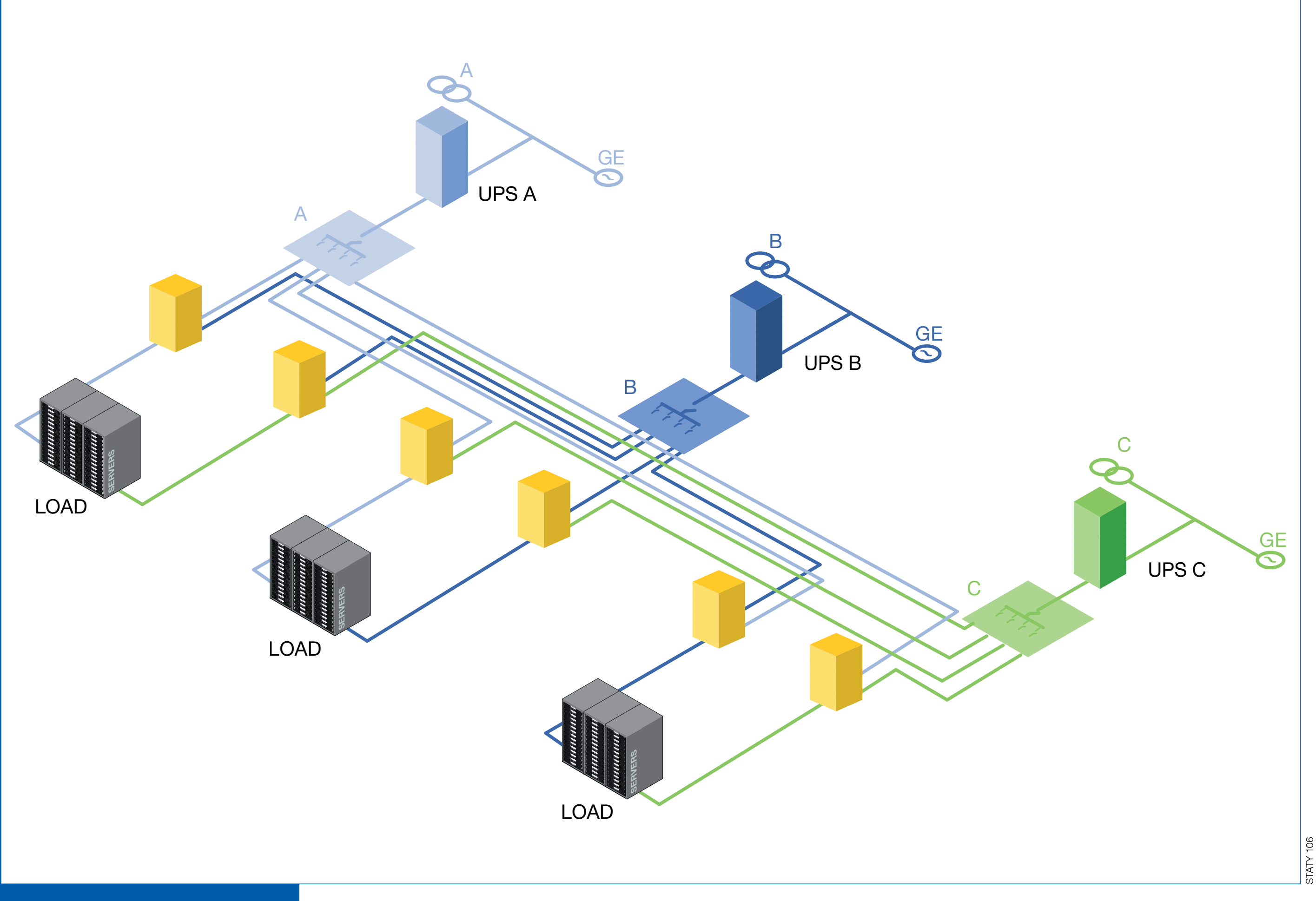
The disadvantages:
- **Significant CAPEX and OPEX:** in order to deliver on its promises, this architecture requires all the electrical equipment (generators, inverters, UPS, switches, etc.) to be duplicated.

New architectures to meet the need to reduce costs

3N4 or 2N3 distributed architecture

Definition

The **4N/3** architecture means that for each unit of power required (represented by **N**), there is **a total capacity of 4 times N** available, but distributed in such a way that only 3 **modules supply** the system at all times, the fourth being a redundancy or reserve.
This approach allows the loss of a power supply module to be tolerated without interrupting the power supply to the system.



Objectives of the architecture 4N3

Distributed architectures, such as 4N3 or 3N2, aim to optimise energy redundancy by sharing it between different systems. For example, 4N3 means that out of a set of four systems, only three are needed to supply the load. This means that the system can continue to operate in the event of a power failure. This concept makes it possible to limit the size of the systems while maintaining an attractive level of redundancy.

Benefits:

- **Shared redundancy between several server rooms:** this optimises the use of UPS and limits capital expenditure.

The disadvantages:

