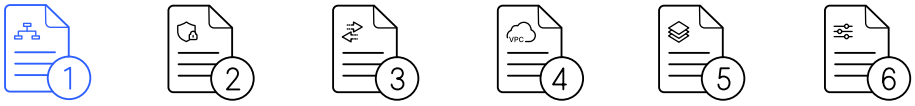
Two-tier and three-tier switch architectures

When structuring the logical architecture of an enterprise network, decisive factors include the efficient and secure transport of data, high scalability, and high availability. A hierarchical switch network topology, with layers that each perform different functions and tasks, is therefore ideal for implementing a LAN infrastructure.

This techpaper provides an overview of three-tier and two-tier switch network topologies and the hierarchy layers of an enterprise LAN. The aim is to provide application scenarios that suit customer needs and company size with a focus on recommendations from the LANCOM switch portfolio.

This paper is part of the **series "switching solutions"**.
Click on the icons to find out more about the information available from LANCOM:



Basics Two-tier & three-tier switch architectures	**Basics** Switch security with IEEE 802.1X	**Design guide** Redundancy concepts for switch networks	**Setup guide** VPC configuration with LANCOM switches	**Setup guide** Stacking with LANCOM switches	**Setup guide** Configuration options LANCOM XS-6128QF

Switch network designs in overview

Three-tier design for large networks

A three-tier model of network design is a proven and well-known basic architecture, which is widely used for campus networks. Core-layer switches make up the top layer or core of the network. The aggregation or distribution switches are the intermediary layer between the core and access layers. The lowest tier is the access layer, which is used to connect all of the various end devices, such as PCs, printers, and other network components such as routers or access points.

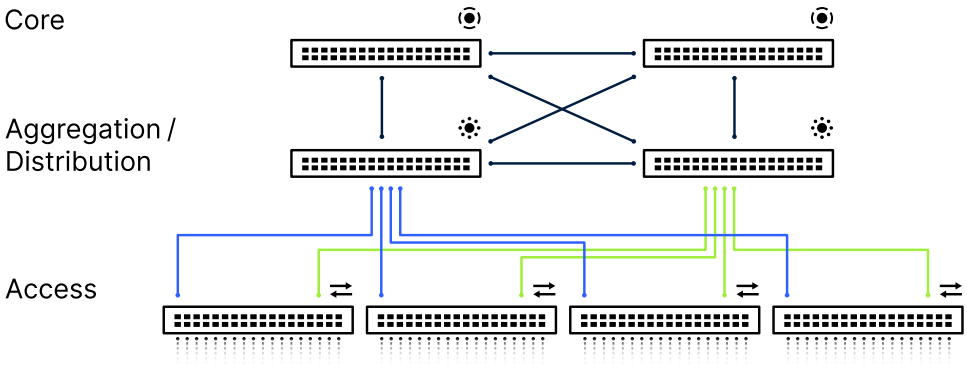


Figure 1:
Three-tier model

Two-tier design for small to medium-sized scenarios

For small and medium-sized companies, LAN infrastructures often “get by” with a combined core and distribution layer, known as a **“collapsed backbone”**. In these cases, the aggregation/distribution switches combine the functions of the top core layer with the tasks of the aggregation/distribution layer.

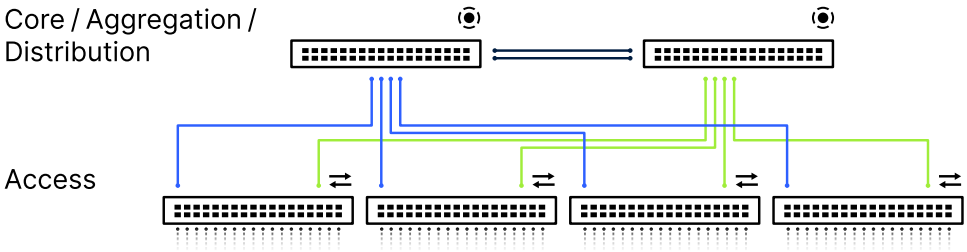


Figure 2:
Two-tier model

Tasks of the three switch layers

Depending on the manufacturer, different names are used for the switches on the core, aggregation/distribution, and access layers. For example, devices that LANCOM refers to as aggregation switches can also be referred to as distribution switches.

