Center for Embedded Systems

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Synchronizing Finite State Machine Controllers for Distribution Systems

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Project Overview and Description

- **Project Description**

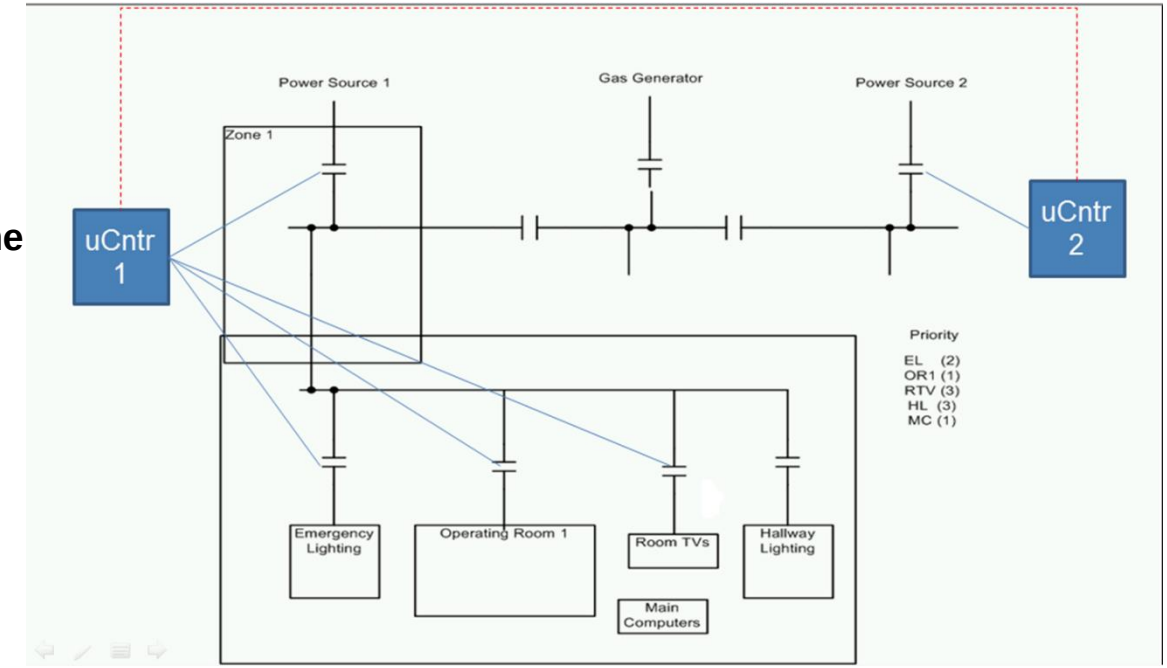
  Distribution system: Suppliers (Generators)
  Consumers (Loads)

  Network of Switches/Relays

  Generators and switches controlled by FSM Controllers

- **Problem**

- **Response to Failure Events**
- **Synchronize individual FSMs**
- **decentralized/distributed scheme**
- **message passing**
- **consensus**



Approach

- **Novelty**

Existing work:

Fault-tolerance in Distributed Asynchronous Systems

Mathematical theory on decentralized control & coordination of Discrete-Event Systems (DES)

No experimental verification has been given in the literature for specific systems.

Contribution:

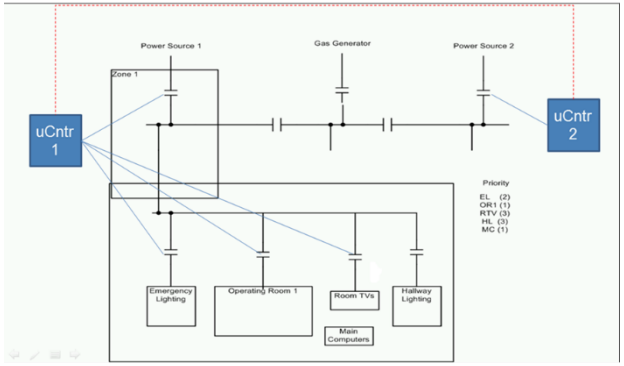
Customized synchronization and reconfiguration procedures are developed with realistic constraints.