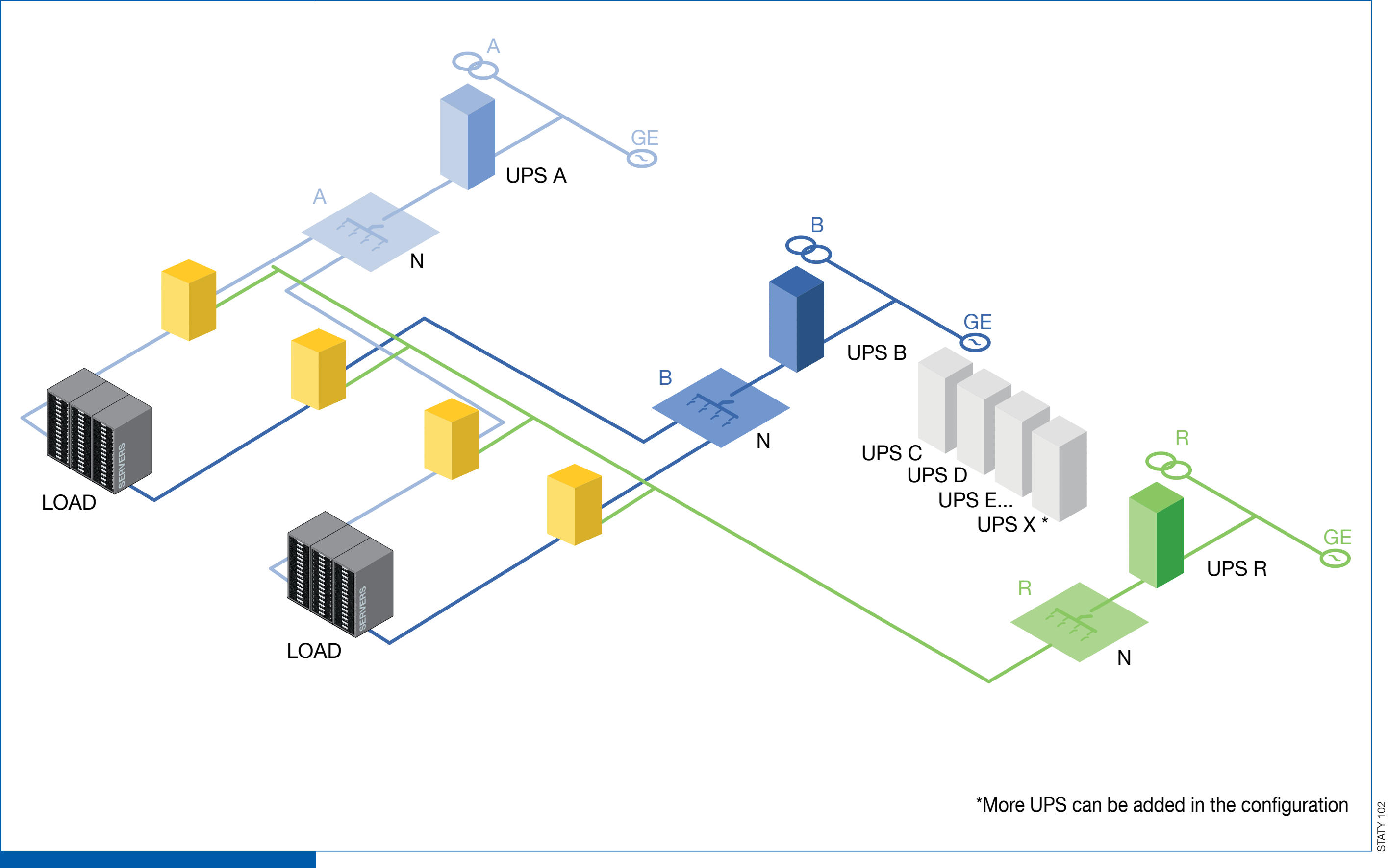
- **Constant monitoring of loads required:** the performance of the UPS installed must be beyond reproach, and consequently particular attention must be paid to power management in order to ensure optimum system operation.
- **Cabling complexity:** this configuration requires all the UPS equipment to be installed beforehand, which imposes cabling constraints and limits its compatibility with the modularity requirements of Data Centres.
- **Reliability based on the effectiveness of a single back-up system:** by their very nature, distributed architectures do not incorporate advanced technologies capable of preventing electrical system failures, or preventing the propagation of faults in networks by isolating them and transferring the remaining loads. As a result, the reliability of the power systems in these Data Centres relies heavily on the effectiveness of a single back-up system.

For organisations with tight budgets wishing to mitigate the direct and indirect costs associated with a complete blackout caused by electrical failures, it is highly advisable to invest in measures that reduce the impact of such failures on operations. A crucial strategy for achieving this objective is to guarantee a robust level of redundancy for all power systems without having to make the heavy investment required of a 2N architecture.

This architecture has been designed to optimise equipment yields and costs without impacting on electrical availability and quality.

Understanding "Catcher" architecture

Definition
The "Catcher" model (sometimes also called "catcher bus" or "catcher system") is a design where the redundancy function is separated from the main systems and centralised on a single system. This system is combined with STS which "catches" the load in the event of a fault in one of the main systems by transferring the critical load from one to the other.



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Using the same philosophy as distributed architecture, the aim is to limit the power of the main systems in order to limit the impact of the initial investment and running costs. The Catcher architecture is unique in allowing 100% use of the main systems, since redundancy is centralised in the Catcher system.

With Catcher architecture, a 1MW room will require a 1MW UPS upstream and STS of around 1600 amps. In the event of a UPS fault, this STS will guarantee load transfer to a spare UPS or Catcher, which will also serve as redundant equipment for other rooms.

Benefits:

- **Optimised UPS sizing:** the implementation of a static transfer switch (STS) reduces the capacity of the UPS systems and the batteries that they require. This configuration allows the installation of UPS systems and batteries sized specifically for each room. In comparison, a distributed architecture requires oversized UPS systems in order to handle the entire load of a room in the event of failure.
- **Cost control:** with the Catcher configuration, initial investment and operating costs are considerably reduced.

The disadvantages:

- **Best suited to large structures:** Catcher architectures are particularly well suited to large infrastructures, where power and redundancy requirements are high, such as large-scale Data Centres, hospitals or complex industrial installations. Catcher architecture represents an ideal solution for maintaining high levels of service and operational security.

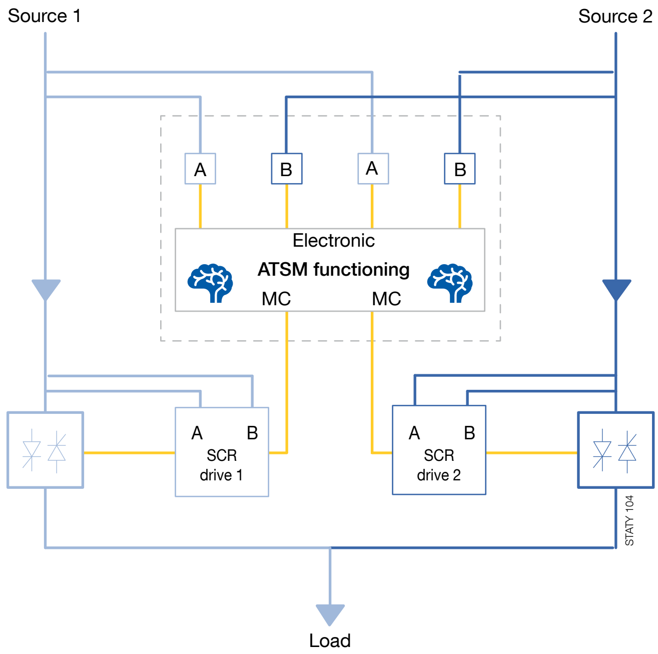
"Data Centres increasingly need to be deployed rapidly, so they need architectures that are modular and easy to replicate. The Catcher model fits in very well with this logic. It enables almost ideal distribution. With this type of deployment, you can start with a room and a redundant block, then add rooms as required. All you need to do is add a UPS and an STS, as the backup UPS is already there."