1) Core switches

Core switches represent the heart of the network and are the top layer of a three-tier network. With its high throughput, a core switch mainly handles non-blocking switching tasks on layer 2 (the data-link layer) and routing tasks on layer 3 (the network layer). This switch is mainly used in campus networks or data centers and is characterized by very high performance and maximum data throughput. Its principal function is to forward data packets as efficiently and latency-free as possible, either from distribution

layers (e.g. WAN, DMZ), from the data-center LAN, or between aggregation/distribution switches via the central distributor core switch (packet forwarding).

2) Aggregation / distribution switches

The aggregation or distribution layer describes the hierarchical layer that collects (aggregates) the uplinks from the access layer below it. In the uplink direction, i.e. upwards in the hierarchy, and depending on the deployment scenario, the aggregation/distribution switches provide high-bandwidth (10G / 25G / 40G / 100G) connections to the core switches (three-tier scenarios design). In smaller scenarios, these switches themselves can additionally perform the task of the core (i.e. two-tier design). Typically performed on the aggregation/distribution layer are L3 tasks such as DHCP server functions, i.e. IP address management or the predefinition of network routes across one or more network segments. This reduces the load on the router or firewall, if applicable. Stacking, i.e. the redundant operation of aggregation/distribution switches, increases the reliability of the aggregation layer, and connecting the relevant access switches to two different network nodes in the aggregation/distribution layer ensures an extremely high level of reliability (HA – high availability) for near-to uninterrupted network operations.

3) Access switches

The access layer connects the clients to the network. This includes, for example, access points, PCs, IP telephones, networked machines or IoT sensors. Switches on the access layer generally feature large numbers of ports and distribute the network to the connected clients. They can also be used as a power supply for the end devices. For this to work, the switch and the end devices must support Power over Ethernet (PoE).

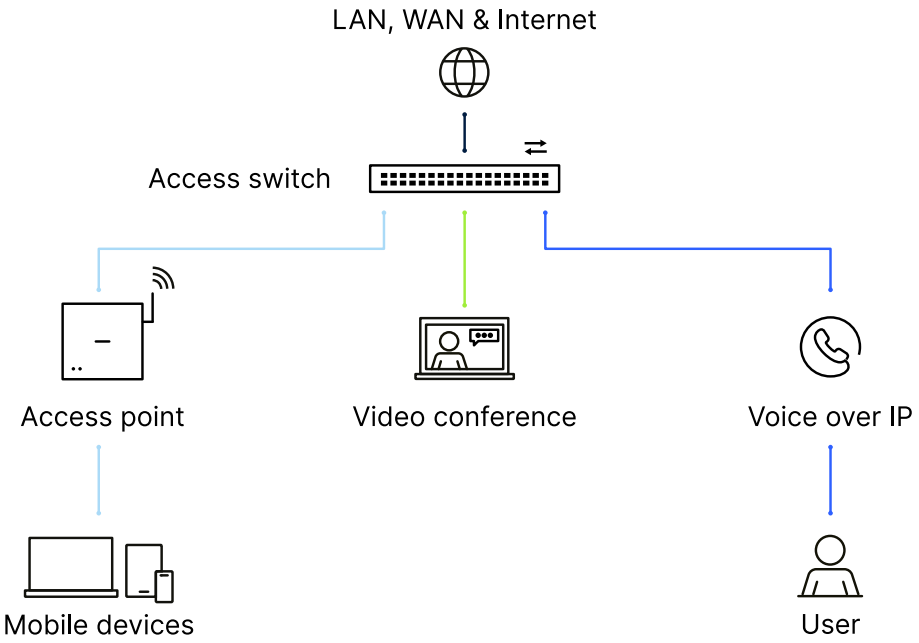


Figure 3:
Access switches on the application layer

The right network topology for any size of company

LANCOM offers core, aggregation/distribution, and access switches, i.e. a full range of products for campus switching. This allows for the implementation of network scenarios, whatever the requirements or size. This can include all network scenarios from retail networks to production LANs and logistics centers, office towers, and campuses—starting with smaller (SE), medium-sized (ME) scenarios, and ranging to large enterprise (LE) networks.

The design of LANCOM core and aggregation/distribution switches features ports that are exclusively industry standard ports and not proprietary interfaces. These switches also come with full layer-3 functionality. Covered by a limited lifetime warranty, they are subject to up to 10 years of replacement service.

