Maximum Capacity Setup and Configuration

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January 10, 2022

The IntelliTeam® Automatic Restoration System offers the user a number of configurable parameters that limit the amount of load the IntelliTeam system is allowed to restore. These include **Maximum Source Capacity**, **Default Source Segment Loading**, and **Maximum Capacity** settings, among others.

The user-configurable **Maximum Capacity** setting is defined as the maximum load (in amperes) a team member can carry because of limitations such as conductor size and device rating. This is configured separately for each team in which the switch is a member.

The **Maximum Capacity** setting by team allows configuring a switch location to support different capacities in each direction. This has some obvious applications, such as actual switch capacity and wire size. However, other applications make this feature even more powerful. Users can be inventive using independent capacity settings to solve unique circuit conditions.

Maximum Capacity Definition

"Maximum Capacity" is the maximum load (in amperes) a team member can carry because of limitations such as conductor size and device rating. The **Maximum Capacity** setting used for any single team member is the maximum capacity associated with the team on the downstream side of the switch. This is true when determining the capacity of an alternate circuit, when used by the restoration logic to decide whether a switch may be closed to energize load, and during contract requests.

For this document, the terms "downstream", "load side," and "requesting side", refer to the same direction. That direction can be further defined as the direction in which load will be restored or is in the process of being restored.

When planning an IntelliTeam system circuit the maximum capacity for switches must be determined for the IntelliTeam system for restoration without overloading a switch and/or source. These examples show how to plan for these limitations and how to configure them.

For the circuit shown in Figure 1, the **Maximum Capacity** setting must be determined for each switch in relation to each team.

At every switch, capacity can be considered in two directions:

- The direction of normal current flow from a source substation to a normally open tie switch
- The direction current will flow when a restoration event is occurring, from the normally open tie switch toward the source of the faulted circuit, including branch lines on that portion of the circuit

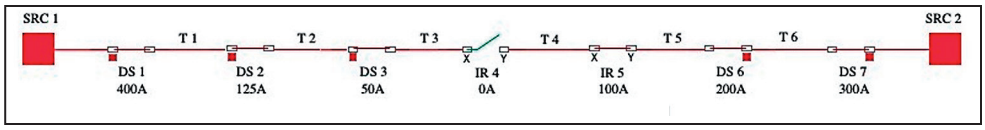

Figure 1. The sample team one-line diagram.

Switch capacity limitation is another consideration for setting the **Maximum Capacity** setting. When this is the only limitation, the reduced capacity can be entered in the **Maximum Capacity** setpoint for this team member in the teams on both sides of the switch.

Using Figure 2 as an example, when DS3 is a third-party switch with a 6801 control and it has a limit of 500 amps continuous load-carrying capability, the team member associated with DS3 in team T2 and the team member associated with DS3 in team T3 would be configured with a maximum capacity of 500 amps.

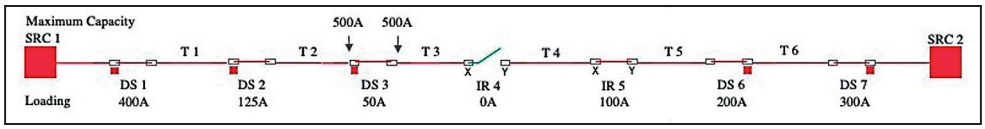

Figure 2. The maximum capacity for switch DS3.

Configuration of the **Maximum Capacity** setting for switch DS3 on the *Setup>Restoration>IntelliTeam SG>Team 2* and *Team 3* screens might look like Figure 3 on page 4, although other team member records might be chosen in the configuration.

