

Networking Requirements

RoboCup Small Size League

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Background

The network in a RoboCup SSL event is used to pass data from the centralized vision system and the centralized referee to the team AI's. Communication is unicast or multicast, depending on the specific applications within the league.

Physical Network

The physical layout described here is a balance between number of switches and cable length. Ultimately, another physical config could be used provided that each team near the field has a connection and it is approved by the Organizing Committee.

Competition Field

A competition field will have two 24-port switches located at the back corners of the field to best serve the team work stations located around the field. If the competition is providing cables to the teams, they will need cables between 2m and 10m, depending on which seating location the team is assigned.

The switches on competition fields will have ports configured for both the competition VLAN and the corresponding practice field VLAN to support teams that do not have mobile compute setups. Port configurations are detailed in the Switch Configuration section.

Practice Field

A practice field requires one 24-port switch. Teams are generally expected to provide their own cables at the practice field, but a few cables up to 3m in length may be provided, since teams at the practice field will be transient. Port configurations are detailed in the Switch Configuration section.

Switch Interconnects

The last 4 ports on each switch are allocated for interconnects. Due to the topology of most SSL tournaments, it is expected (but not required), that all the switches at all the competition fields will be chained together towards a single uplink.

The uplinks between switches can be copper or fiber. Once the final field layout is determined, the interconnect lengths should be calculated. Copper interconnects can be used for lengths up to 100m. Fiber interconnects can be used for longer runs, but additional care should be taken to protect the cables..

Networks

VLANs

There should be one VLAN allocated per playing field. The intent is that the network for each competition field is only available at that field and that each practice field network is available at both the practice field and its corresponding competition field.

Network Configuration

Each field VLAN should have a unique subnet that is at least a /25 of private address space (10.0.0.0/8, 172.16.0.0/12, or 192.168.0.0/16). Each field network should be connected to the internet via a NAT, but field networks should be fully isolated from each other and any other networks in the venue.

Reserved Addresses

In each subnet used, the first four and the last IP addresses are reserved for use by the organizers and network operators. For example, in the subnet 10.0.0.0/24, the following five IP addresses are reserved and should not be included in the DHCP range:

- 10.0.0.0 - Subnet address
- 10.0.0.1 - Gateway
- 10.0.0.2 - Reserved for future use
- 10.0.0.3 - Static IP for the RoboCup SSL Game Controller Server
- 10.0.0.255 - Network broadcast address

DHCP Options

DHCP should be enabled for each VLAN. All addresses not reserved as listed above should be included in the DHCP address range. The settings below are based on the assumption that the subnet is assigned the 10.0.0.0/24 address block.

Setting Name	Value
DHCP Address Lease Time	3600 seconds
DHCP Lease Pool Start	10.0.0.4
DHCP Lease Pool End	10.0.0.254

The specific networks chosen by the network vendor should be communicated to the SSL Organizing Committee at least 2 weeks prior to the event to provide enough time for information to be distributed to teams.

Switch Configuration

The switch configuration is split into settings that should be set on all switches, regardless of location and those specific to certain switches.

All switches are assumed to be 24-port models. If larger switches are used, the number of trunking ports should be held constant and the number of competition/practice field ports should be maintained at the ratio outlined for the 24-port switches.

Aggregation Switch

An aggregation switch may be optionally used to collect the uplink connections from the field switches. In the absence of an aggregation switch, the field switches may be connected to each other.

Common Field Switch Config

Each port should be configured to allow access from multiple MAC addresses.

Each access (non-uplink) port should block traffic attempting to backfeed DHCP into the network.