Bastian Gsell
Product Manager at Socomec

Part 2

The role of the STS in a Data Centre

STS: A more reliable infrastructure, without interruption or compromise



Energy availability is directly linked to the quality of the power supply and load tolerance. For critical applications such as those operating in a Data Centre, power from the electrical grid is not enough to guarantee the required continuity. **That's why it's essential to deploy solutions that ensure maximum availability of power.**

In this context, the use of UPS and STS will significantly improve the quality and availability of energy.

Static transfer system:
how it works and how it works

Static transfer system (STS) technology is sometimes little known, however, it is capable of transferring an electrical load very quickly between two power sources, generally two UPS. STSs are based on semiconductor components such as thyristors .

When the load's power source exceeds its tolerance thresholds, the STS transfers it to an alternative source. This guarantees "high availability" of the power supply for sensitive or critical installations. In the case of STS use, this transfer takes around 4 to 6 ms (less than one cycle), which respects the tolerances indicated in the ITIC curves.

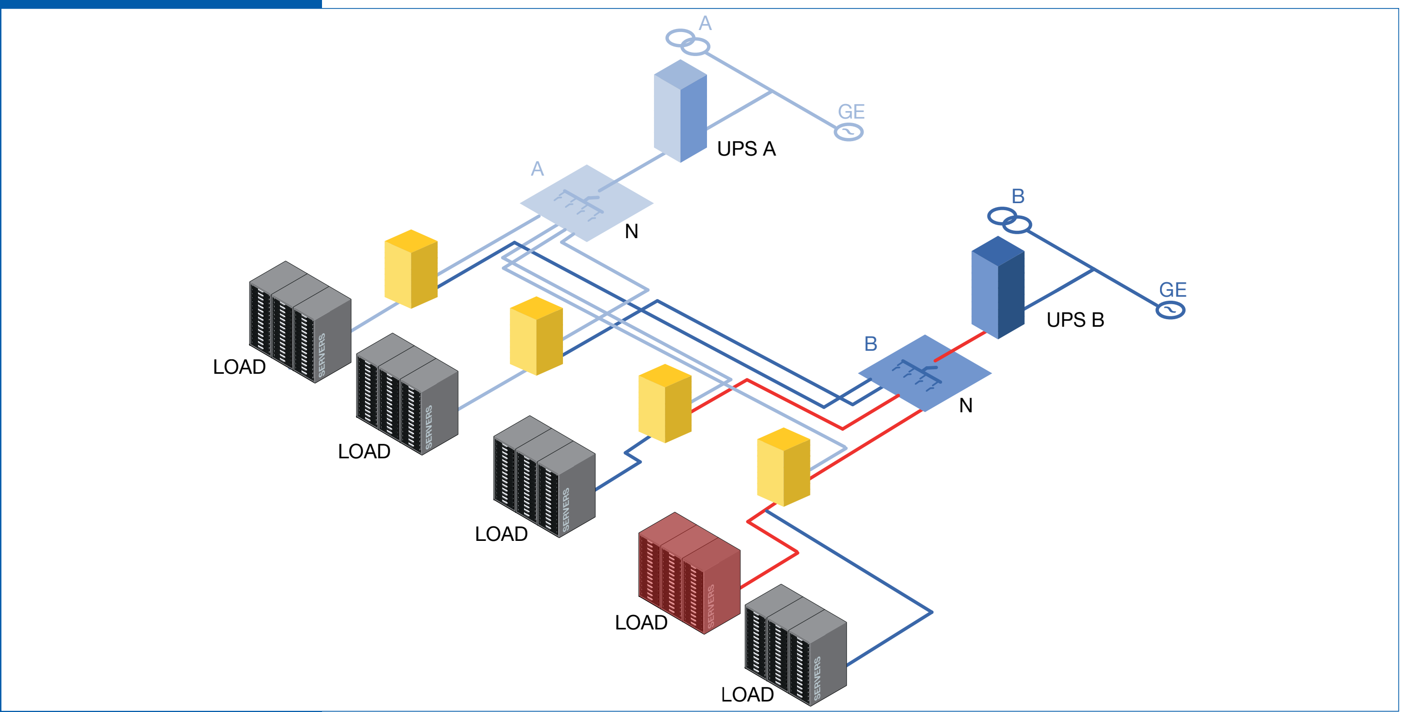
STS can protect different loads

The STS also offers additional protection during maintenance operations or in the event of abnormal events or downstream disturbances. In the event of a downstream disturbance on a single source, all the loads connected to it suffer the electrical fault (see figure below). It may take several milliseconds for the protections to clear the fault. If this time exceeds 20 ms, healthy computer loads connected in parallel with the faulty load may be affected. The STS can protect the various loads by preventing them from being supplied by a disturbed source by rapidly switching to the healthy replacement source. This increases the energy available to trip the protection, enabling the propagation of the fault to be eliminated more quickly.

STS incorporate continuous measurement of source quality, enabling them to detect the unavailability of a UPS and transfer its load to another UPS for protection. These systems are also able to transfer the load by phase in order to avoid any transient currents, which increase the risk of loss of load.

The installation of an STS is in itself an opportunity to reduce its carbon footprint

Finally, faced with one of the greatest challenges of our time, Socomec's research is also focused on sustainability. Installation of the STS is in itself an opportunity to reduce carbon footprint through the implementation of an optimised architecture. In fact, by reducing the need to oversize UPS and their batteries, the installation of STS contributes directly to reducing the carbon footprint of a Data Centre. Not only are UPS adapted more precisely to actual load requirements, but excessive use of hardware and energy resources is also avoided. This approach not only reduces the energy consumption of the UPS itself, but also that of the batteries and other associated components. Less material required means fewer resources extracted and transformed, which reduces the environmental impact associated with equipment production and end-of-life. In addition, this reduction in hardware also means less electronic waste, contributing to more sustainable management of technological resources in Data Centres.



