



ScoreExpress: Technical Requirements

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1. Inleiding

Als je ScoreExpress gebruikt voor je competitie, wil je zeker zijn van een stabiele en betrouwbare installatie. Daar komt meer bij kijken dan enkel de software. Er is een infrastructuur nodig waarop het systeem wordt ontplooit.

In de volgende hoofdstukken worden de verschillende aspecten van de technische installatie van het scoresysteem toegelicht en worden enkele adviezen geformuleerd voor het selecteren van je apparatuur.

We hanteren daarbij de volgende principes:

- Het systeem moet snel genoeg zijn en stabiel werken om een vlotte wedstrijd te verzekeren.
- Je wil een beveiligd systeem, zodat onbevoegden geen toegang krijgen tot het scoresysteem.
- Het systeem moet eenvoudig op te zetten zijn, ook voor mensen die niet noodzakelijk een technische achtergrond hebben, in het bijzonder als je hetzelfde systeem regelmatig voor wedstrijden inzet.

2. Network

The backbone of your scoring system is the network which interconnects all parts of the system. A good network setup is half of the effort for a good result.

Before diving into the technical details of the network, we want give you some general lines of advice:

Separate the scoring network from other network traffic

There are several good reasons to keep your scoring network separate from all other network usage in the venue:

- **Security:** not giving other uses access to the scoring network is a first step into keeping the network safe.
- **Avoid overload:** If the network is only used for the scoring system, you have a clear picture of the load you might expect. If you allow other users to freely access the network, you might end up with some users who will consume more network capacity than expected and slowing down the scoring system.

Don't rely on the venue's network

Mostly for the same reasons as mentioned in the previous paragraph, it is a risk to rely on the network facilities already present in the competition venue.

Unless you have the opportunity to work together closely with the technical staff of the venue, to make sure all of the requirements regarding separation of the scoring network from other network usage and guarantees regarding reserved capacity, you want to deploy your own network backbone.

Using your own network setup makes life easier

If you are having a one-off event, setting up the network might be complicated anyway. If you are, however, organizing competitions on a regular basis, using a fixed set of devices to set up your network will make your life much easier, because you don't need to configure your network from scratch for every event. You deploy your set of devices in the same way for each event. The only thing which will vary from venue to venue is the way you connect your network to the internet.

So what do you need then?

A complete network set-up consists of following items:

- A router, completed with switches where necessary.

- Network cables to connect your key devices to the router.
- One or more access points to add WiFi to your network.

In the next pages, we discuss each of these items in detail.

✿ Note that we try to give some general guidance for acquiring network equipment for your scoring system setup. In this respect, we try to keep it as simple as possible without making compromises regarding capacity and stability. If you have needs that exceed the basic setup described here or feel uncertain about anything, we strongly recommend to seek for expert advice.

2.1. Router

The router is the traffic controller of your network, providing a couple off services needed to keep your network sane:

- Providing a network/internet gateway: the router is the border control between the scoring network and any other network it is connected to, including internet connection.
- Firewall: to keep your network safe, most routers offer a firewall service which will prevent unauthorized access to your network from outside.
- DHCP server: this is the server which distributes IP-addresses to the devices connected to the network.

Both firewall and DHCP server are services which can also be provided by separate devices, but in order not to make things more complicated than needed, it seems better to use the services that are already provided by most routers on the market by default.

Router requirements

- Consumer grade routers often have WiFi on board, for reasons that we will explain in detail in the page about the WiFi setup, we prefer not to combine the router and WiFi function.
- Maximal throughput of the router might be important (and scales with the number of users on the network). Consumer market routers can have high throughput numbers, but tend to focus on providing fast connections to a small number of users. Professional devices will be more focused on providing stable connections to a larger number of users.
- By default most routers on the market offer external network/internet connection by means of a cable. If you are sure that this is possible in the venue(s) your will be using, or don't need internet access during your competition, this might be sufficient. Otherwise you might want to shop for a router which has other means of connecting to the internet, such as WAN over WiFi or a 4G (mobile network) fallback.
- Routers tend to have a rather small number of network connections (2 to 10). If you need more connections, it might be easier and certainly cheaper to add one or more switches to the setup (see next page) than buying a router with more connections.