Irrespective of the classification into SME or Enterprise segment, the following planning parameters are also fundamental to the design of the network:

→ **Wirespeed system architecture:**
All LANCOM switches are engineered to feature a non-blocking system architecture. What that means is that the switch has sufficient internal resources to handle maximum transfer rates from all of the ports. In brief, LANCOM core, aggregation/distribution, and access switches can process all connected clients at “wirespeed” and without any bandwidth limitations.

→ **Uplink blocking factor:**
The available bandwidth between the switch layers (access – aggregation/ distribution – core) is defined by the capacity of the uplink ports. The individual uplink ports can be bundled by link aggregation (LACP protocol). This increases the available uplink capacity in stages and thus reduces the blocking factor (sum of downlink to uplink capacity).

→ **Stacking blocking factor:**
A stack is a group of switches that physically behave as a single device. If several switches operate as a stack, the blocking factor between these stack-members is defined by the downlink capacity to the stacking capacity. Stacking makes use of uplink ports or, if available, dedicated stacking ports. The blocking factor is reduced by an increase in the port capacity of the stacking ports. A non-blocking stacking capacity is said to exist when the sum of the downlink capacity is covered by the sum of the stacking capacity.

Small enterprise (SE) networks

Small LAN environments, such as at a chain-store branch, usually feature only a few end devices, e.g. two to three access points, three to four cash registers, and the office computer of the branch manager. Sufficient for this scenario is usually a single access switch operated directly at the WAN gateway. However, even in these traditionally smaller environments, progress in digitalization is leading to a rapidly growing numbers of network users and end devices that need to be networked. Even in supposedly small environments, it can quickly become necessary to use an aggregation/distribution switch if a number of distributed company buildings (e.g. another office building, a warehouse, gates) or remote peripheral elements (e.g. barriers, displays, cameras) need to be integrated into the network.

These smaller, distributed networks are the ideal backdrop for a cost-effective solution such as the entry-level aggregation switch LANCOM XS-5110F. With its eight fiber-optic SFP+ ports and two additional multi-Gigabit (10 / 5 / 2.5 / 1G) Ethernet ports, this switch is the ideal upper-layer instance for connecting additional access switches or NAS/server components. To support these scenarios, the SFP+ ports 7 and 8 can be defined as stacking ports in the software settings. A stack can consist of up to eight aggregation switches. This ensures a high level of scalability and the possibility of increasing the number of ports.

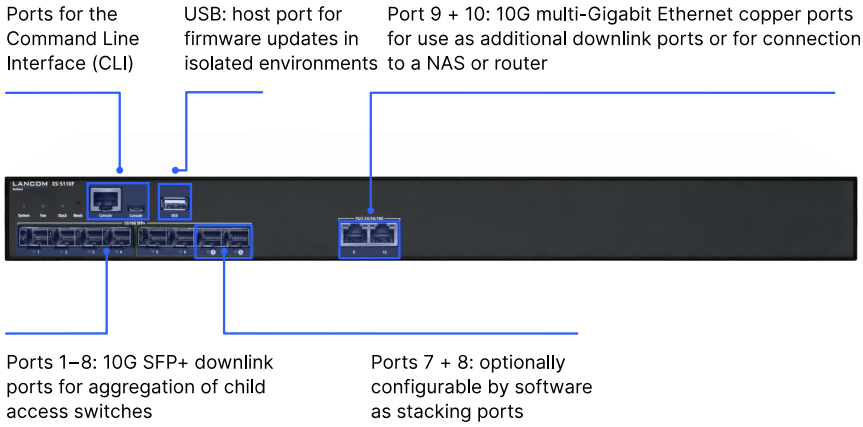


Figure 4:
LANCOM XS-5110F port layout

Medium scenarios (mid-sized enterprise (ME) networks)

Medium-sized local area networks, such as those required by medium-sized companies, authorities, administrations or schools, cannot be implemented without the use of an aggregation layer (aggregation/distribution switches). Reasons for this may be the geographically distributed company buildings, larger building complexes with several floors, or in-house (often redundant) data centers. Depending on the size, complexity and scale, non-blocking network operations may require at least one or even several aggregation/distribution switches. We recommend a two-tier design with a collapsed backbone featuring an uplink to the router and/or data storage.