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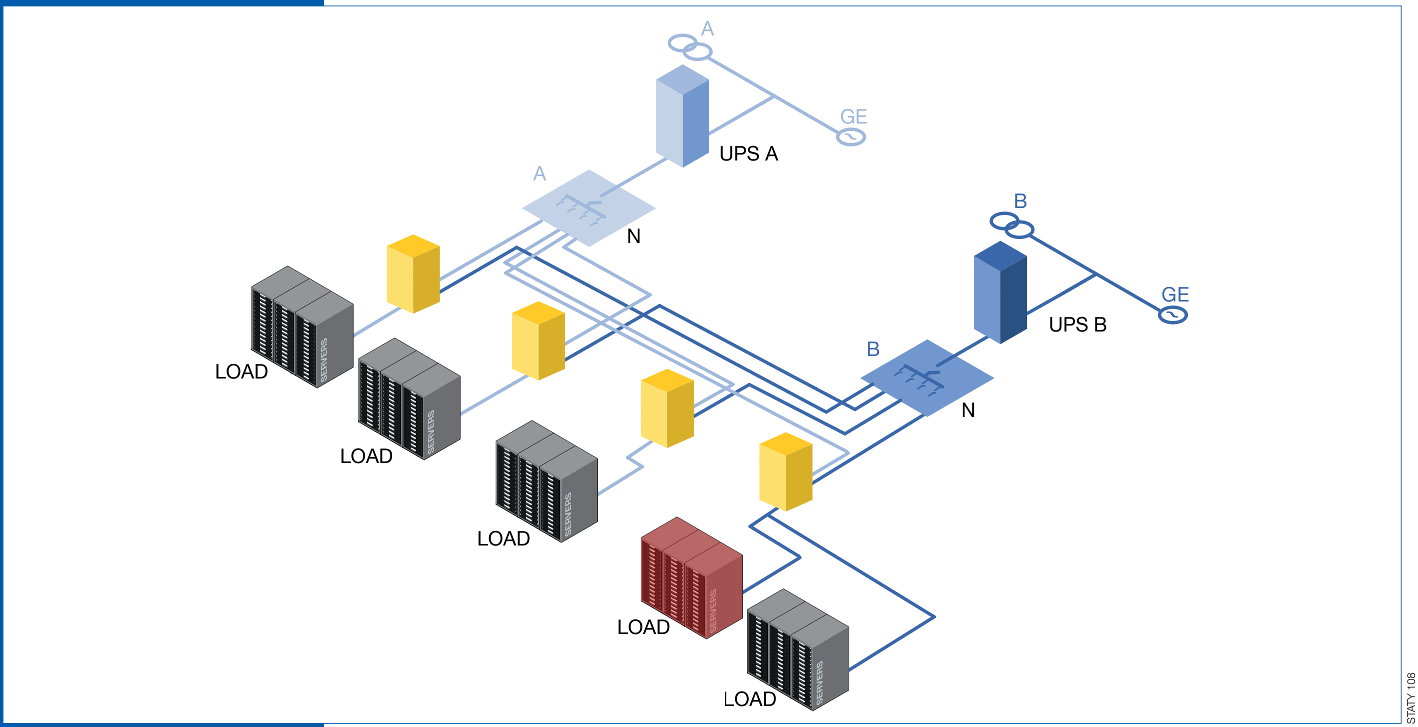
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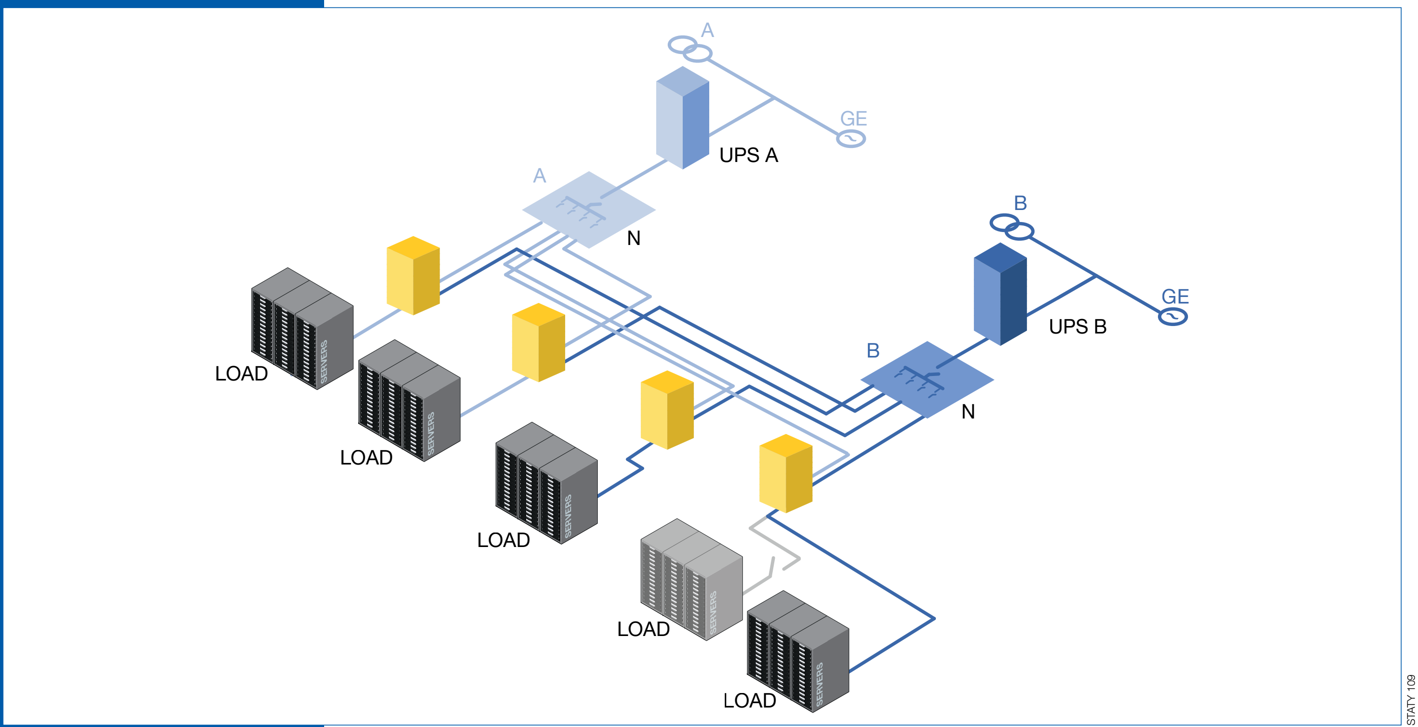
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ATS

STS

ATS and STS: Which solution for which need?

