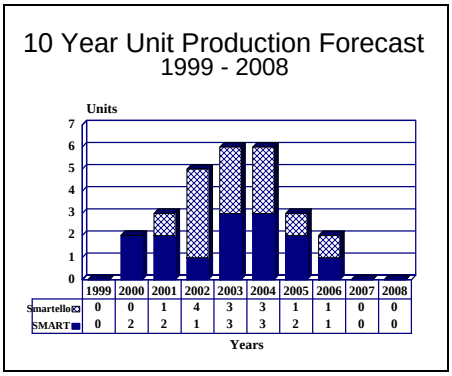
Signaal SMART - Archived 4/99

Outlook

- SMART-L to finish sea trials in 1999
- Land-based version of SMART-L currently under development
- Both German and the Netherlands navies have ordered SMART-L for Type 124 and De Zeven Province air-defense frigates, respectively
- Hybrid "Smartello" system to be installed on all tri-nation Project Horizon air-defense frigates



Orientation

Description. SMART is a family of multi-beam 3-D naval radars, each with slightly differing missions. SMART-S is an all-weather, F-band air surveillance and acquisition radar for targeting. SMART-L is a long-range volume-search radar operating in the D-band, evolved from the SMART-S design. It is particularly designed against small high-speed anti-ship missiles.

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Licensee. No known production licenses have been granted.

Status. SMART-S & MW.08: Believed to be in production, but not in service.

SMART-L: Completing sea trials. Production to begin in 1999-2000 with first in-service date scheduled for 2001.

Smartello: Continued testing. Production tentatively scheduled to begin in 2000 with first in-service date scheduled for 2002.

Total Produced. Approximately 40 SMART-S/L and MW.08 systems are estimated to have been built to date.

Application. SMART-L is used for early detection and tracking of very small aircraft and missiles. SMART-S is capable of automatic detection of targets in the medium-to-long range, featuring automatic track initiation and accurate multi-target tracking.

Platform. The SMART family radars are used on warships of frigate-size and larger. The SMART-L radar, however, is also suitable for patrol craft-sized vessels.

Price Range. SMART-S is estimated to cost around US$10 million per unit, while MW.08 is priced at around US$8 million. SMART-L will probably cost in the region of US$12 million.

Technical Data

	Metric	US
Specifications		
SMART-S		
Range (0.1m² target SW3):	45 km	25 nm
Frequency band:	F-band (10 cm)	
Antenna system weight:	1,500 kg	3,300 lb
Antenna size:	5.3x2.1 m	
Antenna rotation speed:	27 rpm	
Vertical beamwidth (receiving antennas):	9 degrees	
Horizontal beamwidth:	2 degrees	
Transmitter cabinet weight:	1,300 kg	2,860 lb
Processing cabinet weight:	710 kg	1,564 lb
Hydraulic power unit weight:	450 kg	991 lb
Waveguide drier weight:	83 kg	183 lb
SMART-L		
Range – patrol aircraft:	400 km	216 nm
– fighter plane:	220 km	
– stealth missile:	55 km	
Tracking capacity – air targets:	1,000	
– surface targets:	40	
– jammer tracks:	32	
Frequency band:	D-band (former L band)	
Antenna system weight:	6,200 kg	13,650 lb
Antenna size:	9.2x4.4x3.7 m	33x14.5x12.1 ft

Design Features. Generally, SMART is a family of three-dimensional radars for detection and surveillance purposes, against anti-ship missiles and aircraft.

SMART-S. SMART-S is designed to cope with anti-ship missiles, providing data handling and weapons system control. It is intended to cope with missiles with radar cross sections as small as 0.1 square meters and approach speeds of up to Mach 3 approaching both at low altitude and in steep dive. The targets can be either sea-skimmers or approaching at angles of up to 70 degrees.

The main characteristics of the SMART-S system are gapless elevation coverage from horizon to zenith; automatic target detection followed by automatic initiation and 3-D target tracking; prompt delivery of accurate target track at a high refresh rate enabling lock-on of associated weapon control trackers; direct control of guns against surface targets; direct control of continuous wave illuminators in combination with semi-active homing missiles; advanced processing techniques such as digital Fast Fourier Transform (FFM), FFT Doppler processing, and automatic target detection, initiation and tracking; Built In Test Equipment (BITE), ensuring automatic diagnostics and failure reporting; and data bus compatibility.

The antenna is hydraulically stabilized. The transmitting part of the antenna consists of a squint-free, single element array type radiator with a vertical coverage of 90 degrees.