Power over Ethernet (PoE+)

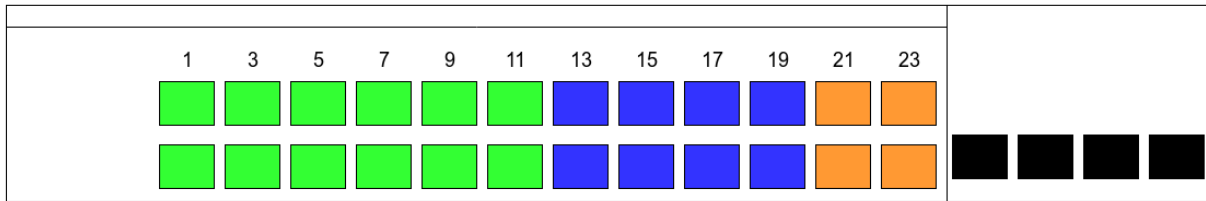
Each field will have at least two Raspberry Pis being powered via PoE+. If the switches do not support PoE themselves, PoE injectors need to be supplied.

Competition Fields

The first 12 ports (Green) on each competition switch should be allocated to the VLAN associated with the competition field.

The next 8 ports (Blue) on each competition switch should be allocated to the VLAN of the corresponding practice field.

The final 4 (Orange) ports should be allocated for VLAN trunking to upstream and downstream switches.

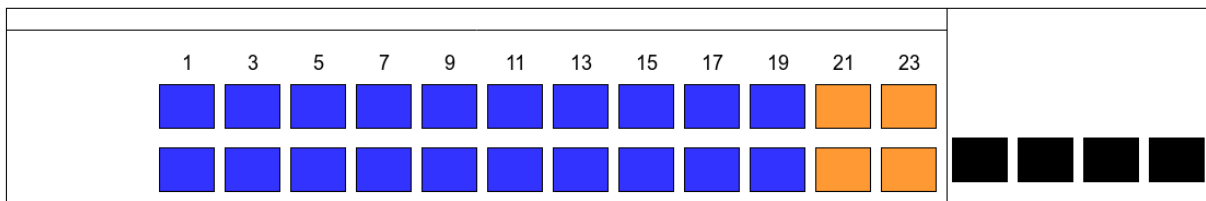


If the switches being used have specific ports for uplink (SFP/SFP+ ports), shown in black in the above diagram, it is up to the network implementer to decide whether to use those ports or the last four copper ports for switch interconnect.

Practice Fields

All ports (Except those allocated for trunking) at the practice field should be configured to the VLAN associated with the practice field. These are shown in blue on the diagram

The last 4 ports (or as many as required) shall be allocated for uplink to/from other switches, shown in orange on the diagram below..



Wireless Spectrum Allocations

RoboCup SSL Teams are responsible for implementing their own wireless protocols for robot control. Many teams elect to use Nordic RF or Xbee chips that operate in the 2.4Ghz spectrum. Spectrum is typically allocated to the Small Size League, which will be re-allocated by the SSL Organizing Committee in 1Mhz-wide blocks to the appropriate SSL teams, based on their technical requirements and their preferences. Previous RoboCups have allocated all of the 2.4GHz spectrum to the Small Size League.

As of 2018, one team was using 5GHz Wi-Fi. They will need a 20MHz wide channel for broadcast. Additionally, the league requests an additional 20MHz wide channel in the 5GHz range in case another team chooses to use 5GHz Wi-Fi for communications.

A 3rd 20MHz-wide 5Ghz channel is requested to support SSL competition logistics. This spectrum is used for non-critical communications that make running the event easier for the organizers.

Any teams not covered by the above frequency request likely use the 900MHz ISM band, which is technically only legal in Region 2 (North and South America). As of 2018, only 2 teams were still using this spectrum.

Appendix A: Example 4 field configuration

This portion of the guide is to lay out a specific configuration that would work well for a competition with two competition fields and two practice fields, which is the layout requested for RoboCup 2019. This example does not have an aggregation switch.

Throughout this guide, switches will be referred to by the shorthand created by appending the field to the switch ID. For example, the 2nd switch on Field C will be switch C2.

Fields

The 4 fields at this event are as follows:

- Field A: Division A Competition Field
- Field B: Division A Practice Field
- Field C: Division B Competition Field
- Field D: Division B Practice Field

Networks

Each field should be allocated a /25 or larger, so we will allocate a /24 to each field in this example.

