LANCOM Techpaper

Hierarchical switch infrastructures

When setting up the logical architecture of a company network, especially with regard to the LAN infrastructure, it is vital to make in-depth considerations of the individual data paths and, separately, the efficient and secure transport of data. The result of this a hierarchical structure of a company LAN that implements the various functions and tasks of the network devices, in particular for the switches that are so important for distributing data traffic.

This paper describes the different tasks performed by the hierarchical levels of a company LAN and uses example scenarios based on LANCOM switches to illustrate how company networks of different sizes and complexity can be structured. Ranging from small environments up to very large enterprise networks, we describe the lower-most access layer used by the end devices, the interim layer for aggregation and distribution, as well as the top or core layer of the network.

Requirements for a modern LAN

The ongoing digitalization of all areas of life and work brings with it the increasing networking of a wide variety of client devices. A key aspect to ensure the reliable data exchange is the intelligent and secure networking of these clients. Efficient logistics are essential for moving the data from where it is created to where it is consumed. This may be at the same company location or at a remote branch, depending on where the data packets have to be further processed. Furthermore, the available bandwidths on the local LAN (local area network) have increased from a few Mbps to several 100 Gbps, i.e. by a factor of 100,000. At the same time, for many companies nowadays it is business-critical that the data, which actually makes up an immense proportion of overall corporate value, is only accessible to the people or machines that are authorized to use it. This makes it vital that the physical LAN connections, which are used to connect workstation computers, access points, networked machines or IoT sensors, do not provide a point of entry for unauthorized users. So the effective management of access authorizations and a clear separation of independent user contexts are additional essential aspects in network planning. Another key focus is business-critical factors such as the high availability of networks. Disruptions of a network, or parts of it, can lead to production stoppages or even the failure of entire communications infrastructures and the immense follow-up costs that go with it.

The following is an introduction to three-layer network design, followed by an overview of the various application scenarios recommended by LANCOM (Page 4). We go on to redundancy concepts (Page 6) followed by the possibilities of switch stacking (Page 6). The document concludes by outlining the possible applications for the LANCOM aggregation switches (Page 8).

Three-layer network design (“three-tier model”)

A tried, tested and widely accepted basic architecture in the understanding and construction of modern LAN network architectures is the three-layer network design. But to help with a better understanding of the three-layer model, we should first explain some terms and the layers used in this model.

How the layers are named

To better understand the terms access, aggregation and core switch, which will be explained in more detail later, we should mention that the various manufacturers each use different names. For example, the term “aggregation switch” refers to the layer used to network the access switches on the access layer used by the end users. From the other perspective, the switches on the top layer have the task of distributing from the core layer to the access layer, and are therefore referred to by some manufacturers as “distribution switches”. So a lot depends on the nomenclature of the particular manufacturer. LANCOM has decided on the term “aggregation switches” on the second layer, as this term most accurately reflects the task of linking the core and access layers.

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 have to support Power over Ethernet (PoE).

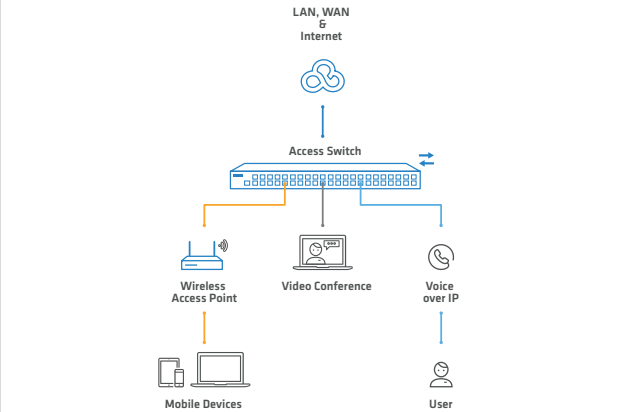


Fig. 1: Access switches on the application layer

Aggregation switches

The term “aggregation layer” refers to 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 switches are used to connect with high bandwidths (10G / 25G / 40G / 100G) to the core switches (“three-tier scenarios”, see below). In smaller scenarios, these switches can additionally perform the task of the core (“two-tier scenario”, see below). Typically performed on the aggregation 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, which takes a great load off of the router or, if applicable, the firewall. Operating redundant aggregation switches (stacking) increases the reliability of the aggregation layer, and connecting the relevant access switches to two different network nodes in the aggregation layer ensures an extremely high level of reliability (HA – high availability) for near-to uninterrupted network operations. Loop-prevention mechanisms are extremely important here, in that they avoid having to use the rather ineffective spanning tree protocol and replace it with a better solution, namely redundancy through stacking.

Core switches

The core switch forms the top layer and, in the three-layer model, this is the backbone of the network. With its high throughput, it 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 data centers and features very high performance and maximum data throughput. It's 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 switches via the central distributor core switch (packet forwarding).

These layers form the three-tier model

The lowest tier is the access layer, which connects all of the end devices such as PCs, laptops, servers, and wireless devices. The switches on this access layer then connect upwards to the next tier, i.e. the aggregation layer. In "three-tier scenarios", the aggregation switches connect the access layer with the core layer or, in smaller two-tier networks, they actually form the top layer of the network hierarchy (i.e. a "collapsed backbone"), see figure 3.