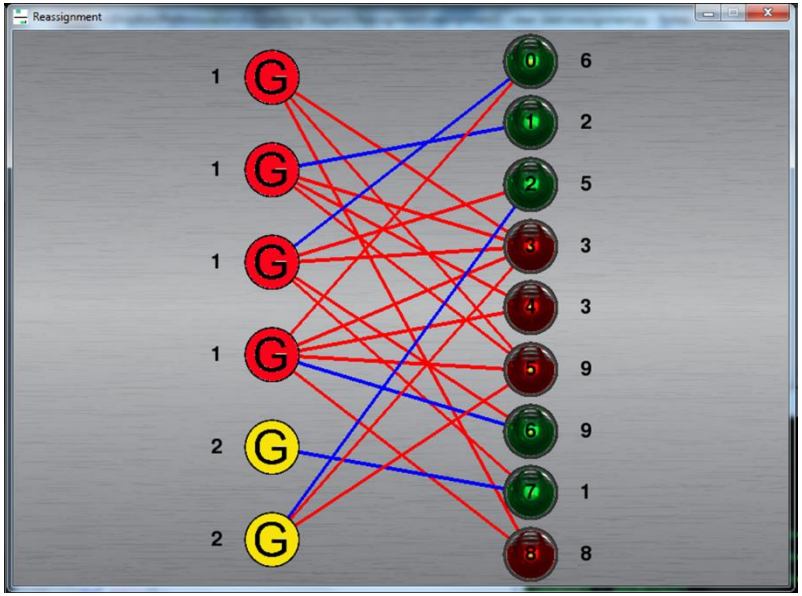
OMNET simulation.

Project Status

Progress to date

1) Developed in OMNET a decentralized algorithm so that all controllers learn the current topology of the network.
2) Developed Bipartite Matching Formulation to associate Generators to Loads with priorities.
3) Enhanced with Dynamic Incremental Matching to respond to failures without starting from scratch.





