Finland's SAM procurement candidate review:

The Continental competitor from France

SAMP/T & ASTER

The previous issue of Suomen Sotilas reviewed NASAMS, one of the finalists in Finland's surface-to-air missile (SAM) procurement program.

SAMP/T the other finalist in consideration is very different. Higher performance by many parameters, but with a price tag. A range of 100 km makes the Norwegian competitor's range of 25 km seem puny in comparison. Though it is not feasible to engage attack aircraft at over 25 km, e.g. AWACS planes can be detected and fought from afar.

It will be quite difficult to choose between the two disparate systems, with the decision being more political in nature, rather than based on purely military or technological considerations.

The impending choice of a SAM solution will also highlight the kind of threat scenarios Finland sees most likely to exist in the future in the Baltic region.

TEXT: PAULI THOMENIUS
LT COLONEL, GENERAL STAFF (RETIRED)

SAMP/T is a product of the French-Italian EUROSAM. In addition to being deployed in both countries, it is also in use in Saudi Arabia and in the UK. In Europe, SAMP/T has often replaced the old HAWK SAMs. While the Norwegian NASAMS uses the same missile as e.g. the F/A-18 Hornet, the SAMP/T system's synergy gains are in modularity:

- -French ARABEL or Italian EMPAR radars
- -ASTER 30 or ASTER 15 missiles
- -2-6 launch platforms (16-48 standby-missiles)
- - Missile adaptable to other platforms

Typically a SAMP/T unit consists of a fire control center and the ARABEL radar, and 4-6 launch platforms (max 48 missiles), all on truck platforms. With four platforms the system requires 14 operators. In h24 operations this may seem too little, but extensive automation allows a constant rest cycle for the personnel.

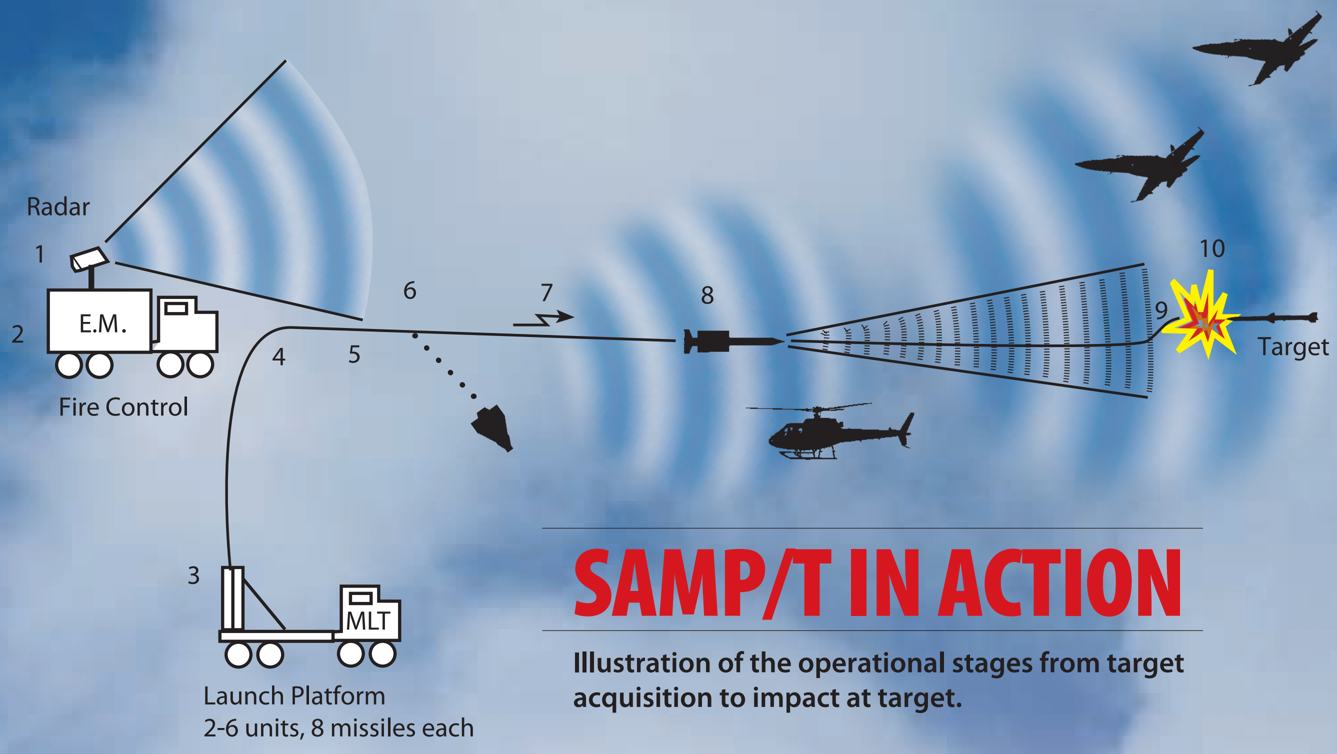
In Finland, range has been considered the crucial factor, even at the cost of fire rate. Here SAMP/T shines, allowing engagement of planes at up to 100kms and missiles at 25 kms. The latter may refer to low-flying cruise or anti-shipping missiles invisible to radar not far away due to the Earth's curvature. The minimum range for ASTER 30 is 3km and ASTER 15 1.7 km. ASTER 30's more powerful first stage drives the missile further before maneuvering is possible.