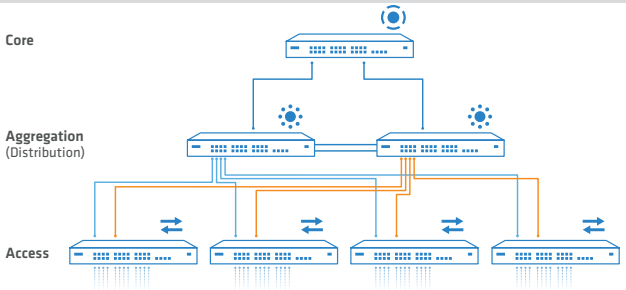


Fig. 2: Hierarchical LAN structure based on a three-tier model

Core switch network scenarios

The terms "three- and two-tier scenario" mentioned above are explained in more detail later.

Three-tier design

In very large scenarios, such as on larger company or university campuses, the core switch forms the top layer and the aggregation switches form the intermediary layer between the core and access layers. This is known as a three-tier design.

Two-tier design

Core switches are highly expensive and are mostly used for large-scale networks and data centers. Smaller to medium-sized scenarios generally manage with a single device or stack that combines the core and aggregation layers into one (known as a "collapsed backbone"). In these cases, the aggregation switch combines the functions of the top core layer of the network topology with the tasks of the aggregation layer.

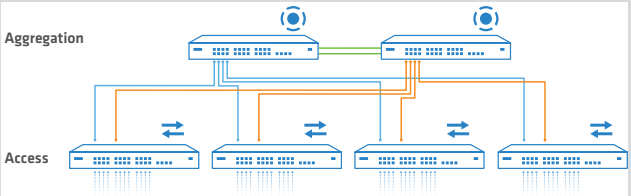


Fig. 3: Hierarchical LAN structure based on a two-tier model

The right network topology for any scenario

We at LANCOM offer a complete range of offerings for campus switching, so allowing our partners to implement network scenarios with different network requirements and sizes. The current portfolio of LANCOM aggregation and access switches, and the option of combining them to meet any requirement, opens up a wide variety of scenarios that can be implemented, ranging from smaller (SME) to medium-sized (ME) scenarios and even up to large enterprise (LE) networks.

Smaller scenarios (small and medium enterprise (SME) 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 these supposedly small environments, the use of an aggregation switch can quickly become necessary especially if numerous 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 8 fiber-optic SFP+ ports and 2 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.

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. 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 extent, at least one or even several aggregation switches may be necessary. This is where LANCOM offers the XS-5116Q, a 10G stackable, managed fiber aggregation switch for medium-sized, distributed networks. The XS-5116QF is a high-performance device with a total of 14 SFP+ ports (10G), 2 of which are designed as multi-Gigabit Ethernet combo ports, for medium-sized networks and non-blocking network operation. Two 40G uplink ports (QSFP+) can be used for a broadband uplink to the core layer or to a data-center LAN. However, this model is recommended for a "collapsed core" scenario, i.e. a two-tier network design with 10G uplink to the router and/or data storage. 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.

Large-enterprise scenario (LE) networks

The LANCOM XS-6128QF, the largest model of the 10G stackable managed fiber-aggregation switches, enables the implementation of large, decentralized enterprise networks with virtualized applications. This model has consistently been optimized for operational efficiency and reliability and, like the LANCOM switches mentioned earlier, it is engineered to feature exclusively industry-standard ports

and is free of any proprietary interfaces. With a total of 20 SFP+ ports (10G), 4 of which are multi-Gigabit Ethernet combo ports, this aggregation switch operates as a high-performance distribution platform for large numbers of lower-layer access switches. Four dedicated SFP-DD (50G) backplane stacking ports provide a non-blocking/ wirespeed connection between all of the devices in a stack. LANCOM offers SFP-DD-DAC50 stacking cables in 1 m and 2.5 m lengths. It is also possible to use SFP28 25G modules, which can connect decentralized, i.e. distant locations with half the bandwidth. This model supports stacks with up to eight switches and thus up to eight times the port capacity, and that with up to 224 uplink / downlink ports. A massive backhaul capacity is available either via 2 QSFP+ (40G) or 4 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. The switch offers basic L3 features and currently under development are dynamic routing functions.

This portfolio of aggregation switches and the equally extensive range of access switches makes LANCOM extremely well positioned to implement practically any application. We can cater for all network scenarios in the small & medium enterprise segment, including retail networks, production LANs, logistics centers, office towers, or campuses.

Wirespeed system architecture and available uplink and downlink bandwidths

The right combination of aggregation and access switches depends on parameters such as the absolute number of required ports, the bandwidth requirements of the individual clients, and the blocking factor for the uplinks/ downlinks, i.e. the ratio of the downlink to the uplink and/ or stacking capacity.

Wirespeed system architecture of the switches

All LANCOM switch models are engineered to have 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 aggregation 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 – 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

If several switches are operated as a stack, the blocking factor between these stack-member switches 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.

Redundancy concept

In particular for the higher quality LANCOM switch models, a consistent redundancy concept plays an important role. This ensures the highest levels of reliability and optimal network availability.

Redundant power supplies

"Hot-swappable" PSUs allow the switches to be exchanged and operated without interruption if a power supply unit is defective. For this reason, the two aggregation switches XS-5116QF and XS-6128QF are equipped with a slot for a second power supply unit. If one of the two power supply units should fail, the defective power supply unit can be replaced while the affected switch continues to work. This redundancy concept is maintained right through to the access layer: The LANCOM GS-3152XSP can also be equipped with a second PSU, which doubles the PoE power output of the switch and thus ensures that all connected PoE end devices receive sufficient power.