SMART-L. The SMART-L currently forms the primary sensor for the next-generation Dutch air defense systems. This will also include the Evolved Sea Sparrow Missile and the APAR fire control radar.

SMART-L is a D-band pulse-Doppler radar with 16 simultaneous receive beams in elevation and 360 degree azimuth scanning to provide automatic long range air target location and tracking.

SMART-L uses spread-spectrum techniques to defeat electronic countermeasures. Tracking capacity includes up to 1,000 air targets and 40 surface contacts. It has the demonstrated capability of tracking stealth targets in the F-117 category at ranges out to 55 km. A large, electronically stabilized 8.2 m antenna is part of the system, rotating at 12 rpm. The vertically-polarized antenna is built out of layered composite materials and weighs 6.2 tons. It has a stack of 24 horizontal stripline arrays. All of these are used for reception and 16 for transmission.

SMART-L is also equipped with an integral I-band frequency-modulated continuous wave (FMCW) radar that uses technology derived from the Scout covert navigation radar program. This is used for low probability of intercept surface search. An IFF antenna is also mounted on the primary array.

SMART-L uses the new solid-state D-SSTX transmitter unit. This transmitter consists of seven solid-state units in parallel, each having up to 216 parallel transistor junctions. This arrangement can produce a total of 300 W peak power. When employed in a one-driving-four configuration, terminating in 16 transistors in parallel, a basic amplifier designated the PA module, produces 4 kW. Combining up to 32 PA modules enables power to be boosted to 100 kW peak power. Since this is generated by 512 transistors, a single failure is inconsequential, while the failure of 10 of the 32 PA modules reduces range by only 10 percent. The transmitter unit is microprocessor-controlled and offers remote status and control by serial data link.

Front-end processing electronics architecture is based on a Texas Instruments C-40 digital signals processor with application-specific integrated circuit technology to concentrate the 16 parallel processing channels into a confined area. Back-end processing comprises commercially available Sun SPARC boards in Signaal's SigMA/Splice architecture.

SMART-L is the version for medium-range detection of small stealth air targets, long-range detection of conventional aircraft, and to provide a high ECCM performance and guidance support for patrol aircraft, as well as to carry out surface surveillance.

Operational Characteristics. The SMART radar operates in the F-band, ensuring a favorable compromise between range and low-level performance, clutter rejection and antenna size. The radar produces a single transmitting beam and multiple receiving beam, and employs a high-power Traveling Wave Tube (TWT) transmitter. Both SMART-S and SMART-L have multiple low-noise receiving channels, including RF and IF electronics.

The target echoes are received by an array of 16 stripline squint-free receiving antennas, each of which receives signals from the complete elevation coverage. An accurate elevation measurement is produced by means of a digital beam former, which combines all outputs of the receiving antenna. Beam forming results in 12 virtual beams, together covering 90 degrees in elevation. The output signals of the beam-forming circuit are handled further by an FFT processor for target speed information, clutter rejection and jamming suppression. Target track initiation and tracking of all surface and air targets within the detection envelope is performed automatically by means of two general purpose computers. Tracking data is transferred to the ship's command and control system via computer interfaces.

Anti-clutter and ECCM features of the SMART-S radar include fully coherent chain, broad band operation with possible burst agility, high RF power output, automatic RF and Pulse Repetition Frequency (PRF) selection, very low antenna sidelobes both in transmission and reception, 3-D radar with pencil beams, Doppler FFT processing, automatic thresholding of clutter and jamming, automatic jamming analysis sensor, pulse compression, automatic STC, and possible sector transmitting and emission control. SMART is able to track 160 air targets, 40 surface targets or two surface targets for designation to guns. For the complete integration of any type of IFF, an IFF antenna, rotary joint and IFF extractor are incorporated.

Variants/Upgrades

Land-Based SMART-L. The land-based SMART-L began development in mid-1998, and is initially targeted at the Hungarian requirement for three D-band radars. The land-based version will be designed to be transportable with a fairly rapid set-up and break down time. The system will retain all characteristics of the naval version.

MW.08. This is the short/medium range 3-D radar of choice for installation on the MEKO class frigates being widely built for the export market. Fundamentally the MW.08 is a G/H-band version of SMART-S.

Skyspy 3D. Signaal had begun development on a land-based version of MW.08 under the designation Skyspy 3D. However, this program was ultimately dropped.

SMART-L. A D-band version of SMART-S, tasked with long range 3D air surveillance. It forms the primary sensor for the next-generation Dutch air defense systems.