Rapid ranged Fire

The system's radar is constantly picking up targets and can follow more than 100 concurrently. The antenna revolves every second and vertical scanning is done electronically, no movement required. Missiles are underway in seconds after first sighting. The 8 missiles of a platform can be launched in under 10 seconds, an excellent firerate. The system is vehicle-mounted, on regular military

ARABEL is a constant-search radar capable of identifying and tracking over 130 targets, providing fire control on 10 targets simultaneously, and can update missiles' target data (up-link). The system can launch missile(s) in six seconds from target identification.

The system coverage is full 360 degrees horizontally, vertically -5 to 90 degrees.



SAMP/T IN ACTION

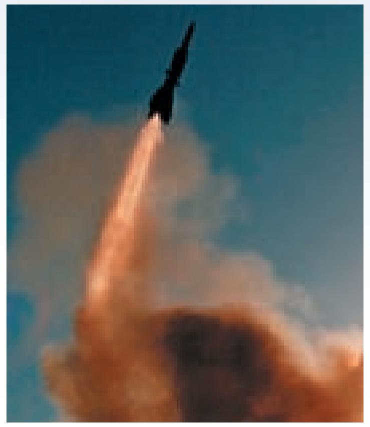
Illustration of the operational stages from target acquisition to impact at target.

1. Radar picks up a potential target contact
2. Fire Control identifies the contact (IFF)
3. One or more missiles launched at target
4. Missile steers towards the target using rear thrusters
5. Missile switches to inertial guidance (flying towards the set coordinates using internal location sensors)
6. The spent booster stage is jettisoned
7. In the inertial guidance mode the missile may receive new targeting data through the ground station up-link
8. Missile switches to active target acquisition using its own radar; the missile is on an angular speed trajectory that leads to the target rendezvous point.
9. In the final stage the missile may jump laterally using its side thrusters (PIF-PAF) , this will result in a direct hit or in the worst case scenario within 2 meters of the target
10. The fuse activates and ignites the warhead, destroys target

Mach and G

The Mach number (M)

= velocity related to the speed of sound. Mach is a plain number, not a constant, but speed is often indicated as e.g. “Mach 1.2”. The speed of sound at +20C air is approximately 343 m/s. The speed of sound is affected by the density of the air, which in turn is dependent on the temperature. Air temperature decreases by about 5C per kilometer gained, e.g. at 10km it is about -50C.



Acceleration due to Earth's gravity (G)

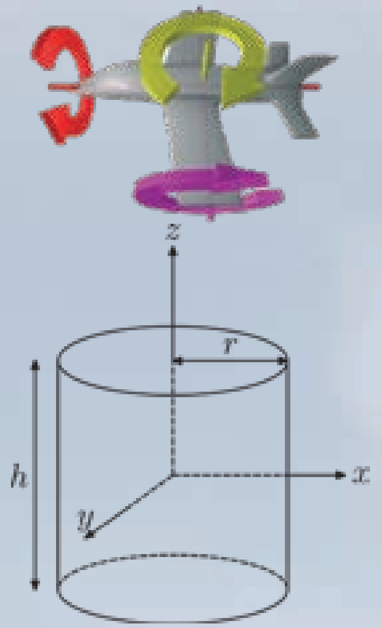
= acceleration of an object in free fall per time unit. One G equals 9.81m/s per second (m/s²), meaning the speed increases every second by 9.81 m/s. In a vacuum this applies likewise to a lead shot than a sheet of paper. A pilot in a G-resistant suit can withstand an acceleration of about 8G.

Warhead fragmentation

The pre-shaped shrapnel warhead is often rectangular in shape, so as to not leave space between the fragments. In comparison, the ball shrapnel found in smaller missiles are easier to produce, and reasonably aerodynamic.