The differences between an Automatic Transfer Switch (ATS) and a Static Transfer Switch (STS) lie in the type of requirements they serve.

For example, an ATS uses mechanical components to switch from one power source to another. This transfer can cause a short interruption to the power supply, which is acceptable in certain less critical industrial or commercial installations or office buildings. On the other hand, it is less suitable for sensitive infrastructures such as Data Centres, banks or healthcare establishments.

Unlike the ATS, the STS uses semiconductors (thyristors) to switch from one source to another. This enables almost instantaneous switching, in the order of a few milliseconds. This capability is crucial for critical applications that cannot tolerate even very short power and electrical interruptions. The STS is therefore ideal for sectors requiring high availability of power, such as banking and finance, healthcare and Data Centres.

4 benefits of STS for Data Centres

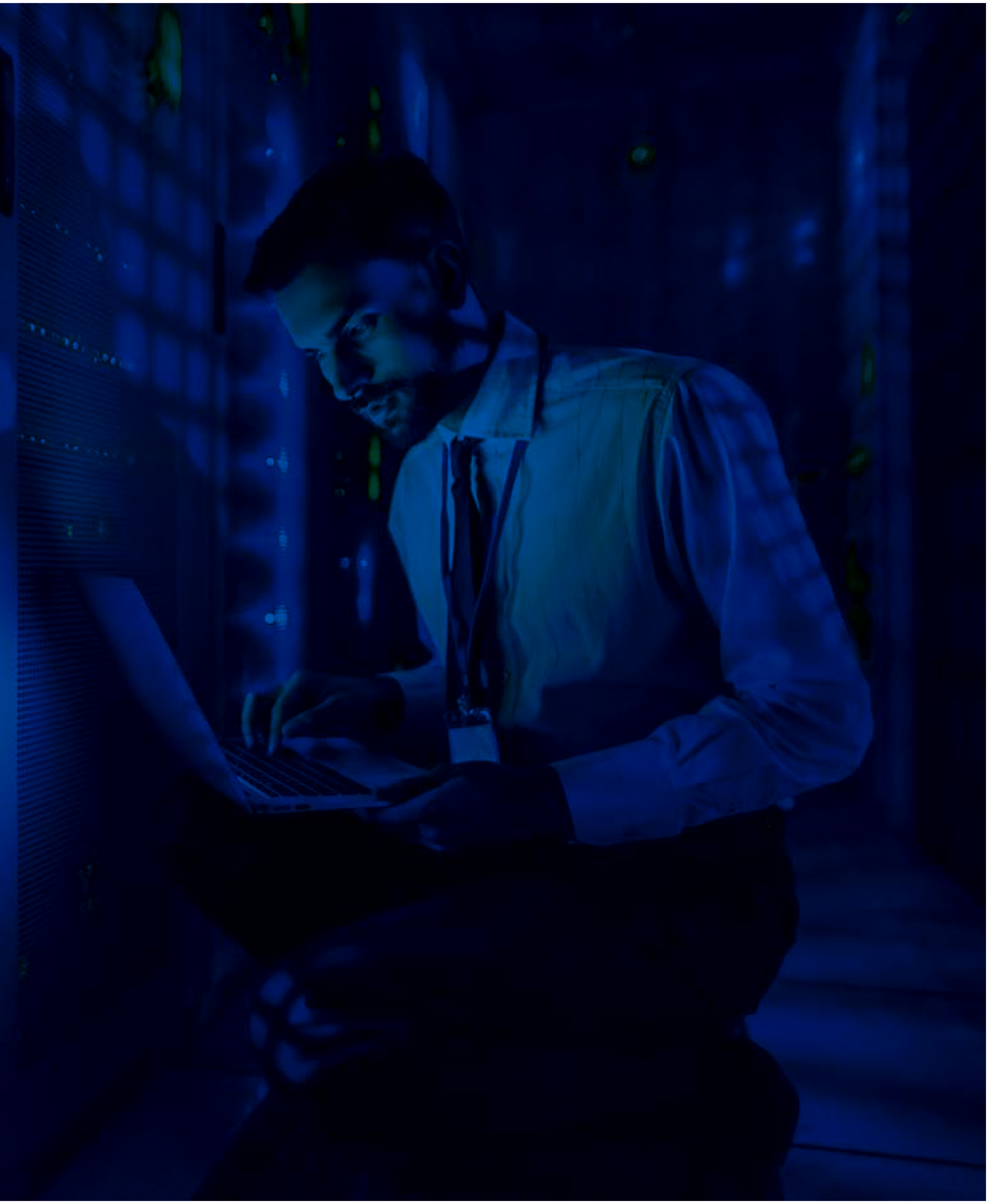
- **Increase the reliability of the power supply** to sensitive installations.
- **Make it easier to maintain the installation** without having to carry out specific manipulations on the electrical distribution (bypass, etc.).
- **Prevent the fault** from spreading by isolating it and transferring the remaining charges.
- **Simplify the design and extension** of installations guaranteeing a high-availability power supply.

"STS technology makes it possible to achieve high levels of energy availability while keeping costs under control"

Xavier Mercier
EMEA Marketing Director at Socomec

Part 3

How does Socomec guarantee the availability of energy for Data Centres?



STATYS: proven performance, field-tested technology

Closer look at the benefits of the STATYS range

In a world where continuity of power supply is crucial and synonymous with competitiveness, Socomec's STATYS range makes perfect sense. After more than 35 years of experience and millions of hours of use, Socomec has never stopped improving its range. The 4th generation of STATYS guarantees permanent availability of the power supply for applications ranging from 32 to 1800 A.

This range is particularly suited to environments where reliability is non-negotiable, such as Data Centres, healthcare facilities and other critical infrastructures.

All products are compatible with any type of UPS as well as with any source providing A/C power.

The STATYS range guarantees optimum resilience for total electrical availability, meeting all integration requirements, thanks to:

- **double redundant electronic** power supply (X4),
- **redundancy of the microcontroller**, physically separated for greater security, avoiding the risk of inhibiting the STS's ability to discriminate between the power quality levels of the sources and choosing the most appropriate for the load.
- **SCR driver** that also incorporates independent, redundant power supplies and a fault detection system,
- **an "auto-hold" function** guarantees continuity of power supply even in the event of an internal problem,
- **redundant cooling** including a fan failure monitoring system,
- **segregation of the main functions** to prevent the propagation of potential internal faults.

