Sift -Out Modular Redundancy

Redundancy is simply the addition of information, resources, or time beyond what is needed for normal system operation. Hardware redundancy is the addition of extra hardware, usually for the purpose either detecting or tolerating faults.

Fault tolerant is achieved by Modular redundancy which is type of hardware redundancy. Fault-masking and spare-switching have been the two most common forms of modular redundancy.

In fault-masking the failed channel is masked by the good channel. Fault tolerance, **F** is measured by maximal number of channels that be failed without disrupting the masking process.

In spare switching structure contain active and passive categories of channels. In which active channel makes the functional core of the structure and passive channel which are also spare channels are in standby mode and replaces the active channel if it fails.

In third division of redundant structures,there are no standby channels. All the channels are active at the beginning of the mission time. However, upon the occurrence of a failure, the structure reconfigures itself in such a way that the contribution of the failed channel is reduced or eliminated. NMR and TMR are examples of this kind of redundancy structure.

Scheme

In a sift out redundancy scheme there are L identical channels. Whenever there is a fault, the faulty channel is removed, means contribution of that channel nullified. There is an assumption that at one point of time only one of the channels can fail i.e. two or more channels cannot fail simultaneously. After removing one of the channels the system becomes an (L-1) redundancy scheme.

In sift out redundancy (L-2) channels are the maximal limit of the failure. Thus, Sift-out redundancy has a fault tolerance L-2. So, the module will operate correctly till (L-2) failure. When the module is reduced to two channels and one of them fails, the system is unable to detect which one failed. Sift-out is a 2-out-of-L structure, or an L-down-to-two redundancy.

Implementation

Structure of Sift-out modular redundancy uses L identical modules that are configured into a system using special circuits called comparators, detectors, and collectors. The function of the comparator is used to compare each module's output with remaining modules' outputs. The function of the detector is to determine which disagreements are reported by the comparator and to disable a unit that disagrees with a majority of the remaining modules.

Comparators are used to compare the outputs of the channels. The comparator is a set of ${}^{L}C_2$ XOR gates. The detector is a sequential circuit with [${}^{L}C_2$+ L] NOR gates. The signal F_i is equal to zero when channel i is fault-free. F_i is equal to 1 when channel i has failed and when i is working Fi is equal to 0. The final step is the collector, with (L + 1) NOR gates. Each good channel feeds one input to the last NOR gate. Each bad channel provides a logical value 0 as input to the last gate. The output of this gate is the correct output of the system, provided that at least two channels are good.

COMPARISON WITH OTHER SCHEMES

Triple Modular Redundancy (TMR) :

In the basic TMR configuration, the system is organized into three identical channels that feed a voting element. The voting element compares the output signals of the three channels and selects the signal on which the majority of the channels agree.

A sift-out configuration with three channels has the same fault tolerance as a TMR configuration.The scheme already has the built-in capability of automatic error detection and fault isolation. The value of the variable Fi provides immediate information about the state of channel i (good if $F_i = 0$; bad if $F_i = 1$). This is an important advantage in commercial computers where redundancy is considered primarily for easing maintenance operations rather than improving reliability.

N-tuple Modular Redundancy (NMR) :

The fault tolerance of an NMR configuration is only $F = (N - 1)/2$; the fault tolerance of a sift-out configuration with the same number of channels is $F = N - 2$. When comparing the NMR voting unit with the sift-out restoring organ, the former is found to be less complex than the latter for small values of N, but the situation inverts as N increases. In addition, the disadvantages already mentioned for the TMR, of which NMR is a generalization, are to be considered.

Hybrid Modular Redundancy (HMR) :

Hybrid redundant systems combine the advantages of NMR systems (instant internal fault-masking) and standby systems (increased reliability for long time missions). Due to greater fault tolerance, they yield a more efficient hardware utilization than the NMR systems.

Increasing the number of spares complicates the switch so much, that beyond a given point the overall reliability starts to degrade. Sift-out redundancy has a fault tolerance as high or higher than hybrid redundancy, as well as a simpler implementation.

Self-Purging Redundancy :

Self-purging redundancy is, like sift-out redundancy, a responsive structure with an L, down-to-2 strategy. Self-purging redundancy has L channels feeding a threshold voter. Errors are detected by comparison of the channel output with the voter output. When a channel fails, its output is forced to zero. This is logically equivalent to disconnecting failed modules from the voter.

The advantages of sift-out redundancy are inherent fault detection, fault-isolation capability, facilitating diagnosis and self-repair, adjustable order of redundancy, efficient use of hardware, straight forward implementation.

So, the sift-out redundancy have the **applications** in Logic circuits whose continuous real-time operation is essential, systems that need to be ultra-reliable for over a long period of time, Complex multiprocessor systems in which similar subsystems are used to perform critical and subcritical tasks and Redundant systems with easy maintenance requirements.