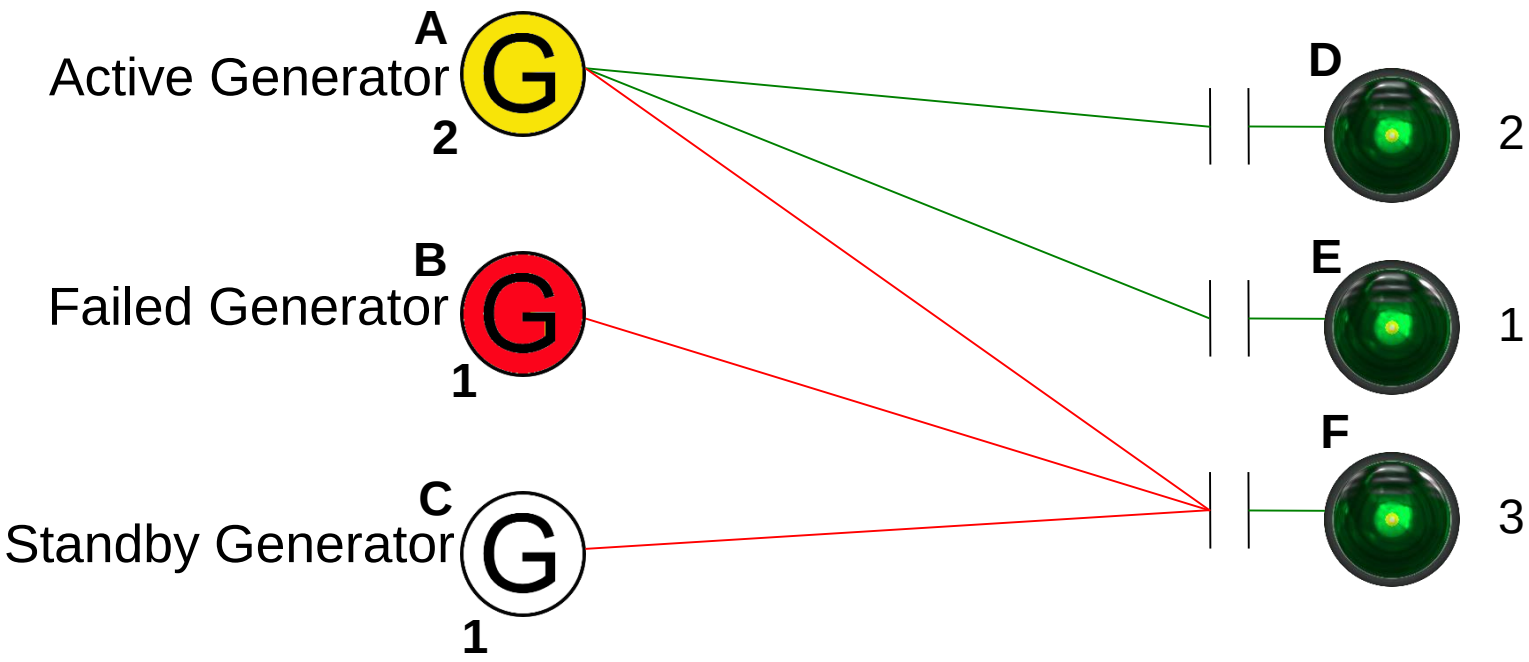
Project Tasks/ Deliverables

	Description	Date	Status
1	Decentralized algorithm in OMNET	FALL14	DONE
2	Bipartite Matching Formulation	FALL14	DONE
3	Dynamic Incremental Matching	FALL14	DONE
4	Customizing parameters/weights for the matching model.	SPRING 15	
5	Relay Configuration Algorithm	SPRING 15	
6	Timing Considerations and Scheduling for Hand-overs during Reconfiguration	SPRING 15	

(1) Relay Configuration: Not all graph matchings are possible

(2) Hand-Over: Requires scheduling actions.