- Field A: 192.168.2.0/24 (VLAN 2)
- Field B: 192.168.3.0/24 (VLAN 3)
- Field C: 192.168.4.0/24 (VLAN 4)
- Field D: 192.168.5.0/24 (VLAN 5)

Layout

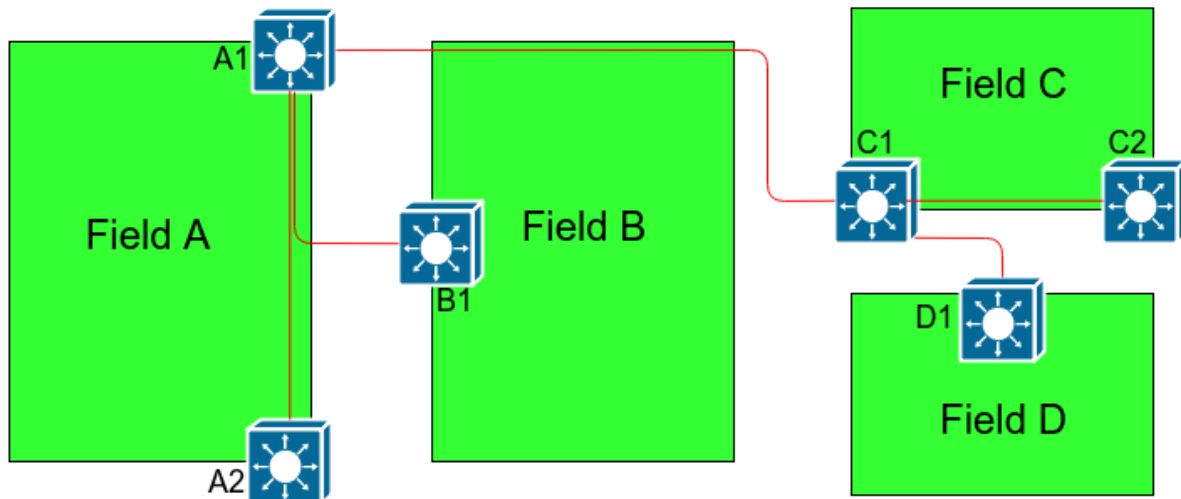


Diagram showing the rough placement of switches on a common 4-field competition layout. Red lines represent switch interconnects. Team walkways are between Field A / B and between Field C / D. The public would be watching from the unused space to the left of field A and above all of the fields in the diagram.

Field A Switches

Field A is a Division A competition field. It will have two 24-port switches located at each of the back two corners.

In this example, there is no aggregation switch, so one of the field A switches will be connected to the router (or upstream connection eventually leading to a router).

Switch A1 will have ports 1-12 configured to VLAN 2, ports 13-20 configured for VLAN 3, and ports 21-24 reserved for trunking. Port A1-24 will be connected to the uplink/router.

Switch A2 will have ports 1-12 configured to VLAN 2, ports 13-20 configured for VLAN 3, and ports 21-24 reserved for trunking. Port A2-24 will be connected to port A1-21.

Field B Switches

Switch B1 will have ports 1-20 configured to VLAN 3 and ports 21-24 reserved for trunking. Port B1-24 will be connected to port A1-23.

Field C Switches

Switch C1 will have ports 1-12 configured to VLAN 4, ports 13-20 configured for VLAN 5, and ports 21-24 reserved for trunking. Port C1-24 will be connected to port A1-22.

Switch C2 will have ports 1-12 configured to VLAN 4, ports 13-20 configured for VLAN 5, and ports 21-24 reserved for trunking. Port C2-24 will be connected to port C1-21.

Field D Switches

Switch D1 will have ports 1-20 configured to VLAN 5 and ports 21-24 reserved for trunking. Port D1-24 will be connected to port C1-23.