– or counterforce, sending attack weapons against TBM launch sites or aggressor's high value sites.

The required functions for ATBM defense systems are :

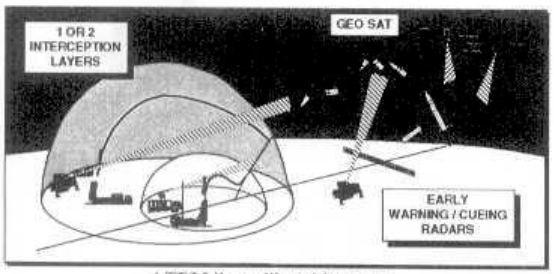
- TBM launch surveillance and [early] detection (Early Warning),
- TBM launch site location,
- Threatened sites / areas determination through ballistic trajectory prediction,
- TBM inflight destruction by interception systems.

If we consider not only the crisis / war phase of conflicts involving Tactical Ballistic Missiles, but also peace time, some other essential missions must be added for ATBM defense systems, related to Intelligence function :

- ballistic activity (flight tests ...) surveillance,
- TBM technical characterization (intelligence purpose ; defense readiness improvement, ...).

«Classical» ATBM architectures for meeting these needs are made of :

– Early Warning Satellite Systems (such as US DSP), in charge of wide area surveillance, TBM launch detection & location through IR plume signature : their ability to predict the ballistic trajectory and estimate impact point location is generally rather limited,
– Medium-Long Range radars also capable of surveillance, and generally dedicated to the accurate tracking of TBM in order to provide precise estimate of impact point and precise cueing data for interceptors guidance. These radars are themselves often cued by the Satellite System,
– One to several families of interceptors : theater high altitude interceptors (see US Navy Theater Wide, US THAAD, ...), or low endo interceptor systems such as US Patriot / ERINT, Aster missile (Fr / It), where the interceptors are associated to smaller, dedicated "Fire Control Radars". Due to the small size of the defended area they provide, the latter are usually called "Point Defense Weapon Systems".
These interceptors families may be deployed simultaneously on a given theater, for enhancing defense efficiency through successive layers and shoot-look-shoot policy.



ATBM "usual" architectures

3.3 Introduction of InfraRed Airborne sensor systems in ATBM architectures

When we look at needed functions in an ATBM defense system and at the "observable features" of Tactical Ballistic Missiles that are described here above, we can rapidly imagine a conceptual observation system fulfilling a large number of needed observation functions.

Indeed, since TBM plumes can be detected from geosynchronous orbit, by sensors looking for them against earth background, they should be detected by comparable sensors placed on aerial platforms, and looking for them against [less emissive and less cluttered] limb / sky background : the penalty due to transmission losses on a rather horizontal line of sight will not lead, of course, to a 36000 km detection range (which is not needed in that case !), but transmission laws indicate that today achievable high flight altitudes lead to «high» transmission coefficients.

Moreover, the observation configuration of InfraRed sensors on airborne platforms is particularly favorable for targets tracking after their burnout, as we have already mentioned. The contrast against sky background is high, while transmission rate improves with line of sight elevation.

Thus appears the concept of «Early Warning / Early Tracking / Early Cueing» InfraRed High Altitude airplane.

Starting from these assessments about general principles, our technical analyses did confirm the high performance levels that it can achieve, and led us to go further into overall design and evaluation.

4. PERFORMANCE AND DESIGN OVERVIEW

4.1 Detection and tracking performance

The two major parameters which determine the detection range of an IR airborne sensor looking for TBM plumes against limb / sky background are :

- the sensor IR observation wavelength band,
- the platform altitude.

The choice of the first parameter is driven by the spectral characteristics of plume emission (depending on propellant nature : liquid / solid), the spectral characteristics of atmosphere absorption on the line of sight, and the spectral characteristics of background emission (mean level and clutter). In that area, the trade-off analysis leads to privilege the MWIR band.

The choice of the second parameter is driven by two factors, the [lowest] integrated transmission on the line of sight, and the [lowest] risk of presence of clouds on the line of sight. Of course, the first of these two factors has to be selected in relation with the IR band selection.

IR transmission rate variations as a function of the sensor altitude show that TBM plume detection ranges do increase when platform altitude varies from 15 to 18 km, and has less significant increase when taking higher altitudes.

The non-interception of the line of sight by clouds means as well that the platform must fly over 15-16 km (especially in subtropical area).