SMART-S. SMART-S is the F-band, medium-to-long range version of the SMART family of radars. It was tested at sea in 1990 and is now fully operational. It is capable of automatic detection of targets, followed by automatic track initiation and accurate tracking of these targets.

SMART-S has a unique multi-target tracking capability, dealing simultaneously with high-priority targets such as small and fast low-flying or high-incoming anti-ship missiles as well as all other types of air and surface targets.

T-1850L "SMARTELLO". The Smartello is the new system selected by the Joint Project Office for the Anglo-Italian-French Common New Generation Frigate (CNGF) Project Horizon. This radar replaces Astral originally specified as the long-range radar for these ships. Smartello is being developed by GEC-Marconi as prime contractor, with Signaal and Thomson-CSF as primary subcontractors. Essentially Smartello is a very long range radar (LRR) that combines the technologies of the SMART-L with those offered by GEC-Marconi on their Martello.

It is expected to use the SMART-L antenna, with the solid-state transmitters integrated in that construction. As a result, the need for below-decks space is significantly reduced, and a complex rotary joint is not needed. That, in turn, makes the phase shifter design much less complex.

Program Review

Background. The SMART radars have been given a high priority by the Dutch ministry of defense since the development program was announced in 1981. The system was under continued development through 1985. In 1983, Signaal and UK-based manufacturer MEL reached formal agreement on a joint proposal to the UK MoD. The companies, at that time both members of the Philips Group, joined in a bid to meet the Royal Navy's requirement for a new surveillance and target indication radar system for the new Type 23 frigates. The Signaal/MEL proposal was based substantially on the SMART radar system, with approximately 80 percent of the work to be carried out in the UK by MEL, had the bid been successful. The Royal Navy, however, chose a different system. The MW.08 is the medium/short-range radar of choice for installation on the MEKO class frigates and is achieving substantial success in that role.

SMART-S is now in service on board the Royal Netherlands Navy's Karel Doorman Class of frigates and has been retrofitted to the two Jacob van Heemskerck class AAW frigates, where it will be used to target Standard SM-1 missiles. It was also specified for the German F-123 Brandenburg class frigates. The MW.08 derivative of SMART-S was selected for the Portuguese Vasco da Gama class (MEKO-200s) and the Greek Hydra class (also a MEKO 200 version). Installations have since then spread to a wide range of other ships as well.

In 1991, Signaal announced it was developing a long-range D-band version of SMART, designated SMART-L. This development was originally intended to be part of the now-defunct NATO Anti-Air Warfare System (NAAWS). It has now become the prime sensor for the next-generation Dutch air defense system and will operate in conjunction with Evolved Sea Sparrow missiles and APAR control radars. SMART-L was initially planned for installation on the new air defense frigates being designed as a joint venture between the Dutch and German navies. This program became trilateral when Spain joined the consortium. The trilateral frigate will combine an area air defense missile system with the SMART-L and APAR radars, and place that air defense system into a nationally-specified hull. In 1995, however, Spain decided to withdraw from the APAR program and adopt the US-sourced AEGIS equipment. This also meant that the size of ships became larger.

The July 1991 contract specified the delivery of eight new SMART-L radars from 1995 onwards. These would replace the older LW.08 radars on Dutch air defense warships. An initial production rate of two SMART-L sets per year from 1995 onwards was projected with initial platforms being the two Heemskerck class air defense frigates.

This contract was followed in November 1991 by the inauguration of the ARTIST (Advanced Radar Techniques for Improved Surveillance and Tracking) program. This is intended as a research project to study the latest technological developments in the field of data processing for air defense systems and will lead to the design of a fully integrated air warfare system. This will initially be based around the Evolved Sea Sparrow

Missile but could be expanded to handle Standard SM-2MR. The ARTIST program was scheduled to run for 42 months and involve Signaal as main contractor and FEL-TNO (Physics and Electronics Laboratory) as subcontractor. The air defense system emerging from ARTIST is designed to integrate the SMART-L and SMART-S radars, a phased-array version of the STING fire control radars (this subsequently emerging as APAR), infra-red sensors and anti-aircraft missiles.

Orders placed during 1992 included two MW.08 systems to equip the Vosper 83 meter corvettes bought by Oman. The decision to mount a powerful 3-D radar on these relatively small ships was the result of Omani insistence on providing a capable defense against missile-firing helicopters. This involved the installation of the modular Crotale-NG missile system and made essential a 3-D air surveillance capability.

Also released were the first provisional diagrams of the new Dutch-German air defense ships. These have evolved as enlarged versions of the Karel Doorman class (first the F-123 Brandenburg class for the German navy, followed by the F-124 Sachsen class) with a SMART-L long-range radar, a SMART-M target acquisition system and APAR missile guidance radars.