Redundancy through switch stacking

Further redundancy mechanisms come with the fail-safe stacking (see below) of the LANCOM switches or by interconnecting them intelligently. This makes it possible to set up distributed scenarios by operating one access switch at two aggregation switches at the same time. It is irrelevant whether the stack is physically located at a single location or at geographically dispersed locations and connected via fiber optics / GBIC modules. Uninterrupted operation is assured, even in the event of maintenance, failure, or replacement of one of the aggregation switches—a basic requirement for modern enterprise (HA) network architectures and the operation of business-critical applications.

Stacking

Failsafe stacking

Modern network architectures must be scalable, secure and flexibly expandable: The LANCOM switch family 51XX and 61XX can be flexibly expanded using an integrated failsafe stacking mechanism. Stacking, which literally refers to stacking switches on top of one another, refers to the connection of two or more switches, preferably of the same model and port speeds. This method combines several physical switches into a single logical unit, which is then very simple to configure and manage. The advantage of this is that the different switches can be addressed at a common MAC address and a common IP address ("single IP / single management") and the entire stack behaves like a chassis-based system.

Failsafe stacking means that new stack members added under the stack master receive their configuration automatically from the master. The first member switch connected directly to the master can act as a standby master (or backup master) and temporarily become the configuration instance in the event of failure or replacement of the master switch. It is also possible for a stack member switch to be removed or replaced without interrupting ongoing operations and without rebooting the stack. When the device is replaced, the last valid configuration and firmware version from the stack master are automatically transferred to the newly added switch. The boot sequence of the new member does not influence the other devices and, if access switches are redundantly connected to the stack, the entire network remains unaffected.

Uninterrupted operation of the stack during firmware updates

The in-service software upgrade mechanism "ISSU" guarantees the availability of the network even when the stack is going through a software upgrade. The stack members restart one after the other, and not all at the

same time. Where the access switches are redundantly connected to an upper-layer aggregation switch stack (one access switch is connected to two different stacking members), the software upgrade does not interrupt the network operations.

The LANCOM switch family supports three different forms of stacking: “software stacking”, “hardware stacking”, and “non-blocking hardware stacking”.

Software stacking

The LANCOM XS-5110F has two SFP+ downlink ports that are easily configured as stacking ports in the software. With the LANCOM XS-5116QF, two QSFP+ uplink ports are available for a software-defined reconfiguration as stacking ports, and a stack can be formed using these redefined interfaces.

Hardware stacking

In this case, predefined stacking ports are built into the switch hardware. A separate CPU that is independent of the network traffic provides the necessary computing capacity.

Non-blocking hardware stacking

Here, the stacking ports are also provided in the hardware, i.e. with their own CPU computing capacity that is independent of the network traffic. The stacking capacity is at least as large as the sum of the bandwidth of all available downlink ports. This ensures a non-blocking system architecture within the stack. The LANCOM top model, the LANCOM XS-6128QF, supports this stacking method.

Stacking topologies

Switches can be connected to one another in two ways to form a stack. A distinction is made between series connection, known as daisy-chain topology, and ring or loop topology.

Daisy-chain topology (switch clustering)

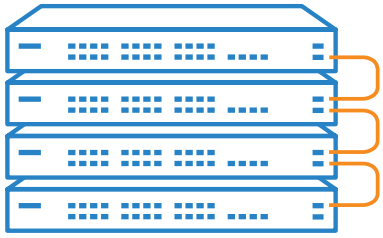


Fig. 4: Daisy-chain topology

The daisy chain is structured as follows: The top switch, the master, forwards the configuration via a cable to the members connected to it in series. The disadvantage of this topology is that the failure of one switch breaks the stack into two separate segments, which can no longer communicate with each other. This is why this topology is only recommended for a stack of two switches. An advantage would be that only one of the available switch ports is “taken up” for stacking. (Important notice: If at all, this method should only be used in a stack of 2 and where ports are absolutely at a premium. This topology cannot prevent a link error / GBIC from breaking the stack, thus causing a loop and potentially an uncontrolled broadcast storm that would ultimately collapse the network. For this reason, LANCOM recommends the use of the ring topology as described below.)

Ring topology (fail-safe stacking)

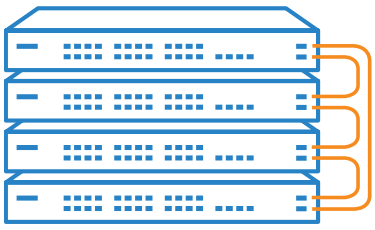


Fig. 5: Ring topology

A ring topology provides a high level of reliability. As the name suggests, this structure is very much like a ring. Instead of being connected in series, the switches are all interconnected to form a closed ring. If one switch fails, the data traffic is routed in the opposite direction (“wrapping”). Although this maximizes redundancy, stacking takes up

two ports on each switch—unless dedicated stacking ports are available, as with the LANCOM XS-6128QF. LANCOM XS-series aggregation switches are capable of implementing stacks with up to eight devices.

Port expansion

Another advantage from stacking in addition to the redundancy is the number of extra ports. For example, a stack of two provides twice as many ports and, when expanded to a maximum, the stack offers eight times the number of ports. A stack can be considered to be a switch that provides a higher number of ports while being treated as a single device.

The right combination for every scenario

We have so far discussed the limiting conditions of setting up various network scenarios based on the three-tier model as well as the basics for port expansion, creating redundancy, and the different stacking topologies. The various combinations of the three LANCOM aggregation switch models and also the various LANCOM access switch models offer us a large number of possible network designs and made-to-measure application scenarios.

