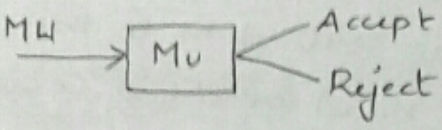
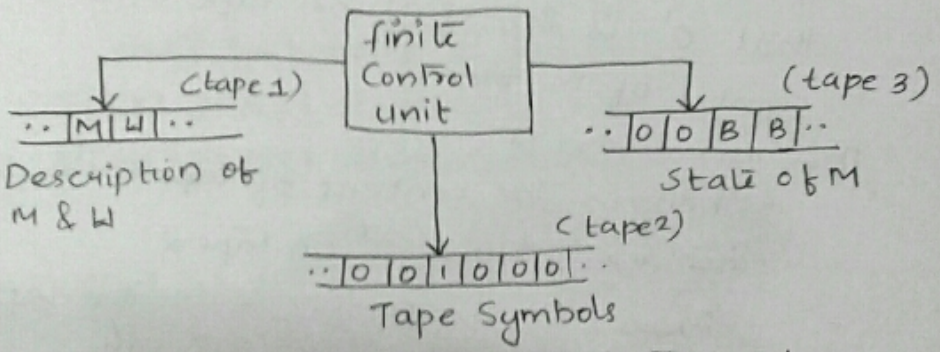
Universal Turing Machine

* It is a TM for all other TM
* UTM is a multitape TM
* A reprogrammable TM called universal TM (M_U) is an automaton that takes as input the description of any TM M and a string w.
* M_U can simulate the computation of M on w.



$$M_U = \{ \langle M, w \rangle / M \text{ is a TM and } M \text{ accepts } w \}$$

Organisation of a Universal TM



UTM is a multitape TM consists of 3 tape.

* First tape holds description of M and input w.
* Second tape is used to hold the simulated tape of M using the same format has for the code of M ie, tape symbol x_i of M will be represented as 0's and tape symbols will be separated by '1'.
* Third tape of M_U hold the current state of M. In which the state q_i is represented by i number of zeros.

The operation of M_U can be summarised as follows:

Step 1 :- Check code for M is valid for some TM 'M'. It not halt without accepting.

Step 2 :- Initialize second ~~steps~~ tape to contain the input w in its coded form

Eg:-

I/p	0	1	B
coded form	0	00	000

Step 3 :- Place start state of M to the third tape. Then move the head of M_U's second tape to the first simulated cell.

Step 4 :- To simulate a move of M, M_U searches on its first tape for a transition $0^i|0^j|0^k|0^l|0^m$ such that 0^i is the state on tape 3. 0^j is the tape symbol of M. ~~then~~

This transition is

- changes the content of tape 3 to 0^k
- Replace 0^j with 0^l on tape 2
- Move head on tape 2 to the left/right depending on the value of 0^m.

Step 5 :- If M has no transition that match simulated symbol and tape in step 4. M hold in the simulated configuration M.

Step 6 :- If M enters its accepting, then the M_U accept.