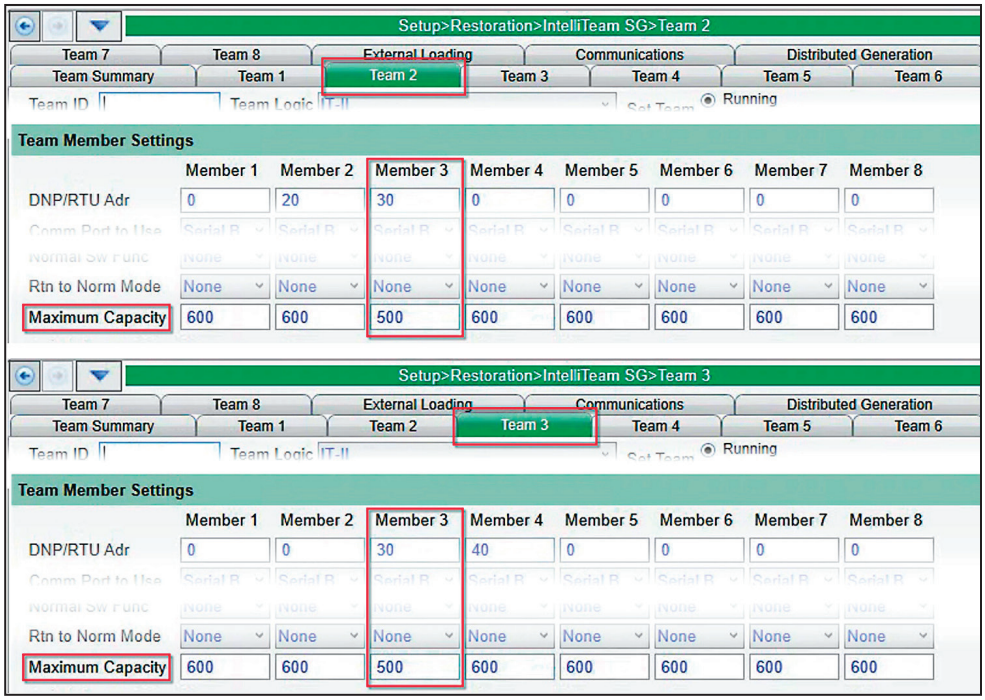

Figure 3. Configuring the Maximum Capacity setpoint of switch DS3.

A capacity limitation for the wire beyond the switch in either direction is another **Maximum Capacity** setting consideration. When this is a limitation, reduce the capacity appropriately for the team member associated with this switch of the team in the direction toward the limitation.

Using Figure 4 as an example, when a section of the circuit between IR4 and IR5 is only able to carry 400 amps of continuous load, the team T4 side of switch IR5 should be configured with the lower **Maximum Capacity** setting. This ensures the capacity of SRC2 as an alternate source will never exceed 400 amps.

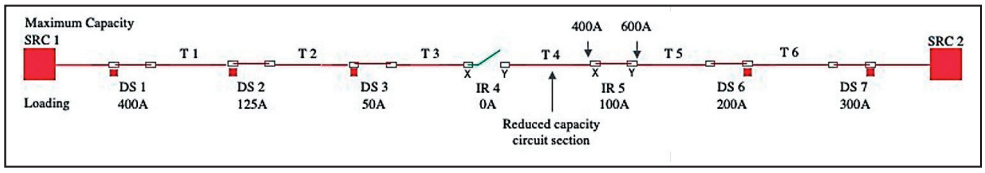

Figure 4. Reducing the Maximum Capacity for team T4.

Configuration of the **Maximum Capacity** setting for switch IR5 on the *Setup>Restoration>IntelliTeam SG>Team 4* and *Team 5* screens might look like Figure 5 on page 5. However, other team member configurations might be chosen in the configuration.