Configuration aspects

When configuring your router, you might take following thing into consideration:

IP range

Most routers come with a default setting for the IP-range that is used to assign IP-addresses to the connected devices. For example: 192.168.0.*, which means that in most cases the router itself will be using the address 192.168.0.1 and assign addresses 192.168.0.2 to 192.168.0.254 to the devices.

It is a good idea to change this range. First off all, since you will want to integrate with the network in the venue, chances are high that this network will be using the same range, which might cause conflicts. Switching to a less obvious range will avoid this problem.

Another limitation of the default range, is the maximal number of addresses which can be used (about 250). Even if this might seem more than enough, you need to take into account that the number of occupied addresses can be higher than the actual number of active devices. For many competitions there might never be a problem, however if you are changing to a different range, you can as well chose one that has more addresses available.

Fixed IP addresses

In the router (actually the DHCP server), you can assign a fixed IP address to devices. This is linked with the so called mac-address of the network connection: each network device has a unique id.

Some devices can only work with a fixed IP-address (e.g. network connected printers). For other devices such as the computer(s) that you will use as a server for the scoring system, it is optional but strongly advised to use a fixed IP-address.

Examples of routers

Ubiquiti EdgeMax Routers

Ubiquiti offers range of routers with good value for money, including a wide range of setup possibilities for network configuration, security and monitoring network activity.

The smallest device in the range is the EdgeRouter X, which has 4 local network connections and an WAN (internet) connection. This device will serve you well for setups with up to about 30 users.

<https://www.ubnt.com/edgemax/edgerouter-x/>

For larger setups, you can upgrade to EdgeRouter Lite, which has 4 times the capacity in terms of throughput.

<https://www.ubnt.com/edgemax/edgerouter-lite/>

If you really want to be sure about capacity, you might consider the EdgeRouter (no suffix), which doubles the capacity once more.

<https://www.ubnt.com/edgemax/edgerouter/>

Peplink routers

If you want to have a router with multiple options for connecting to the internet, you will want to check out the Peplink routers. They are specializing in routers with redundant broadband connections in order to secure a permanent internet connection.

PepWave Surf SOHO

The [Pepwave Surf SOHO](#) is a model which can be connected to your network over UTP cable and has built-in fall-back for connecting to the internet over WiFi (WiFi as WAN). The 4G mobile connection is supported through a USB port, where you can plug in 4G modem.

2.2. Switches and Cables

Most routers are limited in the number of network ports. If you need more network (cabled) connections, you can upgrade your router to a model with more connections, however this will turn out to be rather expensive. A better way is to add a switch to your setup.

A switch is a device which allows you to connect multiple devices to your network and makes sure that traffic is steered along the right cables to arrive at its destination. You can use one or multiple switches in your network. Extending the number of connections is the first reason to use a switch, but you can also use a switch to branch the network at a different place than where you keep the router, in order to be able to use shorter cables to connect your devices to the network.

Switch requirements

- **Number of Ports:** The first thing to decide is how many connections (ports) your switch needs to provide. Whatever the number of connections you expect to be using, it is better to add some headroom, also because upgrading to a larger switch will cost less than buying a second one. Keep in mind that connecting a switch to the router will consume one port on each device.
- **Connection speed:** Switches will provide ports with a certain connection speed. Right now you will find 10/100 Mbps and 1Gbps (also listed as 10/100/1000 Mbps) variations. Although 10/100 connections will provide enough speed for most application users, you want to make sure that the server has a 1Gbps connection to the main switch/router. When buying a new switch, it is best to choose a model with 1Gbps ports only.
- **Managed vs Unmanaged:** when looking at the offerings for switches you will find that some models are managed. Although managed switches will allow you to do some really cool things, you probably don't need one, unless you really know why you do.
- **Power over Ethernet (PoE):** switches with PoE will inject power into your network connections, such that devices connected to the switch can draw power from the network cable. Only devices with support for PoE can do this. If you have a lot of devices with PoE support, buying a switch with PoE ports will be worth the extra expense. If you only have few devices that need PoE, you can also consider the use of PoE power injectors. These are small devices that add power into a UTP connection. Note that there are different standards for PoE, when combining a PoE switch with PoE devices, make sure they are compatible.