The speculation around the Korean KDX program resulted in the selection of a weapons/sensor/command system from BAeSEMA. This package includes the MW.08 as the target acquisition radar. Although statements have been to the contrary, the KDX program is now set to run to a minimum of six hulls and could reach 12 or perhaps even 15. In the latter scenarios, the ships are likely to be built in several groups of the same family, with incremental capabilities. The first batch of three is designated as the Okpo class, and the follow-up series is presently known as the KDX-2 class.

In late 1994, the French Astral radar was deselected as the primary long-range search radar for the Anglo-Italian-French Project Horizon Common New Generation Frigate. While no reasons for this move have been officially released, it has been suggested that a combination of performance concerns and the fact that the equipment was originally selected on a non-competitive basis were significant. Bids for a new, long-range search radar were invited, with the Signaal SMART-L reported to be a most favored alternative to Astral from the start of the proceedings. The new radar is said to combine the best features of the GEC-Marconi S-753 Martello radar and the SMART-L. The new radar is designated T-1850L, nicknamed Smartello.

In 1995, future SMART sales received a mild blow when Spain – which had come on board the SMART derivative APAR program in 1992/93 – abruptly pulled out of the program. Spain cited cost and a lack of meaningful industrial participation as the main reasons for this departure. The F-100 class frigates that were to receive SMART were instead equipped with the US SPY-1 D/F AEGIS radar.

Through 1997-98 the SMART-L system underwent land-based factory testing at the Signaal range in Hengelo, The Netherlands. A wide variety of tests were performed on targets ranging in size from tennis ball sized (to represent a stealth aircraft) to a MiG-29 going Mach 2+.

After land testing the EMD unit was then mounted on the RNLN HrMs Tromp, a guided missile frigate, for sea trials. The system was mounted in place of the SM-1 missile launcher which was removed for the trials. Sea-based testing is expected to last through mid-1999 with the first production SMART-L beginning delivery in 2001.

In 1998, Signaal released information on a planned land-based, transportable derivative of the SMART-L system. This version will apparently retain its 400 km detection range as well as maintaining its performance against stealth aircraft and ballistic missile tracking. The system is being initially targeted for Hungary which has a requirement for three D-band air-defense radars. As an interesting side note, this system will be the first land-based air-defense radar to be developed by Signaal since the 1990 takeover by Thomson-CSF.

Also in 1998, the Royal Netherlands Navy (RNLN) placed an order for three to four SMART-L systems that will be installed on the De Zeven Province class of air defense frigates. Additionally the T1850-L “Smartello” system was selected as the long-range surveillance radar for the tri-nation Horizon air-defense frigate.

Funding

SMART-S was developed under the Netherlands MoD funding with the MW.08 export variant being financed by corporate resources. SMART-L is being developed under a government contract.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Signaal	50.0(Estimated)	Feb 1998 – The Royal Netherlands Navy (RNLN) signed a contract for the delivery of four SMART-L radar systems. The radars will be installed on four Air Defense and Command Frigates (LCF) of the RNLN. The first unit is scheduled to be delivered in 2001.

Timetable

Month	Year	Major Development
	1981	Development program initiated
	1983	Signaal/MEL enter joint venture agreement
	1985	Ordered by Netherlands for first Doorman frigates
	1986	Ordered by Portugal for Vasco Da Gama frigates
	1987	Ordered by Netherlands for second Doorman frigates
	1988	Ordered by Netherlands for Heemskerck retrofit
	1989	Ordered by Germany for F-123 frigates
	1989	Ordered by Greece for MEKO 200 frigates
	1990	SMART sea trials commence
	1990	MW.08 enters service in Portugal
Jul	1991	SMART-L development contract awarded
Nov	1991	ARTIST research contract signed
	1992	SMART-S enters service
	1993	Spain joins SMART derivative APAR program
	1995	SMART-L prototype delivered
	1995	Spain cancels participation in APAR program
	1997- 1998	SMART-L begins land-based testing at Signaal's Hengelo facility
Feb	1998	Turkish navy receives first modified Yildiz class FAC equipped with MW.08 radar
	1998	Hybrid SMART system, designated "Smartello," chosen as long-range surveillance radar for tri-nation Project Horizon frigates
	1998- 1999	SMART-L installed on HrMs Tromp for sea-based testing
	2000	Scheduled delivery of first production SMART-L system
	2001	Scheduled delivery of first production Smartello system for Horizon frigates