In the following, we will show how different combinations of the LANCOM aggregation switches LANCOM XS-5110F, LANCOM XS-5116QF and LANCOM XS-6128QF in combination with the LANCOM access switch family can be adapted to the classifications of small, medium, and large networks described earlier. We will present some typical application scenarios as recommended by LANCOM. These options cannot be considered to be exhaustive. Also, every customer and every scenario bring their own challenges, depending on the environment and business model, as well as the actual on-site conditions. The application scenarios and network topologies for small, medium, and large local networks shown below are example designs and can easily be adapted to the actual customer scenarios.

These example scenarios each consist of a single device or a stack of the three LANCOM aggregation switch models operated in combination with the access switch models of the LANCOM GS-3152 series (LANCOM GS-3152XSP, LANCOM GS-3152XP, LANCOM GS-3152X), which are equipped with 48 downlink ports. The maximum number of available client ports from the example designs can be assumed to be an upper guideline value.

Recommended stacking topology for LANCOM XS-5110F – managed 10G fiber aggregation switch for smaller, distributed networks

The aggregation switch XS-5110F, the LANCOM entry-level model for smaller scenarios, has the following port configuration: Eight 10G SFP+ downlink ports for directly connecting up to 8 access switches. Also, two 10G copper ports (ports 9 and 10) that can be used for either downlink or uplink usage, i.e. for connection to a gateway (e.g. LANCOM ISG-4000) and / or server or data storage (NAS – network attached storage).

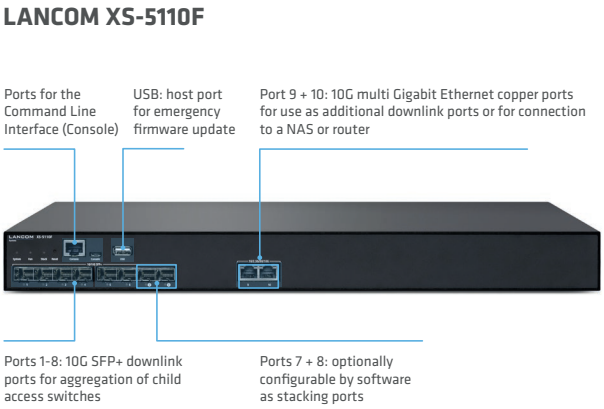


Fig. 6: Port configuration of the LANCOM XS-5110F

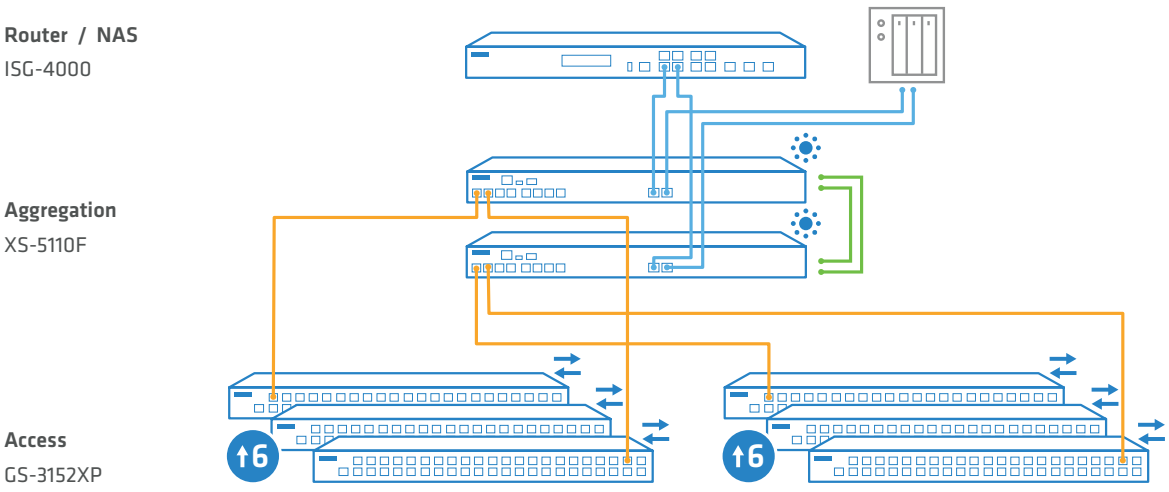
Recommended stack structure and the resulting maximum network size with the LANCOM XS-5110F

Even though both of these stacking topologies were outlined earlier, LANCOM generally recommends the ring topology. In the case of the LANCOM XS-5110F, 2 SFP+ ports are required for stacking, which leaves only 6 SFP+ ports available for the downlink (see figures 7 and 9).

This means that in a stack of max. eight XS-5110F switches, up to 48 downlink ports are available.

Since high-density environments require the access switches to be connected redundantly, up to 24 access switches can be networked.

XS-5110F STACKING SCENARIO
GENERAL



In **ring topology stacking**, ports 7 and 8 are reconfigured as stacking ports, therefore connection of **max. 6 access switches per aggregation switch**

10G uplink to router / NAS
10G stacking connection
1G downlink connection

Fig. 7: General scenario with ring topology, even with only two stacked switches

The following calculation illustrates this in detail.

Calculation of a redundant scenario for a ring-topology stack	
n * m/2 = possible number of access switches	
n	Number of aggregation switches (min. 2 – max. 8)
m	Downlink ports (max. 6)
/2	Redundant connection of one access switch to two aggregation switches
8 * 6/2 = 24 (max.)	

