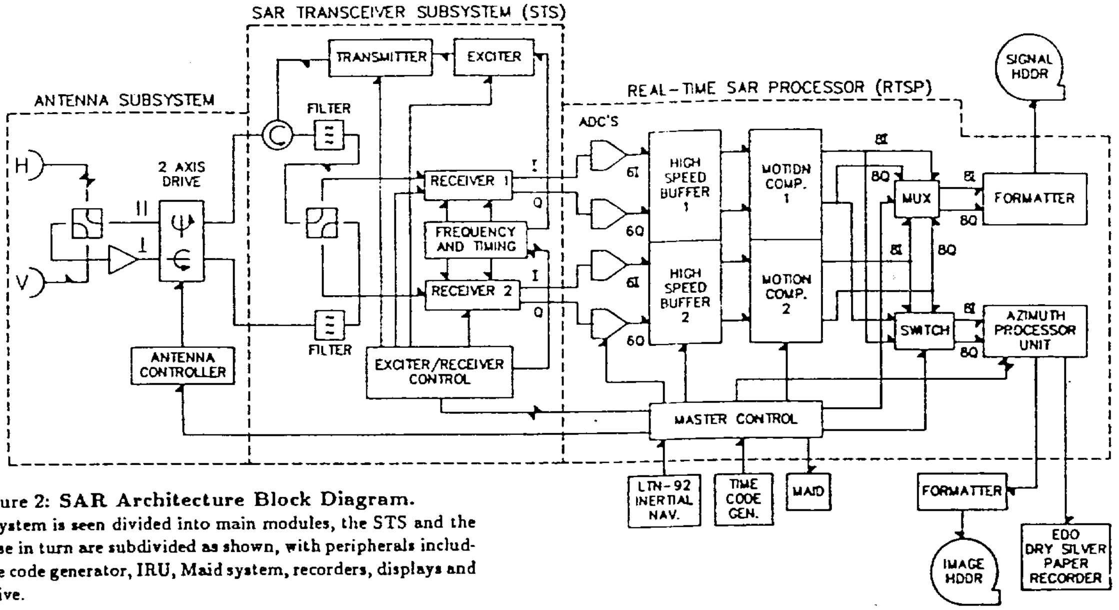

Figure 2: **SAR Architecture Block Diagram.**
The SAR system is seen divided into main modules, the STS and the RTSP. These in turn are subdivided as shown, with peripherals including the time code generator, IRU, Maid system, recorders, displays and antenna drive.

2.4 Sensitivity Time Control (STC).

The principle behind STC in radar systems is discussed in [17] for real-aperture radars. SAR receivers in which the range pulses are compressed prior to the ADC must accommodate the large dynamic range of the range-focussed, radar returns. Large variations are possible depending on the terrain type, radar viewing geometry, and antenna gain pattern. ADC modules whose bandwidths are sufficiently large to accomodate the received signals typically have 30 to 40 dB dynamic ranges. The gain of the radar receiver is therefore varied in time to compensate for the deterministic (and quasi-deterministic) elements of the radar range equation.

These elements, each depending on geometry, include: the two-way antenna elevation pattern G_tG_r ; the $1/R^3$ fall off with slant range; the variation of radar reflectivity with incidence angle (θ), $\sigma_o/sin\theta$; and the atmospheric attenuation, $exp(-\alpha R)$. They in turn enter the radar range (and thus the signal power) equation as a product which is integrated over the azimuth beam pattern of the antenna.

For the purposes of dynamic range matching, a simple model approximation is used for the gain control equation. The terrain is assumed to be uniform with an average incidence angular dependent backscatter. The reflected power can then be represented to be proportional to:

$$\frac{1}{g_{STC}} = \frac{G_T(\theta-\theta_o)G_R(\theta-\theta_o)\sigma_o(\theta)e^{-\alpha R}}{R^3\sin(\theta)} \qquad (1)$$

Here, g_{STC} is the Sensitivity Time Control (STC) function which is then applied to the incoming signals for ADC dynamic range control. Provided that the antenna patterns and terrain type are well modelled, two desirable effects are produced:

1. The dynamic range of the signal lies within the dynamic range of the ADC most of the time; and
2. Systematic variations in the processed image intensity with slant range are minimized.

If the radar is operating linearly and if the STC function is well known, quantitative relationships between the radar returns and the scene are retrievable by removing the STC function from the processed image.

The elevation bore sight angle θ_o is selected from a look-up table in the radar processor which has been optimized for minimum dynamic range and maximum signal to noise (SNR). The antenna pattern is represented as a 4th order polynomial in dB. The following equation is used to model [13] the distributed target SNR for the optimization.

$$SNR = \frac{P_oG_tG_r\lambda^2}{(4\pi R)^3} \times \frac{\sigma_o(\theta)}{kTBFL} \times \frac{\Delta R\beta}{sin\theta} \qquad (2)$$

Here P_o is the peak power of the transmitted pulse; λ is the radar wavelength; ΔR is the uncompressed pulse length; β is the azimuth beam width; k is Boltzman's constant; B is the equivalent rectangle measure of bandwidth; F is the receiver figure of noise; L is the Ohmic loss in the radar system and atmosphere; and T is the receiver noise temperature.

The STC is implemented as 5 possible selections: TEST, LAND, Smooth WATER, Rough WATER and ICE. The TEST mode corresponds to an STC of 1, resulting in no modification to the received signal as a function of range. The other modes correspond to nominal terrain reflectance laws modelled for their respective types. In each of these cases, an antenna pattern is chosen to be