Most switches don't have much to configure, simply plug the power and plug the network cables. When buying a switch from well known brands such as Netgear, TP-link, HP or Cisco, there is not much you can do wrong.

Network Cables

At first sight there is not much to say about network cables, but we still want to give some small hints about what to look for:

- Network cables come in all sorts of lengths. We mostly don't buy cables shorter than 3 meter, because shorter cables are often unpractical. The longest (loose) cables we buy are 50 meter. If you need longer cables, you should buy cables on reels. Note that the maximal usable length for a UTP cable is 100m.
- UTP connectors (RJ 45) have a small plastic clip which clicks into the port when you plug the cable. These clips are very vulnerable and break off easily when you handle the cable. When the clip is broken, the cable will not be properly fixated and the network connection will be unstable. To avoid this, it is better to buy cables that have protection of the clip (see picture).
- When buying longer cables, you want to make sure that they are not too sturdy, because this will make it hard to roll them up. If you want to keep your sanity while handling long cables you might find following instruction video useful: [How to Coil Cables | The Over Under Technique](#) . It has saved us already countless hours of messing around with cables.
- When you store many cables in a box (UTP or other) it is better to bind them, so they don't get mixed. Many people use adhesive tape to bind their cable, however we prefer to use reusable velcro ties strips.



2.3. Access Points

If you want to use wireless devices (such as tablets for the judges), you will need to add WiFi to your setup.

As mentioned briefly before, we prefer not to use a router with built-in WiFi. There are a couple of reasons for that:

- Most routers with built-in WiFi are made for small networks and will probably not be powerful enough for a scoring system.
- For larger setups, i.e. large competition venues or competitions with many users, you will want to use multiple access points to cover the space and provide enough capacity.
- For optimal coverage, you want to put the WiFi antenna's up in the air, the router on the other hand is best located closer to the floor.

For these reasons, we advise to use a router without built-in WiFi (or with the WiFi switched off) and extend your network with one or more so called Access Points.

An access point (AP) is a device that is connected to your network through a UTP cable and has antenna's to distribute the network traffic over WiFi.

Access Point Requirements

- **Dual radio (2.4 + 5G):** Support for both the 2.4G and the 5G frequency ranges is important. You need 2.4G support because there are still devices being used that don't support 5G. 5G on the other hand is important, because the 2.4G band is heavily used already in most public venues, so it might be difficult to find a usable channel there. The 5G band might also be used already, but offers many more channels, so there will always be unused channels. Some AP's will automatically distribute clients over both bands to increase capacity.
- **Automatic Channel selection (preferably with DFS support):** an AP with automatic channel selection, will scan the environment to find out which channels are used by other WiFi networks and try to select the best available channel. If you have an AP without automatic channel selection, you need to check for yourself if the AP is not using a channel that is already used by other networks and change the AP configuration accordingly. DFS is an option which works in combination with automatic channel selection. Some 5G channels can only be used under the condition that no radar stations are close by. An AP with DFS, will detect the presens of radar signals and block the appropriate channels. Without DFS, these channels are always blocked.
- **AP controller:** in the range of professional AP's, some models depend on an external controller for their operation. The controller is the part that has the WiFi configuration (with the name of the network, the security settings, etc...). Working with an external controller might be interesting if

your installation is permanent. When working with a setup that needs to be flexible and is built-up temporarily, it is easier to work with AP's that don't depend on an external controller.

- **AP co-operation:** if you ever want to use multiple AP's in your network, you want to make sure that they play nice together. You want to work with a single network name and password, such that devices can seamlessly connect through the AP that has the best signal (also called roaming). To achieve this, it is required that you deploy AP's that are capable to co-operate. In most cases this means that you will need to use AP's of the same brand at least or even the same model. Be sure to check how the AP's you want use can be configured to work together to create a single WiFi network.
- **WiFi standards:** Speeds and standards of WiFi connections have evolved over time. The most recent standard currently widely available is 802.11ac. When buying new access points, you want at least support for this standard. The AP's will also be downward compatible with devices that don't support the latest standard. Support for this standard is not only important for maximal speed of the connection, the latest standards also provide better support for multiple simultaneous connections and are thus be better suited for many users.
- **Number of radio's:** Modern AP's use all kinds of techniques to maximize network throughput, but the 802.11ac standard introduced a common standardized way to allow simultaneous communication with multiple client devices: MU-MIMO, which stands for Multi User Multiple In Multiple Out. This technique allows the AP to send data to multiples clients in parallel. In order to do that , the AP uses multiple radio's. In the specifications of the AP you will find things like 2x2 MIMO or 3x3 MIMO. The numbers mentioned stand for the number of radio's used to receive and send out data respectively. A higher number of radio's implies support for more simultaneous connections and thus a higher throughput.

