Spanning Tree Protocol (STP)

Redundancy is an essential part of network design and must be implemented at every possible point in network.
Most PCS have a single NIC (network interface card) so they can only be plugged into a single switch, while typically important servers have multiple NICs so they can be plugged into multiple switches for redundancy.
STP is a layer 2 protocol enabling layer 2 redundant networks within the LAN.
Broadcast Storm: network is full of looping broadcast frames that no legitimate traffic can pass through it.
MAC address flapping refers to a network issue where a Media Access Control (MAC) address repeatedly and rapidly alternates between different switch ports. This can cause disruption in network connectivity and lead to performance problems. All of these problems are due to redundant paths resulting in layer 2 loops.
Switches from all vendors run STP by default, it prevents layer 2 loops by placing redundant ports in a blocking state, essentially disabling the interface that act as backups to enter forwarding state if an active interface fails.
Interfaces in a forwarding state send and receive all normal traffic while in blocking state only send or receive STP messages called BDPUS (BRIDGE PROTOCOL DATA UNITS) and some other specific traffic.
Bridges were used before switches and after Hubs, STP wnbled switches send Hello BPDUS out of all interfaces once every 2 seconds, only switches use STP, if a switch receives hello BPDU on an interface it knows that this interface is connected to another switch. (at last only root bridge sends BPDUS and remaining forward only these BPDUS).
Switches use the switch with the lowest Bridge ID field to elect the root bridge for the network, all ports in a root bridge are in forwarding state and other switches must have a path to reach the root bridge.
Bridge ID → 16 bits for bridge priority by default 32768 and 6 bytes for MAC address.
An interface connecting to an end host doesn't receive any PBDUS so it's safe to be in forwarding state.
PVST used by Cisco switches: per VLAN spanning tree runs a separate STP instance in each VLAN.
Bridge ID: Bridge Priority in4096 increments + Extended System (VLAN) ID.
Designated Ports: are ports in a forwarding state. (non root switches select one of their ports to become root ports).
When a switch is powered on it assumes it's the root bridge until it receives a superior BPDU.
Root ports are ports in a forwarding state (the interface with the lowest root cost will be root port or connected to neighbor with lowest bridge ID or lowest neighbor port ID (port priority + port number)) .
Root cost: the total cost of outgoing interfaces along the path to the root bridge (sending). (root bridge has 0 cost on ints).
A port connected to another switch's root port must be designated.
Every collision domain has a single spanning tree designated port (the switch with the lowest root cost or lowest bridge id).
Command: show spanning-tree <vlan-id> optional. Command: show spanning-tree detail
Command: show spanning tree summary. alternate= non-designated.

Blocking and Forwarding are stable states while Listening and Learning are transitional states which are passed through when an interface is activated or when a blocking port must transition to a forwarding port due to change in network topology and Disabled when interface is administratively shutdown and it's a stable state.
Interfaces in blocking state drop regular network traffic but receive BPDUS and don't forward them or learn MAC adds.
After blocking interfaces with designated or root roles enter listening state (15 secs by Forward delay timer), interfaces in listening state only forward or receive BPDUS not regular traffic and don't learn MAC addresses.
After listening state a designated or root port will enter learning state (15 secs by forward delay timer), only sends or receives BPDUS not regular traffic but learns MAC address from regular traffic. Forwarding is a normal switch port.

Hello timer: how often the root bridge sends hello BPDUS (2 seconds).
BPDUS are forwarded by designated ports only.
Forward Delay timer: the period of listening and learning states.
Max Age timer: how long an interface waits to change STP topology, reset with every hello BPDU, If reached 0 the switch will re evaluate its STP choices like root bridge, local root, designated and non designated ports, to transfer a port from non designated to designated or root it takes 50 seconds while forwarding to blocking can undergo immediately as it can cause no layer 2 loops, It acts as a maximum value for the Message Age parameter in the BPDU, message age is subtracted from max age. PVST → ISL trunk encapsulation while PVST+ dot1q.
Only configurations of root bridge timers are used.

STP toolkit: Portfast: can be enabled on interfaces connected to end hosts to allow them to bypass immediately to forwarding state → at a certain interface run the command spanning-tree portfast. (works only on access ports).
Run command spanning-tree portfast default to enable portfast on all access ports.
BPDU guard: if an interface with BPDU guard enabled receives BPDU it will shut down to prevent looping.
On a certain interface run the command: spanning-tree bpduguard enable.
Command: spanning-tree portfast bpduguard default enables guard on all portfast - enabled interfaces.
To re enable a port that was disabled by the guard run shutdown then no shutdown on the interface.
Root guard: if enabled on an interface, if it receives a superior BPDU on it, the new root bridge will not be accepted and the interface will be disabled.
Loop guard: if enabled on an interface, even if it stops receiving BPDUS, it will not start forwarding but will be disabled.
Command: spanning tree mode <mode>.
Command: spanning-tree vlan <vlan-id> root primary to set the current switch's priority 4096 lower then the current root.
Equivalent to spanning-tree vlan <vlan-id> priority <pri>.
Spanning tree load balancing: not always blocking the same interfaces in all VLANs.
Spanning tree port settings.
Choose a specific interface and run spanning-tree vlan <vlan-id> cost or port-priority (in incs of 32)
First half of port is is STP port priority.
STP BDPUS are forwarded by designated ports.
In STP a lower number is of a higher priority.