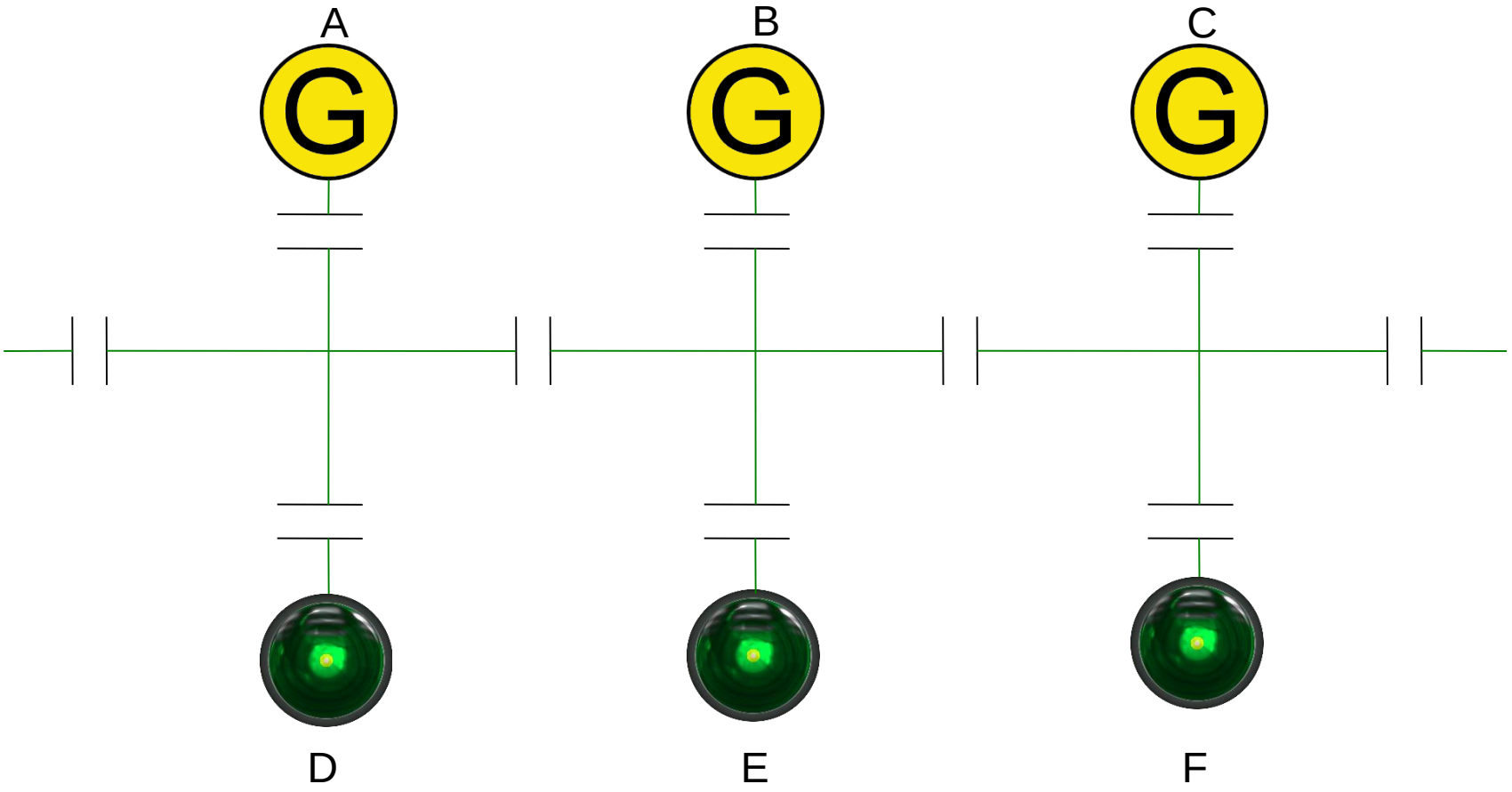
Hand-over Scheduling



countdown of 7
until generator can come online

countdown of 5
until load runs out of battery

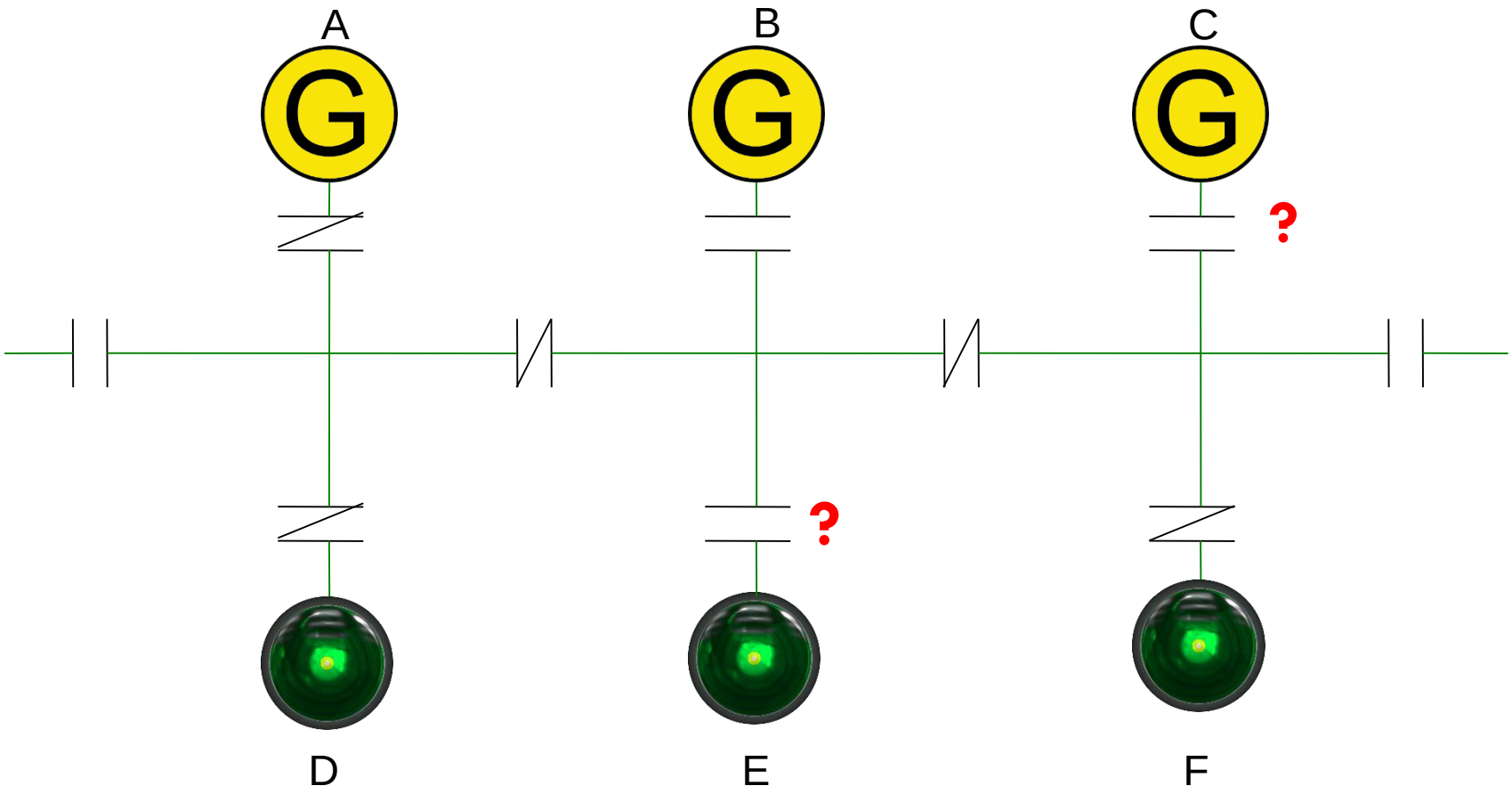
Technical Detail 1 Relay Configuration



Many possible matchings
(A-D, B-E, C-F)
(A-D, A-E, A-F)