Examples of access points

Ubiquiti UniFi Access Points

Ubiquiti has a range of access points available under the UniFi subbrand. There are different models, with different maximal speeds and MIMO configurations.

To configure the UniFi access points you will need to install the UniFi controller software package on a computer. After initial setup, the controller software is not needed in the network for the access points to operate, unless you need to change the configuration.

All models of the UniFi line use the same firmware package and are able to be used together in the same network. With the controller software you can assign the AP's to the same network (SSID). You can even create multiple SSID's, all running from the same AP's. You could use this feature to have more control over who can connect to your network, e.g. you can add an temporary SSID for one event to give a group access during the event and remove the SSID for the next event.

The UniFi access points are powered of the network connection (PoE). To use them you will need either a PoE enabled switch, or use a PoE injector. The PoE injector is included with some packages, check carefully when ordering to see if you need to order them separately.

We have been using the UniFi AP-AC PRO for events with up to 40 users without reaching the limits of its capacities. According to specs, one access point can handle 200 users, but we expect this to be mostly theoretical.

The newer model AP-AC HD increases the specs once more (mostly by an upgrade to 4×4 MIMO) and has support for up to 500 users according to specs. For a smaller setup, you can also consider the AP-AC Lite.

We have found the spacial coverage of the access points to be sufficient for venues where the users are up 30 meters away from the AP in an open space. If you need to cover bigger distances, we would recommend to use a second AP.

Ruckus Access Points

Ruckus has a long tradition of providing WiFi devices for large user groups. Compared to similar priced devices from other brands, the specs might not look too impressive, however we have found no issues using their R510 model with a large number of users (i.e. up to 70 users). In general this brand is trusted to run very stable with large numbers of users.

Ruckus has a wide variety of AP's, be sure to select a model that works stand alone (without external controller).

The R 510 model that we have been using, has a built-in configuration web page, which you can access from your computer to setup the SSID and security settings. The access points have cooperation built in. The first AP in the network automatically becomes the master. All other AP's connected afterwards, will mirror the setup of the master AP.

The AP's are also designed to be powered with PoE, however they also have a DC 9V connector (adapter not included with the package).

3. Server PC

If the network is the backbone of your scoring system, the computer which will run the server at the competition venue is the brain.

Server PC requirements

For most competitions a reasonably fast laptop PC should be able to serve the application. When choosing a PC, we will mostly focus on a device which will run stable and reliable.

Hardware quality

The last thing you want, is for your server PC to break down during the competition. First of all we recommend to use a laptop computer as a server, because of its battery. When you have a power break, the laptop will keep running, at least until you manage to restore power. If you don't want to use a laptop as a server, make sure to look into a [UPS set-up](#).

In this respect, you don't want to use a PC which running on its last breath. If you're running a laptop, make sure the battery is actually usable for at least a couple of hours on full charge.

Some other choices with respect to hardware can offer you some extra security, for example SSD drives a less likely to crash than classic HD's, because they don't have moving parts.

When buying PC's, especially for servers, we stick to professional models from well known brands such as HP, Lenovo, Dell or Apple.

A last thing to look for when buying PC for running the server is the input and output ports on the computer. At least you will need a connector for the network cable. You also want to have one or more usb ports to plug in usb keys, printers, etc...

A video out might also be important if you want to use the PC with an extra screen.

Operating System and Installation

The server software can be installed on a range of operating systems (OS). By default, we will provide installers for Windows as well as OS X (Mac). Linux servers will also be supported.

Operating systems for mobile devices, including Android, Chromebook, Windows Mobile and iOS will not be supported.

Installing the server software is straight forward: you download the executable package from the website and save the file to a location where you want to keep it. After downloading, you can start the application directly with the executable.