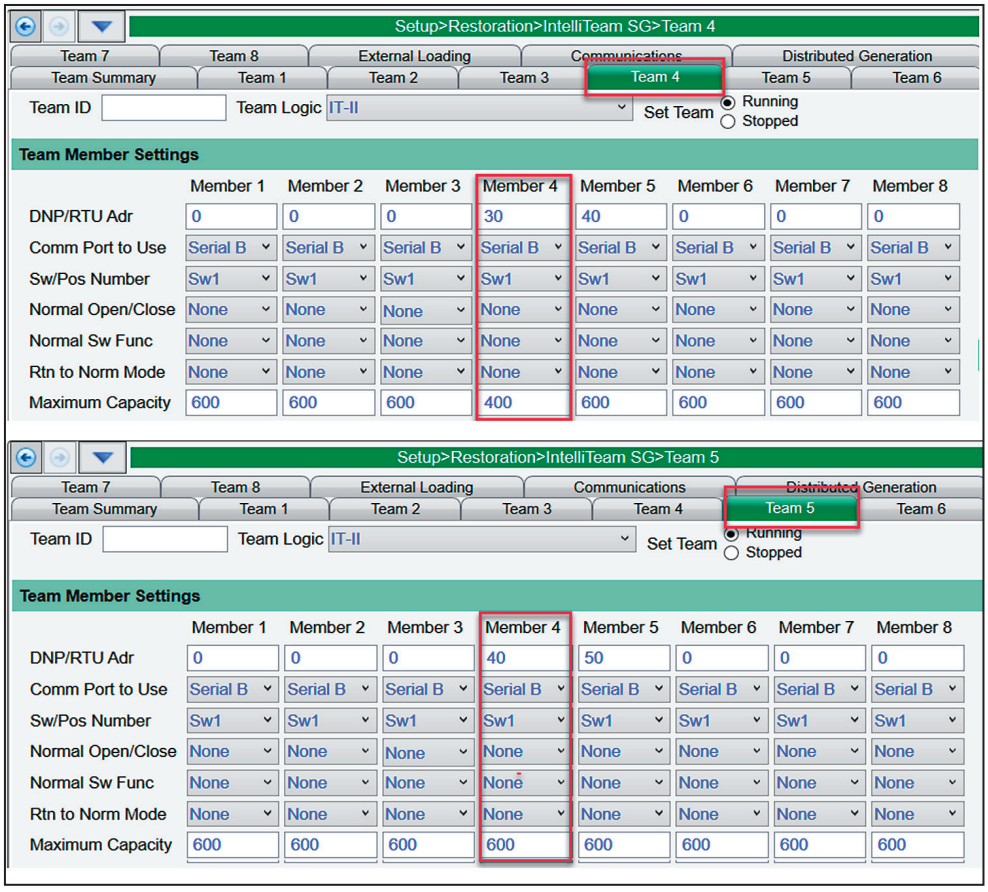

Figure 5. Configuring the Maximum Capacity setpoint of switch IR5.

Similarly, if it's necessary to limit the load source SRC1 can restore when a fault occurs on the source SRC2 circuit, configure the **Maximum Capacity** setting of switch IR4 on the team T4 side to 400 amps as well.

Finally, artificial limitations can be imposed restricting how much load can be restored using the **Maximum Capacity** setting. Rather than actual physical limitations at or near the switch, this limitation can simply be for overall system load management reasons.

The limitation of restored load can be done in three ways:

(a) Artificially reduce the capacity of a circuit to act as an alternate source during an event by setting the **Maximum Capacity** setting of any switch on that circuit in the team record for the team downstream from that circuit source. See Figure 6.

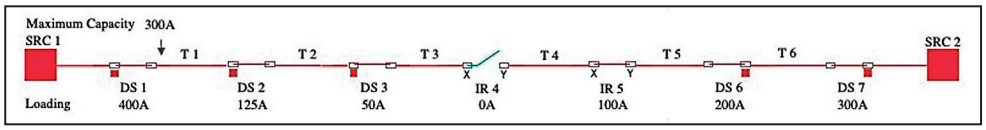

Figure 6. Reducing the maximum capacity for source SRC1.

Configuration of the **Maximum Capacity** setting for switch DS1 on the *Setup>Restoration>IntelliTeam SG>Team 1* screen might look like Figure 7, though other team member records might be chosen in your configuration.

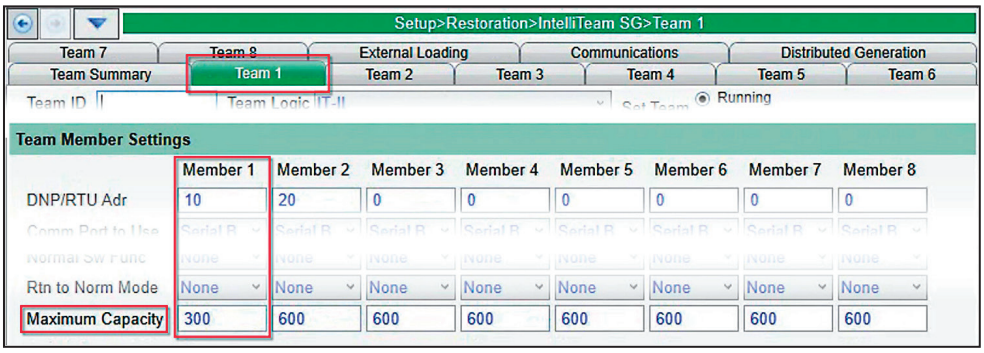

Figure 7. Configuring the Maximum Capacity setpoint of switch DS1.

In this example, the **Maximum Capacity** setting of switch DS1 within team T1 reduces the capacity calculated for source SRC1 at each switch to no more than 300 A.

(b) Artificially reduce the capacity of the normally open tie switch in the direction where load will be restored for a particular circuit event. Set the **Maximum Capacity** setting in the team member of the team on the side of the tie switch where the tie switch will be closing to pick up load. This can be set separately for the teams on both sides of the tie switch. See Figure 8.

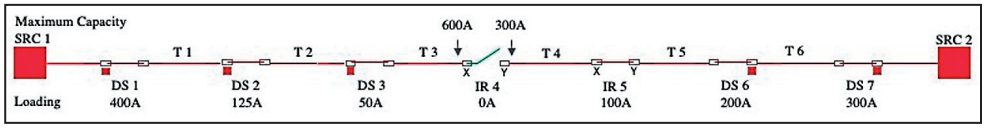

Figure 8. Reducing the maximum capacity for team T4.