(A-D, B-E, B-F)
(A-D, A-F, C-E)

Not all are feasible due to Relay Dependencies

Technical Detail 2 Relay Configuration

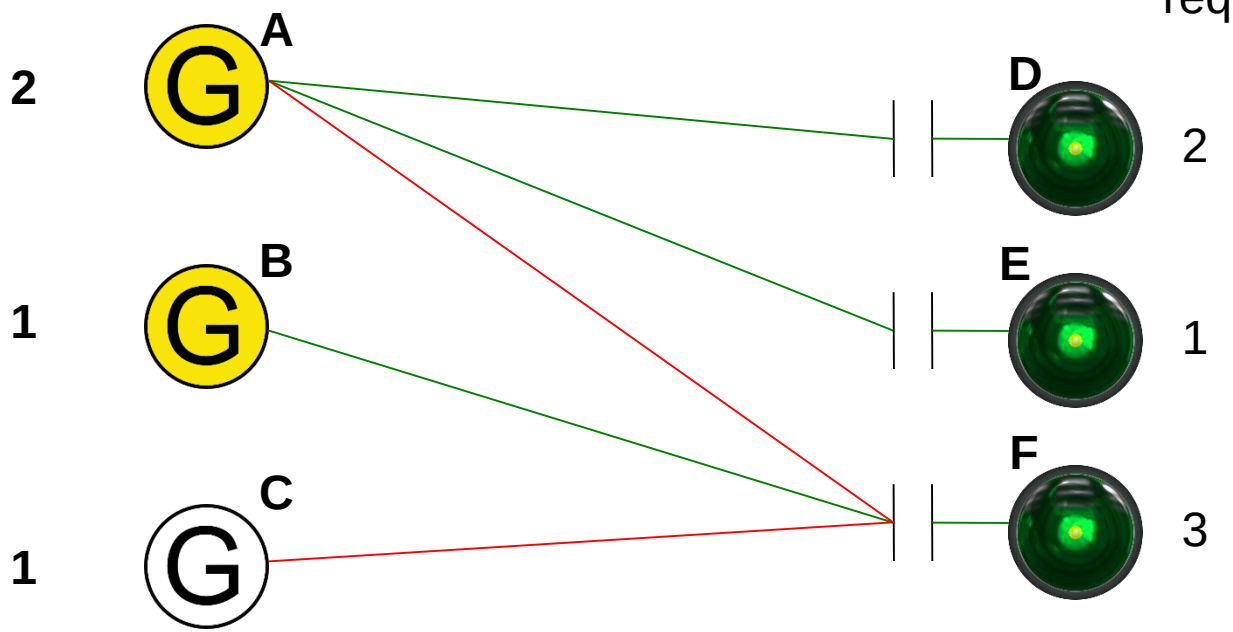


Infeasible matching
(A-D, A-F, C-E) **A-D** **A-F** **C ? E**

Technical Detail 3 Hand-Over Scheduling

Initial Setup

Generator capacities:



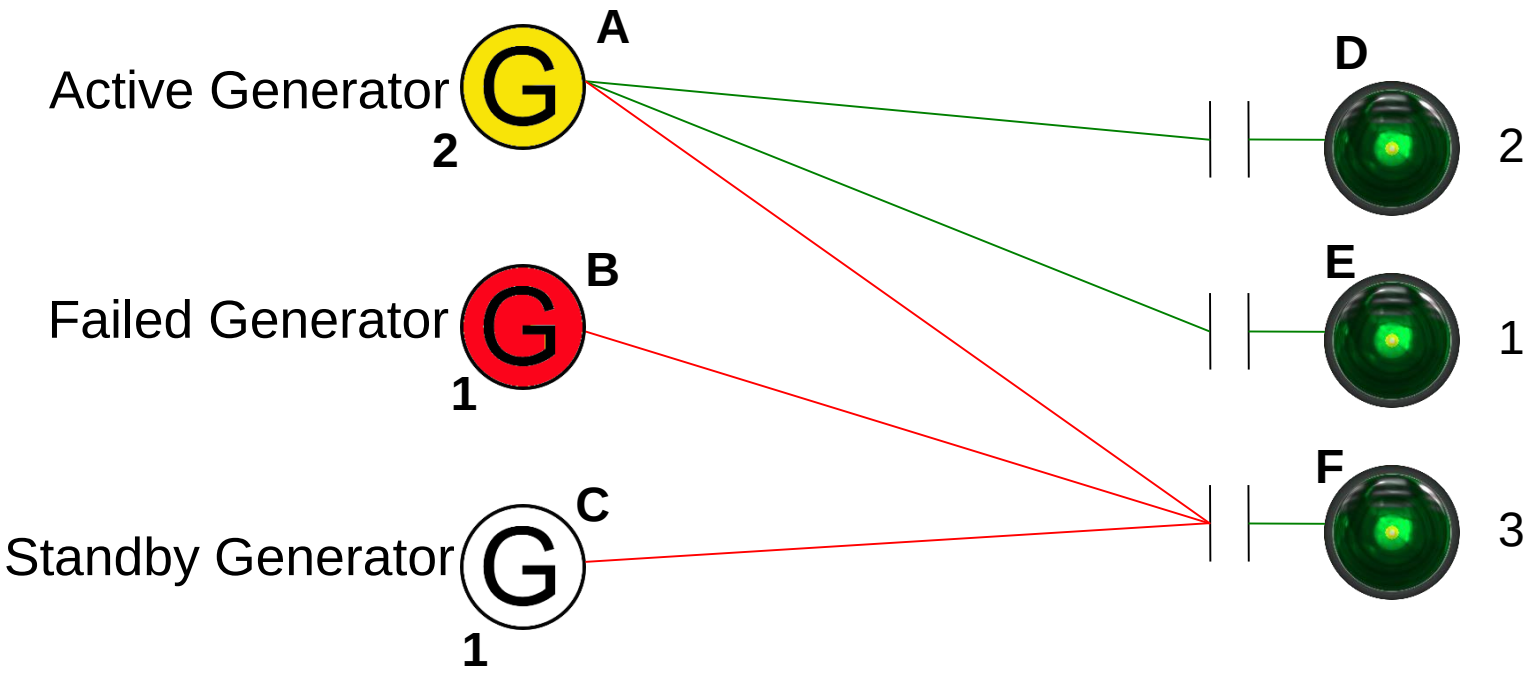
Loads each have a power supply requirement of 1.

Load priorities:

1 means more important.

Technical Detail 4 Hand-Over Scheduling

Generator B fails



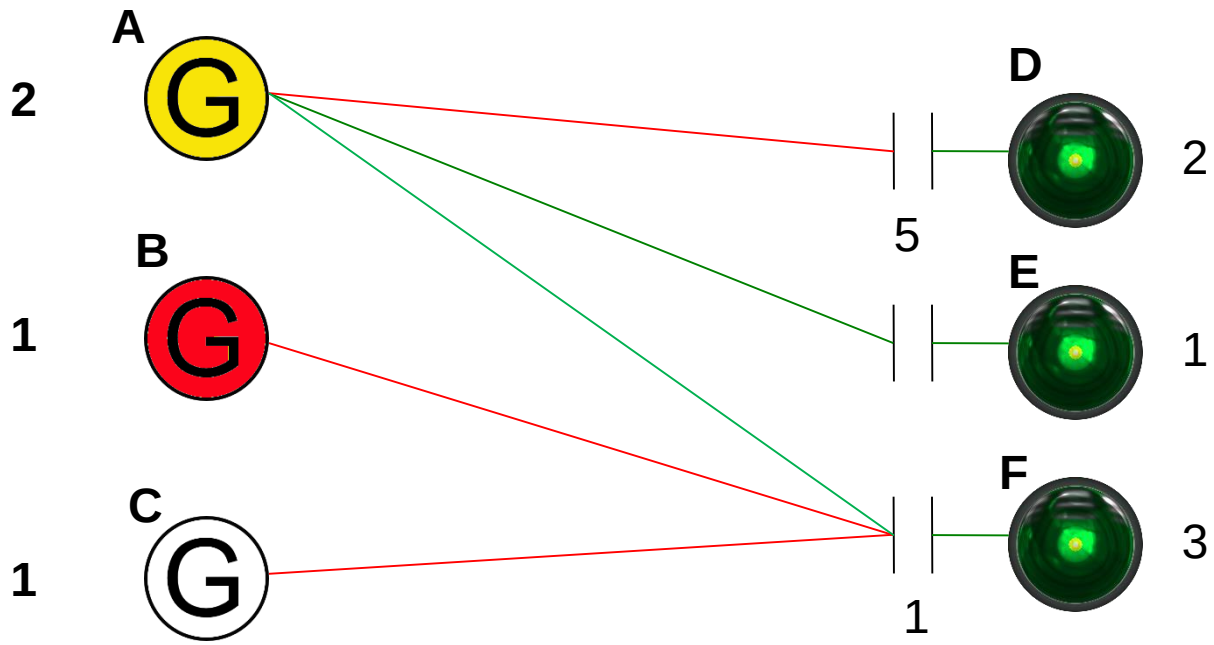
countdown of 7
until generator C
can come online