In order to keep the server running smoothly and stable, you want to make sure that all other software and services which are not needed during the competition are switched off. In the ideal case, you install the software on a clean installation of the PC and only install other packages that are needed for the competition. Note that most other things you need to do during the event, can also be done on a second computer.

4. Judge Devices

The judge console of the application has been optimized to be used in combination with tablet computers. This does not mean that judges will not be able to do their work with other types of computers, but in our opinion tablets are the most efficient way to provide each judge with a device.

There are some exceptions though. In trampoline for example, the number of score values for a single exercise is too big to fit easily on a tablet screen. For those cases we have been using Chromebooks, which are a good mix of a laptop (screen size and keyboard) and tablets (touchscreen, battery life).

Tablet requirements

When looking for tablets to use for the judges, keep following thing in mind:

- **Battery life:** you need to plan for the tablets to work during the whole competition. Even if switching out tablets can be done very fast, it is mostly not feasible to have a spare tablet for each judge to charge while they are working. So you either make sure that battery autonomy is long enough for a whole competition day (and possibly load during breaks) or you will need to have power outlets at the judge tables to charge.
- **WiFi:** as mentioned in the section about Access Points, it is preferred to work with a 5G WiFi band. Make sure that the tablets you provide support 5G.
- **Screen size:** the minimal screen size is 7 inch, but 10 inch is preferred.

Storage space is not needed for running the scoring interface, so you can chose the lowest spec there.

Alongside with the tablets, you should think about the transportation of the tablets. You can keep the tablets in their original boxes, but this will be cumbersome to pack and unpack each time and in the long run the boxes will wear.

There are companies who sell cases for transporting tablets. Most of them also have the power sockets for charging the tablets built-in. The price tag for these cases might high, but they offer a great comfort and will certainly prolong the lifetime of your tablets.

Chromebook requirements

If you want to use Chromebooks for the judges you want to look for the same qualities as the tablets, except for the screen, which should have Full HD (1920 × 1080) resolution at least. Also be sure to choose a model with touch screen.

Device examples

Tablets

So far, we haven't tested with a lot of different models of tablets. Based on the features listed, we have selected the Acer Iconia One 10 B3-A40-K86R model and have been quite satisfied with the results. It has support for 5G WiFi, 10 inch screen with a resolution of 1200 × 800. When fully charged, we manage get at least 7 hours of active use out of them. Charging them in the breaks, allows us to use them for the longest of competition days.

Chromebooks

Also for the Chromebooks, we have landed with Acer devices, currently Acer Chromebook R13 CB5-312T, which is rather high-end in the Chromebook range. The screen is 13 inch with Full HD resolution. It is also quite sturdy in the standard position (keyboard on the table and screen in upward position), which is important when using the touchscreen.

You can also put it in so called 'tent' mode, or flip the screen over to put it in tablet mode.

5. Power Supply

Even if it is a commodity, you want to spend some attention to the power supply for the devices that are required to keep the scoring system alive.

You want to make a distinction between devices which are vital and vulnerable (e.g. because they don't have a battery), devices that are vital but have battery backup and devices that are not vital.

The first precaution that you can take to prevent power outage, is to make sure that all of your power cables and outlet are secure:

- If possible, you should branch from a different circuit than any other systems which will have a high power consumption during the event, such as sound and light.
- Protect your power cables and connections for accidental breaking. If cables are running along the floor, make sure they fixed with tape or cable trays. Fixate power plugs with tape if you think someone might accidentally pull the plug. Many power strips have a power switch nowadays. You might prefer to use power strips without a switch or make sure they are positioned such that the switch cannot be flipped accidentally.

If you want to be sure to run without interruption in case of a power outage, you might consider to use an uninterruptible power supply (UPS). This is a device with a battery which can be used to ensure that some devices of your setup keep running during a power cut. A UPS will also protect your devices against peak voltages.

When using a UPS, the key is to connect all the critical devices that don't have their own battery. This includes the network devices (routers, switches, AP's) and any PC's without battery. On the other hand, be careful not to connect devices with high power consumption (e.g. printers) to the UPS, because they will drain the battery very fast and prevent the UPS from working properly even when the power is on.