More than
8,000 units
are already in operation worldwide

The **4th**
generation of STS

More than
6,200,000
MTBF hours in the field

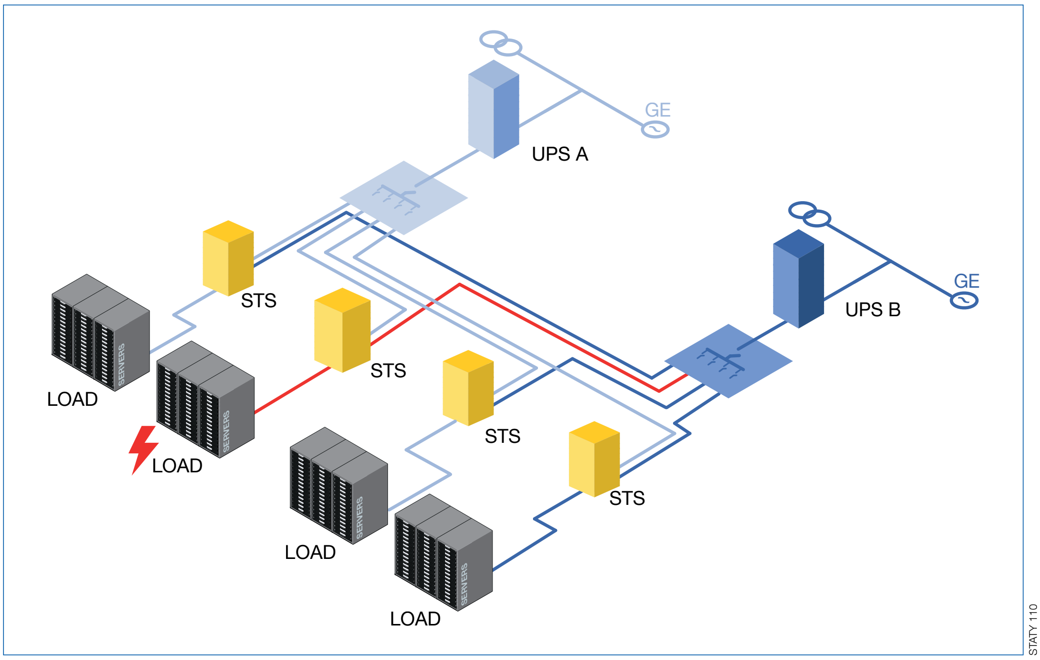
Risk and failure management: STATYS guarantees

The strong added value of the STS lies in its ability to transfer energy from one source to another, but this is not its only advantage. It can also detect downstream faults. In this case, the STATYS will isolate the fault so that the loss of load does not affect the rest of the network.

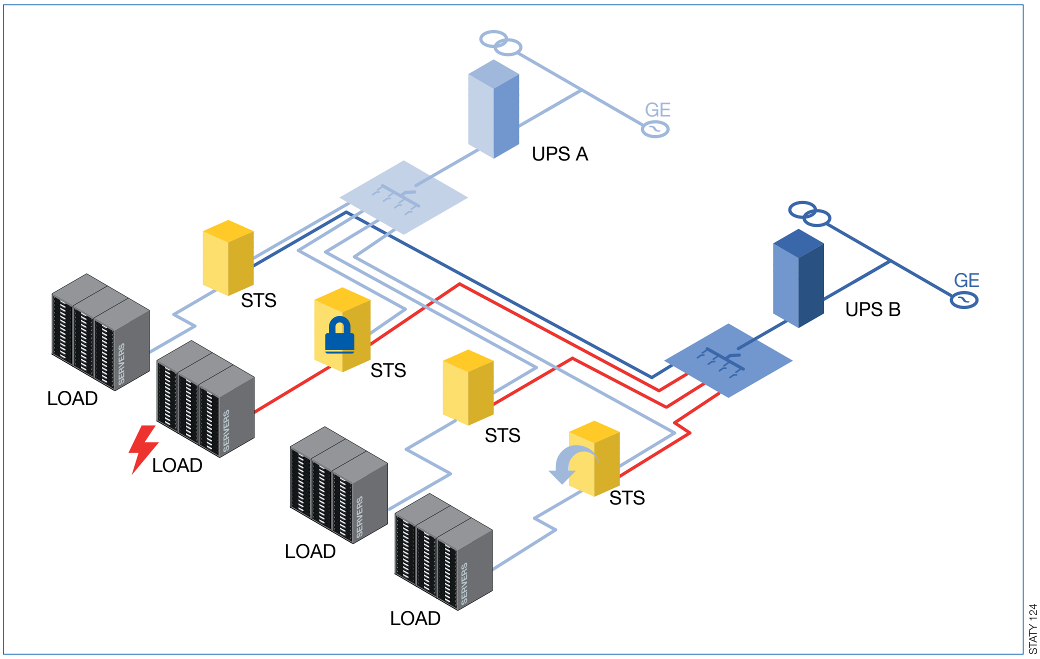
Example of STS operation for a downstream fault in a 2N architecture