countdown of 5 until
load F runs out of battery

Technical Detail 5 Hand-Over Scheduling

Countdown
6 4
5 3
4 2
2 1

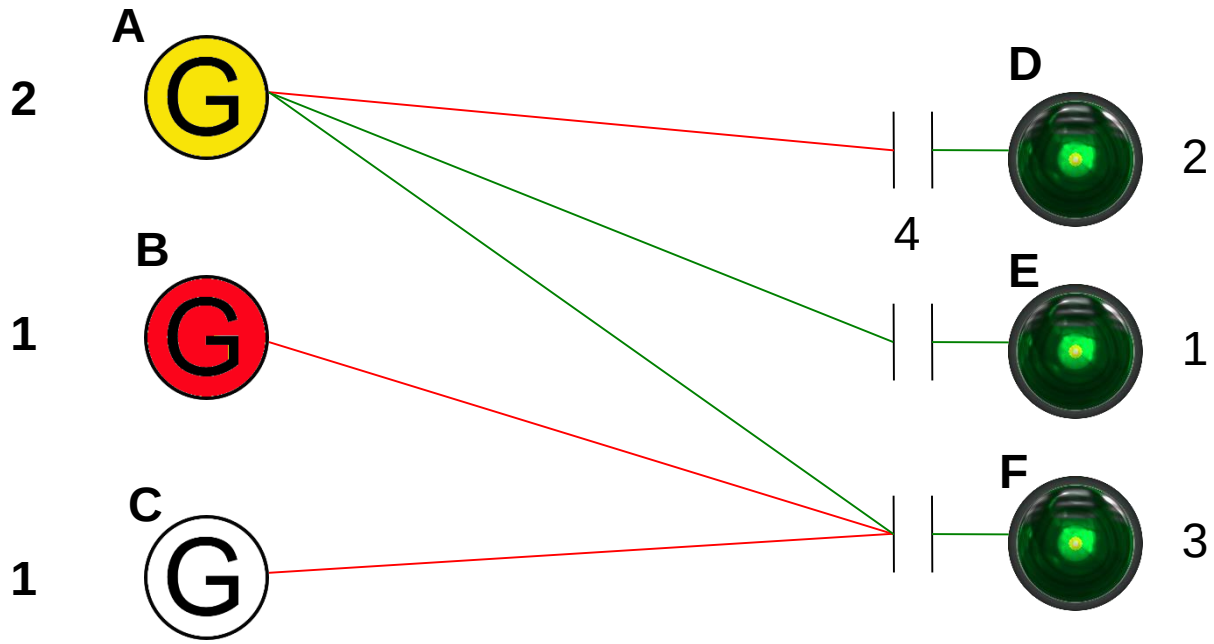
At this time, power supply from Gen A is redirected from Load D to Load F,
despite the fact that D has priority over F,
in order to maintain constant up-time for all loads.



Technical Detail 5 Hand-Over Scheduling

Countdown
6 4
5 3
4 2
2 1
1 0

At this time, Gen C becomes available.



Technical Detail 7 Hand-Over Scheduling

Countdown
6 4
5 3
4 2
2 1
1 0

Now Gen C supplies Load F

and Load D is supplied by Gen A again.