Here LANCOM offers the XS-5116QF (440 Gbps switching capacity) and the sustainably optimized, operationally efficient, high availability XS-6128QF (1,000 Gbps switching capacity) matching 10G stackable, managed fiber aggregation switches.

The LANCOM XS-5116QF is a high-performance device with a total of 14 SFP+ ports (10G), two of which are designed as multi-Gigabit Ethernet combo ports. Two QSFP+ ports provide a broadband uplink to the core layer or to a data-center LAN. Thanks to the implemented stacking function, up to eight switches of this model can be used for high availability (HA), redundant scenarios in business-critical environments. Power supply units that can be hot-swapped during operation offer a further increase to reliability. With this model, too, the two QSFP+ ports can be redefined in software as stacking ports. Since this is standard Ethernet technology using standard media types, it is also possible to combine far-distant network nodes into a stack with the help of tried-and-tested fiber GBIC modules.

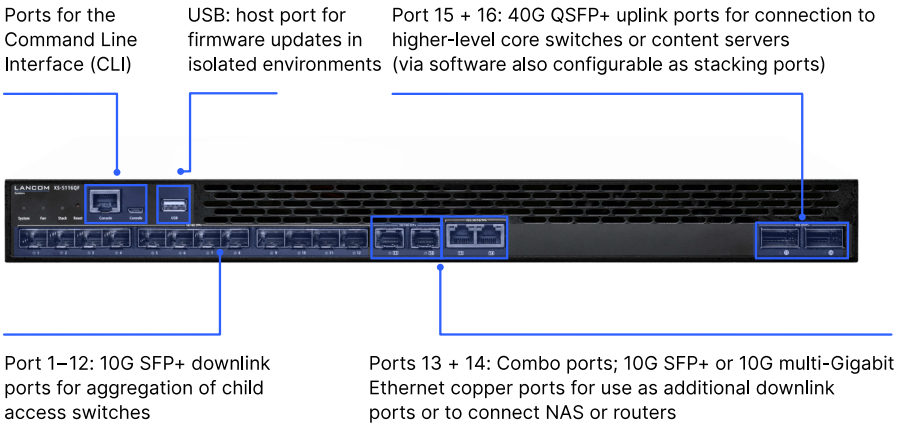


Figure 5:
LANCOM XS-5116QF port layout

The LANCOM XS-6128QF features a total of 20 SFP+ ports (10G), four of which are multi-Gigabit Ethernet combo ports, and operates as a high-performance distribution platform for an even higher number of lower-layer access switches. Four dedicated SFP-DD stacking ports (50G) provide a non-blocking/wirespeed connection between all of the devices in a stack. This model also supports stacks with up to eight switches and thus up to eight times the port capacity. A massive backhaul capacity is available either via two QSFP+ (40G) or four SFP28 (25G) high-speed uplink ports. These combo uplink ports provide great flexibility when connecting to the upper-layer core switch with either 25G or 40G. It is even possible to set up a high-performance connection to a data center by using LACP to bundle the four SFP28 (25G) ports to form a 100G connection. Two redundant power supply units and a fan system can be swapped out during operations, which maximizes high availability. Since the uplink / downlink ports are based on standard Ethernet technology using standard media types, it is easy to combine far-distant network nodes by using tried-and-tested fiber GBIC modules.

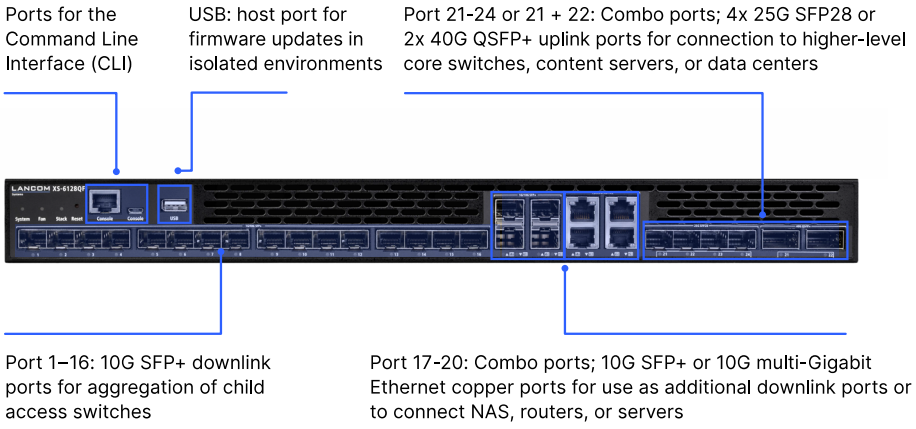


Figure 6a:
LANCOM XS-6128QF port layout (front)