Worldwide Distribution

France. Two Smartello systems ordered for Horizon frigates
Germany. Four SMART-S systems on F-123 frigates; Four on SMART-L systems on order for Type 124 frigates
Greece. Four MW.08 systems on MEKO-200HN frigates
Italy. Three Smartello systems ordered for Horizon frigates
Netherlands. Four Smart-L ordered for De Zeven Province frigates; two SMART systems on Heemskerck frigates; eight SMART on Karel Doorman frigates
Oman. Two MW.08 systems on Qahir corvettes
Portugal. Three MW.08 systems on Vasco da Gama frigates
South Korea. Three MW.08 on Okpo frigates; up to six MW.08 radar orders for KDX frigate
Turkey. Three MW.08 on Yildiz FACs
UK. Eight Smartello systems ordered for Horizon frigates

Forecast Rationale

The SMART family of long-range surveillance radars has enjoyed a fairly successful production run since its debut in the mid-1980s. A wide variety of nations selected the original system, the SMART-S, or its export derivative, the MW.08, for use on new-build ships or as part of a modernization program. In 1991 Signaal began development work on the next radar of the SMART series designated SMART-L.

The SMART-L radar significantly improved on the SMART-S, particularly in the area of stealth aircraft detection. The -L is able to detect an F-117 sized stealth aircraft at published ranges out to 55 km. The -L is currently undergoing sea trials on a Netherlands Tromp class frigate. Testing is expected to be completed in 1999 with the first production unit being delivered in 2000.

Another boon for future SMART production rests with the adoption of the Smartello radar as the long-range surveillance radar that is to be fitted to all tri-nation Project Horizon air-defense frigates. Smartello is being developed by GEC-Marconi as prime contractor, with Signaal and Thomson-CSF as primary subcontractors. Essentially Smartello is a very long range radar (LRR) that combines the technologies of the SMART-L with those offered by the GEC-Marconi Martello radar.

Another future boost in SMART sales could occur if Signaal is successful in developing a land-based, transportable version of the -L. The company is currently designing such a system whose primary target is Hungary- which has a standing requirement for three such systems. However, Signaal is believed to be on rather shaky ground for this endeavor because its last known land-based radar work, Vanguard, was scuttled in 1990 when Thomson-CSF purchased Signaal. Signaal's competitors for this contract, Alenia and Lockheed Martin, have a solid reputation in the land-based radar market that would be hard for Signaal to overcome.

The ten-year forecast is split almost evenly between SMART-L/MW.08 and Smartello systems. Both Germany and the Netherlands have ordered three and four SMART-L system, respectively. These systems are to be fitted to the German Type 124 and the Netherlands De Zeven Province class air-defense frigates. All six remaining MW.08s are to go to South Korea for installation on that nation's KDX frigates.

For Project Horizon, the tri-nation air defense frigate, the Smartello system beat its competition including the initially favored Astral radar. This has guaranteed that a minimum of 13 systems will be procured through the mid-2000s in order to equip all currently planned Horizon production.

No allotment has been made for additional radars due to a lack of indicators that would point to additional orders. No tenders or trials are known in which the SMART systems are currently involved. Additionally, forecasted sales of the land-based variant have been omitted due to the aforementioned difficulty of penetrating a market already dominated by other players.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level				Speculative		
Designation	Application	thru 98	99	00	01	02	03	04	05	06	07	08	Total 99-08
SIGNAAL MW.08	FFG (SOUTH KOREA)	3	0	1	1	1	1	1	1	0	0	0	6
SIGNAAL MW.08	Prior Prod'n:	13	0	0	0	0	0	0	0	0	0	0	0
SIGNAAL SMART	FFG (GERMAN NAVY)	4	0	0	1	0	1	1	1	0	0	0	4
SIGNAAL SMART	FFG (DE ZEVEN PROVINCIEN) (RNLN)	10	0	1	0	0	1	1	0	1	0	0	4
SIGNAAL SMART	Prior Prod'n:	10	0	0	0	0	0	0	0	0	0	0	0
T-1850L SMARTELLO	CNGF HORIZON (FRANCE)	0	0	0	0	1	0	0	1	0	0	0	2
T-1850L SMARTELLO	CNGF HORIZON (ITALIAN NAVY)	0	0	0	0	1	0	1	0	1	0	0	3
T-1850L SMARTELLO	CNGF HORIZON (UKRN)	0	0	0	1	2	3	2	0	0	0	0	8
Total Production		40	0	2	3	5	6	6	3	2	0	0	27