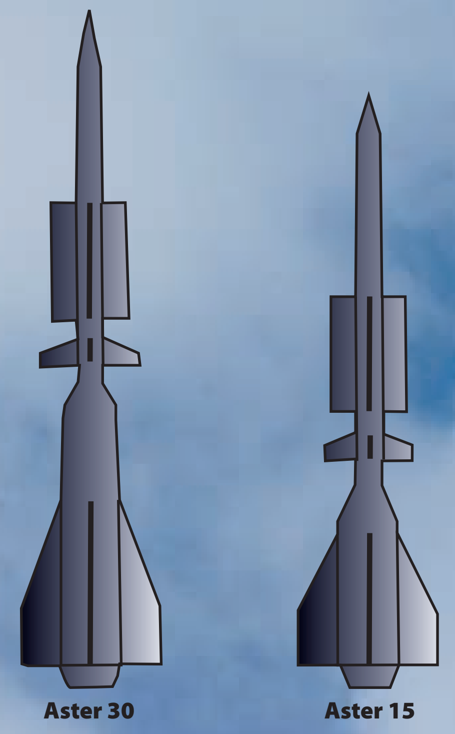
Inertial guidance

The missile is laid on a target, given as a set of coordinates. The intended goal point is thus known, but in addition the missile needs to know its exact position. No external information is conveyed to the missile, and it does not observe the stars or the ground. Location information is arrived at through acceleration sensors. The missile measures acceleration for the three axis (x,y,z), by integrating the acceleration in relation to time, while duration is an integral of the missile’s speed. As a result, the missile is constantly aware of its own coordinates, and approaches the target by tuning the control fins. Should the goal point change due to modifications in the target’s trajectory (speed change, swerving), the radar ground system’s up-link is used to point the missile to a new goal point. In the final phase of the flight in the target’s proximity, the missile switches to active target acquisition with its own radar.



	Aster 15	Aster 30
speed:	M 3+ (~1 000 m/s)	M 4.5 (~1 400 m/s)
range (min-max):	1.7 - 30 km	3 - 120 km
flight altitude (max.):	13 km	20 km
length:	4.2 m	5.2 m
diameter:	180 mm	180 mm
launch weight:	310 kg	510 kg

ASTER models 15 and 30 differ only when the initial stage booster is seen. The Model 30's long range is due to the large amount of propellant. The missiles have gained their operational status in 2001, having mostly been put to use as the air defence missile of choice in the British, French, and Italian navies.



trucks, all wheel drive is not necessary.

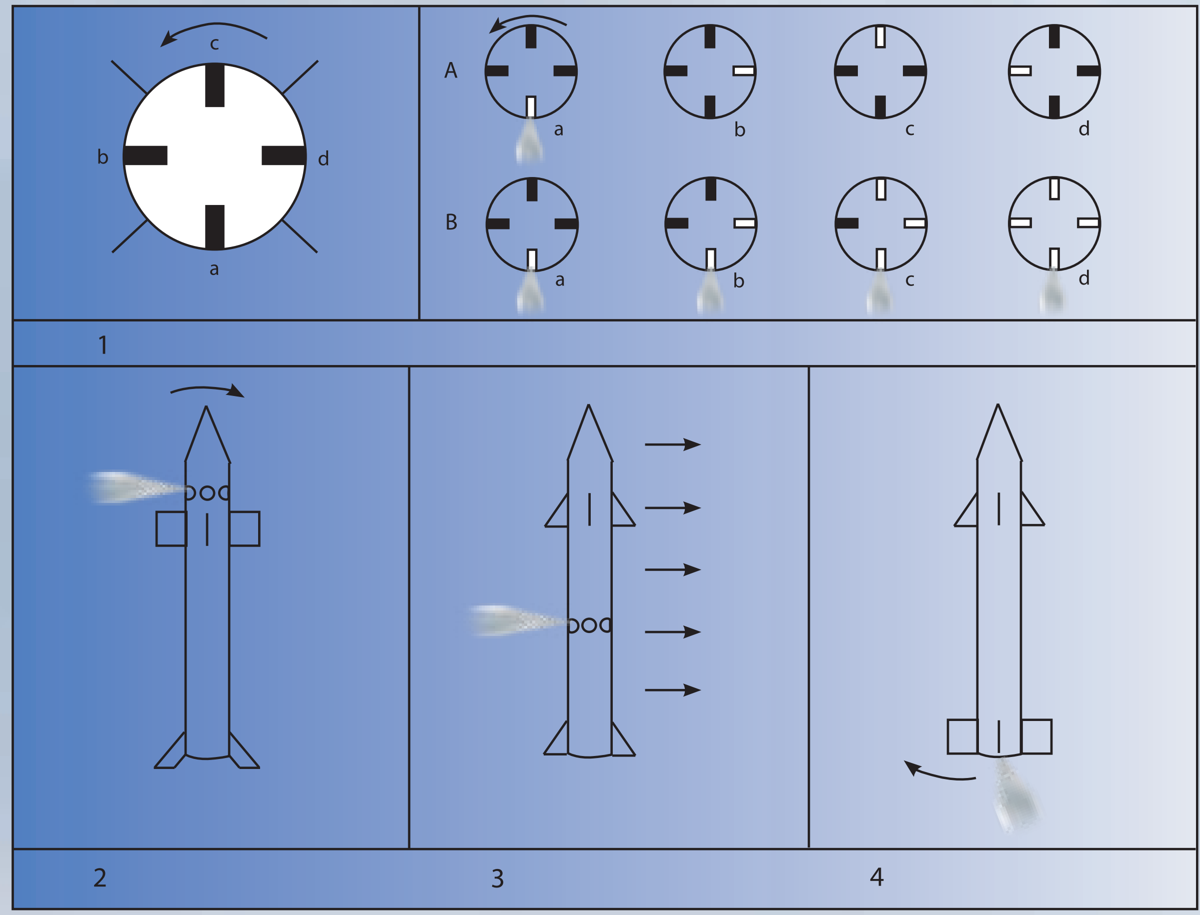
Operation is remote-controlled by a handful of operators. Setup requires personnel, however, as does reloading.