Scenario for creating redundancy in the stack with up to eight aggregation switches

XS-5110F TWO-TIER SMALL AND MEDIUM ENTERPRISE SCENARIO
(UP TO 8 SWITCHES IN THE STACK)

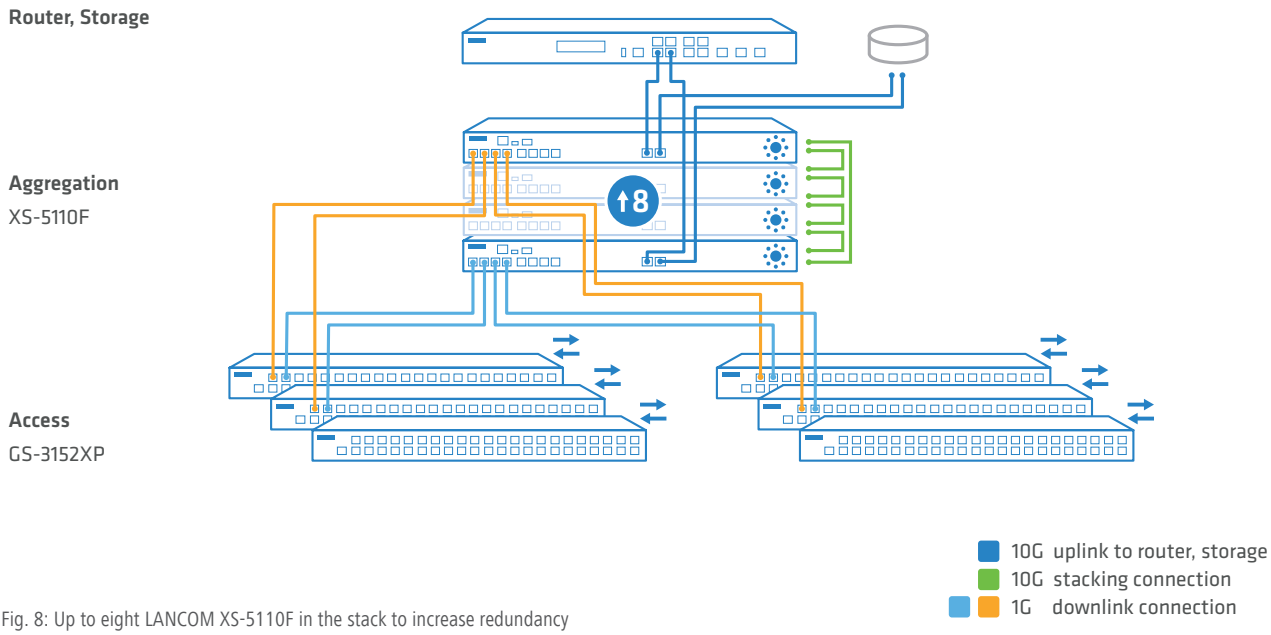


Fig. 8: Up to eight LANCOM XS-5110F in the stack to increase redundancy

XS-5110F STACKING SCENARIO
REDUNDANCY WITH UP TO **8 SWITCHES IN STACK**

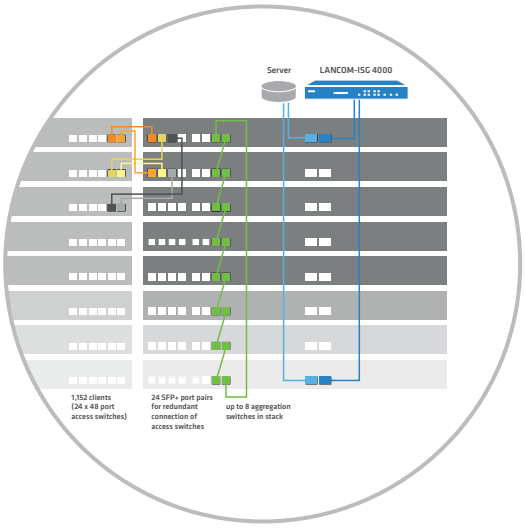


Fig. 9: Detailed view of up to eight LANCOM XS-5110F in ring-topology stacking

LANCOM XS-5116QF – managed 10G fiber aggregation switch for medium-sized, distributed networks

The LANCOM XS-5116QF is the ideal solution for supporting the aggregation layer in medium-sized, distributed scenarios. In addition to its 12 10G SFP+ downlink ports for aggregating the equivalent number of lower-layer access switches, this model has two further combo ports that can either act as additional downlink ports to increase the number of aggregated access switches to up to 14, or for uplinking in the direction of the WAN or connected storage. The two 40G QSFP+ ports 15 and 16 can either be used for a very broadband uplink to the core or a server aggregation layer. They can also be reconfigured in software to be stacking ports. The advantage compared to the smaller LANCOM XS-5110F model is that no downlink capacities are lost when the switches are stacked.

LANCOM XS-5116QF

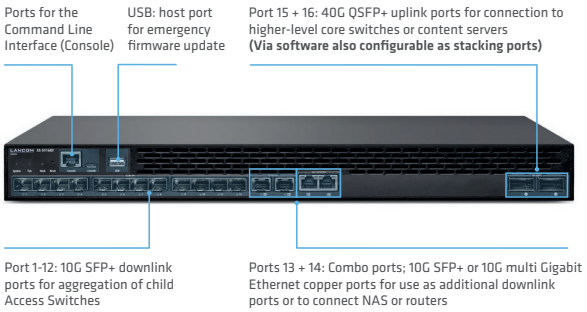


Fig. 10: Port configuration of the LANCOM XS-5116QF

Calculation of a redundant scenario for a ring-topology stack	
n * m/2 – 2 * 2 = possible number of access switches	
n	Number of aggregation switches (min. 2 – max. 8)
m	Downlink ports (14 x SFP+)
/2	Redundant connection of one access switch to two aggregation switches
2*2	10G ports (for connecting storage and router)
8 * 14/2 - 4 = 52 (max.)	