Short-circuit scenario

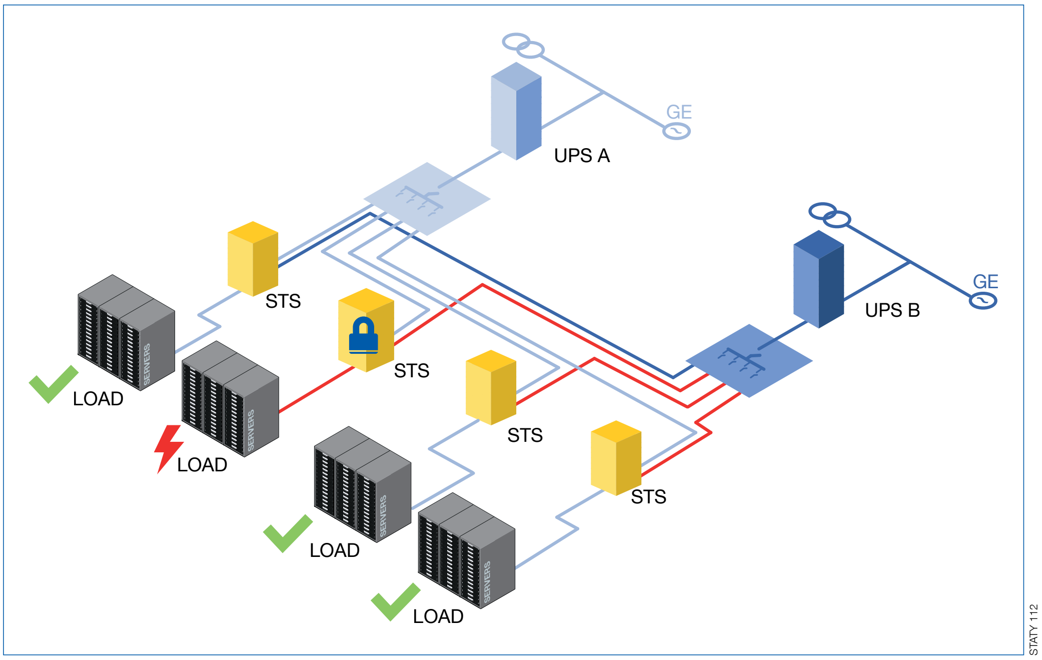
Short-circuit on a load



The STS detects and isolates the fault to prevent propagation. The load is transferred to the alternative power source



The STS concerned is locked. The load is protected. Continuity of service is ensured



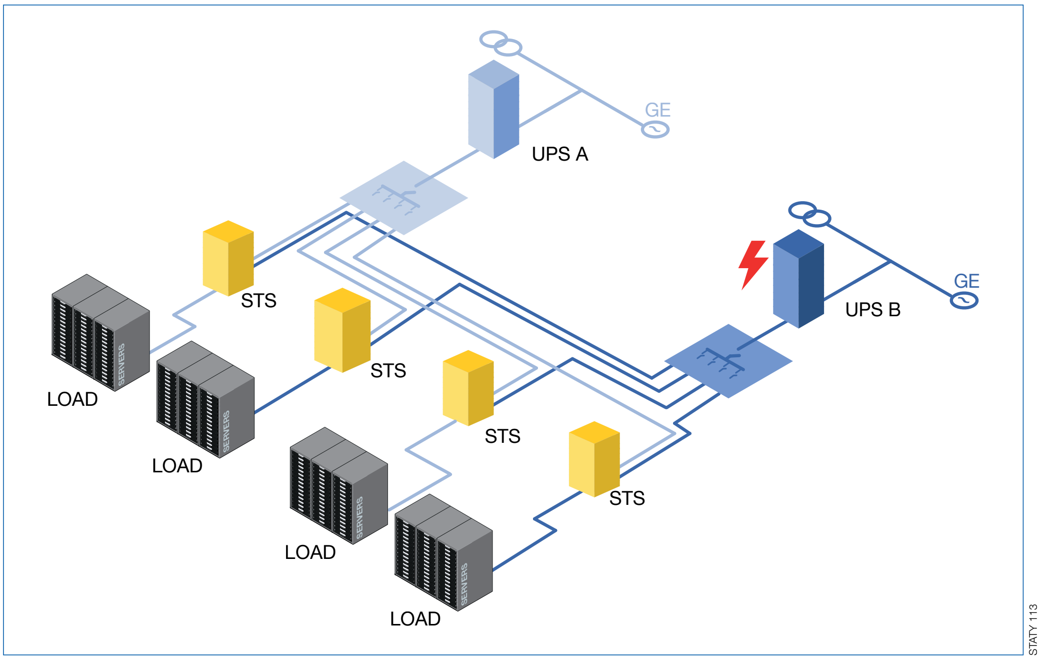
A short-circuit on one load will affect all the other loads supplied by the same source. This phenomenon is linked to the voltage drops that a short-circuit produces. The UPS affected by this short-circuit will aim to supply as much energy as possible in order to open the protection as quickly as possible, however, the tripping time can exceed 20ms depending on the conditions and the design of the protection. Using the STS, the fault can be detected and isolated to prevent any propagation.

In the event of a short-circuit downstream of the STS, the fault must first be isolated to prevent it spreading, and only then can the operator be notified. Any other STS connected to the same source protects its load by switching immediately to another source without propagating the fault.

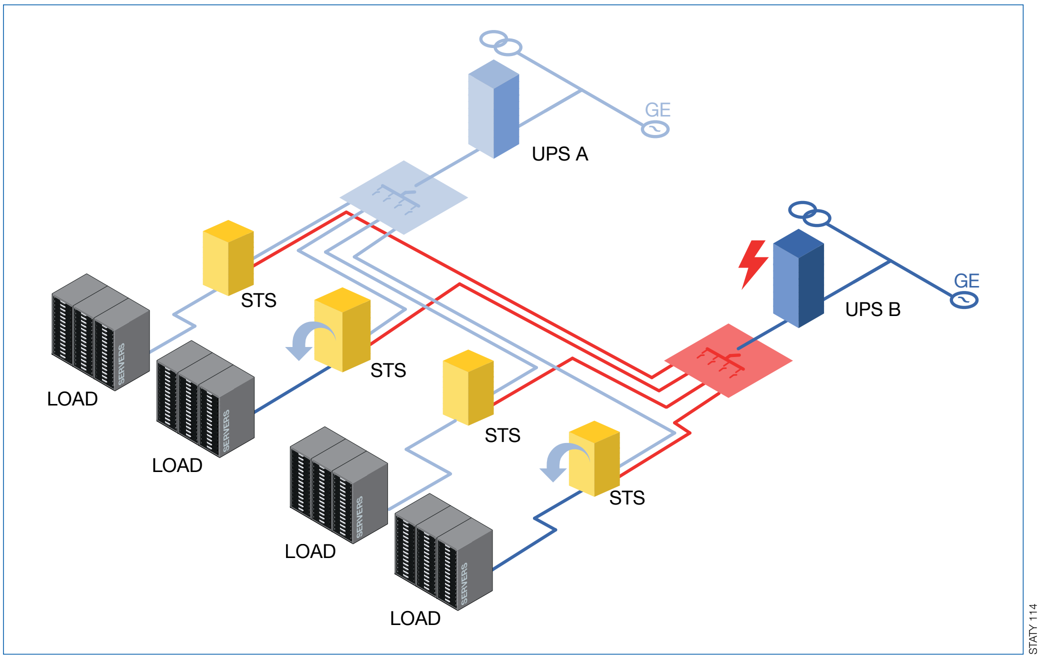
For a fault upstream of the STS, the fault isolation strategy consists of transferring all loads to the healthy network.