Configuration of the **Maximum Capacity** setting for switch IR4 on the *Setup>Restoration>IntelliTeam SG>Team 3* and *Team 4* screens might look like Figure 9 on page 7, though other team member records might be chosen in your configuration.

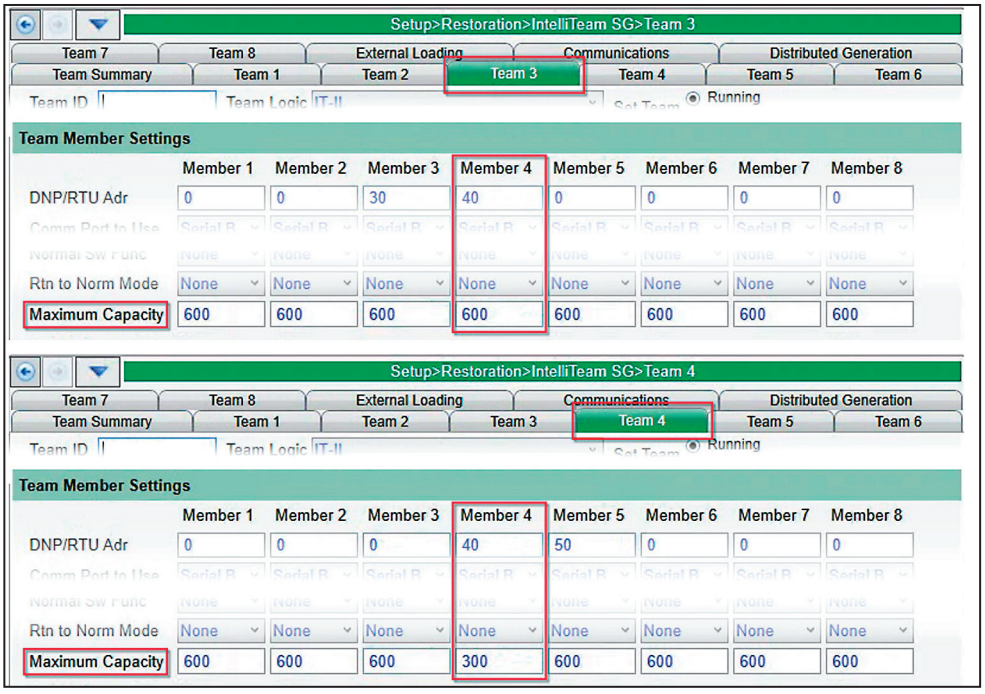

Figure 9. Configuring the Maximum Capacity setpoint of switch IR4.

For example, to limit the source SRC2 circuit load that can be restored from source SRC1, set the **Maximum Capacity** setting of the switch IR4 team member in team T4 to an appropriately lower value, such as 300 A.

(c) Artificially reduce the capacity of a switch on the side toward its normal source. This side is being restored by this switch when a circuit event occurs. See Figure 10.

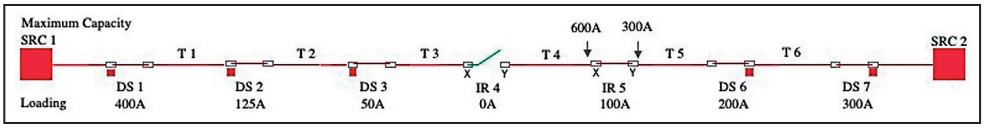

Figure 10. Reducing the maximum capacity for team T5.

Configuration of the **Maximum Capacity** setting for switch IR5 on the *Setup>Restoration>IntelliTeam SG>Team 4* and *Team 5* screens might look like Figure 11 on page 8, though other team member records might be chosen in the configuration.