XS-5116QF TWO-TIER MID-SIZED ENTERPRISE SCENARIO (UP TO 8 SWITCHES IN THE STACK)

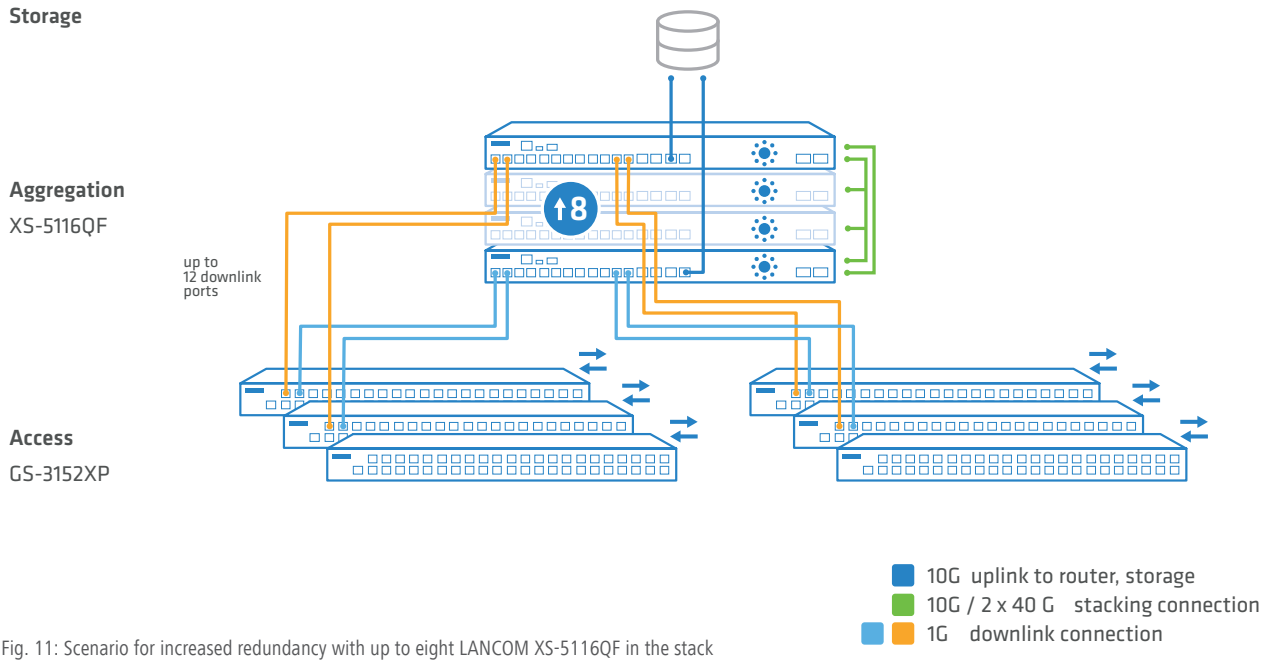


Fig. 11: Scenario for increased redundancy with up to eight LANCOM XS-5116QF in the stack

LANCOM Systems

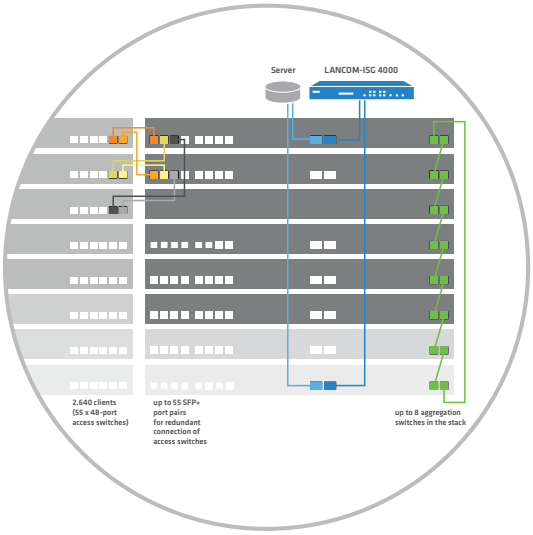


Fig. 12: Detailed view of up to eight LANCOM XS-5116QF in ring-topology stacking

LANCOM XS-6128QF – managed 10G fiber aggregation switch for high performance in distributed networks

Characterizing the LANCOM XS-6128QF are its high-throughput uplink ports and four dedicated 50G stacking ports. Consequently, even in a stacked state the device supports a high-bandwidth uplink to an upper-layer core, as well as a 100G connection to a data center or storage.

Its design concept aims for a very low total cost of ownership (TCO) due to all of its ports being natively available. This saves the customer from having to use an expensive modular structure, as is the approach of many competitor models. Ex-factory, this model supports all of the maximum port options from combo downlink (copper / fiber) and combo uplink (25G / 40G) fiber ports. All ports are industry standard, including for stacking, so no expensive proprietary cables are required. For example, the option of using SFP+ modules in the 4x 25G SFP28 ports allows for up to 4 additional SFP+ ports. This model also supports decentralized stacking thanks to the option to use standard short- and long-range modules.