Two missiles

ASTER 30 is taller than ASTER 15 by one meter and weighs 200kg more due to the booster stage. At impact, both missiles weigh about 100 kg, initial stage has been detached and fuel is low.

The speed of ASTER 30 is astounding 1 400 m/s (Mach 4.5), and lateral acceleration (agility) is equally impressive at 60G. The accuracy of the missile is more than adequate. Getting near should be enough with the proximity fuse, but ASTER attempts a hit nonetheless. In a near-miss situation, the missile jumps laterally towards the target. Comparable missiles can seldom do this due to the thin air at altitude making plane guidance impractical. In the terminal phase, ASTER utilizes thruster guidance (PIF-PAF Pilotage induit en force - Pilotage aérodynamique en force) that works even

During transport, the launch tubes are horizontal, but once in positions, they are erected for the vertical launch.



Thruster guidance

1 = thruster jet location, ignited when a bearing change is needed. A = slight turn, D = powerful turn (apparently ASTER is not a rotating missile but uses the 2 side thrusters when needed)

2 = side thrusters near tip (Russian Igla design)
3 = side thrusters on both sides at mass center (ASTER)
4 = turning using the rear thruster (e.g. right after launch)

outside atmosphere.

The system is well-suited for defending against missiles, and larger targets are even easier for ASTER.

The warhead explodes to high-speed fragments, allegedly directed towards the target. Usually AA missiles fragment in a 360 sector. How the focused shrapnel is implemented is unknown at this time, although multiple ignition locations in the warhead have sometimes resulted in directed blasts.

The SAMP/T system can be equipped with either the French ARABEL or the Italian EMPAR radar.

SAMP/T Radar and fire control

Installs on a mobile platform. Here seen on regular military trucks with a load-bearing capacity of 10 t.

Once deployed and in positions, the system requires a crew of only two operators due to the highly automatised functionality. It is only the reloading of the missiles that requires further personnel.

NASAMS vs. SAMP/T

Naturally at this stage in the project the military cannot provide relevant comparison data, so our review is based on external experts' assessments of the systems. Trying to guess the eventual winner is pointless, as besides the technological aspects also the politics play an important role. Also, comparisons are inherently subjective, sometimes risky, and often lead to repercussions. It is again interesting to see which system is chosen and what, if any, arguments for the choice are offered. So far there has been little discussion about the whole procurement process.