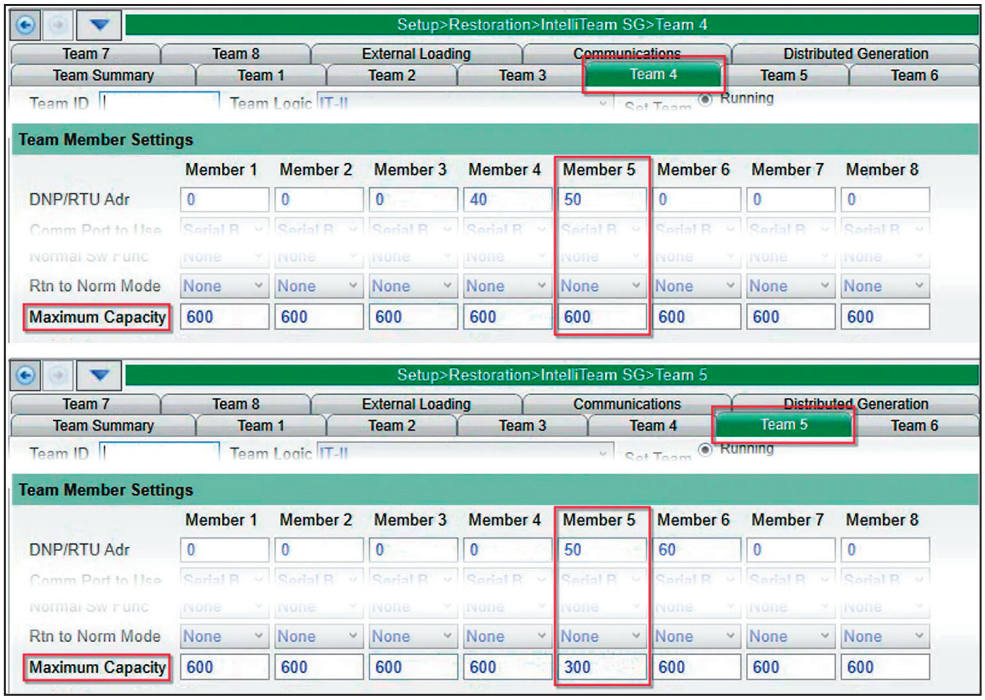

Figure 11. Configuring the Maximum Capacity setpoint of switch IR5.

In this example, switch IR5 will be limited to 300 A when attempting to restore team T5 from source SRC1, regardless of the source SRC1 capacity calculated by previous switches during the restoration.

Note: This planning and configuration process applies to both the **IT-II** mode and the **IT-SG Rapid Self-Healing** (RSH) mode. If **IT-SG RSH** mode is declined, restoration will revert to **IT-II** mode. Because of this, the **Maximum Capacity** setting must be configured in all locations where capacity is limited, whether it is a physical limitation or an artificial limitation.

IntelliLink® Setup Software

When the **Team Logic** setting is configured for **IT-II** mode, configuration of the **Maximum Capacity** setting is located on the *Setup>Restoration>IntelliTeam SG>Team X* screen. Each team setup screen has independently configurable **Maximum Capacity** settings for each team member. When the switch is a member of only one team, such as a source/sub switch, only the active team requires configuration. See Figure 12.

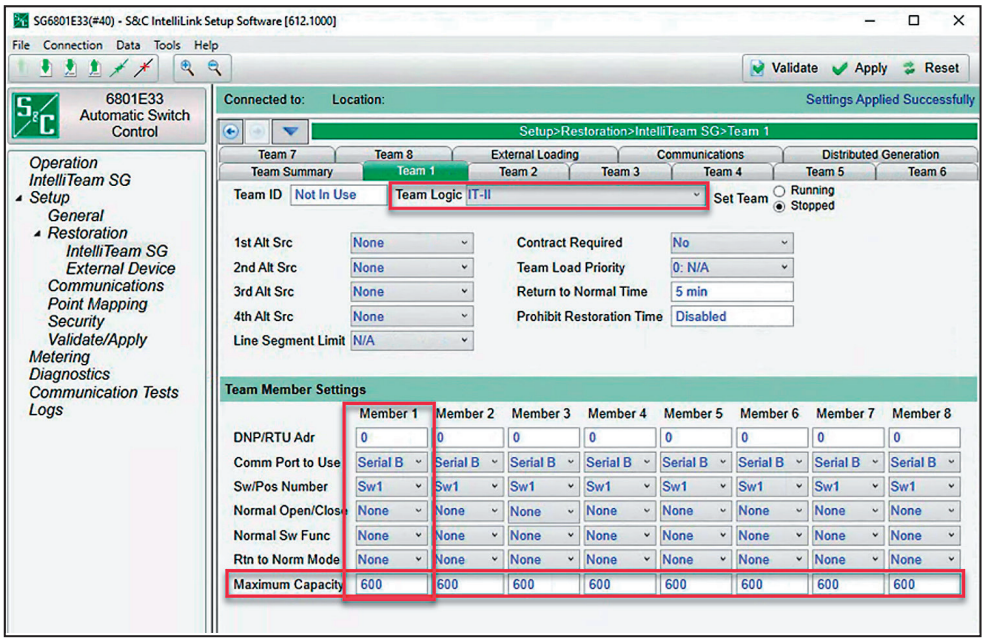

Figure 12. The *Setup>Restoration>IntelliTeam SG>Team 1* screen.