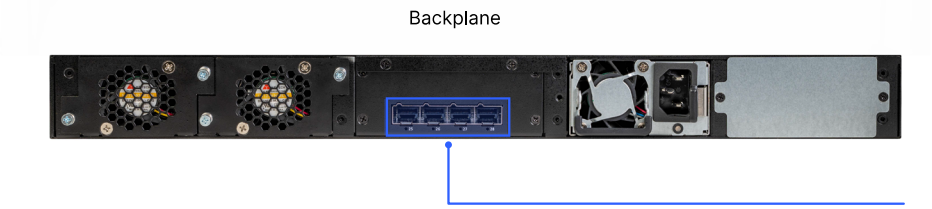


Figure 6b:
LANCOM XS-6128QF port layout (back)

Distributed enterprise and campus scenarios – large-enterprise (LE) networks

For very large enterprise infrastructures with several sites, also known as campus networks, we recommend the three-tier design with switches on three hierarchical layers. This is the only way to meet the high demands of bandwidth-intensive applications and to process data packets with maximum efficiency and minimum latency.

The LANCOM CS-8132F is ideal for operation as a central hub in campus networks. This 100G fiber core switch offers massive CPU power and high-performance switching chips to reliably execute switching tasks on layer 2 (the data link layer) and routing tasks on layer 3 (the network layer). With 32 high-performance 100G QSFP28 industry-standard ports and up to 6.4 Tbps of switching capacity, it is the ideal switch for forwarding the entire server-rack traffic. 100% network uptime is achieved by coupling two core switches via Virtual Port Channel (VPC) or Multi-Chassis Link Aggregation Group (MC-LAG). In the event of a failure or downtime (e.g. during a firmware update), one of the two devices can take over the work of the other device without interruption. Flexible memory expansion and feature upgrades through third-party software are enabled thanks to the integrated 64GB SSD. For fast and uninterruptable communications, the LANCOM CS-8132F features two integrated PSUs (power supply units) and three hot-swappable fans. For optimal cooling in racks, the switch comes in two hardware variants; optionally with front-to-back or back-to-front airflow (F2B or B2F airflow design).