TEXT: PETRI ÄLKKI

SAM finalists reviewed

NASAMS	SAMP/T
Range, reach	Range- reach (1)
Vertical reach (2)	Vertical reach
Technological innovations	Technological innovations (3)
Number of sites secured(4)	Number of sites secured
Synergies (5)	Synergies
Requirements for deployment - multiple radars, accepts radars on slopes	**Requirements for deployment** - dominant radar, needs a slope-free view
Flight path Active target acquisition	**Flight path (6)** Active target acquisition, coupled with lateral jump capability
Combat resiliency - multiple radars, radar shifting capability - radar-seeking missiles do not immediately knock out the whole system - light and portable (6 missiles) platforms and radars	**Combat resiliency** - one main radar - 8 missile platforms - rapid rate of fire enables

In the above diagram, performance is indicated by the horizontal area per parameter, compared to the other system. Conversely, the row height illustrates the operative importance of a parameter.
Thus it is the overall area that gives the systems' relative performance – under the conditions prevalent in Finland.

1) SAMP/T would have merited an even higher score, but at great distances low-flying targets are below the radar.

2) It may be that less vertical reach is beneficial when deciding how the responsibilities of the missile and the fighter defenses are divided.

3) For example: the ASTER missile is equipped with three different steering methods: initial thrust direction, planes, side thrusters.

4) With a "unit price" difference of 1:2, the same amount of money buys a different number of batteries.

5) Single, shared missile with the F/A-18 Hornet fighters is beneficial for logistics and training, but may prove a disadvantage in fighting.

6) No points deducted for vertical launch. During the launch delay the NASAMS platform has time to swivel to the correct orientation.

COMPETITION

MTV3 Finland's announcement in November that NASAMS is the winner did not prompt any comments. Perhaps a few eyebrows were raised as to the source of such information: The decision will likely be made higher up than in the Defence Command or the Ministry of Defence, meaning our usual sources don't offer predictions as to the outcome. Our sources in the political level fall silent, too. As it is, both systems on offer could be leveraged for industrial or trade policy gains. Concerning the deal and the final price tag, it is certainly wise to keep the winner under the lid for as long as possible.

Our anonymous sources in the air defence branch are divided over the missile system issue. Both systems have their advocates, and there are also proponents for the continuing use of the current SA-11 Buk system. According to a high-ranking military source, the NASAMS and SAMP/T are very close competitors. One junior officer source has it that SAMP/T is the unequivocal winner. One consideration is that the range of the SAMP/T would require integration in the Air Force organisation, while NASAMS could be a part of the Army's anti-aircraft arsenal. In this regard, SAMP/T could herald the return of air defence in the domain of the Air Force, already underway. Likewise, this development could also be attributed to NASAMS, due to the same missile being already in use in the F/A-18 Hornets.

In all probability, Finland's air defence will become a part of the Air Force, with similar personnel effects as when the coastal artillery and the Navy were combined earlier. From the perspective of national defence, the organisation of command structures is as paramount in making anti-aircraft defence an organic part of the air defence, as it is in guaranteeing the troops a joint real-time air situation awareness and adequate protection against the modern airborne threats.

TEXT : JAAKKO PUUPERÄ

MISSILE COMPARISON

Finland's existing missile systems in comparison with the SAM procurement program finalists

ON DISCOUNT €400 000 000

MISSILE	FLIGHT TRAJECTORY	GUIDANCE	CONTROLS	WARHEAD	LAUNCH
SA-16, SA-18 Igla MANPADS (5)	angular velocity	passive IR homing (2)	frontal planes, initial side thrusters	touch fuse shaped charge and fragmentation	small ejector boost (soft launch)
Mistral MANPADS	angular velocity	passive IR homing (2)	planes	touch fuse, pre-fragmented	small ejector boost (soft launch)
Bolide MANPADS	radial	radar beam homing(3)	planes	proximity fuse, pre-fragmented	small ejector boost (soft launch)
Crotale NG	radial	radar beam homing(3)	planes	proximity fuse, pre-fragmented	no separate launch engine
SA-11 Gadfly Buk	angular velocity	semi-active homing (3)	aft planes	proximity fuse, pre-fragmented	single engine with two stages, accelerate and boost
SA-3 Goa Petšora (5)	half-lead (half of the lead assumed not to lose the missile from radar)	radio command (3)	frontal planes	proximity fuse, pre-fragmented	large launch stage engine
NASAMS	angular velocity (1)	active homing (2)(4)	planes	proximity fuse, pre-fragmented	no separate launch engine
SAMP/T	angular velocity (1) vertical launch	active homing (2)(4)	initial adjustable thruster, planes in mid-flight, terminal side thrusters	proximity fuse, pre-fragmented, focused blast	large launch stage

1) Inertial guidance initially
2) No ground equipment guidance necessary in the terminal stage when IR missiles are used, not even in the early phase.
3) Missile guidance requires additional ground equipment
4) Before the active terminal phase the missile can receive updates through the radar up-link
5) Obsolete system, included for comparison purposes.