Follow these steps to configure the **Maximum Capacity** setting:

STEP 1. For each active team member, enter a value in the **Maximum Capacity** field on the *Setup>Restoration>IntelliTeam SG>Team 1* screen representing the team member's ability to carry load during a circuit restoration as if this team member is the present source for the team or it will become the source for the team when the switch is closed to restore load.

STEP 2. Repeat this for other teams where this device is a team member and enter the **Maximum Capacity** setting on the *Setup>Restoration>IntelliTeam SG>Team X* screen relevant for the team based on any limitations it may have. See the "Determining Maximum Capacity" section on page 3 for limitation examples.

STEP 3. Repeat this process for every device part of the IntelliTeam II system.

STEP 4. Configure all other relevant IntelliTeam configuration needs for each device in the *Setup>Restoration>IntelliTeam SG* screens.

STEP 5. Change the **Set Team** option to **Running** mode in the *Setup>Restoration>IntelliTeam SG>Team X* screen(s), and validate and apply the settings for each device. See Figure 13 on page 10.

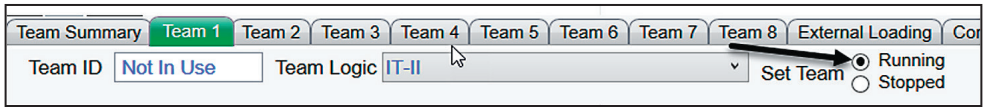

Figure 13. The Set Team mode in the Running state.

IntelliTeam® Designer Software

When using any form of **IT-SG** mode, configuration of the **Maximum Capacity** setting in the IntelliTeam Designer application is on the *Netlist Configuration>Team Member Attributes* screen. See Figure 14.

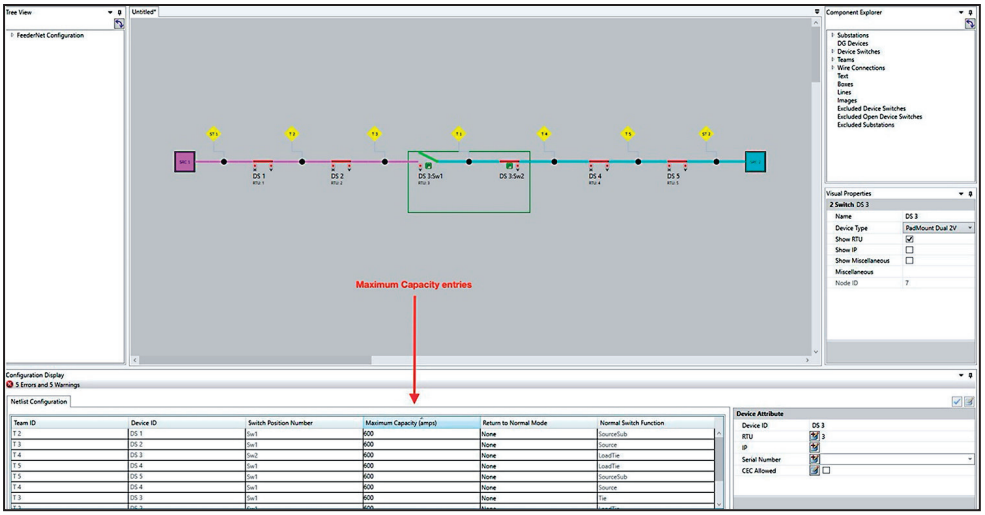

Figure 14. The *Netlist Configuration>Team Member Attributes* screen.

Follow these steps to configure the **Maximum Capacity** setting:

STEP 1. Draw a circuit using IntelliTeam Designer. See S&C Instruction Sheet 1044-570, "IntelliTeam® Designer: *User's Guide*," for information about drawing a circuit with IntelliTeam Designer.

STEP 2. Enter all necessary configuration parameters in the Netlist configuration area of the IntelliTeam Designer application. See S&C Instruction Sheet 1044-570, "IntelliTeam® Designer: *User's Guide*," for information about configuring a circuit with IntelliTeam Designer.

STEP 3. Assess the maximum capacity requirement for each switch and line segment. Then, enter values in the **Maximum Capacity** setting for each team member and for each team in which the switch is a member on the *Netlist Configuration>Team Member Attributes* screen.

STEP 4. Save and validate the circuit and correct any validation errors if they occur.

STEP 5. Open the Communications Manager software and push the netlist to the devices. See S&C Instruction Sheet 1044-570, "IntelliTeam Designer: User's Guide," for information about pushing the netlist with IntelliTeam Designer.