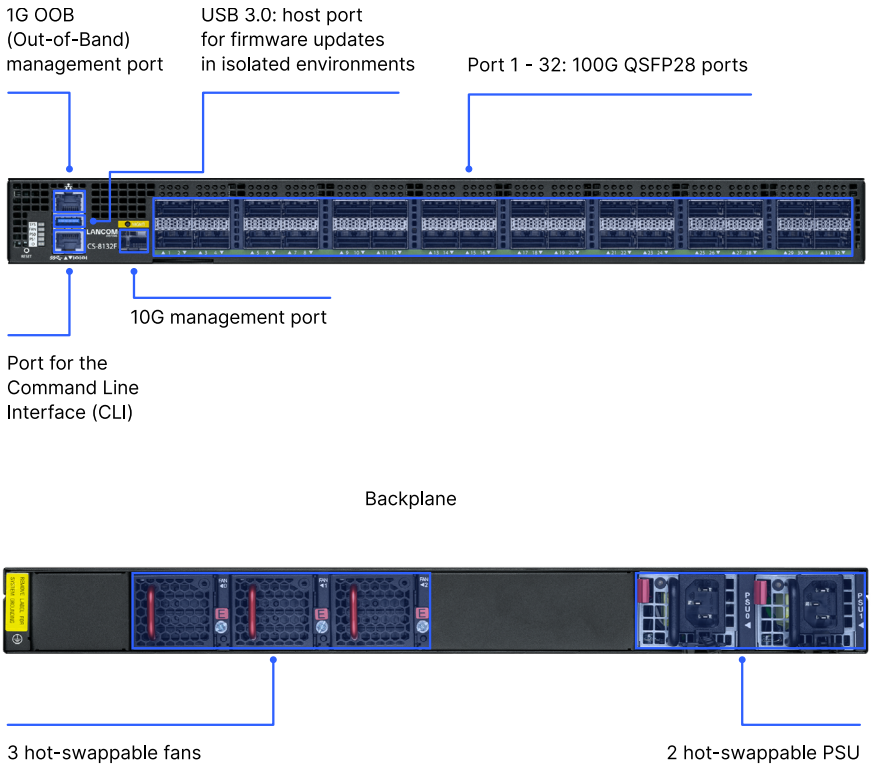


Figure 7:
LANCOM CS-8132F port layout

Suitable for the second layer, in addition to the three aggregation switches already mentioned, is the LANCOM YS-7154CF. This 25G stackable fiber aggregation switch offers up to 3.6 Tbps switching capacity with 48× 25G SFP28 and 6× 100G QSFP28 ports, providing greater switching performance in terms of connectivity options and data throughput. Similar to the core switch, this model also supports VPC/MC-LAG and offers either F2B or B2F airflow. Two integrated PSUs and five hot-swappable fans provide the necessary high availability for switch architectures with 100% uptime.

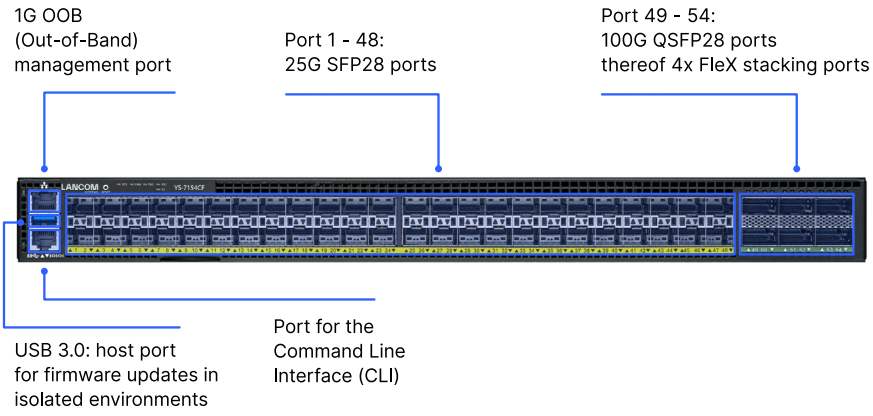


Figure 8a:
LANCOM YS-7154CF port layout
(front)

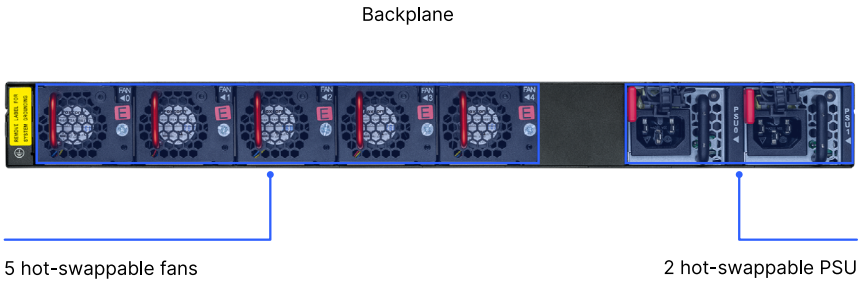


Figure 8b:
LANCOM YS-7154CF port layout (back)

Conclusion

The descriptions of the scenarios selected here show the variety of options available with the new core and aggregation/distribution switches as well as their different levels of performance. By intelligently combining these LANCOM models with the powerful and cost-effective LANCOM access switches, a wide range of possible applications in two- or three-tier networks is available.

Are you planning to set up or expand your network with LANCOM switches?

Experienced LANCOM technicians and the specialists from our system partners will help you with the planning, installation and operation of a needs-based, high-performance and future-proof LANCOM network designs.

Do you have any questions about our switches, or are you looking for a LANCOM sales partner?

Please give us a call:

Sales in Germany

+49 (0)2405 49936 333 (D)

+49 (0)2405 49936 122 (AT, CH)

LANCOM Systems GmbH
A Rohde & Schwarz Company
Adenauerstr. 20/B2
52146 Wuerselen | Germany
info@lancom.de | lancom-systems.com