This aggregation switch model satisfies the high requirements and port capacities required for medium-sized enterprise networks. Here, too, the maximum number of LANCOM XS-6128QF in the stack is eight units. Considering the port configuration, the 20 available downlink ports makes it possible to operate up to 20 access switches redundantly at two aggregation switches. Theoretically, a stack of eight could connect up to 80 access switches.

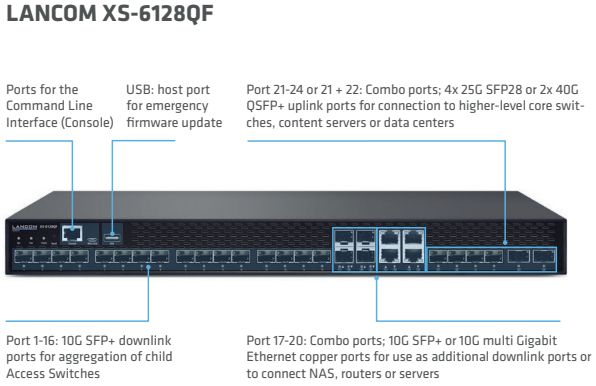


Fig. 13: Port configuration of the LANCOM XS-6128QF

Calculation of a redundant scenario for a ring-topology stack	
n * m/2 = possible number of access switches	
n	Number of aggregation switches (max. 8)
m	Downlink ports (max. 20)
/2	Redundant connection of one access switch to two aggregation switches
8 * 20/2 = 80 (max.)	

LANCOM XS-6128QF

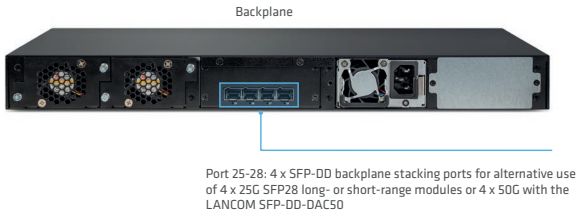


Fig. 14: Stacking ports on the back panel of the LANCOM XS-6128QF (4 x 50G)

The LANCOM XS-6128QF has 4 dedicated SFP-DD (50G) hardware stacking ports on the rear panel. These can be used to connect the stack units with a total of 200G port capacity.

Large Enterprise – very large networks in a three-tier scenario based on the LANCOM XS-6128QF

Our design recommendation: The following scenario describes an aggregation switch stack consisting of eight XS-6128QFs with a connection to a data center or a core switch. This network design is suitable, for example, for large campus networks in many parts of a building, but also in large enterprise networks with thousands of employees in multi-storey building complexes.

This example operates eight LANCOM XS-6128QF as an aggregation switch and the LANCOM GS-3152XP as an access switch.

A total of 160 SFP+ downlink ports are available on the 8-unit cluster, which can be used to redundantly connect 80 access switches, with each access switch providing a maximum of 48 client ports. What this means is: This network connects up to max. 80 access switches of the previously mentioned model, each operating 48 downlink ports, i.e. up to 3,840 clients can be connected. The uplink ports on these aggregation switches as described above are used to connect to the upper-layer core. The 4x 50G SFP-DD stacking ports on the rear panel provide 200 Gbps port capacity. This corresponds exactly to the 20x SFP+ downlink ports (non-blocking). Full-duplex operation offers a stacking capacity of 400 Gbps.

Illustrative calculation
8 * XS-6128QF * 20 downlink ports = 160 downlink ports 160 downlink ports / 2 (redundant operation) = 80 access switches
80 possible access switches (each with 48 downlink ports) = 80 access switches * 48 downlink ports = **3,840 ports**

As an illustration of the performance available from the calculation outlined above, i.e. a structure that connects up to 3,840 clients, we can take the example of an imposing office tower on the Frankfurt skyline. The second highest building in the metropolis on the river Main provides office space for almost 3,000 people spread over 56 floors. For the three-tier scenario required there, the LANCOM XS-6128QF would be the ideal solution for the aggregation layer (the distribution layer throughout the building) and also on the network layer if the system described below were to be established (see scenario in fig. 17).

Fig. 15: Detailed view of up to eight LANCOM XS-6128QF in ring-topology stacking

XS-6128QF TWO-TIER LARGE ENTERPRISE SCENARIO (UP TO 8 SWITCHES IN THE STACK)