STEP 6. After the netlist has been pushed, the configured **Maximum Capacity** settings are shown on the *IntelliLink Setup>Restoration>IntelliTeamSG> Team X* screens and are read-only.

Note: When the **Team Logic** setting is configured in any form of **IT-SG** mode, the **Maximum Capacity** setting on the screen is read-only.

This example uses the **Maximum Capacity** and **Extended Load** values in Figure 15.

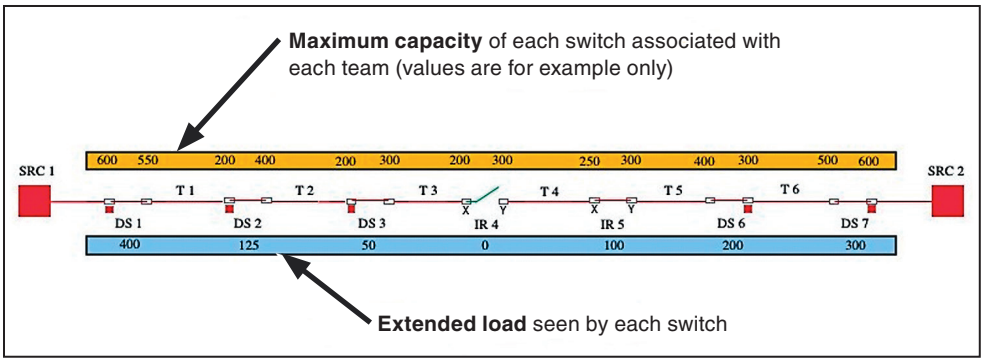

Figure 15. The maximum capacity and extended load seen by each switch.

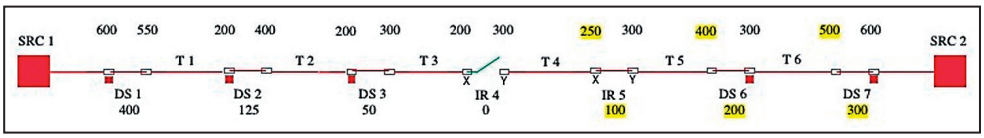

Figure 16. The alternate circuit capacity.

Determine the capacity of the alternate circuit. In this example, there are no source-sub capacity data available. See Figure 16. Follow these steps to review the example as it progresses:

STEP 1. At switch DS7 in Figure 15, use the maximum capacity configured for the team on the downstream side of switch DS7, team T6. Switch DS7 is configured for 500 A on the team T6 side. Subtract the extended load seen by switch DS7 from the maximum capacity: 500 – 300 = 200 A of available source SRC2 capacity. Team T6 has 200 A real capacity.

STEP 2. At switch DS6, use the maximum capacity configured for the team on the downstream side of switch DS6, team T5, which is 400 A. Subtract the switch DS6 extended load from the maximum capacity: 400 – 200 = 200 A. Switch DS6 has 200 A of local capacity. Compare the switch DS6 local capacity with the upstream team T6 real capacity. In this case, they are the same, 200 A. Team T5 has 200 A of real capacity.

STEP 3. At switch IR5, use the maximum capacity configured for the team on the downstream side of switch IR5, team T4, which is 250 A. Subtract the switch IR5 extended load from the maximum capacity: 250 – 100 = 150 A. Switch IR5 has 150 amps of local capacity. Compare the switch IR5 local capacity with the upstream team T5 real capacity. 150 is less than 200, so use the lesser. Team T4 has 150 A of real capacity.

Effectively, alternate source circuit SRC2 has an available capacity of 150 A that it can offer to source SRC1 circuit should an outage occur.

This example continues with an outage and a restoration. See Figure 17.

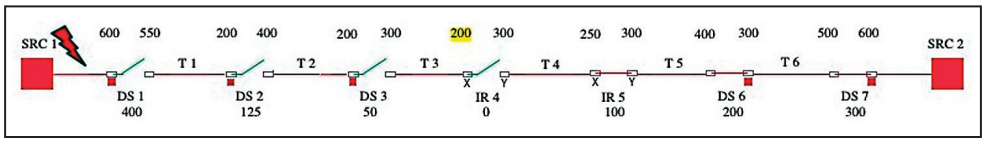

Figure 17. The fault at source SRC1.

STEP 4. Following the initial fault and subsequent sectionalizing, team T3 requests normally open switch IR4 to close. Switch IR4 compares team T3 pre-fault loading, 50 A, with both its maximum capacity and the real capacity of the alternate circuit. The alternate circuit real capacity of 150 A is greater than the 50 A of team T3 load. The switch IR4 maximum capacity, using the 200 A setting in the downstream requesting team, team T3, is also greater than the 50 A of the team T3 load.