Upstream fault scenario at the STS

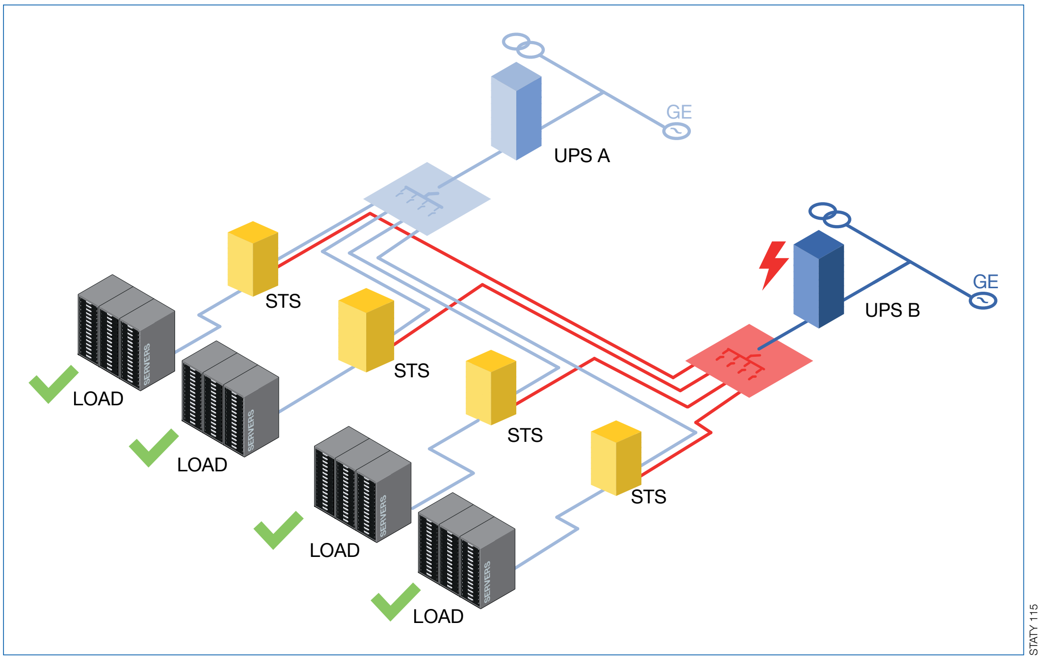
Fault upstream of the STS



Transfer of loads to the healthy source



Loads protected



In the event of a power supply failure, such as a short-circuit in the UPS, a maintenance fault or even a handling error, the STS will detect the absence of power and immediately transfer the loads to an alternative power source in order to guarantee power supply continuity.

How does Socomec meet its customers' expectations in the field?

3 questions to Mauro Cappellari,

International Key Account Manager at Socomec

What types of Data Centre is Socomec's STATYS offer aimed at?

Our range stands out in the market for the breadth of power it covers. The products range from 32 A to 1800 A, and all incorporate the same redundancy. The STATYS range is suitable for all Data Centre sizes, from Edge to Hyperscale.

How do you support your customers?

We listen to their needs and adapt to their requirements and specifications.
For high-power Data Centres (over 10 megawatts), we generally have to adapt our products to ensure perfect coordination with the customer's needs in terms of protection, dimensions or noise, for example. For some STS, we even go so far as to modify the protection internally so that it matches the customer's design.
We are able to tailor the product to the expectations and constraints of major infrastructures.

A case study to illustrate your ability to customise your STS?

A major player in the Data Centre industry, specialising in colocation, decided to switch from a 3N +1 architecture (4 UPS in parallel) without STS support to a Catcher design. They had targeted our 1800 A STS. However, the STS had to have particular dimensions and meet additional specific requirements, particularly in terms of seismic resistance.
We worked directly with the customer to adapt our product, and then delivered a turnkey solution that could be connected directly without having to touch the installation. This made-to-measure static transfer system was first installed in a Data Centre in Italy, and has since been integrated into a number of the company's other projects.

And the future? R&D focused on optimising electrical architectures

For 35 years, Socomec has been innovating to improve the performance, reliability and efficiency of its equipment for Data Centres.

Today, the Group's R&D teams are working on several areas of improvement and development. In particular, they are focusing on making architectures more secure.

More broadly, the R&D teams are looking at ways of further optimising Data Centre architectures, taking ever greater account of operators' economic, competitive, regulatory and security constraints.

As studies show, many operators will struggle to meet new sustainability reporting requirements, or even the demands of some customers. Socomec is constantly looking for solutions that enable uninterrupted power supply while reducing its carbon footprint.

In the context of the major environmental challenges of our time, Socomec is actively committed every day to minimising its environmental impact by developing eco-designed products and promoting the principles of the circular economy.

Reducing our carbon footprint has become a crucial strategic objective, not only to anticipate the future but also to continue strengthening our performance. By placing sustainability at the heart of our activities, Socomec aims to become a benchmark partner to support our customers in their transition to more sustainable, low-carbon energy solutions.

Socomec: our innovations supporting your energy performance

1 independent manufacturer

4,400 employees worldwide

8 % of sales revenue dedicated to R&D

400 experts dedicated to service provision

Your power management expert

POWER SWITCHING

POWER MONITORING

POWER CONVERSION

ENERGY STORAGE

EXPERT SERVICES

The specialist for critical applications

- Control, command of LV facilities
- Safety of persons and assets

- Measurement of electrical parameters
- Energy management

- Energy quality
- Energy availability
- Energy storage

- Prevention and repairs
- Measurement and analysis
- Optimisation
- Consultancy, commissioning and training

A worldwide presence

12 production sites

- France (x3)
- Italy (x2)
- Tunisia
- India
- China (x2)
- USA (x2)
- Canada

30 subsidiaries and commercial locations

- Algeria • Australia • Austria • Belgium • China • Canada
- Dubai (United Arab Emirates) • France • Germany
- India • Indonesia • Italy • Ivory Coast • Malaysia
- Netherlands • Poland • Portugal • Romania • Serbia
- Singapore • Slovenia • South Africa • Spain • Sweden
- Switzerland • Thailand • Tunisia • Turkey • UK • USA

80 countries
where our brand is distributed

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