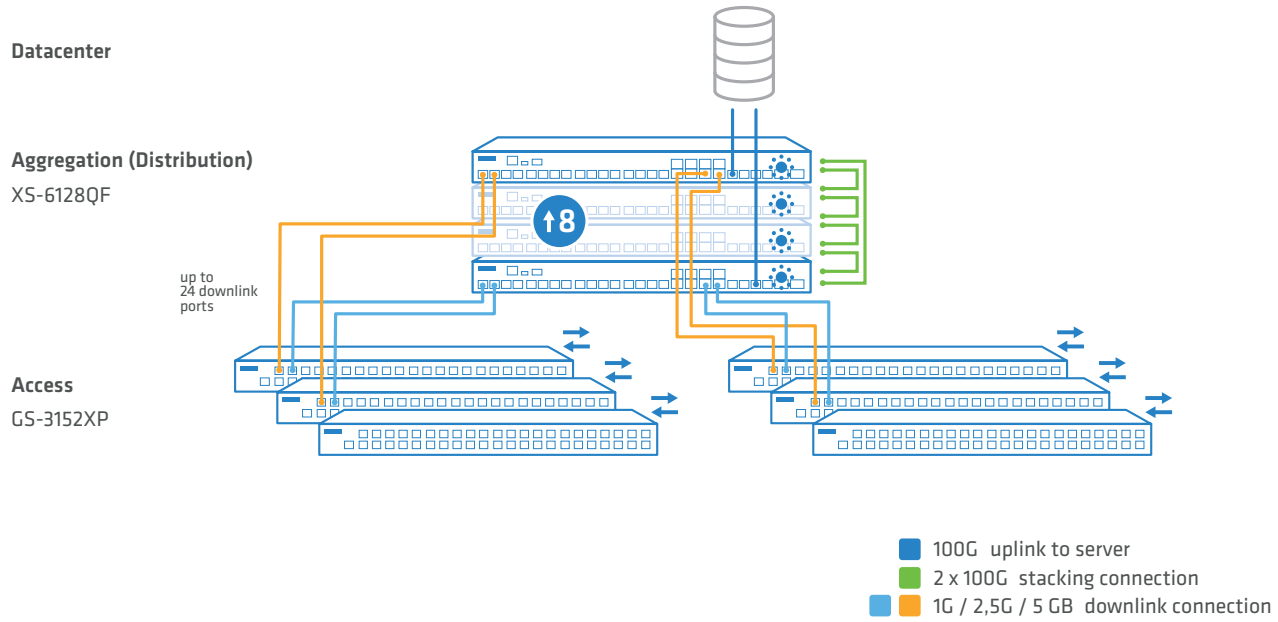


Fig. 16: Collapsed core scenario and uplink to the data center with the LANCOM XS-6128QF

XS-6128QF THREE-TIER LARGE ENTERPRISE SCENARIO (UP TO 8 SWITCHES IN THE STACK)

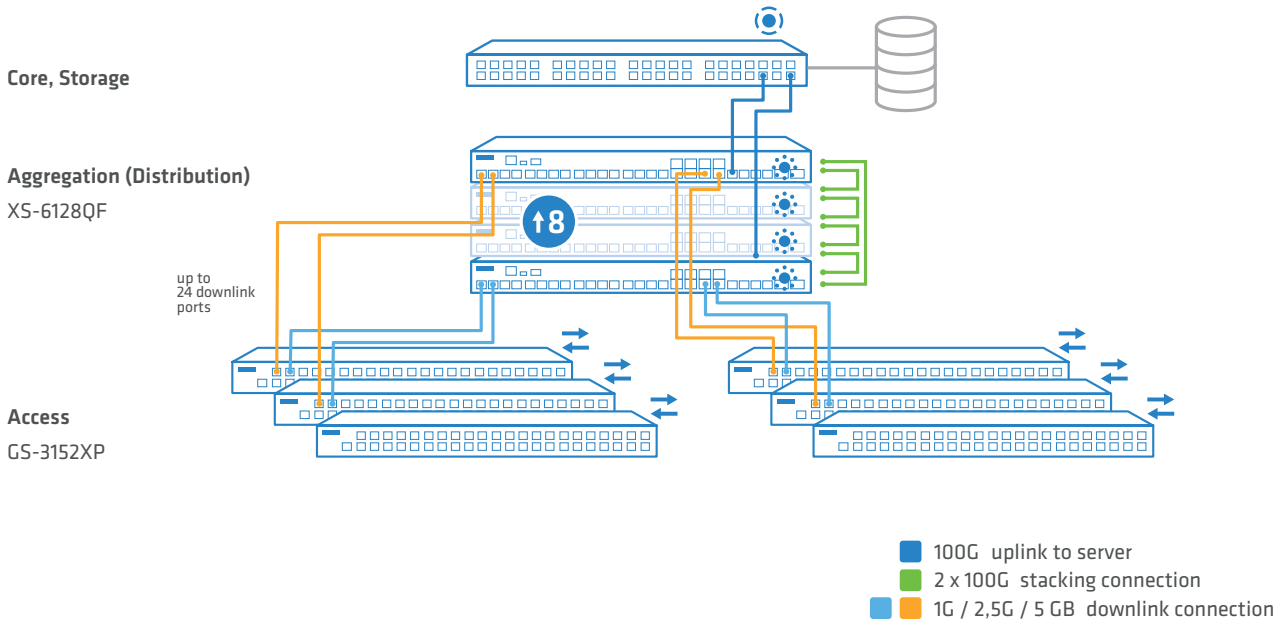


Fig. 17: Three-tier scenario for increased redundancy with up to eight LANCOM XS-6128QF in the stack

Summary

The descriptions of the scenarios selected here aim to shows the variety of options available with the new LANCOM aggregation switches and their different levels of performance. The intelligent combination of these LANCOM devices with the high-performance and cost-effective access switches from LANCOM means that there are almost no limits on the possible applications—in particular for medium-sized companies. This paper deliberately focused on calculations that allow for maximum redundancy. Operating without redundancy of course increases the number of available ports, but LANCOM does not recommend this to its customers. Since every network exists under its own unique conditions, the application examples considered here cannot claim to be exhaustive and are no substitute for individual network planning, which has to be tailored to the customer's particular needs. Ideally you should include our design recommendations at the planning stage in order to ensure high availability and to minimize costly downtimes.

In particular when selecting the access switches, which this paper only mentions in passing, there are many other parameters to take into account apart from just the number of ports. This includes, for example, the total power demand for PoE (Power over Ethernet), the manageability or L3 features of the respective switching family, high availability requirements (fail-safe) from redundant power supplies, uplink speed, and the distance to the aggregation switch (Ethernet-standard copper cable reaches 100m, fiber-optics achieve kilometers of range) among others.

The extensive LANCOM switch portfolio offers made-to-measure solutions for the particular requirements of your infrastructure.

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