STEP 5. Disregarding all other restoration logic for this example, switch IR4 is allowed to close followed by switch IR4 reducing the alternate source real capacity by the load being restored. Team T3 is assigned the updated real capacity of (150 – 50 =) 100 A. See Figure 18.

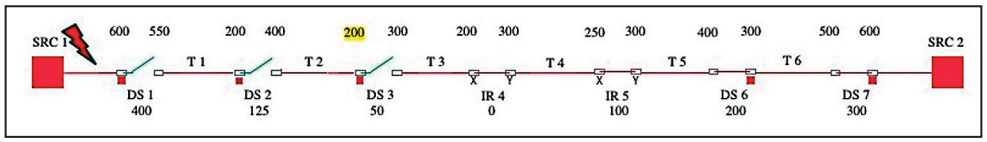

Figure 18. The team T3 load is supplied when switch IR4 closes.

STEP 6. Next, team T2 requests switch DS3 to close. Switch DS3 compares team T2 pre-fault loading, 75 A, with both its maximum capacity and the real capacity of the alternate circuit. The alternate circuit real capacity of now 100 A is greater than the 75 A of team T2 load. This is good so far. The switch DS3 maximum capacity, using the 200 A setting in the downstream requesting team, team T2, is also greater than the 75 A of team T2 load.

STEP 7. Disregarding all other restoration logic, switch DS3 is allowed to close followed by switch DS3 reducing the alternate source real capacity by the load being restored. Team T2 is assigned the updated real capacity of (100 – 75 =) 25 A. See Figure 19.

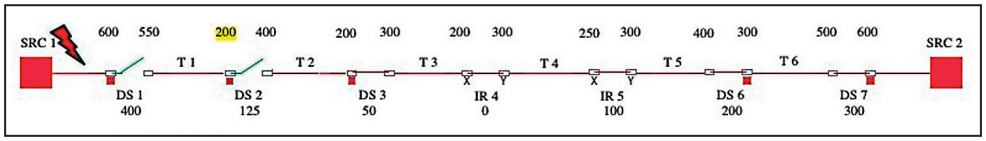

Figure 19. Switch DS3 is closed and team T2 is assigned 25 A real capacity.

STEP 8. Finally, team T1 requests switch DS2 to close. Switch DS2 compares the team T1 pre-fault loading, 275 A, with both its maximum capacity and the real capacity of the alternate circuit. The alternate circuit real capacity of now 25 A is less than 275 A. This is not good. The switch DS2 maximum capacity, using the 200 A setting in the downstream requesting team, team T1, is less than the 275 A of team T1 load. This is also not good.

STEP 9. Switch DS2 is not allowed to close because the switch maximum capacity on the downstream requesting side is insufficient and because the alternate source has insufficient capacity. Either alone would of course prevent the restoration. See Figure 20.

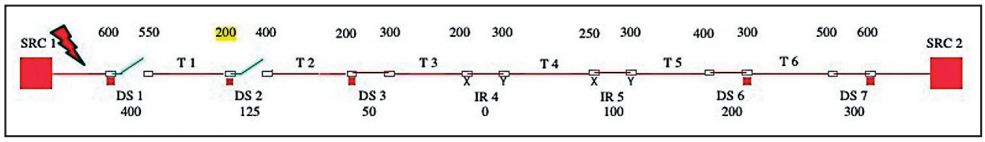

Figure 20. The switch DS2 cannot close to support the excessive load, and switch DS1 remains open to isolate the fault.

Looking at Figure 21, the yellow highlighted maximum capacities were used when determining the real capacity of the source SRC2 circuit, each taken from the downstream team configuration of each team member.

The green highlighted maximum capacities were used during the restoration of source SRC1 load, each taken from the requesting team side, or downstream side from the restoring source's perspective, of each team member.

As this example illustrates, the maximum capacity used always originates from the downstream/requesting team's data to provide the local switch maximum capacity during restorations.

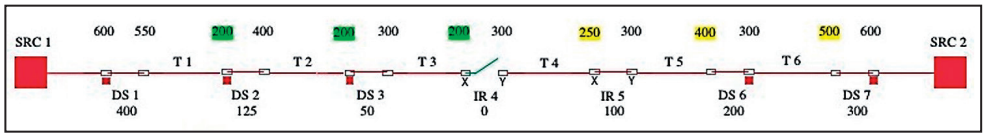

Figure 21. The Maximum Capacity settings used in this example.